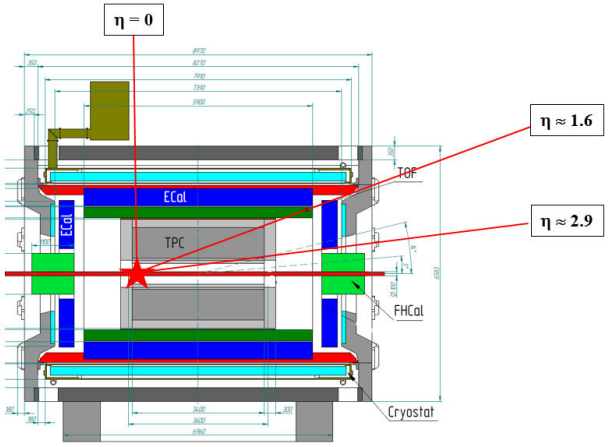
MPD trigger efficiency in the fixed target mode

V. Riabov

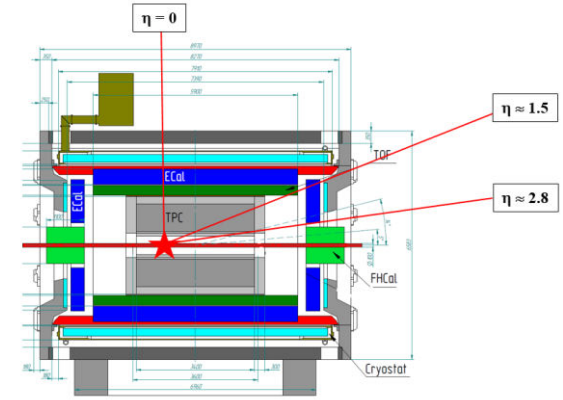
Fixed target configurations

- With a target located at z = -150 cm



E_{beam}	$\sqrt{s_{NN}}$ collider mode	$\sqrt{s_{NN}}$ FXT mode	η_{CM}	CMS coverage
2.0	4	2.4	0.7	-0.7; 0.9 (2.2)
5.5	11	3.5	1.23	-1.23; 0.37 (1.67)

- With a target located at z = -115 cm



E_{beam}	$\sqrt{s_{NN}}$ collider mode	$\sqrt{s_{NN}}$ FXT mode	η_{CM}	CMS coverage
2.0	4	2.4	0.7	-0.8; 0.8 (2.1)
5.5	11	3.5	1.23	-1.33; 0.27 (1.57)

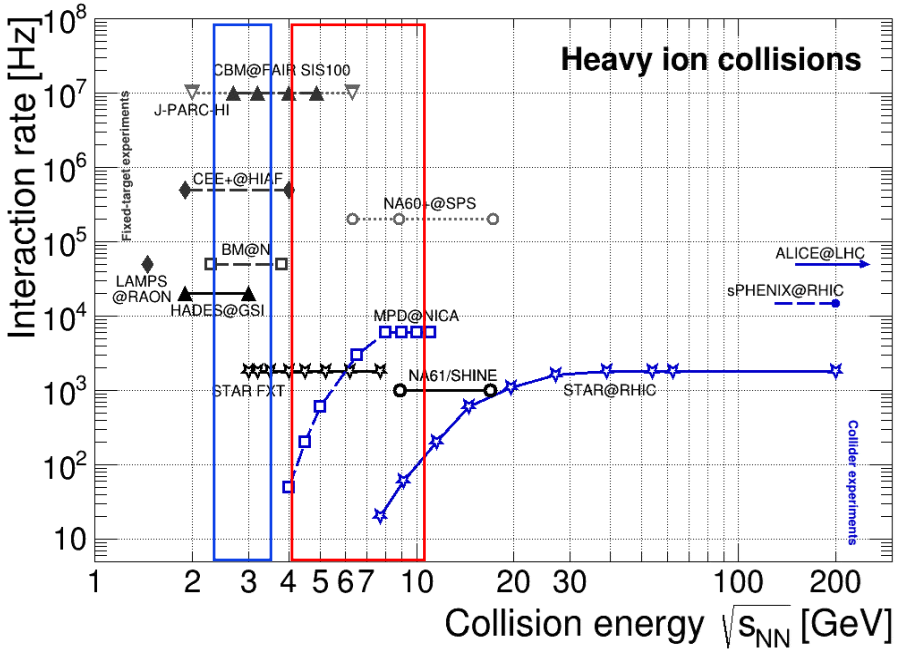


Table 2.1: The basic parameters of the TPC

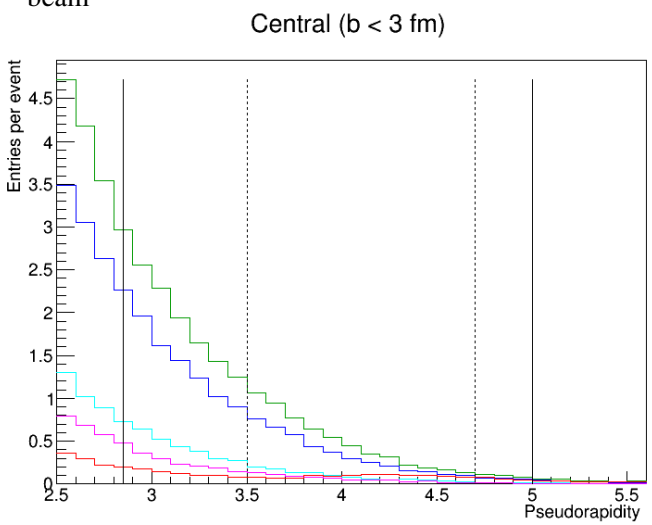
Item	Dimension
Length of the TPC	340 cm
Outer radius of vessel	140 cm
Inner radius of vessel	27 cm
Outer radius of the drift volume	133 cm
Inner radius of the drift volume	34 cm
Length of the drift volume	163 cm (of each half)

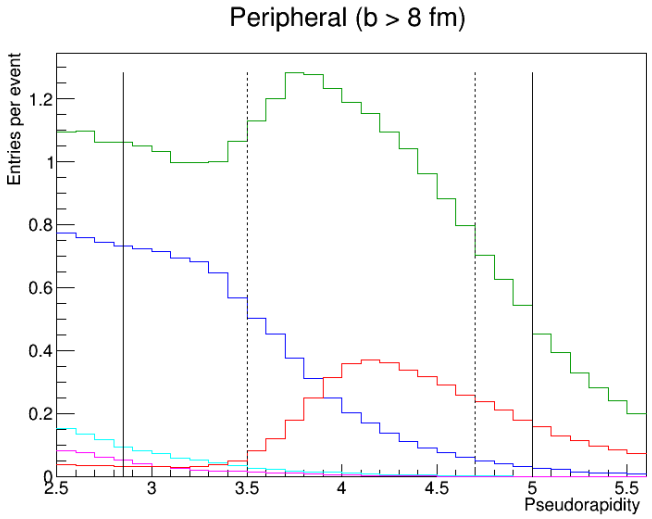
Trigger efficiency simulation

- Request 26 configuration
- DCM-QGSM-SMM is run in FXT mode at two energies: E_{lab} = 2.0·A GeV and E_{lab} = 5.5 ·A GeV
- Two target positions were considered:
  - ✓ x = 0, y = 0, z = -150 cm → full detector configuration, all FFD-W materials changed to air (no detector)
  - ✓ x = 0, y = 0, z = -115 cm → full detector configuration
- 30,000 events for each energy and target location
- Three subsystems for trigger formation:
  - ✓ FFD-E (FFD-W ignored)
  - ✓ FHCAL-E (FHCAL-W ignored)
  - ✓ TOF, use fast logical signals from 280 MRPCs (fires if at least one hit detected in the whole MRPC chamber)

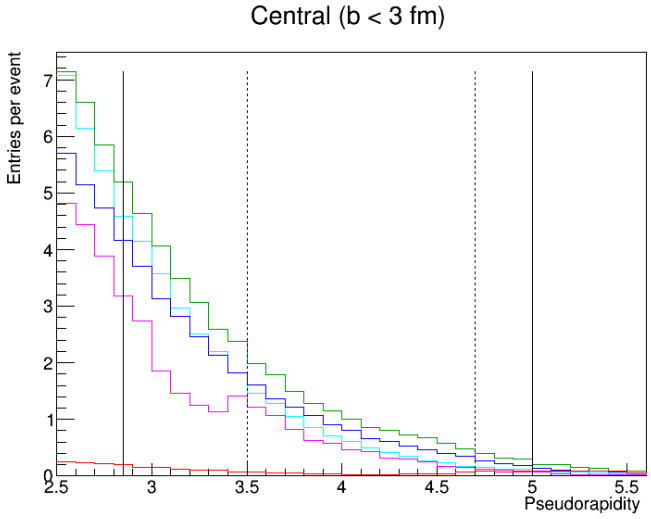
Particle composition

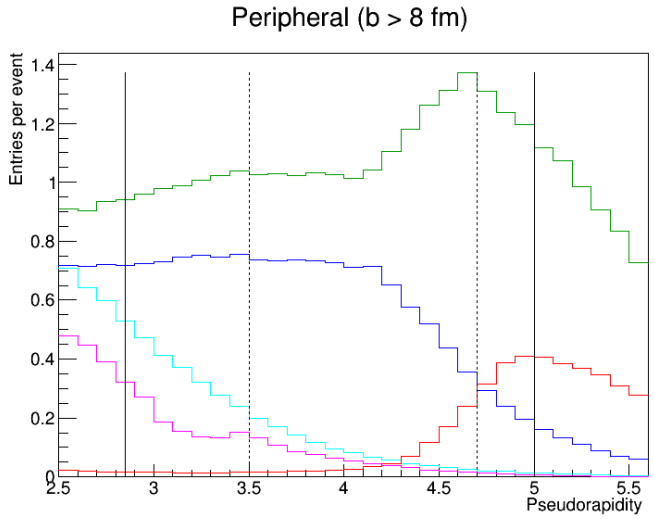
- E_{beam} = 2 A·GeV





- E_{beam} = 5.5 A·GeV





FFD

FHCAL

Pions

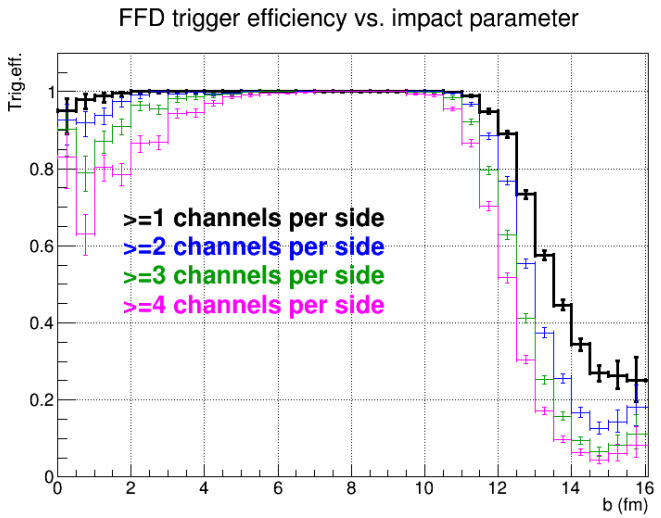
Protons

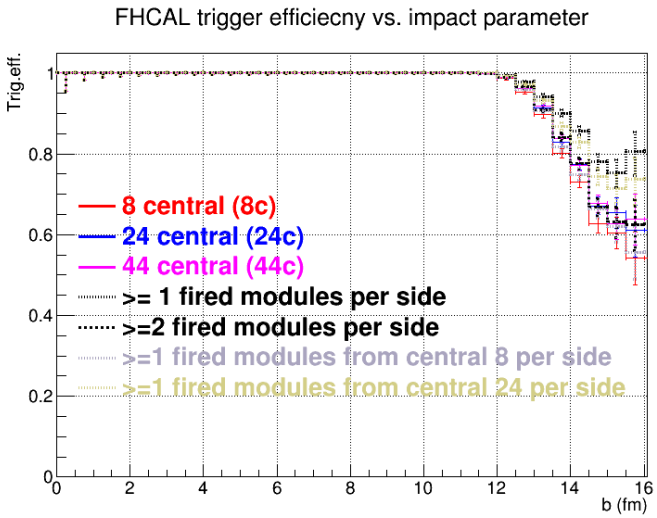
Neutrons

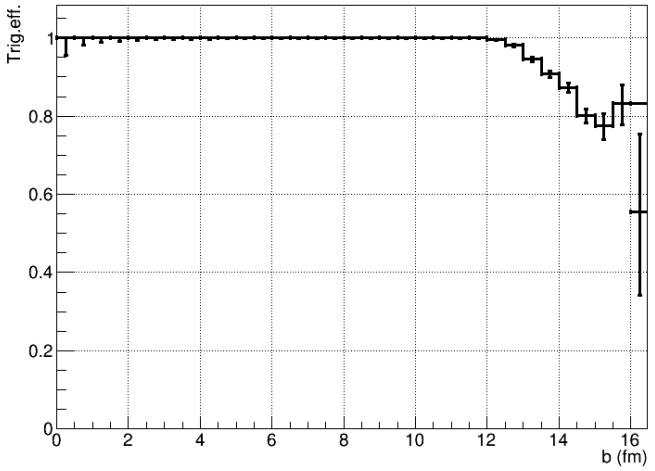
Fragments

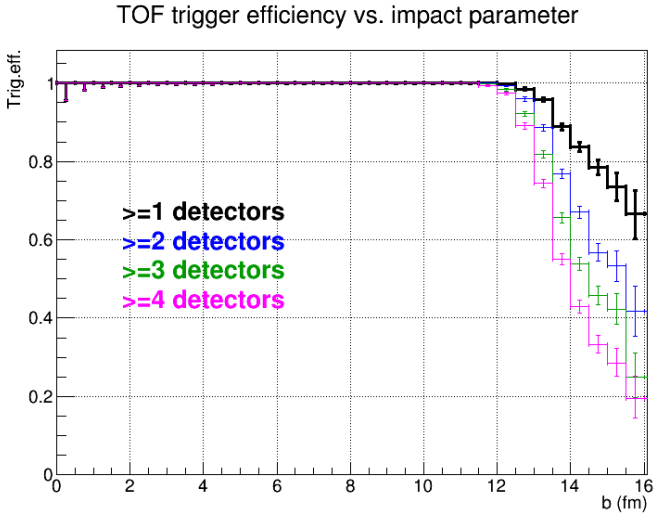
Photons

Trigger efficiency, E = 2 AGeV, Z_{vertex} = -150 cm





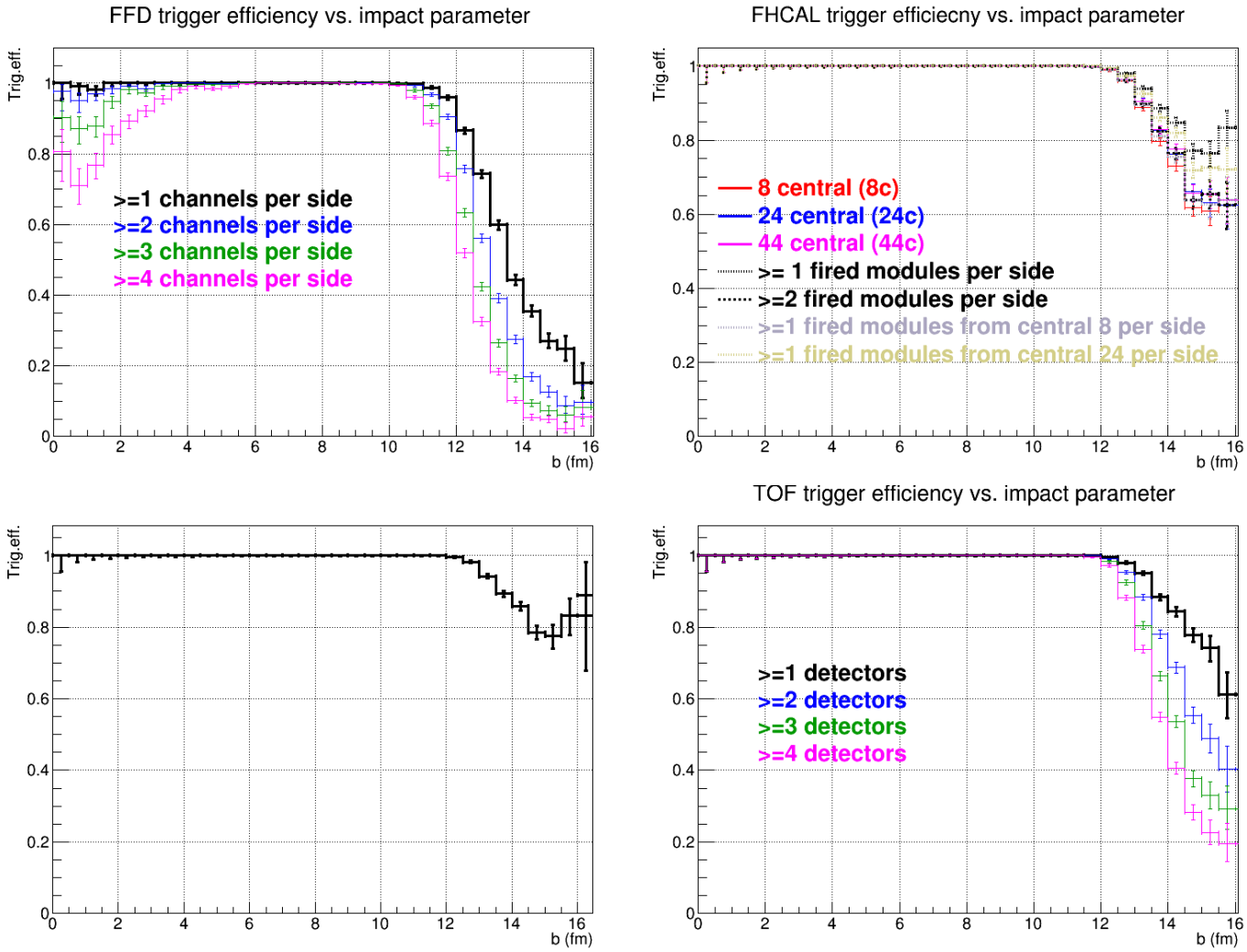




- Efficiency:
  - ✓ FFD: 74, 78, 82, 88%
  - ✓ FHCAL: 96, 96, 97, 98%
  - ✓ FFD|FHCAL: 98%
  - ✓ TOF: 91, 93, 95, 98%

- Trigger efficiency is comparable or better than that in the collider mode at top NICA energies

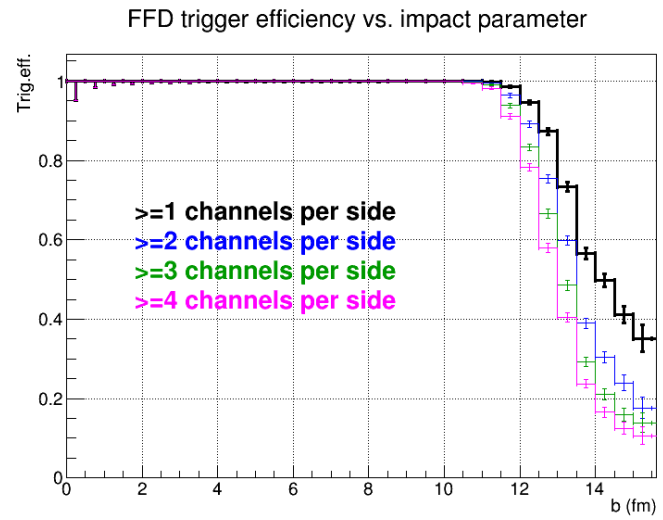
Trigger efficiency, E = 2 AGeV, Z_{vertex} = -115 cm

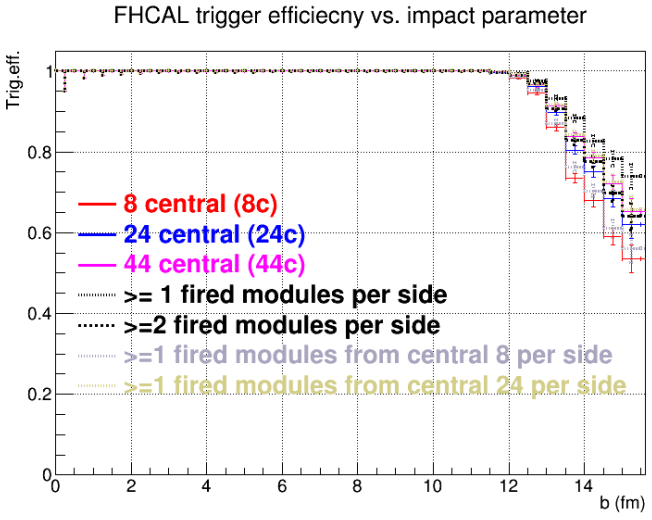


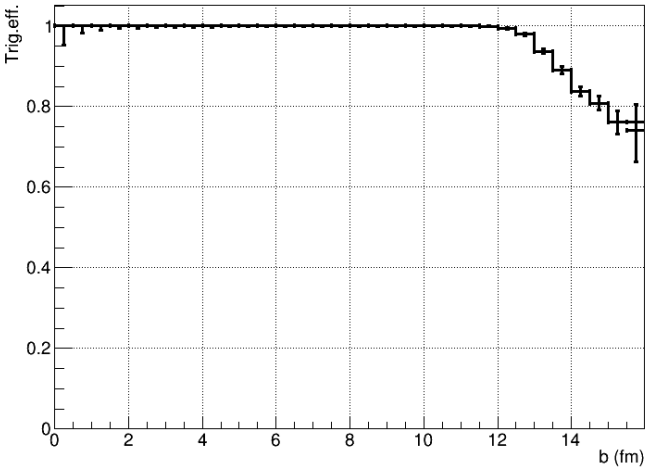
- Efficiency:
  - ✓ FFD: 74, 78, 82, 88%
  - ✓ FHCAL: 95, 96, 97, 98%
  - ✓ FFD|FHCAL: 98%
  - ✓ TOF: 91, 93, 95, 98%

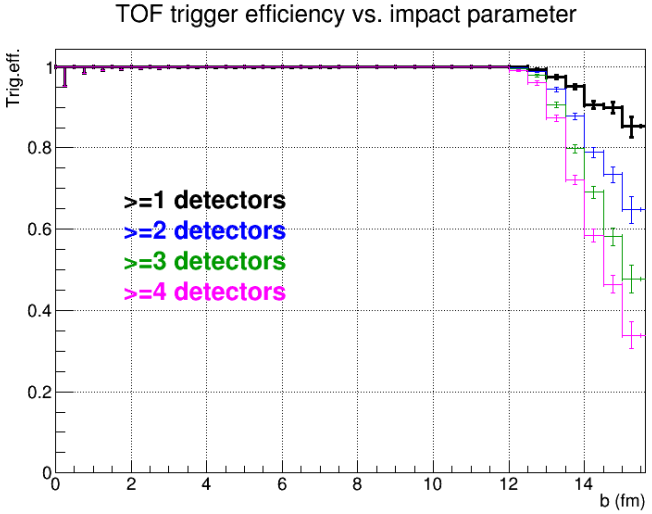
- Marginal dependence on the target position

Trigger efficiency, E = 5.5 AGeV, Z_{vertex} = -150 cm





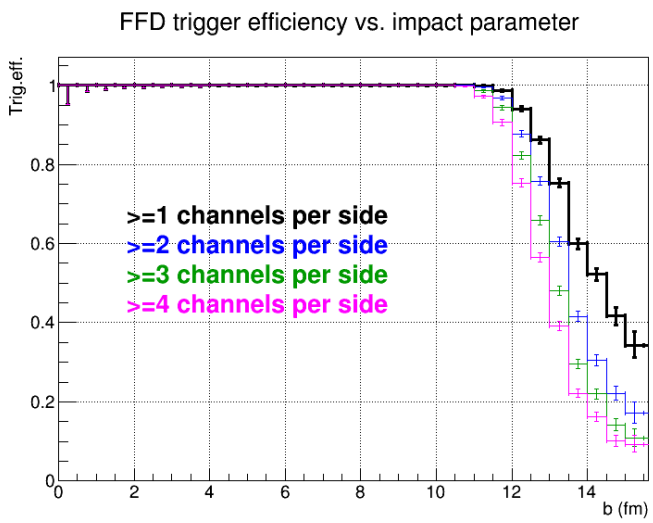


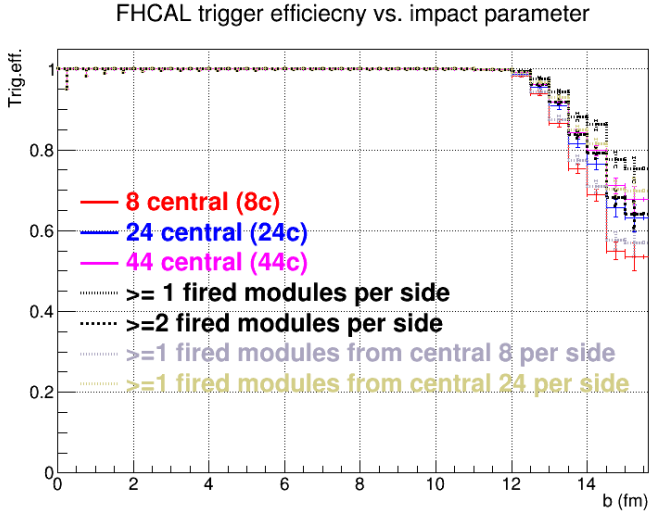


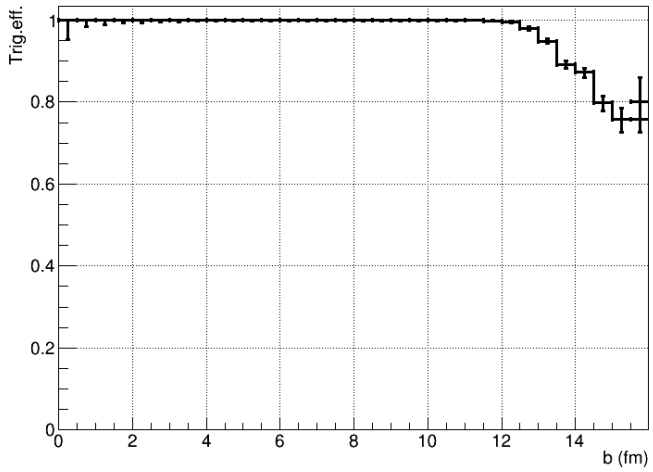
- Efficiency:
  - ✓ FFD: 83, 85, 88, 92%
  - ✓ FHCAL: 96, 96, 97, 98%
  - ✓ FFD|FHCAL: 98%
  - ✓ TOF: 94, 96, 97, 99%

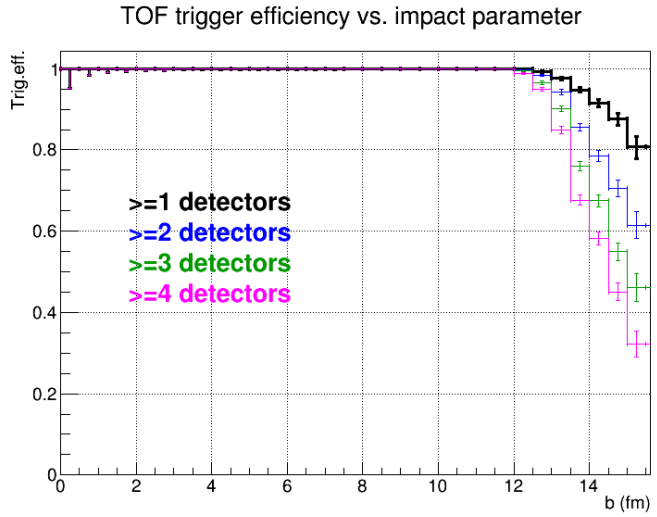
- Trigger efficiency is comparable or better than that in the collider mode at top NICA energies
- Trigger efficiency is higher at higher beam energy for the FFD and TOF, ~ same for the FHCAL

Trigger efficiency, E = 5.5 AGeV, Z_{vertex} = -115 cm







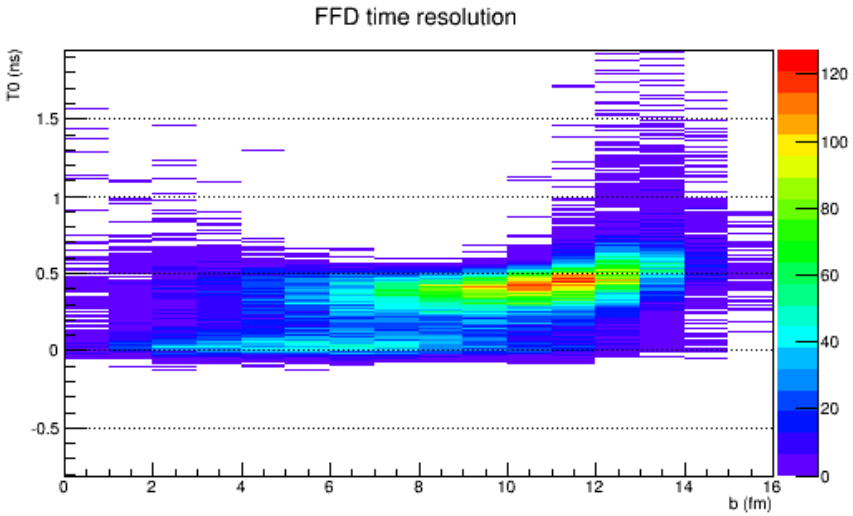


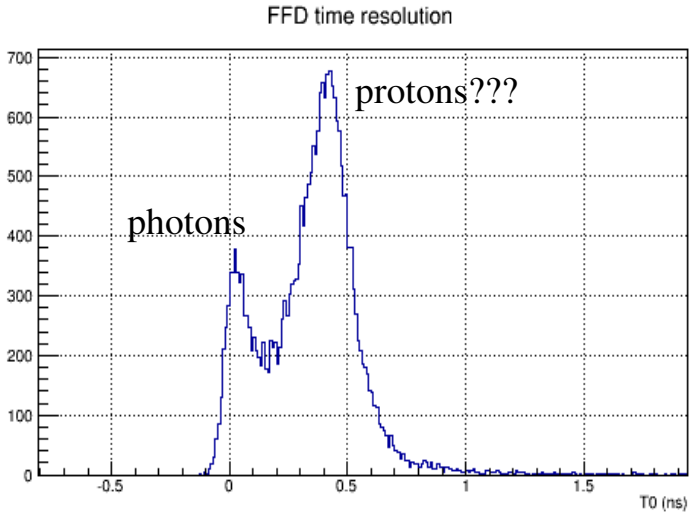
- Efficiency:
  - ✓ FFD: 82, 84, 88, 92%
  - ✓ FHCAL: 96, 96, 97, 98%
  - ✓ FFD|FHCAL: 98%
  - ✓ TOF: 94, 96, 97, 99%

- Marginal dependence on the target position

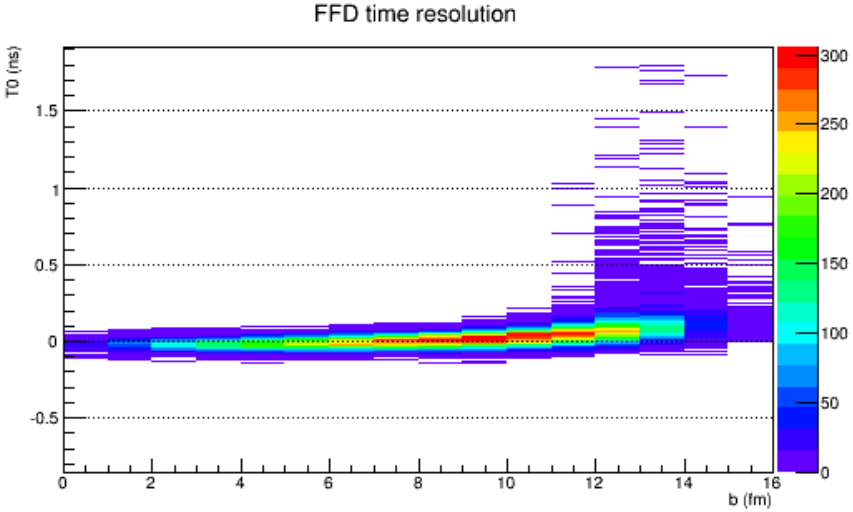
FFD: T0 = T_{FFD} - L/c

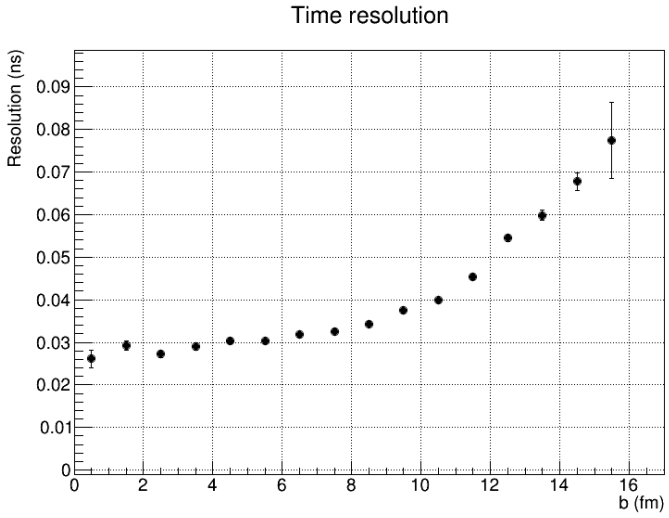
- E = 2 AGeV:





- E = 5.5 AGeV:

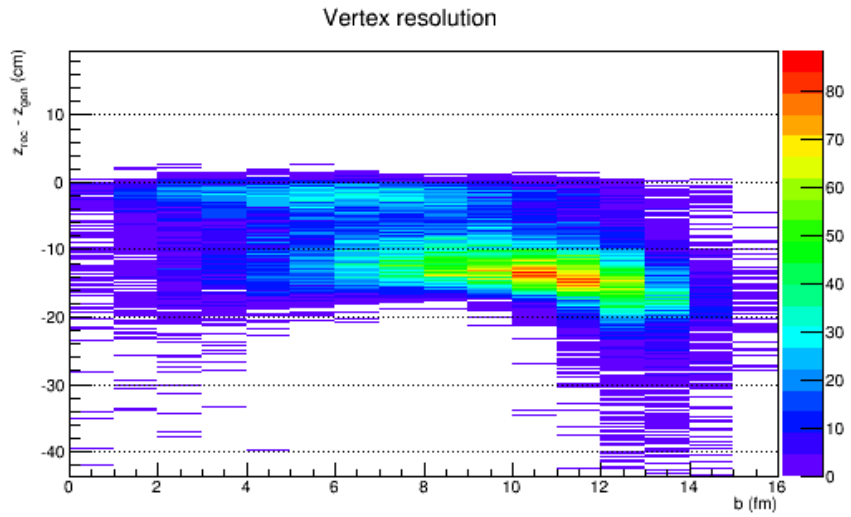


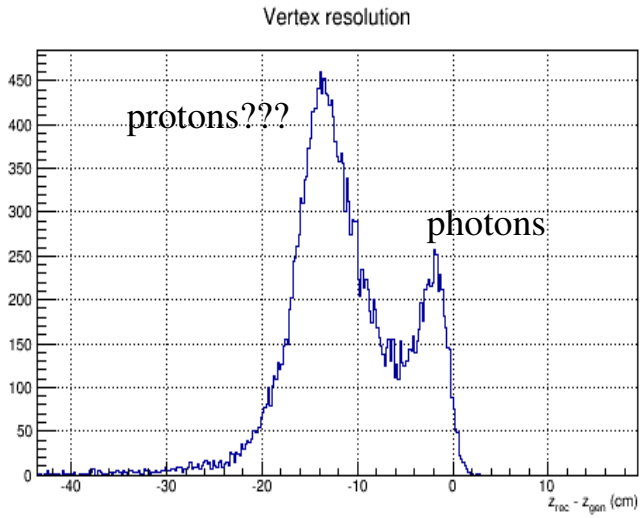


- Good T0 resolution at higher beam energy with σ ~ 50 ps, large centrality bias
- Smearing of T0 at lower beam energies

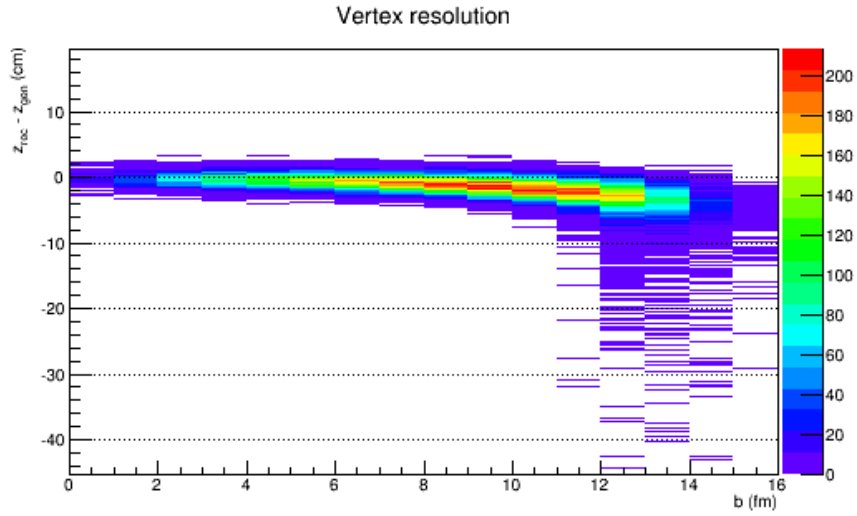
Vertex reconstruction: $z_{rec} = Z_{FFD\text{-}E} - T_{FFD} \cdot c$

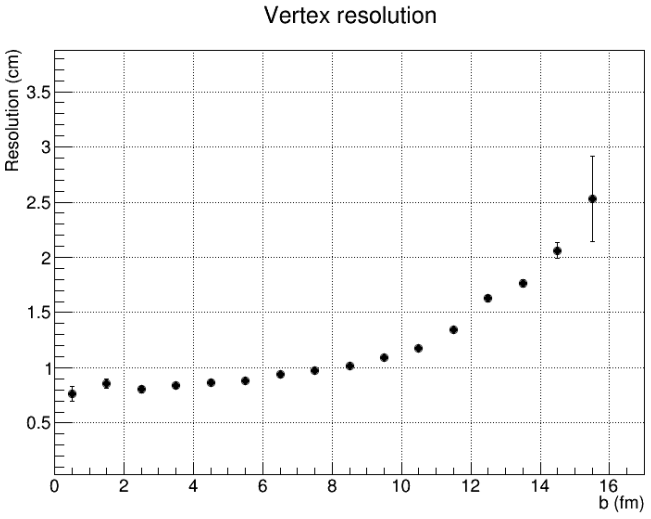
- E = 2 AGeV:





- E = 5.5 AGeV:

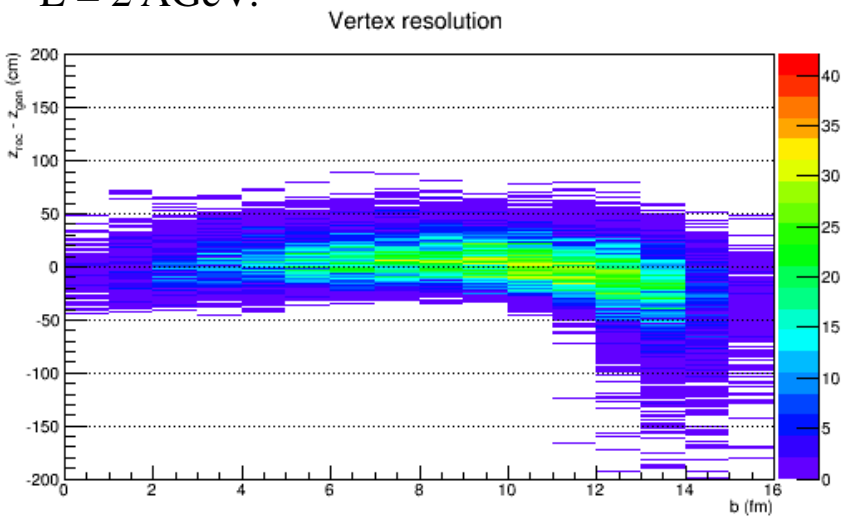


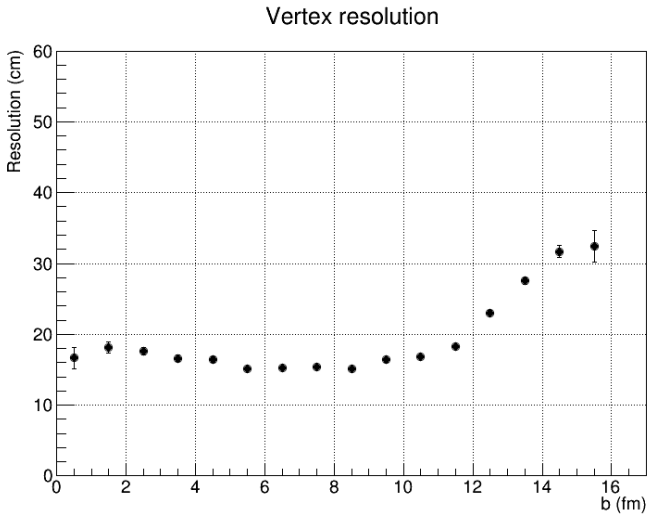


- Good vertex resolution at higher beam energy with σ ~ 50 ps, large centrality bias
- No precise vertexing at lower beam energies

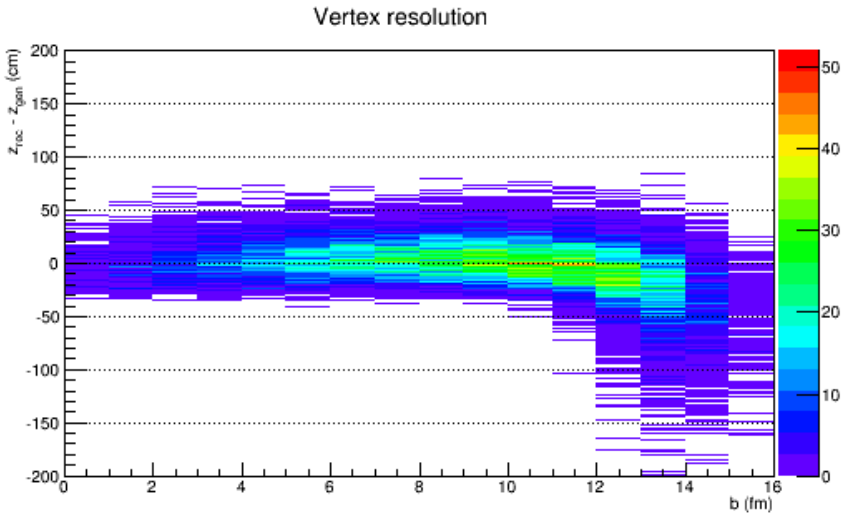
Vertex reconstruction: $z_{rec} = Z_{FHCAL} - T_{FHCAL} \cdot c$

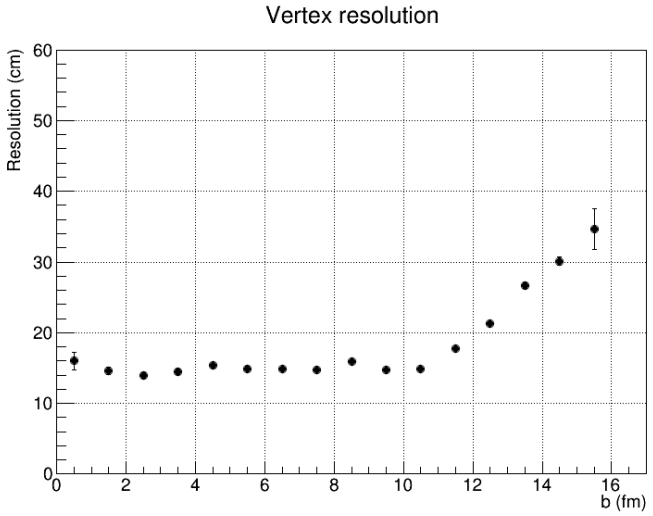
- E = 2 AGeV:





- E = 5.5 AGeV:





- At both beam energies the FHCAL vertex resolution is practically the same

Conclusions

- MPD trigger system based on the FFD. FHCAL and TOF provides high efficiency in the FXT mode
- Potential problems with T0 and vertex at lower beam energies

BACKUP