Overview of ALICE results

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Autonomous University of Puebla (MX)

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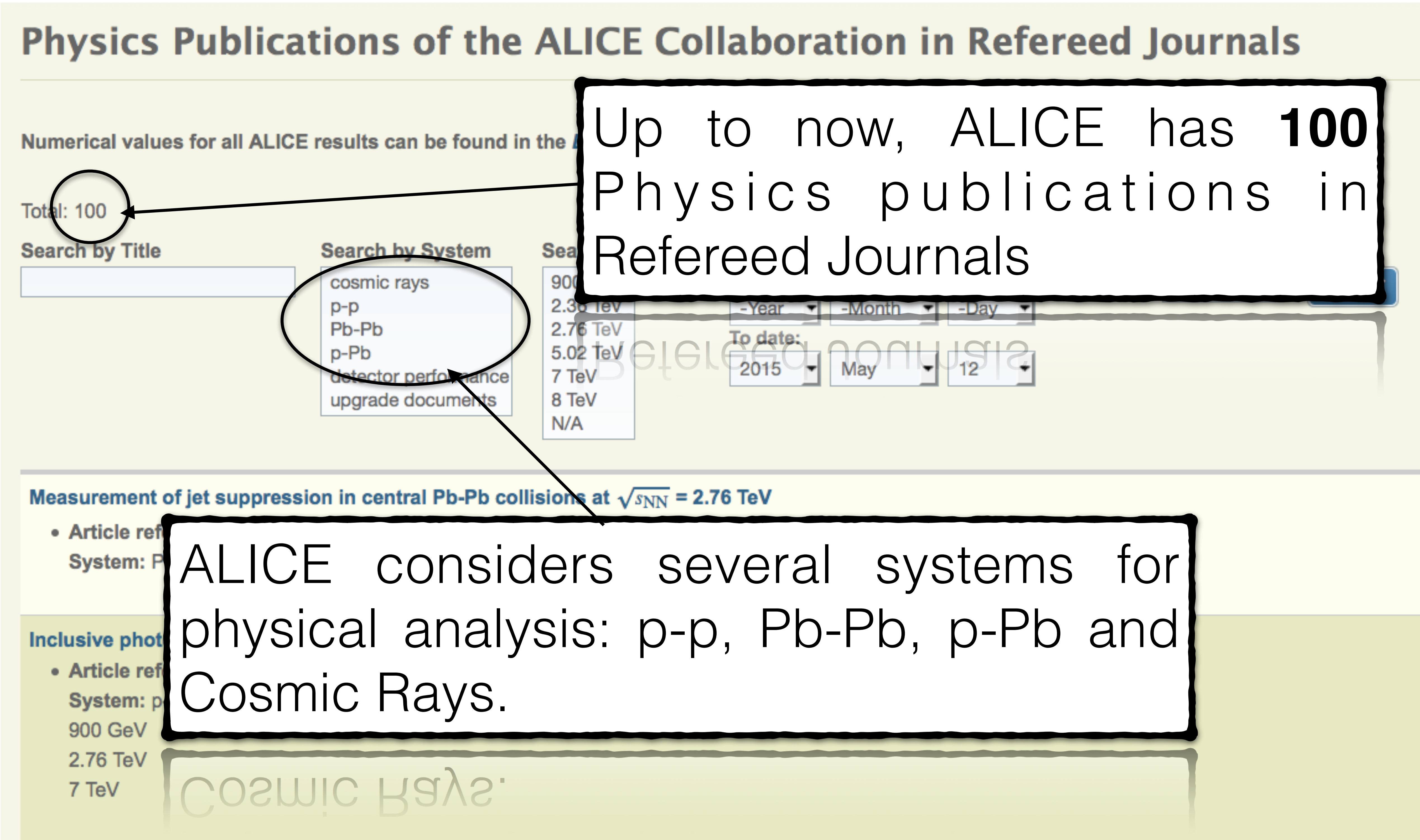
NOTE (1/2)


Physics Publications of the ALICE Collaboration in Refereed Journals
Numerical values for all ALICE results can be found in the
Total: 100
Search by Title
Search by System
cosmic rays
p-p
Pb-Pb
p-Pb
detector performance
upgrade documents
900
2.36 TeV
2.76 TeV
5.02 TeV
7 TeV
8 TeV
N/A
-Year
-Month
-Day
To date:
2015
May
12
Measurement of jet suppression in central Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV
Article ref
System: P
Inclusive phot
Article ref
System: p
900 GeV
2.76 TeV
7 TeV
Up to now, ALICE has **100** Physics publications in Refereed Journals
ALICE considers several systems for physical analysis: p-p, Pb-Pb, p-Pb and Cosmic Rays.

NOTE (2/2)

In this talk, a review of ALICE results during Run 1 on elliptic flow, Global features of collisions, diffraction, photo-production of vector mesons and cosmic ray physics will be given.

Outline of this talk

- Introduction
- ALICE detector
- ALICE results on Elliptic Flow
- ALICE results on Global features of collisions
- ALICE results on Diffraction
- ALICE results on photo-production of vector mesons
- ALICE results on Cosmic Ray Physics
- Activities of the Mexican Group during Run 1 and LS1
- Plans and perspectives for Run 3
- Summary

Introduction

Quantum Chromodynamics (QCD) is the theory of Strong Interactions (forces between quarks, gluons, protons, neutrons …)

Quarks and gluons remain confined (quarks and gluons cannot be isolated) inside hadrons (protons, neutrons)

Interaction becomes very weak at high energies/small length scales (2004 Nobel Prize to Gross, Politzer, Wilczek)

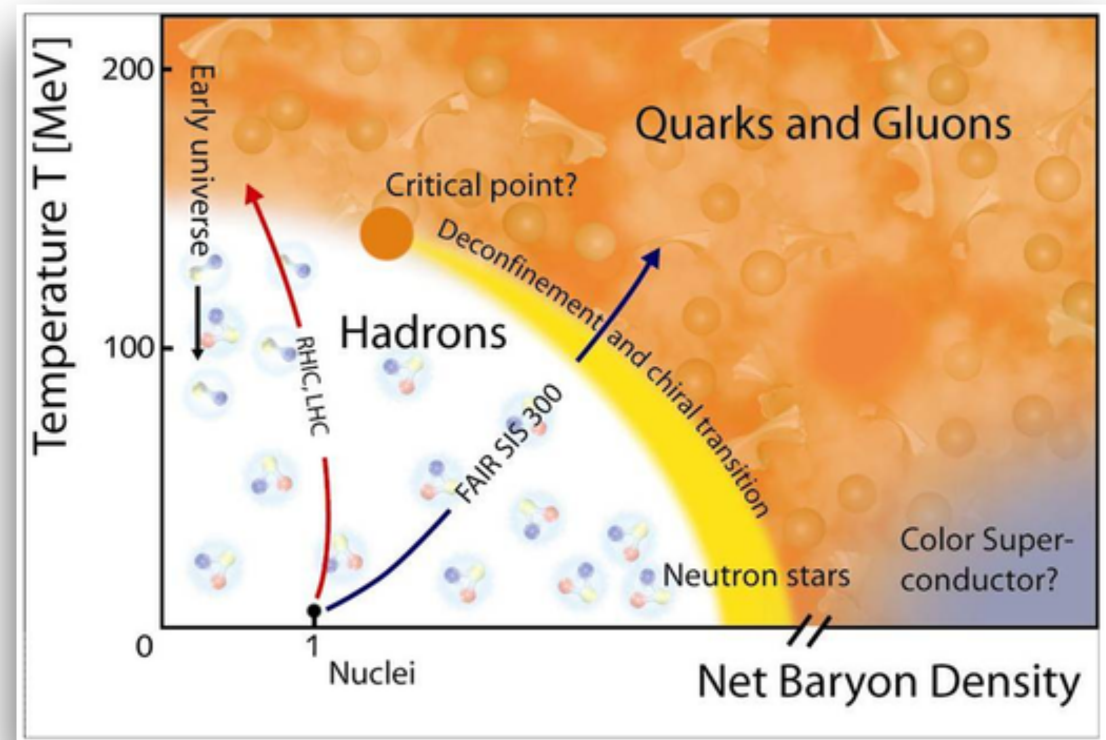
Under extreme conditions of high density and/or temperature there should be a deconfinement of quarks and gluons, and hadrons should undergo a phase transition.

Introduction

Heavy-ion physics allows us to study QCD matter under extreme conditions of high temperature and energy density

Hadronic matter

- deconfined quarks and gluons.
- study of the phase diagram and the properties of the hot QCD matter.
- the conditions required for the formation of QGP can be experimentally accessed in relativistic heavy-ion collisions(HIC).

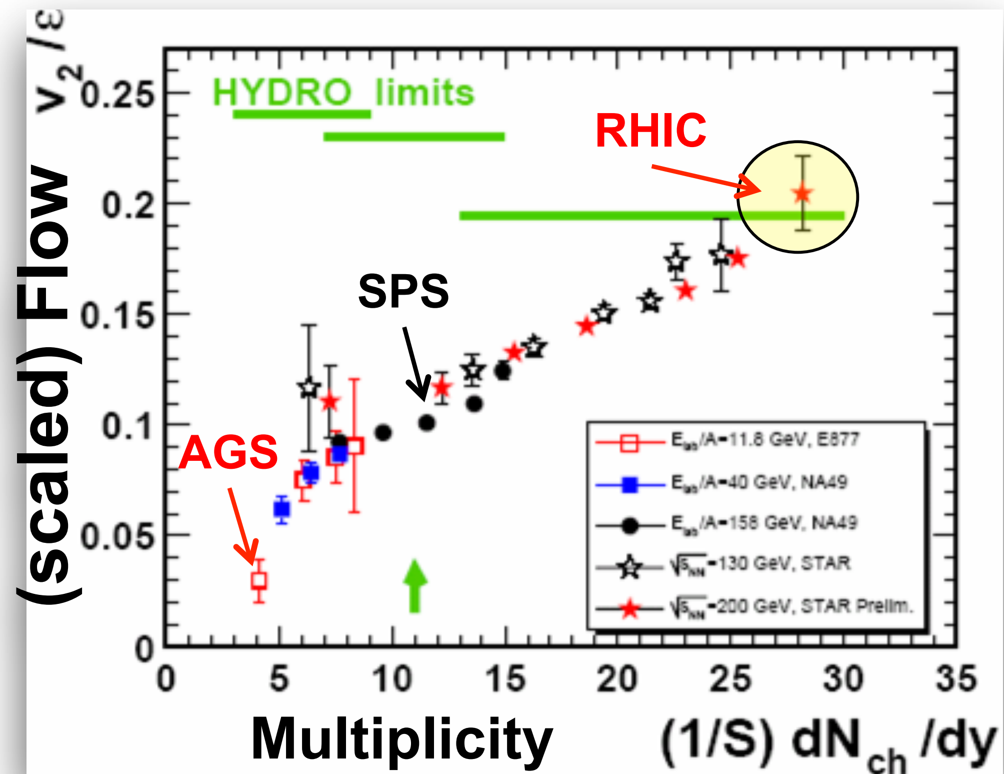


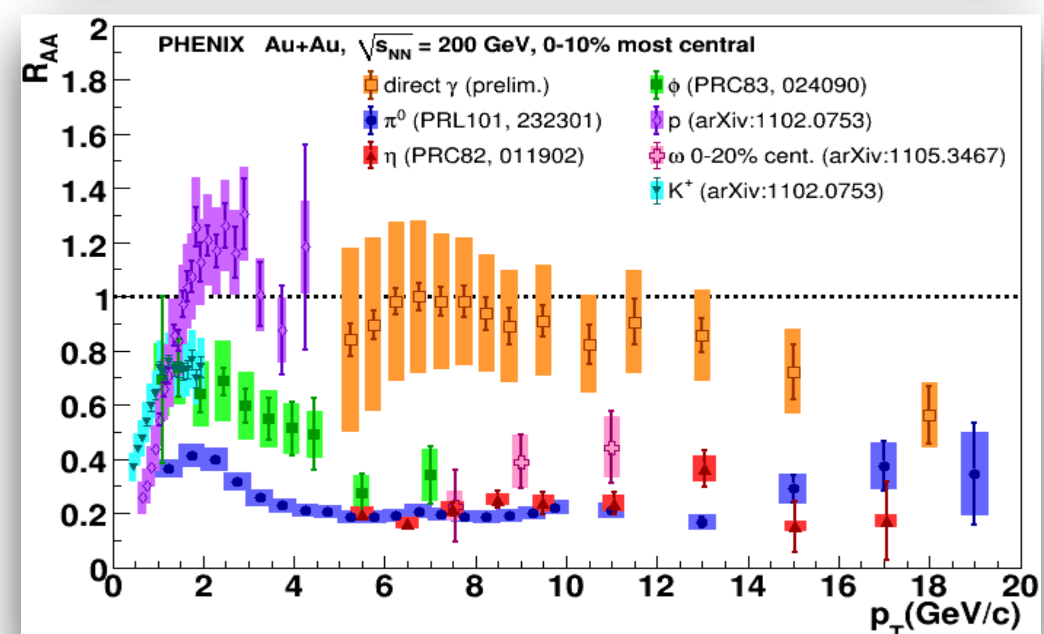
past	GSI	SIS	~2 GeV
	BNL	AGS	~5 GeV
	CERN	SPS	~20 GeV
present	BNL	RHIC	~200 GeV
	CERN	LHC	~5 TeV
future	GSI	FAIR	~45 GeV

Introduction

Some signatures of the QGP in Heavy-ion collisions:

- Collective flow: radial and anisotropic
- Long-range angular correlations (hydrodynamical evolution of the medium)
- Suppression of high pT hadrons (energy loss of partons in the medium)
- Enhancement of thermal photons and dileptons due to the emission from the plasma





Introduction

LHC conditions

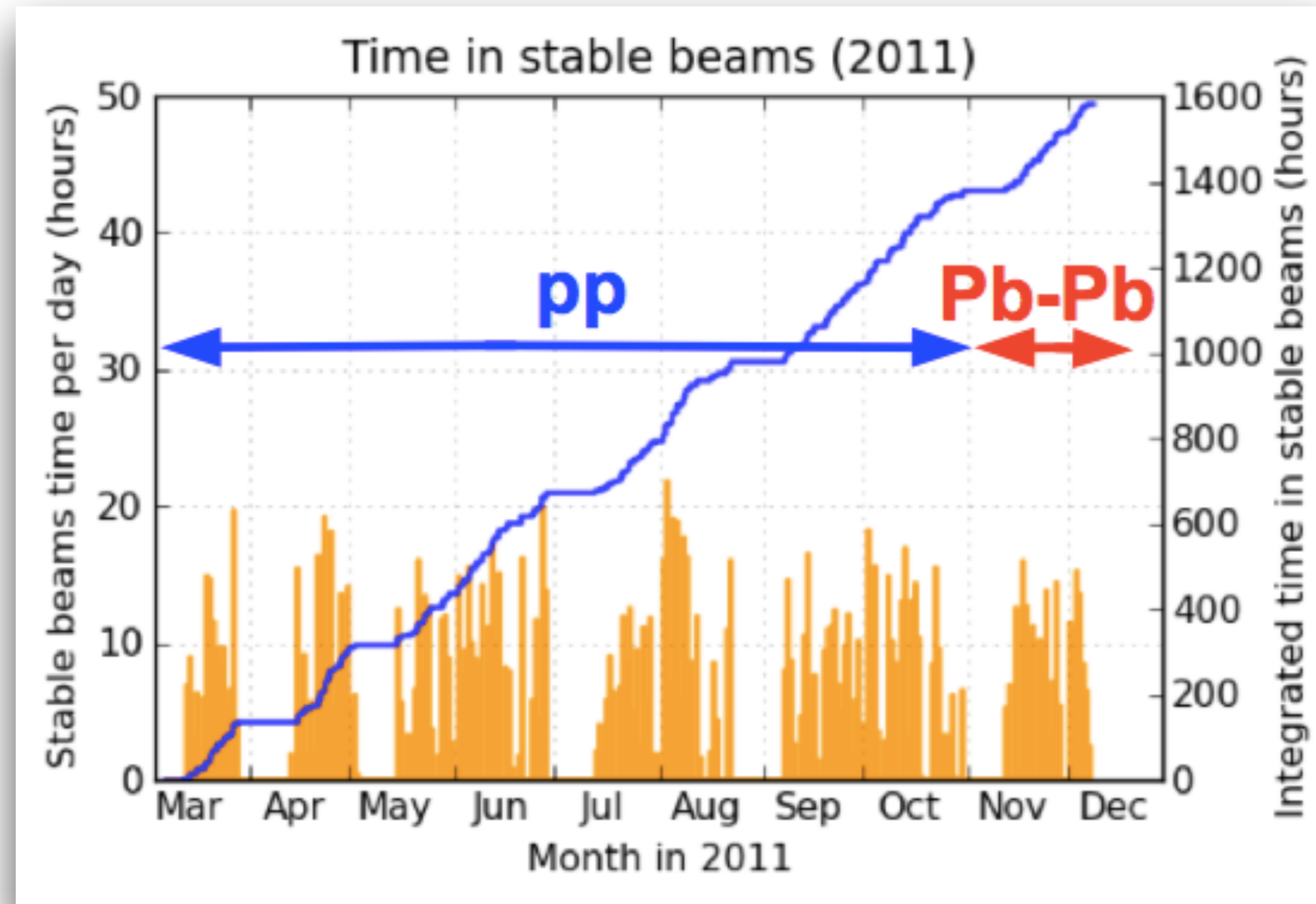
- Large QGP temperature, volume, energy density and lifetime.
- Large cross section for hard probes: high pT, jets, heavy quarks.
- Small net-baryon density at mid rapidity corresponding to the conditions in the early Universe.
- First principle methods (pQCD, Lattice Gauge Theory) more directly applicable
- New generation of detectors: ATLAS, CMS, ALICE and LHCb (for p-Pb runs)

Introduction

LHC operation in 2010 and 2011:

March - October: p-p collisions (~ 1400 hours of stable beam)

November: 4 weeks of Pb-Pb collisions (~ 200 hours)

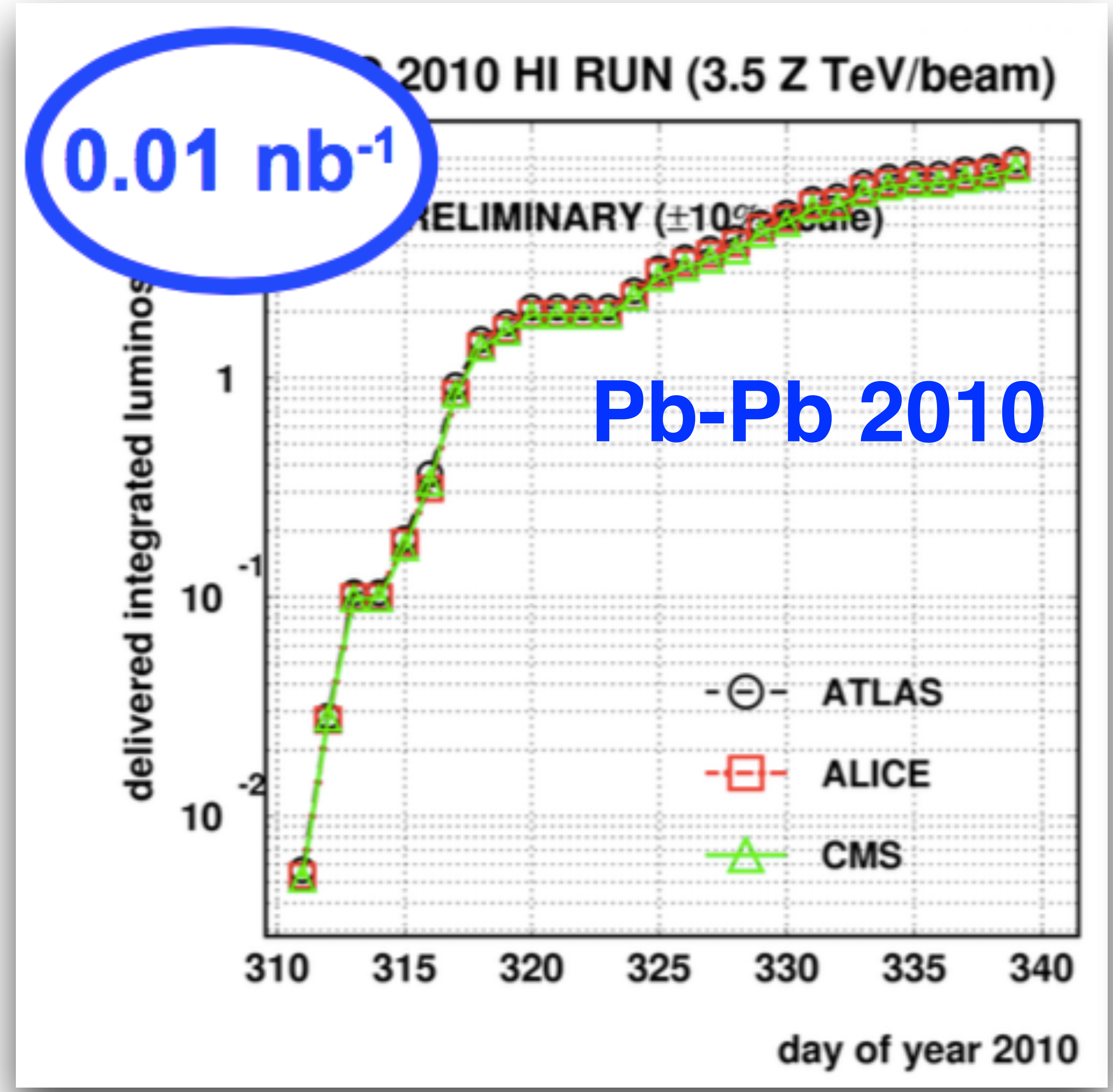


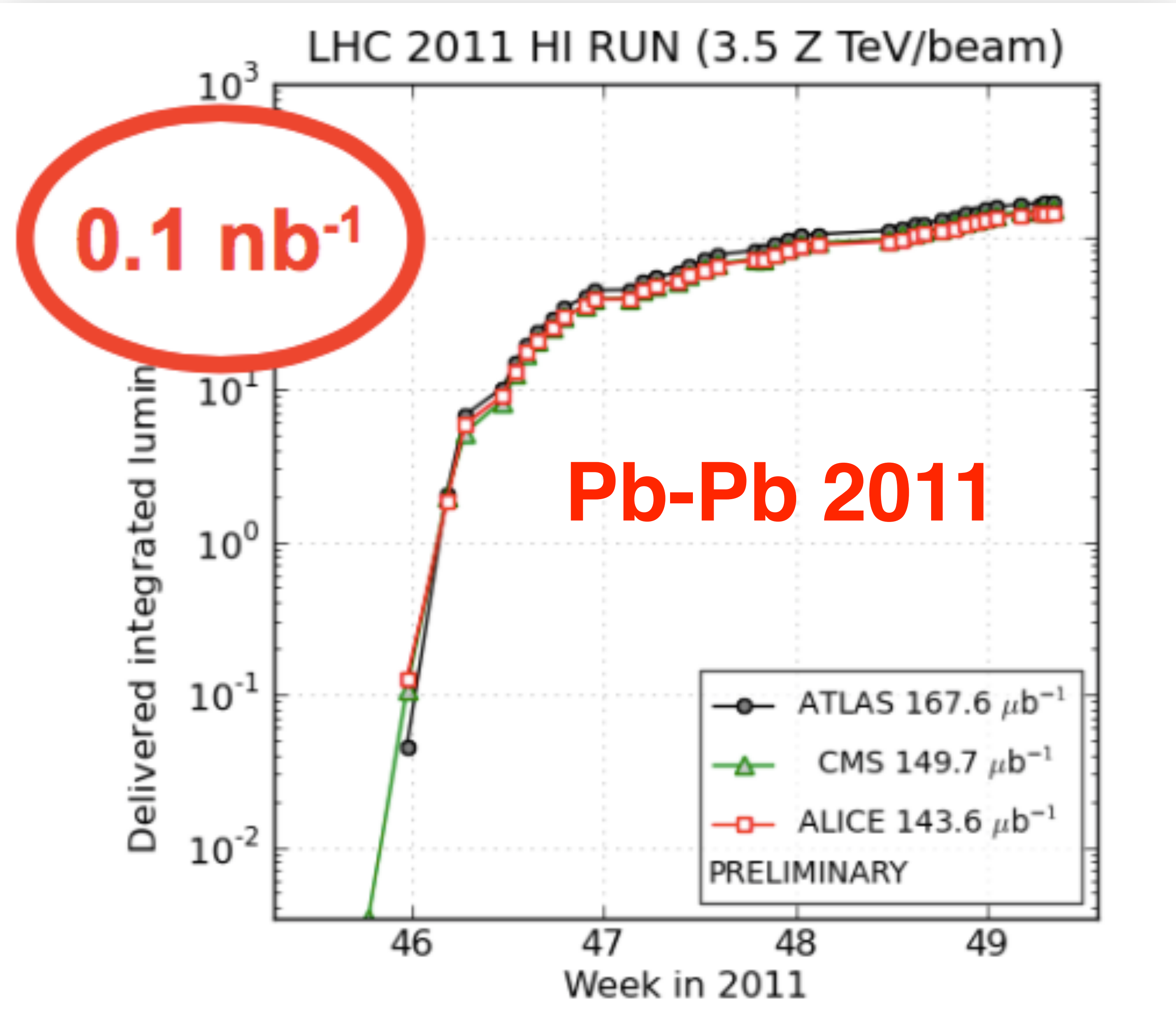
In 2015: re-start of p-p collision runs in May-June, heavy ion run from mid of November.

Introduction

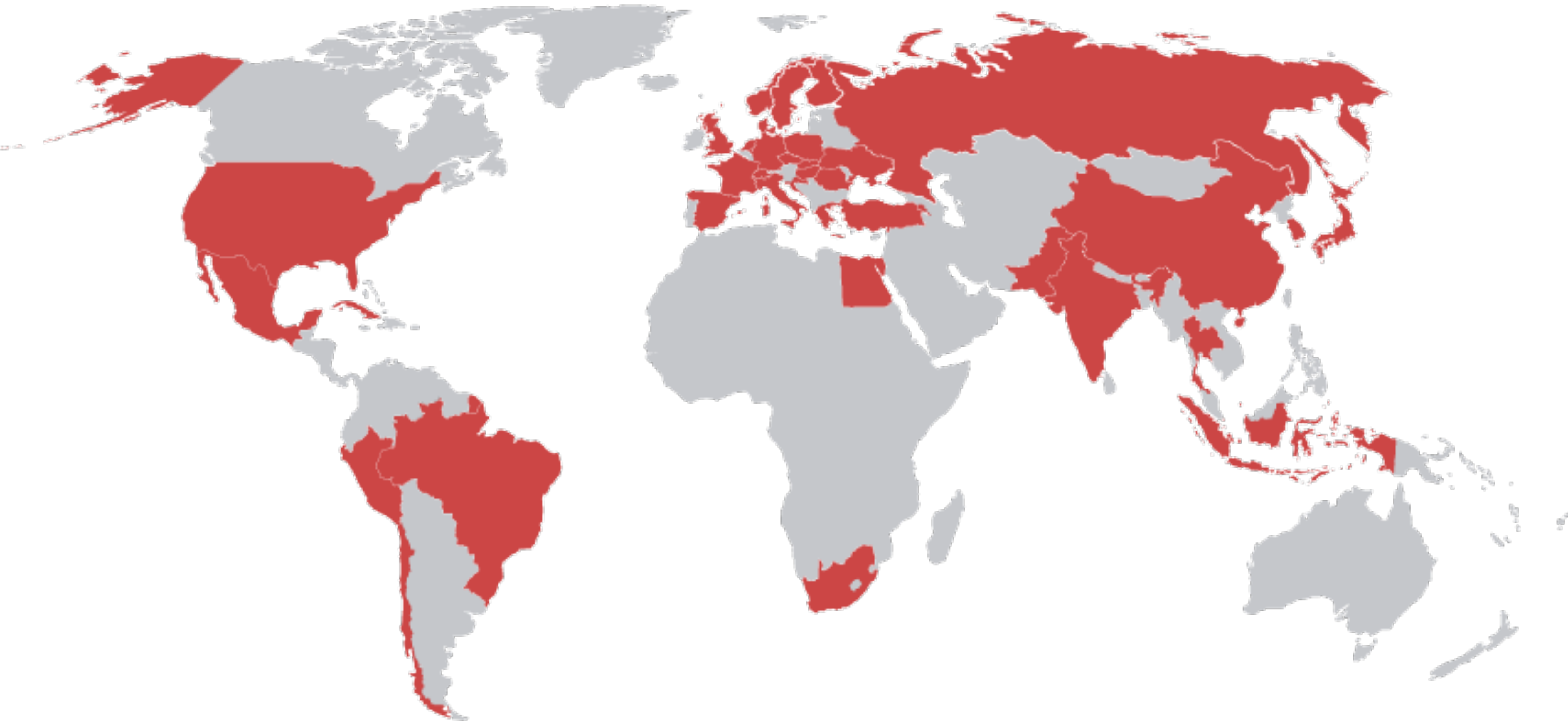
LHC operation in 2011 (Heavy Ion runs):

In 2011, LHC reached amazing interaction rates, beating its own expectations.





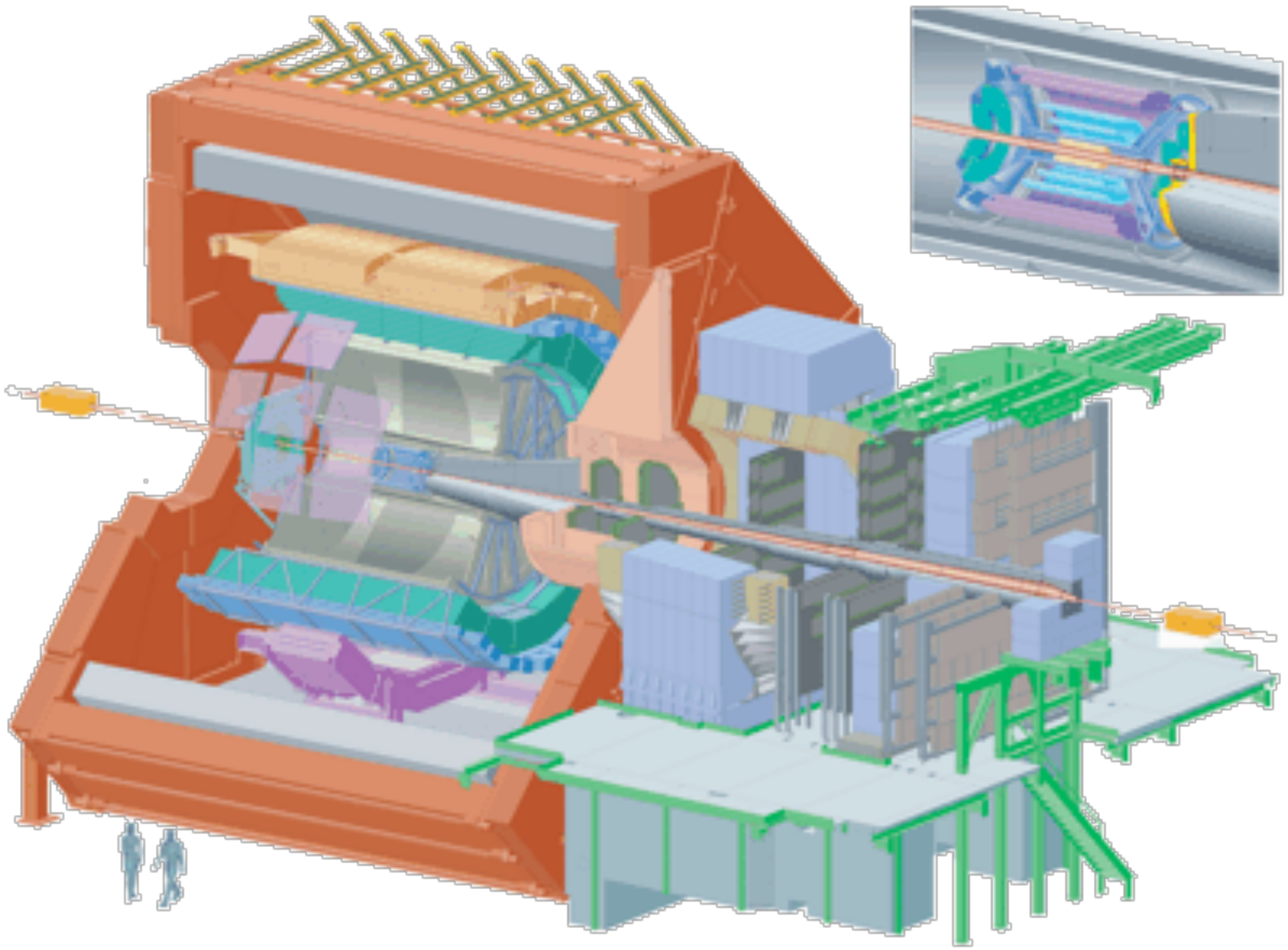
A Large Ion Collider Experiment



37 countries, 151 institutes, 1550 members

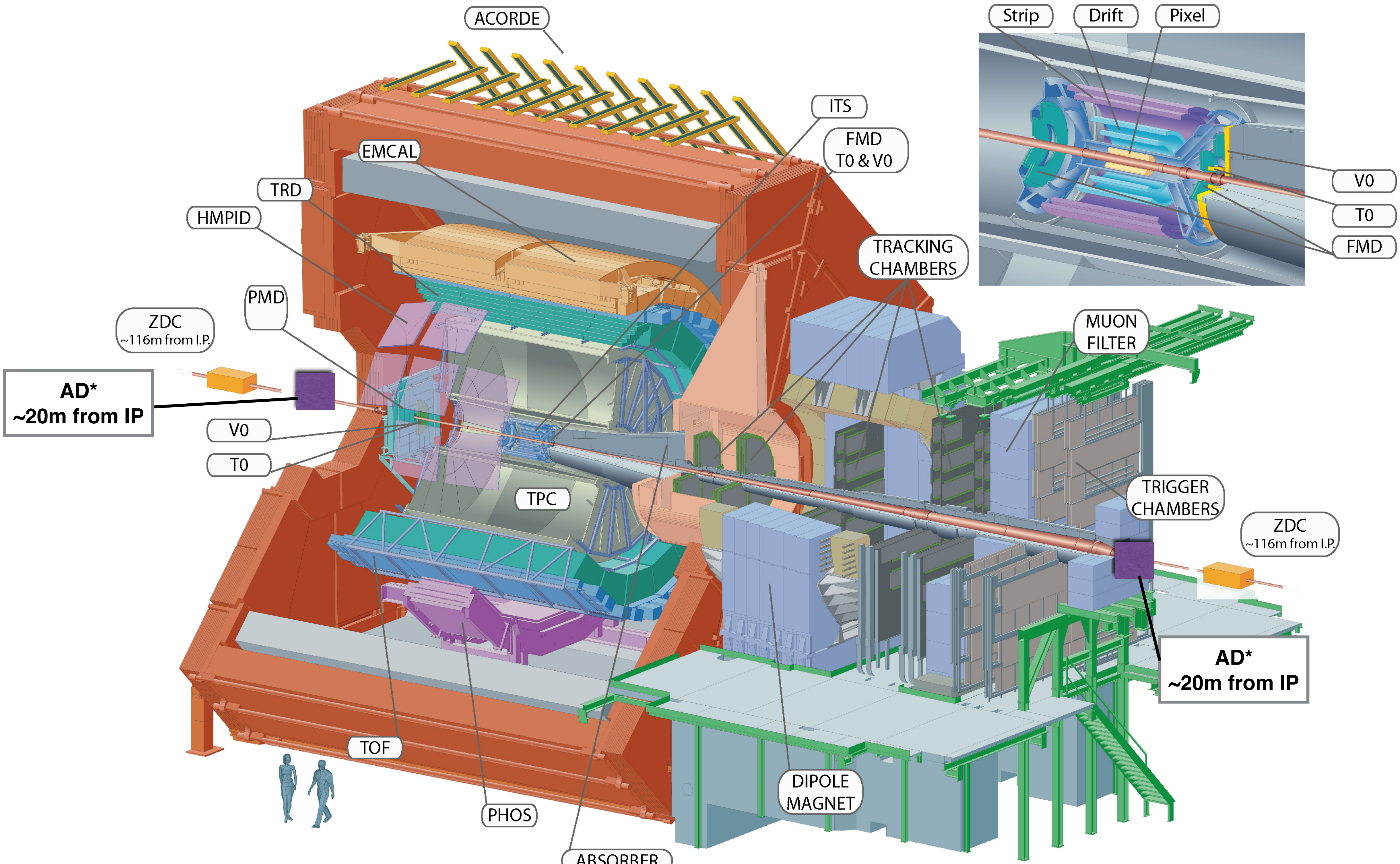
http://aliceinfo.cern.ch/

A Large Ion Collider Experiment



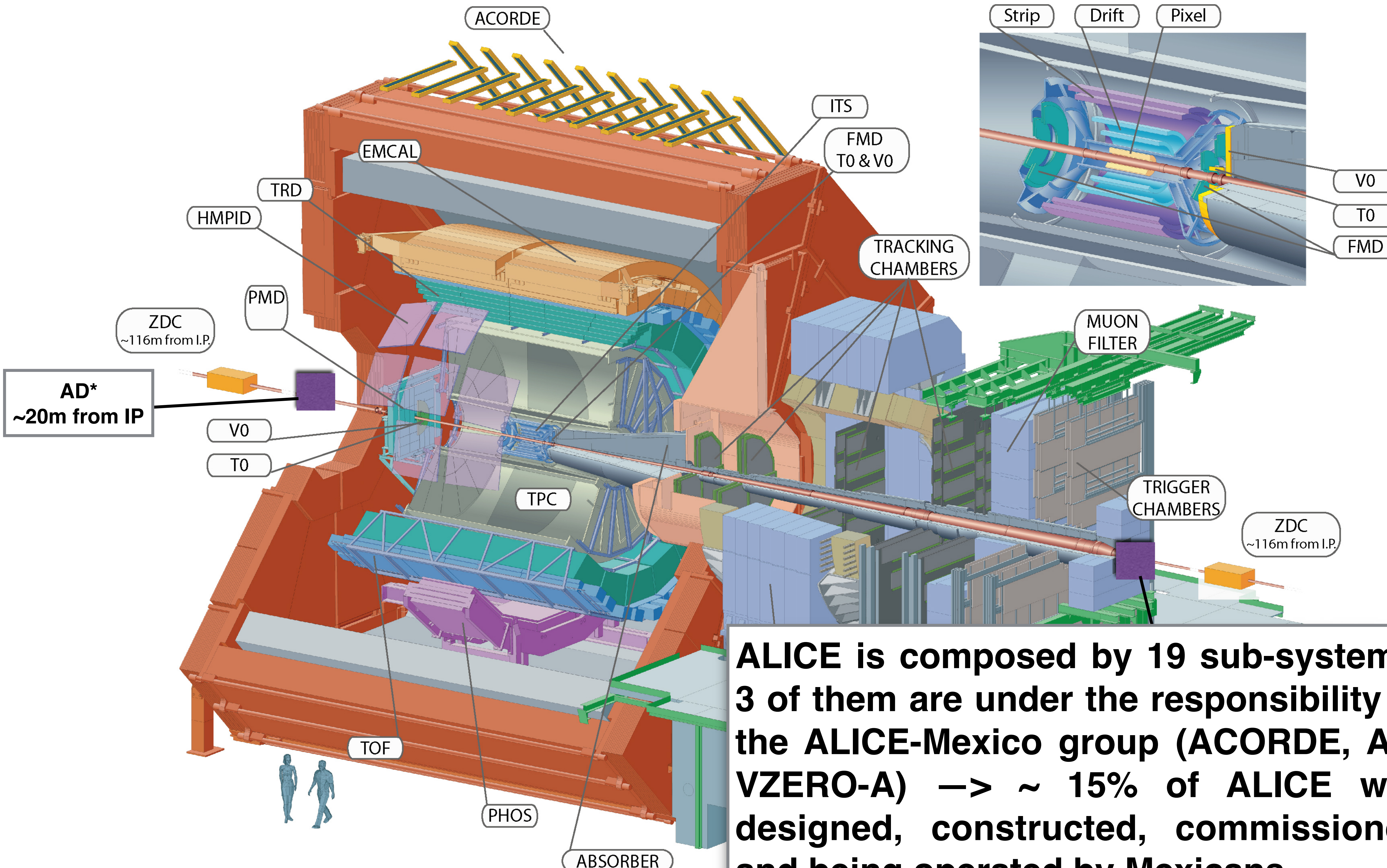
The ALICE Collaboration has built a **dedicated heavy-ion detector** to exploit the unique physics potential of nucleus-nucleus interactions at LHC energies. Our **aim is to study the physics of strongly interacting matter at extreme energy densities, where the formation of a new phase of matter, the quark-gluon plasma**, is expected. The existence of such a phase and its properties are key issues in QCD for the **understanding of confinement and of chiral-symmetry restoration.** For this purpose, we are carrying out a comprehensive study of the hadrons, electrons, muons and photons produced in the collision of heavy nuclei. **ALICE is also studying proton-proton collisions both as a comparison with lead-lead collisions and in physics areas where ALICE is competitive** with other LHC experiments.

A Large Ion Collider Experiment



* detector installed for Run 2

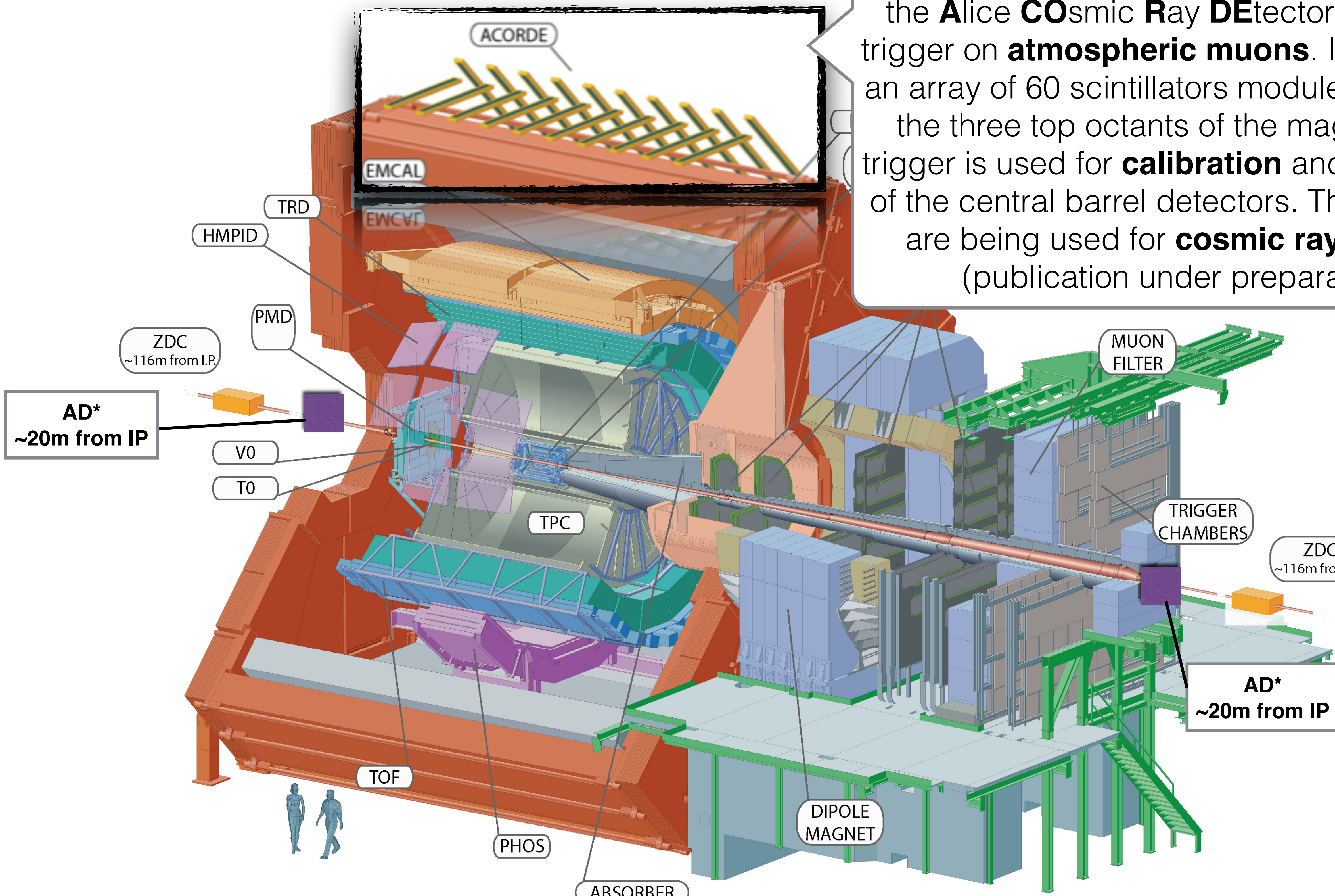
A Large Ion Collider Experiment



ALICE is composed by 19 sub-systems, 3 of them are under the responsibility of the ALICE-Mexico group (ACORDE, AD, VZERO-A) —> ~ 15% of ALICE was designed, constructed, commissioned and being operated by Mexicans.

*** detector installed for Run 2**

A Large Ion Collider Experiment

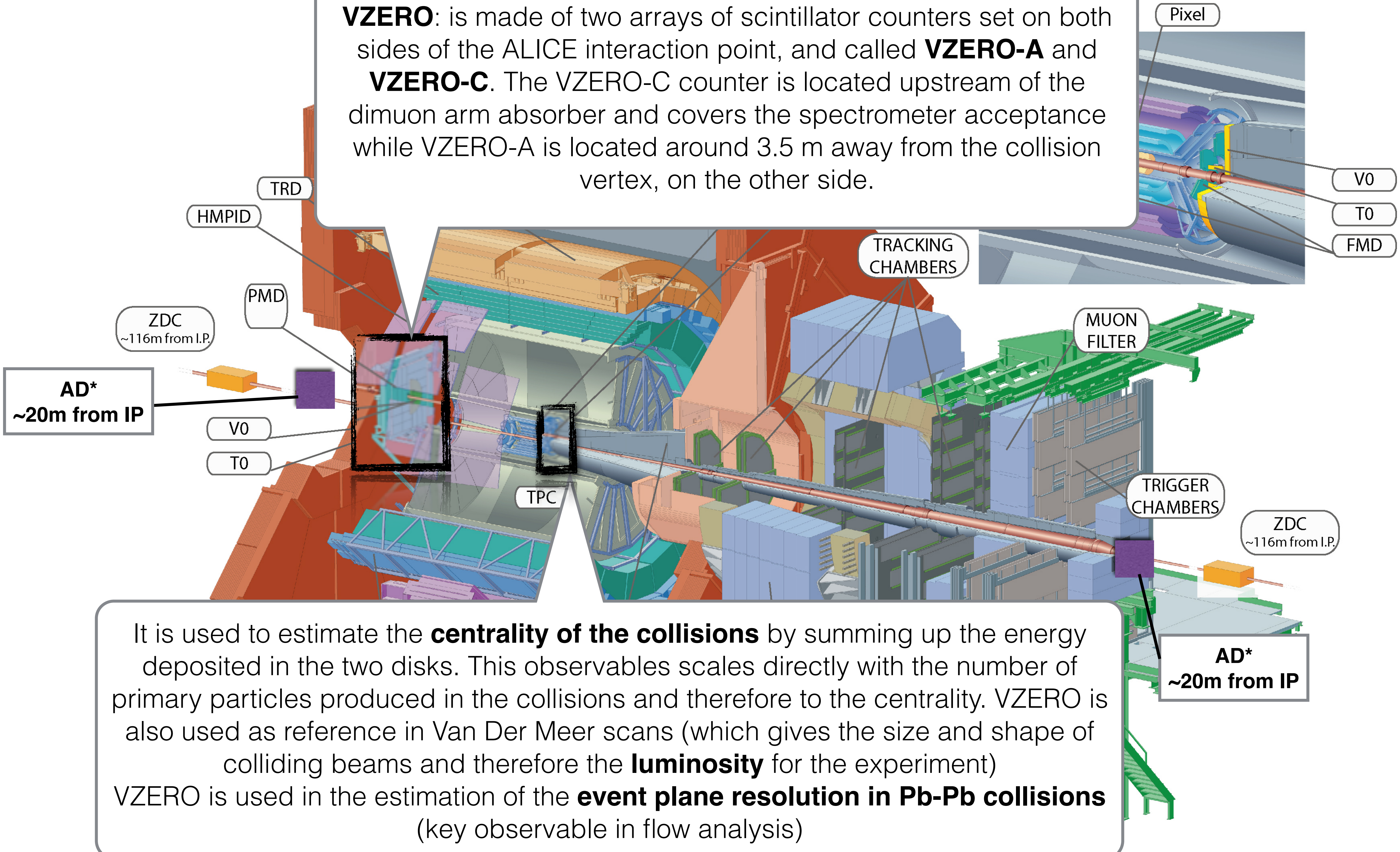


the **A**lice **CO**smic **R**ay **DE**tector is used to trigger on **atmospheric muons**. It consists of an array of 60 scintillators module located on the three top octants of the magnet. This trigger is used for **calibration** and **alignment** of the central barrel detectors. These events are being used for **cosmic ray studies** (publication under preparation)

*** detector installed for Run 2**

A Large Ion Collider Experiment

VZERO: is made of two arrays of scintillator counters set on both sides of the ALICE interaction point, and called **VZERO-A** and **VZERO-C**. The VZERO-C counter is located upstream of the dimuon arm absorber and covers the spectrometer acceptance while VZERO-A is located around 3.5 m away from the collision vertex, on the other side.

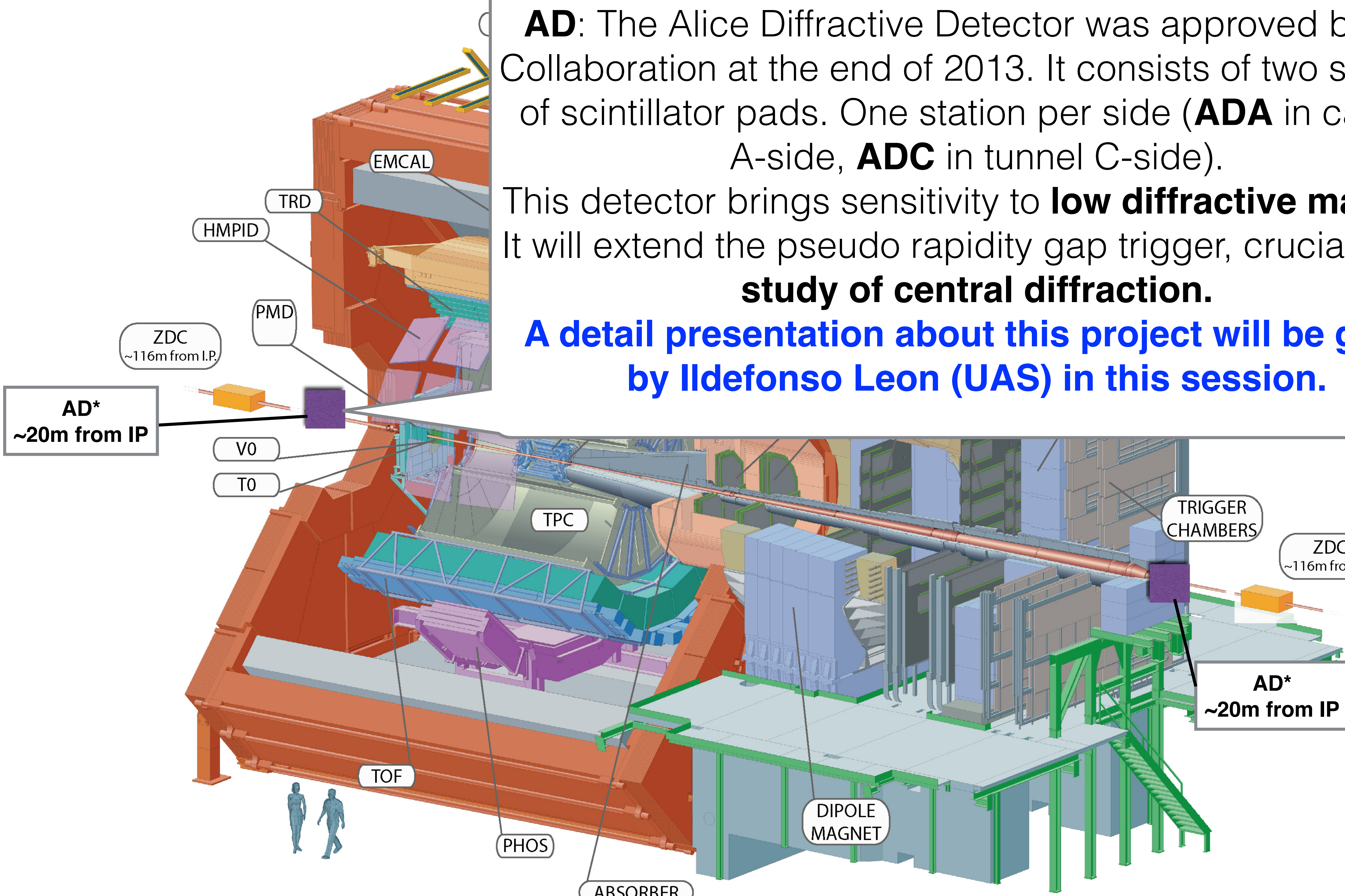


It is used to estimate the **centrality of the collisions** by summing up the energy deposited in the two disks. This observables scales directly with the number of primary particles produced in the collisions and therefore to the centrality. VZERO is also used as reference in Van Der Meer scans (which gives the size and shape of colliding beams and therefore the **luminosity** for the experiment)
VZERO is used in the estimation of the **event plane resolution in Pb-Pb collisions** (key observable in flow analysis)

*** detector installed for Run 2**

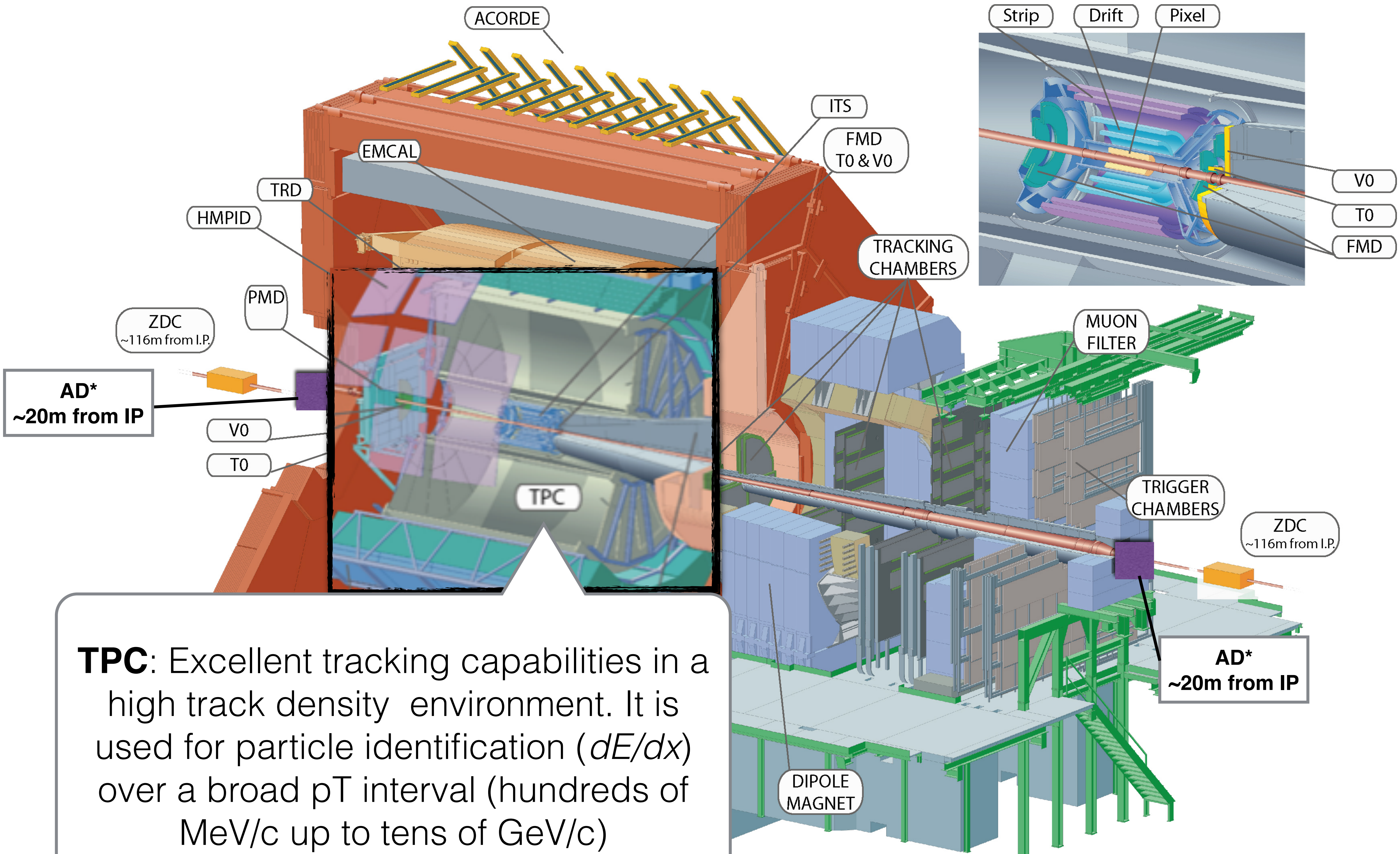
A Large Ion Collider Experiment

AD: The Alice Diffractive Detector was approved by the Collaboration at the end of 2013. It consists of two stations of scintillator pads. One station per side (**ADA** in cavern A-side, **ADC** in tunnel C-side).
This detector brings sensitivity to **low diffractive masses.** It will extend the pseudo rapidity gap trigger, crucial in the **study of central diffraction.**
A detail presentation about this project will be given by Ildefonso Leon (UAS) in this session.



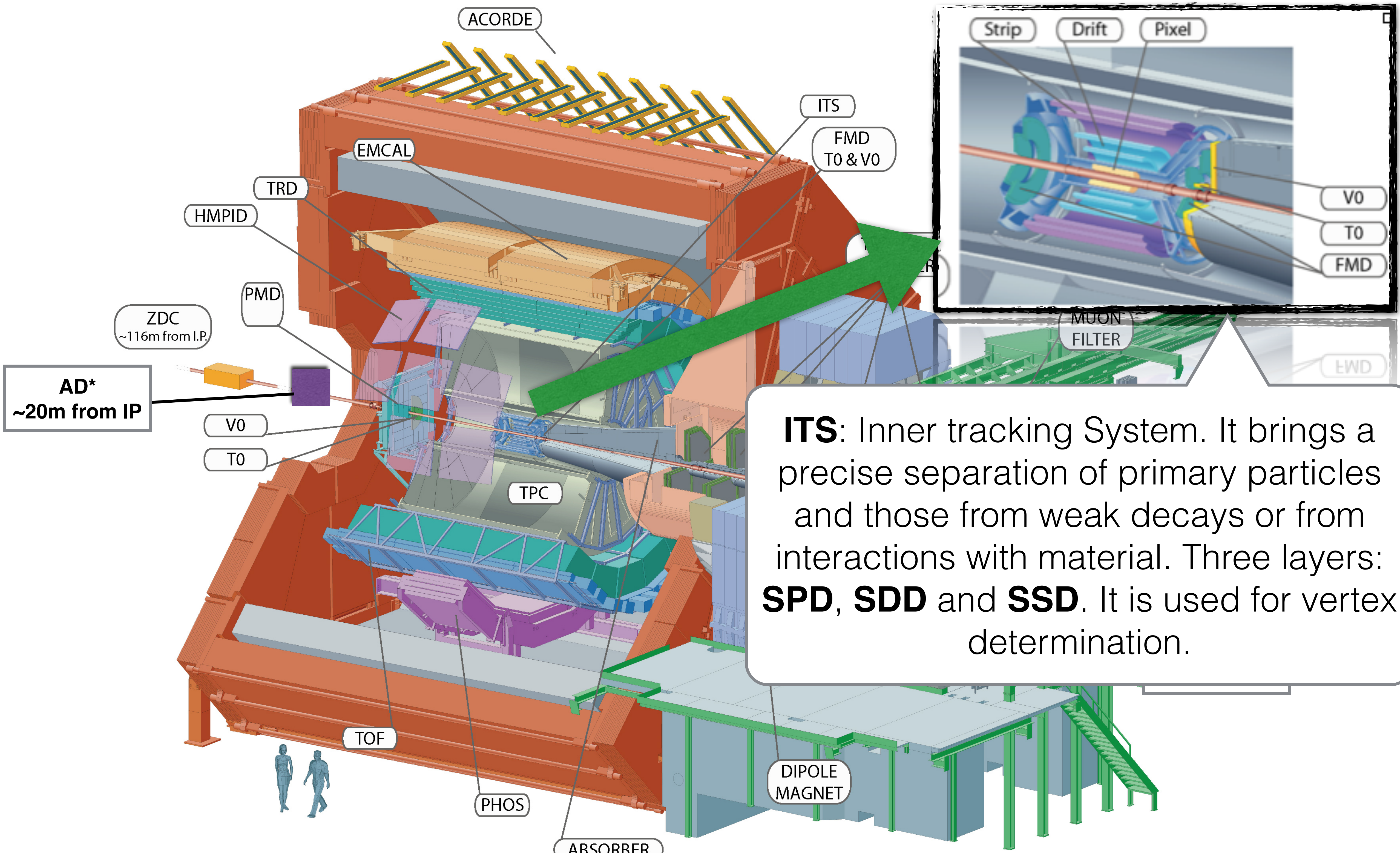
*** detector installed for Run 2**

A Large Ion Collider Experiment



TPC: Excellent tracking capabilities in a high track density environment. It is used for particle identification (*dE/dx*) over a broad pT interval (hundreds of MeV/c up to tens of GeV/c)

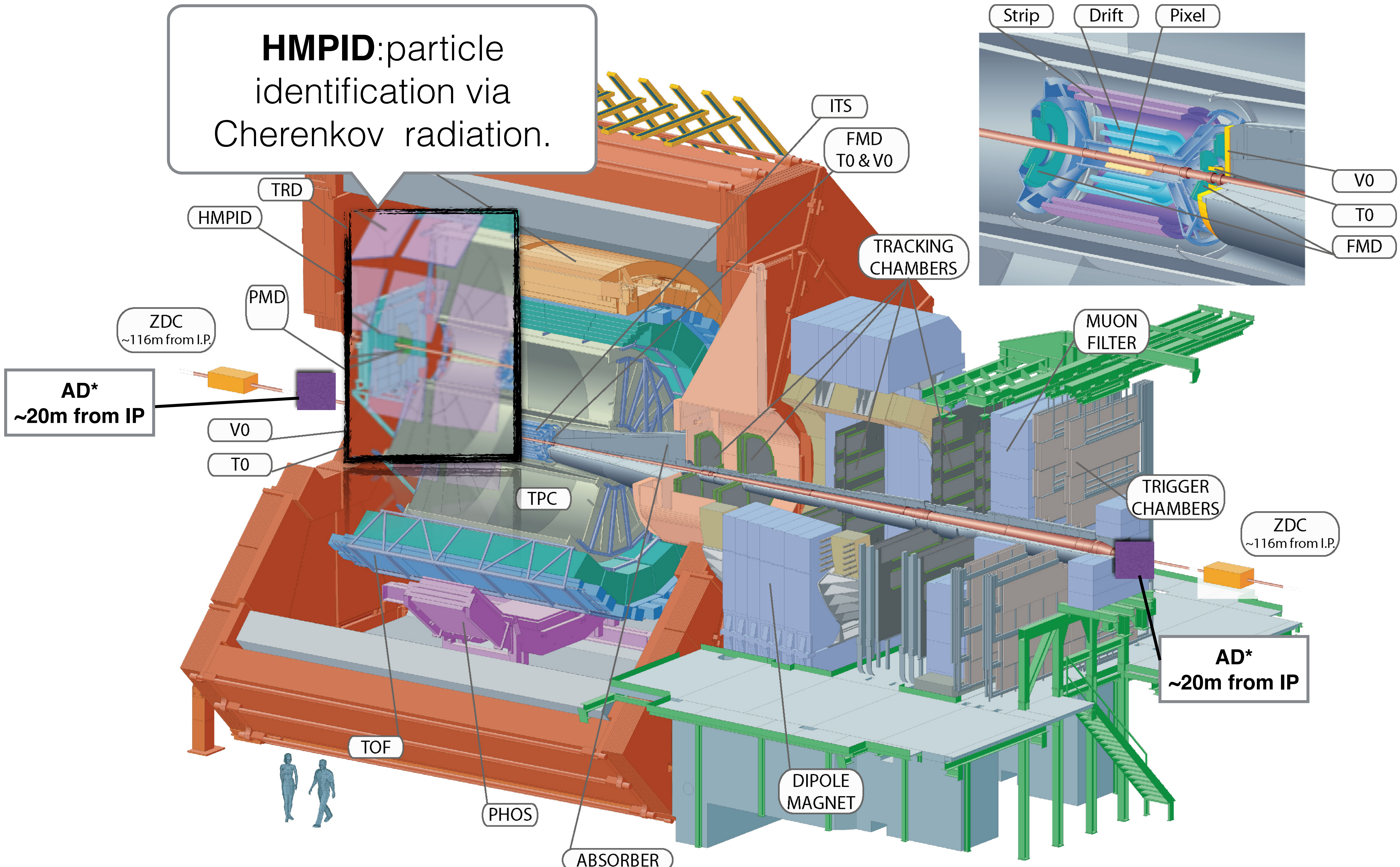
A Large Ion Collider Experiment



ITS: Inner tracking System. It brings a precise separation of primary particles and those from weak decays or from interactions with material. Three layers: **SPD**, **SDD** and **SSD**. It is used for vertex determination.

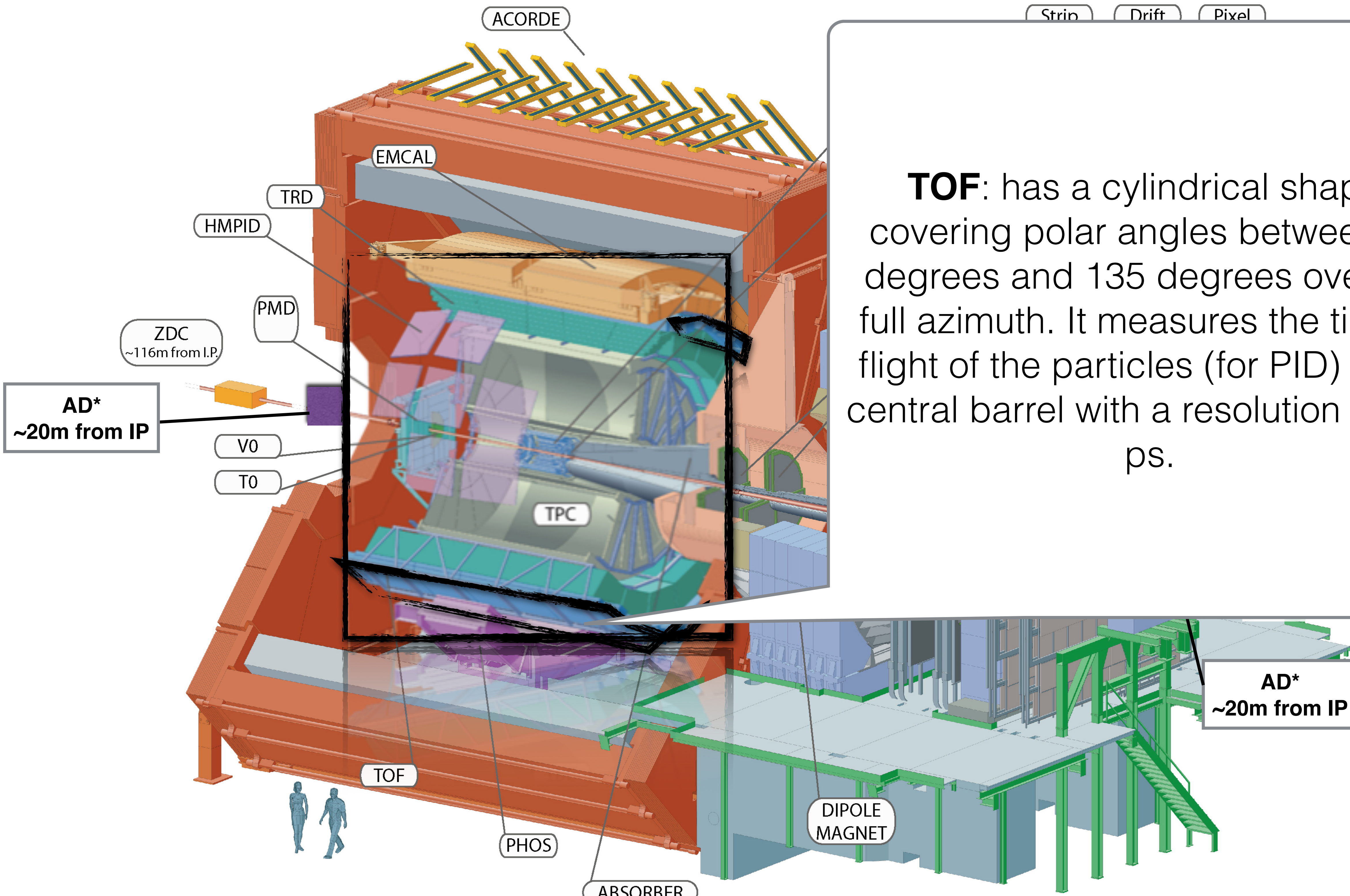
*** detector installed for Run 2**

A Large Ion Collider Experiment



* detector installed for Run 2

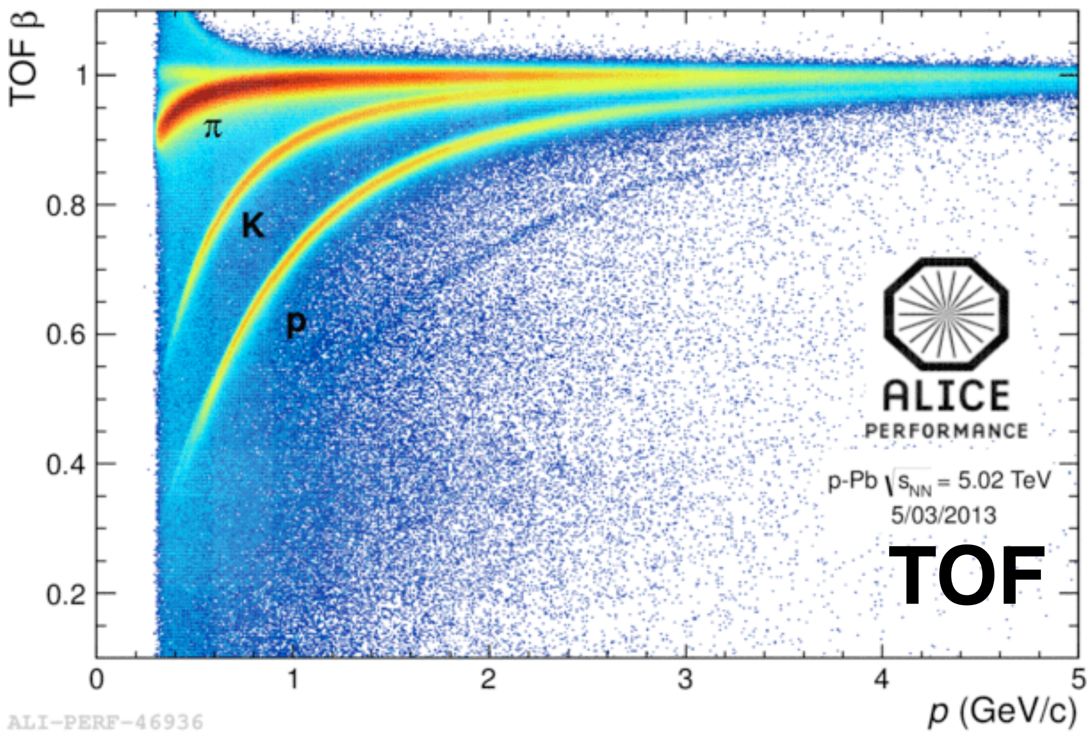
A Large Ion Collider Experiment

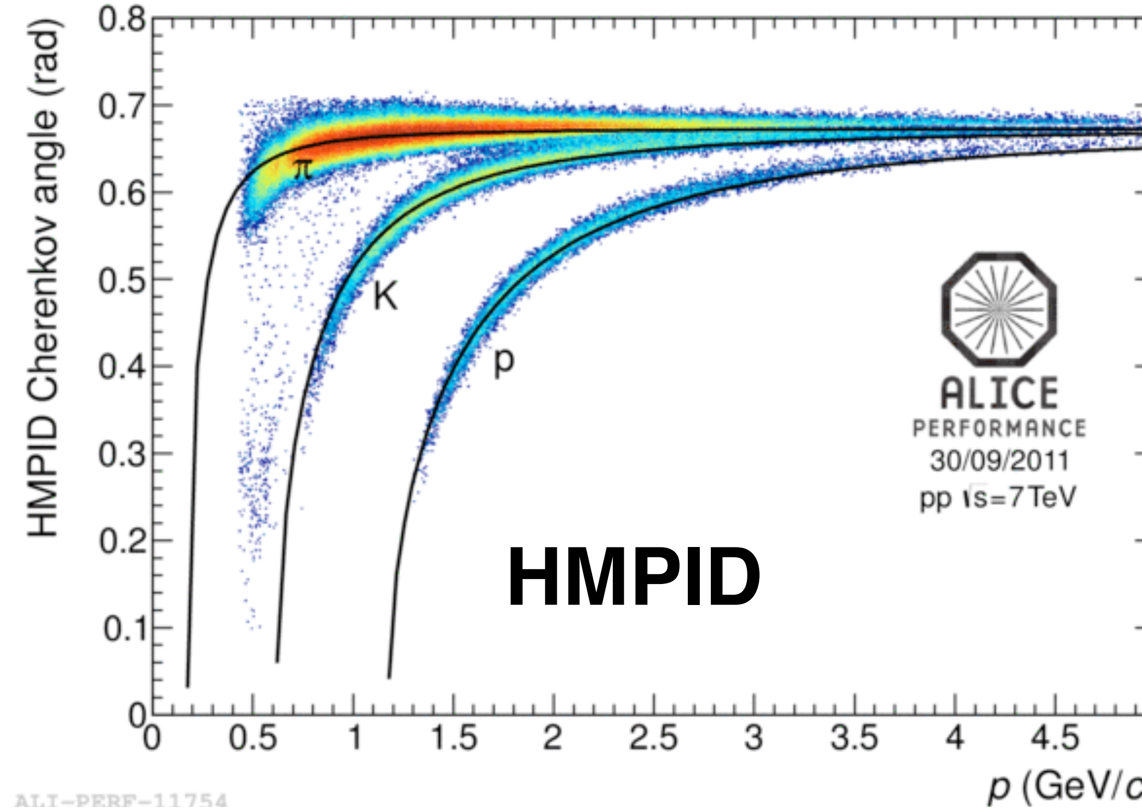


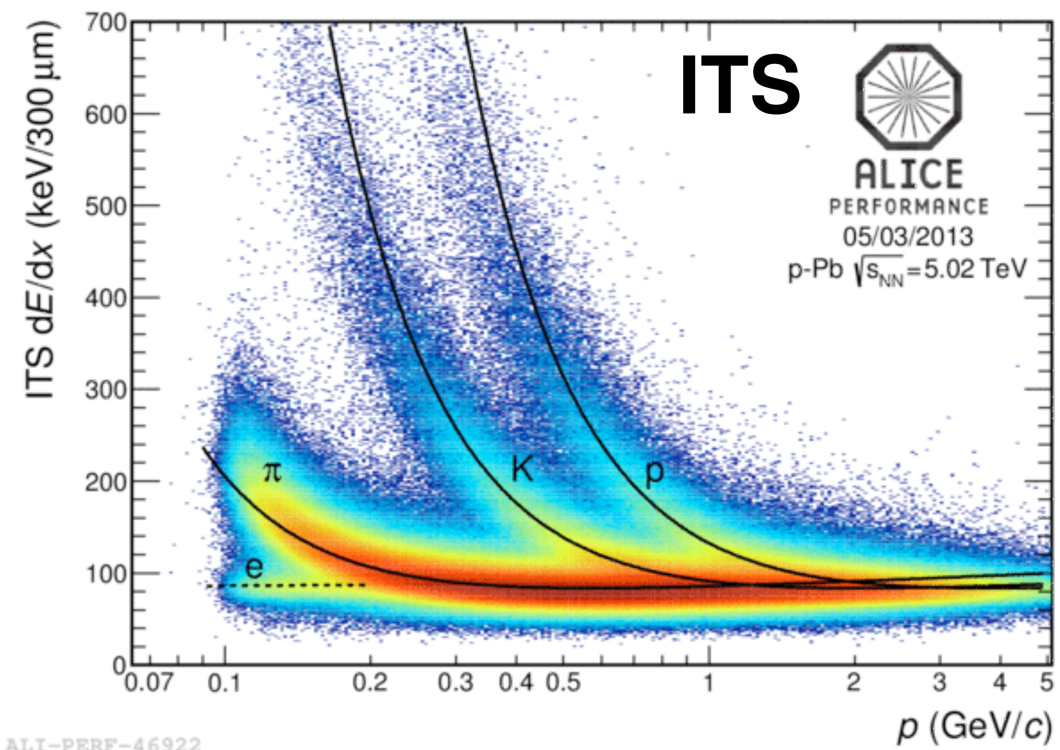
TOF: has a cylindrical shape, covering polar angles between 45 degrees and 135 degrees over the full azimuth. It measures the time of flight of the particles (for PID) in the central barrel with a resolution of 100 ps.

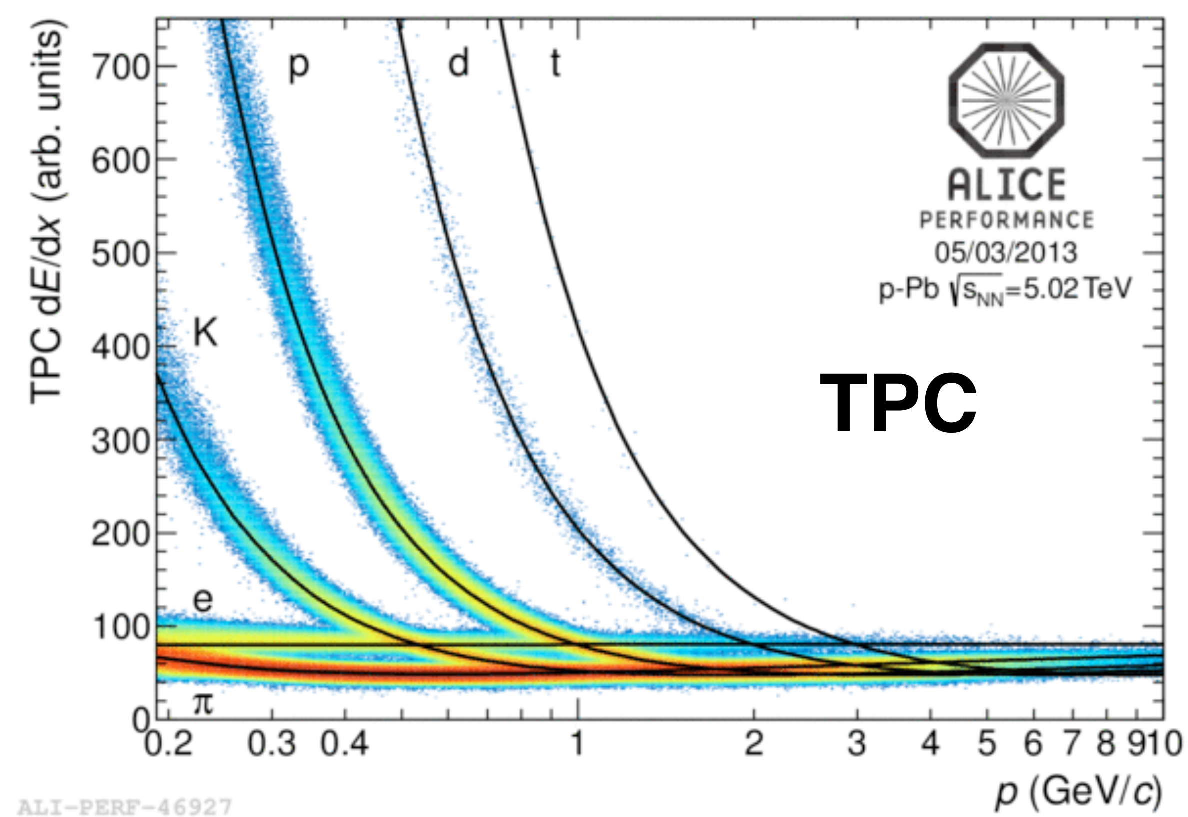
*** detector installed for Run 2**

A Large Ion Collider Experiment









Several PID methods are used in ALICE.

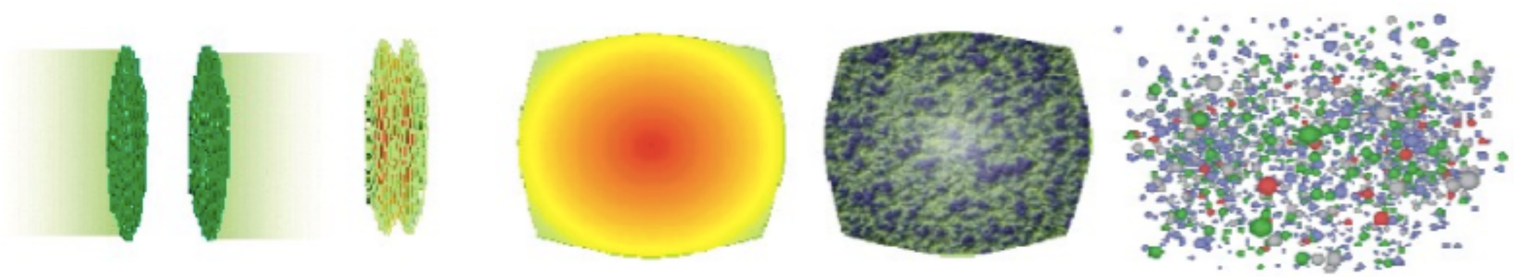
A Large Ion Collider Experiment

Collected data sample by ALICE during Run 1 of LHC:

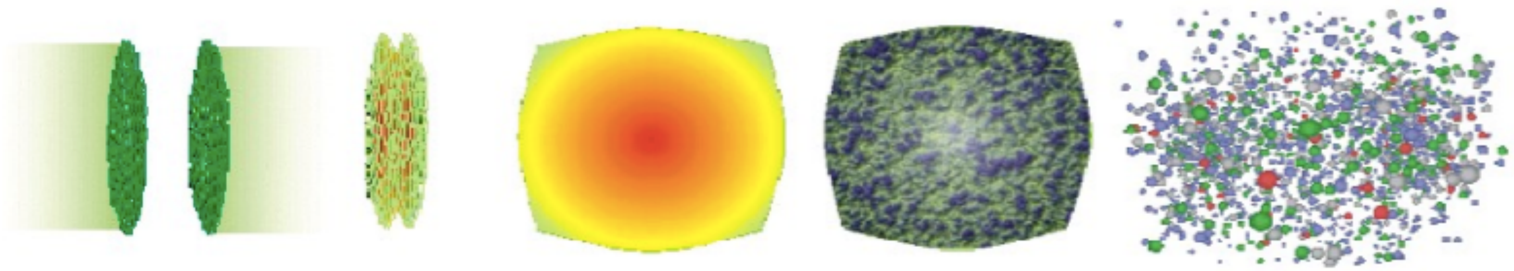
Year	System	Energy (TeV)	Luminosity
2010	p-p	7	11 nb^{-1}
	Pb-Pb	2.76	10 μb^{-1}
2011	p-p	2.76	1.1 nb^{-1}
		7	4.8 pb^{-1}
	Pb-Pb	2.76	0.1 nb^{-1}
2012	p-p	8	9.7 pb^{-1}
2013	p-Pb	5.02	15 nb^{-1}
	Pb-p	5.02	

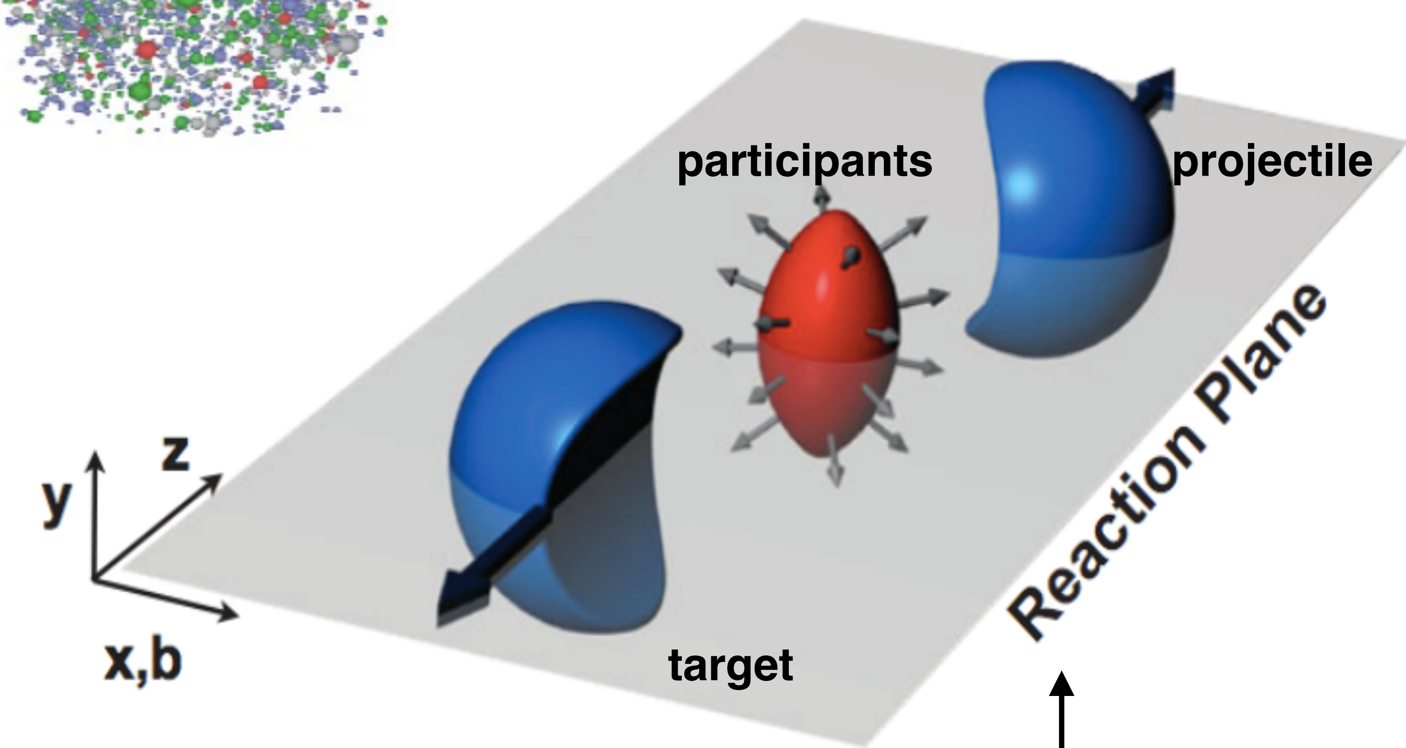
ALICE results on Elliptic Flow

ALICE results on Elliptic Flow



ALICE results on Elliptic Flow





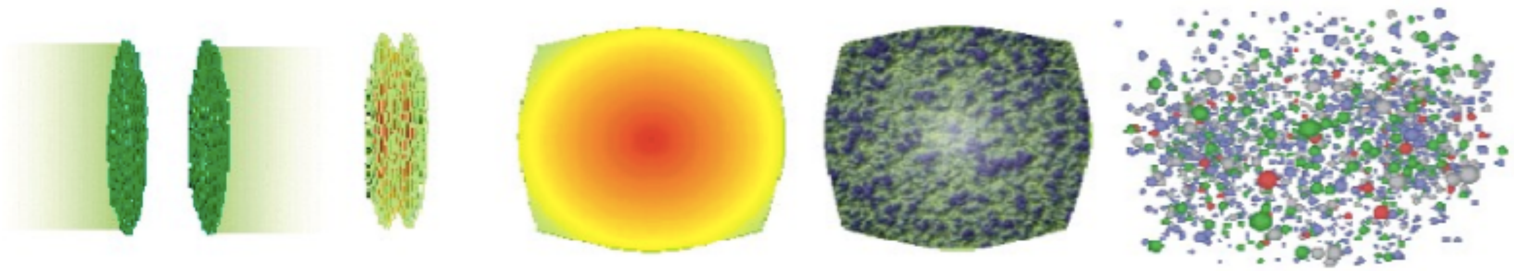
defined by the beam axis z and the impact parameter direction

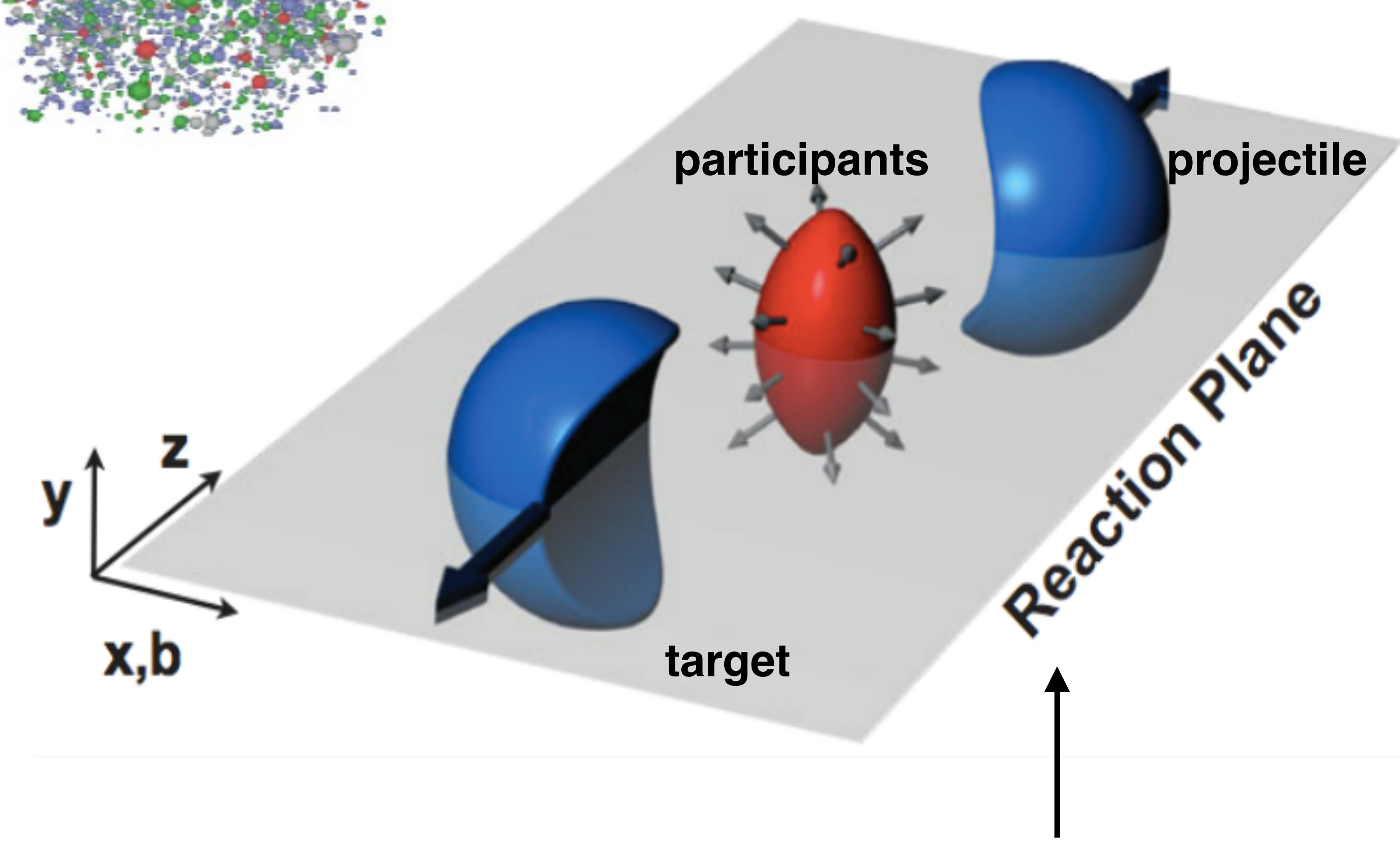
ALICE results on Elliptic Flow

The azimuthal dependence for the particle yield can be written in the form of a Fourier series:

$$E\frac{d^3N}{d^3p} = \frac{1}{2\pi}\frac{d^2N}{p_t dp_t dy}\left(1 + \sum_{n=1}^{\infty} 2v_n \cos[n(\phi - \Psi_R)]\right)$$

E: energy of the particle
p: momentum
p_t: transverse momentum
ϕ: azimuthal angle
ψ_R: reaction plane angle
v_n: differential flow (v_1, directed flow and v_2 elliptic flow)





defined by the beam axis *z* and the impact parameter direction

ALICE results on Elliptic Flow

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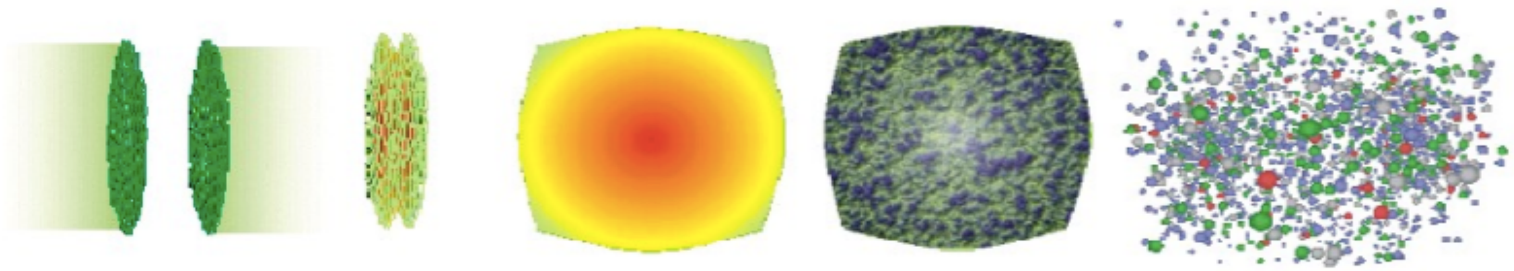
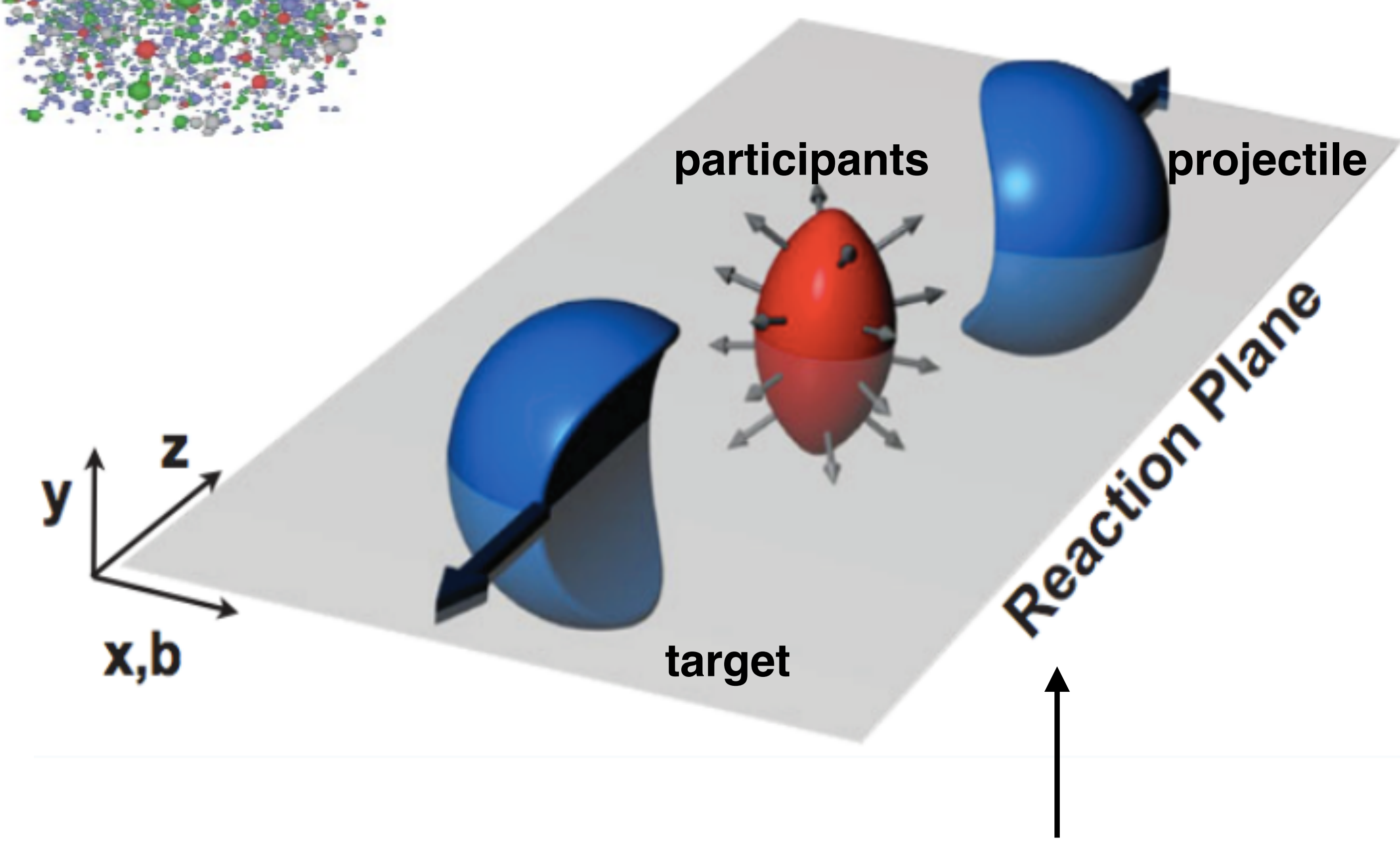
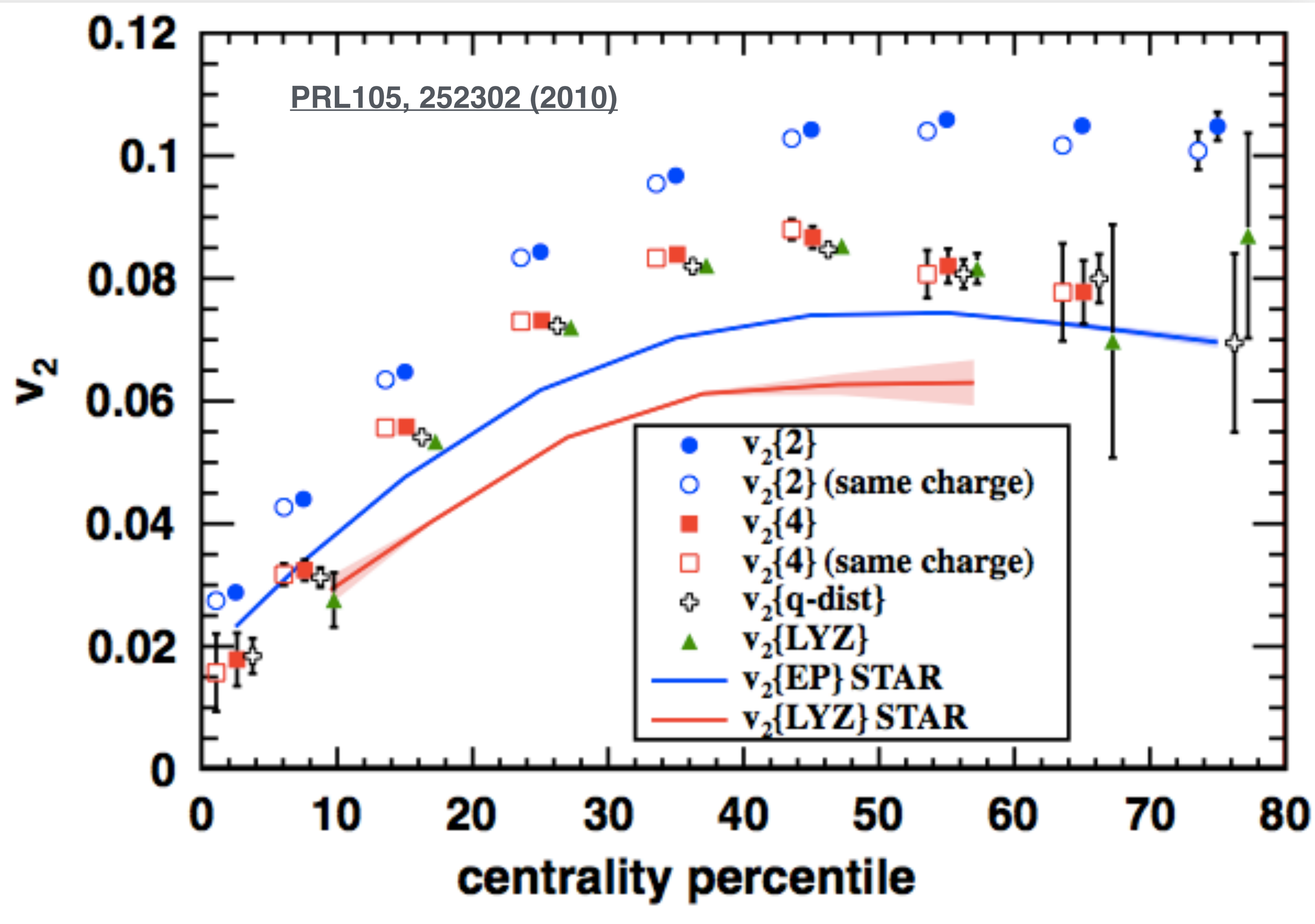


- Flow provides information on the equation state and the transport properties of matter created in a heavy-ion collision.
- Azimuthal anisotropy in particle production is the clearest experimental signature of collective flow.
- Elliptic flow depends on the ratio of shear viscosity to entropy ratio: η/s.
- Measurements of elliptic flow at RHIC revealed that hot and dense matter created in the collision there flows as a good fluid (almost no friction)



defined by the beam axis z and the impact parameter direction

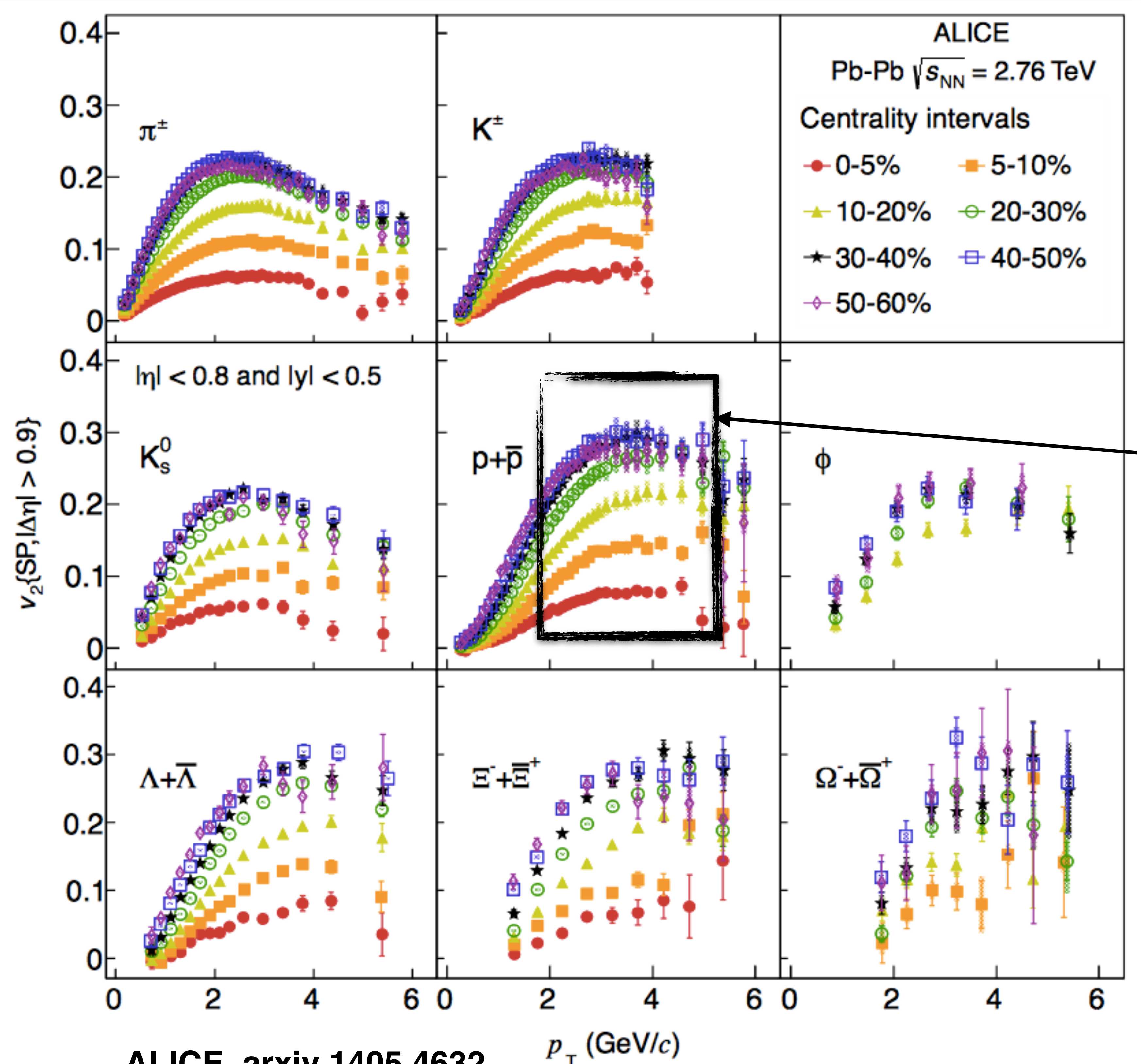
ALICE results on Elliptic Flow



The elliptic flow and the properties of the created matter in HIC can be studied with unprecedented precision at LHC due to the larger particle multiplicity compared with RHIC.

- The measurements from ALICE show that the elliptic flow of charged particles increases by about 30% compared with flow measured at RHIC at 0.2 TeV.
- This result indicates that the hot and dense matter created in HIC behaves like a fluid with almost zero friction —> strong constraint on the temperature dependence of η/s.

ALICE results on Elliptic Flow



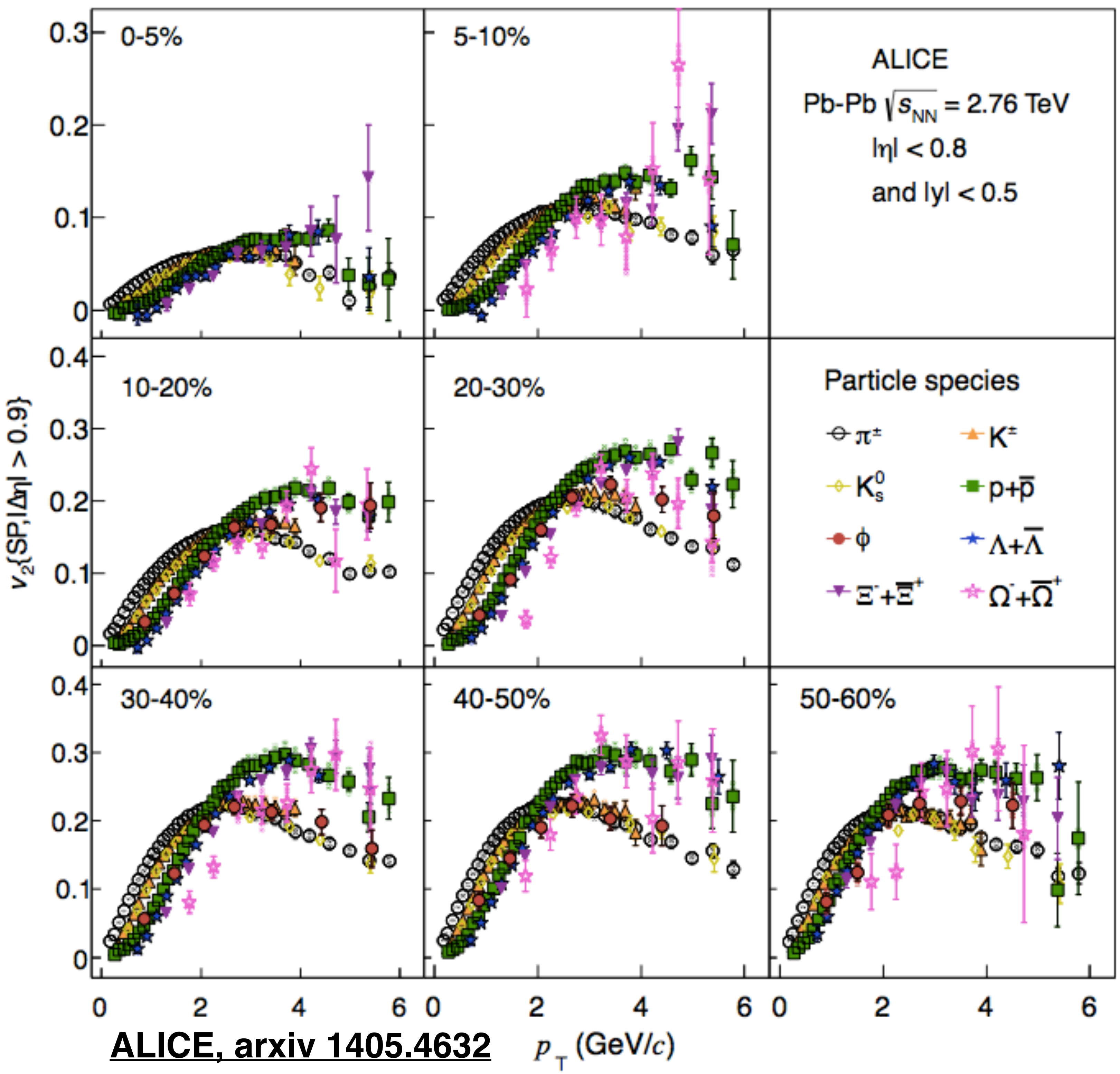
ALICE, arxiv 1405.4632

Maximum value of v_2 for all particles in 40-50% of centrality.

Peak position moves with centrality

Similar behavior for multi-strange particles.

ALICE results on Elliptic Flow



ALICE, arxiv 1405.4632

At a fixed value of p_T, heavier particles have a smaller value of v_2 than lighter ones.

A clear mass ordering is seen for all centralities in the low-p_T region (i.e. $p_T \leq 3$ GeV/c)

Produced matter at LHC seems to favour a value of η/s smaller than twice the mechanical limit.

ALICE results on Global features of collisions

ALICE results on Global features of collisions

First p-p collisions at LHC as observed by ALICE: **Eur.Phys.J.C65:111-125,2010**

Global characteristics of p-p collisions are important whenever entering a new energy regime with hadron colliders:

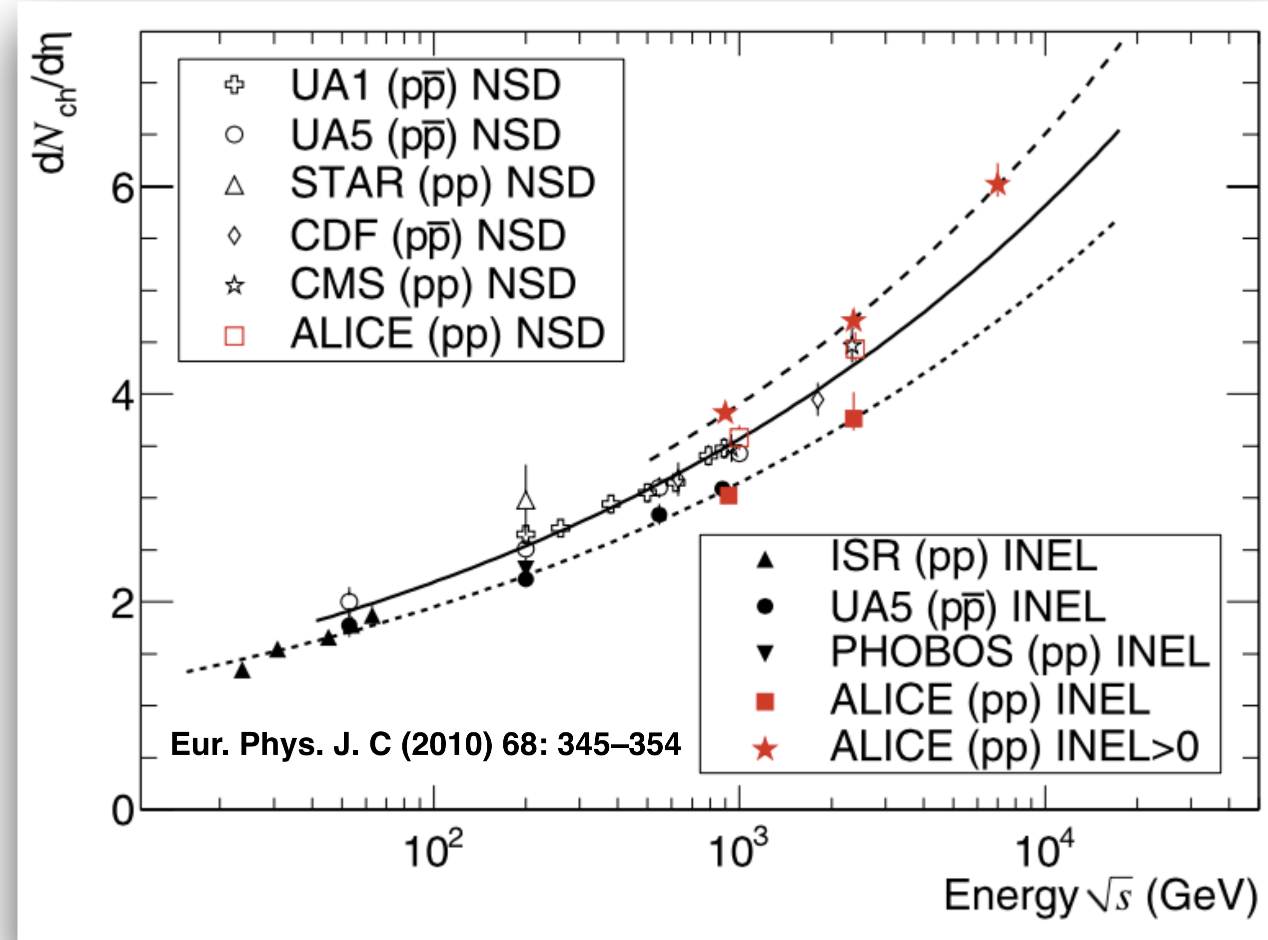
- **charged particle multiplicity**
- **pseudo-rapidity density (*dN/dη*)**

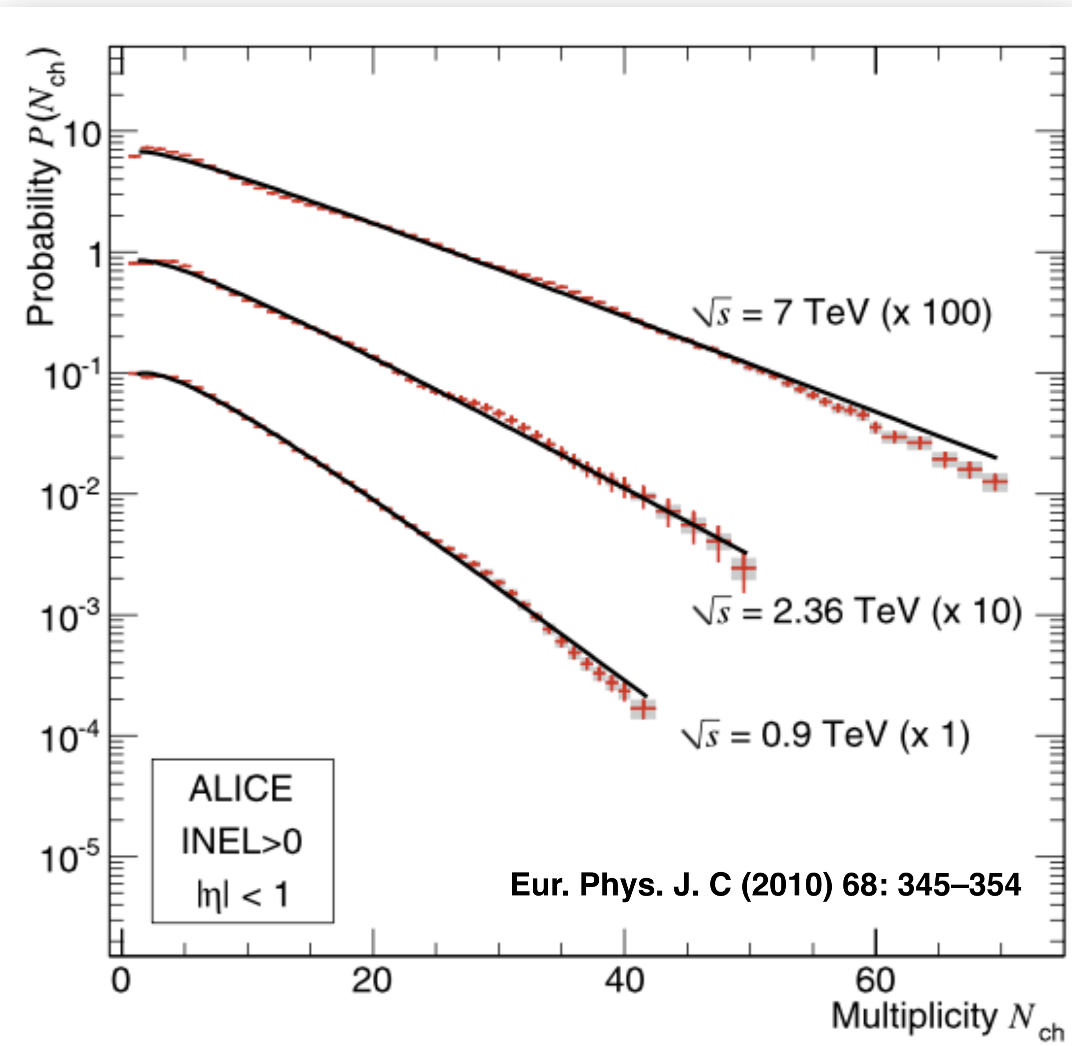
These measurements have been used to improve, or reject, models of particle production.

- these interactions (dominated by soft processes) are useful to study QCD in the non-perturbative regime.
- such studies are also important for the understanding of backgrounds for measurements of hard and rare interactions.

ALICE results on Global features of collisions

INEL>0 values are higher than inelastic and non single-diffractive values, as expected.

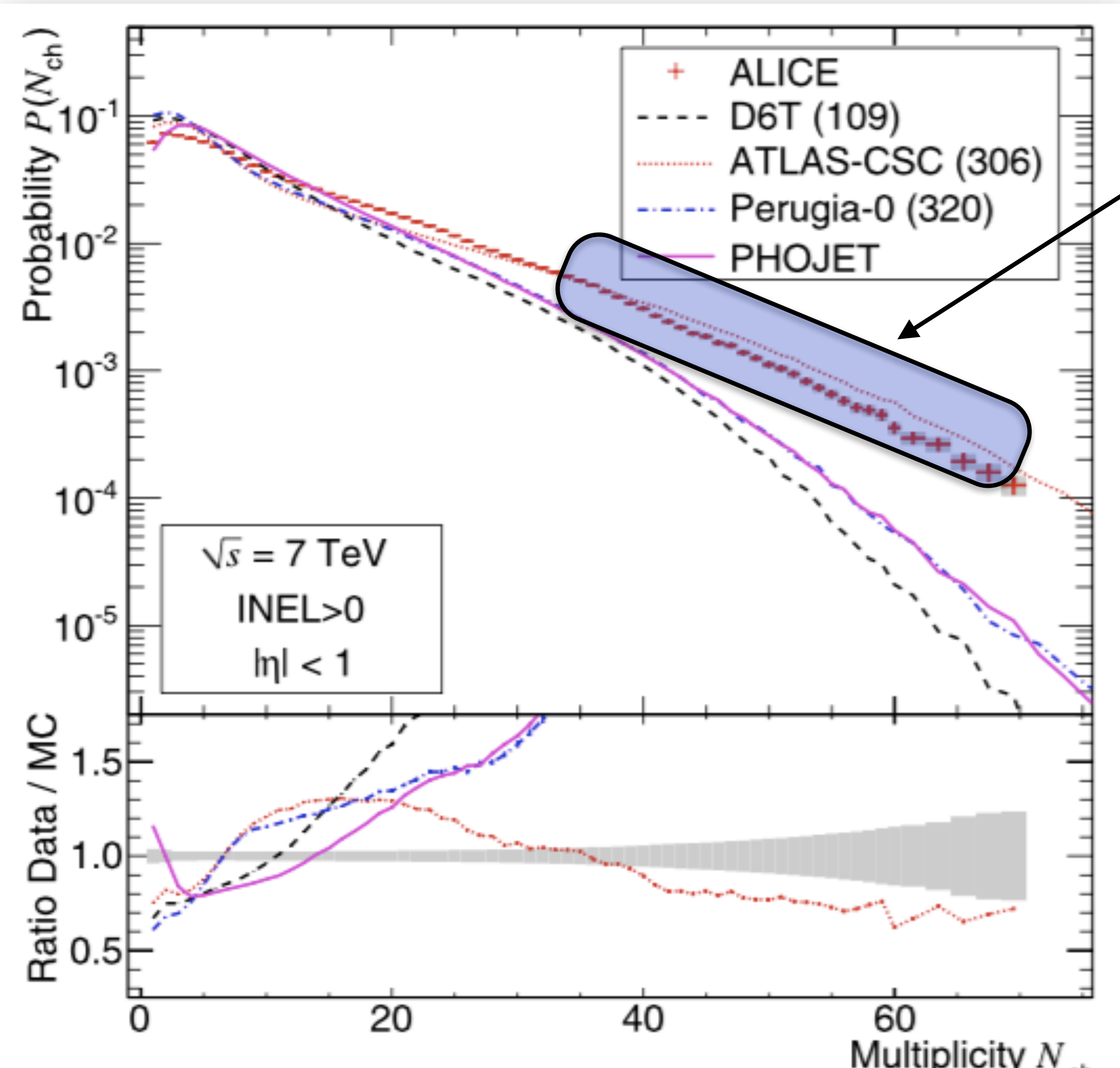




Small wavy fluctuations are seen at multiplicities above 25.

The unfolded distributions at 0.9 TeV and 2.36 TeV are described well by Negative Binomial Distribution (NBD).

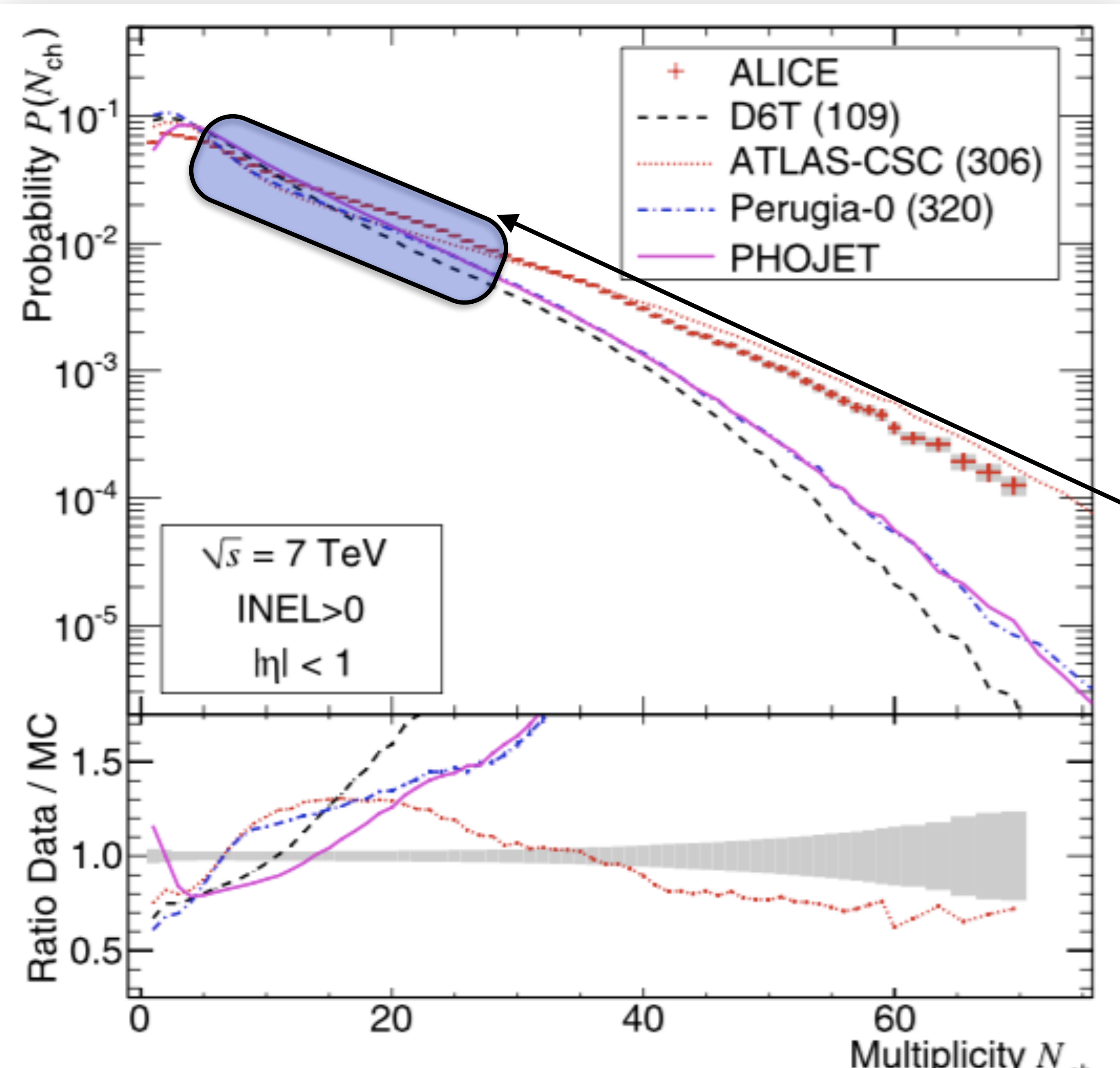
ALICE results on Global features of collisions



Eur. Phys. J. C (2010) 68: 345–354

PYTHIA tune ATLAS-CSC is close to the data at high multiplicities ($N_{ch} > 25$).

ALICE results on Global features of collisions

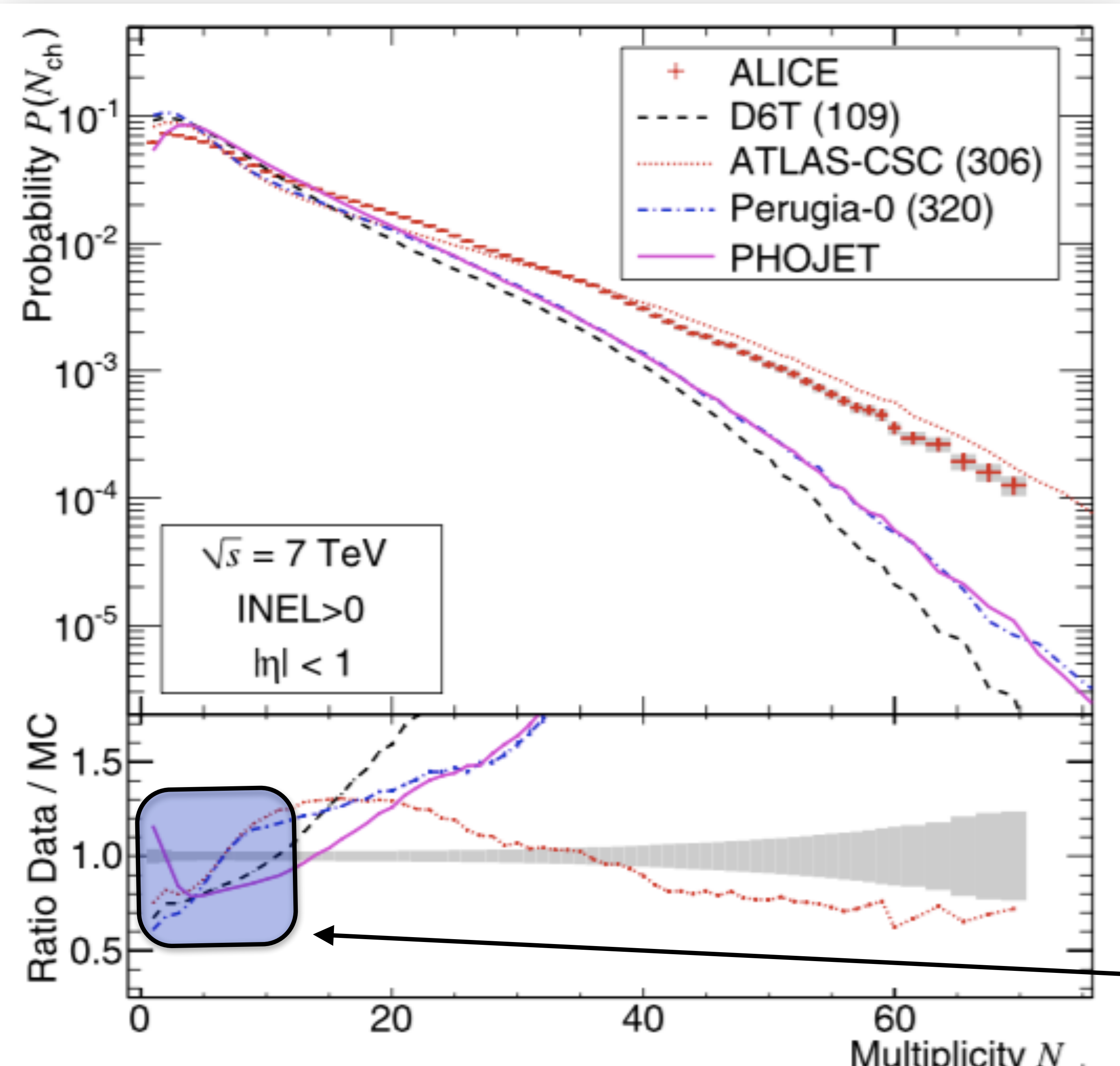


Eur. Phys. J. C (2010) 68: 345–354

PYTHIA tune ATLAS-CSC is close to the data at high multiplicities ($N_{ch} > 25$).

However, it does not reproduce the data in the intermediate multiplicity region ($8 < N_{ch} < 25$)

ALICE results on Global features of collisions



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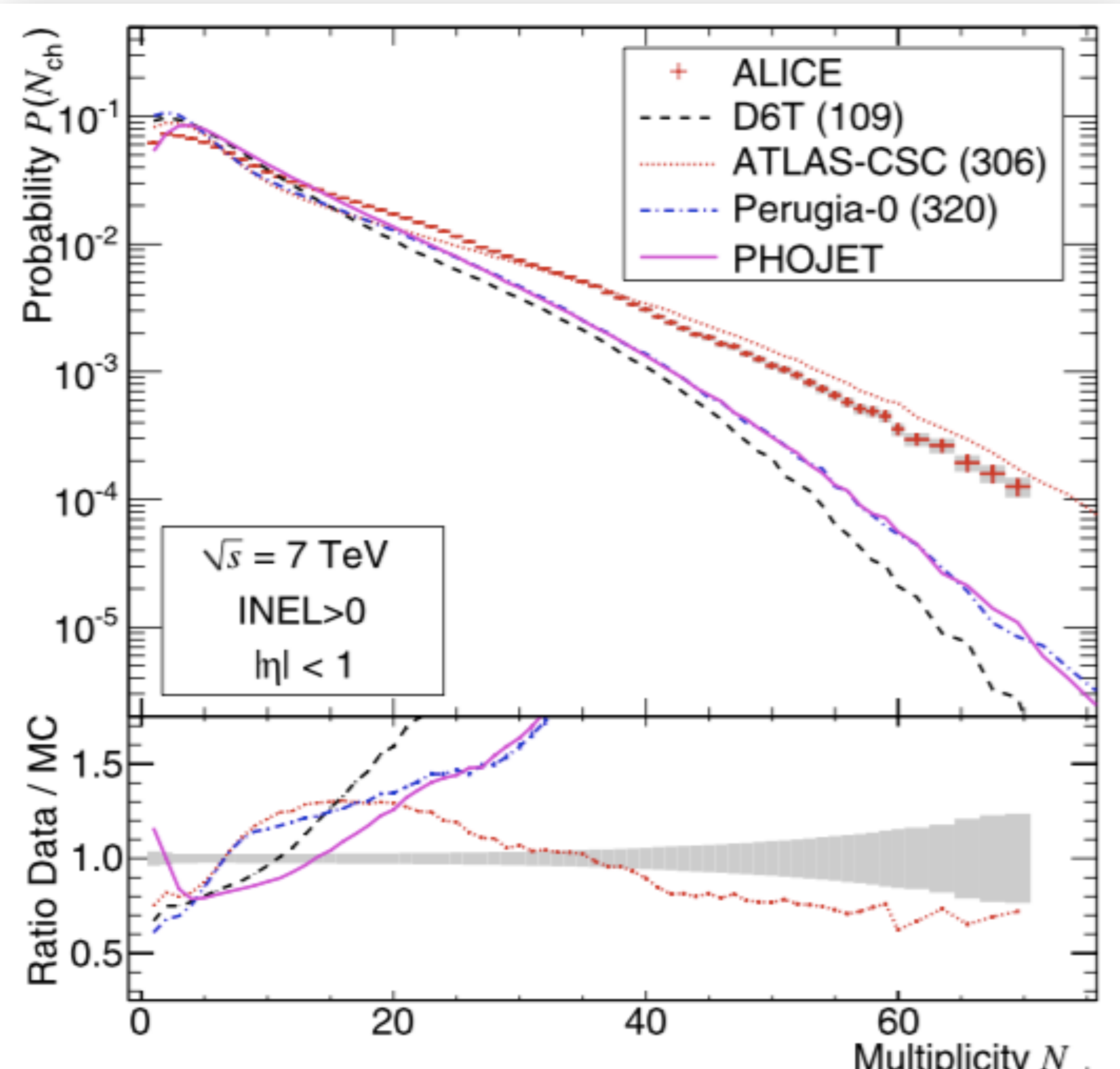
PYTHIA tune ATLAS-CSC is close to the data at high multiplicities ($N_{ch} > 25$).

However, it does not reproduce the data in the intermediate multiplicity region ($8 < N_{ch} < 25$)

At low multiplicities ($N_{ch} < 5$), there is a large spread between different models.

ALICE results on Global features of collisions

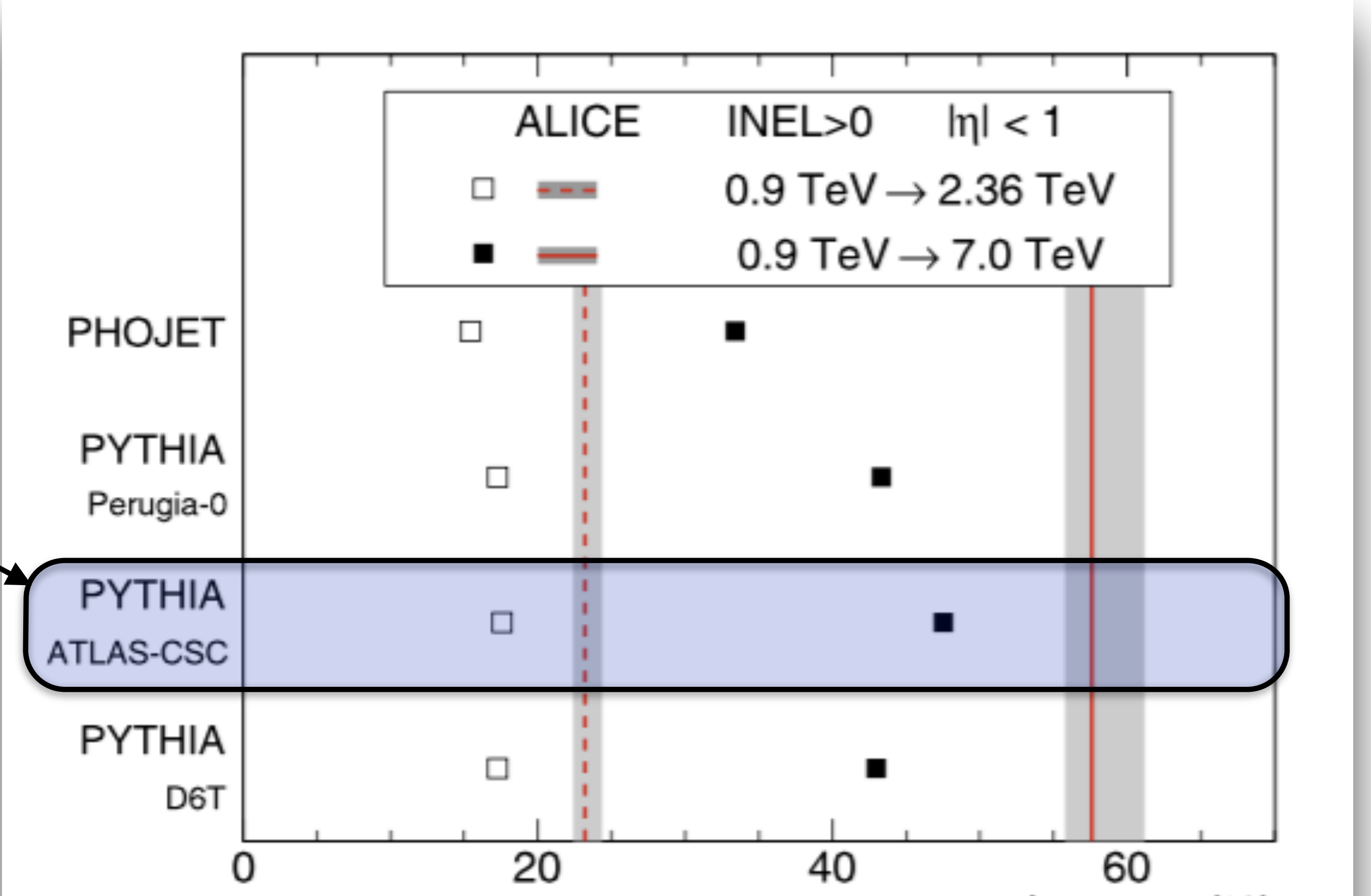


Eur. Phys. J. C (2010) 68: 345–354

The shape of the measured multiplicity distribution **is not reproduced** by any of the generators considered. The discrepancy does not appear to be concentrated in a single region of the distribution, and **is different for each models.**

ALICE results on Global features of collisions

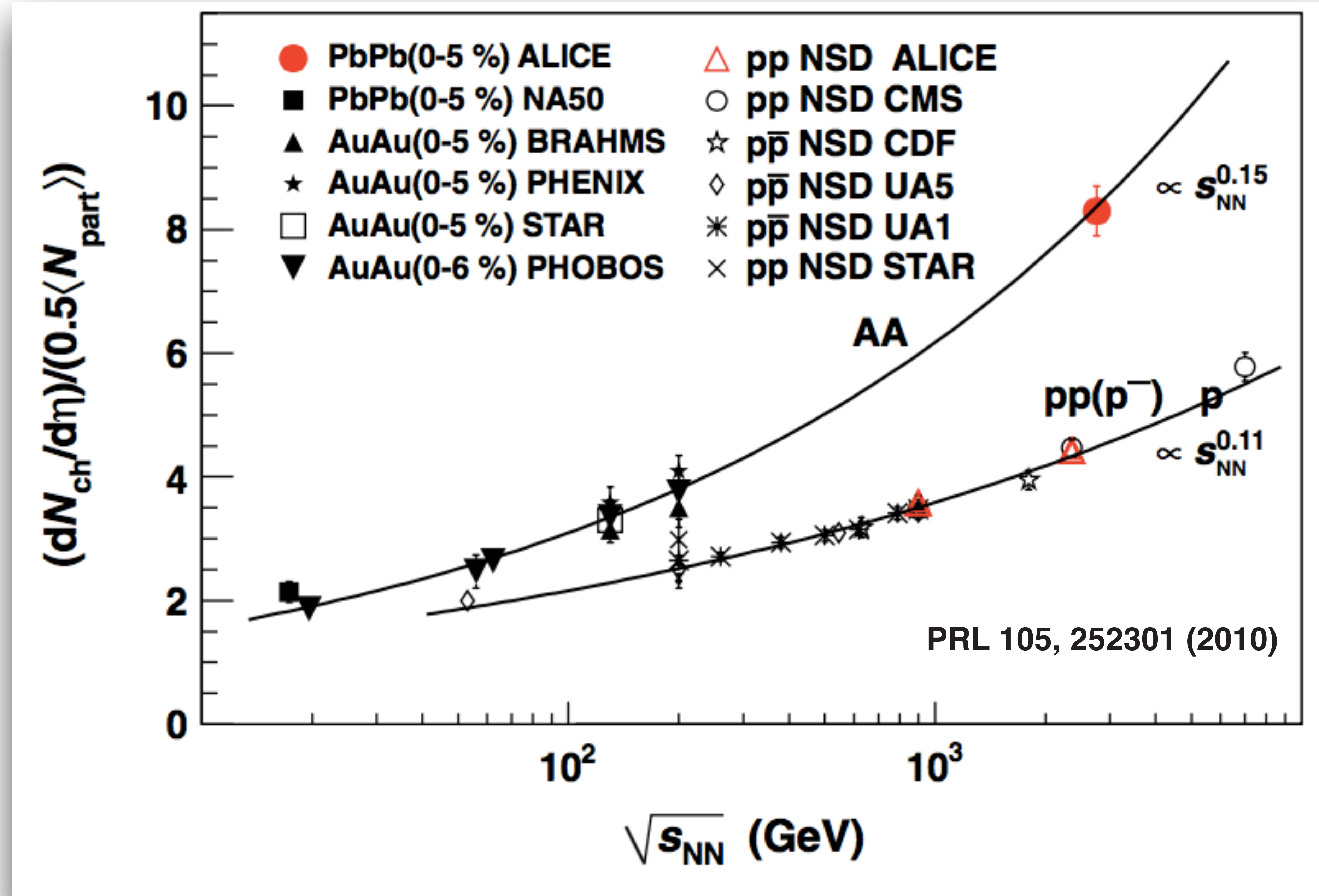
The measured value of pseudo-rapidity density is significantly higher than that obtained from the models (except PYTHIA tune ATLAS-CSC)



Eur. Phys. J. C (2010) 68: 345–354

The increase of the pseudo rapidity density with increasing centre-of-mass energies is significantly higher than the obtained with several tunes of currently used models.

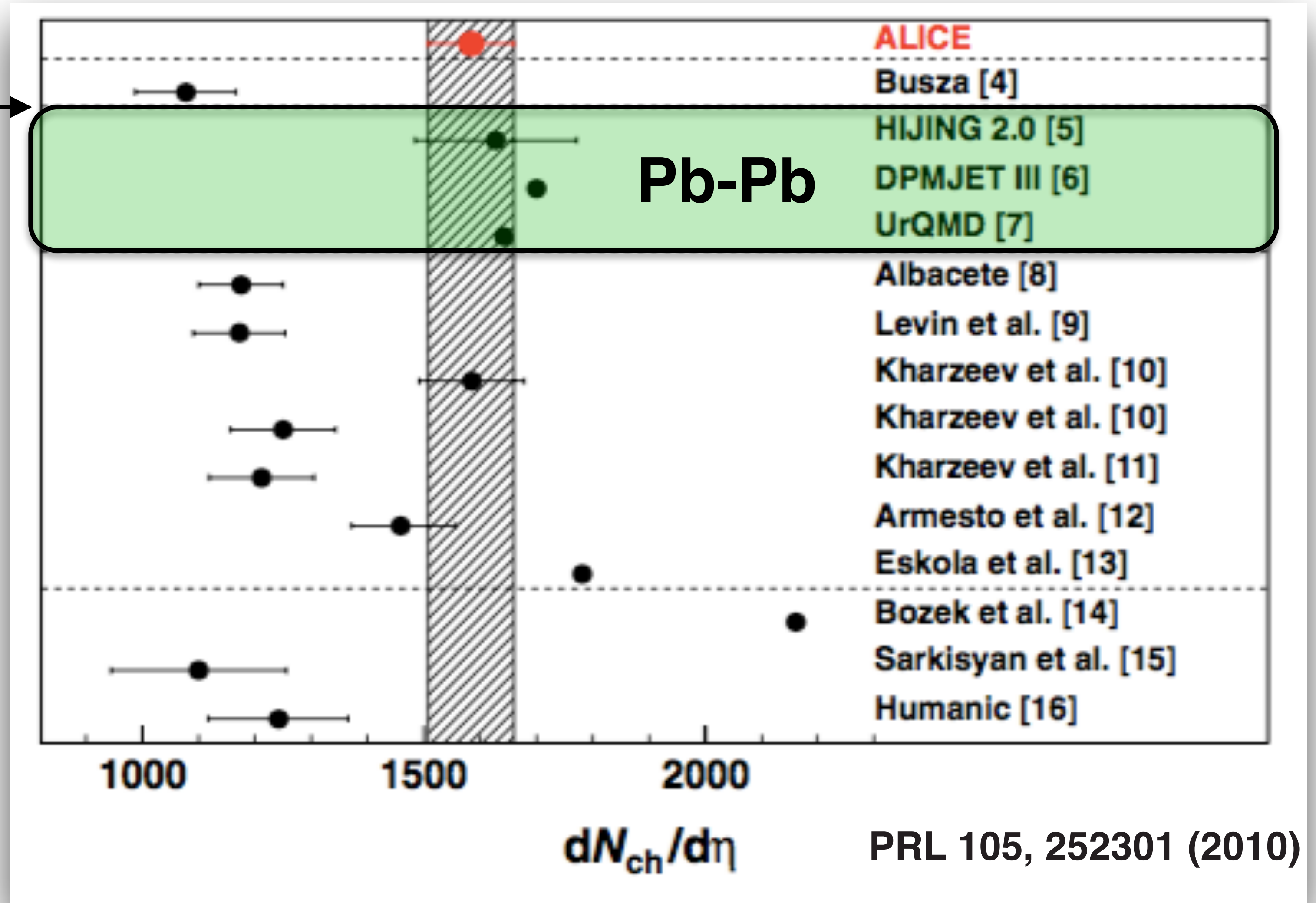
ALICE results on Global features of collisions



The energy dependence is steeper for heavy-ion collisions than for p-p.

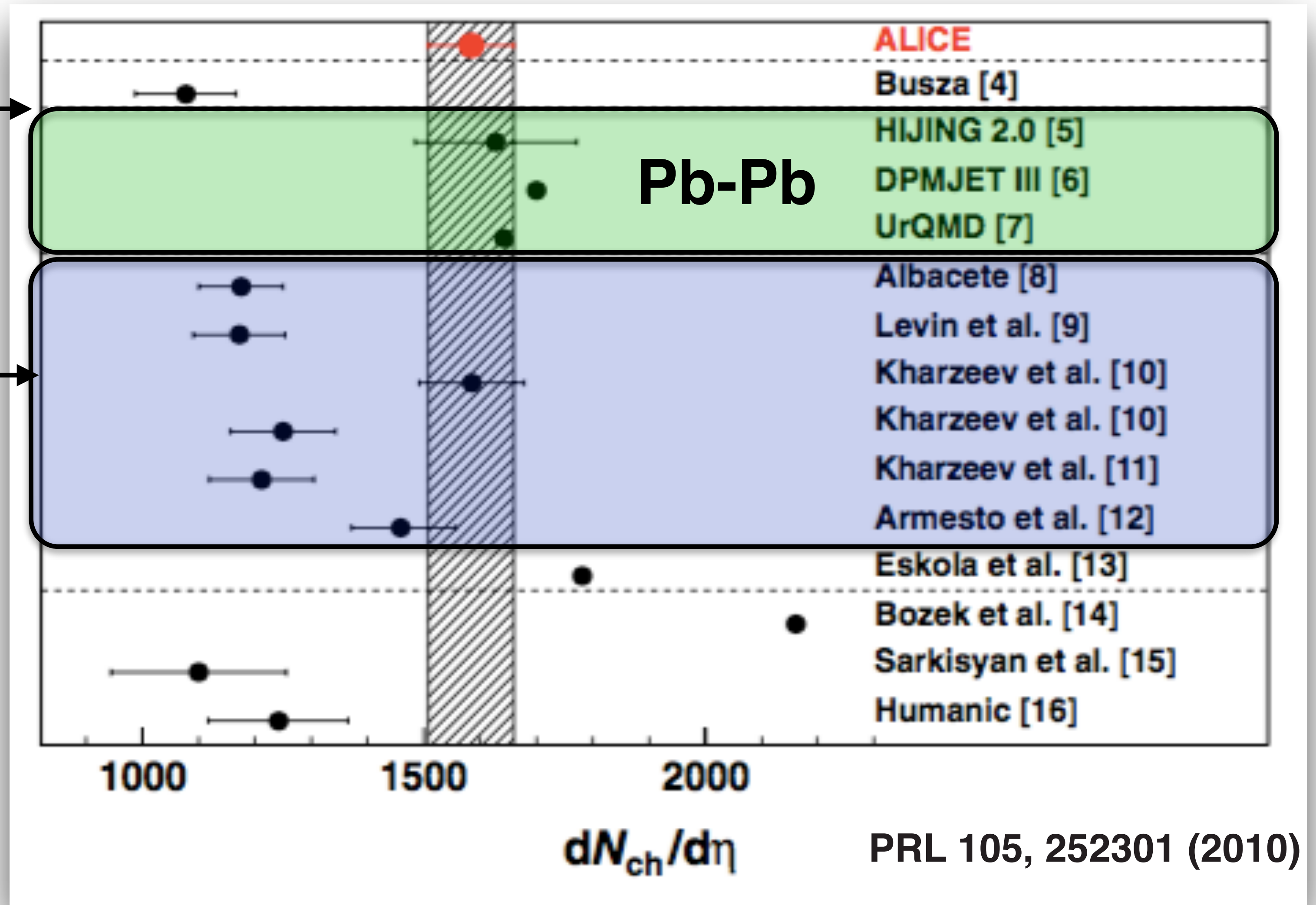
ALICE results on Global features of collisions

- pQCD Monte Carlo generator based on Hijing model tuned to 7 TeV p-p data without jet-quenching [5], dual parton model [6] or Ultra Relativistic Quantum Molecular Dynamics model [7]



ALICE results on Global features of collisions

- pQCD Monte Carlo generator based on Hijing model tuned to 7 TeV p-p data without jet-quenching [5], dual parton model [6] or ultra relativistic quantum molecular dynamics model [7]
- Models based on initial-stage gluon density saturation have a range of prediction depending on the specific implementation [8-12].



ALICE results on Global features of collisions

- pQCD Monte Carlo generator based on Hijing model tuned to 7 TeV p-p data without jet-quenching [5], dual parton model [6] or ultra relativistic quantum molecular dynamics model [7]
- Models based on initial-stage gluon density saturation have a range of prediction depending on the specific implementation [8-12].
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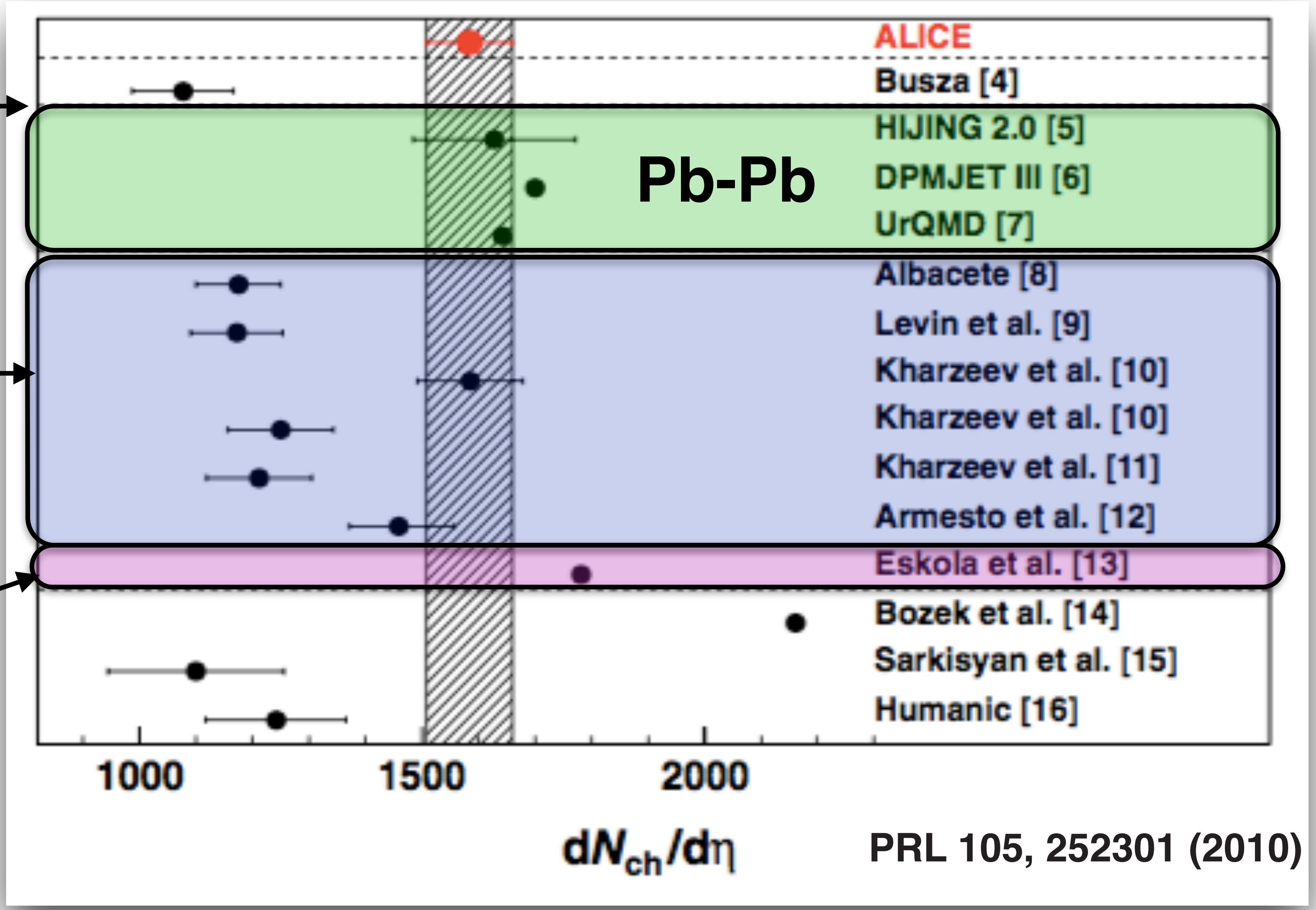

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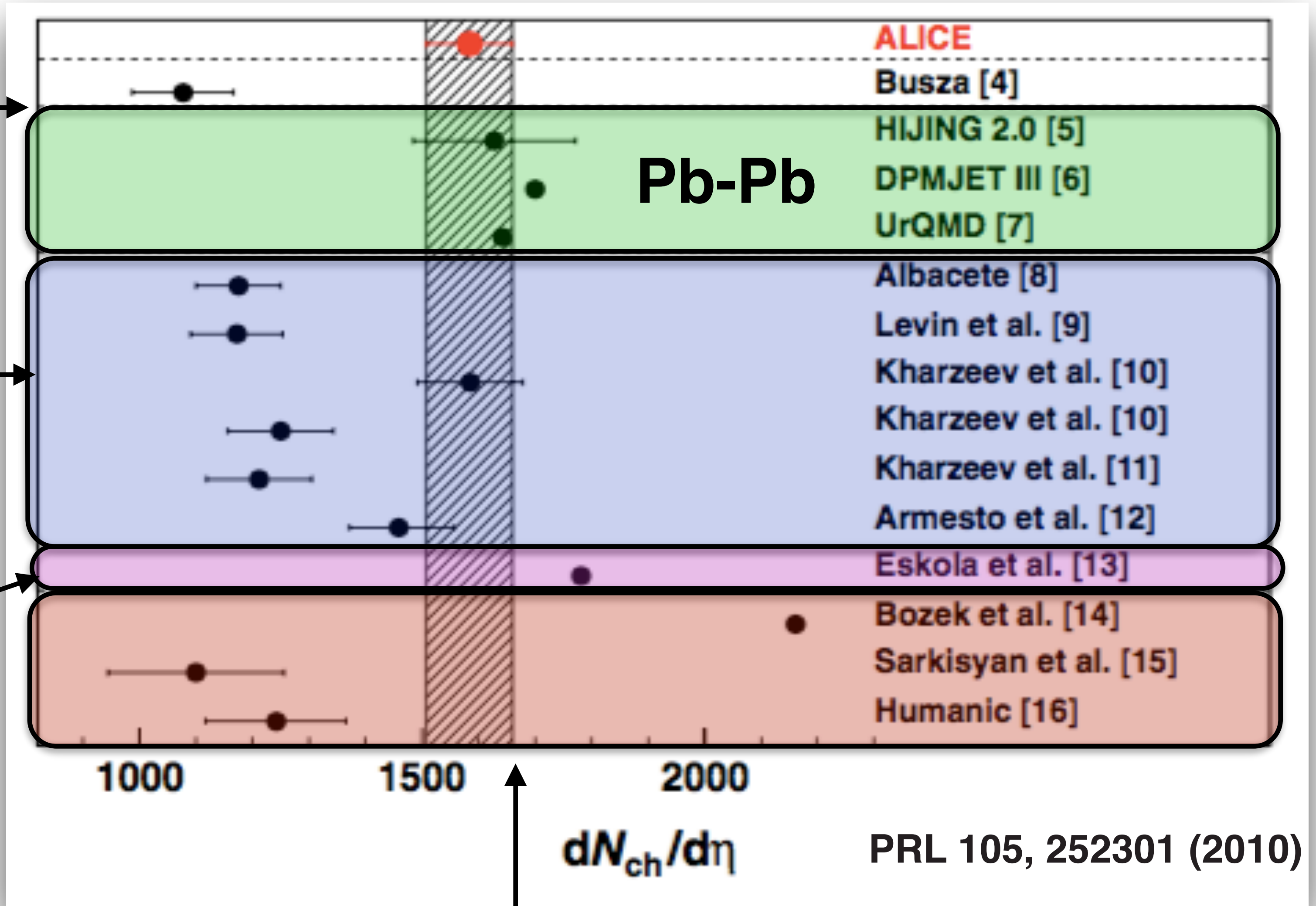

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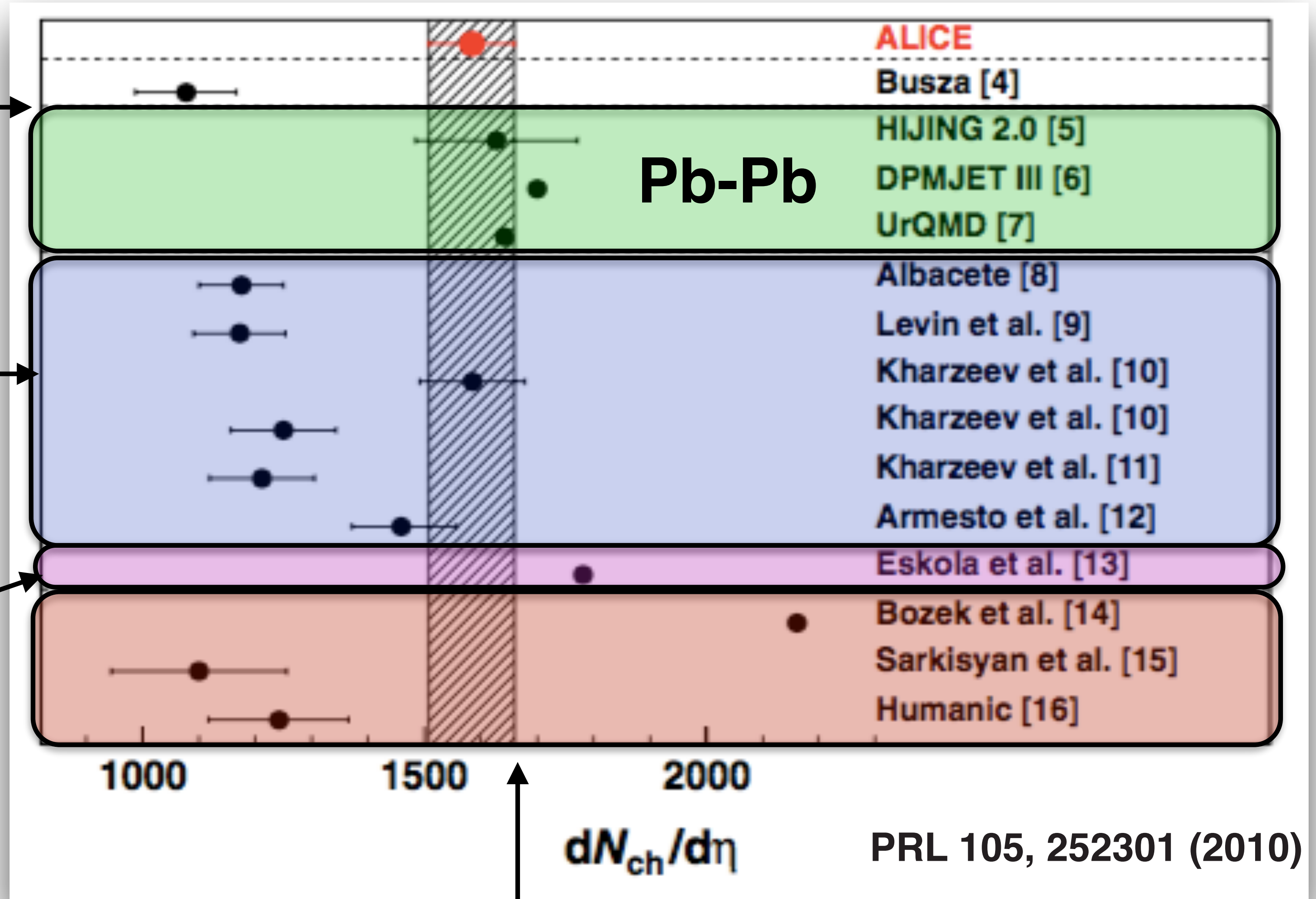

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This result provides an essential constraint for models describing high energy nucleus-nucleus collisions.

ALICE results on Diffraction

ALICE results on Diffraction

- In a diffraction reaction, no quantum number are exchanged between the particles colliding at high energies.
- Diffraction is elastic (or quasi elastic) scattering caused by the absorption of components of the wave function of the incoming particles: *p-p->p-p*, *p-p->pX* (single proton dissociation, Single Diffractive), *p-p->XX* (both protons dissociate, Double Diffractive).
- A diffractive process is characterized by a large rapidity gap (LRG).
- Needed so as to understand the structure of high energy cosmic ray phenomena.

In high energy p-p collisions about 40% of the total σ_{tot} comes from diffractive processes, like elastic scattering, SD, DD. Need to study diffraction to understand the structure of σ_{tot} and the nature of the underlying events which accompany the sought-after rare hard subprocesses

ALICE results on Diffraction

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$$\sigma_{\mathrm{Tot}} = \sigma_{\mathrm{elastic}} + \sigma^{\mathrm{Non-Diffractive}} + \sigma_{\mathrm{SD}} + \sigma_{\mathrm{DD}}$$

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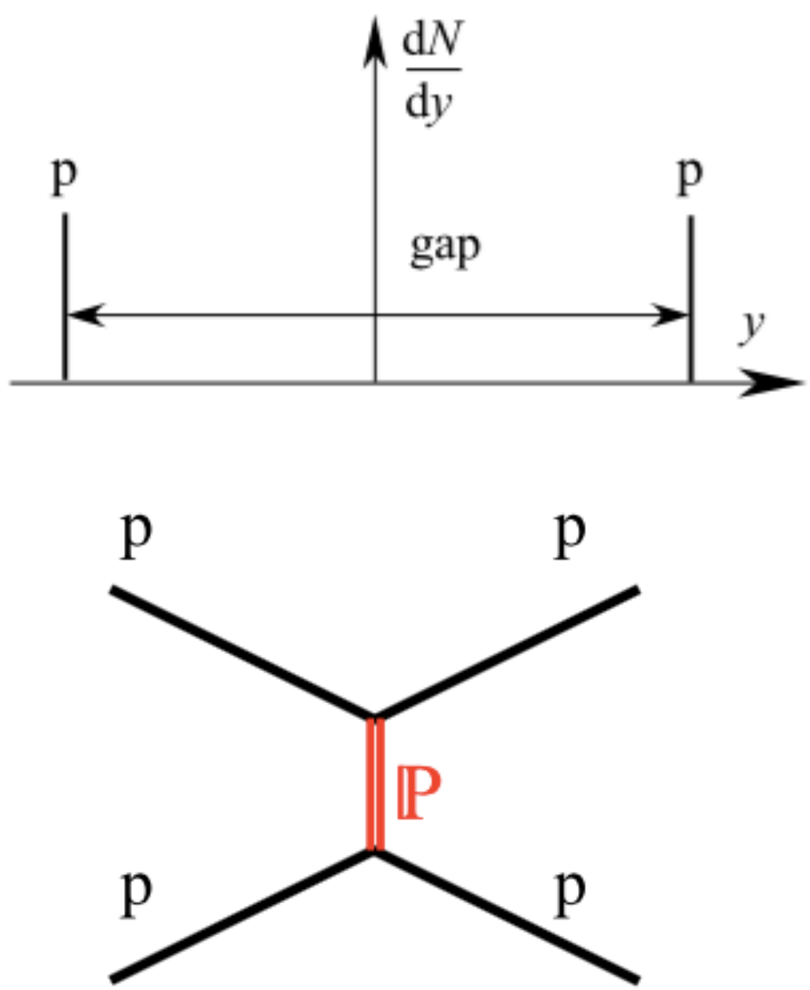
ALICE results on Diffraction

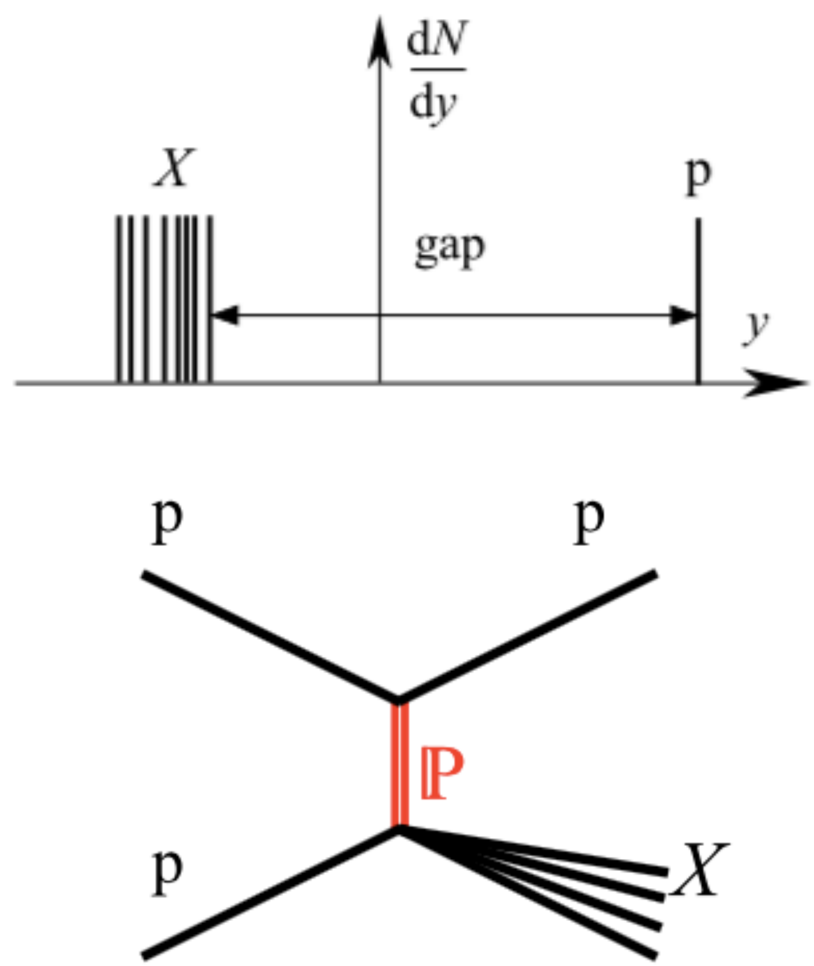
Measuring SD and DD with ALICE

Strategy: measure gap distribution (SPD, VZERO and FMD) over 8 units in η.

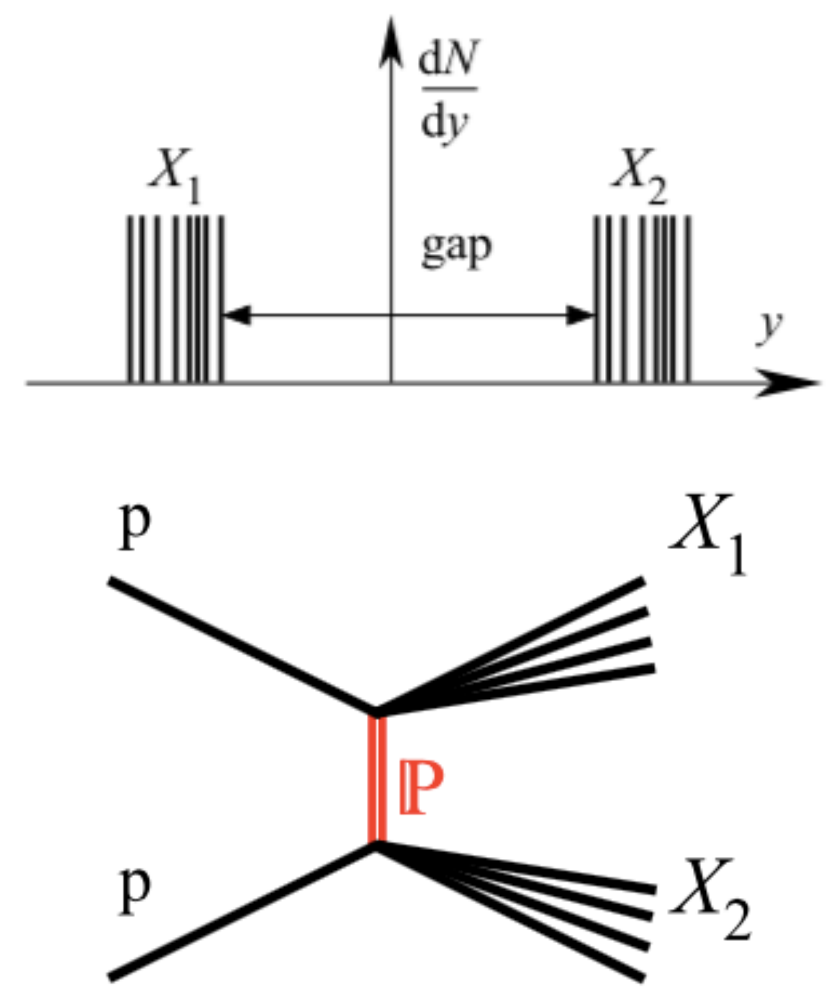
Elastic



Single diffractive



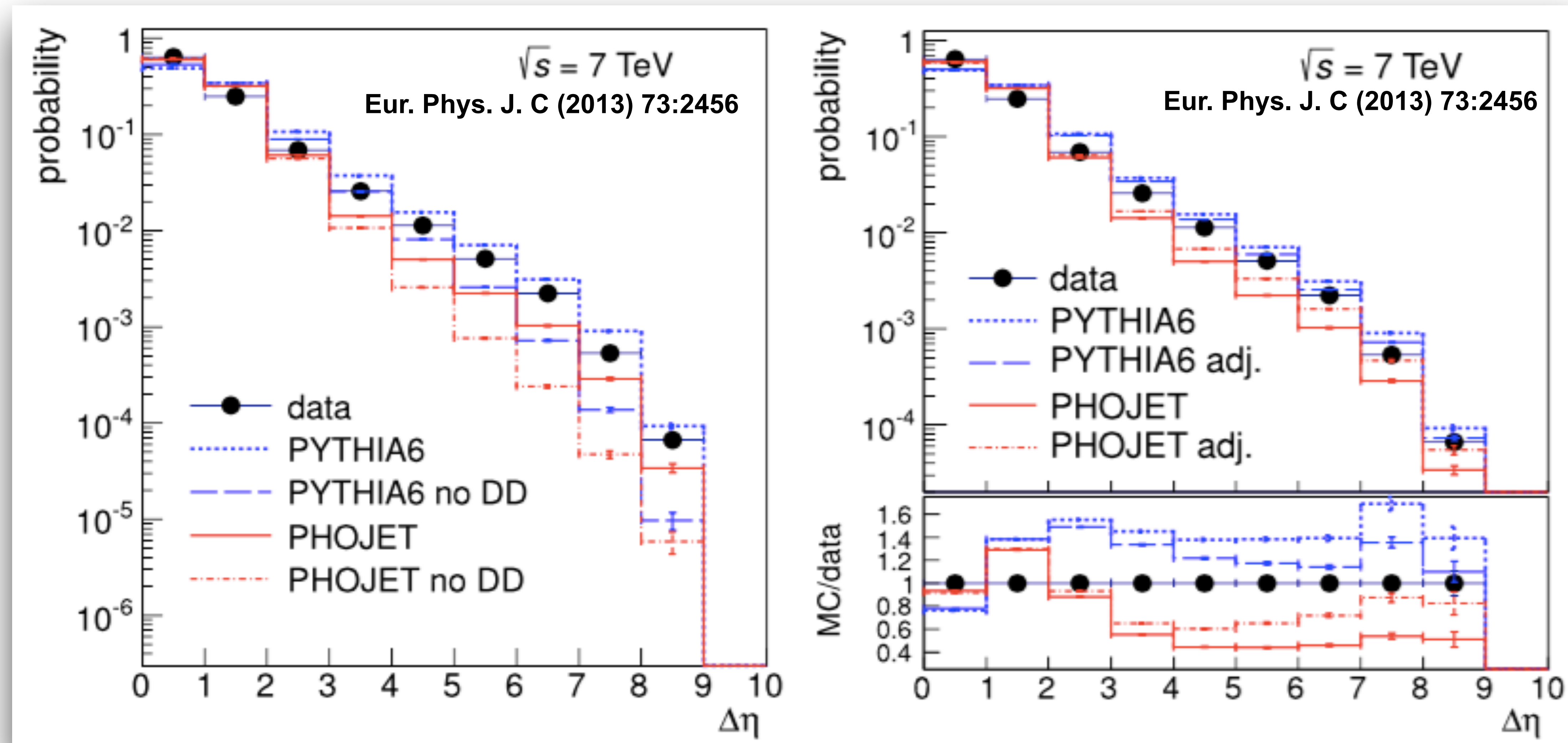
Double diffractive



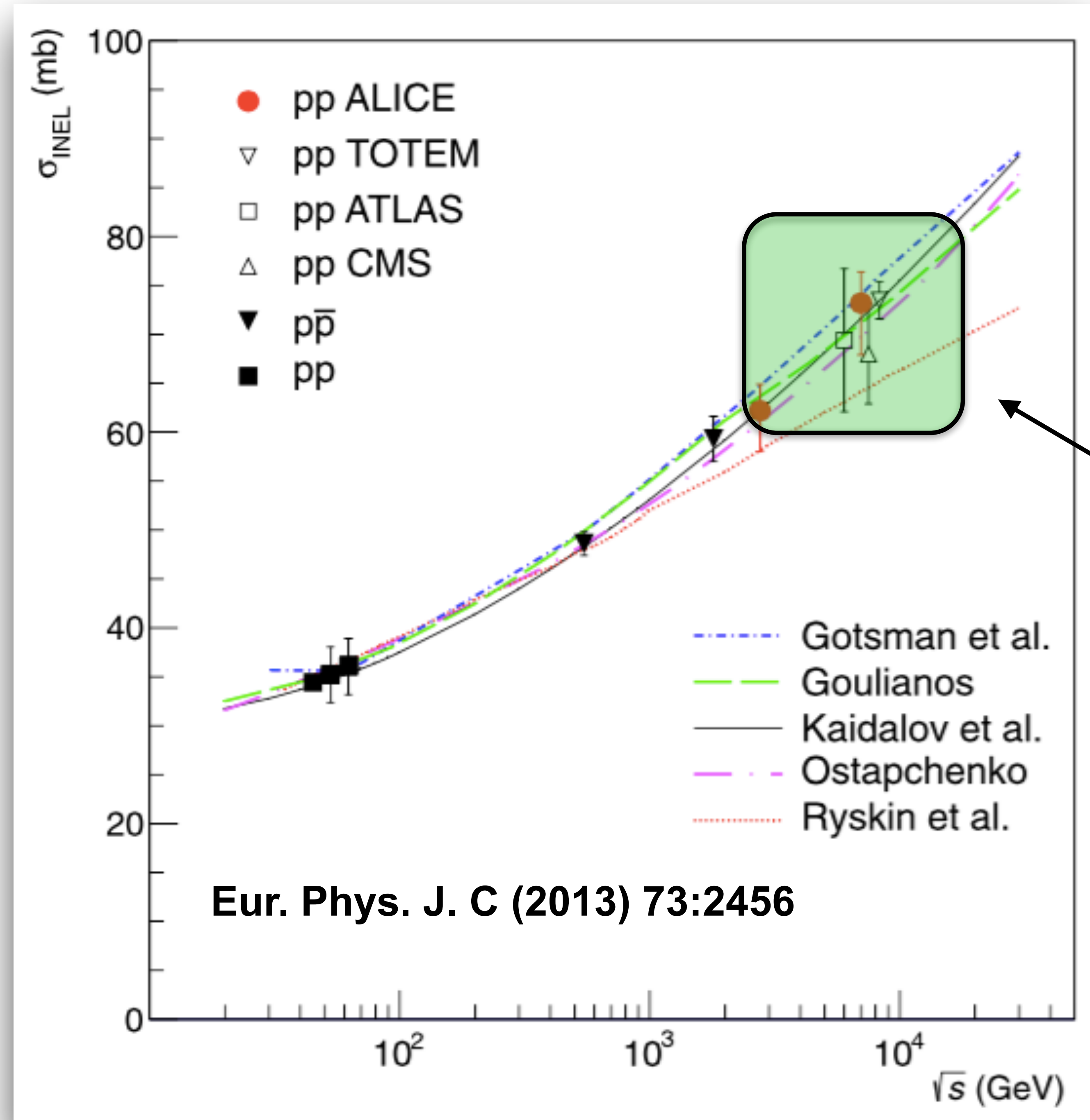
ALICE results on Diffraction

Measuring SD and DD with ALICE

As in ATLAS and CMS one gets sensitivity to Diffraction, however PYTHIA and PHOJET differ.

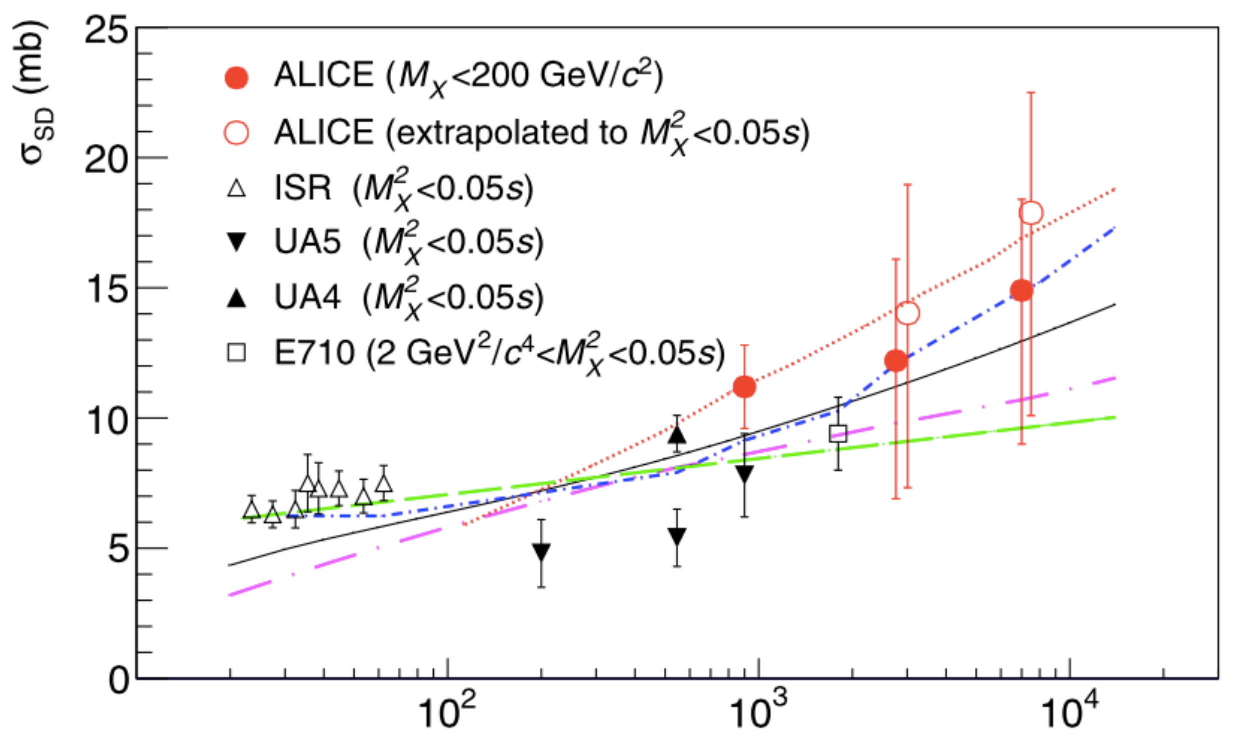


ALICE results on Diffraction



- The result of ALICE is consistent with the measurements by ATLAS, CMS and TOTEM (slightly higher than the ATLAS and CMS values)
- The LHC data favour slightly the higher prediction values.

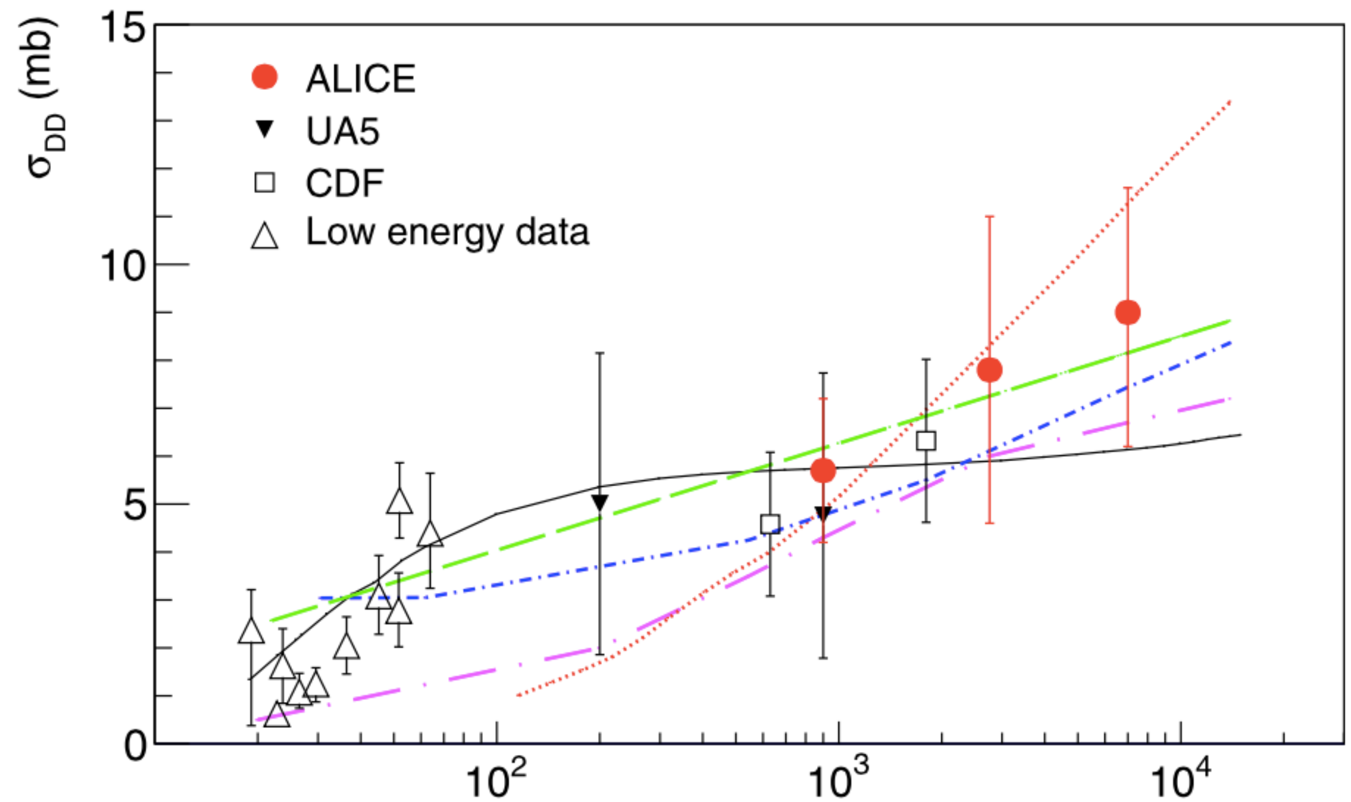
ALICE results on Diffraction



Eur. Phys. J. C (2013) 73:2456

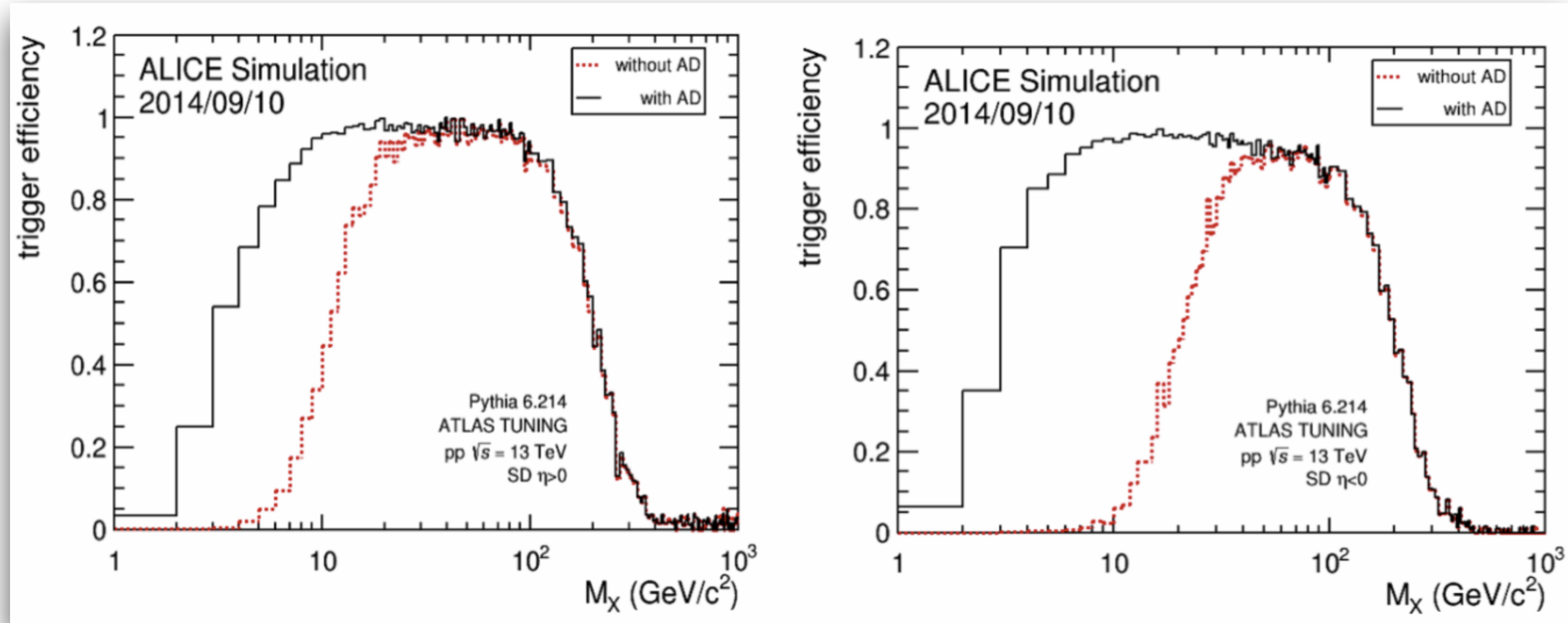
Within large uncertainties, ALICE measurements are in agreement with the data from UA5, UA4 and CDF.

With the inclusion during LS1 of the Alice Diffractive Detector (AD), ALICE could extend its studies on diffractive events at higher energies.



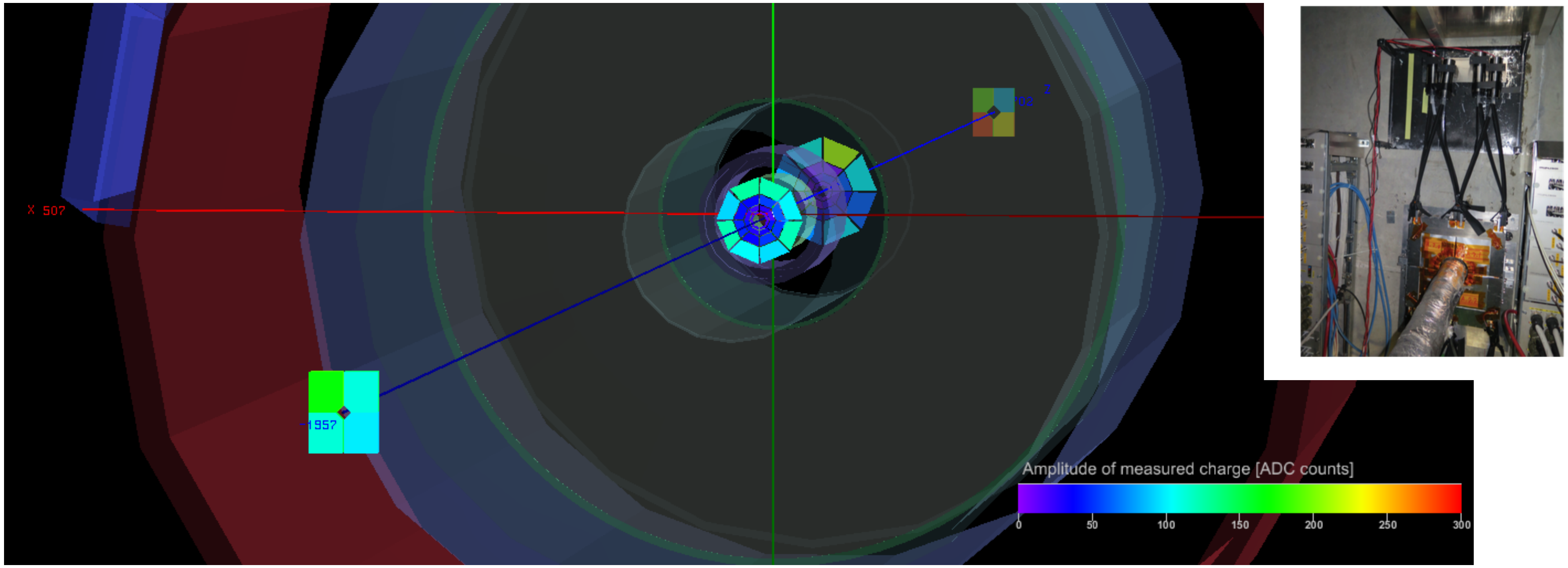
Eur. Phys. J. C (2013) 73:2456

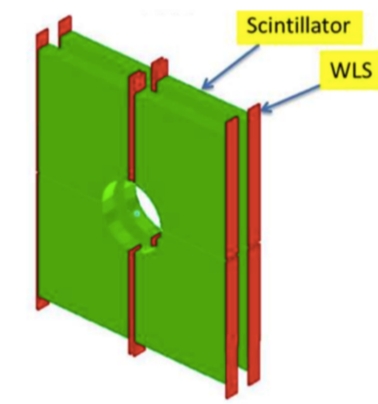
ALICE results on Diffraction



The AD detector will increase the sensitivity to diffractive masses close to threshold ($m_p + m_\pi$) and also partially compensate for the loss of trigger efficiency for MB events

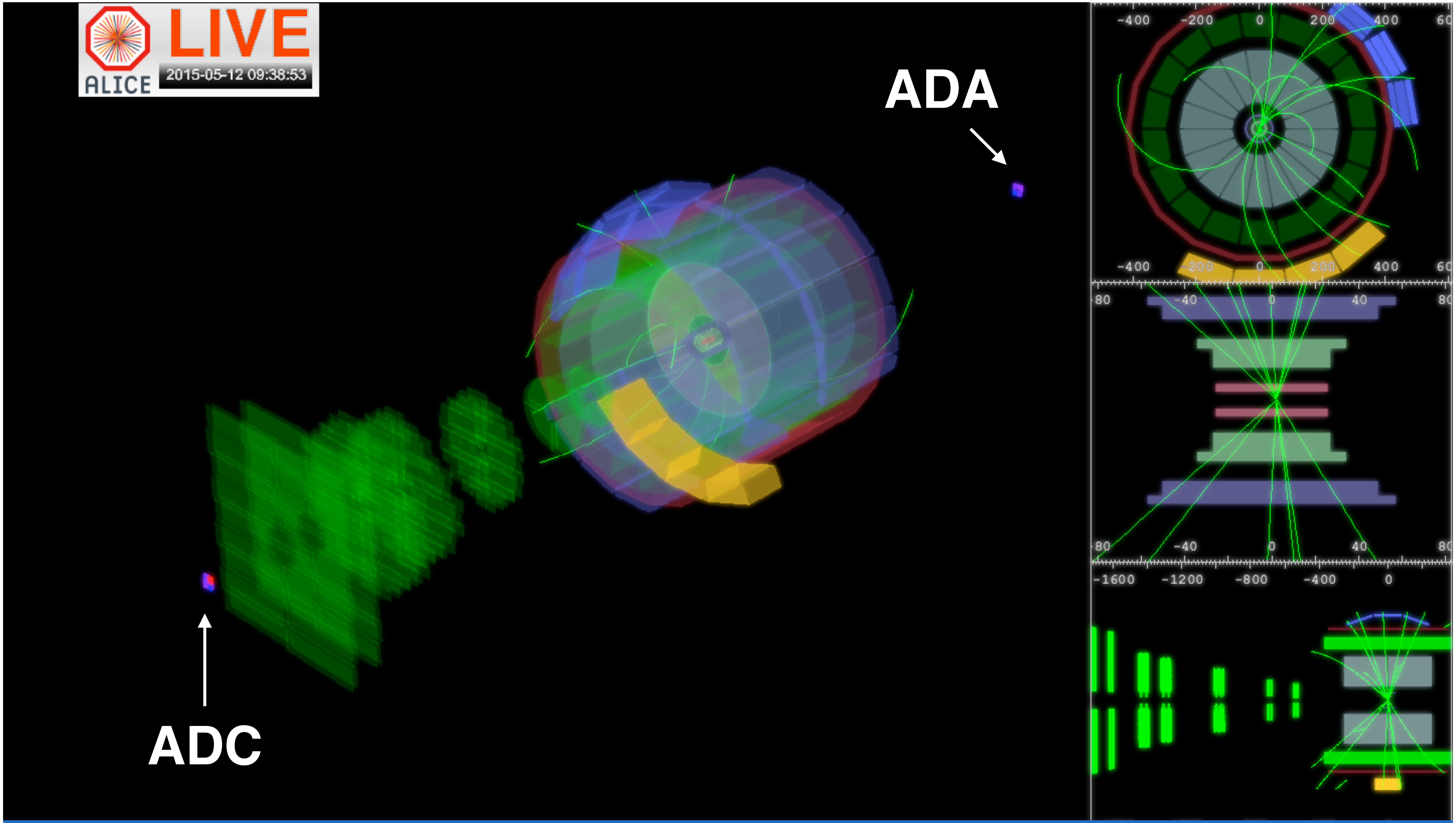
ALICE results on Diffraction



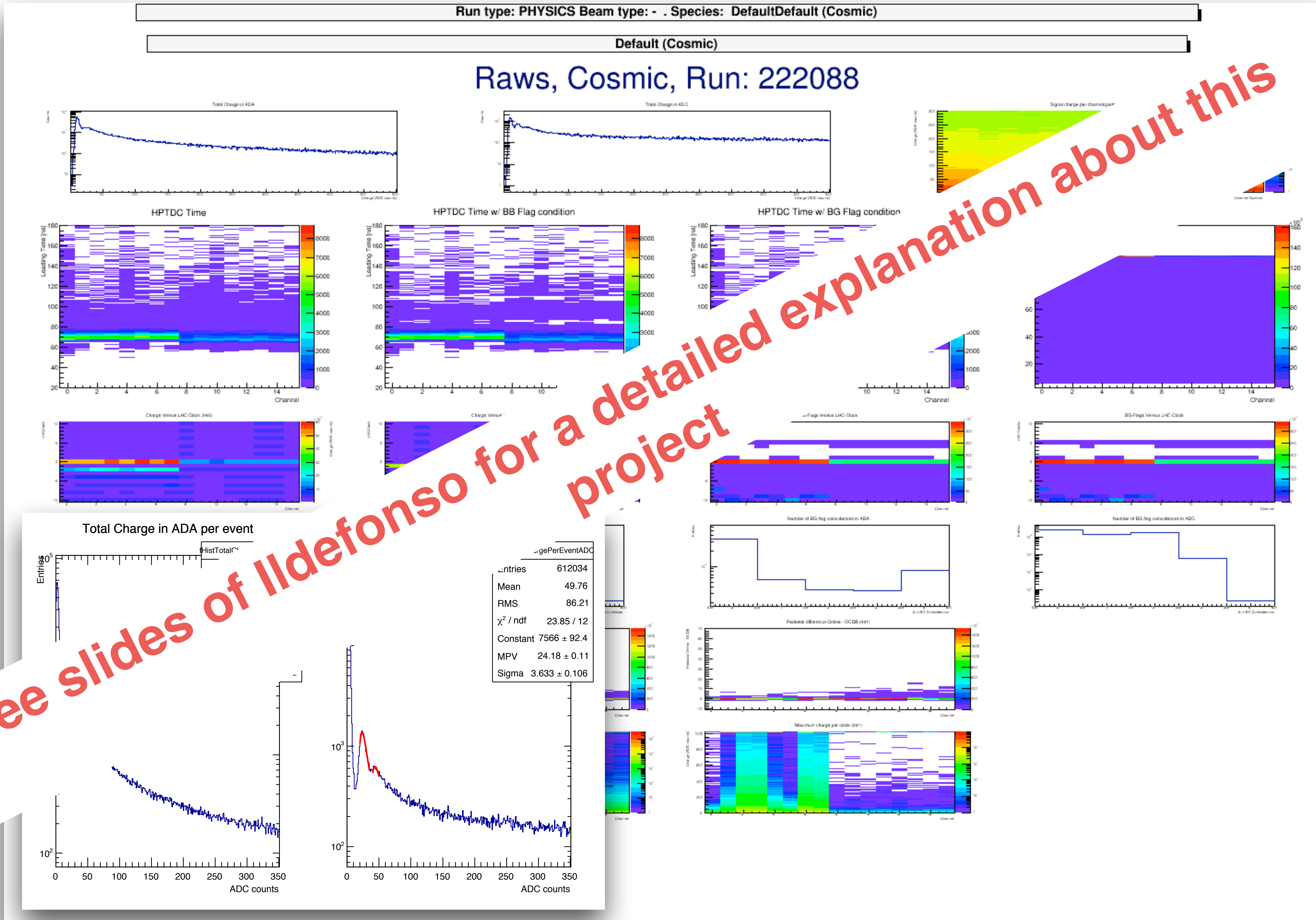


- AD will provide a level zero trigger signal which will be useful for diffractive cross section measurements.
- It will extend the pseudo rapidity gap trigger.
- Additionally, AD will provide an extended centrality trigger in both Pb-Pb and p-Pb collisions studies.

ALICE results on Diffraction



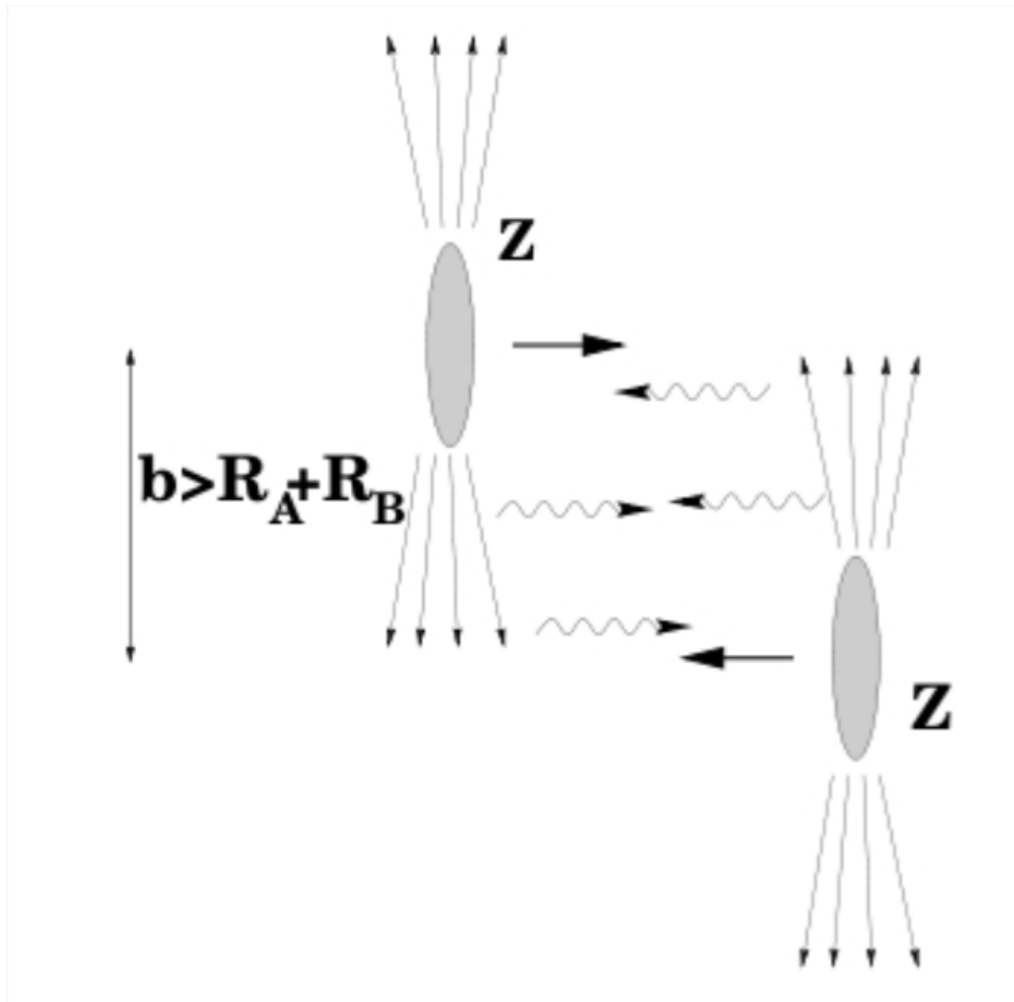
ALICE results on Diffraction



See slides of Ildefonso for a detailed explanation about this project

ALICE results on photo-production of vector mesons

ALICE results on photo production of vector mesons



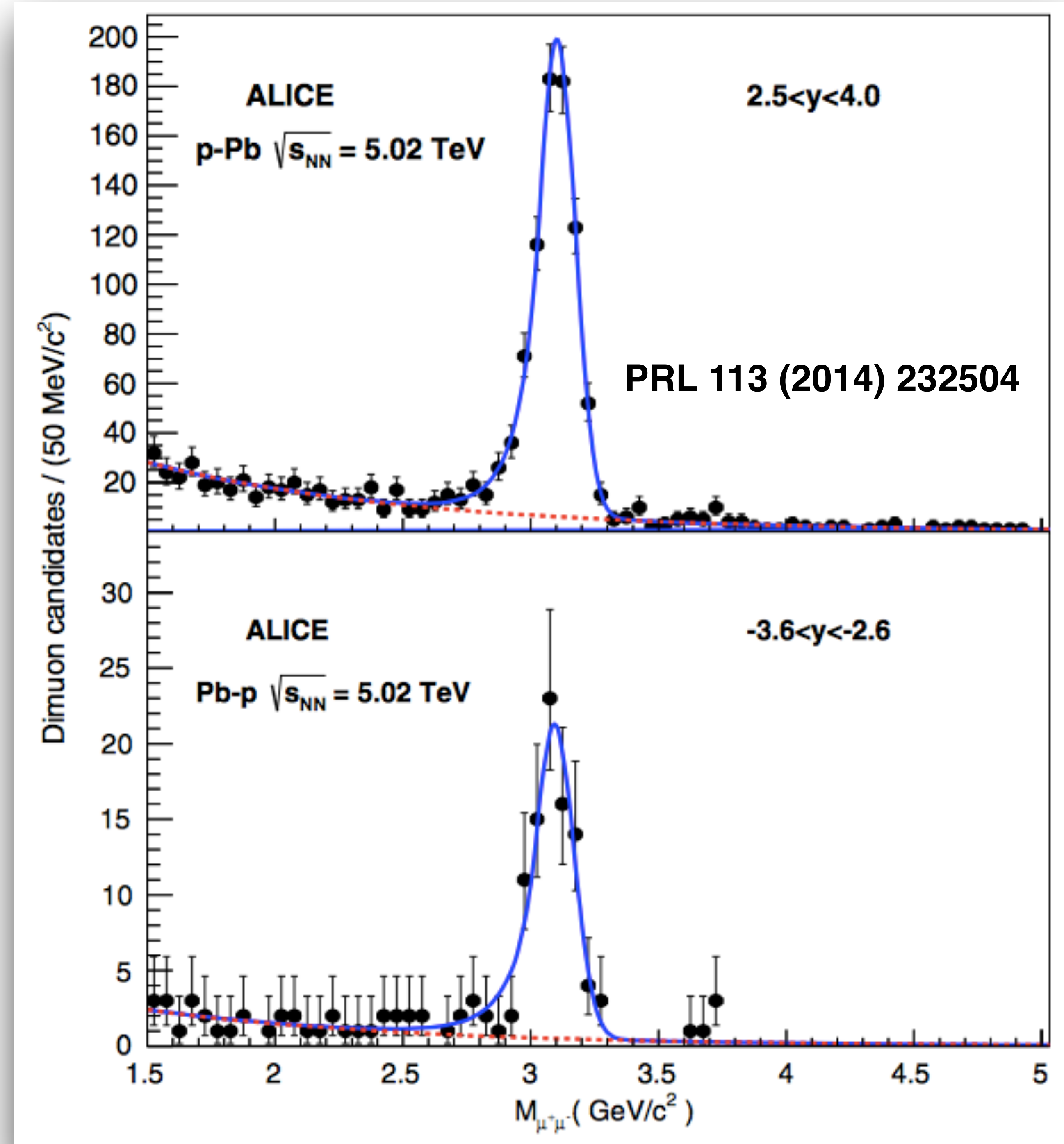
- The photo production of vector mesons can be studied in ultra peripheral collisions (UPC) at LHC.
- UPC occurs if b > R_A+R_B —> the photons and nuclei can interact in several ways.
- Hadronic interactions are suppressed: only interactions mediated by the strong electromagnetic field behaving as a flux of virtual photons possible.
- LHC is used as a photon collider.
- Study of saturation phenomena and nuclear gluon shadowing are possible.

ALICE results in UPC:

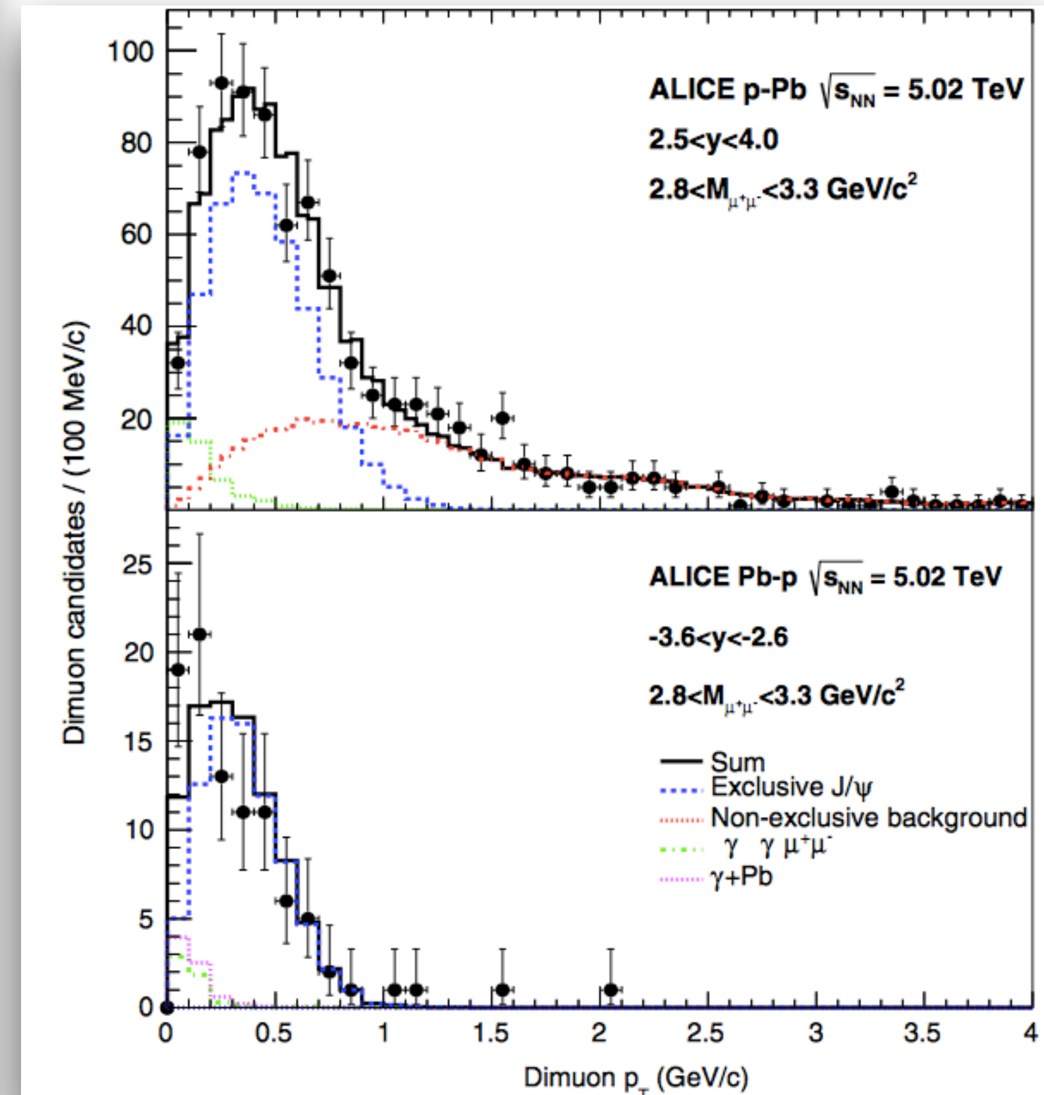
- PRL 113 (2014) 232504 —>p-Pb ***J/ψ*** photo production
- Phys. Lett. B718, 1273 - 1283 (2013) —> Pb-Pb ***J/ψ*** photo production, forward rapidities
- Eur. Phys. J. C73, 2617 (2013) —> Pb-Pb ***J/ψ*** photo production, central rapidities.
- arXiv:1503.09177 [nucl-ex], submitted to JHEP —> Pb-Pb ρ^0 photo production

ALICE results on photo production of vector mesons

p-Pb ***J/ψ*** photo production

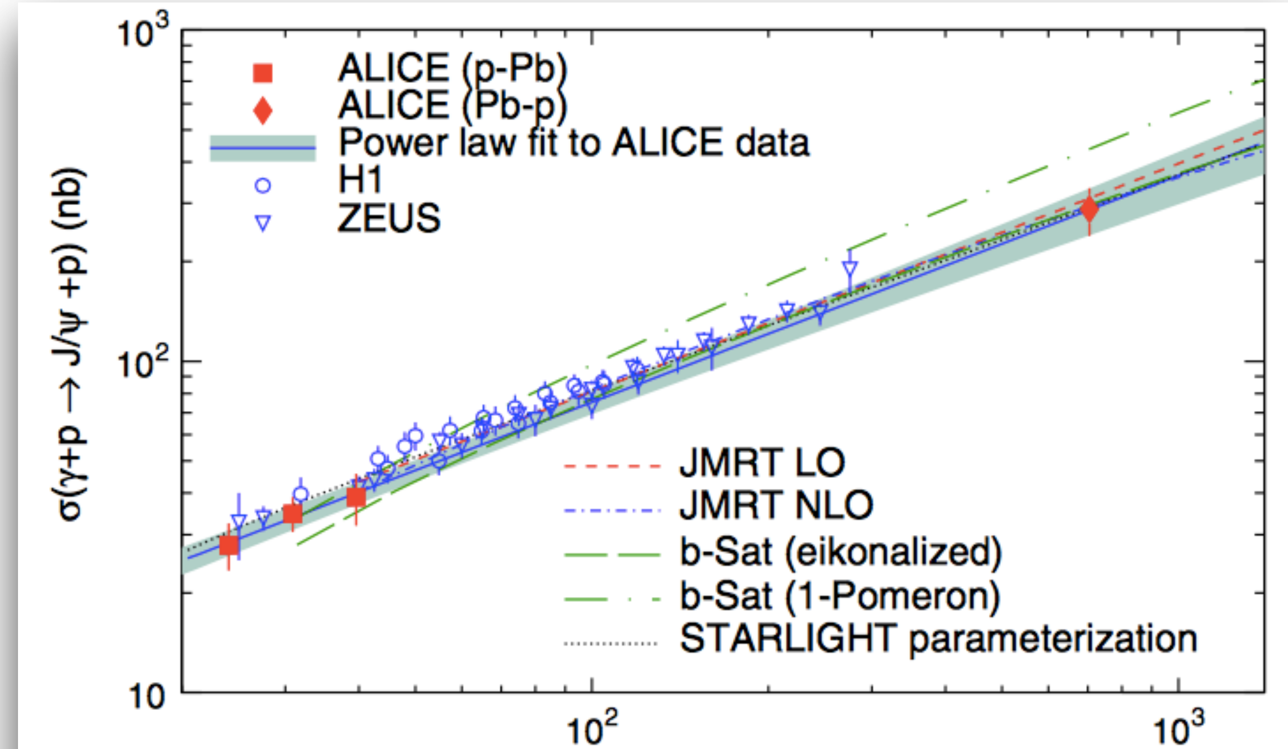


- Clear ***J/ψ*** peak is visible in both data sets.
- Both distributions are well described by a Crystal Ball parametrization

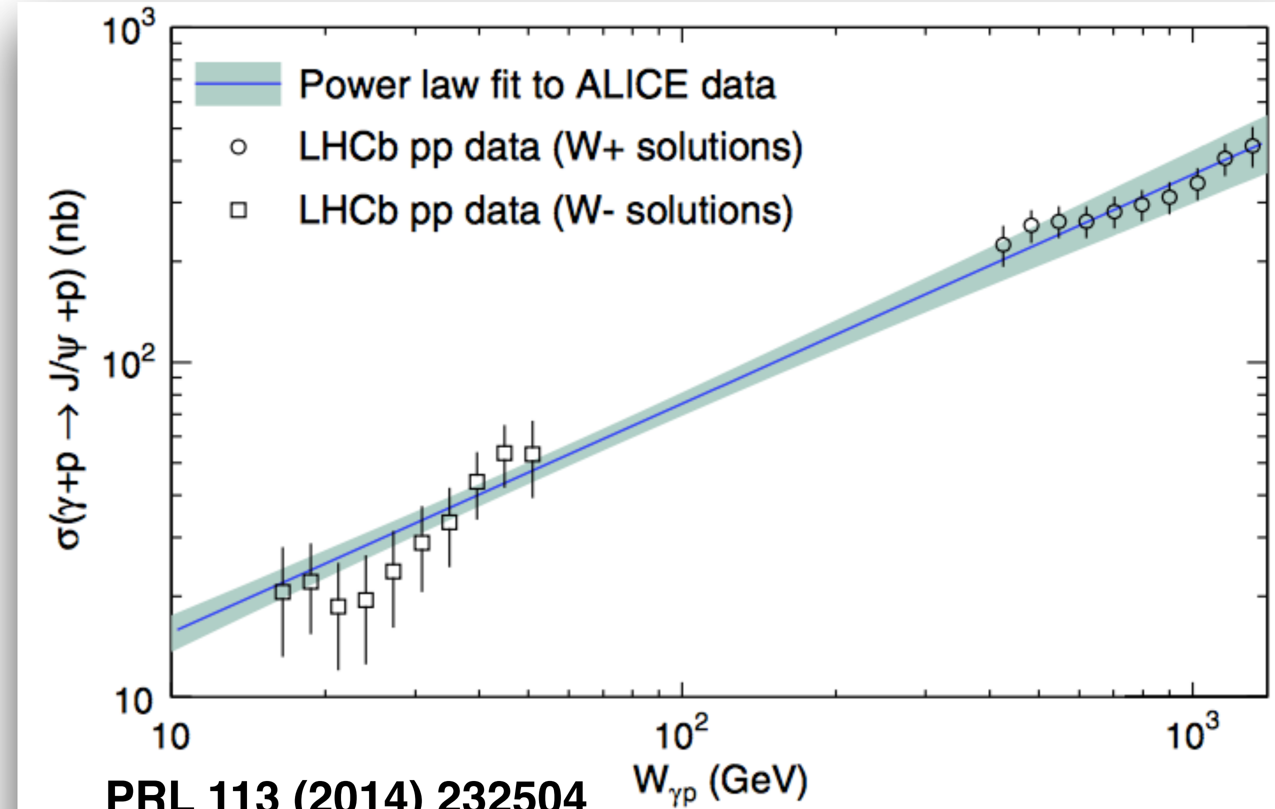


- pT spectrum described by templates of the processes: **exclusive**, **elastic** and **non-exclusive**

ALICE results on photo production of vector mesons



PRL 113 (2014) 232504



PRL 113 (2014) 232504

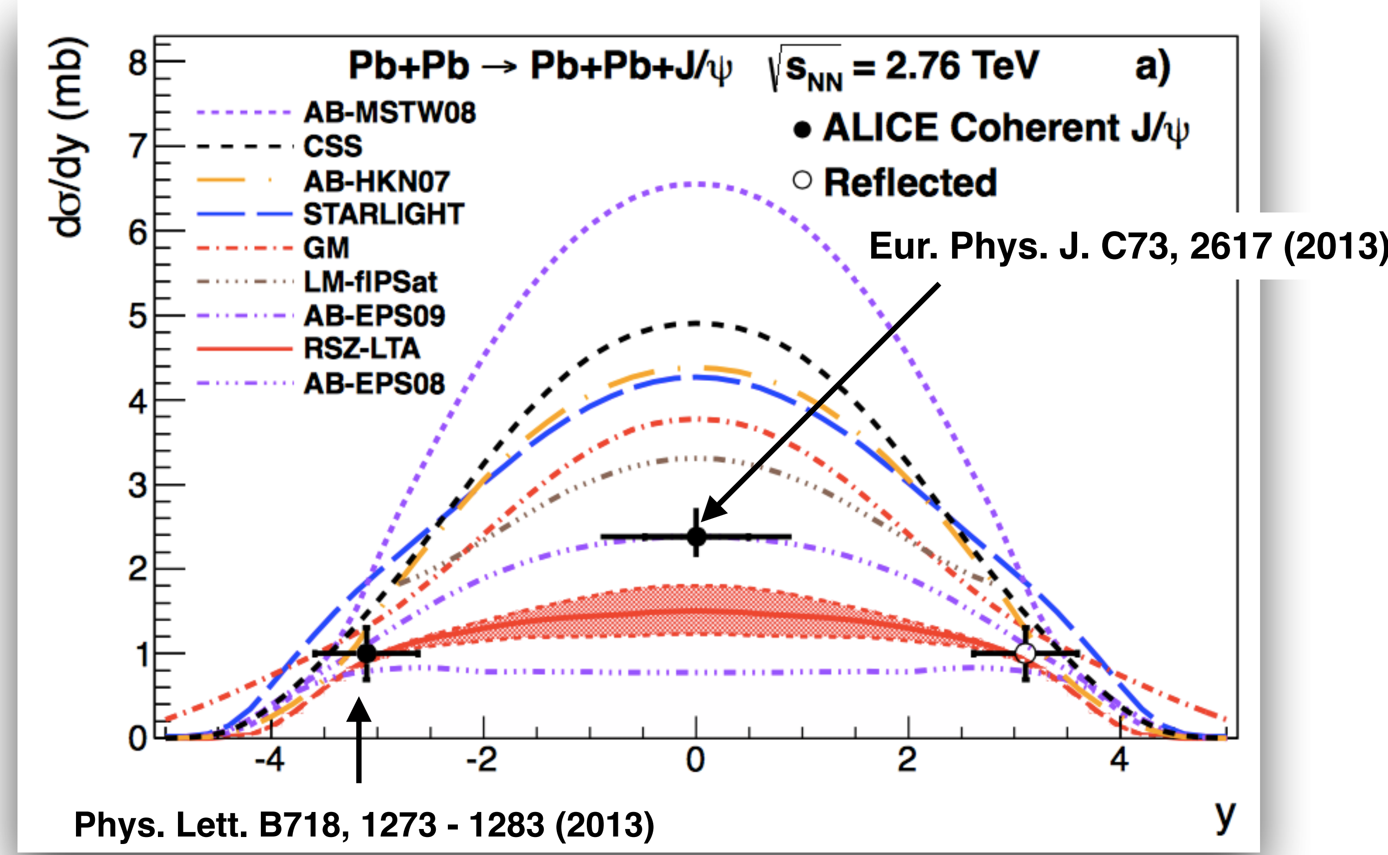
- Parameter of ALICE fit in agreement with HERA
- Models based on VDM, standard pQCD (LO and NLO like) and including saturation describe ALICE data
- LHCb solutions consistent with the power-law fit obtained from ALICE results

First measurement of exclusive *J/ψ* photo production in p-Pb collisions —> ALICE data compatible with power law dependence of $\sigma(W_{\gamma p})$ up to about 700 GeV
No change in the behavior of the gluon PDF in the proton is observed between HERA and LHC energies.

ALICE results on photo production of vector mesons

Pb-Pb *J/ψ* photo production

- **AB:** Adeluyi, Bertulani, PRC85 (2012) 044904
  LO pQCD scaled by an effective constant to correct for missing contributions. MSTW assumes no nuclear effects, the other incorporate nuclear effects according different nuclear PDFs
- **CSS:** Cisek, Szczurek, Schäfer, PRC86 (2012) 014905
  Color dipole model based on unintegrated gluon distribution of the proton
- **STARLIGHT:** Klein, Nystrand, PRC60 (1999) 014903
  VDM coupled to a Glauber approach and using Hera data to fix the γp cross section
- **GM:** Gonçalves, Machado, PRC84 (2011) 011902
  Color dipole model, where the dipole nucleon cross section is from the IIM saturation model
- **RSZ:** Rebyakova, Strikman, Zhalov, PLB 710 (2012) 252
  Based on LO pQCD amplitude for two gluon exchange where the gluon density incorporates shadowing computed in leading twist approximation
- **LM:** Lappi, Mäntysaari, PRC87 (2013) 032201
  color dipole model + saturation



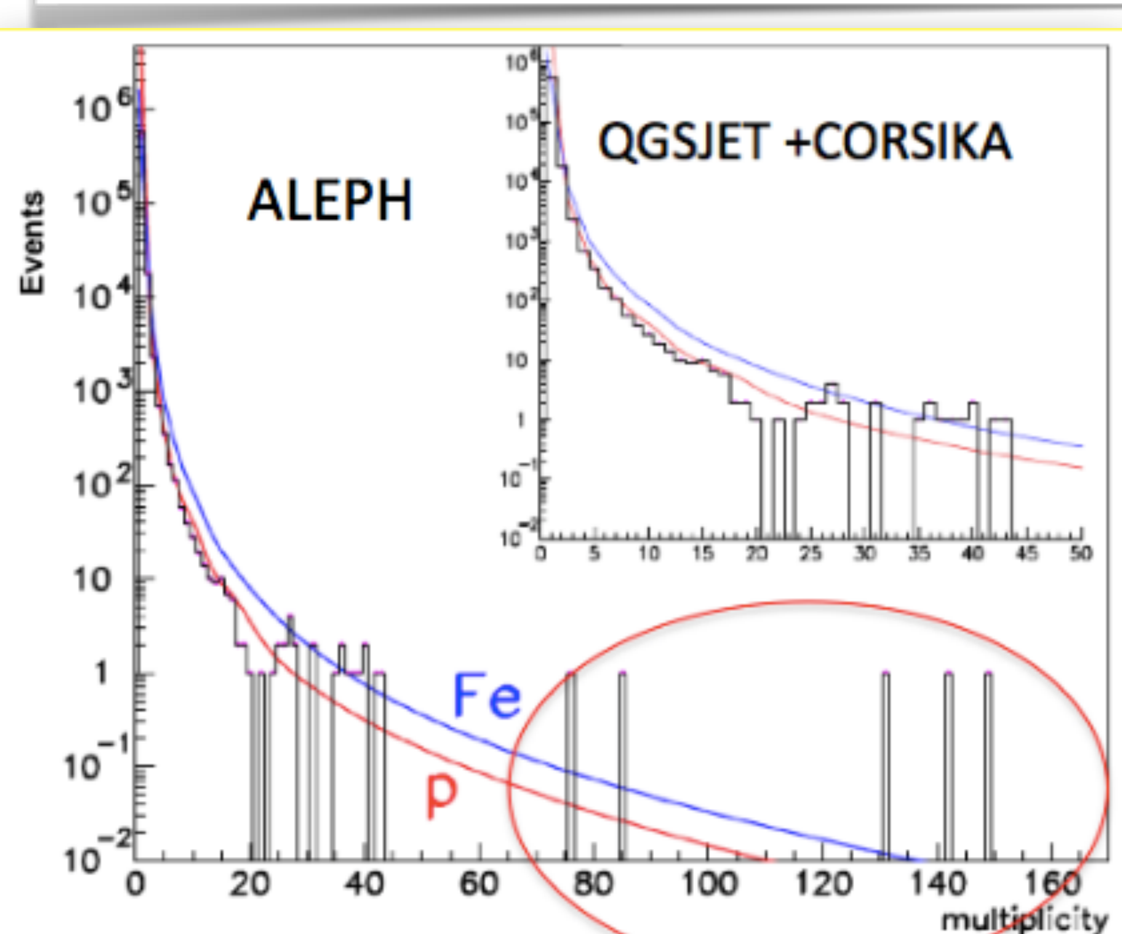
Best agreement with the model which incorporates nuclear gluon shadowing (observed partial depletion of nuclear gluon density) according to the EPS09 parametrization.

ALICE results on Cosmic Ray Physics

ALICE results on Cosmic Ray Physics

LEP experiments were pioneers in the study of atmospheric muon bundles

- ALEPH: 140 m of rock, momentum muon threshold p > 70 [GeV/c]/cos θ
  - ✓ underground scintillators, horizontal area of HCAL ~ 50 m^2, TPC projected area ~ 16 m^2
- DELPHI: 100 m of rock, momentum muon threshold p > 52 [GeV/c]/cos θ
  - ✓ Hadron calorimeter with an horizontal area ~ 75 m^2, muon barrel, TPC, TOF and outer detectors
- L3+C: 30 m of rock, momentum muon threshold p > 20 [GeV/c]/cos θ + surface array
  - ✓ Scintillator surface array of 200 m^2, trigger, muon barrel with horizontal area ~100 m^2, etc



Astroparticle Physics 19 (2003) 513–523

- These muon bundles are not well described.
- Even the combination of extreme assumptions of highest measured flux value and pure iron spectrum fails to describe the abundance of high multiplicity events.

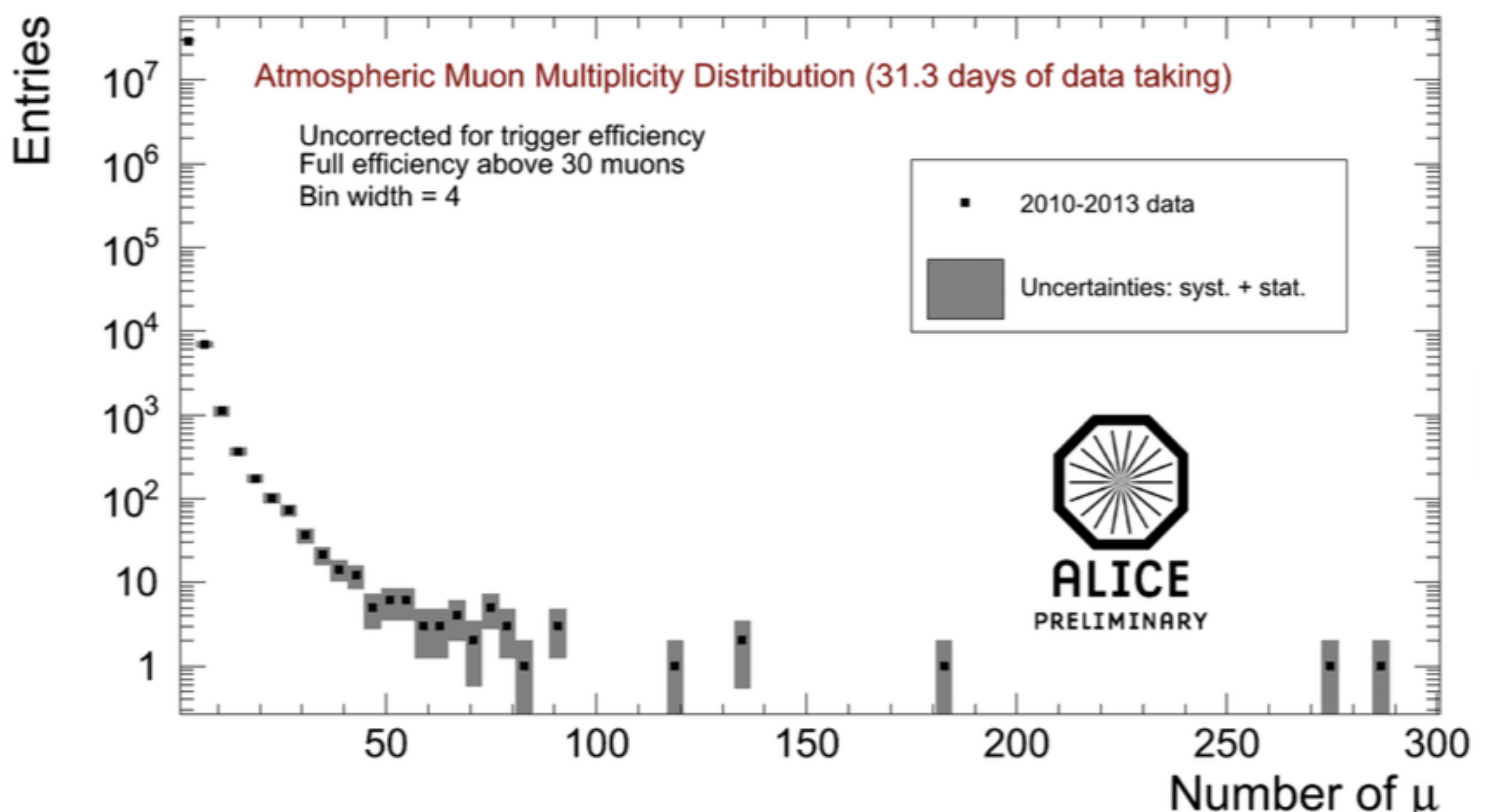
ALICE results on Cosmic Ray Physics

Between the years 2010 and 2013, ALICE collected several million events during the cosmic data taking sessions. The run selection took into account the relevant system for cosmic ray studies: ACORDE, SPD and TOF as trigger detectors and the TPC as readout.

Year	Days of data taking	Mag. Field OFF	Mag. Field ON
2010	4.4	1.4	3
2011	13.4	0	13.4
2012	11	2.7	8.3
2013	2.5	0	2.5
Total	**31.3**	**4.1**	**27.2**

The total sample corresponds to 31.3 days of data taking.

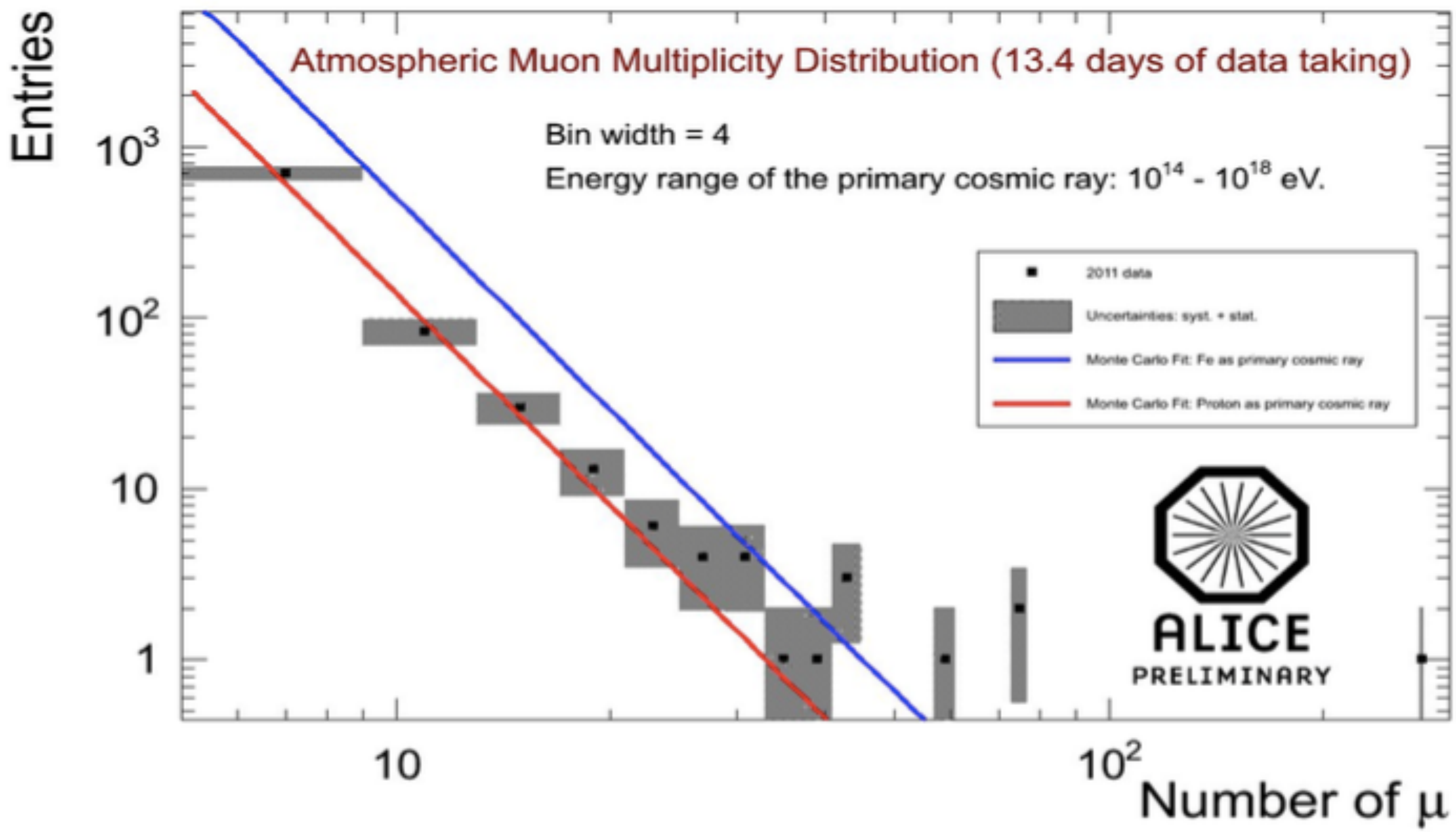
ALICE results on Cosmic Ray Physics



ALICE collected 6 events with more than 100 atmospheric muons during 31.3 days of data taking with TOF and ACORDE triggers

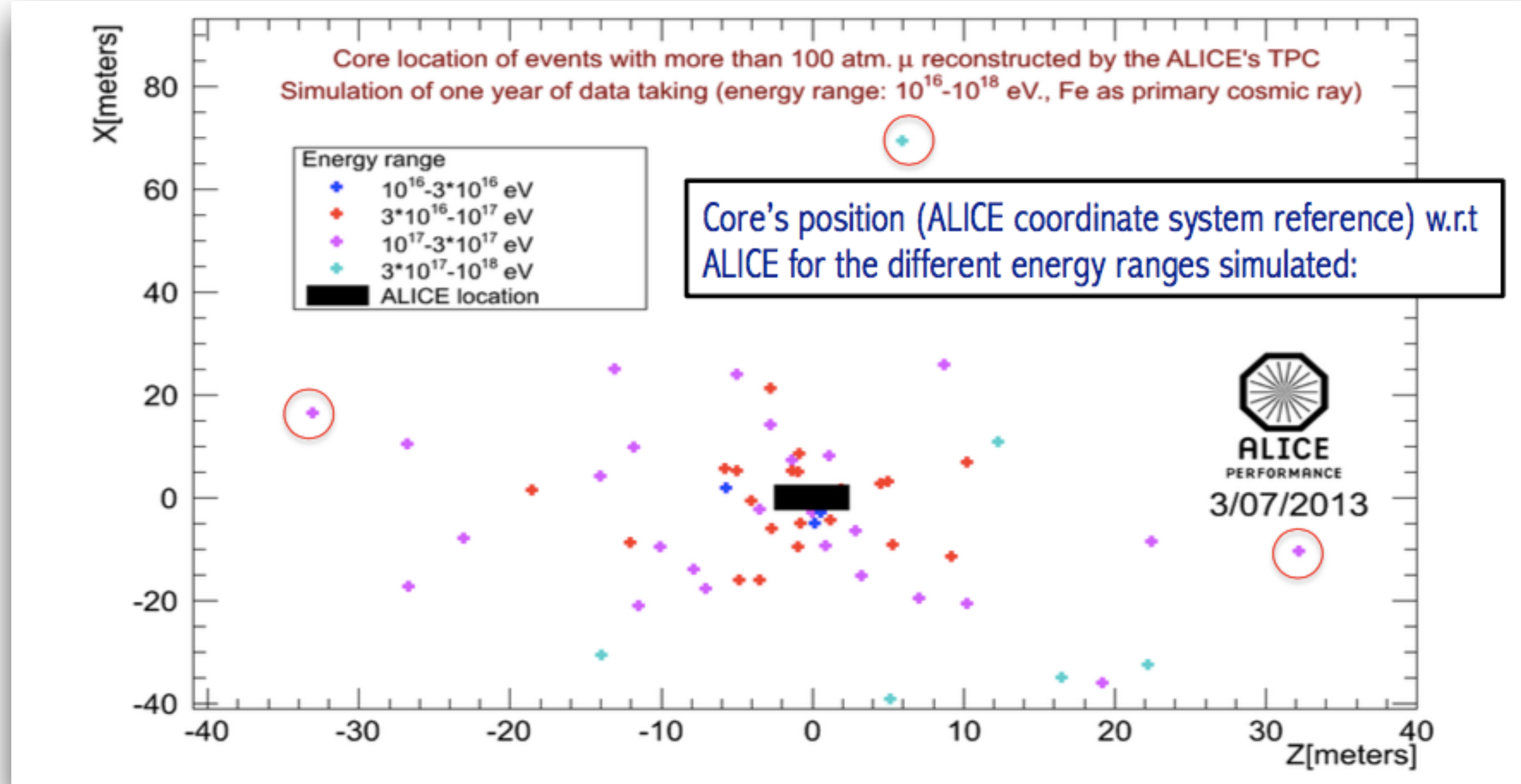
ALICE results on Cosmic Ray Physics

As a first step, we compare the MMD (from 2011 data, 13.4 days) with the MC. The comparison of MC with the full sample would appear in the forthcoming publication that is in preparation.



- Primary energy range of the simulation : $10^{14} < E < 10^{18}$ eV
- The data are, as expected, in between the pure Proton composition (light elements) and pure Fe (heavy elements).
- The lower multiplicities (lower primary energies) are closer to pure Proton as expected.

ALICE results on Cosmic Ray Physics



- ✓ The black rectangle shows the ALICE's surface in the XZ plane (the core of 8 events are located within ALICE's location).
- ✓ Most of the HME events have a core located very close to ALICE (< 30 m), only some events are out of this distance (red circles, 3/72 events)

ALICE results on Cosmic Ray Physics

Model	Primary cosmic ray	HME rate [/day]	HME rate [Hz x 10^{-6}]	Uncertainty (%), sys.+stat. in quadrature
QGSJET II-03	p	1 event in 11.8 days	0.9	17
	Fe	1 event in 5.7 days	2	20
QGSJET II-04	p	1 event in 10.7 days	1.1	17
	Fe	1 event in 4.9 days	2.3	20
Real data		1 event in 6.3 days	1.8	40

- ✓ These events, already detected in the past from some LEP experiments like ALEPH and DELPHI, and actually without any explanation, have been recorded also in ALICE.
- ✓ Using CORSIKA 6990 with the QGSJET II-03 as hadronic interaction model and the more recent CORSIKA 7350 with QGSJET II-04, the first hadronic interaction model tuned with the LHC data, we are able to reproduce the rate of HME.

Activities of the Mexican group during Run 1 and LS1

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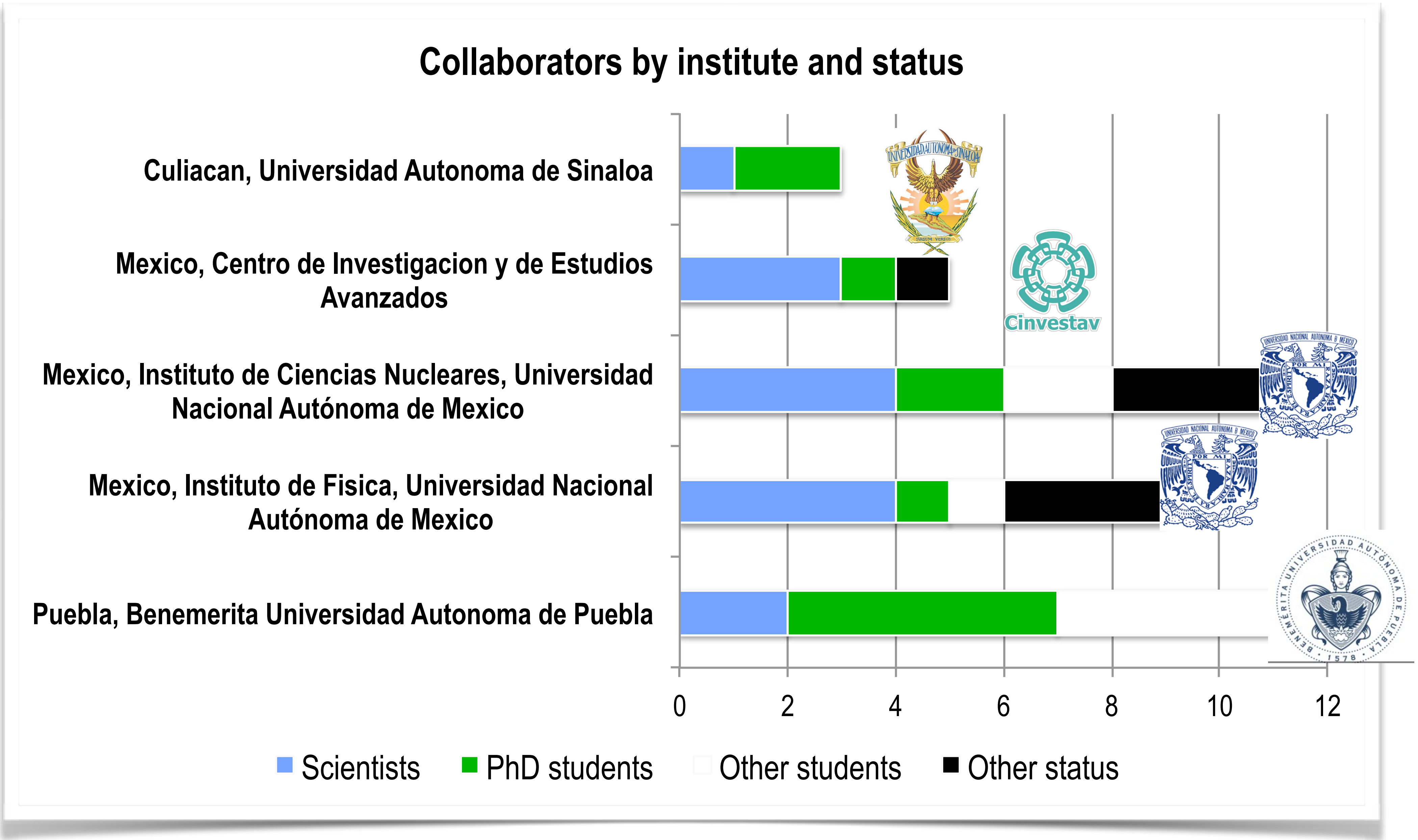
México in ALICE



ALICE activities in México

Detectors:

- **ACORDE**: calibration/alignment for central barrel detectors of ALICE and cosmic ray studies.

- **AD**: detector installed during LS1 for diffractive studies. To be operational during Run 2. AD will be used to monitor the luminosity on-line.

- **VZERO-A**: level zero trigger. VZERO-A data used in all the ALICE's publications.

Computing: GRID (Tier 1 and 2), Detector Control System (DCS), Offline of ACORDE and AD. Data Quality Monitoring (DQM) of ACORDE.

ALICE activities in México

Analysis:

- **Light Flavor physics: particle spectra and event shape engineering.**
- **Anti-nuclei studies.**
- **Ultra-peripheral collisions: J/ψ, ρ^0 and ρ' photo production.**
- **Cosmic Ray Physics: muon bundles, cosmic charge ratio and horizontal muons studies.**
- **Diffractive physics for Run 2: diffractive cross section, two/ four bodies decays.**

ALICE activities in México

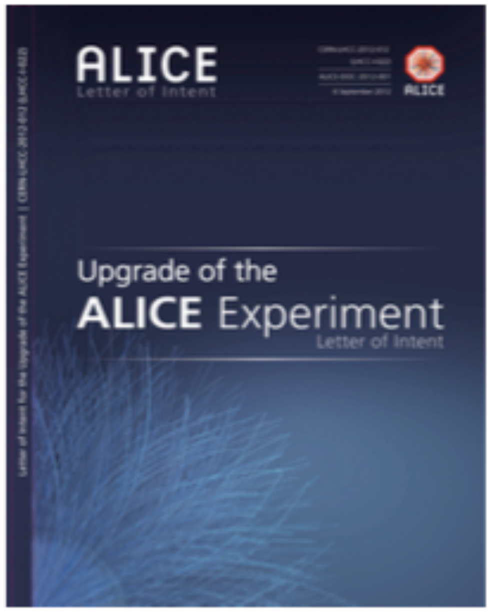
Upgrade for Run 3

- **Trigger detector: Fast Interaction Trigger (FIT), upgrade of VZERO system.**
- **Studies on event plane resolution for Run 3.**
- **Upgrade of Central Trigger Processor of ALICE for Run 3.**
- **TPC upgrade: development of a pico-Amperimeter.**
- **Upgrade of Cosmic Ray Trigger: ACORDE Plus.**

Plans and perspectives for Run 3

Plans and perspectives for Run 3

- LHC schedule for heavy ion running
- ALICE goals and upgrade strategy for the LHC Run 3 and Run 4
- Upgrade plans
- Expected physics performance



Plans and perspectives for Run 3

Requirements

Minimum bias trigger selection (very low signal/background ratio for most of the physics signals)

High Rate: 50 kHz

Large data sample: $L_{int} > 10\ nb^{-1}$

Improve (add) heavy flavour vertexing at central (forward) rapidity

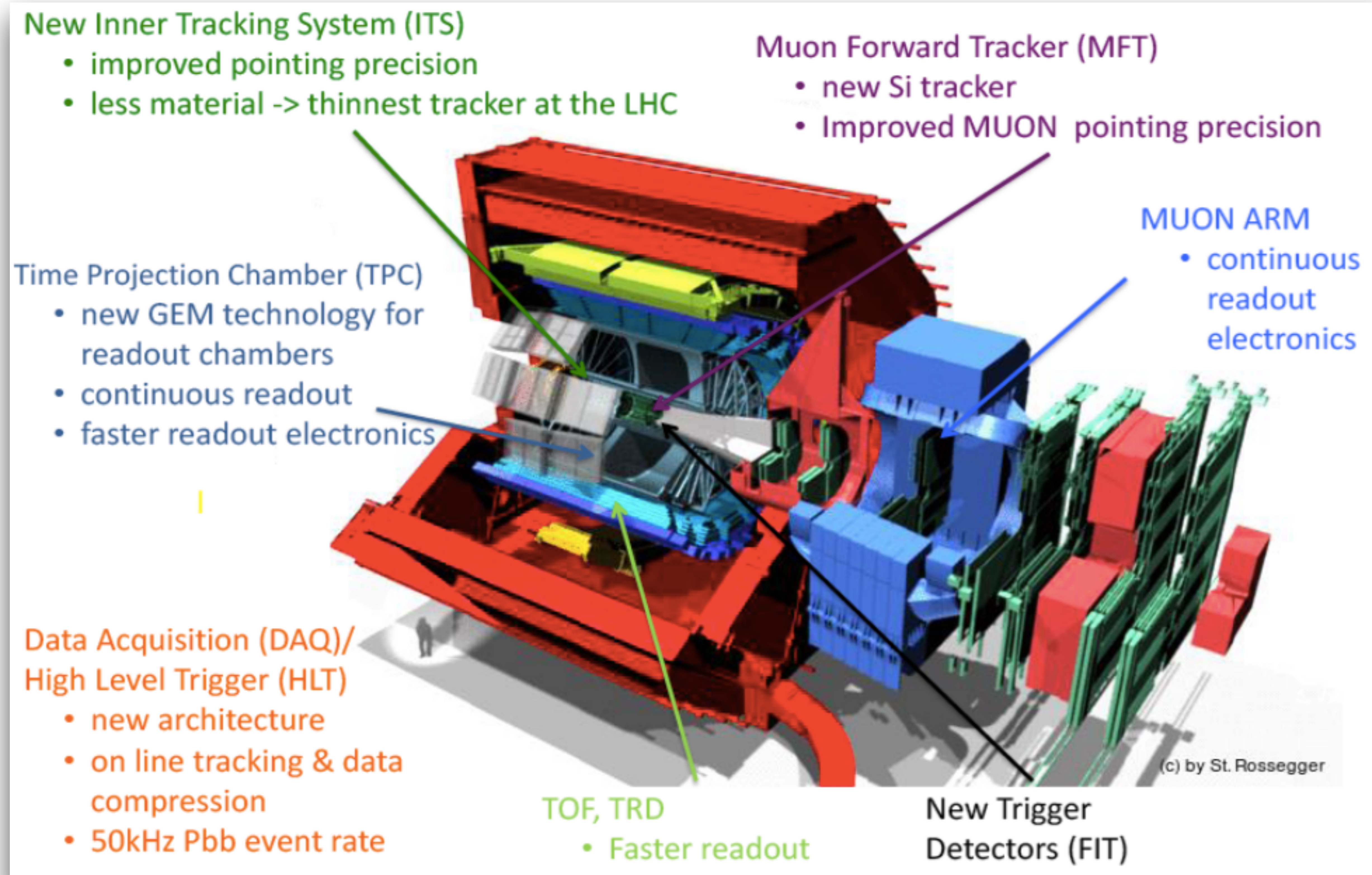
Improve low p_T tracking efficiency

Plans and perspectives for Run 3

Strategy

Forward trigger detectors upgrade
Integrated online & offline structure (O^2 project)
New Inner Tracking System at midrapidity
New Muon Forward Tracker in front of the muon absorber
TPC with GEM readout + new pipelined electronics (dead-time free)

Plans and perspectives for Run 3



Plans and perspectives for Run 3

Upgrade Physics Reach

Observable	Approved * p_T^{Amin} (GeV/c)	Approved * statistical uncertainty	Upgrade ** p_T^{Umin} (GeV/c)	Upgrade ** statistical uncertainty
Heavy Flavour				
D meson R_{AA}	1	10 % at p_T^{Amin}	0	0.3 % at p_T^{Amin}
D meson from B decays R_{AA}	3	30 % at p_T^{Amin}	2	1 % at p_T^{Amin}
D meson elliptic flow ($v_2 = 0.2$)	1	50 % at p_T^{Amin}	0	2.5 % at p_T^{Amin}
D from B elliptic flow ($v_2 = 0.1$)		not accessible	2	20 % at p_T^{Umin}
Charm baryon-to-meson ratio		not accessible	2	15 % at p_T^{Umin}
D_s meson R_{AA}	4	15 % at p_T^{Amin}	1	1 % at p_T^{Amin}
Charmonia				
J/ψ R_{AA} (forward rapidity)	0	1 % at 1 GeV/c	0	0.3 % at 1 GeV/c
J/ψ R_{AA} (mid-rapidity)	0	5 % at 1 GeV/c	0	0.5 % at 1 GeV/c
J/ψ elliptic flow ($v_2 = 0.1$)	0	15 % at 2 GeV/c	0	5 % at 2 GeV/c
ψ(2S) yield	0	30 %	0	10 %
Dielectrons				
Temperature (intermediate mass)		not accessible		10 %
Elliptic flow ($v_2 = 0.1$)		not accessible		10 %
Low-mass spectral function		not accessible	0.3	20 %
Heavy Nuclear States				
Hyper(anti)nuclei ${}^{4}_{\Lambda}$H yield		35 %		3.5 %
Hyper(anti)nuclei ${}^{4}_{\Lambda\Lambda}$H yield		not accessible		20 %

Luminosity for minimum bias data

* 0.1 nb^{-1} out of 1 nb^{-1} delivered luminosity
** 10 nb^{-1} integrated luminosity

ALICE upgrade LOI, http://cds.cern.ch/record/1475243/

Summary

ALICE is a great instrument to study heavy-ion collisions at the highest ever reached energy.

Heavy-ion collisions can serve as a laboratory for interesting physics not directly related to the quark gluon plasma.

ALICE is ready for Run 2 and is preparing important upgrades for Run 3.

ALICE-México group contributes strongly in several areas: software, hardware, detector development, physical analysis and upgrade for Run 3.