RUN3

# Multiplicity Dependent Λ(1520) Production in pp Collisions in ALICE

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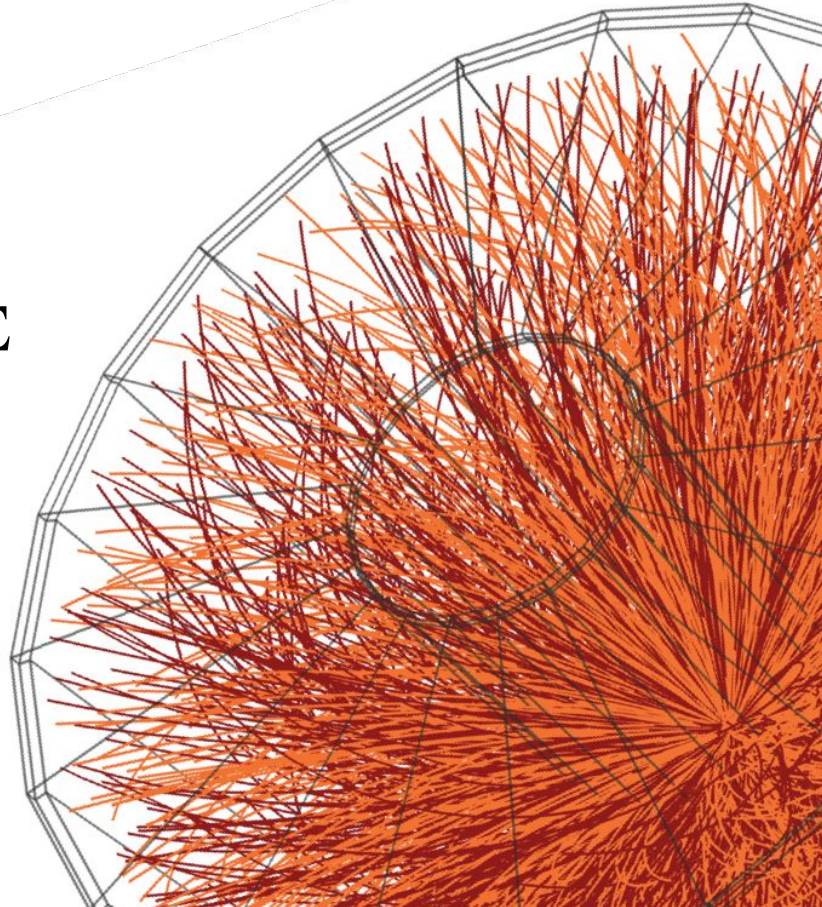


# Outline

- Motivation
- Analysis Method
  - Data samples and event selection
  - Track selection and PID selection
  - Signal extraction (inv. mass, fit, fit parameters)
  - Correction: Acceptance x Efficiency
- Normalised Spectra
- Summary and Outlook

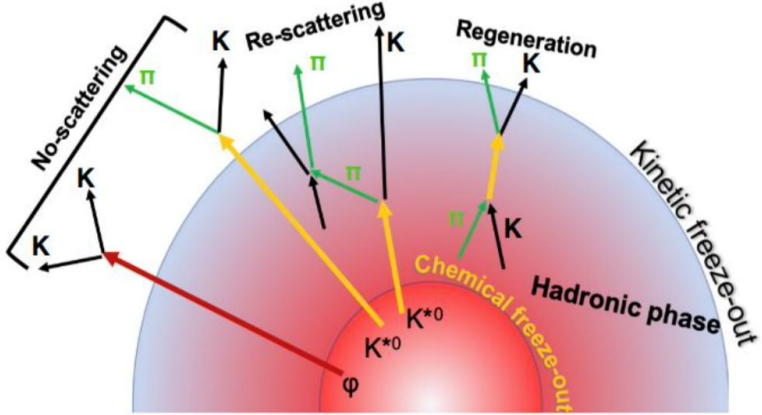
# Hadronic Resonances

Primary goal of ALICE is to study QGP: a state of quasi-free partonic medium formed at extreme high temperature and density in heavy-ion collisions

Hadronic resonances ($\rho^0$, $\phi$, $\Lambda^*$, $K^{*0}$, $\Sigma^*$, $\Xi^*$ etc.) have lifetimes of the order of fm/c

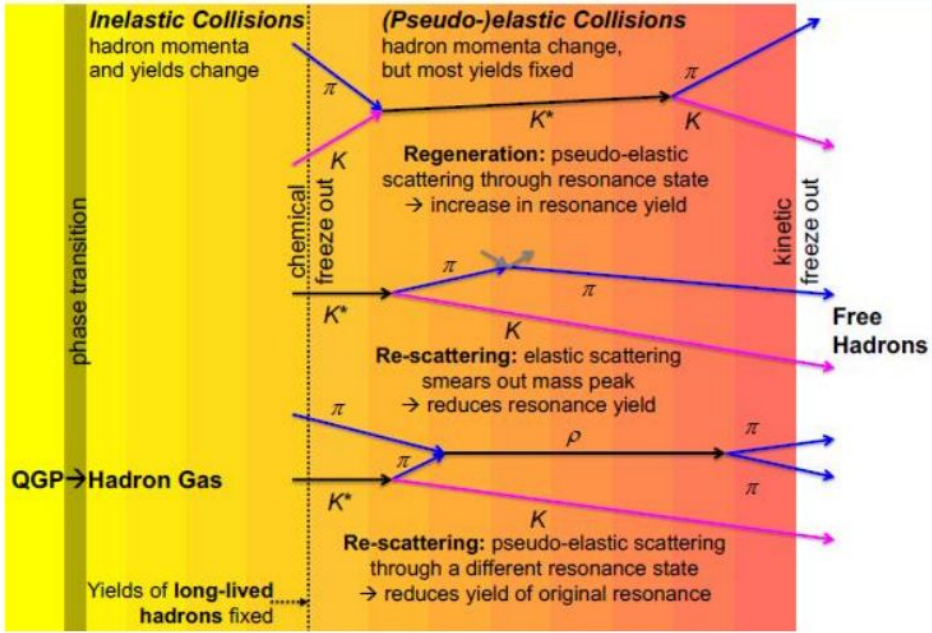
$$\tau_{resonance} \sim \tau_{fireball}$$

Hadronic resonances are good candidates to probe the various stages of the evolution of the QCD fireball and the properties of the strongly-coupled QCD matter




**Lifetime (fm/c):**
**$\rho(1.3) < K^{*0}(4.2) < \Sigma^*(5.5) < \Lambda^*(12.6) < \Xi^*(21.7) < \phi(46.2)$**

# Hadronic Resonances



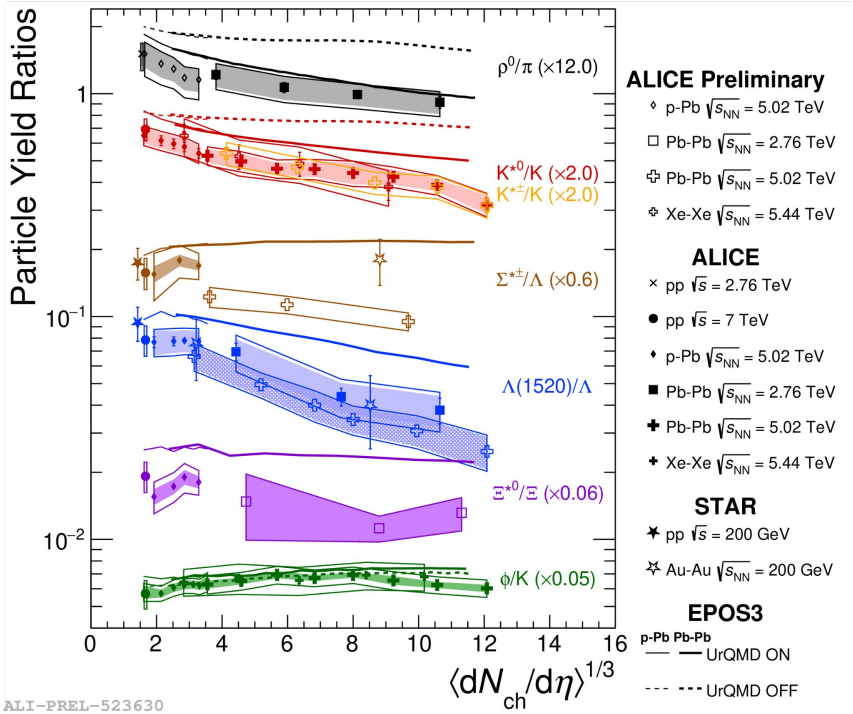

Measured resonance yield is affected by hadronic processes after chemical freeze-out:
Re-scattering phenomena: Elastic scattering or pseudo-elastic scattering
→ Reduction of the resonance yield

Regeneration phenomena: Pseudo-elastic scattering

→ Enhancement of the resonance yield

**Final resonance yields depend on**:
- Chemical freeze out temperature
- Lifetime of hadronic phase
- Resonance lifetimes
- Scattering cross sections of decay products

# Motivation for Choosing Λ(1520)




- Lifetime of Λ(1520) resonance (τ ~ 12.6 fm/c) is longer than $K^{*0}(892)$ meson (τ ~ 4.16 fm/c) but shorter than the $\phi$ (1020) meson (τ ~ 46.3 fm/c)

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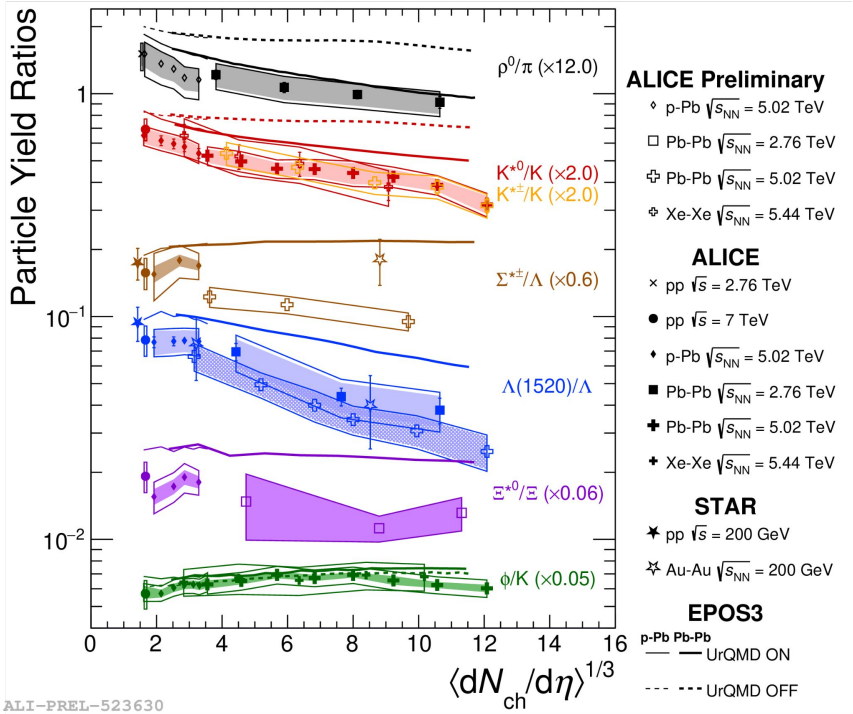


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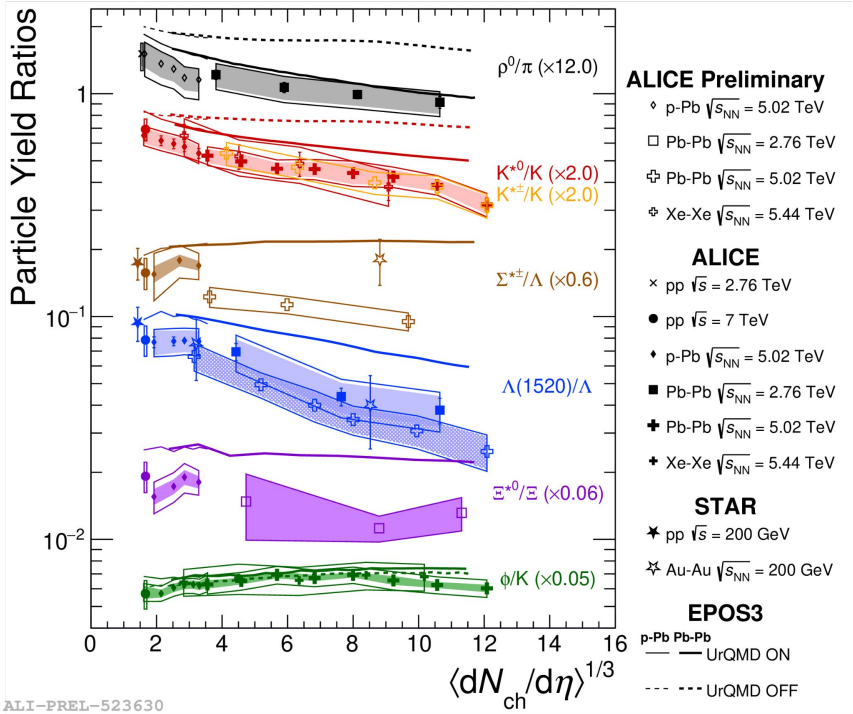


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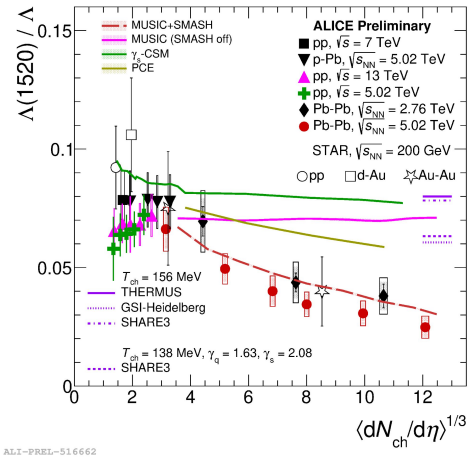
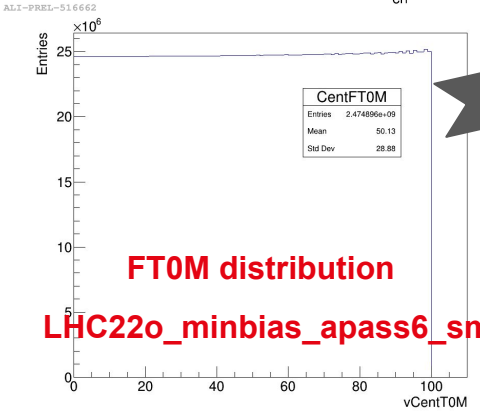
- Previous measurements show that the yield of $K^{*0}(892)$ is found to be suppressed also in small system, whereas $\phi(1020)$ meson is not suppressed
- Makes Λ(1520) resonance an optimal probe to set an upper limit to the lifetime of the hadronic phase.

# Motivation for Analysing Run3 data



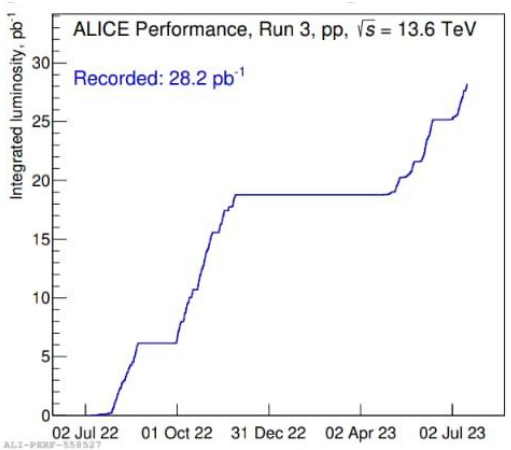

FT0M distribution

LHC22o_minbias_apass6_small

| CentFT0M | |
|---|---|
| Entries | 2.474896e+09 |
| Mean | 50.13 |
| Std Dev | 28.88 |

Run Number: 526641

- **13.6 TeV**: Largest data sample available
  - Enables differential resonance studies (eg. resonance flow, correlation study)
  - Yield measurements as initial confirmation for the analysis framework




28.2 pb$^{-1}$ in pp at 13.6 TeV ~ 2T collisions

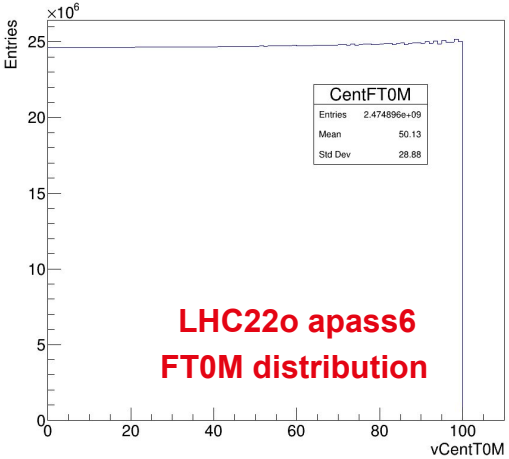
# Data Samples and Event Selection

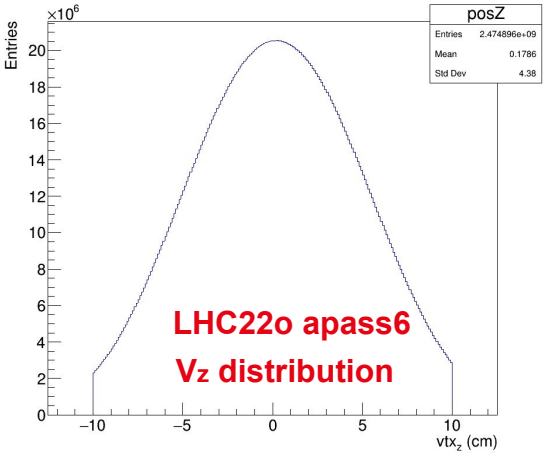
- **pp 13.6 TeV**
  - **Data set:** LHC22o_pass6_minBias_small

    **Accepted events:** ~ 2.5B
  - **MC:** LHC23f3b

    **~400k** events (unanchored resonance injected MC)
  - Anchored reproduction: Ongoing - QA has issues

- **Event selection:** sel8(), $|V_z| < 10$ cm



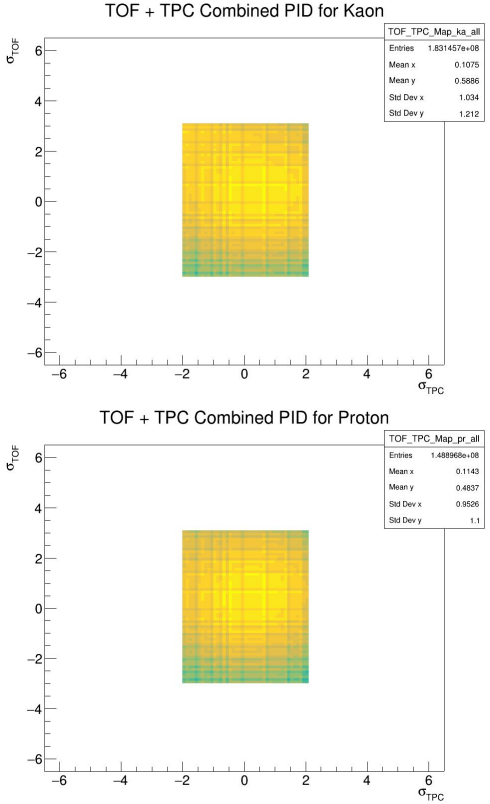



# Track Selection and PID Selection

- **Track and PID selections**

| Selection Criteria | Λ(1520) |
|---|---|
| isGlobalTrack()<br>kQualityTracks \| kPrimaryTracks \| kInAcceptanceTracks | 🎯 |
| $\|DCA_{xy}\|$ | < 0.1 cm |
| $\|DCA_{z}\|$ | < 0.1 cm |
| *nTPCXrows* > 70 | 🎯 |
| $p_T$ > 0.15 GeV/c | 🎯 |
| $\|\eta\|$ < 0.8 | 🎯 |
| $\|y_{pair}\|$ < 0.5 | 🎯 |
| $\|\sigma_{TPC}\|$ < 2.0 | for K upto 0.5 GeV/c<br>for p upto 0.8 GeV/c |
| $\|\sigma_{TOF}\|$ < 2.0<br>$\|\sigma_{TPC}\|$ < 3.0 as VETO if hasTOF() | for K upto 5 GeV/c<br>for p upto 8 GeV/c |

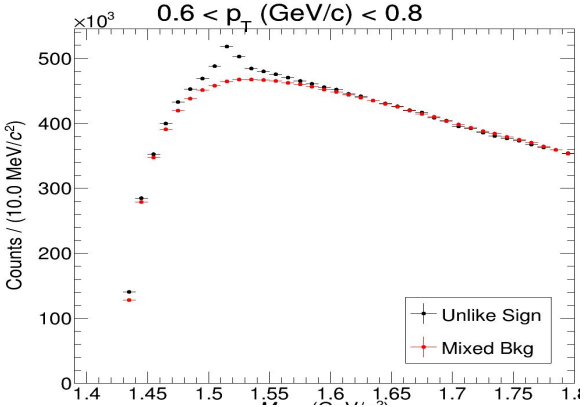
**TPC-TOF nσ map of Λ(1520) daughters**

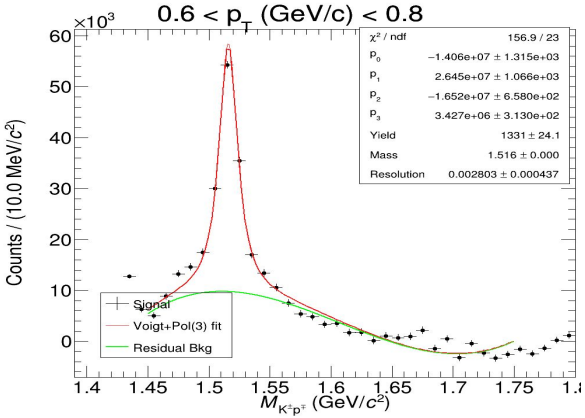


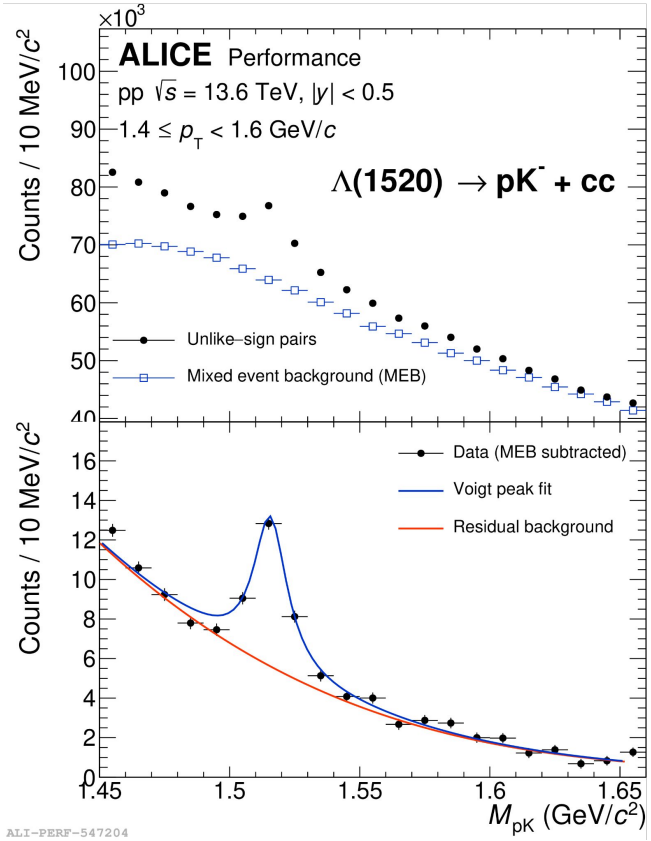
# Analysis Details

- **Invariant mass distribution** from **p+K** unlike-sign pair.
- **Background:**
  - Mixed-event
- **$p_T$ intervals:**
  - [0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 3.0, 3.5, 4.0, 5.0, 6.0]
- **Fit:**
  - Voigtian + 3rd order polynomial
- **Mixed-event bkg.:**
  - Number of Event mixing = 5, Difference in |Vz| < 1 cm, in FT0M Multiplicity bin < 10%

# Signal Extraction: Invariant Mass Distribution

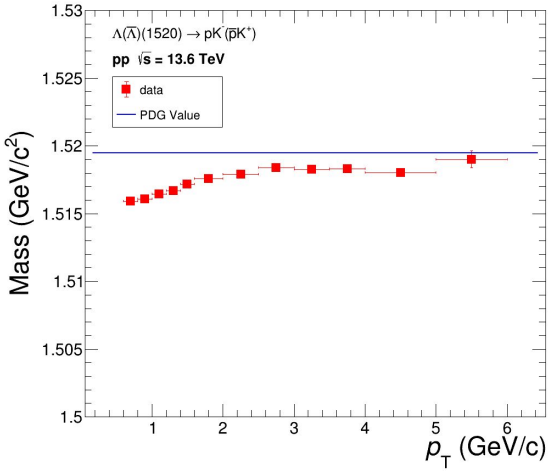


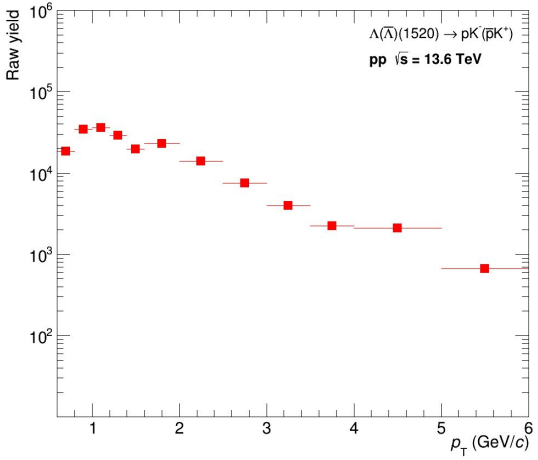




- **Examples of invariant mass distribution**
- **Fit with fixed signal widths (PDG value)**
  - Voigtian + 3rd order polynomial

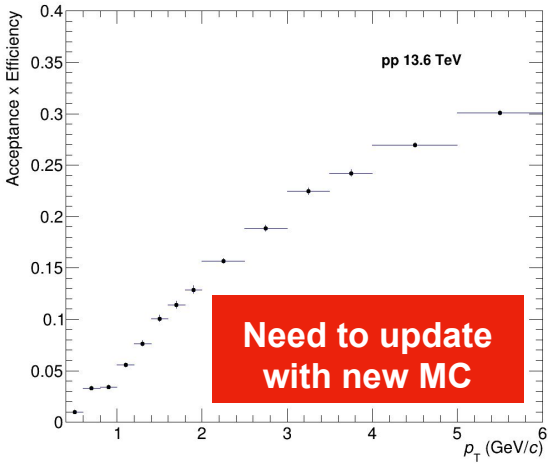
# Signal Extraction: Fit Parameters



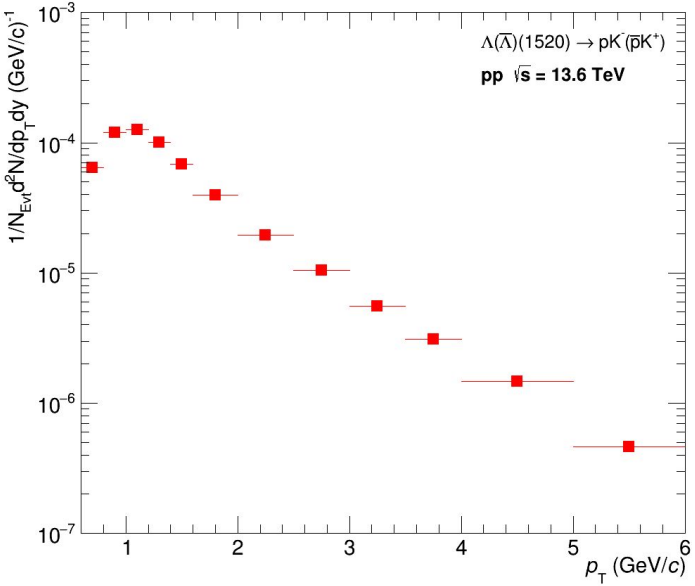

- **Fit mean:** at lower $p_T$ bin shifted: Similar behaviour with the Run 2
  - **Line**: PDG value
- **Raw yields**:
  - Extracted from the bin counting method.
  - Fit width is fixed to the PDG value.

# Reconstruction Efficiency



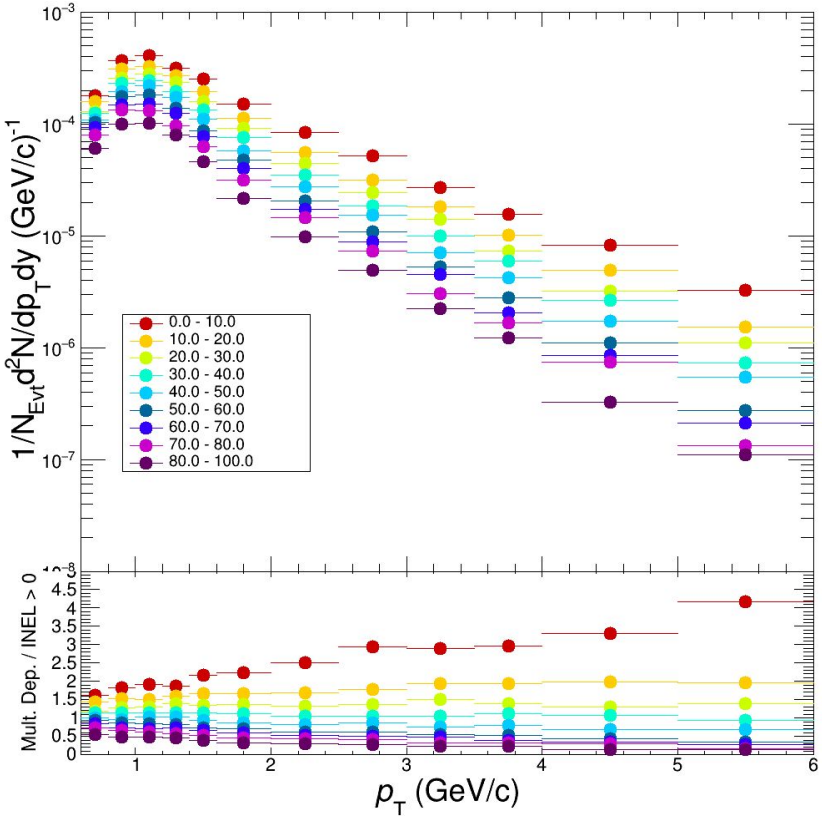

- **Acceptance x Efficiency =** Number of reconstructed **Λ(1520)** decays to **p+K** using analysis acceptance and cut / Number of generated **Λ(1520)** in |y|<0.5
- **Used MC:**
  - Resonance injected MC (LHC23f3a)

# Normalised $p_T$ Spectra (MB)




- **Normalised spectra:** $\frac{1}{N_{evt}} \frac{d^2N}{dp_T dy} = \frac{1}{N_{evt}} \frac{Y_{raw}}{dp_T dy}$ B.R.

# Normalised $p_T$ Spectra (INEL > 0)




Normalised spectra

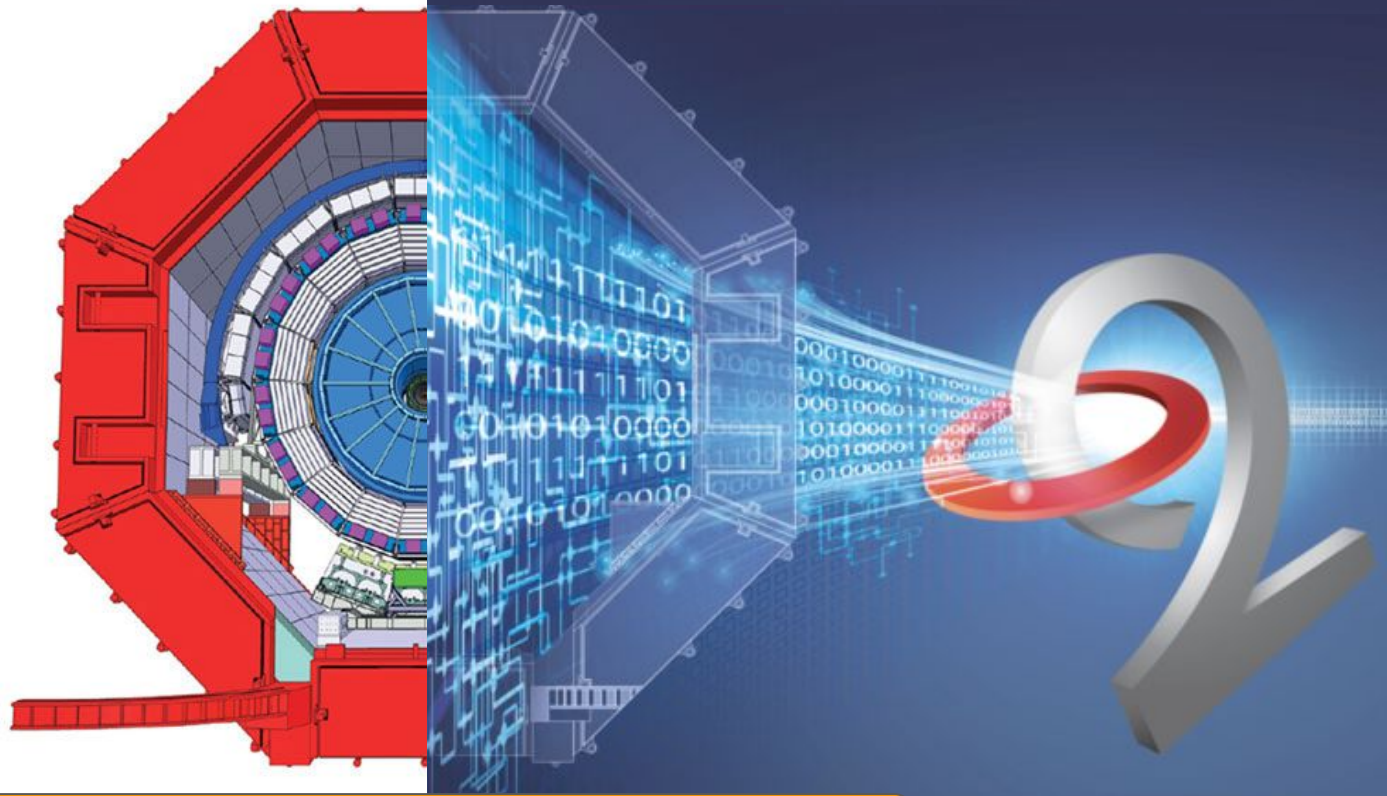
- Hardening of spectra is observed

# Summary and Outlook

- Summary:
  - Signal Extraction has been done - Performance plot approved for 13.6 TeV.
  - Yield extraction has been done for INEL > 0 events.

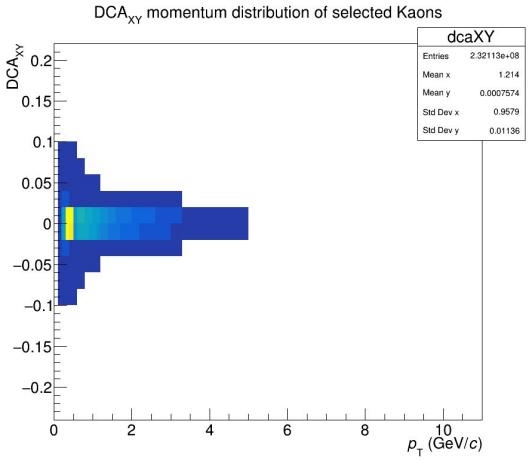
  Analysis Note: https://alice-notes.web.cern.ch/node/1449

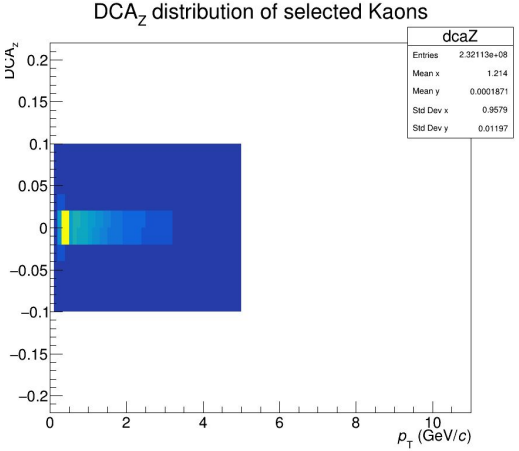
- Outlook:
  - Finalisation of anchored MC production
  - Wrap up the study for preliminary.

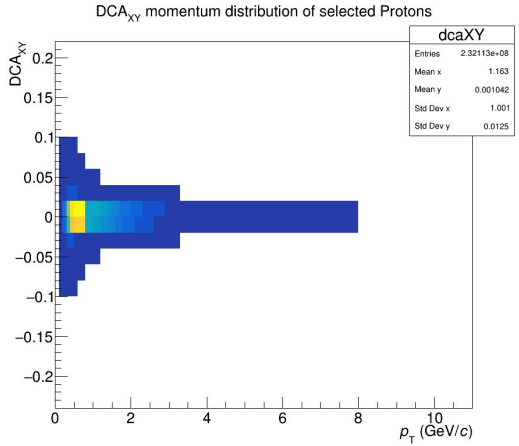


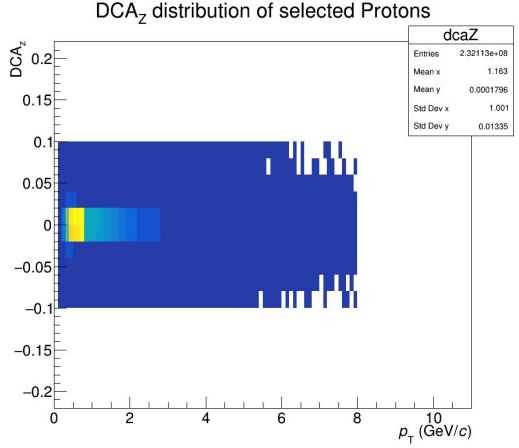
Thank you for your attention

# Back up


DCA$_{XY}$ momentum distribution of selected Kaons
dcaXY
Entries 2.32113e+08
Mean x 1.214
Mean y 0.0007574
Std Dev x 0.9579
Std Dev y 0.01136
DCA$_{XY}$
$p_T$ (GeV/$c$)


DCA$_Z$ distribution of selected Kaons
dcaZ
Entries 2.32113e+08
Mean x 1.214
Mean y 0.0001871
Std Dev x 0.9579
Std Dev y 0.01197
DCA$_Z$
$p_T$ (GeV/$c$)


DCA$_{XY}$ momentum distribution of selected Protons
dcaXY
Entries 2.32113e+08
Mean x 1.163
Mean y 0.001042
Std Dev x 1.001
Std Dev y 0.0125
DCA$_{XY}$
$p_T$ (GeV/$c$)


DCA$_Z$ distribution of selected Protons
dcaZ
Entries 2.32113e+08
Mean x 1.163
Mean y 0.0001796
Std Dev x 1.001
Std Dev y 0.01335
DCA$_Z$
$p_T$ (GeV/$c$)