ALICE Status Report

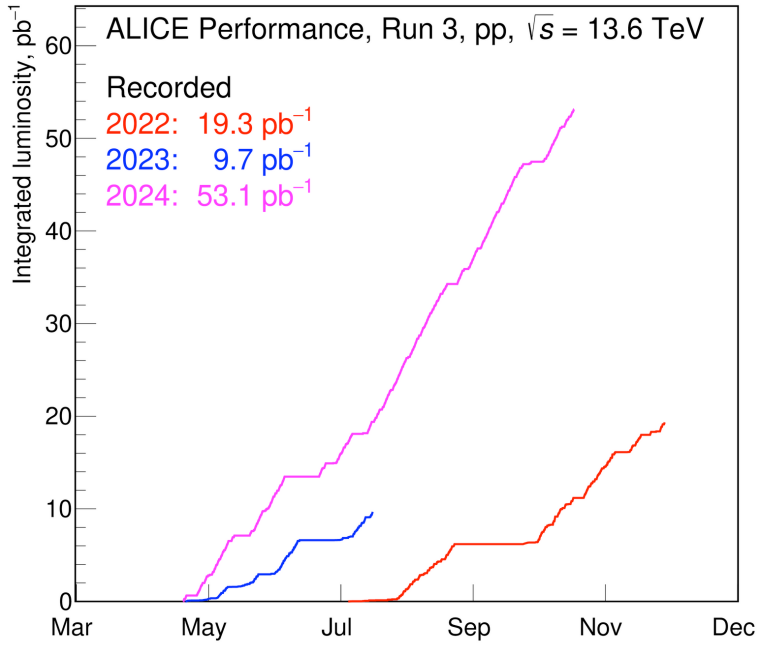
Andrea Ferrero
on behalf of the ALICE collaboration

LHCC Meeting – Open Session
November 18 2024

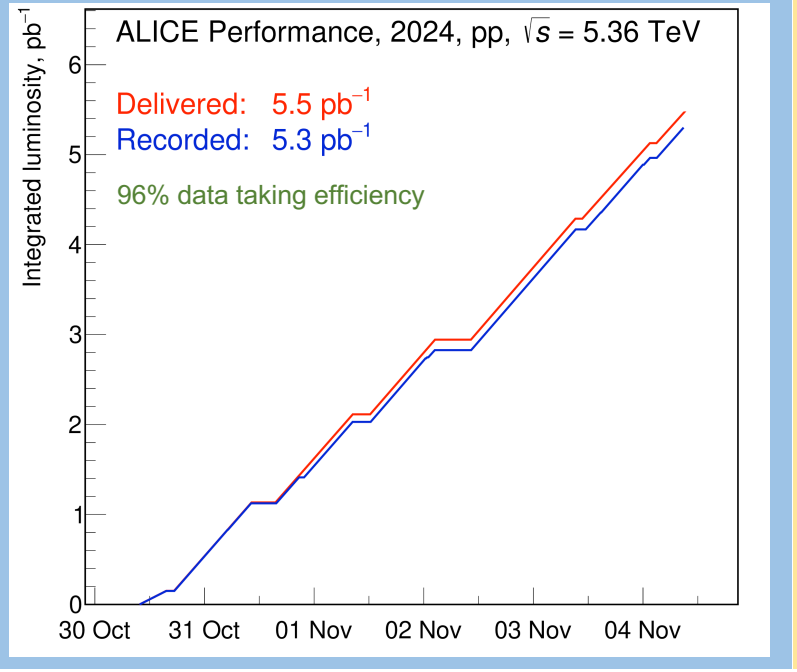
Status of 2024 data taking

- Very successful proton-proton data taking in 2024
- Luminosity targets reached both at top energy and at the reference energy for Pb-Pb

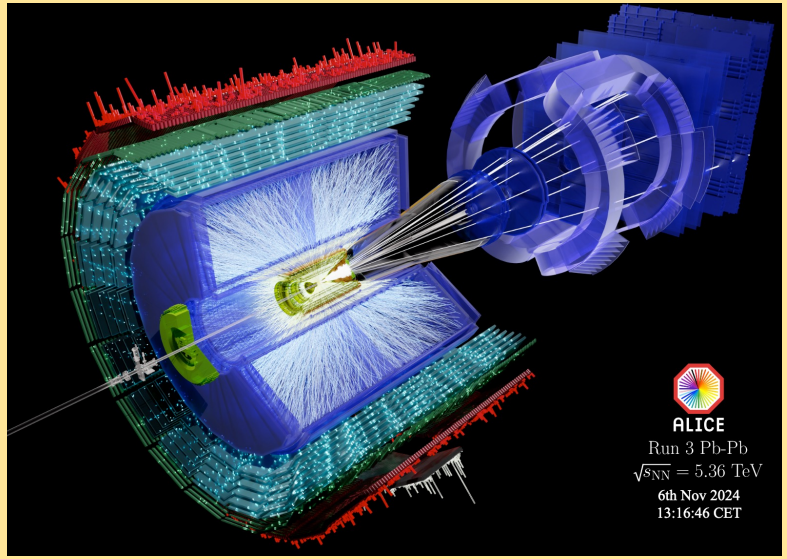
Proton run at 6.8 TeV
Completed on October 16th



Proton reference run at 2.68 TeV
Completed on November 4th



Pb-Pb run ONGOING!



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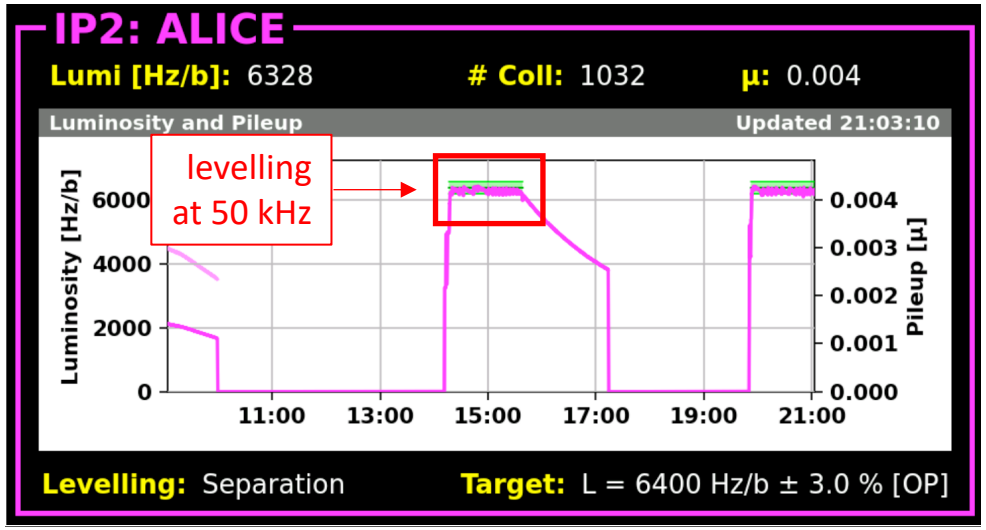
Status of 2024 Pb-Pb run

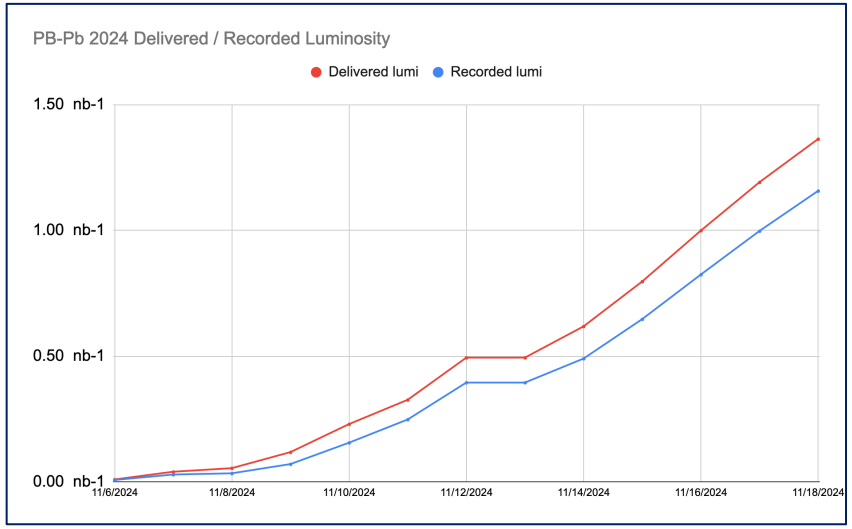
Collision rate and data processing:

- Levelling at 50 kHz for >1h at start of fill
- Stable processing with all detectors

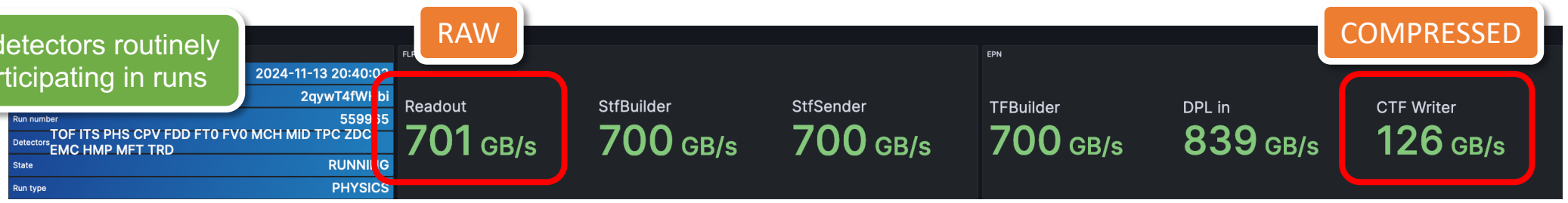


Delivered and recorded luminosity:

- >1.3 nb^{-1} delivered so far
- >85% data taking efficiency



All detectors routinely participating in runs



New Papers

Papers submitted since last LHCC

1. Measurement of $f_1(1285)$ production in pp collisions at $\sqrt{s}$ = 13 TeV, arXiv:2409.11936
2. First measurement of $D_{s1}(1^+)(2536)^+$ and $D^*_{s2}(2^+)(2573)^+$ production in proton-proton collisions at $\sqrt{s}$ = 13 TeV at the LHC, arXiv:2409.11938
3. Investigating charm quark energy loss in medium with the nuclear modification factor of D^0-tagged jets, arXiv:2409.11939
4. Coherent J/Ψ photoproduction at midrapidity in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV, arXiv:2409.11940
5. Addendum: Dielectron production in proton-proton and proton-lead collisions at $\sqrt{s_{NN}}$ = 5.02 TeV, arXiv:2409.12025
6. Exposing the parton-hadron transition within jets with energy-energy correlators in pp collisions at $\sqrt{s}$ = 5.02 TeV, arXiv:2409.12687
7. Measurement of the inclusive isolated-photon production cross section in pp and Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV, arXiv:2409.12641
8. First observation of strange baryon enhancement with effective energy in pp collisions at the LHC, arXiv:2409.12702
9. Search for quasi-particle scattering in the quark-gluon plasma with jet splittings in pp and Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV, arXiv:2409.12837
10. Multimuons in cosmic-ray events as seen in ALICE at the LHC, arXiv:2410.17771
11. First measurement of A = 4 (anti)hypernuclei at the LHC, arXiv:2410.17769
12. Medium-induced modification of groomed and ungroomed jet mass and angularities in Pb-Pb collisions at 5.02 TeV, arXiv:2411.03106
13. Proton emission in ultraperipheral Pb-Pb collisions at $\sqrt{s}$ = 5.02 TeV, arXiv:2411.07058
14. Measurements of differential two-particle number and transverse momentum correlation functions in pp collisions at $\sqrt{s}$ = 13 TeV, arXiv:2411.07059
15. Observation of partonic flow in proton-proton and proton-nucleus collisions, arXiv:2411.09323
16. System size and energy dependence of the mean transverse momentum fluctuations at the LHC, arXiv:2411.09334
17. Measurement of ω meson production in pp collisions at $\sqrt{s}$ = 13 TeV, arXiv:2411.09432
18. Light neutral-meson production in pp collisions at $\sqrt{s}$ = 13 TeV, arXiv:2411.09560x
19. Studying charm hadronisation into baryons with azimuthal correlations of Λ_c^+ with charged particles in pp collisions at $\sqrt{s}$ = 13 TeV, arXiv:2411.10104

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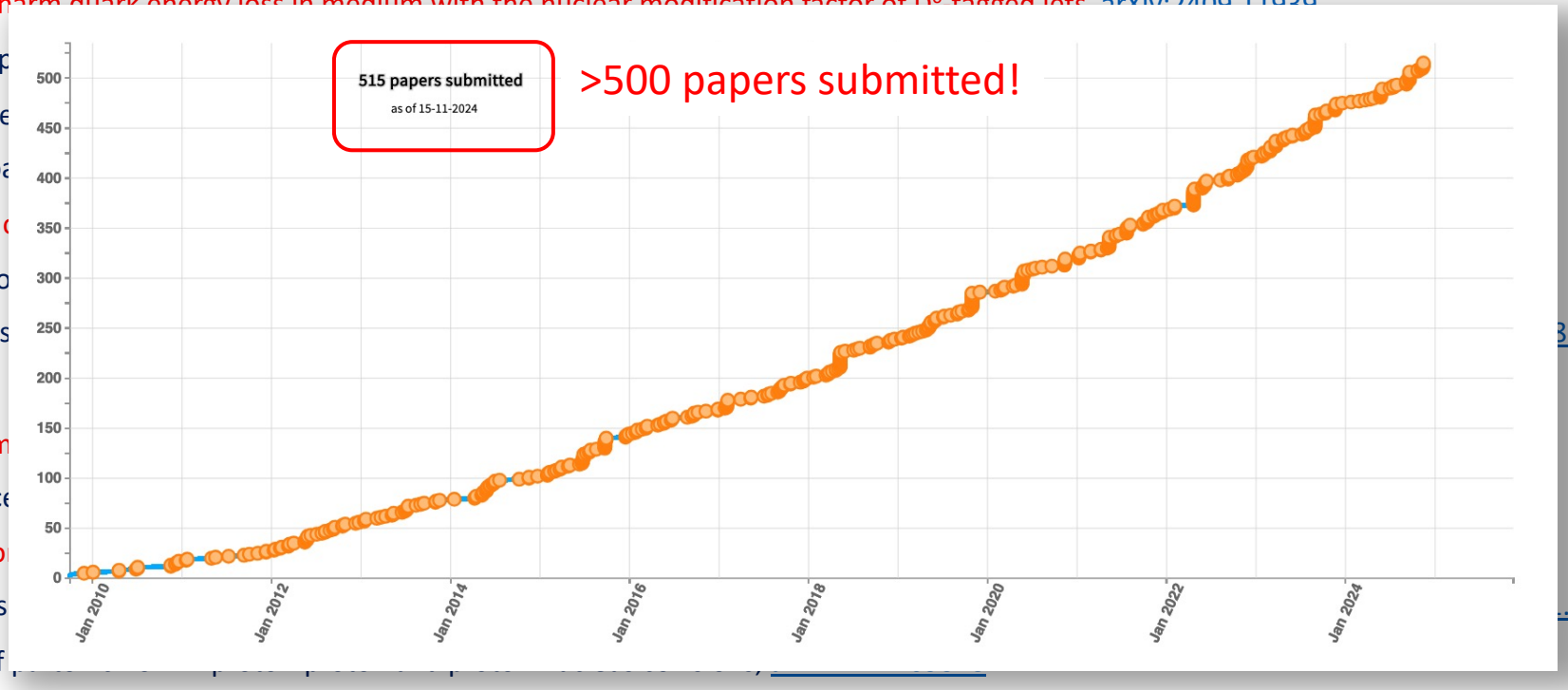
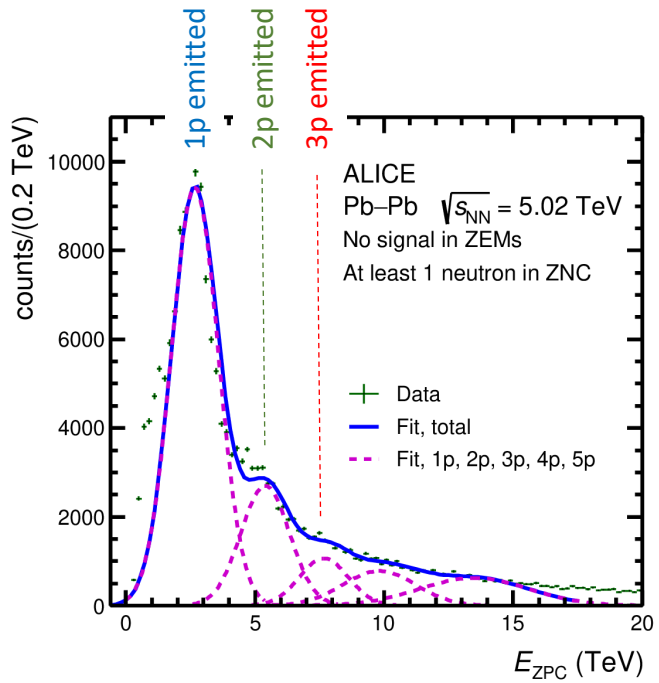


Proton emission in Pb-Pb UPC

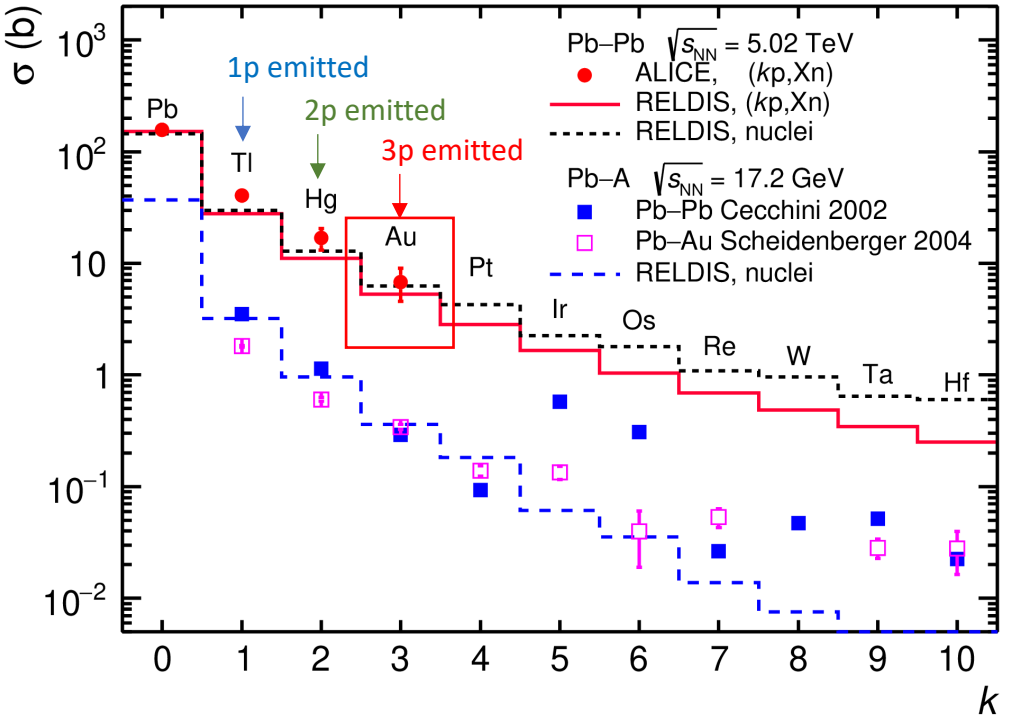
First measurement of proton emission cross-sections in UPC of ^{208}Pb nuclei

Production of Pb, Ti, Hg and Au isotopes determined from 0p, 1p, 2p, 3p emission cross-sections

We estimate that about 1.6×10^{-11} g of gold isotopes were produced at the LHC in the four experiments during Runs 1 and 2.



ALI-PUB-587894



ALI-PUB-587906

arXiv:2411.07058

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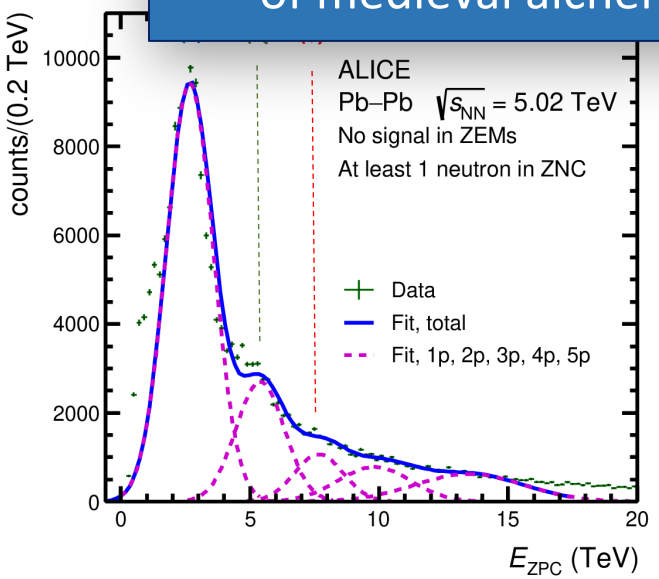
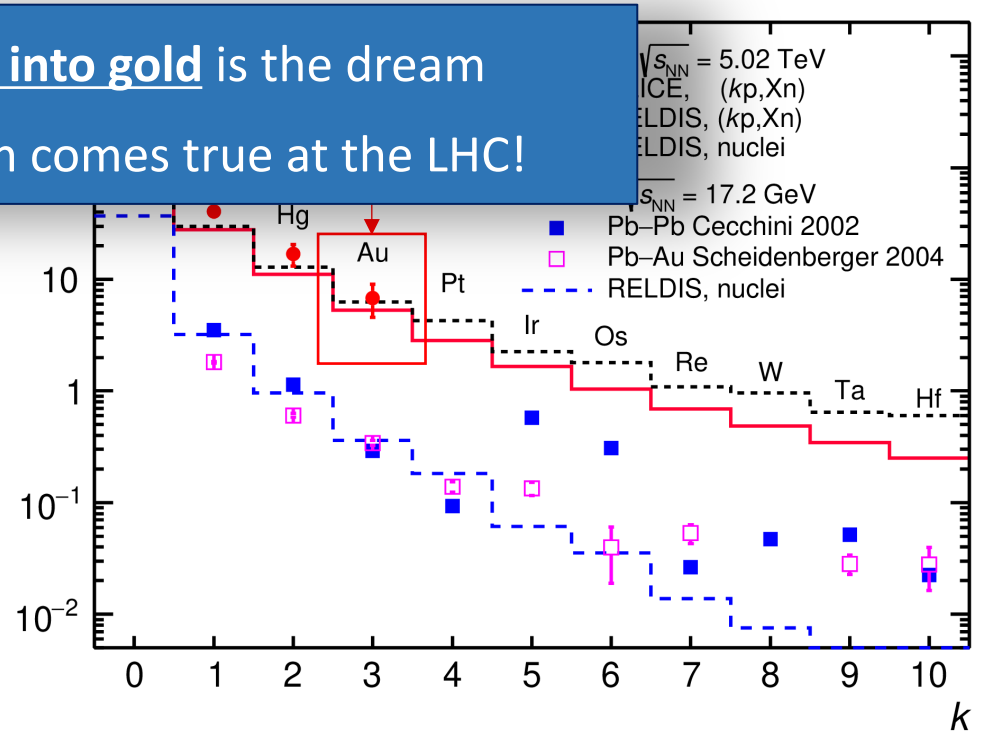
The **transmutation of lead into gold** is the dream of medieval alchemists which comes true at the LHC!



ALI-PUB-587894

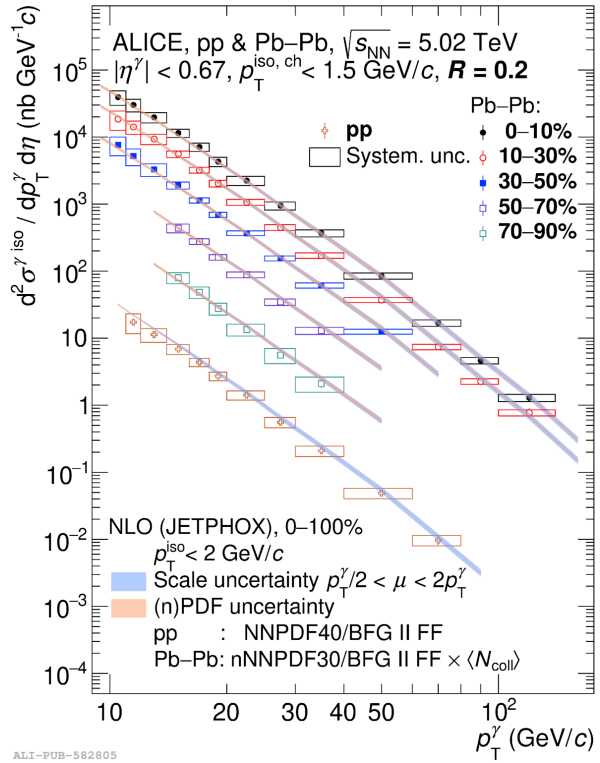


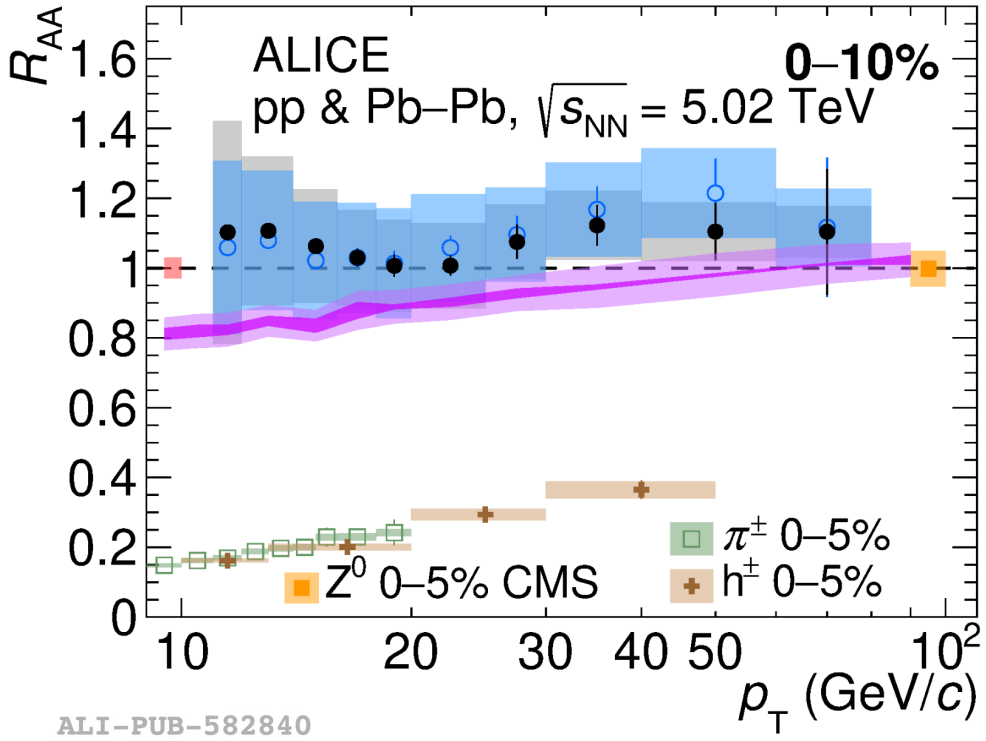
ALI-PUB-587906

arXiv:2411.07058

Isolated-photon production

- Cross-section measured over a wide p_T range ($10 < p_T < 140$ GeV/c in 0-30% centrality range)
- R_{AA} consistent with unity as expected
  - No modification of the prompt γ yield in the QGP
  - Agreement within uncertainties with NLO predictions and with PYTHIA in peripheral collisions

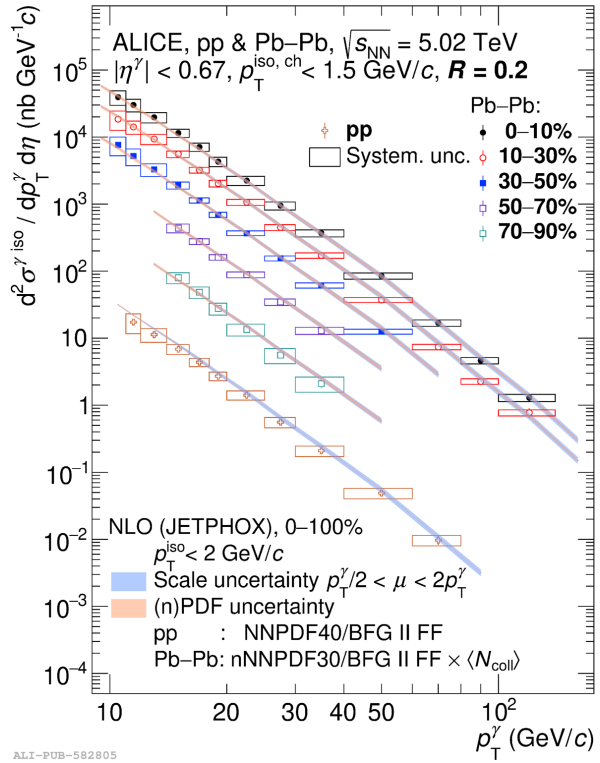


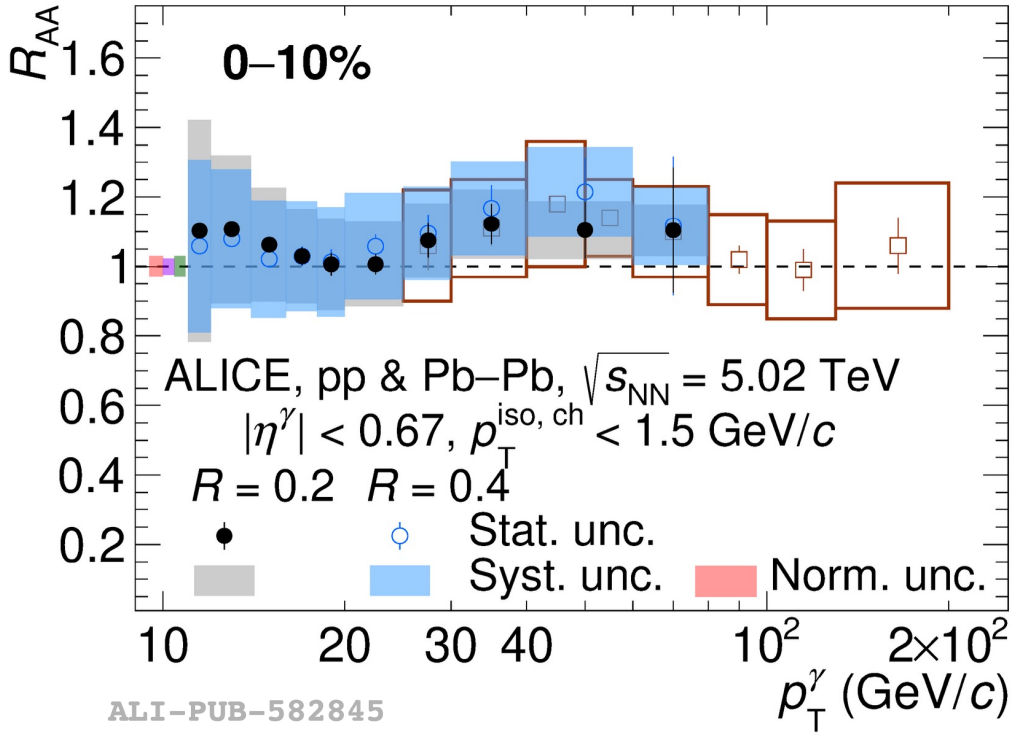


arXiv:2409.12641

Isolated-photon production

- Cross-section measured over a wide p_T range ($10 < p_T < 140$ GeV/c in 0-30% centrality range)
- R_{AA} consistent with unity as expected
  - No modification of the prompt γ yield in the QGP
  - Agreement with CMS results in the overlapping p_T region



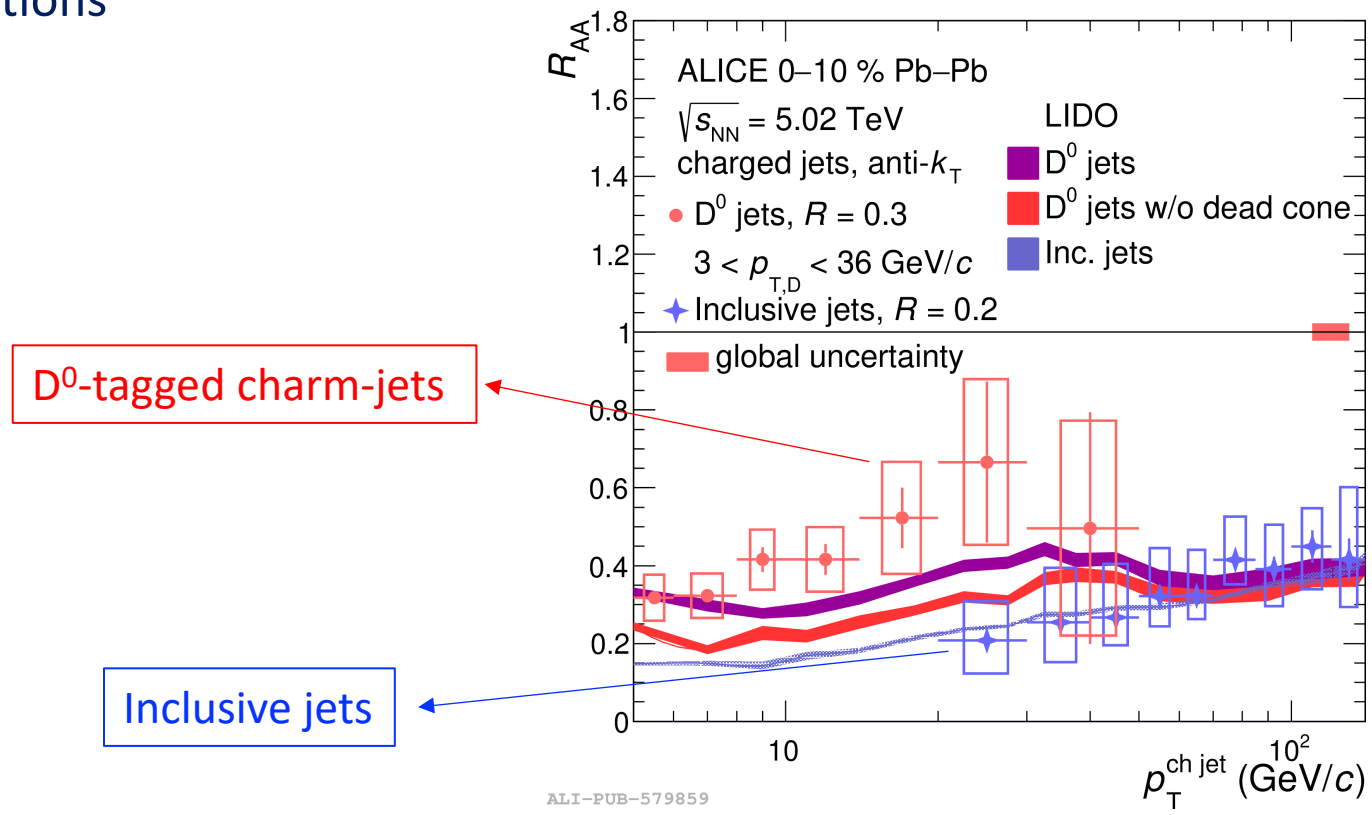


arXiv:2409.12641

Energy loss in medium with charm jets

First measurement at LHC of R_{AA} for charm-jets tagged with D^0 mesons

- Lower suppression compared to light-quark and gluon jets
- Quark mass and gluon colour charge effects qualitatively described by LIDO predictions



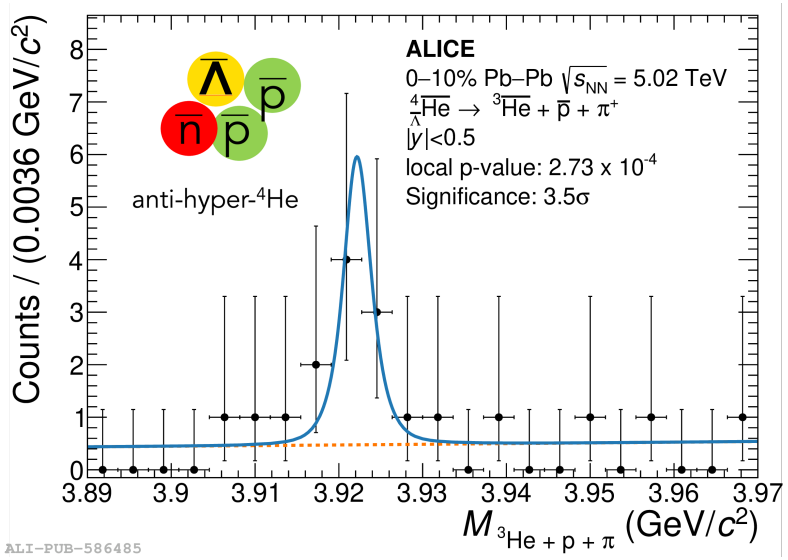
arXiv:2409.11939

A=4 (anti)hypernuclei

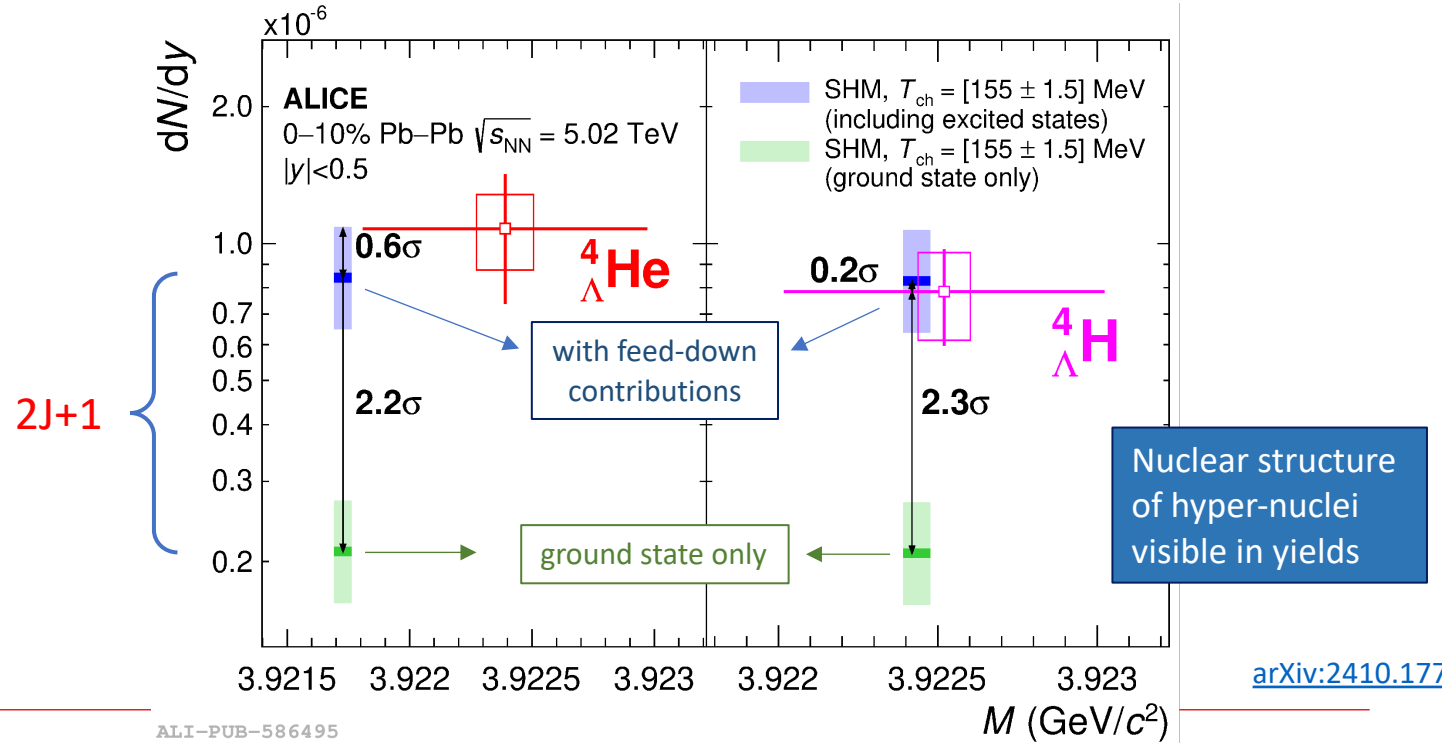
First measurement at the LHC of A=4 (anti)hypernuclei => (anti)$^{4}_{\Lambda}\mathrm{H}$ and (anti)$^{4}_{\Lambda}\mathrm{He}$

- First evidence of $^{4}_{\Lambda}\overline{\mathrm{He}}$ antihypernucleus
- Integrated yields hint at presence of feed-down contributions from excited states

$^{4}_{\Lambda}\overline{He}$ observed with 3.5σ significance



Comparison with SHM predictions at T_{ch} = 155 MeV



arXiv:2410.17769

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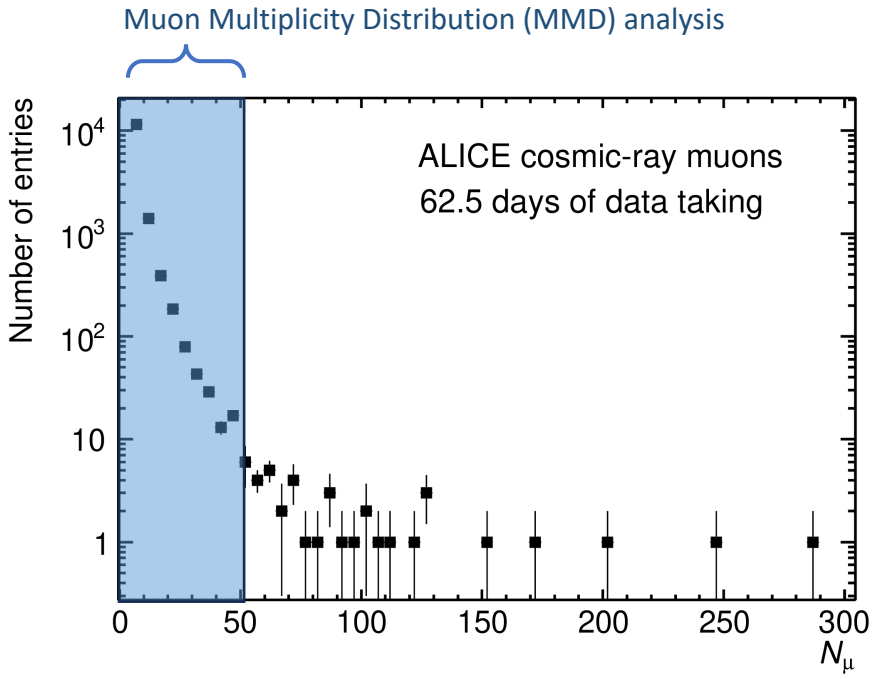
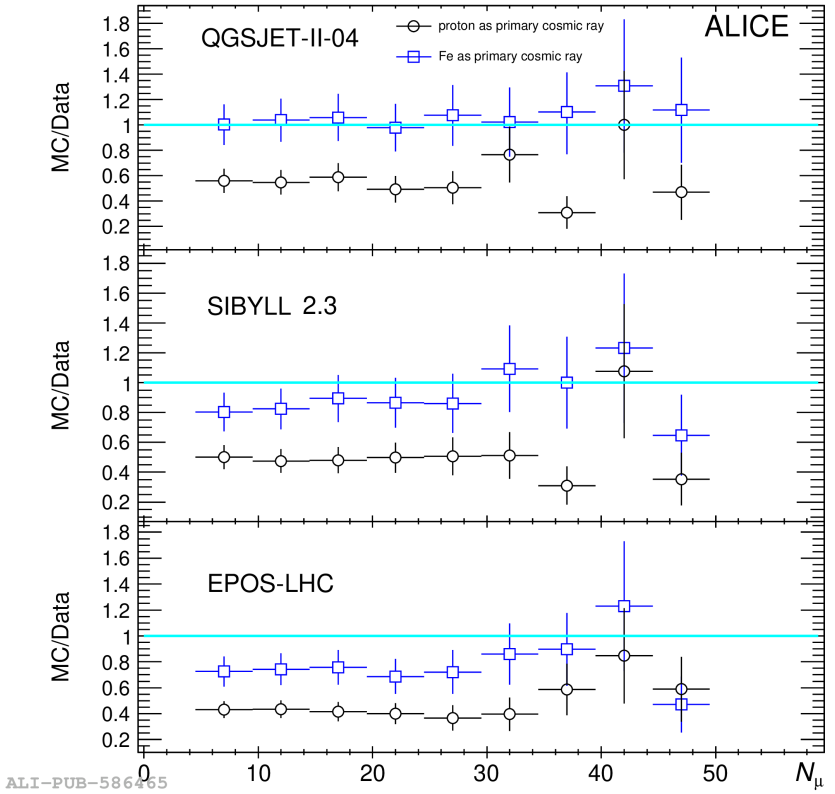
Multimuon events from cosmic rays

- 65.2 days of data collected by ALICE between 2015 and 2018 during pauses of the LHC
- Comparison with model predictions assuming protons and Fe nuclei as primary cosmic rays
- Heavier cosmic rays favoured by the ALICE data





MC/Data ratio for $4 < N_\mu < 50$

- QGSJET with primary Fe rays yields ratio ~1
- Other models are below data at low muon multiplicities
- Lighter to heavier primary rays composition with increasing energy not described by models

arXiv:2410.17771

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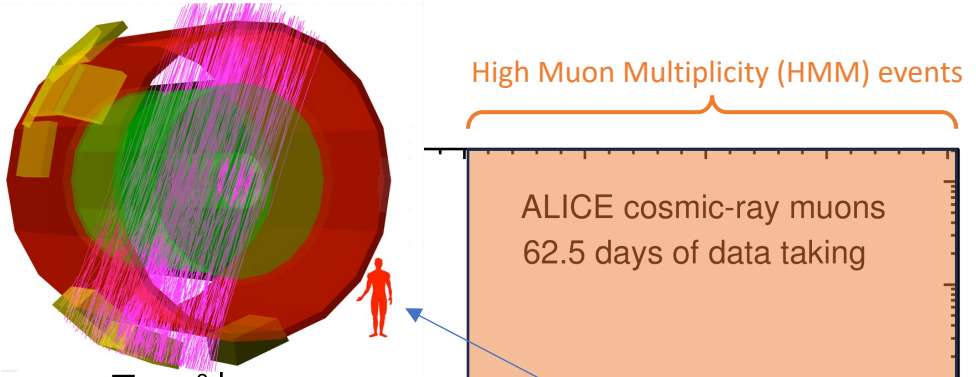
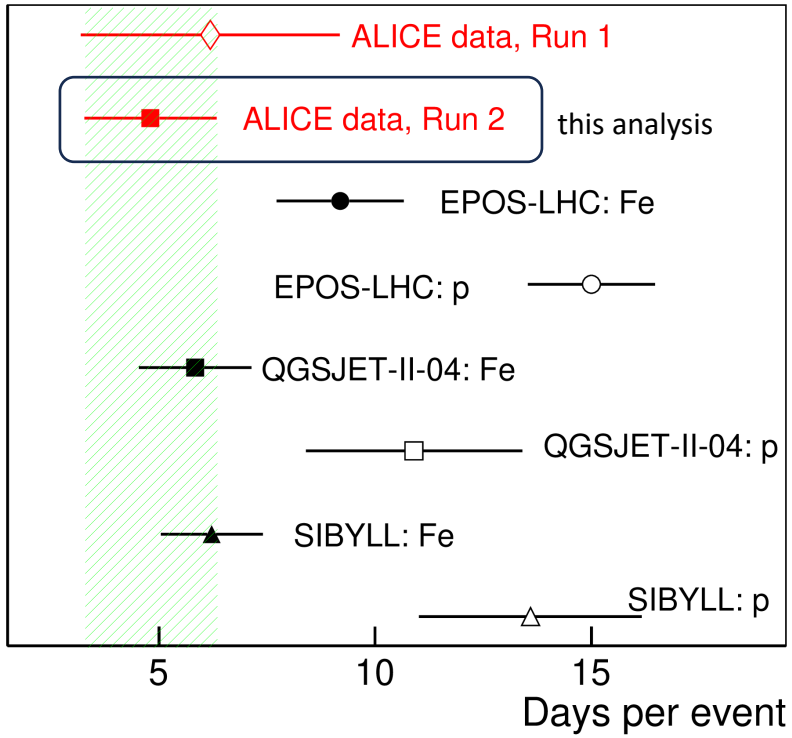




Rate of HMM events ($N_\mu > 100$)

- Average primary energy ~10^{17} eV
- Heavier primary rays seem to be favoured as well by the data

arXiv:2410.17771

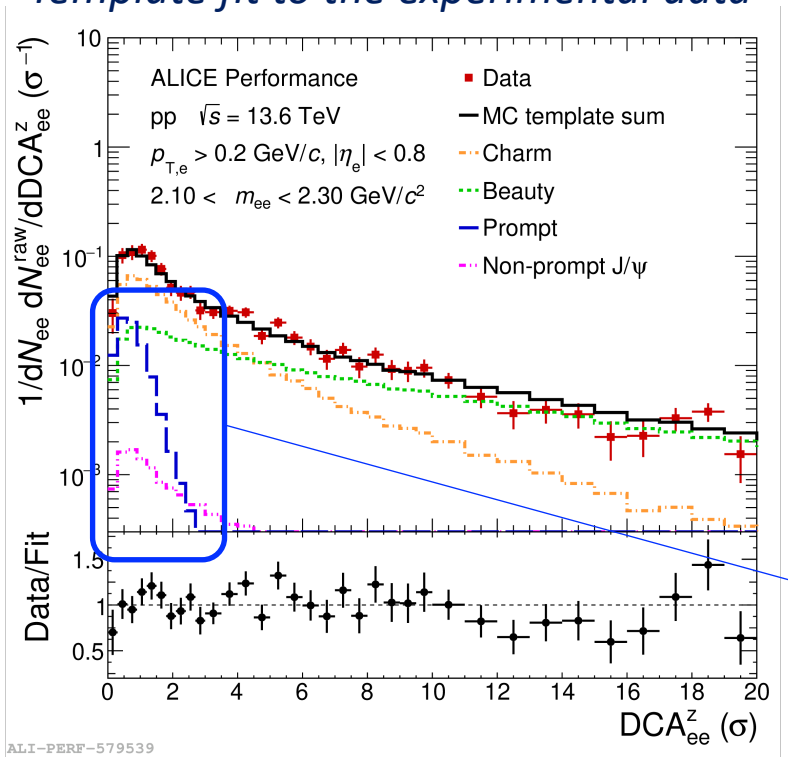
Preliminary Run 3 Results

Di-electron reconstruction performance in Run 3

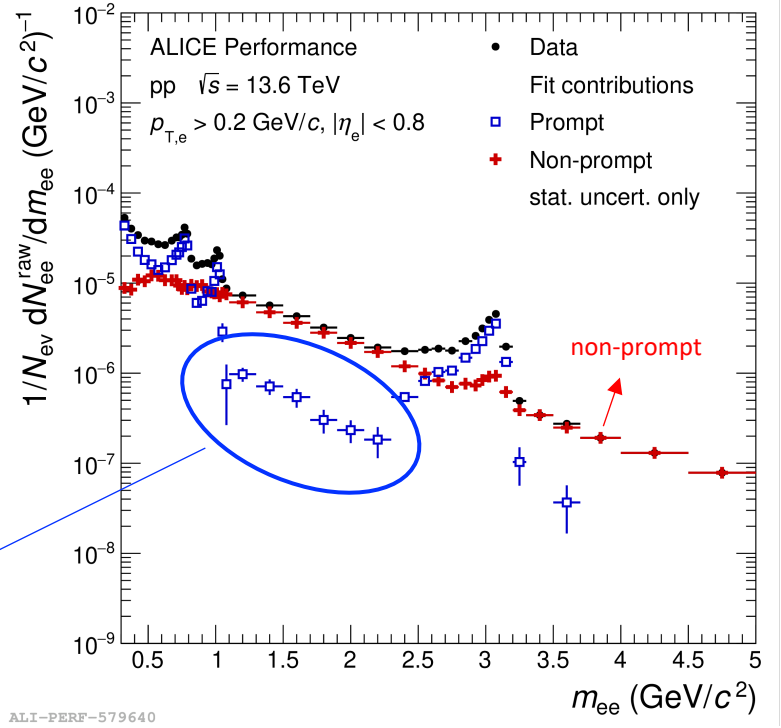
- Substantially larger data sample and better pointing resolution thanks to upgraded ITS
- Improved Distance of Closest Approach (DCA) determination
  - Allows separation of prompt (e.g. thermal) and non-prompt (HF background)

Run 3 Performance

Template fit to the experimental data



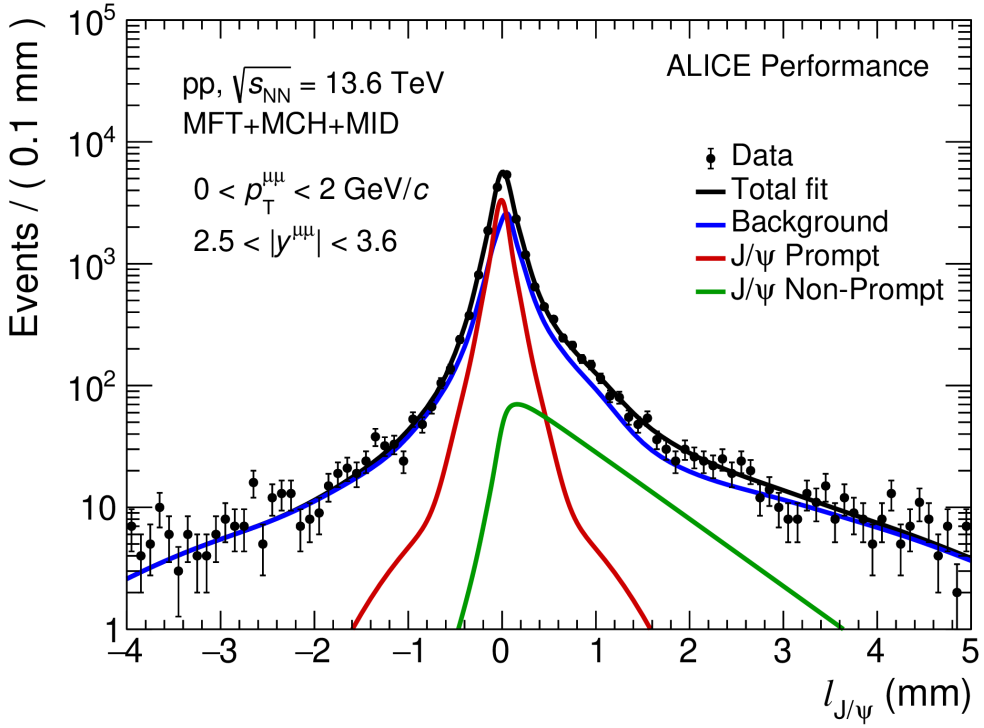
prompt



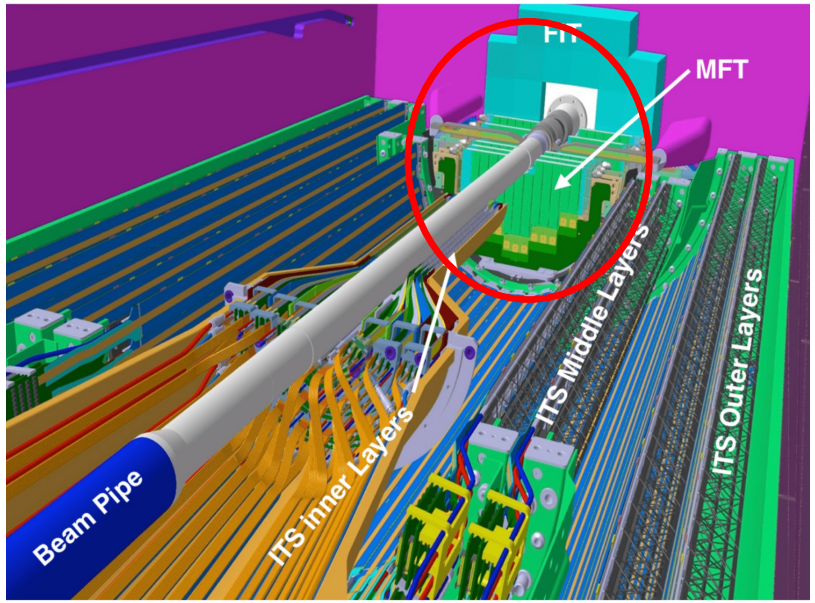
Di-muon reconstruction performance in Run 3

- Improved reconstruction of displaced vertices thanks to the new MFT detector
- Allows separation of prompt and non-prompt J/Ψ in the forward region

Run 3 Performance

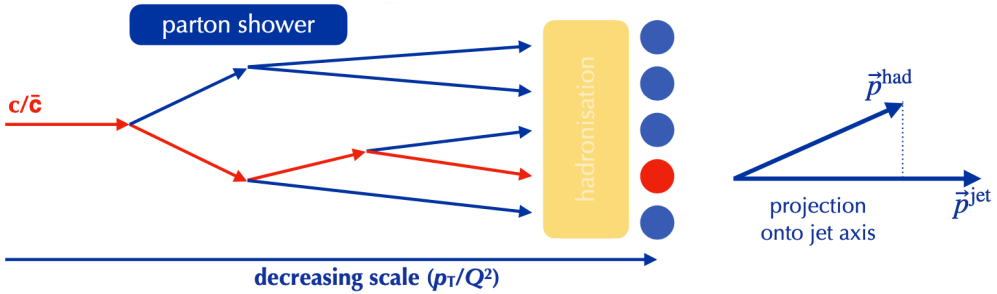


Muon Forward Tracker (**MFT**)

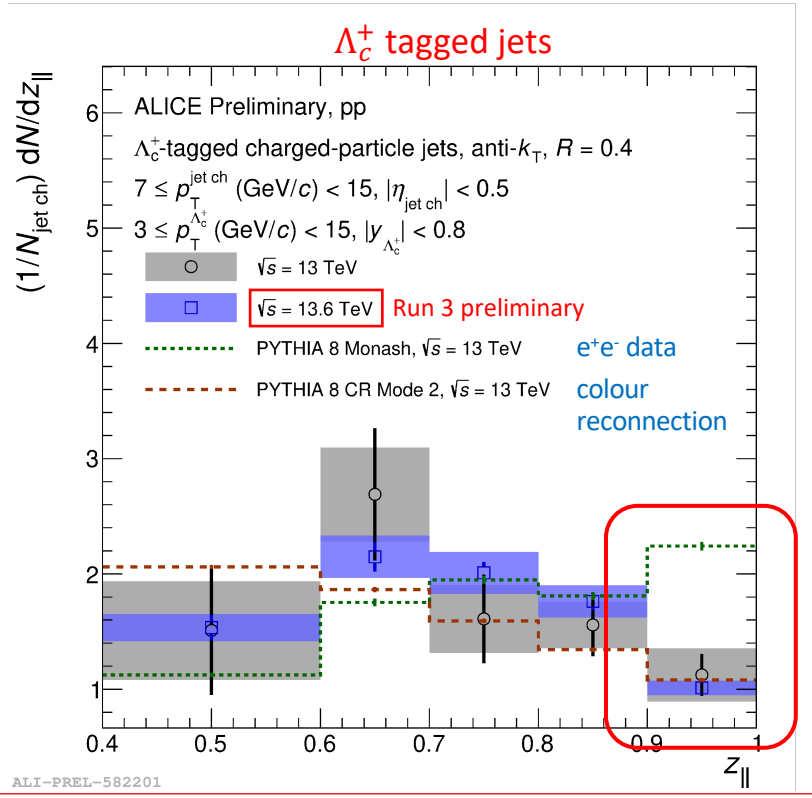


Probing the charm quark fragmentation

- Charm-tagged jet-fragmentation studies with pp collisions
  - Distribution of longitudinal jet momentum fraction carried by Λ_c^+ baryons and D^0 mesons
  - Λ_c^+ hadronization probing the universality of the fragmentation description
- Significant gain in precision for Λ_c^+ tagging with Run 3 data



$$z_{\parallel} = \frac{\vec{p}^{\,\mathrm{jet}} \cdot \vec{p}^{\,\mathrm{had}}}{\vec{p}^{\,\mathrm{jet}} \cdot \vec{p}^{\,\mathrm{jet}}}$$



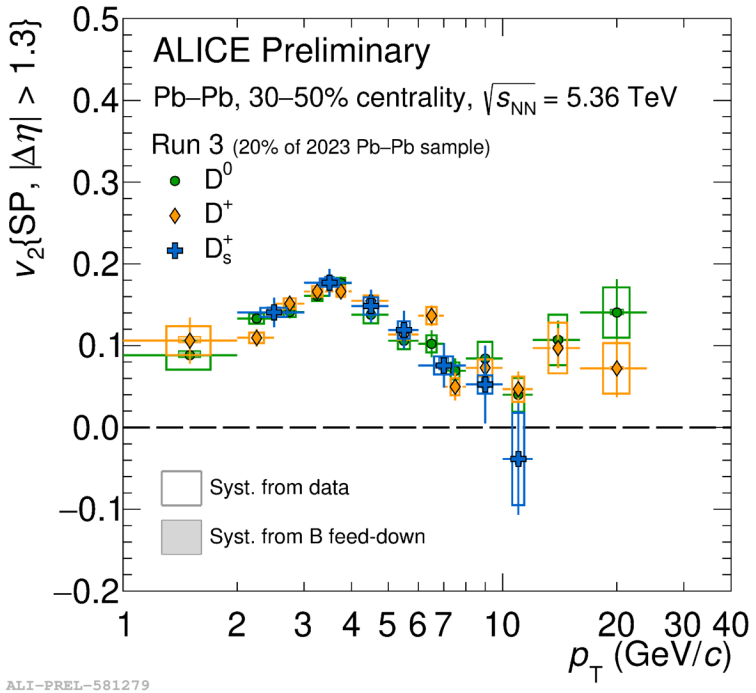
Run 3 Preliminary

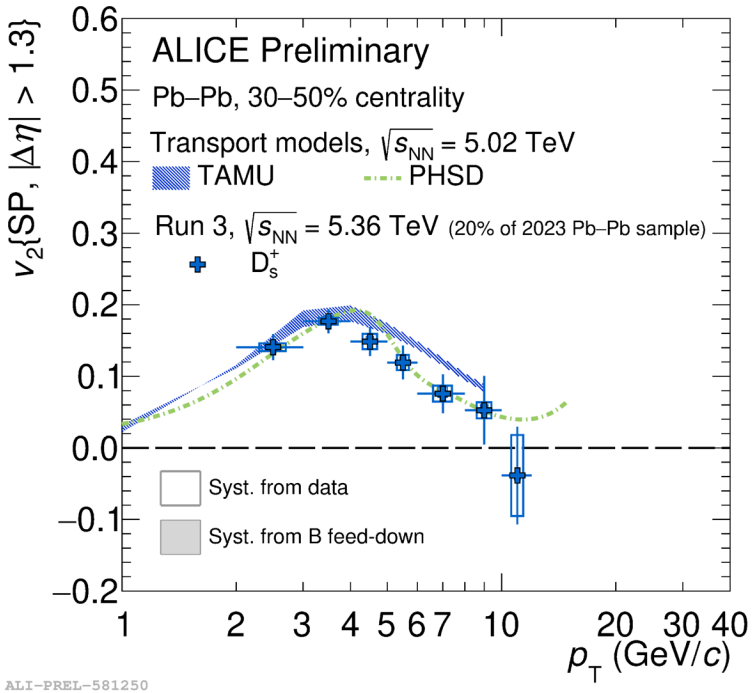
PYTHIA with colour reconnection favoured wrt tuning from e⁺e⁻ data

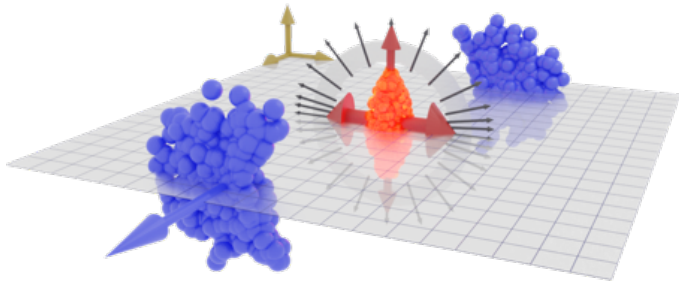
Strange and non-strange D-mesons elliptic flow

- Prompt D-meson elliptic flow v_2 measured with Run 3 Pb-Pb data sample
- No significant difference between D and D_s
- Strange D-meson v_2 also reproduced by transport models

Run 3 Preliminary

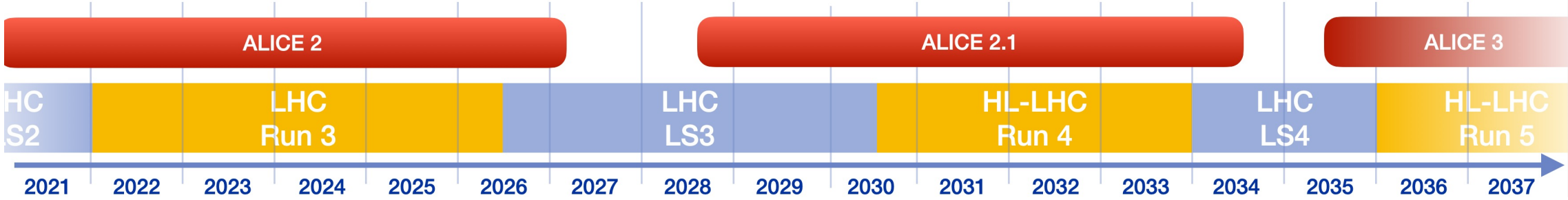






Future Upgrades

Timeline of future upgrade projects

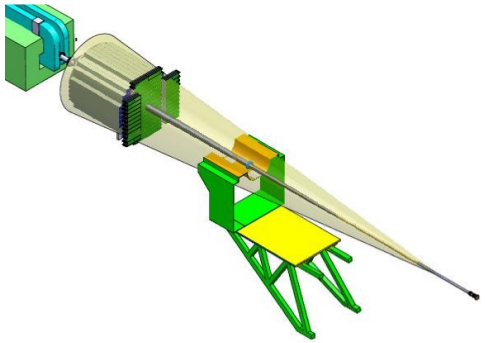


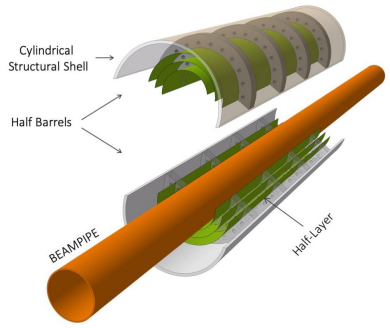
LS3: FoCal & ITS3

- Specific upgrades for Run 4
- TDRs approved this year
- Now proceeding towards final design in view of start of production next year

FoCal TDR: CERN-LHCC-2024-004

ITS3 TDR: CERN-LHCC-2024-003

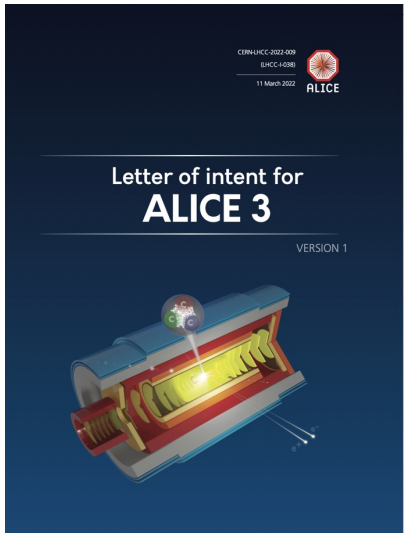




LS4: ALICE3

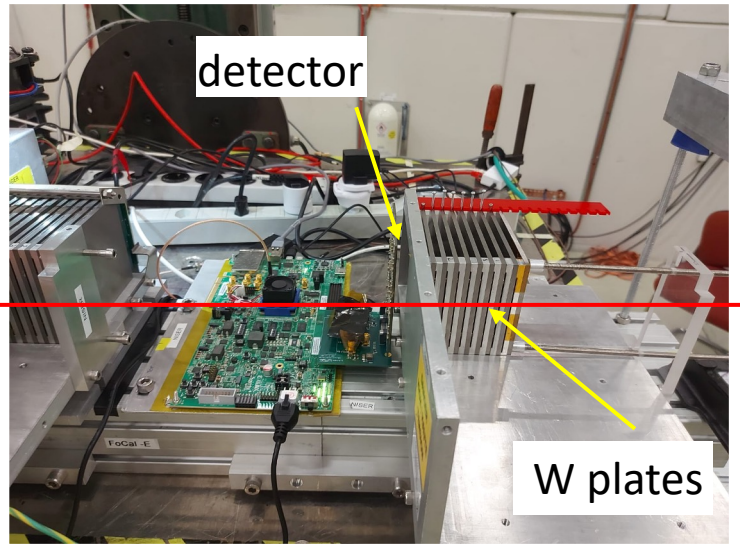
- New detector for Runs 5 and 6
- Scoping document submitted to LHCC

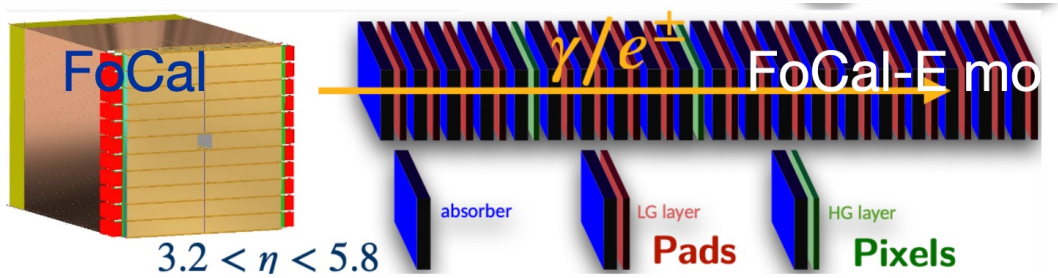
CERN-LHCC-2022-009



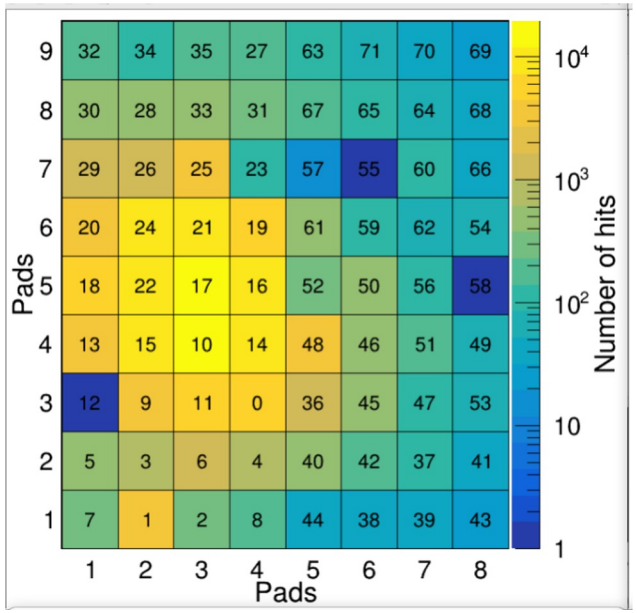
5th ALICE Upgrade Week
Kraków, 7-11 October

FoCal recent highlights

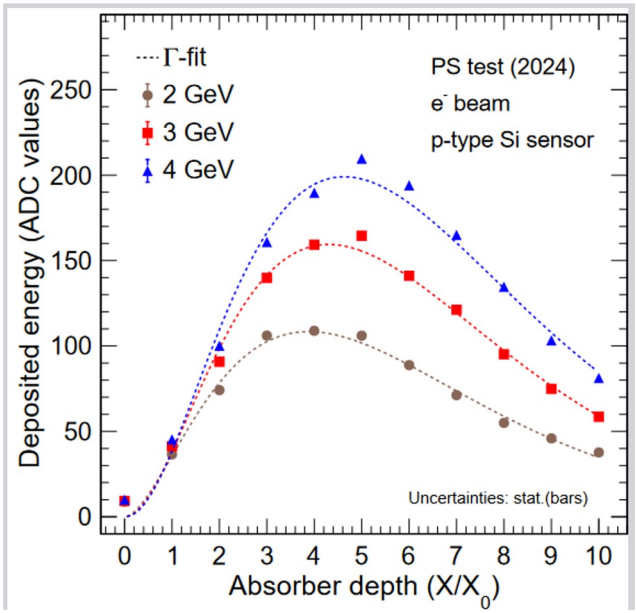




Hitmap: 3 GeV e⁻ Shower in P-type Si pad array with 3 W plates in front



Electron energy loss in detector vs. radiation lengths (no. w plates in front)

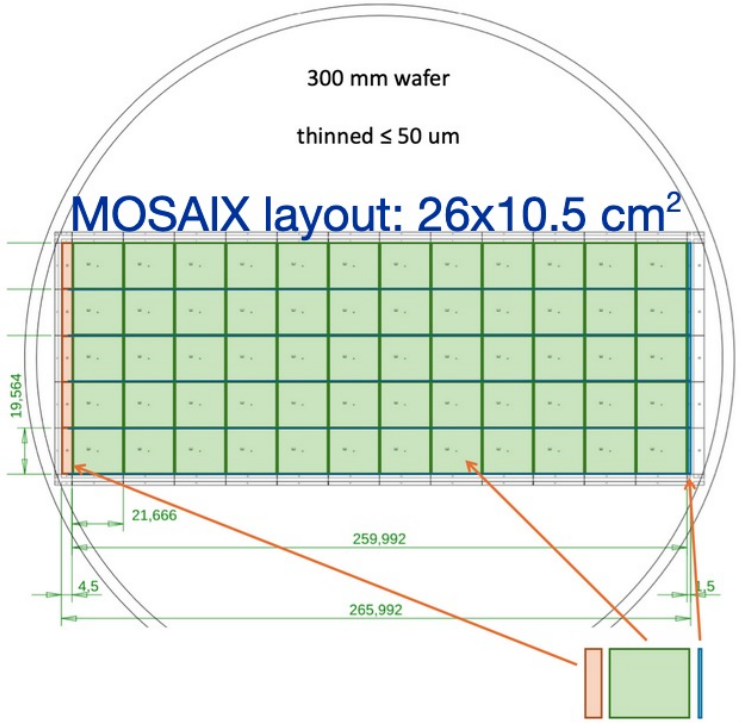


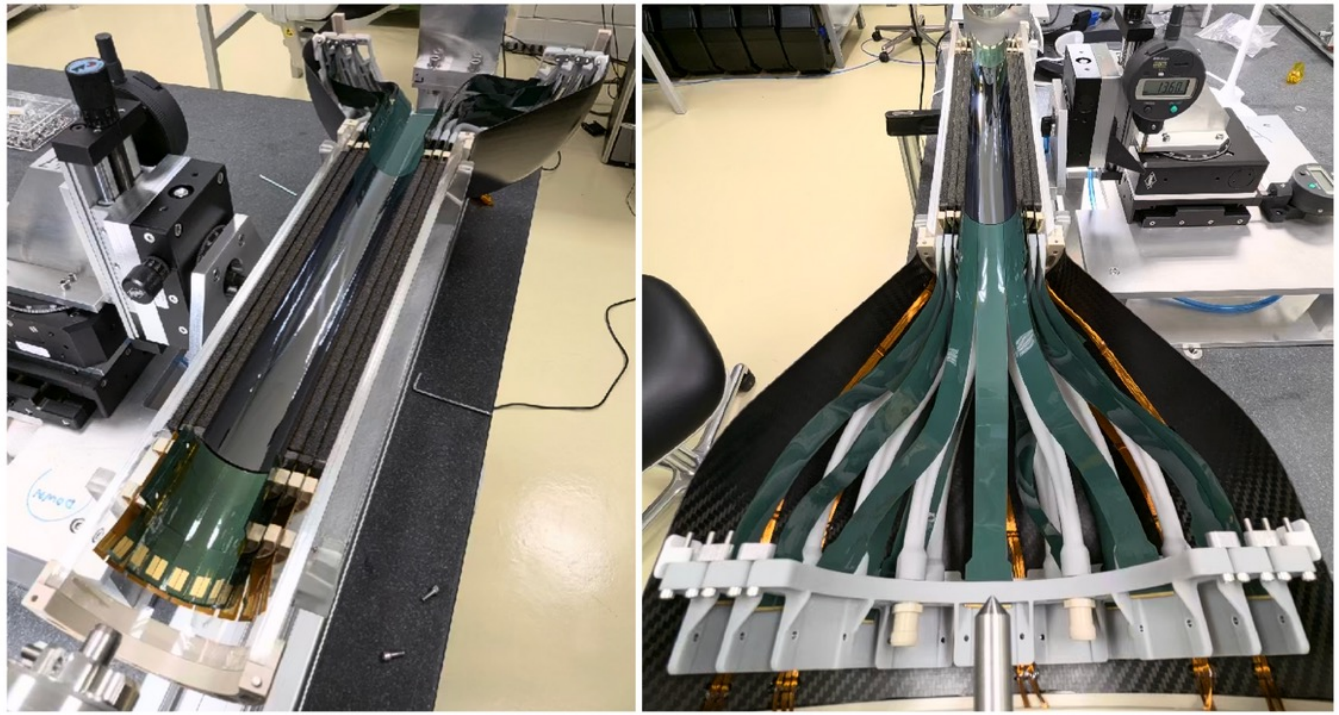
- PRR for Si Pad sensors took place on 8 November
- Sensors from second and third supplier tested in beam

ITS3 recent highlights

ITS3 Engineering Model 3

- All three layers, with dummy sensors
- Mechanical support structure (carbon foam longerons and spacers)
- FPCs integrated on both sides





Preparation of Engineering Run 2, for final sensor (MOSAIX)

- MOSAIX ASIC = 12 Repeated Sensor Units and 2 “service” regions
- Final verification starting
- Test system being set up

ALICE 3 detector for Runs 5-6

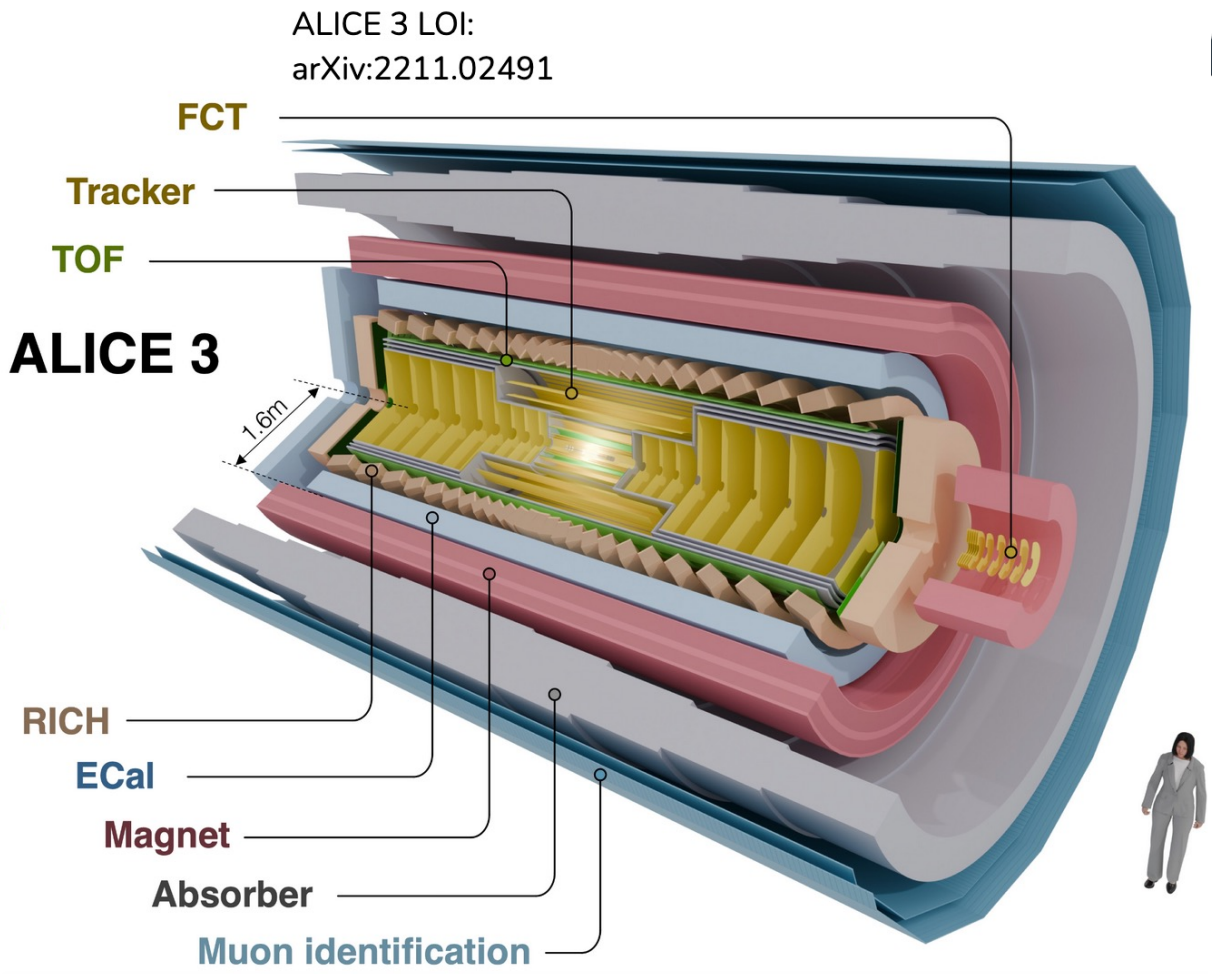
➠ **Novel detector concept**

- Compact and lightweight all-silicon tracker
- Retractable vertex detector with R_{min} = 5 mm
- Extensive particle identification
- Large acceptance $|\eta|<4$
- Superconducting solenoid, B=2T
- Continuous read-out and online processing

➠ **Sensor R&D ongoing**

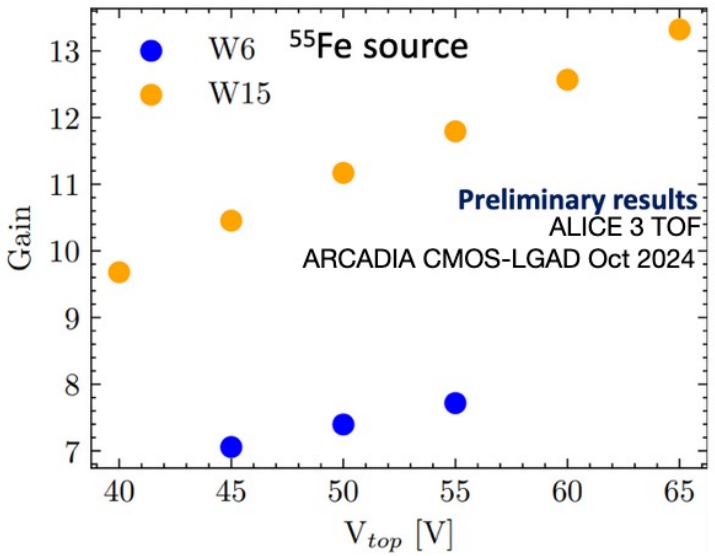
- Test-beams for MID, RICH, TOF a few weeks ago

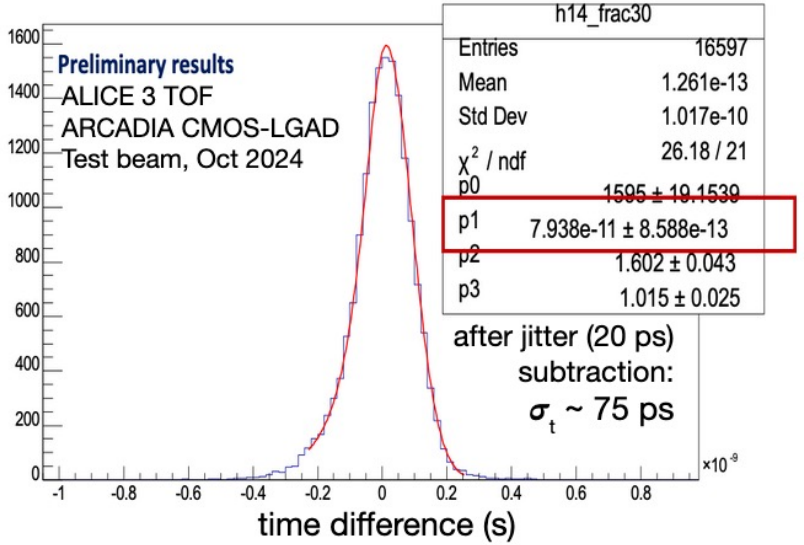
➠ **Scoping Document under review by LHCC referees**

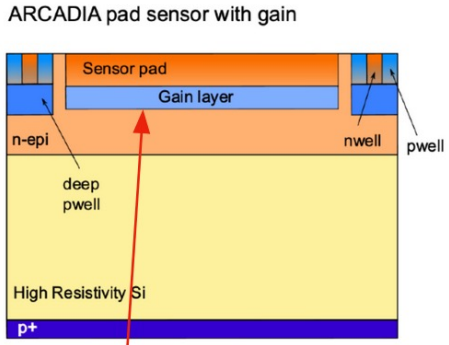


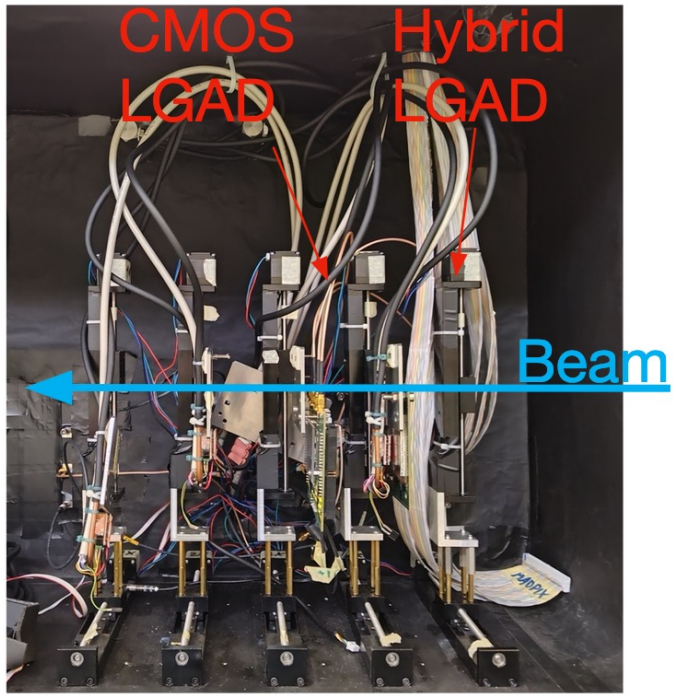
R&D for Time Of Flight

- TOF time resolution specification: **20 ps**
- **First prototype of Monolithic LGAD sensor tested at CERN PS**
  - 50 µm thick, improved gain (~13)
- Time resolution ~75 ps, consistent with current sensor thickness
- Good prospects to reach close to spec with 25 and 15 µm versions





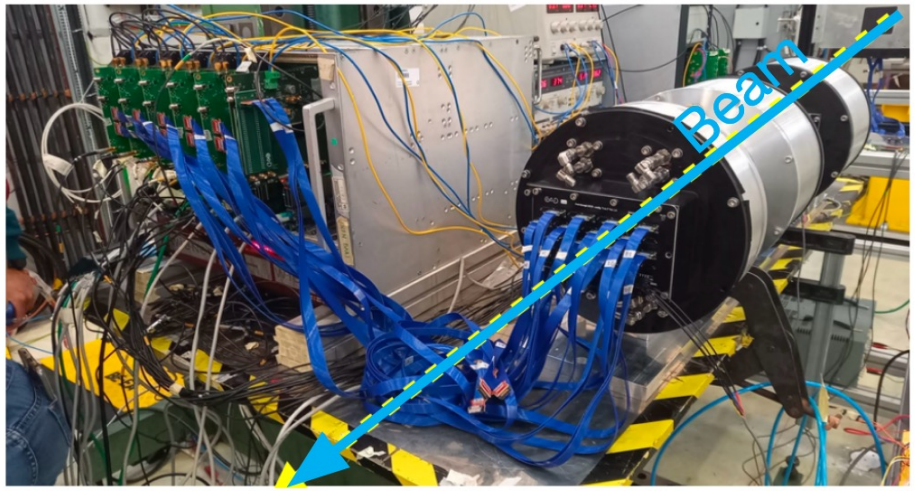


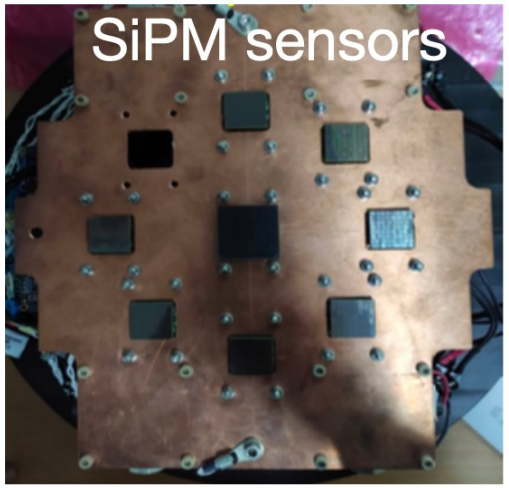


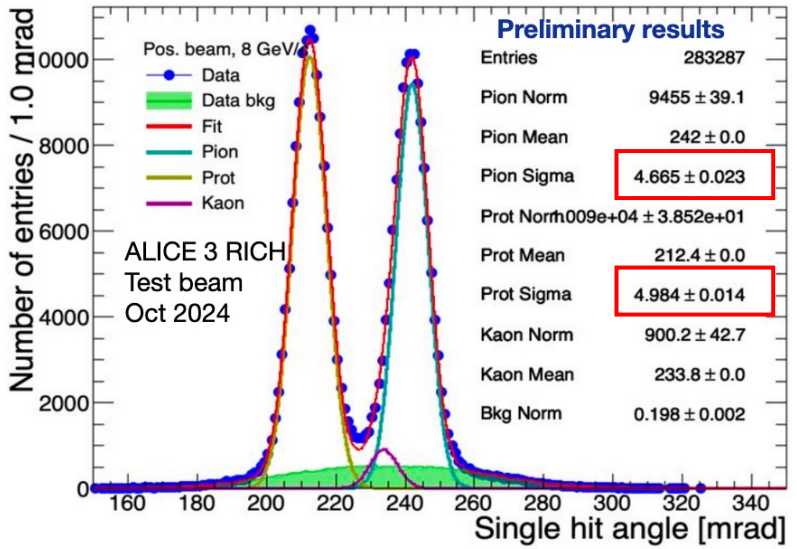
R&D for RICH

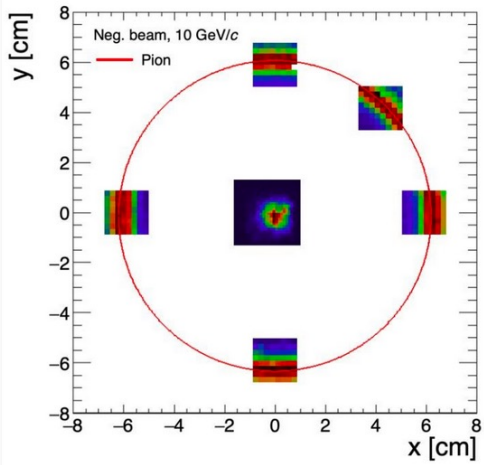
- RICH specification: Cherenkov angle resolution < 6 mrad
- **Testbeam of small-scale prototype in October at CERN PS:**
  - Aerogel radiator
  - SiPM sensors with size of choice (2x2 mm^2)
  - Front-end electronics with picoTDC

Cherenkov angle of pions and protons: 5 mrad single photon resolution









Summary

- 19 publications submitted since the last LHCC meeting

- Run 3 data taking progressing smoothly
  - ✓Proton run at 6.8 TeV completed, >53 pb^{-1} recorded
  - ✓Proton run at reference energy also completed, 5.3 pb^{-1} recorded
  - ✓Pb run ongoing…

- Large and ambitious upgrade program for Run 4 and Run 5/6
  - ✓Scoping document for ALICE3 submitted to the LHCC referees
  - ✓Several R&D activities ongoing