



# ALICE experiment at CERN

Virtual Visit

Tapan Nayak  
26 February 2021



# CERN



**“Science without borders”**



27 km circumference  
~ 100 m underground  
Design Energy:  
14 TeV (pp), 5.5 TeV (Pb-Pb)

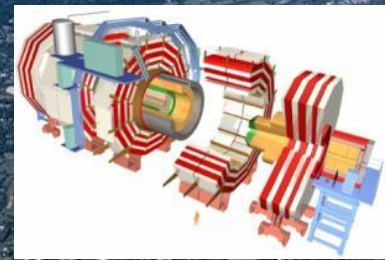


# World's Most Powerful Accelerator: The Large Hadron Collider



Lake Geneva

Jura mountains



**CMS**

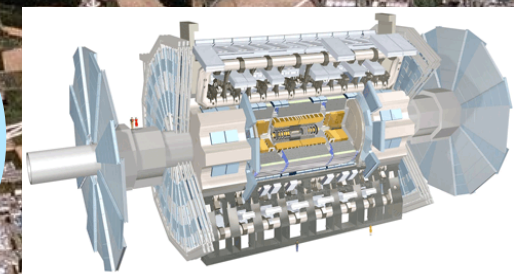


**LHCb**

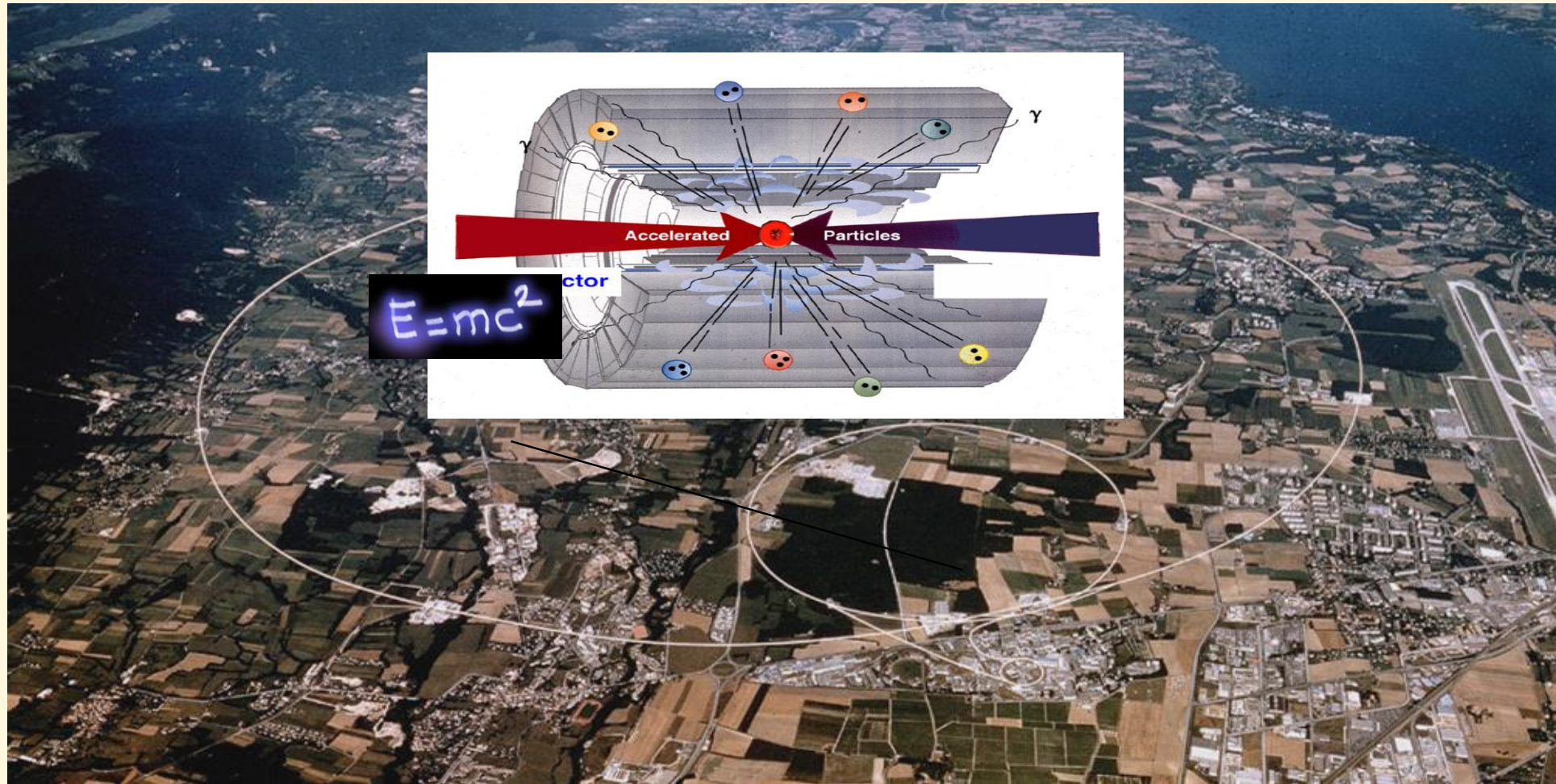
**ATLAS**



**ALICE**



# Experiments: The principle



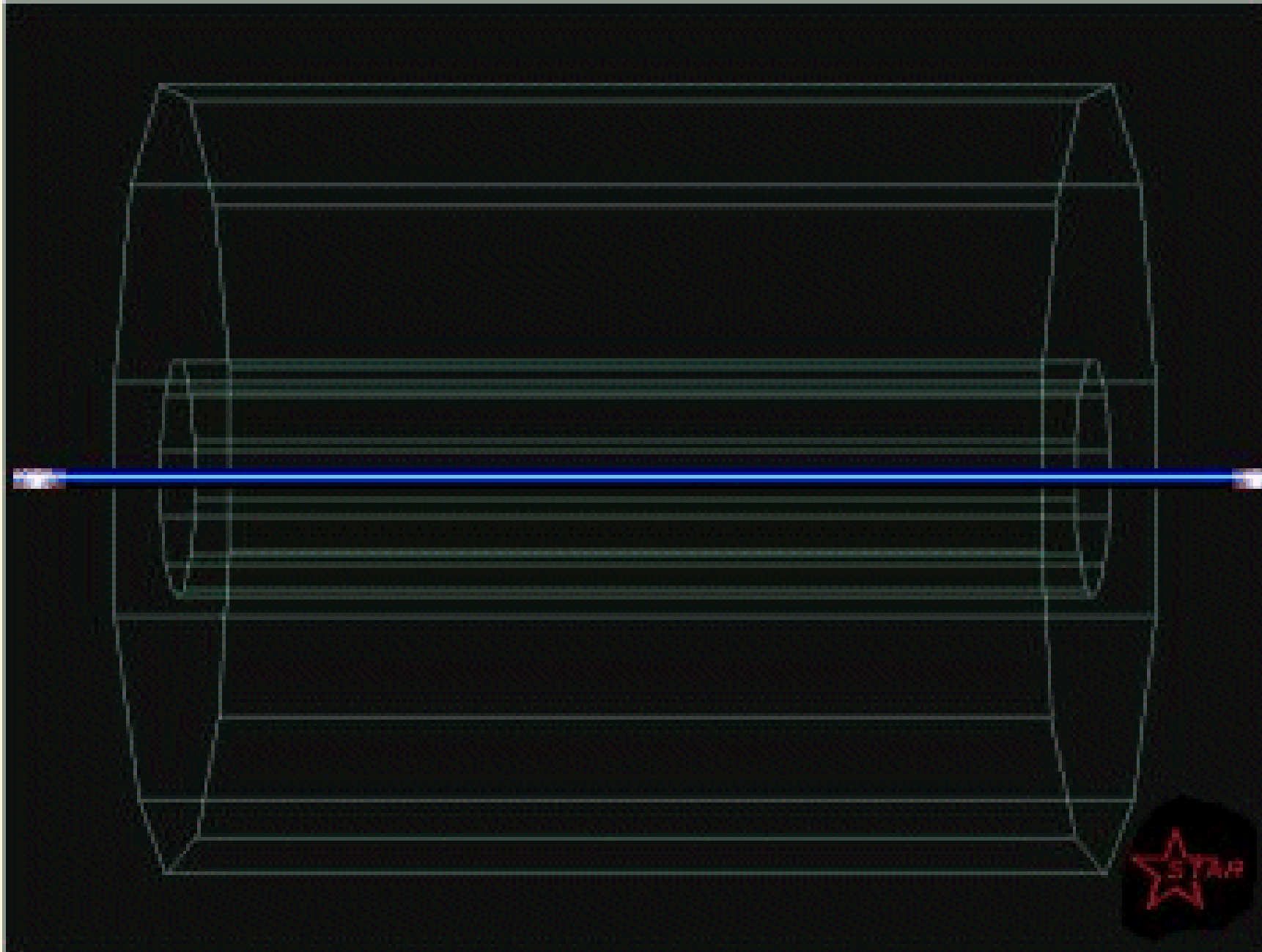
Accelerate Particles,

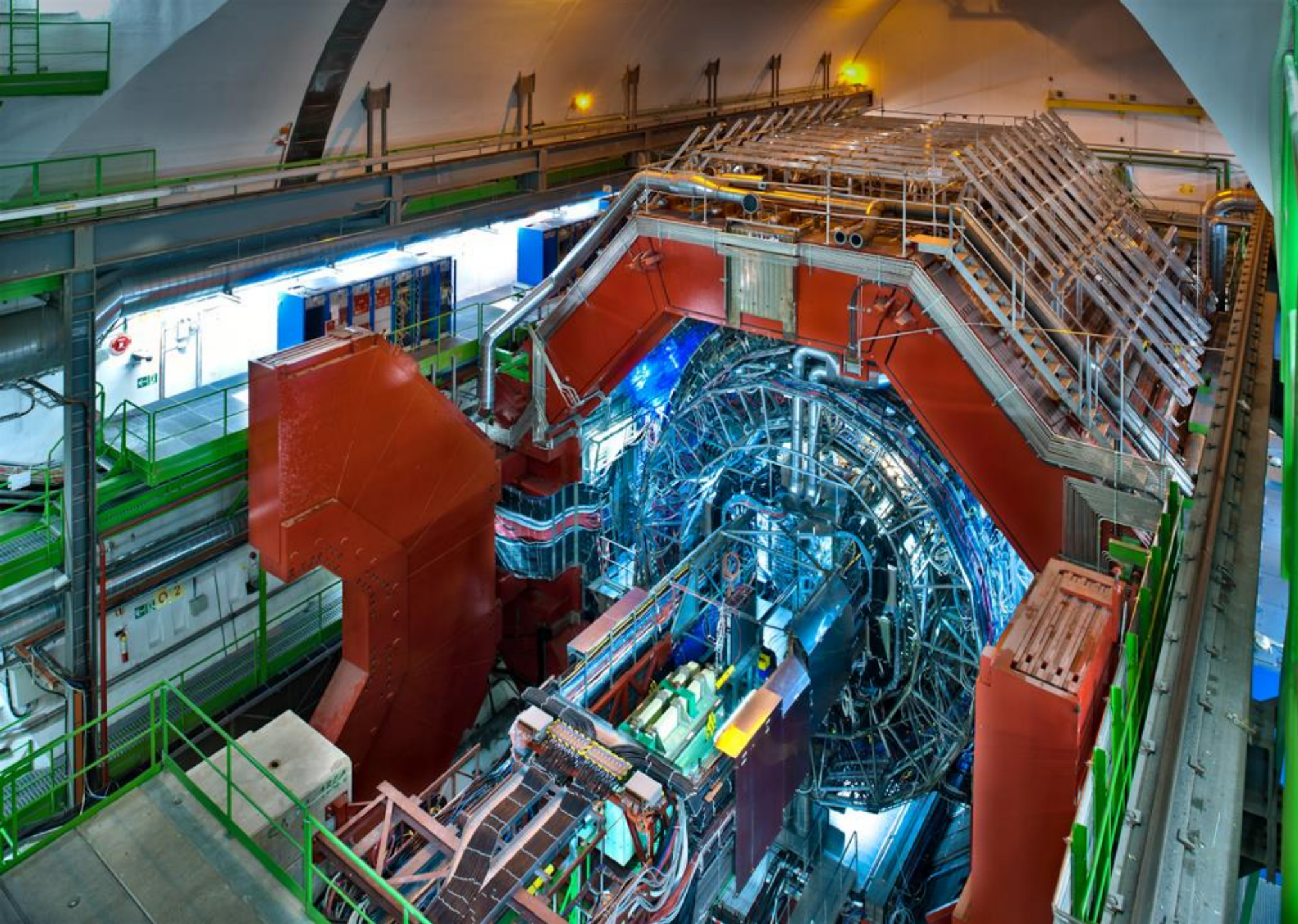
Get them to Collide

Detect the particles produced and store the data

Huge  
technological  
challenges

# Heavy-ion collisions: creating Quark-gluon Plasma



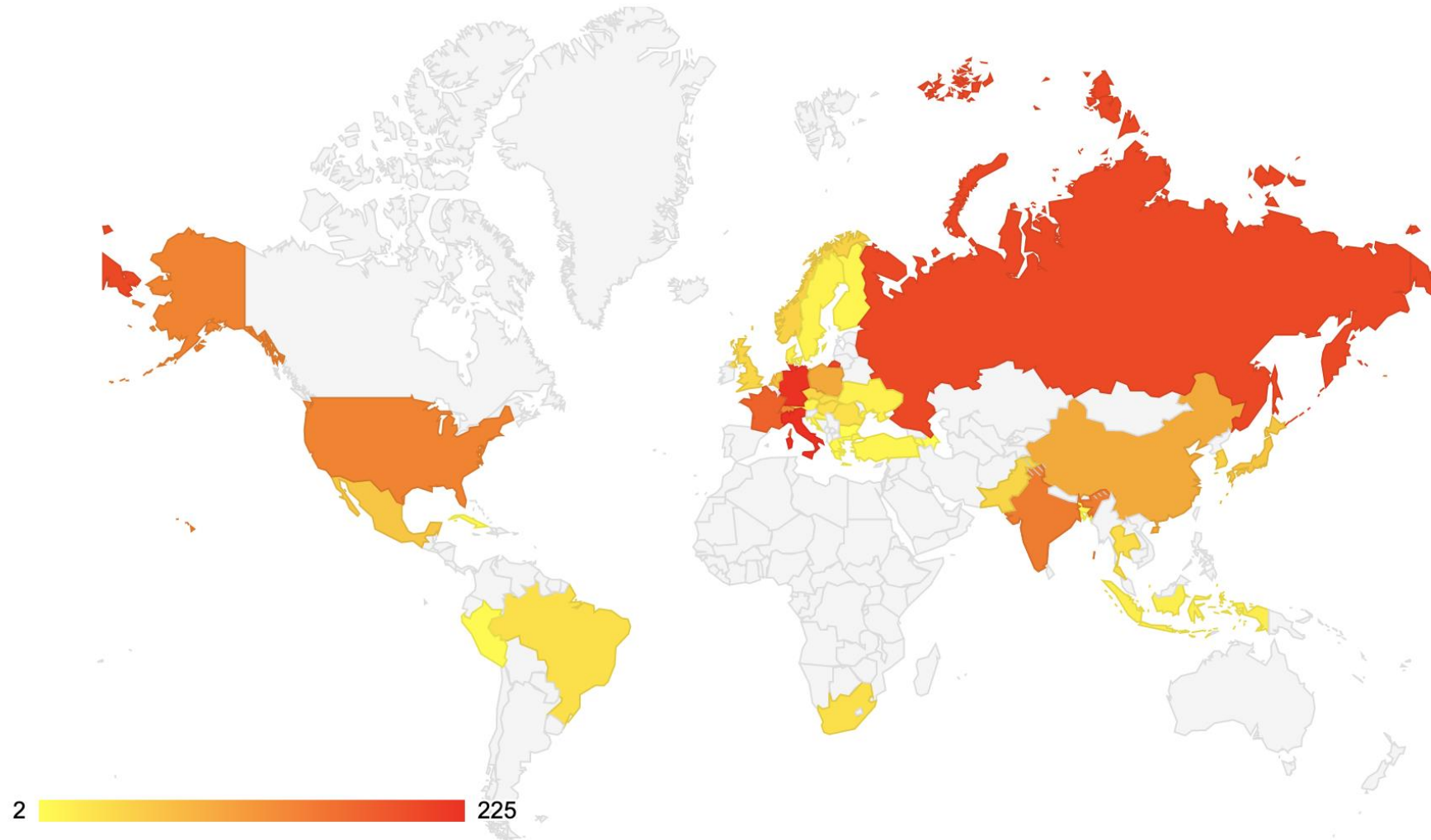


## ALICE at Point-2 of the LHC

- Excellent track and vertex reconstruction capabilities in high multiplicity environment over a wide  $p_T$  range
- Particle identification over a wide momentum range

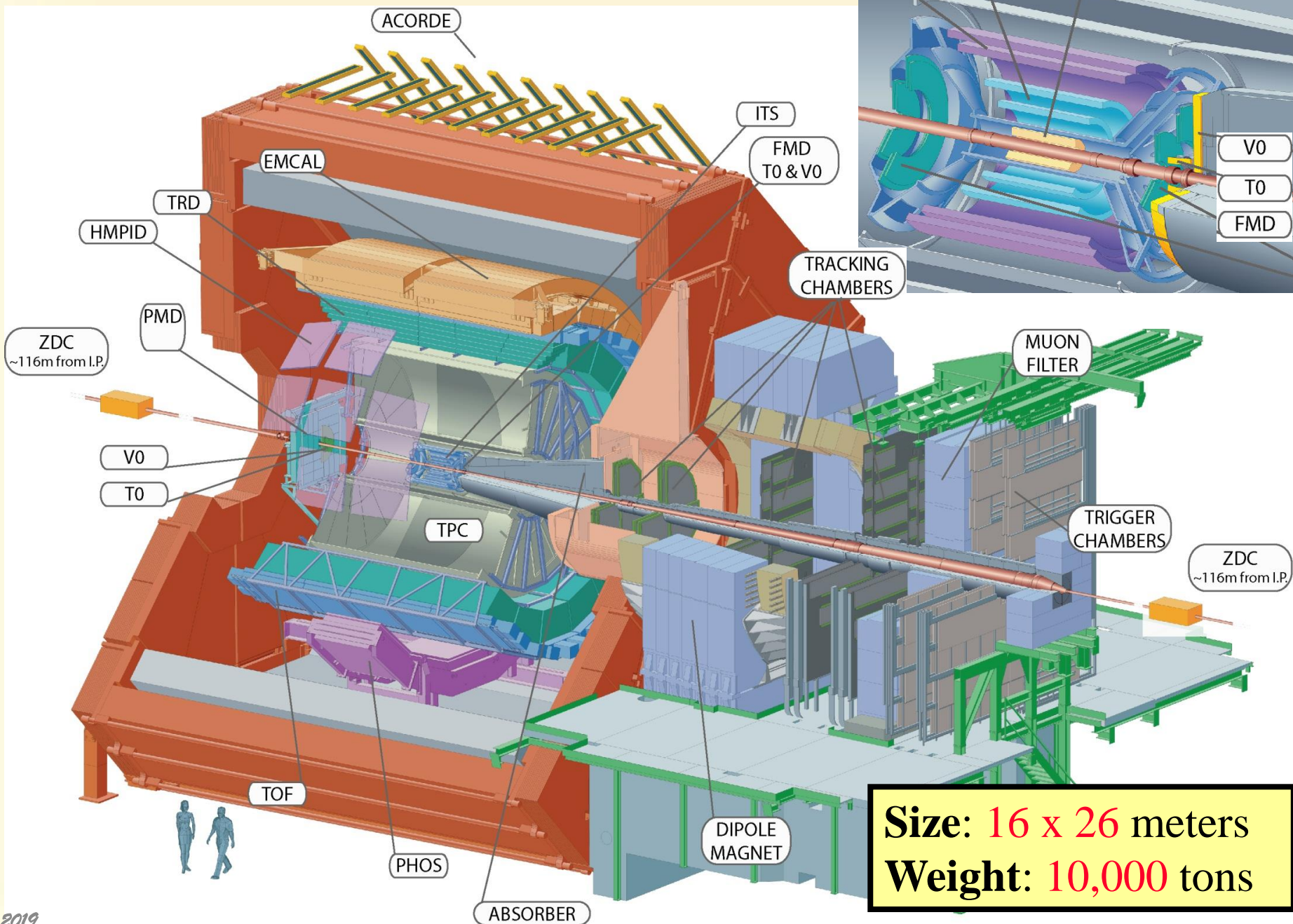
# ALICE Collaboration

39 countries, 175 institutes, 1939 members



# The ALICE detector

Till 2018



## CENTRAL BARREL

- Acceptance:  $|\eta| < 0.9$
- $B = 0.5$  T
- **ITS**: High precision vertexing and centrality
- **ITS+TPC+TOF**: charged track reconstruction, PID
- **TRD**: electron ID
- **EMCAL**: calorimeter

Muon Arm:  
 $-4 < \eta < -2.5$

## SPECIAL detectors:

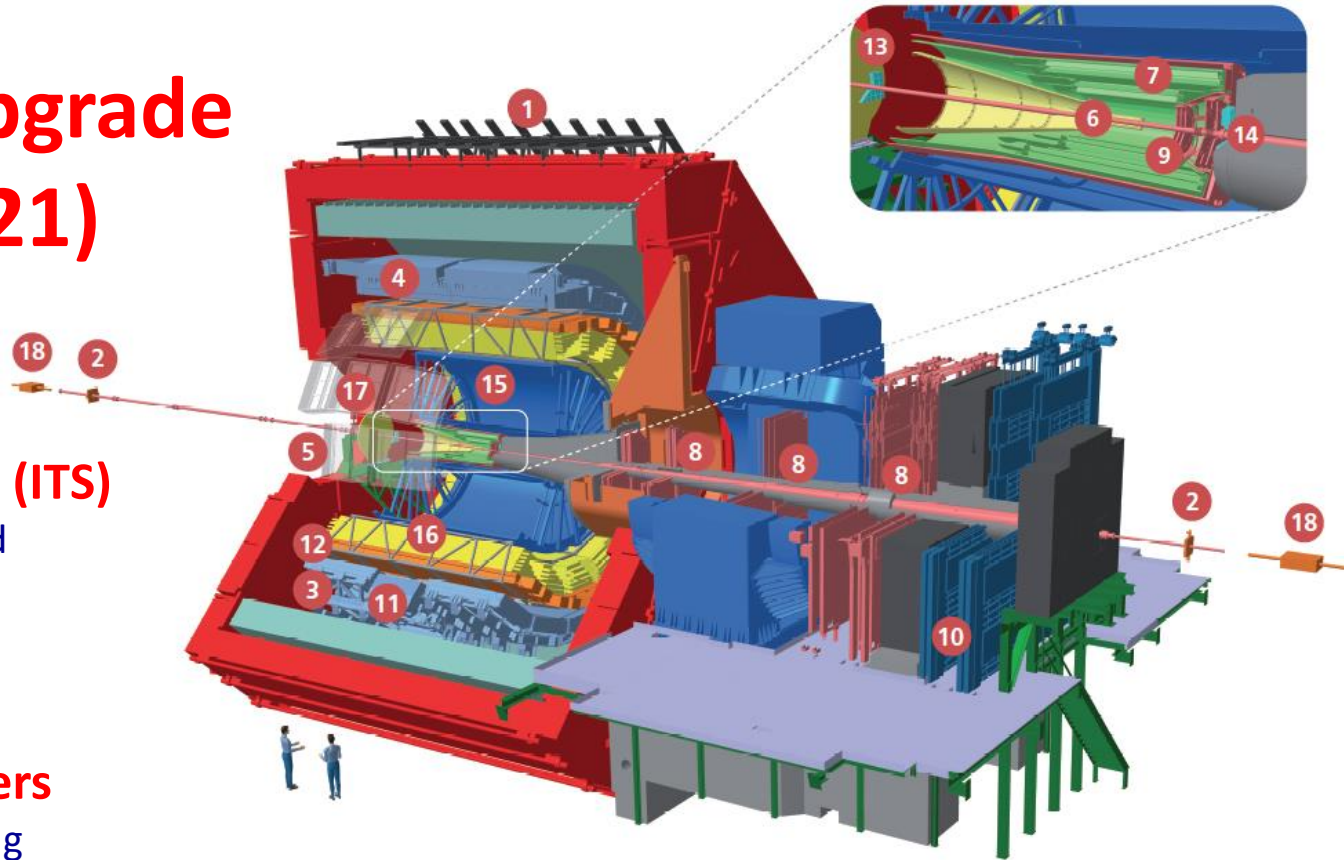
- V0
- FMD
- PMD
- ADC
- ZDC

**Size:** 16 x 26 meters  
**Weight:** 10,000 tons





# ALICE LS2 Upgrade (2019-2021)



- 1 ACORDE | ALICE Cosmic Rays Detector
- 2 AD | ALICE Diffractive Detector
- 3 DCal | Di-jet Calorimeter
- 4 EMCal | Electromagnetic Calorimeter
- 5 HMPID | High Momentum Particle Identification Detector
- 6 ITS-IB | Inner Tracking System - Inner Barrel
- 7 ITS-OB | Inner Tracking System - Outer Barrel
- 8 MCH | Muon Tracking Chambers
- 9 MFT | Muon Forward Tracker
- 10 MID | Muon Identifier
- 11 PHOS / CPV | Photon Spectrometer
- 12 TOF | Time Of Flight
- 13 T0+A | Tzero + A
- 14 T0+C | Tzero + C
- 15 TPC | Time Projection Chamber
- 16 TRD | Transition Radiation Detector
- 17 V0+ | Vzero + Detector
- 18 ZDC | Zero Degree Calorimeter

## New Inner Tacking System (ITS)

- MAPS technology: improved resolution
- Less material,
- Faster readout

## New TPC Readout Chambers

- New readout chambers using 4-GEM technology
- New electronics for continuous readout (SAMPA)

## New Forward Muon Tracker (MFT)

- Vertex tracker at forward rapidity

## Muon Arm

- New electronics (SAMPA)
- New electronics for Muon Trigger

## Online Offline (O2) system

- new computing facility
- on line tracking & data compression
- 50kHz Pb-Pb event rate

## Common Projects:

- Common Readout Unit (CRU)
- SAMPA common FE chip

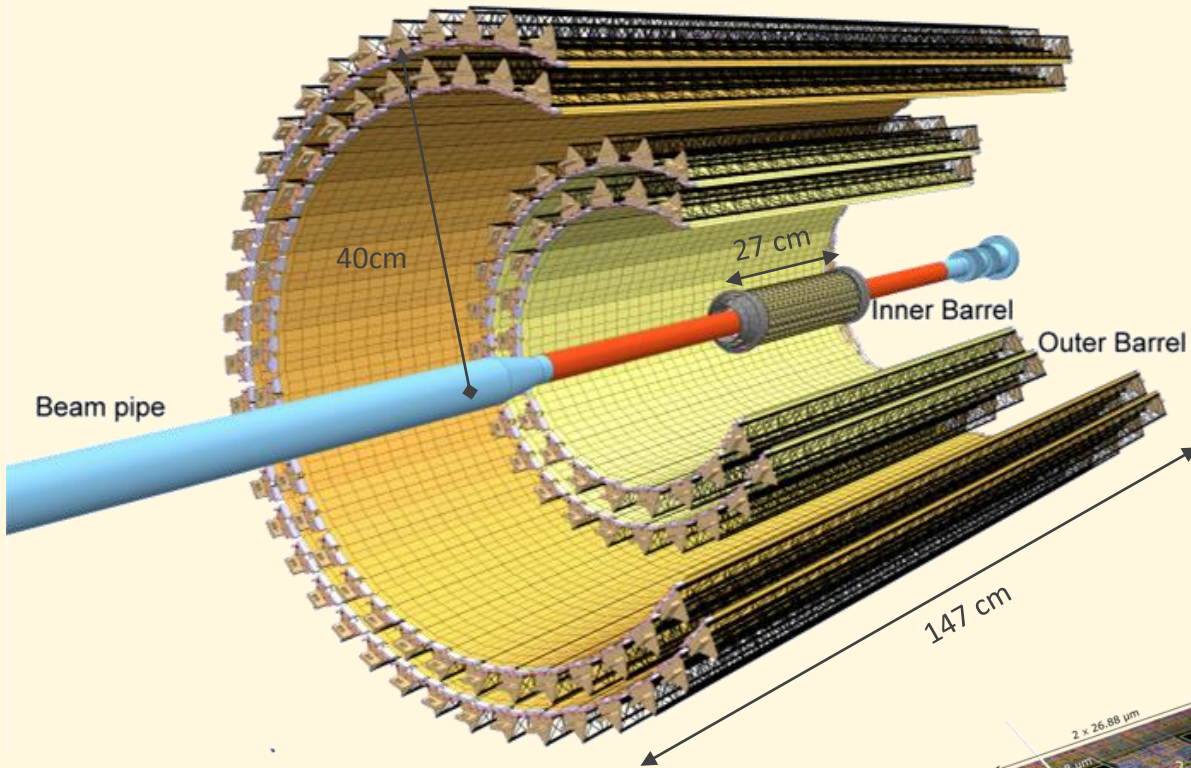
## New Trigger Detectors (FIT, AD)

- + centrality, event plane

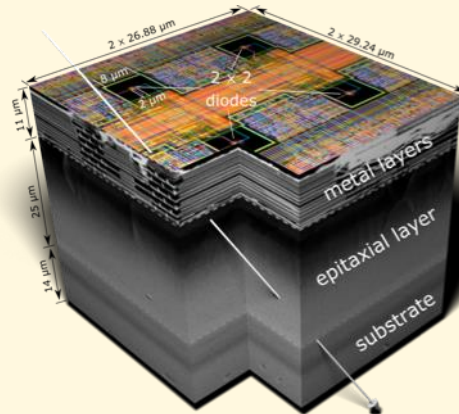
## New Central Trigger Processor (CTP)

Upgraded readout for TOF, TRD, PHOS, EMCAL, CPV, HMPID

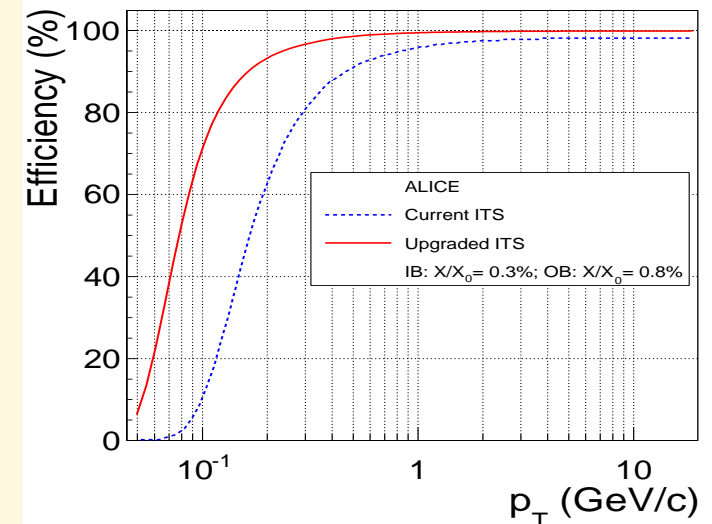
# ITS Upgrade



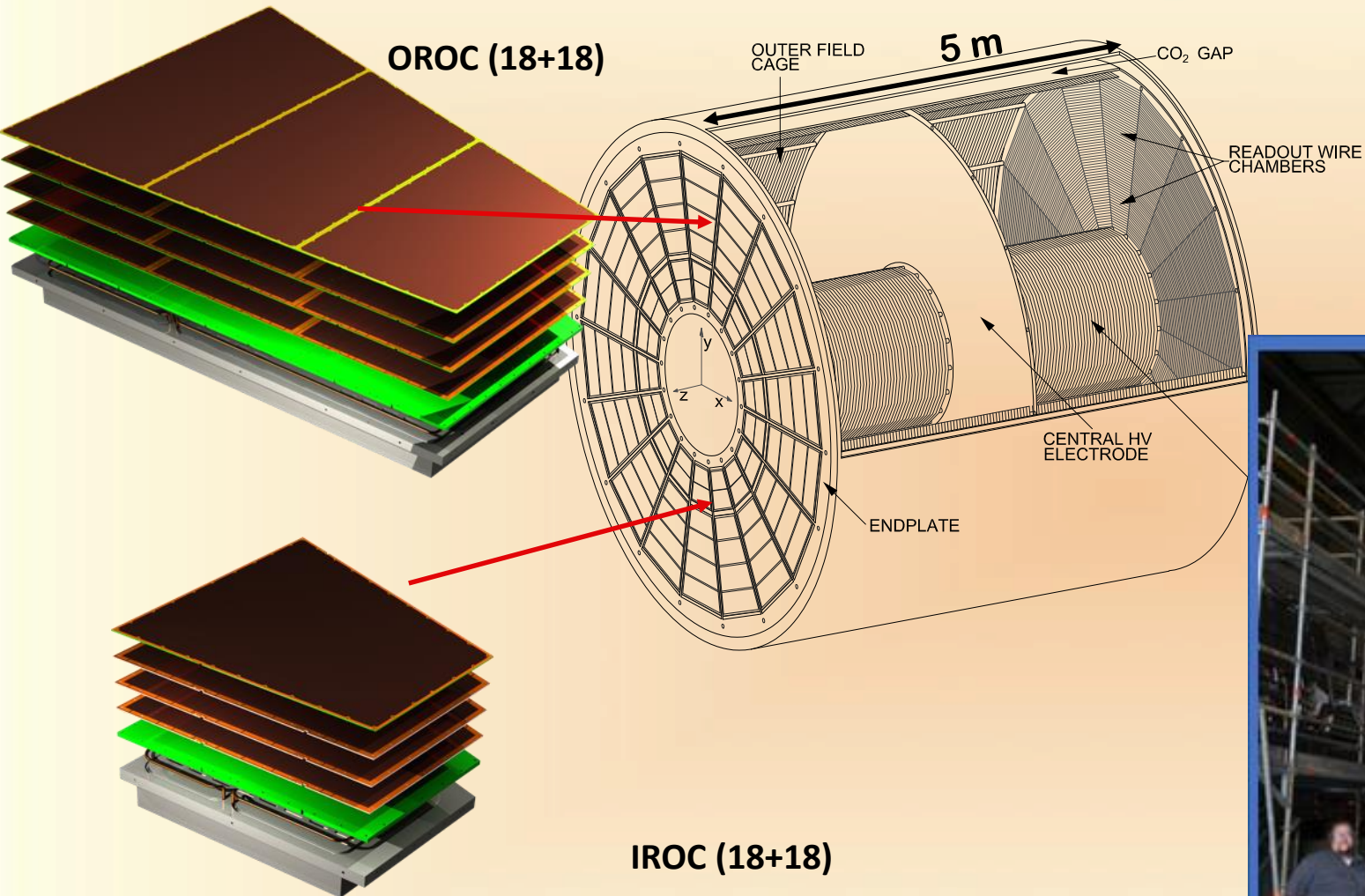
Based on CMOS Monolithic Active Pixel Sensors (MAPS)



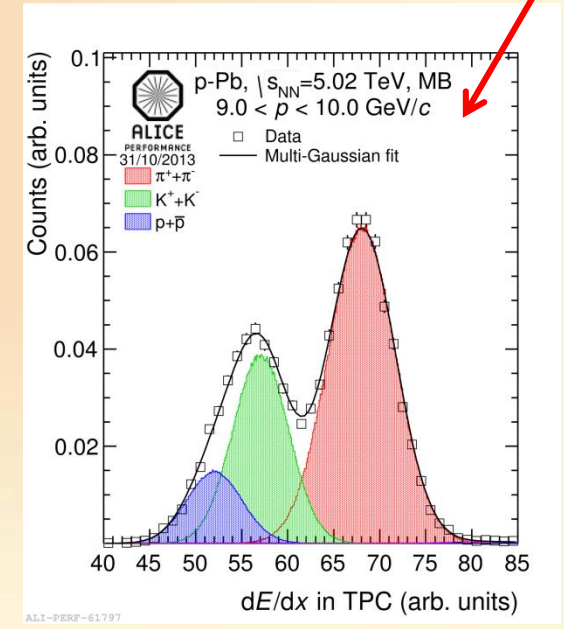
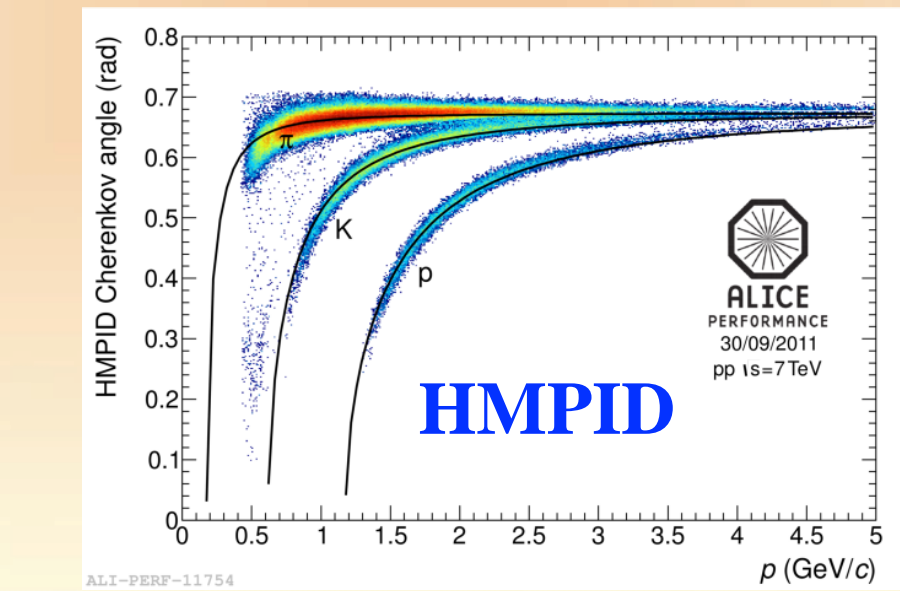
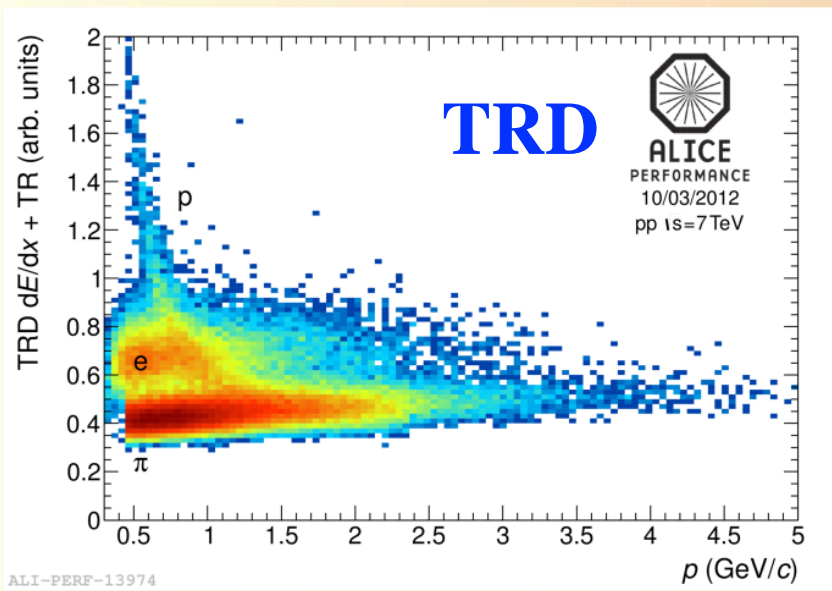
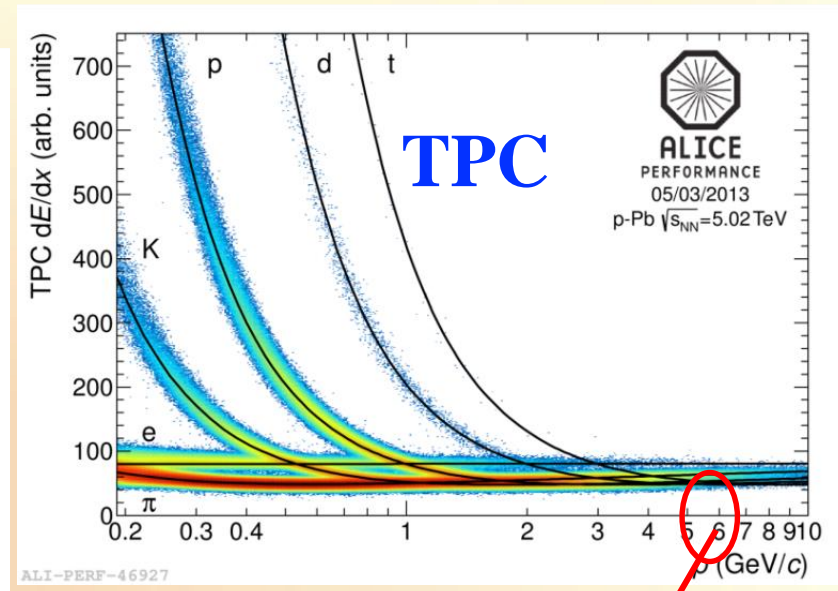
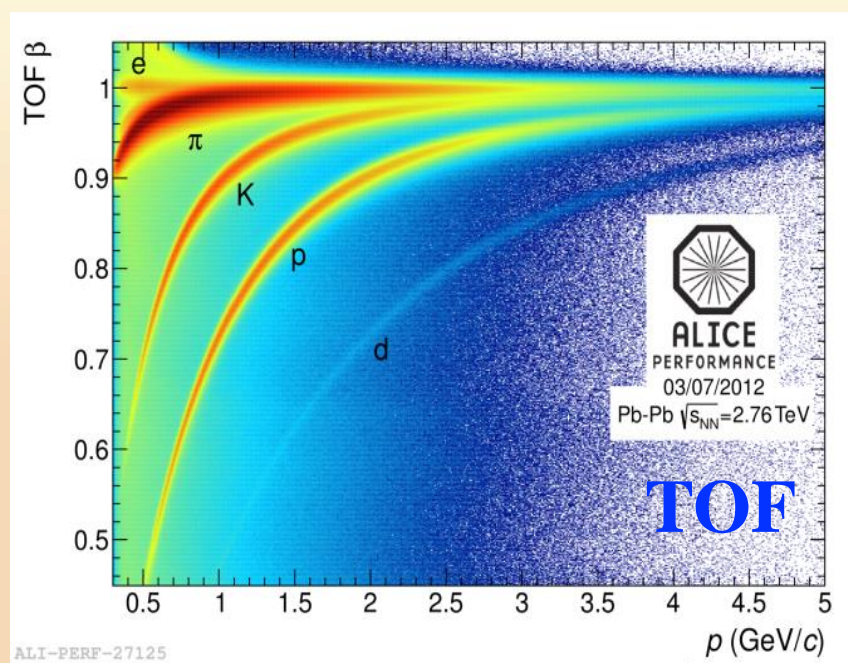
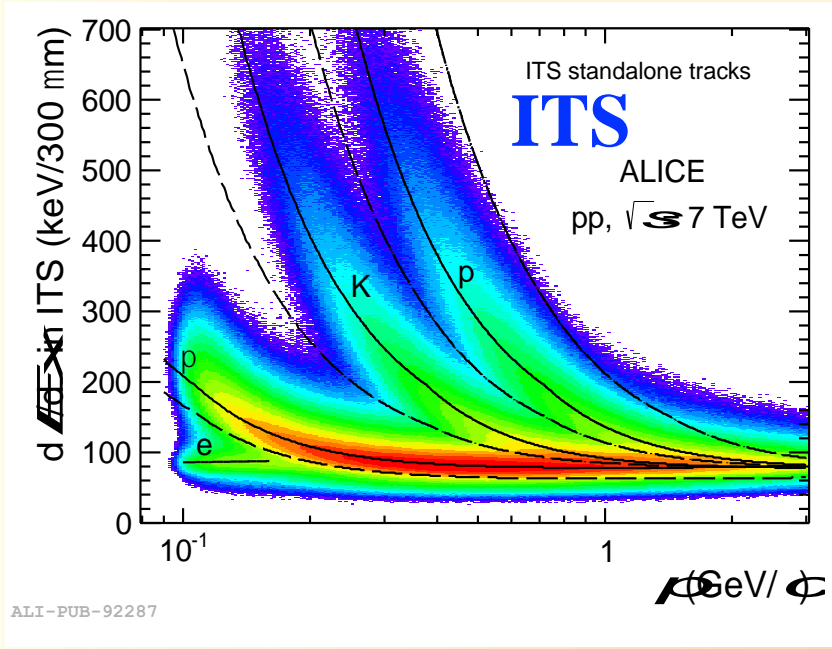
- 7-layer geometry (23 – 400mm),  $|\eta| \leq 1.5$
- 10 m<sup>2</sup> active silicon area (**12.5 G-pixels**)
- Pixel pitch 28 x 28 μm<sup>2</sup>
- Spatial resolution ~5μm
- Power density < 40mW / cm<sup>2</sup>
- Material thickness: ~0.3% / layer (IB)
- Maximum particle rate: 100 MHz / cm<sup>2</sup>

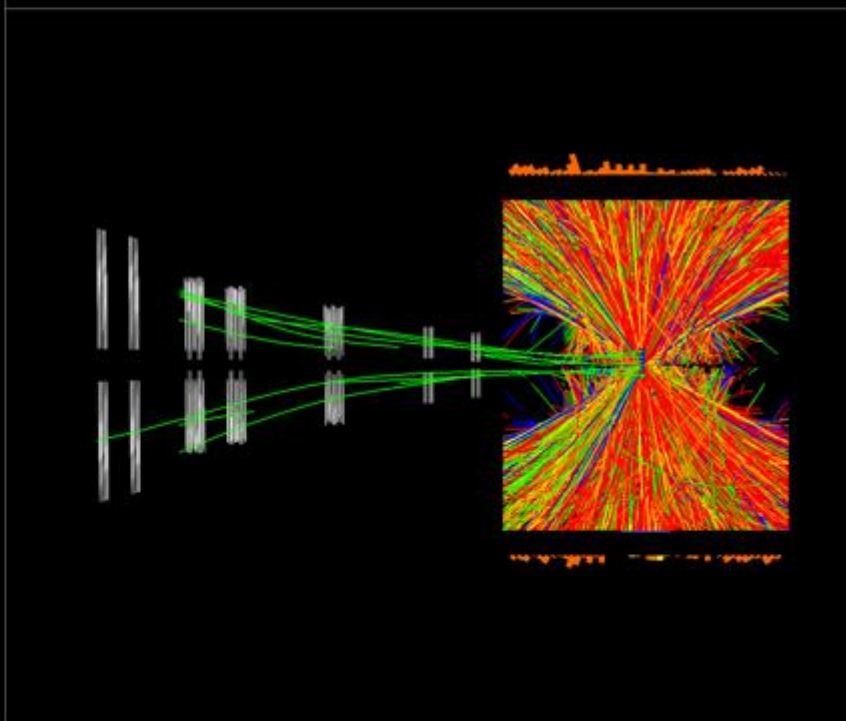
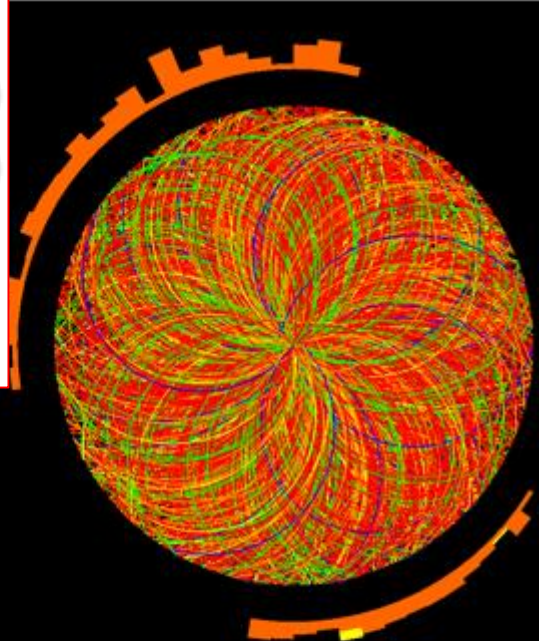
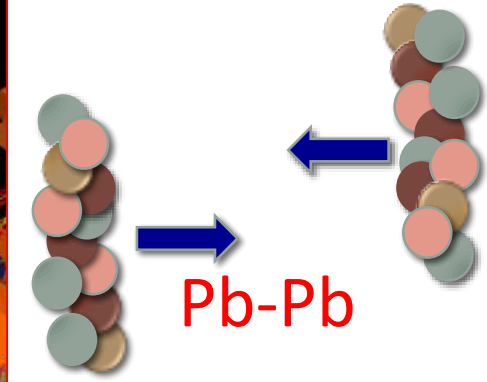
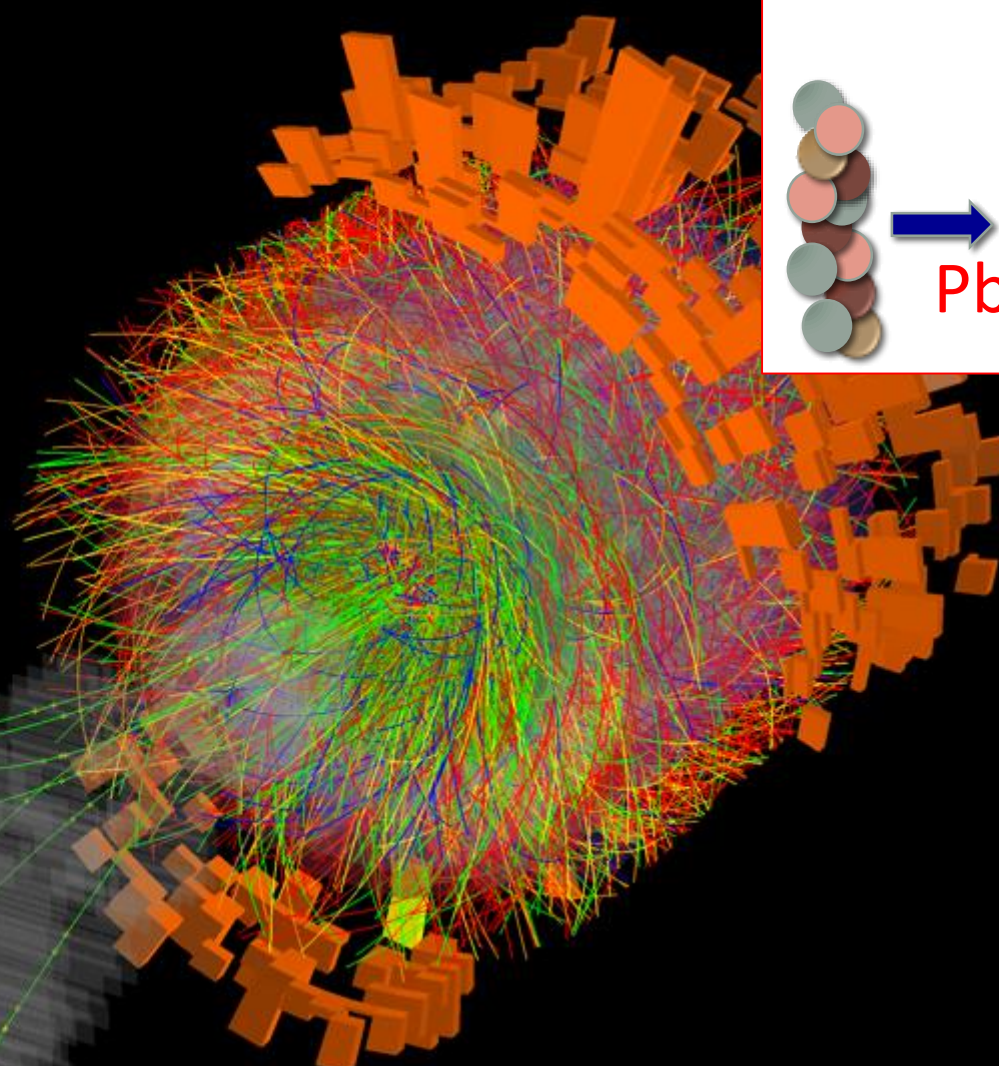


# Time Projection Chamber



# ALICE performance





# Pb-Pb at 5.02 TeV: One PeV Collision

Run:244918  
Timestamp:2015-11-25 11:25:36(UTC)  
System: Pb-Pb  
Energy: 5.02 TeV

# Reconstructing the collision

## What has just happened?

- What particles were created?
- Where were they produced?
- What were the parent particles?

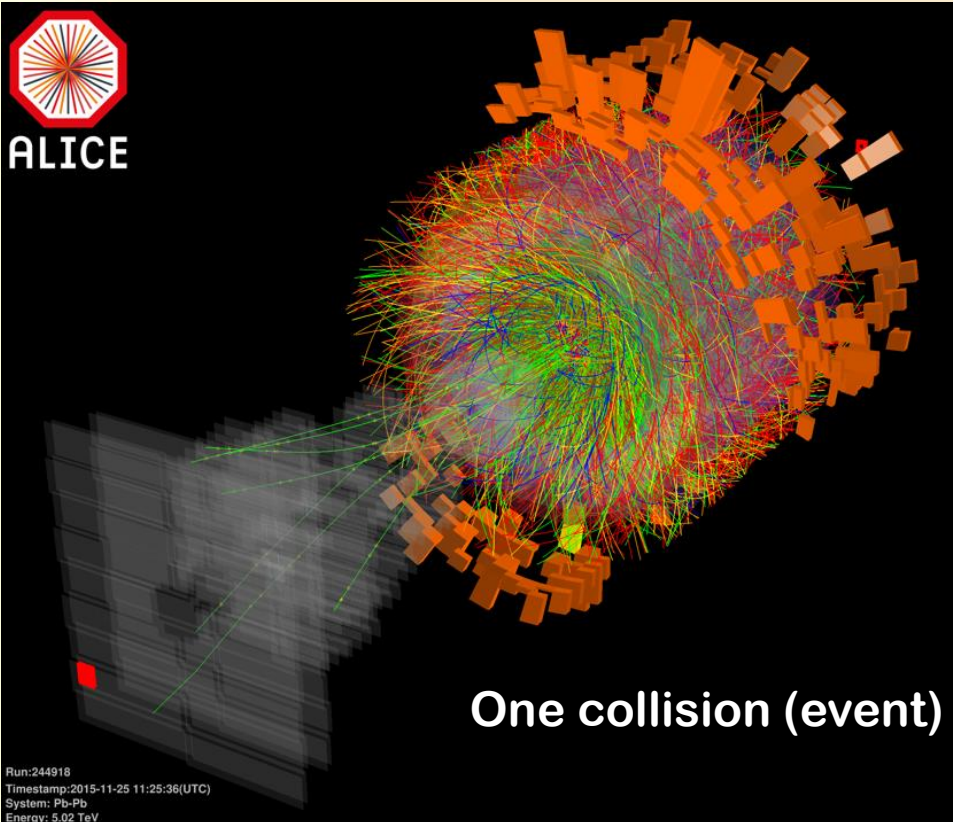
## => Online (live):

- Online data quality monitoring, calibrations.
- Using Triggers to keep events of interest and sends to storage.

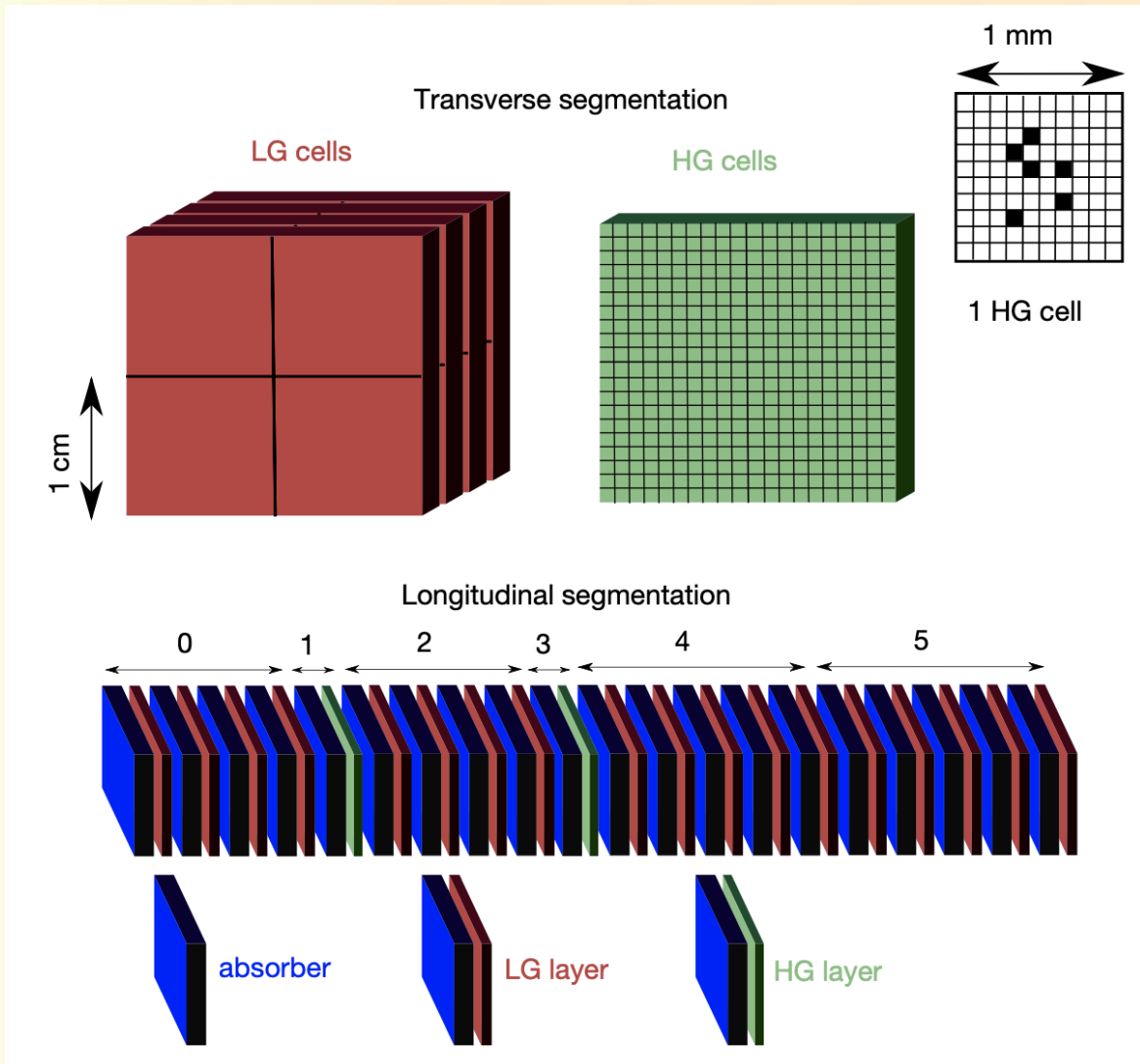
## => Offline: Event reconstruction:

- Vertexing
- Tracking
- Particle identification of each of the tracks

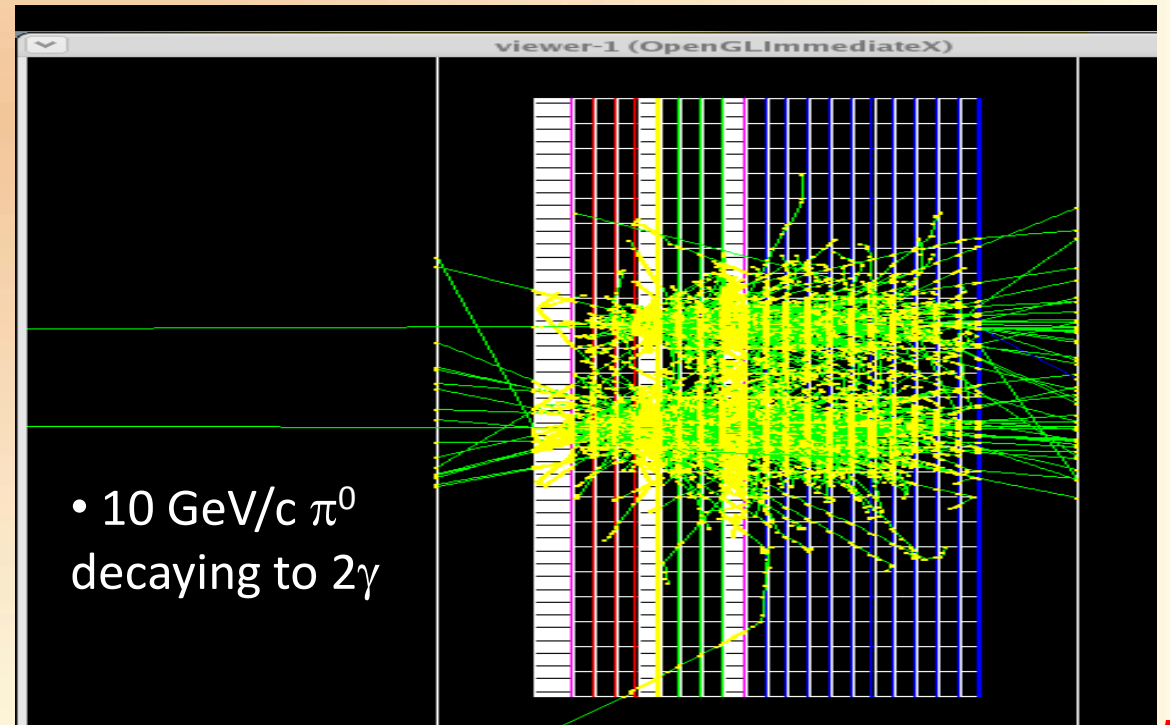
- The data flow from ALICE during Run2 was about 4 GB/second
- The data expected during next run (Run3) will be 3 TB/second



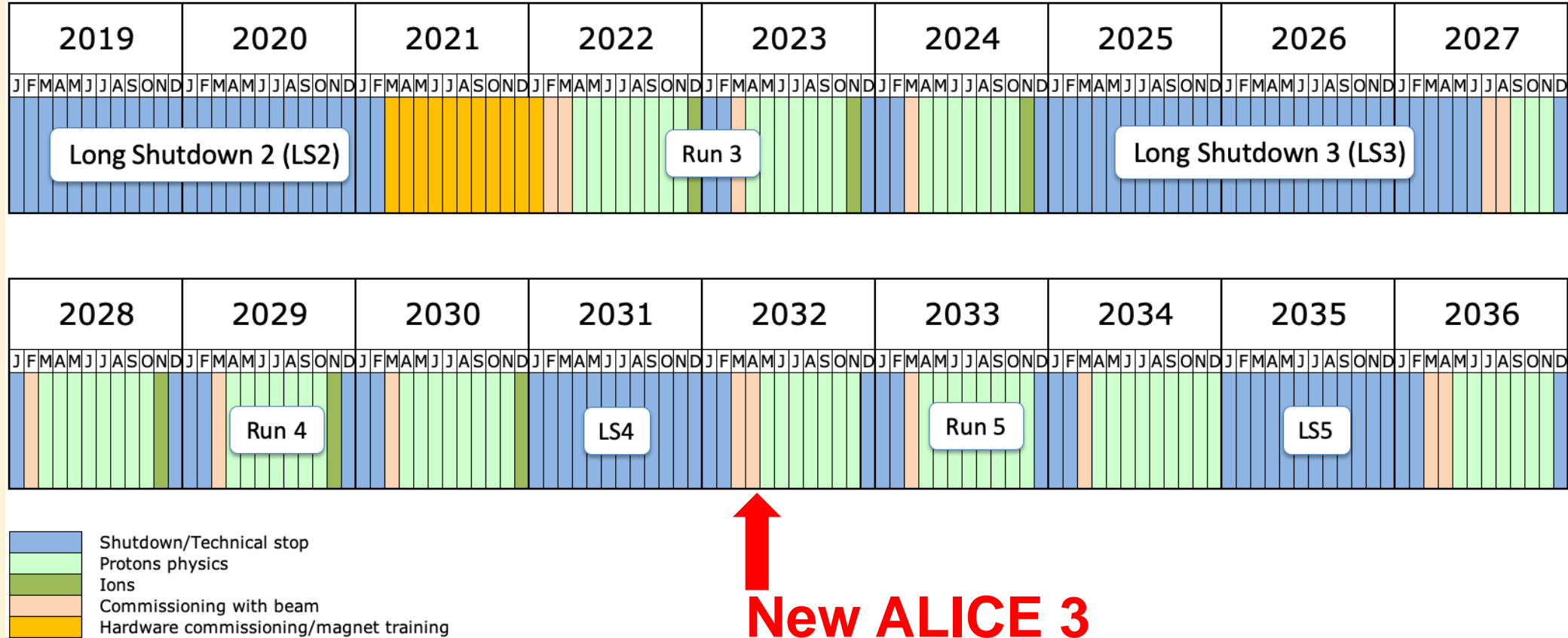
# A Forward Calorimeter (FoCal)



- ✓ Sensivite Medium:
  - Silicon Pad: 1 cm<sup>2</sup>
  - Silicon Pixel: 1 mm<sup>2</sup>
- ✓ Absorber: Tungsten



# Large Hadron Collider: Timeline (tentative)







# ALICE at Point-2 of the LHC

