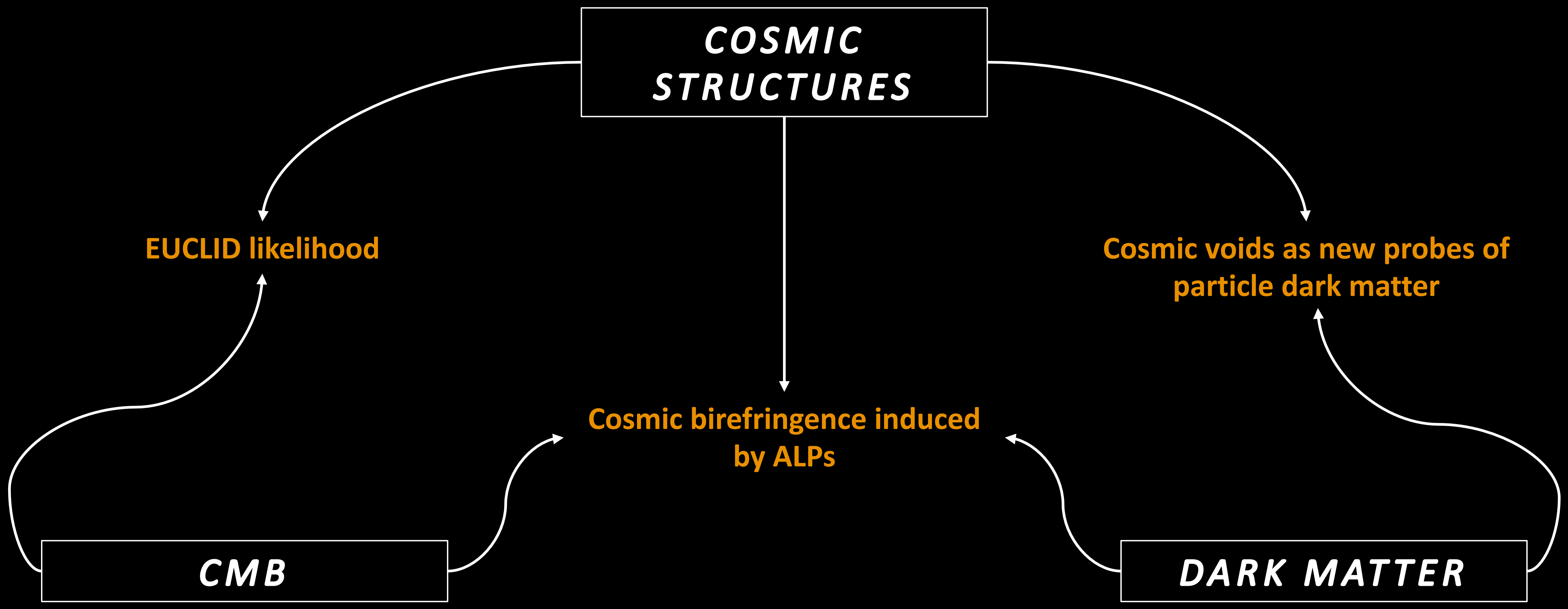
Università degli Studi di Ferrara

Stefano Arcari

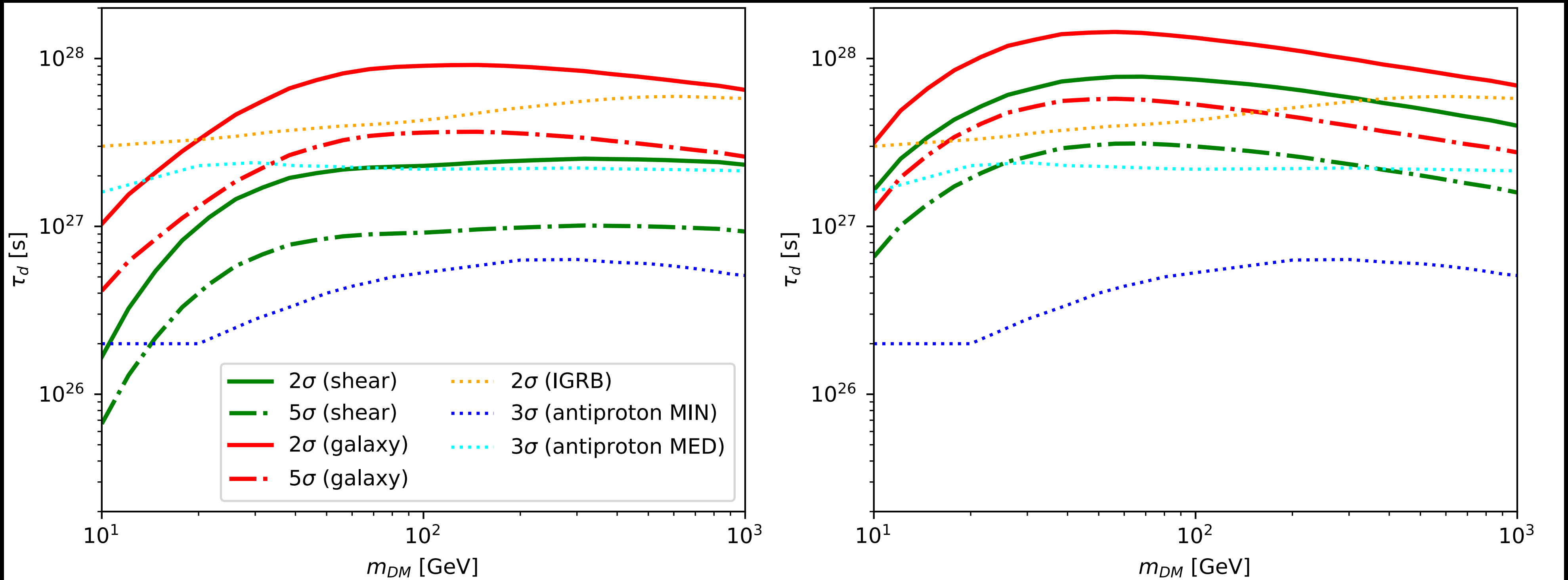
COSMOLOGY and ASTROPARTICLE PHYSICS

ESC22 – Bertinoro – 3 Oct. 2022

REASERCH AREAS



COSMIC VOIDS AS PROBES OF DM



<u>*PROGRAMMING*</u>: OOP C++ for nested integration ans spline interpolation

EUCLID LIKELIHOOD

GOAL

Constrain cosmology from TG cross-correlations

Test modified gravity

PROGRAMMING

Advanced cosmological codes like CAMB or CLOE (Python)

COSMIC BIREFRINGENCE

GOAL

Constrain axions' properties from αG cross-correlations

Test parity violating physics

PROGRAMMING

Advanced cosmological codes like CAMB or CLASS (Python)

PERSONAL GOALS AT ESC

Improve OOP skills and knowledge

Learn and apply parallel computing

Share experiences

Automated method for offline correction of spectrometry data affected by time instability

M. Balogh,[1] A. Herzáň,[1] V. Matoušek,[1] M. Sedlák[1], M. Beňo,[2] J. Dobrovodský,[2] G. Kantay,[1] P. Konopka,[1] P. Noga,[2] A. Repko,[1] A. Špaček,[1] D. Vaňa,[2] M. Venhart,[1] S. Vielhauer[1]

[1] Institute of Physics, Slovak Academy of Sciences, Bratislava, Slovakia
[2] Slovak University of Technology in Bratislava, Slovakia

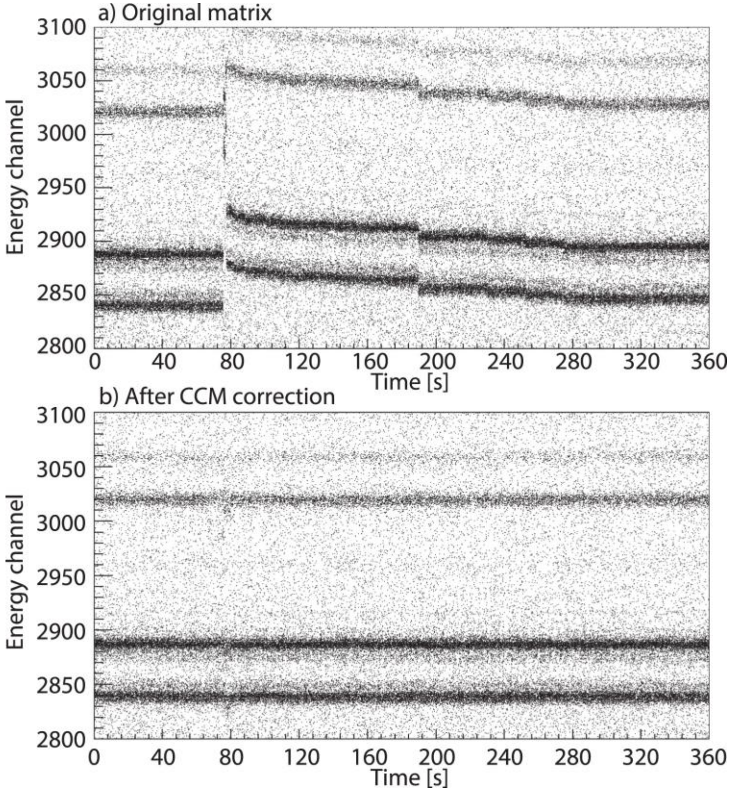
- Cross-correlation Correction Method (CCM)

$$(x \star y)[s] = \sum_{n=1}^{N} x[n] \cdot y[n+s]$$

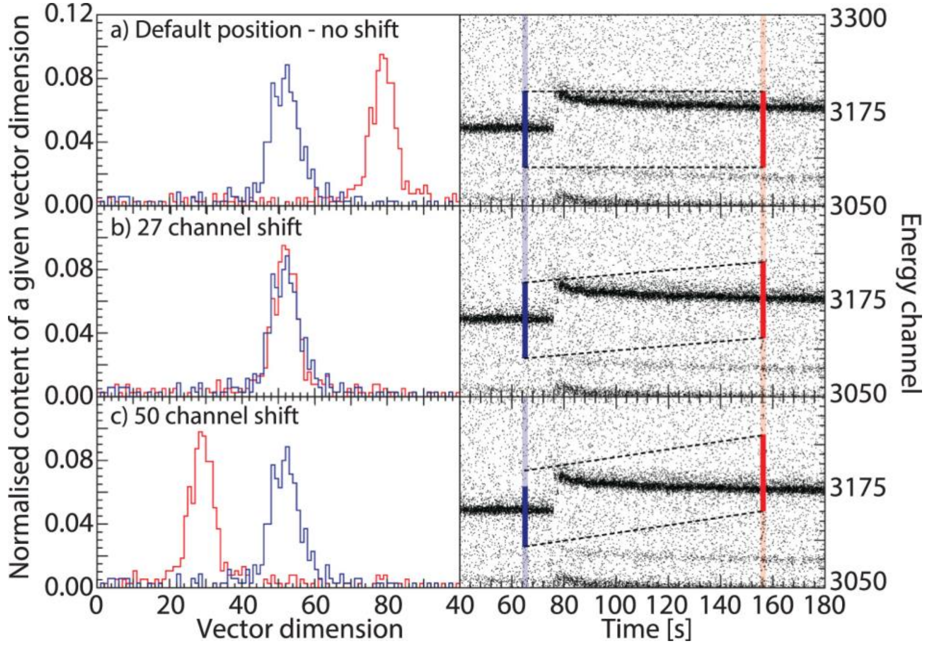
$x[i]$ $y[j]$ – signals
s - offset

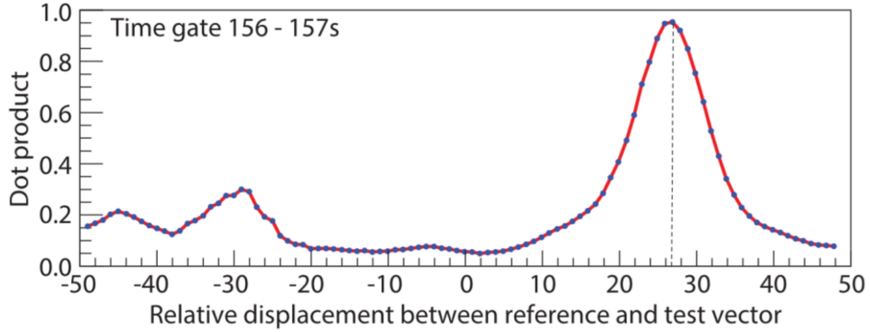
Advantages:

- Peaks are not required, works on any distinct shape
- Can be applied on time-dependent spectra (decay spectroscopy)
- Correction of time instability and energy calibration



Published in NIMA 2021



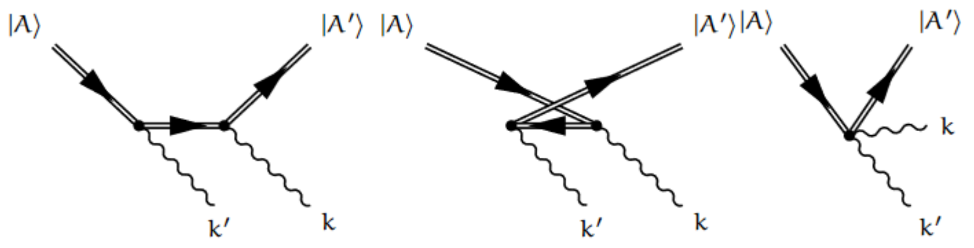


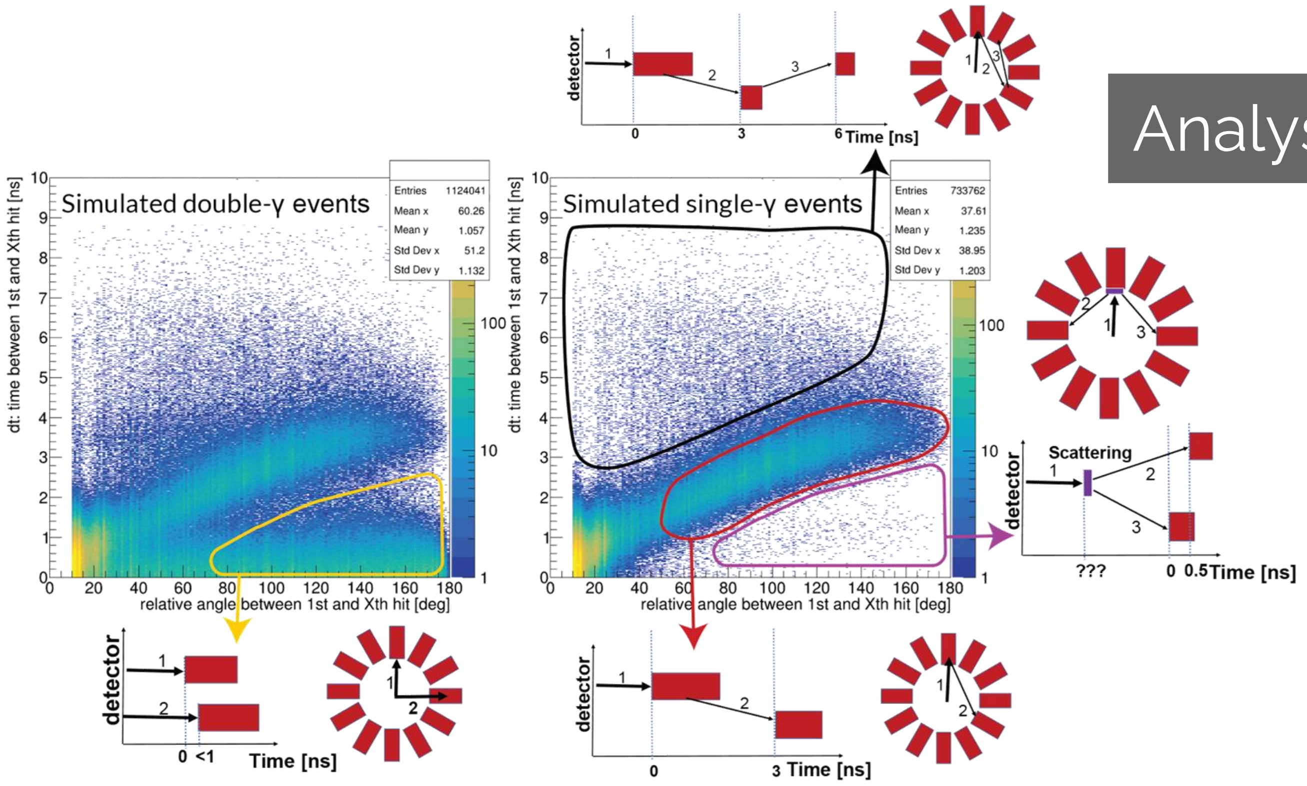
Matus Balogh | matus.balogh@lnl.infn.it

Feasibility study of the competitive double-γ decay measurement

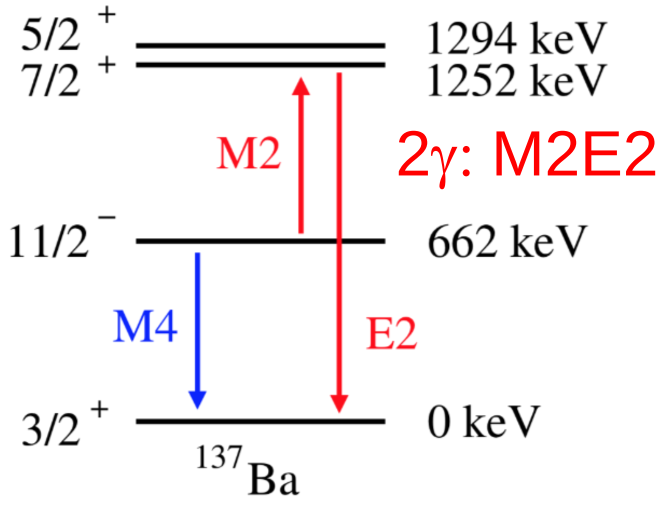
M. Balogh, J. J. Valiente Dobón

- Two photons emitted simultaneously with continuous energy distribution
- Competitive decay with BR less than 10^{-5}
- Mimicked by Compton scattering
- Experimental sensitivity? -> GEANT4 simulations!





Analysis with NN?

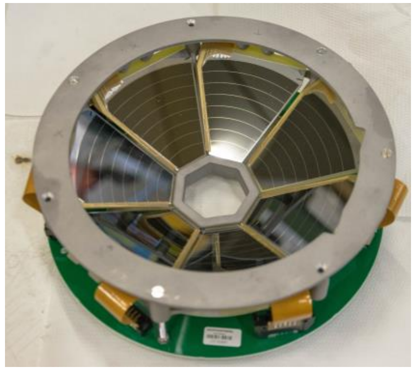


Work in progress

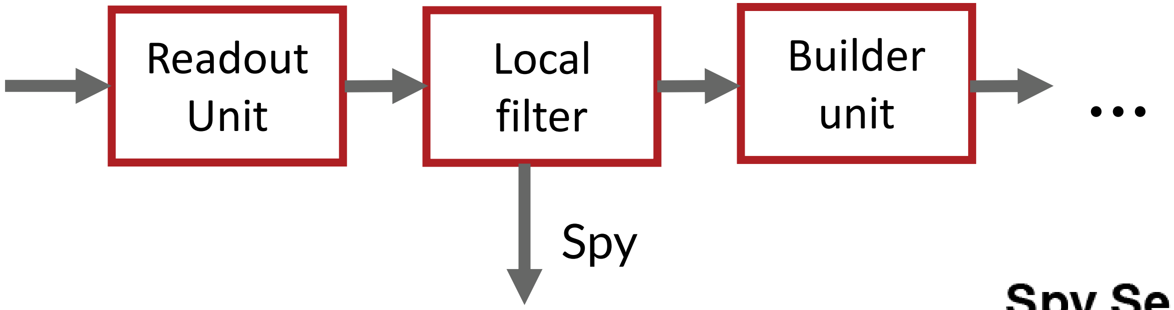
New lightweight LNL Spy framework

M. Balogh, A. Goasduff, F. Galtarossa

SPIDER



DAQ for ancillary detectors at LNL

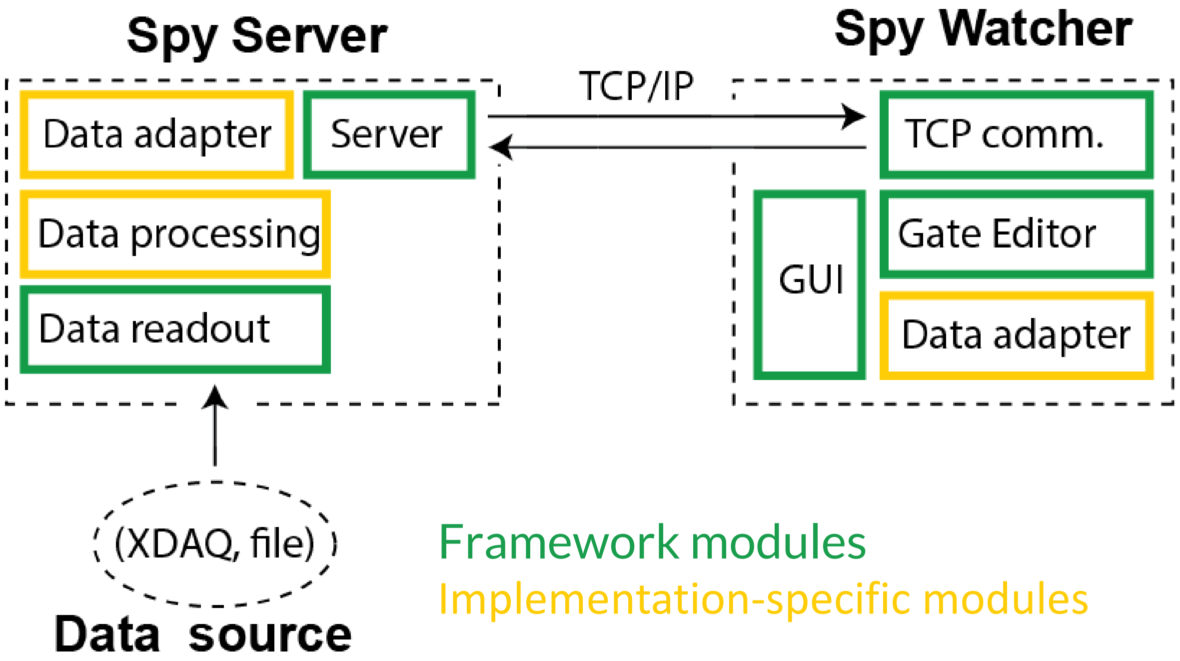


Work in progress

Spy – online data analysis and visualization

LNL Spy framework

- C++14 and ROOT
- *Spy Server* – data readout and processing
- *Spy Watcher* – GUI
- New implementation needs to define only *data adapter* module and *data processing* module



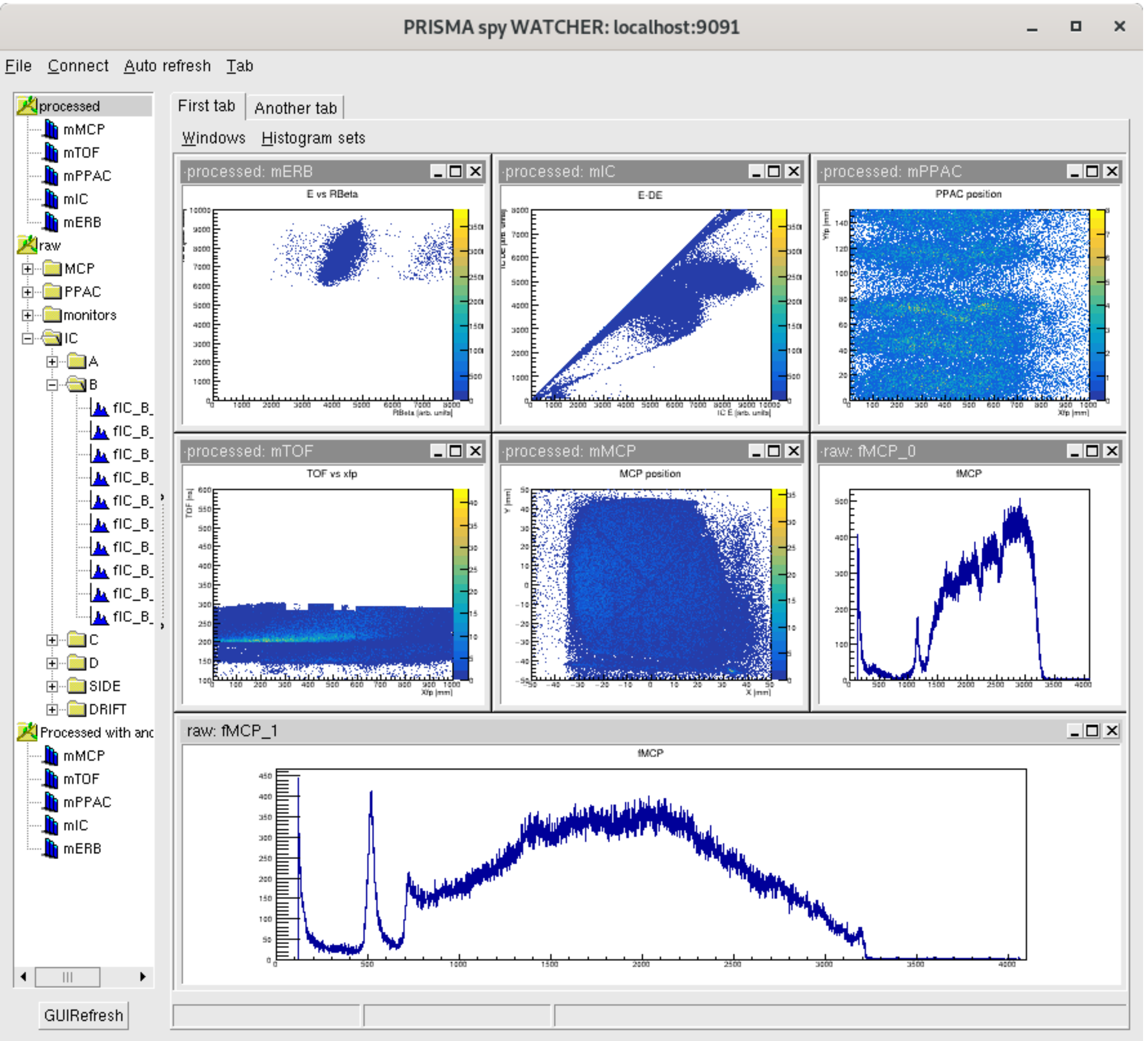
Framework modules

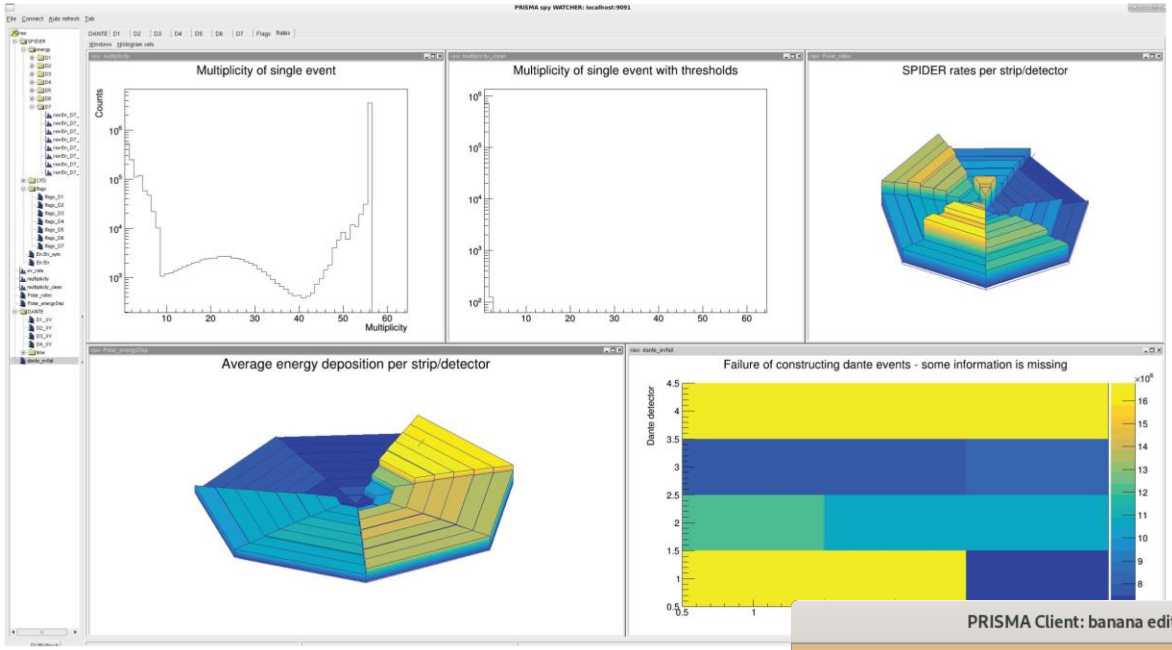
Implementation-specific modules

New lightweight LNL Spy framework

M. Balogh, A. Goasduff, F. Galtarossa

PRISMA implementation

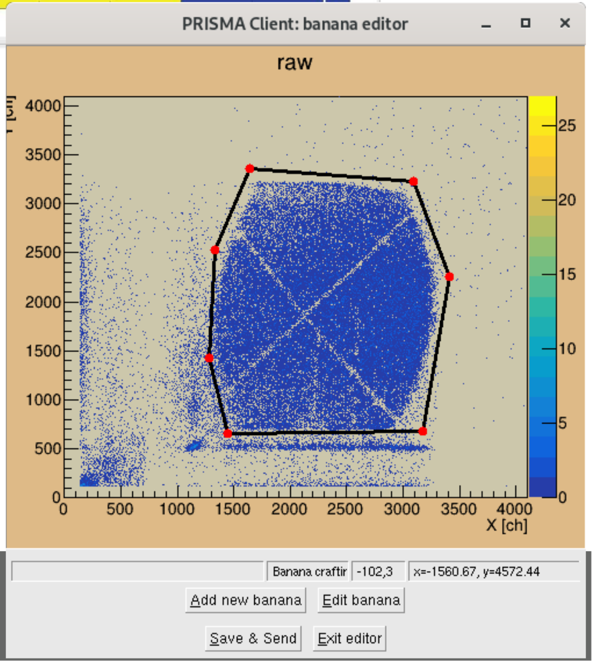




SPIDER implementation

Work in progress

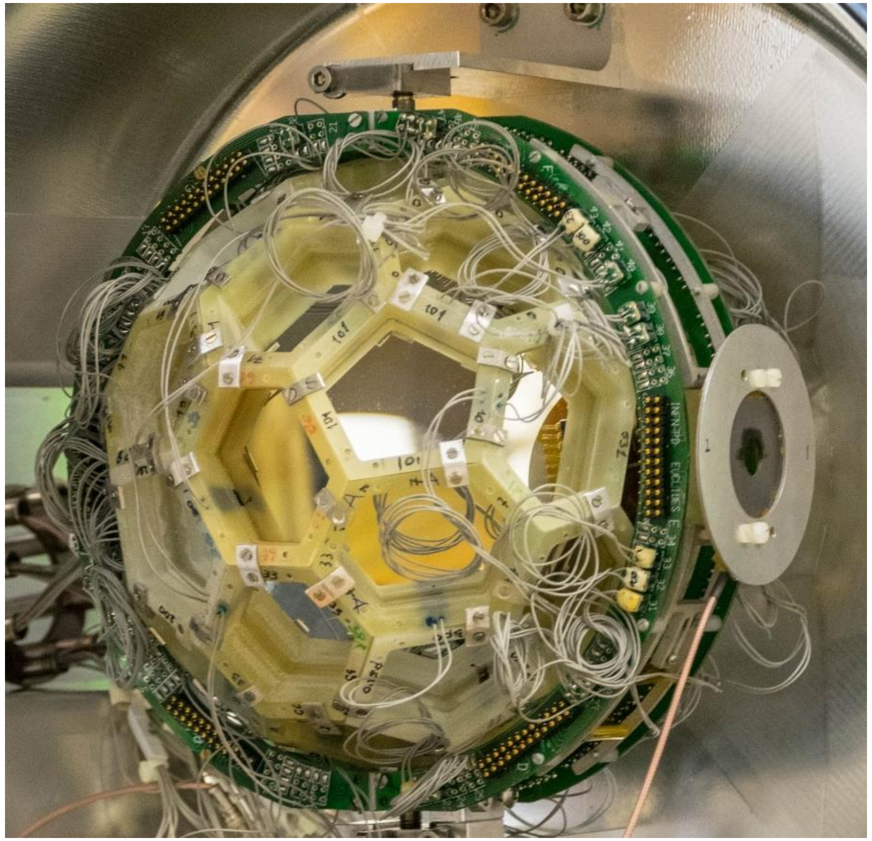
"Banana" editor

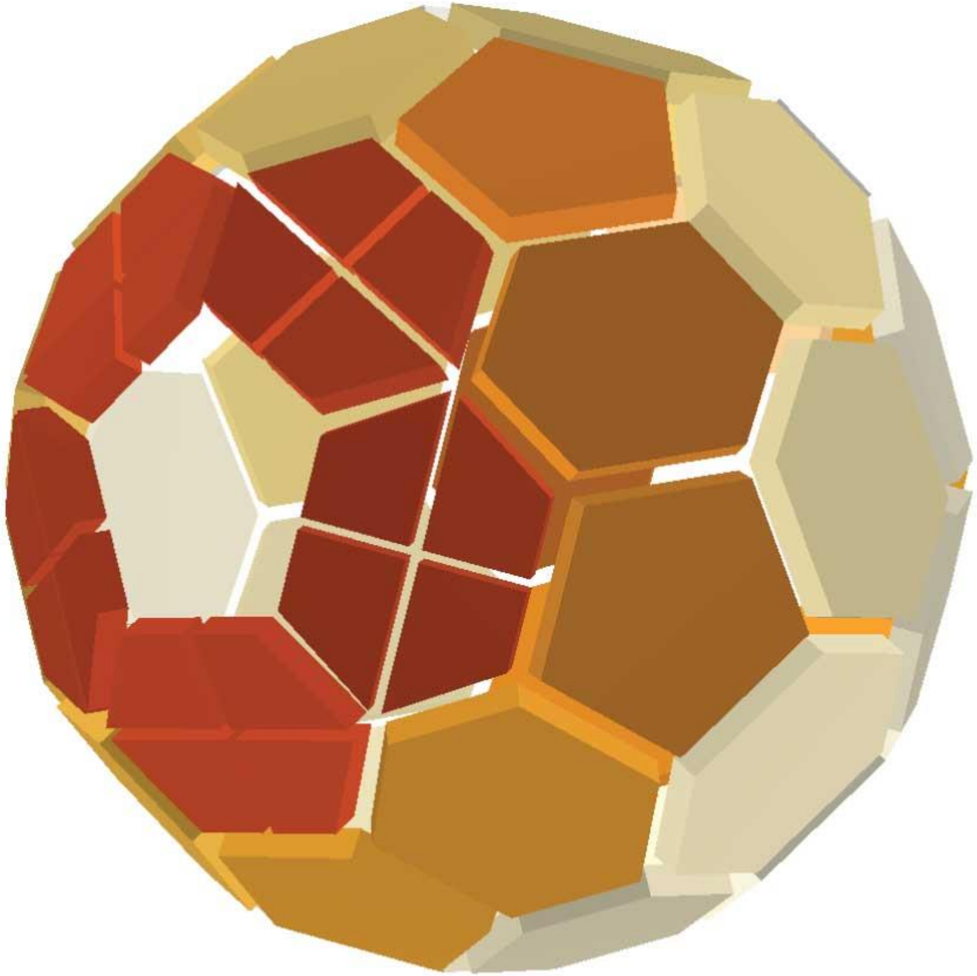


OpenGL visualization for LNL Spy: TGL1D

M. Balogh

- Large number of channels – hard to spot problems
- **EUCLIDES -** dE/E Si-ball telescope, 110 channels
- Work in progress on full implementation of a histogram-like 3D rendered model of a detector





Bartolini Giovanni

Background

- Studied Physics at the University of Perugia (bachelor and master) with Particle Physics curricula
- PhD at CPPM, a Particle Physics laboratory in Marseille, working for ATLAS experiment. Subjects of my PhD thesis where the calibration of bjet trigger in Run2 and analysis of ttH fully hadronic channel.

Bartolini Giovanni

Current activity

- Working for BEAMIDE Srl, a spin-off company of INFN – Perugia Section. Main project of this start-up is related to production of a user-friendly software called MRADSIM for the simulation of radiation effects on electronic devices that used Geant4 as a backend.

13-th "Efficient Scientific Computing" School 2022

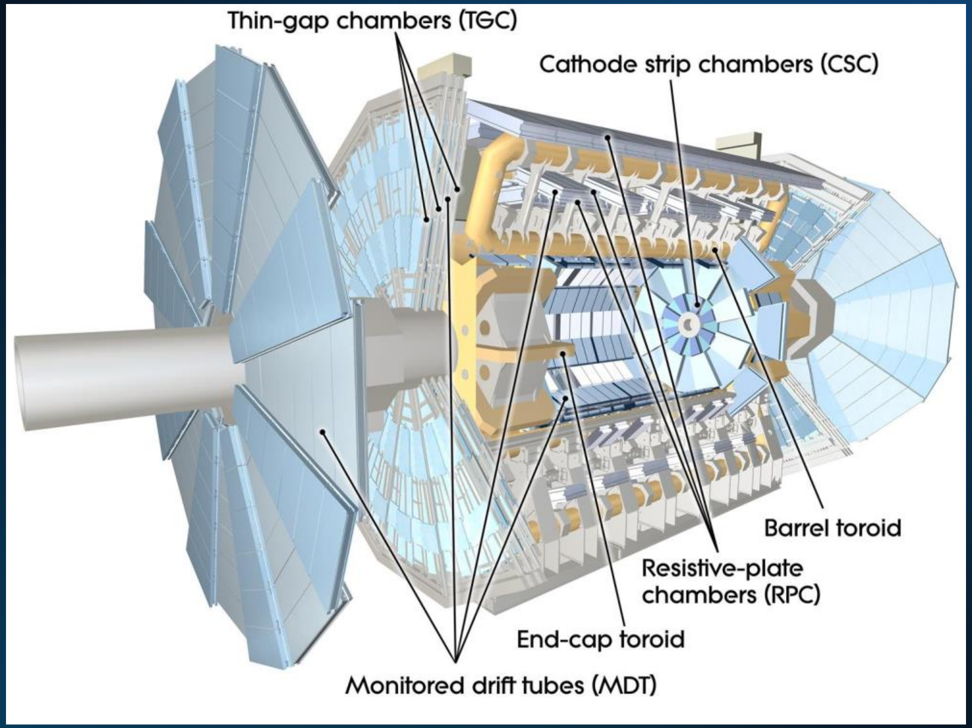
GIANLUCA BIANCO

3-8 OCTOBER 2022

My research activities

- Who am I?
  - PhD student in Physics at Alma Mater Studiorum – University of Bologna (37° cycle)
  - Associate member of INFN working for the ATLAS experiment
- Computing interests:
  - Software engineering, data analysis, machine learning, quantum computing…
- Research activities:
  - **Top quark physics**: study of the quantum interference between singly- and doubly-resonant top-quark production in the $WbWb$ phase-space with the ATLAS detector (*poster*)
  - **Detectors**: development of offline data-analysis tools for ATLAS RPC detector data-quality monitoring (*this talk*) ➡ code repository link (restricted to ATLAS)

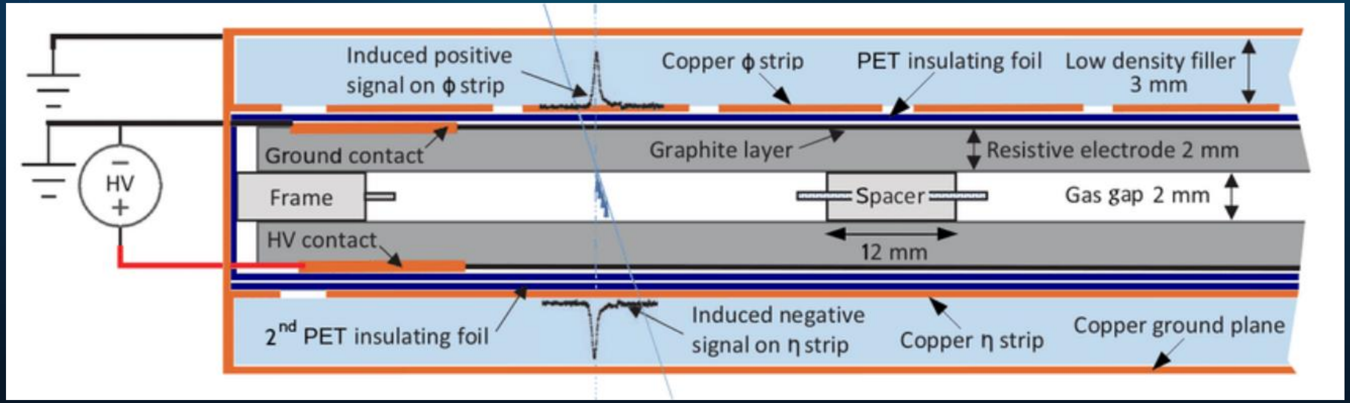
The ATLAS RPC Detectors



ATLAS Muon spectrometer

Properties:

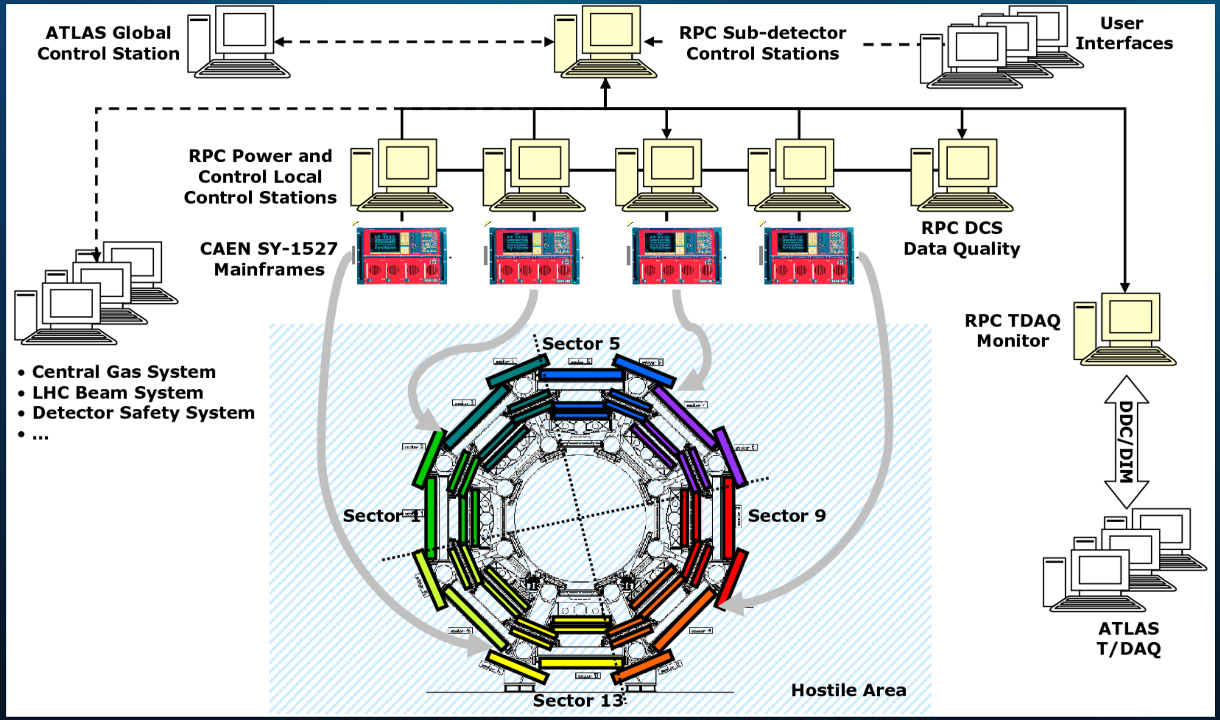
- Are used in *L1 muon trigger* to detect muons
- Are arranged in six concentric layers
- Operate in toroidal magnetic field
- ~ 3700 gas volumes and $\sim 4000\ \mathrm{m}^2$ of total surface



A single ATLAS RPC Detector

The RPC Detector Control System (DCS)

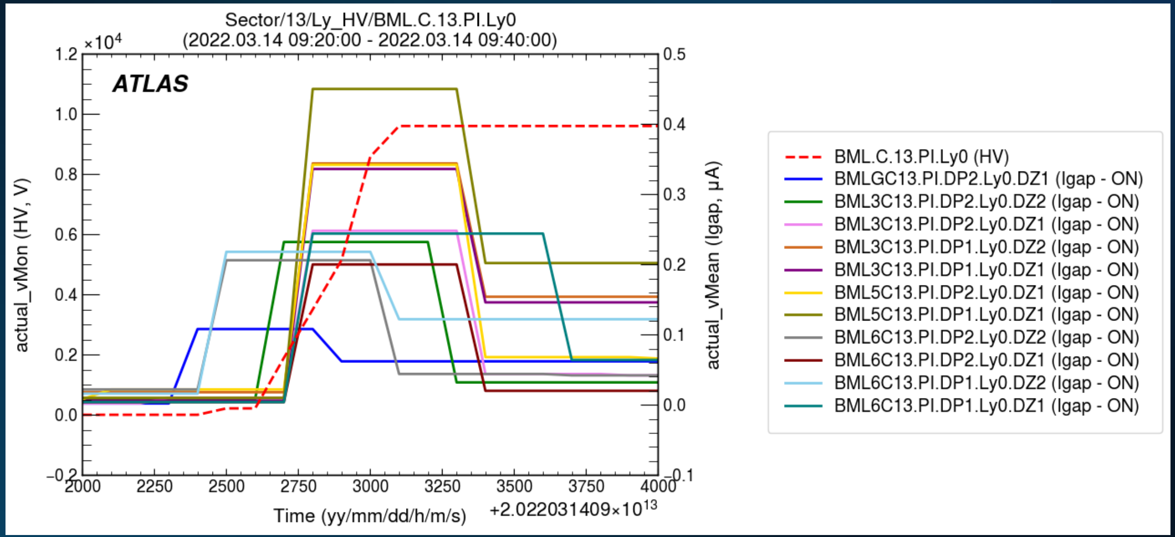
- Used to monitor the RPC conditions
- Control all related subsystems (supply of low and high voltages, trigger electronics, detector infrastructure and environment conditions)
- Store all the relevant information into the ATLAS database for analyses
- My task: develop algorithms which will be used to publish plots on the web, updating the gas leakages monitoring



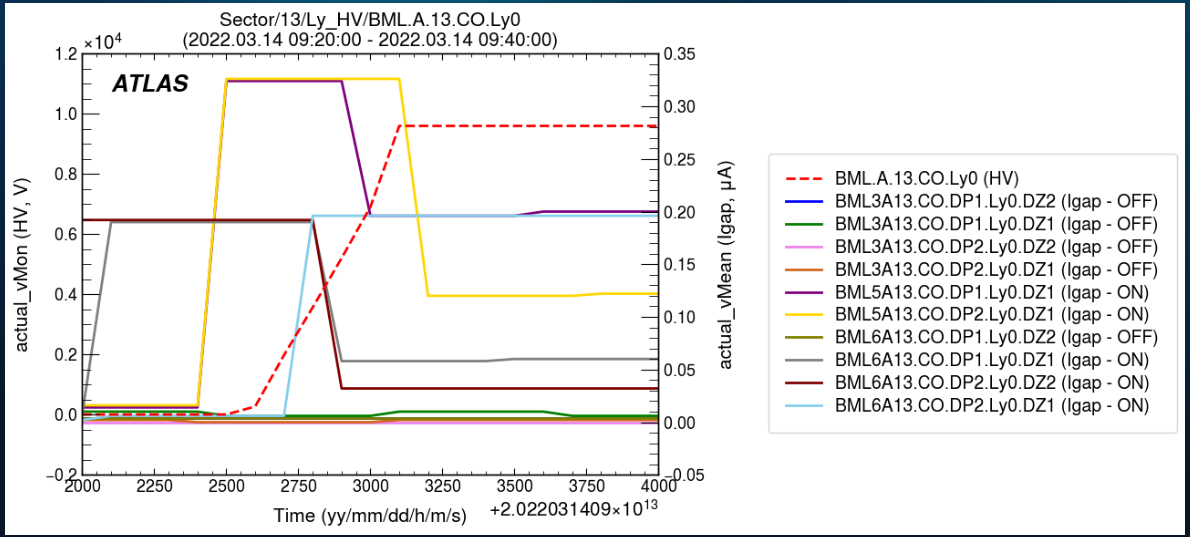
The RPC DCS

Study of the HV-I_{gap} mapping

- Check **mapping** implemented in DCS between HV and I_{gap} channels of each RPC chamber
- Igap channels with variation less or equal than 0.01 μA considered as "OFF" (not mapped), otherwise considered as "ON" (correctly mapped).



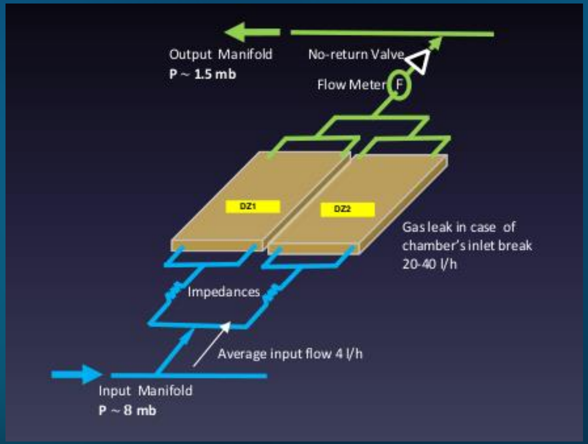
Example of HV channel with <u>correct mapping</u>



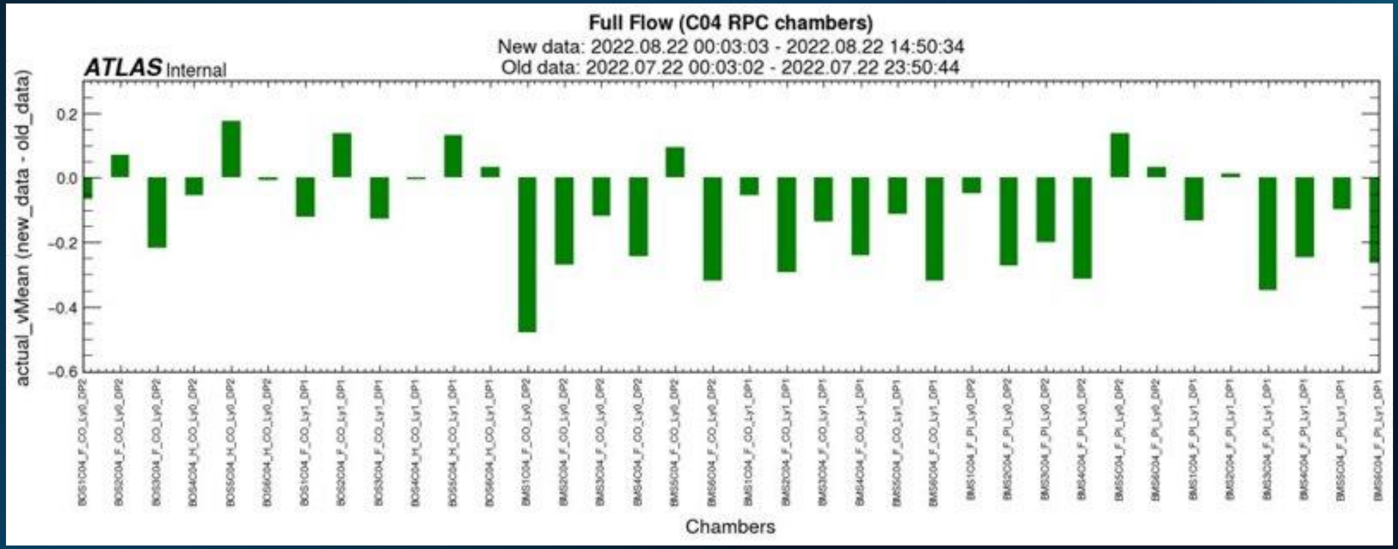
Example of HV channel with <u>mapping problem</u>

Study of the gas leakages

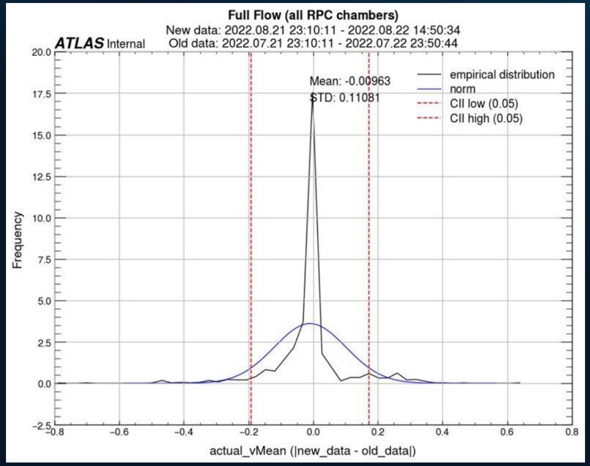
- Investigate gas volumes leaks using info from flowmeters of the gas group
  - <u>1068 flowmeters</u> of the chambers
  - <u>128 flowmeters</u> on the manifold lines distributing the gas



Overview of a flowmeter



FullFlow difference among *SectorC04* chambers



FullFlow differences distribution

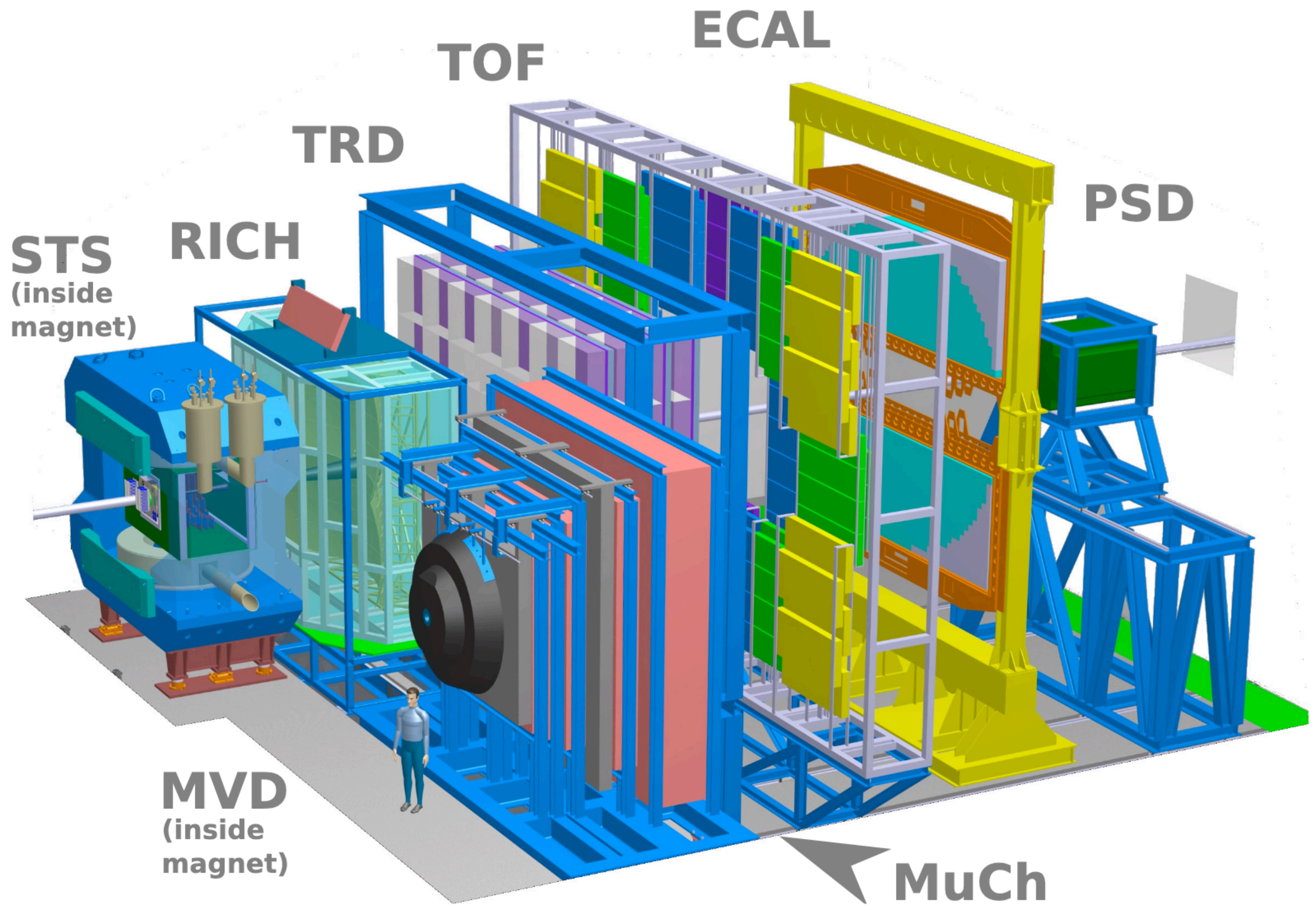
Detector Alignment for CBM

ESC 2022

Nora Bluhme | Goethe University Frankfurt | FIAS | AG Lindenstruth

CBM Compressed Baryonic Matter

- Facility for Antiproton and Ion Research FAIR
- Investigation of particles under extreme conditions



Alignment

Finding the real Detector Geometry

- Shifts and Rotations of Detector Components

- **Track based alignment:**
  Adjusting all the detector elements in such a way that data makes the most sense.

- Misalignment $\longrightarrow$ residuals between measured and reconstructed hits

- $\displaystyle \sum_{tracks} \sum_{hits} \frac{(hit - hitmodel(\vec{d}, \vec{t}))}{\sigma^2}^2 \longrightarrow$ minimization

- Usually the inversion of a huge matrix is involved

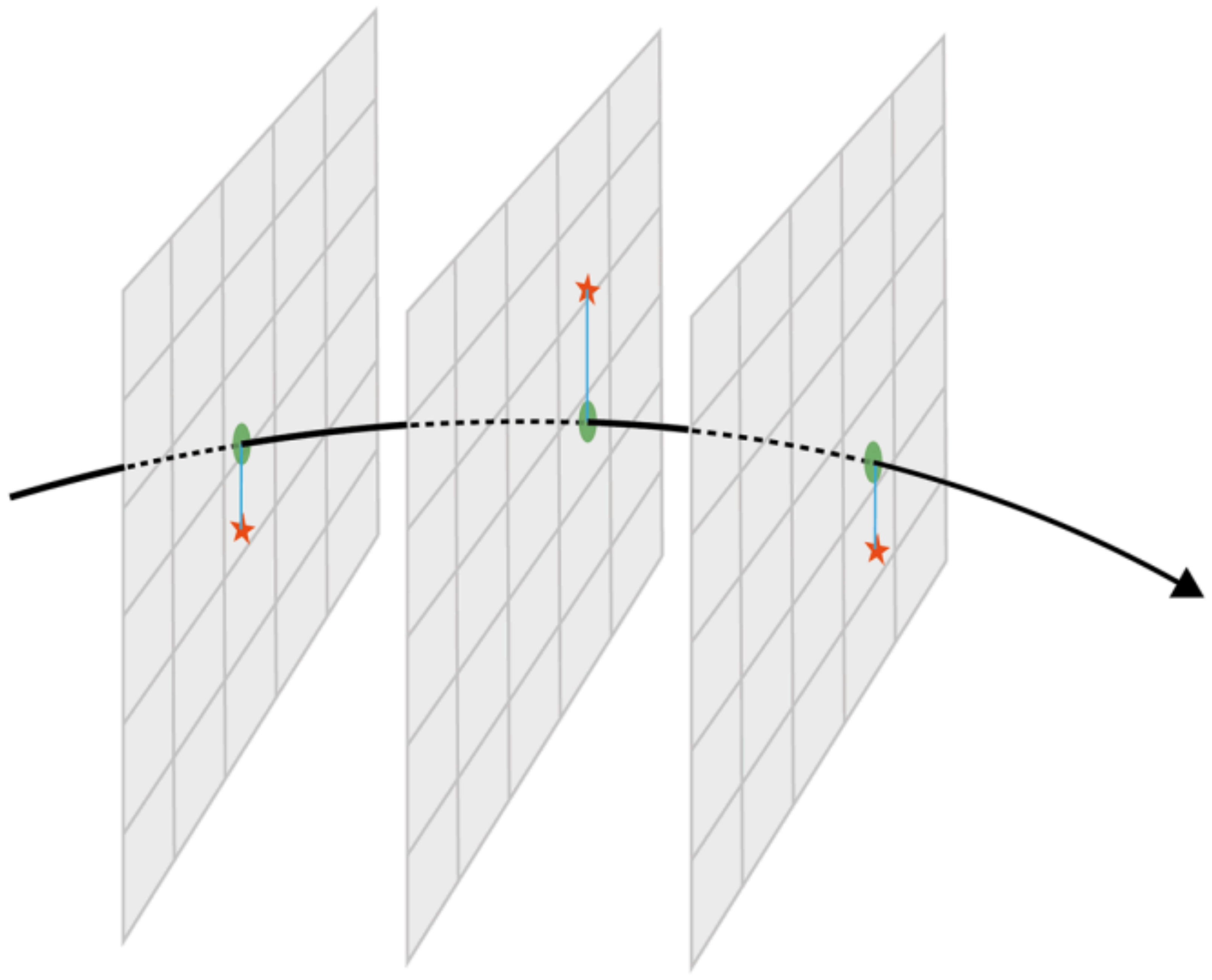


Image: ATLAS Collaboration

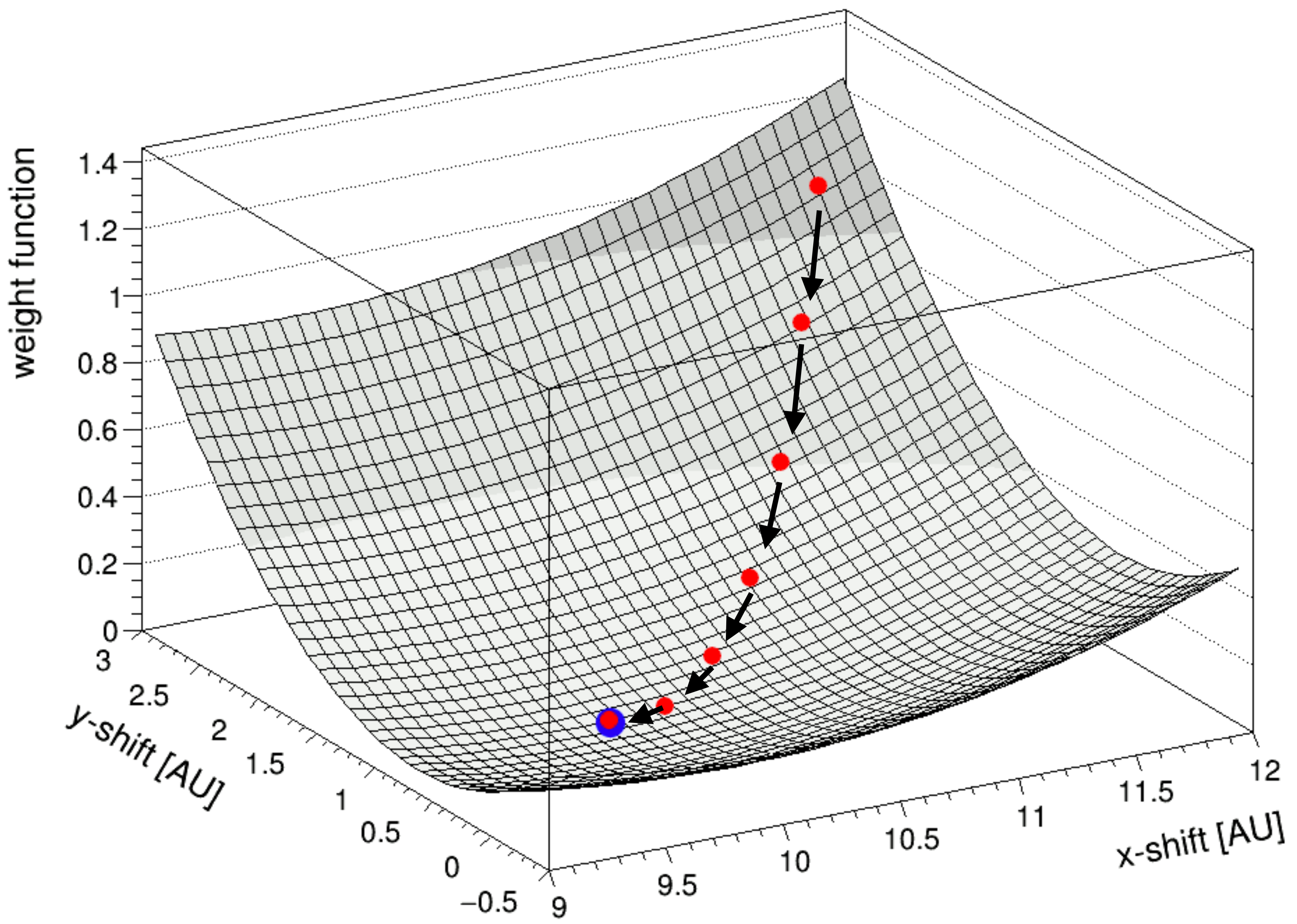
Brute Force Approach

The Idea

- Known precision gives us the **validity range**
- Scanning the parameter space for the function minimum
- Iteration over the individual parameters (moving them back and forth in tiny steps)

If weight function value improves
→ keep the change

Else → discard and try opposite direction

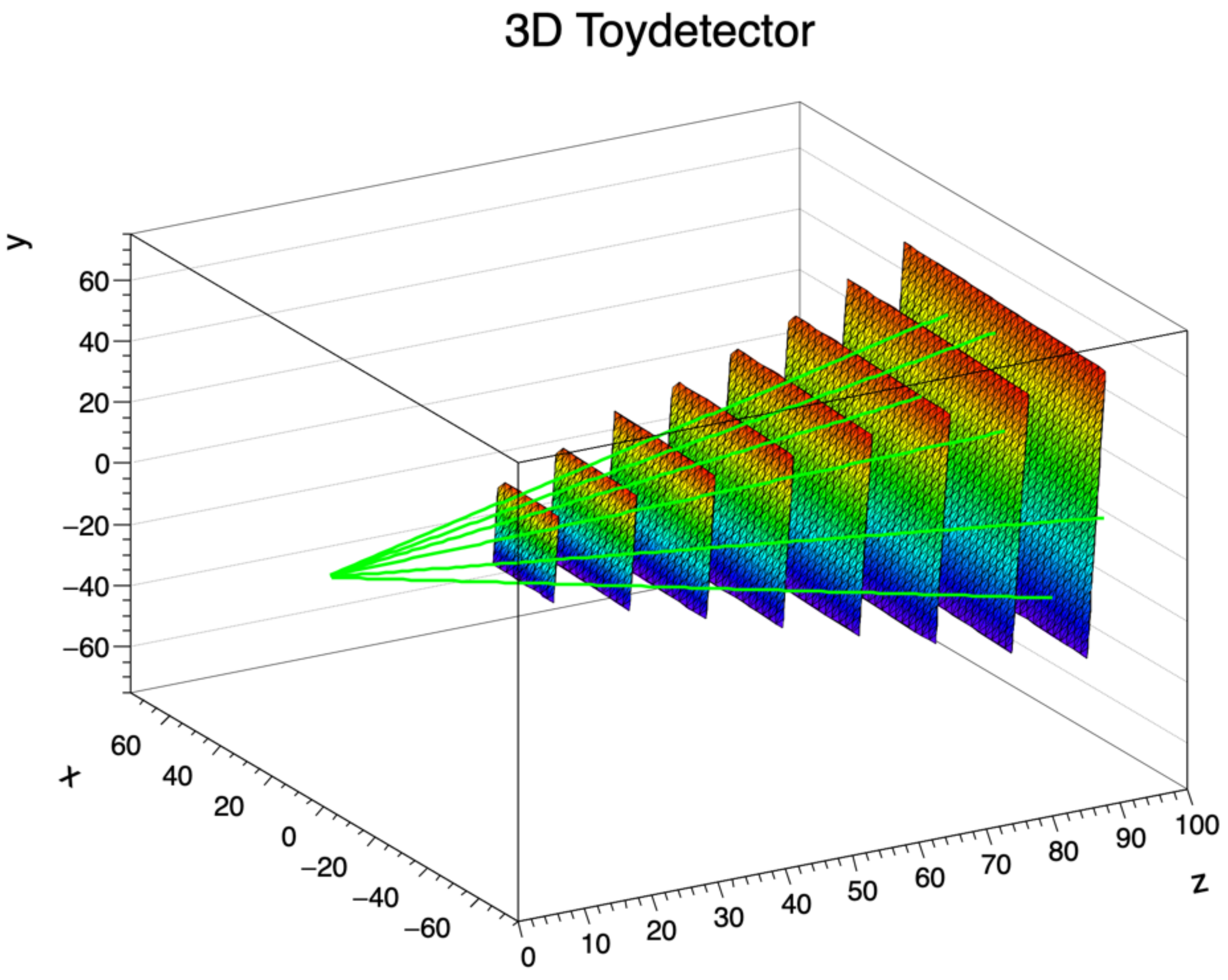


Brute Force Approach

Advantages

- We can use inequality constraints
  (e.g. validity range)
- We can apply non linear constraints
- We can combine optimization methods
- We use the real cost function as reality check
- We have valid intermediate results
- Runtime potentially linear in #parameters

(verified with toy detector simulation)



Thank You For Your Attention!

Presentation of my research activity

Student: Laura Buonincontri
School on Efficient Scientific Computing - 3–8 Oct 2022

INFN PADOVA
Istituto Nazionale di Fisica Nucleare
Sezione di Padova

Università degli Studi di Padova

Main fields of interests

- I am a 3rd year Phd student working for the **Muon Collider** and the **LHCb group** in Padova

Muon collider activites:

➢ Higgs physics at Muon Collider

➢ b-jets identification

LHCb activities:

➢ Search for H to $b\bar{b}$ and H to $c\bar{c}$

Higgs physics at muon collider

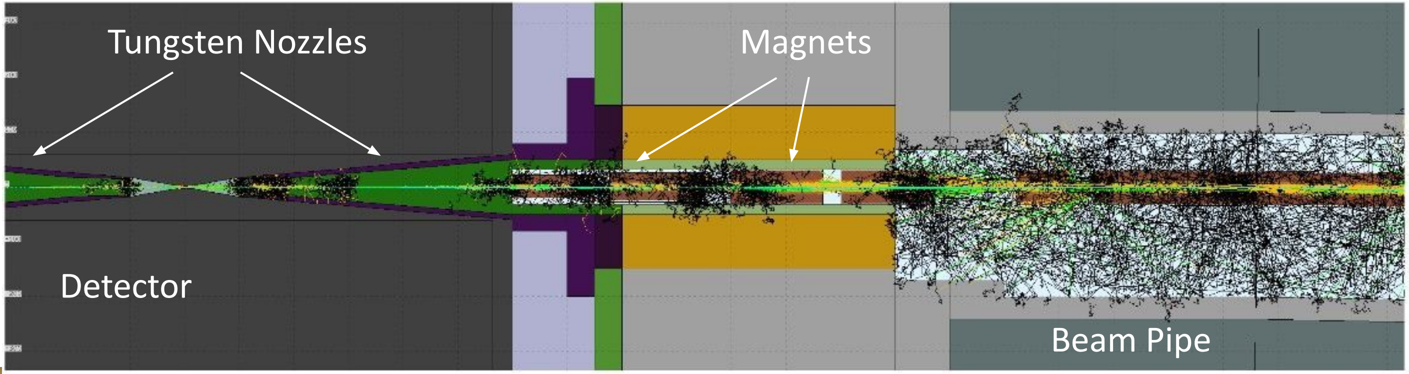
- Project for Future Collider where muons are collided at **high energy** and **high luminosity**
- Measurement of Higgs physics parameters is a priority in Future Colliders physics program

Muon Collider is ideal place to study Higgs physics:

➔ high rates of H, HH, HHH will be produced

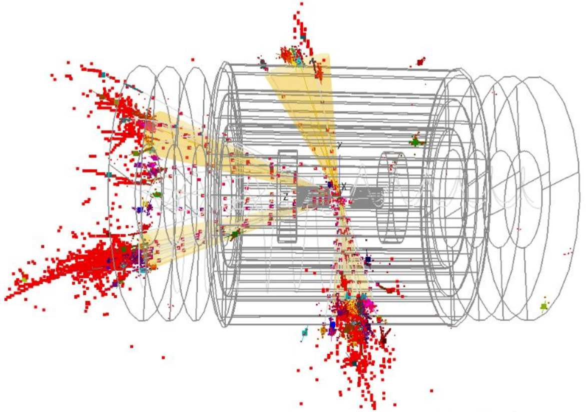
➔ studies to determine the uncertainty on the Higgs couplings to bosons and fermions and the Higgs self-couplings are currently ongoing

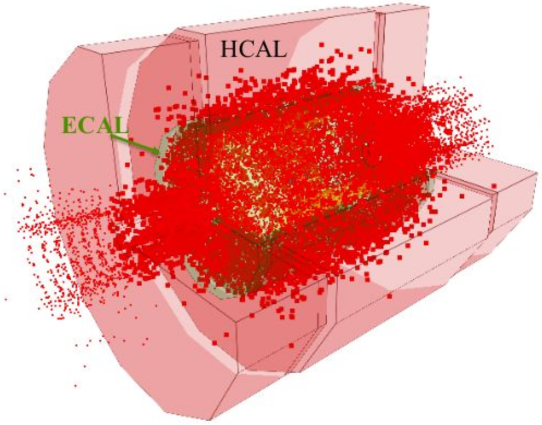
- I am focused in the study of single and double Higgs production processes with the Higgs decaying into bb
- In order to perform physics studies at Muon Collider the Beam-Induced Background (BIB) effects on the detector performance have to be determined

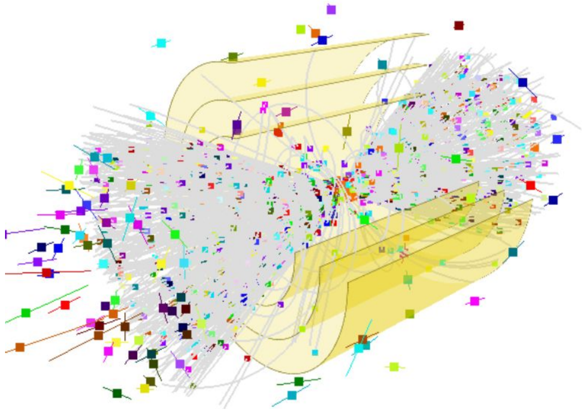


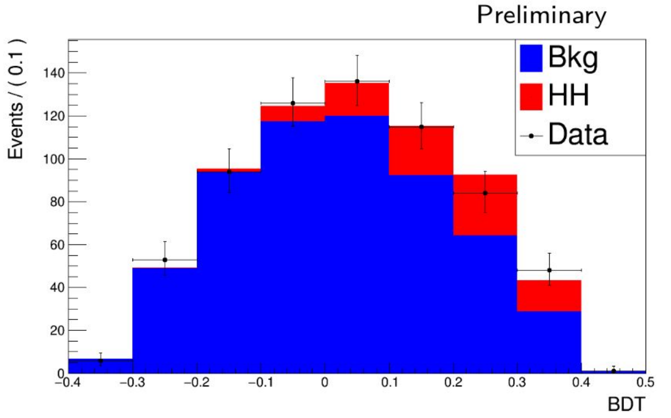
Analysis of simulated processes at muon collider

- All the studies are performed via full simulation including the BIB:
  - events are generated via Monte Carlo
  - detailed simulation of the interaction of particles with the detector
  - algorithms are applied to simulate the detectors response and to reconstruct tracks, jets,...
- Software framework: ILCSoft framework for **simulation**
- I tune the algorithm parameters to deal with the BIB
- I use Root and statistics/machine learning tools provided by Root for **data analysis**



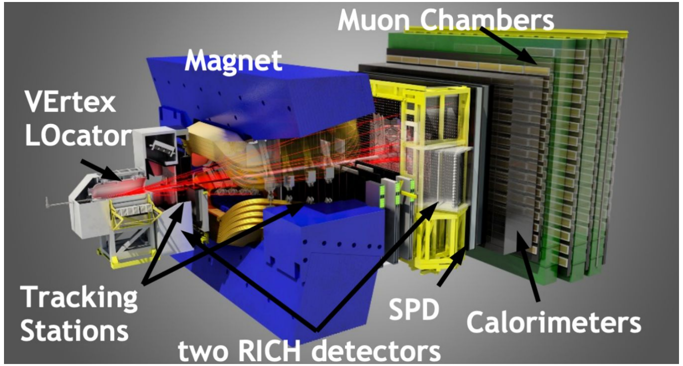


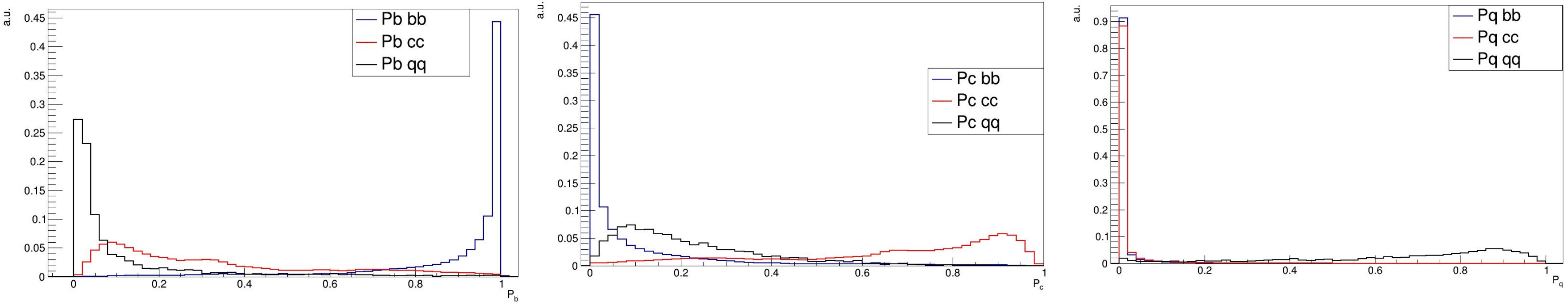




Higgs searches at LHCb

- Search for Higgs boson decay into b and c quarks pairs at LHCb with the full Run II $\mathcal{L}$ ~ 6 fb^{-1}
- I am using a DNN-based jet flavour tagging to separate b vs c vs (u,d,s,g)
- Secondary Vertices (SV) found into jets with tagging algorithm
- Inputs: SV features, global quantities of the jet, features of charged and neutral particles in the jet





- I am using RooFit and RooStat to perform likelihood fits

What I expect from this school

- Improve my competences in C++ coding
- Learn the best ways to optimize my codes (for example learning how to use memory effectively)
- Have a clear overview of the new trends in hardware architectures and specialized devices for computing
    - need for computing power and fast devices in my research field is growing fast

Università degli Studi di Padova

Dipartimento di Fisica e Astronomia Galileo Galilei

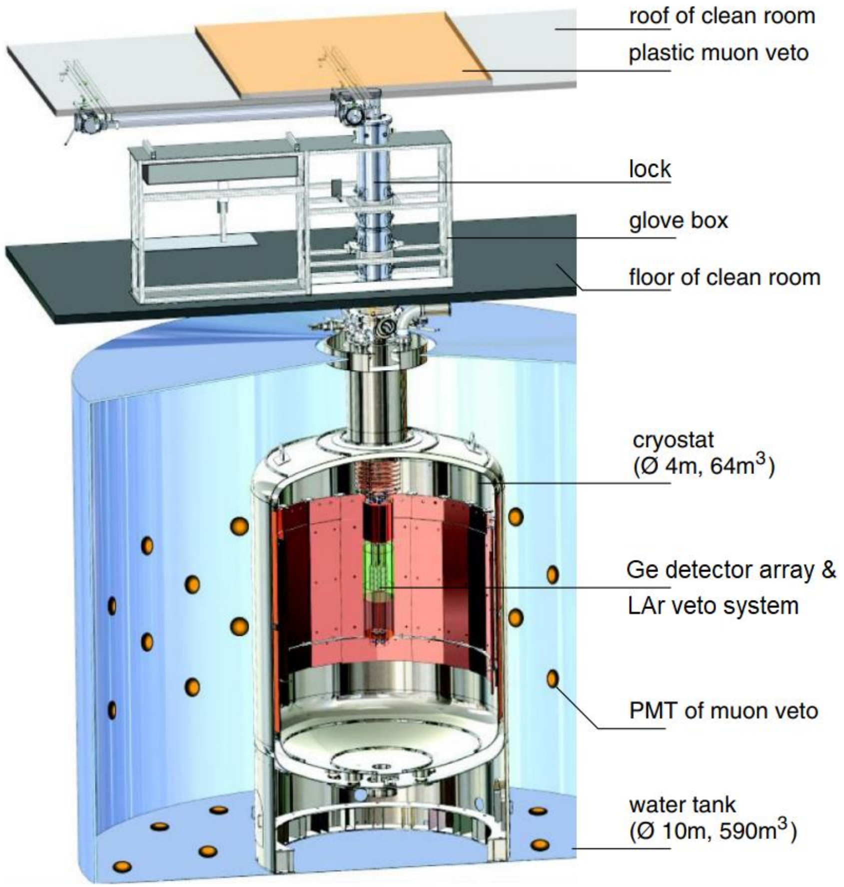
INFN Padova
Istituto Nazionale di Fisica Nucleare
Sezione di Padova

Sofia Calgaro

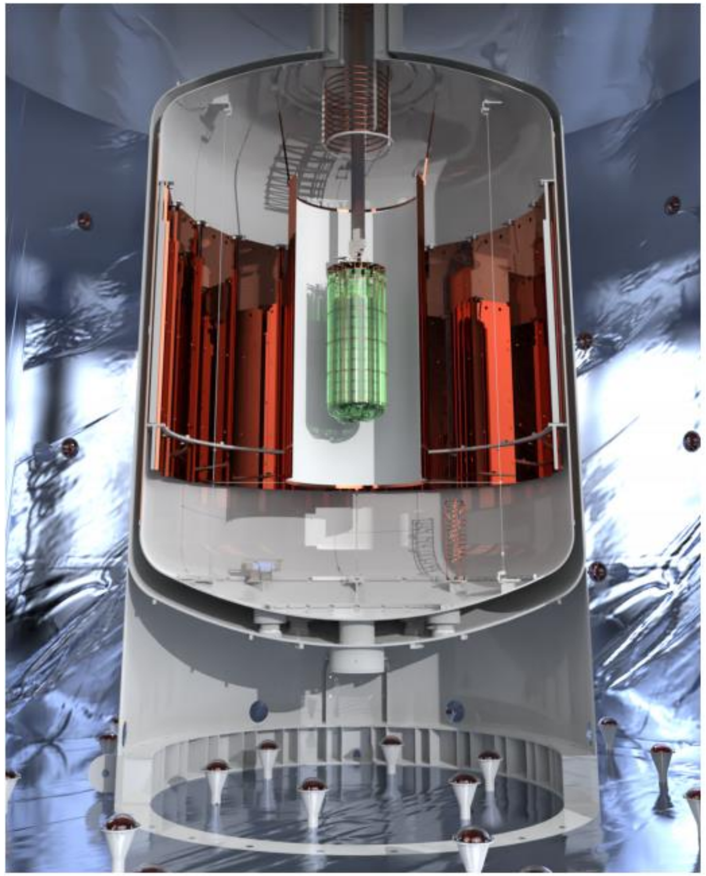
ESC22 School

Bertinoro, 2-8 October 2022

GERDA (Germanium Detector Array)



LEGEND (Large Enriched Germanium Experiment for Neutrinoless $\beta\beta$ Decay)



Bayesian analysis for new physics @ keV scale

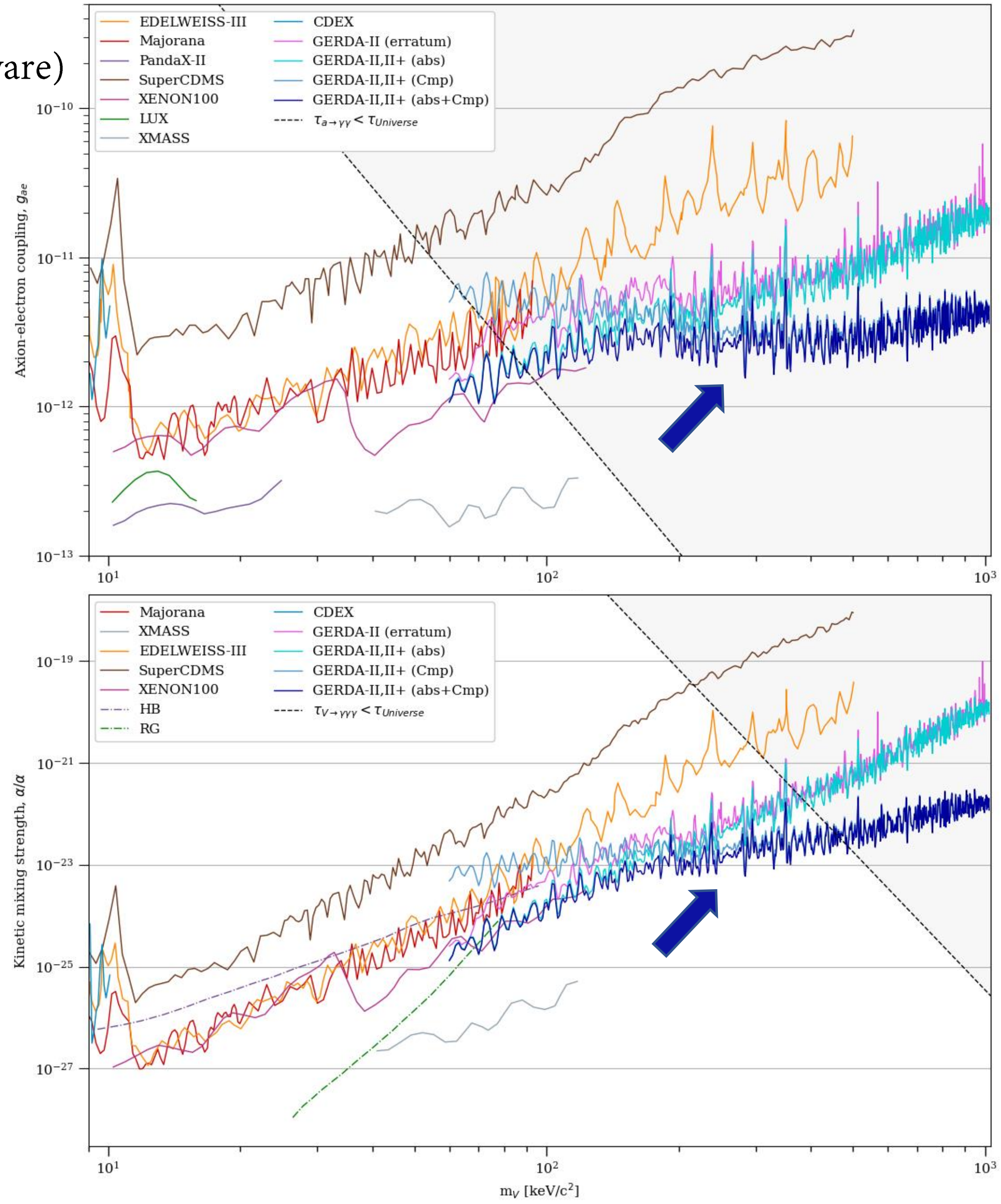
Monitoring tool for studying detectors' response

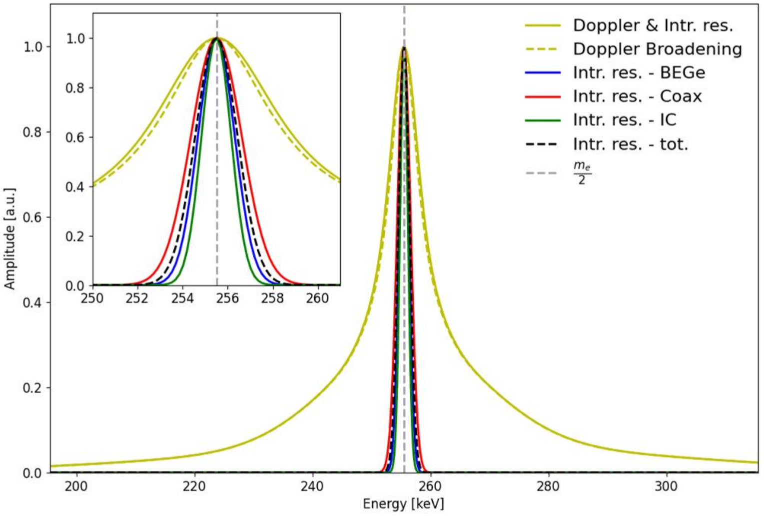
- **Detect or set an exclusion limit** on the type of interactions which can induce a **Gaussian peak** in the GERDA spectrum using a **Bayesian analysis** (BAT C++ software)

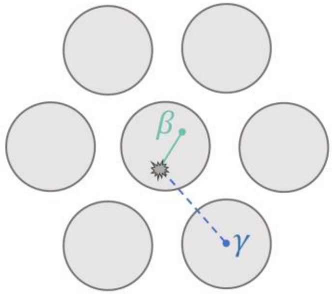
- **Pseudoscalar/vector SuperWIMPs, $\boldsymbol{\phi}$**
  - Absorption process: $\phi + \mathrm{Z} \rightarrow Z' + e^-$
  - Dark Compton scattering: $\phi + e^- \rightarrow e^- + \gamma$

- **Electron decay,** $e^- \rightarrow \boldsymbol{\gamma + \nu}$ $\boldsymbol{(E_\gamma = m_e/2 = 255.5\ keV)}$
  - Inclusion of Doppler broadening effect
  - $\tau_{e \rightarrow \nu + \gamma} > 5.15 \cdot 10^{25}\ yr$ @ 90% C.I.

- **Invisible neutron decay,** $n \rightarrow 2dark,\ 3\nu$ $\boldsymbol{(E_\gamma = 264.7\ keV, Q_\beta = 919\ keV)}$
  - $\tau_{n \rightarrow inv} > 1.0 \cdot 10^{23}\ yr$ @ 90% C.I.

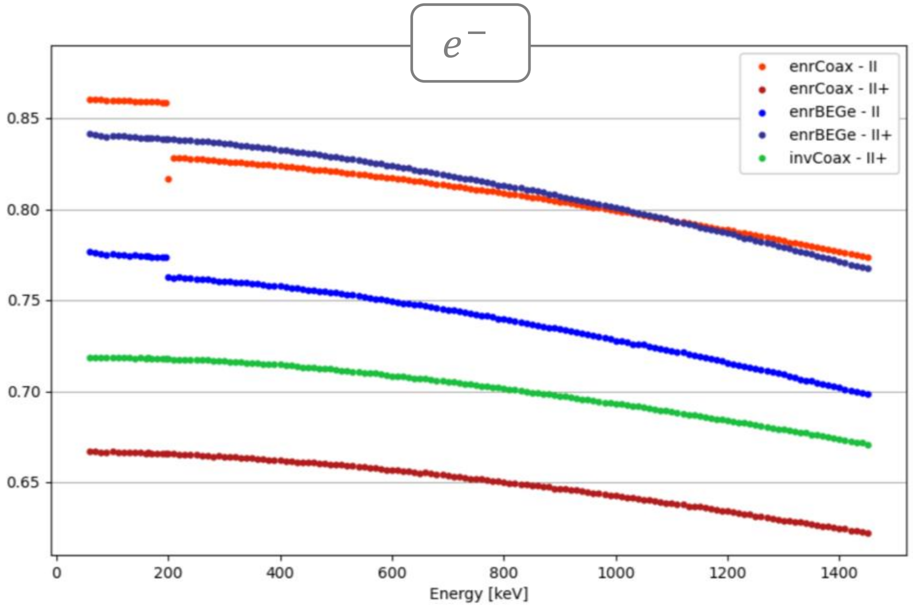


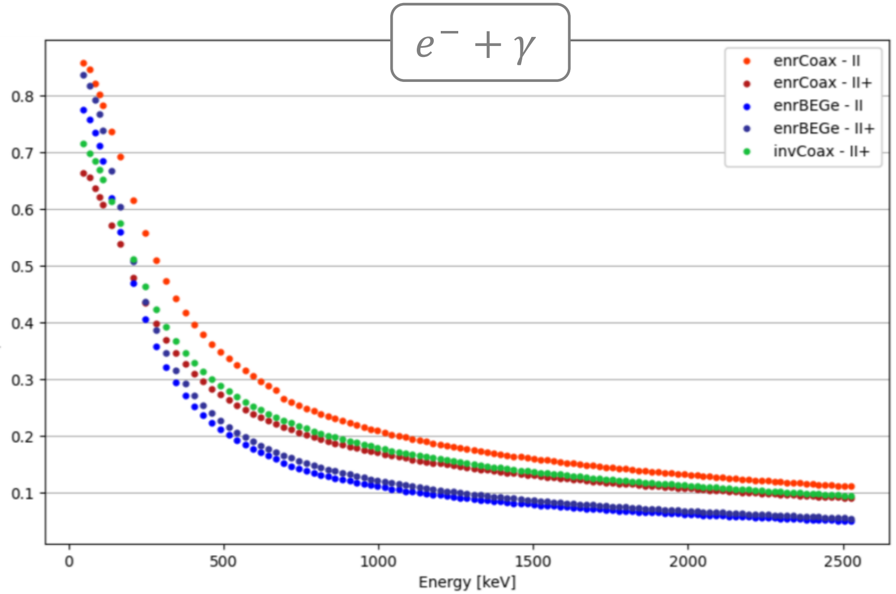


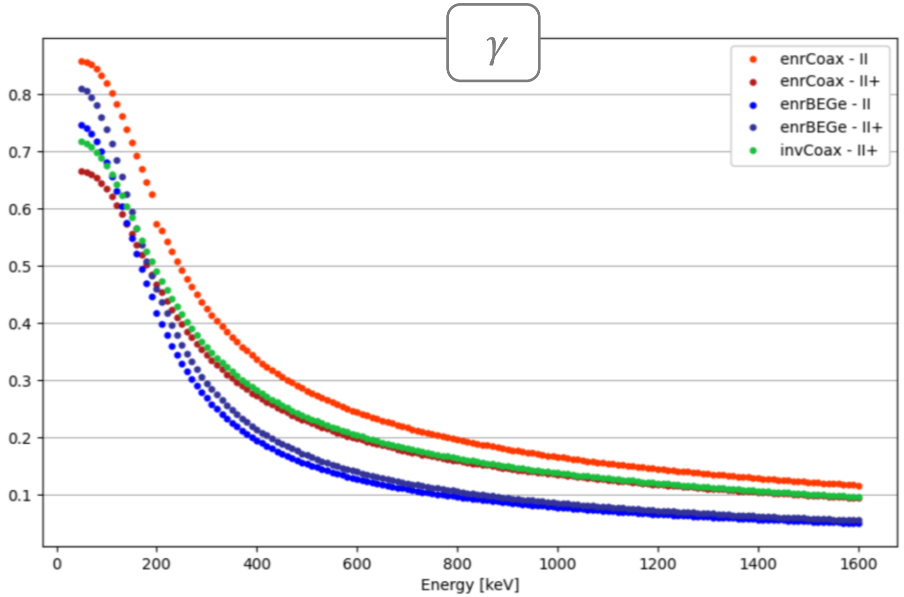


$$^{76}\mathrm{Ge} \xrightarrow{n\ decay} {}^{75}\mathrm{Ge} \rightarrow {}^{75}\mathrm{As}^* + \beta$$
$$\rightarrow {}^{75}\mathrm{As}^{g.s.} + \beta + \gamma$$

- Study of **final state detection efficiencies** by using the **Geant4-based MaGe** framework for:
  - SuperWIMPs
    - Absorption (e^-)
    - Compton ($e^- + \gamma$)
  - Electron decay (γ)
  - Neutron decay (^{75}Ge decay)



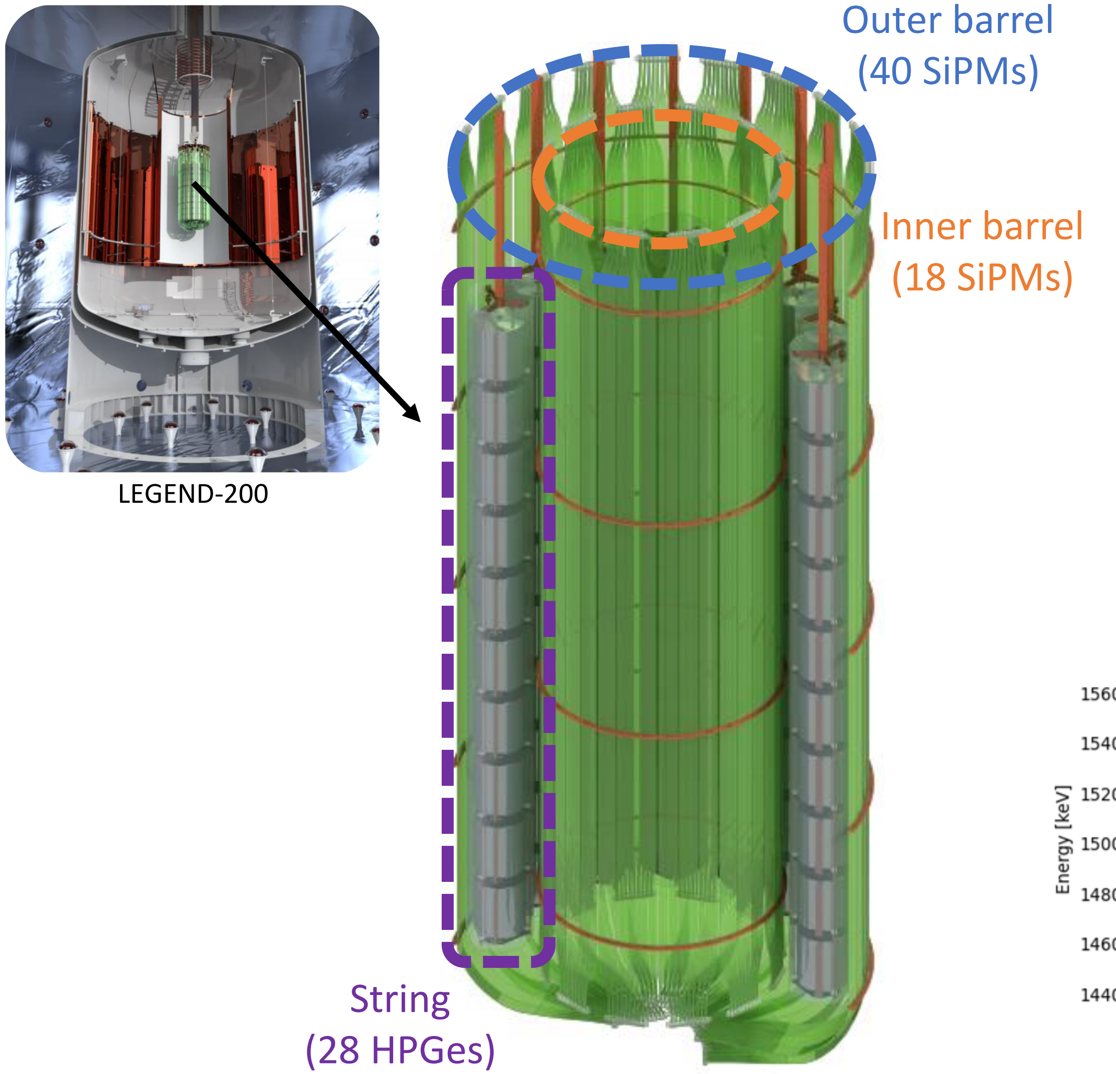


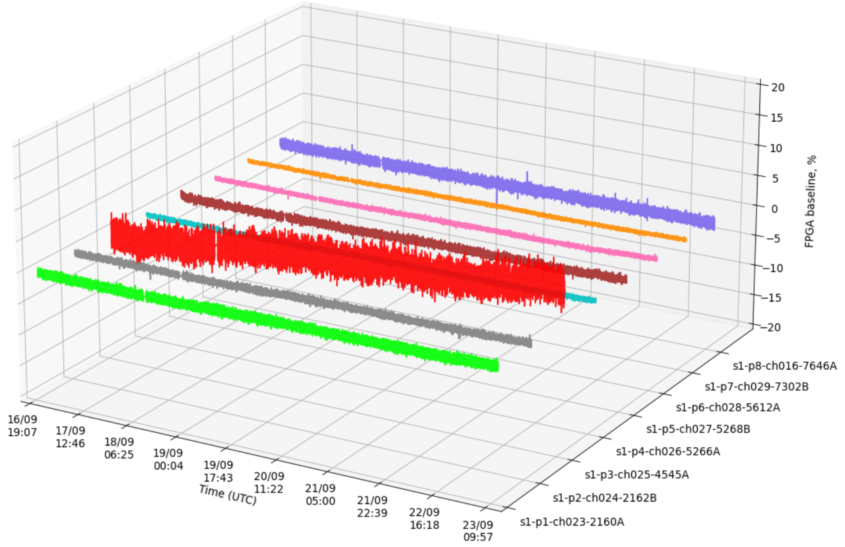


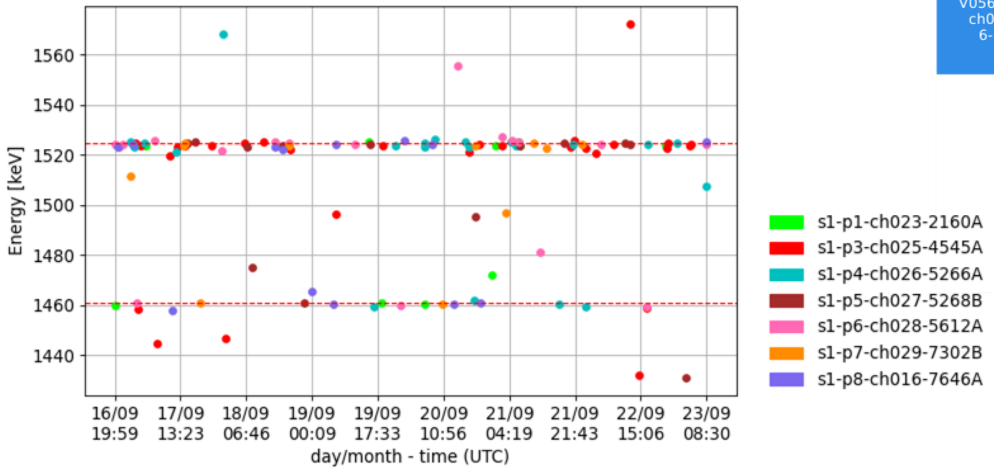
Detector	**Phase**	$\varepsilon_{M2,\,LAr}$	ε_D
EnrCoax	lowthr	0.0009	0.0008
	II	0.0007	
	II+	0.0010	
EnrBEGe	lowthr	0.0030	0.0026
	II	0.0023	
	II+	0.0032	
InvCoax	II+	0.0016	0.0016

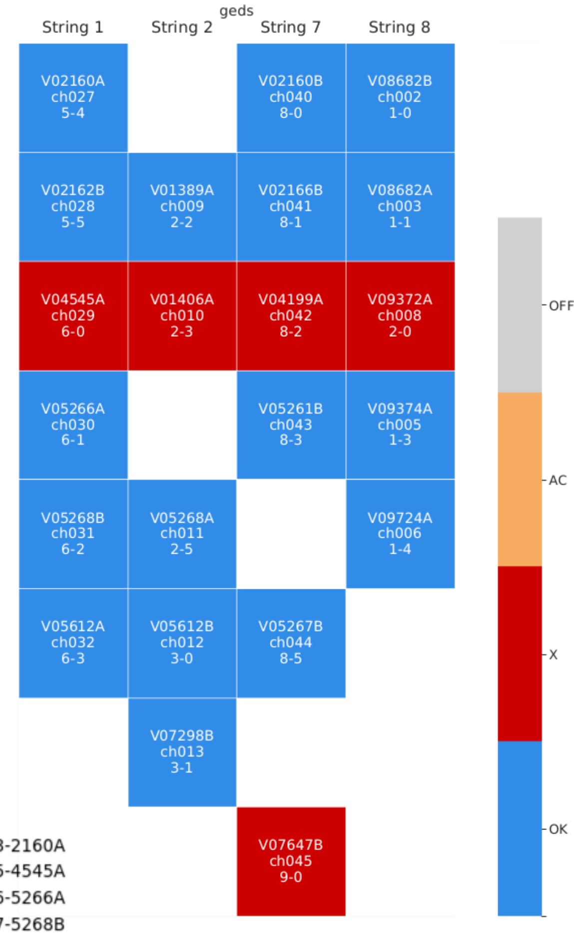
Total efficiency (exposure weighted mean): 0.0019

- **Offline monitoring Python-based software tool**
- Previously tested on **HADES** (High Activity Disposal Experimental Site) and **PGT** (Post Gerda Test) **data**
- Now tested on **LEGEND-60 commissioning** data









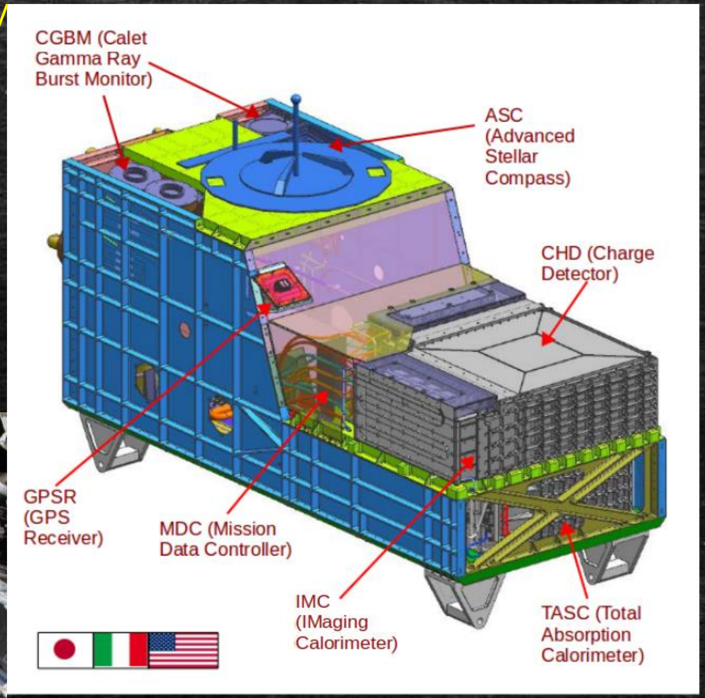
Caterina Checchia

Ph.D. University of Siena
INFN – Sezione di Pisa

My current research activity:
Astroparticle direct measurement: CALET on the International Space Station (ISS)

CALET on the ISS

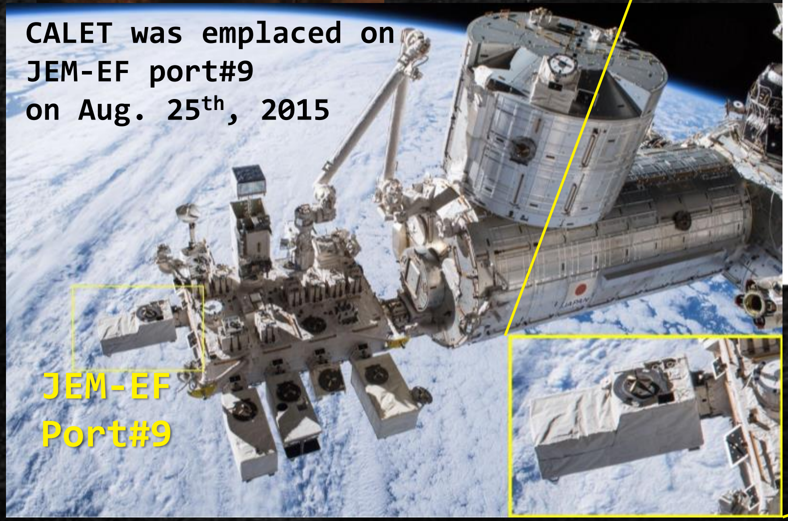
CALET launch on Aug. 19th, 2015
on Japanese H2-B rocket



JEM Standard Payload

- Mass: 612.8 kg
- Size: 1850 mm (L) x 800 mm (W) x 1000 mm (H)
- Power Consumption: 507 W (max)
- Telemetry: Medium (Low) 600 (50) kbps (6.5 GB/day)

CALET was emplaced on JEM-EF port#9 on Aug. 25th, 2015



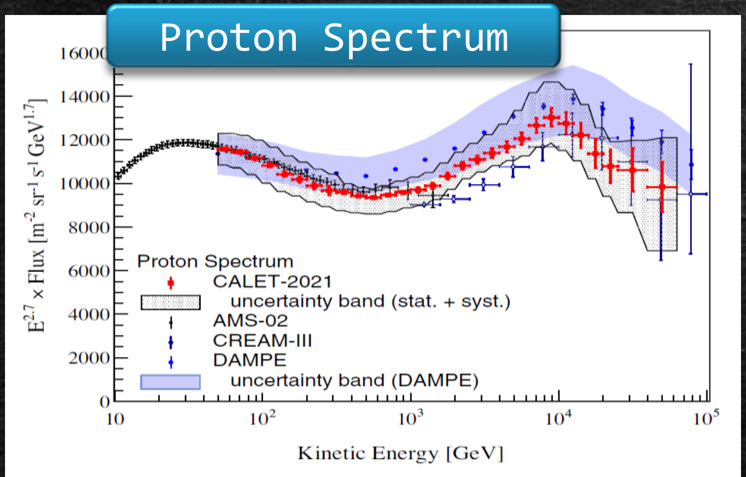
CALET started scientific observations on Oct. 13th, 2015
More than 3.4 billion events collected so far.

CALET scientific objectives

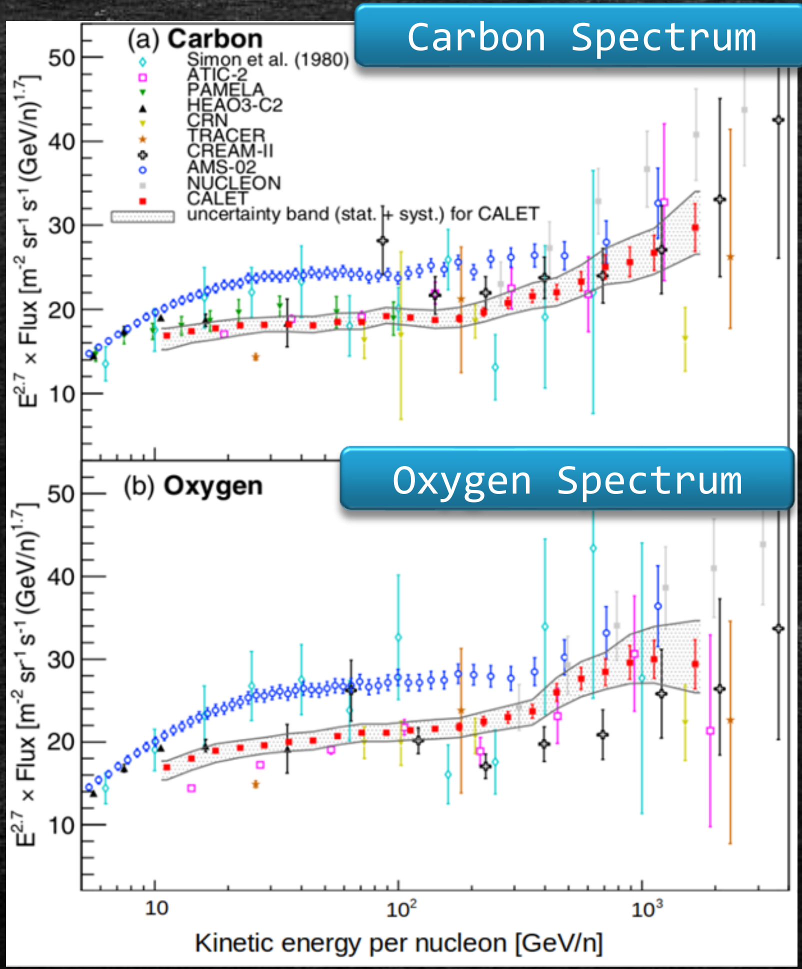
A 30-radiation length deep calorimeter designed to detect electrons and gamma rays up to 20 TeV and cosmic rays up to 1 PeV with an extensive physics program.

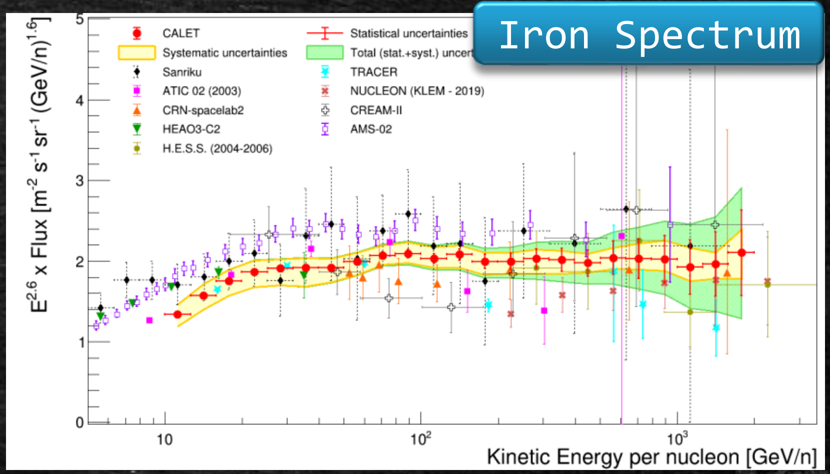
Science Objectives	Observation Targets	Energy Range
Nearby CR sources	Electron Spectrum	100 GeV – 20 TeV
Dark Matter	Signatures in e/γ spectra	100 GeV – 20 TeV
CR origin and Acceleration	Electron spectrum p-Fe individual spectra Ultra Heavy Ions ($26<Z<40$)	1 GeV – 20 TeV 10 GeV – 10^3 TeV Few GeV/n
Galactic CR Propagation	B/C sub-Fe/Fe ratios	Up to some TeV/n
Solar Physics	Electron flux	$<$ 10 GeV
Transient phenomena (GRB, e.m. counterpart of GW)	Gamma and X-rays	7 keV – 20 MeV

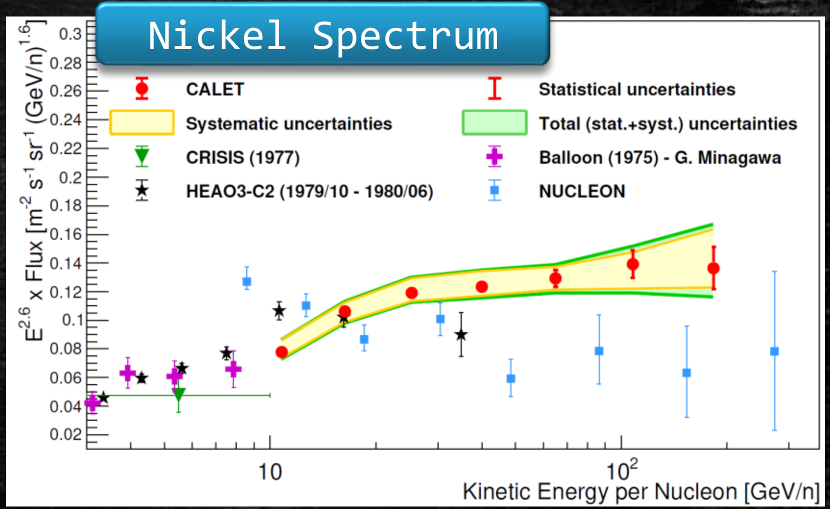
CALET main results



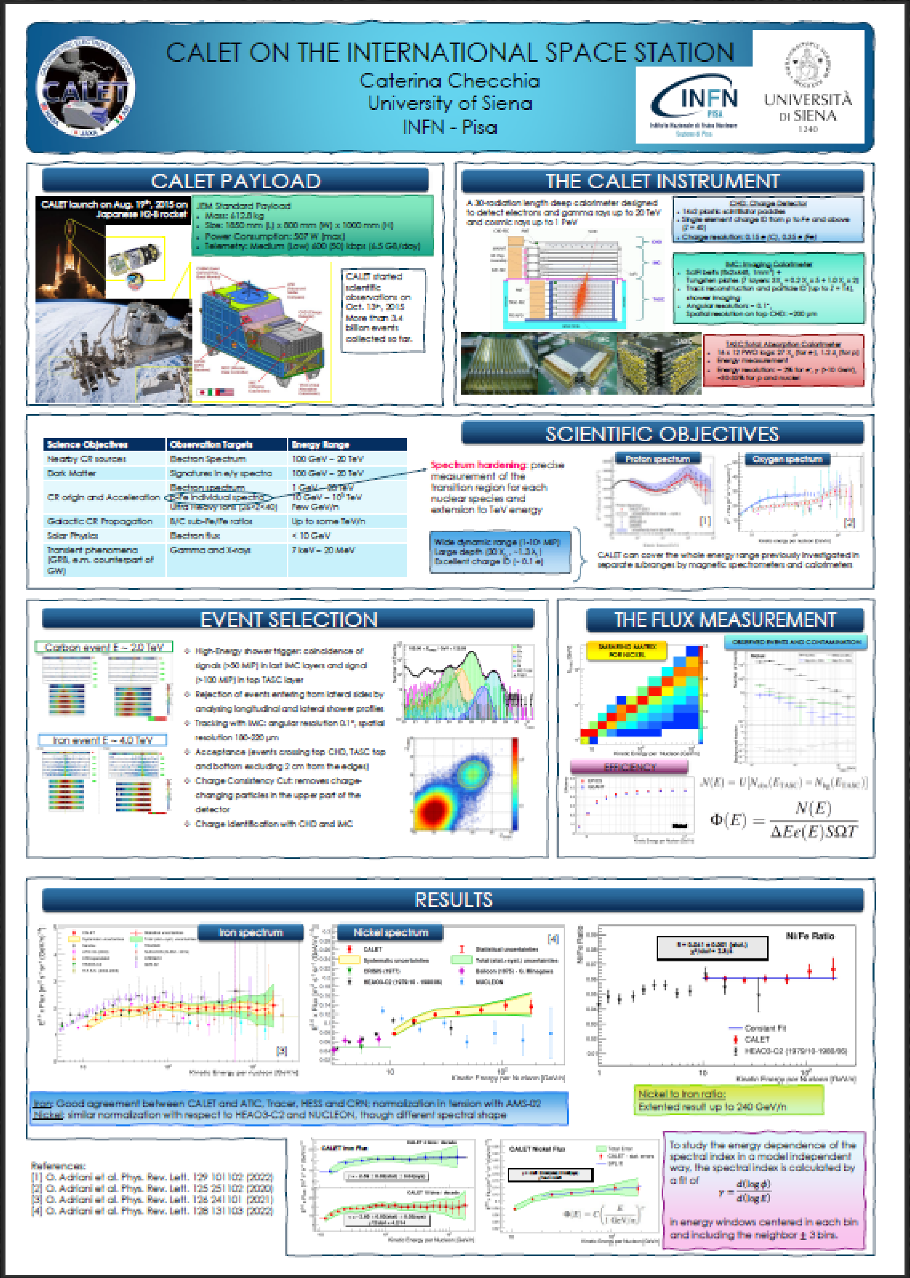
CALET observes CR nuclei measuring the transition region for each nuclear species with high precision up to the TeV energy scale.







For further details ...



Claudia Caterina Delogu @ ESC 2022

- PhD student from Padua on the ENUBET project

- Design of a monitored neutrino beam
  → tag large-angle K decay products in an instrumented decy region

  - Beamline simulation

  - Detector prototypes

Enhanced

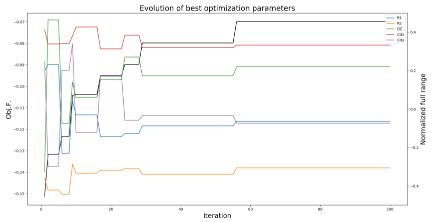
NeUtrino

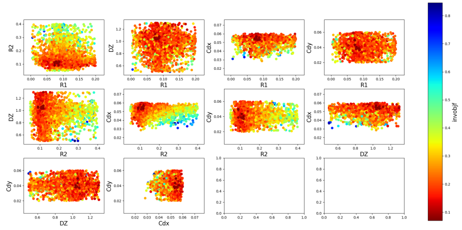
BEams

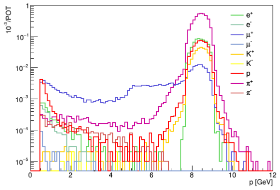
from kaon Tagging

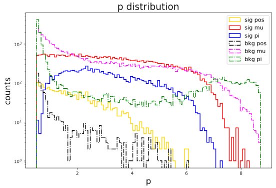
Beamline design

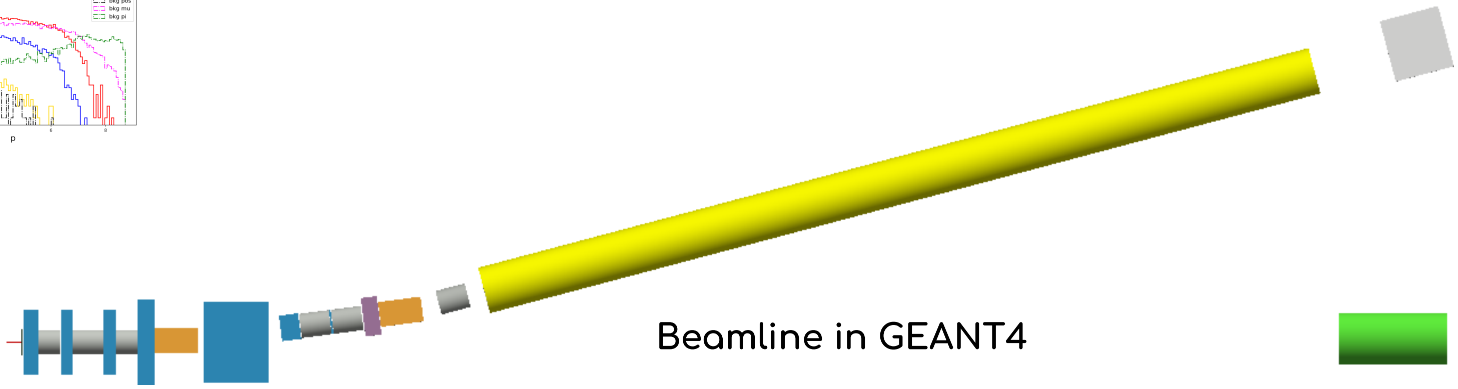
- **GEANT4** simulation of transfer line (magnets, collimators…)
  - ~24k lines of code (+ debug tools, data analysis codes)
  - Cluster submission
- Applicaton of a Genetic Algorithm for collimator optimization
- Simulation data analysis







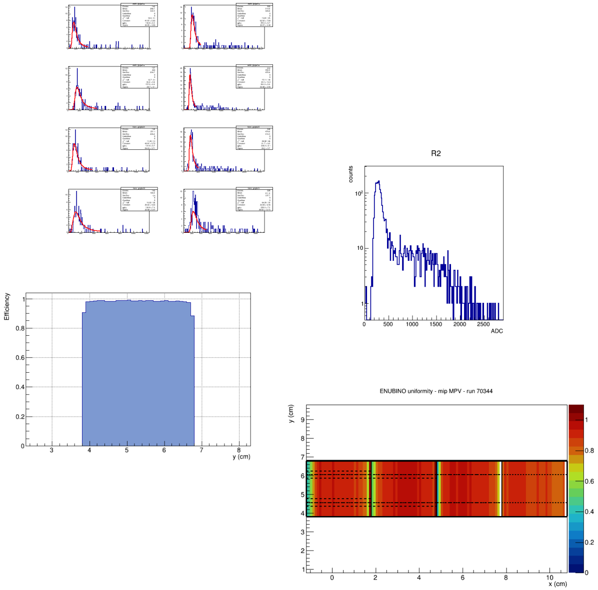


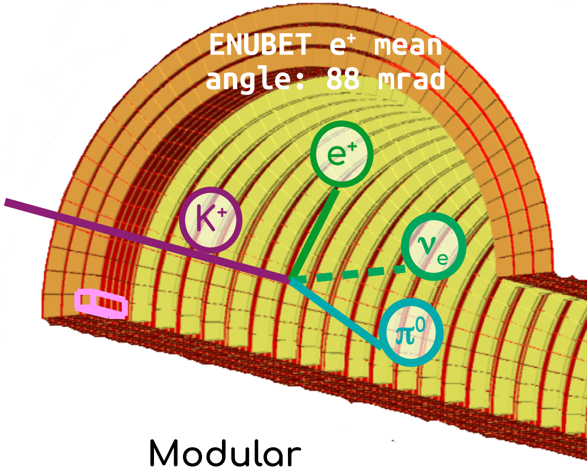


Beamline in GEANT4

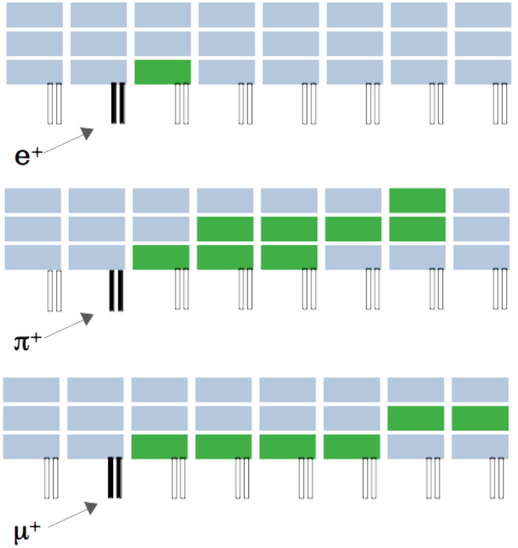
Detector prototypes

- Calorimeter
  - Construction and test of a calorimeter prototype
  - Testbeam data analysis (**ROOT**)





Modular calorimeter for particle ID



Ask me for more details!

3rd - 8th October 2022
Bertinoro (FC) - Italy

ESC 2022

13th INFN International School on "Efficient Scientific Computing"

Tommaso Diotalevi
(INFN-CNAF and University of Bologna)

Who am I and what I do

- **PhD** in Physics, since June 2022, at the **University of Bologna.**
  Thesis title: "*Application of Deep Learning techniques in the search for BSM Higgs bosons in the $\mu\mu$ final state in CMS*"

- Member of the **CMS Collaboration** since 2016;

- Currently, research fellow at **INFN-CNAF** (Software Development unit) and teaching tutor in "General Physics" at the University of Bologna.

Research activities:

- Physics analysis on the BSM Higgs boson sector, with the usage of Deep Learning parameterised Neural Networks.

- Development of an API, entirely written in C++, allowing clients to manage disk residency on tape stored files, in the context of the Worldwide LHC Computing grid (WLGC)

Previous research

- Collection and parsing of system logs and prototypal analytics services with the Elastic (ELK) suite at the INFN-CNAF data center;
- Monitoring data transfer latencies in CMS computing operations, creating new metrics to alert admins about stuck subscriptions;
- Development of a Deep Learning based muon trigger algorithm for the Phase-2 upgrade of the CMS detector, with an application also on FPGA hardware for fast inference.
- Studies on possible refit techniques for muons with high transverse momentum, using learning techniques, in collaboration with the CMS muon physics object group;

Responsibilities

- Monte Carlo simulations' production contact, for the needs of physical analyses in the Higgs boson sector of the CMS Collaboration.

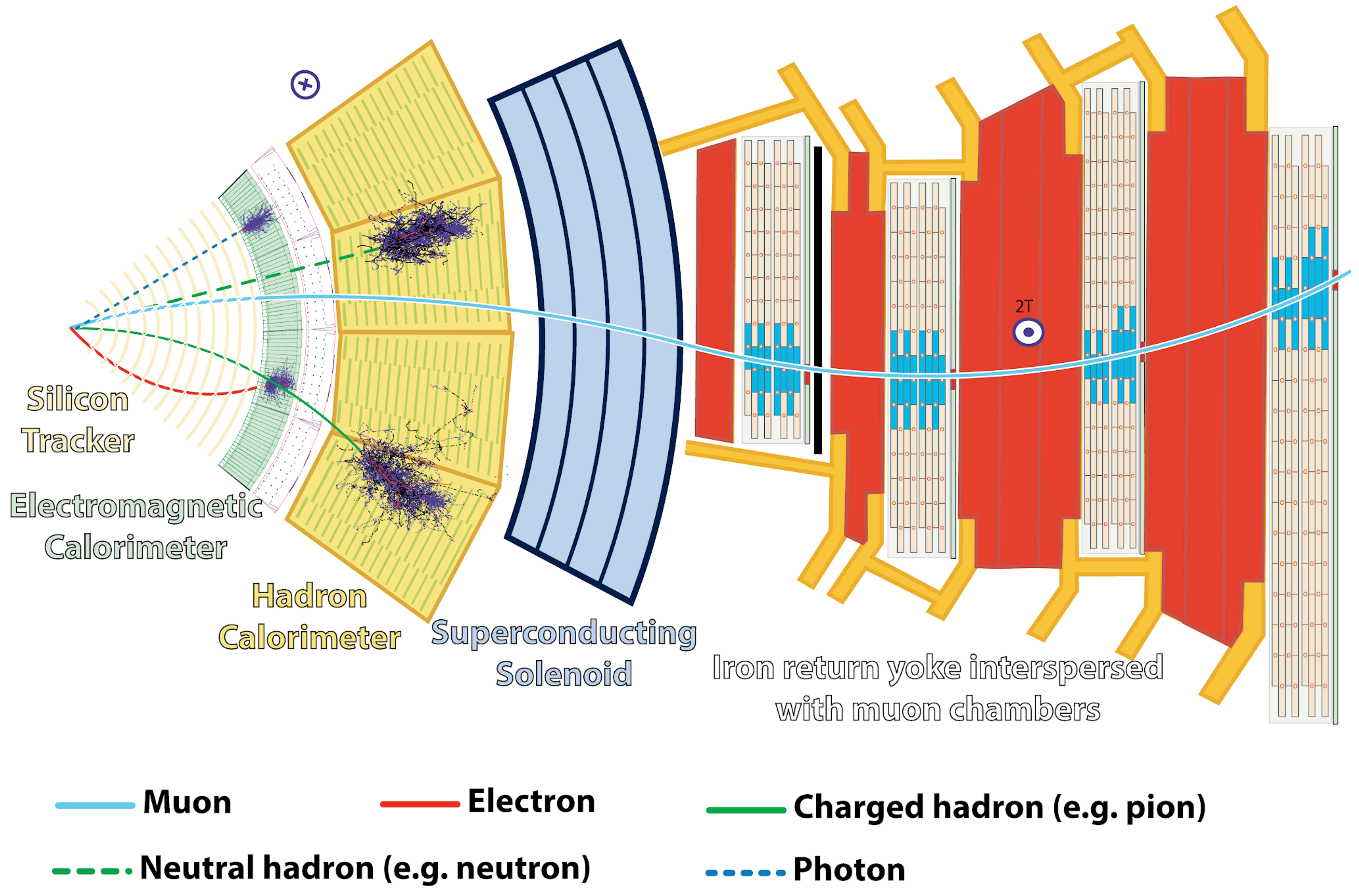
BSM Higgs to $\mu\mu$ analysis

- Beyond the Standard Model (BSM) theories have been formulated trying to solve open questions of the Standard Model, e.g. neutrino masses, dark matter/energy, gravitational force etc…

- The Minimal Supersymmetric Standard Model (MSSM) predicts the existence of new particles, each one connected to its relative Standard Model partner. This also applies on the **Higgs sector**, where new particles of unknown mass are predicted by such theory.

- The $\mu\mu$ final state is interesting, since the channel can be fully reconstructed and the $m_{\mu\mu}$ precisely measured thanks to the **CMS excellent muon momentum resolution**.

- Analysis performed on data collected during proton-proton collision at $\sqrt{s} = 13$ TeV by the CMS experiment.

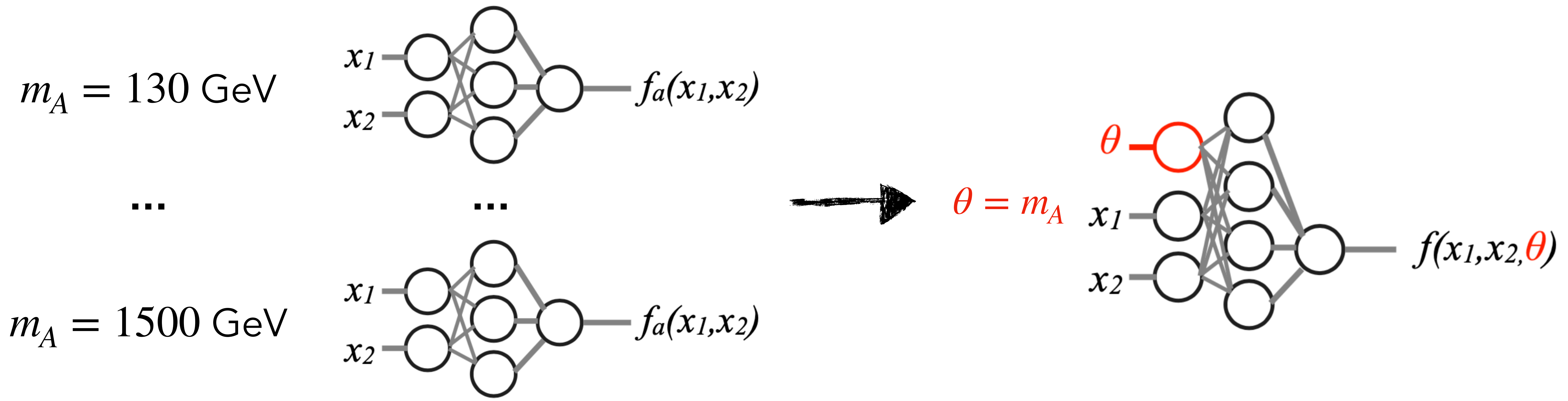


BSM Higgs to $\mu\mu$ analysis

- Multiple mass hypothesis, corresponding to different potential new Higgs bosons. Signal samples produced using Monte Carlo simulations in the [130,1500] GeV range.

Discrimination between signal and background events:

- Usage of **parameterised Neural Networks**, capable of replacing N single networks each one trained at a specific mass point into **one single network**, adding the mass parameter in the input layer, together with the physical variables ($\overrightarrow{x_i}$) - *only at training time*.



✅ Computationally less expensive;
✅ Capability of interpolating between mass points.

More info: link

Tape REST API

- Currently, storage managers (e.g. StoRM, dCache, etc…) operating on the WorldWide LHC Computing GRID (WLCG) handle primarily disk related operations.
  However, compared to disk, tape storage is much cheaper and capable of storing much more data, but with a huge downside in terms of data recall and IO speed.

- The **WLCG tape REST API** offers a common HTTP interface allowing clients to manage disk residency of tape stored files and observe the progress of file transfer on disk.

- This API, as the name suggest, is RESTful and consists of a single endpoint handling different operations:

  - ✦ The stage bulk-request of any requested tape-stored files, making them available on disk;
  - ✦ The progress tracking of a previously staged bulk-request;
  - ✦ The cancellation of previously staged file replicas from disk;
  - ✦ The request information about the progress of file's staging.

- The API, when operational, will be accessed via authentication mechanisms like X509 + VOMS (proxy-based) or token based (JWT).

Thanks for the attention!

📩 tommaso.diotalevi@cnaf.infn.it

🌐 www.tommasodiotalevi.it

Research activity – P. Grutta

Probing strong field QED at the LUXE experiment at DESY

UNIVERSITÀ DEGLI STUDI DI PADOVA

INFN

LUXE @ DESY, Germany

Laser **U**nd **X**FEL **E**xperiment is a new experiment at DESY to perform precision measurements of the transition into the non-linear regime of quantum electrodynamics (QED), and to search for new particles beyond the Standard Model coupling to photons.

Scientific goals

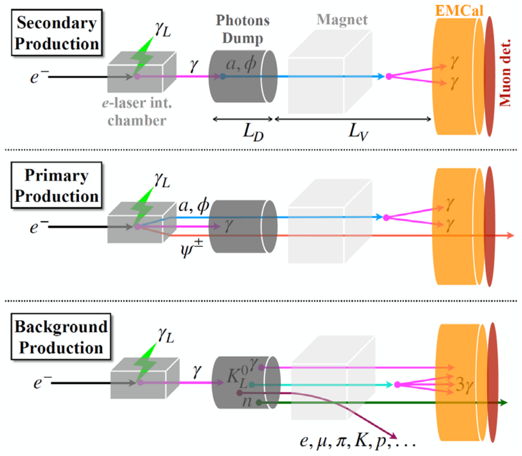
- Study the onset on non-perturbative strong field QED transition in a clean environment, by considering the three processes
  - non-linear Compton;
  - Breit-Wheeler;
  - trident
- Landmark for the first experimental observation of Schwinger pair production of e^+/e^- by field induced tunnelling out of the EM vacuum

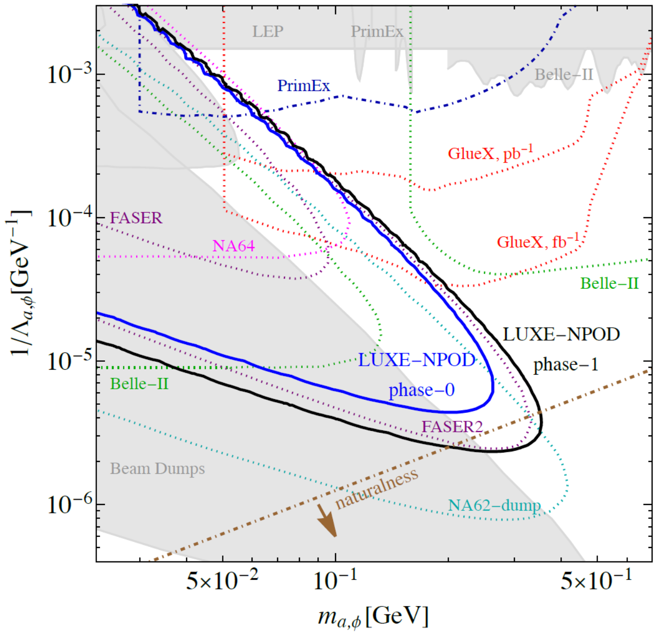
Strong field QED relevant in

- gravitational collapse of BH
- propagation of cosmic rays
- surface of magnetars
- nuclear physics of Z>137
- future high energy lepton colliders

New physics scenarios

LUXE (phase-1) is expected to reach the sensitivity required to probe the edge of the parameter space of natural models of axion-like-particles (ALPs) and scalars, by using an optical and solid beam dump and an EM calorimeter

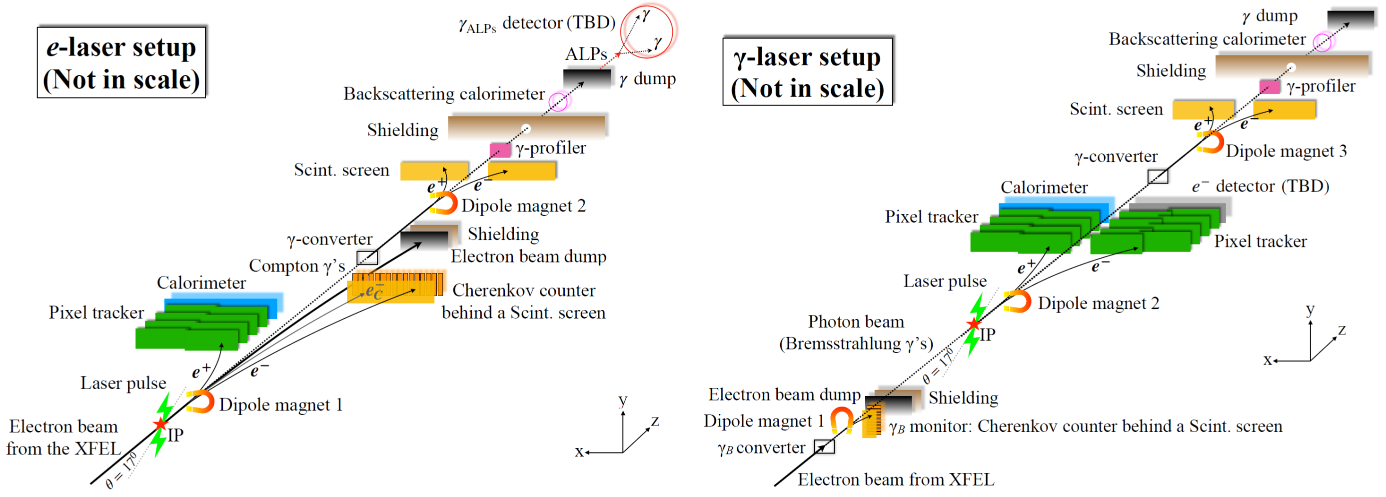




The Gamma Beam Profiler

The electron-laser interaction is characterised by the classical non-linearity parameter ξ, the energy parameter η and the quantum non-linearity parameter χ.

Shot-to-shot variations in laser parameters and non-uniformity over the whole interaction point (IP) region require online measure of the high intensity Compton beam profile. This task is met by the **Gamma Beam Profiler** detector, a sapphire (Al_2O_3) micro-strip detector placed 11.5m downstream the IP.



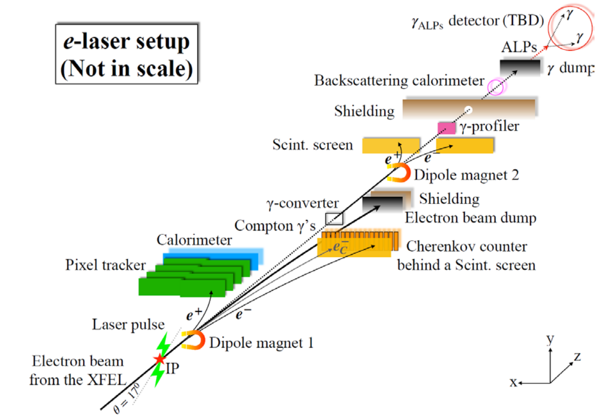
The GBP will measure the transverse angular distribution of the gamma-ray photons, which will yield important information on the interaction, such as the quality of overlap and intensity of the laser with the electron beam at the IP -> $\xi^2 \sim (\sigma_{\parallel}^2 - \sigma_{\perp}^2)$

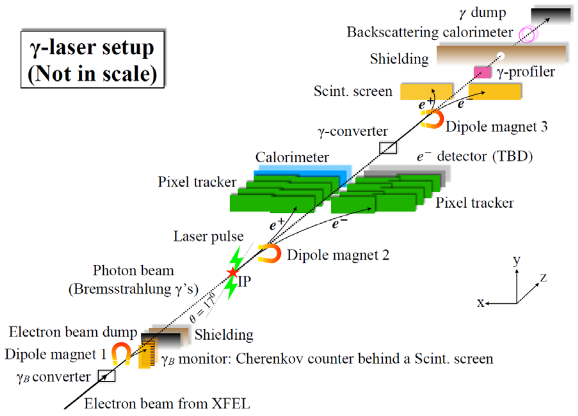
The expected high flux of photons per bunch crossing (BX) implies that such a detector must be radiation hard at the level of ~ MGy per year, together with the capability of reconstructing the beam profile position/width with a spatial resolution of the order of 5 um.

The Gamma Beam Profiler

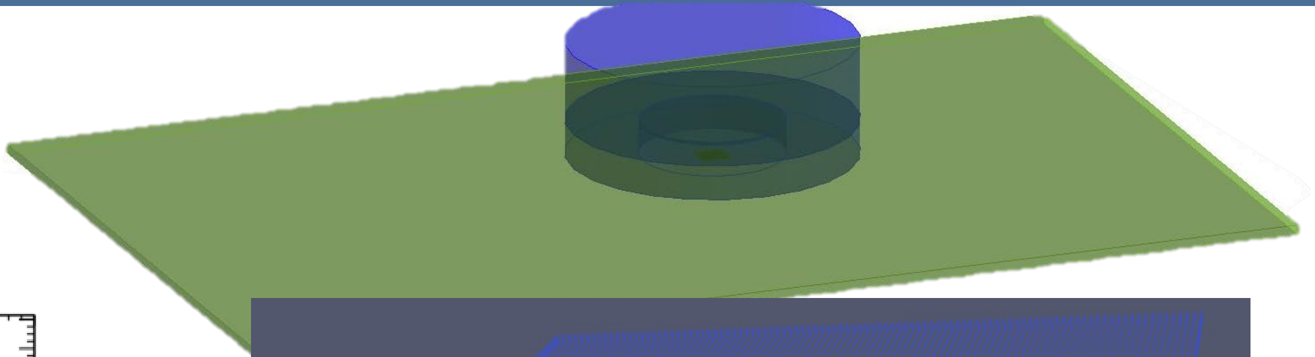
Computational physics involved in the research activity

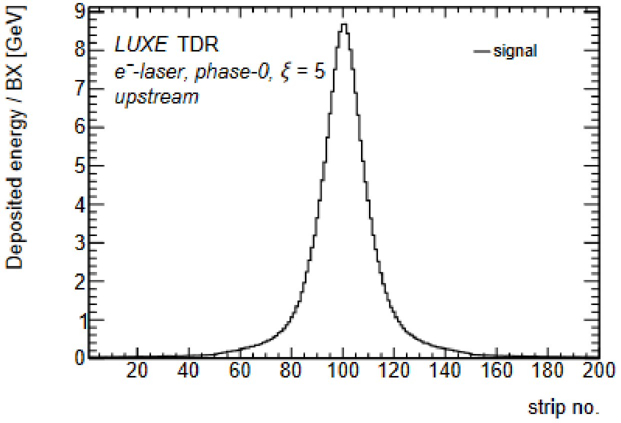
- Detector sensitivity/resolution and optimization
  - Particle transport simulations based on the C++ Geant4 framework
  - Detector response with front-end sim.of the digitized signal with the C++ Allpix2 framework
  - Finite-element simulations involving ELMER

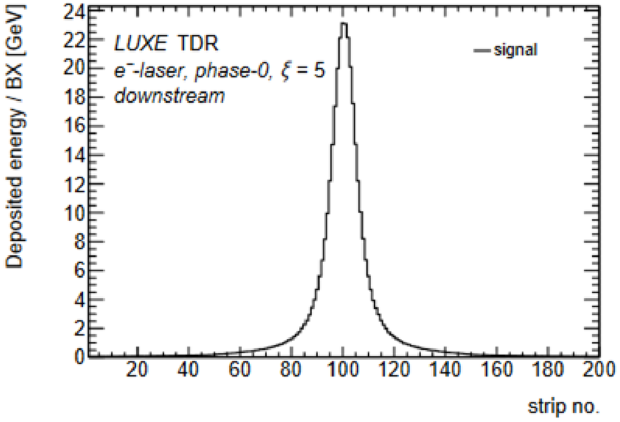


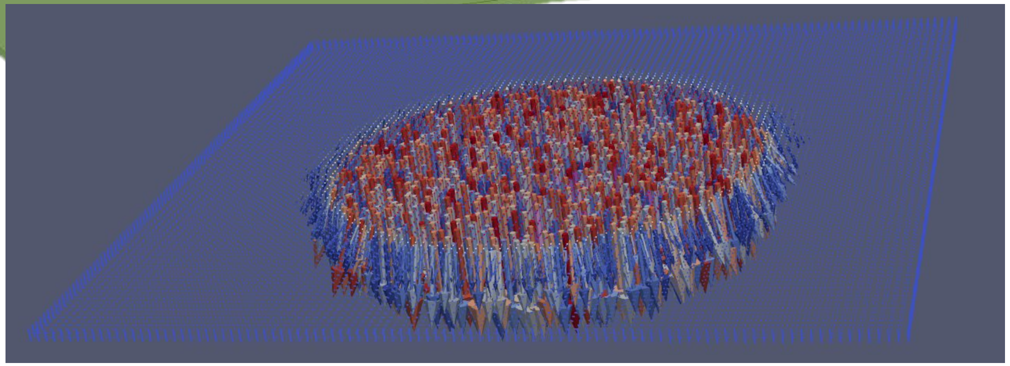


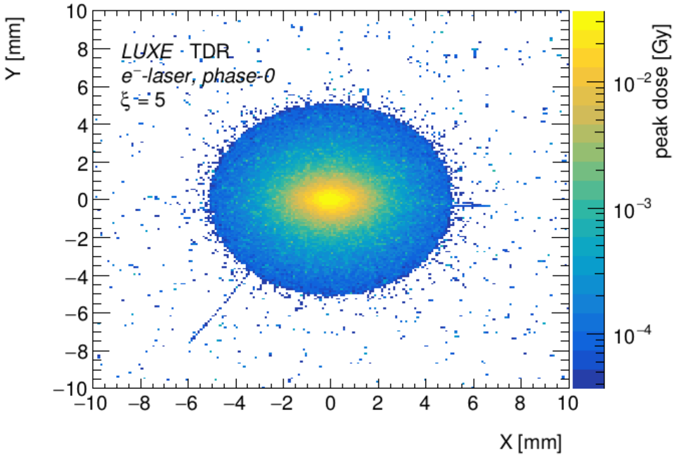
R&D on sapphire detectors

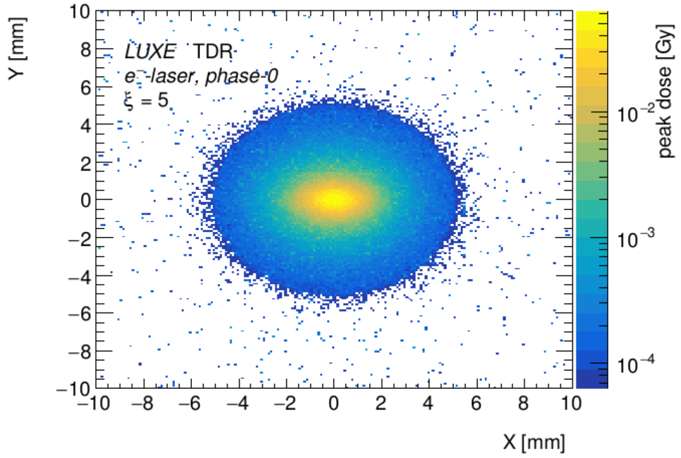


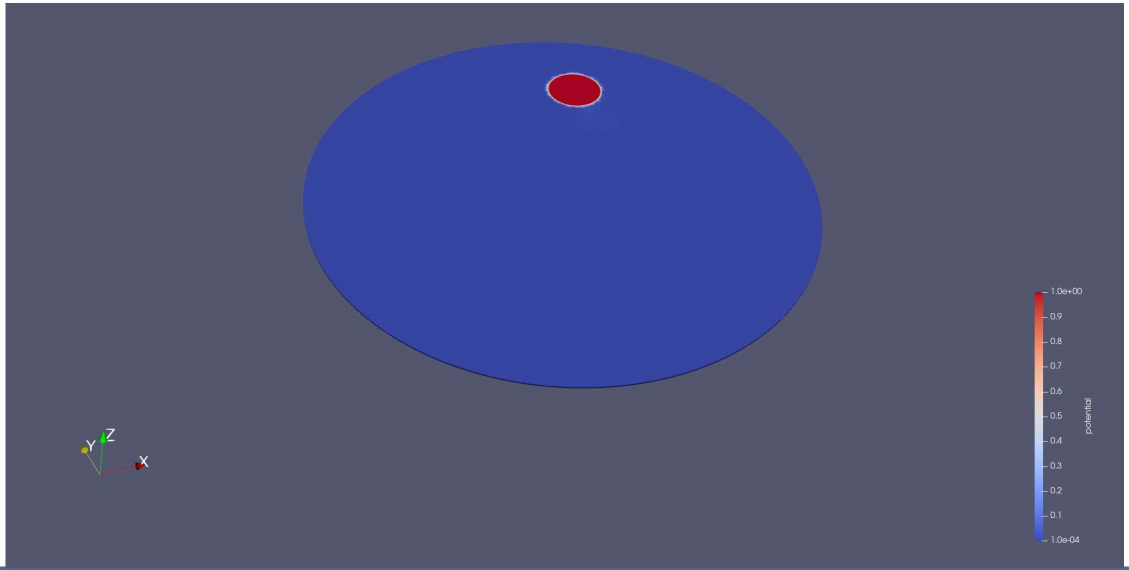












Optimizing ATLAS data workflow

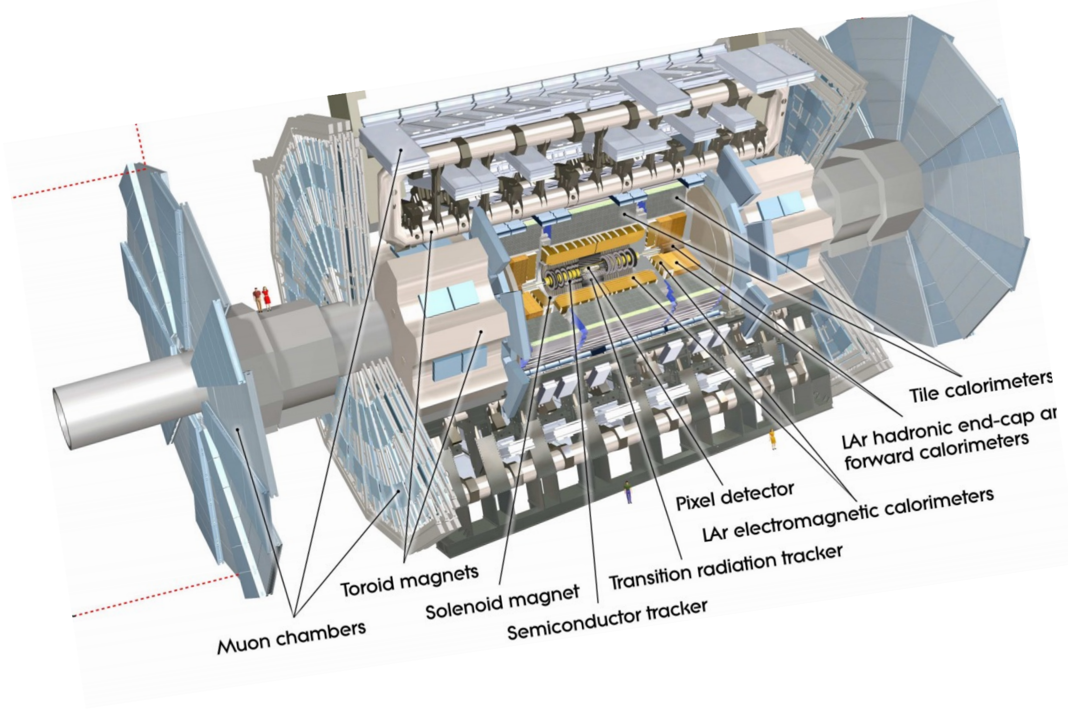
School on Efficient Scientific Computing - Bertinoro

October 2022

Caterina Marcon – INFN Milano

INFN MILANO
Istituto Nazionale di Fisica Nucleare
Sezione di Milano

The ATLAS esperiment & data workflow



The **ATLAS** detector is the **largest** of the four major LHC experiments

- Its working energy range is at the **TeV scale**
- During Run 2, data has been collected at a rate of **~1 kHz** -> for future runs rates of **~10 kHz** are expected

Generation → Simulation → Digitaliazation → Reconstruction → AOD creation & Derivation → Analysis

Simulated data

Real Data → Reconstruction

- The correct interpretation of data depends on computer **simulations**
- The ATLAS software is a globally distributed project of **millions of lines of code**
- Before being analysed, both real and MC data, undergo different processing steps

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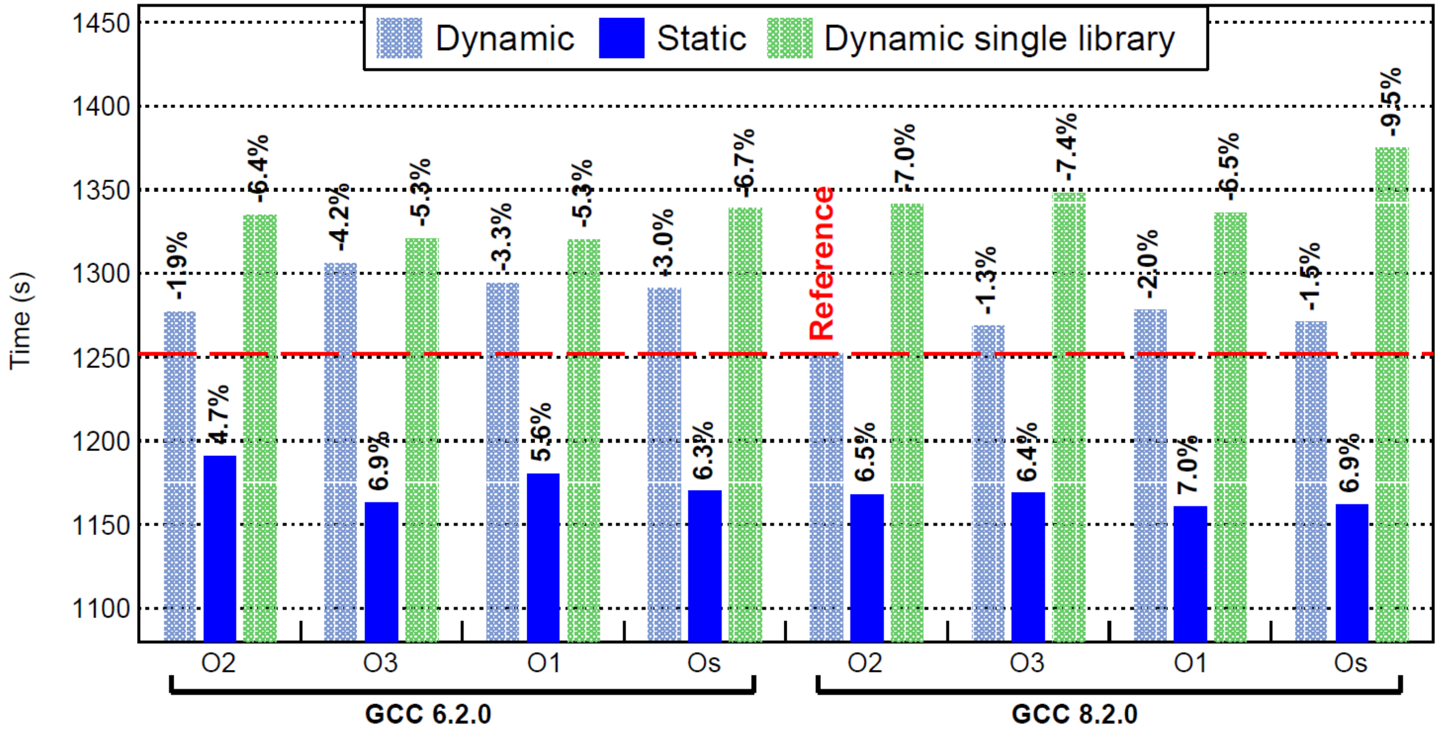
Geant4 simulation execution time: different build types

- Detector **simulations** account for almost **40% of the CPU** workload of the ATLAS experiment
- A broad R&D program is ongoing to reduce the time spent for simulations by optimizing the **Geant4 CPU and memory footprints**
- The impact on execution time of **different build types and compiler optimizations** has been evaluated



- **Static build** shows an improvement of up to **7%**
- The **single library** approach exhibits an **increase of ~ 10% in execution time**

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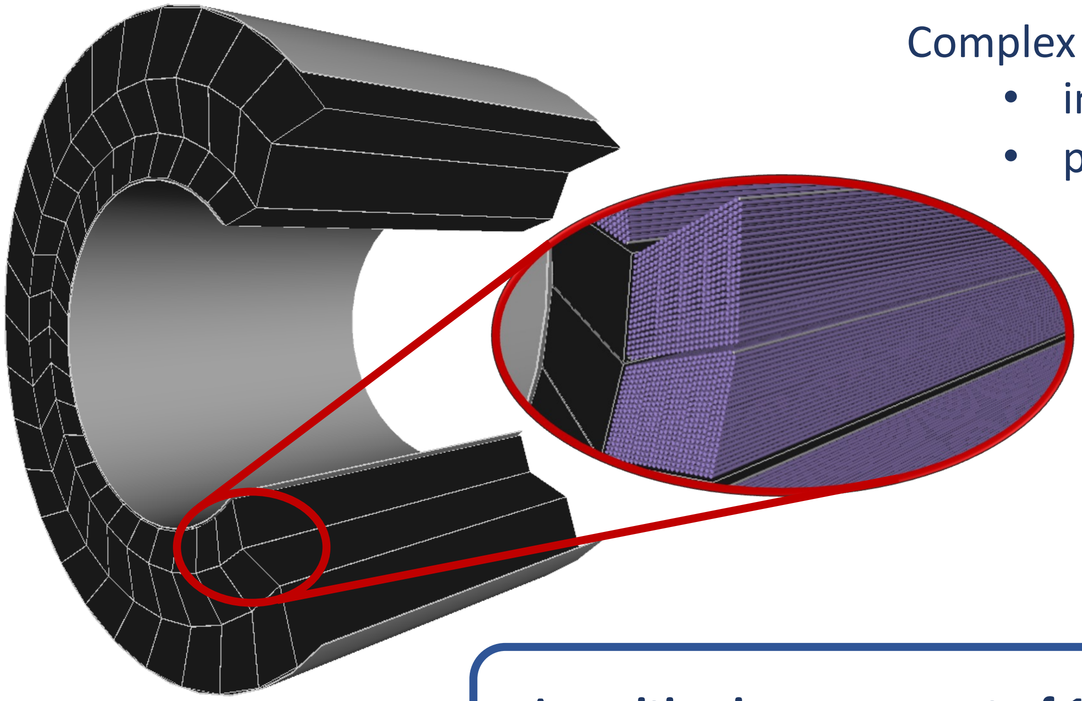
Optimization of detector geometry description

Ongoing effort to increase the efficiency of **the ATLAS TRT geometry description**



Complex volumes built with **Boolean solids**:

- inefficient
- prone to tracking issues, especially for coincident surfaces

Alternative shapes tested:

- extruded solid: **`BREP`**
- generic trapezoid: **`arb8`**

These can lead to:

- fewer lines of code → better maintainability
- fewer calculations → faster execution times

A **positive improvement of 1.5%** is observed for the **`arb8` representation**, whereas the **`BREP` solid exhibits a minor degradation** with respect to the reference boolean solids

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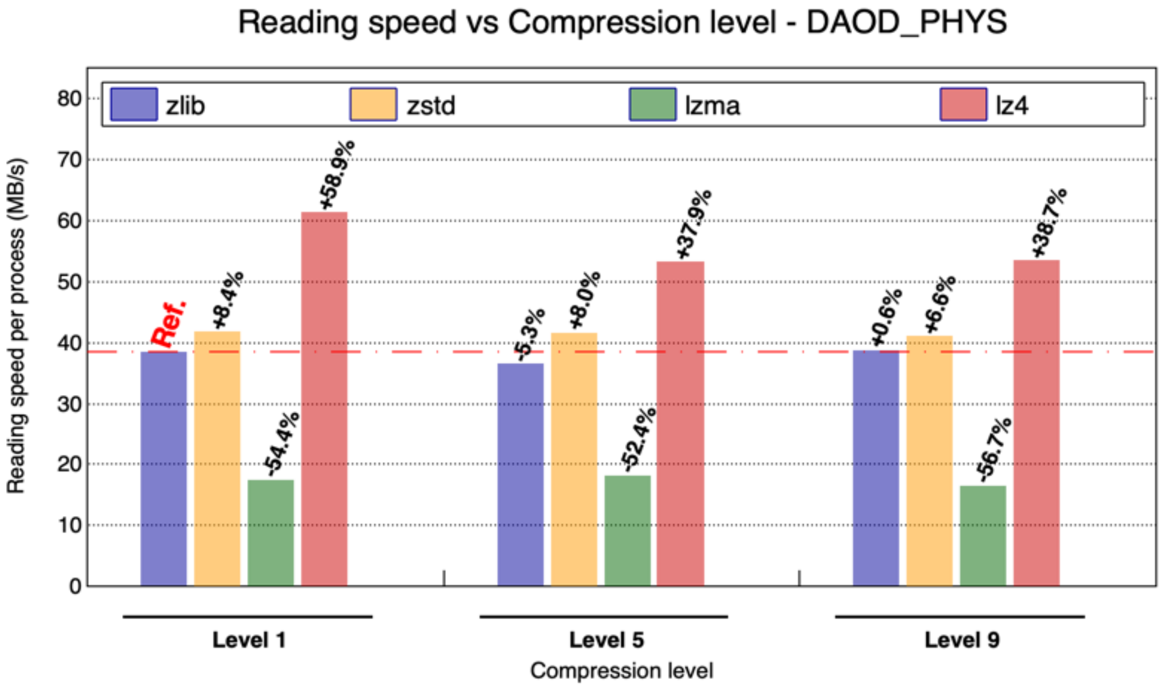
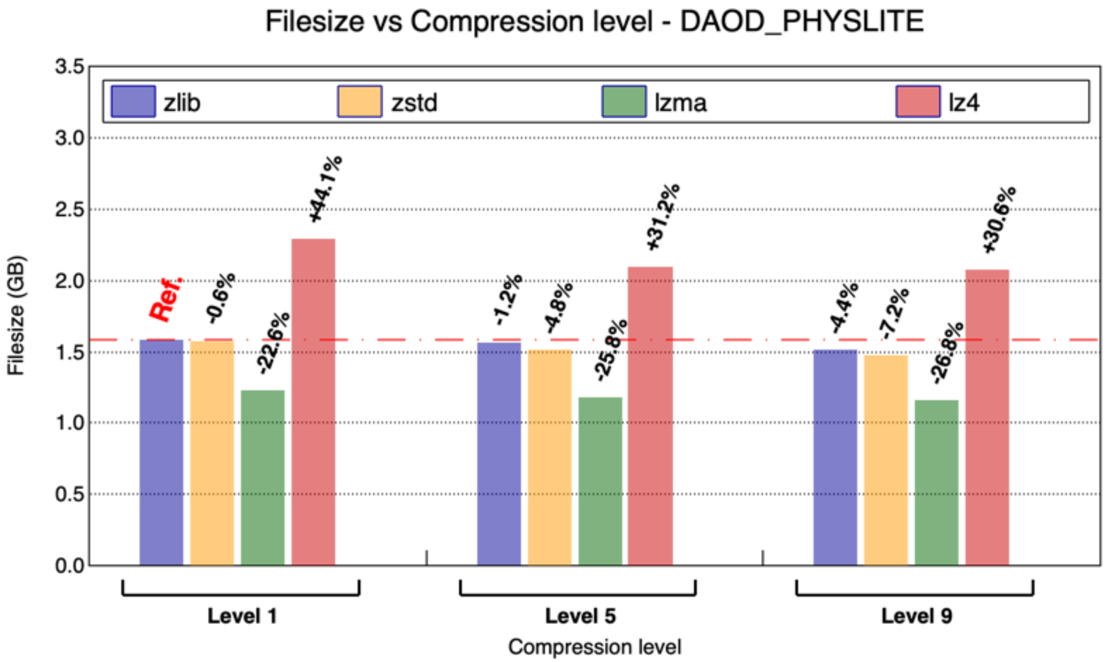
Impact of ROOT compression algorithms on derived data

- In coming runs, larger event rates will require more processing power
- The **disk space** required to store the events will grow accordingly
- The need for data compression has already grown significantly: more interest in profiling the **compression algorithms** provided by **ROOT**.

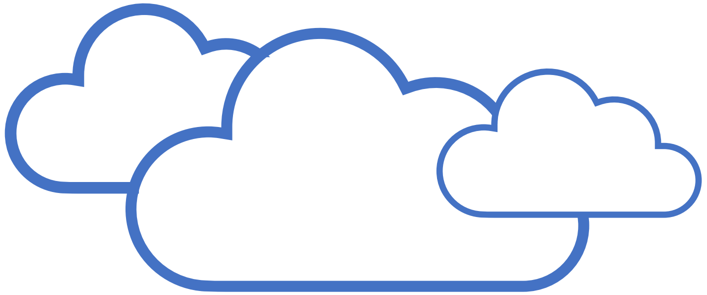




- **Lz4** is the **fastest in reading** but results in the **largest files**
- **Lzma** provides much **better compression** at the cost of significantly **slower reading speed**

Implementing an ATLAS analysis workflow on INFN cloud resources

- From March 2021 the **INFN Cloud** is available:
  - It supports scientific computing, software development, training and serves as an extension of local computing and storage resources
  - It is also possible to create virtual and customised environments, both for individual users and for scientific collaborations
- Goal: implement a **complex physics analysis** (e.g. Higgs to two photons decay) on **INFN cloud resources**



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