



FVLLMONTI

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school report*

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DOCUMENT ABSTRACT

This deliverable, D.6.11, presents a comprehensive report on the workshops and summer school events held and organized during the project lifecycle (e.g E3AI Summer School held in Bordeaux in June 2023). The report aims to underscore the event's impact on disseminating and exploiting project results, aligning with the objectives of Work Package 6: to enhance communication and exploit project outcomes within the scientific community and beyond. The deliverable is principally filled with insights on the E3AI summer school's success. Future actions and activities involved in the T.6.3 are presented too.



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LIST OF ACRONYMS / GLOSSARY

AB: Advisory Board	PO: Project Officer
AI: Artificial intelligence	PR: Project Reporting
BSS: Bordeaux Summer school	PT: Partner
CFS: Certificate of Financial Statement	PU: Public
CO: Confidential	S: Summer school
D: Deliverables	TK: Task
D&E: Dissemination & Exploitation	V: Version
DoA: Description of Action	WP: Work Package
EC: European Commission	WPL: Work Package Leader
E3AI: Energy efficient embedded artificial intelligence	W: Workshops
FS: Financial Statement	
GA: Grant Agreement	
KPI: Key project indicators	
M: Month of the project	
O: Organization	
P: Participation	
PC: Project Coordinator	
PM: Project Manager	
PNB: Project NetBoard	

PROJECT OVERVIEW – DISSEMINATION OBJECT BASIS

The FVLLMONTI project represents a pivotal step in the advancement of neuromorphic computing technologies. This project is at the forefront of the fourth industrial revolution, addressing the European priority for an innovative, inclusive, and sustainable society. Its core objective is to develop a groundbreaking, lightweight in-ear device that facilitates efficient speech-to-speech translation. This endeavor addresses the current limitations of Internet of Things (IoT) devices, which are often energy inefficient and reliant on internet connectivity.

The FVLLMONTI project is distinctive for its exploration into 3D stacked hardware layers of artificial neural networks (NNs) utilizing vertical nanowire field-effect transistors (VNWFEs). This technology is set to transcend the capabilities of traditional 2D electronic architectures and conventional CMOS technology. The project focuses on mitigating the high energy consumption and intensive computation needs of current NNs used in machine translation, along with the data protection and privacy issues associated with server-based implementations.

Emphasizing a fine-grained hardware and software co-optimization strategy, the project aspires to achieve the most efficient machine translation possible. The consortium comprises a diverse group of experts in nanoelectronics, unconventional logic design, reliability, system-level design, machine translation, and cognitive sciences. It notably includes 50% junior researchers and 90% first-time participants in FETPROACT, demonstrating its commitment to fostering new talent and innovative thinking.

The FVLLMONTI project is fundamentally exploratory, aiming to transition from one Technology Readiness Level (TRL) to another (e.g. from TRL2 to TRL4), building upon existing state-of-the-art technologies. While initial results have been more conceptual, the project is now progressing towards more tangible outcomes as it approaches the end of the second reporting period (RP2). This progression underscores the project's dedication to pushing technological boundaries and contributing significant new knowledge and innovations in the field.

For more information about this pioneering project, please refer to the project's page on the CORDIS website: [FVLLMONTI Project on CORDIS](#).

- **DOI:** [10.3030/101016776](https://doi.org/10.3030/101016776)
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- **Type of Funding - Agency:** Research and Innovation Actions (RIA)
- **Funding amount:** 4 760 060 euros
- **Theme:** Neuromorphic computing technologies

I. PRINCIPAL TECHNOLOGY DEVELOPMENT RELATED OBJECTIVES

The FVLLMONTI vision is to develop regular 3D stacked hardware layers of NNs empowering the most efficient machine translation thanks to fine-grained hardware / software co-optimization. This will be achieved through actual VNWFET fabrication by setting up a design-technology co-optimization (DTCO) approach. More specifically, FVLLMONTI is organized around 4 specific objectives:

- **Compactness** From fabricated low-complexity hardware to minimal neural network compute cube (N2C2). This objective concentrates on the compactness of the elements in the FVLLMONTI value chain from low-level logic blocks up to a critical compute function in N2C2 to ensure the computation resource footprint.
- **Performance** Energy-delay-product assessment of the computational layer, the embedded Non-Volatile Memory (e-NVM) and interconnects. This objective is designed to quantify the conventional figure-of-merit energy-delay-product (EDP) towards fast and ultra-low-power data transfer between the e-NVM using ferroelectric-gated VNWFET and the computing layer, thereby addressing the whole FVLLMONTI value chain from low-level logic blocks up to a critical compute function in N2C2.
- **Validation** of the VNWFET technology for live English-French streaming speech recognition to text. Here we focus on exploring the use of VNWFET-based 3D logic cells and e-NVM blocks in multiple layers of NNs enabling ultra-compact and energy-efficient Transformers NNs for Automatic Speech Recognition (ASR) and Machine translation (MT). Their compactness and EDP will be compared with general-purpose architectures with CNN accelerators. To validate the approach, the target application is live English-French streaming speech recognition to text.
- **Robustness** of the 3D NN Architecture. The objective is to assess the reliability of VNWFET devices at the early step of their development. The impact of the identified wear out failure mechanisms will be appraised on the whole FVLLMONTI value chain: N2C2, 3D NN architecture and up to the ASR and MT application. Beyond the specific translation application, the final intent is to demonstrate the intrinsic 3D NN architecture robustness.

II. TECHNICAL EXPECTED RESULTS

In line with the above objectives the present project achievements will be measured based on the following technical key performance indicators (KPIs):

- **KPI1:** Functional logic blocks (LB) using Junctionless (JL) VNWFET with two stacked-gate layers and polarity-controllable (PC) VNWFETs with one stacked-gate layer
- **KPI2:** Functional e-NVM cell using hafnium oxide ferroelectric-gated VNWFET. Data retention and endurance suitable for Logic-In-Memory (LiM) Applications
- **KPI3** Area assessment for 1-bit full adder designs featuring reconfigurable and/or non-volatile functionality

- **KPI4** EDP assessment for JL VNWFETs, I_{ON} of at least $300 \mu A/\mu m$ at a supply voltage below 0.9V with scaled gate length
- **KPI5** EDP assessment for PC VNWFETs, I_{ON} of at least $10 \mu A/\mu m$ at a supply voltage below 2 V
- **KPI6** EDP assessment for read and write operation of a single transistor ferroelectric VNWFET cell with 3 V write voltage and 2 V operation voltage or below
- **KPI7** EDP assessment of 1-bit FA designs exploiting reconfigurability and/or e-NVM function
- **KPI8** NN compression size
- **KPI9** For ASR and MT, EDP assessment
- **KPI10** Word Error Rate (WER) on read English and French
- **KPI11** Bi-Lingual Evaluation Understudy (BLEU) score
- **KPI12** Intrinsic 3D NN architecture robustness, irrespective of the application: Architectural Vulnerability Factor (AVF)

These KPIs form the foundation of our dissemination strategy. However, effective dissemination requires more than just publications and conference talks. It involves simplifying our presentation of results and engaging in meaningful dialogue with diverse audiences. Each dissemination channel requires a tailored approach, ensuring that our scientific work is communicated clearly and compellingly. This approach underscores the importance of adaptability and strong argumentation in our dissemination efforts, highlighting the challenge and significance of scientific communication in highly technical fields.

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DISSEMINATION STRATEGY OVERVIEW

The overall aim is to maximize the dissemination potential of FVLLMONTI and broaden the utilization of project outcomes. Dissemination activities then, must be tailored in such a way as to reach targeted audiences more efficiently through appropriately selected dissemination channels and tools. This section describes the different kinds of stakeholders that the FVLLMONTI consortium will target within the context of the project's dissemination and communication activities. The table below, provides an overview of the identified target audiences as the FVLLMONTI D&E activities ones, with details concerning the related intended communication actions, and specifying which communication tools are most suitable for the various target groups.

Key tasks include:

- Developing the project's visual identity and public dissemination materials.
- Broadcast channels animation, with dedicated and created content.
- Tracking project publications and disclosures.
- Managing the Data Management Plan.
- Informing partners of relevant events and conferences.
- Enhancing visibility through social networks and event organization/participation.

Target groups	Content	Used Channels	Targeted Channels
Scientific community	General information about the project Scientific results Technological innovations New findings	Project website ● Workshops ●● Conferences ● Publications in peer-reviewed scientific journals ●	Factsheets ● Summer school ●
Industry leaders / Industrial end-users	General information about the project New findings Technological innovations Scientific results	Project website ● Industrial conferences ●● Other Dissem. events ● Publications in peer-reviewed Scientific journals ● Advisory board meetings ●	Factsheets ● Policy briefs ● Trade fairs ● Workshops ●●

Dissemination plan involving Workshops and Summer school implementation

Implementation Indicators:

- Implemented or continuous management
- In progress, initiated process
- Option for a concrete dissemination action are monitored

The strategy detailed in the D.6.4 (M38), is well intricately connected with the T.6.3 event's achievements, to ensure that our work and innovations, are effectively shared with targeted audiences.

WORKSHOPS HELD (M38)

In the European research landscape, workshops and summer schools are vital platforms for sharing knowledge and fostering collaboration between students, science communities and broader industries. They play a pivot role in advancing scientific fields by enabling the exchange of innovative ideas and techniques with concrete realizations.

FVLLMONTI Workshop

1. "First extraction of thermal contribution in 3D Vertical Junctionless gate-all-around Nanowire Transistors", by B. Burucoa, AVIC, Bordeaux, France, Sep. 2021.
2. "Characterization and Modeling of vertical Junctionless silicon nanowire transistors for 3D logic circuits", by Y. Wang, GDR-SOC2, Strasbourg, France, June 2022.
3. "Analysis of an Inverter Logic Cell based on 3D Vertical NanoWire Junction-Less Transistors" by L. Réveil, GDR-SOC2, Strasbourg, France, June 2022.
4. "Methodology for thermal contribution extraction of 3D Vertical Nanowire Transistors", by B. Burucoa, GDR-SOC2, Strasbourg, France, June 2022.
5. "Characterization and Modeling of Vertical Si nanowire transistors (VNWFET) for 3D logic circuits", by Y. Wang, FETCH, Vaud, Switzerland, Feb. 2023
6. G. Ansaloni, R. Medina and A. Amirshahi, "System Exploration with gem5-X", at E3AI Summer school, Bordeaux, France, 2023.
7. Gerhard RZEPA, Christian Schleich, "Circuit-design & Hands-on project on GTS Software", at E3AI Summer School, Bordeaux, France, June 2023.
8. Marina DENG, Chhandak MUKHERJEE, Magali DE MATOS, "On wafer measurement of emerging technology", at E3AI Summer School, Bordeaux, France, June 2023
9. I. O'Connor, D. Atienza, J. Trommer, O. Baumgartner, G. Larrieu, C. Maneux, "Emerging technology-based 3D compute cubes for edge intelligence," X-GDR BarCamp sur les Défis d'Implémentation de l'IA : Sécurité, Fiabilité, Soutenabilité et Nouvelles Technologies, Aussois, 13-15 December 2023
10. Amirshahi, Alireza, Giovanni Ansaloni, and David Atienza. "Accelerator-driven Data Arrangement to Minimize Transformers Run-time on Multi-core Architectures.". 15th Workshop on Parallel Programming and Run-Time Management Techniques for Many-Core Architectures and 13th Workshop on Design Tools and Architectures for Multicore Embedded Computing Platforms (PARMA-DITAM 2024), Munich, Germany, January 18, 2024.
11. Cristell Maneux, Giovanni Ansaloni, Axel Pomepui-Guihard, « workshop for EIC Projects - Uniting European Innovators for Deep Tech Advancements", Online, Feb.2024
12. Pathak, K., 2023, June. Validating Full-System RISC-V Simulator: A Systematic Approach. In RISC-V Summit Europe 2023.
13. "Investigation of nanoscale electrothermal effects in JLNT device", by H. Rezgui, GDR-SOC2, Lyon, France, June 2023

14. “Evidence of Trapping and Electrothermal Effects in Vertical Junctionless Nanowire Transistors”, by Y. Wang, GDR-SOC2, Lyon, France, June 2023

Table 1– M38 List of Workshops participation or organization as a result of the project

Dissemination to young scientists, and to other near disciplines with the potential for relevant collaboration, is also important, as it helps to encourage new research and innovation capabilities, and to provide opportunities for cutting-edge science. Throughout the FVLLMONTI project, this type of dissemination is implemented by workshops organization, but also via interdisciplinary coaching of the PhDs and Post-Docs of the consortium. Currently, 9 members of the FVLLMONTI team undergo a PhD supervision in their respective University.

E3AI SUMMERSCHOOL IN BRIEF (06/203)

I. BORDEAUX SUMMER SCHOOL & THE E3AI AS AN INTERNATIONAL EVENT

The Bordeaux Summer Schools, hosted annually by the University of Bordeaux from May to September, offer a comprehensive educational experience. They encompass a variety of disciplines including neuroscience, demography, oenology, and cardiology. These summer schools are primarily aimed at advanced students (second and third cycle) and young researchers. The programs are designed to be interdisciplinary, providing attendees with a broad spectrum of knowledge and skills. These summer schools not only enrich the educational journey of the participants but also contribute significantly to their professional and academic development in diverse scientific and research fields.

The E3AI summer school represented a unique opportunity for the University of Bordeaux to position itself as a world class leader in an emerging field with a high impact potential for both industry and academia. This potential is clearly shown by the support received by the university through three separate projects recently funded by the European Commission (HERMES; RADIOSPIN; FVLLMONTI). Each of these projects addresses a widely different application area from language processing to 6G communications and healthcare, showing a high potential for significant impact in other applications areas. Making Embedded Artificial Intelligence a research priority at University of Bordeaux will drive its vision towards a future of responsible and green Artificial Intelligence.

Starting from the basis of existing research, and going to the extended network of partner projects with a similar research vision, the university reinforced on-going collaborations maximizing impact. For example, the FVLLMONTI project is part of a network of 4 other research projects including COMPRISE, NeurONN, MISEL, and WiPLASH. As part of this collaboration, projects are sharing information, news and events to their respective research communities directly and through social media.

The organising committee, the invited speakers as well as the participants all have an international background, setting the basis for future collaborations in terms of research and training (e.g Summer school V2). The summer school will highlight the active participation of researchers from the University of Bordeaux to EU funded research projects that leverage international and interdisciplinary research networks. It showcased existing initiatives at University of Bordeaux in the area of Artificial Intelligence including the Smart4D and TIC Santé clusters that currently involve almost thirty start-ups. In addition the international attractivity of the University of Bordeaux in our field, with three chairs in Artificial Intelligence that were recently named including Pierre-Yves Oudeyer - Inria Bordeaux, Sylvain Saïghi - IMS UBx, and Meghyn Biennu, LaBRI UBx; will permit us to look forward and capitalize on our whole expertise.

II. EVENT SCIENTIFIC SIDE IN BRIEF

The E3AI had three principal pivot motivations and objectives. They are the following ones:

- **Educational objectives:** The educational objectives of the summer school reflect the highly interdisciplinary nature of the Embedded Artificial Intelligence research area, covering on one side topics related to fabrication, characterisation, modelling, design, simulation and exploration of neuromorphic devices and on the other side application-specific topics including speech and text processing, 6G communications, and radio frequency oscillators. The core objective of the summer school is to cover hardware-related aspects of neural networks while aiming to provide participants with a basic understanding of neural network implementation. More specifically during the summer school participants will learn about:
 - *Introductory aspects of neural networks*
 - *Hardware enhancement using Artificial Intelligence*
 - *Electrical characterization of functionality*
 - *Logic cell design*
 - *System simulation and exploration*
 - *TCAD and compact modelling using 3D layout*
 - *Fabrication of vertical Gate All Around (GAA) transistors*
 - *Spintronics for hardware neural network accelerators*
 - *6G: design of transceivers implemented in an autonomous system*
 - *Communications at sub-THz frequencies in CMOS technology*
 - *Transformer architectures for machine translation and speech processing*
 - *Applications in recognition of RF fingerprints and breast cancer*
- **Scientific motivations:** Artificial intelligence and deep learning applications currently require massive amounts of computing resources that are not easily accessible for low-latency applications handling sensitive data. Massive data sources have to be pushed to multiple high-speed computers in remote server farms, raising serious concerns related to security and privacy.

A possible solution comes from executing machine learning models on embedded devices, a topic generally known as Embedded Artificial Intelligence. This calls for a close integration of software and hardware solutions with highly optimized machine learning models and a new generation of lightweight, energy-efficient embedded hardware suitable for executing neural networks on edge devices. The E3AI summer school aims to equip participants with the interdisciplinary knowledge and skills needed to develop innovative circuit architectures and execute extremely data intensive applications on resource constrained devices.

- **Teaching methods:** Plenary lectures led by local and international experts from academia and industry. In addition, we will organize a poster session where participants can present their research projects and discuss connections with summer school topics. Moreover, several practical sessions are planned where participants will work with dedicated design software and visit the measurement laboratory.

E3AI SUMMERSCHOOL – ON SITE ORGANIZATION

The two principal stakeholders were the IMS Laboratory as *Project holder*, and the University of Bordeaux project team, mentioned as *BSS Project team* in the following section of the document. With respect to the following calendar, the event has been organized on 6 months, without considering the time for call response the past summer before the event, with proposal submission by the project holder.

1. *Preparation process*

Reservation of spaces and premises

Timeline: December 2022

Prerequisites: Room needs communicated during the call for applications

Who in charge: BSS Project team

Optioning of hotel rooms for participants and speakers

Timeline: January 2023

Who in charge: BSS Project team

Creation/update of websites and web and print communication materials

Timeline: January 2023

Prerequisites: Preliminary program / List of speakers

Who in charge: BSS Project team

Validation of content and communication materials

Timeline: January 2023

Who in charge: IMS Project holder

Start of the call for applications

Timeline: January 2023 - week 4

Prerequisites: Validation of website content and communication materials

Who in charge: BSS Project team and IMS Project holder for distribution

End of the call for applications

Timeline: March 31, 2023 (10 weeks)

Who in charge: BSS Project team

Selection of applications and sending of the final program of the school

Timeline: April 3 to 7, 2023

Prerequisites: Sending of the application summary by the project team

Who in charge: IMS Project holder

Sending of notifications and launch of online registrations

Timeline: April 11 to 14, 2023

Prerequisites: Return of candidate selection, Set up of PayBox

Who in charge: BSS Project team and IMS Project holder

End of online registrations

Timeline: May 2, 2023 (3 weeks)

Prerequisites: Closing PayBox

Who in charge: BSS Project team

Sending email "Looking forward to seeing you"

Timeline: 2 weeks before the start of the school, Reminder 1 week before the start

Prerequisites: Confirmed scientific and social program

Who in charge: BSS Project team

Holding of the summer school

Timeline: from the 19th to 23th of June

Prerequisites: Goodies, program, kakemonos, Support for welcoming participants

Who in charge: BSS Project team and IMS Project holder

Sending email "Thank you for coming"

Timeline: Last day of the summer school

Prerequisites: Issuing of certificates and satisfaction questionnaire

Who in charge: BSS Project team

2. Tasks summary – Effort repartition

In sum, the BSS service provided comprehensive online support, including website development, content creation based on our application dossier, and project holder's approval for publication. They also offered extensive communication and promotional assistance, supplying customized tools and materials in English and French, such as promotional brochures, a dedicated website, mailings, acceptance/refusal notifications, and email templates. Additionally, BSS facilitated the venue booking, managed online payments for participant registration, and secured early accommodation options. On-site support during the event's first day included participant welcome, communication tool distribution, signage setup, and photographer coordination.

In contrast, the IMS Laboratory, as the project holder, was responsible for developing the scientific and social program, managing the on-site summer school's scientific activities, selecting candidates in amount of the event, seeking financial partnerships, handling external speakers' expenses, and coordinating on-site service providers.

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E3AI SUMMERSCHOOL PROGRAM AND PARTICIPATIONS

Monday June 19 th	Tuesday June 20 th	Wednesday June 21 st		Thursday June 22 nd	Friday June 23 rd	
11.30 – 12.30 Registration	09.00 – 10.00 Circuit design - introduction to GTS software <i>Gerhard Rzepa, Christian Schleich</i> Conference room - B0.01	09.00 – 11.30 Lecture 2 Enhanced technologies for communication <i>Didier Belot, François Rivet, Maxandre Fellman</i> JP Dom amphitheatre - A0.85		09.00 – 12.30 Hands-on session Design and training of a basic neural network (GrAI) Part 1 <i>Sylvain Saighi, Adrien F. Vincent, Valentin Meunier</i> JJ. Riviere - A0.48	10.00 – 12.00 Group 1 FVLLMONTI: system exploration with gem5-X <i>Giovanni Ansaloni, Alireza Amirshahi, Rafael Medina Morillas</i> Carac Nanocom	10.00 – 12.00 Group 2 Hermes: communication boosted by artificial intelligence <i>François Rivet, Maxandre Fellman</i> JJ. Riviere - A0.48
	10.00 – 12.00 Hands-on project <i>Gerhard Rzepa, Christian Schleich</i> JJ. Riviere - A0.48	11.30 – 12.30 Group 1 On-wafer measurement of emerging technology <i>Chhandak Mukerjee</i> JP Dom amphitheatre - A0.85	11.30 – 12.30 Group 2 Hands-on project <i>Magalie de Matos, Marina Deng</i> JP Dom amphitheatre - A0.85			
12.30 – 13.30 Lunch	12.30 – 13.30 Lunch	12.30 – 13.30 Lunch		12.30 – 13.30 Lunch	12.00 – 13.00 Farewell lunch	
13.30 – 14.00 Opening <i>Cristell Maneux, François Rivet, Sylvain Saighi</i> JP Dom amphitheatre - A0.85		13.30 – 14.30 Group 1 Hands-on project <i>Magalie de Matos, Marina Deng</i> Carac Nanocom	13.30 – 14.30 Group 2 On-wafer measurement of emerging technology <i>Chhandak Mukerjee</i> Carac Nanocom	13.30 – 15.00 Hands-on session Design and training of a basic neural network (GrAI) Part 2 <i>Sylvain Saighi, Adrien F. Vincent, Valentin Meunier</i> JJ. Riviere - A0.48		
14.00 – 17.00 Lecture 1 Theoretical introduction to the technologies <i>Emilio Calvanese, Sylvain Pelloquin, Thomas Mikolajick, Alice Mizrahi</i> JP Dom amphitheatre - A0.85	13.30 – 14.30 Circuit design - introduction to CADENCE <i>François Rivet, Nathalie Deltimple</i> Conference room - B0.01	14.30 – 17.00 Lecture - Hardware view of neural networks and their typology <i>Sylvain Saighi, Adrien F. Vincent, Valentin Meunier</i> JJ. Riviere - A0.48		15.00 – 17.00 Lecture 3 Applications <i>Jean-Luc Rouas, Michel Païndavoine</i> JP Dom amphitheatre - A0.85		
17.00 – 18.00 Discussion <i>JP Dom amphitheatre - A0.85</i>	17.30 – 17.00 Hands-on project <i>François Rivet, Nathalie Deltimple</i> JJ. Riviere - A0.48			17.00 – 18.00 Discussion <i>IMS laboratory hall</i>		
19.00 – 21.00 Welcome reception				19.00 – 21.00 Gala dinner		

Figure 1 : E3AI scheduled Program

1. *E3AI Teaching Modules descriptions*

Lecture 1 - Theoretical introduction to the technologies

The objective of this lectures is to present various state of the art technologies for Embedded Artificial Intelligence.

Part 1: The first part of the lecture introduced vertical nanowire field-effect transistors (VNWETs), a promising candidate for building blocks that enable 3D neuromorphic computing, increasing device performance and density. These innovative transistors can be configured as 3D stacked hardware layers that closely mirror the architecture of a typical neural network.

Part 2: This talk presented a very short overview of the major analog and RF technology features of the 28nm FDSOI planar CMOS technology. The benefits of FD-SOI technology for analog/RF circuits then been discussed, with a focus on IoT applications. Attendees learned about design techniques that take full advantage of the unique capabilities of FD-SOI, including body biasing to efficiently modulate on the fly SoC solutions from high performance operation to energy efficiency mode. This further enhances the excellent analog/RF performances of these devices. The second part of this presentation focused on novel design techniques that take full benefit of the new fourth transistor electrode (the body tie) and permit to get concurrent solutions that overcome the existing state of the art.

Part 3: This short lecture provided an overview of how one can use the physics of spintronic nanodevices to implement various functions commonly found in neural networks, e.g., activation function, synaptic weight, multiply-and-accumulate (MAC) operation, etc. Exploiting the richness of intrinsic behaviours offered by such a technology could pave the way for low-latency and low-energy hardware implementations of neural networks, in particular for RF signal processing.

Part 4: Yumain, formerly Global Sensing Technologies, is one of the French leaders in embedded artificial intelligence including sensors and neural networks (edge-computing). This presentation will provide an overview of the industrial applications that require embedded artificial intelligence.

Hands-on session - Circuit design with CADENCE

Cadence is a leading EDA and Intelligent System Design provider delivering hardware, software, and IP for electronic design. Students learned the basis of integrated circuit design using AMS 0.35um technology with the simulation of an inverter. They played on transistor dimensions, observe the electrical characteristics by several kind of simulations and draw conclusions.

Hands-on session - Circuit design with GTS

The GTS framework provided a sophisticated graphical user interface that allows users to design 3D nano structures. Participants learned how to view and analyse simulation results.

Lecture - On-wafer measurement of emerging technology

This tutorial covered dedicated DC and RF measurement techniques for on-wafer characterization of emerging technologies such as vertical nanowire transistors. Particular focus has been given to novel parameter extraction methods for important device parameters such as threshold voltage, thermal impedance, traps, gate capacitances and test-structure parasitic elements. The lecture covered the theoretical premise for several of these methods while the practical session will offer hands-on experience with some of these techniques in an experimental environment.

Hands-on session - On-wafer measurement of emerging technology

In this session, participants have been able to visit the IMS characterisation room and learn more about on-wafer measurements directly in the lab.

Lecture - Hardware view of neural networks and their typology

This talk introduced the event-based computing paradigm for neural networks. This computational approach requires few operations and is inherently suitable for embedded artificial intelligence. After presenting the interest of low power in artificial intelligence, the presentation reviewed existing industrial products, which will show the interest to pursue a research effort in the field of neuromorphic. The presentation focused on both inference and learning, based on concrete cases from research work carried out at the IMS.

Hands-on session - Design and training of a basic neural network

In this session, we used a user-friendly simulator of spiking neural networks. This simulator allowed students to play with the different parameters of the network for a training on a standard database. The neural networks constituted should be consistent with the technological elements discussed in the previous days.

Lecture – AI Applications

This lecture highlighted three separate applications of Embedded Artificial Intelligence including speech recognition and machine translation, 6G communications, as well as image recognition in industrial context (e.g. RF fingerprints and breast cancer). The goal of the first application was to build a lightweight in-ear device that allows on-device speech-to-speech translation, without requiring internet connectivity. The second application was motivated by the fact that Radio Frequency Integrated Circuits (RFIC) have made it possible to democratise communications with ever-greater data exchanges, allowing an increase in communication potential from one generation with 6G in sight and beyond.

Hands-on session – FVLLMONTI Demonstrator - System exploration with gem5-X

During this session, students have been introduced to the gem5-X system simulator and its main features. A hands-on tutorial which allowed attendees to acquire experience in simulating the execution of AI applications on complex systems, identify bottlenecks and deploy hardware and software optimization strategies.

Hands-on session - Hermes Demonstrator - Linearization of radio frequency power amplifiers

A novel concept for linearization of Radio Frequency (RF) Power Amplifiers (PAs) have been presented. The Walsh Transform is used for both a conversion scheme from digital to analogue and as a computational basis for evaluating a digital PA predistorter (DPD) model. The mathematical properties of the Walsh theory are exploited to enhance the convergence speed of conventional DPD algorithms and reduce their computational complexity. An experimental demonstration exhibits the performances of a broadband PA's DPD with simulations and measurements results of a 3-4GHz PA. For similar accuracy, the proposed method converges as fast as conventional algorithms with linear computational complexity instead of quadratic one.

2. E3AI involved Experts

Complete name	Structure	Project provenance	Grade	Expertise	Country provenance
Giovanni Ansaloni	EPFL	FVLLMONTI	Higher education teacher & researcher	System Exploration & Simulation	Switzerland
Didier Belot	CEA-leti	HERMES	Senior Scientist, researcher	6G: design of transceivers implemented in an autonomous system	France
Jean Luc Rouas	Labri	FVLLMONTI	Researcher	Transformer architectures for machine translation and speech processing	France
Emilio Calvanese	CEA-Leti	HERMES	Researcher	6G: design of transceivers implemented in an autonomous system	France
Nathalie Deltimple	IMS Laboratory	HERMES	Higher education teacher & researcher	Communications at sub-THz frequencies in CMOS technology	France
Marina DENG	IMS Laboratory	FVLLMONTI	Higher education teacher & researcher	Electrical characterization of functionality	France
Maxandre FELLMANN	IMS Laboratory	HERMES		Communications at sub-THz frequencies in CMOS technology	France
Magali de Matos	IMS Laboratory	FVLLMONTI	Higher education teacher & researcher	Electrical characterization of functionality	France
Rafael Medina Morillas	EPFL	FVLLMONTI	Researcher	System Exploration & Simulation	Switzerland
Valentin Meunier	IMS Laboratory	RadioSpin	Researcher	Spintronics for hardware neural network accelerators	France
Thomas Mikolajick	NamLab institute/T U Dresden	FVLLMONTI	Scientific Director	Nanoelectronics materials	Germany
Alice Mizrahi	Thales TRT	Radio Spin	Researcher	Spintronics for hardware neural network accelerators	France
Chhandak Mukherjee	IMS Laboratory	FVLLMONTI	Researcher	Electrical characterization of functionality	France
Sylvain Pelloquin	LAAS CNRS	FVLLMONTI	Researcher	Fabrication of vertical Gate All Around (GAA) transistors	France

François Rivet	IMS Laboratory	HERMES	Higher education teacher & researcher	6G: design of transceivers implemented in an autonomous system	France
Michel Paindavoine	N/C	YUMAIN Project/Hermes	Researcher	Hardware enhancement using artificial intelligence	France
Gerhard Rzepa	GTS	FVLLMONTI	Searcher	TCAD and compact modelling using 3D layout/ Logic cell design	Austria
Christian Schleich	GTS	FVLLMONTI	Searcher	TCAD and compact modelling using 3D layout/ Logic cell design	Austria
Sylvain Saïghi	IMS Laboratory	RadioSpin	Higher education teacher & researcher	Introductory aspects of neural networks	France
Adrien V.Vincent	IMS Laboratory	RadioSpin	Higher education teacher & researcher	Introductory aspects of neural networks	France

Table 2: E3AI experts detailed presentation

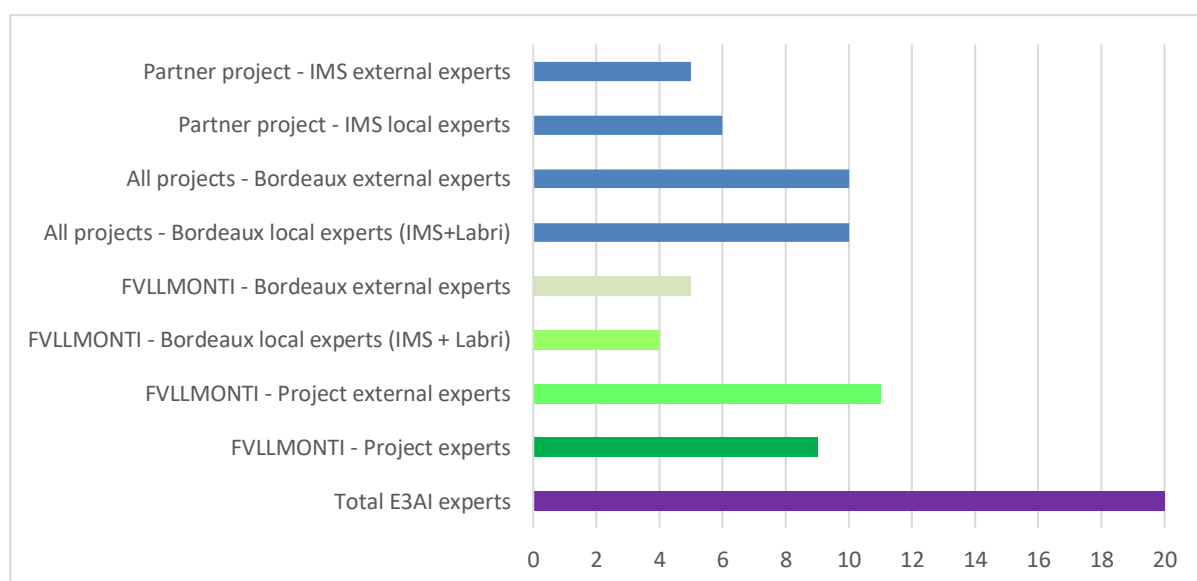


Figure 2: E3AI experts and affiliations

With relation to the table and figure mentioning the partner projects provenance, the global representation of the whole experts presents during the E3AI indicates that 45% of them was representants and/or partners of the FVLLMONTI project. The remaining experts came from our partner project as RadioSpin and HERMES. Each of the experts was covering, thanks to their respective specializations, the entire program of the summer school as indicated in the first parts of the overview.

Experts Nationality

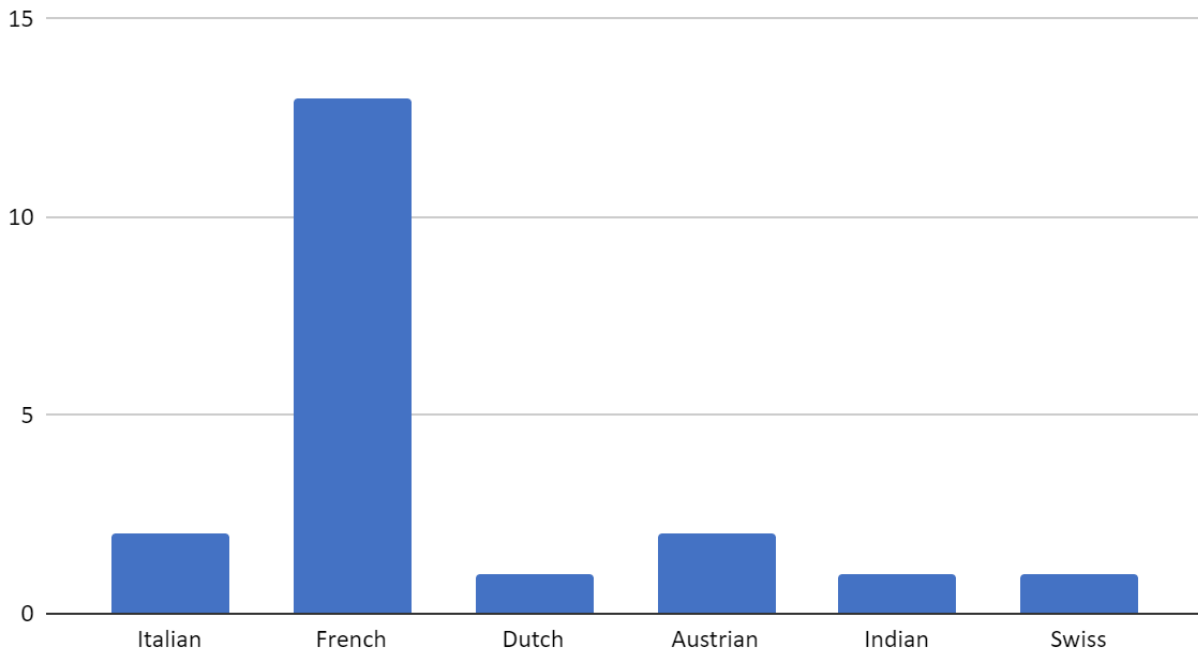


Figure 3: E3AI experts nationalities

A majority of the experts came from France (65%), with regard to their affiliation home structures. All the out of France experts were coming from the FVLLMONTI Project as EPFL, NamLab or Global TCAD Solutions (25%). In sum, the whole representation of the expert's was covering a European aspect of the various provenances and expertises. If we are attached to the nationalities, experts were 95% European.

FVLLMONTI experts' participations highlights:

- **[EPFL]** Session led by Giovanni Ansaloni and Rafael Medina Morillas was a comprehensive session on Computing Systems Performance Evaluation using gem5-X. Attendees learned to run full system simulations, define emulated systems, execute applications, and interpret key statistics. The session culminated in a design space exploration, illustrating gem5-X's utility in early performance evaluations of computing systems.
- **[IMS Laboratory]** Separately, Magali de Matos and Marina Deng conducted a hands-on tutorial on DC and RF measurements for vertical nanowire transistor characterization. This session delved into novel parameter extraction methods, revealing crucial device parameters. Parallel to this, Chhandak Mukherjee offered a lecture, providing deeper insight into the practical applications of these techniques.
- **[Global TCAD Solution]** Participants gained valuable insights into the integration of device variability in simulations. This knowledge is crucial for understanding its impact on performance and reliability, unlocking the potential of layout, geometrical, and material parameters. The session focused on cell design using TCAD tools for power-performance analysis, marking a shift away from traditional scaling. A dedicated workshop also delved into the co-optimization of circuit design and process technology.

3. E3AI involved students

Call opening date for candidature submission: 08/02/2023

Call closing date or candidature submission: 11/04/2023

Requirements: CV; Cover letter; abstract of the research project

Total number of candidatures: 27 students

Total number of selected candidatures: 20 students

Surname	First Name	Nationality	Student grade	Structure
Alhachem	Christina	Lebanese	PhD student	CEA, Grenoble, France
Alzate Banguero	Melissa	Colombian	PhD student	ESPCI - PSL
Anik	Istiaq	Bangladeshi	Master	University of Lyon, Lyon
Balti	Nidhal	Tunisian	PhD student	University of Rennes, France
BAZZI	Ali	Lebanese	PhD Student	CEA-Leti, Grenoble France
Gan	Qi	Chinese	PhD student	Telecom Paris, France
Gibertini	Paolo	Italian	Master	NamLab gGmbH, Dresden, Germany
Mannaa	Sara	Lebanese	PhD Student	Ecole Centrale de Lyon (ECL- INL)
Pezzullo	Gennaro Junior	Italy	PhD student	University of Rome "Camus Bio-Medico"
Réveil	Lucas	Français	Master	IMS laboratory, University of Bordeaux
Rezgui	Houssem	Tunisian	PhD student	IMS laboratory, University of Bordeaux
Shahroodi	Taha	Iranian	PhD student	TU Delft, Netherlands
Shaikh	Muhammad Bilal	Pakistan	PhD student	Edith Cowan University
Shen	Yukai	Chinese	PhD student	University Carlos III of Madrid
Vanhatalo	Tara	English	PhD student	IMS laboratory, University of Bordeaux
Wang	Yifan	Chinese	PhD student	IMS laboratory, University of Bordeaux
Yu	Pengbo	Chinese	PhD student	EPFL, Switzerland
Cakirlar	Cigdem	Turkish	PhD student	Faculty of Electrical and Computer Engineering, Toronto Canada
Neckel Wesling	Bruno	Brazilian	PhD student	IMS laboratory, University of Bordeaux
Timmermans	Jordi	Dutch	PhD student	University of Groningen, Netherlands

Table 3: E3AI accepted applications for in presence participation

Home organization

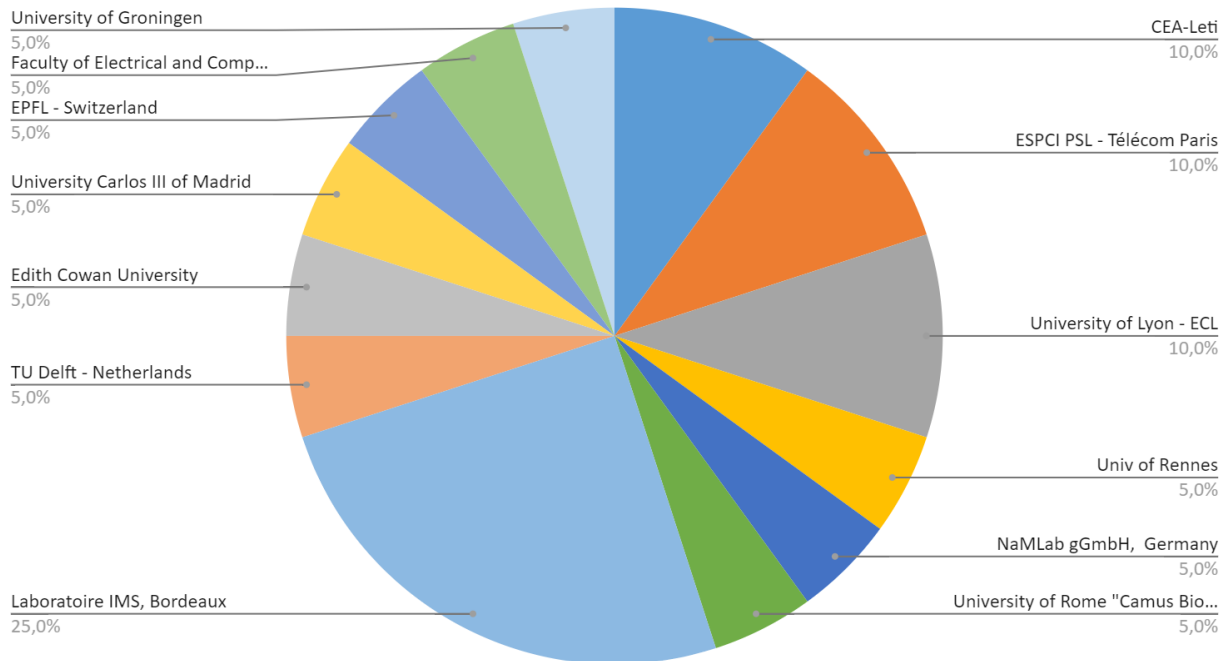


Figure 4: E3AI students by Home structure

95% of the in-presence participants came from European teaching and research structures, including a percentage of 60 for French ones. With regard to the nationalities, the international scope of European research is more significant, according to the fact that home organization involved in itself, international various representations:

Students Nationality

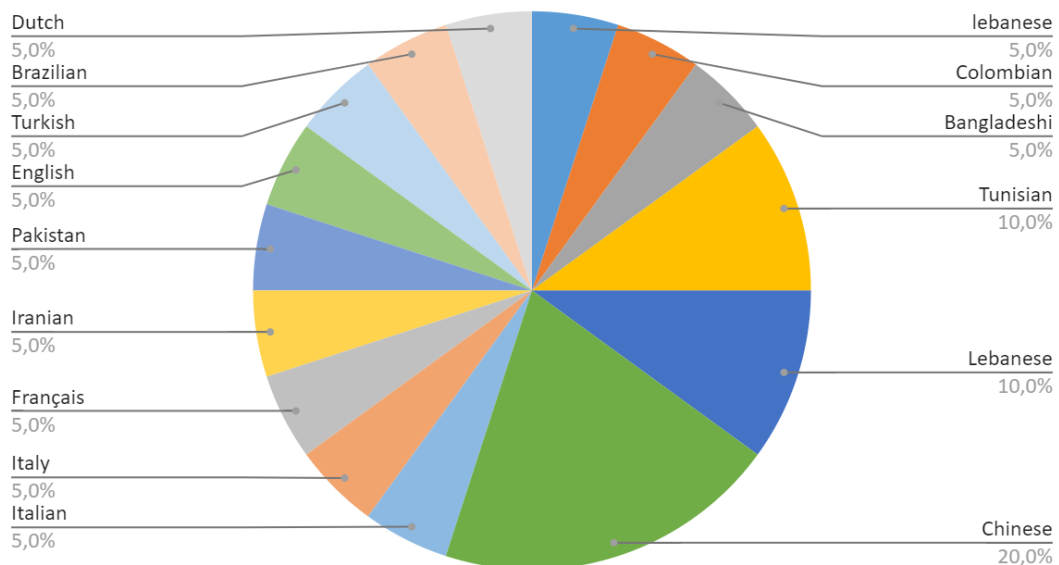


Figure 5: E3AI students nationalities

Except the home organization and affiliation structure of the participants students, only based on their nationality, the representation of them indicates that only 25% of them were European national people. This number confirm the international dimension announced above. 75% were extra European, including: 35% of people coming from Middle East countries; 30% of people coming from Asian countries; and 10% coming from Latin America countries. 85% of them were reaching a PhD degree, while the remaining part of them was reaching a Master degree (below).

E3AI Students University degree

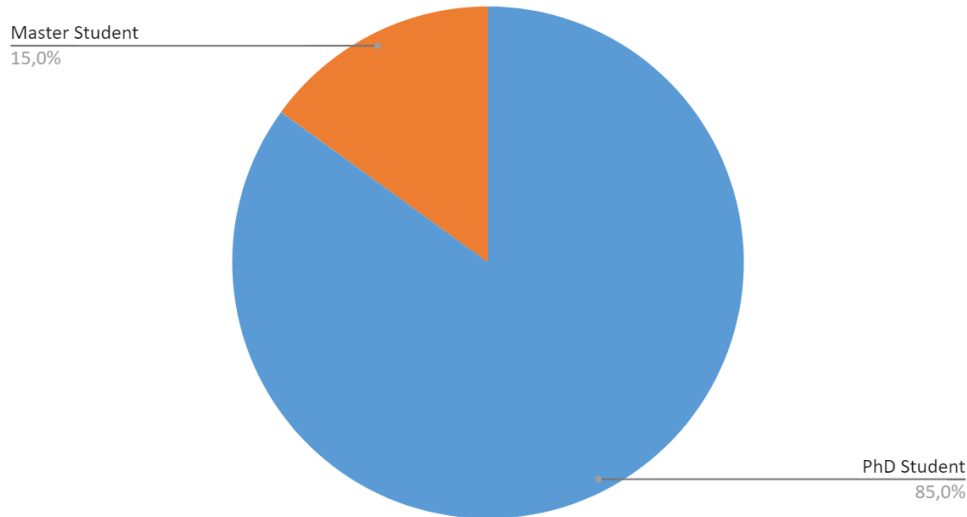


Figure 6: E3AI students reached degree

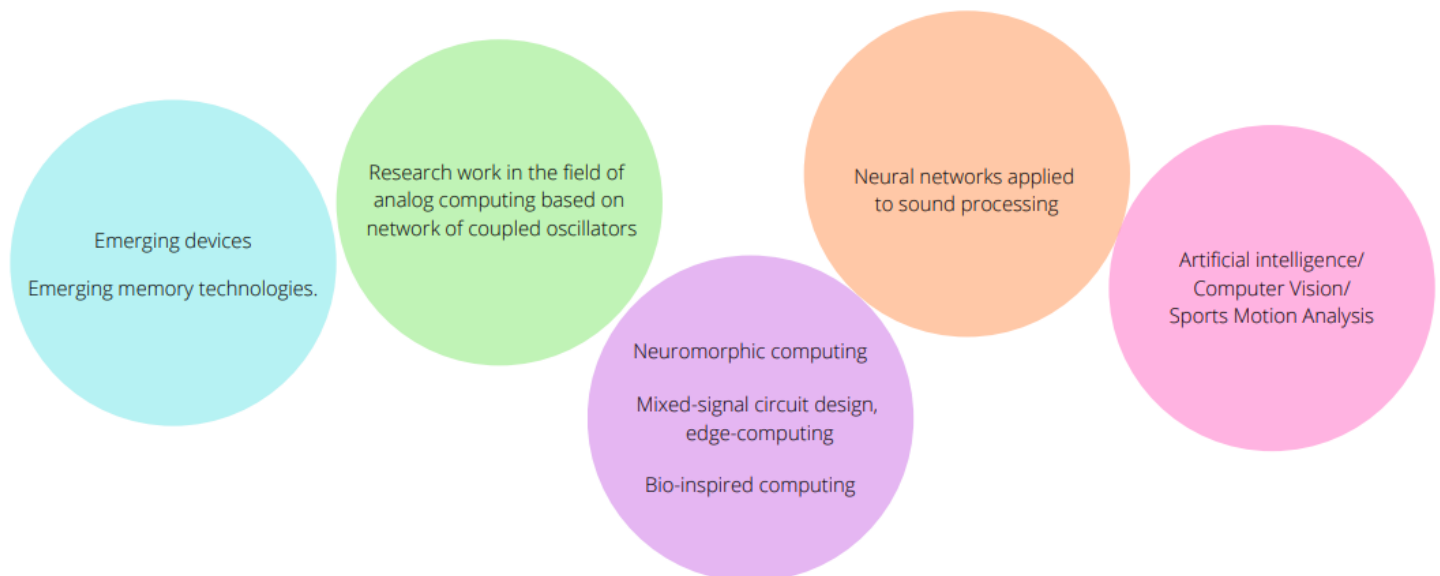


Figure 7: E3AI students research field

E3AI SURVEY RESULTS

Our local service provider Bordeaux Summer school (BSS), organized a survey at the end of the event, to consider the overall E3AI students satisfaction rates about the event, on a scale from 1 to 5¹: All consideration taken, the rates must be read with a critical eye. Starting from the principle that frame of the questions, and sincerity of the answers must be criticized according to the high average of the total notes.

Evaluated item	Note from one to five
Event Scheduling (dates)	4.9
Event duration	4.7
Location attractivity	4.9
Chosen scientific topic	4.5
Courses content (Lectures and Hands-On sessions)	4.1
Speakers qualification/quality	4.2
Proposed accommodations	2.9
Social program	4.7
Registration process	4.5
Communication leading up to the event	4.5
Registration fee amount	4.5

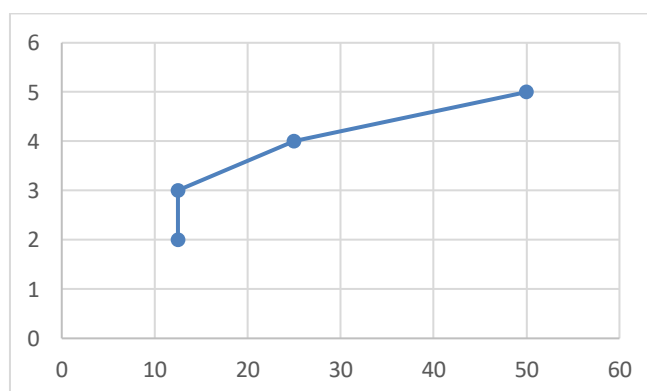
Table 4: E3AI satisfaction answers from BSS survey

Here is the total list of questions submitted to the participants at the end of the event. To properly read the shared datas, please consider on the left axis, the rate from 1 to five given to the related question. On the axis below, consider the workforce percentage who respond to the answer. The datas are extracted and reused with the same framing of the reference previously exposed.

11 questions
16 respondents

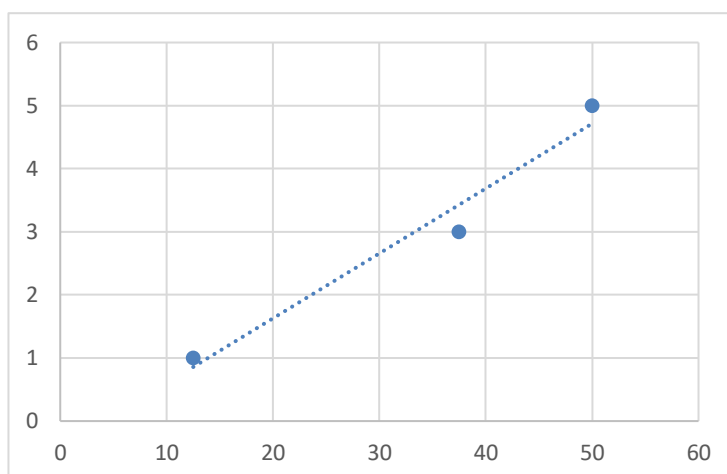
Figures have been established with data extraction from the survey.

- Prior to the summer school, were you sufficiently informed about the course content?

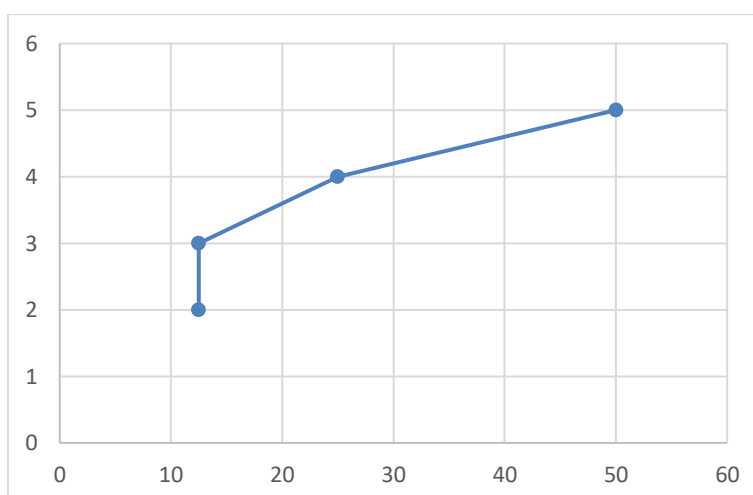


¹[BSS] Bordeaux Summer School survey on E3AI event, June 2023, 16 people on 20 have responded to the requested questions. Answers to the questions have been selected in order to underline the course content and global satisfaction.

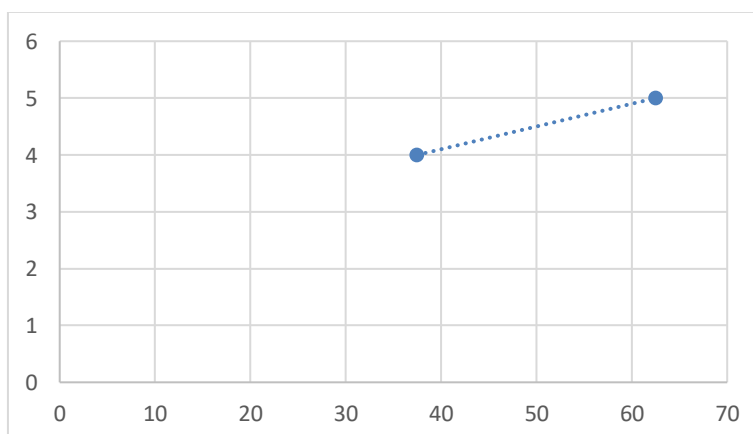
- Did the course correspond to your expectations?



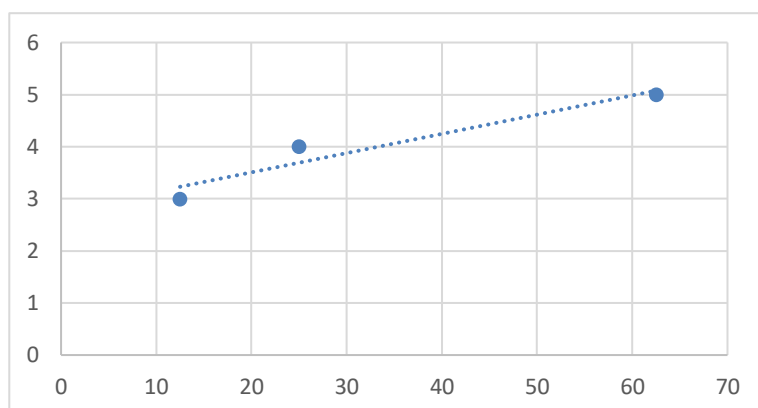
- Was the course material adapted to the content (reading lists, papers, presentations, etc.)?



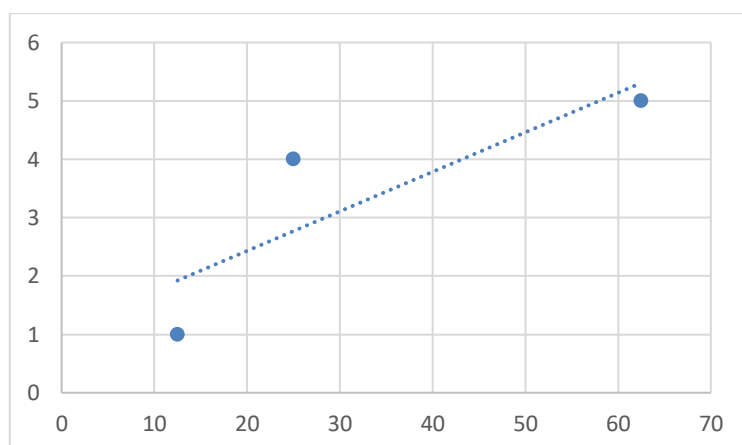
- Did the activities in this course gave you sufficient practice and feedback?



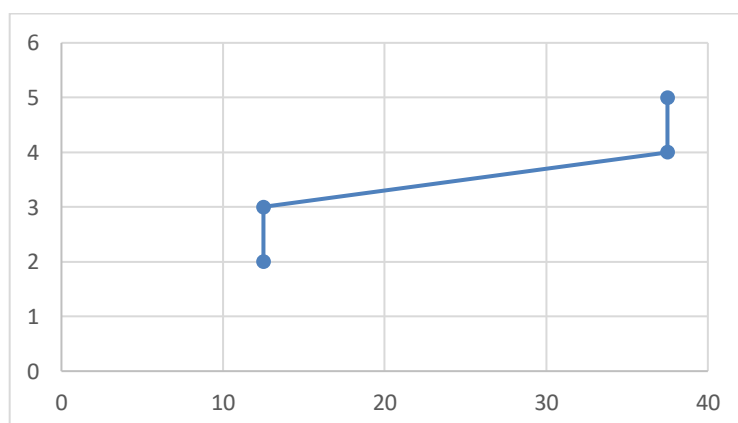
- Was the pace and level of the course appropriate?



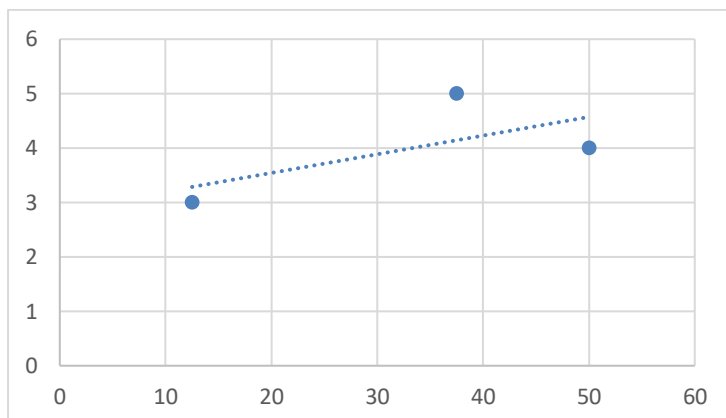
- Were the speakers well prepared?



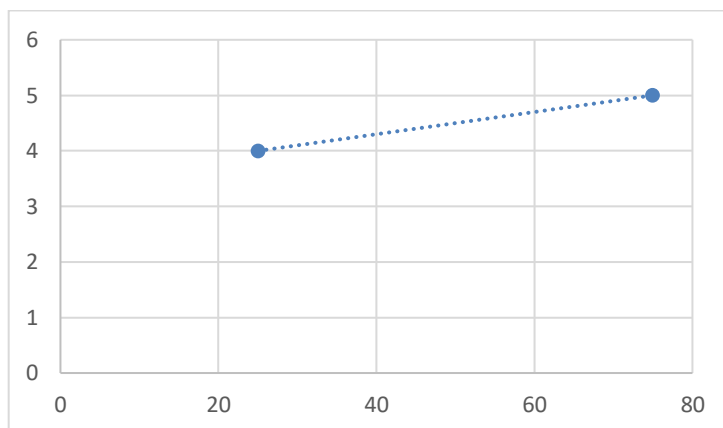
- Was the program well structured (sufficient time for discussion, etc)?



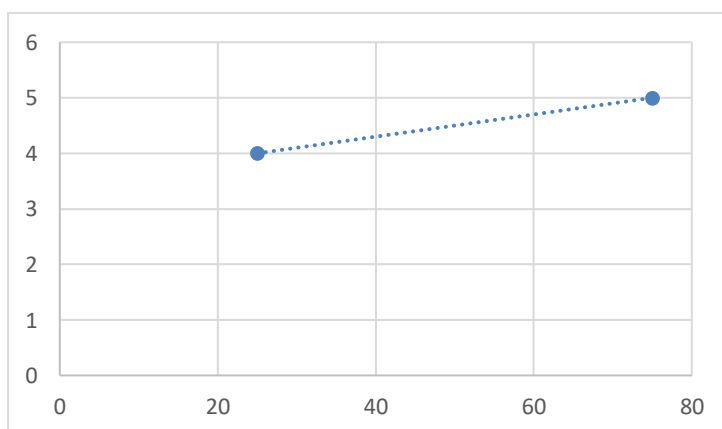
- Did the course improve your skills in this particular field?



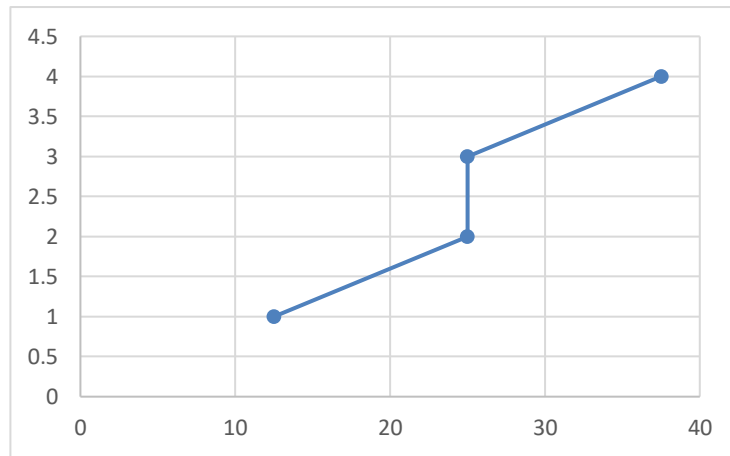
- How responsive was the Bordeaux Summer School team to your questions and concerns?



- Based on your experience, would you recommend Bordeaux Summer Schools?



- Based on your experience of the Bordeaux Summer Schools, how likely are you to pursue your studies/research/work in Bordeaux?

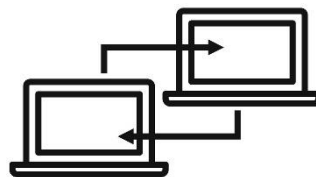


About remote participants

Remote participants have been trained via zoom sessions. For each item of the scheduled program, as sessions described above, one zoom session was proposed. We couldn't get a count of the total participant number due to logistical concerns and lack of tools to remedy to it. However, we know that the biggest part of them was coming from the IEEE CAS network. Indeed, remote sessions was free of financial charges and available for people justifying a graduation or membership status of our partner structures, requested and asked during their registration on the Bordeaux summer school website.

Both Hermes and FVLLMONTI project manager could answer question and manage time concerns of the zoom's sessions, participant needs, during the sessions. Also, during one of the zoom sessions, the BEE branch broadcasted our session in order to share it to another associative network (without condition of registration).

At the end of the event, sessions have been recorded and shared to the IEEE CAS members responsables in order to keep a trace of our activities, but also share to the absent students from their structure, our event. Also, experts' presentations which could be shared (free of restrictions – because of the shared results), have been transferred to these same responsables (still the IEEE CAS in case – presentations were available on demand, or with respect to engagements for fundings prerequisite to the event realization).



EUROPEAN SCOPE OF THE EVENT

Including the participants and expert's provenance, structure or nationality included, the European scope of this event is presented here with a focus on European commission funded projects partnerships in its organization. By this choice, there is not only an international frame which is mentioned as a global perspective of partners, stakeholders or involved people, but with a science made focus, which should permit a better separation, by an intermediary object of framing.

I. EVENT GENERAL CONTRIBUTIONS - FIRST OCCURRENCE

In the complex governance of the event, from organization to realization and involved actor's consideration, the main ones retained for this document section are the three European funded projects as whole entities. All started from their initiative: FVLLMONTI; RadioSpin; Hermes project. Each of the projects is coordinated in the IMS Laboratory by the respective experts: Cristell Maneux, Sylvain Saïghi, François Rivet. The E3AI initiative has been proposed by the FVLLMONTI project to the others ones in order to bring collaboration between experts of each field of research and discipline, but also initiate a possibility to create a cluster of high collaborating students.

Thanks to the European dynamics influence in research areas, the University of Bordeaux developed since many years its ways to open herself to the international by proposing a new model of teaching with various services, sticking to the French and European policies agendas. This University brought as a service, the international office. This office proposed to the universities research structures, laboratories and training-teaching units a way to support them in their willingness to organise summer schools. As exposed above, it brought people and experts from Europe and broader thanks to the European fundings at initial. In sum, the European dynamics is in the core of the initiative by multiple ways, thanks to its influence, direct or indirect one.

As a reminder, the summer school is also a WP6 obligation from the FVLLMONTI project. It means that engagements taken in the project proposal few years ago considered the purpose and usefulness of this event in its first writing, with relation to the global scope of the entire project realization, with respect to the EU notes and aspects to consider -Grant agreement conditions and EU framing of its fundings programs-. Considered as a success, the E3AI couldn't have been realized without this multiple factor of influence coming from Europe, by direct or indirect ways.

The event permit in sum:

- To gather around a training week high range expert coming from different European structures of research, in order to permit knowledge diffusion and sharing in a coherent scientific program.
- To gather students, PhD and master ones, around a training week; in order to permit them to create scientists' networks; learn knowledge from European funded projects, considered as cutting-edge and innovative science; learn about EU and fundings ways for research other than national possibilities.
- To permit to three European projects to improve their visibility and maximise their impact, with the help of the University of Bordeaux, with respect to their respective dissemination and communication obligations.
- To permit to the University to capitalize on the action and initiative of their proper research structures, in order to develop internal services inscribed in the current western era dynamics of research, as the international office.

- To consolidate the consortium of three European funded projects, thanks to the social events scheduled during the E3AI, with respect for consideration of the event assigned experts and students who participate to the full summer school week.

II. E3AI SUMMER SCHOOL'S FUTURE

The E3AI summer school will now be organized as a bi-annual event located in Bordeaux, with a second edition planned for 2025. This will coincide with the final year of the three European projects involved and will further disseminate their key findings. The summer school will further consolidate existing interactions within the Embedded Artificial Intelligence community at University of Bordeaux and more broadly in France and Europe, setting the basis for a self-driven event.

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E3AI SUMMERSCHOOL COMMUNICATION

Our principal broadcast channels have been the FVLLMONTI LinkedIn account, plus the one of Hermes project via reposts and relays, as an online support (Examples. Part 1). But also, a website has been dedicated to the E3AI thanks to the BSS. On site communication have been used too, in order to indicate and inform students during the event about the current processes and its implementation (Examples. Part 2).

LinkedIn statistics for one-week publications:

- LinkedIn impressions total: 7700
- LinkedIn interactions total: 150
- LinkedIn reposts total: 25

Publication examples (6/12) Part I – LinkedIn activities (event external publics).

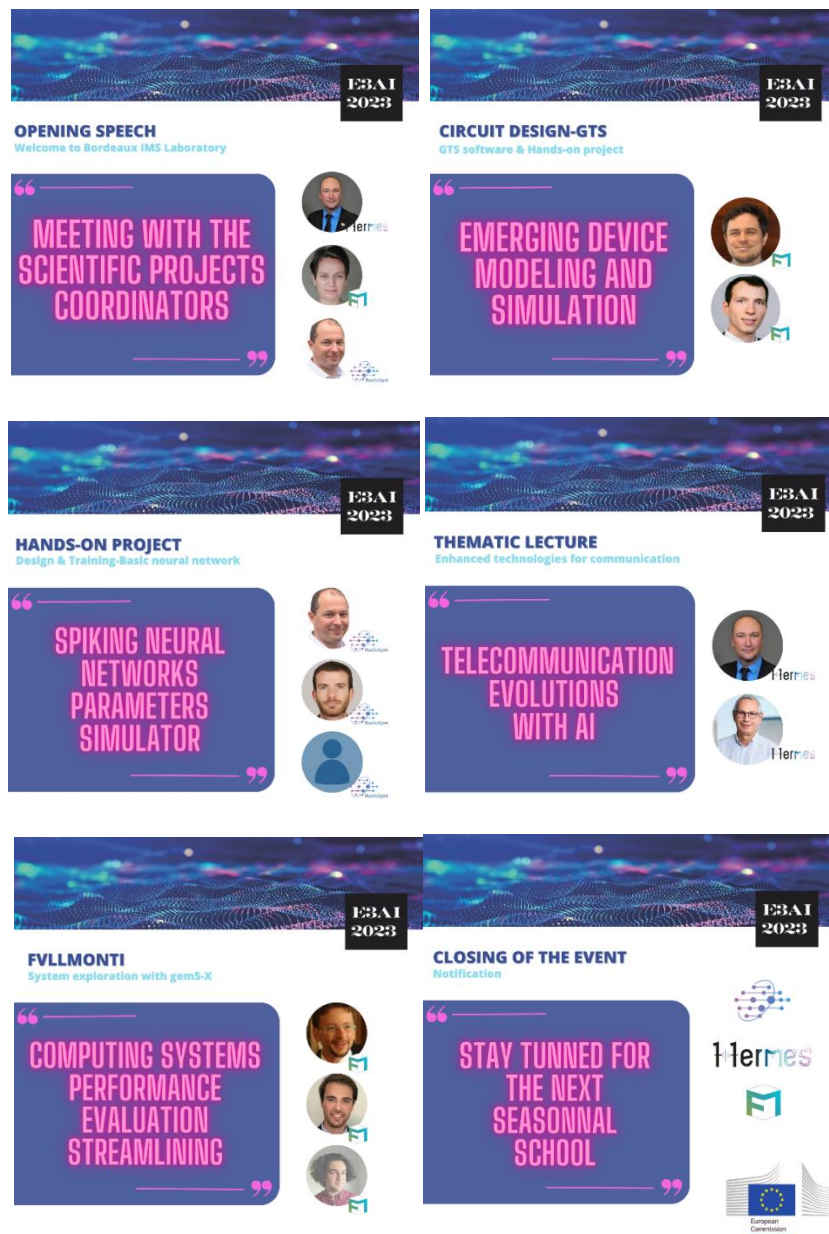


Figure 8: From Day one to End Day publications examples

Publication examples (4/6) Part II – On-site activities (event' participant publics + Laboratory people).

Tools and broadcast channels: Laboratory video screens; projection tools

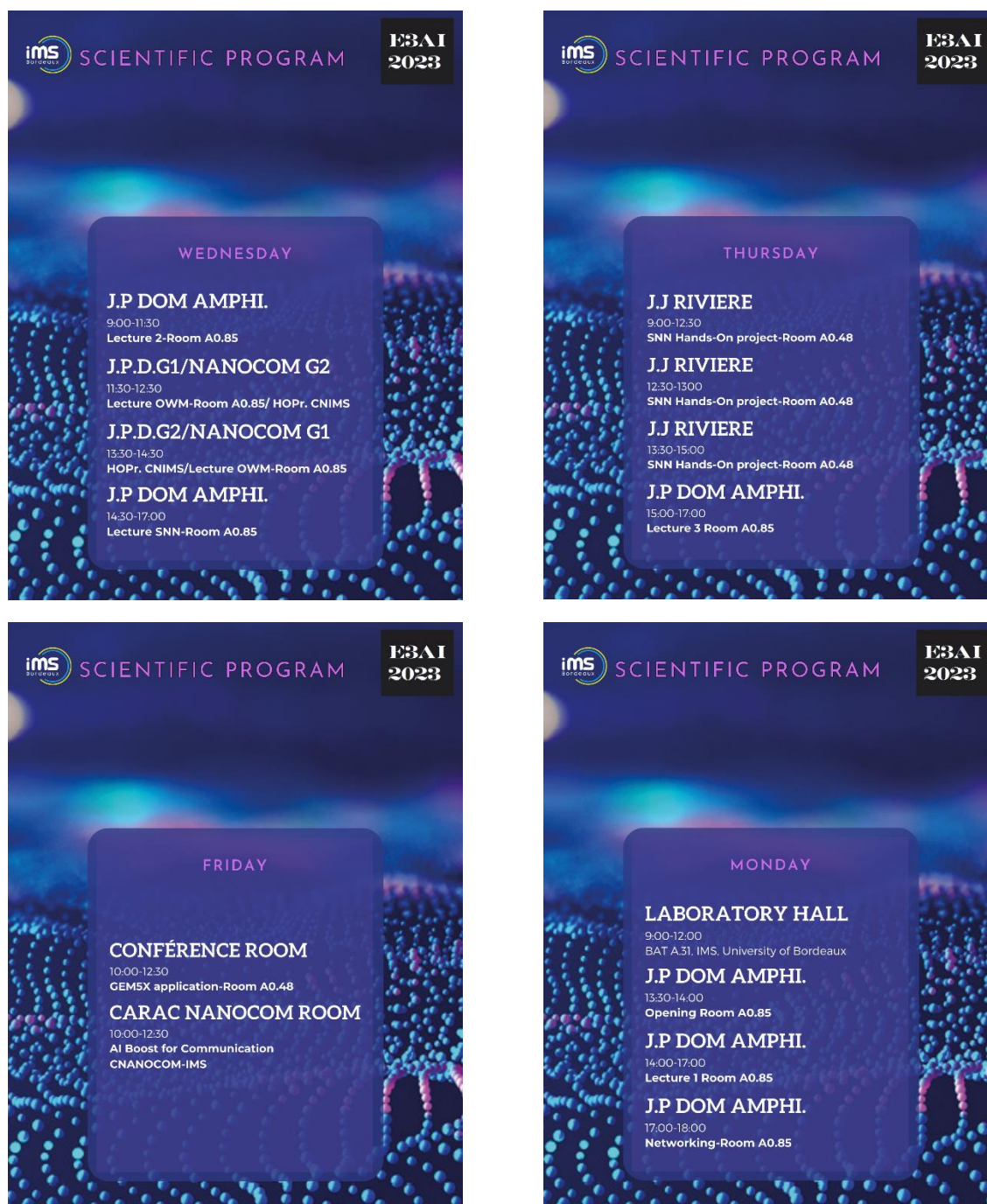


Figure 9: From Day one to End Day on-site publications examples

All the diffusion channels and communication used tools tried to ensure a real coherence of shared contents, in a dynamic continuation of communication activities during all the week. Also a graphic chart has been respected in all of these areas of actions to pursue these objectives. The presented content is a part of the project holder activities which have been made in plus, to support the lacks of communication activity which was expected before its realization. Consider this communication planned actions during the event as a plus which permit, to keep contact with some of the students and bring them to be part of our online WP6 more general obligations and goals.

FINANCIAL CONCERNS OVERVIEW

I. BUDGET AND PARTNERSHIPS

EXPENDITURES		INCOMES	
CATEGORY	Cost (Tax free)	CATEGORY	Cost (Tax free)
Restauration	3 517,00 €	Registration fees	5 109,09 €
Breakfast - CROUS	280,00 €	Category 1- accomodation	2 036 €
Lunch - D1 Buffet - Maison Dulou	525,00 €	Category 2- no accomodation	709 €
Lunch - D2 Plateau repas - Capdevielle	699,00 €	Category 3- accomodation included	2 364 €
Lunch - D3 Buffet - Maison Dulou	588,00 €	Options	- €
Lunch - D4 Buffet - Capdevielle	800,00 €	xxxxx	- €
Coffee-breaks	625,00 €	xxxxx	- €
		Partnerships & fundings	17 006,00 €
Participants: experts & students	12 641,00 €	Partner 1-FVLLMONTI	- €
Accommodation - CROUS	3 150,00 €	Partner 2-HERMES	- €
Accommodation - Ténéo Talence Espeleta	2 386,00 €	Partner 3-RadioSpin	- €
Transports & flights - Expert	3 500,00 €	IEEE CAS funding	4 600,00 €
Travel agency taxes	45,00 €	Chair GrAI (for accomodation)	5 816,00 €
Taxis and other costs	800,00 €	Idex BSS Ouv. conv. 1/2 SUB équilibre	3 500,00 €
Experts gifts	1 000,00 €	Idex BSS Rééq. 2/2 SUB équilibre	3 090,00 €
Experts income for participation	1 760,00 €		
Social program	5 060,00 €		
Space rental	- €		
Opening & Welcome diner, MAMA Shelter (19/06)	2 750,00 €		
Closing diner, Café Français (22/06)	1 680,00 €		
External lunch - Bistrot Régent (23/06)	630,00 €		
Communication	74,00 €		
Dedicated website	Prog. BSS		
Graphic chart & communication supports	Prog. BSS		
Bags & Congress tools	Prog. BSS		
Prints & Goodies	Prog. BSS		
Identification access pass	Prog. BSS		
Emailing	Prog. BSS		
Visit cards	74,00 €		
Scientific secretariat	440,00 €		
Paybox subscription (online payment)	440,00 €		
Other costs	383,00 €		
Public transports tickets	383,00 €		
Photography service	Prog. BSS		
Tourism documentation	Prog. BSS		
Total expenditures	22 115 €	Total incomes	22 115 €

Figure 10: E3AI Provisional budget – Validated by University of Bordeaux Financial direction

The first officialised provisional budget, fixed between the FVLLMONTI and Hermes project managers with the IMS Laboratory Financial department, was expecting an expenditure total reaching 22 115 euros. No contributions from the three EU projects were necessary, thanks to the partnerships financial offers which led to contracts.

Partnerships:

- **IEEE CAS:** The Society brings engineers, researchers, scientists and others involved in circuits and systems applications access to the industry's most essential technical information, networking opportunities, career development tools and many other exclusive benefits. Local members with similar technical interests engage in professional exchange through the Society's 10 regional chapters in the United States, Canada, Europe, the Middle East, Africa, Latin America, Asia, Australia. Key objectives of the IEEE CAS and program include:
 - Enhancing Engineering Fields: The Society aims to advance electrical, electronics, and related engineering practices, thereby improving professional standards.
 - Fostering Collaboration: It promotes cooperation and technical information exchange among members.
 - Hosting Educational Meetings: The Society organizes meetings to discuss relevant scientific and artistic literature.
 - Developing Engineering Standards: A key role involves initiating and developing engineering standards.
 - Supporting Member Needs: Through committees, the Society addresses the needs of its members and affiliates.

Found by: Hermes Project, 5000 dollars amount



Figure 11: IEEE CAS Society visual identities

The Green AI Chair: known as the GrAI project, focuses on hardware AI. It started on September 1, 2020, and is planned to run for four years. The project's primary purpose is to develop and advance AI technologies with an emphasis on energy efficiency and sustainability. Key objectives of the Green AI Chair include:

- Edge Computing: Implementing computation close to sensors to minimize data transmission and processing overhead.
- Neuromorphic Computing Technologies: Developing AI technologies inspired by the biological processes of the human brain, aiming for efficiency and adaptability.
- Embedded Systems: Integrating AI capabilities directly into hardware systems for more efficient processing.
- Low-Power AI: Focusing on AI solutions that consume minimal power, contributing to the sustainability of AI technologies

Founded by: Radio Spin Project, 5816 euros amount, to cover accommodation expenditures.



Figure 12: Green Ai Chair-project consortium visual identity

The Initiative of Excellence (IdEx): part of the French government's "*Programme d'investissements d'avenir*" (Future Investments Program) launched in 2010. The primary goal of this initiative is to stimulate employment, enhance productivity, and boost national competitiveness. Specifically, IdEx represents a series of integrated investment programs assigned to higher education and research institutions.

For the University of Bordeaux, IdEx has been a pivotal factor in its transformation and development, following its establishment from the merger of three universities. As a result of this initiative, the University of Bordeaux, after a probationary period starting in 2011, was among the first three French universities to be definitively labelled as a university of excellence by an international jury in 2016. The university received a grant of 700 million euros, significantly aiding its development trajectory and accelerating its evolution into a major international research university. Key objectives of the IdEx principle and program include:

- Stimulating Employment: Creating job opportunities and enhancing the workforce's skills.
- Enhancing Productivity: Improving efficiency and effectiveness in research and education.
- Increasing National Competitiveness: Boosting France's global standing in education and research.
- Facilitating Institutional Mergers: Encouraging the consolidation of universities to form larger, more comprehensive institutions.
- Promoting Research and Innovation: Advancing cutting-edge research and fostering innovation in various fields.
- Internationalizing Higher Education: Elevating the global profile and reach of French universities.
- Financial Support for Development: Providing substantial funding to support the strategic development of universities.

Founded by: FVLLMONTI Project, 7000 euros amount, given in two times among the event lifecycle.



Figure 13: Excellence initiative French government label visual identity (PiA)

The overall financial concerns have been managed in local, at the IMS Laboratory, by its financial department. The coordination of actions between all actors haven't been a simple concern, this is why project managers have been assigned to the logistical and information tasks during all the process, described above. Reality and time didn't avoid issues in the process, this is why some the items where the BSS should help the IMS Laboratory and project holder -as experts' accommodations and communication-, support them in the event implementation, the project managers of Hermes and FVLLMONTI had to cover the lacks by their proper actions with extra-tasks. Concerning budgets ones, they've been impacted by one week before realization modifications on scientific program as module repartition reorganization.



Figure 14: Overall actors of the E3AI general organization and involvement

II. EVENT ACTUAL COSTS

Expenditures - Bordeaux Summer School E3AI			Incomes	
Service provider	Engagement	Cost (ex. tax)	Funding Client	Total (ex. tax)
REGENT	23-19946	619,76	FUNDING CAS IEEE	4509,89
TOQUE CUIVREE	23-19951	426,25	INSCRIPTION SSCHOOL	5182
CAFE FR	23-19954	1 248,03	CHAIR Green AI	5536,25
VELOCE SCHLEICH	DP	807,00	IDEX (2 times considered)	1800
VELOCE BELOT	DP	387,88		
VELOCE RZEPA	DP	807,02		
VELOCE POLLEQUIN	DP	87,50		
VELOCE MEDINA	DP	154,71		
VELOCE ANSALONI	DP	233,33		
VELOCE CALVANESE	DP	363,88		
MAMA	23-18393	2 032,76		
CROUS	23-18400	280,00		
CAPDEVIELLE	23-18402	1 499,40		
DULOU	23-18386	1 279,00		
CAE	23-20480	331,59		
VELOCE PAINDAVOINE	DP	266,50		
TBM	23-25565	336,27		
Didier BELOT	OM 13542	251,99		
CROUS HEBERGEMENT	23-19170	3 150,00		
VELOCE HERBEGEMENTS	23-15620	2 386,25		
TOTAL		16 949,12 €	TOTAL	17028,14

Table 5: E3AI actual costs

In conclusion, the financial management of the E3AI event demonstrates effective budgeting and financial expertise. Starting with a balanced budget of 22,115 euros for both expenditures and incomes, the event concluded with a positive outcome, having incurred slightly less expenses (16,949.12 euros) than the final income (17,028.14 euros). This indicates not only prudent financial planning but also efficient cost control during the event, resulting in a modest surplus. Such financial discipline is commendable in event management, reflecting both fiscal responsibility and adept handling of financial resources.

REPORT CONCLUSION

The writing conclusion of the deliverable is proposed as the following bullet-point list (below), respecting the various sections created to report the event in its various aspects. It includes the introduction and body of the document, principally detailing the E3AI event.

- **Recapitulation of Achievements:** The FVLLMONTI project, particularly through its workshop's participation or organization, and summer school, has contributed to the field of Embedded Artificial Intelligence as committed and willed initially. It permitted to play an active role in fostering collaborations and knowledge sharing across Europe.
- **Expert Contributions:** The involvement of experts from various European research projects and institutions provided a multifaceted learning experience. Their diverse specializations covered the entire program of the summer school, effectively disseminating knowledge in various sub-fields of AI. Also, their contribution to workshops and PhD supervision, involved in the project itself, permit to underline our progresses towards our initial commitments.
- **Impact on Students:** The program significantly impacted the students, with a notable presence of PhD and master's degree candidates during E3AI. It offered them an opportunity to network, gain insights from EU-funded projects, and understand the broader scope of research funding in Europe.
- **Financial and Organizational Aspects:** The financial management and organization of the E3AI event were executed according to what was expected initially. The coordination between different stakeholders, including financial partnerships and logistical arrangements, contributed to the event's smooth execution.
- **Communication and Outreach:** The effective use of various communication channels, like LinkedIn and a dedicated website, played a notable role in maximizing the event's outreach. Regarding the D.6.4 (M38) comments about our web and social results, E3AI event was a notoriety success. The consistency in the communication strategy ensured coherent messaging and successful engagement with the various involved audiences.
- **Looking Forward:** The future bi-annual organization of the E3AI Summer School, with plans for the next edition in 2025, will continue to build upon this success. It will further enhance the visibility and impact of the FVLLMONTI project and its partners, solidifying the role of these educational events in the scientific community.

= End of the document =