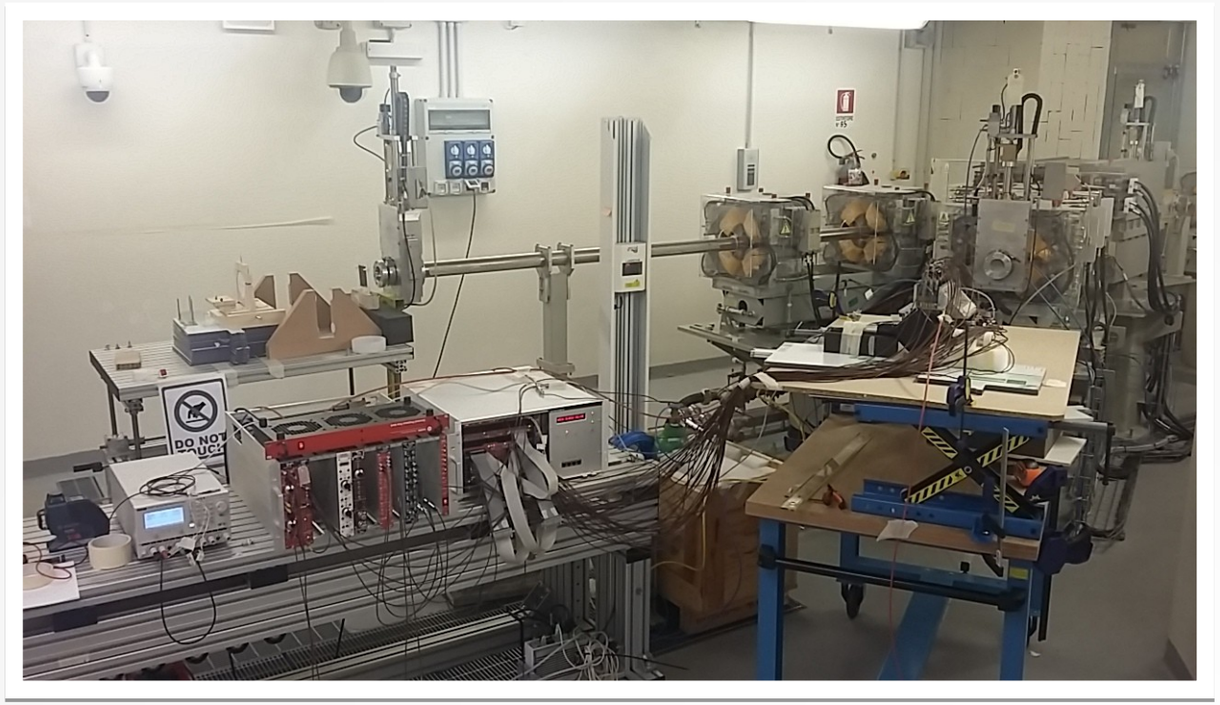


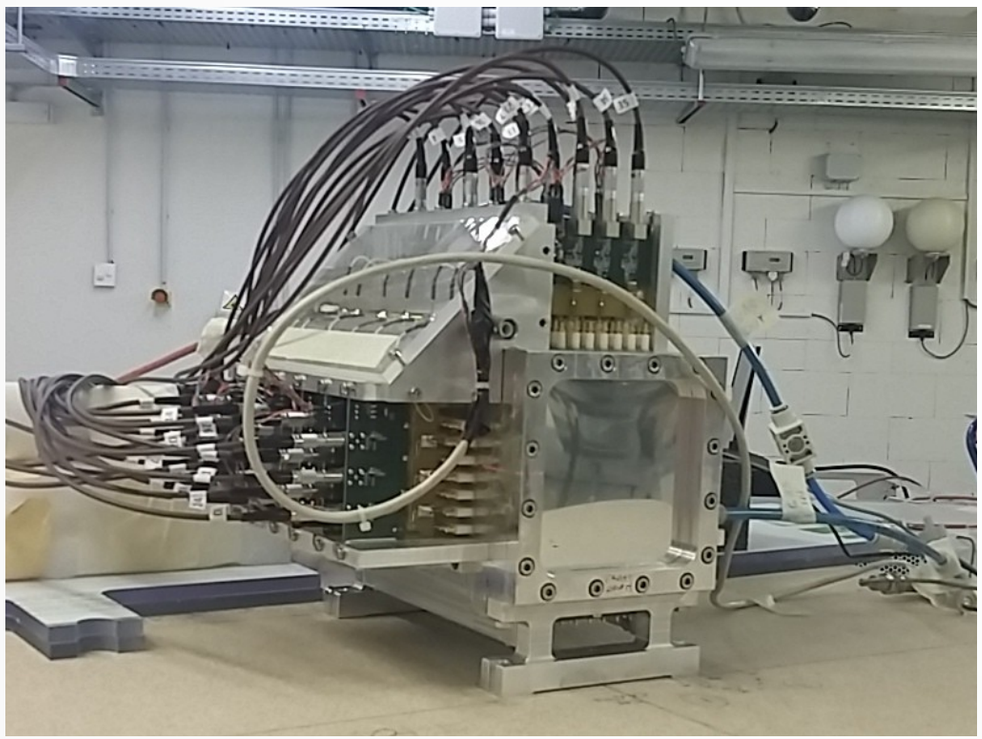
Foot collaboration meeting

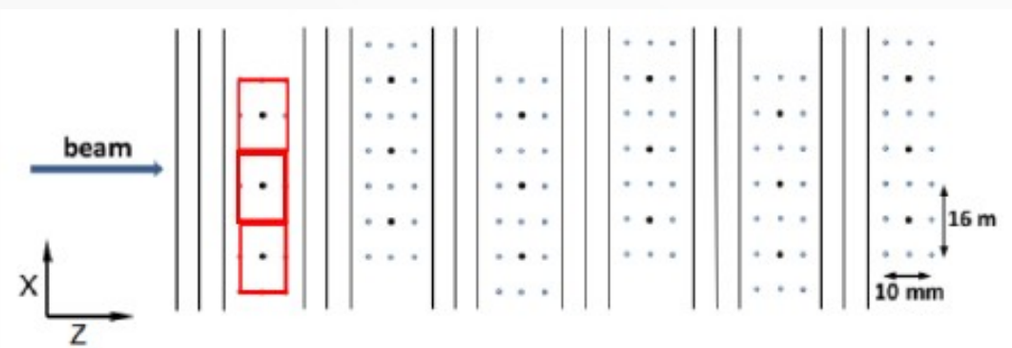
3-5 December 2018

Beam Monitor status

G.Battistoni S.Colombi Y.Dong A.Embriaco C.La Tessa
I.Mattei M.Rovituso F.Tommasino S.M.Valle

Detector specs & goals





Detector specs.

- Drift chamber of 11cm x 11cm x 20cm
- 12 staggered layers with 3 drift cells per layer
- Rectangular cell shape (16mm x 10mm)
- Ar/CO2 @ 80/20%

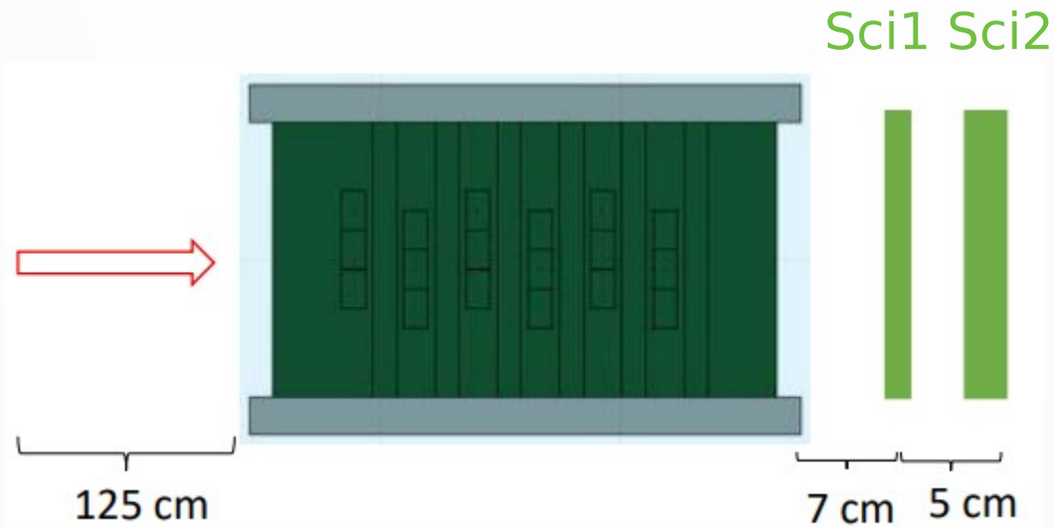
Purpose in FOOT

- Incident beam direction
- Primary position

Test @ Trento 10/2018

Experimental setup

Beam
Protons @
70-228 MeV



Sci1
3 mm thickness

Sci2
6 mm thickness

Trigger purpose

Beam Monitor

- Flux system in the irradiation room
- Isocenter at BM entrance window
- 100k Events/dataset, Rate ~1 KHz

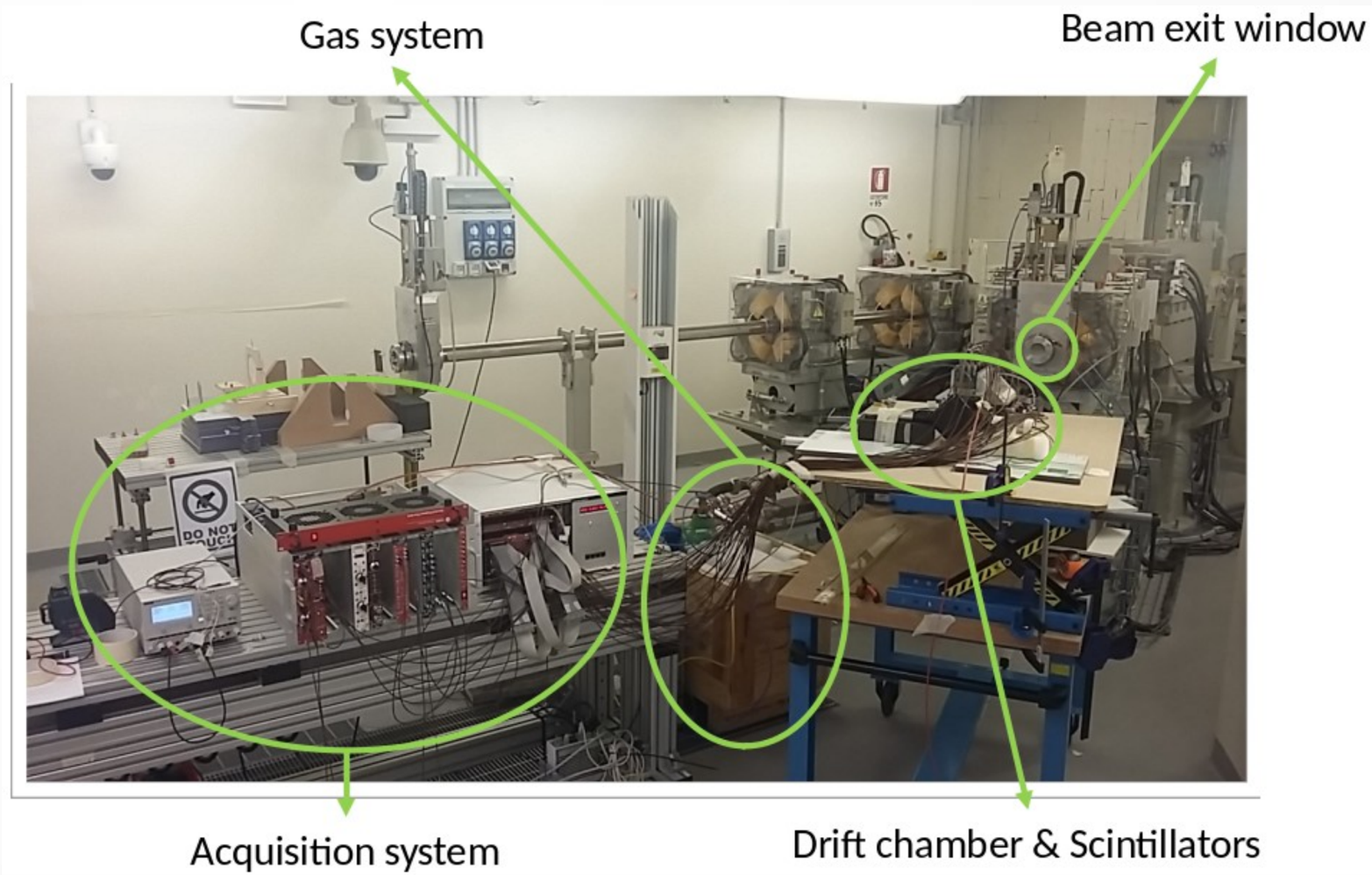
Experimental setup & goals

Acquisition

- TDC V1190B:
  36 ch + trigger
- Scaler: 15 ch + trigger

Outline

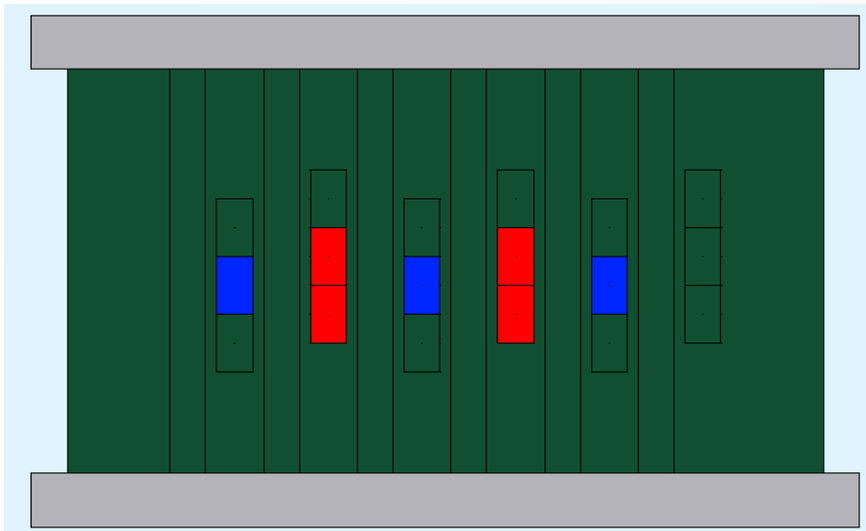
- Efficiency vs HV
- Beam spot reconstruction vs beam energy
- BM shifted
- Tantalum + wedge
- Spatial resolution



Efficiency vs HV

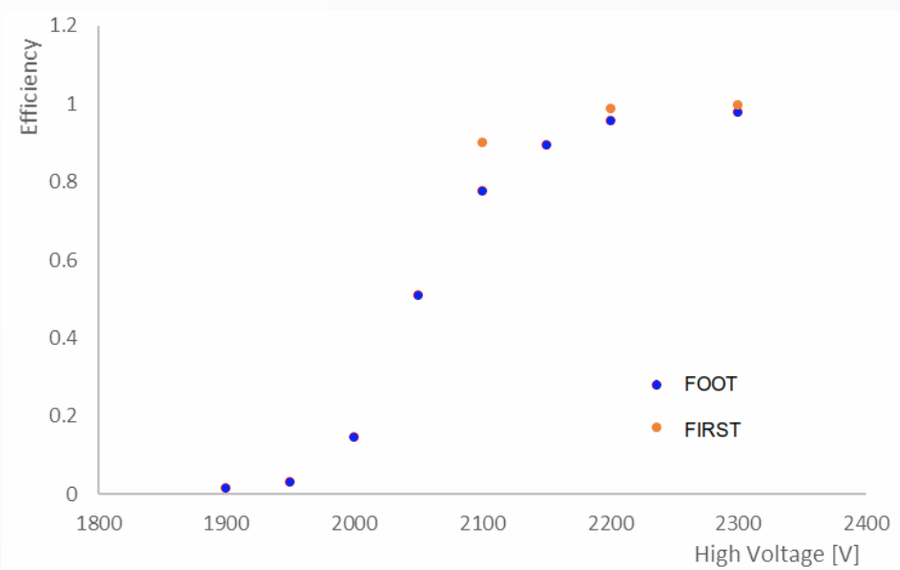
Efficiency=Probe/Pivot

- Pivot: N events with three consecutive fired wires in even (odd) layers
- Probe: N events with 2 hits in the odd (even) layers between the pivots
- Adopted at FIRST (Paoloni et al)



Experimental

- Protons @ 83 MeV
- HV range: 1900-2300 V
- HV steps: 50 V

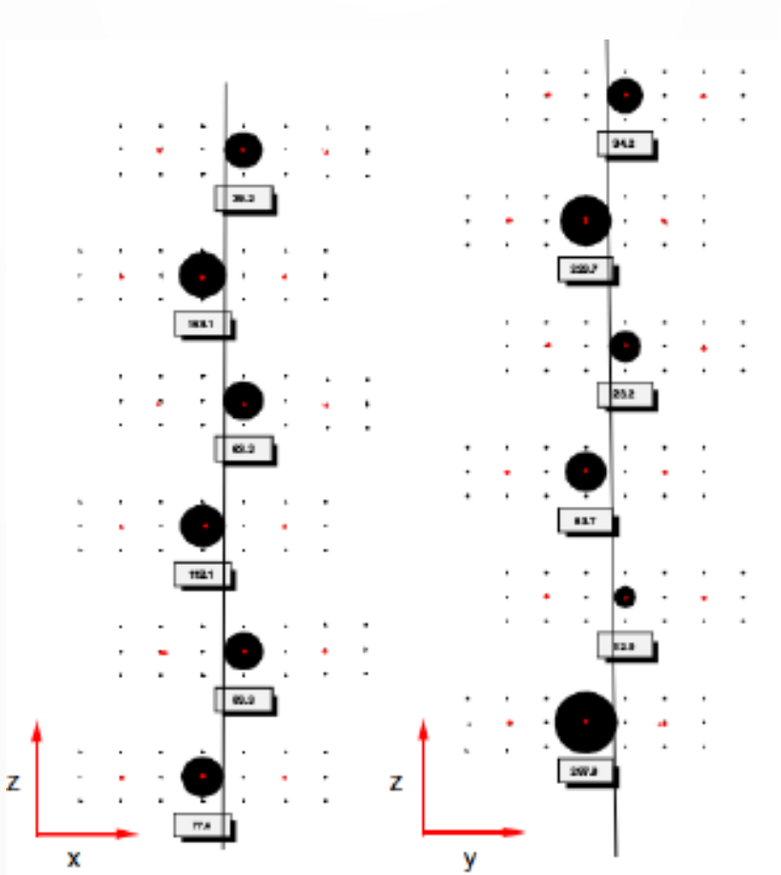


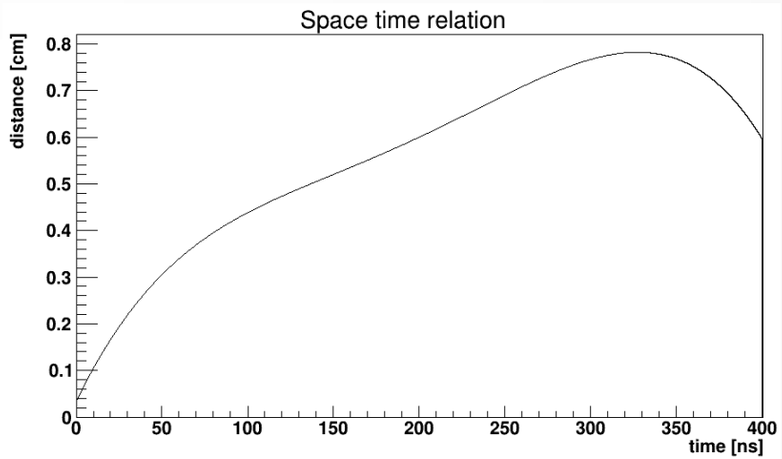
Agreement with FIRST data

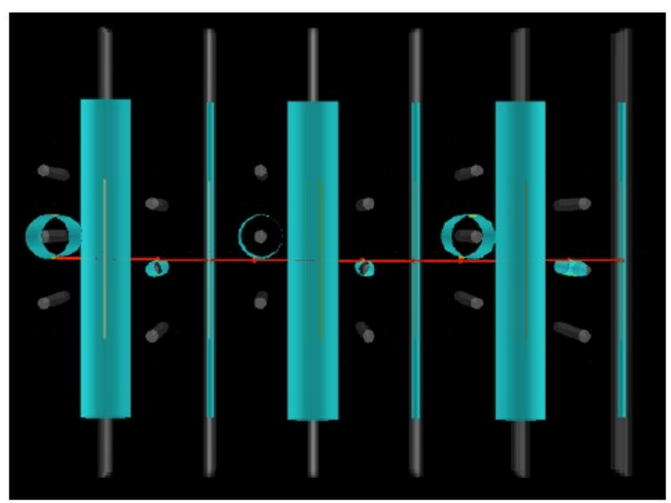
Track reconstruction

- SHOE: analyzing software
- Genfit simple kalman fitter(*)
- FIRST space-time rel(*) (tuned on C ion beam, with different working point)

(*) up to now





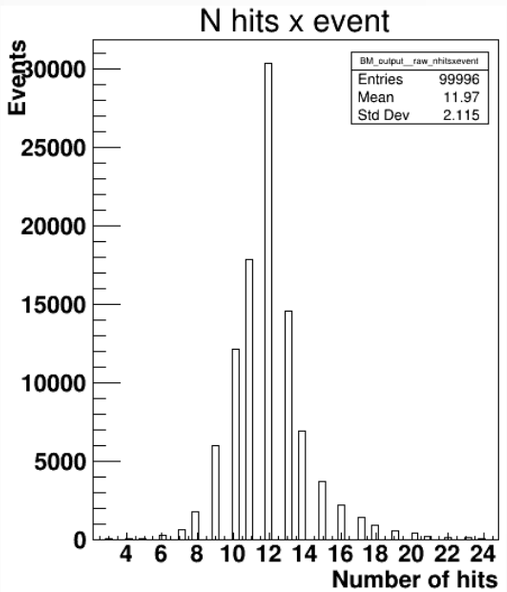


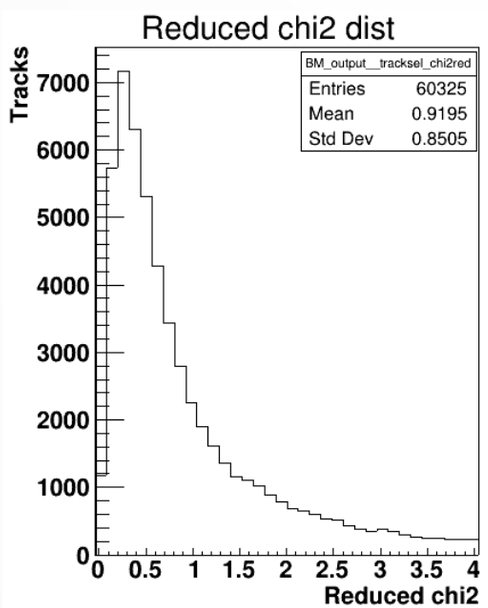
Hit preselection

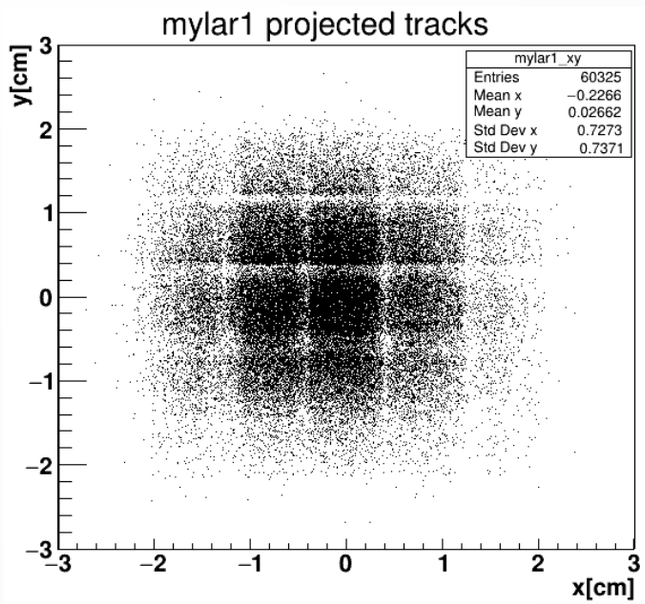
- At least 4 hits/view
- Max nhits < mean nhits + 2

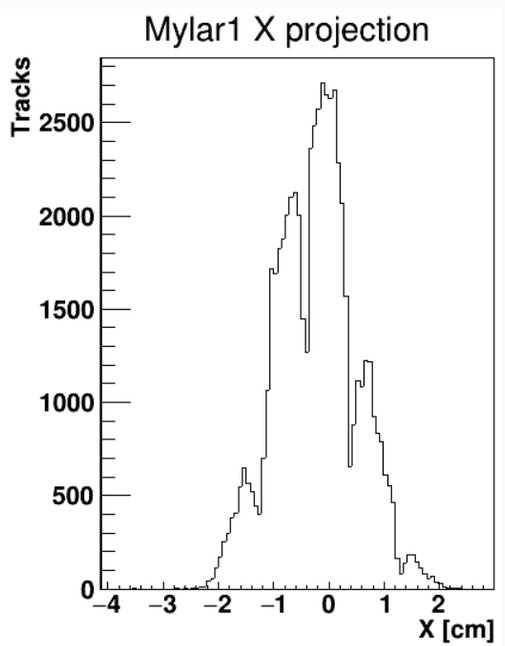
Reconstruction sample

Sample dataset: P @ 80MeV; HV 2150 V







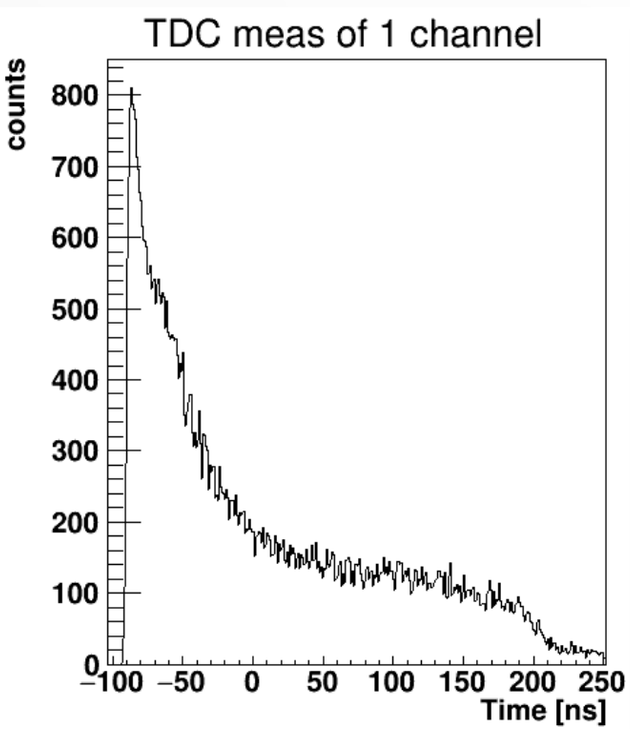


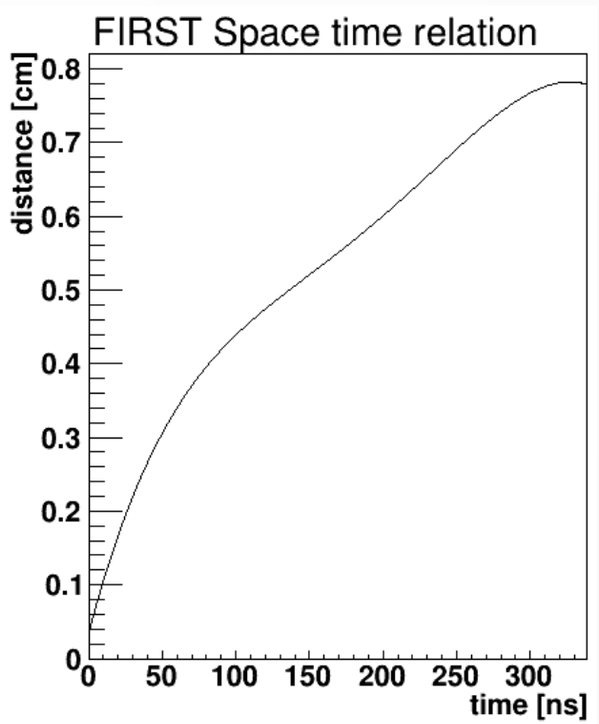
- ✔ HV=2150-2200 V is a good working point
- ✔ Reduced chi2 acceptable
- ✖ Blank space in the reconstructed tracks profile!!!

Blank space effect

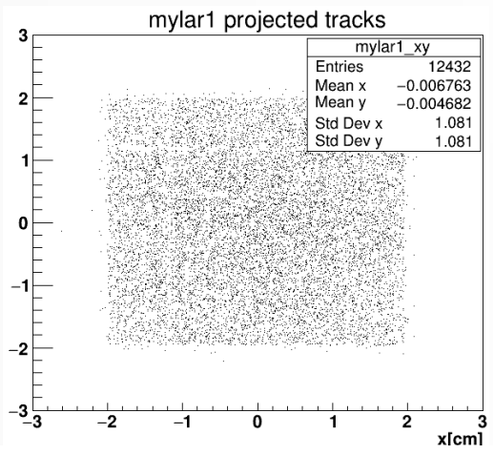
Some of the possible causes

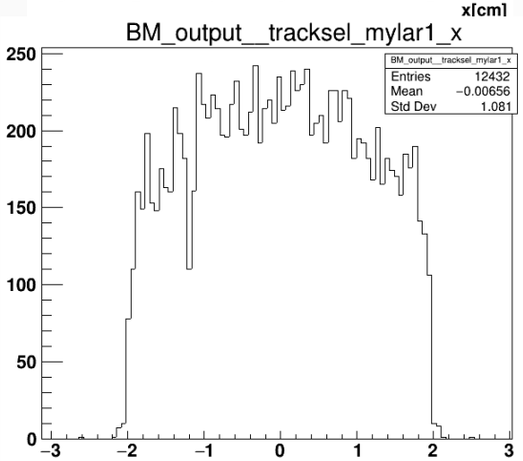
- **ST rel**: BM TDC signal up to ~300 ns ⟶ Drift distance with FIRST strel up to ~ 0.78
- **TDC T0**: Shift of the drift distance ⟶ No drift distance ~0.8-0



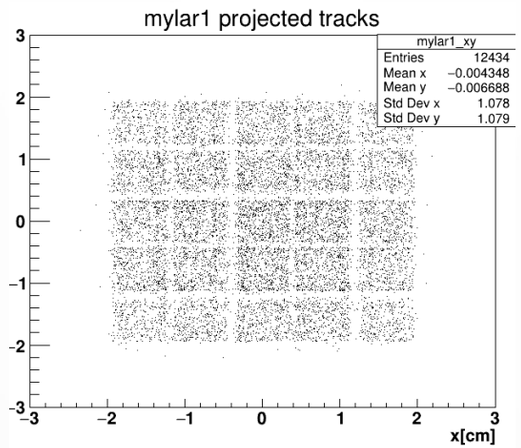


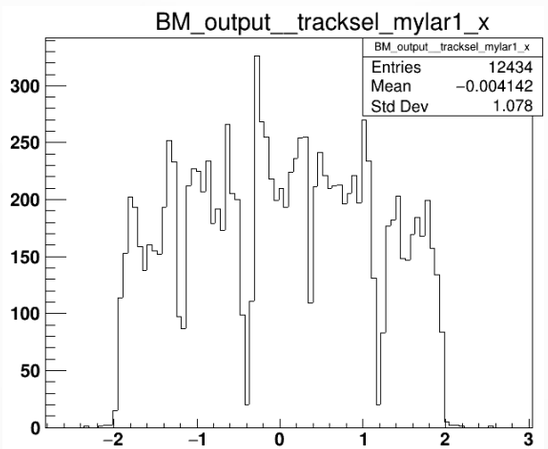
MC preliminary studies



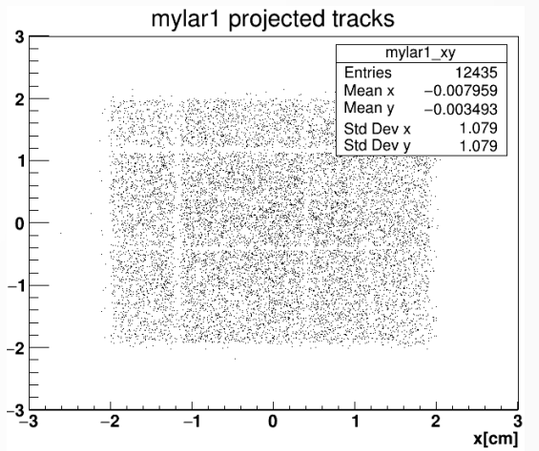


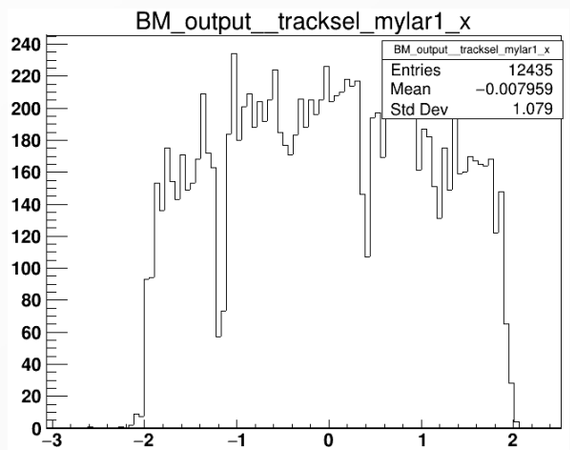
MC reference





T0 shift (-6ns)

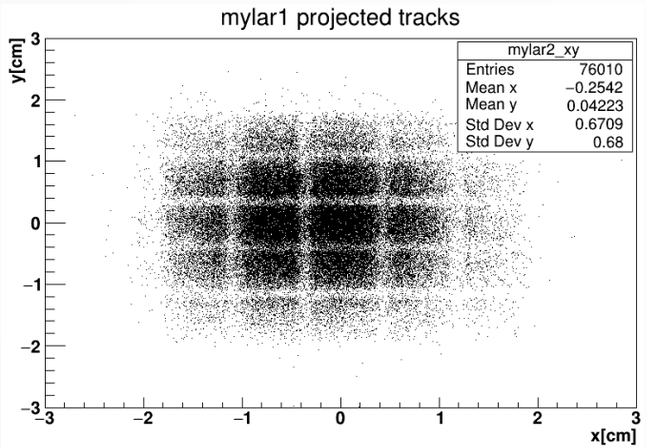


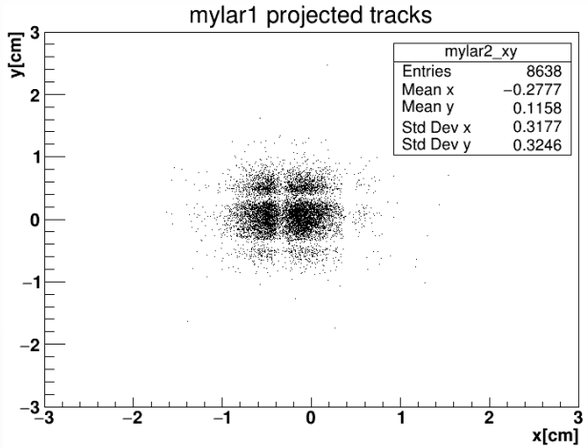


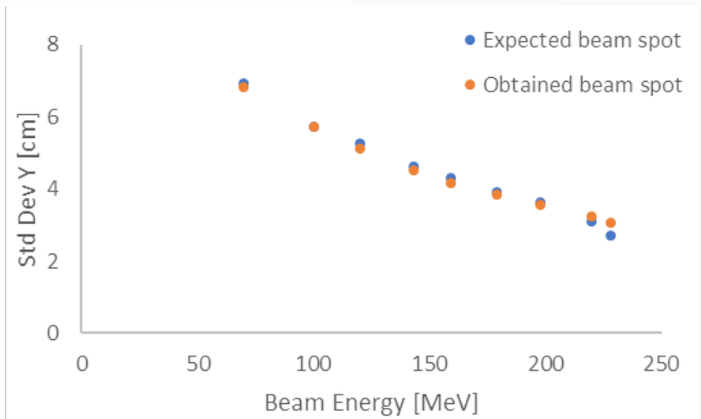
ST rel (FIRST ST rel*0.8/0.78)

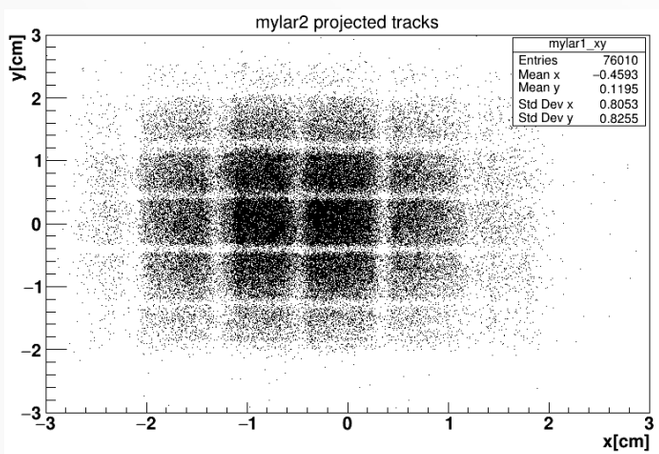
BM needs st rel calibration

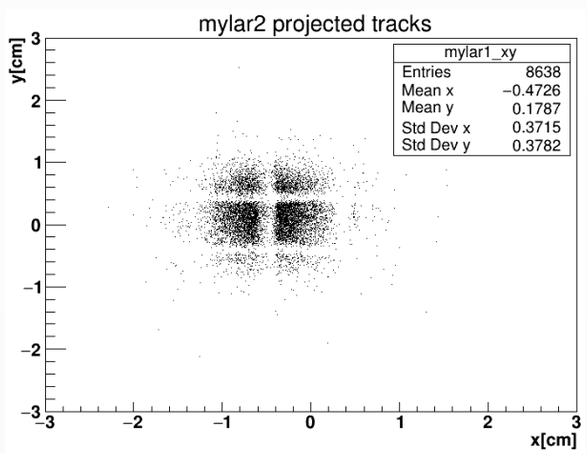
Spot reconstruction vs P energy

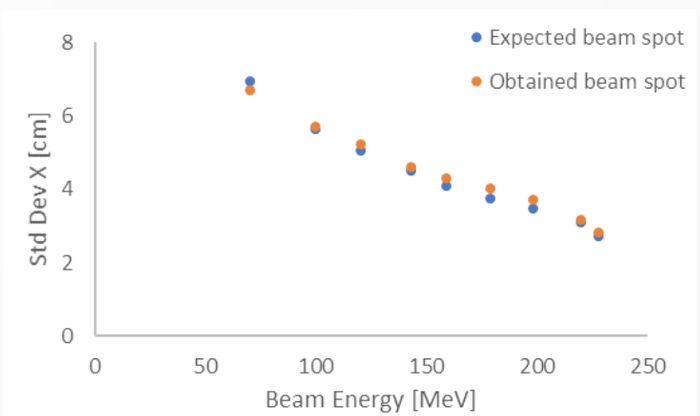










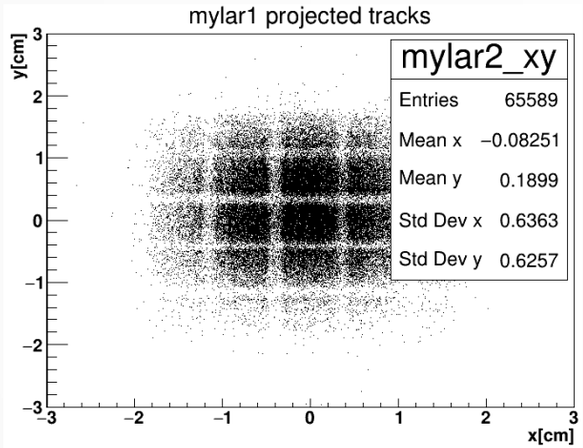


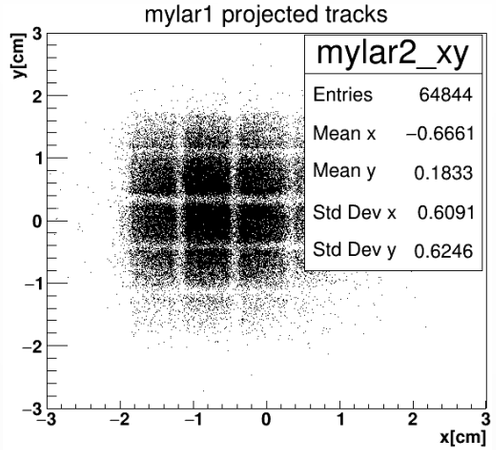
70 MeV

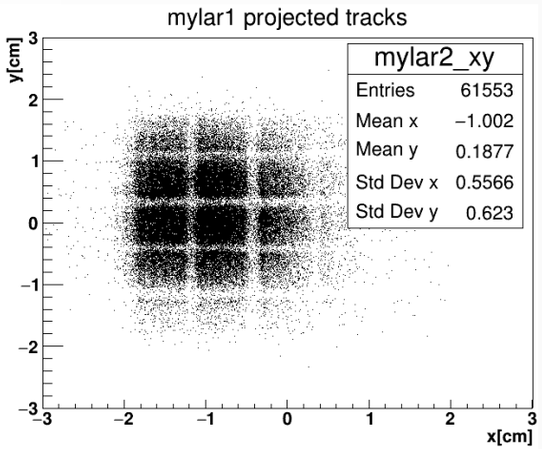
220 MeV

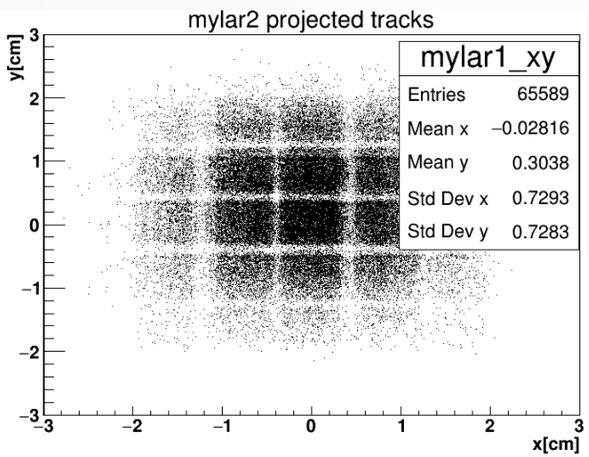
Comparison
(Tommasino et al)

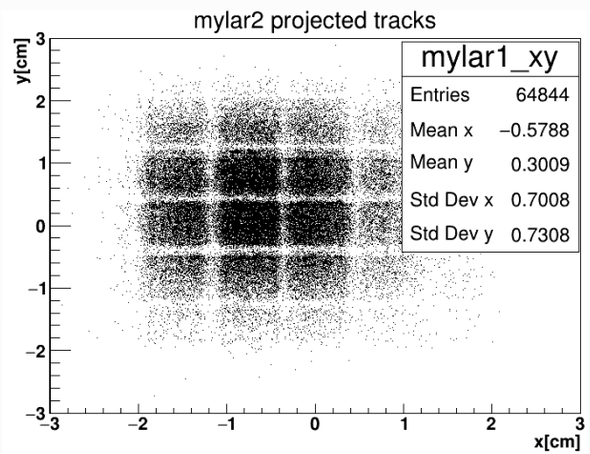
Spot reconstruction vs shift

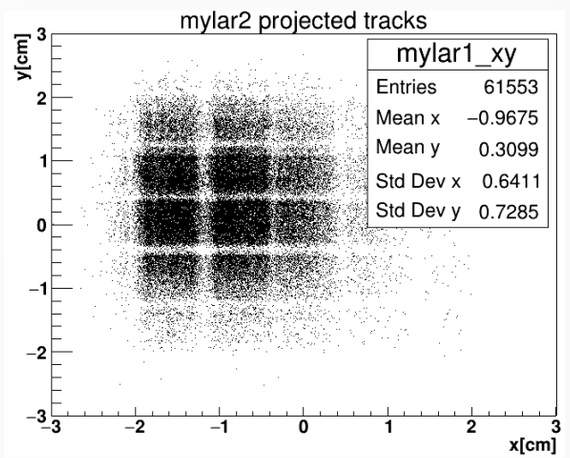












Pos0

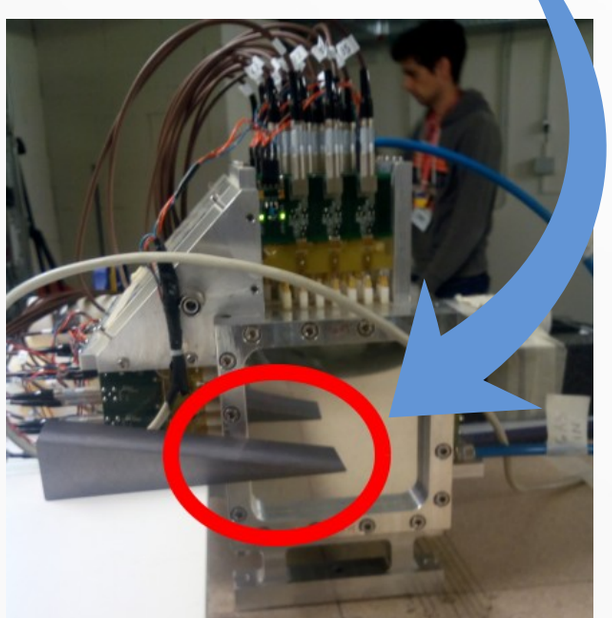
-0.5 cm X shift

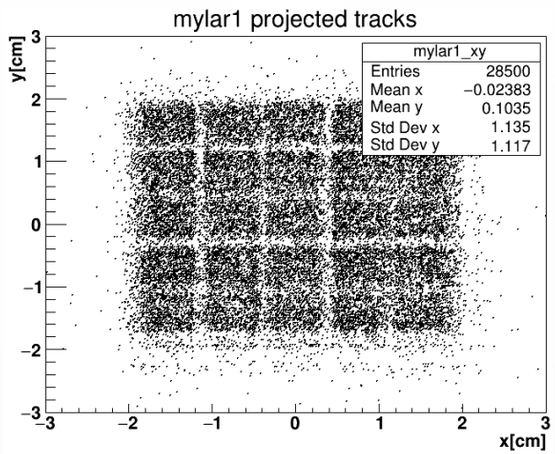
-1.0 cm X shift

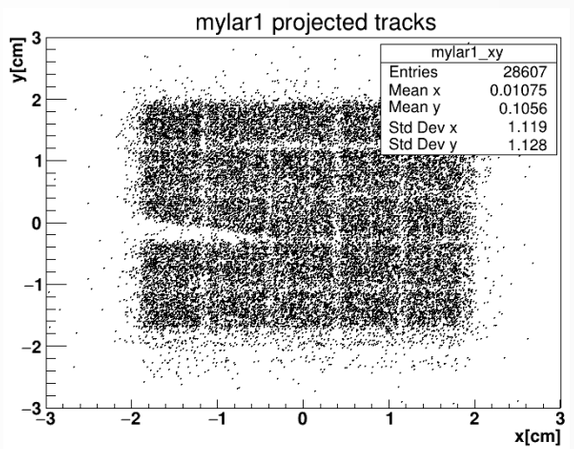
Tantalum & wedge

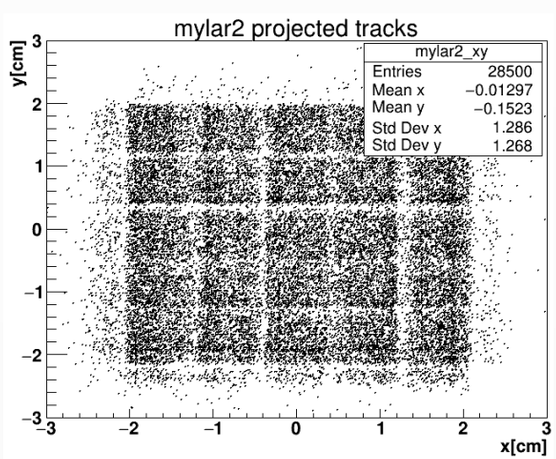
Let's irradiate the whole detector

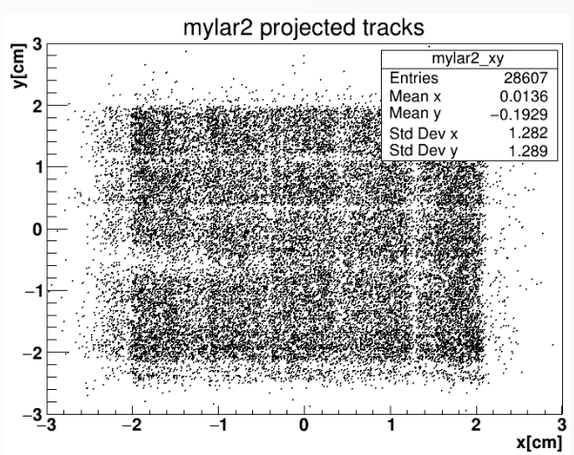
- Add 2.5 mm Tantalum layer at the beam exit window
- Tantalum + wedge
- P @ 148 MeV



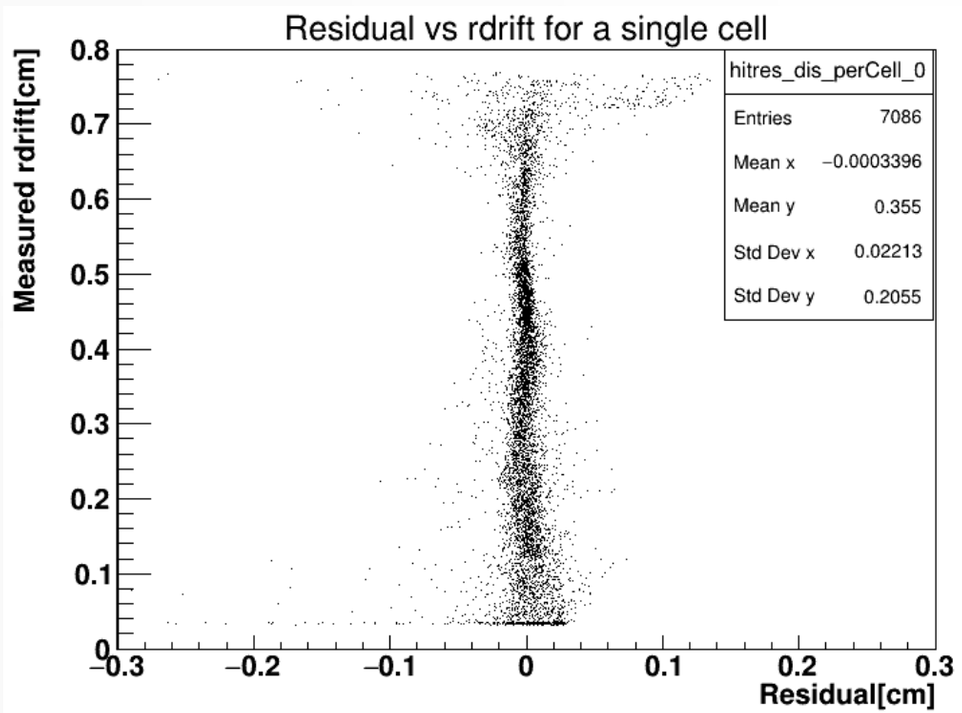


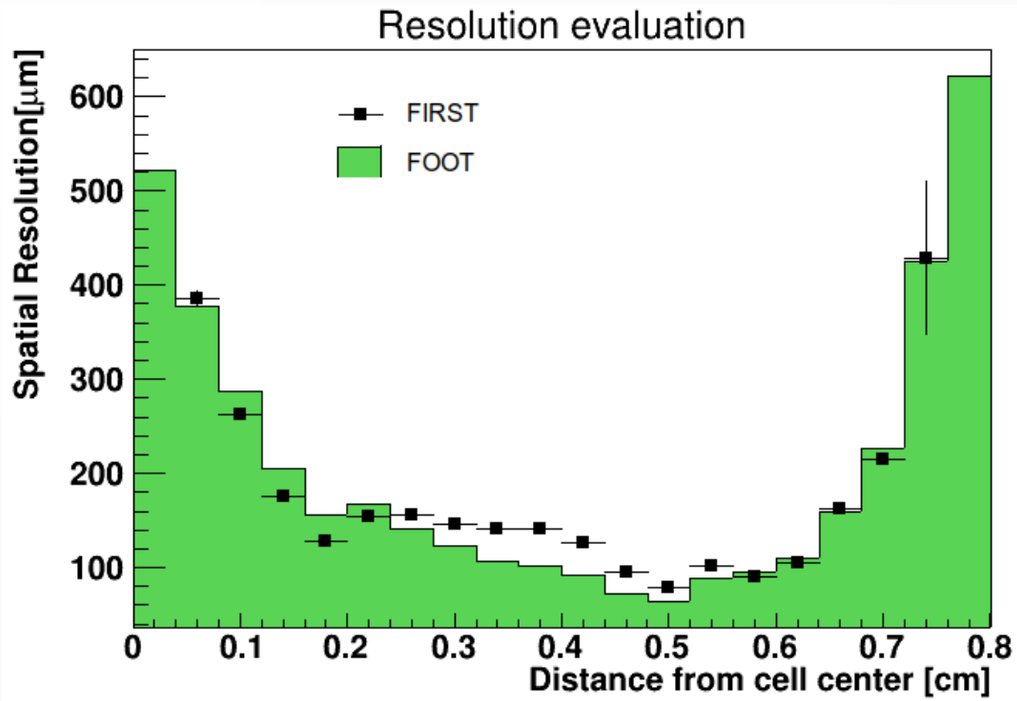






Spatial resolution





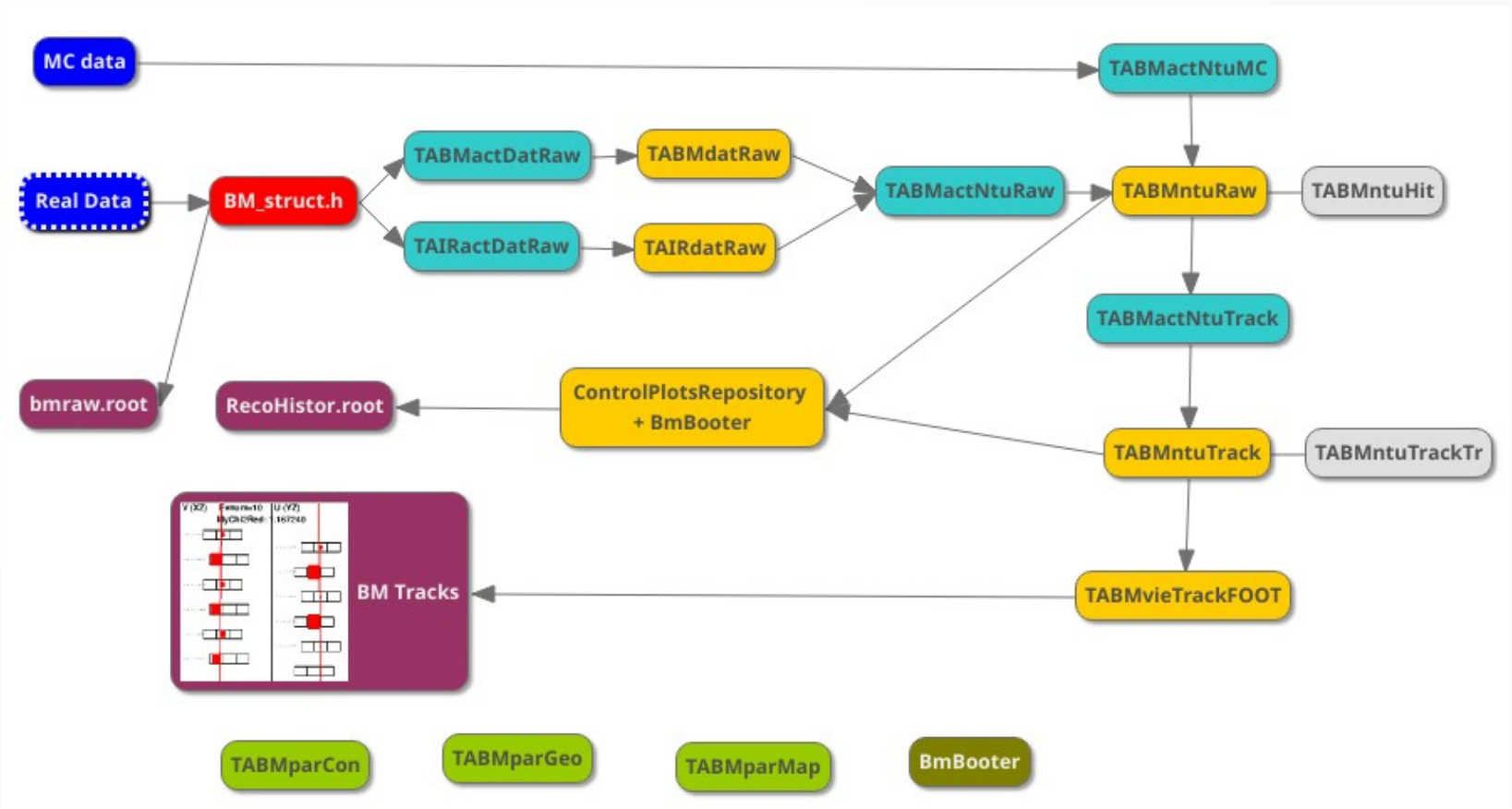
- Residual = fitted drift distance – measured drift distance
- Spatial resolution from Tantalum dataset

Agreement with FIRST Resolution

BM in SHOE

Beam Monitor branch: bm_calibration

- Used both for MC and real data analysis
- No fragments reco. Independent detector
- Managed by BmBooter (~Booter)
- No relevant changes for the GSI test



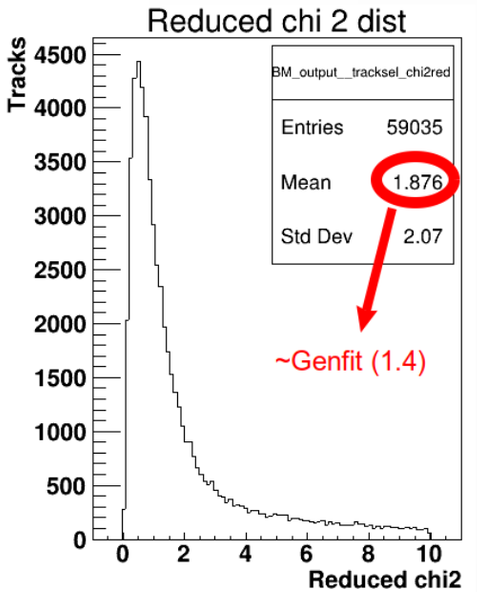
Fit algorithms

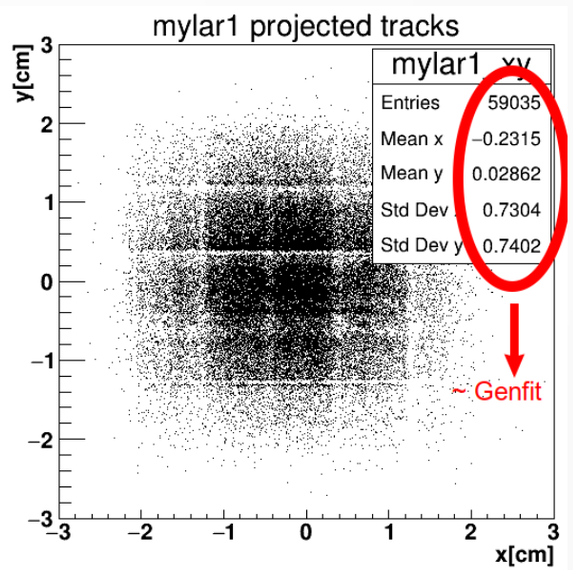
Genfit

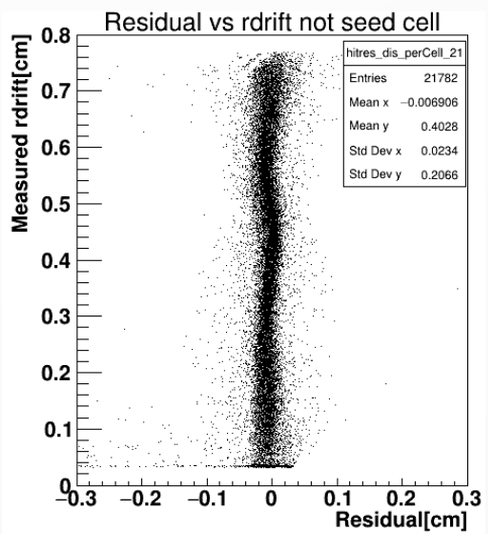
- ✖ Not fast as desired
- ✖ Debug not easy
- ✔ Works with magnetic field

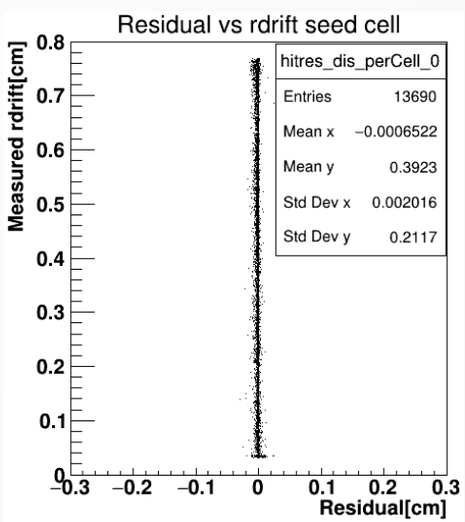
Least chi2 fit

- • FIRST least chi2 fit restored
- ✔ Fast, easy to debug
- ✖ No magnetic field
- • Still under study and improvement (e.g.: seed cell bias)









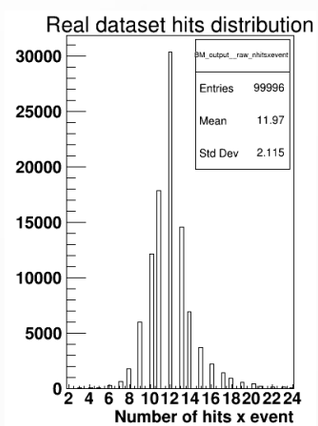
Software improvement

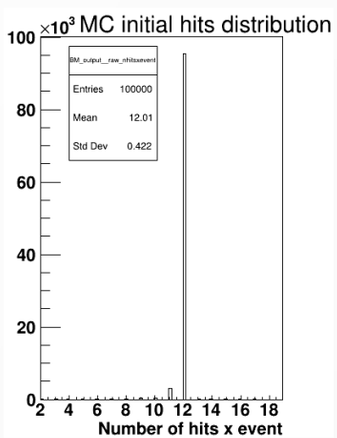
Prefit based on Legendre polynomy

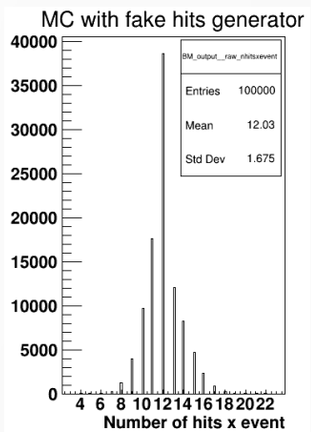
- Provide initial seed and hit clustering
- Can be used both by Genfit and least chi2
- (Alexopoulos et al: https://doi.org/10.1016/j.nima.2008.04.038)

MC studies

- Cut real hits, add fake hits
- Reconstruction vs MC truth







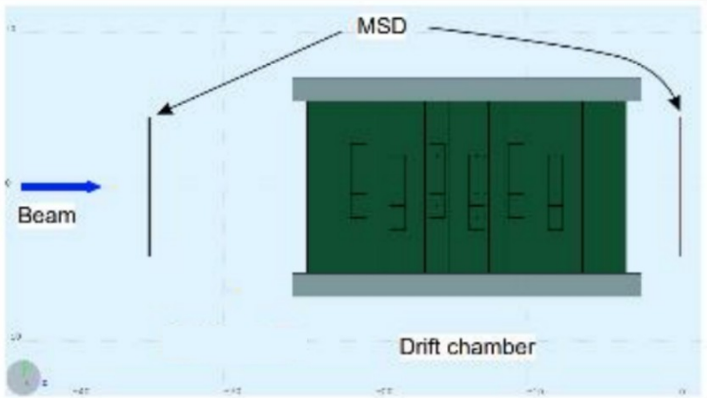
ST relation self calibration software

- Iterative procedure to self calibrate the BM st rel (Thanks Vincenzo)

Next steps

Calibration test with MSD @Trento with protons

- 12-14 (15) December/2018 (Next Week)
- 4.5 (7.5) Hours of beam time
- ST relation calibration (use of Tantalium layer?)



Calibration test with MSD @ CNAO with Carbon ion

- January (?)
- Working point, efficiency measurement, performance assessment, ST relation
- MSD measurements

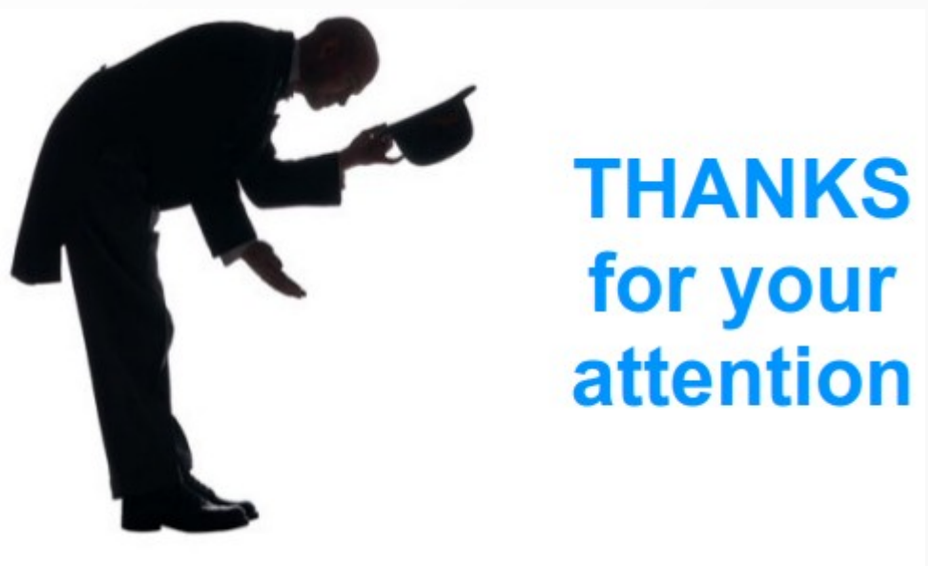
Real data acquisition with Emulsions @ GSI with Carbon ion

- March/2018
- Beam profile measurement, need online monitoring? Other requirements?

Conclusion & outlook

Conclusion

- ✔ Efficiency on Protons ~ 0.9 (~FIRST)
- ✔ Spot reconstruction in agreement with other independent measurement
- ✔ Spatial resolution ~ 200 μm (~FIRST)
- ✖ Need space time calibration



Outlook

- Calibration tests
- Tracking reconstruction Improvement
- Test the V15 (BM with magnetic field)
- MC studies

BACK UP

BmBooter

- bm_calibration branch: from the master branch of the software meeting held in Bologna
- The detector relevant libraries are mainly in TABMbase/*
- Configuration libraries (TABMpar*) initialized in Booter.cxx

BmBooter.hxx

```
//initialize
void Initialize( TString instr_in, Bool_t isdata_in);
void evaluateT0();//evaluate the T0 from datafile

//process
void Process();
void FillDataBeamMonitor();
void Projecttracktr(); //to save the tracktr2dprojects matrix
void ResidualDistance();//to save the residual_distance matrix

//read data event
Bool_t read_event(Bool_t);//read an event from the datafile and charge bmstruct, it returns true if it read the event,
false if the file is end
Bool_t drop_event();//read an event from datafile and discharge it, it return false if the file is end
void monitorQDC(vector<Int_t>& adc792_words);
void clear_bmstruct(Bool_t forced);
void PrintBMstruct();// to print the content of bmstruct

//finalize
void Finalize();
void PrintSTrel(); //print the st relations in RecoHistos
void PrintEFFpp(); //print the efficiency evaluation with the pivot-probe method
void PrintProjections();// print the projected fitted tracks saved in tracktr2dprojects
void PrintResDist();//print the residual_distance matrix
void Allign_estimate();  //estimate the bm allignment with the residual methods and print the results
void evaluate_cell_occupy(); //fill the cell_occupy matrix
void efficiency_pivot_probe();//evaluation of the efficiency with the eff_pp matrix (pivot-probe method), made with the
cell_occupy matrix
void efficiency_paoloni();//evaluation of the efficiency with the "Paoloni" method
void efficiency_fittedplane();//evaluation of the efficiency with the "Paoloni" method on fitted tracks
```

Resolution fit