High energy nuclear physics at the LHC

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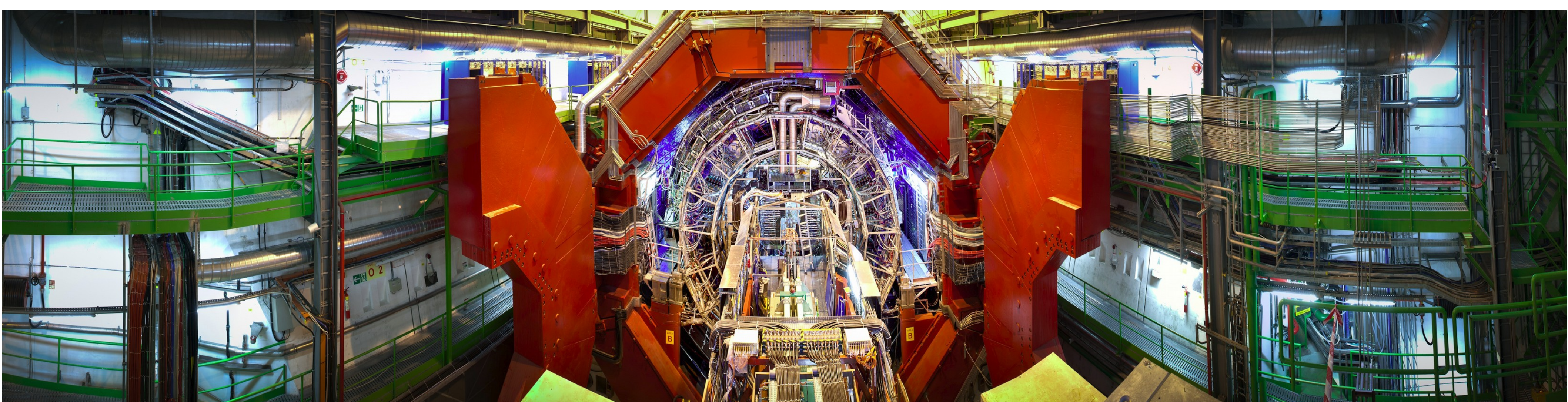
2017/04/05

ALICE
A JOURNEY OF DISCOVERY



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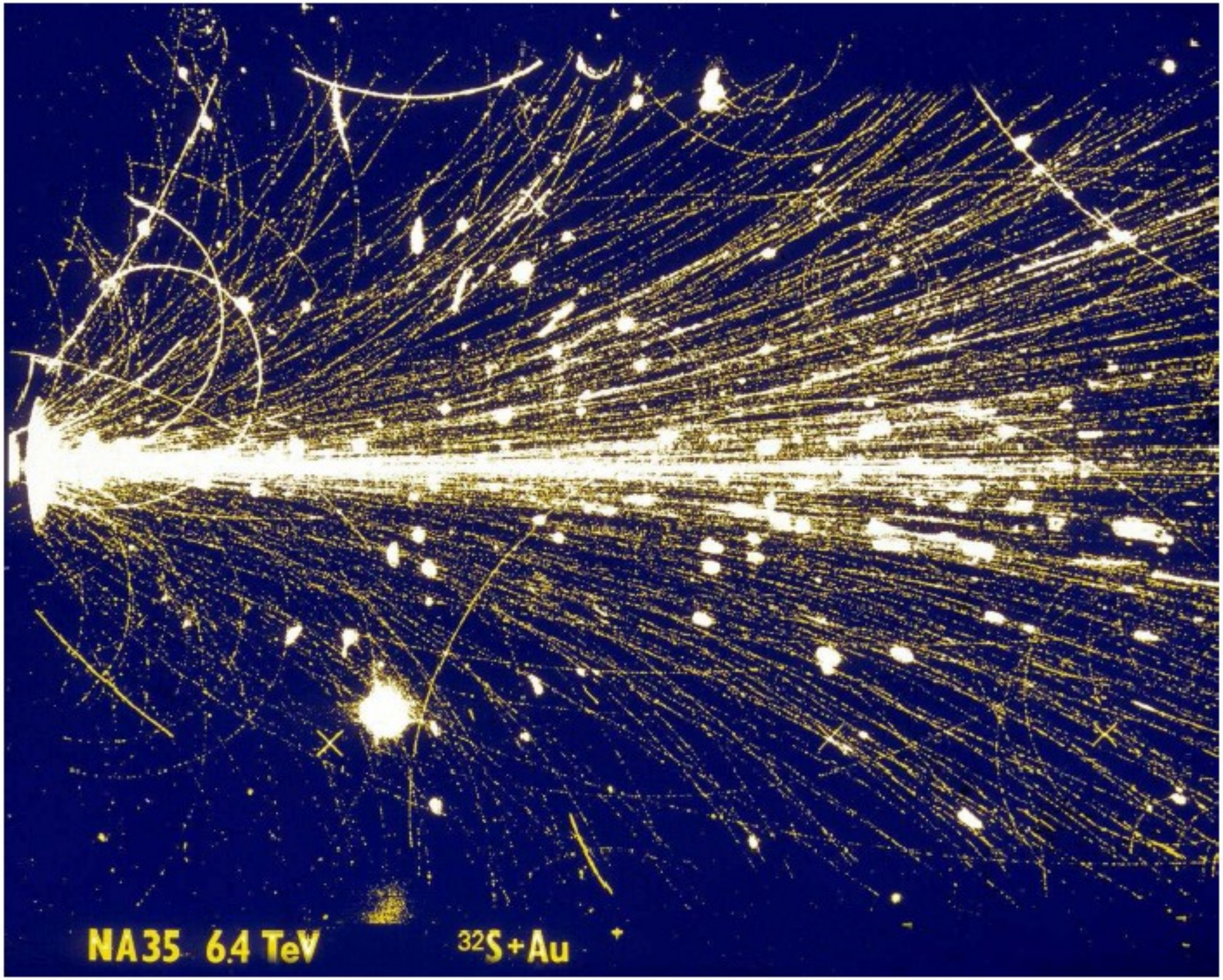
- Introduction
- The ALICE detector
- Physics results

Introduction

What are ultra-relativistic heavy-ion collisions?

- Collisions of (heavy) nuclei at energies much higher than nucleon mass



Heavy ion accelerators

- Past:
  - Bevalac @ LBL, Berkeley (1980-1990): $\sqrt{s_{NN}}$=2.4 GeV
  - AGS @ BNL, Brookhaven (1985-1995): $\sqrt{s_{NN}}$=4.8 GeV
  - SPS @ CERN, Geneva (1987-2004): $\sqrt{s_{NN}}$=17.3 GeV
- Present:
  - SIS @ GSI, Darmstadt: $\sqrt{s_{NN}}$=2.5 GeV
  - RHIC @ BNL, Brookhaven: $\sqrt{s_{NN}}$=200 GeV
  - LHC @ CERN, Geneva: $\sqrt{s_{NN}}$=2760, 5020 GeV
- Future:
  - FAIR @ GSI, Darmstadt (~2020): $\sqrt{s_{NN}}$=5 GeV

Levels of the nuclear world

- Nuclei

  a large variety (Z=1-118, A=2-294), sizes: ~10^{-14} m

  nucleons are bound by about 1% of their mass ($m_p \approx m_n = 1.7\text{x}10^{-27}$ kg)

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- Quarks

  6 flavours (light: u,d; “intermediate”: s; heavy: c,b; “super-heavy”: t)

  each in 3 “colours” (to build colourless hadrons: qqq, $\overline{qqq}$, $q\bar{q}$, …)

  sizes: point-like (<10^{-19} m)

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- … all governed by the strong interaction
- Gravitation is negligible
- (electro)weak interactions act only indirectly (decays, final state interactions)

Quantum Chromo-Dynamics (QCD)

- 6 quarks, 3 colours (RGB)
  and 8 gluons (coloured!)

$$L_{QCD} = \overline{\psi}_i \left(i \left(\gamma^{\mu} D_{\mu} \right)_{ij} - m \delta_{ij} \right) \psi_j - \frac{1}{4} G^a_{\mu\nu} G^{\mu\nu}_a$$

- ...difficult to calculate
  - No analytical solutions (except 1+1)

Quantum Chromo-Dynamics (QCD)

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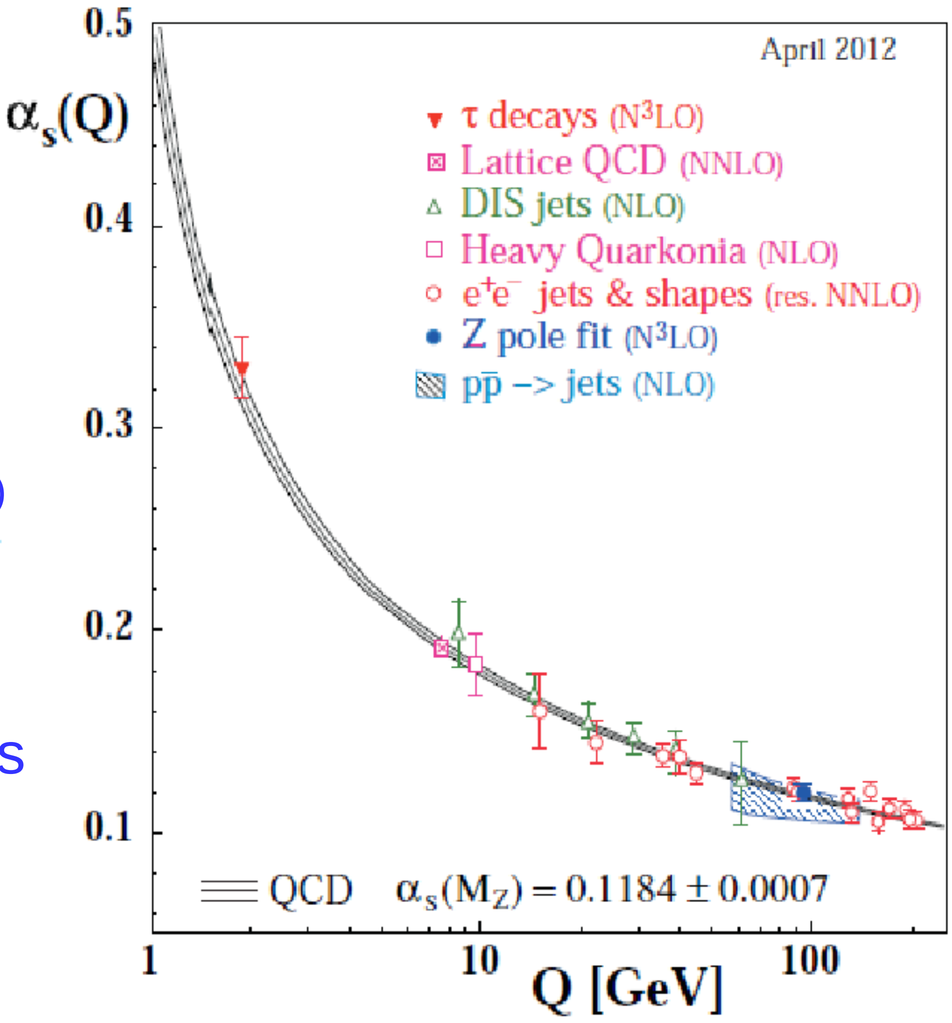
  - No analytical solutions (except 1+1)
- **High *Q*:** asymptotic freedom
  Physics Nobel prize 2004 (Wilczek, Gross, Politzer)
- Typically solvable using perturbative theory
- Tested extensively at modern colliders



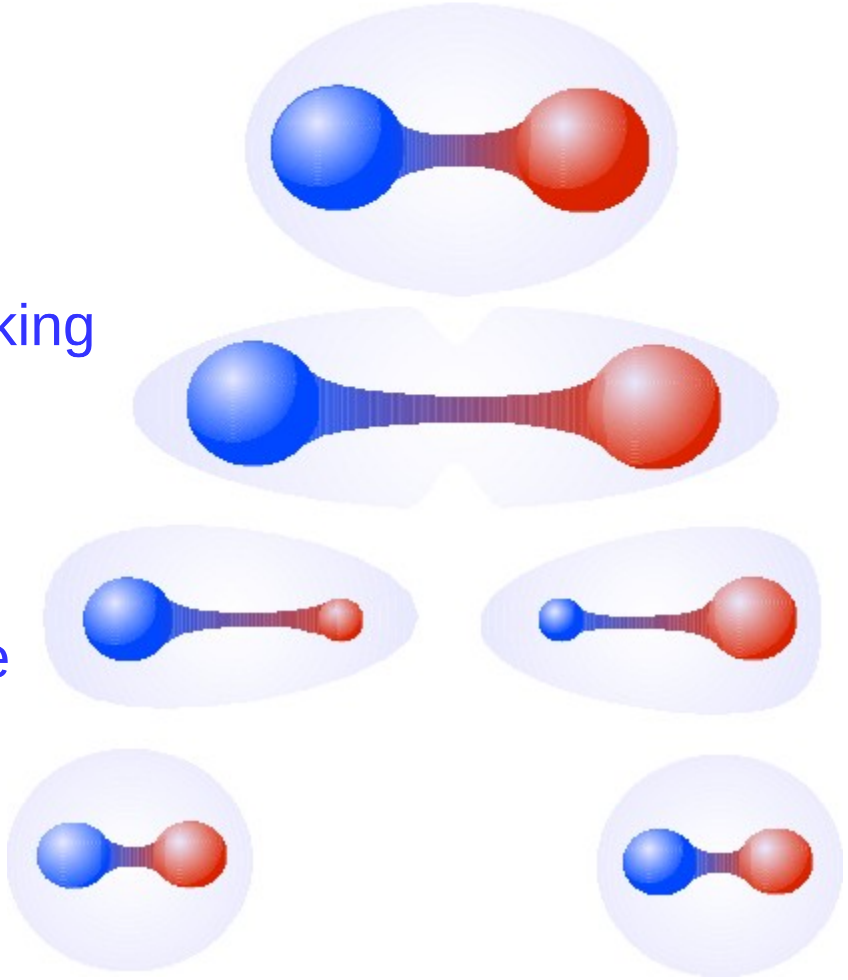
S.Bethke, arXiv:1210.0325

Quantum Chromo-Dynamics (QCD)

- 6 quarks, 3 colours (RGB)

  and 8 gluons (coloured!)
- ...difficult to calculate
  - No analytical solutions (except 1+1)
- **Low *Q*:** confinement / chiral symmetry breaking

  Physics Nobel Prize 2008 (Y.Nambu)
  - Non-perturbative, largely unknown
  - One of the millenium problems
  - Most of the visible matter in the Universe



High energy nucleus-nucleus collisions: the scope

- Create in the laboratory a chunk of **deconfined matter** (also called Quark-Gluon Plasma, QGP / sQGP) and study its properties and phase diagram

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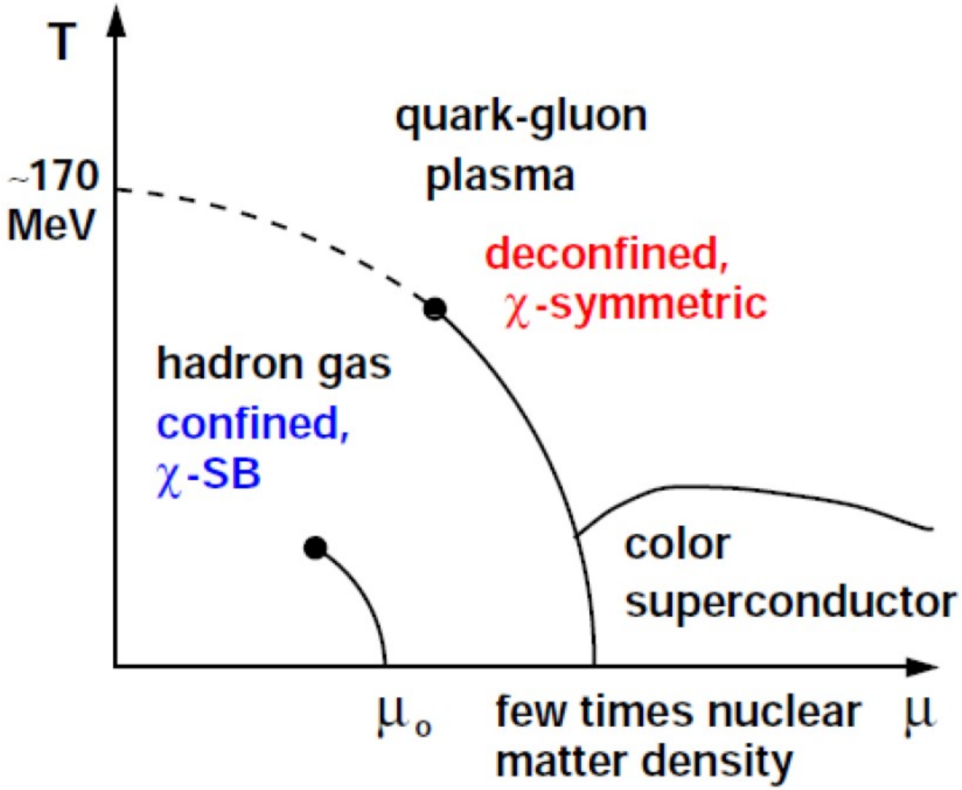
- Relevance for:
  - Completeness of QCD studies (low-Q, finite T and μ)

    Phase diagram of nuclear matter:
    - Chiral / deconfinement phase transitions



Braun-Munzinger, Wambach, Rev.Mod.Phys.81 (2009) 1031

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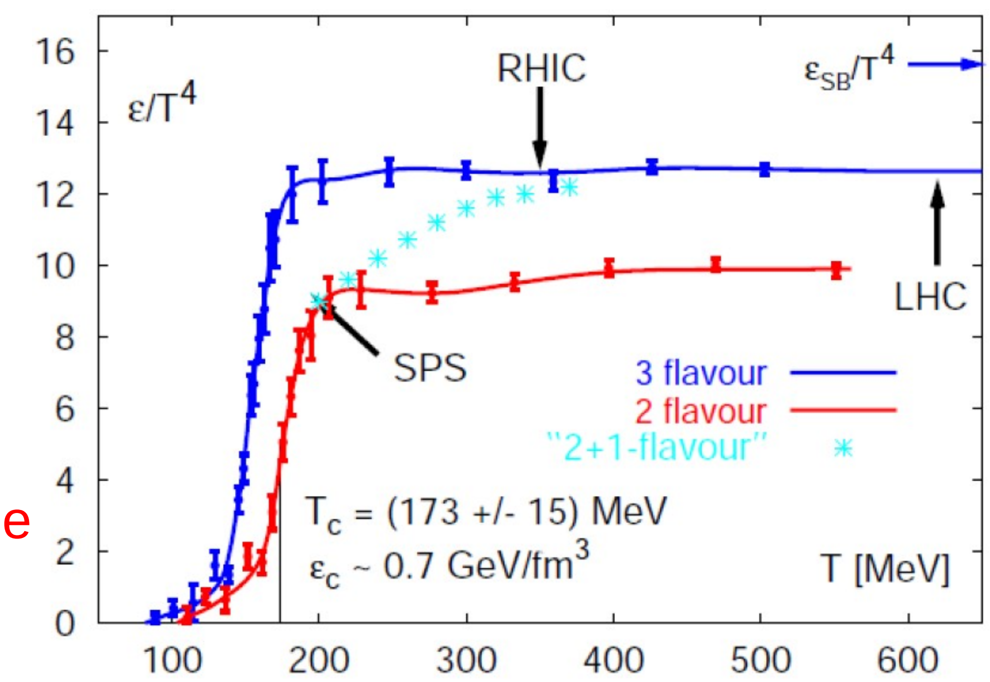
    Phase diagram of nuclear matter:
    - Chiral / deconfinement phase transition
    - Lattice QCD calculations conclude transition is cross-over type

      (Y.Aoki et al., Nature 443 (2006) 675)
    - "Critical" temperature: T_C≈155-160 MeV

(A.Bazavov et al., arXiv:1111.1710, S.Borsanyi et al., arXiv:1005.3508)



F. Karsch, hep-lat/0106019

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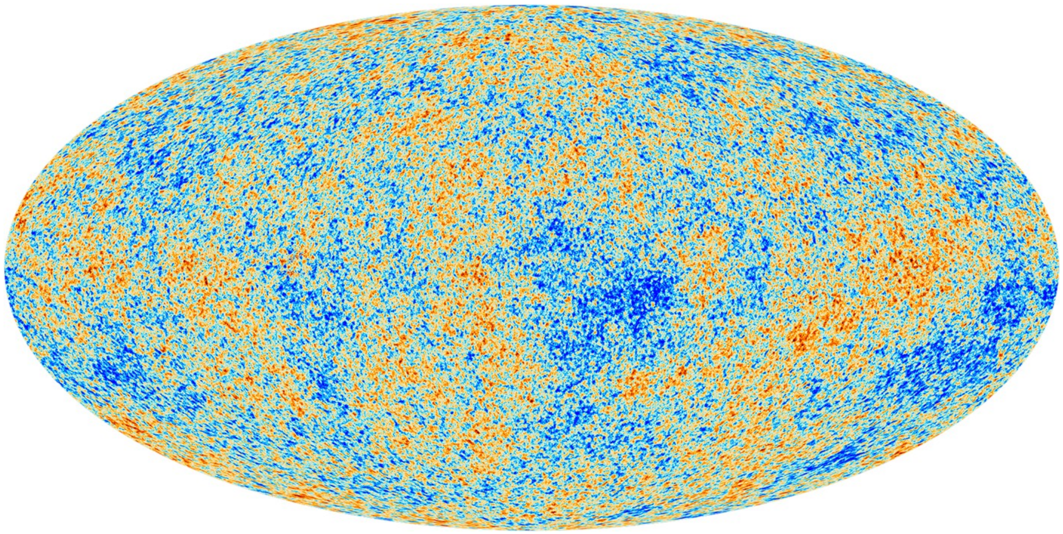
- Relevance for:
  - Completeness of QCD studies
  - Cosmology: access early Universe conditions (10^{-5} s)



Cosmic microwave background seen by Planck

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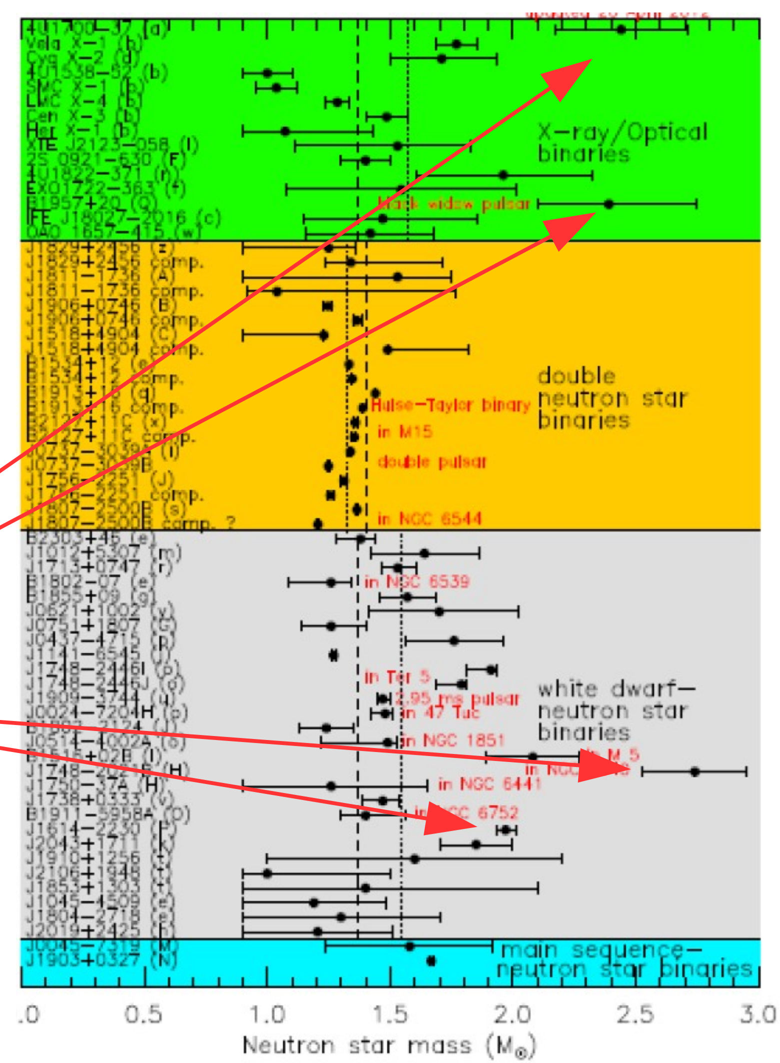
- Relevance for:
  - Completeness of QCD studies
  - Cosmology
  - Astrophysics: neutron stars mass controlled by the equation of state (EoS) of nuclear matter
  - “Canonical” mass: 1.4 M_{sun}
  - How can the outliers exist ?
    - Stiffer EoS at larger nuclear densities



J.M.Lattimer, arXiv:1305.3510

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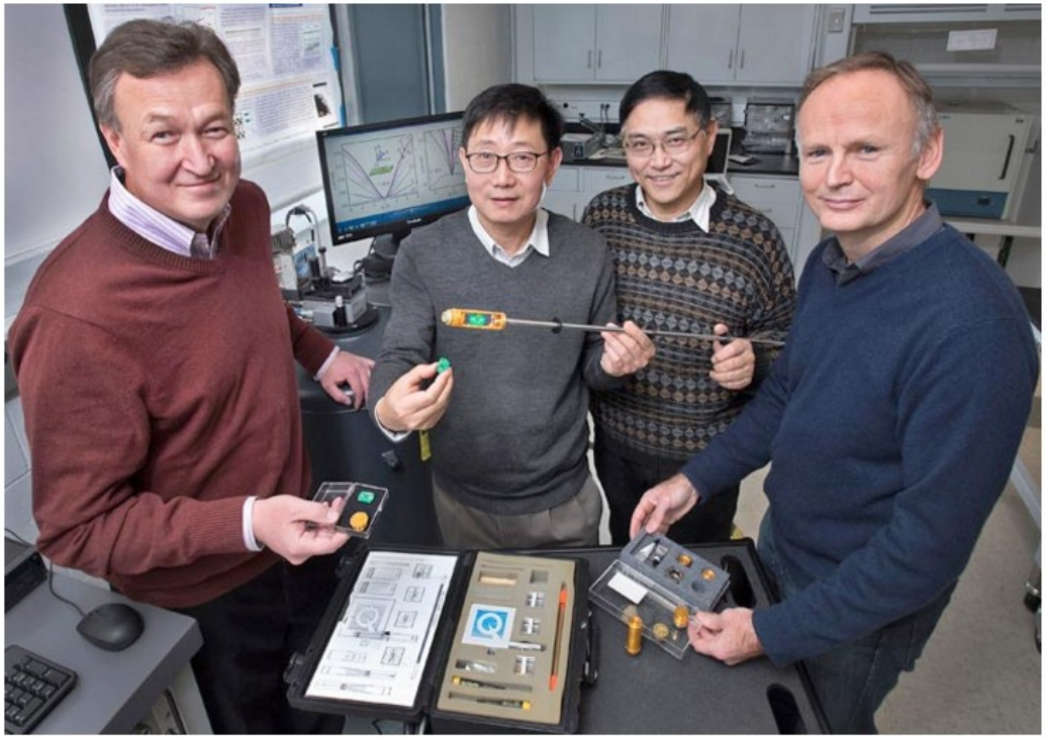
- Relevance for:
  - Completeness of QCD studies
  - Cosmology
  - Astrophysics
  - Solid state physics:
    Chiral magnetic effect first studied in HIC, now discovered in condensed matter experiments

Chiral Magnetic Effect Generates Quantum Current

Separating left- and right-handed particles in a semi-metallic material produces anomalously high conductivity

February 8, 2016



Nuclear theorist Dmitri Kharzeev of Stony Brook University and Brookhaven Lab with Brookhaven Lab materials scientists Qiang Li, Genda Gu, and Tonica Valla in a lab where the team measured the unusual high conductivity of zirconium pentatelluride. + ENLARGE

Q.Li, D.Kharzeev et al., Nature Physics Letters (in press)

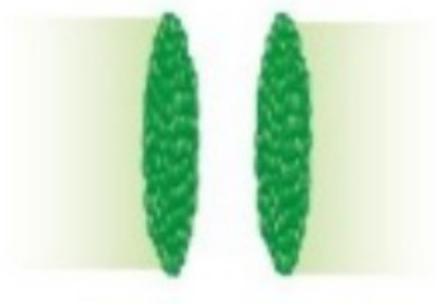
High energy nucleus-nucleus collisions: the scope

- Create in the laboratory a chunk of **deconfined matter** (also called Quark-Gluon Plasma, QGP / sQGP) and study its properties and phase diagram

- Relevance for:
  - Completeness of QCD studies
  - Cosmology
  - Astrophysics
  - Solid state physics
- Because quarks cannot be observed as free, the deconfined state can only be detected via the fingerprints it leaves on “normal” nuclear matter (hadrons) ...extremely challenging

Stages of a high-energy nucleus-nucleus collision

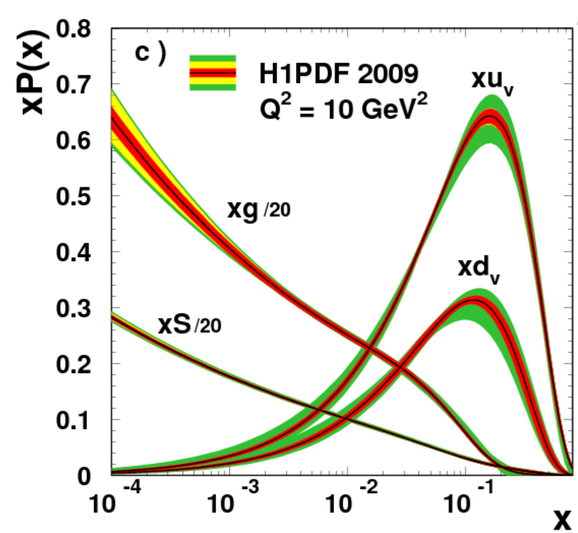
Initial state

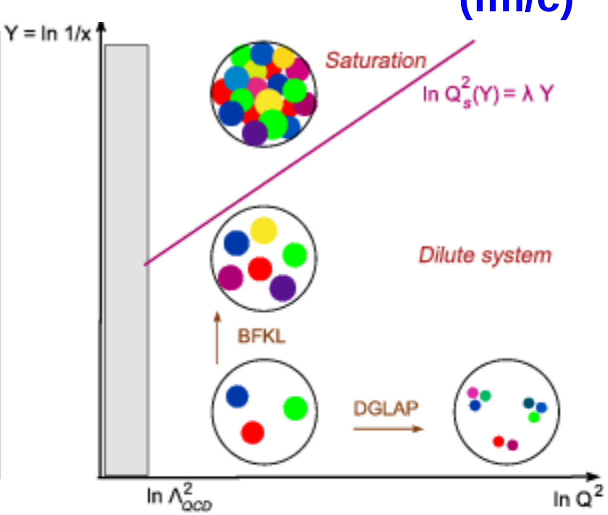


0
0

t (s)
(fm/c)

- Highly Lorentz contracted nuclei
- Initial state extremely important
  - Gluon shadowing ?
  - Color Glass Condensate ?





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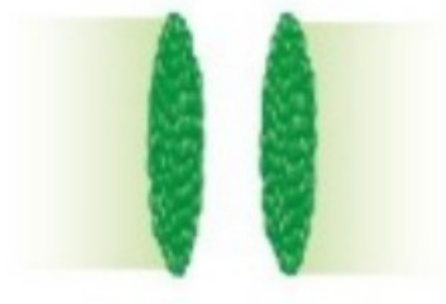
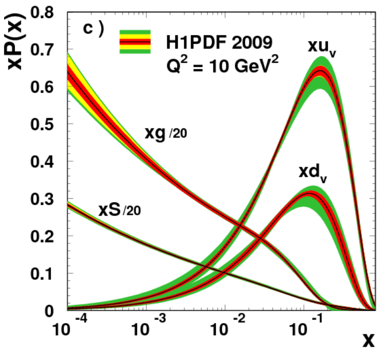
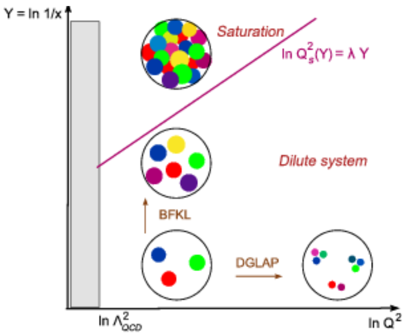


0
0

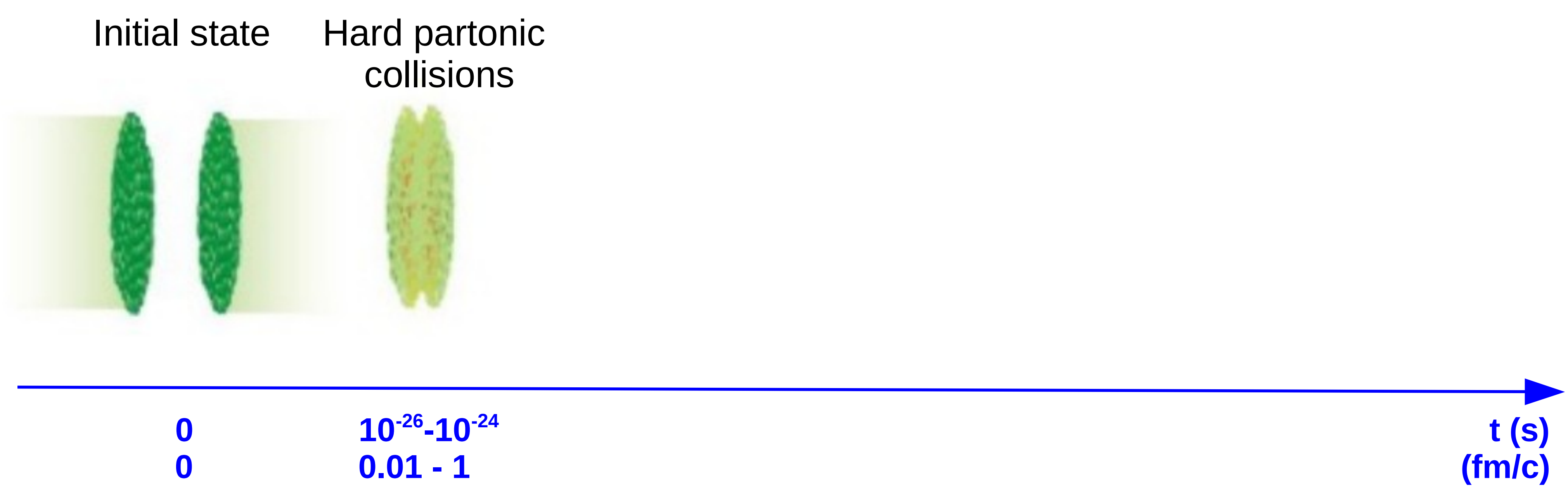
t (s)
(fm/c)





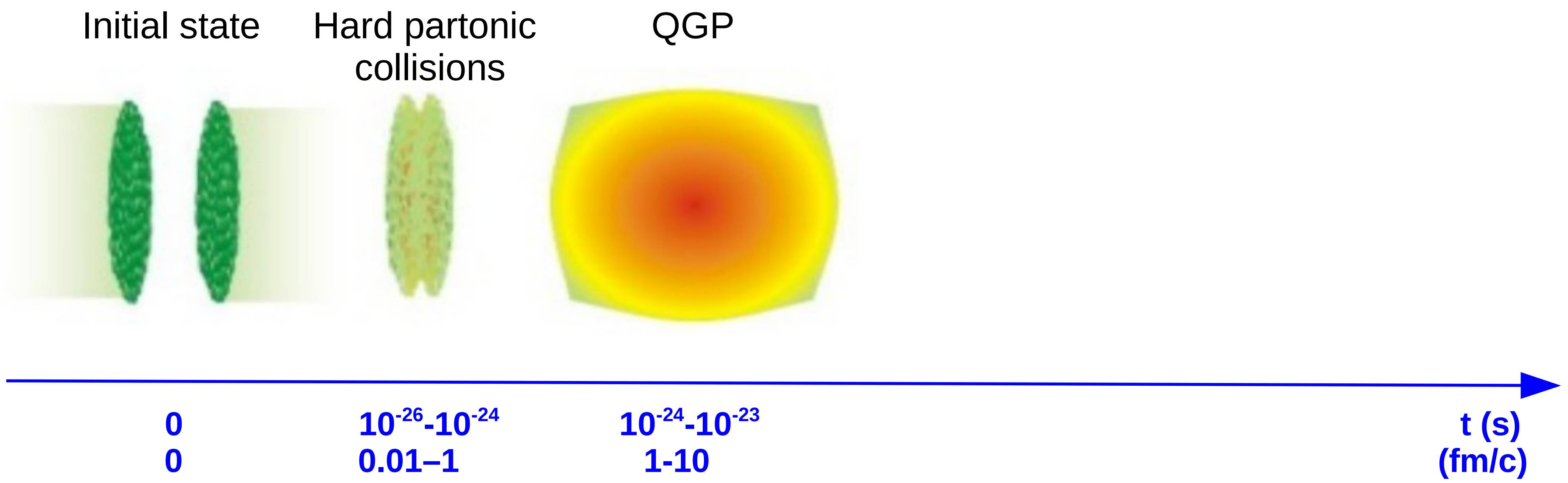
- Highly Lorentz contracted nuclei
- Initial state extremely important
  - Gluon shadowing ?
  - Color Glass Condensate ?
  - Crucial for disentangling the so called “cold nuclear matter”(CNM) effects from genuine hot medium effects

Stages of a high-energy nucleus-nucleus collision



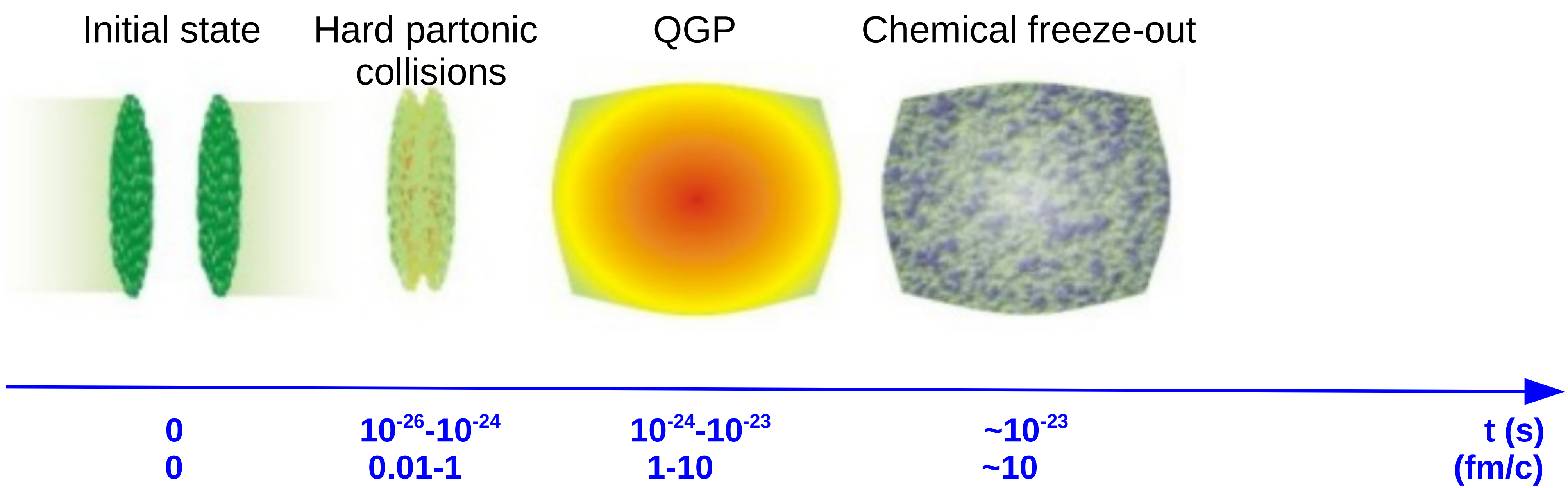
- Initial hard collisions take place
- Most of the entropy is created now
- Equilibrium (thermalization) takes place rapidly

Stages of a high-energy nucleus-nucleus collision



- Deconfined Quark-Gluon Plasma phase
- System expands and cools hydrodynamically

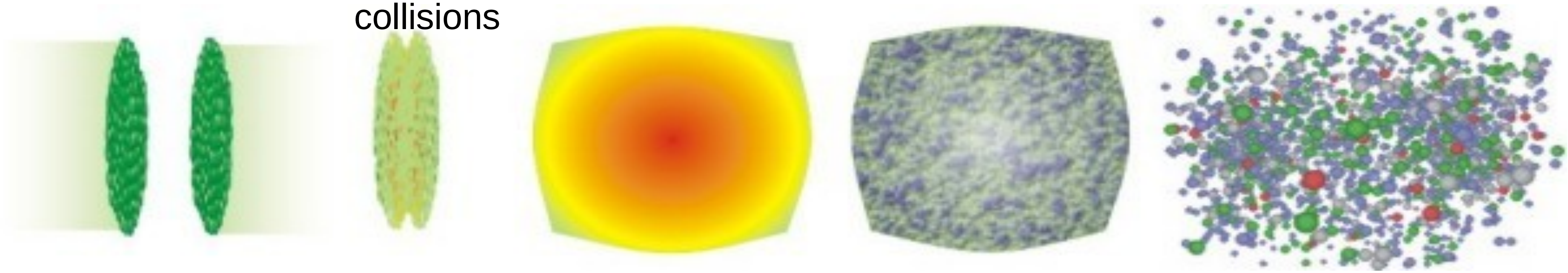
Stages of a high-energy nucleus-nucleus collision



- Hadronization: quarks and gluons form hadrons
- Non-perturbative process
- Chemical freeze-out: inelastic collisions cease; yields of various particle species are frozen

Stages of a high-energy nucleus-nucleus collision

Initial state	Hard partonic collisions	QGP	Chemical freeze-out	Kinetic freeze-out	



0	10^{-26}-10^{-24}	10^{-24}-10^{-23}	~10^{-23}	10^{-23}-10^{-22}	t (s)
0	0.01-1	1-10	~10	10-100	(fm/c)

- Kinetic freeze-out:
  - Elastic collisions cease
  - Kinetic distributions are frozen

- We measure only at the latest stages but we want to understand the hard partonic and the QGP stages!

What are the conditions that can be achieved?

(extracted from data and models)

- *Temperature: T*=100-1000 MeV or up to 1 million times that in the center of the Sun

  1MeV ≈ 10 billion degrees Kelvin

- *Pressure*: *P*=100-300 MeV/fm^3 (1MeV/fm^3 ≈ 10^{28} atmospheres)

  center of the Earth: 3.6*10^6 atmospheres

- *Density*: ρ=1-10ρ_0 (ρ_0: density of a Au nucleus = 2.7*10^{14} g/cm^3)

  Density of Au = 19 g/cm^3

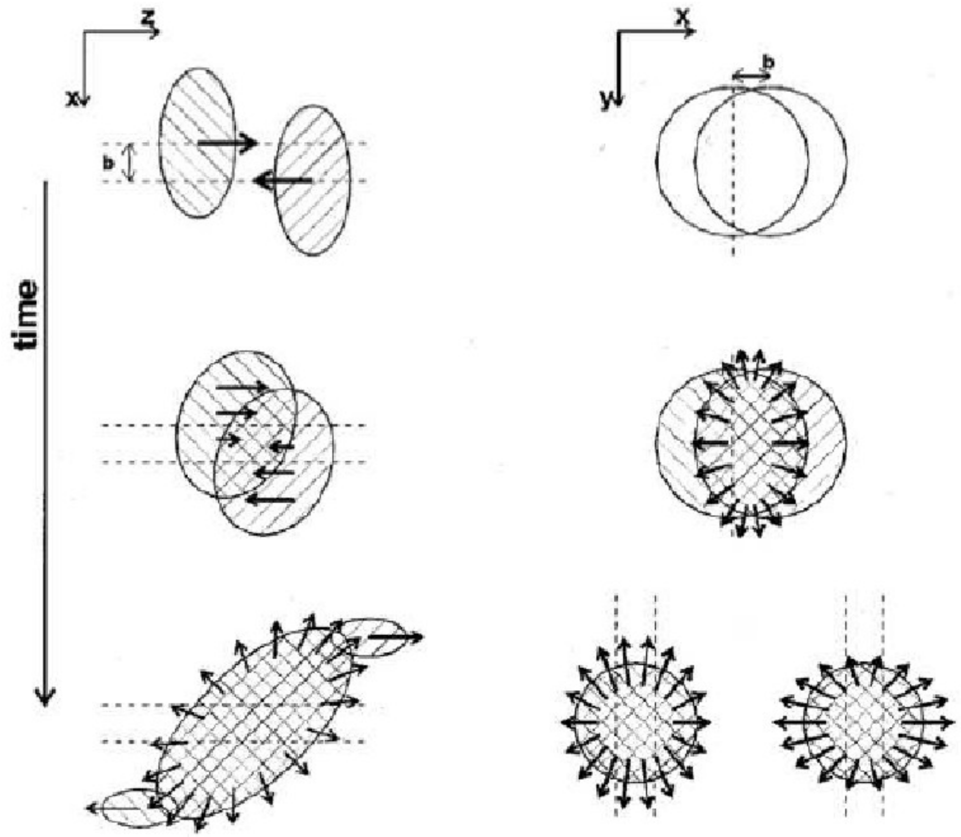
- *Volume*: about 2000 fm^3 (1 fm = 10^{-15} m)

- *Duration*: about 10 fm/c (or about 3*10^{-23} sec.)

What are the "control parameters"

- Energy of the collision (per nucleon pair $\sqrt{s_{NN}}$)
- Centrality of the collision (number of "participating" nucleons, N_{part})

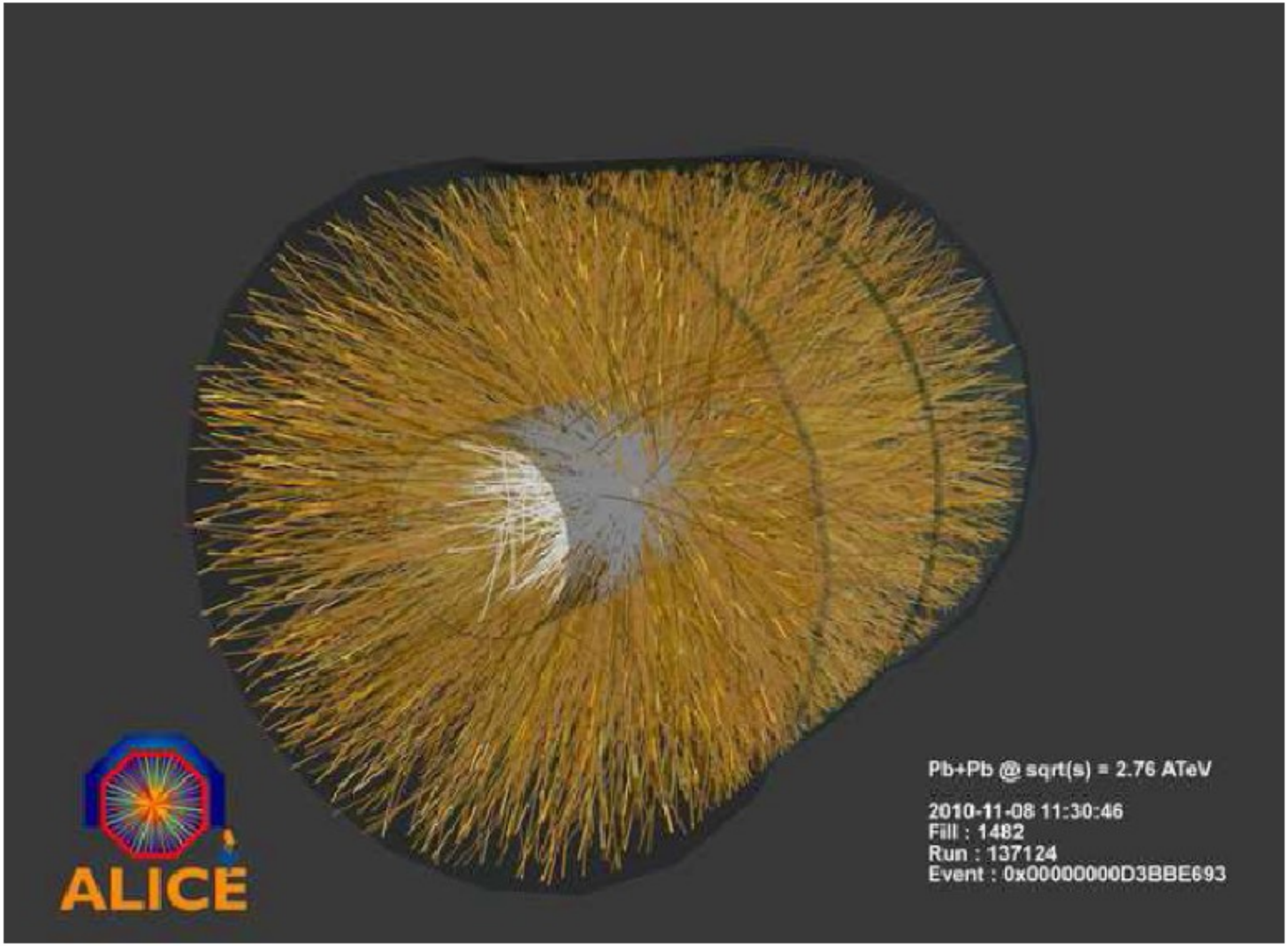
  typically measured in percentage of the geometric cross-section ($\sigma_{geom}=\pi(2R)^2$)



N.Herrman, J.P.Wessels, T.Wienold, Ann.Rev.Nucl.part.Sci. 49(1999) 581

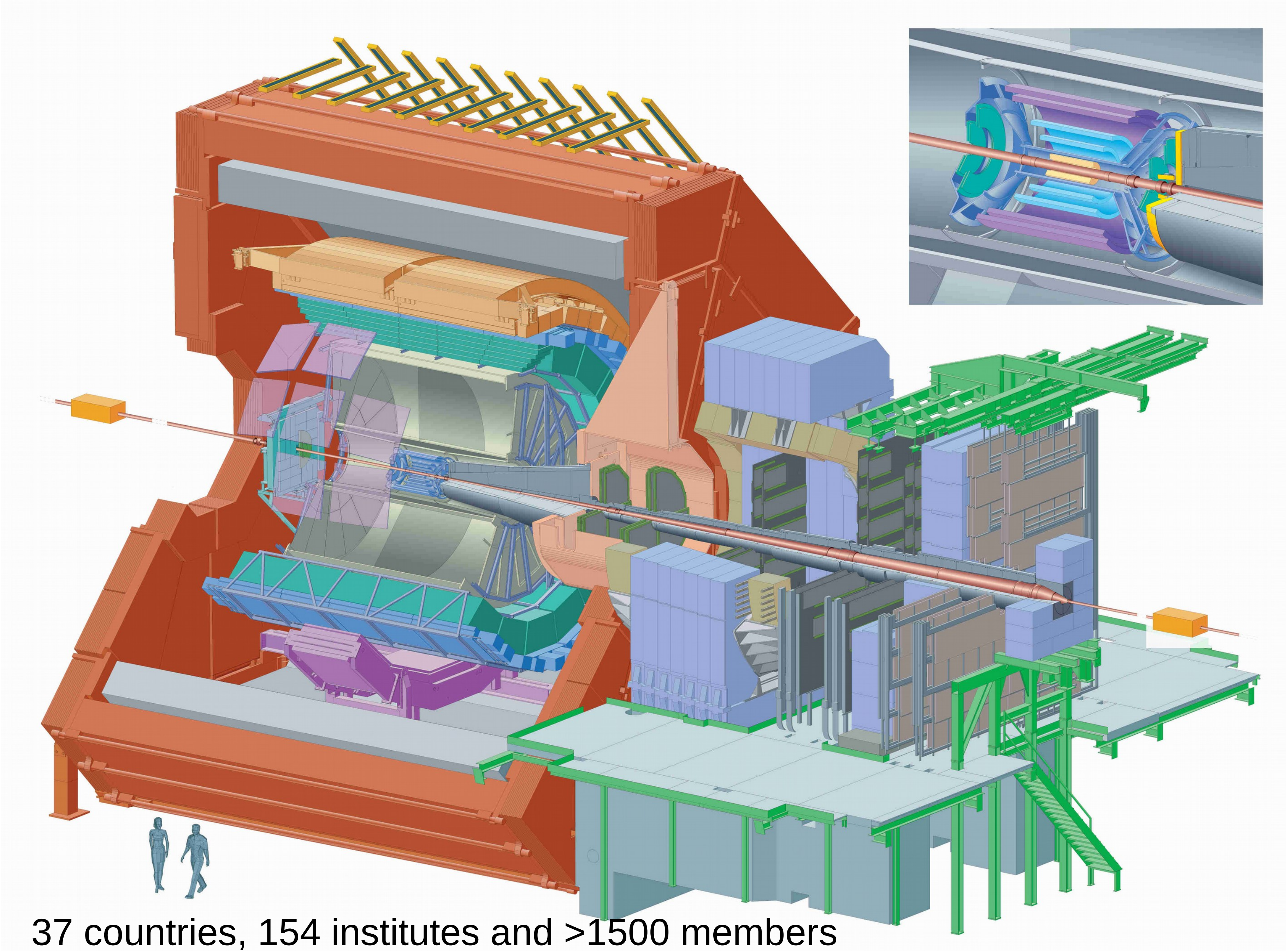
The ALICE detector

How to “measure” the early Universe in the lab?



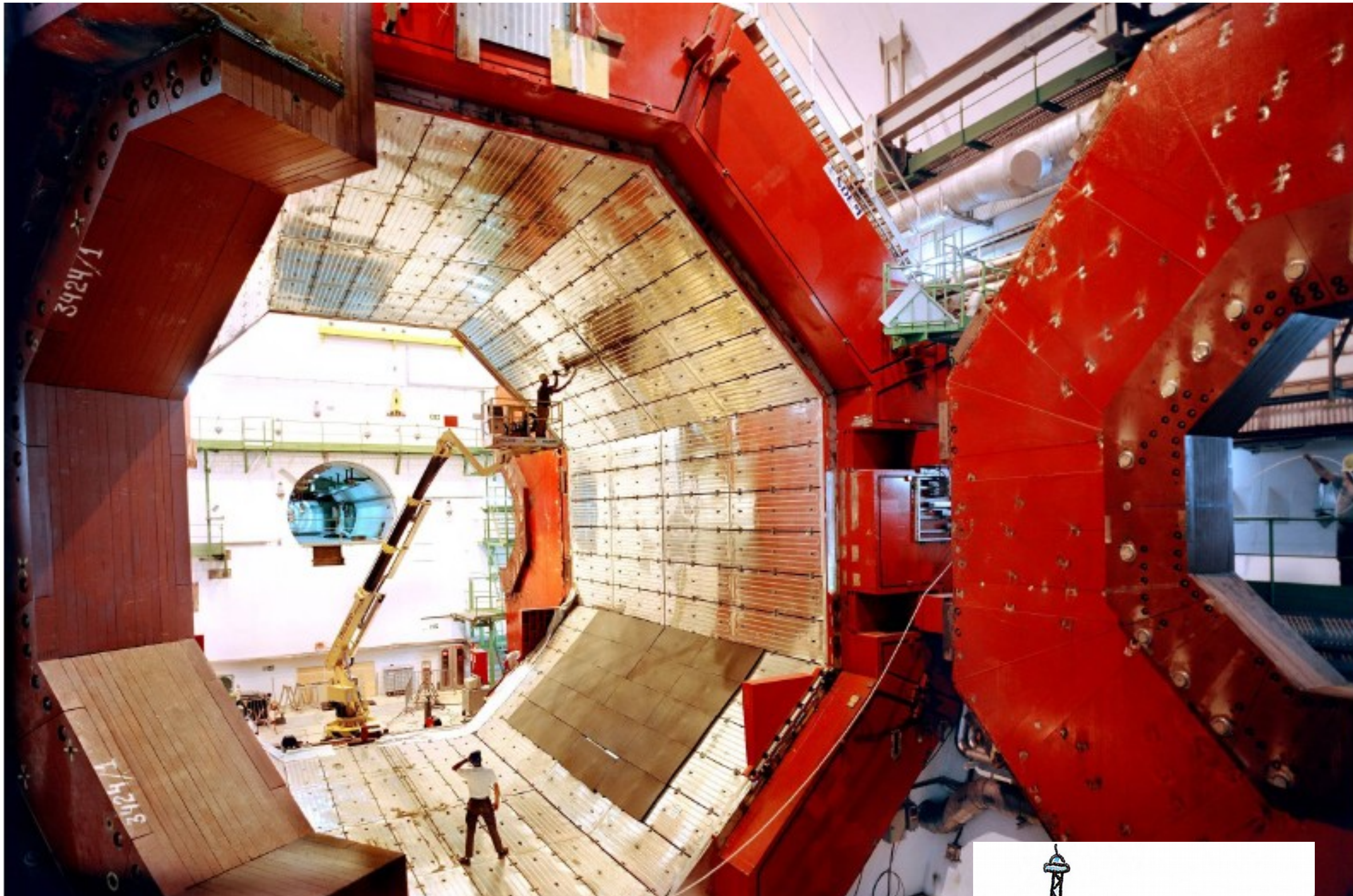
- A 3D picture (with 500 million voxels) of a central collision (about 3000 primary tracks)
- We take millions of such pictures to be analyzed offline

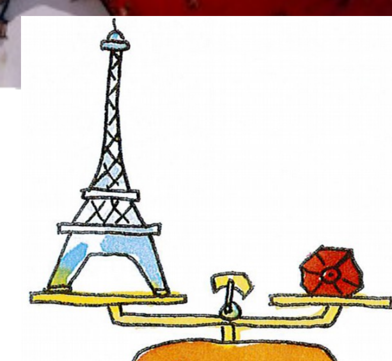
The ALICE detector



37 countries, 154 institutes and >1500 members

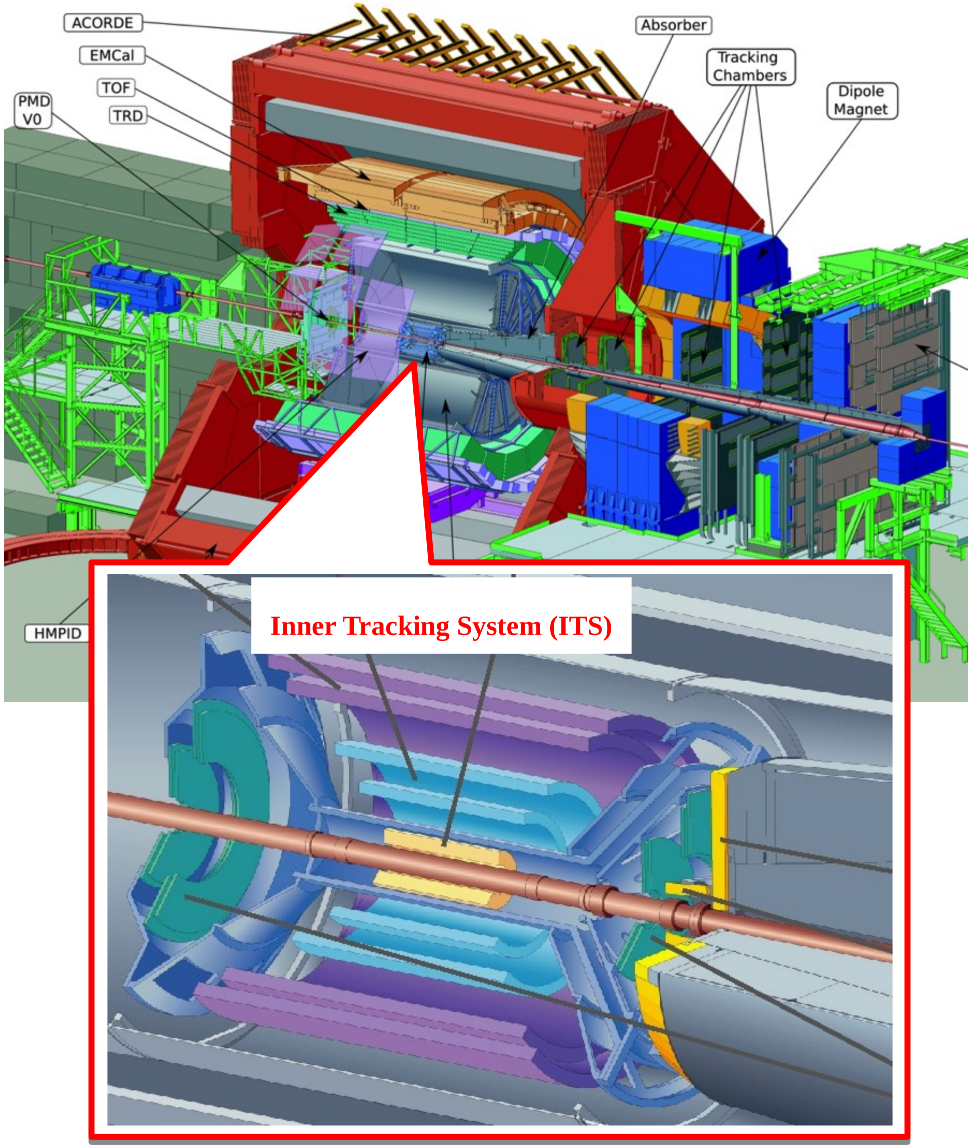
The L3 solenoid magnet





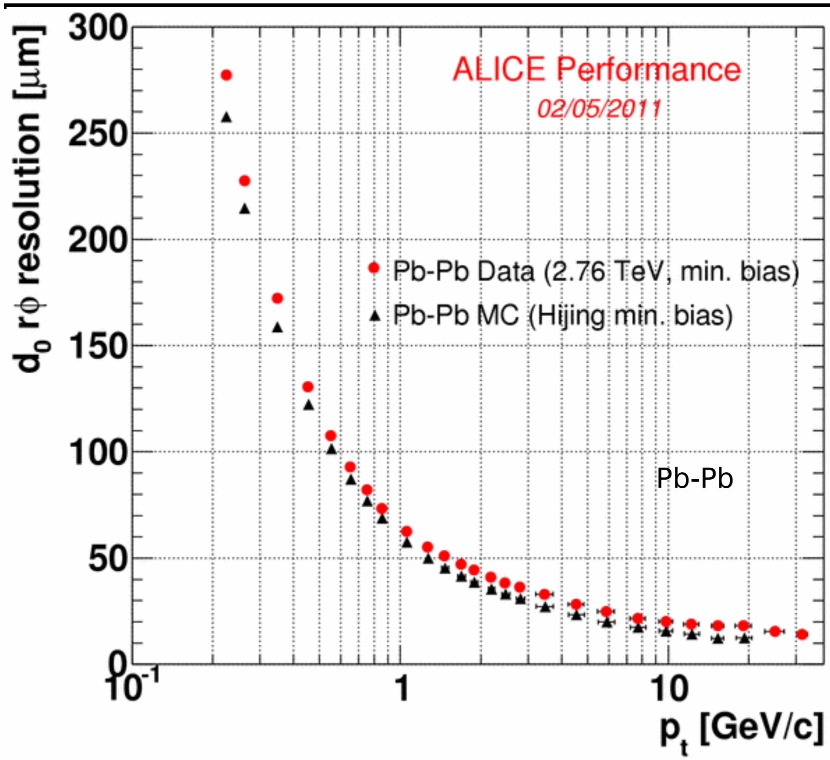
- It creates a uniform 0.5 T magnetic field
- As heavy as the Eiffel tower

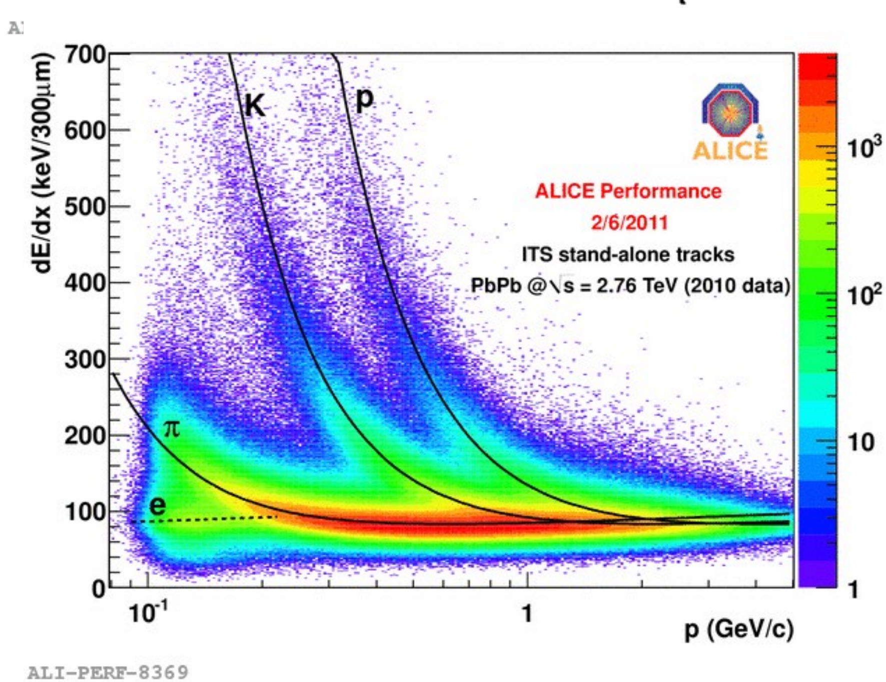
The Inner Tracking System (ITS)



- Barrel geometry detector
- Key detector for ALICE trigger system
- Measures global properties of the event: particle multiplicity

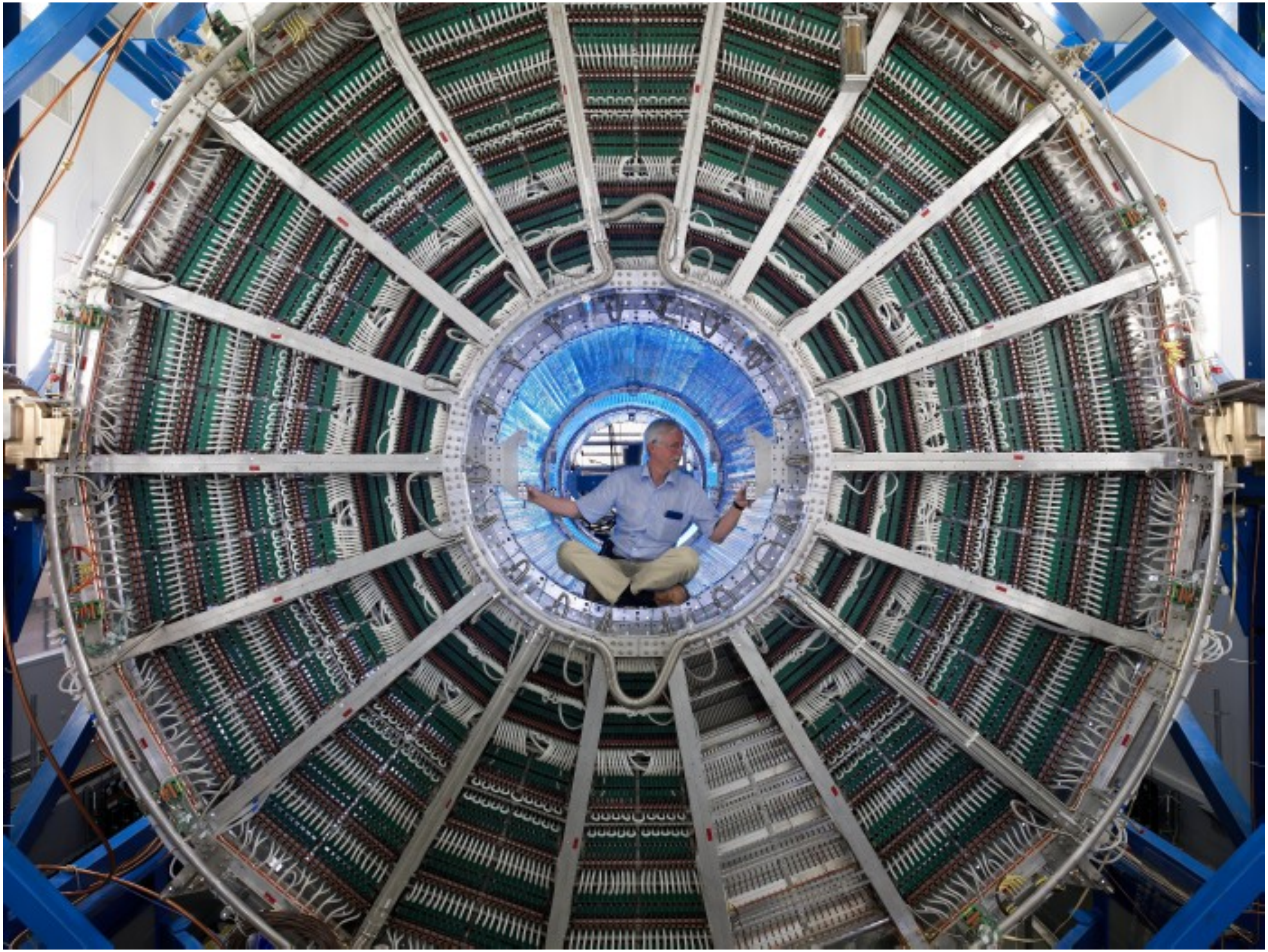
Inner Tracking System (ITS)





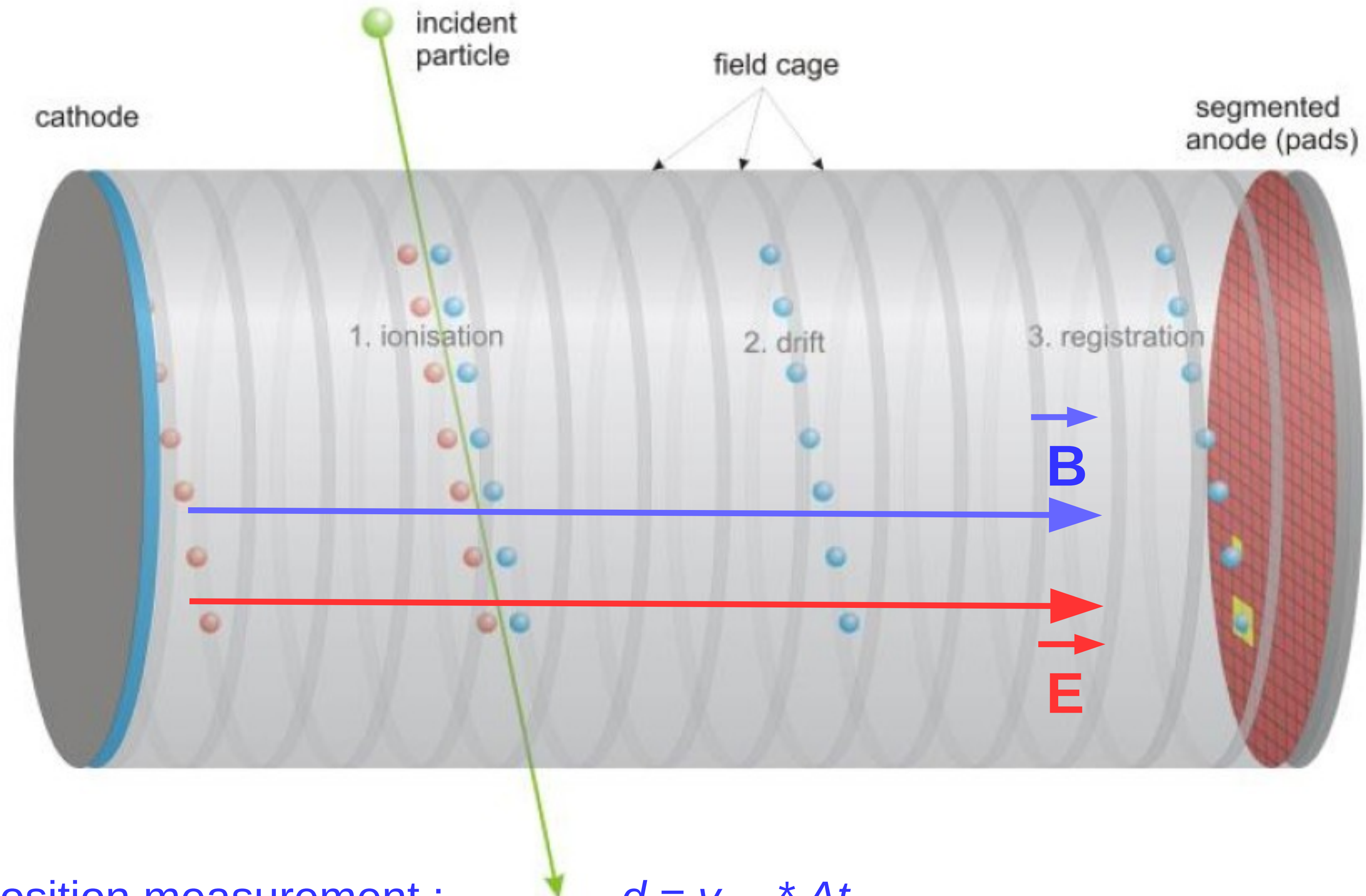
- 6 layers of silicon detectors with very high spatial resolution
  - Locates the collision vertex and secondary vertices from heavy quark decays
- It also performs particle identification via linear energy loss, but less precise than TPC

The TPC



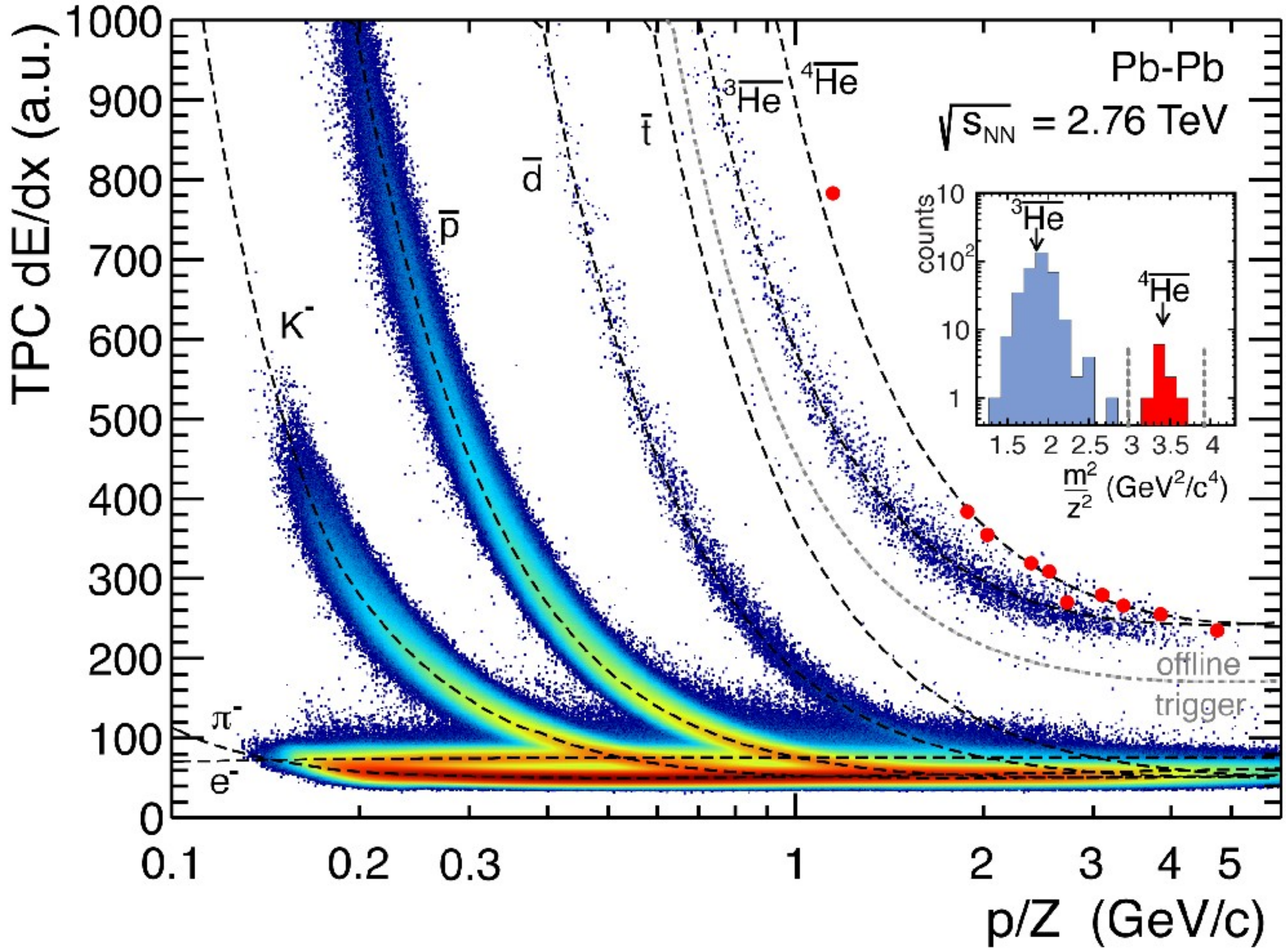
- The Time Projection Chamber is the main ALICE detector
- It is the largest TPC in the world
- 500 Mega-voxel 3D digital camera -> takes ca. 1000 pictures per second

TPC working principle



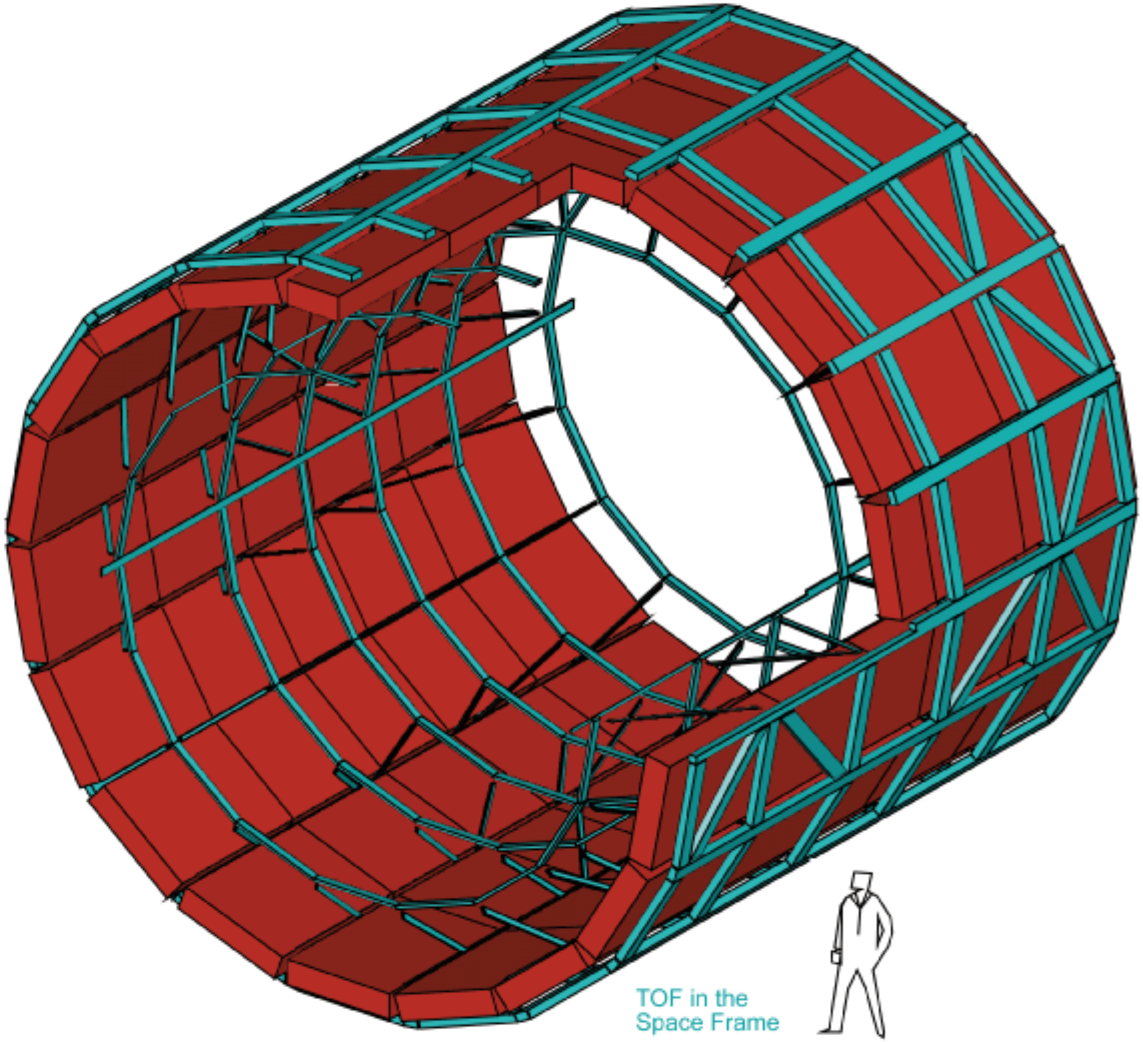
- Position measurement : $d = v_{drift} * \Delta t$
- Momentum measurement: $p_T = q*B*r$

Particle identification with the TPC



- Particles are identified using their specific energy loss in the TPC gas volume
- Highest mass anti-nuclei observed with the current data sample: anti-^{4}He

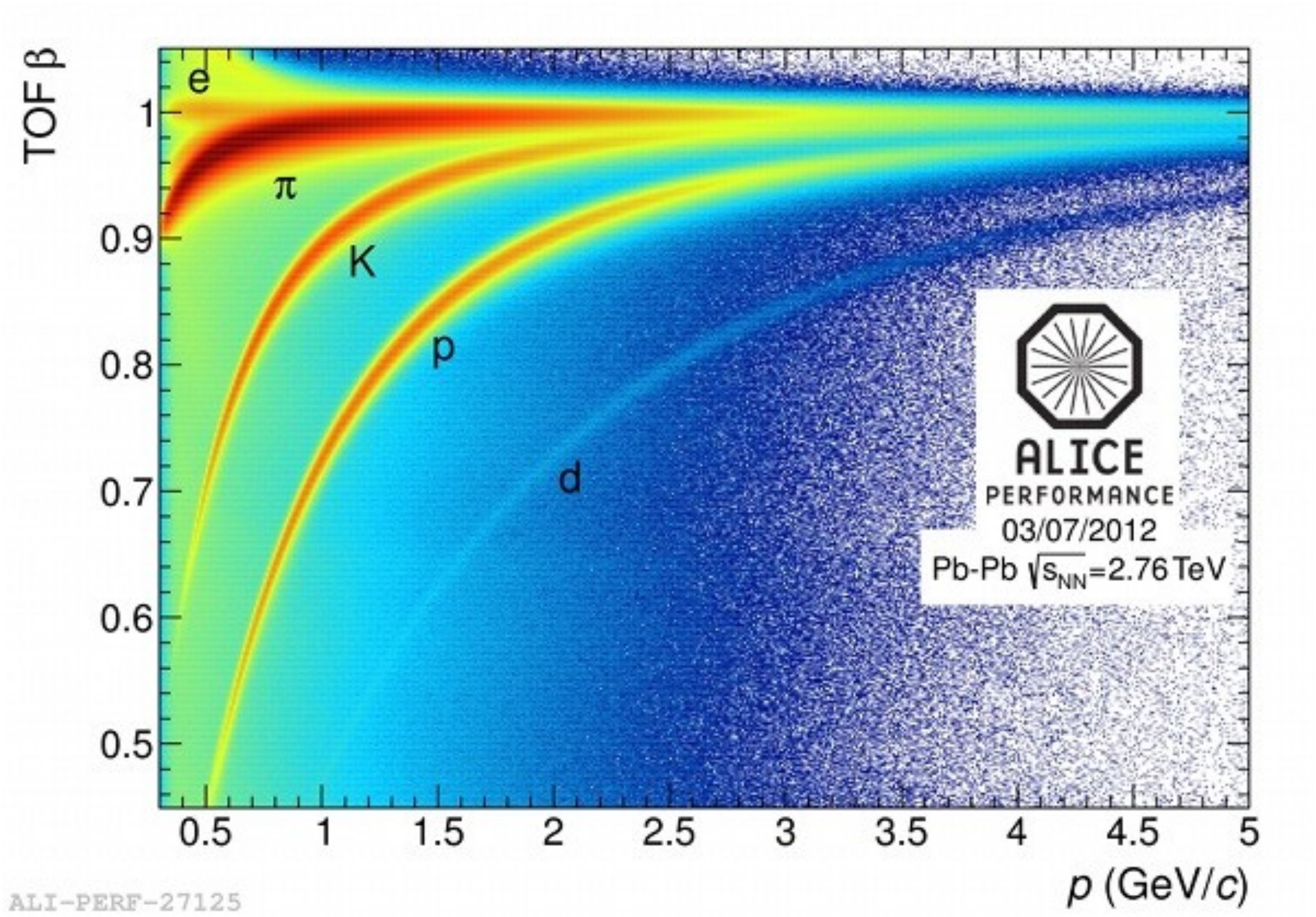
The Time-of-Flight detector (TOF)



$V = L/\Delta t$

- Measures the time of flight between the collision start and arrival at the detector
- In conjunction with the momentum measurement from tracking -> particle identification
- Time resolution: 10^{-10} s

Particle identification using TOF



- Extends the particle identification of the TPC to higher momentum

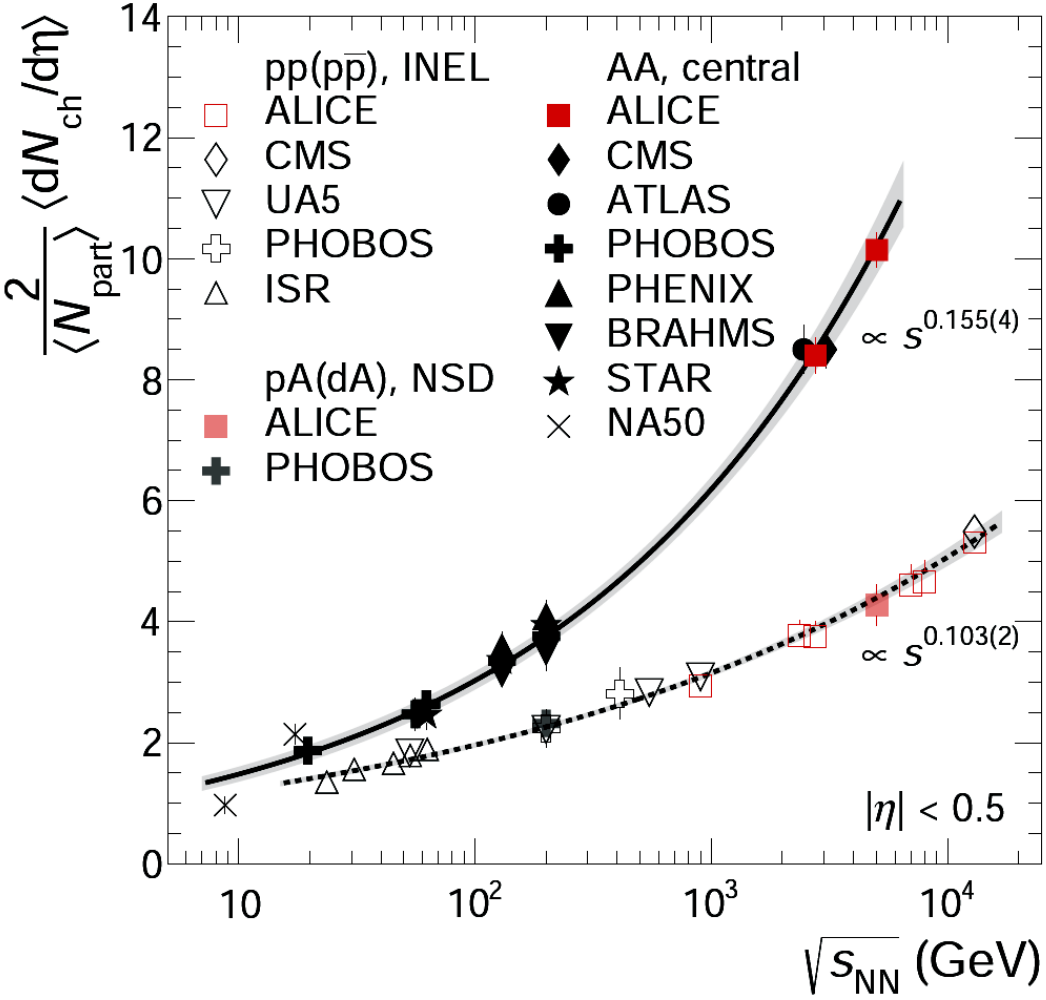
Other detectors

- ALICE is using a wide range of detector technologies covering a large portion of the available kinematics
- Some of the not mentioned detectors are:
  - Transition Radiation Detector (TRD): electron identification
  - Electromagnetic Calorimeter (EMCAL): electrons and photons
  - Photon Spectrometer (PHOS): electrons and photons
  - Zero Degree Calorimeter (ZDC): spectator neutrons and protons
  - Muon Spectrometer (MUON): muon reconstruction at forward rapidity
  - VZERO, TZERO: trigger detectors
  - Cerenkov detector (HMPID): hadron identification at high momentum
  - ...

Physics results

Bulk particle production

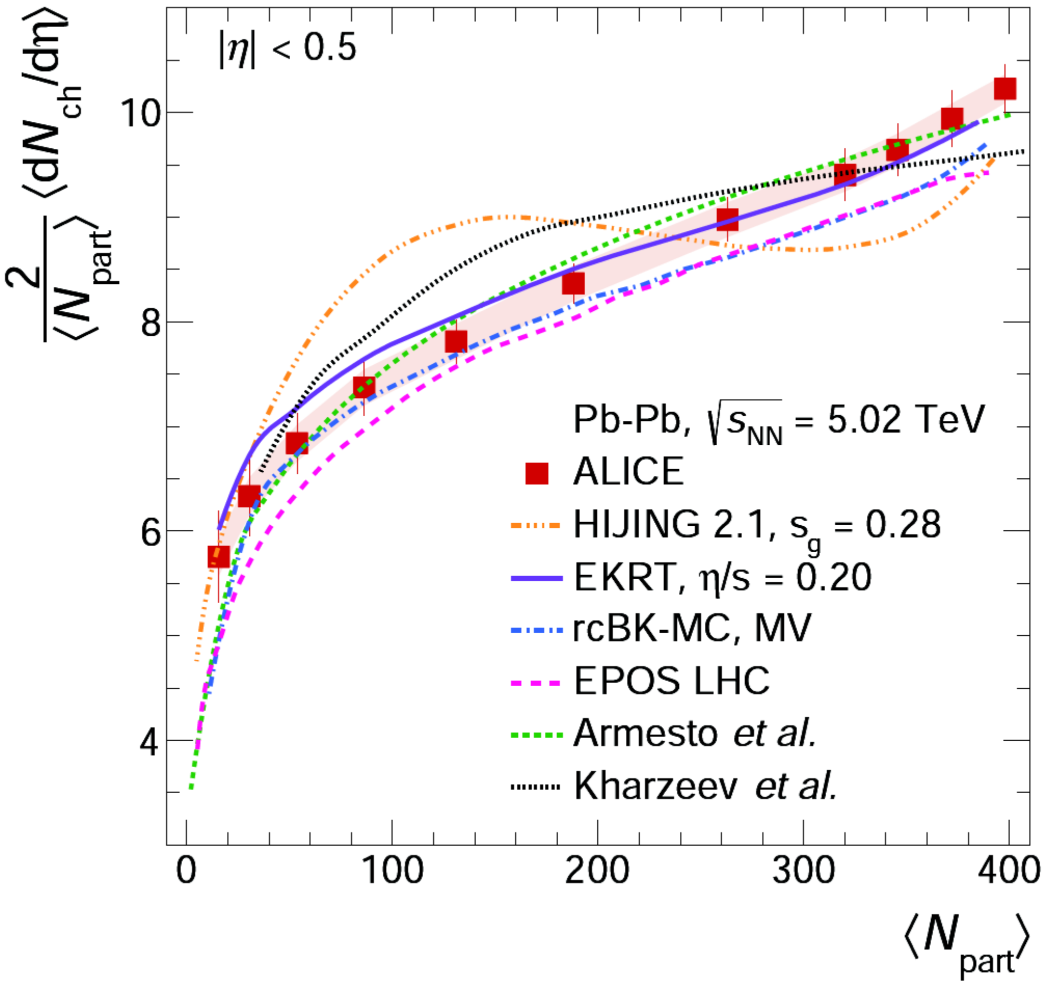
ALICE Collaboration, arXiv:1512.06104



- Yield per participant pair is larger in nuclear collisions than in proton-proton collisions:
  - large entropy production
- The difference between nuclear and pp collisions also grows rapidly with energy

Bulk particle production

ALICE Collaboration, arXiv:1512.06104



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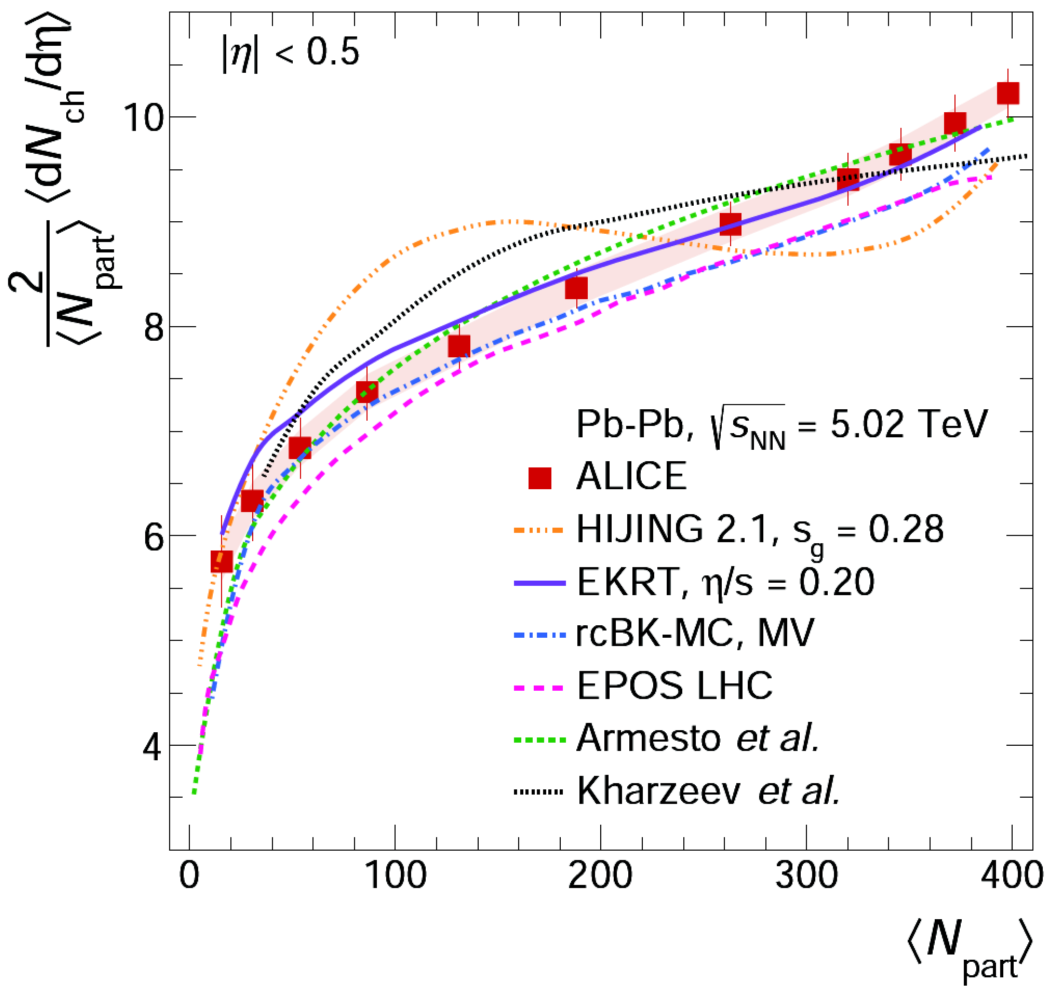
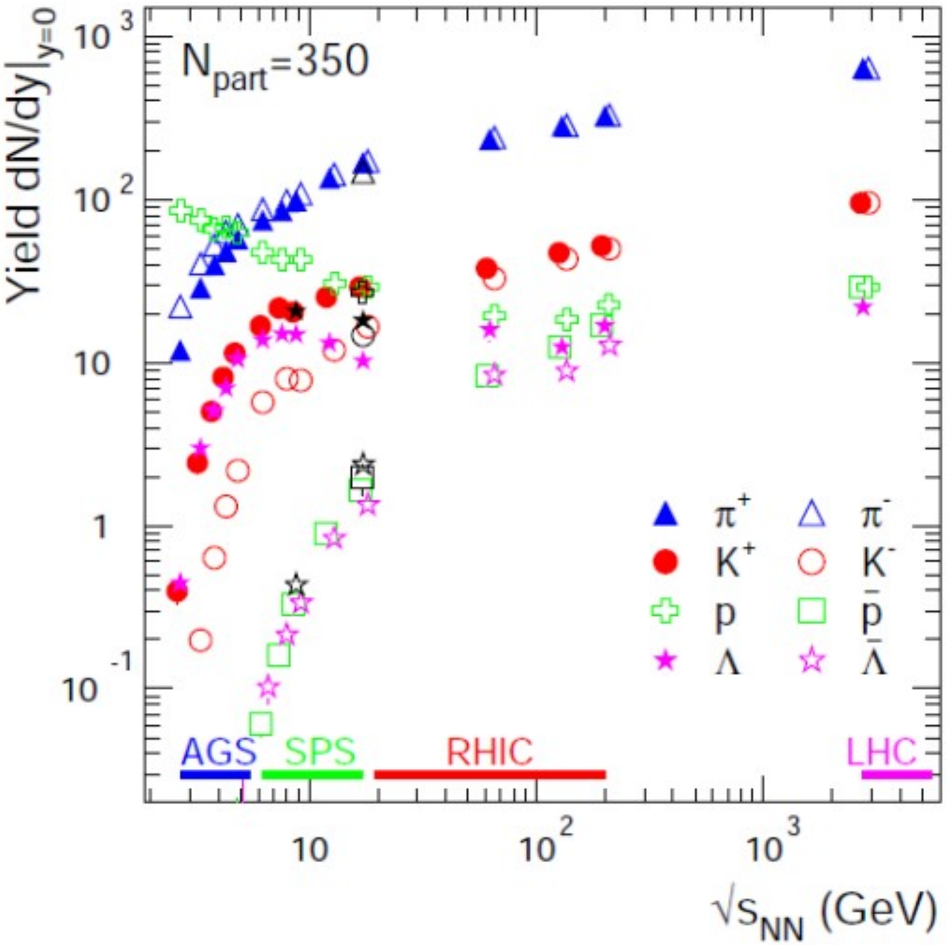


- Yield per participant pair is larger in nuclear collisions than in proton-proton collisions:
  - large entropy production
- The difference between nuclear and pp collisions also grows rapidly with energy
- Yield per participant pair also grows towards more central collisions
- These results allow to quantify the initial energy density and set constraints on initial state models, e.g. CGC

Identified hadron yields



- Lots of particles, most newly created ($E=mc^2$)
- A great variety of species:

  $\pi^{\pm}(u\bar{d},d\bar{u})$, m=140 MeV

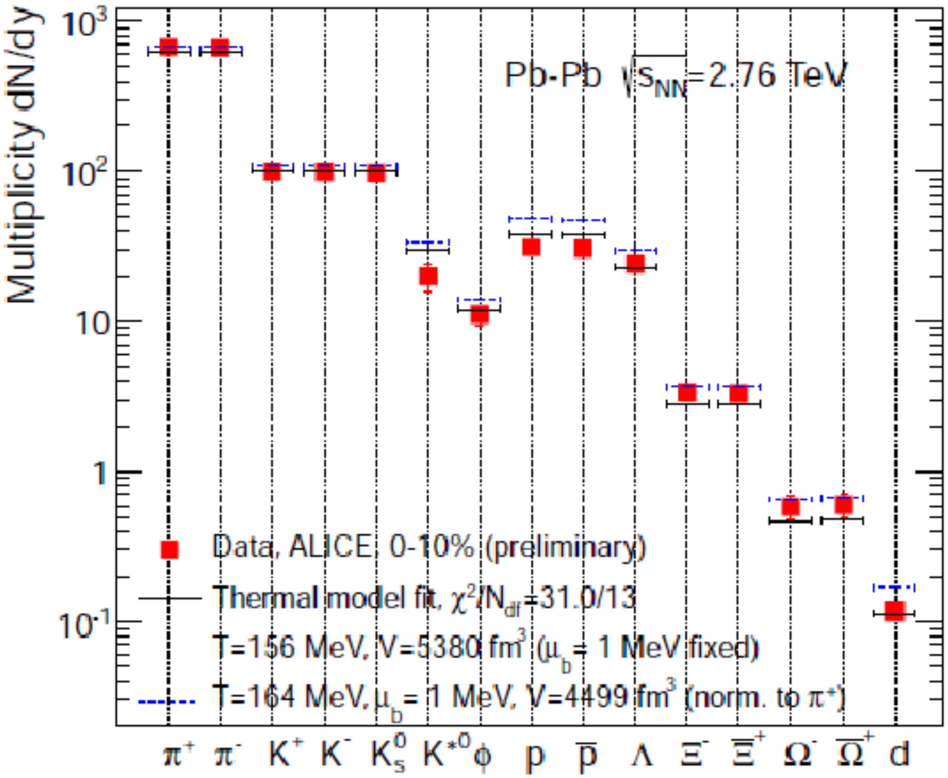
  $K^{\pm}(u\bar{s},s\bar{u})$, m=494 MeV

  p(uud), m=938 MeV

  Λ(uds), m=1116 MeV

  also: Ξ(dss), Ω(sss), …
- Abundancies follow mass hierarchy, except at low energies where remnants from the incoming nuclei are significant
- What do we learn?

Chemical freeze-out: hadron yields



- Thermal fits of hadron abundancies:

$$n_i = N_i/V = -\frac{T}{V}\frac{\partial \ln Z_i}{\partial \mu} = \frac{g_i}{2\pi^2}\int_0^\infty \frac{p^2 \mathrm{d}p}{\exp[(E_i-\mu_i)/T]\pm 1}$$

- Quantum numbers conservation

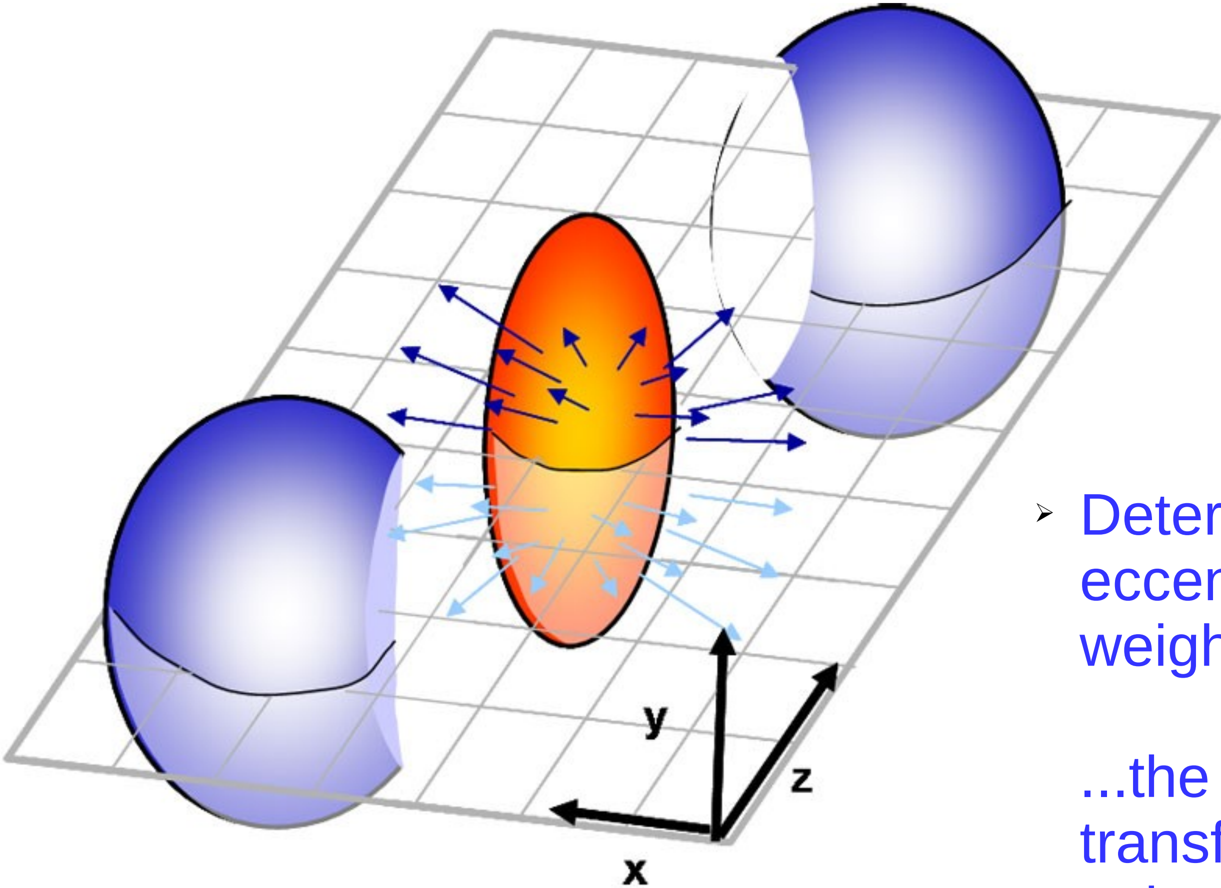
  $\mu=\mu_B B+\mu_{I3} I_3+\mu_S S+\mu_C C$

- Hadron yields N_i can be obtained using only 3 parameters: (T_{chem},μ_B,V)

- The hadron abundancies are in agreement with a thermally equilibrated system

  T_{chem}=155-165 MeV

Elliptic flow (v_2). What is that?



$$\frac{dN}{d\phi} \sim [1 + 2v_1 \cdot \cos(\phi) + 2v_2 \cdot \cos(2\phi)]$$

ϕ = azimuthal angle with respect to reaction plane,

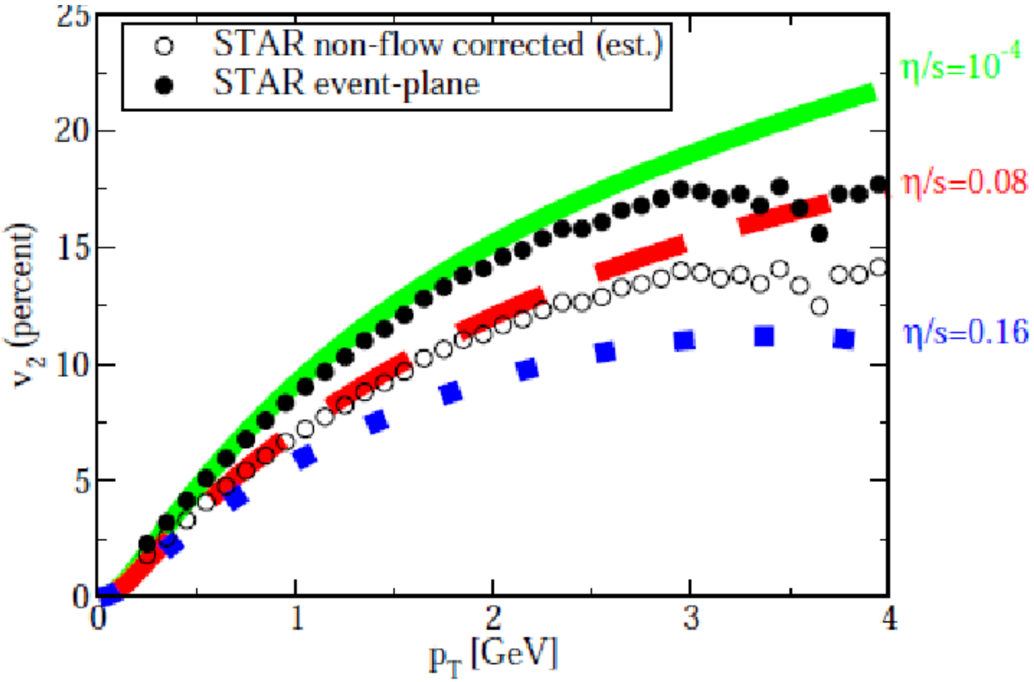
$$v_2 = \langle \cos(2\phi) \rangle$$

0,180°: in-plane, 90,270°: out-of-plane

- Determined by the initial spatial eccentricity, with energy density as weight

  ...the strongly coupled system transforms it into momentum anisotropy

Elliptic flow in high energy HIC



Luzum & Romatschke, arXiv:0804.4015

- Hydrodynamical models assume local thermal equilibrium
- Treats the whole collision history starting from the moment the system reaches equilibrium

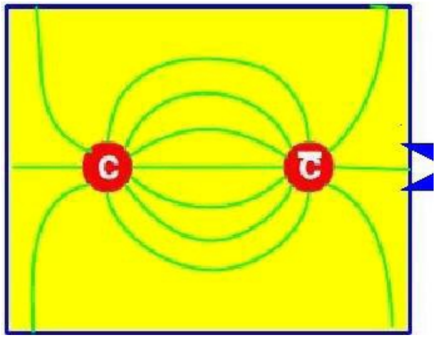
- What do we learn from data?
  - Equation of state of the QGP
  - Shear viscosity

- Shear viscosity much smaller than for any known substance
- Lower bound conjectured from AdS/CFT: $\eta/s = 1/4\pi \approx 0.08$

Kovtun, Son, Starinets hep-th/0405231

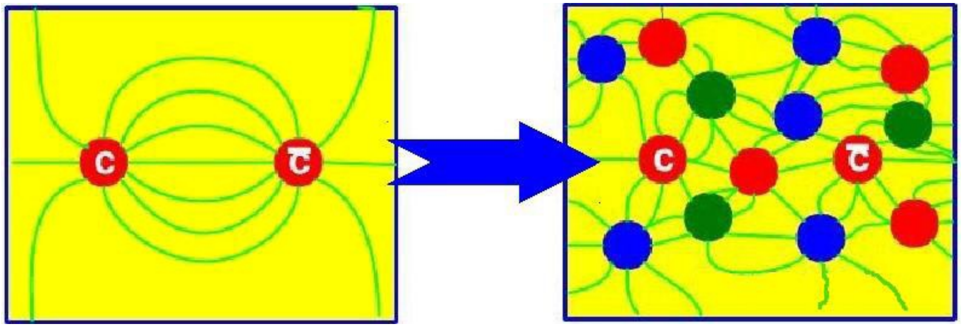
Heavy quarkonium and the QGP

- What are heavy quarkonia ?
  - Bound states of heavy quark anti-quark pairs, e.g. ψ ($c\bar{c}$) and ϒ ($b\bar{b}$) families
  - Relatively large binding energy, e.g. for J/ψ is ~600 MeV
- Due to their large mass, heavy quarks can be produced only in initial hard partonic collisions and their number is conserved during the collision history
  - Ideal probe for QGP



Heavy quarkonium and the QGP

- The original idea (Matsui and Satz, PLB 178 (1986) 416):
  - In a deconfined medium with high density of color charges, the QCD analogue of the Debye screening can lead to heavy quarkonium suppression
  - No J/ψ if $\lambda_D < r_{J/\psi}$



Heavy quarkonium and the QGP

- The original idea (Matsui and Satz, PLB 178 (1986) 416):
  - In a deconfined medium with high density of color charges, the QCD analogue of the Debye screening can lead to heavy quarkonium suppression
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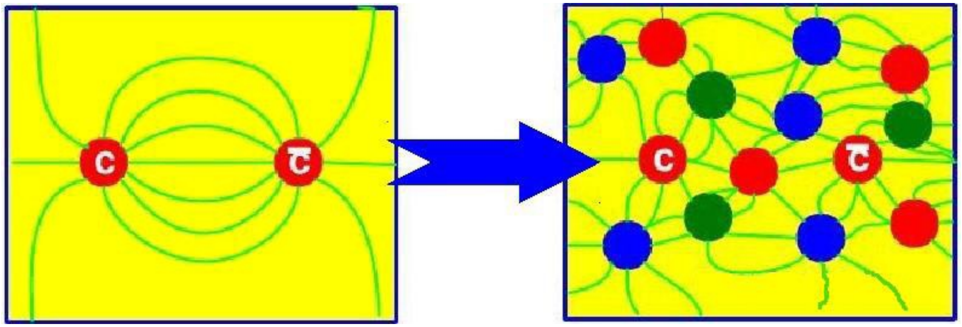
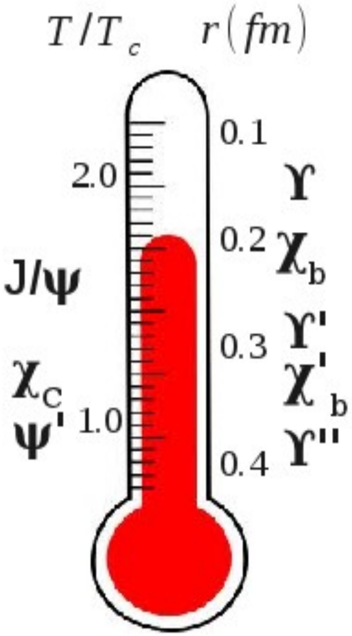
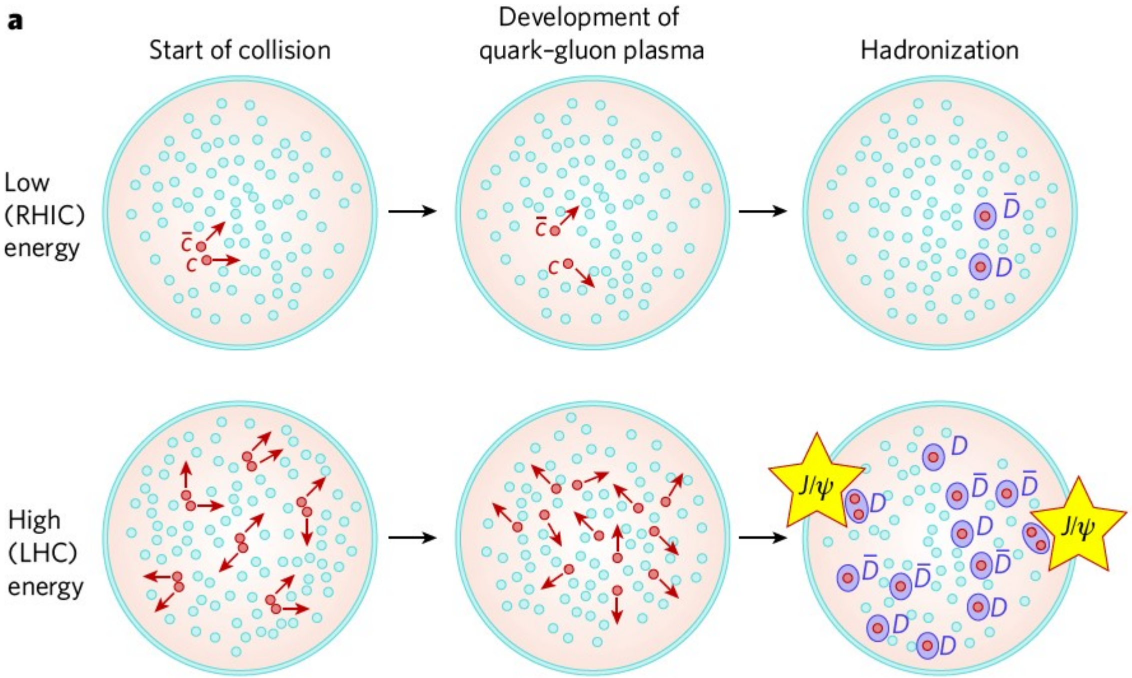
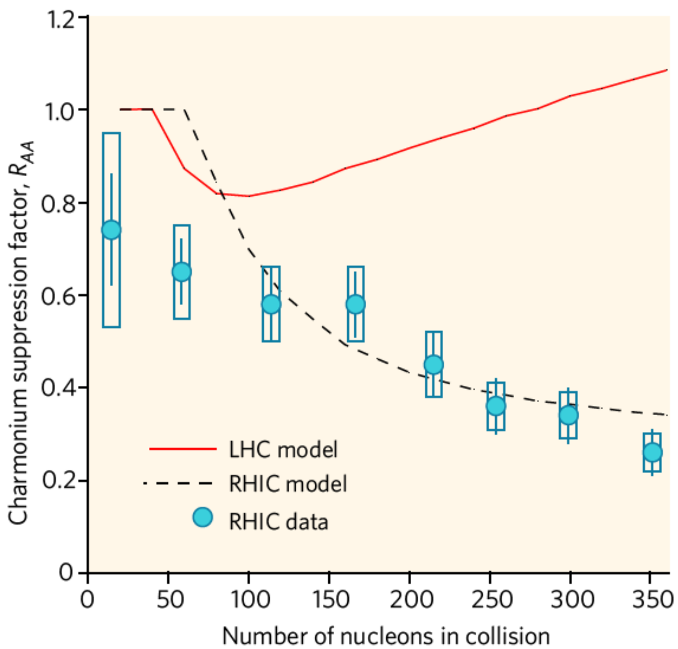




- The Debye length in QGP is a function of temperature so J/ψ and the other quarkonium states are expected to melt at different temperatures:
  - “Sequential melting”

Heavy quarkonium in the QGP (re-generation)

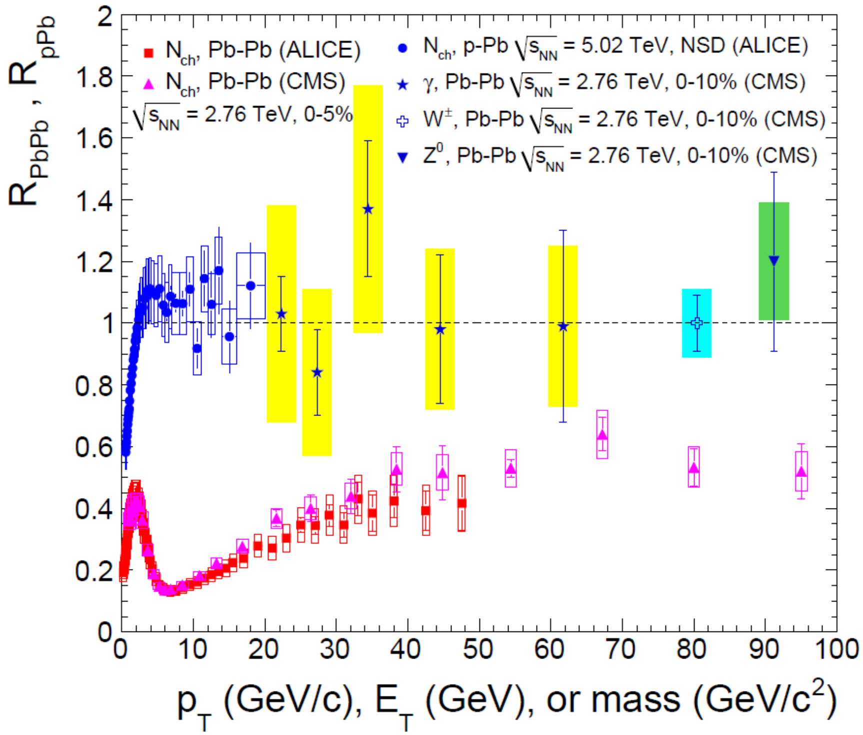




Nature 448 (2007) 302-309

- Melting ↔ formation of quarkonium states Thews et al., PRC 63 (2001) 054905
- Enhancement of quarkonia states from $Q\bar{Q}$ pairs at the phase boundary
  - Open charm and quarkonia abundancies calculated assuming statistical hadronization.
  - Braun-Munzinger and Stachel, PLB 490 (2000) 196

Medium effects (the nuclear modification factor)



p-Pb, ALICE PRL110(2013)082302
Pb-Pb, ALICE, Phys.Lett.B720 (2013)52
Pb-Pb, CMS, EPJC (2012) 72

γ, CMS, PLB 710 (2012) 256
$W^{\pm}$, CMS, PLB715 (2012) 66
Z^0, CMS, PRL106 (2011) 212301

$$R_{AA} = \frac{1}{N_{coll}} \times \frac{Y_{AA}}{Y_{pp}}$$

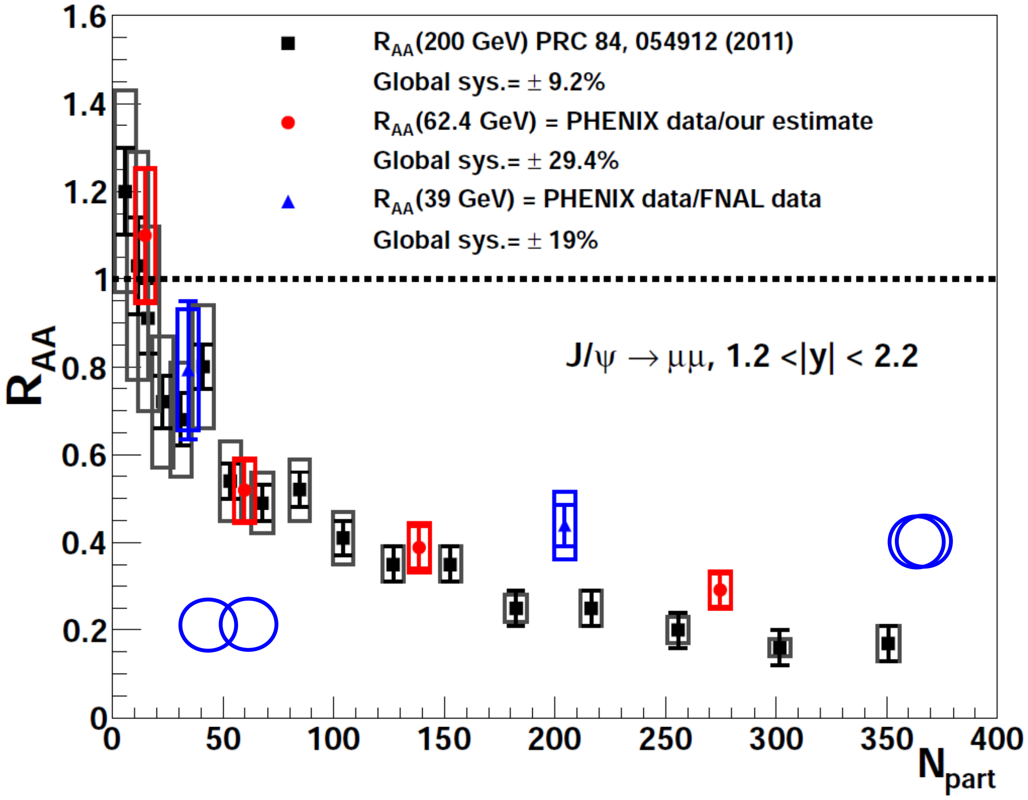
- N_{coll}: the number of binary nucleon-nucleon collisions
- Superposition of NN collisions → $R_{AA}=1$
  Suppression → $R_{AA}<1$
  Enhancement → $R_{AA}>1$

- Weakly interacting particles are not affected by the QGP
  - Photons, $W^{\pm}$ and Z^0 bosons R_{AA} are compatible with 1

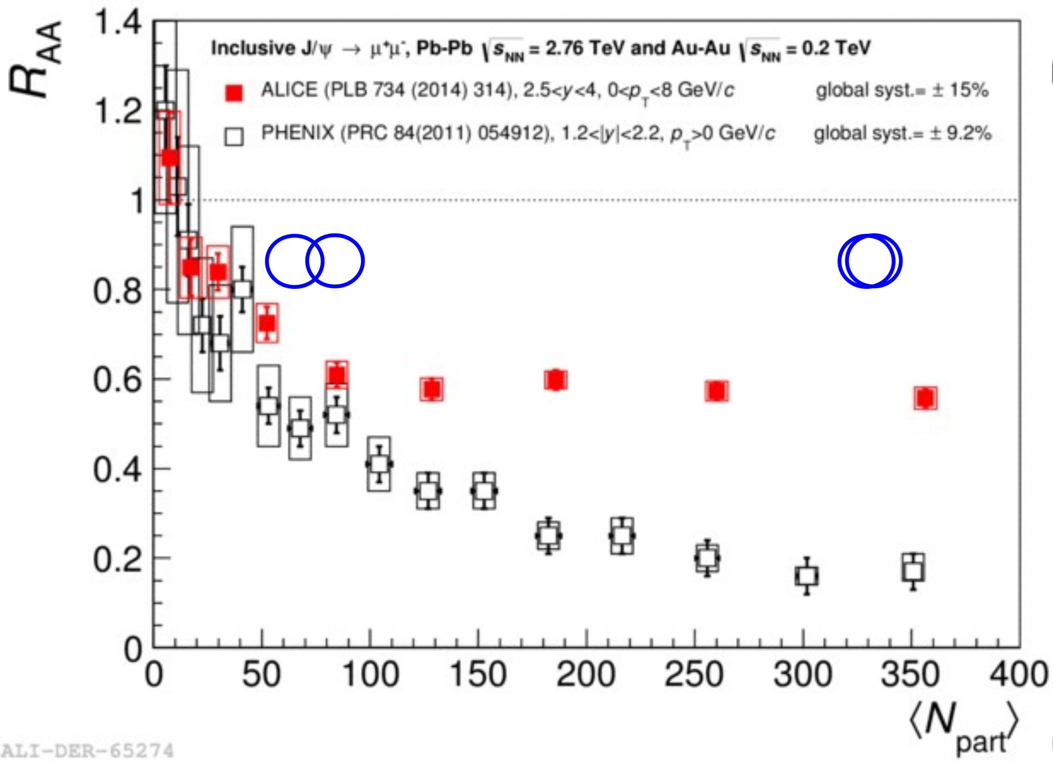
J/ψ suppression in Au-Au collisions at RHIC

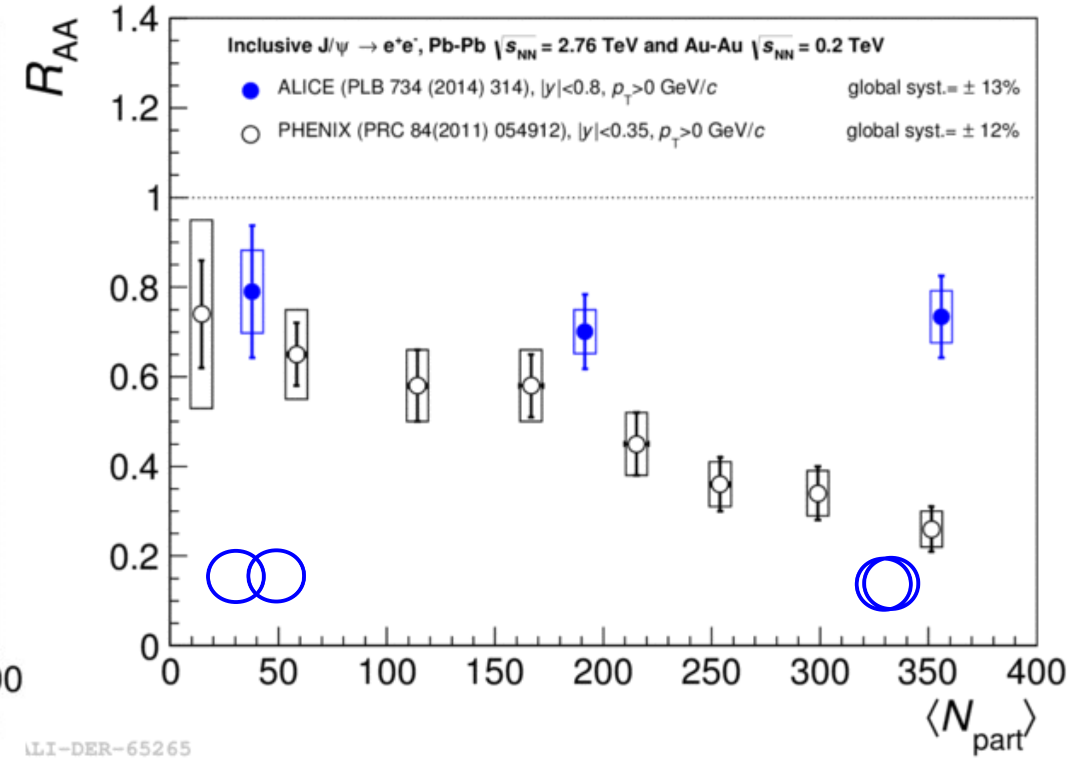
- Strong suppression observed in central Au-Au collisions at RHIC energies
- Direct evidence of color screening?
- Not completely clear yet: we still need to take into account feed-down from higher mass states (e.g., χ_c, ψ(2S)) and "cold nuclear matter" effects
  - Work ongoing

PHENIX arXiv:1208.2251



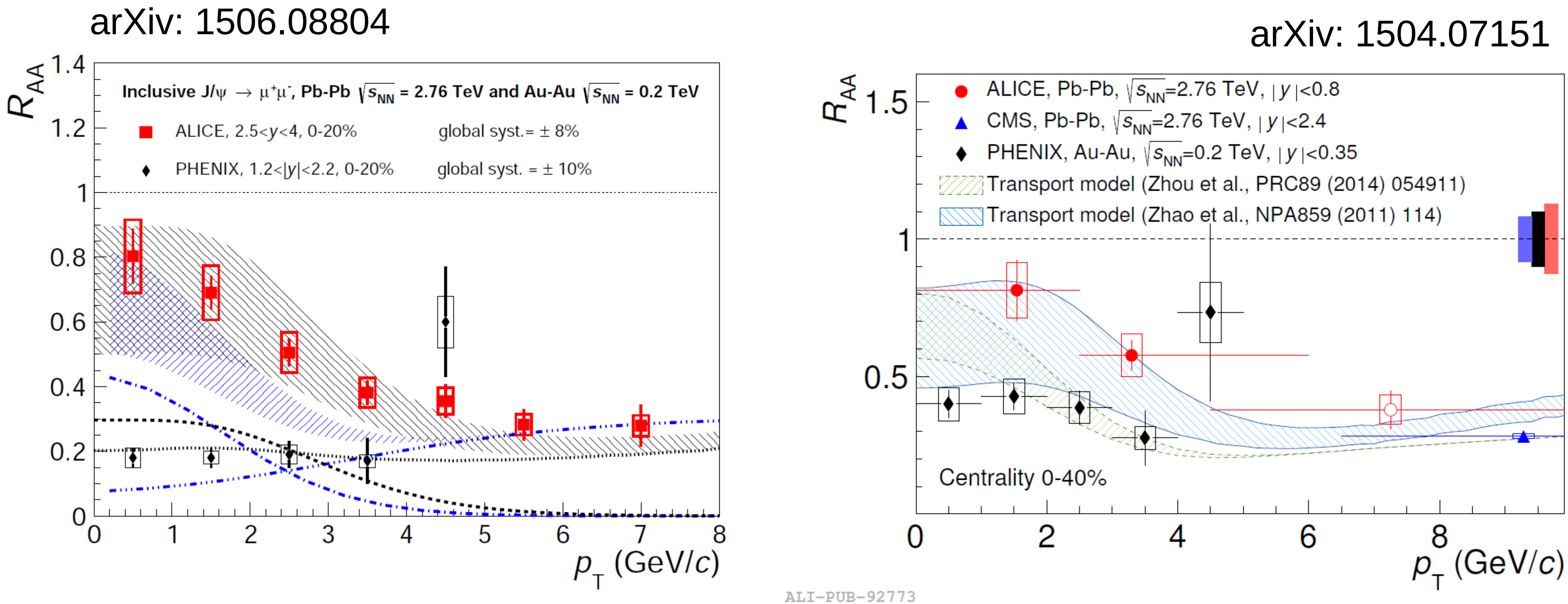
J/ψ at the LHC





- Clear J/ψ suppression seen for all centralities
- ALICE results show smaller suppression compared to lower energies (PHENIX) in central collisions
- A new regime of quarkonium production has been reached at LHC!!!

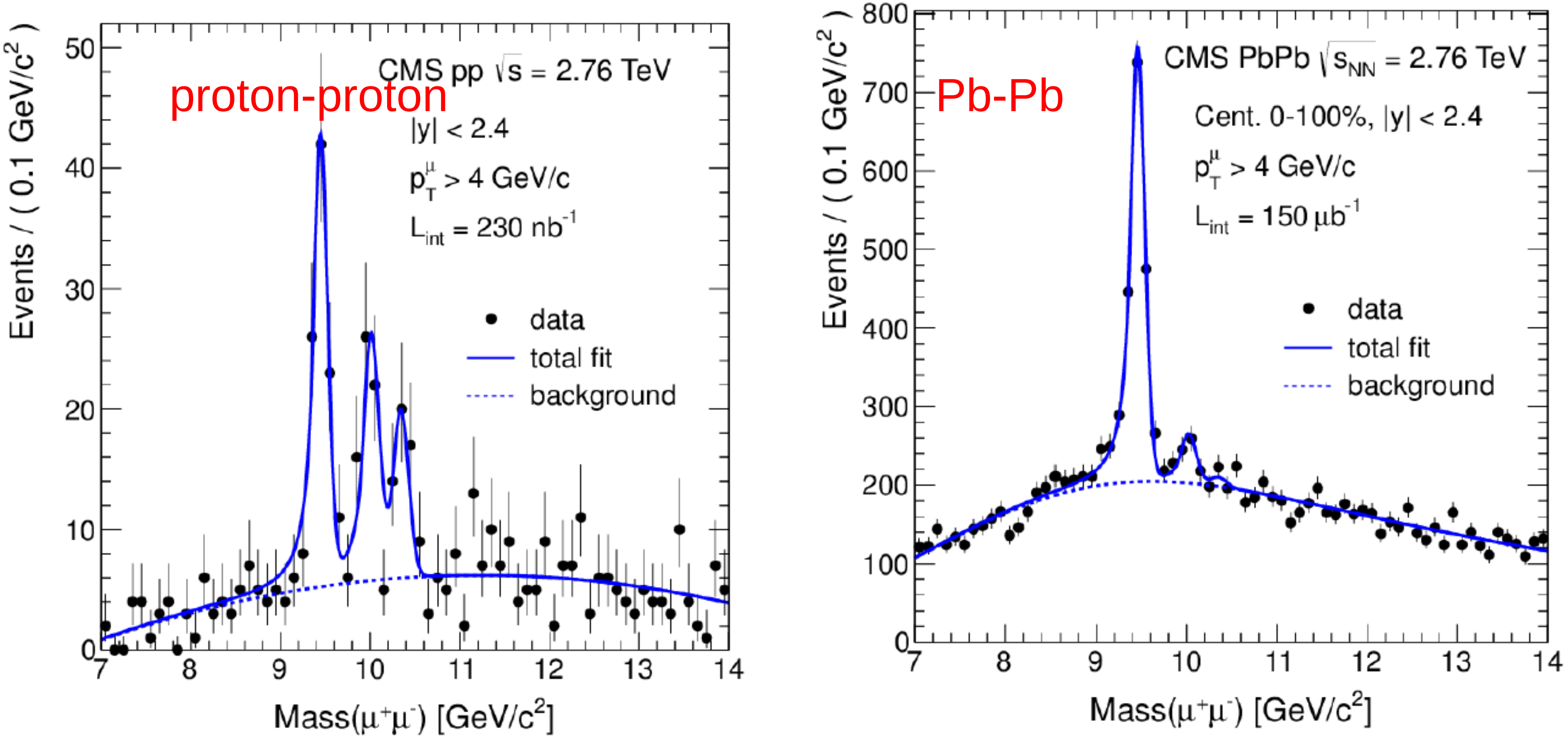
J/ψ suppression vs p_T



- Striking difference between LHC and RHIC data at low p_T
- Clear evidence for (re)generation ?
  - From simple phenomenological considerations a large J/ψ enhancement is expected at low transverse momentum

Bottomonium ($b\bar{b}$)

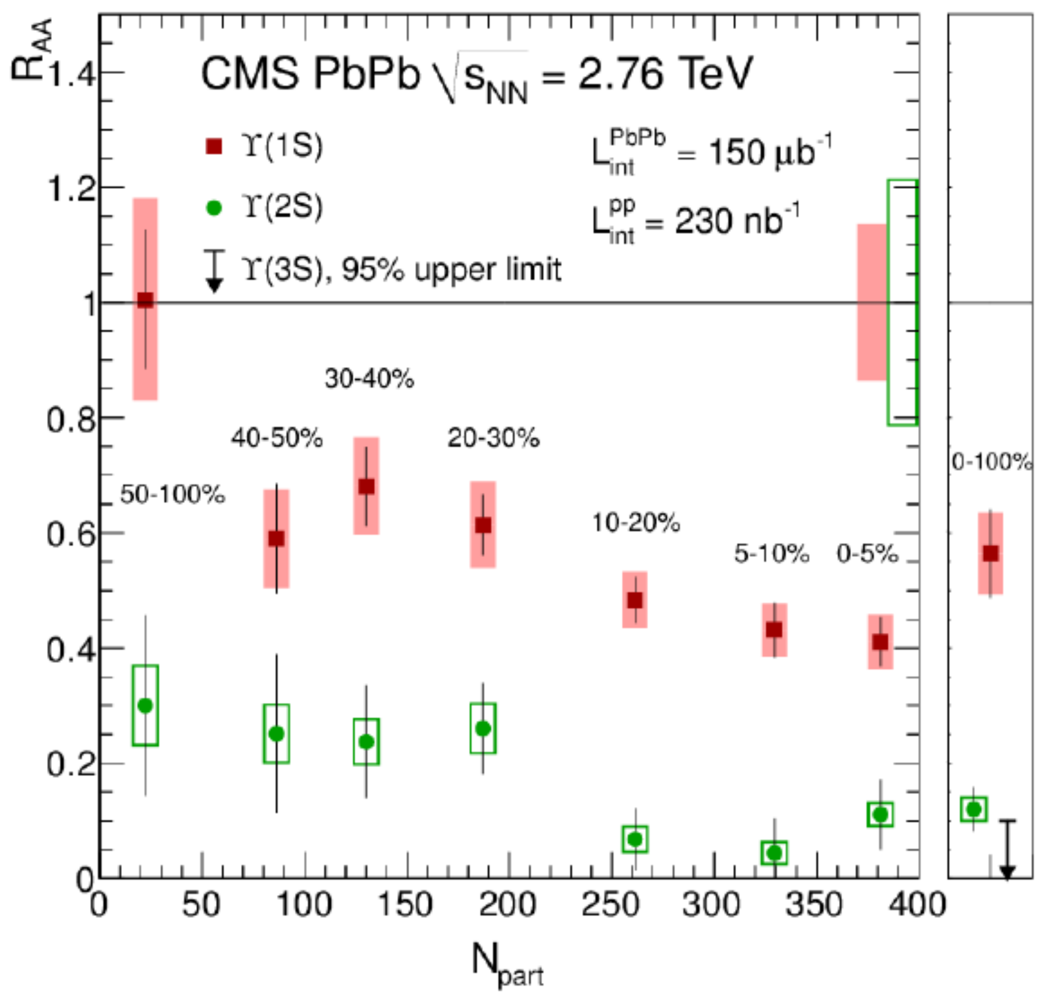
PRL109 (2012) 222301



- CMS and ALICE measured the suppression of the Upsilon meson family
- A clear suppression of the Upsilon(2S) and Upsilon(3S) relative to the ground state is observed in Pb-Pb

Inclusive Υ production vs centrality

PRL109 (2012) 222301



- CMS and ALICE measured the suppression of the Upsilon meson family
- A clear suppression of the Upsilon(2S) and Upsilon(3S) relative to the ground state is observed in Pb-Pb
- Evidence for sequential melting: R_{AA}\{Y(1S)\} > R_{AA}\{Y(2S)\} > R_{AA}\{Y(3S)\}

Conclusions

- The aim of studying the high energy heavy ion collisions is to better understand QCD in conditions not possible in particle physics: confinement, phase diagram of nuclear matter, chiral symmetry restoration
- The conditions reachable are similar to the ones during the early Universe (1 microsecond) and in the core of neutron stars
- This field incorporates knowledge from many other areas of physics:
  - Thermodynamics, hydrodynamics, string theory (AdS/CFT)
- … and technology
  - Detection technologies, Electronics, Computing
- And provides input for fields like:
  - Cosmology, astrophysics, solid-state physics, etc.
- This is a relatively young and very challenging field of study with a rich phenomenology, the manifestation of many-body QCD

What we do in the ALICE-Oslo group

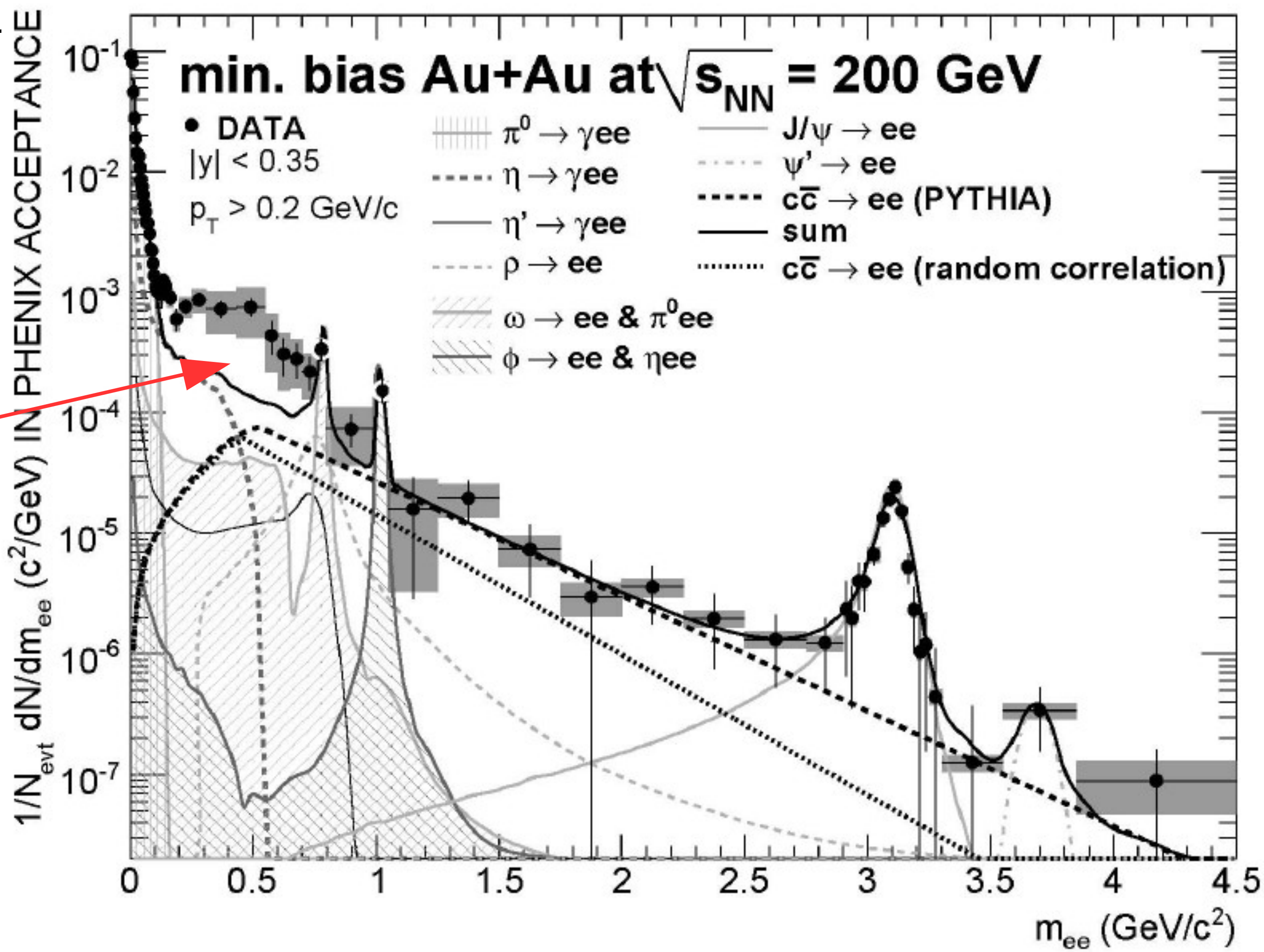
- Team leader: Prof.Trine Tveter
- Main physics topics:
  - Charmonium production in Pb-Pb, p-Pb and pp collisions
  - Three-particle correlations
  - Elliptic flow
- Detector expertise:
  - Time Projection Chamber (TPC)
  - Photon Spectrometer (PHOS)
  - Transition Radiation Detector (TRD)

Backup

Electromagnetic probes

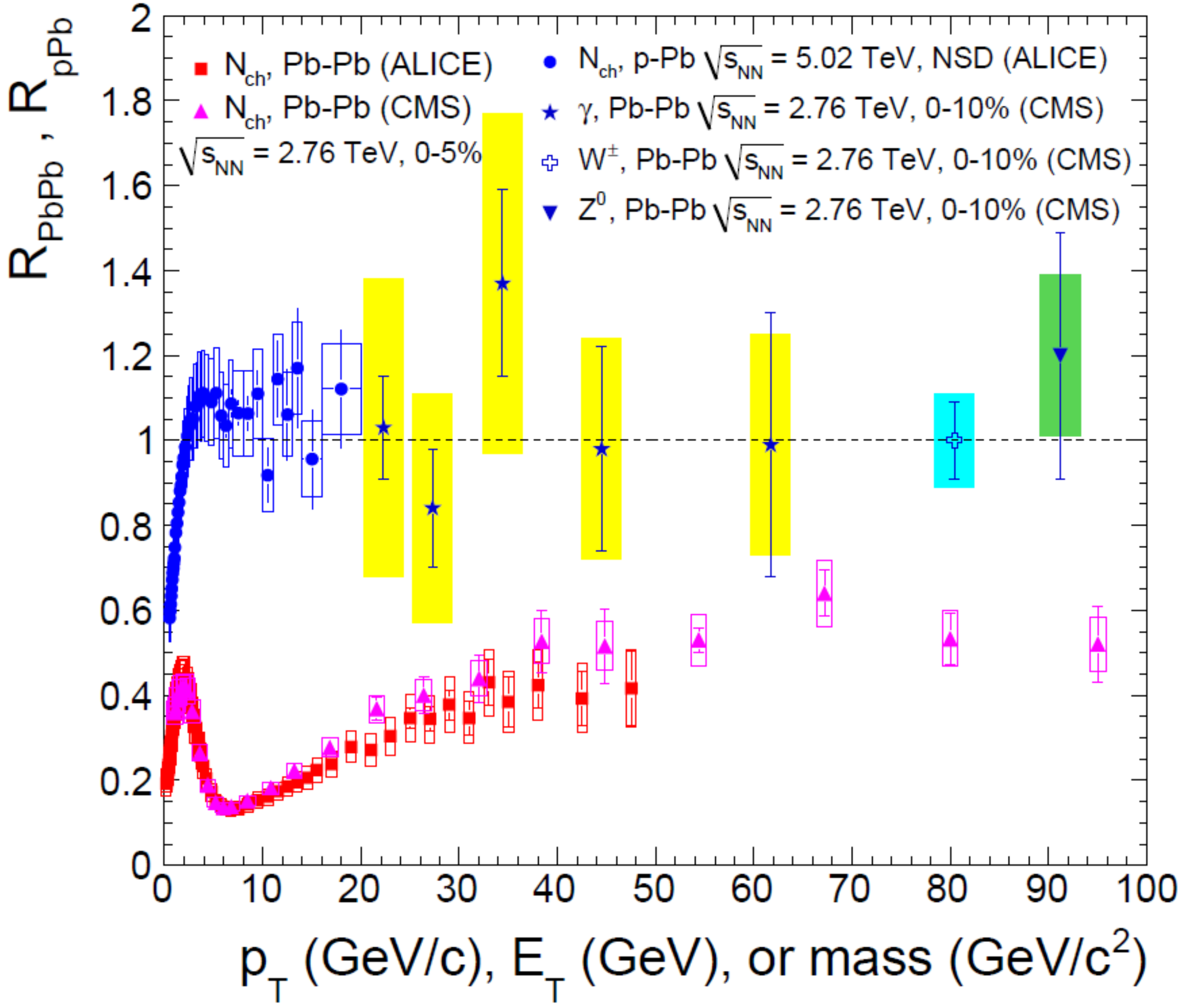
- Direct photons and low mass di-leptons
  - Probe of the thermal radiation of the fireball
  - Very clean information because of no re-interactions with QCD medium

Low mass di-electrons in PHENIX data



An excess is found at masses below 0.6-0.7 GeV/c^2

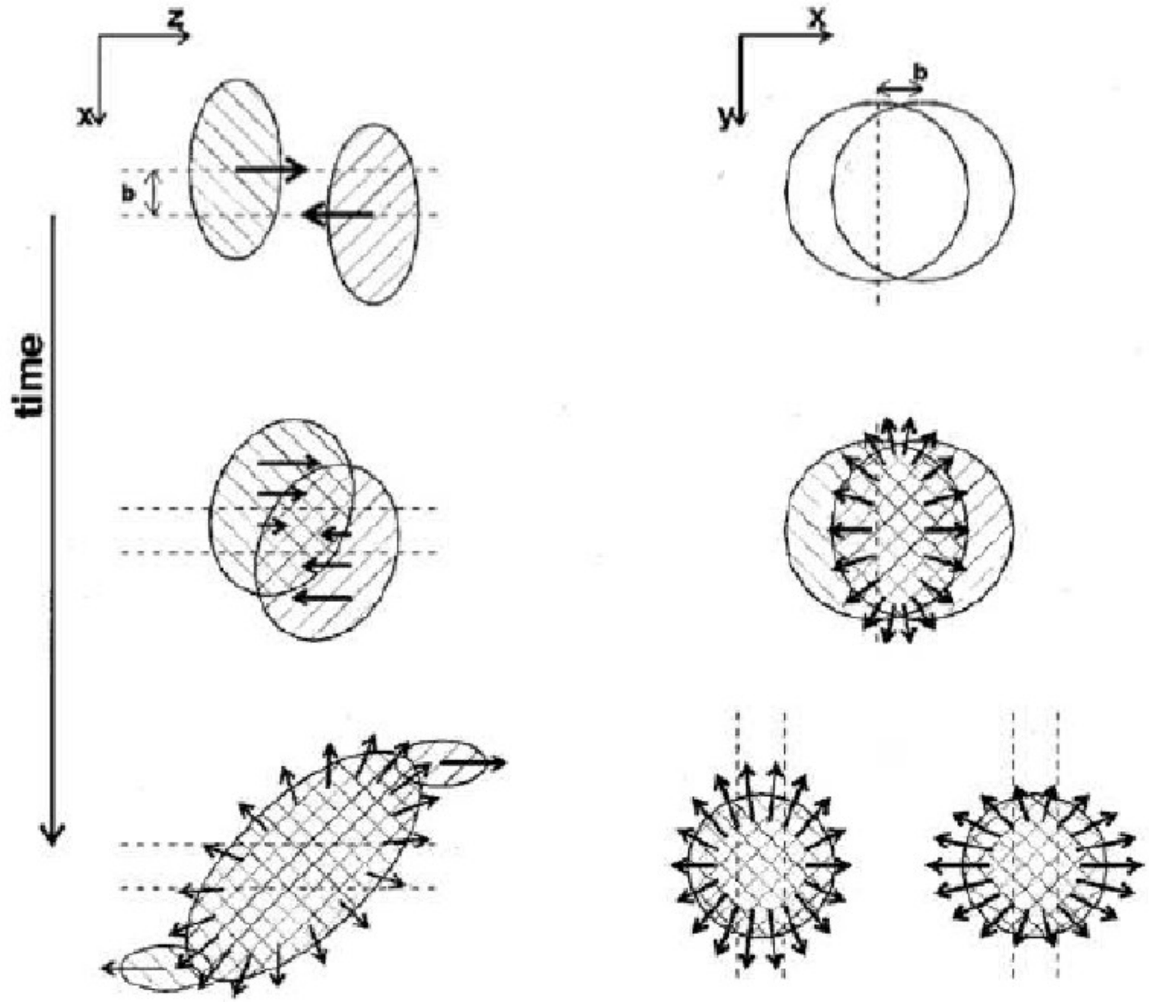
Electromagnetic probes



- Z^0, $W^{\pm}$, high momentum photons
  - No direct information on the QGP, but they act as standard candles for the nuclear modification effects: R_{AA}=1

Concepts: participants and spectators

- In nucleus-nucleus collisions at high energies, geometric concepts are applicable



N.Herrman, J.P.Wessels, T.Wienold, Ann.Rev.Nucl.part.Sci. 49(1999) 581

What are the “control parameters”

- Energy of the collision (per nucleon pair $\sqrt{s_{NN}}$)
- Centrality of the collision (number of “participating” nucleons, N_{part})

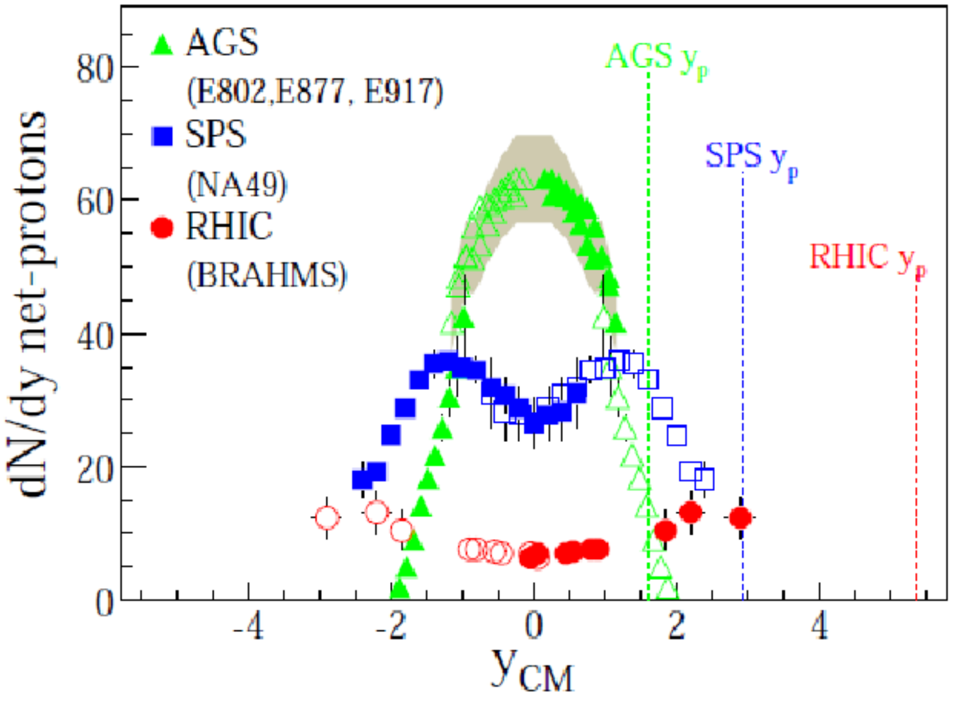
  typically measured in percentage of the geometric cross-section ($\sigma_{geom}=\pi(2R)^2$)

- Not all beam energy is spent

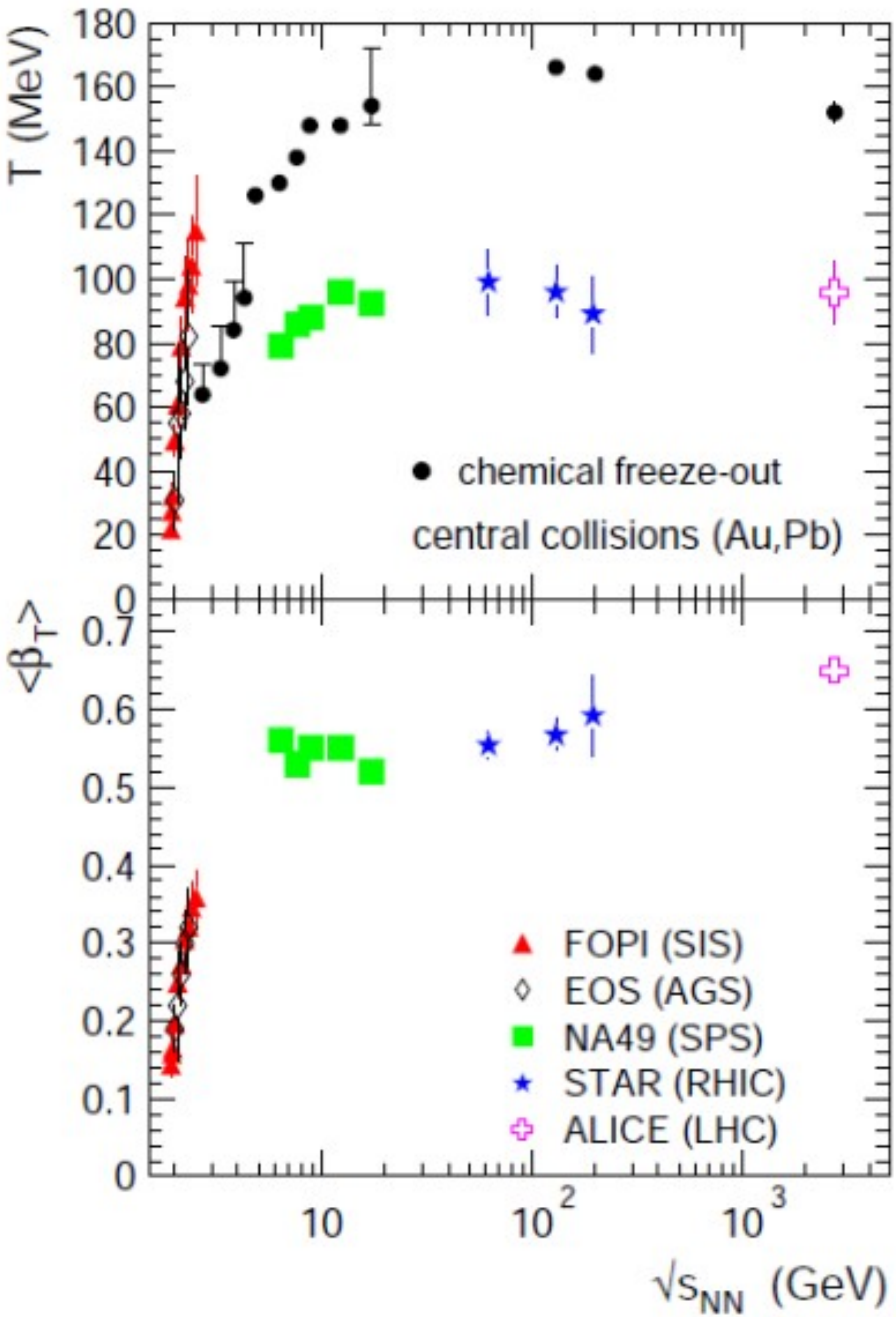
  … quantified by nuclear stopping

  net proton counting (N_p-$N_{\bar{p}}$)

  BRAHMS Collaboration, Phys.Rev.Lett.93 (2004) 102301



The kinetic freeze-out



- Hydro-like “Blast-wave” fits allow to extract parameters like :

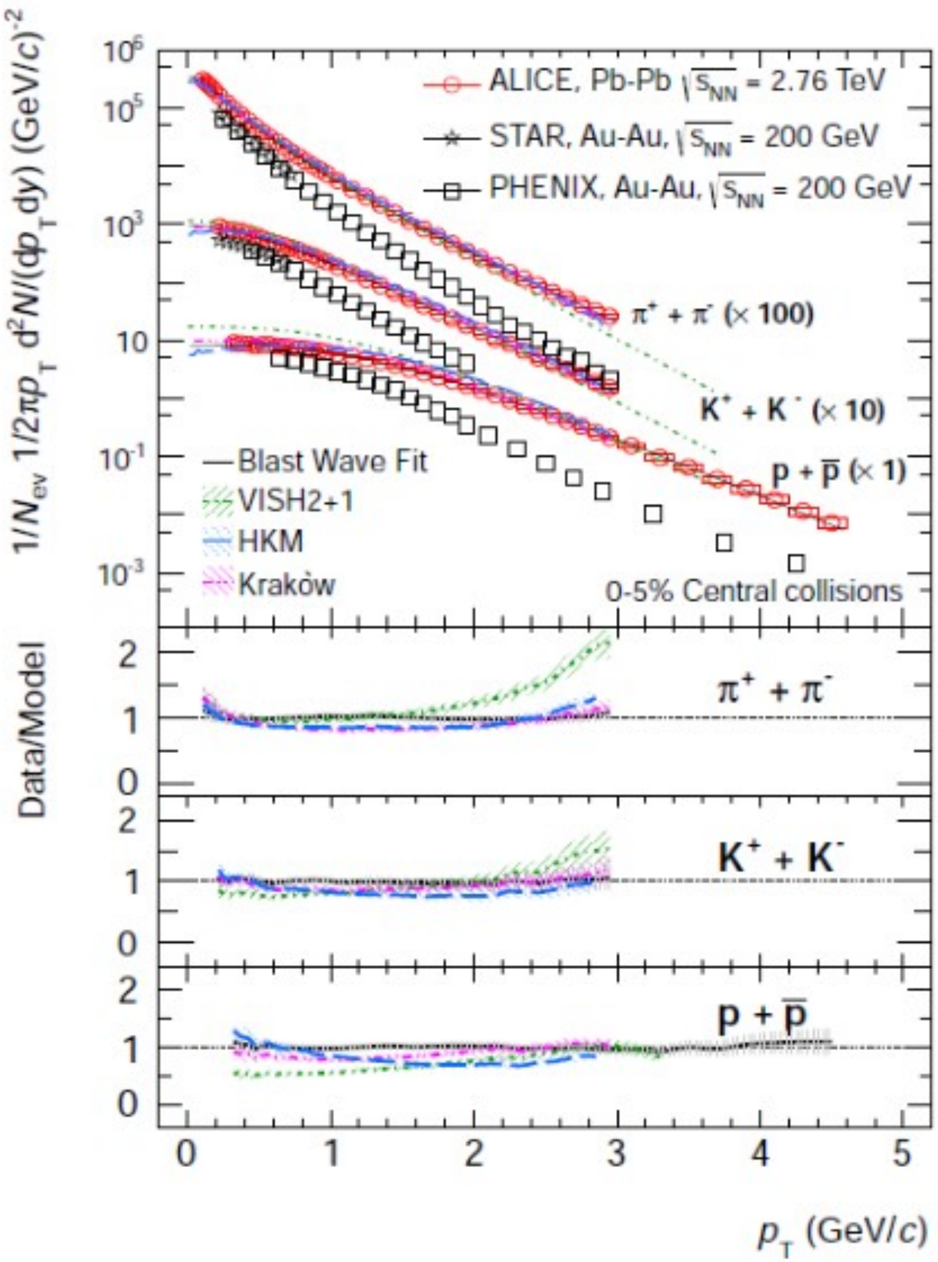
  T_{kine} = kinetic freeze-out temperature

  <β> = collective average velocity

- Light quark hadrons “flow” with a collective velocity of 65% c additional to their own individual movement

- arXiv: 1210.8126

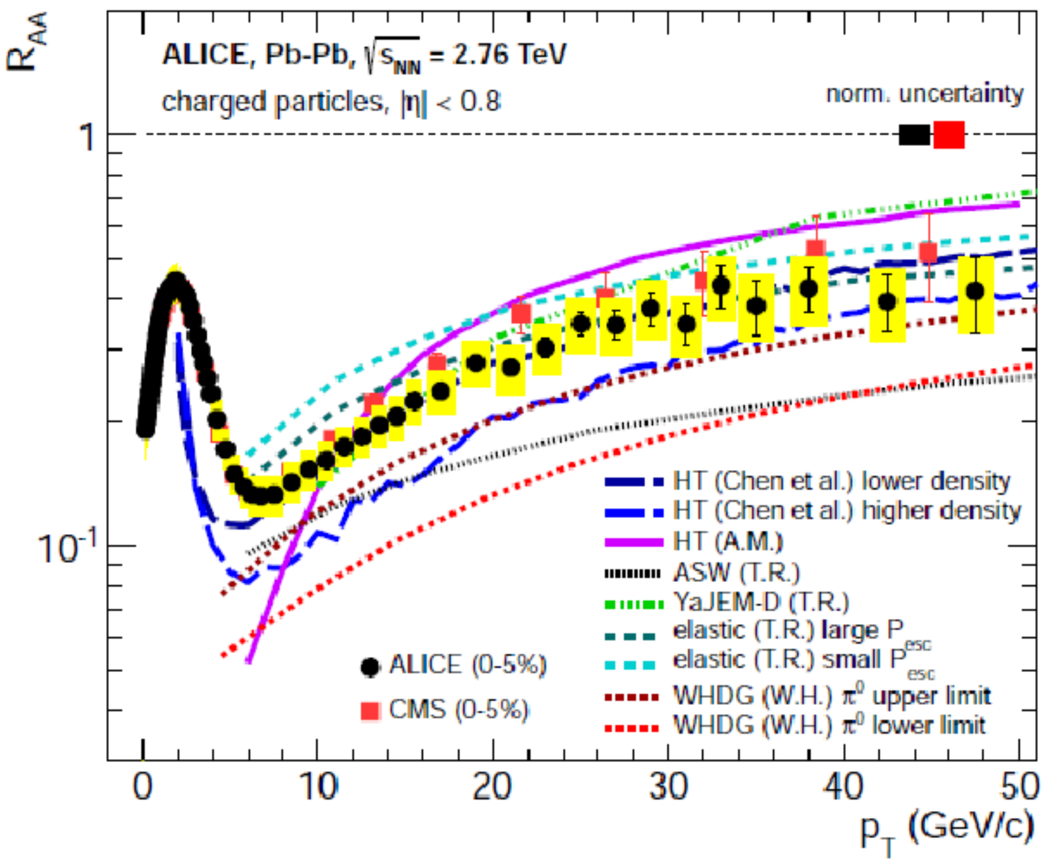
The kinetic freeze-out



ALICE, PRL 109 (2012) 252301

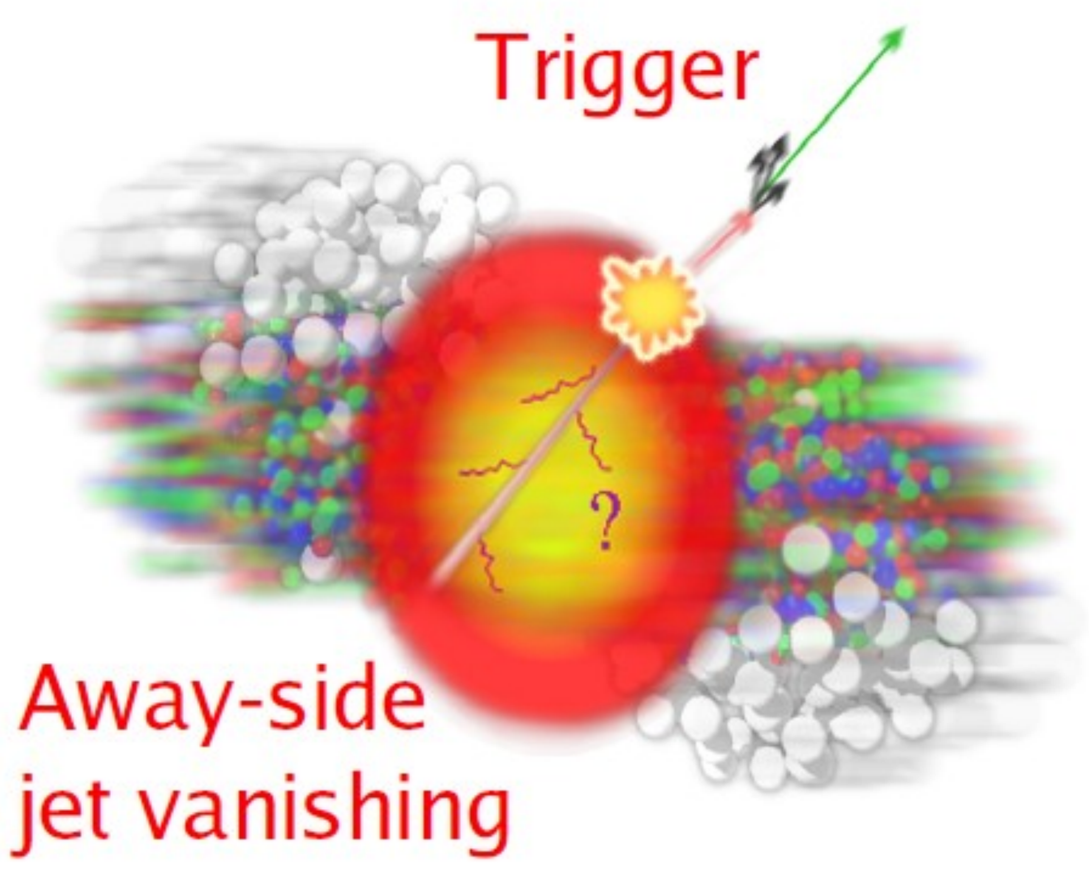
- At the LHC, spectra are harder than at RHIC ($\sqrt{s_{NN}}$=200GeV)
- The mass dependence of the spectra “hardness” indicates collective motion / flow
- Hydrodynamical models reproduce the data → the fireball expands hydrodynamically nearly as a perfect fluid (very low viscosity)

Jet quenching at the LHC



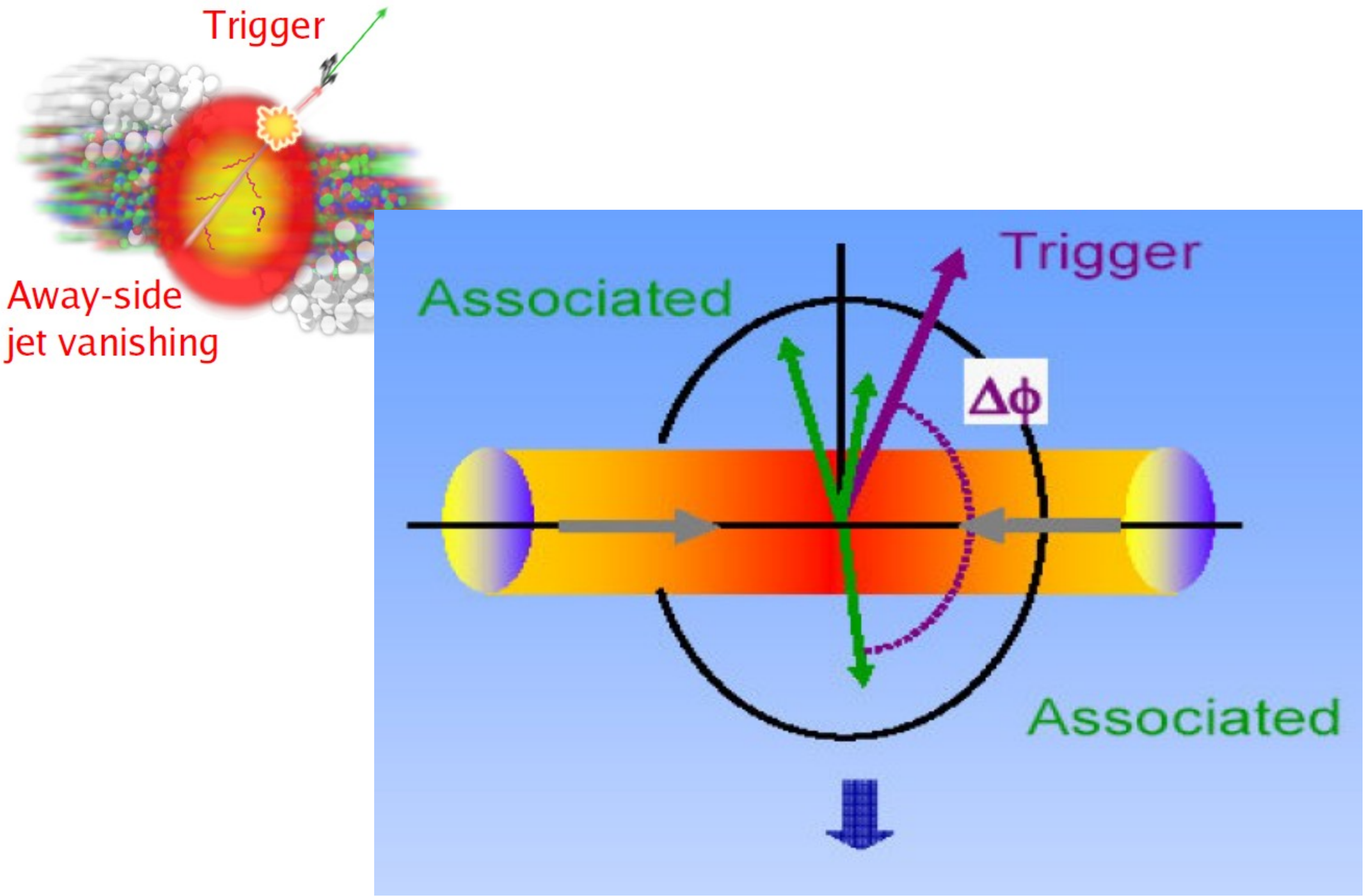
- Strong suppression observed (stronger than at RHIC)
- Reaching a factor of about 7 at p_T=7-8 GeV/c
- Remains substantial even beyond 50 GeV/c
- A lot of activity in theoretical description of parton energy loss in hot deconfined matter

Two-particle azimuthal correlations



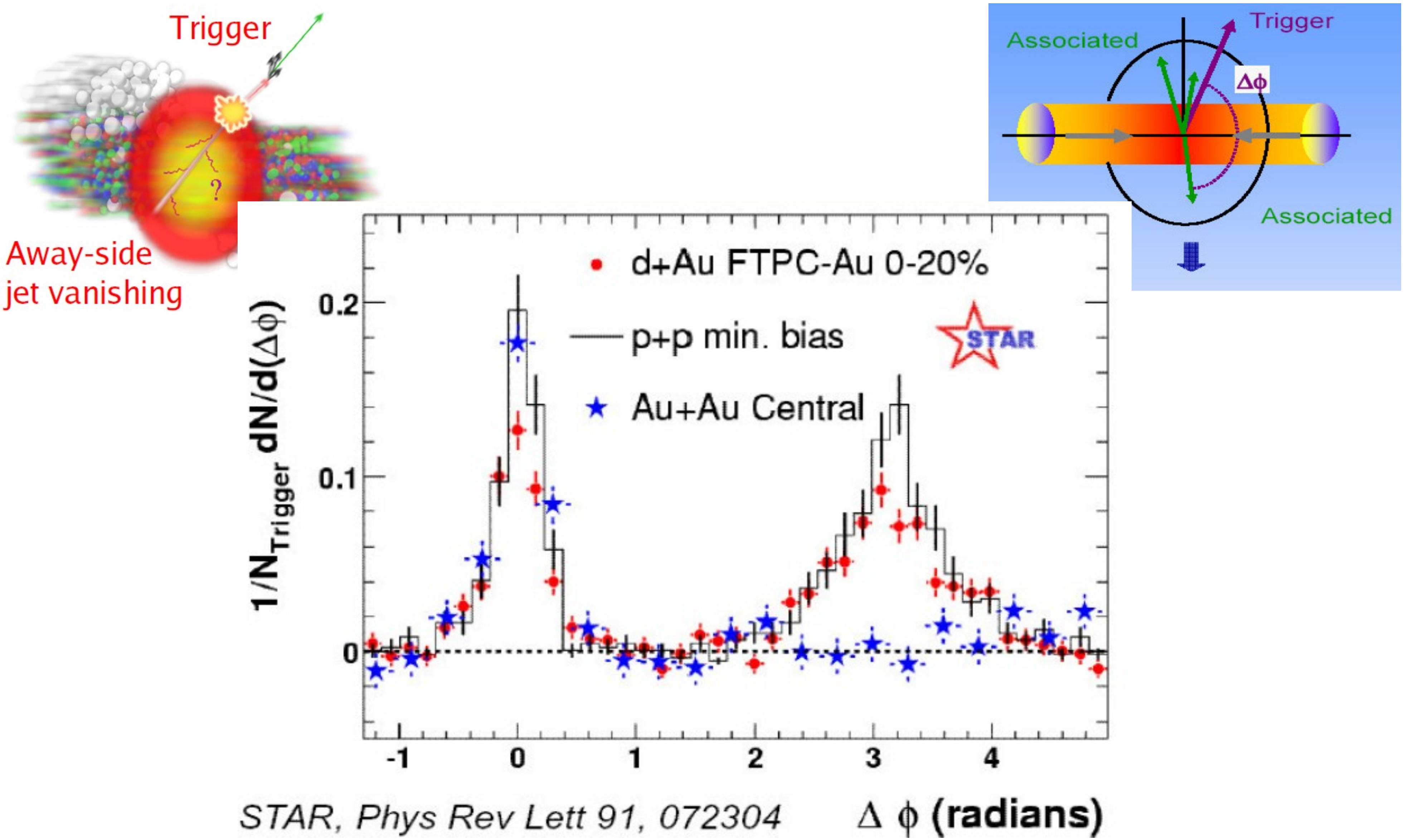
- High momentum di-jets are created in hard interactions of the initial partons
- Tipically, one of the jets traverse a smaller path through the QGP and escapes, while the other can be quenched (surface bias)

Two-particle azimuthal correlations



- Test the strength of this effect using two-particle correlations

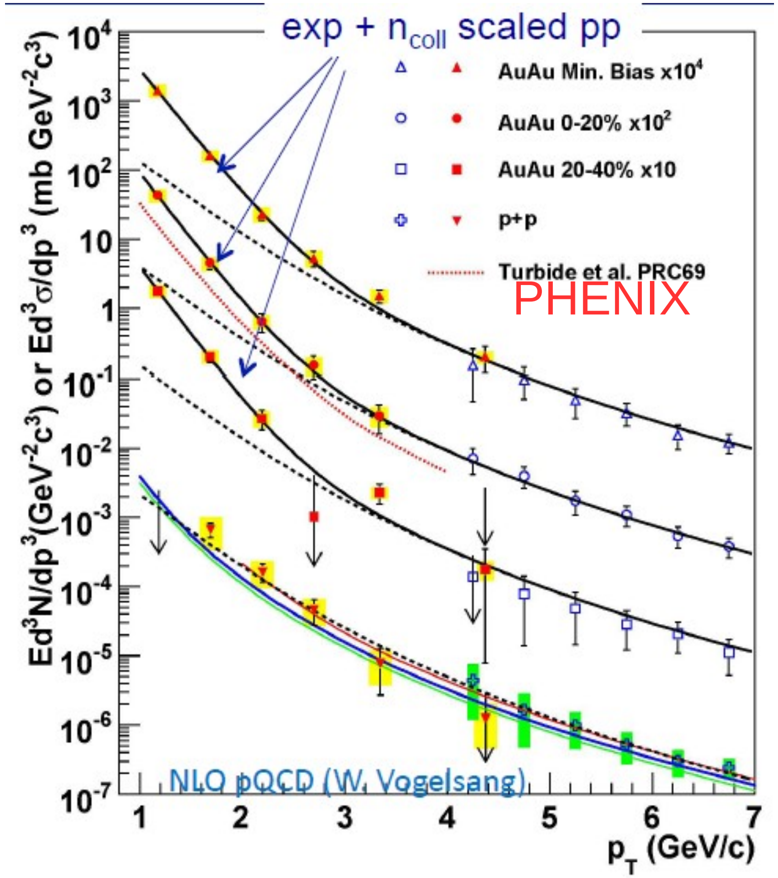
Two-particle azimuthal correlations



- Dissapearance of the associated particle is observed in nuclear collisions, while no effect is observed in pp and d-Au collisions.

Electromagnetic probes

- Direct photons and low mass di-leptons
  - Probe of the thermal radiation of the system via quark anti-quark annihilation
  - Very clean information because of no re-interactions with the QCD medium

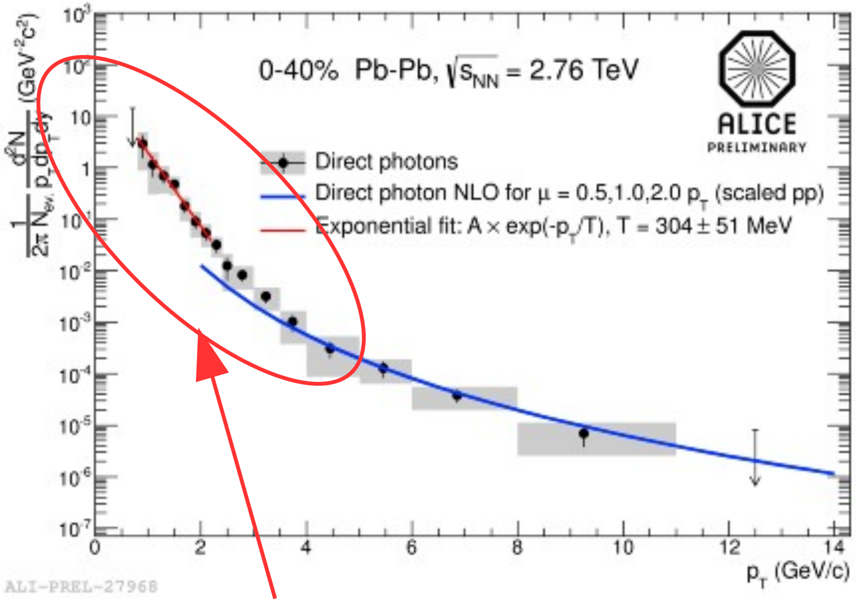


$T_{ave} = 221 \pm 19^{stat} \pm 19^{syst}$ MeV

$T_{ave} \sim 2.2 \times 10^{12}$ K

Electromagnetic probes

- Direct photons and low mass di-leptons
  - Probe of the thermal radiation of the system via quark anti-quark annihilation
  - Very clean information because of no re-interactions with the QCD medium



T = 304 ± 51 MeV

T ~3.0 x 10^{12} K

The highest temperature ever recorded!!!

Impact on the physics community

(ALICE publications)

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(961) ALICE Collaboration (K. Aamodt (Oslo U.) et al.). 2008. 259 pp.
Published in **JINST 3 (2008) S08002**
DOI: 10.1088/1748-0221/3/08/S08002
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2. **Elliptic flow of charged particles in Pb-Pb collisions at 2.76 TeV**
(483) ALICE Collaboration (K Aamodt (Bergen U.) et al.). Nov 2010. 10 pp.
Published in **Phys.Rev.Lett. 105 (2010) 252302**
DOI: 10.1103/PhysRevLett.105.252302
e-Print: **arXiv:1011.3914 [nucl-ex]** | PDF
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Heavy ion physics

3. **ALICE: Physics performance report, volume II**
(477) ALICE Collaboration (B Alessandro (ed.) (Turin U. & INFN, Turin) et al.). 2006. 746 pp.
Published in **J.Phys. G32 (2006) 1295-2040**
DOI: 10.1088/0954-3899/32/10/001
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
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4. **ALICE: Physics performance report, volume I**
(403) ALICE Collaboration (F Carminati (ed.) et al.). 2004. 247 pp.
Published in **J.Phys. G30 (2004) 1517-1763**
DOI: 10.1088/0954-3899/30/11/001
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
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Technical

5. **Suppression of Charged Particle Production at Large Transverse Momentum in Central Pb--Pb Collisions at $\sqrt{s_{NN}} = 2.76$ TeV**
(399) ALICE Collaboration (K. Aamodt (Bergen U.) et al.). Dec 2010. 16 pp.
Published in **Phys.Lett. B696 (2011) 30-39**
CERN-PH-EP-ALICE-2010-004
DOI: 10.1016/j.physletb.2010.12.020
e-Print: **arXiv:1012.1004 [nucl-ex]** | PDF
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Heavy ion physics

6. **Centrality dependence of the charged-particle multiplicity density at mid-rapidity in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV**
(334) ALICE Collaboration (Kenneth Aamodt (Bergen U.) et al.). Dec 2010. 14 pp.
Published in **Phys.Rev.Lett. 106 (2011) 032301**
DOI: 10.1103/PhysRevLett.106.032301
e-Print: **arXiv:1012.1657 [nucl-ex]** | PDF
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7. **Charged-particle multiplicity density at mid-rapidity in central Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV**
(289) ALICE Collaboration (K Aamodt (Bergen U.) et al.). Nov 2010. 10 pp.
Published in **Phys.Rev.Lett. 105 (2010) 252301**
DOI: 10.1103/PhysRevLett.105.252301
e-Print: **arXiv:1011.3916 [nucl-ex]** | PDF
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Heavy ion physics

8. **Higher harmonic anisotropic flow measurements of charged particles in Pb-Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV**
(263) ALICE Collaboration (K. Aamodt (Bergen U.) et al.). May 2011. 10 pp.
Published in **Phys.Rev.Lett. 107 (2011) 032301**
CERN-PH-EP-2011-073
DOI: 10.1103/PhysRevLett.107.032301
e-Print: **arXiv:1105.3865 [nucl-ex]** | PDF
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Detailed record - Cited by 263 records 250+

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9. **Charged-particle multiplicity measurement in proton-proton collisions at $\sqrt{s} = 7$ TeV with ALICE at LHC**
(225) ALICE Collaboration (K. Aamodt (Oslo U.) et al.). 2010. 11 pp.
Published in **Eur.Phys.J. C68 (2010) 345-354**
DOI: 10.1140/epjc/s10052-010-1350-2
e-Print: **arXiv:1004.3514 [hep-ex]** | PDF
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10. **Charged-particle multiplicity measurement in proton-proton collisions at $\sqrt{s} = 0.9$ and 2.36 TeV with ALICE at LHC**
(224) ALICE Collaboration (K. Aamodt (Oslo U.) et al.). Apr 2010.
Published in **Eur.Phys.J. C68 (2010) 89-108**
DOI: 10.1140/epjc/s10052-010-1339-x
e-Print: **arXiv:1004.3034 [hep-ex]** | PDF
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Heavy ion physics

- ALICE top 10 cited papers, all with > 200 citations
- Moreover ...

Impact on the physics community

(ATLAS publications)

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1. **Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the L**
(4121) ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*). Jul 2012. 24 pp.
Published in **Phys.Lett. B716 (2012) 1-29**
CERN-PH-EP-2012-218
DOI: 10.1016/j.physletb.2012.08.020
e-Print: **arXiv:1207.7214 [hep-ex]** | PDF
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Higgs discovery

2. **The ATLAS Experiment at the CERN Large Hadron Collider**
(3414) ATLAS Collaboration (G. Aad (Marseille, CPPM) *et al.*). 2008. 437 pp.
Published in **JINST 3 (2008) S08003**
DOI: 10.1088/1748-0221/3/08/S08003
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Technical

3. **Expected Performance of the ATLAS Experiment - Detector, Trigger and Physics**
(1705) ATLAS Collaboration (G. Aad *et al.*). Jan 2009. 1852 pp.
SLAC-R-980, CERN-OPEN-2008-020
e-Print: **arXiv:0901.0512 [hep-ex]** | PDF
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Detailed record - Cited by 1705 records 1000+

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4. **The ATLAS Simulation Infrastructure**
(991) ATLAS Collaboration (G. Aad (Freiburg U.) *et al.*). 2010. 53 pp.
Published in **Eur.Phys.J. C70 (2010) 823-874**
DOI: 10.1140/epjc/s10052-010-1429-9
e-Print: **arXiv:1005.4568 [physics.ins-det]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
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5. **Electron performance measurements with the ATLAS detector using the 2010 LHC proton-proton collision data**
(614) ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*). Oct 2011. 45 pp.
Published in **Eur.Phys.J. C72 (2012) 1909**
CERN-PH-EP-2011-117
DOI: 10.1140/epjc/s10052-012-1909-1
e-Print: **arXiv:1110.3174 [hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Link to all figures including auxiliary figures
Detailed record - Cited by 614 records 500+

Technical

6. **ATLAS: Detector and physics performance technical design report. Volume 1**
(583) ATLAS Collaboration (A. Airapetian *et al.*). May 1999. 475 pp.
CERN-LHCC-99-14, ATLAS-TDR-14
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Library Record
Detailed record - Cited by 583 records 500+

Technical

7. **Jet energy measurement with the ATLAS detector in proton-proton collisions at $\sqrt{s} = 7$ TeV**
(552) ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*). Dec 2011. 100 pp.
Published in **Eur.Phys.J. C73 (2013) 3, 2304**
CERN-PH-EP-2011-191
DOI: 10.1140/epjc/s10052-013-2304-2
e-Print: **arXiv:1112.6426 [hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Link to all figures including auxiliary figures
Detailed record - Cited by 552 records 500+

pp jet physics

8. **Combined search for the Standard Model Higgs boson using up to 4.9 fb^{-1} of pp collision data at $\sqrt{s} = 7$ TeV with the ATLAS detector at the LHC**
(532) ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*). Feb 2012. 8 pp.
Published in **Phys.Lett. B710 (2012) 49-66**
CERN-PH-EP-2012-019
DOI: 10.1016/j.physletb.2012.02.044
e-Print: **arXiv:1202.1408 [hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Link to all figures including auxiliary figures
Detailed record - Cited by 532 records 500+

Higgs discovery

9. **ATLAS: Detector and physics performance technical design report. Volume 2**
(522) ATLAS Collaboration (A. Airapetian *et al.*). May 1999. 519 pp.
CERN-LHCC-99-15, ATLAS-TDR-15
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; CERN ATLAS Server; CERN Library Record; Fermilab BOOKS Database; Link to Fulltext
Detailed record - Cited by 522 records 500+

Technical

10. **Luminosity Determination in pp Collisions at $\sqrt{s} = 7$ TeV Using the ATLAS Detector at the LHC**
(458) ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*). Jan 2011. 24 pp.
Published in **Eur.Phys.J. C71 (2011) 1630**
CERN-PH-EP-2010-069
DOI: 10.1140/epjc/s10052-011-1630-5
e-Print: **arXiv:1101.2185 [hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
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Detailed record - Cited by 458 records 250+

Technical

- ATLAS top 3 most cited scientific papers include the Higgs discovery papers and pp jet physics (as expected)

Impact on the physics community

(ATLAS publications)

11. **Observation of a Centrality-Dependent Dijet Asymmetry in Lead-Lead Collisions at $\sqrt{s_{NN}} = 2.77$ TeV with the ATLAS Detector at the LHC**
(406) ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*). Nov 2010. 19 pp.
Published in **Phys.Rev.Lett. 105 (2010) 252303**
DOI: 10.1103/PhysRevLett.105.252303
e-Print: **arXiv:1011.6182 [hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Link to all figures including auxiliary figures
Data: INSPIRE | HepData
Detailed record - Cited by 406 records 250+

Heavy ion physics

12. **ATLAS: Technical proposal for a general-purpose p p experiment at the Large Hadron Collider at CERN**
(404) ATLAS Collaboration (W.W. Armstrong (Alberta U.) *et al.*). Dec 1994. 289 pp.
CERN-LHCC-94-43
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Library Record; Fermilab BOOKS Database
Detailed record - Cited by 404 records 250+

Technical

13. **Performance of Missing Transverse Momentum Reconstruction in Proton-Proton Collisions at 7 TeV with ATLAS**
(403) ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*). 2012. 22 pp.
Published in **Eur.Phys.J. C72 (2012) 1844**
CERN-PH-EP-2011-114
DOI: 10.1140/epjc/s10052-011-1844-6
e-Print: **arXiv:1108.5602 [hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Link to all figures including auxiliary figures
Detailed record - Cited by 403 records 250+

Technical

14. **ATLAS inner detector: Technical design report. Vol. 1**
(358) ATLAS Collaboration. Apr 1997. 270 pp.
CERN-LHCC-97-16, ATLAS-TDR-4
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN ATLAS Server; Fermilab BOOKS Database
Detailed record - Cited by 358 records 250+

Technical

15. **Measurements of Higgs boson production and couplings in diboson final states with the ATLAS detector at the LHC**
(350) ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*). Jul 4, 2013. 32 pp.
Published in **Phys.Lett. B726 (2013) 88-119, Erratum-ibid. B734 (2014) 406-406**
CERN-PH-EP-2013-103
DOI: 10.1016/j.physletb.2013.08.010, 10.1016/j.physletb.2014.05.011
e-Print: **arXiv:1307.1427 [hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Link to Article from SCOAP3
Data: INSPIRE | HepData
Detailed record - Cited by 350 records 250+

Higgs discovery

16. **Commissioning of the ATLAS high-performance b-tagging algorithms in the 7 TeV collision data**
(346) ATLAS Collaboration. Jul 21, 2011.
ATLAS-CONF-2011-102, ATLAS-COM-CONF-2011-110
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; Link to Fulltext
Detailed record - Cited by 346 records 250+

Technical

17. **Improved luminosity determination in pp collisions at sqrt(s) = 7 TeV using the ATLAS detector at the LHC**
(330) ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*). Feb 18, 2013. 27 pp.
Published in **Eur.Phys.J. C73 (2013) 8, 2518**
CERN-PH-EP-2013-026
DOI: 10.1140/epjc/s10052-013-2518-3
e-Print: **arXiv:1302.4393 [hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service
Detailed record - Cited by 330 records 250+

Technical

18. **Measurement of the top quark-pair production cross section with ATLAS in pp collisions at $\sqrt{s} = 7$ TeV**
(329) ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*). Dec 2010. 30 pp.
Published in **Eur.Phys.J. C71 (2011) 1577**
CERN-PH-EP-2010-064
DOI: 10.1140/epjc/s10052-011-1577-6
e-Print: **arXiv:1012.1792 [hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Link to all figures including auxiliary figures
Detailed record - Cited by 329 records 250+

Top-quark

19. **Charged-particle multiplicities in pp interactions measured with the ATLAS detector at the LHC**
(318) ATLAS Collaboration (G. Aad (Freiburg U.) *et al.*). Dec 2010. 70 pp.
Published in **New J.Phys. 13 (2011) 053033**
CERN-PH-EP-2010-079
DOI: 10.1088/1367-2630/13/5/053033
e-Print: **arXiv:1012.5104 [hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Link to all figures including auxiliary figures
Data: INSPIRE | HepData
Detailed record - Cited by 318 records 250+

Soft-QCD pp physics

20. **Search for squarks and gluinos using final states with jets and missing transverse momentum with the ATLAS detector in $\sqrt{s} = 7$ TeV proton-proton collisions**
(316) ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*). Sep 2011. 9 pp.
Published in **Phys.Lett. B710 (2012) 67-85**
CERN-PH-EP-2011-145
DOI: 10.1016/j.physletb.2012.02.051
e-Print: **arXiv:1109.6572 [hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Link to all figures including auxiliary figures
Data: INSPIRE | HepData
Detailed record - Cited by 316 records 250+

Supersymmetry searches

- Heavy-ion physics papers rank among the highest cited papers in ATLAS, despite the very small physics working group
- Most cited heavy-ion paper by ATLAS rankes 4th, but several others are following closely ...

Impact on the physics community

(CMS publications)

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HEP **3,553** records found 1 - 250 jump to record: 1

1. **Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC** — Higgs discovery
(4039) CMS Collaboration (Serguei Chatrchyan (Yerevan Phys. Inst.) *et al.*). Jul 2012. 42 pp.
Published in **Phys.Lett. B716 (2012) 30-61**
CMS-HIG-12-028, CERN-PH-EP-2012-220
DOI: 10.1016/j.physletb.2012.08.021
e-Print: **arXiv:1207.7235 [hep-ex]** | **PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; ADS Abstract Service; Link to PRESSRELEASE; Interactions.org article
Detailed record - Cited by 4039 records 1000+

2. **The CMS experiment at the CERN LHC** — Technical
(2611) CMS Collaboration (S. Chatrchyan (Yerevan Phys. Inst.) *et al.*). Aug 2008. 361 pp.
Published in **JINST 3 (2008) S08004**
DOI: 10.1088/1748-0221/3/08/S08004
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; ADS Abstract Service
Detailed record - Cited by 2611 records 1000+

3. **CMS technical design report, volume II: Physics performance** — Technical
(1178) CMS Collaboration (G.L. Bayatian (Yerevan Phys. Inst.) *et al.*). 2007. 585 pp.
Published in **J.Phys. G34 (2007) 995-1579**
CERN-LHCC-2006-021, CMS-TDR-008-2
DOI: 10.1088/0954-3899/34/6/S01
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; Link to Fulltext
Detailed record - Cited by 1178 records 1000+

4. **Combined results of searches for the standard model Higgs boson in pp collisions at $\sqrt{s}=7$ TeV** — Higgs discovery
(675) CMS Collaboration (Serguei Chatrchyan (Yerevan Phys. Inst.) *et al.*). Feb 2012.
Published in **Phys.Lett. B710 (2012) 26-48**
CMS-HIG-11-032, CERN-PH-EP-2012-023
DOI: 10.1016/j.physletb.2012.02.064
e-Print: **arXiv:1202.1488 [hep-ex]** | **PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; ADS Abstract Service; Fermilab Today Result of the Week; Fermilab Library Server (fulltext available)
Detailed record - Cited by 675 records 500+

5. **Particle-Flow Event Reconstruction in CMS and Performance for Jets, Taus, and MET** — Technical
(544) CMS Collaboration. Apr 28, 2009.
CMS-PAS-PFT-09-001
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; Link to Fulltext
Detailed record - Cited by 544 records 500+

6. **Determination of Jet Energy Calibration and Transverse Momentum Resolution in CMS** — Technical
(508) CMS Collaboration (Serguei Chatrchyan (Yerevan Phys. Inst.) *et al.*). Jul 2011.
Published in **JINST 6 (2011) P11002**
CERN-PH-EP-2011-102, CMS-JME-10-011
DOI: 10.1088/1748-0221/6/11/P11002
e-Print: **arXiv:1107.4277 [physics.ins-det]** | **PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; ADS Abstract Service
Detailed record - Cited by 508 records 500+

7. **CMS physics: Technical design report** — Technical
(483) CMS Collaboration (G.L. Bayatian (Yerevan Phys. Inst.) *et al.*). 2006. 521 pp.
CERN-LHCC-2006-001, CMS-TDR-008-1
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Library Record; CERN Server; Fermilab BOOKS Database
Detailed record - Cited by 483 records 250+

8. **CMS, the Compact Muon Solenoid: Technical proposal** — Technical
(389) CMS Collaboration. Dec 1994. 289 pp.
CERN-LHCC-94-38, CERN-LHCC-P-1
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; Fermilab BOOKS Database
Detailed record - Cited by 389 records 250+

9. **Combination of standard model Higgs boson searches and measurements of the properties of the new boson with a mass near 125 GeV** — Higgs discovery
(379) CMS Collaboration. Apr 17, 2013. 33 pp.
CMS-PAS-HIG-13-005
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; Link to Fulltext
Detailed record - Cited by 379 records 250+

10. **Observation and studies of jet quenching in PbPb collisions at nucleon-nucleon center-of-mass energy = 2.76 TeV** — Heavy ion physics
(362) CMS Collaboration (Serguei Chatrchyan (Yerevan Phys. Inst.) *et al.*). Feb 2011. 26 pp.
Published in **Phys.Rev. C84 (2011) 024906**
CERN-PH-EP-2011-001, CMS-HIN-10-004
DOI: 10.1103/PhysRevC.84.024906
e-Print: **arXiv:1102.1957 [nucl-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; ADS Abstract Service; Fermilab Library Server (fulltext available)
Detailed record - Cited by 362 records 250+

- CMS has a few heavy-ion papers in its top-cited scientific papers

Impact on the physics community

(CMS publications)

11. **Observation of Long-Range Near-Side Angular Correlations in Proton-Proton Collisions at the LHC**
(323) CMS Collaboration (Vardan Khachatryan (Yerevan Phys. Inst.) *et al.*). Sep 2010.
Published in **JHEP 1009 (2010) 091**
CMS-QCD-10-002, CERN-PH-EP-2010-031
DOI: 10.1007/JHEP09(2010)091
e-Print: **arXiv:1009.4122** **[hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Link to SYMMETRY; Fermilab Library Server (fulltext available); OSTI Information Bridge Serv
Detailed record - Cited by 323 records 250+

Heavy ion physics

12. **Transverse-momentum and pseudorapidity distributions of charged hadrons in pp collisions at \sqrt{s}=7 TeV**
(296) CMS Collaboration (Vardan Khachatryan (Yerevan Phys. Inst.) *et al.*). May 2010. 26 pp.
Published in **Phys.Rev.Lett. 105 (2010) 022002**
CERN-PH-EP-2010-009, CMS-QCD-10-006
DOI: 10.1103/PhysRevLett.105.022002
e-Print: **arXiv:1005.3299** **[hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Fermilab Library Server (fulltext available)
Data: INSPIRE | HepData
Detailed record - Cited by 296 records 250+

Soft-QCD pp physics

13. **Observation of a new boson with mass near 125 GeV in pp collisions at \sqrt{s} = 7 and 8 TeV**
(282) CMS Collaboration (Serguei Chatrchyan (Yerevan Phys. Inst.) *et al.*). Mar 19, 2013. 117 pp.
Published in **JHEP 1306 (2013) 081**
CMS-HIG-12-036, CERN-PH-EP-2013-035
DOI: 10.1007/JHEP06(2013)081
e-Print: **arXiv:1303.4571** **[hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service
Detailed record - Cited by 282 records 250+

Higgs discovery

14. **Search for Supersymmetry at the LHC in Events with Jets and Missing Transverse Energy**
(278) CMS Collaboration (Serguei Chatrchyan (Yerevan Phys. Inst.) *et al.*). Sep 2011. 16 pp.
Published in **Phys.Rev.Lett. 107 (2011) 221804**
CERN-PH-EP-2011-138, CMS-SUS-11-003
DOI: 10.1103/PhysRevLett.107.221804
e-Print: **arXiv:1109.2352** **[hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Fermilab Library Server (fulltext available); Link to Fulltext; Link to Fulltext
Detailed record - Cited by 278 records 250+

Supersymmetry searches

15. **Electron reconstruction and identification at sqrt(s) = 7 TeV**
(278) CMS Collaboration. 2010.
CMS-PAS-EGM-10-004
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; Link to Fulltext
Detailed record - Cited by 278 records 250+

Technical

16. **Commissioning of the Particle-Flow reconstruction in Minimum-Bias and Jet Events from pp Collisions at 7 TeV**
(275) CMS Collaboration. 2010.
CMS-PAS-PFT-10-002
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; Link to Fulltext
Detailed record - Cited by 275 records 250+

Technical

17. **Transverse momentum and pseudorapidity distributions of charged hadrons in pp collisions at $\sqrt{s} = 0.9$ and 2.36 TeV**
(269) CMS Collaboration (Vardan Khachatryan (Yerevan Phys. Inst.) *et al.*). Feb 2010. 31 pp.
Published in **JHEP 1002 (2010) 041**
CMS-QCD-09-010, CERN-PH-EP-2010-003
DOI: 10.1007/JHEP02(2010)041
e-Print: **arXiv:1002.0621** **[hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Fermilab Library Server (fulltext available)
Data: INSPIRE | HepData
Detailed record - Cited by 269 records 250+

Soft-QCD pp physics

18. **Performance of CMS muon reconstruction in pp collision events at $\sqrt{s} = 7$ TeV**
(264) CMS Collaboration (Serguei Chatrchyan (Yerevan Phys. Inst.) *et al.*). Jun 2012.
Published in **JINST 7 (2012) P10002**
CMS-MUO-10-004, CERN-PH-EP-2012-173
DOI: 10.1088/1748-0221/7/10/P10002
e-Print: **arXiv:1206.4071** **[physics.ins-det]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service
Detailed record - Cited by 264 records 250+

Technical

19. **Identification of b-quark jets with the CMS experiment**
(257) CMS Collaboration (Serguei Chatrchyan (Yerevan Phys. Inst.) *et al.*). Nov 2012. 69 pp.
Published in **JINST 8 (2013) P04013**
CMS-BTV-12-001, CERN-PH-EP-2012-262
DOI: 10.1088/1748-0221/8/04/P04013
e-Print: **arXiv:1211.4462** **[hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server ; ADS Abstract Service; Fermilab Today Result of the Week
Detailed record - Cited by 257 records 250+

Beauty-quark

20. **Search for Supersymmetry in pp Collisions at 7 TeV in Events with Jets and Missing Transverse Energy**
(237) CMS Collaboration (Vardan Khachatryan (Yerevan Phys. Inst.) *et al.*). Jan 2011. 32 pp.
Published in **Phys.Lett. B698 (2011) 196-218**
CERN-PH-EP-2010-084, CMS-SUS-10-003
DOI: 10.1016/j.physletb.2011.03.021
e-Print: **arXiv:1101.1628** **[hep-ex]** | PDF
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
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Supersymmetry searches

- CMS has a few heavy-ion or heavy-ion inspired papers in its top-cited scientific papers