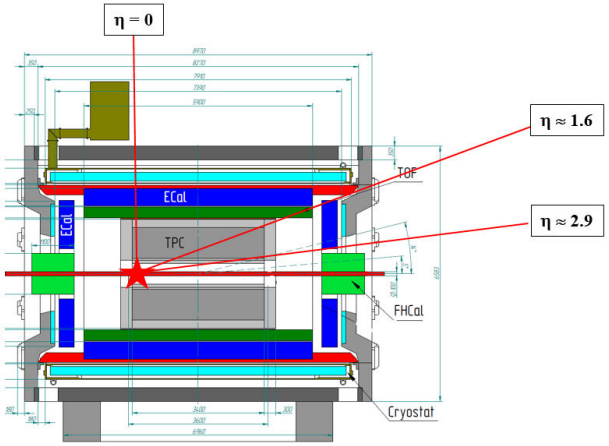
MPD trigger efficiency in the fixed target mode (light collision systems)

V. Riabov

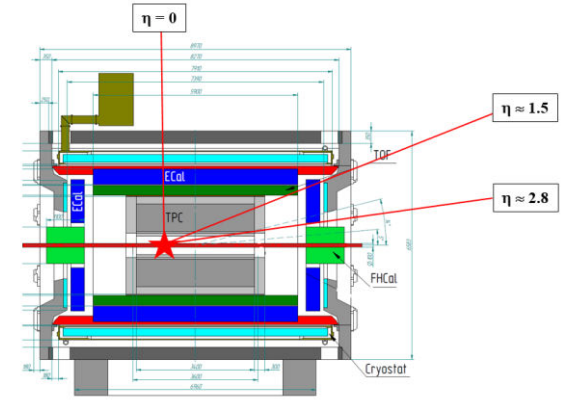
Fixed target configurations

- With a target located at z = -150 cm

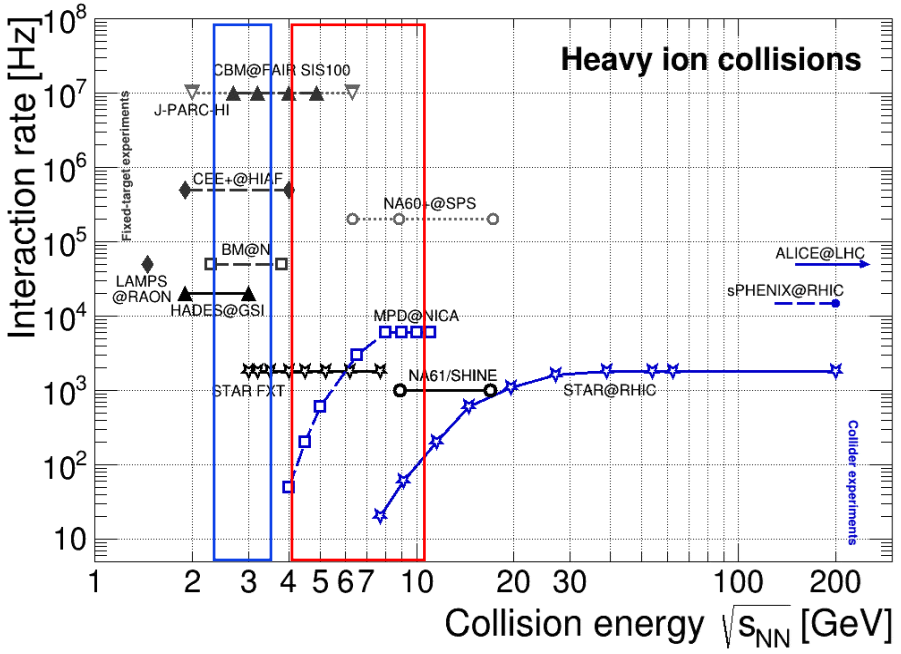


E_{beam}	$\sqrt{s_{NN}}$ collider mode	$\sqrt{s_{NN}}$ FXT mode	η_{CM}	CMS coverage
2.0	4	2.4	0.7	-0.7; 0.9 (2.2)
5.5	11	3.5	1.23	-1.23; 0.37 (1.67)

- With a target located at z = -115 cm



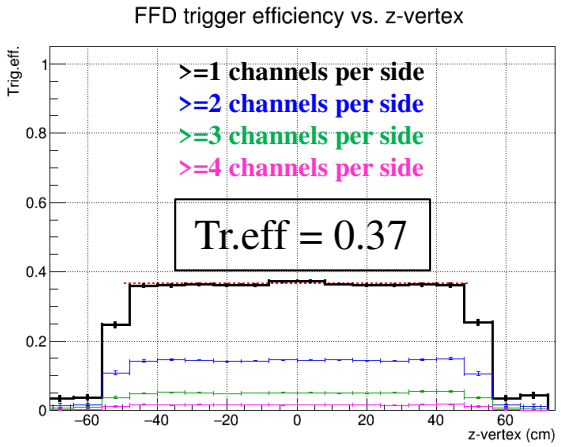
E_{beam}	$\sqrt{s_{NN}}$ collider mode	$\sqrt{s_{NN}}$ FXT mode	η_{CM}	CMS coverage
2.0	4	2.4	0.7	-0.8; 0.8 (2.1)
5.5	11	3.5	1.23	-1.33; 0.27 (1.57)

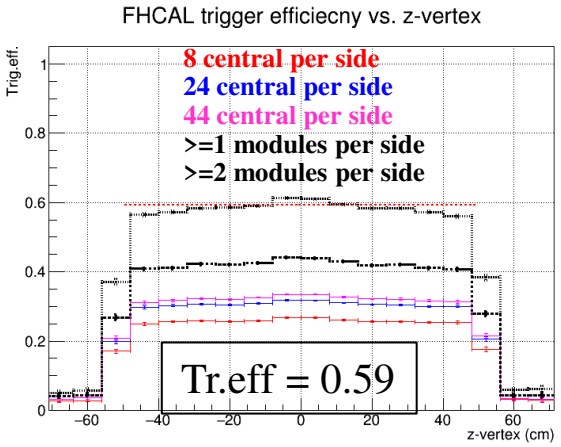


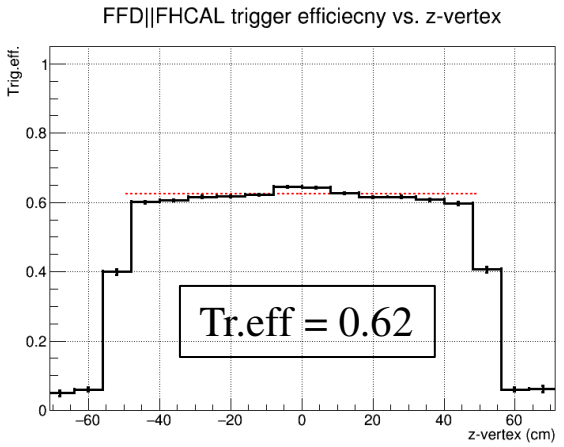
- In heavy-ion collisions:
  - ✓ MPD trigger system based on the FFD, FHCAL and TOF provides high efficiency in the FXT mode
  - ✓ potential problems with online T0 and vertex at lower beam energies
- What about light collision systems, C+C and d+d, d+W?

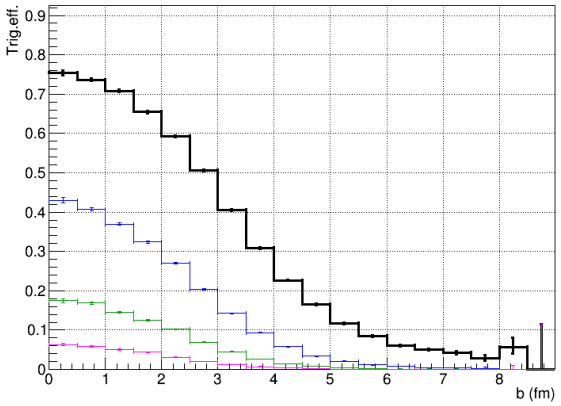
Collider mode, light systems

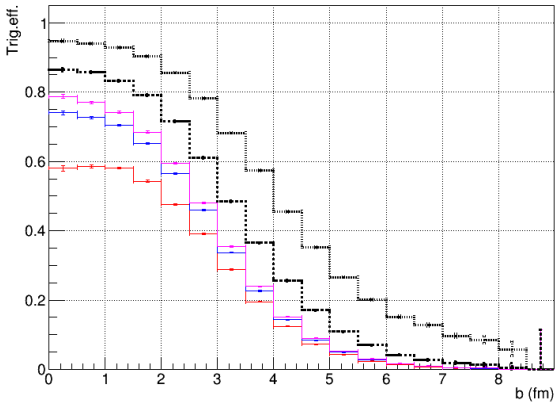
- CC@9.2 GeV, DCM-QGSM-SMM, MpdRoot with Geant-4
- See NICA seminar on 09.09.2021 for details

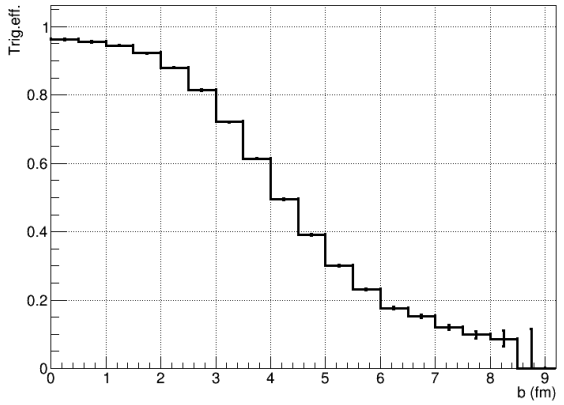












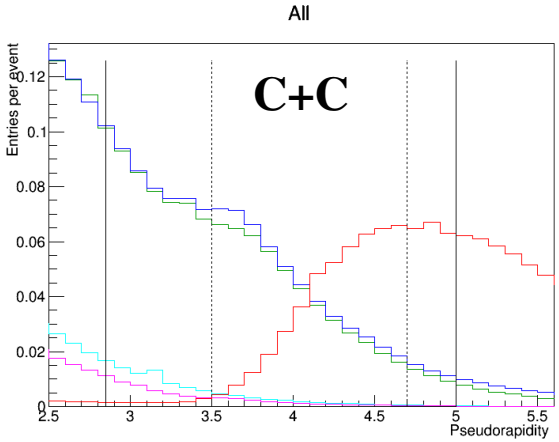
- FFD and FHCAL trigger on ~40% and ~60% of CC@9.2 collisions
- Trigger efficiency never reaches a 100% level, even in most central collisions
- What is efficiency in the fixed-target mode?

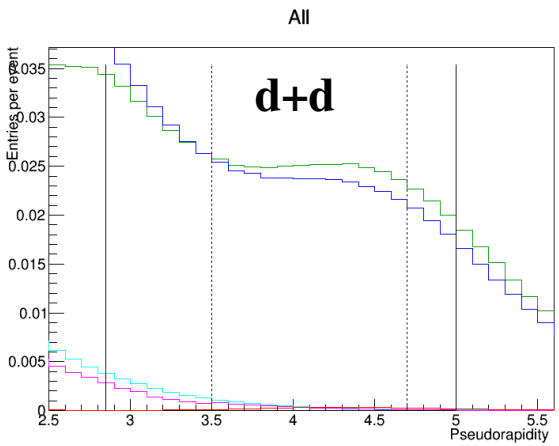
FXT mode, light systems

- Request 26 configuration
- DCM-QGSM-SMM is run in FXT mode at two energies: E = 2.0·A GeV and E = 5.5 ·A GeV
- One target position was considered:
  - ✓ x = 0, y = 0, z = -115 cm → full detector configuration
- C+C (1.5 M events), d+d (9M events)
- 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)

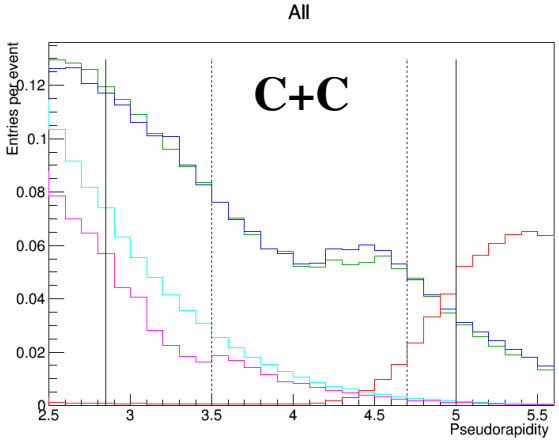
Particle composition

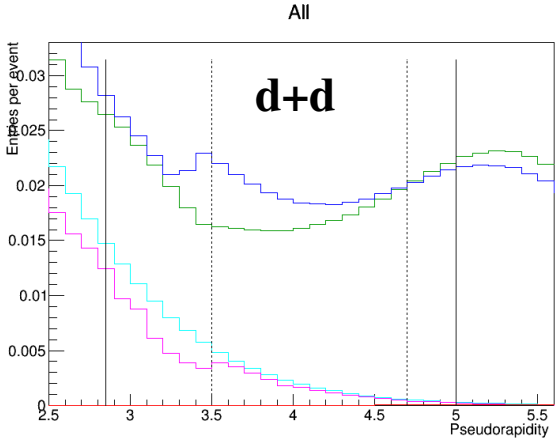
- E_{beam} = 2 A·GeV





- E_{beam} = 5.5 A·GeV





FFD

FHCAL

Pions

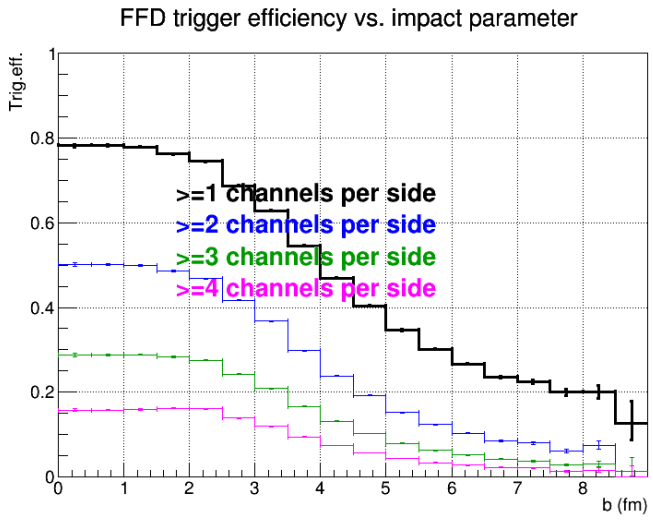
Protons

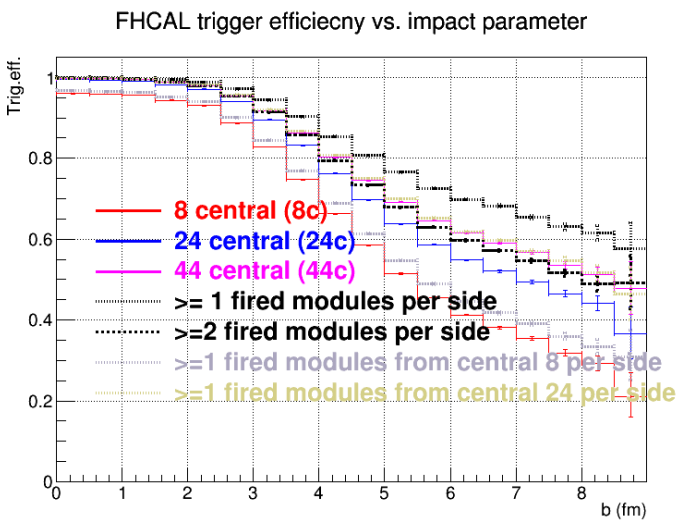
Neutrons

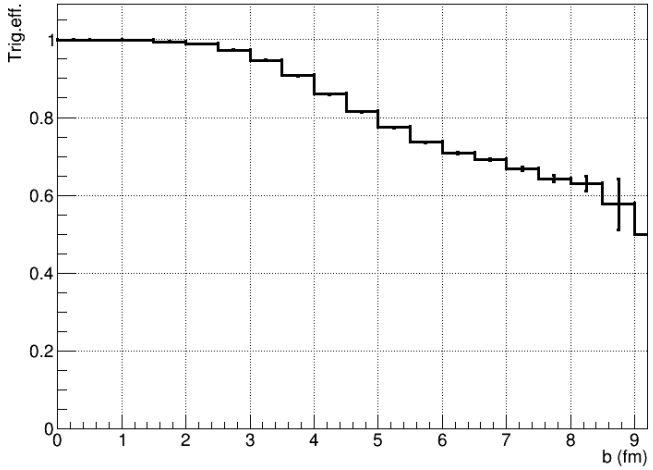
Fragments

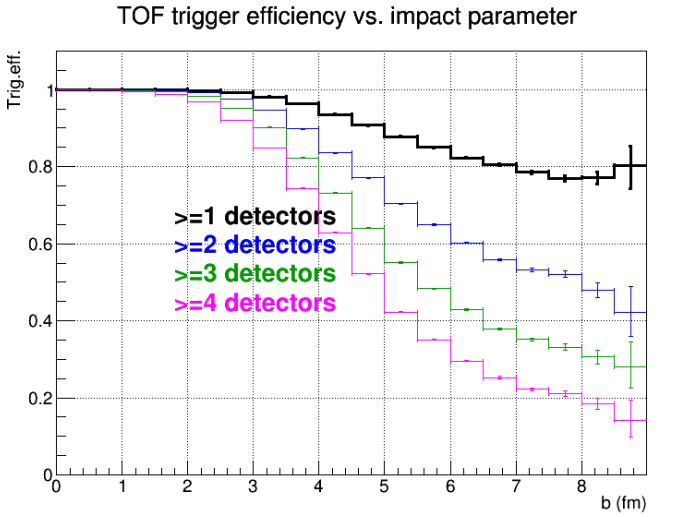
Photons

Trigger for C+C, E_{beam} = 5.5 AGeV





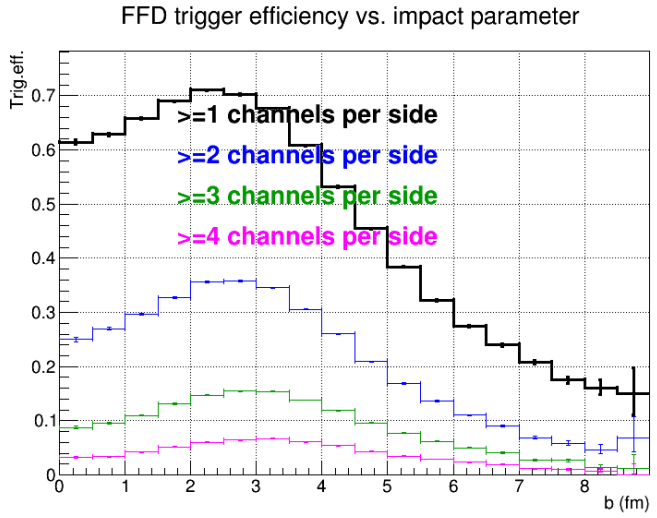


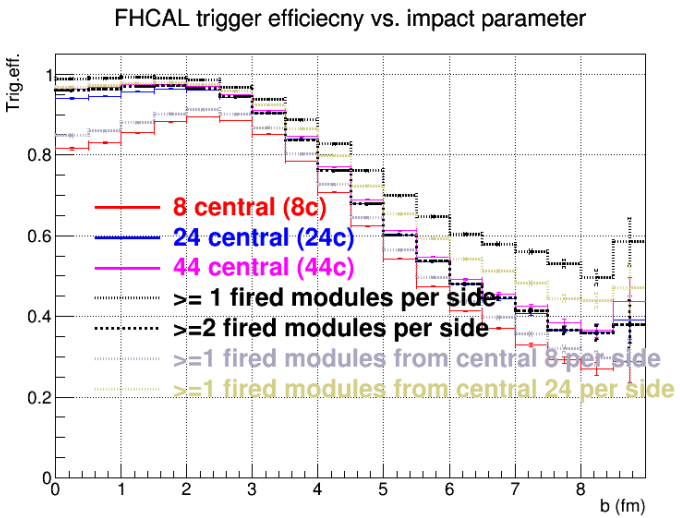


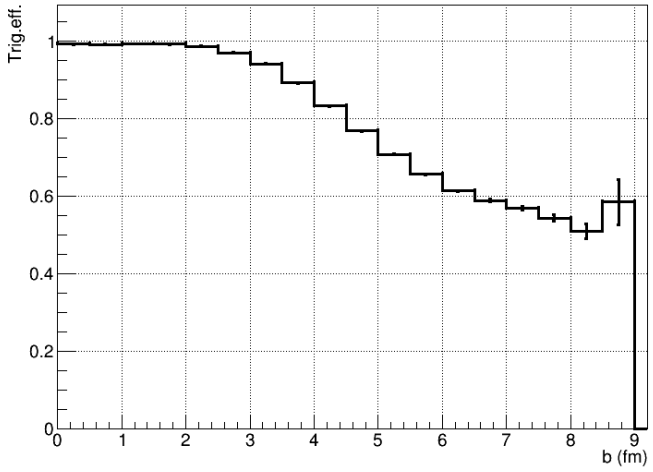
- Efficiency:
  - ✓ FFD: 10, 17, 30, 53%
  - ✓ FHCAL: 80, 83, 84, 88%
  - ✓ FFD|FHCAL: 88%
  - ✓ TOF: 70, 77, 85, 94%

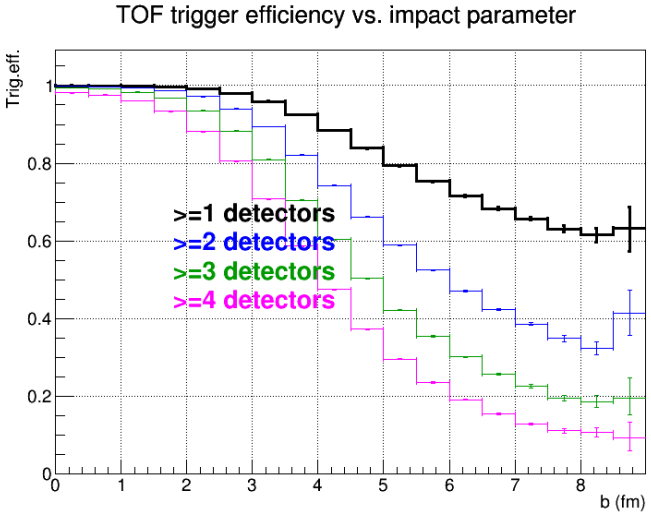
- Low FFD trigger efficiency; strong dependence of trigger efficiency on ‘number of hits’ selection
- Trigger efficiency is higher than that in the collider mode at higher energy of $\sqrt{s_{NN}}$ = 9.2 GeV

Trigger for C+C, E_{beam} = 2 AGeV







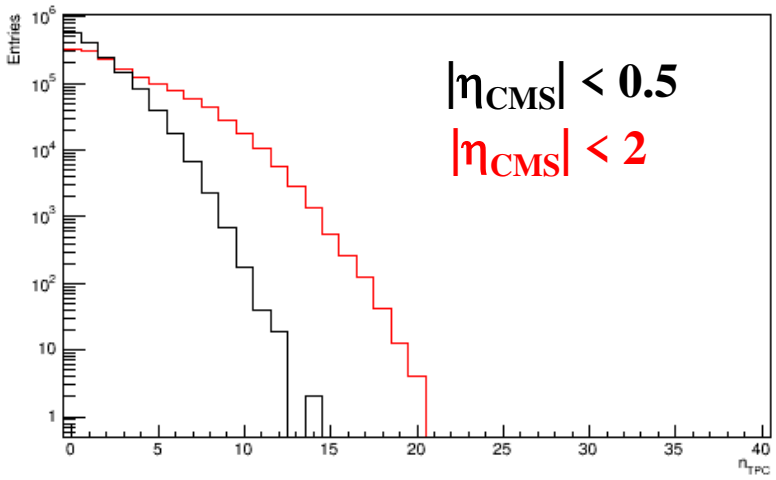


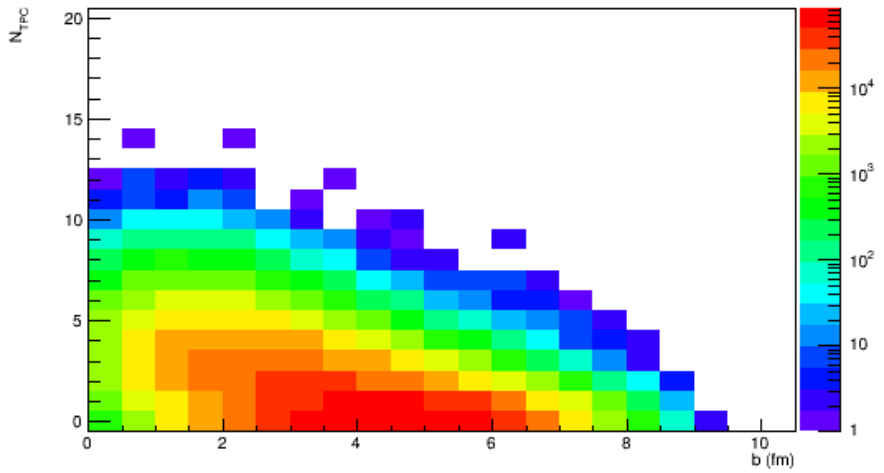
- Efficiency:
  - ✓ FFD: 5, 11, 26, 55%
  - ✓ FHCAL: 79, 79, 82, 85%
  - ✓ FFD|FHCAL: 85%
  - ✓ TOF: 58, 68, 78, 90%

- Low FFD trigger efficiency; even stronger dependence of trigger efficiency on ‘number of hits’ selection

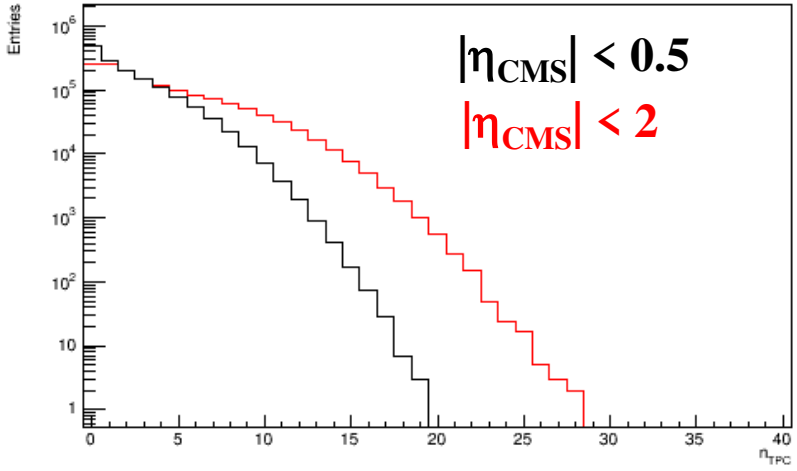
C+C, track multiplicities (n_{hits}>10, |DCA| < 2 cm, p_T > 100 MeV/c)

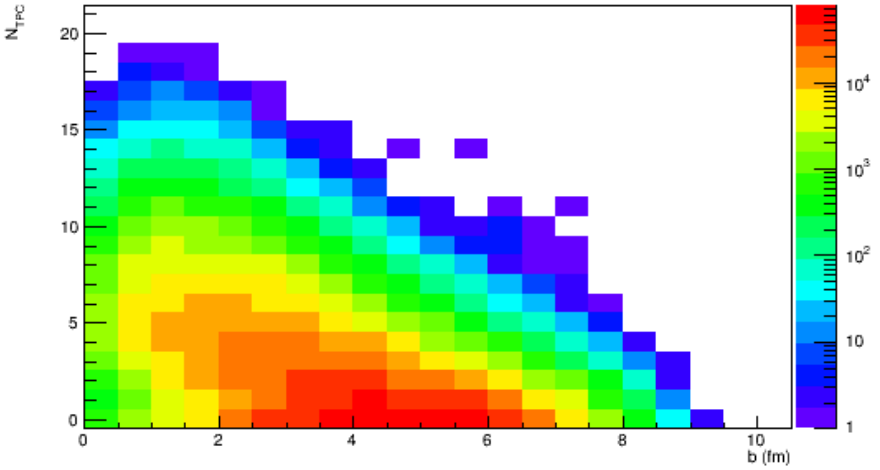
- E_{beam} = 2 A·GeV





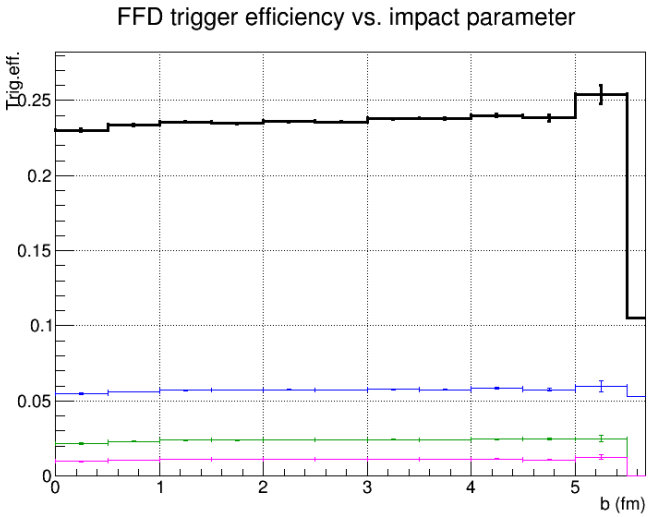
- E_{beam} = 5.5 A·GeV

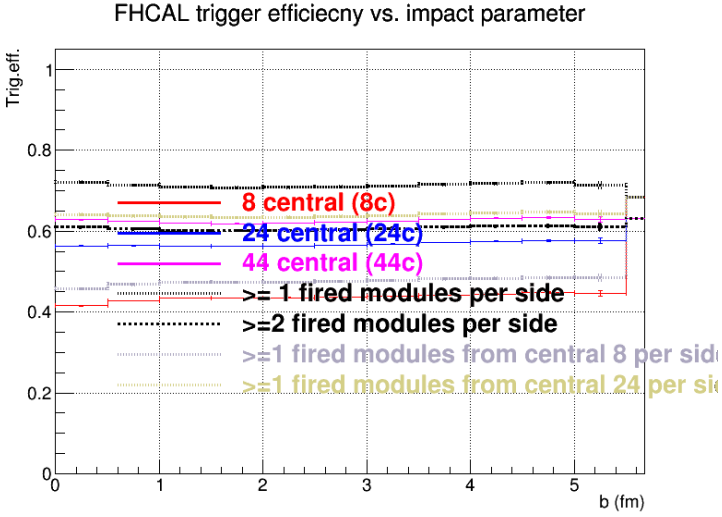


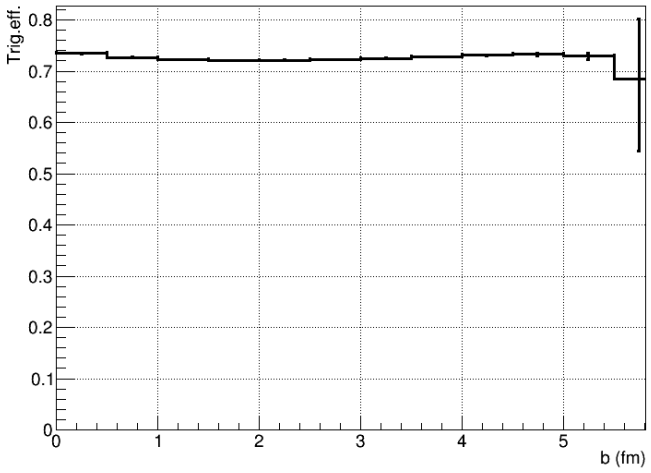


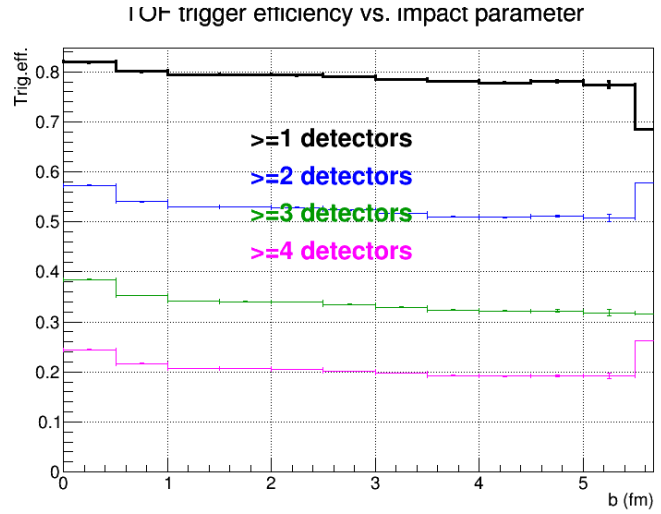
- Even most central collisions may have zero TPC multiplicity

Trigger for d+d, Ebeam = 5.5 AGeV









Efficiency:

FFD: 1, 2, 6, 24%

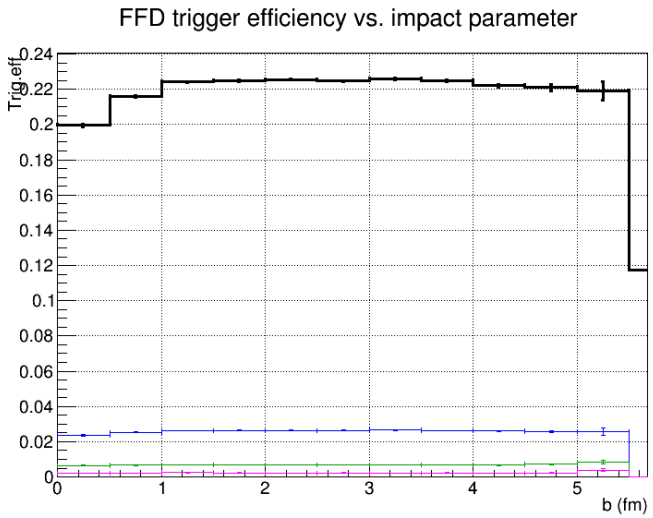
FHCAL: 56, 60, 64, 72%

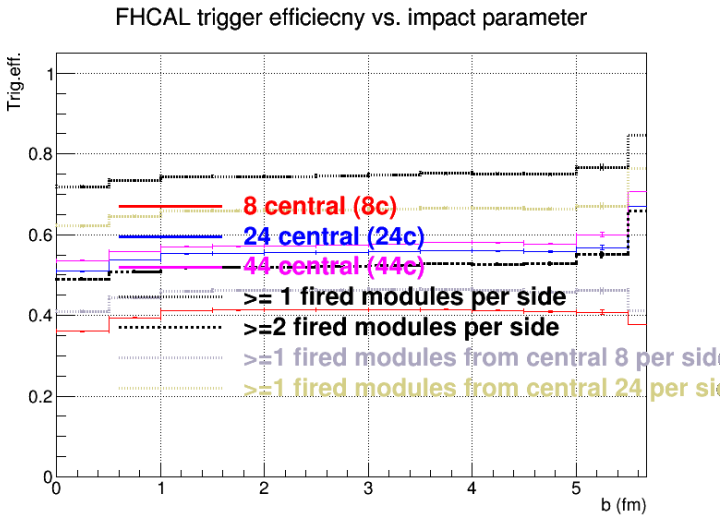
FFD|FHCAL: 72%

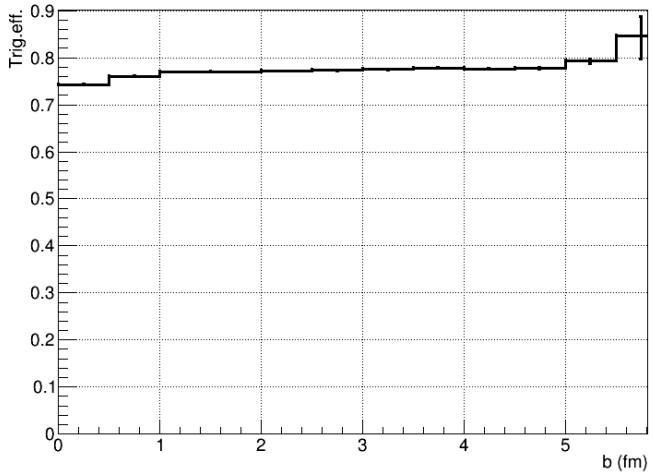
TOF: 20, 34, 53, 80%

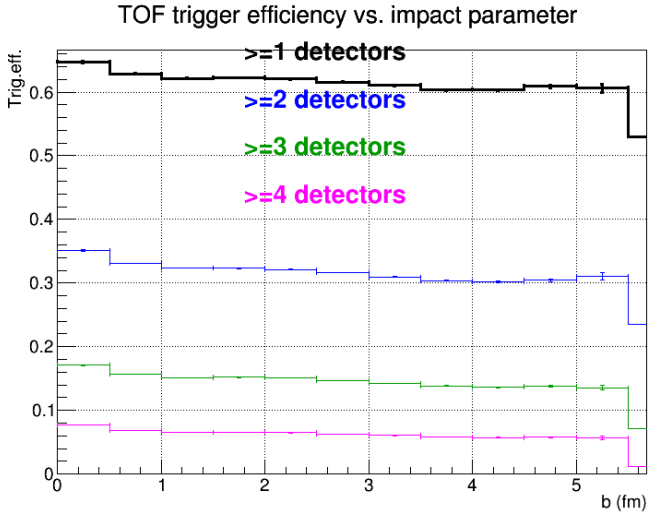
- Strong dependence of trigger efficiency on ‘number of hits’ selection for all subsystems
- Weak dependence on centrality

Trigger for d+d, E = 2 AGeV







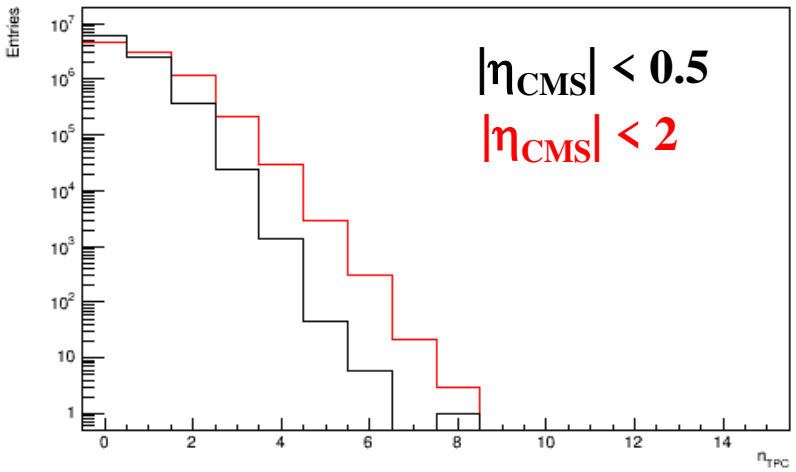


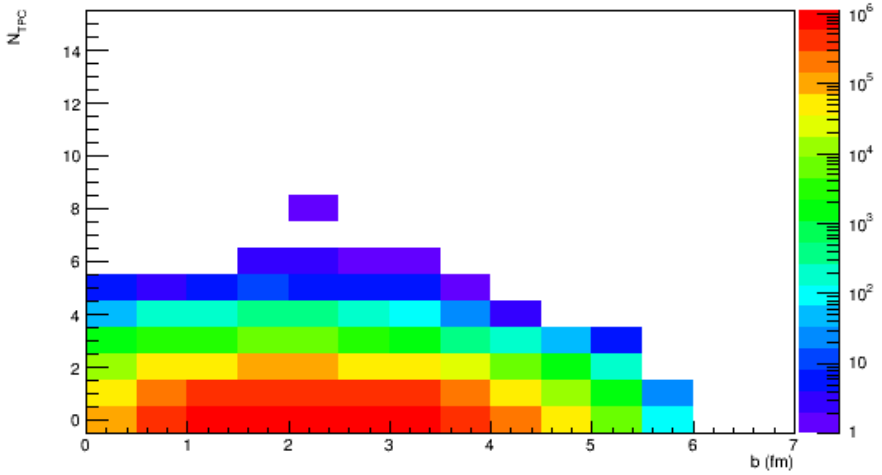
- Efficiency:
  - ✓ FFD: 0, 1, 1, 22%
  - ✓ FHCAL: 55, 52, 66, 75%
  - ✓ FFD|FHCAL: 77%
  - ✓ TOF: 7, 15, 32, 62%

- Event stronger dependence of trigger efficiency on ‘number of hits’ selection
- Weak dependence on centrality

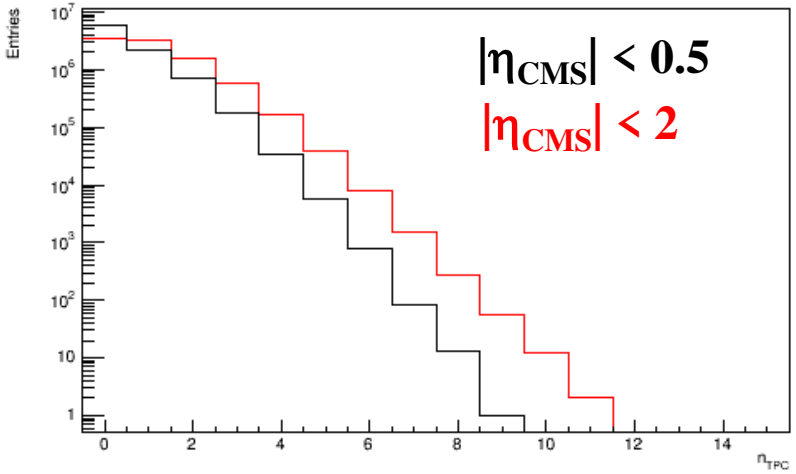
C+C, track multiplicities (n_{hits}>10, |DCA| < 2 cm, p_T > 100 MeV/c)

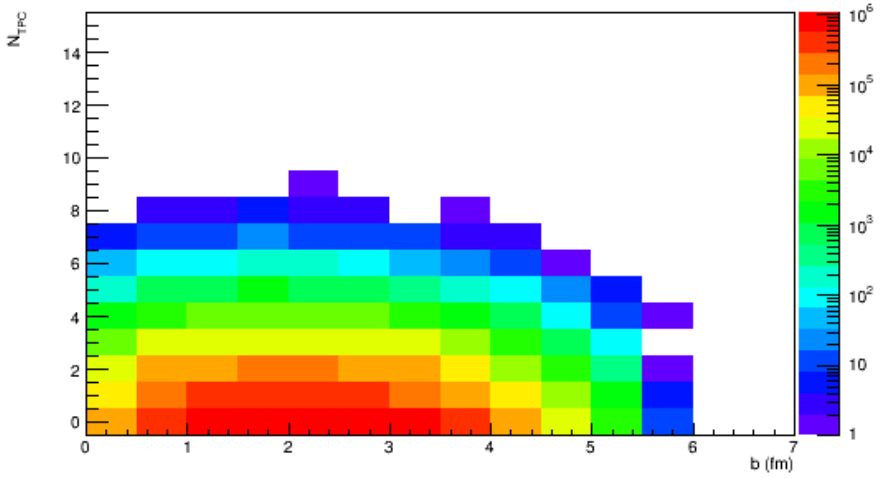
- E_{beam} = 2 A·GeV





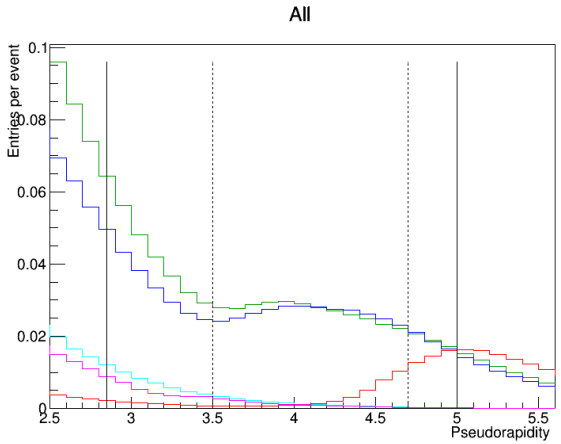
- E_{beam} = 5.5 A·GeV





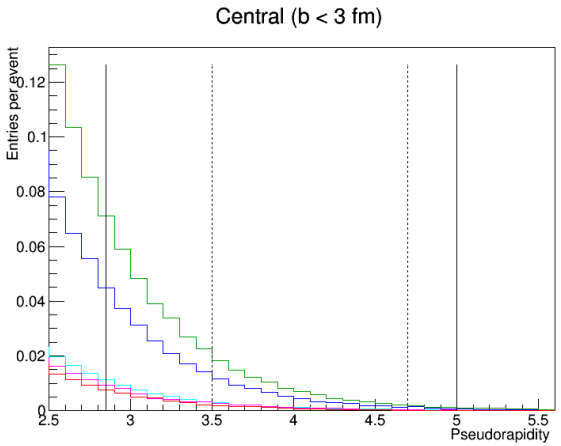
- Even most central collisions may have zero TPC multiplicity

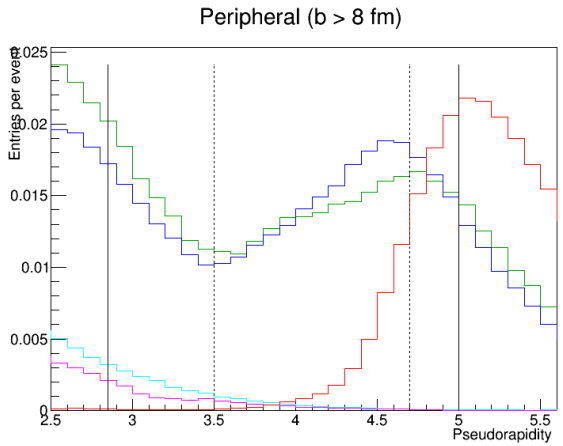
d+W, E_{beam} = 3.5 GeV (d-beam on W-wire)



FFD

FHCAL





Pions

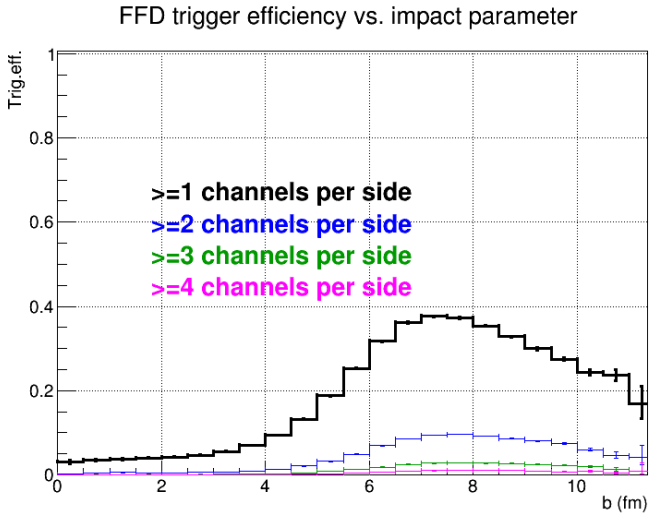
Protons

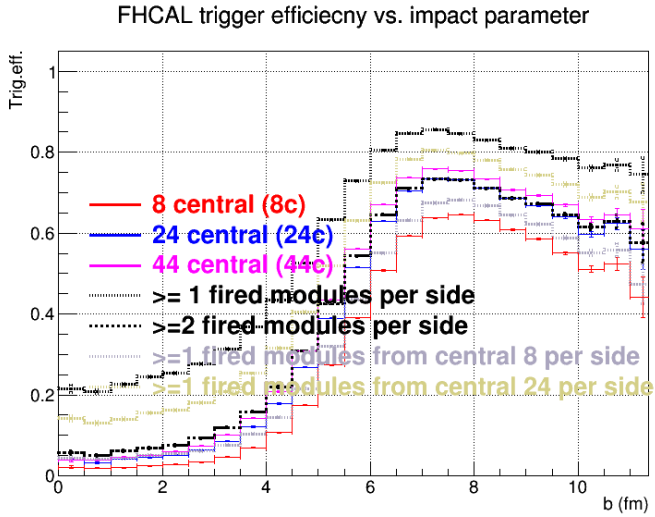
Neutrons

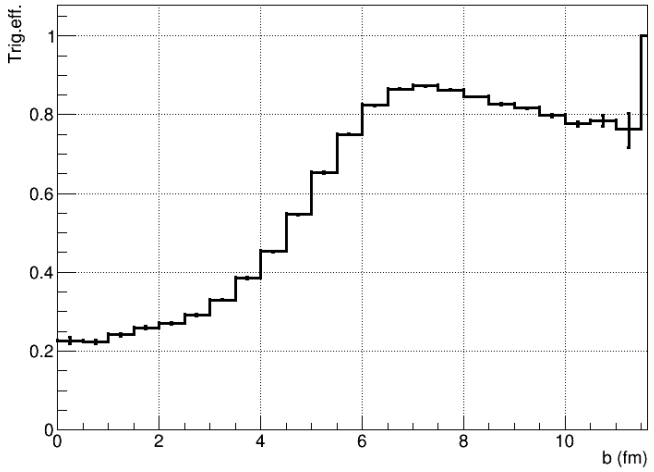
Fragments

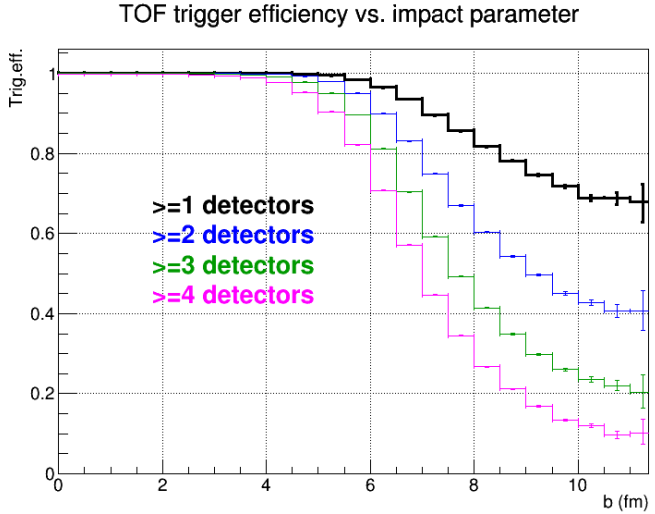
Photons

Trigger for d+W, E_{beam} = 3.5 AGeV





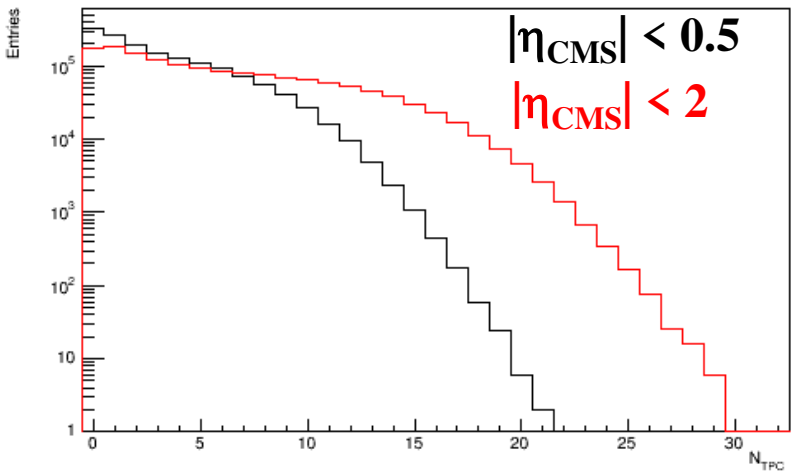


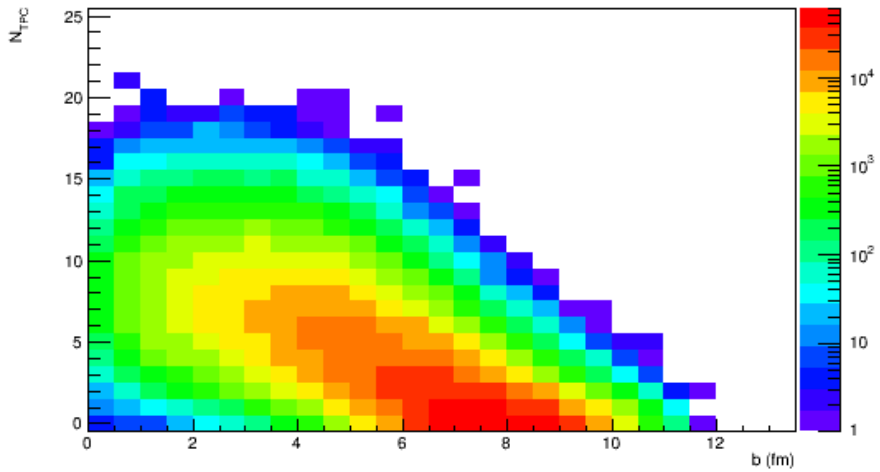


- Efficiency:
  - ✓ FFD: 0.6, 1.7, 6, 25%
  - ✓ FHCAL: 60, 53, 60, 69%
  - ✓ FFD|FHCAL: 70%
  - ✓ TOF: 65, 74, 84, 93%

- Efficiency of forward detectors is very small
- Central TOF detector provides reasonable efficiency for event selection

d+W, track multiplicities (n_{hits}>10, |DCA| < 2 cm, p_T > 100 MeV/c)





- Multiplicity-b correlation is wide but may provide decent centrality selection

Conclusions

- MPD trigger system based on the FFD, FHCAL and TOF is more efficient in the FXT mode
- Trigger system (with TOF) is sufficient for light nuclei like carbon, problems with centrality selection
- Trigger efficiency for lighter ions like deuterons is too low
- In asymmetric d+W collisions, forward detectors are inefficient, central TOF is good
- Common: problems with T0 (online and offline) due to small FFD efficiency

BACKUP