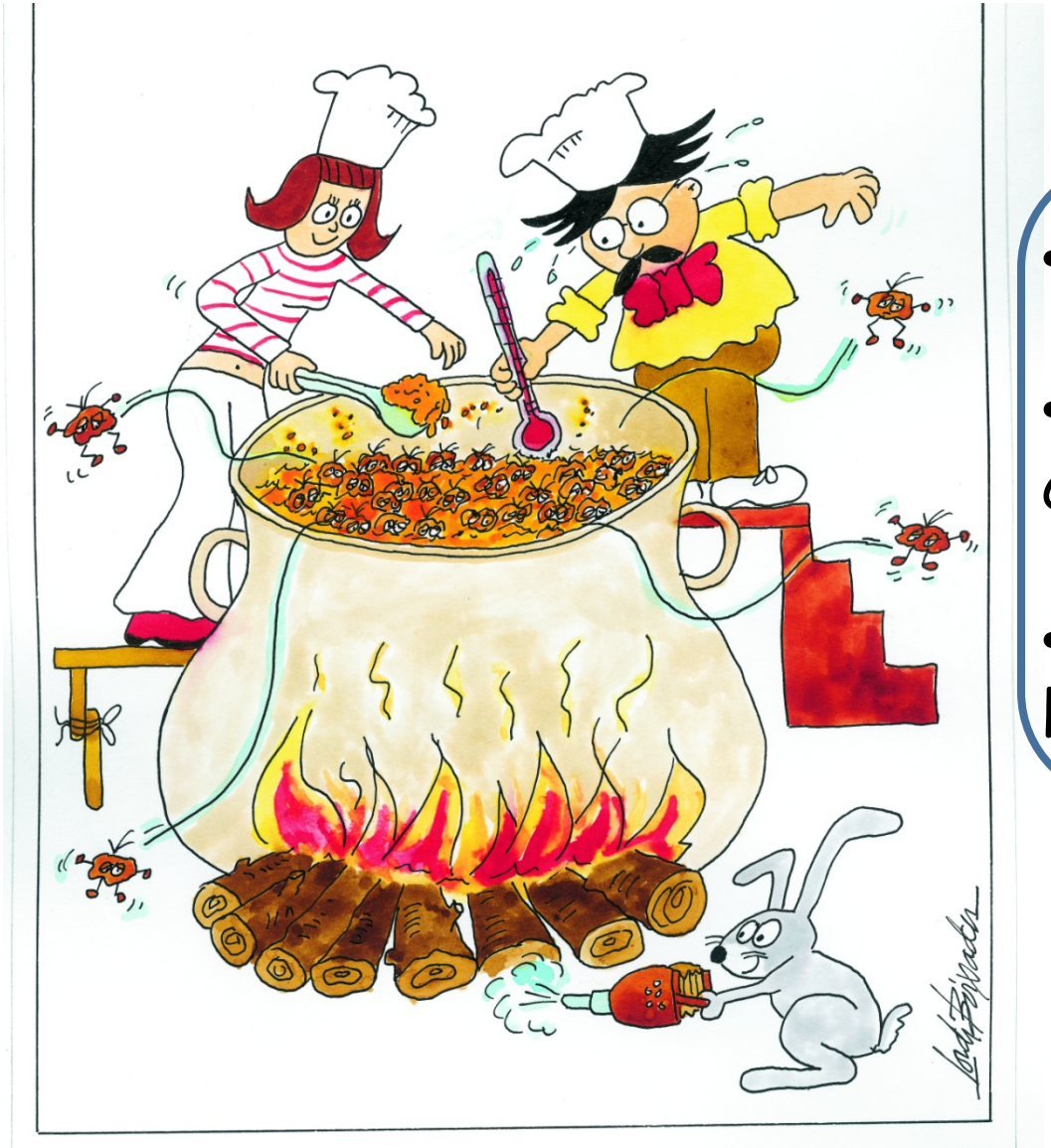
Alice
l'esperimento e la fisica

Pasquale Di Nezza

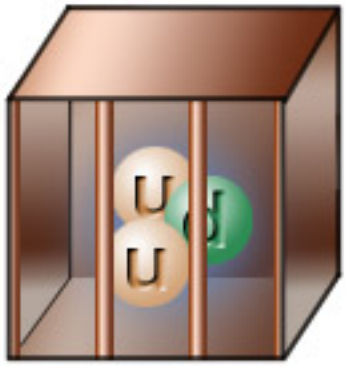
Alice … in viaggio nel tempo

Fino a circa un centomillesimo di secondo dal Big Bang (10^{-37} - 10^{-5} s) l'Universo era formato da una "zuppa" di quark e gluoni … il Quark Gluon Plasma (QGP)

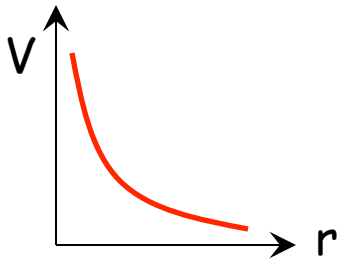


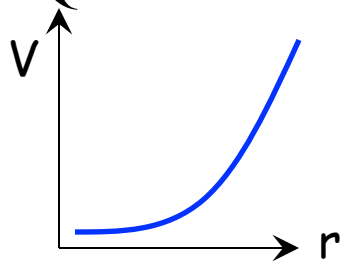
- Perchè studiare il QGP?
- Quali sono le caratteristiche del QGP?
- E' possibile riprodurlo in laboratorio?

Liberta' Asintotica → Confinamento



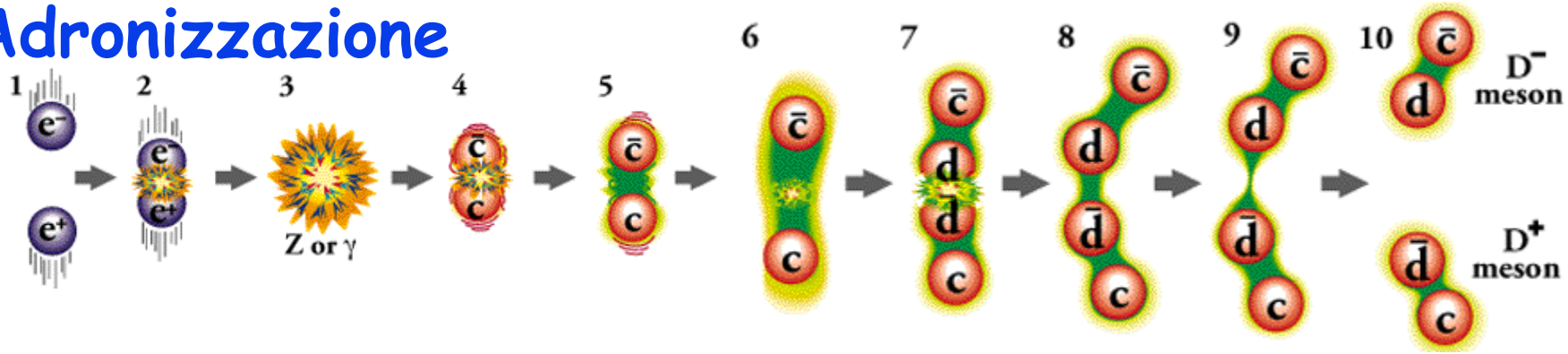
$$V_{Coulomb} \propto \frac{q_1 q_2}{r} \quad \Rightarrow \quad V_{QCD} \propto e^{k \cdot r}$$



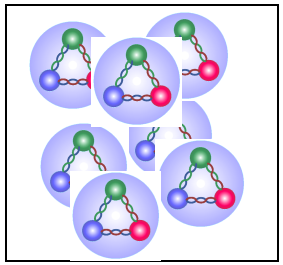


Allontanando i quark, si crea una tensione con energia sufficiente a creare altre particelle (1000 MeV / fm)

Adronizzazione

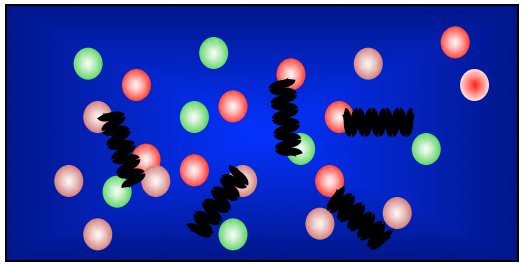


Bisogna creare un sistema che abbia una densità enorme (ptc a distanza infinitesima) tale da rendere trascurabile l'interazione forte



adroni

ENERGIA



Quark Gluon Plasma

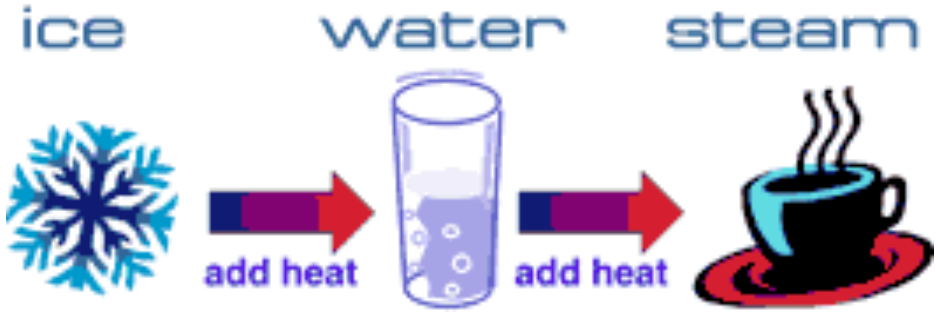
Nobel Prize 2005

D. Gross
H.D. Politzer
F. Wilczek

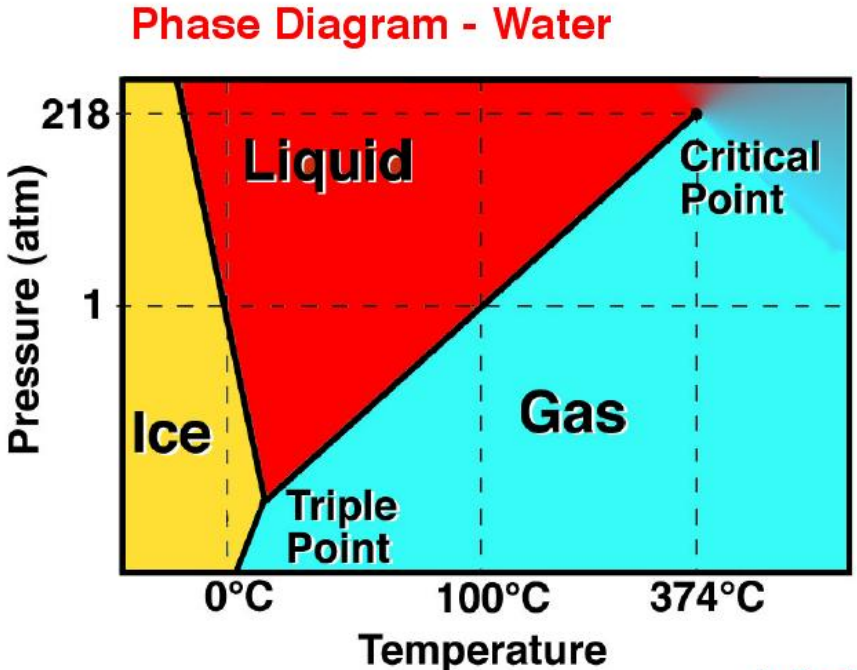
QCD Asymptotic Freedom (1973)

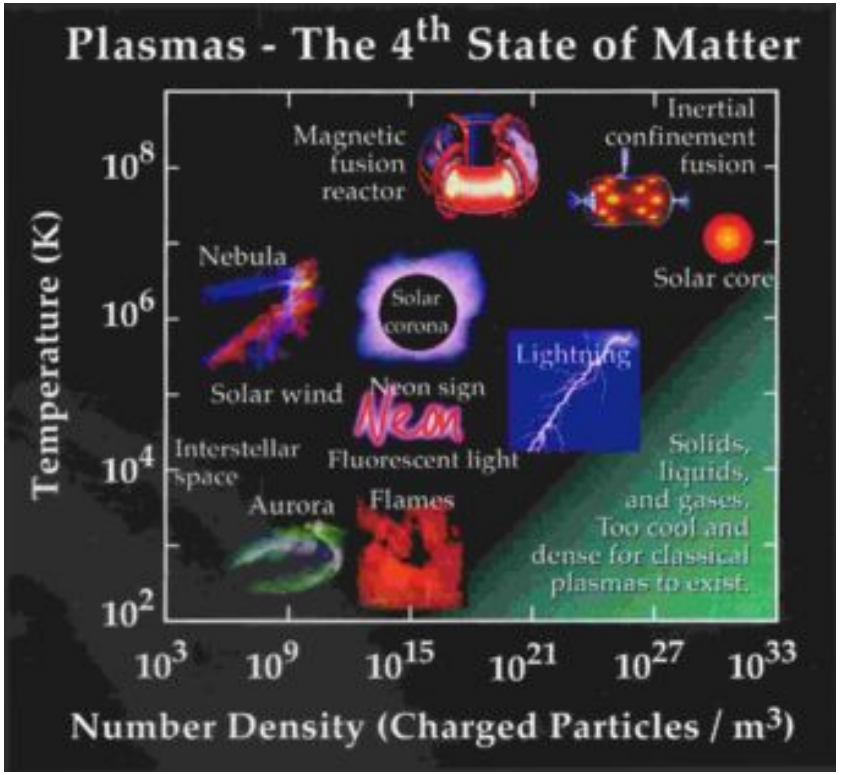
"Before [QCD] we could not go back further than 200,000 years after the Big Bang. Today…since QCD simplifies at high energy, we can extrapolate to very early times when nucleons melted…to form a quark-gluon plasma."
David Gross, Nobel Lecture (RMP 05)

Fasi della materia "normale"



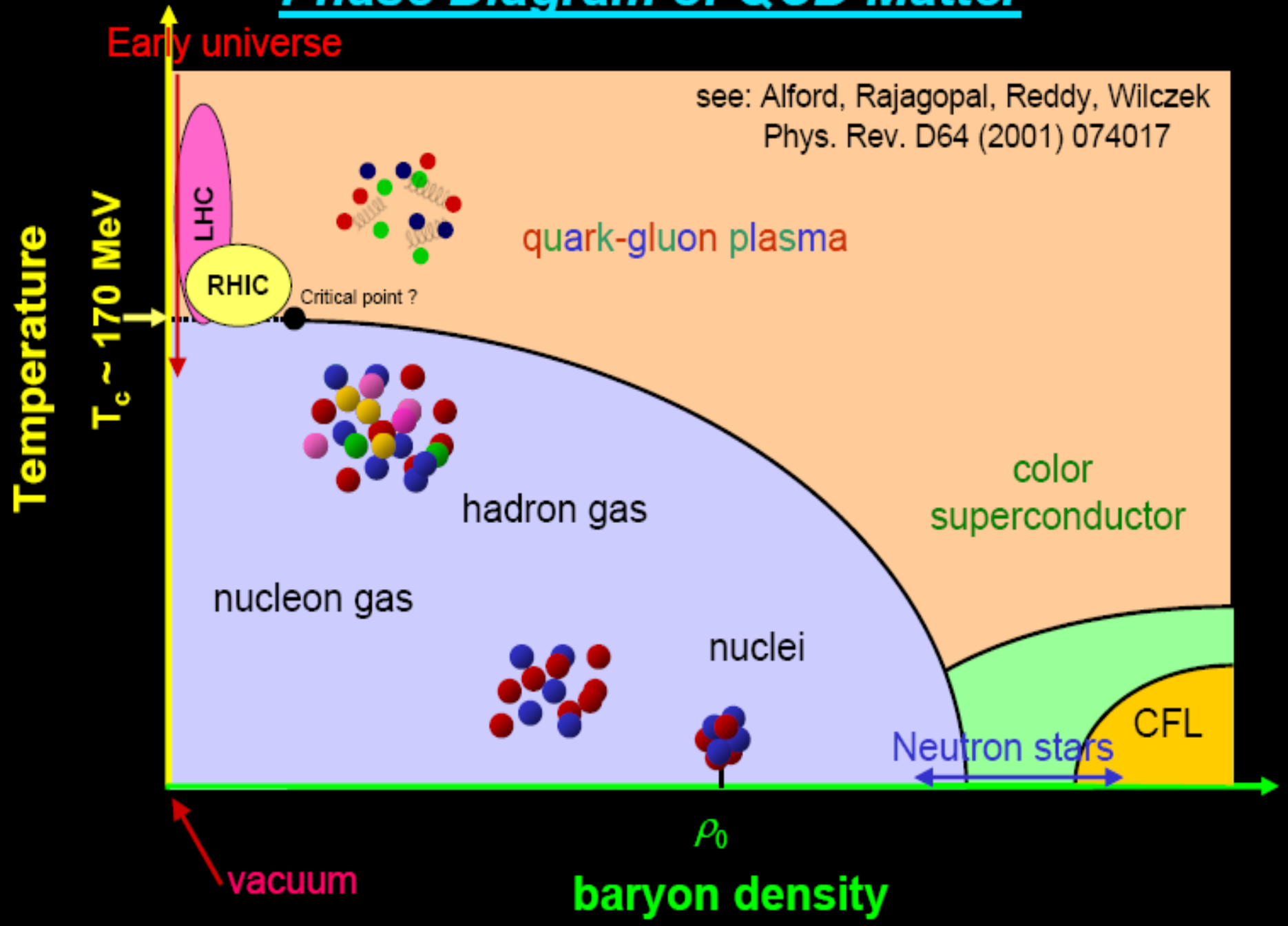
solido liquido gassoso





Plasma Classico

Phase Diagram of QCD Matter



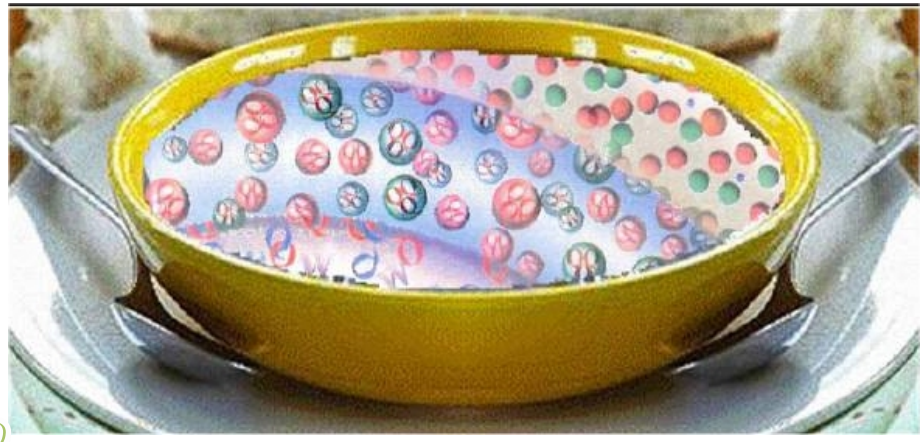
Una "zuppa" ricca di informazioni

Evoluzione spazio-temporale della nascita di un adrone

Proprietà della QCD ad alte temperature: gradi di libertà, viscosità, conduttività, …

Flusso ellittico

Restaurazione della simmetria chirale



Freezout

Puzzle barionico

Instabilità di plasma, caos di colore

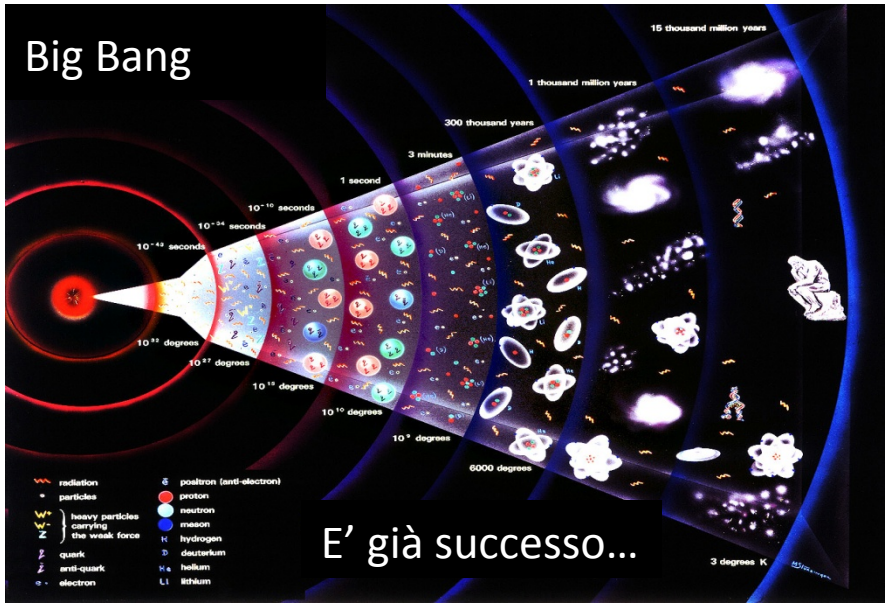
Transizione di fase q-g nelle teorie cosmologiche dell'Universo primordiale

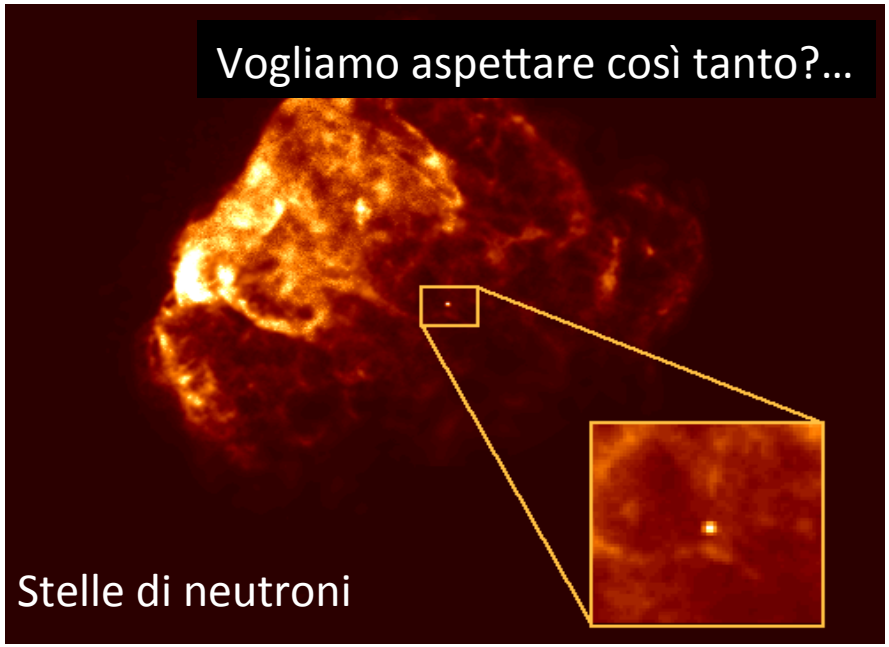
Equazione di stato della QCD

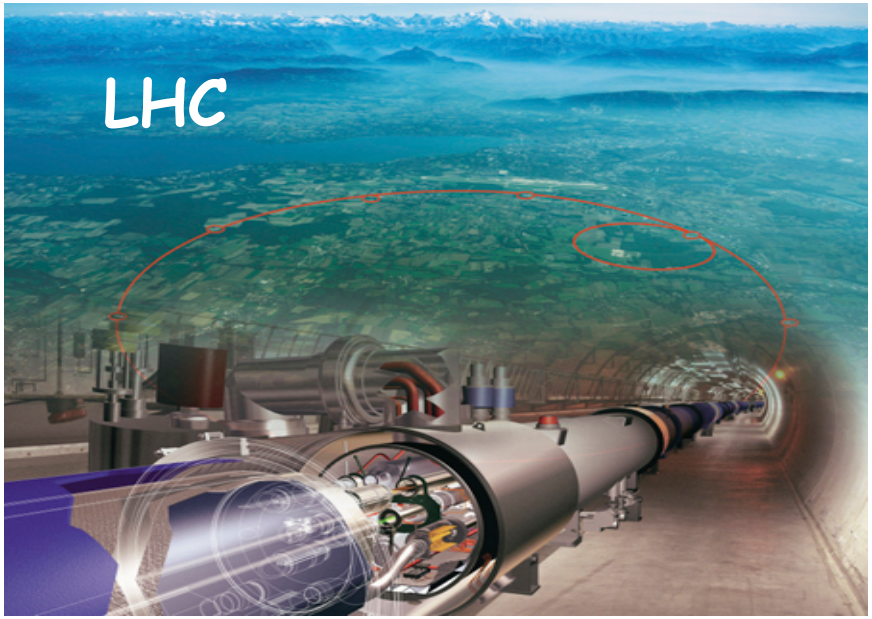
Perdita di energia partonica

Composizione chimica

Dove si produce il QGP ?

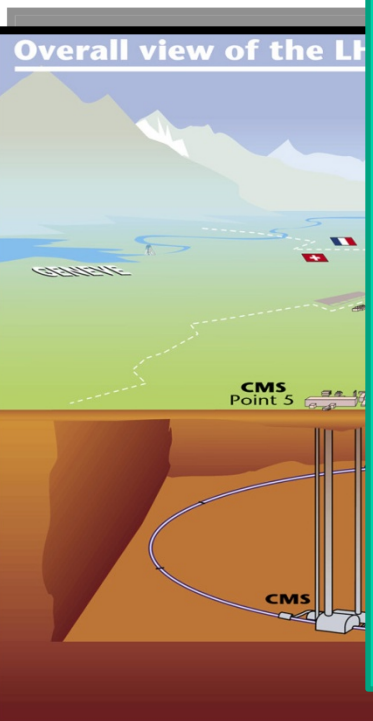


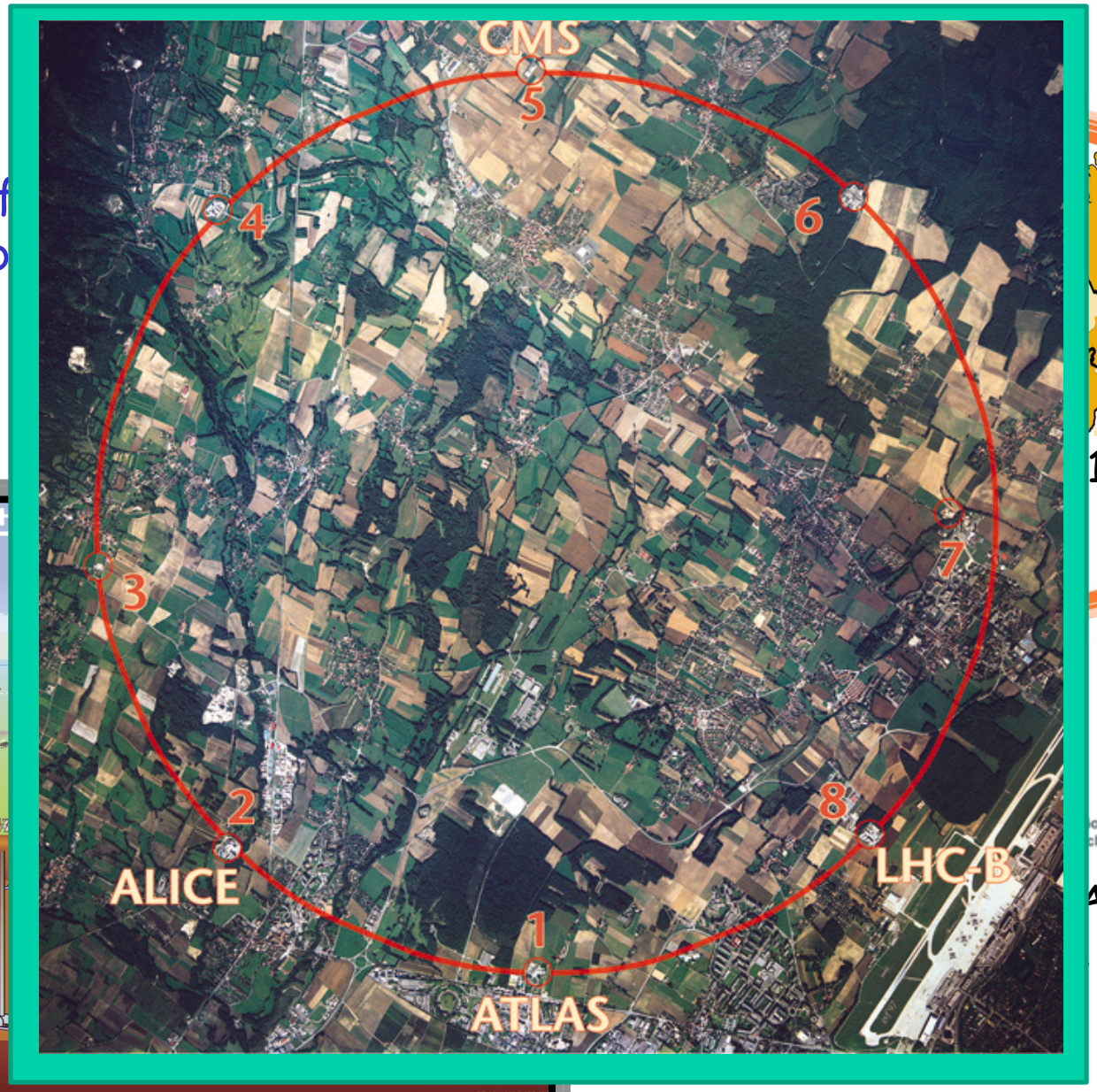




ALICE: A Large Ion Collider Experiment

Alice è l'unico
dedicato alla f
(5.5 TeV PbPb





1000 fisici

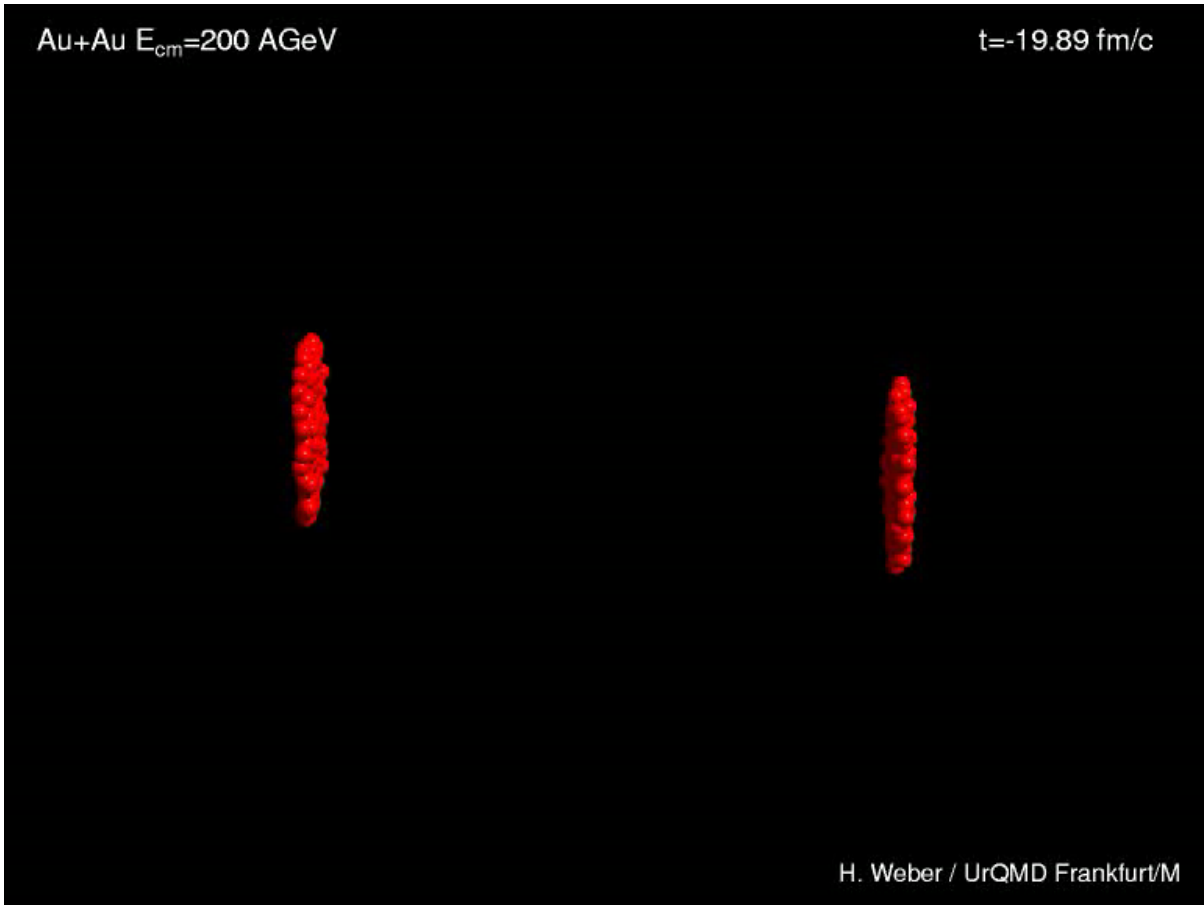
onale
cleare

A, BO, CA,
SA, TO, TS

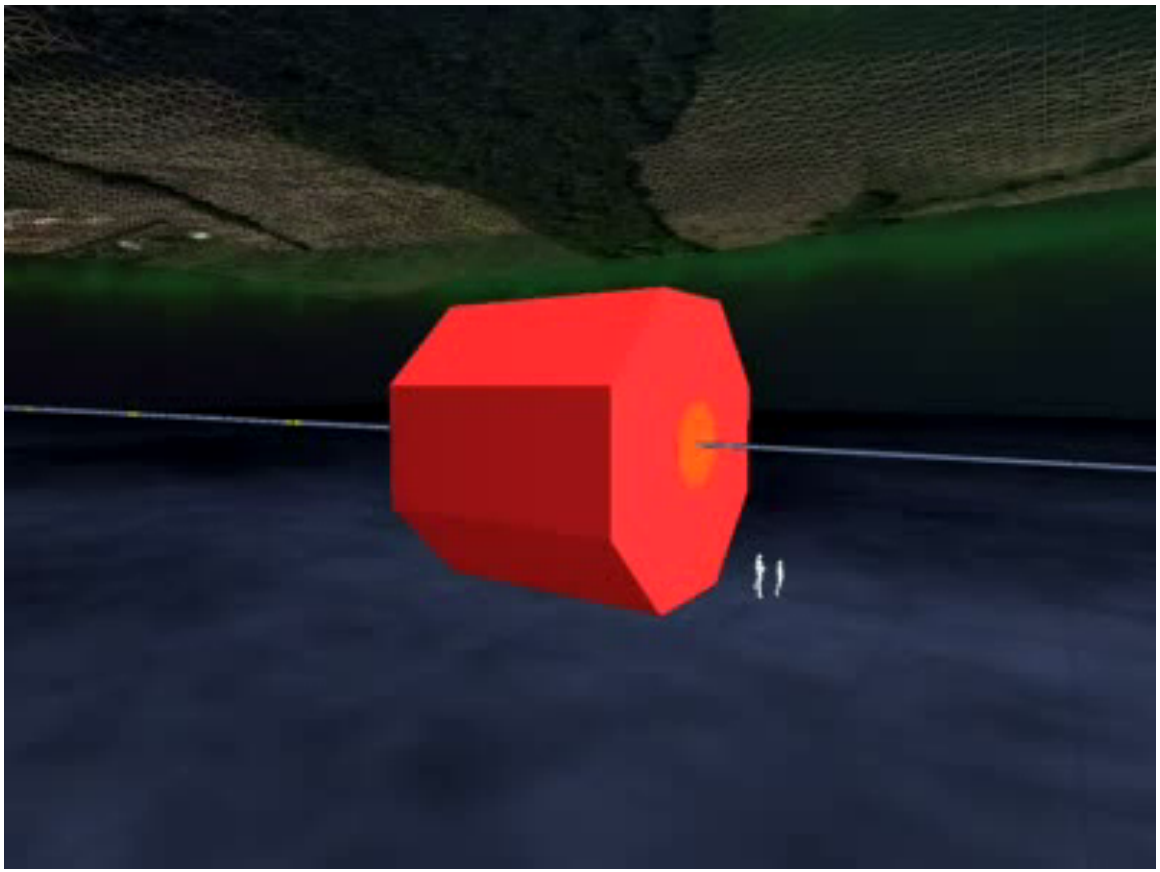
QGP attraverso gli Heavy Ions

Energia: $E_{beam} = 7\frac{Z}{A}\text{TeV} \Rightarrow \sqrt{s} = 5.5\ \text{TeV/A per Pb - Pb}$

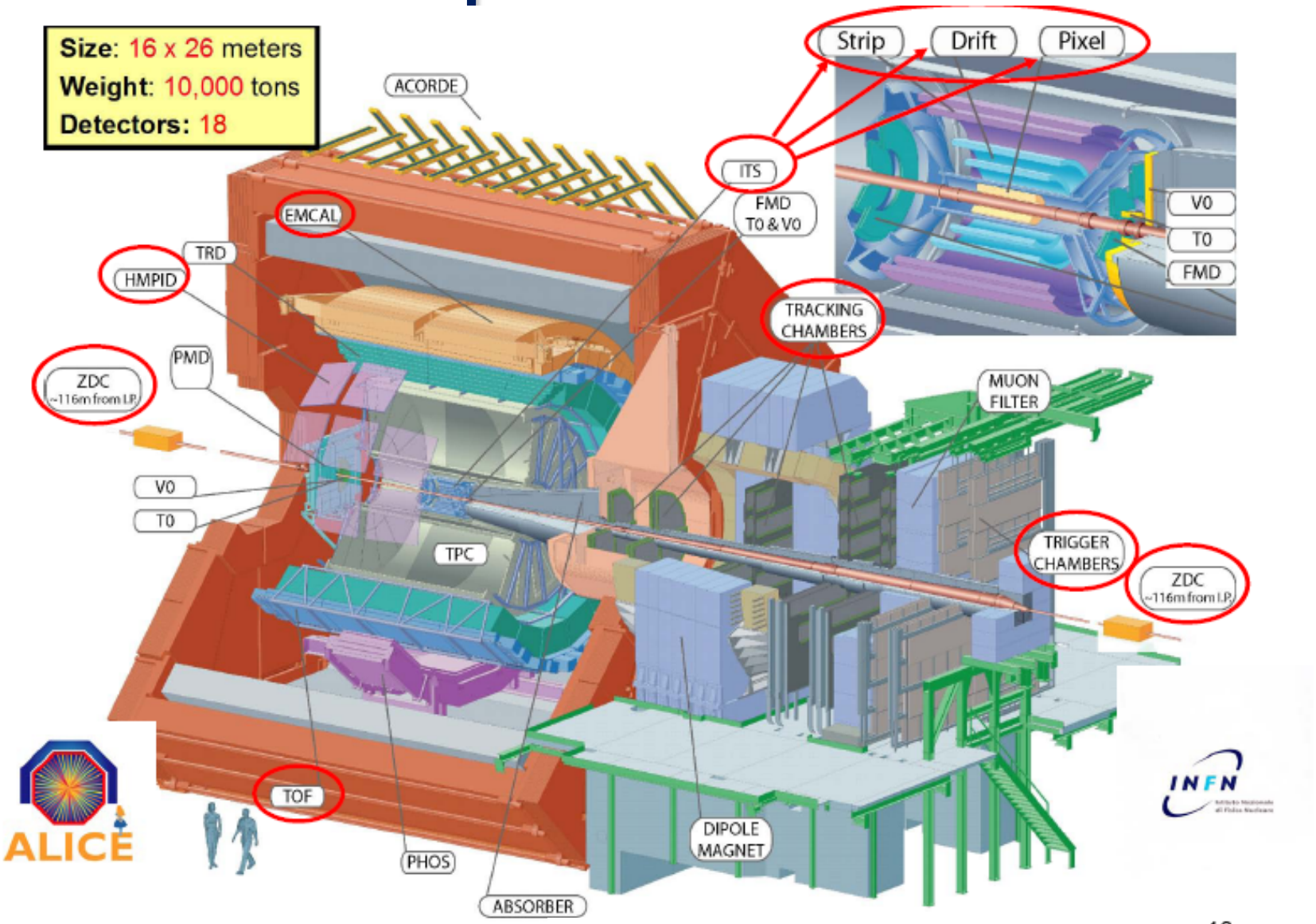
2 nuclei di Piombo collidono ad altissima energia creando un sistema ad altissima densità



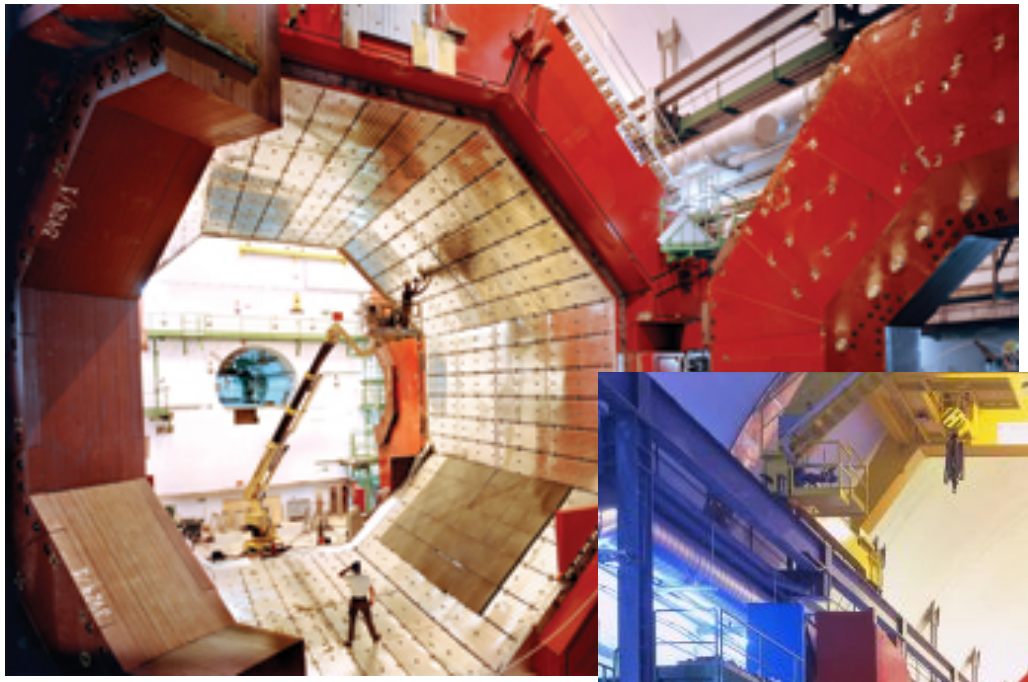
La collisione in Alice

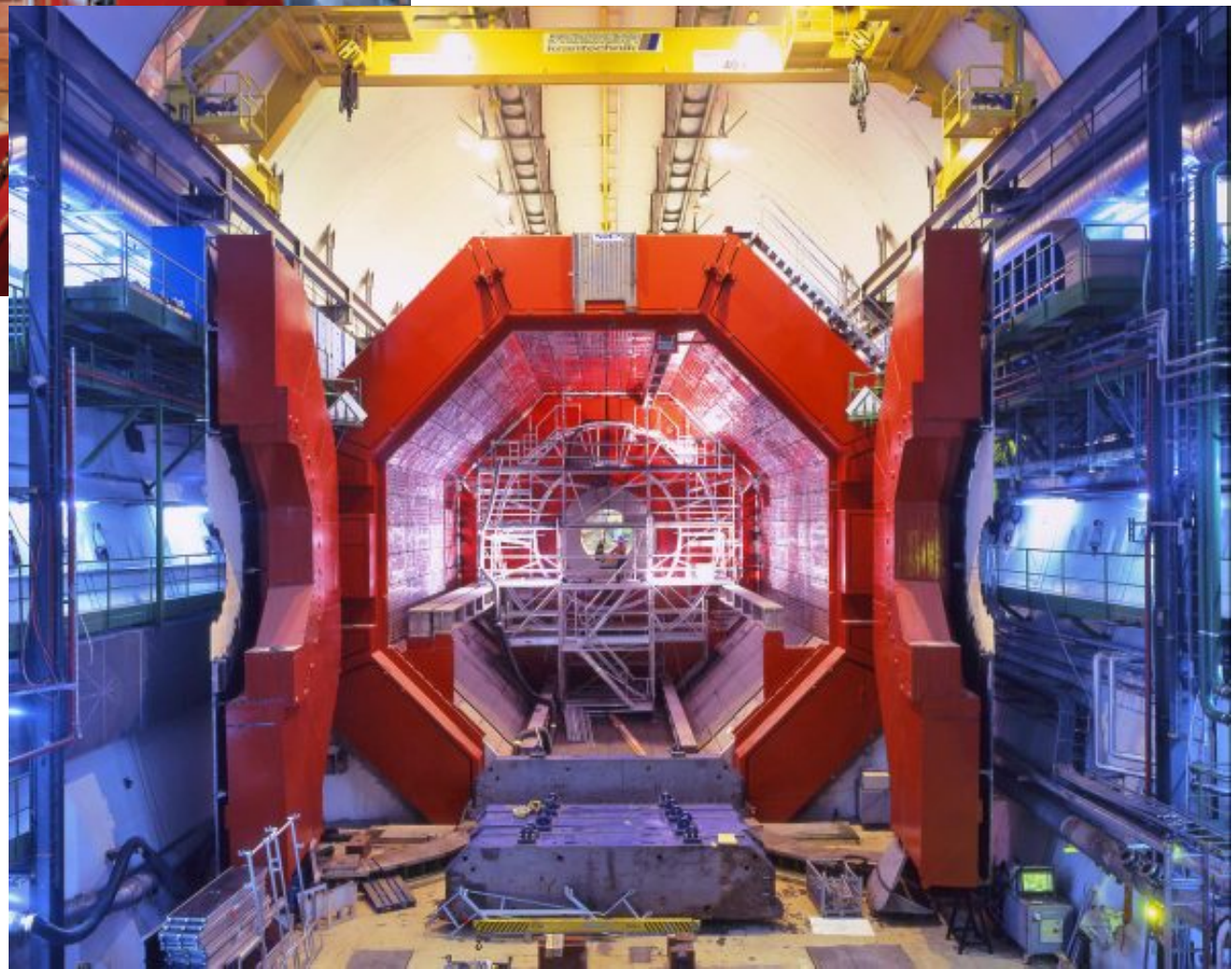


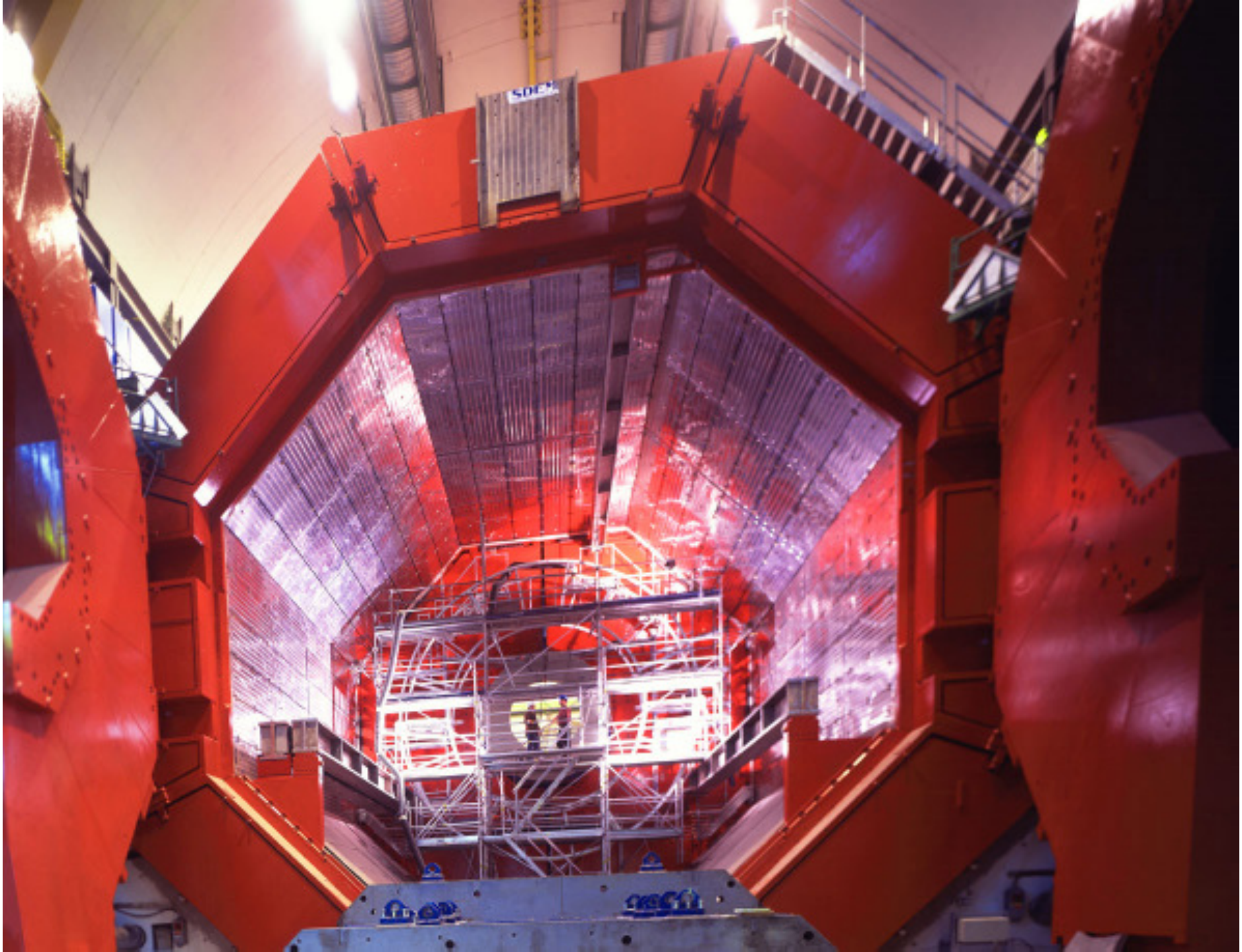
Lo spettrometro

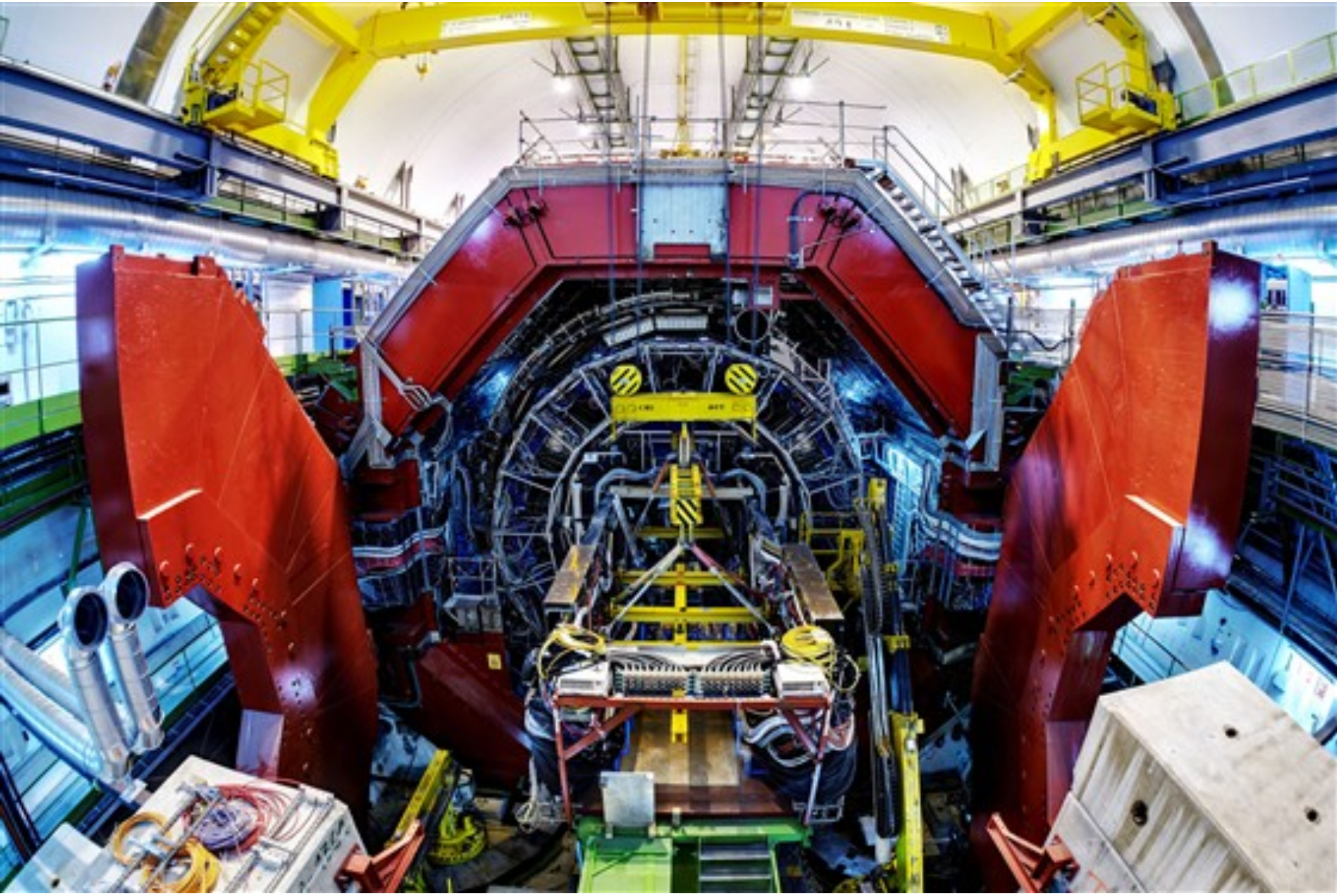


: Rivelatori sotto la completa o parziale responsabilità INFN

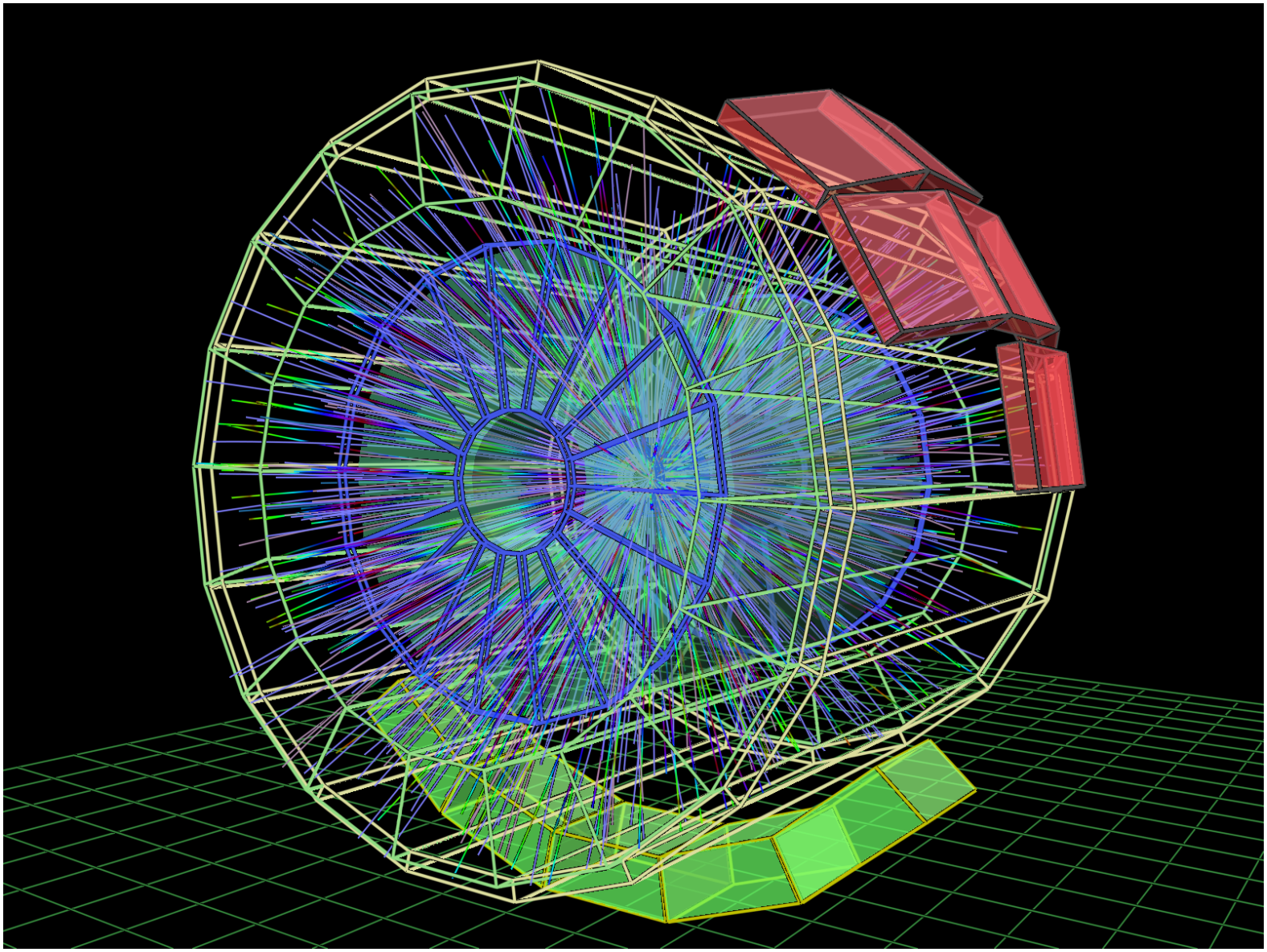




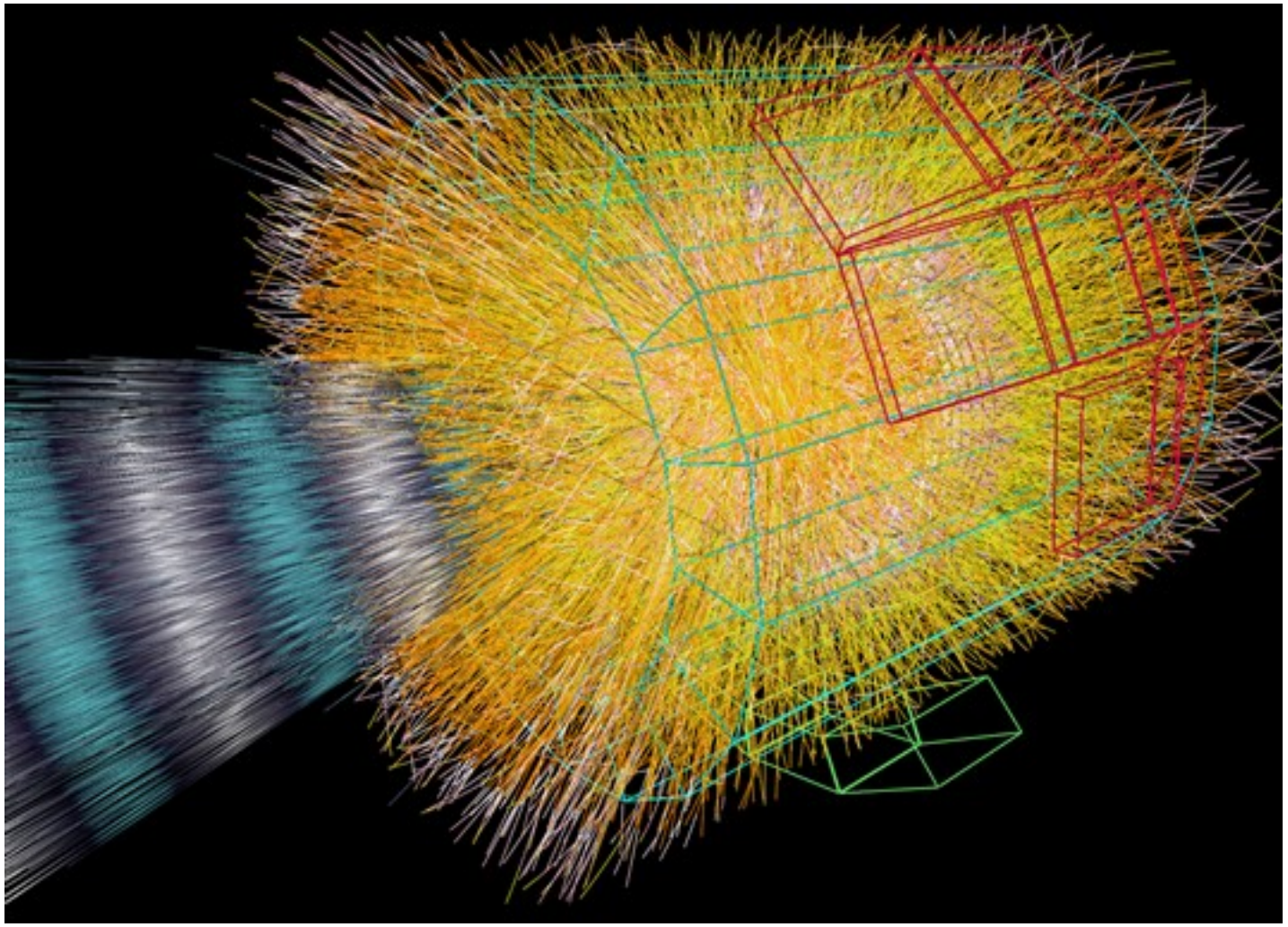




Eventi pp in Alice



Eventi PbPb in Alice

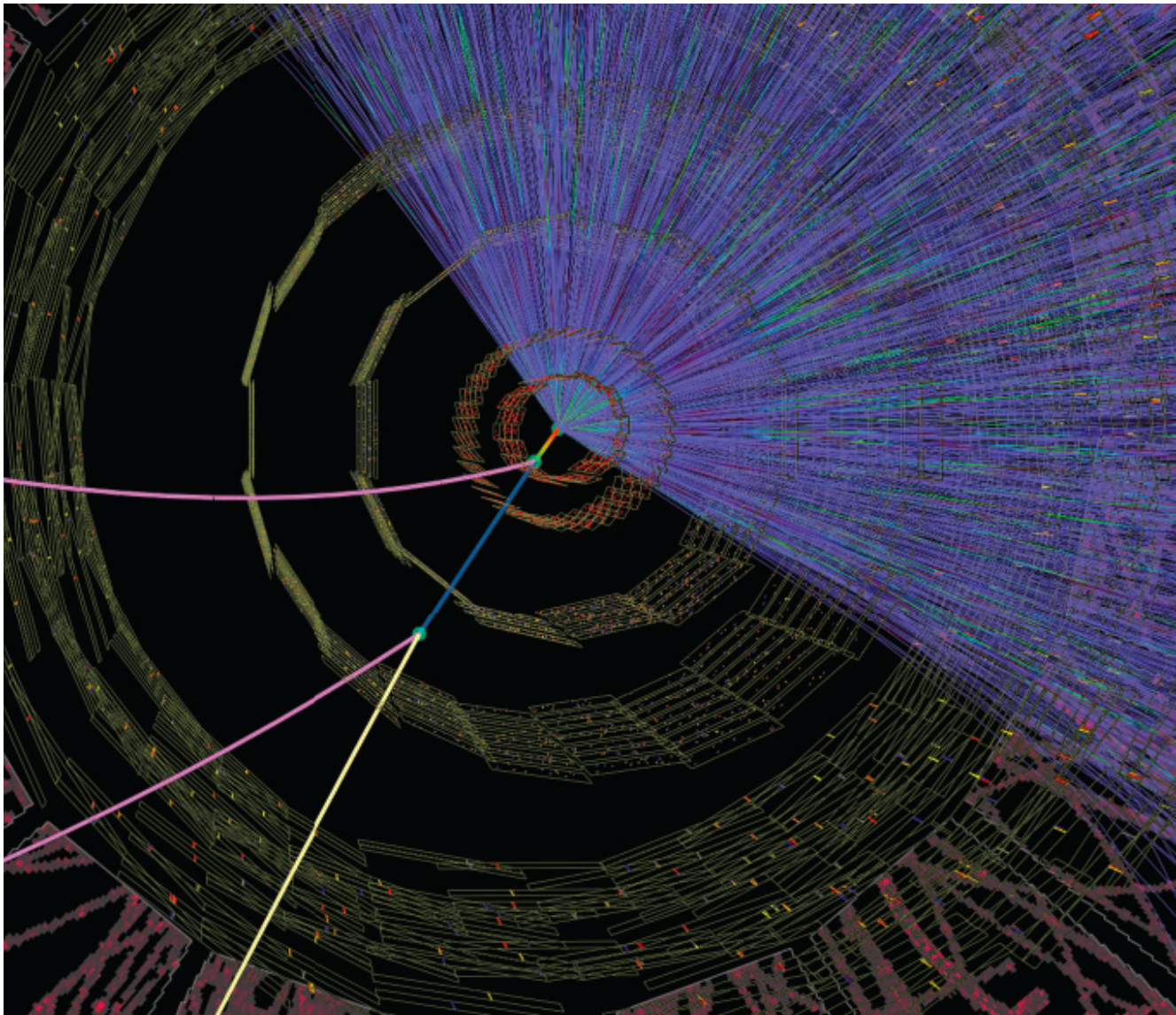


Migliaia di tracce prodotte ad ogni interazione (25 ns)

Selezione di tracce "buone"

Eccellente tracking + vertice + Identificazione di particelle (PID)

$\Xi^- \rightarrow \Lambda\pi^-$



$\pi(u\overline{u})$ $\quad p(uud)$

$Ks(d\overline{s})$ $\quad n(udd)$

$\Lambda(uds)$

$K^0_s \rightarrow \pi^+\pi^-$

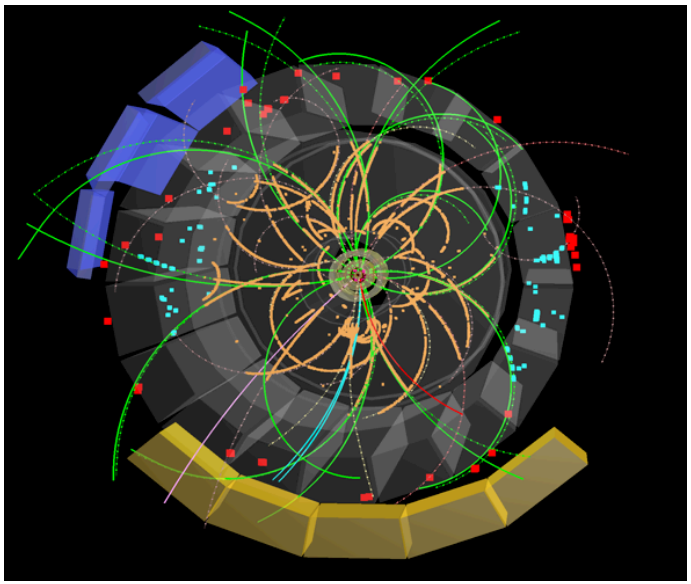
$\tau = 0.89 \times 10^{-10}$ s

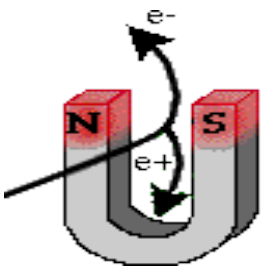
$c\tau = 3\times10^{10}$ cm $s^{-1} \times 0.89 \times10^{-10}$ s = 2.67 cm dal punto d'interazione

$\Lambda \rightarrow \pi^-p$

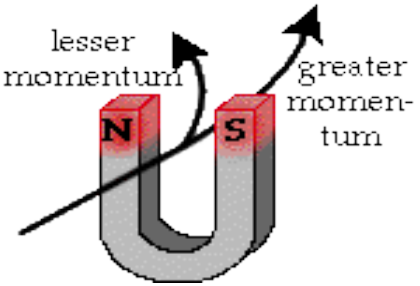
$\tau = 2.6 \times 10^{-10}$ s

$c\tau = 3\times10^{10}$ cm $s^{-1} \times 10^{-9}$ s = 7.2 cm dal punto d'interazione





Identifica
la carica

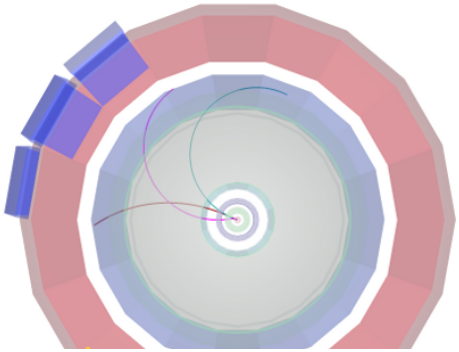


Misura
l'impulso

$\Xi^- \rightarrow \Lambda\pi^-$

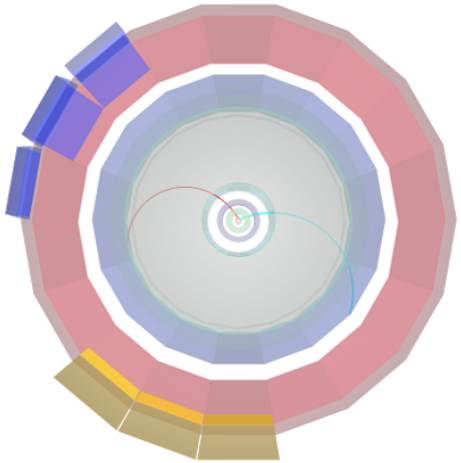
$\downarrow$

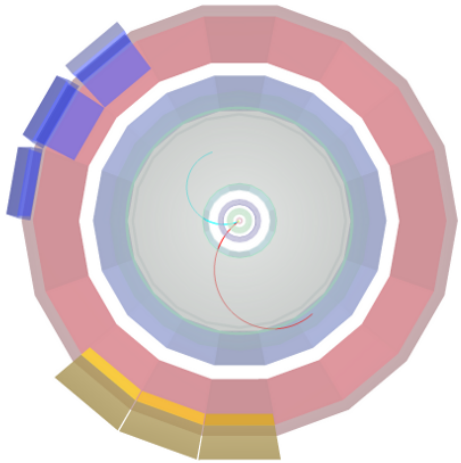
$\Lambda \rightarrow \pi^- p^+$

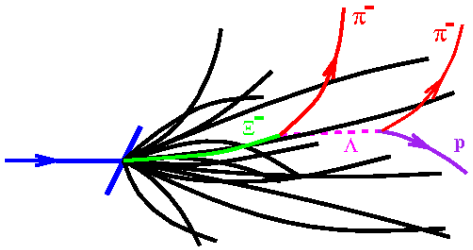


Simmetrico

Asimmetrico







$K^0_s \rightarrow \pi^+\pi^-$

$\Lambda \rightarrow \pi^- p^+$

Decadimento di un "cascade"

- Identificazione e conteggio di particelle strane →calcolo massa invariante →inserimento in istogramma

- Istogrammi (anche) "a mano"

- Rapporto di stranezza: tabella 1 e 2

- Integrazione dei risultati

- Sottrazione fondo

- Rapporto segnale/fondo

- Evidenza di QGP?