Λ^0-reconstruction in embedded and experimental data in RUN7

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Analysis meeting

October 26, 2020

Almost realistic embedding of $\Lambda^0 \to \pi^- + p$ decay products:

1. Input

- Creating stores with Λ^0
- Creating a list of reconstructed events where V_p is reconstructed

2. Simulation

- Passing the stores to BM@N Central Tracker simulations
- Finding at least one Λ^0 to be reconstructed for a given vertex in considering event

3. Monitoring

- Having possibilities to know all information on Monte Carlo decay products.

The whole chain (select - pass - embed) is available for anyone who is interested in ...

4. Digitization and embedding

- Creating digits from Λ^0 decay products corresponding to considering event
- Doing correspondence between digits from decay products to channel and serial numbers of ADC

From the 5th Collab. meeting ...

- Problems with GEM mapping (**FIXED**)
- Realistic signal scaling (**DONE**)
- Detector efficiencies (**IN PROGRESS**)

Integral probability correspondence approach

- Strip signal histograms are created for Monte Carlo and real data
- Integral probability distributions are built separately for each element of the Central Tracker.
- For each MC digit probability value is taken
- The value of Exp signal corresponding to that probability value is considered as rescaled MC signal.

Working cycle

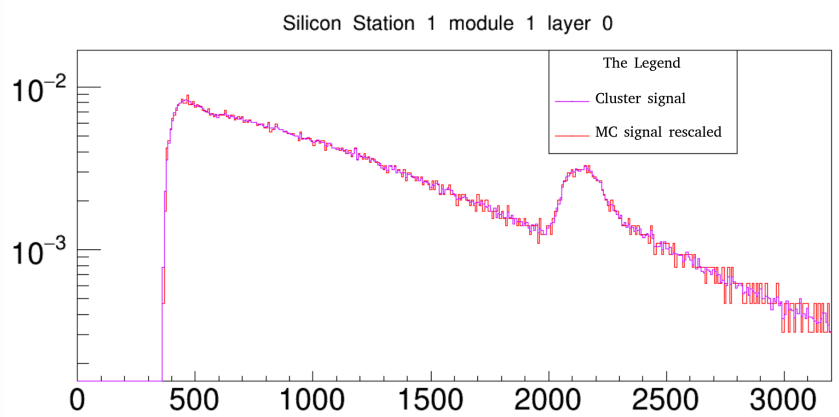
MC signal

$\Downarrow$

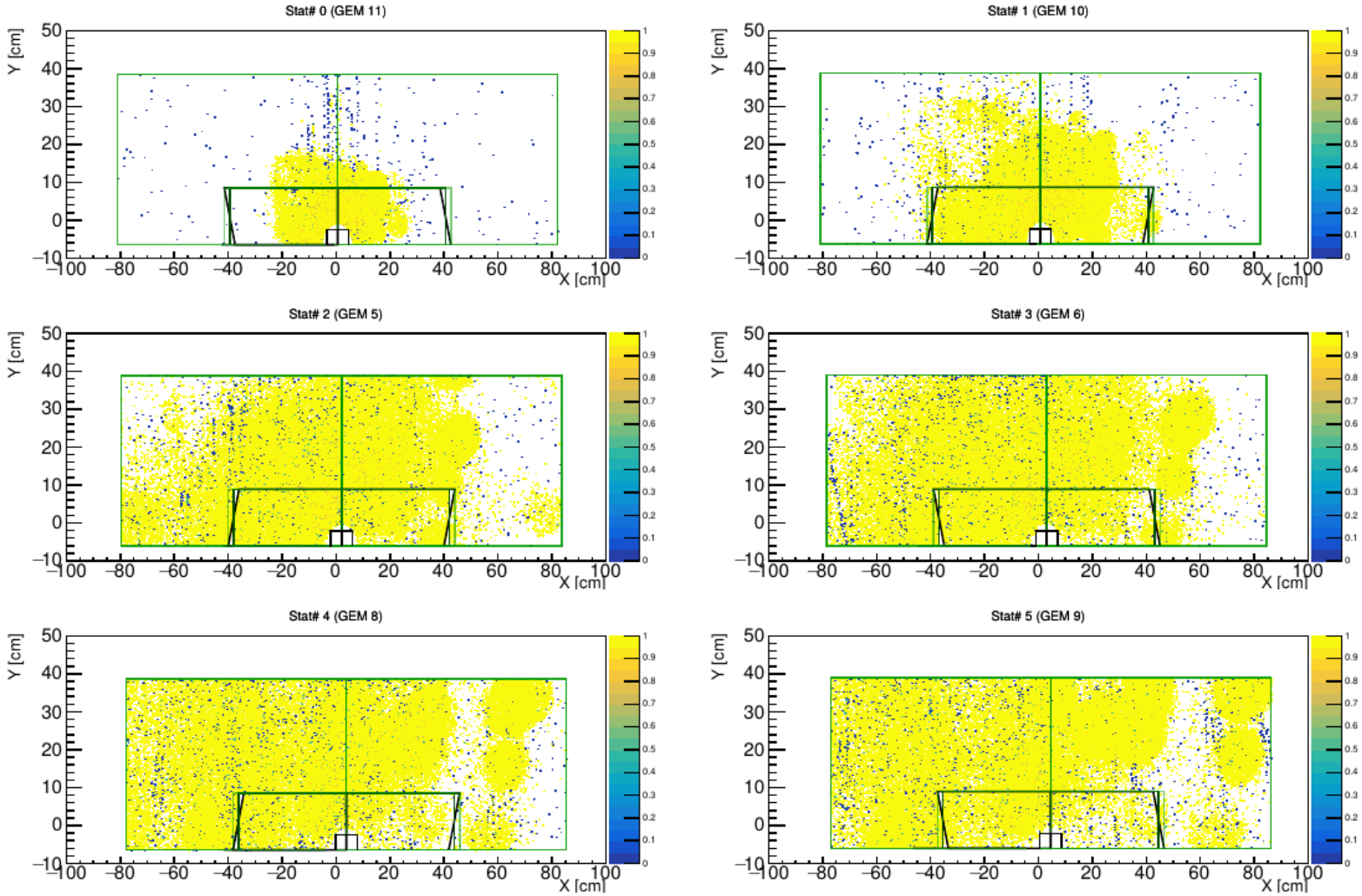
MC = experimental integral probability

$\Downarrow$

rescaled "experimental" signal



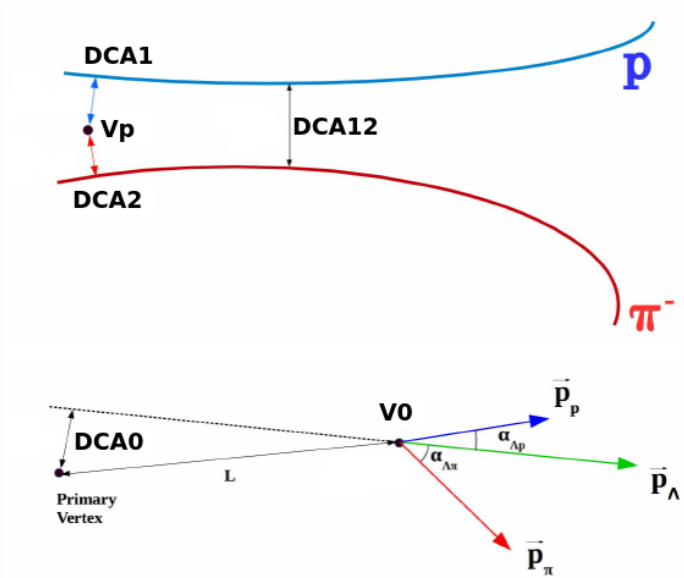
Efficiency of the procedure



Fixed the problem attributed to GEM zones connected to common ADC.
Average efficiency for each plane (zone) of GEM tracker is more than 90%

Experimental data, analysis definitions, cuts ...

Λ^0 decay scheme:



- DCA0, DCA12, DCA1 and DCA2 are "minimum required" cuts to be used with given definitions in the figure.
- The cuts do implicit restrictions on a path of Λ^0.

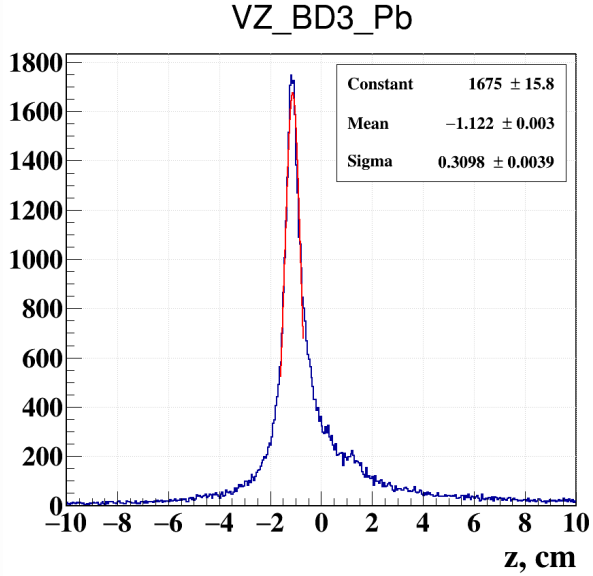
$N_{rec.tracks} > 1$ [MEvents], Ar part of RUN7

No primary vertex cut: 51.5

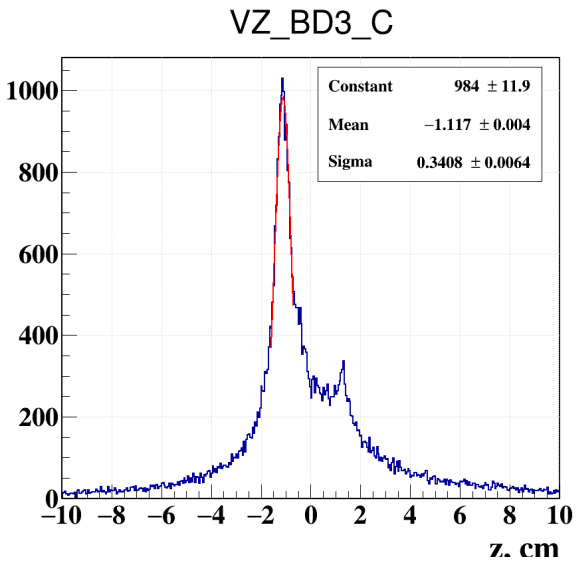
	BD1+FD2	BD2	BD3	FD2	FD3
Pb	2.13	-	1.16	-	2.75
Sn	4.81	0.20	1.88	0.56	5.59
Cu	4.61	0.24	1.89	0.56	5.68
Al	5.23	0.24	2.13	0.80	5.63
C	1.94	0.42	0.54	0.60	1.86
	18.72	1.1	7.6	2.52	21.51

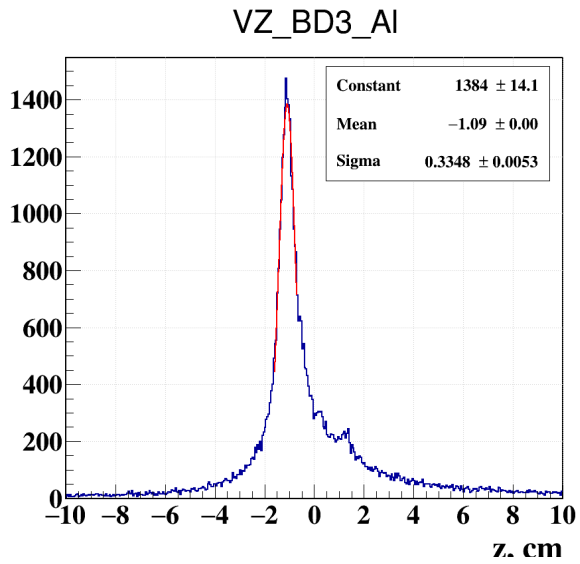
With primary vertex cut: ≈ 5

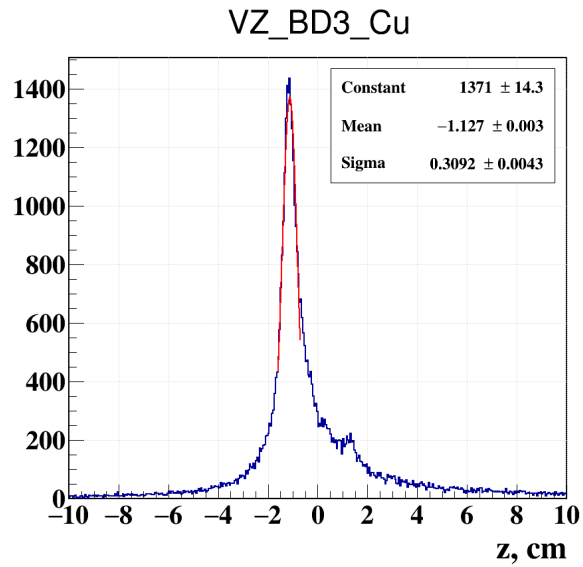
Cut on V_p: **-3** $< V_p(Z) <$ **3 cm**

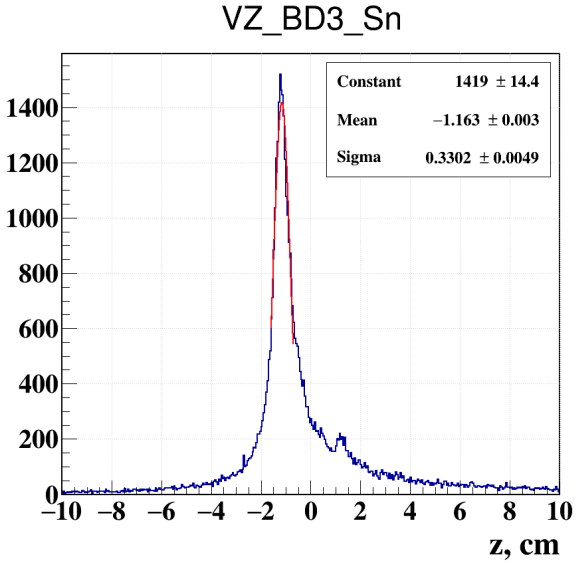


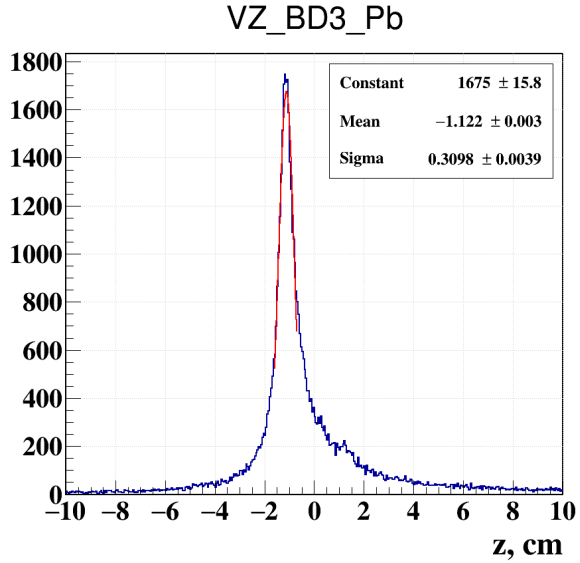
Primary vertex resolution









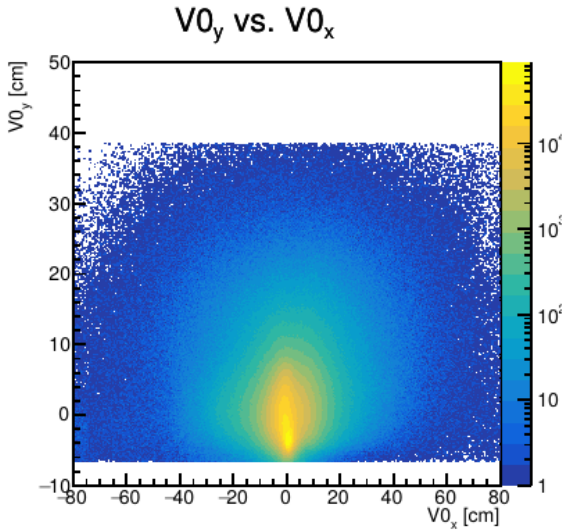


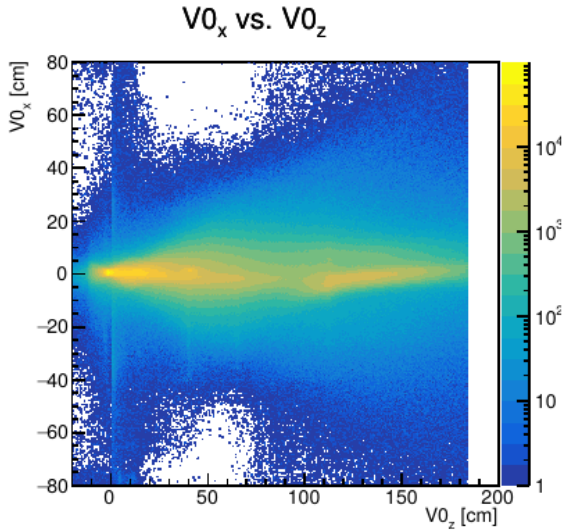
- Average V_p resolution along Z is close to 3 mm for all targets (2.6 - 3.4 mm)
- The resolution has approximately the same trend for all trigger conditions

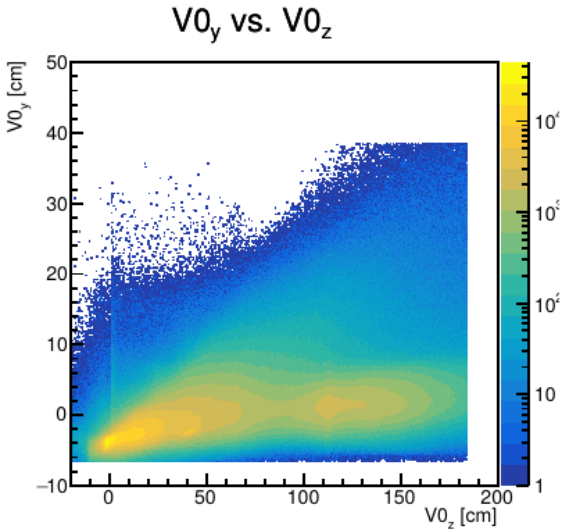
Searching for V_0, algorithm ...

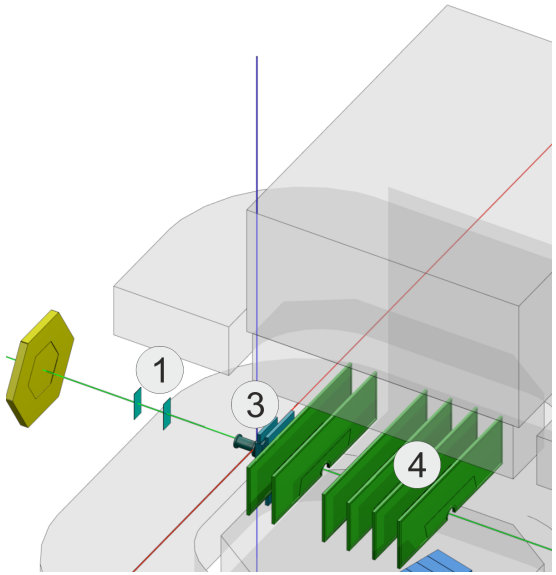
- **A pair of two tracks with different signs of Q_p is considered as a candidate to be from Λ^0 decay.**
- **The chosen tracks are put into a corridor of relatively big width along Z-axis.**
- **The corridor is separated into small parts by virtual planes corresponding to some values of Z.**
- **The tracks are extrapolated to those Z by the Kalman filter mechanism aimed at calculating 2d-distance between.**
- **A set of calculated distances corresponding to the known Z-values is approximated with $\mathbf{P(z)} = az^2 + bz + c$. It allows one to reject pairs that can produce a non-diserable edge minimum ($a < 0$) occurred widely when processing pairs.**
- **If a considering pair has a $P(z)$ parameterization with $a > 0$, a found minimum is considered as approximation to V_0. The minimum is taken from available calculated distances but not the parameterization used.**
- **The corridor is divided by factor 2 to reproduce the steps of algorithm already mentioned. The algorithm works till to the corridor width is less than a chosen threshold or the pair does not become to satisfy restrictions.**

Reconstructed V_0





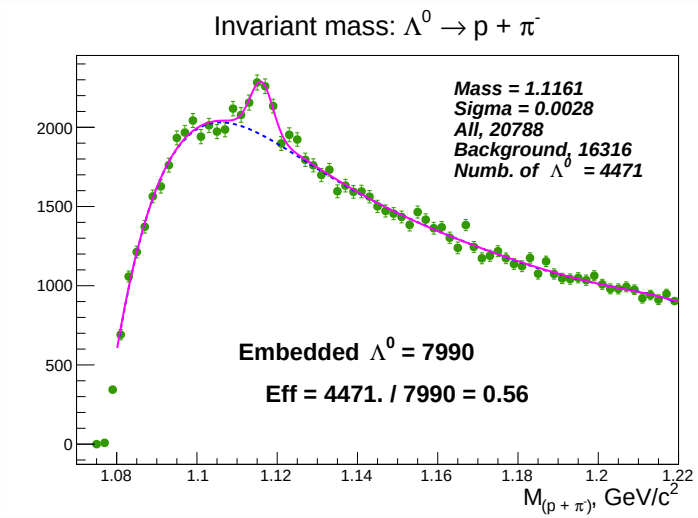




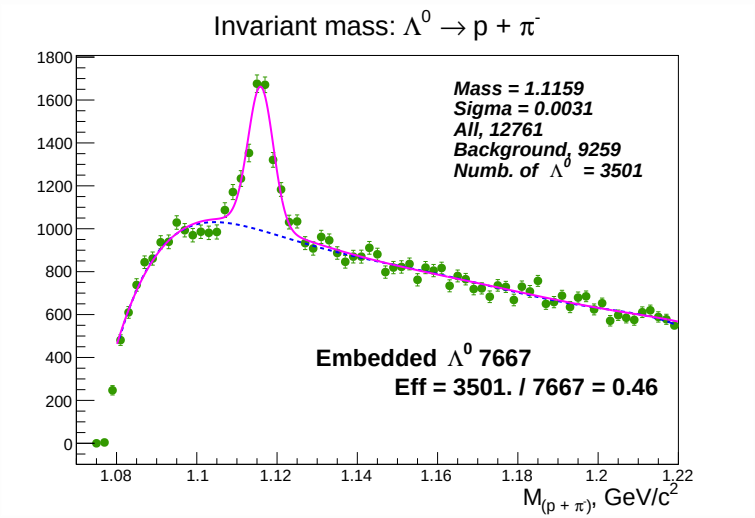
- **Seen probable acceptance for reconstructed secondary vertices in all directions**
- **A really visible kink (break) in XZ-direction around Z = 100 cm is explained by reconstructed tracks having four hits in the second part of GEM-tracker.**

Reconstruction of embedded Λ^0

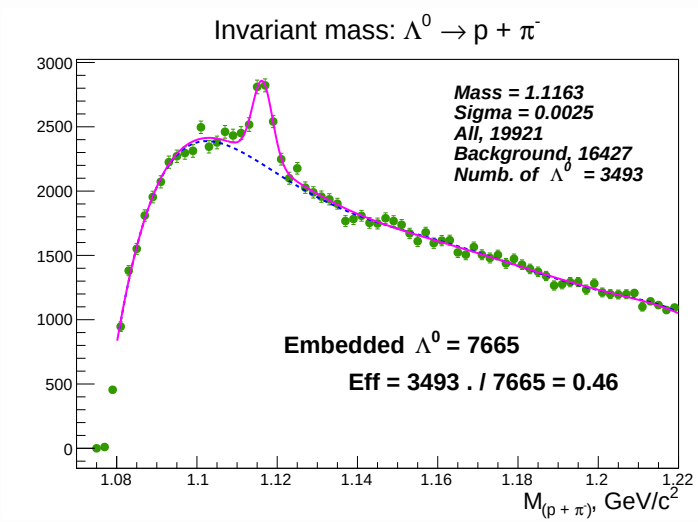
BT+BD1+FD2



BT+BD3



BT+FD3



- Embedding is done with the developed algorithm
- Used only cut on DCA12 (< 0.2cm)

- Embedded Λ^0's look to be reconstructed for all trigger conditions used with approximately the same efficiency
- A room how to fit background and signal regions of spectrum exists ...
- Efficiencies extracted from Monte Carlo (related to tracking procedure) should be calculated and implemented in a more precise manner ...

Λ^0 in experimental data

Why?

- New improved tracking for the BM@N Central Tracker (signal filtering, approach for searching for track candidates ...)
- New robust primary vertex finder

To get more, see the status report of S. Merts on October 27

Steps to be passed:

- Test different scenarios of SILICON veto
- Find appropriate values for cuts (dca0, dca1, dca2, dca12) for different targets

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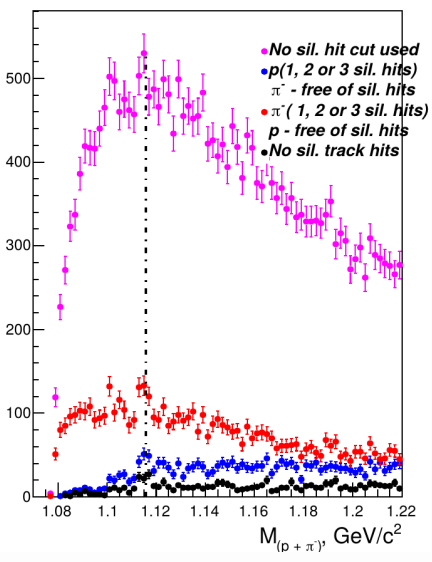
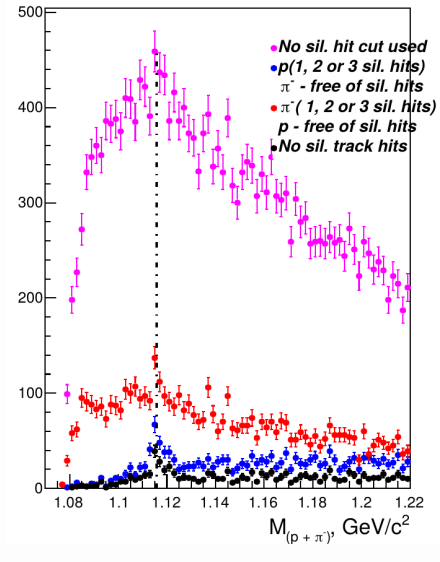
- Try to do estimations of Λ^0's reconstructed from experimental data

Testing silicon veto scenarios ...

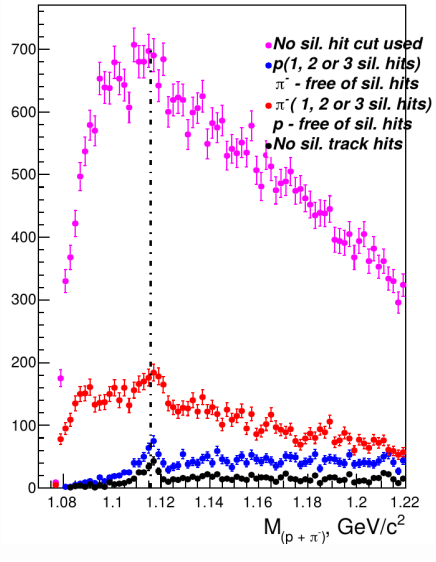
ArAl



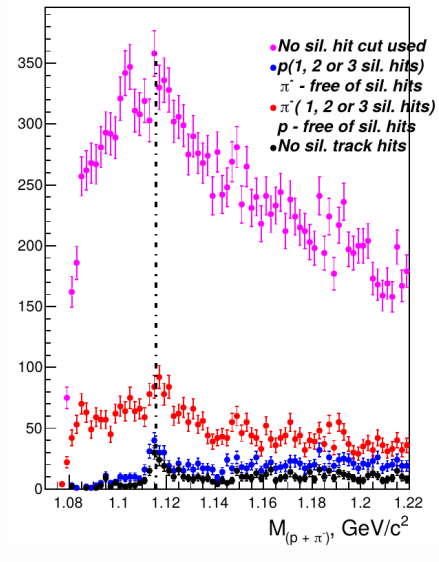
ArSn



ArCu



ArPb



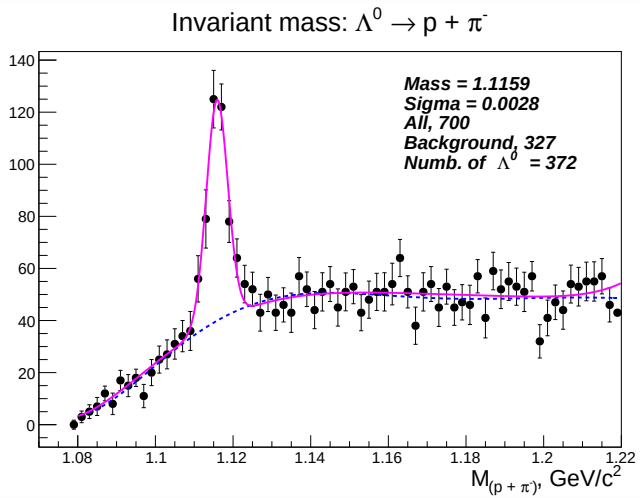
Approximate cut values obtained:

	DCA0 [cm]	DCA12 [cm]	DCA1 [cm]	DCA2 [cm]
Pb	1.	0.4	1.	2.
Sn	1.	0.4	1.	3.
Cu	1.	1.	1.	4.
Al	1.	1.	1.	4.

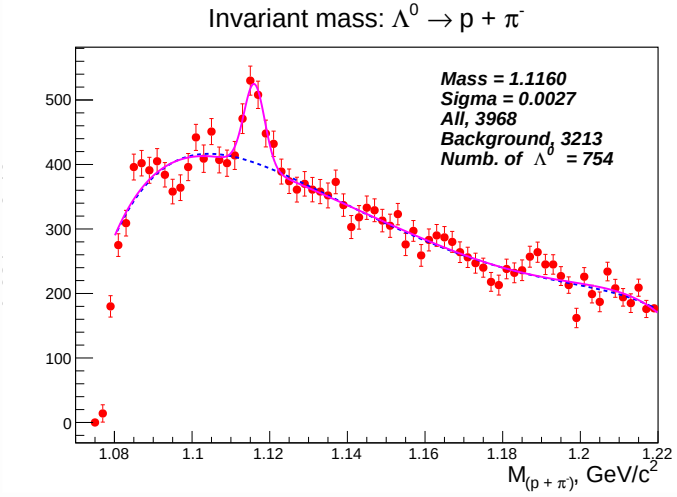
- Silicon veto allowed us to see the signal for all targets
- Trying not to use the veto but the cuts already obtained ...

Testing silicon veto scenarios (all targets)...

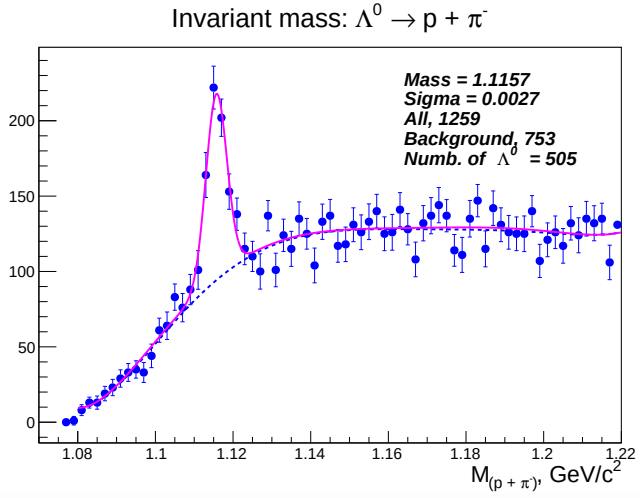
Protons and pions (full silicon veto)



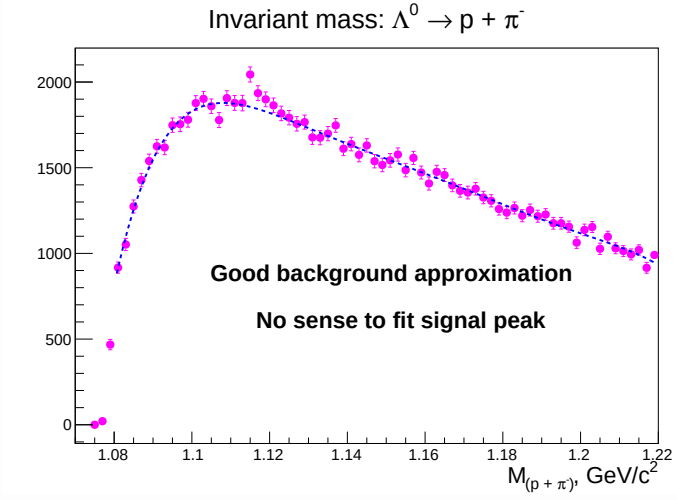
Free protons and constrained pions



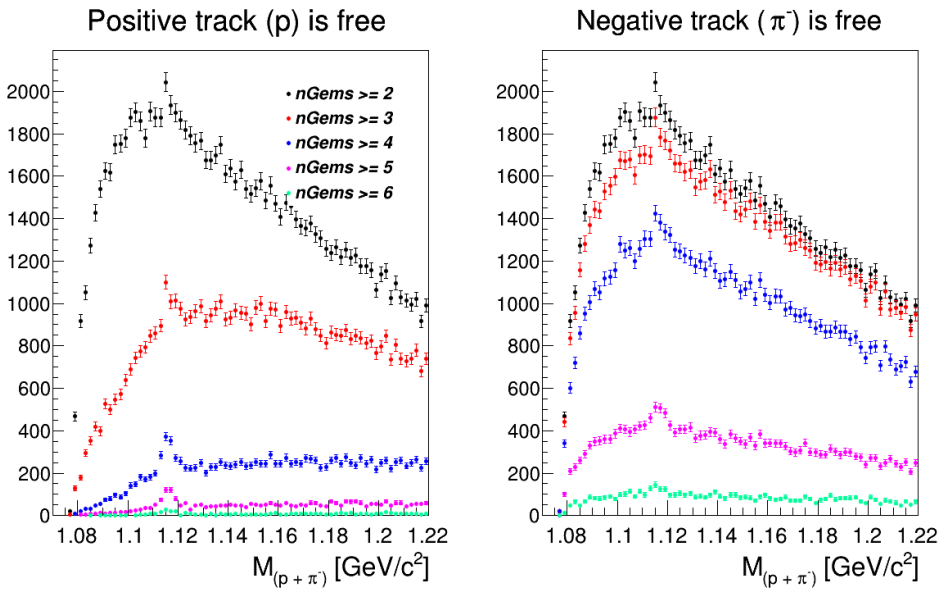
Free pions and contrained protons

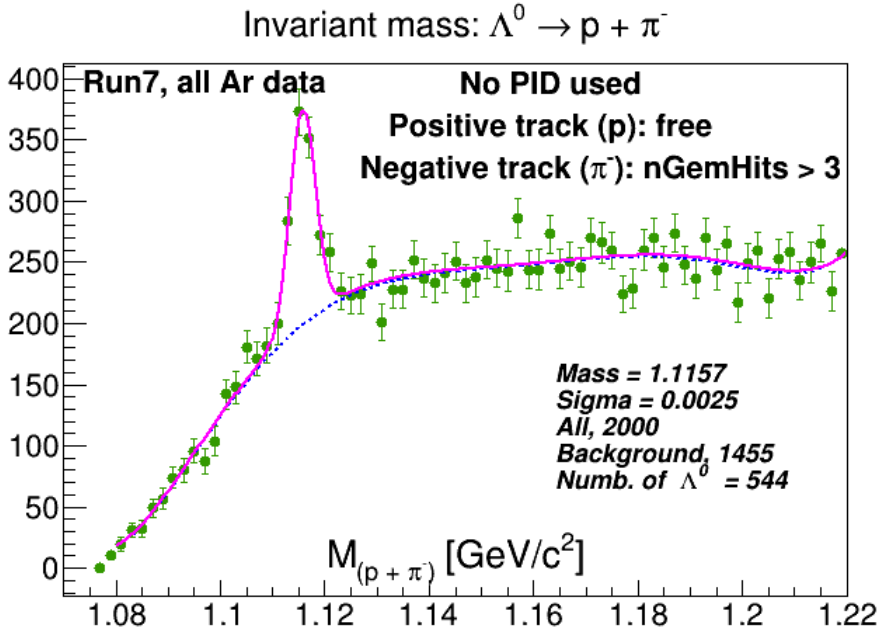


Protons and pions as they are



First Λ^0's in experimental data of RUN7





- The analysis covers argon part of the last run
- It is based on 5 MEvents (all targets + all triggers)
- No any type of veto for SILICON / GEM used

Reco track (central tracker):

nHits = nSiliconHits + nGemHits

Λ^0-signal became visible. Trying to increase number of reconstructed Λ^0's ...

Ok, the signal from $\Lambda^0 \to \pi^- + p$ exists...

What is next?

- **To do a fully realistic embedding (by adding the detector efficiencies)**
- **To use the embedding for "fine" tuning of tracking procedure to maximize the reconstructed signal**
- **To get Λ^0 efficiency spectra in p_T and η space**
- **To do an improvement in the alignment procedure of the BM@N Central Tracker (ALCOPACK)**
- **...**

Thank you for your attention!