Aspects relevant to background reduction: an alternative view

Kalliopi Kanaki

European Spallation Source

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Personal introduction

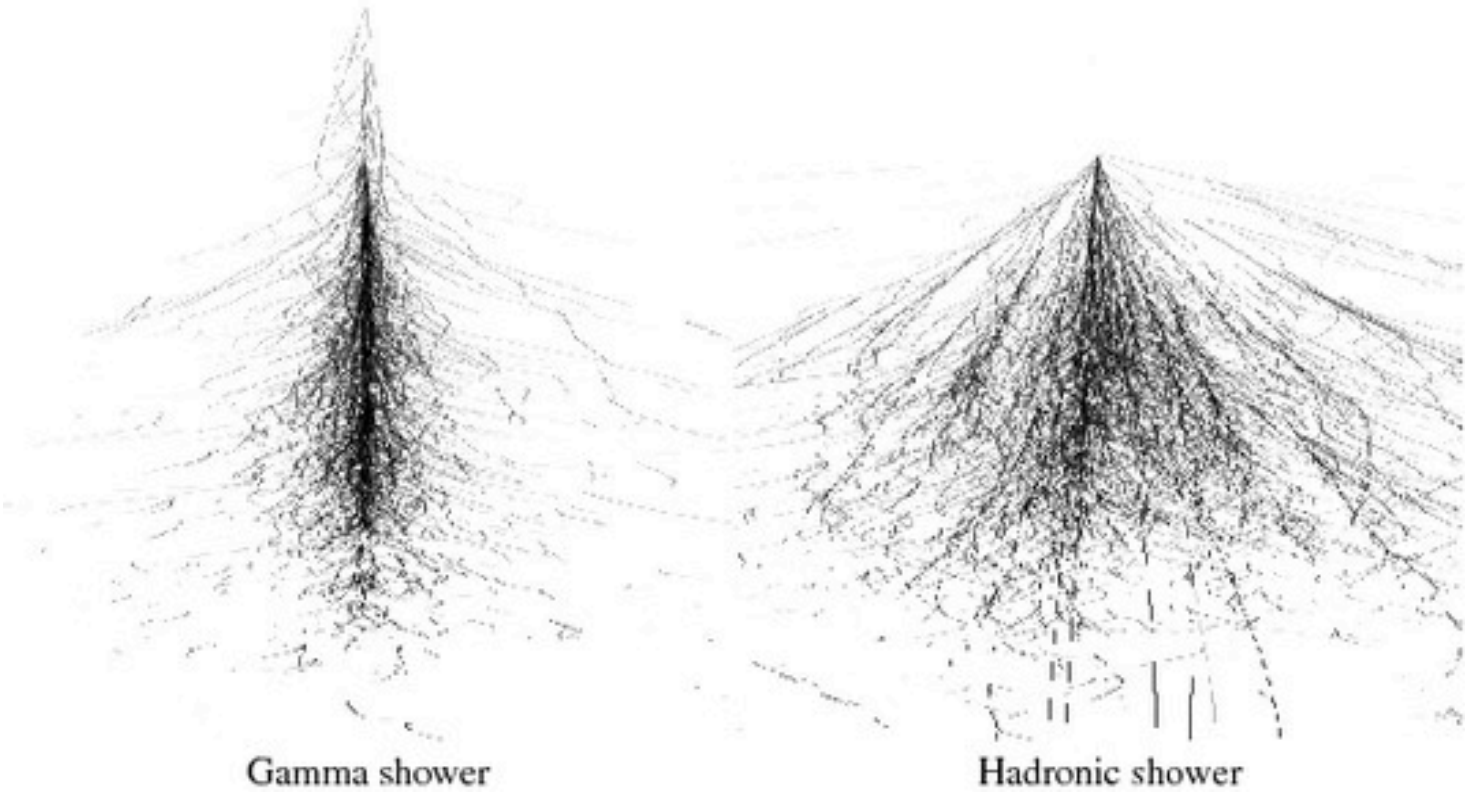
Experience mostly within high energy nuclear physics (heavy-ion physics with HADES@GSI, ALICE@CERN)

- PhD in strange particle production (C+C @ 2 AGeV)
- scintillators and gaseous detectors (drift chambers, TPC)
  - construction and commissioning
  - raw data analysis
- software implementation
  - development of diagnostic tools for online TPC monitoring
  - quality assessment for particle track reconstruction (online-offline comparison)
  - online TPC calibration algorithms
  - online physics algorithms

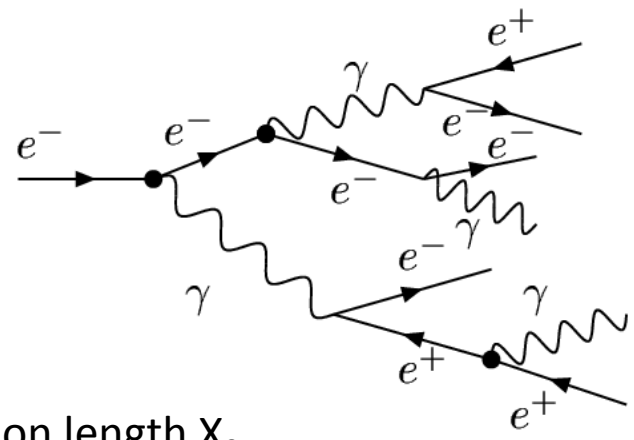
Electromagnetic vs. hadronic showers

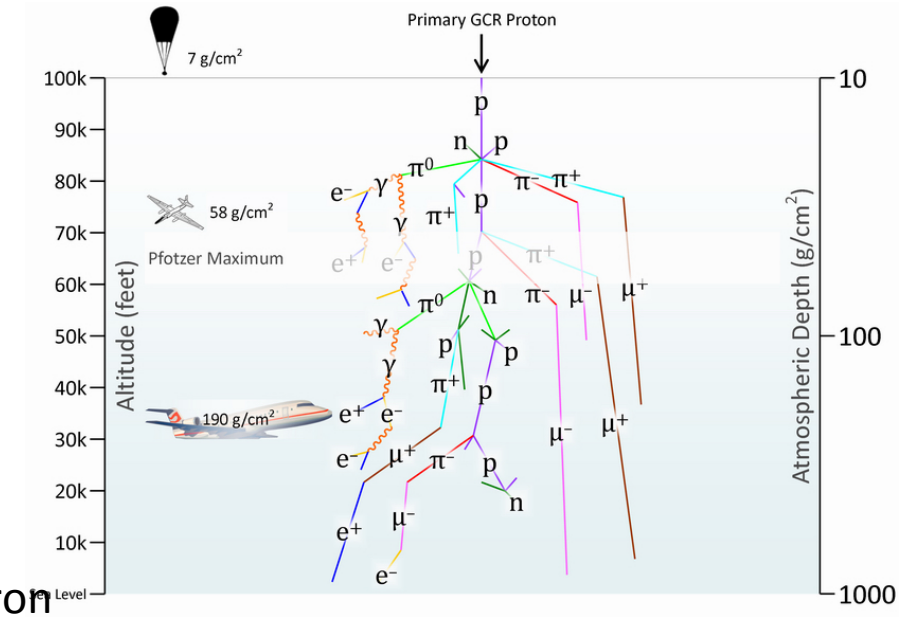
- slender shape
- axially symmetric around the primary direction

- irregular shape due to large p_t particles
- contain EM showers



Useful quantities





radiation length X_0

- material dependent, f(A, Z)
- mean distance over which a high-energy electron loses all but 1/e of its energy via bremsstrahlung

or

- 7/9 of the mean free path for pair production

shower depth $X = X_0 \ln(E_0/E_c)/\ln 2$

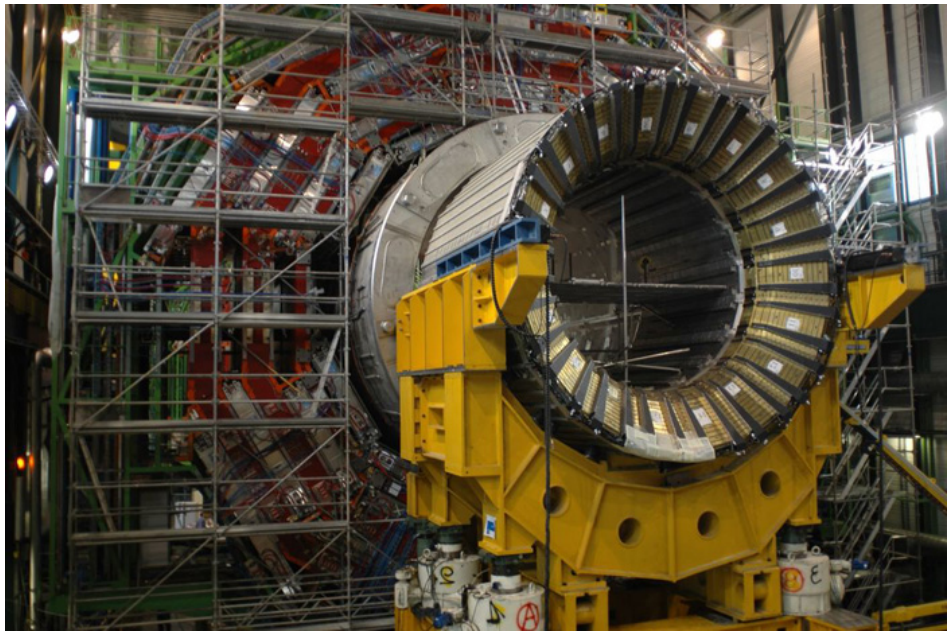
Molière radius: transverse scale of the EM shower

- $f(X_0, Z)$

interaction length λ

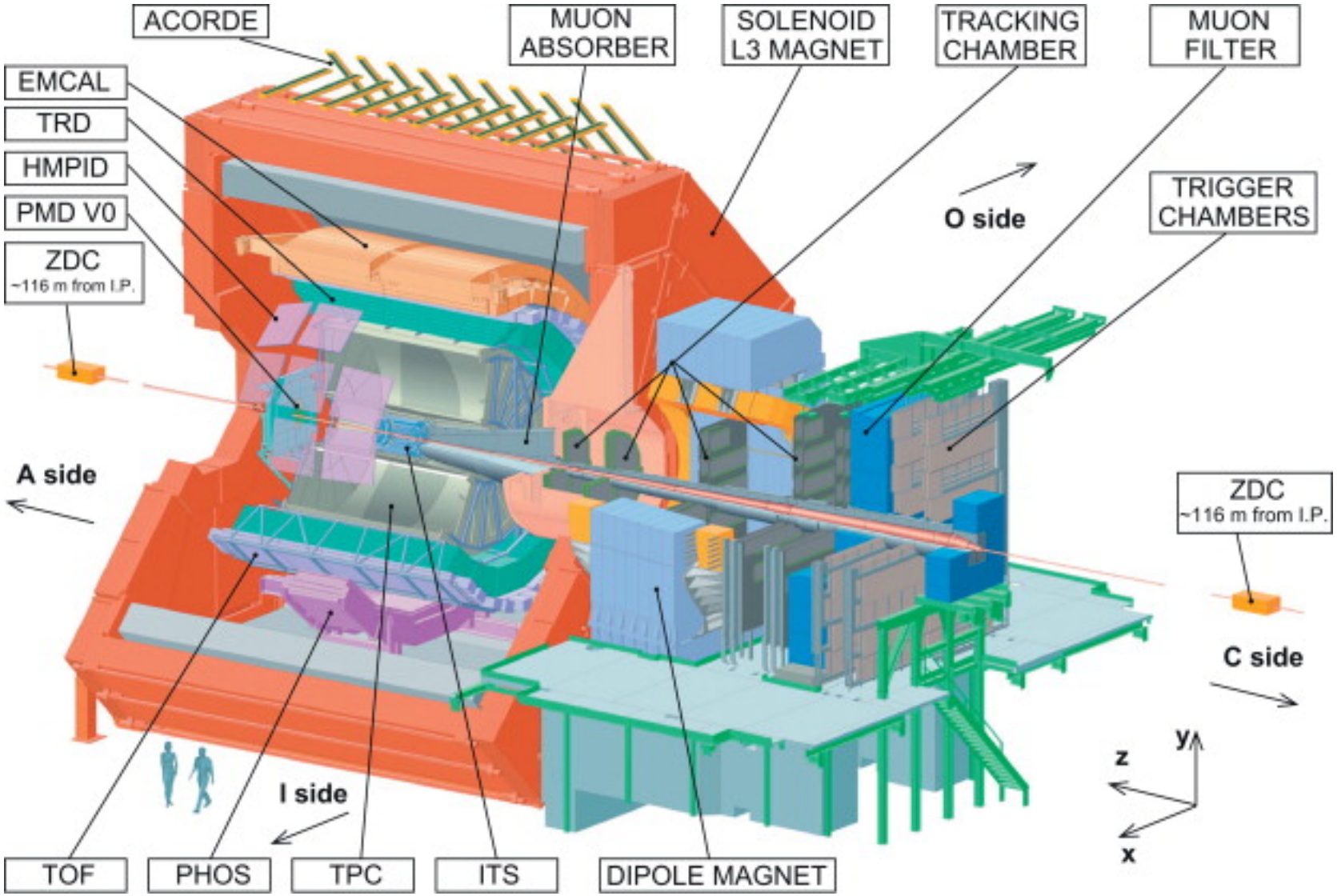
- material, particle and energy dependent
- mean distance travelled by a hadron before undergoing an inelastic nuclear interaction
- inverse of macroscopic cross section

Hadronic calorimeter@CMS



EM calorimeter@ALICE

The ALICE detector at CERN



ALICE calorimeter characteristics

PHOS

Density	8.28 g/cm^3
Radiation length	0.89 cm
Interaction length	19.5 cm
Molière radius	2.0 cm
Melting point	1123 °C
Hardness	4 Moh
Refractive index along ζ axis ($\lambda = 632$ nm)	2.16
Hygroscopicity	none
Chemical activity	inert

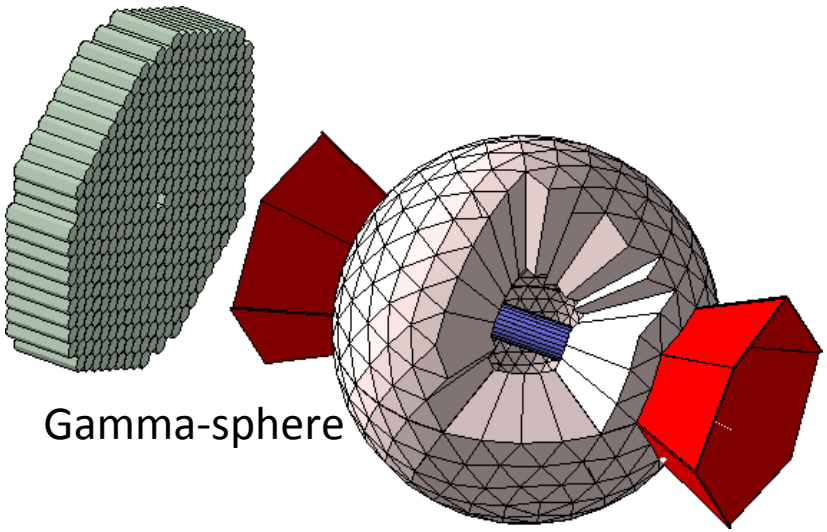
EMCAL

Quantity	Value
Tower Size (at η=0)	$\sim$6.0 $\times$ $\sim$6.0 $\times$ 24.6 cm (active)
Tower Size	$\Delta\phi \times \Delta\eta = 0.0143 \times 0.0143$
Sampling Ratio	1.44 mm Pb / 1.76 mm Scintillator
Number of Layers	77
Effective Radiation Length X_o	12.3 mm
Effective Moliere Radius R_M	3.20 cm
Effective Density	5.68 g/cm^2
Sampling Fraction	10.5
Number of Radiation Lengths	20.1
Number of Towers	12,288
Number of Modules	3072
Number of Super Modules	10 full size, 2 one-third size
Weight of Super Module	$\sim$7.7 metric tons (full size)
Total Coverage	$\Delta\phi = 107^o$, -0.7 $< \eta <$ 0.7

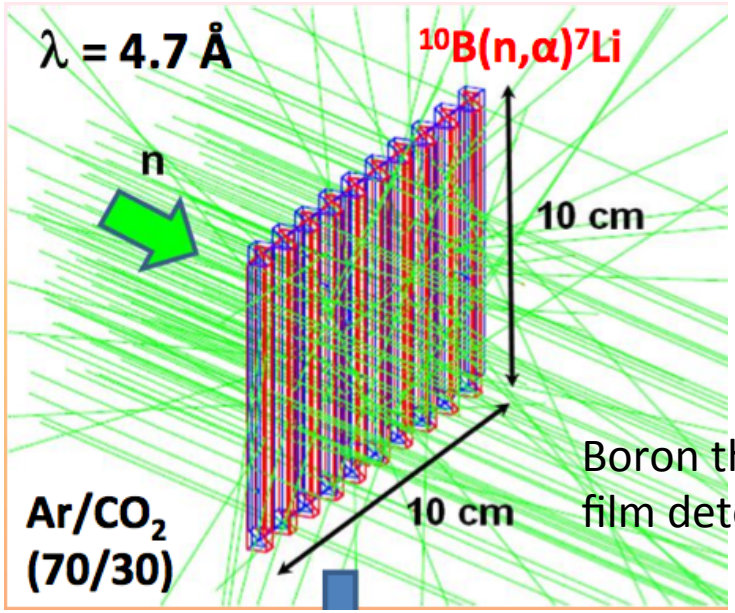
Simulation tools: GEANT

- toolkit for the simulation of the passage of particles through matter
- high energy physics, nuclear physics, accelerator physics, medical physics, space science, DNA response to radiation
- includes EM, hadronic interactions, particle decays
- open source, available to everyone

GEANT application examples

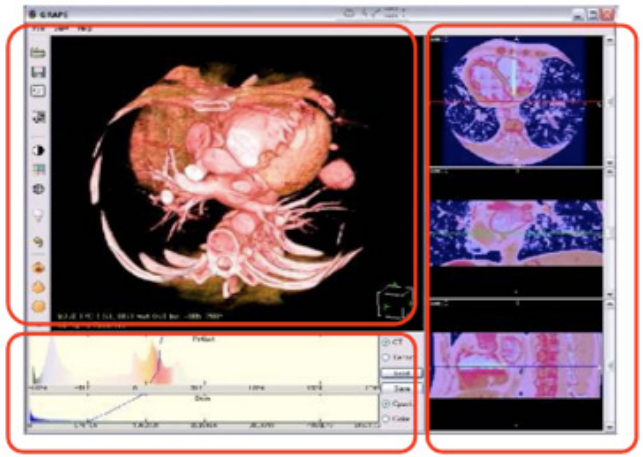


Gamma-sphere

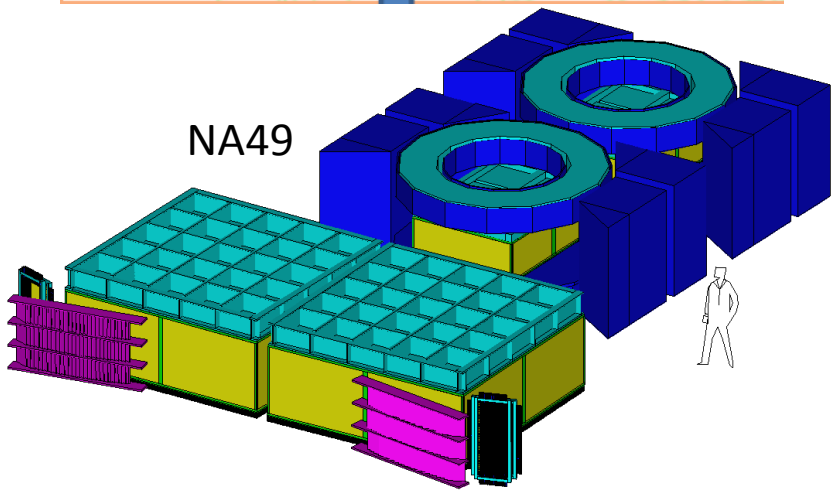


Boron thin film detectors

medical physics

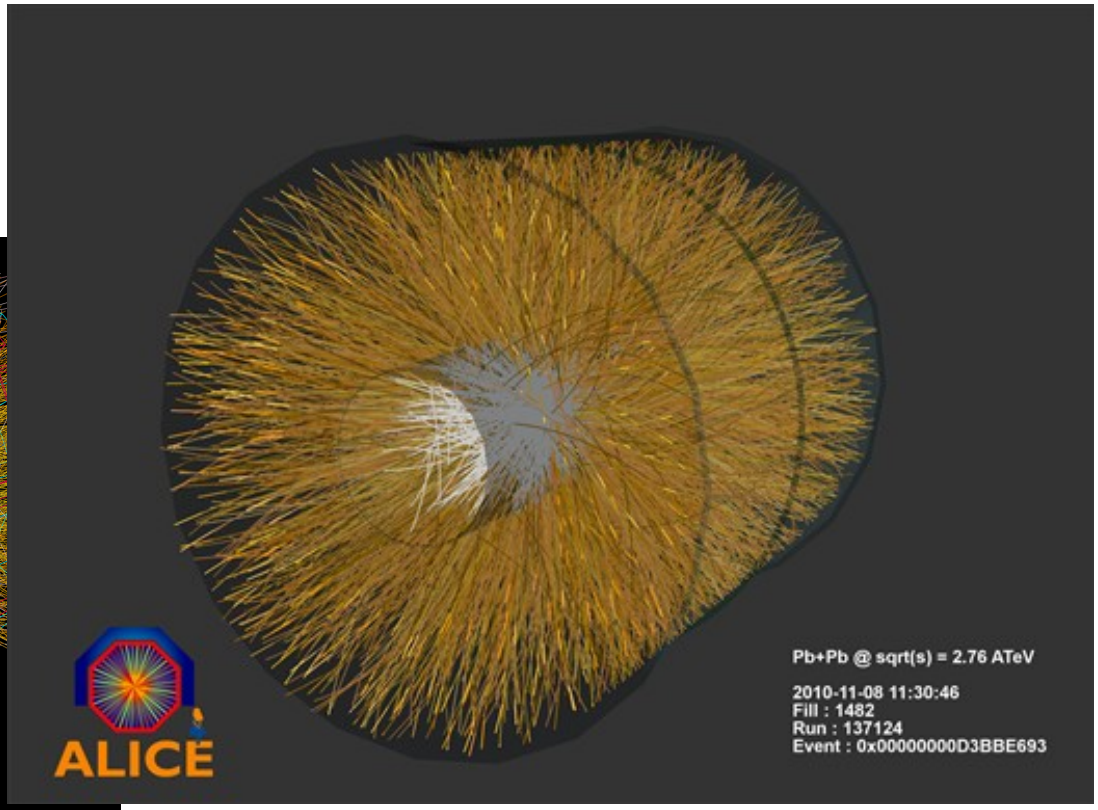


Opacity curve and color map editor

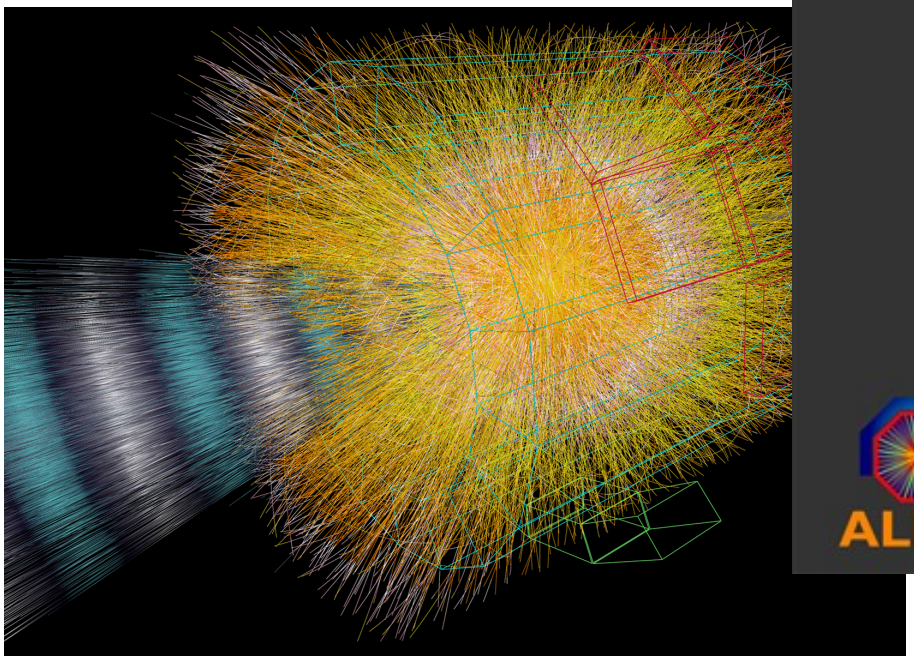


ALICE events: simulated and real data

first Pb-Pb event in November 2010



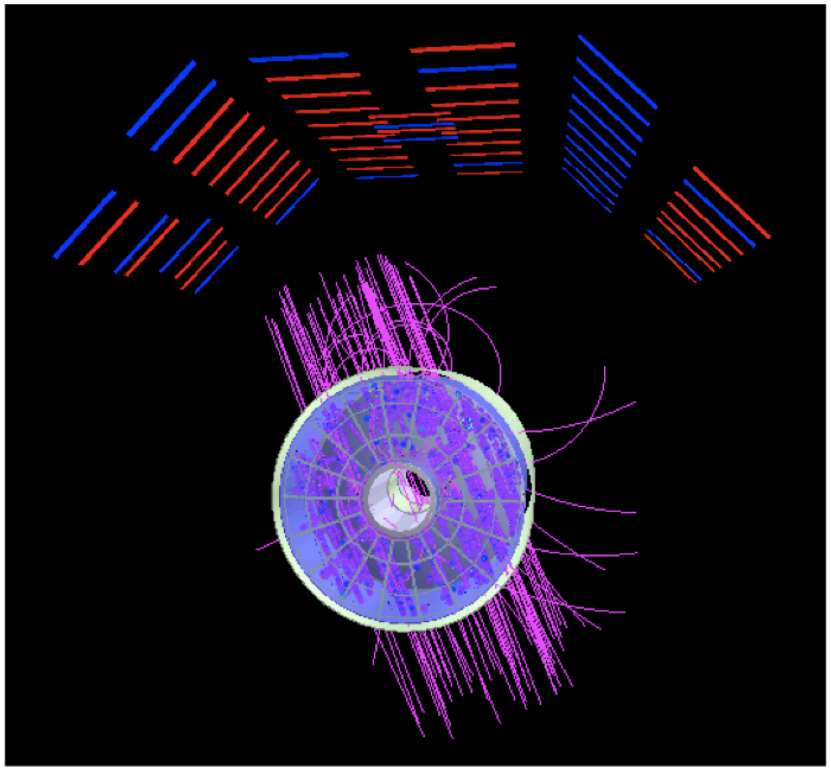
simulated Pb+Pb event with μ particles



Possible contributions to an SNS-ESS collaboration

- Particle physics experience
- Development of simulation framework for the neutron community, open to everybody for use (official release in March)
- Proposal to combine passive and active shielding
  - add a monitoring aspect within a detector
  - work with the background, detect it and reject it
  - use of algorithms to distinguish S from B
  - both at hardware and software level
  - available experience with these commonly used techniques in HEP

An active cosmic radiation detector/ shield for ALICE



- ACORDE detector detects cosmic rays going through the rest of the subsystems
- a simple tracking algorithm reconstructs these tracks
- rejection or used for the TPC calibration
- “veto” and trigger concepts