

An Express Data Production Chain in the STAR Experiment

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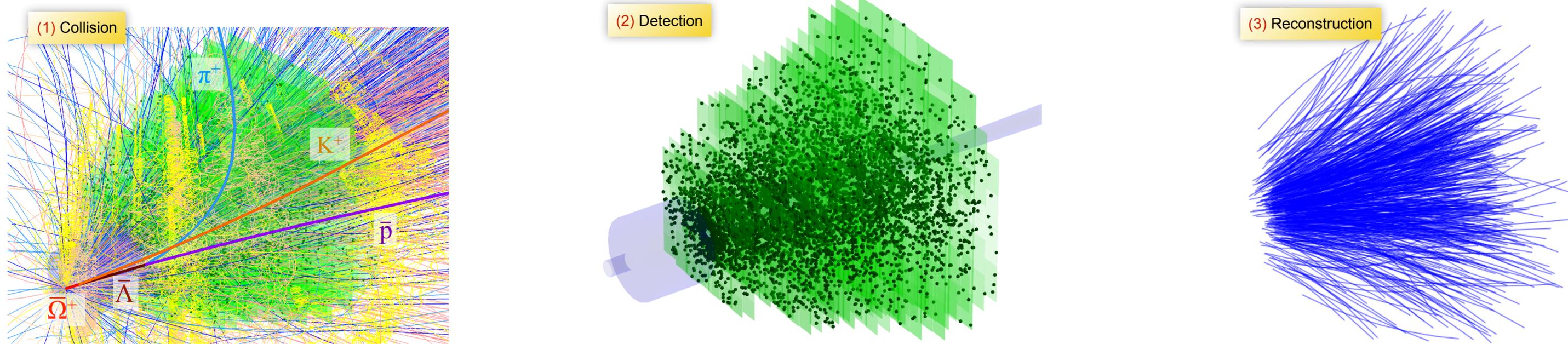
³GSI Helmholtz Center for Heavy Ion Research, Darmstadt, Germany

⁴BNL Brookhaven National Laboratory, Upton, NY, USA

⁵Kent State University, Kent, OH, USA

- CBM experiment and FAIR Phase-0
- STAR BES-II: Express data production
- STAR BES-II: Express physics analysis
- STAR BES-II: Express workflow diagram
- Summary and perspectives

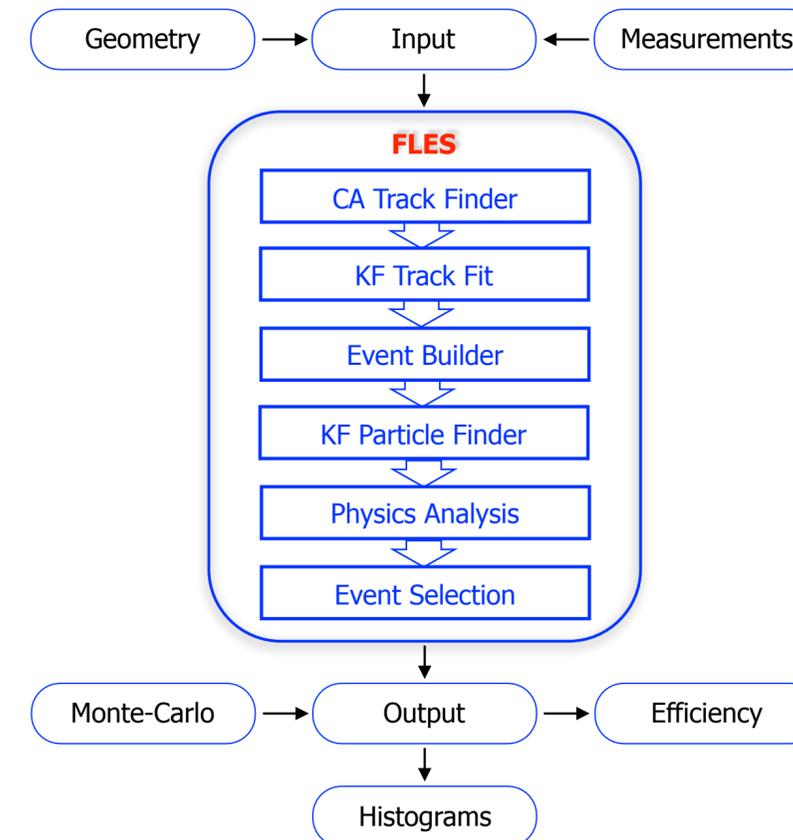
Reconstruction Challenge in CBM



The full event reconstruction will be done **on-line** at the **First-Level Event Selection (FLES)** and **off-line** using the same **FLES** reconstruction package.

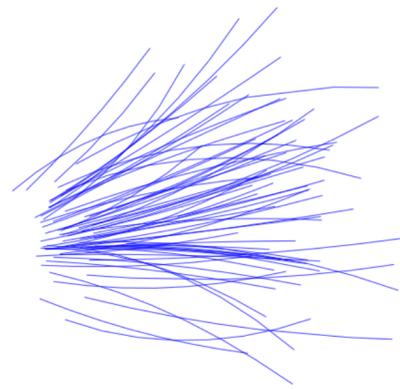
- Cellular Automaton (CA) Track Finder
- Kalman Filter (KF) Track Fitter
- KF short-lived Particle Finder

All reconstruction algorithms are **vectorized** and **parallelized**.

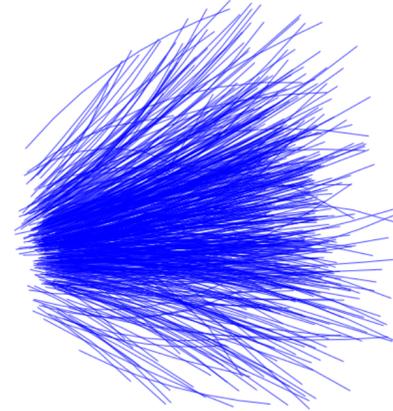


CBM STS Cellular Automaton Track Finder

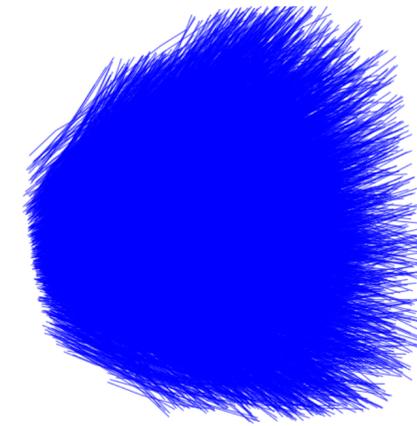
A number of minimum bias events is gathered into a group (super-event), which is then treated by the CA track finder as a single event.



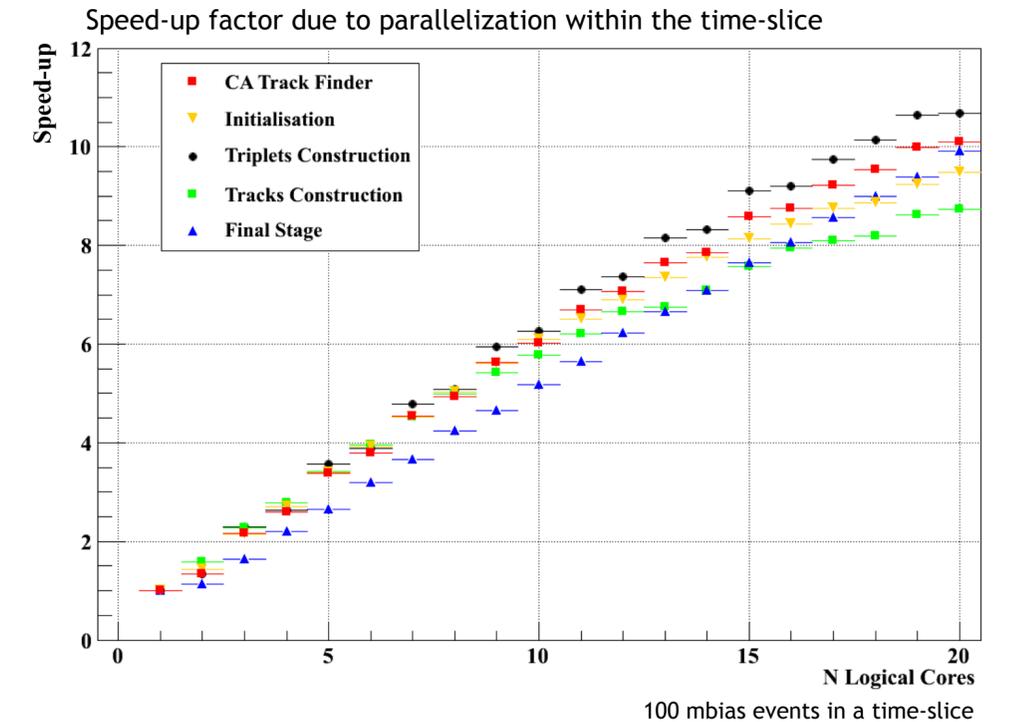
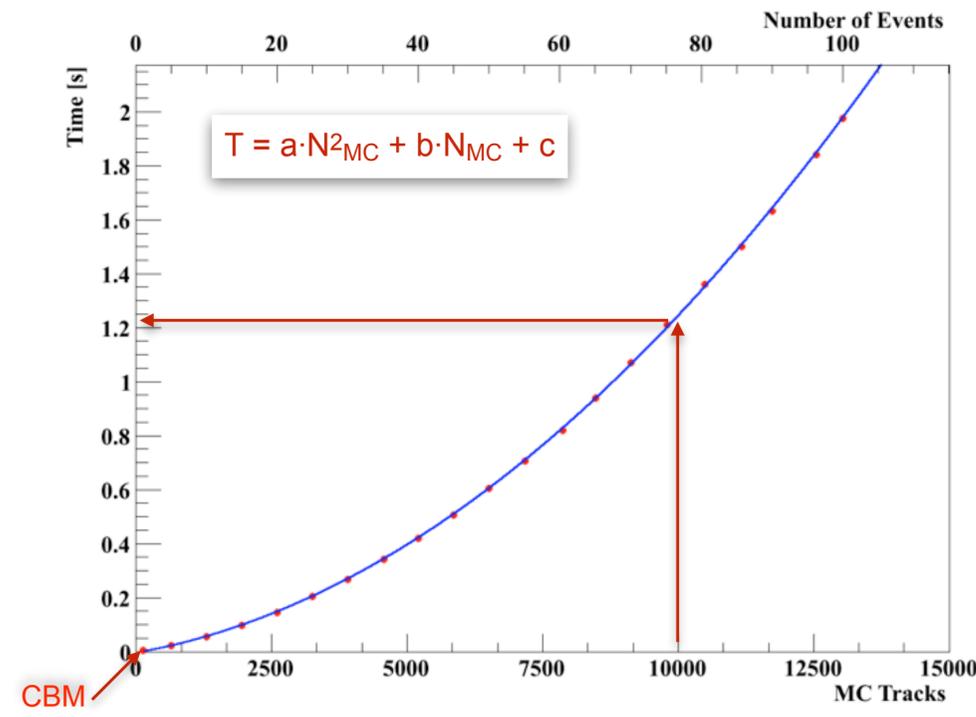
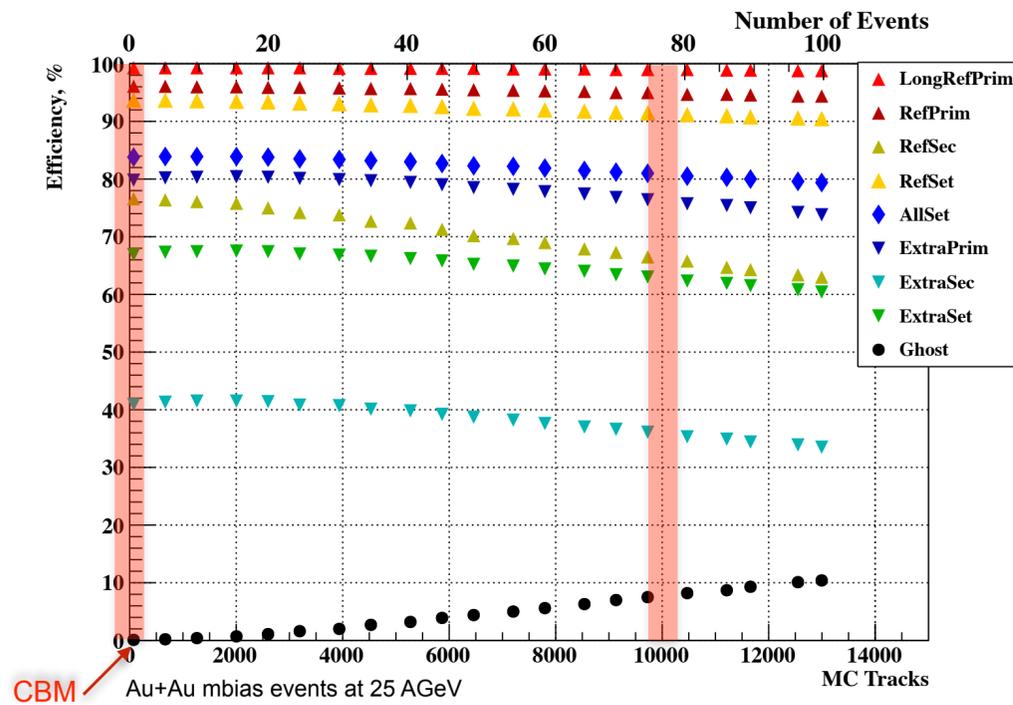
1 mbias event, $\langle N_{reco} \rangle = 109$



5 mbias events, $\langle N_{reco} \rangle = 572$

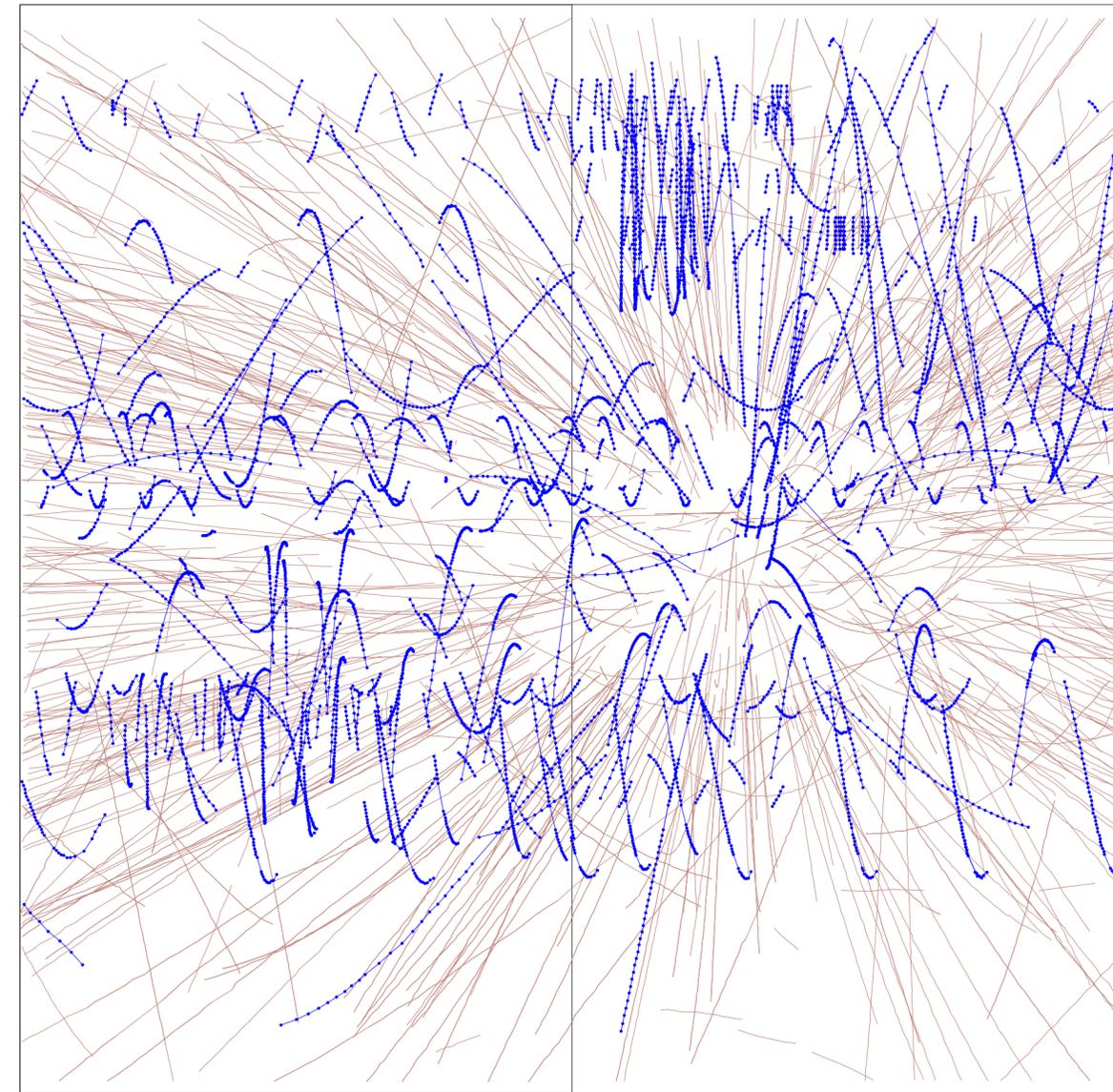
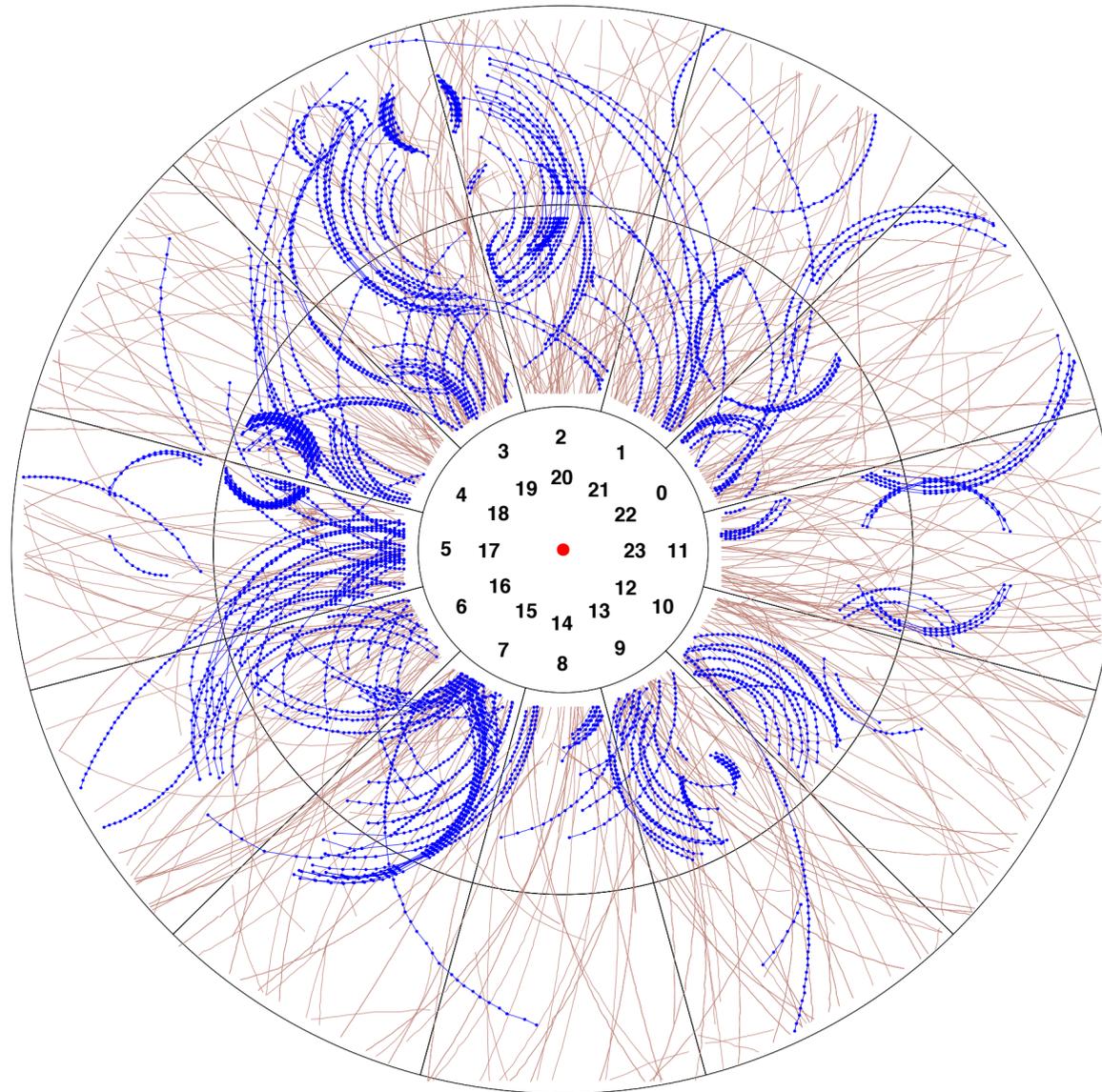


100 mbias events, $\langle N_{reco} \rangle = 10340$



Reliable reconstruction efficiency, time as a second order polynomial w.r.t. to the track multiplicity, 3D time is recovered in 4D

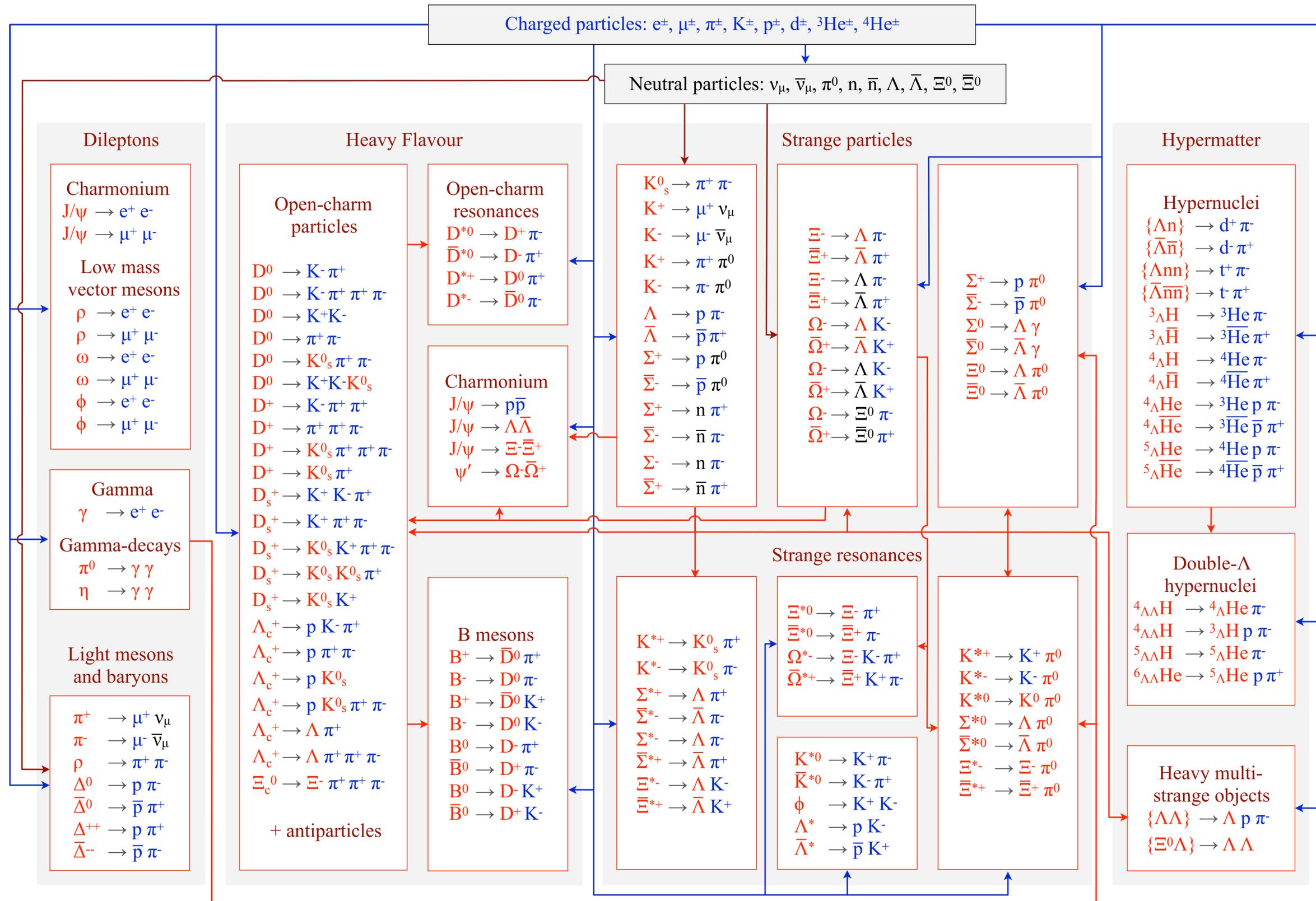
STAR TPC Cellular Automaton Track Finder



- The CA track finder has been extended to find loopers of **low-momentum** particles (+ GenFit).
- Solution of the looper problem allows us to **increase** the pseudo rapidity **acceptance** for tracks with $p_T < 0.4$ GeV/c.

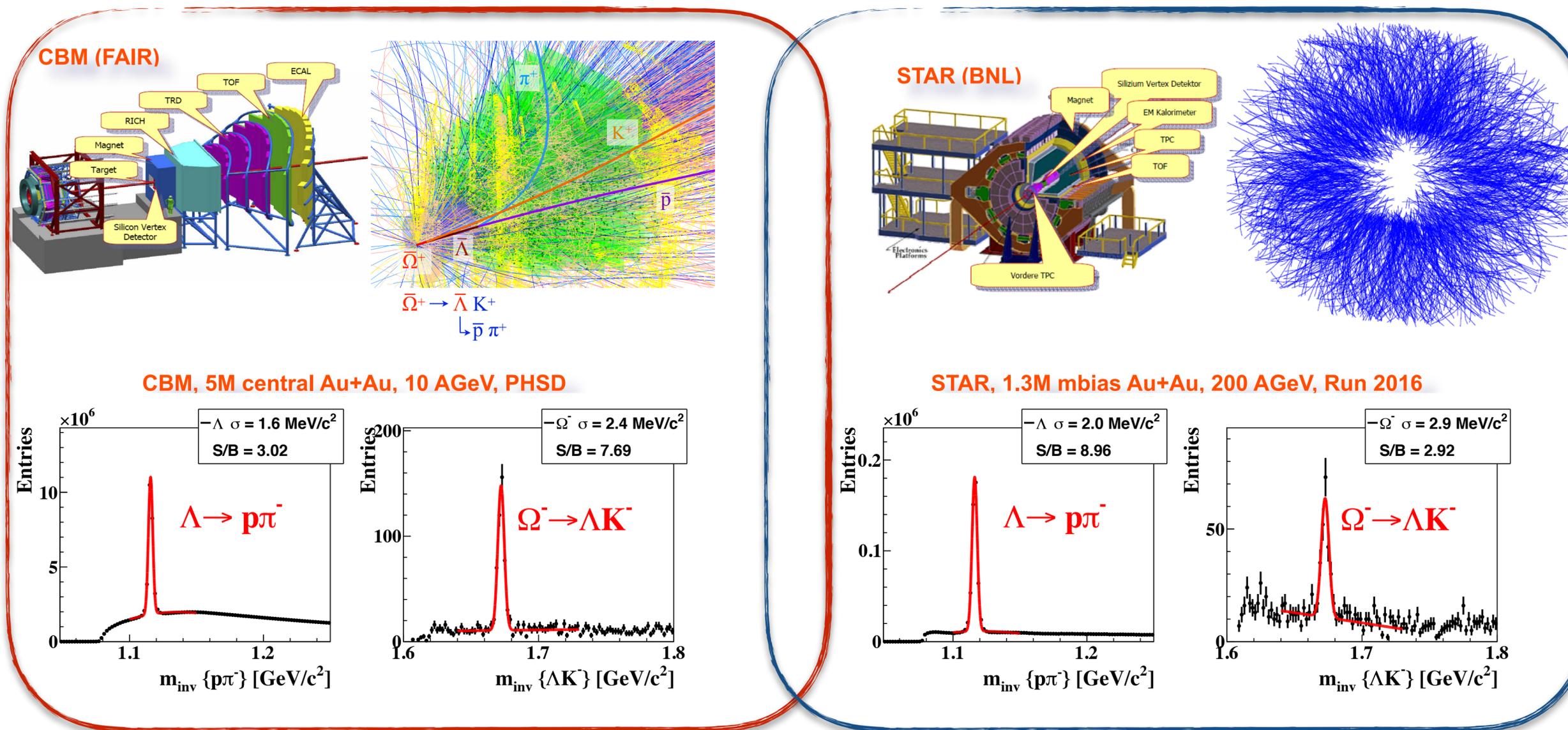
200 events AuAu at 200 GeV

Kalman Filter Particle Finder



CBM -> STAR: Reconstruction and Analysis Software

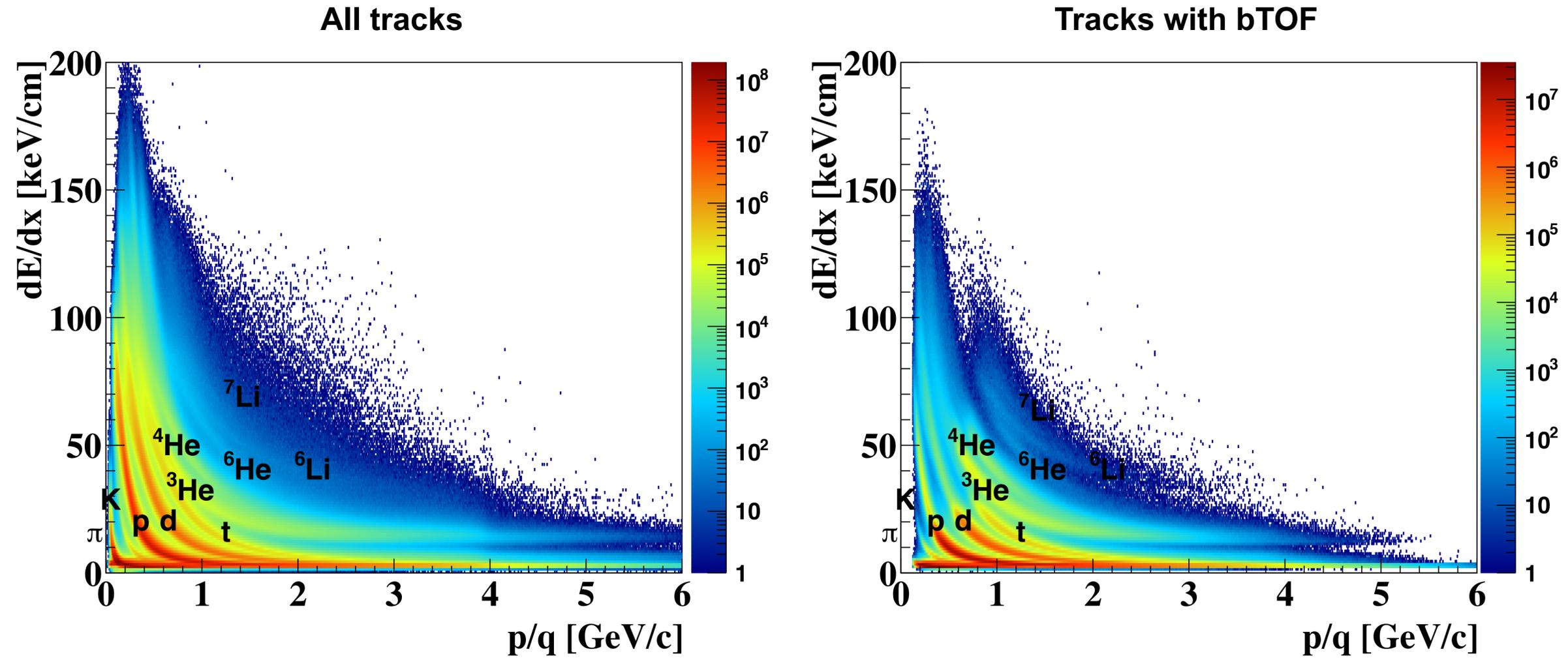
Within the FAIR Phase-0 program the CBM KF Particle Finder has been adapted to STAR and applied to real data of 2014, 2016 and BES-I.



- ✓ Since 2013 (online) and 2016 (offline) the **CA track finder** is the **standard STAR track finder** for data production. Use of CA provides **25% more D0** and **20% more W**.
- ✓ The **KF particle finder** provides a **factor 2 more signal particles** than the standard approach in STAR. The integration of the KF particle finder into the **official STAR repository** for use in physics analysis is currently in progress.

Preparing for the real-time express physics analysis during the BES-II runs (2019-2020)

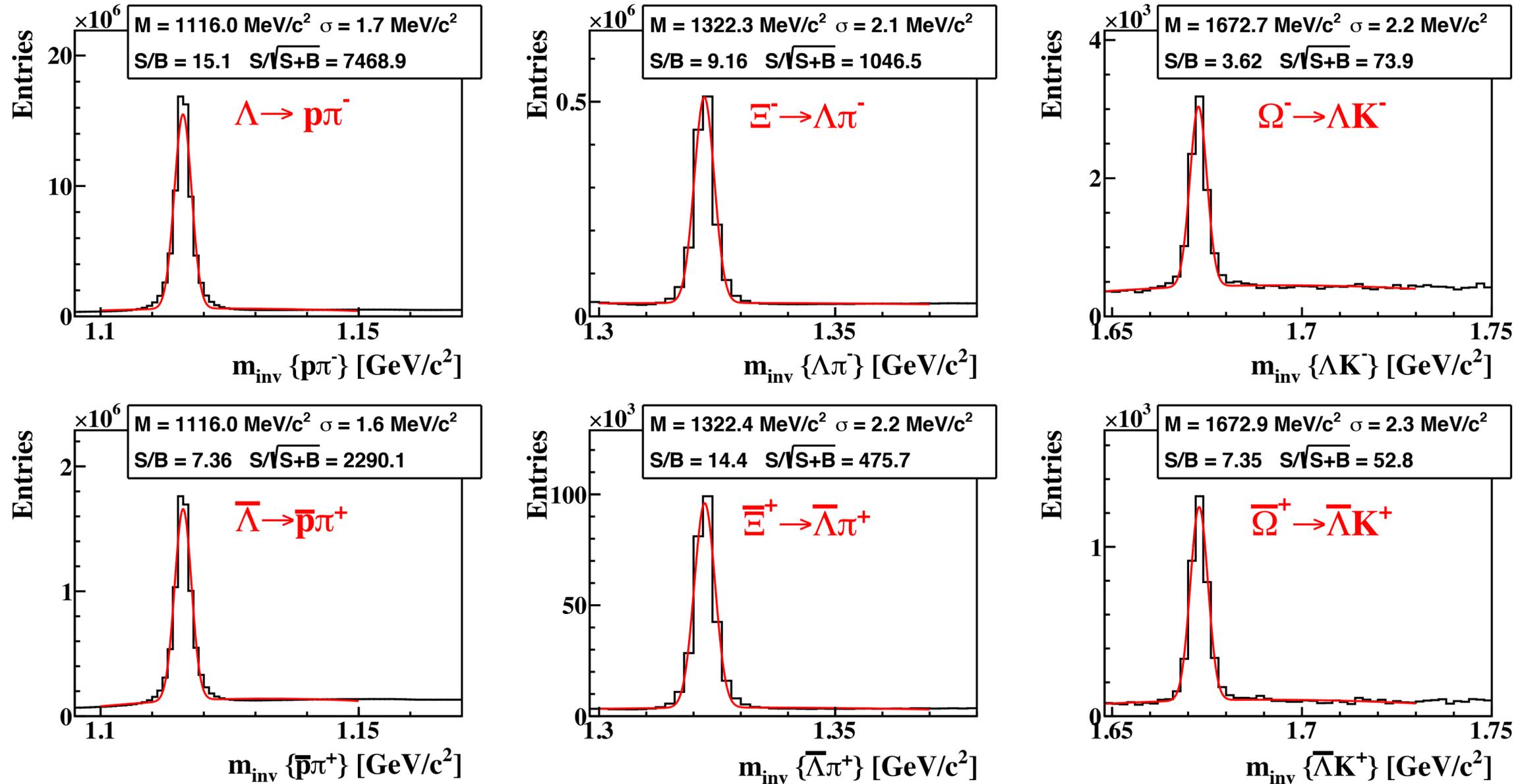
BES-II: xProduction (2019)



- Express production provides **high quality** of the dE/dx measurement.
- The **cumulative spectra** for **fixed target** mode (3, 3.2, 3.9 GeV) are shown.
- We clearly see particles up to ${}^7\text{Li}$.

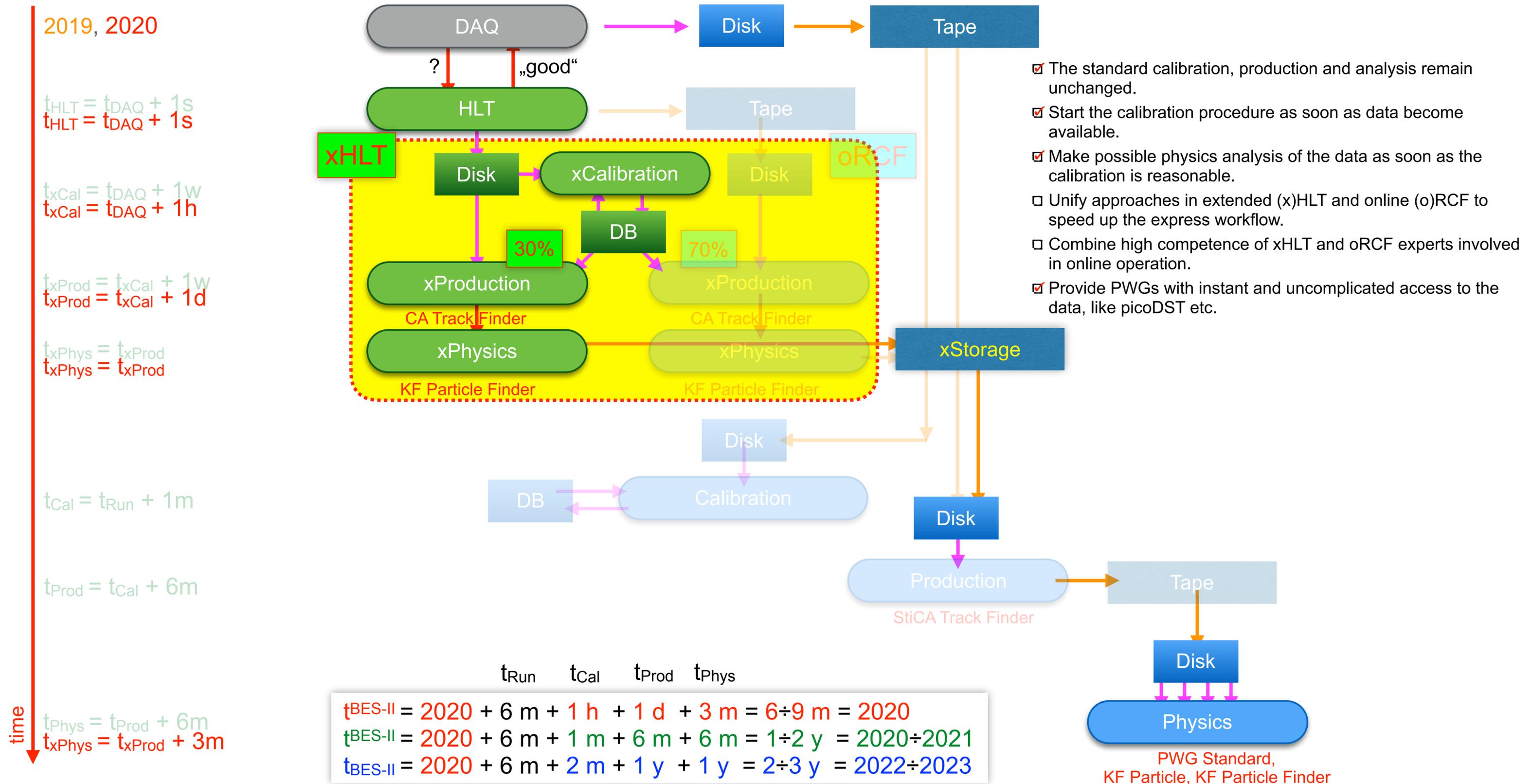
BES-II: xHyperons (2019)

200M AuAu events at 14.5 GeV, 2019 BES-II express production



- With the express calibration and alignment we reconstruct hyperons with high significance and low level of background.
- Hyperons are clearly seen at all BES-II energies: 3, 3.2, 3.9, 7.7, 9.1, 14.5, 19.6, 27 GeV.
- High significance allows extraction of spectra.

BES-II: eXpress+Standard Data Production and Analysis (2019)



Summary and Perspectives

- Within the FAIR Phase-0 program the fast algorithms of the FLES (First-Level Event Selection) package developed for the CBM experiment (FAIR/GSI, Germany) are adapted for online and offline processing in the STAR experiment (BNL, USA).
- Using the same algorithms creates a bridge between online and offline, which makes it possible to combine online and offline resources for data processing.
- On the basis of the STAR HLT farm an express data production chain was created, which extends the functionality of HLT in real time up to the analysis of physics.
- The same express data production chain can be used on the RCF farm, which is used for fast offline production with the similar tasks as in the extended HLT.
- The chain of express analysis does not interfere with the chain of standard analysis.
- An important advantage of express analysis is that it allows to start calibration, production and analysis of the data as soon as they are received.
- Use of the express analysis can be beneficial for BES-II data production and help accelerate science discovery by helping to obtain results within a year after the end of data acquisition.

We will soon make our algorithms available under GPL license:

- the [Kalman Filter](#) to estimate trajectory parameters ([0.5 \$\mu\$ s/core/track](#));
- the [Cellular Automaton](#) for searching for particle trajectories in STS ([100 \$\mu\$ s/core/track](#));
- the [Cellular Automaton](#) for searching for particle trajectories in TPC ([70 \$\mu\$ s/core/track](#));
- the [KF Particle Finder](#) package with more than 150 decay channels implemented ([100 \$\mu\$ s/core/decay](#)).

If you have an interest in these algorithms, please contact me.