

Phase Zero for the MPD at NICA

April 30, 2020

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Studies for an improved Phase Zero

How can we have trigger capabilities (efficiency and vertex determination)? How can we also say something about luminosity? and crucially! how can we distinguish beam-gas interactions veto?

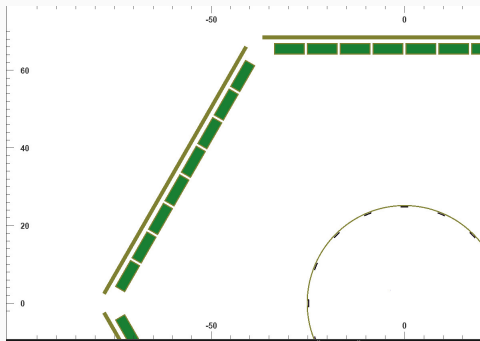
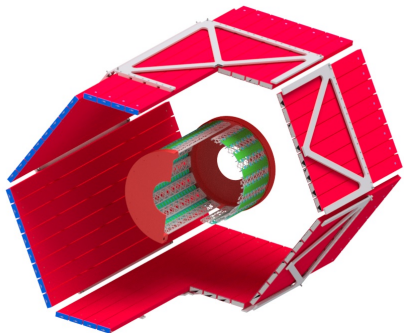
New geometry that assumes three components (from innermost to outermost):

- miniBeBe → **MBB**
- **MCORD**
- BeBe → **BMD** (Oleg's recent updated geometry in MPDroot)

In this presentation:

MPD Phase Zero: MBB + MCORD + BMD

MPD Phase Zero detector geometry



Inner detector → miniBeBe cylinder [71.4 cm length, 52 cm diameter]

Outer detector → 6 hexagonal MCOR sections [174 cm length, 65 cm distance (nearest surface)]

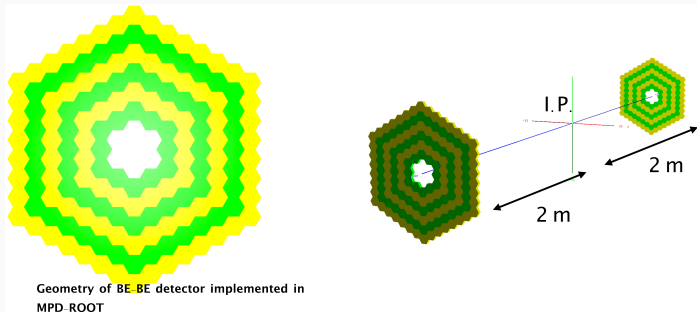
currently testing slight variations on this geometry

Detector concept: geometry

Main role of MPD beam-beam counter detector (BEBE):

Produce a signal for the MPD Level-0 trigger

- ✓ two hodoscope detectors, 2 m from IP at opposite sides
- ✓ each hodoscope has 162 hexagonal plastic scintillator cells arranged in 6 concentric rings



Abstract

The MPD-Phase0 geometry has been simulated. This geometry assumes MBB, MCORD, BMD (beam-monitoring detector) detectors only. The simulation was done to evaluate the trigger capabilities of MPD-Phase0 detector for heavy-ion collisions as well as beam-gas interactions veto. Trigger efficiencies for MBB and MCORD have been obtained for Bi-Bi collisions at 9 GeV center of mass energy.

More details on BMD detector (NIM-A paper):

<https://doi.org/10.1016/j.nima.2019.163150>

<https://arxiv.org/abs/1809.10553>



Nuclear Instruments and Methods in
Physics Research Section A:
Accelerators, Spectrometers, Detectors
and Associated Equipment

Volume 953, 11 February 2020, 163150



A beam-beam monitoring detector for
the MPD experiment at NICA

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Monte Carlo description

Beam-Beam studies:

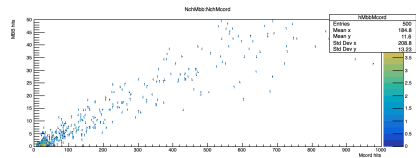
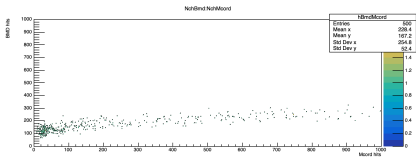
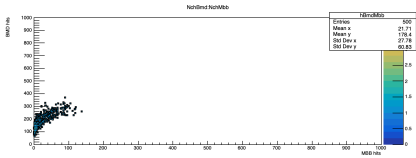
- Generator model: UrQMD
- Beam: Bi+Bi
- cms energy: 9 GeV
- detectors: MBB, MCORD (bebe3) and BMD (beam-monitoring detector)
- Number of events: 500
- Centrality range: 0%-90%
- vertex smearing

Beam-gas studies:

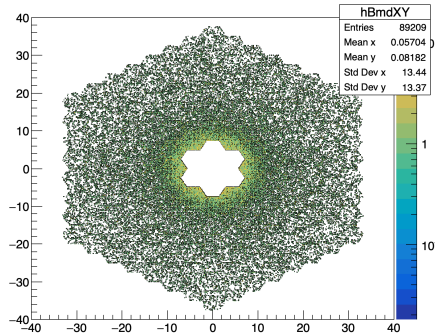
- Generator model: UrQMD
- Beam: p-O
- cms energy: 9 GeV
- detectors: MBB, MCORD (bebe3) and BMD (beam-monitoring detector)
- Number of events: 100,000
- Z-vertex location: +/- 5,10,15 and 19 meters from I.P. (width of 3.5 meters)

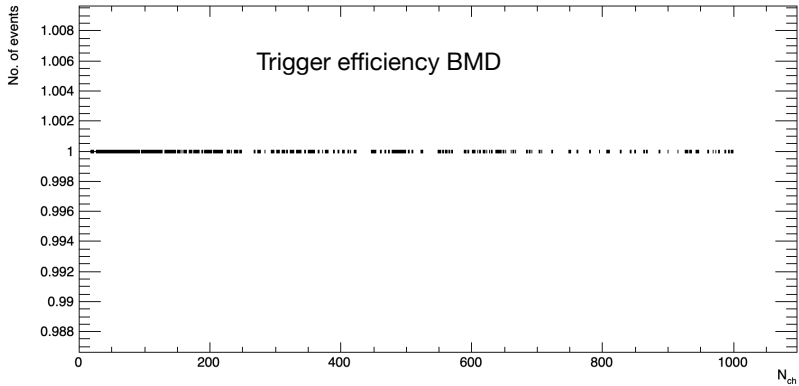
Warning: I used MPD-ROOT with a merge of two branches (MBB and MCORD)

MPD Phase Zero Beam-Beam studies

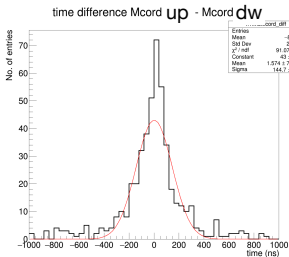


Bmd points X:Y

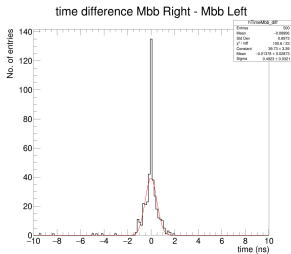




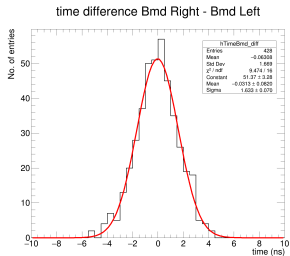
Monte Carlo study: Beam-Beam



MCORD



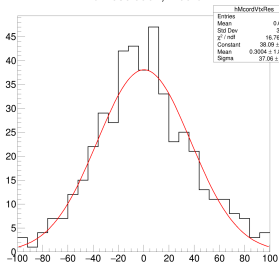
MBB



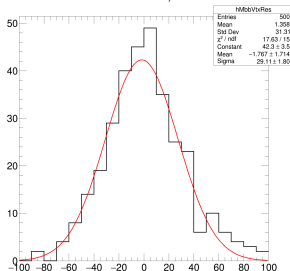
BMD

Monte Carlo study: Beam-Beam

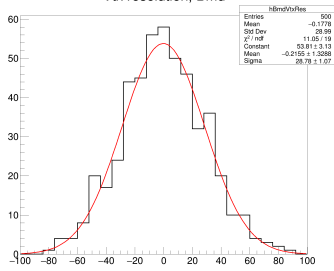
Vtx resolution, Mcord



Vtx resolution, Mbb



Vtx resolution, Bmd

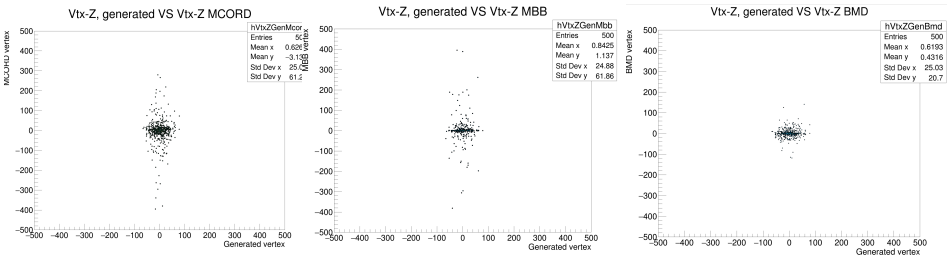


$$0.5 * (time_{up} - time_{dw})c$$

$$0.5 * (time_{right} - time_{left})c$$

$$0.5 * (time_{right} - time_{left})c$$

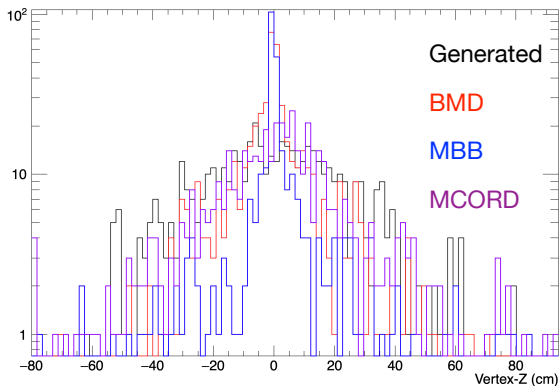
Monte Carlo study: Beam-Beam VertexGen - VertexBMD



none of this detectors (MCOR, MBB and BMD) are able to give an accuracy determination of Z-vertex. Large spread is observed for MCOR and MBB.

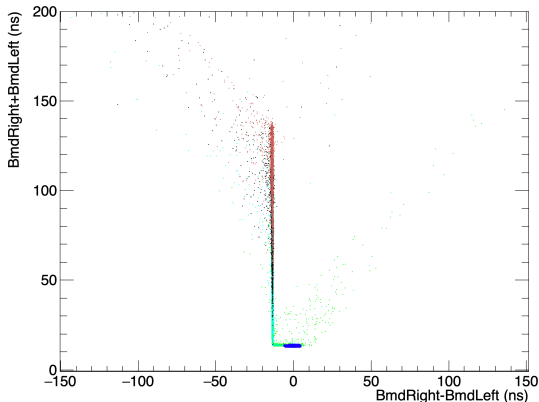
BMD detector shows the best resolution for vertex determination (previous slide)

Monte Carlo study: Beam-Beam VertexGen - VertexBMD



MPD Phase Zero Beam-Gas studies

Bmd-righ+Bmd-left VS Bmd-right-Bmd-left (leading time)



leading time : time of flight of the first hit in the detector

BMD (beam-gas)

BMD (beam-gas / 5 m w.r.t. IP)

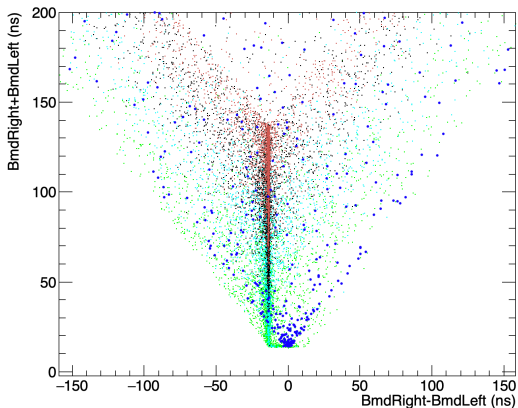
BMD (beam-gas / 10 m w.r.t. IP)

BMD (beam-gas / 15 m w.r.t. IP)

BMD (beam-gas / 19 m w.r.t. IP)

beam-gas interactions closer to IP (< 10 m) can not be vetoed by BMD (green and cyan points).

Bmd-righ+Bmd-left VS Bmd-right-Bmd-left (average time)



average time : average hit time

BMD (beam-gas)

BMD (beam-gas / 5 m w.r.t. IP)

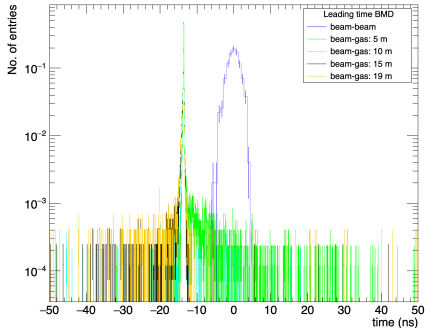
BMD (beam-gas / 10 m w.r.t. IP)

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BMD (beam-gas / 19 m w.r.t. IP)

beam-gas interactions closer to IP (< 10 m) can not be vetoed by BMD (green and cyan points).

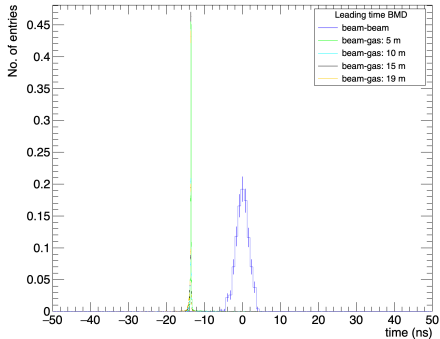
time difference Bmd Right - Bmd Left



the tail of beam-gas interactions overlaps with beam-beam events

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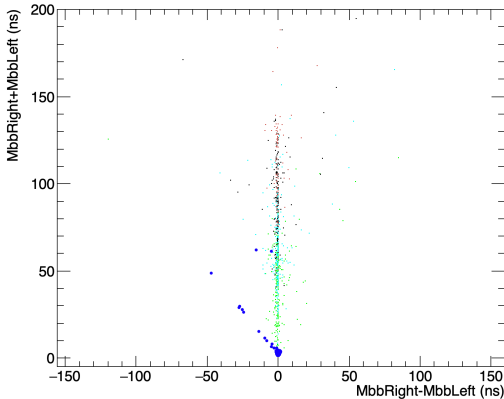
time difference Bmd Right - Bmd Left



In principle it may be possible to veto beam-gas interactions with BMD

leading time : time of flight of the first hit in the detector

Mbb-right+Mbb-left VS Mbb-right-Mbb-left (leading time)



MBB (beam-gas)

MBB (beam-gas / 5 m w.r.t. IP)

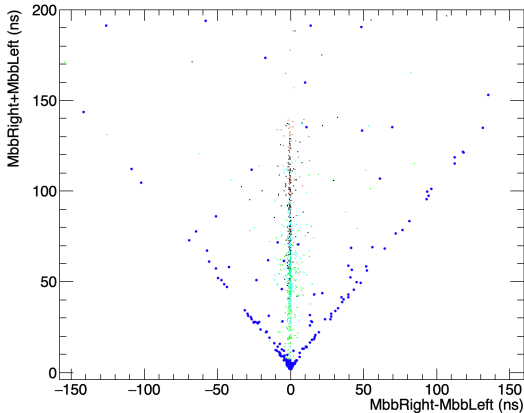
MBB (beam-gas / 10 m w.r.t. IP)

MBB (beam-gas / 15 m w.r.t. IP)

MBB (beam-gas / 19 m w.r.t. IP)

beam-gas interactions closer to IP (< 10 m) can not be vetoed by MBB (green and cyan points).

Mbb-righ+Mbb-left VS Mbb-right-Mbb-left (average time)



average time : average hit time

MBB (beam-gas)

MBB (beam-gas / 5 m w.r.t. IP)

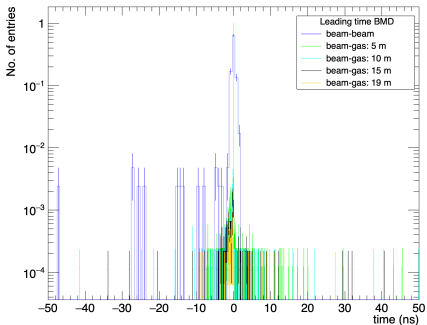
MBB (beam-gas / 10 m w.r.t. IP)

MBB (beam-gas / 15 m w.r.t. IP)

MBB (beam-gas / 19 m w.r.t. IP)

beam-gas interactions closer to IP (< 10 m) can not be vetoed by MBB (green and cyan points).

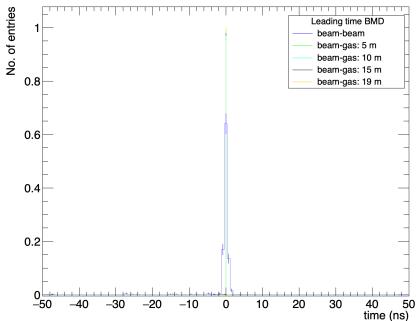
time difference Mbb Right - Mbb Left



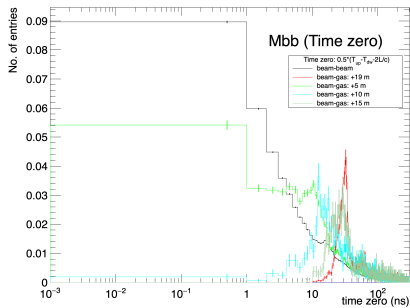
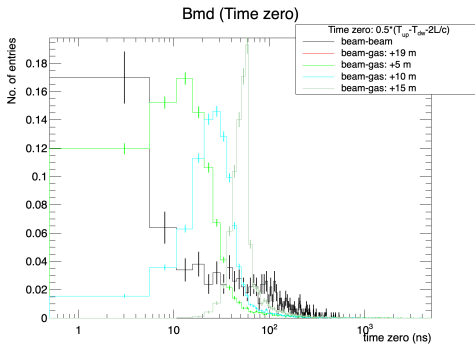
beam-gas interactions overlaps
with beam-beam events

Mario Rodriguez / mario.rodriguez@correo.buap.mx

time difference Mbb Right - Mbb Left



it is not possible to veto
beam-gas interactions with
MBB



Final comments

MCORD + MBB can provide online centrality triggers (previous presentation)

MCORD + MBB can not veto beam-gas interaction from beam-beam events

BMD is needed to veto beam-gas interactions from beam-beam events.

BMD is a forward detector. It is suitable to contribute to luminosity studies of NICA beam (simulations are needed here)

BMD and MBB can provide some information of vertex location along Z-axis.

MPD-Phase0 should consider to include BMD detector. Otherwise, MPD-Phase0 won't be able to distinguish beam-gas interactions from beam-beam collision events

This analysis with a large statistic for Bi-Bi events is a work in progress.