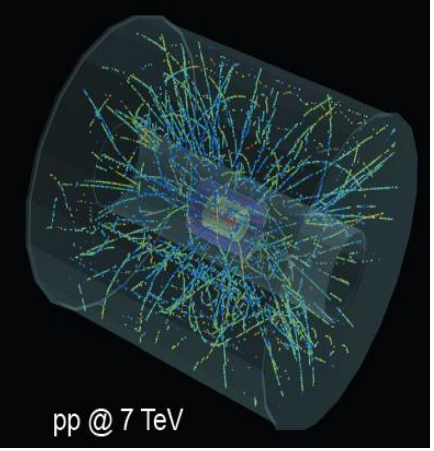
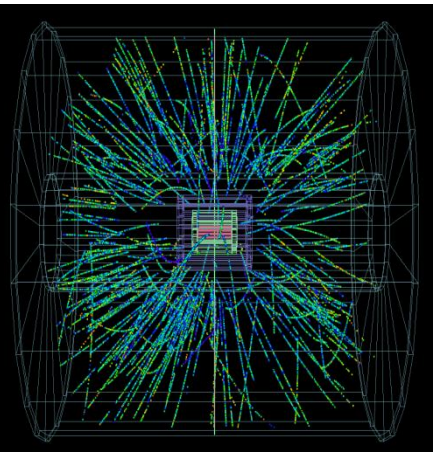
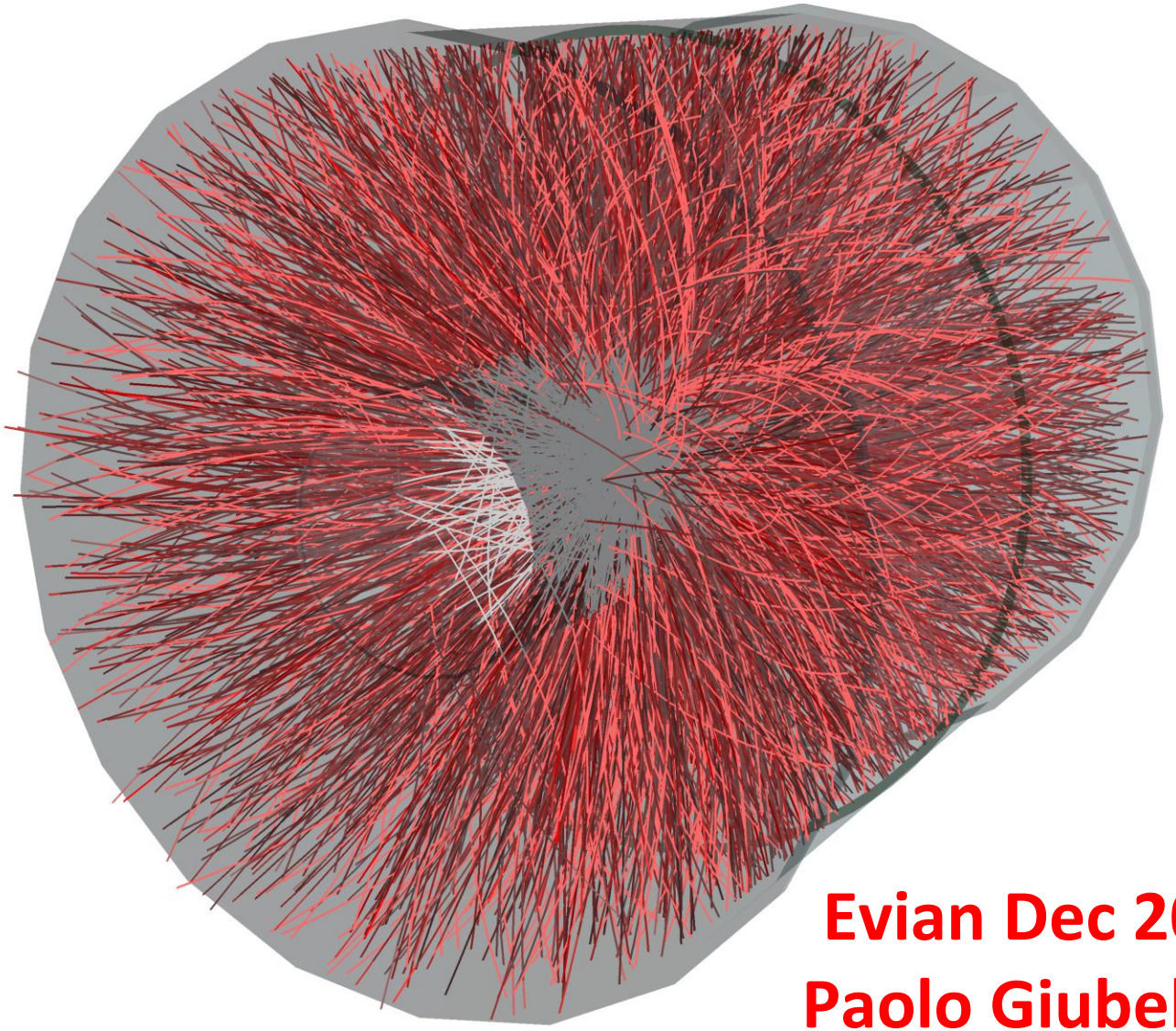




ALICE 2012

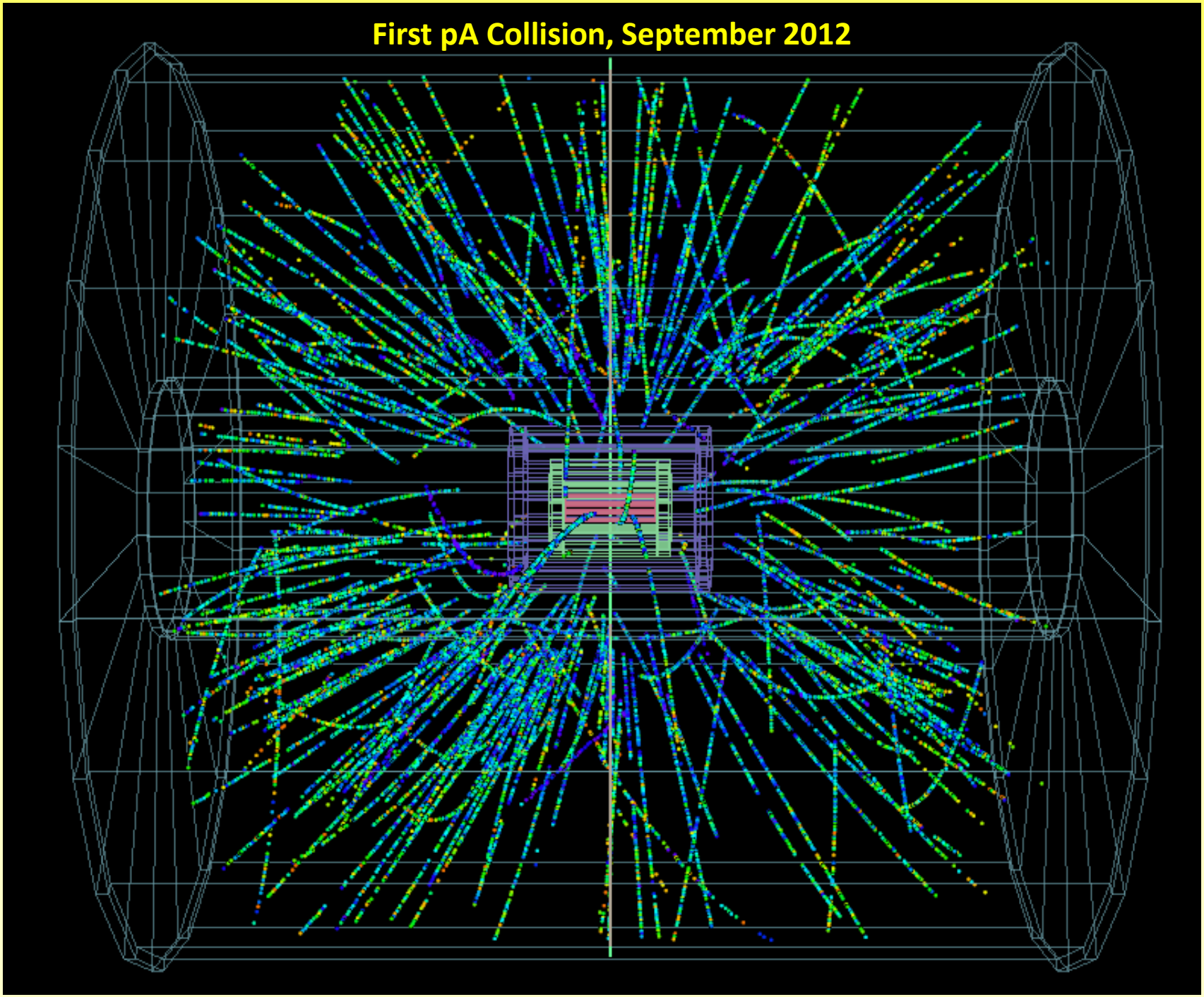


ALICE

Evian Dec 2012

Paolo Giubellino

First pA Collision, September 2012



ALICE

Goals of the ALICE 2012/13 run

System	√s (TeV)	Days of running	Integrated luminosity
pp	8	145	2-5 pb^{-1}
pPb	5.02	24	> 30 nb^{-1}

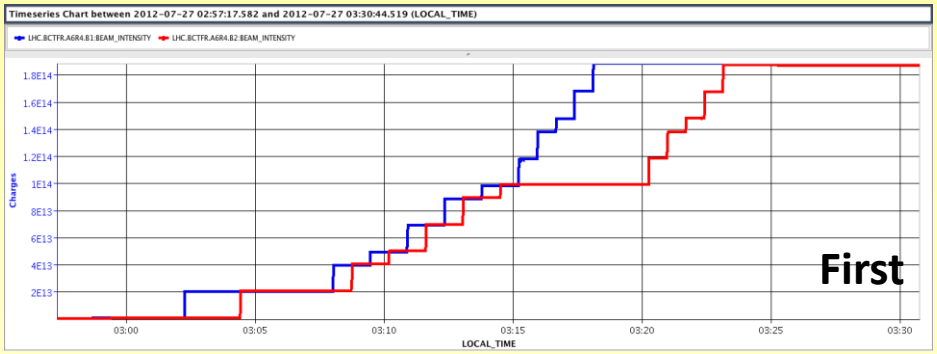
- **pp:** integrate luminosity for comparison with the high-lumi 2011 Pb run, together with already taken data in 2011 pp run
  - main-sat. collisions (luminosity goal 5 $\mu b^{-1}s^{-1}$)
  - collect 10^9 events minimum bias
  - 2 pb^{-1} for rare triggers in central barrel (hard processes scale as $N_{coll} \sim A^2$)
    - EMCAL (jet, γ, electron), PHOS (γ), diffractive, high multiplicity, TRD (jet, electron)
  - 10 pb^{-1} for forward muon arm(Υ, Υ', Υ'', W)
- **p-Pb:** for separation of initial and final state effects on PbPb measurements (→ parton saturation, shadowing, …)
    - Heavy flavor production, Quarkonia, Jet rates, Direct photons,,…
  - expected peak luminosity ~ $1x10^{29}$ ($cm^{-2}s^{-1}$) = 100 ($mb^{-1}s^{-1}$) → min. bias rate: 200 kHz
  - integrate luminosity >~ 30 nb^{-1}

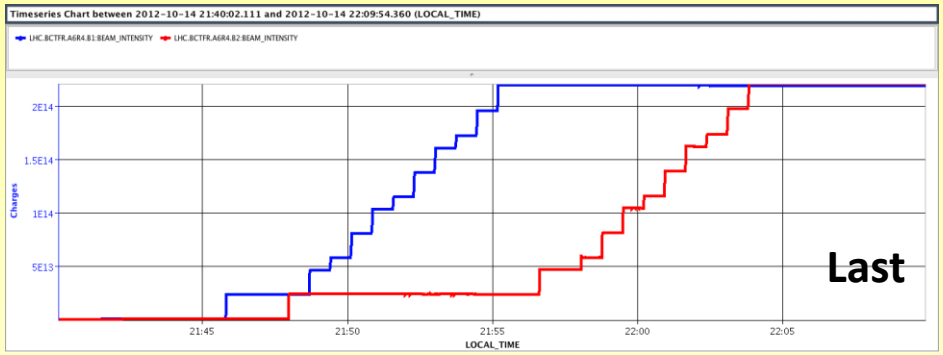
Background

At the beginning of the 2012 pp data taking period ALICE was heavily affected by background from high vacuum pressure in the Long Straight Sections and in particular from the TDI.

Due to the 'particle load' on the detector we could turn on and start data taking with all the detectors only 5-6 hours after declaration of stable beam.

The new injection procedure were applied very quickly → **significantly better vacuum pressure**



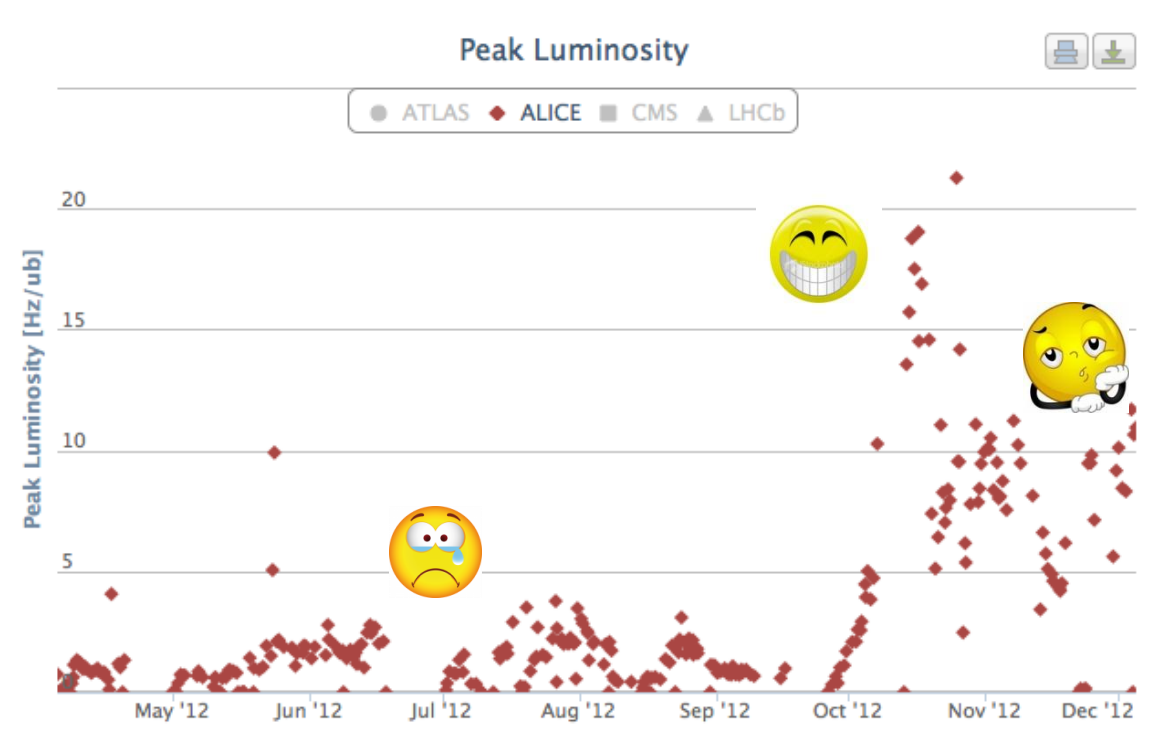


Thanks a lot!!!

… and thank you in advance for the further improvement in LS1!

Enhanced satellites

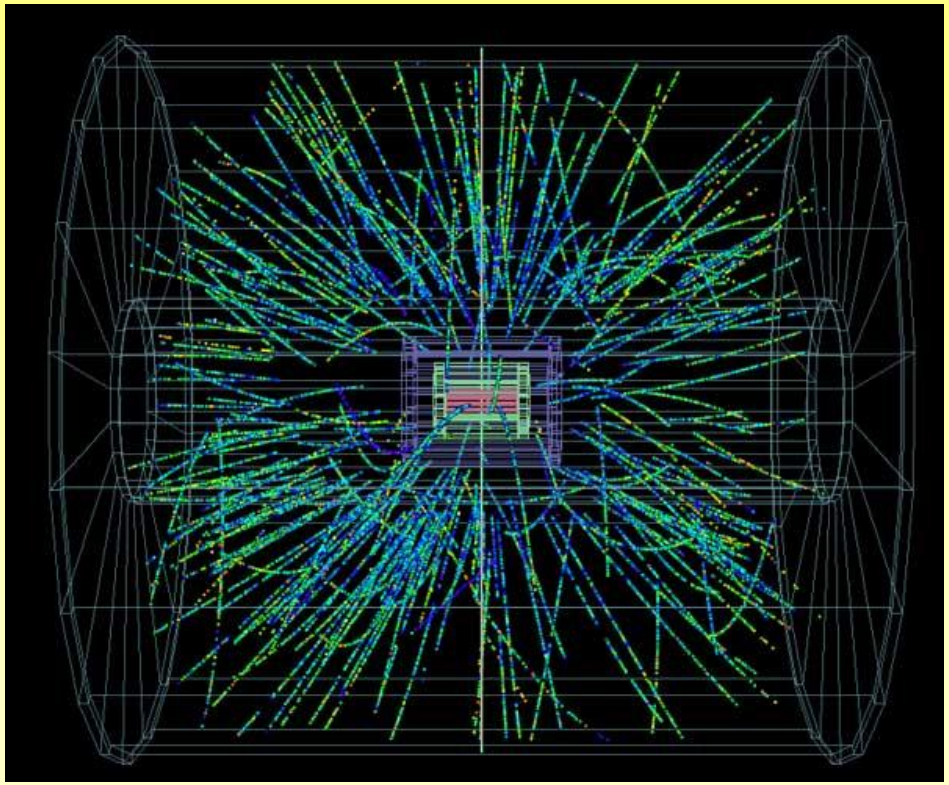
- In 2012 pp run, issue of insufficient luminosity by natural satellites (typical avg. luminosity ~ 1 $\mu b^{-1}s^{-1}$ which is a factor five below needs)
- After TS3, machine started to try **"enhanced satellite"** mode
- We could run at above 5-7 $\mu b^{-1}s^{-1}$ average most of the time in the last two months of the pp data taking period.



Thanks for the effort to improve the ALICE luminosity

pA pilot run

- 12-13 September for one fill at 4xZ TeV
- Good event rate of about 200 Hz, with 8 colliding bunches



ALICE took data in three phases

1. **ADJUST**
   (before Stable b)
   - 680 k e s
   (IT

2.
   ( )
   - all the detectors

3. **STAB BEAMS - Displaced vertex**
   - **p-direction (+50cm): 260 k ev.**
   - **Pb-direction (-50cm): 370 k ev.**

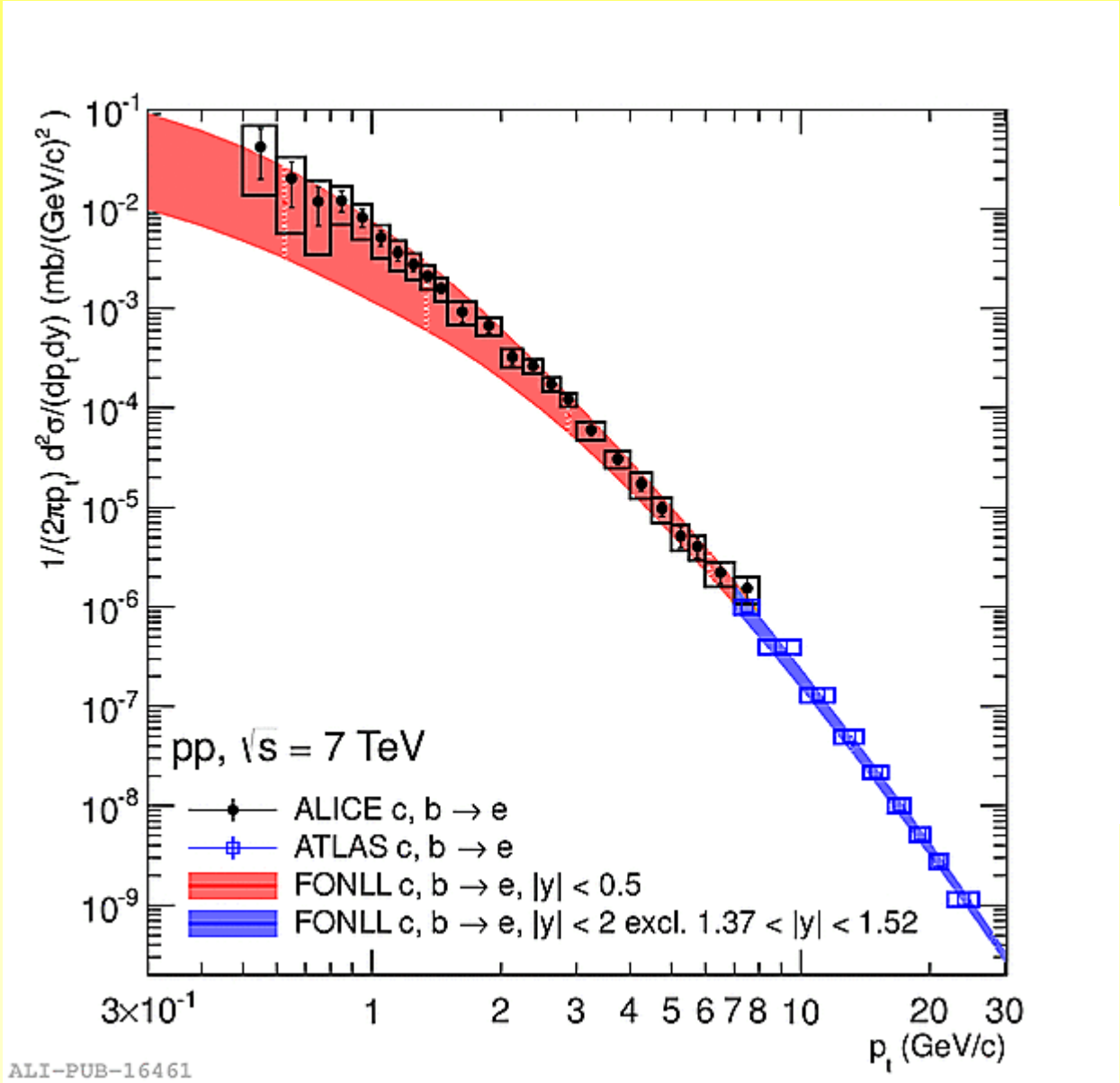
WOW!
Thank you!!!

- **Very successful and results already published**

A wealth of results…

- Two reference conferences in 2012 for the presentation of new HI results.
  - Hard Probes, 27 May - 1 June
    - 5 plenary talks
    - 14 parallel talks
    - 11 posters
  - Quark Matter, 13-18 August
    - 7 plenary talks
    - 30 parallel talks
    - 45 posters
- And many more.. (over 350 talks in 2012)

pp: complementary to ATLAS and CMS



Electrons from the decay of heavy flavor hadrons

Example: insight into charm production in p-p collisions at sqrt(s)=7 TeV

New: D meson yield measured as a function of charged parti. mult. of p-p collision

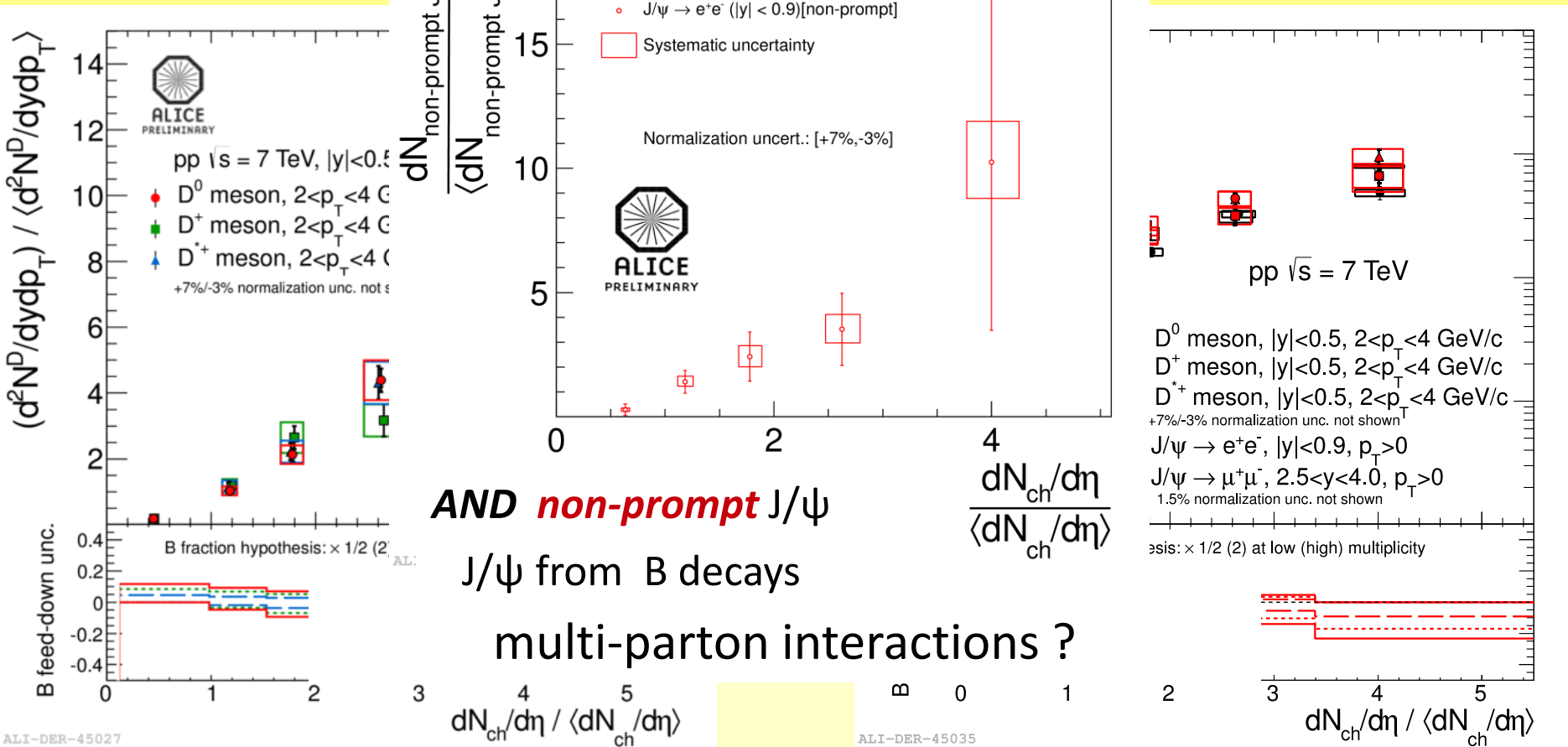
⇒ Sensitivity to soft vs. hard scale in charm production

Linear increase of yield with $dN_{ch}/d\eta$

– measur… end for D as for J/ψ

Similar behavior fo… B712 (2012) 165

- from 2 t…



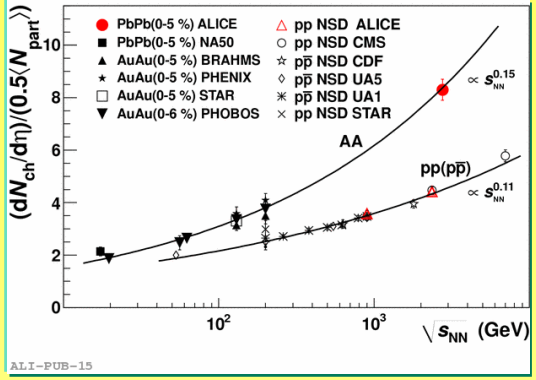
AND non-prompt J/ψ

J/ψ from B decays

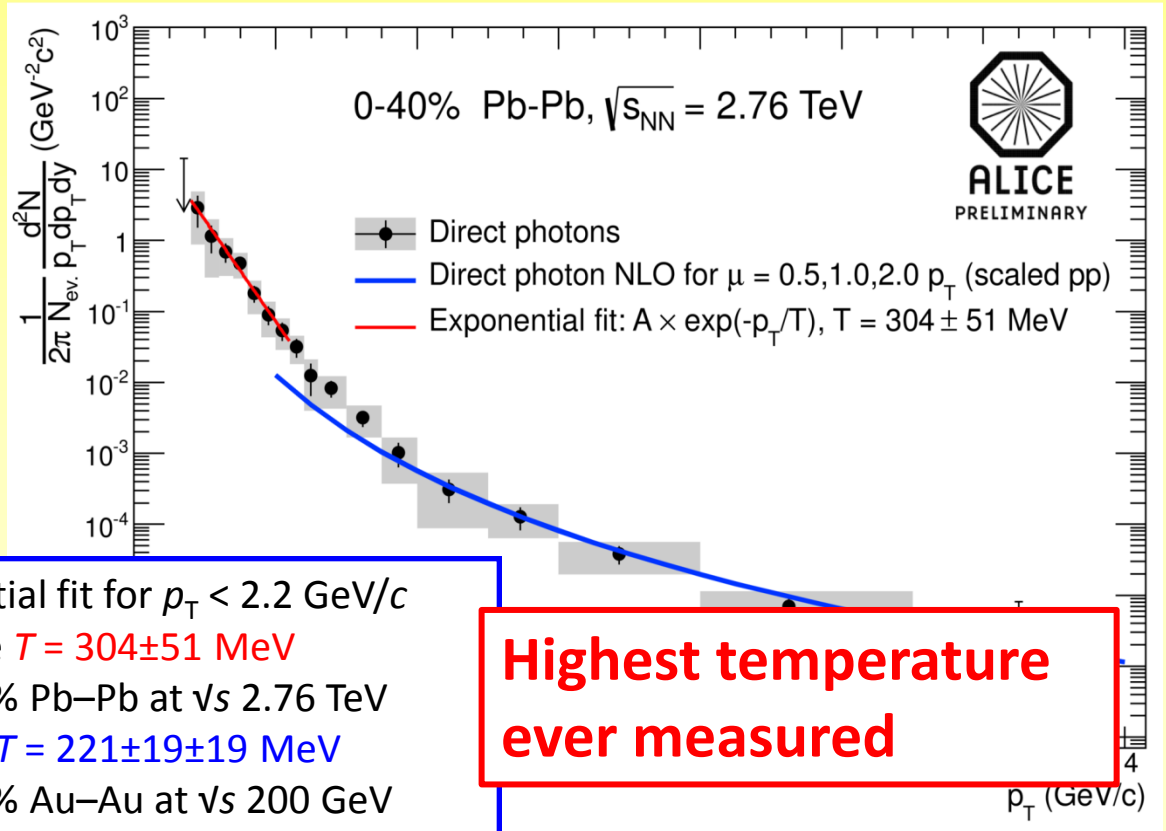
multi-parton interactions ?

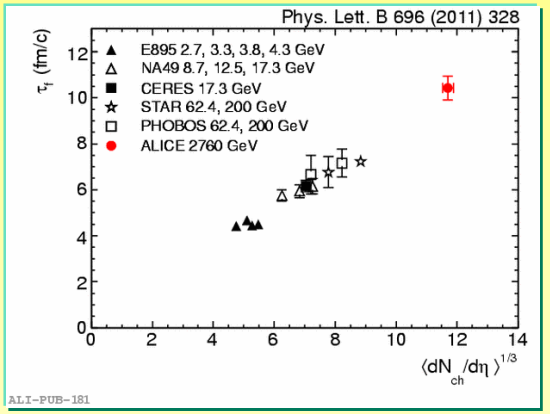
Pb-Pb:Global properties

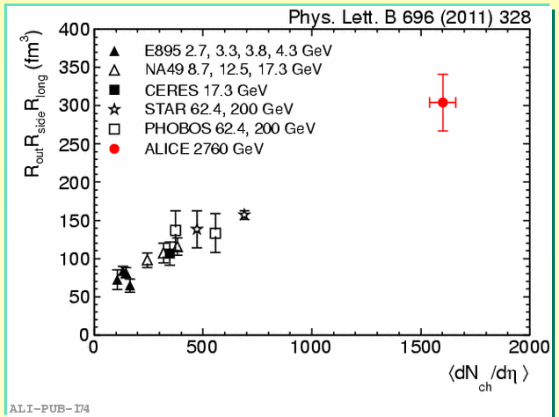
- From the very first 2010 analysis, fireball at LHC denser, larger and longer lived than at RHIC
  - **Energy density ≈ 3 x RHIC**
  - **Volume ≈ 2 x RHIC (≈ 300 fm³)**
  - **Lifetime ≈ +20% (≈ 10 fm/c)**
- **Now, measure T from photon spectrum**



$$\varepsilon(\tau) = \frac{E}{V} = \frac{1}{\tau_0 A}\frac{dN}{dy} < m_t >$$





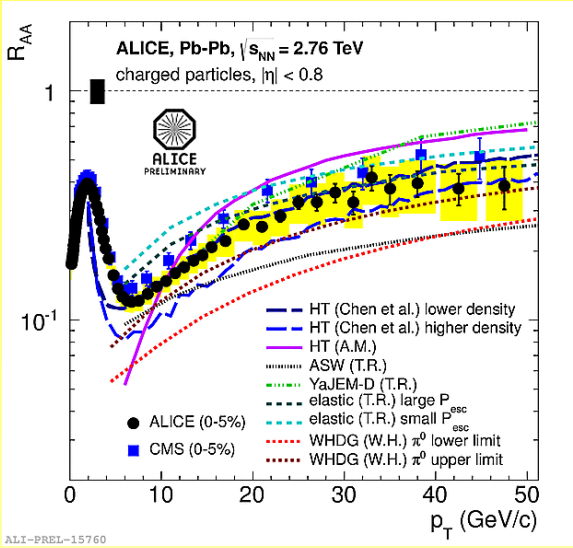


Exponential fit for p_T < 2.2 GeV/c
inv. slope T = 304±51 MeV
for 0–40% Pb–Pb at √s 2.76 TeV
PHENIX: T = 221±19±19 MeV
for 0–20% Au–Au at √s 200 GeV

Highest temperature ever measured

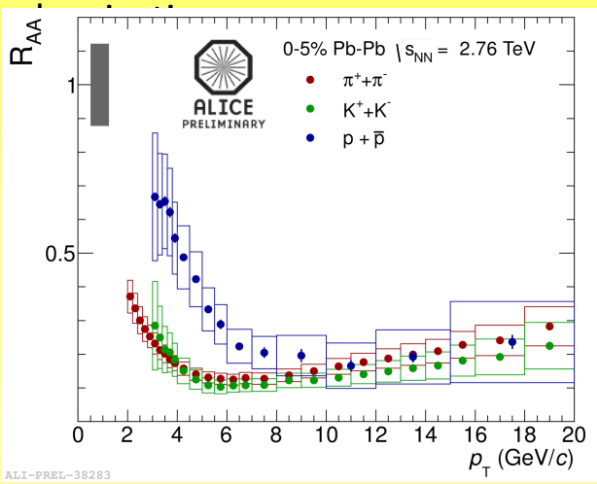
Pb-Pb: Characterising the medium

- From the energy loss measurements



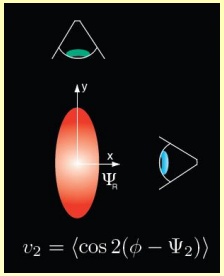
- To particle species dependence

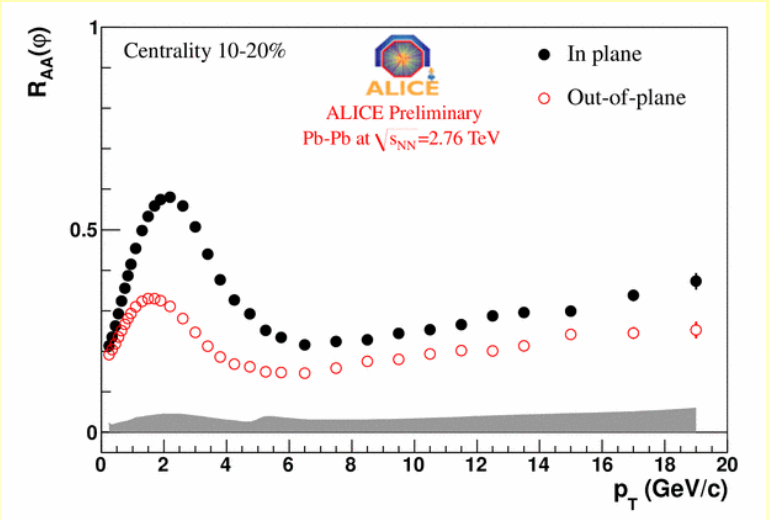
→ collective behaviour, in-medium h



- dependence on angle wrt event plane

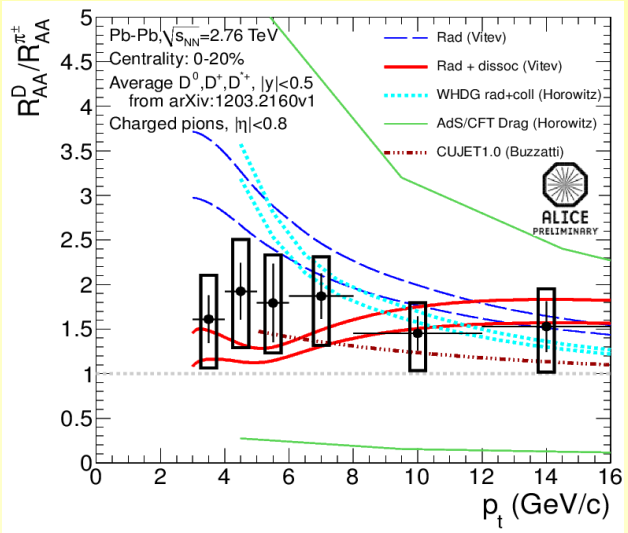
→ path length dependence of energy loss





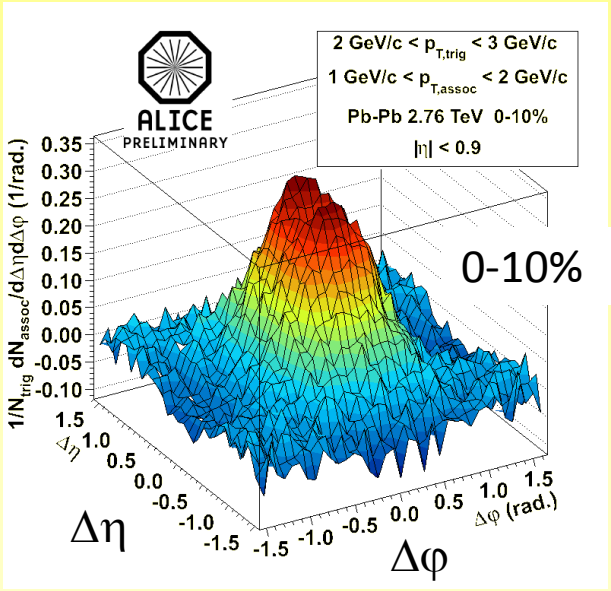
- flavour dependence

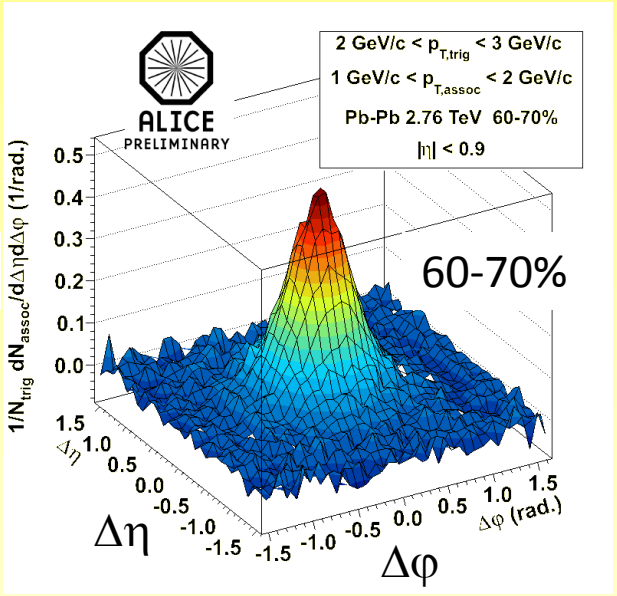
→ parton colour-charge dep. of energy loss

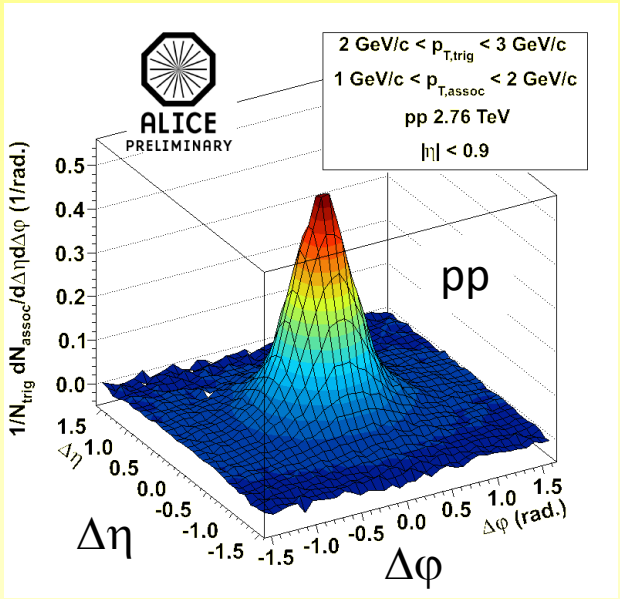


Looking into Jet quenching: di-hadron correlations in ($\Delta\varphi$,$\Delta\eta$)

- Strong quenching in central HI collisions at LHC
  - Quenched energy reappears at low p_T, also outside the jet cone
- Modification of the near-side jet peak in central collisions

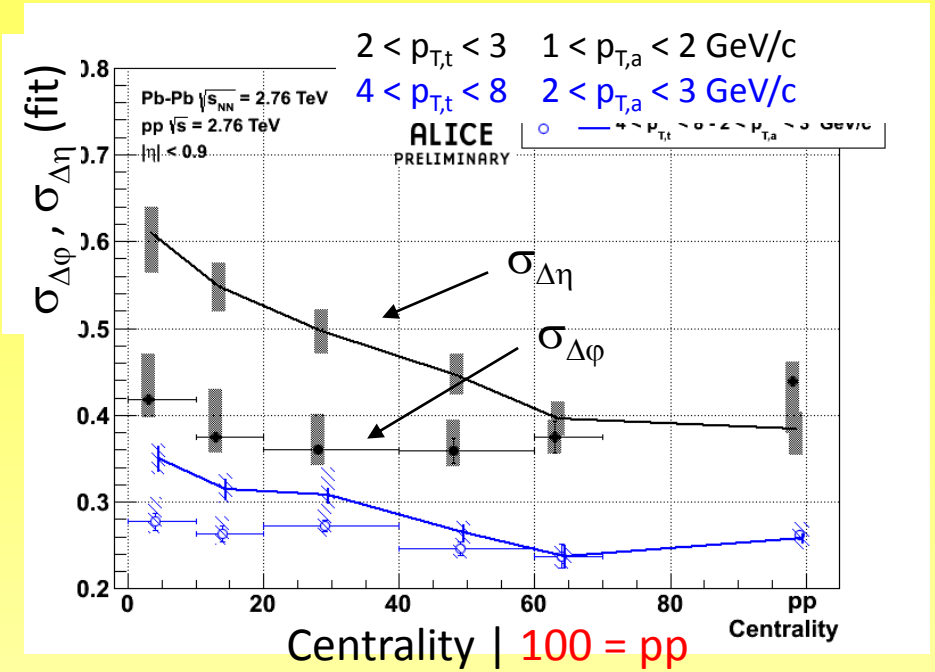






Central PbPb **Peripheral PbPb** **pp**

Interaction of jet with medium?



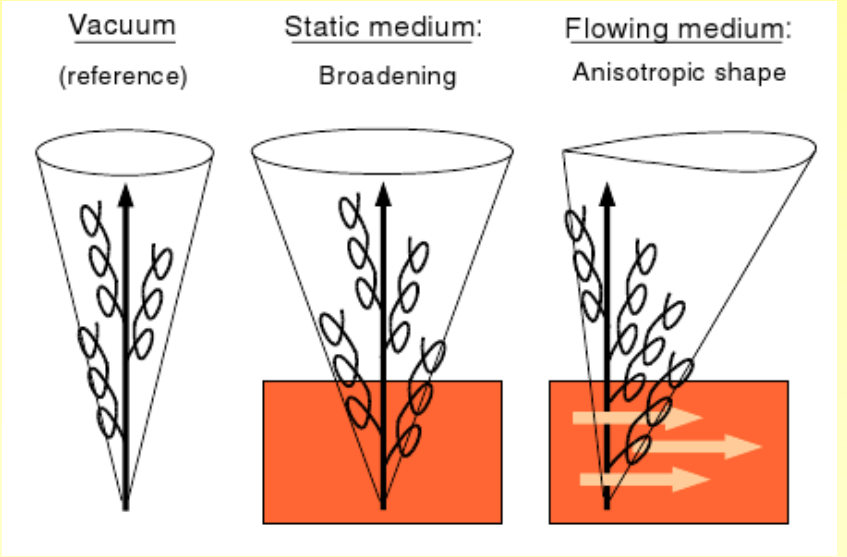
Significant increase of $\sigma_{\Delta\eta}$ towards central events

- $\sigma_{\Delta\varphi}$ independent of centrality within uncertainties
- $\sigma_{\Delta\eta} > \sigma_{\Delta\varphi}$ (eccentricity ~ 0.2)

Observation consistent with

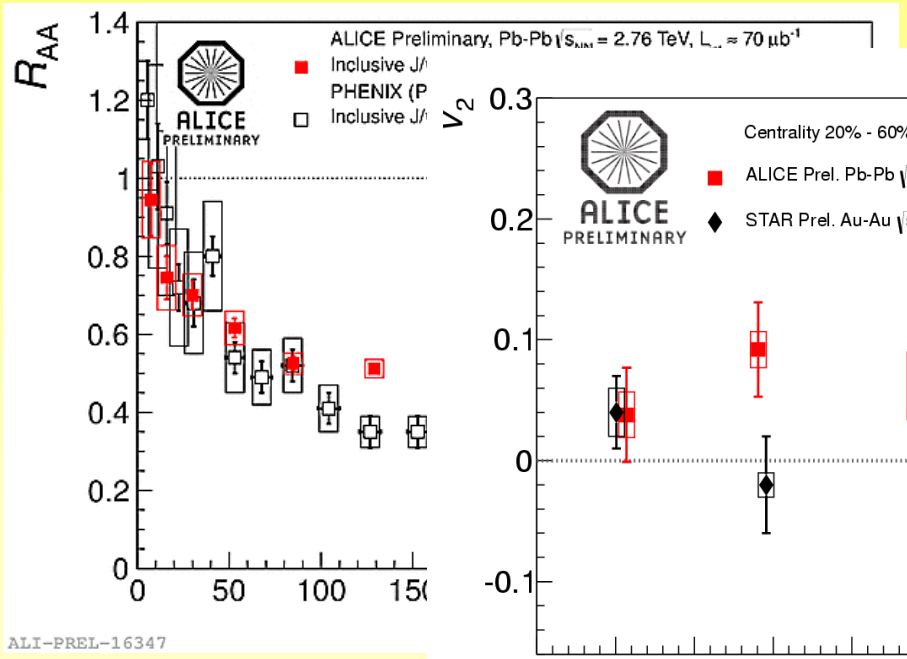
- suggestion that longitudinal flow deforms the conical jet shape (Armesto, Salgado, Wiedemann, PRL 93,242301 (2004))
- AMPT (A MultiPhase Transport Code) MC which describes collective effects (e.g. v_2, v_3, v_4) in HI collisions at LHC using partonic and hadronic rescattering (PRC72 06490 (2005))

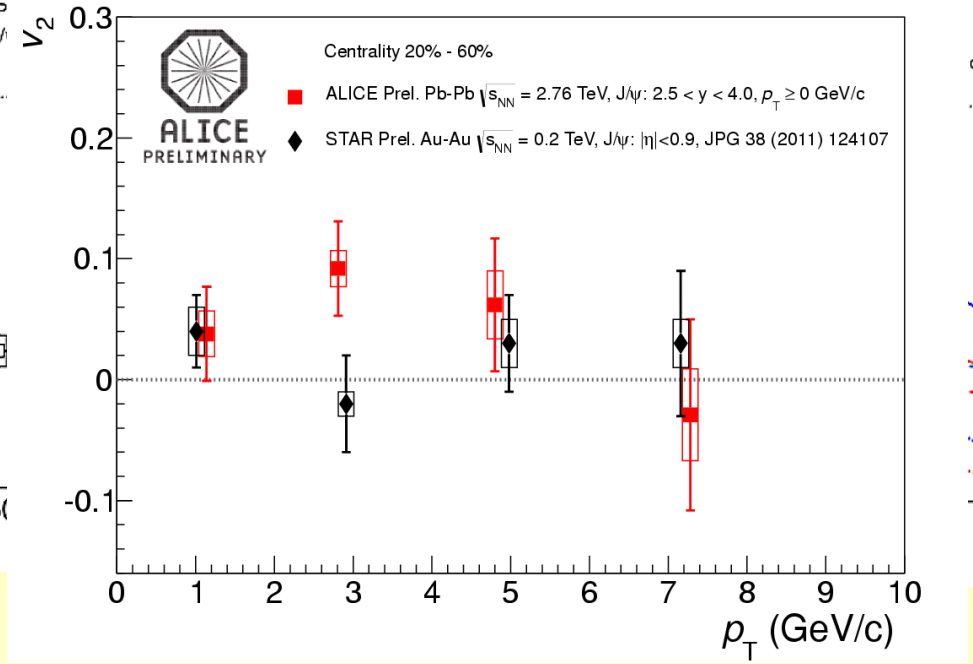
Interplay of flow with the jet?

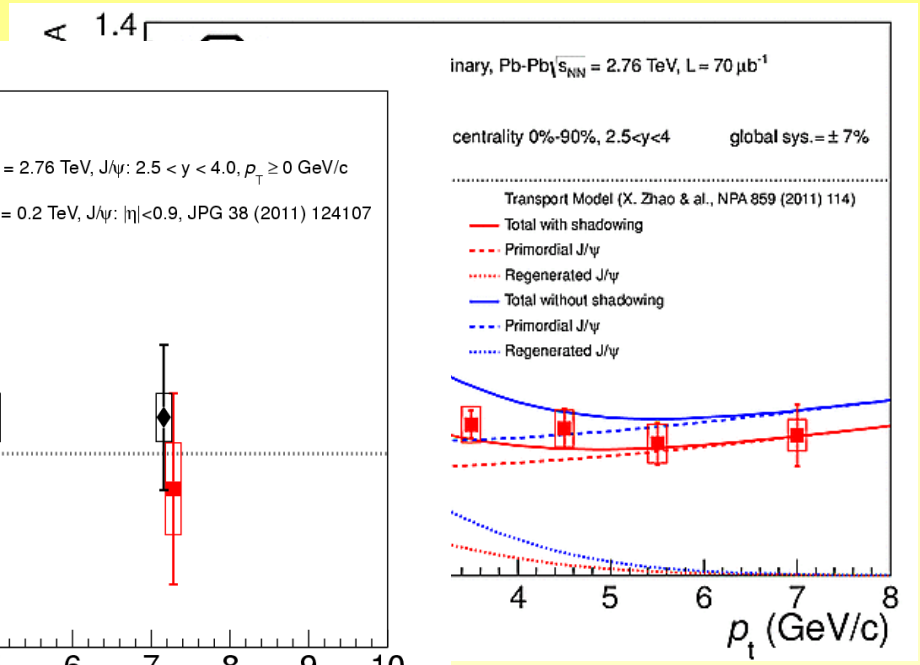


Pb-Pb: Quarkonia

- J/ψ: less suppressed than at RHIC!
  - + very weak centrality dependence…
- suppression increases with p_T
  - → regeneration from $c\bar{c}$ recombination?

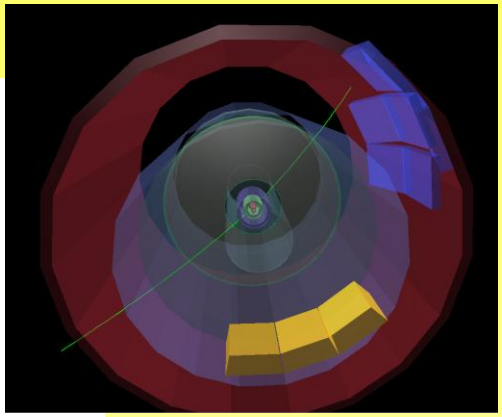


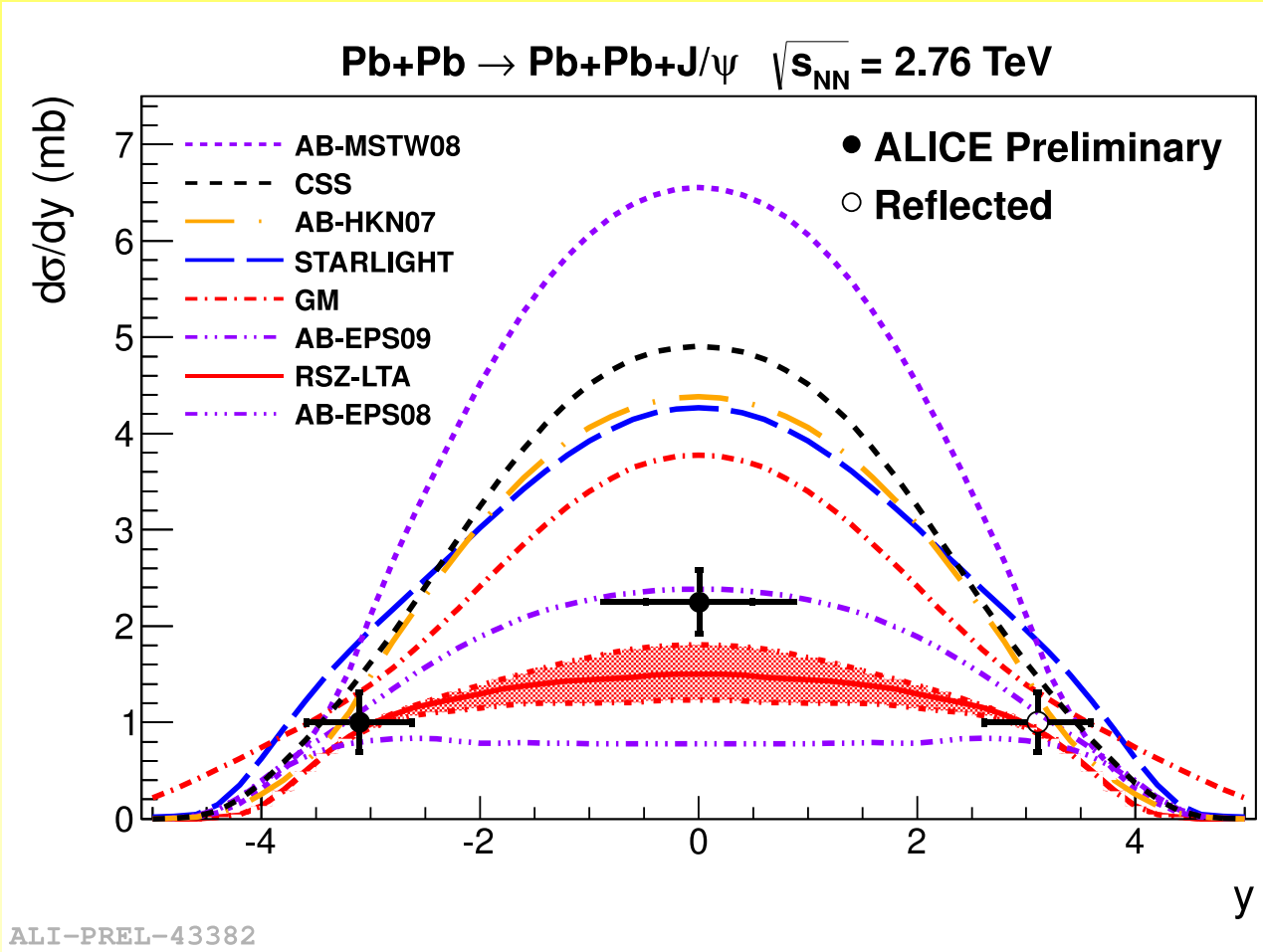




- And a hint of flow...

Pb-Pb: many more measurements…

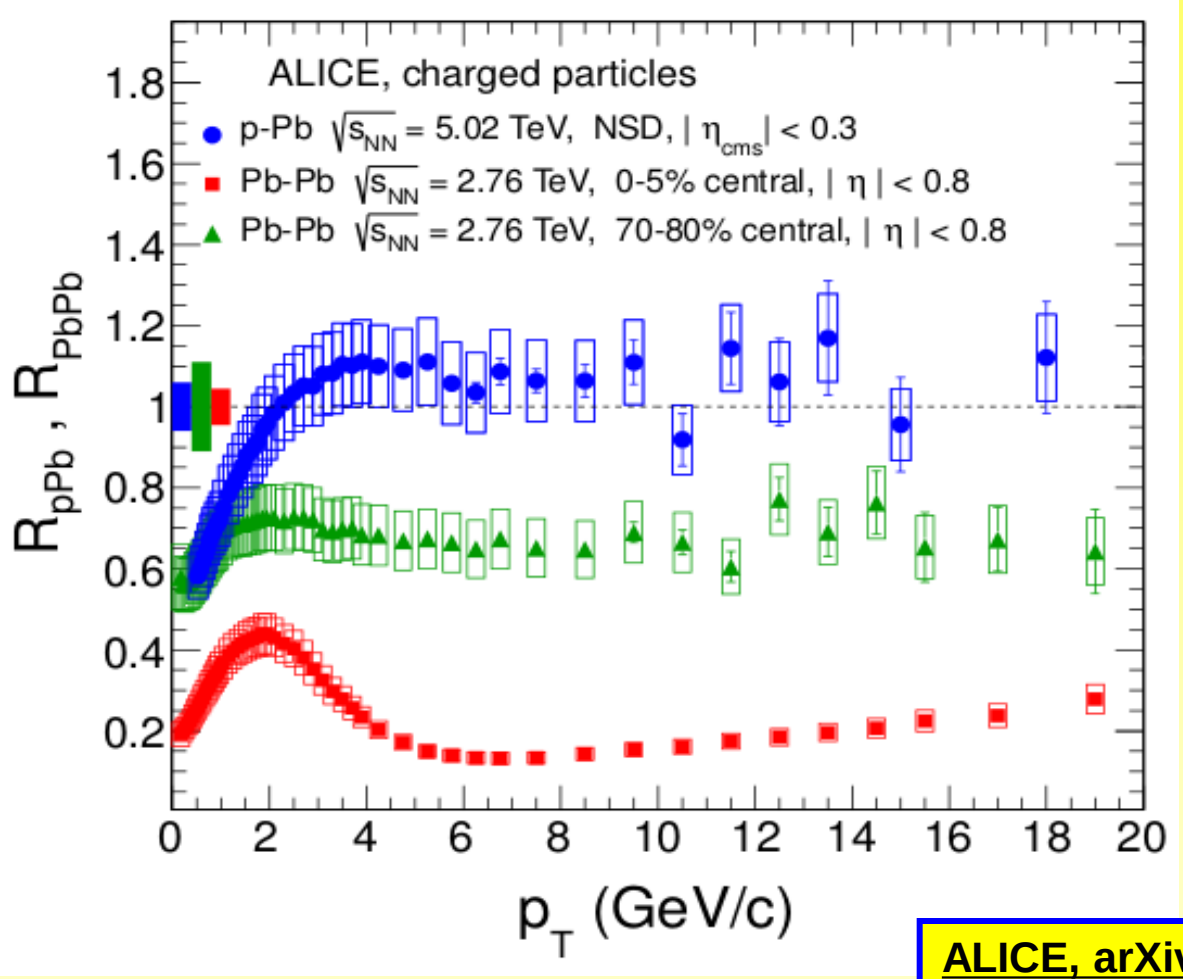


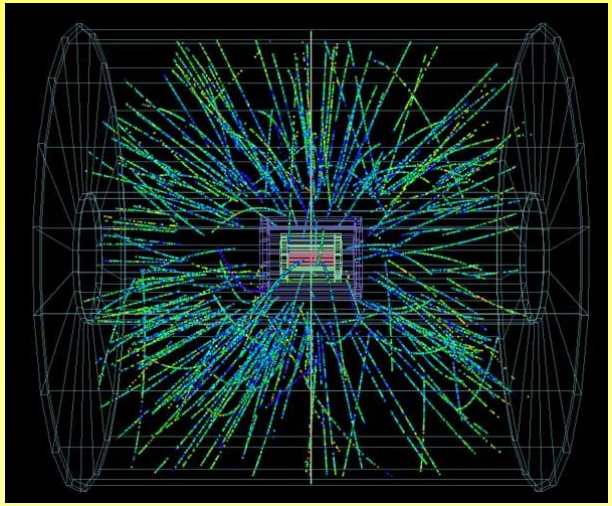


Probing nuclear structure with photonuclear collisions

Coherent J/ψ photo production at mid- and forward-rapidity

The nuclear modification factor in p-Pb





ALICE, arXiv:1210.4520

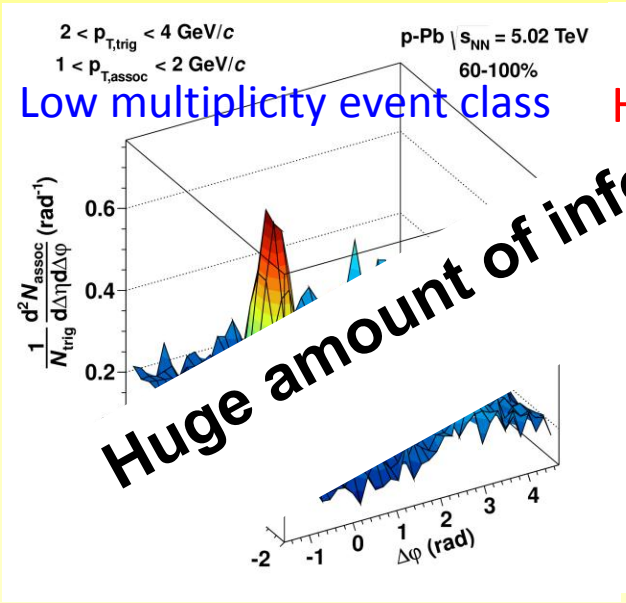
High-p_T charged particles exhibit binary scaling. Initial state effects are small.

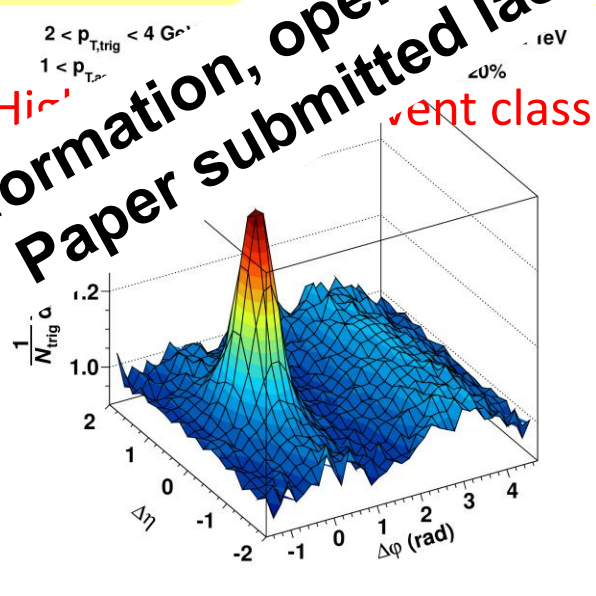
What we see in Pb-Pb is a final state medium effect.

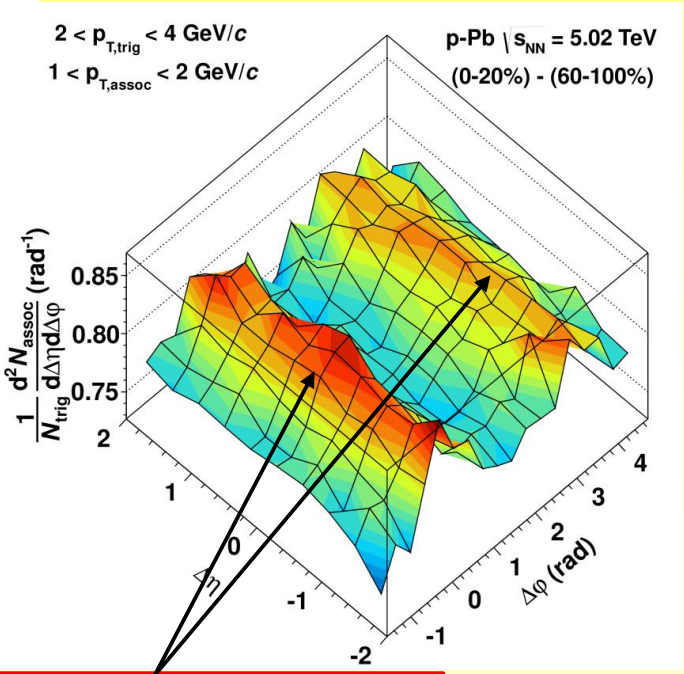
Correlations in pA: subtracting low-mult from the high-mult…

- A double-ridge structure appears, with remarkable properties:
  - Can be expressed in terms of $v_{2,3}$, Fourier coefficients of single particle azimuthal distribution, with $v_{2,3}$ increasing with p_T and v_2 also with multipli
  - **Same yield near and away side for all classes of p_T and multiplicity suggest common underlying process**
  - Width independent of yield
  - No suppression of away side observed (its observati ues at RHIC is considered a sign of saturation effects)
  - In agreement with viscous hydro calculatio

Huge amount of information, opening a new window in the field
Paper submitted last week





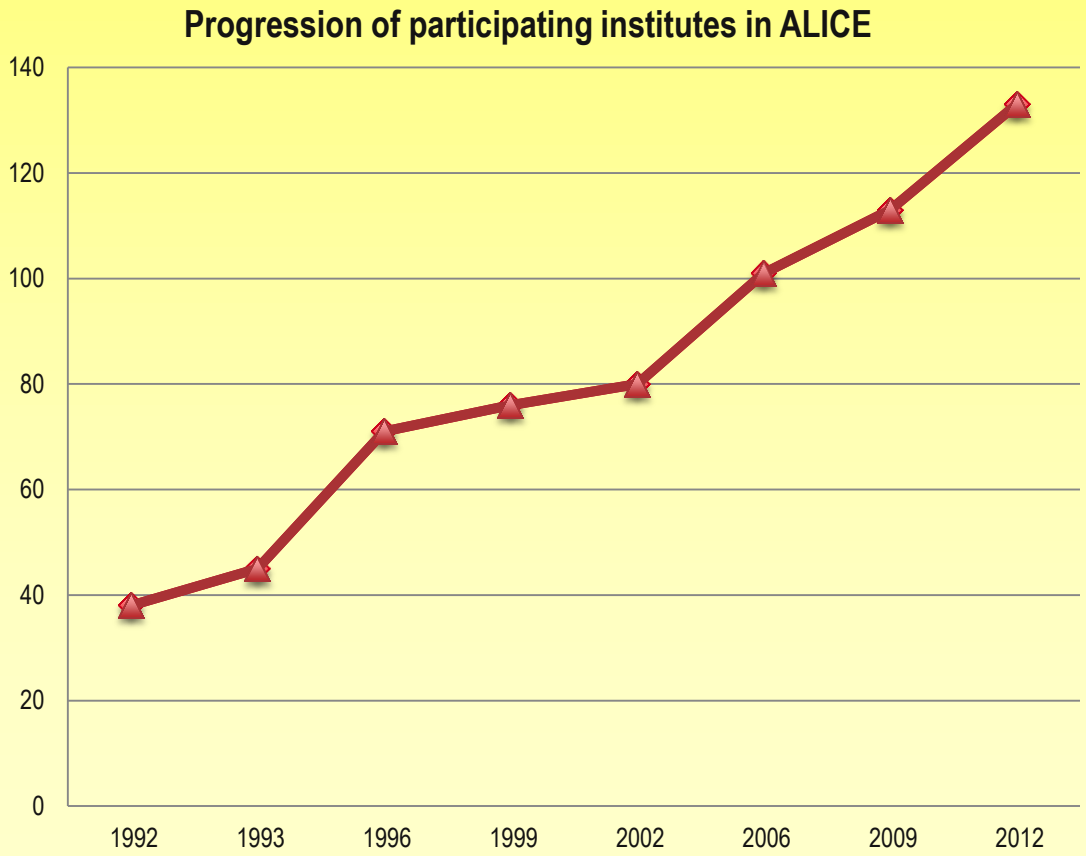


Double-ridge structure

The future

ALICE continues to grow…

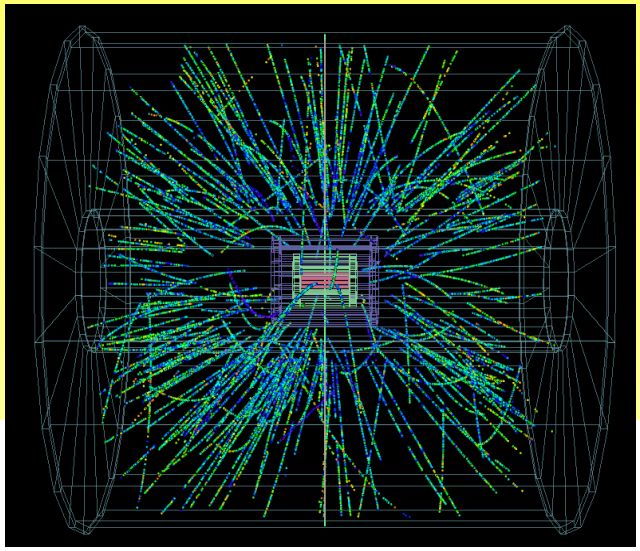
- After two decades of life, ALICE continues to be a very attractive project….
- 12 new institutes joined ALICE in the last year!

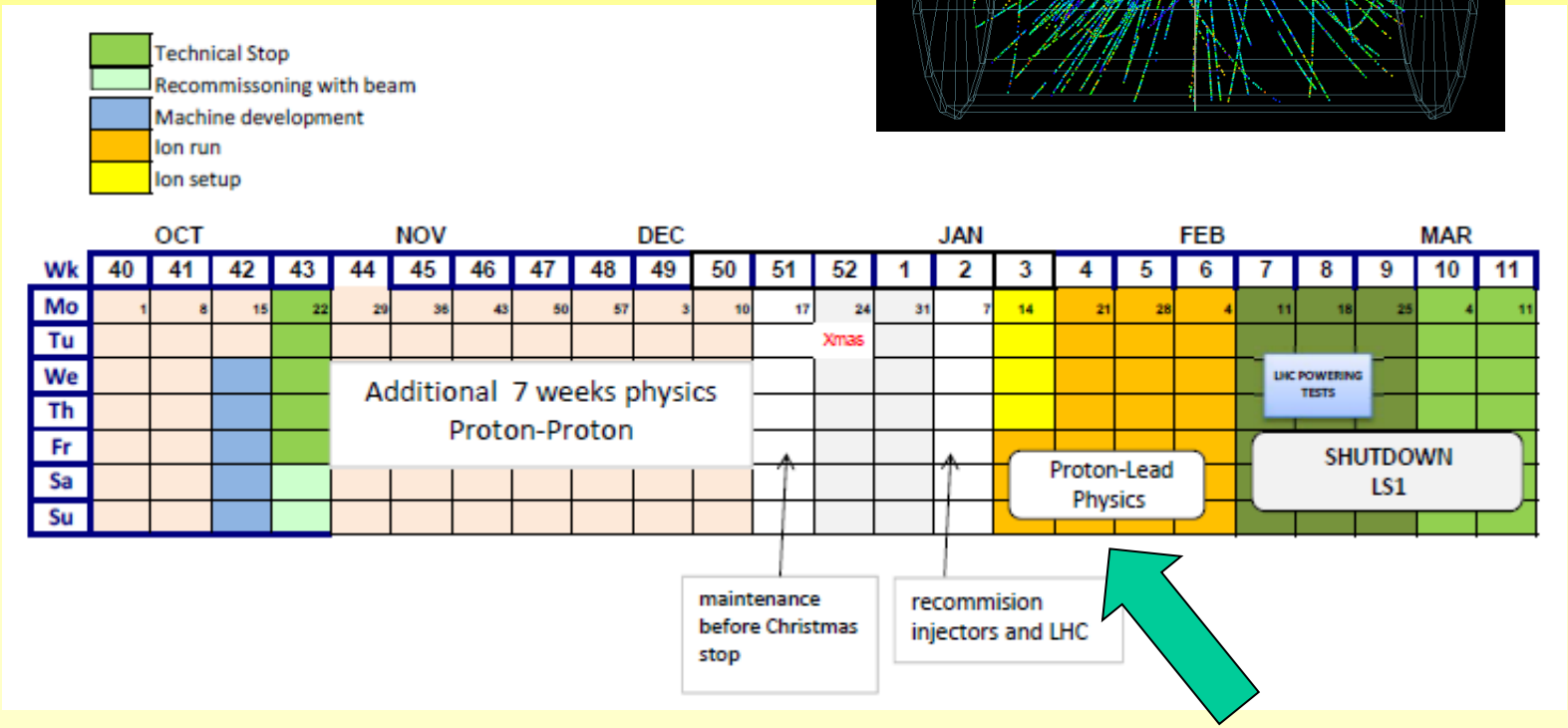


- The Collaboration is in excellent health!

The immediate future

- The pPb run…
  - Aim at least 30 nb^{-1}

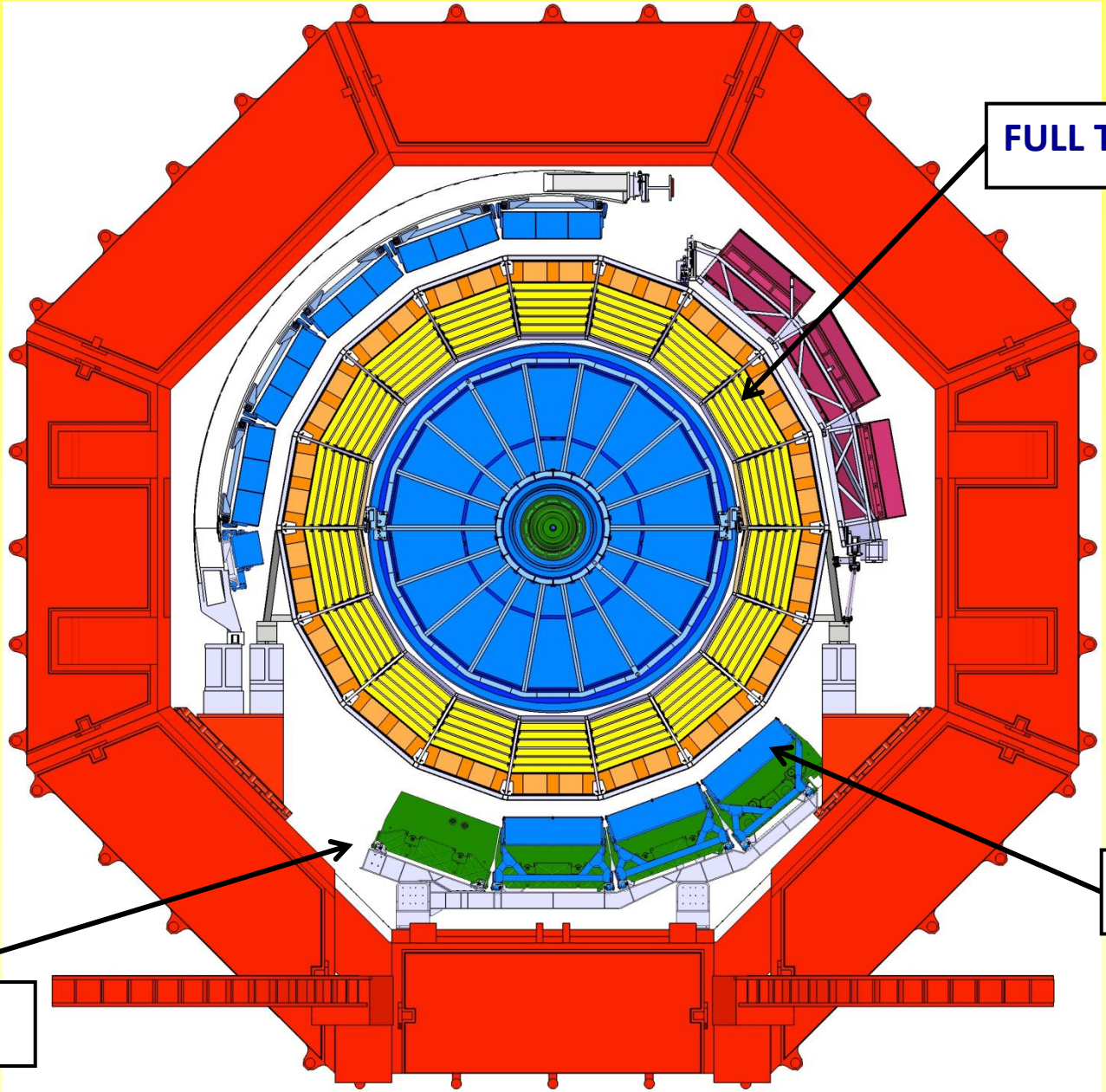




Short-term: LS1 plan

New installations

- 5 TRD modules
- 8 DCal modules (approved in 2010)
- Add 1 PHOS module



ALICE Upgrade: Objectives

- **Detailed characterization of the Quark-Gluon-Plasma**
- **Measurement of heavy-flavour transport parameters**
  - Diffusion coefficient (QGP eq. of state, η/s) → HF azimuthal anisotropy and R_{AA}
  - In-medium thermalization and hadronization → HF baryons and mesosn
  - Mass dependence of energy loss → HF R_{AA}
- **Measurement of low-mass and low-p_t di-electrons**
  - Chiral symmetry restoration → ρ spectral function
  - γ production from QGP (temp.) → low-mass dilepton continuum
  - Space-time evolution of the QGP → radial and elliptic flow of emitted radiation
- **J/ψ , ψ', and χ_c states down to zero p_t**
  - statistical hadronization vs. dissociation/recombination scenario
  - transition between low and high transverse momenta
  - density dependence – central vs. forward production
- **Heavy nuclear states**
  - mass-4 and -5 (anti-)hypernuclei
  - search for H-dibaryon, Λn bound states, etc.

➡ requires high statistics and precision measurements

Experimental Strategy

Upgrade ALICE rate capability and precision for the last 3 years of the approved program and extend it for about three more, after LS3

- The relevant observables are at low-transverse m
  (complementary/orthogonal
  - ce its
- ated
  ll
  ne)
  - and trigger detectors
- Improve vertexing and tracking at low p_t:
  - New, smaller radius beam pipe
  - New inner tracker (ITS) with improved material, precision and rate capability

- So, compared to today, "HI-Lumi Pb" will give ALICE:
  - **1000** times more statistics
  - Better vertexing
  - Better tracking at low transverse momentum
  - While preserving tracking and PID

ALICE Upgrade Physics Reach

p_T coverage (p_T^{min}) and statistical error for current ALICE with approved programme and upgraded ALICE with extended programme. Error in both cases at p_T^{min} of "approved".

Topic	Observable	Approved (1/nb delivered, 0.1/nb m.b.)	Upgrade (10/nb delivered, 10/nb m.b.)
Heavy flavour	D meson R_{AA}	p_T>1, 10%	p_T>0, 0.3%
	D from B R_{AA}	p_T>3, 30%	p_T>2, 1%
	D meson elliptic flow (for v_2=0.2)	p_T>1, 50%	p_T>0, 2.5%
	D from B elliptic flow (for v_2=0.1)	not accessible	p_T>2, 20%
	Charm baryon/meson ratio (Λ_c/D)	not accessible	p_T>2, 15%
	D_s R_{AA}	p_T>4, 15%	p_T>1, 1%
Charmonia	J/ψ R_{AA} (forward y)	p_T>0, 1%	p_T>0, 0.3%
	J/ψ R_{AA} (central y)	p_T>0, 5%	p_T>0, 0.5%
	J/ψ elliptic flow (forward y, for v_2 =0.1)	p_T>0, 15%	p_T>0, 5%
	ψ'	p_T>0, 30%	p_T>0, 10%
Dielectrons	Temperature IMR	not accessible	10% on T
	Elliptic flow IMR (for v_2=0.1)	not accessible	10%
	Low-mass vector spectral function	not accessible	p_T>0.3, 20%
Heavy nuclei	hyper(anti)nuclei, H-dibaryon	35% ($^4_\Lambda$H)	3.5% ($^4_\Lambda$H)

Running scenario after the upgrade

- Pb–Pb
  - **int. luminosity per year 2.85 nb^{-1} (peak L = 7x10^{27} cm^{-2}s^{-1})**
  - needed int. luminosity 10 nb^{-1}, statistics 8x10^{10} events
  - 3.5 month of running
  - +1 month of special run at low field for dileptons
- p–Pb
  - max event rate 200 kHz, flat (L = 10^{29} c
  - needed int. luminosity 50 nb^{-1} events
  - 0.5 month of dedic
- pp
  - ate 200 kHz, flat (L = 3x10^{30} cm^{-2}s^{-1})
  - needed int. luminosity 6 pb^{-1}, statistics 4x10^{11} events
  - ~ 2 months of dedicated pp run

We will be asking for more Pb-Pb lumi for a while!

The list above fulfills the ALICE physics program as presented in the LoI.

A run with lower mass nuclei (e.g. Ar) could be considered in addition, if a physics case for it would emerge.

ALICE Upgrades, History

- Studies ongoing since 2010
- Strategy Document submitted to LHCC in March 2012
  - Followed by six months of intense exchanges between ALICE and the Committee
- Working Group with ATLAS and CMS
  - to assess relative capabilities
- Town meeting of the whole HI community (at CERN June 29th)
  - Very important meeting, resulting in a common document of the Community submitted to the Cracow one, and indicating clearly the extension of the LHC HI program, including the ALICE upgrade, as its first priority. Remarkable coherence of ALICE, ATLAS and CMS
    - "***The top priority for future quark matter research in Europe is the full exploitation of the physics potential of colliding heavy ions in the LHC.***"
- NUPECC also submitted a document to Cracow,
  - Stresses the commitment of the Nuclear Physics Community to the ALICE long term programs, "top priority for European Nuclear Physics"
- Cracow European Strategy Meeting
  - Heavy Ion Physics an integral part of the future LHC program till at least the mid 2020s

LoI and ITS CDR for the Upgrades, Submitted to the LHCC sept 6th

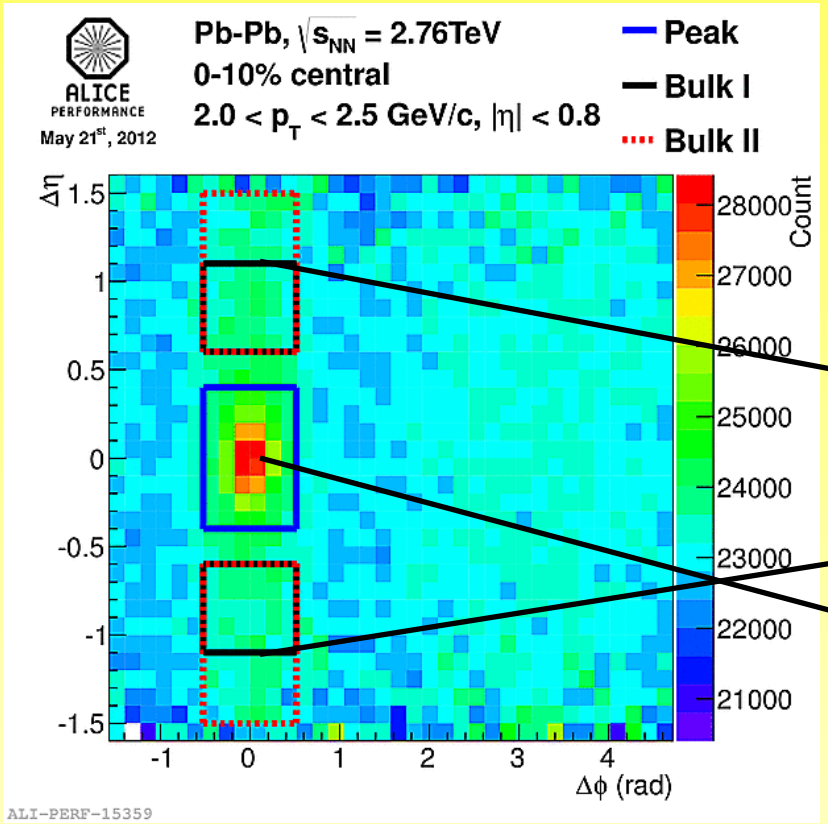
- **LHCC** On September 27, the LHCC has endorsed the ALICE Upgrade LoI and ITS CDR.:
  "The LHCC commends this joint approach to heavy ion physics and endorses the upgrade plans of the ALICE collaboration. The committee is looking forward to the seeing the detailed technical solutions presented in the respective TDRs."
- **ALICE looking forwards to an exciting long-term future!**

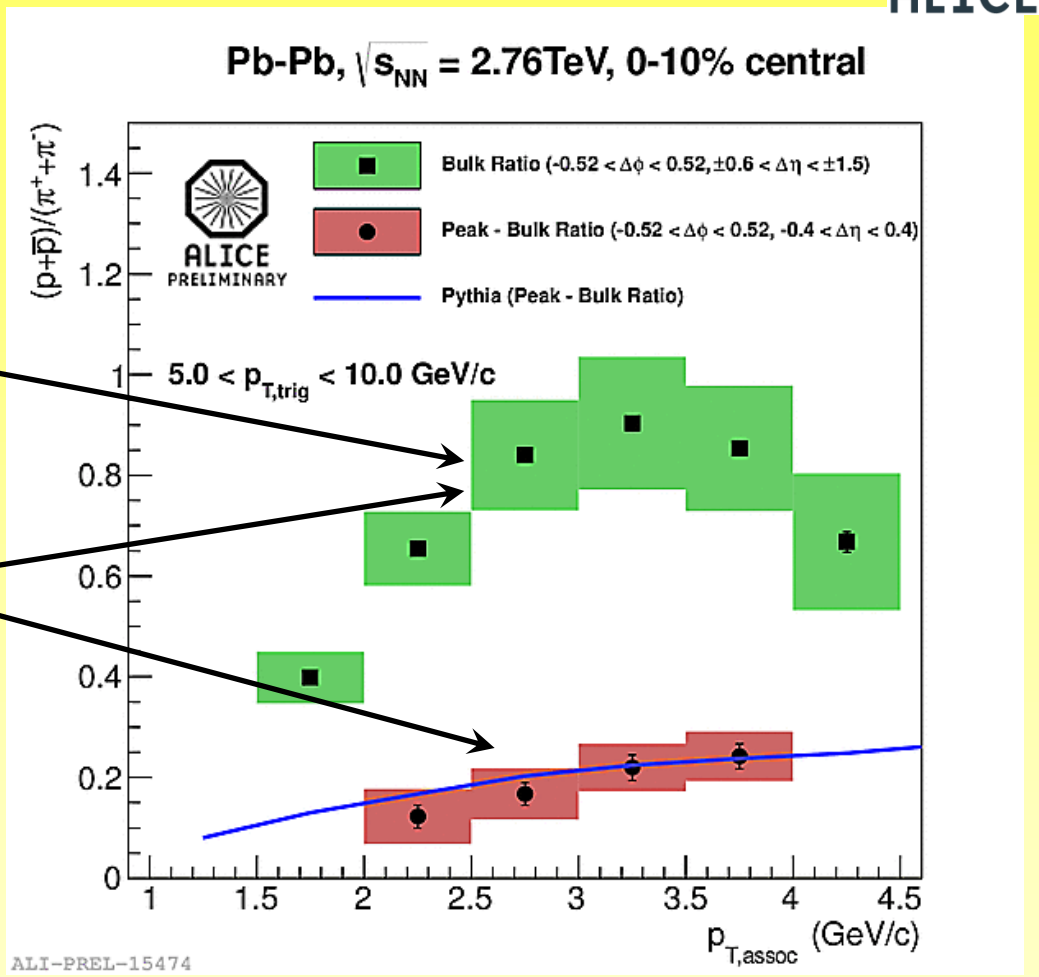
Upgrades, following steps

- **RRB 29 Oct -1 Nov**
  - Extension of the construction MoU
  - General Endorsement of the Upgrade by the FA
  - Support from FA for the R&D
- **Research Board Nov 28**
  - Positive comment of LHCC recommendation
  - Request to LHC of studies of luminosity increase for Pb beams
- **TDRs** in O(1 year)
  - Will define the construction design
  - Will contain the specific commitments of the Institutions to the projects
  - Followed by MoU addendum (or addenda)
- **R&D**
  - Continues vigorously throughout the process, with substantial funding, agreed within each project.


Thank you for yet another amazing year!!!
… see you in January for more!

PID in jet structures



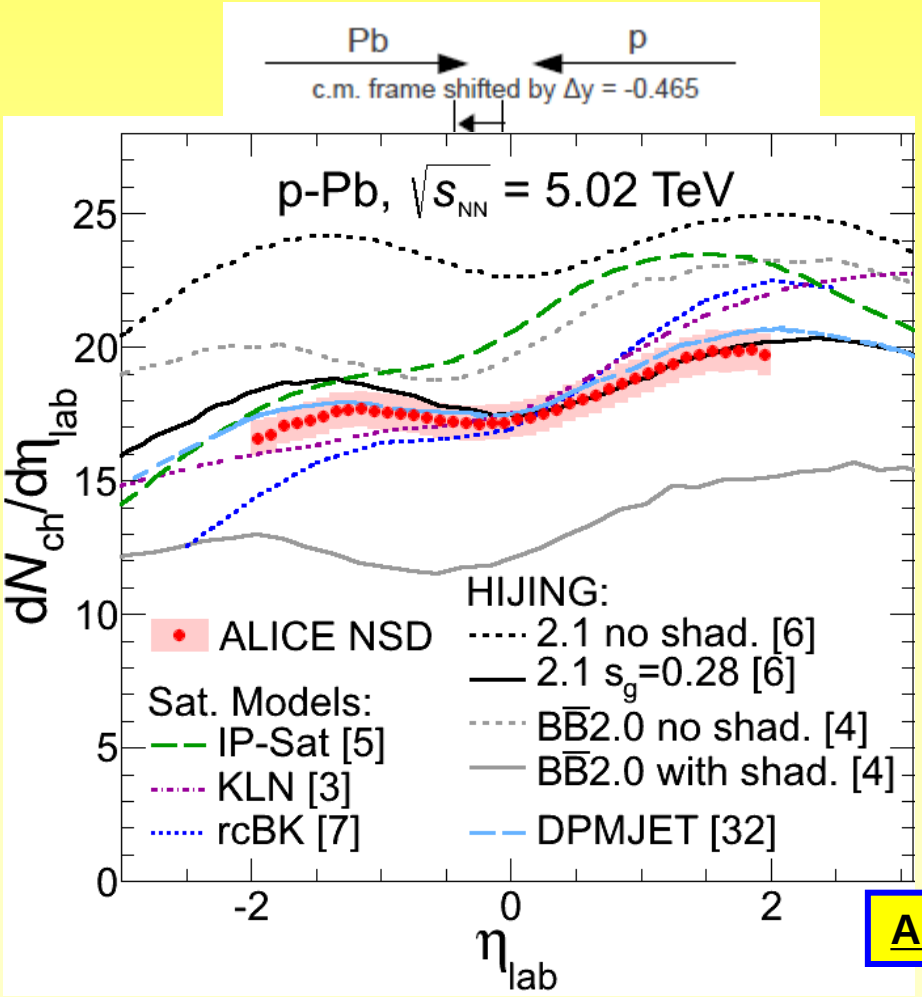


near-side peak (after bulk subtraction): p/π ratio compatible with that of pp (PYTHIA)
bulk region: p/π ratio strongly enhanced – compatible with overall baryon enhancement
jet particle ratios not modified in medium ? still might be surface bias…

p-Pb: Pseudorapidity density

- Measurement based on tracklets (SPD)
- Non-single-diffractive event selection

Norm. uncertainty: 3.1%



ALICE, arXiv:1210.3615

Saturation models predict steeper η-dependence which is not observed in the data.