



ALICE @ FCPPN/L

“Study of QCD matter with the ALICE detector”

Nicole Bastid (LPC, CNRS-IN2P3, UCA, Clermont-Ferrand, France)

Xiaoming Zhang/Daicui Zhou (IOPP, CCNU, Wuhan, China)

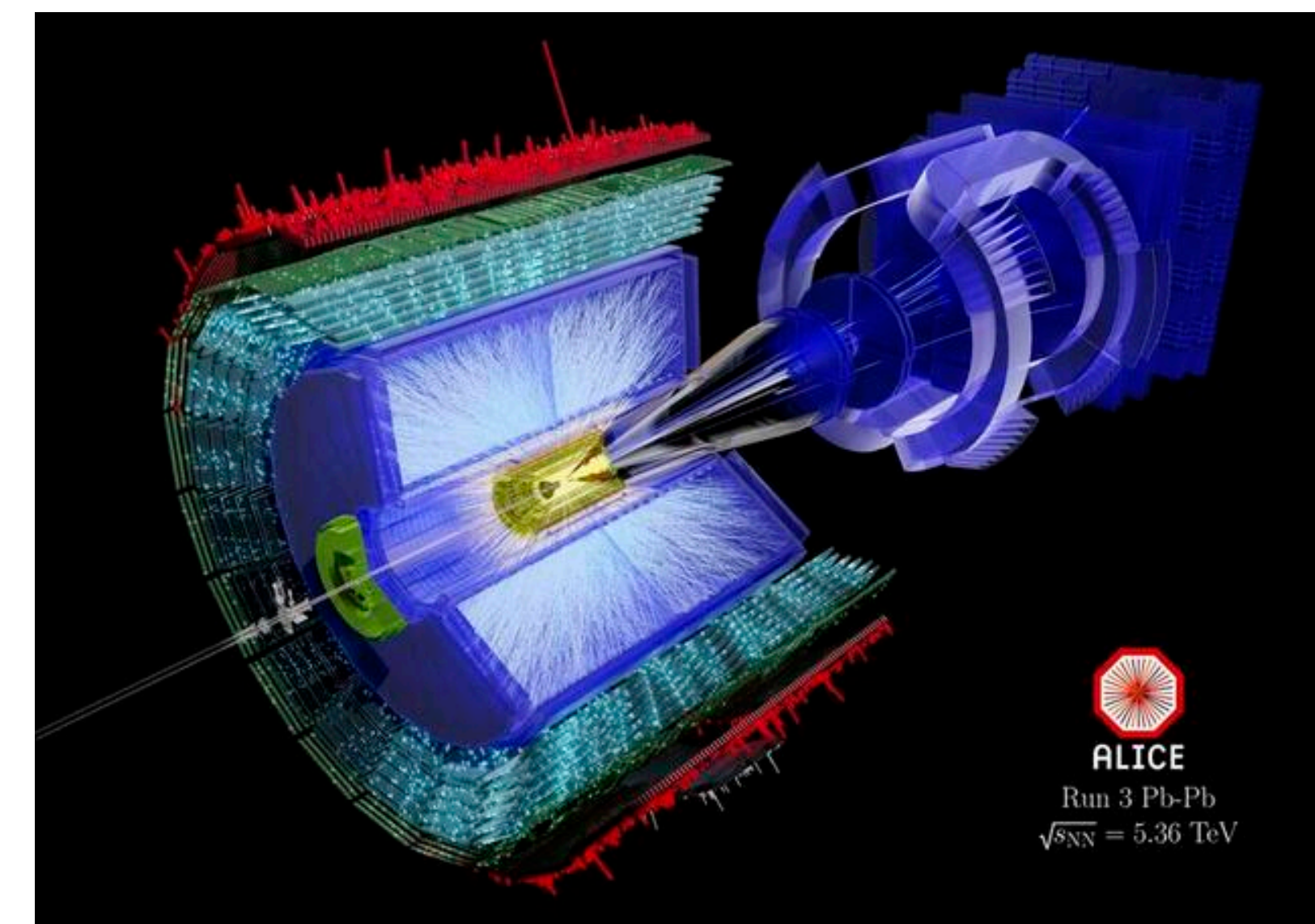
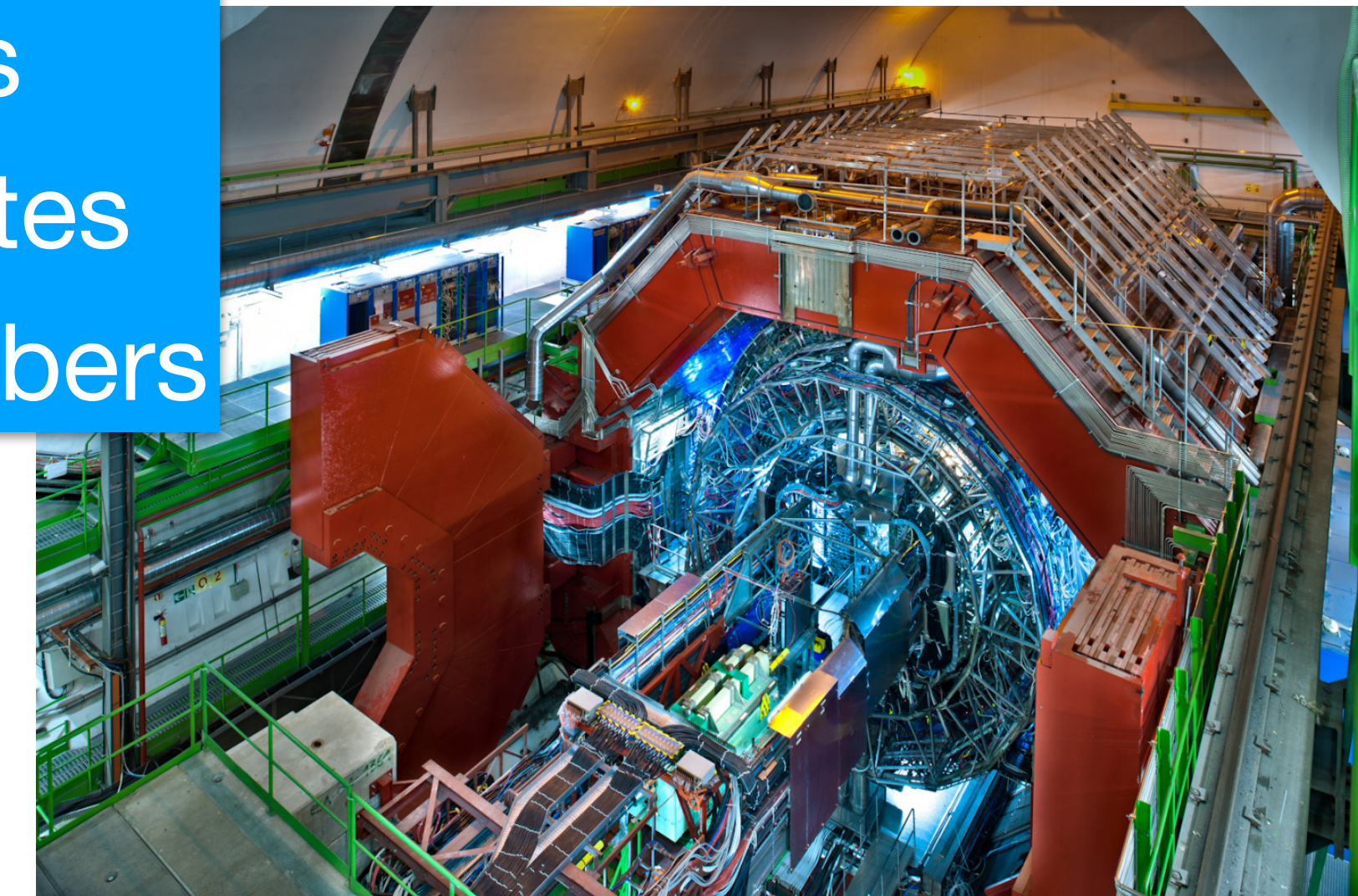
**The 17th FCPPN/L workshop
29 June – 3 July 2026, Lyon, France**

ALICE Collaboration

3

A large ion collider experiment — ALICE

- 36 countries
- 164 institutes
- 1938 members

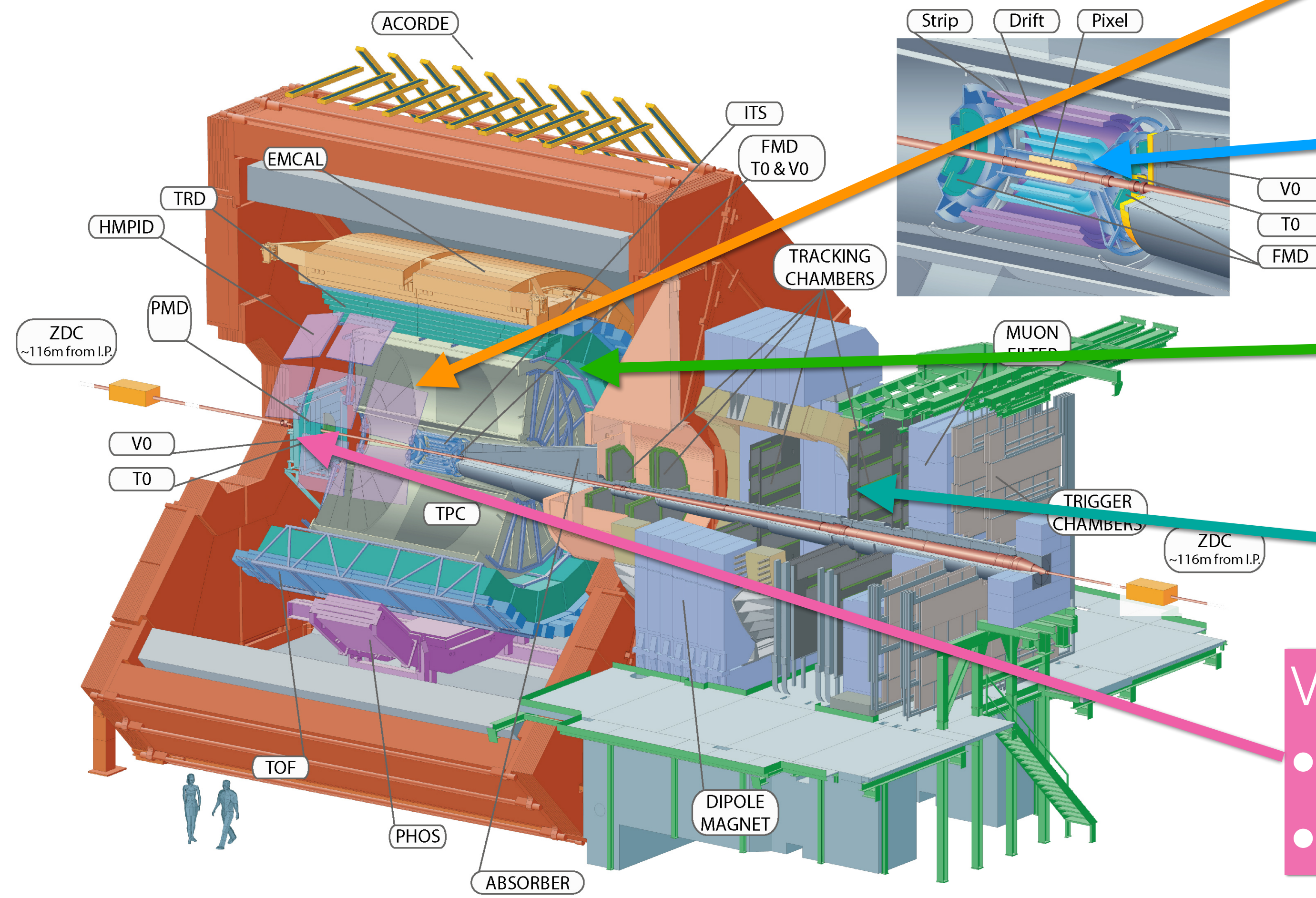


Study the primordial matter existed after the Big Bang via ultra-relativistic heavy-ion collision “little bang”

ALICE experiment at the LHC

4

- ALICE: A heavy-ion detector at the LHC
- Study of strongly-interacting matter at extreme temperatures and energy densities



Time Projection Chamber (TPC)

- $|\eta| < 0.9$, charged-particle tracking and identification (PID)

Inner Tracking System (ITS)

- $|\eta| < 0.9$, vertexing

Time of Flight (TOF)

- $|\eta| < 0.9$, triggering, pileup rejection, PID

Muon spectrometer

- $2.5 < |\eta| < 4$, $\mu \leftarrow c, b$, $\mu \leftarrow W^\pm/Z^0$

V0 (V0A and V0C)

- V0A: $2.8 < \eta < 5.1$, V0C: $-3.7 < \eta < -1.7$
- Triggering and multiplicity determination

A journey through QCD

5

2010-2013

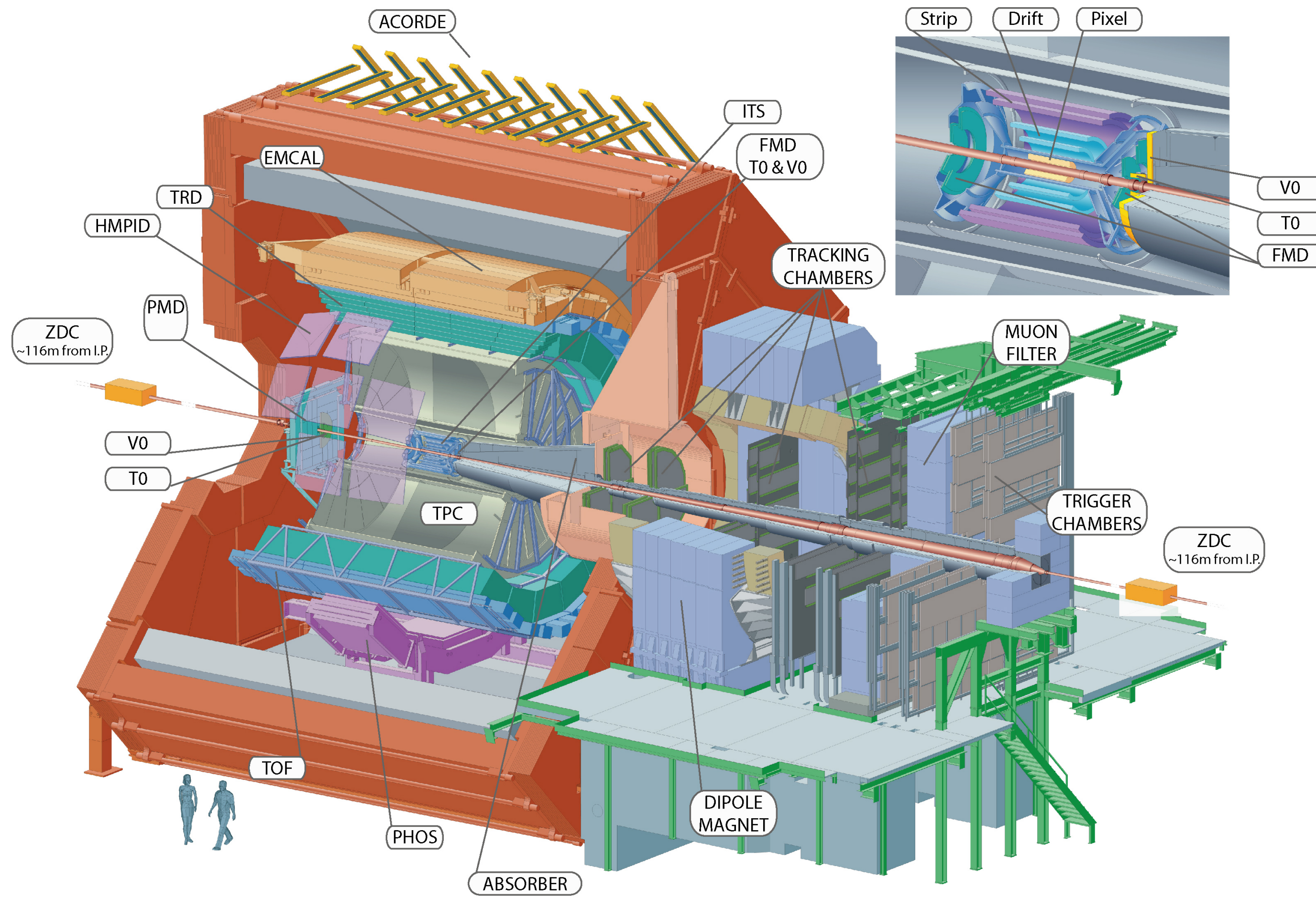
2015-2018

Run 1

LS1

Run 2

ALICE 1



CERN-EP-2022-227

27 October 2022



ALICE *Eur. Phys. J. C*84 (2024) 813

The ALICE experiment:
A journey through QCD

**ALICE Physics achievement
2009–2018**

- **QGP properties**
- Spin physics
- Nuclear structures
- Hadronic physics
- Fundamental symmetries
- Contribution to cosmology

ALICE at LHC Run 3 (2022–now)

6

2010-2013

2015-2018

2022-2026

Run 1

LS1

Run 2

LS2

Run 3

ALICE 1

ALICE 2

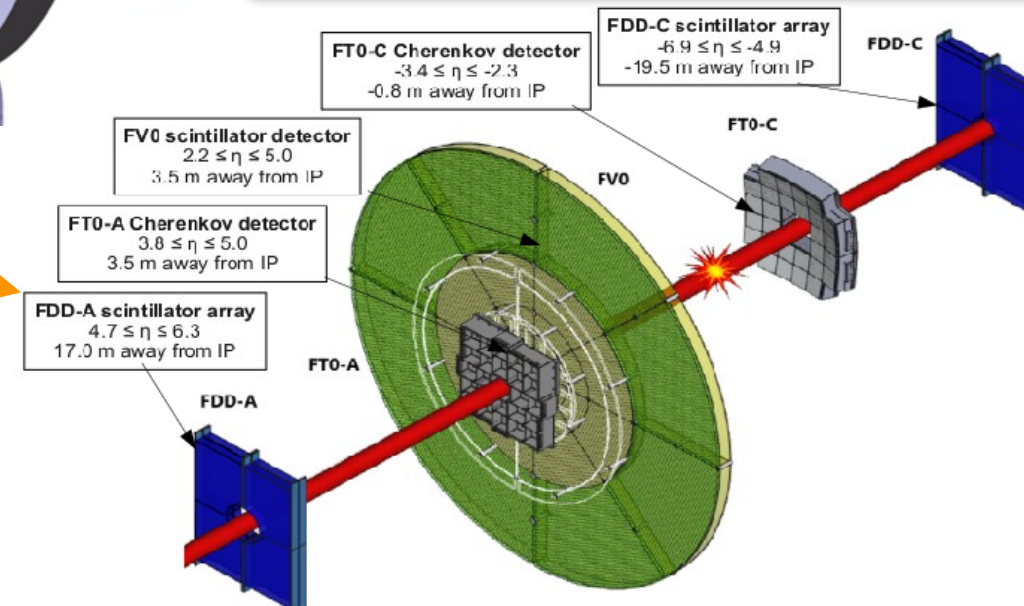
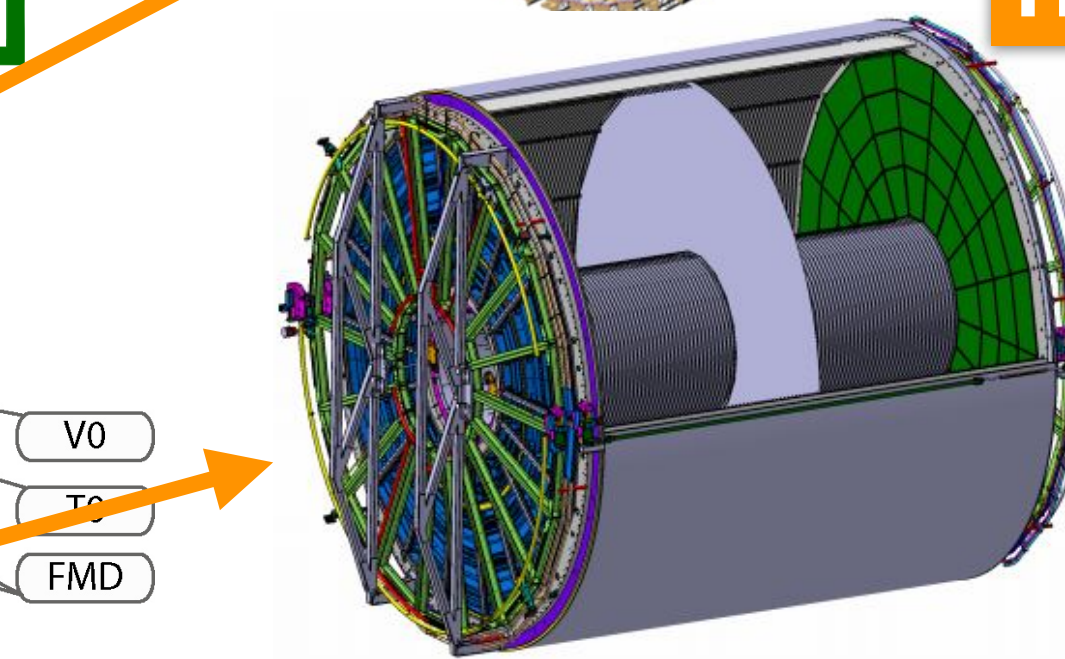
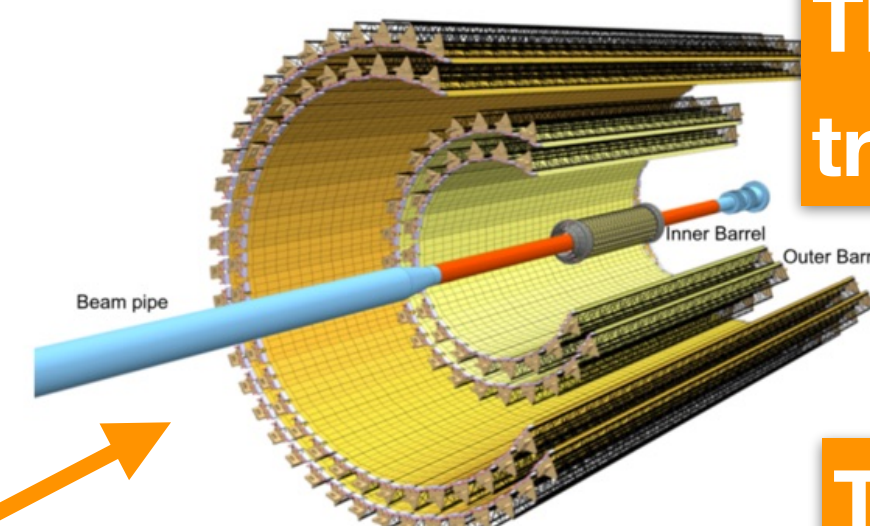
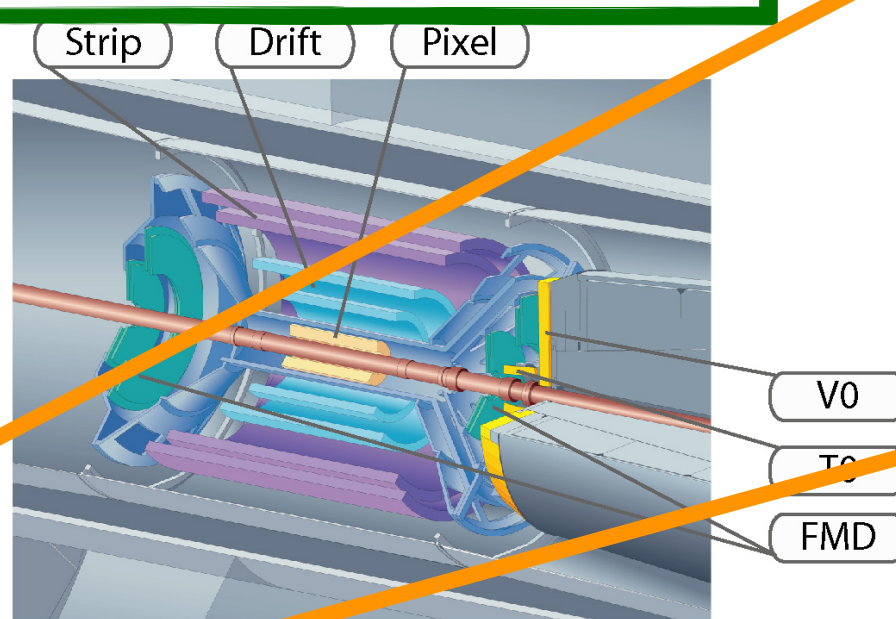
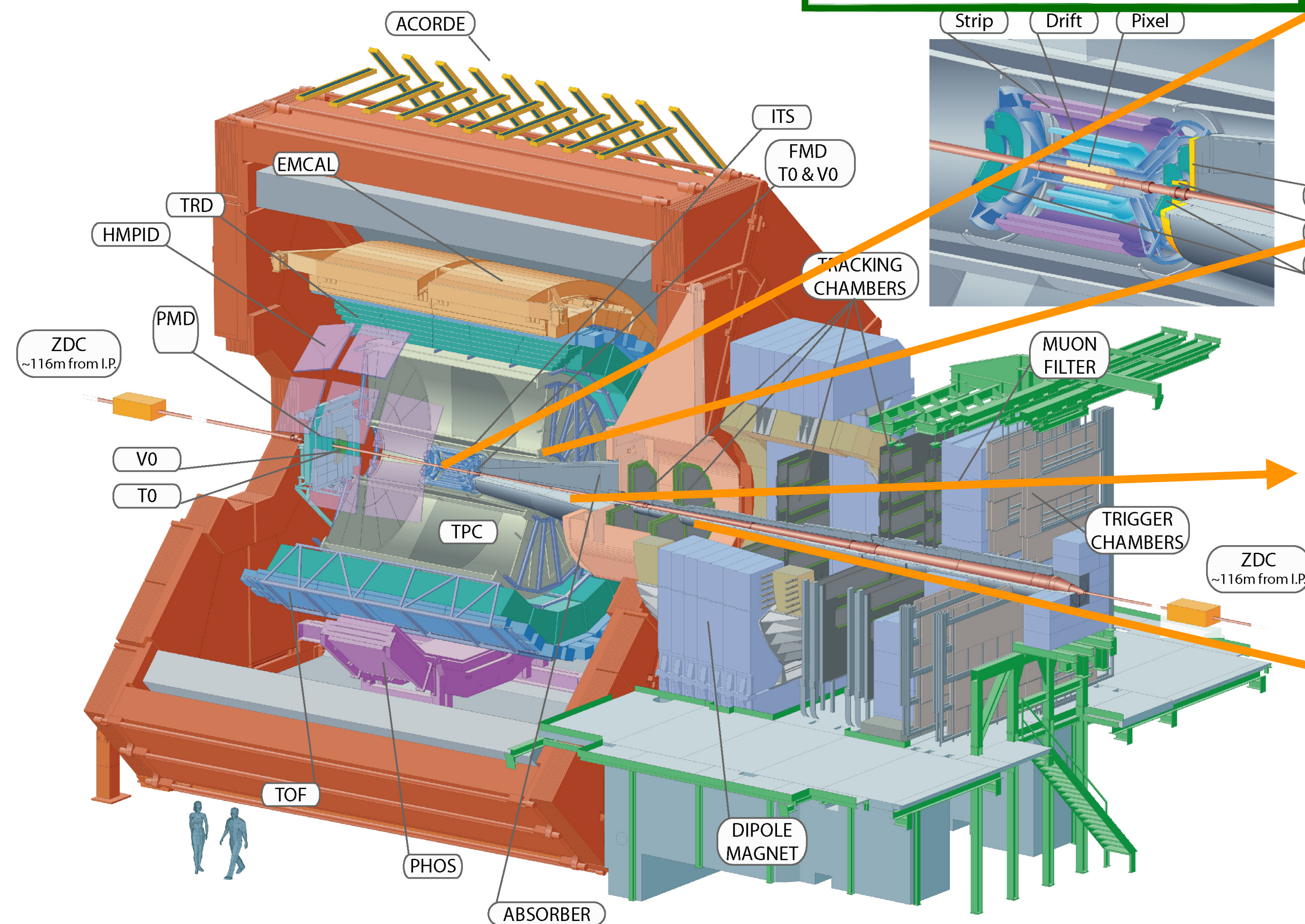
The 2nd generation inner tracking system (ITS2)

Time projection chamber (TPC)

- **pp** data taking at **500 kHz**
- **Pb–Pb** data taking up to **50 kHz**
- Improved vertexing
- Improved tracking at **low p_T**

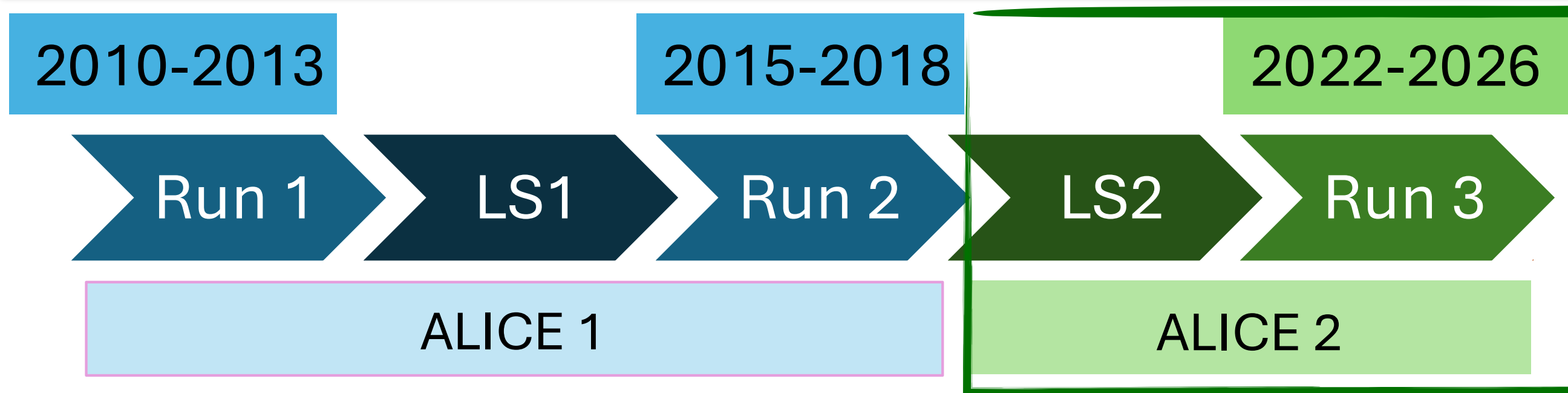
Muon forward tracker (MFT)

Fast integration trigger (FIT)

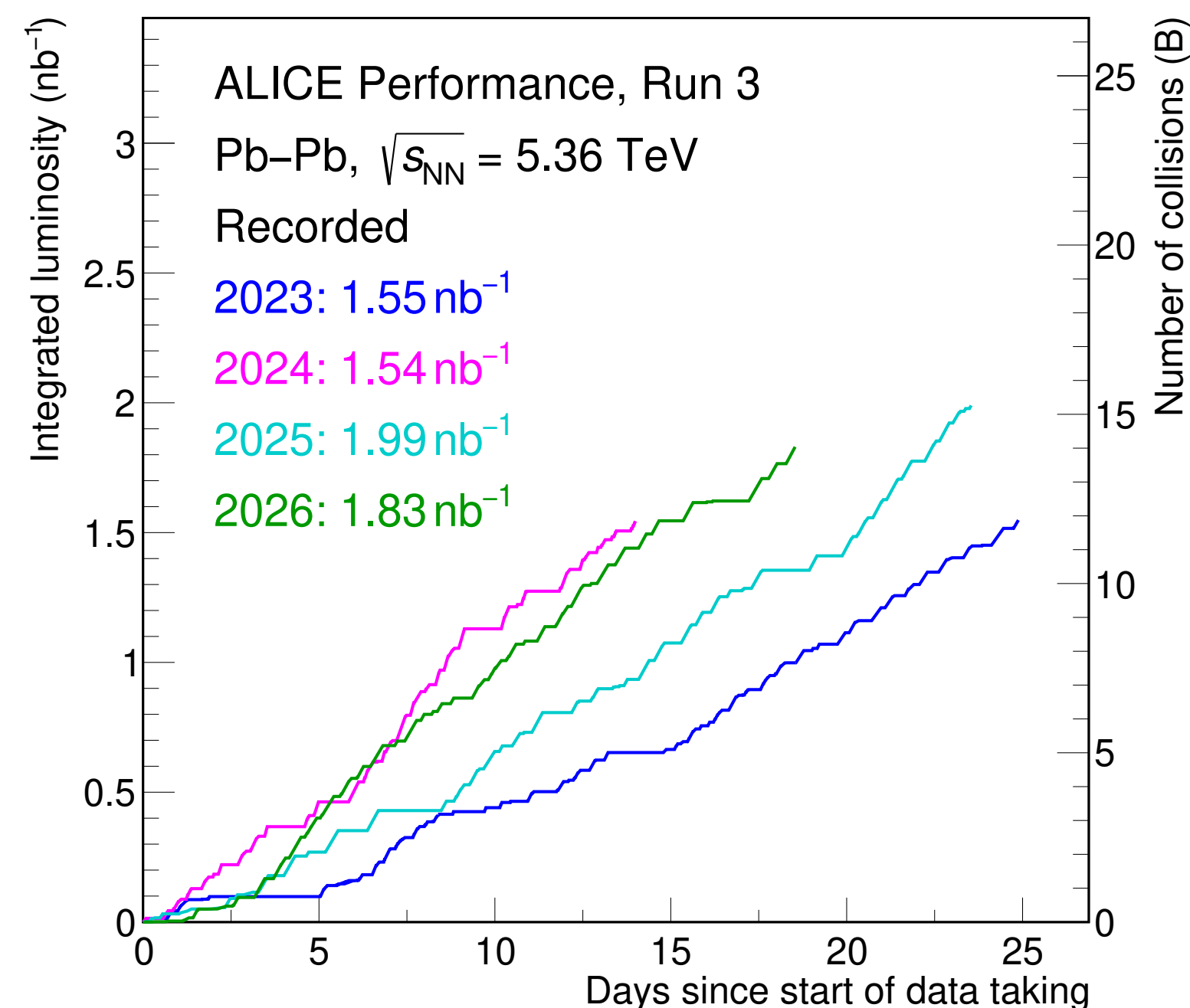


ALICE data taking in Run 3

7

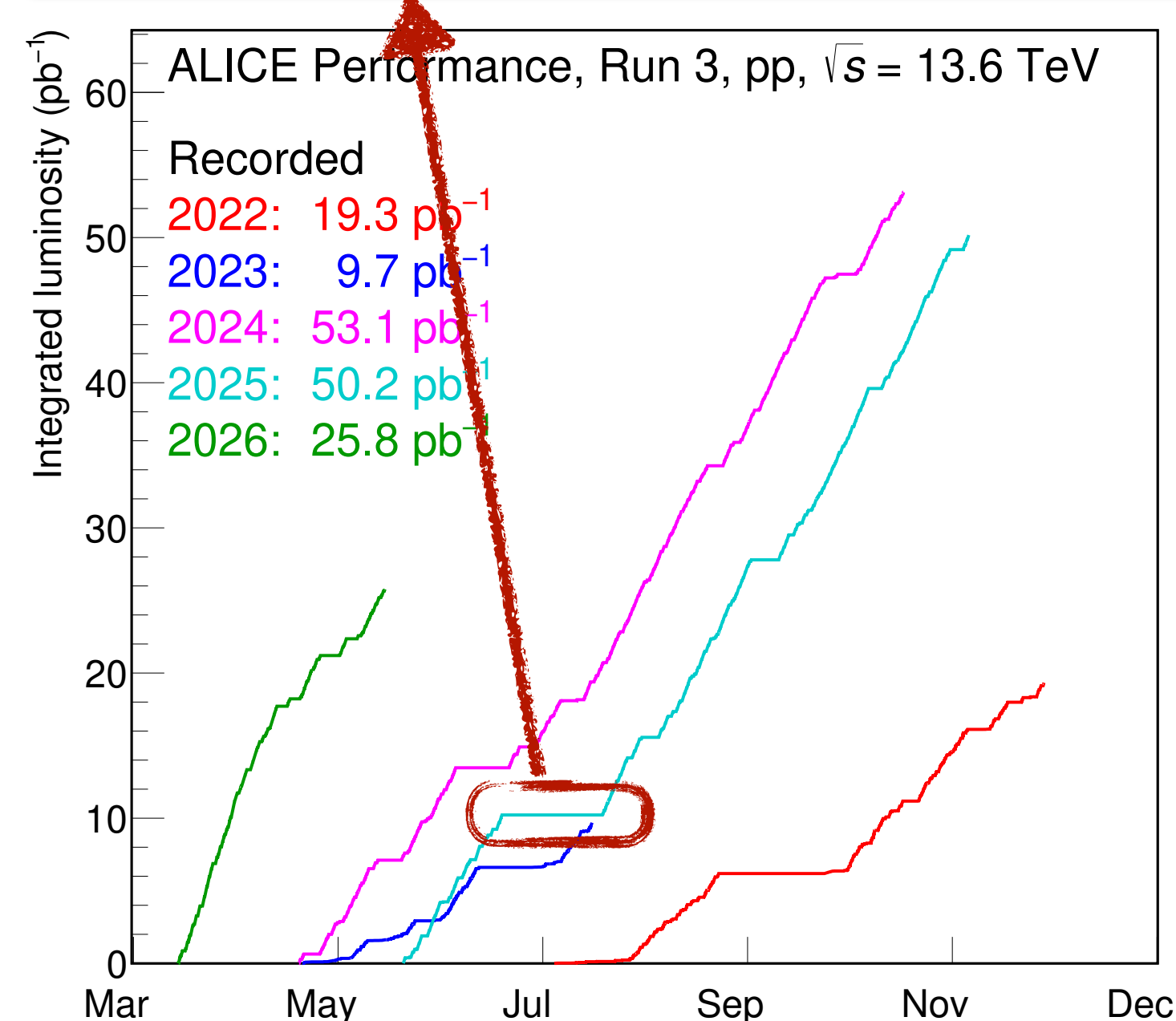


	L_{int}	MB events
p-O	7.27 nb ⁻¹	3×10^9
OO	5.01 nb ⁻¹	6×10^9
Ne-Ne	0.84 nb ⁻¹	10^9



ALI-PERF-634120

Pb-Pb: 52 billion MB events
x160 more than Runs 1+2



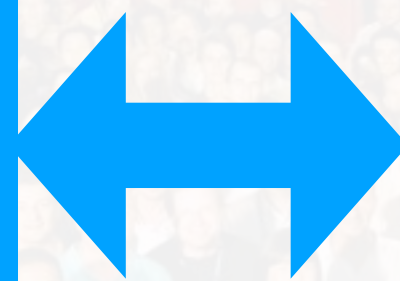
ALI-PERF-632114

pp: 8 trillion MB events
x1000 more than Runs 1+2

7 Chinese institutes and 8 French institutes

China institutes

- CCNU, Wuhan
- CIAE, Beijing
- CUG, Wuhan
- HUST, Wuhan
- HUT, Wuhan
- USTC, Hefei
- Fudan, Shanghai



France institutes

- IPNL & CC-IN2P3, Lyon
- IPNO, Orsay
- IPHC, Strasbourg
- LPC, Clermont-Fd
- LPSC, Grenoble
- Subatech, Nantes
- IRFU, Saclay

Shopping list (keywords)

Photons and neutral hadrons

Low mass vector particles

Flow and correlations

Light flavour spectra

Open heavy flavours

Electroweak bosons

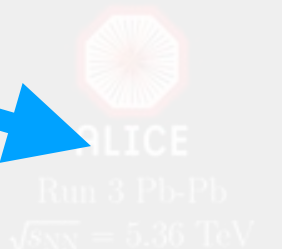
Quarkonia

Jets

Detector contributions

- ➔ Ongoing: MUON, MFT and ITS2
- ➔ Upgrades: ITS3, ALICE3

Study the primordial matter existed at the beginning of the universe
via ultra-relativistic heavy-ion collision



French Group			Chinese Group		
Name	Status	Affiliation	Name	Status	Affiliation
Leader			Leader		
BASTID Nicole	PR	IN2P3/LPCA	ZHANG Xiaoming	PR	IOPP/CCNU
Baldisseri Alberto	Physicist	IRFU	Zhou Daicui	PR	IOPP/CCNU
Barreau Emilie	PhD	IN2P3/Subatech	Huang Guangming	PR	IOPP/CCNU
Batigne Guillaume	MC	IN2P3/Subatech	Zhou Daimei	PR	IOPP/CCNU
Belikov Iouri	DR	IN2P3/IPHC	Ying Zongbao	PR	IOPP/CCNU
Castillo Castellanos Javier	Physicist	IRFU	Ma Yugang	PR	FUDAN & ECNU
Cheshkov Cvetan	DR	IN2P3/IP2I	Li Xiaomei	Researcher	CIAE
Conesa-Balbastre Gustavo	CR	IN2P3/LPSC	Wang Yaping	PR	IOPP/CCNU
Crochet Philippe	DR	IN2P3/LPCA	Zhao Lei	PR	USTC
Di Bella Valério	PhD	IN2P3/IPHC	Zhang Yifei	PR	USTC
Faivre Julien	CR	IN2P3/LPSC	Zhang Song	PR	FUDAN
Furget Christophe	PR	IN2P3/LPSC	Tang Zebo	PR	USTC
Germain Marie	CR	IN2P3/Subatech	Mao Yaxian	PR	IOPP/CCNU

Guernane Rachid	CR	IN2P3/LPSC	Pei Hua	PR	IOPP/CCNU
Guilbaud Maxime	MC	IN2P3/Subatech	Shou Quiye	Ass. PR	FUDAN
Hippolyte Boris	PR	IN2P3/IPHC	Zhu Jianhui	Ass. PR	FUDAN
Kuhn Christian	DR	IN2P3/IPHC	Wang Dong	PR	IOPP/CCNU
Lambert Stanislas	PhD	IN2P3/Subatech	Yang Ping	Ass. PR	IOPP/CCNU
Lopez Xavier	PR	IN2P3/LPCA	Gao Chaosong	Ass. PR	IOPP/CCNU
Lotteau Clément	PhD	IN2P3/IP2I	Pen Xinye	Ass. PR	CUG & IOPP/CCNU
Maire Antonin	CR	IN2P3/IPHC	Bai Xiaozhi	PR	IOPP/CCNU
Mattei Lorenzo	PhD	IN2P3/LPCA	Hou Yongzhen	Lecturer	CUG & IOPP/CCNU
Mattioli Kara	MC	IN2P3/Subatech	Wang Yubiao	PhD	IOPP/CCNU
Millot Louise	PhD	IN2P3/LPSC	Xu Lang	Joint-PhD	IOPP/CCNU
Pillot Philippe	CR	IN2P3/Subatech	Zhang Maolin	Joint-PhD	IOPP/CCNU
Shabeita Alexandre	CR	IN2P3/Subatech	Su Youpeng	PhD	IOPP/CCNU
Stocco Diego	CR	IN2P3/Subatech	Feng Wenhui	PhD	IOPP/CCNU
Tabikh Ahmad	PhD	IN2P3/LPSC	Liu Rixin	Master	IOPP/CCNU
Uras Antonio	CR	IN2P3/IP2I	Xu Xiaotong	Master	IOPP/CCNU
Xu Lang	Joint-PhD	IN2P3/IP2I	Wang Yuting	Master	IOPP/CCNU
Zhang Maolin	Joint-PhD	IN2P3/LPCA	Liu Jun	Engineer	IOPP/CCNU

62 members in 2026 (36 members in 2009)

History and achievements

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- ~6/year bilateral visits of senior physicists and engineers/technicians
- 3 postdoc exchanges since 2009
- > 10 defended joint-PhD theses since 2008
- > 20 master student trainings since 2007

All former joint-PhDs got permanent or postdoc positions in academic filed

- 2 joint-PhD defenses are scheduled in 2026
- 4 ongoing joint-PhD programmes
- 2 master student trainings are proposed in 2026



Published paper (10)

- **ALICE Collaboration** ([R. Xu et al.](#)), Inclusive isolated photon production in pp collisions, *Eur. Phys. J. C* **85** (2025) 98
- **ALICE Collaboration** ([X. Zhang et al.](#)), Ξ_c^0 production in p–Pb collisions, *Eur. Phys. J. C* **85** (2025) 86
- **ALICE Collaboration** ([M. Germain et al.](#)), Isolated prompt photon production in pp and p-Pb collisions, *Eur. Phys. J. C* **85** (2025) 1407
- **ALICE Collaboration** ([G. Balbastre et al.](#)), Inclusive isolated-photon production in pp and Pb-Pb collisions, *Eur. Phys. J. C* **85** (2025) 553
- **ALICE Collaboration** ([X. Bai et al.](#)), Coherent J/ψ photoproduction in Pb-Pb collisions, *Phys. Lett. B* **871** (2025) 139952
- **ALICE Collaboration** ([M. Zhao et al.](#)) Exploring nuclear structure with multiparticle azimuthal correlations, *Phys. Lett. B* **869** (2025) 139855
- **ALICE Collaboration** ([J. Zhu et al.](#)), Multiplicity dependence of Ξ_c^+ and Ξ_c^0 production in pp collisions, *JHEP* **2512** (2025) 038
- **ALICE Collaboration** ([M. Li et al.](#)) First measurement D^{*+} spin alignment in Pb–Pb collisions, *JHEP* **2510** (2025) 094
- **ALICE Collaboration** ([C. Cheshkov, A. Uras et al.](#)), Multiplicity-dependent inclusive J/ψ production in pp collisions, *JHEP* **2507** (2025) 238
- **ALICE Collaboration** ([Y. Ding et al.](#)), Multiplicity dependence of Y production in pp collisions, *Nucl. Phys. B* **1011** (2025) 116786

Submitted papers (4)

- **ALICE Collaboration** (X. Zhang *et al.*), Jet energy flow modification in heavy-ion collisions, [arXiv:2606.20061](#), submitted to *Phys. Rev. C*
- **ALICE Collaboration** (G. Balbastre *et al.*), Isolated photon-hadron correlations in Pb–Pb collisions, [arXiv:2605.02342](#), submitted to *Eur. Phys. J. C*
- **ALICE Collaboration** (L. Xu *et al.*), Transverse-momentum fraction of strange hadrons in mini-jets in pp collisions, [arXiv: 2603.19387](#), submitted to *Phys. Lett. B*
- **ALICE Collaboration** (X. Zhang *et al.*), Evidence of prompt Λ_c baryon and D meson elliptic flow in Pb–Pb collisions, [arXiv: 2603.18966](#), submitted to *Phys. Rev. Lett.*

Papers under the ALICE review (4)

- **ALICE Collaboration** (L. Xu *et al.*), Multiplicity dependence of the transverse momentum fraction of (multi-)strange particles in mini-jets in pp collisions, [tagged journal: Phys. Lett. B](#)
- **ALICE Collaboration** (Y. Ding *et al.*), Upsilon polarization in pp collisions, [tagged journal: Phys. Lett. B](#)
- **ALICE Collaboration** (Y. Hou *et al.*), Search for jet quenching and acoplanarity in p-Pb collisions, [tagged journal: JHEP](#)
- **ALICE Collaboration** (L. Mattei *et al.*), Relative charmonium production in pp collisions, [tagged journal: JHEP](#)

In addition, **41 presentations** given by students and faculties in conferences and workshops, including **QM'25**, **EPS-HEP'25**, and **ATHIC'25**

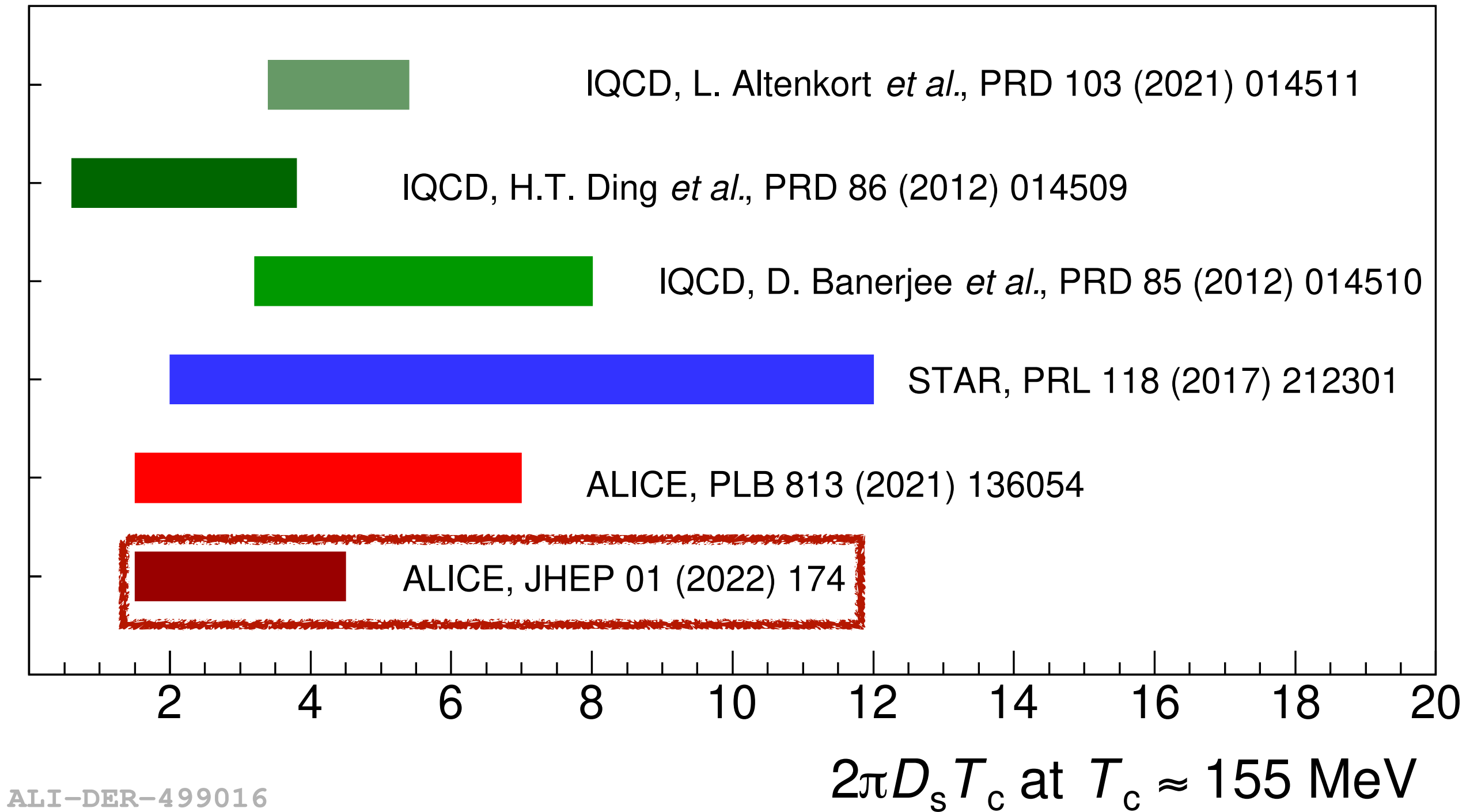
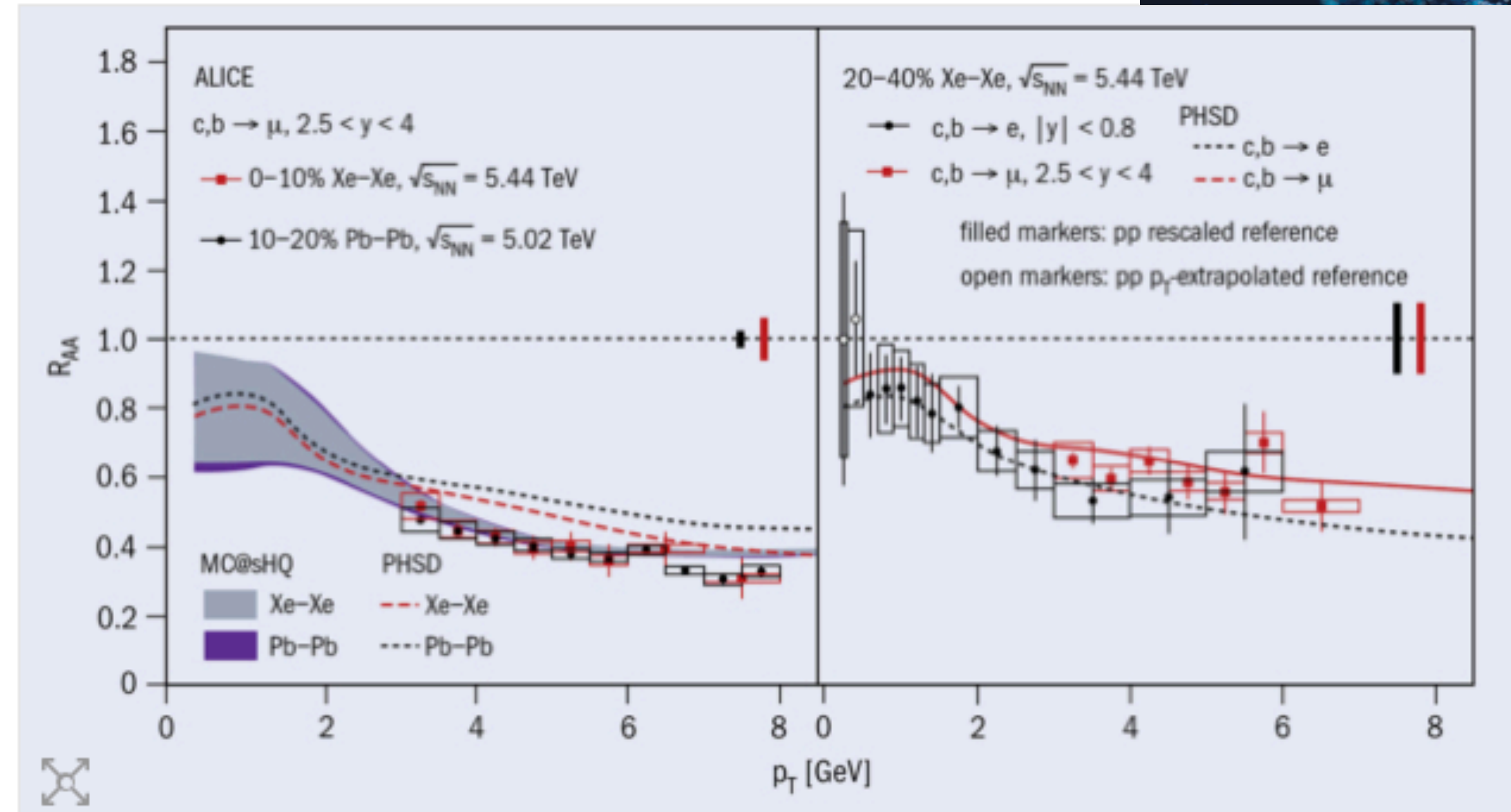
Heavy quark transport properties

13

STRONG INTERACTIONS | NEWS

Heavy flavours probe QGP geometry

22 January 2021



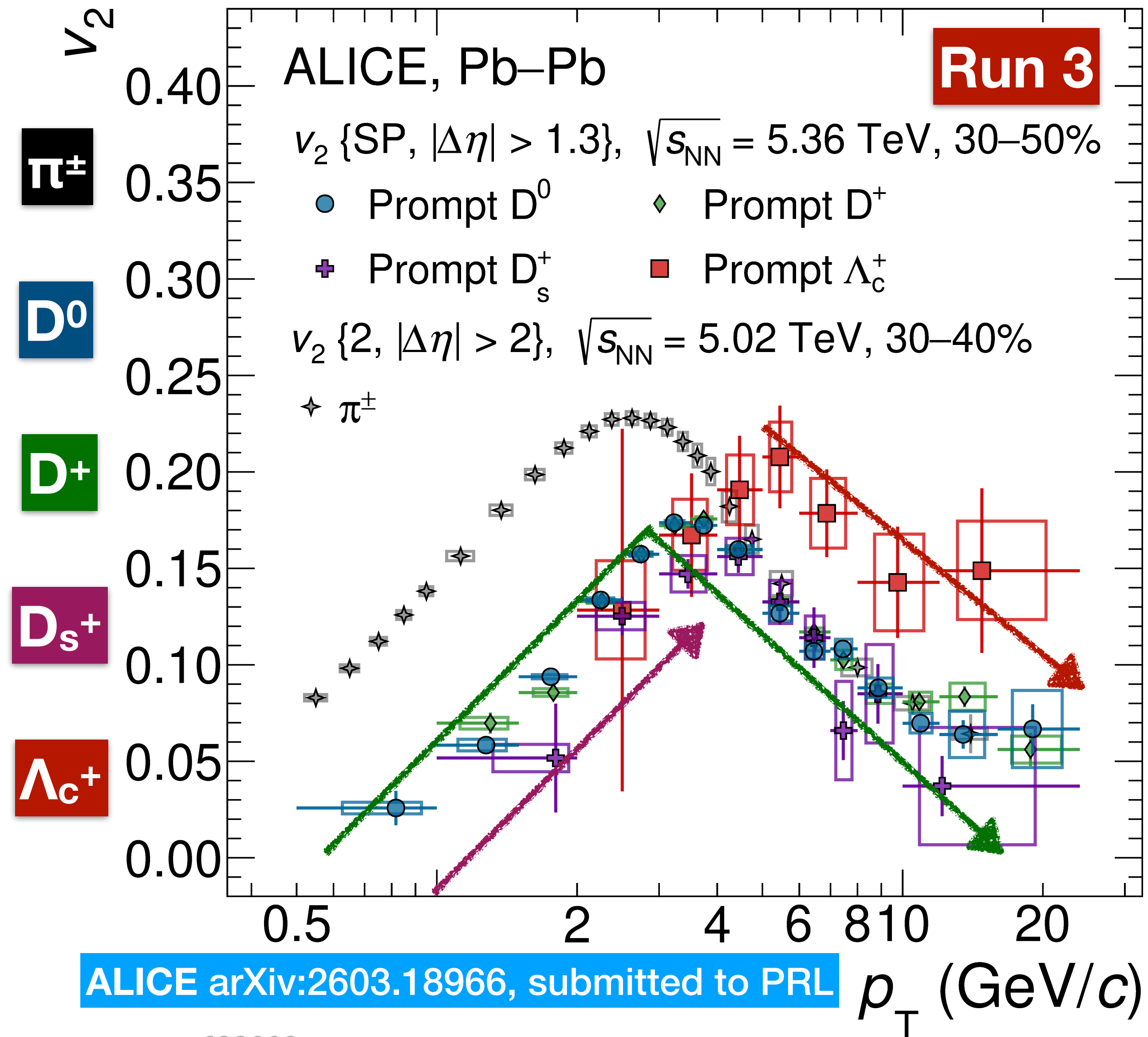
ALI-DER-499016

$$1.5 < 2\pi D_s(T) < 4.5$$

$$\tau_{\text{charm}} = (m_{\text{charm}} / T) D_s(T) = 3\text{--}9 \text{ fm}/c < \tau_{\text{medium}} \approx 10 \text{ fm}/c$$

➡ Indicate charm may thermalize in the medium

ALICE Phys. Rev. Lett. 125 (2020) 022301
ALICE Phys. Rev. Lett. 109 (2012) 112301
ALICE Phys. Lett. B819 (2021) 136637
ALICE Phys. Lett. B820 (2021) 136558
ALICE Phys. Lett. B770 (2017) 459
ALICE Phys. Lett. B753 (2016) 41
ALICE Phys. Lett. B708 (2012) 265
ALICE JHEP 1909 (2019) 008



Low and intermediate- p_T

$$v_2(D_s^\pm) < v_2(D^0) \approx v_2(D^\pm) < v_2(\pi^\pm)$$

→ Sequential hadronization

Zhuang et al., Phys. Rev. Lett. 136 (2026) 232301

Springer Proc. Phys. 250 (2020) 275

Intermediate and high- p_T

$$v_2(\Lambda_c^+) > v_2(D_s^+) \approx v_2(D^0) \approx v_2(D^+) \approx v_2(\pi^\pm)$$

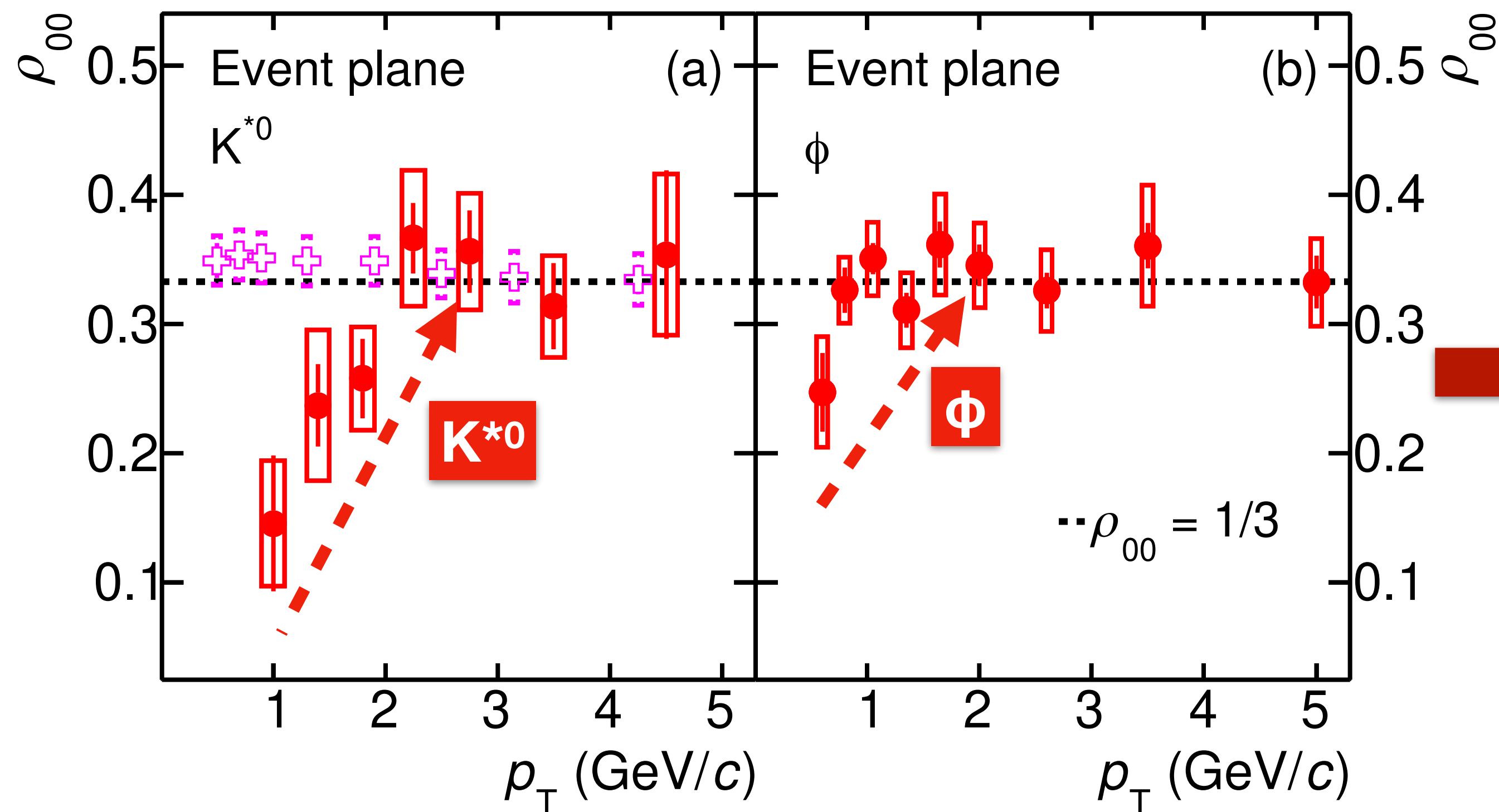
→ Strong evidence of coalescence

Further reveal the transport dynamics of heavy quarks in the QGP medium and provide high-precision microscope tomography of the QGP

Spin alignment of vector mesons

15

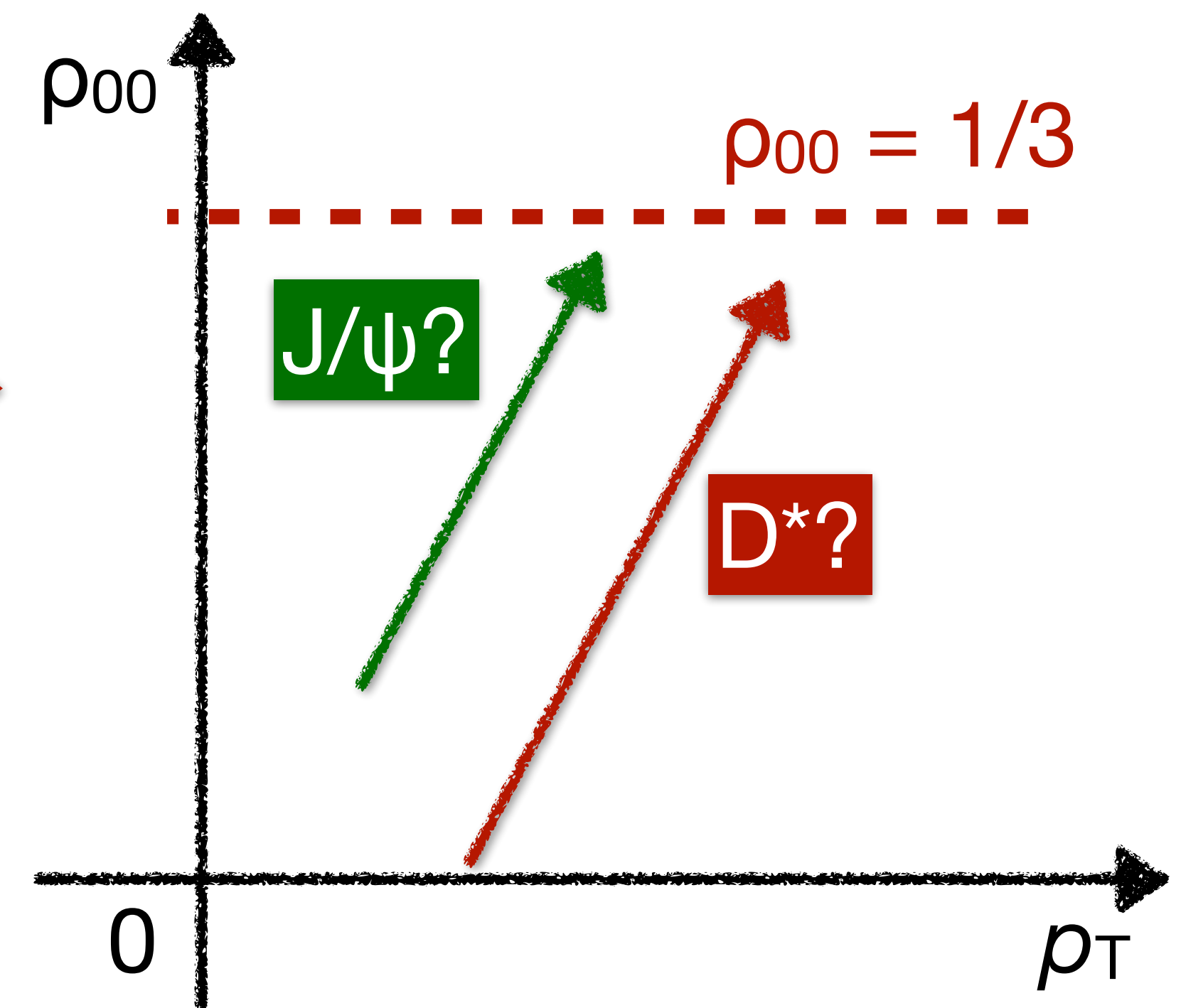
ALICE *Phys. Rev. Lett.* 125 (2020) 012301



ALI-PUB-520388

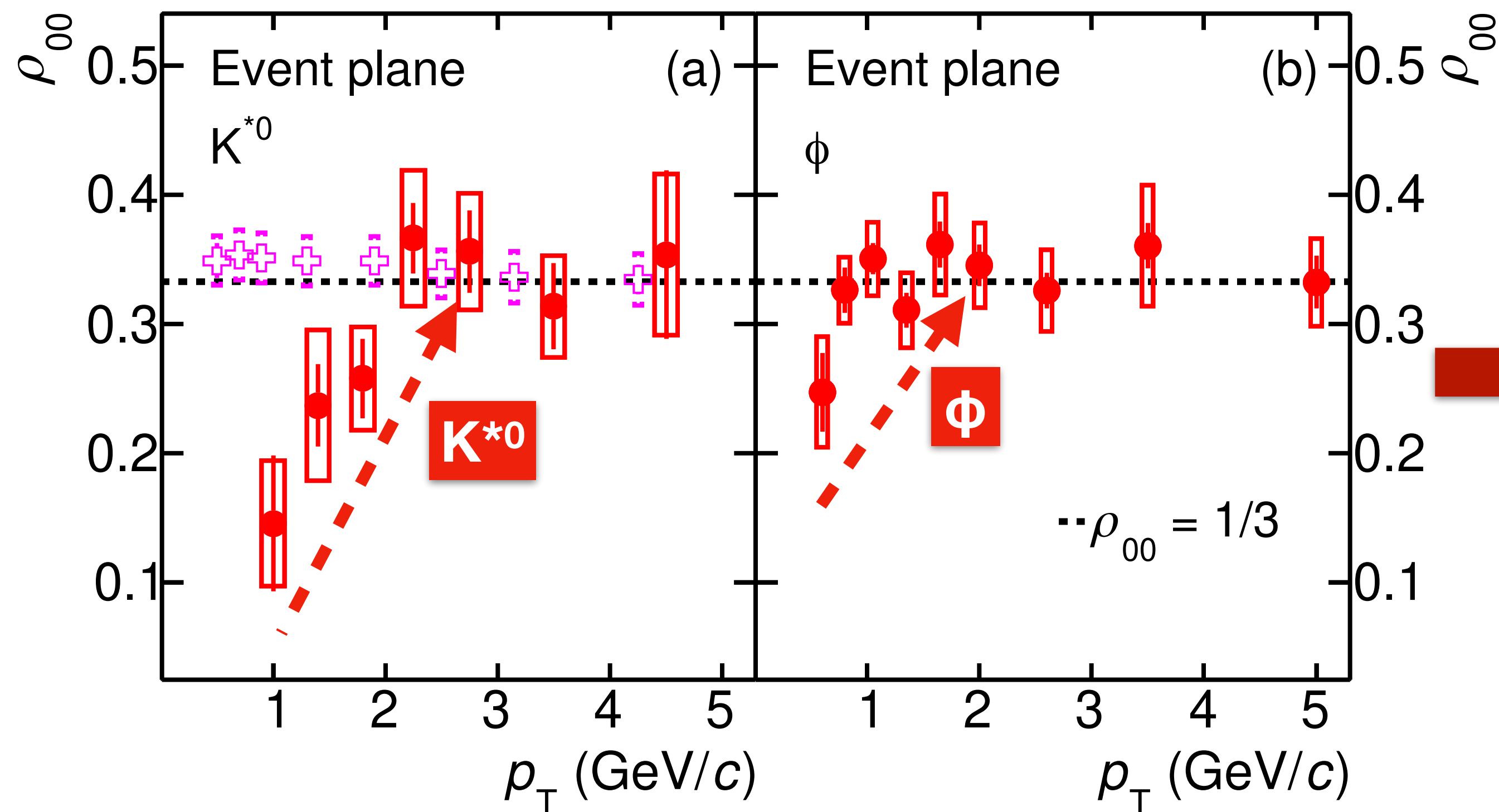
Inconsistent with early direct extrapolation from Λ measurements

Prediction at heavy-quark sector



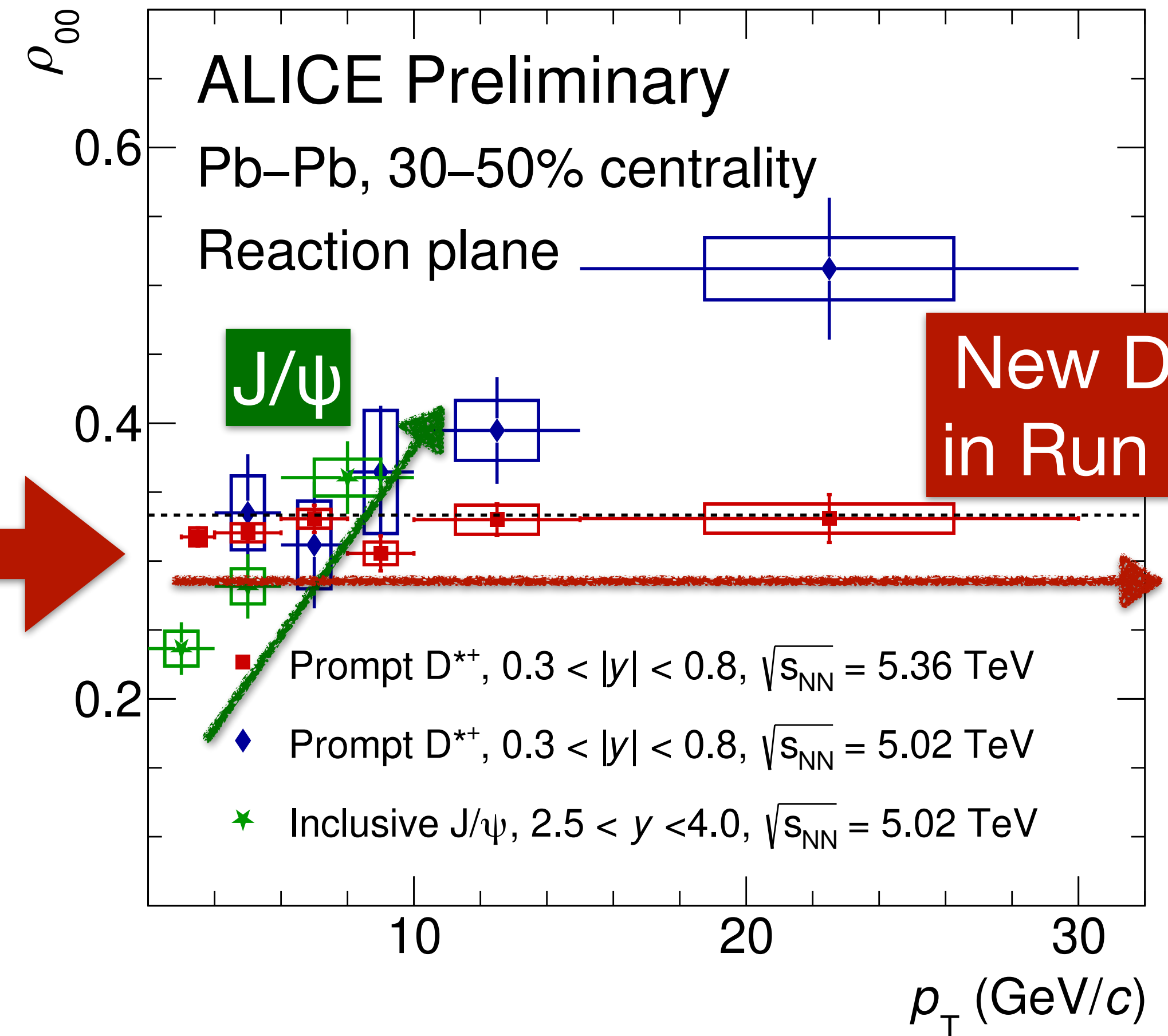
Would a similar trend show at heavy-quark sector?

ALICE Phys. Rev. Lett. 125 (2020) 012301



ALI-PUB-520388

Inconsistent with early direct extrapolation from Λ measurements

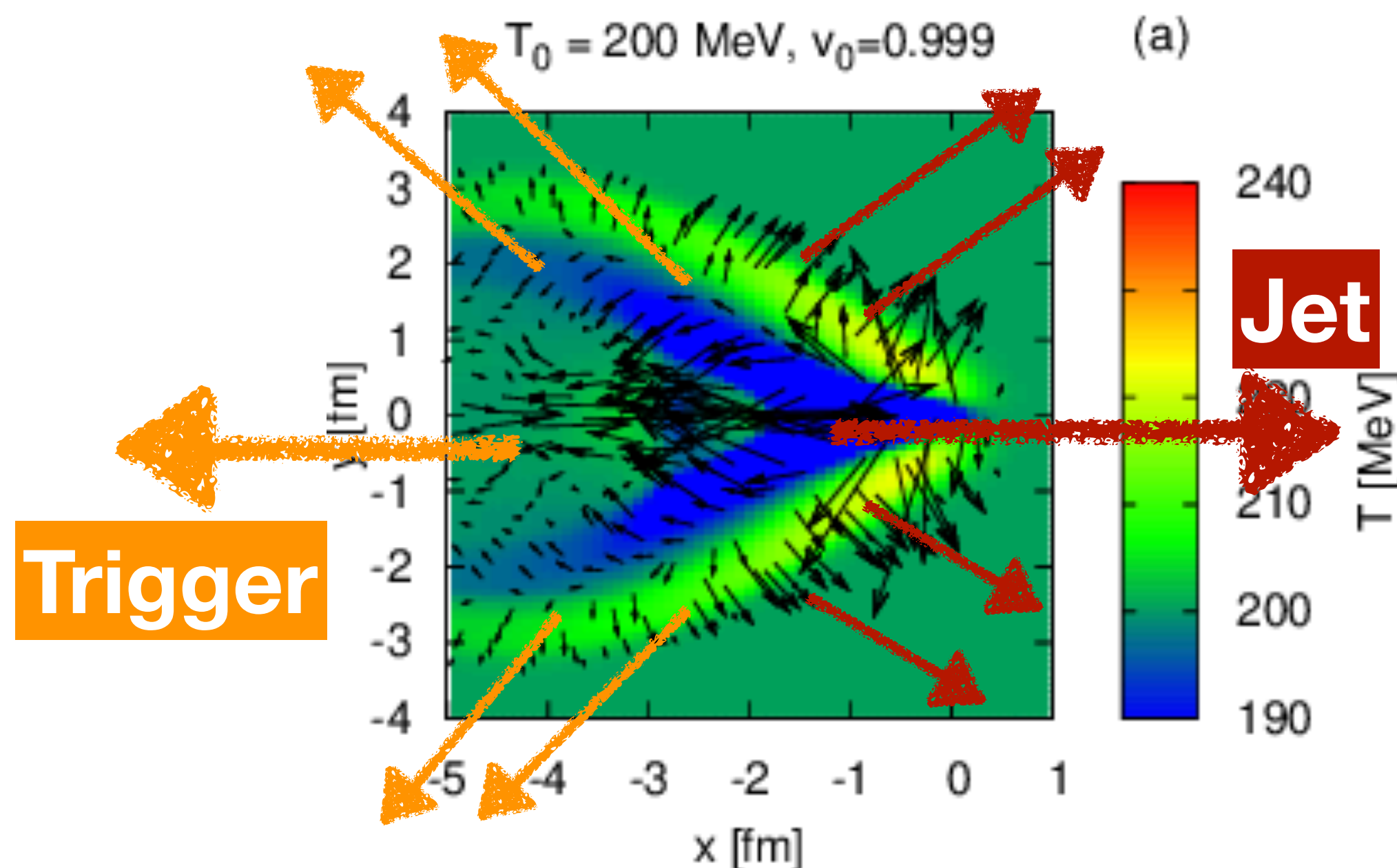


ALI-PREL-633298

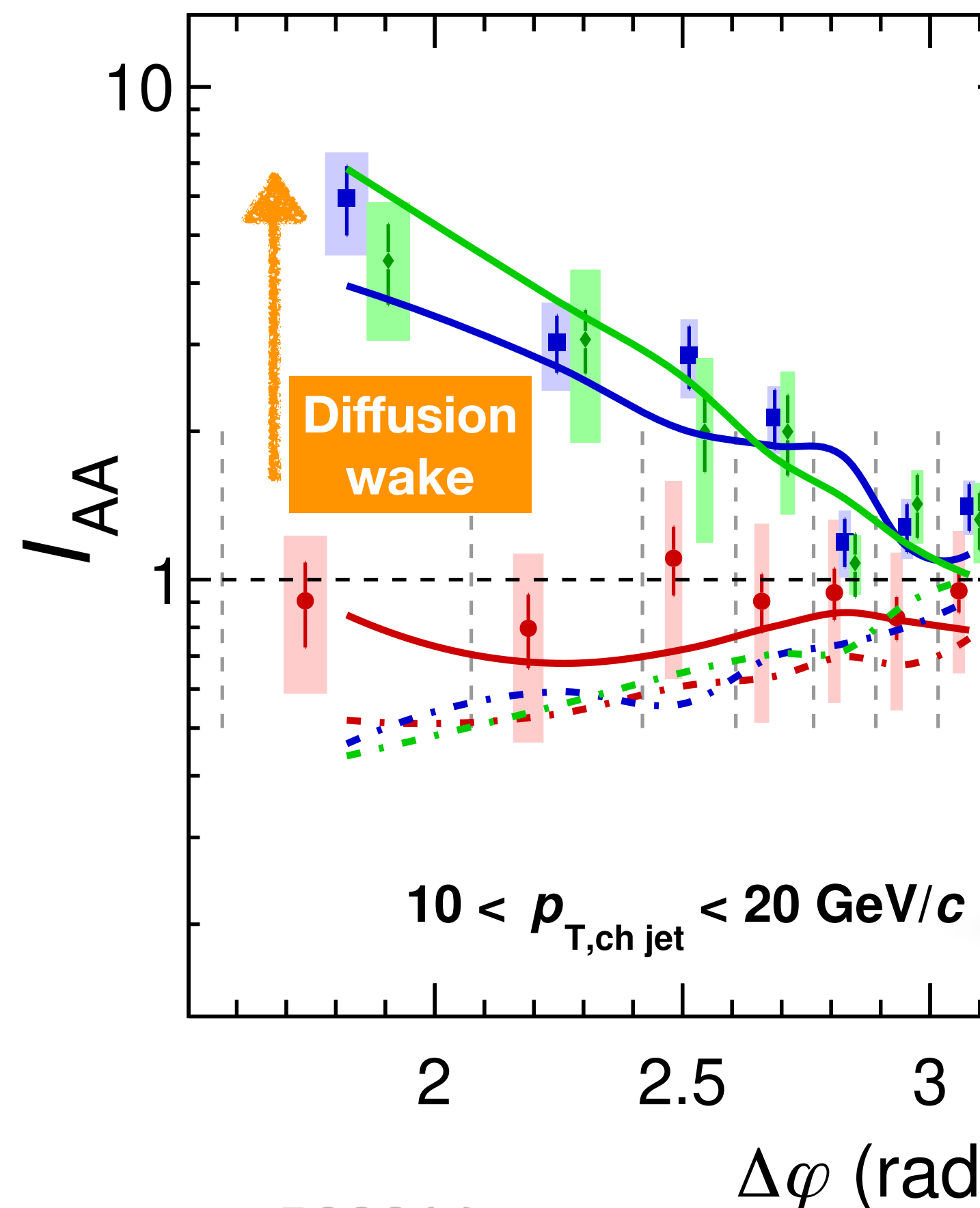
Charm quarks exhibit different spin alignment and polarization behaviors

Jet diffusion wake in QGP medium

17



ALICE *Phys. Rev. Lett.* 133 (2024) 022301



ALICE
 $\sqrt{s_{NN}} = 5.02 \text{ TeV}$, Pb-Pb 0–10 %
Ch-particle jets, anti- k_T
TT{20,50} – TT{5,7}

$R = 0.2$ JEWEL:
 $R = 0.4$ recoils off
 $R = 0.5$ recoils on, 4MomSub

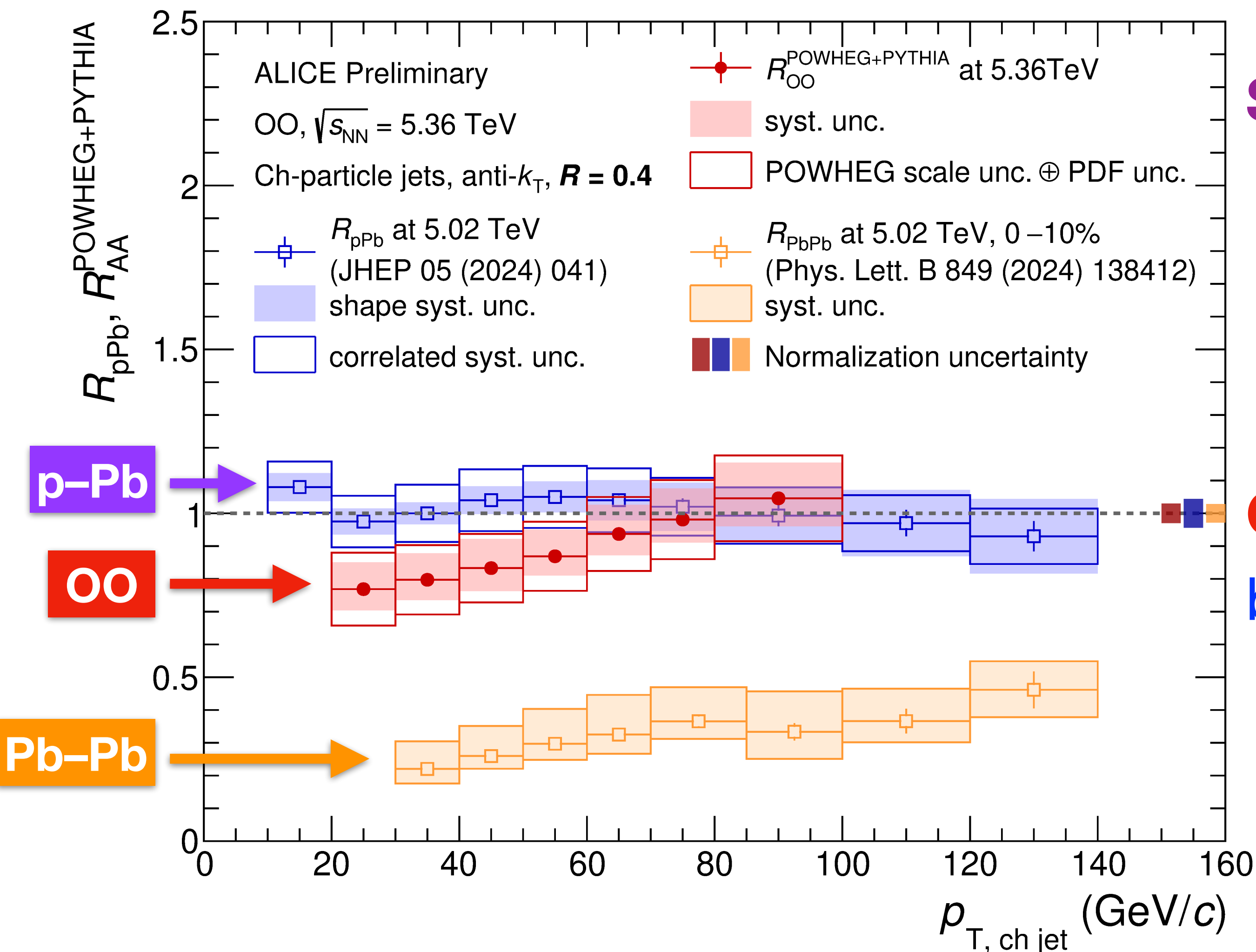
Y.-X. Mao
29/06, 17:35

Y.-Z. Hou
30/06, 10:05

ALI-PUB-583314

New approach to accessing **soft-interacting**
medium hydrodynamics **via hard probes**

W.-H. Feng
29/06, 17:55



ALI-PREL-635358

Small system collisions (e.g., pp, p–Pb)

- ➡ QGP-like signatures arise with increasing event multiplicity
- ➡ No jet quenching signal observed

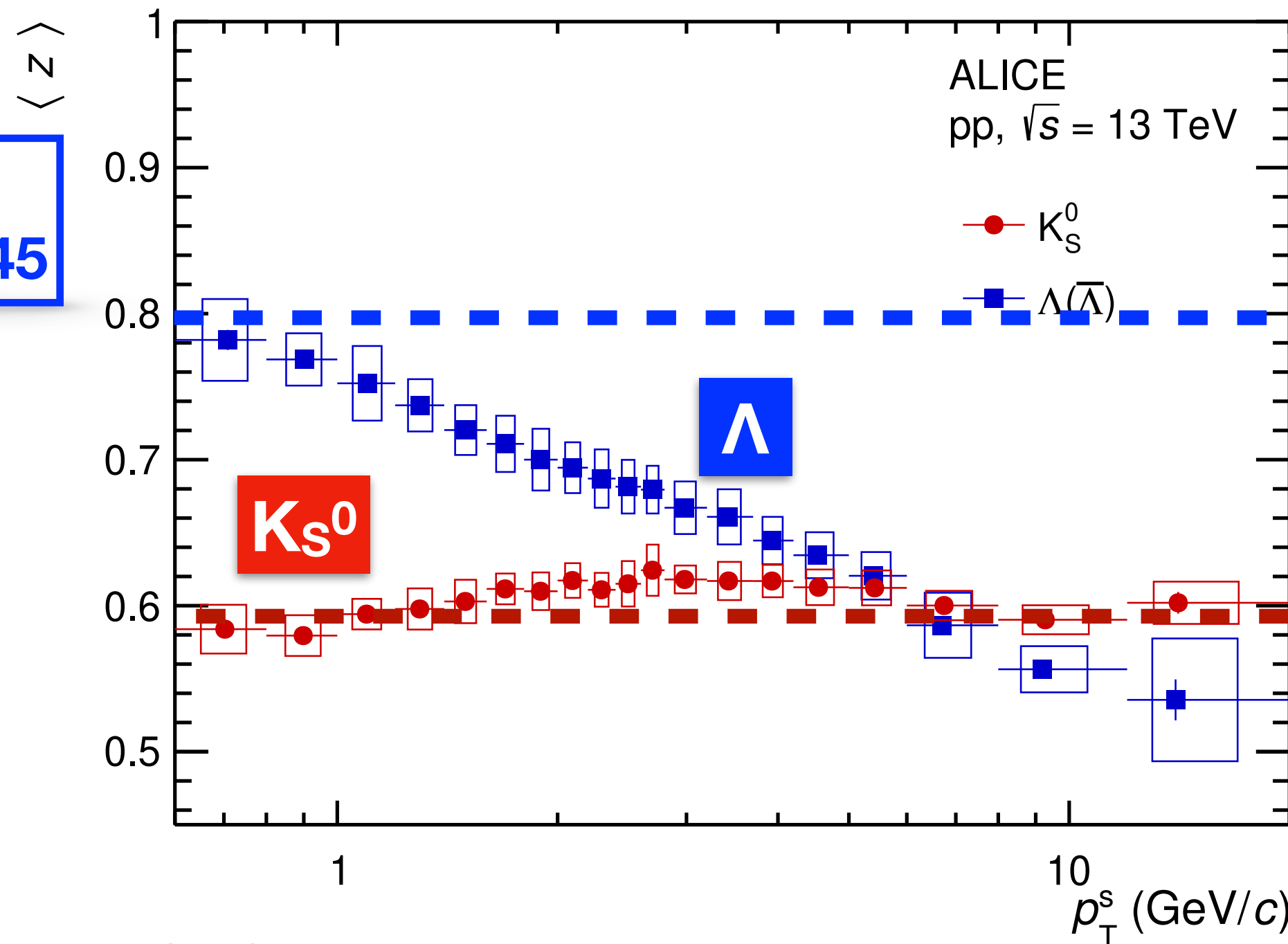
OO collisions — bridge multiplicity gap between pp, p–Pb and Pb–Pb

- ➡ No evidence of suppression in OO
- ➡ **New constraints** on **jet transport dynamics**, e.g., in-cone vs. out-of-cone radiations

p_T -fraction of K_S^0 , Λ and $\Xi^\pm$ in mini-jets

19

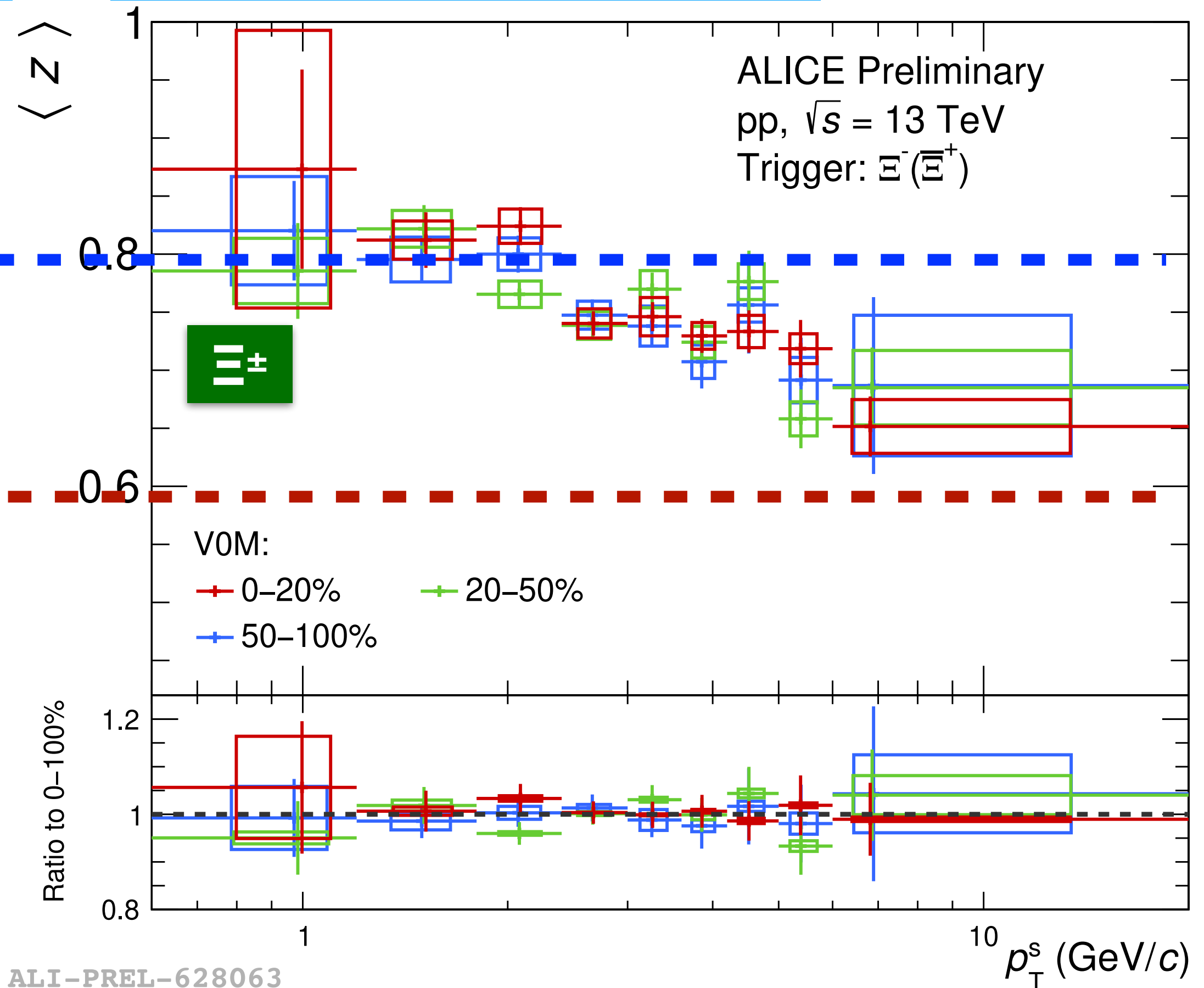
ALICE arXiv:2603.19387, submitted to PLB



ALI-PUB-624748

**Different behaviors between
baryons and mesons**

Paper is under the ALICE review



ALI-PREL-628063

- ➡ Indicate harder fragmentation or larger isolated production of baryons
- ➡ **New attribution** of QGP-like baryon-to-meson enhancement in small systems

Isolated direct photon production

20

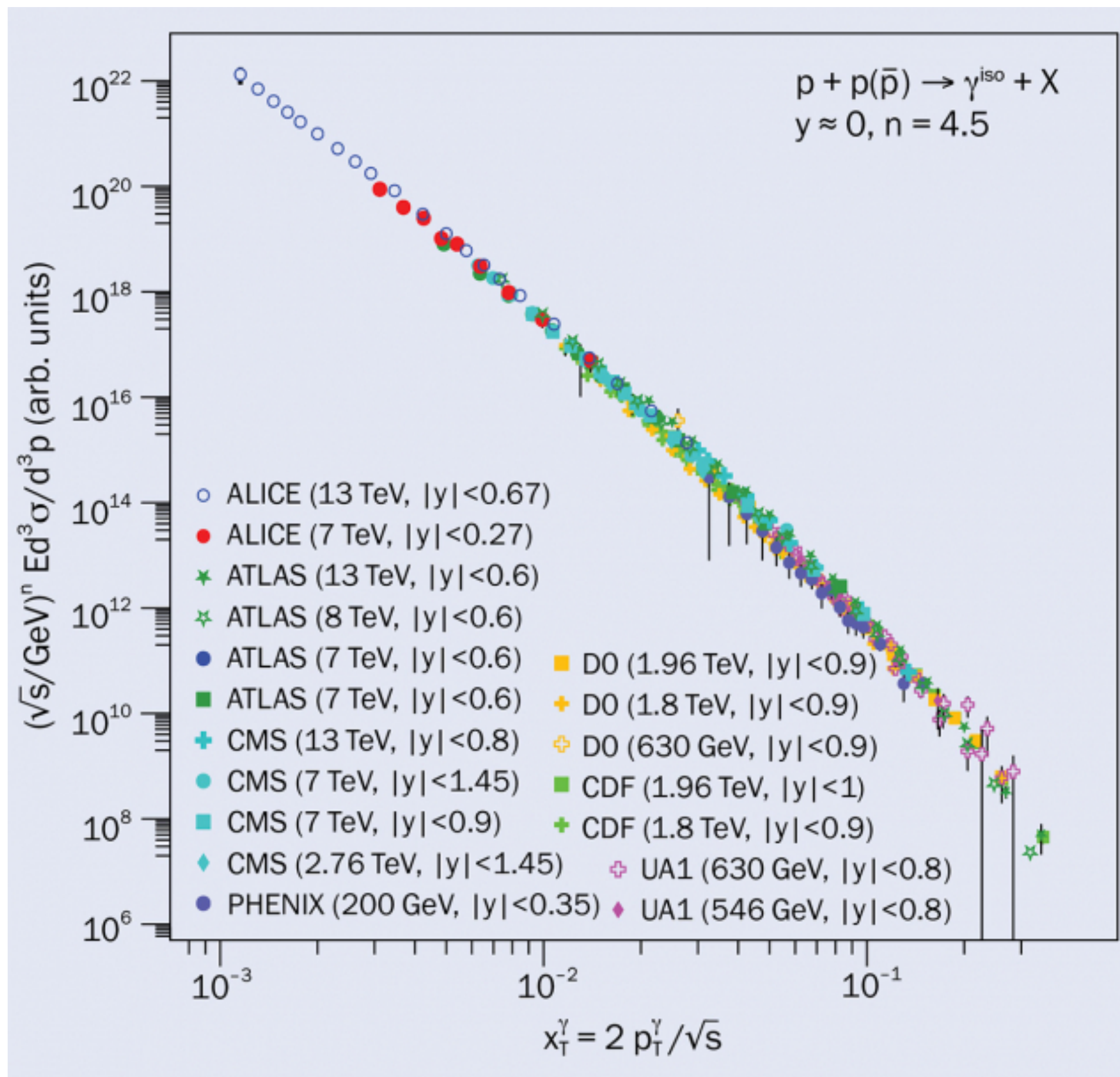
ALICE *Eur. Phys. J. C*85 (2025) 98

CERN COURIER

STRONG INTERACTIONS | NEWS

Isolating photons at low Bjorken x

27 January 2025



G. C. Balbastre
29/06, 17:15

- **Newest** measurements of **isolated photons** with ALICE
- **First access** to the low **Bjorken-x** regime **down to 10^{-3}**
- **Clearly follows** the **scaling behavior** established by previous measurements
- Provides **new constraints** on nucleon **parton distribution functions (PDFs)**

Ongoing upgrades — ITS3 and FoCal

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2010-2013

2015-2018

2022-2026

2030-2033

Run 1

LS1

Run 2

LS2

Run 3

LS3

Run 4

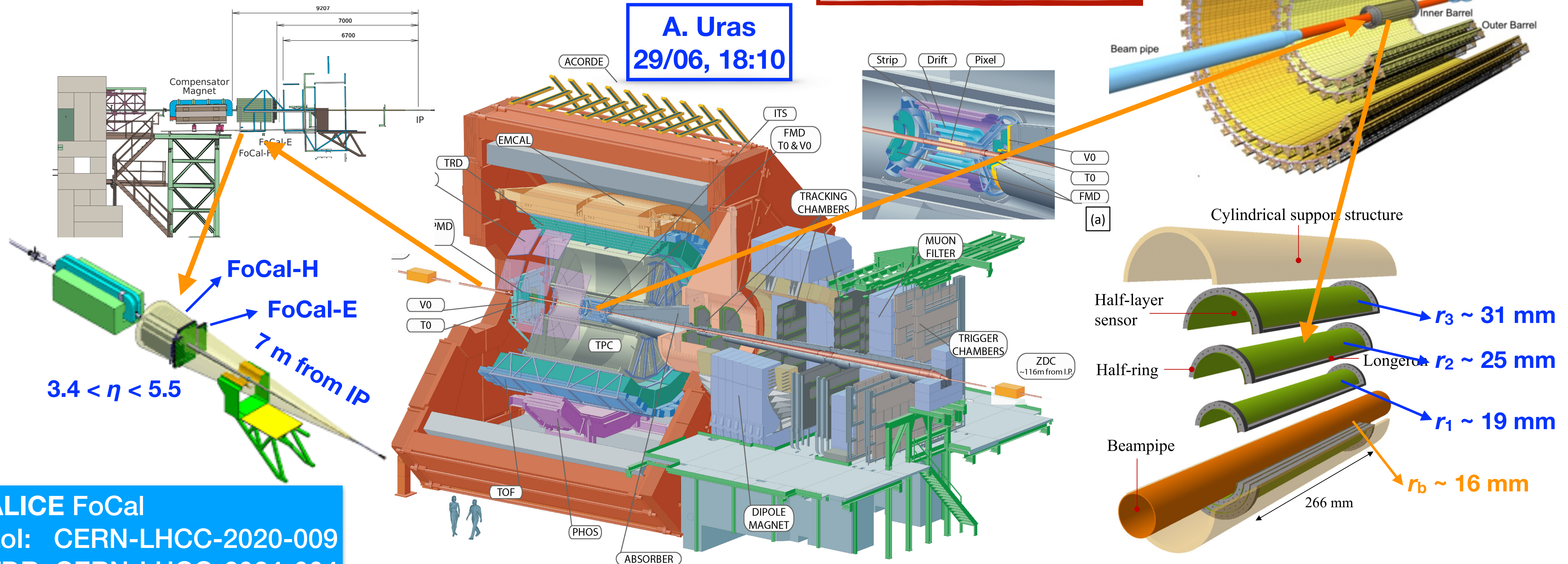
ALICE 1

ALICE 2

ALICE 2.1

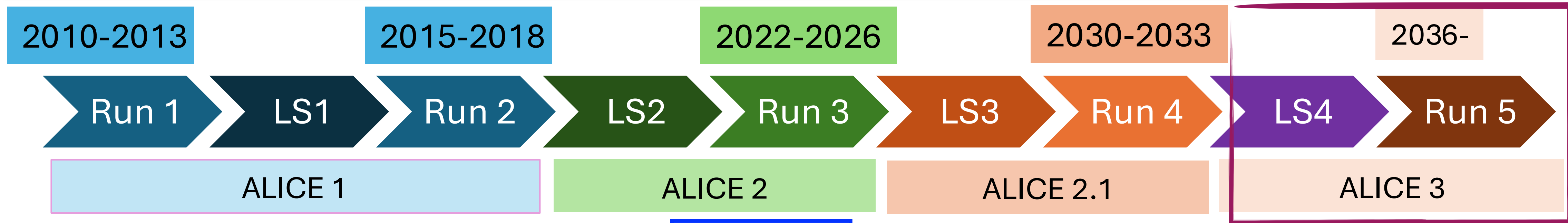
A. Uras
29/06, 18:10

ALICE ITS3 TDR
CERN-LHCC-2024-003



Next-generation experiment

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ALICE 3
Letter of intent

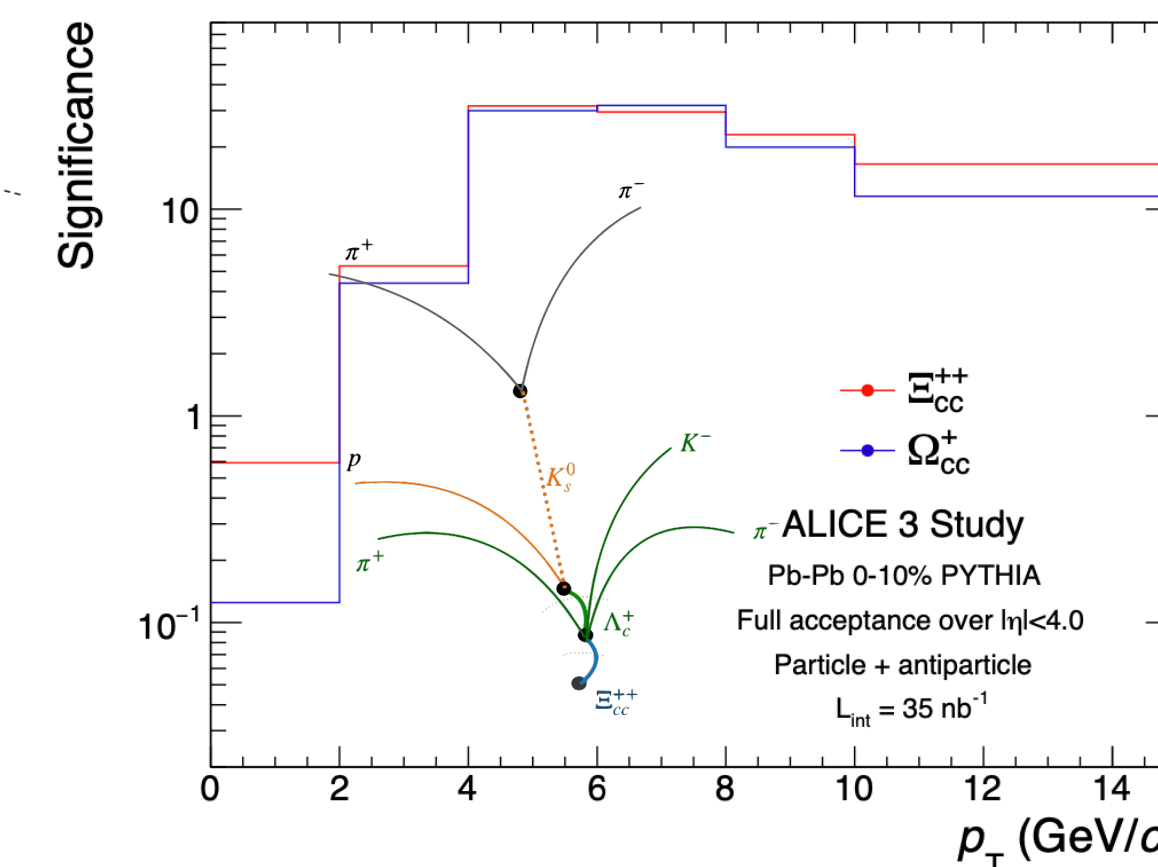
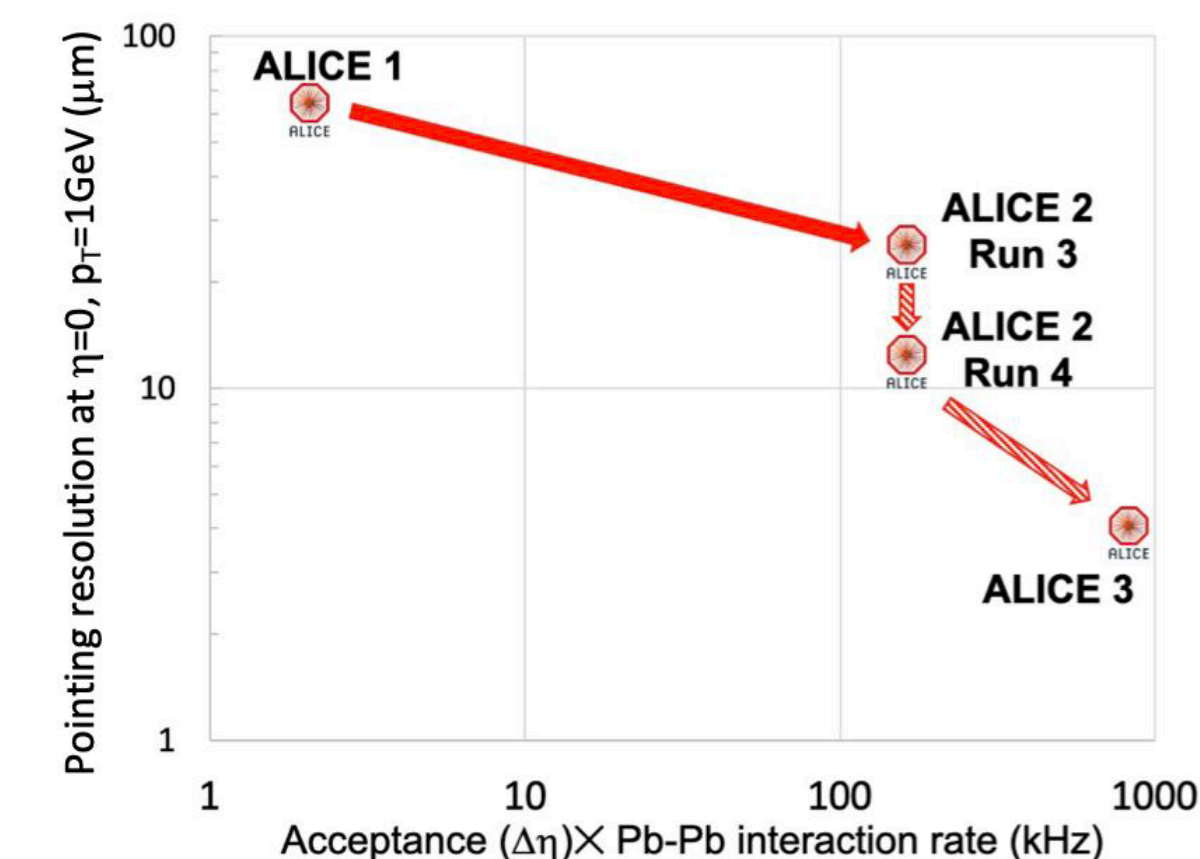
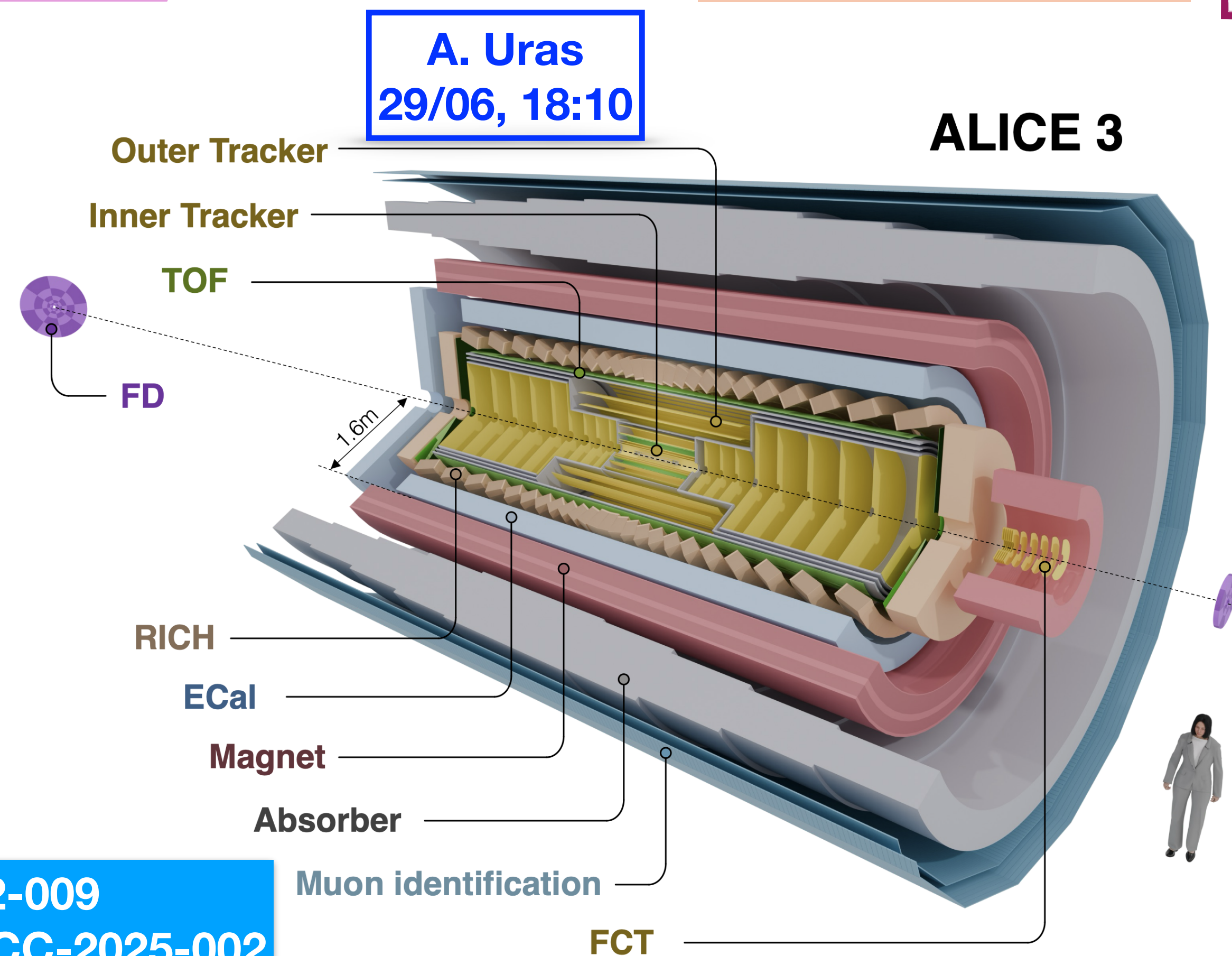
CERN-LHCC-2022-009
(LHCC-4-038)
4 November 2022

ALICE arXiv:2211.02491

A next-generation heavy-ion experiment at the LHC

VERSION 2

ALICE3 LoI: CERN-LHCC-2022-009
Scoping document: CERN-LHCC-2025-002



Next-generation experiment

23

2010-2013

2015-2018

2022-2026

2030-2033

2036-

ALICE @ FCPPN/L is continuing to strengthen the cooperation for ALICE 3 and beyond, with the common interest in next-generation detector upgrade projects and exciting physics exploration

ALICE
Letter of intent

ALICE
A next
experiment at the LHC

VERSION 2



ALICE3 LoI: CERN-LHCC-2022-009
Scoping document: CERN-LHCC-2025-002

FD

1.6m

RICH

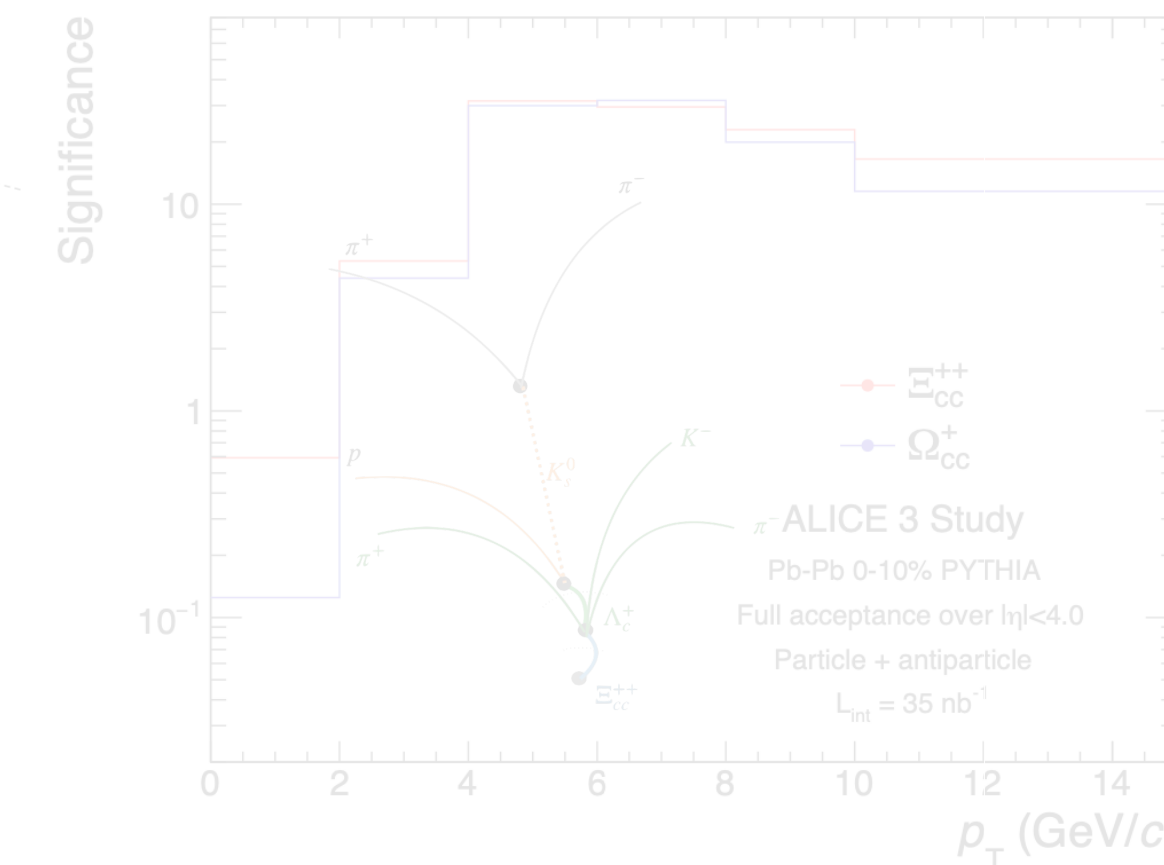
ECal

Magnet

Absorber

Muon identification

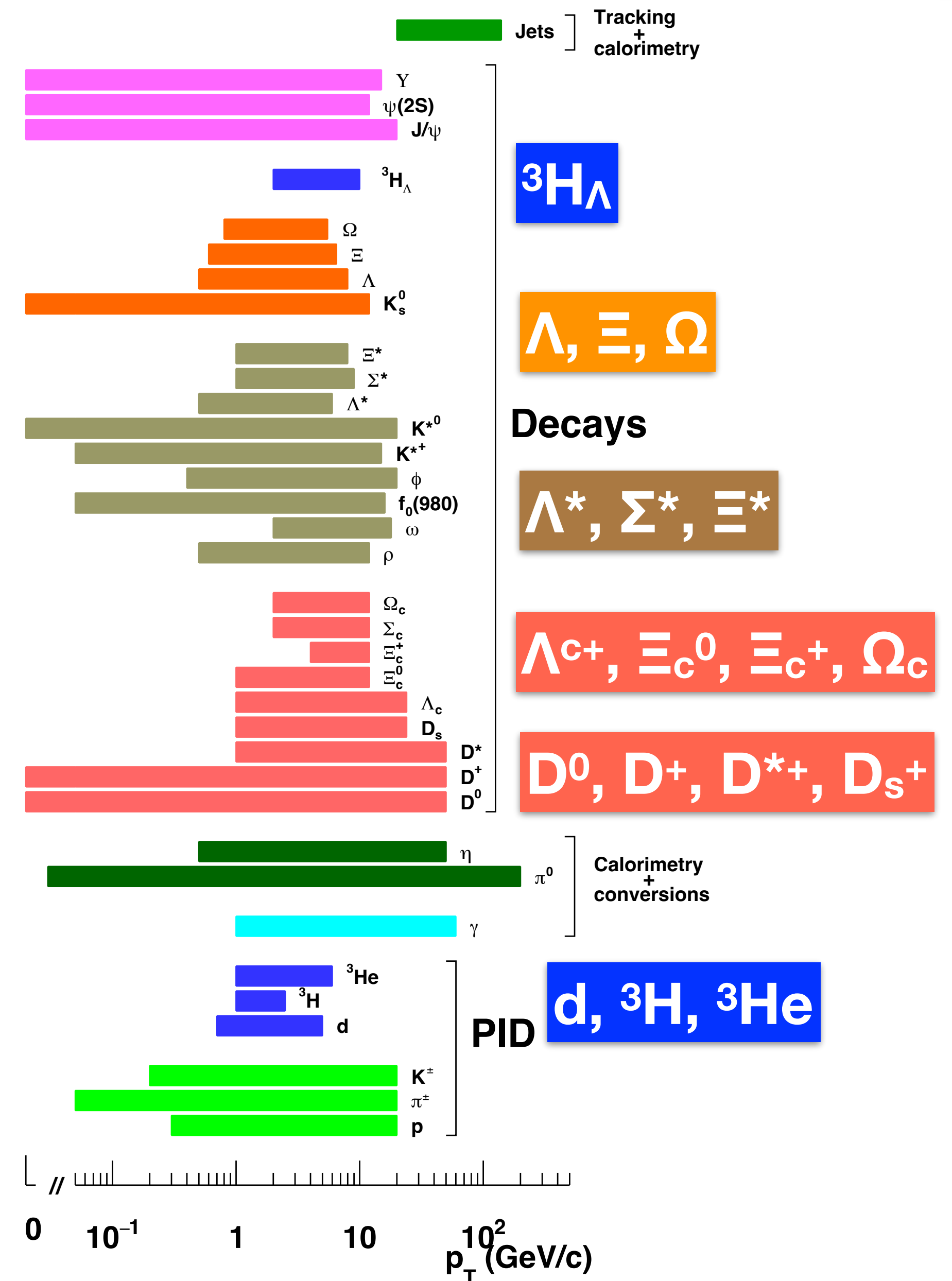
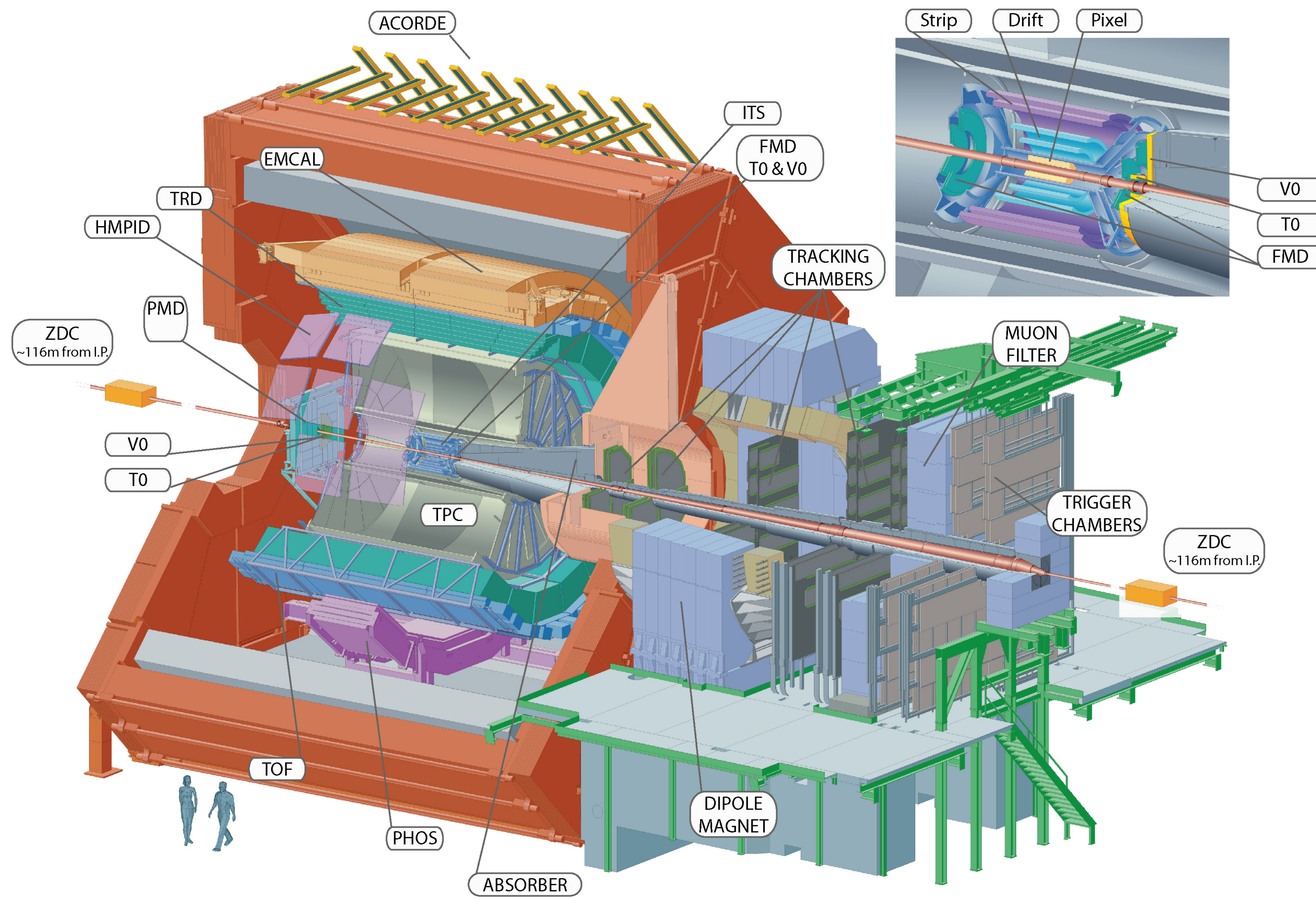
FCT

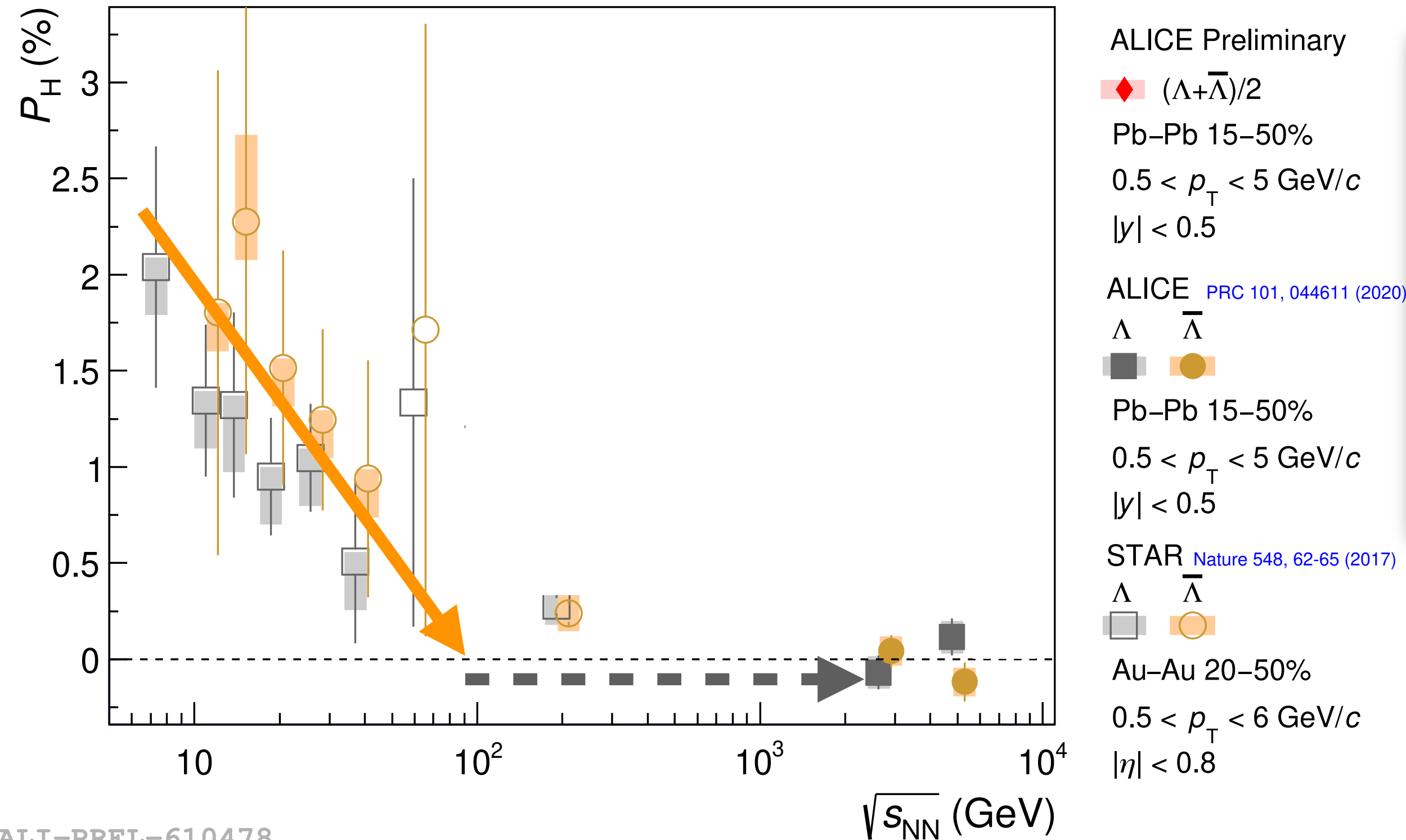


ALICE capability

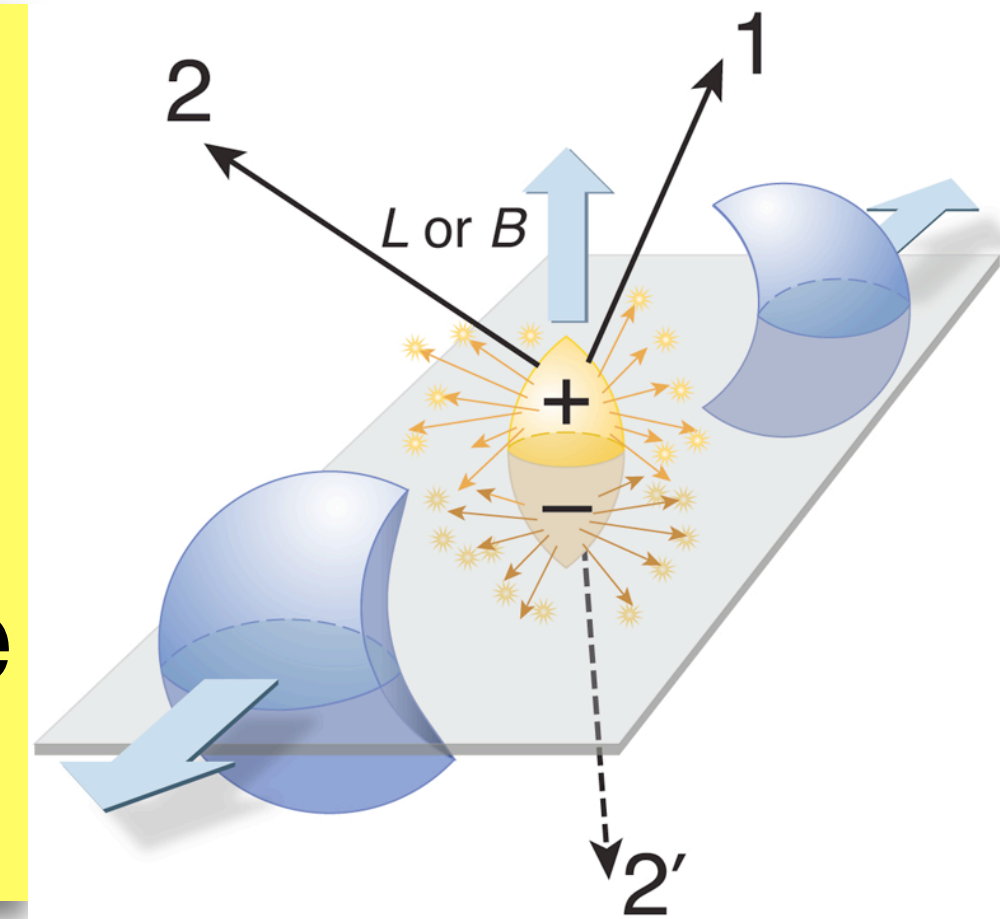
25

- ALICE: A heavy-ion detector at the LHC
- Study of strongly-interacting matter at extreme temperatures and energy densities





Large orbital angular momentum and strong magnetic fields in non-central collisions induce global polarization

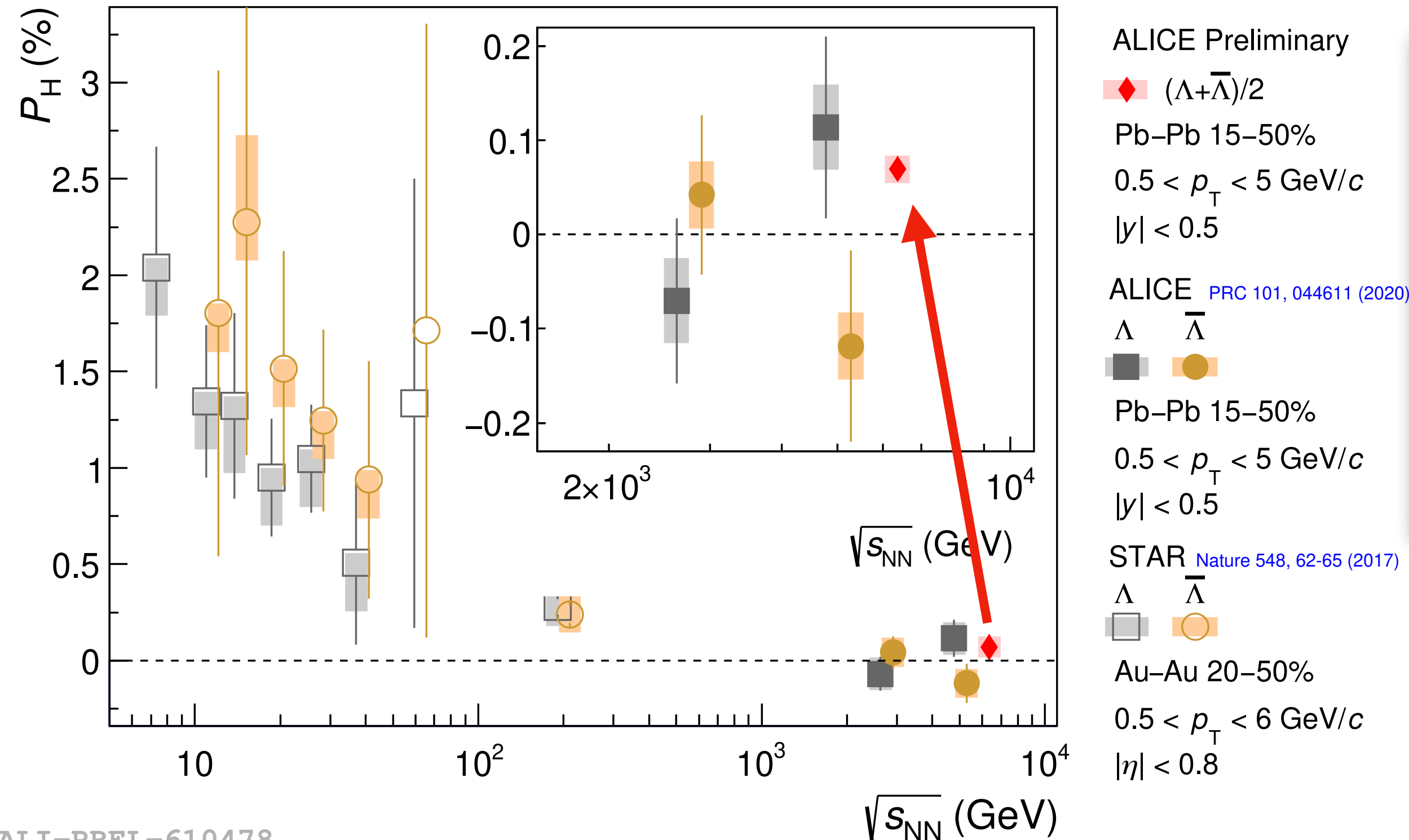


Z.-T. Liang and X.-N. Wang, *Phys. Rev. Lett.* **96** (2006) 039901

Z.-T. Liang and X.-N. Wang, *Phys. Lett.* **B629** (2005) 20

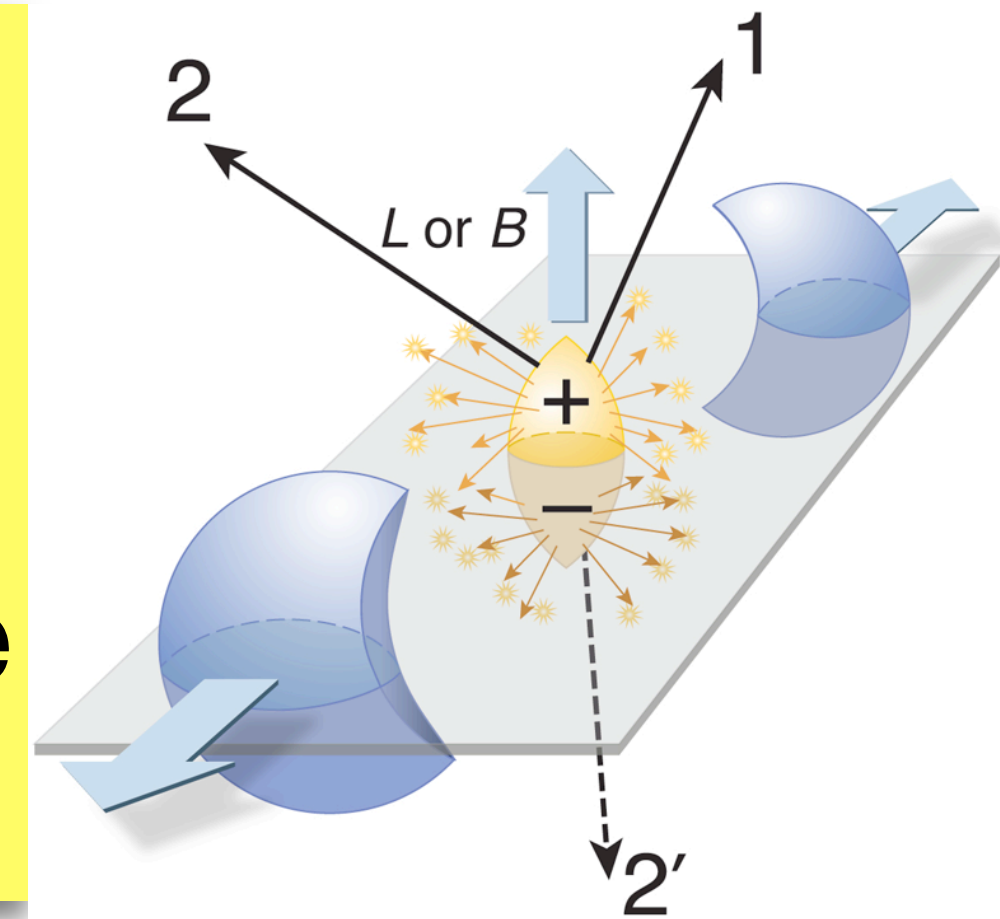
STAR *Nature* **548** (2018) 62 **STAR** *Nature* **614** (2023) 244

➡ LHC Run 1 and 2: Global polarization consistent with zero (large uncertainties)



ALI-PREL-610478

Large orbital angular momentum and strong magnetic fields in non-central collisions induce global polarization



Z.-T. Liang and X.-N. Wang, *Phys. Rev. Lett.* **96** (2006) 039901

Z.-T. Liang and X.-N. Wang, *Phys. Lett.* **B629** (2005) 20

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➡ LHC Run 1 and 2: Global polarization consistent with zero (large uncertainties)

➡ New Run 3: First observation of polarized hyperons at LHC energies with 5σ

New efforts are ongoing on measuring polarization between particle and anti-particle, which is **sensitive to the magnetic field!**