A Large Ion Collider Experiment

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22-09-2009 BND Summerschool Rathen

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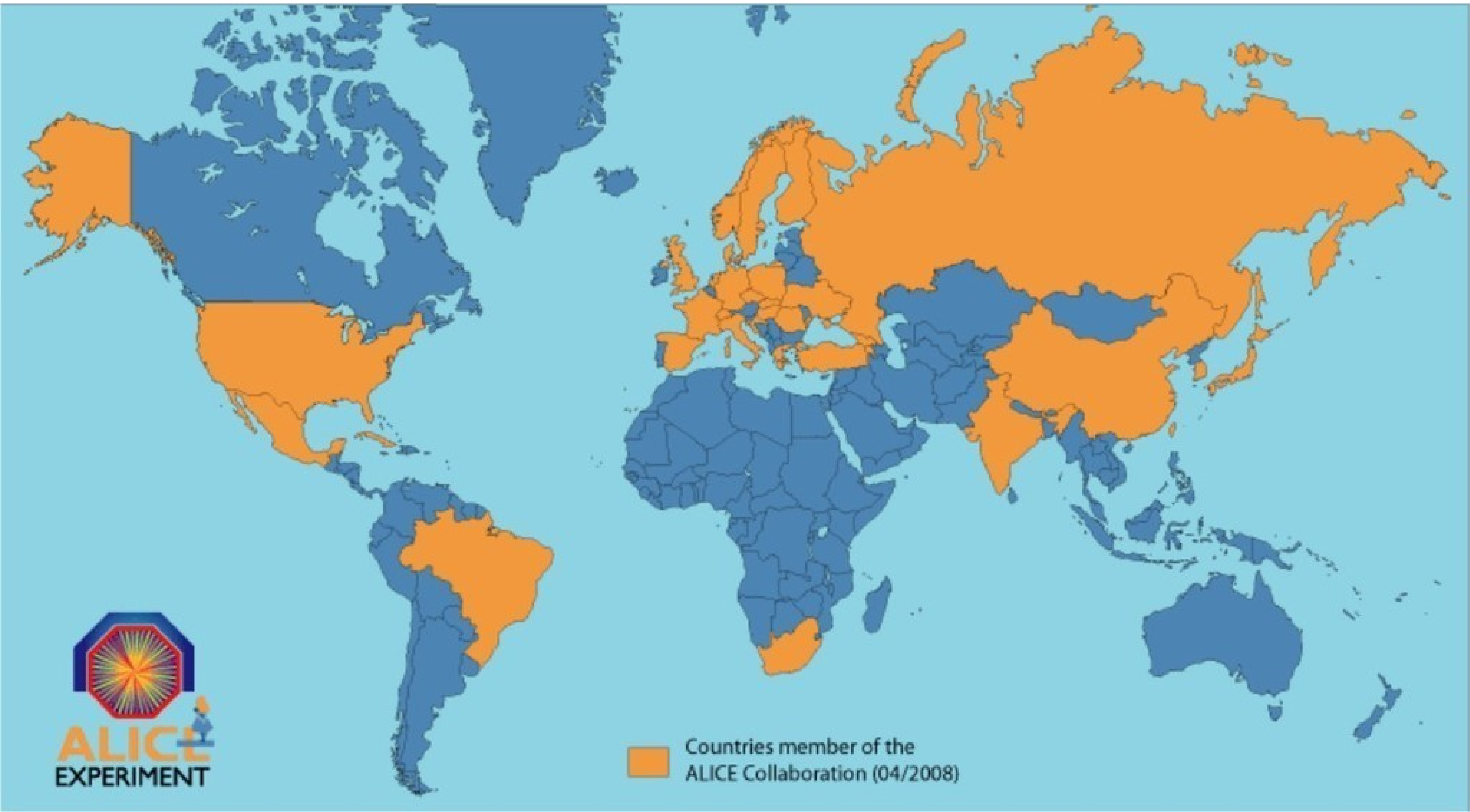
ALICE – who are we?

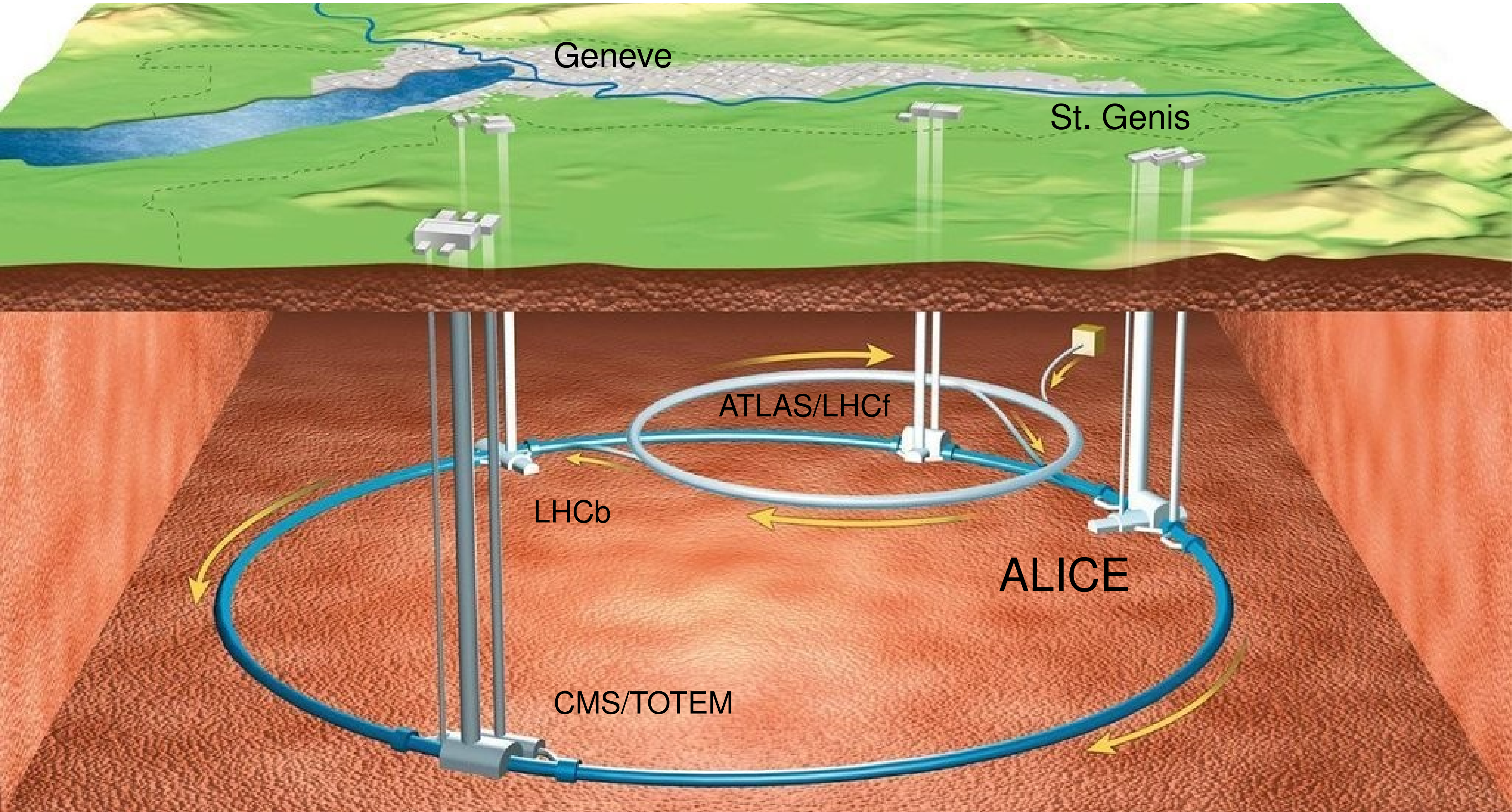
- 1000 people from 109 institutes in 31 countries



ALICE – the collaboration

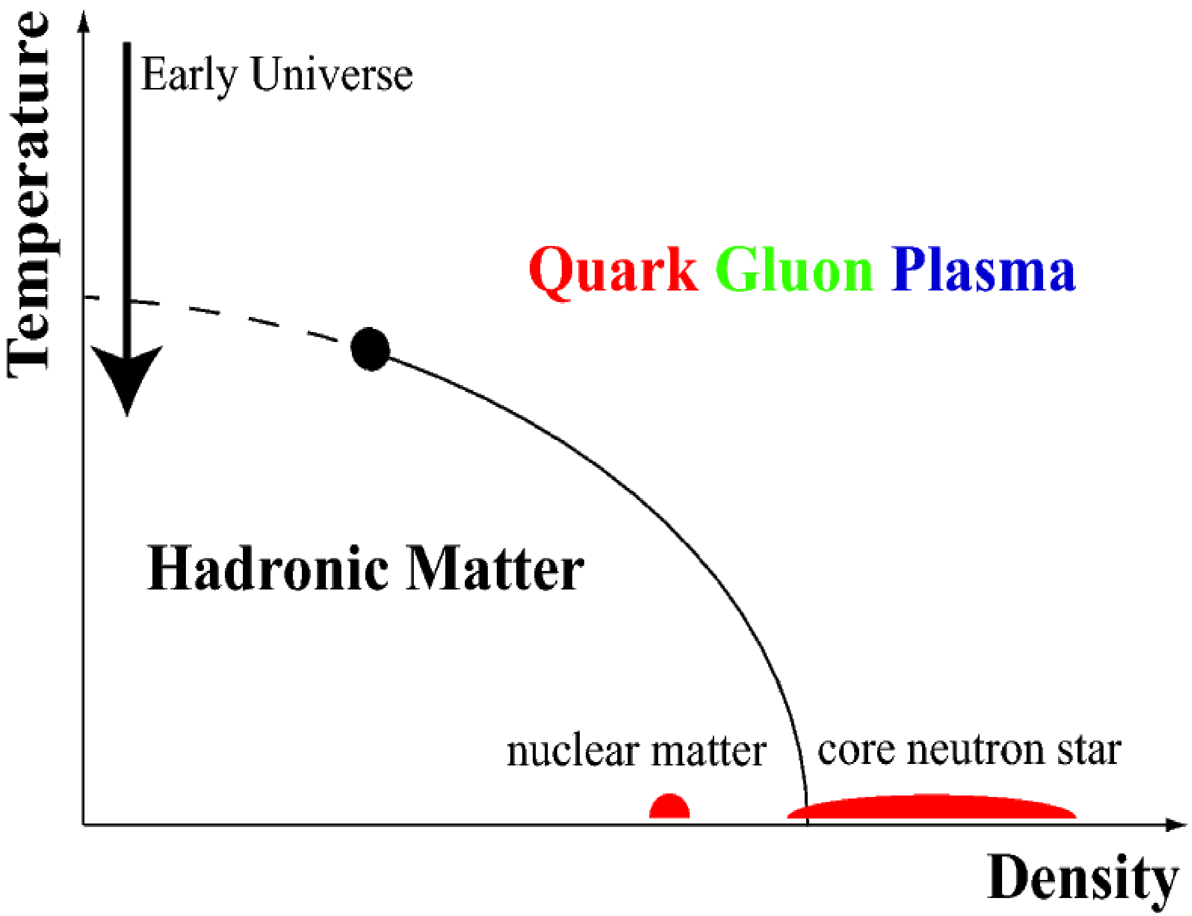
The obligatory LHC picture

(this time fully PC wrt the Other experiments)



QGP, the short story

- What happens when you compress and heat matter to very high densities and temperatures?

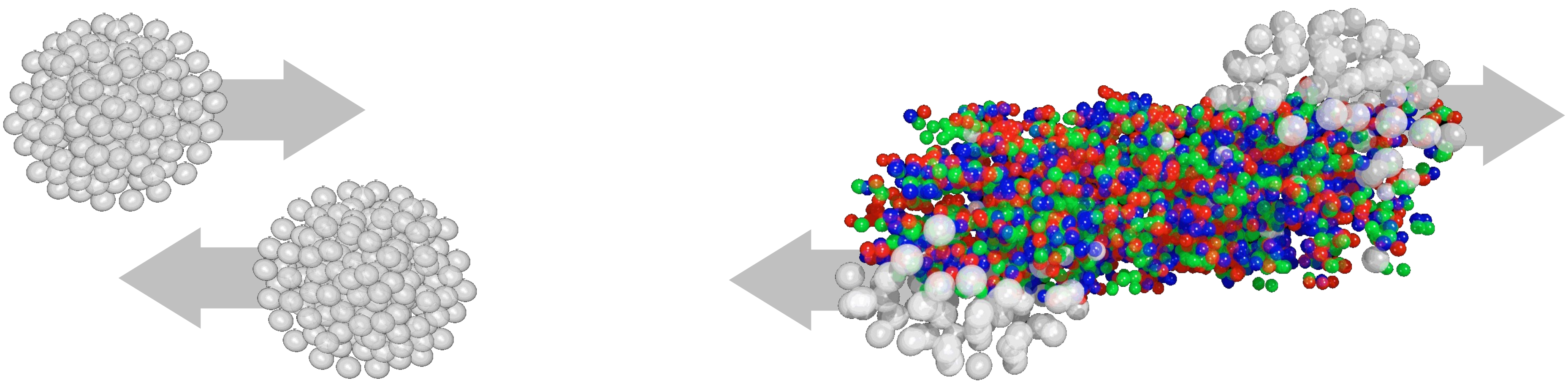


- QGP: few microseconds after the big bang
- perhaps in the core of neutron stars

- Understand the properties (equation of state) of QGP.

QGP in the lab

- We can (???) make QGP by colliding heavy nuclei with large energies

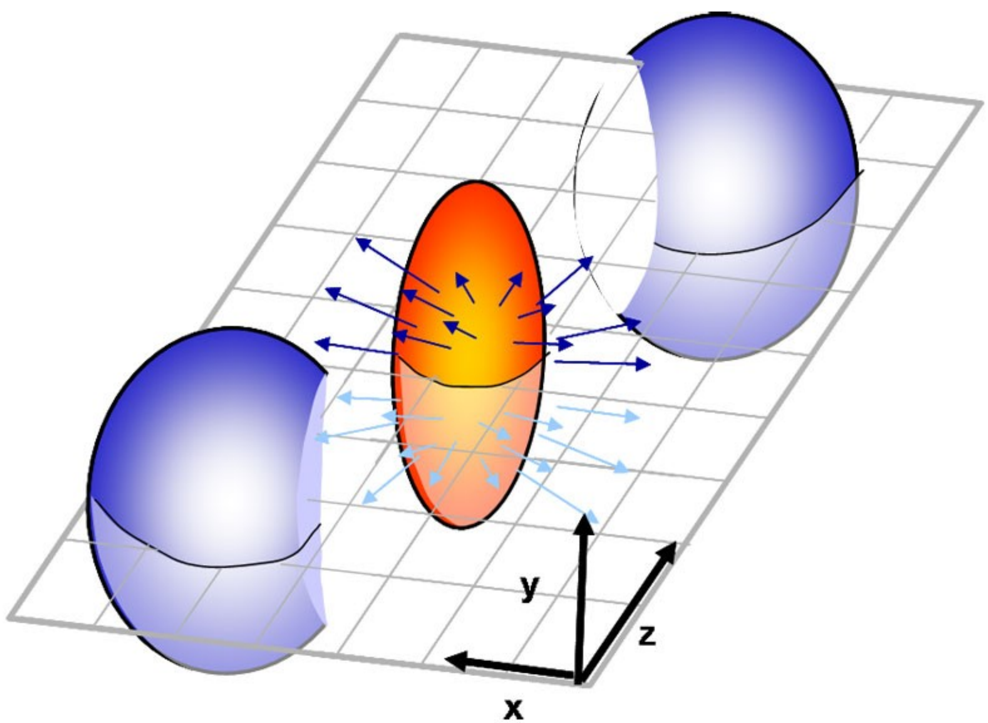


- Experiments began in early '80s at Berkeley and presently at RHIC (Brookhaven)
- In the near future cm energy >25x higher at CERN LHC

Observables

- Flow – measure for anisotropic particle distribution

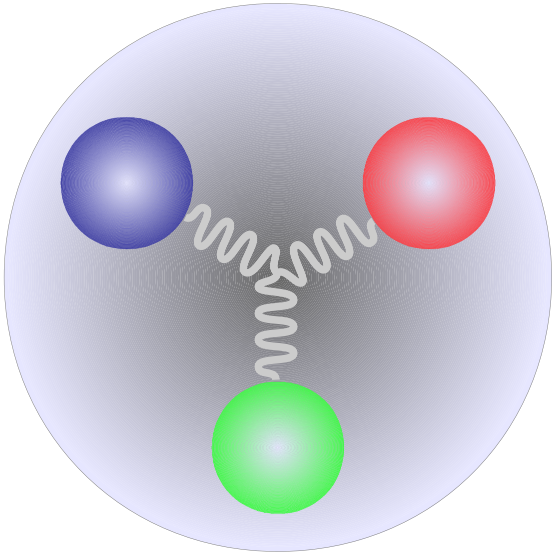
$$E\frac{d^3N}{d^3p}=\frac{1}{2\pi}\frac{d^2N}{p_t\,dp_t\,dy}\left\{1+2\sum_{n=1}^{\infty}v_n(p_t,y)\cos\left[n\left(\phi-\Psi_R\right)\right]\right\}$$



- Also others like hard probes, jet quenching

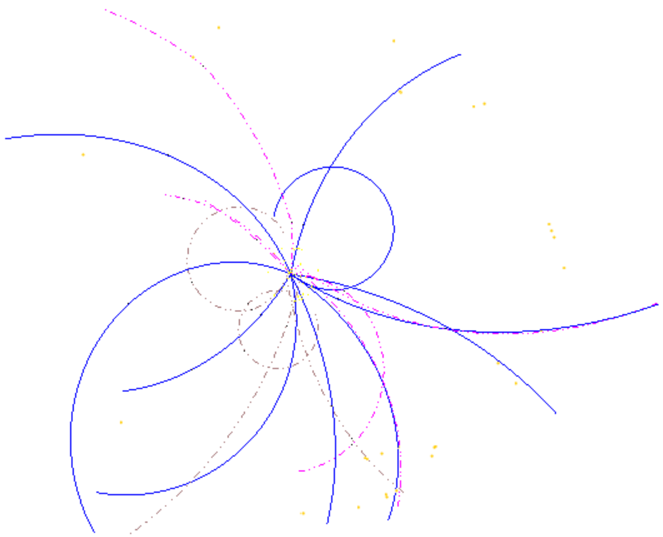
QCD questions

- By studying the macroscopic properties (e.g. flow) gain insight in the underlying microscopic theory (QCD).
  - Confinement

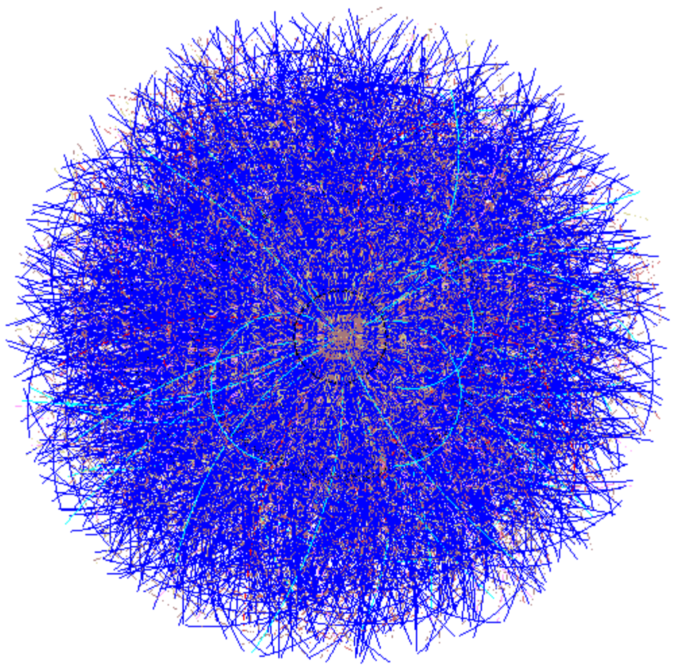


  - QCD mass generation (proton 100x heavier than constituent quarks)

ALICE design challenge



Simulated p-p collision



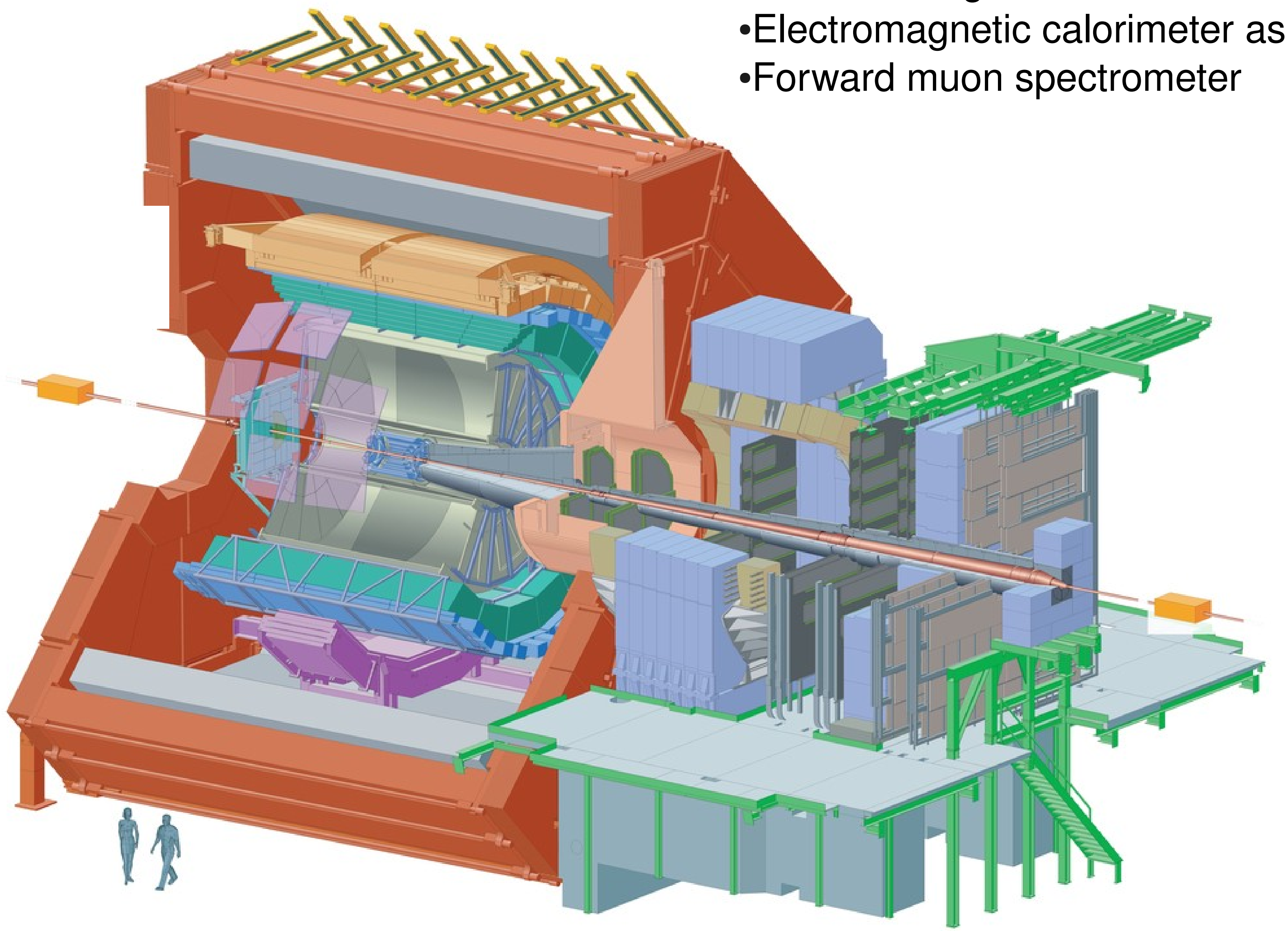
Simulated Pb-Pb collision

- High multiplicity environment (up to 20k particles).
- Particle tracking over a broad range of momenta (100MeV~100GeV). (we need N, phi, y, pt for flow)
- Particle identification.
- Secondary vertex finding (e.g. D0 decay)

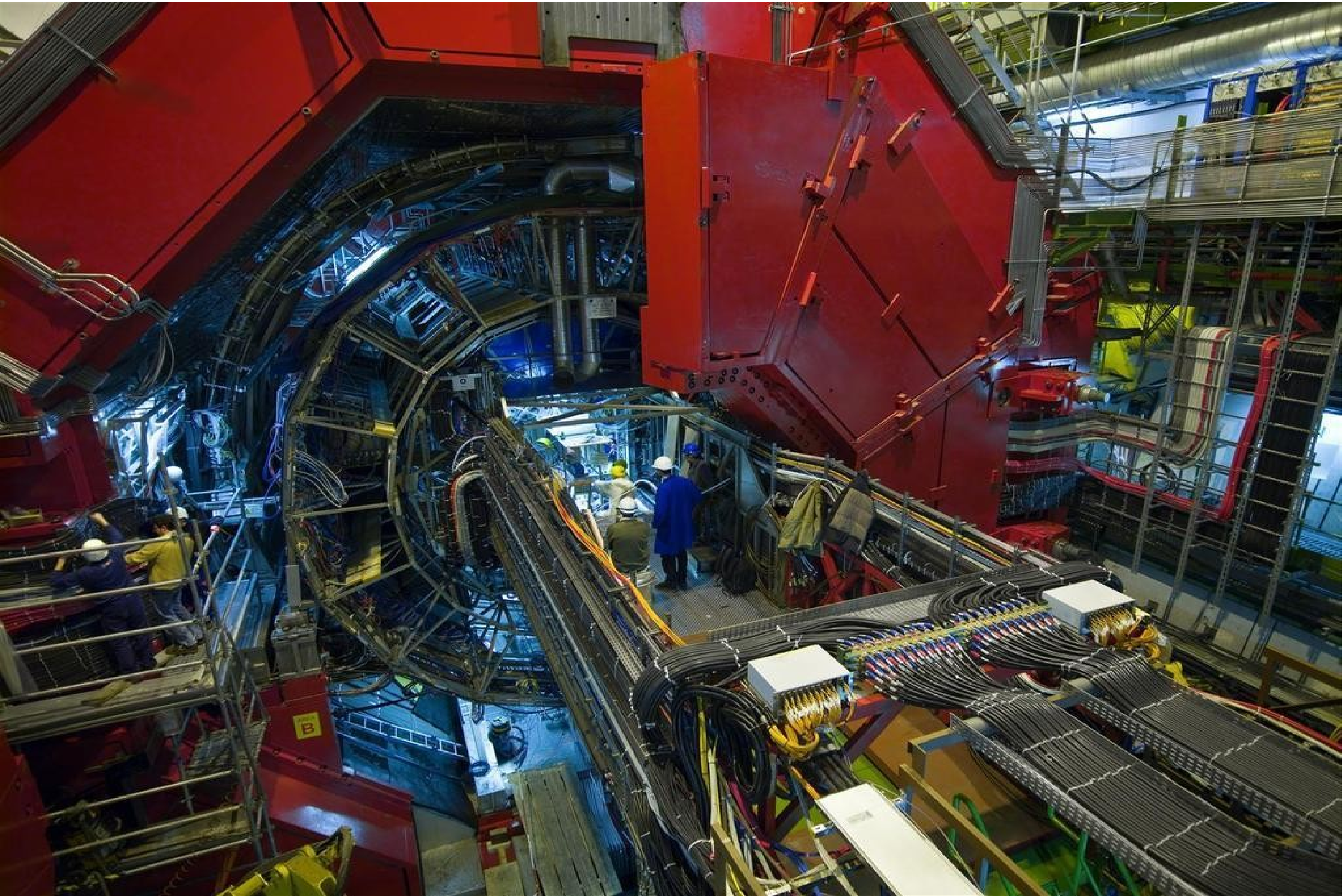
ALICE detector

How is ALICE different?

- Mostly a tracking detector
- Main tracking device is a Time Projection Chamber
- Electromagnetic calorimeter as outermost layer
- Forward muon spectrometer

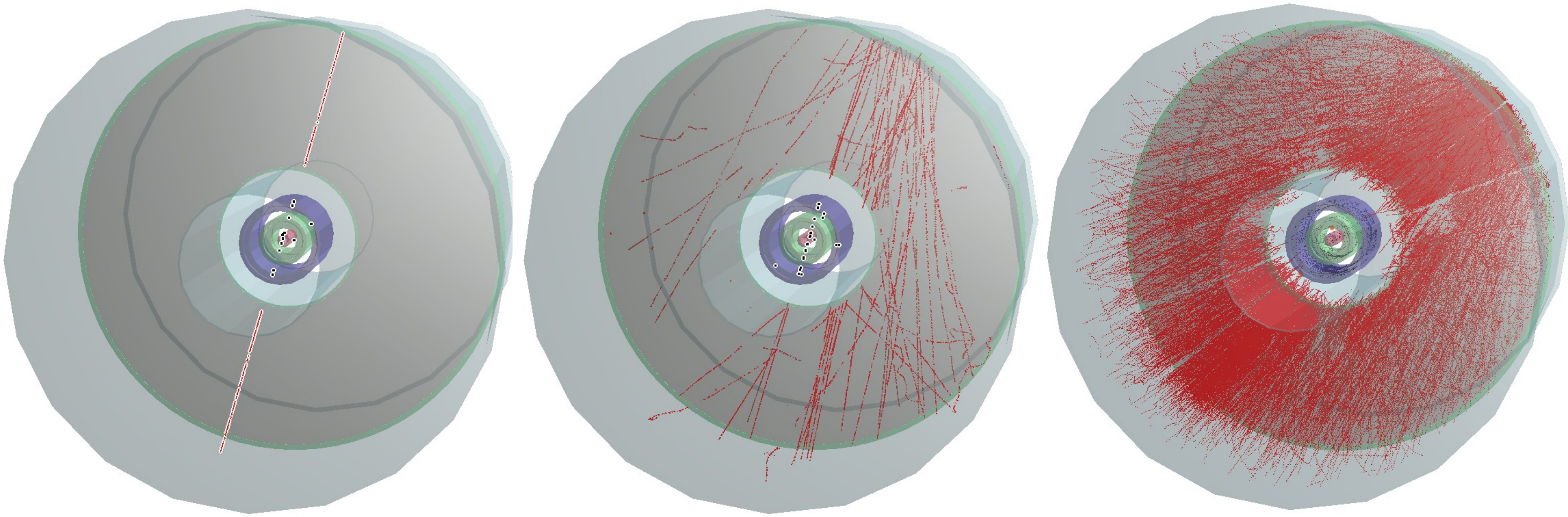


ALICE detector in real life



First measurements: cosmics

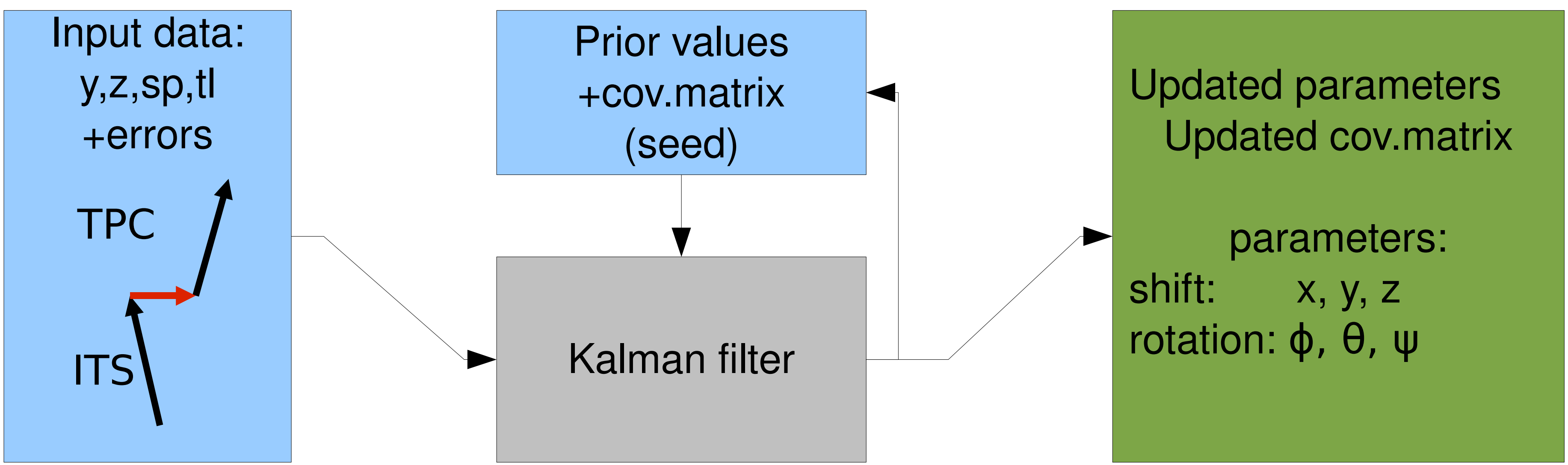
- Cosmics used for alignment&calibration



- Single cosmic particle
- Particle showers caused by a cosmic interacting with matter above the detector

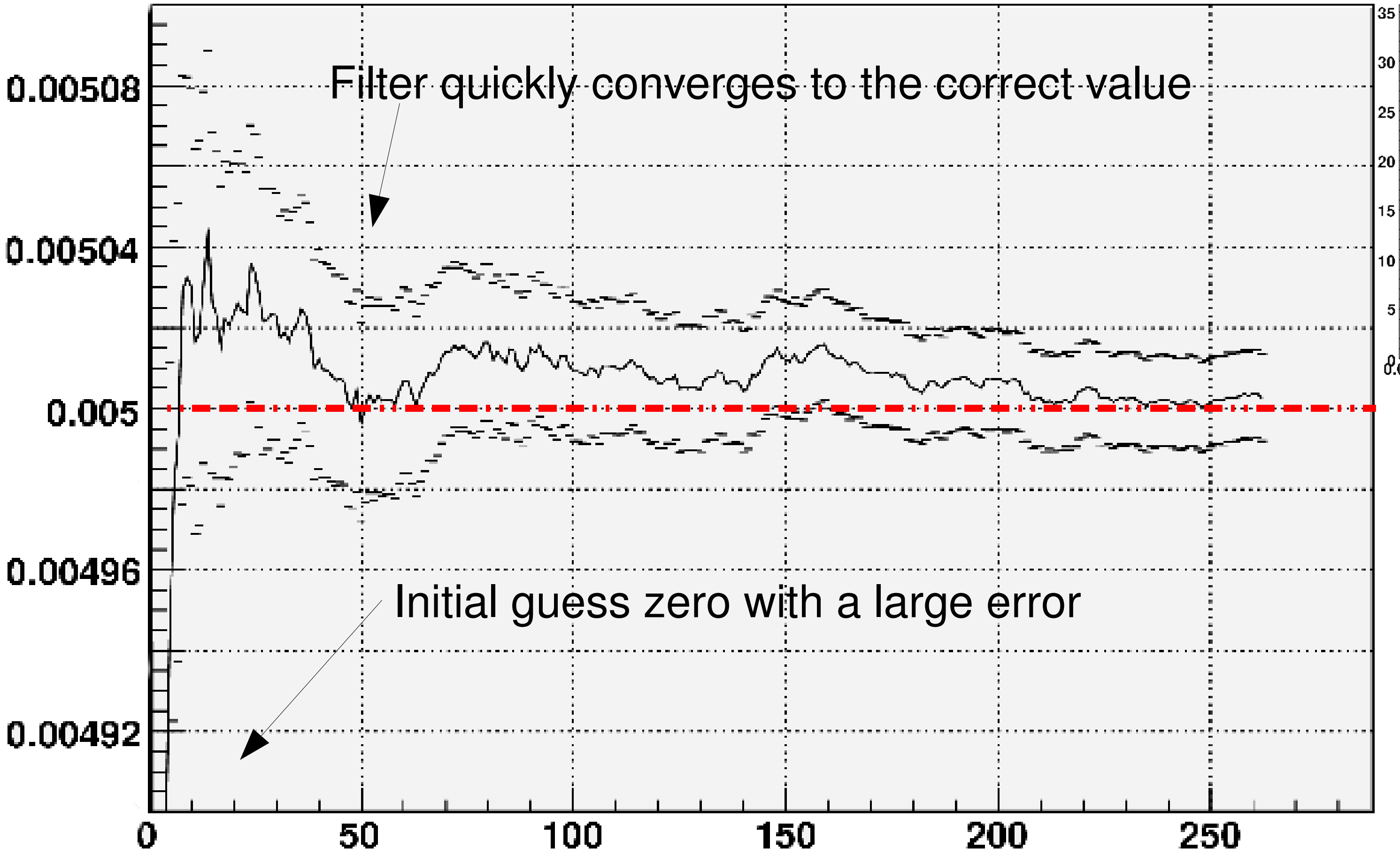
Relative ITS-TPC alignment

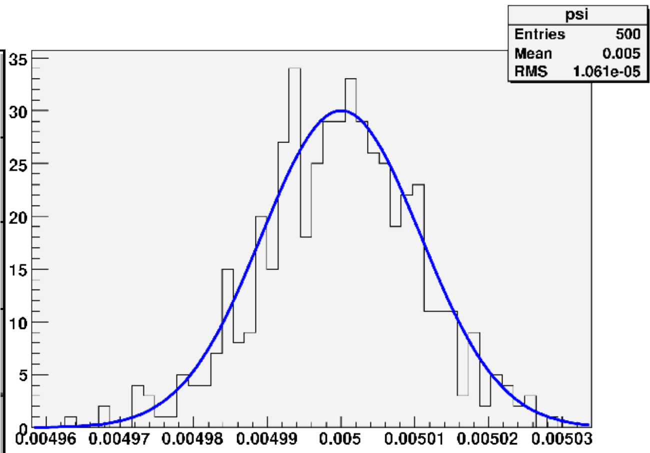
- Tracking in the main tracking devices, the Inner Tracking System (silicone) and the TPC (gaschamber) is independent.
- For good track matching and momentum resolution need to align.
- Why not do it iteratively (on the fly) using a Bayesian-like estimator?
- Kalman filter ideal for the job.



Performance with simulated cosmics

- Example of the convergence of the fit with the number of updates.





Distribution of results for independent datasets

TPC calibration

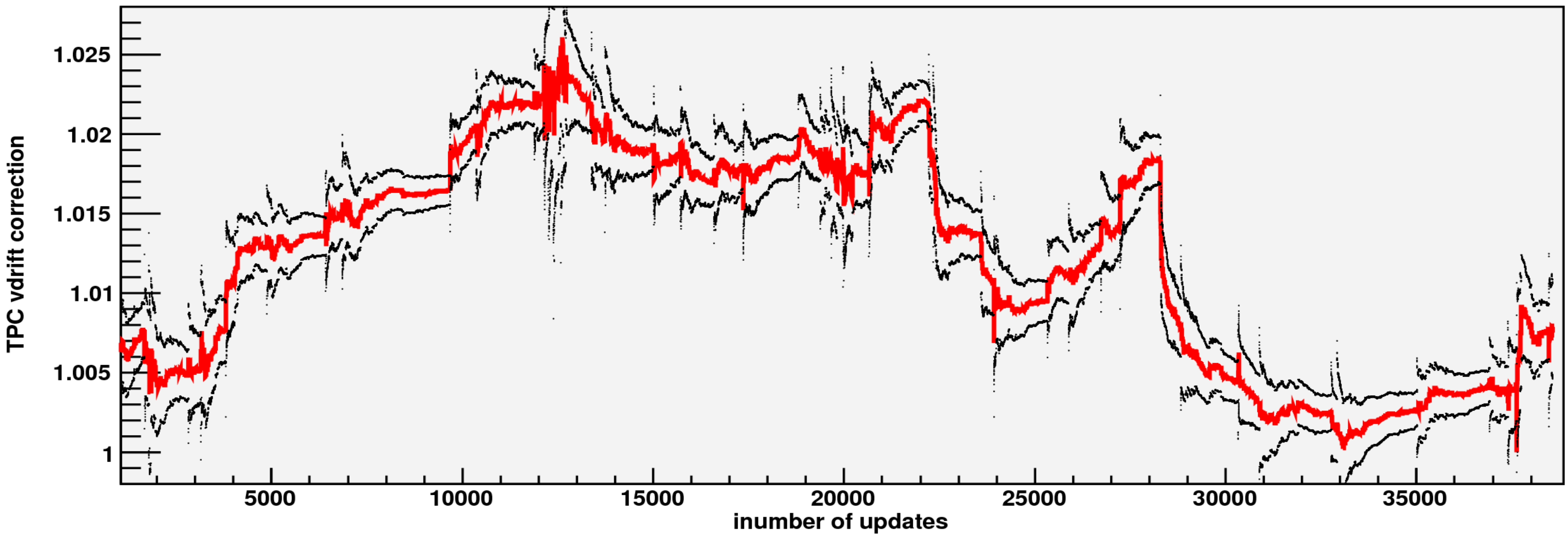
- Relative ITS-TPC alignment procedure is sensitive to TPC calibration (most notably drift velocity and trigger time offset t0).

- Drift velocity is time dependent(ambient pressure, temperature etc.).

- Calibration of TPC is done together with alignment inside the Kalman filter.

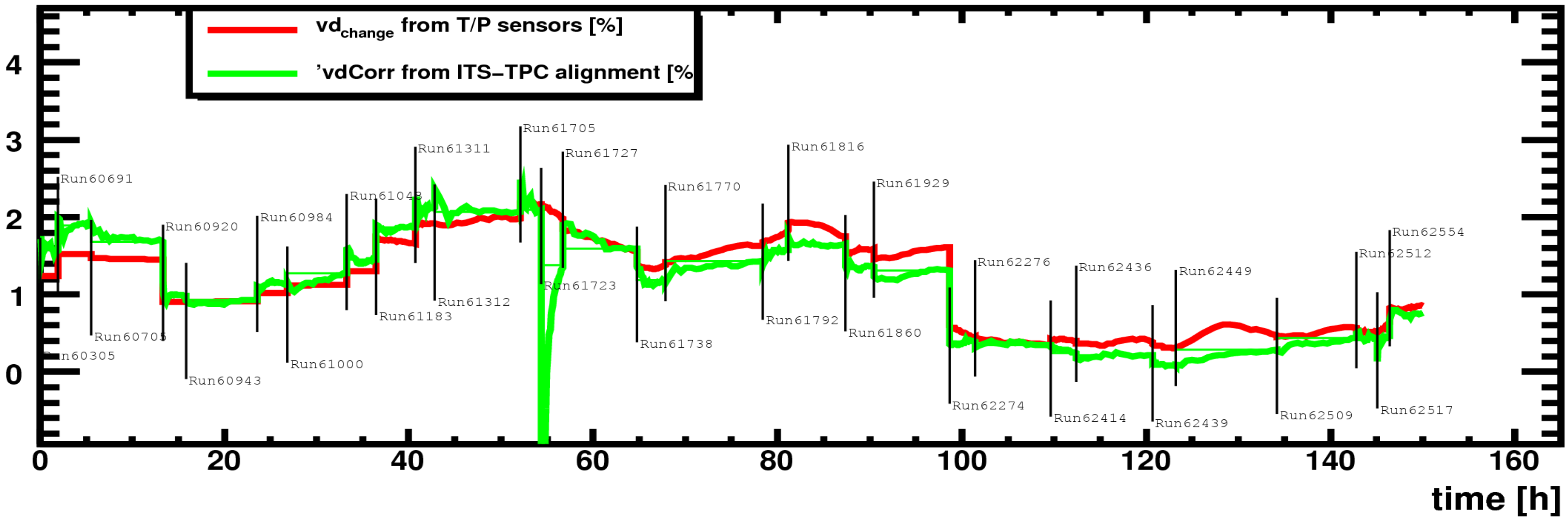
- Kalman filter is fast - we use it to monitor the TPC calibration on the fly during data taking using the full reco chain (prompt offline).

TPC drift velocity calibration



- Time dependence of the TPC drift velocity correction for the analyzed runs.
- Varies from run to run as expected due to (mostly) pressure changes
- Variations are ~2% - means a few centimeters of apparent shift

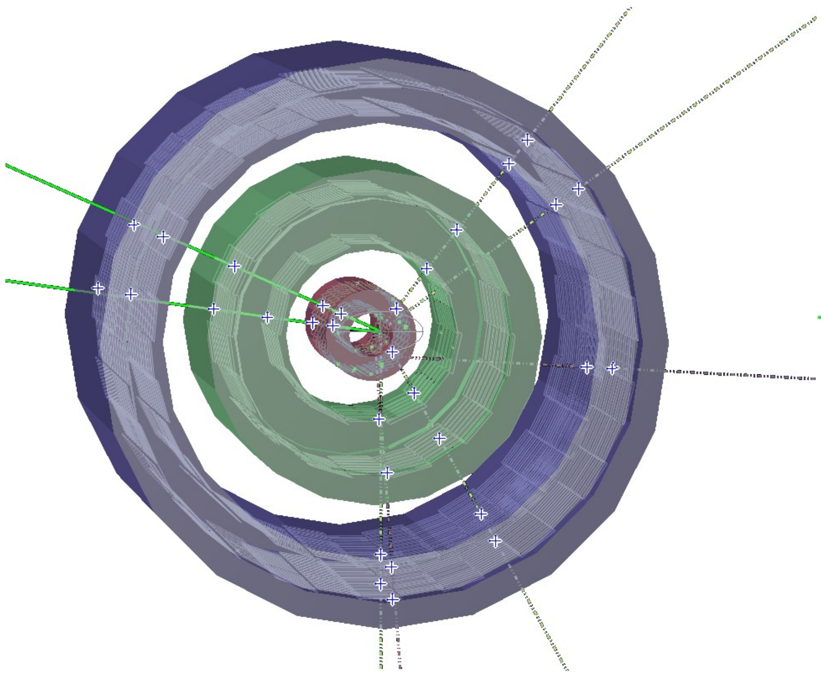
TPC calibration check

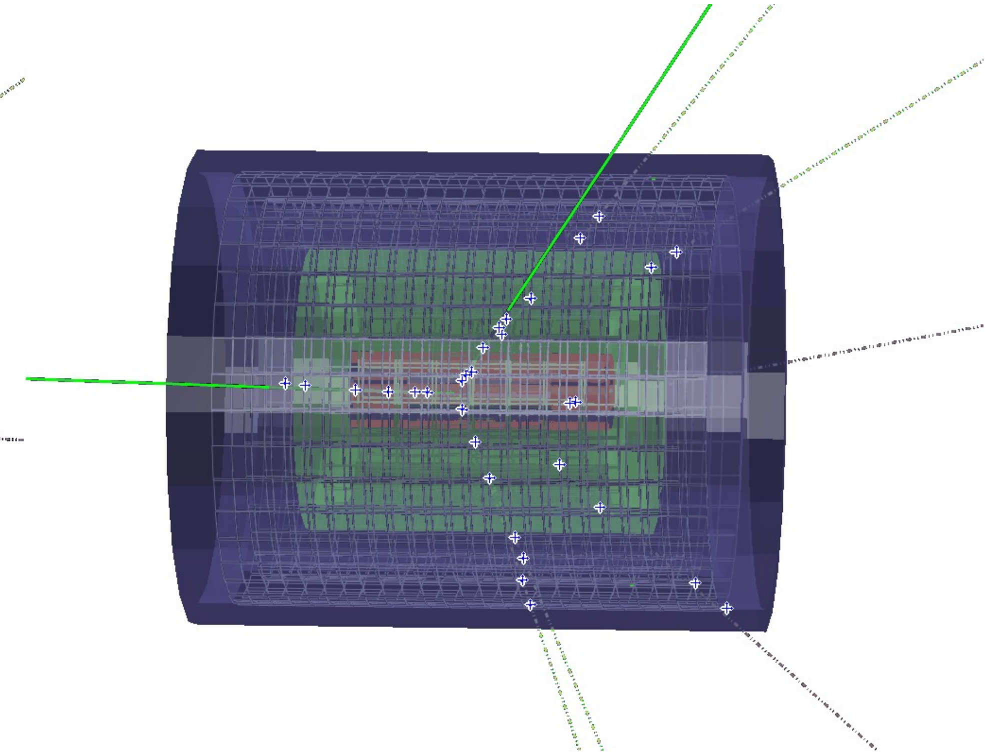


- Drift velocity ~ density ~ T/p.
- Red curve is T/p from sensor data.
- Green curve is the velocity correction from tracks.
- Gas composition not taken into account.

Backup

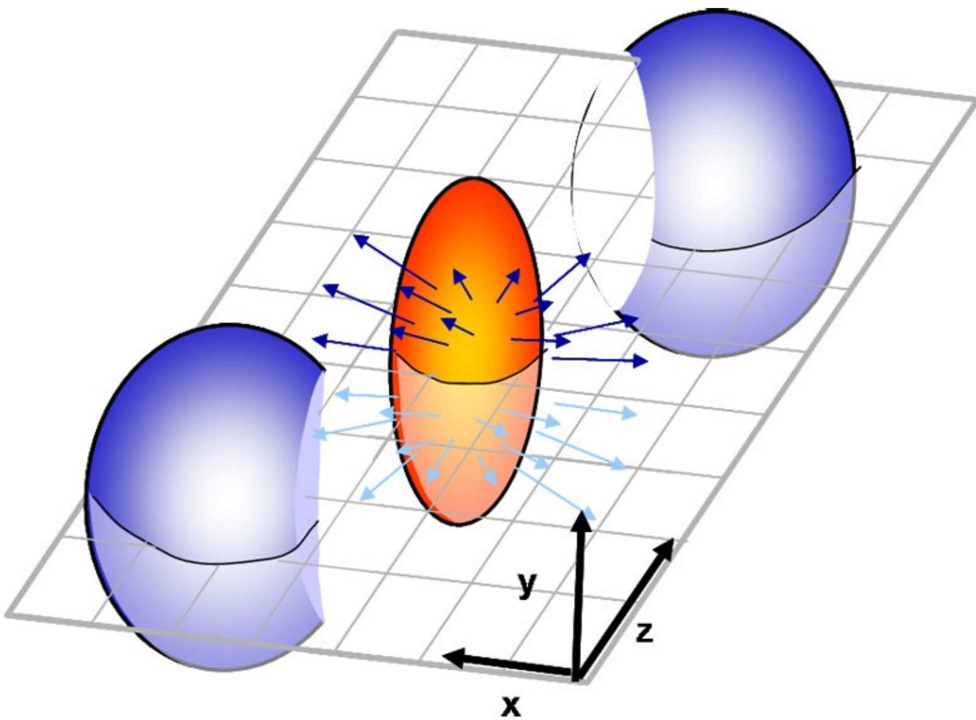
First “collision”



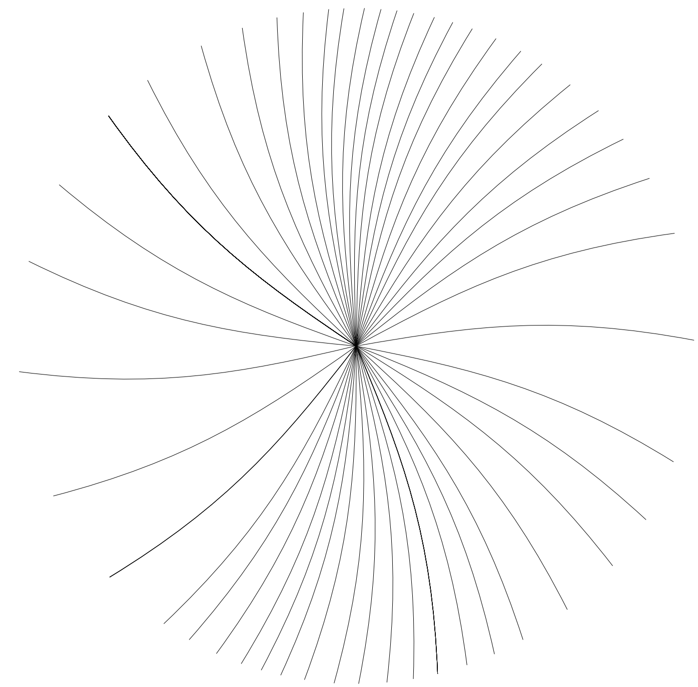


- Beam 2 was circulated for a while in the night 11/12 September without full collimation, the halo collided with the material in the Inner Tracking System.

Flow



Underlying event



Observation
(charged particles)