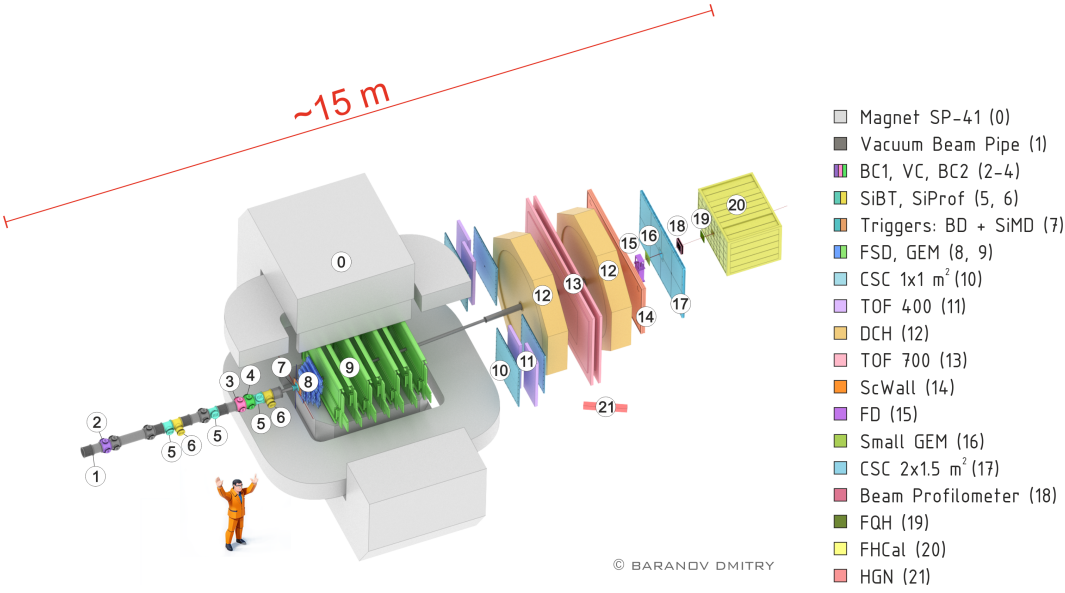
Coordinate and time alignment of the TOF-700 detector

Sergei Merts, Vasilisa Lenivenko

Analysis and Detector Meeting of the BM@N Experiment

13/03/24


~15 m
0
1
2
3
4
5
6
7
8
9
10
11
12
13
12
14
15
16
17
18
19
20
21
© BARANOV DMITRY
Magnet SP-41 (0)
Vacuum Beam Pipe (1)
BC1, VC, BC2 (2-4)
SiBT, SiProf (5, 6)
Triggers: BD + SiMD (7)
FSD, GEM (8, 9)
CSC 1x1 m^2 (10)
TOF 400 (11)
DCH (12)
TOF 700 (13)
ScWall (14)
FD (15)
Small GEM (16)
CSC 2x1.5 m^2 (17)
Beam Profilometer (18)
FQH (19)
FHCal (20)
HGN (21)

TOF-700 setup

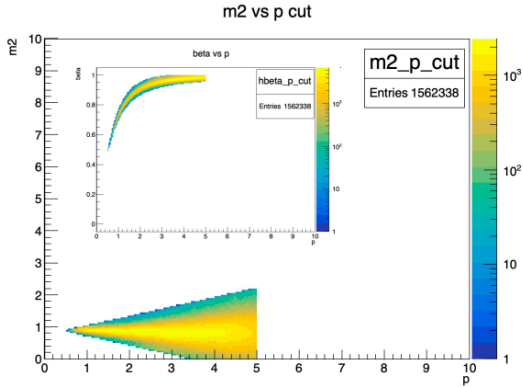
59 modules with 32/16 strips

Time correction

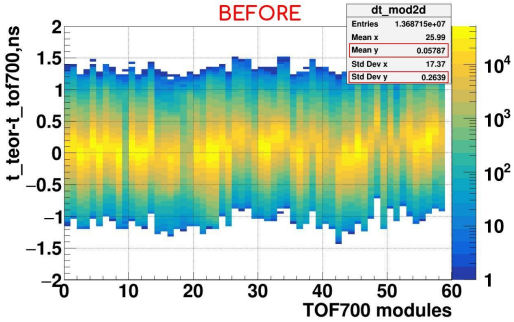
- Select protons by mass
- For each selected proton calculate theoretical time of flight by length (L) and momentum (ρ)
  $T_{theor} = \frac{L \cdot \sqrt{m^2+\rho^2}}{\rho \cdot c}$
- Calculate time correction
  $dT = T_{theor} - T_{TOF}$
- Use dT to correct T_{TOF} for each particles

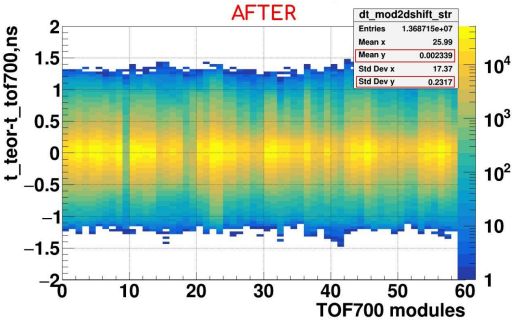
Repeat independently for each module (59) / strip (32×59)

Used statistics: 1e6 events

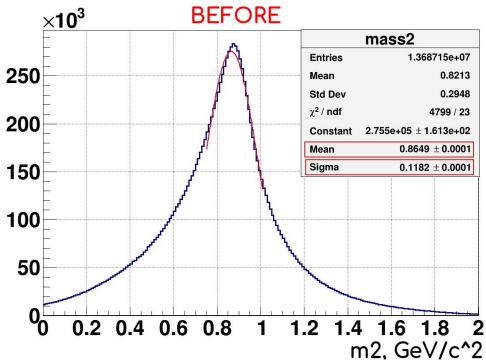


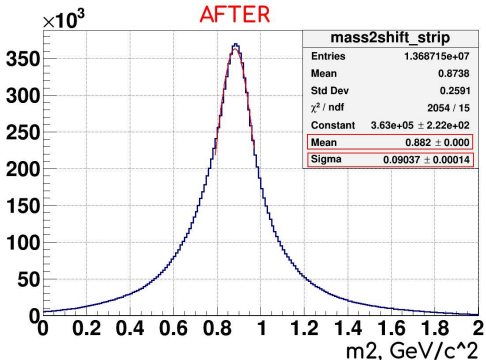
Time difference for protons by modules



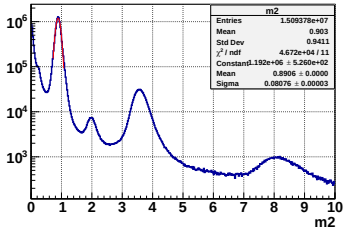


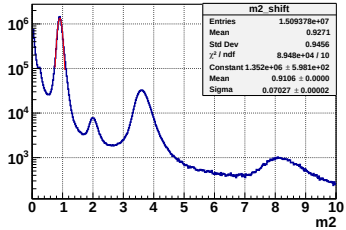
Mass for protons



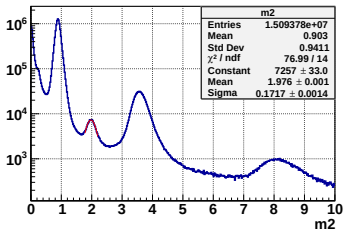


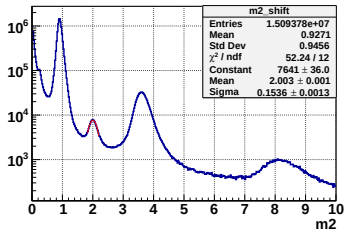
Proton mass (0.880)



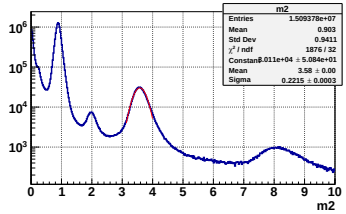


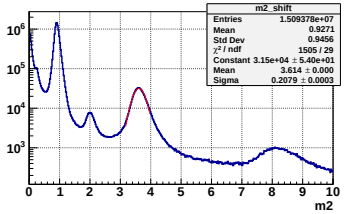
He3 mass (1.980)



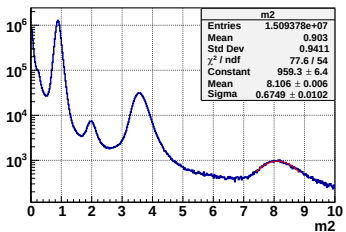


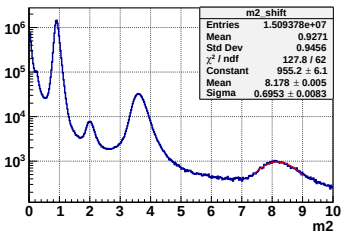
Deutron mass (3.519)





Tritium mass (7.919)





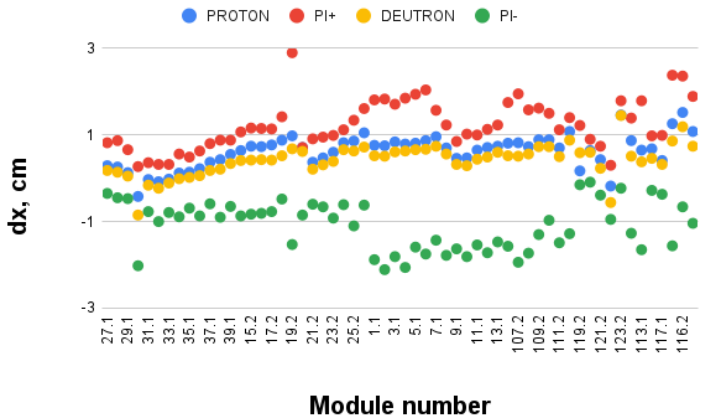
Coordinate correction

The next conditions and cuts were used

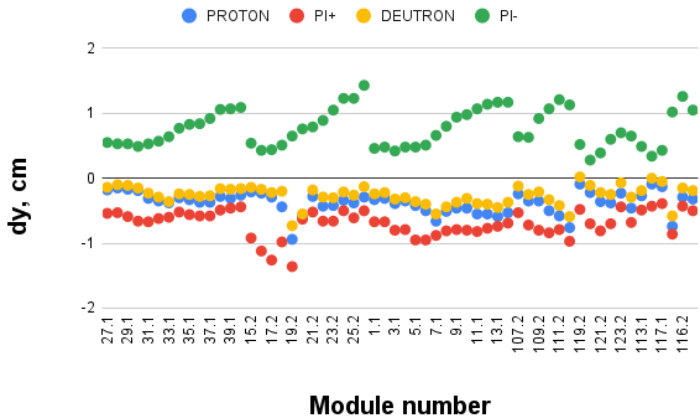
- ≈22e6 events
- At least 2 tracks in primary vertex
- $-1.0 < \mathrm{PV_X} < 1.5$
  $-1.0 < \mathrm{PV_Y} < 1.2$
  $-0.5 < \mathrm{PV_Z} < 0.5$
- At least 5 hits on track
- Time corrections implemented

Matching

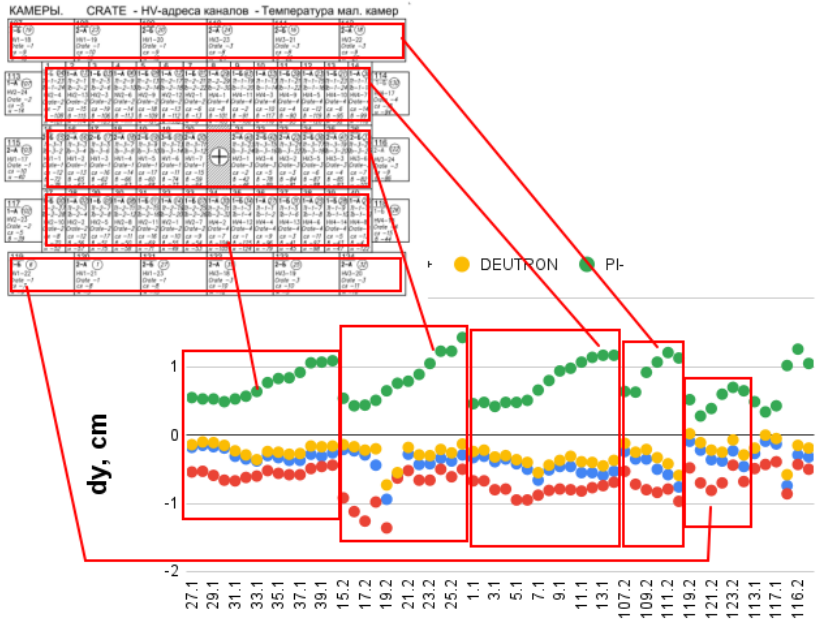
- Propagate track to PV_Z, if distance between PV and track on PV_Z more than 1.0 cm, skip track
- Propagate track to TOF-700 planes
- Find nearest hit in ± 3 cm for X and Y directions
- Calculate length of track
- Correct time by proton peak correction coefficients
- Calculate mass and momentum of track
- Fill independent distributions for protons, π^-, π^+ and deuterons



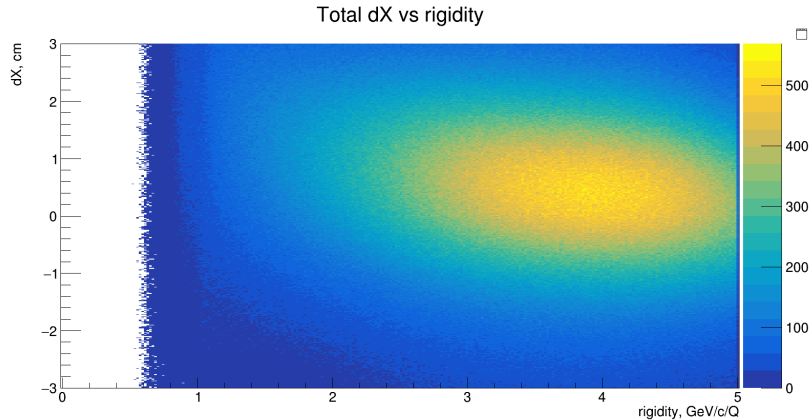
There is module and momentum dependence



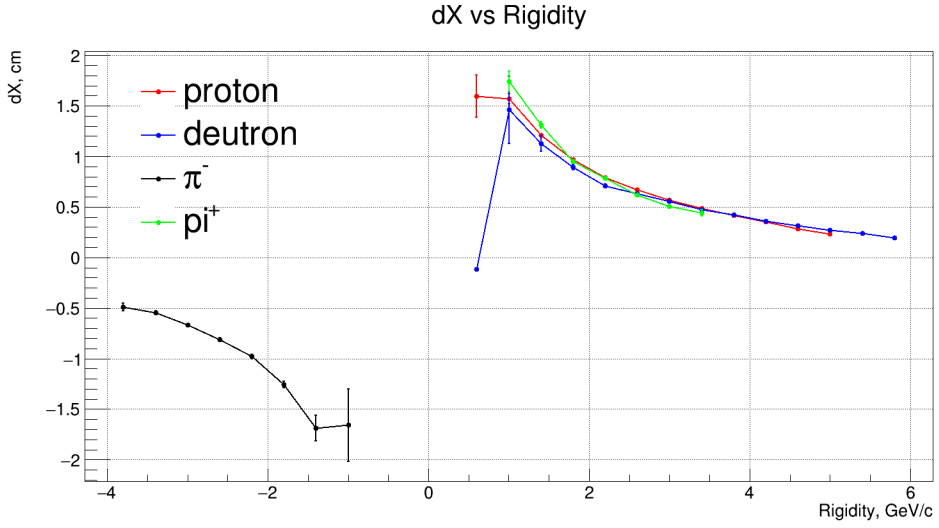
There is module and momentum dependence

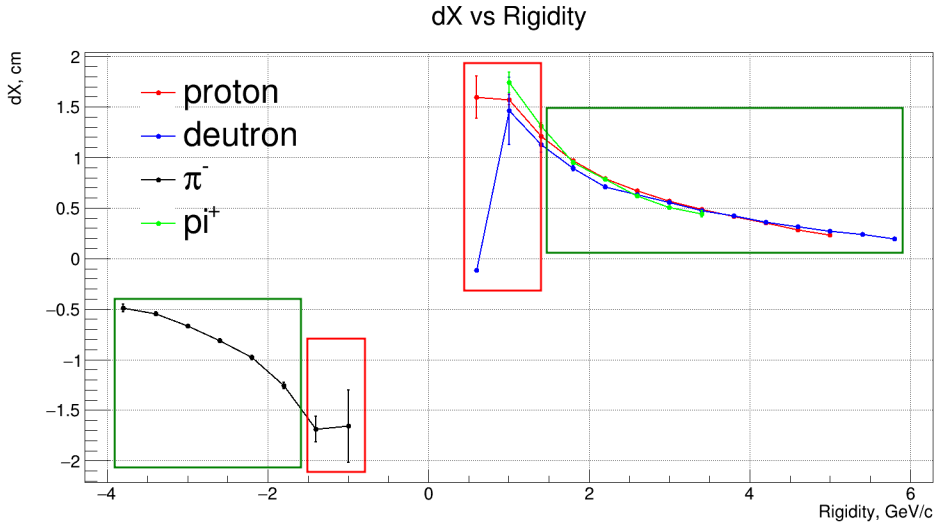

КАМЕРЫ.
CRATE - HV-адреса каналов - Температура мал. камер
DEUTRON
PI-
dy, cm
1
0
-1
-2
27.1
29.1
31.1
33.1
35.1
37.1
39.1
15.2
17.2
19.2
21.2
23.2
25.2
1.1
3.1
5.1
7.1
9.1
11.1
13.1
107.2
109.2
111.2
119.2
121.2
123.2
113.1
117.1
116.2

dX vs momentum for selected protons

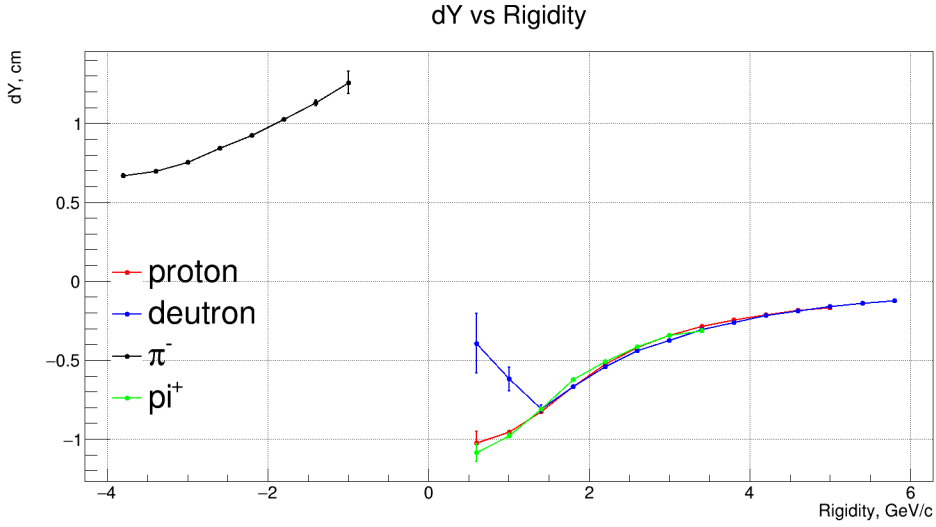


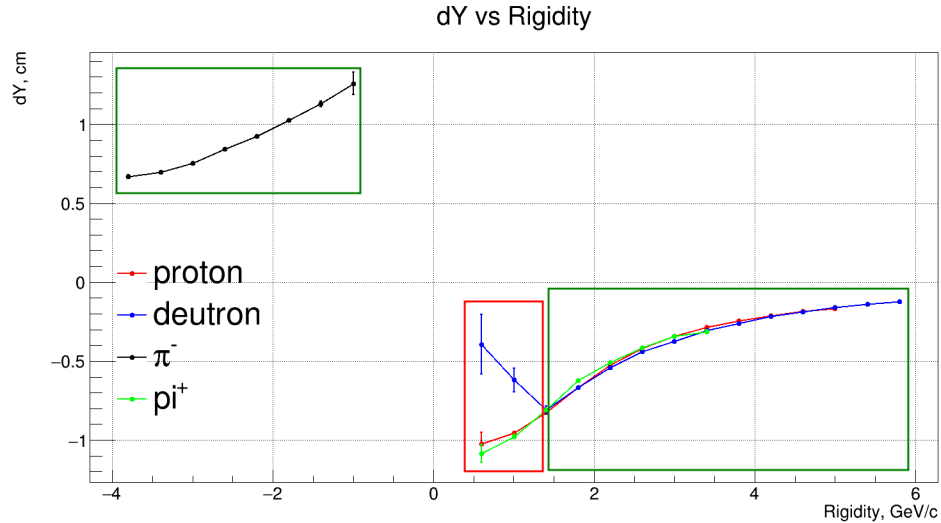
Plot was divided by slices of 0.4 GeV/c
Spectrum in slice fitted by “gaus+pol2” function and mean value used to get momentum dependence


dX vs Rigidity
dX, cm
Rigidity, GeV/c
proton
deutron
π-
pi+
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−4
−2
0
2
4
6

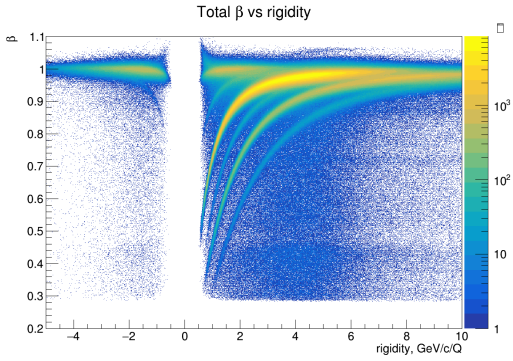


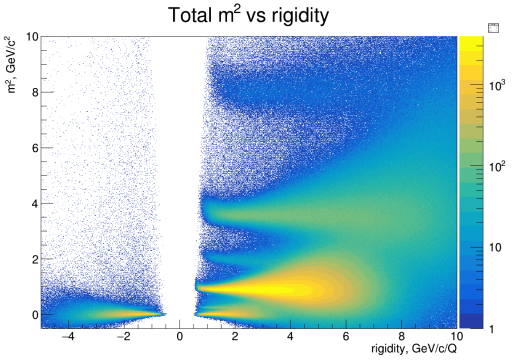
Lack of statistics for low momenta


dY vs Rigidity
dY, cm
1
0.5
0
−0.5
−1
−4
−2
0
2
4
6
Rigidity, GeV/c
proton
deutron
π-
pi+



Lack of statistics for low momenta





Much better separation of fragments and presence of K^-

Next steps

- Fit momentum dependencies for dX and dY on higher statistics
- Get momentum independent shifts of modules
- Recalculate time shifts (because of track length changing)
- Implement time corrections in TOF-700 hit maker
- Implement momentum dependencies and coordinate alignment in global tracking (track to hit matching)
- Ask for new data production

Analysis teams can already start working with these corrections! (Vasilisa and I can help)