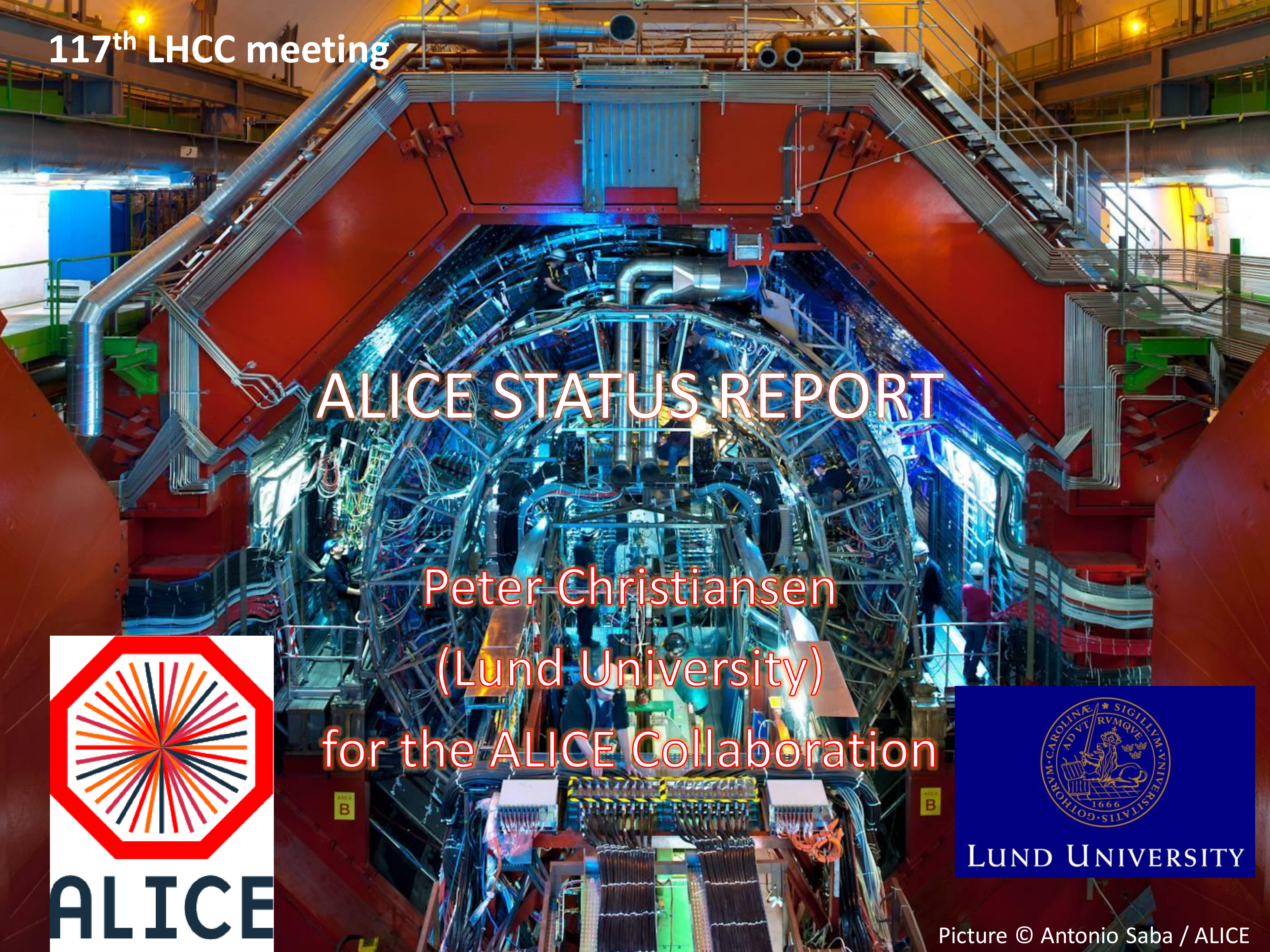
117th LHCC meeting

ALICE STATUS REPORT

Peter Christiansen
(Lund University)
for the ALICE Collaboration



Picture © Antonio Saba / ALICE

Outline

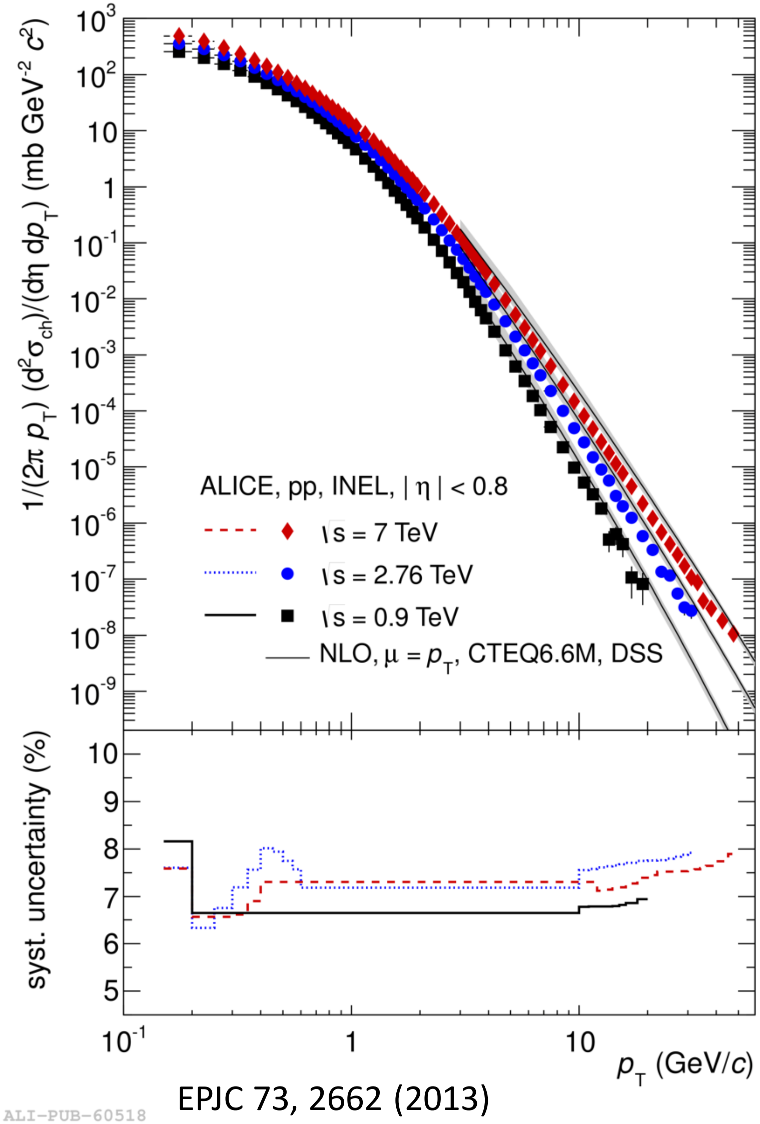
- Recent physics results
- Run 1 performance with a focus on run 2
- LS1 progress
- Run 3 upgrade TDRs

Published and submitted papers since last LHCC meeting

- "Directed Flow of Charged Particles at Midrapidity Relative to the Spectator Plane in Pb-Pb Collisions at $\sqrt{s_{NN}}$=2.76 TeV", Phys. Rev. Lett. 111, 232302 (2013)
- "Multiplicity dependence of pion, kaon, proton and lambda production in p–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV", Phys. Lett. B 728 (2014) 25-38
- "Multi-strange baryon production at mid-rapidity in Pb–Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV", Phys. Lett. B 728 (2014) 216–227
- "Energy Dependence of the Transverse Momentum Distributions of Charged Particles in pp Collisions with ALICE", Eur. Phys. J. C (2013) 73, 2662
- "Two and Three-Pion Quantum Statistics Correlations in Pb-Pb Collisions at $\sqrt{s_{NN}}$=2.76 TeV at the LHC", Phys. Rev. C 89, 024911 (2014)
- 2 more accepted

- "Production of charged pions, kaons and protons at large transverse momenta in pp and Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV", http://arxiv.org/abs/1401.1250
- "Performance of the ALICE Experiment at the CERN LHC", http://arxiv.org/abs/1402.4476

N_{ch} p_T spectra in pp collisions for all beam energies



EPJC 73, 2662 (2013)

pQCD:

$$\underbrace{\text{pdf} \otimes \sigma_{parton-parton}}_{\text{Jets are ok!}} \otimes\ FF$$

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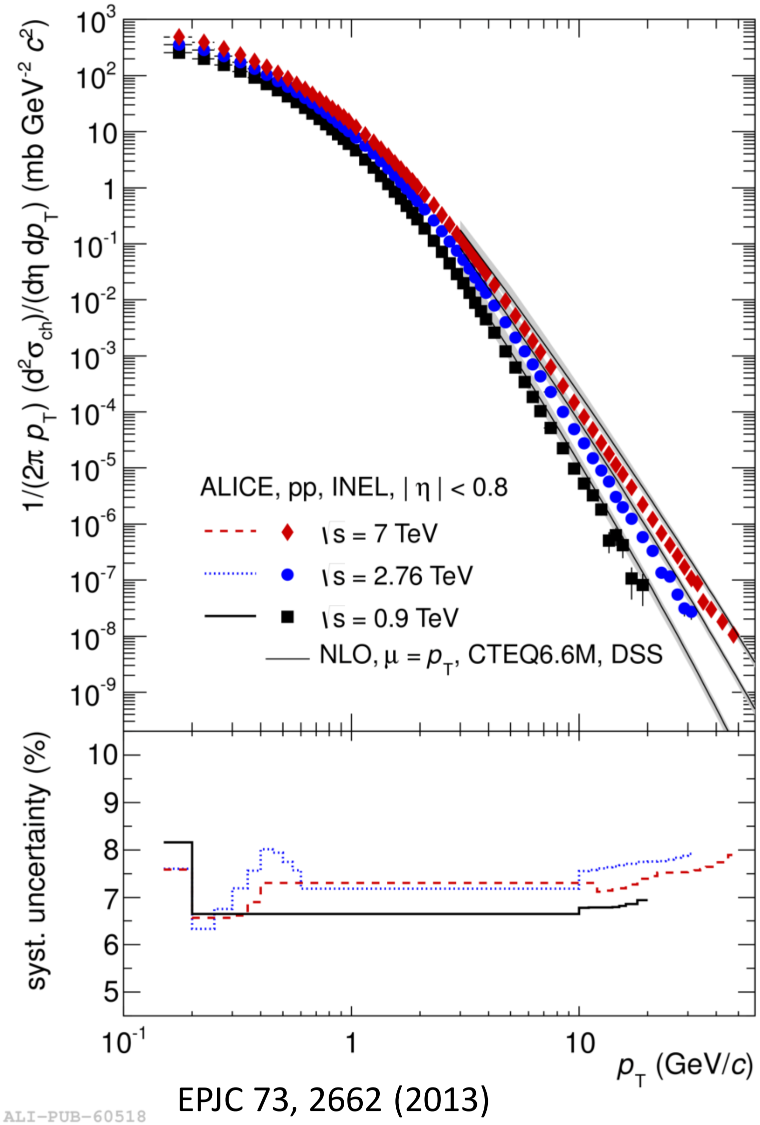
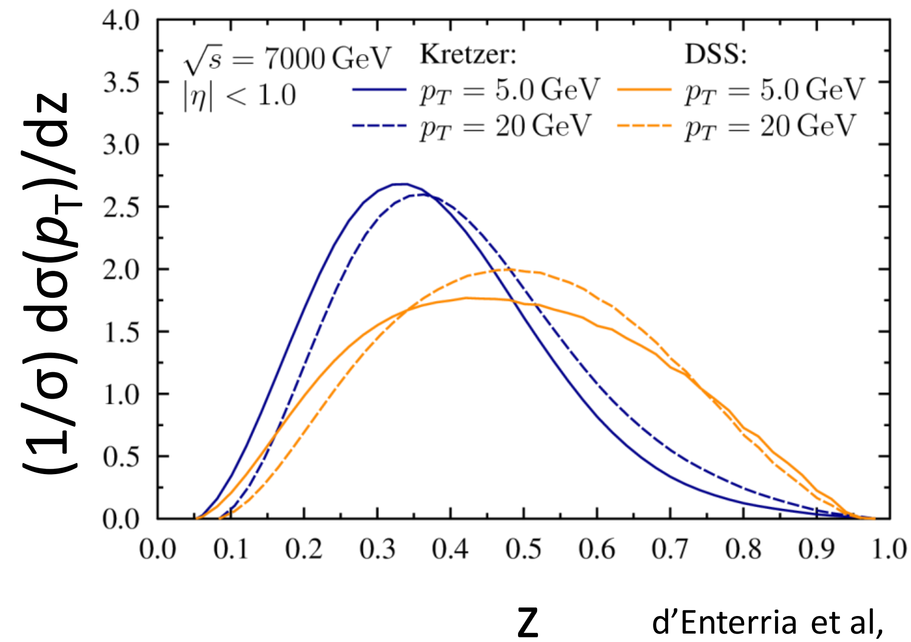


EPJC 73, 2662 (2013)

pQCD:

$$\underbrace{\text{pdf} \otimes \sigma_{parton-parton}}_{\text{Jets are ok!}} \otimes \; FF$$

Fragmentation regions contributing at two p_T's



d'Enterria et al, arXiv:1311.1415

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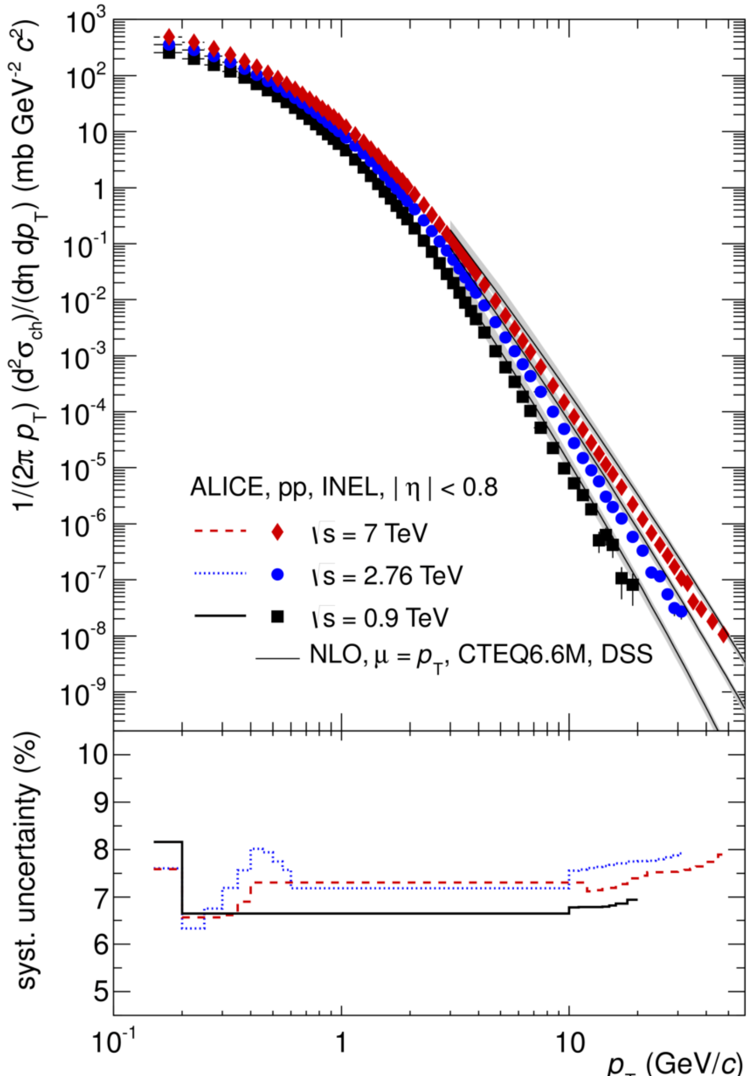
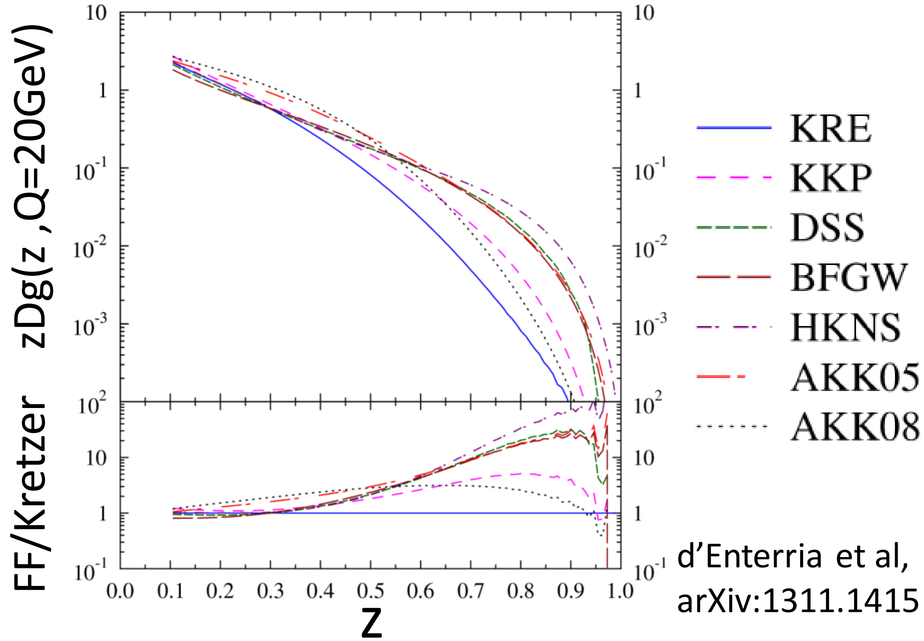


ALI-PUB-60518

EPJC 73, 2662 (2013)

In particular gluon FFs disagree!

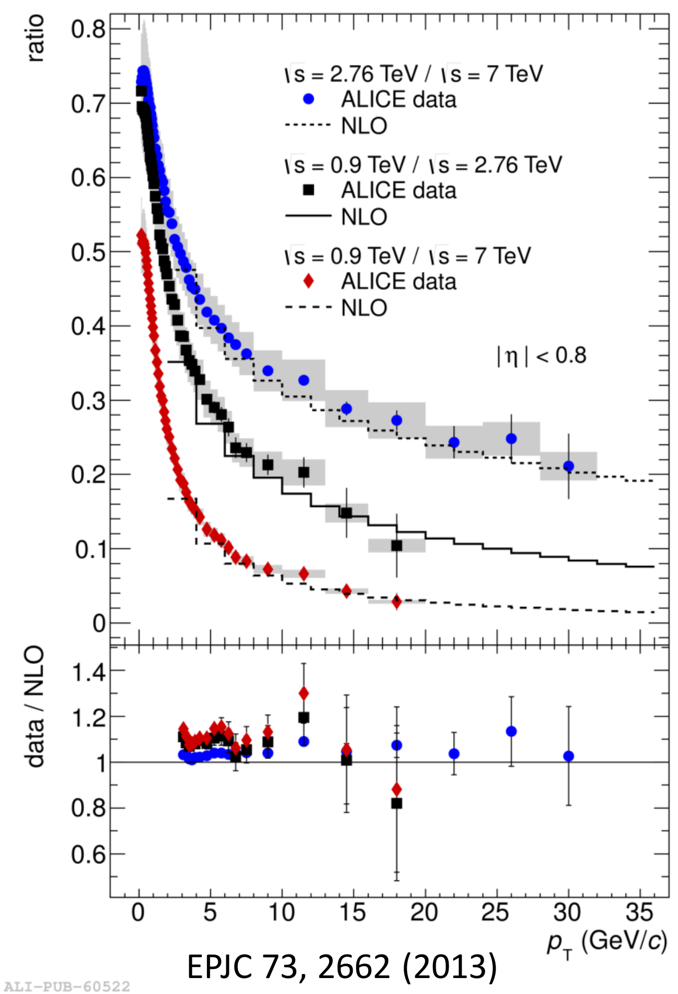


d'Enterria et al, arXiv:1311.1415

"These observations indicate that only the region above $p_T \approx 10$ GeV/c of these charged-hadron data, with theoretical scale uncertainties below ±20%, should be included in forthcoming global fits of parton-to-hadron fragmentation functions."

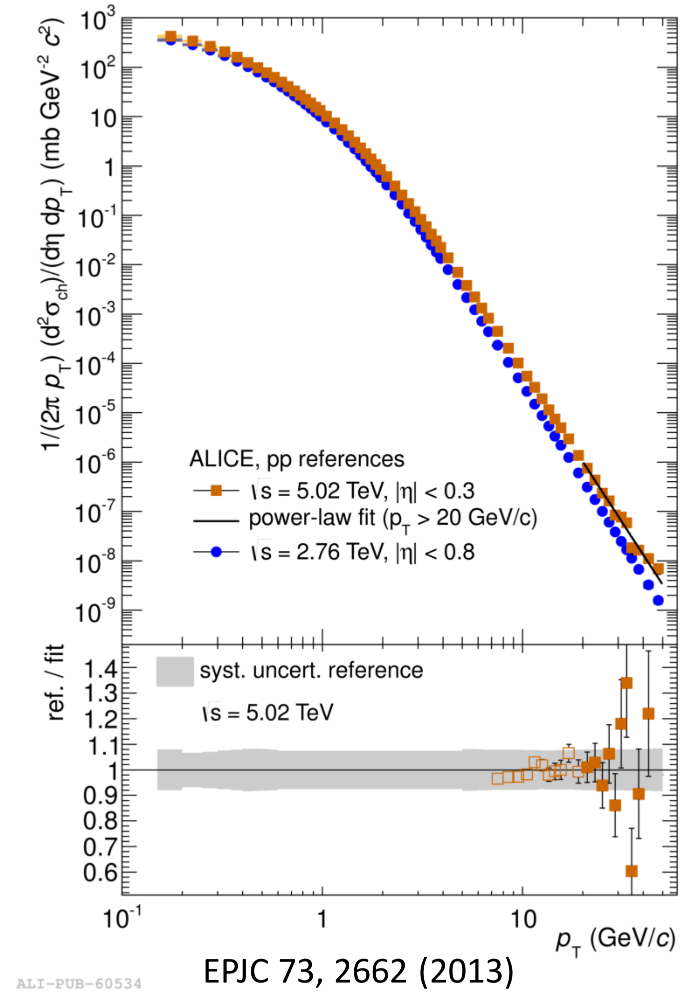
Constructing baseline reference spectra

Ratios between spectra at two energies are described by NLO



EPJC 73, 2662 (2013)

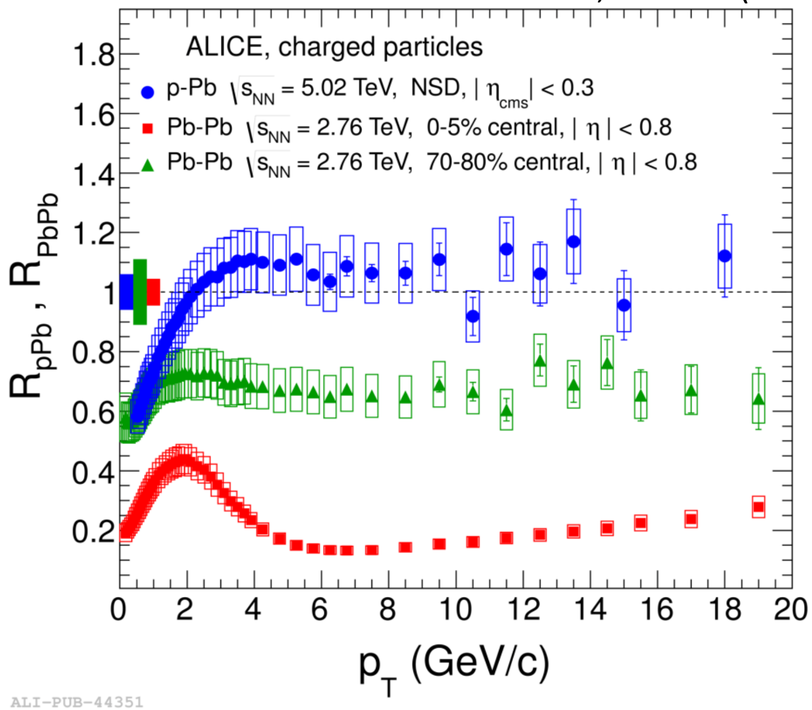
Constructed references are consistent with NLO scaling from √s=7 TeV pp results



EPJC 73, 2662 (2013)

The nuclear modification factor in p-Pb and Pb-Pb

PRL 110, 082302 (2013)



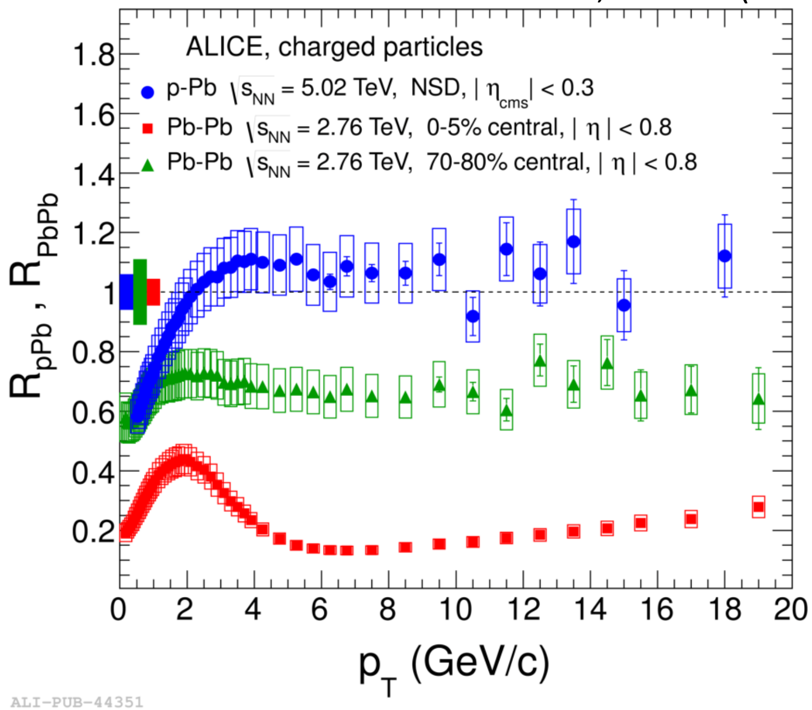
$$R_{\mathrm{AA}} = \frac{d^2N^{\mathrm{AA}}/dp_{\mathrm{T}}d\eta}{\langle T_{\mathrm{AA}}\rangle d^2\sigma^{\mathrm{pp}}/dp_{\mathrm{T}}d\eta}$$

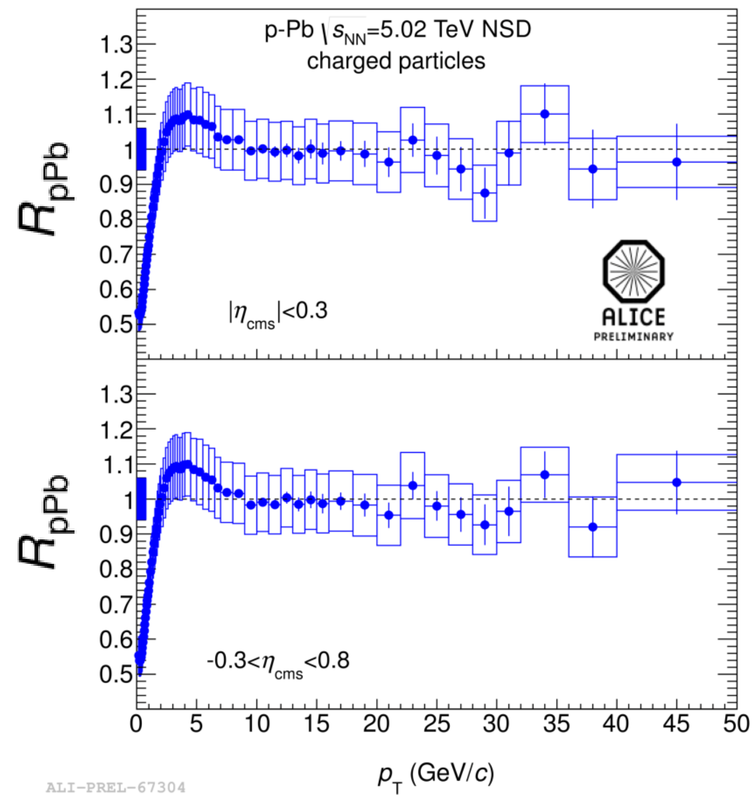
$\langle T_{AA}\rangle \sigma^{pp} = \langle N_{coll}\rangle$ is # binary collisions

For pQCD processes:
R_{AA}<1: suppression
R_{AA}=1: no nuclear effects
R_{AA}>1: enhancement

The nuclear modification factor in p-Pb and Pb-Pb

PRL 110, 082302 (2013)



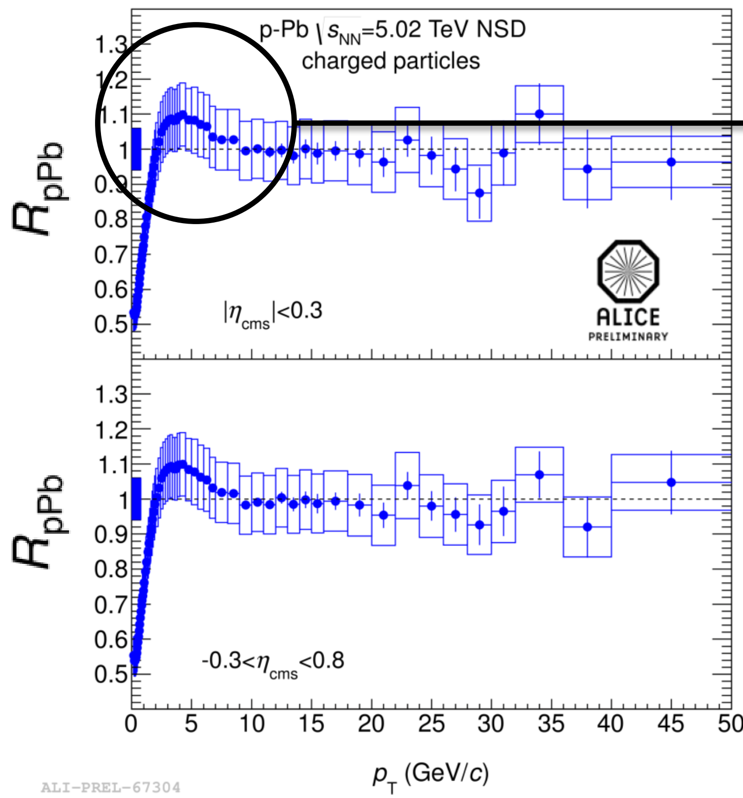


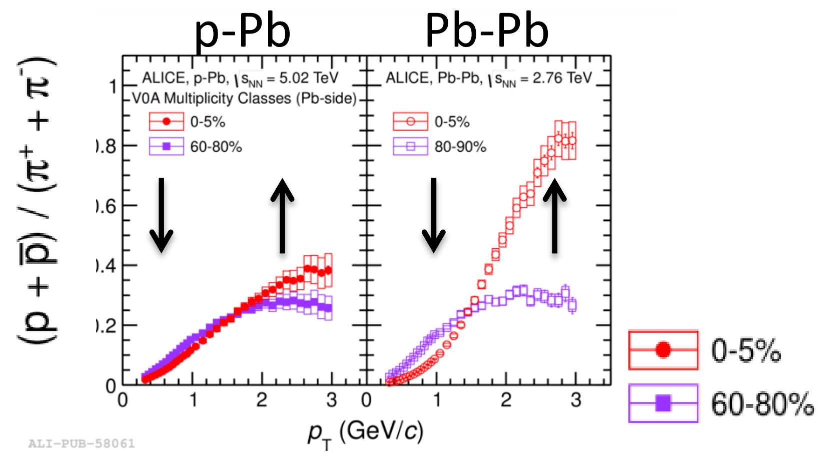
$$R_{\mathrm{AA}} = \frac{d^2N^{\mathrm{AA}}/dp_{\mathrm{T}}d\eta}{\langle T_{\mathrm{AA}}\rangle d^2\sigma^{\mathrm{pp}}/dp_{\mathrm{T}}d\eta}$$

$\langle T_{AA}\rangle \sigma^{pp} = \langle N_{coll}\rangle$ is # binary collisions

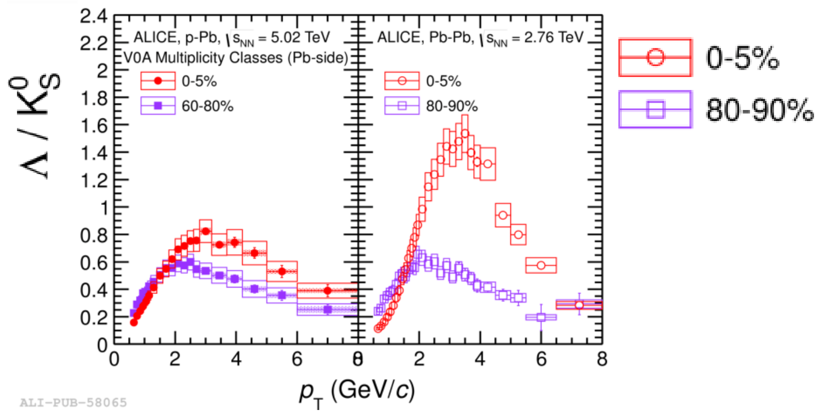
The new ALICE preliminary results are consistent with no modications up to p_{T} = 50 GeV/c.

Using particle identification to understand the structure





PLB 728 (2014)



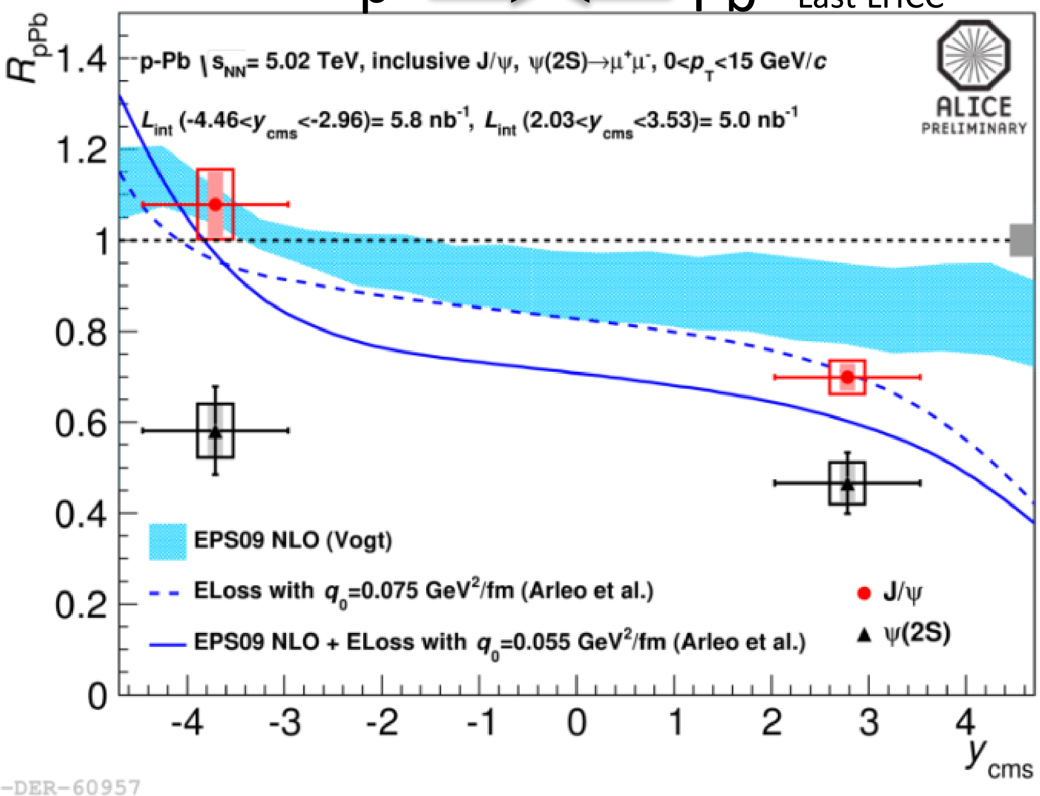
Collectivity in small systems?
Color glass condensate, hydrodynamics, color reconnection, or ?

A hot topic for XXIV QUARK MATTER DARMSTADT 2014

$R_{\text{p-Pb}}$ for ψ(2S): the p_T dependence

The ψ(2S) suppression in the direction of the Pb nuclei is not expected by Cold Nuclear Matter effects or energy loss
Could be due to a co-mover effect?

p → ← Pb Last LHCC



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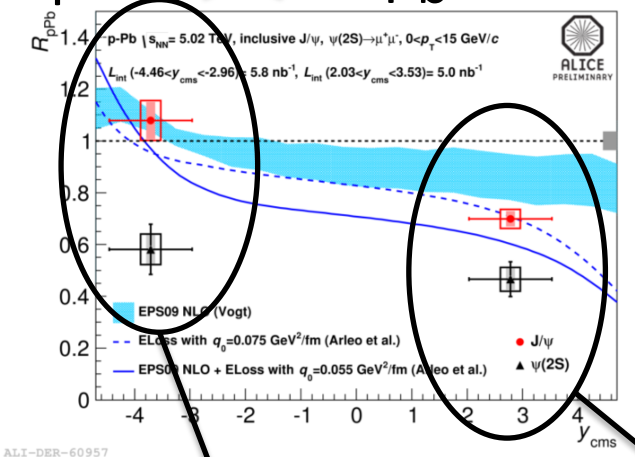
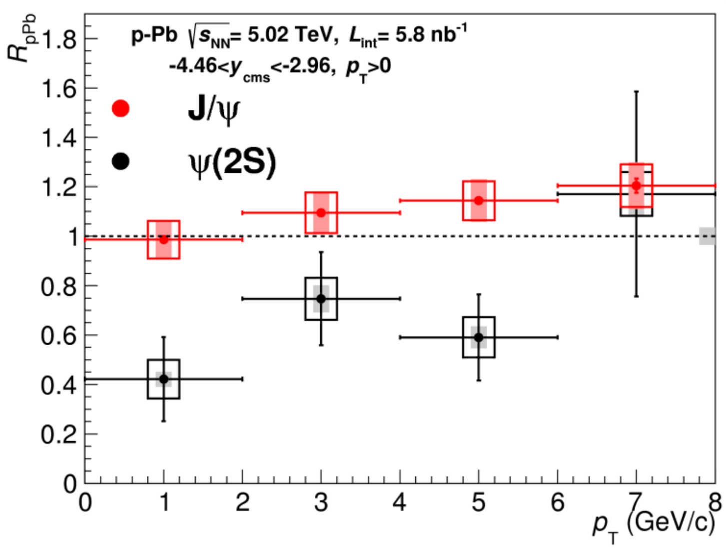
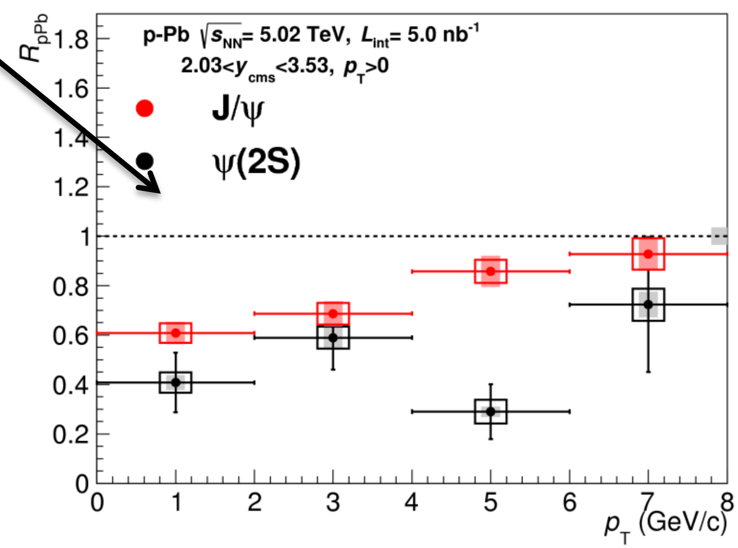




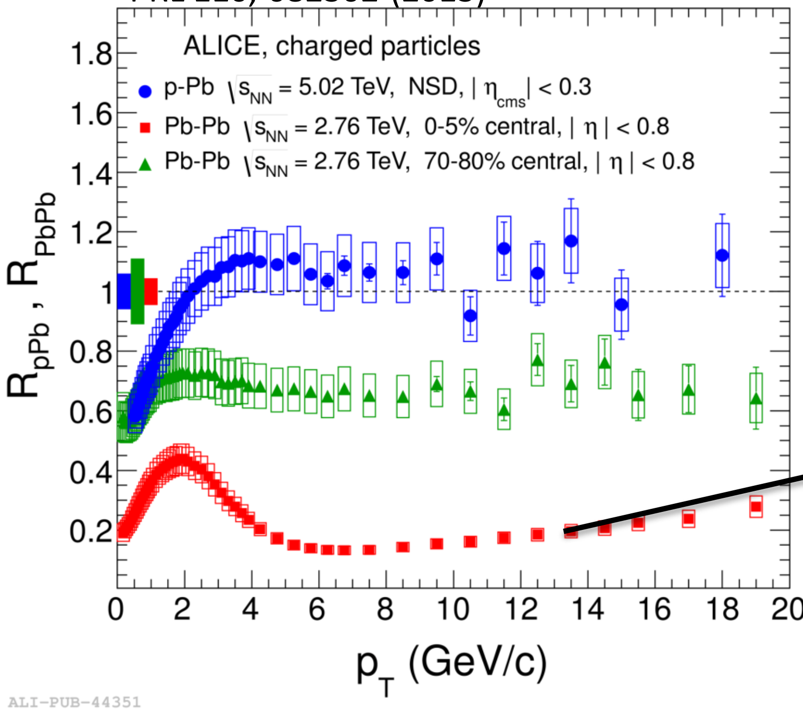


The ψ(2S) suppression in the direction of the Pb nuclei is not expected by Cold Nuclear Matter effects or energy loss
Could be due to a co-mover effect?

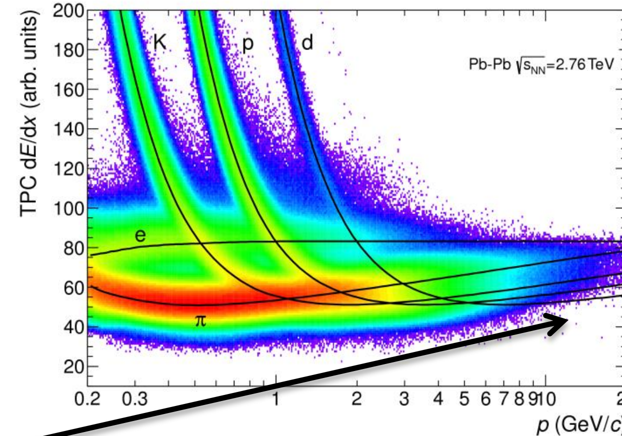
Need more statistics (run 2) to make a firm conclusion on the question if the suppression is p_T dependent.

Extending the R_{AA} to identified particles

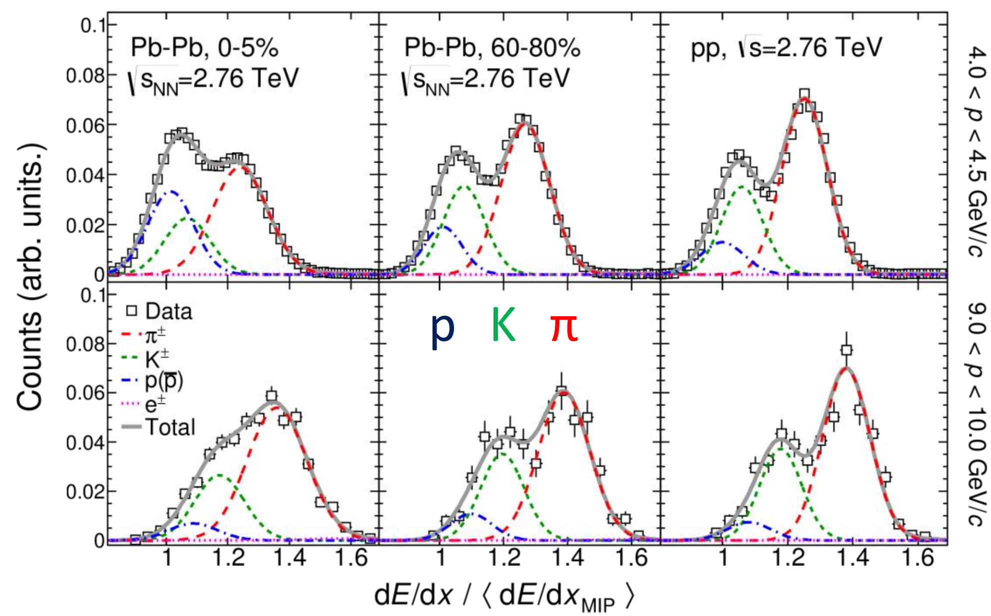
PRL 110, 082302 (2013)



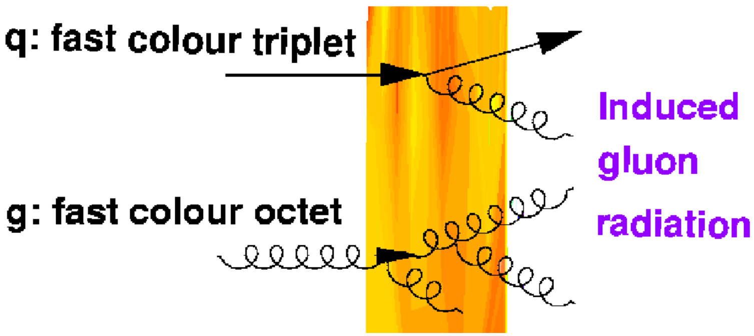
arXiv:1402.4476



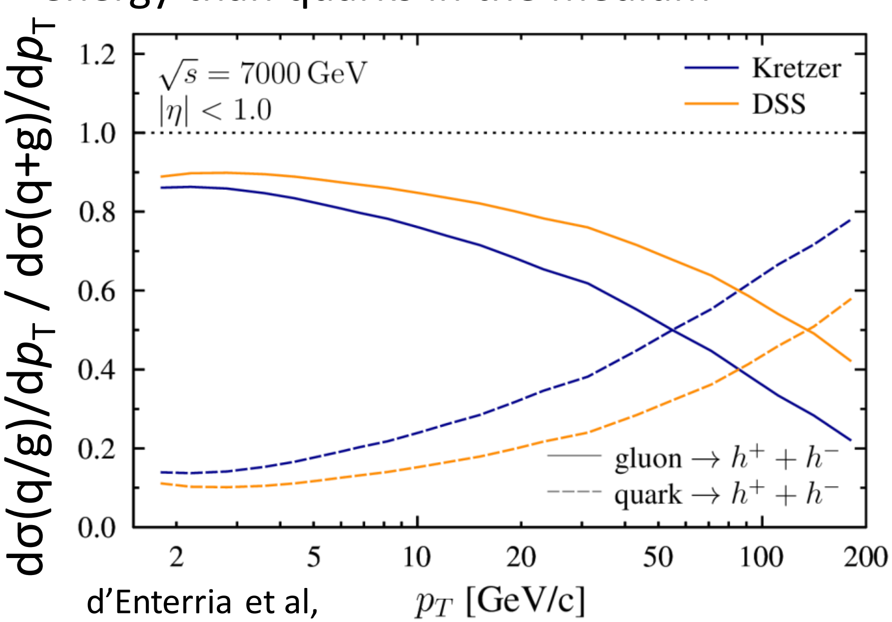
arXiv:1401.1250



Motivation: searching for "footprints" of the energy loss



Gluons lose 2 times (color factor) more energy than quarks in the medium



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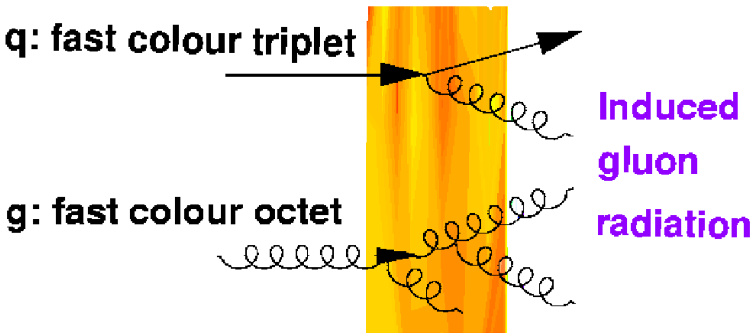

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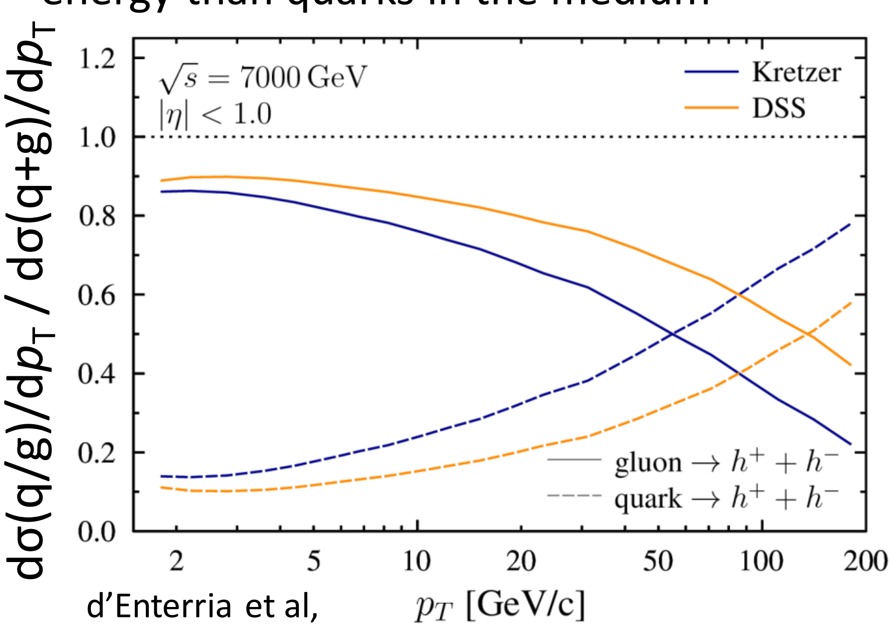

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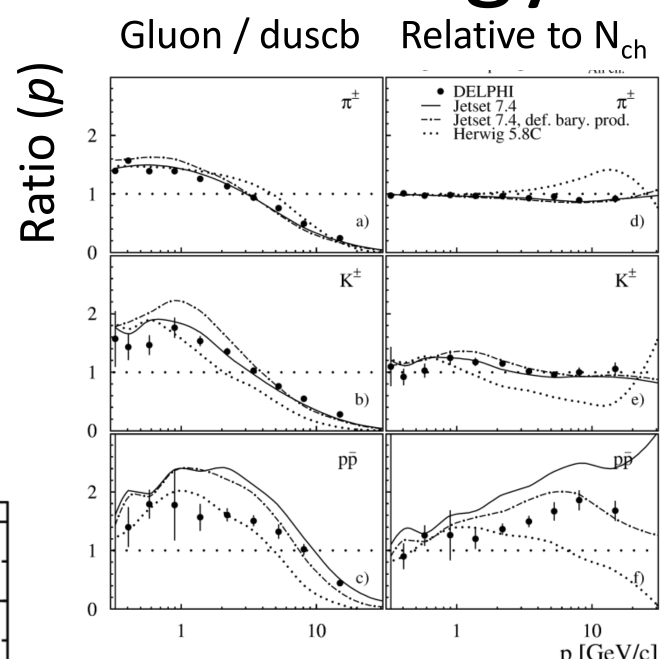
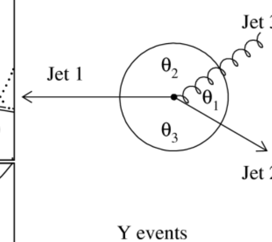


DELPHI Collaboration EPJC17, 207 (2000)



Several other ideas:

Color flow (Sapeta, Wiedemann, EPJC55, 293, 2008)

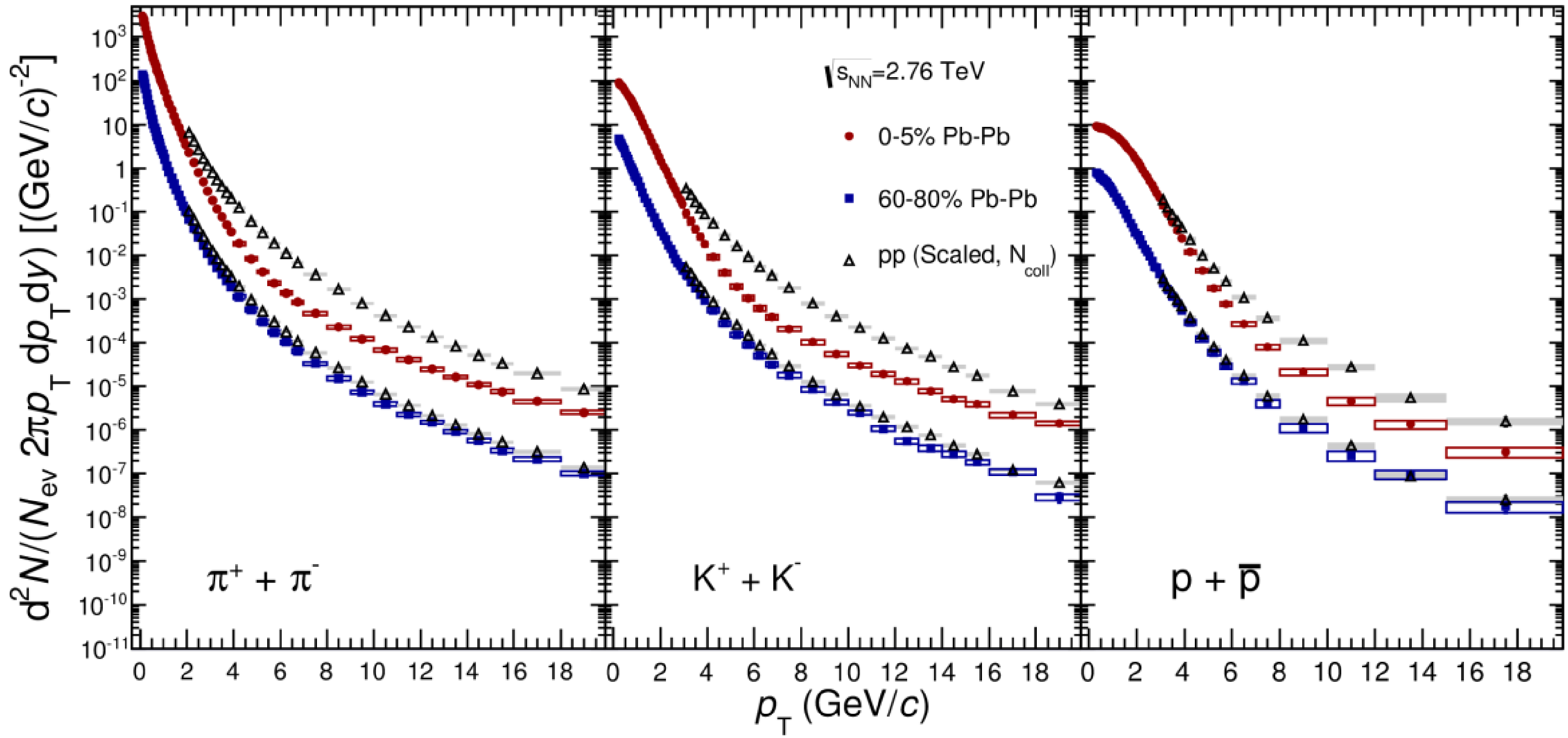
Color structure (Aurenche, Zakharov, EPJC71, 1829, 2011)

In medium formation time effects (Bellwied, Markert, PLB691, 208, 2010)

Magnitude of the effects are large (50+%) since it is linked to the large energy loss

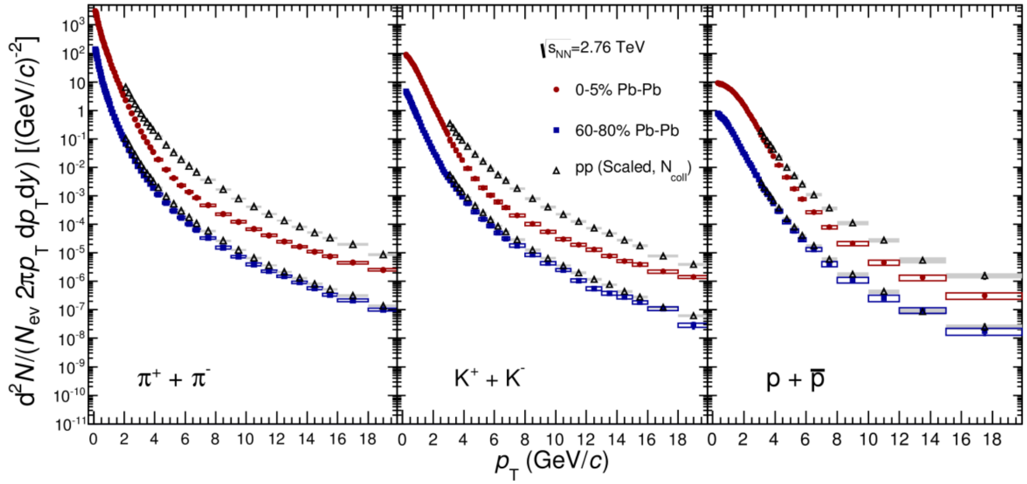
Charged π, K, and p spectra in pp and Pb-Pb collisions

arXiv:1401.1250



The π, K, p spectra measured in pp collisions for p_T > 10 GeV/c are in themselves important for constraining identified FFs

Particle ratios in pp and Pb-Pb collisions



arXiv:1401.1250

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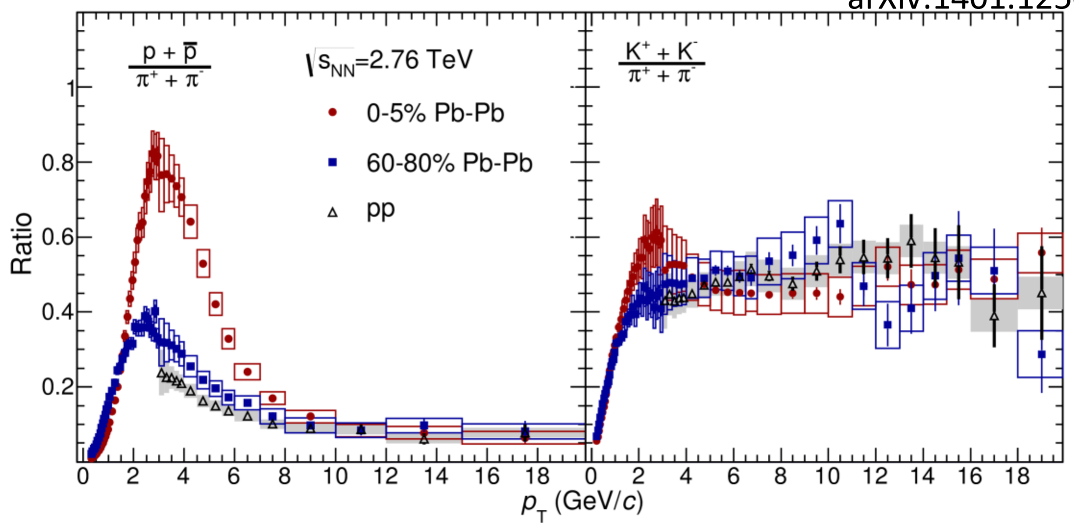
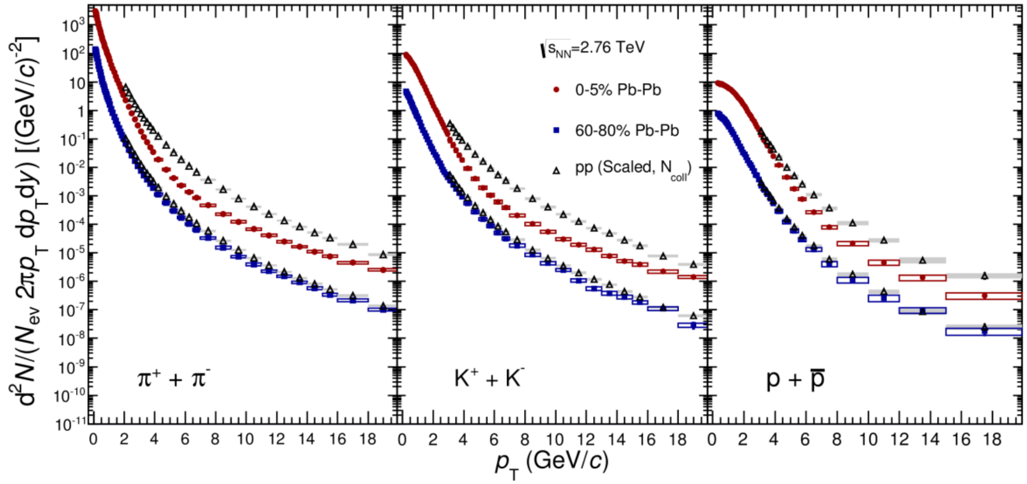


Particle ratios in pp and Pb-Pb collisions



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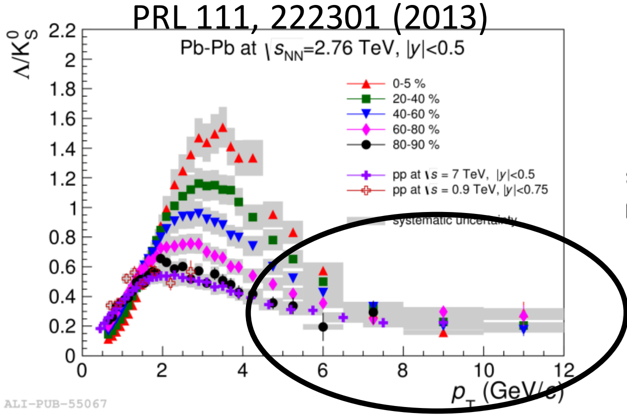
PRL 111, 222301 (2013)



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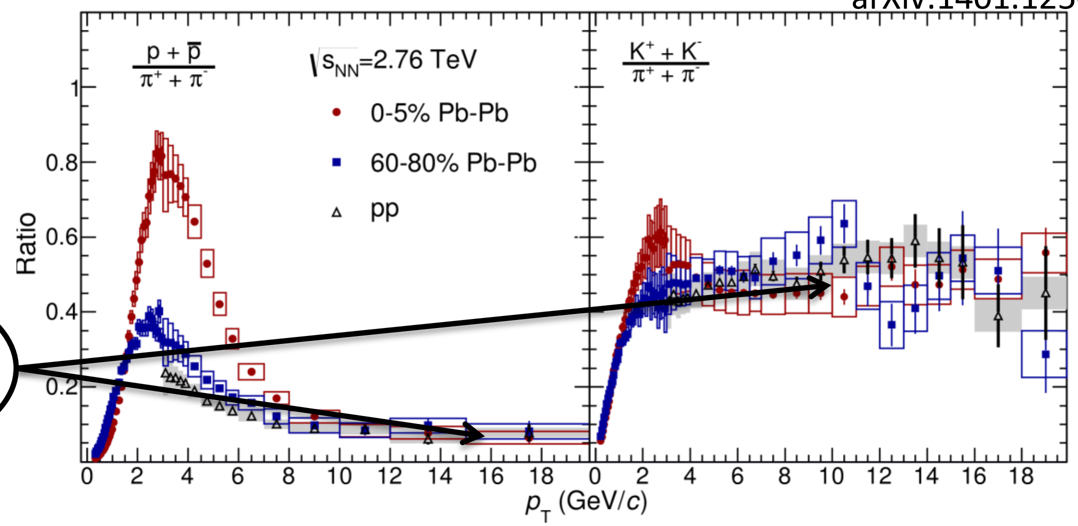
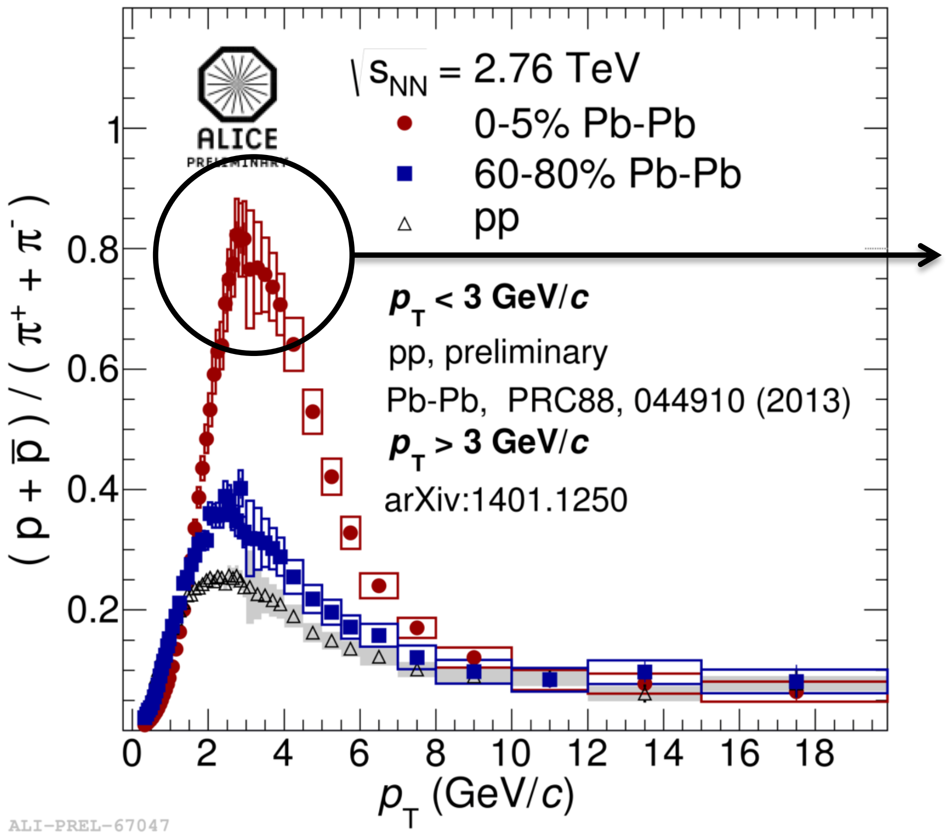
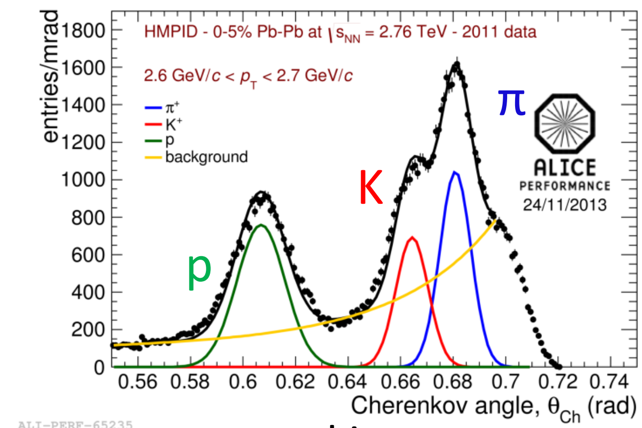


Pb-Pb particle ratios are consistent with those obtained in pp collisions for p_T > 10 GeV/c

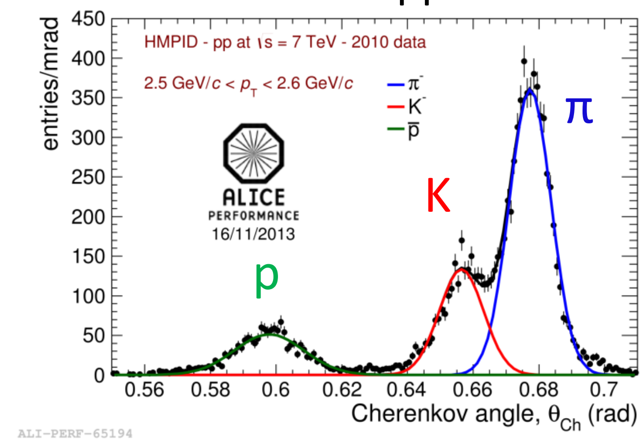
Improving the precision around the p/π peak



HMPID performance in Pb-Pb



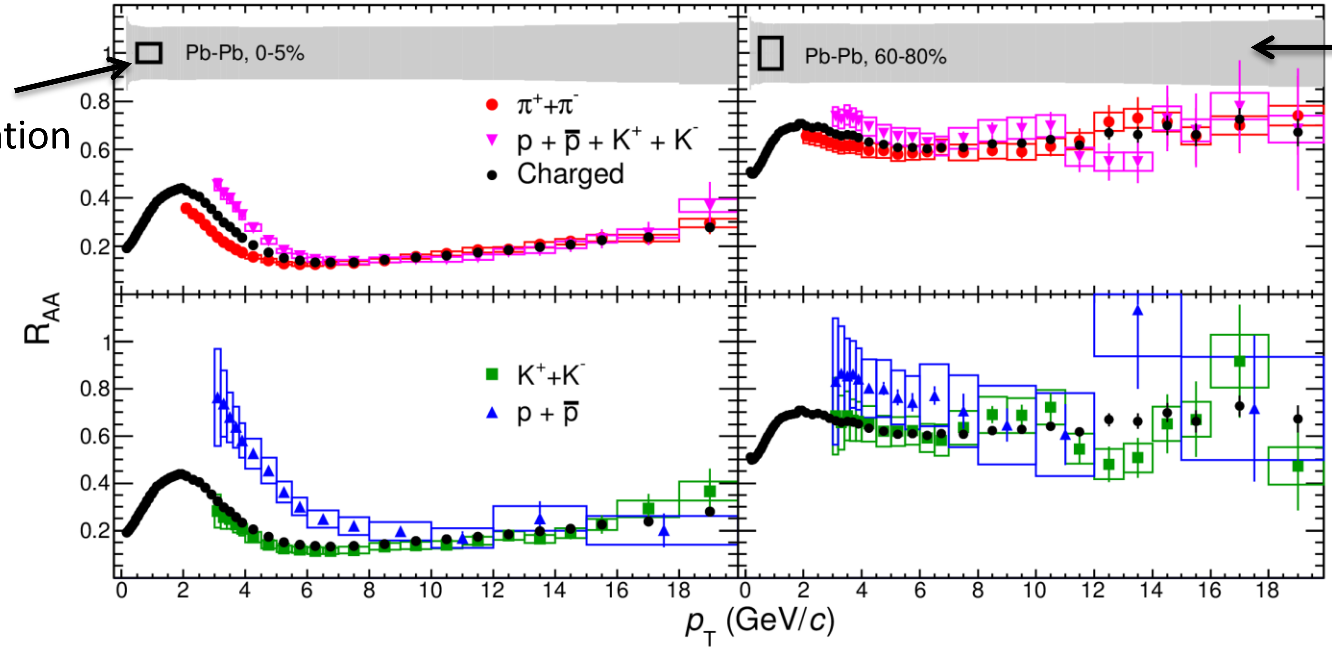
and in pp



HMPID is the ALICE Ring Imaging Cherenkov detector

The nuclear modification factor R_{AA}

Common normalization



Common systematics

arXiv:1401.1250

The nuclear modification factors are consistent for π, K, p for p_T > 10 GeV/c.
For 0-5% Pb-Pb collisions:
K and π are consistent to within ~10% (syst)
p and π are consistent to within ~25% (syst)
The results rules out popular ideas of jet quenching where the large energyloss is coupled to large leading order particle species dependent effects.

The nuclear modification factor R_{AA}

Common normalization

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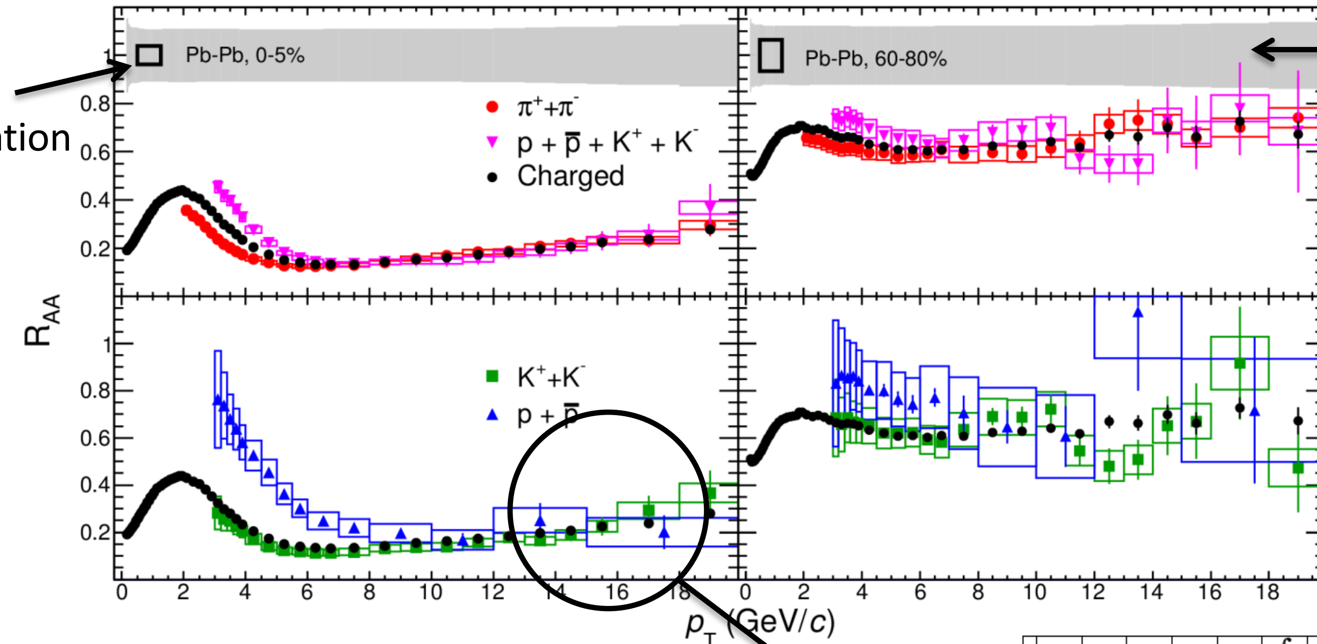

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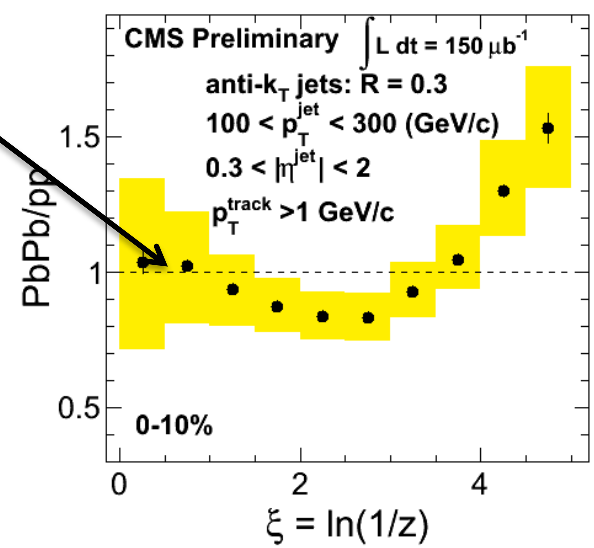
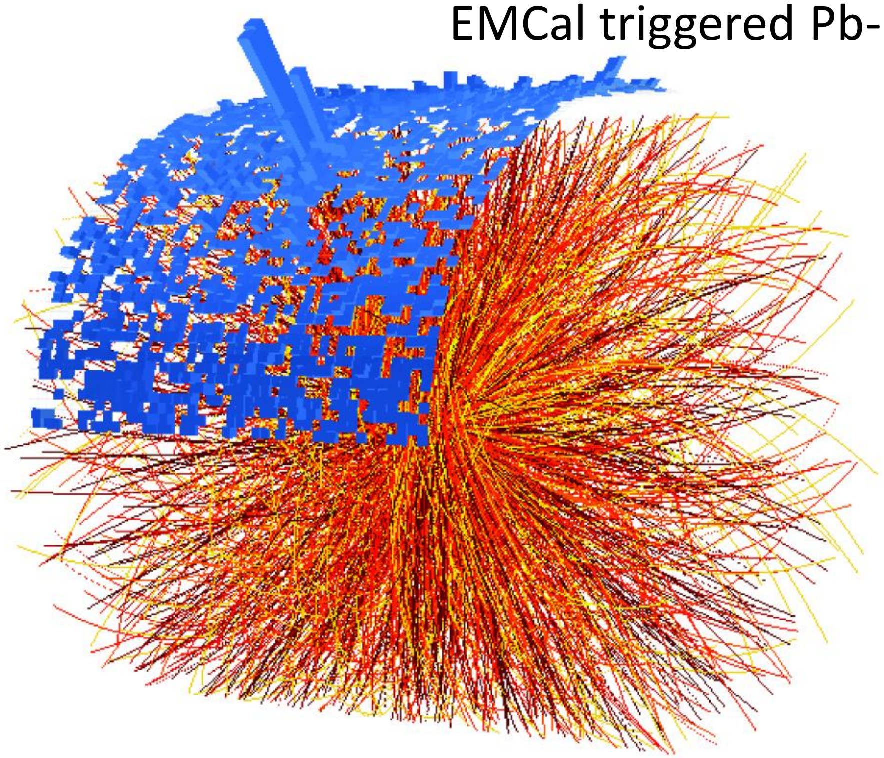


CMS-PAS-HIN-12-013

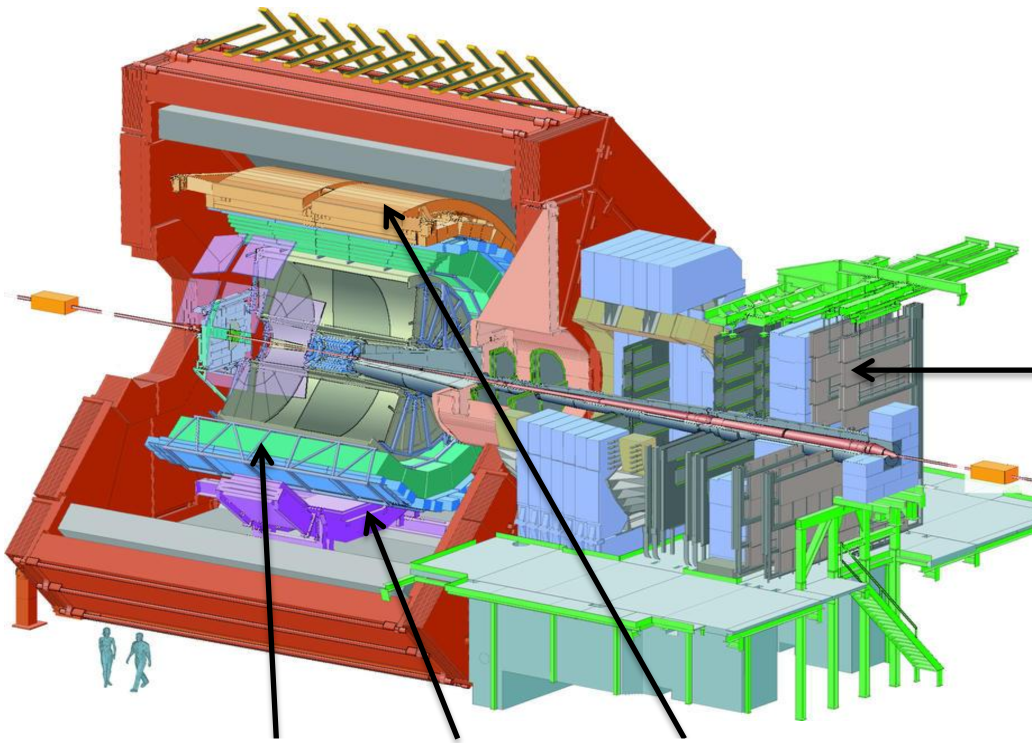
Run 1 performance with a focus on run 2


EMCal triggered Pb-Pb event

arXiv:1402.4476

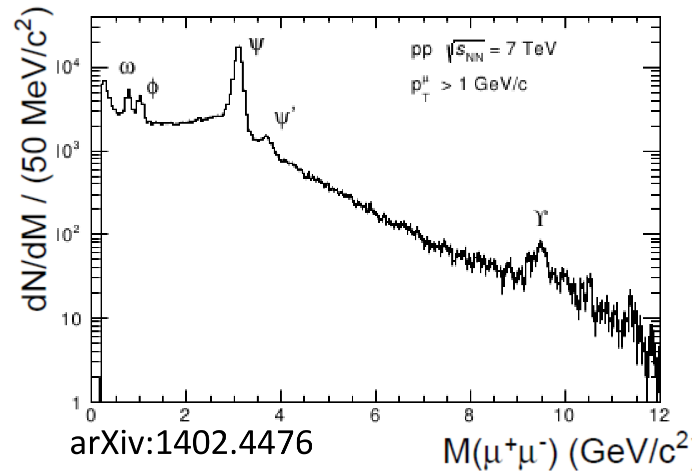
ALICE measurements during the full-energy LHC Run 2 (2015–2017) will, on one hand, focus on low p_T observables where triggering is not possible. The goal here is to increase the statistics to ~500 million minimum bias Pb–Pb events. Concerning rare probes, it is planned to inspect 1 nb^{-1} Pb–Pb interactions in the rare-trigger running mode.

ALICE main trigger capabilities



	TRD $\|\eta\| < 0.8$	PHOS $\|\eta\| < 0.12$	EMCal $\|\eta\| < 0.7$
2008	4	1	0
2009	7	3	2
2010	7	3	2
2011	10	3	5
2012	13	3	5 1/3
2013	13	3	5 1/3
goal	18	5	5 1/3

Muon arm pp dimuon-triggered data in 2011, $\mathcal{L} = 1.35\ \mathrm{pb}^{-1}$

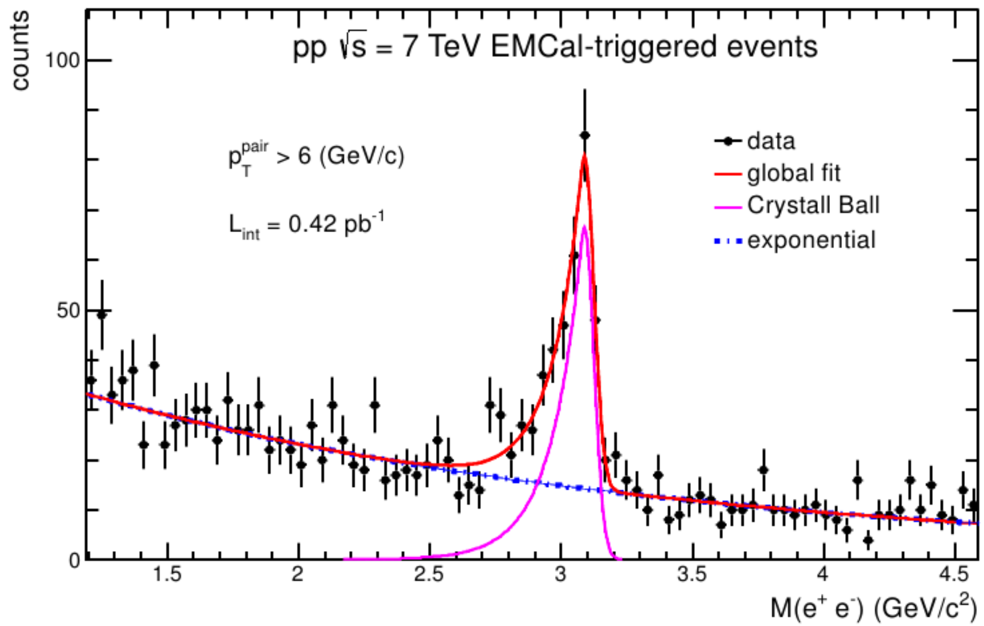


arXiv:1402.4476

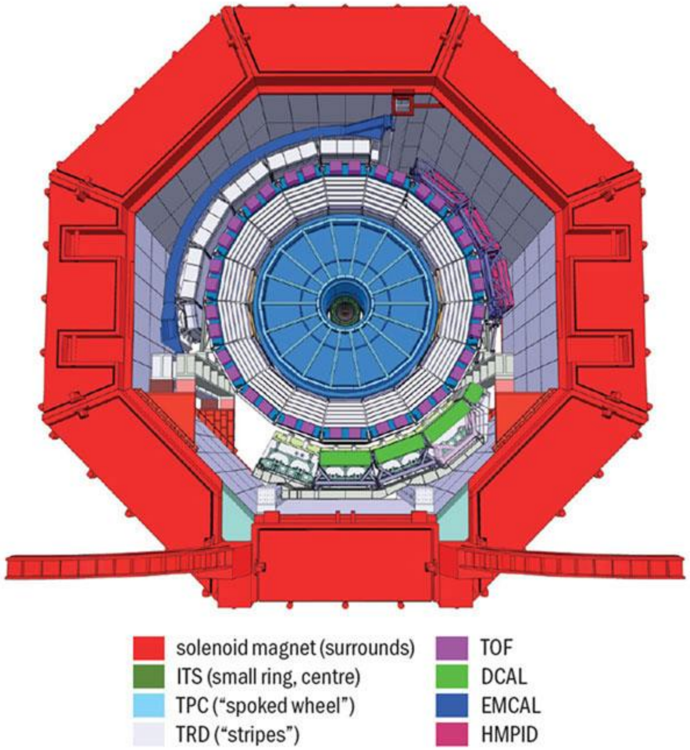
EMCal rare triggers	
E0	EMCal L0
EJE	neutral jet primary
EJE2	neutral jet secondary
EGA	photon by EMC primary
EGA2	photon by EMC secondary
TRD rare triggers	
TJE	charged jet
TQU	electron for quarkonia
TSE	electron for open beauty
MUON rare triggers	
MSL	single muon low
MSH	single muon high
MUL	dimuon unlike sign
MLL	dimuon like sign

EMCal trigger

Invariant mass in EMCal-triggered pp events
arXiv:1402.4476

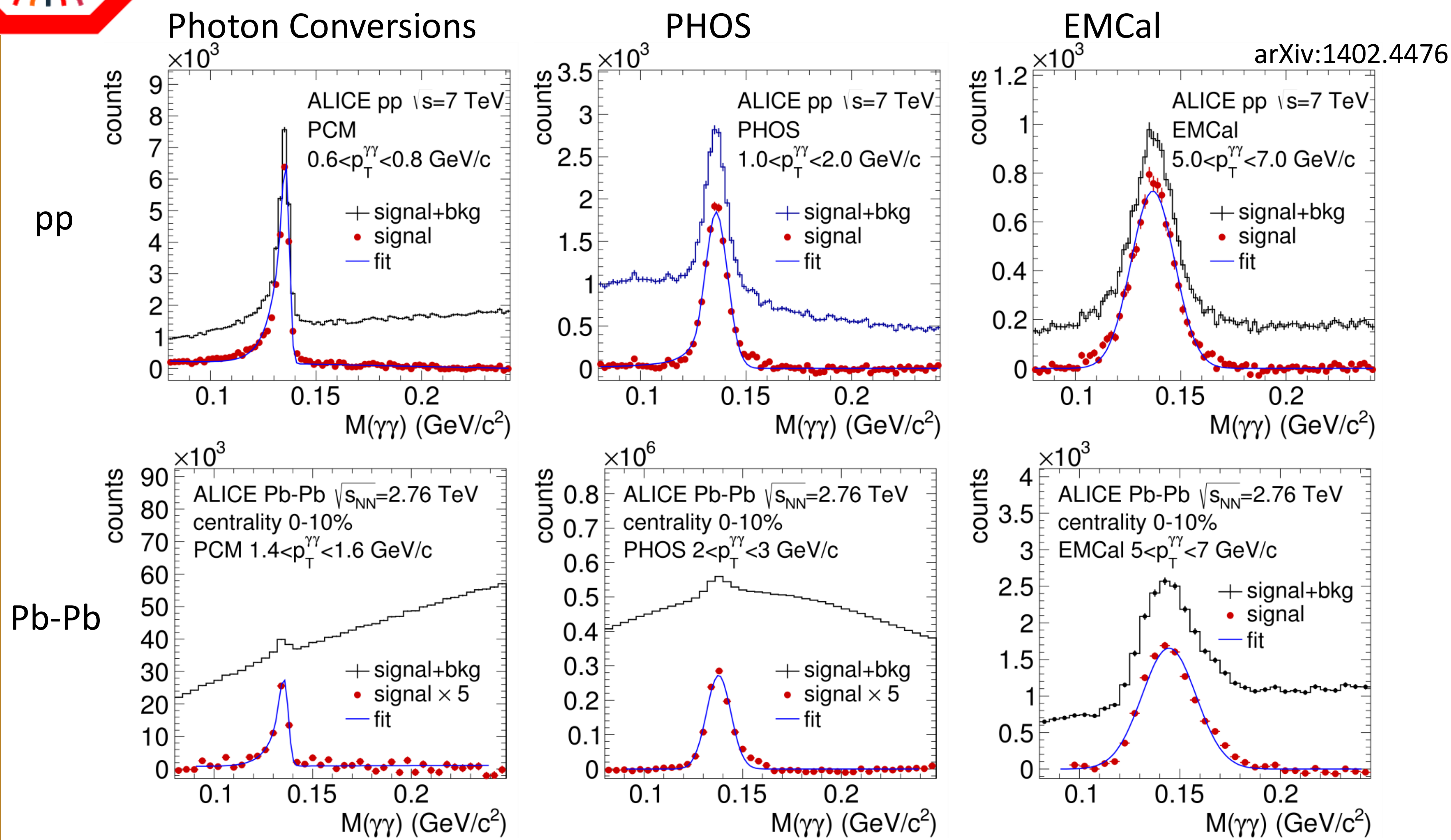


The EMCal triggering is necessary for ALICE to utilize efficiently the collision rates of run 2 which can be up to 10-20 kHz for Pb-Pb.



The existing EMCal will be complemented in run 2 by the new Di-Jet Calorimeter DCal to enable "back-to-back" analyses

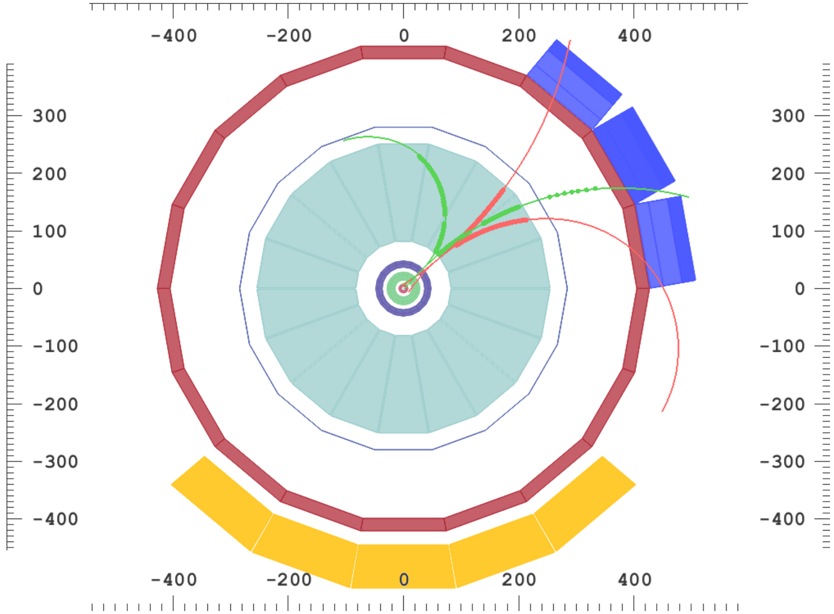
Examples of π^0 reconstruction



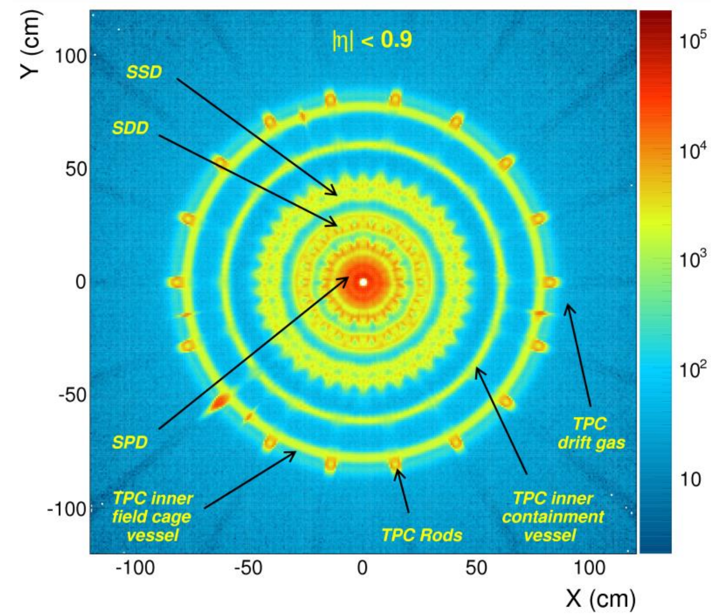
Photons from π^0 decays consistutes the largest background for thermal (soft) and direct (hard) photon measurements.

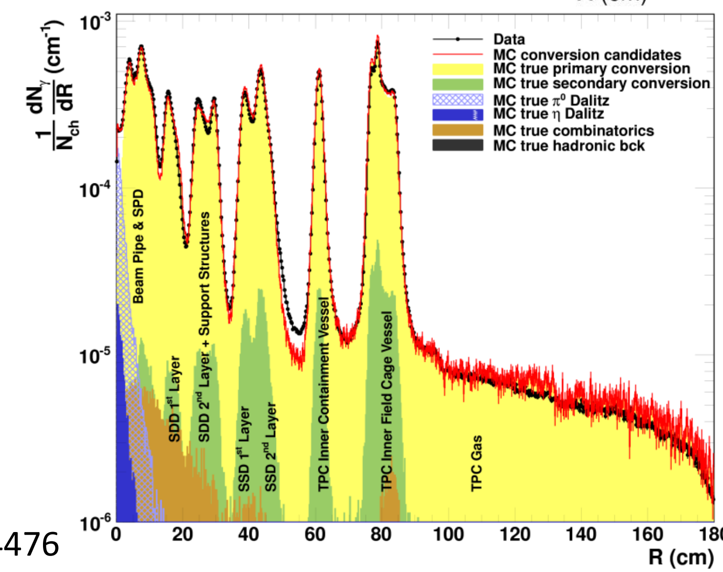
Material budget

$\pi^0 \rightarrow 2\gamma$ converts to $2(e^- + e^+)$



arXiv:1402.4476





The integrated detector material for $R < 180$ cm and $|\eta| < 0.9$ amounts to a radiation thickness of $11.4 \pm 0.5\%\ X_0$ and results in a conversion probability of about 8.5%.

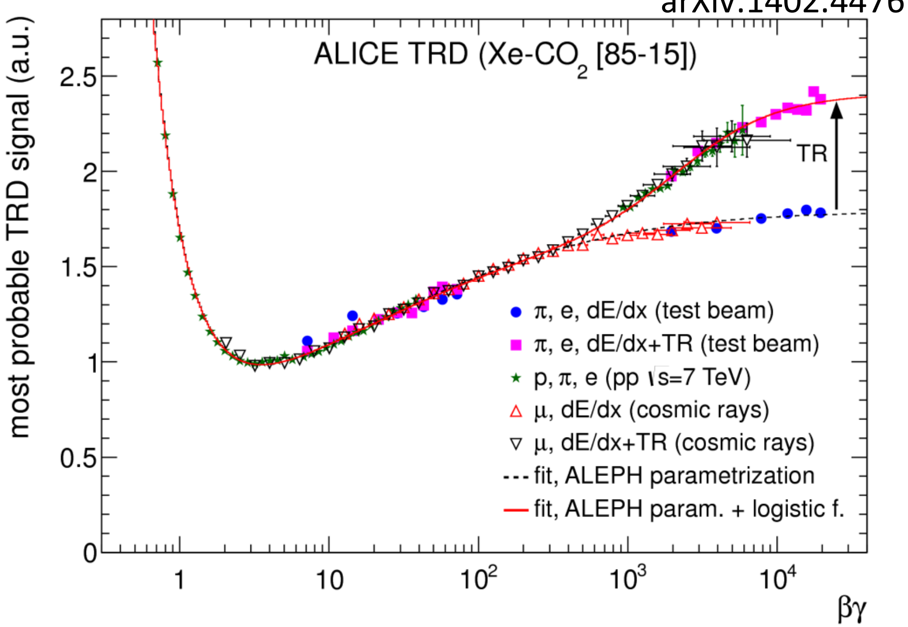
This precision goes directly into all photon analyses.

arXiv:1402.4476

TRD performance

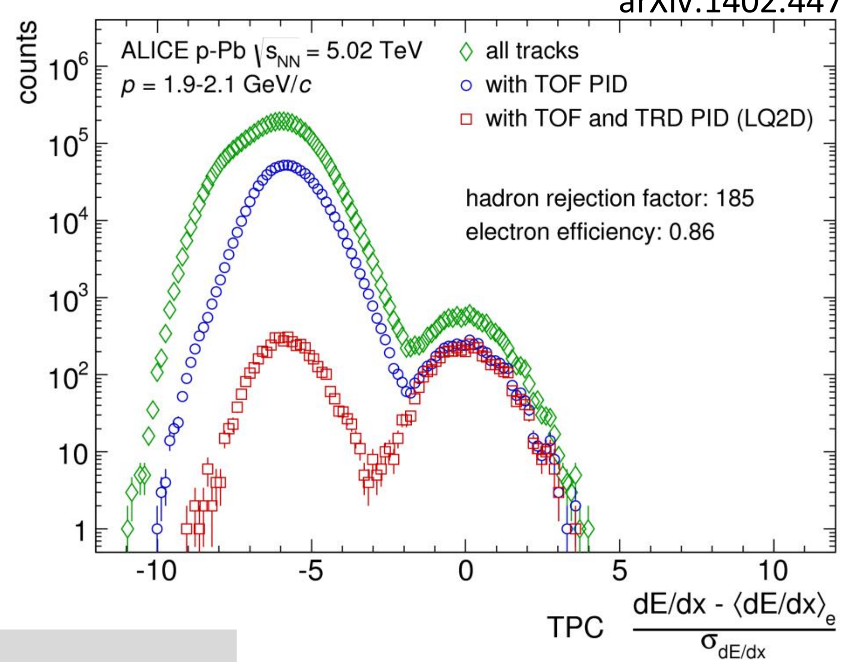
TRD energy loss signal w/o radiator

arXiv:1402.4476



Example of TRD pion rejection

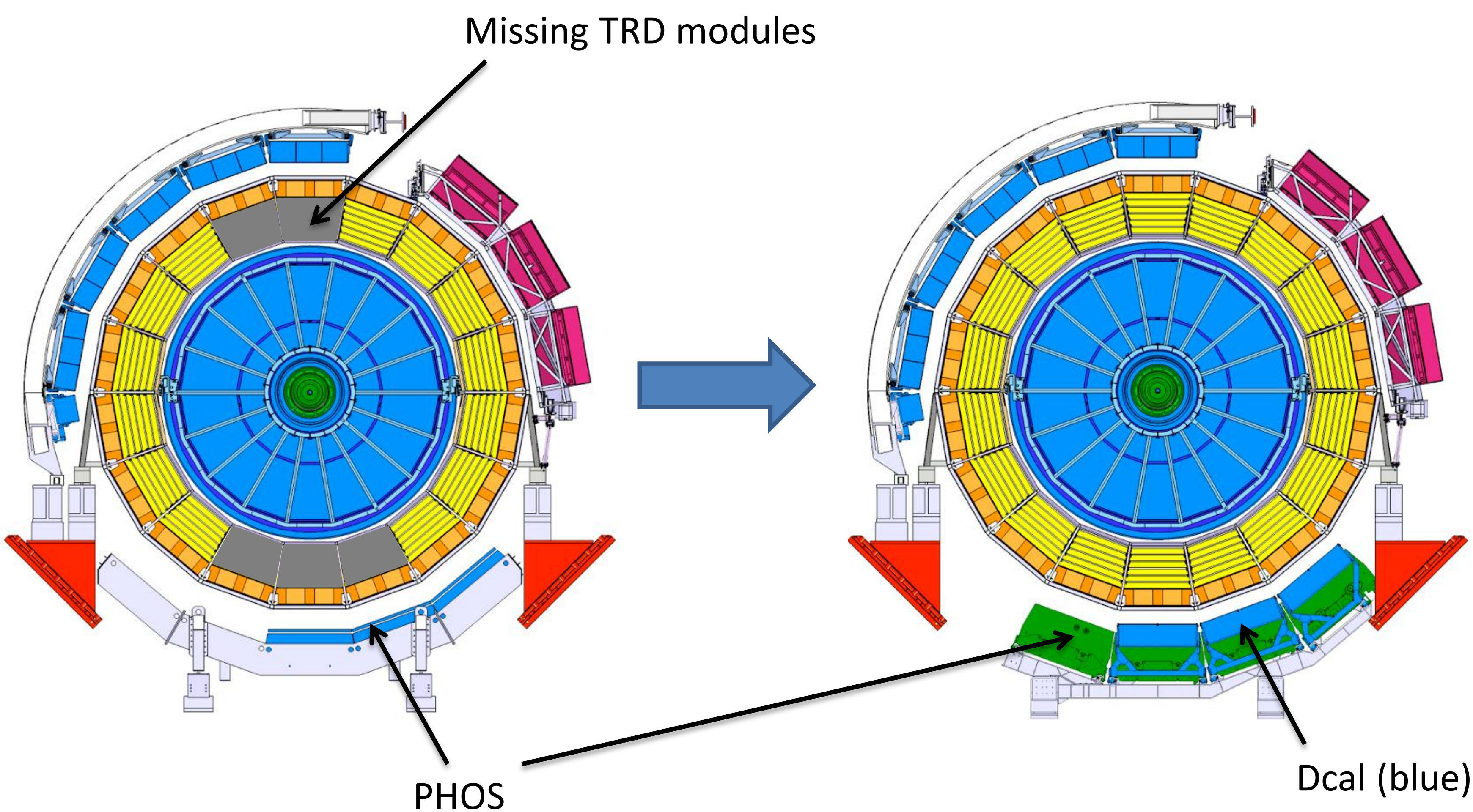
arXiv:1402.4476



The TRD with its large acceptance and triggering capabilities at intermediate p_T = 2–5 GeV/c is particularly suited for dilepton measurements, including quarkonia, while the trigger capabilities of EMCal (and PHOS) complements these capabilities in a smaller acceptance and makes it possible to sample the full luminosity for high-p_T electron measurements (from heavy-flavor decays).

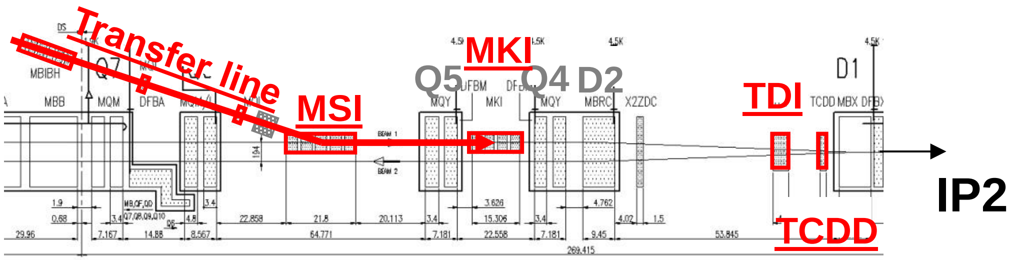
In terms of tracking the TRD is critical for extending the tracking to p_T > 50 GeV/c and it will play an important role in calibrating the upgraded GEM TPC (run 3).

LS1 activities



TDI rework to decrease the background

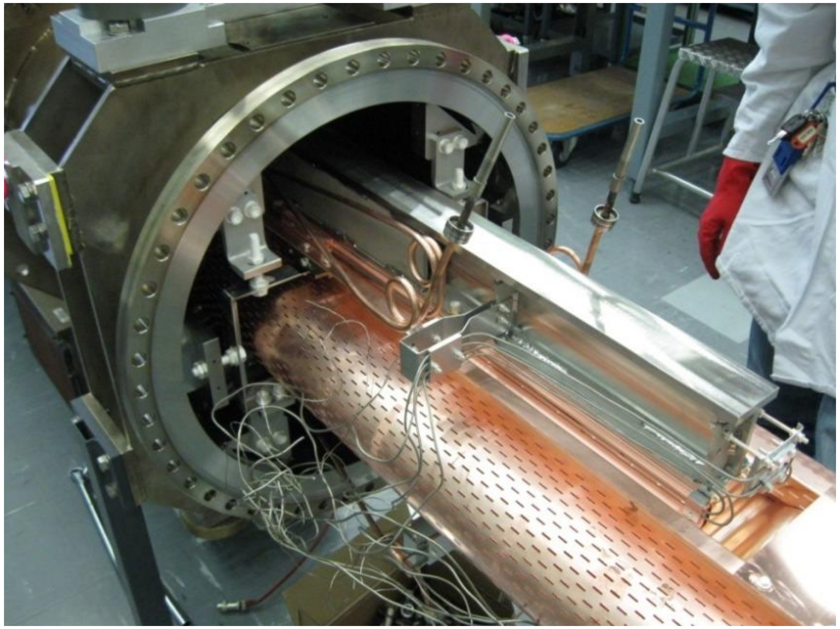
High vacuum pressure in the long straight sections upstream of ALICE were causing excessive background from beam-gas collisions during ALICE pp operations in 2012.



The TDI injection collimator was identified as one of the main sources of this problem.

The TDI is at this moment on the surface and is being refurbished in order to mitigate these problems:

- Beam screens are being replaced
- More pump capacity
- NEG (Non Evaporable Getter) coating
- More JAW cooling and decreasing of impedance



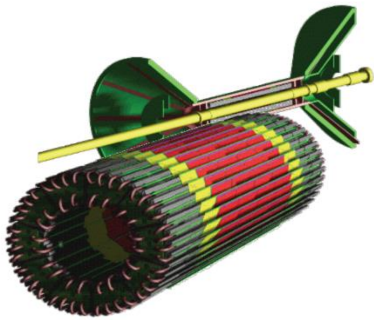
Availability of P2 services during 2014

Week number	From	To	Intervention type: Cooling						Gas		Electricity
2	6-Jan	12-Jan	Chilled water upgrade (phase II)								
3	13-Jan	19-Jan									
4	20-Jan	26-Jan							Gas Control Systems (GCS) migration	MCH/MTR	
5	27-Jan	2-Feb								MTR/PMD	
6	3-Feb	9-Feb								TRD	
7	10-Feb	16-Feb			Replacement UW pumps						
8	17-Feb	23-Feb									
9	24-Feb	2-Mar								HMPID	27-28.3: stop UX racks
10	3-Mar	9-Mar									400V/18kV power cut
11	10-Mar	16-Mar									10.3: AUG
12	17-Mar	23-Mar									
13	24-Mar	30-Mar								TPC	29.3: autotransfert
14	31-Mar	6-Apr				Portable chiller					
15	7-Apr	13-Apr		SF2		No cooling P2				TOF	
16	14-Apr	20-Apr					PLC relocation UX->CR5				
17	21-Apr	27-Apr					Det cooling maintenance	TRD / SDD-SSD			
18	28-Apr	4-May				No cooling UX25 racks and detector cooling		TOF-PHOS-EMC		CPV	
19	5-May	11-May						TPC / HMPID			6.5: test reseau secour
20	12-May	18-May						SPD			
21	19-May	25-May									
22	26-May	1-Jun									

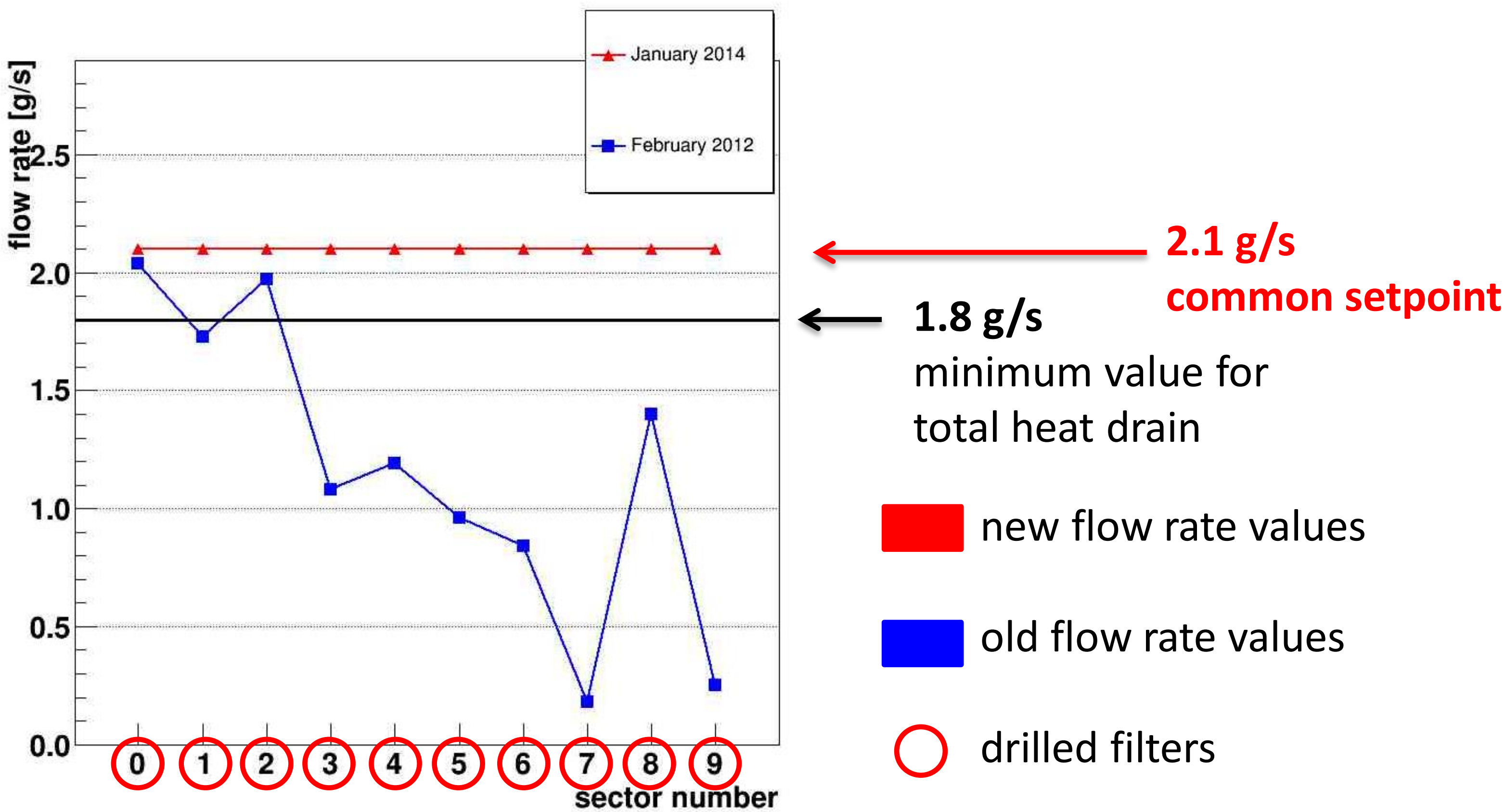
Many service interruptions due to technical infrastructure maintenance at this moment

→ negotiated stable conditions as from June 1st

SPD cooling fixed



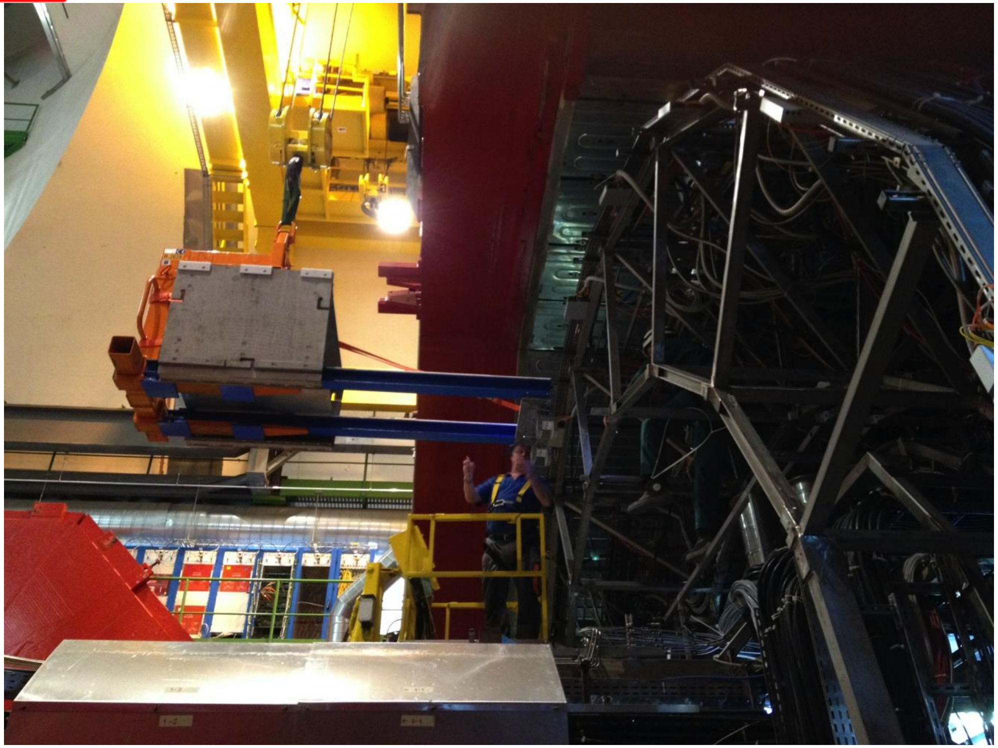
- Silicon Pixel detector had problems of cooling power due to clogged filters in front of the detector in an inaccessible region
- Complex remote drilling operation successfully reestablished the nominal flow
- Comparison with February 2012, before the drilling started

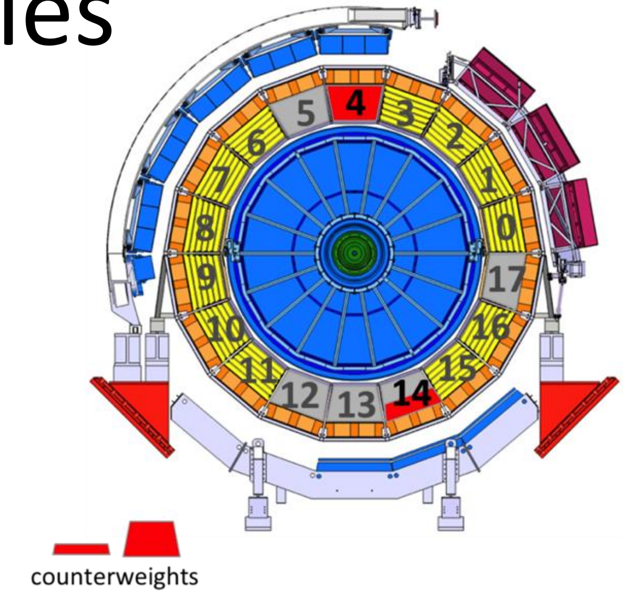


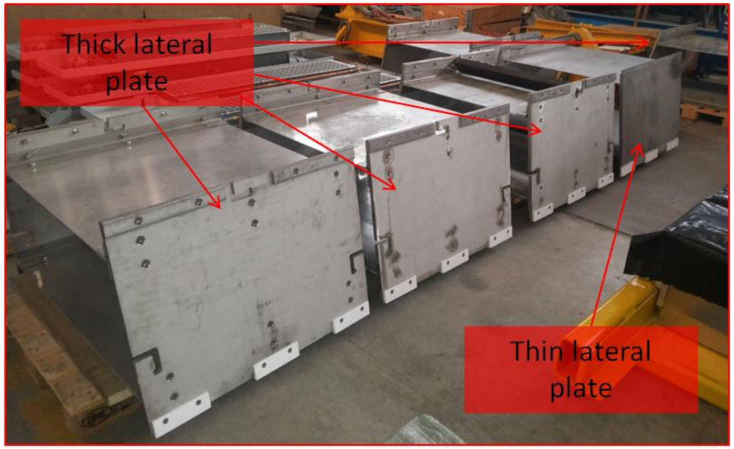
DAQ – CR1 coming back to life

DAQ in CR1 being reinstalled after full replacement and extension of hardware.
Goal: DAQ available from June 1st 2014 for global commissioning

Preparations for installation of TRD modules



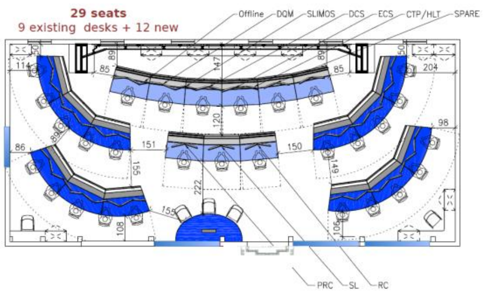




Counterweights are installed.
Installation of TRD modules starts in May.
Module 12 and 13 are at CERN.
Module 14 well on the way.
At this moment things are according to plan.

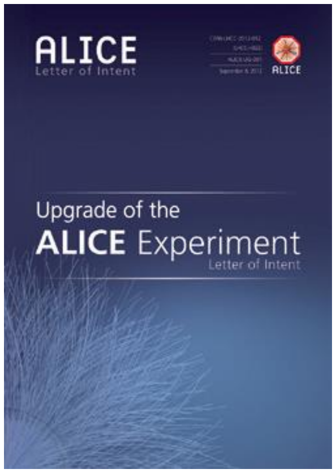
ALICE Control Room refurbishing

- Floor, ceiling & lights in place
- Ventilation ongoing
- Fire detection in March
- New desks in April
- Finalize cabling in May



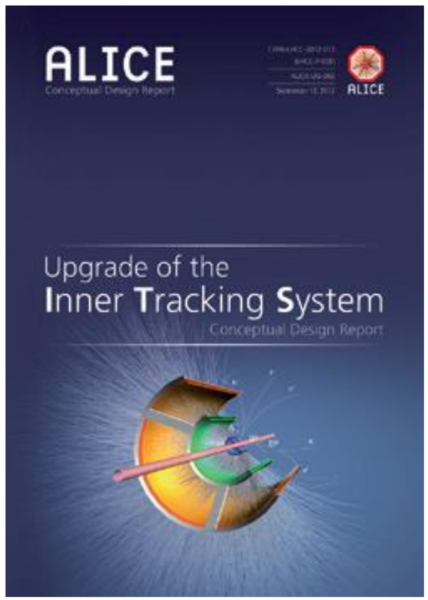
Computer rendering

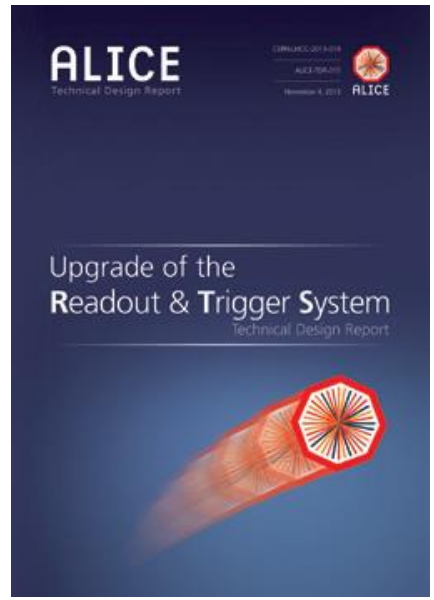
ALICE upgrades for LS2



Original LOI

The TDR family is growing





ALICE TPC Upgrade TDR was submitted on monday

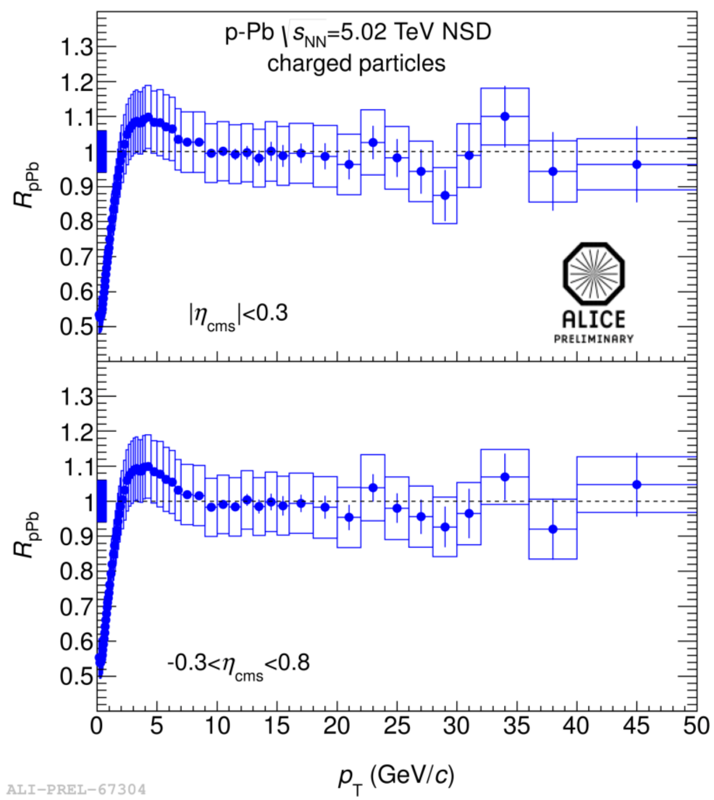
Two more TDRs are under preparation:
Online-Offline (O^2), Muon Forward Tracker (MFT)

Conclusions

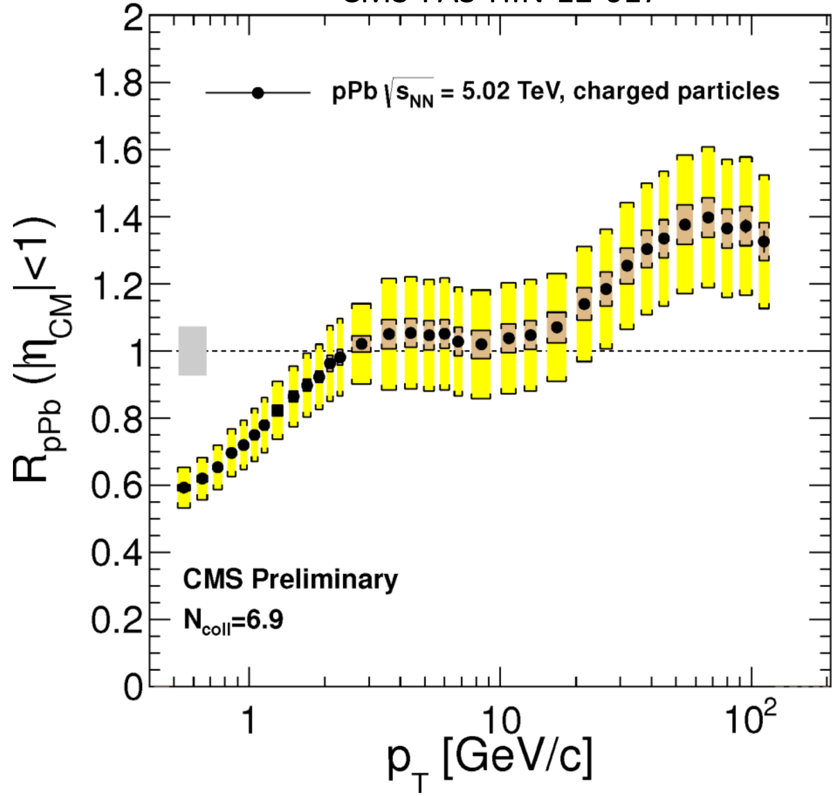
- ALICE has published 5 papers and submitted 2 new papers since last LHCC
- New results highlights the importance of p_T spectra for pQCD and for understanding the energy loss mechanism in detail
- Preparations for run 2 analysis are going well
- The many ongoing consolidation activities at Point 2 during LS1 are on schedule
- ALICE TPC upgrade TDR submitted to LHCC

Backup slides

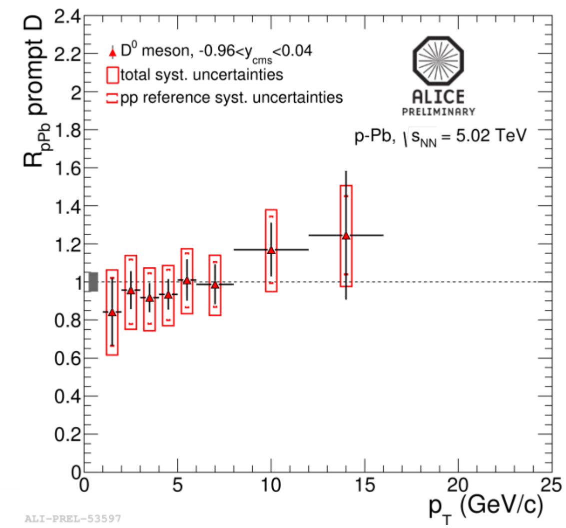
The nuclear modification factor in p-Pb

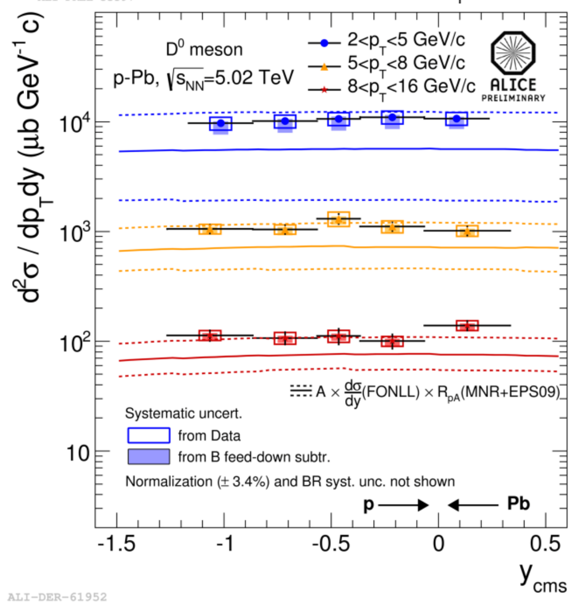


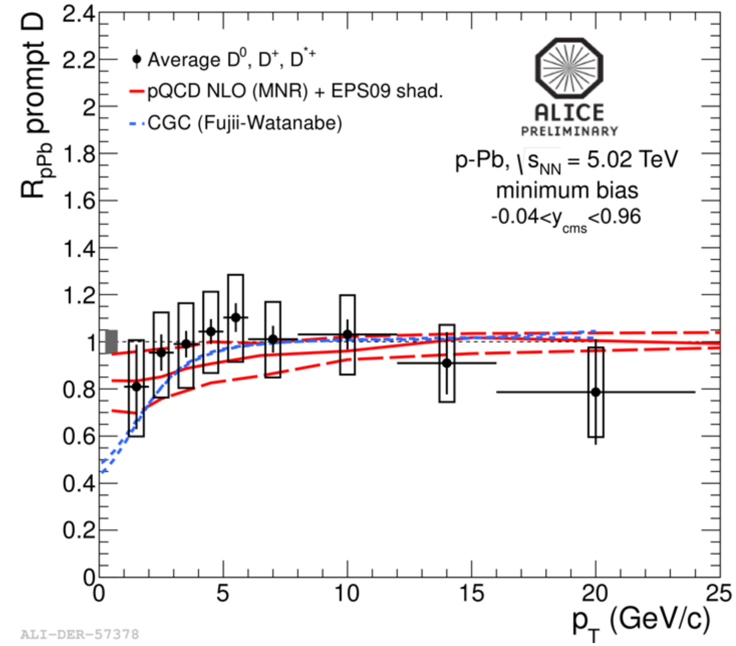
CMS-PAS-HIN-12-017



D meson production in p-Pb collisions



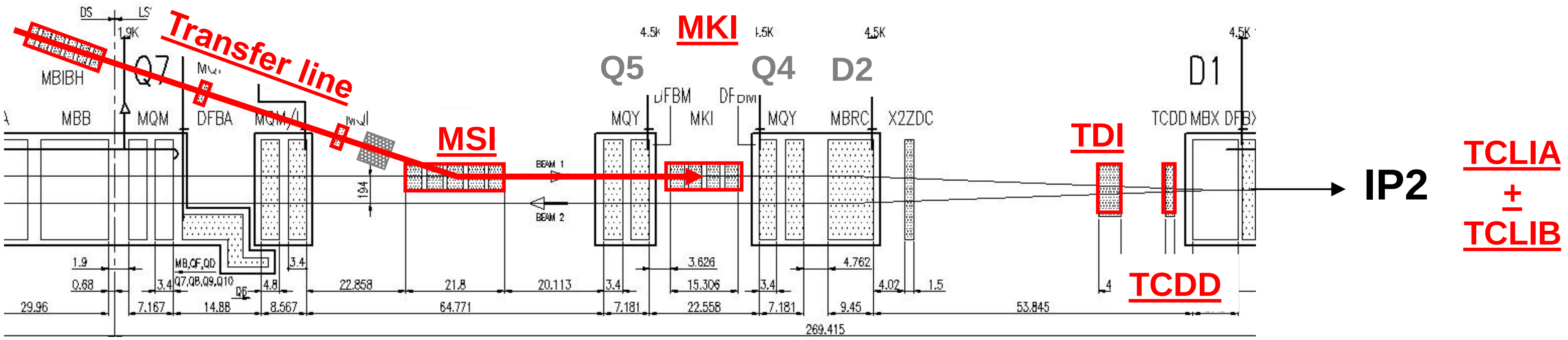




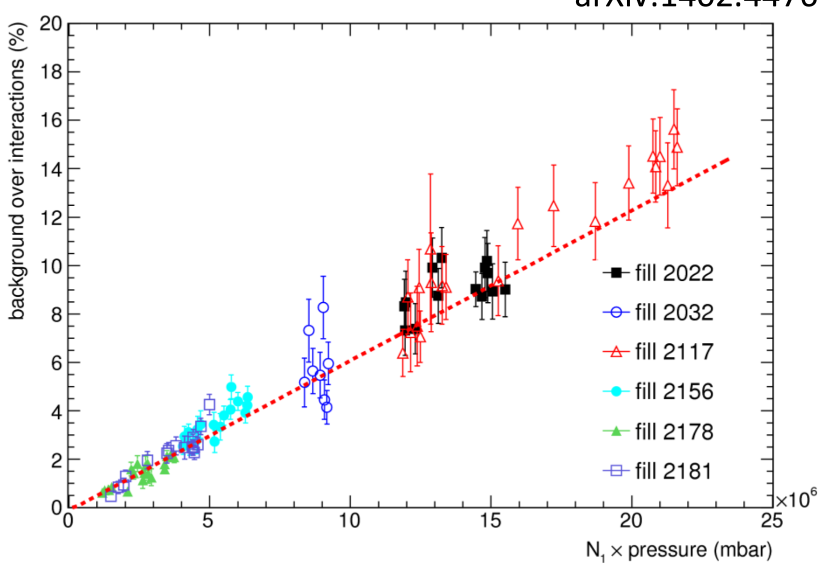
Production of D mesons at mid-rapidity are also in agreement with binary scaling at high p_T. No evidence for anti-shadowing.

D^0 poduction in agreement with FONLL QCD calculations (large systematic uncertainty).

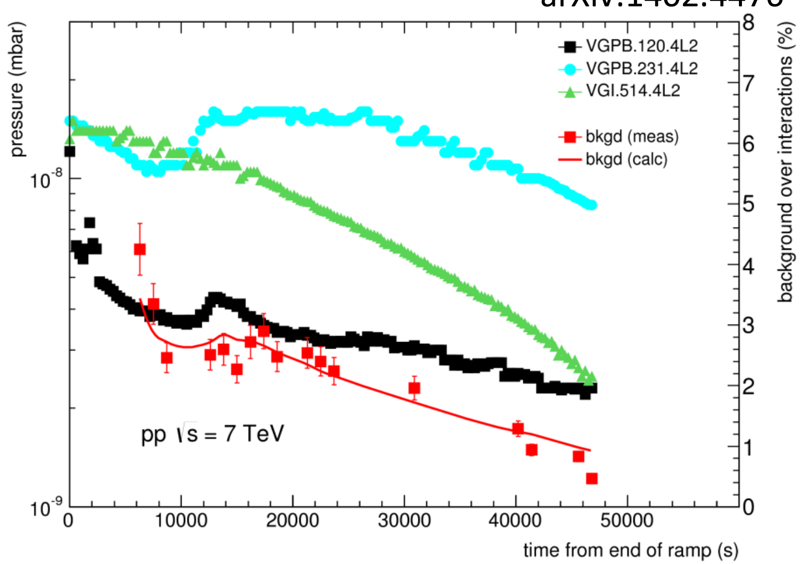
TDI vacuum pressure and the large background



arXiv:1402.4476



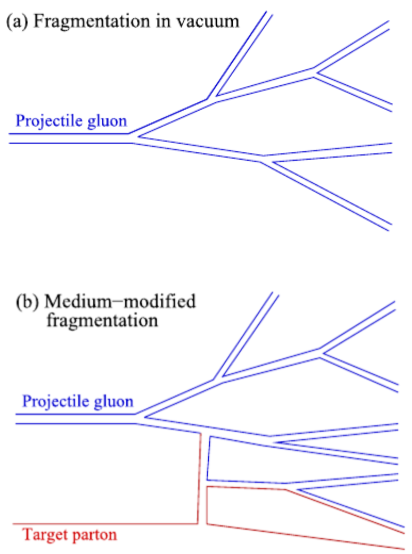
arXiv:1402.4476



Pressure measured in Long Straight Section 2 (LSS2)

Why expect particle species dependent R_{AA} at high p_T?

- Large effects at intermediate p_T – does this effect just disappear?
- The low value of R_{AA} suggests that most hard partons interacts strongly with the medium

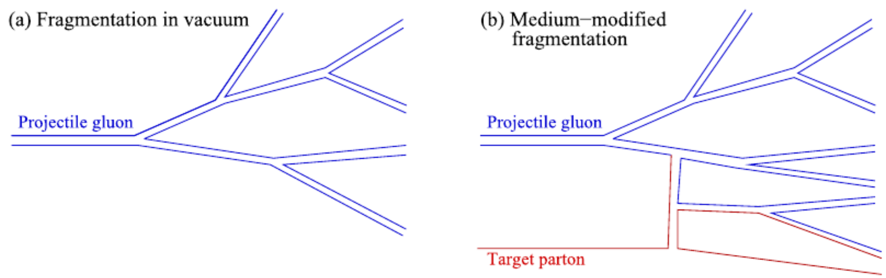


S. Sapeta and U.A. Wiedemann, Eur.Phys.J. C55 (2008) 293:

- Indirect
  - “in all models of radiative parton energy loss, the interaction of a parent parton with the QCD medium transfers color between partonic projectile and target. <u>This changes the color flow in the parton shower and is thus likely to affect hadronization</u>.”
- Direct
  - “In addition, flavor or baryon number could be exchanged between medium and projectile.”

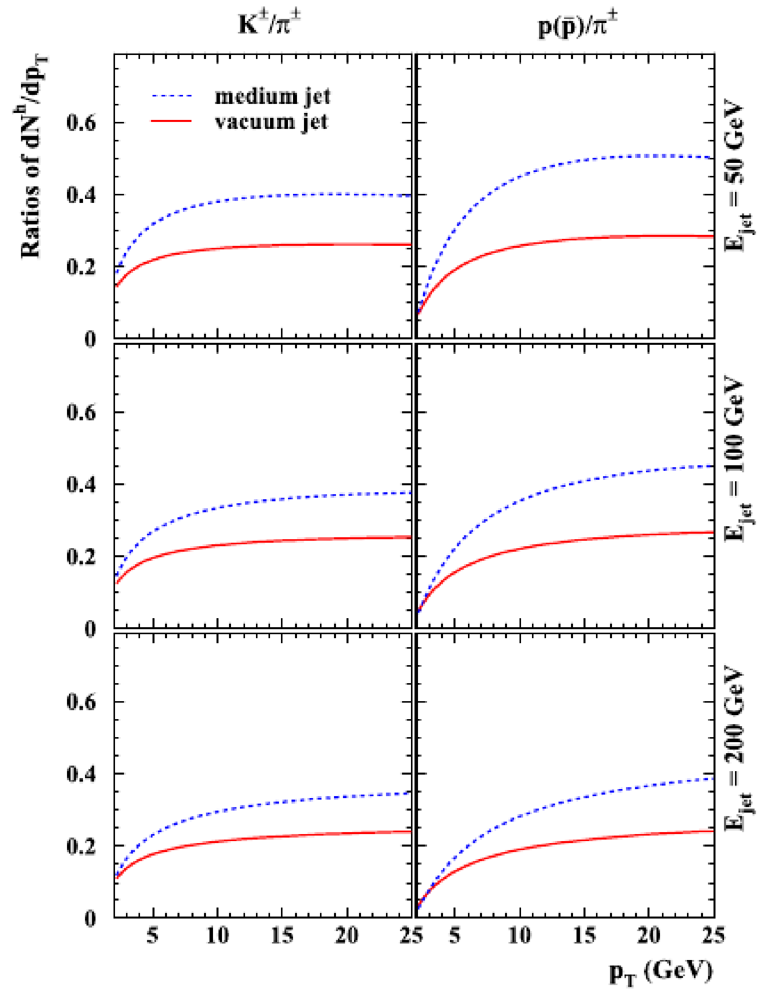
A general model with particle species dependent modifications

S. Sapeta and U.A. Wiedemann, Eur.Phys.J. C55 (2008) 293



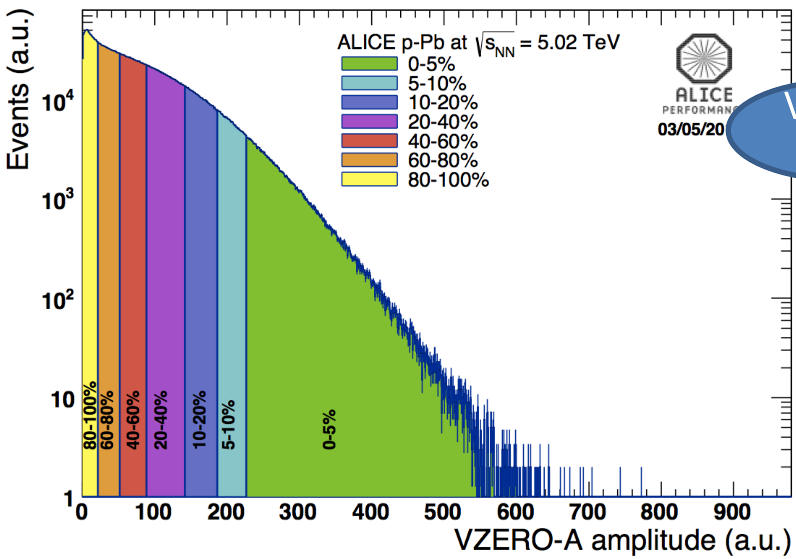
- Effect <u>inside jet</u>
- But for p_T >> 8 GeV/c we expect all hadrons to belong to jets

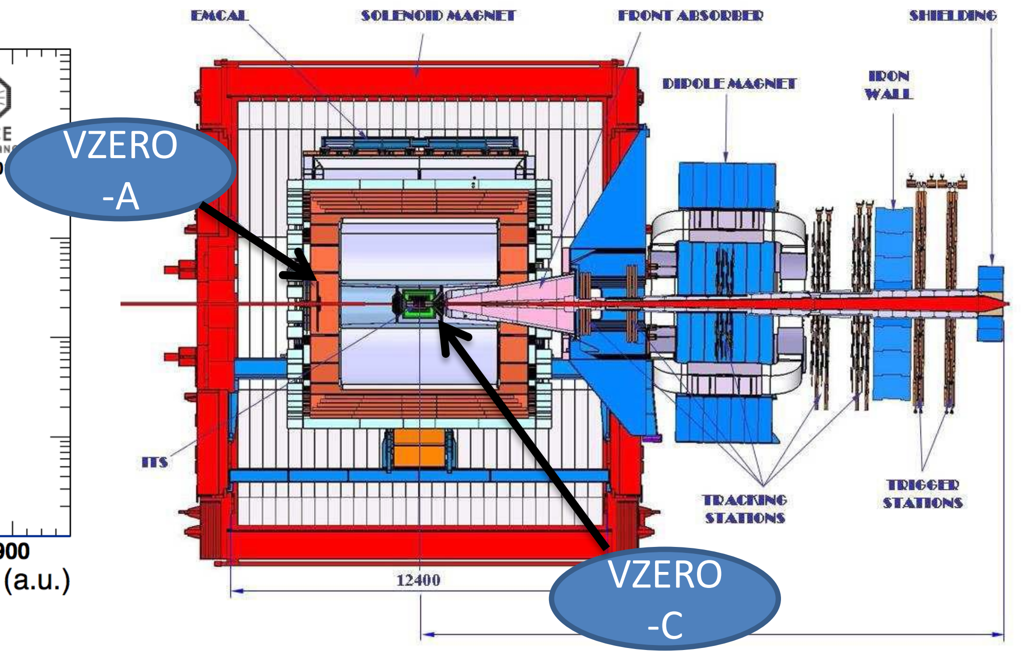
- Question: what do we learn about the interaction between parton and medium?



ALICE: trigger and multiplicity

p $\longrightarrow$ $\longleftarrow$ Pb ($y_{CM}=y_{LAB}+0.465 \longrightarrow$)





- VZERO used for triggering and multiplicity (A side)
- Fluctuations in the number of hard scatterings are important because of the small number of participants $\Rightarrow$ weaker multiplicity vs. impact parameter correlation than in Pb-Pb