Reconstruction of Weak Decays in Au+Au Collisions at 1.23A GeV with HADES

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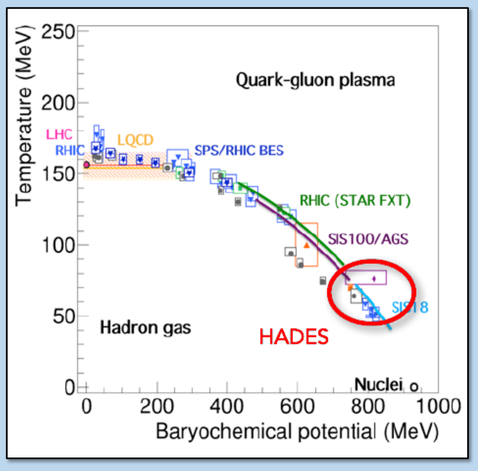
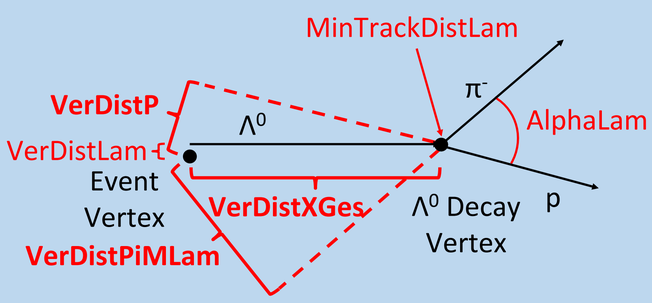
Motivation

- Highest baryochemical potential at freeze out
- Newly produced Quark flavor: Strangeness
  - Production below energetic threshold in NN collisions
  - Sensitive to properties of created system



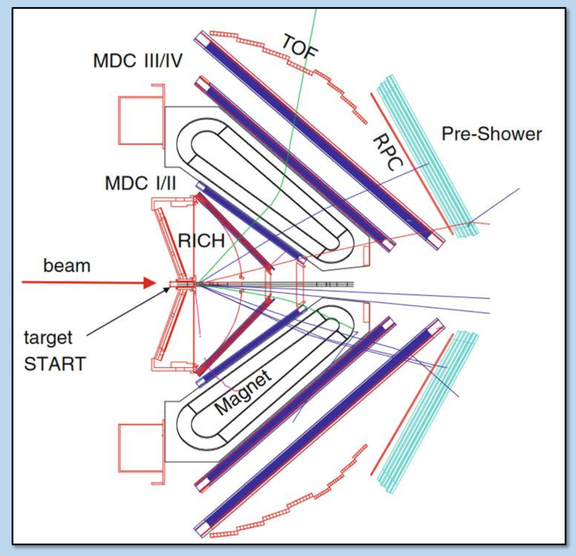


$\Lambda^0 \rightarrow p + \pi^-$ decay topology

- Weakly decaying strange particles (Λ^0, K^0_S, Ξ^- …):
  - Identifiable via decay topologies
  - High purity, low efficiency

HADES

- Fixed target experiment at GSI Helmholtzzentrum für Schwerionenforschung - Germany
- High acceptance for detection of leptons and hadrons
- Tracking with **M**ini **D**rift **C**hambers (MDC)
- Particle Identification: Time of Flight and/or dE/dx

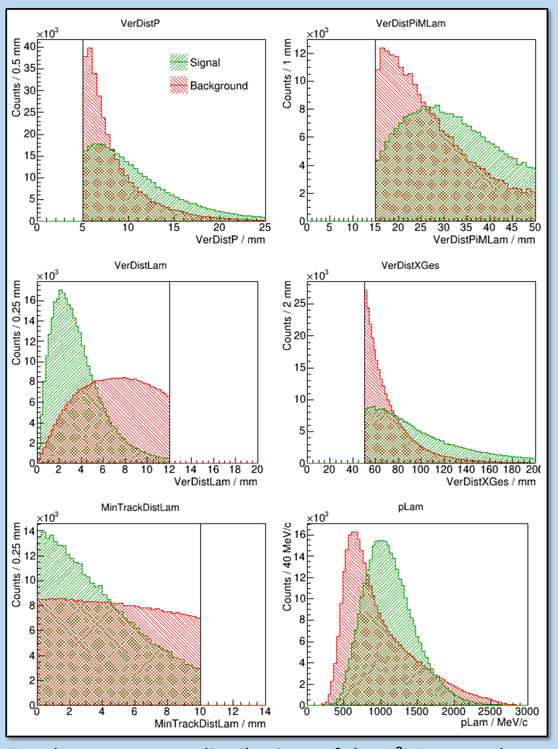


Schematic setup of HADES

- Collision system Au (1.23A GeV) + Au $\left(\sqrt{s_{NN}} = 2.41\ \text{GeV}\right)$ 40% most central events selected

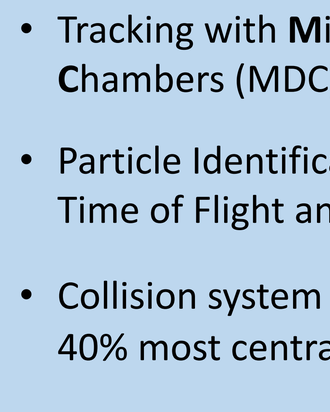
Neural Network

- The challenge: ≈ 10 π and ≈ 100 p per event rare signal ≈ 10^{-2} Λ^0 and K^0_S
  - Large combinatorial background
- The solution: Multi-Layer-Perceptron (MLP) from the Toolkit for Multi-variant data analysis (TMVA)
- Trained on weak decay topology parameter
  - Simulated Signal (green) and Mixed-Event-Background (red)

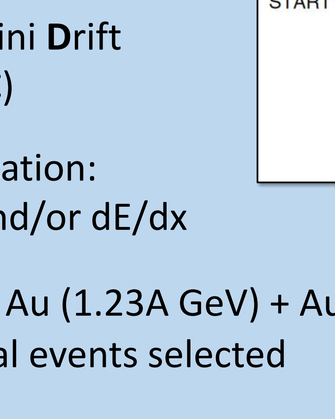


Topologyparameter distributions of the $\Lambda^0 \rightarrow p + \pi^-$ decay

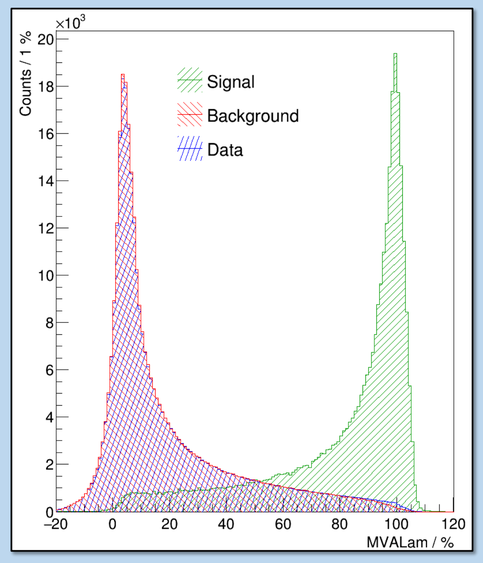
- MVA Response shows very high discrimination power
- Data are dominated by background
- Small amount of signal can be separated by cutting at ≈ 90%
- Below: Λ^0 mass spectra



Standard method

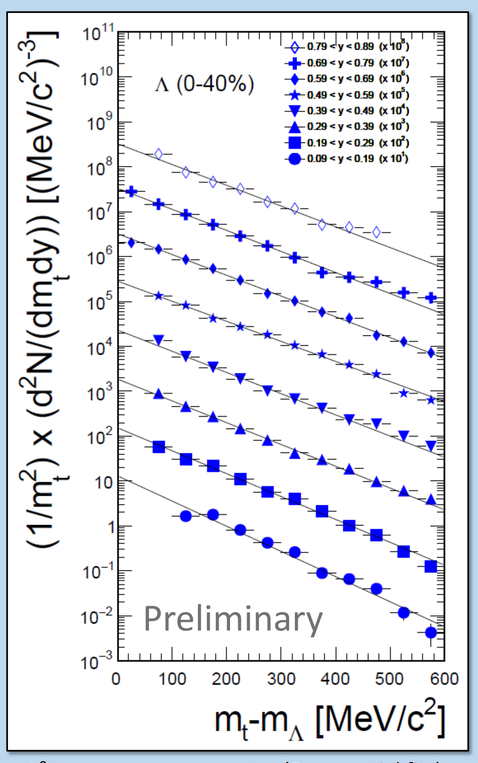


With Neural Network



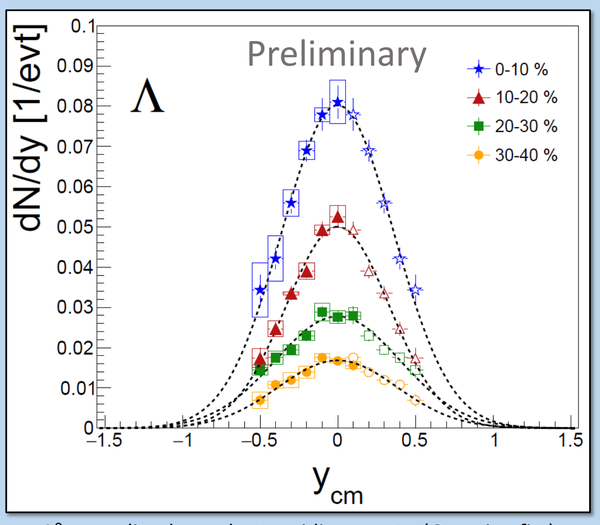
- Neural Network improves signal significantly compared to standard method

Results



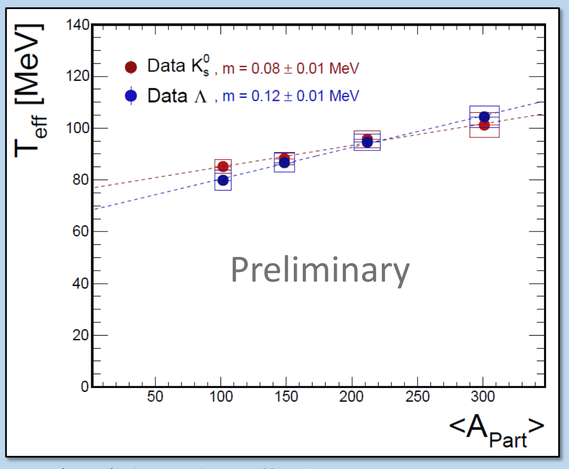
Λ^0 transverse mass spectra (Exponential fits)

- Reduced transverse mass and rapidity differential analysis for 4 centrality classes
- Left: Transverse mass spectra Below: Rapidity spectra

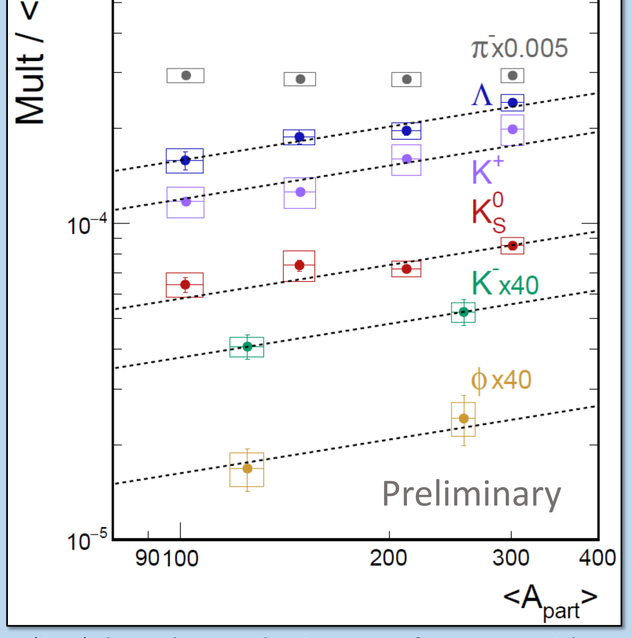


Λ^0 centrality dependent rapidity sepctra (Gaussian fits)

- Right: Similar $\langle A_{part} \rangle$ dependence for all strange particles multiplicities
- $M \sim \langle A_{part} \rangle^{\alpha}$ $\alpha = 1.35 \pm 0.07$
- Below: T_{eff} of Λ^0 rises faster than of K^0_S (radial boost?)



$\langle A_{part} \rangle$ dependent effective tempertures T_{eff}



$\langle A_{part} \rangle$ dependent production rates of strange particles

Supported by: GSI
HGS-HIRe for FAIR
Helmholtz Graduate School for Hadron and Ion Research
HIC for FAIR
Helmholtz International Center
EMMI
FAIR
Bundesministerium für Bildung und Forschung

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