Monte Carlo feasibility studies for heavy-ion interactions

V.Vasendina, A.Zinchenko
VBLHEP, JINR, Dubna, Russia

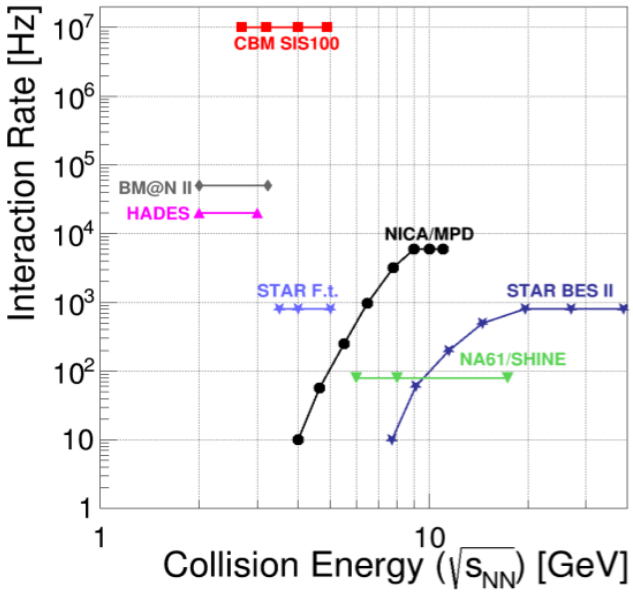
The 8-th BM@N Collaboration Meeting
3 - 8 October 2021, LHEP, JINR

Outline

- ✓ BM@N experiment
- ✓ BM@N geometry in future runs
- ✓ BM@N tracker performance
- ✓ MC simulations for Run 8 (Xe+A in 2022):
  - ✓ K^0_s reconstruction
  - ✓ Λ reconstruction
  - ✓ Ξ^- reconstruction
  - ✓ ${}_{\Lambda}H^3$ reconstruction
- ✓ MC simulations for Run ? (Au+Au in 202?):
- ✓ Summary and next steps

BM@N experiment

Rate capability of heavy-ion experiments
(running and under construction)



T. Ablyasimov et al., (CBM Collaboration)
Eur. Phys. J. A 53 (2017) 60

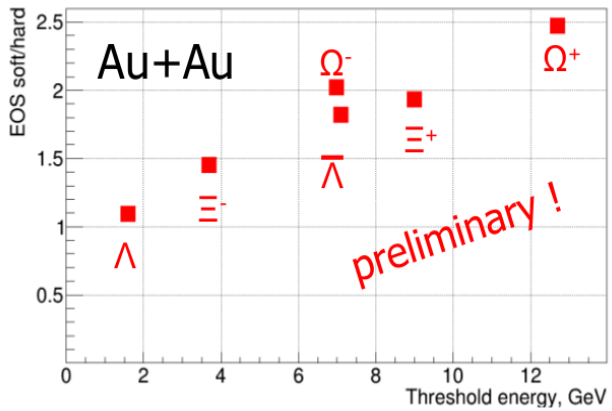
NICA Heavy Ion Complex

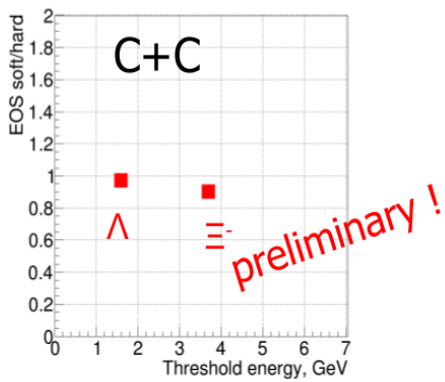
BM@N: *beams from p to Au, heavy ion energy 1-3,8 AGeV,Au intensity up to 2 MHz*

BM@N experiment - physics

Multi-strange hyperons: promising observables for the EOS of symmetric matter at Nuclotron beam energies

Hyperon yield in heavy ion collisions at 4A GeV (BM@N energies):
soft EOS (K=240 MeV) / hard EOS (K=350) MeV

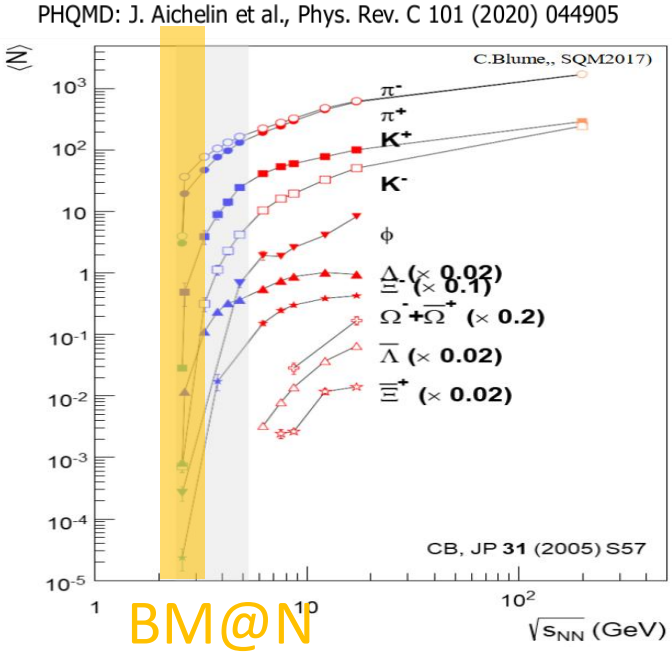




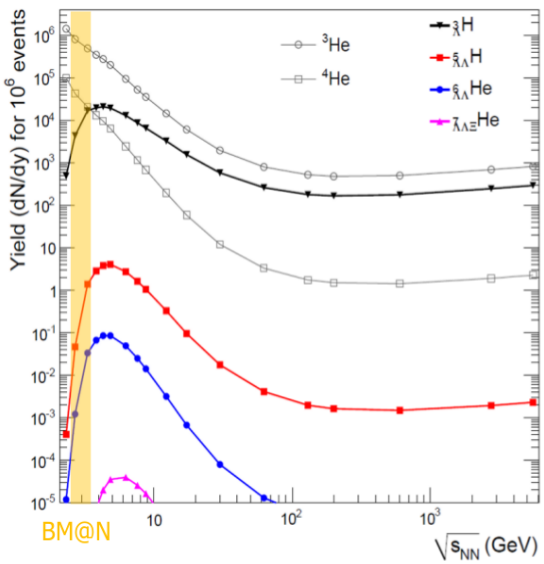
PHQMD: J. Aichelin et al., Phys. Rev. C 101 (2020) 044905

Reference measurement reduce:

- systematic errors of experiment and theory
- contributions from SRC, in-medium cross sections, momentum-dependent interactions

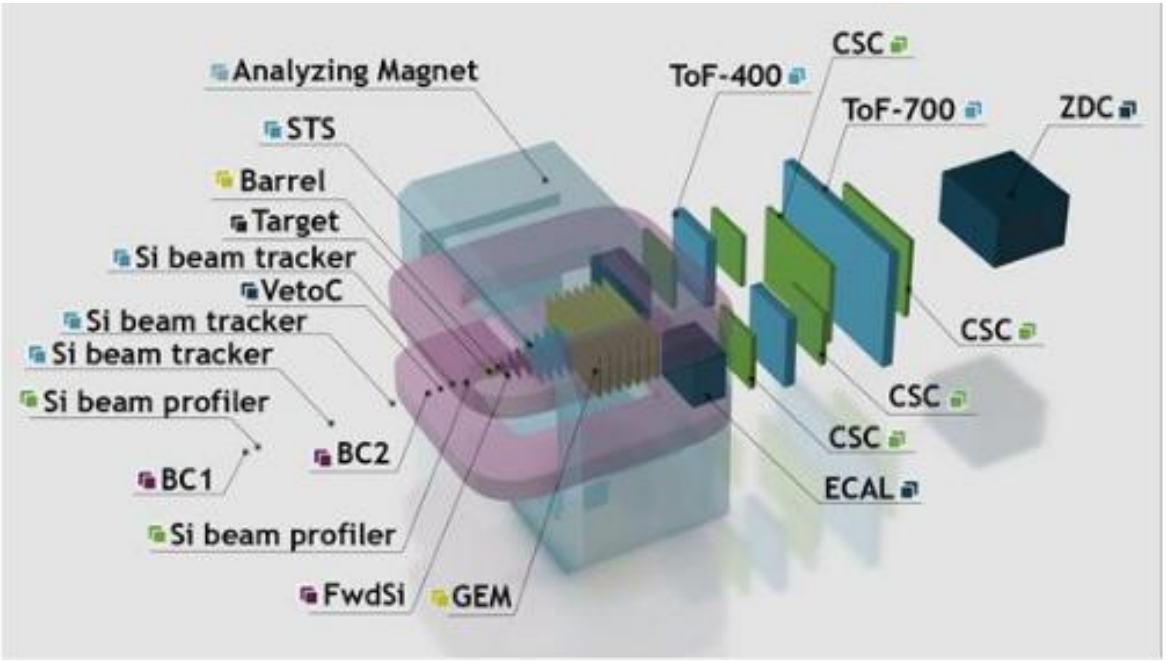


Hypernuclei production in heavy-ion collisions

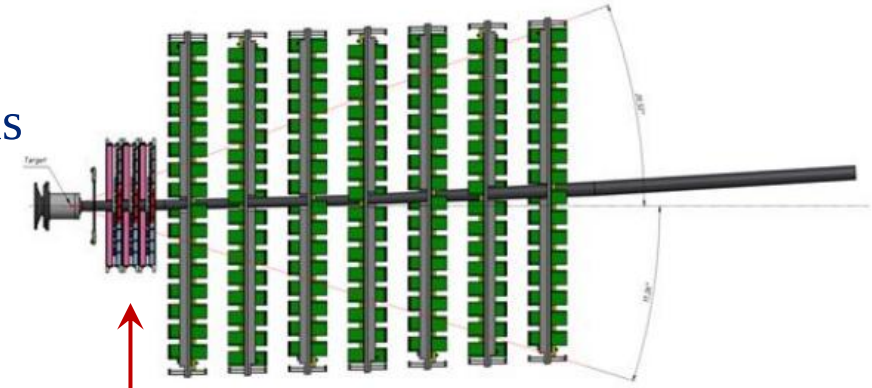


Statistical Hadronization Model: A. Andronic et al., Phys. Lett. B697 (2011) 203

Detector geometry in future runs

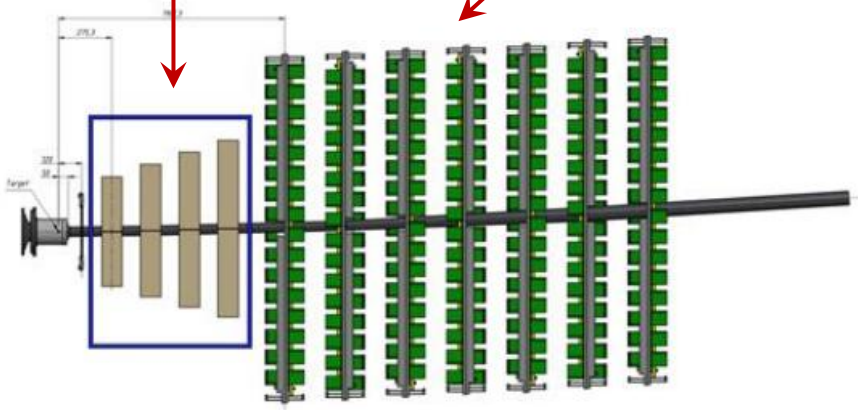


3 (4) stations



Si tracker

GEMs

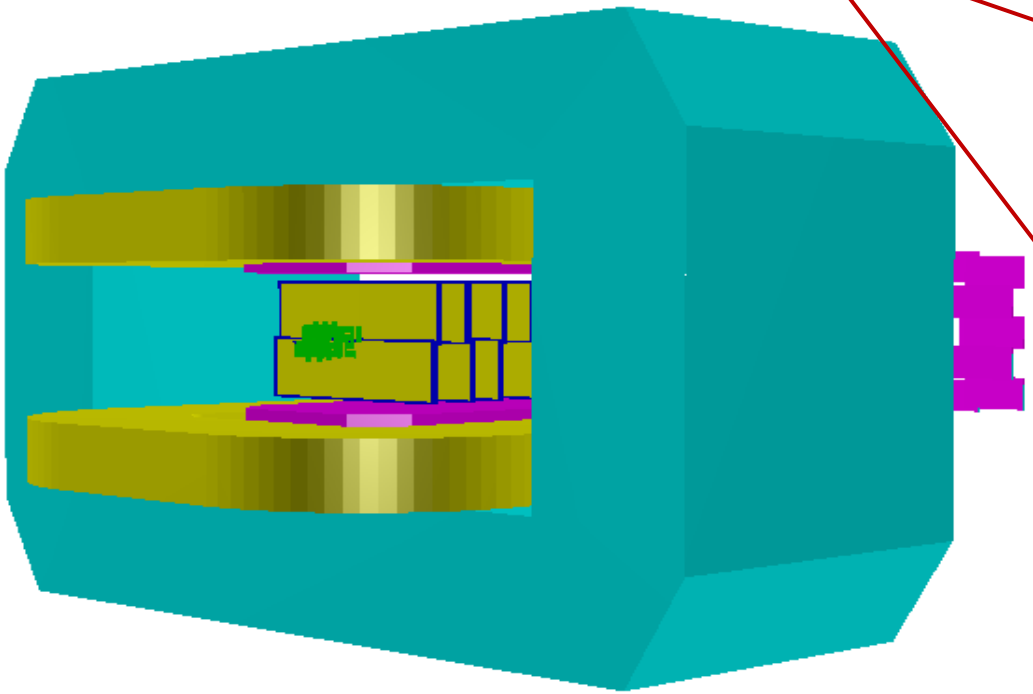


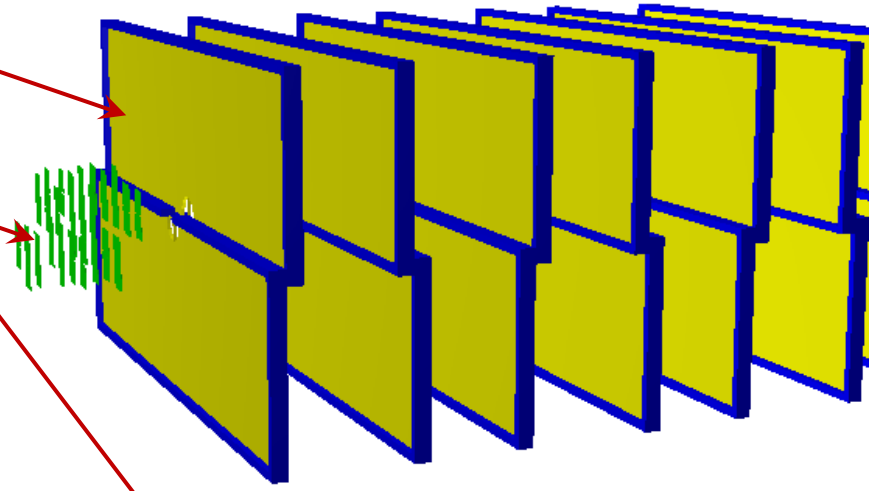
4 station STS (CBM-type)

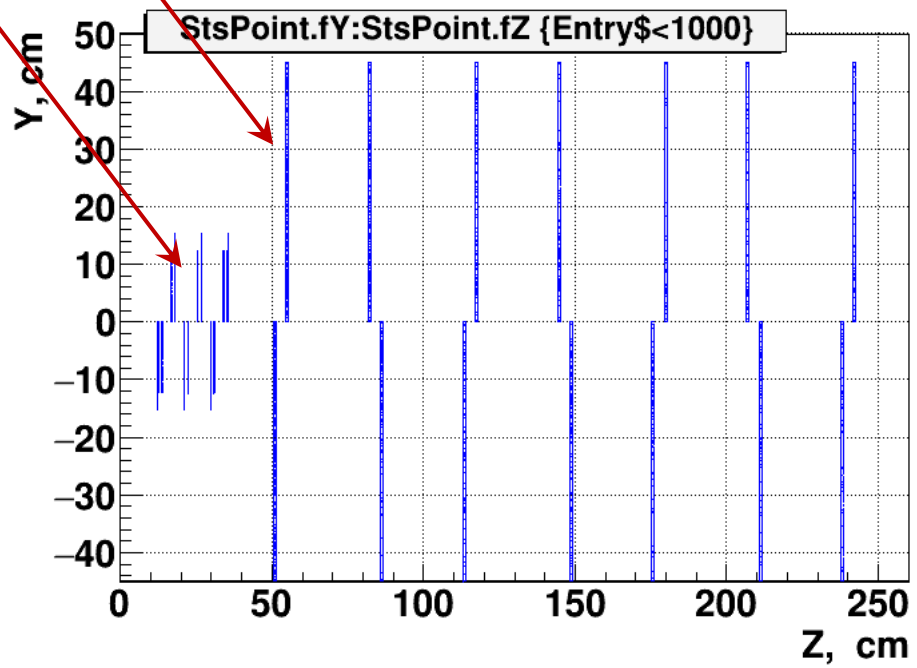
Detector geometry in Run 8

GEMs

Si stations

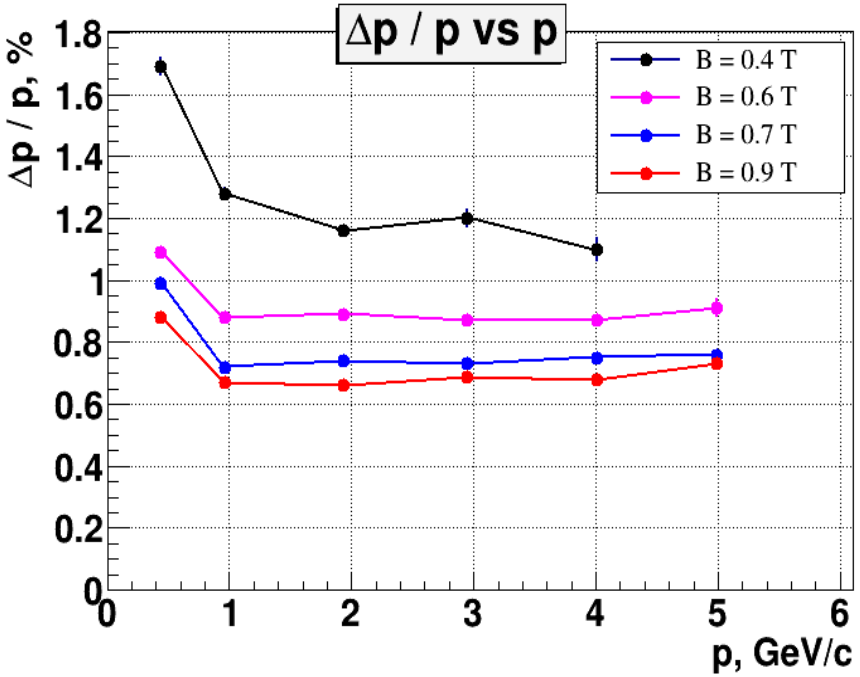


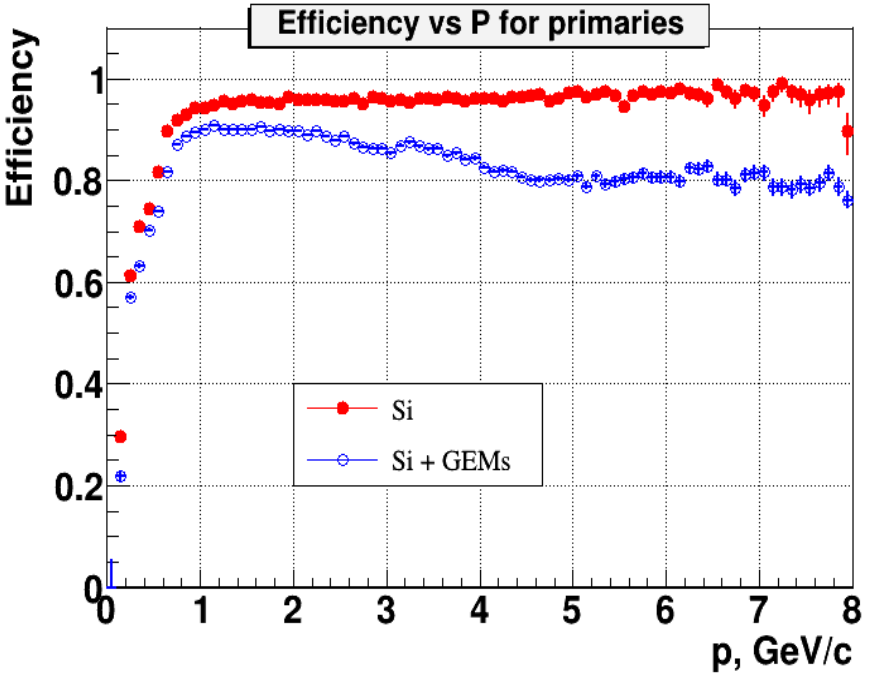




Expected in spring 2022
Xe + CsI
I Xe Cs - neighbours in periodic table of elements
Up to 10 kHz data taking rate

Tracker performance





Data set in Run 8

Detectors: Si (3 stations) + GEMs (7 stations)

Generator: DCM-SMM, Xe+Sn at T_0 = 3.9A GeV ($\sqrt{s_{NN}}$ = 3.296 GeV), 10k-5M min. Bias events

PID: TOF (if needed)

Statistics: K^0_s – 8818 within 50 cm of primary vertex (in 10k events)

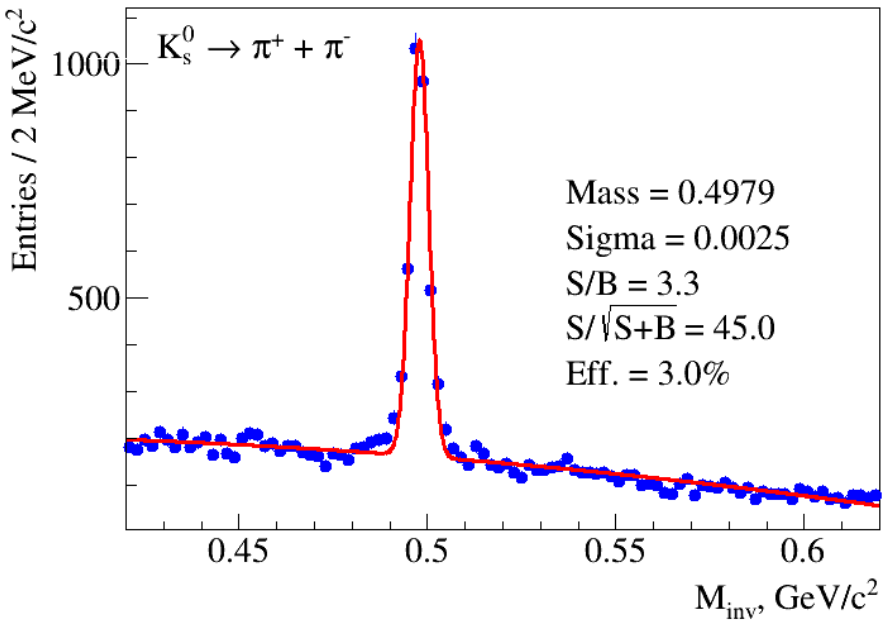
Λ – 10225 within 50 cm of primary vertex (in 10k events)

Ξ^- – 111 in 10k (54175 in 5M)

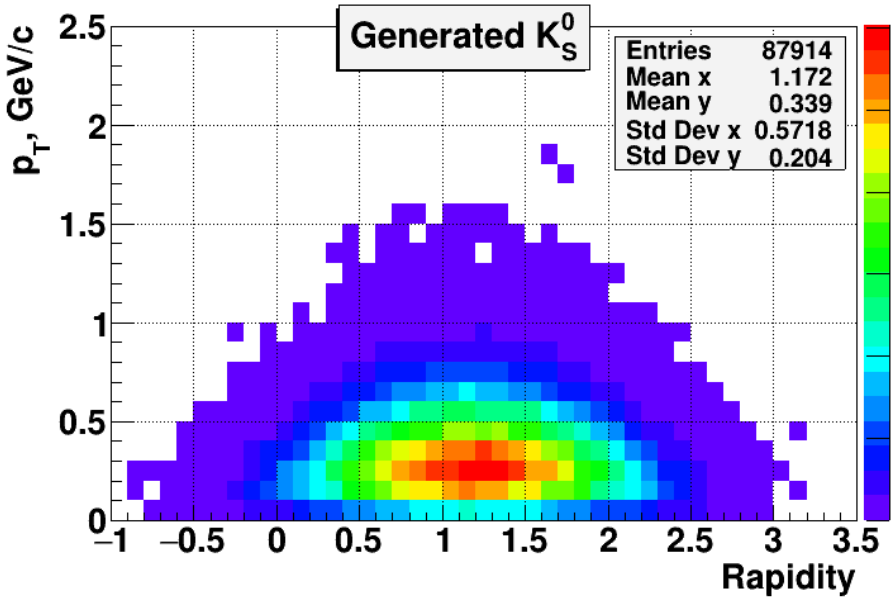
Ω^- – 95 in 5M

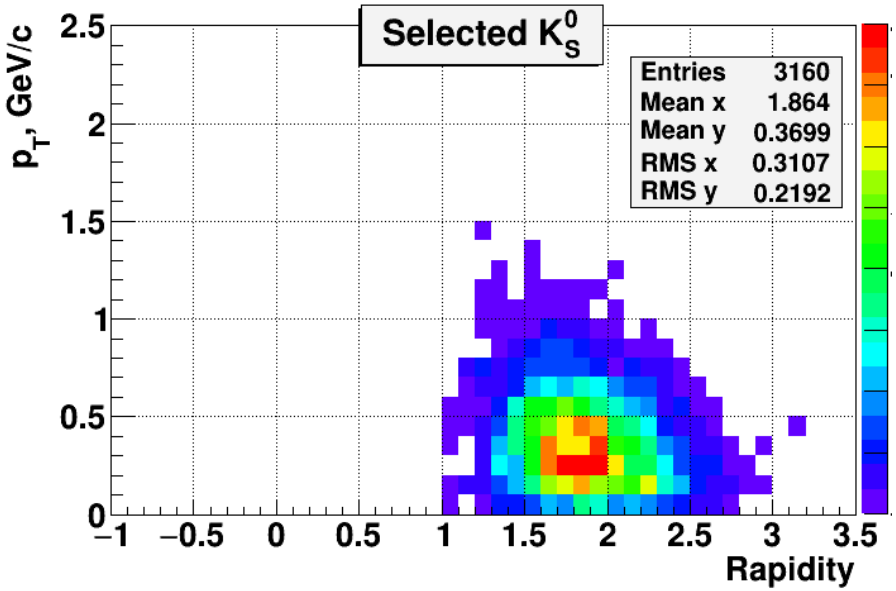
${}_{\Lambda}H^3$ – 6309 in 5M → enriched ${}_{\Lambda}H^3$ sample (randomly add 1 ${}_{\Lambda}H^3$ per 30 events according to y-p_T distribution) → scale factor 27.4

K^0_s reconstruction in Run 8

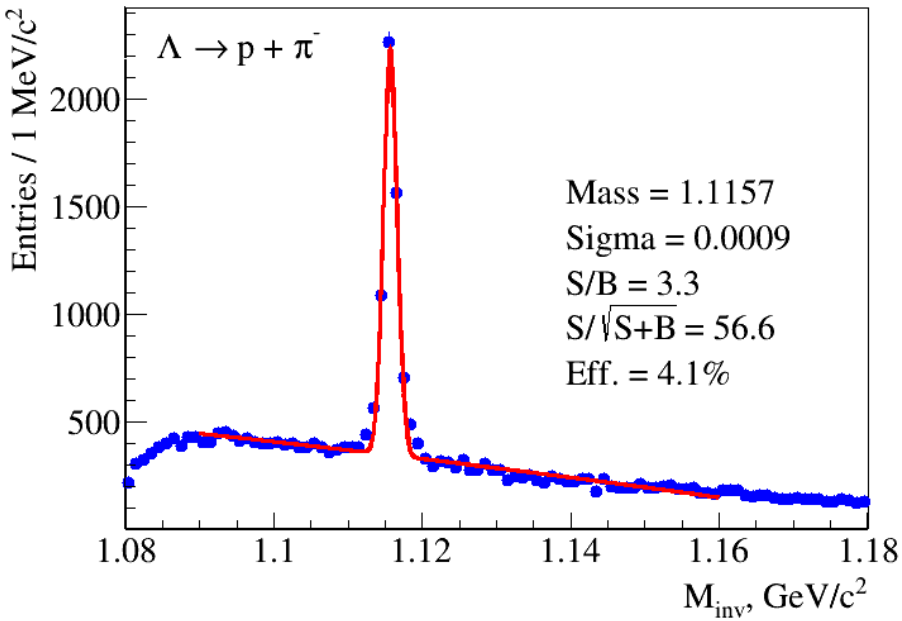


10k interactions

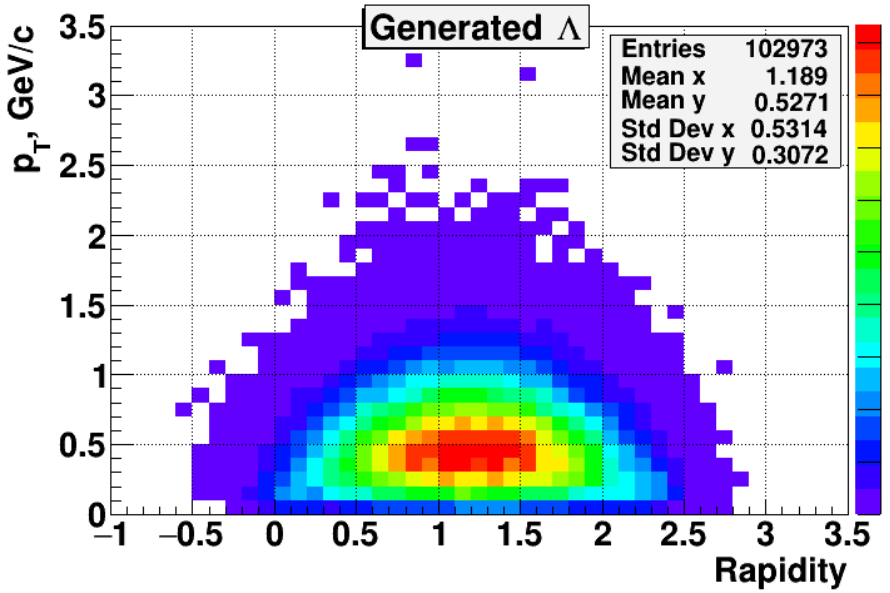


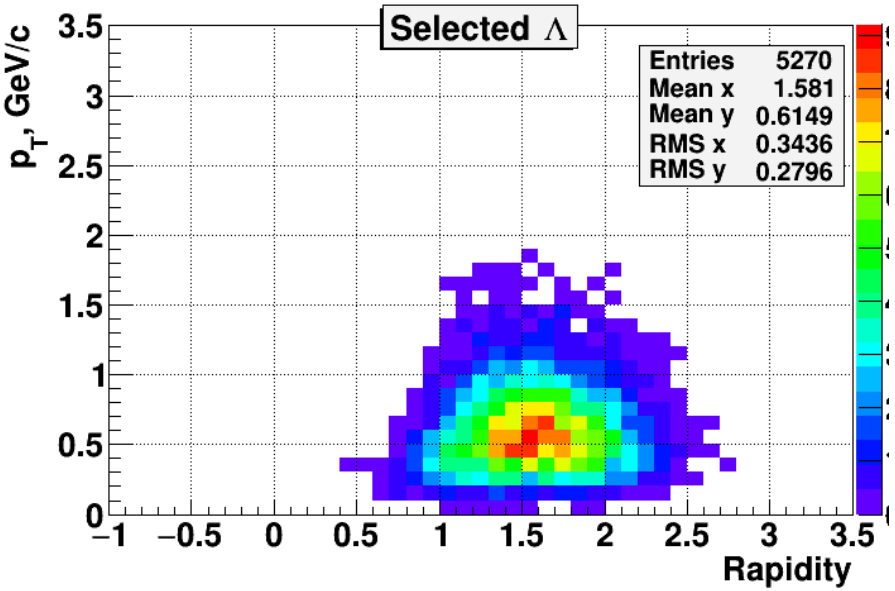


Λ reconstruction in Run 8

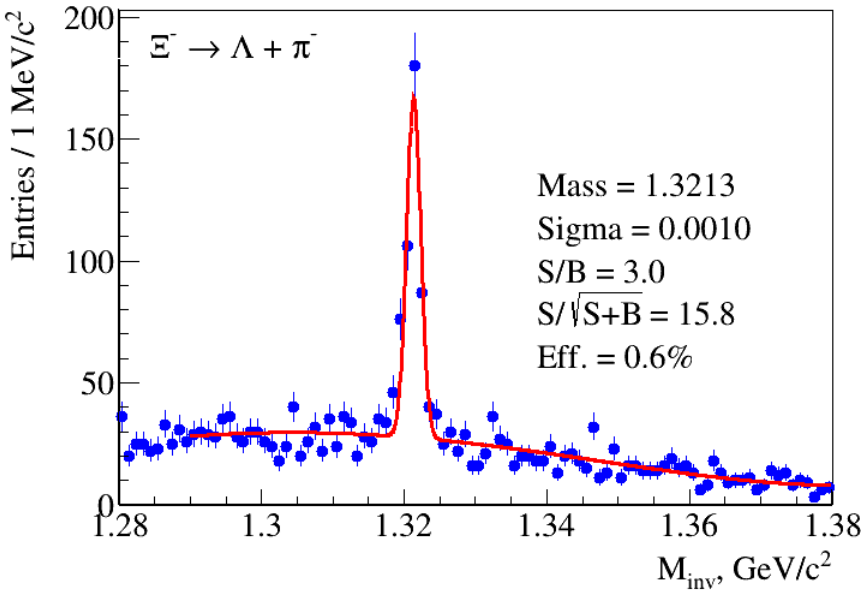


10k interactions

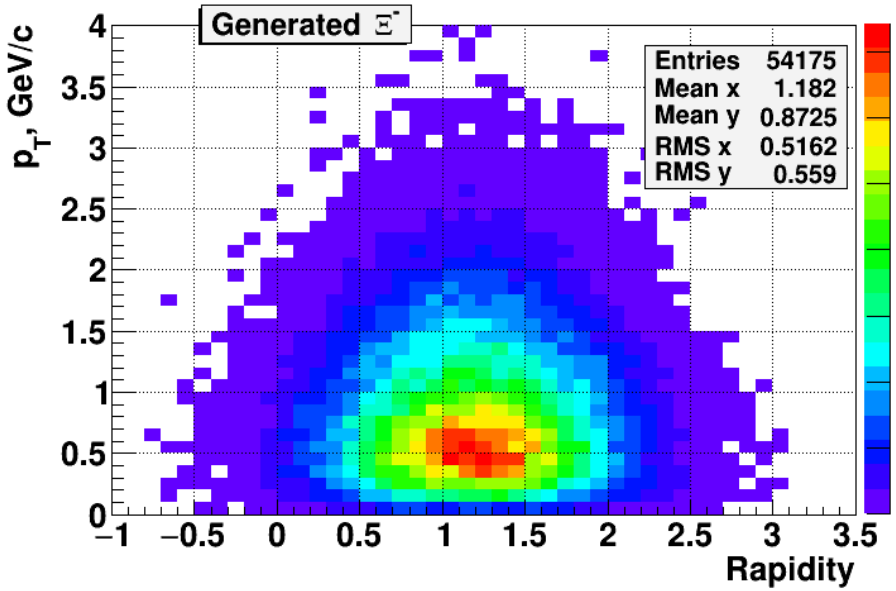


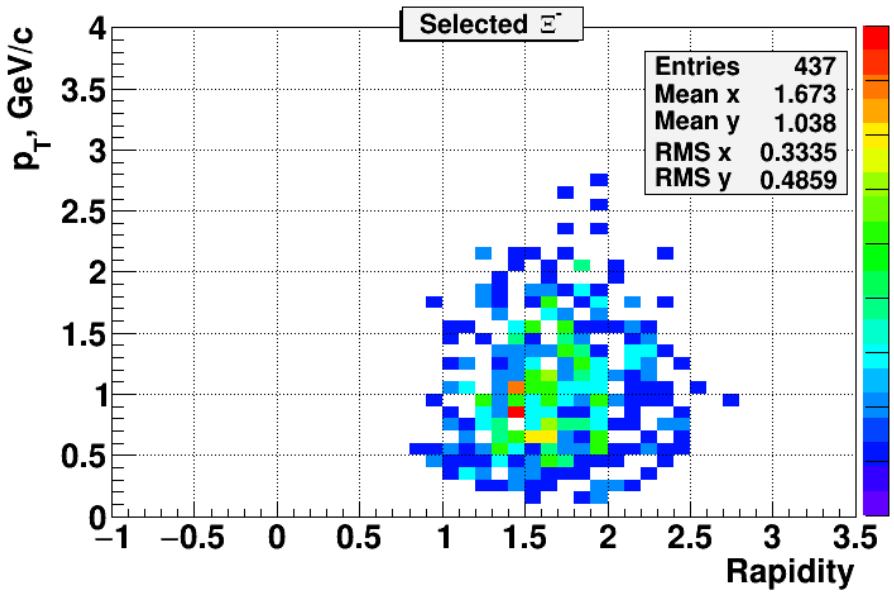


Ξ^- reconstruction in Run 8

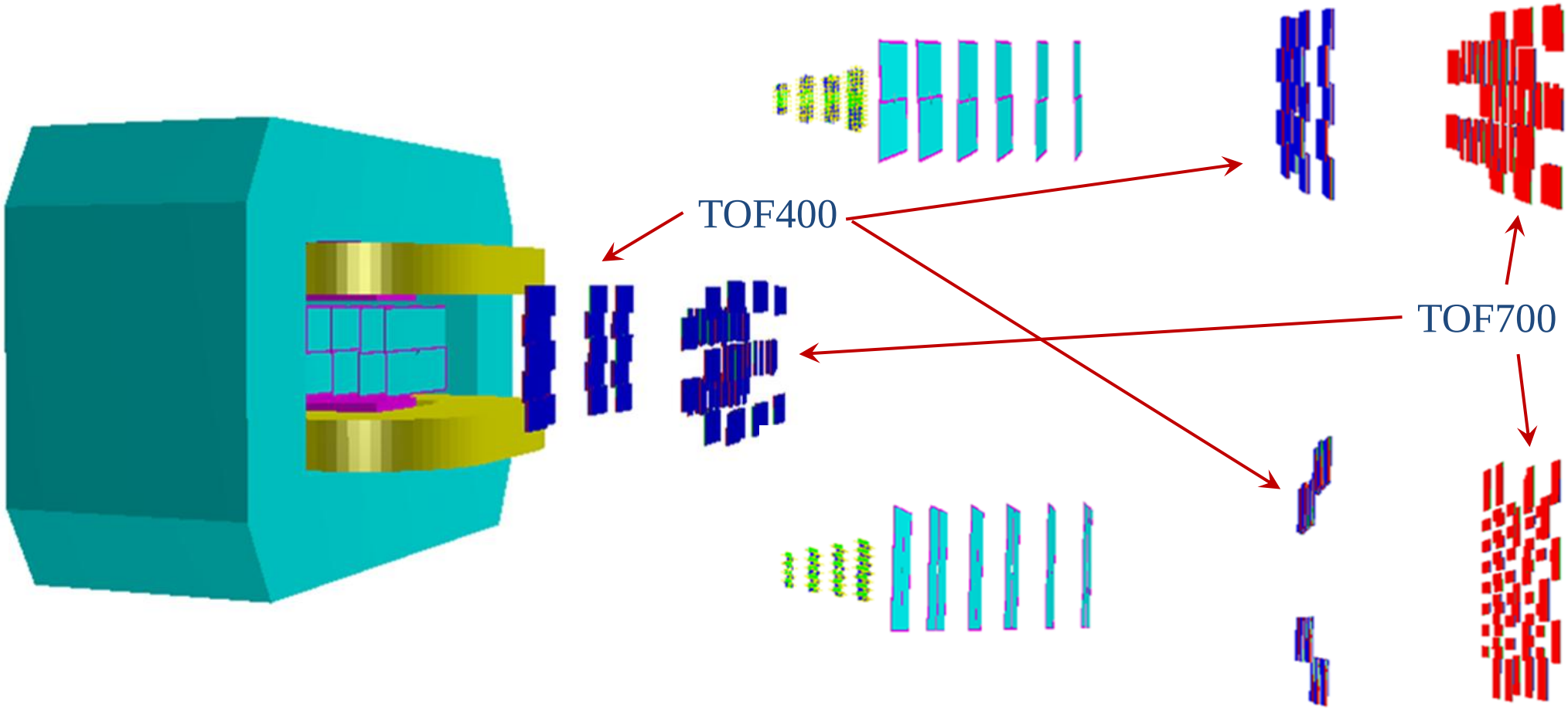


5M interactions

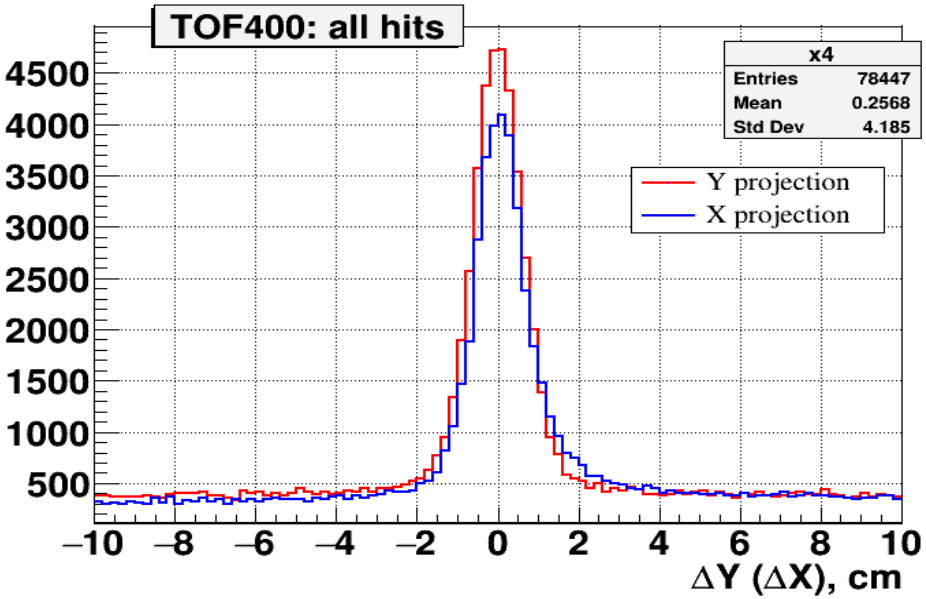


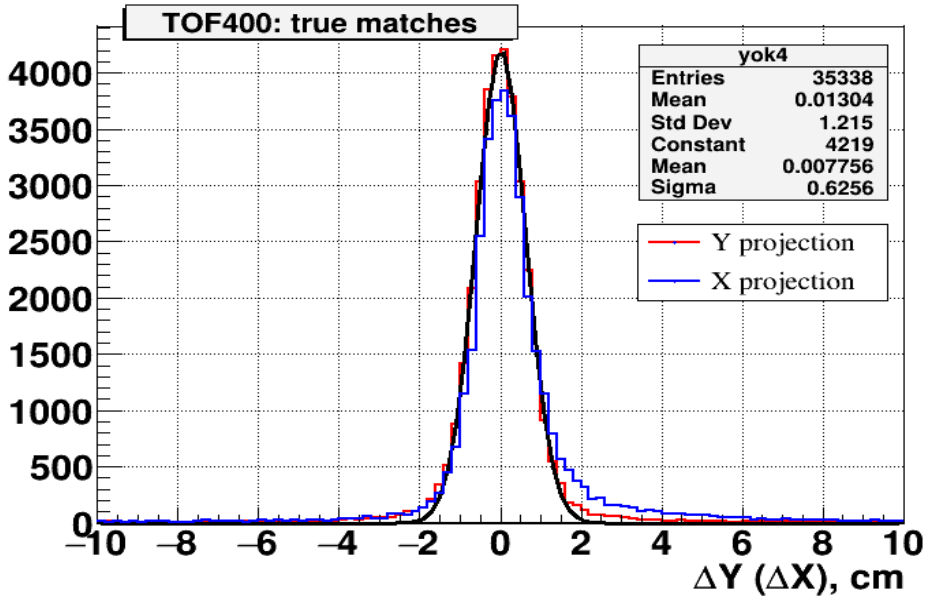


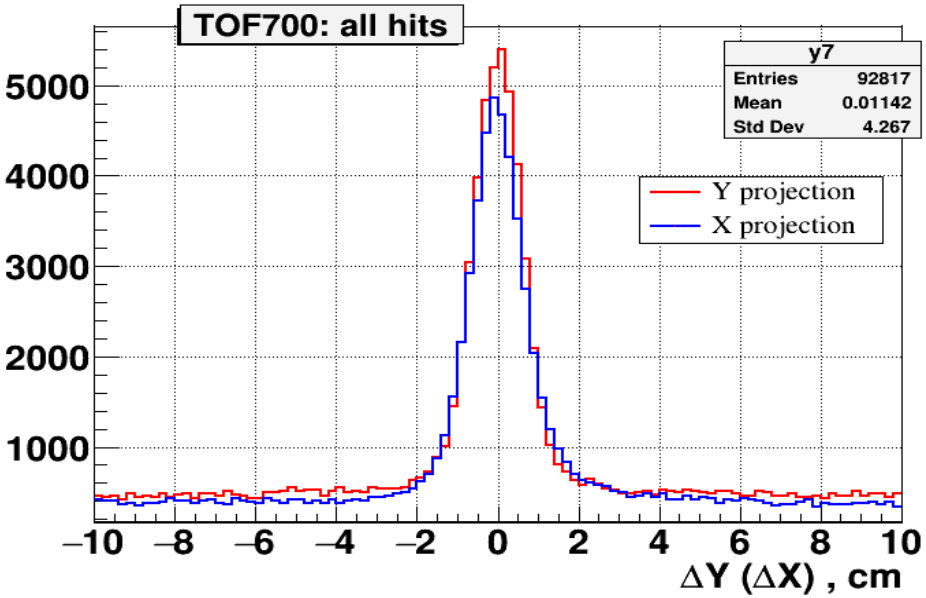
Detector geometry with TOF

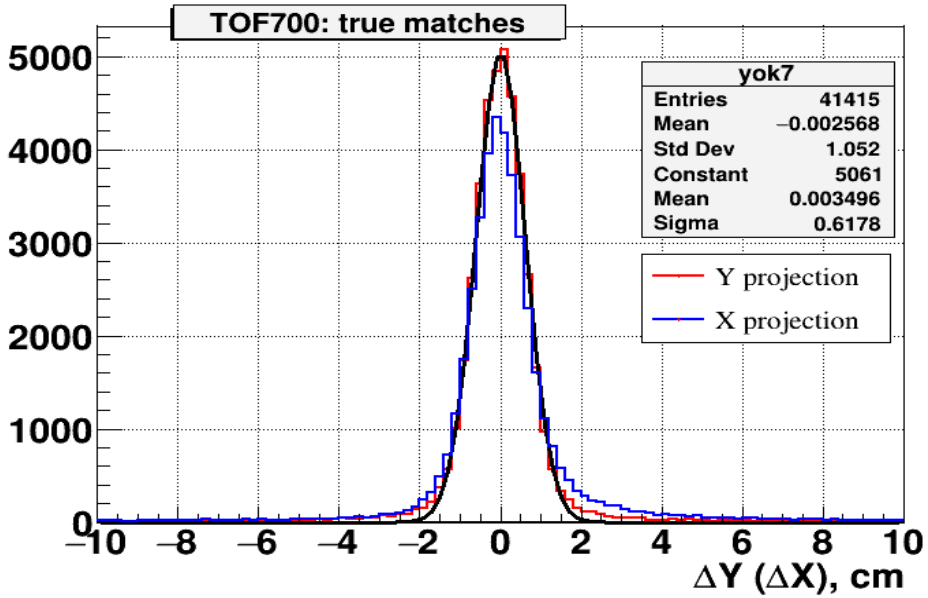


Matching with TOF

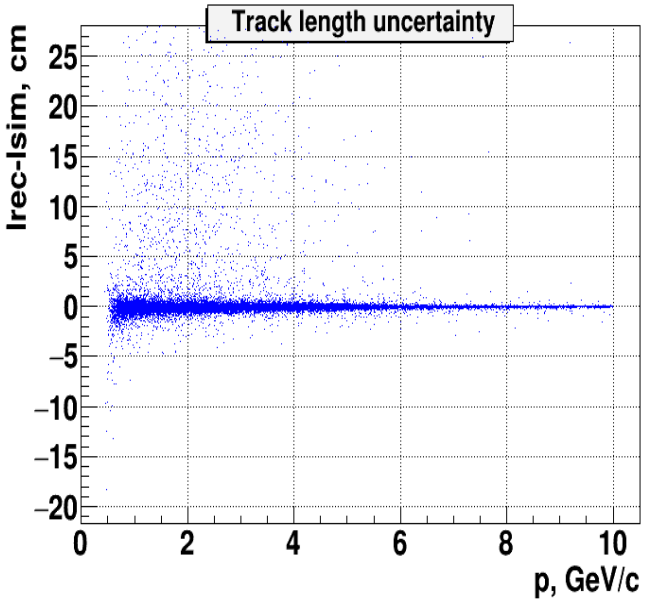


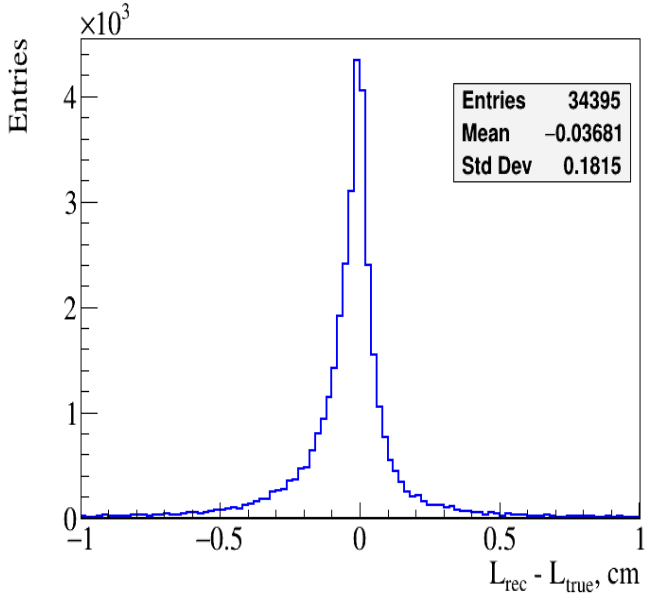


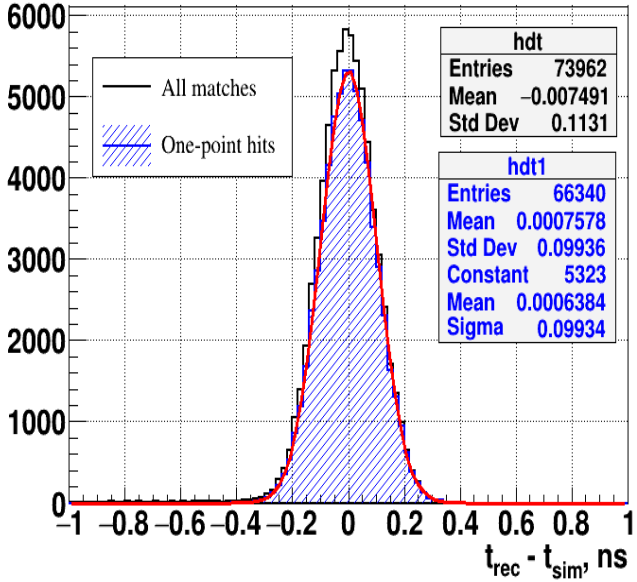


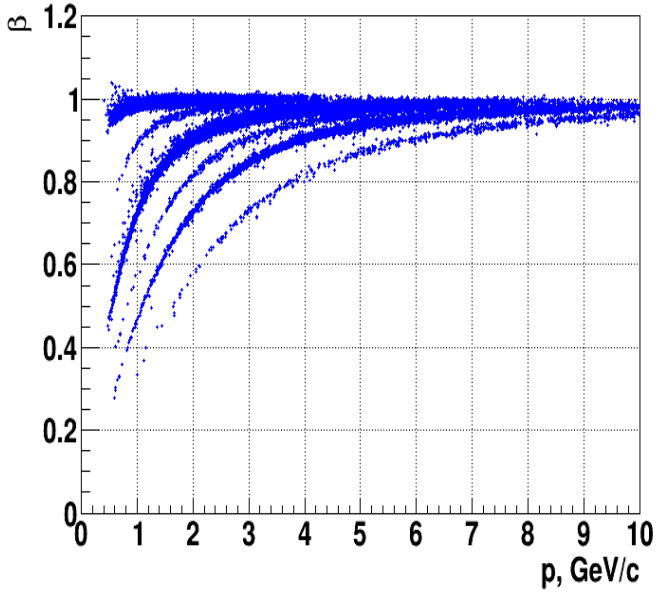


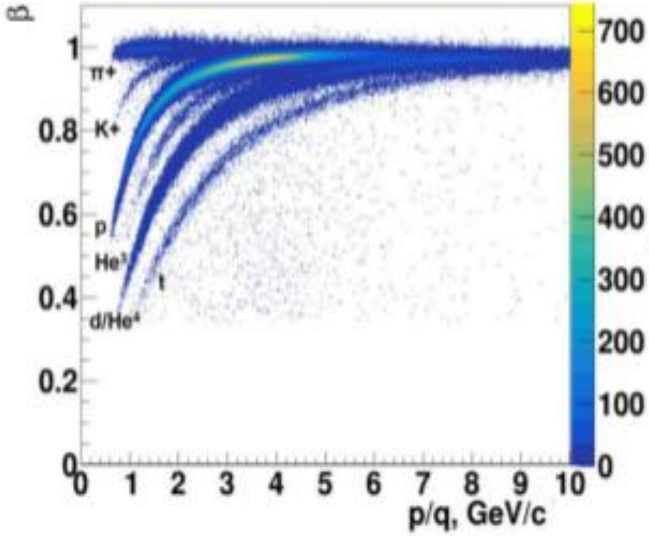
Particle identification with TOF

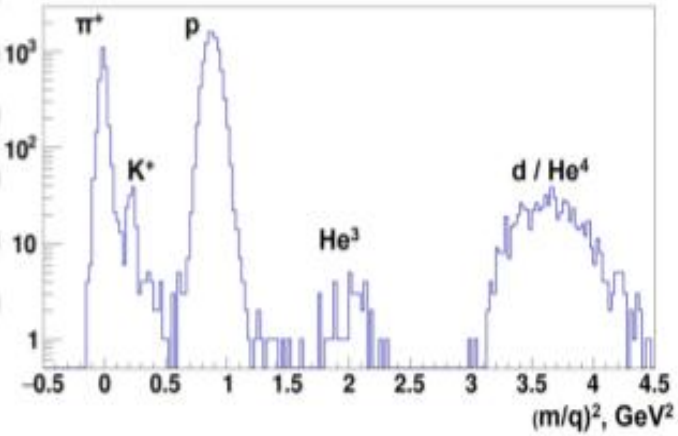




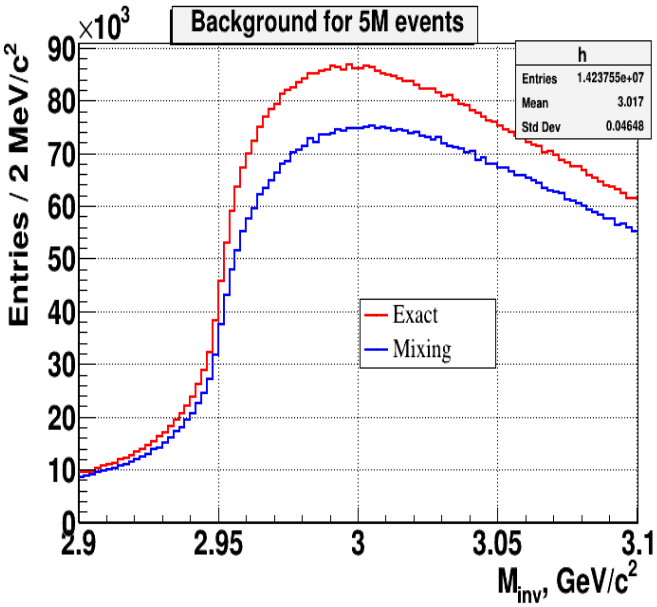


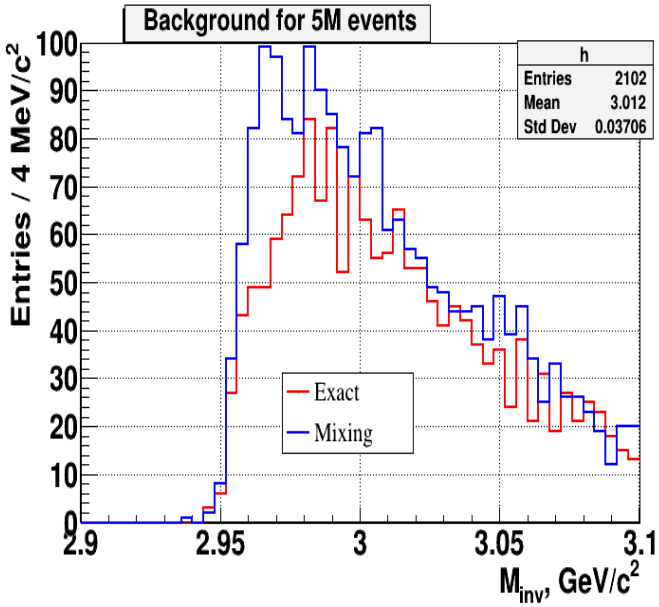


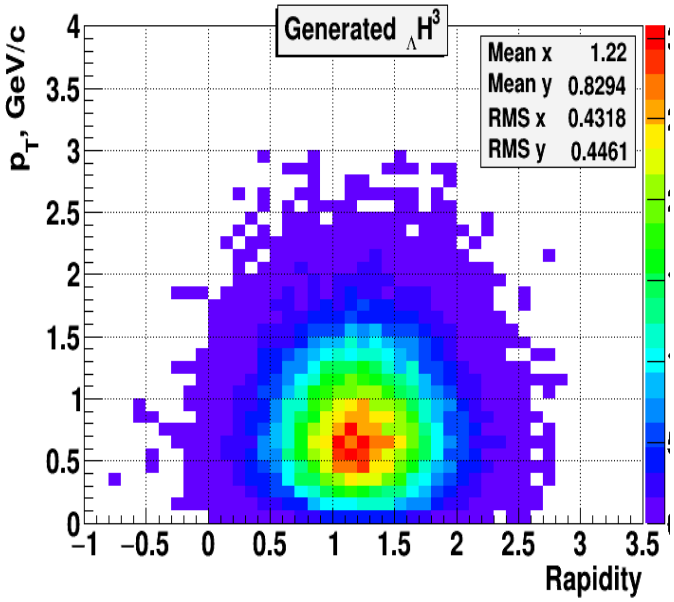


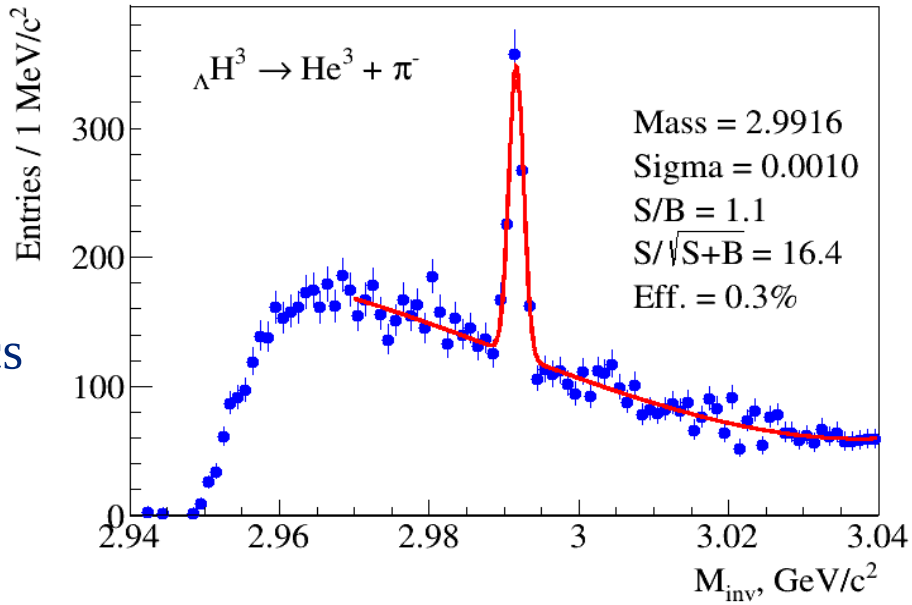


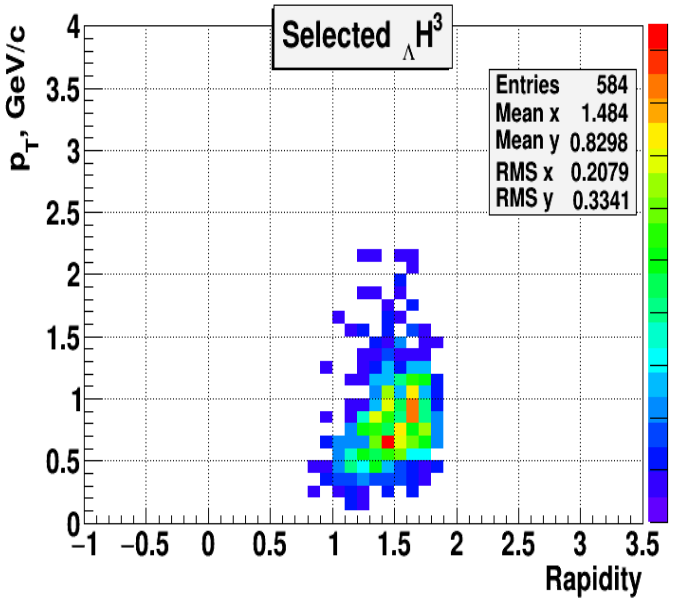
$_{\Lambda}H^3$ reconstruction in Run 8









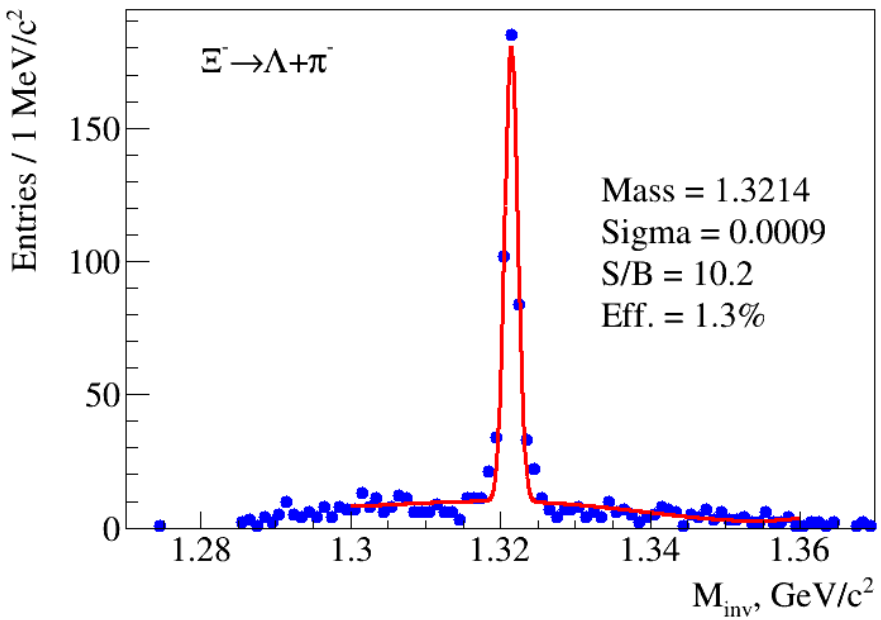


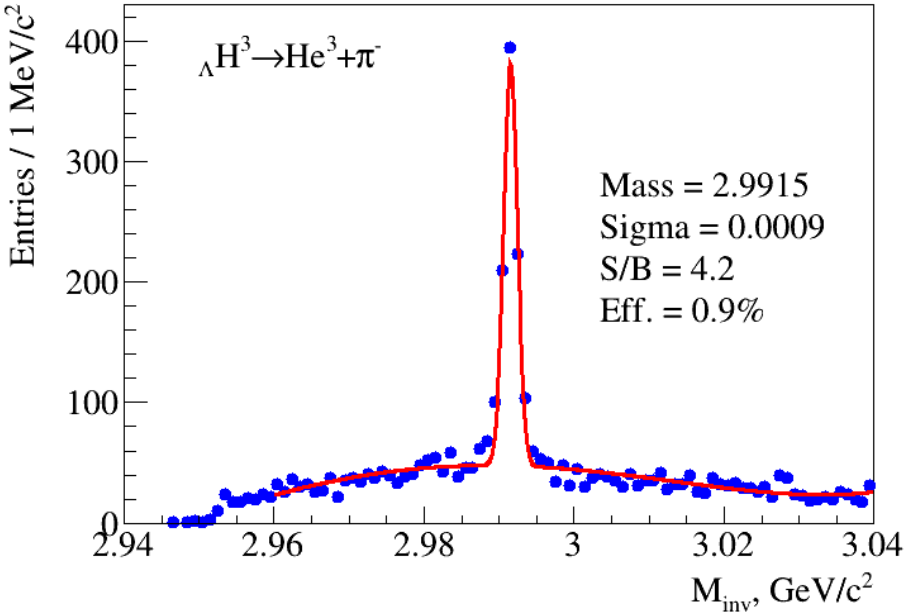
Equivalent statistics
~140M events

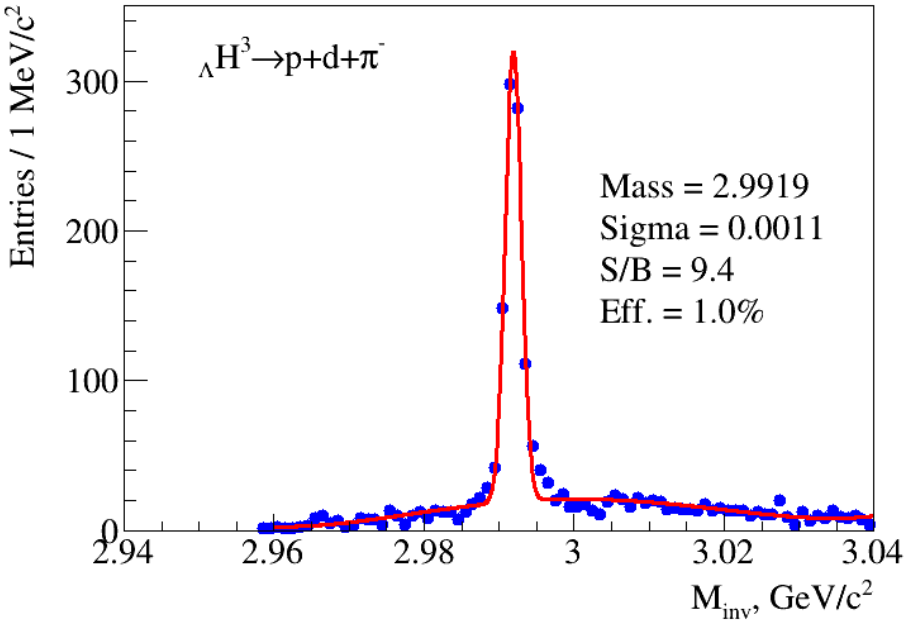
Data set for Au+Au

Detectors:	STS + GEMs + TOF
Magnetic field:	B = 0.8 T
PID:	*beta* in TOF
Generator:	PHQMD, 0.5M events,
	Au+Au at T_0 = 4A GeV, b = 0-5 fm
Production rate :	Ξ^- – 529, ${}_{\Lambda}H^3$ – 1689 (per 10k events)

Ξ^- and ${}_{\Lambda}H^3$ reconstruction

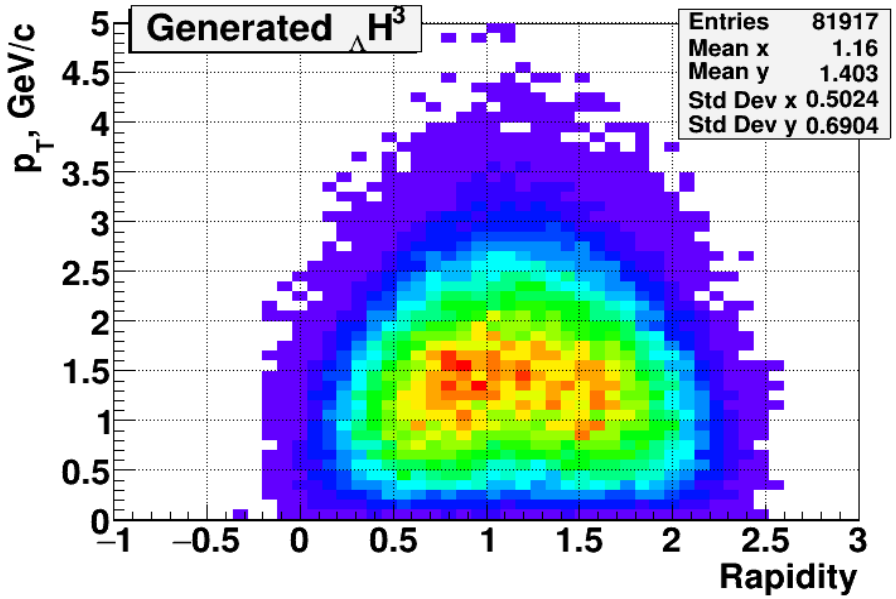


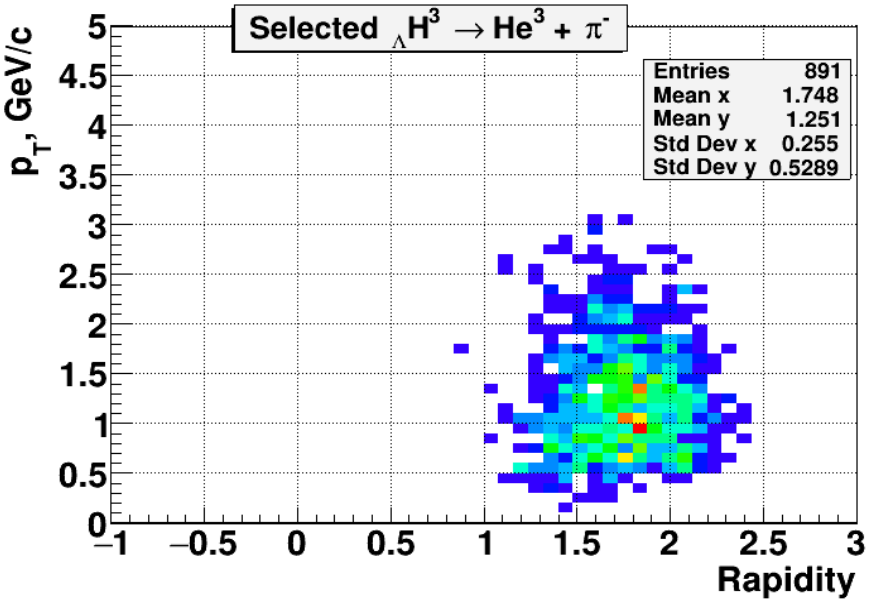


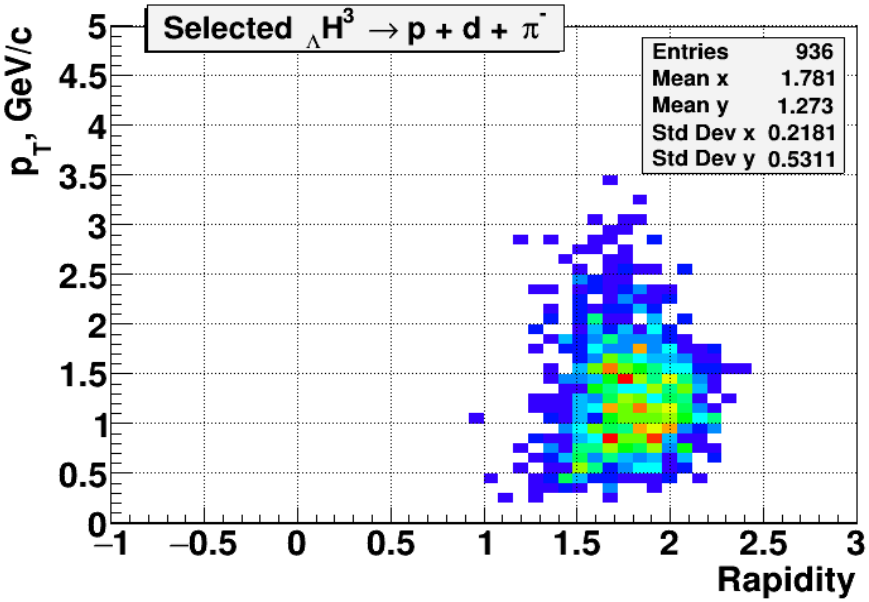


Efficiency = (reconstructed, identified and selected *Hyp*) / (all generated *Hyp* after GEANT within 50 cm of PV)
– ***includes branching ratios, detector acceptance and reconstruction efficiency***

$_{\Lambda}H^3$ phase space







Summary and next steps

- ✓ BM@N detector is expected to be ready for the heavy-ion run in its full configuration
- ✓ Monte Carlo feasibility results show its good prospects for strangeness production studies
- ✓ Preparation of reconstruction and analysis methods and their software implementation is under way, as well as their testing on data from Monte Carlo simulation and technical BM@N runs with C and Ar beams in partial set-ups

- ✓ Use realistic geometry files for simulation: might require modifications / additions in track fitter.

This work was supported by the
Russian Foundation for Basic Research (RFBR):
grant No. 18-02-40036