Strangeness and Hypernuclei reconstruction with Day-1 and CFV setup

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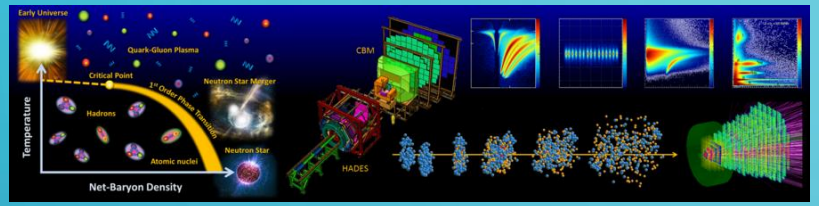
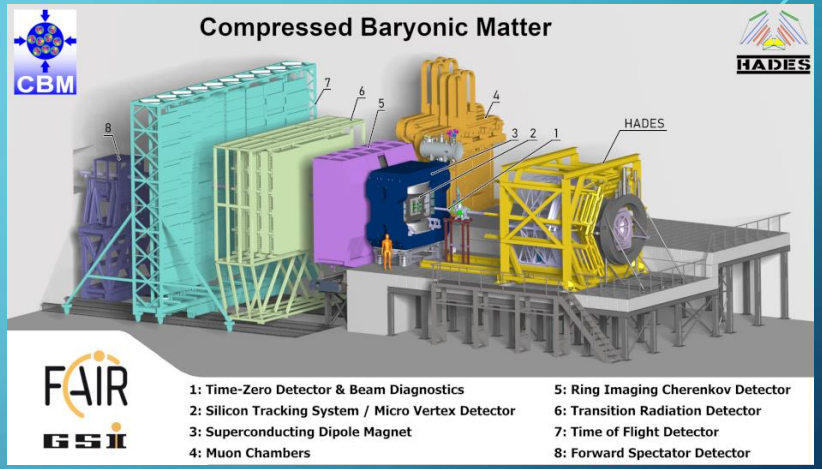
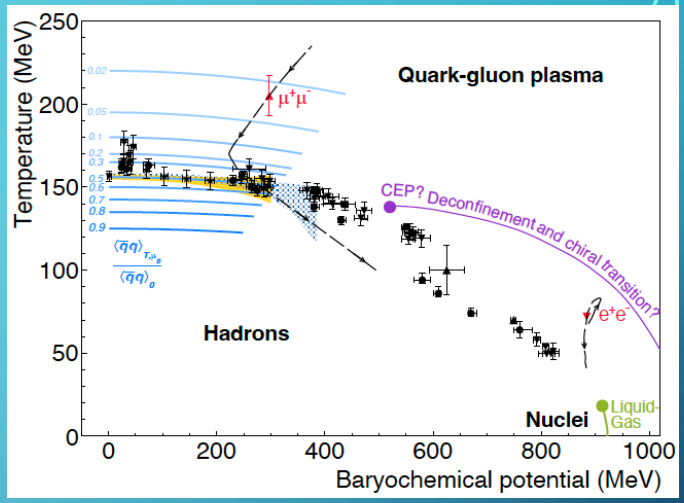




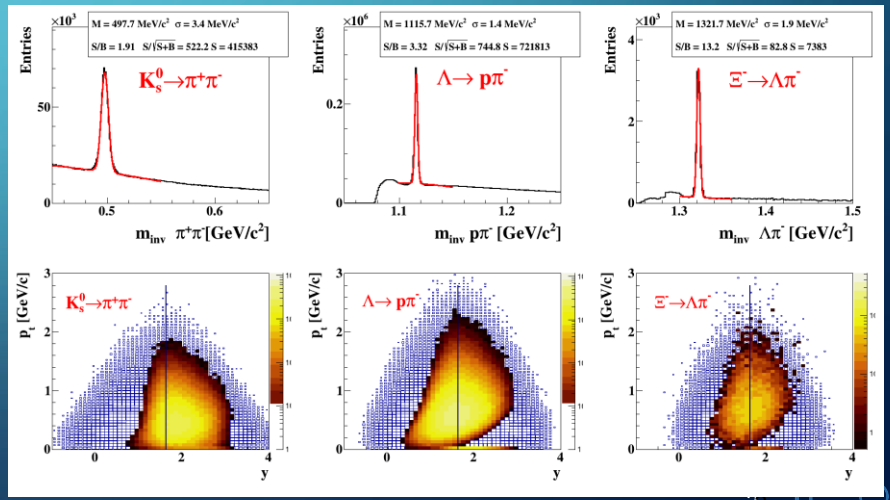
- Motivations
- Strangeness and Hypernucei with:
  Au+Au mbias at 12 AGeV Day 1 vs CFV
- Geant4 vs Geant3 & VT25
- Summary

Strangeness – K, Λ, Ξ, Ω, Σ

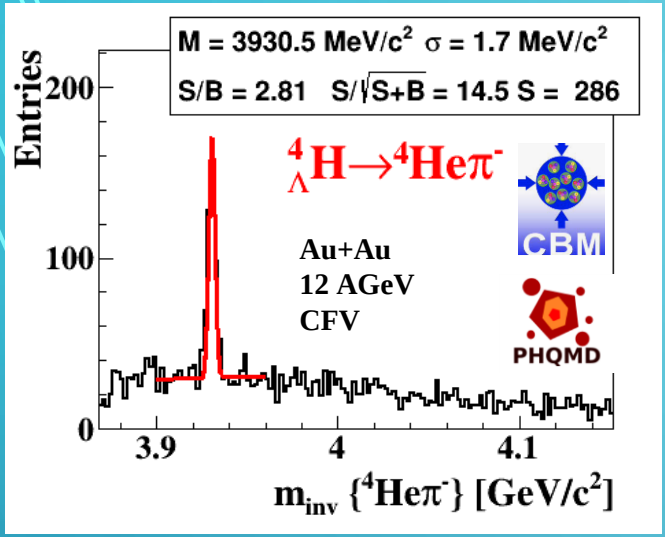
- Understanding the Equation of State (EoS) of dense matter
- Exploring the phase diagram of QCD
- The presence of hyperons (including Λ and Σ) in neutron star cores is a topic of intense research, as it can significantly affect their properties, such as mass and radius.
- Testing theoretical models of hadronic matter
- Exploring the potential for exotic states of hyperon-rich matter

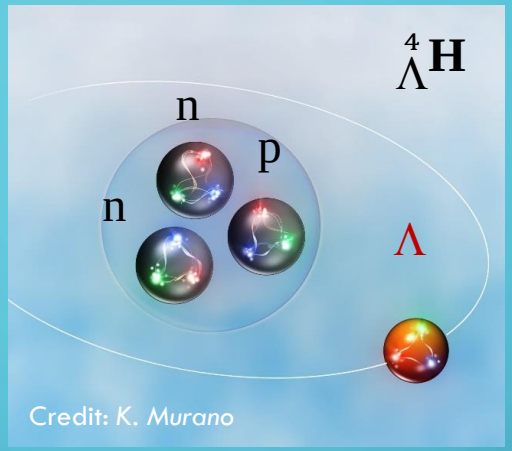


CFV

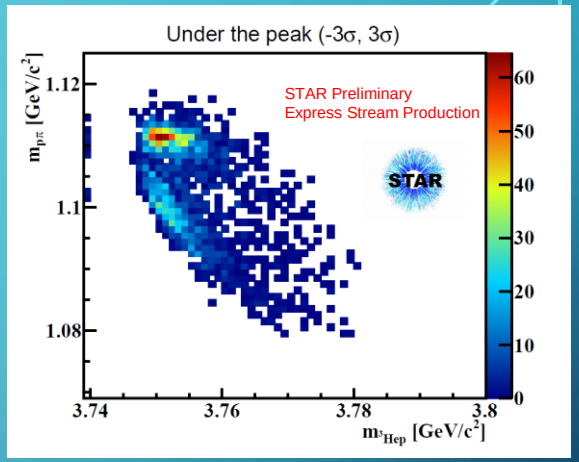


Hypernuclei



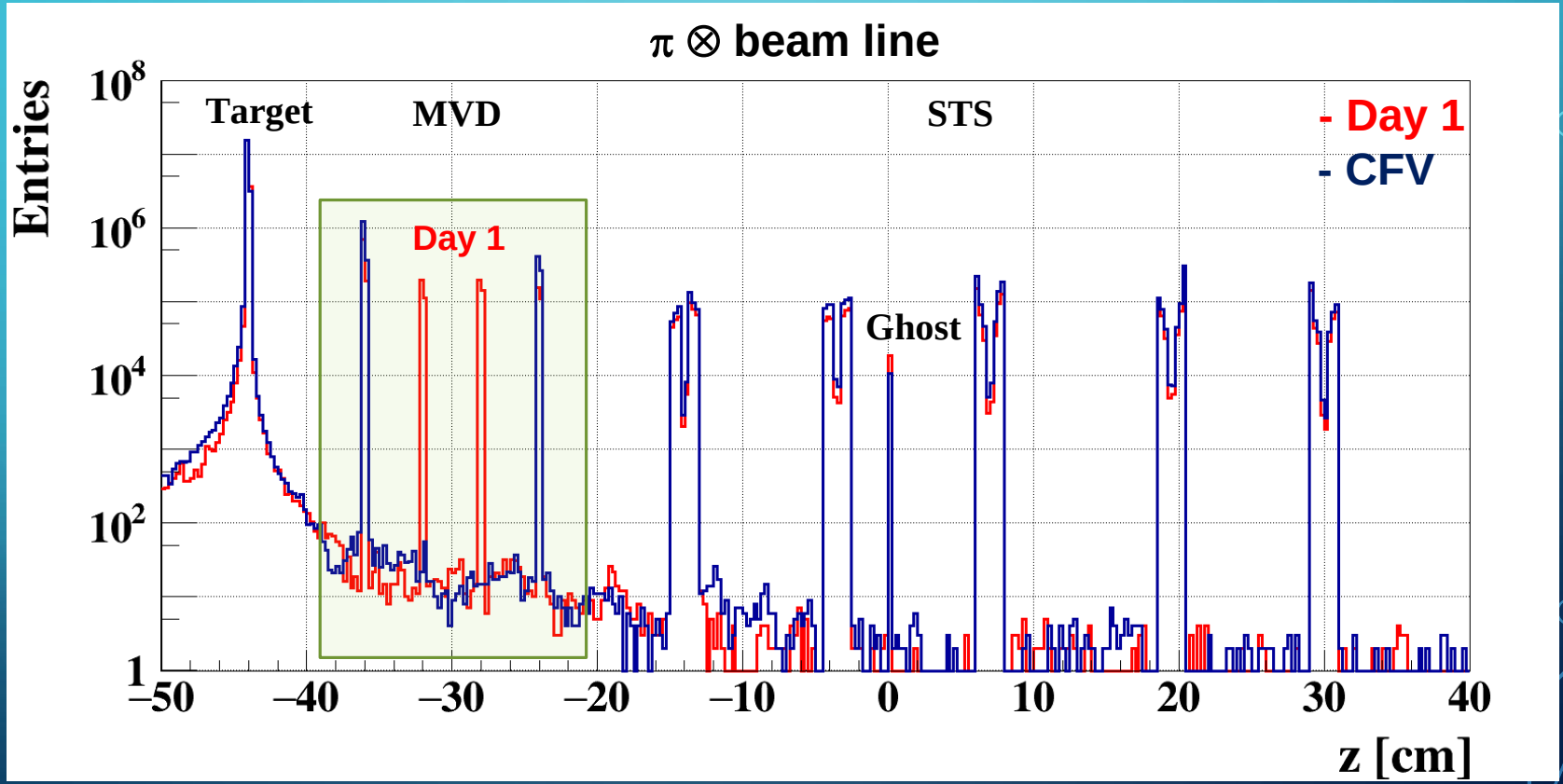


$^4_\Lambda$He → ^{4}Li$_{GS}$* + π^- → ^{3}He + p + π^-



- Precise measurements of hypernuclei lifetime (**YN** & **YY** interaction)
- Strangeness in high density nuclear matter, EoS for NS, Hadronic phase of HI collisions
- Measurement of branching ratios of hypernuclei decays, Dalitz plots for 3-body decays
  - hypernuclei internal structure
- Measurements of B_Λ in the hypernuclei - direct access to the hyperon-nucleon **YN** interaction
- Double lambda hypernuclei (CBM!) offer a unique opportunity to study the interaction between strange baryons and provide crucial information for understanding the structure of neutron stars.

Day -1 and CFV geometries (G4 tomography)



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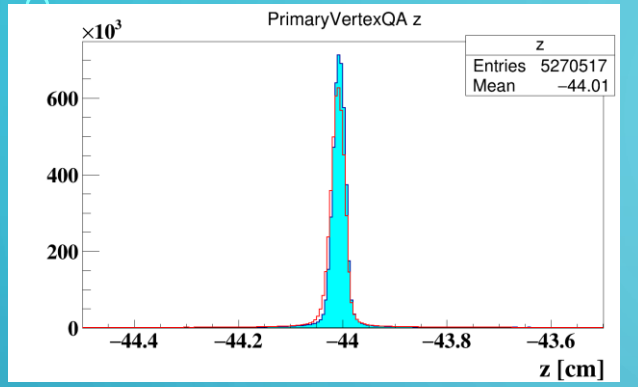
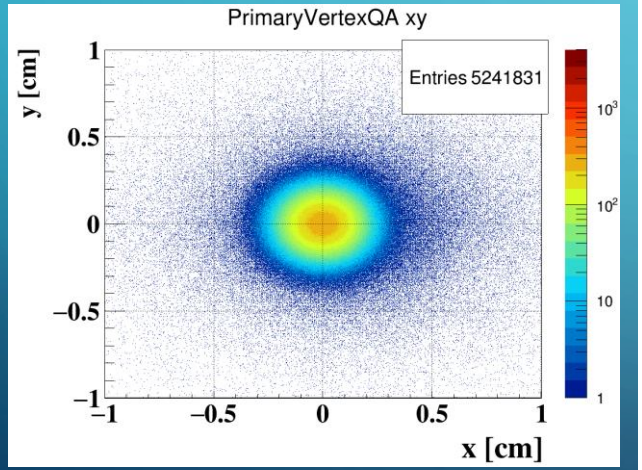
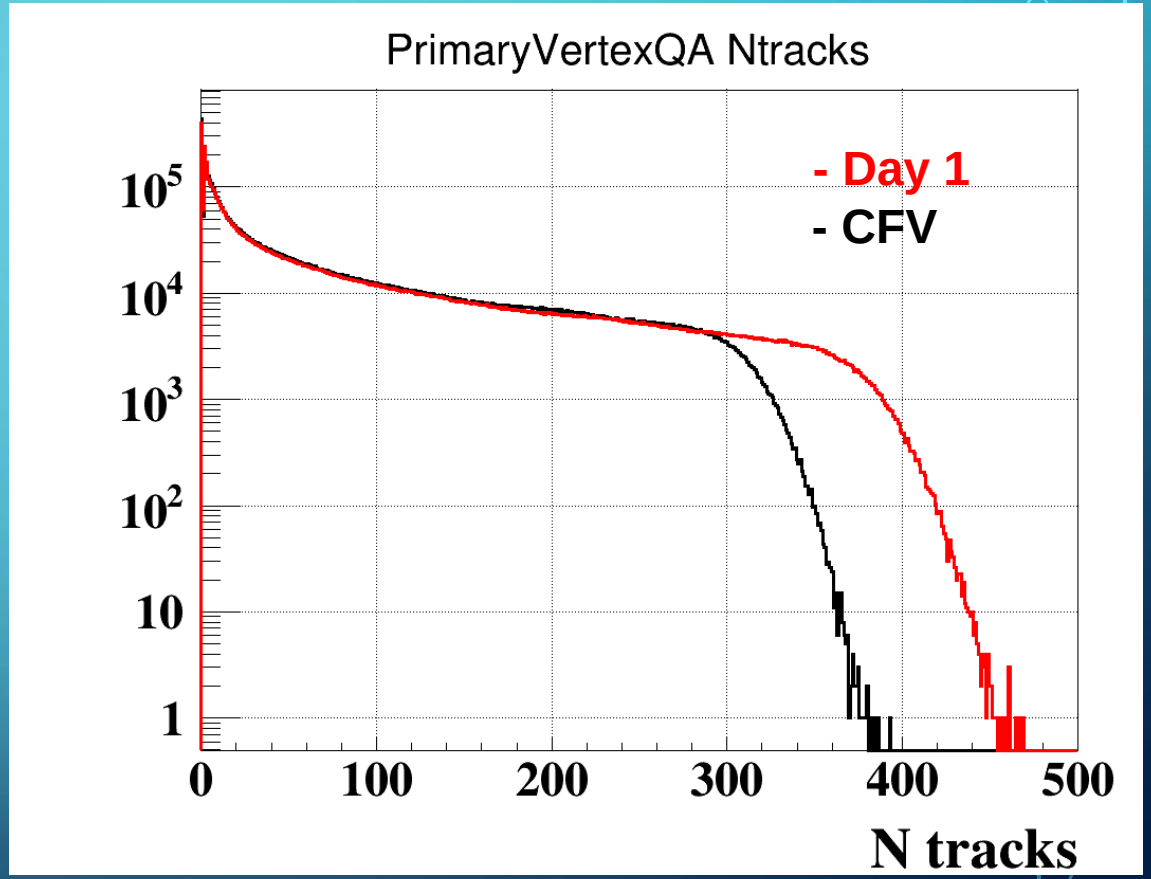
/lustre/cbm/users/fkornas/mc/data/release/jul25_patches/phqmd_winn/geant3(4)

F. Linz

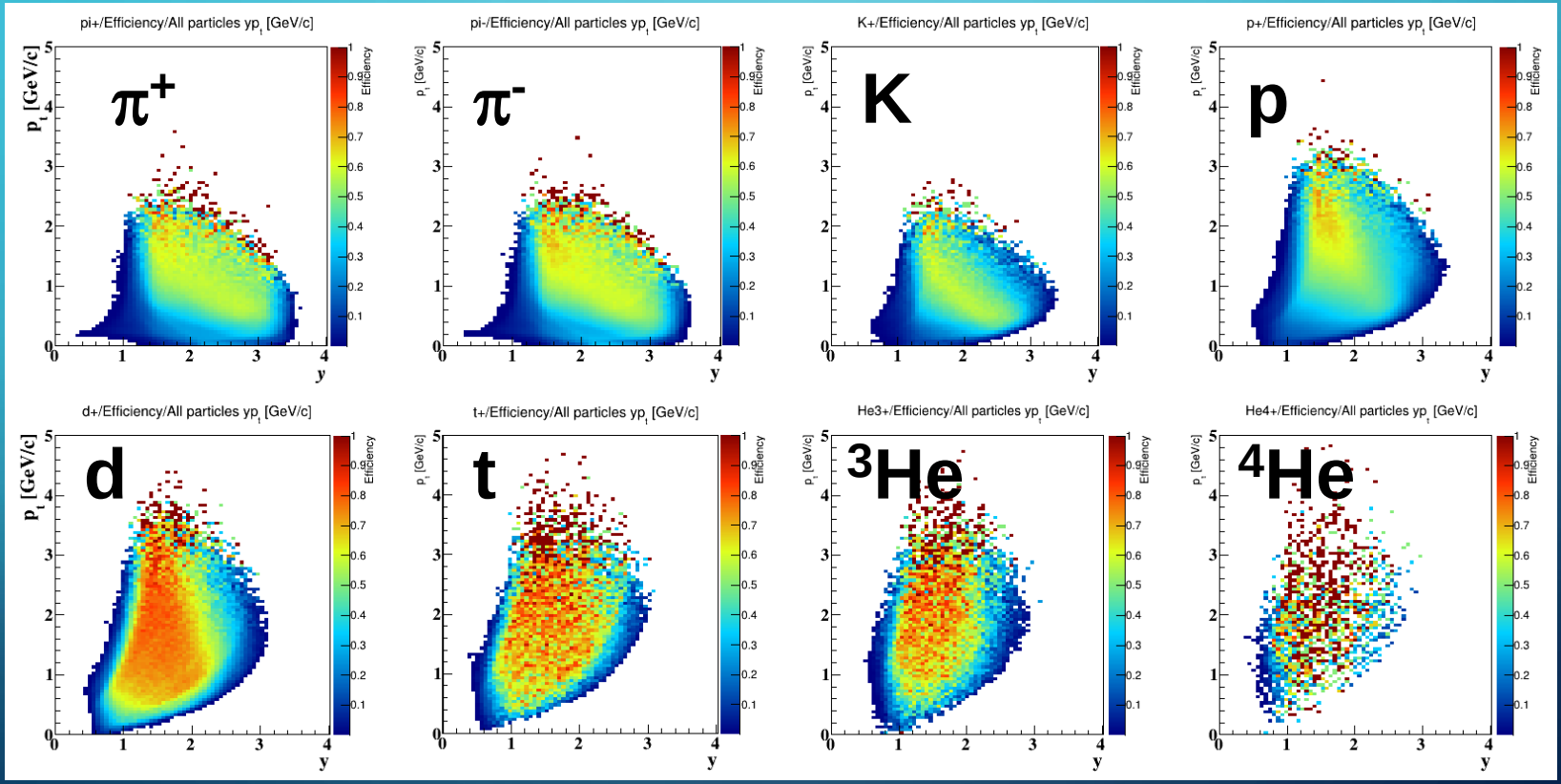
Primary Vertex at Day -1 and CFV geometries, Geant3 5M PHQMD mbias events



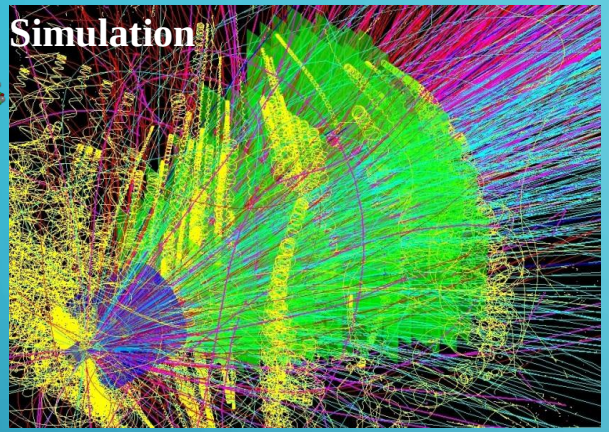




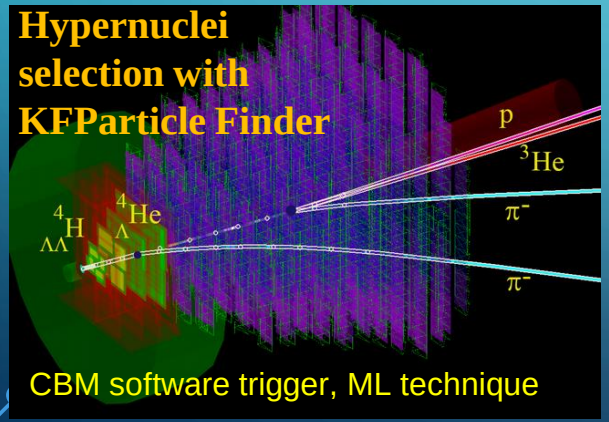
PID detectors MVD+STS & TOF (fixed)



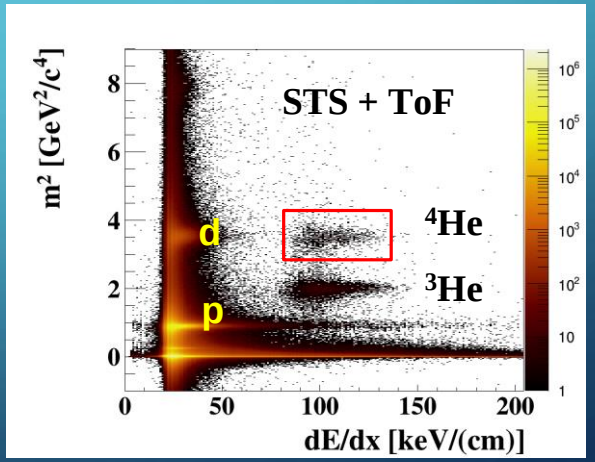
The CBM L1 track finder (EB & TB) & PID detectors



- The theoretical models like UrQMD, PHSD and PHQMD are used.
- Track finder is based on the Cellular Automaton method.
- High efficiency for track reconstruction of more then **94%**, including fast (more then **90%)** and slow (more then **65%**) **secondary** tracks.
- **Time-based** track finder is developed, efficiency is stable with respect to the interaction rate.
- Low level of split and wrongly reconstructed (ghost) tracks.



Au+Au @ 12 AGeV mb



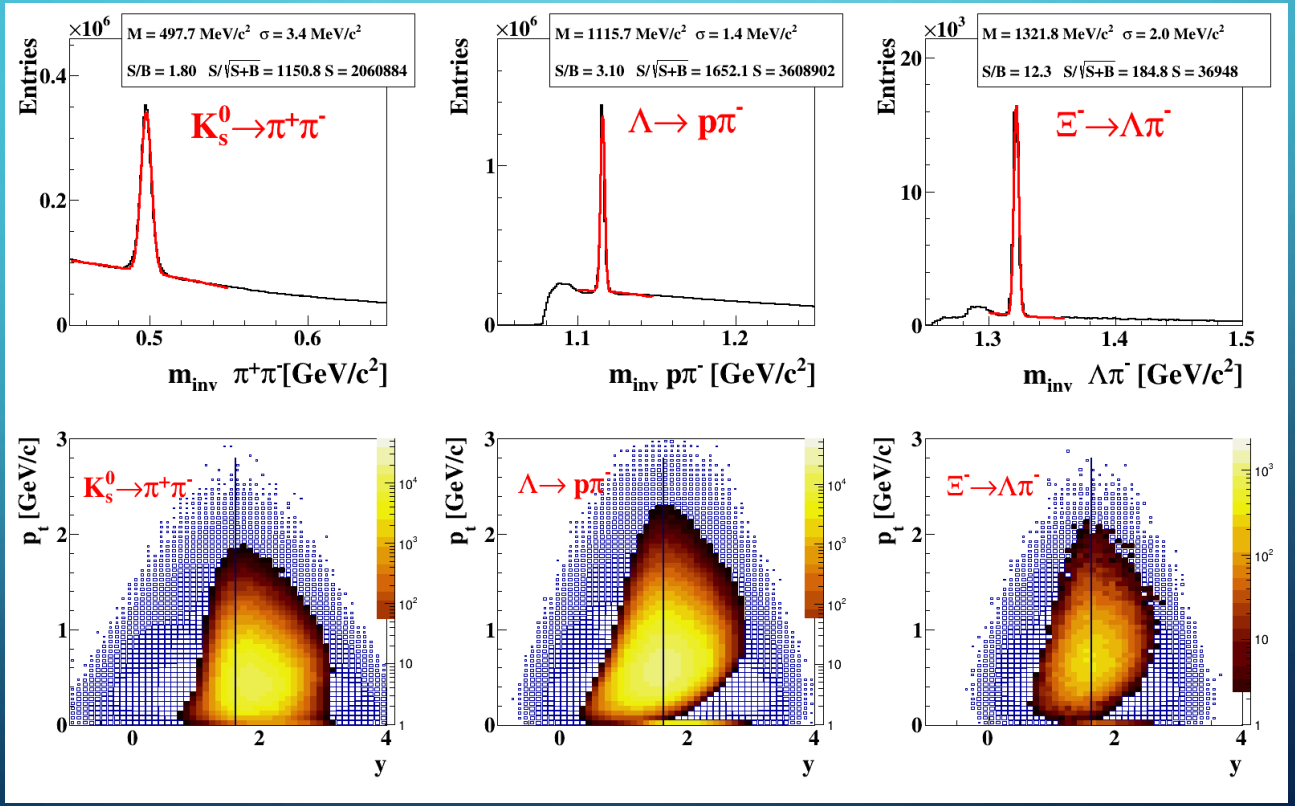
8 ms/core track finder
1 ms/core KFParticle Finder

PID detectors:

- **ToF** - hadron identification;
- **STS** heavy fragments identification by dE/dX
- **TRD** electron and heavy fragments identification

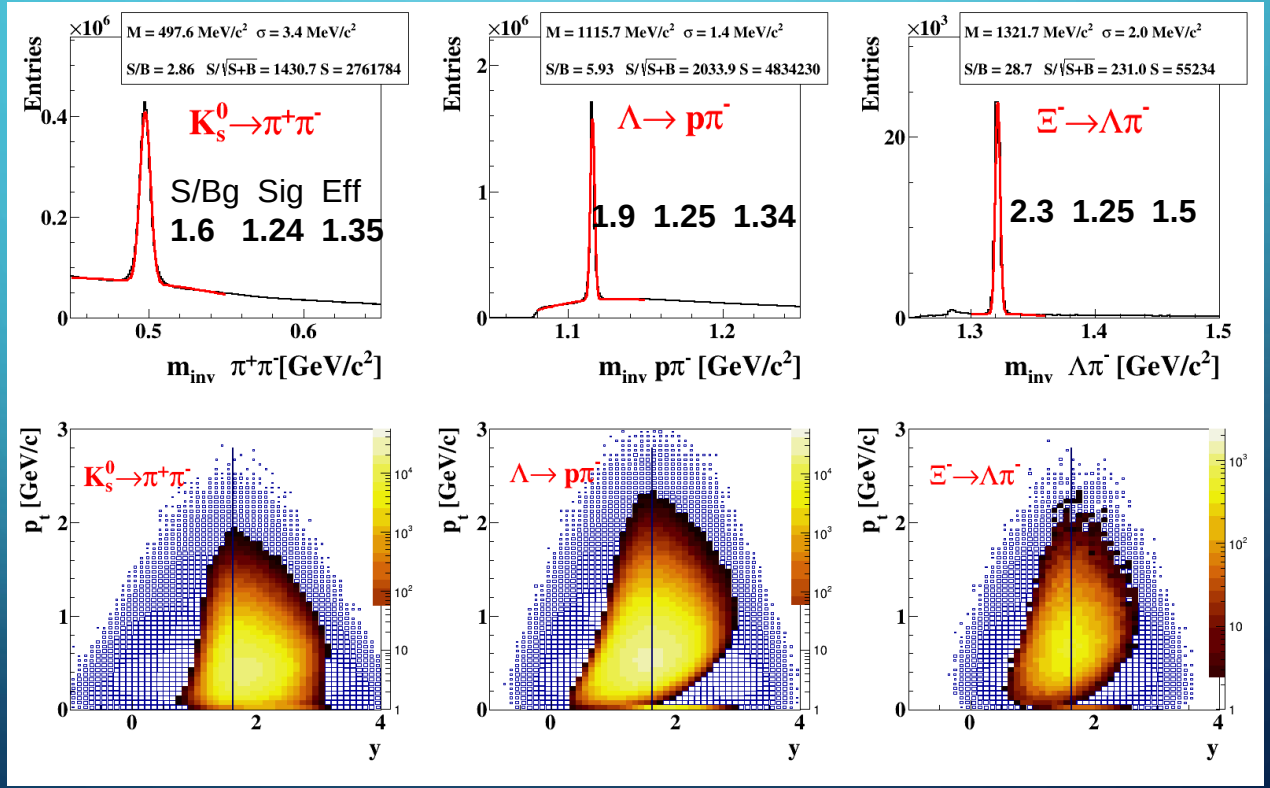
Strangeness: CFV PHQMD 5M G3 mbias Au +Au at 12 AGeV (50 sec !)

- Λ particle looks like a perfect candidate to be measured at day one
- K_s and Ξ^- are byproducts, Ξ^- is a trigger particle candidate
- Bulk hadron physics signals will be measured with CFV geometry



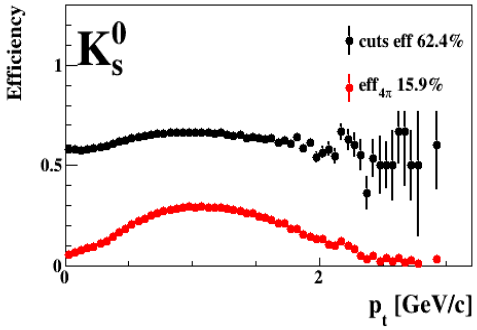
Strangeness: Day 1 PHQMD 5M G3 mbias Au +Au at 12 AGeV (50 sec !)

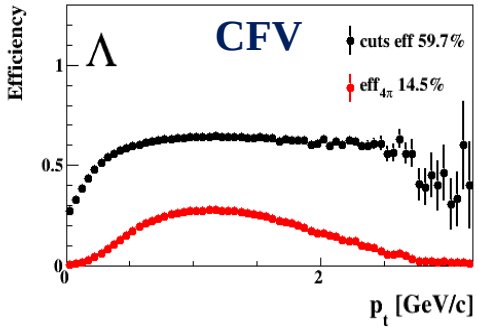
- Λ particle looks like a perfect candidate to be measured at day one
- K_s and Ξ^- are byproducts, Ξ^- is a trigger particle candidate
- Day 1 CBM Detector can significantly improve the quality of hadron data

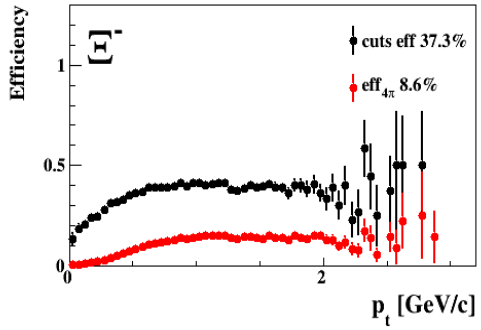


Strangeness: Day 1 vs CFV PHQMD 5M G3 mbias Au +Au at 12 AGeV

- Day 1 CBM Detector can significantly improve the quality of hadron data collection







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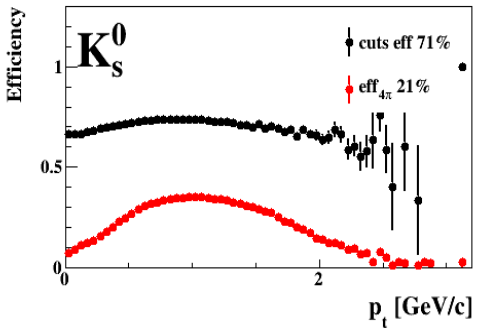

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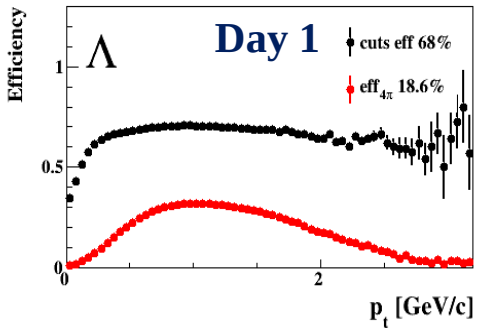

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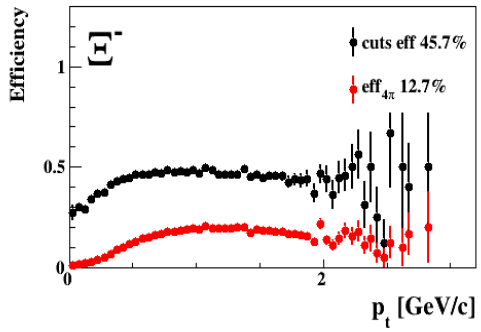
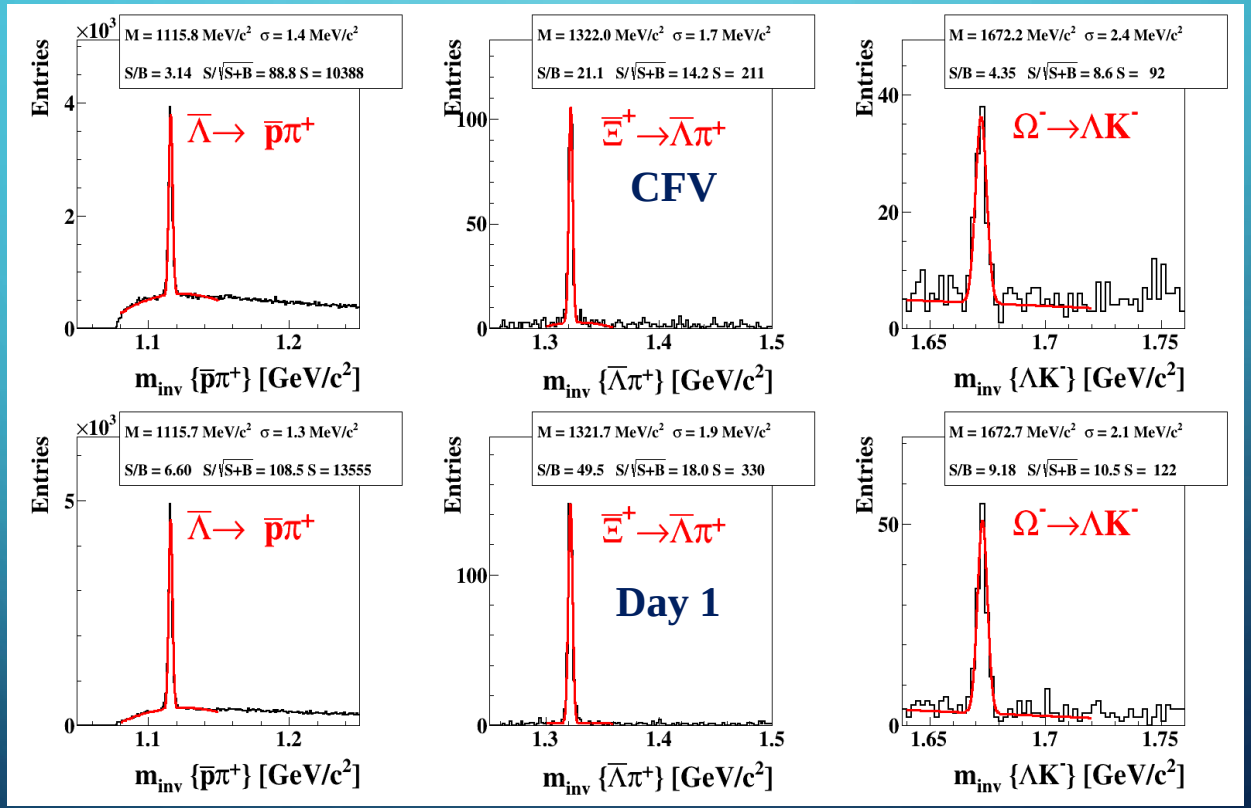
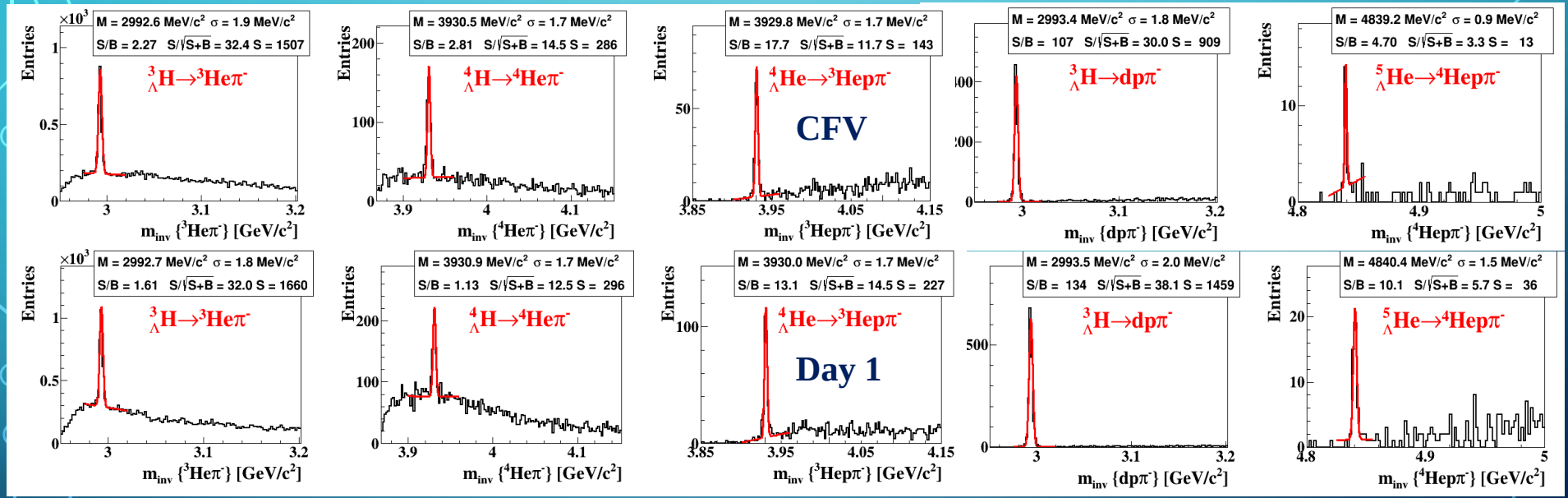


Strangeness rare probes: PHQMD 5M G3 mbias Au +Au at 12 AGeV (50 sec !)

- rare signals will be measured with CFV geometry
- Day 1 CBM Detector can significantly improve the quality of rare signals



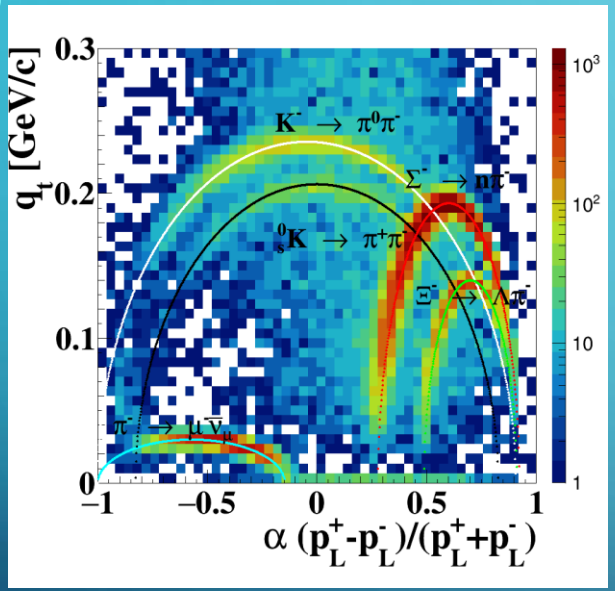
Hypernuclei: PHQMD 5M G3 mbias Au +Au at 12 AGeV (50 sec !)



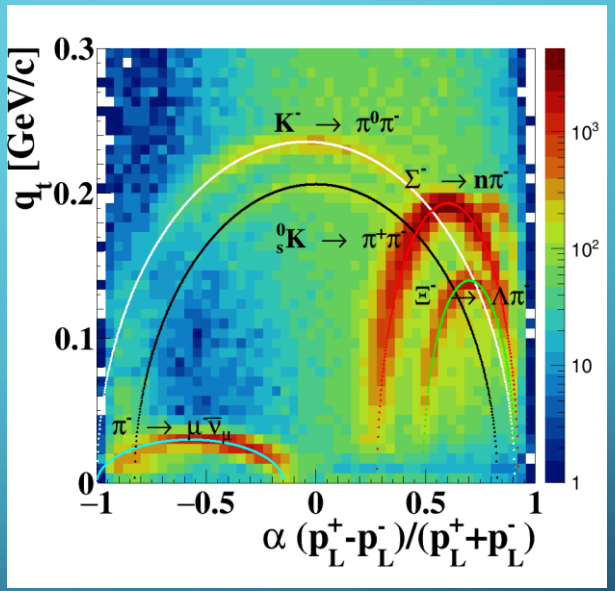
S/Bg ratio is better for CFV (cuts for Day 1 need to be improved)
Significance and efficiency better for Day 1

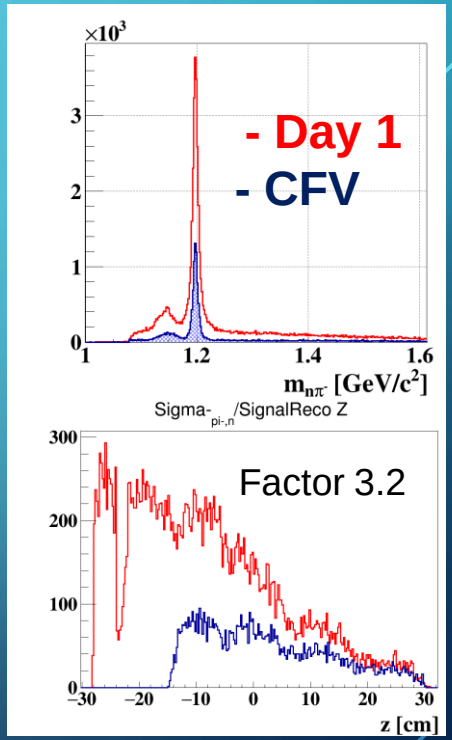
Strangeness: Σ^- m^3 Day 1 vs CFV PHQMD 1M G4 mbias Au +Au at 12 AGeV

CFV



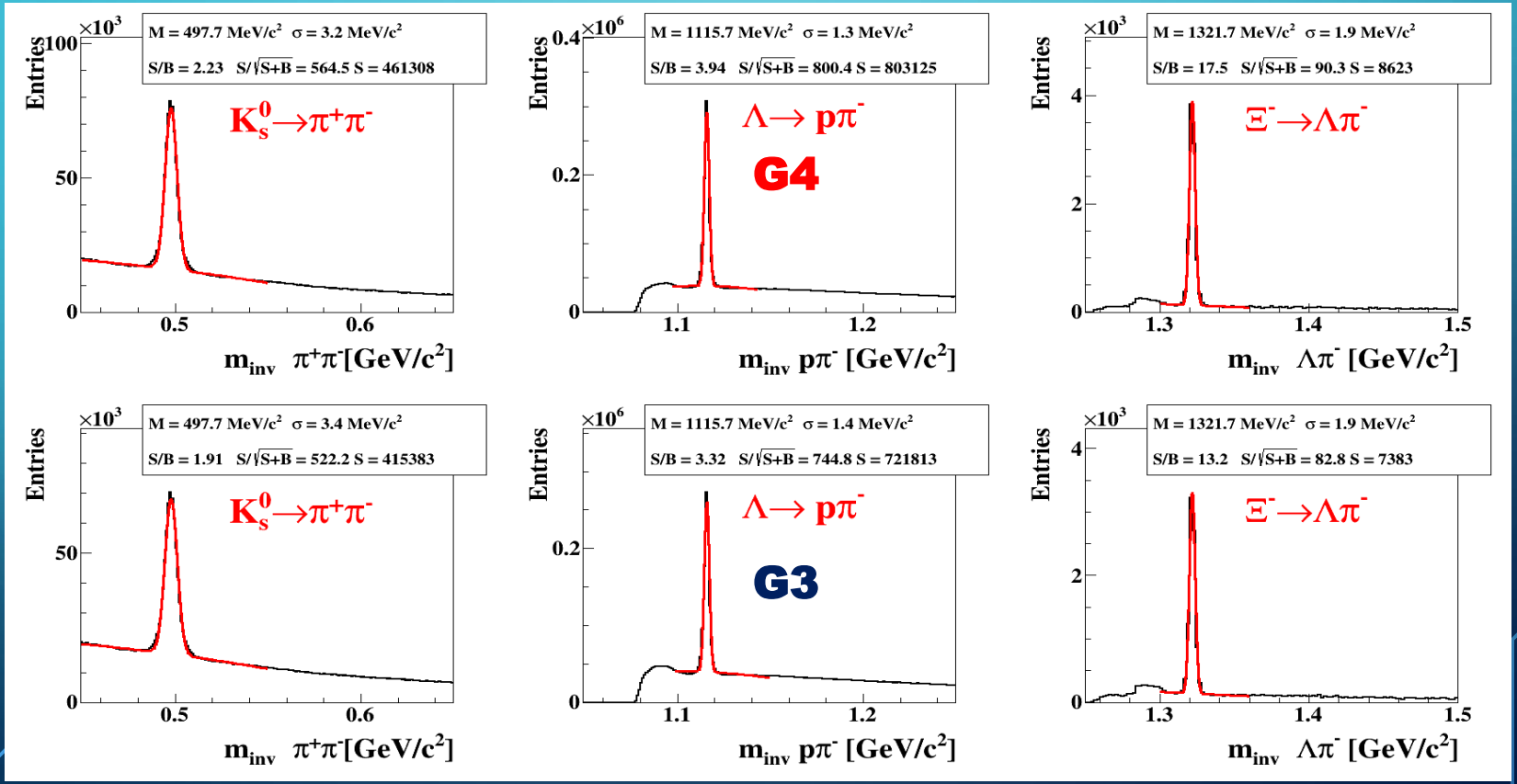
Day -1



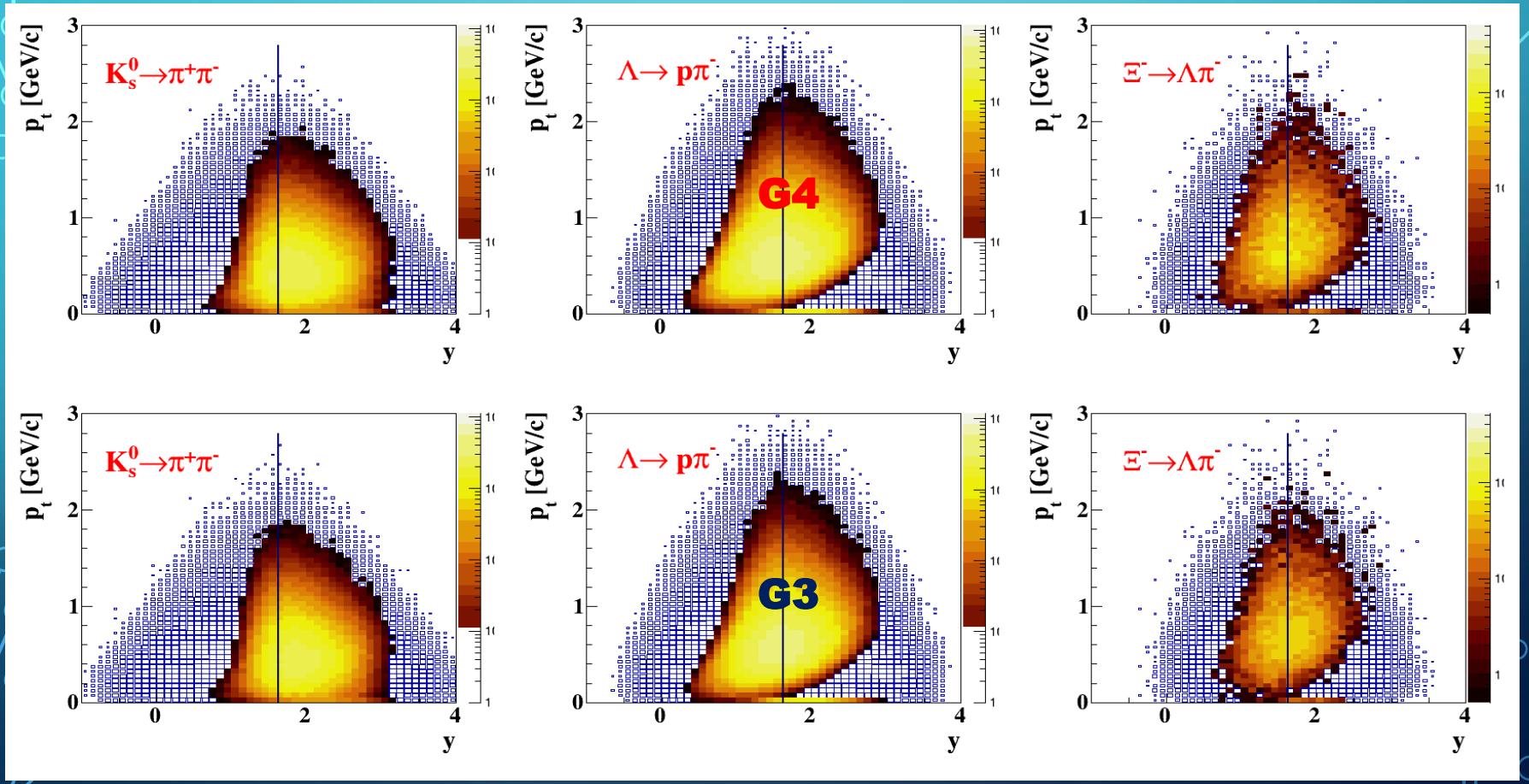


Strangeness: G4 vs G3 PHQMD 1M mbias Au +Au at 12 AGeV CFV

- Physics performance is slightly better with Geant 4

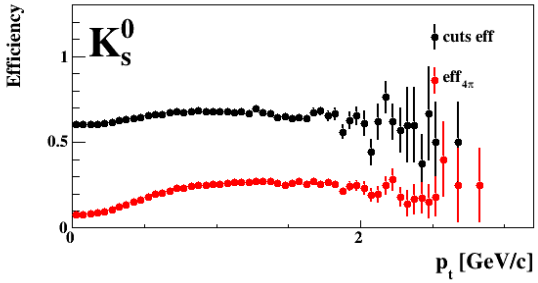


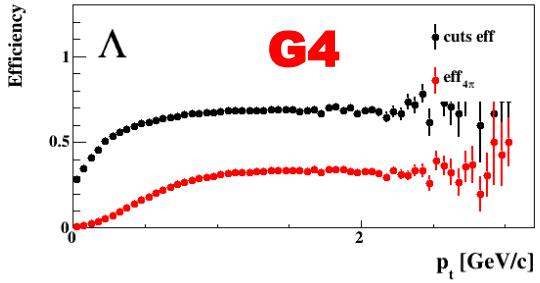
Strangeness: G4 vs G3 PHQMD 1M mbias Au +Au at 12 AGeV CFV

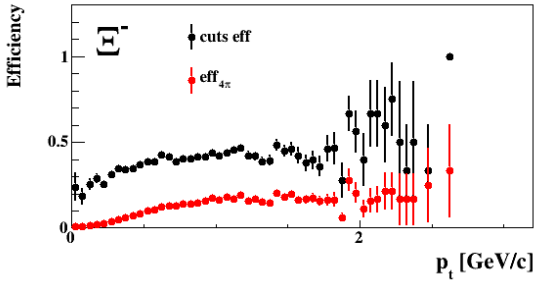


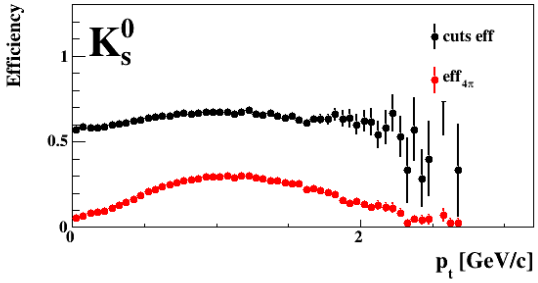
Strangeness: G4 vs G3 PHQMD 1M mbias Au +Au at 12 AGeV CFV

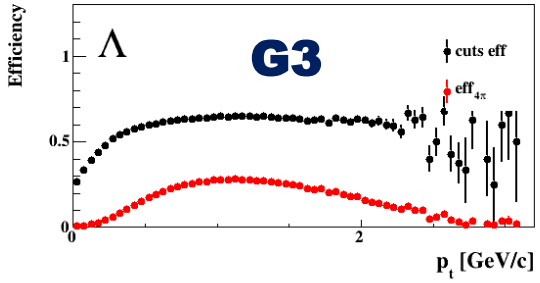
- **Physics performance is similar, slightly better with Geant 4**

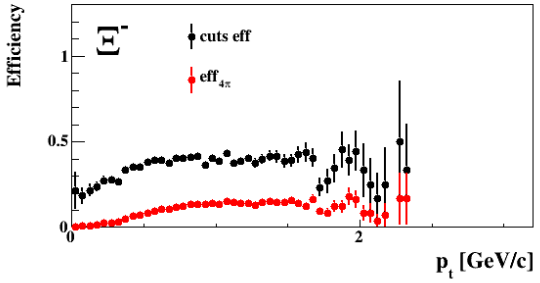












Summary

- PHQMD model successfully used for CBM vt25 test
- CFV and Day 1 geometries are under detailed study
- Main hadron physics results could be achieved with CFV geometries
- Day 1 CBM Detector can significantly improve the quality of hadron data collection
- Geant 4 and Geant 3 engines used for simulation. Physics performance is similar, slightly better with Geant 4

Plans

- TB simulations at intermediate and high interaction rate
- First CBM vertical test / data challenge 2025 (V. Friese)

Thank you for your attention!