EUROPEAN COMMISSION

Horizon Europe Framework Programme (HORIZON)
HORIZON-EIC HORIZON EIC Grants
HORIZON Action Grant Budget-Based

GA No. 101070417

Computation Systems Based on Hybrid Spin-wave–CMOS Integrated Architectures

SPIDER - Deliverable report

D7.1- Dissemination, exploitation, and communication plan

Disclaimer/ Acknowledgment

Funded by the European Union (under grant agreement No. 101070417).

About SPIDER

In the future, the miniaturisation of electronic devices– epitomised by Moore's law – will be progressively limited by increasing power densities and the associated chip heating. Moreover, autonomous microelectronic applications, for example for the Internet of Things, demand high performance at ultralow power. Therefore, much research has recently focused on disruptive computing technologies that limit power consumption and optimise performance per circuit area. Spin wave computing is a disruptive spintronic technology that uses the interference of spin waves for computation and has considerable potential for power and area reduction per computing throughput. Despite much recent progress in the realisation of spin wave logic gates, no concept for a complete computing system exists today that is based only on spin waves. Thus, to advance from devices to systems, spin wave devices need to be complemented by CMOS in a hybrid spin wave–CMOS system. Using an interdisciplinary approach joining partners with expertise in materials science, physics, device manufacturing, electrical engineering, circuit design, and packaging, SPIDER targets the demonstration of a complete operational hybrid spin wave–CMOS computing system. To date, complex spin wave circuits are yet to be realised. SPIDER targets to fill this gap by developing spin wave logic circuits based on majority gates. To embed these circuits into a CMOS environment, SPIDER will design mixed signal CMOS chips that can drive spin wave circuits and read out computation results. The spin wave and CMOS chips will then be combined on an interposer to obtain the final hybrid system. This work will pave the way towards viable spin wave chips and provide a first benchmark of spin wave computing at the system level. Based on the results, SPIDER will then develop a roadmap to advance spin wave technology to compete with CMOS in technology nodes below 1 nm.

SPIDER consortium members

Document information

Deliverable No.	D7.1
Related WP	WP7
Deliverable Title	Dissemination, exploitation, and communication plan
Deliverable Date	31 – May - 2023
Deliverable Type	Report
Lead Author	Moritz Geilen (RPTU)
Co-Author(s)	Xia Han (IMEC), Christoph Adelmann (IMEC), Paolo Bortolotti (THALES), Martin Hempel (Fraunhofer), Philipp Pirro (RPTU), Alina Bunea (IMT), Pantazis Anagnostou (TUD), Florin Ciubotaru (IMEC), Panagiotis Kassanos (Akronic)

Document history

Date	Revision	Prepared by	Approved by	Description
30/05/2023	1	Task Leader	WP leader	First draft
01/06/2023	2	WP Leader	Coordinator	Final

Dissemination level

PU	**Public**	x
SEN	**Sensitive**	

Publishable summary

This deliverable covers the dissemination, exploitation and communication activities of the SPIDER project. It starts by describing the dissemination activities that have already been carried out in the first six months, such as the project's website and social media presence. This is followed by an outline of the planned activities for each partner. In the course of the SPIDER project, a wide variety of results will be generated that can be used by the partners. Due to the different backgrounds of the partners, a detailed exploration plan is developed for each of them. Finally, details of the SPIDER communication strategy are presented, which will be implemented through a combination of an effective visual identity and specific materials and channels (website, LinkedIn, etc.) that will follow the same style and pattern.

Contents

List of acronyms, abbreviations, and definitions

Abbreviation	Definitions
WP	Work package
GA	Grant Agreement
EC	European Commission

1. Introduction

The aim of WP 7 “Dissemination, communication, and exploitation” is to maximize the visibility, impact, and acceptance of the results produced by the project, which will involve disseminating and exploiting these results beyond the consortium. This will be accomplished through various means, such as publications in peer-reviewed journals, participation in exhibitions, industry fairs, conferences, and symposia, utilizing digital, print, and social media channels where appropriate, and creating websites for research exchange and industry outreach.

Task 7.1 focuses on dissemination, exploitation, and communication and will develop and issue to enhance the project's impact during the maximum scientific and technical progress phase. The dissemination (scientific and industrial) activities will be led by IMEC, with all partners participating.

To reinforce global communication and exploitation efforts, digital dissemination will be a crucial part of the SPIDER project. An online project webpage and social media accounts on LinkedIn will serve as tools for raising awareness, accelerating knowledge diffusion of project developments among global industry and scientific stakeholders. Throughout the project, achieved objectives and delivered results will be communicated digitally, widening the project’s diffusion both in Europe and globally.

In this deliverable 7.1 we will discuss the strategies how to disseminate the results generated in SPIDER to the different stakeholders. In addition, a plan will be drawn up on how the results can be used by the individual partners.

2. Dissemination

This part describes the dissemination plan for the SPIDER project. The project coordinator IMEC will lead the dissemination activities with the support of all the partners. The dissemination activities will be continuously monitored during the project. The main objective of the dissemination and communication activities is to maximize the general impact of the project.

2.1. Dissemination material

In the deliverables, project results as well as the way towards these results are described. Unfortunately, not all the information in these deliverables can be shared due to confidentiality and IP limitations. To solve this issue, the template of the deliverables contains a fixed chapter called "publishable summary" in which the public information can be shared. That means that all the deliverables that are marked in the GA as SEN (Sensitive) will have a derived version in which only the public information is saved and made available to the General Public with the results section of the project website: www.spider-horizon.eu .

2.2. Online visibility

2.2.1. Website

The Website www.spider-horizon.eu is being created with the following sections: Project, Technology, Partners, Results, News/Events. We can identify the information in static and dynamic information.

Static information

This data is not changed during the project, unless an amendment is issued to the grant agreement, that is accepted by the EC.

- PROJECT: This information contains the introduction, facts and figures and links to other funded projects,
- TECHNOLOGY: this section contains the objectives, concept, and approach
- PARTNERS: All the partners and their role in the project is mentioned.

Dynamic information

This information is updated regularly, depending on when the information becomes available.

- RESULTS: All the deliverables (or at least the publishable summary in case of confidential deliverables) are uploaded as soon as they become available. Publications (including public presentations) will be included here as well.
- NEWS/EVENTS: Any news or events where SPIDER will be present, are announced here.

2.2.2. Social Media

Social media is nowadays a strong mean of communication in all fields and sectors. The presence in social media channels will be reinforced via the SPIDER project LinkedIn company page: https://www.linkedin.com/company/spider-horizon-project/

2.3. Monitoring

A spreadsheet to trace all the dissemination activities being carried out during the project has been prepared. The spreadsheet is available in SPIDER MS Teams Workspace and can be edited by all partners at any time.

2.4. Conclusions

In this dissemination plan, we stipulated the major action the dissemination of the results of the SPIDER project. This list of actions is never limited to this deliverable. All the project partners are obligated but also dedicated to take every opportunity to promote the project and to disseminate its results, always taking the measures of the project's consortium agreement into account, as not to endanger another partner's exploitation plans.

2.5. Plans

2.5.1. IMEC

The activities of SPIDER are aligned with IMEC's research program on spintronic logic that includes major companies from the entire semiconductor industry supply chain, especially all leading semiconductor manufacturers. Therefore, IMEC's focus will be on the dissemination of the results towards industrial audiences. A major route will be IMECs semiannual Program Technical Week with over 800 participants from IMECs research partners in the semiconductor industry. This will also allow for obtaining feedback on SPIDER's approach and results from key industrial players. In addition, IMEC will disseminate SPIDER results via academic conferences and peer-reviewed publications towards a more academic audience in the fields of spintronics and magnonics.

IMEC also hosts events that target the general public, e.g. an Open Door Day or the Flemish Day of Science. SPIDER will aim at contributing to these events at least once during the duration of the project by communicating topics related to spintronics and magnetism.

2.5.2. AKRONIC

Akronic is exploiting two parallel paths with regards to dissemination and communication. One is to exploit LinkedIn, where through posts of individual Akronic members or through the company's LinkedIn page or the project's LinkedIn page, we communicate the progress of the project and various developments. The second is through publication of papers in scientific journals as open access articles and in peer-reviewed conference proceedings. In this way, we will target both industrial and academic communities in the fields of future computing systems and RF/mm-wave microelectronics. We aim to participate in conferences in the field of microelectronics and circuit design. These conferences, in addition to a publication that can be referenced by others, will allow Akronic to receive valuable feedback from experts in the field, share knowledge and meet others working in relevant fields. They also give the opportunity for more people to become familiar with Akronic, its services and products, as well as with the SPIDER project. The latter will be of great value to the microelectronics community, as magnonics is a growing field that is not yet attracted much attention from this community. Following

experimental validation of the microchips we will design and fabricate we will aim towards journal papers, focused on the microelectronics we will develop, while other papers will follow through the combined work with our SPIDER partners when the different project elements come together to form a complete system.

2.5.3. RPTU

We want to show that European research and industry is developing disruptive technologies that lead to more energy efficient integrated circuits. RPTU's interest to exploit the results generated within SPIDER is mainly on the side of fundamental research. Hence the target audience is the scientific community in spintronics and magnonics. These will be addressed by publication of our results in scientific journals. By publishing the results as open access articles or by making them available on well-known repositories, such as arXiv, we want to make them accessible to the largest possible audience. Further we will participate in various international spintronics and magnonics conferences to present our research outcomes. These conferences are an excellent platform to meet experts in the field, share knowledge, and receive valuable feedback. We aim to participate in at least two major conferences every year.

In addition to disseminating the results to the scientific community, we plan to make the ideas and results available to a broader public. On the one hand, we plan to use the results of the project in teaching, for example in lectures for university students. On the other hand, we will present the project to the public at local events for the public, such as the "Tag der Physik" (Day of Physics), "Nacht, die Wissen schafft (Night that creates knowledge) and other scientific fairs.

2.5.4. IMT

IMT will mainly focus on disseminating the results of the project in the academic environment and towards the education of future professionals in the field. We plan to participate in one to two IEEE conferences per year, mainly in the microwave and microelectronics areas (e.g., IEEE European Microwave Week, IEEE International Microwave Symposium, IEEE Asia-Pacific Microwave Conference, IEEE International Semiconductor Conference – CAS). Our dissemination actions will start to materialize in the second year of the project, when the first experimental results of the system circuit blocks will become available. The scientific community we target has limited contact with the spin-wave computing field, which will lead to interesting inter-disciplinary approaches and discussions and a better understanding on how to reconcile microwave engineering with spintronics. We aim to publish the results, in collaboration with other SPIDER partners, in high-ranking journals in full open-access format. Alternatively, pre-prints will be uploaded to online repositories such as arXiv. The publications will be highlighted on platforms such as ResearchGate or LinkedIn. We plan to organize a dedicated workshop as a satellite event to the IEEE International Semiconductor Conference in either the second or third year of the project. One additional dissemination direction is related to graduate and post-graduate lectures taught to students attending the University "Politechnica" of Bucharest.

2.5.5. FRAUNHOFER

Fraunhofer IZM aims a dissemination of the results through multiple channels and tailored for different target groups. Initially, the results of SPIDER subsystems and the planned SPIDER overall demonstrator will be presented in cooperation with the project partners in appropriate journals and at conferences. Here, we strongly follow the suggestions of journals and conferences made by the partners, who are already involved for decades in expert circles on magnetic spin waves. Furthermore, Fraunhofer IZM will publish further technical papers on sub-aspects of packaging. Here too - together with partners from the consortium - corresponding publications and conference papers will be prepared. In particular, the specifically developed packaging methods for the phase-correct annealing (essentially through precisely controlled lengths) of a large set of channels promises to be of great importance for applications in wireless telecommunications (5G/6G, WiFi) and radar sensor technology. Since with such techniques the transmit beam can be precisely controlled by driving different antenna elements with a defined phase offset. This is presented in technical papers on packaging (e.g. IMPAS, IMPACT) and on radar conferences (e.g. EuRAD and RadConf). In addition to providing highly technical information about the project and sub-technologies, Fraunhofer IZM will use its established social media channels to present the main project content in a comprehensible way, even for laypersons in this field, and to highlight the potential added value of the targeted developments. Likewise, the knowledge generated in the SPIDER project will be incorporated into university knowledge transfer, as Fraunhofer IZM will take on teaching activities there in cooperation with universities and colleges. The same applies to the transfer of knowledge in the context of qualification theses, which are prepared directly at Fraunhofer IZM or are supervised at corresponding institutions.

2.5.6. TUD

TUD will disseminate the theoretical and experimental results of the project in the academic environment. Specifically, our target is the further spread of knowledge on spin wave devices in all similar fields and future professionals. To achieve that, our plan is to publish our results and conclusions in collaboration with the other SPIDER partners though publications in conferences who mainly focus on magnonics and spintronics. The goal is to increase the interest and research in the field of spin waves by showing their true potential. These publications will start to materialize from the start of the second year of the project when our results will be thoroughly examined and analyzed. Apart from publications, preprints of publications will be uploaded to arXiv enhancing in that way the accessibility to a wider public.

2.5.7. THALES

THALES will follow the communication and dissemination guidelines which have been set by the Grant Agreement and accepted by the consortium. We will disseminate SPIDER's results towards other R&D researchers by peer-reviewed scientific publications and international conferences and presentations in national and international conferences and workshops. Of course, we will focus on the dissemination and communication towards industrial partners by participating to dedicated industrial workshops (e.g., EFECS) and by organizing dedicated meetings with Thales Business Units to present them the latest results.

3. Exploitation

3.1. Plans per partner

3.1.1. IMEC

IMEC's exploitation interests lies mainly in the generation of intellectual property (IP) in the fields of spin-wave logic devices and circuits. IMEC positions itself as a research center that links fundamental research in academia with industrial applications in the semiconductor industry. IMEC's business model is based on leading-edge industrially-relevant semiconductor research together with multiple partners all along the semiconductor industry supply chain up to integrated device manufacturers and system level companies. Projects such as SPIDER are central to ensure that IMEC remains at the forefront of industrially-relevant research on beyond-CMOS logic technologies, e.g. disruptive spintronic approaches for logic circuits, and continues to lead the industry in this field. IP generation and patent filing are key activities in this framework. Therefore, IMEC will exploit SPIDER results mainly by broadening its IP generation and by keeping and attracting industrial research partners to its research program on spintronic logic.

3.1.2. AKRONIC

SPIDER and Akronic's outputs within this project, will further enhance the R&D capabilities of the company and will further strengthen our position and capability in securing future Horizon Europe projects in relevant fields. SPIDER's success is something we plan to leverage towards that direction. In addition, the project with further strengthen out IP portfolio and more importantly, our silicon proven IP portfolio. It provides a platform to de-risk some of our offerings and to strengthen our propositions to our customers, while also allowing us to improve past designs. We will thus exploit the project, its success and its outputs to attract more customers and to polish our profile and position in the global RF/mmWave microelectronics industry. The project also allows a growth in the technical know-how of the company and the training and growth of our younger technical staff, that are invaluable to the company and the outcomes of other internal and customer-based product activities.

3.1.3. RPTU

RPTU's interest in exploiting the results generated by the project is mainly focused on fundamental research. As the combination of magnonic with CMOS will open up a completely new field of research, we want to investigate the necessary fundamental understanding and technical know-how for this technology. This will address the questions of how the magnonic system can be tailored to the CMOS environment to enable the most efficient coupling.

In the long term, investigating complex magnonic logic gates that go beyond the Majority gate is a key area for exploitation. This research will enable the development of more efficient and powerful systems that can be used in a wide range of applications. The SPIDER project will lay the groundwork for this area of research and will potentially arouse interest of new industry partners.

3.1.4. IMT

IMT will exploit the results obtained through the SPIDER project to further advance our understanding of the complex field of microwave spintronic devices and hybrid CMOS/spinwave systems. This knowledge will assist in the establishment of new research directions within IMT, as well as facilitate the participation in future national and EU projects. The results will further be exploited in the training of young professionals attending the Masters and PhD programs of the University "Politehnica" of Bucharest, Faculty of Electronics.

3.1.5. FRAUNHOFER

Since the research questions processed in SPIDER by Fraunhofer IZM are also highly relevant for the further development of high-frequency packaging technology, the research results from SPIDER are also transferred directly to these projects. In particular, the real measurement of complex test setups with regard to their high-frequency characteristics carried out in SPIDER interactively provides valuable insights, since these are highly inhomogeneous systems with a wide mix of materials, such data are required to calibrate models and, In general, a basic understanding of possible packaging concepts to get.

3.1.6. TUD

Our goal is to exploit the results obtained from the SPIDER project to further enhance our knowledge and understanding of the field of spin waves and how they can be integrated to computing systems. Surely, these results will guide us to new research projects that will examine new ideas and concepts that will help the field of spin wave computing advance even further.

3.1.7. THALES

The objective of THALES in SPIDER is to prove that the spin-wave technology can be integrated with CMOS to make dedicated functions, in the beginning for the function studied in SPIDER but eventually with the aim of generalizing this approach to other devices, i.e., radiofrequency devices. On one side we will work on the design and characterization of the building blocks of SW devices (transducers, amplifiers, directional couplers, phase shifters, etc.) in order to optimize those building blocks and potentially identify novel functions; we expect IP to be generated on these aspects. Furthermore, we will support the other partners involved on the integration and assembling stage, both from EW simulation and physical assembly of the devices. The tests for benchmarking expected at the end of the project, and more general most of the reports of WP6, will be the ideal results to be used to ocnvince other industrial partners of the potential of SW technology. We will also take advantage of the network SpinTronicFactory in order to further stress the link with other existing activities on the spintronic domain to reinforce our vision that spintonics in general (and magnonics more specifically) can be a game changer in future applications. Indeed, at the end of the SPIDER projects the community will have several examples (at least from the other funded project at the same call but more generally within other running projects in similar subject) of proof-of-concept integrating spintronic technology with CMOS. Follow-up project at higher TRL will allow to bring this integration to another level and allow the emergence of spintronic devices in different markets. However, this will be possible only if several

existing bottlenecks will be solved, including the heterogeneous integration, which is indeed one of the main objective of the SPIDER's project.

4. Communication Plan

This part describes the communication plan for the SPIDER project, including the different tools, channels and means of communication that will be implemented throughout the project duration. It contains the project visual identity and specific materials and channels, and the main strategic and operative guide that shall govern the overall project dissemination and communication activities. These guidelines will help to ensure that relevant information is shared with appropriate audiences on a timely basis by the most effective means. The project coordinator, IMEC, will lead the dissemination activities with the support of all partners. The main objective of the dissemination and communication activities is to maximize the general impact of the project.

The communication strategies will be implemented through a combination of an effective visual identity and specific materials and channels (website, LinkedIn, etc.) that will follow the same style and pattern.

Primary dissemination starts with the project visibility. Templates to be used for presentations, reports, and public deliverables will be provided by IMEC to all partners as a Communication Toolkit.

The visual identity of SPIDER revolves around the logo and the templates. The logo created for the project will be used in all dissemination and communication activities. The SPIDER logo is available in the SPIDER MS Teams Workspace, hosted by IMEC, and accessible to all the partners.

4.1. Project Identity

4.1.1. Logo

The project logo was created at the beginning period of the project. Four versions were approved by all partners and look like this:

Figure 1: Four versions of SPIDER logo

The logo is to be used on all the communication about the project. All members are free to choose which one to use depending on the scenarios (e.g., positive horizontal version is PPT-friendly and print-friendly).

4.1.2. Project templates

The visual identity of the project will be reinforced by using specific project templates. In this sense, IMEC has produced *.docx and *.ppt templates that should be used for all deliverables, milestone reports and presentations. There might be slight adaptations of the templates as the project progresses, based on the practical experience from using them or for other reasons like a partner changing its logo, etc.

4.1.3. Website

The SPIDER website is a key channel to disseminate the project contents and at the same time a communication tool to promote the project and its visibility. The website www.spider-horizon.eu is being created. It is hosted by IMEC not only for the duration of the project, but 3 years longer after the end date of the project.

At this moment, the website is still under construction. Soon, we plan to share general information, publications, deliverables, news... about the project SPIDER.

Figure 2: Preview of the SPIDER website

4.1.4. Social Media

We decided to be active on LinkedIn. For this we created a 'company' page: https://www.linkedin.com/company/spider-horizon-project.

Xia Han (IMEC) and Veroni Ballet (IMEC) are currently "Super admin" of this company site, who manage everything on the page, including managing all other admins. Active members from all partners have been assigned the role "Content admin", which allows them to post and manage content, comment as the Page, and export analytics. It has been agreed by all partners that no approval procedure is required for contents being posted to the LinkedIn SPIDER company page.

5. Conclusions

This deliverable covers the dissemination, exploitation and communication activities of the SPIDER project and describes how the results generated in the frame of the project are used by the partners and communicated to the different stakeholders. It is a living document that will be adapted during the course of the project to reflect the current status of the actions undertaken and planned.