



ALICE



LHCP Boston 2024

ALICE highlights overview

Francesco Mazzaschi on behalf of the ALICE Collaboration

12th Large Hadron Collider Physics Conference, 04/06/24

The ALICE Run 3 detector

Major upgrades completed for ALICE for the LHC Run 3 started in 2022

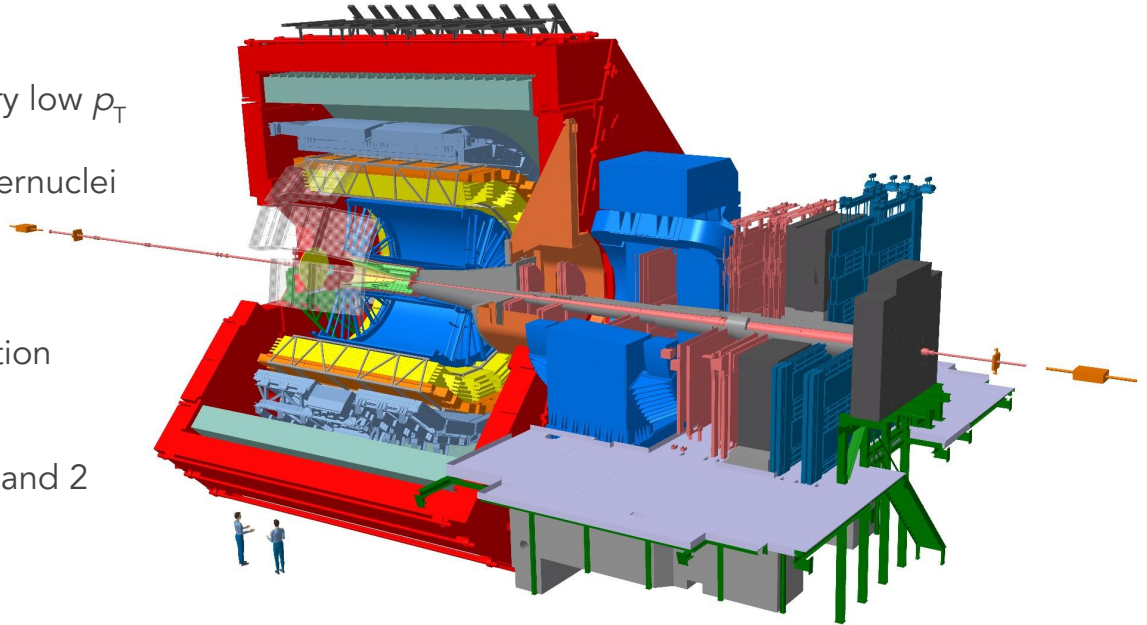
Physics motivation

High-precision measurements of quark-gluon plasma (QGP) properties

- Heavy-flavor hadrons and quarkonia at very low p_T
- Vector mesons and low-mass dileptons
- High-precision measurements of light hypernuclei

Requirements

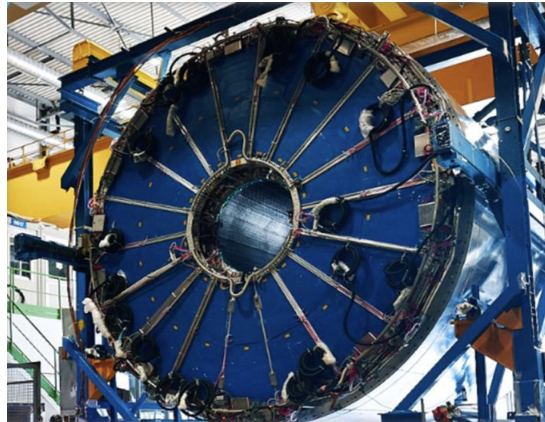
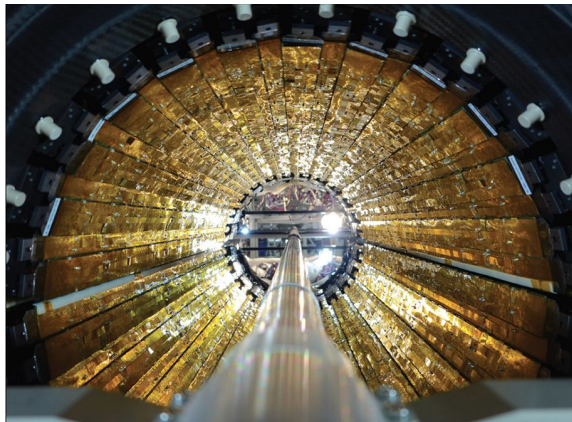
- Increase minimum-bias Pb-Pb data interaction rate of 50 kHz (~ 1 kHz in Run 2)
- Collect 13 nb^{-1} in Run 3 and 4 → x100 minimum-bias statistics with respect to Run 1 and 2
- Improve tracking resolution at low p_T



ALICE Upgrades for LHC Run 3

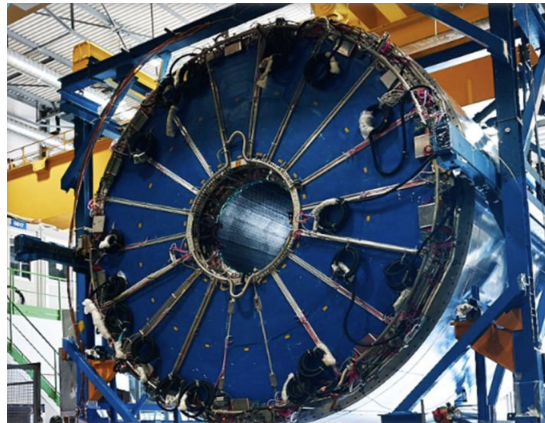
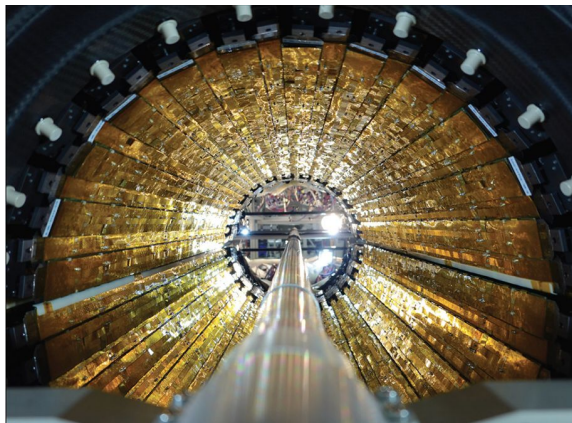


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Detector Upgrades

- Inner Tracking System (ITS)
- Time Projection Chamber (TPC)

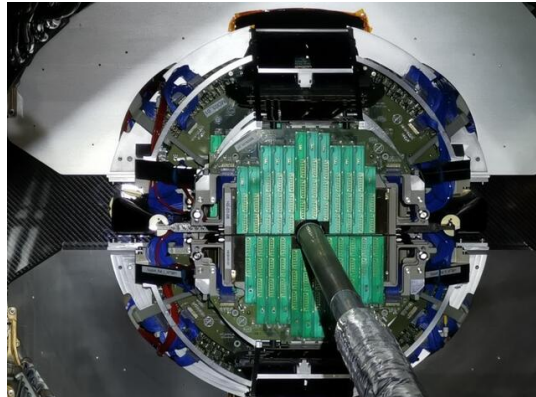
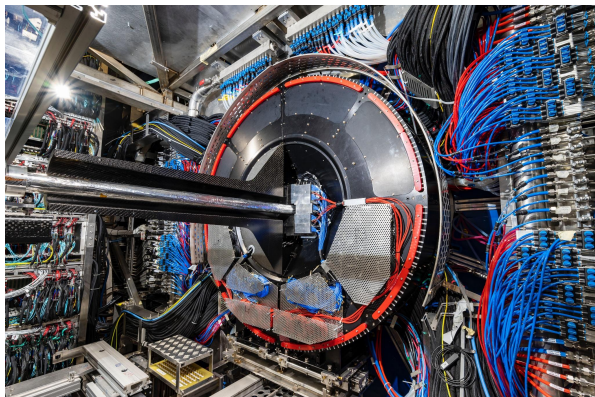


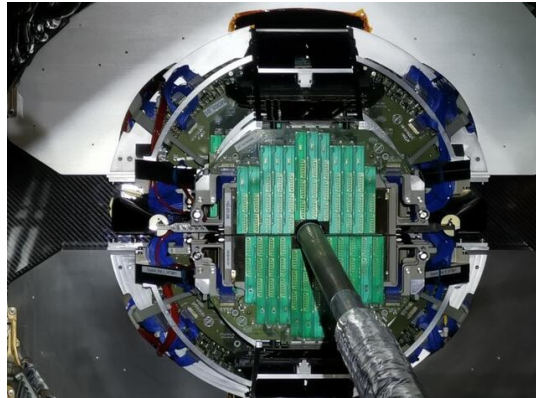
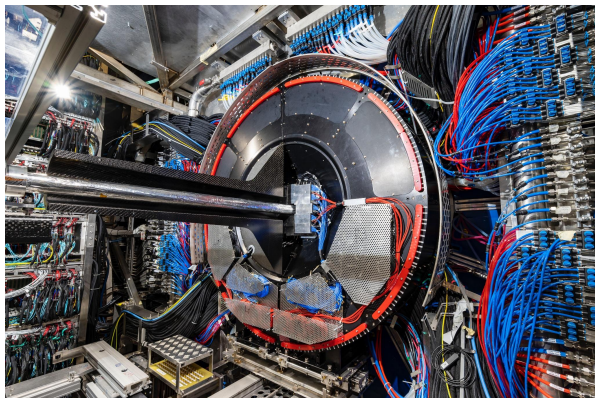
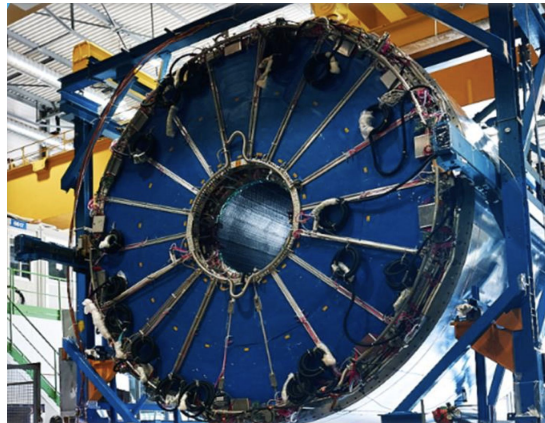
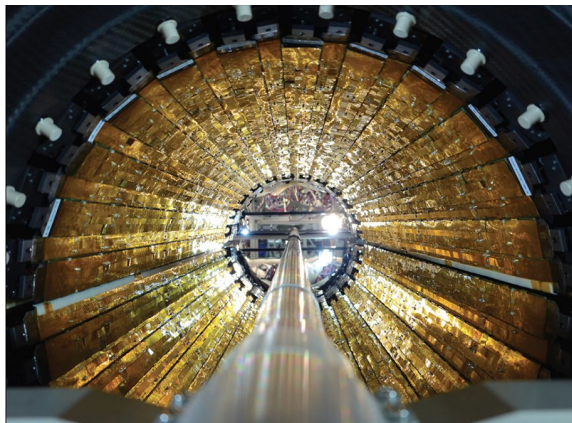
Detector Upgrades

- Inner Tracking System (ITS)
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New detectors

- Fast Interaction Trigger (FIT)
- Muon Forward Tracker (MFT)





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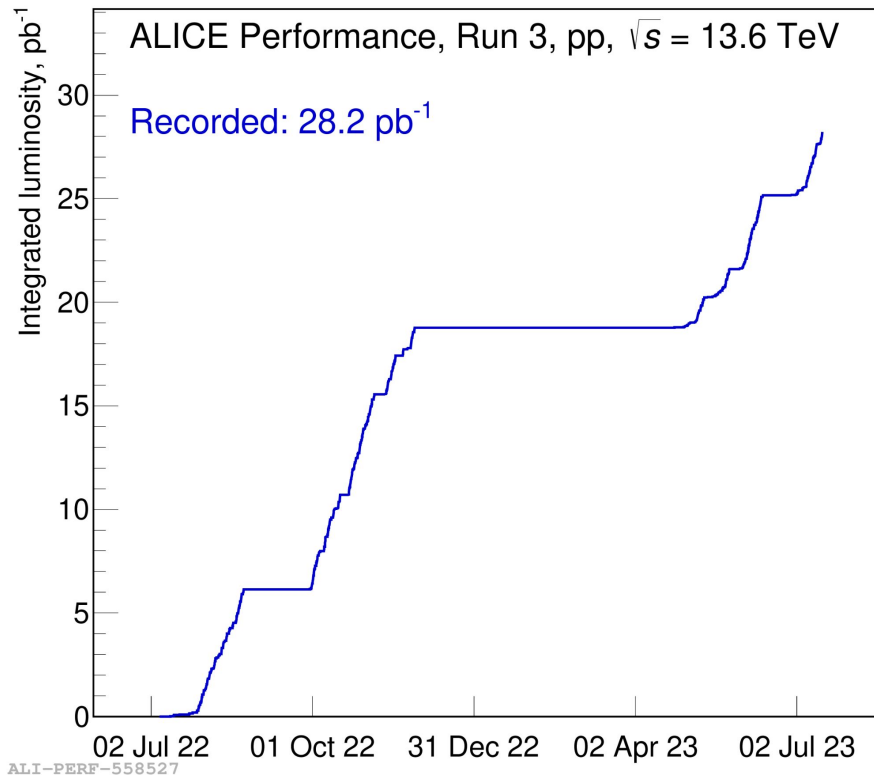
- Fast Interaction Trigger (FIT)
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DAQ and reconstruction

- New Trigger/Readout System
- New Online/Offline System (O²)



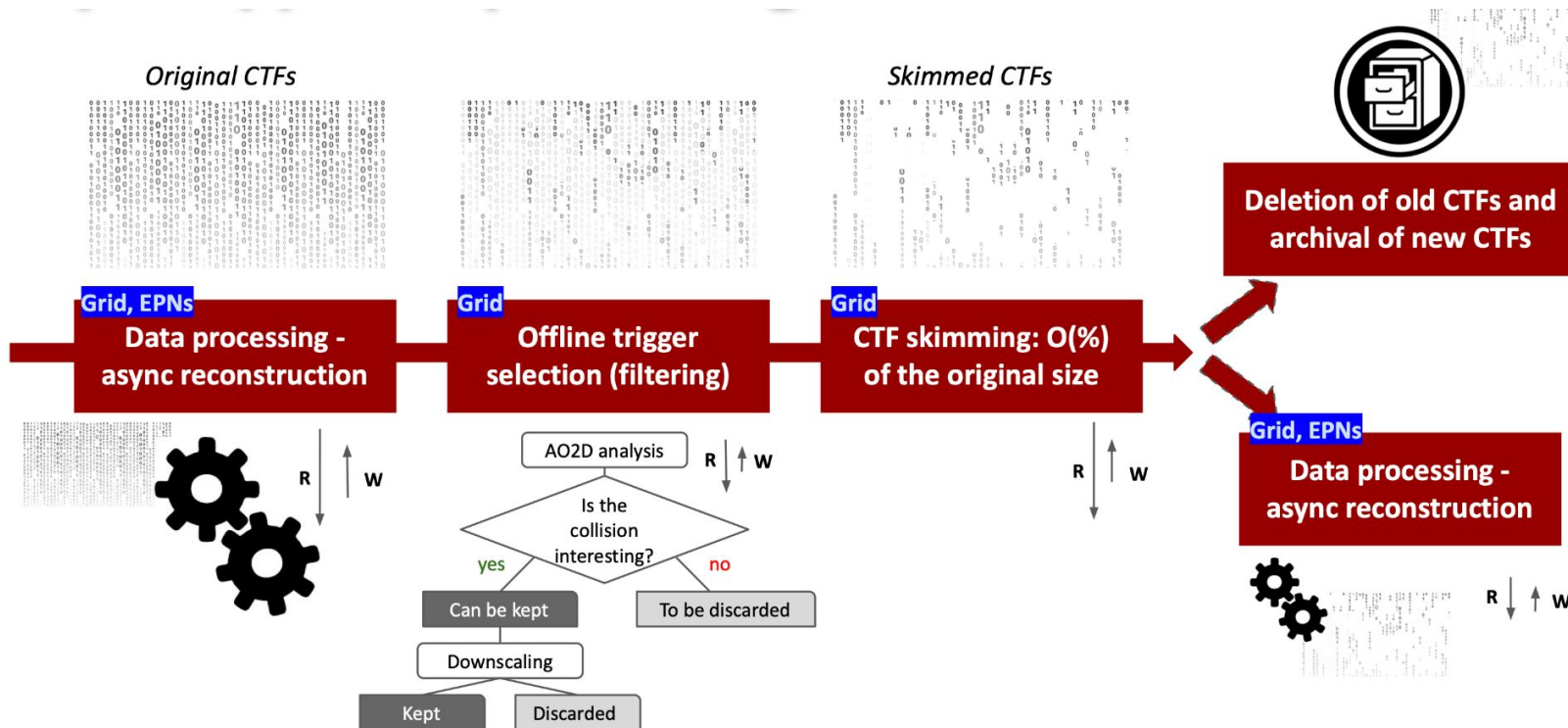
- Regular pp production running at 500 kHz interaction rate (IR)
 - **2022**: ~ 1 trillion, 56 PB of 13.6 TeV pp data collected
 - **2023**: ~ 650B, 37 PB of 13.6 TeV pp data collected
- ALICE buffer size: 150 PB, to be mostly taken by the Pb–Pb sample
 - pp data needs to be filtered to reduce their size on disk
 - **offline trigger program**



Skimming pp data



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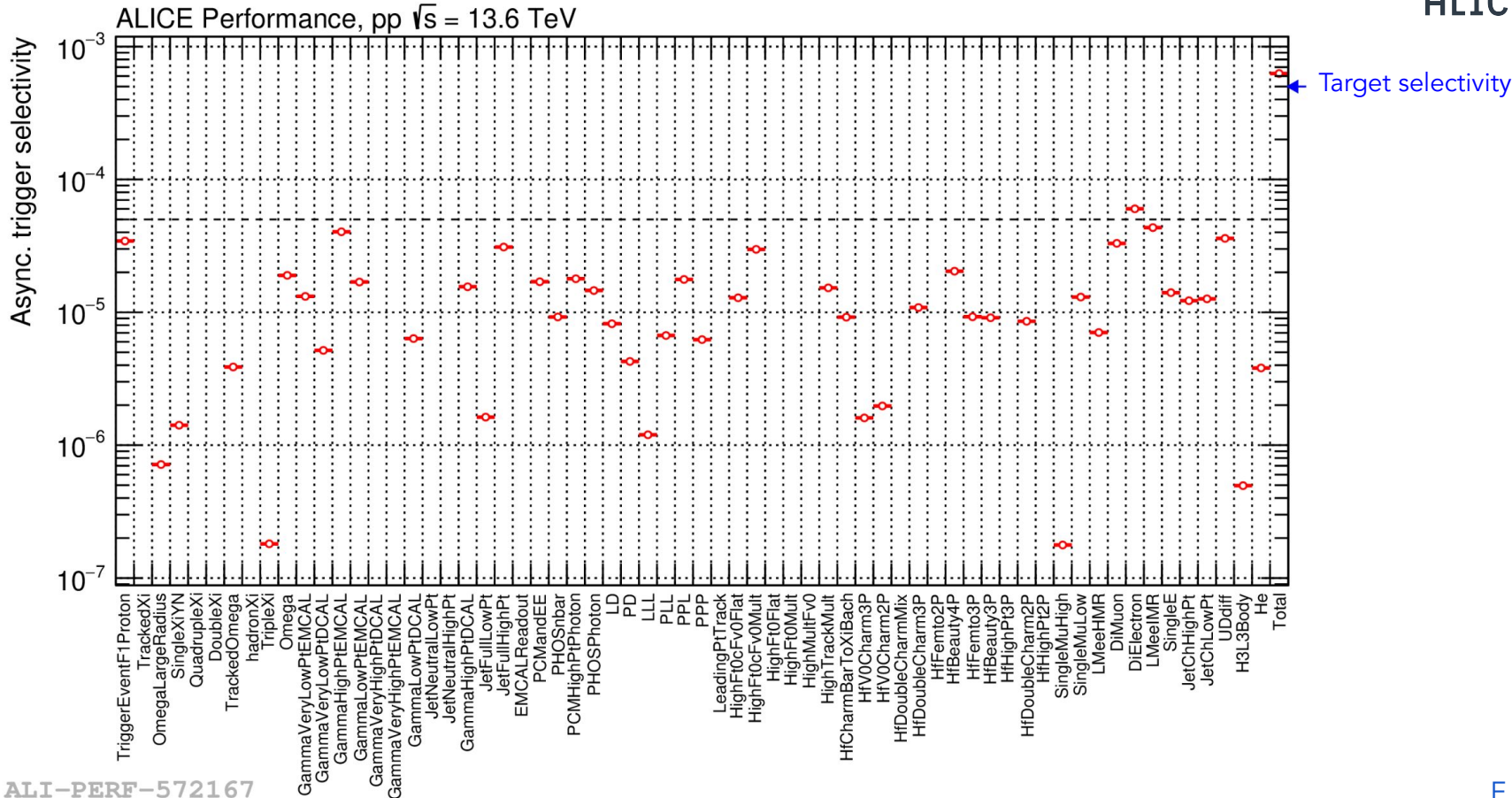


NB: sizes of symbols/images only for illustration purposes

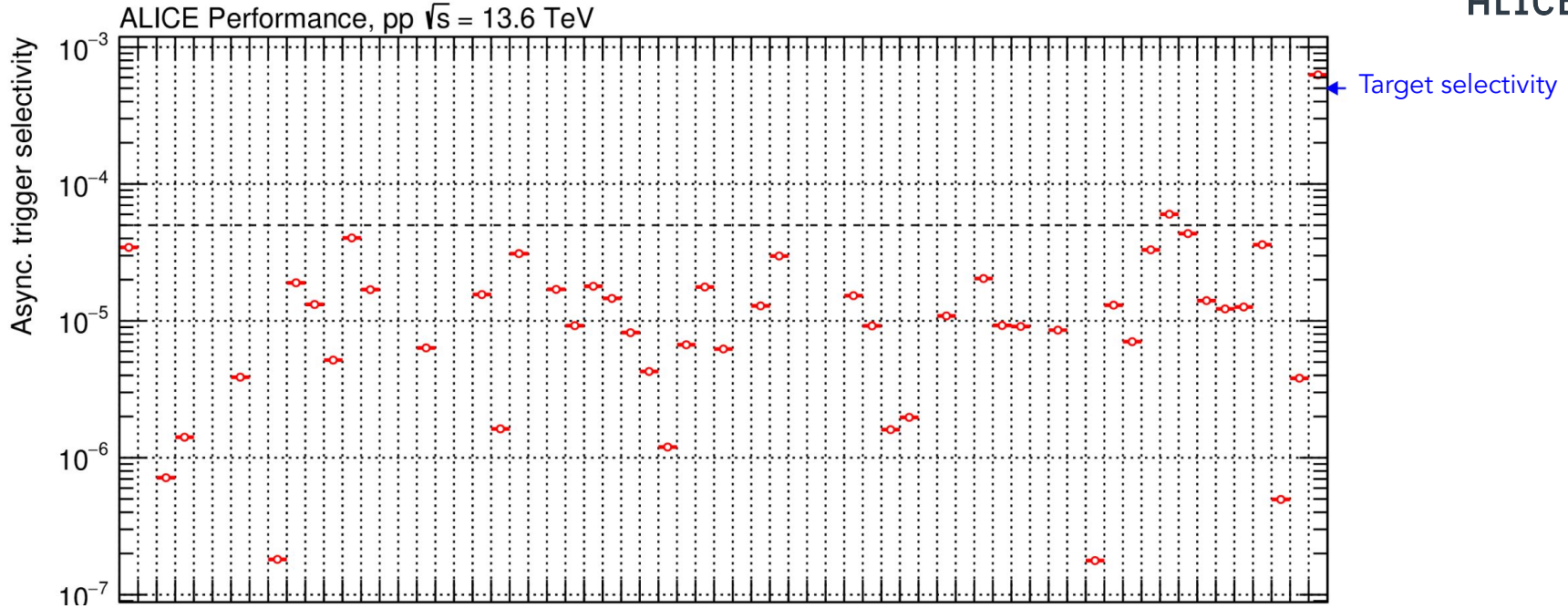
Skimming pp data: selectivity



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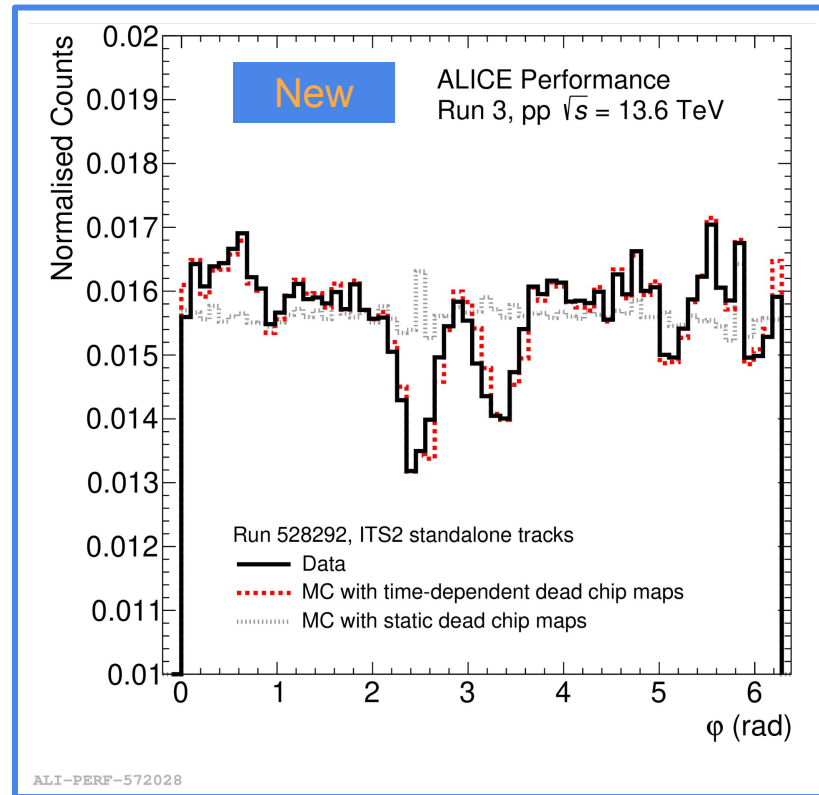
Skimming pp data: selectivity



- Trigger quotas divided among the different physics channels ranging from HF physics to hypernuclei and exotica
 - Selectivity achieved $6.4e-4$
- Original CTFs deleted and skimmed CTFs archived on tape

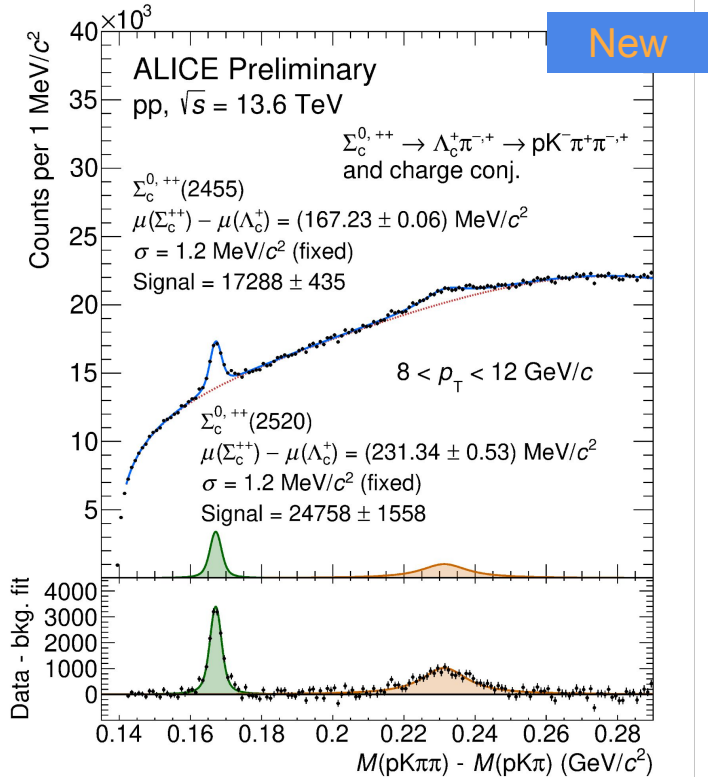
Reconstruction software improvements

- ITS detector alignment
- TPC space-charge distortion calibration
- ITS-TPC fake matches rejection for heavy-ionising particles
- Dead channel time dependent maps describe loss of acceptance in the anchored MC simulations (ITS, TPC, MFT)

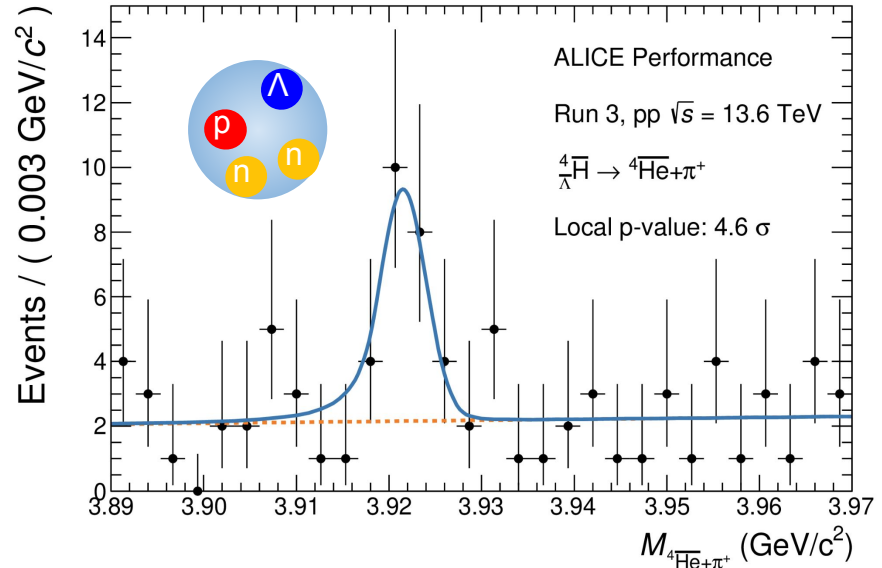


Rare signals in pp collisions @ 13.6 TeV

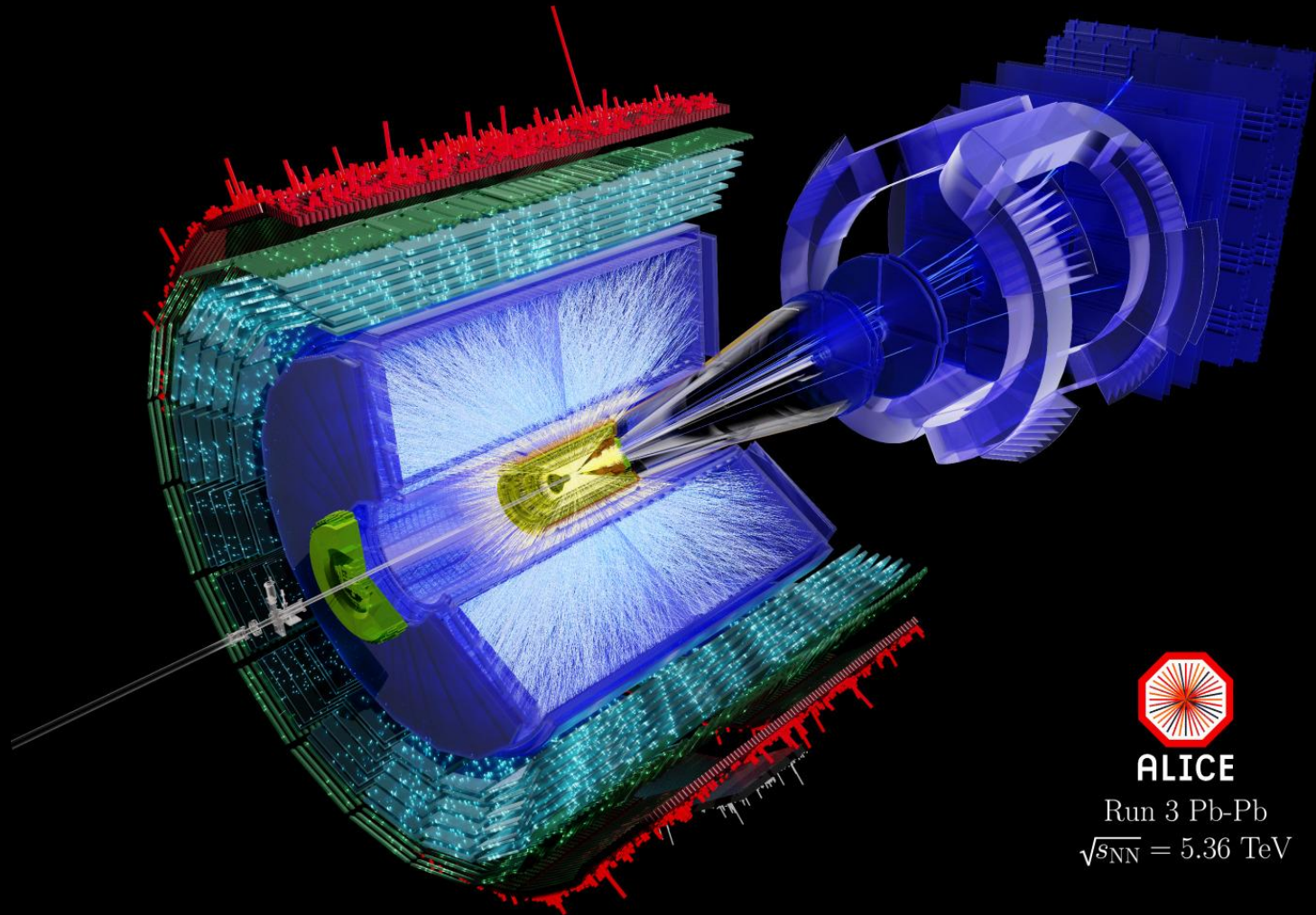
Heavy-flavour: $\Sigma_c^{0,++}(2520)$ measured for the first time at the LHC



Light-flavour: ${}^4_{\Lambda} \text{H}$ measured for the first time in small colliding systems



More details in the talks of:
 S. Politano', Wednesday 5th June, 14:30
 L. Barioglio, Tuesday 4th June, 15:00

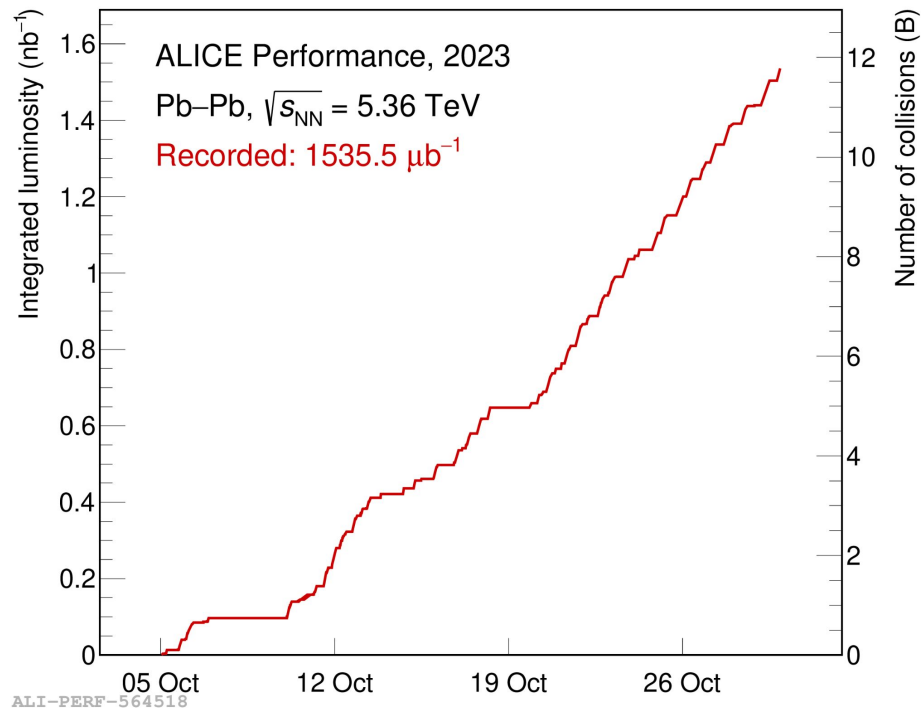


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Run 3 Pb-Pb

$\sqrt{s_{NN}} = 5.36$ TeV

- Regular Pb–Pb production running at 50 kHz interaction rate (IR)
 - 50 times higher IR than Run 1+2
 - 12 B Min Bias collisions recorded
 - ~ 100 PB of Pb–Pb data
- LHC beam background spotted by ALICE during the Pb–Pb data taking
 - collimated flux of particle, locally parallel to the beam pipe
 - collaboration with LHC operators, flux deviated
 - only 6% of the data affected



Reconstruction improvements in Pb–Pb

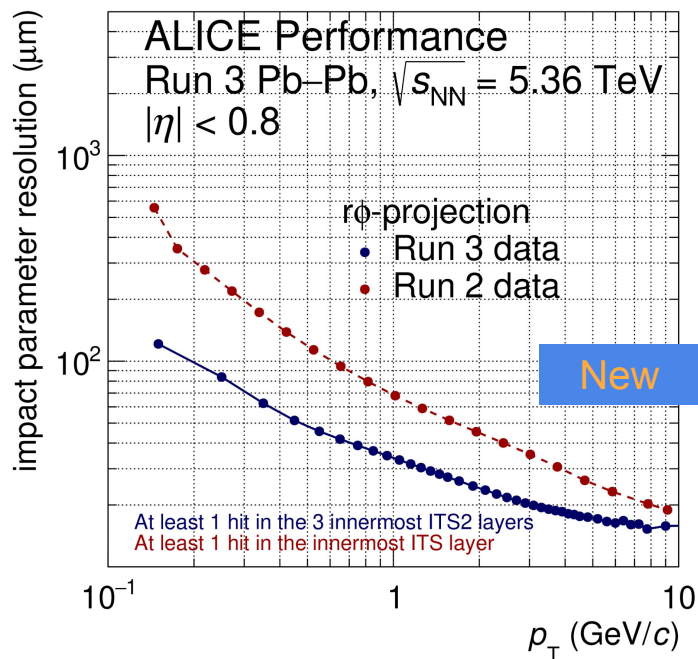


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Reconstruction improvements in Pb–Pb

ITS alignment + TPC space-charge distortion calibration

- Impact parameter resolution ~ 5 times smaller than Run 2 with the new ITS at low p_T ($< 30 \mu\text{m}$ above $1.5 \text{ GeV}/c$)



Reconstruction improvements in Pb–Pb

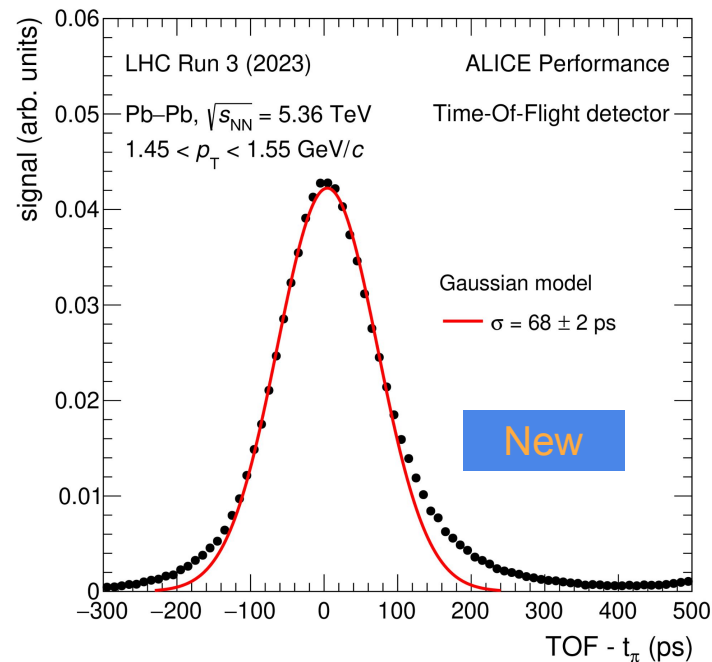
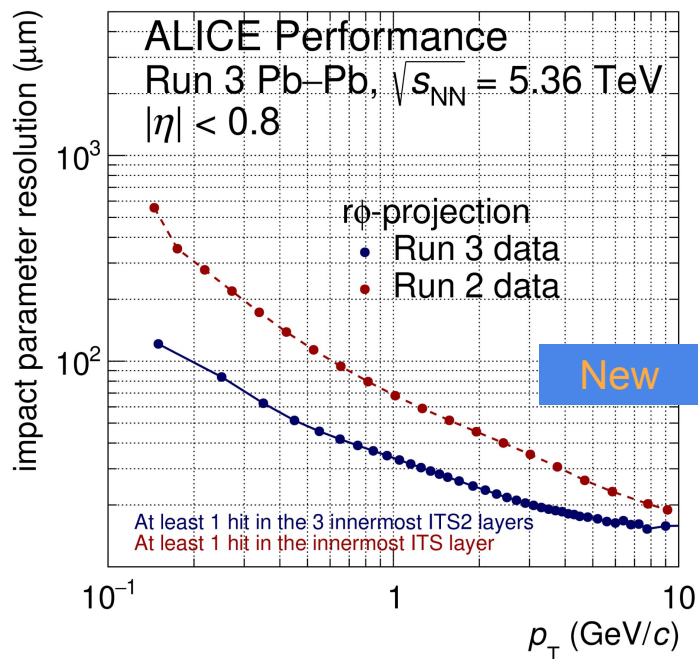


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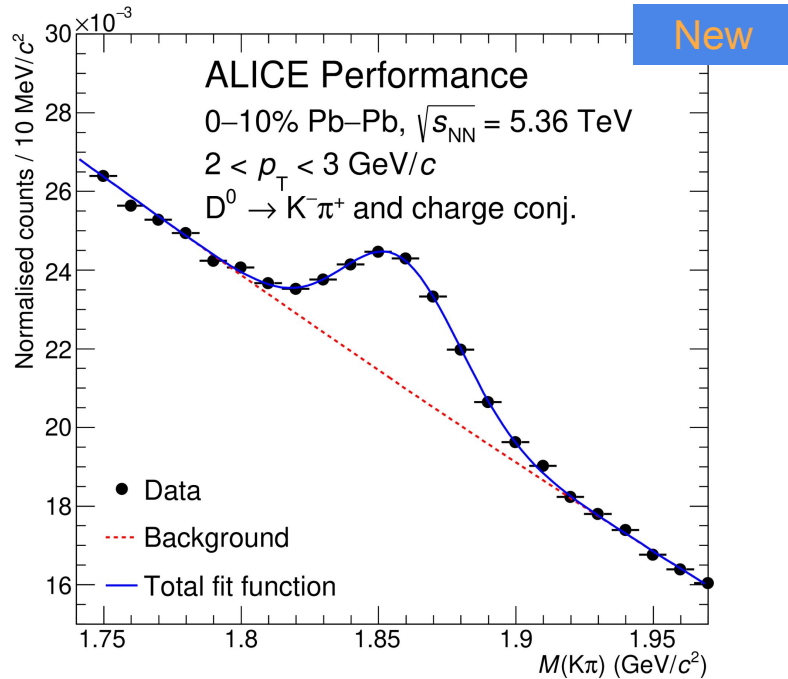
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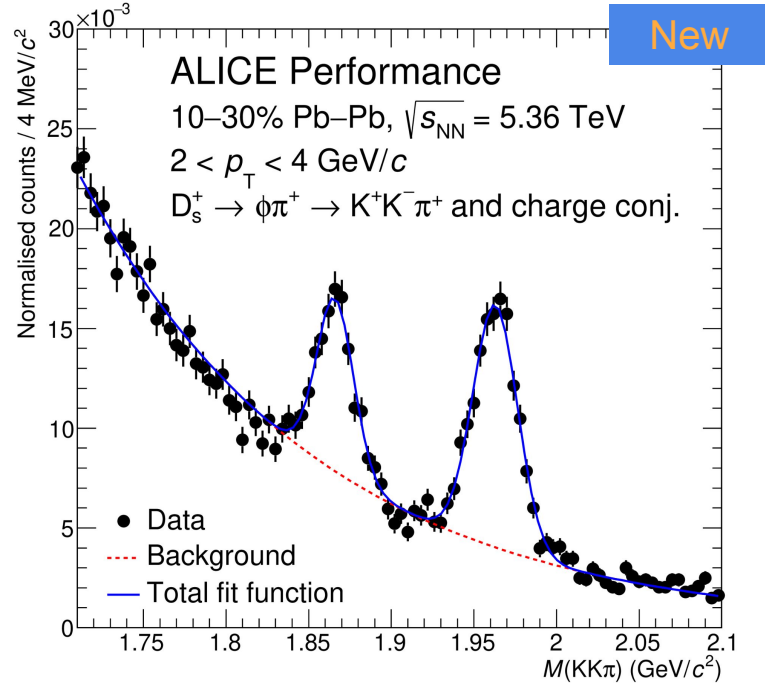
Improvements in the TOF calibration, performance compatible with the Run 1+2 ones



- First signal extraction of D_0 , D_s^+ meson in Pb–Pb collisions in Run 3



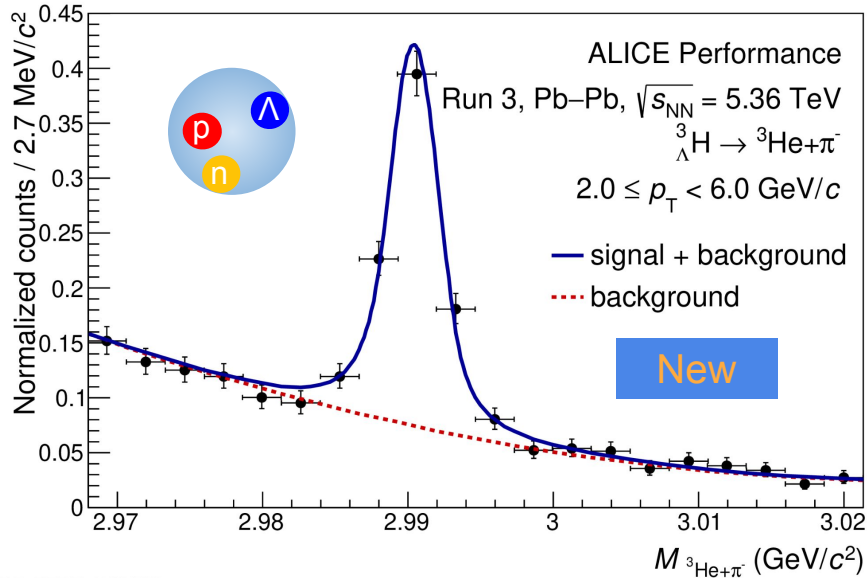
ALI-PERF-568645



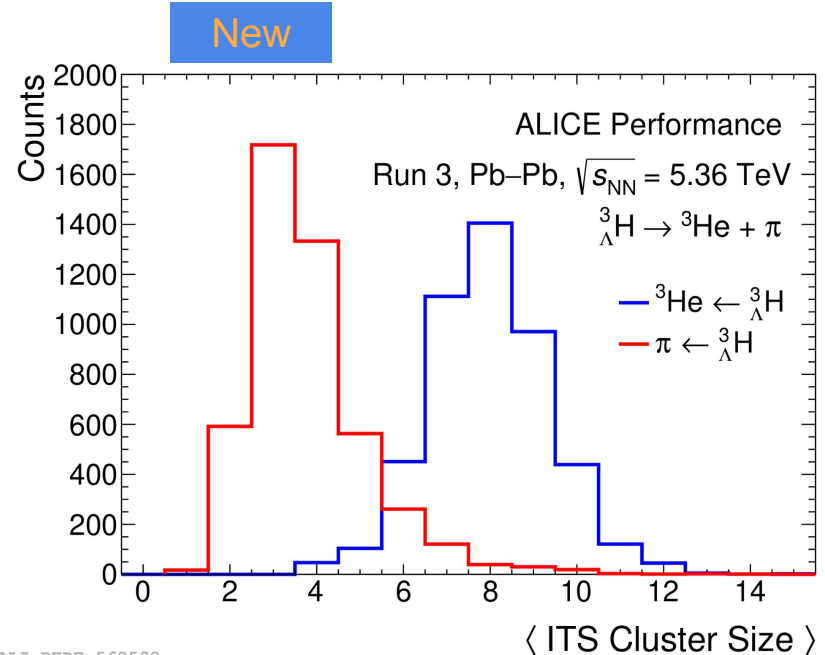
ALI-PERF-568632

Hypernuclei and heavily-ionising particles

- Hypertriton two-body decay channel reconstruction
- Use of ITS cluster size to tag ${}^3\text{He}$ daughter track and reduce ITS-TPC fake matchings
 - PID capabilities of a silicon digital detector !



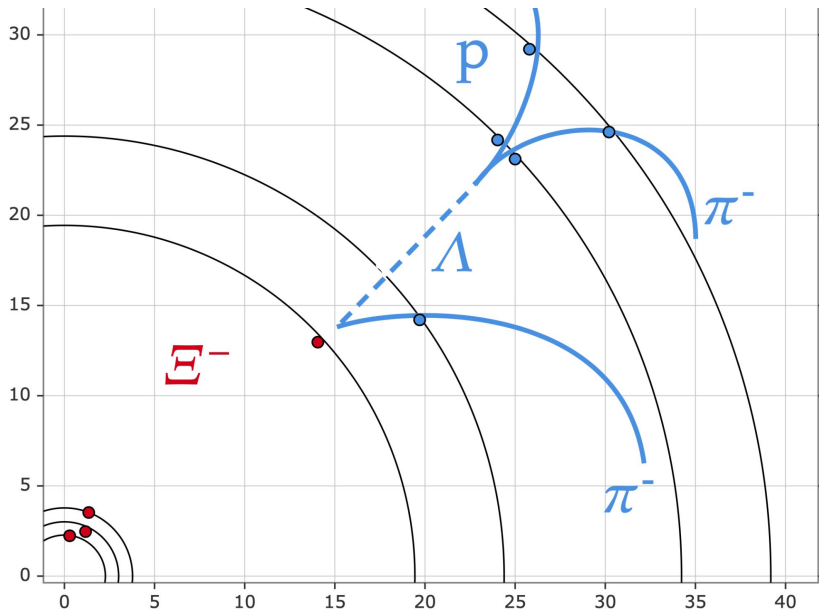
ALI-PERF-568600



ALI-PERF-568592

Strangeness tracking

- ITS2 Inner Barrel has the first three layers within 4 cm

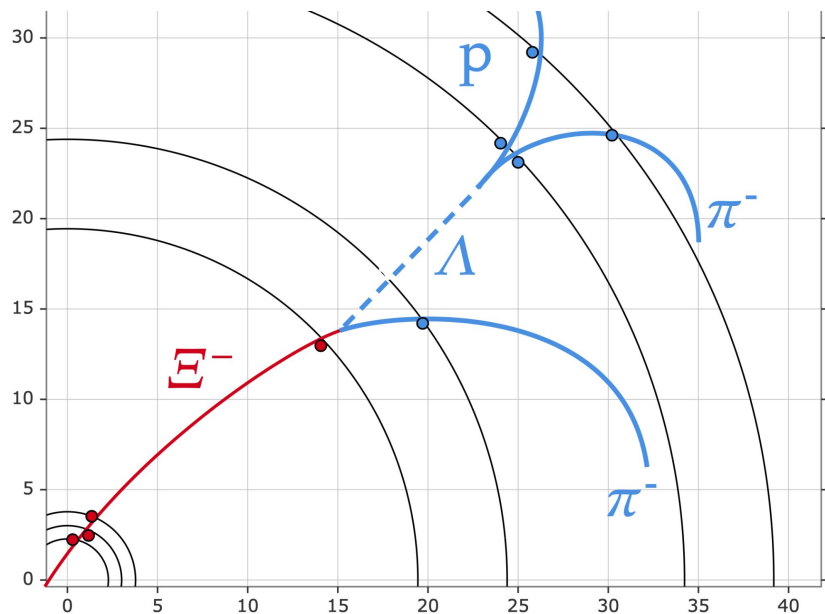


Strangeness tracking

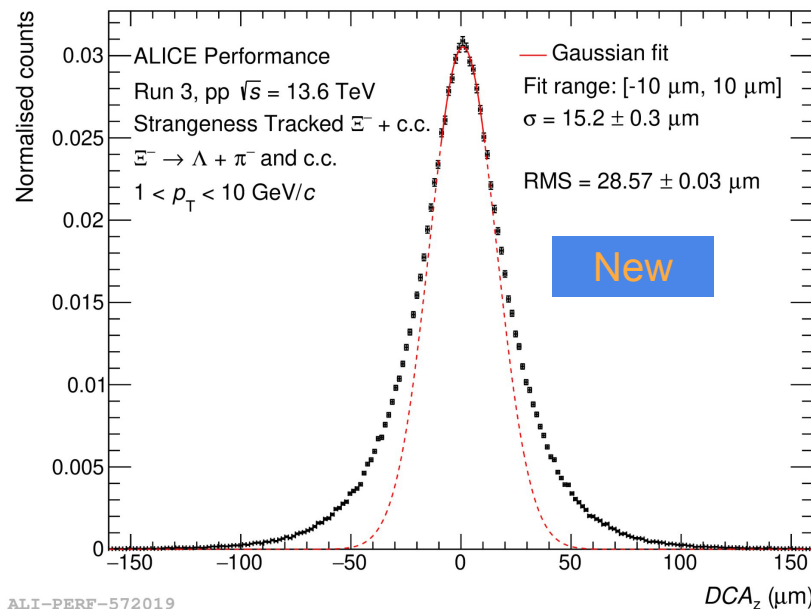
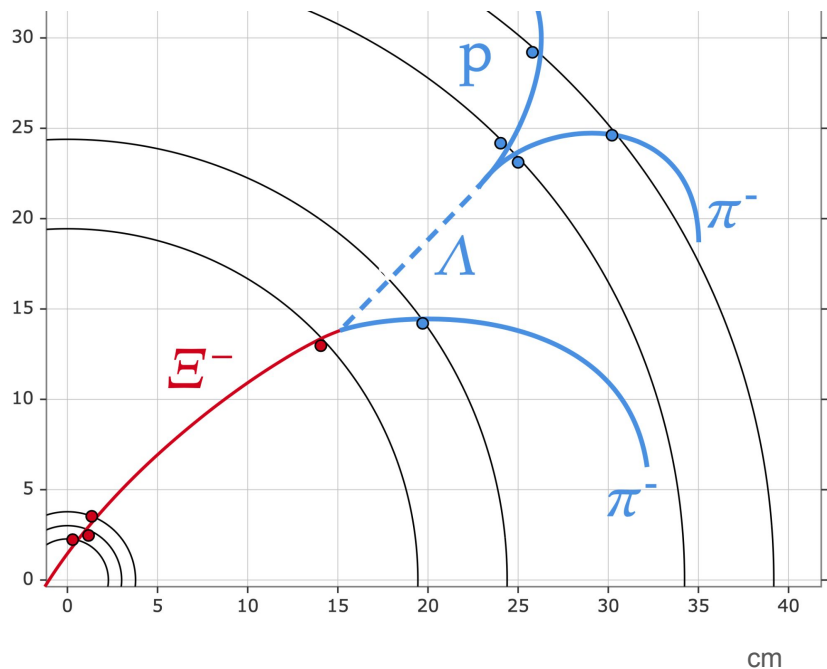


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- ITS2 Inner Barrel has the first three layers within 4 cm
 - Direct tracking of charged weak-decaying particles



- ITS2 Inner Barrel has the first three layers within 4 cm
 - Direct tracking of charged weak-decaying particles
 - Applications: non-prompt cascade studies, hypernuclei, exotic bound states



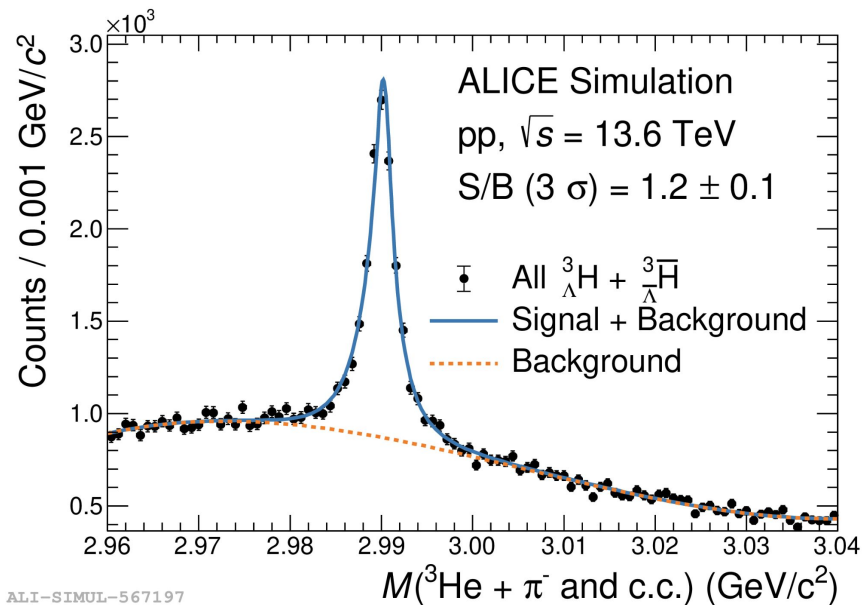
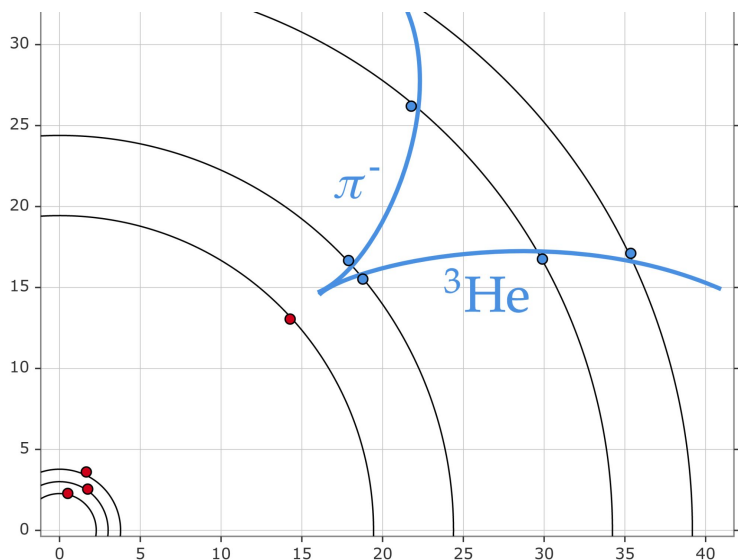
- Improvements in the reconstruction software for both data and MC
 - tracking efficiency, particle identification, impact parameter resolution ...
- pp at $\sqrt{s} = 13.6$ TeV and 500 kHz interaction rate (IR)
 - working offline triggers to save space on disk
 - first preliminary physics results and rare signals observation
- Pb–Pb at $\sqrt{s_{NN}} = 5.36$ TeV and 50 kHz interaction rate (IR)
 - ~ 1 month of data taking: more statistics than in Run 1 + 2
 - first invariant mass spectra of heavy and light flavour particles
- New: strangeness tracking algorithm for measurements of non-prompt cascades, hypernuclei, exotic bound states

Backup



- ITS2 Inner Barrel has the first three layers within 4 cm
 - Direct tracking of charged weak-decaying particles
- Applications: non-prompt cascade studies, hypernuclei, exotic bound states

Before strangeness tracking



Strangeness tracking



- ITS2 Inner Barrel has the first three layers within 4 cm
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After strangeness tracking

