

COMCHA

A. Oyanguren & L. Fiorini

COMCHA School
09/04/2026



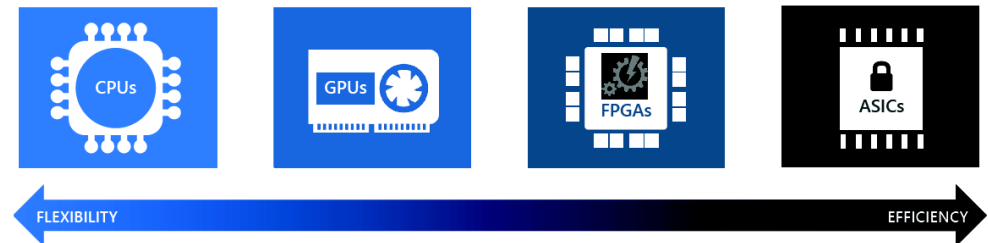
Spanish Network on Advanced Computing for Fundamental and Applied Physics:

Implement emerging computing technologies to tackle the next-generation computational challenges in physics research.

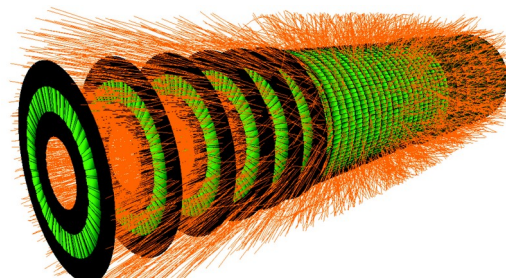
Motivations

- Research is evolving towards new computational technologies to face the expected requirements for many of the upcoming projects (**HL-LHC**, Super-B factory, multi-messenger astronomy, ...)
- Physics communities are exploring new disruptive technologies to address the foreseen computational problems:

- **New hardware solutions** (GPUs, FPGAs, Neuromorphics, Quantum Computing)

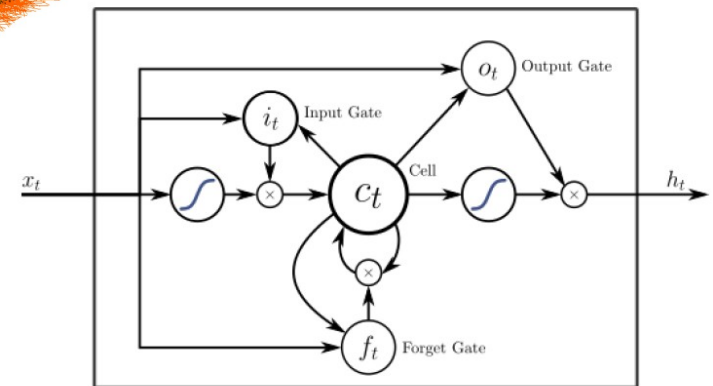


- **New and unconventional reconstruction techniques** (Long-lived particles, ...)



- **New data analysis strategies** (Machine Learning, Algo parallelisation)

- **More efficient computing** (energy consumption, ...)

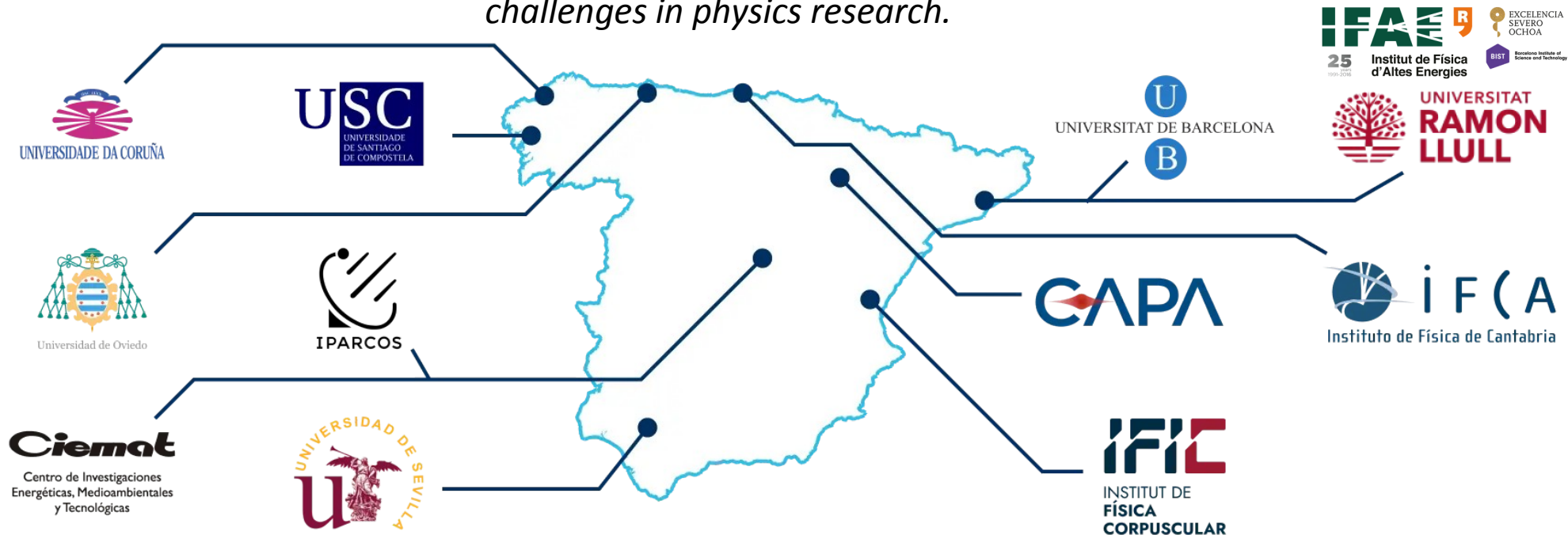


COMCHA Network



<https://comcha.es/>

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Implement emerging computing technologies to tackle the next-generation computational challenges in physics research.

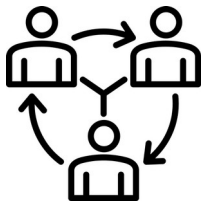


11 research centers / universities + two computing infrastructures

COMCHA Objectives



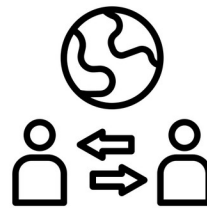
Main objectives:



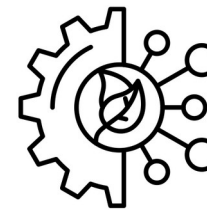
Collaboration



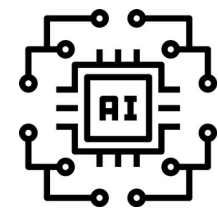
Training



Internalization



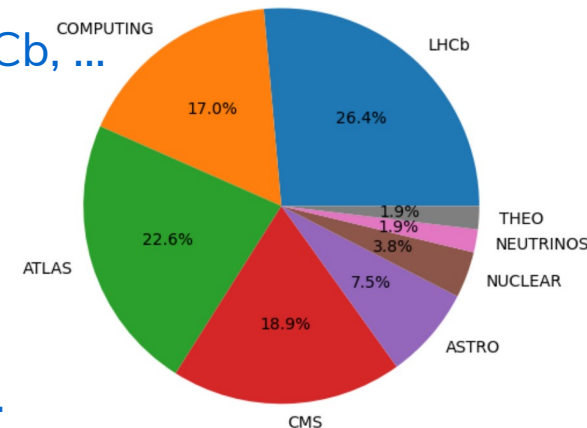
Sustainability



Industry

Activities: (→ examples)

- Reconstruction & Data Processing → triggers in ATLAS, CMS, LHCb, ...
- Simulation & Modeling → MC in hybrid systems, ...
- AI Methods → differential computing, LLMs, ...
- Computing Platforms & Infrastructure → GPUs, FPGAs, ARM, ...
→ Artemisa, PIC, High-Low
- Data Management & Analysis → WLCG, advanced techniques, ...
- Emerging Technologies → Quantum computing, neuromorphics, ...
- Collaboration & Community → Workshops and schools, interaction with other institutions (HSF, HEP-IRIS, AIHUB)

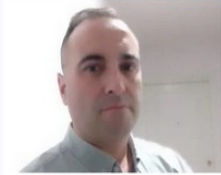


COMCHA Organization



Executive board:

<https://comcha.es/>

Executive Board				
 Arantza Oyanguren (IFIC) Coordinator	 Luca Fiorini (IFIC) Coordinator	 Xavier Cid Vidal (IGFAE)	 Diego Martínez Santos (UdC)	 Veronika Chobanova (UdC)
 Santiago Folgueras (ICTEA-UO)	 Pietro Viscia (ICTEA-UO)	 Pablo Martínez del Árbol (IFCA)	 Xavier Vilasis (URL)	 Elizabeth Golobardés (URL)
 Carla Marin (UB)	 Daniel Cagigas (ETSI-US)	 Miguel Ángel Martínez del Amor (ETSI-US)	 Héctor Gómez (CAPA-UZ)	 Cristina Fernández (CIEMAT)
 Daniel Nieto Castaño (UCM)	 Martin Borstad Eriksen (IFAE)	 Jose Enrique García Navarro (IFIC)	 Jose Salt Cairós (IFIC)	 Isidro González Caballero (ICTEA)

COMCHA Coordinates and Events

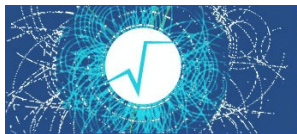
- COMCHA Web:
 - <https://comcha.es/>
- Mailing list (low traffic):
 - <http://pegaso.ific.uv.es/mailman/listinfo/comcha>
- In person events:
 - Schools organized every two years
 - Workshops organized every two years (alternating with schools)
 - Yearly meeting during CPAN days
- Strong connection with international organizations:
 - [HSF](#), [Iris-HEP](#), [ROOT](#), [AIHUB](#)

2nd COMCHA School (IFIC)



3rd COMCHA School (IFTFA)

CPAN 2025 (Valencia)



Backup

COMCHA & GRID

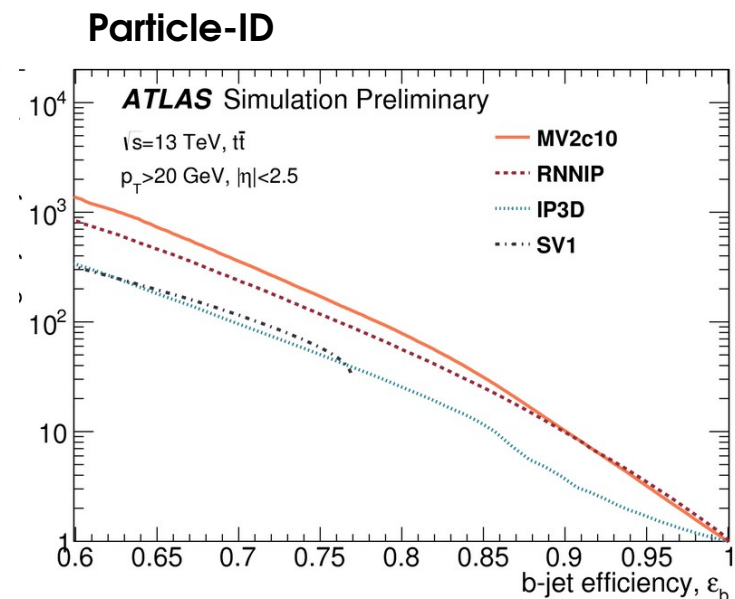
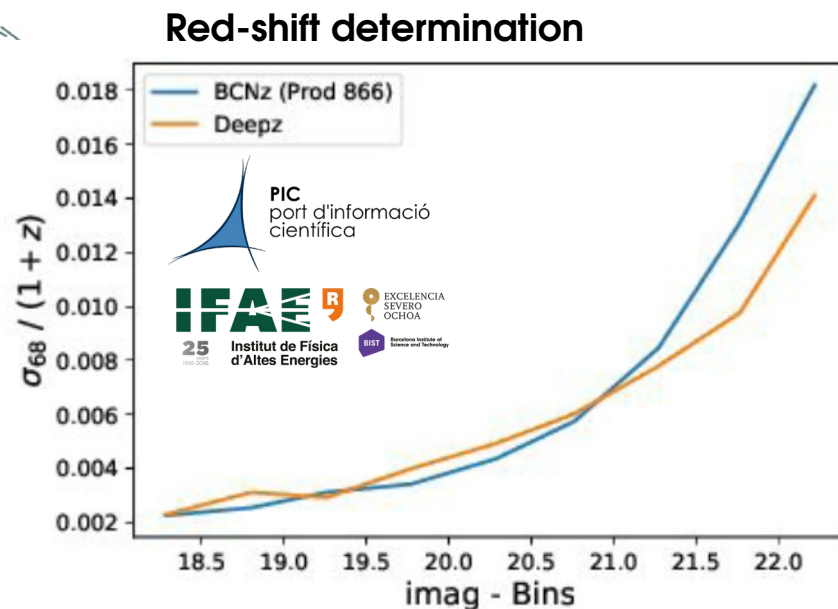
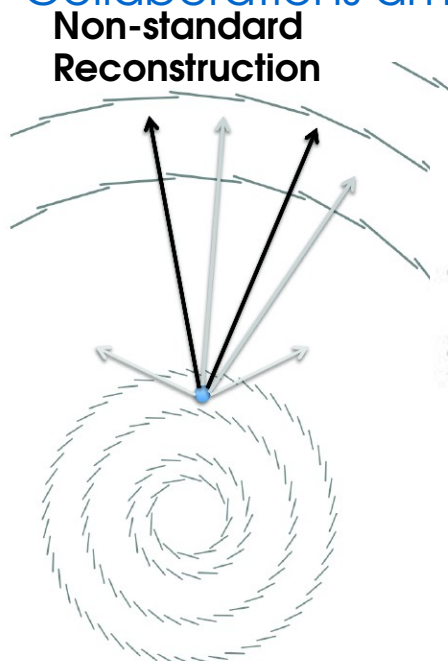
COMCHA doesn't overlap with GRID activities, even if we are in good contact.

COMCHA focuses on “*intensive*” computing challenges.

Applications: improve physics analysis → trigger systems, signal reconstruction, data analysis:

- Improving reconstruction algorithms
- Application of new technologies:
 - Machine Learning, Deep Learning
- New hardware technologies:
 - GPUs, FPGAs, etc.
- Application of vectorization and parallelization of new processors.

Collaborations among groups from different fields.



Activity Example: DNN Signal Reco

arXiv.org > physics > arXiv:1903.02439

Search or Article

(Help | Advanced se

Physics > Instrumentation and Detectors

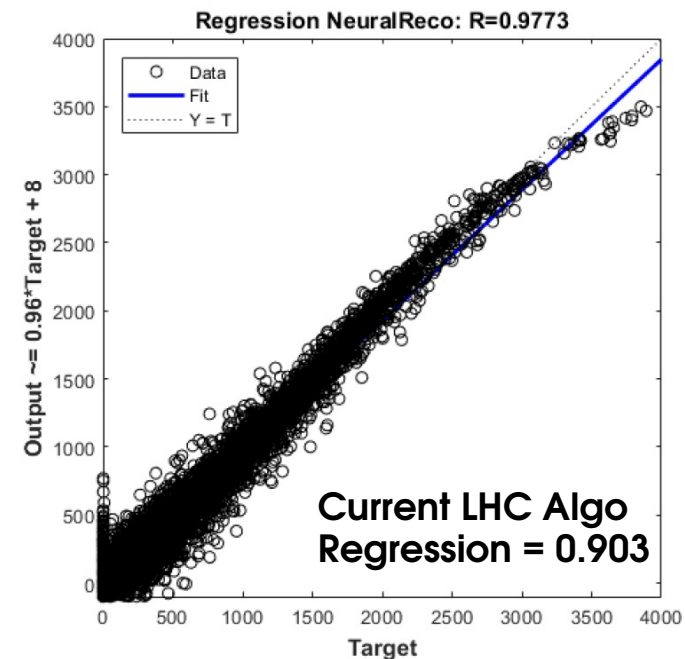
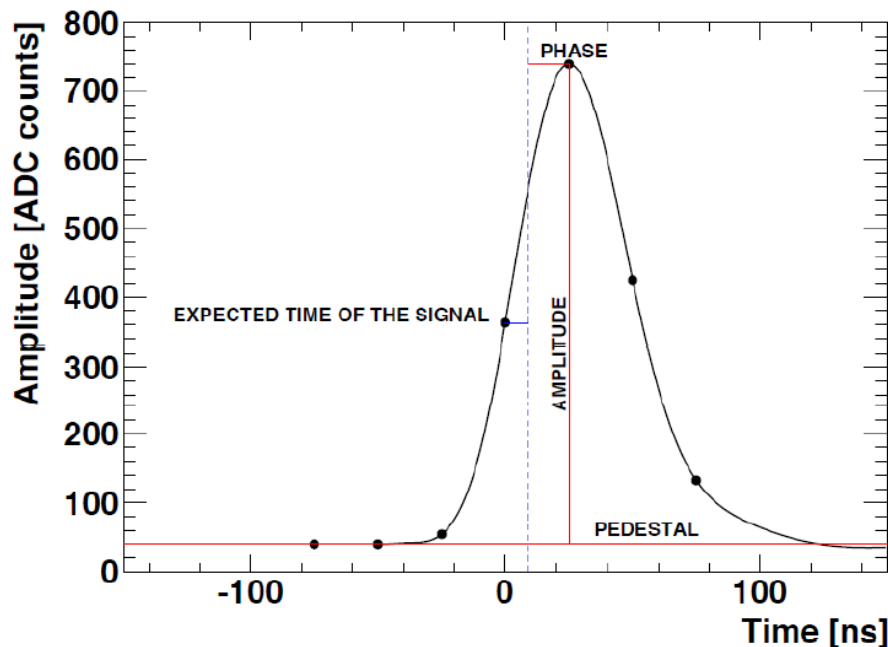
FPGA implementation of a deep learning algorithm for real-time signal reconstruction in radiation detectors under high pile-up conditions

J. L. Ortiz, F. Carrió, A. Valero

(Submitted on 6 Mar 2019)

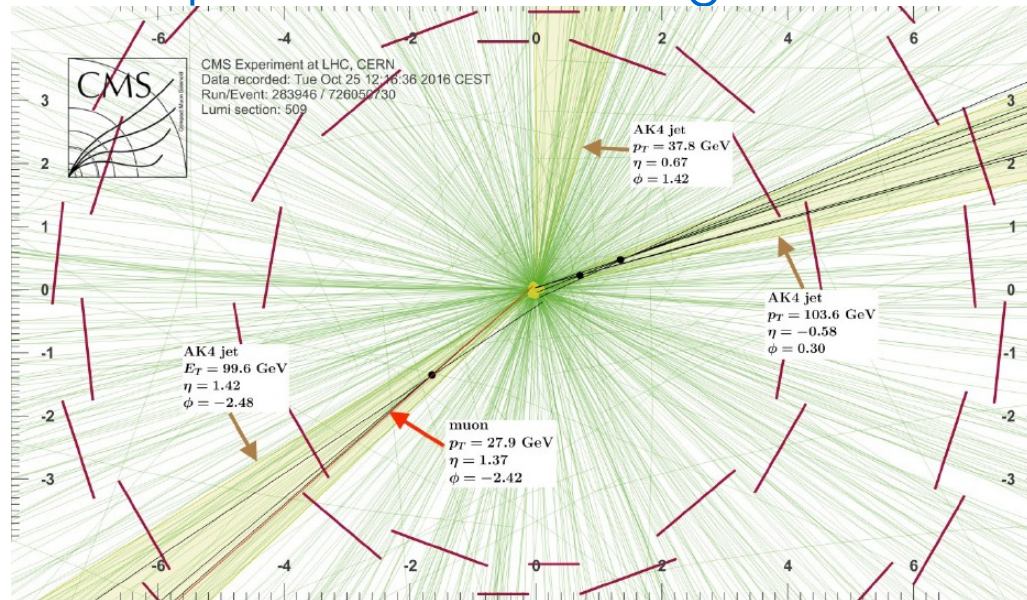


- **Deep NN for real-time signal reconstruction** at the HL-LHC.
- HL-LHC pileup degrades the pulse quality, LHC algos performance deteriorates.
- 128 FPGAs to process the full ATLAS Tile Calorimeter.
- Each FPGA process 96 different signals with 40 MHz rate



Activity Example: ML Tracking

- **Searches for long lived particles** using ML techniques.
- Track reconstruction using Long Short-Term Memory (LSTM) Neural Networks for tracks displaced from the origin.



- Following closely the recent Kaggle **Machine Learning Tracking Challenge**, HEP pattern recognition using HL-LHC simulated data

Featured Prediction Competition

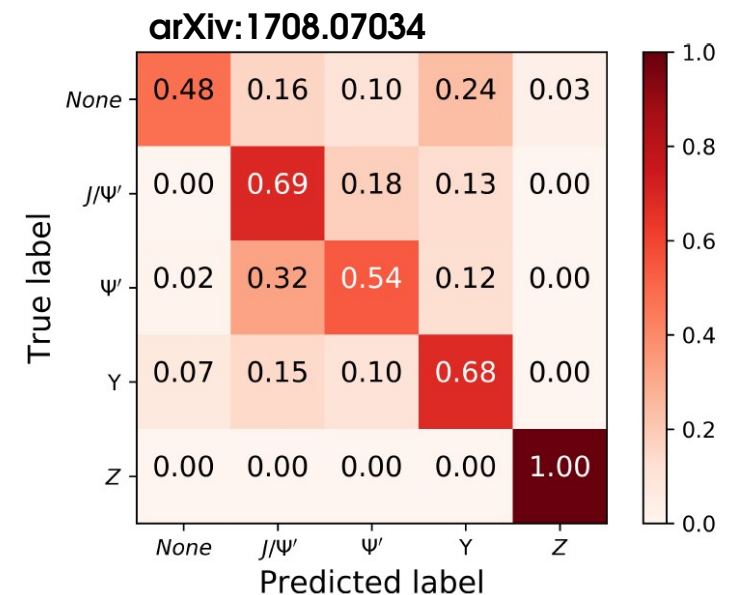
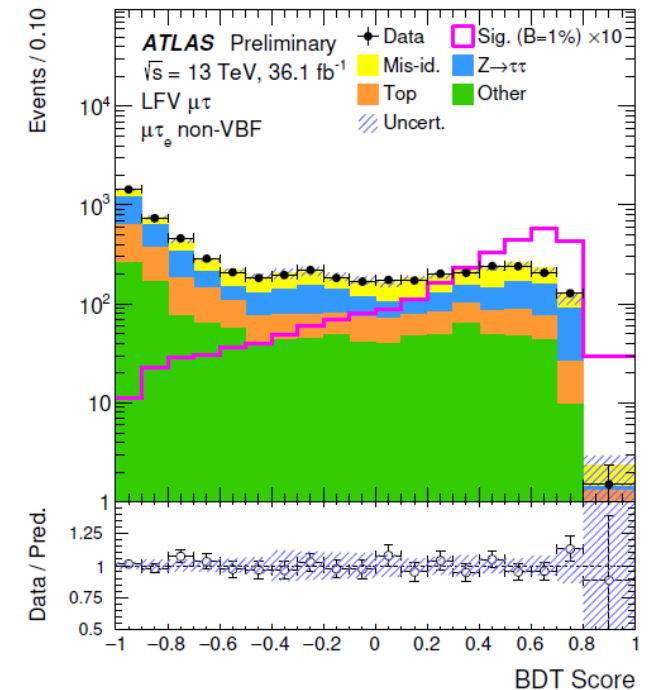
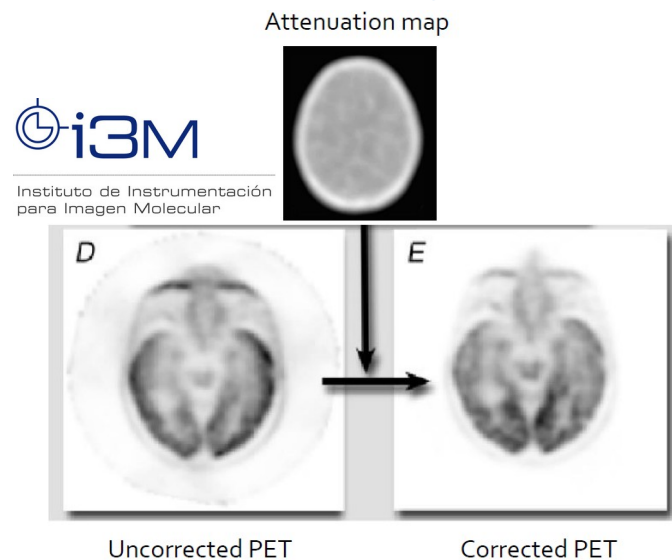
TrackML Particle Tracking Challenge
High Energy Physics particle tracking in CERN detectors

CERN · 653 teams · 9 months ago

\$25,000
Prize Money

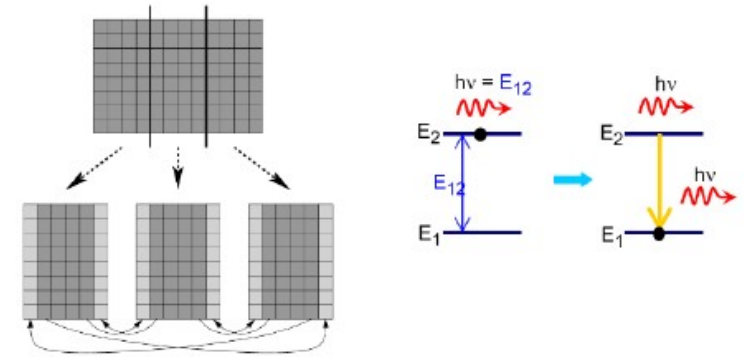
Activity Example: Machine & Deep Learning

- Application of **Machine Learning** in LHC searches for new physics.
- **Computer Vision** (ConvNets) Network for event classification, muon tomography and search for long-lived particles
 - Application as well for satellite imaging, medical diagnosis, etc.
- Improvement of PET imaging (Attenuation correction) with **Deep Learning**



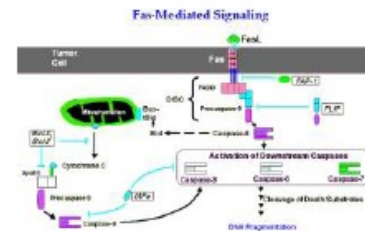
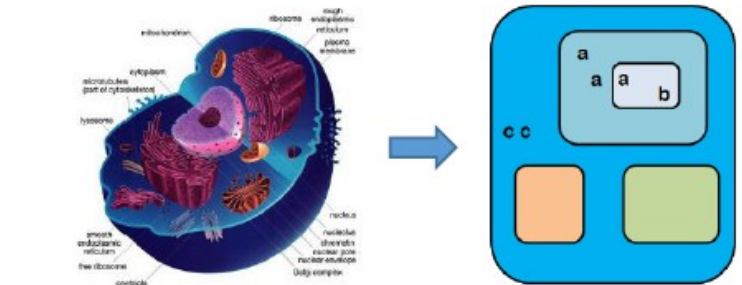
Activity Example: Parallel Computing

- Study benefit of **advanced vectorization** capabilities of modern processors (SSE, AVX 2.0...)
- Allows the processing of multiple data with a single order
- → Single Instruction Multiple Data (SIMD) (e.g.: matrix calculations for Kalman filters)



- **Natural Parallel Computing** using bio-inspired models to model complex systems:

- Cellular Automata
- Membrane Computing
- Parallel Genetic Algorithms
- Parallel implementation:
 - Clusters
 - GPU
 - Multi-threading
 - GRID



Current COMCHA Initiatives

- **COMCHA School:**

- preparation ongoing for the first COMCHA school on Machine Learning at URL-Barcelona
- Dates: October 2019



UNIVERSIDAD
**RAMON
LLULL**

- **COMCHA Thematic Network:**

- Proposal with 14 nodes from 11 Institutes.
- Groups working on collider physics, operations and computing (9), neutrino and astroparticle (1), nuclear (1), cosmology (1), medical physics (1), applied physics (1).

→ **Aim is to include any interested group, e.g. Theory groups (contact us!).**

- **COMCHA Roadmap:**

- Prepare in 2019 a roadmap of COMCHA for the next 4-5 years to converge the effort along well defined objectives.

Conclusions

- To make new discoveries and better measurements at the HL-LHC, we need **new computing paradigms**.
- Adapting new computer technologies to high density environments is a common problem in HEP and outside HEP, but research groups and experiments tend to act separately.
- COMCHA started to address this problem at **national level**, aiming to explore computing models and **share experience and help collaboration** among groups and experiments.
- COMCHA initiatives are taking shapes: regular discussion meetings, COMCHA school, Thematic Network Proposal, etc..
- COMCHA is recognized at international level, invitations to HOW 2019, CHEP 2019, ...
- If you are interested, just subscribe to the distribution list:
 - <http://pegaso.ific.uv.es/mailman/listinfo/comcha>

