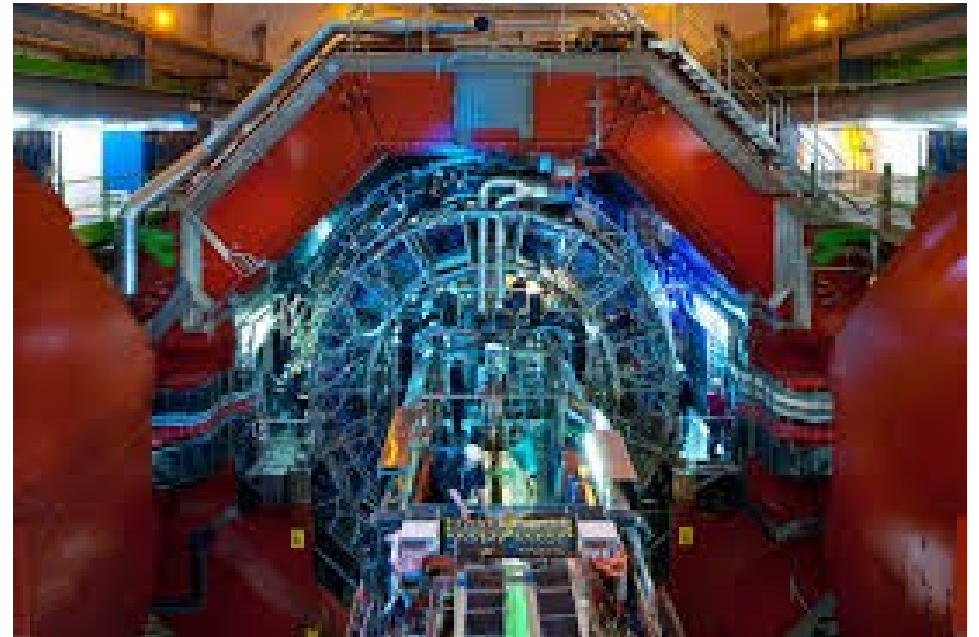




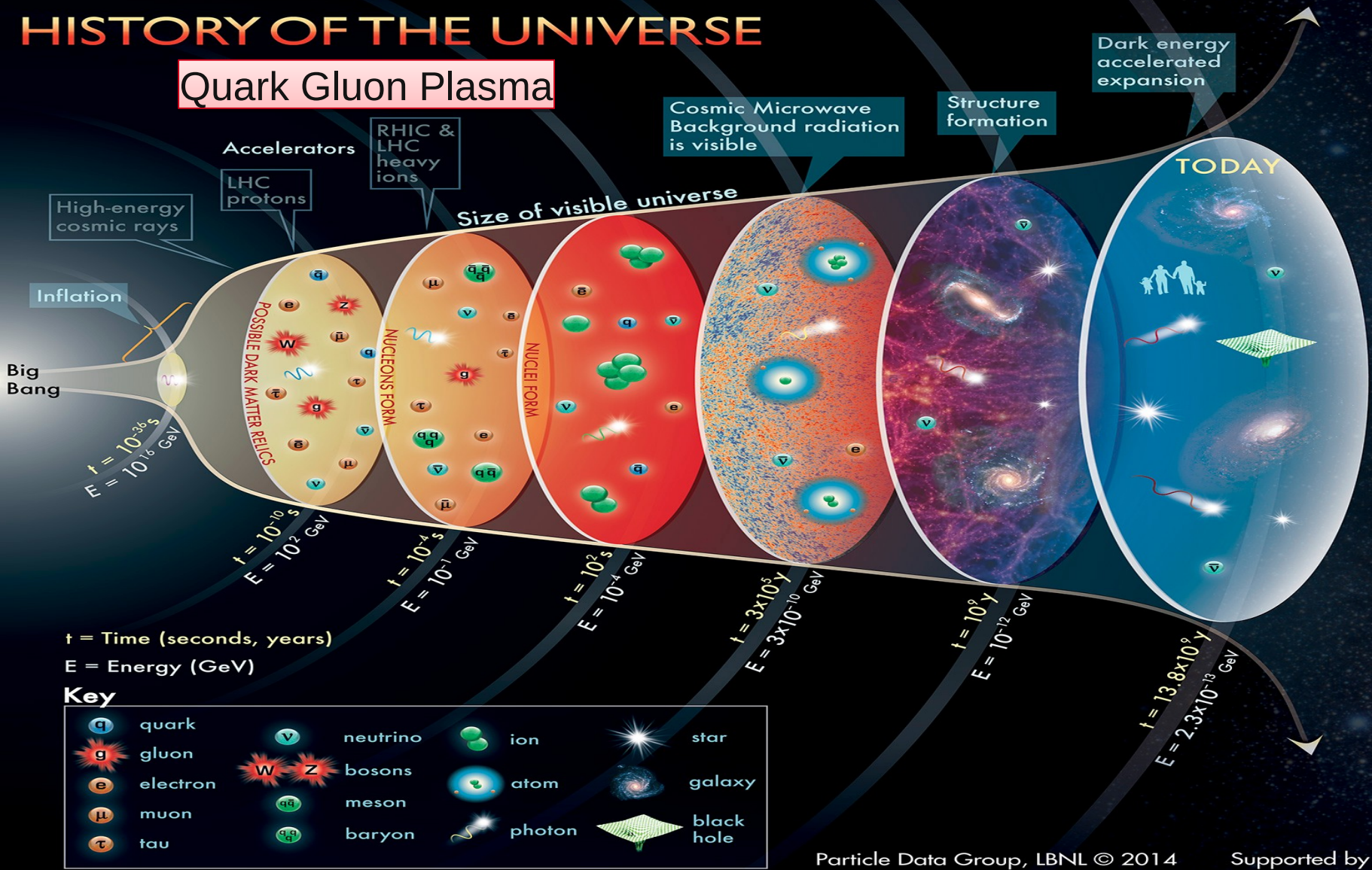
**ALICE**



Florian Bury

# HISTORY OF THE UNIVERSE

## Quark Gluon Plasma

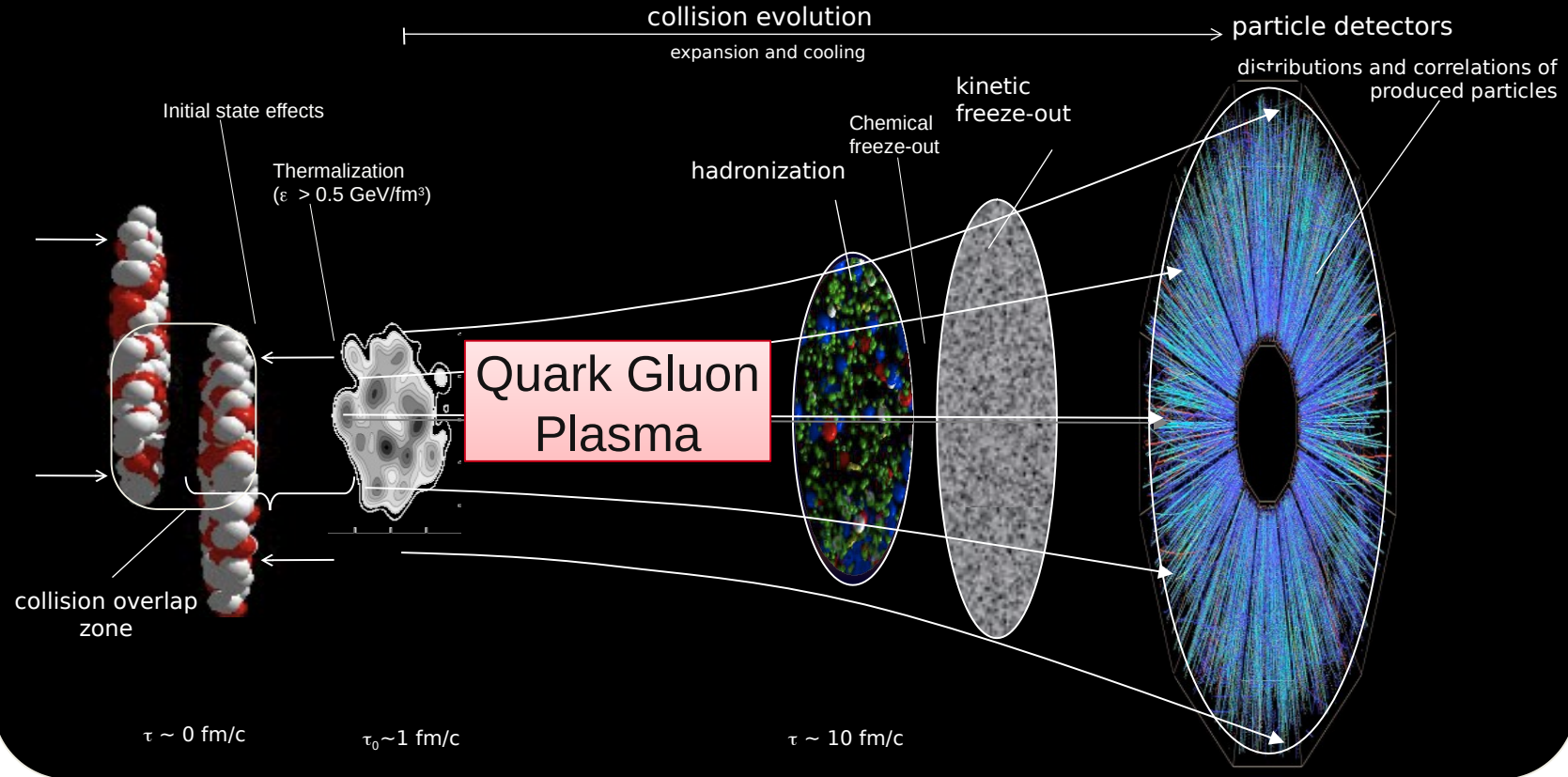


t = Time (seconds, years)  
E = Energy (GeV)

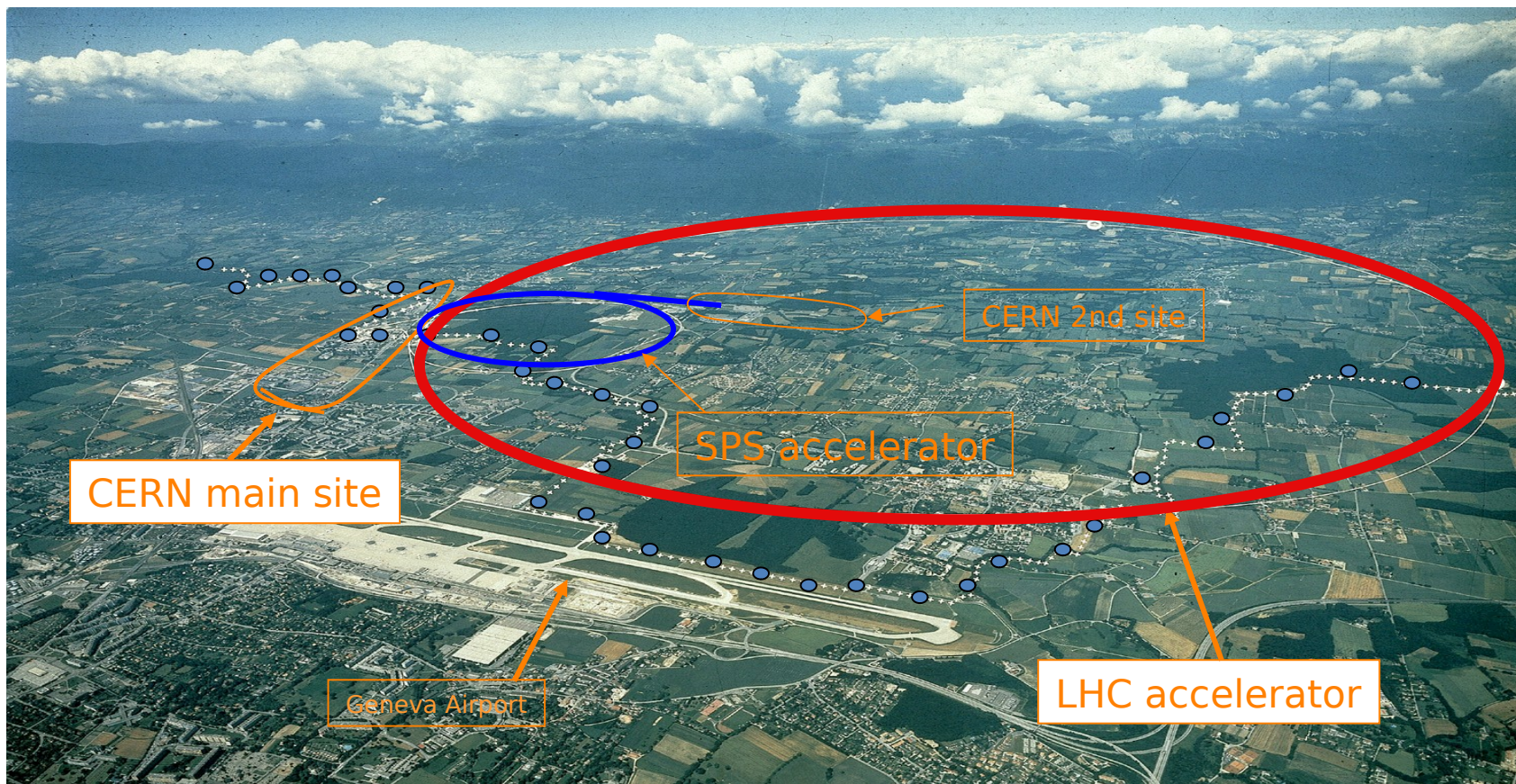
### Key

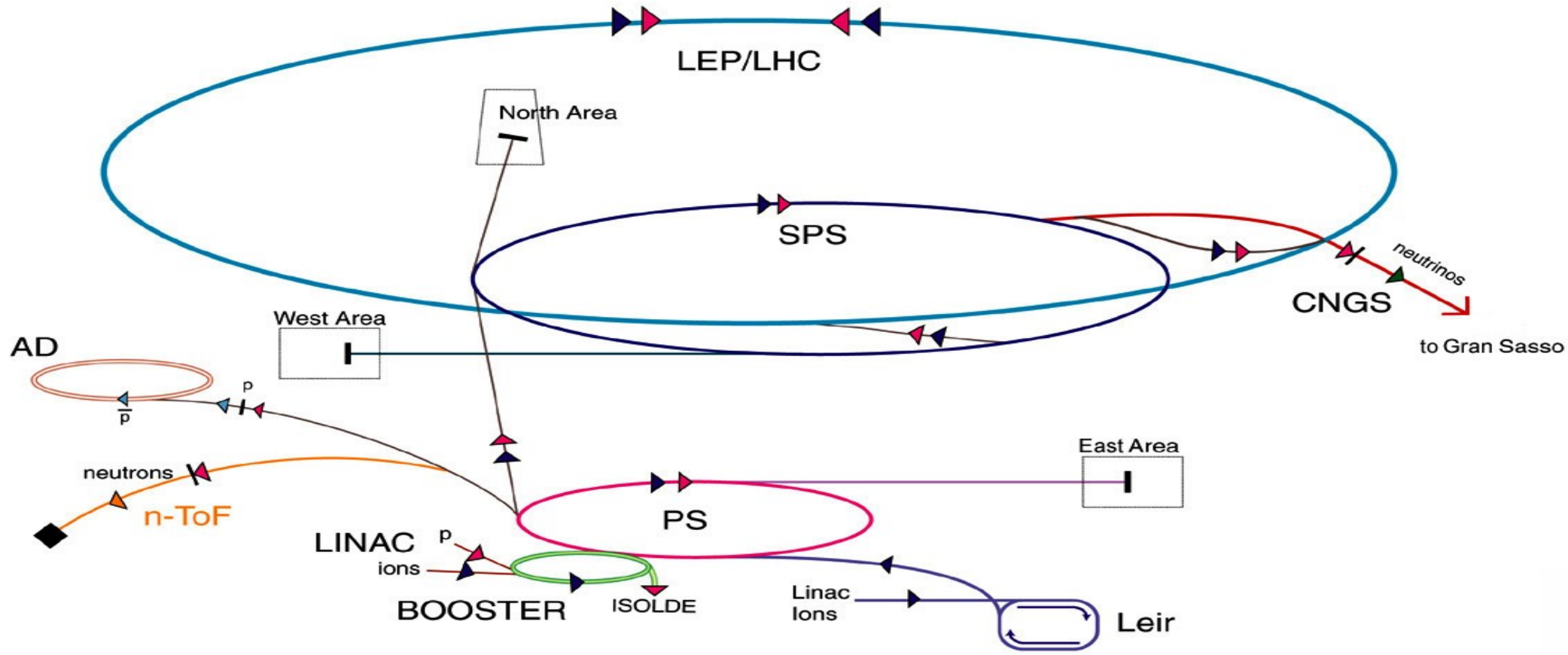
	quark		neutrino		ion		star
	gluon		bosons		atom		galaxy
	electron		meson		photon		black hole
	muon		baryon				
	tau						

# HEAVY ION COLLISIONS









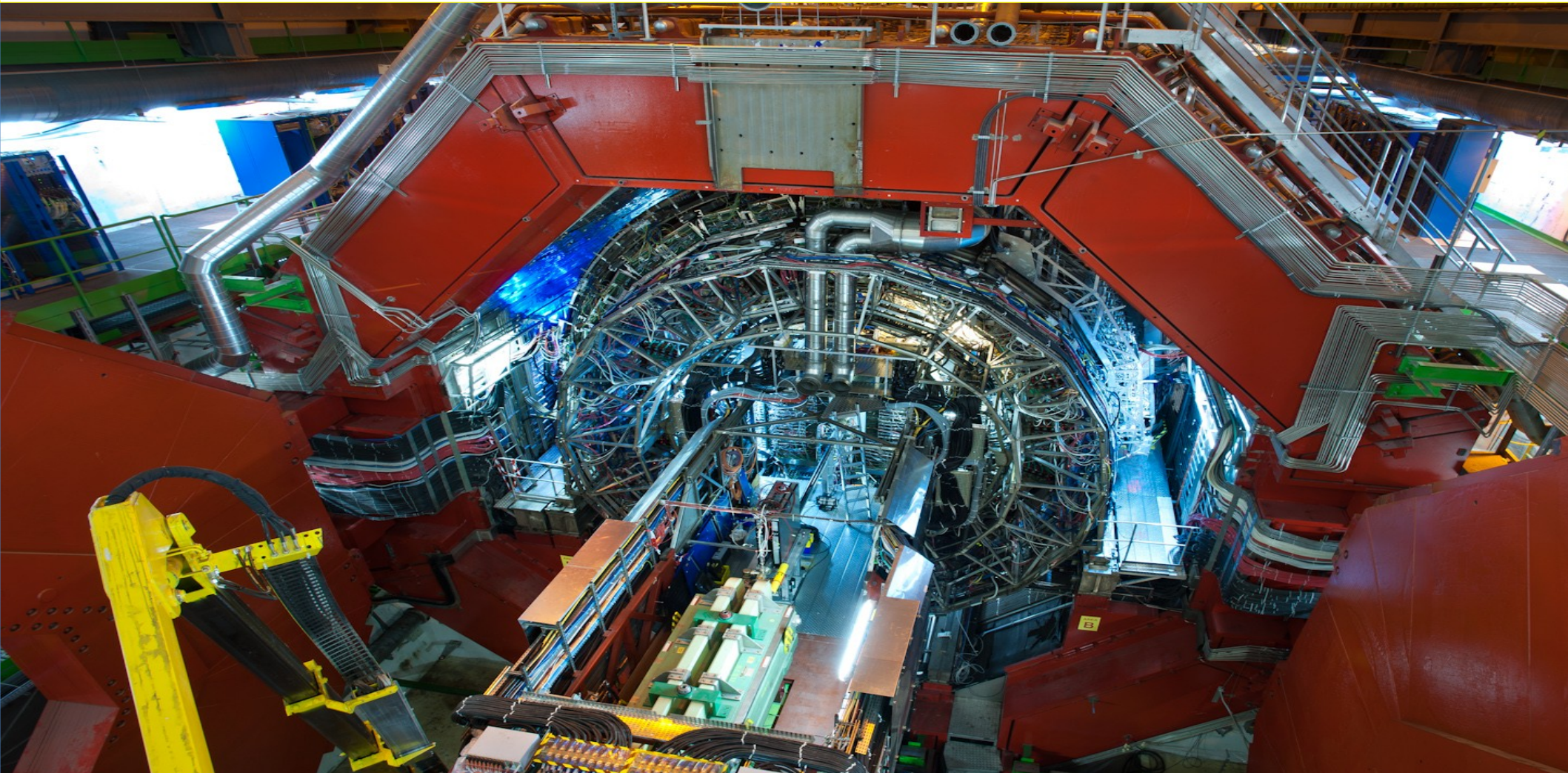
- ▶ p (proton)
- ▶  $\bar{p}$  (antiproton)
- ▶ ion
- ▶ neutron
- ▶ proton/antiproton conversion
- ▶ neutrino

- AD Antiproton Decelerator
- PS Proton Synchrotron
- SPS Super Proton Synchrotron

- LHC Large Hadron Collider
- n-ToF Neutron Time of Flight
- CNGS CERN Neutrinos to Gran Sasso



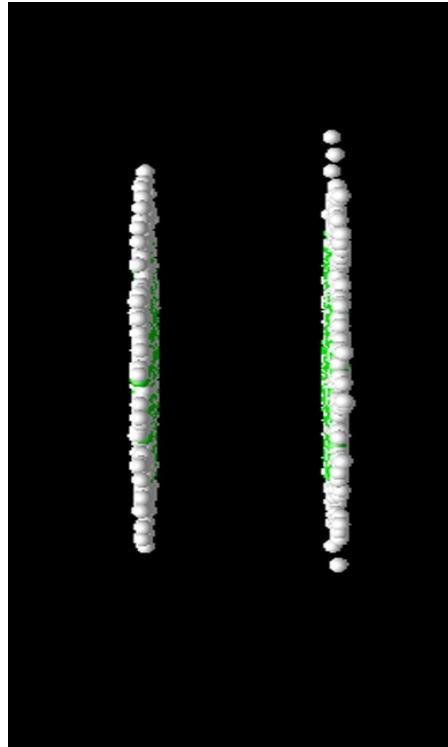
# ALICE : A Large Ion Collider Experiment



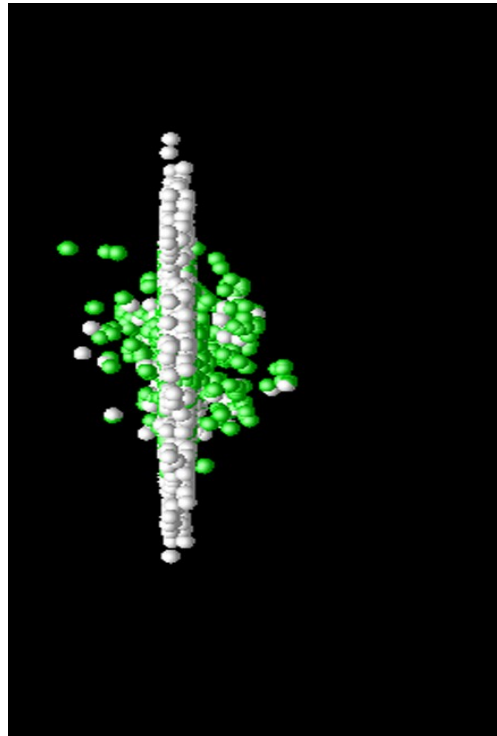
16 m x 16 m x 26 m 10 000 tons installed 56 m underground (@ point 2 of LHC)

# Le mini Big Bang

1. Les noyaux accélérés vont subir une collision frontale



# Le mini Big Bang

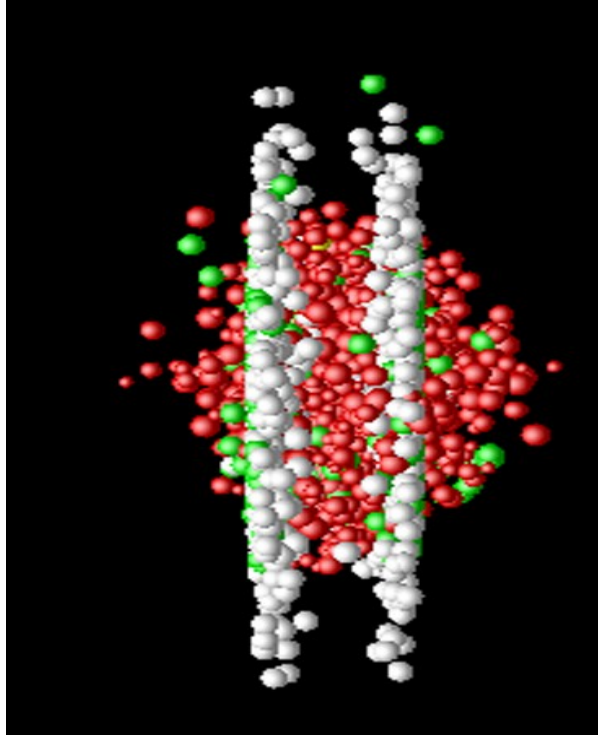


1. Les noyaux accélérés vont subir une collision frontale

2. L'énergie de la collision se matérialise sous forme de quarks et gluons



# Le mini Big Bang

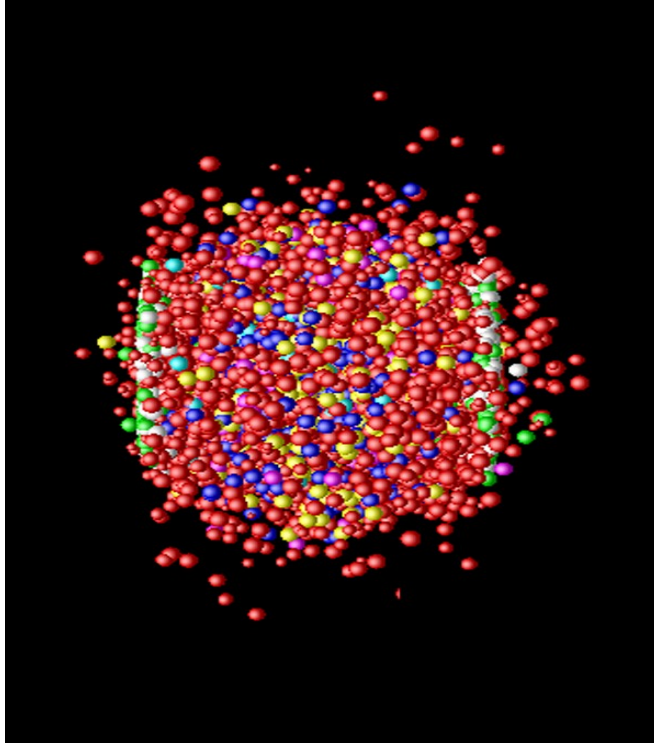


1. Les noyaux accélérés vont subir une collision frontale

2. L'énergie de la collision se matérialise sous forme de quarks et gluons

3. Les quarks et gluons interagissent sous l'effet de l'interaction forte: la matière tend vers l'équilibre

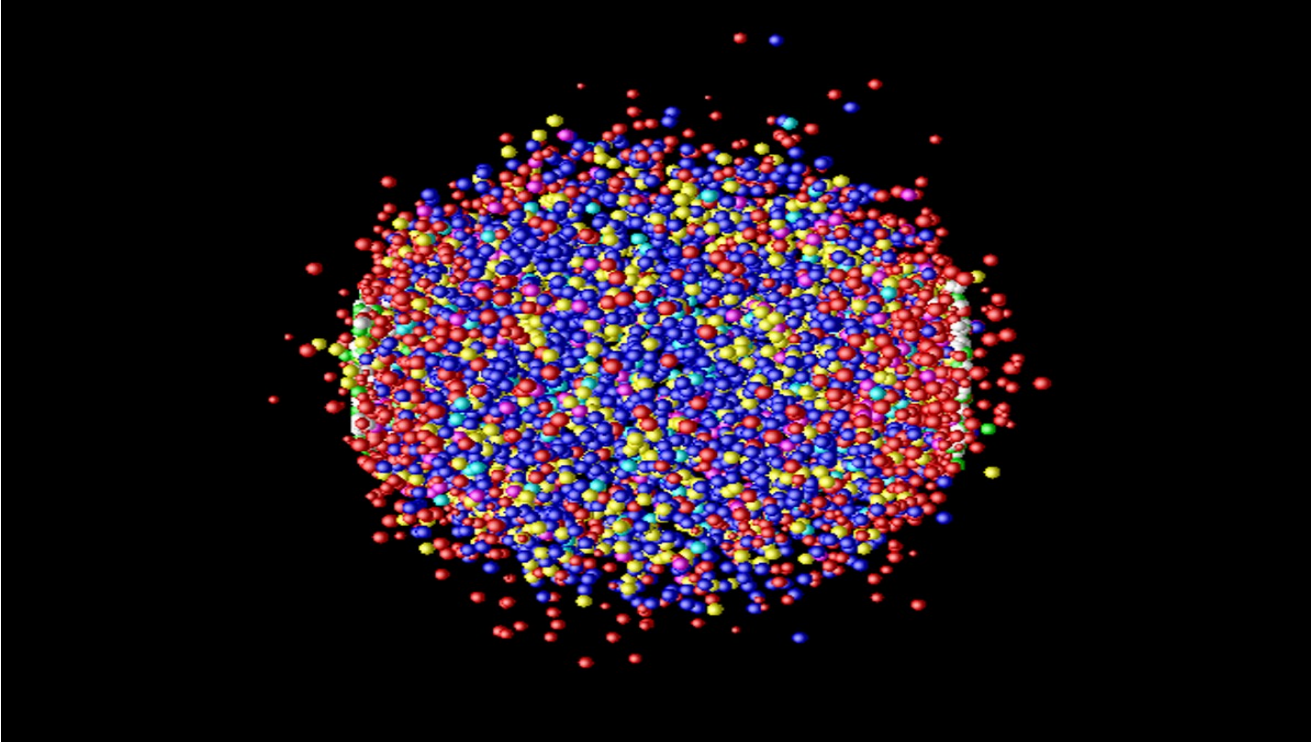
# Le mini Big Bang



1. Les noyaux accélérés vont subir une collision frontale
2. L'énergie de la collision se matérialise sous forme de quarks et gluons
3. Les quarks et gluons interagissent sous l'effet de l'interaction forte: la matière tend vers l'équilibre
4. Le système se dilue et se refroidit

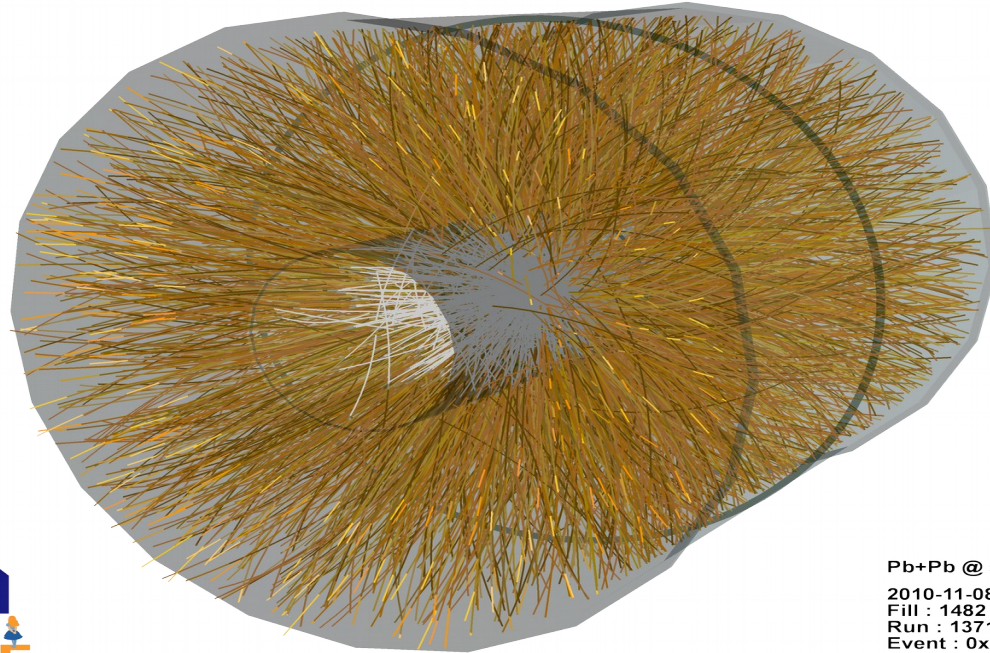


# Le mini Big Bang



1. Les noyaux accélérés vont subir une collision frontale
2. L'énergie de la collision se matérialise sous forme de quarks et gluons
3. Les quarks et gluons interagissent sous l'effet de l'interaction forte: la matière tend vers l'équilibre
4. Le système se dilue et se refroidit
5. Quarks et gluons condensent pour former des hadrons

# A COLLISION IN ALICE



Pb+Pb @  $\sqrt{s}$  = 2.76 ATeV  
2010-11-08 11:30:46  
Fill : 1482  
Run : 137124  
Event : 0x00000000D3BBE693

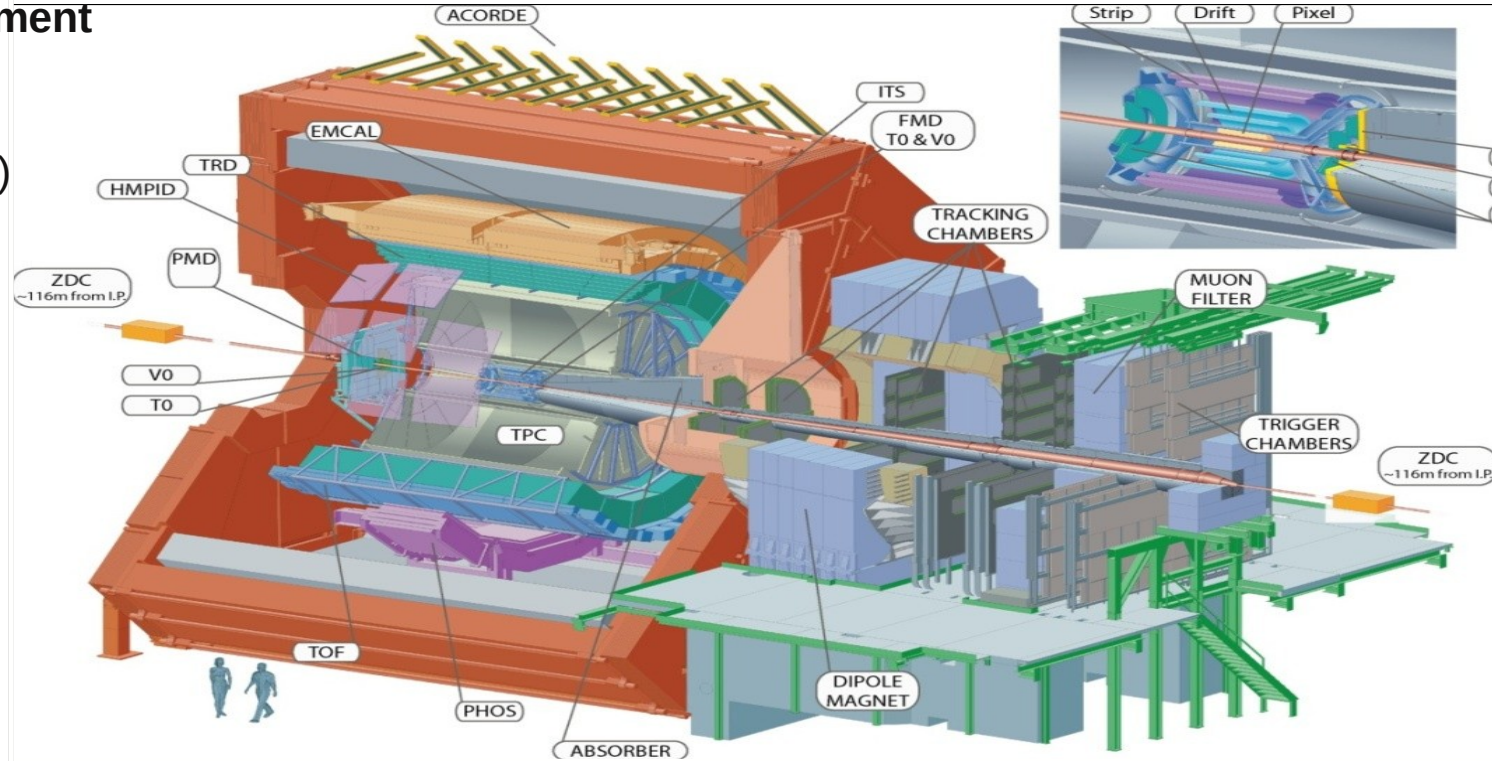
~ 1600 charged particles per rapidity unit in central collisions!



# ALICE

## A Large Ion Collider Experiment

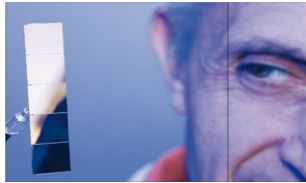
- Particle tracking (low momentum)
- Particle Identification (PID)



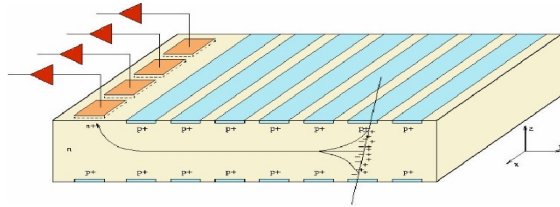
# INNER TRACKING SYSTEM

6 layers of silicon detectors for high track and vertex reconstruction with **high spatial resolution**

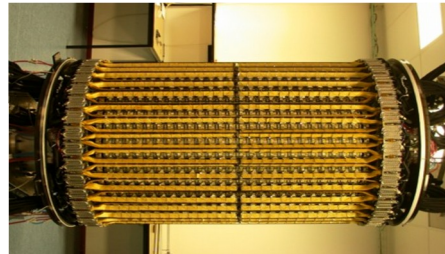
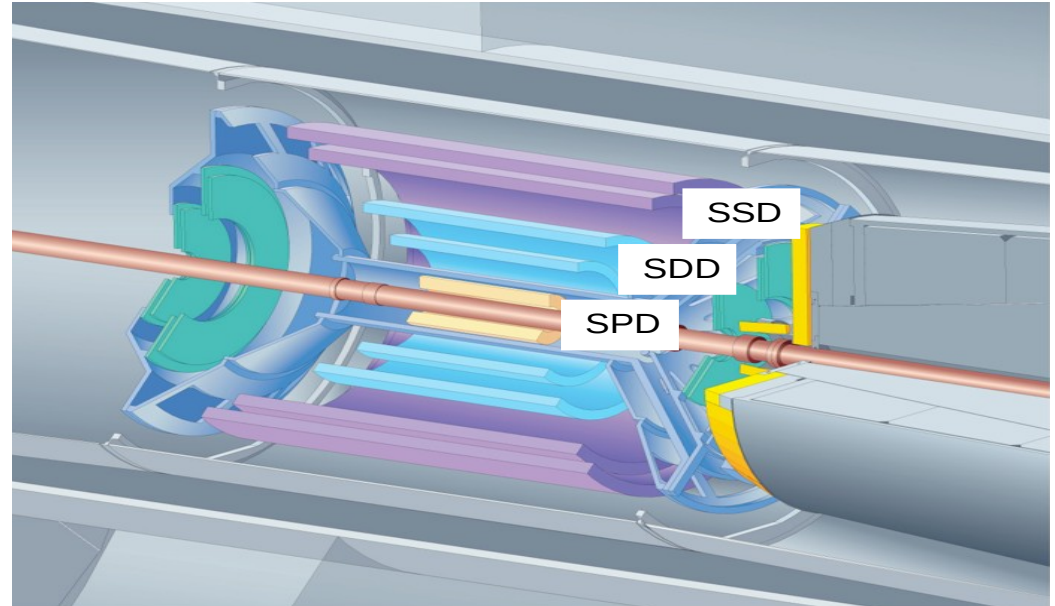
- Silicon Pixel Detector (SPD)



- Silicon Drift Detector (SDD)

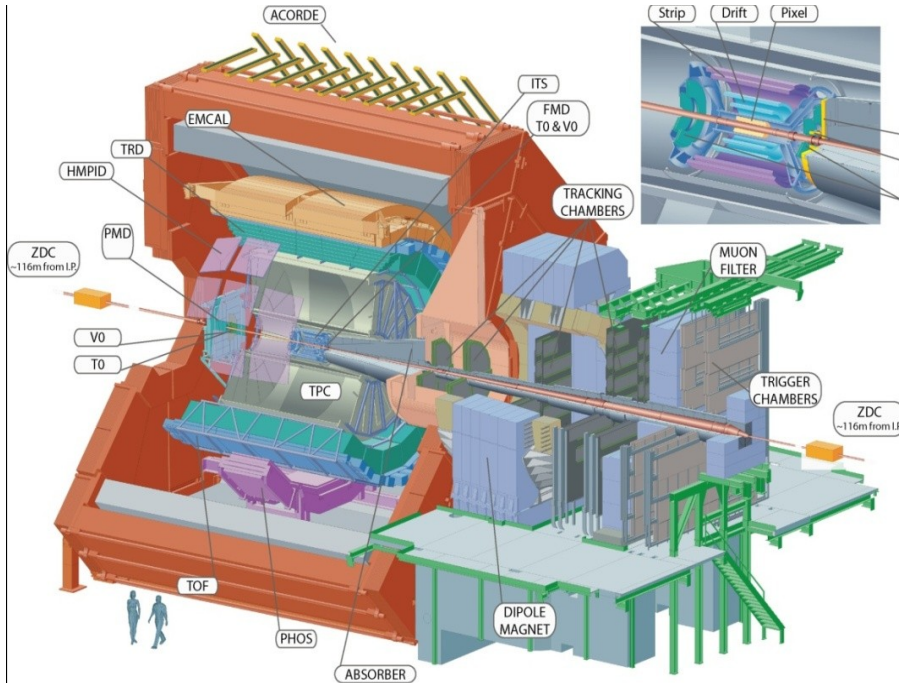


- Silicon Strip Detector (SSD)



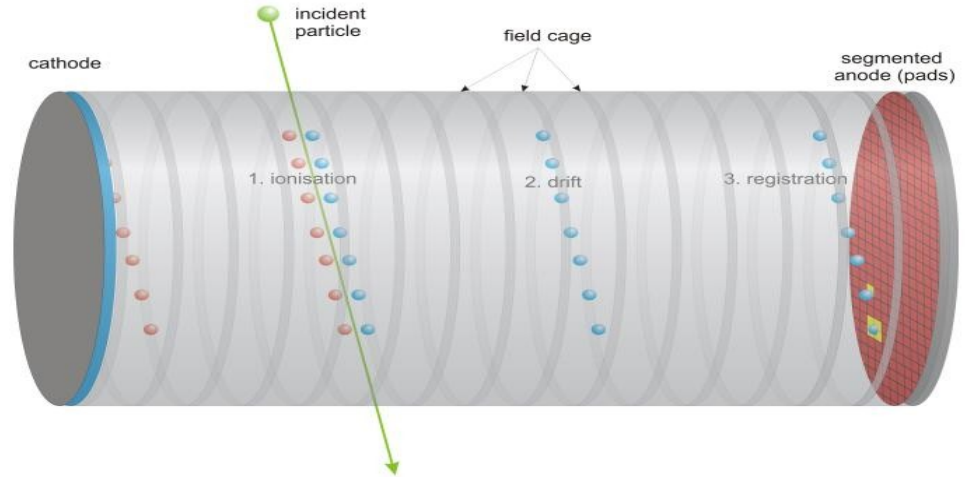
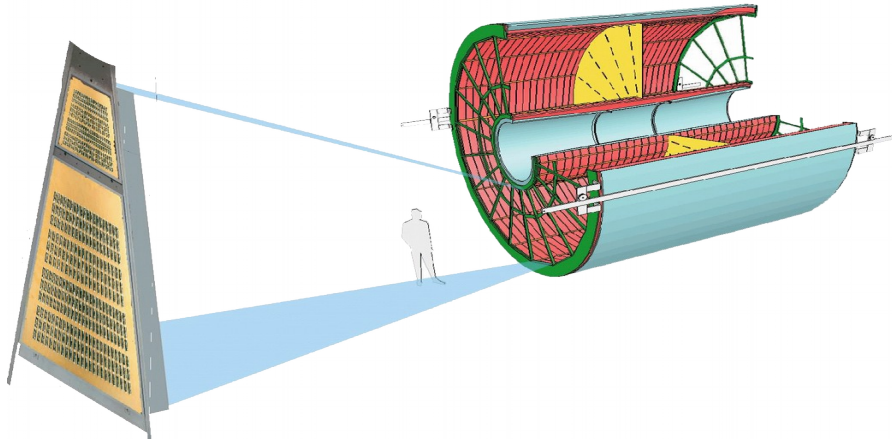


# TIME PROJECTION CHAMBER

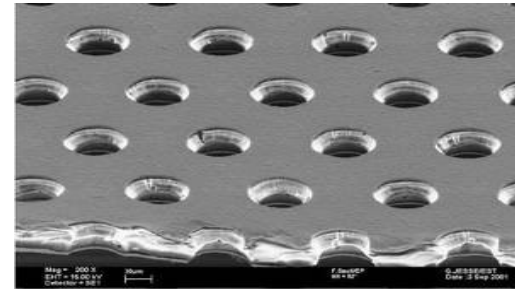


- The “heart” of ALICE
  - Tracking
  - Particle identification
- The largest ever built in the world:  $\sim 90 \text{ m}^3$
- Designed to track up to 8000 particles per rapidity unit

# TIME PROJECTION CHAMBER



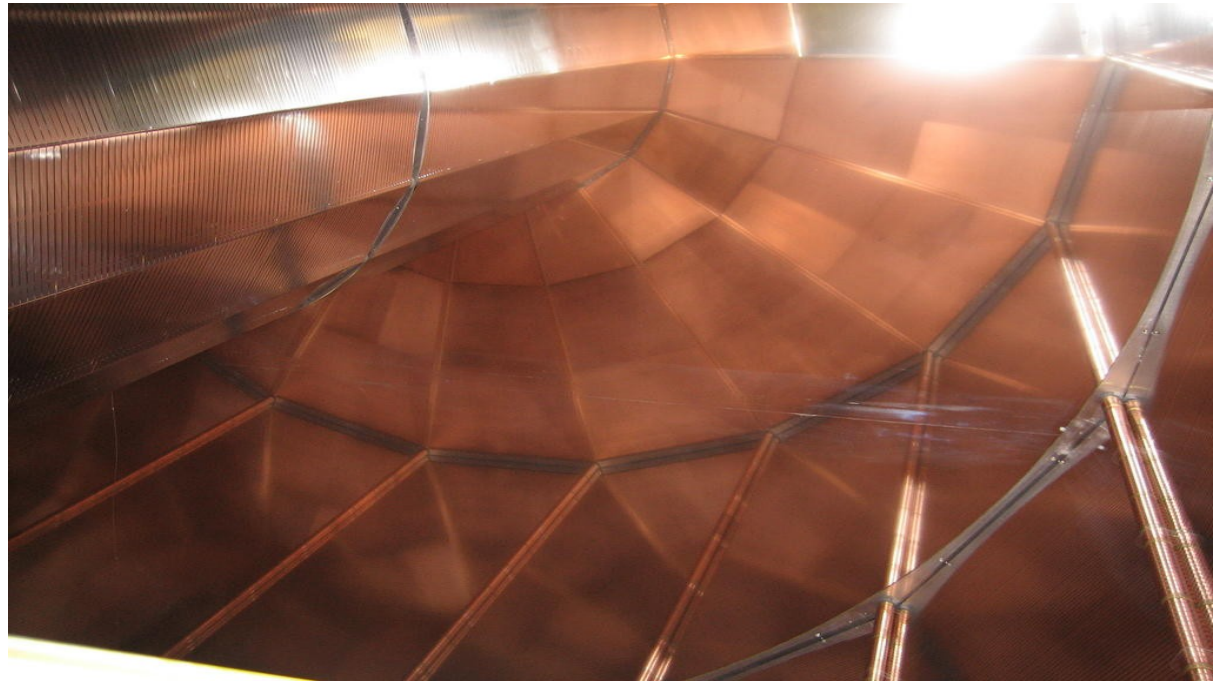
ALICE TPC readout with  
Multi Wire Proportional Chambers  
(Upgrade with GEMs in 2018/19)



# TIME PROJECTION CHAMBER



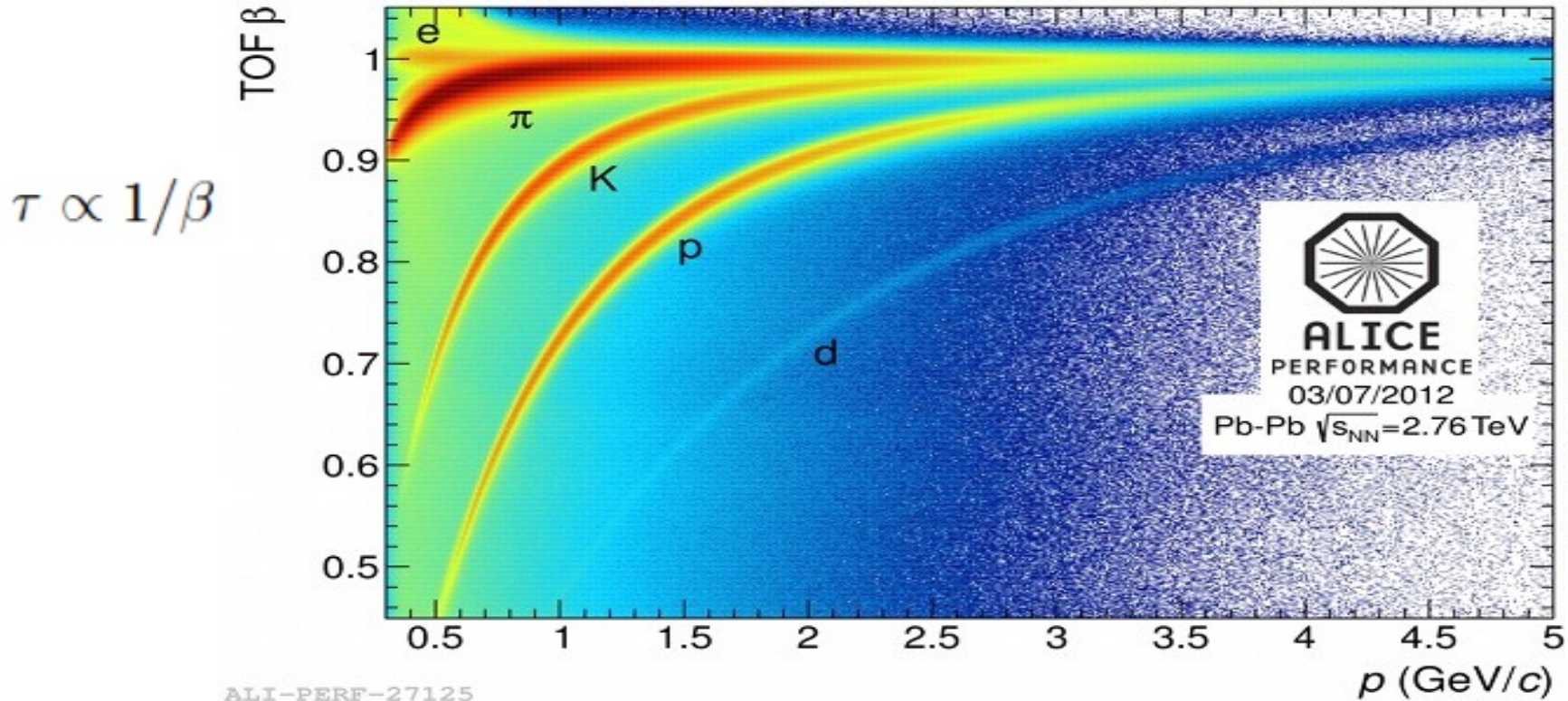
Readout chamber



Field cage, looking at the central electrode

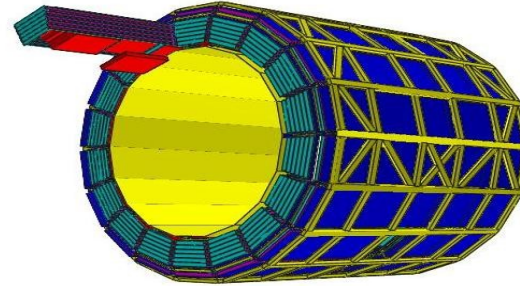


# PID: TIME OF FLIGHT

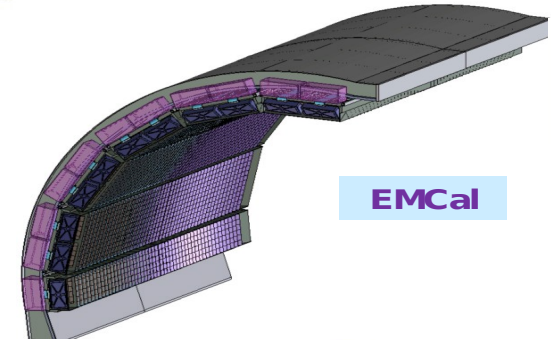


$$p = m_0 \beta \gamma c$$

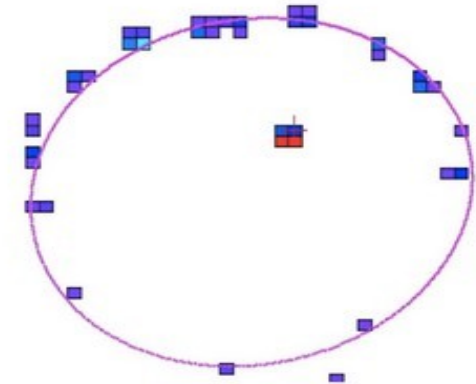
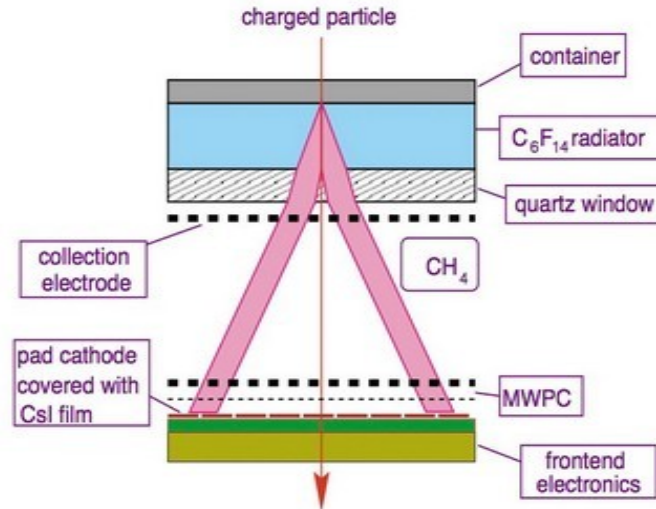
## TRANSITION RADIATION DETECTOR



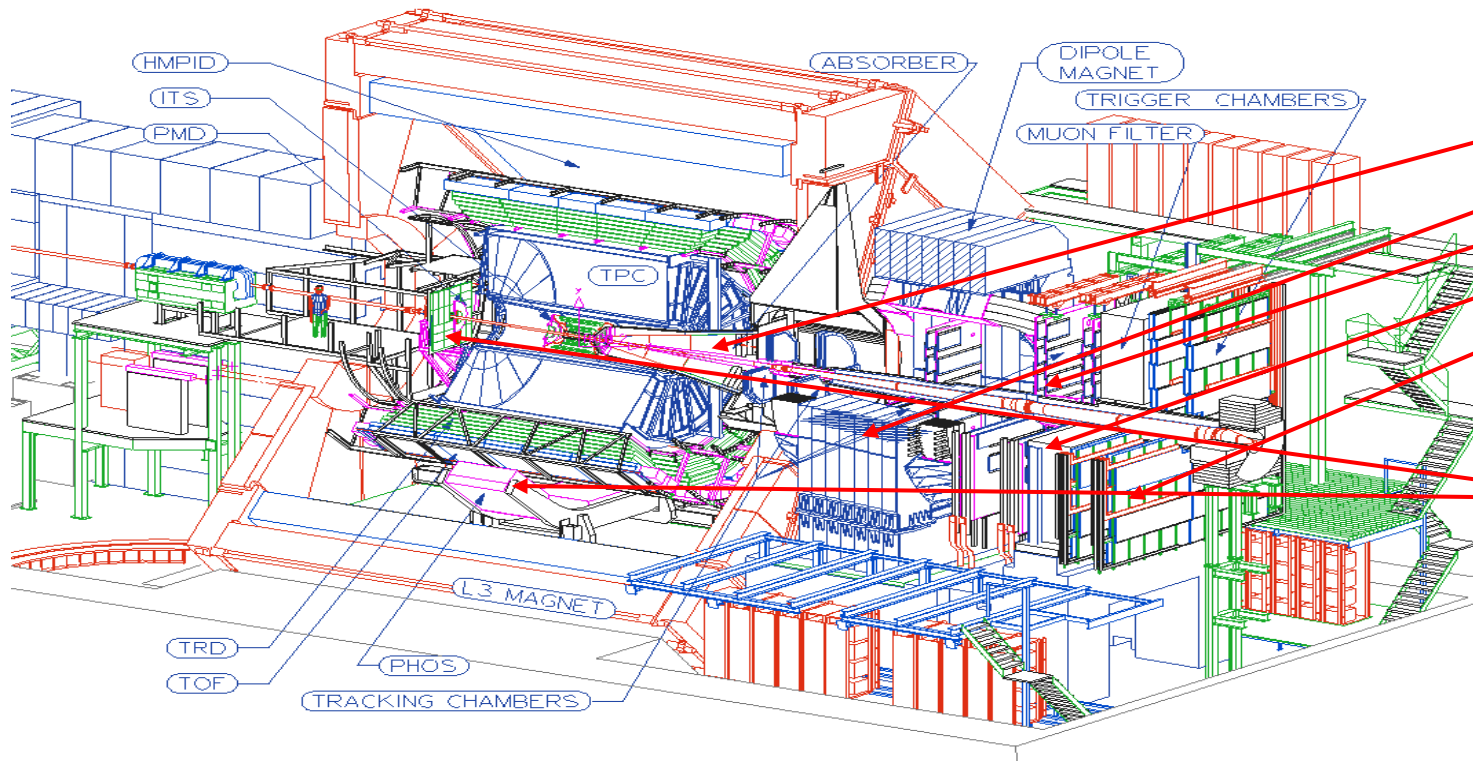
## CALORIMETERS



## CHERENKOV LIGHT DETECTOR



# ... et quelques détecteurs spécialisés



Spectromètre de muons :

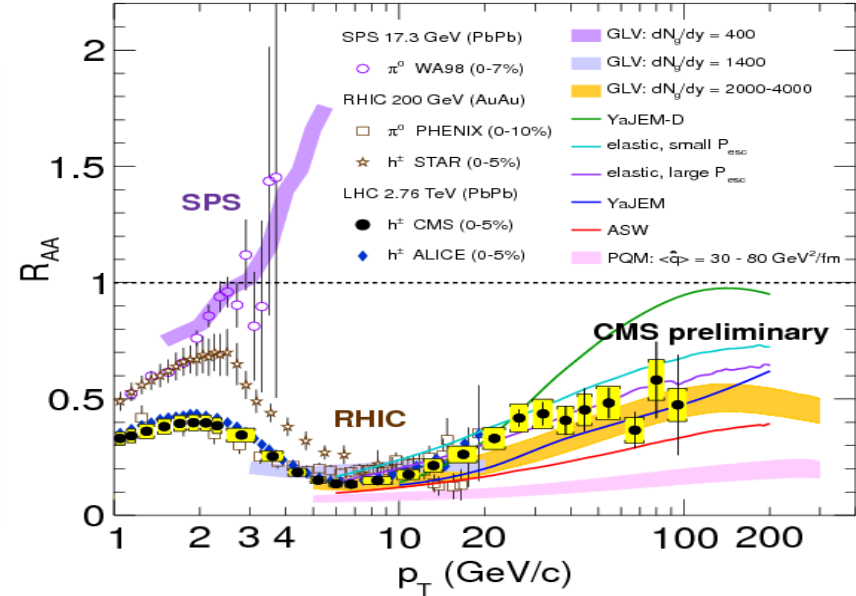
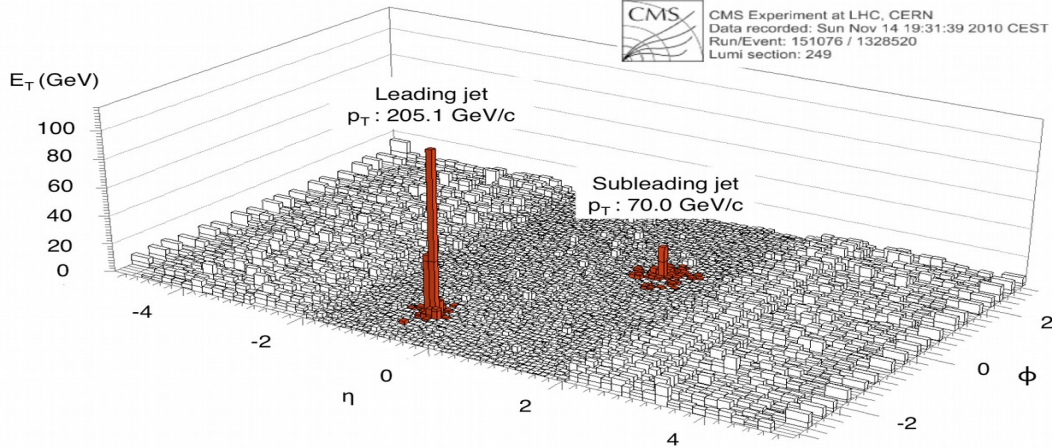
- Absorbent passif
- B dipole
- Trajectographe
- Filtre
- Déclencheur

Photons



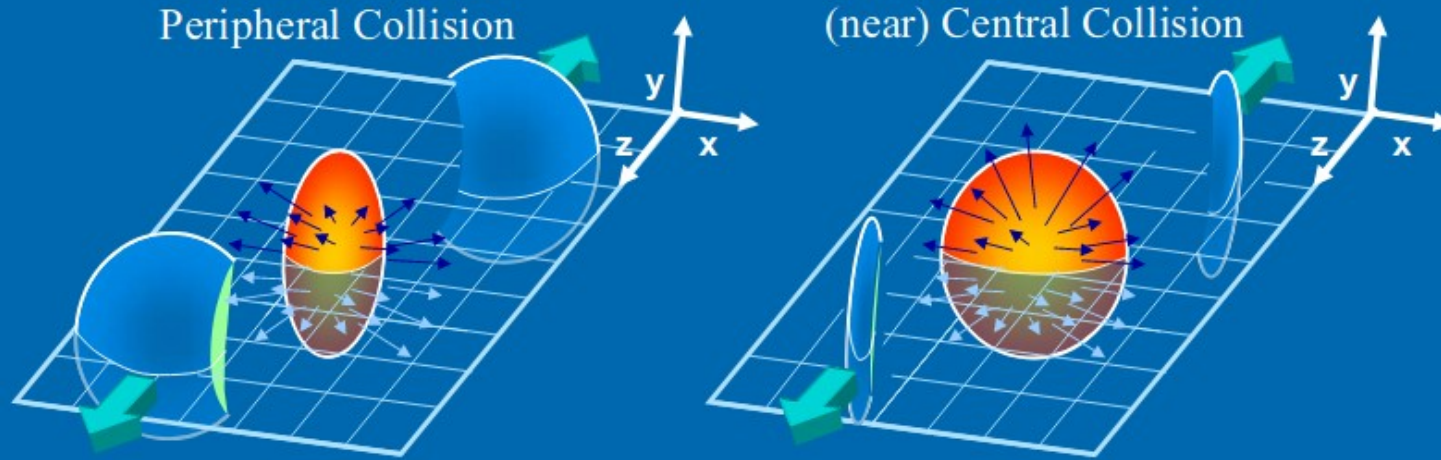
# JET QUENCHING

CMS, Phys.Rev. C84 (2011) 024906



Energy loss of quarks in medium lead to quenching of jets and suppression of high  $p_T$  particles

# Centrality Dependence



Centrality measured by the multiplicity of charged particles

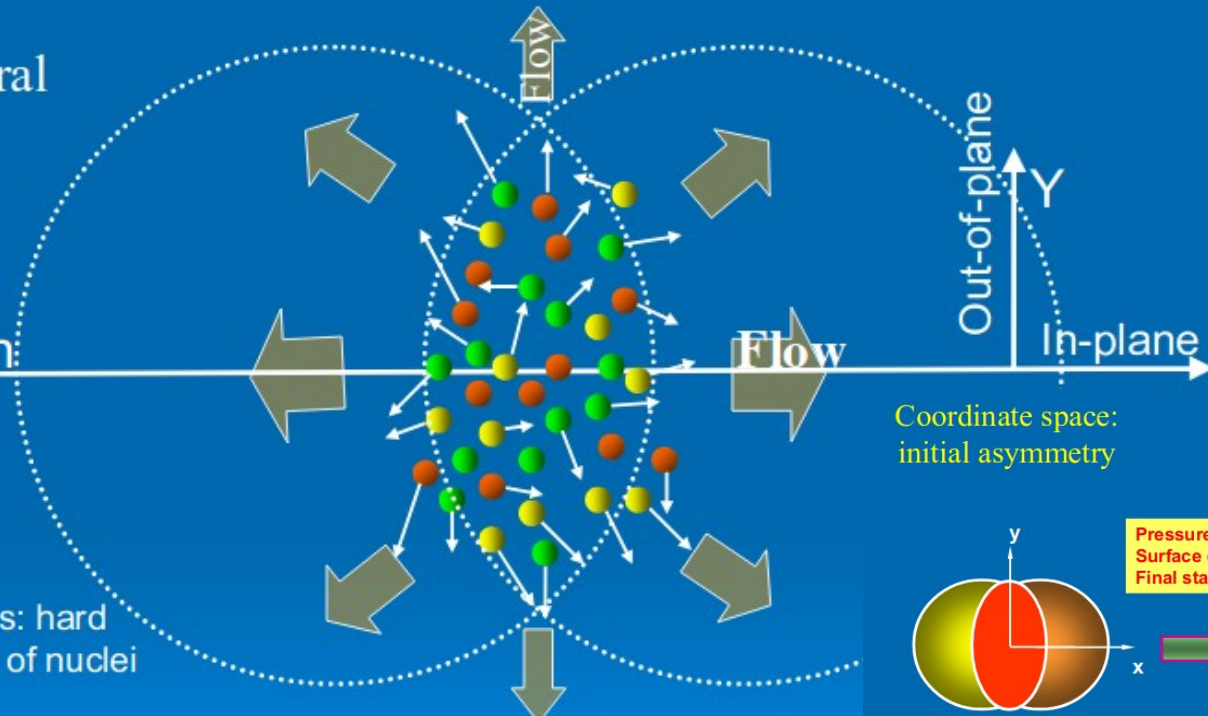
# Collective behavior



Mid-central collision

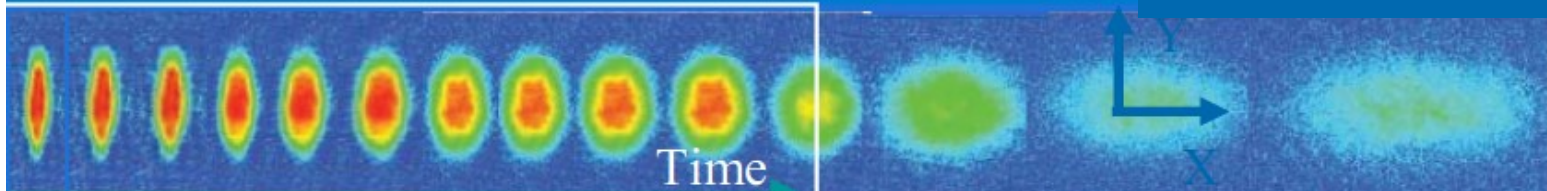
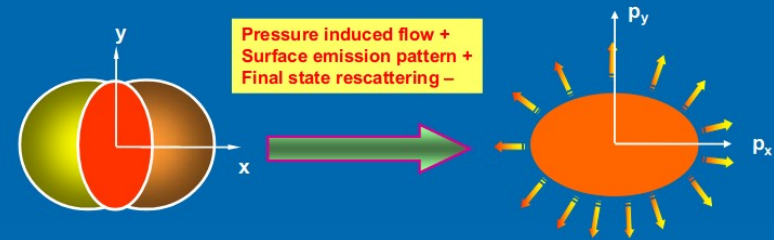
Reaction plane

Dashed lines: hard sphere radii of nuclei



Coordinate space:  
initial asymmetry

Momentum space:  
final asymmetry





# Elliptic Flow

$$\frac{dX}{d\varphi} = \frac{X_0}{2\pi} (1 + 2v_1 \cos(\varphi - \Psi_{RP}) + 2v_2 \cos(2(\varphi - \Psi_{RP})) + \dots)$$

Elliptic flow coefficient

$$v_2 = \langle \cos(2(\varphi - \Psi_{RP})) \rangle$$

