JOINT INSTITUTE
FOR NUCLEAR RESEARCH

Study of the interaction trigger for Au + Au collisions in BM@N experiment

Lashmanov N., Sedykh S. A., Yurevich V. I.

Content:

Target Area Detector Performance :

- *Target area detectors*
- *Background conditions*
- *Efficiency of triggering Au+Au collisions*
- *Centrality selection with BD and SiD triggers*

Forward Detector Performance:

- *Fragment Detector*
- *Forward Hadron Calorimeter*

Interaction Trigger Concept:

- *Beam Trigger (BT)*
- *Min. Bias Trigger (MBT)*
- *Centrality Trigger (CCT)*

Introduction

THE TRIGGER DETECTOR SYSTEM CONSISTS OF:

BEAM COUNTERS

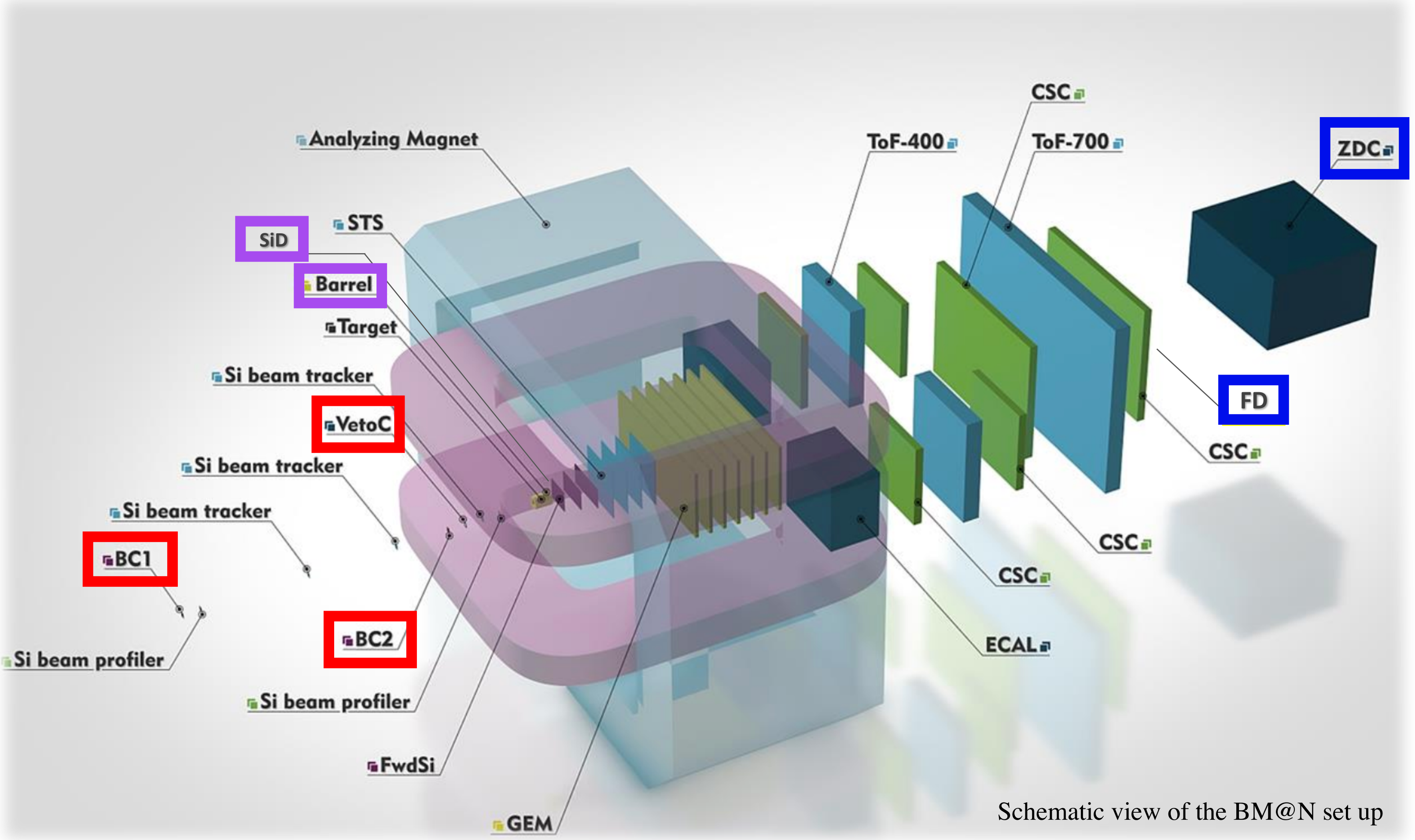
Detecting each beam particle incident on the target

TARGET AREA DETECTORS

Scintillation barrel and silicon multichannel detectors measuring multiplicity of secondary charged particles

FORWARD DETECTORS

Cherenkov detector of beam ion fragments and hadron calorimeter



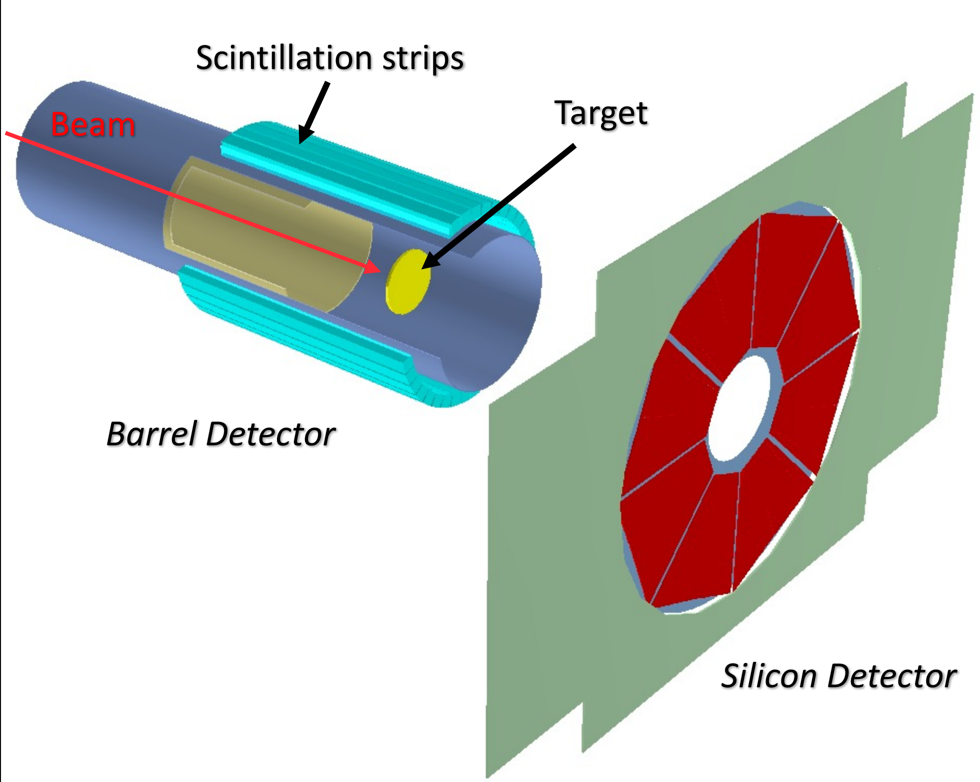
Schematic view of the BM@N set up

- The fast interaction trigger is based on information coming from the target area and forward detectors and is used for effective selection of collision events in the BM@N target.
- The detector and interaction trigger performance for Au + Au collisions at energy of 4 A GeV were studied by Monte-Carlo simulation with a code DCM-QGSM + GEANT4.

Target Area Detector Performance

Barrel Detector

- The BD consists of 40 scintillation strips $150 \times 7 \times 7$ mm^3.
- The inner radius of the strip cylinder is 46 mm.
- The BD covers a region of large polar angles and detects the charged particles, mainly protons and pions, produced in nucleus – nucleus collisions.



The geometry of the target area of the BM@N experiment.

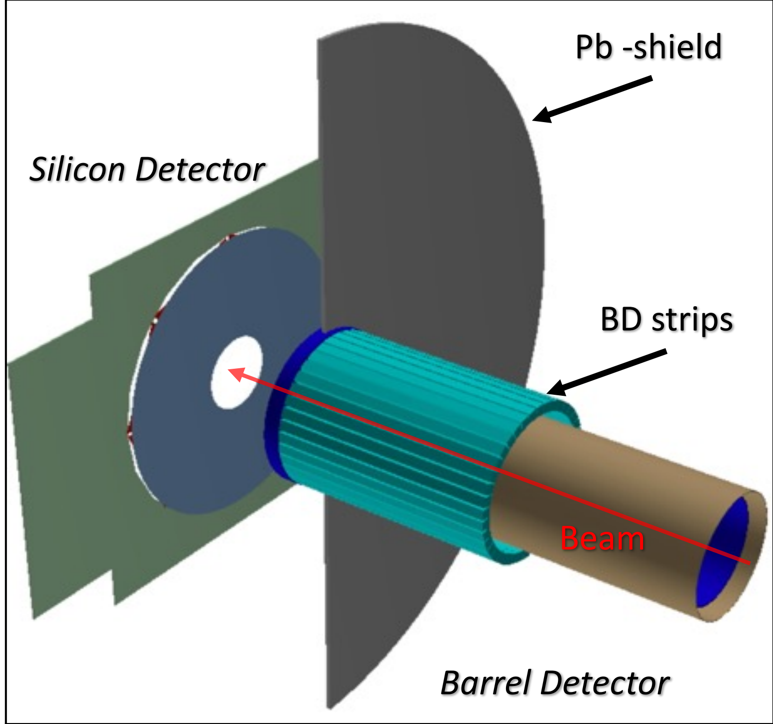
Silicon Detector

- The forward angle region is covered by the SiD with inner and outer radii of 25 and 93 mm respectively.
- The distance from the target to SiD is 120 mm.
- The SiD has a thickness of 525 μm and consists of 64 trapezoidal strips.

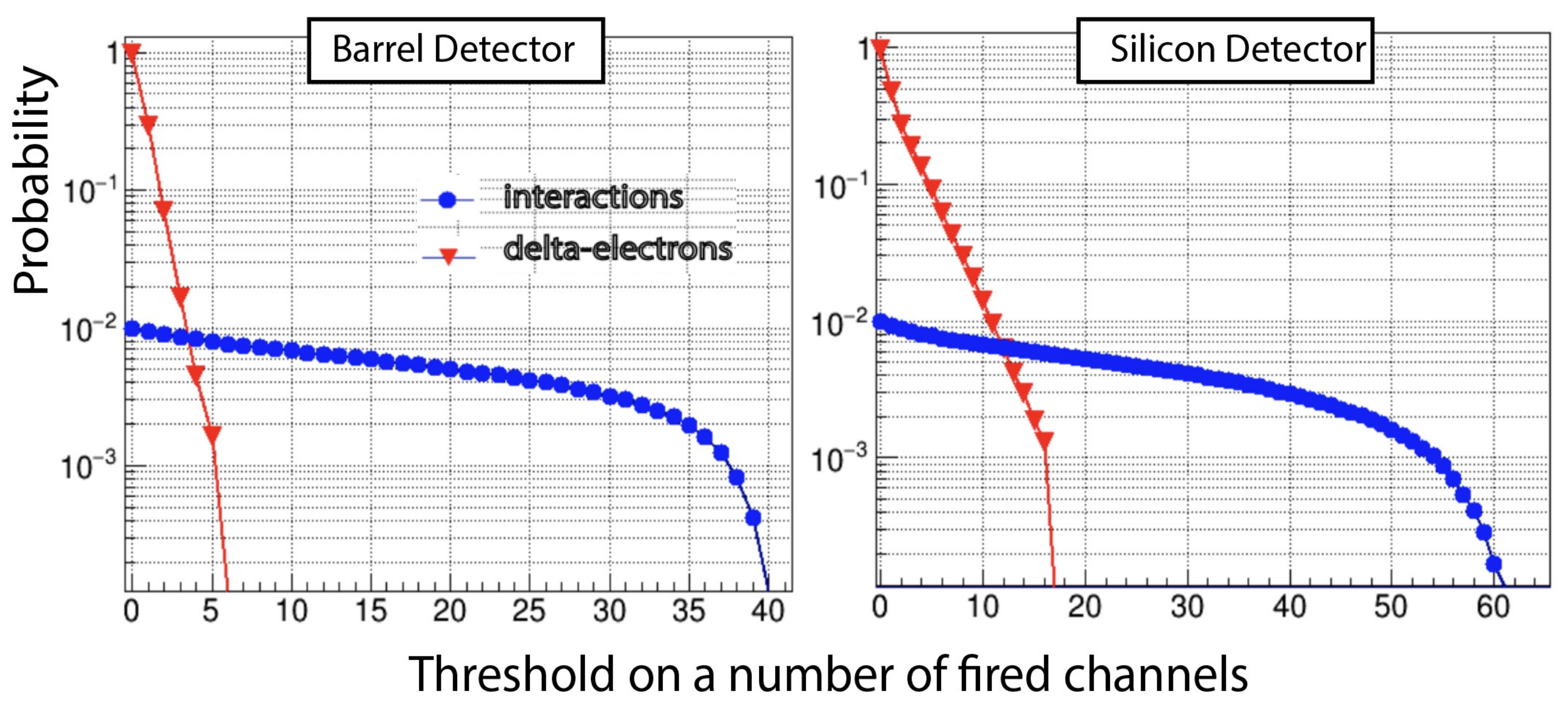
- The BM@N target area with multichannel detectors – Barrel Detector (BD) and Silicon Detector (SiD) – is schematically shown in figure. The Au target with a thickness of 300 µm is placed inside the BD at a distance of 50 mm from the end of BD.
- The target area is located inside the BM@N magnet with a field of B = 0.9 T

Background conditions

- Background conditions were studied by Monte-Carlo simulation with a code DCM-QGSM + GEANT4.
- The δ – electron background produced by Au ions in the target can make an essential contribution to the number of fired channels in BD and SiD detectors.



- *Inner shield*: Pb - cylinder 5 mm thick;
- *Outer shield*: Half-disk segment, R = 25 cm, L = 1 cm.

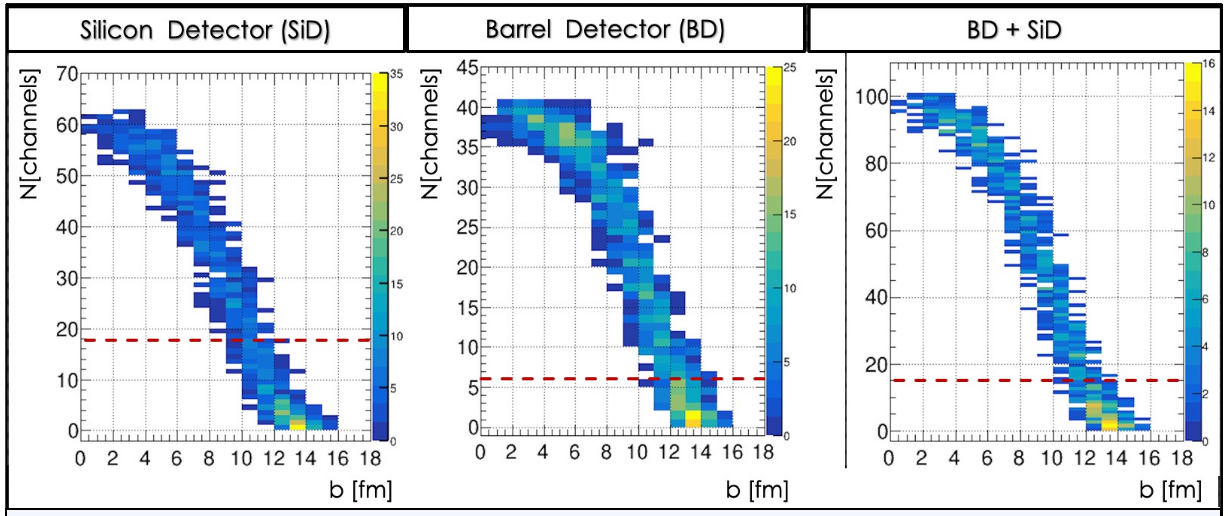


The probability of true (blue) and false (red) triggers in the registration of Au + Au collisions as a function of the threshold on the number of counts in BD (left) and SiD (right) detectors.

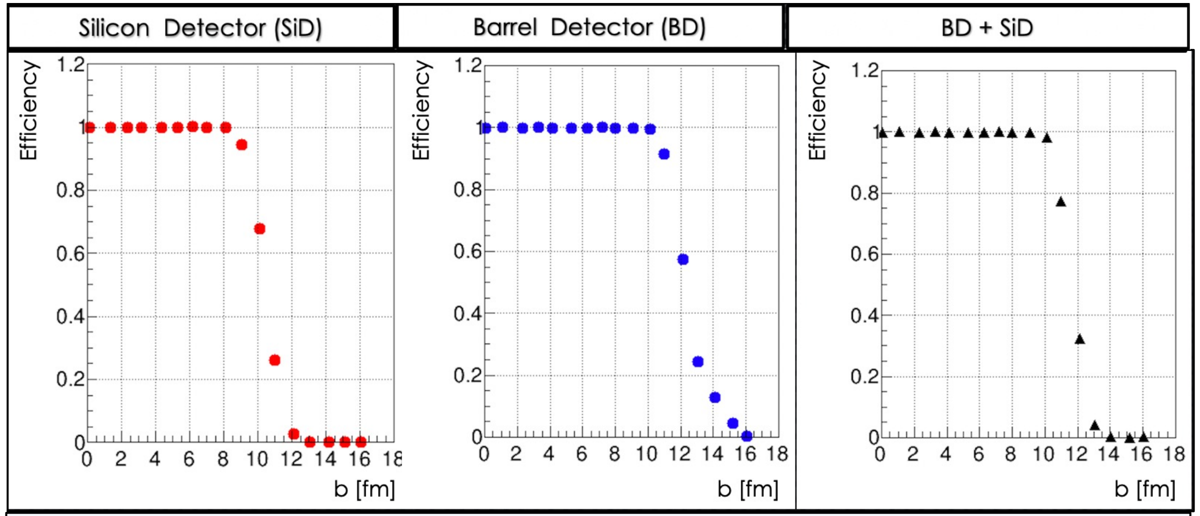
Efficiency of triggering Au+Au collisions

- Target Area Detector performance is evaluated with heavy ion collisions simulation data.
- The total granularity of the target area detectors is 40 + 64 = 104 channels.
- The threshold conditions for suppression of the δ -electron background:
  - 18 channels in the SiD, 6 channels in the BD.

- With this condition the efficiency is 100% for central and semi-central Au+Au collisions for both the individual detectors and sum of the detector responses.



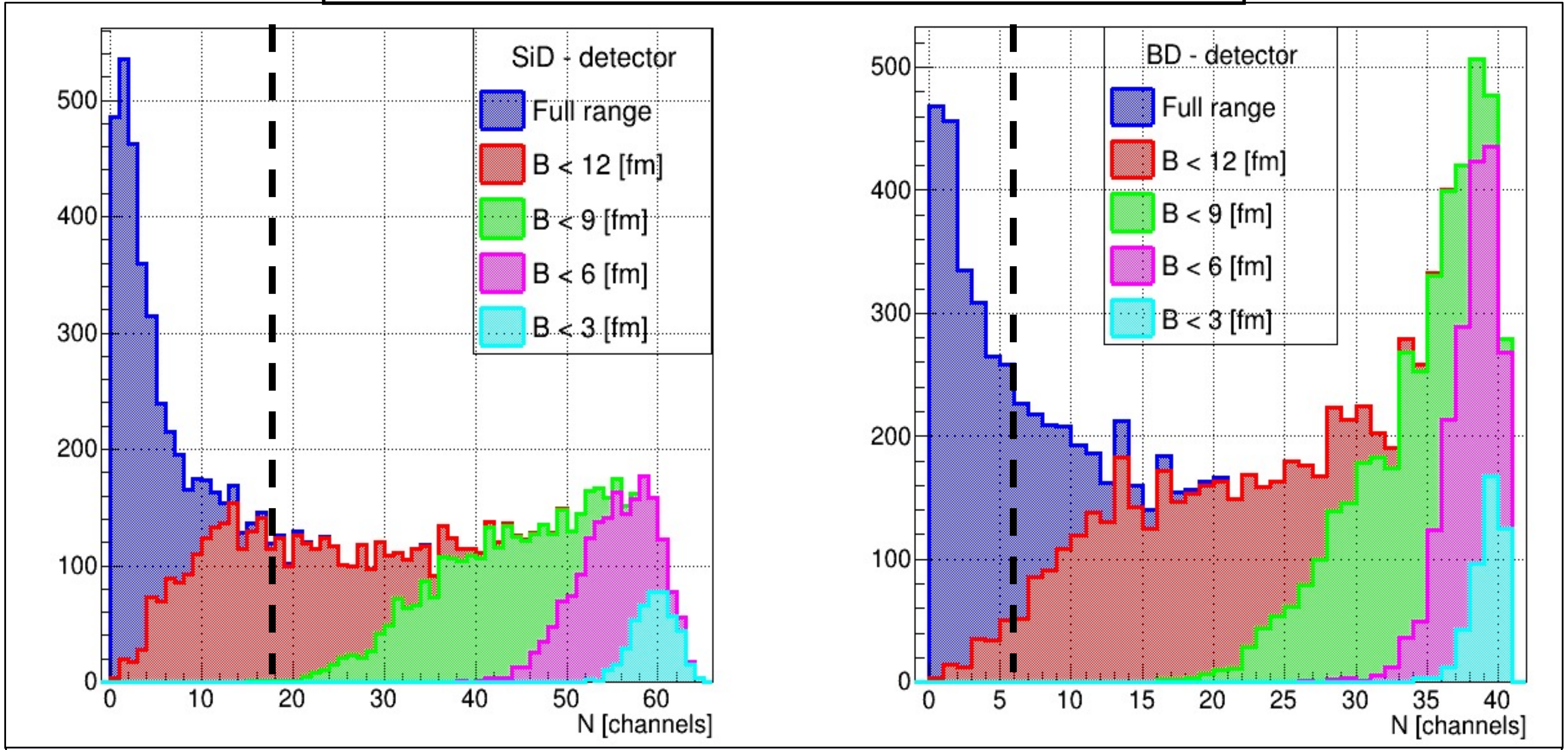
The number of counts in the trigger detectors (SiD, BD, BD+SiD) in the registration of Au+Au collisions depending on the impact parameter.



Efficiency of the trigger detectors (SiD, BD, BD+SiD) in the registration of Au+Au collisions as a function of the impact parameter

Centrality selection with BD and SiD triggers

DCM-QGSM, Au + Au, 4 GeV/n



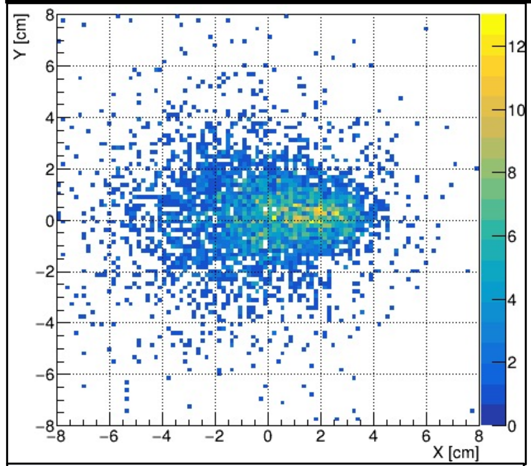
Fired channels of detectors (SiD, BD) for the centrality determination.

- Background from δ –electrons limits our ability to organize Min. Bias trigger with multichannel detectors (BD and SiD).

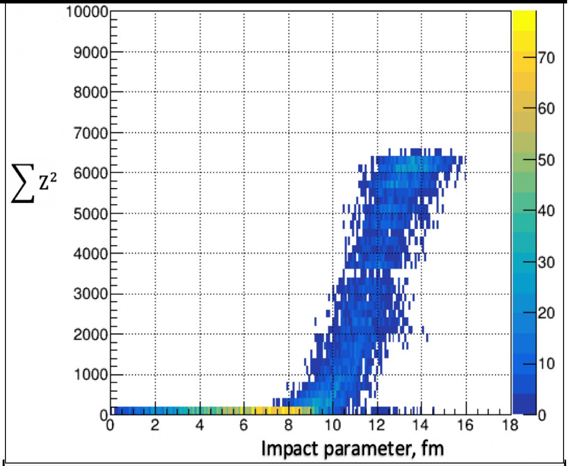
Fragment Detector (FD)

- *Fragment Detector (FD)* with transverse dimensions 160x160 mm^2 will be placed after the vacuum pipe in front of the calorimeter (FHCal).

DCM-QGSM, Au + Au, 4 GeV/n



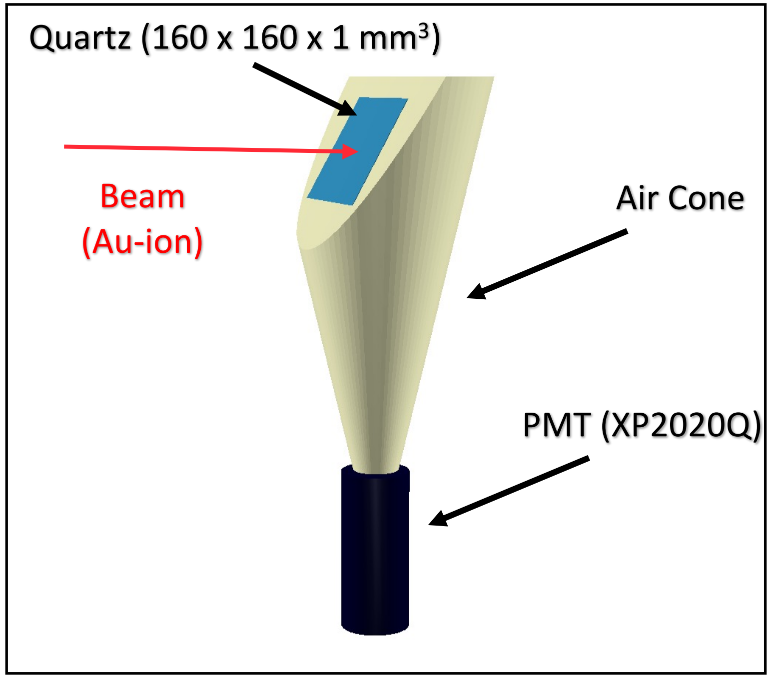
Distribution of charged fragments in the forward detector. (Z > 6).

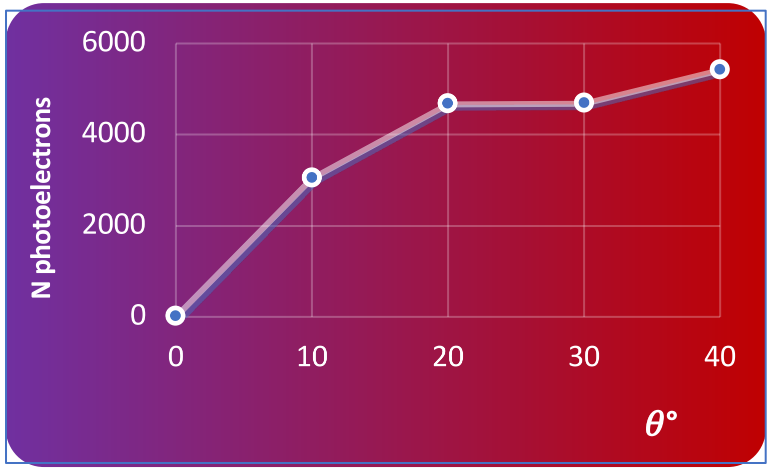


The square sum of the charges as a function of the impact parameter.

- The amplitude of the summed signal from the FD can be used:
  - for vetoing non-interaction events;
  - for generating a trigger on central and semi-central collisions;
  - for additional offline characterization of peripheral collisions.

Calculation of the Cherenkov light yield from Au-ion



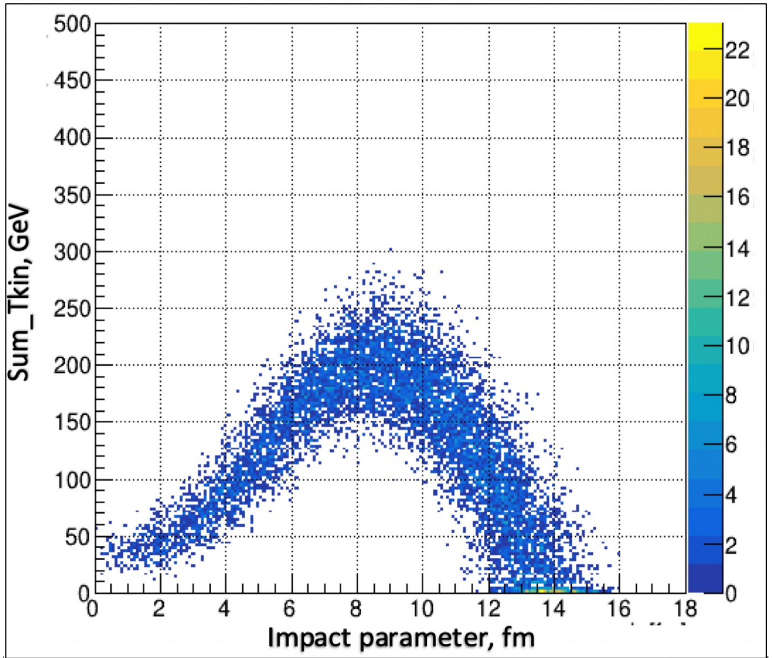


$\boldsymbol{n}(\lambda) = [1{,}453 \div 1{,}550]$

$\boldsymbol{\lambda} = [170 \div 650]$ nm

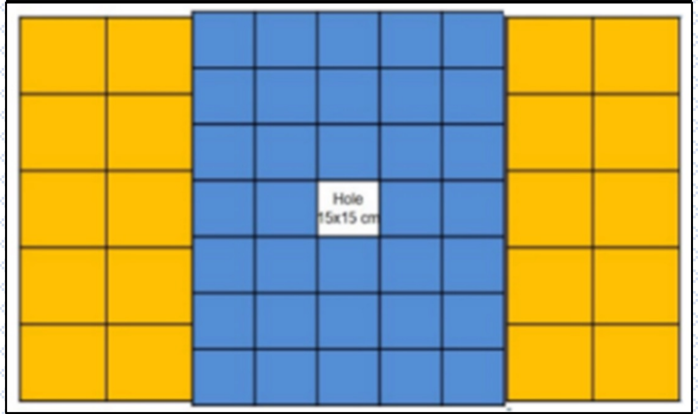
Forward hadron calorimeter (FHCal)

- In future BM@N runs the new FHCal will replace the ZDC at the end of the beam line at a distance of 9 m from the target.
- The FHCal has a hole in the beam area, and consists of two types of modules for inner and outer regions with transverse size 150x150 mm^2 and 200x200 mm^2, respectively.
- In the current study, the MC simulations were used to explore the possibility to include the signals from the FHCal in the trigger.



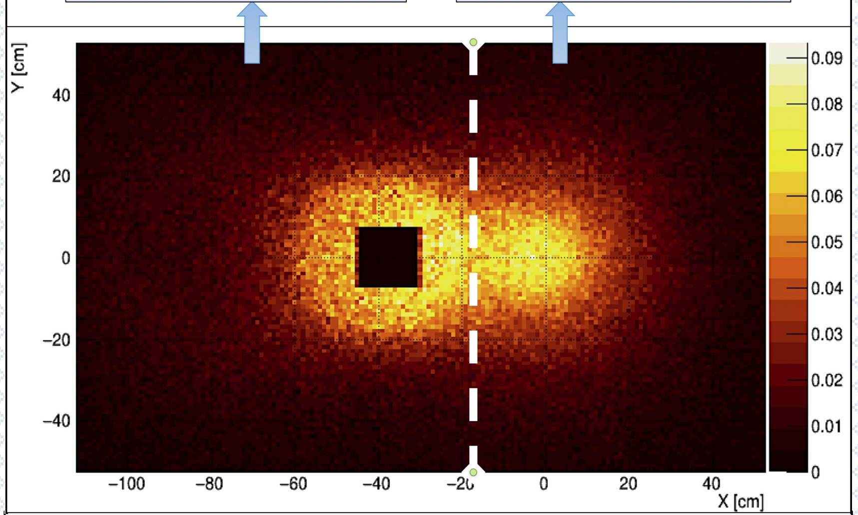
Summed energy of all neutrons in FHCal as a function of the impact parameter.

Proposed geometry of new FHCal BM@N.



Charged fragments zone

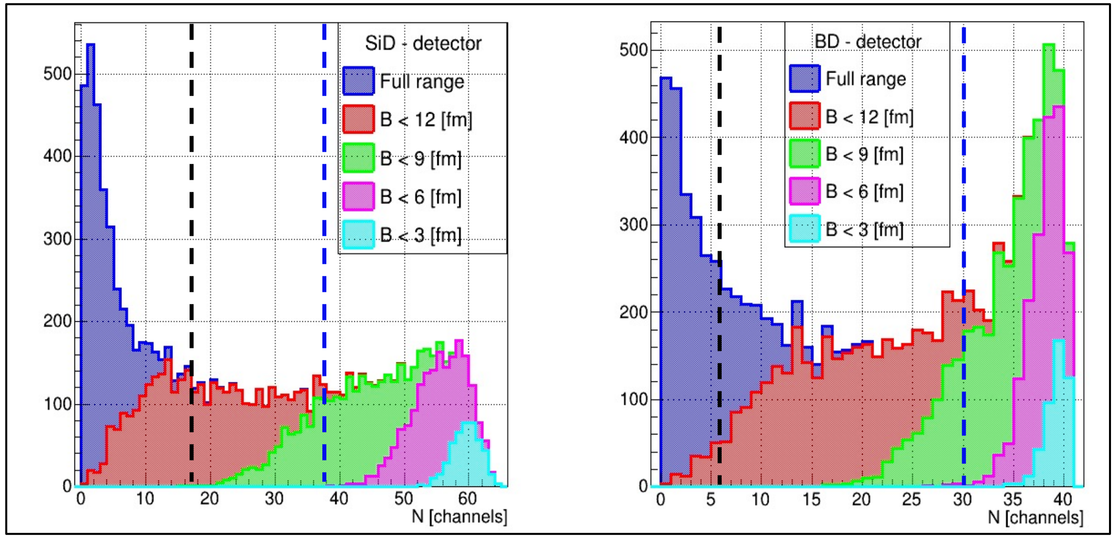
Neutron zone

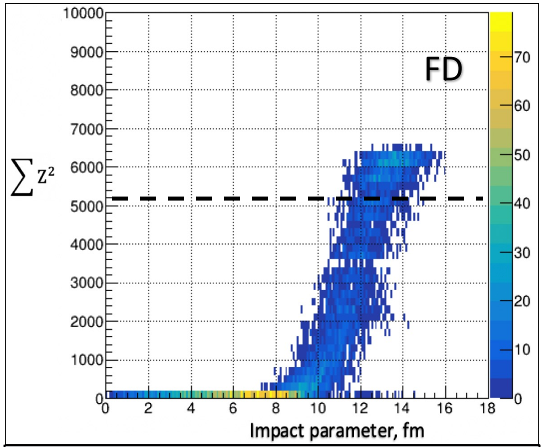


Estimation of the average energy of the interaction products per event in the FHCal area. [GeV].

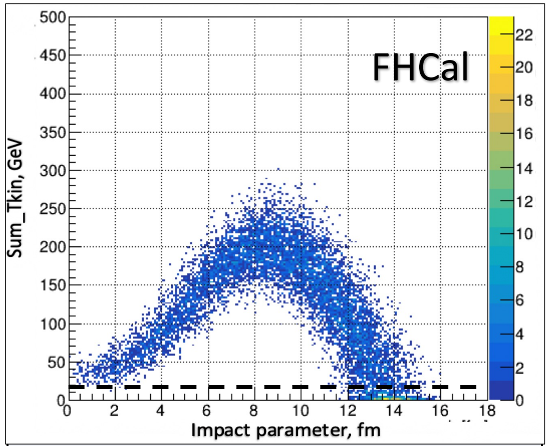
Interaction Trigger Concept

Trigger type	Trigger logic
Beam Trigger (BT)	BT = BC1 * VC_{veto} * BC2
Min. Bias Trigger (MBT)	MBT = BT * FD_{veto} * FHCal
Centrality Trigger 1 (CCT1)	CCT1 = MBT * BD(low) * SiD(low)
Centrality Trigger 2 (CCT2)	CCT2 = MBT * BD(high) * SiD(high)
No Interaction Trigger (NIT)	NIT = BT * $FD_{Au\text{-}ion}$ * $FHCal_{veto}$





The square sum of the charges as a function of the impact parameter.



Summed energy of all neutrons in FHCal as a function of the impact parameter.

JOINT INSTITUTE
FOR NUCLEAR RESEARCH

BM@N

Baryonic Matter at Nuclotron

Thank you for your attention