EUROPEAN COMMISSION
Research Executive Agency

Director

GRANT AGREEMENT

NUMBER 101022473 — SuperCONtacts

This **Agreement** ('the Agreement') is **between** the following parties:

on the one part,

the **Research Executive Agency (REA)** ('the Agency'), under the powers delegated by the European Commission ('the Commission'), represented for the purposes of signature of this Agreement by Head of Unit, Research Executive Agency , Excellent Science, Marie Skłodowska-Curie Individual Fellowships: European, Jean-Bernard VEYRET,

and

on the other part,

'the beneficiary':

CONSIGLIO NAZIONALE DELLE RICERCHE (CNR), established in PIAZZALE ALDO MORO 7, ROMA 00185, Italy, VAT number: IT02118311006, represented for the purposes of signing the Agreement by Director, LUCIA SORBA.

The parties referred to above have agreed to enter into the Agreement under the terms and conditions below.

By signing the Agreement, the beneficiary accepts the grant and agrees to implement it under its responsibility and in accordance with the Agreement, with all the obligations and conditions it sets out.

The Agreement is composed of:

Terms and Conditions

Annex 1 Description of the action

Annex 2 Estimated budget for the action

2a Additional information on the estimated budget

Annex 3 Accession Forms

Annex 4 Model for the financial statements

Annex 5 Not applicable

Annex 6 Not applicable

TERMS AND CONDITIONS

TABLE OF CONTENTS

CHAPTER 1 GENERAL....9

ARTICLE 1 — SUBJECT OF THE AGREEMENT....9

CHAPTER 2 ACTION....9

ARTICLE 2 — ACTION TO BE IMPLEMENTED....9

ARTICLE 3 — DURATION AND STARTING DATE OF THE ACTION....9

ARTICLE 4 — ESTIMATED BUDGET AND BUDGET TRANSFERS....9

4.1 Estimated budget....9

4.2 Budget transfers....9

CHAPTER 3 GRANT....9

ARTICLE 5 — GRANT AMOUNT, FORM OF GRANT, REIMBURSEMENT RATES AND FORMS OF COSTS....9

5.1 Maximum grant amount....9

5.2 Form of grant, reimbursement rate and form of costs....9

5.3 Final grant amount — Calculation....10

5.4 Revised final grant amount — Calculation....10

ARTICLE 6 — ELIGIBLE AND INELIGIBLE COSTS....11

6.1 General conditions for costs to be eligible....11

6.2 Specific conditions for costs to be eligible....11

6.3 Ineligible costs....12

6.4 Consequences of declaration of ineligible costs....13

CHAPTER 4 RIGHTS AND OBLIGATIONS OF THE PARTIES....13

SECTION 1 RIGHTS AND OBLIGATIONS RELATED TO IMPLEMENTING THE ACTION....13

ARTICLE 7 — GENERAL OBLIGATION TO PROPERLY IMPLEMENT THE ACTION....13

7.1 General obligation to properly implement the action....13

7.2 Consequences of non-compliance....13

ARTICLE 8 — RESOURCES TO IMPLEMENT THE ACTION — THIRD PARTIES INVOLVED IN THE ACTION....13

ARTICLE 9 — IMPLEMENTATION OF ACTION TASKS BY BENEFICIARIES NOT RECEIVING EU FUNDING....14

ARTICLE 10 — PURCHASE OF GOODS, WORKS OR SERVICES....14

ARTICLE 11 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES AGAINST PAYMENT....14

ARTICLE 12 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES FREE OF CHARGE....14

ARTICLE 13 — IMPLEMENTATION OF ACTION TASKS BY SUBCONTRACTORS....14

ARTICLE 14 — IMPLEMENTATION OF ACTION TASKS BY LINKED THIRD PARTIES....14

ARTICLE 15 — FINANCIAL SUPPORT TO THIRD PARTIES....14

ARTICLE 16 — PROVISION OF TRANS-NATIONAL OR VIRTUAL ACCESS TO RESEARCH INFRASTRUCTURE....14

SECTION 2 RIGHTS AND OBLIGATIONS RELATED TO THE GRANT ADMINISTRATION....14

ARTICLE 17 — GENERAL OBLIGATION TO INFORM....14

17.1 General obligation to provide information upon request....14

17.2 Obligation to keep information up to date and to inform about events and circumstances likely to affect the Agreement....14

17.3 Consequences of non-compliance....15

ARTICLE 18 — KEEPING RECORDS — SUPPORTING DOCUMENTATION....15

18.1 Obligation to keep records and other supporting documentation....15

18.2 Consequences of non-compliance....16

ARTICLE 19 — SUBMISSION OF DELIVERABLES....16

19.1 Obligation to submit deliverables....16

19.2 Consequences of non-compliance....16

ARTICLE 20 — REPORTING — PAYMENT REQUESTS....16

20.1 Obligation to submit reports....16

20.2 Reporting periods....16

20.3 Periodic reports — Requests for interim payments....16

20.4 Final report — Request for payment of the balance....16

20.5 Information on cumulative expenditure incurred....17

20.6 Currency for financial statements....17

20.7 Language of reports....17

20.8 Consequences of non-compliance....17

ARTICLE 21 — PAYMENTS AND PAYMENT ARRANGEMENTS....18

21.1 Payments to be made....18

21.2 Pre-financing payment — Amount — Amount retained for the Guarantee Fund....18

21.3 Interim payments — Amount — Calculation....18

21.4 Payment of the balance — Amount — Calculation — Release of the amount retained for the Guarantee Fund....19

21.5 Notification of amounts due....20

21.6 Currency for payments....20

21.7 Payments to the beneficiary 20
21.8 Bank account for payments 20
21.9 Costs of payment transfers 20
21.10 Date of payment 20
21.11 Consequences of non-compliance 21
ARTICLE 22 — CHECKS, REVIEWS, AUDITS AND INVESTIGATIONS — EXTENSION OF FINDINGS 21
22.1 Checks, reviews and audits by the Agency and the Commission 21
22.2 Investigations by the European Anti-Fraud Office (OLAF) 23
22.3 Checks and audits by the European Court of Auditors (ECA) 23
22.4 Checks, reviews, audits and investigations for international organisations 23
22.5 Consequences of findings in checks, reviews, audits and investigations — Extension of findings 23
22.6 Consequences of non-compliance 25
ARTICLE 23 — EVALUATION OF THE IMPACT OF THE ACTION 25
23.1 Right to evaluate the impact of the action 25
23.2 Consequences of non-compliance 26
SECTION 3 RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND AND RESULTS 26
SUBSECTION 1 GENERAL 26
ARTICLE 23a — MANAGEMENT OF INTELLECTUAL PROPERTY 26
23a.1 Obligation to take measures to implement the Commission Recommendation on the management of intellectual property in knowledge transfer activities 26
23a.2 Consequences of non-compliance 26
SUBSECTION 2 RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND 26
ARTICLE 24 — AGREEMENT ON BACKGROUND 26
24.1 Agreement on background 26
24.2 Consequences of non-compliance 27
ARTICLE 25 — ACCESS RIGHTS TO BACKGROUND 27
25.1 Exercise of access rights — Waiving of access rights — No sub-licensing 27
25.2 Access rights for other beneficiaries, for implementing their own tasks under the action 27
25.3 Access rights for other beneficiaries, for exploiting their own results 27
25.4 Access rights for affiliated entities 27
25.5 Access rights for the researcher 27
25.6 Consequences of non-compliance 27
SUBSECTION 3 RIGHTS AND OBLIGATIONS RELATED TO RESULTS 27
ARTICLE 26 — OWNERSHIP OF RESULTS 27

26.1 Ownership by the beneficiary that generates the results.... 27
26.2 Joint ownership by several beneficiaries.... 28
26.3 Rights of third parties (including personnel).... 28
26.4 Agency ownership, to protect results.... 28
26.5 Consequences of non-compliance.... 29
ARTICLE 27 — PROTECTION OF RESULTS — VISIBILITY OF EU FUNDING.... 29
27.1 Obligation to protect the results.... 29
27.2 Agency ownership, to protect the results.... 29
27.3 Information on EU funding.... 29
27.4 Consequences of non-compliance.... 30
ARTICLE 28 — EXPLOITATION OF RESULTS.... 30
28.1 Obligation to exploit the results.... 30
28.2 Results that could contribute to European or international standards — Information on EU funding.... 30
28.3 Consequences of non-compliance.... 30
ARTICLE 29 — DISSEMINATION OF RESULTS — OPEN ACCESS — VISIBILITY OF EU FUNDING.... 30
29.1 Obligation to disseminate results.... 30
29.2 Open access to scientific publications.... 31
29.3 Open access to research data.... 31
29.4 Information on EU funding — Obligation and right to use the EU emblem.... 32
29.5 Disclaimer excluding Agency responsibility.... 32
29.6 Consequences of non-compliance.... 32
ARTICLE 30 — TRANSFER AND LICENSING OF RESULTS.... 32
30.1 Transfer of ownership.... 32
30.2 Granting licenses.... 33
30.3 Agency right to object to transfers or licensing.... 33
30.4 Consequences of non-compliance.... 33
ARTICLE 31 — ACCESS RIGHTS TO RESULTS.... 33
31.1 Exercise of access rights — Waiving of access rights — No sub-licensing.... 33
31.2 Access rights for other beneficiaries, for implementing their own tasks under the action.... 33
31.3 Access rights for other beneficiaries, for exploiting their own results.... 33
31.4 Access rights of affiliated entities.... 33
31.5 Access rights for the EU institutions, bodies, offices or agencies and EU Member States.... 33
31.6 Access rights for the researcher.... 34
31.7 Consequences of non-compliance.... 34

SECTION 4 OTHER RIGHTS AND OBLIGATIONS....34

ARTICLE 32 — RECRUITMENT AND WORKING CONDITIONS FOR THE RECRUITED RESEARCHER....34

32.1 Obligations towards the recruited researcher....34

32.2 Consequences of non-compliance....36

ARTICLE 33 — GENDER EQUALITY....36

33.1 Obligation to aim for gender equality....36

33.2 Consequences of non-compliance....36

ARTICLE 34 — ETHICS AND RESEARCH INTEGRITY....36

34.1 Obligation to comply with ethical and research integrity principles....36

34.2 Activities raising ethical issues....37

34.3 Activities involving human embryos or human embryonic stem cells....37

34.4 Consequences of non-compliance....38

ARTICLE 35 — CONFLICT OF INTERESTS....38

35.1 Obligation to avoid a conflict of interests....38

35.2 Consequences of non-compliance....38

ARTICLE 36 — CONFIDENTIALITY....38

36.1 General obligation to maintain confidentiality....38

36.2 Consequences of non-compliance....39

ARTICLE 37 — SECURITY-RELATED OBLIGATIONS....39

37.1 Results with a security recommendation....39

37.2 Classified information....39

37.3 Activities involving dual-use goods or dangerous materials and substances....39

37.4 Consequences of non-compliance....40

ARTICLE 38 — PROMOTING THE ACTION — VISIBILITY OF EU FUNDING....40

38.1 Communication activities by the beneficiary....40

38.2 Communication activities by the Agency and the Commission....40

38.3 Consequences of non-compliance....42

ARTICLE 39 — PROCESSING OF PERSONAL DATA....42

39.1 Processing of personal data by the Agency and the Commission....42

39.2 Processing of personal data by the beneficiary....42

39.3 Consequences of non-compliance....42

ARTICLE 40 — ASSIGNMENTS OF CLAIMS FOR PAYMENT AGAINST THE AGENCY....43

CHAPTER 5 BENEFICIARY'S ROLES AND RESPONSIBILITIES — RELATIONSHIP WITH COMPLEMENTARY BENEFICIARIES — RELATIONSHIP WITH PARTNERS OF A JOINT ACTION....43

ARTICLE 41 — BENEFICIARY'S ROLES AND RESPONSIBILITIES — RELATIONSHIP WITH COMPLEMENTARY BENEFICIARIES — RELATIONSHIP WITH PARTNERS OF A JOINT ACTION....43

41.1 Roles and responsibility towards the Agency....43

41.2 Internal division of roles and responsibilities....43

41.3 Internal arrangements between beneficiaries — Consortium agreement....43

41.4 Relationship with complementary beneficiaries — Collaboration agreement....43

41.5 Relationship with partners of a joint action — Coordination agreement....44

CHAPTER 6 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — SANCTIONS — DAMAGES — SUSPENSION — TERMINATION — FORCE MAJEURE....44

SECTION 1 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — SANCTIONS....44

ARTICLE 42 — REJECTION OF INELIGIBLE COSTS....44

42.1 Conditions....44

42.2 Ineligible costs to be rejected — Calculation — Procedure....44

42.3 Effects....44

ARTICLE 43 — REDUCTION OF THE GRANT....44

43.1 Conditions....44

43.2 Amount to be reduced — Calculation — Procedure....45

43.3 Effects....45

ARTICLE 44 — RECOVERY OF UNDUE AMOUNTS....45

44.1 Amount to be recovered — Calculation — Procedure....45

ARTICLE 45 — ADMINISTRATIVE SANCTIONS....48

SECTION 2 LIABILITY FOR DAMAGES....48

ARTICLE 46 — LIABILITY FOR DAMAGES....48

46.1 Liability of the Agency....48

46.2 Liability of the beneficiary....48

SECTION 3 SUSPENSION AND TERMINATION....48

ARTICLE 47 — SUSPENSION OF PAYMENT DEADLINE....48

47.1 Conditions....48

47.2 Procedure....48

ARTICLE 48 — SUSPENSION OF PAYMENTS....49

48.1 Conditions....49

48.2 Procedure....49

ARTICLE 49 — SUSPENSION OF THE ACTION IMPLEMENTATION....50

49.1 Suspension of the action implementation by the beneficiary....50

49.2 Suspension of the action implementation, by the Agency....50
ARTICLE 50 — TERMINATION OF THE AGREEMENT....51
50.1 Termination of the Agreement by the beneficiary....51
50.2 Termination of the participation of one or more beneficiaries, by the beneficiaries....52
50.3 Termination of the Agreement, by the Agency....52
SECTION 4 FORCE MAJEURE....54
ARTICLE 51 — FORCE MAJEURE....54
CHAPTER 7 FINAL PROVISIONS....55
ARTICLE 52 — COMMUNICATION BETWEEN THE PARTIES....55
52.1 Form and means of communication....55
52.2 Date of communication....55
52.3 Addresses for communication....56
ARTICLE 53 — INTERPRETATION OF THE AGREEMENT....56
53.1 Precedence of the Terms and Conditions over the Annexes....56
53.2 Privileges and immunities....56
ARTICLE 54 — CALCULATION OF PERIODS, DATES AND DEADLINES....56
ARTICLE 55 — AMENDMENTS TO THE AGREEMENT....56
55.1 Conditions....57
55.2 Procedure....57
ARTICLE 56 — ACCESSION TO THE AGREEMENT....57
ARTICLE 56a — TRANSFER OF THE AGREEMENT TO A NEW BENEFICIARY....57
56a.1 Conditions....57
56a.2 Procedure....57
56a.3 Effects....58
ARTICLE 57 — APPLICABLE LAW AND SETTLEMENT OF DISPUTES....58
57.1 Applicable law....58
57.2 Dispute settlement....58
ARTICLE 58 — ENTRY INTO FORCE OF THE AGREEMENT....59

CHAPTER 1 GENERAL

ARTICLE 1 — SUBJECT OF THE AGREEMENT

This Agreement sets out the rights and obligations and the terms and conditions applicable to the grant awarded to the beneficiary for implementing the action set out in Chapter 2.

CHAPTER 2 ACTION

ARTICLE 2 — ACTION TO BE IMPLEMENTED

The grant is awarded for the action entitled '**Solid state diffusion for atomically sharp interfaces in semiconductor-superconductor hybrid structures — SuperCONtacts**' **('action')**, as described in Annex 1.

ARTICLE 3 — DURATION AND STARTING DATE OF THE ACTION

The duration of the action will be **24 months** as of the effective starting date notified by the beneficiary, which must be within 12 months from the date the Agreement enters into force ('starting date of the action').

ARTICLE 4 — ESTIMATED BUDGET AND BUDGET TRANSFERS

4.1 Estimated budget

The '**estimated budget**' for the action is set out in Annex 2.

It contains the estimated eligible costs and the forms of costs, broken down by beneficiary, budget category (see Articles 5, 6)

4.2 Budget transfers

Not applicable

CHAPTER 3 GRANT

ARTICLE 5 — GRANT AMOUNT, FORM OF GRANT, REIMBURSEMENT RATES AND FORMS OF COSTS

5.1 Maximum grant amount

The '**maximum grant amount**' is **EUR 171 473.28** (one hundred and seventy one thousand four hundred and seventy three EURO and twenty eight eurocents).

5.2 Form of grant, reimbursement rate and form of costs

The grant reimburses **100 %** of the action's eligible costs (see Article 6) ('**reimbursement of eligible costs grant**') (see Annex 2).

The estimated eligible costs of the action are EUR **171 473.28** (one hundred and seventy one thousand four hundred and seventy three EURO and twenty eight eurocents) .

Eligible costs (see Article 6) must be declared under the following forms ('**form of costs**'):

(a) for **costs for the recruited researcher** (living, mobility and family allowances): on the basis of the amount(s) per unit set out in Annex 2 ('**unit costs**') and

(b) for **institutional costs** (research, training and networking costs and management and indirect costs): on the basis of the amount per unit set out in Annex 2 (**unit costs**).

5.3 Final grant amount — Calculation

The '**final grant amount**' depends on the actual extent to which the action is implemented in accordance with the Agreement's terms and conditions.

This **amount** is calculated by the Agency — when the payment of the balance is made (see Article 21.4) — in the following steps:

Step 1 – Application of the reimbursement rate to the eligible costs

Step 2 – Limit to the maximum grant amount

Step 3 – Reduction due to substantial errors, irregularities or fraud or serious breach of obligations

5.3.1 Step 1 — Application of the reimbursement rate to the eligible costs

The reimbursement rate (see Article 5.2) is applied to the eligible costs (unit costs; see Article 6) declared by the beneficiary and approved by the Agency (see Article 21).

5.3.2 Step 2 — Limit to the maximum grant amount

If the amount obtained following Step 1 is higher than the maximum grant amount set out in Article 5.1, it will be limited to the latter.

5.3.3 Step 3 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations — Reduced grant amount — Calculation

If the grant is reduced (see Article 43), the Agency will calculate the reduced maximum grant amount by deducting the amount of the reduction (calculated in proportion to the seriousness of the errors, irregularities or fraud or breach of obligations, in accordance with Article 43.2) from the grant amount set out in Article 5.1.

The final grant amount will be the lower of the following two:

- the amount obtained following Steps 1 and 2 or
- the reduced grant amount following Step 3.

5.4 Revised final grant amount — Calculation

If — after the payment of the balance (in particular, after checks, reviews, audits or investigations;

see Article 22) — the Agency rejects costs (see Article 42) or reduces the grant (see Article 43), it will calculate the '**revised final grant amount**'.

This amount is calculated by the Agency on the basis of the findings, as follows:

- in case of **rejection of costs**: by applying the reimbursement rate to the revised eligible costs approved by the Agency;
- in case of **reduction of the grant**: in proportion to the seriousness of the errors, irregularities or fraud or breach of obligations (see Article 43.2).

In case of **rejection of costs and reduction of the grant**, the revised final grant amount will be the lower of the two amounts above.

ARTICLE 6 — ELIGIBLE AND INELIGIBLE COSTS

6.1 General conditions for costs to be eligible

Unit costs are eligible ('**eligible costs**') if:

(a) they are calculated as follows:

{amounts per unit set out in Annex 2

multiplied by

the number of actual units}.

(b) the number of actual units complies with the following:

- the units must be actually used or produced in the period set out in Article 3;
- the units must be necessary for implementing the action or produced by it, and
- the number of units must be identifiable and verifiable, in particular supported by records and documentation (see Article 18).

6.2 Specific conditions for costs to be eligible

Costs are eligible, if they comply with the general conditions (see above) and the specific conditions set out below for each of the following two budget categories:

A. **Costs for the recruited researcher** (A.1 Living allowance, A.2 Mobility allowance and A.3 Family allowance) are eligible, if:

(a) the number of units declared:

(i) corresponds to the actual number of months spent by the recruited researcher on the research training activities and

(ii) does not exceed 24 months;

(b) the recruited researcher complies with the following conditions:

(i) be recruited by the beneficiary under an **employment contract** (or other direct contract with equivalent benefits, including social security coverage) or — if not otherwise possible under national law — under a fixed amount fellowship agreement with minimum social security coverage, including periods of secondment to partner organisations.

(ii) be employed full-time, unless the Agency has approved a part-time employment for professional, personal or family reasons (see Article 55), and

(iii) be working exclusively for the action.

(c) the costs have been fully incurred for the benefit of the recruited researcher.

This latter condition is met if:

{{{**total remuneration costs** (salaries, social security contributions, taxes and other costs included in the remuneration under the employment contract or other direct contract) or **total fixed-amount fellowship costs** for the researcher during the action

plus

total mobility costs (household, relocation and travel expenses and, if they must be paid under national law, taxes, duties and social security contributions) for the researcher during the action}

plus

total family costs for the researcher during the action}

divided by

the number of actual units}.

is equal to or higher than the following amount:

{{amount per unit cost set out in Annex 2 as living allowance

plus

amount per unit cost set out in Annex 2 as mobility allowance}

plus

if it is due, amount per unit cost set out in Annex 2 as family allowance}.

B. **Institutional costs** (B.1 Research, training and networking costs and B.2 Management and indirect costs) are eligible if the costs for the recruited researcher (living allowance, mobility allowance, family allowance; see above) are eligible.

6.3 Ineligible costs

'Ineligible costs' are:

(a) costs that do not comply with the conditions set out above (in Article 6.1), in particular costs incurred during suspension of the action implementation (see Article 49);

(b) costs declared under another EU or Euratom grant (including grants awarded by a Member State and financed by the EU or Euratom budget and grants awarded by bodies other than the

Agency for the purpose of implementing the EU or Euratom budget), in particular, indirect costs if the beneficiary is already receiving an operating grant financed by the EU or Euratom budget in the same period, unless it can demonstrate that the operating grant does not cover any costs of the action.

6.4 Consequences of declaration of ineligible costs

Declared costs that are ineligible will be rejected (see Article 42).

This may also lead to any of the other measures described in Chapter 6.

CHAPTER 4 RIGHTS AND OBLIGATIONS OF THE PARTIES

SECTION 1 RIGHTS AND OBLIGATIONS RELATED TO IMPLEMENTING THE ACTION

ARTICLE 7 — GENERAL OBLIGATION TO PROPERLY IMPLEMENT THE ACTION

7.1 General obligation to properly implement the action

The beneficiary must implement the action as described in Annex 1 and in compliance with the provisions of the Agreement and all legal obligations under applicable EU, international and national law.

7.2 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 8 — RESOURCES TO IMPLEMENT THE ACTION — THIRD PARTIES INVOLVED IN THE ACTION

The beneficiary must have the appropriate resources to implement the action.

If it is necessary to implement the action, the beneficiary may:

- call upon entities with a capital or legal link to the beneficiary[1], to implement certain action tasks described in Annex 1 (i.e. hosting and training of the researcher);

- call upon partner organisations to implement certain action tasks described in Annex 1 (i.e. hosting and training the researcher during a secondment).

In this case, the beneficiary retains sole responsibility towards the Agency for implementing the action.

[1] '**Entities with a capital or legal link**' are entities that have a link with the beneficiary, in particular, a legal or capital link, which is neither limited to the action nor established for the sole purpose of its implementation.

ARTICLE 9 — IMPLEMENTATION OF ACTION TASKS BY BENEFICIARIES NOT RECEIVING EU FUNDING

Not applicable

ARTICLE 10 — PURCHASE OF GOODS, WORKS OR SERVICES

Not applicable

ARTICLE 11 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES AGAINST PAYMENT

Not applicable

ARTICLE 12 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES FREE OF CHARGE

Not applicable

ARTICLE 13 — IMPLEMENTATION OF ACTION TASKS BY SUBCONTRACTORS

Not applicable

ARTICLE 14 — IMPLEMENTATION OF ACTION TASKS BY LINKED THIRD PARTIES

Not applicable

ARTICLE 15 — FINANCIAL SUPPORT TO THIRD PARTIES

Not applicable

ARTICLE 16 — PROVISION OF TRANS-NATIONAL OR VIRTUAL ACCESS TO RESEARCH INFRASTRUCTURE

Not applicable

SECTION 2 RIGHTS AND OBLIGATIONS RELATED TO THE GRANT ADMINISTRATION

ARTICLE 17 — GENERAL OBLIGATION TO INFORM

17.1 General obligation to provide information upon request

The beneficiary must provide — during implementation of the action or afterwards — any information requested in order to verify eligibility of the costs, proper implementation of the action and compliance with any other obligation under the Agreement.

17.2 Obligation to keep information up to date and to inform about events and circumstances likely to affect the Agreement

The beneficiary must keep information stored in the Participant Portal Beneficiary Register (via the electronic exchange system; see Article 52) up to date, in particular, its name, address, legal representatives, legal form and organisation type.

The beneficiary must immediately inform the Agency of any of the following:

(a) **events** which are likely to affect significantly or delay the implementation of the action or the EU's financial interests, in particular:

(i) changes in its legal, financial, technical, organisational or ownership situation (or those of an entity with a capital or legal link);

(ii) changes in the name, address, legal form or organisation type of an entity with a capital or legal link;

(b) **circumstances** affecting:

(i) the decision to award the grant or

(ii) compliance with requirements under the Agreement.

17.3 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 18 — KEEPING RECORDS — SUPPORTING DOCUMENTATION

18.1 Obligation to keep records and other supporting documentation

The beneficiary must — for a period of five years after the payment of the balance — keep records and other supporting documentation in order to prove the proper implementation of the action and the costs it declares as eligible.

It must make them available upon request (see Article 17) or in the context of checks, reviews, audits or investigations (see Article 22).

If there are on-going checks, reviews, audits, investigations, litigation or other pursuits of claims under the Agreement (including the extension of findings; see Articles 22), the beneficiary must keep the records and other supporting documentation until the end of these procedures.

The beneficiary must keep the original documents. Digital and digitalised documents are considered originals if they are authorised by the applicable national law. The Agency may accept non-original documents if it considers that they offer a comparable level of assurance.

18.1.1 Records and other supporting documentation on the scientific and technical implementation

The beneficiary must keep records and other supporting documentation on scientific and technical implementation of the action in line with the accepted standards in the respective field.

18.1.2 Records and other documentation to support the costs declared

The beneficiary must keep adequate records and other supporting documentation to prove the number of units declared and that the costs for the recruited researcher (living allowance, mobility allowance, family allowance) have been fully incurred for the benefit of the researcher.

18.2 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, costs insufficiently substantiated will be ineligible (see Article 6) and will be rejected (see Article 42), and the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 19 — SUBMISSION OF DELIVERABLES

19.1 Obligation to submit deliverables

The beneficiary must submit the '**deliverables**' identified in Annex 1, in accordance with the timing and conditions set out in it.

19.2 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the Agency may apply any of the measures described in Chapter 6.

ARTICLE 20 — REPORTING — PAYMENT REQUESTS

20.1 Obligation to submit reports

The beneficiary must submit to the Agency (see Article 52) the report(s) set out in this Article. They include the requests for payment and must be drawn up using the forms and templates provided in the electronic exchange system (see Article 52).

20.2 Reporting periods

The action is divided into the following '**reporting periods**':

- RP1: from month 1 to month 24

20.3 Periodic reports — Requests for interim payments

Not applicable

20.4 Final report — Request for payment of the balance

The beneficiary must — within 60 days following the end of the reporting period — submit a final report to the Agency.

The **final report** must include the following:

(a) a '**final technical report**' containing:

(i) an **overview of the results** towards the objectives of the action, including milestones and deliverables identified in Annex 1.

This report must include explanations justifying the differences between work expected to be carried out in accordance with Annex 1 and that actually carried out.

The report must also detail the exploitation and dissemination of the results.

The report must indicate the communication activities.

(ii) a **summary** for publication by the Agency;

(iii) the answers to the '**questionnaire**', covering issues related to the action implementation and the economic and societal impact, notably in the context of the Horizon 2020 key performance indicators and the Horizon 2020 monitoring requirements;

(b) a '**final financial report**' containing a ' **financial statement**' (see Annex 4) which includes the **request for payment of the balance**.

The financial statement must detail the eligible costs (see Article 6) for each budget category (see Annex 2).

The beneficiary must declare all eligible costs, even if they exceed the amounts indicated in the estimated budget (see Annex 2). Amounts which are not declared in the financial statement will not be taken into account by the Agency.

The beneficiary must certify that:

- the information provided is full, reliable and true;
- the costs declared are eligible (see Article 6), and
- the costs can be substantiated by adequate records and supporting documentation (see Article 18) that will be produced upon request (see Article 17) or in the context of checks, reviews, audits and investigations (see Article 22).

20.5 Information on cumulative expenditure incurred

Not applicable

20.6 Currency for financial statements

Financial statements must be drafted in euro.

20.7 Language of reports

The report(s) (including financial statements) must be submitted in the language of the Agreement.

20.8 Consequences of non-compliance

If the report(s) submitted do not comply with this Article, the Agency may suspend the payment deadline (see Article 47) and apply any of the other measures described in Chapter 6.

If the beneficiary breaches its obligation to submit the report(s) and if it fails to comply with this obligation within 30 days following a written reminder sent by the Agency, it may terminate the Agreement or apply any of the other measures described in Chapter 6.

ARTICLE 21 — PAYMENTS AND PAYMENT ARRANGEMENTS

21.1 Payments to be made

The following payments will be made to the beneficiary:

- one **pre-financing payment**;
- one or more **interim payments**, on the basis of the request(s) for interim payment (see Article 20), and
- one **payment of the balance**, on the basis of the request for payment of the balance (see Article 20).

21.2 Pre-financing payment — Amount — Amount retained for the Guarantee Fund

The aim of the pre-financing is to provide the beneficiary with a float.

It remains the property of the EU until the payment of the balance.

The amount of the pre-financing payment will be EUR **120 031.30** (one hundred and twenty thousand thirty one EURO and thirty eurocents).

The Agency will — except if Article 48 applies — make the pre-financing payment to the beneficiary within 30 days, either from the entry into force of the Agreement (see Article 58) or from 10 days before the starting date of the action (see Article 3), whichever is the latest.

An amount of EUR **8 573.66** (eight thousand five hundred and seventy three EURO and sixty six eurocents), corresponding to 5% of the maximum grant amount (see Article 5.1), is retained by the Agency from the pre-financing payment and transferred into the '**Guarantee Fund**'.

21.3 Interim payments — Amount — Calculation

Interim payments reimburse the eligible costs incurred for the implementation of the action during the corresponding reporting periods.

The Agency will pay to the beneficiary the amount due as interim payment within 90 days from receiving the periodic report (see Article 20.3), except if Articles 47 or 48 apply.

Payment is subject to the approval of the periodic report. Its approval does not imply recognition of the compliance, authenticity, completeness or correctness of its content.

The **amount due as interim payment** is calculated by the Agency in the following steps:

Step 1 — Application of the reimbursement rates

Step 2 — Limit to 90% of the maximum grant amount

21.3.1 Step 1 — Application of the reimbursement rates

The reimbursement rate(s) (see Article 5.2) are applied to the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) declared by the beneficiary (see Article 20) and approved by the Agency (see above) for the concerned reporting period.

21.3.2 Step 2 — Limit to 90% of the maximum grant amount

The total amount of pre-financing and interim payments must not exceed 90% of the maximum grant amount set out in Article 5.1. The maximum amount for the interim payment will be calculated as follows:

{90% of the maximum grant amount (see Article 5.1)

minus

{pre-financing and previous interim payments}}.

21.4 Payment of the balance — Amount — Calculation — Release of the amount retained for the Guarantee Fund

The payment of the balance reimburses the remaining part of the eligible costs incurred by the beneficiary for the implementation of the action.

If the total amount of earlier payments is greater than the final grant amount (see Article 5.3), the payment of the balance takes the form of a recovery (see Article 44).

If the total amount of earlier payments is lower than the final grant amount, the Agency will pay the balance within 90 days from receiving the final report (see Article 20.4), except if Articles 47 or 48 apply.

Payment is subject to the approval of the final report. Its approval does not imply recognition of the compliance, authenticity, completeness or correctness of its content.

The **amount due as the balance** is calculated by the Agency by deducting the total amount of pre-financing and interim payments (if any) already made, from the final grant amount determined in accordance with Article 5.3:

{final grant amount (see Article 5.3)

minus

{pre-financing and interim payments (if any) made}}.

At the payment of the balance, the amount retained for the Guarantee Fund (see above) will be released and:

- if the balance is positive: the amount released will be paid in full to the beneficiary together with the amount due as the balance;

- if the balance is negative (payment of the balance taking the form of recovery): it will be deducted from the amount released (see Article 44.1.2). If the resulting amount:

- is positive, it will be paid to the beneficiary
- is negative, it will be recovered.

The amount to be paid may however be offset — without the beneficiary's consent — against any other amount owed by beneficiary to the Agency, the Commission or another executive agency (under the EU or Euratom budget), up to the maximum EU contribution indicated, for the beneficiary, in the estimated budget (see Annex 2).

21.5 Notification of amounts due

When making payments, the Agency will formally notify to the beneficiary the amount due, specifying whether it concerns an interim payment or the payment of the balance.

For the payment of the balance, the notification will also specify the final grant amount.

In the case of reduction of the grant or recovery of undue amounts, the notification will be preceded by the contradictory procedure set out in Articles 43 and 44.

21.6 Currency for payments

The Agency will make all payments in euro.

21.7 Payments to the beneficiary

Payments will be made to the beneficiary.

Payments will discharge the Agency from its payment obligation.

21.8 Bank account for payments

All payments will be made to the following bank account:

Name of bank: BANCA NAZIONALE DEL LAVORO S.P.A.
Full name of the account holder: CONSIGLIO NAZIONALE DELLE RICERCHE
IBAN code: IT75N0100503392000000218150

21.9 Costs of payment transfers

The cost of the payment transfers is borne as follows:

- the Agency bears the cost of transfers charged by its bank;
- the beneficiary bears the cost of transfers charged by its bank;
- the party causing a repetition of a transfer bears all costs of the repeated transfer.

21.10 Date of payment

Payments by the Agency are considered to have been carried out on the date when they are debited to its account.

21.11 Consequences of non-compliance

21.11.1 If the Agency does not pay within the payment deadlines (see above), the beneficiary is entitled to **late-payment interest** at the rate applied by the European Central Bank (ECB) for its main refinancing operations in euros ('reference rate'), plus three and a half points. The reference rate is the rate in force on the first day of the month in which the payment deadline expires, as published in the C series of the *Official Journal of the European Union*.

If the late-payment interest is lower than or equal to EUR 200, it will be paid to the beneficiary only upon request submitted within two months of receiving the late payment.

Late-payment interest is not due if the beneficiary is an EU Member State (including regional and local government authorities or other public bodies acting on behalf of a Member State for the purpose of this Agreement).

Suspension of the payment deadline or payments (see Articles 47 and 48) will not be considered as late payment.

Late-payment interest covers the period running from the day following the due date for payment (see above), up to and including the date of payment.

Late-payment interest is not considered for the purposes of calculating the final grant amount.

21.11.2 Not applicable

ARTICLE 22 — CHECKS, REVIEWS, AUDITS AND INVESTIGATIONS — EXTENSION OF FINDINGS

22.1 Checks, reviews and audits by the Agency and the Commission

22.1.1 Right to carry out checks

The Agency or the Commission will — during the implementation of the action or afterwards — check the proper implementation of the action and compliance with the obligations under the Agreement, including assessing deliverables and reports.

For this purpose the Agency or the Commission may be assisted by external persons or bodies.

The Agency or the Commission may also request additional information in accordance with Article 17.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

22.1.2 Right to carry out reviews

The Agency or the Commission may — during the implementation of the action or afterwards — carry out reviews on the proper implementation of the action (including assessment of deliverables and reports), compliance with the obligations under the Agreement and continued scientific or technological relevance of the action.

Reviews may be started up to two years after the payment of the balance. They will be formally notified to the beneficiary and will be considered to have started on the date of the formal notification.

The Agency or the Commission may carry out reviews directly (using its own staff) or indirectly (using external persons or bodies appointed to do so). It will inform the beneficiary of the identity of the external persons or bodies. It has the right to object to the appointment on grounds of commercial confidentiality.

The beneficiary must provide — within the deadline requested — any information and data in addition to deliverables and reports already submitted (including information on the use of resources).

The beneficiary may be requested to participate in meetings, including with external experts.

For **on-the-spot** reviews, the beneficiary must allow access to its sites and premises, including to external persons or bodies, and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the review findings, a '**review report**' will be drawn up.

The Agency or the Commission will formally notify the review report to the beneficiary, which has 30 days to formally notify observations ('**contradictory review procedure**').

Reviews (including review reports) are in the language of the Agreement.

22.1.3 Right to carry out audits

The Agency or the Commission may — during the implementation of the action or afterwards — carry out audits on the proper implementation of the action and compliance with the obligations under the Agreement.

Audits may be started up to two years after the payment of the balance. They will be formally notified to the beneficiary and will be considered to have started on the date of the formal notification.

The Agency or the Commission may carry out audits directly (using its own staff) or indirectly (using external persons or bodies appointed to do so). It will inform the beneficiary of the identity of the external persons or bodies. It has the right to object to the appointment on grounds of commercial confidentiality.

The beneficiary must provide — within the deadline requested — any information (including complete accounts, individual salary statements or other personal data) to verify compliance with the Agreement.

For **on-the-spot** audits, the beneficiary must allow access to its sites and premises, including to external persons or bodies, and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the audit findings, a '**draft audit report**' will be drawn up.

The Agency or the Commission will formally notify the draft audit report to the beneficiary, which has 30 days to formally notify observations ('**contradictory audit procedure**'). This period may be extended by the Agency or the Commission in justified cases.

The '**final audit report**' will take into account observations by the beneficiary. The report will be formally notified to it.

Audits (including audit reports) are in the language of the Agreement.

The Agency or the Commission may also access the beneficiary' statutory records for the periodical assessment of unit costs or flat-rate amounts.

22.2 Investigations by the European Anti-Fraud Office (OLAF)

Under Regulations No 883/2013[2] and No 2185/96[3] (and in accordance with their provisions and procedures), the European Anti-Fraud Office (OLAF) may — at any moment during implementation of the action or afterwards — carry out investigations, including on-the-spot checks and inspections, to establish whether there has been fraud, corruption or any other illegal activity affecting the financial interests of the EU.

22.3 Checks and audits by the European Court of Auditors (ECA)

Under Article 287 of the Treaty on the Functioning of the European Union (TFEU) and Article 161 of the Financial Regulation No 966/2012[4], the European Court of Auditors (ECA) may — at any moment during implementation of the action or afterwards — carry out audits.

The ECA has the right of access for the purpose of checks and audits.

22.4 Checks, reviews, audits and investigations for international organisations

Not applicable

22.5 Consequences of findings in checks, reviews, audits and investigations — Extension of findings

22.5.1 Findings in this grant

Findings in checks, reviews, audits or investigations carried out in the context of this grant may lead to the rejection of ineligible costs (see Article 42), reduction of the grant (see Article 43), recovery of undue amounts (see Article 44) or to any of the other measures described in Chapter 6.

Rejection of costs or reduction of the grant after the payment of the balance will lead to a revised final grant amount (see Article 5.4).

Findings in checks, reviews, audits or investigations may lead to a request for amendment for the modification of Annex 1 (see Article 55).

---

[2] Regulation (EU, Euratom) No 883/2013 of the European Parliament and of the Council of 11 September 2013 concerning investigations conducted by the European Anti-Fraud Office (OLAF) and repealing Regulation (EC) No 1073/1999 of the European Parliament and of the Council and Council Regulation (Euratom) No 1074/1999 (OJ L 248, 18.09.2013, p. 1).

[3] Council Regulation (Euratom, EC) No 2185/1996 of 11 November 1996 concerning on-the-spot checks and inspections carried out by the Commission in order to protect the European Communities' financial interests against fraud and other irregularities (OJ L 292, 15.11.1996, p. 2).

[4] Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002 (OJ L 298, 26.10.2012, p. 1).

Checks, reviews, audits or investigations that find systemic or recurrent errors, irregularities, fraud or breach of obligations may also lead to consequences in other EU or Euratom grants awarded under similar conditions ('**extension of findings from this grant to other grants**').

Moreover, findings arising from an OLAF investigation may lead to criminal prosecution under national law.

22.5.2 Findings in other grants

The Agency or the Commission may extend findings from other grants to this grant ('**extension of findings from other grants to this grant**'), if:

(a) the beneficiary is found, in other EU or Euratom grants awarded under similar conditions, to have committed systemic or recurrent errors, irregularities, fraud or breach of obligations that have a material impact on this grant and

(b) those findings are formally notified to the beneficiary — together with the list of grants affected by the findings — no later than two years after the payment of the balance of this grant.

The extension of findings may lead to the rejection of costs (see Article 42), reduction of the grant (see Article 43), recovery of undue amounts (see Article 44), suspension of payments (see Article 48), suspension of the action implementation (see Article 49) or termination (see Article 50).

22.5.3 Procedure

The Agency or the Commission will formally notify the beneficiary the systemic or recurrent errors and its intention to extend these audit findings, together with the list of grants affected.

22.5.3.1 If the findings concern **eligibility of costs**: the formal notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings;

(b) the request to submit **revised financial statements** for all grants affected;

(c) the **correction rate for extrapolation** established by the Agency or the Commission on the basis of the systemic or recurrent errors, to calculate the amounts to be rejected if the beneficiary:

(i) considers that the submission of revised financial statements is not possible or practicable or

(ii) does not submit revised financial statements.

The beneficiary has 90 days from receiving notification to submit observations, revised financial statements or to propose a duly substantiated **alternative correction method**. This period may be extended by the Agency or the Commission in justified cases.

The Agency or the Commission may then start a rejection procedure in accordance with Article 42, on the basis of:

- the revised financial statements, if approved;

- the proposed alternative correction method, if accepted;

or

- the initially notified correction rate for extrapolation if it does not receive any observations or revised financial statements, does not accept the observations or the proposed alternative correction method or does not approve the revised financial statements.

If the Agency or the Commission accepts the alternative correction method proposed by the beneficiary, it will formally notify the application of the accepted alternative correction method.

22.5.3.2 If the findings concern **substantial errors**, **irregularities or fraud or serious breach of obligations**: the formal notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings and

(b) the flat-rate the Agency or the Commission intends to apply according to the principle of proportionality.

The beneficiary has 90 days from receiving notification to submit observations or to propose a duly substantiated alternative flat-rate.

The Agency or the Commission may then start a reduction procedure in accordance with Article 43, on the basis of:

- the proposed alternative flat-rate, if accepted

or

- the initially notified flat-rate, if it does not receive any observations or does not accept the observations or the proposed alternative flat-rate.

22.6 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, any insufficiently substantiated costs will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 23 — EVALUATION OF THE IMPACT OF THE ACTION

23.1 Right to evaluate the impact of the action

The Agency or the Commission may carry out interim and final evaluations of the impact of the action measured against the objective of the EU programme.

Evaluations may be started during implementation of the action and up to five years after the payment of the balance. The evaluation is considered to start on the date of the formal notification to the beneficiary.

The Agency or the Commission may make these evaluations directly (using its own staff) or indirectly (using external bodies or persons it has authorised to do so).

The beneficiary must provide any information relevant to evaluate the impact of the action, including information in electronic format.

23.2 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the Agency may apply the measures described in Chapter 6.

SECTION 3 RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND AND RESULTS

SUBSECTION 1 GENERAL

ARTICLE 23a — MANAGEMENT OF INTELLECTUAL PROPERTY

23a.1 Obligation to take measures to implement the Commission Recommendation on the management of intellectual property in knowledge transfer activities

If the beneficiary is a university or other public research organisation it must take measures to implement the principles set out in Points 1 and 2 of the Code of Practice annexed to the Commission Recommendation on the management of intellectual property in knowledge transfer activities[5].

This does not change the obligations set out in Subsections 2 and 3 of this Section.

The beneficiary must ensure that the researchers and the third parties mentioned in Annex 1 are aware of them.

23a.2 Consequences of non-compliance

If the beneficiary breaches its obligations under this Article, the Agency may apply any of the measures described in Chapter 6.

SUBSECTION 2 RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND

ARTICLE 24 — AGREEMENT ON BACKGROUND

24.1 Agreement on background

The beneficiary must identify (in writing) the background for the action.

'**Background**' means any data, know-how or information — whatever its form or nature (tangible or intangible), including any rights such as intellectual property rights — that:

(a) is held by the beneficiary before its accession to the Agreement, and

(b) is needed to implement the action or exploit the results.

[5] Commission Recommendation C (2008) 1329 of 10.4.2008 on the management of intellectual property in knowledge transfer activities and the Code of Practice for universities and other public research institutions attached to this recommendation.

24.2 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 25 — ACCESS RIGHTS TO BACKGROUND

25.1 Exercise of access rights — Waiving of access rights — No sub-licensing

To exercise access rights, this must first be requested in writing ('**request for access**').

'**Access rights**' means rights to use results or background under the terms and conditions laid down in this Agreement.

Waivers of access rights are not valid unless in writing.

Unless agreed otherwise, access rights do not include the right to sub-license.

25.2 Access rights for other beneficiaries, for implementing their own tasks under the action

Not applicable

25.3 Access rights for other beneficiaries, for exploiting their own results

Not applicable

25.4 Access rights for affiliated entities

Not applicable

25.5 Access rights for the researcher

The beneficiary must — on a royalty-free basis — give access to the recruited researcher to background necessary for their research training activities under the action.

25.6 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

SUBSECTION 3 RIGHTS AND OBLIGATIONS RELATED TO RESULTS

ARTICLE 26 — OWNERSHIP OF RESULTS

26.1 Ownership by the beneficiary that generates the results

Results are owned by the beneficiary that generates them.

'**Results**' means any (tangible or intangible) output of the action such as data, knowledge or information — whatever its form or nature, whether it can be protected or not — that is generated in the action, as well as any rights attached to it, including intellectual property rights.

26.2 Joint ownership by several beneficiaries

Not applicable

26.3 Rights of third parties (including personnel)

If third parties (including personnel) may claim rights to the results, the beneficiary must ensure that it complies with its obligations under the Agreement.

If a third party generates results, the beneficiary must obtain all necessary rights (transfer, licences or other) from the third party, in order to be able to respect its obligations as if those results were generated by the beneficiary itself.

If obtaining the rights is impossible, the beneficiary must refrain from using the third party to generate the results.

26.4 Agency ownership, to protect results

26.4.1 The Agency may — with the consent of the beneficiary — assume ownership of results to protect them, if the beneficiary intends — up to four years after the period set out in Article 3 — to disseminate its results without protecting them, except in any of the following cases:

(a) the lack of protection is because protecting the results is not possible, reasonable or justified (given the circumstances);

(b) the lack of protection is because there is a lack of potential for commercial or industrial exploitation, or

(c) the beneficiary intends to transfer the results to a third party established in an EU Member State or associated country[6], which will protect them.

Before the results are disseminated and unless any of the cases above under Points (a), (b) or (c) applies, the beneficiary must formally notify the Agency and at the same time inform it of any reasons for refusing consent. The beneficiary may refuse consent only if it can show that its legitimate interests would suffer significant harm.

If the Agency decides to assume ownership, it will formally notify the beneficiary within 45 days of receiving notification.

No dissemination relating to these results may take place before the end of this period or, if the Agency takes a positive decision, until it has taken the necessary steps to protect the results.

[6] For the definition, see 2.1(3) of Regulation (EU) No 1290/2013 of the European Parliament and of the Council of 11 December 2013 laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" ('**Rules for Participation Regulation No 1290/2013**') (OJ L 347, 20.12.2013 p.81): '**associated country**' means a third country which is party to an international agreement with the Union, as identified in Article 7 of the H2020 Framework Programme Regulation No 1291/2013. Article 7 sets out the conditions for association of non-EU countries to Horizon 2020.

26.4.2 The Agency may — with the consent of the beneficiary — assume ownership of results to protect them, if the beneficiary intends — up to four years after the period set out in Article 3 — to stop protecting them or not to seek an extension of protection, except in any of the following cases:

(a) the protection is stopped because of a lack of potential for commercial or industrial exploitation;

(b) an extension would not be justified given the circumstances.

The beneficiary that intends to stop protecting results or not seek an extension must — unless any of the cases above under Points (a) or (b) applies — formally notify the Agency at least 60 days before the protection lapses or its extension is no longer possible and at the same time inform it of any reasons for refusing consent. The beneficiary may refuse consent only if it can show that its legitimate interests would suffer significant harm.

If the Agency decides to assume ownership, it will formally notify the beneficiary within 45 days of receiving notification.

26.5 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to the any of the other measures described in Chapter 6.

ARTICLE 27 — PROTECTION OF RESULTS — VISIBILITY OF EU FUNDING

27.1 Obligation to protect the results

The beneficiary must examine the possibility of protecting its results and must adequately protect them — for an appropriate period and with appropriate territorial coverage — if:

(a) the results can reasonably be expected to be commercially or industrially exploited and

(b) protecting them is possible, reasonable and justified (given the circumstances).

When deciding on protection, the beneficiary must consider its own legitimate interests.

27.2 Agency ownership, to protect the results

If the beneficiary intends not to protect its results, to stop protecting them or not seek an extension of protection, the Agency may — under certain conditions (see Article 26.4) — assume ownership to ensure their (continued) protection.

27.3 Information on EU funding

Applications for protection of results (including patent applications) filed by or on behalf of the beneficiary must — unless the Agency requests or agrees otherwise or unless it is impossible — include the following:

> "The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 101022473".

27.4 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 28 — EXPLOITATION OF RESULTS

28.1 Obligation to exploit the results

The beneficiary must — up to four years after the period set out in Article 3 — take measures aiming to ensure '**exploitation**' of its results (either directly or indirectly, in particular through transfer or licensing; see Article 30) by:

(a) using them in further research activities (outside the action);

(b) developing, creating or marketing a product or process;

(c) creating and providing a service, or

(d) using them in standardisation activities.

This does not change the security obligations in Article 37, which still apply.

28.2 Results that could contribute to European or international standards — Information on EU funding

If results are incorporated in a standard, the beneficiary must — unless the Agency requests or agrees otherwise or unless it is impossible — ask the standardisation body to include the following statement in (information related to) the standard:

> "Results incorporated in this standard have received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 101022473".

28.3 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced in accordance with Article 43.

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 29 — DISSEMINATION OF RESULTS — OPEN ACCESS — VISIBILITY OF EU FUNDING

29.1 Obligation to disseminate results

Unless it goes against its legitimate interests, the beneficiary must — as soon as possible — '**disseminate**' its results by disclosing them to the public by appropriate means (other than those resulting from protecting or exploiting the results), including in scientific publications (in any medium).

This does not change the obligation to protect results in Article 27, the confidentiality obligations in Article 36, the security obligations in Article 37 or the obligations to protect personal data in Article 39, all of which still apply.

If the beneficiary intends not to protect its results, it may — under certain conditions (see Article 26.4.1) — need to formally notify the Agency before dissemination takes place.

29.2 Open access to scientific publications

The beneficiary must ensure open access (free of charge online access for any user) to all peer-reviewed scientific publications relating to its results. In particular, it must:

(a) as soon as possible and at the latest on publication, deposit a machine-readable electronic copy of the published version or final peer-reviewed manuscript accepted for publication in a repository for scientific publications.

Moreover, the beneficiary must aim to deposit at the same time the research data needed to validate the results presented in the deposited scientific publications;

(b) ensure open access to the deposited publication — via the repository — at the latest:

(i) on publication, if an electronic version is available for free via the publisher, or

(ii) within six months of publication (twelve months for publications in the social sciences and humanities) in any other case.

(c) ensure open access — via the repository — to the bibliographic metadata that identify the deposited publication.

The bibliographic metadata must be in a standard format and must include all of the following:

- the terms "Marie Skłodowska-Curie Action";
- the project name, acronym and grant number;
- the publication date and, if applicable, length of embargo period;
- a persistent identifier.

29.3 Open access to research data

Regarding the digital research data generated in the action ('**data**'), the beneficiary must:

(a) deposit in a research data repository and take measures to make it possible for third parties to access, mine, exploit, reproduce and disseminate — free of charge for any user — the following:

(i) the data, including associated metadata, needed to validate the results presented in scientific publications as soon as possible;

(ii) other data, including associated metadata, as specified and within the deadlines laid down in the '**data management plan**' (see Annex 1);

(b) provide information — via the repository — about tools and instruments at the disposal of the

beneficiary and necessary for validating the results (and — where possible — provide the tools and instruments themselves).

This does not change the obligation to protect results in Article 27, the confidentiality obligations in Article 36, the security obligations in Article 37 or the obligations to protect personal data in Article 39, all of which still apply.

As an exception, the beneficiary does not have to ensure open access to specific parts of its research data if the achievement of the action's main objective, as described in Annex 1, would be jeopardised by making those specific parts of the research data openly accessible. In this case, the data management plan must contain the reasons for not giving access.

29.4 Information on EU funding — Obligation and right to use the EU emblem

Unless the Agency requests or agrees otherwise or unless it is impossible, any dissemination of results (in any form, including electronic) must:

(a) display the EU emblem and

(b) include the following text:

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 101022473".

When displayed together with another logo, the EU emblem must have appropriate prominence.

For the purposes of its obligations under this Article, the beneficiary may use the EU emblem without first obtaining approval from the Agency.

This does not however give it the right to exclusive use.

Moreover, the beneficiary may not appropriate the EU emblem or any similar trademark or logo, either by registration or by any other means.

29.5 Disclaimer excluding Agency responsibility

Any dissemination of results must indicate that it reflects only the author's view and that the Agency is not responsible for any use that may be made of the information it contains.

29.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 30 — TRANSFER AND LICENSING OF RESULTS

30.1 Transfer of ownership

The beneficiary may transfer ownership of its results.

It must however ensure that its obligations under Articles 26.2, 26.4, 27, 28, 29, 30 and 31 also apply to the new owner and that this owner has the obligation to pass them on in any subsequent transfer.

This does not change the security obligations in Article 37, which still apply.

30.2 Granting licenses

The beneficiary may grant licences to its results (or otherwise give the right to exploit them), if:

(a) this does not impede the rights under Article 31

(b) not applicable.

This does not change the dissemination obligations in Article 29 or security obligations in Article 37, which still apply.

30.3 Agency right to object to transfers or licensing

Not applicable

30.4 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 31 — ACCESS RIGHTS TO RESULTS

31.1 Exercise of access rights — Waiving of access rights — No sub-licensing

The conditions set out in Article 25.1 apply.

The obligations set out in this Article do not change the security obligations in Article 37, which still apply.

31.2 Access rights for other beneficiaries, for implementing their own tasks under the action

Not applicable

31.3 Access rights for other beneficiaries, for exploiting their own results

Not applicable

31.4 Access rights of affiliated entities

Not applicable

31.5 Access rights for the EU institutions, bodies, offices or agencies and EU Member States

The beneficiary must give access to its results — on a royalty-free basis — to EU institutions, bodies, offices or agencies, for developing, implementing or monitoring EU policies or programmes.

Such access rights are limited to non-commercial and non-competitive use.

This does not change the right to use any material, document or information received from the beneficiary for communication and publicising activities (see Article 38.2).

31.6 Access rights for the researcher

The beneficiary must — on a royalty-free basis — give, access to the recruited researcher to results necessary for the research training activities under the action.

31.7 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

SECTION 4 OTHER RIGHTS AND OBLIGATIONS

ARTICLE 32 — RECRUITMENT AND WORKING CONDITIONS FOR THE RECRUITED RESEARCHER

32.1 Obligations towards the recruited researcher

The beneficiary must respect the following recruitment and working conditions for the researcher recruited under the action:

(a) take all measures to implement the principles set out in the Commission Recommendation on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[7] and ensure that the researcher is aware of them;

(b) ensure that the researcher enjoys at the place of the implementation at least the same standards and working conditions as those applicable to local researchers holding a similar position;

(c) ensure that the employment contract, other direct contract or fixed amount fellowship agreement (see Article 6) specifies:

(i) the name of the supervisor for the research training activities as indicated in Annex 1;

(ii) the starting date and duration of the research training activities under the action;

(iii) the monthly support for the researcher under this Agreement (in euro and, if relevant, in the currency in which the remuneration is paid);

(iv) the obligation of the researcher to work exclusively for the action;

(v) the obligation of the researcher not to receive for activities carried out in the frame of

[7] Commission Recommendation 2005/251/EC of 11 March 2005 on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers (OJ L 75, 22.3.2005, p. 67).

the action, other incomes than those received from the beneficiary (or any other entity referred to in Annex 1);

(vi) the obligation of the researcher to inform the beneficiary as soon as possible of any events or circumstances likely to affect the Agreement (see Article 17);

(vii) the arrangements related to the intellectual property rights between the beneficiary and the researcher — during implementation of the action and afterwards;

(viii) the obligation of the researcher to maintain confidentiality (see Article 36);

(ix) the obligation of the researcher to ensure the visibility of EU funding in communications or publications and in applications for the protection of results (see Articles 27, 28, 29 and 38);

(d) assist the researcher in the administrative procedures related to the recruitment;

(e) inform the researcher about:

- the description, conditions, location and the timetable for the implementation of the research training activities under the action and the name of the supervisor;
- the rights and obligations of the beneficiary toward the researcher under this Agreement;
- the obligation of the researcher to complete and submit — at the end of the research training activities — the evaluation questionnaire and — two years later — follow-up questionnaire provided by the Agency;

(f) ensure that the researcher does not receive, for activities carried out in the frame of the action, other incomes than those received from the beneficiary (or any other entity referred to in Annex 1);

(g) ensure that the researcher does not have to bear any costs for the implementation of the action as described in Annex 1;

(h) host the researcher at its premises (or at the premises of an entity with a capital or legal link);

(i) provide training and the necessary means for implementing the action (or ensure that such training and means are provided by entities with a capital or legal link);

(j) ensure that the researcher is adequately supervised;

(k) ensure that — at the beginning of the research training activities — a career development plan is established together with the supervisor;

(l) support the secondment of the researcher to a partner organisation in a Member State or associated country as set out in Annex 1:

- for actions with a duration up to 18 months: for a maximum of three months or
- for actions with a duration of more than 18 months: for a maximum of six months;

32.2 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 33 — GENDER EQUALITY

33.1 Obligation to aim for gender equality

The beneficiary must take all measures to promote equal opportunities between men and women in the implementation of the action. It must aim, to the extent possible, for a gender balance at all levels of personnel assigned to the action, including at supervisory and managerial level.

33.2 Consequences of non-compliance

If the beneficiary breaches its obligations under this Article, the Agency may apply any of the measures described in Chapter 6.

ARTICLE 34 — ETHICS AND RESEARCH INTEGRITY

34.1 Obligation to comply with ethical and research integrity principles

The beneficiary must carry out the action in compliance with:

(a) ethical principles (including the highest standards of research integrity)

and

(b) applicable international, EU and national law.

Funding will not be granted for activities carried out outside the EU if they are prohibited in all Member States or for activities which destroy human embryos (for example, for obtaining stem cells).

The beneficiary must ensure that the activities under the action have an exclusive focus on civil applications.

The beneficiary must ensure that the activities under the action do not:

(a) aim at human cloning for reproductive purposes;

(b) intend to modify the genetic heritage of human beings which could make such changes heritable (with the exception of research relating to cancer treatment of the gonads, which may be financed), or

(c) intend to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including by means of somatic cell nuclear transfer.

In addition, the beneficiary must respect the fundamental principle of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity[8].

This implies compliance with the following fundamental principles:

- **reliability** in ensuring the quality of research reflected in the design, the methodology, the analysis and the use of resources;
- **honesty** in developing, undertaking, reviewing, reporting and communicating research in a transparent, fair and unbiased way;
- **respect** for colleagues, research participants, society, ecosystems, cultural heritage and the environment;
- **accountability** for the research from idea to publication, for its management and organisation, for training, supervision and mentoring, and for its wider impacts

and means that the beneficiary must ensure that persons carrying out research tasks follow the good research practices and refrain from the research integrity violations described in this Code.

This does not change the other obligations under this Agreement or obligations under applicable international, EU or national law, all of which still apply.

34.2 Activities raising ethical issues

Activities raising ethical issues must comply with the '**ethics requirements**' set out as deliverables in Annex 1.

Before the beginning of an activity raising an ethical issue, the beneficiary must have obtained:

(a) any ethics committee opinion required under national law and

(b) any notification or authorisation for activities raising ethical issues required under national and/or European law

needed for implementing the action tasks in question.

The documents must be kept on file and be submitted upon request by the beneficiary to the Agency (see Article 52). If they are not in English, they must be submitted together with an English summary, which shows that the action tasks in question are covered and includes the conclusions of the committee or authority concerned (if available).

34.3 Activities involving human embryos or human embryonic stem cells

Activities involving research on human embryos or human embryonic stem cells may be carried out, in addition to Article 34.1, only if:

- they are set out in Annex 1 or
- the beneficiary has obtained explicit approval (in writing) from the Agency (see Article 52).

[8] The European Code of Conduct for Research Integrity of ALLEA (All European Academies). http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf

34.4 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 35 — CONFLICT OF INTERESTS

35.1 Obligation to avoid a conflict of interests

The beneficiary must take all measures to prevent any situation where the impartial and objective implementation of the action is compromised for reasons involving economic interest, political or national affinity, family or emotional ties or any other shared interest ('**conflict of interests**').

It must formally notify to the Agency without delay any situation constituting or likely to lead to a conflict of interests and immediately take all the necessary steps to rectify this situation.

The Agency may verify that the measures taken are appropriate and may require additional measures to be taken by a specified deadline.

35.2 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 36 — CONFIDENTIALITY

36.1 General obligation to maintain confidentiality

During implementation of the action and for four years after the period set out in Article 3, the parties must keep confidential any data, documents or other material (in any form) that is identified as confidential at the time it is disclosed ('**confidential information**').

If the beneficiary requests, the Agency may agree to keep such information confidential for an additional period beyond the initial four years.

If information has been identified as confidential only orally, it will be considered to be confidential only if this is confirmed in writing within 15 days of the oral disclosure.

Unless otherwise agreed between the parties, they may use confidential information only to implement the Agreement.

The beneficiary may disclose confidential information to its personnel, third parties mentioned in Annex 1 or a partner organisation only if they:

(a) need to know to implement the Agreement and

(b) are bound by an obligation of confidentiality.

This does not change the security obligations in Article 37, which still apply.

The Agency may disclose confidential information to its staff, other EU institutions and bodies. .It may disclose confidential information to third parties, if:

(a) this is necessary to implement the Agreement or safeguard the EU's financial interests and

(b) the recipients of the information are bound by an obligation of confidentiality.

Under the conditions set out in Article 4 of the Rules for Participation Regulation No 1290/2013[9], the Commission must moreover make available information on the results to other EU institutions, bodies, offices or agencies as well as Member States or associated countries.

The confidentiality obligations no longer apply if:

(a) the disclosing party agrees to release the other party;

(b) the information was already known by the recipient or is given to him without obligation of confidentiality by a third party that was not bound by any obligation of confidentiality;

(c) the recipient proves that the information was developed without the use of confidential information;

(d) the information becomes generally and publicly available, without breaching any confidentiality obligation, or

(e) the disclosure of the information is required by EU or national law.

36.2 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 37 — SECURITY-RELATED OBLIGATIONS

37.1 Results with a security recommendation

Not applicable

37.2 Classified information

Not applicable

37.3 Activities involving dual-use goods or dangerous materials and substances

Not applicable

[9] Regulation (EU) No 1290/2013 of the European Parliament and of the Council of 11 December 2013 laying down the rules for the participation and dissemination in "Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020)" (OJ L 347, 20.12.2013 p.81).

37.4 Consequences of non-compliance

Not applicable

ARTICLE 38 — PROMOTING THE ACTION — VISIBILITY OF EU FUNDING

38.1 Communication activities by the beneficiary

38.1.1 Obligation to promote the action and its results

The beneficiary must promote the action and its results by providing targeted information to multiple audiences (including the media and the public) in a strategic and effective manner.

This does not change the dissemination obligations in Article 29, the confidentiality obligations in Article 36 or the security obligations in Article 37, all of which still apply.

Before engaging in a communication activity expected to have a mainstream media coverage the beneficiary must inform the Agency (see Article 52).

38.1.2 Information on EU funding — Obligation and right to use the EU emblem

Unless the Agency requests or agrees otherwise or unless it is impossible, any communication activity related to the action (including in electronic form, via social media, etc.) and any infrastructure, equipment and major results funded by the grant must:

(a) display the European Union emblem and

(b) include the following statement:

> For communication activities: "This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101022473".
>
> For infrastructure, equipment and major results: "This *[infrastructure][equipment][insert type of result]* is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101022473".

When displayed together with another logo, the EU emblem must have appropriate prominence.

For the purposes of its obligations under this Article, the beneficiary may use the EU emblem without first obtaining approval from the Agency.

This does not, however, give it the right to exclusive use.

Moreover, it may not appropriate the EU emblem or any similar trademark or logo, either by registration or by any other means.

38.1.3 Disclaimer excluding Agency and Commission responsibility

Any communication activity related to the action must indicate that it reflects only the author's view and that the Agency and the Commission are not responsible for any use that may be made of the information it contains.

38.2 Communication activities by the Agency and the Commission

38.2.1 Right to use the beneficiary' materials, documents or information

The Agency and the Commission may use, for its communication and publicising activities, information relating to the action, documents notably summaries for publication and public deliverables as well as any other material, such as pictures or audio-visual material received from the beneficiary (including in electronic form).

This does not change the confidentiality obligations in Article 36 and the security obligations in Article 37, all of which still apply.

If the Agency's or the Commission's use of these materials, documents or information would risk compromising legitimate interests, the beneficiary may request the Agency or the Commission not to use it (see Article 52).

The right to use the beneficiary's materials, documents and information includes:

(a) **use for its own purposes** (in particular, making them available to persons working for the Agency, the Commission or any other EU institution, body, office or agency or body or institutions in EU Member States; and copying or reproducing them in whole or in part, in unlimited numbers);

(b) **distribution to the public** (in particular, publication as hard copies and in electronic or digital format, publication on the internet, as a downloadable or non-downloadable file, broadcasting by any channel, public display or presentation, communicating through press information services, or inclusion in widely accessible databases or indexes);

(c) **editing or redrafting** for communication and publicising activities (including shortening, summarising, inserting other elements (such as meta-data, legends, other graphic, visual, audio or text elements), extracting parts (e.g. audio or video files), dividing into parts, use in a compilation);

(d) **translation**;

(e) giving **access in response to individual requests** under Regulation No 1049/2001[11], without the right to reproduce or exploit;

(f) **storage** in paper, electronic or other form;

(g) **archiving**, in line with applicable document-management rules, and

(h) the right to authorise **third parties** to act on its behalf or sub-license the modes of use set out in Points (b),(c),(d) and (f) to third parties if needed for the communication and publicising activities of the Agency or the Commission.

If the right of use is subject to rights of a third party (including personnel of the beneficiary), the beneficiary must ensure that it complies with its obligations under this Agreement (in particular, by obtaining the necessary approval from the third parties concerned).

[11] Regulation (EC) No 1049/2001 of the European Parliament and of the Council of 30 May 2001 regarding public access to European Parliament, Council and Commission documents, OJ L 145, 31.5.2001, p. 43.

Where applicable (and if provided by the beneficiary), the Agency or the Commission will insert the following information:

> "© – [year] – [name of the copyright owner]. All rights reserved. Licensed to the Research Executive Agency (REA) and the European Union (EU) under conditions."

38.3 Consequences of non-compliance

If the beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 39 — PROCESSING OF PERSONAL DATA

39.1 Processing of personal data by the Agency and the Commission

Any personal data under the Agreement will be processed by the Agency or the Commission under Regulation No 45/2001[12] and according to the 'notifications of the processing operations' to the Data Protection Officer (DPO) of the Agency or the Commission (publicly accessible in the DPO register).

Such data will be processed by the '**data controller**' of the Agency or the Commission for the purposes of implementing, managing and monitoring the Agreement or protecting the financial interests of the EU or Euratom (including checks, reviews, audits and investigations; see Article 22).

The persons whose personal data are processed have the right to access and correct their own personal data. For this purpose, they must send any queries about the processing of their personal data to the data controller, via the contact point indicated in the privacy statement(s) that are published on the Agency and Commission websites.

They also have the right to have recourse at any time to the European Data Protection Supervisor (EDPS).

39.2 Processing of personal data by the beneficiary

The beneficiary must process personal data under the Agreement in compliance with applicable EU and national law on data protection (including authorisations or notification requirements).

The beneficiary may grant its personnel access only to data that is strictly necessary for implementing, managing and monitoring the Agreement.

The beneficiary must inform the personnel whose personal data are collected and processed by the Agency or the Commission. For this purpose, it must provide them with the service privacy statement(s) (see above), before transmitting their data to the Agency or the Commission.

39.3 Consequences of non-compliance

[12] Regulation (EC) No 45/2001 of the European Parliament and of the Council of 18 December 2000 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data (OJ L 8, 12.01.2001, p. 1).

If the beneficiary breaches any of its obligations under Article 39.2, the Agency may apply any of the measures described in Chapter 6.

ARTICLE 40 — ASSIGNMENTS OF CLAIMS FOR PAYMENT AGAINST THE AGENCY

The beneficiary may not assign any of its claims for payment against the Agency to any third party, except if approved by the Agency on the basis of a reasoned, written request.

If the Agency has not accepted the assignment or the terms of it are not observed, the assignment will have no effect on it.

In no circumstances will an assignment release the beneficiary from its obligations towards the Agency.

CHAPTER 5 DIVISION OF BENEFICIARIES' ROLES AND RESPONSIBILITIES — RELATIONSHIP WITH COMPLEMENTARY BENEFICIARIES — RELATIONSHIP WITH PARTNERS OF A JOINT ACTION

ARTICLE 41 — BENEFICIARY'S ROLES AND RESPONSIBILITIES — RELATIONSHIP WITH COMPLEMENTARY BENEFICIARIES — RELATIONSHIP WITH PARTNERS OF A JOINT ACTION

41.1 Roles and responsibility towards the Agency

The beneficiary has full responsibility for implementing the action and complying with the Agreement.

The beneficiary is itself responsible for:

(a) monitoring that the action is implemented properly (see Article 7);

(b) informing the Agency immediately of any events or circumstances likely to affect significantly or delay the implementation of the action (see Article 17);

(c) submitting the deliverables and report(s) to the Agency (see Articles 19 and 20);

(d) submitting to the Agency in good time any documents or information required by it

and may not delegate or subcontract these tasks to any third party (including entities with a capital or legal link and partner organisations).

41.2 Internal division of roles and responsibilities

Not applicable

41.3 Internal arrangements between beneficiaries — Consortium agreement

Not applicable

41.4 Relationship with complementary beneficiaries — Collaboration agreement

Not applicable

41.5 Relationship with partners of a joint action — Coordination agreement

Not applicable

CHAPTER 6 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — SANCTIONS — DAMAGES — SUSPENSION — TERMINATION — FORCE MAJEURE

SECTION 1 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — SANCTIONS

ARTICLE 42 — REJECTION OF INELIGIBLE COSTS

42.1 Conditions

The Agency will — **at the payment of the balance** or **afterwards** — reject any costs which are ineligible (see Article 6), in particular following checks, reviews, audits or investigations (see Article 22).

The rejection may also be based on the **extension of findings from other grants to this grant** (see Article 22.5.2).

42.2 Ineligible costs to be rejected — Calculation — Procedure

Ineligible costs will be rejected in full.

If the rejection of costs does not lead to a recovery (see Article 44), the Agency will formally notify the beneficiary of the rejection of costs, the amounts and the reasons why (if applicable, together with the notification of amounts due; see Article 21.5). The beneficiary may — within 30 days of receiving notification — formally notify the Agency of its disagreement and the reasons why.

If the rejection of costs leads to a recovery, the Agency will follow the contradictory procedure with ‘pre-information letter’ set out in Article 44.

42.3 Effects

If the Agency rejects costs at the **payment of the balance**, it will deduct them from the total eligible costs declared, for the action, in the final summary financial statement (see Articles 20.3 and 20.4). It will then calculate the payment of the balance as set out in Articles 21.3 or 21.4.

If the Agency rejects costs **after the payment of the balance**, it will deduct the amount rejected from the total eligible costs declared, in the summary financial statement. It will then calculate the revised final grant amount as set out in Article 5.4.

ARTICLE 43 — REDUCTION OF THE GRANT

43.1 Conditions

The Agency may — **at the payment of the balance** or **afterwards** — reduce the maximum grant amount (see Article 5.1), if:

(a) the beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed:

(i) substantial errors, irregularities or fraud or

(ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles) or

(b) the beneficiary (or a natural person who has the power to represent or take decision on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2).

43.2 Amount to be reduced — Calculation — Procedure

The amount of the reduction will be proportionate to the seriousness of the errors, irregularities or fraud or breach of obligations.

Before reduction of the grant, the Agency will formally notify a '**pre-information letter**' to the beneficiary:

- informing it of its intention to reduce the grant, the amount it intends to reduce and the reasons why and

- inviting it to submit observations within 30 days of receiving notification

If the Agency does not receive any observations or decides to pursue reduction despite the observations it has received, it will formally notify **confirmation** of the reduction (if applicable, together with the notification of amounts due; see Article 21).

43.3 Effects

If the Agency reduces the grant at **the payment of the balance**, it will calculate the reduced grant amount for the action and then determine the amount due as payment of the balance (see Articles 5.3.4 and 21.4).

If the Agency reduces the grant **after the payment of the balance**, it will calculate the revised final grant amount (see Article 5.4). If the revised final grant amount is lower than the final grant amount, the Agency will recover the difference (see Article 44).

ARTICLE 44 — RECOVERY OF UNDUE AMOUNTS

44.1 Amount to be recovered — Calculation — Procedure

The Agency will — **at the payment of the balance** or **afterwards** — claim back any amount that was paid, but is not due under the Agreement.

44.1.1 Recovery after termination of a beneficiary's participation

Not applicable

44.1.2 Recovery at payment of the balance

If the payment of the balance takes the form of a recovery (see Article 21.4), the Agency will formally notify a '**pre-information letter**' to the beneficiary:

- informing it of its intention to recover, the amount due as the balance and the reasons why;
- specifying that it intends to deduct the amount to be recovered from the amount retained for the Guarantee Fund; and
- inviting it to submit observations within 30 days of receiving notification.

If no observations are submitted or the Agency decides to pursue recovery despite the observations it has received, it will **confirm recovery** (together with the notification of amounts due; see Article 21.5) and:

- pay the difference between the amount to be recovered and the amount retained for the Guarantee Fund, **if the difference is positive** or
- formally notify to the beneficiary a **debit note** for the difference between the amount to be recovered and the amount retained for the Guarantee Fund, **if the difference is negative**. This note will also specify the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Agency or the Commission will **recover** the amount:

(a) by '**offsetting**' it — without the beneficiary's consent — against any amounts owed to the beneficiary by the Agency, the Commission or another executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU's financial interests, the Agency or the Commission may offset before the payment date specified in the debit note;

(b) by **drawing on the Guarantee Fund**. The Agency or the Commission will formally notify the beneficiary the debit note on behalf of the Guarantee Fund and recover the amount:

(i) not applicable

(ii) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the payment date in the debit note, up to and including the date the Agency or the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC[13] applies.

44.1.3 Recovery of amounts after payment of the balance

If, the revised final grant amount (see Article 5.4) is lower than the final grant amount, the beneficiary must repay the difference to the Agency.

The Agency will formally notify a **pre-information letter** to the beneficiary:

- informing it of its intention to recover, the due amount and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If no observations are submitted or the Agency decides to pursue recovery despite the observations it has received, it will **confirm** the amount to be recovered and formally notify to the beneficiary a **debit note**. This note will also specify the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Agency or the Commission will **recover** the amount:

(a) by '**offsetting**' it — without the beneficiary's consent — against any amounts owed to the beneficiary by the Agency, the Commission or another executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU's financial interests, the Agency or the Commission may offset before the payment date specified in the debit note;

(b) by **drawing on the Guarantee Fund**. The Agency or the Commission will formally notify the beneficiary the debit note on behalf of the Guarantee Fund and recover the amount:

(i) not applicable

(ii) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the date for payment in the debit note, up to and including the date the Agency or the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC applies.

[13] Directive 2007/64/EC of the European Parliament and of the Council of 13 November 2007 on payment services in the internal market amending Directives 97/7/EC, 2002/65/EC, 2005/60/EC and 2006/48/EC and repealing Directive 97/5/EC (OJ L 319, 05.12.2007, p. 1).

ARTICLE 45 — ADMINISTRATIVE SANCTIONS

In addition to contractual measures, the Agency or the Commission may also adopt administrative sanctions under Articles 106 and 131(4) of the Financial Regulation No 966/2012 (i.e. exclusion from future procurement contracts, grants, prizes and expert contracts and/or financial penalties).

SECTION 2 LIABILITY FOR DAMAGES

ARTICLE 46 — LIABILITY FOR DAMAGES

46.1 Liability of the Agency

The Agency cannot be held liable for any damage caused to the beneficiary (or to third parties) as a consequence of implementing the Agreement, including for gross negligence.

The Agency cannot be held liable for any damage caused by the beneficiary or third parties involved in the action, as a consequence of implementing the Agreement.

46.2 Liability of the beneficiary

Except in case of force majeure (see Article 51), the beneficiary must compensate the Agency for any damage it sustains as a result of the implementation of the action or because the action was not implemented in full compliance with the Agreement.

SECTION 3 SUSPENSION AND TERMINATION

ARTICLE 47 — SUSPENSION OF PAYMENT DEADLINE

47.1 Conditions

The Agency may — at any moment — suspend the payment deadline (see Article 21.2 to 21.4) if a request for payment (see Article 20) cannot be approved because:

(a) it does not comply with the provisions of the Agreement (see Article 20);

(b) the report has not been submitted or is not complete or additional information is needed, or

(c) there is doubt about the eligibility of the costs declared in the financial statement and additional checks, reviews, audits or investigations are necessary.

47.2 Procedure

The Agency will formally notify the beneficiary of the suspension and the reasons why.

The suspension will **take effect** the day notification is sent by the Agency (see Article 52).

If the conditions for suspending the payment deadline are no longer met, the suspension will be **lifted** — and the remaining period will resume.

If the suspension exceeds two months, the beneficiary may request the Agency if the suspension will continue.

If the payment deadline has been suspended due to the non-compliance of the report (see Article 20) and the revised report or statement is not submitted or was submitted but is also rejected, the Agency may also terminate the Agreement (see Article 50.3.1(l)).

ARTICLE 48 — SUSPENSION OF PAYMENTS

48.1 Conditions

The Agency may — at any moment — suspend payments, in whole or in part, if:

(a) the beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed or is suspected of having committed:

  (i) substantial errors, irregularities or fraud or

  (ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles) or

(b) the beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2).

If suspension concerns the payment of the balance, — once suspension is lifted — the payment or the recovery of the amount(s) concerned will be considered the payment of the balance that closes the action.

48.2 Procedure

Before suspending payments, the Agency will formally notify the beneficiary:

- informing it of its intention to suspend payments and the reasons why and

- inviting it to submit observations within 30 days of receiving notification.

If the Agency does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify **confirmation** of the suspension. Otherwise, it will formally notify that the suspension procedure is not continued.

The suspension will **take effect** the day the confirmation notification is sent by the Agency.

If the conditions for resuming payments are met, the suspension will be **lifted**. The Agency will formally notify the beneficiary.

The beneficiary may suspend implementation of the action (see Article 49.1) or terminate the Agreement (see Article 50.1 and 50.2).

ARTICLE 49 — SUSPENSION OF THE ACTION IMPLEMENTATION

49.1 Suspension of the action implementation by the beneficiary

49.1.1 Conditions — Procedure

49.1.1.1 The beneficiary may suspend implementation of the action or any part of it, if exceptional circumstances – in particular *force majeure* (see Article 51) – make implementation impossible or excessively difficult.

In this case, the beneficiary must immediately formally notify suspension to the Agency (see Article 52), stating:

(a) the reasons why and

(b) the expected date of resumption.

The suspension will **take effect** the day this notification is received by the Agency.

Once circumstances allow for implementation to resume, the beneficiary must immediately formally notify the Agency and request an **amendment** of the Agreement to set the date on which the action will be resumed, extend the duration of the action and make other changes necessary to adapt the action to the new situation (see Article 55) — unless the Agreement or the participation of a beneficiary has been terminated (see Articles 50).

The suspension will be **lifted** with effect from the resumption date set out in the amendment. This date may be before the date on which the amendment enters into force.

Costs incurred during suspension of the action implementation are not eligible (see Article 6).

49.1.1.2 The beneficiary may request suspension of the action implementation (or any part of it) for professional, personal or family reasons (including parental leave).

For this purpose, the beneficiary must formally notify a request for **amendment** (to make the necessary changes and to set the date of resumption) in accordance with Article 55.

The suspension **will take effect** on the date set out in the amendment.

Costs incurred during suspension of the action implementation are not eligible (see Article 6).

49.2 Suspension of the action implementation, by the Agency

49.2.1 Conditions

The Agency may suspend implementation of the action or any part of it, if:

(a) the beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed or is suspected of having committed:

(i) substantial errors, irregularities or fraud or

(ii) serious breach of obligations under the Agreement or during the award procedure

(including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles);

(b) the beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2), or

(c) the action is suspected of having lost its scientific or technological relevance.

49.2.2 Procedure

Before suspending implementation of the action, the Agency will formally notify the beneficiary:

- informing it of its intention to suspend the implementation and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If the Agency does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify **confirmation** of the suspension. Otherwise, it will formally notify that the procedure is not continued.

The suspension will **take effect** five days after confirmation notification is received by the beneficiary (or on a later date specified in the notification).

It will be **lifted** if the conditions for resuming implementation of the action are met.

The beneficiary will be formally notified of the lifting and the Agreement will be **amended** to set the date on which the action will be resumed, extend the duration of the action and make other changes necessary to adapt the action to the new situation (see Article 55) — unless the Agreement has already been terminated (see Article 50).

The suspension will be lifted with effect from the resumption date set out in the amendment. This date may be before the date on which the amendment enters into force.

Costs incurred during suspension are not eligible (see Article 6).

The beneficiary may not claim damages due to suspension by the Agency (see Article 46).

Suspension of the action implementation does not affect the Agency's right to terminate the Agreement (see Article 50), reduce the grant or recover amounts unduly paid (see Articles 43 and 44).

ARTICLE 50 — TERMINATION OF THE AGREEMENT

50.1 Termination of the Agreement by the beneficiary

50.1.1 Conditions and procedure

The beneficiary may terminate the Agreement.

The beneficiary must formally notify termination to the Agency (see Article 52), stating:

- the reasons why and
- the date the termination will take effect. This date must be after the notification.

If no reasons are given or if the Agency considers the reasons do not justify termination, the Agreement will be considered to have been '**terminated improperly**'.

The termination will **take effect** on the day specified in the notification.

50.1.2 Effects

The beneficiary must — within 60 days from when termination takes effect — submit: the report under Article 20.3.

If the Agency does not receive the reports within the deadline (see above), only costs which are included in the report will be taken into account.

The Agency will **calculate** the final grant amount (see Article 5.3) and the balance (see Article 21.4) on the basis of the report(s) submitted. Only costs incurred until termination are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

Improper termination may lead to a reduction of the grant (see Article 43).

After termination, the beneficiary's obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

50.2 Termination of the participation of one or more beneficiaries, by the beneficiaries

Not applicable

50.3 Termination of the Agreement, by the Agency

50.3.1 Conditions

The Agency may terminate the Agreement, if:

(a) not applicable;

(b) a change to the beneficiary's legal, financial, technical, organisational or ownership situation or those of its third parties mentioned in Annex 1 is likely to substantially affect or delay the implementation of the action or calls into question the decision to award the grant;

(c) not applicable;

(d) implementation of the action is prevented by force majeure (see Article 51) or suspended by the beneficiary (see Article 49.1) and either:

  (i) resumption is impossible, or

  (ii) the necessary changes to the Agreement would call into question the decision awarding the grant or breach the principle of equal treatment of applicants;

(e) the beneficiary is declared bankrupt, being wound up, having its affairs administered by the

courts, has entered into an arrangement with creditors, has suspended business activities, or is subject to any other similar proceedings or procedures under national law;

(f) the beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has been found guilty of professional misconduct, proven by any means;

(g) the beneficiary does not comply with the applicable national law on taxes and social security;

(h) the action has lost scientific or technological relevance;

(i) not applicable;

(j) not applicable;

(k) the beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed fraud, corruption, or is involved in a criminal organisation, money laundering or any other illegal activity;

(l) the beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed:

(i) substantial errors, irregularities, fraud or

(ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles);

(m) the beneficiary (or the natural person who has the power to represent or take decisions on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2);

(n) despite a specific request by the Agency, the beneficiary does not request an amendment to the Agreement to end the participation of a partner organisationor an entity with a capital or legal link that is in one of the situations under points (e), (f), (g), (k), (l) or (m) and to reallocate its tasks;

(o) the beneficiary has not started the action or notified the effective starting date of the action within the period indicated in the Article 3;

(p) the researcher cannot continue implementing the research training activities, or has committed fraud, including submission of false information or failure to provide required information for the purpose of the action.

50.3.2 Procedure

Before terminating the Agreement, the Agency will formally notify the beneficiary:

- **informing** it of its intention to terminate and the reasons why and
- inviting it, within 30 days of receiving notification, to submit observations and — in case of

Point (l.ii) above — to inform the Agency of the measures to ensure compliance with the obligations under the Agreement.

If the Agency does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify to the beneficiary **confirmation** of the termination and the date it will take effect. Otherwise, it will formally notify that the procedure is not continued.

The termination will **take effect**:

- for terminations under Points (b), (e), (g), (h), (l.ii) and (o) above: on the day specified in the notification of the confirmation (see above);
- for terminations under Points (d), (f), (k), (l.i), (m), and (p) above: on the day after the notification of the confirmation is received by the beneficiary.

50.3.3 Effects

The beneficiary must — within 60 days from when termination takes effect — submit: the report under Article 20.3.

If the Agreement is terminated for breach of the obligation to submit report(s) (see Articles 20.8 and 50.3.1(l)), the beneficiary may not submit any report(s) after termination.

If the Agency does not receive the reports within the deadline (see above), only costs which are included in the report will be taken into account.

The Agency will **calculate** the final grant amount (see Article 5.3) and the balance (see Article 21.4) on the basis of the report(s) submitted. Only costs incurred until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

This does not affect the Agency's right to reduce the grant (see Article 43) or to impose administrative sanctions (Article 45).

The beneficiaries may not claim damages due to termination by the Agency (see Article 46).

After termination, the beneficiary's obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

SECTION 4 FORCE MAJEURE

ARTICLE 51 — FORCE MAJEURE

'Force majeure' means any situation or event that:

- prevents either party from fulfilling their obligations under the Agreement,
- was unforeseeable, exceptional situation and beyond the parties' control,
- was not due to error or negligence on their part (or on the part of third parties involved in the action), and
- proves to be inevitable in spite of exercising all due diligence.

The following cannot be invoked as force majeure:

- any default of a service, defect in equipment or material or delays in making them available, unless they stem directly from a relevant case of force majeure,
- labour disputes or strikes, or
- financial difficulties.

Any situation constituting force majeure must be formally notified to the other party without delay, stating the nature, likely duration and foreseeable effects.

The parties must immediately take all the necessary steps to limit any damage due to force majeure and do their best to resume implementation of the action as soon as possible.

The party prevented by force majeure from fulfilling its obligations under the Agreement cannot be considered in breach of them.

CHAPTER 7 FINAL PROVISIONS

ARTICLE 52 — COMMUNICATION BETWEEN THE PARTIES

52.1 Form and means of communication

Communication under the Agreement (information, requests, submissions, 'formal notifications', etc.) must:

- be made in writing and
- bear the number of the Agreement.

All communication must be made through the Participant Portal **electronic** exchange system and using the forms and templates provided there.

If — after the payment of the balance — the Agency finds that a formal notification was not accessed, a second formal notification will be made by registered post with proof of delivery ('formal notification on **paper**'). Deadlines will be calculated from the moment of the second notification.

Communications in the electronic exchange system must be made by persons authorised according to the Participant Portal Terms & Conditions. For naming the authorised persons, the beneficiary must have designated — before the signature of this Agreement — a 'legal entity appointed representative (LEAR)'. The role and tasks of the LEAR are stipulated in his/her appointment letter (see Participant Portal Terms & Conditions).

If the electronic exchange system is temporarily unavailable, instructions will be given on the Agency and the Commission websites.

52.2 Date of communication

Communications are considered to have been made when they are sent by the sending party (i.e. on the date and time they are sent through the electronic exchange system).

Formal notifications through the **electronic** exchange system are considered to have been made when they are received by the receiving party (i.e. on the date and time of acceptance by the receiving party, as indicated by the time stamp). A formal notification that has not been accepted within 10 days after sending is considered to have been accepted.

Formal notifications **on paper** sent by **registered post** with proof of delivery (only after the payment of the balance) are considered to have been made on either:

- the delivery date registered by the postal service or
- the deadline for collection at the post office.

If the electronic exchange system is temporarily unavailable, the sending party cannot be considered in breach of its obligation to send a communication within a specified deadline.

52.3 Addresses for communication

The **electronic** exchange system must be accessed via the following URL:

https://ec.europa.eu/research/participants/portal/desktop/en/projects/

The Agency will formally notify the beneficiary in advance any changes to this URL.

Formal notifications on paper (only after the payment of the balance) addressed **to the Agency** must be sent to the official mailing address indicated on the Agency's website.

Formal notifications on paper (only after the payment of the balance) addressed **to the beneficiary** must be sent to its legal address as specified in the Particiapnt Portal Beneficiary Register.

ARTICLE 53 — INTERPRETATION OF THE AGREEMENT

53.1 Precedence of the Terms and Conditions over the Annexes

The provisions in the Terms and Conditions of the Agreement take precedence over its Annexes.

Annex 2 takes precedence over Annex 1.

53.2 Privileges and immunities

Not applicable

ARTICLE 54 — CALCULATION OF PERIODS, DATES AND DEADLINES

In accordance with Regulation No 1182/71[14], periods expressed in days, months or years are calculated from the moment the triggering event occurs.

The day during which that event occurs is not considered as falling within the period.

ARTICLE 55 — AMENDMENTS TO THE AGREEMENT

[14] Regulation (EEC, Euratom) No 1182/71 of the Council of 3 June 1971 determining the rules applicable to periods, dates and time-limits (OJ L 124, 8.6.1971, p. 1).

55.1 Conditions

The Agreement may be amended, unless the amendment entails changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

Amendments may be requested by any of the parties.

The beneficiary may, in particular, request a change of the time spent on the action (part-time employment) for professional, personal or family reasons (including parental leave).

55.2 Procedure

The party requesting an amendment must formally notify a request to the other party (see Article 52).

The notification must include:

(a) the reasons why;

(b) the appropriate supporting documents.

The Agency may request additional information.

The party receiving the request must formally notify its agreement or disagreement, within 45 days of receiving notification (or any additional information the Agency has requested). This deadline may be extended, if necessary for the assessment of the request. If no notification is received within the deadline, the request is considered to have been rejected.

An amendment **enters into force** on the day of the signature by the Agency or the beneficiary, depending on which is later.

An amendment **takes effect** on the date agreed by the parties or, in the absence of such an agreement, on the date on which the amendment enters into force.

ARTICLE 56 — ACCESSION TO THE AGREEMENT

Not applicable

ARTICLE 56a — TRANSFER OF THE AGREEMENT TO A NEW BENEFICIARY

56a.1 Conditions

The beneficiary may request that the research training activities are transferred to a new beneficiary, if there are serious reasons affecting its capacity to implement the action (without being entitled to any additional EU funding for doing so).

56a.2 Procedure

The beneficiary must formally notify a **request for amendment** to the Agency (see Article 55).

The request must include:

- the reasons why;
- the date the change takes effect;
- the opinion of the researcher and its supervisor;
- a proposal for the necessary changes, including — if necessary — the appointment of the new supervisor and the Accession Form for the new beneficiary(see Annex 3).

The change **will take effec** on the day set out in the amendment.

56a.3 Effects

If the request for amendment is accepted by the Agency, the Agreement will be **amended** to introduce the necessary changes in order to reallocate the tasks of the former beneficiary (see Article 55).

In this case, the former beneficiary must:

- transfer immediately the remaining contribution to the new beneficiary and
- submit — within 30 days from the change — a '**transfer report**', containing an overview of the progress of the work and the individual financial statement (see Article 20).

The maximum grant amount will be split between the former beneficiary and the new beneficiary, on the basis of the number of actual units in line with Article 6.

The former and the new beneficiary must agree on arrangements concerning the management of intellectual property rights and other issues under the Agreement.

If the Agency considers that the reasons provided do not justify the transfer, it will reject the request specifying the grounds for the rejection.

ARTICLE 57 — APPLICABLE LAW AND SETTLEMENT OF DISPUTES

57.1 Applicable law

The Agreement is governed by the applicable EU law, supplemented, if necessary by the law of Belgium.

57.2 Dispute settlement

If a dispute concerning the interpretation, application or validity of the Agreement cannot be settled amicably, the General Court — or, on appeal, the Court of Justice of the European Union — has sole jurisdiction. Such actions must be brought under Article 272 of the Treaty on the Functioning of the EU (TFEU).

If a dispute concerns administrative sanctions, offsetting or an enforceable decision under Article 299 TFEU (see Articles 44, 45 and 46), the beneficiary must bring action before the General Court — or, on appeal, the Court of Justice of the European Union — under Article 263 TFEU. Actions against offsetting and enforceable decisions must be brought against the Commission (not against the Agency).

ARTICLE 58 — ENTRY INTO FORCE OF THE AGREEMENT

The Agreement will enter into force on the day of signature by the Agency or the beneficiary, depending on which is later.

SIGNATURES

For the beneficiary

LUCIA SORBA with ECAS id nsorbalu signed in the Participant Portal on 09/03/2021 at 11:53:13 (transaction id SigId-14585-r0Muc7SqE81giWhfSinsGu31NulmNPoHPzzsdU8H3DgfuERDGRAffQv4SZwtqAYLwzLB1WTYHh5SFQbbmQYPDUG-rS0vSrmBGYC1I1repCAzSs-2fSlXwGiCzXkLqFjg7PQzIvBBGZmYU24GJDN1DuYzT6cIilyuY4A8NViiy1QiIa9UnuwXCR5zGosPQqghrCEqgO). Timestamp by third party at 2021.03.09 11:53:20 CET

For the Agency

Signed by Kaisa Helena HELLEVUO with ECAS id helleka as an authorised representative on 11-03-2021 08:58:22 (transaction id SigId-3709-caO3tziLkplgRyZmsRQLmik71ZzMDzI4hSGIV5JAzNjMVGBJZbfipCcyFcSoVcAbjRKhRIYzrwph58Ro8HkhFqS-yntOf97TTHqOw27tDe3E5y-E4ZoPNLfCPXmqizTsvVbYDg9FoiZzLmTJrivjSydTbpziL0adTE8jnHRKUToHIBsr39aivMnctPUvezrjSzj1zY0) 2021.03.11 08:59:04 CET

EUROPEAN COMMISSION
Research Executive Agency

The Director

ANNEX 1 (part A)

Standard European Fellowships

NUMBER — 101022473 — SuperCONtacts

Table of Contents

1.1. The project summary....3
1.2. The list of beneficiaries....4
1.3. Workplan Tables - Detailed implementation....5
1.3.1. WT1 List of work packages....5
1.3.2. WT2 List of deliverables....6
1.3.3. WT3 Work package descriptions....7

1.1. The project summary

Project Number [1]	101022473	Project Acronym [2]	SuperCONtacts

One form per project

General information	
Project title [3]	Solid state diffusion for atomically sharp interfaces in semiconductor-superconductor hybrid structures
Starting date [4]	Start date to be notified; must lie within 12 months of grant agreement signature
Duration in months [5]	24
Call (part) identifier [6]	H2020-MSCA-IF-2020
Topic	MSCA-IF-2020 Individual Fellowships
Fixed EC Keywords	Semiconductors and insulators, Superconductivity, Low-temperature physics
Free keywords	solid state diffusion, Cooper pair injection, Josephson junction, quantum dot

Abstract [7]

The emerging field of superconducting optoelectronics has the potential to impact future quantum processing, communication and encryption. Hybrid light-emitting diodes exhibit emission of entangled photons enhanced by the superconducting state, while novel superconductor (Su) based lasers and quantum light sources have been proposed. Despite the amount of research done in semiconductor (Se) p-n physics and superconductivity, the practical integration between these two field of research is poor mainly due to the weak control of high quality Se/Su interfaces. This project proposes to overcome these limitations with a new fabrication technique, based on the metallic diffusion of metals in Se nanowires (NWs), for the realization of atomically sharp Su/Se interfaces with an epitaxial relationship.
Starting from a material search I will then investigate the Al (Tc~1K) diffusion into n-doped InAs NWs as well as V and Nb (all Tc>5 K) diffusion into InAs, Si, Ge and GAs NWs. The band structures and resulting contact types (Schottky or Ohmic) of the different material systems will be studied numerically and tested at cryogenic temperatures to find the best material combination. Doping of the nanowires will be tuned to demonstrate superconducting correlations in both p- and n-doped NWs, an essential step for the realization of superconducting diodes. Diffusion through in-situ (S)TEM heating experiments will allow me to control the Su/Se/Su junctions up to the ultimate limit of few nanometers. These ultra-short JJs will allow to enhance the superconducting correlations. Ballistic transport will be probed down to ultra-low temperatures (~10 mK). and the quantification of the mean free path and the quality of the interfaces will take place. By embedding these ultra-short JJs in a superconducting quantum interference device I will be able to control the intensity supercurrent as well as achieving ultimate magnetic-sensitivity ready for novel technological applications.

1.2. List of Beneficiaries

Project Number [1]	101022473	Project Acronym [2]	SuperCONtacts

List of Beneficiaries

No	Name	Short name	Country	Project entry month[8]	Project exit month
1	CONSIGLIO NAZIONALE DELLE RICERCHE	CNR	Italy	1	24

1.3. Workplan Tables - Detailed implementation

1.3.1. WT1 List of work packages

WP Number[9]	WP Title	Lead beneficiary[10]	Start month[12]	End month[13]
WP1	Data Management	1 - CNR	1	24

1.3.2. WT2 list of deliverables

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D1.1	Data Management Plan	WP1	1 - CNR	ORDP: Open Research Data Pilot	Confidential, only for members of the consortium (including the Commission Services)	6

1.3.3. WT3 Work package descriptions

Work package number [9]	WP1	**Lead beneficiary** [10]	1 - CNR
Work package title	Data Management		
Start month	1	**End month**	24

Objectives

To improve and maximise access to and re-use of research data generated by the action

Description of work and role of partners

WP1 - Data Management [Months: 1-24]
CNR
To develop a Data Management Plan, outlining how research data will be handled during the action, and after it is completed. The Plan is not a fixed document; it evolves and gains more precision and substance during the lifespan of the project.

Participation per Partner

Partner number and short name [10]

List of deliverables

Deliverable Number[14]	**Deliverable Title**	**Lead beneficiary**	**Type**[15]	**Dissemination level**[16]	**Due Date (in months)**[17]
D1.1	Data Management Plan	1 - CNR	ORDP: Open Research Data Pilot	Confidential, only for members of the consortium (including the Commission Services)	6

Description of deliverables

The Data Management Plan describes the data management life cycle for all data sets that will be collected, processed or generated by the action. It is a document describing what data will be collected, processed or generated and following what methodology and standards, whether and how this data will be shared and/or made open, and how it will be curated and preserved.

D1.1 : Data Management Plan [6]

The Data Management Plan describes the data management life cycle for all data sets that will be collected, processed or generated by the action. It is a document describing what data will be collected, processed or generated and following what methodology and standards, whether and how this data will be shared and/or made open, and how it will be curated and preserved.

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

2. Project acronym

Use the project acronym as given in the submitted proposal. It can generally not be changed. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

3. Project title

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

4. Starting date

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry into force of the Grant Agreement (NB : entry into force = signature by the Agency). Please note that if a fixed starting date is used, you will be required to provide a written justification.

5. Duration

Insert the duration of the project in full months.

6. Call (part) identifier

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

7. Abstract

8. Project Entry Month

The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

9. Work Package number

Work package number: WP1, WP2, WP3, ..., WPn

10. Lead beneficiary

This must be one of the beneficiaries in the grant (not a third party) - Number of the beneficiary leading the work in this work package

11. Person-months per work package

The total number of person-months allocated to each work package.

12. Start month

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

13. End month

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

14. Deliverable number

Deliverable numbers: D1 - Dn

15. Type

Please indicate the type of the deliverable using one of the following codes:

R	Document, report
DEM	Demonstrator, pilot, prototype
DEC	Websites, patent fillings, videos, etc.
OTHER	
ETHICS	Ethics requirement
ORDP	Open Research Data Pilot
DATA	data sets, microdata, etc.

16. Dissemination level

Please indicate the dissemination level using one of the following codes:

PU	Public
CO	Confidential, only for members of the consortium (including the Commission Services)
EU-RES	Classified Information: RESTREINT UE (Commission Decision 2005/444/EC)
EU-CON	Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC)
EU-SEC	Classified Information: SECRET UE (Commission Decision 2005/444/EC)

17. Delivery date for Deliverable

Month in which the deliverables will be available, month 1 marking the start date of the project, and all delivery dates being relative to this start date.

18. Milestone number

Milestone number:MS1, MS2, ..., MSn

19. Review number

Review number: RV1, RV2, ..., RVn

20. Installation Number

Number progressively the installations of a same infrastructure. An installation is a part of an infrastructure that could be used independently from the rest.

21. Installation country

Code of the country where the installation is located or IO if the access provider (the beneficiary or linked third party) is an international organization, an ERIC or a similar legal entity.

22. Type of access

TA-uc	if trans-national access with access costs declared on the basis of unit cost,
TA-ac	if trans-national access with access costs declared as actual costs, and
TA-cb	if trans-national access with access costs declared as a combination of actual costs and costs on the basis of unit cost,
VA-uc	if virtual access with access costs declared on the basis of unit cost,
VA-ac	if virtual access with access costs declared as actual costs, and
VA-cb	if virtual access with access costs declared as a combination of actual costs and costs on the basis of unit cost.

23. Access costs

Cost of the access provided under the project. For virtual access fill only the second column. For trans-national access fill one of the two columns or both according to the way access costs are declared. Trans-national access costs on the basis of unit cost will result from the unit cost by the quantity of access to be provided.

1. Excellence

1.1. Quality and credibility of the research / innovation project; level of novelty, appropriate consideration of inter-/multidisciplinary and gender aspects

Introduction

The emerging field of semiconductor-superconductor hybrid-structure physics is increasingly gaining momentum[1]. Building on the vast and application-oriented knowledge acquired in semiconductor physics in the last century, this new field combines it with the extraordinary properties described by superconductor physics, such as dissipation less current and electron coupling through Cooper pair formation. Theoretical proposals of novel devices capable of revolutionizing our life are plentiful. Most notably these are hybrid light-emitting diodes[2,3], novel superconductor-based lasers[4], entangled photon detectors[5] and quantum light sources[6,7] which have the potential to impact future quantum processing, communication and encryption. The p-n junction and quantum dot (QD) superconducting light sources can be based on the integration of Josephson junctions (JJs). These and superconductor coupled wave guides and photonic Bell-state analyzers are all based on contacting the superconducting material with one or two contact leads which form the connection between the superconductor and the semiconductor. They are the injection point of Cooper pairs into semiconductor and therewith the critical liaison between the two where the properties of one type of material can interact with those of the other material. The quality of the interface is therefore of utmost importance for the hybridization of the nanodevice. Up to now, major experimental problems occur in the fabrication of such high quality interfaces making the promises of superconducting light emitting sources far from reality.

In this project, I will fill this gap proposing a technology transfer of the solid-state diffusion technique from metal- to superconductor-interfaces with a semiconductor. Thanks to this technique, atomically sharp interfaces with an epitaxial relationship with the adjacent materials have been produced. Such clean and very controlled interfaces would be a big advancement for superconductor-semiconductor hybrid structures. I want to employ nanowires (NWs) as the semiconducting component which are already a well-established building block for this technique and very efficient for optoelectronic devices. Through this project it will be possible to make an important step towards the realization and control of JJs in n- and p-doped NWs. This will be essential to extend the knowledge of superconductor-semiconductor interfaces at the nanoscale and will provide a useful technique for future device miniaturization.There are still gaps in the experimental know-how in the field and with this project I propose a new fabrication protocol of superconductor-semiconductor material systems, a material selection which in the near future will allow the development of JJ-based devices (such as the superconducting quantum light sources or detectors) and novel outstanding devices which will significantly improve the state-of-the-art. It will therewith represent one important aspect towards the realization and commercialization of other semiconductor-superconductor structures.

State-of-the-art

Complementary metal-oxide-semiconductor (CMOS) transistor down-scaling has been a major driving force in the semiconductor industry and research. Silicidation which is a thermally activated solid-state diffusion reaction is a promising technique that has the potential to contribute in this field. Controlling the silicidation process allows the precise fabrication of short-channel devices advancing the downscaling of the transistor unit and improving the control of electrical contact quality. Silicidation consists of a replacement reaction. Through annealing, the contact metal intrudes into the silicon building block where it forms metal silicides (first pioneered with Si NWs and metallic NiSi[8] replacement diffusion). Their improved contact quality is due to atomically sharp metal–semiconductor interfaces. These were shown to have ideal resistivities of about 10 μΩ cm and remarkably high failure-current densities of $>10^8$ A cm^{-2}.

This solid-state diffusion through Joule heating has been experimented with and successfully extended from the Si-SiNi system to several other material systems such as

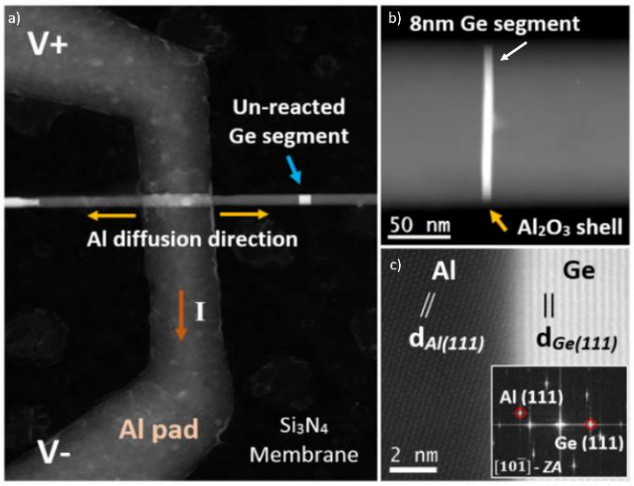


Fig.1. STEM micrographs of a Ge NW contacted by an Al lead. Ge can be seen as the bright and Al as the dark contrast. (a) Al diffusion from contact lead into NW (b) nm thick Ge segment within NW (c) Zoom-in to the Al-Ge interface, inset: diffraction pattern. (adapted from Luong et al. 2020)

[1] Bouscher, S., et al *J. Opt.* **2017** *19* 103003
[2] Sasakura, H., et al *Phys. Rev. Lett.* **2011** *107*, 157403
[3] Suemune, I., et al *Appl. Phys. Express* **2010** *3*, 054001
[4] Godschalk, F., et al *Phys. Rev. Lett.* **2011** *107*, 073901
[5] Sabag, E., et al *Phys. Rev. B* **2017** *95*, 094503
[6] Suemune, I., Jpn. J. Appl. Phys. **2006** *45*, 9264
[7] Khoshnegar, M., *Phys. Rev. B* **2011** *84*, 104504
[8] Wu, Y., et al *Nature* **2004**, *430* (6995), 61–65

Si–PtSi[9], Si–$CoSi_2$[10], Si–Pd[11], Si–Ti[11], Si–$Cu_3Si/CuSi_2$[12], Ge–Cu_3Ge[13], Ge–Mn[14], Ge–Al[15,16], ZnO–In[17], as well as GaAs-Au[18], GaAs–AuGa[19], GaAs–NiGeAu[20], GaAs–Ge/Ni/Ge/Au[21] and GaAs–Pd/Ge/Au[21] (given in the format 'NW material–diffused phase'). Epitaxial relationships have been observed in several systems, most notably in the Ge–Al material system where the solid-state diffusion leads to a monocrystalline Al phase which is in epitaxial relation with the remaining Ge NW (see Fig.1). This significantly improves the contact quality making it an "ideally clean" contact and allows the precise positioning of the sharp metallic interface in the NW (see Fig.1b).

The use of the solid-state diffusion technique for significantly improved interface quality and therewith also contact formation addresses one of the key issues in solving the experimental challenges of making very efficient hybrid devices, often limited by the interface barrier formation. Moreover, at the same time it will be the key to fabricating the ultra-short JJ itself. The use of this technique needs therefore to be extended to the family of superconducting materials. Due to a number of difficulties this has, not been done so far. The issues include: difficulties in experimentally mastering the use of more exotic materials which are superconducting, challenges in high resolution nanofabrication, lack of capabilities for in-situ SEM and (S)TEM heating experiments and also difficulties in testing different materials systems due to the unavailability of the suitable materials or of high-end cooling apparatuses such as dilution refrigerators for measuring superconducting materials with T_c significantly under 4 K.

Overview of the Action

The innovation in this project is the mastering of the solid-state diffusion technique and applying it beyond the classically used metal-semiconductor material systems, specifically to superconductor-semiconductor hybrid systems, which will give rise to an enormous improvement in the category of contact sensitive superconductor nanodevices. This enabling technology transfer can take place in conjunction with the NEST lab in Pisa and the CNRS lab in Grenoble and will be a playground for the study of fundamental physics as well as open up new opportunities for a number of applications.

For example, it will enable the realization of complex optoelectronic devices such as the structure shown in Fig.2 which consists of a JJ formed by a n-type doped, a QD and a p-doped part which will realize the emission of entangled photon pairs[22,23]. This QD-JJ structure is extremely challenging to realize and is the outlook for the successful completion of this project.

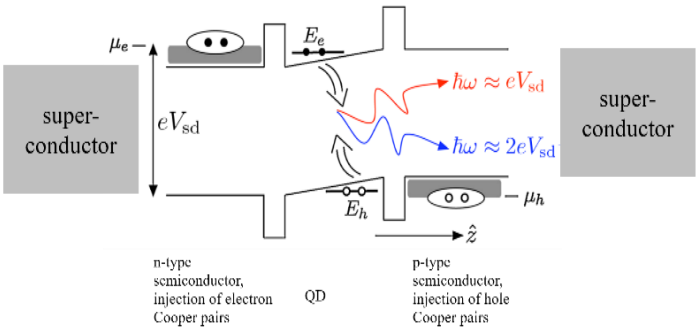


Fig.2. Potential heterostructure design for superconductor/ n-type semiconductor/ QD/ p-type semiconductor/ superconductor hybrid structures proposed for Josephson junction Light Emitting Diodes. (modified from Recher et al. 2010, Suemune et al. 2006)

The stepping stones towards the realization of this ultimate goal are the core of this project proposal. In work package WP1 a thorough material search will take place for suitable candidates of the superconducting and the semiconducting material and the necessary solid-state diffusion tests will be carried out. The gained knowledge will allow to proceed to WP2 wherein the most promising material systems will be used for the fabrication and characterization of the first JJ made by the solid-state diffusion technique. In WP3 the first NW p-doped JJ will be demonstrated. The subsequent WP4 will build on the knowledge and acquired know-how and comprises investigations of the current phase relationships of the fabricated JJs via a SQUID interferometer that will implement an ultra-sensitive magnetometer.

Objectives of the Action

SuperCONtacts aims to pursue the following the work packages (WP):

WP 1. Material search for suitable candidates of the superconducting and the semiconducting material and the necessary solid-state diffusion tests:

The starting point of this project will involve experimentally known materials, which are individually well understood. These first tests will be done with Al diffusion into n-doped InAs NWs. This one is especially interesting because Al is a successful contacting metal in hybrid JJ fabrication. Through earlier works it is known that at the

[9] Lin, Y.-C., et al *Nano Lett.* **2008**, *8* (3), 913–918
[10] Chou, Y.-C., et al *Nano Lett.* **2008**, *8* (8), 2194–2199
[11] Dellas, N. S. PhD thesis **2011**
[12] Holmberg, V.C., et al *Nano Lett.* **2011**, *11* (9), 3803–3808
[13] Burchhart, T., et al *Nano Lett.* **2009**, *9* (11), 3739–3742
[14] Lensch-Falk, J. L et al *Nano Lett.* **2008**, *8* (9), 2669–2673
[15] Kral, S.; *Nano Lett.* **2015**, *15* (7), 4783–4787
[16] Luong, M. A. et al *ACS Appl. Nano Mater.* **2020**, *3* (2), 1891–1899
[17] Wang, S.-C. et al *Nano Lett.* **2014**, *14* (6), 3241–3246
[18] Fauske, V. T. et al *Nano Lett.* **2016**, *16* (5), 3051–3057
[19] Orrù, M. et al *Phys. Rev. Appl.* **2015**, *4* (4), 044010
[20] Orrù, M. et al *Semicond. Sci. Technol.* **2014**, *29* (5), 054001
[21] Gutsche, C. et al *J. Appl. Phys.* **2011**, *110* (1), 014305
[23] Recher, P., et al *Phys. Rev. Lett.***2010** *104*, 156802

Al/InAs interface the work functions of these two materials form a favorable non-Schottky contact[24,25]. By comparing the JJs obtained with the diffusion technique with the conventional ones, I will be able to establish the quality of this novel technique and demonstrate the improved miniaturization of the junctions (see below).

After that, the project endeavors into undiscovered realms of material search. The most promising material, which also has not been studied yet, is vanadium (V) diffusion. V has a critical superconducting temperature (T_c) of 5.13 K and is therewith interesting for applications that are liquid He-cooled, much more appealing than the Al technologies working at ~1 K. As can be seen in the phase diagram in Fig. 3, V is expected to form a monocrystalline phase upon diffusion into InAs, similar to the replacement process taking place in Al-Ge, which forms atomically sharp interfaces. V has been successfully implemented into other applications at NEST institute where the deposition and use of the material is well mastered for hybrid InAs superconducting devices[26] InAs NWs can be grown with high crystalline quality at NEST. P-type and n-type doping, as well as p-n junction structures and QD structures with InP and InAsP can be grown, making this an ideal platform for the project. At NEST the possibility to annealing metal-NW structures is given[27,28].

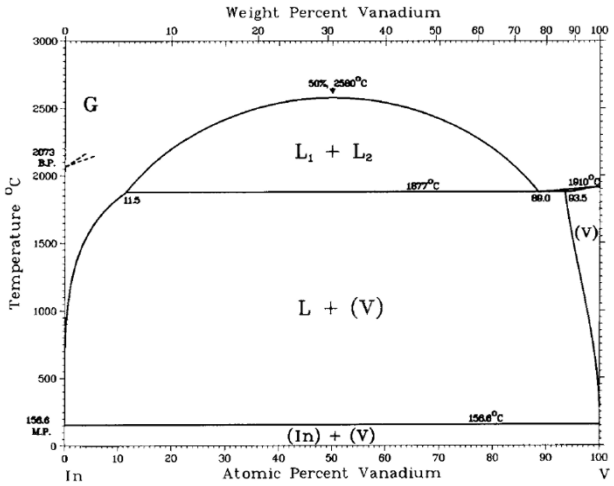


Fig.3. Vanadium-Indium phase diagram (from Smith et al. 1985).

In the same manner, four other promising material systems will be investigated and the most promising and controllable of the six will be chosen for the next steps of the project. Other NW candidates that are considered, are well understood and available in our lab or through our collaboration are: Si, GaAs and Ge. Diffusion of V into Si, GaAs and Ge NWs is proposed due to the high T_c of resulting alloy phases (16.8 K, 14.1 K, 6.9 K for V_3Si, V_3Ga, V_3Ge respectively) and the readily available know-how of the n- and p-type doping of the Si, GaAs and Ge NWs. The respective phase diagrams likewise suggest a good likelihood of formation of the desired alloy phases. Candidate five is Nb diffusion into Ge NWs which has an equally good phase diagram and is extremely promising due to the high T_c of Nb_3Ge of 22 K. At NEST lab experience with Nb layers is also present and will be built upon in this project. Higher T_c devices are desirable due to the dropping costs of measurement setups by two orders of magnitude.

WP 2. Ultra-short JJ: Fabrication and characterization of the first JJ with the solid-state diffusion technique

Application of the technology transfer. After the first crucial tests and the decision which materials to continue with, the project proceeds to WP2. **Fabrication:** Here the first in-NW JJ fabricated through the solid-state diffusion technique will be realized. This will be especially interesting because the solid-state diffusion technique will open up the possibility of making ultra-short and ultra-clean interface JJs which have so far not been realized, yet are extremely interesting for outstanding device applications. In fact, the sharp interface will allow, for the first time, the realization of JJs with well-defined length and much shorter (<10 nm) than the typical NW mean free path (~30 nm) and the superconducting coherence length (~100 nm for Al). This will be possible through the collaboration with CNRS Grenoble and the in-situ (Scanning) Transmission Electron Microscopy ((S)TEM) heating experiments mastered there[29]. I already demonstrated the full control of the diffusion length, interface position and JJ length.

Characterization: The measurement of the super current across the JJ will be carried out which allows the extraction of the critical current I_c. From the temperature evolution of $I_c(T)$ is possible to distinguish between the ballistic and diffusive nature of the transport in the NW. Also the scaling of both the normal state resistance and $I_c(T)$ as a function of the length of the NW will provide important insight on the transport properties of the JJ including the transmission probability and mean free path. Moreover, via multi-terminal devices will be possible to quantify the interface resistance obtained with this technique.

WP 3. Demonstration of first p-doped JJ:

The bottleneck of a p-type semiconductor contact to a JJ is a crucial point in the development of several hybrid superconductor-semiconductor heterostructures. Problems arise due to the formation of oxide layers on the semiconductor surface, depleted surface states and/ or mismatches of the work functions and Fermi levels. Most of these issues can be circumvented by using the solid-state diffusion technique where only the intrinsic band structure differences between the semiconductor and the superconductor remain. It is critical to achieve an Ohmic contact between the different components of the superconductor-semiconductor hybrid structure in order to guarantee that

[24] Strambini, E. et al *Nat. Nanotechnol.* **2020**, *15* (8), 6560660
[25] Tiira, J. et al *Nat. Commun.* **2017**, *8*(1), 1494
[26] Giazotto, F. et al *Nat. Phys.* **2011**, *7* (11), 857–861
[27] David, J., et al *Nano Lett.* **2017** *17* 4, 2336–2341
[28] Rossella, F., *Nano Lett.* **2016** *16* 9, 5521–5527
[29] Spies, M. et al *Nanotechnology* **2020**, *31*(47), 472001

the device functionality is not disrupted by a Schottky-type potential barrier, or at least, that the Schottky barrier is minimized to still allow the injection of Cooper pairs. The most successful contacting schemes yielding Ohmic contacts in the case of p-InAs have been done with Ti/Pt[30,31] Pt/Au[32] and in p-InP NWs through a gradual interface based on p-doped InAsP with Ti/Pt/Au[33] The presence of a Schottky barrier e.g. in InAs – Al as a function of the Zn dopant in the NW will be explored. The barrier should disappear at large doping levels[33]. Experiments have also been done with V in multilayer architectures on p-InAsP[34]. To the best of my knowledge, no studies have worked on characterizing the contact type between plain V and p-doped GaAs, Si or Ge or Nb and p-doped Ge. The work functions of the different involved materials will be simulated with help of a materials science theorist at the host institution having an expertise in such calculations and the respective contacts characterized experimentally. Realizing an Ohmic p-type contact with a JJ is an important stepping stone towards hybrid superconductor-semiconductor structures. Together with the achievements of WP2 this gives two essential components: the p-type contact and an ultra-short junction. The same fabrication and characterization steps outlined in WP2 will be repeated with p-doped NWs for the experimental part of WP3.

WP 4. Current-phase relationships for short JJs towards an ultra-sensitive magnetometer:

The quality of the interfaces and the smallness of the JJ investigated in WP2 will be further studied in WP4 with a superconducting quantum interference device (SQUID). It is expected that in the very short limit the simple sinusoidal-like current phase relation (CΦR) of a JJ evolves towards a very skewed current phase relation[35]. This peculiar function can be detected from the evolution of the critical current of a SQUID interferometer as a function of the magnetic fluxthanks to the the ring interferometer. Such a distortion will not only demonstrate the short limit achieved with the developed technique but will also strongly improve the sensitivity of the interferometer to magnetic fields. Conventional SQUID are already the state-of-the-art of sensitive magnetometers essential for the detection of very low levels of magnetic fields which are already applied in medicine (magnetoencephalography, magnetic field imaging in cardiology, magnetic marker monitoring, magnetogastrography, magnetic resonance imaging), manufacturing industry (magnetic property measurement systems) and astronomy (cold dark matter search) and will be improved through the work of this project.

The successful fulfillment of WP4 will lead to patenting a new state-of-the-art magnetometer.

For these very advanced magnetometers a few possible geometries that will be tested are given in Fig.4. but the ideas are not limited to those and will be explored during the project. The area where the magnetic flux is measured by the SQUID is the region circled by a dotted green line. During this WP4 the interface quality of the solid-state diffused superconductor and the semiconductor material constituting the JJs in the NW is investigated while, at the same time, fabricating and characterizing a novel ultra-sensitive magnetometer.

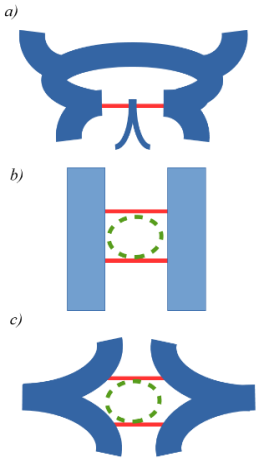


Fig.4. Potential geometries for the SQUID structures explored in WP4. (a) one NW geometry (b-c) two NW geometry.

Research methodology and approach

The research outlined above is based on two major concepts: the solid-state diffusion technique and the realization of ultra-short in-NW JJs and related novel SQUID structures.

The solid-state diffusion technique: It has been pioneered with silicides especially for CMOS technology and has been mastered in Grenoble at CNRS for the Si-Al and Ge-Cu systems. I will be able to access and built upon that knowledge and know-how accumulated at the collaborating institution. Depending on the phase relationships between the involved elements, single element or alloy phases can form within the formerly semiconducting structure. The interesting aspect for applications is that this replacement process happens with a smooth and ordered layer-by-layer fashion, making and displacing an atomically sharp interface. Through the application of mentioned bias a controlled interface position can be chosen. This allows tailor-made nanodevices with atomically sharp interfaces which are highly interesting for a number of applications.

The innovation of this project is extending the already used diffusing metals to superconducting and higher T_c (>5 K) superconducting materials. These will open up the path to the development of ballistic JJs and highly sensitive magnetometers based on those JJs.

The ultra-short in-NW JJ and novel ultra-sensitive SQUID structures: Different JJ architectures have intensively been investigated by Dr. Elia Strambini and Dr. Giazotto, with promising applications e.g. as a phase battery[36], heat

[30] Katz, A. et al *J. Appl. Phys.* **1990**, *68* (8), 4141–4150
[31] Katz, A et al *J. Vac. Sci. Technol. B Microelectron. Process. Phenom.* **1990**, *8* (5), 1125–1127
[32] Lysczek, E. M. et al *Electron. Lett.* **2003**, *39* (25), 1866–1868
[33] Cavalli, A. et al *Nano Lett.* **2016**, *16* (5), 3071–3077
[34] Wang, S. H. et al. *J. Electrochem. Soc.* **2006**, *153* (5), G479
[35] Golubov, A.A. et al *Rev. Mod. Phys.* **2004**, *76* (2), 411-469
[36] Strambini, E. et al *Nat. Nanotechnol.* **2020**, *15* (8), 656–660

interferometer[37], quantum electron pump[26] and others. I will be able to build upon their knowledge and experience during my time in their group.

A JJ is based on the Josephson effect which describes the supercurrent from one superconductor to another if they are sufficiently close and separated solely by a weak link (which can be of varied nature). This current flows indefinitely without the application of a bias. The fabrication of an ultra-short JJs which is much smaller than the electron mean-free path of the semiconducting NW (~30 nm) and the coherence length (~ 100 nm) will allow realizing a highly sensitive SQUID. It will also allow the investigation of the Josephson physics in new attractive regimes, like ballistic transport and short-junction regime, which are very appealing also for other quantum technological aspects[36] e.g the Andreev bound-states qubits[38] or the implementation of exotic Majorana modes[39]. With the techniques explored and developed in this project their sensitivity will be increased through the ultra-short JJ and the improved interface qualities.

Originality and innovative aspects

Furthering the state-of-the-art, the novelty of this project builds on solid-state diffusion of "high" T_c superconducting materials into semiconducting nanostructures. The innovation is to bring the improved contact quality from semiconductor physics to the superconductor field where one of the most limiting factors of superconductor-normal material-superconductor devices will be tackled. Within the superconductor field the opportunity to fabricate atomically sharp and even epitaxial interfaces will revolutionize the fabrication and development of many contact sensitive devices. These will significantly contribute towards quantum computation, encryption and communication.

Interdisciplinary aspects

This experimental research project is a fundamentally interdisciplinary undertaking. Its interdisciplinary nature is fueled by the expertise of its different contributing members and comprises fields of condensed matter and applied physics such as low temperature, superconductor and semiconductor physics, electronics, material science and crystallography as well as nanofabrication and -engineering. This Marie Sklodovska Curie fellowship will enable me to bring together the existing theoretical and experimental knowledge relating to cutting-edge entangled photon emission devices and it will give me the opportunity to establish the missing links between the fields.

1.2. Quality and appropriateness of the training and of the two way transfer of knowledge between the researcher and the host

The proposed project is a win-win situation for both of the cooperating parties.

The experienced researcher will contribute significantly at the host institution. The solid-state diffusion technique is an enabling technology opening up a wide array of applications especially in the realm of hybrid superconducting nano-devices. This technology requires significant specific background knowledge that the experience researcher has. These include the fabrication of state-of-the-art in-situ (S)TEM devices starting from the fabrication of the fundamental building block of a silicon nitride membrane indispensable to carry out in-situ (S)TEM experiments, to the successful specimen placement and electrical contacting of it, the electrical ex-situ and in-situ characterization all the way to in-situ (S)TEM heating experiments which lead to the solid-state replacement reaction. These are valuable skills that the experienced researcher has, which are currently not present at the host institution. They will, however, be of significant impact at the host institute because the technology enables a significant change for the contact sensitive superconductor-normal material-superconductor devices that are investigated at the host institute. The atomic control of the superdonductor diffusion will enable the realization of ultra-small Josephson junction. Besides the proposed project, the transfer of knowledge will therefore impact also other and future projects at the host institute already well established in the physics of hybrid JJs.

In return the experienced researcher will benefit enormously from the experience, theoretical understanding and experimental know-how concerning electronic superconducting devices as well as from the cutting-edge lab facilities in the superconducting quantum electronics group, such as the several dilution fridges and the ultra-low noise electrical setups. I will be able to acquire and deepen my understanding in the following areas:

Superconductor physics: I will be trained in the field of superconducting physics which is the main expertise of the hosting lab. Especially the theoretical understanding and the experimental techniques related to JJ measurements and SQUID sensitivity quantification will widen my horizons.

Superconducting electronic transport characterization: I will advance my skills of transport measurements at the host institute which has world-renowned expertise in the field of superconducting electronics. I will be trained in low temperature and transport measurements with dilution fridges (T<10 mK), and low noise electrical setups (<pA).

Fabrication of superconducting-semiconducting heterostructures: The host institution has shown mastery of superconductor-based nano-devices of different materials such as Ti, V, Nb and Pb. It will give me the opportunity

[37] Giazotto, F., et al *Nature* **2012** *492* 401–405

[38] https://jqi.umd.edu/sites/default/files/andreev_qubit_-_bretheau.pdf

[39] Zhang. H., *Nature Comm.* **2017** *8* 16025

to extend my experience of semiconductor device fabrication to more complex material systems such as superconducting-semiconducting heterostructures.

1.3. Quality of the supervision and of the integration in the team/ institution

The National Enterprise of NanoScience and NanoTechnology (NEST lab) is an excellent lab with many interdisciplinary branches which is built on the participation of three different scientific institutions: the Italian National Research Center (CNR), the Instituto Italiano di Tecnologia (IIT) and the Scuala Normale Superiore di Pisa (SNS). Scientists within NEST freely collaborate between these institutes. The CNR-Nano is devoted to frontier research in nanoscience and nanotechnology located in SNS, a highly-selective public institution of university education. SNS secures a good participation of young graduate and undergraduate students to the Institute research activities. Moreover, the team of superconductivity (SQEL http://web.nano.cnr.it/sqel/) have already demonstrated the ability to integrate young scientists and PhDs coming from different European countries. I have already had the opportunity to integrate into the team with the start of my current PostDoc position in July 2020. At the start of the Marie Sklodovka Curie project I will already be well established in and familiar with the host institution.

Qualifications and experience of the host supervisors

Dr. Elia Stambini has an outstanding experience in nanofabrication and cryogenic electrical characterization of mesoscopic systems at low dimensionality including ballistic and diffusive semiconductors, metals and hybrid superconducting/magnetic devices. After a PhD and a postdoctoral fellowship at Scuola Normale Superiore in Pisa (2005-2011) he joined the MESA+ Institute of Nanoelectronics in Twente with a three-year postdoctoral fellowships (2010-2014). He was awarded a personal Marie Sklodovska Curie grant used to begin his own project at Nano-CNR in Pisa where he was appointed as researcher (2014-Present). Today he is responsible of the laboratories of superconductivity at NEST, he is supervising the postdocs and PhDs of the SQEL group and he is responsible of various national and international grants.

Dr. Francesco Giazotto is a research scientist (permanent, III livello, II fascia) at NEST Istituto Nanoscienze-CNR, Pisa, Italy. He co-authored 121 scientific publications and 2 patents (H-index: Google Scholar 38). He gave 75 invited talks at international conferences and universities. He is the group leader of a research group which consists of 15 persons including master students (2), PhD students (4), postdoc researchers (3 out of which 2 are MSC fellows), temporary research scientists (3) and research scientists (2). His main research interests are: Quantum Transport and electronic properties of low dimensional hybrid heterostructures; Quantum technology; Non-equilibrium effects in hybrid nanostructures; Thermal effects in mesoscopic systems; Spin-dependent phenomena in equilibrium and out-of-equilibrium hybrid systems; Spin-orbit interaction in two-dimensional electron gases; Josephson effect in out-of-equilibrium systems; Phase-coherent thermal effects at the nanoscale; Quantum magnetometry; Superconducting spintronic; THz radiation detection.

Qualifications and experience of the collaboration partner

CNRS Institut Neel Grenoble is an internationally competitive solid state physics research lab. It hosts leading experts in low temperature research, electronic properties of solids, magnetism and crystallography. It is closely tied to and continually recruiting students from the University Grenoble-Alpe. In the last five years more than 2000 publications originated from the researchers of the institute. 5(+4) ERC grants, 12(+28) other EU grants and 68(+71) nationals grants were awarded as the main (collaborating) institute. 174 PhD degrees and 117 habilitations were awarded. In total, 280 permanent researchers were employed as well as 127 postdoctoral researchers and 70 visiting researchers.

Dr. Martien den Hertog has longstanding experience with high-end (S)TEM characterization techniques, the carrying out of in-situ (S)TEM experiments on nanostructures and is an internationally recognized scientist. She studied Chemistry at the University of Utrecht, Netherlands from 2000 to 2005, with a Master entitled 'Chemistry and Physics'. She performed her PhD at CEA-Grenoble, France from 2006-2009 under supervision of Jean-Luc Rouviere entitled 'Characterization of silicon nanowires by transmission electron microscopy'. She performed her postdoctoral research on TEM of II-VI Nanowires at French National Center for Research CNRS Institut Neel in Grenoble, where she is a permanent research scientist since 2010. She obtained her Habilitation as research supervisor (HDR) in 2018 from the University of Grenoble. Her research focused on the correlation of Transmission Electron Microscopy based techniques with optical and electrical characterization on the same single semiconductor nanowire and develop electrical in-situ TEM. She is author or co-author of more than 75 publications in international journals (H=20 WoS), 1 book chapter, more than 15 invited presentations and 1 patent. She supervised 6 PhD, 4(+2 underway) PostDoc and 4 MSc, 4 BSc students as well as an ERASMUS student. She has been principal investigator of a young researcher ANR project (COSMOS), two local projects and a PHC project with the technical University of Vienna, and was awarded an ERC-Starting Grant that began in 2018. Additionally, she was involved in six other ANR projects. In 2019 she has been awarded the Bronze Medal of CNRS due to her research activities in correlated and in-situ TEM experiments.

1.4. Potential of the researcher to reach or re-enforce professional maturity/ independence during the fellowship

In the past I have demonstrated a high level of independence through studying abroad for four years in the USA while being an internationally competitive athlete (participating as highly as Olympic Trials and medaling at national championships) and subsequently another four years again abroad this time in France. During those times I also published my first papers in top-level international peer reviewed journals which now accumulate to be 13, out of which I am first-author on 5 (see CV) and started to participate in and give talks at international conferences. This competitive and scientific background will benefit me during the PostDoc fellowship and beyond.
The Marie Sklodovska Curie fellowship will allow me to reinforce my professional maturity and independence in several ways. I will extend my knowledge of the state-of-the-art to superconductor physics and electronics and their device applications. It will join my background in semiconductor physics and material sciences which will make me become an interdisciplinary and well-rounded scientist. I will also get trained in further experimental techniques most notably low temperature transport measurements of superconducting devices. The PostDoc fellowship will likewise allow me to start and lead my own research project. This will be a major opportunity for me to work maturely and independently while being hosted at an excellent European research institute. These experiences will allow me to strategically position myself for an independent research position within the European Union. The collaborations born out of this project will continue to accompany and support me on my way to such a position. I will furthermore be able to draw from the existing collaborations of the host institute comprising expert scientists around the world in order to extend my own research network.

2. Impact

2.1. Enhancing the future of career prospects of the researcher after the fellowship

My career goal is obtaining an independent and permanent research position in one of Europe's leading institutes or alternatively a permanent research position in the high-tech sector. Obtaining the prestigious Marie Sklodovska Curie fellowship will allow me to make several big steps towards these ambitious career development goals.
Recently, I made significant contributions to the field of correlated structural and electro-optical studies, especially on single semiconductor NW structures during my PhD project between the groups of Dr. Martien den Hertog, Dr. Eva Monroy and Dr. Bruno Gayral at CEA and CNRS in Grenoble, France. Besides acquiring significant know-how in semiconductor physics, nano-device fabrication and characterization, I gained important experience in managing the interplay of several scientific experts on a single project. The MSC project will constitute an important step in advancing my scientific and non-scientific skills. It will therewith impact my career enormously and propel me towards a permanent position in a leading European research institute or the high-tech sector. Specifically, it will impact the following areas:
International experience: With this PostDoc project I will be able to strengthen the ties between two major European labs while placing myself in a key position of the collaboration. The resulting collaboration as well as existing collaboration of both of the involved institutes will help me expand my scientific research network. This will be very useful in my future as a leading researcher. It will likewise broaden my scientific awareness and cultural skills which will be important in the context of international working environments.
Cutting-edge research: The proposed project tackles several of the main bottlenecks hampering the development of solid-state single entangled photon emitters. While these have theoretically been proposed in the past, their experimental realization is still lacking. The successful demonstration of ballistic JJs through the solid-state diffusion technique as well as p-type conductance in JJs are two great steps towards the realization of this goal which will eventually lead to new paradigms in quantum communication, processing and encryption. Additionally, the demonstration of a novel ultra-sensitive magnetometer based on the JJs fabricated with the here elaborated technique will enhance the current state-of-the-art in that field and open up opportunities of further applications.
Project management: Handling and conceiving complicated and large experiments is a valuable skill to have in modern scientific research. This Marie Sklodovska Curie fellowship will allow me to do so. I will likewise play a key role in the collaboration of two of Europe's leading solid-state physics research labs. That will allow me to acquire strong coordination and communication skills which are so valuable nowadays, as well as leadership and project management skills. It will give me the opportunity to enlarge my scientific community network and widen my opportunities for further collaborations with internationally recognized labs.
New career perspectives: After successful completion of the MSC project the foundations are laid for the JJ-LED. It will put me into an excellent position to apply for an ERC starting grant from the European Union, which would provide the necessary funding for starting a fully independent research line led by myself. My research interests fit very well into the Quantum Technologies Flagship launched in 2018 which opens up many opportunities for the mentioned research. With grant as prestigious as the MSC, I would be able to continue on the realization of the superconductor-semiconductor hybrid structures proposed Nazarov et al. and even proceed to the optical measurements necessary to prove emission of entangled photon pairs. I would be able to carry out such research at different host institutes, such as the CNR-Nano, IIT or SNS in Pisa or CNRS Néel in Grenoble. It would likewise put me into a great position to obtain a permanent research position in one of the aforementioned research labs.

As an alternative, the MSC project would put me into a great position to work for a company in the international high-tech sector. It would make me be a promising candidate for European cutting-edge companies such as Single Quantum (by Prof. Val Zwiller, the leading single photon detector company), Leiden Cryogenics (the leading dilution fridge producer), SupraCon (leading SQUID and microfabrication company) or MAGNICON (world-leader in high-performance SQUID electronics, low-noise SQUID sensors and customized SQUID systems). The last two are based in Germany, where due to my proficiency in my native language German, I will be able to integrate easily.

2.2. Quality of the proposed measures to exploit and disseminate the project results

Dissemination and exploitation of generated knowledge: The results of the different work packages will be published in international peer-reviewed journals which have high impact factors such as Nature, Science, NanoLetters, Physical Review B and Applied Physics Letters. The funding of the Marie Sklodovska Curie project will gladly and clearly be communicated. That way, the relevant peers from the scientific community, as well as from industry and professional organizations are communicated with. This step will be enhanced by attending relevant scientific conferences and workshops as well as specific seminars where the research results will be presented and face-to-face dissemination will take place. In accordance with the "Dissemination and Exploitation section of the Horizon 2020" framework, the research results of this project will be openly accessible on the websites on the host and collaborating institutions as well as on open access platforms such as "ArXiV", "ResearchGate" and "LinkedIn". Especially on the latter two, a specific thread concerning this Marie Sklodovska Curie project will be opened and regularly updated. That way peers, relevant cooperators and interested people can follow the evolution of the research.

Intellectual Property Rights: Whenever possible, the successful results of the project will be protected by the filing of an (inter-)national patent. I will be supported in such a step by the Intellectual Property Department of the host institute and the expertise of the SQEL group already owning different patents on superconducting technologies.

2.3. Quality of the proposed measures to communicate the project activities to different target audiences

The city of Pisa has a history of providing a liberal, science-friendly environment. Those can still be observed today as a number of scientific outreach activities are regularly proposed, as well as by the presence of the most talented students at the Scuola Normale. Technological advances and scientific findings find a platform for communication in events such as the European Researcher's Night, Pint of Science and scientific expositions such as the one at Palazzo BLU. These will provide excellent platforms for public outreach where I will be able to communicate my research and the projects results and goals with a public of diverse backgrounds. The host institution's prestige also attracts attention from communication channels such as radio, television and online magazines. It will further give me the opportunity to spread the knowledge about my scientific findings. Besides these, the ongoing advancements of the project will obviously be published on the host organization's own website.

3. Quality and Efficiency of the Implementation

GANTT CHART

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Work Packages								1					2				3							4
Deliverable							1	1					2				3							4
Milestone								1									2							
Secondment																								
Conference																								
Seminar																								
Dissemination																								
Public engagement																								
Risk management																								
IPR																								

3.1. Coherence and Effectiveness of the work plan, including appropriateness of the allocation of tasks and resources

The two-year work plan is outlined in the following. It will be carried out by a team consisting of Dr. Giazotto (group leader), Dr. Strambini (supervisor), me as a Marie Sklodovska Curie fellow and if possible two Master's students, which I will supervise and train, in the process.

WP 1. (month 1-8): Material search for suitable candidates of the superconducting and the semiconducting material and the necessary solid state diffusion tests:

Months 1-3. The first tests will be done with Al (T_c~1K) diffusion into n-doped InAs NWs. The components are individually well understood and through previous tests the formation of a non-Schottky contact is known for heavily doped Nanowires. Nanowires are already grown and available at the host institution.

Months 3-8. The following tests will be with higher (>5 K) T_c superconductors. Tests 2-5 consist of V diffusion into InAs, Si, GaAs and Ge NWs, respectively. Diffusion of V into Si, GaAs and Ge NWs is proposed due to the high T_c of resulting alloy phases (16.8 K, 14.1 K, 6.9 K for V_3Si, V_3Ga, V_3Ge respectively). Test 6 is Nb diffusion into Ge NWs which is extremely promising due to its high T_c of 22K.

The tasks of this work package will be carried out in three steps (outlined below) for each proposed material system:

Task 1: In-situ SEM-based heating experiments with most promising material systems. This step will be carried out on standard substrates, e.g. Si wafers. The superconducting material will be evaporated onto the substrate in the shape of contact pads. Subsequently, NWs will be drop cast or mechanically dispersed onto the substrate surface. Observation of the resulting sample will follow employing an SEM. Then contacting of individual NWs with electron beam lithography will be carried out. At this point the sample is ready for in-situ SEM Joule heating experiments through the contacts (through the use of IMINA micromanipulators inside the SEM which are present at the host institution). The solid state diffusion of the superconducting material into the semiconducting NW can be observed live and be chemically quantified through in-SEM EDX measurements. The diffusion dynamics will be characterized in this step. They include diffusion reaction onset, speed and regularity of propagation and the chemical composition of resulting propagated material. These steps constitute the experimental basis of this project.

Task 2: SEM-based sample processing on (S)TEM-compatible membrane chips and observation in (S)TEM. Once the most promising material system has been determined the experiments will be repeated on (S)TEM compatible membranes[29]. This will allow observation of the resulting heterostructured NW in (S)TEM. The exact position of the diffusion interface, crystal orientation of the propagated and the original material as well as higher resolution chemical EDX quantification of the newly diffused phase will be determined.

Task 3: Electrical characterizations of the interfaces

For all the combination of materials, samples will be processed with four or more contacts[25]. In these samples, it will be possible to measure the interface resistance by comparing the four wire with the two or three wire characterizations performed first at room temperature and then at low temperature for the most promising devices. The low temperature characterizations will allow me to quantify also the critical temperature T_c of the processed compounds. The contact types (Schottky, Ohmic) will likewise be explored numerically with nextnano[3] and COMSOL simulation tools.

At the end of WP1 a fabrication report summarizing the experimental work will be drafted. It is the first deliverable D1.1. Furthermore, a material science focused publication deliverable D1.2 about the contact formation and the diffusion processes of the different material systems will be written. A point of decision-making arises then: Milestone M1 will be the moment where the most suitable material system will be chosen for the further proceeding of the project. With the perspective of a mass production of this technology the environmental impact of each material will be considered and will pay an important role in the decision.

WP 2. Fabrication and characterization of the first JJ with the solid state diffusion technique:

Months 9-10:

Task 1: (partial secondment) In-situ S(T)EM-based preparation of first and also very short JJ. Superconducting metal diffusion into the semiconducting NW will be carried out in order to attain a very short JJ. The sample preparation will be done at the host institution and the in-situ heating experiment at Institut Néel Grenoble. The in-situ (S)TEM heating experiment will allow live observation and immediate control of diffusion lengths for achieving the JJ, as well as higher resolution chemical quantification of the diffused material through TEM-EDX. It will allow full control over the metal diffusion into the semiconducting NW and therewith a precise control of the diffusion length and interface position will be achieved.

Months 11-13:

Task 2: Low temperature, low noise conductance measurements. After the successful fabrication of an ultra-short JJ through the in-situ (S)TEM heating experiments the junction will be characterized in the low temperature and low noise transport setups at the host institute. The measurement of the super current I_s across the JJ will be carried out in order to extract the critical current I_c as a function of temperature (T) and magnetic fields (B). Within these ultra-short JJs ballistic transport is expected and will be confirmed by the $I_c(T)$ evolution. Moreover, the scaling of $I_c(T)$ for the samples of different lengths will allow to quantify the mean free path and the quality of the interfaces. For this porpoise multi terminal devices will be fabricate on the same NW to maintain the reproducibility on the semiconducting characteristics. Finally, the evolution of $I_c(B)$ in a vectorial magnetic field will allow me to investigate the anomalous JJ and the impact of the magnetic field in these ultra-short junctions.

The fabrication and characterization of this device is a very important result which will lead to one or more high-impact publications (Deliverable D2).

WP 3. Demonstration of first p-doped JJ:

Months 14-17:

The task allocations of WP3 will be carried out the same way as in the same order as in WP1. While the experiments up this step (WP1-2) have been carried out on heavily n-doped doped NWs, the next point is repeating the experiments with different doping levels and concentrations. As a first step, the n-doping will be reduced in several steps and studied in order to observed at which point of doping concentration the Schottky barrier starts forming. Then, unintentionally doped NWs with a side or back-gate will be fabricated which will allow studying the impact of charge modulation on the JJ. Finally, p-type doped NWs will be investigated in order to produce and study a clean contact at high doping levels.

The device fabrication and characterization will be carried out as described in WP2. The successful development of hole conducting JJ, as proposed in this part of the project is an important step towards the realization of JJ-LEDs and worthy of a high-impact publication (Deliverable D3) in a leading international journal for being the first p-JJ fabricated. This is also the point of Milestone M2 where the relative success of WP2 compared to WP3 will be assessed and the nature of the final JJs in WP4 decided. Again, an important weight in the decision will be given to the best and environmentally most friendly combination of materials.

WP 4. Investigations of the current phase relationships with an ultra-sensitive SQUID:

Months 18-20:

Task 1: Different geometries will be investigated to fabricate a superconducting quantum interference device (SQUID) based on the solid-state diffusion technique, some are given in Fig.3. The development of further geometries is considered. These steps will be carried out in the SEM facilities at the host organization and with the in-situ (S)TEM setup at the collaborating organization and their exact execution depends on the final geometry chosen. The superconducting material deposition will take place at the host institute the same way as in WP1-3. For the single NW geometries the dropcast mechanism will be continued. For two NW geometries mechanical placement with micromanipulators are envisioned. The final device will be fabricated on in-situ capable membranes as in the previous steps.

Months 21-24:

Task 2:

The sensitivity of the fabricated SQUIDs will be investigated at the low temperature, low noise transport setups at the host institute. In order to investigate the interface qualities the current-phase relationship (CΦR) of the JJs in the SQUID will be probed. It is expected that in the very short limit the simple sinusoidal-like current phase relation (CΦR) of a JJ evolves towards a very skewed current phase relation[35]. Within a SQUID interferometer this can be observed as a function of the magnetic flux. Such a distortion will testify the strong improvement the sensitivity of the interferometer to magnetic fields.

The results of this WP4 will be important and directly result in a contribution (Deliverable D4) in a peer-reviewed international journal of high impact factor. Before the publication, if the magnetic sensitivity of the device will be better than the sate-of-the-art SQUID, patenting will be considered and discussed together with the technology transfer of CNR (Giulio Bollino)

3.2. Appropriateness of the management structure, and procedures including risk management

Project organization and management structure: I will be part of the Superconducting Quantum Electronics Lab headed by Dr. Giazotto and supervised by Dr. Strambini. Full administrative support as well as full access to academic journals is provided by CNR Nano and NEST. Necessary accesses such as for cleanroom facilities, low transport lab and safety trainings for cryogenic, nano, electrical and chemical risks are provided. Weekly meeting with the supervising persons will ensure the necessary guidance and management as well as timely completion of the project. Patenting and IPR will be considered and supervised by the transfer technology office of CNR.

Risks management:

(1) The **CoViD epidemic** which started in 2020 may prevent me from going to Grenoble to the collaborating institute and carry out the planned tasks there. Should that be the case, the aspects of the projects necessitating the setups in Grenoble will be carried out by Dr. den Hertog or one of her collaborators. The prepared samples will be transferred by mail.

(2) It is possible that the diffusion tests with the **p-type doped** NWs will not produce Ohmic contacts within the allocated time for that part of the project due to the difficulties of the material. In that case the project will be continued with n-type doped and intrinsically doped samples equipped with gate electrodes. Alternatively, p-type doped NWs could be obtained through the collaborating partners of Prof. Sorba (TU Eindhoven) or others.

(3) It is possible that the diffused material will not form in a **monocrystalline** phase. An Al_2O_3[16] or Si[40] shell on the NW have been shown to improve the control over the reaction speed and the epitaxy between the interfacing materials during solid state diffusion will be considered an option for the experiment.

3.3. Appropriateness of institutional environment (infrastructure)

The host institute will provide office space, literature access, library support, computing equipment, a number of softwares. Additionally, I will have full access to the tailor-made low-noise electronic setups necessary to measure the low current (<pA) of the fabricated SQUID structures. I will likewise have full access to dilution fridges where the superconducting states of the fabricated devices will be attained and wherein the measurements will take place. Both are available as part of Dr. Giazotto's lab.

The collaborating institution will allow me access to the in-situ (S)TEM facilities and a fruitful collaboration with Dr. den Hertog. I will likewise obtain in-situ compatible silicon nitride membranes for the sample fabrication.

[40] Sistani, M. et al *ACS Nano* **2019**, *13* (12), 14145–14151

4. CV of the experienced researcher

PERSONAL INFROMATION

Name Maria Spies
Nationality German

EDUCATION

17 Oct 2019 **Ph.D. in Nanophysics** Université de Grenoble-Alpe, France.
29 Sept 2014 **M.Sc. in Physics** at the HHU Düsseldorf, Germany.
(Erasmus at Université de Nantes)
11 Dec 2011 **B.Sc. in Physics** at the New Mexico State University, Las Cruces, USA.
27 July 2008 **Abitur** at Sportgymnasium Magdeburg, Germany.

WORK EXPERIENCE

1 Oct 2016 – 30 Sept 2019 **Doctoral researcher** at *CEA –INAC and CNRS-Institute Neel*, Grenoble, France
- Nanophysics: correlated advanced characterization of heterostructured nano-scale group III-V photodetectors and emitters by microphotoluminesence, scanning and transmission electron microscopy, electrical characterization; device fabrication in clean room, simulations of optical properties with nextnano[3]
- Thesis title: "Correlated electro-optical and TEM studies on single III-N nanowire heterostructures"

10 Feb 2016 – 10 Aug 2016 **Research Engineer** at *Groupe de Physique des Matériaux, Université de Rouen, Normandie*, Rouen, France
- laser wide angle atom probe tomography (APT) and laser LEAP high resolution APT on diamond nanotips, studying the possibility of sub-bandgap absorption

1 Feb 2014 – 30 Sept 2014 **Research Assistant** at *Max-Planck-Institut für Eisenforschung*, Düsseldorf, Germany
- APT, SEM, CL, EDX, EBDS, STEM imaging on semiconductor kesterite
- Thesis title: "Influence of growth conditions on the opto-electronic properties, microstructure and chemistry of $Cu_2ZnSnSe_4$ thin-films"

15 June 2012 – 15 Aug 2012 **Research Assistant** at *Erasmus Medisch Centrum*, Rotterdam, Netherlands
- FFT analysis of ultrasound, photoacoustics response of lipid microbubbles with dyes attached to the shell, transducer recorded

12 June 2011– 25 Aug 2011 **Internship** at *Department of Electrical Engineering*, University of Nebraska-Lincoln, Lincoln, NE, USA
- Ellipsometry study of optical properties of sublimation-deposited epitaxial Graphene on SiC (3C, 4H), spectroscopic mapping

1 Jan 2011 – 15 May 2012 **Research Assistant** at *Department of Physics*, New Mexico State University (NMSU), Las Cruces, NM, USA
- Ellipsometry studies of optical properties of thin films: $SrTiO_3$, NiPt, $LaAlO_3$

15 May 2010 – 31 Dec 2010 **Research Assistant** at *Department of Astronomy*, NMSU, Las Cruces, NM, USA

SKILLS

Optical and material characterization
- Electrical device characterization, TEM, SEM, Microphotoluminescence, FIB, Atom Probe Tomography, Ellipsometry, Cathodoluminescence

Computer skills

- Origin by OriginLab, Nextnano[3] QW device simulation, basic Matlab, Python and Fortran programming

Clean room experience

- Device design, SiN TEM grid fabrication, contacting of single nano-objects, electron beam lithography

PUBLICATIONS & CONFERENCES

Author of 14 (5 first author) publications in peer-reviewed international journals.
Presenter of 6 talks at international conferences.

ORCID ID: 0000-0002-3570-3422

INVITED REVIEWS

[1] **Photodetectors based on wurtzite semiconductor heterostructures**
Maria Spies, and Eva Monroy
Semiconductor Science and Technology 34 (5), 053002 (2019)

[2] **Correlated and in-situ electrical transmission electron microscopy studies and related membrane fabrication**
Maria Spies, Zahra Sadre-Momtaz, Jonas Lähnemann, Minh Anh Luong, Bruno Fernandez, Thierry Fournier, Eva Monroy, Martien I den Hertog
Nanotechnology 0957-4484 (2020)

JOURNAL ARTICLES

[1] **Correlated electro-optical and structural study of electrically tunable nanowire quantum dot emitters**
Maria Spies, Akhil Ajay, Eva Monroy, Bruno Gayral and Martien I. den Hertog
Nano Letters 1, 314- 319 (2019)

[2] **In-Situ Transmission Electron Microscopy Imaging of Aluminum Diffusion in Germanium Nanowires for the Fabrication of Sub-10 nm Quantum Disks**
Minh Anh Luong, Eric Robin, Nicolas Pauc, Pascal Gentile, Masiar Sistani, Alois Lugstein, Maria Spies, Bruno Fernandez, and Martien I. den Hertog
ACS Appl. Nano Mater., 3, 2, 1891-1899 (2020)

[3] **Effect of Bias on the Response of GaN Axial p–n Junction Single-Nanowire Photodetectors**
Sergi Cuesta, Maria Spies, Victor Boureau, Fabrice Donatini, Moïra Hocevar, Martien I. den Hertog, and Eva Monroy
Nano Letters 8, 5506–5514 (2019)

[4] **Intersubband absorption in GaN nanowire heterostructures at mid-infrared wavelengths**
Akil Ajay, Rodrigo Blasco, Jakub Polaczyński, Maria Spies, Martien I. Den Hertog, and Eva Monroy
Nanotechnology 29, 385201 (2018)

[5] **Effect of the nanowire diameter on the linearity of the response of GaN-based heterostructured nanowire photodetectors**
Maria Spies, Jakub Polaczyński, Akhil Ajay, Dipankar Kalita, Minh Anh Luong, Jonas Lähnemann, Bruno Gayral, Martien I den Hertog, and Eva Monroy
Nanotechnology 29, 255204 (2018)

[6] **Monolithic Axial and Radial Metal–Semiconductor Nanowire Heterostructures**
Masiar Sistani, Minh Anh Luong, Martien I. den Hertog, Eric Robin, Maria Spies, Bruno Fernandez, Jun Yao, Emmerich Bertagnolli, and Alois Lugstein

Nano Letters 12, 7692–7697 (2018)

[7] **Thermal Diffusivity of Diamond Nanowires Studied by Laser Assisted Atom Probe**
Laurent Arnoldi, Maria Spies, Jonathan Houard, Ivan Blum, Aurianne Etienne, Rinat Ismagilov, Alexander Obraztsov, and Angela Vella
Applied Physics Letters 112 (14), 143104 (2018)

[8] **Bias-controlled spectral response in GaN/AlN single-nanowire ultraviolet photodetectors**
Maria Spies, Martien I. Den Hertog, Pascal Hille, Jörg Schörmann, Jakub Polaczyński, Bruno Gayral, Martin Eickhoff, Eva Monroy, and Jonas Lähnemann
Nano Letters 17, pp 4231–4239 (2017)

[9] **Impact of Annealing on Electrical Properties of $Cu_2ZnSnSe_4$ Absorber Layers**
Thomas P. Weiss, Alex Redinger, Germain Rey, Torsten Schwarz, Maria Spies, Oana Cojocura-Mirédin, Pyuck-Pa Choi, and Susanne Siebentritt
Journal of Applied Physics 120 (4), 045703 (2016)

[10] **Bulk-like Dielectric Properties from Metallo-Organic Solution–Deposited $SrTiO_3$ Films on Pt-Coated Si Substrates**
Claire V. Weiss, Jilian Zhang, Maria Spies, Lina Abdallah, Stefan Zollner, M. W. Cole, and S.Pamir Alpay
Journal of Applied Physics 111 (5), 054108 (2012)

[11] **Dielectric Function of $LaAlO_3$ from 0.8 to 6 EV between 77 and 700 K**
Cayla M.Nelson, Maria Spies, Lina S. Abdallah, Stefan Zollner, Yun Xu, and Hongmei Luo
Journal of Vacuum Science and Technology - Vacuum Surface Films, 30 (6), 061404 (2012)

INVITED CONFERENCES AND SEMINARS

[1] **Correlated electro-optical and TEM studies on single III-V nanowire heterostructures**
Maria Spies, Martien I. den Hertog, Bruno Gayral, and Eva Monroy
CNRS-CRHEA Laboratory, Vallebonne, France, November 14, 2019

[2] **GaN/AlN dots-in-a-wire photodetectors**
Akhil Ajay, Maria Spies, Jonas Lähnemann, Martien I. den Hertog, Bruno Gayral, and Eva Monroy
10th Biannual Conf. on Quantum Dots (QD2018), Toronto, Canada, June 25-29, 2018

[3] **III-Nitride nanowire photodetectors: from linear UV sensors to nanowire-QWIP**
Akhil Ajay, Jonas Lähnemann, Maria Spies, Jakub Polaczyński, Martien I. den Hertog, and Eva Monroy
SPIE Optics + Photonics, San Diego, USA, Aug 19-23, 2018

[4] **GaN/AlN nanowire photodetectors: from the UV to the IR**
Akhil Ajay, Maria Spies, Jonas Lähnemann, Martien I. den Hertog, and Eva Monroy
MRS Fall Meeting 2018, Boston, USA, Nov 25-30, 2018

CONTRIBUTIONS TO INTERNATIONAL CONFERENCES

[1] (Poster) **Understanding the growth and physical properties of single GaN nanowire quantum dots**
M. Spies, A. Ajay, E. Monroy, B. Gayral, and M. I. den Hertog
11th International Conference on Quantum Dots, Muinch, Germany, May 18 – 22, 2020

[2] (Poster) **Electrical tunability of single quantum dots embedded in GaN nanowires**
M. Spies, A. Ajay, F. Donatini, M. I. Den Hertog, E. Monroy and Bruno Gayral
Nanowire Week 2019, Pisa, Italy, September 23 – 27, 2019

[3] (Oral) **Tunable QCSE in GaN/AlN nanowire single quantum dots**
Maria Spies, Akhil Ajay, Fabrice Donatini, Martien I. den Hertog, Eva Monroy, and Bruno Gayral
International Conference on Nitride Semiconductors, Bellevue, WA, USA, July 7-12, 2019

[4] (Poster) **Heterostructured GaN/AlN nanowires with linear photoresponse**
Maria Spies, Jakub Polaczyński, Akhil Ajay, Dipankar Kalita, Jonas Lähnemann, Bruno Gayral, Martien I. den Hertog, and Eva Monroy
International Conference on Superlattices, Nanostructures and Nanodevices, Madrid, Spain, July 23-27, 2018

[5] (Oral) **GaN/AlGaN nanowire heterostructures for mid-infrared intersubband technology**
Akhil Ajay, Rodrigo Blasco, Jakub Polaczyński, Maria Spies, Martien I. Den Hertog, and Eva Monroy
Compound Semiconductor Week 2018, Boston, USA, May 29 - June 1, 2018

[6] (Oral) **Linearity of the photoresponse in heterostructured GaN/AlN nanowires**
Maria Spies, Jakub Polaczyński, Akhil Ajay, Dipankar Kalita, Jonas Lähnemann, Bruno Gayral, Martien I. den Hertog, and Eva Monroy
Nanowire Week, Hamilton, Ontario, Canada, June 11-15, 2018

[7] (Oral) **Single-Nanowire Photodetectors with GaN/AlN superlattice and bias-dependent spectral response**
Maria Spies, Jonas Lähnemann, Martien I. Den Hertog, Pascal Hille, Jörg Schörmann, Jakub Polaczyński, Bruno Gayral, Martin Eickhoff, and Eva Monroy
EMRS Fall Meeting, Warsaw, Poland, Sept 18-21, 2017

[8] (Poster) **Bias-controlled spectral response in GaN/AlN nanowire photodetectors**
Maria Spies, Jonas Lähnemann, Pascal Hille, Jörg Schörmann, Jakub Polaczyński, Martien I. den Hertog, Bruno Gayral, Martin Eickhoff, and Eva Monroy
12th International Conference on Nitride Semiconductors (ICNS12), Strasburg, France, July 24-28, 2017

[9] (Poster) **Bias-controlled spectral response in GaN/AlN nanowire photodetectors**
Maria Spies, Jonas Lähnemann, Pacal Hille, Jörg Schörmann, Jakub Polaczyński, Martien I. den Hertog, Bruno Gayral, Martin Eickhoff, and Eva Monroy
17th TEM-UCA Workshop, Cadiz, Spain, July 17-21, 2017

[10] (Oral) **GaN/AlN nanowire photodetectors with bias-controlled spectral response**
Maria Spies, Jonas Lähnemann, Pascal Hille, Jörg Schörmann, Jakub Polaczynski, Martien I. den Hertog, Bruno Gayral, Martin Eickhoff, and Eva Monroy
Nanowire Week, Lund, Sweden, May 29 - June 2, 2017

[11] *(Oral)* **Atom Probe Tomography analysis of single-crystal diamond mirco-needles**
Maria Spies, Jonathan Houard, Ivan Blum, Aurianne Etienne, and Angela Vella
5th International Workshop on Nanocarbon Photonics and Optoelectronics, Imatra, Finland, Aug 1-6, 2016

[12] (Oral) **Sequential process or co-evaporation: Comparison of IVT and admittance data**
Thomas Paul Weiss, Alex Redinger, Germain Rey, Torsten Schwarz, Maria Spies, Oana Cojocura-Mirédin, Pyuck-Pa Choi, and Susanne Siebentritt
MRS Spring Meeting, San Francisco, CA, USA, April 6-10, 2015

[13] *(Oral)* **High temperature coevaporation of $Cu_2ZnSnSe_4$**
Alex Redinger, Germain Rey, Torsten Schwarz, Maria Spies, Oana Cojocura-Mirédin, Pyuck-Pa Choi, and Susanne Siebentritt
E-MRS Spring Meeting, Lille, France, May 26-30, 2014

ACCOMPLISHMENTS & AWARDS

Athletic Achievements in swimming:

- University level (USA):
  - Athletic scholarship at Division I swim team at NMSU (Aug 2008- May 2012)
  - 4x school record holder, 3x WAC Champion, Outstanding Swimmer 2009
  - participant at NCAA championships (one of the most competitive in the world)
- Nationwide (Germany):
  - Junior National Team 2005, 2006

- participant Olympic Trials 2008, 2012
- 3rd at open National Championships 2008

RESEARCH GAP

2015 For a better evaluation of my track record, one should consider the loss of one research year before the start of my PhD. The need for personal reflection had arisen after 11 years (2002-2013) of highest level athletic competition (> 20 hours of physical training alongside school work and university studies, regular week-long absences due to training camps, many regional/ national/ international competitions and championships throughout each season). The time served as a period of reorientation which resulted in the start of my research career in 2016.

INDEPENDENT THINKING AND LEADERSHIP QUALITIES

During my research career I have demonstrated my ability to work and think independently. While I was working on my PhD with axially heterostructured nanowires I have noticed and subsequently circumvented the aging process detrimental to the photoemission from quantum dots. I have likewise optimized the fabrication of in-situ compatible Si_3N_4 membrane chips with further chip labels (accessible during micro-photoluminescence and TEM measurements), alternative etching techniques and a design less prone to parasitic etching at chip intersections.

During my PhD in Grenoble I had the opportunity to co-supervise and train two M2 Master's students and one M1 Master's student. That involved training them in electrical device transport measurements, photocurrent measurements, electron beam lithography and clean room fabrication techniques.

5. Capacity of the Participating Organizations

Participating organizations	Legal Entity Short Name	Country	Supervisor	Role of Partner Organization
Beneficiary:	NEST, Instituto-CNR, Pisa	Italy	Dr. Elia Strambini	
Partner Organization:	Institut Néel, CNRS, Grenoble	France	Dr. Martien den Hertog	Hosting secondments

Beneficiary	NEST, Instituto-CNR, Pisa, Italy
General Description	NEST, the National Enterprise for nanoScience and nanoTechnology, is an interdisciplinary research center with excellent facilities and staff. Scientists with backgrounds in physics, chemistry and biology jointly work on furthering the boundaries on nanoscale devices for applications as varied as nanoelectronics, nanobioobjects and nanophotonics. The NEST lab is founded on the collaboration between three major institutes which are the Scuola Normale Superiore (SNS), the Instituto Italiano di Tecnologia (IIT) and the Italian National Research Council (CNR). Scientists within NEST freely collaborate between these institutes. The Nanoscience lab is an Institute of the CNR devoted to frontier research in nanoscience and nanotechnology located in the SNS which is a highly-selective public institution of university education. SNS secures the participation of young graduate and undergraduate students to the Institute research activities. External funding of CNR Nano for the period 2018-2019 alone was around 8 million Euros. Two European projects from the Horizon 2020 program started last year. At the same time several projects got granted on the regional level: one FAS project and four "Bando Ricerca Salute" of Tuscany region, one of Emilia-Romana region, one with "Fondazione Carilucca, one with ELA International and also the project Core3 which is part of the European Graphene Flagship.
Academic Organization	Yes
Role and Profile of key persons (supervisors)	**Dr. Elia Stambini,** CNR scientist, is the supervisor of this project. He has an extensive experience in nanofabrication and cryogenic electrical characterization of mesoscopic systems at low dimensionality including ballistic and diffusive semiconductors, metals and hybrid superconducting/magnetic devices. After a PhD and a post-doctoral fellowship at Scuola Normale Superiore in Pisa (2005-2011) he joined the MESA+ Institute of Nanoelectronics in Twente with a three-year postdoctoral fellowships (2010-2014). He was awarded a personal Marie-Curie grant used to begin his own project at Nano-CNR in Pisa where he was appointed as researcher (2014-Present). Today he is responsible of the laboratories of superconductivity at NEST, he is supervising the post-docs and PhDs of the SQEL group and he is responsible of various national and international grants. **Dr. Francesco Giazotto,** CNR scientist, is the group leader of the team working on this project. He is a research scientist (permanent, III livello, II fascia) at NEST Istituto Nanoscienze-CNR, Pisa, Italy. He co-authored 121 scientific publications and 2 patents (H-index: Google Scholar 38). He gave 75 invited talks at international conferences and universities. He is the group leader of a research group which consists of 15 persons including master students (2), PhD students (4), postdoc researchers (3), temporary research scientists (3) and research scientists (2). His main research interests are: Quantum Transport and electronic properties of low dimensional hybrid heterostructures; Quantum technology; Non-equilibrium effects in hybrid nanostructures; Thermal effects in mesoscopic systems; Spin-dependent phenomena in equilibrium and out-of-equilibrium hybrid systems; Spin-orbit interaction in two-dimensional electron gases; Josephson effect in out-of-equilibrium systems; Phase-coherent thermal effects at the nanoscale; Quantum magnetometry; Superconducting spintronic; THz radiation detection. **Prof. Lucia Sorba**, Director of the CNR-Nano, provides the legal commitment of the research contract.
Dept./ Division/ Laboratory/	Scienze Fisiche e tecnologiche della materia, CNR-Nano Superconducting Quantum Electronics Lab
Key Research Facilities, Infrastructure and Equipment	The relevant research infrastructure available for the project comprises: **Fabrication facilities:** state-of-the-art nano-fabrication facilities, a cleanroom with 2 electron-beam lithography systems, 2 thermal evaporators, an electron-beam evaporator with angular evaporation and in-situ oxidation, and chemical work benches and hoods. **Superconductivity laboratory:** with He3/He4-dilution fridges (one with optical access) of T= 5 mK and 5 T magnetic fields, and precision electronics for low-noise transport measurements. **Characterization facilities**: SEM, TEM, AFM, etc.
Independent research premises?	CNR-Nano is guaranteeing the full employment of the researcher without predetermined working hours as well as full access to its own excellent research facilities.
Previous and current involvement in research and training programs	A list of 5 EU/ international/ national projects Dr. Giazotto or Dr Strambini currently are/ have been principal investigator in: -SUPERTED (H2020 FETOPEN, 4 years, grant **550 kEuro**, 2018-2022) -COMANCHE (ERC Consolidator Grant, 5 years, grant: **1750 kEuro**, 2014-2019). -SUPERMAG (MSCA-IF-IEF, 2 years, grant **180 kEuro**, 2015-2017) -EUSUPER (MSCA-IF-EEF, 2 years, grant **180 kEuro**, 2018-2020) -SCIADRO (Tuscany Region, Italy 2 years, grant: **700 kEuro**, 2016-2018).
Relevant publications and/or research/ innovation products	1) **E. Strambini**, … **F. Giazotto,** A Josephson phase battery. Nature Nanotechnology, 1–5 (2020). 2) A. Iorio, … **F. Giazotto, E. Strambini**, Vectorial Control of the Spin–Orbit Interaction in Suspended InAs Nanowires. Nano Lett. 19, 652–657 (2019). 3) J. Tiira, **E. Strambini,** … **F. Giazotto,** Magnetically-driven colossal supercurrent enhancement in InAs nanowire Josephson junctions. Nature Communications. 8, 14984 (2017). 4) **E. Strambini**, … **F. Giazotto**, The ω-SQUIPT as a tool to phase-engineer Josephson topological materials. Nat Nano. 11, 1055–1059 (2016). 5) **F. Giazotto**, et al, A Josephson quantum electron pump. Nat. Phys. 7, 857–861 (2011).

Partner Organization	Institut Néel, CNRS, Grenoble, France
General Description	CNRS Institut Neel Grenoble is an internationally competitive solid state physics research lab. It hosts leading experts in low temperature research, electronic properties of solids, magnetism and crystallography. It is closely tied to and continually recruiting students from the University Grenoble-Alpe. In the last five years more than 2000 publications originated from the researchers of the institute. 5(+4) ERC grants, 12(+28) other EU grants and 68(+71) nationals grants were awarded as the main (collaborating) institute. 174 PhD degrees and 117 habilitations were awarded. In total, 280 permanent researchers were employed as well as 127 postdoctoral researchers and 70 visiting researchers.
Academic Organization	Yes
Role and Profile of key persons (supervisors)	**Dr. Martien den Hertog** has longstanding experience with high-end (S)TEM characterization techniques, the carrying out of in-situ (S)TEM experiments on nanostructures and is an internationally recognized scientist. She studied Chemistry at the University of Utrecht, Netherlands from 2000 to 2005, with a Master entitled 'Chemistry and Physics'. She performed her PhD at CEA-Grenoble, France from 2006-2009 under supervision of Jean-Luc Rouviere entitled 'Characterization of silicon nanowires by transmission electron microscopy'. She performed her postdoctoral research on TEM of II-VI Nanowires at French National Center for Research CNRS Institut Neel in Grenoble, where she is a permanent research scientist since 2010. She obtained her Habilitation as research supervisor (HDR) in 2018 from the University of Grenoble. Her research focused on the correlation of Transmission Electron Microscopy (TEM) based techniques with optical and electrical characterization on the same single semiconductor nanowire (NW) and develop electrical in-situ TEM. She is author or co-author of more than 75 publications in international journals (H=20 WoS), 1 book chapter, more than 15 invited presentations and 1 patent. She supervised 6 PhD, 4(+2 underway) PostDoc and 4 MSc, 4 BSc students as well as an ERASMUS student. In 2019 she has been awarded the Bronze Medal of CNRS due to her research activities in correlated and in-situ TEM experiments.
Dept./Division/ Laboratory/	Physics Light Matter (PLUM) group within in Materials Radiation and Structure (MRS) department
Key Research Facilities, Infrastructure and Equipment	Institut Neel has high-tech research facilities ranging from a fully equipped clean room (electron beam lithography, nanobeam, reactive ion etching, masker, SEMs, …) to in-situ compatible (S)TEM facilities.
Previous and current involvement in research and training programs	Dr. den Hertog has been principal investigator of a young researcher ANR project (COSMOS), two local projects and a PHC project with the technical University of Vienna, and was awarded an ERC-Starting Grant that began in 2018. Additionally, she was involved in six other ANR projects.
Relevant publications and/or research/ innovation products	1) Luong, M. A. …**M.I. den Hertog** *ACS Appl. Nano Mater.* **2020**, *3* (2), 1891–1899 2) Spies, M. …**M.I. den Hertog** *Nanotechnology* **2020**, *31*(47), 472001 3) Sistani, M. …**M.I. den Hertog**… *ACS Nano* **2019**, *13* (12), 14145–14151 4) Sistani, M. … **M.I. den Hertog** … *Appl. Phys. Lett.* **2020** *116* 013105 5) El hajraoui, K. …**M.I. den Hertog** … *Nano Lett.* **2019** *19* 12, 8365–8371

6. Ethical Issues

No ethical or security issues are expected in this project.

ESTIMATED BUDGET FOR THE ACTION

				Estimated eligible[1] costs (per budget category)											EU contribution		
				A. Costs for the recruited researcher						B. Institutional costs				Total costs	Reim-bursement rate %	Maximum EU contrib.[2]	Maximum grant amount[3]
				A.1 Living allowance		A.2 Mobility allowance		A.3 Family allowance		B.1. Research, training and networking costs		B2. Management and indirect[4] costs					
			Form of costs[5]	Unit		Unit		Unit		Unit		Unit					
				Costs per unit[6]	Total a[7]	Costs per unit[6]	Total b[7]	Costs per unit[6]	Total c[7]	Costs per unit[6]	Total d[7]	Costs per unit[6]	Total e[7]	f=a+b +c+d+e	g	h	i
1. CNR	Number of units (person-months)	24.00	1. CNR	5 094.72	122 273.28	600.00	14 400.00	500.00	0.00	800.00	19 200.00	650.00	15 600.00	171 473.28	100.00	171 473.28	171 473.28

[1] See Article 6 for the eligibility conditions.
[2] This is the theoretical amount of EU contribution that the system calculates automatically (by multiplying all the budgeted costs by the reimbursement rate). This theoretical amount is capped by the 'maximum grant amount' (that the Commission/Agency decided to grant for the action) (see Article 5.1).
[3] The 'maximum grant amount' is the maximum grant amount decided by the Commission/Agency. It normally corresponds to the requested grant, but may be lower.
[4] The indirect costs covered by the operating grant (received under any EU or Euratom funding programme; see Article 6.3(b)) are ineligible under the GA. Therefore, a beneficiary that receives an operating grant during the action duration cannot declare indirect costs for the year(s)/reporting period(s) covered by the operating grant (i.e. the unit cost for management and indirect costs will be halved for person-months that are incurred during the period covered by the operating grant), unless they can demonstrate that the operating grant does not cover any costs of the action.
[5] See Article 5 for forms of costs.
[6] See Annex 2a 'Additional information on the estimated budget' for the details on the costs per unit.
[7] Total = costs per unit x number of units (person - months).
[8] ONLY FOR AMD: To be used if beneficiary changes during the action.

ANNEX 2a

ADDITIONAL INFORMATION ON THE ESTIMATED BUDGET

- **Instructions and footnotes in blue will not appear in the text generated by the IT system (since they are internal instructions only).**
- **For options *[*in square brackets*]*: the applicable option will be chosen by the IT system. Options not chosen will automatically not appear.**
- **For fields in [grey in square brackets] (even if they are part of an option as specified in the previous item): IT system will enter the appropriate data.**

Marie Skłodowska-Curie unit costs

MSCA-IF unit costs

Costs for the recruited researcher(s) — Living allowance

Units: months spent by the researcher(s) on the research training activities ('person-months')

Amount per unit *: see Annex 2

* Amount calculated as follows:
{the monthly living allowance for researchers in MSCA-IF actions
multiplied by
country-specific correction coefficient of the country in which the researcher is recruited}

The monthly living allowance and the country-specific correction coefficients are set out in the Work Programme (section 3 MSCA) in force at the time of the call:

- for calls *before* Work Programme 2018-2020:
  - for the monthly living allowance:
    - IF: **EUR 4 650**
  - for the country-specific correction coefficients: see Work Programme 2014-2015 and Work Programme 2016-2017 (available on the Participant Portal Reference Documents page)
- for calls *under* Work Programme 2018-2020:
  - for the monthly living allowance:
    - IF: **EUR 4 880**
  - for the country-specific correction coefficients: see Work Programme 2018-2020 (available on the Participant Portal Reference Documents page).

Estimated number of units: see Annex 2

Costs for the recruited researcher(s) — Mobility allowance

Units: months spent by the researcher(s) on the research training activities ('person-months')

Amount per unit[1]: see Annex 2

Estimated number of units: see Annex 2

[1] Same amount for all beneficiaries.
Amount for the mobility allowance set out in the Main Work Programme — MSCA in force at the time of the call.

Costs for the recruited researcher(s) — Family allowance

Units: months spent by the researcher(s) on the research training activities ('person-months')

Amount per unit[2]: see Annex 2

Estimated number of units: see Annex 2

Institutional costs — Research, training and networking costs

Units: months spent by the researcher(s) on the research training activities ('person-months')

Amount per unit[3]: see Annex 2

Estimated number of units: see Annex 2

Institutional costs — Management and indirect costs

Units: months spent by the researcher(s) on the research training activities ('person-months')

Amount per unit[4]: see Annex 2

Estimated number of units: see Annex 2

---

2 Same amount for all beneficiaries.
Average based on the amount for the family allowance set out in the Main Work Programme — MSCA in force at the time of the call (half of the number of units with family, half without).

3 Same amount for all beneficiaries.
Amount for research, training and networking costs set out in the Main Work Programme — MSCA in force at the time of the call.

4 Same amount for all beneficiaries.
Amount for management and indirect costs set out in the Main Work Programme — MSCA in force at the time of the call.

ⓘ print format A4

MODEL ANNEX 4 FOR H2020 MGA MSCA-IF — MONO

FINANCIAL STATEMENT FOR BENEFICIARY [name] FOR REPORTING PERIOD [reporting period]

			Eligible[1] costs (per budget category)											EU contribution		
			A. Costs for the recruited researcher						B. Institutional costs				Total costs	Reimbursement rate %	Maximum EU contribution	Requested EU contribution
			A.1 Living allowance		A.2 Mobility allowance		A.3 Family allowance		B.1. Research, training and networking costs		B2. Management and indirect[2] costs					
		Form of costs[3]	Unit		Unit		Unit		Unit		Unit					
			Costs per unit[4]	Total a[5]	Costs per unit[4]	Total b[5]	Costs per unit[4]	Total c[5]	Costs per unit[4]	Total d[5]	Costs per unit[4]	Total e[5]				
Beneficiary	Number of units (person-months)	**Beneficiary**														

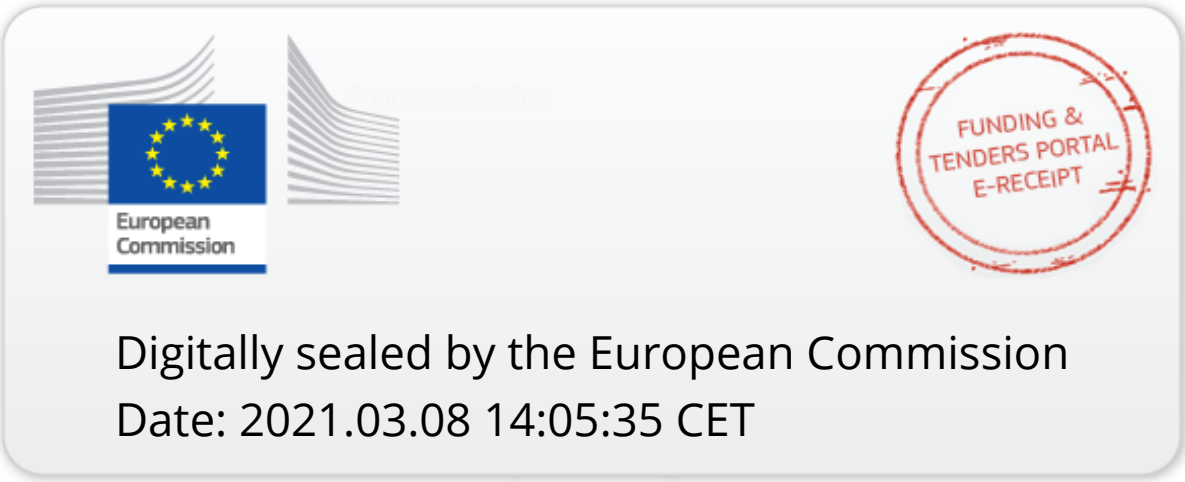
Checkbox 1:	I confirm that the total amount of the allowances used (including compulsory deductions) for the researcher is equal to or higher than the living allowance, the mobility allowance and the family allowance as set out in Annex 2 of the Agreement.

Checkbox 2:	Did you receive any EU/Euratom operating grant during this reporting	❍ YES ❍ NO		
	If yes, pls indicate how many of the total person-months (see 'total beneficiary' above) were incurred DURING the period covered by the operating grant?	Number of person-months		
	If yes, can you confirm all of the following: - the operating grant is a partial operating grant (i.e. does not cover your entire annual budget) - you have used analytical accounting which allows for a cost accounting management with cost allocation keys and cost accounting codes - you have recorded: - all costs incurred for the operating grant (i.e. personnel, general running costs and other operating costs linked to the work programme) and - all costs incurred for the action grants (including all the indirect costs linked to the action) - you have used allocation keys and cost accounting codes to identify and separate the recorded costs (i.e. to allocate them to either the action grant or the operating grant) - you have done the allocation in a way that leads to a fair, objective, realistic result.	❍ YES ❍ NO		

The beneficiary hereby confirms that:
The information provided is complete, reliable and true.
The costs declared are eligible (see Article 6).
The costs can be substantiated by adequate records and supporting documentation that will be produced upon request or in the context of checks, reviews, audits and investigations (see Articles 17, 18 and 22).

ⓘ Please declare all eligible costs, even if - for actual costs, unit costs and flat-rate costs - they exceed the amounts indicated in the estimated budget (see Annex 2). Only amounts that were declared in your individual financial statements can be taken into account lateron, in order to replace other costs that are found to be ineligible.

[1] See Article 6 for the eligibility conditions
[2] The indirect costs claimed must be free of any amounts covered by an operating grant (received under any EU or Euratom funding programme; see Article 6.3(b)). If you have received an operating grant during this reporting period, indirect costs will not be reimbursed for the person-months incurred during the period covered by the operating grant, unless you can demonstrate that the operating grant does not cover any costs of the action.
[3] See Article 5 for the forms of costs
[4] See Annex 2a 'Additional information on the estimated budget' for the details on the costs per unit.
[5] Total = costs per unit x number of units (person-months)



This electronic receipt is a digitally signed version of the document submitted by your organisation. Both the content of the document and a set of metadata have been digitally sealed.

This digital signature mechanism, using a public-private key pair mechanism, uniquely binds this eReceipt to the modules of the Funding & Tenders Portal of the European Commission, to the transaction for which it was generated and ensures its full integrity. Therefore a complete digitally signed trail of the transaction is available both for your organisation and for the issuer of the eReceipt.

Any attempt to modify the content will lead to a break of the integrity of the electronic signature, which can be verified at any time by clicking on the eReceipt validation symbol.

More info about eReceipts can be found in the FAQ page of the Funding & Tenders Portal.

(https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/support/faq)