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Proposal Evaluation Form

EUROPEAN COMMISSION

Horizon Europe Framework Programme (HORIZON)

Evaluation Summary Report - Research and innovation actions

Call: HORIZON-CL4-2021-DIGITAL-EMERGING-01
Type of action: HORIZON-RIA
Proposal number: 101070287
Proposal acronym: SWAN-on-chip
Duration (months): 36
Proposal title: Low power spintronics wireless autonomous node (SWAN) integrated circuits developed via spintronics technology accelerator platform
Activity: HORIZON-CL4-2021-DIGITAL-EMERGING-01-14

N.	Proposer name	Country	Total Cost	%	Grant Requested	%
1	LABORATORIO IBERICO INTERNACIONAL DE NANOTECNOLOGIA	PT	762,566.25	23.98%	762,566	23.98%
2	AARHUS UNIVERSITET	DK	459,430	14.45%	459,430	14.45%
3	JOHANNES GUTENBERG-UNIVERSITAT MAINZ	DE	250,937.5	7.89%	250,938	7.89%
4	UNIVERSITA DEGLI STUDI DI MESSINA	IT	214,375	6.74%	214,375	6.74%
5	THALES	FR	250,393.75	7.87%	250,394	7.87%
6	ISTITUTO P.M. SRL	IT	240,000	7.55%	240,000	7.55%
7	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	FR	270,682.5	8.51%	270,683	8.51%
8	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	FR	452,657.5	14.23%	452,658	14.23%
9	INSTITUT POLYTECHNIQUE DE GRENOBLE	FR	279,328.75	8.78%	279,329	8.78%
	Total:		3,180,371.25		3,180,373	

Abstract:
One of the central keystones of the digital transformation of society is the Internet of Things (IoT) paradigm, however recent focus has turned to the energy consumption of the billions of IoT sensor nodes. In order for the realisation of a 'Green IoT', low-power sensor nodes are essential, to extend node lifetime, reduce carbon footprint and reduce costs. Spintronics is an emerging technology which has been demonstrated for several key functionalities associated with wireless sensor networks, including sensing, energy harvesting, communication, memories and novel processing paradigms.

In SWAN-on-chip a spintronics wireless autonomous node (SWAN) is proposed for low-power edge computing. Three homogeneously CMOS integrated spin-chip modules will be developed and benchmarked in the context of low power IoT nodes (namely magnetic field sensor, wireless power transfer, wake-up receiver) (Objective 1), and these spin-chip modules will be brought together into a SWAN prototype functional demonstrator capable of real world data capture and used for specific end user test cases (i.e. electric vehicles and smart metering) (Objective 2).

As well as developing individual spin-chips, a system-on-chip style SWAN-on-chip concept will be validated, with different spintronic functionalities being interconnected via CMOS, either by using multi-functional spintronic stacks or masking techniques to allow multiple spintronics technologies to be processed on a single CMOS wafer (Objective 3).

In addition, the SWAN-on-chip concept will be used to validate the 'spintronics technology accelerator' platform, where the spintronics equivalent circuit models (Spin-EC) and spintronics multi-project wafer (Spin-MPW) will create a European-level pathway for the fabrication of monolithically integrated Spintronic/CMOS technologies required for boosting devices up the spintronics value chain (Objective 3).

Evaluation Summary Report

Evaluation Result

Total score: 13.00 (Threshold: 10)

Criterion 1 - Excellence

Score: **4.00** (Threshold: 3/5.00 , Weight: -)

The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme:
- Clarity and pertinence of the project's objectives, and the extent to which the proposed work is ambitious and goes beyond the state of the art.
- Soundness of the proposed methodology, including the underlying concepts, models, assumptions, inter-disciplinary approaches, appropriate consideration of the gender dimension in research and innovation content, and the quality of open science practices, including sharing and management of research outputs and engagement of citizens, civil society and end users where appropriate.

Objectives are clear and pertinent, adequately put in context in the proposal, which aims to develop spintronic modular spin chips for sensor nodes for CMOS co-integration.
The proposal is very ambitious.
However, the state of the art is not sufficiently clear and the end goal performances are not sufficiently discussed (e.g., power consumption, performance of the CMOS-integrated spintronic devices, spin charge conversion and its efficiency). Hence, it is unclear to which extent the

proposed work will advance beyond the state of the art. This is a shortcoming.
The methodology demonstrates the proposal interdisciplinarity, as it covers aspects from materials, devices, sensors, co-integration for spin chip to demonstrators of multiple stacks on a single CMOS wafer.
The research is original and innovative, with the general specifications for every module clearly presented.
Whilst high level guidelines are provided, certain aspects of the methodology lack sufficient explanation, such as how homogenous CMOS/spintronic co-integration or their monolithic co-integration will be achieved, or the rationale behind Spin-MPW, as the latter could limit the research space for CMOS-compatible MRAM technologies. This is a shortcoming.
Also, the requirement of an external field through some bespoke material engineering of the MTJ is adding complexity to the stack design, making implementation questionable in light of multi-stack technology developments. This is a shortcoming.
Open science practices are convincingly presented in the proposal.

Criterion 2 - Impact

Score: **5.00** (Threshold: 3/5.00 , Weight: -)

The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme:
- Credibility of the pathways to achieve the expected outcomes and impacts specified in the work programme, and the likely scale and significance of the contributions from the project.
- Suitability and quality of the measures to maximise expected outcomes and impacts, as set out in the dissemination and exploitation plan, including communication activities.

The pathways to achieve the outcomes and impacts are adequately described and the envisioned end use demonstrators on smart metering and electrical vehicles increases credibility with respect to the proposal's impact for industry.
Scale and significance of the expected outcomes were broadly described.
Important scientific, economic and societal impacts are expected, if the proposal will be successful.
Dissemination and communication actions are well described and appropriate, targeting different types of audiences.
The exploitation strategy and IPR management are adequately discussed in the proposal. Potential stakeholders, that might be interested in valorization of the research outcome of this proposal are clearly indicated. An industrial advisory board is also presented and relevant to exploit possible results from the project.
However, global spintronics market estimations mentioned in the proposal are not sufficiently justified and supported by relevant references. This is a minor shortcoming.

Criterion 3 - Quality and efficiency of the implementation

Score: **4.00** (Threshold: 3/5.00 , Weight: -)

The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme:
- Quality and effectiveness of the work plan, assessment of risks, and appropriateness of the effort assigned to work packages, and the resources overall.
- Capacity and role of each participant, and the extent to which the consortium as a whole brings together the necessary expertise.

Overall, the work plan is well structured, coherent and appropriately divided into work packages that are relevant to the objectives and are plausible in their scope and timing. The major tasks to be carried out are described with a good level of technical details. The time allocation of tasks and resources is well-balanced as indicated in both the PERT chart and the comprehensive Gantt chart included in the proposal.
The great majority of scientific and technological deliverables are in form of reports, which is a shortcoming. One exception is a circuit or spintronic-chip. Milestones are insufficient for a project of this complexity and decision points are not well supported by relevant deliverables. This is a shortcoming.
Several risks (scientific and management-related) that might endanger reaching the proposed objectives are identified and contingency plans have been proposed.
Shortcomings in the risk assessment are the lack of identification of risks for the implementation of a fully integrated spin-based battery-free sensor node (WP3) and for monolithic integration of spin chips with CMOS.
The consortium has the required expertise and resources to carry out the envisioned work plan.
The roles of the consortium members are adequate, and aligned with their positioning in the spintronics value chain.

Scope of the application

Status: **Yes**

Comments (in case the proposal is out of scope)

Not provided

Exceptional funding

A third country participant/international organisation not listed in the General Annex to the Main Work Programme may exceptionally receive funding if their participation is essential for carrying out the project (for instance due to outstanding expertise, access to unique know-how, access to research infrastructure, access to particular geographical environments, possibility to involve key partners in emerging markets, access to data, etc.). (For more information, see the HE programme guide)

Please list the concerned applicants and requested grant amount and explain the reasons why.

Based on the information provided, the following participants should receive exceptional funding:

Not provided

Based on the information provided, the following participants should NOT receive exceptional funding:

Not provided

Use of human embryonic stem cells (hESC)

Status: **No**

If YES, please state whether the use of hESC is, or is not, in your opinion, necessary to achieve the scientific objectives of the proposal and the reasons why. Alternatively, please state if it cannot be assessed whether the use of hESC is necessary or not, because of a lack of information.

Not provided

Use of human embryos

Status: **No**

If YES, please explain how the human embryos will be used in the project.

Not provided

Activities excluded from funding

Status: **No**

If YES, please explain.

Not provided

Do no significant harm principle

Status: **Yes**

If Partially/No/Cannot be assessed please explain

Not provided

Exclusive focus on civil applications

Status: **Yes**

If NO, please explain.

Not provided

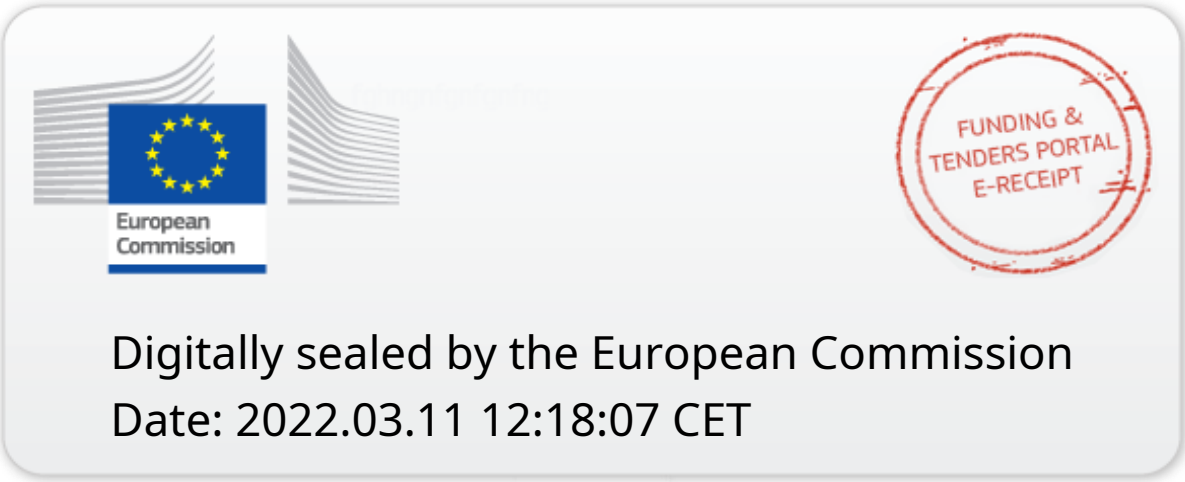
Artificial Intelligence

Status: **No**

If YES, the technical robustness of the proposed system must be evaluated under the appropriate criterion.

Overall comments

Not provided



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