Spoke 2 - status of Open Calls

("Bandi a Cascata")

MS10 - August 2025

Introduction

Timeline

In the initial proposal of ICSC, Open Calls were expected to be a target for MS6 (April 2023), with Innovation Funds following. In the execution of the project, though, it was decided centrally to swap the two activities, with Innovation Funds call happening in June 2023, and their start in September 2023.

The Spoke 2 Steering Group prepared during **Summer 2023** an open document with themes of interest for the Spoke, to be freely distributable and to gather interest between the parties.
The legal framework for the Open Calls by INFN (the Spoke 2 Leader Institution) started in **Fall 2023**; being the first tender notice of this type, it required quite some time and external consulting via a legal firm.

The call for tenders was published **February 19th 2024**, after having been approved by the Giunta Esecutiva (Deliberation 13879, February 15th 2024) with submission open till **March 28th, 2024** (link). The call for tender resulted in 14 proposals; a subsequent phase of administrative checks found quite some technical problems, with the submitters being contacted to solve them when legally admissible.

At the same time, a review committee was proposed on **April 4th 2024** and nominated by the President of INFN on April 23rd (Disposizione 26662). The review team had to wait for the administrative checks and the subsequent fixes and eventually finished the review, which was approved by the INFN Giunta Esecutiva (Deliberation 17116, **June 28th 2024**).

The resulting funding table is shown in Figure 2.

On August 4th 2024 the INFN communicated the projects that the "*atto d'obbligo*" would be signed by **September 5th 2024**, with projects starting at that date.

The scientific kick-off meeting was held on **October 4th** (link to agenda), with the administrative kick-off on **November 7th 2024**.

The projects are all funded September 2024 to August 2025; in case of an extension of the ICSC activities beyond that date, the projects can request an extension.

The Open Calls have been publicized in many venues while the tender was open:

- A webinar organized by INTESA Sanpaolo on **March 8th 2024** (see Figure 1)
- At the Osservatorio per il Supercalolo (Naples, **March 4th 2024**, link)
- Directly contacting the *Responsabile del Tavolo Space Economy* at the *Presidenza del Consiglio* (Andrea Taramelli).



Figure 1: the Webinar Organized by Intesa Sanpaolo to announce the Open Calls

Proposed Themes and Integration with the Spoke 2 Program of Work

The proposed themes, as per the tender, are divided between "Public" and "Industrial" ones; the definition is intended to distinguish in reality between the publicly funded institutions, and the privately funded ones.
Figure 2 shows the selected themes, named IND1-6 and PUB1-8, and are shown in Figures 2 and 3.

N. area	Area tematica	Vincoli
PUB1	Development of data acquisition and trigger strategies in the context high background, rare event experiment, using acceleration on hybrid CPU/FPGA architectures, in the context of the activities of the Spoke2 in ICSC	Per beneficiari pubblici
PUB2	Development of a multipurpose/multi experiment high level cloud infrastructure for small/medium astroparticle experiments, on the infrastructure of ICSC and for the benefit of Spoke 2 use cases	Per beneficiari pubblici
PUB3	Development of a GPU library for massively parallelized simulations of QCD and QCD+QED on the lattice in the context of the activities of the Spoke2 in ICSC	Per beneficiari pubblici
PUB4	Development and performance optimization of typical simulation codes in HEP and Astro, for the use cases of Spoke 2	Per beneficiari pubblici
PUB5	Advanced algorithms for GW experiments (Virgo and ET) in the context of the activities of the Spoke2 in ICSC	Per beneficiari pubblici
PUB6	Studying the quantum Boltzmann equation neutrino flavour conversion in a dense environment in the context of the activities of the Spoke2 in ICSC	Per beneficiari pubblici
PUB7	Development of algorithms for boosted topologies at LHC/FCC, in the context of the activities of the Spoke2 in ICSC	Per beneficiari pubblici
PUB8	Accelerated analysis of Astrophysical data in the Photon Counting Big Data era, in the context of the activities of the Spoke2 in ICSC	Per beneficiari pubblici

Figure 2: the themes for the public call for tenders.

N. area	Area tematica	Vincoli
IND1	Data Management PoCs/pilots with Spoke 2 solutions in industrial environments (datalake, distributed computing, ...)	Per beneficiari privati; non utilizzabile "Ricerca Fondamentale"
IND2	Solutions, implementation and deployment of a computing PoC based on the ARM architecture	Per beneficiari privati; non utilizzabile "Ricerca Fondamentale"
IND3	Porting and optimization (on GPU, on FPGA, on CPU) of algorithms of interest of AstroParticle experiments	Per beneficiari privati; non utilizzabile "Ricerca Fondamentale"
IND4	Realization of tools and pilots for the Space Economy domain, using the infrastructure of the ICSC (portals, market exchange, algorithms, services, ...)	Per beneficiari privati; non utilizzabile "Ricerca Fondamentale"
IND5	Heterogeneous industrial use cases on the Spoke 2 platforms (GPU + FPGA + ARM)	Per beneficiari privati; non utilizzabile "Ricerca Fondamentale"
IND6	Profiling, code engineering and code quality on Spoke 2 code repositories	Per beneficiari privati; non utilizzabile "Ricerca Fondamentale"

Figure 3: the themes for the private call for tenders.

The themes are blended in the Spoke 2 Work Packages, and in particular (see Table 1 for the WP definitions):

- PUB 1 and 7 with WP2;
- PUB 2, 4, 5 and 8 with WP3;
- PUB4 with WP6;
- PUB 3 and 6 an 7 with WP1;
- IND 1 with WP5;
- IND 2 and 5 with WP4;
- IND 3 with WP3 and WP4;
- IND 4 with WP6;
- IND 6 with all the WPs.

WP Number	WP name
1	Design and development of science-driven tools and innovative algorithms for Theoretical Physics
2	Design and development of science-driven tools and innovative algorithms for Experimental High Energy Physics
3	Design and development of science-driven tools and innovative algorithms for Experimental Astroparticle Physics and Gravitational Waves
4	Boosting the computational performance of Theoretical and Experimental Physics algorithms
5	Architectural Support for Theoretical and Experimental Physics Data Management on the Distributed CN infrastructure
6	Cross–domain Initiatives

Table 1: Spoke 2 Work Package names.

Granted funds

The results of the tender process as approved by INFN are shown in Figure 4.

Allegato 1

Ordine	Domanda	Area Tematica	Valutazione	Regioni del Mezzogiorno	Importo richiesto	Importo finanziato	di cui nelle regioni del Mezzogiorno
1	D04-NFL-GW	PUB5	91	NO	€ 120.175,00	€ 120.175,00	- €
2	DO1-GAlAS2	PUB4	90	SI	€ 390.000,00	€ 390.000,00	390.000,00 €
3	D06-FaDER	PUB1	90	NO	€ 132.710,00	€ 132.710,00	- €
4	Dll-DarkSieve	PUB7	90	NO	€ 115.056,24	€ 115.056,24	- €
5	D05-BOODlNl	PUB7	89	NO	€ 138.334,65	€ 138.334,65	- €
6	D08-GeV-Al	PUB4	87	SI	€ 387.877,00	€ 387.877,00	387.877,00 €
7	D02-GEANT-HCP	PUB4	87	NO	€ 155.261,50	€ 155.261,50	- €
8	D09-DATOME	IND1	85	NO	€ 278.000,00	€ 278.000,00	- €
9	D03-LlQUXD	PUB3	85	NO	€ 244.000,00	€ 244.000,00	- €
10	D14-PARSPOC	PUB5	84	NO	€ 189.000,00	€ 189.000,00	- €
11	D10-ERN-DATA	IND1	83	NO	€ 275.156,00	€ 275.156,00	- €
12	D12-SAIFIN	IND4	83	NO	€ 213.360,00	€ 213.360,00	- €
13	D07-SPARCh	PUB4	81	NO	€ 121.166,56	€ 121.166,56	- €
14	D13-BOOST	PUB7	81	NO	€ 357.921,88	€ 357.921,88	- €
				TOTALE	**€ 3.118.018,83**	**€ 3.118.018,83**	**777.877,00 €**

Figure 4: the themes for the provate call for tenders.

Open Calls are numbered from 1 to 14, as DXX-ProjectName.

Out of the total 3,2 MEur of funding, 3,118,019 Eur have been assigned. Not all the themes had applications, but the spirit of the tender was to add activities to the Spoke work plan, with none of them on the critical path; hence, a missing application to any of the themes is not impacting the Spoke overarching goals.

After the start of the realization phase, some projects have expressed desire for remodulation; the requests are currently being analyzed. Some 200kEur of lower funding have been allocated – due to a change in the allocation for the project D01-GAIAS2. The decrease comes from the decision to use computing resources (in the specific case, a server for GPU processing) from the ICSC Datalake, instead of acquiring dedicated resources.

Later in the process, in July 2025, a second survey was conducted in order to identify deviations from the spending schedule, and at the same time to query projects for the need of a 2 months extension, made possible by the ICSC extension to the end of 2025.

While there was no reduction of scope, one project (D03-LIQUXD) has communicated the need to reduce the budget due to the inability to acquire personnel; the project is proceeding as expected, using different resources. That resulted in a -100kEur allocation.

In both cases, the changes were communicated to the ICSC Hub, in order to reuse the money in other initiatives.

At the time of writing, all the projects submitted 3 quarterly reports, up to the end of May 2025. The reports were due for the end of July, and hence not all of them have been validated up to now; in those cases, the 2th report is shown.

In the following part of this document, first a general description of each Open Call is presented, from the initial proposal.
Later, the status at the last available report is presented, as validated by the appointed evaluators.

Short Description of the projects

Project D01-GAIAS2

- **Full Name:** Generative Artificial Intelligence for Air Shower Simulation
- **Executor**: University of Salerno
- **Theme:** PUB4
- **Reference Spoke 2 WP**: WP6
- **Abstract**: The GAIAS2 project, operated by the University of Salerno, intends to create a tool for the simulation of high-energy particle showers due to interactions of primary cosmic rays in the atmosphere using AI (Artificial Intelligence) techniques, and in particular Generative Adversarial Networks. Simulating high-energy secondary cosmic rays is known to be computationally demanding, and the use of an AI hardware platform can greatly alleviate the burden for both the creation of static datasets and algorithms that use “on-the-fly” and “on-request” simulation. Finally, the approach allows to strongly reduce the energy impact of high performance computing for this problem, also mitigating the carbon footprint and the consequences on climate change.

Project D02-GEANT-HCP

- **Full Name:** Simulazioni numeriche di GEANT su piattaforma HPC alla scala dei multi-TeV
- **Executor**: University of Siena
- **Theme**: PUB4
- **Reference Spoke 2 WP**: WP6
- **Abstract**: The general objective of the project is the study and optimization of the performance of simulation codes used in astroparticle physics. In particular, the GEANT4 code, widely used in High Energy Physics (HEP), requires validation at multi-TeV energy scales (much higher than the energies of particles produced in current collider experiments). These energy scales have already been reached by experiments studying cosmic rays on satellites or aboard the International Space Station (ISS). Validation of the simulations can be achieved by comparing them with experimental data obtained from state-of-the-art instruments operating in space, which transmit detailed data back to Earth. This data comes from thousands of detectors and sensors measuring the interactions of both charged and neutral cosmic radiation with the experimental apparatus, particularly with calorimeters.

Project D03-LIQUXD

- **Full Name:** Library for Quantum X-Dynamics
- **Executor**: University of Roma Tre
- **Theme**: PUB3
- **Reference Spoke 2 WP**: WP1
- **Abstract**: In this project, the goal is to implement simulation algorithms for **QCD/QCD+QED** on the lattice within a **high-level, highly efficient library** capable of automatically constructing the loops necessary to evaluate arbitrary tensor expressions, independent of the memory layout used to store the data structures representing the simulated fields. This will allow the decoupling of the algorithm definition from the ordering used to store the internal degrees of freedom and the spacetime on which the particle fields are defined. In this way, it will be possible to write a single version of a given algorithm, which will automatically function

efficiently on both **CPU and GPU architectures**, which require radically different memory layouts.

Project D04-NFL-GW

- **Full Name:** Normalizing Flow Lensing of Gravitational Waves
- **Executor**: University of Genova
- **Theme**: PUB5
- **Reference Spoke 2 WP:** WP3
- **Abstract**: In this project, an innovative approach for the identification and characterization of gravitational wave events resulting from the merger of binary systems, which have been influenced by the phenomenon of strong gravitational lensing, is proposed.

Project D05-BOODINI

- **Full Name:** BOOsting DIscoveries of New Interactions
- **Executor**: University of Genova
- **Theme**: PUB7
- **Reference Spoke 2 WP**: WP2 and WP1
- **Abstract**: the research project aims to focus on both theoretical and experimental approaches to advance our understanding and modeling of events produced in particle colliders characterized by "boosted" topologies. This refers to situations where the states under study are produced with energy (or transverse momentum) much greater than their rest mass. In these cases, if the particle in question decays into hadrons, they will be collimated due to the boost and reconstructed as a single jet. The substructure of this jet will thus provide information about the particle that originated it.

Project D06-FaDER

- **Full Name:** Fast Data and Event Reduction: lowering data volumes in high-intensity experiments
- **Executor**: University of Genova
- **Theme**: PUB1
- **Reference Spoke 2 WP**: WP2

- **Abstract**: The FaDER project aims to develop data volume reduction techniques for particle physics experiments at high-intensity accelerators. The proposal is structured around two main activities, which operate at the levels of data acquisition and real-time selection of collisions to be recorded.

Project D07-SPARCh

- **Full Name:** Simulation of Photons with Accelerated Ray-tracing for Cherenkov detectors
- **Executor**: University of Genova
- **Theme**: PUB4
- **Reference Spoke 2 WP**: WP2
- **Abstract**: The proposed program aims to tackle the problem of simulating the tracking of Cherenkov photons in RICH detectors, a computationally intensive task for a category of detectors that are fundamental for high-energy physics at future accelerators. The goal is to use new methodologies to improve computational capabilities by integrating various technologies such as standalone optical design systems, GPUs, and machine learning techniques. The program is aligned with the objectives of the ICSC spoke 2, as well as with the strategic directions of the international community, and will allow the Italian community to maintain a leadership role in this area of high-energy physics.

Project D08-GeV-AI

- **Full Name:** Generatori di eventi veloci tramite AI
- **Executor**: University of Genova
- **Theme**: PUB4
- **Reference Spoke 2 WP**: WP3
- **Abstract**: The research objective of this proposal is the development of new approaches to create Event Generators based on Machine Learning algorithms (MLEG). The project includes two main activities. The first is the development of MLEG for hadronic physics: in the processes of interest, the particles in the final state exhibit non-trivial correlations that must be accurately reproduced by the generative algorithms. Only by doing so can the information from rare events be correctly

preserved. The second activity focuses on the development of MLEG for Dark Matter research.

Project D09-DATOME - IA

- **Full Name:** Sistema di classificazione automatica di documenti e immagini
- **Executor**: MANGROVIA BLOCKCHAIN SOLUTIONS S.R.L.
- **Theme**: IND1
- **Reference Spoke 2 WP**: WP6
- **Abstract**: The project aims to implement innovative solutions based on artificial intelligence to optimize business processes. The activities include the development of algorithms for document recognition and pattern analysis, the integration of AI techniques to automate and enhance document controls, and the creation of predictive models to detect anomalies in processes. The main objectives are to improve operational efficiency, reduce costs, and increase the reliability of business operations. The project aims to promote coherence across various development stages, prioritizing the search for innovative solutions and long-term economic sustainability.

Project D10-EARN-DATA

- **Full Name:** PROGETTO DI RICERCA SULLA GESTIONE DEI DATI DI CUSTODIA TITOLI E DIRECT INDEXING
- **Executor**: EARNEXT SRL
- **Theme**: IND1
- **Reference Spoke 2 WP**: WP6
- **Abstract**: The research proposal is unique but develops across two distinct activities: improving the process of downloading, managing, and representing securities custody data from banks, and enhancing the so-called Direct Indexing, an advanced Wealth Allocation system customized for the end client.

Project D11-DarkSieve

- **Full Name:** Ricerca di portali a settori Dark attraverSo l' identificazione di getti "boosted" originati da quark dark con tecniche di Machine Learning e nuove tecnologie ai futuri collisori adronici

- **Executor**: UNIVERSITÀ DEGLI STUDI DI UDINE
- **Theme**: PUB7
- **Reference Spoke 2 WP**: WP2
- **Abstract**: In cosmology, dark matter is a hypothetical component of matter not included in the Standard Model (SM) of fundamental interactions. A possible solution is the existence of an entirely new sector of particles and interactions, the *Dark Sector* (DS), which would communicate with the SM via mediating particles, or "portals," characterized by couplings to both sectors. In future hadronic colliders such as the HL-LHC and FCC-hh (FCA), dark quarks (DQ), along with other DS particles, could be produced through the decay of these heavy mediators. The project aims to improve the sensitivity of current searches by 20%, through the development and use of a machine learning (ML) algorithm for identifying and classifying such jets. The use of ML techniques, which is still quite limited in this type of research, would also reduce computational costs compared to the tagging techniques currently employed. Additionally, the project will make it possible to use these algorithms on CPUs derived from mobile devices, thus reducing the energy consumed per operation, and becoming a leading initiative in favor of computational sustainability at the FCA

Project D12-SAIFIN

- **Full Name:** Satellite data and Artificial Intelligence for FINtech
- **Executor**: UNIVERSITÀ DEGLI STUDI GUGLIELMO MARCONI
- **Theme**: IND4
- **Reference Spoke 2 WP**: WP6
- **Abstract**: One of the most promising methods for evaluating trading strategies is based on the analysis of satellite data. The main objective of this project is to develop an algorithmic trading system based on Artificial Intelligence (AI) capable of identifying financial trading strategies by leveraging data and information available from the web and satellite data. The system will consist of two modules, which will form the two work packages of this project: the first will focus on extracting information from the web and satellite data, processing it to generate a synthetic and functional representation. The second module will be the automated trading system itself, where the information derived from the first module will be used to train an AI-based model aimed at determining an effective trading strategy.

Project D13-BOOST

- **Full Name:** Boosted Object and Oriented-Space Topologies from VBS@HL-LHC
- **Executor**: Università degli Studi di Perugia
- **Theme**: PUB7
- **Reference Spoke 2 WP:** WP2
- **Abstract**: The goal of this project is, starting from a detailed critical analysis of existing tools, to study and optimize these tools for the VBS channels of interest for HL-LHC, using advanced machine learning (ML) algorithms and innovative selection and reconstruction tools capable of processing raw data directly from the detectors, starting from the initial trigger selections.

Project D14-PARSPOC

- **Full Name:** PRODUZIONE DI UN ALGORITMO PER IL RICOPRIMENTO DELLO SPAZIO DEI PARAMETRI DI SORGENTI DI OGGETTI COMPATTI IN COALESCENZA
- **Executor**: Università degli Studi di Urbino Carlo Bo
- **Theme**: PUB5
- **Reference Spoke 2 WP**: WP3
- **Abstract**: The aim of our project is to study different methodologies for generating collections of waveforms and develop fast algorithms for their production, optimizing computation time and the number of waves required to achieve the target sensitivity. It will be necessary to study existing codes and develop new ones to improve their performance, exploring the use of GPUs and Machine Learning methods. The developed methods will be tested using the Multi Band Template Analysis pipeline, one of the pipelines currently used in the search for gravitational waves, for the analysis of public data from past scientific runs of the LIGO-Virgo-KAGRA collaboration. The expected outcome could lead to improvements in the analysis of future runs of existing interferometers and contribute to the development of analysis methods for the Einstein Telescope.

Evaluation process during execution

The evaluation of the projects' progress is mediated via a list of evaluators, proposed by the Spoke leaders. These are experts in the field, with no conflict of interest with the proponents, and work in or close to the Spoke 2.
The full list of evaluators, with also the names of the projects' PIs, is present in Figure 5.

	Nome Progetto	Resp Scientifico	Esecutore	Valutatore proposto	mail	Istituzione
1	D04-NFL-GW	Marco Raveri marco.raveri@unige.it	genova	Marco Serra	marco.serra@roma1.infn.it	INFN Roma1
2	DO1-GAIAS2	CRISTIANO BOZZA cbozza@unisa.it	salerno	Giuseppe Piparo	giuseppe.piparo@ct.infn.it	INFN CT
3	D06-FaDER	Carlo Schiavi carlo.schiavi@unige.it	genova	Alexis Pompili	pompili@ba.infn.it	UNIBA
4	DII-DarkSieve	MARINA COBAL marina.cobal@uniud.it	udine	Nicola de Filippis	nicola.defilippis@ba.infn.it	POLIBA
5	D05-BOODINI	Simone Marzani simone.marzani@unige.it	genova	Pietro Govoni	pietro.govoni@unimib.it	UNIMIB
6	D08-GeV-AI	Alessandro Pilloni alessandro.pilloni@unime.it	messina	Lucio Anderlini	lucio.anderlini@fi.infn.it	INFN FI
7	D02-GEANT-HCP	Piersimone marrocchesi piersimone.marrocchesi@unisi.it	siena	Pablo Cirrone	pablo.cirrone@lns.infn.it	INFN LNS
8	D09-DATOME	Samuele Elisei Samuele.elisei@mangrovia.io	mangrovia	Tommaso Boccali	Tommaso.Boccali@pi.infn.it	ONFN PI
9	D03-LIQUXD	Vittorio Lubicz vittorio.lubicz@uniroma3.it	roma3	Michiele Pepe	Michele.Pepe@mib.infn.it	INFN MIB
0	D14-PARSPOC	Gianluca Maria Guidi gianluca.guidi@uniurb.it	urbino	Massimo Bongi	massimo.bongi@unifi.it	UNIFI
1	D10-ERN-DATA	PAOLO BARONI paolo.baroni@earnext.com	EARNEXT	Antonio Stamerra	antonio.stamerra@inaf.it	INAF
2	D12-SAIFIN	Alberto Garinei a.garinei@unimarconi.it	MARCONI	Letizia Caito	letizia.caito@inaf.it	INAF
3	D07-SPARCh	Roberta Cardinale roberta.cardinale@unige.it	genova	Andrea Celentano	andrea.celentano@ge.infn.it	INFN-GE
4	D13-BOOST	Livio Fanò livio.fano@unipg.it	perugia	Antonio Sidoti	antonio.sidoti@bo.infn.it	UNIBO

Figure 5: Spoke 2 evaluators per each Open Call project.

Scientific validation from the latest available report

In this section, the status at the last available report is presented, as validated by the appointed evaluators.

Project DO1-GAIAS2

Last validated report: 2nd quarter
Validator Observations: All project activities have started, and the work programme is in line with that stated by the project proponents. Furthermore, both human and computing resources are currently in line with expectations.
Recommendations: As progress is made, it will be useful for future evaluations to include details such as graphs and results, both to demonstrate the completion of the targets (as envisaged in the project and following the timetable indicated by the proposers) and to show the advancement of activities in progress.
Achievement of Project Objectives:
T1 – Realisation of technical/scientific specifications (quality parameter) for simulating secondary particle showers from high-energy cosmic interactions (Achievement 100 %)

This target is included in Activity A of the project "Definition of benchmark simulations for cosmic ray interactions" and is 100% complete. There was no deviation from the schedule of activities as the stated completion percentage was in line with the expected timeframe for Activity A, set at four months.

T2 – Realisation of the benchmarks for at least 2 different software (quantitative parameter) and for 10 different types of cosmic rays (protons of varying energy) (Achievement 5 0 %)

This target is included in Activity B of the project "Comparison of benchmark simulations with CORSIKA 7 and CORSIKA 8". This activity, as scheduled, started in December 2024. The percentage of completion is consistent with the planned timeline for this activity (to be completed by the end of April 2025).

T3 – realisation of the specifications for GANs (qualitative parameter) (Achievement 33 %)

This target is included in Activity C of the project "Definition of the extended shower model for the neural Network". This activity, as scheduled, started in December 2024. The percentage of completion is consistent with the planned timeline for this activity (to be completed by the end of June 2025)

T4 – Acceleration of the calculation with GANs by at least 50% compared to the traditional simulation with CORSIKA 7/8 (quantitative parameter) (Achievement 14 %)

This target is included in Activity D of the project "Test of extended shower generation with GAN and comparison with benchmark simulations". This activity, as scheduled, started in February 2025. The percentage of completion is consistent with the planned timeline for this activity (to be completed by the end of August 2025)

Outcome of the evaluation: Positive

Project DO2-GEANT-HCP

Last validated report: 2nd quarter
Validator Observations: Positive
Recommendations: N/A
Achievement of Project Objectives: [verbatim]

D/M/T 1 –Adattamento codice di interfaccia con Geant4 che consente di utilizzare specifici modelli di parti-colare rilevanza per la fisica astro particellare (quali EPOS, DPMJET3, e altri).

Achievement 8 %

D/M/T 2 – WP1 Il lavoro è proseguito a partire dalle attività del primo trimestre e come programmato. Sono anche stati monitorati i tempi di esecuzione nel caso di energie superiori a 1 TeV

Achievement: 20 % totale

WP2 – Sviluppo di un codice Geant4 di benchmark per studiare i segnali con il quale vengono studiati i segnali generati dalla radiazione di backscattering emessa dal calorimetro.

Achievement: 15 % totale

WP3 - ottimizzazione algoritmi di simulazione: in corso di studio

Achievement 5%

Outcome of the evaluation: Positive

Project D03-LIQUXD

Last validated report: 2nd quarter

Validator Observations: There have been administrative issues preventing the recruitment of the two postdocs that the project required. It should be addressed the impact of this problem on the execution of the project.

Recommendations: It should be clarified as soon as possible whether the recruitment of the postdocs is still feasible and, if so, the process should proceed without delay.

Addendum as of July 2025: the project asked for a sizeable reduction of budget (-140k), but the work programme should be respected. Still waiting for the validation of the 3rd quarter.

Achievement of Project Objectives:

D/M/T 1 –

During the first 3 months (Phase A), a scouting activity was planned, aimed at obtaining a comprehensive overview of currently existing solutions, a comparison of various frameworks and libraries, and benchmarking. This phase required interaction with individuals affiliated with the center, to select an already-used software platform that could serve as the basis for the development of the required functionalities. One of the planned activities was the recruitment and the training of a Postdoc. The funds for that purpose have not been made

available and, thus, that task has not been accomplished. The team completed the program as expected, except for the final issue noted above, resulting in a 75% overall achievement.

D/M/T 2 –

The second 3 months of activity belong to the second part of the project (Phase B). In this phase, using the platform selected in phase A as a starting point, the functionalities necessary for the implementation of the project are going to be developed on the specific fronts that require it, such as the user interface, the separation of algorithms from the backend that supports the specific architecture, and the implementation of the missing algorithms.

The team has accomplished 40% of the planned activity. In this second Phase a second Postdoc should be hired and trained. However, due to bureaucratic issues, that task has not been done yet.

Outcome of the evaluation: Positive [pending the outcome of the budget reduction]

Project D04-NFL-GW

Last validated report: 2nd quarter

Validator Observations: Significant progress has been made since the previous phase.

Recommendations: According to the report sent by Prof. Raveri, the project completion status is 75% for WP1 and WP2. What remains to be completed is the integration of other data catalogs (Euclid and DESI) and possibly that of O4 LVK. An initial assessment is made of the computational resources needed, which can be further explored later.

Achievement of Project Objectives: [verbatim]

D/M/T 1 – WPN 1.1 Sviluppo degli algoritmi di identificazione di coppie soggette a strong lensing

(Achievement 75 %)

D/M/T 2 – WPN 1.2 Ottimizzazione degli algoritmi di normalizing flow

(Achievement 75 %)

D/M/T WPN 2.1 – Creazione di simulazioni realistiche di cataloghi di onde gravitazionali e galassie

(Achievement 75 %)

Outcome of the evaluation: Positive

Project D05-BOODINI

Last validated report: 2nd quarter
Validator Observations: Positive
Recommendations: N/A
Achievement of Project Objectives: [verbatim]

Attività A.1 – Studio comparativo (Les Houches study) dei nuovi algoritmi di jet flavour recentemente proposti, utilizzando codici di simulazione Monte Carlo allo stato dell'arte.

Miglioramento dell'accuratezza teorica per le frammentazioni dei quark b e c. *(Articoli in via di completamento, sottomesso al database arXiv ed inviato ad una rivista scientifica, livello di raggiungimento: 85%)*

Attività A.2 – Ideazione di nuove variabili di jet substructure definite per la fisica dei quark pesanti e loro studio teorico. Codice in cui vengono implementati risultati per la fenomenologia in fase di debugging.

Implementazione delle osservabili di jet angularities nel codice di analisi della misura sperimentale di Z+bb con collisioni pp a sqrt(s) =13 TeV all'interno della collaborazione ATLAS..

(Articolo sulle nuove osservabili di jet substructure pubblicato sulla rivista JHEP, livello di raggiungimento: 70%)

Attività B.1 – Comprensione di aspetti teorici del Lund jet plane per heavy flavours giunto ad una fase matura. Iniziata discussione su sua implementazione per studi di fenomenologia.

Implementazione Lund plane nel codice di analisi della misura sperimentale di Z+bb con collisioni pp a sqrt(s) =13 teV all'interno della collaborazione ATLAS. *(livello di raggiungimento: 50%)*

Attività B.2 – Terminato studio di variabili di jet substructure e heavy flavour ai future colliders con focus su

FCC-ee.

(Articolo sul jet substructure in collisori leptonici messo su arXiv e inviato ad una rivista scientifica, livello di raggiungimento: 80%)

Attività C.1 – Iniziato studio teorico di osservabili ispirate dal machine-learning e basate sulla geometria degli eventi in collaborazione con gruppo di Parigi.

(livello di raggiungimento: 10%)

Outcome of the evaluation: Positive

Project D06-FaDER

Last validated report: 2nd quarter

Validator Observations: N/A

Recommendations: In the intermediate reports it would be better when describing the activities to explicitly refer each of them to a specific milestone or deliverable foreseen in the project.

Achievement of Project Objectives: [verbatim]

OA.1 –*Realizzazione di un sistema di compressione dati real-time*

(Achievement 60%)

Note: It's relevant that, at the end of this second trimester, the compression (real-time reduction; for MA1.3) algorithm has been implemented and validated on FPGA and the performances have been compared with the results obtained on GPU and CPU server. To optimize the algorithm and its performance, new FPGAs will be considered. There is a good reporting activity including an international workshop.

OA.2 –Implementa*zione di algoritmi rapidi di selezione dati di alto livello*

(Achievement 50%)

Note: It seems relevant that the frame-routing algorithm on CPU has been implemented and tested, and a testbed has been designed and setup, allowing to consider, in input, three different sources of test data.

OB.1 – *Preselezione dei dati prodotti dai rivelatori traccianti*

(Achievement 60%)

Note: Specifically (for MB1.1 and MB1.2), I find relevant the work carried out for the optimization of a CNN- based algorithm for hit filtering. Effort to use this kind of models on FPGA is ongoing. On the other hand, an algorithm for the Primary Vertex location is being tested on simulated data. The work seems well regularly reported within the experimental collaboration of reference.

OB.2 – ***Ottimizzazione della selezione di b-jet e tau-jet***

(Achievement 50%)

Note: It's important having carried out the first tests at high-statistics of the ML algorithm for t-jets identification against jets associated with light quarks with simulated samples. The work is documented within the experimental collaboration of reference and also reported in an organized international workshop.

Outcome of the evaluation: Positive

Project D07-SPARCh

Last validated report: 1st quarter

Validator Observations: Although the project suffered a delay in the start date, not under control of the proponents, all activities look well on track. To compensate for this, proponents already asked for an extension of the project up to December 2025, that seems absolutely reasonable to me.

Recommendations: I suggest making the internal notes documenting the ongoing work available to the whole ICSC community.

Achievement of Project Objectives:

D/M/T 1 – A1.1 Identification of possible software algorithms for generation and tracking of

optical photons in Cherenkov detectors. Achievement 70%.

D/M/T A2.1 – Identification of numerical scorer to evaluate the performances of the different

Algorithms (Achievement 60%)

D/M/T A3.1 / A3.2 – Identification of specific requirements for RICH detectors (Achievement 65%)

D/M/T A4.1 / A4.2 – Software development for fast photons tracking, employing also ML Algorithms (Achievement 10%)

Outcome of the evaluation: Positive

Project D08-GeV-AI

Last validated report: 3th quarter

Validator Observations: The project is progressing steadily and the backlog due to the initial delay on fundings has been almost completely absorbed. The upcoming workshop in Messina, organized as part of this project, with reports from the parties involved in the activities, will represent a crucial milestone for the research activities.

Recommendations: I recommend more emphasis on the release of the developed algorithms and techniques as Free and Open-Source Software.

Achievement of Project Objectives:

WP A - Setup analysis framework for the activity A: Achievement 70%

WP B - Setup analysis framework for the activity B: Achievement 70%

WP A/B – Recruitment of a post-doc researcher: Achievement 100%

WP A/B – Purchase of computing time: Achievement 50%

WP A/B – Workshop and dissemination: Achievement 70%

WP A/B – Meetings and coordination: Achievement 75%

Outcome of the evaluation: Positive

Project D09-DATOME - IA

Last validated report: 3th quarter

Validator Observations: Work ongoing as expected, with improvements in all the tasks and the resolution of previously reported problems.

Recommendations: Demo still not shown to the reviewer. It is imperative before the final report.[Update at the submission of the present document: demo shown and perfectly in line with expectations. Satisfaction in the use of the ICSC resources]

Achievement of Project Objectives: [Verbatim in italian]

Team di DATA SCIENCE: T1 –*Analisi dei requisiti e selezione dei modelli (90 %)*

Sono stati identificati i requisiti chiave e selezionati modelli preliminari basati su benchmark di performance e scalabilità.

Team di DATA SCIENCE: T2 –*Sviluppo e training dei modelli (60 %)*

L'attività si è focalizzata sul finetuning, ottimizzando il massimo numero di token in input/output, la gestione della KV cache e adattando modelli di embedding per specifici requisiti applicativi.

Team di DATA SCIENCE: T3 –*Validazione e testing dei modelli (70 %)*

L'infrastruttura è stata configurata per il monitoraggio continuo, la gestione automatizzata dei modelli e l'integrazione DevOps.

Team di Software Engineering : T1 –*Implementazione dell'infrastruttura MLOps (85 %)*

L'infrastruttura di cui si è dotata Mangrovia è molto soddisfacente e prosegue il suo arricchimento con l'aggiunta di nuovi moduli e servizi custom realizzati internamente.

Team di Software Engineering : T2 –*Sviluppo degli endpoint dell'inference server (85 %)*

Sono stati sviluppati endpoint efficienti per l'inferenza, con attenzione alla sicurezza e all'elaborazione rapida delle richieste.

Team di Software Engineering : T3 –*Creazione del backend per il routing delle richieste (70 %)*

È stato progettato un backend iniziale per gestire il flusso di richieste tra il server di inferenza e i client.

Team di Software Engineering : T14 –*Sviluppo del client web (70 %)*

L'interfaccia utente è in fase di prototipazione avanzata, con focus su usabilità e design responsive.

Outcome of the evaluation: Positive

Project D10-EARN-DATA

Last validated report: 2nd quarter

Validator Observations: Compared to the first quarter, there has been a realignment in the progress of activities and in the reported costs, which, as indicated in the report, also include activities and expenses incurred in the first quarter.

Recommendations: Consistency has improved between the activities described in the report and the milestones presented in the project, divided into the two categories (Data Banks/Direct Indexing). It would be useful to explicitly indicate the milestone number to which the activity description refers. It would also be useful to have a more detailed description of the deliverables obtained, corresponding to what was indicated in the submitted project.

Achievement of Project Objectives: [verbatim]

Milestones relative a "Dati Banche"

M1 (Analisi delle fonti di Dati Bancari) - Con D1 descritto come "Report sull'analisi dei campi e dei valori delle transazioni" **Achievement: 100% (terminato in Q1)**

M2 (Implementazione del Sistema di Data Lake) - con D2 descritto come "Sistema di archiviazione e mappatura funzionante" **Achievement: 100%**

M3 (Implementazione del Machine Learning per il Feedback utente) - con D3 "Sistema esperto di feedback integrato e documentazione utente." - **Achievement: 50%**

M4-M5 Non viene riportato uno stato di avanzamento specifico su queste milestones. **Achievement: 0%**

M6 (Implementazione del Sistema di Error Detection**)** - con D2 descritto come "Sistema di error detection

implementato e testato" **Achievement: 100%**

M7-M8-M9: non descritte. **Achievement: 0%**

Milestones relative a "Direct Indexing"

M1 (Raccolta e Analisi dei Dati) - con D1 "Dataset arricchito e documentazione sull'analisi dei dati."

Achievement: 100% (completato in Q1)

M2 (Revisione e Miglioramento dei Modelli) - con D2 "Modelli stocastici migliorati e calibrati."

Achievement: 100%.

M3 (Mappatura tra Asset/Liabilities/Flussi di Cassa e Modelli) con D3 "Regole di rappresentazione

implementate e verificate." **Achievement: 30%**

M4 (Miglioramento dell'Algoritmo dei Pesi di Asset e Liabilities) Non riportata. **Achievement: 0%**

M5 (Miglioramento della Velocità Computazionale) con D5 "Velocità computazionale migliorata e UX

ottimizzata.". **Achievement: 80%.**

Outcome of the evaluation: Positive

Project D11-DarkSieve

Last validated report: 3th quarter

Validator Observations: Positive

Recommendations: N/A

Achievement of Project Objectives:

D/M/T 1 – "Choice of benchmark models" (100 %)

The study about the benchmark models for the production of dark matter at future circular accelerator was completed.

D/M/T 2 – "Preparation of simulation samples and choice of framework for performance evaluation" (100 %)

Monte Carlo simulations for signal generation according to the benchmark models explored completed.

D/M/T 3 – "Optimization of the separation of the signal over the background and of the energy consumption/computing resources" (100 %)

The activity consisting in the study of the kinematic observables useful to discriminate the signal from the background, has been advanced and close to completion. The task of choosing the parameters to define energy/computational optimization and their measurements has been progressing.

D/M/T 4 – "Statistical analysis and update on reference" (100 %)

The study about the statistical analysis is in progress together with the survey of the paper/references in the literature, for the relevant experimental analyses.

D/M/T 5 – "Dissemination" (30 %)

In addition to the presentation of the results at the SIF conference in September 2025, plan is made for a talk at ATLAS Italia meeting in 2025. Work in progress for a publication.

D/M/T 6 – "Monitoring of the project" (100 %)

The activity consisted of monitoring of the activities involved and for the moment no critical issues have been found in the activity carried out to date even if the remodulation of the project in 12 months instead of the initial 16, could lead to some issues in the future.

Outcome of the evaluation: Positive

Project D12-SAIFIN

Last validated report: 2nd quarter

Validator Observations: N/A

Recommendations: N/A

Achievement of Project Objectives:

D/M/T 2

Task 1.1– Trading system methods - Achievement (second quarter): 100 %

In the reporting period, the project reached 100% of development for Task 1.1, achieving the goals and completing the deliverable planned on time.

The objective of Task 1.1 is to complete the research of advanced methods to implement a robust algorithmic trading system, with a focus on applying Large Language Models (LLM), transformers, and generative AI to the analysis of financial/trading data/news and agriculture remote imaging.

The team has conducted thorough work in the research and development of advanced and innovative methodologies, which form a solid foundation for the subsequent phases of the SAIFIN project.

The progress reports presented provide a detailed and comprehensive description of the activities carried out.

The methodologies and technologies selected (LLMs, generative AI, multi-modal analysis for Earth observation, and Agentic AI) are cutting-edge and highly relevant to address the complexities of the trading

system.

The emphasis on using Deep Learning Models to avoid human bias in the formation of trading signals or insights is a critical and well-addressed aspect, aiming to improve the reliability and objectivity of the system.

The application of attention-based multi-modal systems for extracting crop condition indexes from satellite imagery is particularly innovative. The preliminary analysis phase on LLMs was rigorously conducted, exploring advanced techniques such as Retrieval Augmented Generation (RAG), few-shot prompting, chain-of-thought reasoning, Re-Act, and fine-tuning, as well as the evaluation of FinGPT. This shows a deep understanding of the potential and challenges associated with LLMs in the financial domain.

The exploration of Agentic AI for a multi-agent architecture is a strategic response to the complexity of integrating multiple data sources. The modularity promised by this approach is a significant advantage for the future development and maintenance of the system, increasing the accuracy and depth of final trade recommendations.

Although this first part of the work focuses on methods, future reports could benefit from the inclusion of any preliminary metrics or test/simulation results on the methodologies developed, to show how these new techniques are performing.
There were no deviations from the approved plan.

M1 - Full definition of trading system methods - Achievement (second quarter): 100 %
D1 – Task1.1 final report - Achievement (second quarter): 100 %INFN

Task 2.1– Trading system design - Achievement (second quarter): 25 %
The overall objective of Task 2 is to develop algorithms based on financial pattern recognition and technical indicators (as studied in Task 1.1) and to design/develop the multi-agent architecture of the SAIFIN trading system, leveraging Agentic and Generative AI for trading with satellite imagery. The progress reports presented clearly outline the initial developmental progress of Task 2.
Significant foundational work has been done in algorithm development and, notably, in the comprehensive design of the multi-agent architecture. The detailed breakdown of the activities described in the reports demonstrates a clear understanding of the complexity involved and a well-structured approach to system building.
The initiation of the design for Machine/Deep Learning architectures (including LSTM recurrent models) to directly learn trading signals from data, using patterns/indicators as features, is a strong progress towards system implementation. This approach aligns with the objective of mitigating human bias and leveraging advanced AI capabilities.The detailed design and development of the SAIFIN multi-agent architecture is a notable achievement. The clear definition of specialized agents (Market Intelligence, News Intelligence, Trading Intelligence, Satellite Agent, Decision-Making Agent) demonstrates a well-thought-out strategy to handle diverse data sources and analytical needs. The inclusion and detailed description of the Satellite Agent, capable of processing remote sensing data to derive numerical and textual insights on crop health and yields, is highly innovative and has market relevance. The adoption of an Agentic AI perspective, emphasizing modularity, independent evolution of agents, and a central decision-making layer, addresses the challenge of integrating complex, multi-modal data. This design strongly enhances maintainability,

adaptability, and the accuracy of final trade recommendations. Finally, the consideration of retrieval-augmented pipelines and prompt-engineering guidelines to facilitate effective collaboration among agents highlights a forward-thinking approach.
While comprehensive testing may be in later phases, any preliminary performance indicators or insights from initial algorithm runs (even if not conclusive) could add value to future analysis. There were no deviations from the approved plan.

M2.1 - Fully algorithmic trading system - Achievement (second quarter): (20%)
D2.1 – Fully Algorithmic Trading System - Achievement (second quarter): (20%)

Outcome of the evaluation: Positive

Project D13-BOOST

Last validated report: 2nd quarter
Validator Observations: Some non-critical delays to be monitored in the next evaluation period due to the delays in hiring the personnel. Some non critical delays due to CMS computing framework issues. Both of them do not depend on the team.
Recommendations: It is important to keep going and gain momentum on both the trigger development for HL-LHC and the analysis on Run2 and Run3 data
Achievement of Project Objectives:
WP 1 – development of the reconstruction strategy and event selection for Vector Boson Scattering (VBS) process with boosted final states (Achievement 35 %)
The team is setting up single W production with defined polarization and characterization of the reconstruction algorithms. In parallel the team is setting up the analysis framework using CMS VBS same sign WW production.
WP2 2 – Measurement of the polarization fraction in WBS VZ and VW process. Selection of the longitudinal polarization component (Achievement 20 %)
The team is finishing the MC production of WV and ZV with semileptonic decays. Task is ~1 month late due to general CMS gridpack issues

WP 3 - Setup of computing infrastructure (Achievement 35 %)

The team is setting up of computing infrastructure using the global WPCMG (CMS and INFN Cloud) and local infrastructure (Uninuvola) using also GPU accelerated hw

Outcome of the evaluation: Positive

Project D14-PARSPOC

Last validated report: 3th quarter

Validator Observations: Positive

Recommendations: N/A

Achievement of Project Objectives:

According to the Report for the period from 01/03/2025 to 31/05/2025, the following activities have been carried out:

B.2 - Design and implementation of a new algorithm - Implementation of a new algorithm

According to the documentation, the algorithms that have been selected in the previous phase have been implemented (Python and C/C++) and tested on real and simulated data in order to choose the best one. (Achievement 100%)

C.1 - Testing of the Multi Band Template Analysis pipeline - Production and testing of mock data

According to the documentation, simulated noise and coalescence signals have been produced according to the published sensitivity of the LIGO-Virgo-KAGRA instruments. (Achievement 100%)

Outcome of the evaluation: Positive