Raw data embedding algorithm of decay products from the Λ^0-hyperon decay to experimental data taken from the BM@N Central Tracker

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Analysis meeting

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Steps of the algorithm:

- Creating a store with Λ^0
- Creating a list of eventIds for reconstructed events where vertex is assumed to be defined
- Passing the stores with Λ^0 to BM@N Central Tracker simulations
- Finding at least one Λ^0 to be reconstructed for a given reconstructed vertex in considering event (pure MC)
- Monitoring events with embedded products from Λ^0 decay
- Creating digits from Λ^0 decay products corresponding to considering event (MC + Digitization)
- Doing correspondence between digits from Λ^0 decay products and ADC digits from electronics
- Doing embedding in *.raw.root
- Decoding data with embedded ADC-digits to *.digi.root format to be used for analysis

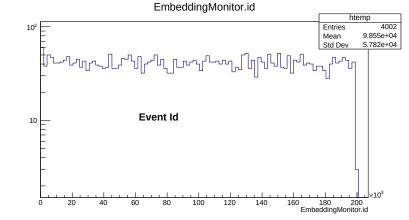
The Algorithm::Creating a store with Λ^0

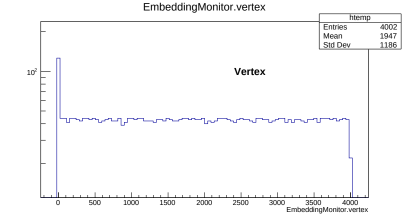
- Λ^0 are taken from MC simulations of the tracker with the LAQGSM model
- Input from the model corresponds to known target, projectile, energy, centrality information got from a DST where protons and pions from Λ^0 decay are embedded to
- Chosen Λ^0 are primary ones
- Cut mechanism on written Λ^0 can be used if necessary (η, ϕ, momentum ...)
- Desirable number of stores to be produced is also operated by user

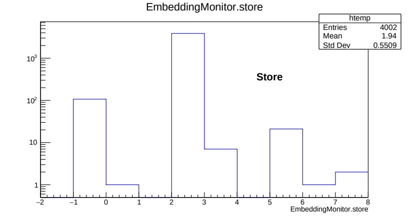
- **Each store is sampled in a set of files (*lambdaXXX_vertexXXX.root*) according to a rule:** $N_{sets} = N_{stores} \cdot N_{vertices}$
- **Each file *lambdaXXX_vertexXXX.root* contains 50 events (of course, being increased / decreased if necessary)**
- **Simulations take into account remain misalignment (with opposite sign) and Lorentz shift corrections applied to each element of the tracker**
- Λ^0 **"starts" from reconstructed position of vertex in considering event**
- **A** Λ^0 **to be chosen is considered to be reconstructable if:**
  - **Decay products have, at least, four points in the acceptance**
  - **Tracks from decay products have one point only for each Z-position of any part of the tracker**
- **First event satisfying the conditions mentioned is assumed to be a candidate for embedding**

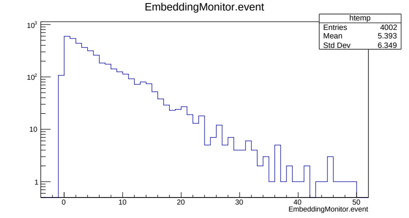
The Algorithm::Monitoring events with embedded products from Λ^0 decay

To get info on eventId, used store, vertex index and, namely, event for embedding

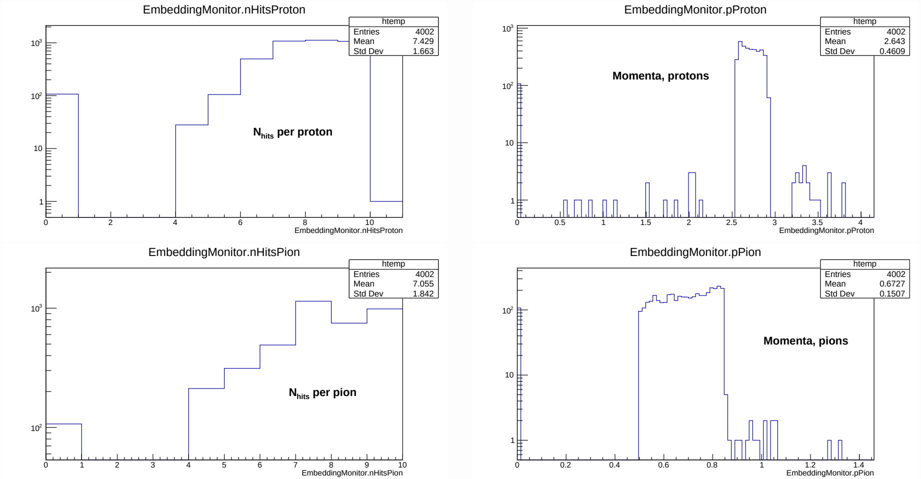




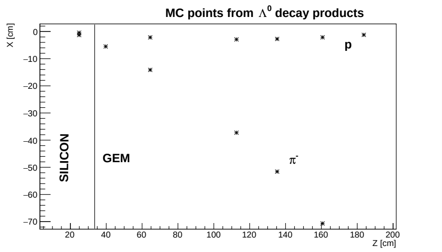


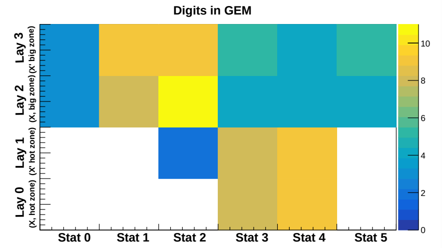


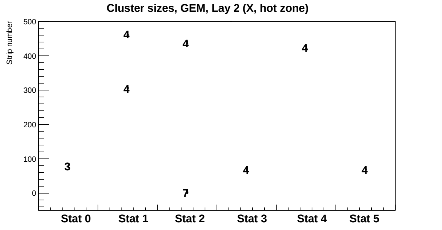
To get info on different characteristics of particles

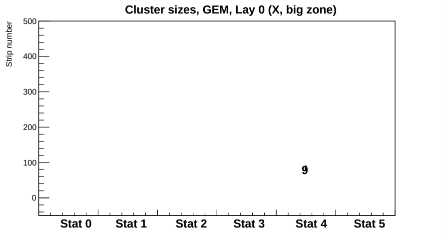


The Algorithm::Creating digits from Λ^0 decay products









Central Tracker, mappings

```
                          GEM
// GEM_id: the second digit 0=left, 1=right;
// Module: 0=00 (mod0,hotZone), 1=01 (mod0,bigZone),
// 2=10 (mod1,hotZone), 3=11 (mod1,bigZone)
   Serial     Ch_lo     Ch_hi   GEM_id  Station  Module
=====================================================
0x76CD410      1024      2047      110        0       0
0x76C8320         0      2047      110        0       1
0x76CB9C0         0      2047      111        0       3
0x76CA266      1024      2047      111        0       2
0x76D08B9       512       767      110        0       1
0x76D4D2B         0      1023      100        1       2
0x76D5044         0      2047      100        1       3
...
```

```
                        SILICON
// Station: 0 - vertex (near), 1 - vertex(far),
// 2 - Forward detector
//Layer: 0 - vertical strips, 1 - sloped strips
Serial     Ch_lo     Ch_hi    GEO_mod   Layer  Station
====================================================
0x80BCBFC   42        46        0        0       2
0x80BCBFC   37        41        0        1       2
0x80BCBFC   32        36        1        0       2
0x80BCBFC   26        30        1        1       2
0x80BCBFC   16        20        2        0       2
0x80BCBFC   21        25        2        1       2
0x80BCBFC    5         9        3        0       2
...
```

BmnStripDigit (GEM or SILICON)

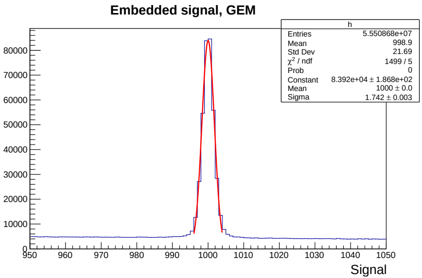
```
Int_t fStation;
Int_t fModule;
Int_t fStripLayer;
Int_t fStripNumber;
Double_t fStripSignal;
```

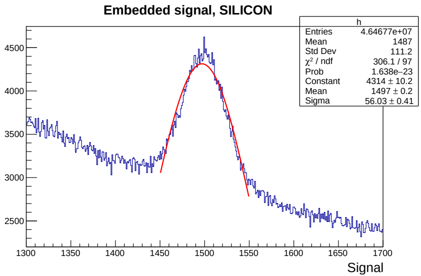
Direct problem: ADC-digits from DAQ $\rightarrow$ Physical digits (decoding)

Inverse problem: Physical digits $\rightarrow$ Incorporation to ADC-digits (embedding) + direct problem

Operating dig. info one has to define corresponding channels & serials using mappings

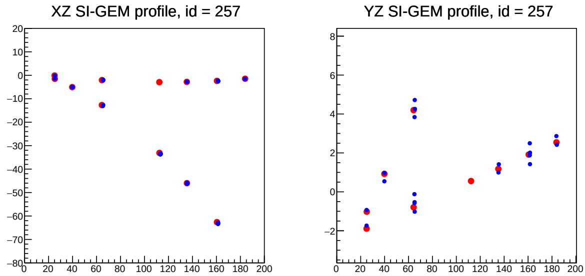
Embedded signal for the BM@N Central Tracker

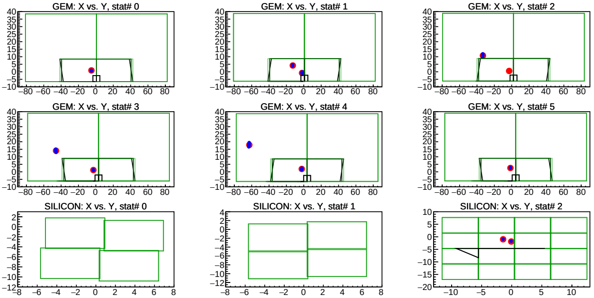




Embedded signal for SILICON part of the tracker looks wider (if comparing with GEM) due to more significant fluctuations of Command Mode when decoding

QA of the embedding procedure

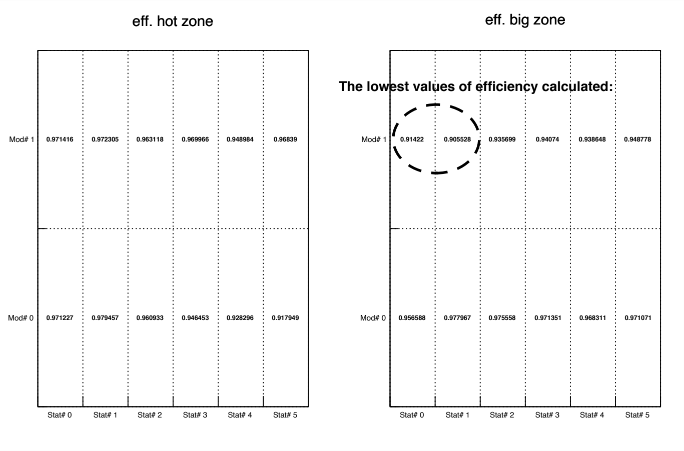




Efficiency of the algorithm

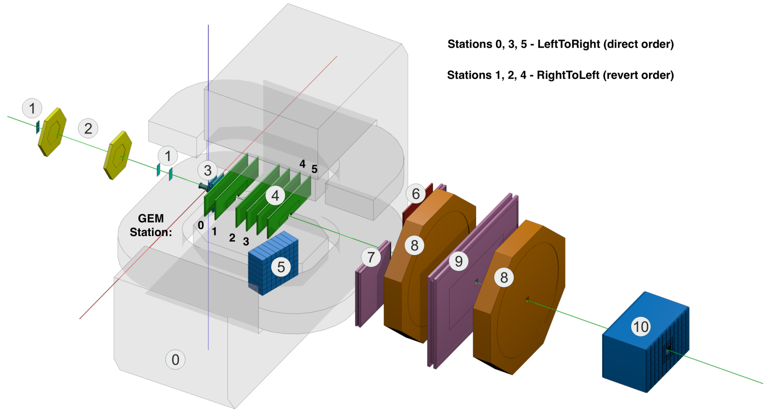
- **Used p and π^- embedded from Λ^0 decay**
  Kinematic range for Λ^0: $1 < \eta < 3$, P > 1.5 GeV /c, $0 < \phi < \pi$
- **Monte Carlo points of all reconstructable products from Λ^0 decay pass all stages of the algorithm**
- **Point is considered as reconstructed if it corresponds to a real hit in the BM@N Central Tracker**
- **Efficiency is calculated for all elements of tracker (GEM, SILICON, modules, hot / big zones)**

Integrated efficiency per each GEM module

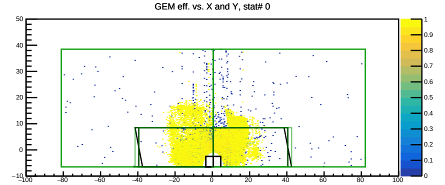


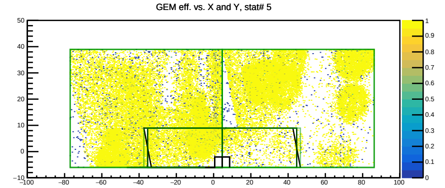
- **Average value of efficiency is close to 0.97. Not so bad, but:**
- **Some problems with a little bit lower values of efficiency are observed for big zones. Trying to understand why ...**

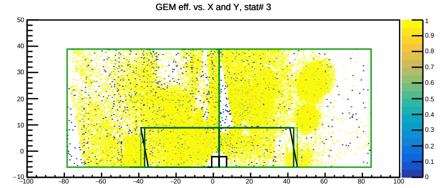
Experimental Setup:

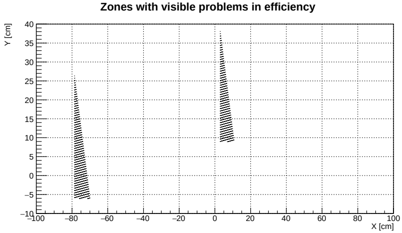


GEM stations with LeftToRight strip order

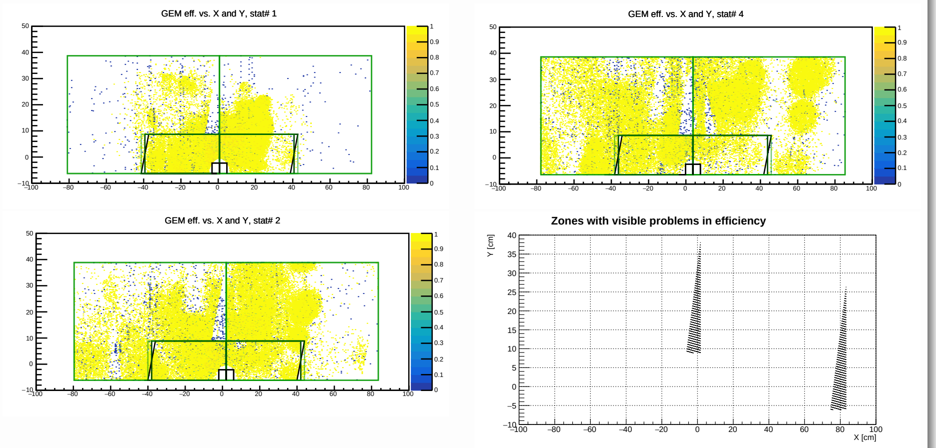








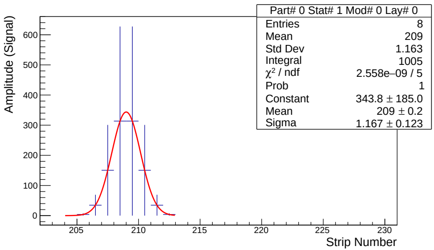
GEM stations with RightToLeft strip order



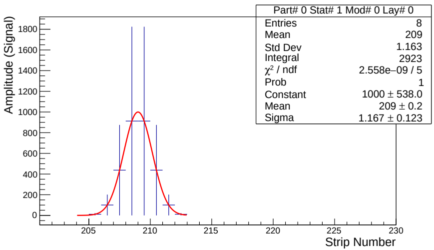
Parameterization of cluster amplitudes

Equal amplitudes for all strips are used now just for testing!

Total integral is close to established value



Maximum amplitude is set to established value



All scenarios tested but not finally implemented

Conclusions

- **Developed an algorithm to be used as a core for embedding MC input to experimental data**
- **At present, everything is not so clear in the GEM-mappings describing some parts (zones) of detector**
- **First results concerning estimation of efficiency for silicon part of the tracker are ready but there is enough to be improved**
- **Needed appropriate scaling of cluster amplitudes from MC data to those one taken from experimental data.**
- **The algorithm in its current stage is suitable to be used for adjustment of tracking procedure aiming at maximizing reconstructed Λ^0**

eff. silicon

	Stat# 0	Stat# 1	Stat# 2
Mod# 7			0.870842
Mod# 6			0.835651
Mod# 5			0.748441
Mod# 4			0.882353
Mod# 3	0.92957		0.979485
Mod# 2	0.836512		0.919103
Mod# 1	0.909913	0.885344	0.883815
Mod# 0	0.880024	0.876986	0.961957