

Electromagnetic Decay of Hyperons at FAIR Phase-0

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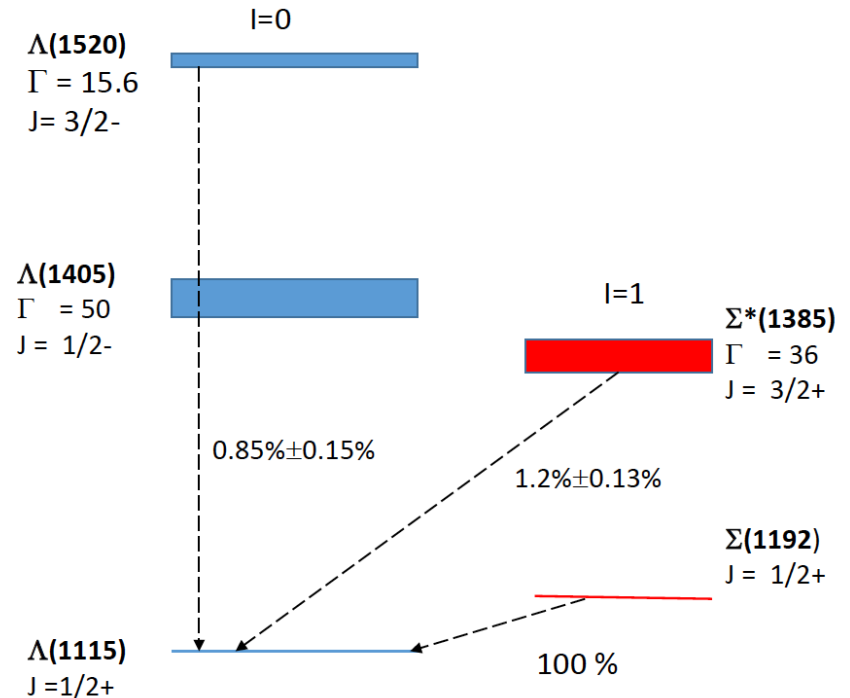
Outlines:

- Motivation.
- HADES Experiment and Upgrade.
- Event Generation.
- Event Reconstruction.
- pp@3.5GeV.
- Conclusion and Outlook.

Motivation:

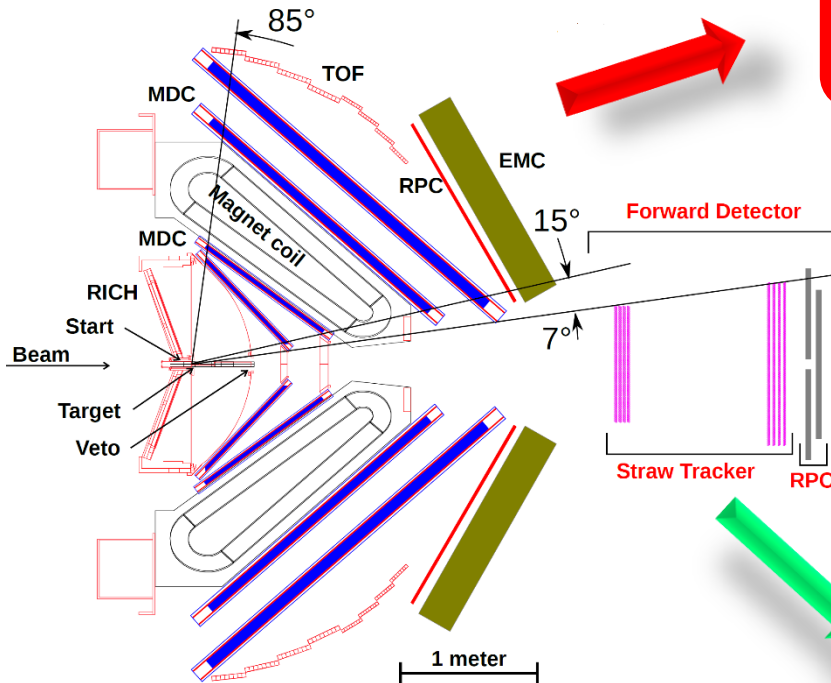


- **The electromagnetic (EM) decay** of baryons provides a detailed information on their **underlying structure**.
- Clean probe of baryon wave functions.
- Understanding of the structure of the strange resonances in the region of small q^2 .
- In addition the **hyperon reconstruction** will benefit from the proposed **Forward Detector** that extends HADES acceptance to forward direction.



HADES Upgrade and the Forward Detector (FD):

FAIR Phase-0 upgrade



Electro Magnetic Calorimeter (**EMC**).
It will provide energy information for
leptons and photons

Resistive Plate Chambers
(**RPC**). Provides information on
time of flight (TOF)

Straw Tracking Stations. Based on PANDA
straw tubes.

In addition:

- RICH Upgrade (Improve e^+e^- eff.).
- DAQ.

Event Generation:



- Production of **Y**, ($\Sigma(1385)$, $\Lambda(1405)$, $\Lambda(1520)$) (**Pluto** event generator) :

$$p(4.5\text{GeV})p \rightarrow pK^+Y$$

$\gamma\Lambda$

Γ_1	$p\pi^-$	$(63.9 \pm 0.5)\%$
Γ_2	$n\pi^0$	$(35.8 \pm 0.5)\%$

Acceptance in the HADES: 18° - 85°

p_{primary}	$p_{\text{secondary}}$	K^+	π^-
44%	29%	62%	57%

Acceptance in the FD: 0.5° - 6.5°

p_{primary}	$p_{\text{secondary}}$	K^+	π^-
11.5%	17%	7%	8.5%

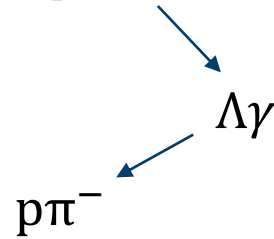
Average

Event Reconstruction :

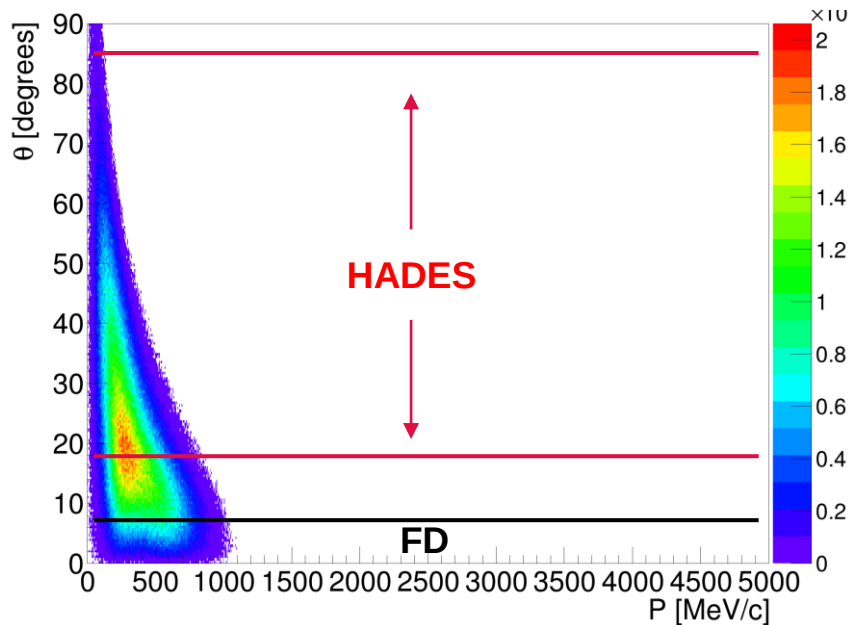
➤ Lambda at HADES and the FD:



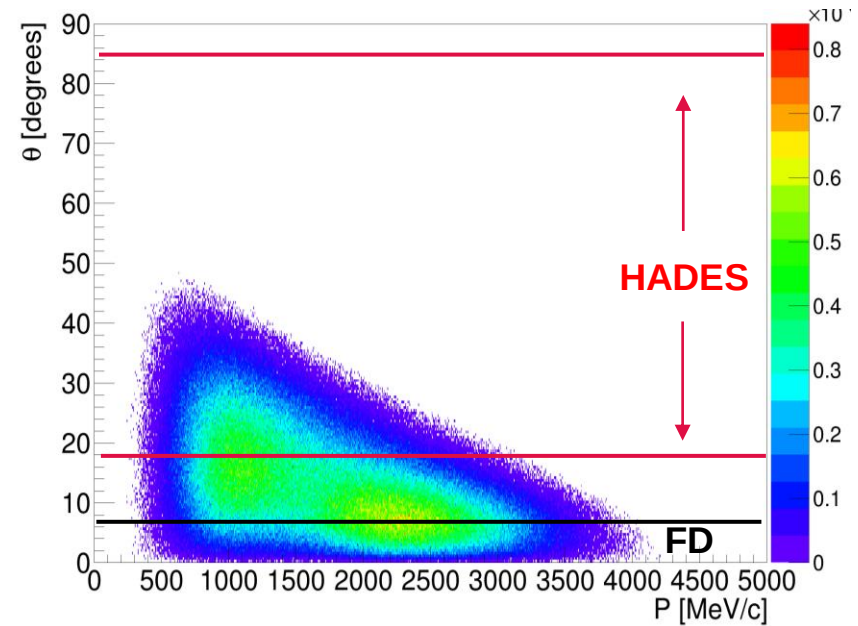
$$p(4.5\text{GeV})p \rightarrow pK^+\gamma$$



$$\Lambda \rightarrow p\pi^-$$

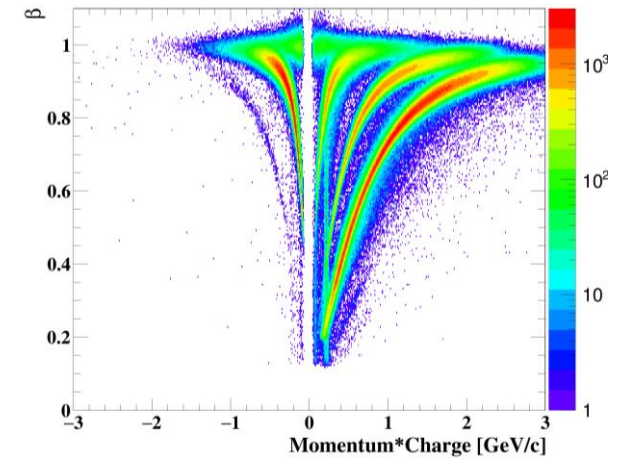
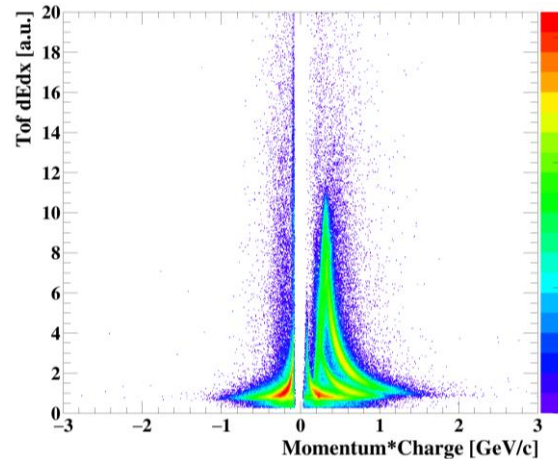
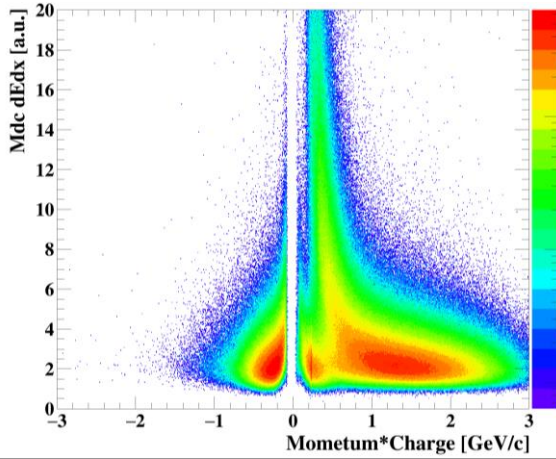


$$\Lambda \rightarrow p\pi^-$$



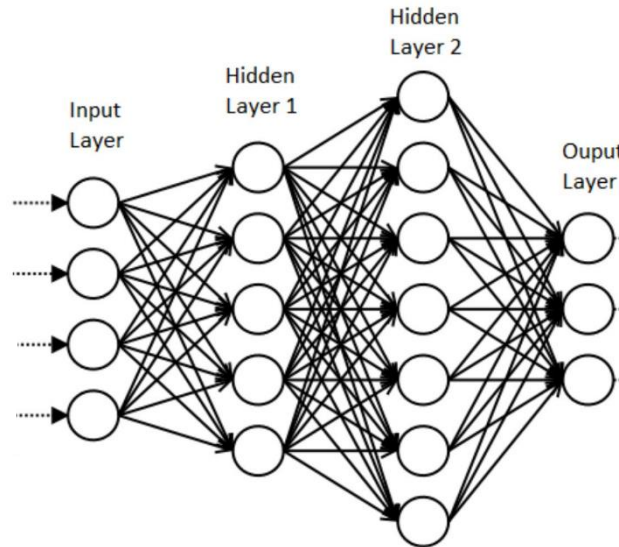
Event Reconstruction :

➤ Charged Particle Identification (PID):



Tracks

pxq
 β
 $Mdc \ dE/dx$
 $Tof \ dE/dx$

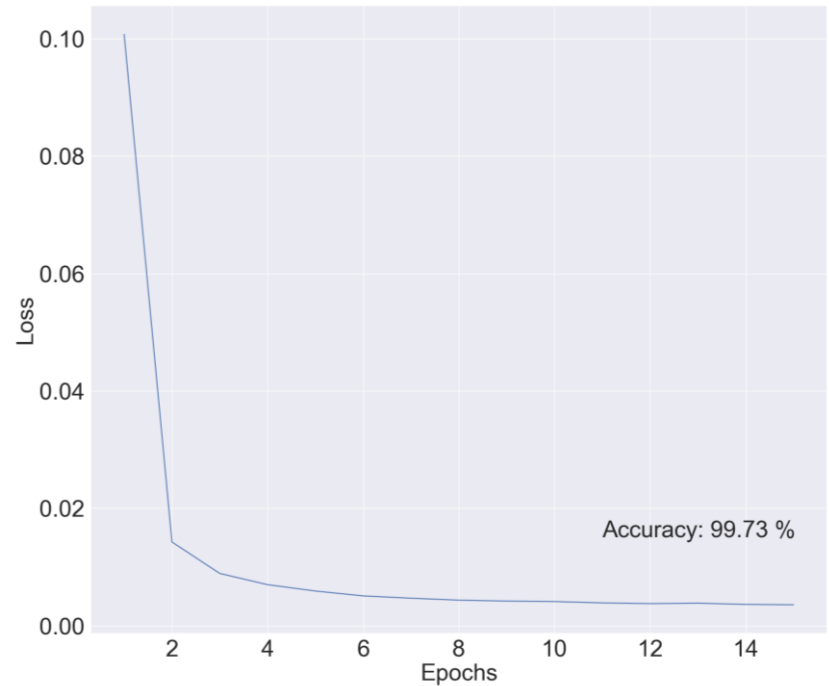
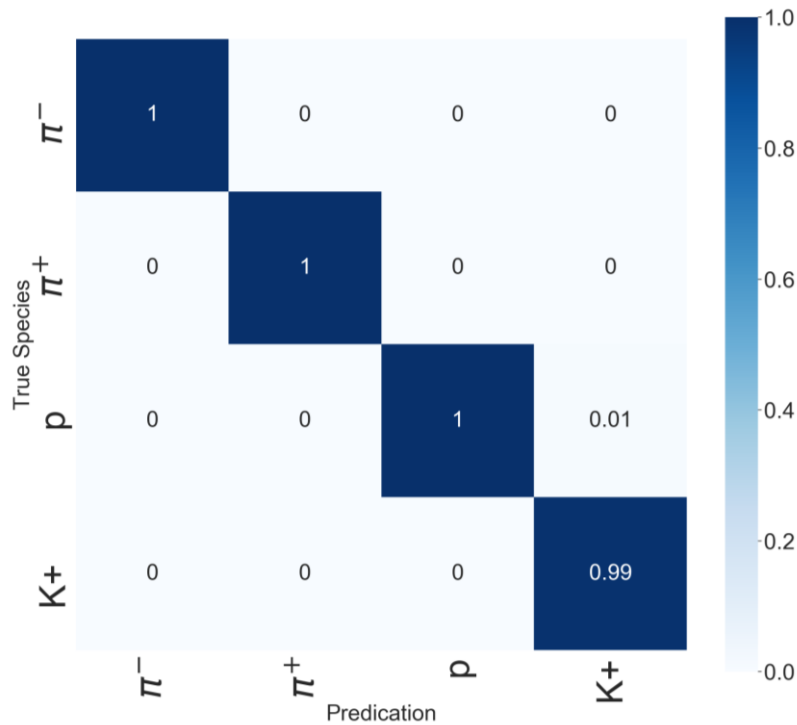


p
 $\pi^\pm$
 $K^\pm$

Particle Candidates

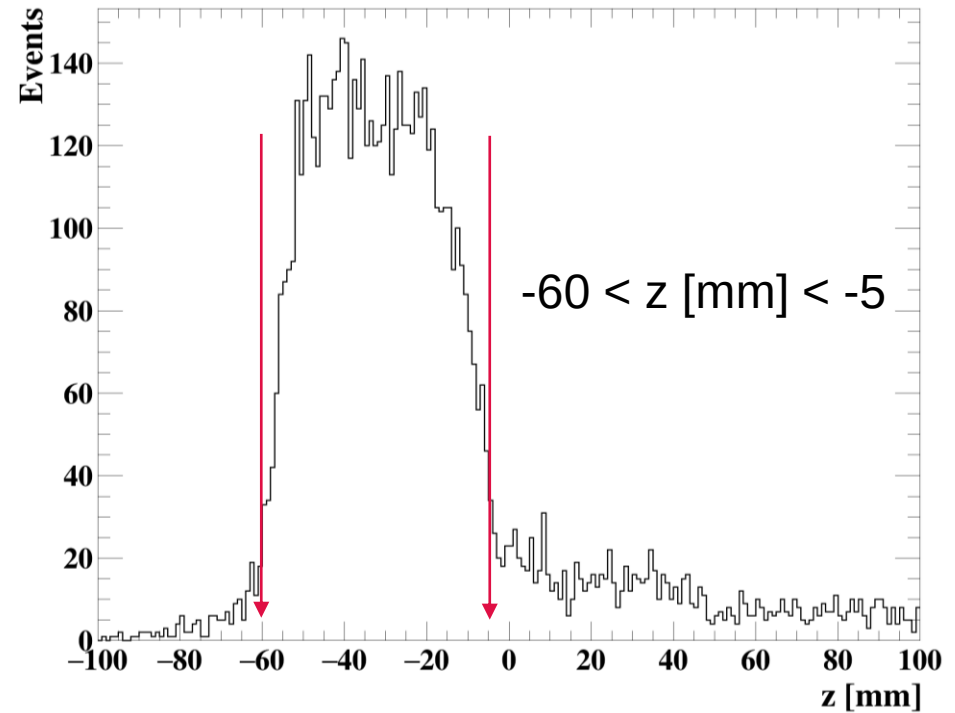
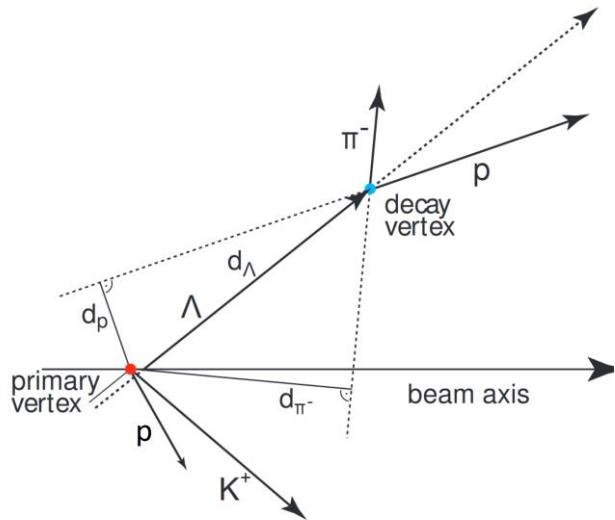
Event Reconstruction :

➤ Charged Particle Identification (PID):



Event Reconstruction :

➤ Primary Vertex Reconstruction:

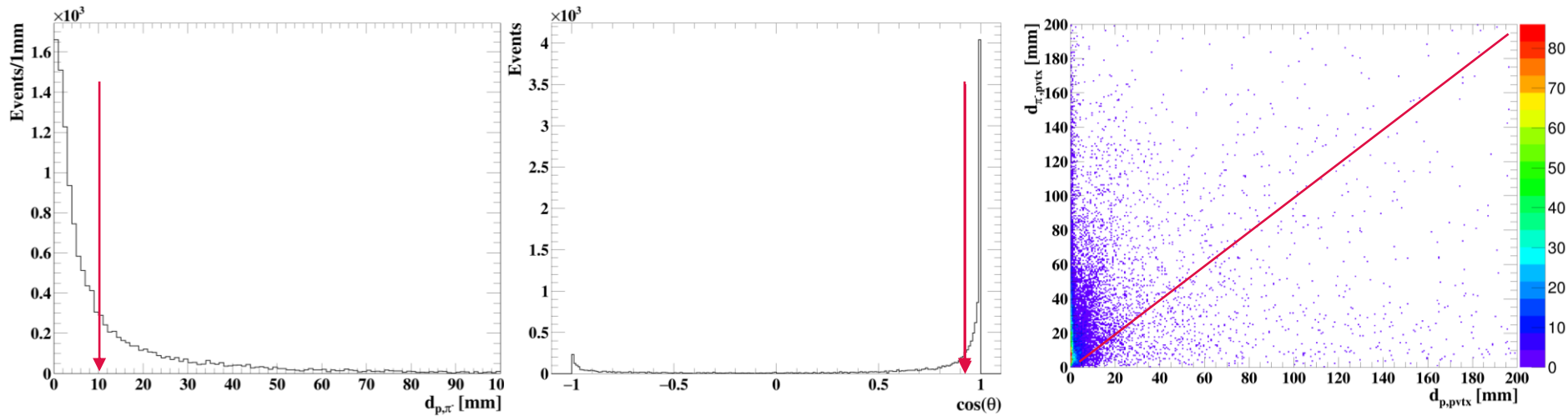


Event Reconstruction :

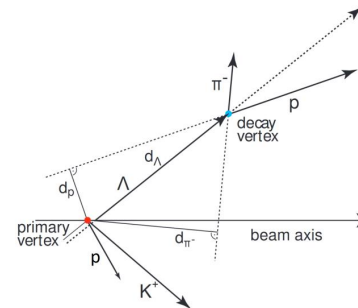
➤ Lambda Reconstruction at HADES:



At **HADES** Lambdas are reconstructed from daughter particles p and π^-



1. Minimum distance between daughter particles < 10 mm.
2. The angle between the pointing vector and the reconstructed momentum $\cos(\theta) > 0.9$.
3. distance of proton to the primary vertex $<$ distance of pion to the primary vertex.

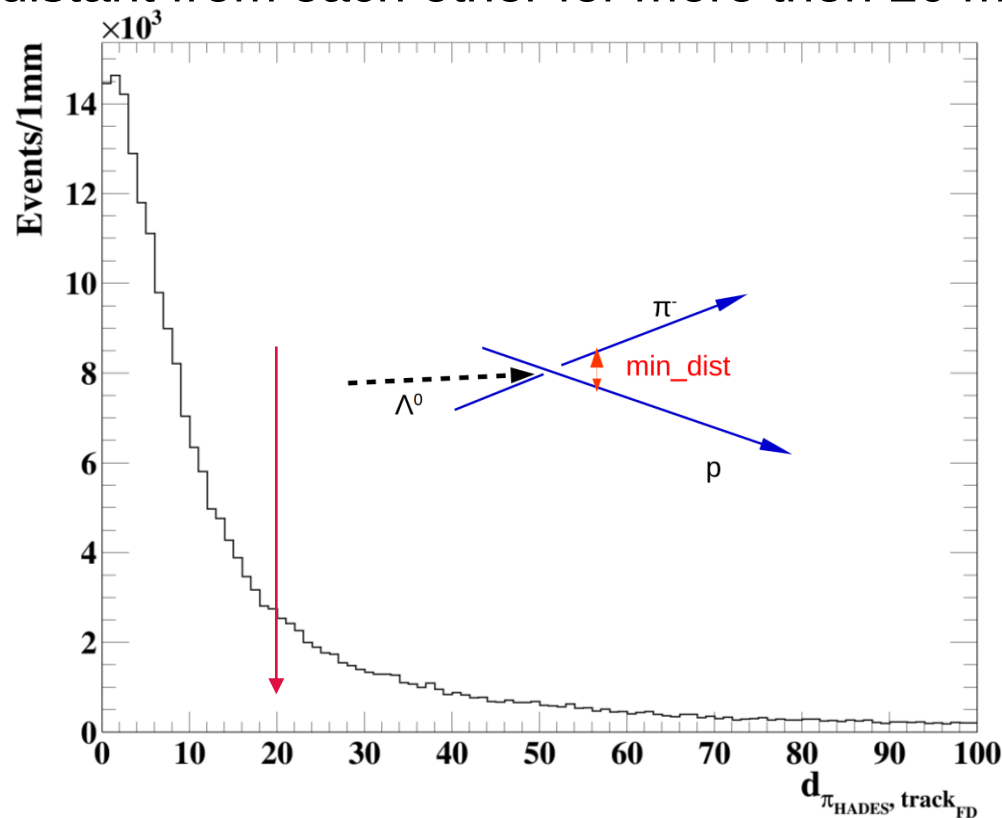


Event Reconstruction :



➤ Lambda Reconstruction at the FD:

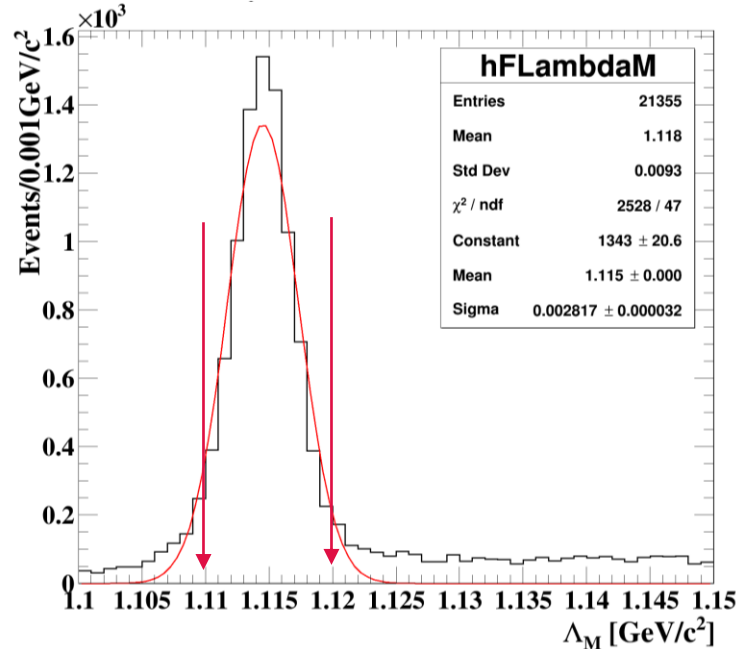
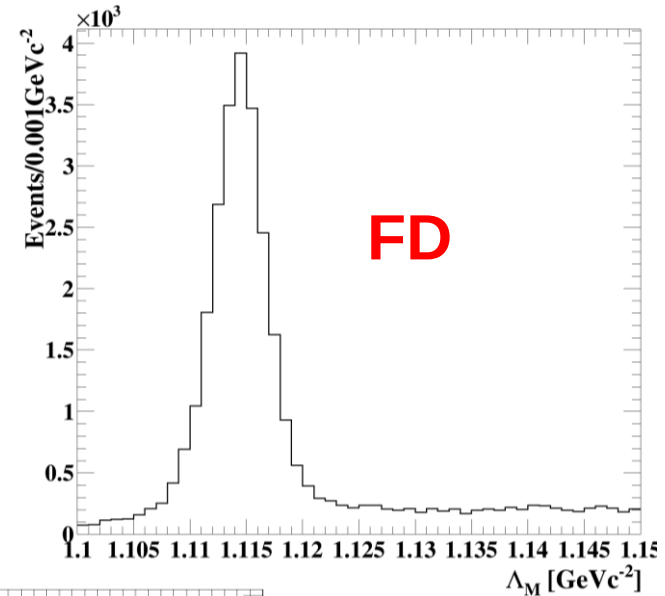
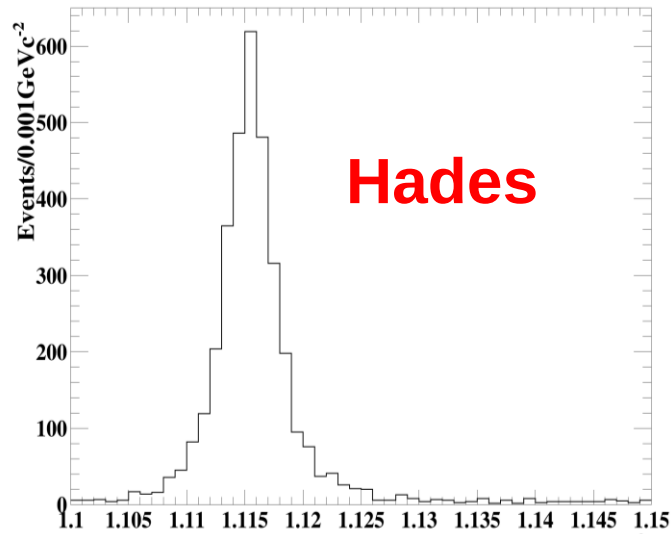
- Combine all tracks from the **FD** and π^- candidates from **HADES**, calculate the minimum distance between the FD track and π^- , and then reject all pairs distant from each other for more than 20 mm.



Event Reconstruction :



➤ Lambdas from HADES and the FD :

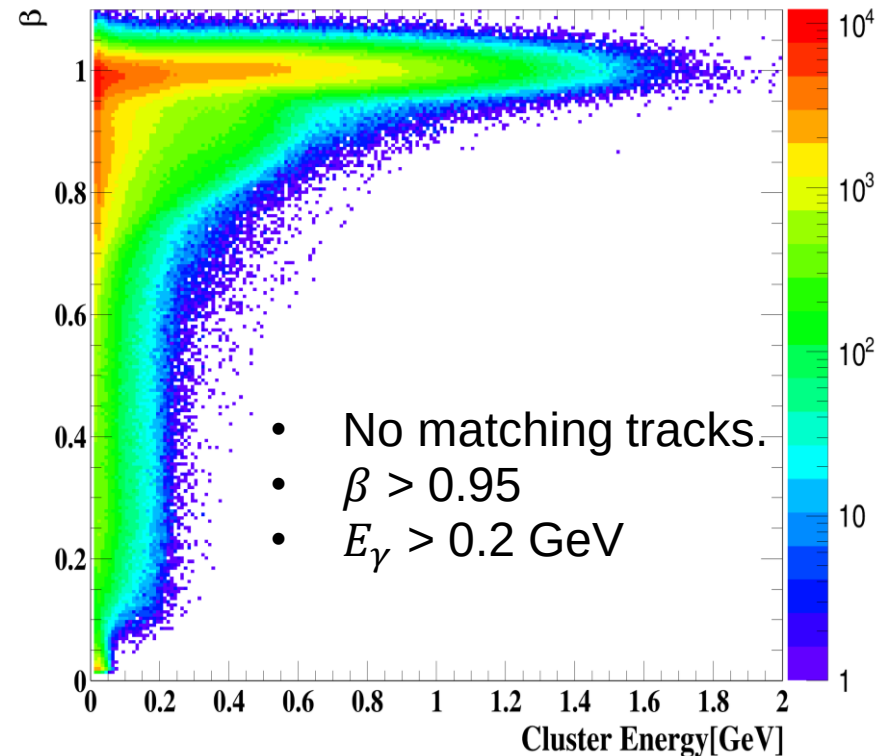
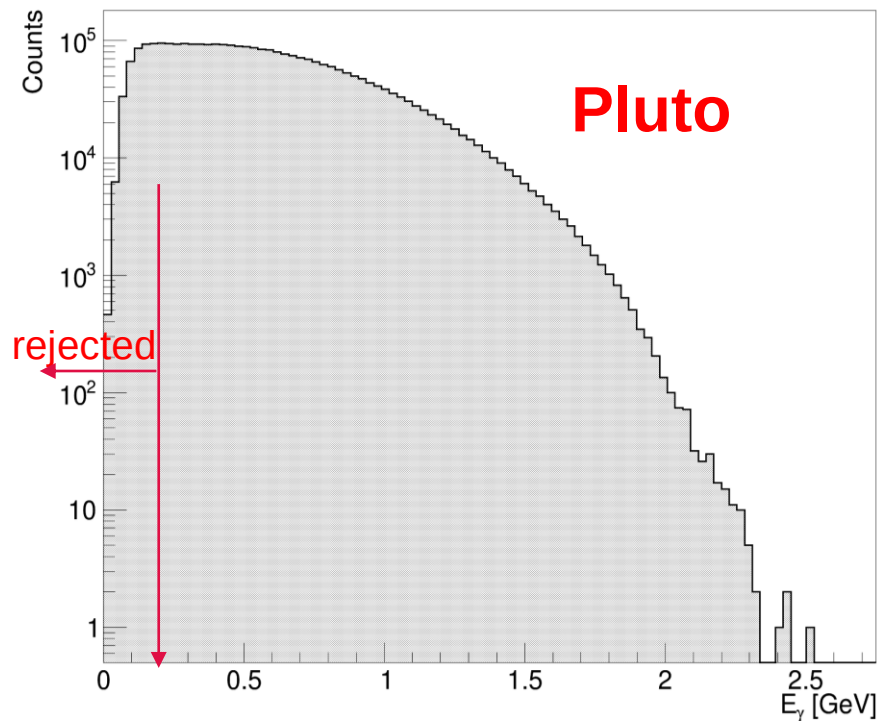


Event Reconstruction :



➤ Photon Identification:

- Photons are identified as energy cluster in the **EMC** with no tracks associated and β close to 1.



Event Reconstruction :

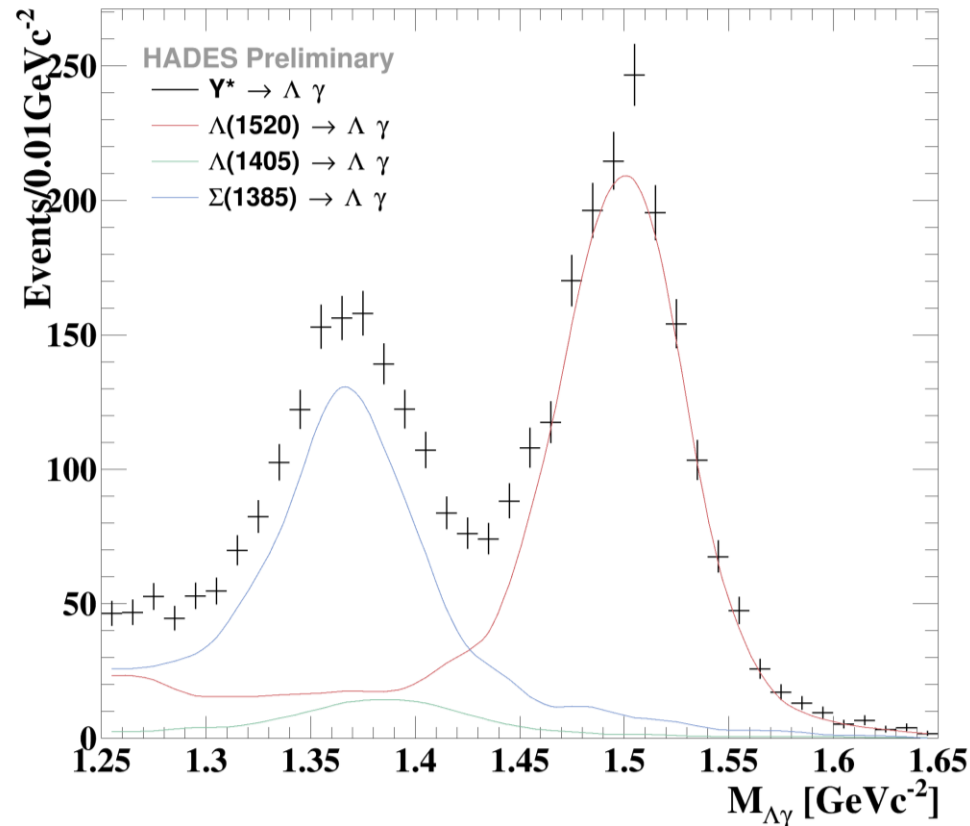
➤ Hyperon Reconstruction:



Channel	$\sigma \times \text{BR}(\Upsilon \rightarrow \Lambda \gamma)$	ϵ
$pp \rightarrow pK^+\Sigma(1385)$	$0.959 \mu b$	0.4%
$pp \rightarrow pK^+\Lambda(1405)$	$0.121 \mu b$	0.3%
$pp \rightarrow pK^+\Lambda(1520)$	$1.137 \mu b$	0.4%

- An estimation of the number of reconstructed hyperons for p(4.5GeV)p, of 28 days of beam time and luminosity $\mathcal{L} = 2 \times 10^{-31} \text{cm}^2 \text{s}^{-1}$ is:

Channel	Decays/day
$pp \rightarrow pK^+\Sigma(1385)$	~ 33.000
$pp \rightarrow pK^+\Lambda(1405)$	~ 5500
$pp \rightarrow pK^+\Lambda(1520)$	~ 39.000

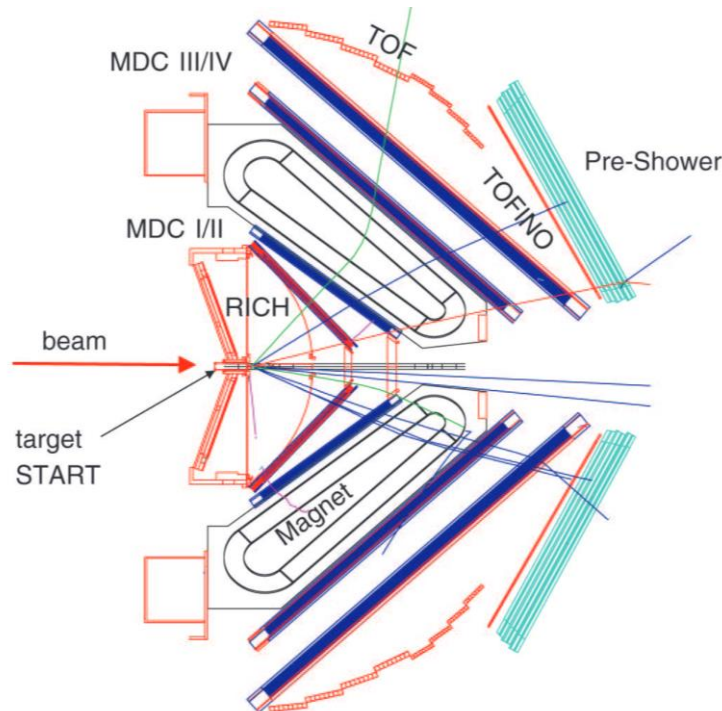


cross section estimation: **Feasibility studies of production and electromagnetic decay studies of hyperons for HADES.** *Krzysztof Nowakowski and Joanna Kubos.*

pp@3.5GeV:

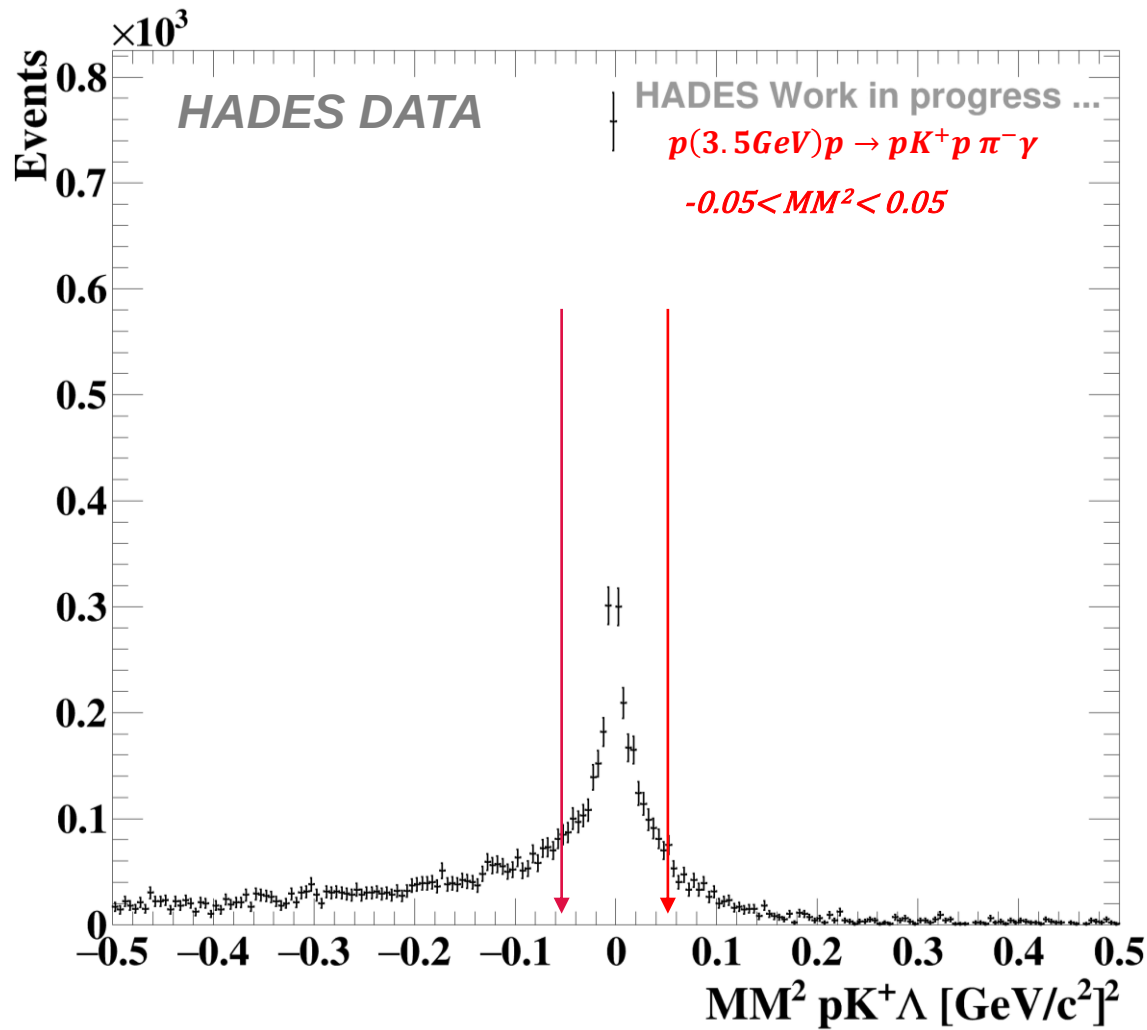
➤ Dataset:

- Data taken in April 2007.
- Liquid hydrogen target had a diameter of 25 mm and a length of 50 mm.
- $1.2 \cdot 10^9$ LVL1 recorded events.
- Can we see a signal of $p(3.5\text{GeV})p \rightarrow pK^+Y \rightarrow \Lambda\gamma$?!

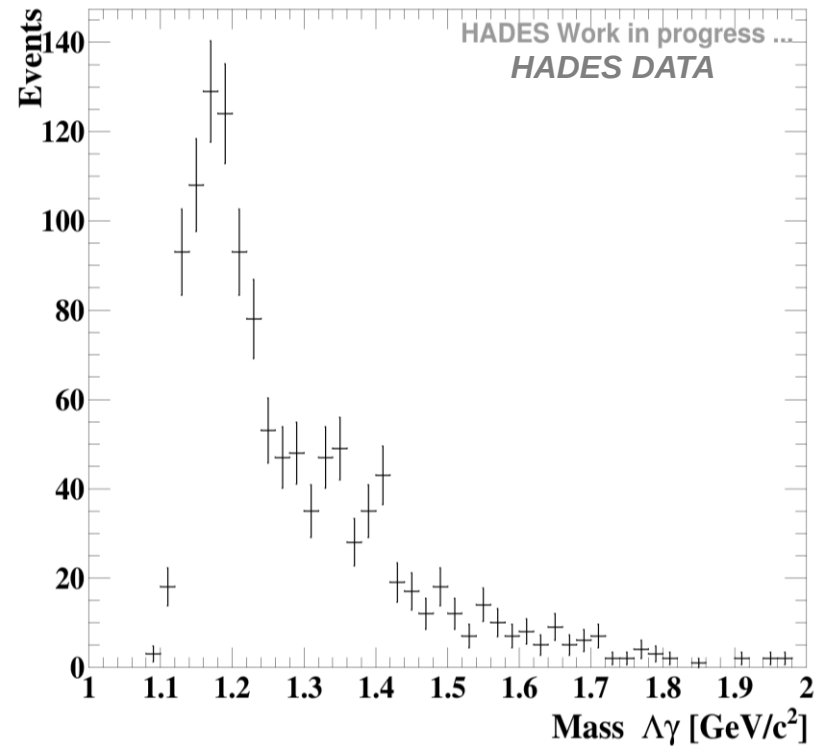
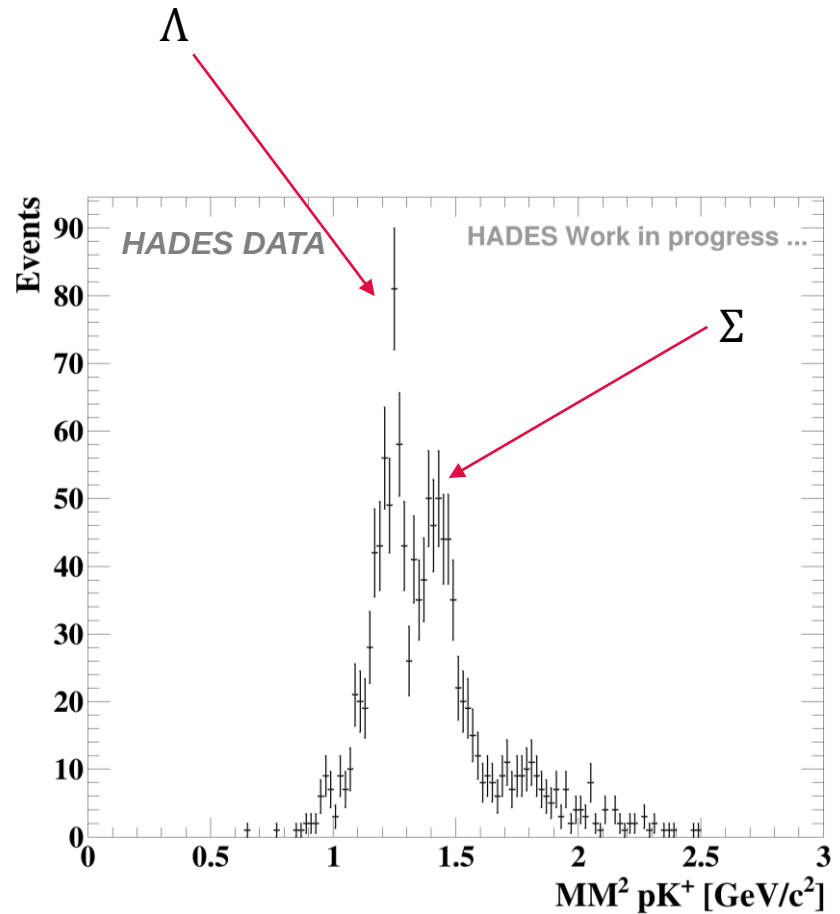


pp@3.5GeV:

➤ Missing Mass as Photon Identification:



pp@3.5GeV:



Conclusion and Outlook:

- Physics case study of radiative decays at FAIR Phase-0
 - The FD will significantly improve the hyperon reconstruction
 - Σ^0 can be measured at $pp@3.5\text{GeV}$.
-
- Add background simulation
 - Waiting for the new data $pp@4.5\text{GeV}$.
 - Looking at $p\text{Nb}@3.5\text{GeV}$ (May2008).

Thank You

Back Up

TRAINING SAMPLES (PID):

- $p(4.5\text{GeV})p \rightarrow p p \pi^+ \pi^- \pi^0$
- $p(4.5\text{GeV})p \rightarrow p K^+ \Sigma^0$
- $p(4.5\text{GeV})p \rightarrow p K^+ \Lambda \pi^0$

Photon Energy Resolution:

