ALICE Run 3 and ALICE3

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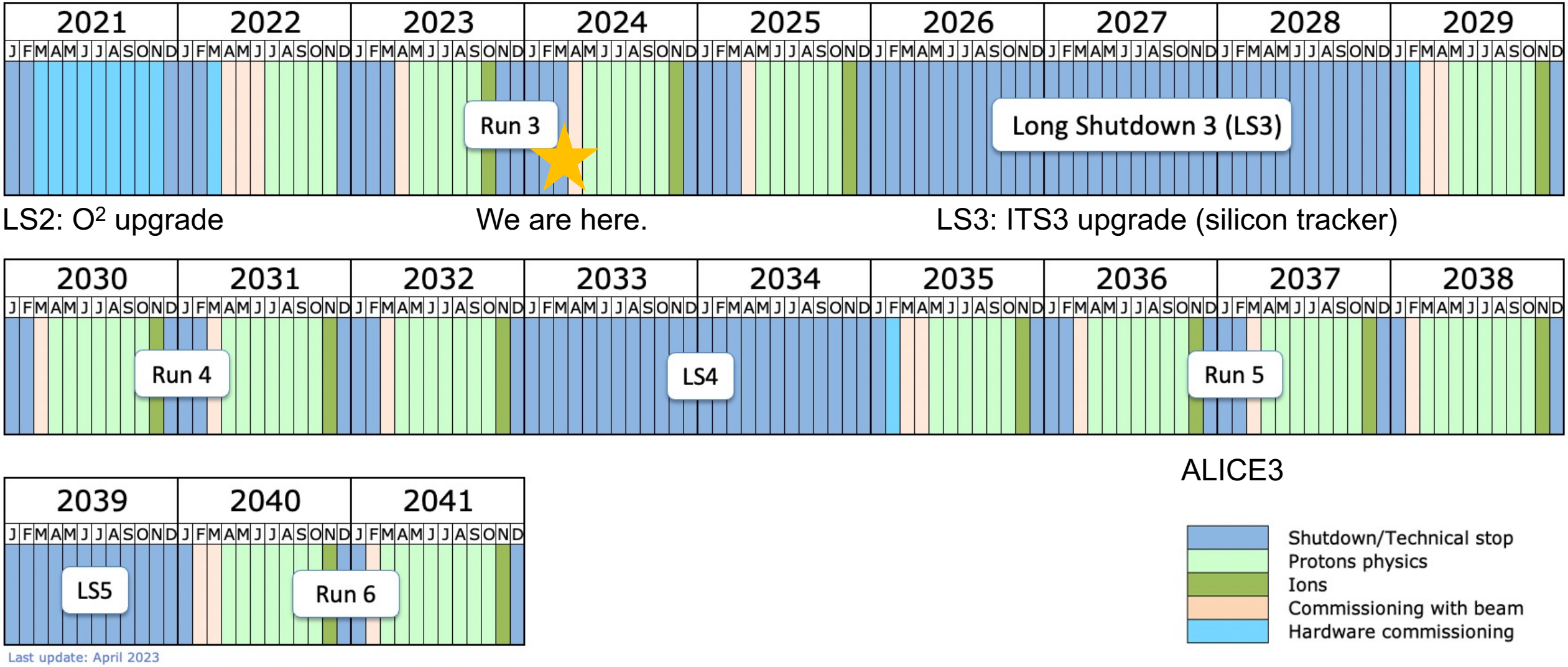
LHC schedule

Longer term LHC schedule

In January 2022, the schedule was updated with long shutdown 3 (LS3) to start in 2026 and to last for 3 years. HL-LHC operations now foreseen out to end 2041.



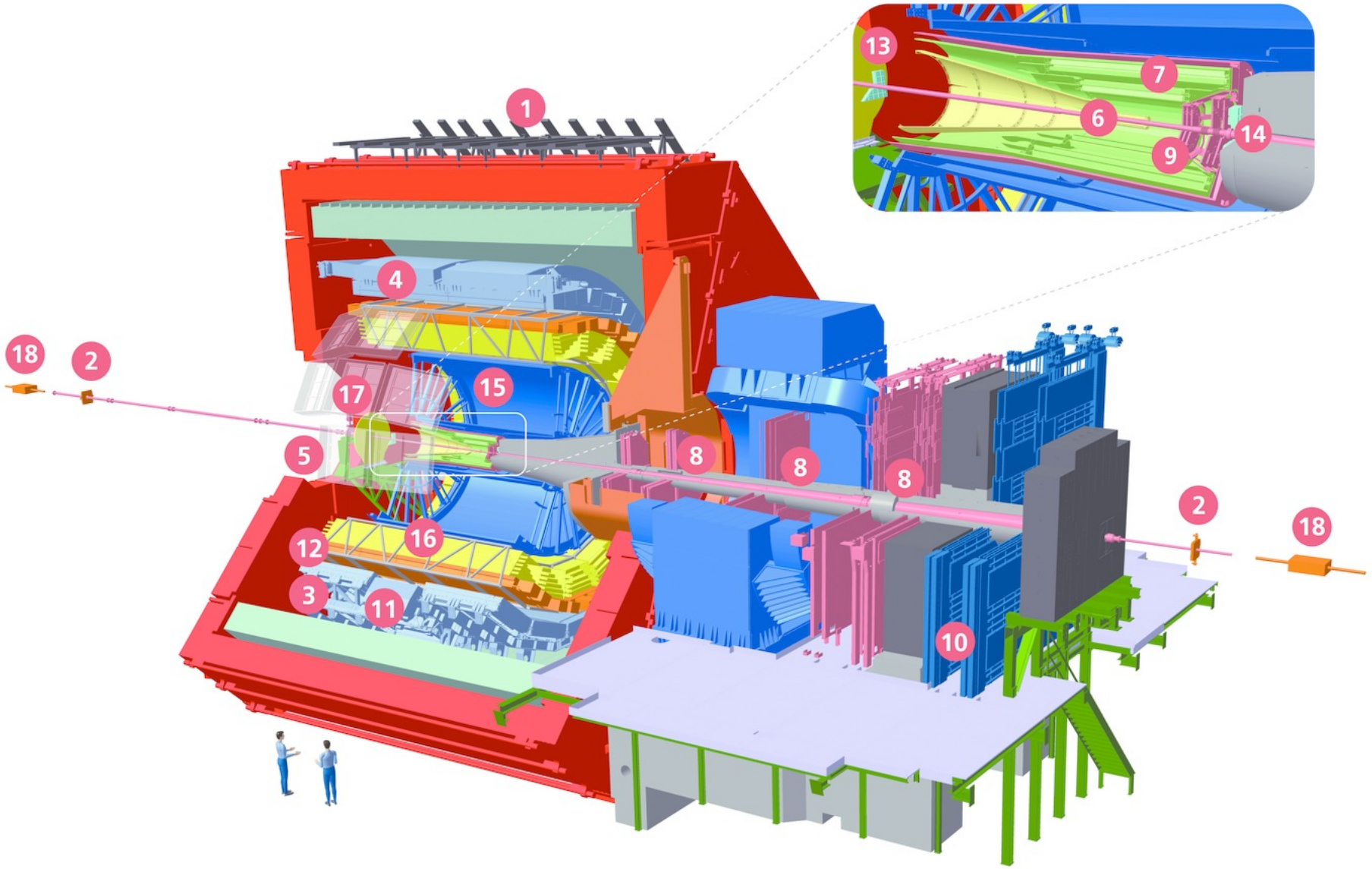
LS2: O^2 upgrade

We are here.

LS3: ITS3 upgrade (silicon tracker)

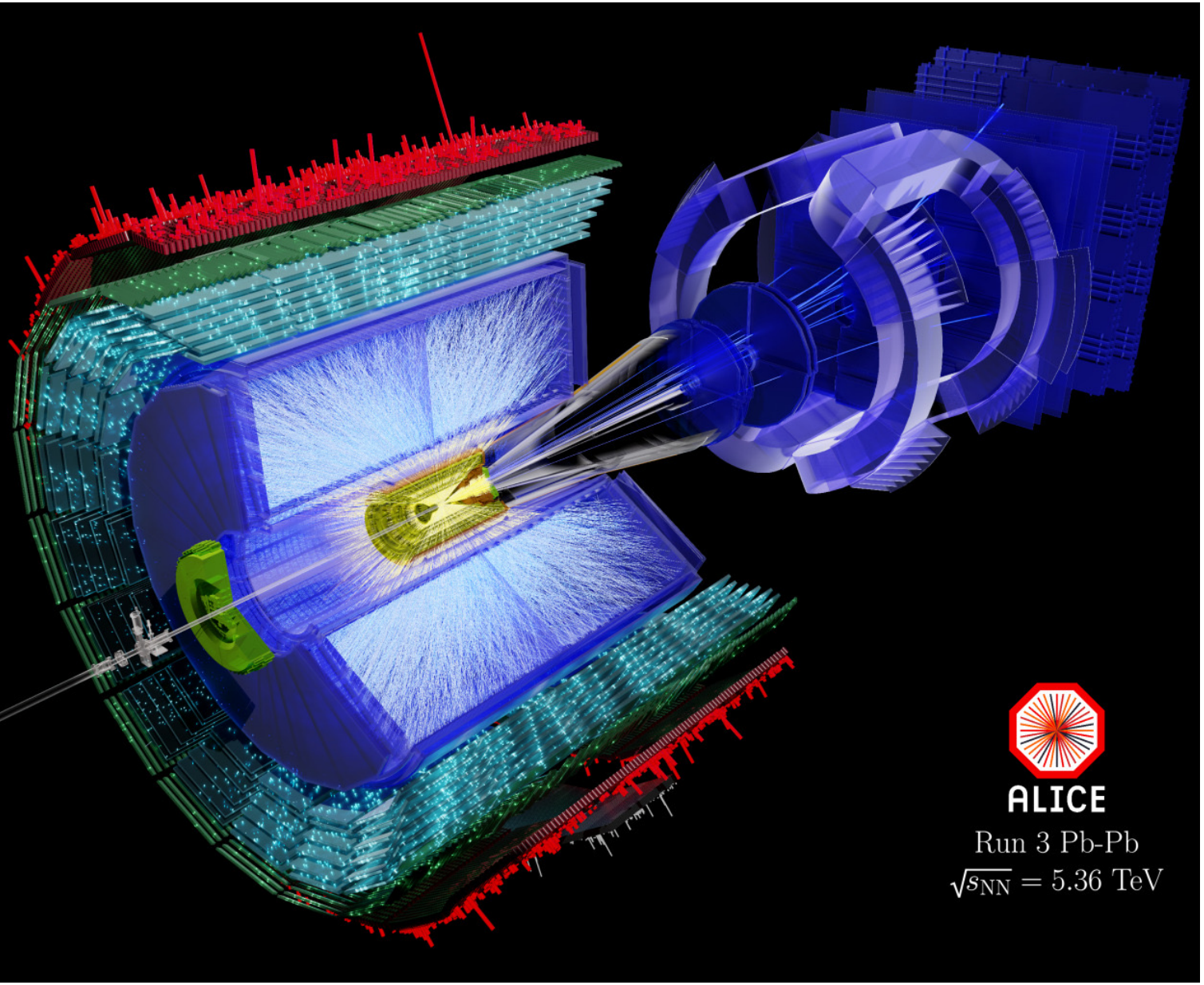
ALICE3

ALICE detectors in LHC Run3



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

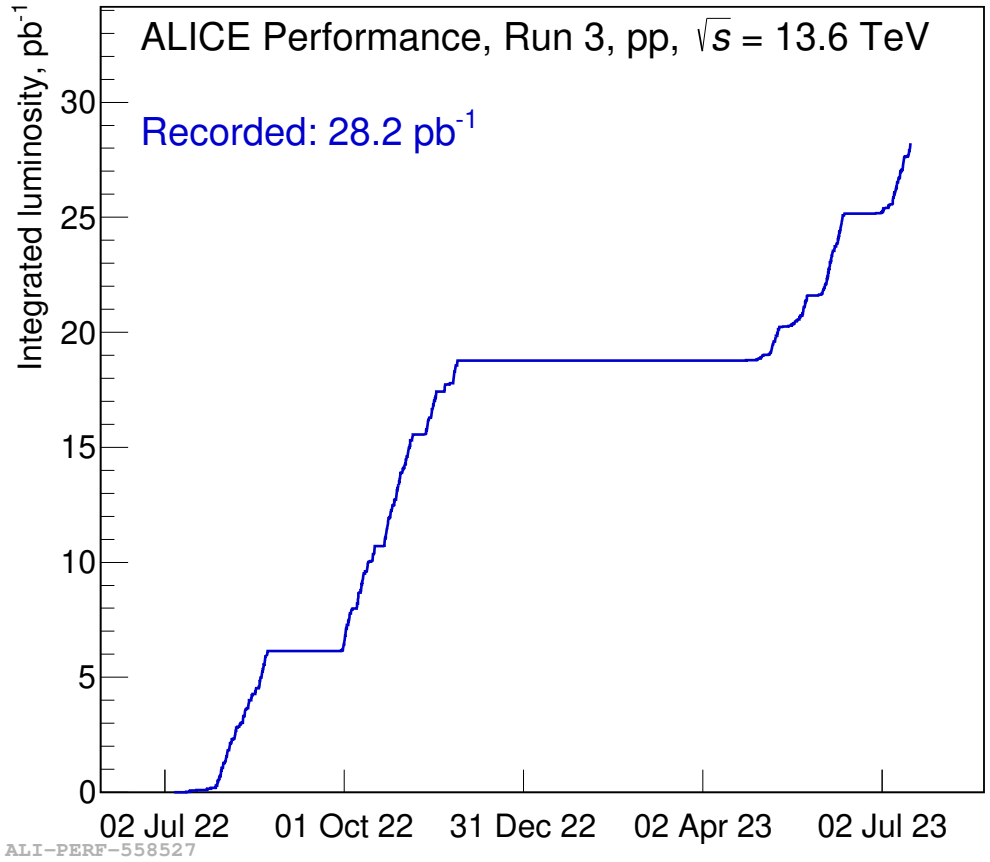
ALICE Run3

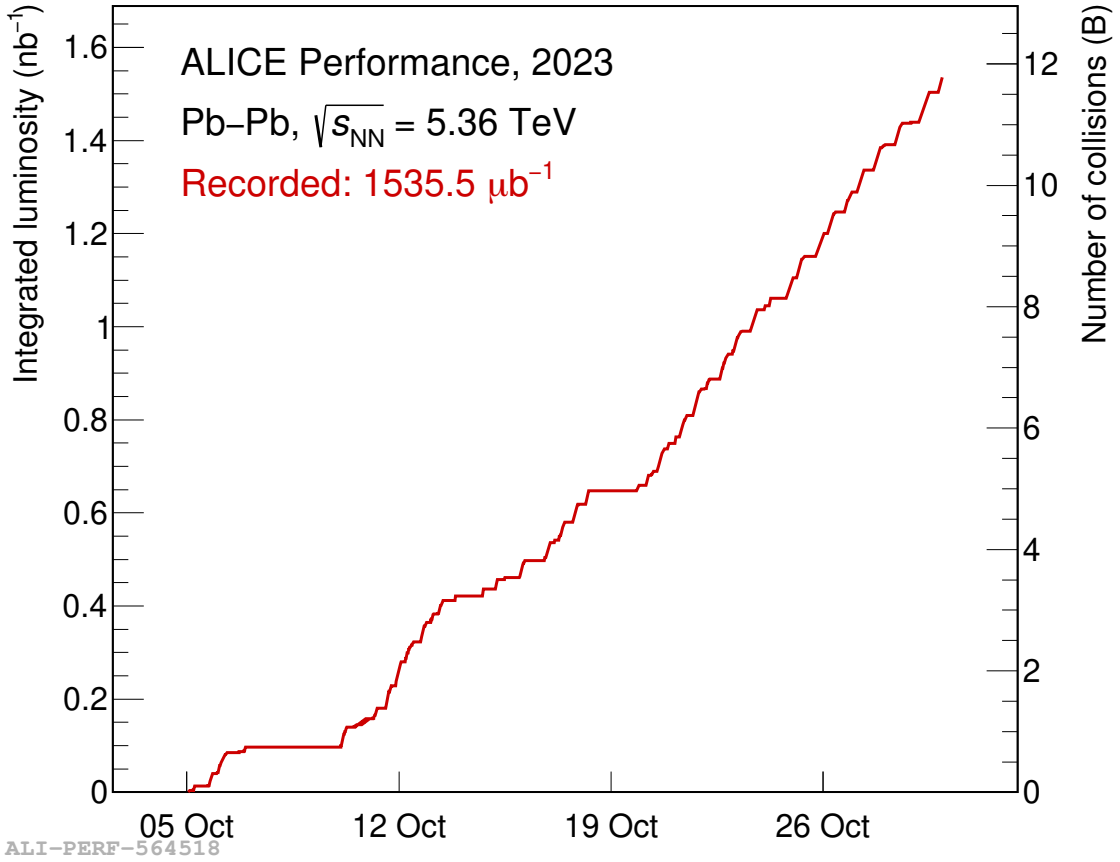


- Highest collision energy $\sqrt{s_{NN}}$ = 5.36 TeV
- $dN_{ch}/d\eta$ ~ 2000 in central collisions

- Upgrade during LS2
  - GEM TPC (fast readout)
  - ITS2 (vertexing resolution)
  - Online-Offline (O^2) reconstruction

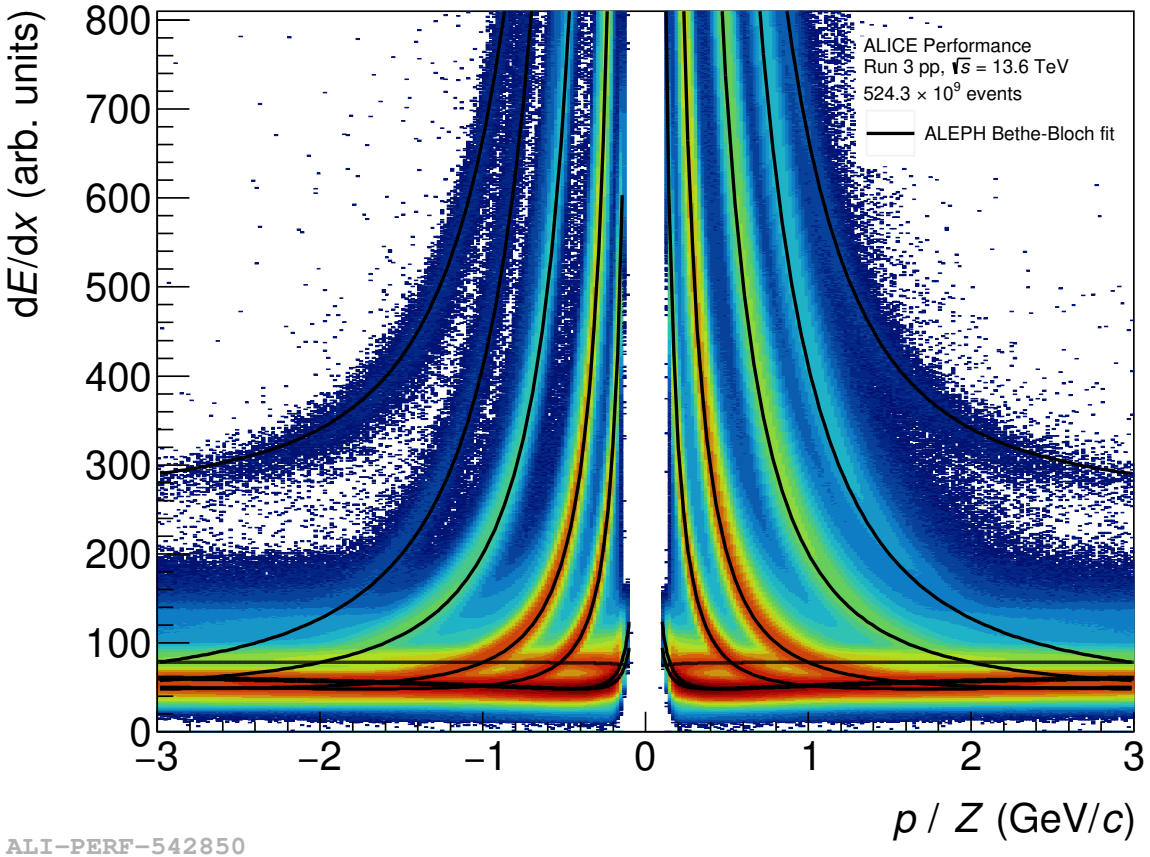
Integrated luminosity in ALICE

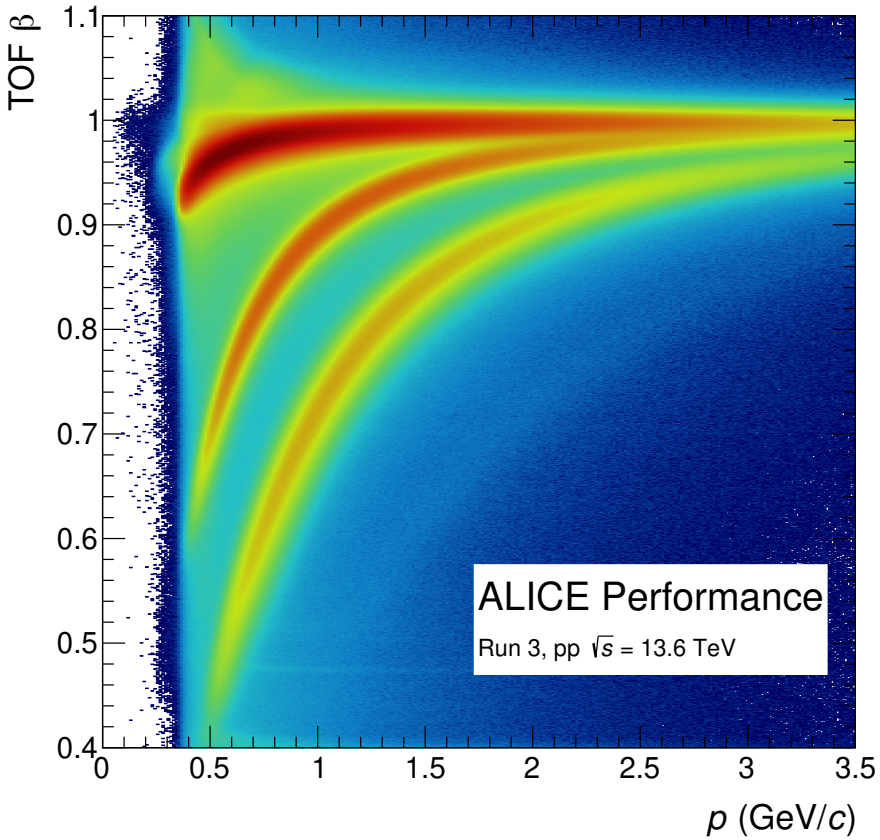




- 28.2 pb^{-1} in pp at 13.6 TeV ~ 2T collisions
- 1.54 nb^{-1} in PbPb at 5.36 TeV ~ 12B collisions

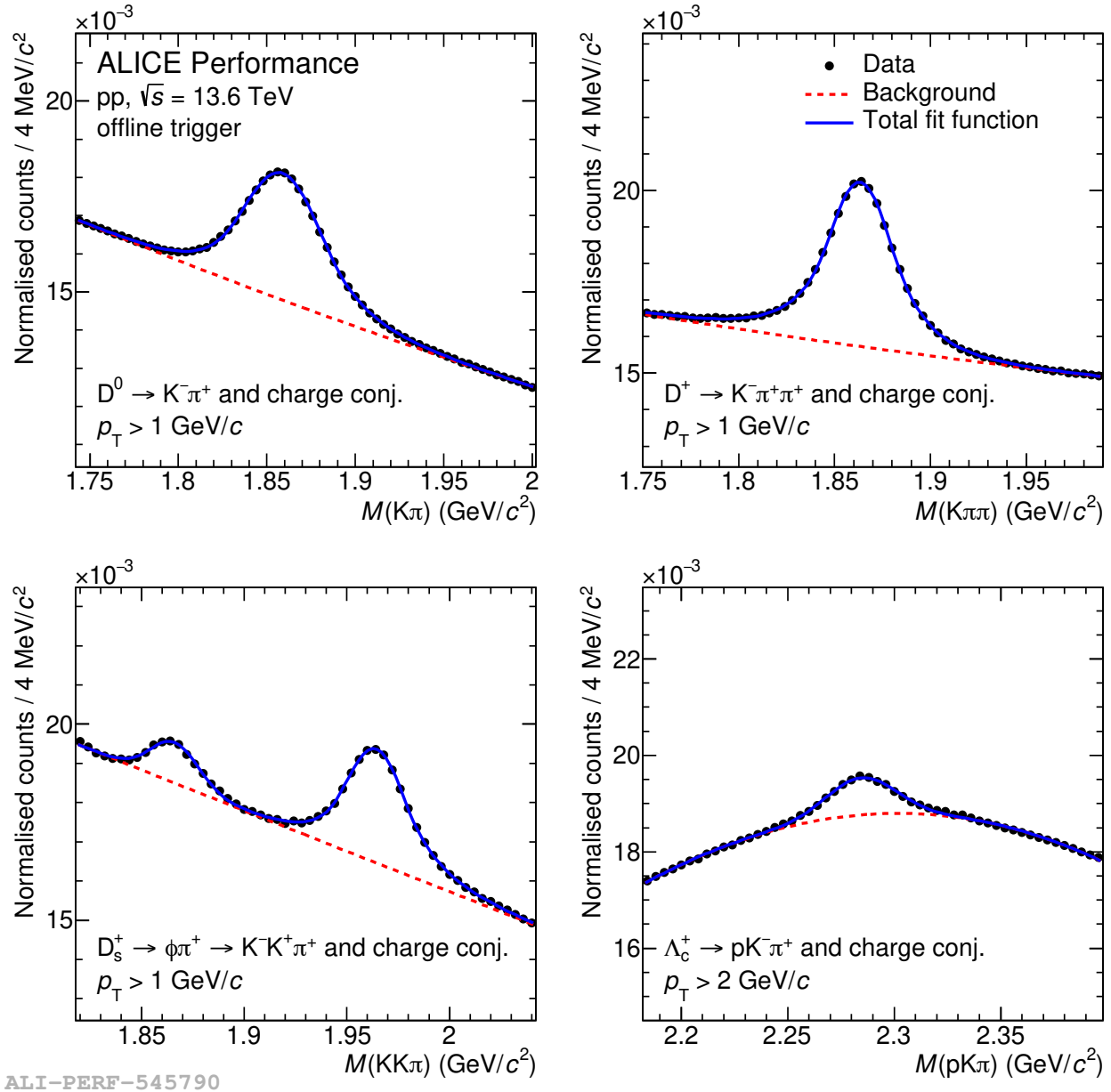
PID performance in Run3





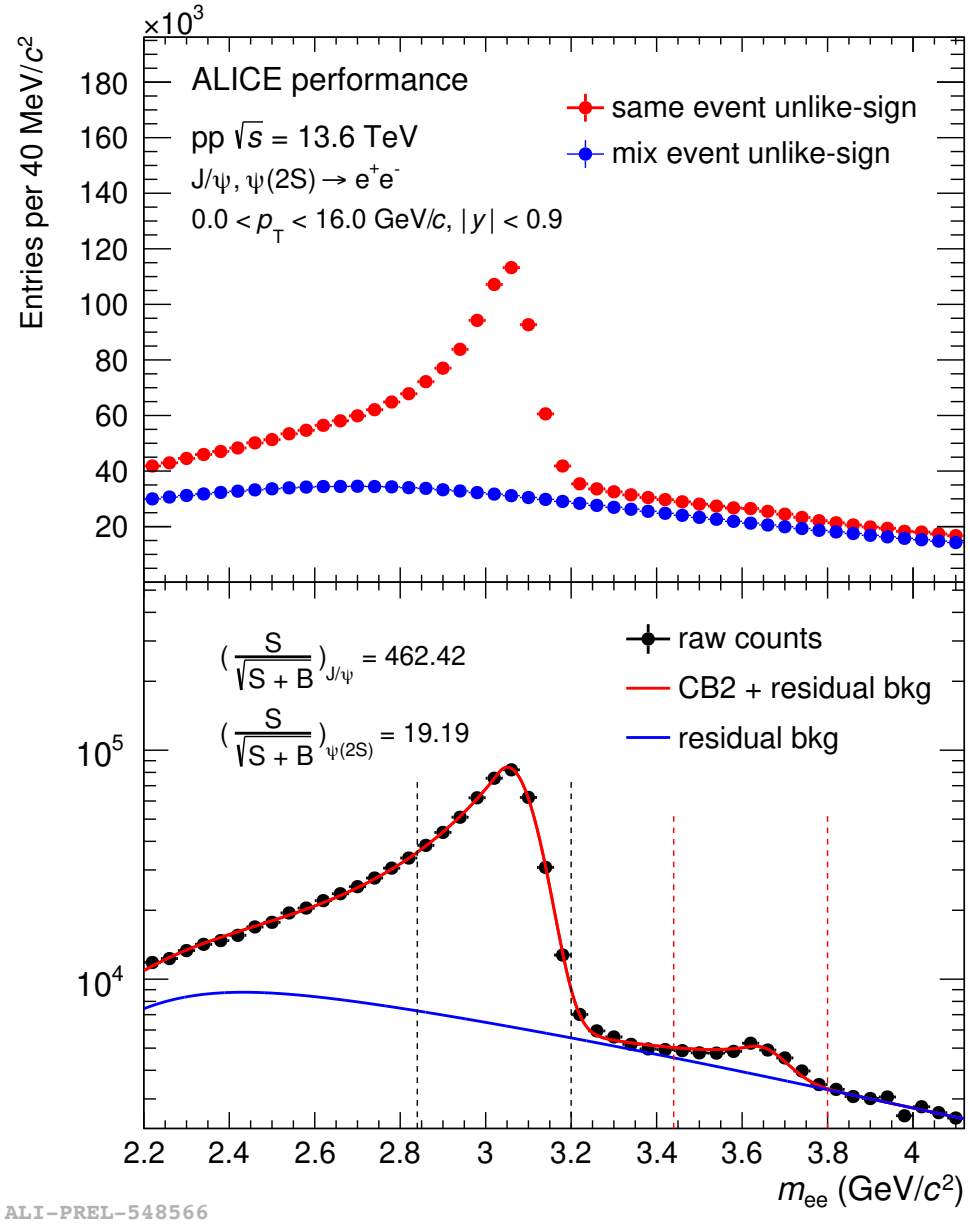
- Clear separation of e/π/K/p/d/t/He with TPC dE/dx
- Clear separation of e/π/K/p with TOF β

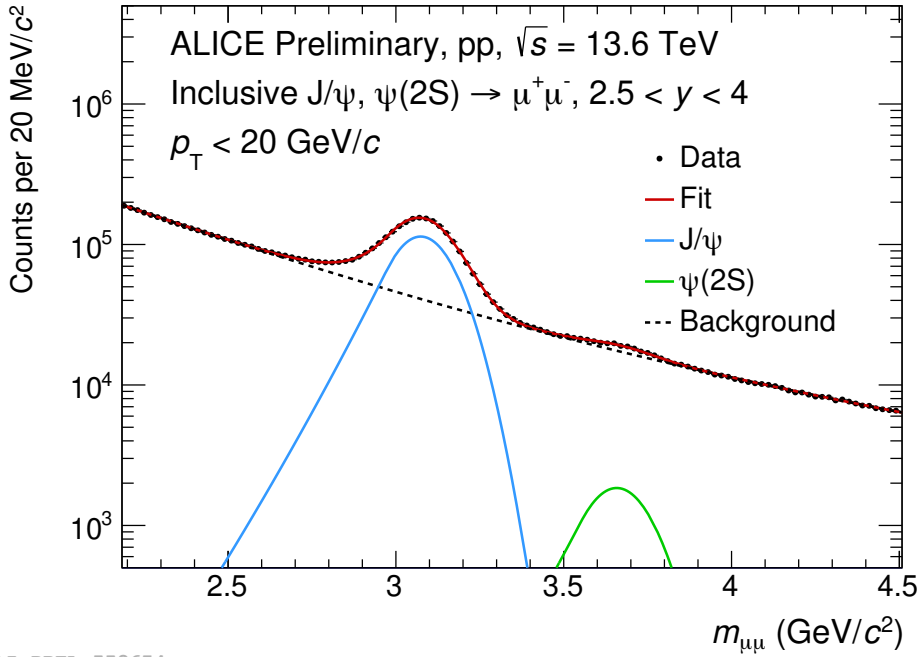
Charmed hadrons in Run 3



- Clear peaks of D mesons and Λ_c^+
- Results from 290B events recorded in 2022
- Promising

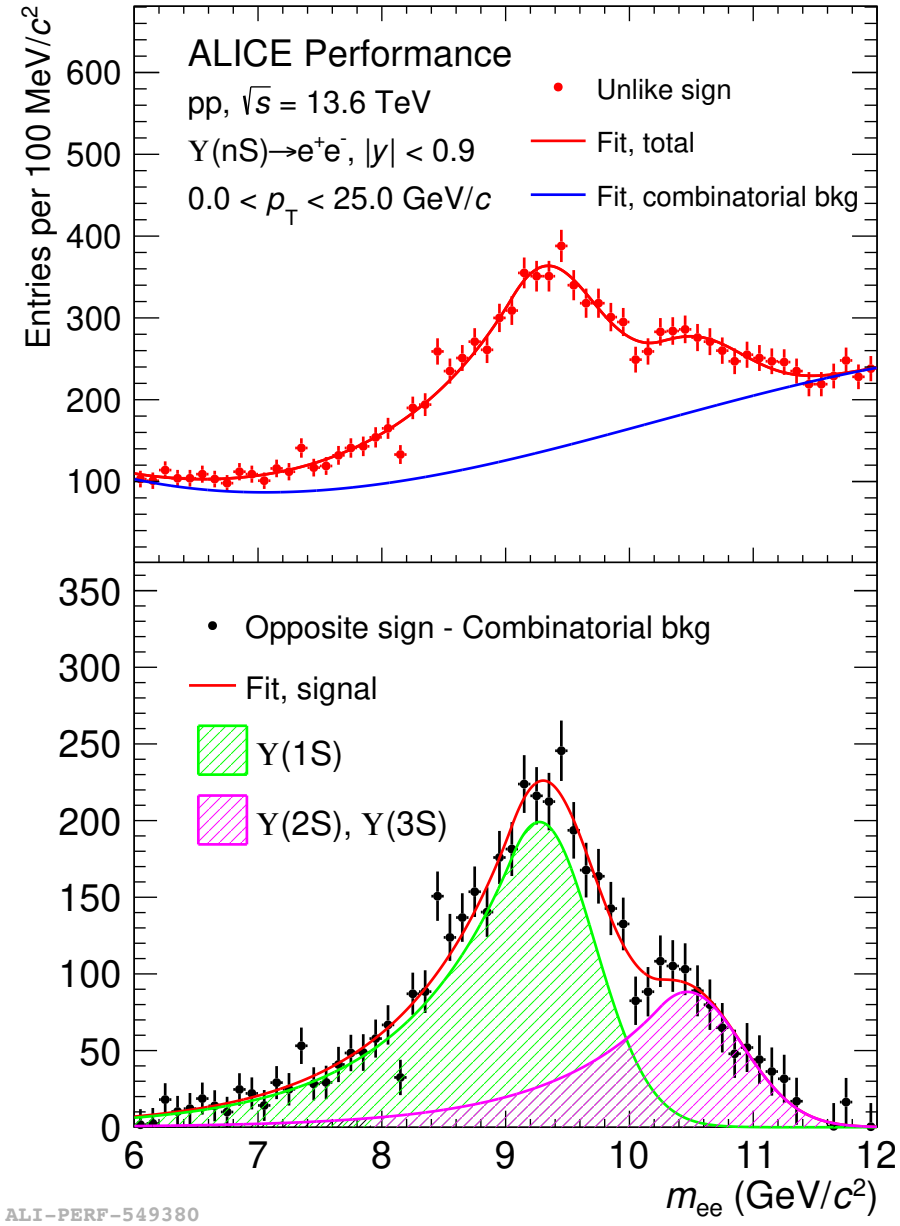
Charmonia in Run 3

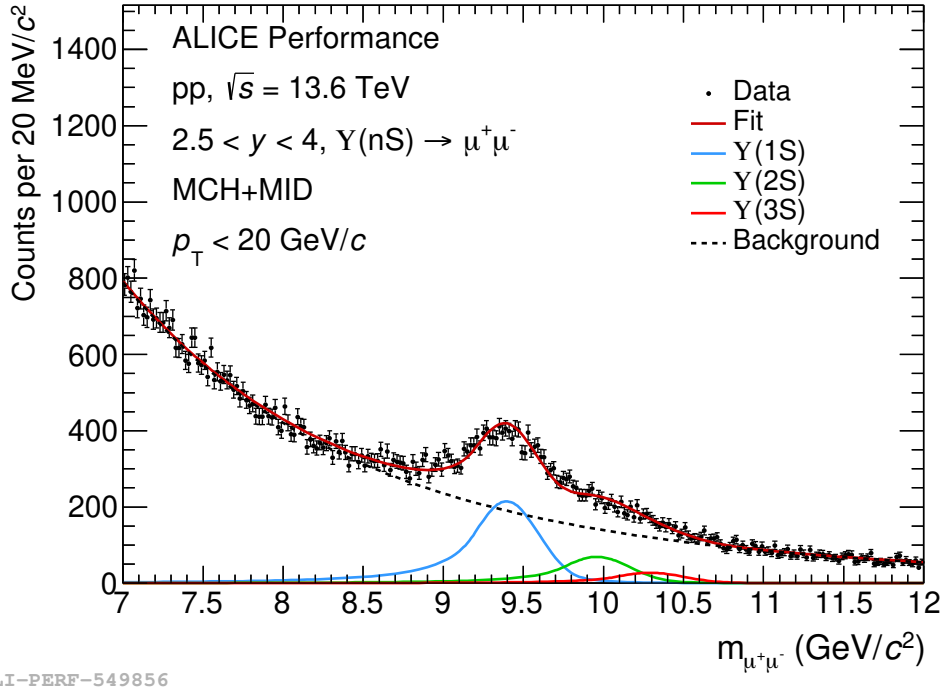




- Clear J/ψ and ψ(2S) peaks in both dielectron and dimuon channels

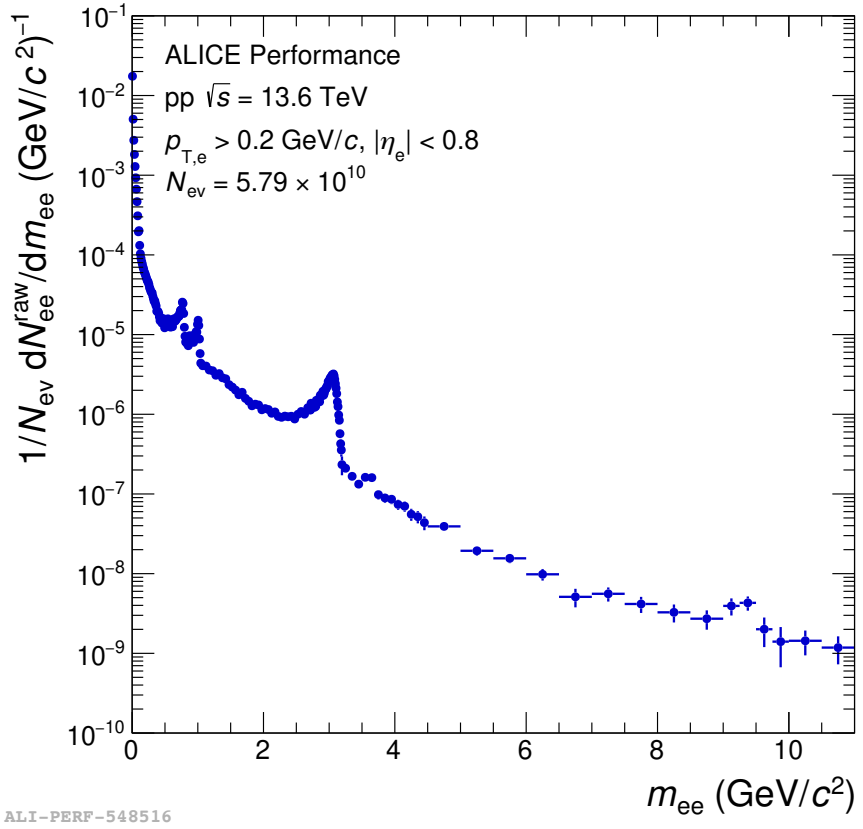
Bottomonia in Run 3

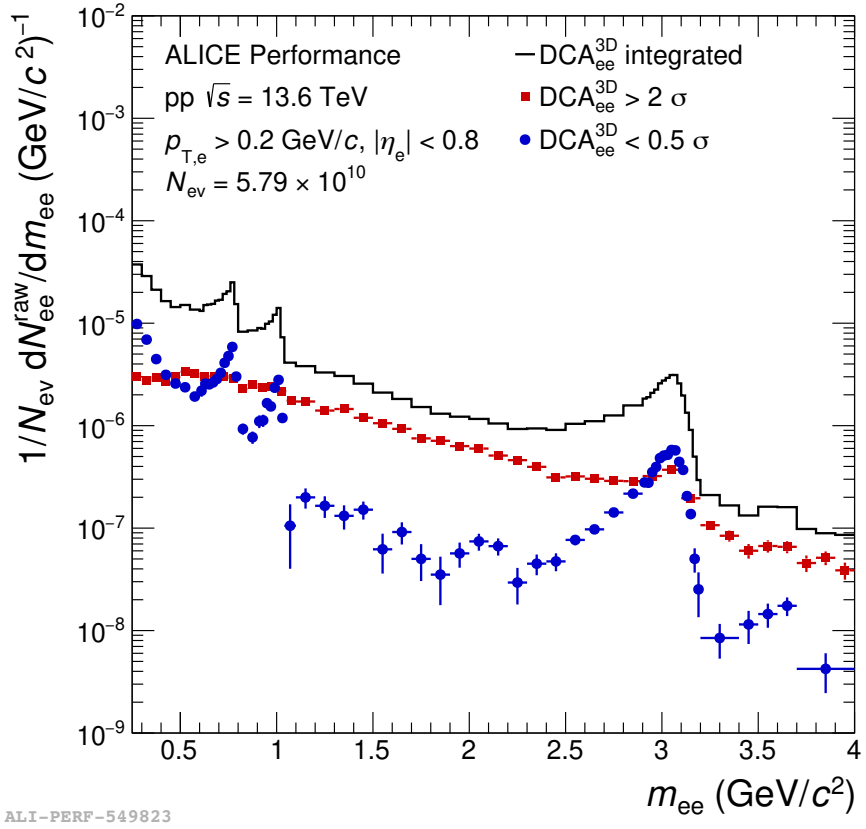


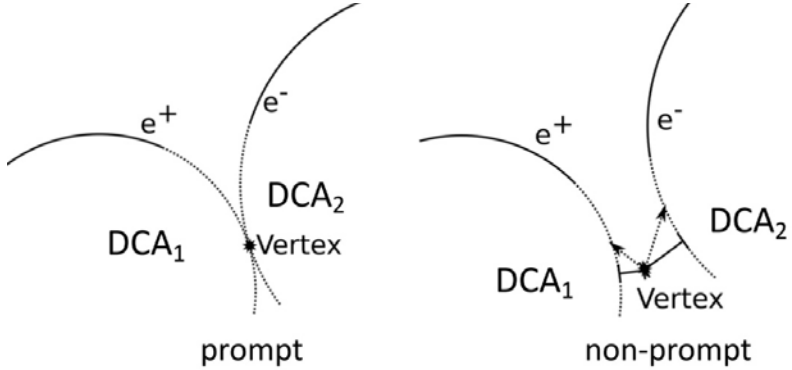


- First bottomonia peaks with dielectron channel in ALICE
  - 500B events analyzed
- Υ(1S), Υ(2S), Υ(3S) peaks

Dielectrons in Run3



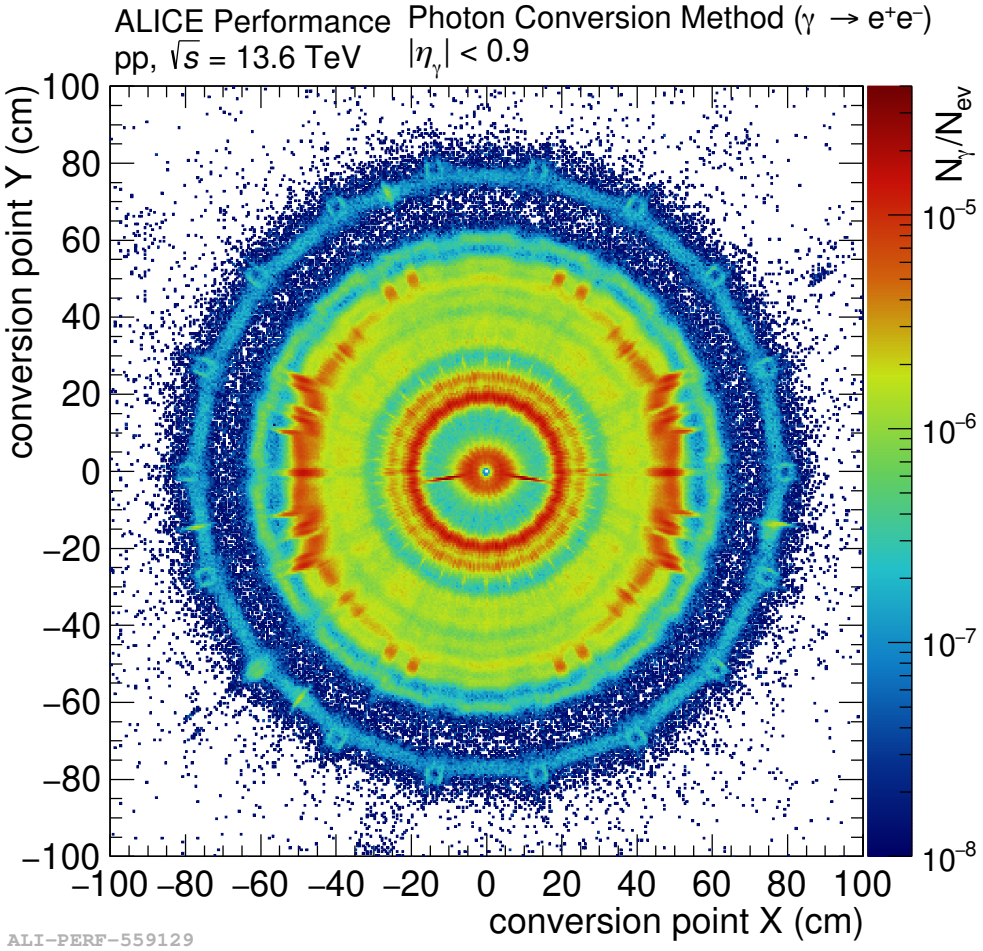


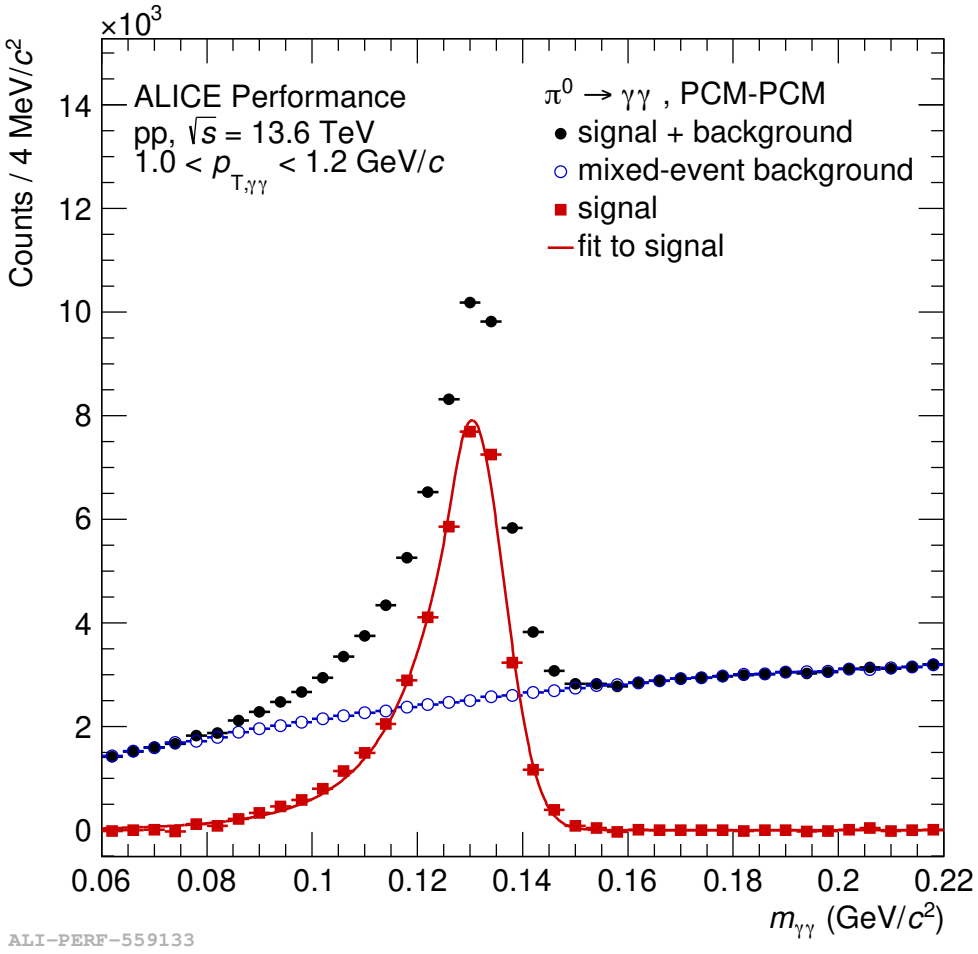


$$DCA_{ee} = \sqrt{\frac{DCA_1^2 + DCA_2^2}{2}}$$

- Clear π^0, η, ω/ρ, ϕ, J/ψ, ψ(2S), and ϒ signals and correlated HF→ee continuum
- DCA analysis based on different life time of emission sources (Distance of Closest Approach)
  - Prompt (mesons and possible thermal radiation)
  - Non-prompt (correlation HF→ee, cτ~150μm for D mesons, 400μm for B mesons)

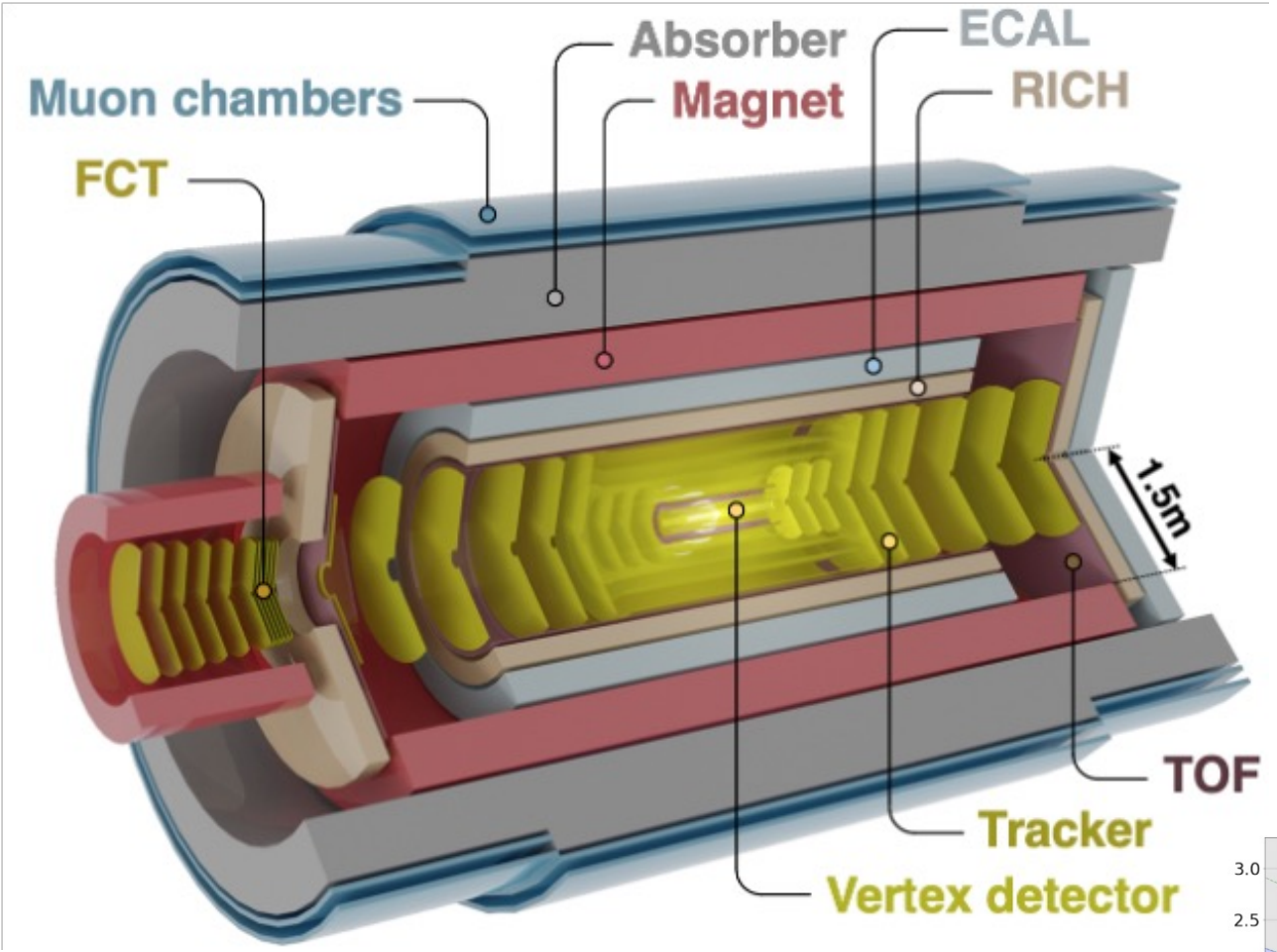
Photon conversions





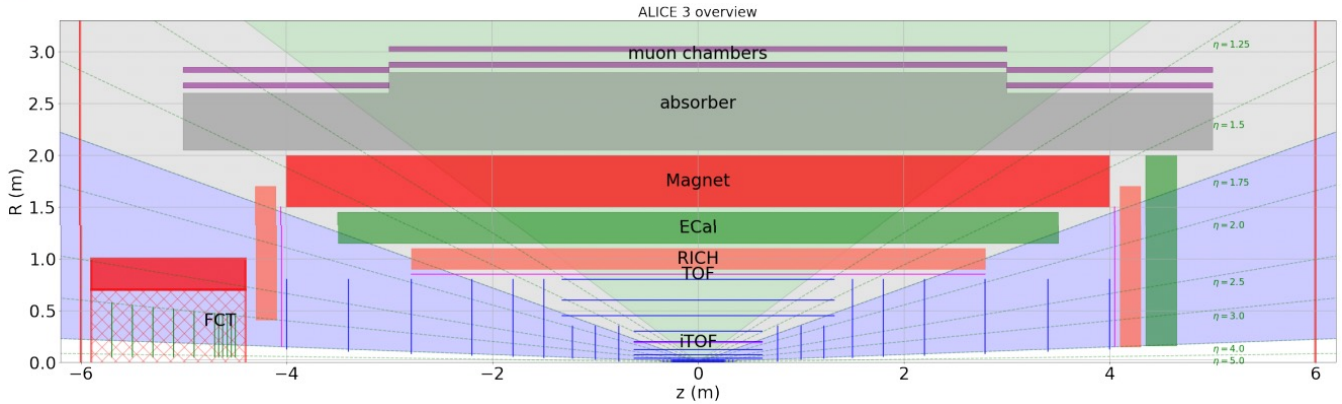
- Critical technique to measure photons at low p_T.
- ITS, TPC, and their support structures are visible.
- Clear reconstruction of $\pi^0 \rightarrow \gamma\gamma$

ALICE3



- Project after 2035
- Advanced silicon technology
  - High-rate data acquisition
  - Precise vertexing with retractable tracker
  - Strong particle identification at low p_T

LoI : arXiv:2211.02491



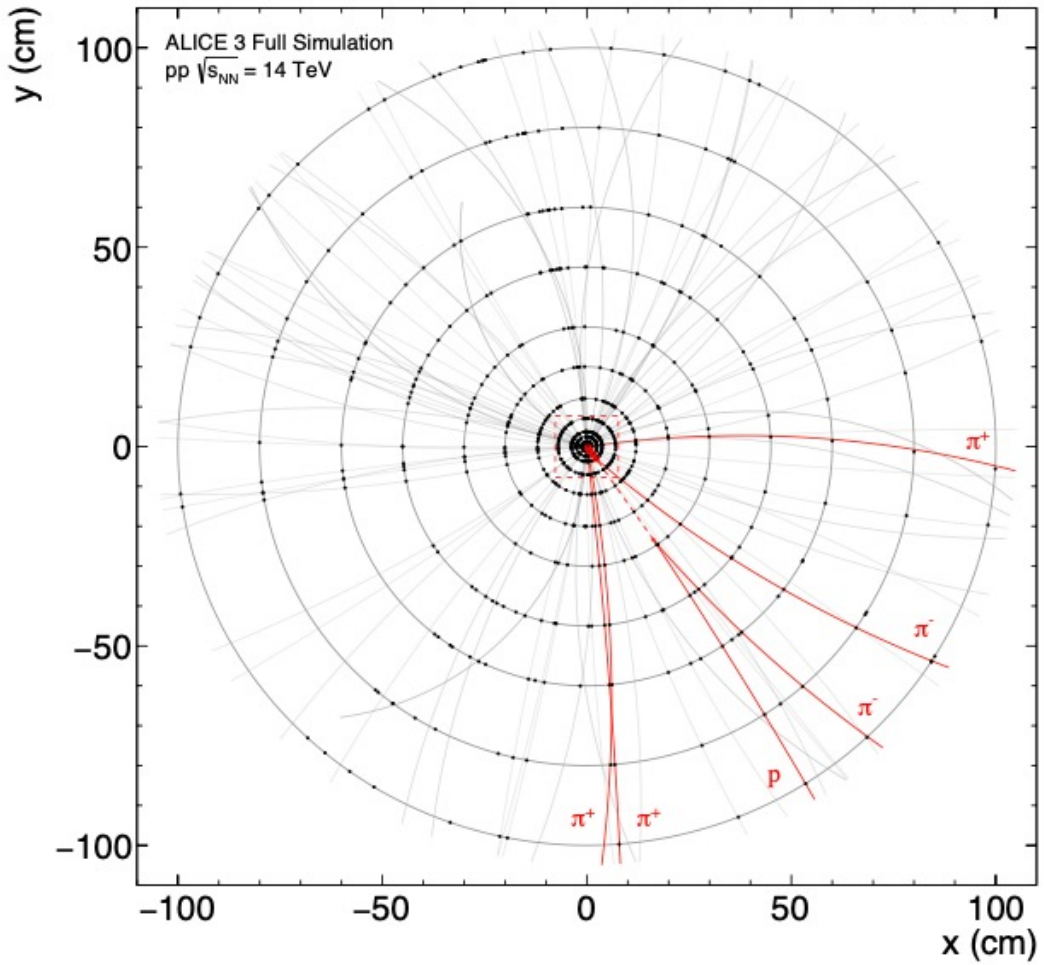
ALICE3 : Main physics goals – 2 pillars –

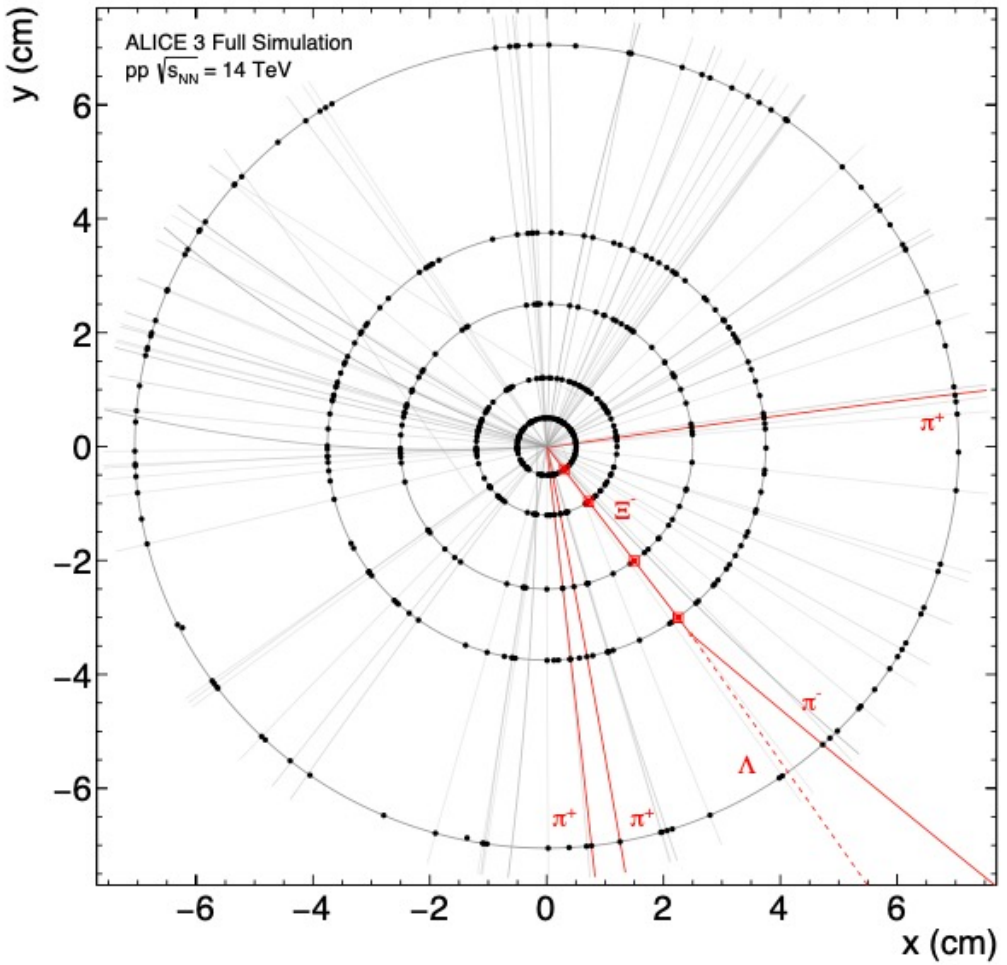
- Electromagnetic probes
  - Thermal radiation
  - Pre-equilibrium radiation
  - Chiral symmetry restoration

- Heavy flavors
  - Multi-charmed hadrons
  - Beauty baryons beyond Λ_b^0
  - XXXX

Again, high statistics and precise vertexing are crucial for both topics.

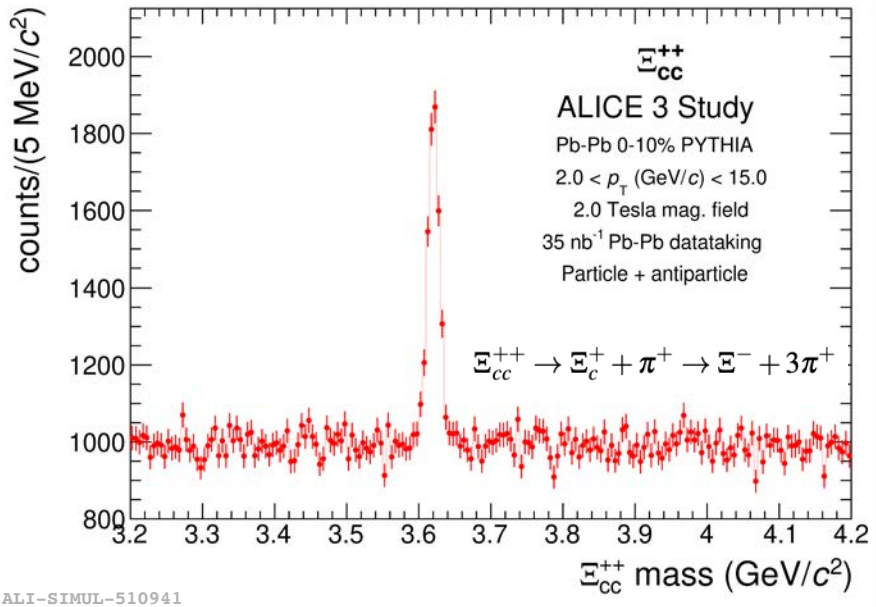
Strangeness tracking

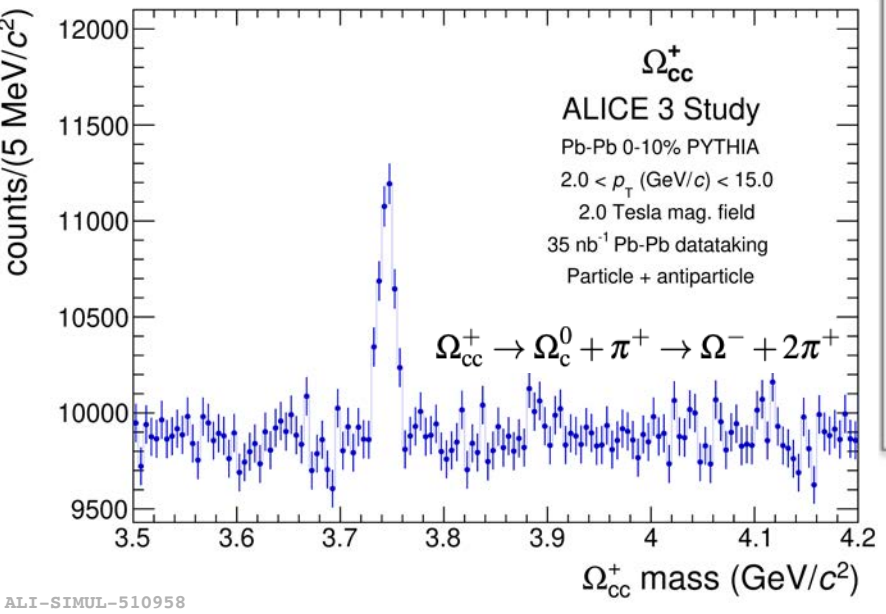


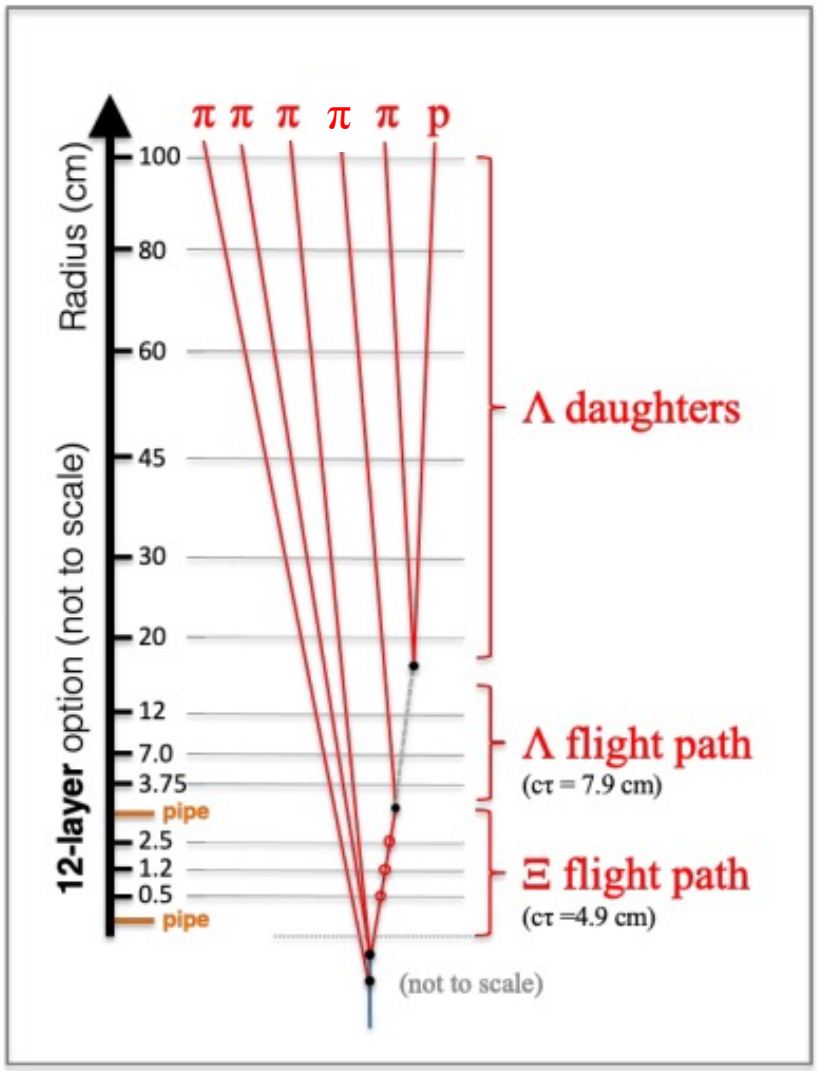


- Retractable tracker allows us to track hyperons, so-called “strangeness tracking”.
- Key to reconstruct multi-charmed hadrons

Multi-charmed hadrons



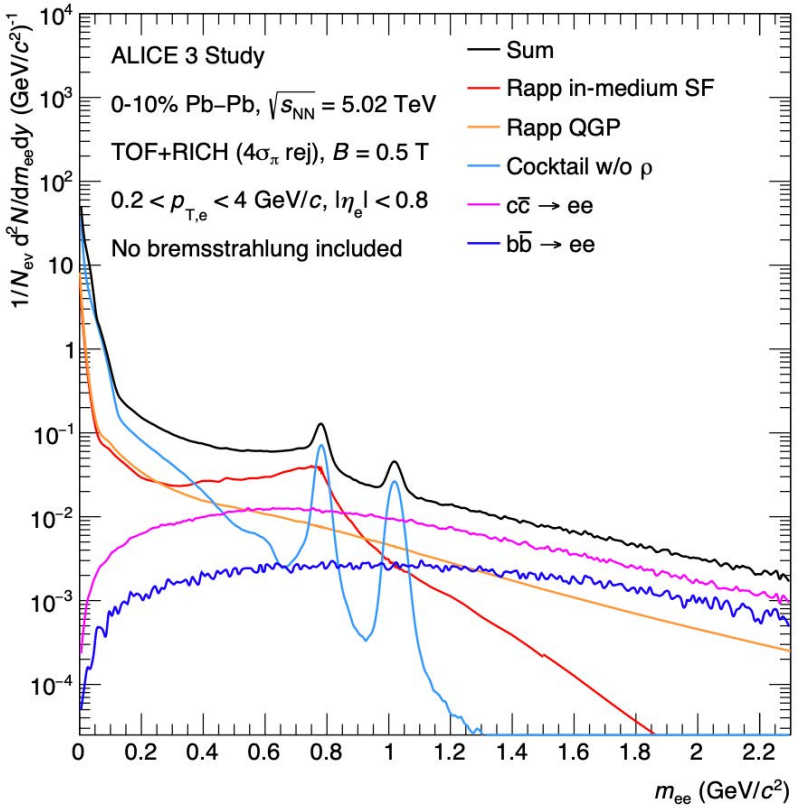


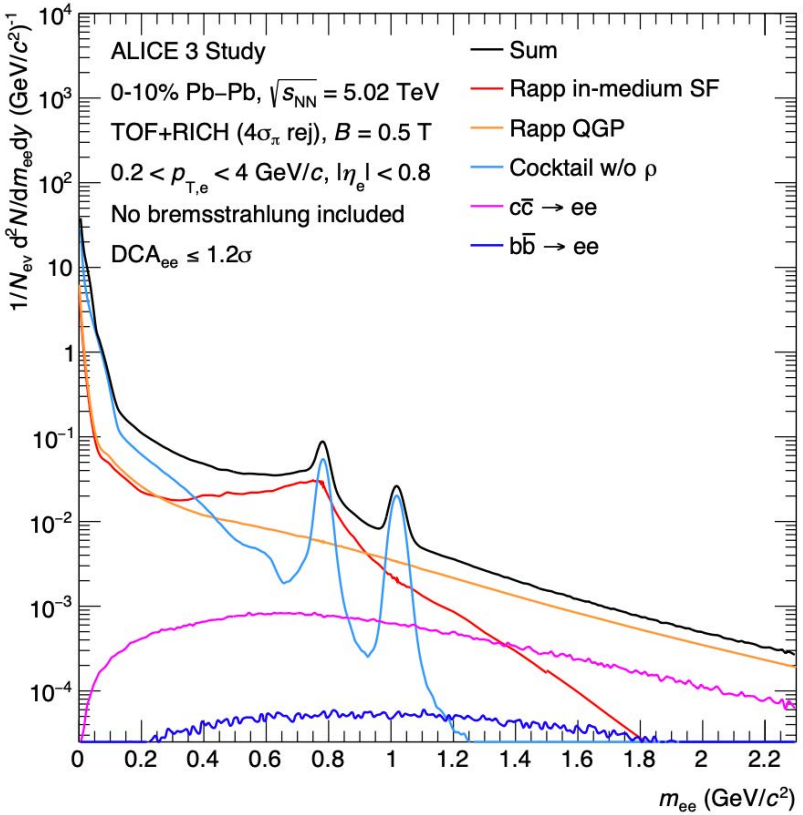


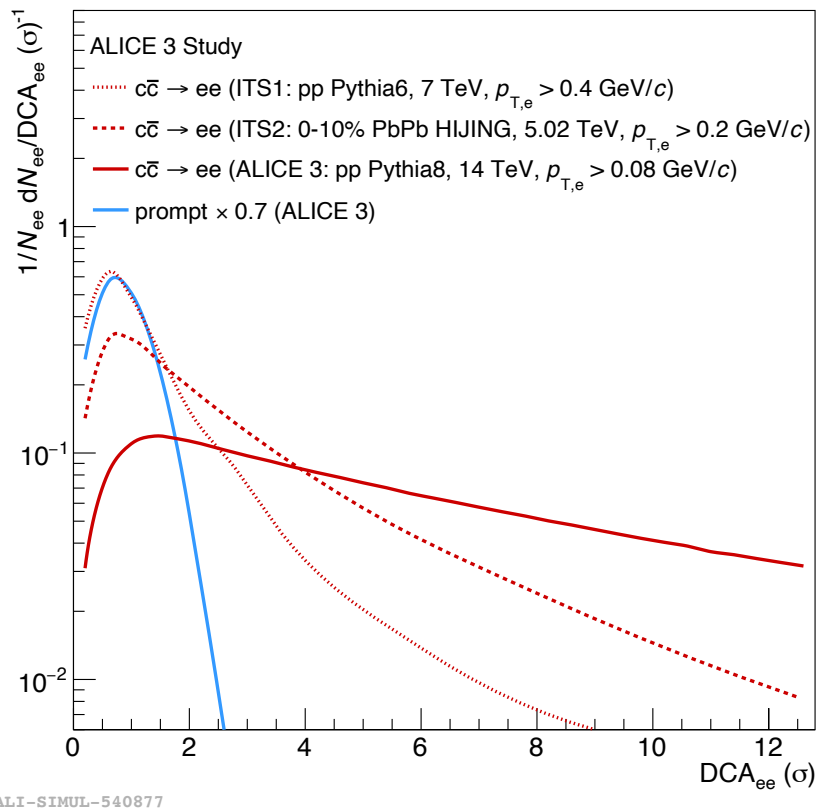
$\Xi_{cc}^{++} \to \Xi_c^+ + \pi^+ \to \Xi^- + 3\pi^+$

- Precise primary and secondary vertexing
- Necessary for multi-charmed hadrons and exotic hadrons.

Electromagnetic radiation

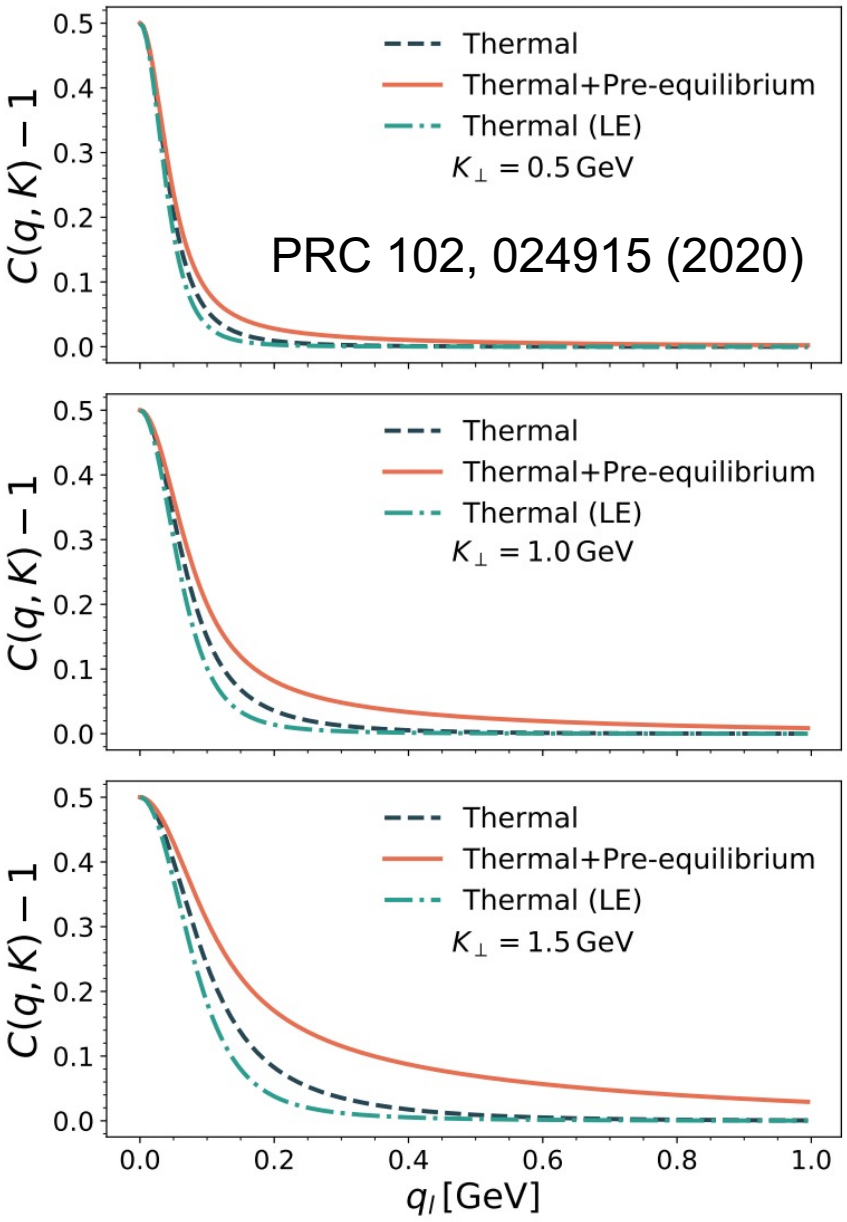






- Determine early stage of the collision
  - e.g. $dN/dm_{ee} \propto \exp(-m_{ee}/T)$ in $1.1 < m_{ee} < 2.0$ GeV/c^2.
- Electrons from charmed hadrons are main background.
  - precise vertexing is necessary.

Direct photon HBT



- Size of emission source (size of QGP)
- Disentangle direct photon puzzle

  - large yield (early emission) and large v_2 (late emission) of thermal photons are not understood.

- High-k_T diphoton pair provides insight on early stage of space-time evolution

PLB 837 (2023) 137647
arXiv:2308.09747
arXiv:2403.04846

Summary

- ALICE upgrade is successfully done during LS2.
- ALICE recorded high statistics in 2022 and 2023.
  - 28.2 pb^{-1} in pp at 13.6 TeV
  - 1.54 nb^{-1} in PbPb at 5.36 TeV
- Nice performance and physics preliminary plots from Run 3

- ALICE3 project with advanced silicon technology
  - retractable tracker in beam pipe
  - PID with TOF, RICH
  - 2 main pillars : EM probes and HF hadrons