



Centro Nazionale di Ricerca in HPC,
Big Data and Quantum Computing

ANNUAL MEETING

Del Centro Nazionale di Ricerca in HPC,
BIG DATA AND QUANTUM COMPUTING

ISOLA D'ELBA – LA BIODOLA, 5 - 8 OTTOBRE 2025

Spoke 2 – Fundamental Research & Space Economy

Tommaso Boccali – INFN Pisa

-
- enel
- ENGINEERING
PER IL SISTEMA TRASPORTO INTEGRATO
- eni
- FERROVIE
ITALIANE
- FINCANTIERI
- fondazione
innovazione urbana
- autostrade // per l'Italia
- HUMANITAS
FONDAZIONE ITALIANA DI SCIENZE UMANE
- iFAB
FONDAZIONE ITALIANA DI FARMACOLOGIA
E SCIENZE ASSOCIATE
- INTESA SANPAOLO
- LEONARDO
- sogei
- ThalesAlenia
space
- Terna
Driving Energy
- UnipolSai
ASSICURAZIONI

Staff Researchers	195
(kEur)	6333
Recruited researchers	28
(kEur)	5067
Phd positions	25
(kEur)	1992
Budget Innovation Grants (kEur)	1800
Budget Cascade Calls (kEur)	3200
Total Budget (kEur)	18391

The Projects

Scientific

1. **19** Flagship Projects (FS): they represent a category of studies; they have KPIs which are analyzed by the reviewers
 - 4 WP1, 5 WP2, 7 WP3, 3 WP6
 - WP4 and WP5 share FSs with the other WPs
2. **0(10-30)** Other projects: they happen in the WPs but are loosely coupled, they are related to the Flagships but they have a much lower reporting structure; no KPIs

Industrial

- Collaboration with internal industries:
 - **11** Innovation Funds, 4 guided by Spoke2
 - 4 ENI, 1 Leonardo, 2 Intesa, 2 IFAB, 2 Unipol/Leitha

External collaborations

- **14** Academic and industrial
 - 4xUNIGE, 1xUNISI, 1xUNIME, 1xUNIUD, 1xUNIROMA3, 1xMangrovia, 1xEarnext, 1xUNIPG, 1xUNISA, 1xUNIURB, 1xMARCONI

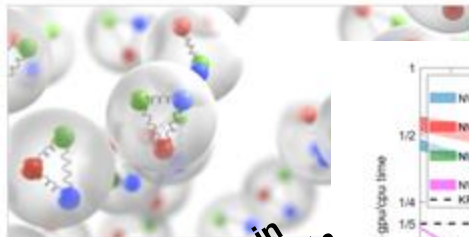
How was participating in the CN essential for us

1. Access to large amount of computing resources
2. Access to diversified state-of-the-art computing resources

Strong Nuclear Force Is Not So Weak at Electroweak Temperatures

May 23, 2025 • Physics 18, 568

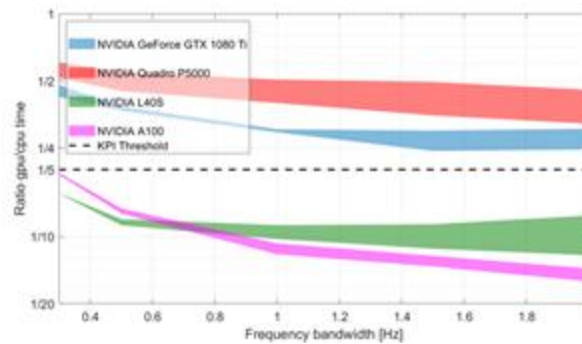
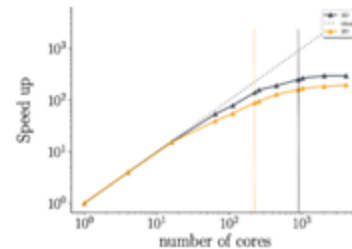
A new model of quark-gluon plasma finds that the strong force was more potent in the early Universe than previously thought.



Optimization of a GPU code in MATLAB for Hough Transform in Gravitational Waves discovery

SYNOPSIS

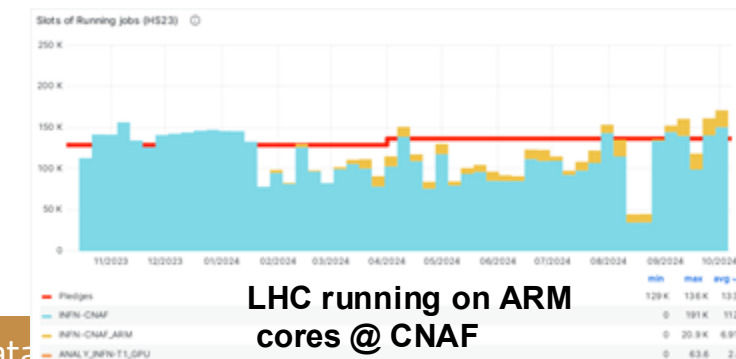
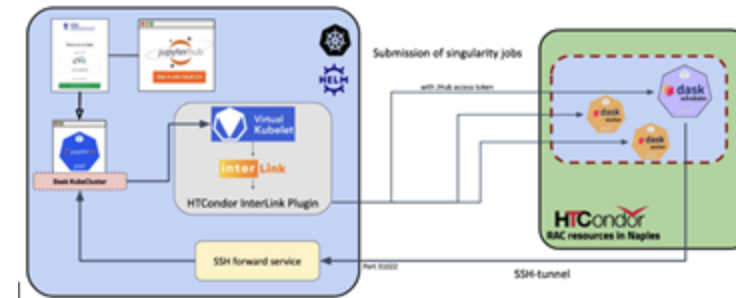
Strong Scaling



Sites	Number jobs	Average jobs/day	Maximum jobs/day	Total hours	Avg job duration	Number sky points	Average skyspts/h
ICSC INFN Grid Bari	40391	3366	10387	625987	15.5	42791152	76.7
ICSC INFN Grid Napoli	5451	545	1394	130109	23.9	5023318	46.5
ICSC Cineca Leonardo	976	244	300	10812	11.1	28356663	2707.5
CNAF	215474	4788	7088	2714237	12.6	197959248	87.8

Extending a Moldable Computer Architecture to Accelerate DL Inference on FPGA

by Mirko Mariotti 1,2,* , Giulio Bianchini 1,2,* , Igor Neri 1 , Daniele Spiga 2 , Diego Ciangottini 2 and Lorian Storch 2,3,*



LHC running on ARM cores @ CNAF

Porting codes to GPU @ LHC

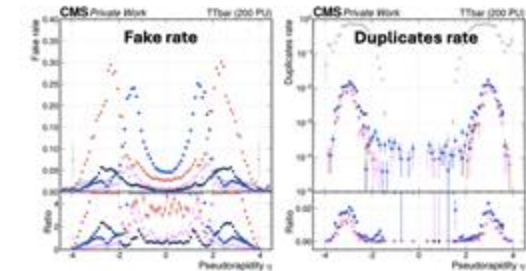


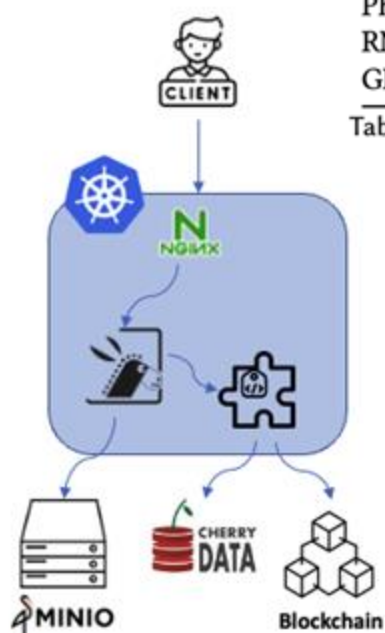
Figure 1: Physics performance of the pile tracks reconstructed at CMS experiment High Level Trigger evaluated on 5000 it

Running on RISC for Energy-Efficient Computing in HEP
Emanuele Simi¹, Tommaso Boccali^{2,3}, Shafiqul Muzaffar^{1,3,4}, Gordon Stewart¹, Simon Skipsey¹, Albert Borely¹, and David Britton¹

How was participating in the CN essential for us

3. Collaboration with industrial Teams

4. Access to AI-enabled high quality machines and platforms



	Precision	Recall	F_1 Score	$F_{0.5}$ Score
Phoenix	0.296	0.214	0.248	0.275
RNN Model	0.37	0.3	0.332	0.35
GNN Model	0.366	0.078	0.128	0.21

Table 2. Performance metrics on the V470MT001A Turbine Test Set

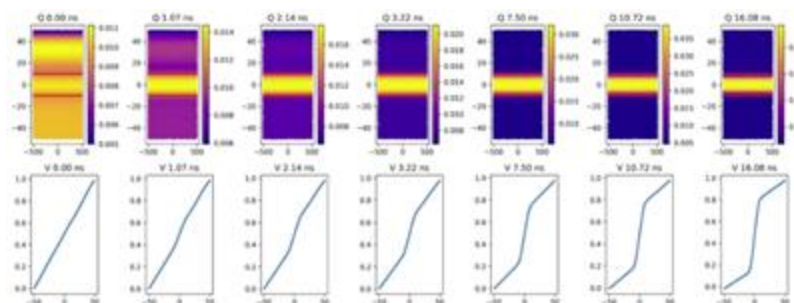
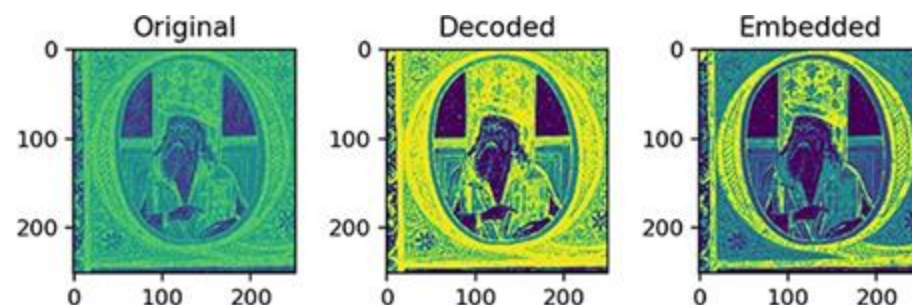
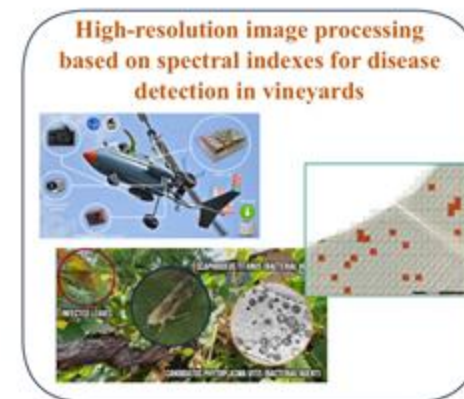
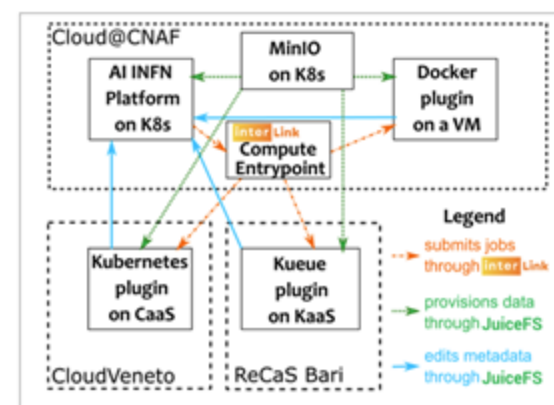


Figure 1.5 - Solution provided by Physics Informed Neural Network trained without external data for the same Differential Equation of the sensor, but in a simplified geometry (a capacitor with high-impedance, thick electrodes).



How was participating in the CN essential for us

5. Enable new collaborations

- Approach is “solution based”: find common solutions to different problems
 - WP4 and WP5 dedicated to interact with other WPs and industrial partners
 - Proved successful, also via the realization of common training opportunities (see later)
- For many, this is the first time collaborations are established between different research domains and with the industry

6. Young collaborators!

- [Developing Expertise of] Young collaborators are the real result of these 3 years
- Will their (and their expertise!) will be maintained?
- A double worry!
 - Will they find a position? (hopefully yes, with the experience they developed)
 - How can we sustain the CN in the next years without them?

How was participating in the CN essential for us

7. Training Opportunities ... (just representative of many more)

First course about the porting on GPUs of code and algorithms

Introductory course to HLS FPGA programming

Second course on porting code and algorithms to GPUs

Introductory course to VHDL and HLS FPGA programming

Mini-Workshop on Data Management

SOSC 2024 Sixth International School on Open Science Cloud

1st AI-INFN Advanced Hackathon

XXI Seminar on Software for Nuclear, Subnuclear and Applied Physics

SOSC 2023 Fifth International School on Open Science Cloud

XXII Seminar on Software for Nuclear, Subnuclear and Applied Physics

Workshop on "Quasi-Interactive Analysis of Big Data with High Throughput"

- Not only HW/SW...but also people!
- Several (open) courses organized in the past three years covering all the different topics touched by the PNRR!

2nd AI-INFN Advanced Hackathon

24-27 Nov 2025
University of Pavia, Pavia
Europe/Rome timezone

Advanced course to FPGA programming

27-29 Oct 2025
INFN Perugia
Europe/Rome timezone

Upcoming courses, next months:
- FPGA Advanced course ([here](#))
- AI-INFN Advanced Hackathon ([here](#))

Currently discussing how to consolidate the courses for the next years of the CN

What was «ok» and was «less ok» - the «less ok» part

From first year and second and third year reports – a trend

Critical aspects

- **Timing** is strict for Innovation Grants: they started on Sept 1°, but legal agreements with industrial parties take time; on top of that, new academic hires will also take time and after the start of PNRR it is difficult to find people (even more in southern regions, which are even more under pressure)
- **Timing** is even more strict for Cascade Calls. We (all the spokes) have plans but making them a tender will take a lot of time. There is the risk that the projects will be only slightly longer than 1 year (which is very short, even more for the academic targets which will need to hire etc ...)
- The **computing requests** to the ICSC's **RAC** are large and challenging, not clear yet which fraction will be possible to accomodate
- A very good fraction of the hiring has been successful; still we feel we have emptied the candidate lists. The next hirings (Innovation Grants, inevitable churn of personnel finding other opportunities, **we will have problems, especially in the Southern Regions**)
- Communications with industries not always easy. Now that we are getting into a more technical ground, things are improving

First year:

- Late with Innovation Grants and even more for Cascade Calls
- No RAC resources available up to Spring 2024
- Personnel hiring still ongoing
- Complex to handshake activities with (some) industries

October 2023

What was «ok» and was «less ok» - the «less ok» part

From first year and second and third year reports – a trend

Critical aspects

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- **Timing** is even more strict for Cascade Calls. We (all the spokes) have plans but making them a tender takes a lot of time. There is the risk that the targets will be only slightly longer than 1 year which is very short, even more for the academic targets which will need to hire etc ...) 
- The **computing resources** of the ICSC's RAC are large and challenging to learn yet which fraction will be possible to use late 
- A very good fraction of the hiring has been successful; so far we have emptied the candidate list for next hirings (Innovation Grants, inevitable turn of personnel finding other opportunities, **we will have problems, especially in the Southern Regions**) 
- Communications with industry are not always easy. Now that we are going to a more technical ground, things are 

Today (?)

Third year:

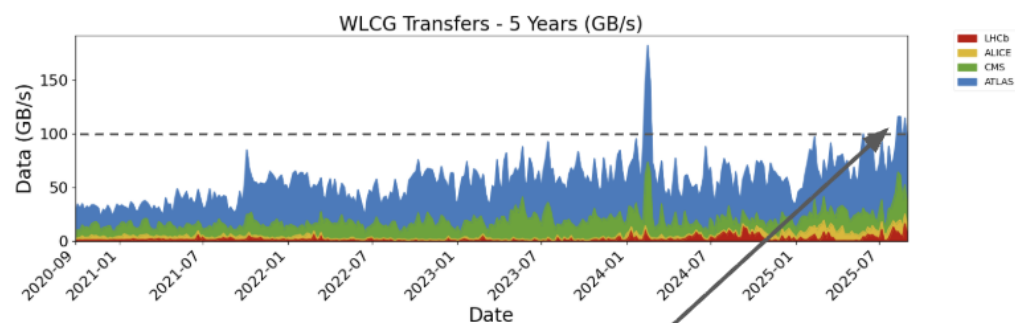
- Innovation Grants in operations and Cascade Calls expected to achieve the goals
- RAC resources in good use, and top-ups granted
- All industrial collaborations reaching goals (with some replanning)
- Personnel leaving (probably natural – a good thing?) + some failed hirings – mostly in BaC and IF; we somehow “survived”
- Lots of discussions on the future; path not yet set

How should the CN continue (Spoke 2 vision)

Our main points:

- The CN was born as a partnership in which Academia had the largest share; it should not drop this aspect
 - *"E' essenziale nel proseguimento del **centro preservare e espandere la componente** di supporto alle **esigenze delle attività scientifiche** riconoscendo la centralità della ricerca fondamentale come **terreno fertile da cui germogliano le innovazioni applicative e industriali**"*
 - *"Inoltre, la componente della ricerca deve essere **valorizzata in quanto polmone di talenti**, formati in contesti accademici di alto livello, che poi possa formare una **coorte di nuovi ricercatori** che partecipino attivamente allo sviluppo del paese in tutti i suoi ambiti ..."*
 - *"E' essenziale che gli Enti e le Università confermino la loro appartenenza al Centro, realizzandone la componente piu' attenta alle nuove tecnologie e portando casi d'uso estremi, **a TRL medio-basso**, indispensabili per la successiva fase di industrializzazione"*
- Who drives the agenda?
 - *"Tale impostazione consente di realizzare un allineamento strutturale **reciproco** tra domanda di innovazione e offerta scientifica, contribuendo a orientare le progettualità in modo coerente con priorità di medio-lungo termine."*
- Organization
 - Consider evolving from "Spokes" (which have a faint link with industries) to a structure driven by (1) Centers of Technical Excellence (2) Enlarged thematic domains

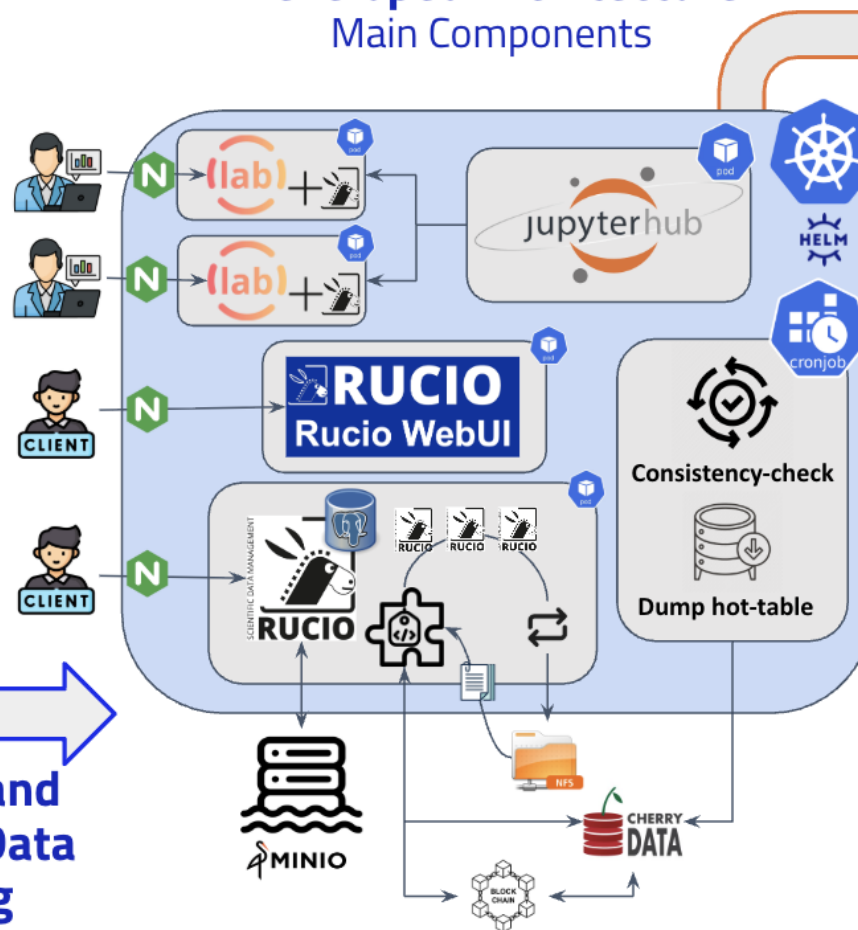
Scientific Background: Data Management



Benchmark summary					
Dataset	Status	Custom plugin?	# files	Total time	Mean time (s)
INAF: fermi	In progress	Yes	1763	2:23:59.946191	4.900707
INAF: pulsar	In progress	Yes	78	0:43:12.879830	33.242049
INAF: birales	In progress	Yes	15	0:00:42.692068	2.846138
TASI	Not started	Yes			
Spacetrack	Completed	Yes	5681116	115:22:43	0.07311292
Spacetrack	Completed	No	5681116	94:42:08	0.06001074

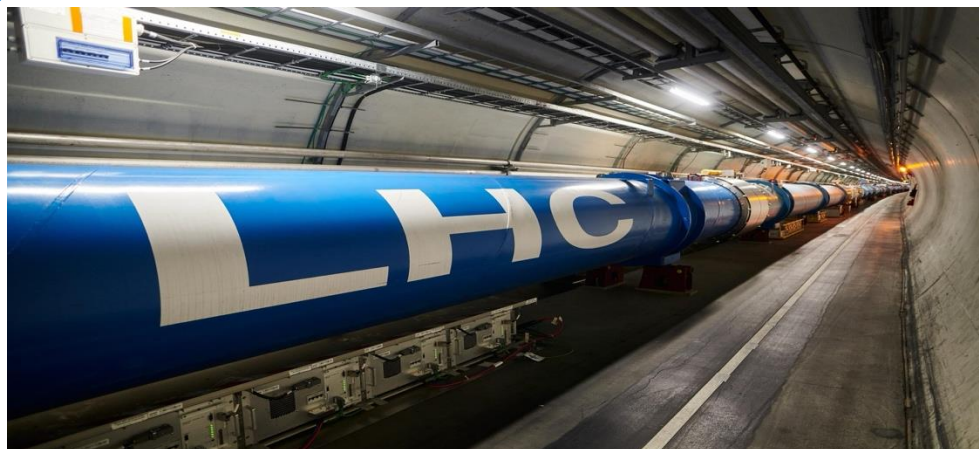
Scientific and
Industrial Data
Handling

Developed Architecture Main Components

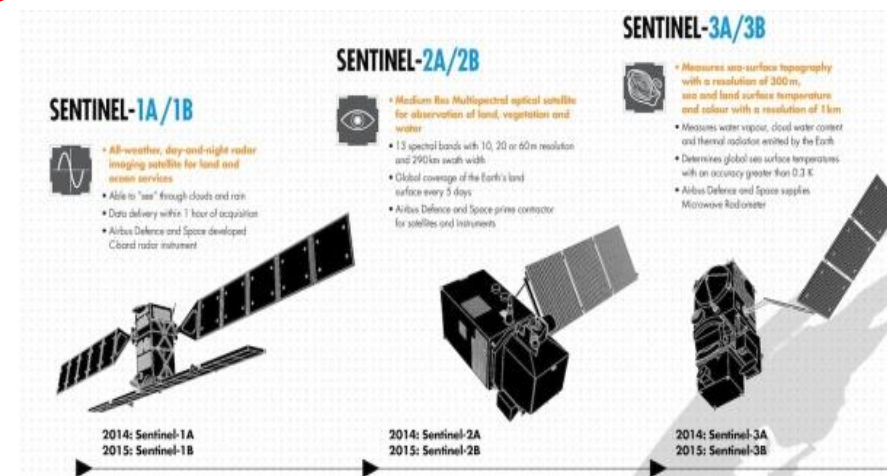
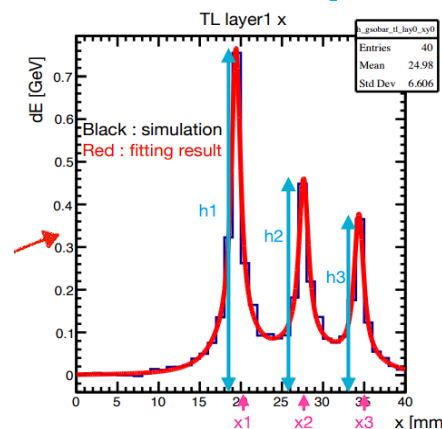
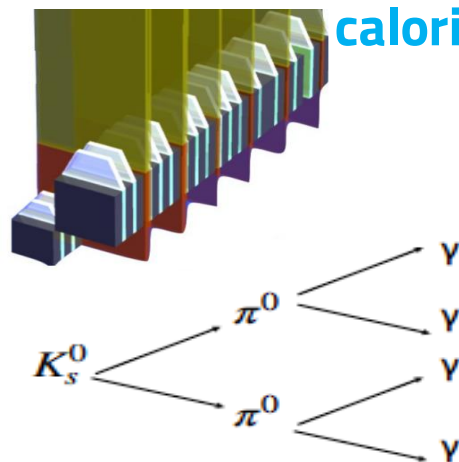


Toward
solutions for
computing at
the "edge"
Specialized HW i.e.
HPC Bubble

Fundamental Physics and Space Economy: Synergies and Differences



Reconstruction of multiple calorimetric clusters (LHCf)



Burned area segmentation after wildfires

