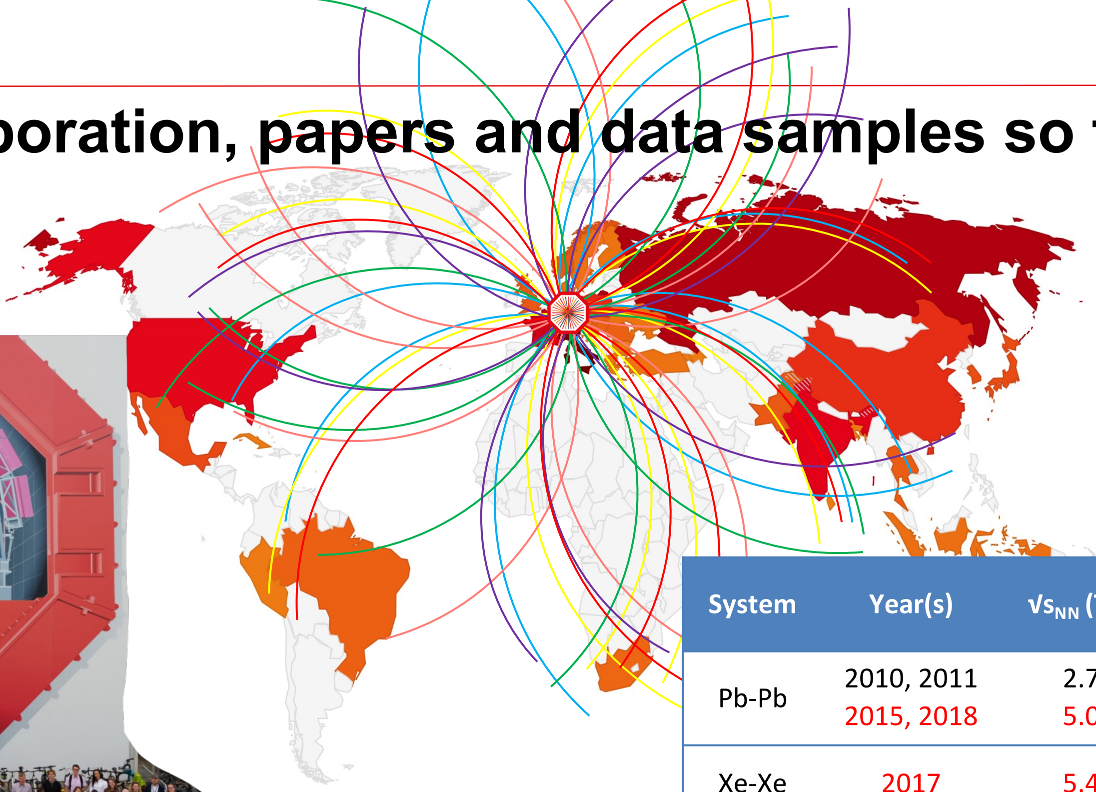
A Large Ion Collider Experiment

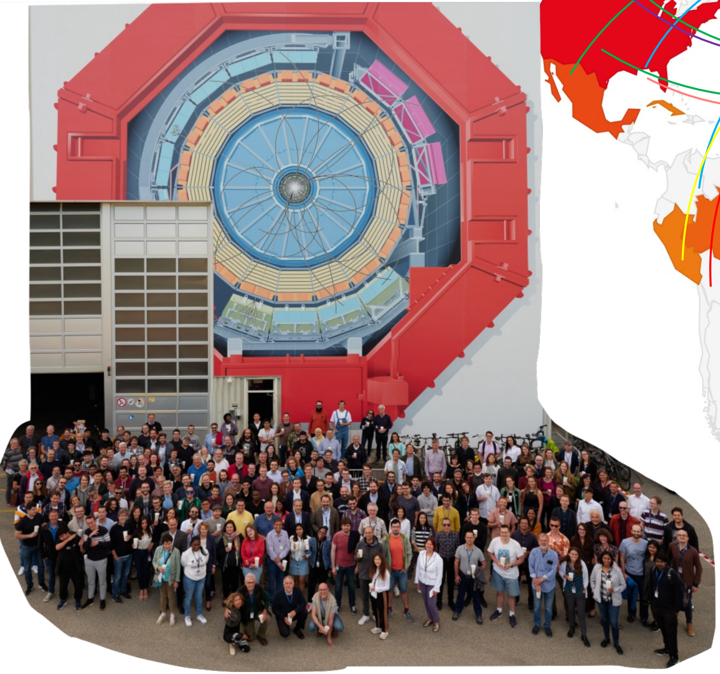
Highlights and Perspectives from ALICE

Andrea Dainese (INFN, Padova)
on behalf of the ALICE Collaboration

Collaboration, papers and data samples so far

1012 Authors
174 Institutes
40 Countries

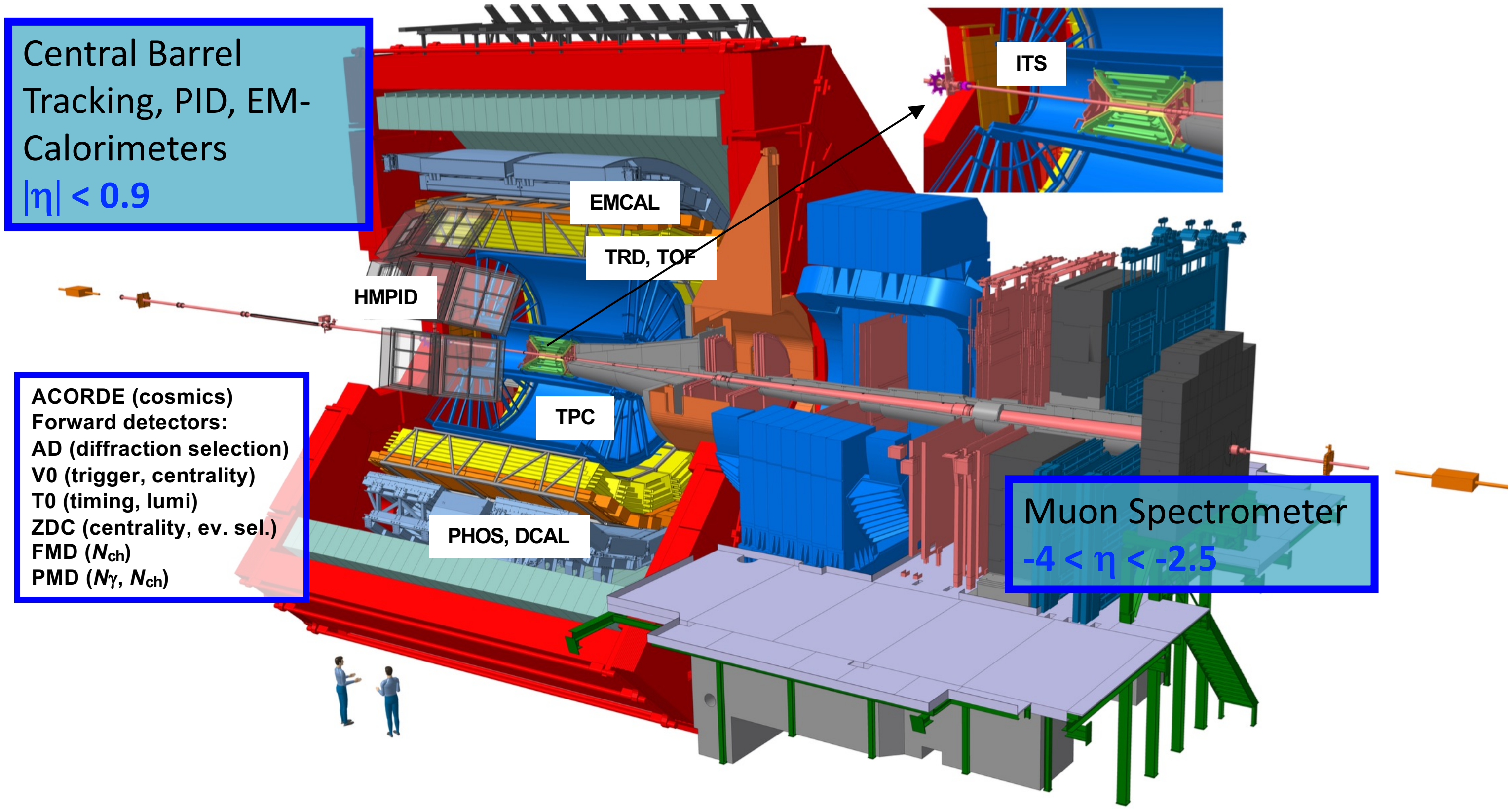




396 papers on 2009-2018 data

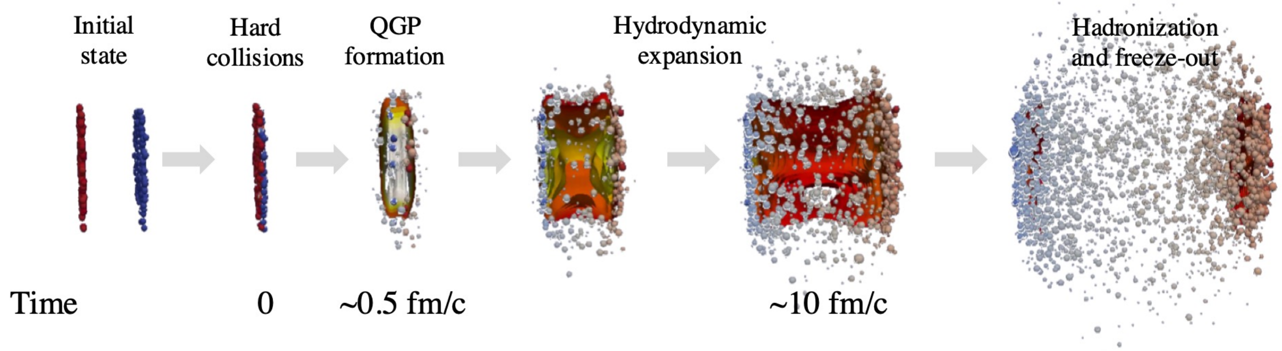
System	Year(s)	$\sqrt{s_{NN}}$ (TeV)	L_{int}
Pb-Pb	2010, 2011 2015, 2018	2.76 5.02	75 μb^{-1} 800 μb^{-1}
Xe-Xe	2017	5.44	0.3 μb^{-1}
p-Pb	2013 2016	5.02 5.02, 8.16	15 nb^{-1} 3 nb^{-1}, 25 nb^{-1}
pp	2009-2013 2015, 2017 2015-2018	0.9, 2.76, 7, 8 5.02 13	200 μb^{-1}, 100 nb^{-1} 1.5 pb^{-1}, 2.5 pb^{-1} 1.3 pb^{-1} 36 pb^{-1}

The ALICE detector (version 1: Runs 1+2)



ALICE physics with HI and pp collisions: quark-gluon plasma and much more QCD

- Explore the deconfined phase of QCD matter → quark-gluon plasma
- **LHC Pb-Pb** → **large energy density** (> 15 GeV/fm^3) & **large volume** (~ 5000 fm^3)



Visualization by J.E. Bernhard, arXiv:1804.06469

→ J. Bielcikova, C. Salgado, Wed plenary

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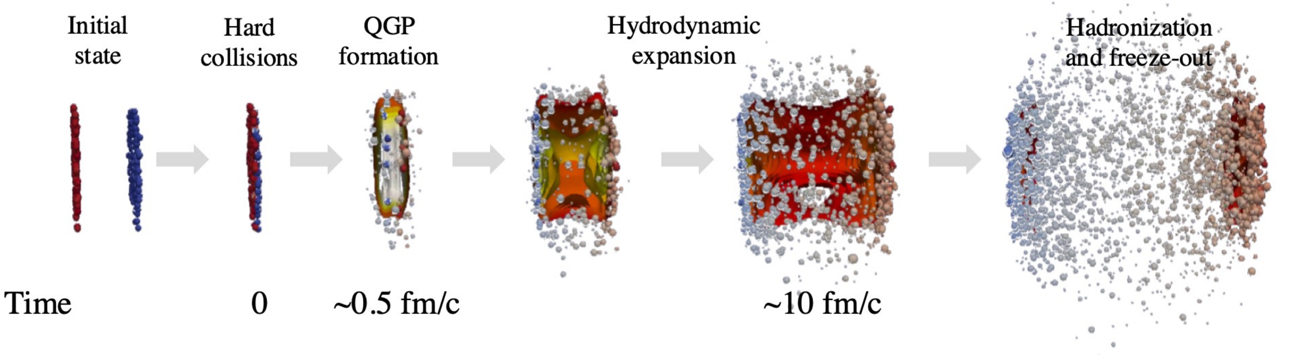

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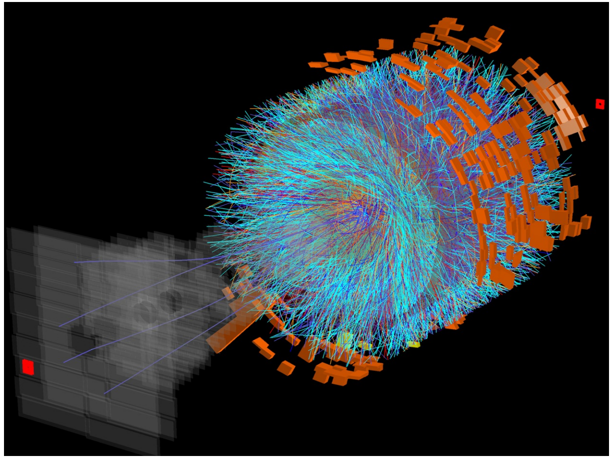

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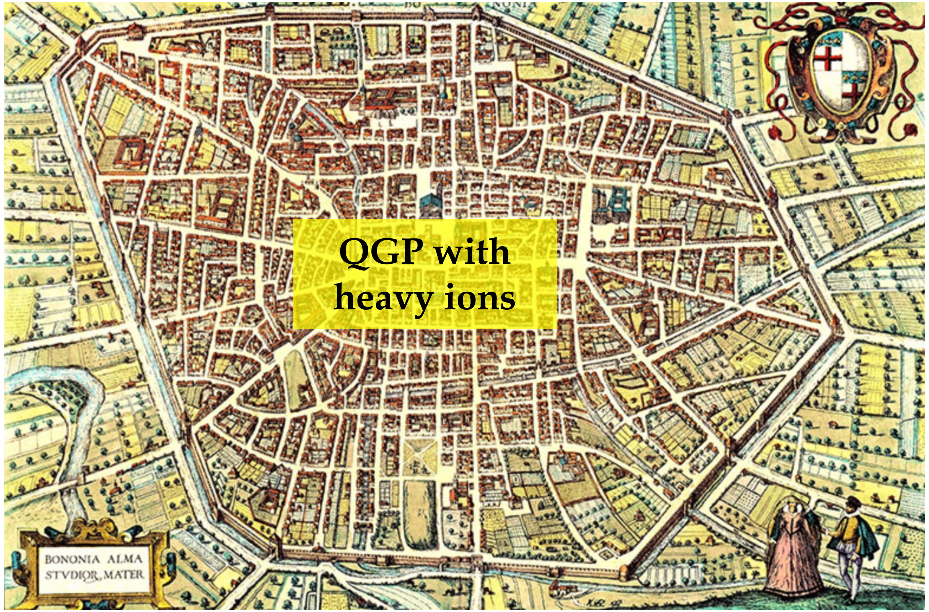

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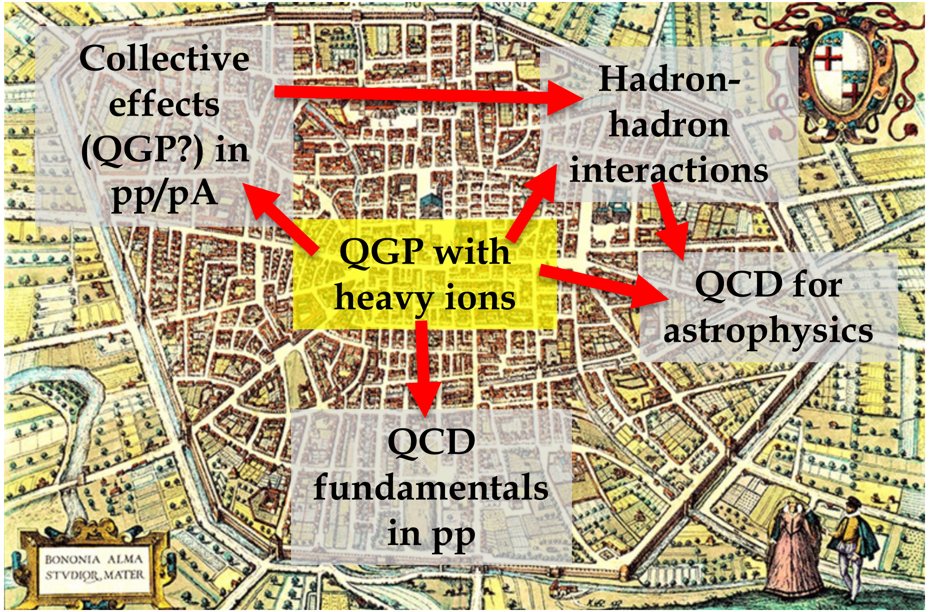
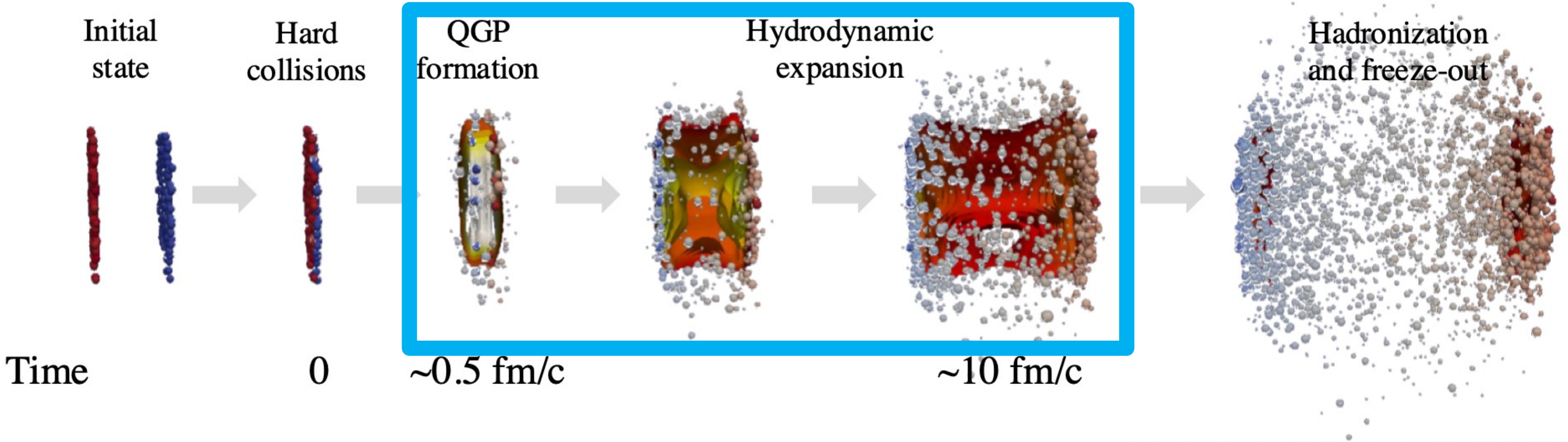


Quarkonium: dissociation and regeneration



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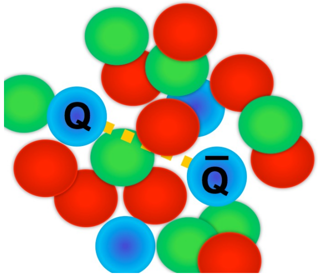
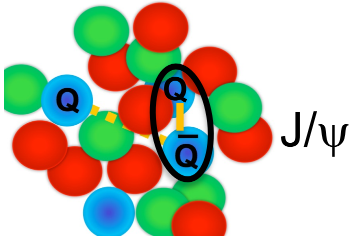


→ Characterise the QGP:

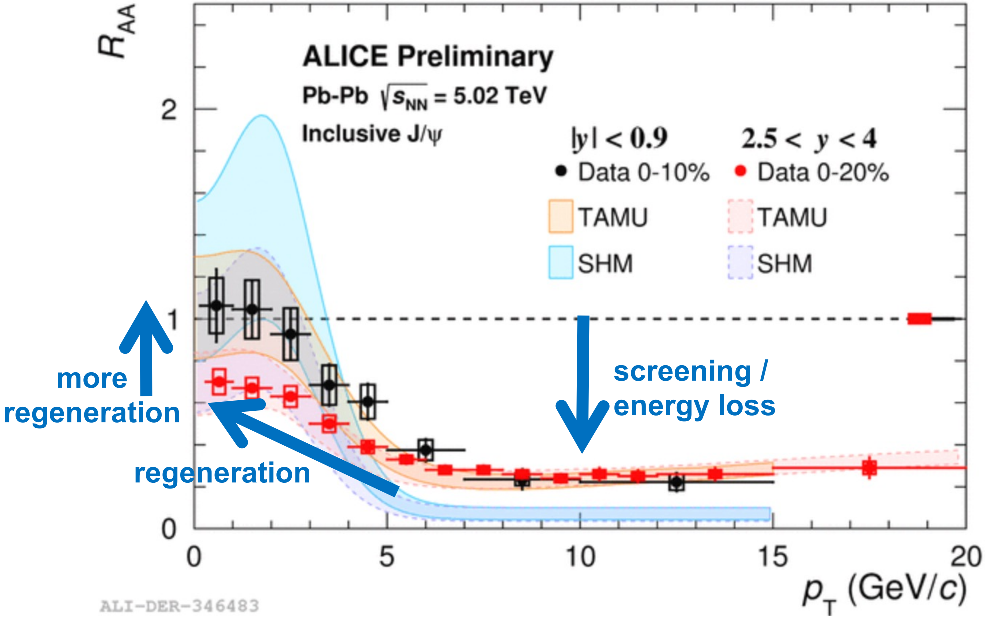
- Colour deconfinement
- Parton interactions
- Expansion dynamics and hadronization

Charmonium dissociation and regeneration

- Reminder: J/ψ suppression due to **colour screening** in the QGP reduced at low p_T and at central rapidity by **$c\bar{c}$ regeneration**
  - ~100 $c\bar{c}$ pairs per central Pb-Pb



$$R_{AA} = \frac{1}{\langle N_{coll} \rangle} \frac{dN/dp_T|_{PbPb}}{dN/dp_T|_{pp}}$$



→ B. Paul, Sat parallel

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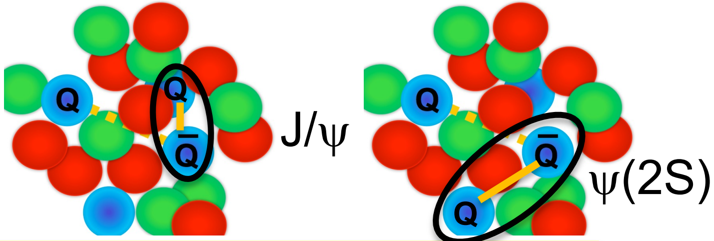
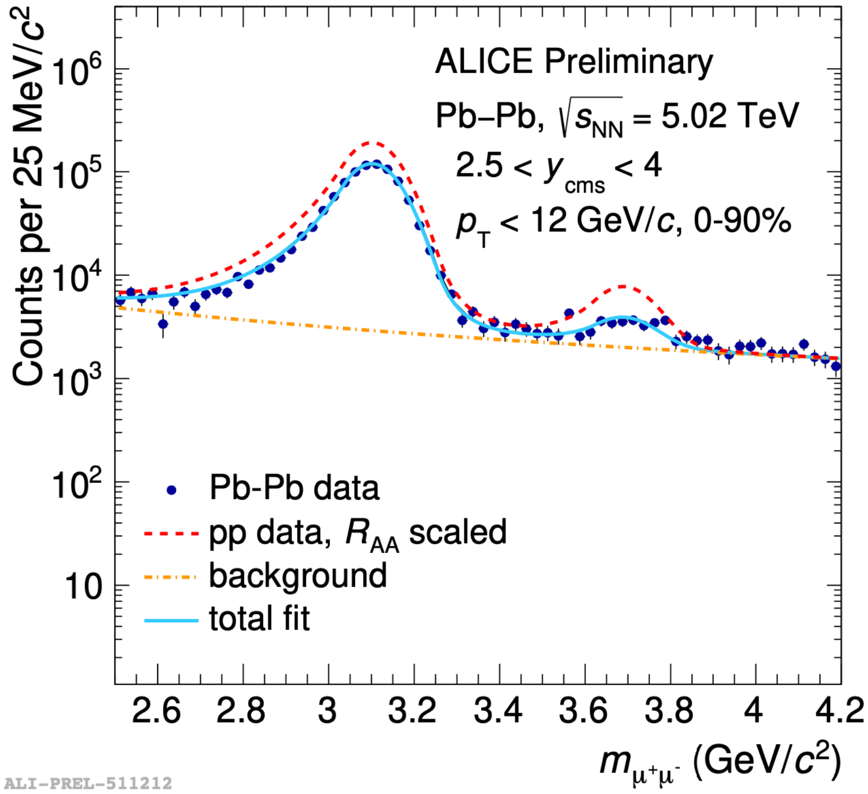


- New result: measured ψ(2S) – ×10 lower binding energy! – to pin down the role of these two mechanisms



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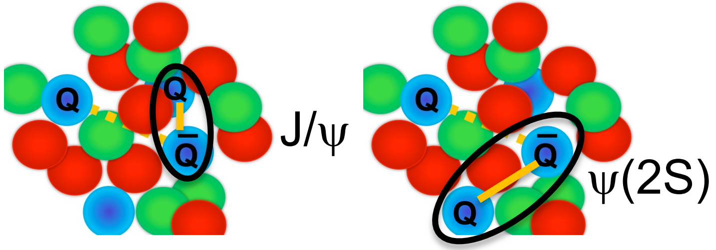

- New result: measured ψ(2S) – ×10 lower binding energy! – to pin down the role of these two mechanisms
- ψ(2S) ~ ×2 more suppressed than J/ψ
- Hint of regeneration at low p_T

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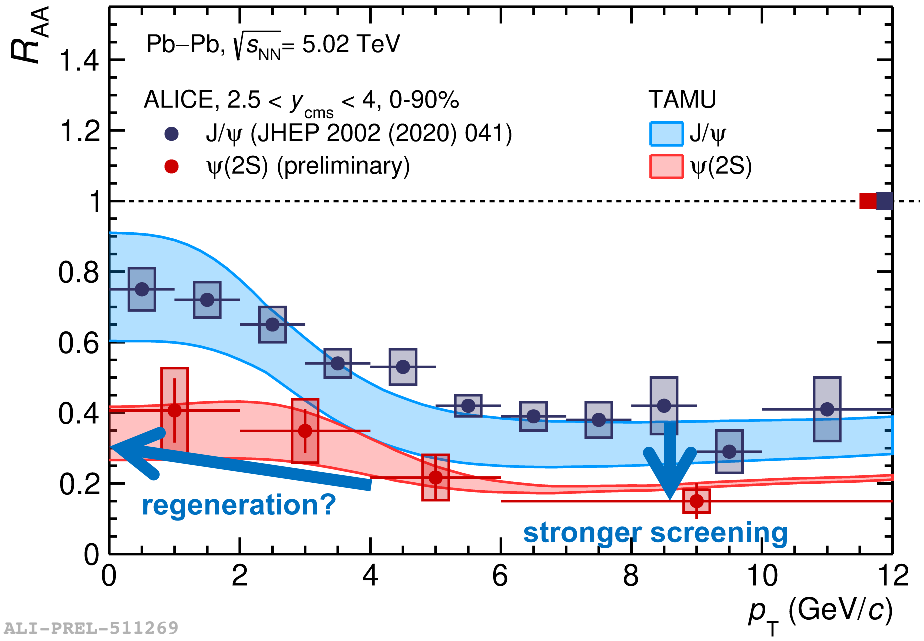
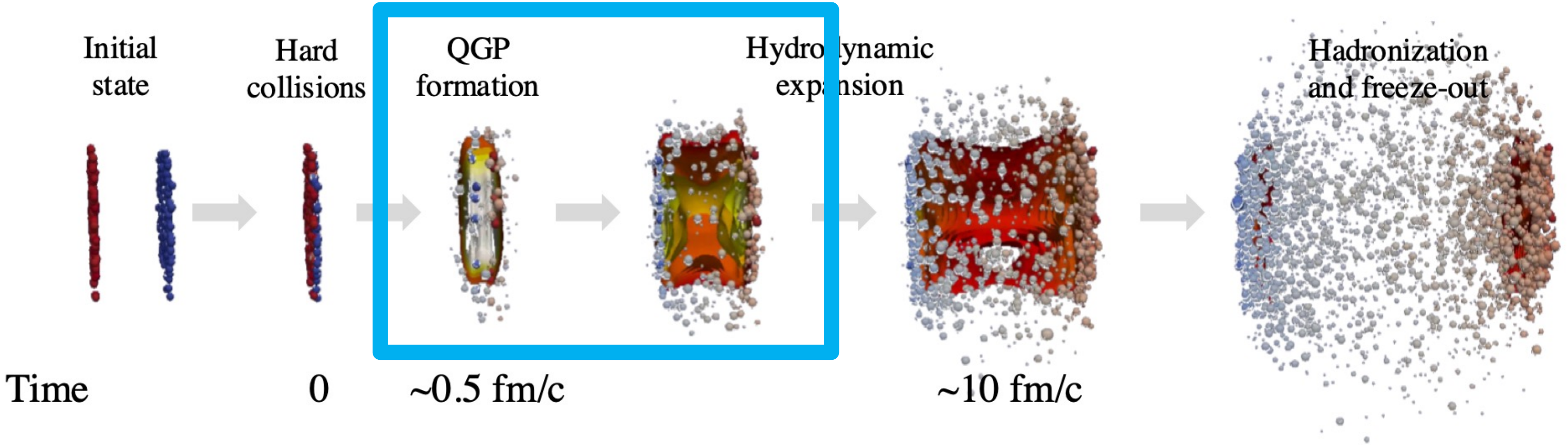


Jets and parton energy loss in the QGP



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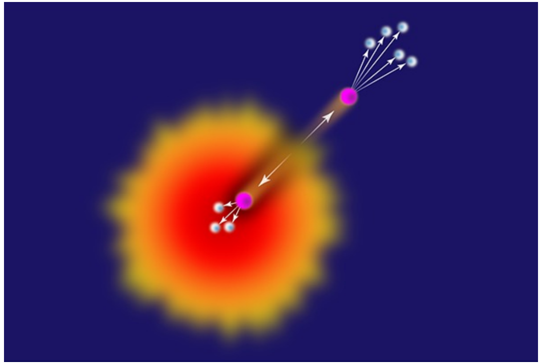

→ Characterise the QGP:

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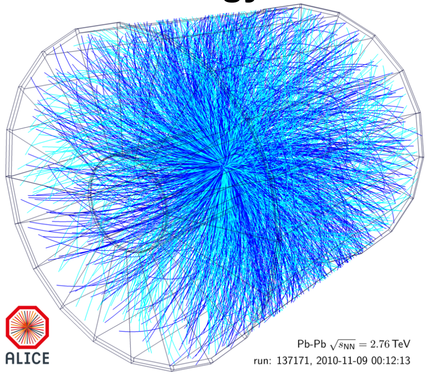
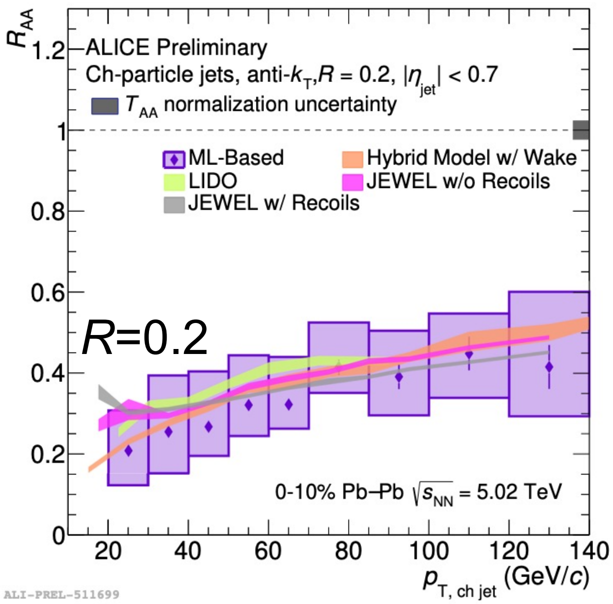
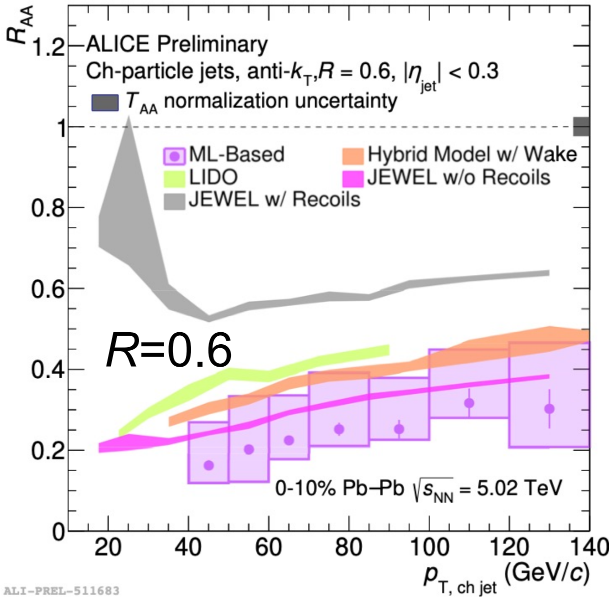
Jet quenching: going to lower p_T with inclusive jets

New machine learning method to subtract underlying Pb-Pb event fluctuations from jet energy:
$\times$ **2 better energy resolution**





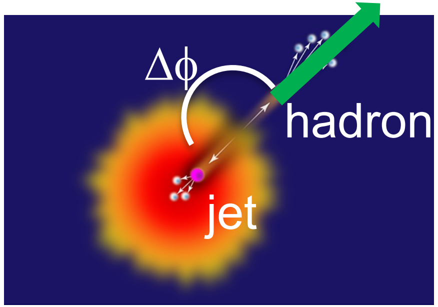


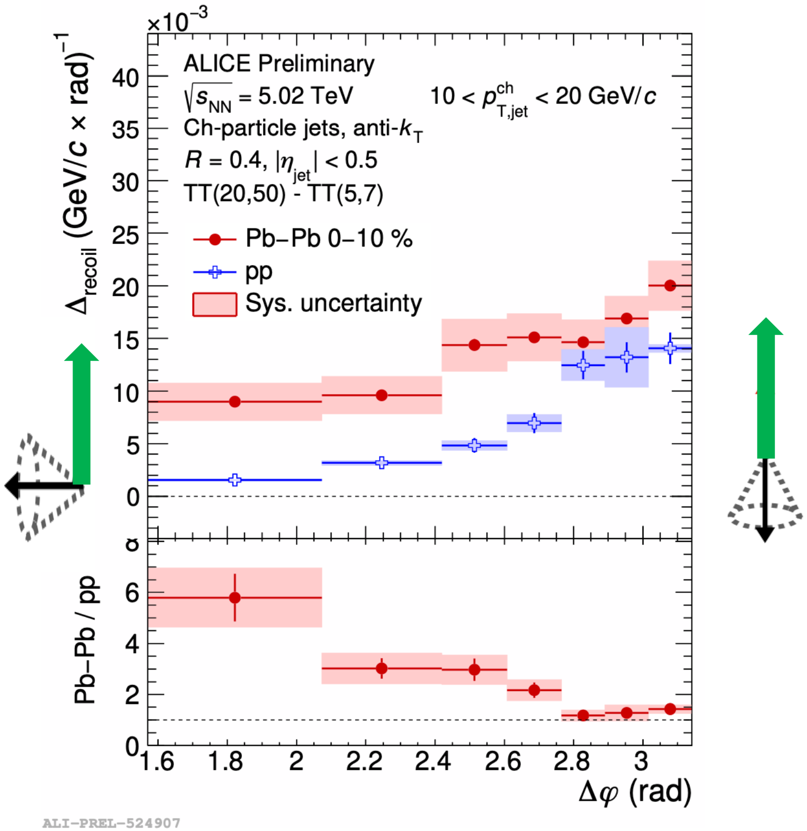
- Large reduction (factor 3-4) of jet yields, down to p_T = 20 GeV/c
- Lost energy not recovered within the jet "cone"
- Suppression may be even larger for larger-cone (R=0.6) low-p_T jets

→ Y. Hou, Fri parallel

Semi-inclusive "soft" jets deflected

- Jets recoiling against a high-p_T hadron
  → down to jet p_T ~ 10 GeV/c



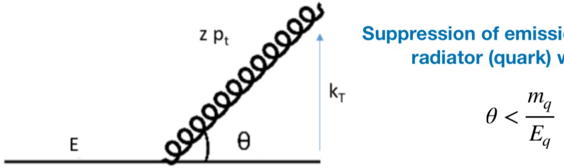


Δ_{recoil} vs Δϕ broader in Pb-Pb than in pp

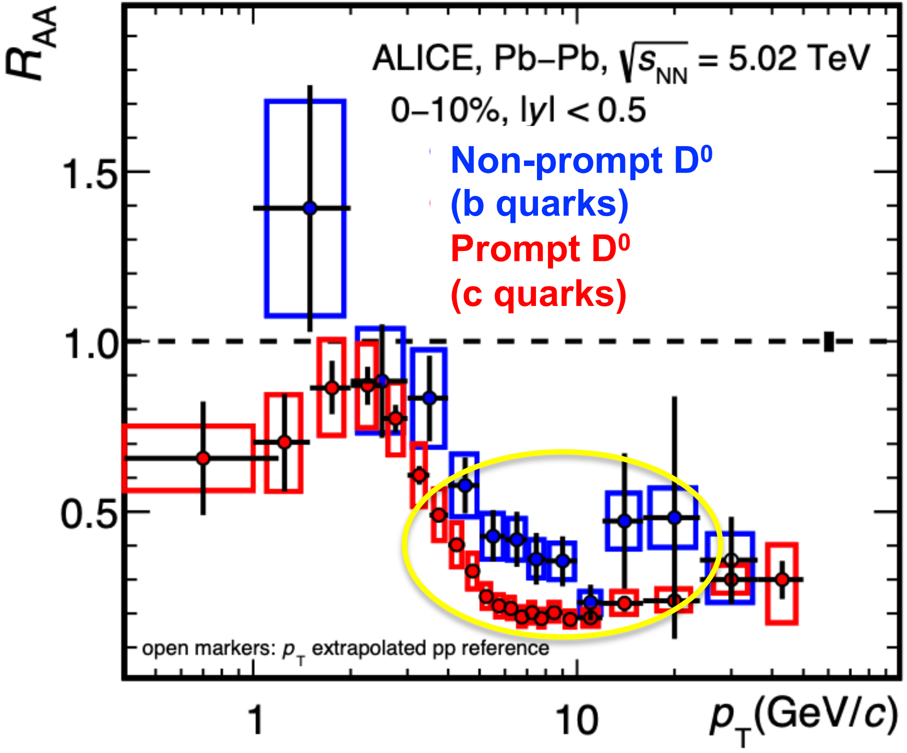
Angular deflection of soft large-R jets:
Scattering on QGP constituents?
Medium response to energy loss?

Quark-mass dependence of energy loss

- Energy loss predicted to depend on QGP density, but also on quark mass
- "Dead cone" effect reduces small-angle gluon radiation for high-mass quarks



- Less suppression for (non-prompt) D mesons from B decays than prompt D mesons



arXiv:2202.00815

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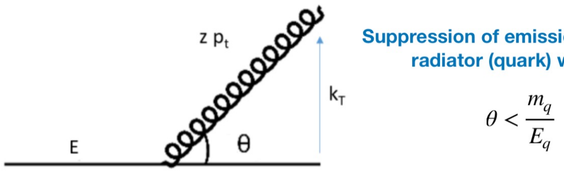
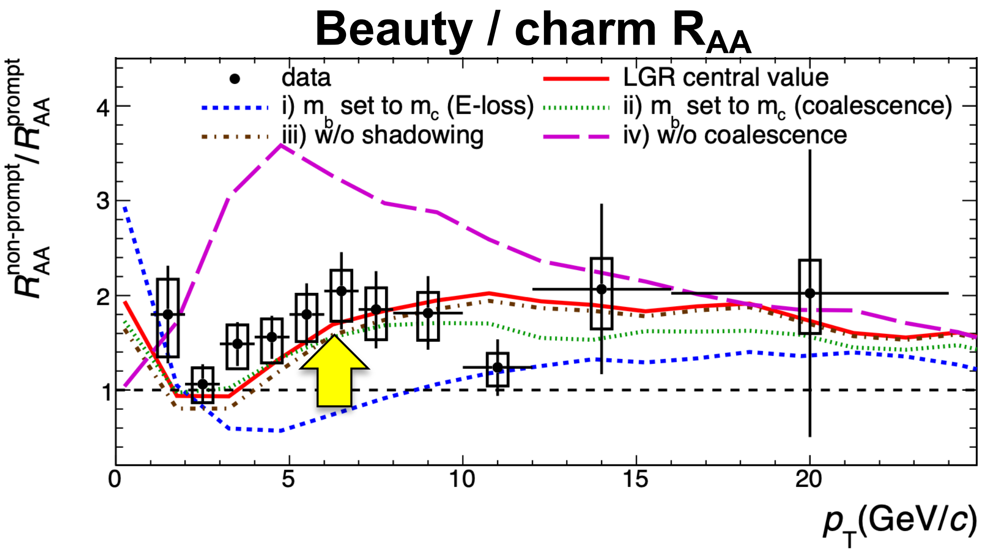


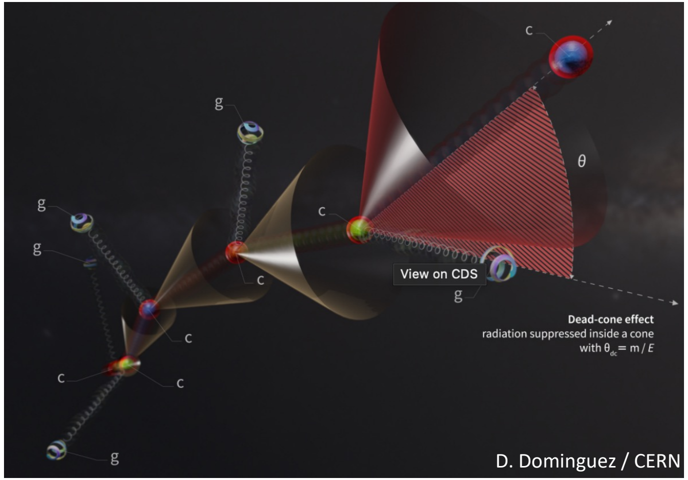
- Less suppression for (non-prompt) D mesons from B decays than prompt D mesons
- Smaller energy loss for b quarks needed to describe the ratio of R_{AA}



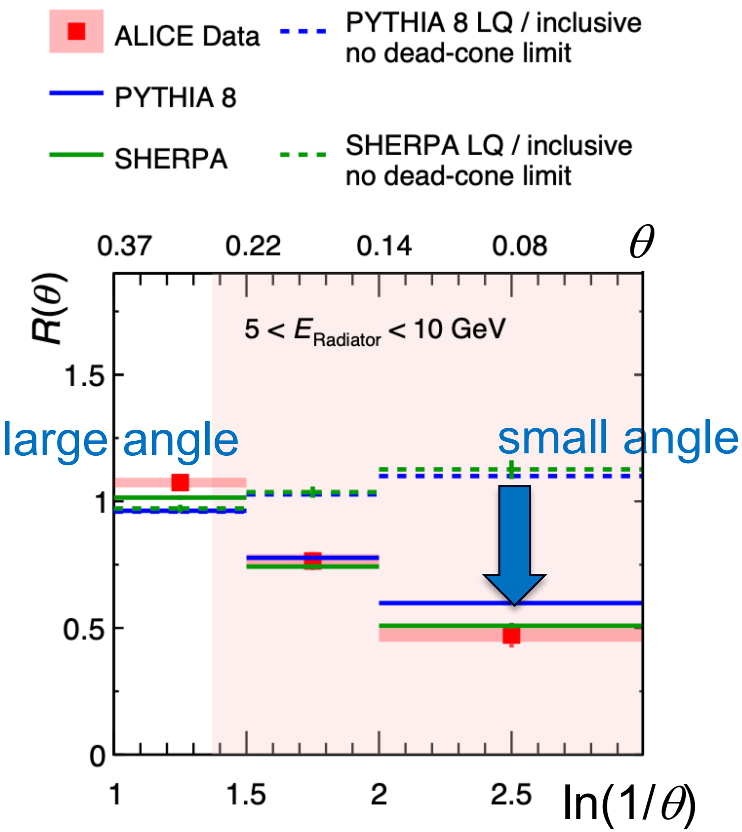
arXiv:2202.00815

In pp: dead-cone effect now exposed by ALICE

- Reduction of gluon radiation from heavy quarks at small angles Dokshitzer, Khoze, Troian, J.Phys.G 17 (1991) 1602

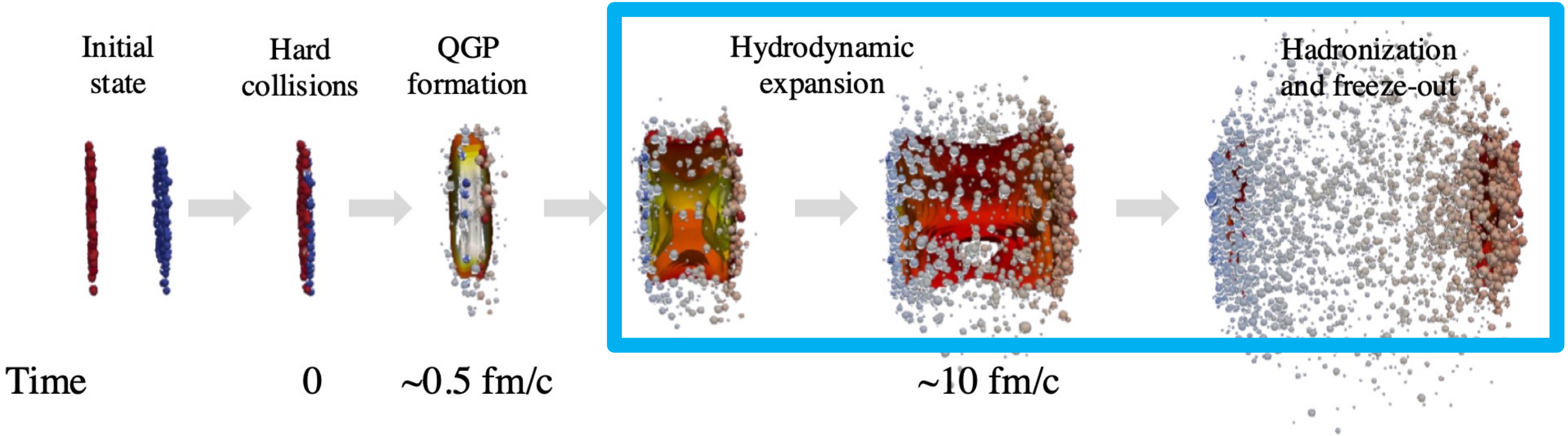


- First direct observation using jet iterative declustering and **Lund plane** analysis of jets that contain a soft D^0 meson

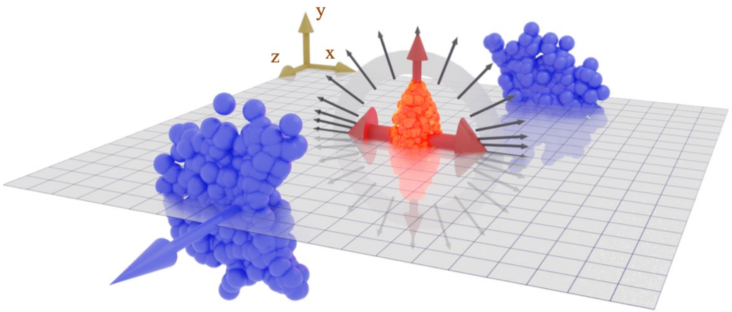


Nature 605 (2022) 7910, 440

Hadron production and flow



Visualization by J.E. Bernhard, arXiv:1804.06469



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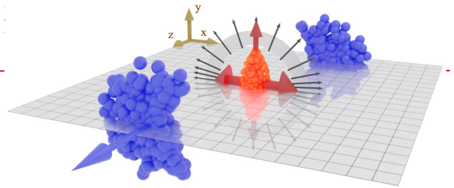
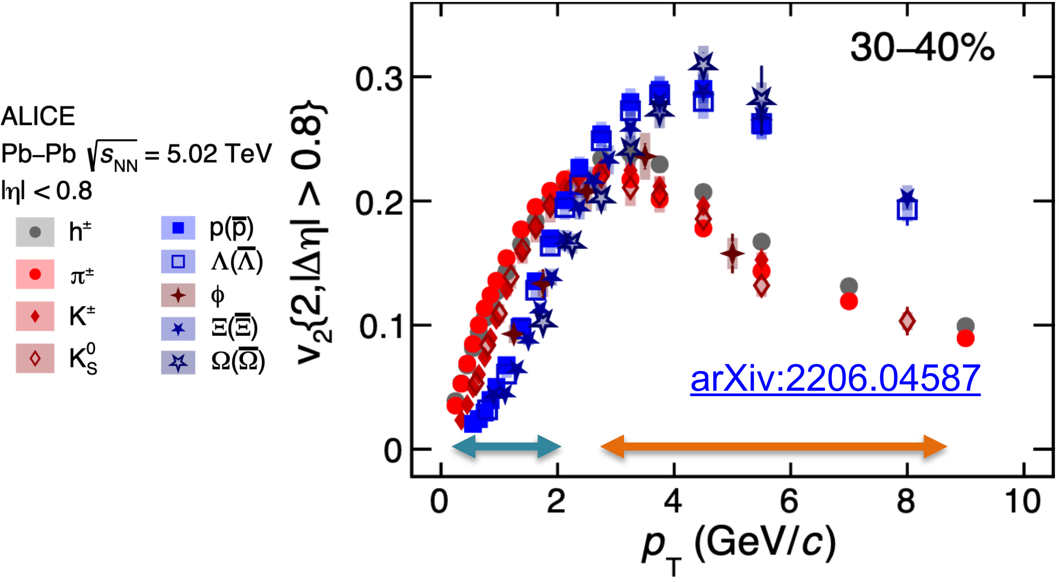


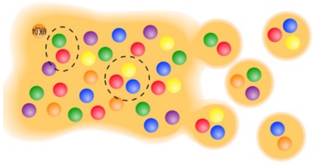
Elliptic flow in Pb-Pb

- Non-central collisions: elliptical geometry $\xrightarrow{\text{expansion (flow)}}$ azimuthal modulation in momentum

$$\frac{dN}{Nd\phi} = 1 + 2v_2 \cos\left(2(\phi - \Psi_{RP})\right) + \textit{higher harmonics } (v_3, v_4, \ldots)$$



Mass ordering at low p_T
→ **hydrodynamic flow**
Baryon vs. meson grouping at higher p_T
→ **quark-level flow + recombination**



Elliptic flow in Pb-Pb … and in pp, p-Pb

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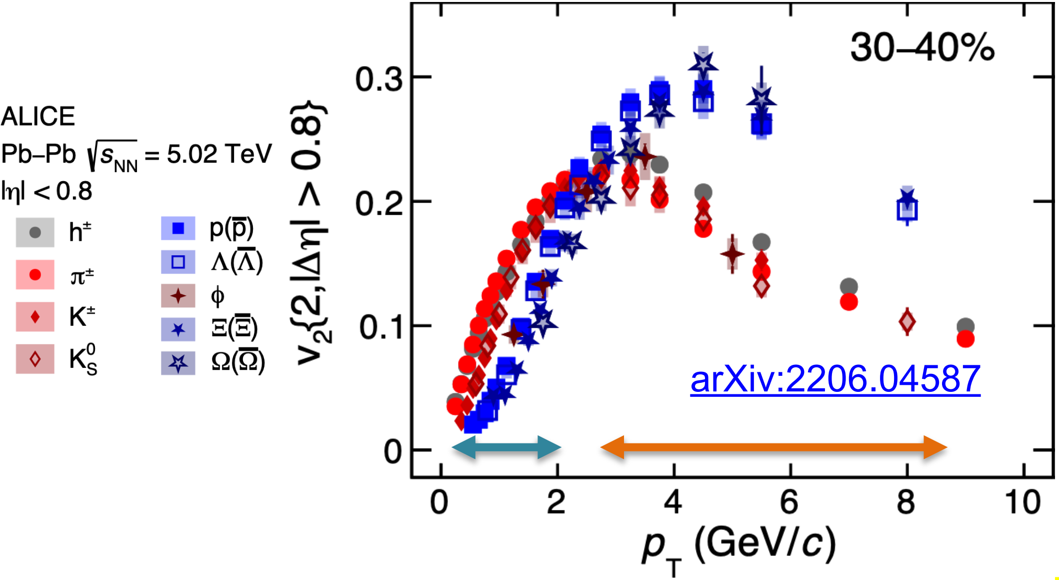
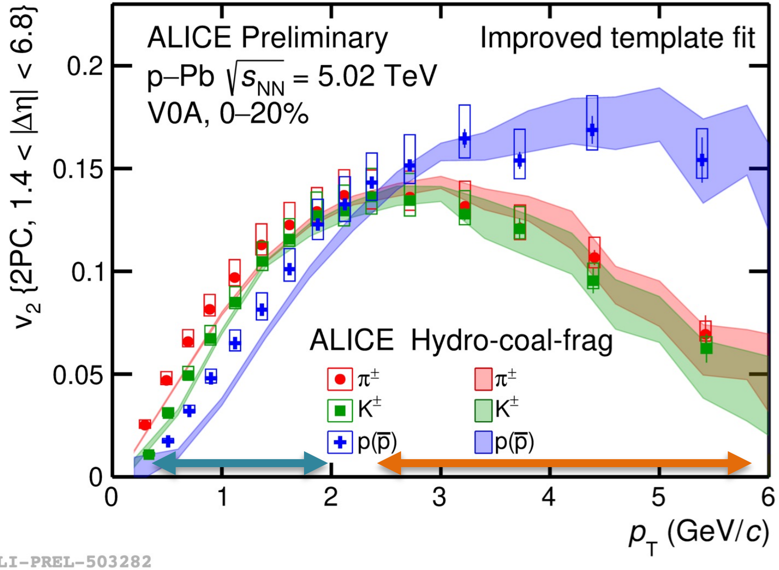
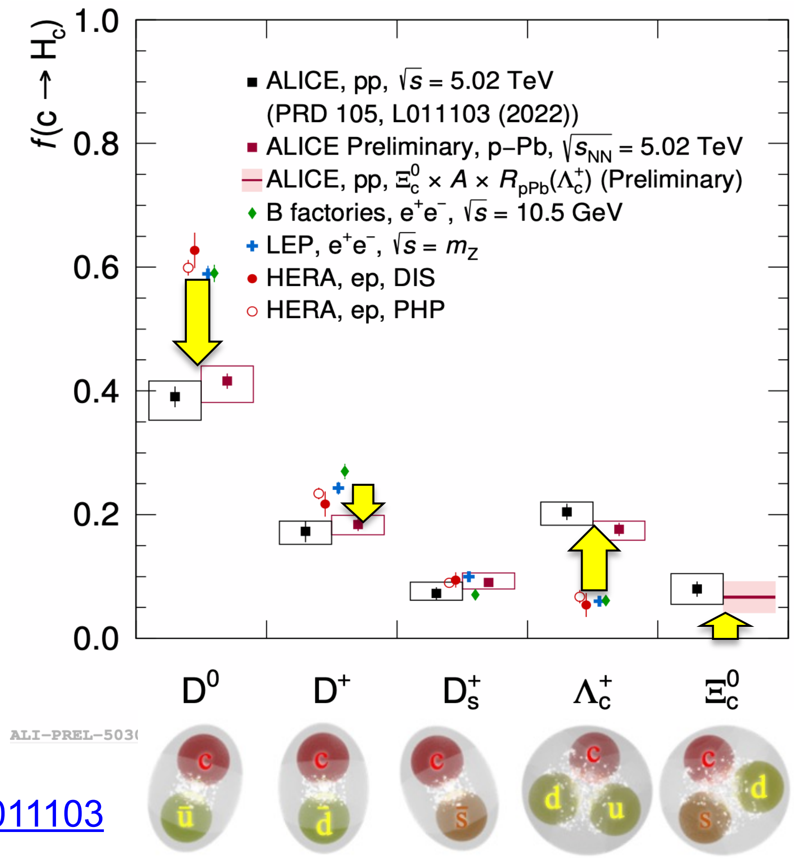




→ quark-level flow + recombination in high-multiplicity p-Pb (and pp)

Hadronization of charm quarks from pp …

- Charm quarks hadronize to baryons with much larger probability in hadronic collisions than in ee and ep collisions
- ~ 30% c → baryons in pp and p-Pb
- *"Breakdown of jet universality, like for strangeness"* T. Sjöstrand (LHCP2022)
- Described by PYTHIA with beyond-leading colour effects, but only for Λ_c, and by hadronization via recombination

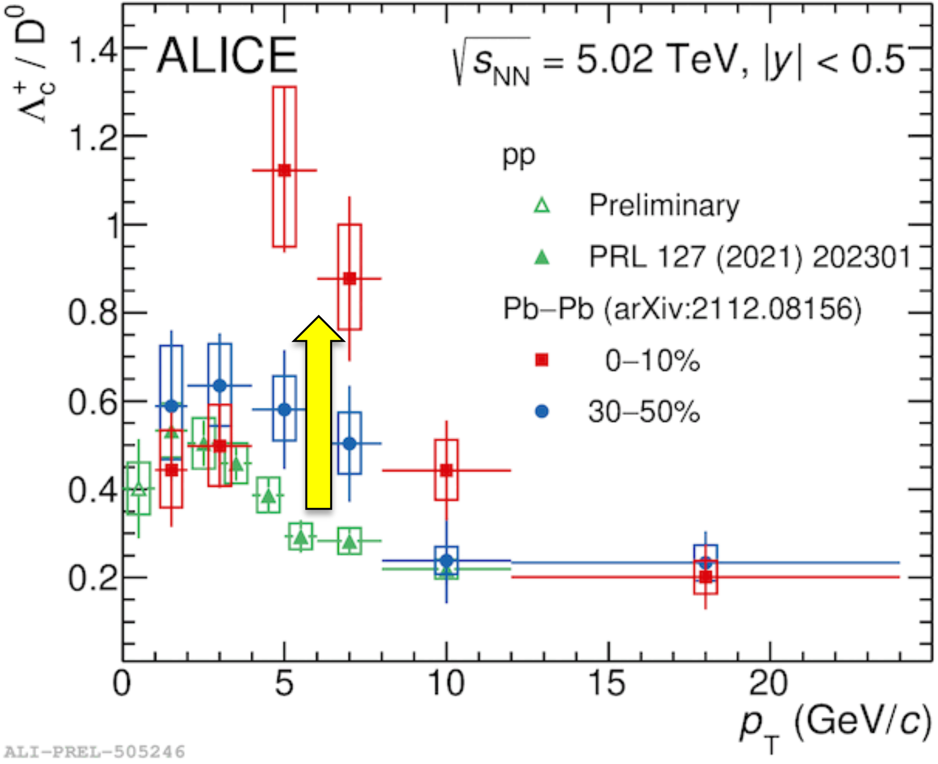


[PRD105 (2022) L011103](PRD105 (2022) L011103)

→ J. Zhou, Thu parallel

Hadronization of charm quarks from pp to Pb-Pb

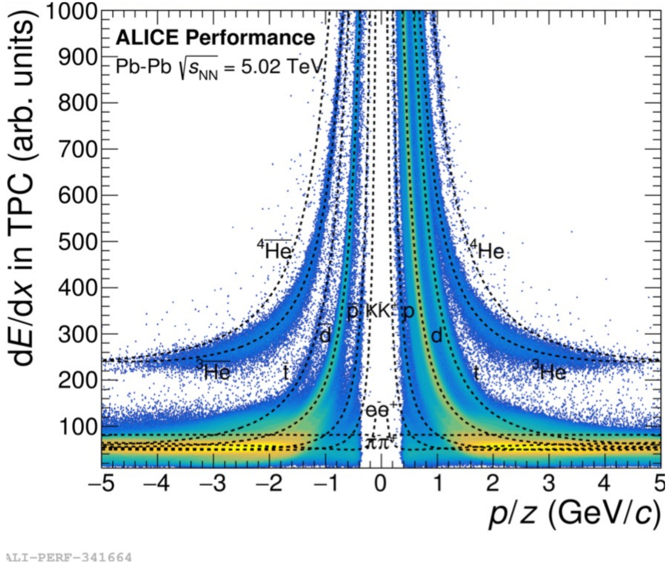
- Additional dynamics in central Pb-Pb collisions: Λ_c/D^0 enhancement at intermediate p_T
- Suggests hadronization by recombination + mass-dependent p_T shift from collective expansion
- Prospects: high-precision, and other baryons, from Run 3 data



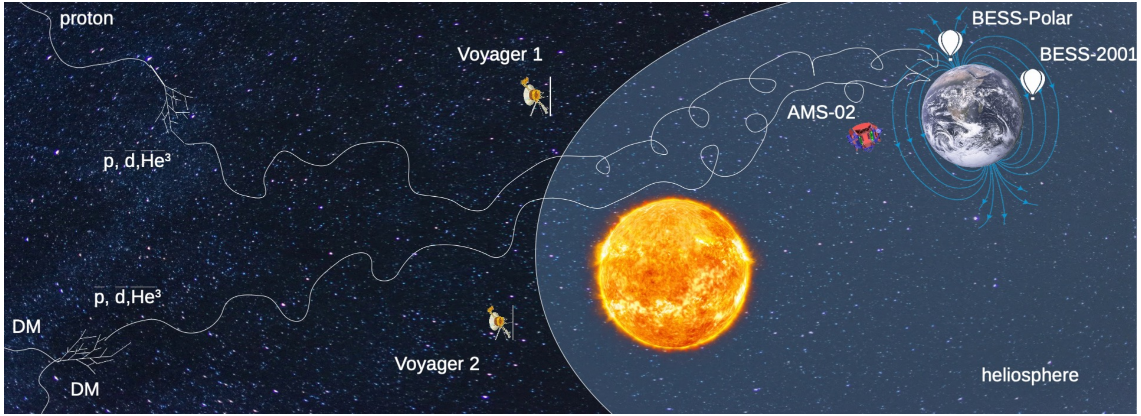
arXiv:2112.08156

LHC: not only nucleus collider, but (anti)nuclei factory

- Accessible in Run 2: d, t, ${}_{\Lambda}^{3}H$, ^{3}He, ^{4}He
- Production not yet fully understood: nucleon coalescence vs. statistical hadronization

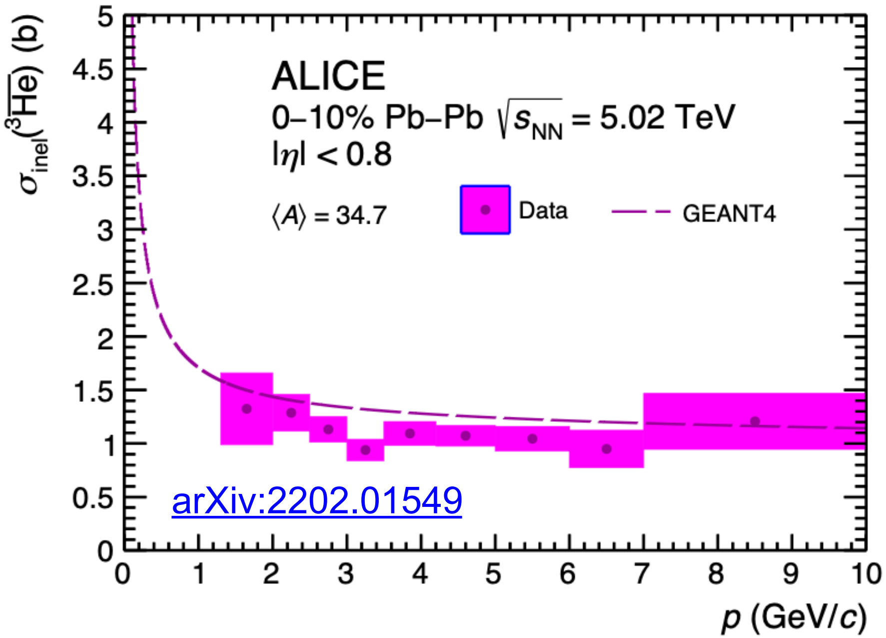


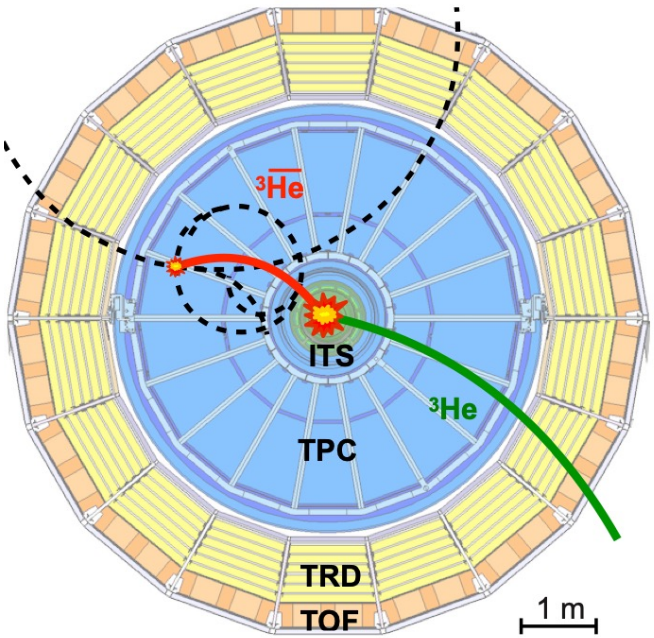
- Strong impact on dark matter searches in Space, e.g. $\chi_0\chi_0 \rightarrow \overline{d}$, $^{3}\overline{He}$+X (AMS-02, GAPS, BESS)
  - Ordinary antinuclei hadroproduction by cosmics is major background
  - Antinuclei absorption in space poorly constrained



Courtesy L. Serksnyte

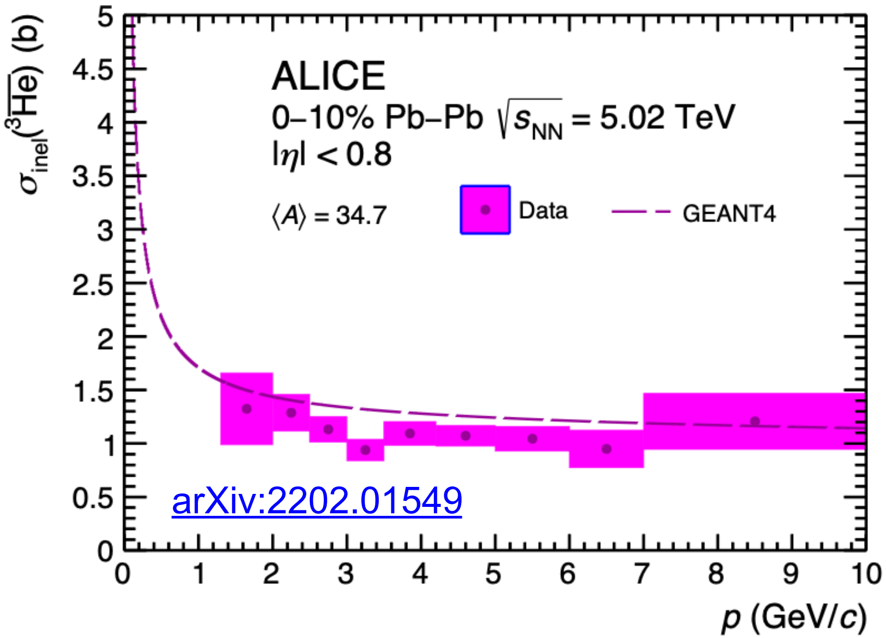
Light antinuclei absorption in ALICE and in the Galaxy

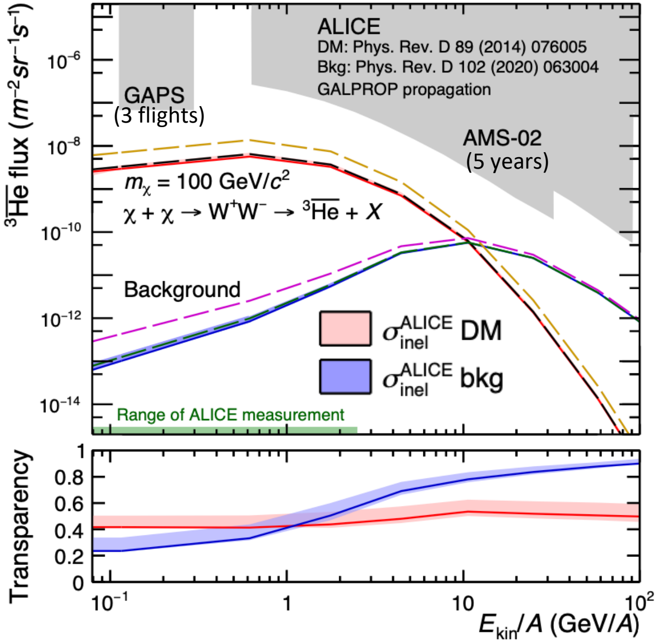




- Novel technique to use detector material as d and ^{3}He absorber: measure σ_{inel}
  - First measurement for $^{3}\overline{He}$

Light nuclei absorption in ALICE and in the Galaxy

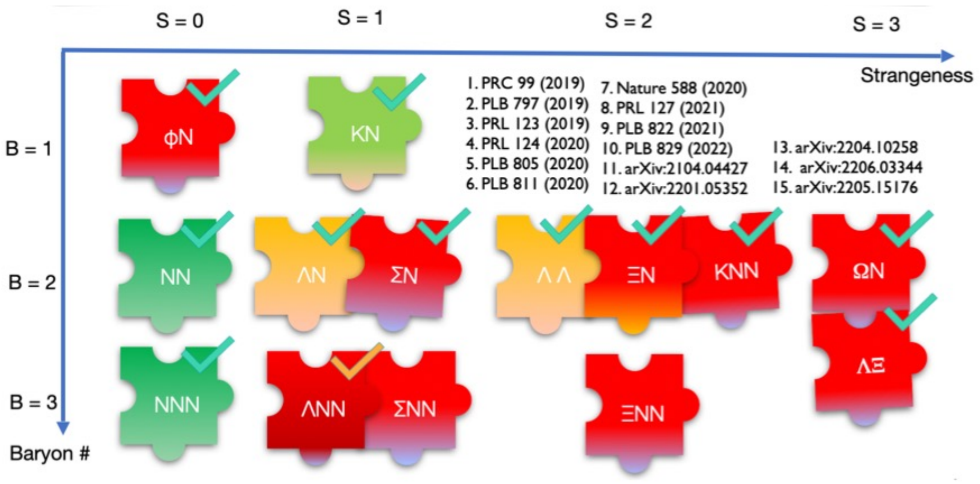


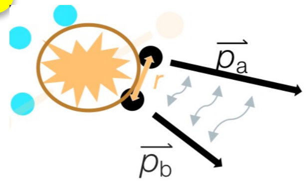


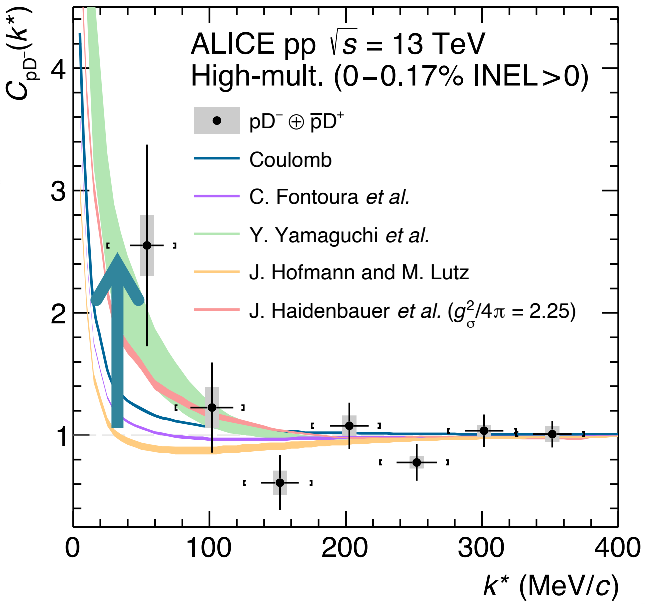
- Novel technique to use detector material as d and ^{3}He absorber: measure σ_{inel}
  - First measurement for $^3\overline{He}$
- Experiment-driven estimate of absorption probability of antinuclei from DM decays and from cosmic-ray background in the Galaxy

QCD interaction among hadron pairs, and triplets

- Use femtoscopy technique to assess residual strong interaction in h-h and h-h-h
  - Poorly known for strange baryons
    - Relevant for neutron star modeling
  - Unknown for charm hadrons and 3-body







First measurement of p-D correlation function:

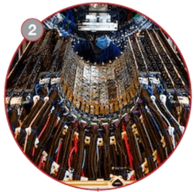
- Attractive interaction
- Estimate of QCD scattering parameters

arXiv:2201.05352

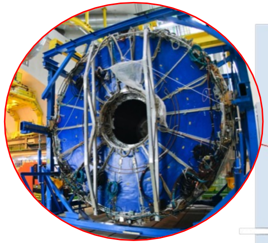
2010-2012		2015-2018		2022-2025		2029-2032		2035-2038		2040-2041
Run I	LS1	Run 2	LS2	Run 3	LS3	Run 4	LS4	Run 5	LS5	Run 6

ALICE 2 Upgrade

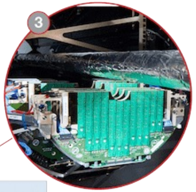
→ Tracking precision ×3
→ Pb-Pb rate ×50



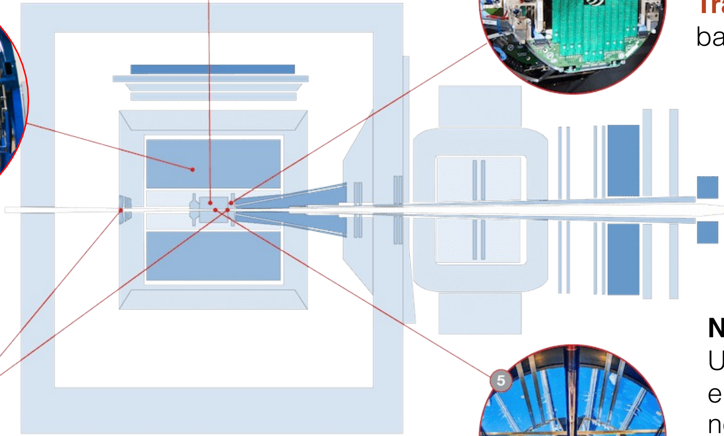
New Inner Tracking System (ITS)
– **7 barrels, 10 m²** silicon tracker
based on MAPS (12.5 G pixels`



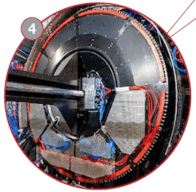
New GEM-based TPC
with continuous readout



New Muon Forward Tracker (MFT) - 5 disks
based on MAPS

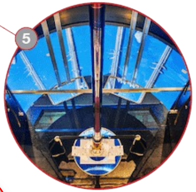


New Trigger and Readout
Upgrade of readout electronics of all detector, new Central Trigger Processor



New Fast Interaction Trigger (FIT)
– 3 detector technologies: interaction trigger, online luminometer, forward multiplicity

New Online/Offline (O2)



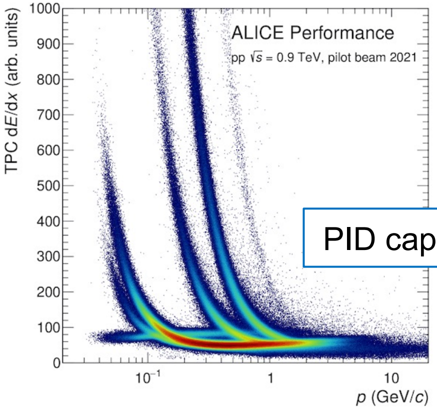
New Beampipe
smaller diameter (36.4 mm), first detection layer at 20 mm

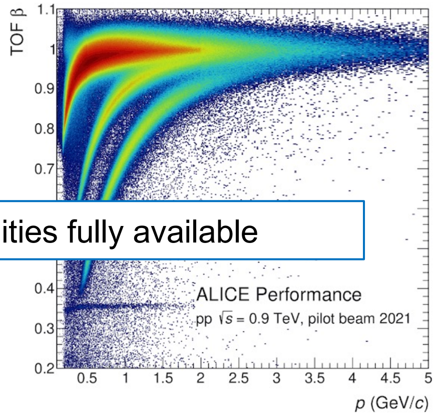
2010-2012 2015-2018 2022-2025 2029-2032

Run I | LS1 | Run 2 | LS2 | Run 3 | LS3 | Run 4 | LS4

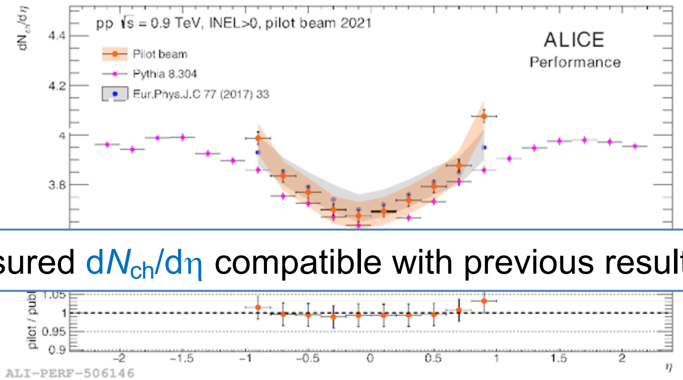
→ A. Landou, R. Munzer, Fri parallel

Commissioning with pilot beam and start of Run 3

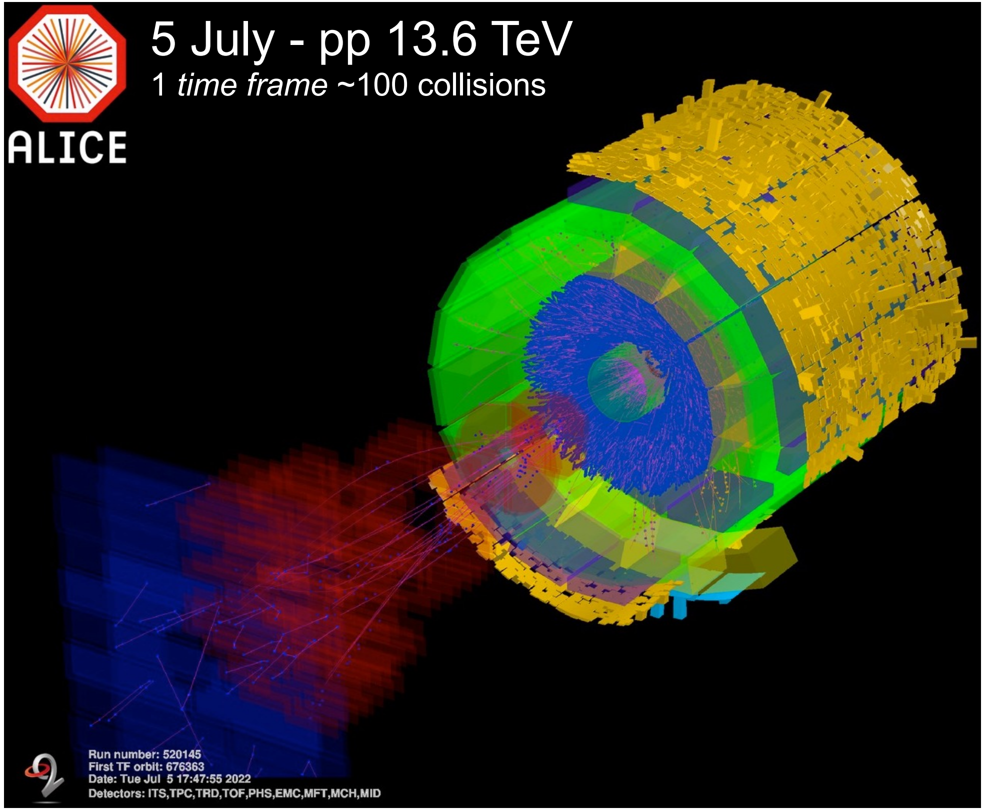




PID capabilities fully available



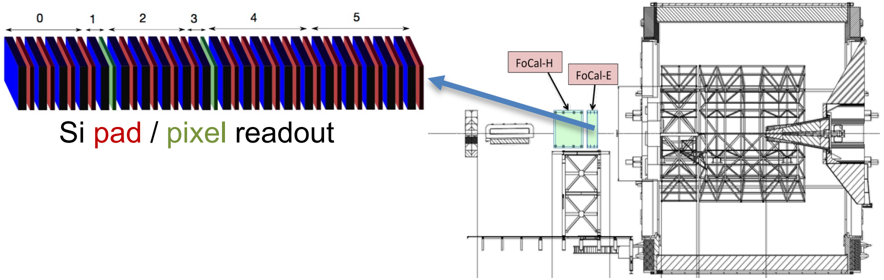
Measured $dN_{ch}/d\eta$ compatible with previous results



→ M. Mager, M. Rauch, Thu parallel

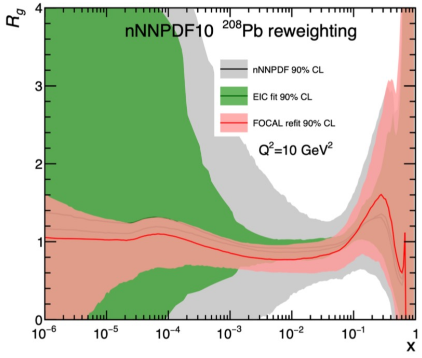
LS3: forward calorimenter and ultra-thin tracker

- FoCal: forward e.m. calo with Si readout for isolated γ measurements $3.2<\eta<5.8$ in p-Pb
- Constrain nuclear PDFs down to $x < 10^{-5}$
- **LoI:** CERN-LHCC-2020-009



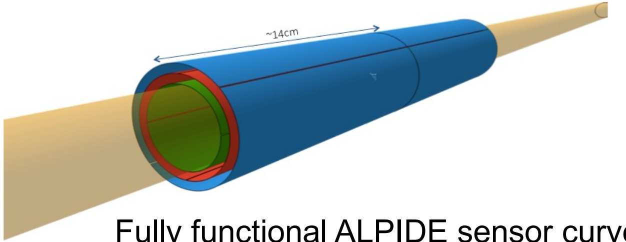
Si pad / pixel readout

Impact on gluon nuclear PDFs:
Present nNNPDF
w/ FoCal pseudodata
w/ EIC pseudodata

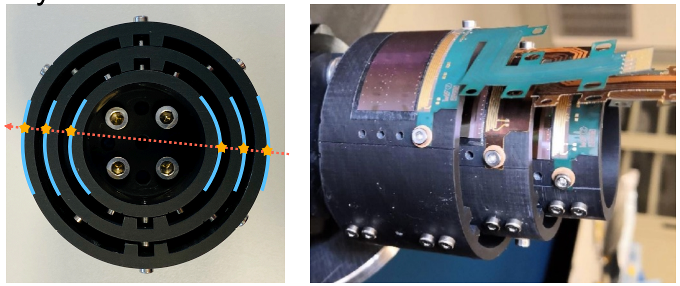


TDRs in 2023

- ITS3: new inner barrel – 3 truly cylindrical MAPS layers around smaller beam pipe
  - $\times$3 less material budget
  - $\times$2 tracking precision and effic. (low p_T)
- **LoI:** CERN-LHCC-2019-018



Fully functional ALPIDE sensor curved to R=1.8 cm



ALICE ITS, NIM A 1028 (2022) 166280

2010-2012		2015-2018		2022-2025		2029-2032		2035-2038		2040-2041
Run I	LS1	Run 2	LS2	Run 3	LS3	Run 4	LS4	Run 5	LS5	Run 6

ALICE 3: next-generation heavy-ion detector

→ N. Jacazio, Thu parallel

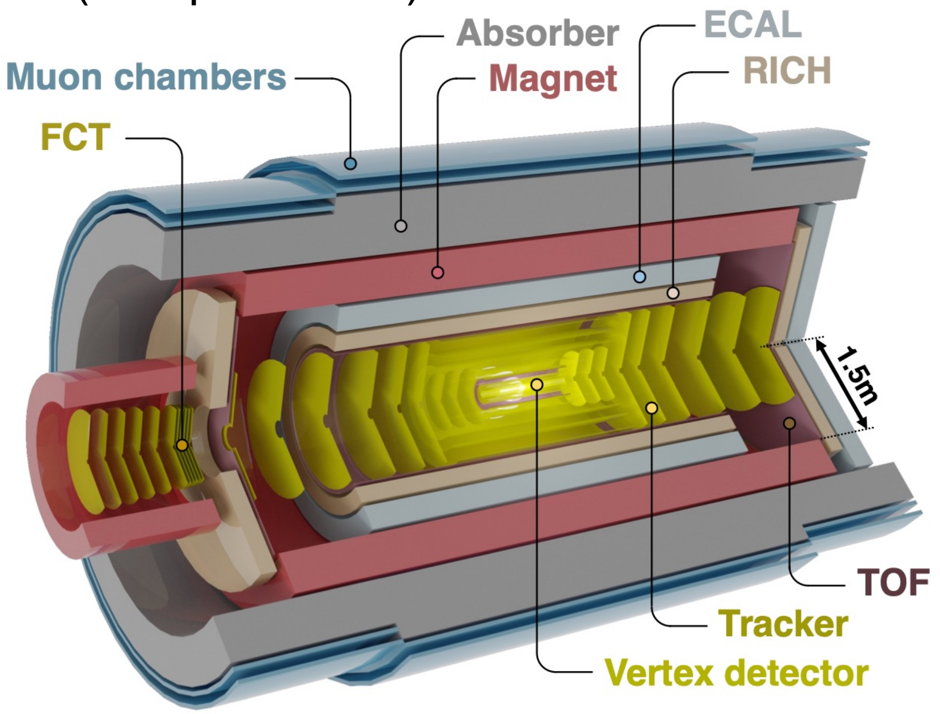
→ Tracking precision × 3: 10 μm at p_T = 0.2 GeV/c

→ Acceptance × 4.5: |η| < 4 (with particle ID)

→ A-A rate × 5 (pp × 25)

Enables unique physics in Run 5+

- Multi-charm hadrons
- Charm - anticharm angular (de)correlation
- Thermal radiation and its time dependence
- Chiral symmetry restoration in QGP
- Charm h-h residual interaction
- …



LoI: CERN-LHCC-2022-009

Conclusions

- Detailed insight on the QGP workings and properties
  - e.g. heavy-quark interactions, jet modifications, expansion and hadronization
- Moreover, a broader and rich QCD research programme
  - pQCD, hadron interactions, formation of hadrons and nuclei
- ALICE 2 detector taking data in Run 3, after major upgrade
- Gearing up LS3 upgrades and proposed new apparatus ALICE 3 for Run 5+

ALICE at ICHEP: 51 talks and posters

TALKS

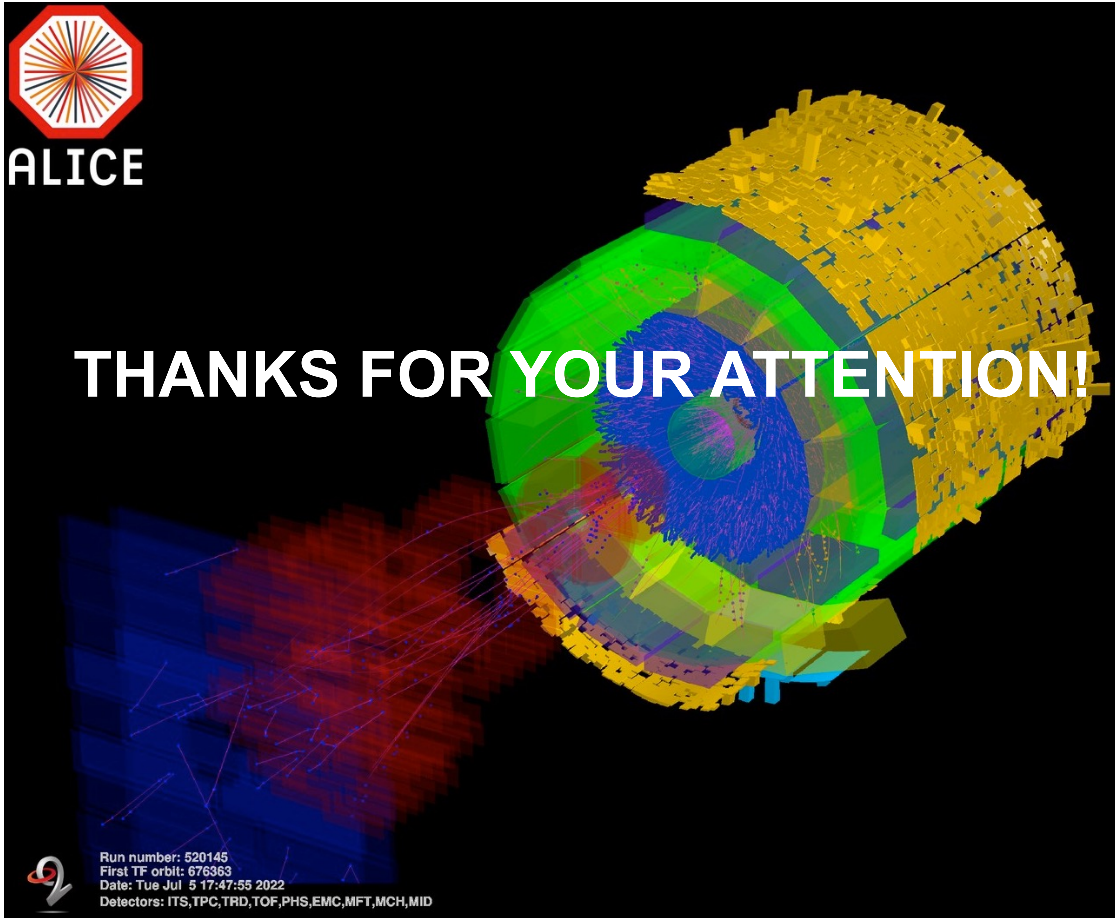
New advancements in symmetry plane correlations and multiharmonic fluctuations in HIC	HI	Marcel Lesch
Measurement of p-d and Λ−d correlations in pp at 13 TeV	strong	Bhawani Singh
Non-identical particle femtoscopy in Pb−Pb collisions at 5.02 TeV	HI	Pritam Chakraborty
Measurement of the inclusive, prompt and non-prompt J/psi production in Pb-Pb	HI	Himanshu Sharma
Quarkonium polarization in Pb-Pb and pp collisions with ALICE	HI	Yanchun Ding
psi2s production and nuclear modification factor in nucleus-nucleus collisions	HI	Biswarup Paul
Quarkonia production and elliptic flow in small systems	HI	Maurice Coquet
Ground and excited quarkonium states as probes of MPI in small systems	strong	Theraa Tork
J/psi photoproduction and dileptons from photon-photon interactions in hadronic Pb-Pb	HI	Raphaelle Bailhache
Neutral mesons up to very high pt as function of multiplicity in pp collisions at 13 TeV	strong	Joshua Leon Konig
Direct photon production and HBT correlations in PbPb at 5TeV	HI	Mike Sas
Thermal radiation and direct photon production in Pb--Pb and pp collisions with dielectrons	HI	Daiki Sekihata
Charm production: constraint to transport models and charm diffusion coefficient	HI	Fabio Catalano
Constraining hadronization with prompt and non-prompt charm baryons from pp to PbPb	strong	Jianhui Zhu
Beauty production in heavy-ion collisions	HI	Biao Zhang
Beauty production in small systems	strong	Katharina Demmich
Weak bosons (W/Z) at mid- and forward rapidity in pp (vs mult), pPb and PbPb	HI	MIngrui Zhao
jet acoplanarity through hadron+jet measurements in Pb-Pb collisions with ALICE	HI	Yongzhen Hou
Searching for jet quenching using high-multiplicity inclusive jet and h+jet semi-inclusive jet in	HI	Artem Kotliarov
Exploring jet interactions in the QGP using jet substructure measurements in Pb-Pb	HI	Raymond Ehlers III
Probing the initial state with isolated photon production in small collision systems	strong	Ran Xu
Study of the dynamics of the production of light nuclei in small systems	HI	Luca Barioglio
The dark side of ALICE: from antinuclei interactions to dark matter searches in space	DM	Manuel Colocci
Measurement of the hypertriton properties and production	strong	Janik Ditzel
Light flavour particle production in the smallest hadronic systems	HI	Mario Kruger
Exploring the late hadronic phase of relativistic heavy-ion collisions with resonances	HI	Prottay Das
Rescattering effects on resonances production in small systems	strong	Nicola Rubini

TALKS

Physics performance of the ALICE experiment in LHC Run 3	operation	Aimeric Landou
Disentangling initial & final state contributions to strangeness production in pp	HI	Francesca Ercolessi
System-size dependence of particle production at mid and forward rapidity with ALICE	HI	Abhi Modak
Luminosity Pb-Pb results + pp	operation	Pietro Cortese
ALICE 3	future	Nicolo Jacazio
ALICE FoCal	operation	Max Rauch
A truly cylindrical inner tracker system	future	Magnus Mager
Preparation of ALICE for LHC Run 3	operation	Robert Munzer
Matters of Diversity and Inclusion at the ALICE Collaboration	diversity	Fernando Flor
ALICE in public outreach and in bricks	outreach	Christian Klein-Boesing
Outreach and educational activities of ALICE in the times of pandemic	outreach	Despina Hatzifotiadou
Enabiling distributed analysis for ALICE Run 3	computing	Ionela Cruceru

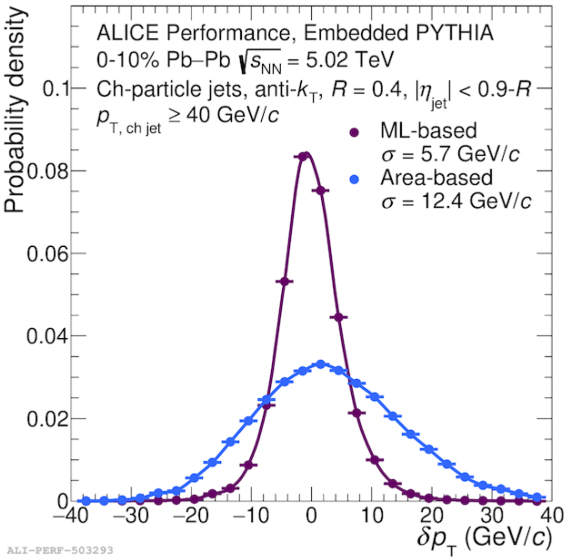
POSTERS

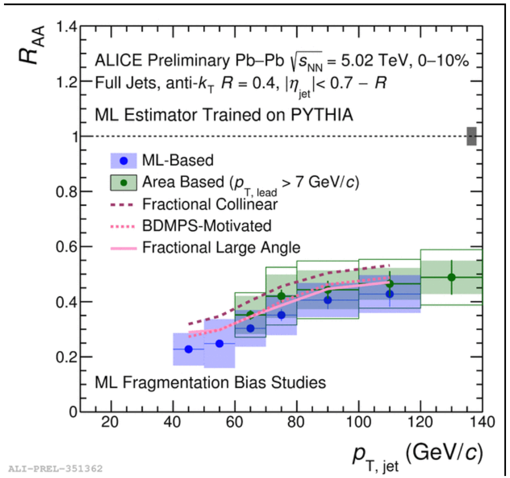
Searching for viscous effects in small systems	strong	Victor Gonzalez
Measurement of $R2(\Delta\eta,\Delta\varphi)$ and $P2(\Delta\eta,\Delta\varphi)$ correlation functions in pp at s√ = 13 TeV	HI	Baidyanath Sahoo
D-meson average production analysis as a func. of multiplicity in pp at \sqrt{s} = 13 TeV	strong	Marco Giacalone
Multiplicity dep. of intra-jet properties in small collision systems with ALICE	HI	Debjani Banerjee
Charged-particle production as a function of multiplicity from small to large collision systems	strong	Mario Kruger
Strangeness production in pp as a function of multiplicity and effective energy	HI	Francesca Ercolessi
Production of ϕ-meson pairs with ALICE: a novel probe for strangeness production	HI	Nicola Rubini
Hadronic resonance production in small collision systems with ALICE at the LHC	HI	Antonella Rosano
Probing the hadronic phase through the study of the Λ(1520) resonance	strong	Neelima Agrawal
Multiplicity-dependent study of Λ(1520) production in pp collisions at s√ = 5.02 and 13 TeV	strong	Sonali Padhan
Charged-particle production as a function of RT in pp, p-Pb and Pb-Pb collisions at 5.02 TeV	HI	Sushanta Tripathy
Charged particle pseudorapidity density in pp collisions at 900 GeV with the ALICE MFT	strong	Sarah Herrmann


ALICE
THANKS FOR YOUR ATTENTION!
Run number: 520145
First TF orbit: 676363
Date: Tue Jul 5 17:47:55 2022
Detectors: ITS,TPC,TRD,TOF,PHS,EMC,MFT,MCH,MID

Jet background substraction with ML

- Shallow neural network with three-layer perceptor
- Training with PYTHIA jets embedded on thermal HI-like underlying event
- Systematic uncertainties from variation of PYTHIA jets: q-only, g-only, mimicking energy loss and large angle radiation

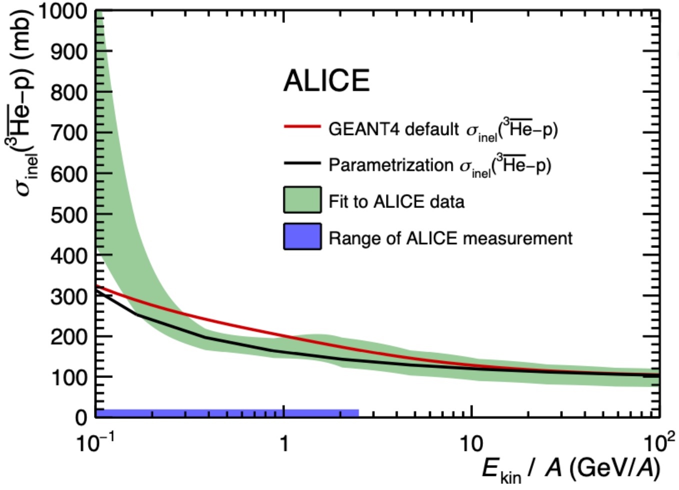


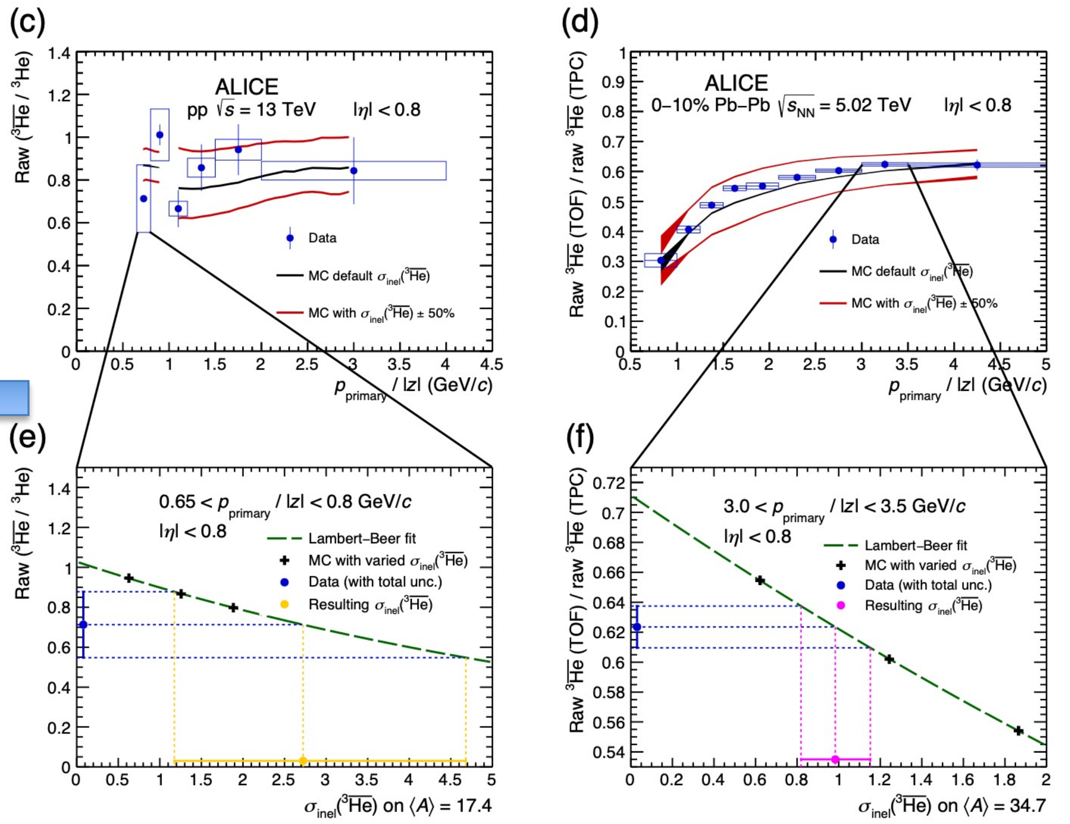


Anti-^{3}He absorption cross section

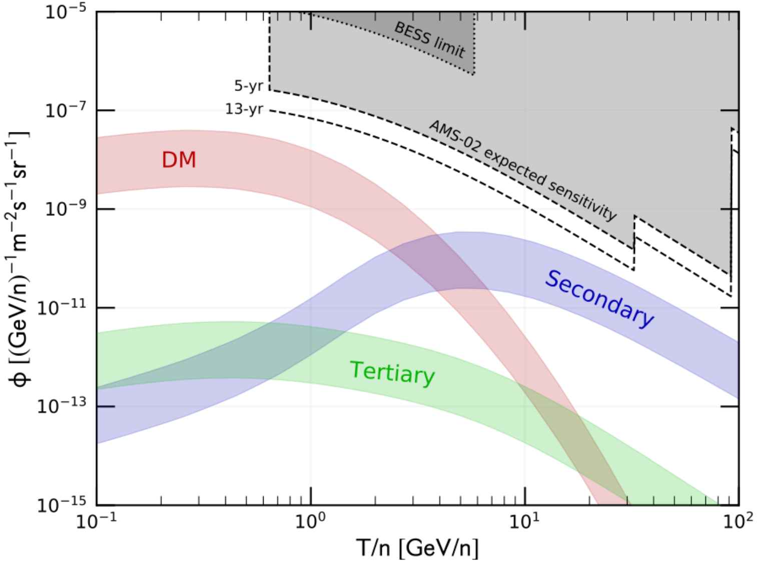
- Compare measured ratios of antinuclei/nuclei or antinuclei TPC/TPC with full simulations with varied GEANT4 cross section
- Determine cross section anti^{3}He-A that best descrides measured ratios
- Extrapolate to anti^{3}He – p
    - 8% additiional systematic unc.

$$\sigma_{hA}^{\mathrm{inel}} = \pi R_A^2 \ln\left(1 + \frac{A\sigma_{hN}^{\mathrm{tot}}}{\pi R_A^2}\right)$$





Anti-^{3}He flux from DM



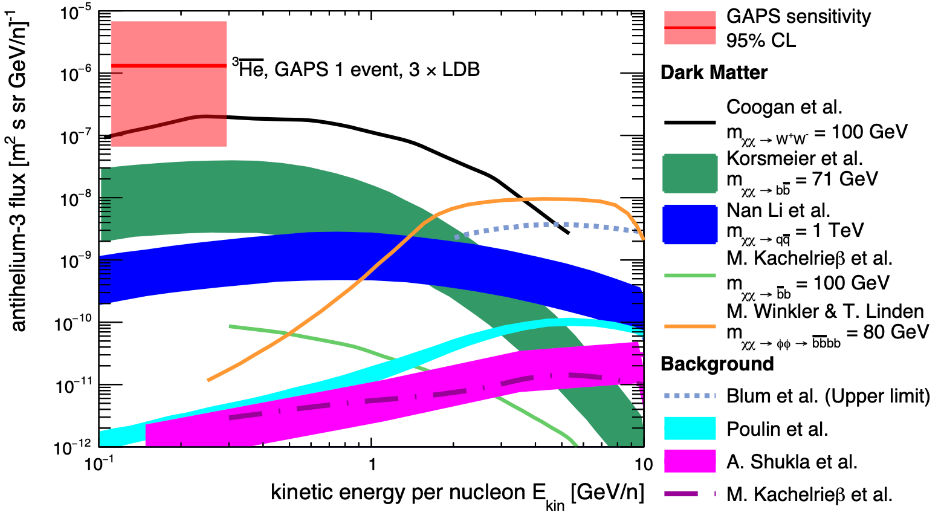
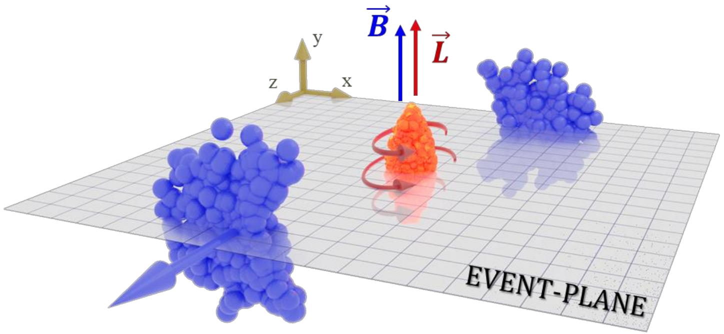


Figure 5: The solid red line shows the single event sensitivity of GAPS to antihelium-3 nuclei (95% confidence level) for three LDB flights of 35 days each. The red box indicates the upper and lower bounds of the 95% confidence level. Also shown are the antihelium-3 flux predicted by a variety of dark matter [26, 25, 21, 27, 28] and standard astrophysical background [29, 48, 49] models. For theoretical predictions, the error bands illustrate uncertainties in the coalescence momentum, but also include propagation uncertainties.

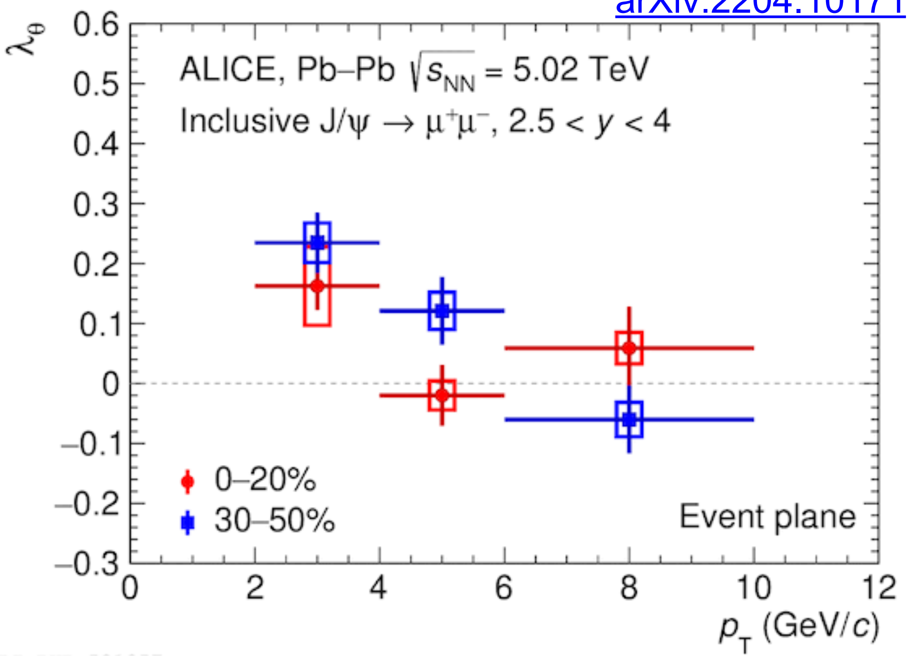
AMS-02, Korsmeier et al., https://arxiv.org/abs/1711.08465 GAPS, https://arxiv.org/pdf/2012.05834.pdf

J/ψ polarization in the direction of L, B

- First evidence of J/ψ polarization with respect to event plane
- Increases in less central collisions and at low p_T (reaching 3.9σ effect)
- Interpretation in terms of early B field and/or vorticity needs detailed theory calculations



arXiv:2204.10171

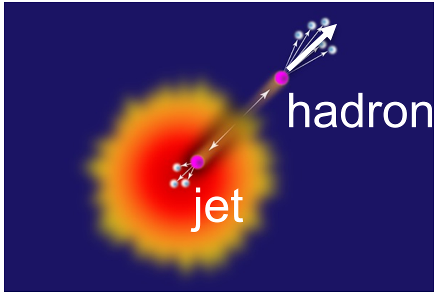


$$W(\theta) \propto \frac{1}{3+\lambda_\theta}(1+\lambda_\theta \cos^2\theta)$$

polar angular distribution of dimuon decay

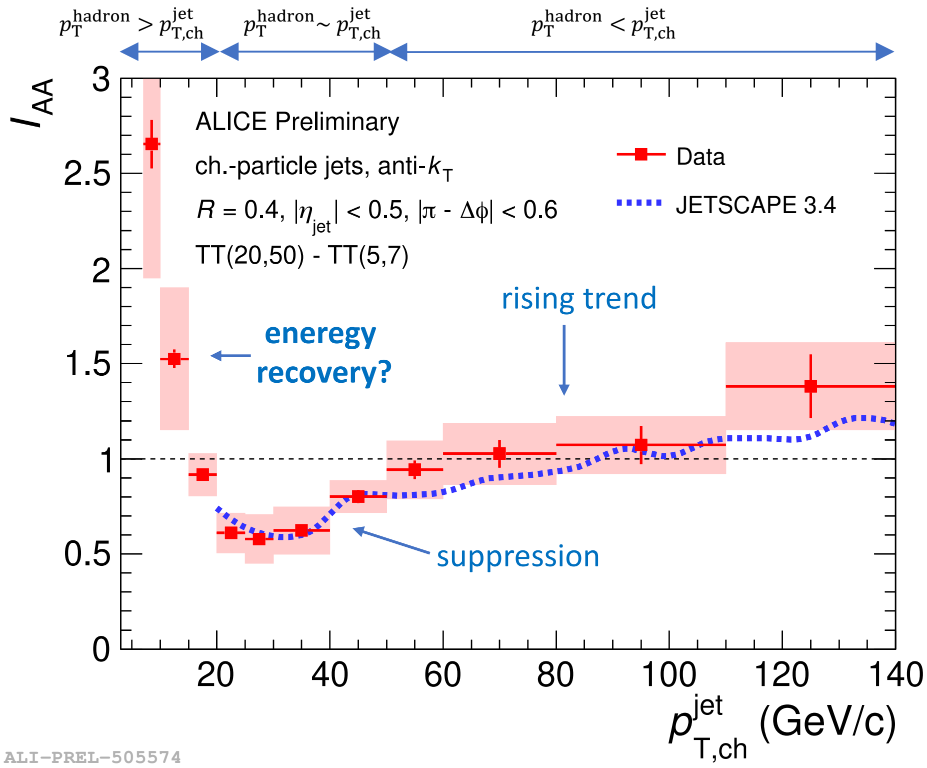
Semi-inclusive "soft" jets enhanced and deflected

- Jets recoiling against a high-p_T hadron → down to jet p_T ~ 5 GeV/c



$$I_{AA} \equiv \frac{\Delta_{\mathrm{recoil}}(\mathrm{Pb-Pb})}{\Delta_{\mathrm{recoil}}(\mathrm{pp})}$$ > 1 at 5-10 GeV/*c*

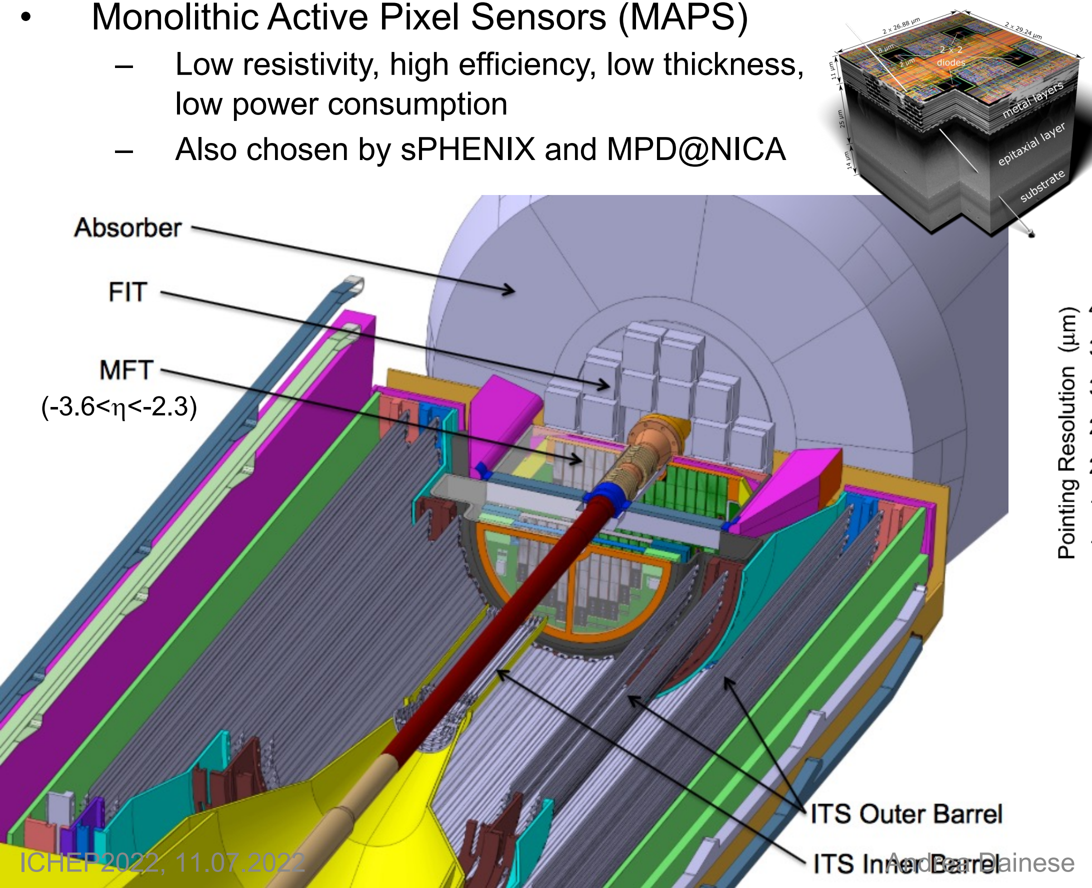
Hint of increased soft jet yield in Pb-Pb wrt pp

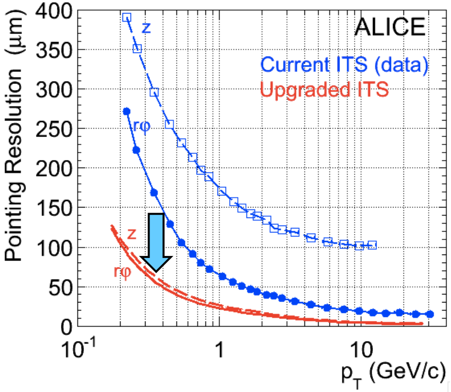


New all-pixel trackers: ITS2 and MFT

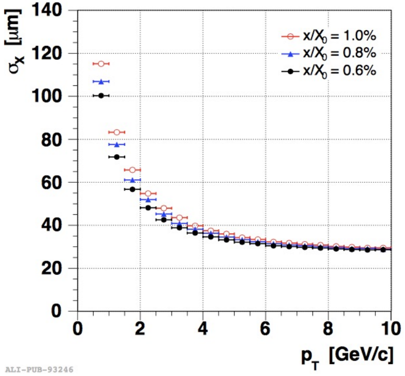
- Monolithic Active Pixel Sensors (MAPS)
  - Low resistivity, high efficiency, low thickness, low power consumption
  - Also chosen by sPHENIX and MPD@NICA

	Current ITS	New ITS2	MFT
N Layers	6	7	5
Inner radius	3.9 cm	2.3 cm	/
Layer thickness	~1.1% X_0	0.3-1.0% X_0	0.8% X_0
Spatial resolution	12x100 μm^2 35x20 μm^2 20x830 μm^2	~5x5 μm^2	~5x5 μm^2





ITS2 tracking precision x3 better in rφ plane, <20 μm above 1 GeV/*c*

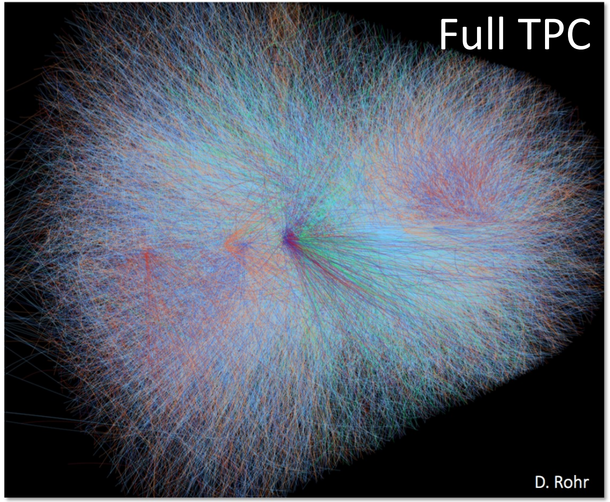


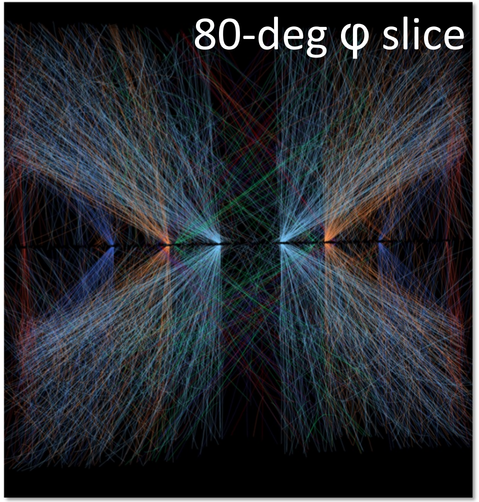
MFT: <100 μm above 1 GeV/*c*

CERN-LHCC-2013-024, CERN-LHCC-2015-001

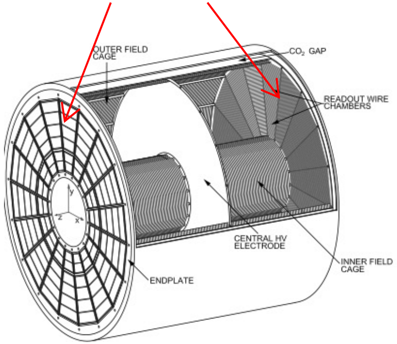
TPC with GEM readout for Pb-Pb at 50 kHz

- Current MWPC: readout rate limited by ion backflow
- New readout chambers (GEM): continuous readout of Pb-Pb at interaction rate of 50 kHz
  - preserve p_T and dE/dx resolution
- 5 interactions on average during TPC drift time (90 μs)
- Calibration and track-to-event assignment in O^2 system

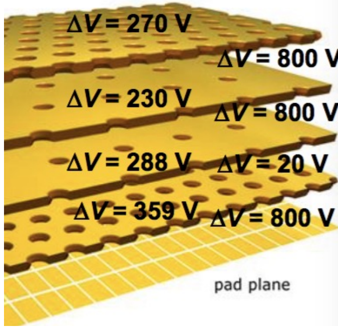


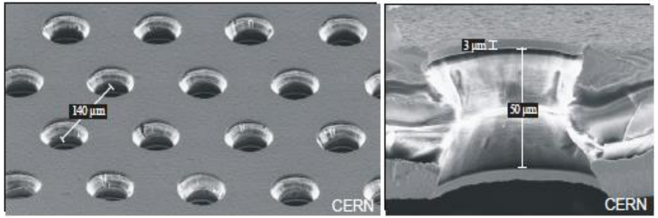


72 readout chambers



Stack of 4-GEM-foils



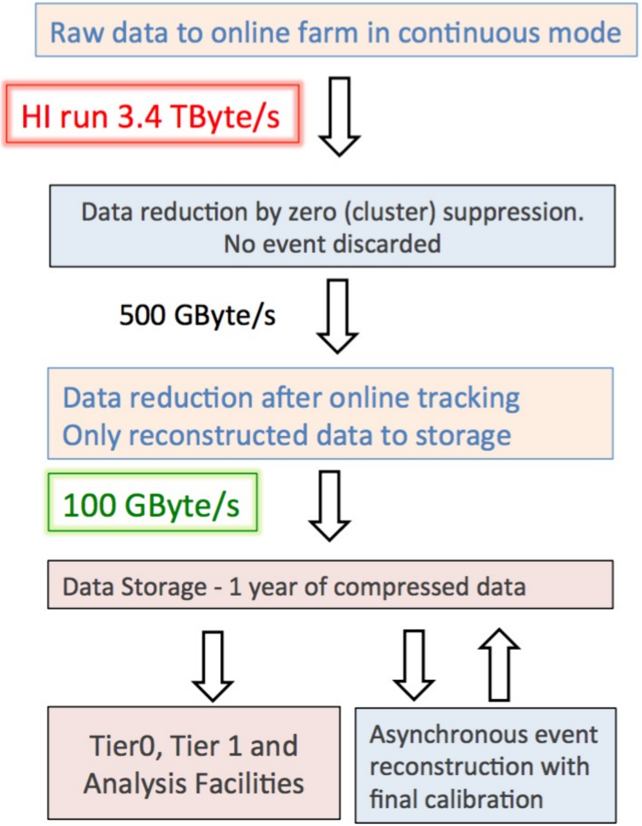


Electron microscope photograph of a GEM foil

CERN-LHCC-2013-020

O^2 Online-Offline System

- O^2 will integrate the present DAQ, HLT and Offline systems
- A large computing farm will process the data online, calibrate the TPC, reject detector noise, and build events
- Data reduction factor >30 in Pb-Pb, without event rejection
  - 3.4 TB/s → 0.1 TB/s to tape



CERN-LHCC-2015-006

ALICE future: pushing the frontiers of precision

2010-2012		2015-2018		2022-2025		2029-2032		2035-2038		2040-2041
Run I	LS1	Run 2	LS2	Run 3	LS3	Run 4	LS4	Run 5	LS5	Run 6

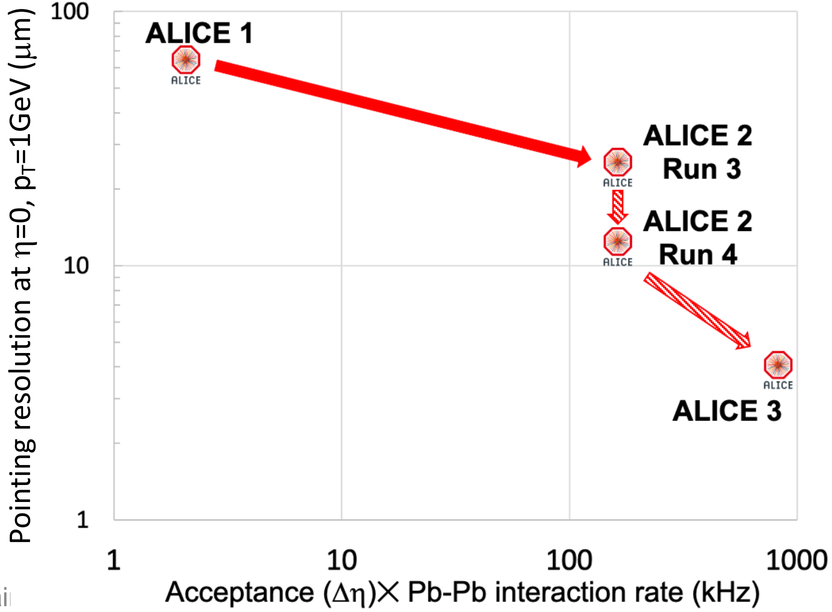
+ ITS3/FoCal

"ALICE 1" → **Major upgrade** → "ALICE 2" → **New detector** → "ALICE 3"

Enhance physics reach by improving:

- **rate capabilities & acceptance**
- **tracking precision**

→ high precision, reduce backgrounds, access rarer probes



Major (expected) open questions after the 2020s

- Nature of **interactions with the QGP** of highly energetic quarks and gluons
- To what extent do quarks of different mass reach **thermal equilibrium** ?
- What are the **mechanisms of hadron formation** in QCD?

→ Systematic measurement of (multi-)charm hadrons

- QGP **temperature** throughout its temporal evolution
- What are the mechanisms of **chiral symmetry restoration** in the QGP?

→ Precision measurements of dileptons

- QCD chiral phase structure → fluctuations of conserved charges
- Nature of exotic charm hadrons → charm hadron-hadron correlations
- ….

2010-2012		2015-2018		2022-2025		2029-2032		2035-2038		2040-2041
Run I	LS1	Run 2	LS2	Run 3	LS3	Run 4	LS4	Run 5	LS5	Run 6

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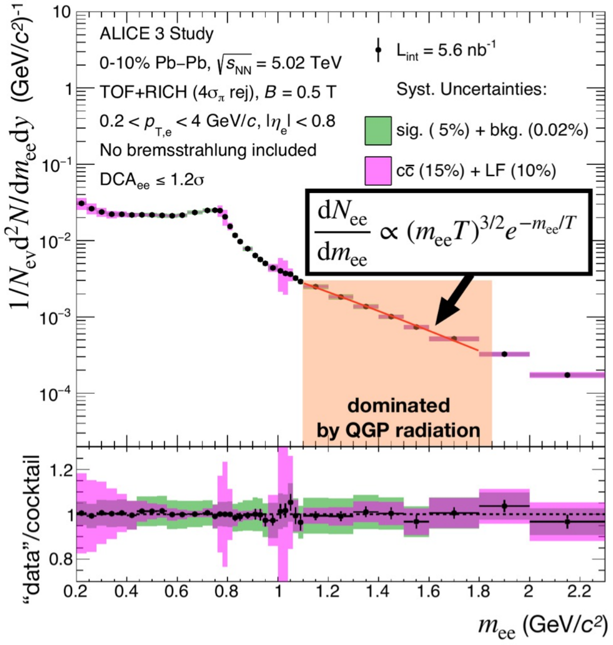
- ….

ALICE 3 physics performance

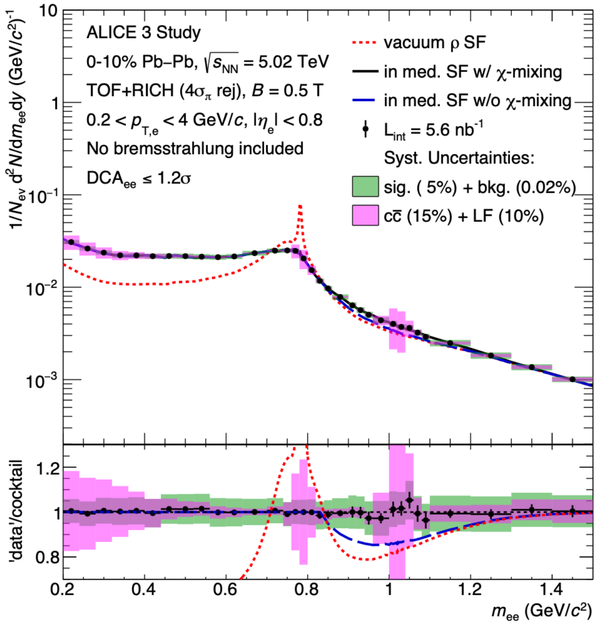
Thermal radiation

Projection for one month Pb—Pb with ALICE 3



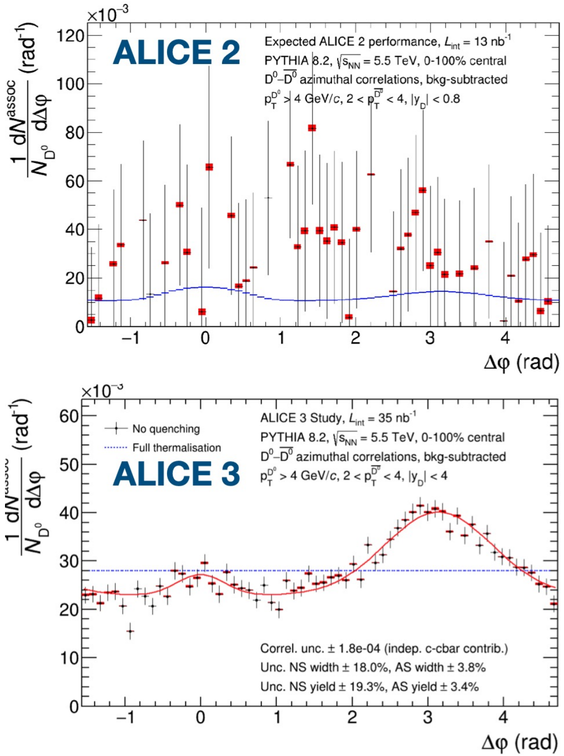
Chiral symmetry restoration: ρ/a_1 mixing

Projection for one month Pb—Pb with ALICE 3

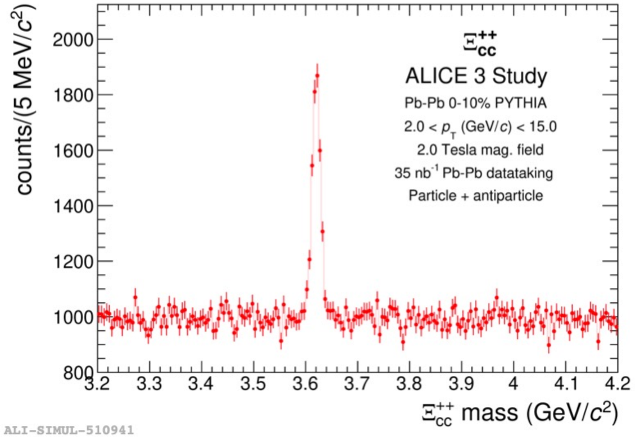


ALICE 3 physics performance

D-Dbar azimuthal corr.

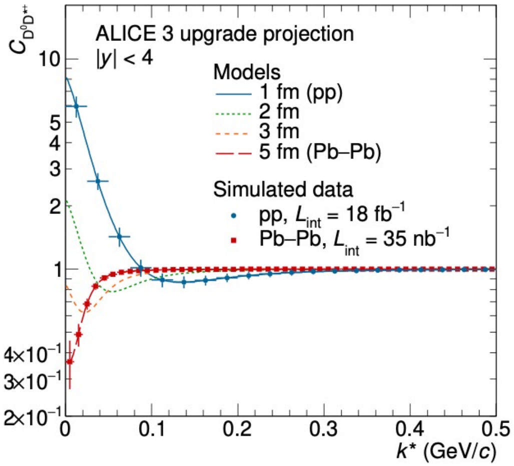


Multi-charm hadrons



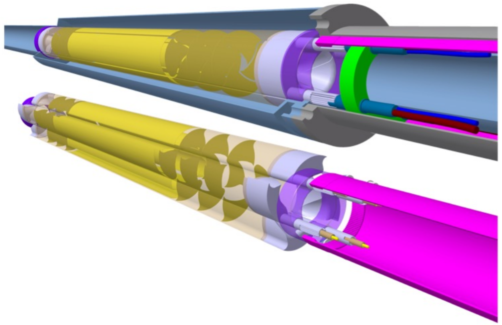
Unique experimental access to multicharm hadrons with ALICE 3 in Pb-Pb collisions

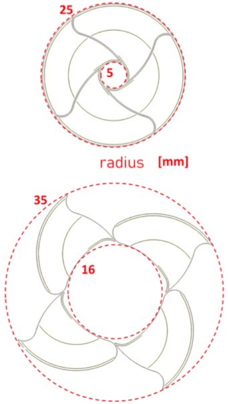
Exotic bound state



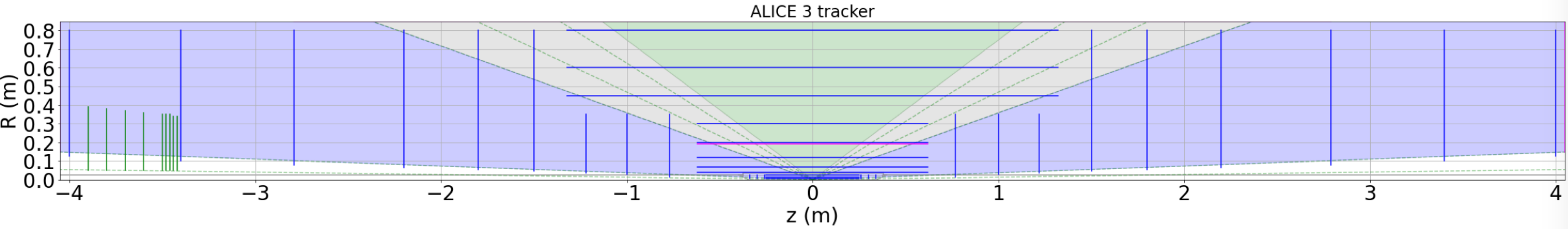
Search for possible DD bound states using momentum correlations

ALICE 3 tracker





Total silicon area ~ 60 m²



ALICE 3 timing layers

Particle identification with Time Of Flight

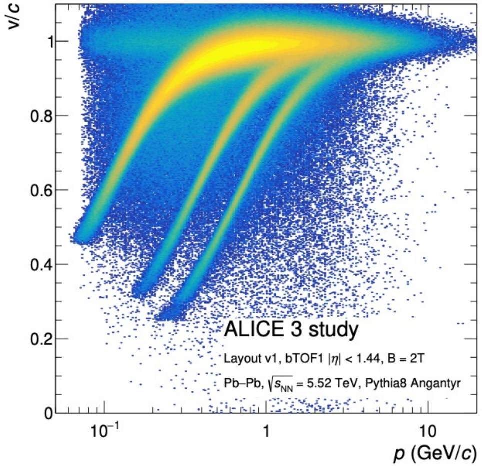
Separation power $\propto L/\sigma_{\mathrm{TOF}}$

Critical for this step:

- distance and time resolution crucial
- larger radius results in lower p_{T} bound

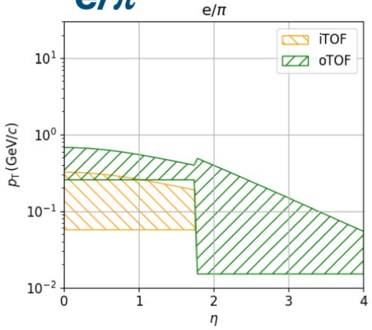
Concept:

- 2 barrel + 1 forward TOF layers
  - outer TOF at R ≈ 85 cm
  - inner TOF at R ≈ 19 cm
  - forward TOF at z ≈ 405 cm
- Silicon timing sensors ($\sigma_{\mathrm{TOF}} \approx 20$ ps)
  - R&D on monolithic CMOS sensors with integrated gain layer
- characterisation of SPADs/SiPMs
  - first tests in beam
- monolithic timing sensors
  - implement gain layer

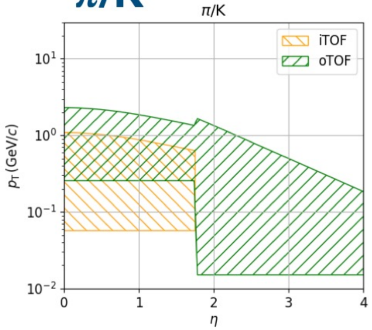


Total silicon area ~ 45 m²

e/π



π/K



ALICE 3 integration and run programme

Installation at LHC

Installation of ALICE 3 around nominal IP2

L3 magnet can remain, ALICE 3 to be installed inside

Cryostat of ~8 m length, free bore radius 1.5 m, magnetic field configuration to be optimized

Running scenario:

6 running years with 1 month / year with heavy-ions

- 35 nb^{-1} for Pb—Pb x 2.5 compared to Run 3 + 4
- Lighter species for higher luminosity under study

pp at s = 14 TeV:

- 3 fb^{-1} / year x 100 compared to Run 3 + 4