"Status of BeBe simulation studies"

MexNICA Collaboration Winter Meeting 2020

Lucina Gabriela Espinoza Beltrán

Benemérita Universidad Autónoma de Puebla

December-2020

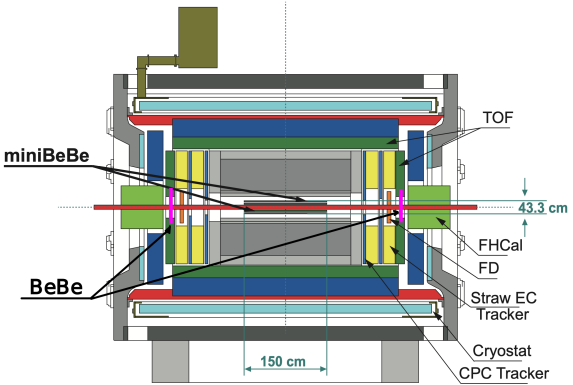
Introduction

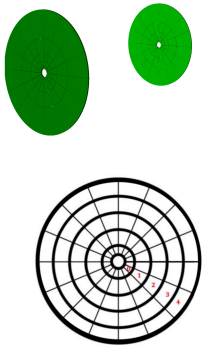
BeBe (Beam-Beam monitor detector) provide valuable information for the next tasks:

- Will be part of the trigger system: to identify and to discriminate beam-beam minimum bias or centrality events from background and beam-beam interactions.
- It will provide the multiplicity of charged particles, key observable for the determination of the centrality of the collisions and event-plane resolution bonus.
- Luminosity measurements, for the determination of total cross-sections of reaction processes.

BeBe Pay Configuration

BeBe Pay with geometry nominal has two matrices of 5 rings, 16 cells in each ring, each matrix has 152 cm of diameter, at 2 m of the IP).





Content

Status of somes studies for the physics performance of BeBe:

- Event plane determination.
- Average hits, energy loss and time of flight per ring on BeBe for different centrality classes.
- Shadow Effect of FFD (Fast Forward Detector) on BeBe
- Efficiencies of BeBe as beam monitoring detector.

Status of BeBe simulation studies: Event Plane resolution

- **Process:** BiBi@9GeV, 500,000 events, Smearing OFF
- **Generator:** UrQMD.
- **Weight function:** Multiplicity (N), Energy Loss (e_{Loss}) and Transverse moment (p_T).

BeBe event plane angle is:

$$\psi^n_{BeBe} = \frac{1}{n} arctan \frac{Q_y}{Q_x}$$

The event plane resolution is:

$$R_{EP} = \langle cos(\psi^n_{BeBe} - \psi_{MC}) \rangle$$

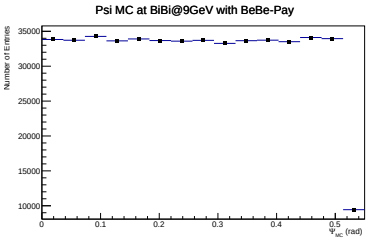
where:
$Qx = \Sigma w_i cos(n\phi_i)$, $Qy = \Sigma w_i sen(n\phi_i)$

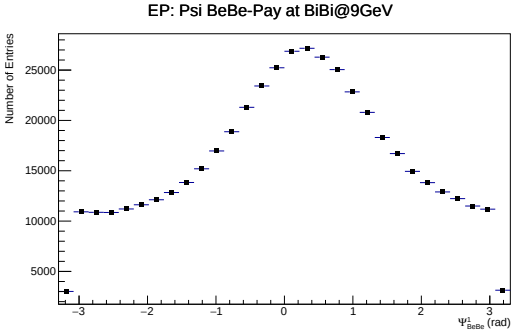
and where: w_i is p_T, e_{Loss} and N.
and n is the harmonic order.

Status of BeBe simulation studies: Event Plane resolution

Psi MC: Randomly assigned during transport from 0 a 30°.

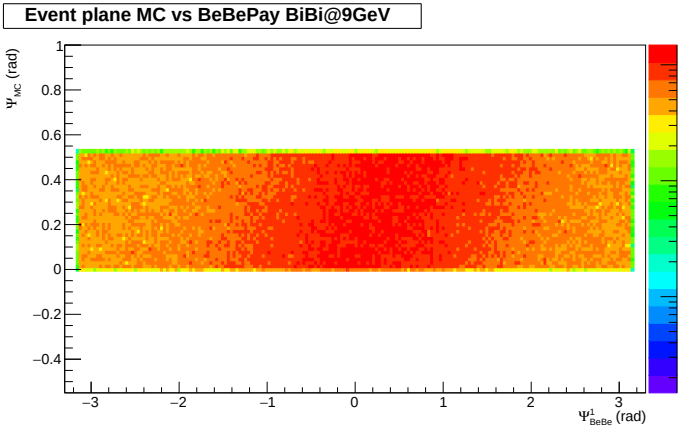
Psi BeBe: It is determined from a weight function in this case the transverse momentum, with this function the flow functions are calculated Q_x and Q_y, with the harmonic n=1 and later you get Ψ^1_{BeBe}.





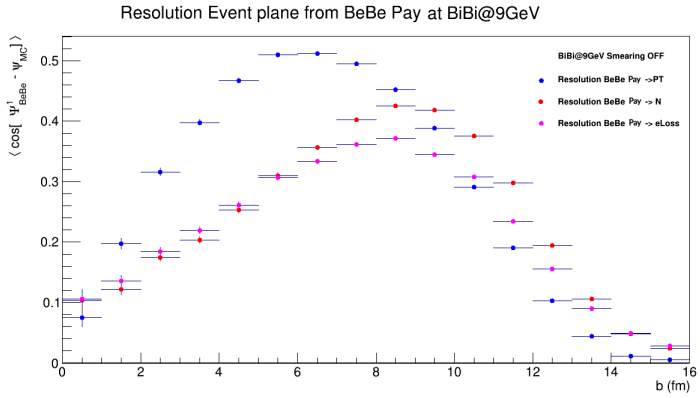
Status of BeBe simulation studies: Event Plane resolution

Psi MC vs Psi BeBe : Correlation between angles.



Status of BeBe simulation studies: Event Plane resolution

Event plane resolution: Since we get Ψ^1_{BeBe} and Ψ_{MC}, the resolution of the event plane with different weight functions:



Status of BeBe simulation studies: Different distributions

We obtain the next distributions for BeBe Pay (see the backup slides):

- Average Hits* per ring (for primary, secondary and all charge particle).
- Average of Energy loss per ring (for primary, secondary and all charge particle).
- Average of time of flight per ring (for primary, secondary and all charge particle).
- Average hits* on the XY plane per ring (for primary, secondary and all charge particle).
- Particle density per cell per ring (for primary, secondary and all charge particle).

The results correspond to the next data sample:

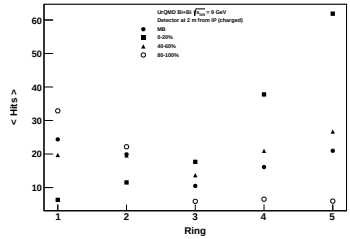
- UrQMD, BiBi@9GeV 1,000,000 events, with flat smearing in Z= 60 cm.

We have two cases for study:

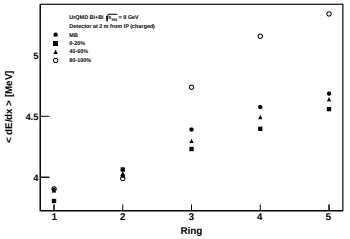
Case 1. mbb+ffd+BeBePay
Case 2. mbb+BeBePay

Case 1: FFD-on

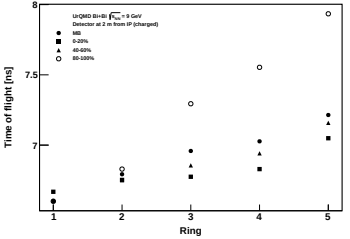
Average Hits for all charge particle



Average eLoss for all charge particle

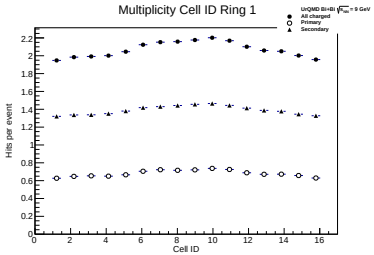


Average Tof for all charge particle

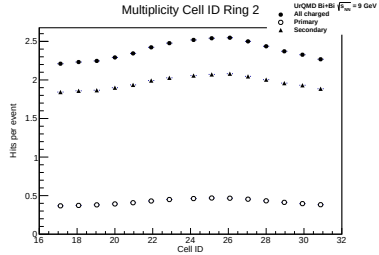


Shadow effect of FFD on BeBe

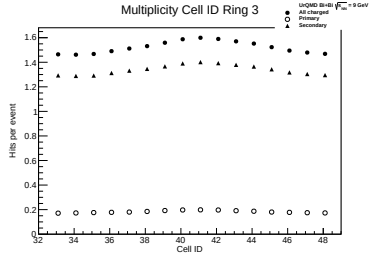
FFD-on



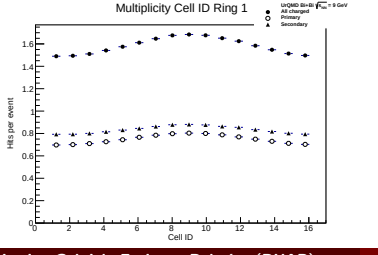
FFD-on



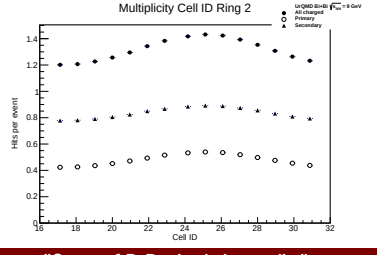
FFD-on



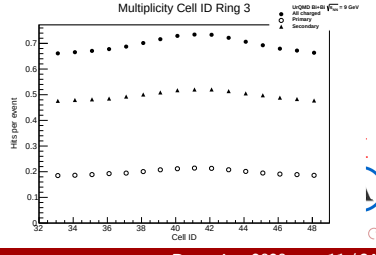
FFD-off



FFD-off



FFD-off



Shadow effect of FFD on BeBe

Next results correspond to the next process:

- UrQMD, BiBi@9GeV 1,000,000 events, with smearing in Z= 60 cm.
- UrQMD, BiBi@9GeV 1,000,000 events, without smearing.

From the total number of secondary charged particles, we obtain the ratios of their distributions for two transport cases under study:

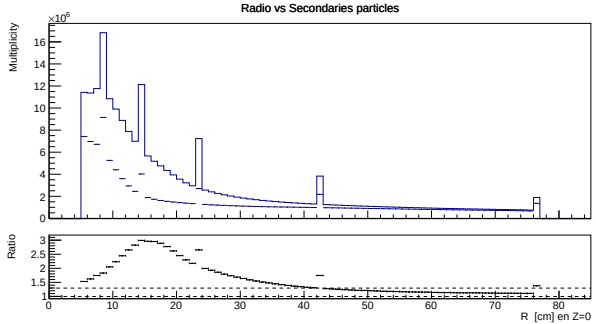
Case 1. mbb+ffd+BeBePay
Case 2. mbb+BeBePay

$$Ratio = \frac{Multiplicity * Case1}{Multiplicity * Case2}$$

Shadow effect of FFD on BeBe

Process: BiBi@9GeV with smearing.

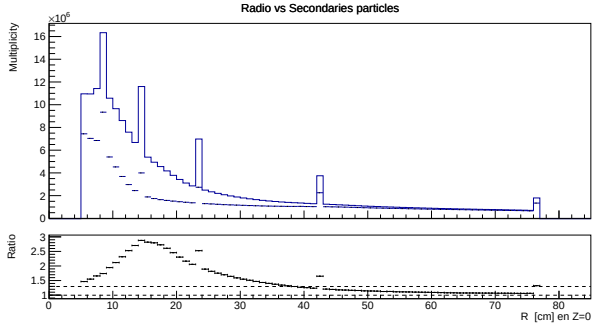
Ratio secondary charged particles vs Radius



Shadow effect of FFD on BeBe

Process: BiBi@9GeV without smearing.

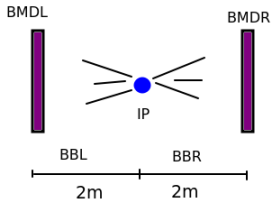
Ratio secondary charged particles vs Radius

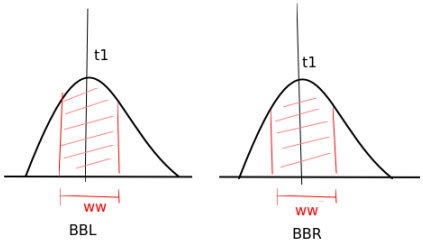


Trigger Efficiencies for BeBe

- We define the trigger with the logical combinations of the state (hit or empty) of the time window established for each matrix.
- The results are for the following time windows and a logical AND and a logical OR between both.

Trigger Efficiencies for BeBe



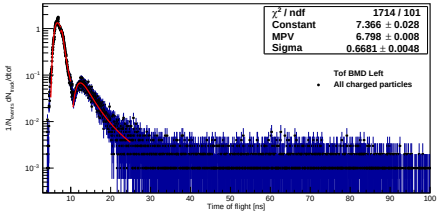


ww window width
t1 central value of the time window

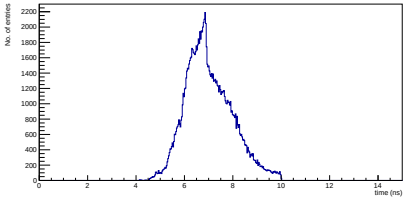
Trigger Efficiencies for BeBe

From the time-of-flight distributions we take the central value of the window and set the width of the window.

Tof BeBe left



window BBL



Trigger Efficiencies for BeBe

We define efficiency as the division between the number of events that meet the time window or the condition of coincidences between them and the total number of events.

$$Efficiencies(\,\%) = \frac{Nevt_{ww}}{Nevt_{total}} x100\,\%$$

Where:
$Nevt_{ww}$= number of events that meet the time window or the condition.
$Nevt_{total}$= total number of events.

Trigger Efficiencies for BeBe

The results correspond to the following processes:

- AuAu@11GeV 1,000,000 evts (with and without Smearing)
- BiBi@9GeV 1,000,000 evts (with and without Smearing)
- PP@11GeV 1,000,000 evts (with and without smearing)
- PP@9GeV 1,000,000 evts (with and without smearing)
- Two cases of geometries in the transport
  - Case 1) mbb+BeBePay+ffd
  - Case 2) mbb+ BeBePay

Trigger Efficiencies for BeBe

Time window for collisions: Central value 7 ns with a width of +- 3 ns (All charged particles).

Transport Detectors: mbb+BeBePay+ffd, 1,000,000 events				
Process	BBR	BBL	BBRandBBL	BBRorBBL
PP@9GeV Con	58.063 %	57.86 %	20.26 %	95.66 %
PP@9GeV Sin	72.85 %	72.79 %	50.12 %	95.52 %
PP@11GeV Con	59.84 %	59.87 %	23.41 %	95.52 %
PP@11GeV Sin	74.31 %	74.42 %	52.7 %	96.03 %
BiBi@9GeV Con	94.07 %	94.07 %	89.88 %	98.26 %
BiBi@9GeV Sin	100 %	100 %	100 %	100 %
AuAu@11GeV Con	100 %	100 %	100 %	100 %
AuAu@11GeV Sin	100 %	100 %	100 %	100 %

Con=with Smearing flat Z=60 cm, Sin= whitout smearing

Trigger Efficiencies for BeBe

Time window for collisions: Central value 7 ns with a width of +- 3 ns (All charged particles).

Transport Detectors: mbb+BeBePay, 1,000,000 events				
Process	BBR	BBL	BBRandBBL	BBRorBBL
PP@9GeV Con	56.07 %	57.86 %	16.79 %	95.17 %
PP@9GeV Sin	71.99 %	72.05 %	49.01 %	95.03 %
PP@11GeV Con	57.66 %	57.46 %	19.26 %	95.85 %
PP@11GeV Sin	73.35 %	73.43 %	51.25 %	95.53 %
BiBi@9GeV Con	100 %	100 %	100 %	100 %
BiBi@9GeV Sin	100 %	100 %	100 %	100 %
AuAu@11GeV Con	100 %	100 %	100 %	100 %
AuAu@11GeV Sin	100 %	100 %	100 %	100 %

Con= with Smearing flat Z=60 cm, Sin= without smearing

Outlook

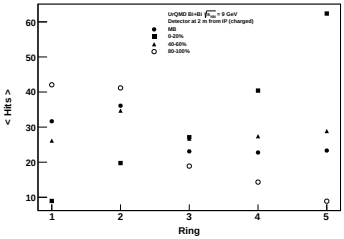
- Centrality studies with BeBe pay configuration
- Granularity studies for the event plane determination.

Thanks

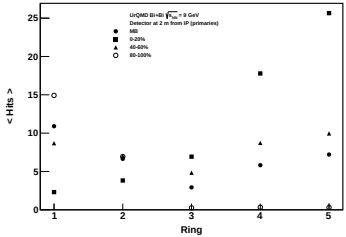
Backup

Average Hits per ring: FFD-on

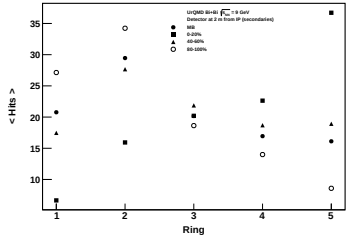
All



Primary

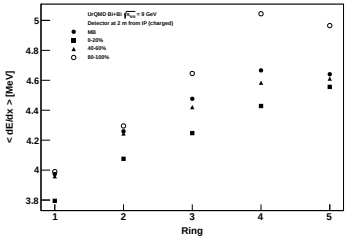


Secondary

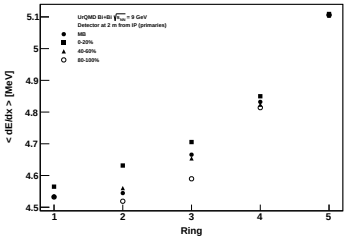


Average of Energy loss per ring: FFD-on

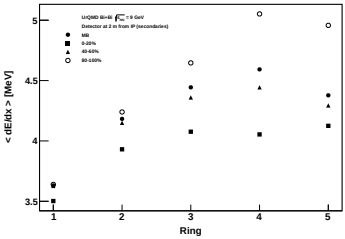
All



Primary

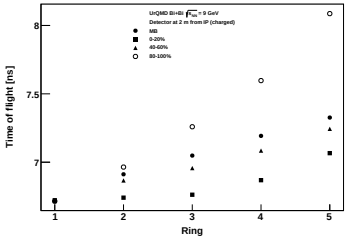


Secondary

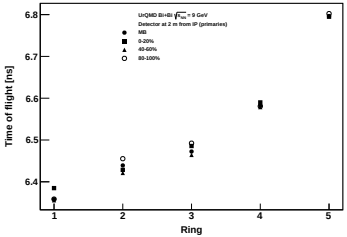


Average of time of flight per ring: FFD-on

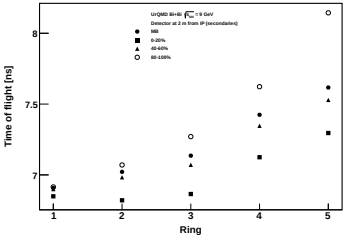
All



Primary

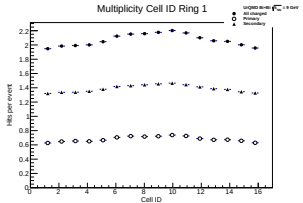


Secondary

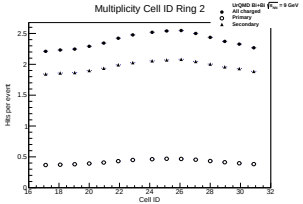


Multiplicity per cell per ring: FFD-on

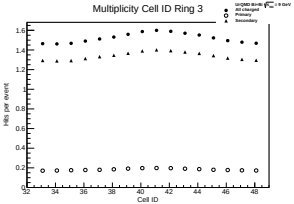
Ring 1



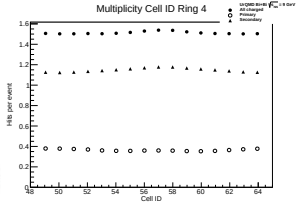
Ring 2



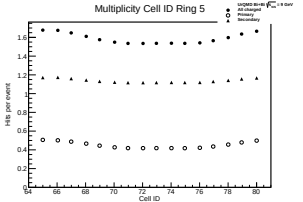
Ring 3



Ring 4



Ring 5

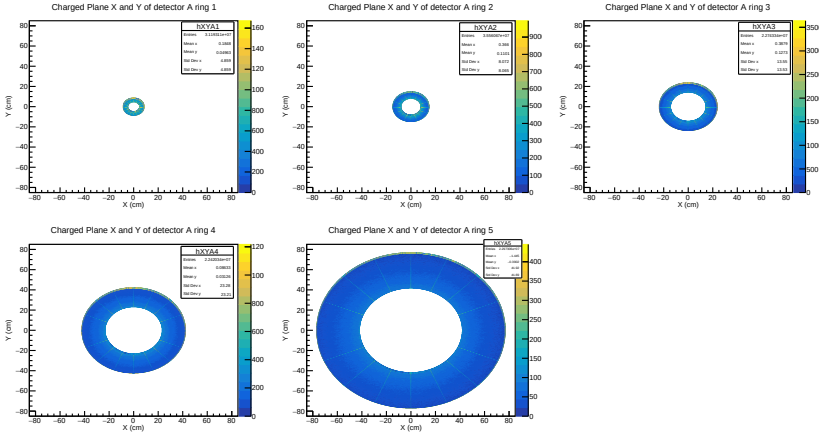


BUAP

MEXNICA

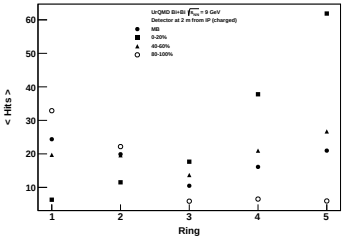
Hits per ring on the XY plane: FFD-on

All charge particles

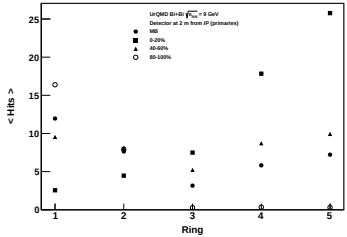


Average Hits per ring: FFD-off

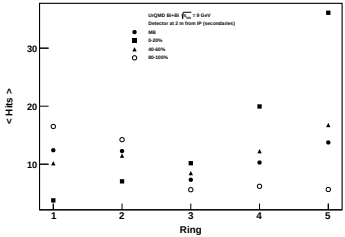
All



Primary

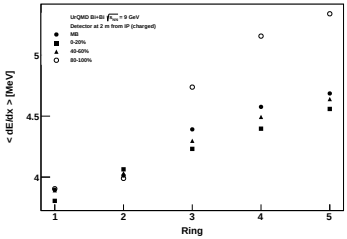


Secondary

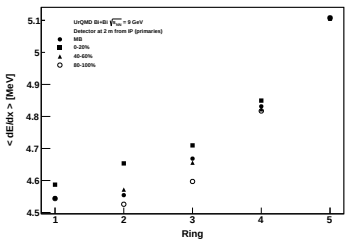


Average of Energy loss per ring: FFD-off

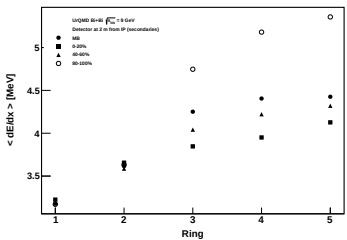
All



Primary

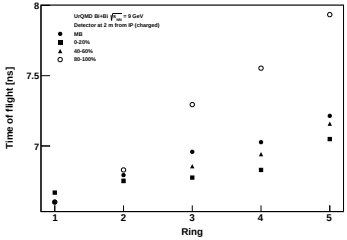


Secondary

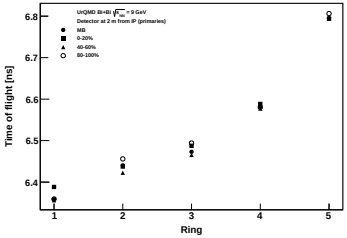


Average of time of flight per ring: FFD-off

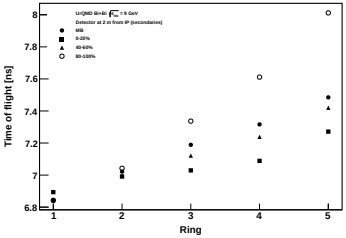
All



Primary

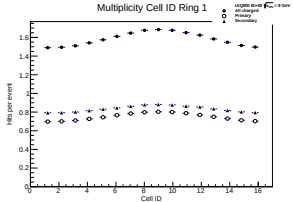


Secondary

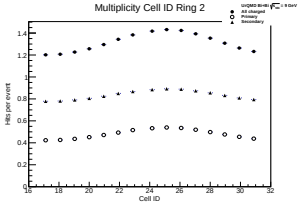


Multiplicity per cell per ring: FFD-off

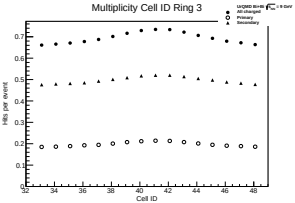
Ring 1



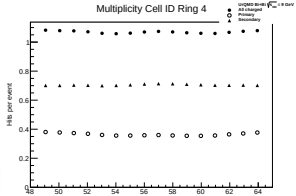
Ring 2



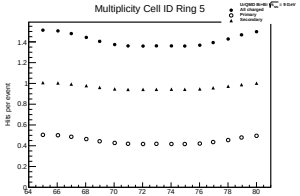
Ring 3



Ring 4



Ring 5



BUAP

MEXNICA

Hits per ring on the XY plane: FFD-off

All charge particle