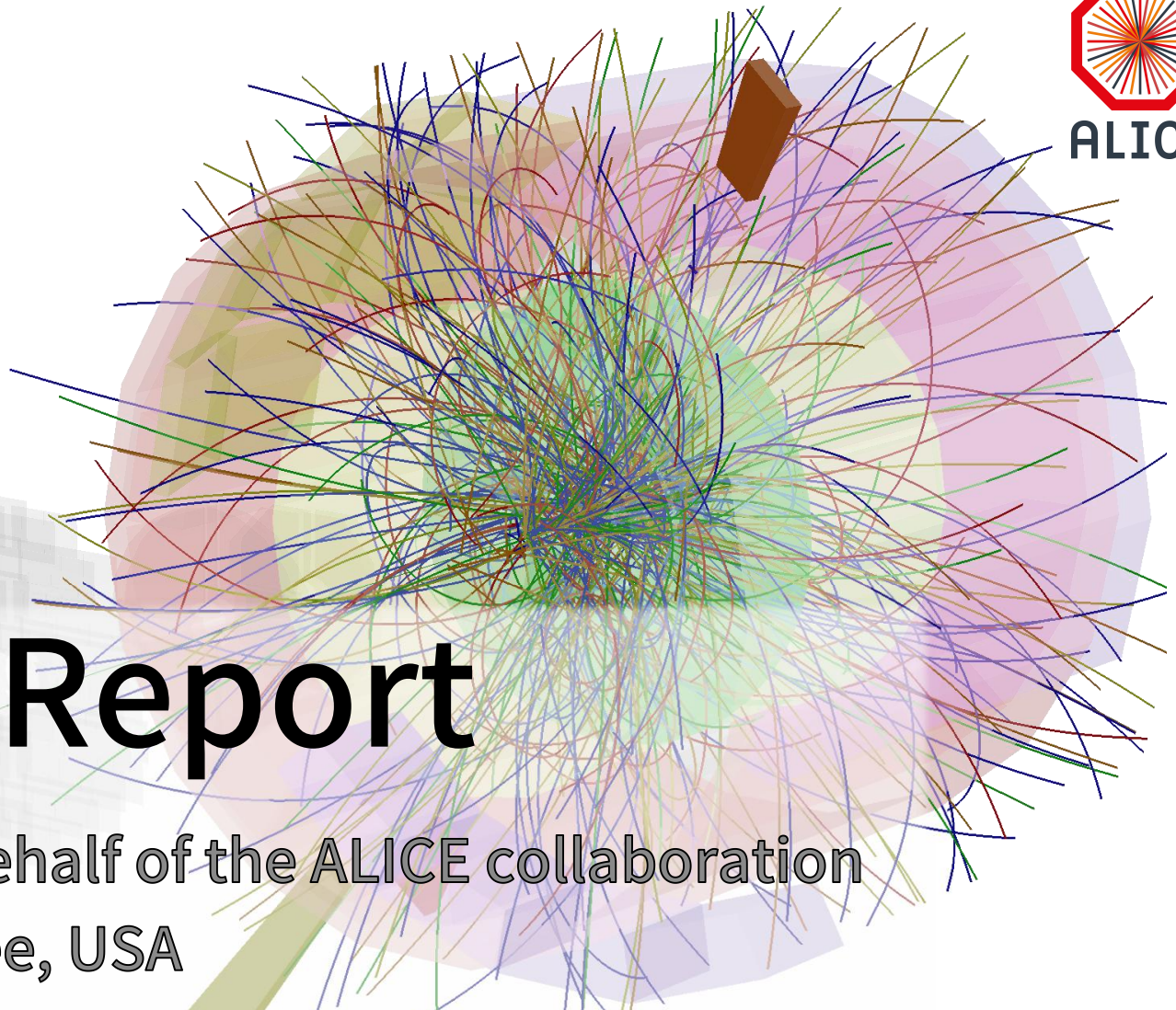


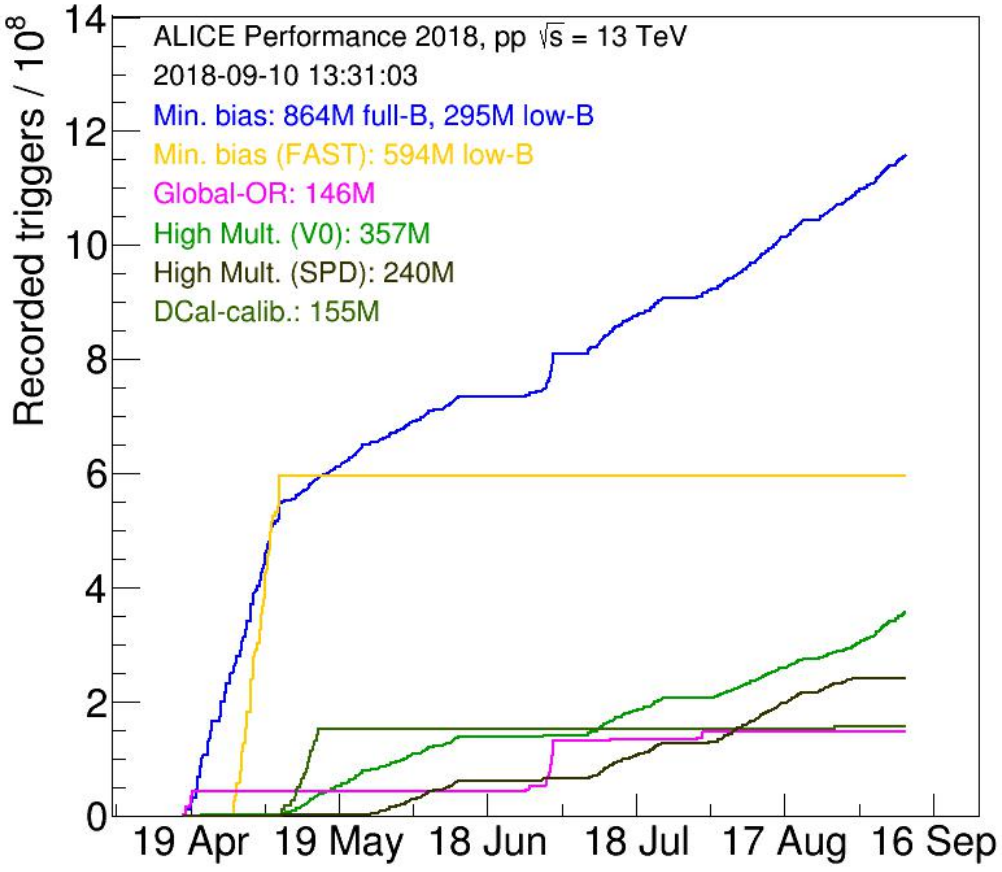
ALICE Status Report

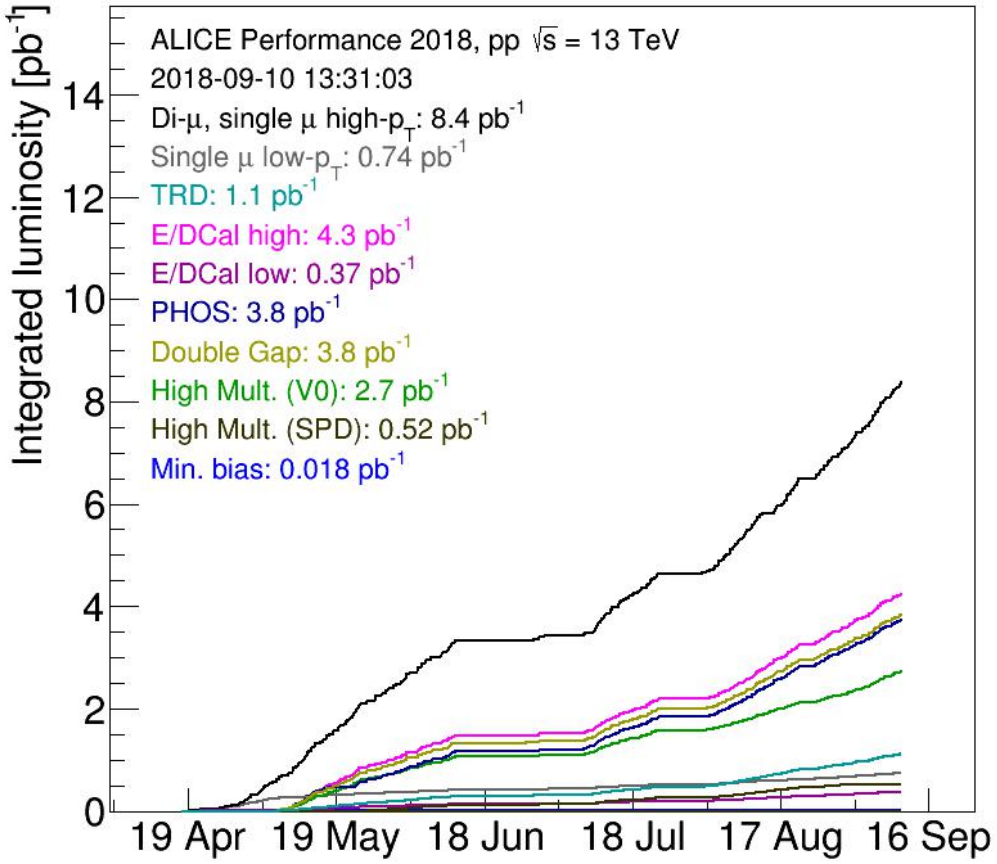
Redmer Alexander Bertens, on behalf of the ALICE collaboration
University of Knoxville, Tennessee, USA

135th LHCC meeting, open session - September 12, 2018

Data taking 2018

nominal running conditions for pp, rich trigger menu





preparations for the end-of-year Pb-Pb campaign fully underway

aiming for 1 nb^{-1}, running at 1 Hz mb^{-1}

Submitted papers

1) "p-p, p-Λ and Λ-Λ correlations studied via femtoscopy in pp reactions at √s = 7 TeV", submitted to PRC, https://arxiv.org/abs/1805.12455

2) "Medium modification of the shape of small-radius jets in central Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV", submitted to JHEP, https://arxiv.org/abs/1807.06854

3) "Measurement of dielectron production in central Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV", submitted to PRC, http://arxiv.org/abs/1807.00923

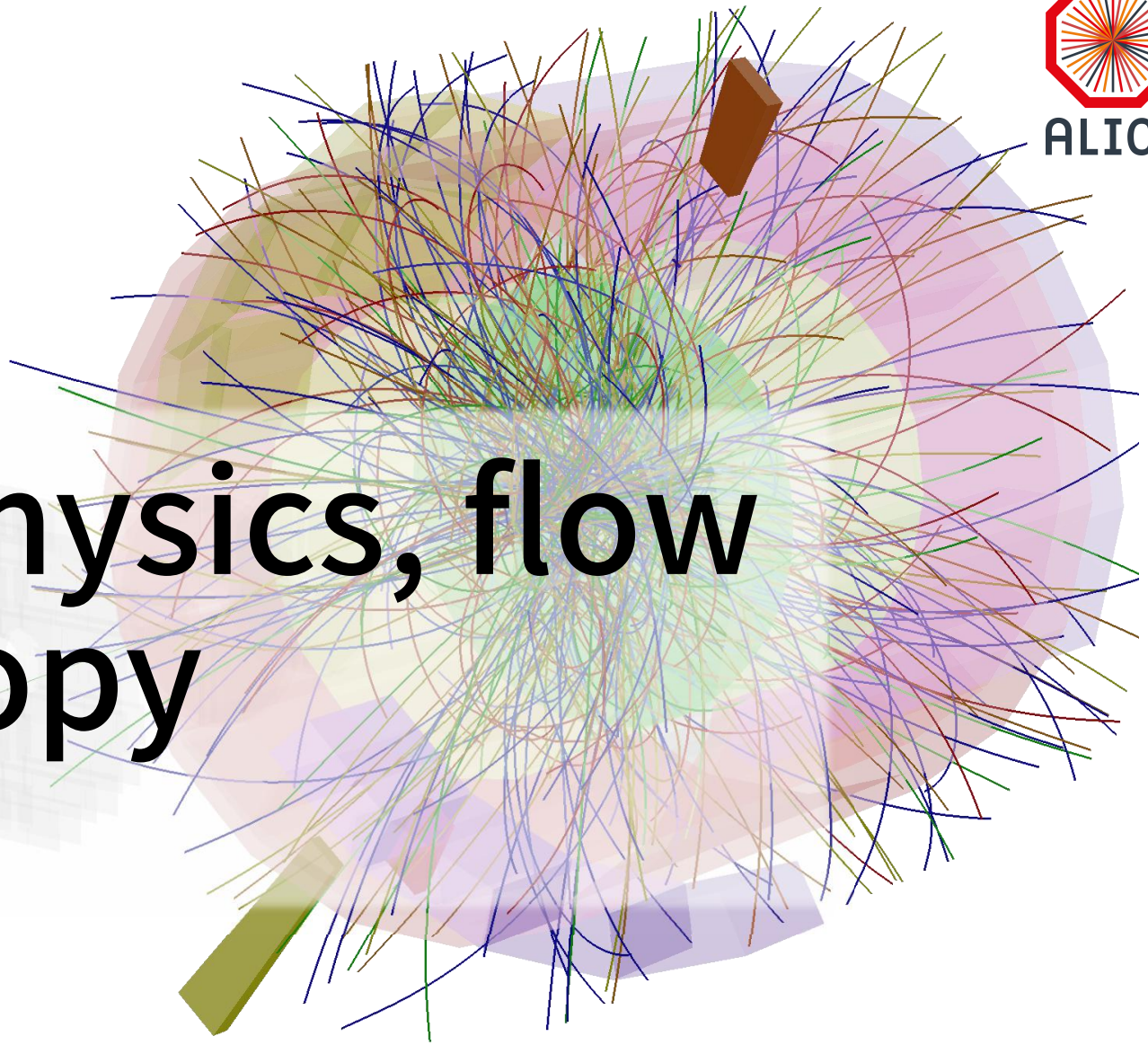
4) "Multiplicity dependence of light flavor hadron production in proton-proton collisions at √s = 7 TeV", submitted to PRC, https://arxiv.org/abs/1807.11321

5) "Charged jet cross section and fragmentation in proton-proton collisions at √s = 7 TeV", https://arxiv.org/abs/1809.03232

6) "Energy dependence of exclusive J/ψ photoproduction off protons in ultra-peripheral p-Pb collisions at √sNN = 5.02 TeV", https://arxiv.org/abs/1809.03235

light flavor physics, flow and femtoscopy

ALICE - physics news



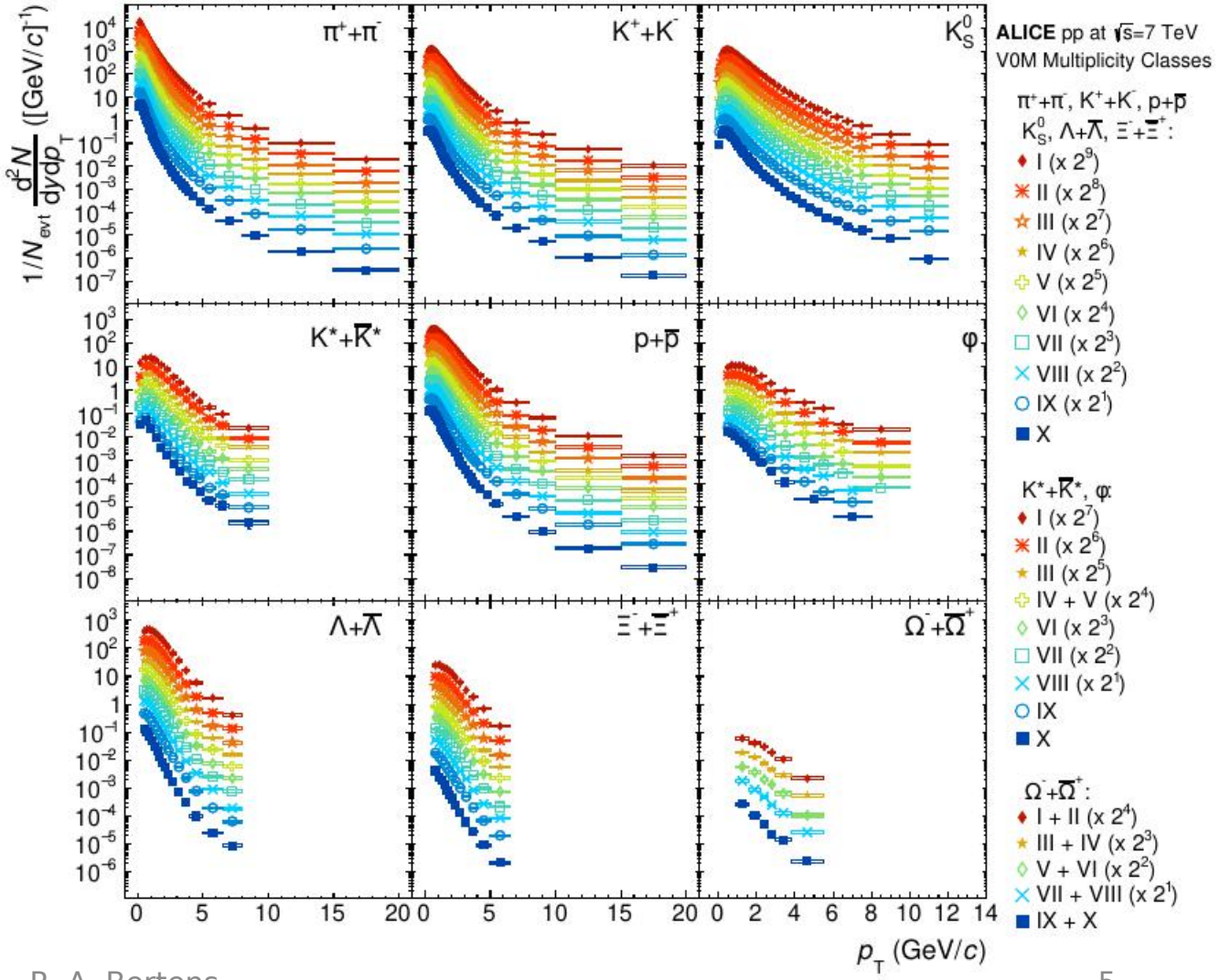
Multiplicity dependence of light-flavor hadron production at 7 TeV pp

arXiv:1807.11321

Multiplicity class	I	II	III	IV	V
$\sigma/\sigma_{\mathrm{INEL}>0}$	0-0.95%	0.95-4.7%	4.7-9.5%	9.5-14%	14-19%
$\langle dN_{\mathrm{ch}}/d\eta \rangle$	21.3 ± 0.6	16.5 ± 0.5	13.5 ± 0.4	11.5 ± 0.3	10.1 ± 0.3
Multiplicity class	VI	VII	VIII	IX	X
$\sigma/\sigma_{\mathrm{INEL}>0}$	19-28%	28-38%	38-48%	48-68%	68-100%
$\langle dN_{\mathrm{ch}}/d\eta \rangle$	8.45 ± 0.25	6.72 ± 0.21	5.40 ± 0.17	3.90 ± 0.14	2.26 ± 0.12

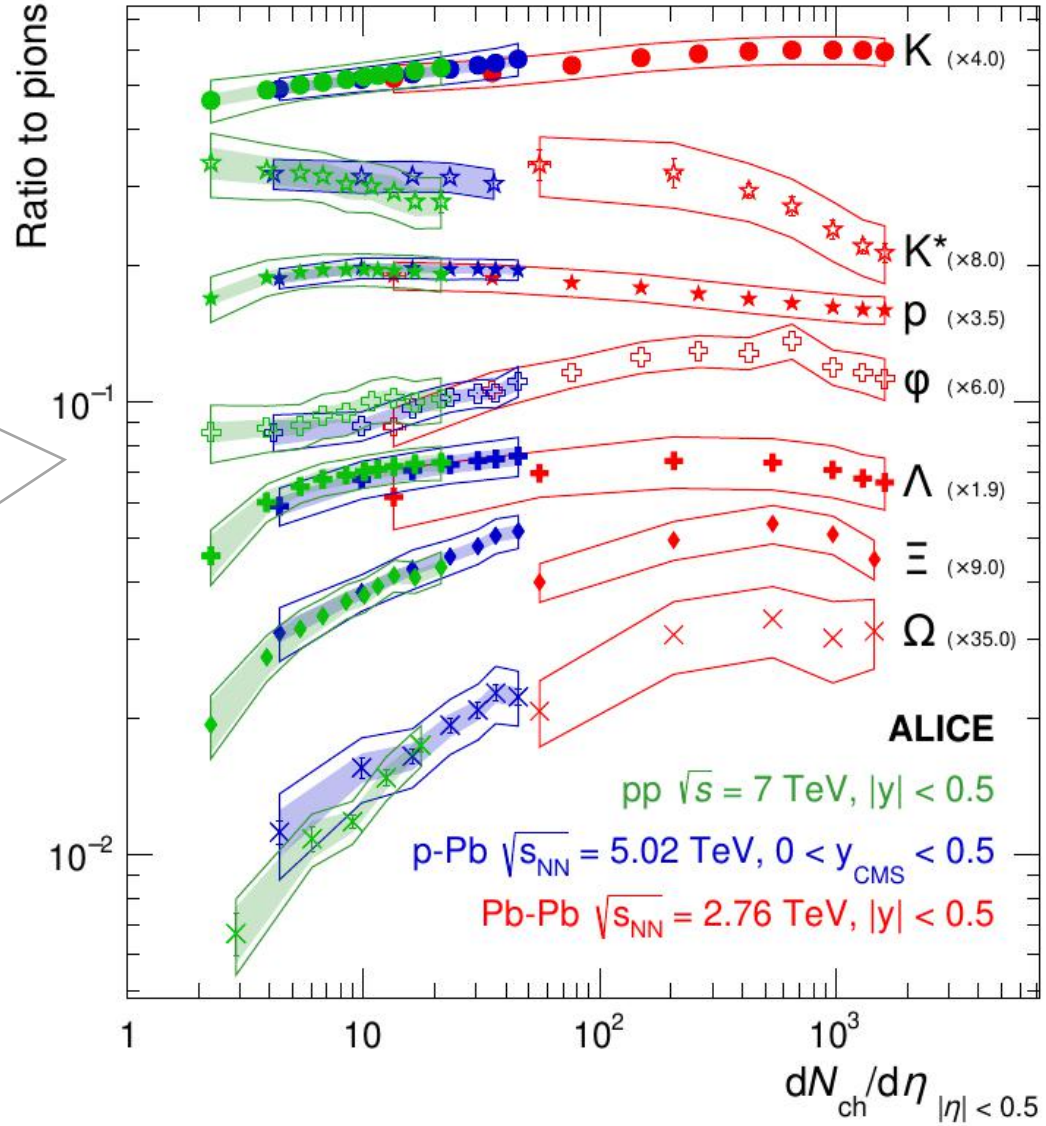
forward multiplicity estimator

probing the evolution of
base physics observables with multiplicity



Particle ratios in pp, p-Pb, Pb-Pb collisions

arXiv:1807.11321



p/π ~ constant

K* rescatters

Λ,Ξ,Ω/π suggests strangeness enhancement

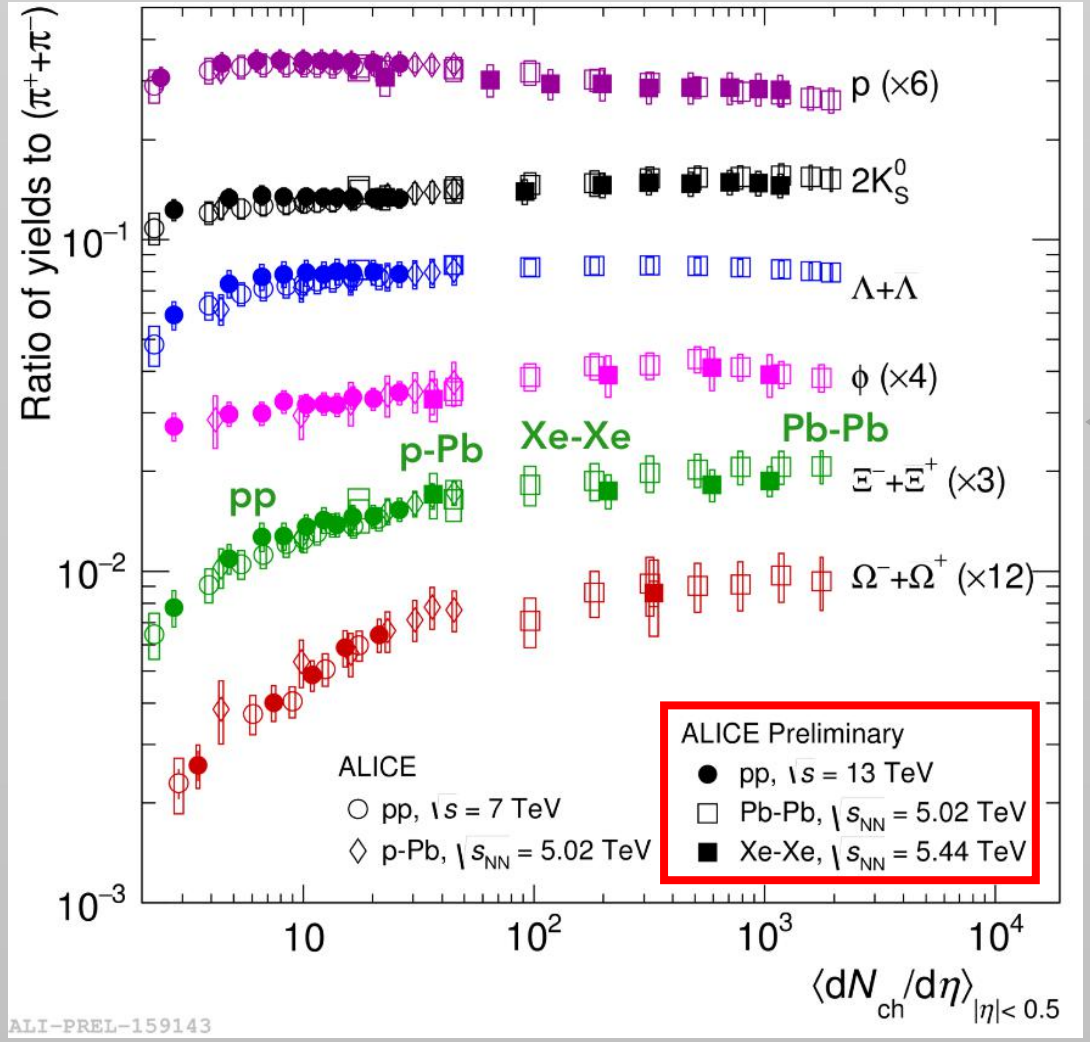
new ϕ/π hidden strangeness (s$\bar{s}$), doesn't follow Λ,Ξ,Ω/π ratio

smooth evolution of yields across sytems and energies

same production mechanism?

Particle ra sions

more results in preparation



smooth evolution with $\langle dN_{ch}/d\eta \rangle$

p/π ~ constant

K* rescatters

Λ,Ξ,Ω/π suggests strangeness enhancement

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smooth evolution of yields across sytems and energies

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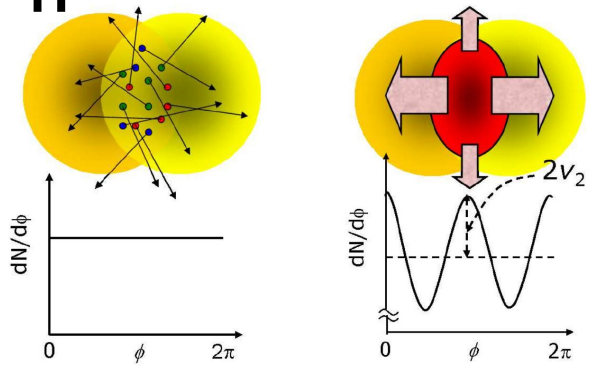
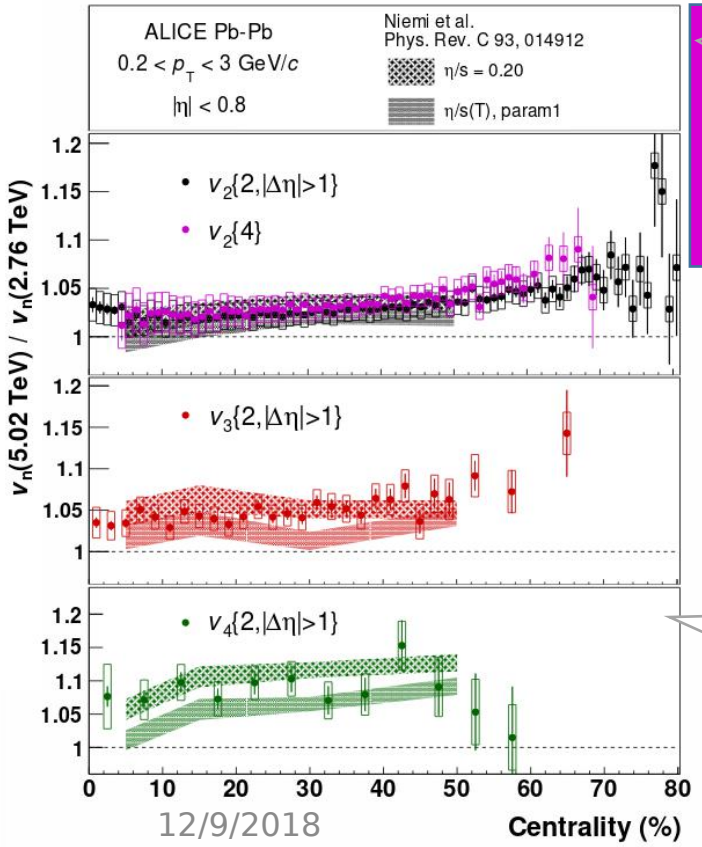
v_n - continuing the path of high precision



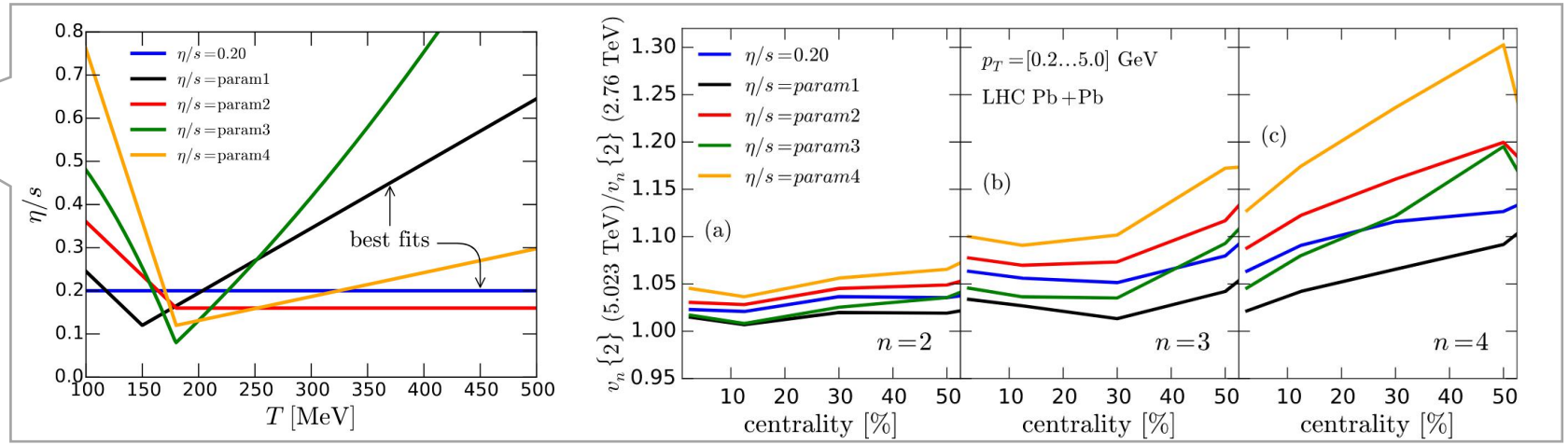


arXiv:1804.02944

v_2

v_3

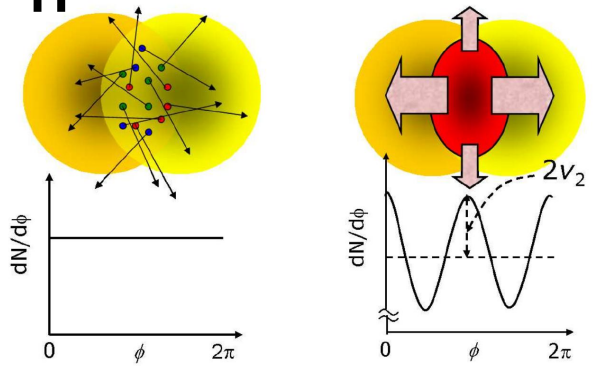
v_4

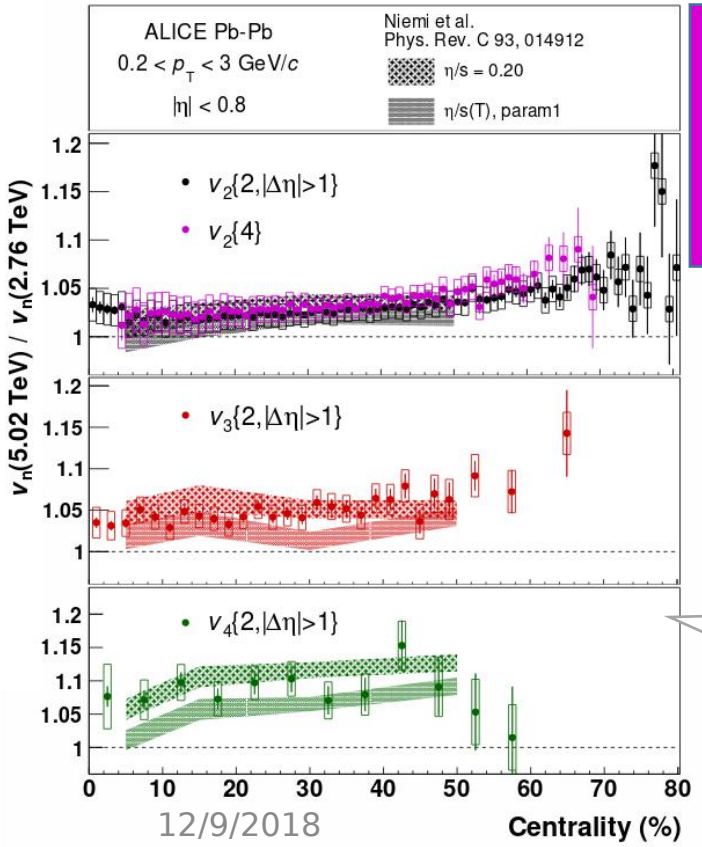


v_2 v_3 v_4

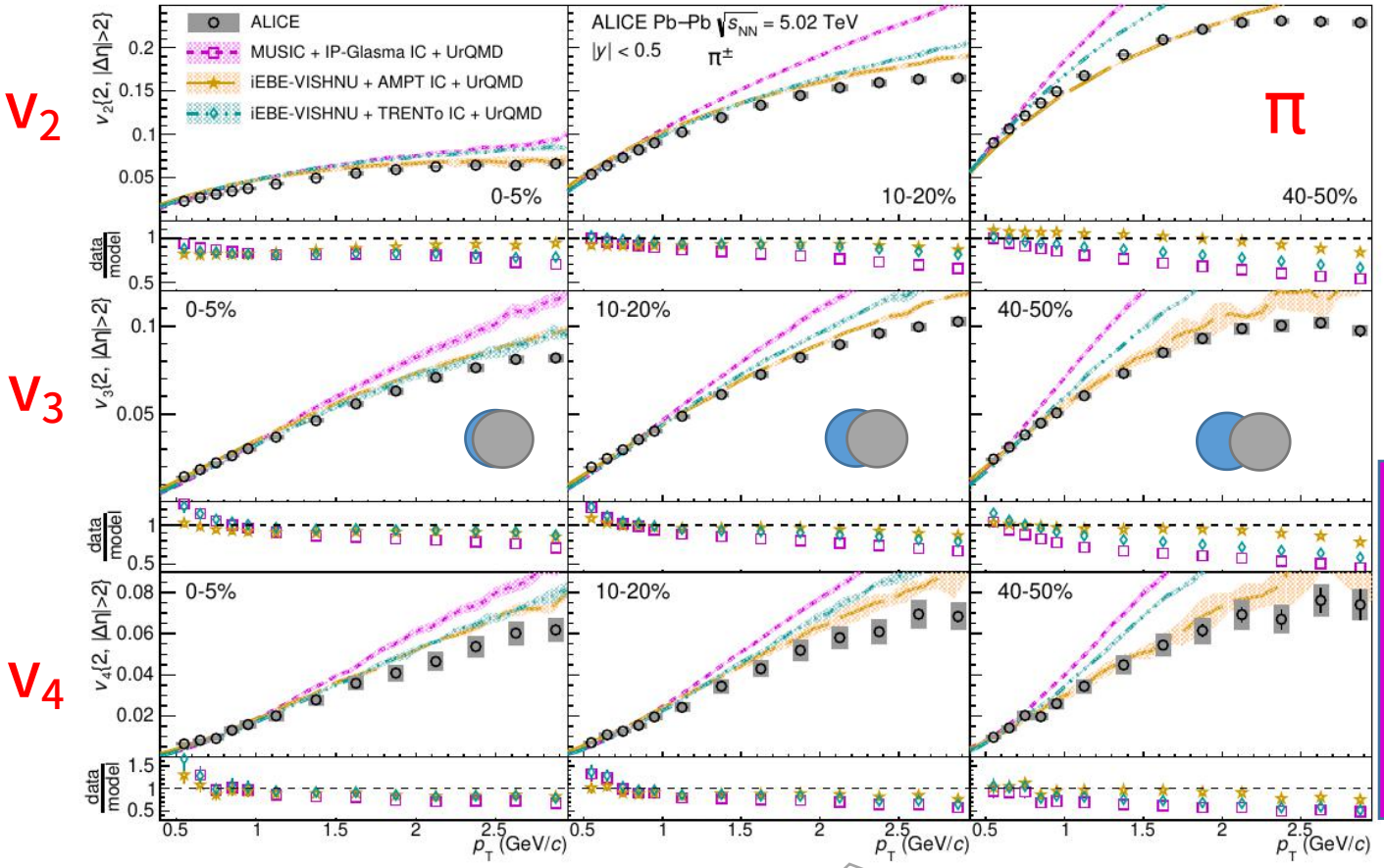
high precision measurements of ratios of v_n at different energies constrain viscosities η/s(T), ζ/s(T)

v_n - continuing the path of high precision





arXiv:1804.02944

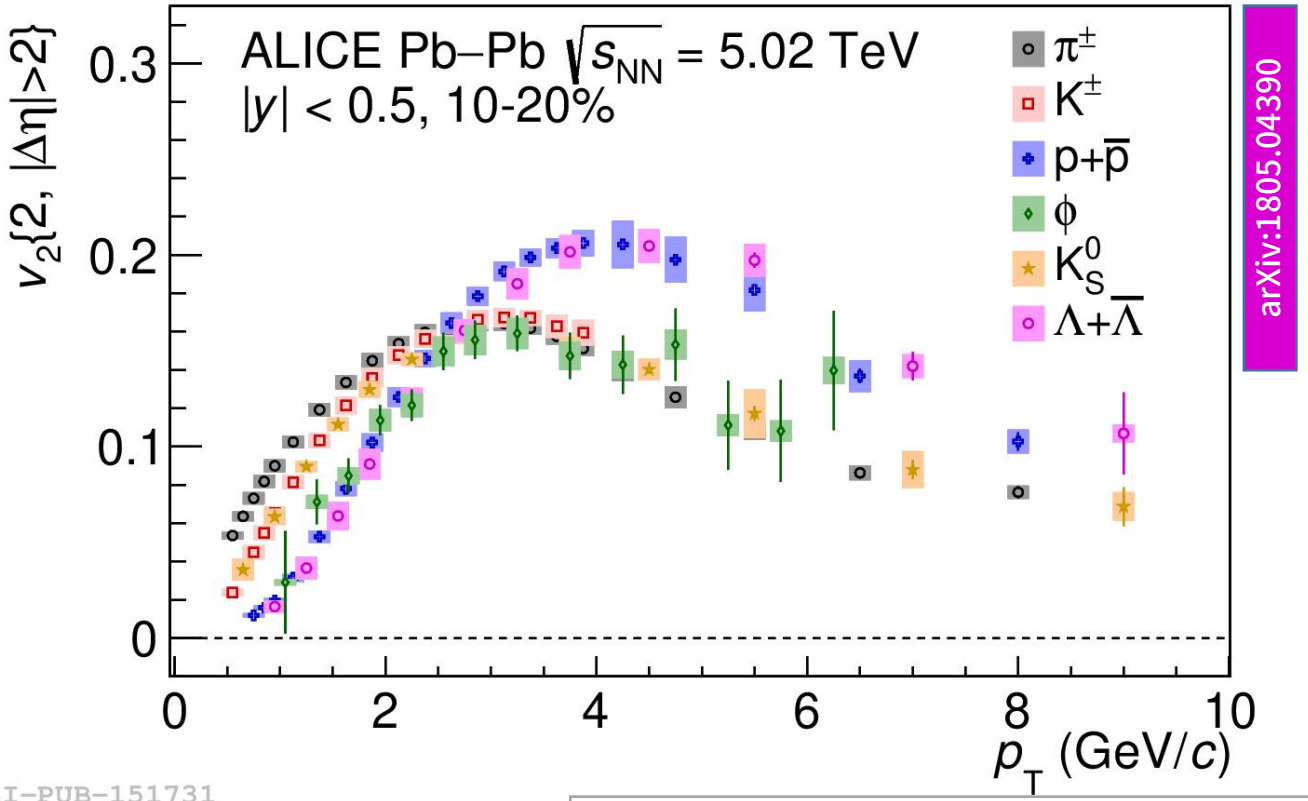


arXiv:1805.04390

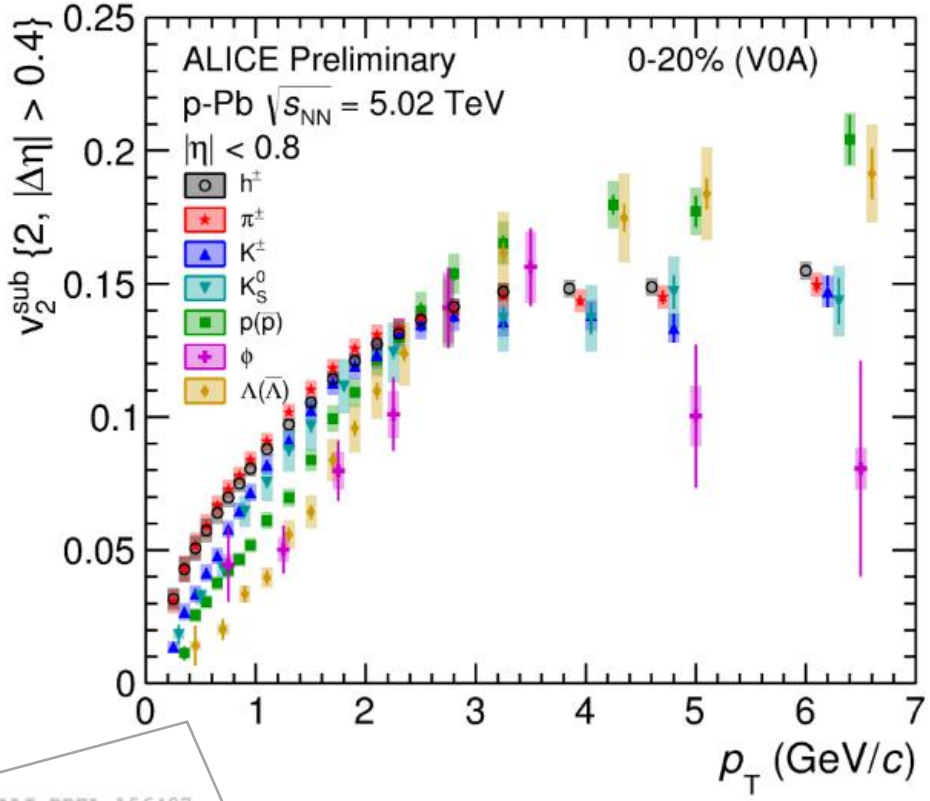
high precision measurements of ratios of v_n at different energies constrain viscosities η/s(T), ζ/s(T)

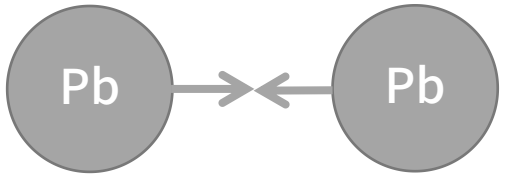
p_T differential shapes sensitive to η/s(T), ζ/s(T), initial conditions

v_n - continuing the path of high precision



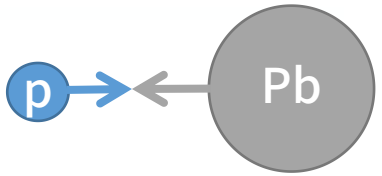
arXiv:1805.04390





v_n of identified particles in p-Pb show similar features as Pb-Pb (mass ordering, baryon/meson splitting)

evolution of collectivity with multiplicity

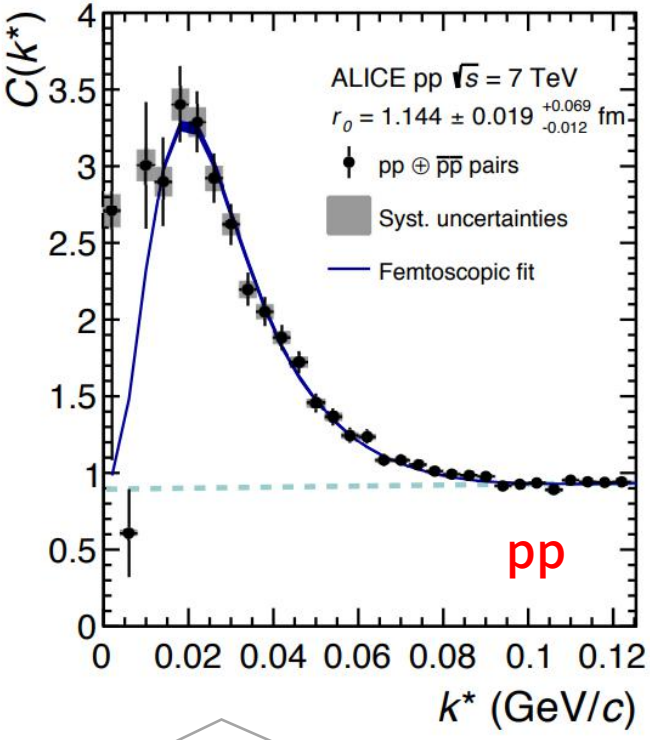


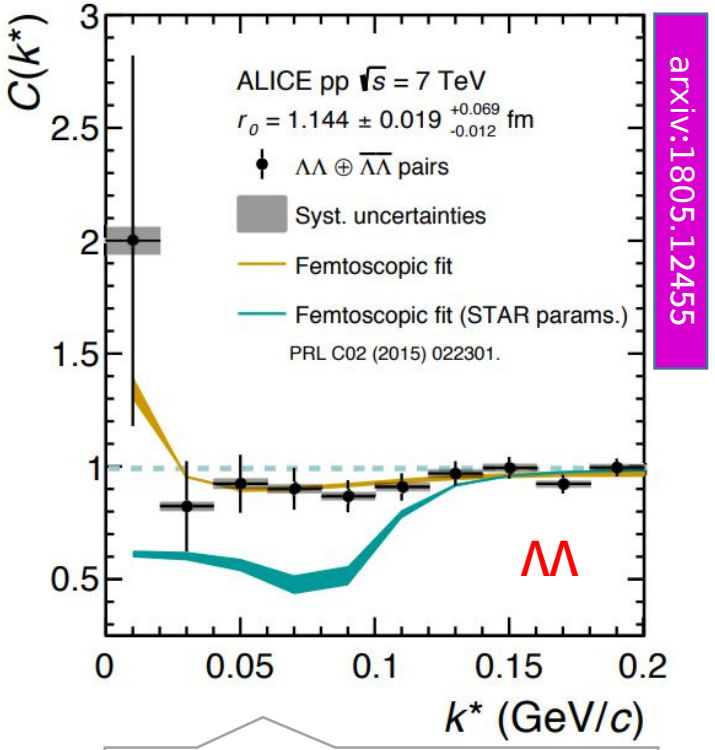
Constraining hyperon-nucleon potentials

exploiting femtoscopy to study unknown correlations among hyperon-nucleon pairs

$$C(k^*) = \int S(r)|\Psi(k^*, \vec{r})|^2 \, d\vec{r}$$

Emission source Two-particle wave function





pp benchmark: correlation well described

ΛΛ shallow attractive interaction favored

Constraining hyperon-nucleon potentials

exploiting femtoscopy to study unknown

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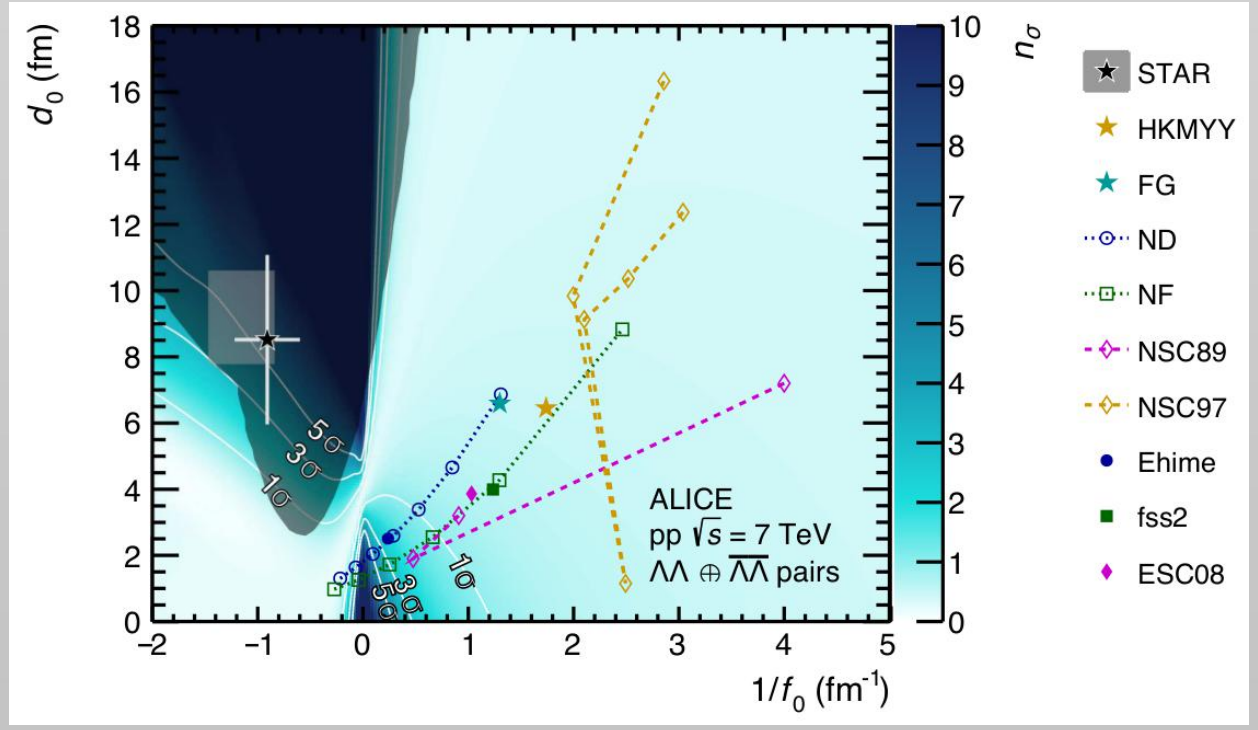
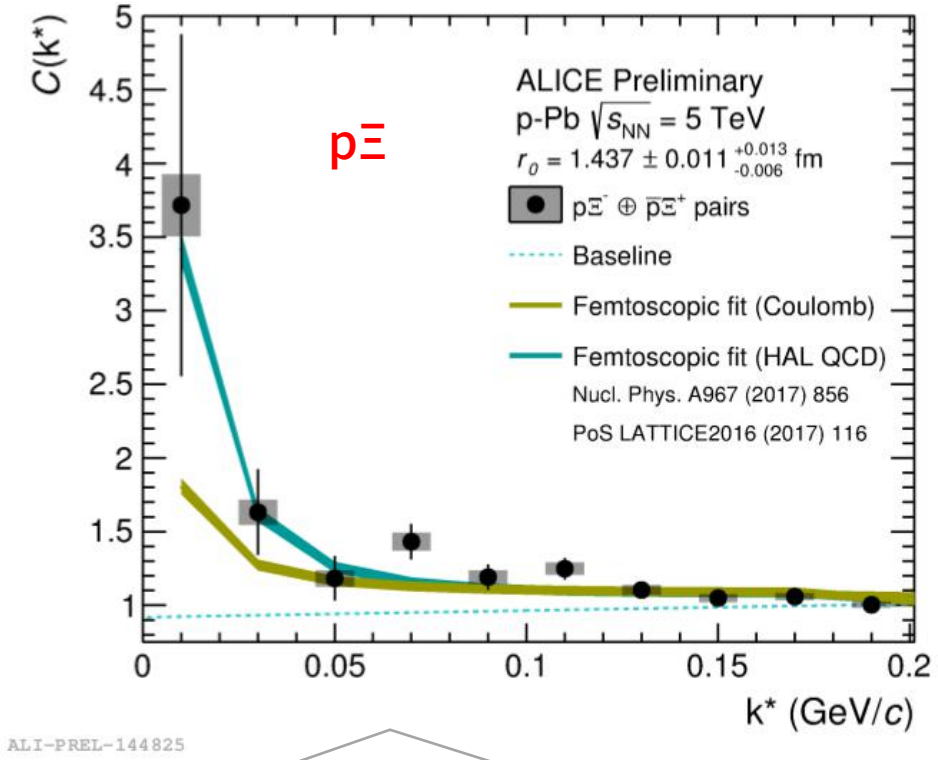


$\Lambda\Lambda$-interaction: strong constraints on the scattering parameter phase space in terms of effective range d_0 and scattering length f_0

arxiv:1805.12455

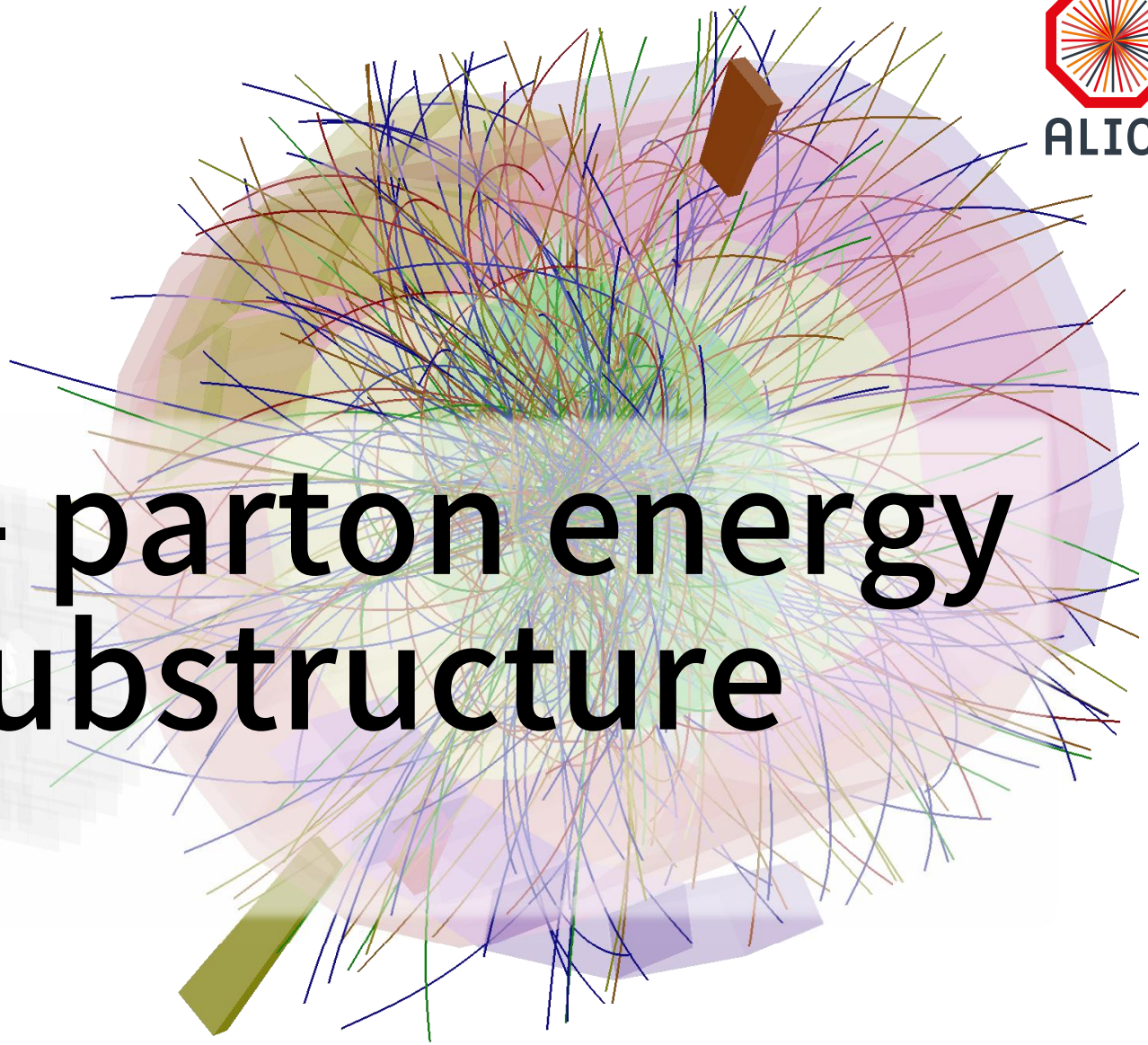


pPb: strong attractive potential for pΞ, in line with calculations by HAL QCD collaboration

described

hard probes - parton energy loss and jet substructure

ALICE - physics news



In-medium energy loss using π^0 spectra

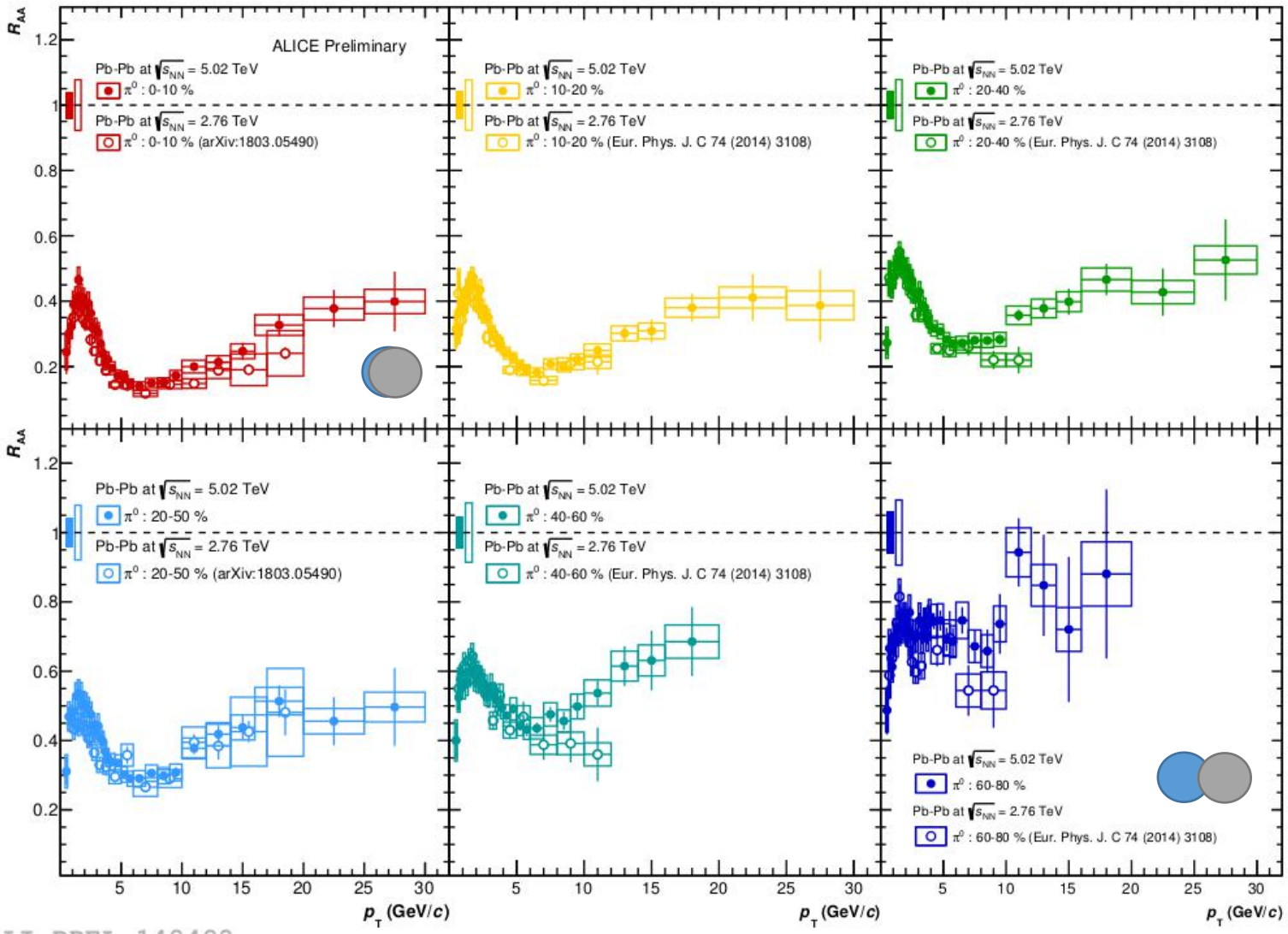
$$R_{AA} = \frac{dN_{AA}/dp_T}{N_{coll} dN_{pp}/dp_T}$$

π^0 spectra measured with high precision up to p_T = 30 GeV/c

significant improvement of uncertainties w.r.t. 2.76 TeV

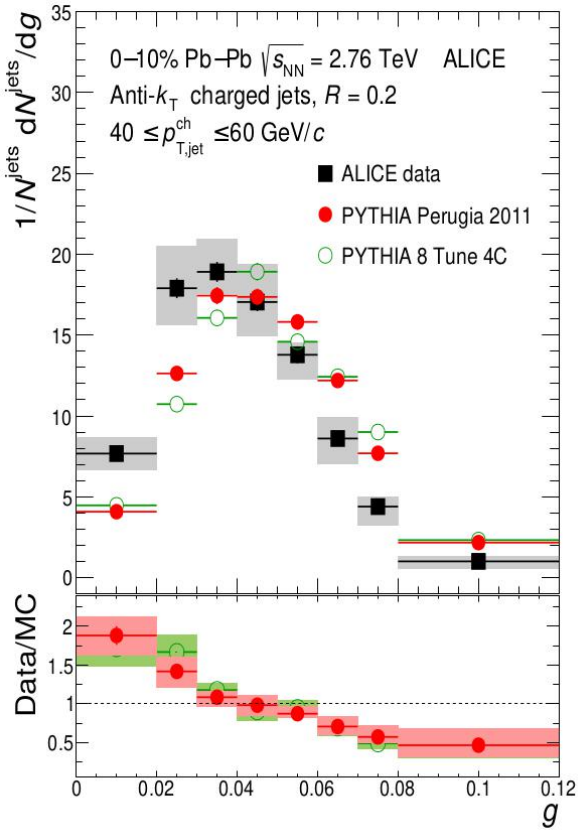
strong centrality dependence in R_{AA}

constrains the role of in-medium path length of energy loss



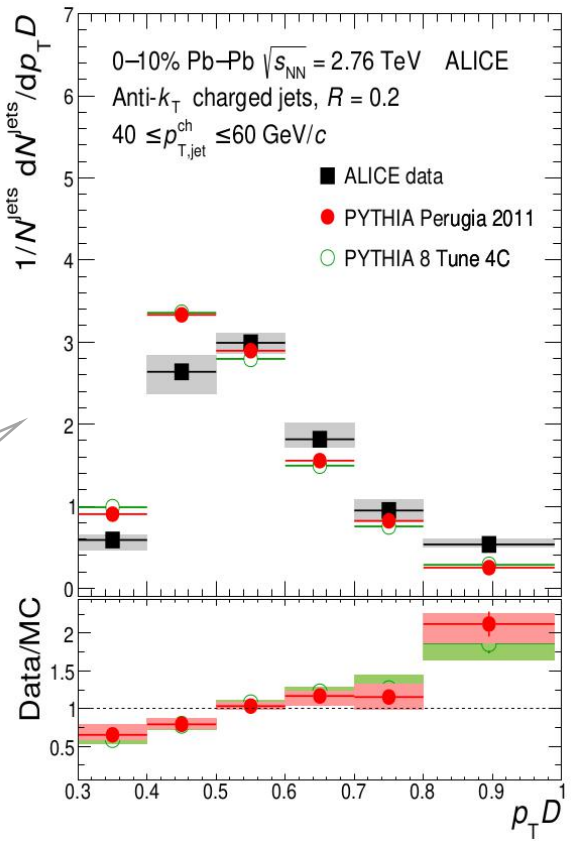
ALI-PREL-149488

Medium modification of jets



$$g = \sum_{i \in \text{jet}} \frac{p_{\text{T},i}}{p_{\text{T,jet}}} \Delta R_{\text{jet},i}$$

$$p_{\text{T}}D = \frac{\sqrt{\sum_{i \in \text{jet}} p_{\text{T},i}^2}}{\sum_{i \in \text{jet}} p_{\text{T},i}}$$



arXiv:1807.06854

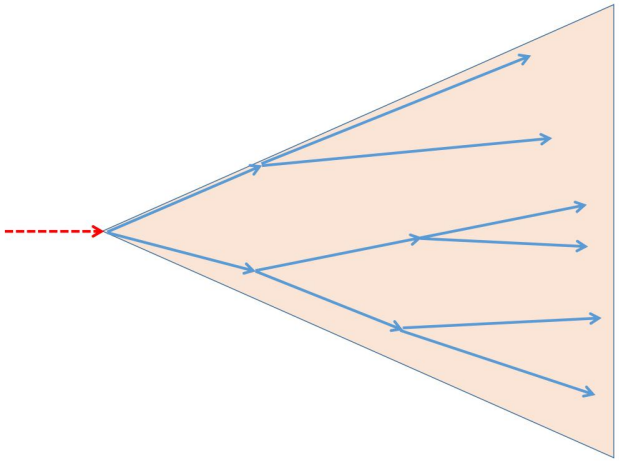
jet girth in PbPb shifted toward lower values w.r.t. pp/PYTHIA

transverse momentum dispersion is shifted toward higher values in Pb-Pb

indicates harder and more collimated (quark-like) fragmentation in Pb-Pb than in vacuum

Exploring the phase space of jet splittings

Intra-jet splittings studied by declustering:



Re-wind last clustering step and evaluate

$$z = \frac{min(p_{T,1}, p_{T,2})}{p_{T,1} + p_{T,2}}$$

Define hard splitting when

$$z > z_{cut}$$

Exploring the phase space of jet splittings

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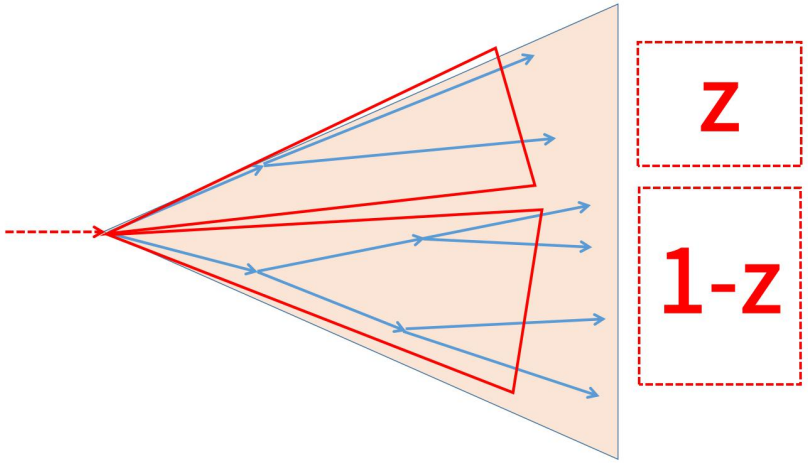

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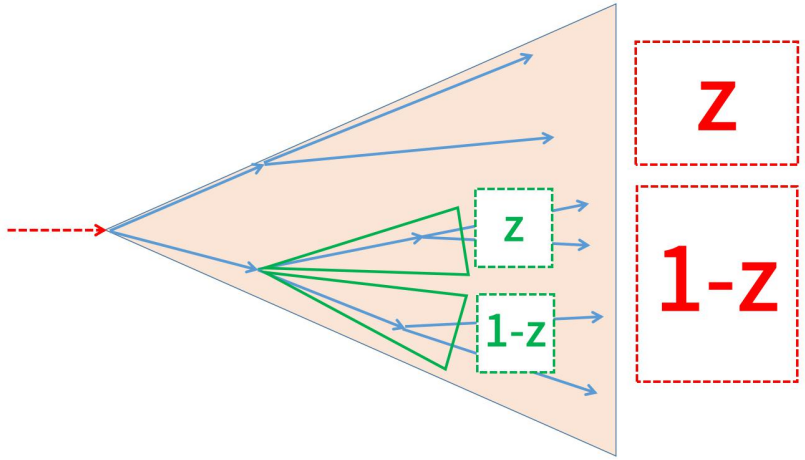

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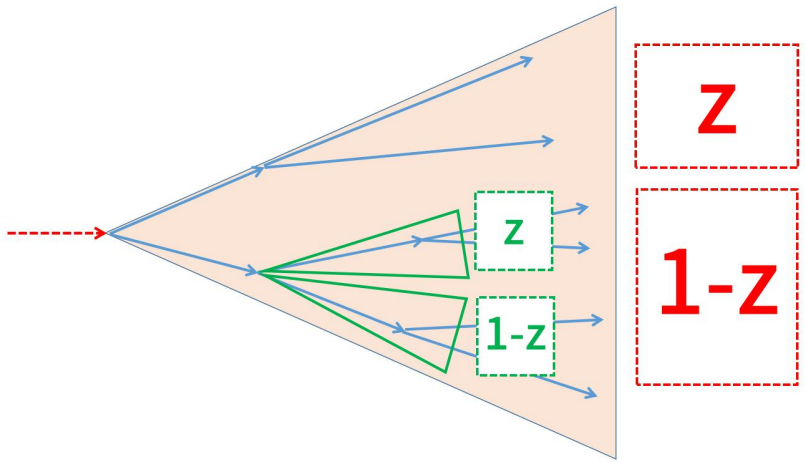
Possible to repeat on hardest prong to find n_{SD} splittings

Exploring the phase space of jet splittings

Intra-jet splittings studied by declustering:



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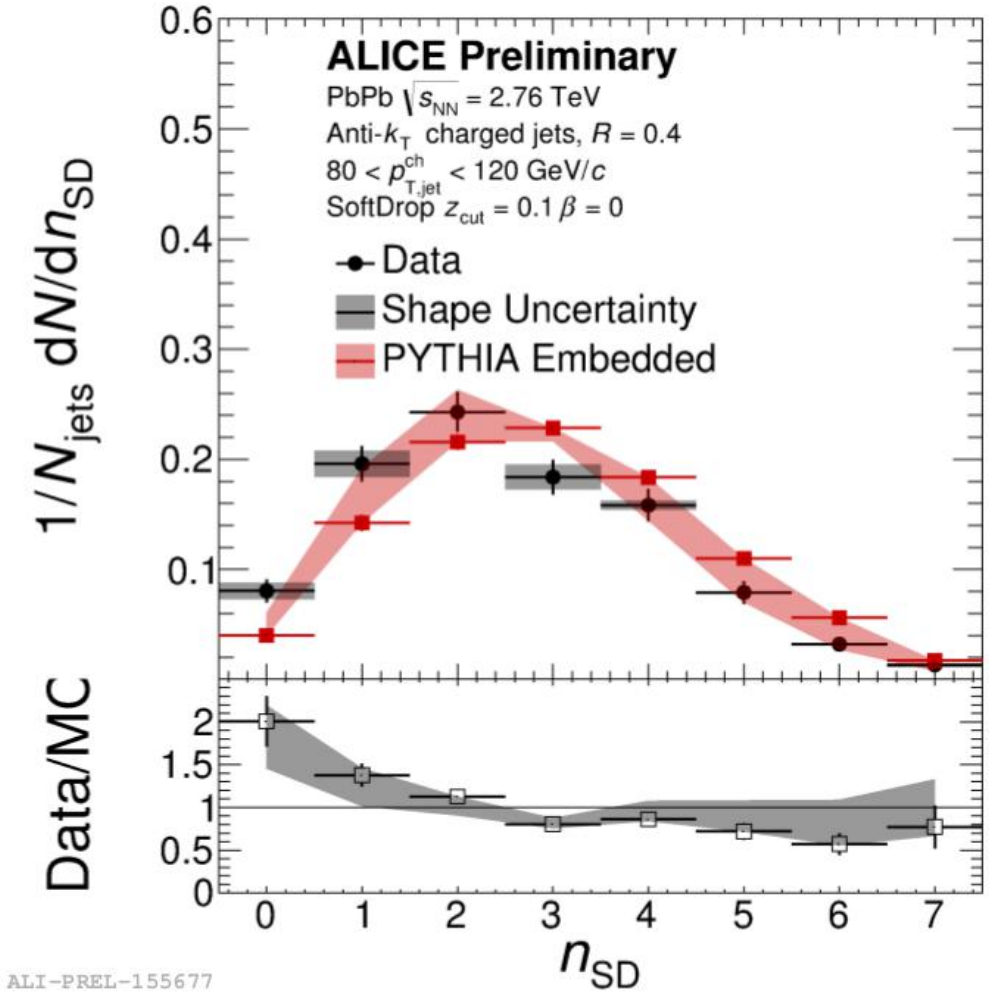
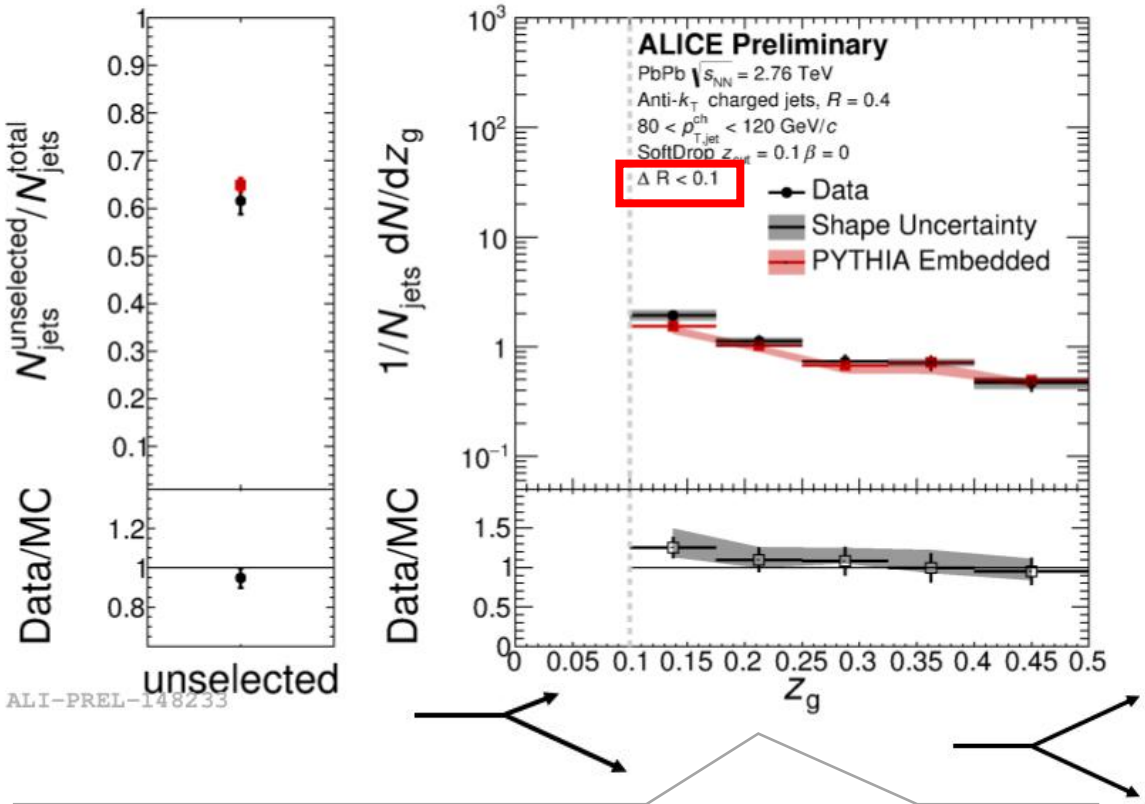
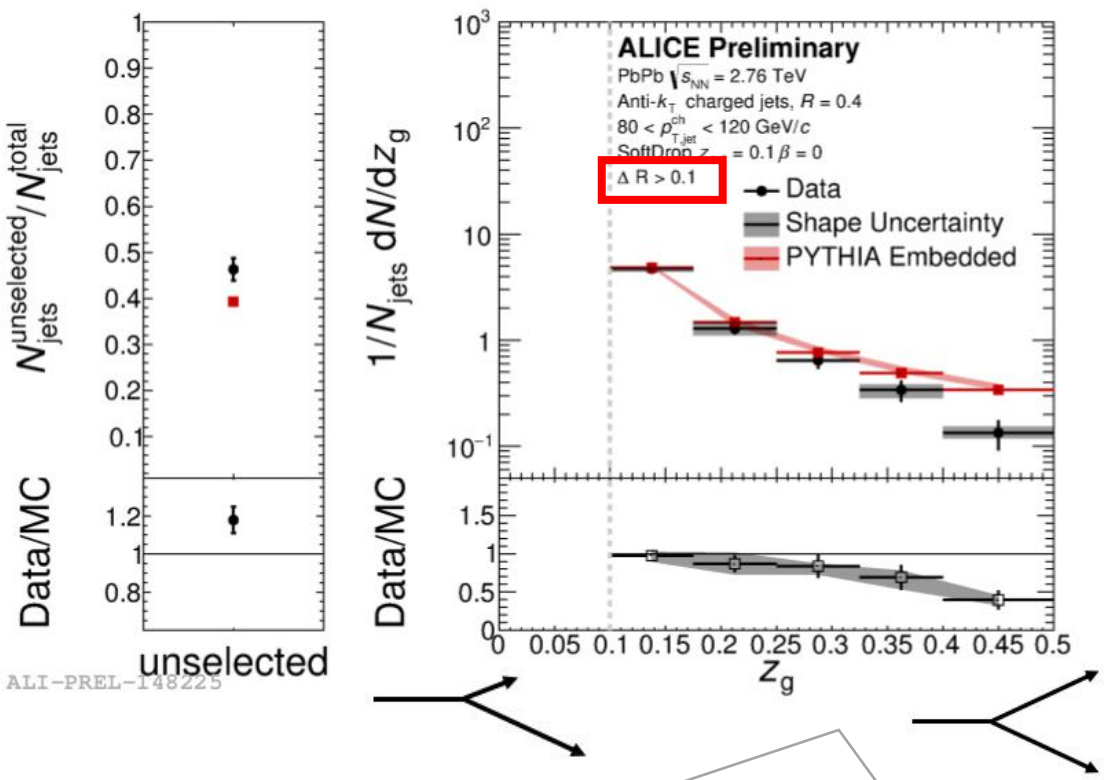


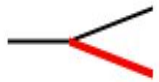
no difference in n_{SD} between PbPb and vacuum

Exploring the phase space of jet splittings

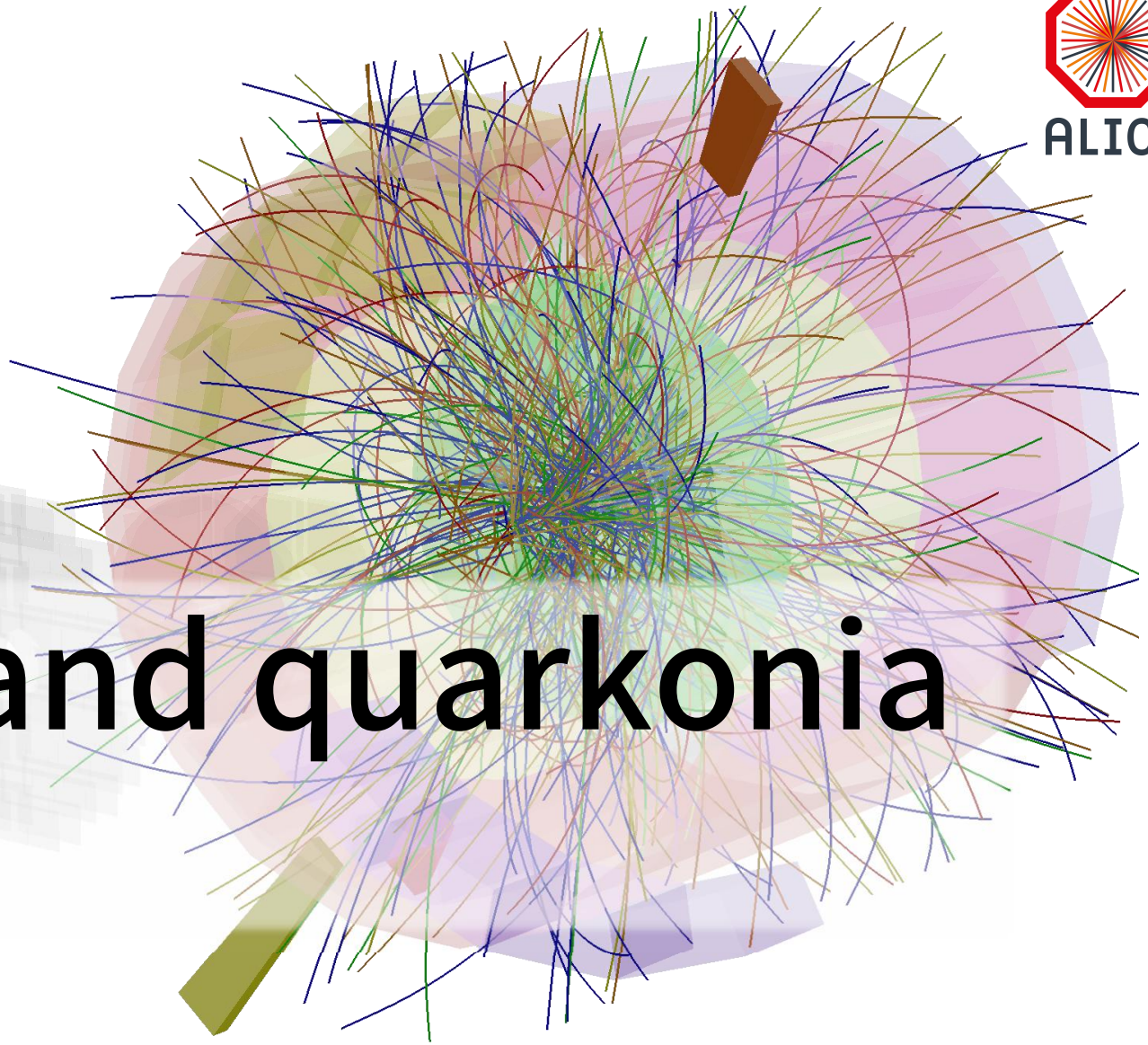




first splitting at **small** angles:
no difference between Pb-Pb jets and vacuum reference



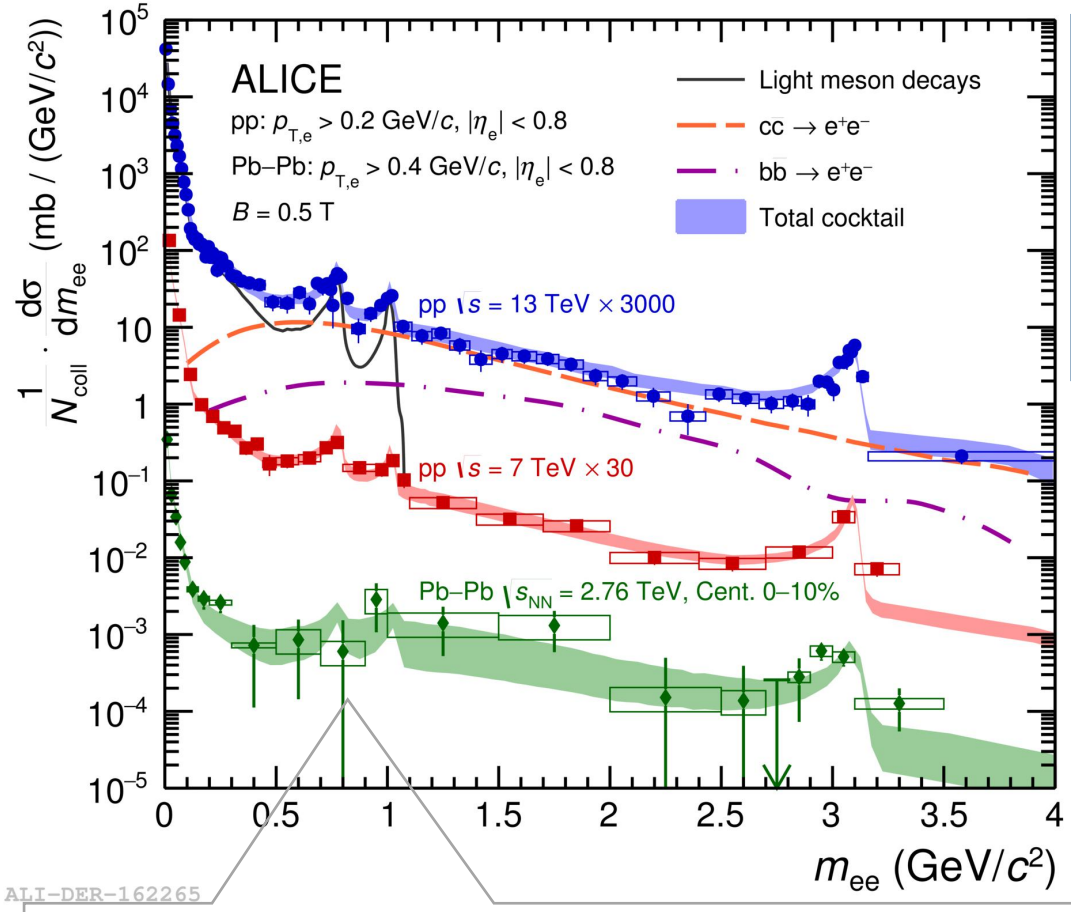
first splitting at **large** angles:
overall suppression in tagged Pb-Pb jets, steeper z_g distribution



di-electrons and quarkonia

ALICE - physics news

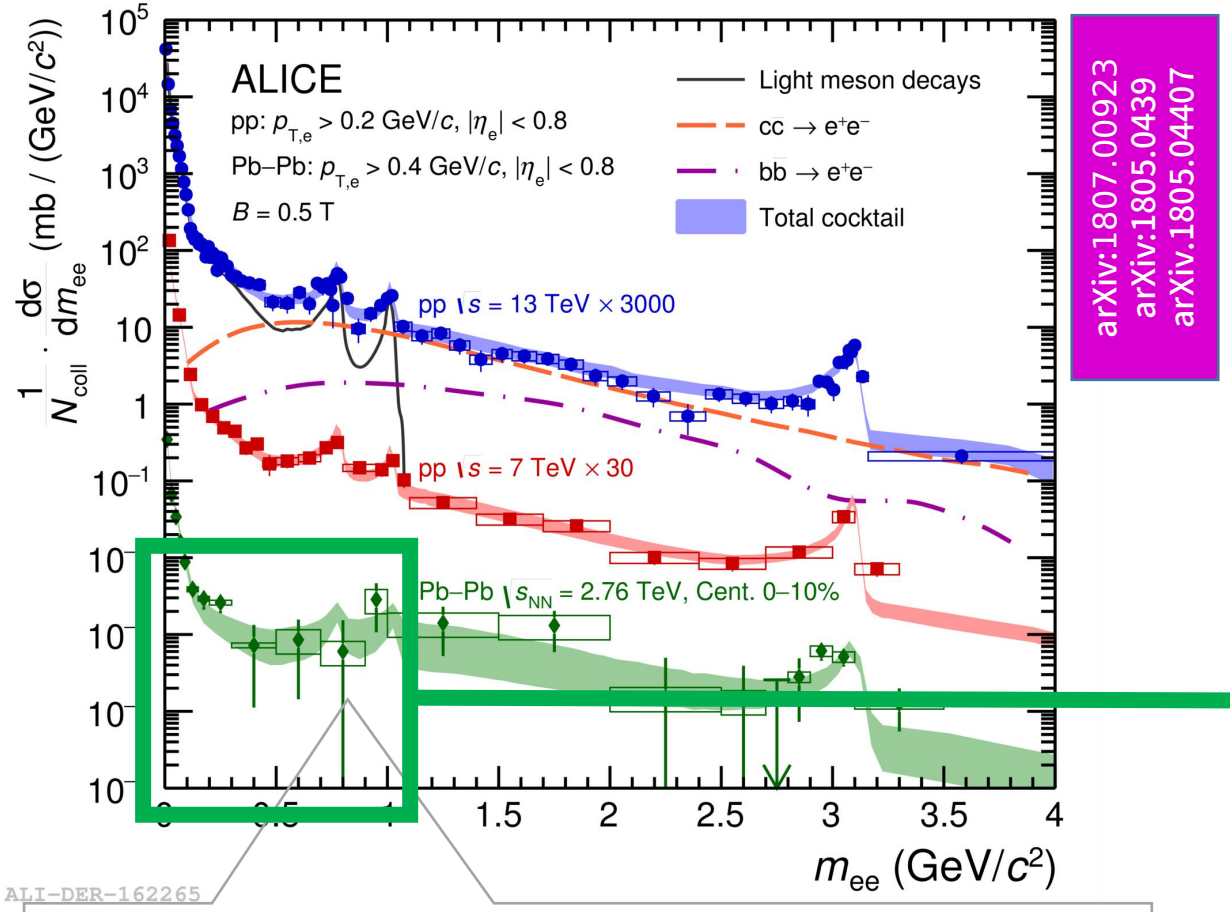
Dielectron production in pp, Pb-Pb



arXiv:1807.00923
arXiv:1805.0439
arXiv.1805.04407

No significant low-mass enhancement from ρ modification in central Pb-Pb collisions
but limited by statistics and cocktail uncertainty

Dielectron production in pp, Pb-Pb



arXiv:1807.00923
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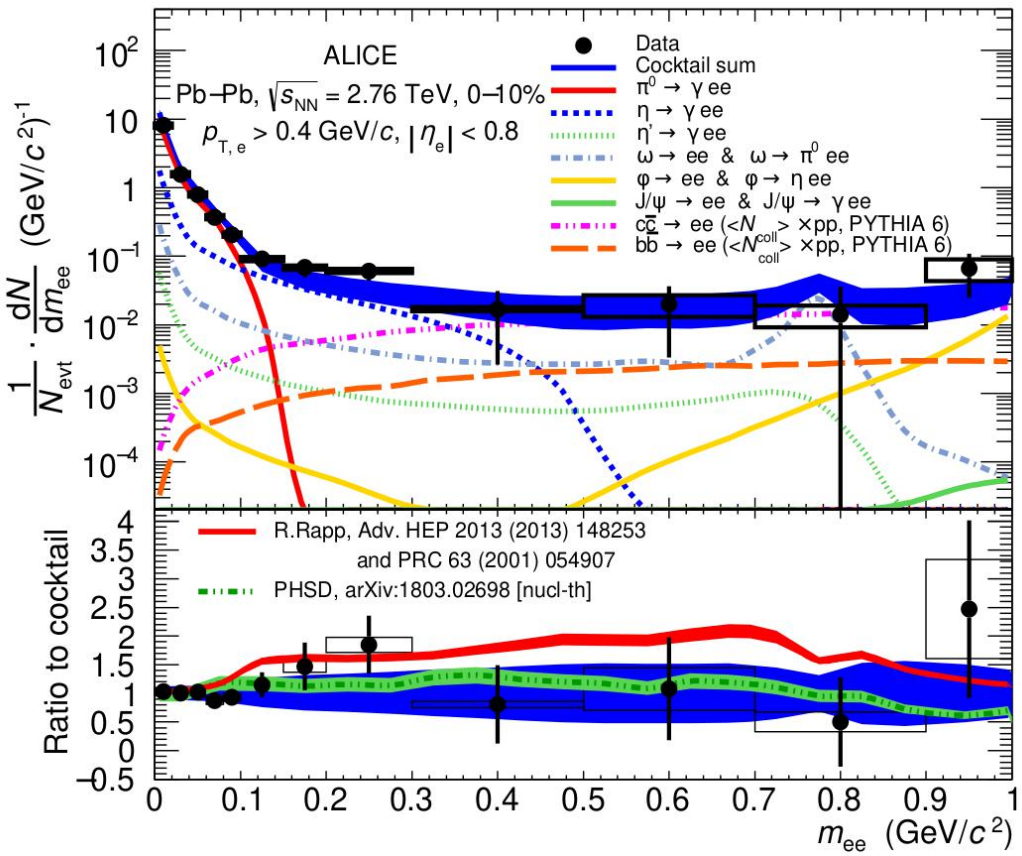


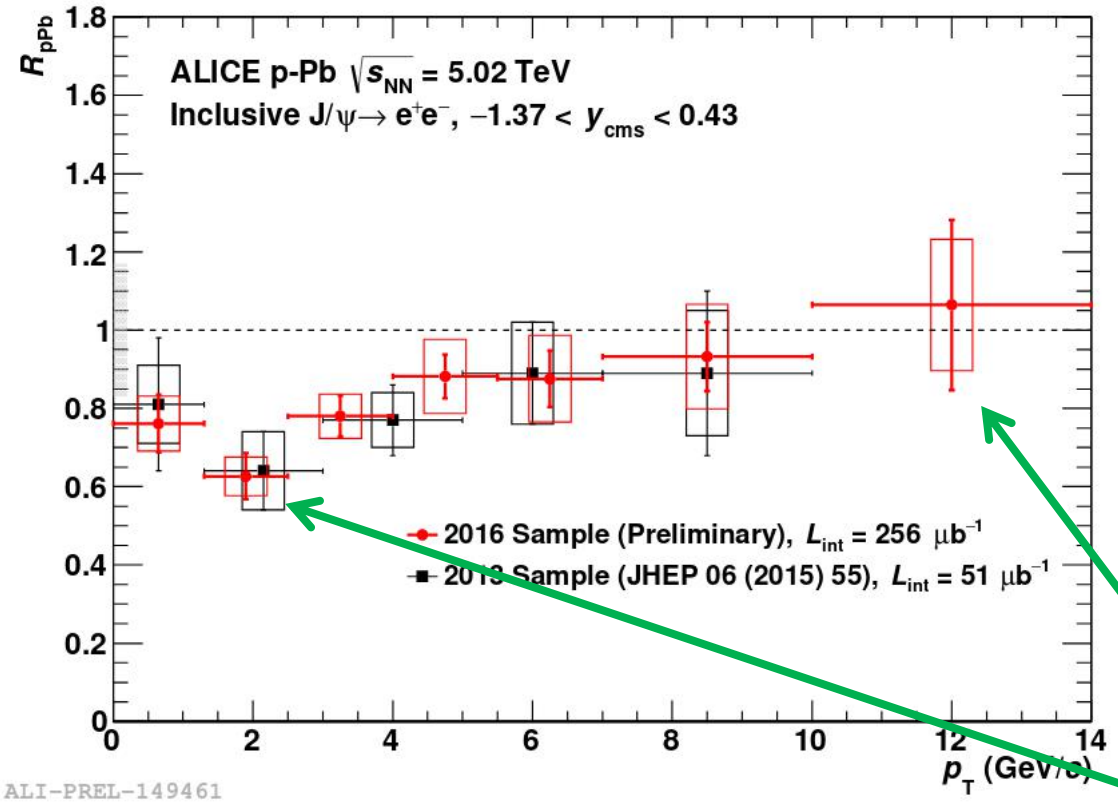
arXiv:1807.00923

No significant low-mass enhancement from ρ modification in central Pb-Pb collisions
but limited by statistics and cocktail uncertainty

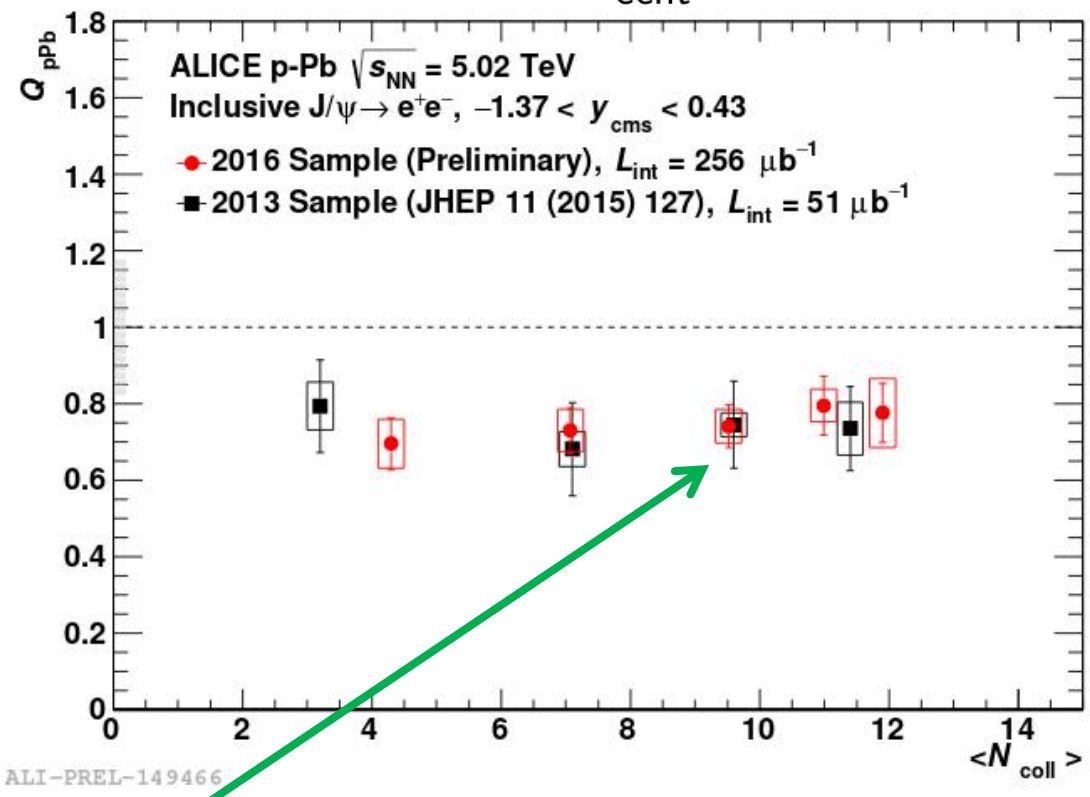
zooming in: data are consistent with expanding fireball model and parton-hadron-string dynamics transport approach that worked well at RHIC&SPS

J/Ψ production in 5 TeV p-Pb collisions

$$R_{AA} = \frac{dN_{AA}/dp_T}{N_{coll} dN_{pp}/dp_T}$$

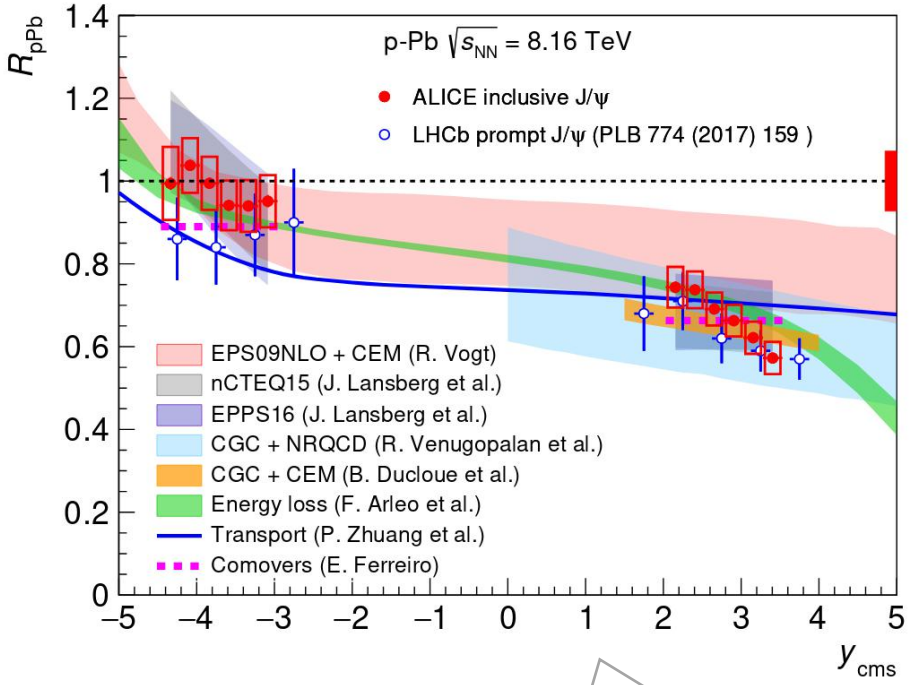


$$Q_{pPb}(p_T, \text{cent}) = \frac{dN^{pPb}_{\text{cent}}/dp_T}{\langle N^{\text{coll}}_{\text{cent}} \rangle \cdot dN^{pp}/dp_T}$$



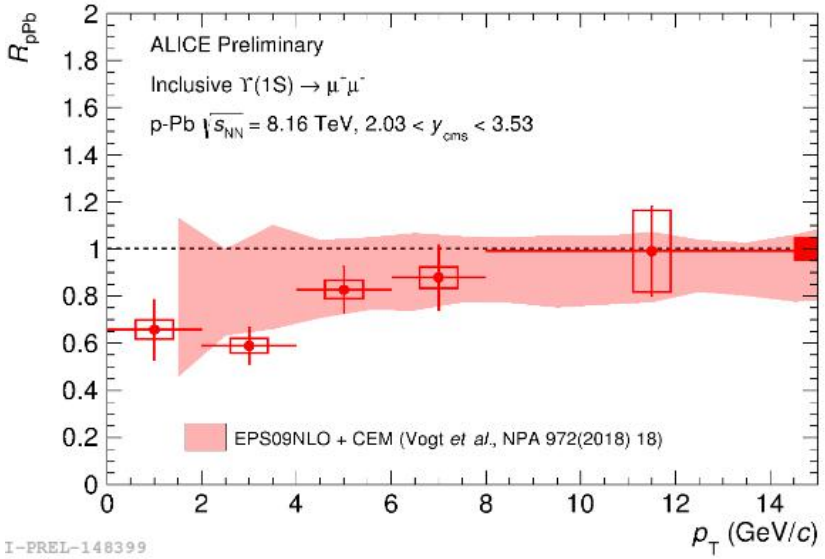
sensitivity to nuclear modification (R_{pPb} and Q_{pPb}) increased with luminosity via reduced uncertainties and increased range

Forward Υ and J/Ψ production at 8 TeV p-Pb

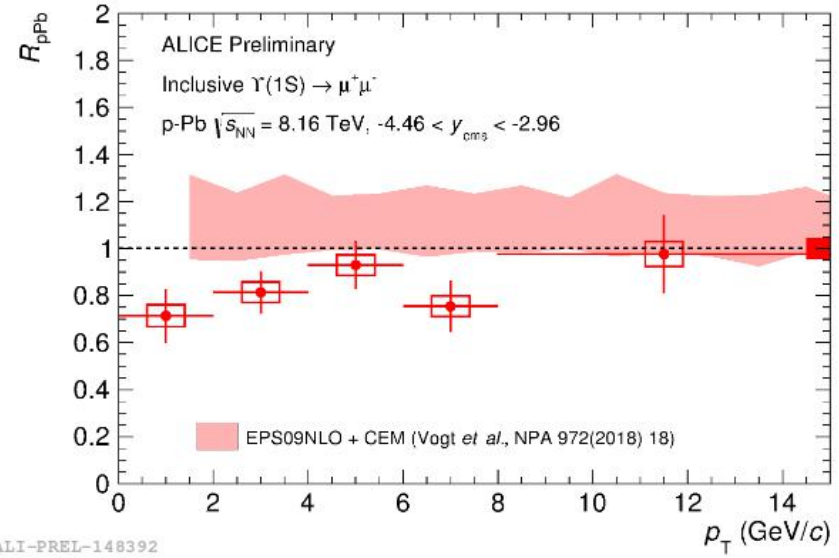


arXiv:1805.04381

both CGC and gluon nPDF's describe the observed J/Ψ suppression

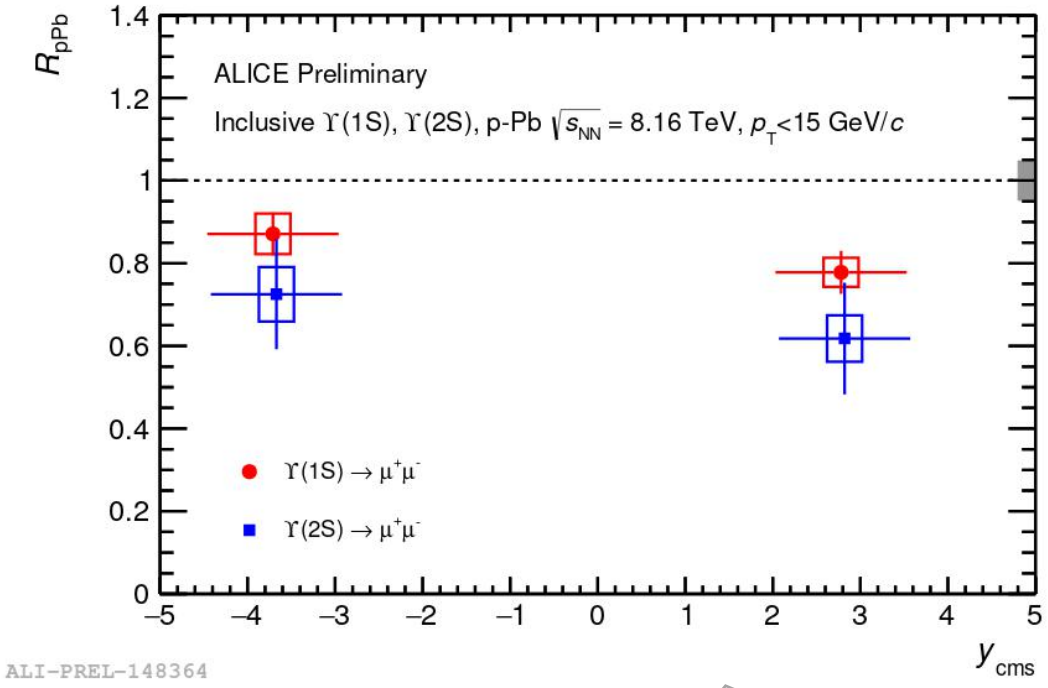


for Υ(1S)
η > 0: suppression with weak p_T dependence

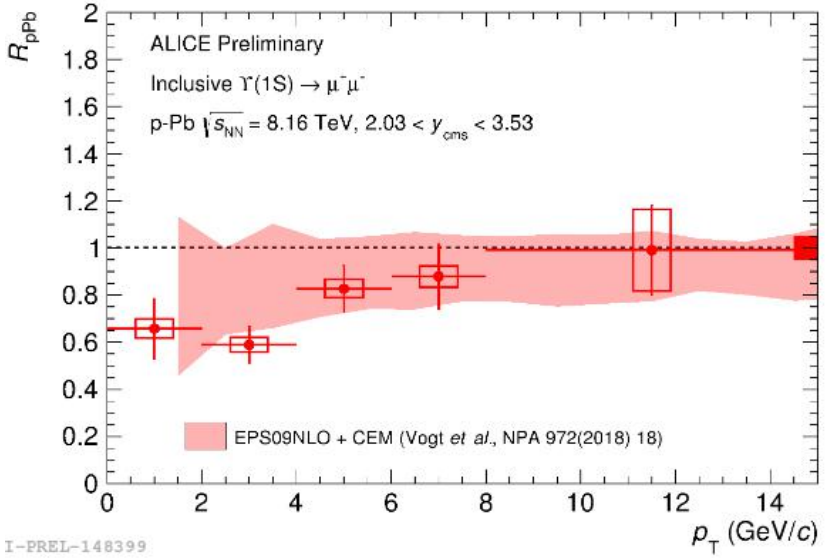


η < 0: suppression not reproduced by shadowing in nPDF

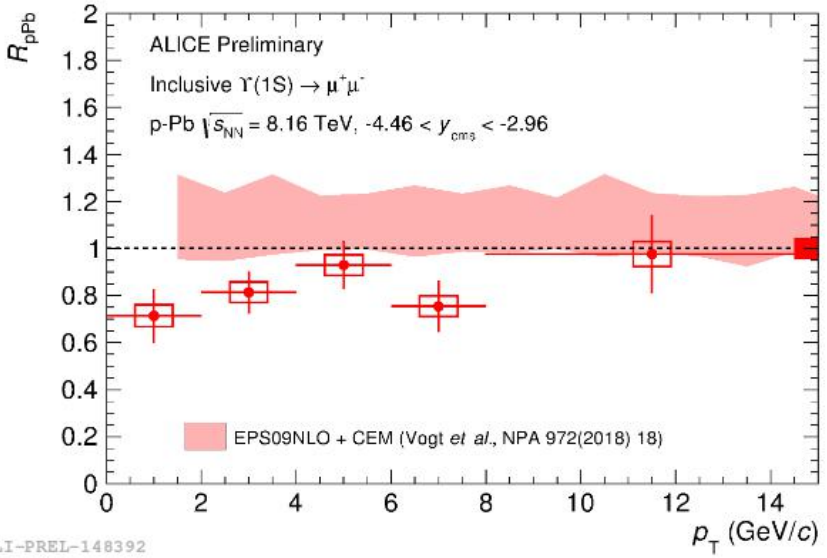
Forward Υ and J/Ψ production at 8 TeV p-Pb



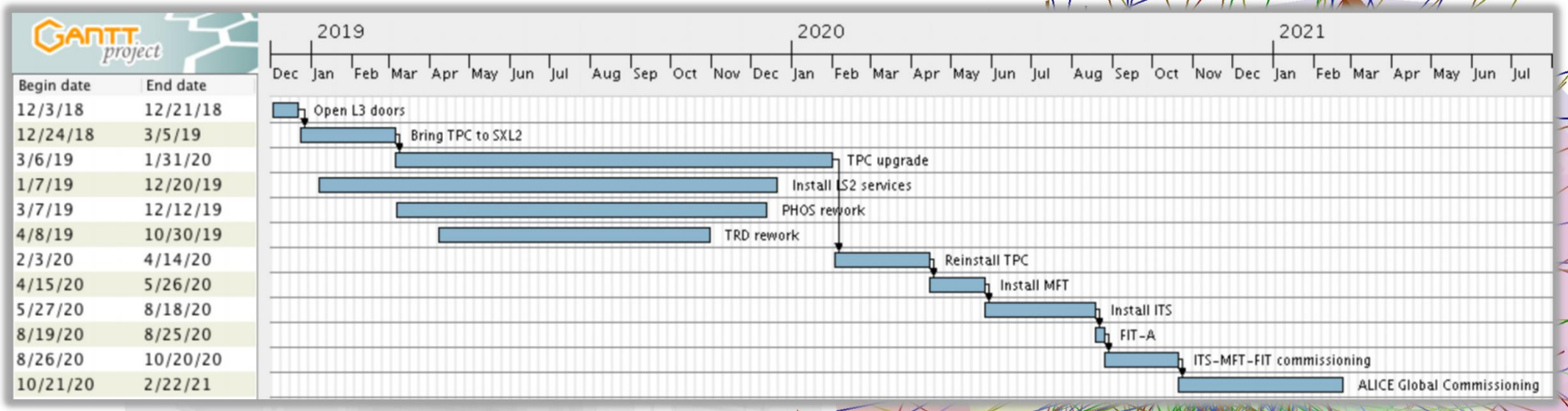
No difference between Υ(1S) and Υ (2S) suppression within uncertainties



for Υ(1S)
η > 0: suppression with weak p_T dependence



η < 0: suppression not reproduced by shadowing in nPDF



upgrades

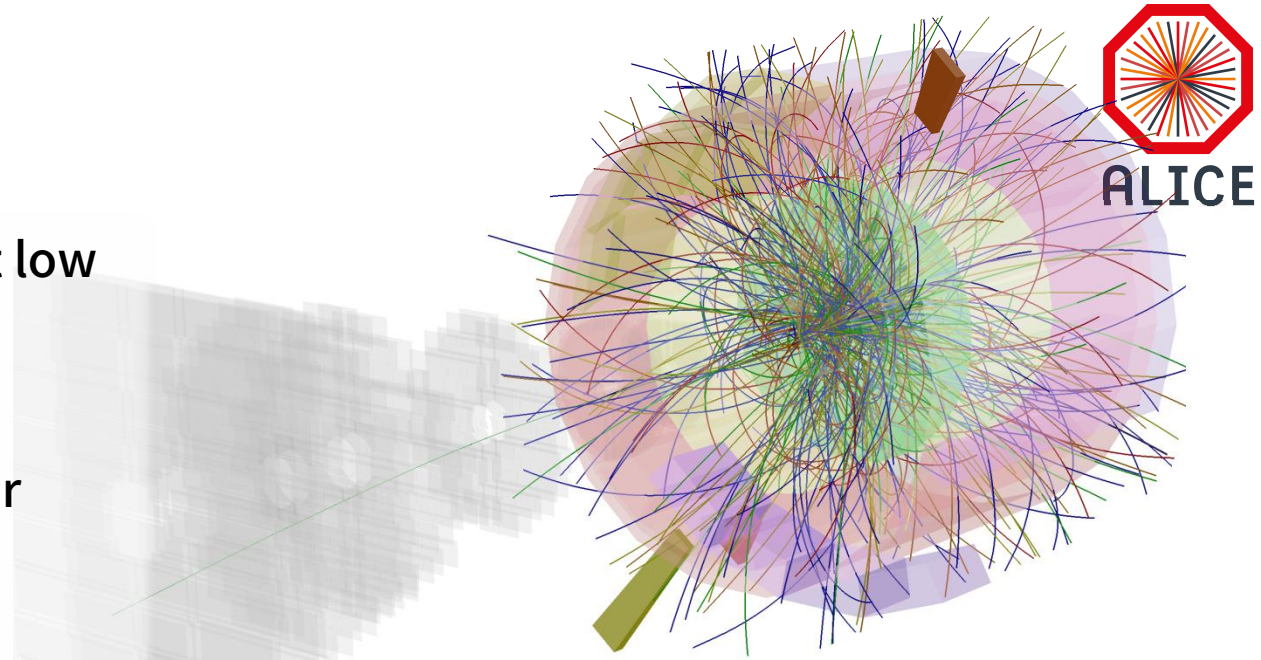
preparing ALICE for RUN 3 and RUN 4

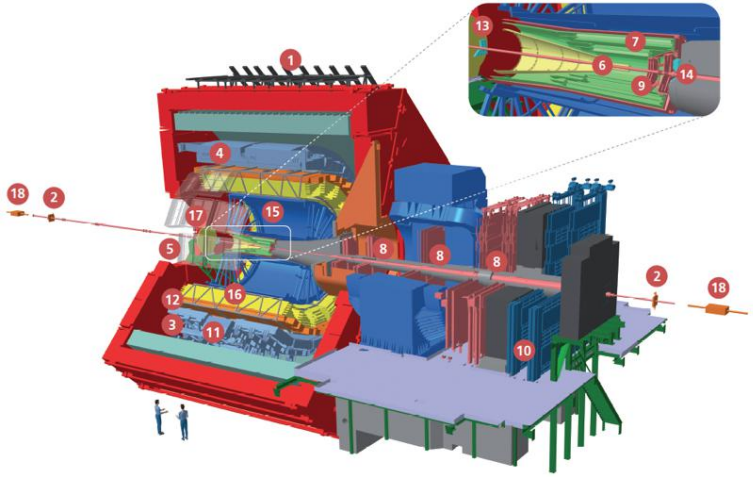
Upgrade strategy

goal: high precision measurements of rare probes at low p_T, cannot be triggered

target at recorded Pb-Pb luminosity ⩾ 10 nb^{-1} (8×10^{10} collisions) gain factor 100 in statisitcs over RUN 1 + RUN 2 program

significantly improve vertexing and tracking





1 ACORDE | ALICE Cosmic Rays Detector
2 AD | ALICE Diffractive Detector
3 DCal | Di-jet Calorimeter
4 EMCal | Electromagnetic Calorimeter
5 HMPID | High Momentum Particle Identification Detector
6 ITS-IB | Inner Tracking System - Inner Barrel
7 ITS-OB | Inner Tracking System - Outer Barrel
8 MCH | Muon Tracking Chambers
9 MFT | Muon Forward Tracker
10 MID | Muon Identifier
11 PHOS / CPV | Photon Spectrometer
12 TOF | Time Of Flight
13 T0+A | Tzero + A
14 T0+C | Tzero + C
15 TPC | Time Projection Chamber
16 TRD | Transition Radiation Detector
17 V0+ | Vzero + Detector
18 ZDC | Zero Degree Calorimeter

detector requirements:

read out all Pb-Pb interactions at a maximum rate of 50kHz (i.e. $L=6 \times 10^{27}$ $cm^{-1}s^{-1}$) continuously or upon minimum bias trigger

perform online data reconstruction based on reconstruction of clusters and tracks

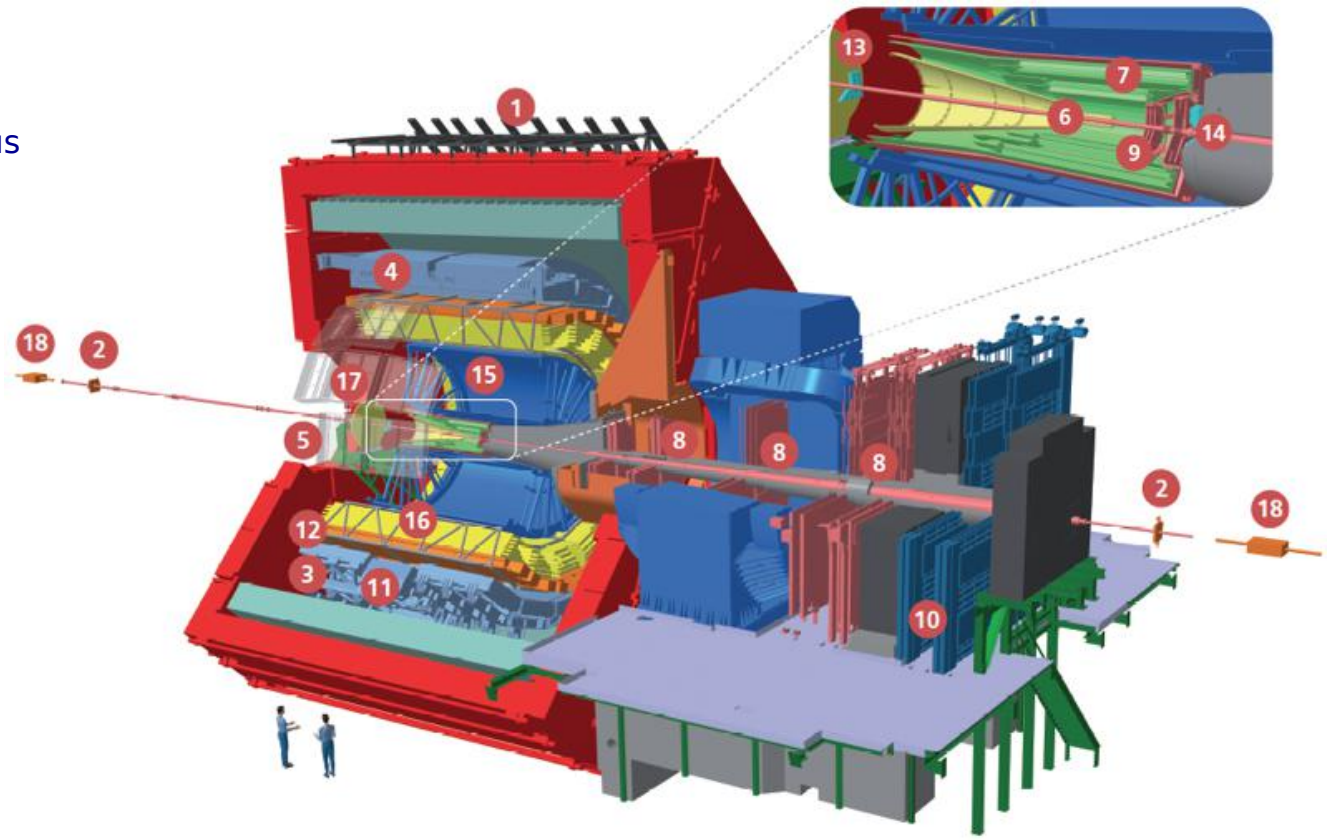
improve vertexing and tracking at low p_T with new Inner Tracking System (ITS)

Upgrades

Time Projection Chamber (TPC)
- New readout chambers using GEM technology
- New electronics for continuous readout (SAMPA)

MUON ARM
- New electronics for Muon Chambers (SAMPA)
- New electronics for Muon Trigger

New Trigger Detectors (FIT)
New Central Trigger Processor (CTP)
TOF, TRD new readout electronics
PHOS, EMCAL, CPV, HMPID improvement of readout rate with existing electronics



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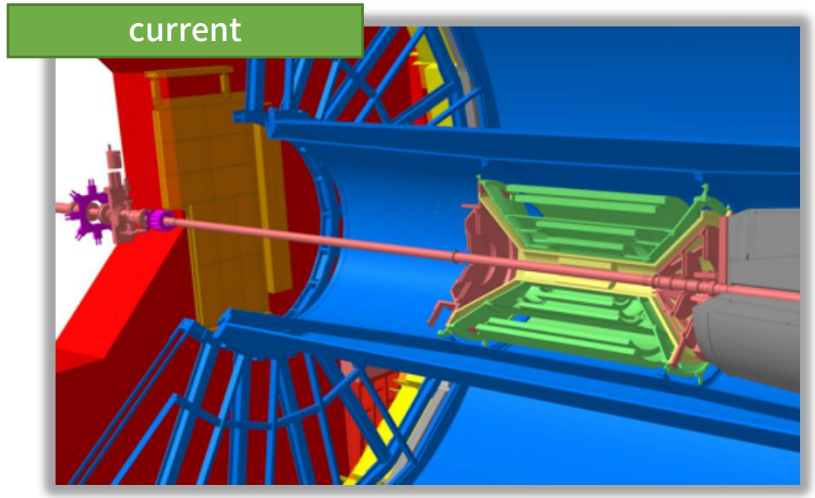
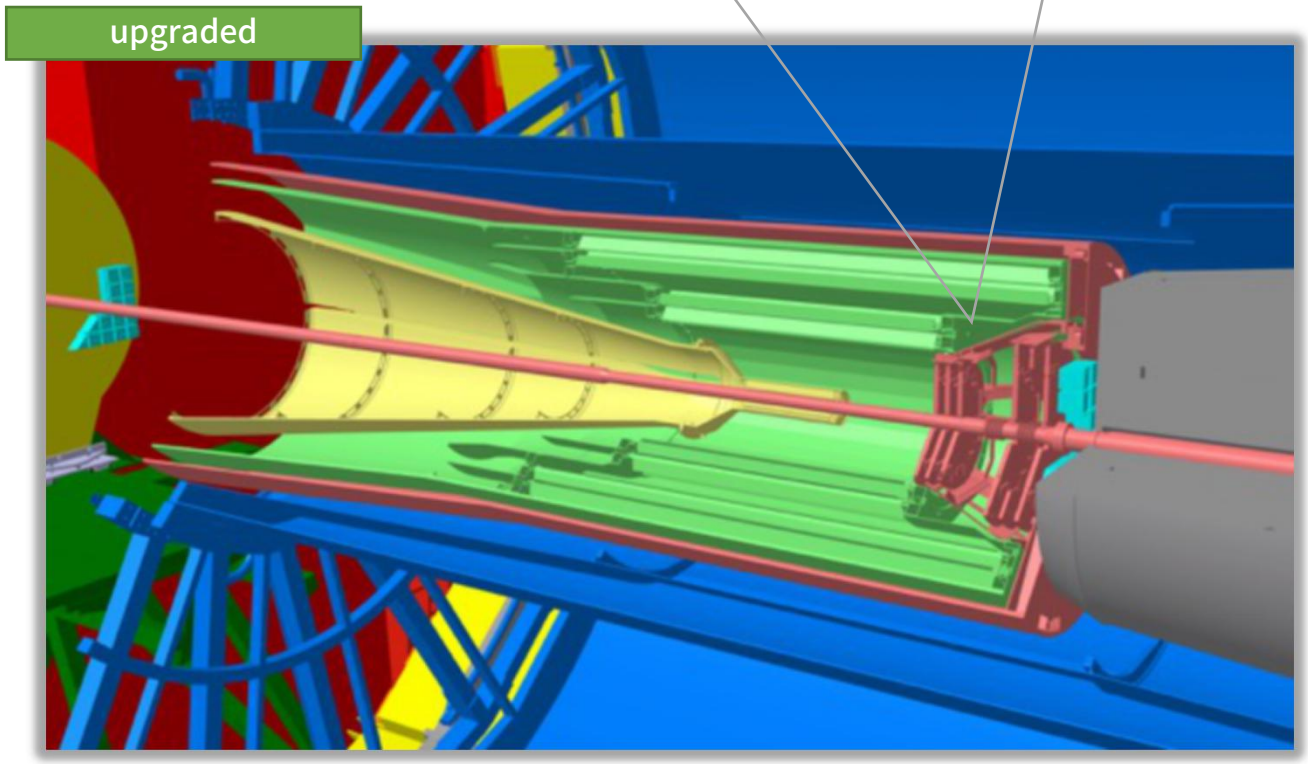
Common Projects:
Common Readout Unit (CRU) for all detectors (PCI card)
SAMPA common FE chip for TPC and Muon arm

Online Offline (O2) system
- New computing facility
- On-line tracking & data compression
- 50kHz PbPb event rate

ITS upgrade and MFT



Muon Forward Tracker (MFT)
- New tracker based on ALPIDE
- Improved MUON pointing precision, prompt vs. decay muons



New Inner Tracking System (ITS)
- Improved pointing precision
- Monolithic CMOS sensors (ALPIDE) with very small material budget
- Smaller beampipe, 1st layer closer

Services and infrastructure

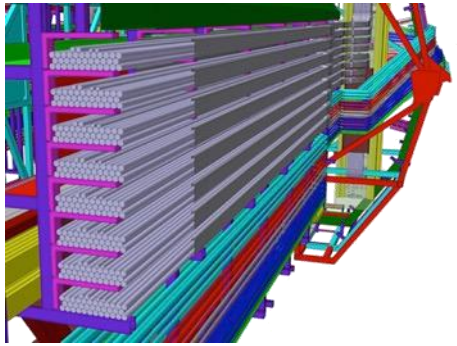
Detailed description of what will be installed: EDMS 1890533

- 5km INOX cooling pipes (MFT, ITS)
- 45km copper cables (ITS, TPC, MFT, FIT, MCH, CPV and ZDC)
- 4.5km of 300mm2 LV cables (TPC/TRD/TOF)
- 20km optical cables (28k links) and 4600 patch cords

Close collaboration with EN-EA and EN-EL

90% of the material ordered, partly already delivered at P2

3 tenders: inox pipes, OF, LV cables



CAD drawings

TPC HV installation (YETS)

Logistics

Services and infrastructure

Detailed c
- 5kr
- 45k
- 4.5
- 20k

Close colla

90% of tl

O2 computing facility infrastructure on its way

Acoustic noise measurement and simulation complete

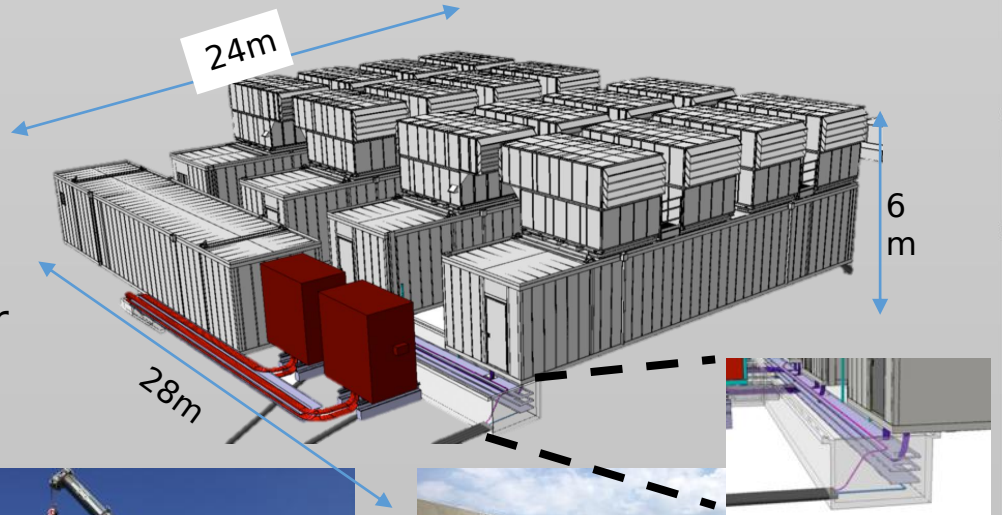
Civil engineering work complete

Cooling and Electrical infrastructure installation ongoing

Power module delivered September 11th

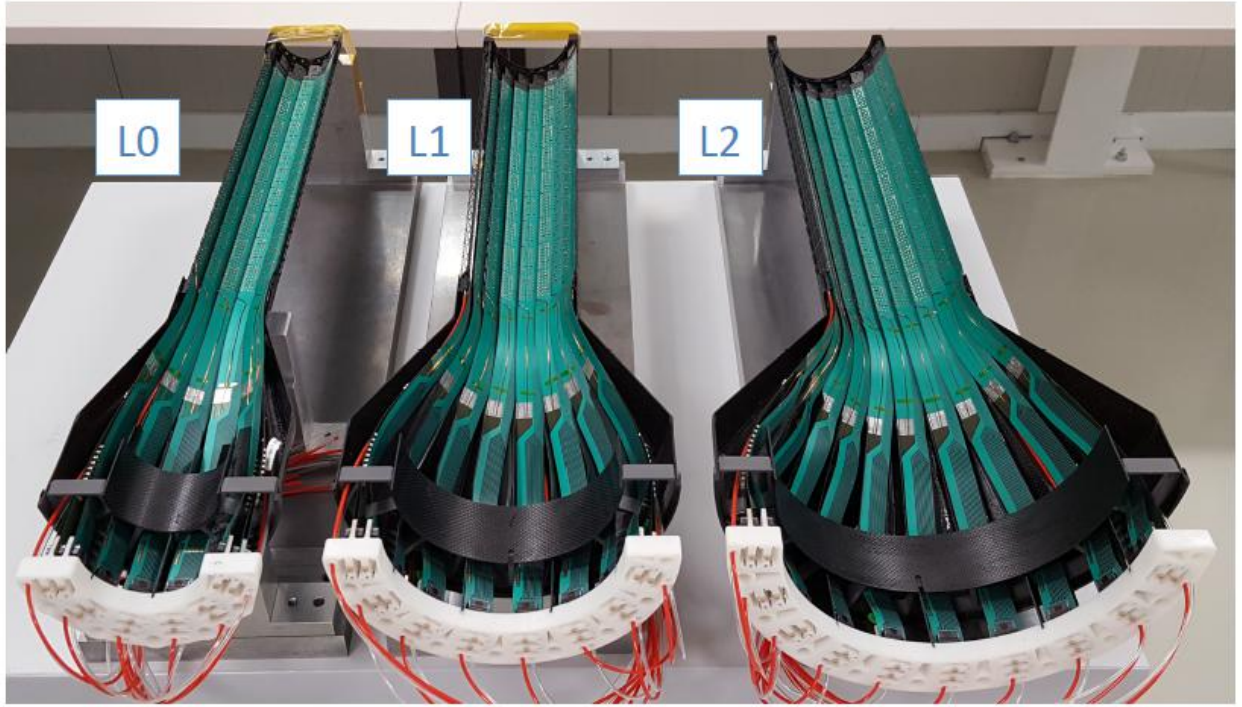
Site Acceptance Test in October/November

2nd batch (2 IT) September 2019

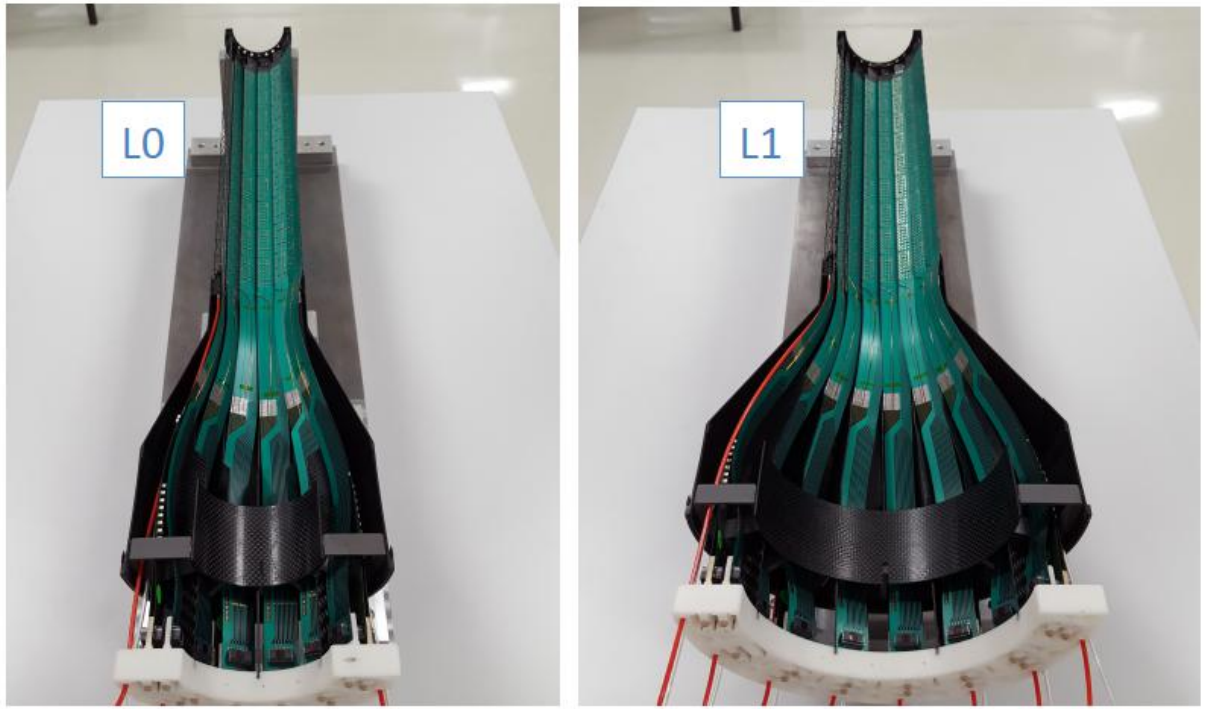


Inner barrel reconstruction (CERN)

Half-Barrel (Bottom)



Half-Barrel (Top)



Time to assemble one layer ≈ 2 hours

⇨ Inner Barrel nearly completed. Last layer will be assembled by mid September

Inner barrel reconstruction (CERN)

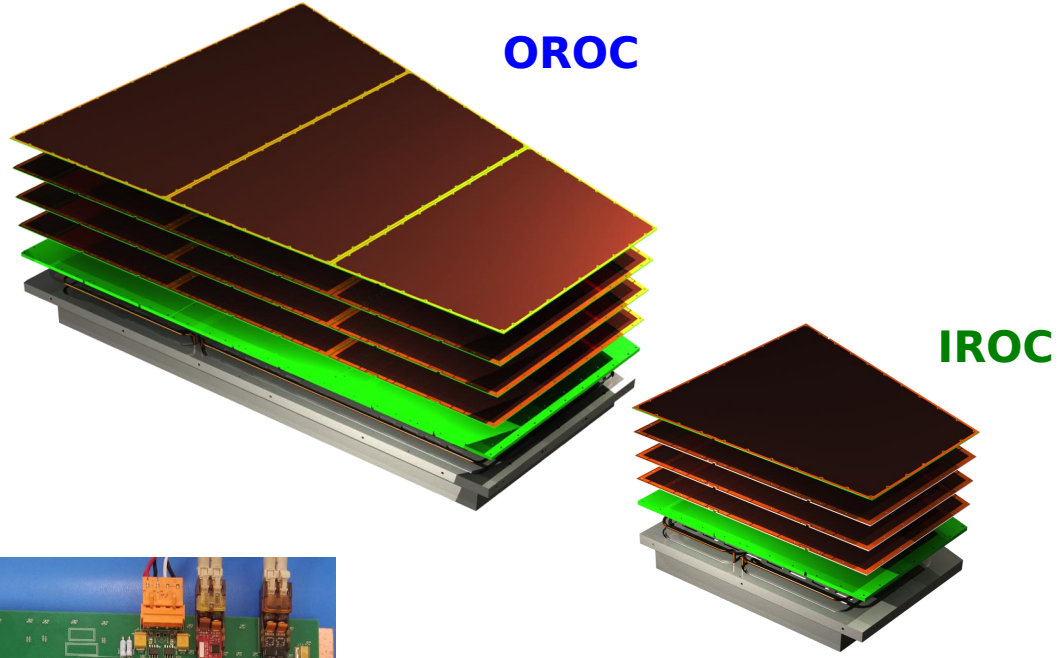
Production of outer structural shell and service barrel (Berkeley)

ITS OB BARREL #2

ITS OB BARREL #1

Dry Assembly done!

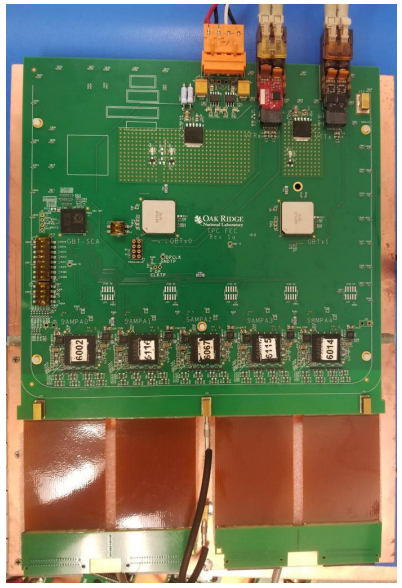
TPC upgrade for continuous readout



80 new GEM-based Readout Chambers

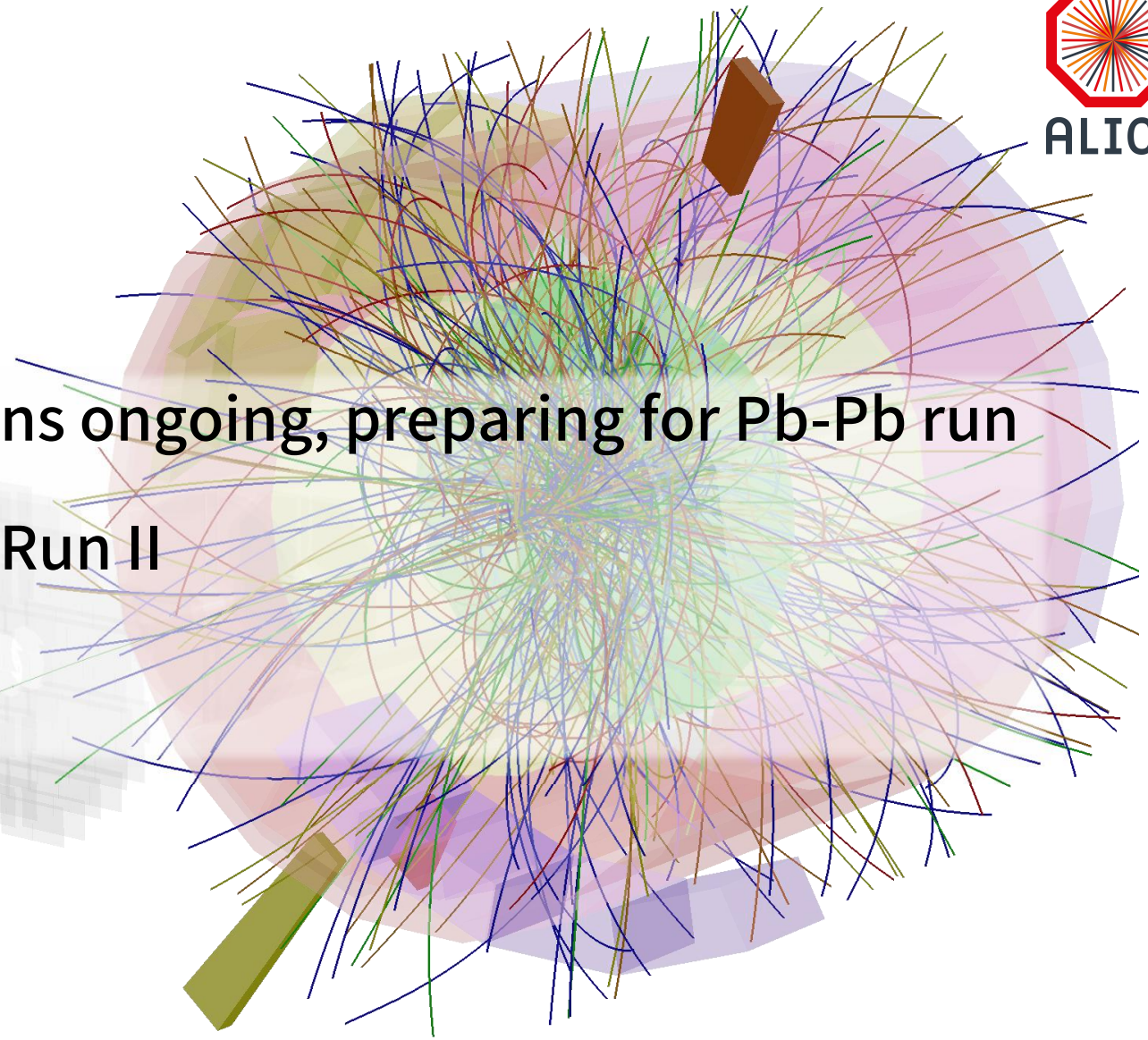
- 40 Inner (IROC) and 40 Outer (OROC)
- Status: 61 assembled, 49 delivered to CERN
- Production finishes in October 2018

ROC storage at CERN P2



3670 new Frontend-Cards

- Design phase finished
- Ready for mass production
- All cards available in March 2019

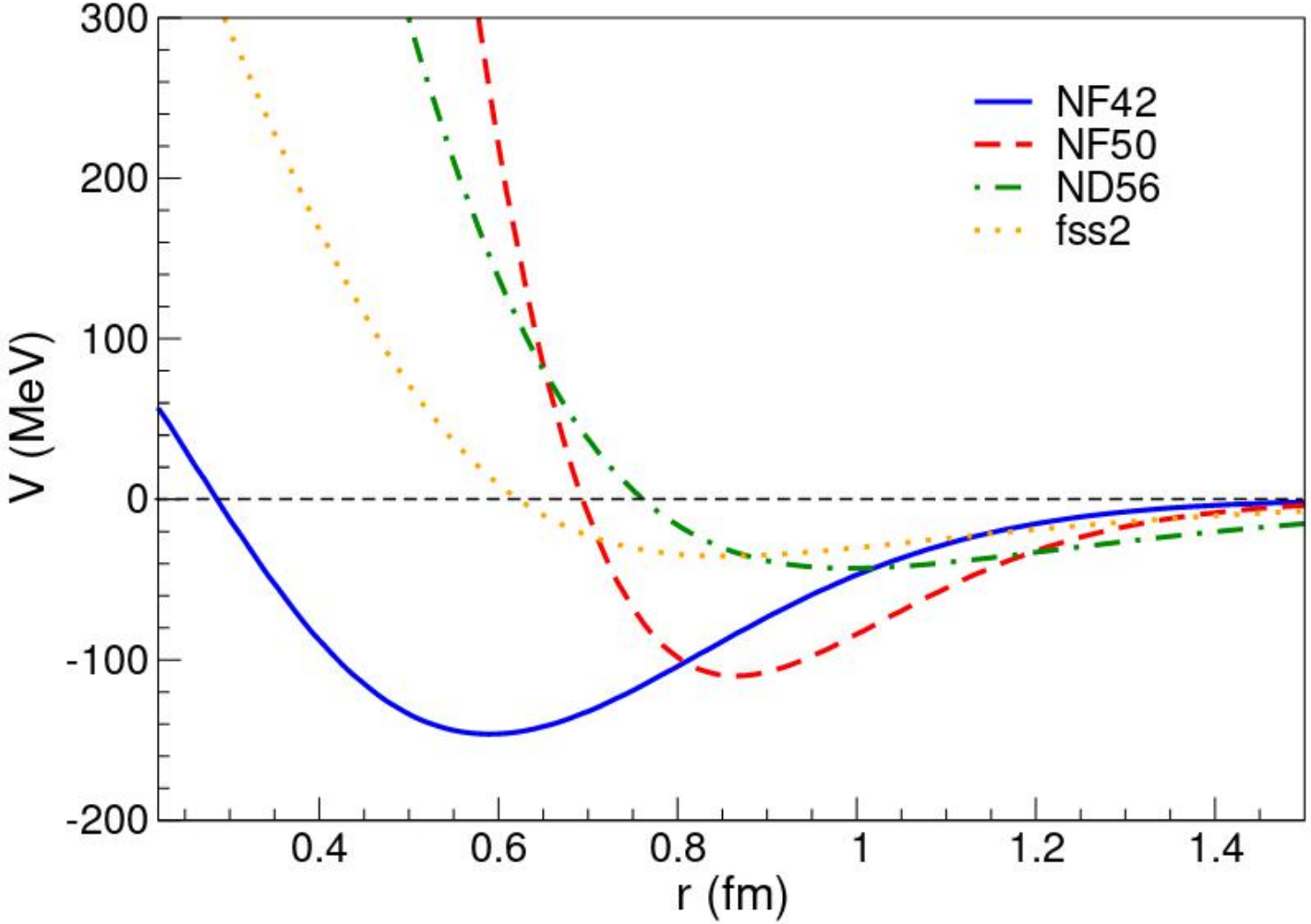


data taking in nominal conditions ongoing, preparing for Pb-Pb run

many new physics results from Run II

upgrades on track for LS2

backup



Eur.Phys.J. C78 (2018) no.5, 394

Fig. 4 Λ-Λ interaction potentials as a function of the relative distance r. The parametrization in Eq. (10) is taken from [70].