Highlights from recent ALICE results

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Contents

Some of the ALICE physics goals:

- **study the properties of Quark-Gluon Plasma**
  I will focus on:

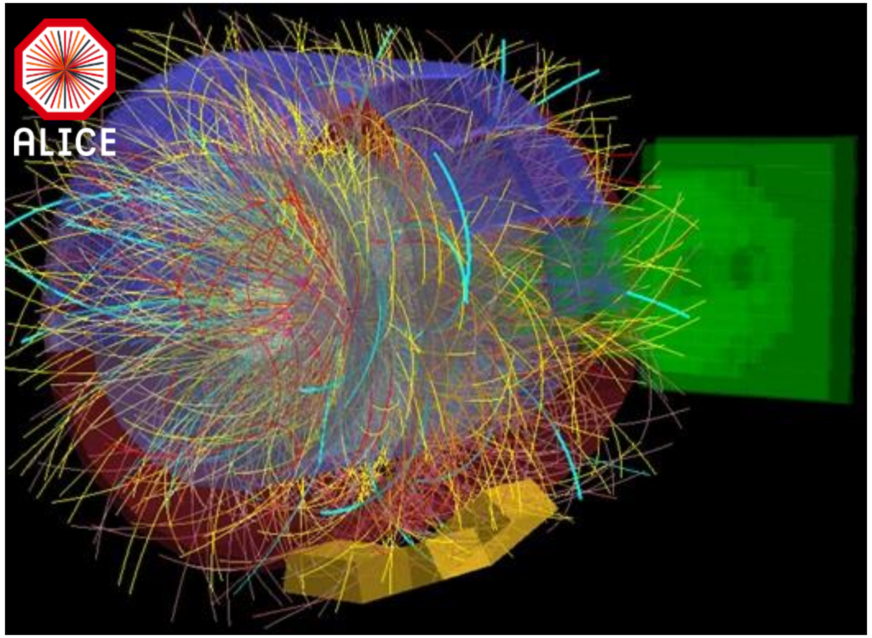
→ Hadron suppression
→ Quarkonia suppression
→ J/ψ elliptic flow in Pb–Pb collisions

New results from Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV

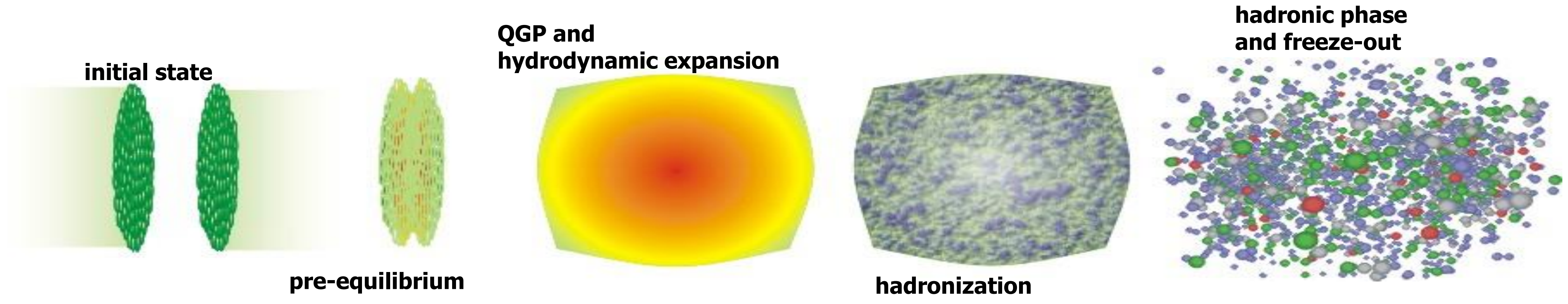
- **study QCD in small systems**

→Enhanced production of multi-strange hadrons in high-multiplicity pp collisions

New results from pp collisions at $\sqrt{s}$ = 7 and 13 TeV



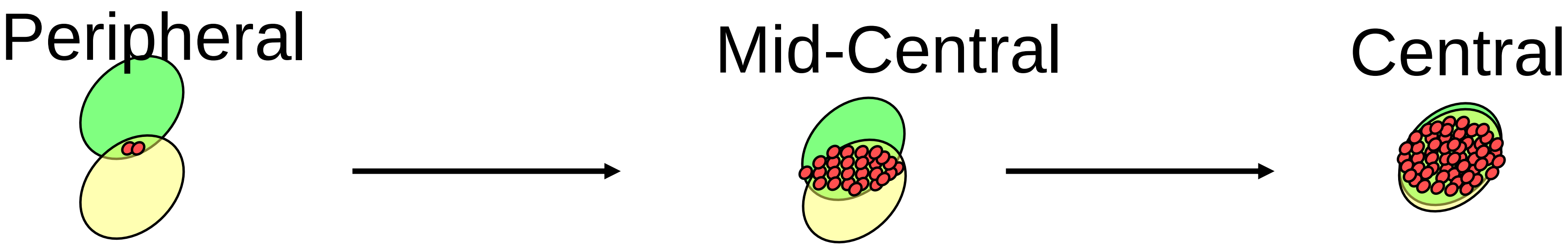
The main windows into the QGP

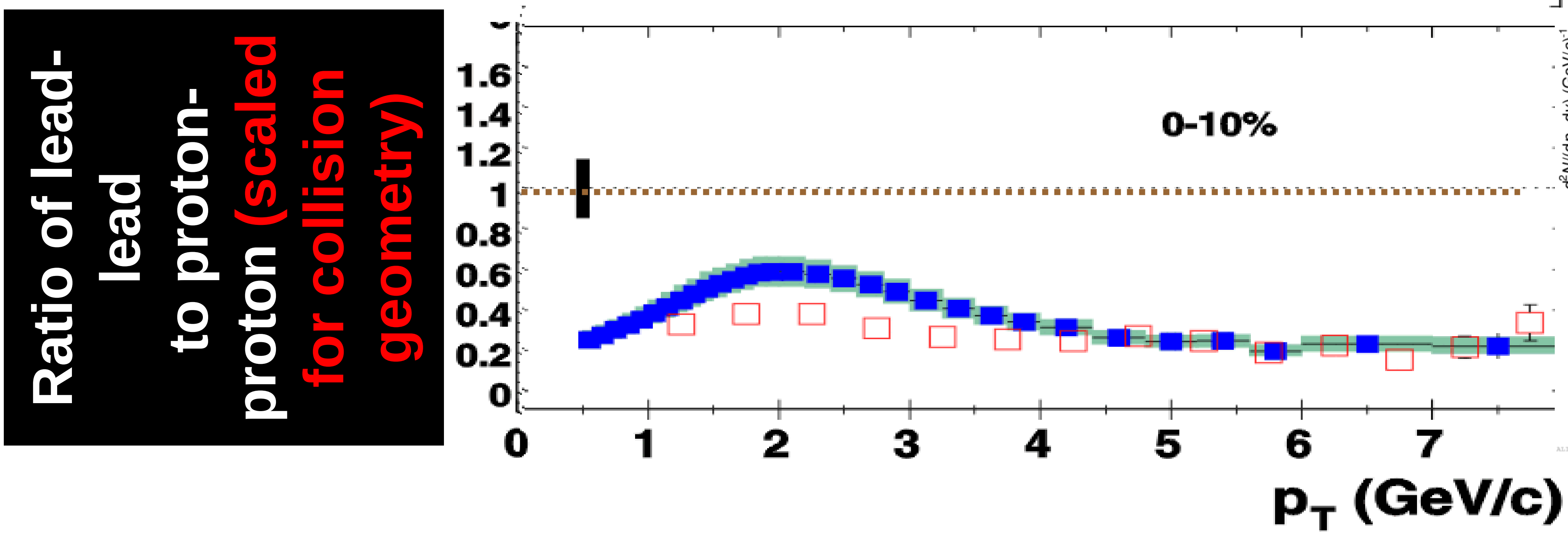


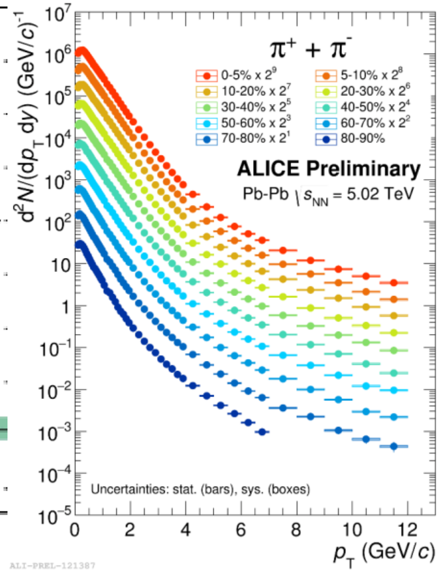
- Particles produced by hadronisation from the QGP (low to intermediate p_T)
- Particles that probe the QGP by interacting with it: high p_T and heavy flavor
- Everything involving a hard scale is produced before the QGP is formed

- We detect only signals from the last stage.

Comparing high momentum particle spectra





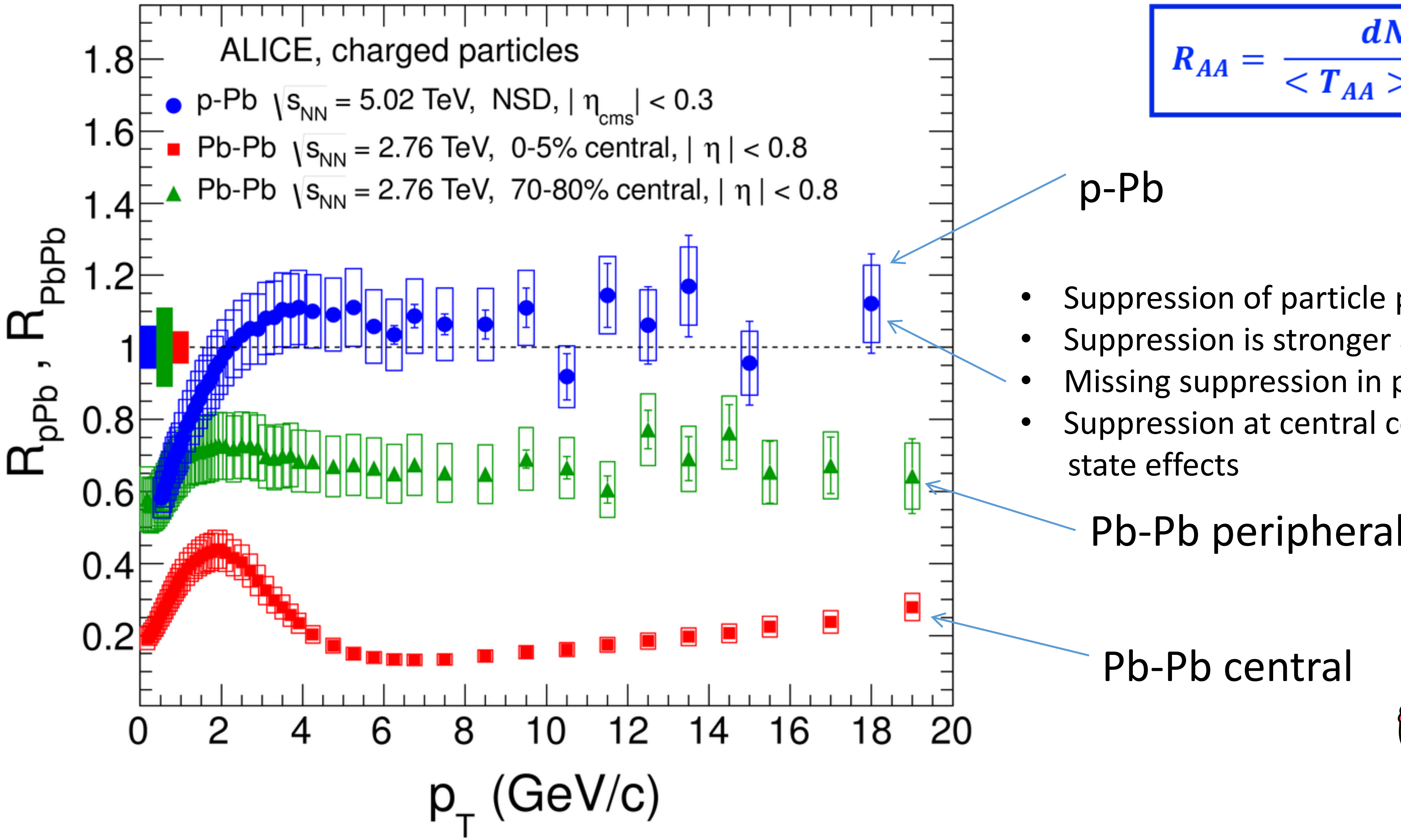


→ We "lose" high momentum particles for central collisions

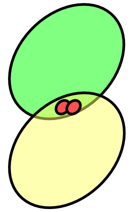
R_{AA} for charged hadrons

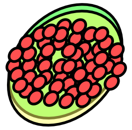
Phys. Rev. Lett. 110 (2013) 082302

$$R_{AA} = \frac{dN_{AA}/dp_T}{< T_{AA} > \times\, d\sigma_{pp}/dp_T}$$



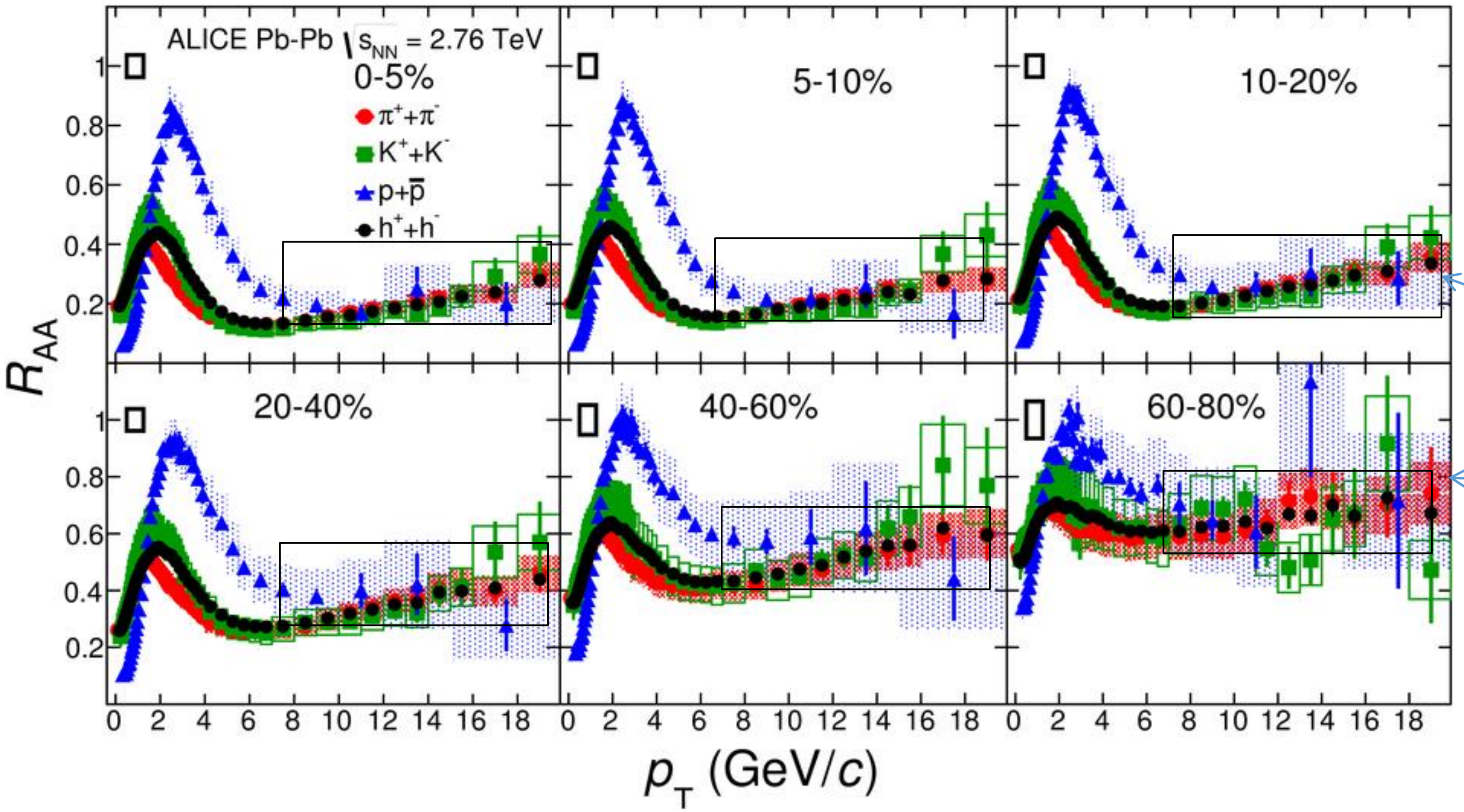
- Suppression of particle production in Pb-Pb collisions
- Suppression is stronger at more central collisions
- Missing suppression in pPb
- Suppression at central collisions **is not** due to initial state effects





R_{AA} for identified particles at different centralities

Phys. Rev. C93 (2016) 034913



Particle composition in jets is not modified significantly.

The fact that all hadrons (high p_T) are suppressed by the same amount is an indication that the energy loss acts on partons, not hadrons.

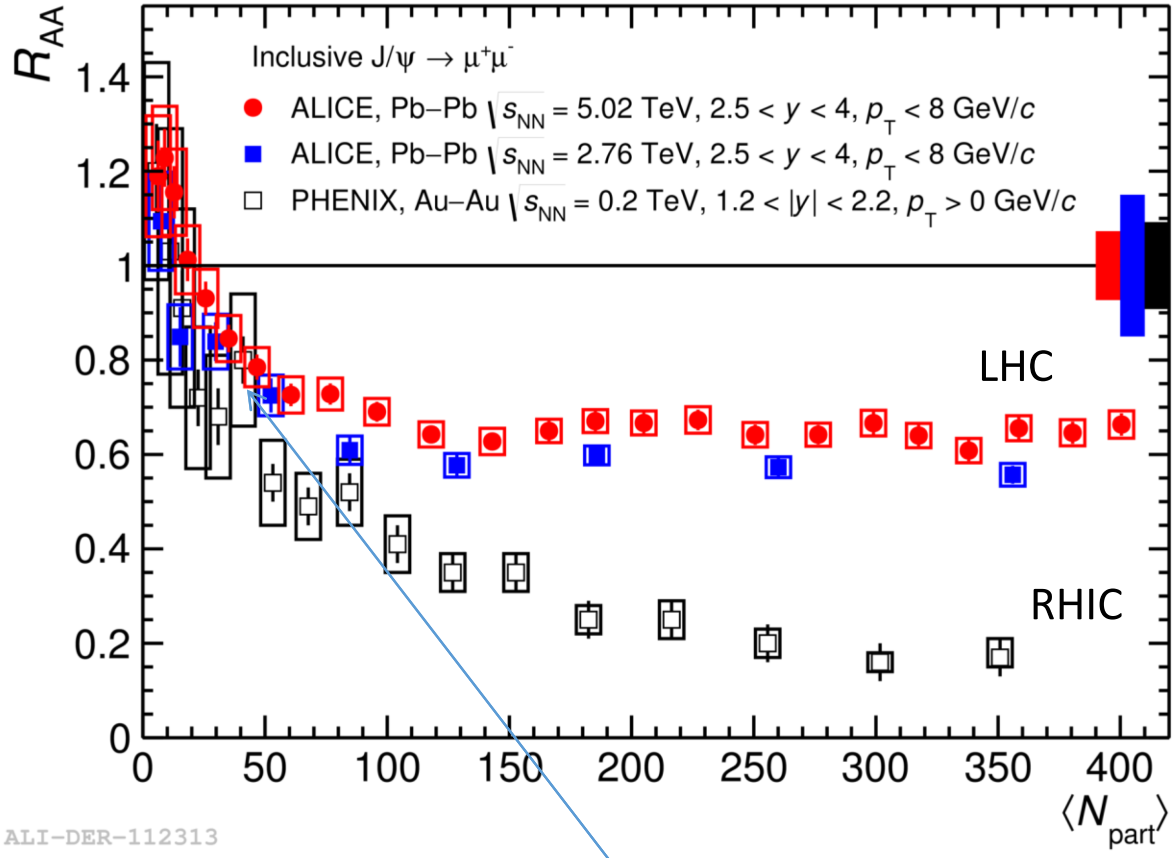
→ «X-ray» of the medium

- R_{AA} at high p_T significantly < 1 for central collisions indicates **strong medium effects**
- R_{AA} for p, K, π, similar for p_T ~8 GeV/c → **flavour-independent energy loss**

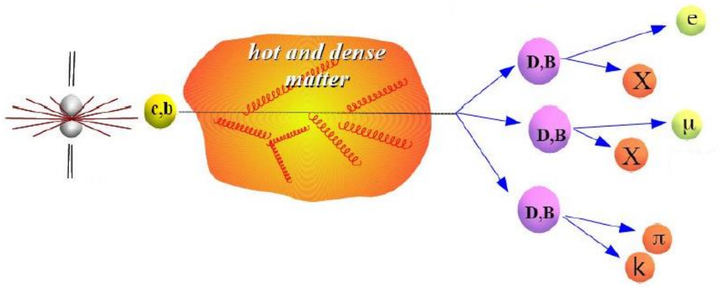
→ **fragmentation functions** not strongly affected by the medium

Heavy-flavour production: Quarkonia in Pb Pb

Phys. Lett. B 766 (2017) 212-224

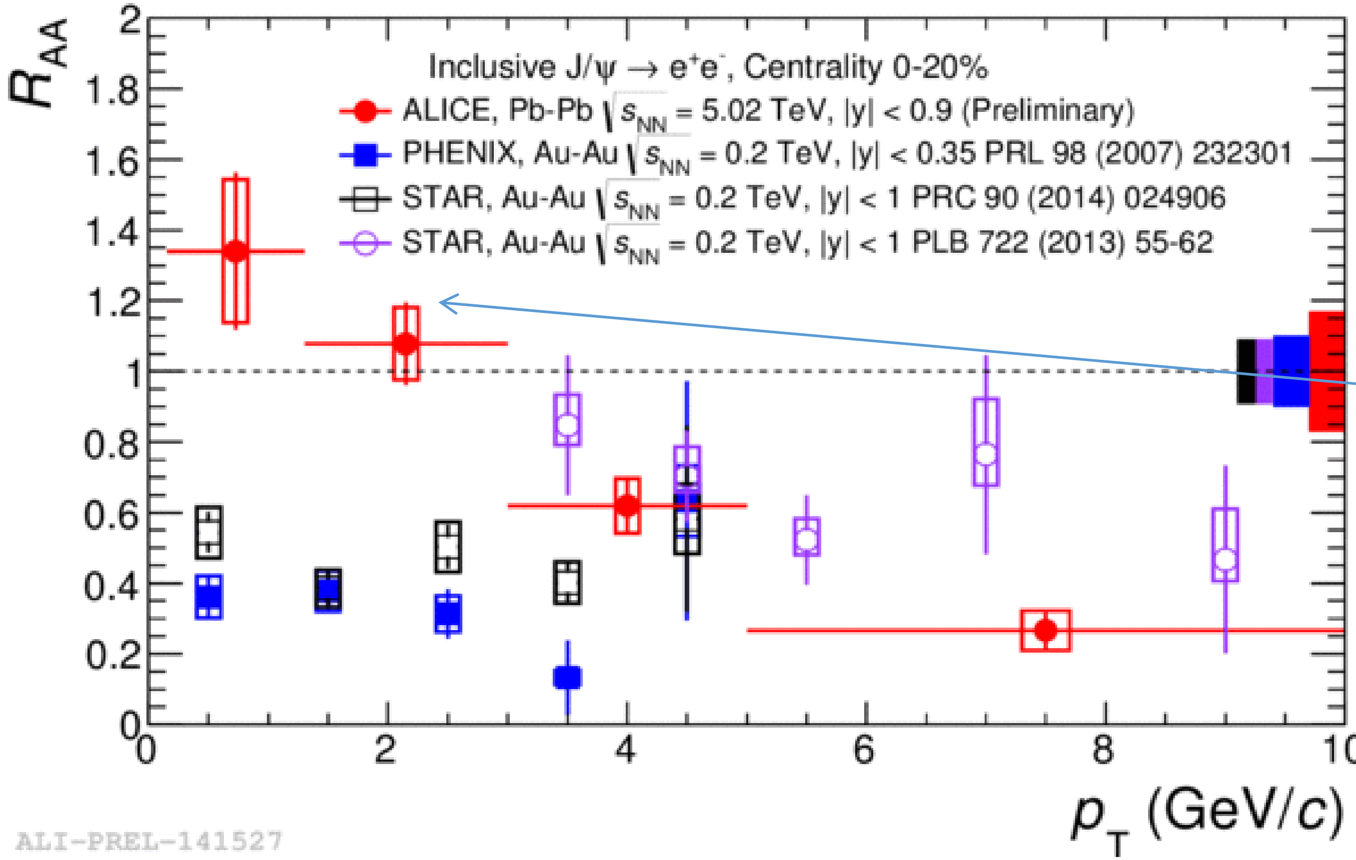


Heavy quarks are produced at early collision stages, and cross the hot and dense medium before hadronising

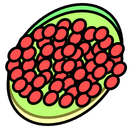


Stronger suppression at RHIC than at LHC despite larger energy density at LHC: regeneration?

Heavy-flavour production: Quarkonia in Pb Pb



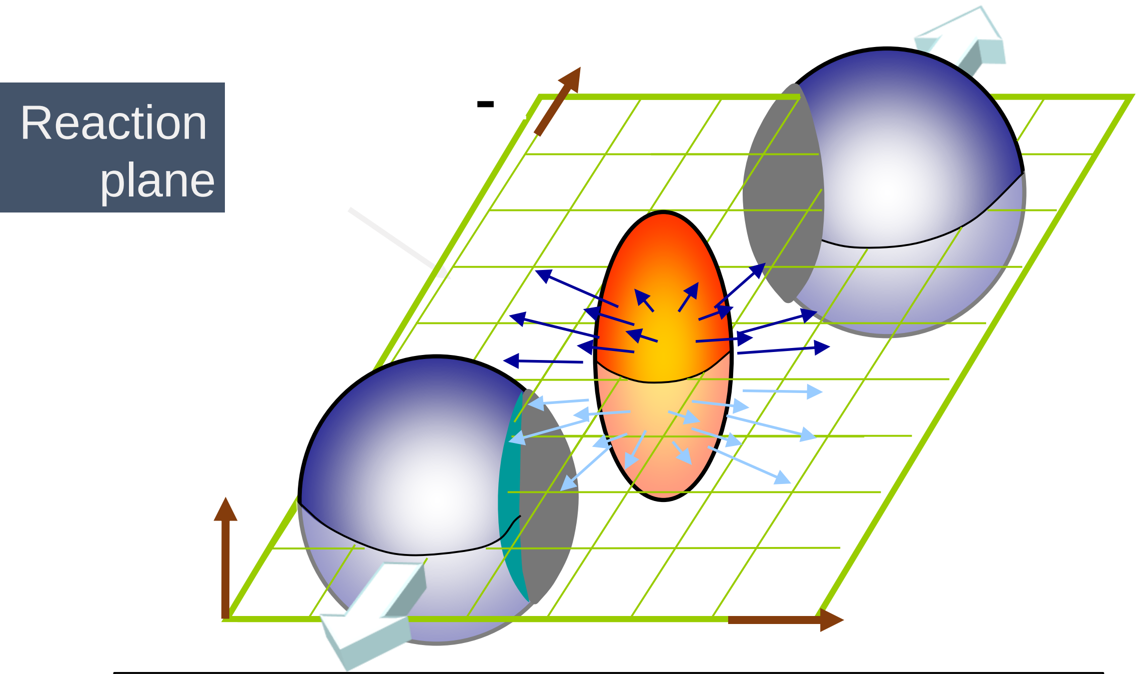
Central



- At low p_T there is no suppression
- Evidence for regeneration
- Regeneration requires deconfinement

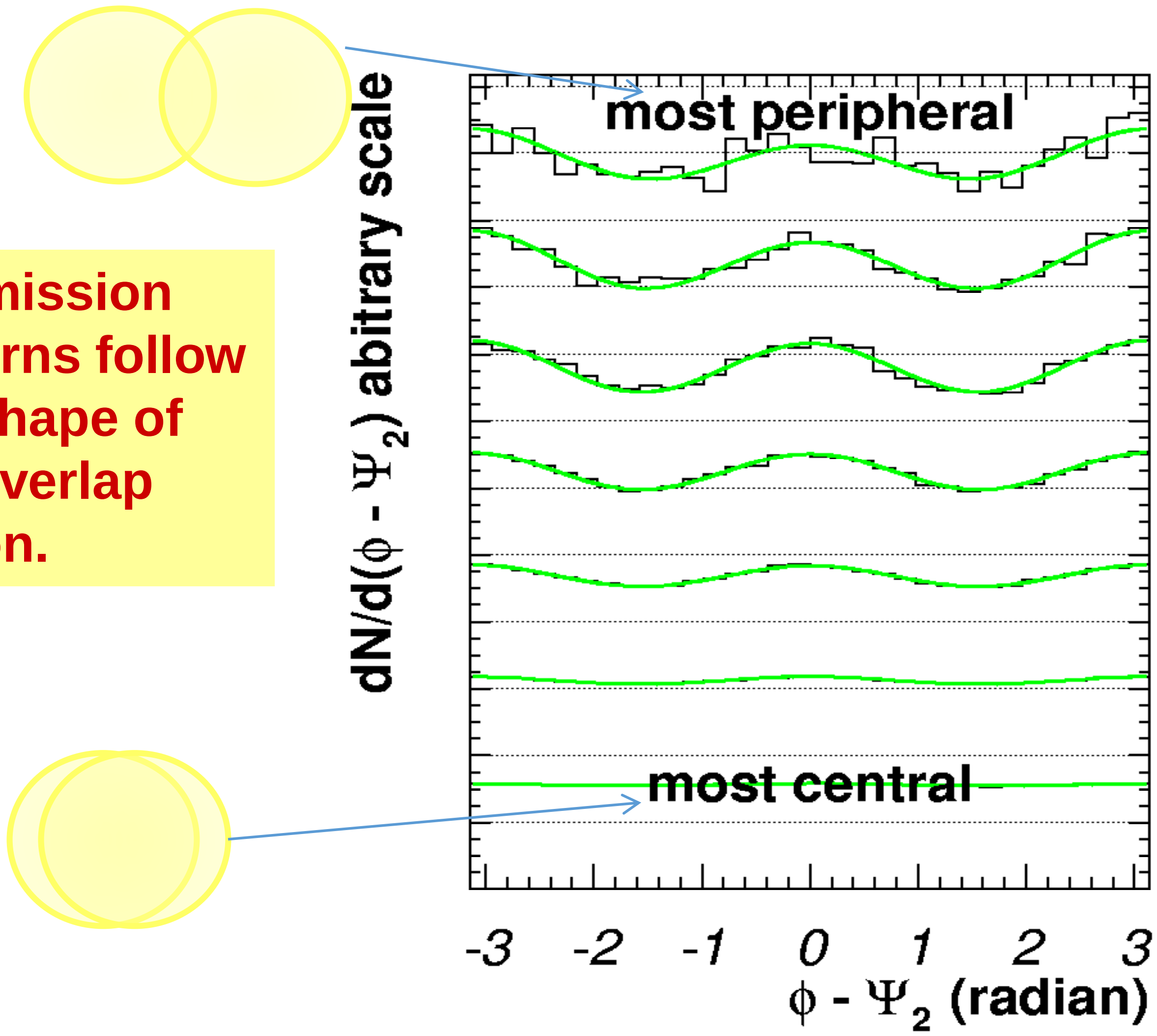
In central collisions: larger suppression for higher p_T

Elliptic flow



$$\frac{dN}{d(\varphi-\theta_R)} = 1 + 2v_n \cos(n(\varphi-\theta_R))$$

→ **Emission patterns follow the shape of the overlap region.**

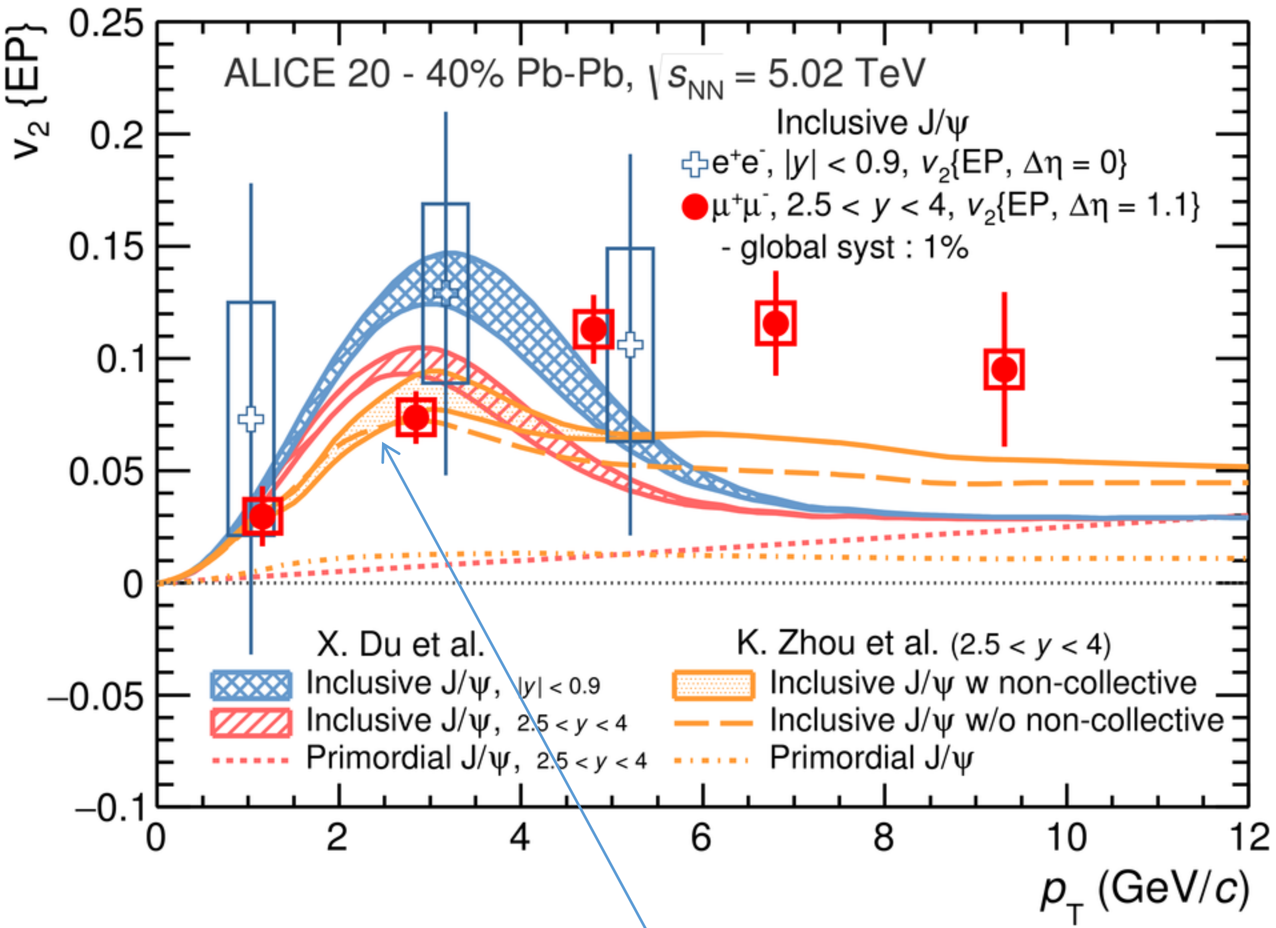


Elliptic flow observable is sensitive to the early evolution of a system

Large v_2 is an indication of early thermalization

Inclusive J/ψ v2 (p_T) at forward and mid-rapidity for central Pb-Pb collisions

Charm Flows



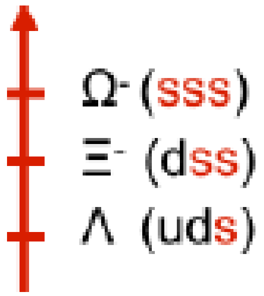
Phys. Rev. Lett. 119 (2017) 242301

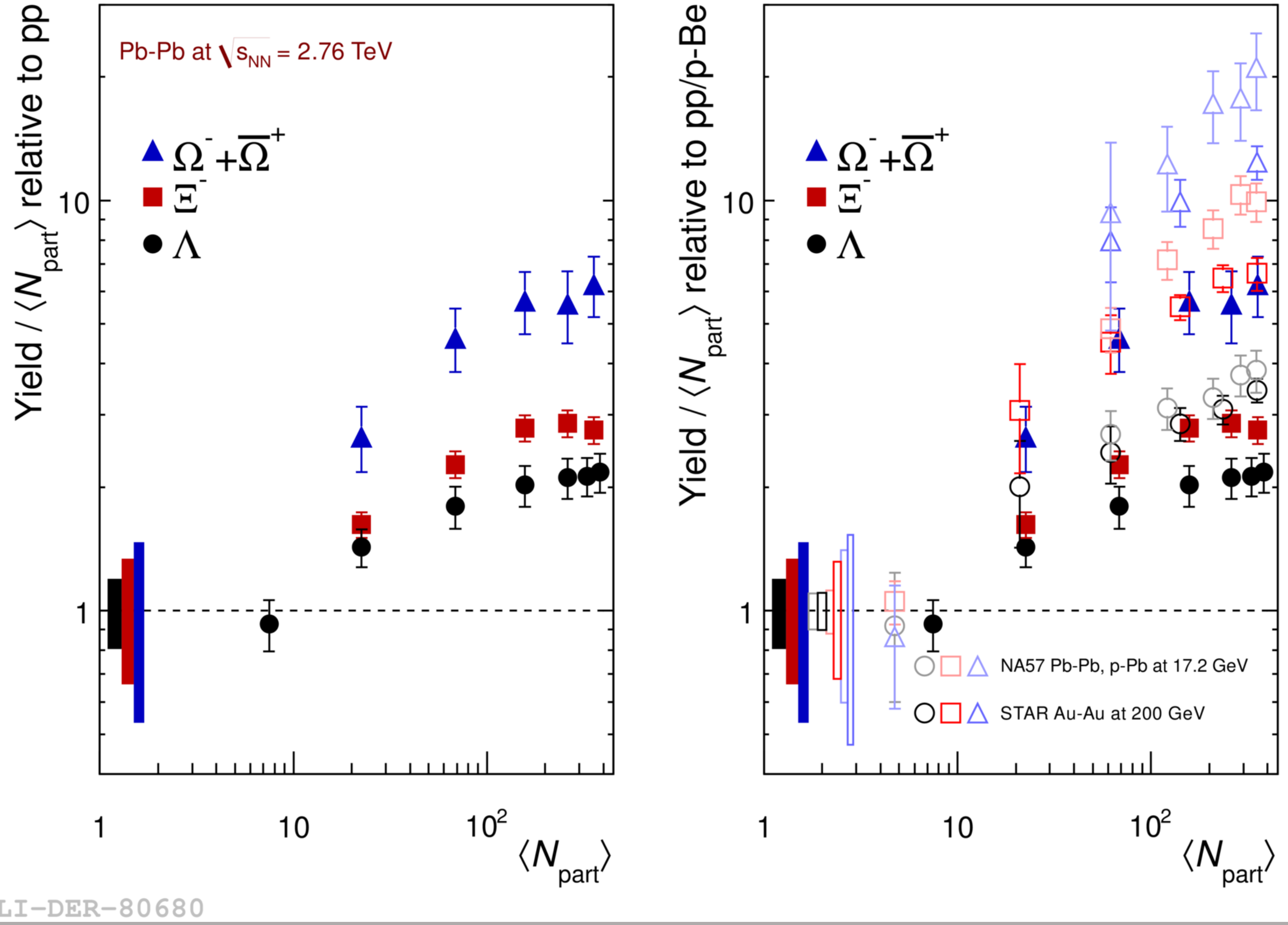
- Strong coupling of c-quark with the medium
- Participation of low p_T charm to collective motion in the QGP
- Hadronisation via recombination enhances flow effects

Strangeness enhancement

Among the first proposed signatures of QGP PRL48(1982)1066
Observed in A-A at SPS, RHIC, LHC

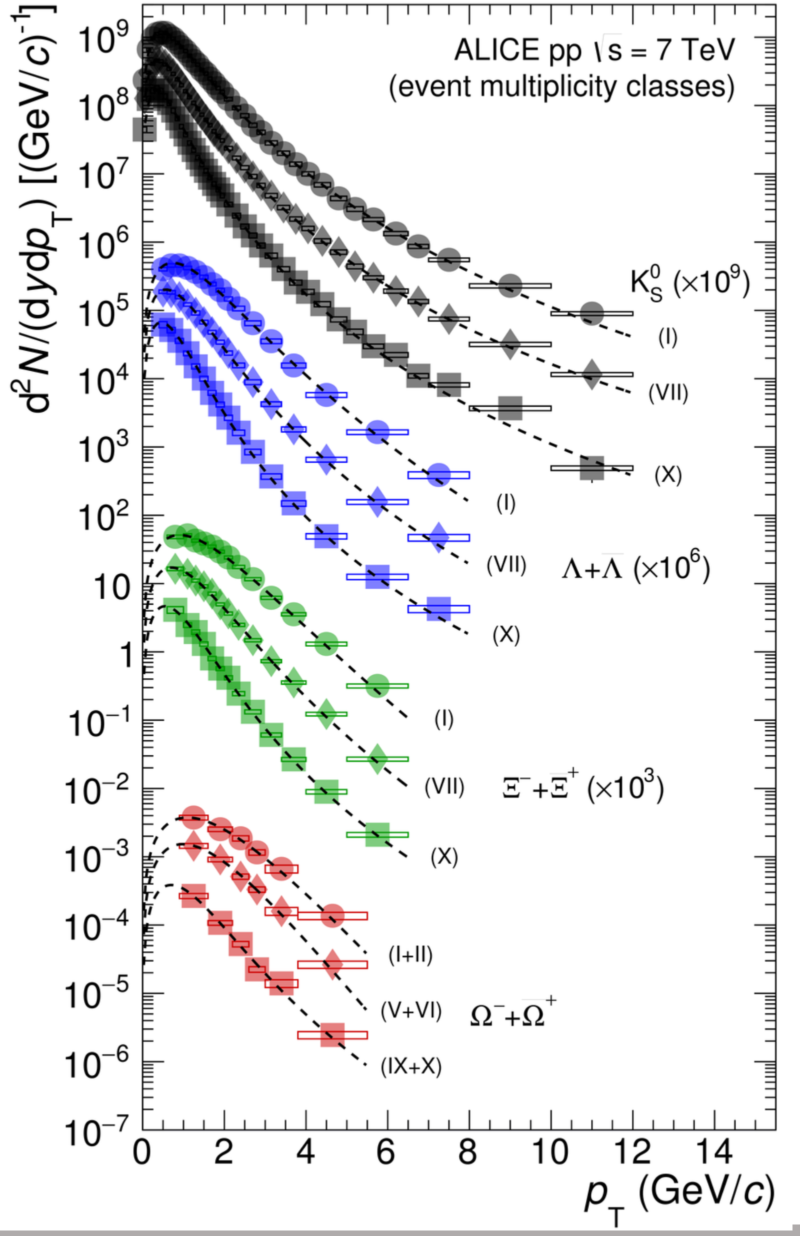
ALICE, Phys. Lett. B 728 (2014) 216





Spectra of primary strange and multi strange hadrons in pp collisions

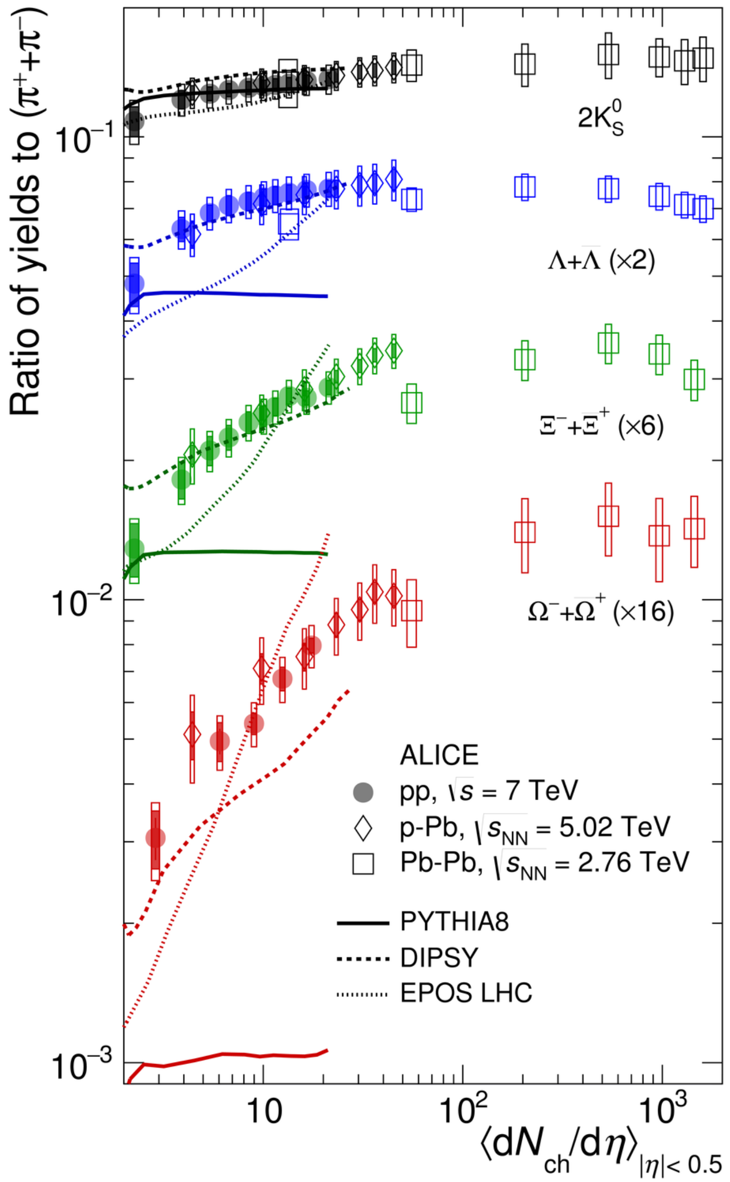
Nature Physics 13 (2017) 535-539



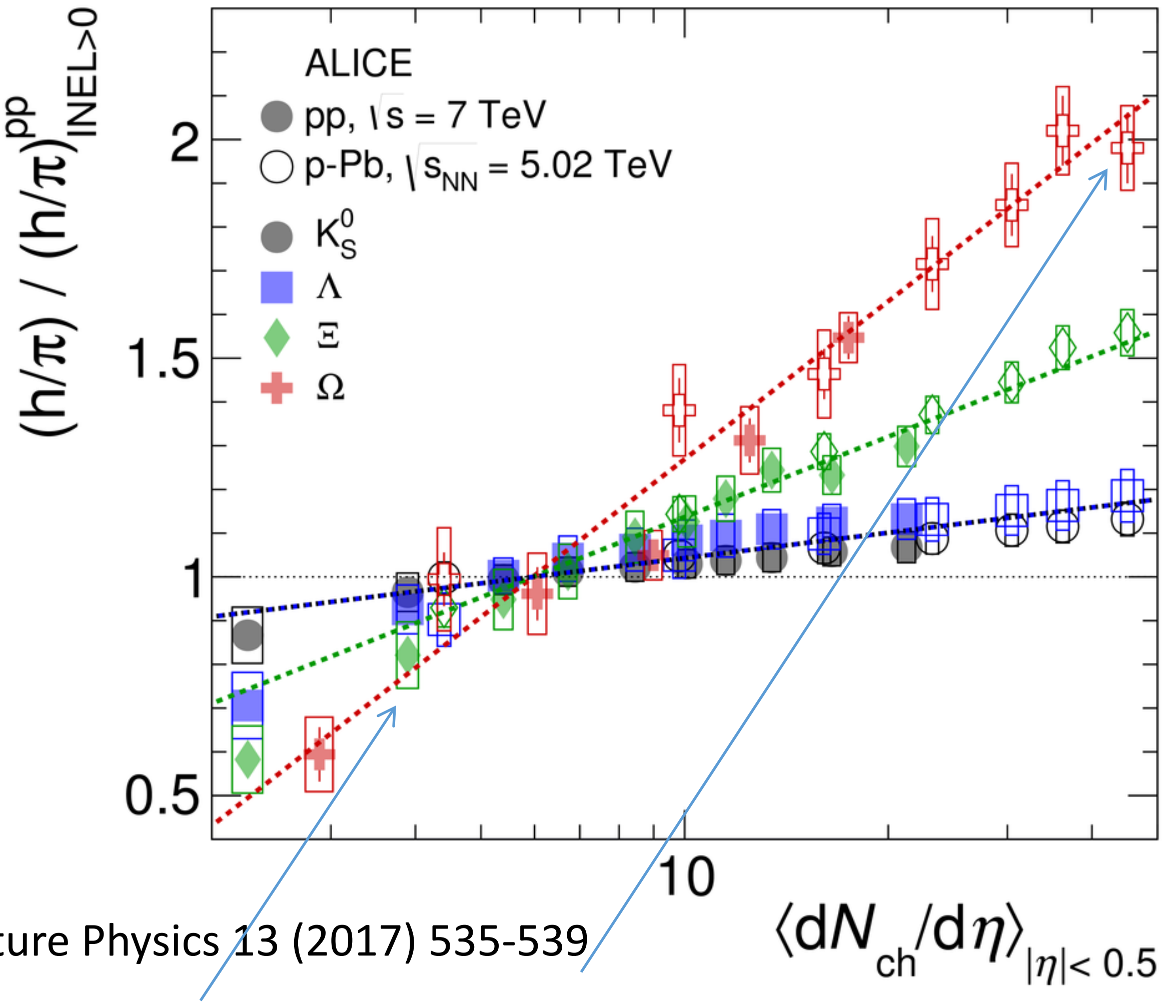
- √s=7 TeV

- Midrapidity |y|<0.5
- At least one charged particle in |η|<1
- Event classes (I-X) progressively decreasing multiplicity.
- In high multiplicity increase of mean p_T

Strangeness enhancement also observed in pp and p-Pb collisions



Smooth evolution of particle ratios with multiplicity

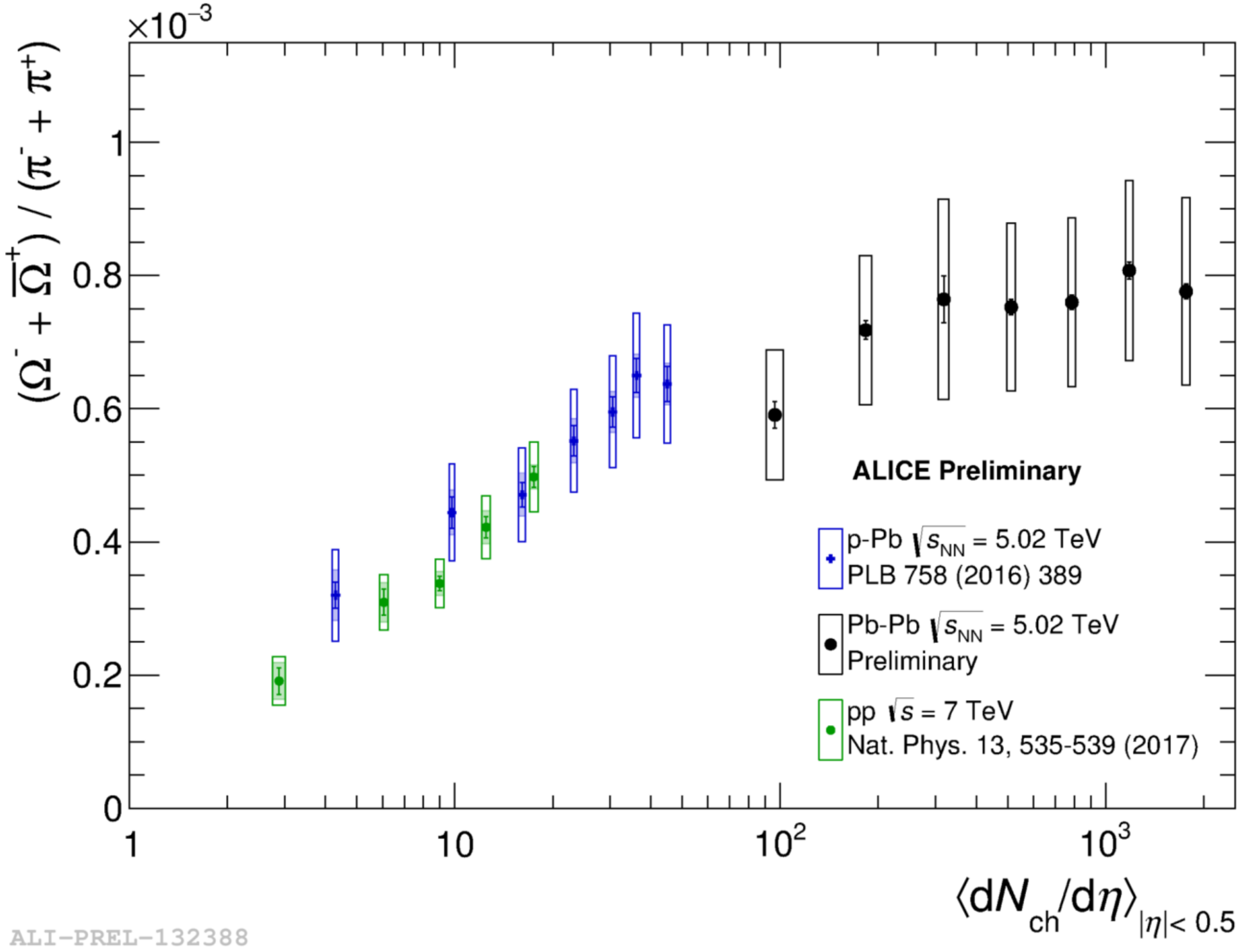


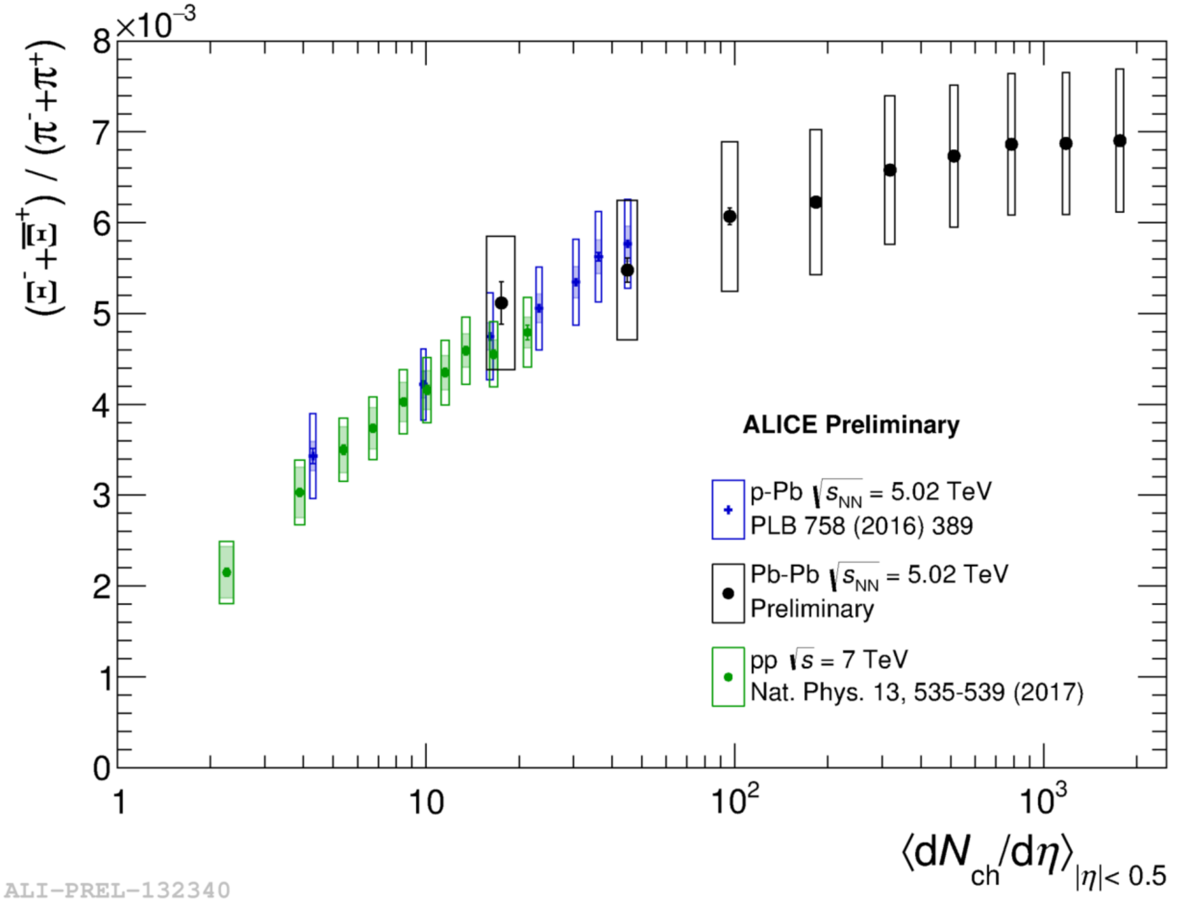
Nature Physics 13 (2017) 535-539

Particle production in minbias and high-multiplicity pp is different.

Ω/π increase for factor 1.5 (high multiplicity to minbias)

Strangeness in Pb-Pb at $\sqrt{s_{NN}}$ =5.02 TeV





- Pb-Pb ratios follow the trend from pp and p-Pb
- The ratios of integrated yield seem to saturate at higher values of $dN_{ch}/d\eta_{ch}$
- Will pp and pPb also saturate?
- High multiplicity triggers at 13 TeV data will allow to look at larger multiplicity in pp

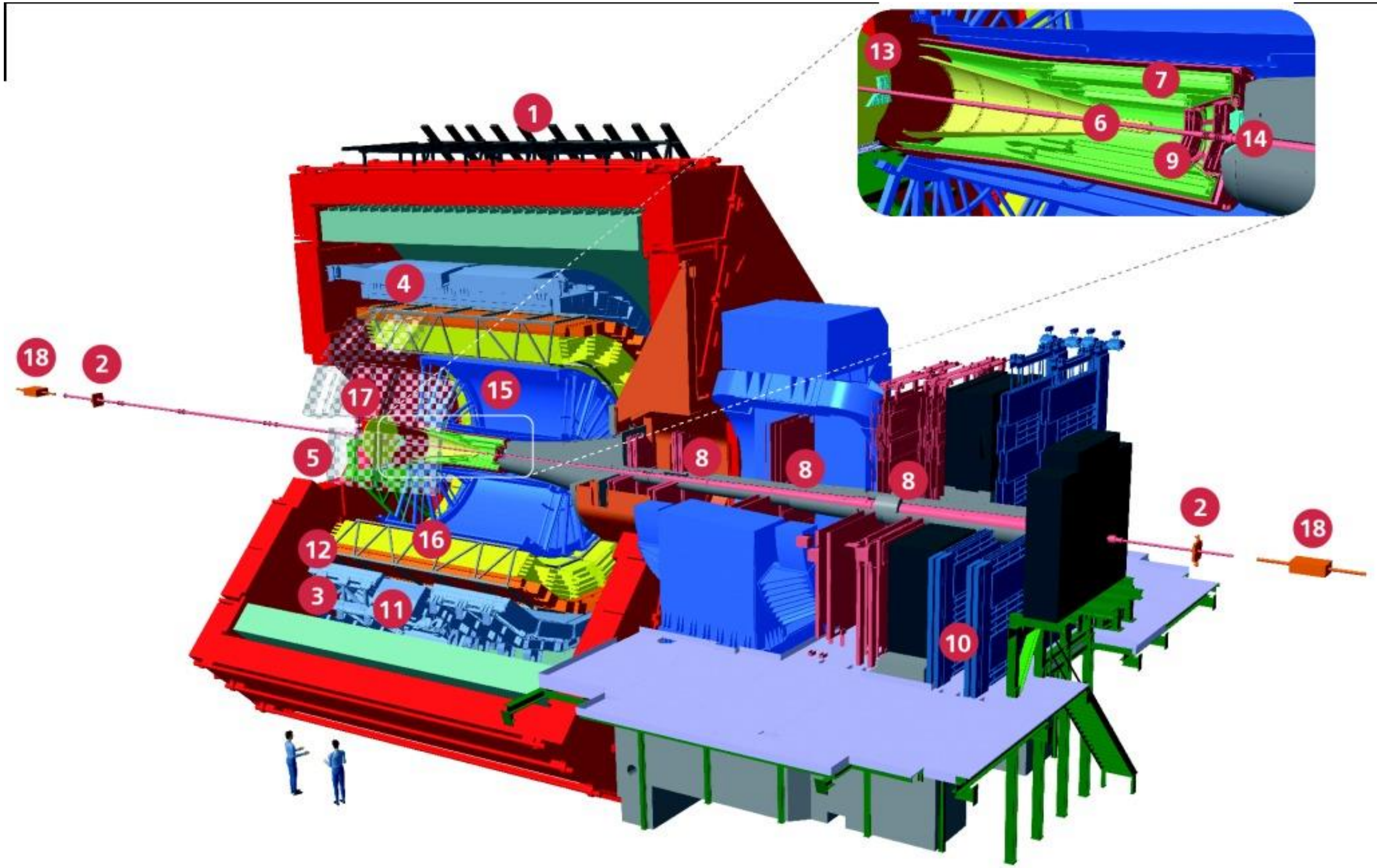
Summary

- The ALICE capabilities allow for the measurement of a **wide range of observables, from hadron and charm suppression to strangeness enhancement**, to characterise the hot and dense Quark Gluon Plasma formed in heavy-ion collisions at the LHC

- ALICE also has a **rich program for non-QGP physics**: QCD studies in small systems which show interesting results

- Please check http://aliceinfo.cern.ch for more...

The ALICE set-up



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