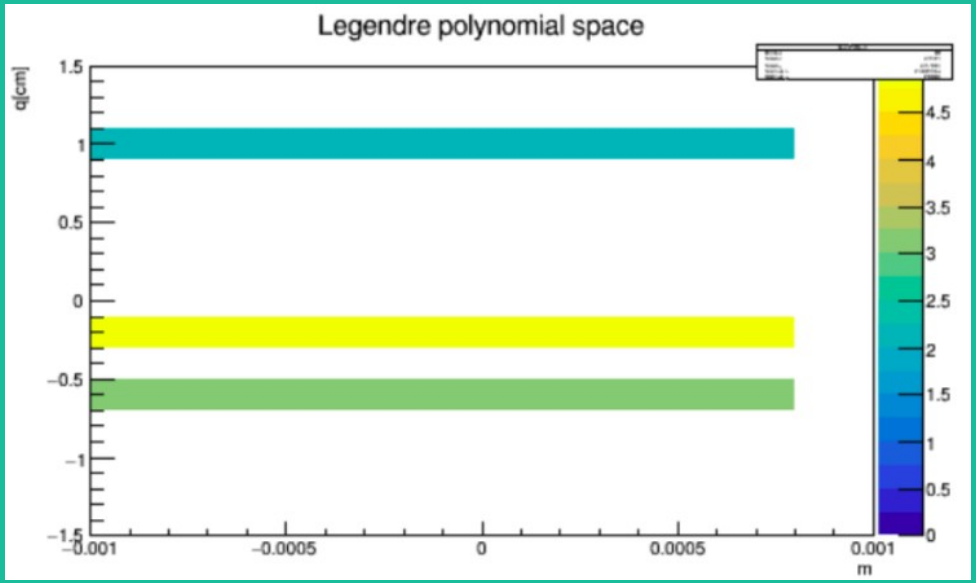
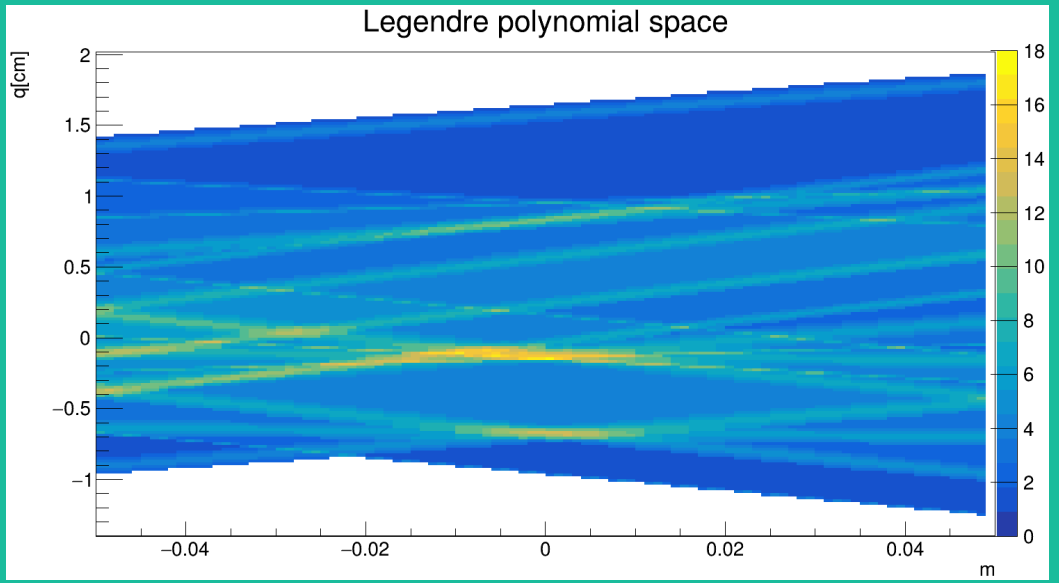
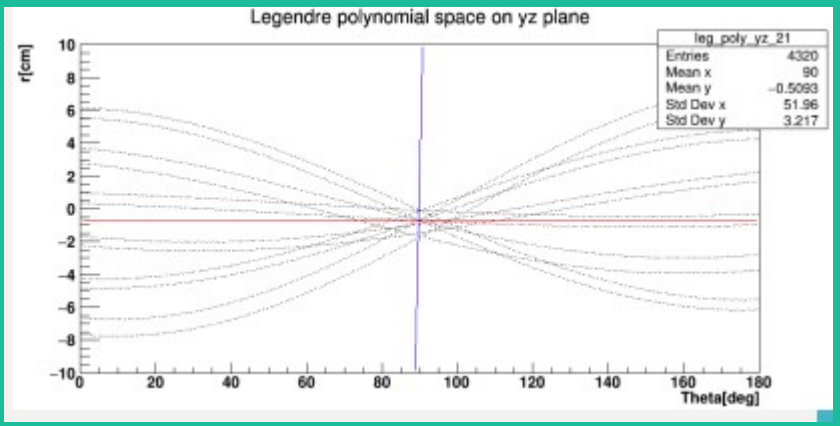






Updates on the BM track reconstruction algorithm

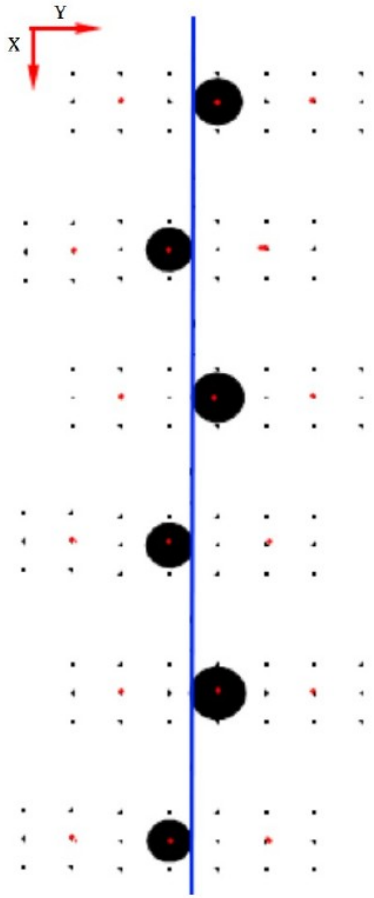
Yunsheng Dong

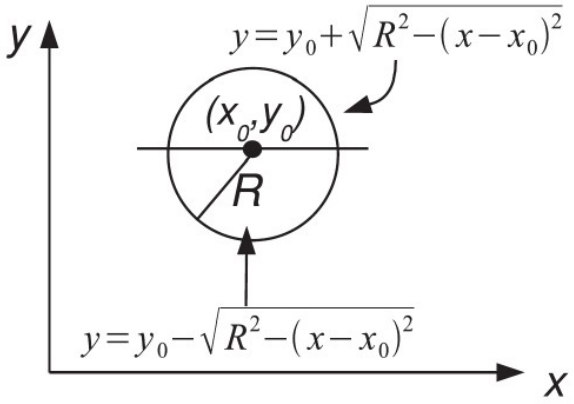
06/06/2023

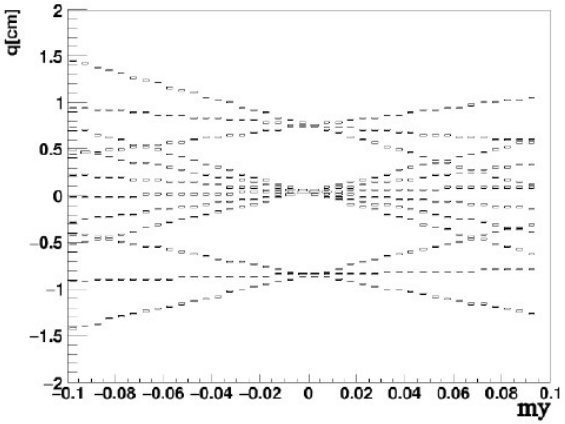
Outline

- Summary of BM tracking
- Issues on GSI2021 data
- First strategy: calibration of reconstruction algorithm parameters
- Second strategy: new Legendre space filling method
- Results with the BM track reco
- Software updates
- Conclusions

Summary of BM tracking







The BM track reconstruction is based on two main steps

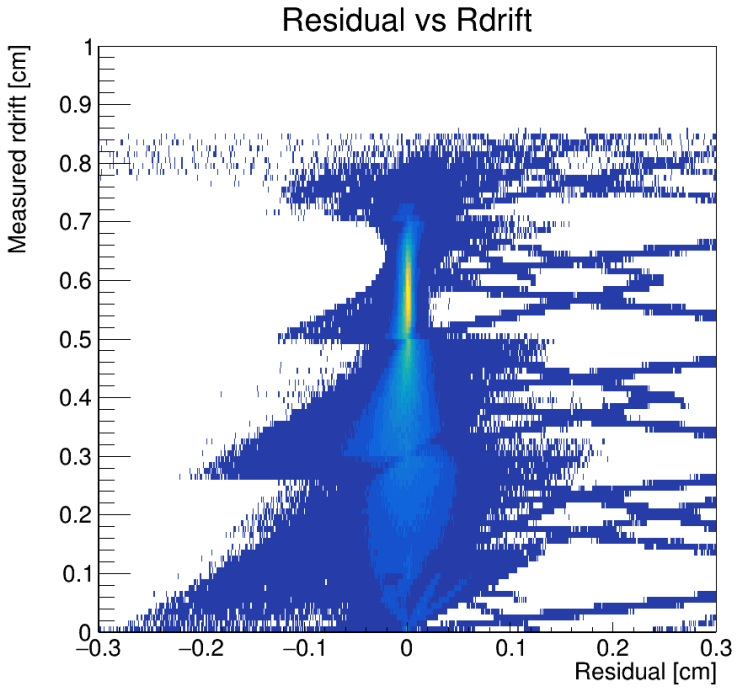
1: The Legendre polynomial

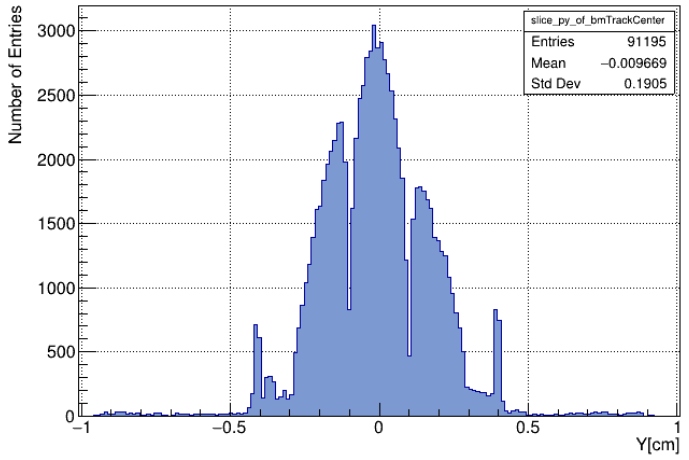
- Convert each BM hit (wire position + drift distance) in two line in the Legendre space
- In the Legendre space, each point represents a tangent line
- Find the peak in the Legendre space iteratively to retrieve the tracks parameters and the associated hits

2: Chi2 minimization with minuit

- Refine the tracking parameters with a chi2 minimization method

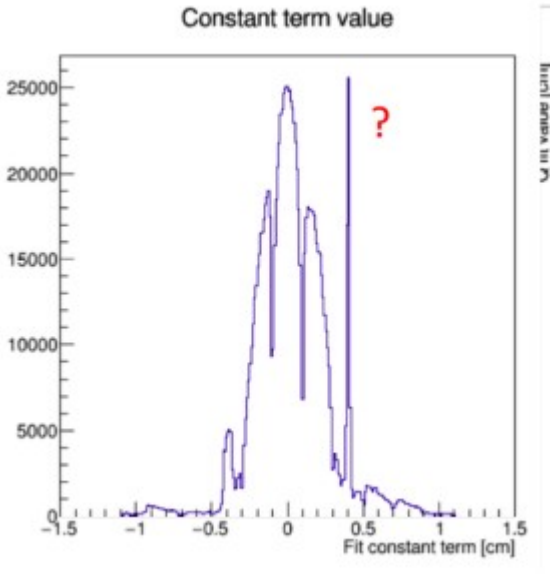
Issues on GSI2021 data



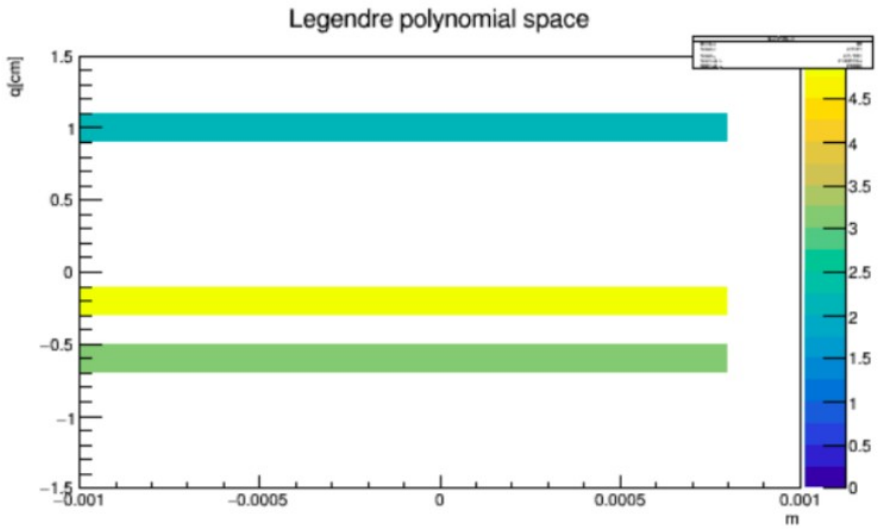


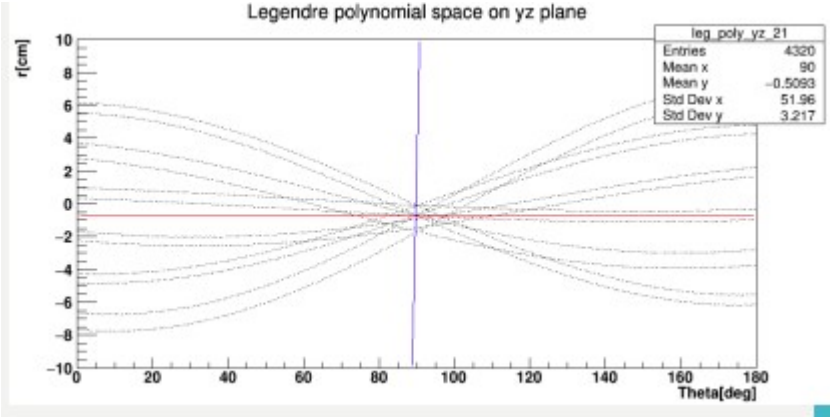
Thanks to Mauro, different BM issues have been pointed out

- The BM residual plot shows strange behaviours
- In some cases there are suspicious peaks in the beam profile



BM parameter optimization





The BM track reconstruction parameters are not optimized: Legendre space parameters

- The range of the Legendre space plot is too narrow and the number of bins are not optimized.
- No cluster can be found if the bins are too many or too small
- There is a rebin procedure to avoid this situation, but it can’t always work
- The cluster position (aka initial estimate of the track parameters) is not significant if the bins are too large

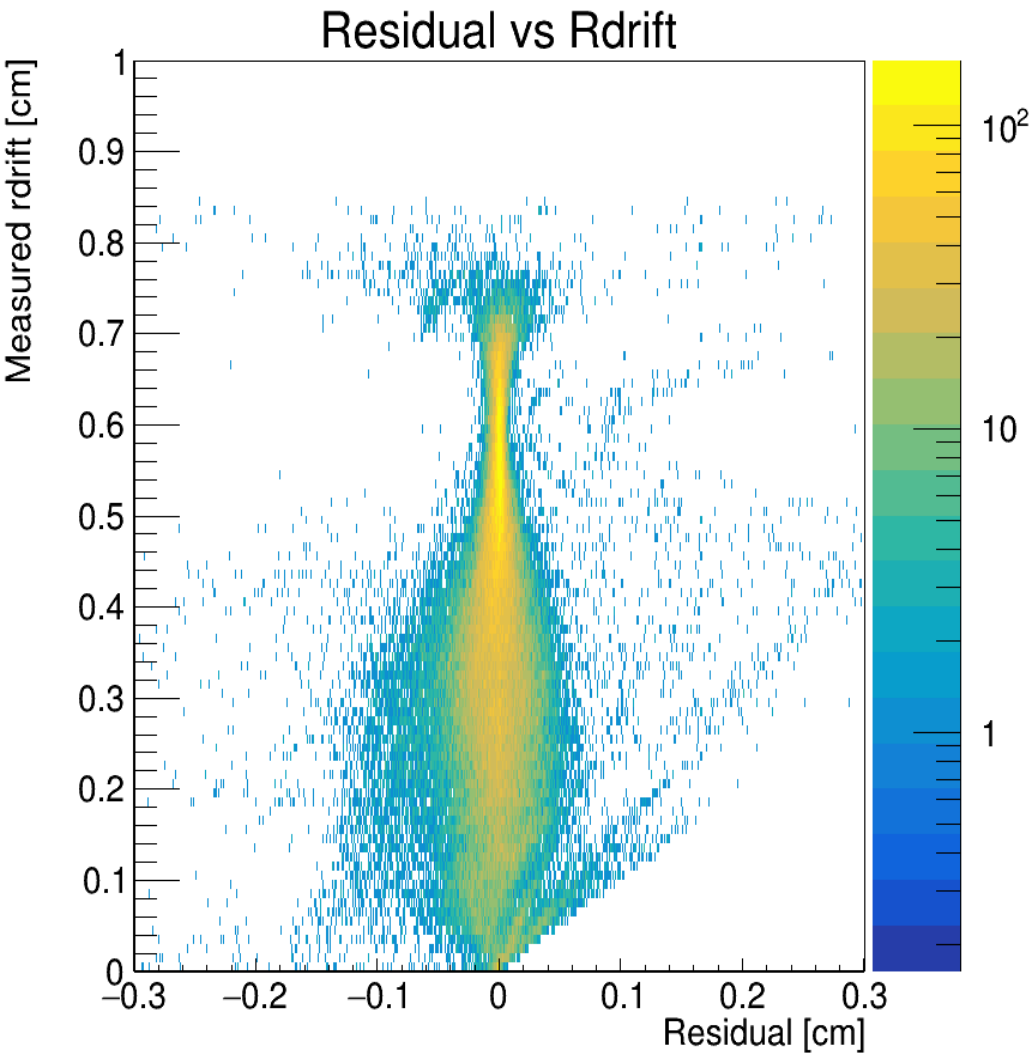
BM parameter optimization

```
//************************ track reconstruction methods and parameters ************
//Max number of iteration for the ch2 track reconstruction method
num_ite:  100

//stepsize in the change of the parameters for the chi2 track reco
par_moveM:  0.001

par_moveQ:  0.001

par_toll:  0.001

//legendre parameter: number of bins in track direction axys (m axys of fLegPolSum)
LegMBin: 10

//legendre parameter: range of track direction axys (m axys of fLegPolSum)
LegMRange: 0.001

//legendre parameter: number of bins in track intercept axys (r axys of fLegPolSum)
LegRBin: 15

//legendre parameter: range of track intercept axys (r axys of fLegPolSum)
LegRRange: 1.5
```

The BM track reconstruction parameters are not optimized: chi2 minimization parameters

- Also the chi2 minimization stepsize of the parameters are not optimized
- The optimization has been done on MC, Trento and old GSI data and not modified yet
- I have been focused on the Space-time relation calibration, but apparently there is also the need to make a calibration on the BM track reconstruction parameters

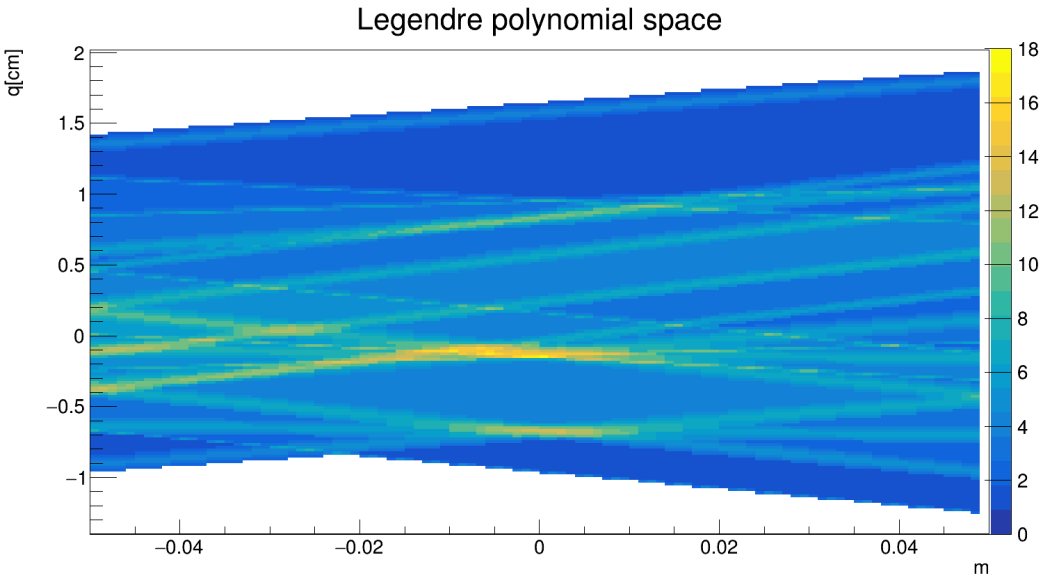
First tentative: calibration of reconstruction algorithm pars



The optimization of the BM track reconstruction algorithm parameters has been done

- Different parameters has been studied and optimized
  (e.g.: Legendre space range and number of bins, chi2 minimization parameters etc.)
- In principle this should be done for each campaign as part of the detector calibration procedure
- The procedure worked, even if it is very slow and cpu consuming

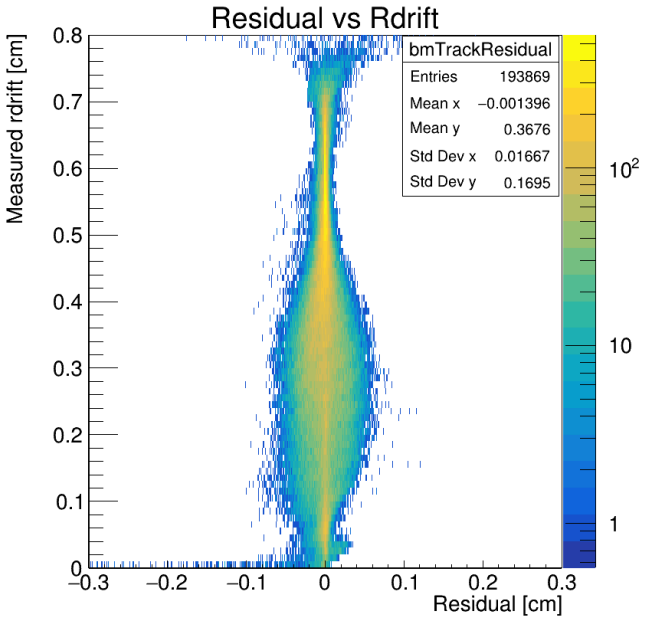
Second tentative: new Legendre space filling method

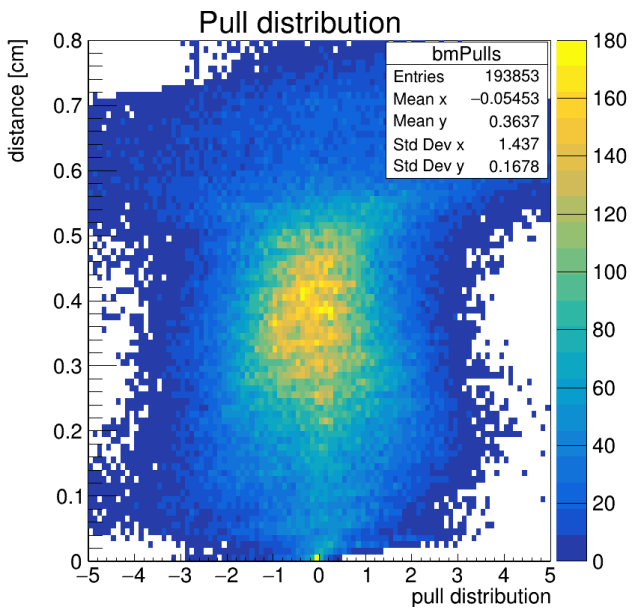


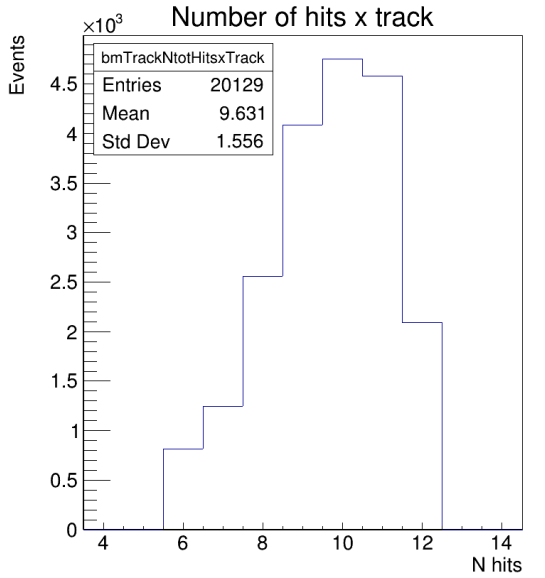
A different strategy for the filling of the Legendre space has been implemented

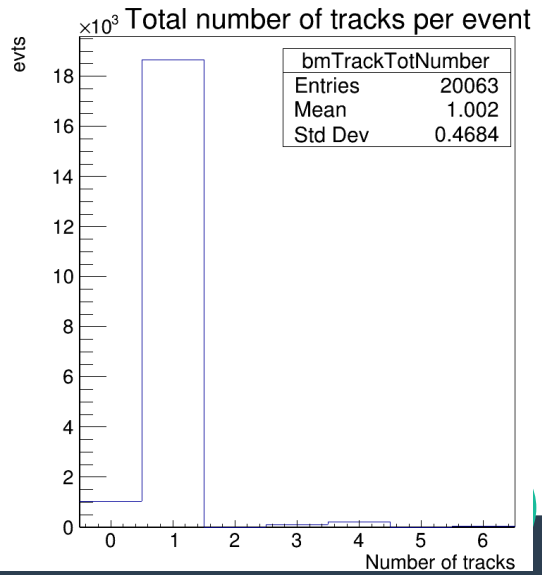
- Fill the Legendre space considering also the drift distance resolution
- This avoid the difficulties related with the use of too small bins
- Avoid also the difficulties to find a proper cluster position
- Both Legendre space and chi2 parametrization has been varied, but no relevant differences has been found
- **With this method, no optimization on the track reco pars are required**

Results with BM track reco v2



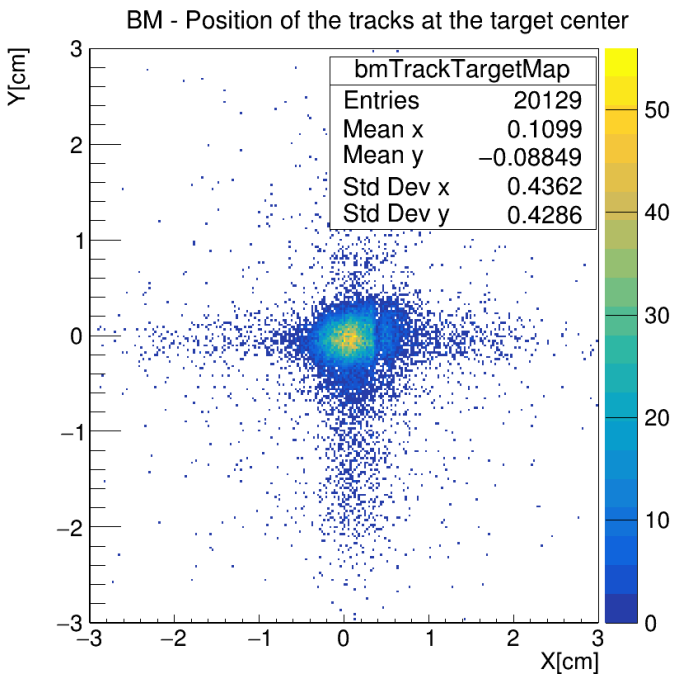


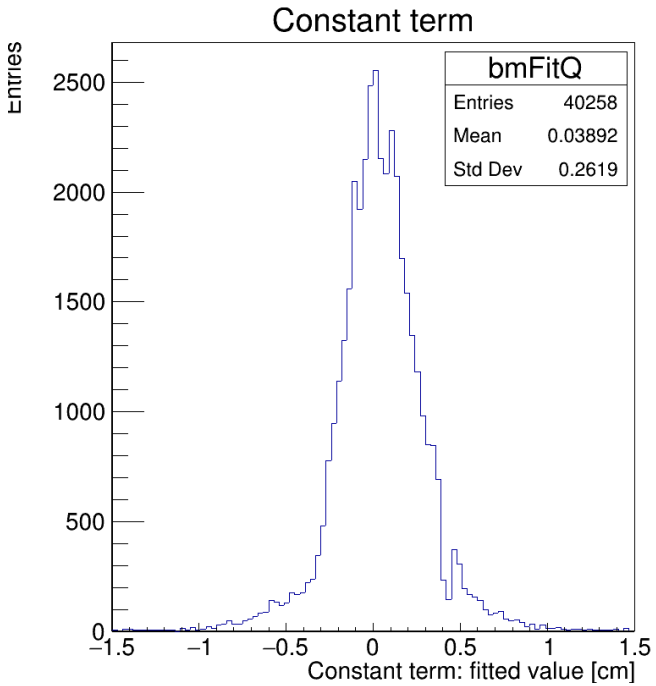


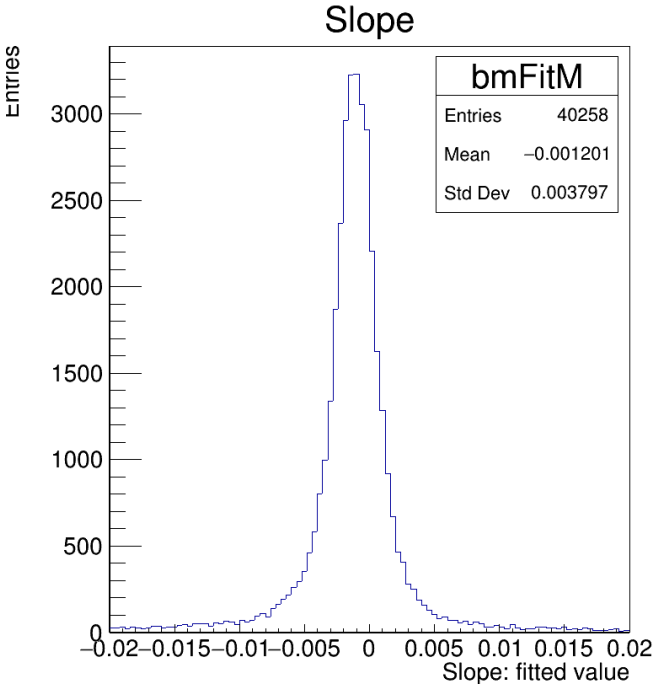


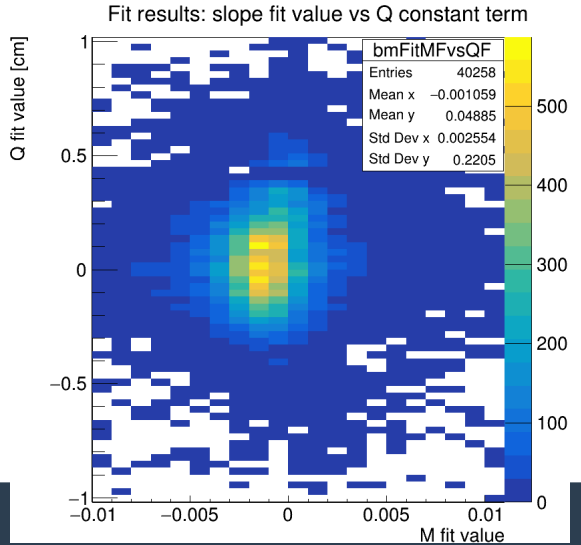
- The residual and the pull distribution do not show too strange behaviour
- Number of hits per track ~ 9/12, probably there are hits that are lost
- Number of events with only one track: 18663/20063=0.93 compatible with the BM calibration @ trento

Results with BM track reco v2



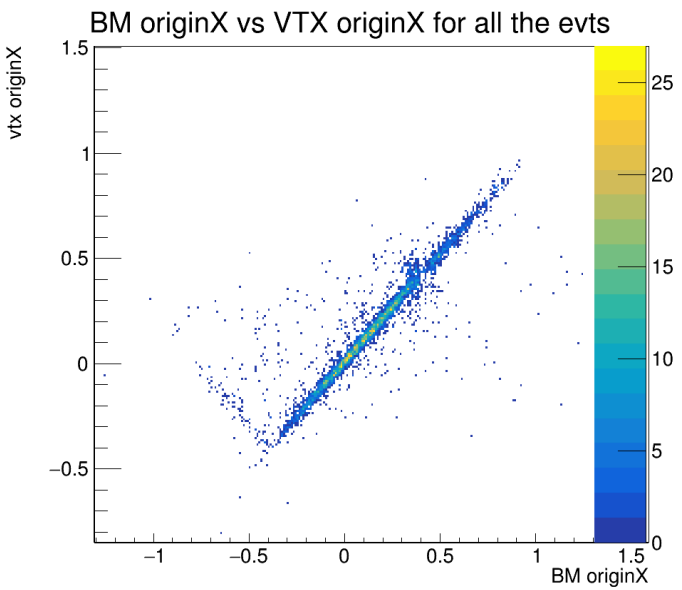


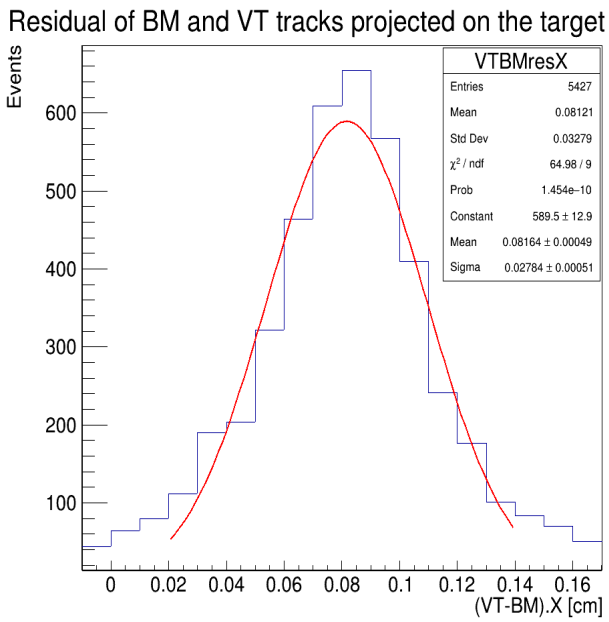


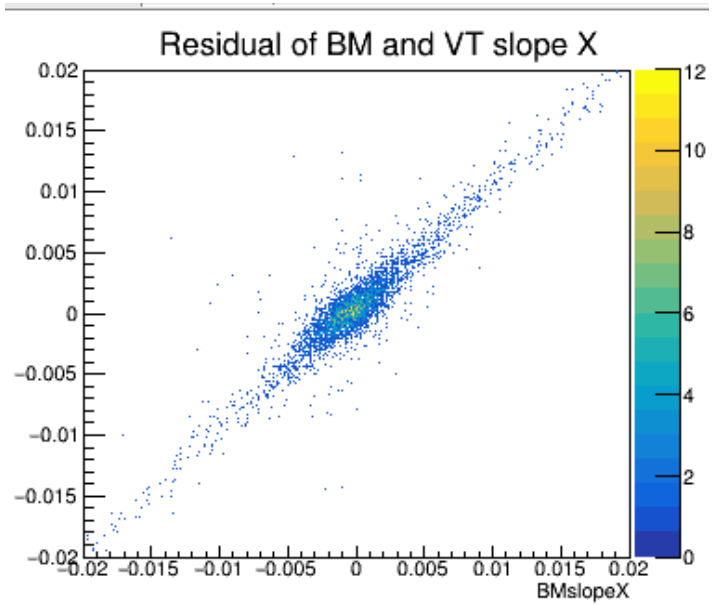


- No suspicious peaks or other strange behaviours has been found on the reconstructed tracks (not yet... at least)

BM vs VT

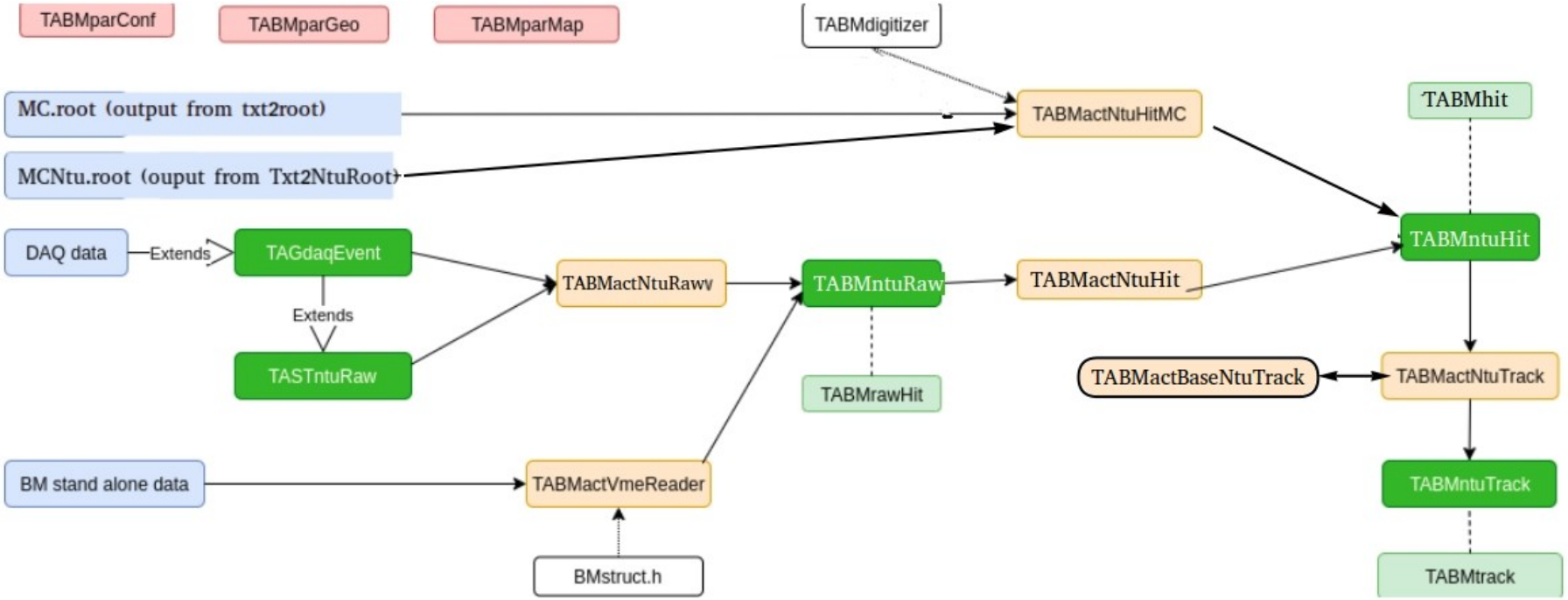






- No unsych data in tier3/GSI2021synched data folder (but only few runs tested)
- BM – VT residual of the order of hundreds of micrometers, compatible with the BM resolution
- Correlation between BM slope.X and the residual of the BM and VTX tracks, not everything is fully understood

Software



TABMactNtuTrack has been split with the addition of TABMactBaseNtuTrack.cxx/hxx to ease the readability of the code and ease the possibility to implement other reconstruction strategy

- TABMactBaseNtuTrack: implement the Legendre space strategy to select the hits and do the first estimate of the track parameters
- TABMactNtuTrack: implement the chi2 minimization to refine the track reconstruction and to compute the hits residuals etc.

Conclusions

- The BM reconstruction algorithm parameters were not optimized for the GSI2021 data, this lead to different strange behaviour on the residual plot and on the BM reconstructed tracks
- A first strategy has been implemented optimizing the reconstruction parameters. It worked, but with this strategy requires an optimization for all the campaign
- A second strategy has been developed modifying the filling of the Legendre space plot. This strategy worked and seems to be almost independent on the reconstruction parameters
- The first analysis on the BM tracks, compared also with the VTX detector shows good results, even if there are few points to be understood better
- The BM reconstruction software is now split in two parts to easy the readability and to be adapted to possible new reconstruction strategy