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FOR NUCLEAR RESEARCH

TOF700 to ZDC track matching on the Ar data at the BM@N experiment

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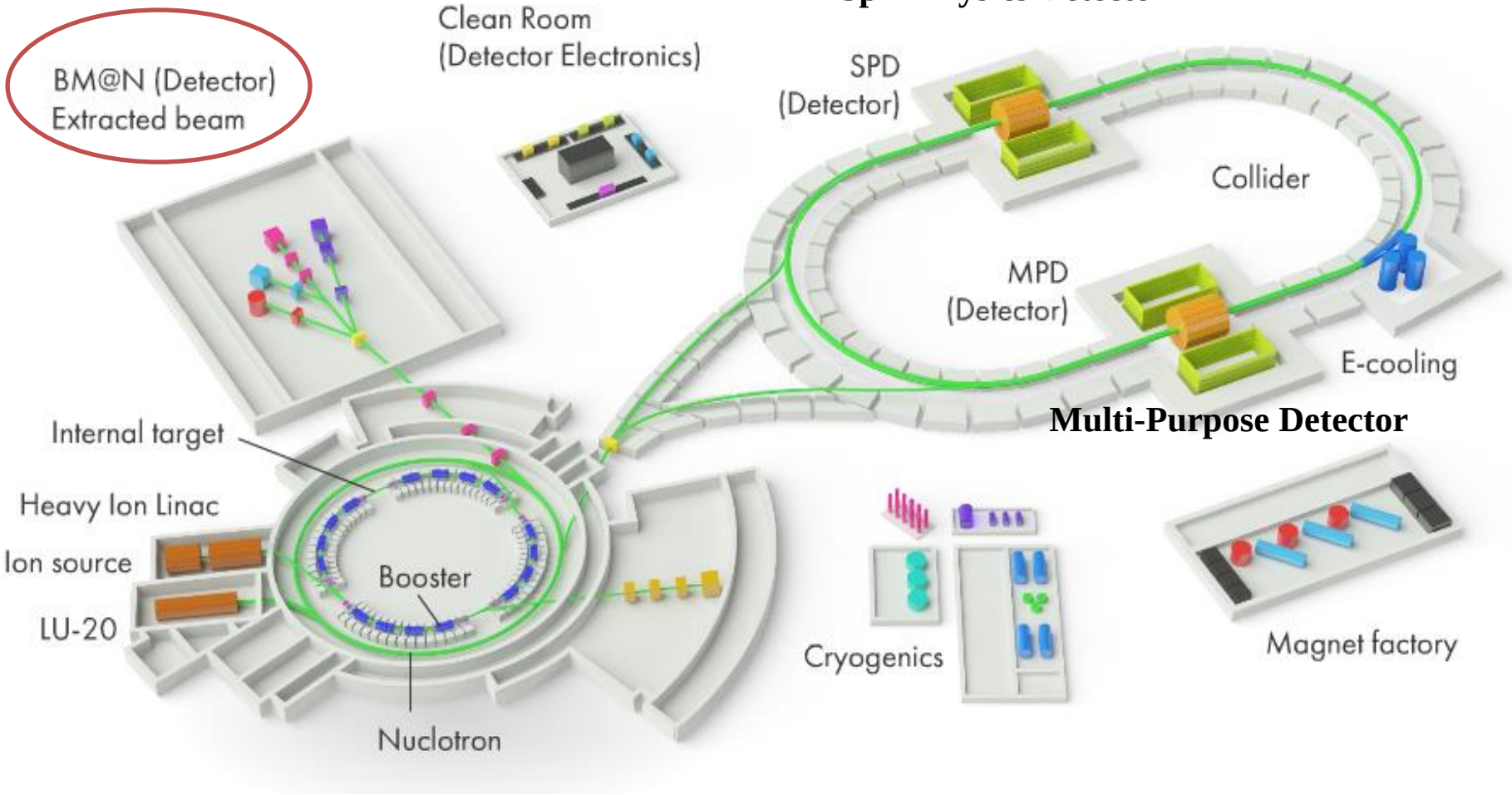
The XXVI International Scientific Conference of Young Scientists and Specialists (AYSS-2022)

NICA project

Baryonic Matter at Nuclotron

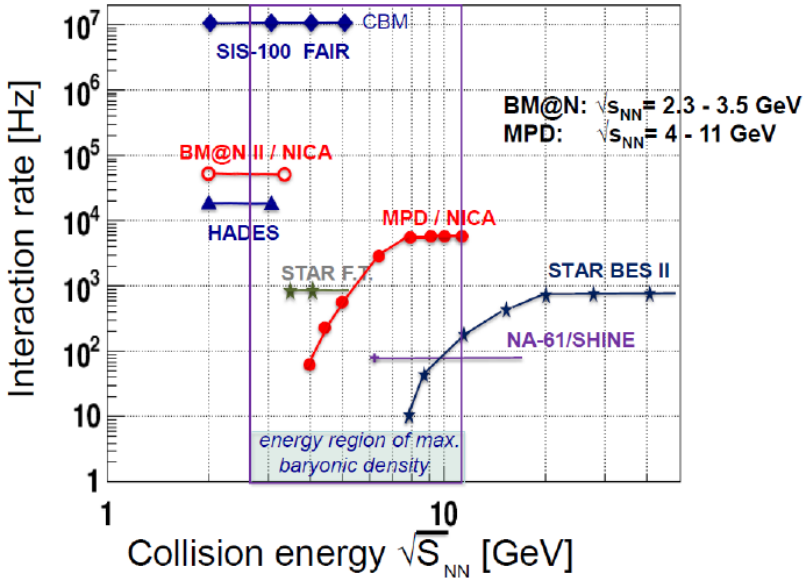


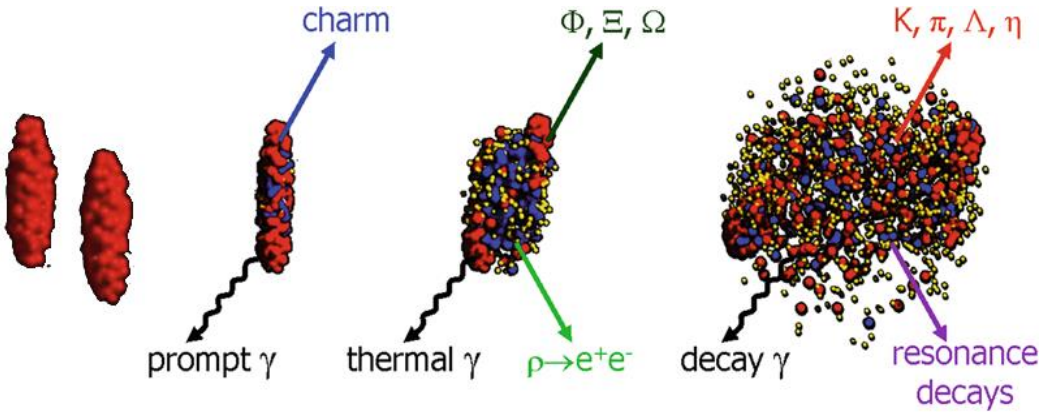
Spin Physics Detector

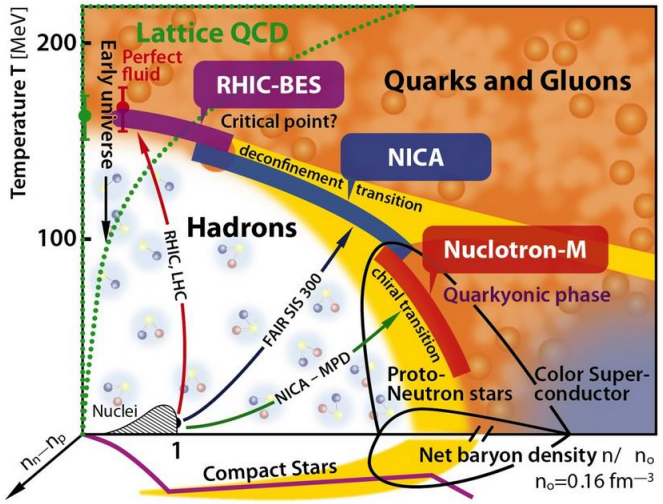
Multi-Purpose Detector

Heavy-Ion Collisions

- At √s energies of **2 - 4.5** GeV, nucleon densities in a collision zone exceed the saturation density by the factor of **3-4.**
- Hadrons with strangeness are early produced in the collision and not presented in the initial state of two colliding nuclei.
- Heavy-ion collisions are a rich source of strangeness, and the coalescence of kaons with lambdas or lambdas with nucleons will produce a vast variety of multi-strange hyperons or of light hypernuclei.

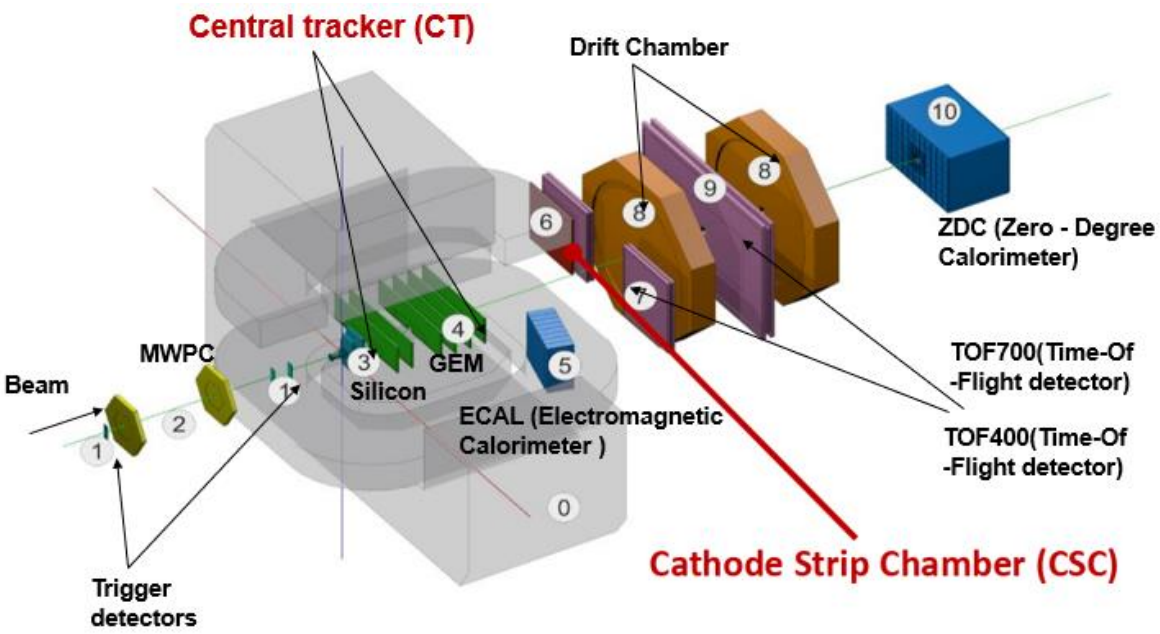






Baryonic Matter at Nuclotron

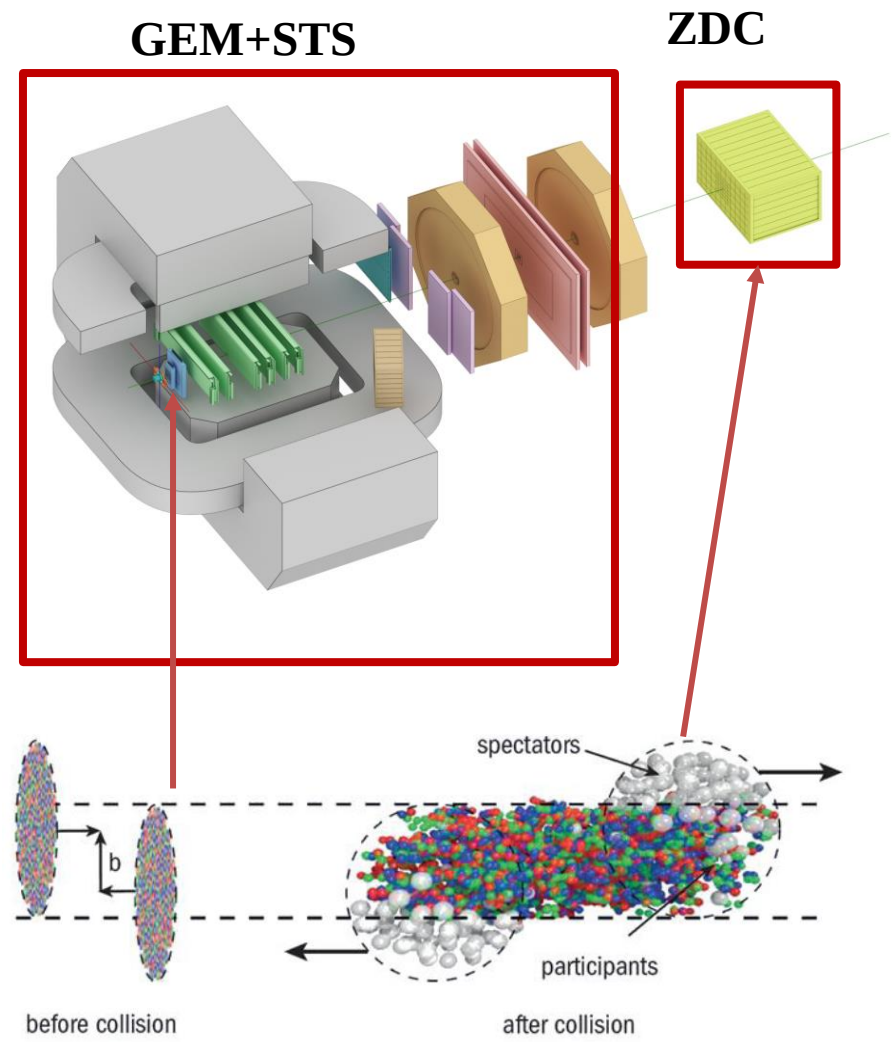
Setup of BM@N for RUN-7 in spring 2018



- BM@N is the first experiment with a fixed target at the NICA.
- It is designed to study nuclear-nuclear collisions at high densities.
- The Nuclotron provides heavy ion beams with energies ranging from 2.3 to 4.5 GeV

November 2017
Technical work before the 7th run

ZDC at BM@N



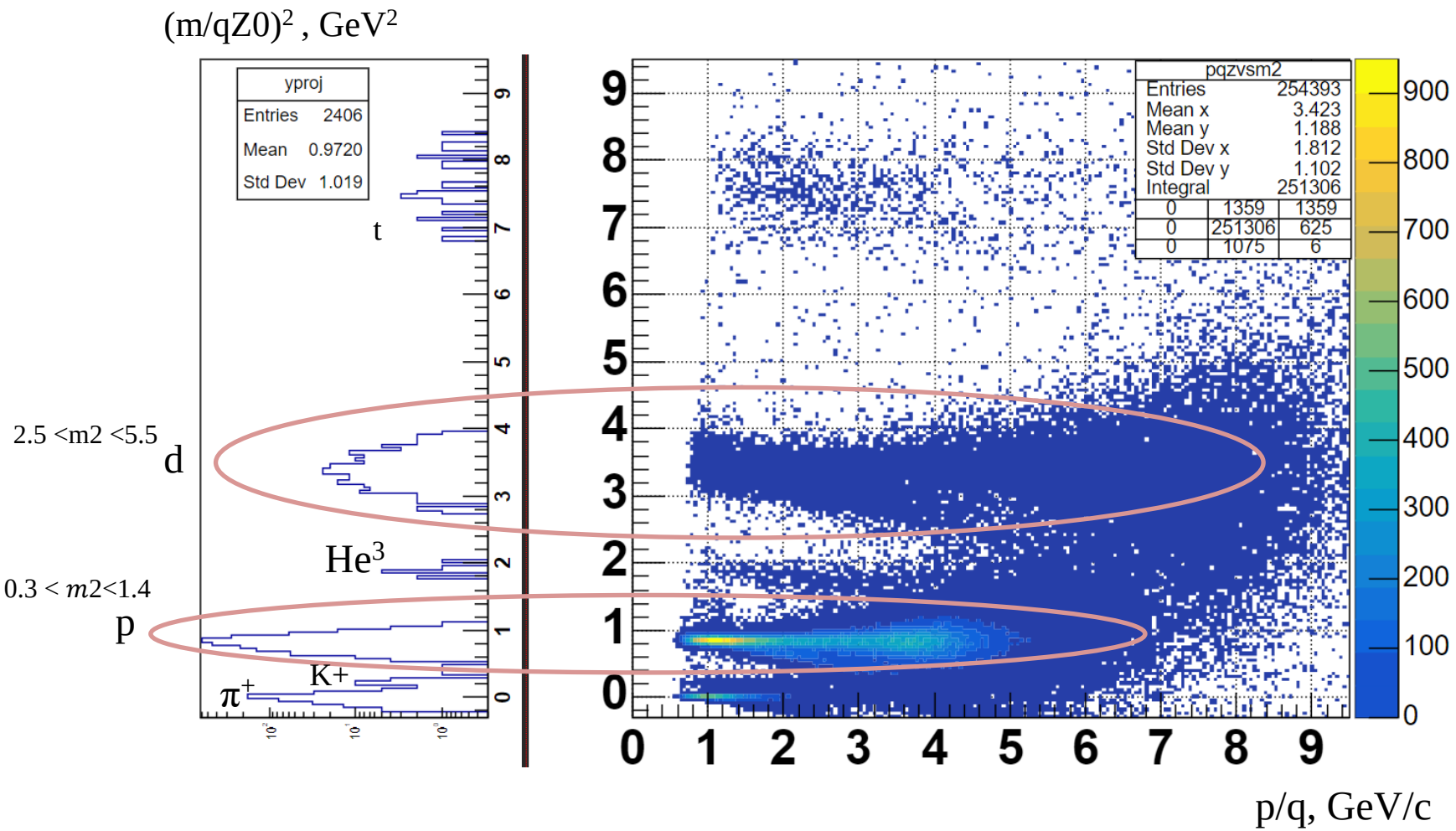
Real-life view of the detector, Run7

- No beam hole.
- Central part consist of 36 modules with sizes 7.5×7.5 cm^2
- Peripheral part contains 68 modules of 15×15 cm^2.
- Total number of modules -104

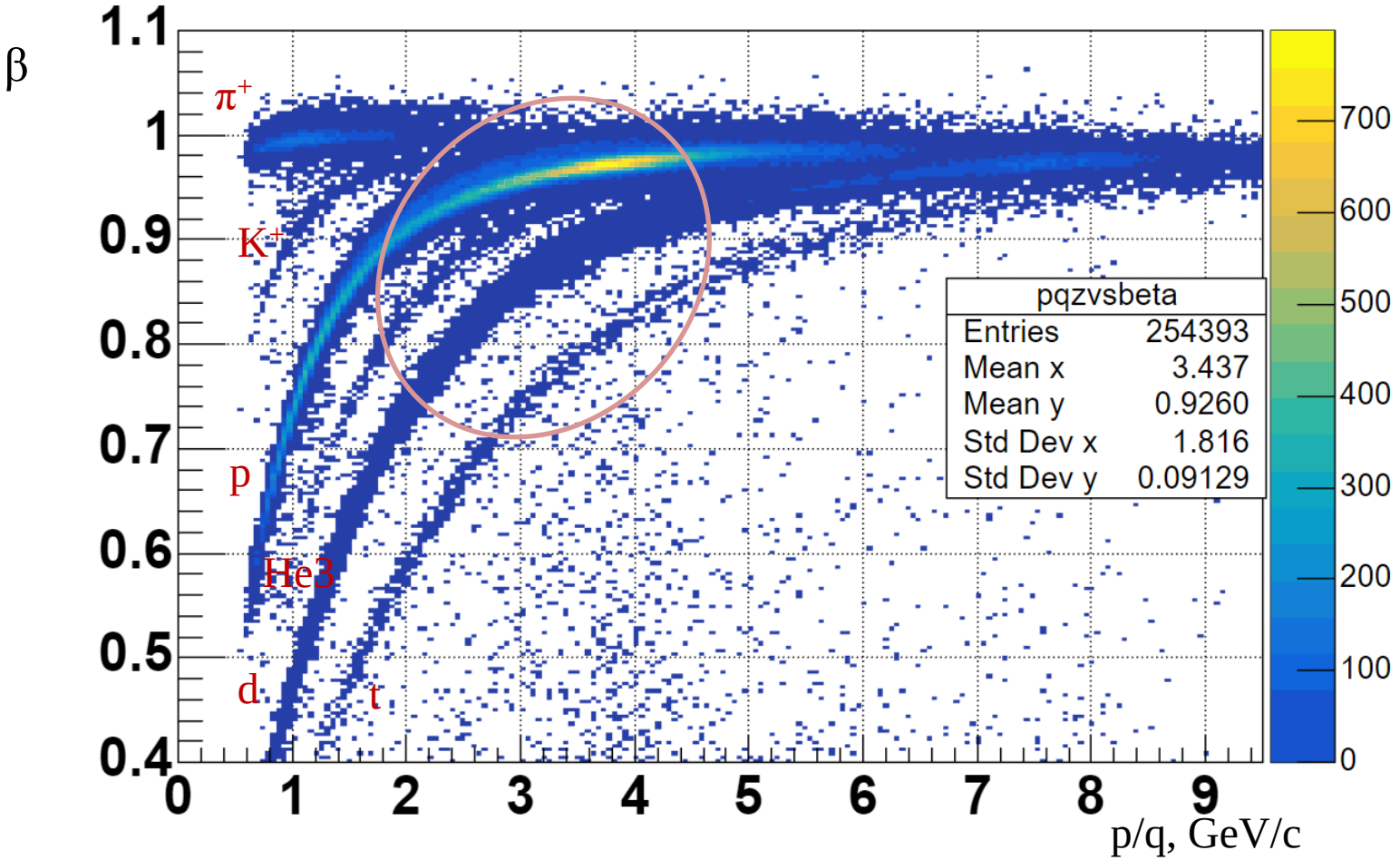
One of the purposes of the ZDC is to select **central events** at the trigger level during data collection.

PID with TOF700

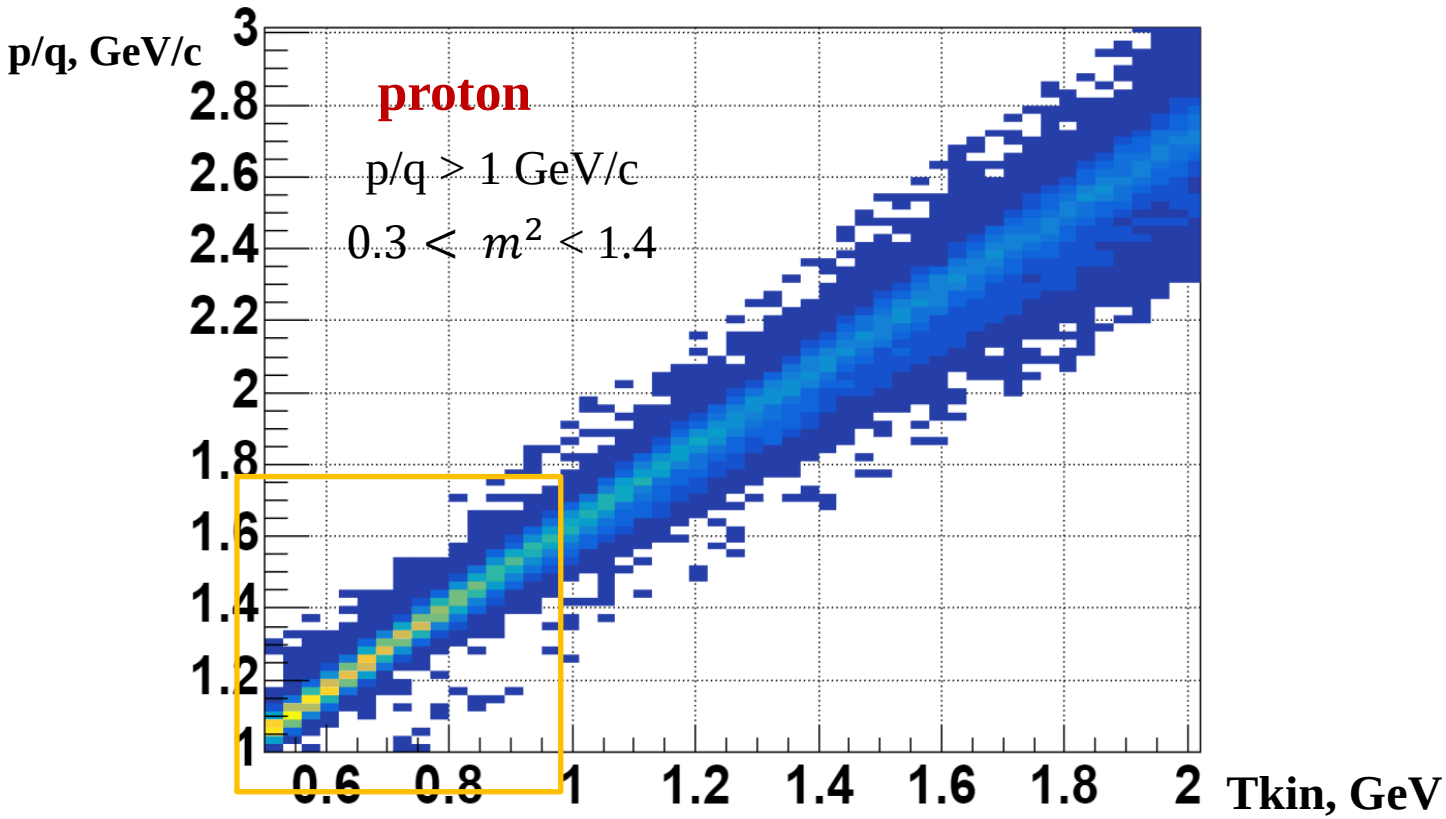
Using tracks from L.Kovachev



PID with ToF700



Expected kinetic energy(Tkin vs p/q)

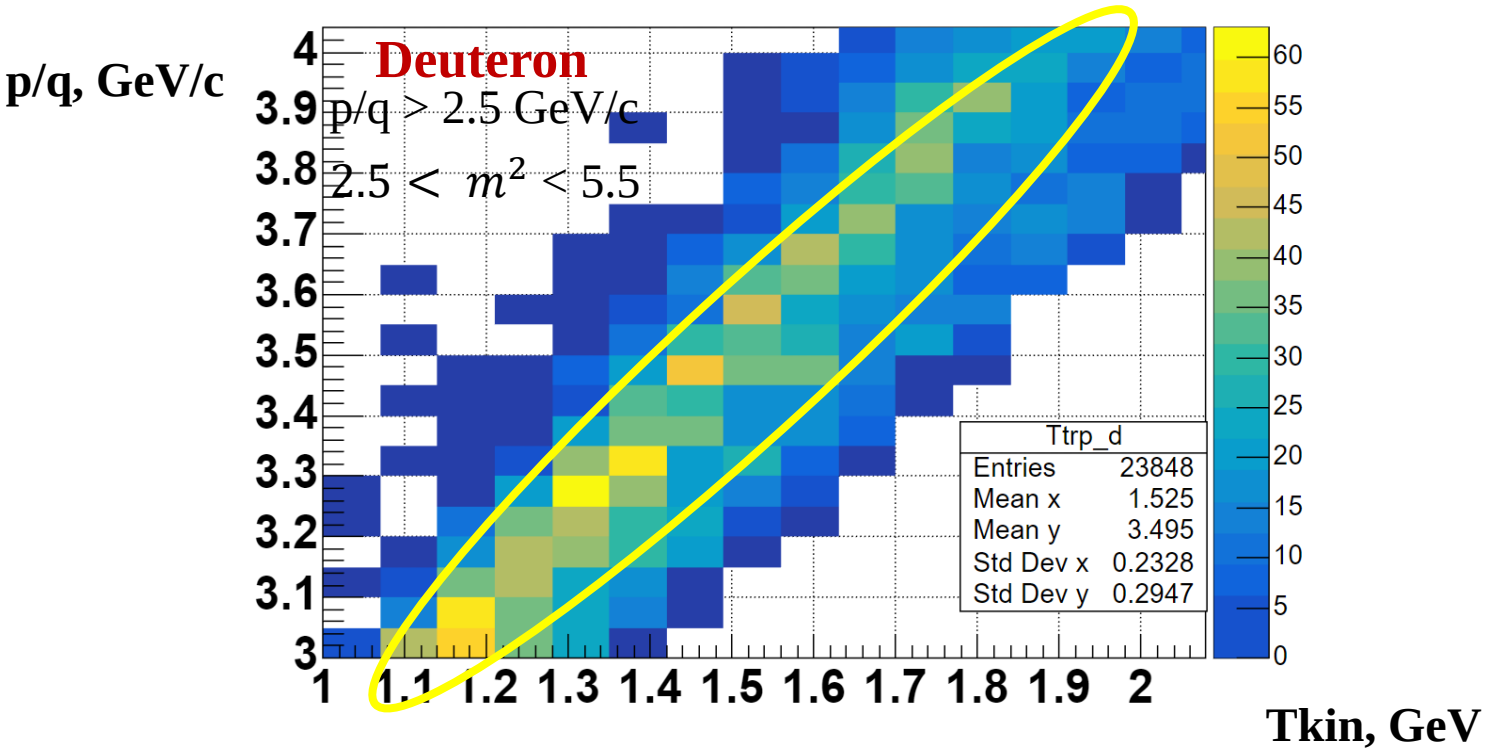


Total energy of the track particles Etot: $\mathrm{Etot} = \sqrt{(p/z \cdot Zid)^2 + m^2 \cdot Z_{id}^2}$

Kinetic energy of the track particles Tkin $Tkin = Etot - \sqrt{m^2 Z_{id}^2}$

where Zid is the charge for the track (1 for the “proton"), p/z is the momentum of the track.

Expected kinetic energy(Tkin vs p/q)

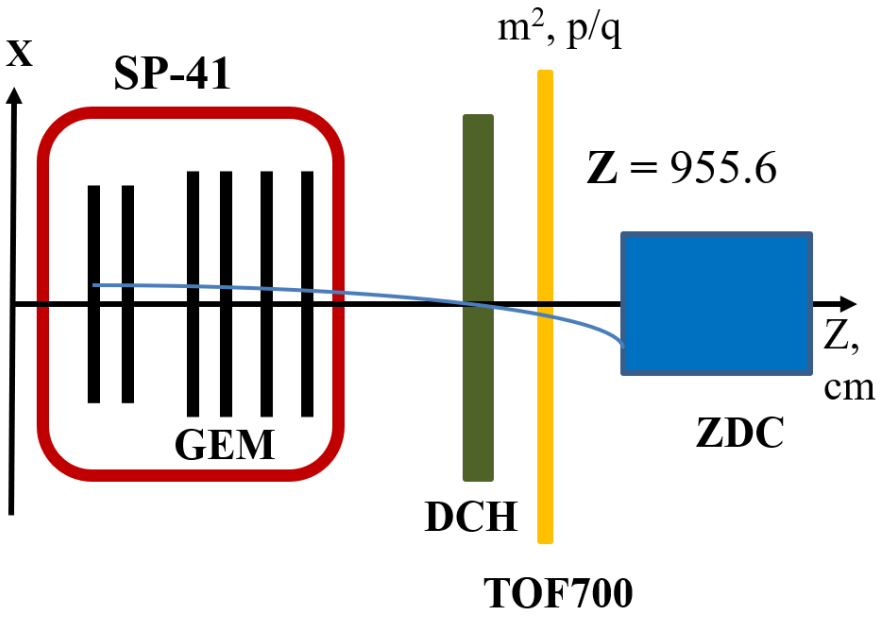


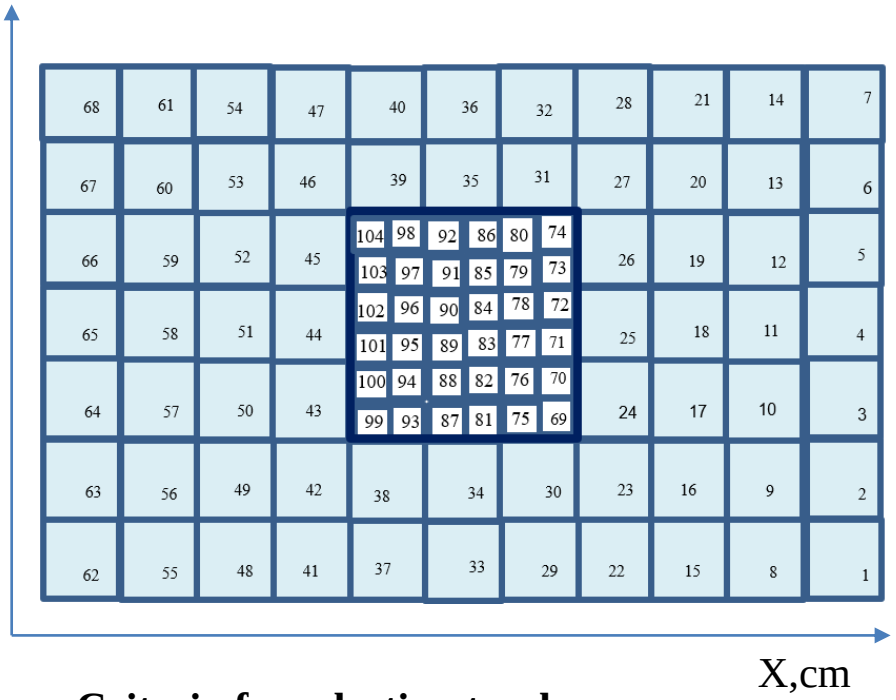
Total energy of the track particles Etot: $\mathrm{Etot} = \sqrt{(p/z \cdot Zid)^2 + m^2 \cdot Z_{id}^2}$

Kinetic energy of the track particles Tkin $Tkin = Etot - \sqrt{m^2 Z_{id}^2}$

where Zid is the charge for the track (1 for the "deuteron"), p/z is the momentum of the track

Extrapolation of tracks from TOF700 to ZDC





Extrapolated coordinates from TOF700 to ZDC:

Xextr = Xtof + (Z – Ztof)*TXtof;

Yextr = Ytof + (Z – Ztof)*TYtof;

Criteria for selecting tracks:

$|Xextr| < 83$ cm,

$|Yextr| < 52$ cm,

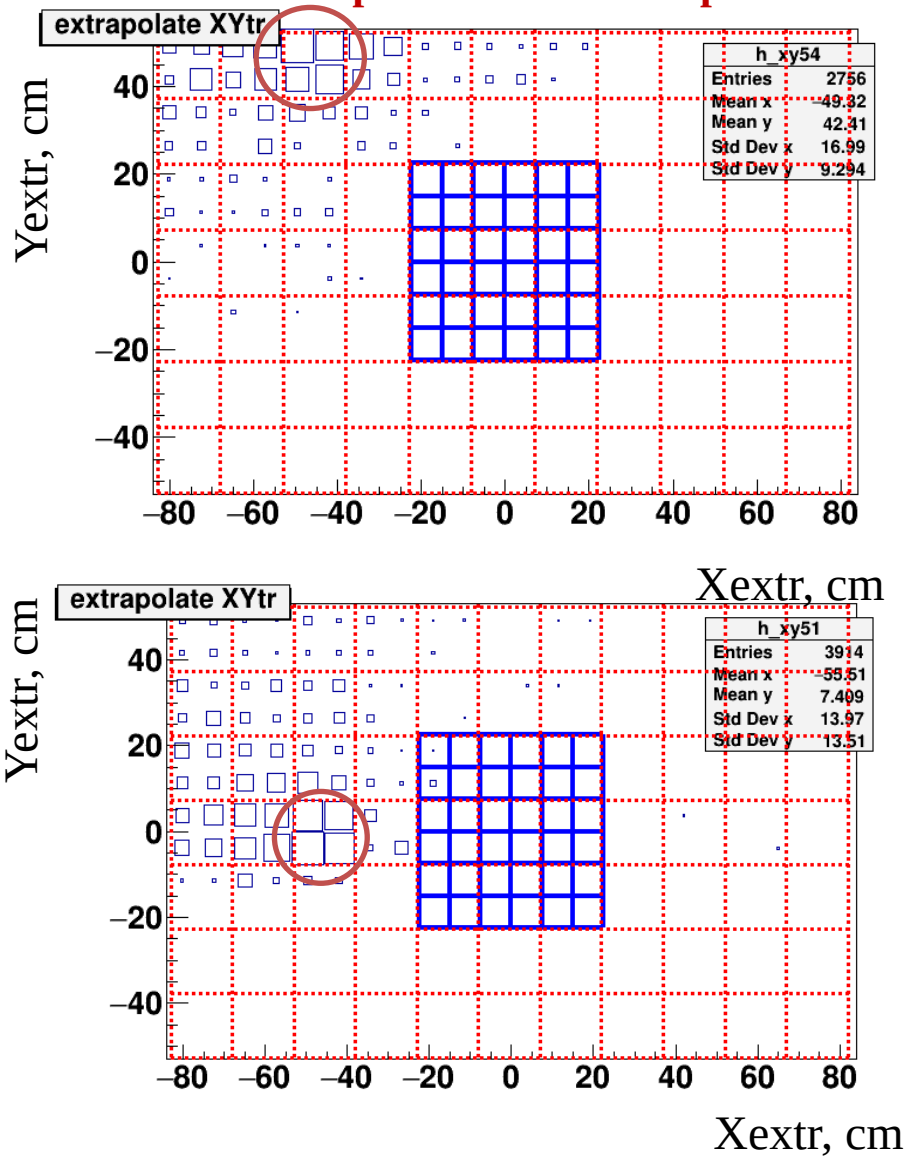
} **Active Zone ZDC**

p/q > 2.5 GeV for the deuteron

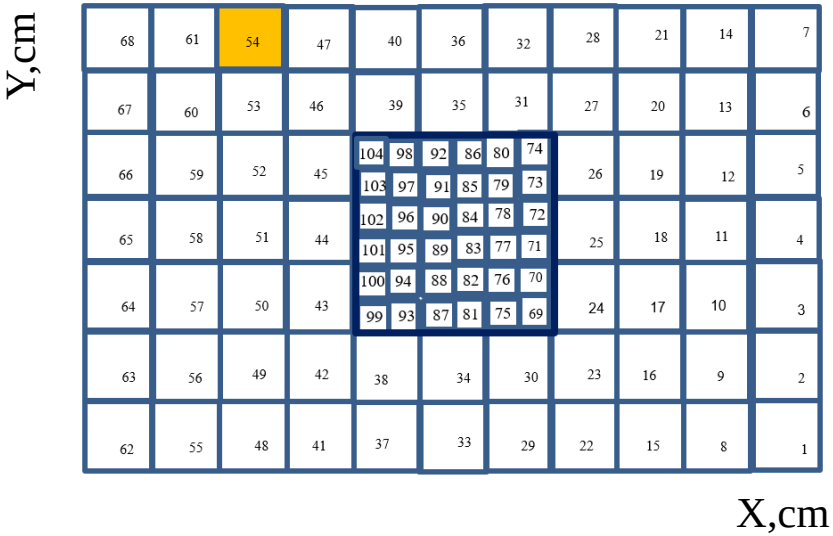
1< p/q <= 5.5 GeV for the proton

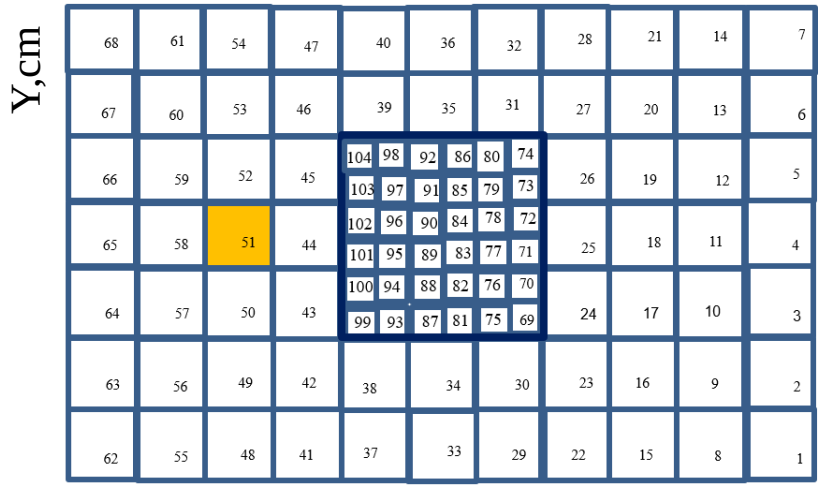
XY– extrapolate for the triggered module

Real position after extrapolation



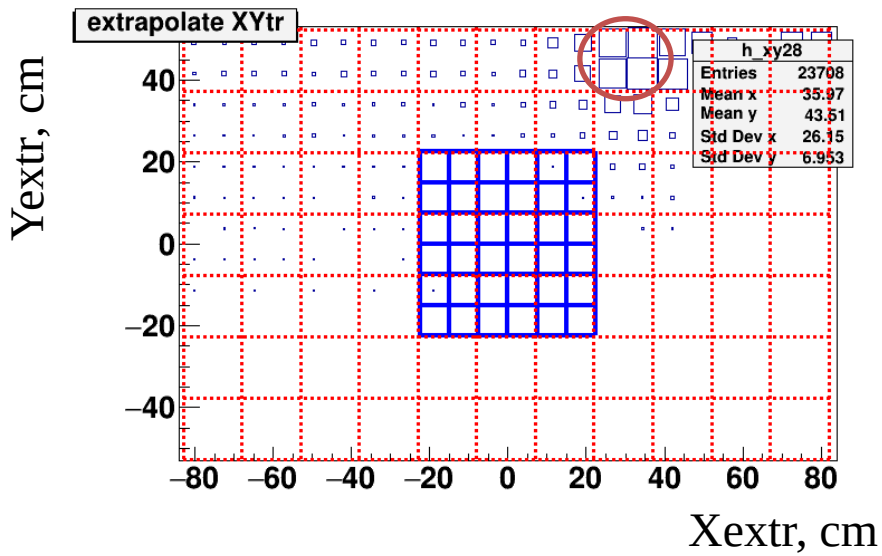
Expected position on the map

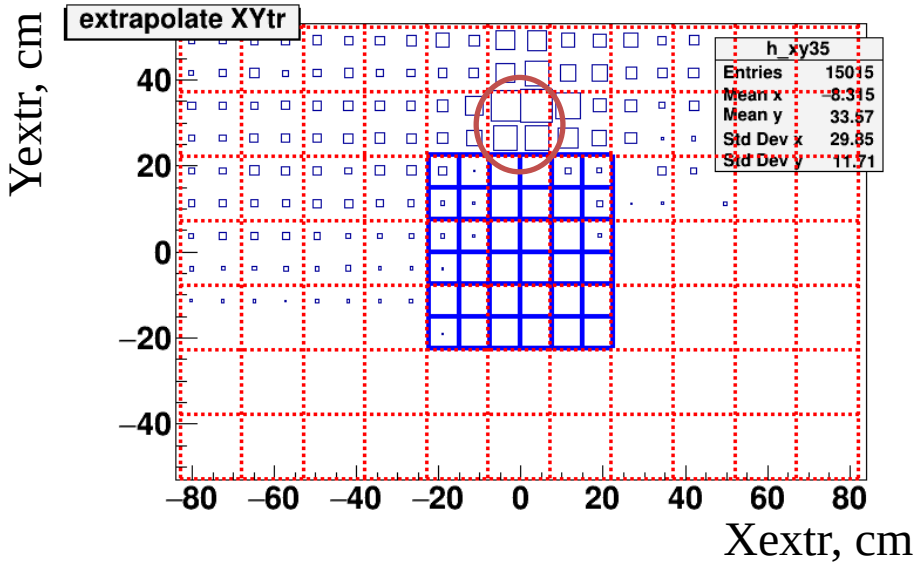




XY– extrapolate for the triggered module

Real position after extrapolation





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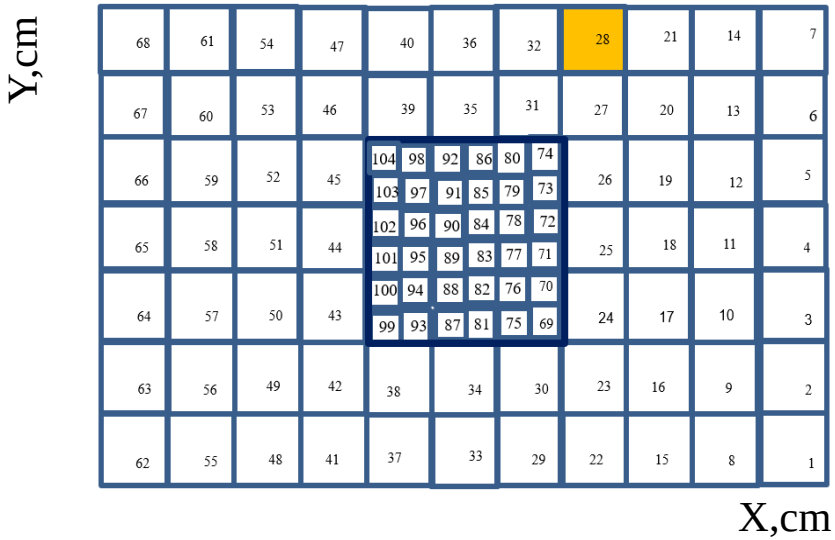
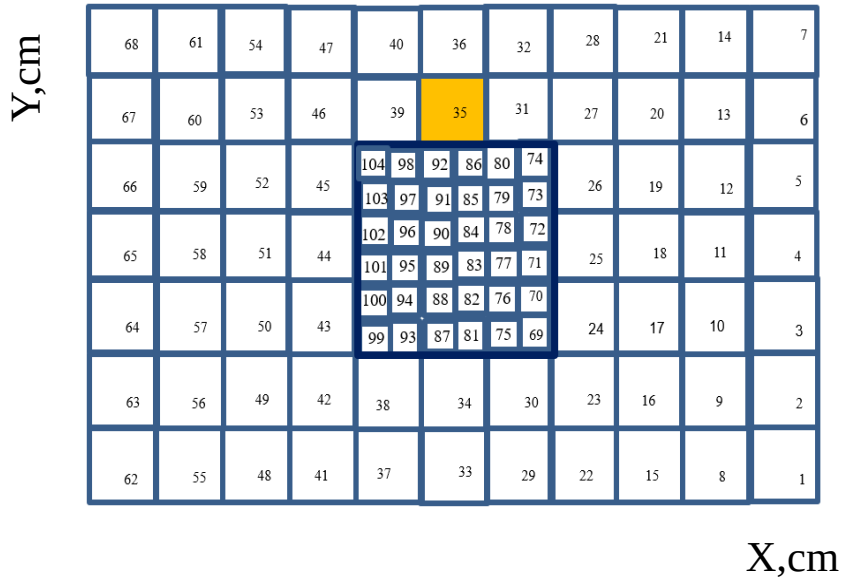
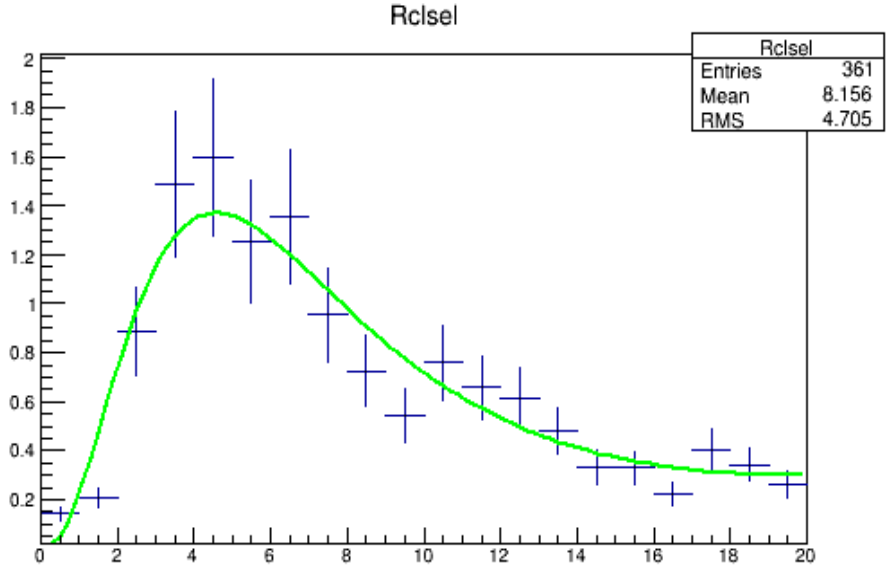




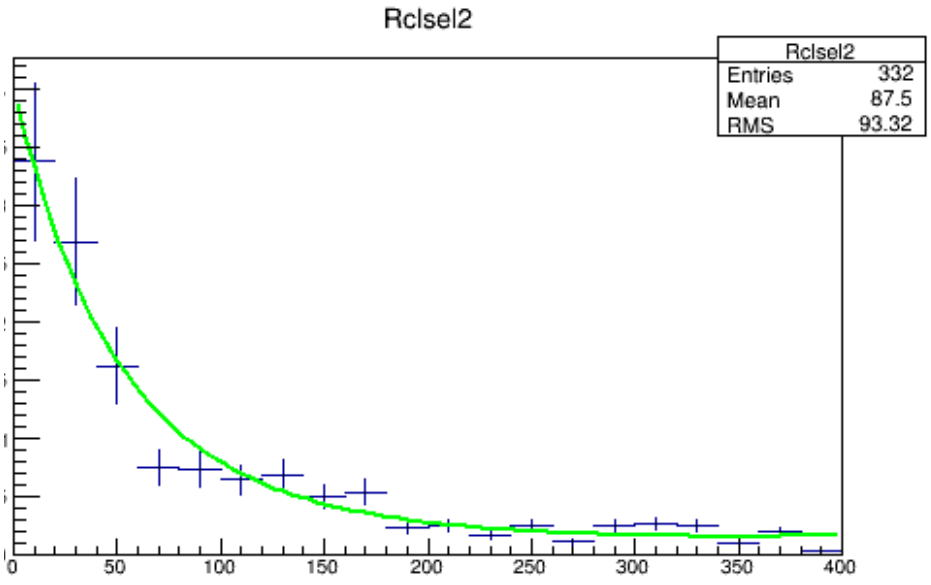
ZDC calibration

Distribution of the RMS cluster width



R_{clust} ,cm

Distribution of the square width

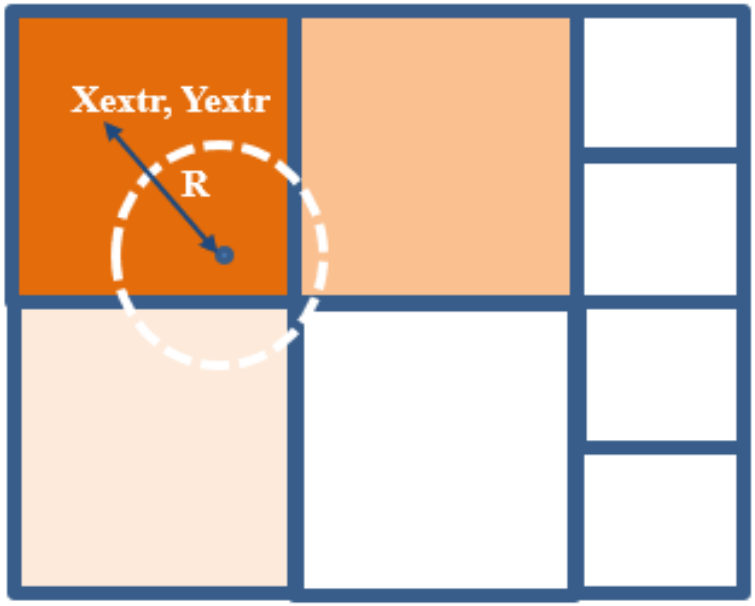


R^2_{clust} ,cm^2

The ZDC was calibrated in 2015. The beam was irradiated with different modules.

From the Figure (R_{clust} , R^2_{clust}) - **selection criterion: R_i < 8 - 9 cm**

Estimate of energy release from the track



ZDC map

68	61	54	47	40	36	32	28	21	14	7
67	60	53	46	39	35	31	27	20	13	6
66	59	52	45	104 98 92 86 80 74			26	19	12	5
65	58	51	44	103 97 91 85 79 73 102 96 90 84 78 72 101 95 89 83 77 71			25	18	11	4
64	57	50	43	100 94 88 82 76 70 99 93 87 81 75 69			24	17	10	3
63	56	49	42	38	34	30	23	16	9	2
62	55	48	41	37	33	29	22	15	8	1

Criteria to the distance:

$R_i < 9\ cm$, k = $\sum_{i=0}^{m} {}^{1}/_{n}$

Total energy release in the circle

$$SumE_{ZDC} = \sum_{i=1}^{104} E_i \cdot k_i \cdot$$

E_i - energy release of the i-th triggered module.

Distance: $R_i = \sqrt{(\mathrm{Xextr} - \mathrm{Xi})^2 + (\mathrm{Yextr} - \mathrm{Yi})^2}$, (**)

Xi - X coordinate of the random point of the i-th triggered module,

Yi - Y coordinate of the random point of the i-th triggered module.

Summary

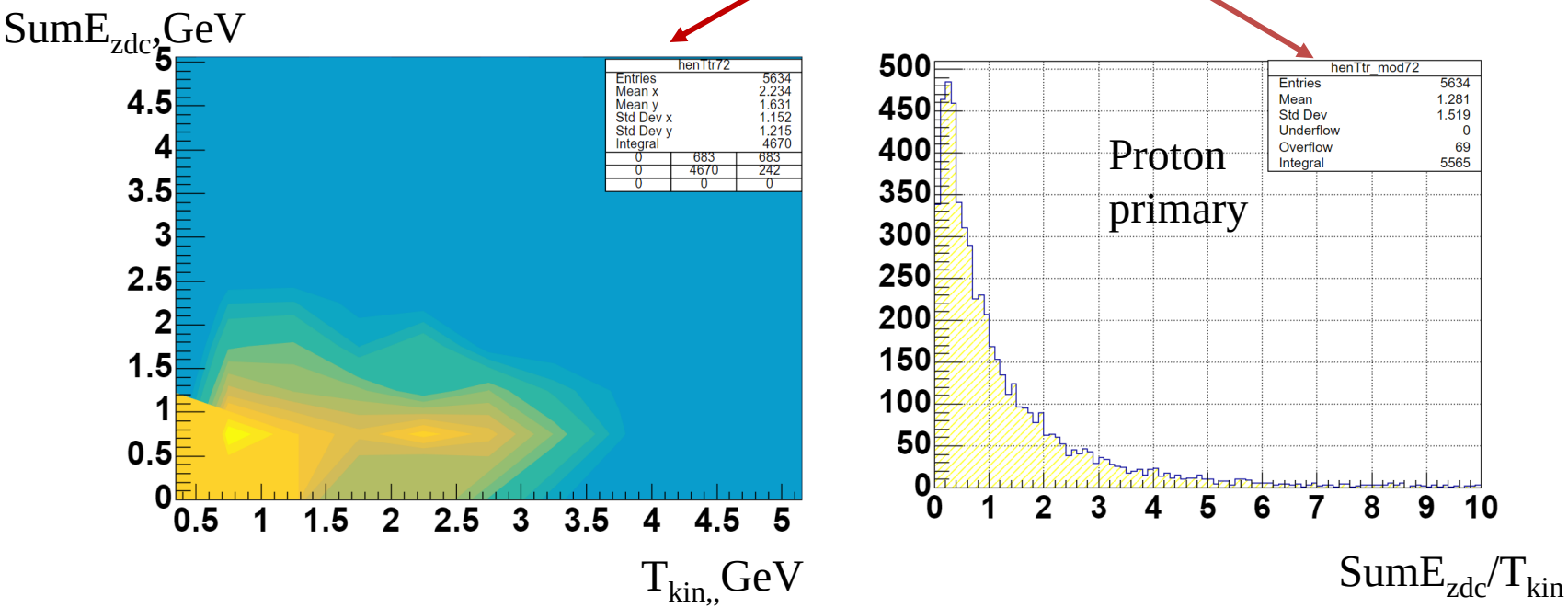
Done:

- ✓ The match between the particle track and the module in ZDC is established;
- ✓ The optimal criteria for the tracks have been selected;
- ✓ Determination of expected kinetic energy ranges(p, d);

Plan:

Search and study of the correlation between the distributions of energy release (E_{zdc}) and track energies(T_{kin} for p,d);

Wait for Run – 8 ☺



Thank you for attention!