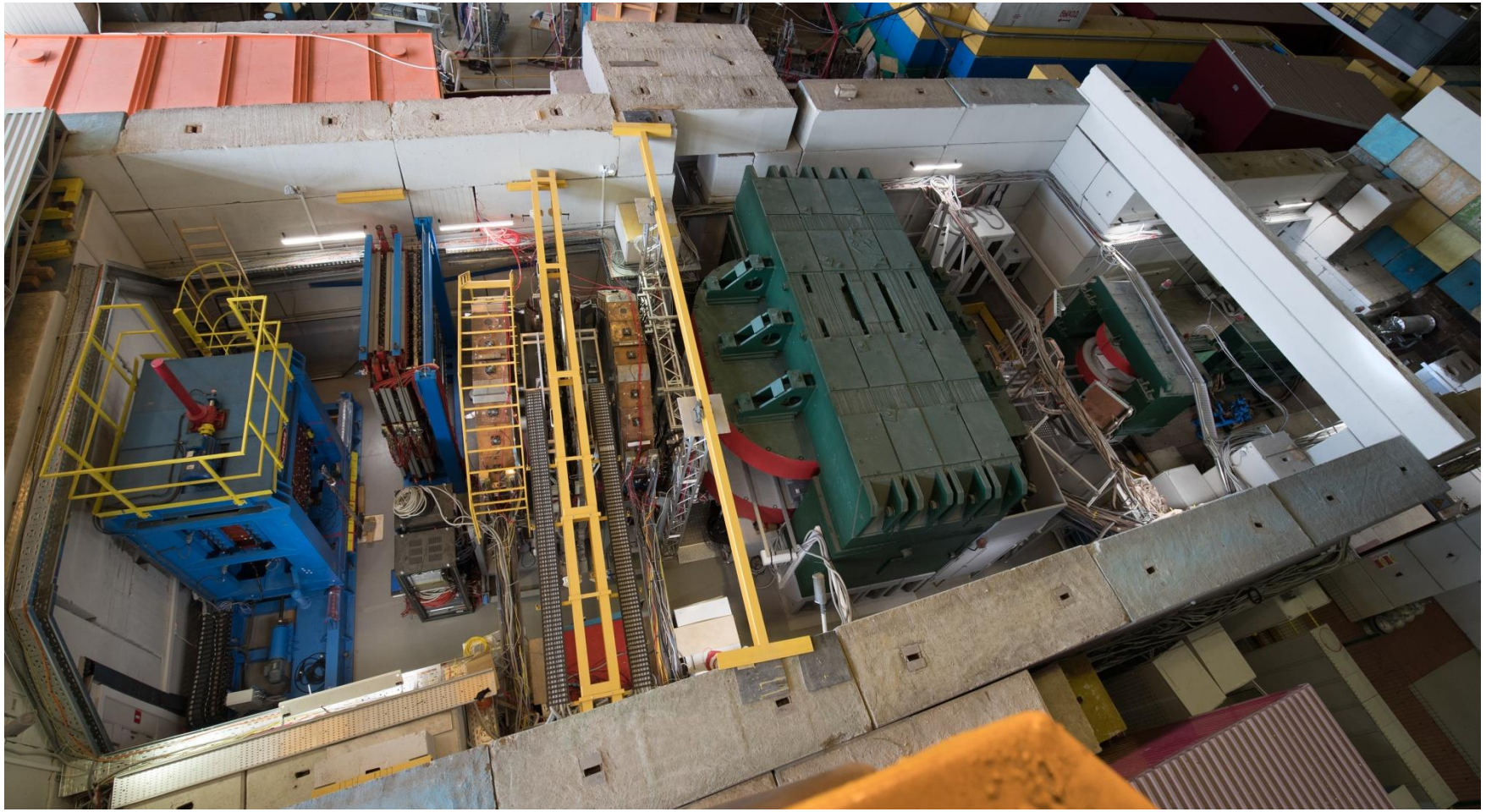
Status of the BM@N experiment

M.Kapishin



Baryonic Matter at Nuclotron (BM@N) Collaboration:

3 Countries, 10 Institutions, 184 participants, 7 Institutions signed MoU + JINR

- *University of Plovdiv, Bulgaria*
- *St.Petersburg University*
- *Shanghai Institute of Nuclear and Applied Physics, CFS, China;*
- *Joint Institute for Nuclear Research;*
- *Institute of Nuclear Research RAS, Moscow*
- *NRC Kurchatov Institute, Moscow combined with Institute of Theoretical & Experimental Physics, NRC KI, Moscow*
- *Moscow Engineer and Physics Institute*
- *Skobeltsin Institute of Nuclear Physics, MSU, Russia*
- *Moscow Institute of Physics and Technics*
- *Lebedev Physics Institute of RAS, Moscow*

Suspended participation in BM@N:

- *Nuclear Physics Institute CAS, Czech Republic*
- *Tubingen University, Germany*
- *GSI, Germany*
- *Warsaw University of Technology, Poland*
- *University of Wroclaw, Poland*

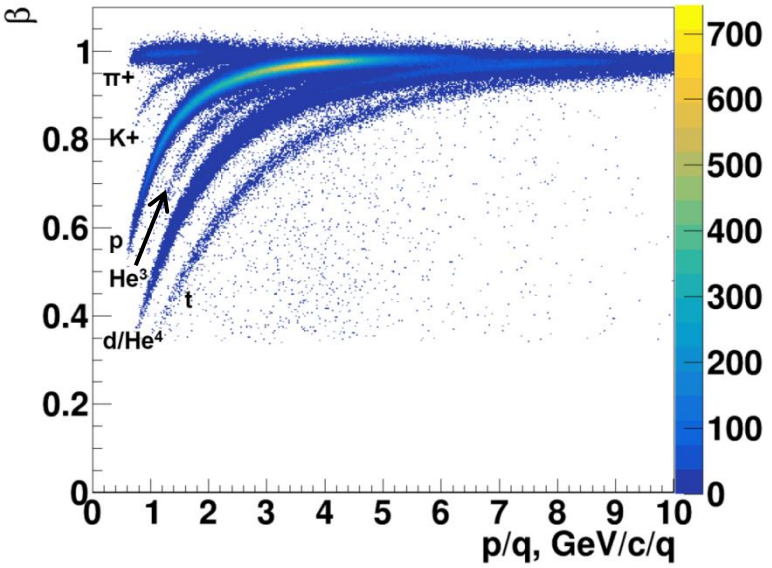
Finished SRC program at BM@N:

- *CEA, Saclay, France;*
- *TU Darmstadt, Germany;*
- *GSI & FAIR, Germany;*
- *Tel Aviv University, Israel;*
- *Massachusetts Institute of Technology, Cambridge, USA.*

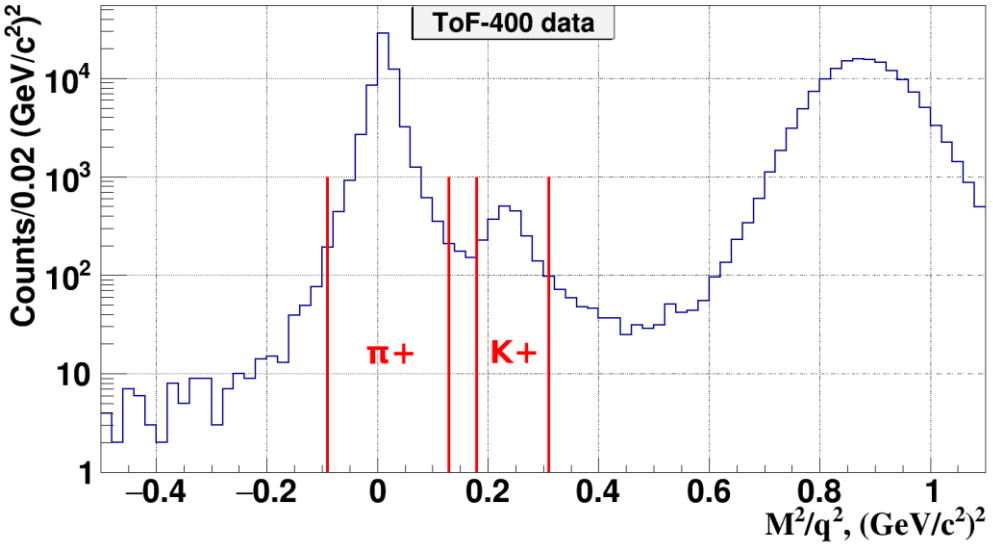
BM@N Collaboration: 184 participants from 10 institutions

9th BM@N Collaboration Meeting 13-16 September 2022: 128 participants (in person and remotely)

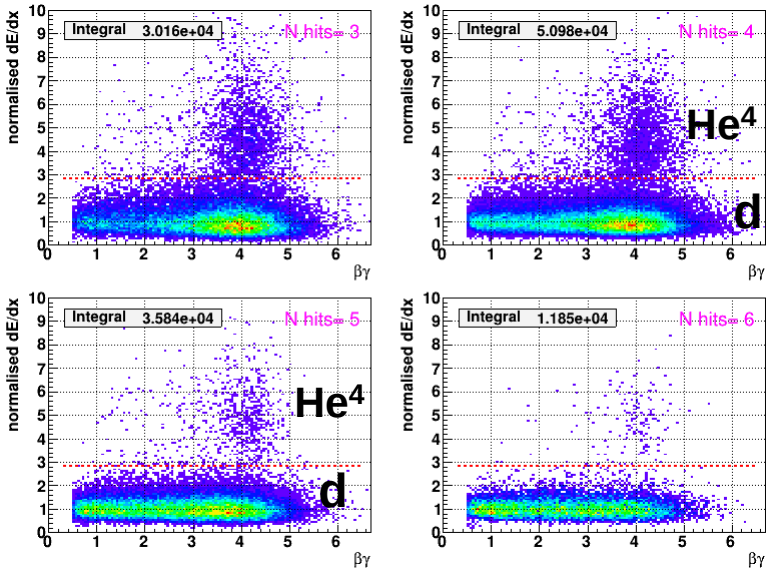
Identification of π+, K+, p, t, He3, d/He4

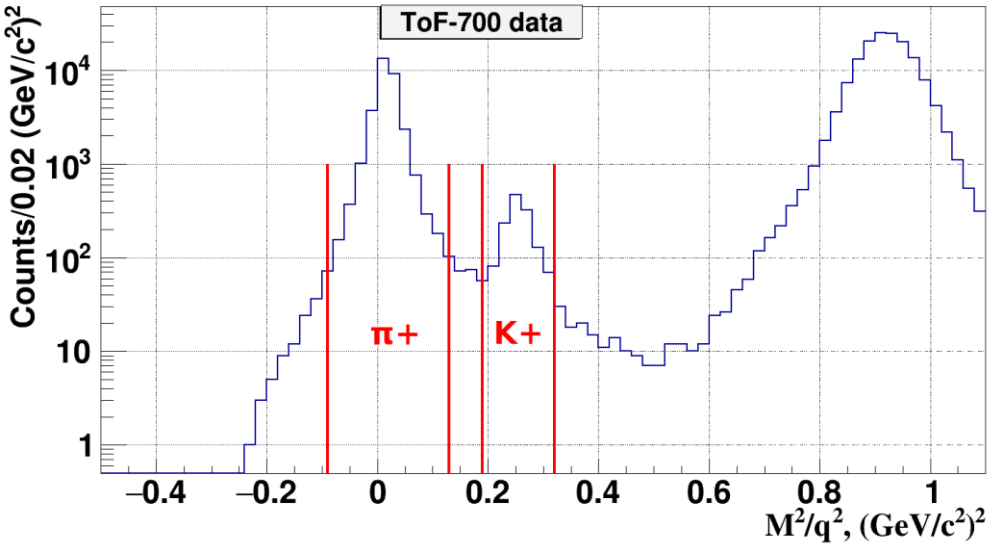


Ar beam , 3.2 AGeV , Ar + Al,Cu,Sn → X



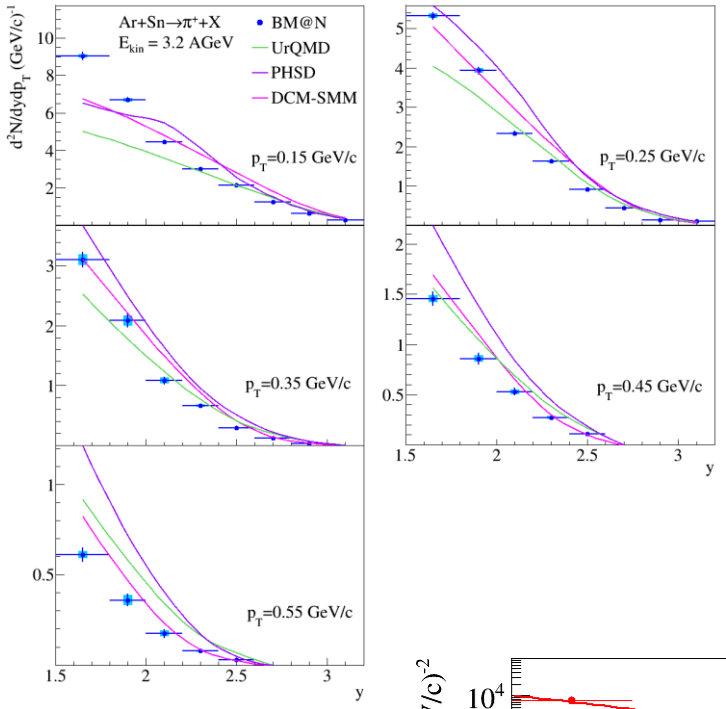
He⁴ / d separation by dE/dx in GEM detectors

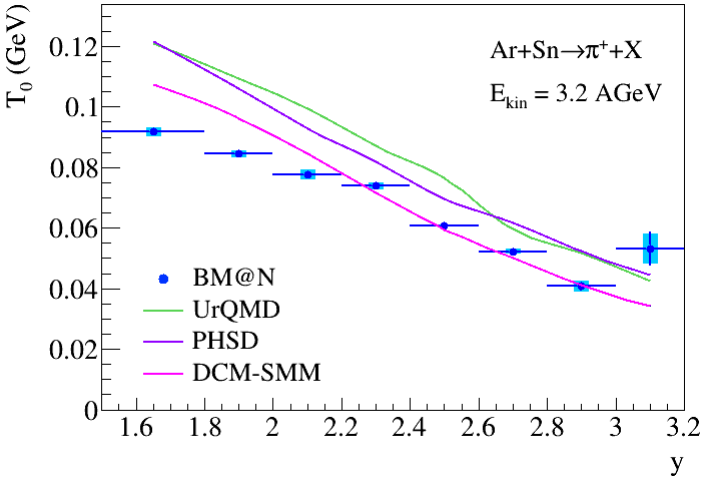


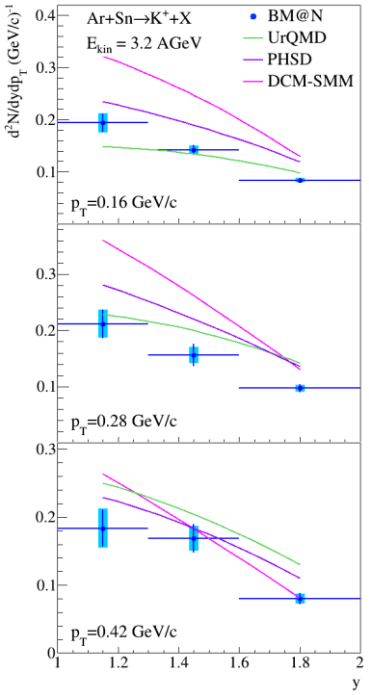


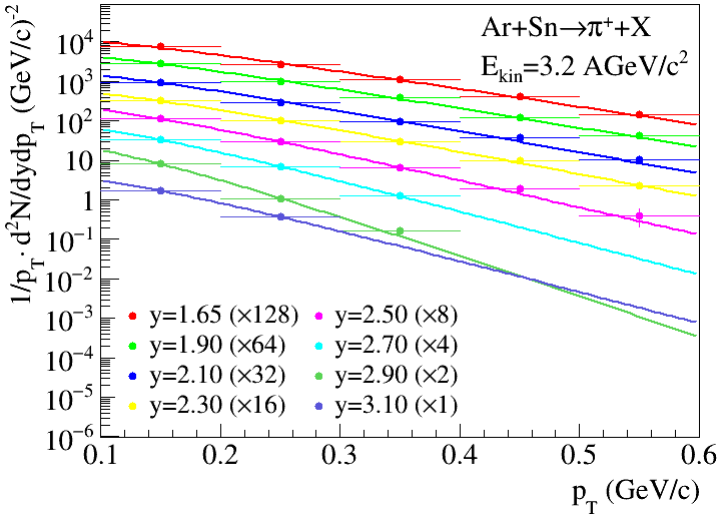
Production of π^+ and K^+ mesons in 3.2 AGeV argon-nucleus interactions at the Nuclotron

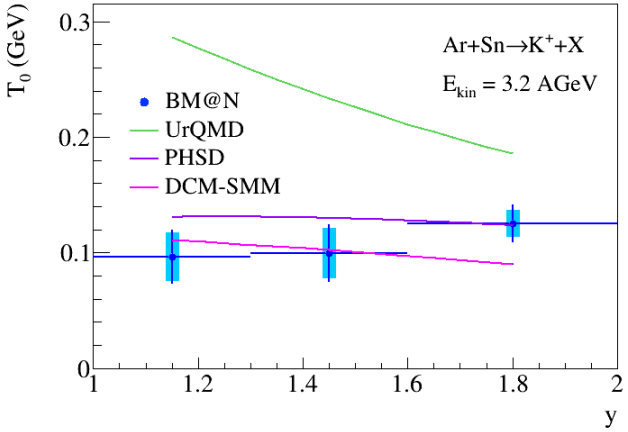
Draft of the paper in circulation at BM@N



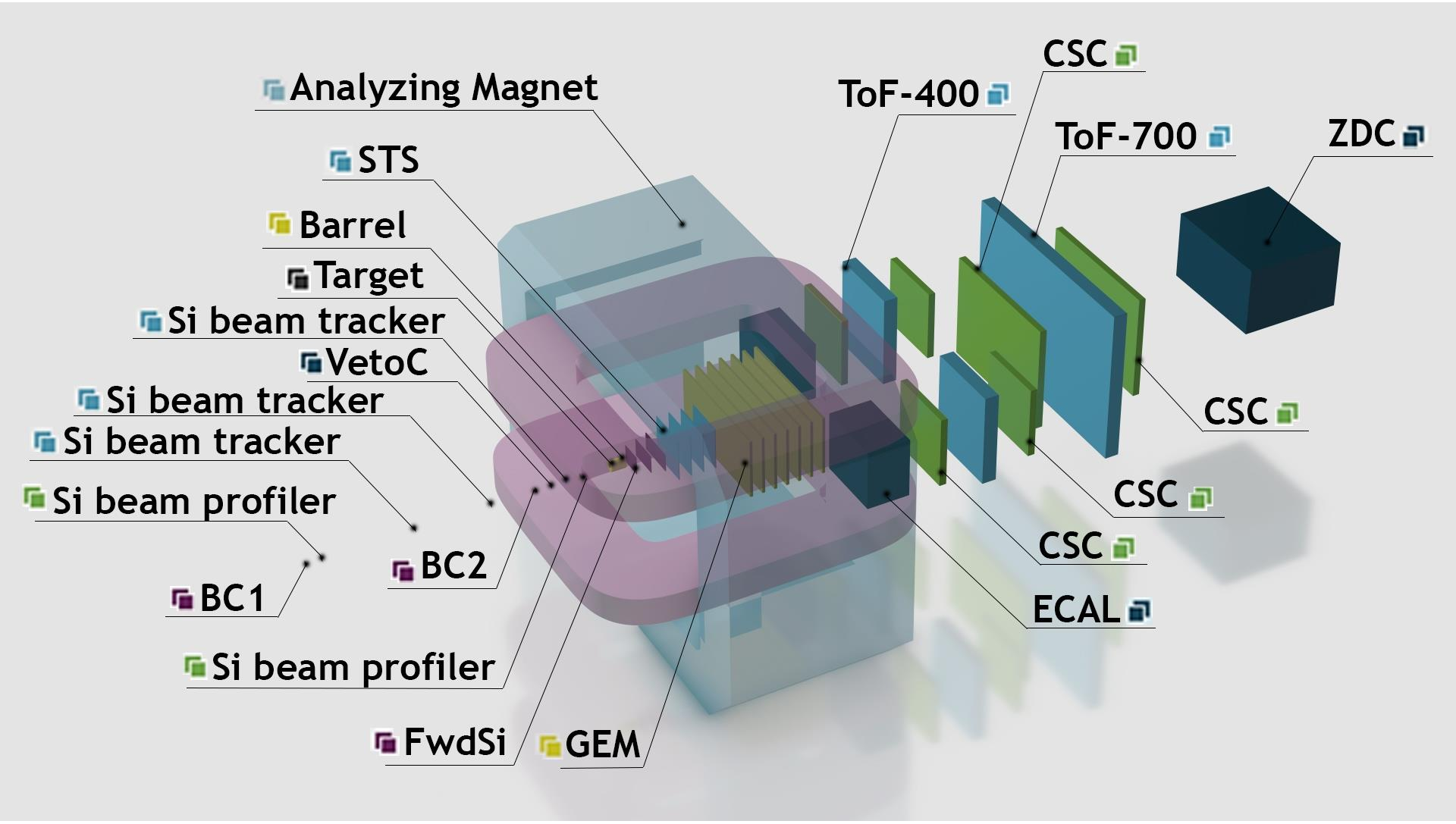








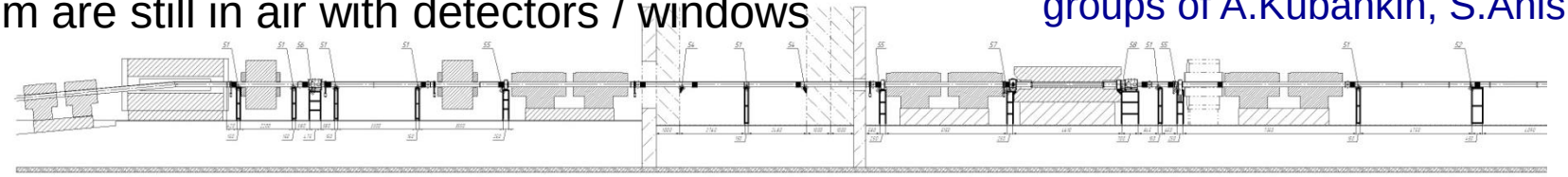
Configuration of BM@N detector for heavy ion program (without beampipe)

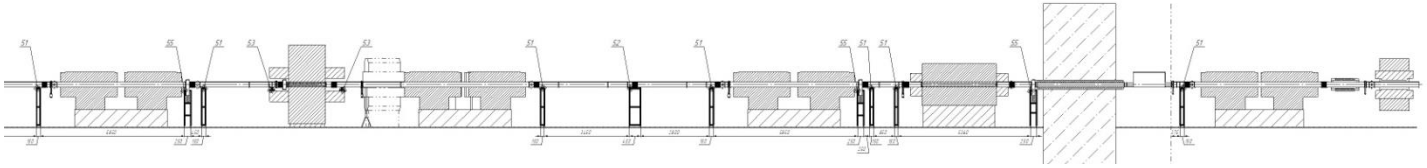


Vacuum ion beam pipe from Nuclotron to BM@N

~5m are still in air with detectors / windows

groups of A.Kubankin, S.Anisimov

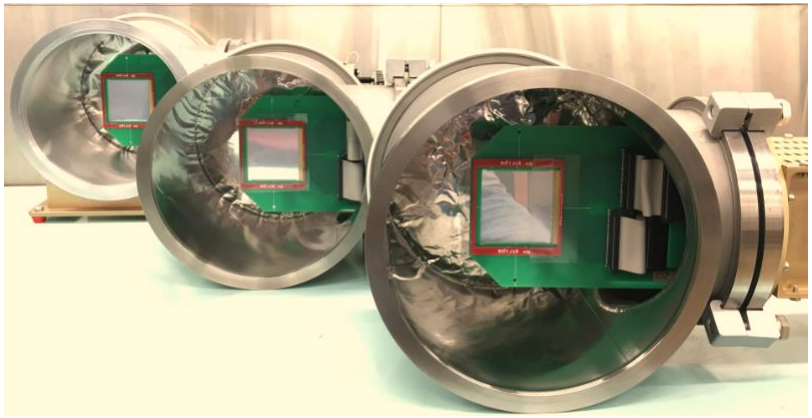




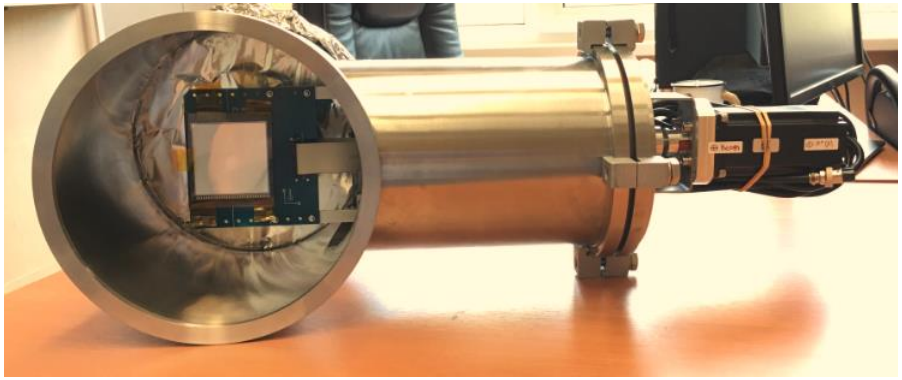
BM@N detector preparation for heavy ion run

FST group of N.Zamiatin

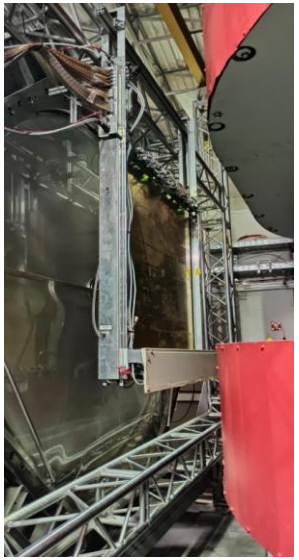
3 Silicon beam tracking detectors



Beam profile meter with Si detector and positioning mechanics



Outer tracker: Cathode Strip Chambers → 4 CSC of 106x106 cm2



Outer tracker group

Big CSC 220x145 cm2

Silicon beam tracking detector in SRC setup

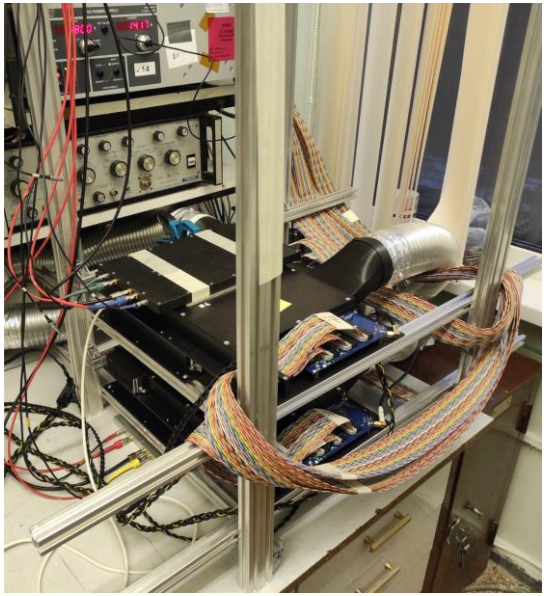
INR RAS group

Forward hodoscope in front of FHCAL

BM@N experiment

Forward Silicon Tracker for heavy ion run

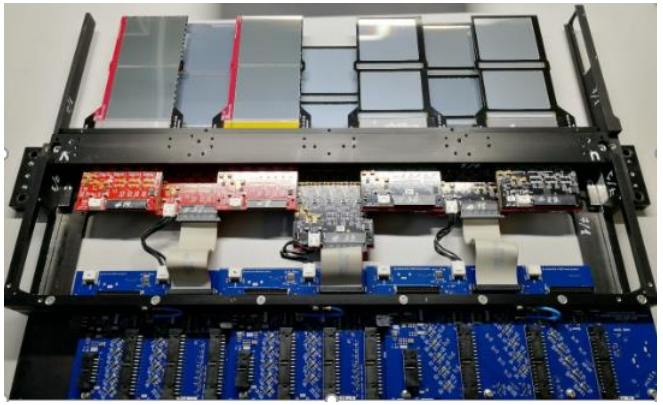
Setup for FST tests with cosmic rays



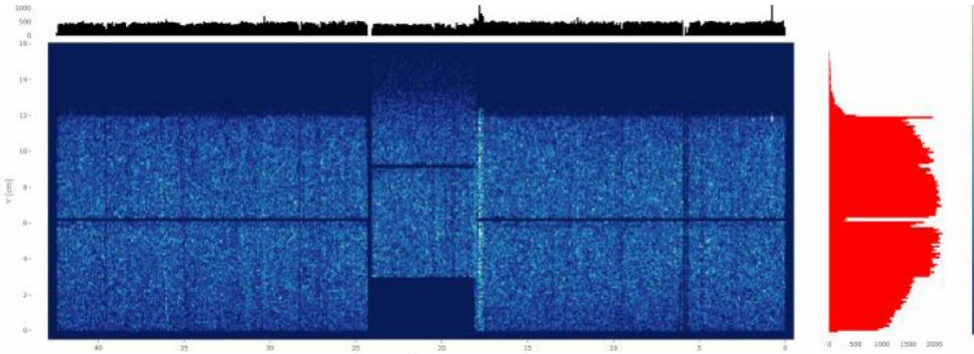
FST support mechanics

FST group of N.Zamiatin

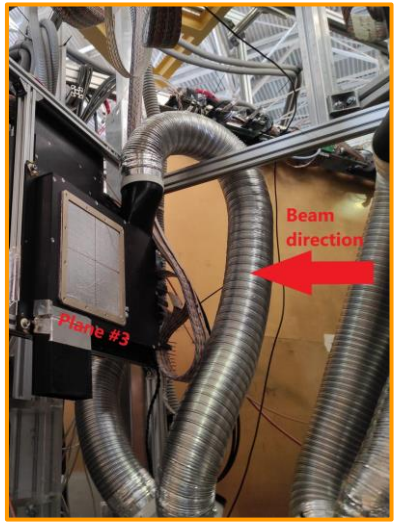
Assembled FST half station of 7 detectors



Cosmic ray X/Y profile of FST half station



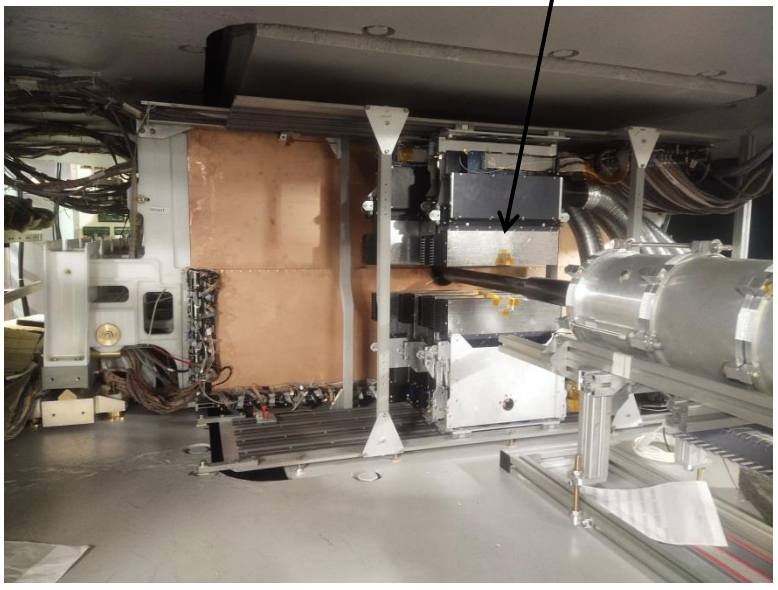
FST modules in SRC setup



►All 48 modules and 4 FST stations with 6, 10,14,18 modules are assembled, tested and installed

BM@N tracking detector installation for heavy ion run

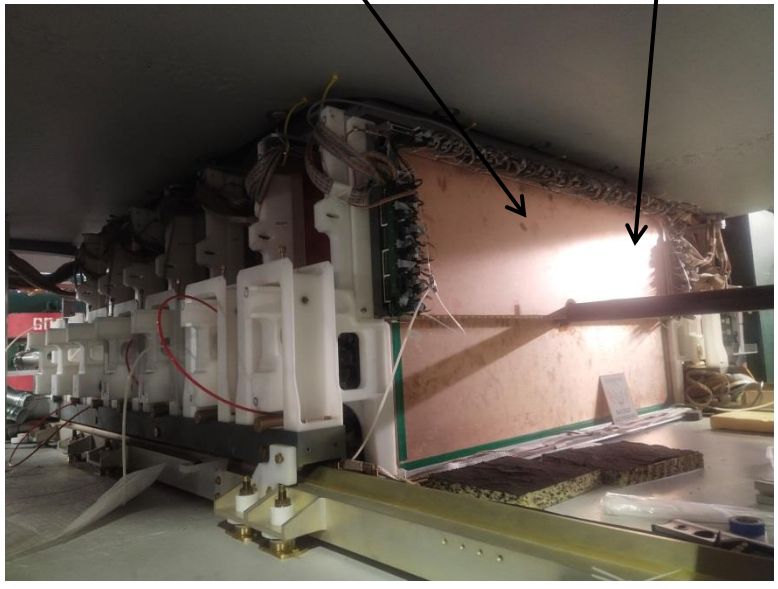
Forward Si tracker detectors in front of GEM detectors



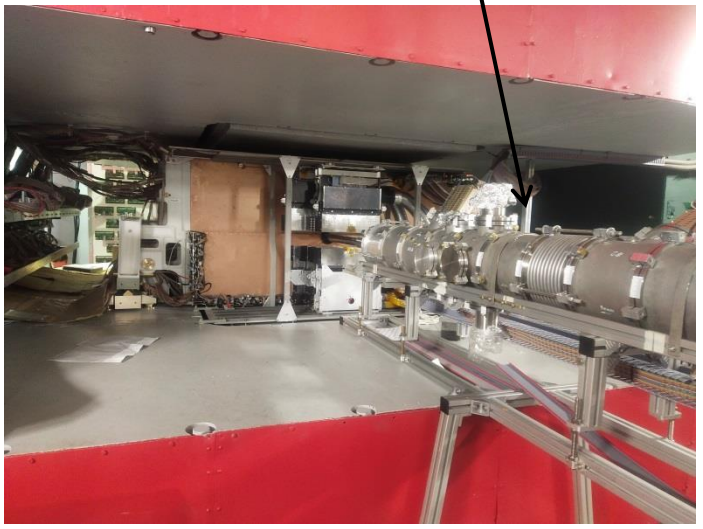
GEM, FST groups + engineer group of S.Piyadin

GEM detectors on positioning mechanics in magnet

Carbon vacuum beam pipe

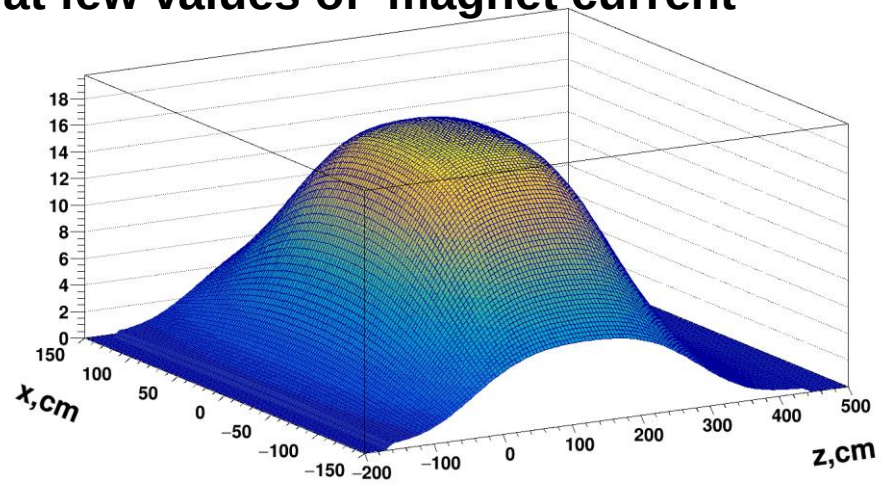


Vacuum boxes for beam detectors

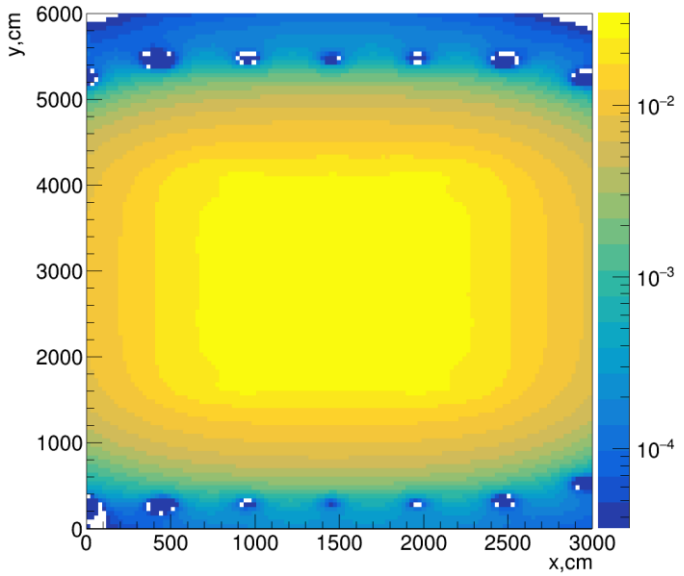


Magnetic field map re-measurement

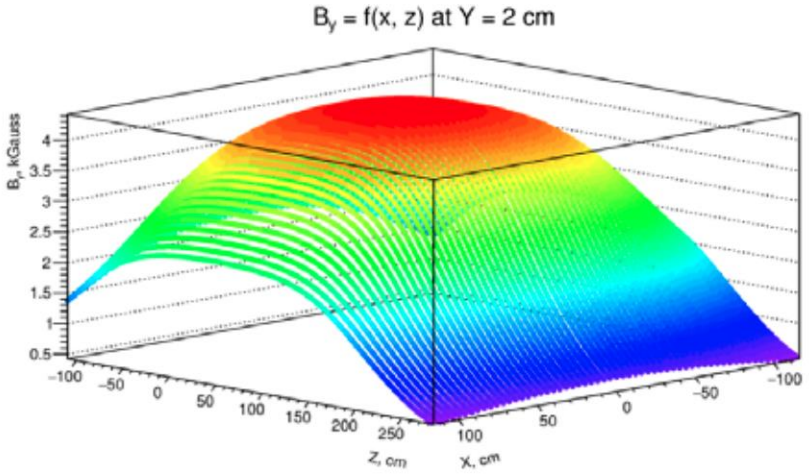
New map measured in a wider X,Z range at few values of magnet current



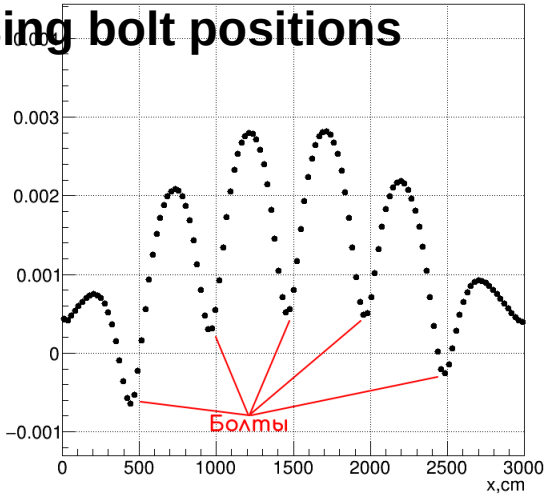
S.Piyadin, R.Shindin, S.Merts, T.Parphilo, B.Kondratiev, M.Mamaev and a team of shifter



Old map measured in a restricted X,Z range at lower magnet current

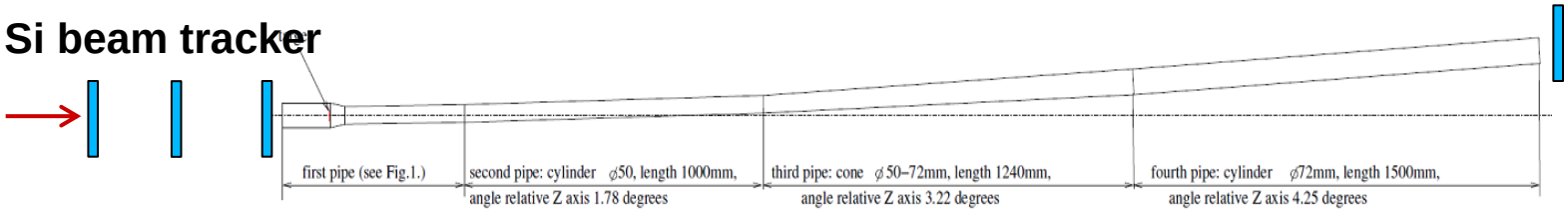


Align X,Z coordinate system using bolt positions



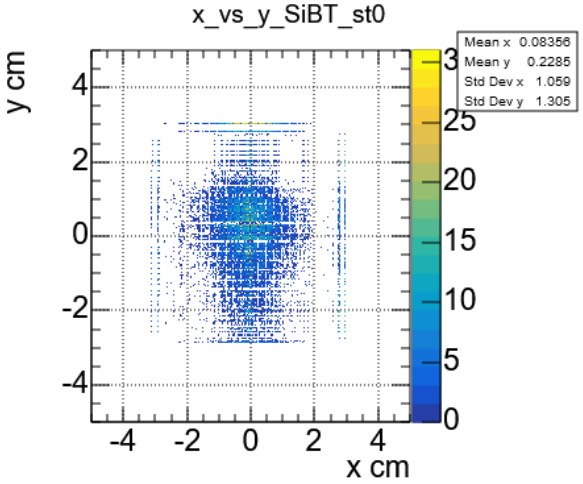
Experimental run in 3.85 AGeV Xe beam with CsI (2%) target

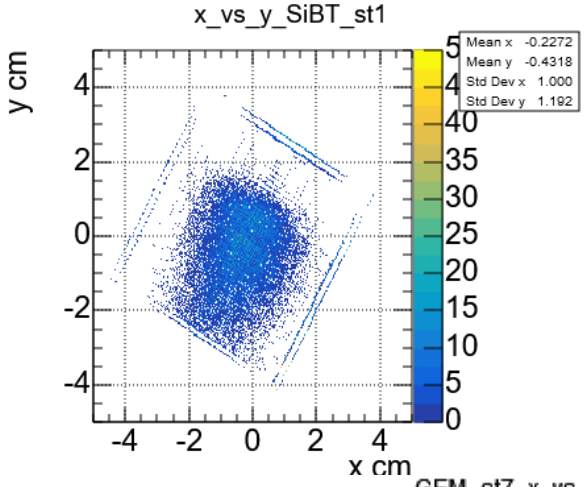
Si beam tracker

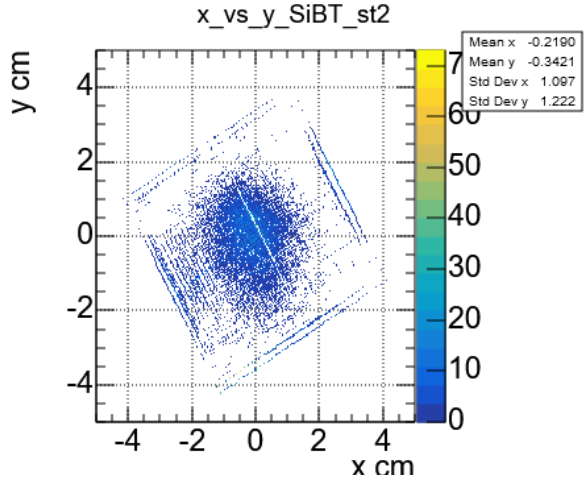


Small GEM as beam profile meter

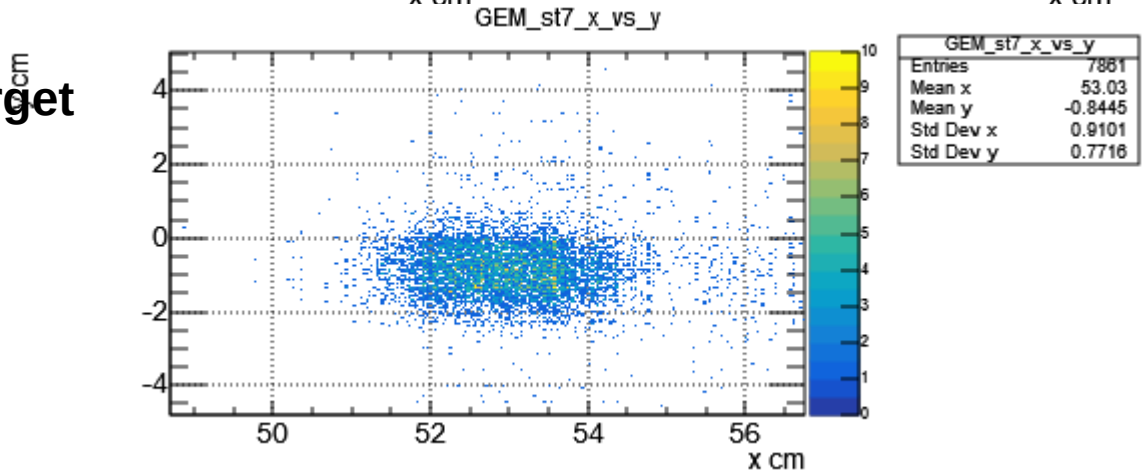
First task of the Xe run → trace beam and monitor its profile in the end of the setup (try to find optimal trajectory to reduce background)





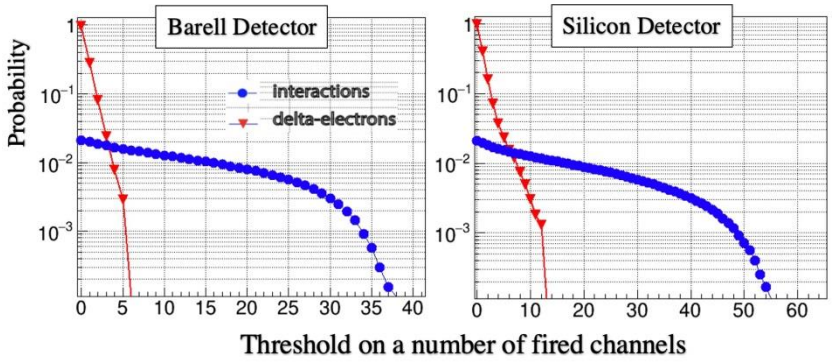


Measured beam spot at target

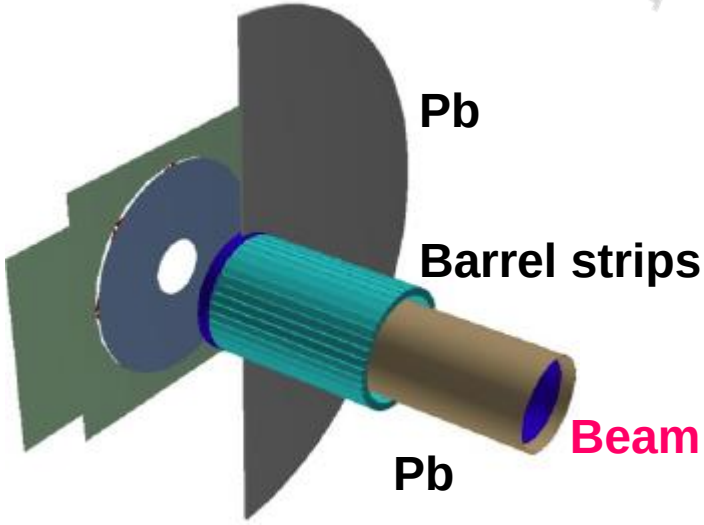


	Ar 2018	Xe 2022
σ_X	5 mm	5 mm
σ_Y	5 mm	6.5 mm

BM@N Trigger detectors



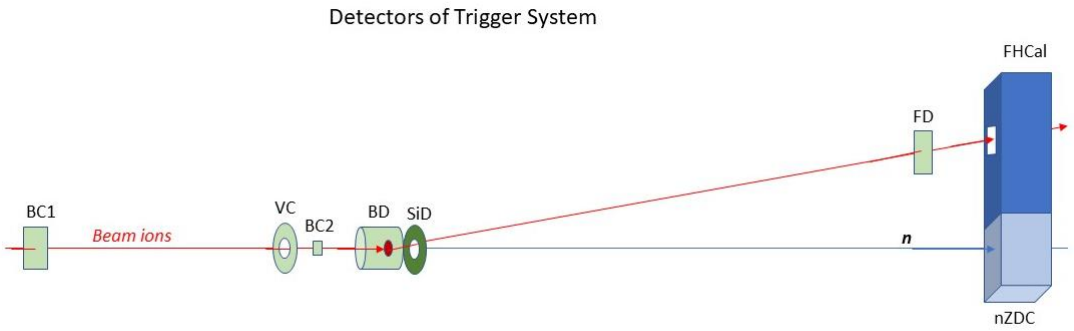
Trigger detectors in target area: multiplicity SiD and Barrel BD



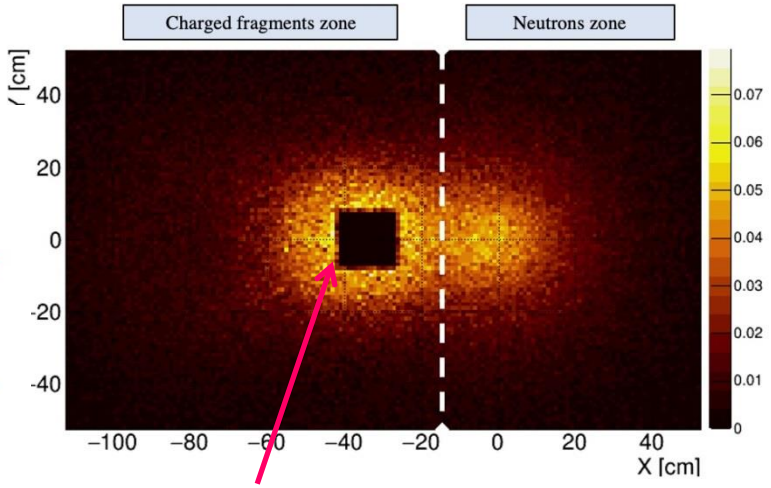
Variants of trigger logics **fraction**

Beam trigger: BT = BC1 * BC2 * VC_{veto} 3 %
Min Bias trigger: MBT = BT * FD Amp < thr 7 %
BD trigger: CCT1 = BT * N(BD)>3 5 %

Combined trigger: CCT2 = MBT * CCT1 **main**



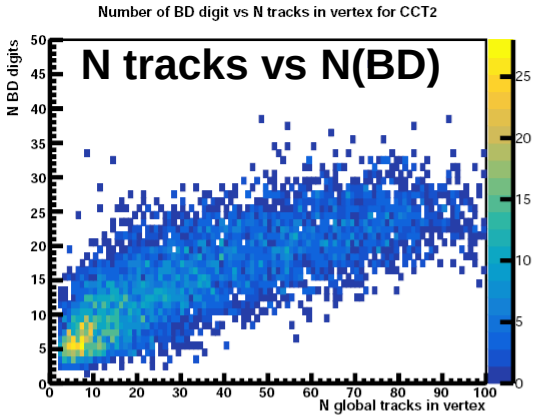
FHCAL rates



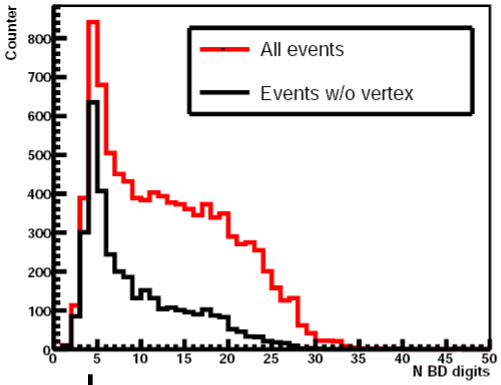
Fragment detector FD

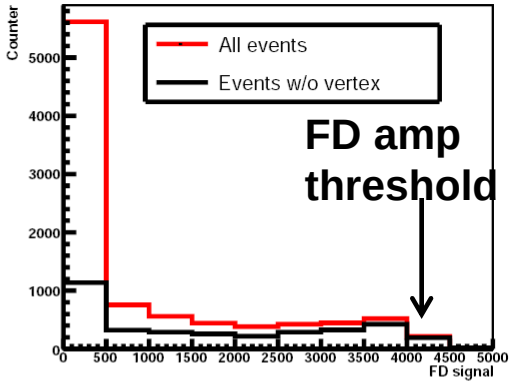
BM@N Trigger selection

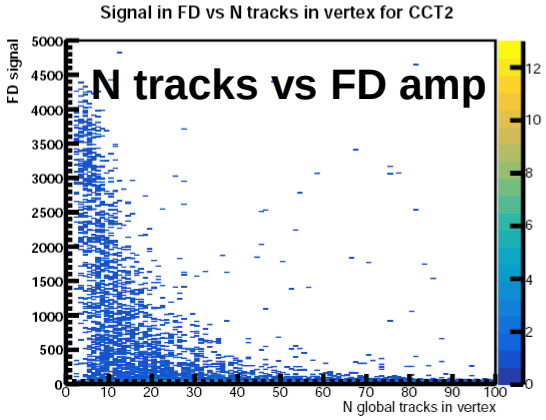
Combined trigger: CCT2 = BT * FD Amp < thr * N(BD) > 3

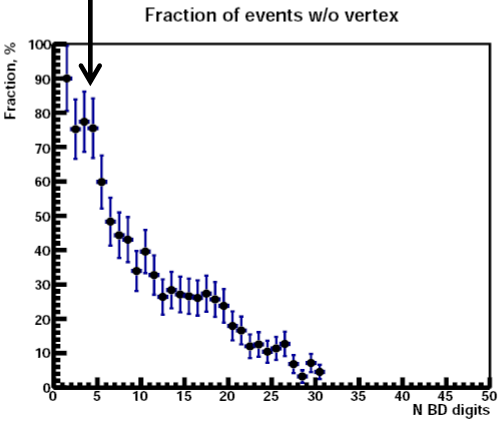


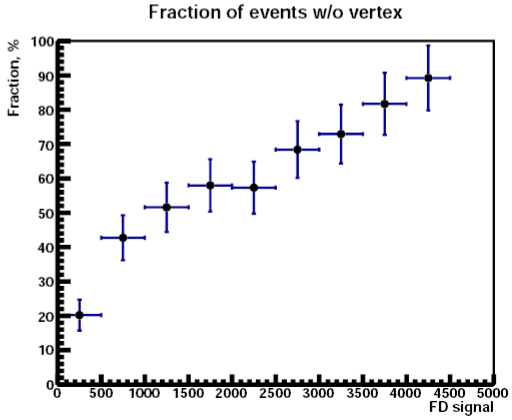
N(BD) > 3 Fraction of events without vertex at target



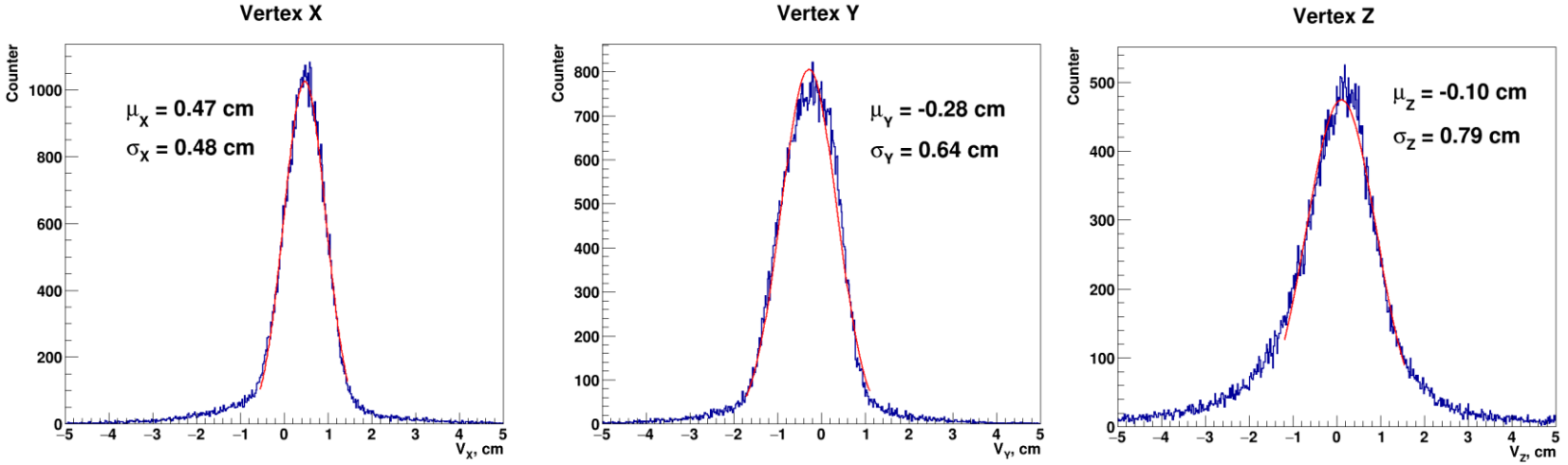




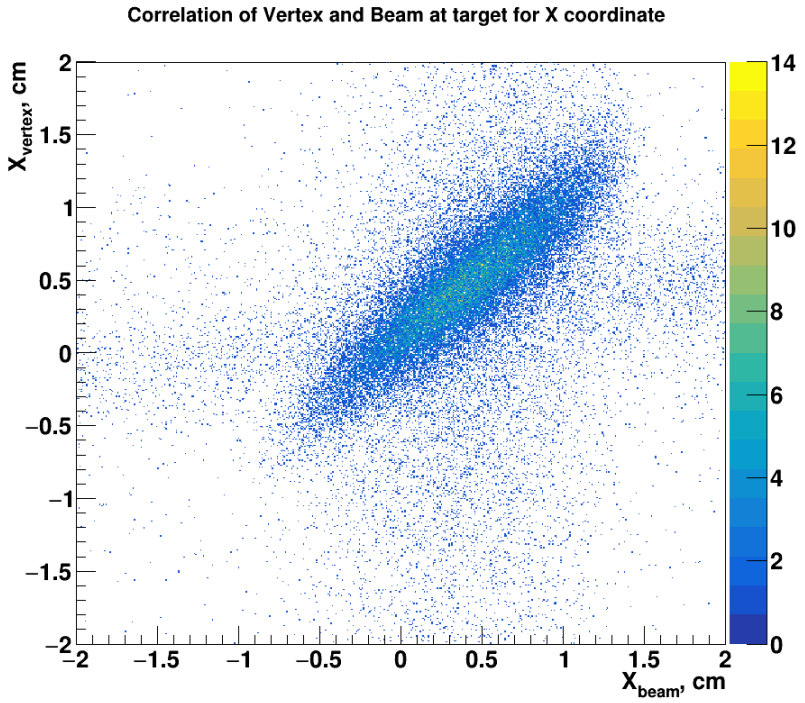


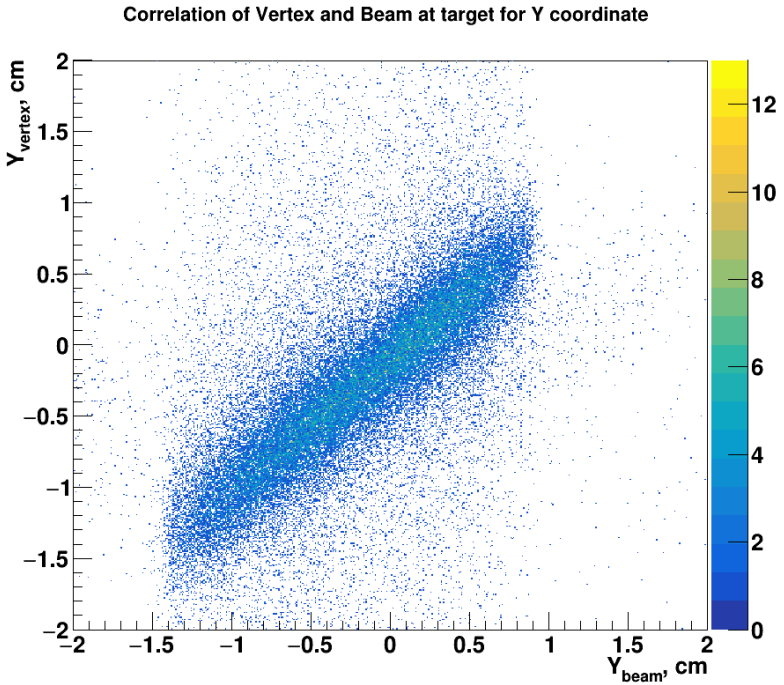


Vertex reconstruction

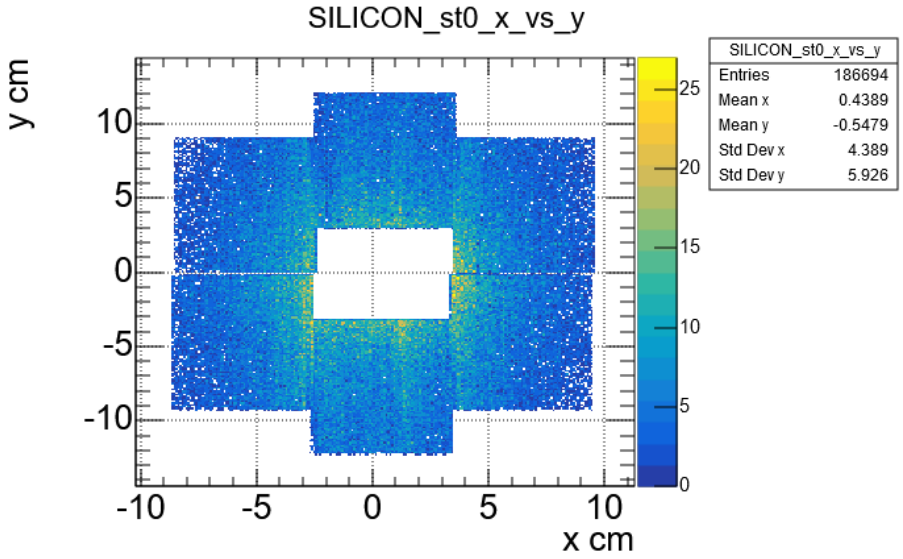


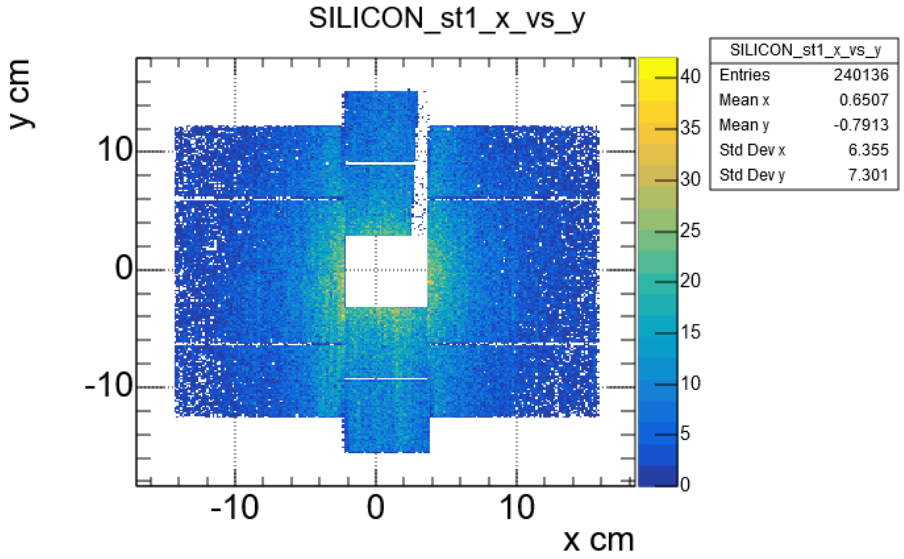
CsI (2%) target

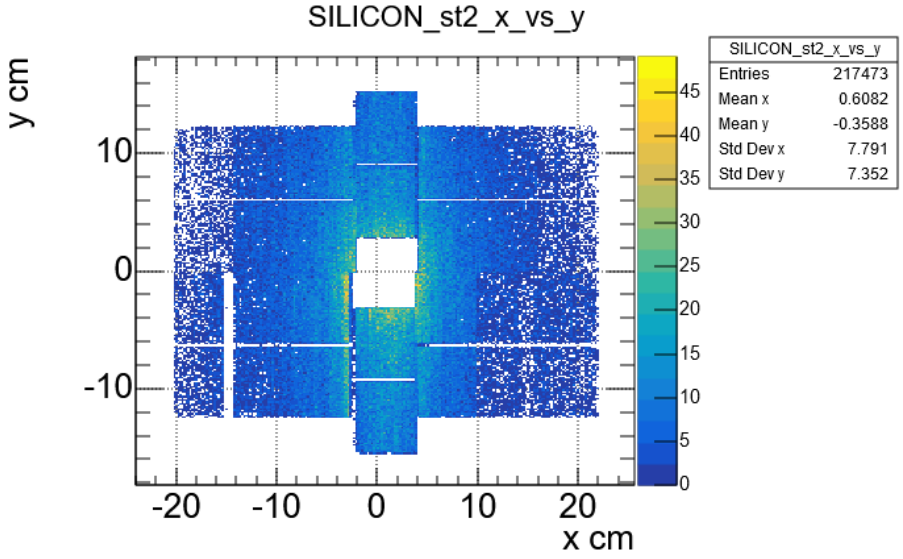


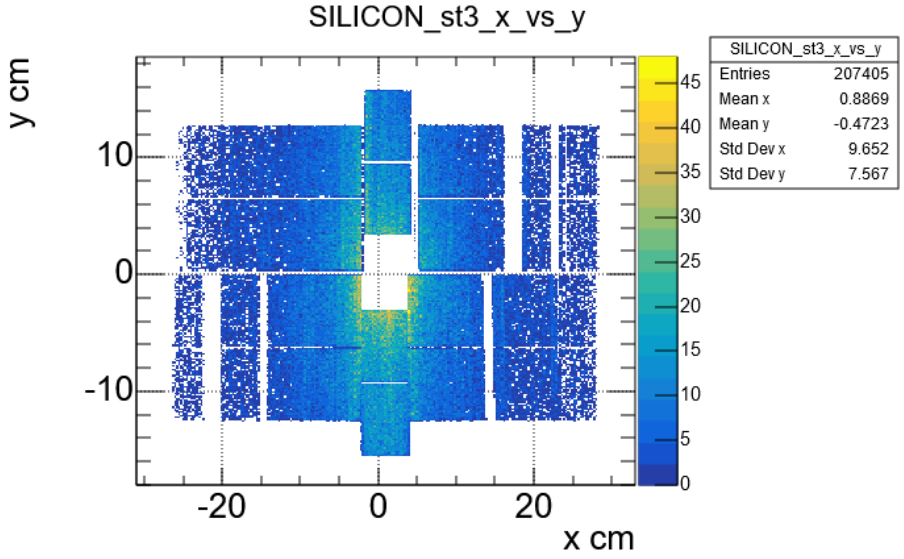


FST hit reconstruction: 4 Si stations



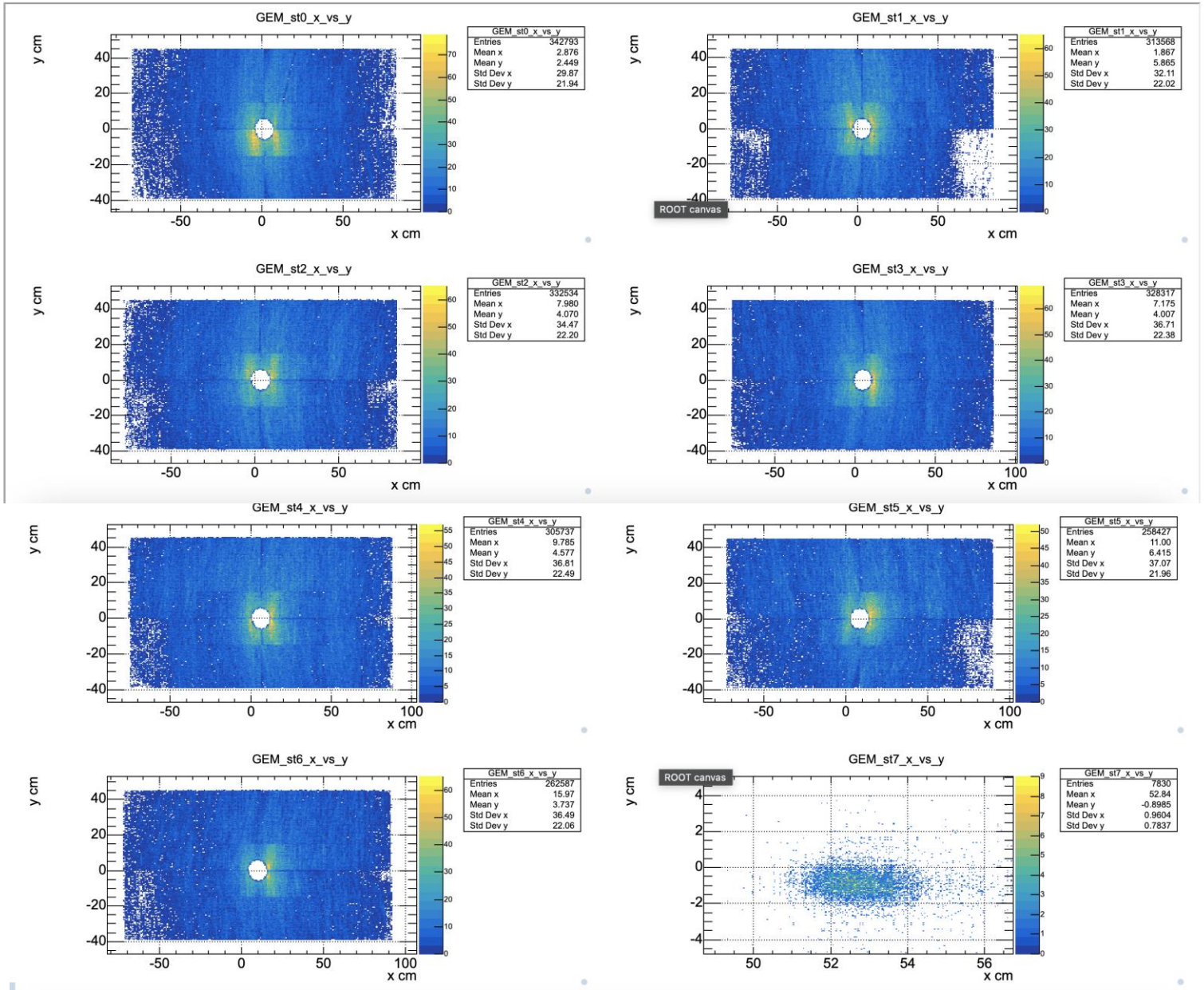






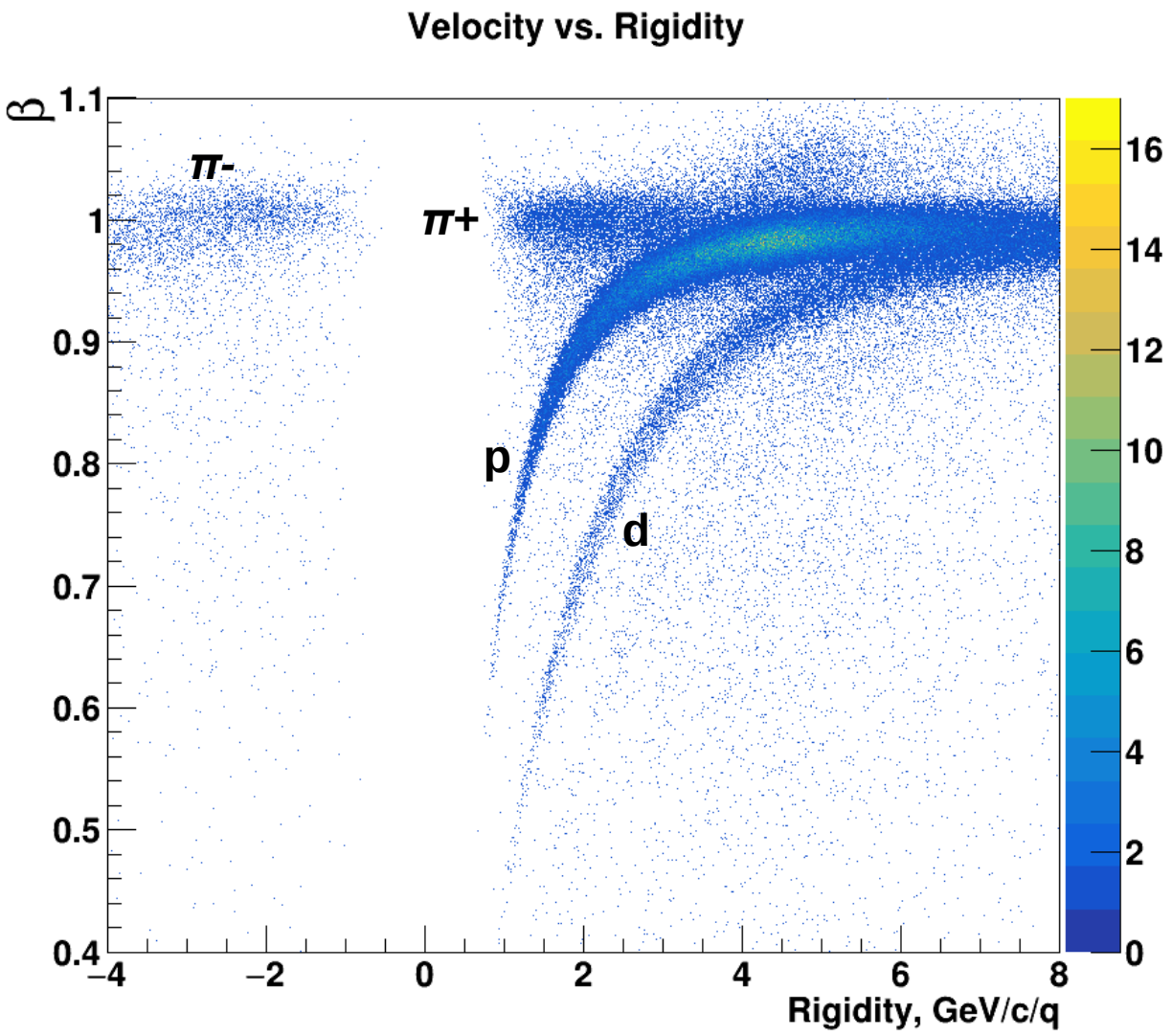
GEM hit reconstruction: 7 stations + small GEM profile meter

GEM Hits



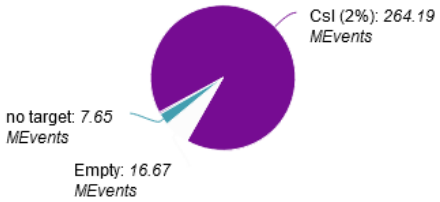
Raw online data: ToF-700 π+, p, d identification

Without dedicated ToF calibration



Trigger rates, DAQ capacity and collected event statistics

Beam Xe (E = 3.8 GeV/n)
Total: 289.77 MEvents



Spill ~2.2 s, cycle 12 s, 500-900k Xe ions per spill

♥ Spill nbr. 235164 16.01.2023 18:45:11

Event statistics, M

beam

triggers

Detectors

BC1_low	1836957
BC1	765200
BC2	681683
VC	152651
NBD>L1	130762
NBD>H1	131236
NSiD>L2	0
NSiD>H2	0
FD	701453
nZDC	102589

Triggers

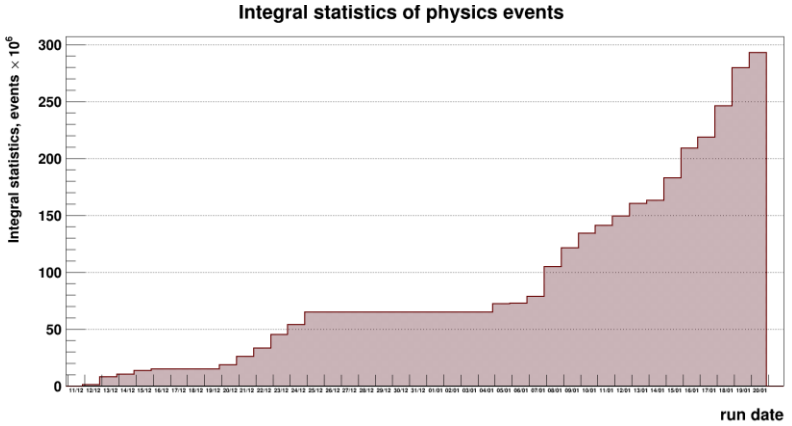
BT	576455
MBT	20761
CCT1	123806
CCT2	9912
NIT	492799

Ratios

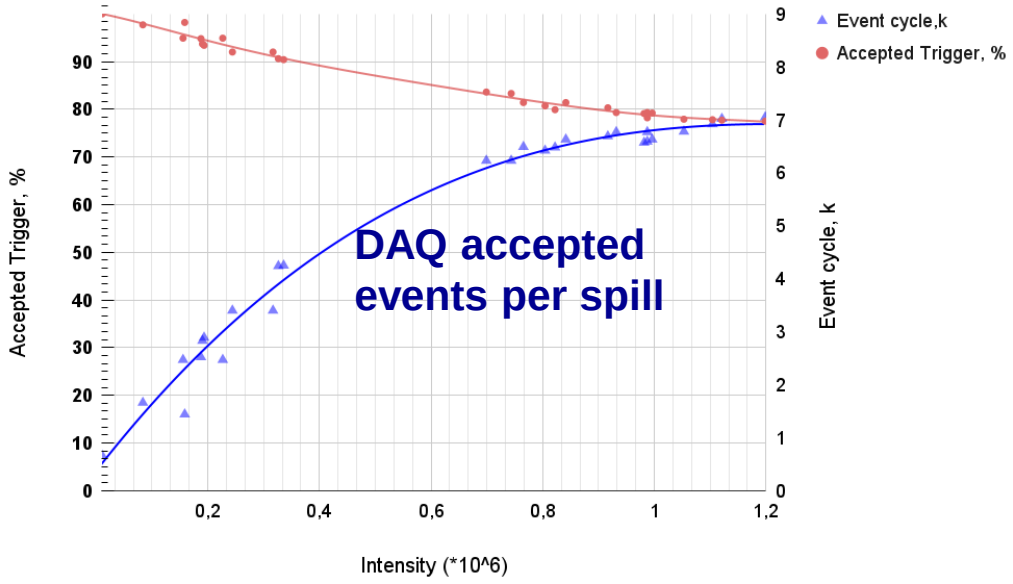
BC1_low/BC1	2.40062
BC2/BC1	0.89086
VC/BC1	0.19949
FD/BC1	0.91669
NBD>L1/BC1	0.17089
NBD>H1/BC1	0.17151
NSiD>L1/BC1	0.00000
NSiD>L2/BC1	0.00000
nZDC/BC1	0.13407
BT/BC1	0.75334
MBT/BT	0.03601
CCT1/BT	0.21477
CCT2/BT	0.01719
NIT/BT	0.85488

Internal signals

pCCT1	130882
pCCT2	130930
MBT1	20905
NIT1	492836
DAQ_Busy	0
BT*/DAQ_Busy	459879
pBT	668899

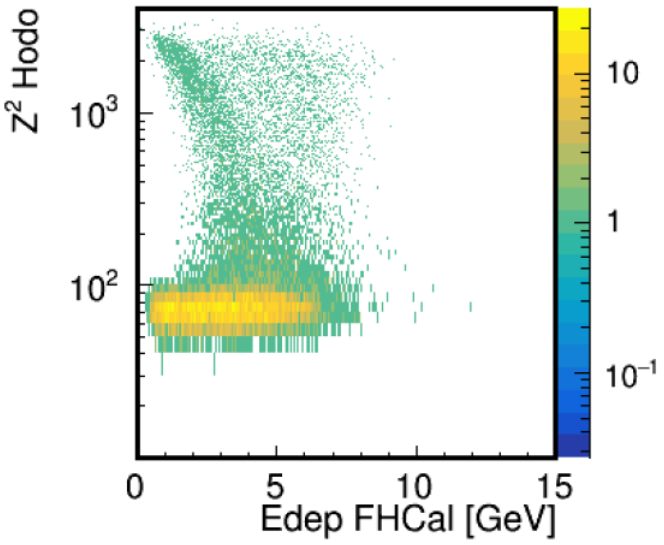


% of DAQ accepted triggers

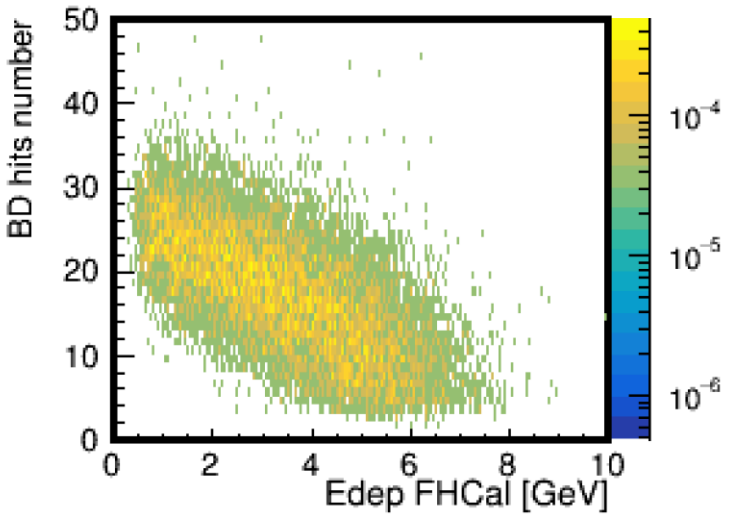


Centrality selection with Hodoscope and FHCal detectors

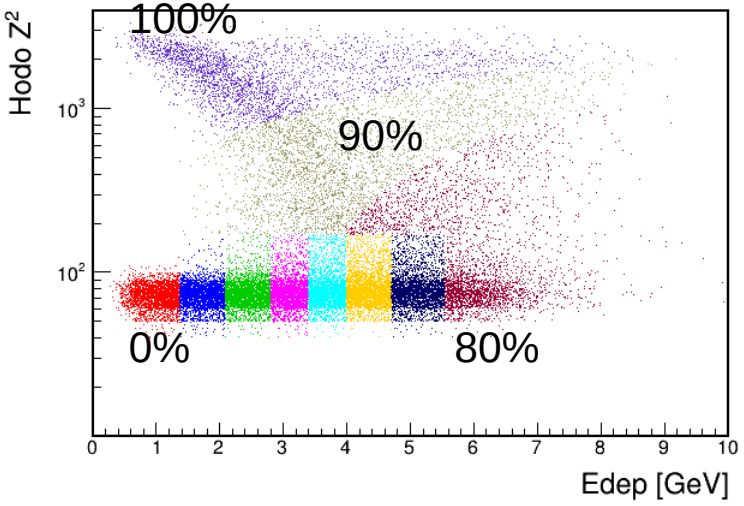
Min bias trigger



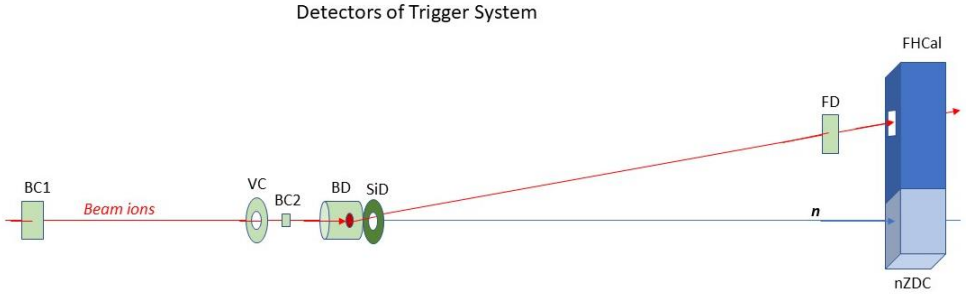
FHCAL: total energy
Fragment Hodoscope: Z^2
Barrel detector BD hits



Color bins – 10% of number of events in each bin



CsI target, Z vertex cut (-1.5 < Z <1.5 cm),
Ntr (vertex) >= 2 , single Xe ion



Thank you
for attention!

Plan for BM@N Experimental physics run in Xe beam **with** CsI target for 800 hours (33 days) in October-December 2022

BM@N: Estimated hyperon yields in Xe + Cs collisions

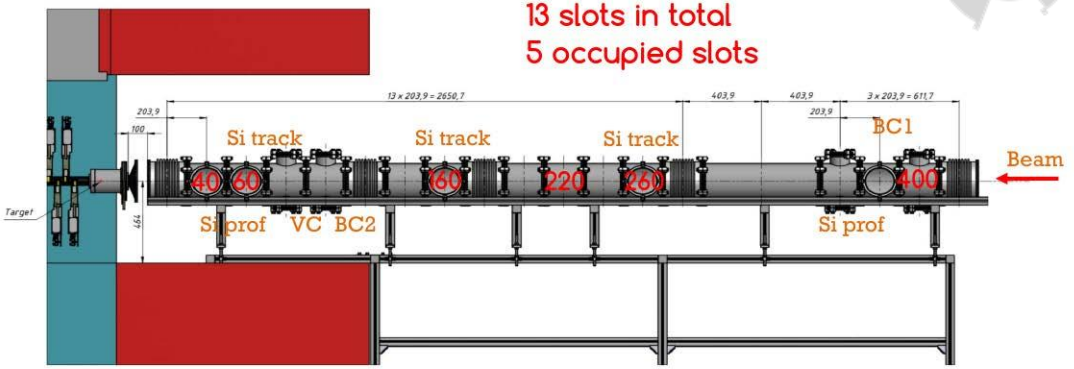
4 A GeV Xe+Cs collisions, multiplicities from PHSD model,
Beam intensity $2.5 \cdot 10^5$/s, DAQ rate $2.5 \cdot 10^3$/s, accelerator duty factor 0.25

$1.8 \cdot 10^9$ interactions
$1.8 \cdot 10^{11}$ beam ions

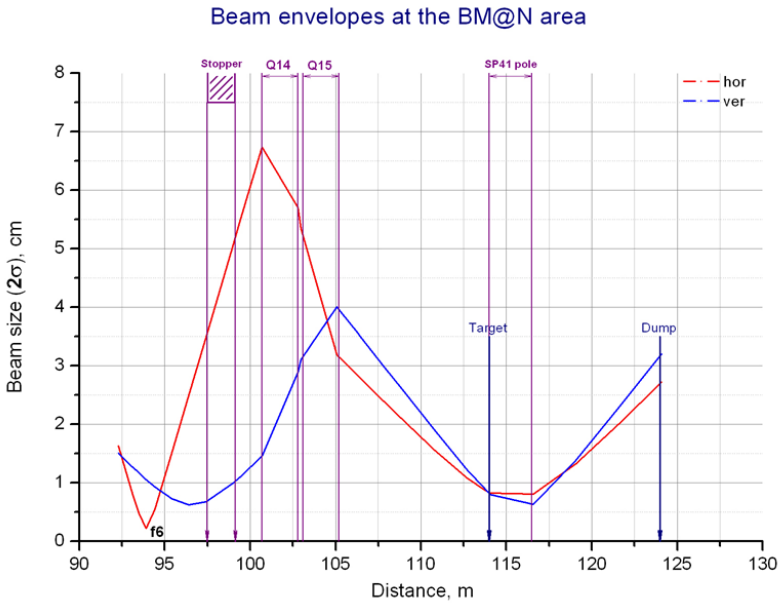
Particle	E_{thr}NN GeV	M b<10 fm	ε %	Yield/s b<10fm	Yield / 800 hours b<10 fm
Λ	1.6	1.5	2	150	$5 \cdot 10^7$
Ξ^-	3.7	$2.3 \cdot 10^{-2}$	0.5	0.55	$2 \cdot 10^5$
Ω^-	6.9	$2.6 \cdot 10^{-5}$	0.25	$3.2 \cdot 10^{-4}$	110
Anti-Λ	7.1	$1.5 \cdot 10^{-5}$	0.5	$3.7 \cdot 10^{-4}$	130

DCM-SMM
x 0.75
x 0.5

Beam tracking with 3 Si detectors



Magnetic Optics in BM@N area: angular beam spread of ~2 mrad



Measured beam spot at target

	Ar 2018	Xe 2022
σ_X	5 mm	5 mm
σ_Y	5 mm	6.5 mm

Vertex and beam angular resolution from simulation of 3 Si detectors (S.Merts)