

IMCC Detector and MDI workshop



MuCol



Istituto Nazionale di Fisica Nucleare



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



International
UON Collider
Collaboration

Detector effects of beam-induced background

DAVIDE ZULIANI^{1,2} ON BEHALF OF THE IMCC



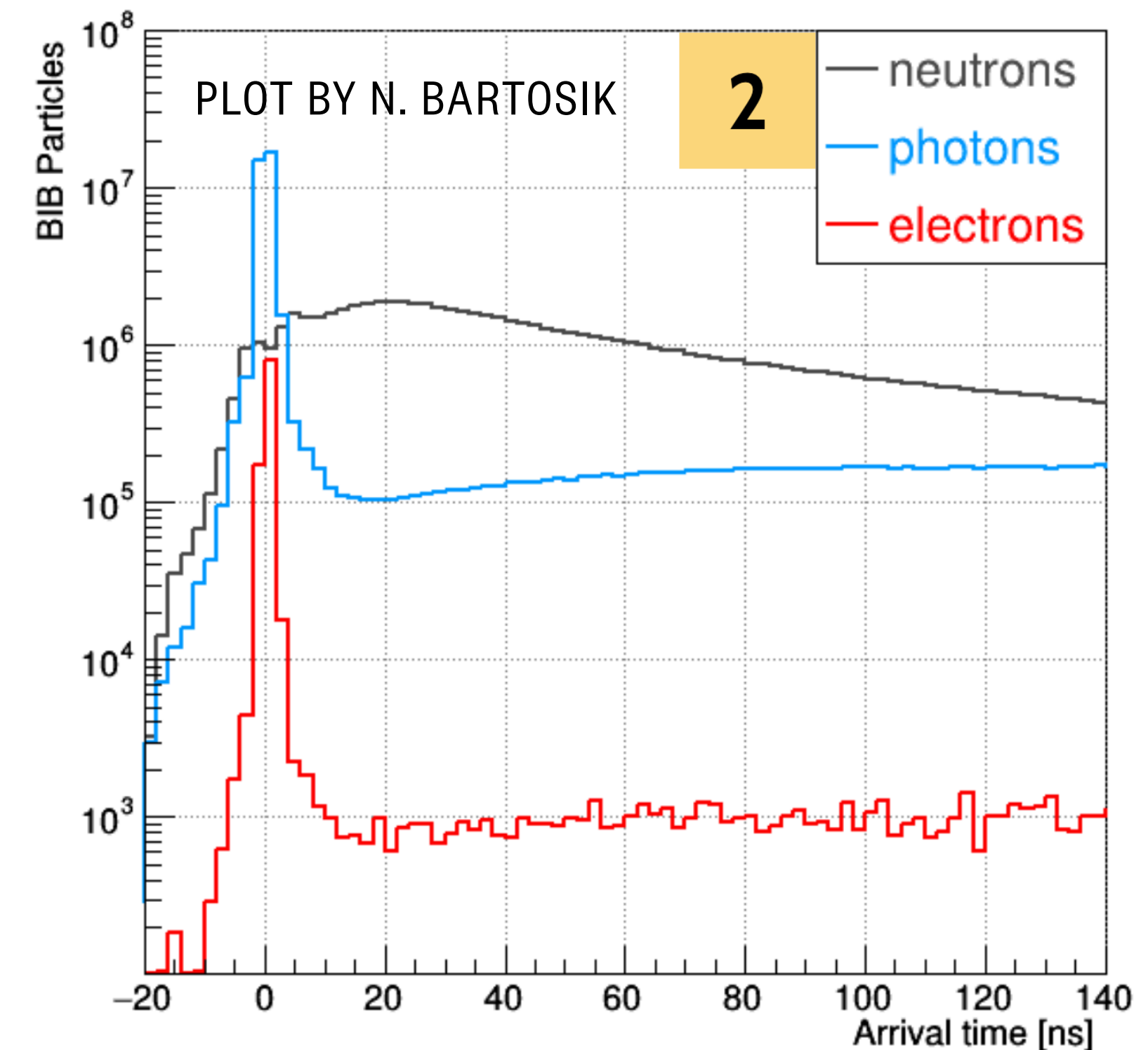
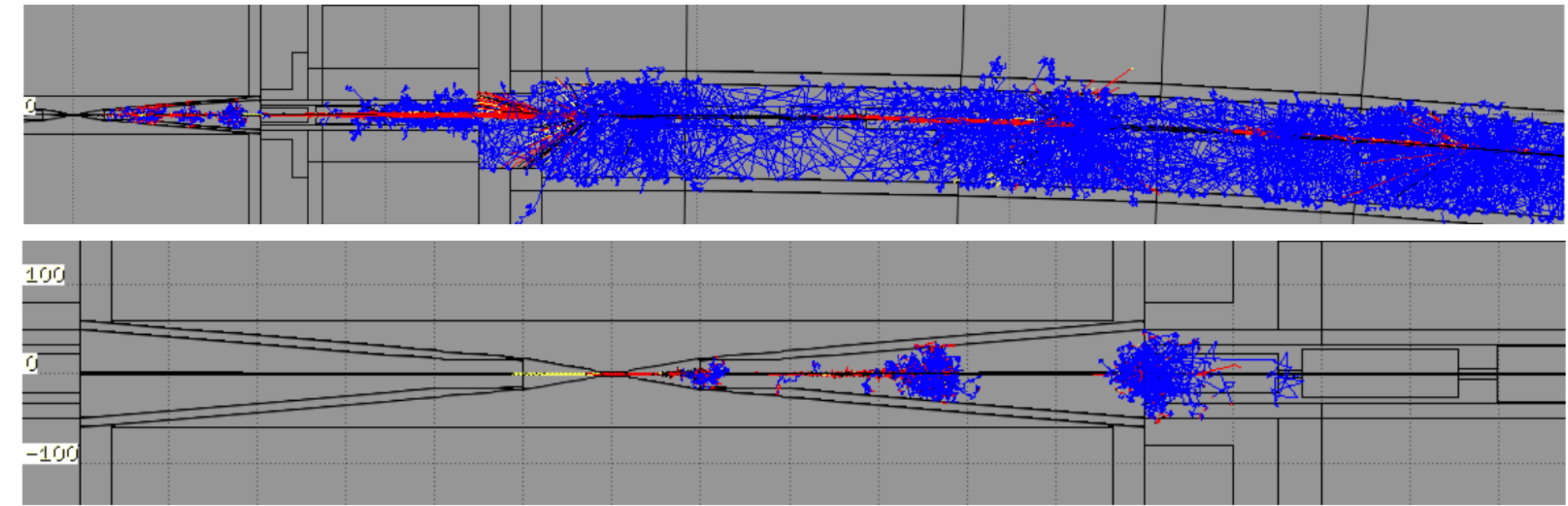
CERN – 26/06/2024

*FOR INFO: DAVIDE.ZULIANI@CERN.CH

¹INFN PADOVA, ²UNIVERSITÀ DI PADOVA

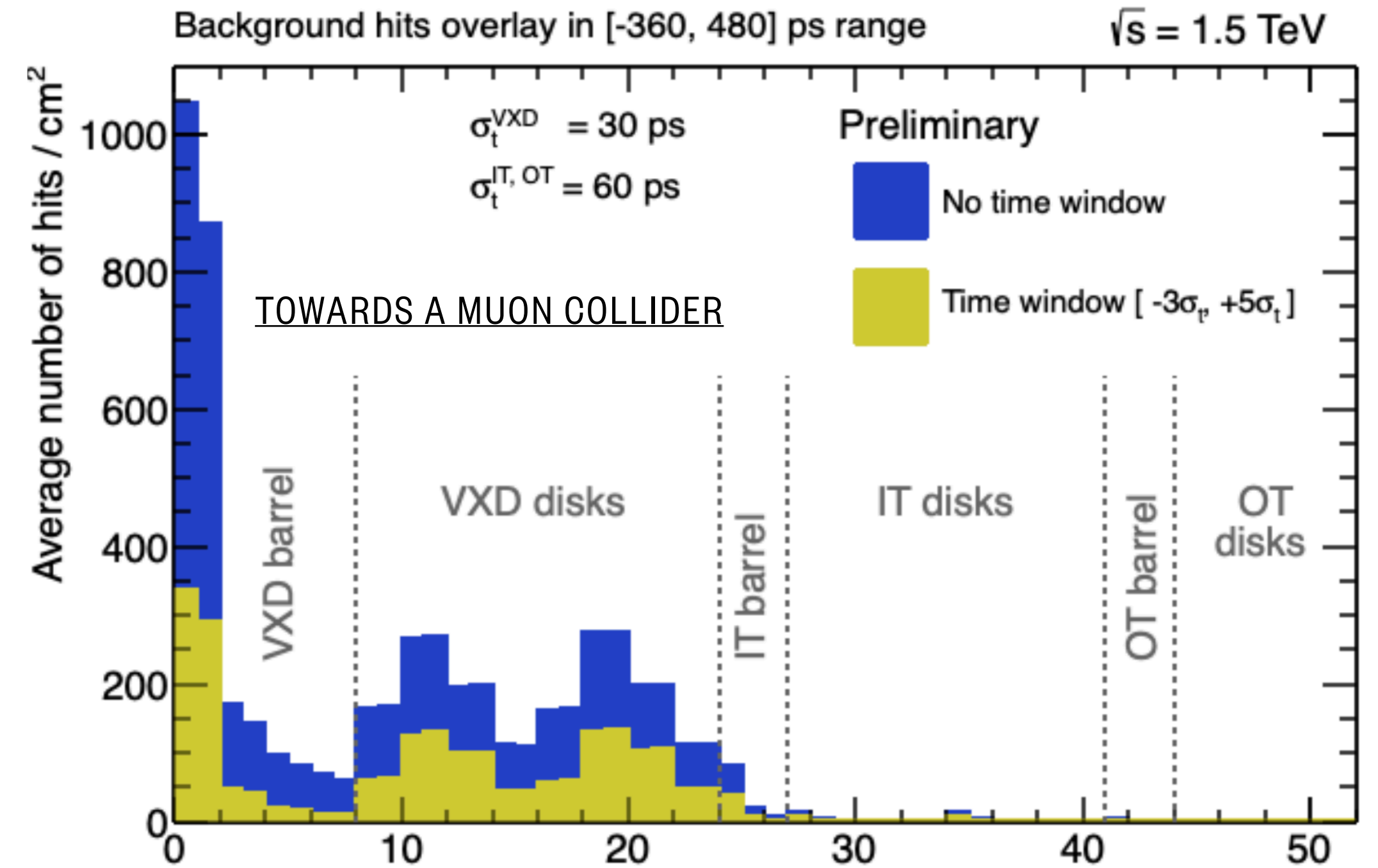
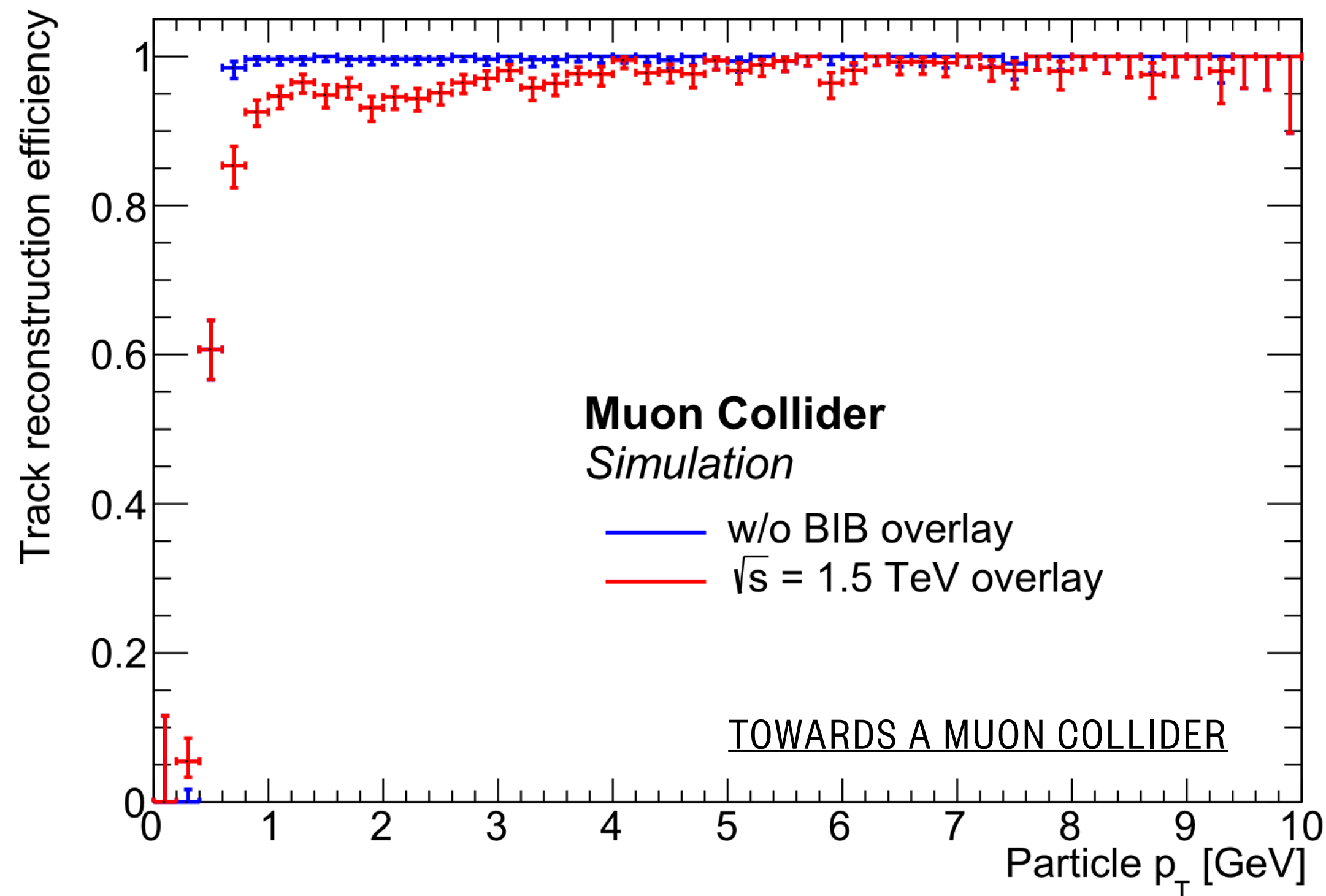
The BIB so far

- Using 1.5 TeV configuration developed by MAP collaboration
- While optimal for the 1.5 TeV case:
 - No configurations for other relevant energies
 - Missing several details (nozzle configurations, generation of muon decays, ...)
- Well understood and under control
 - Several choices have been made and are now part of the framework



BIB in the tracker

- BIB is affecting mainly the inner layers of the tracker (particularly the VXD)
- The timing cut is helping in reducing the occupancy

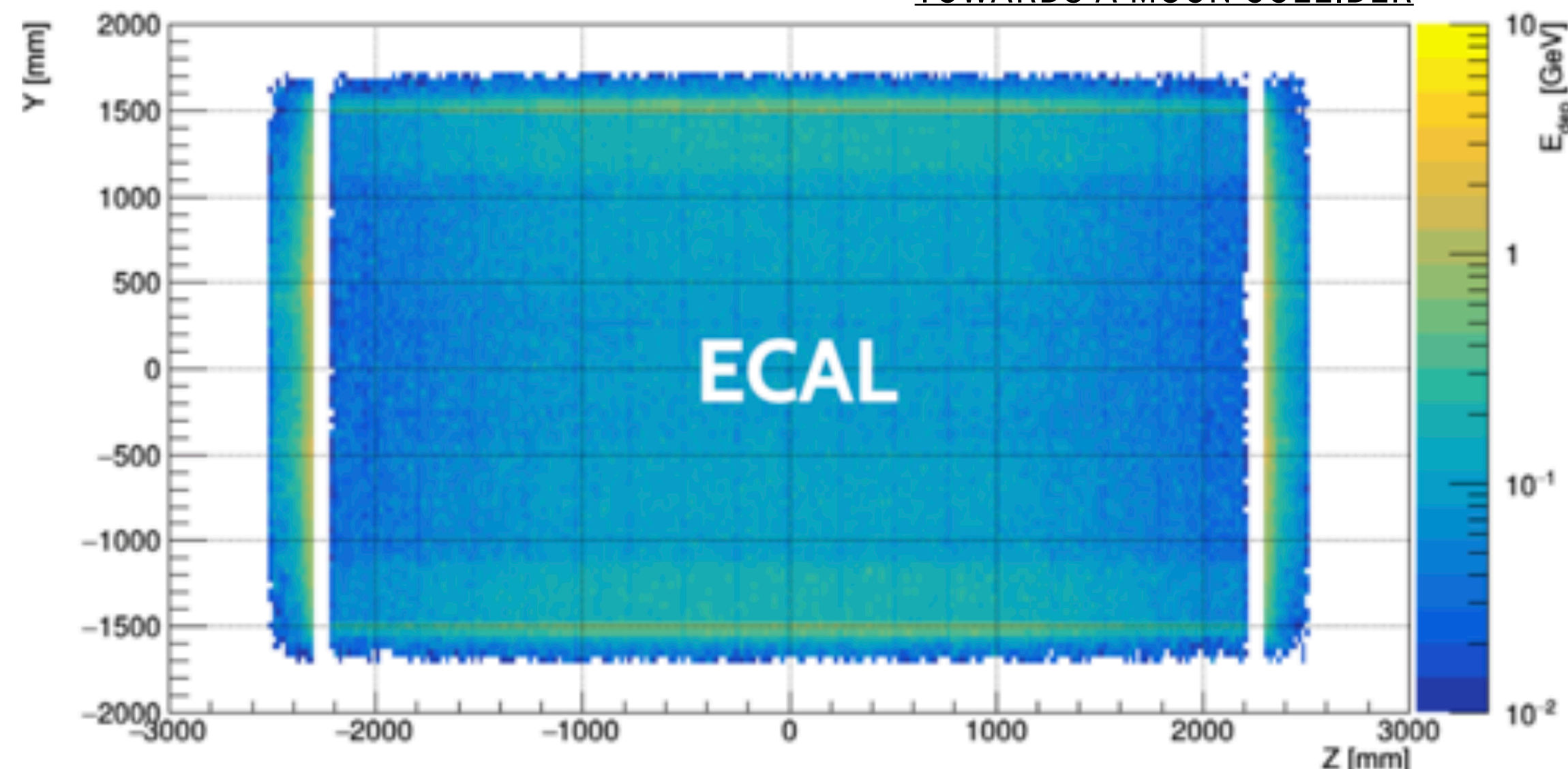


- BIB is affecting:
 - Low p_T region
 - Forward region
- Possible improvement on ACTS side
 - Or maybe, optimise tracker (see talk this afternoon)

BIB in the calorimeters

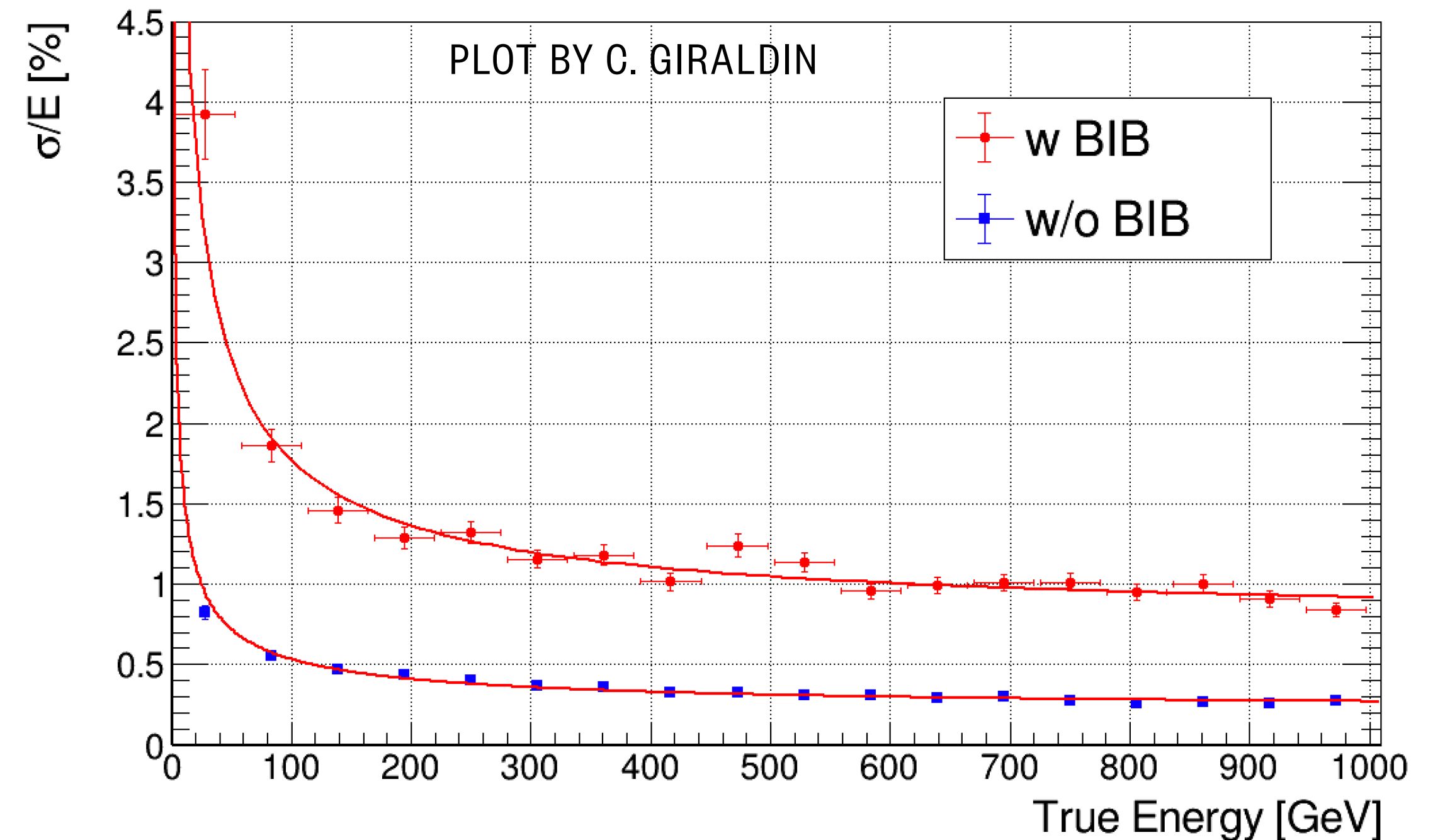
- Main effect of the BIB is on ECAL
 - Diffuse background, mainly in the first layers
 - Cut on time is helpful to reduce BIB
- HCAL is less affected by BIB
- BIB is affecting energy resolution for photons, electrons, jets, ...

TOWARDS A MUON COLLIDER



Muon Collider Simulation

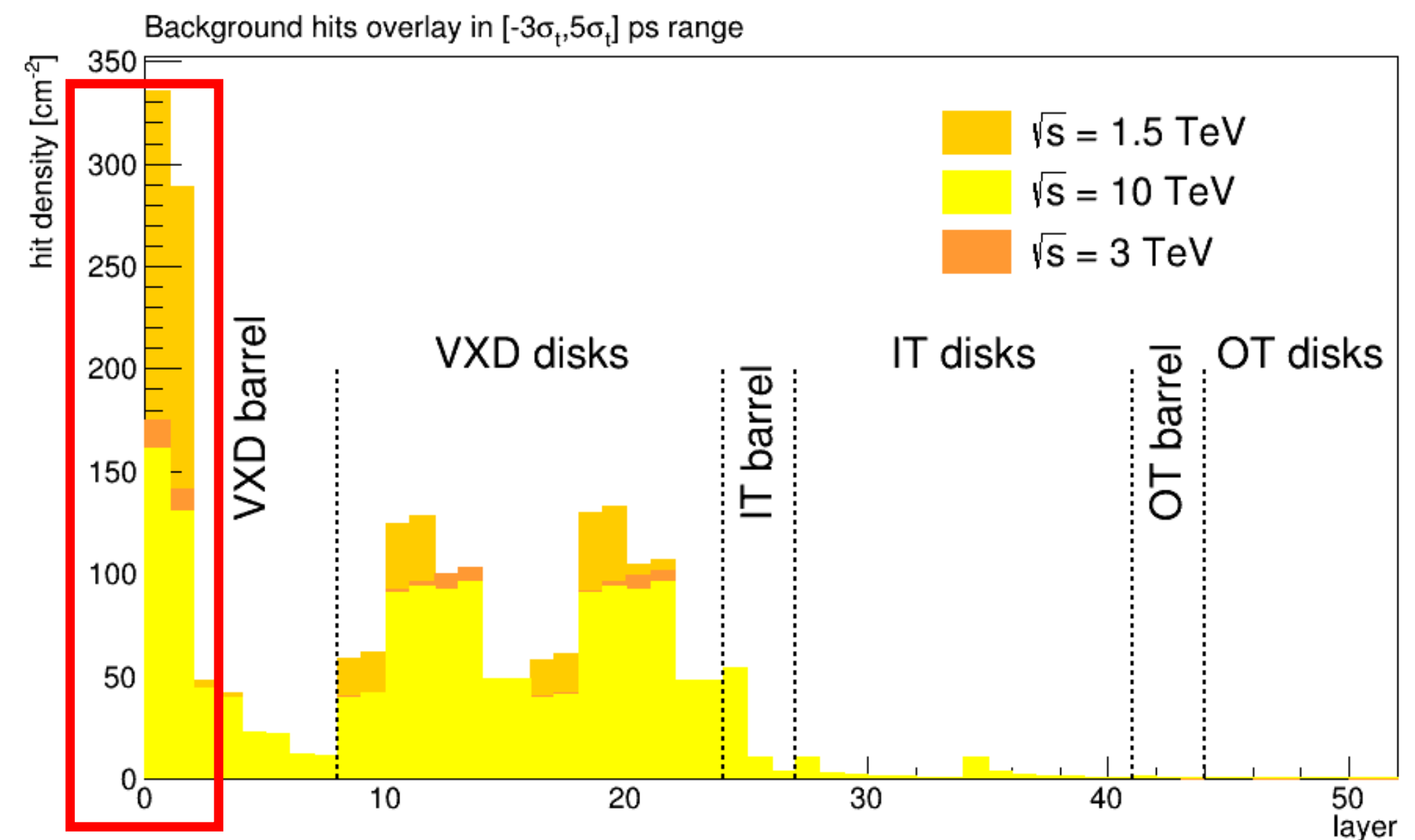
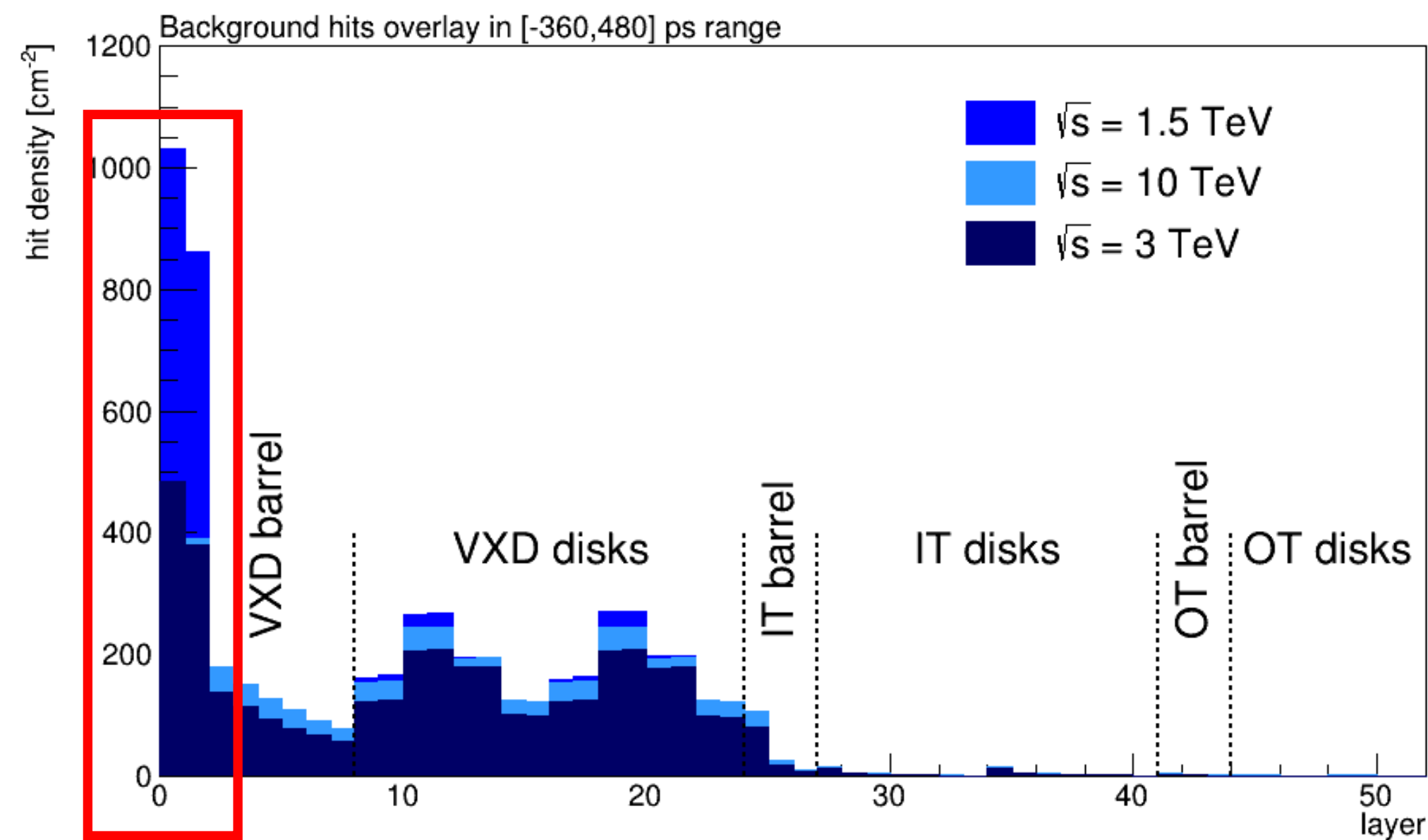
Photons [1-1000] GeV



- Possible optimisation on the cluster reconstruction:
 - Choosing ECAL thresholds
 - Pandora optimisation (particularly on electrons)

Checks between MARS and Fluka

- 3 and 10 TeV BIB configurations are done with Fluka → need some checks wrt MARS
- The starting point, propelling these studies, is these plots here



- **Factor ~2** of difference w.r.t. 1.5 TeV BIB in first vertex layers
- **Effort mainly to check differences in the VXD**

Setup

- The code is able to
 - Analyse the BIB before the interaction with the detector
 - Analyse the BIB impact on the detector
 - Link the hits in the detector to BIB particles
- Check different configurations of BIB:
 - BIB by MARS
 - BIB by Camilla Curatolo (Fluka resembling MAP configuration)
 - BIB by Daniele (Fluka resembling MAP configuration)

IN THE FOLLOWING:

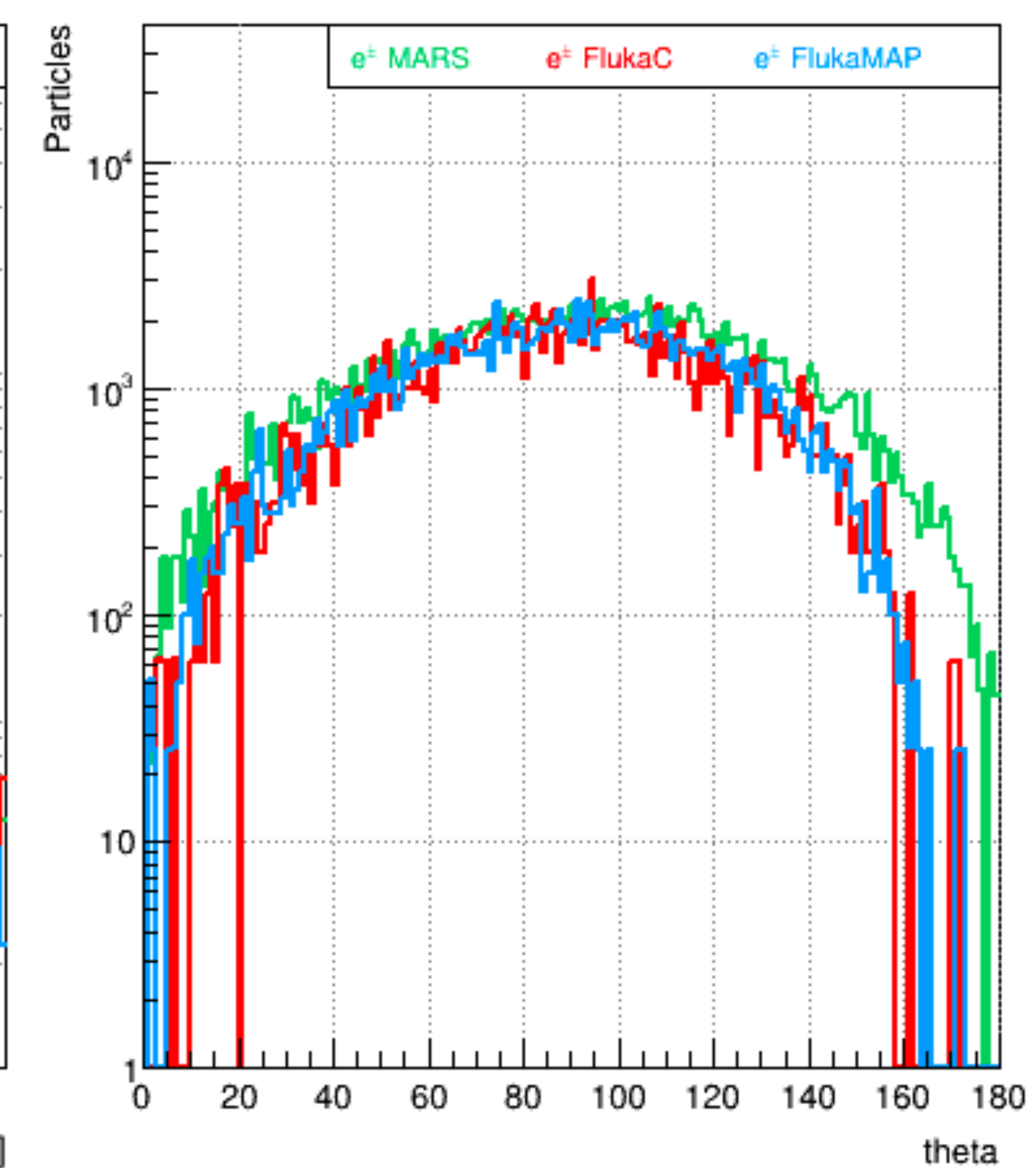
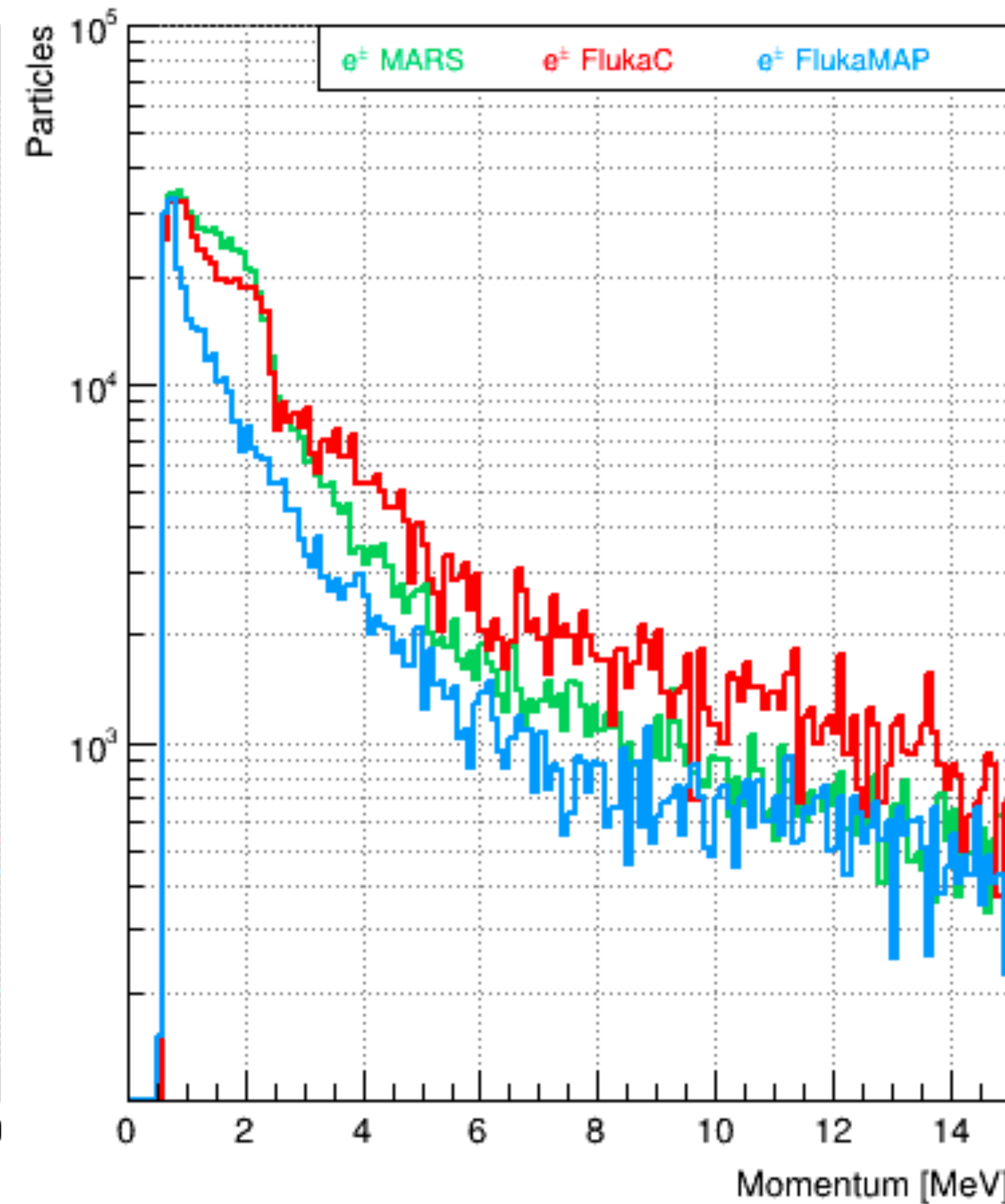
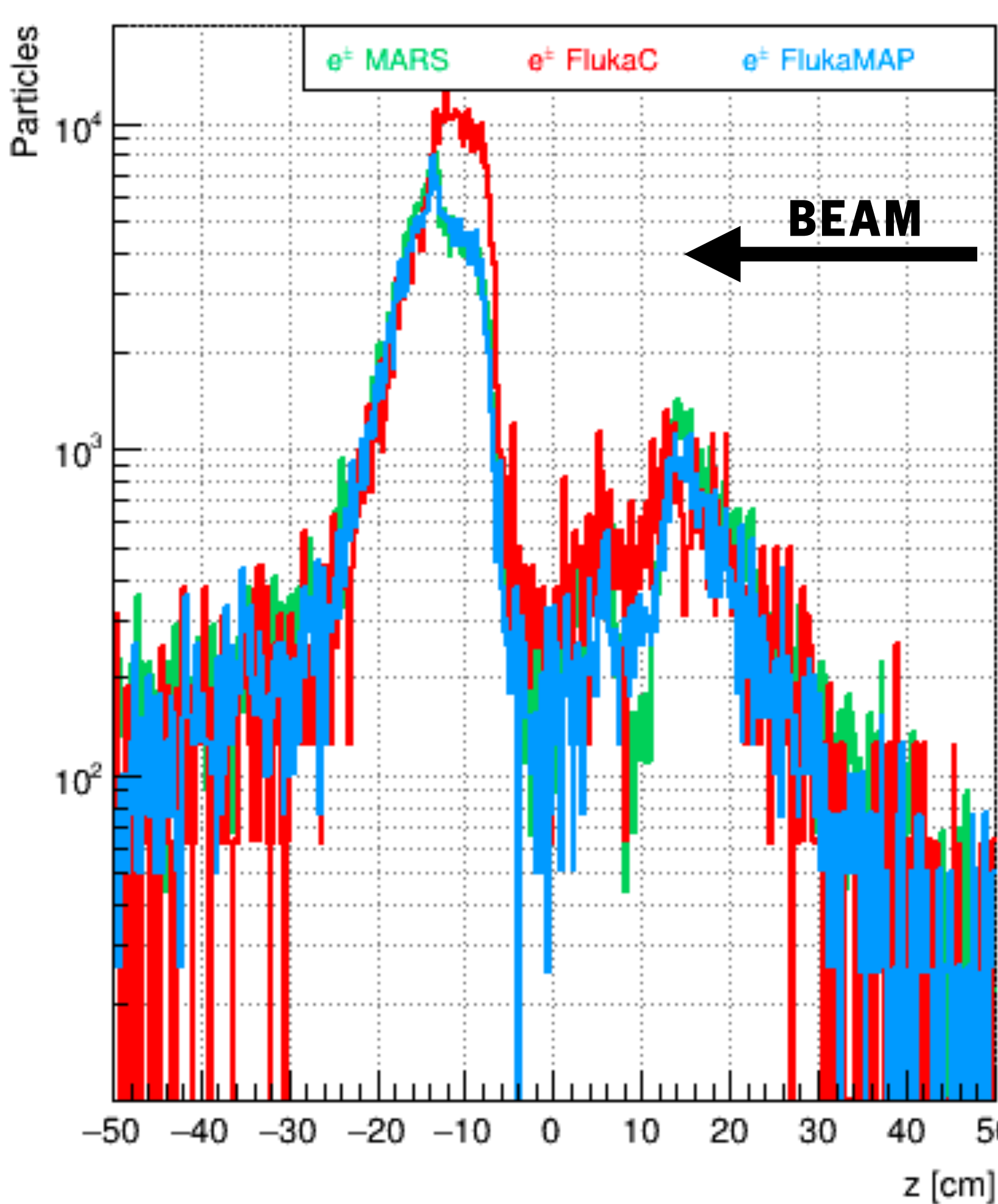
- **JUST ONE BEAM (RIGHT TO LEFT)**
- **JUST ELECTRONS**
- **COMPARISONS AT BIB LEVEL**
- **COMPARISONS AT DETECTOR LEVEL**

- **JUST A SELECTION OF PLOTS
(WEEKS OF PLOTTING)**

Electrons from BIB

BIB LEVEL

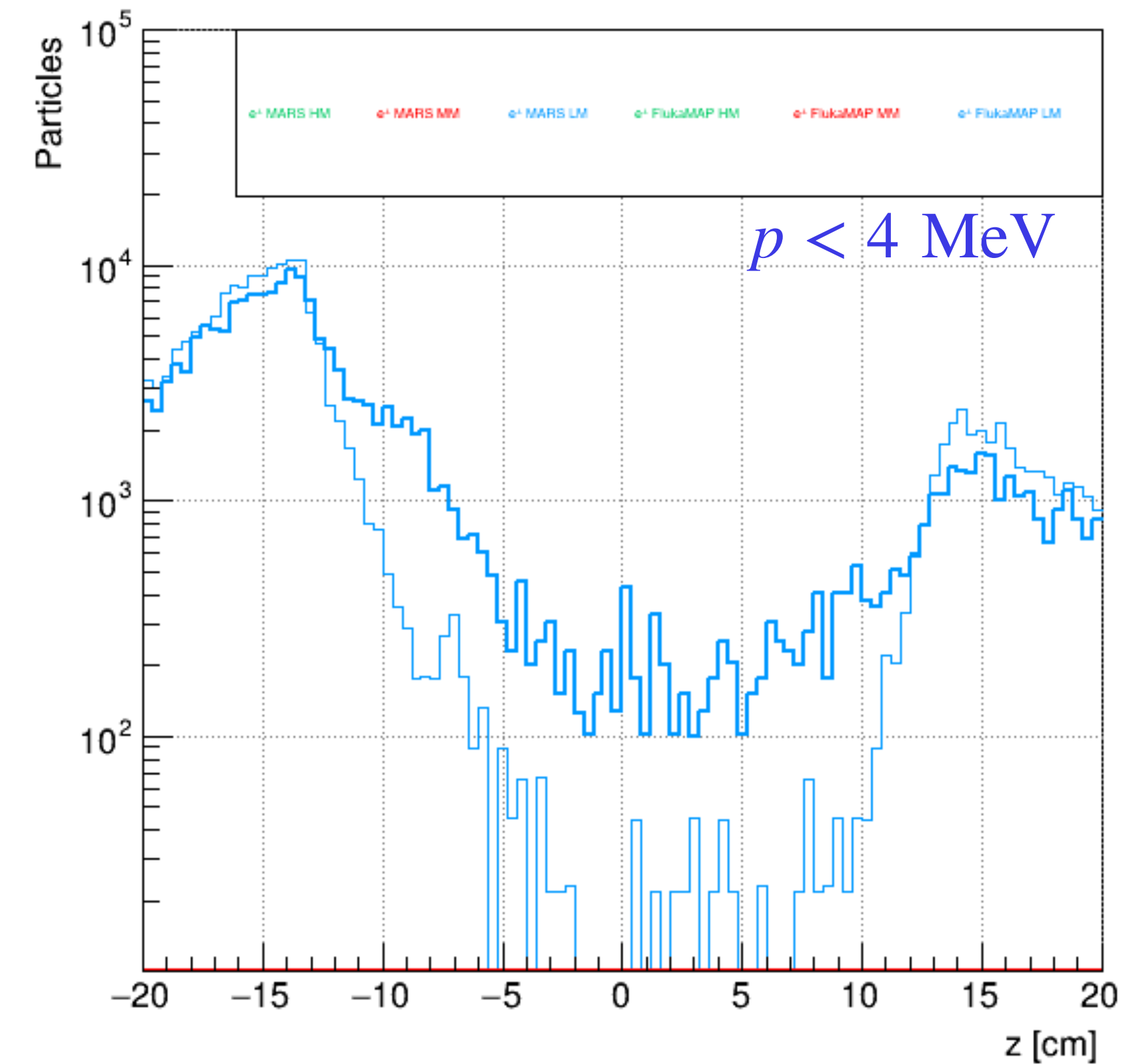
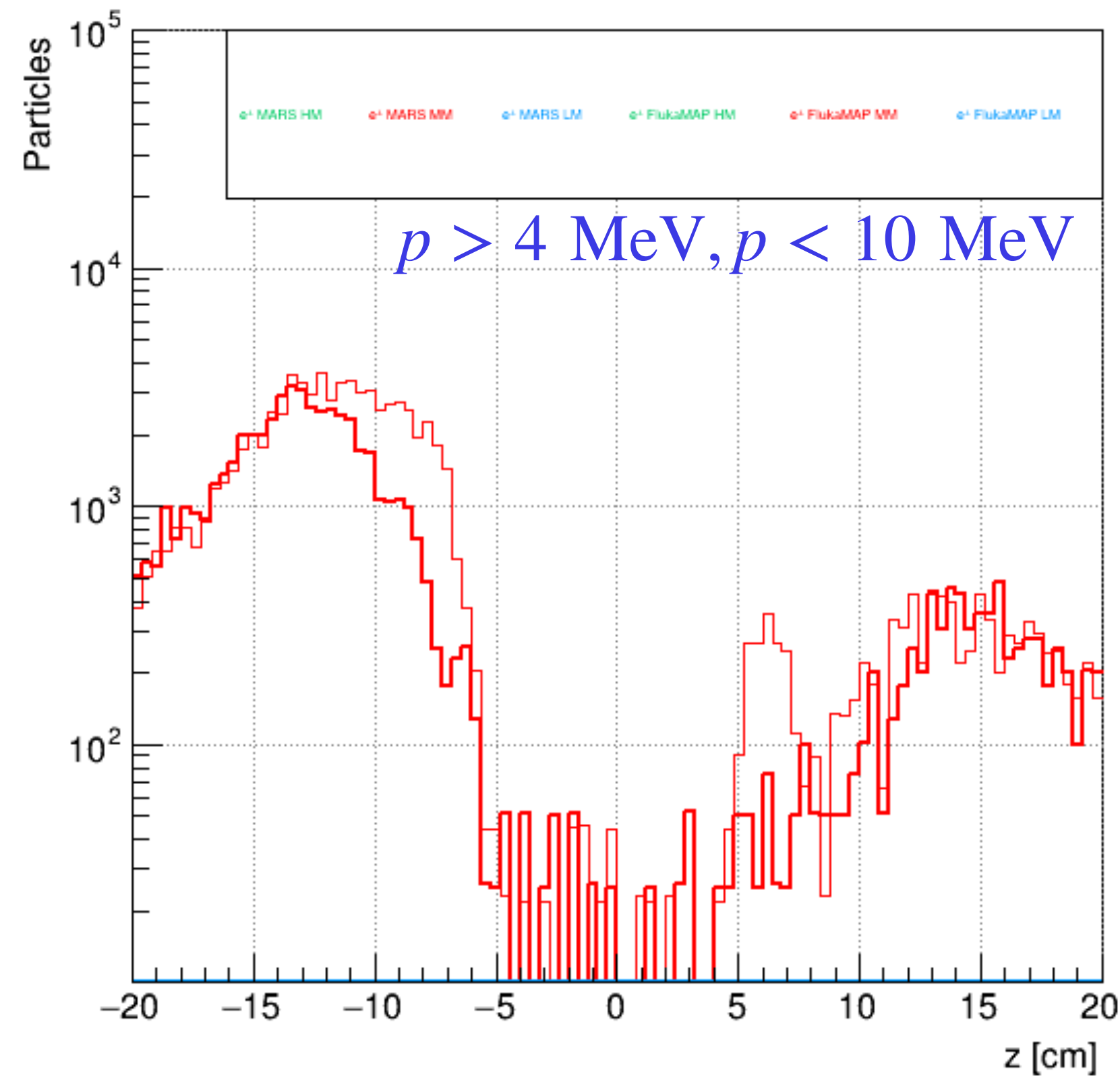
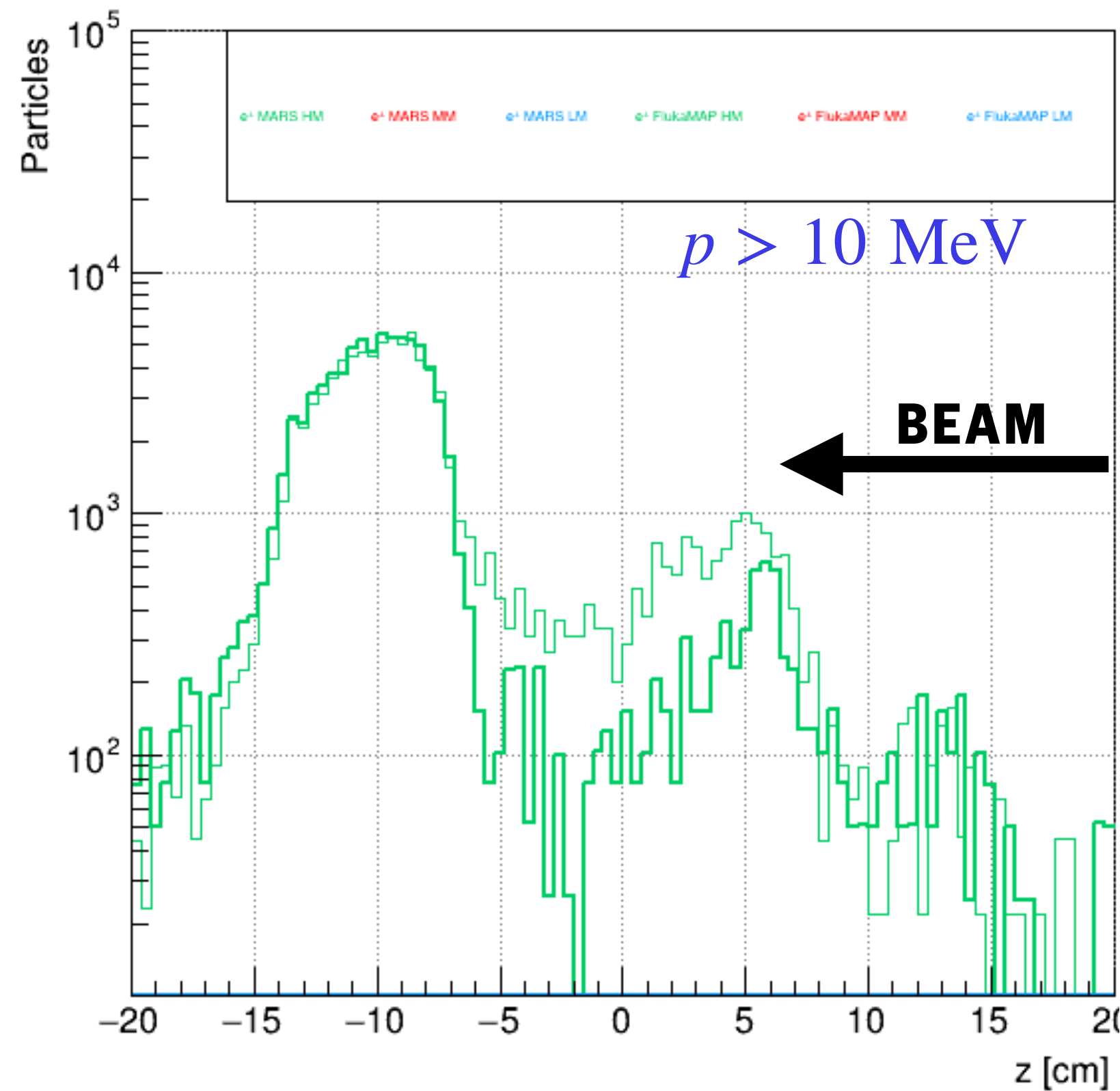
- Focusing on electrons as main responsible for hits in the tracker



Electrons from BIB

BIB LEVEL

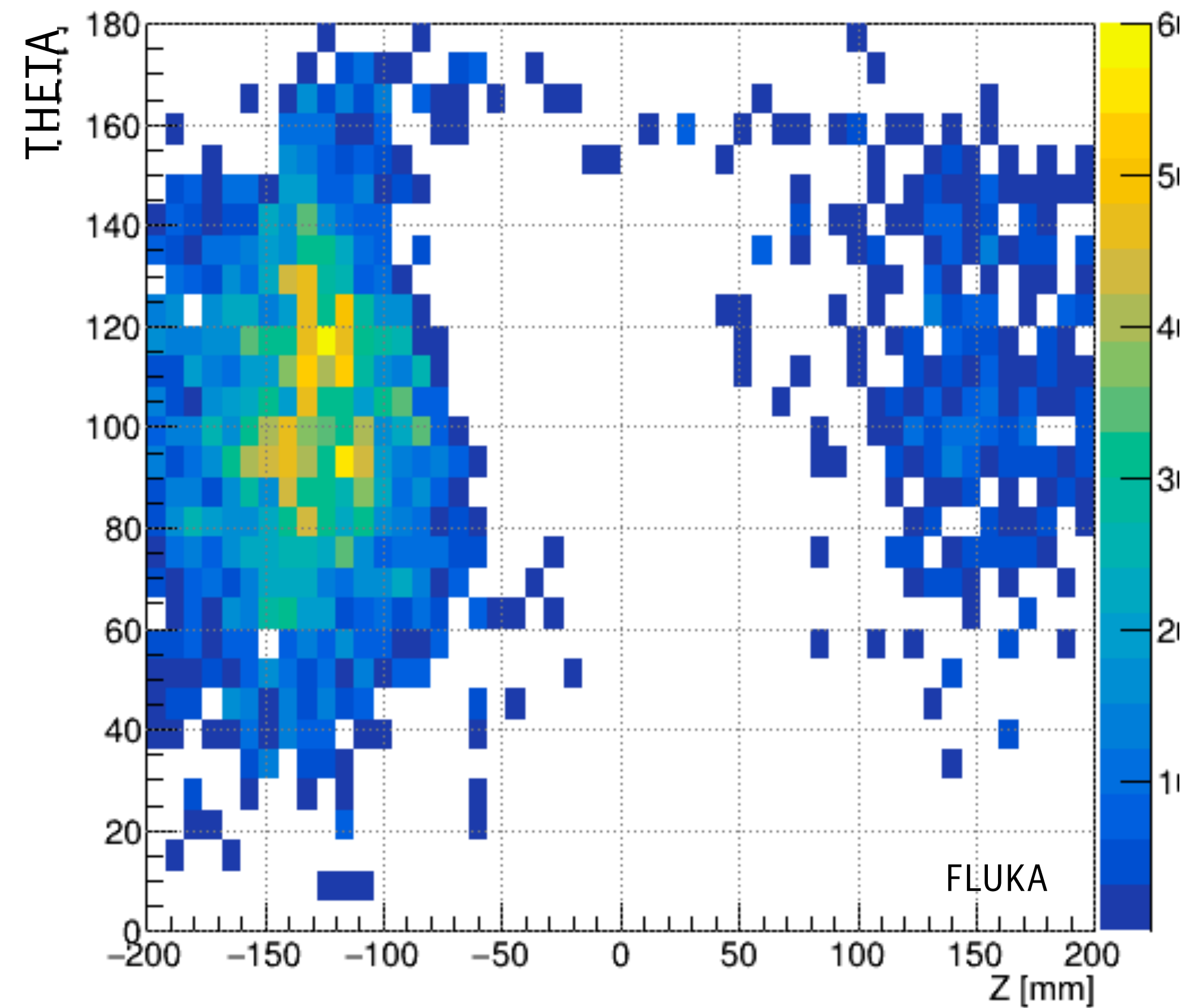
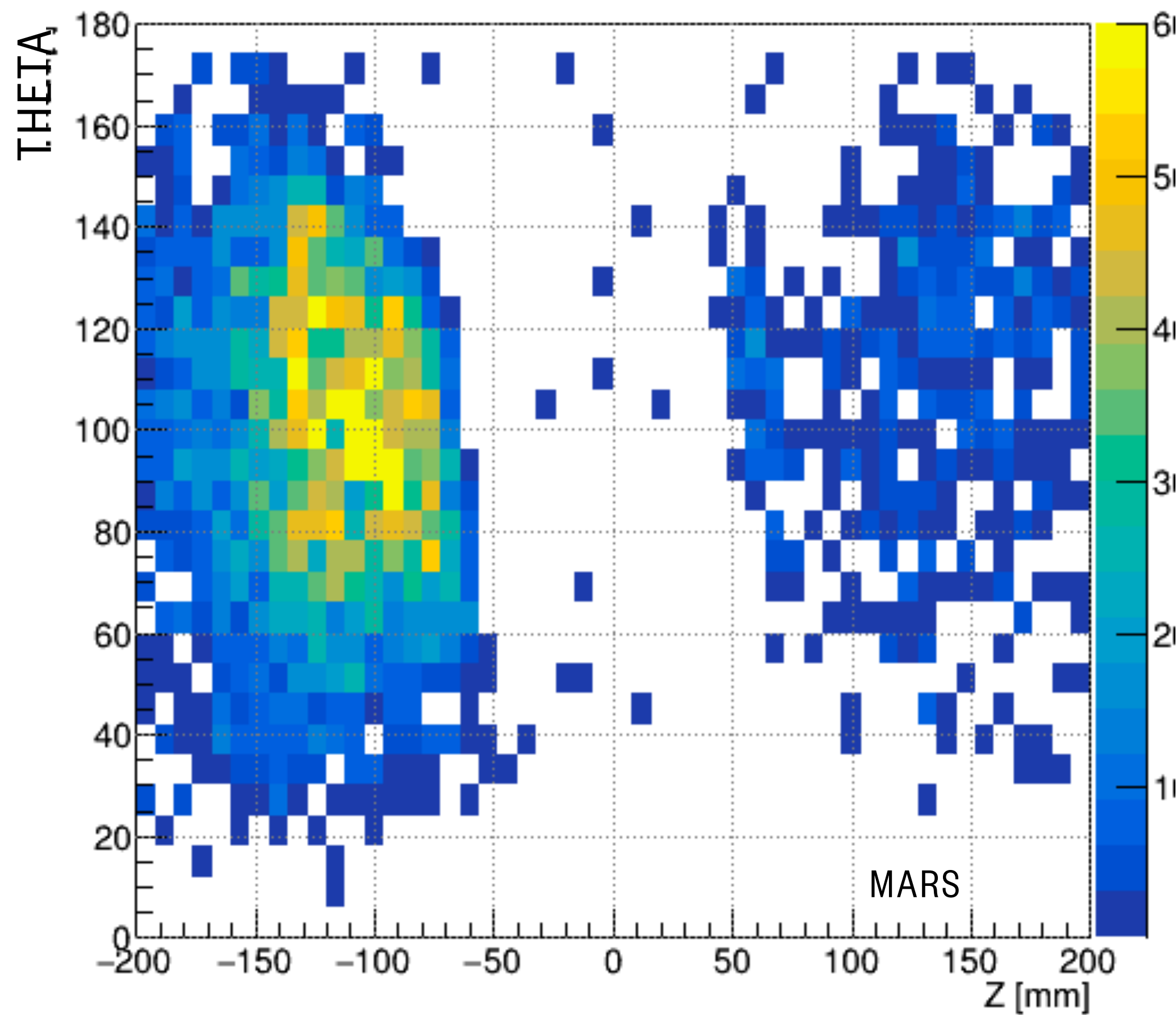
- Already some differences at BIB level
- Electrons at **high**, **medium** and **low** momentum (for *MARS* and **Fluka**)



Electrons from BIB

BIB LEVEL

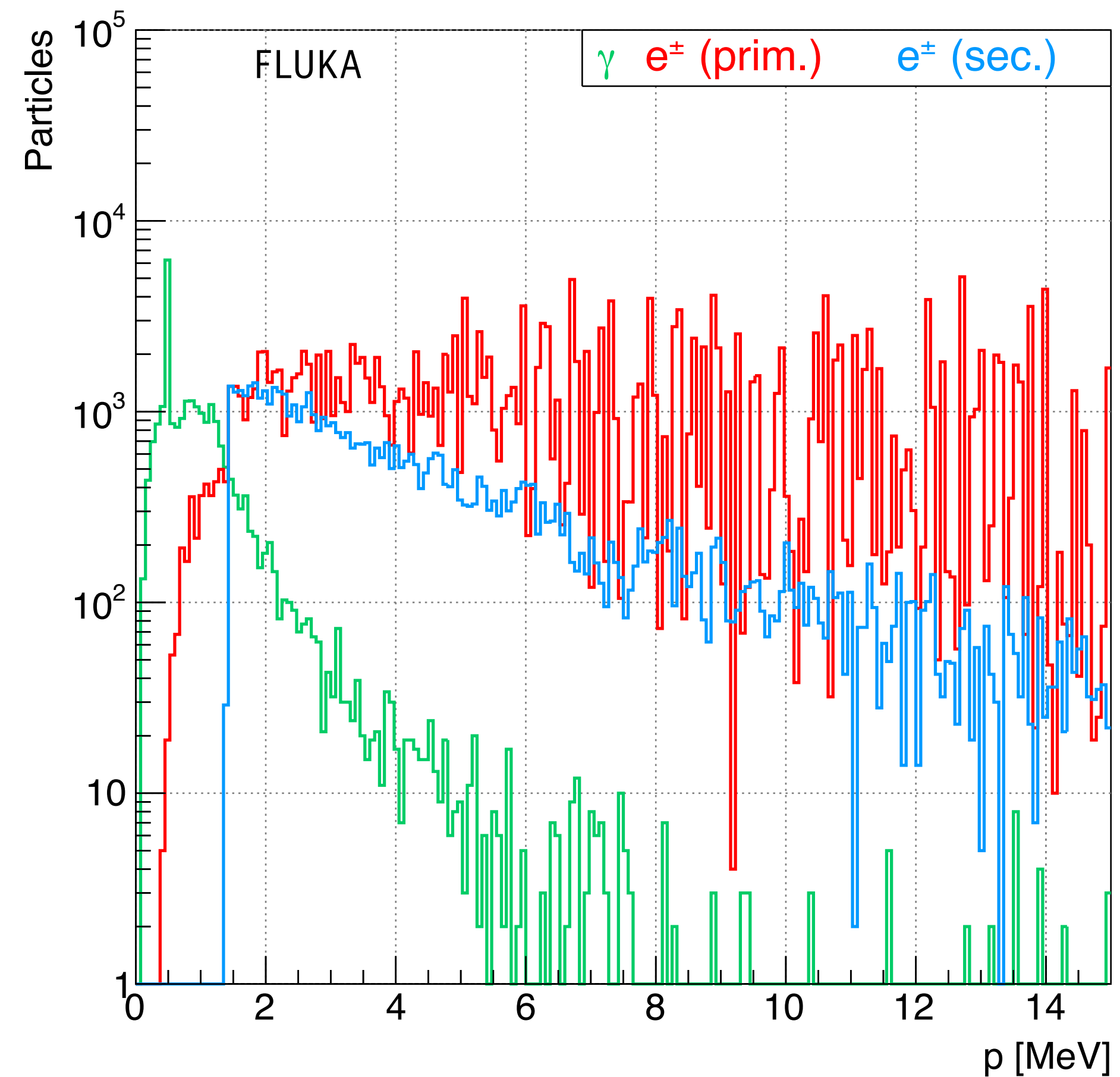
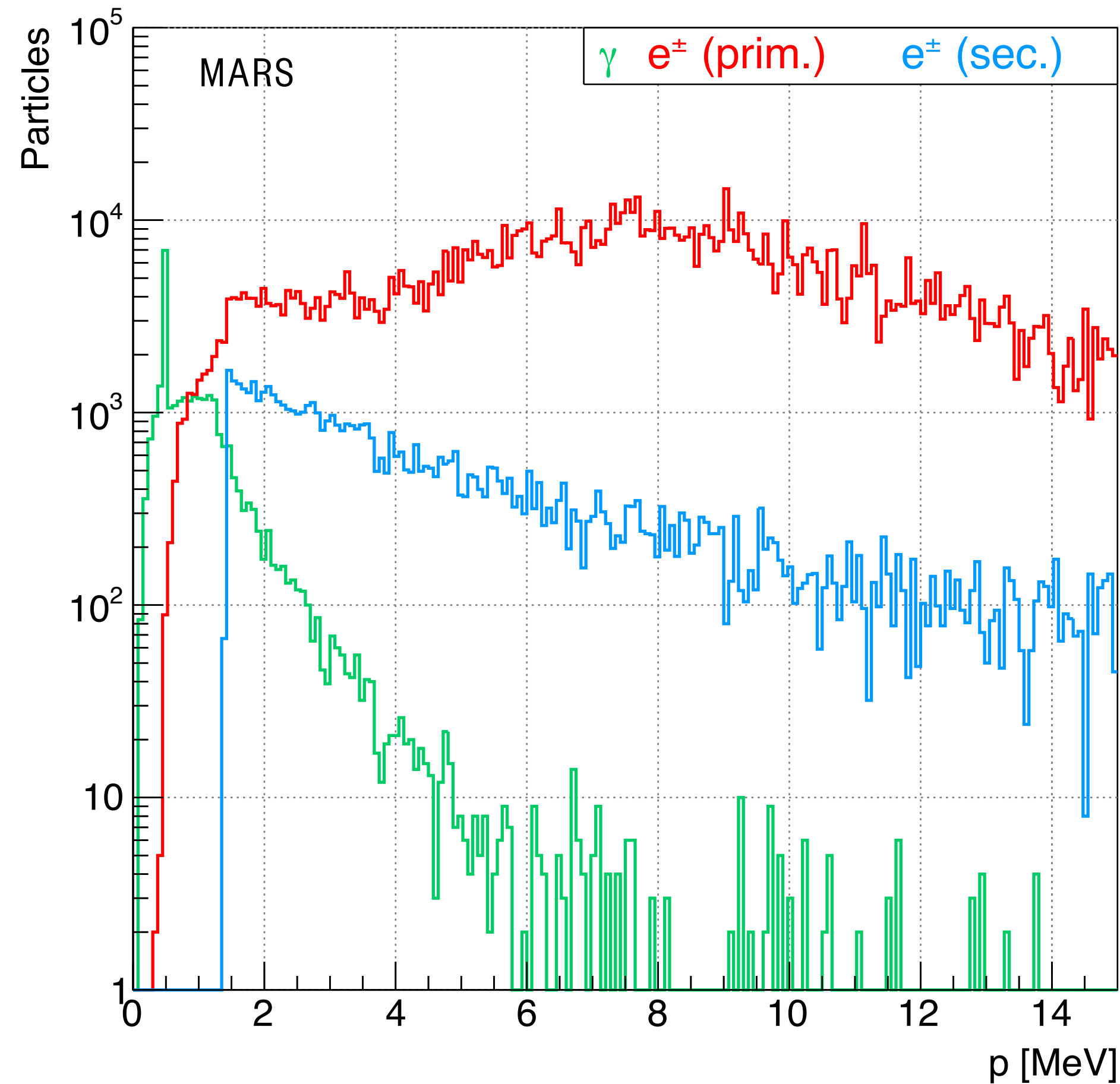
- Already some differences at BIB level → looking at medium momentum electrons



Electrons from BIB + detector

DETECTOR LEVEL

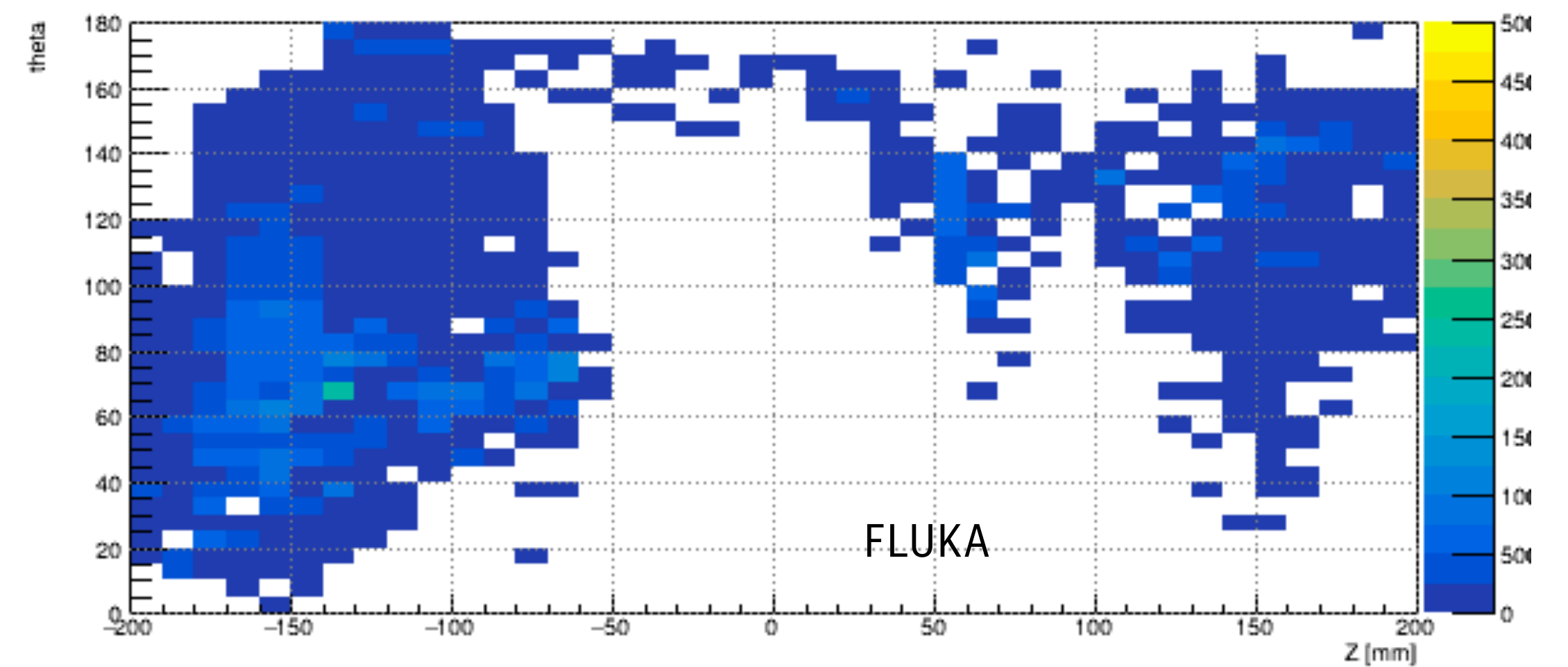
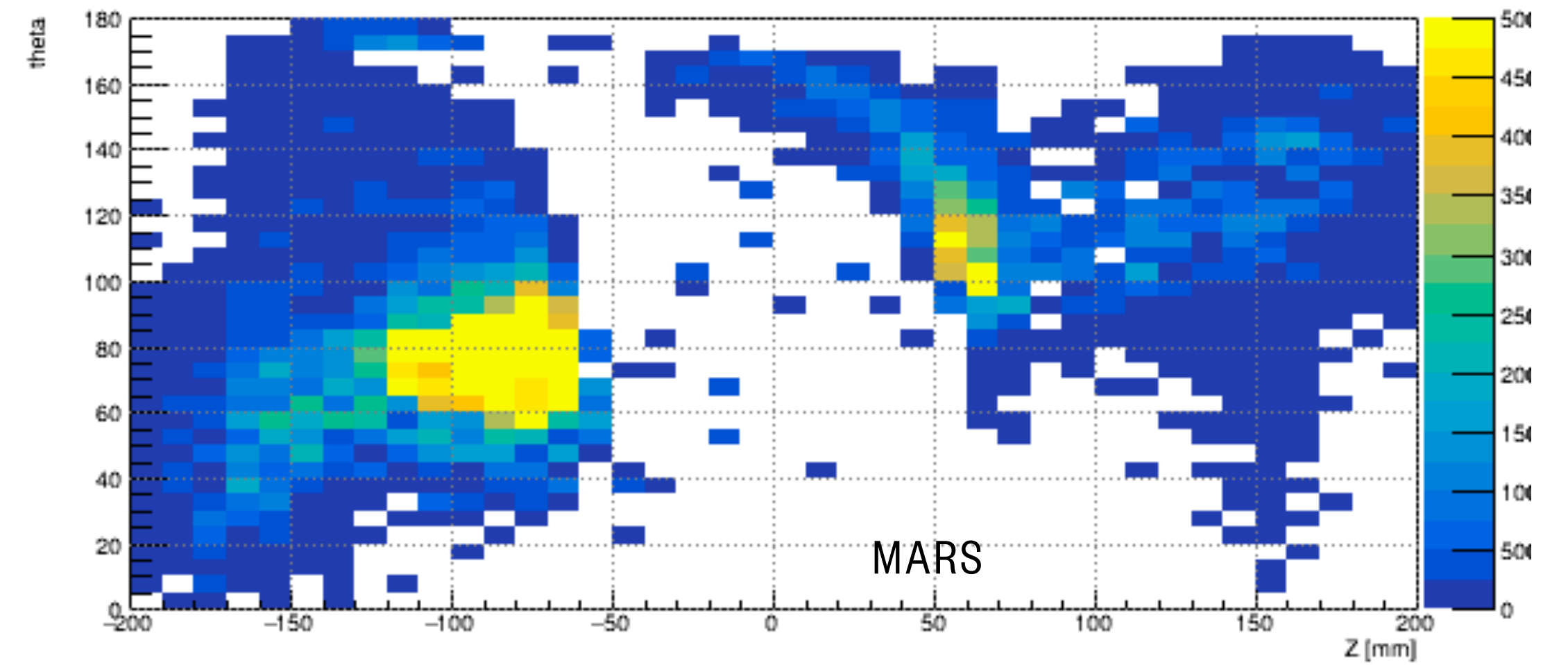
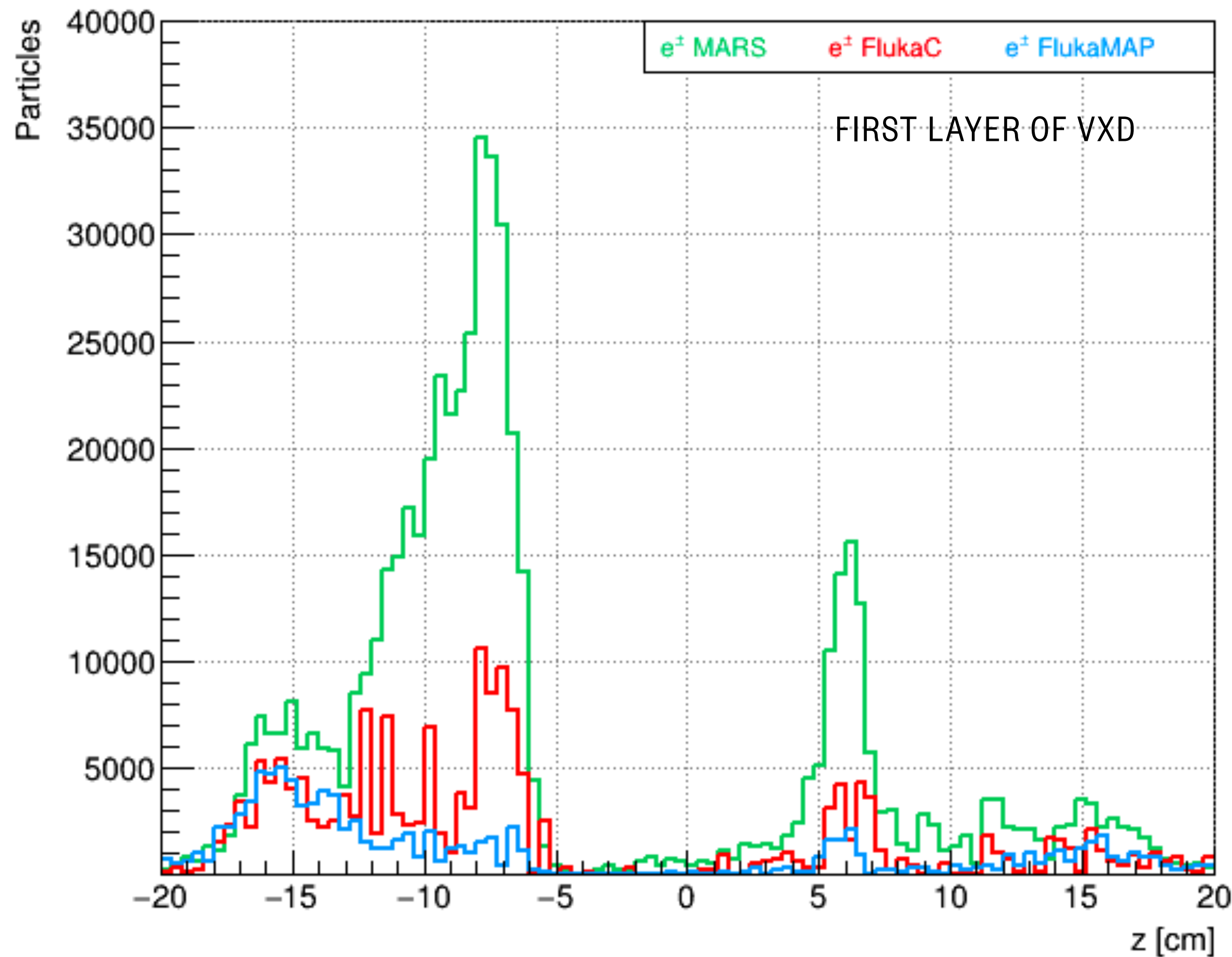
- Now checking distributions of particles leaving hits in the tracker



Electrons from BIB + detector

DETECTOR LEVEL

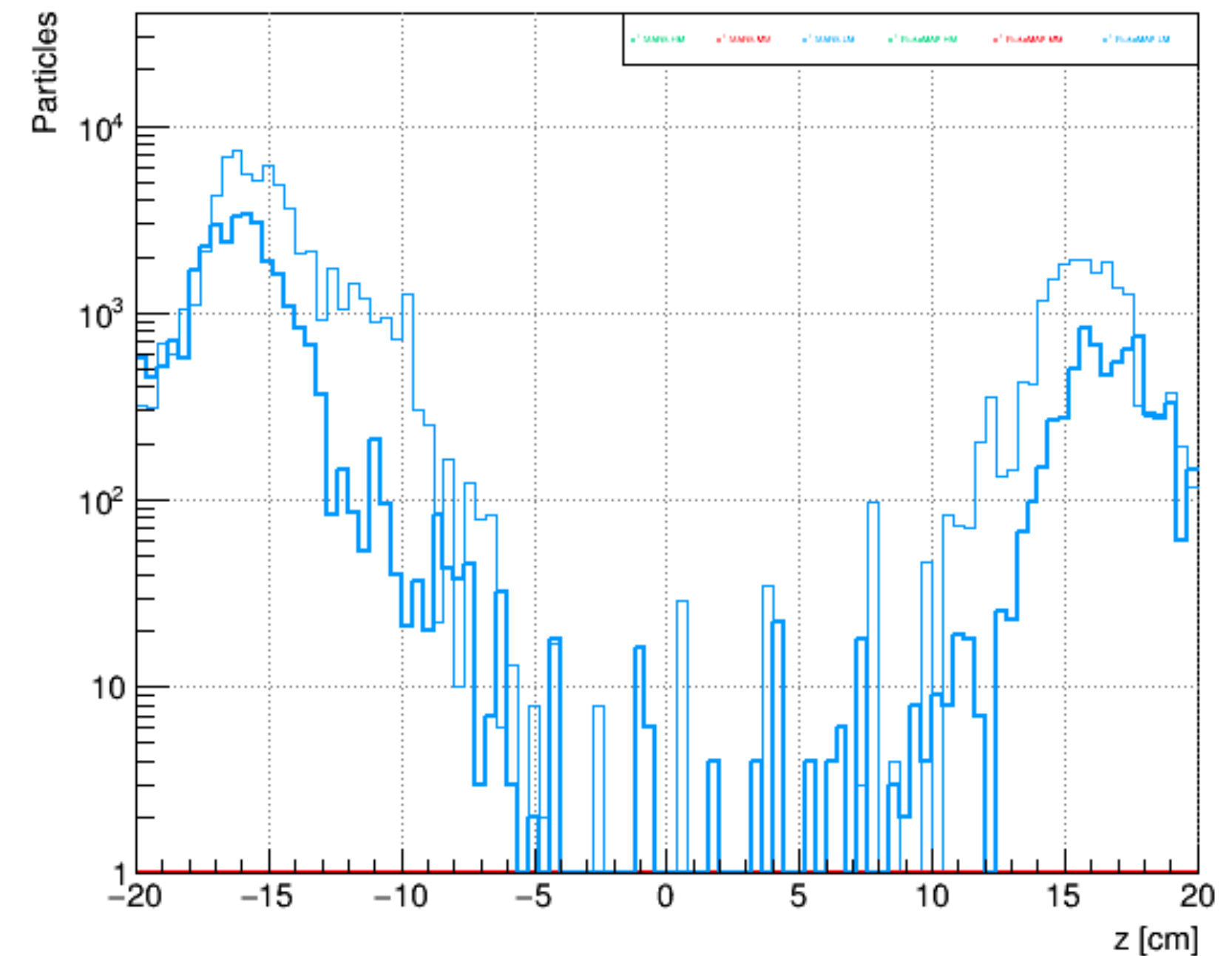
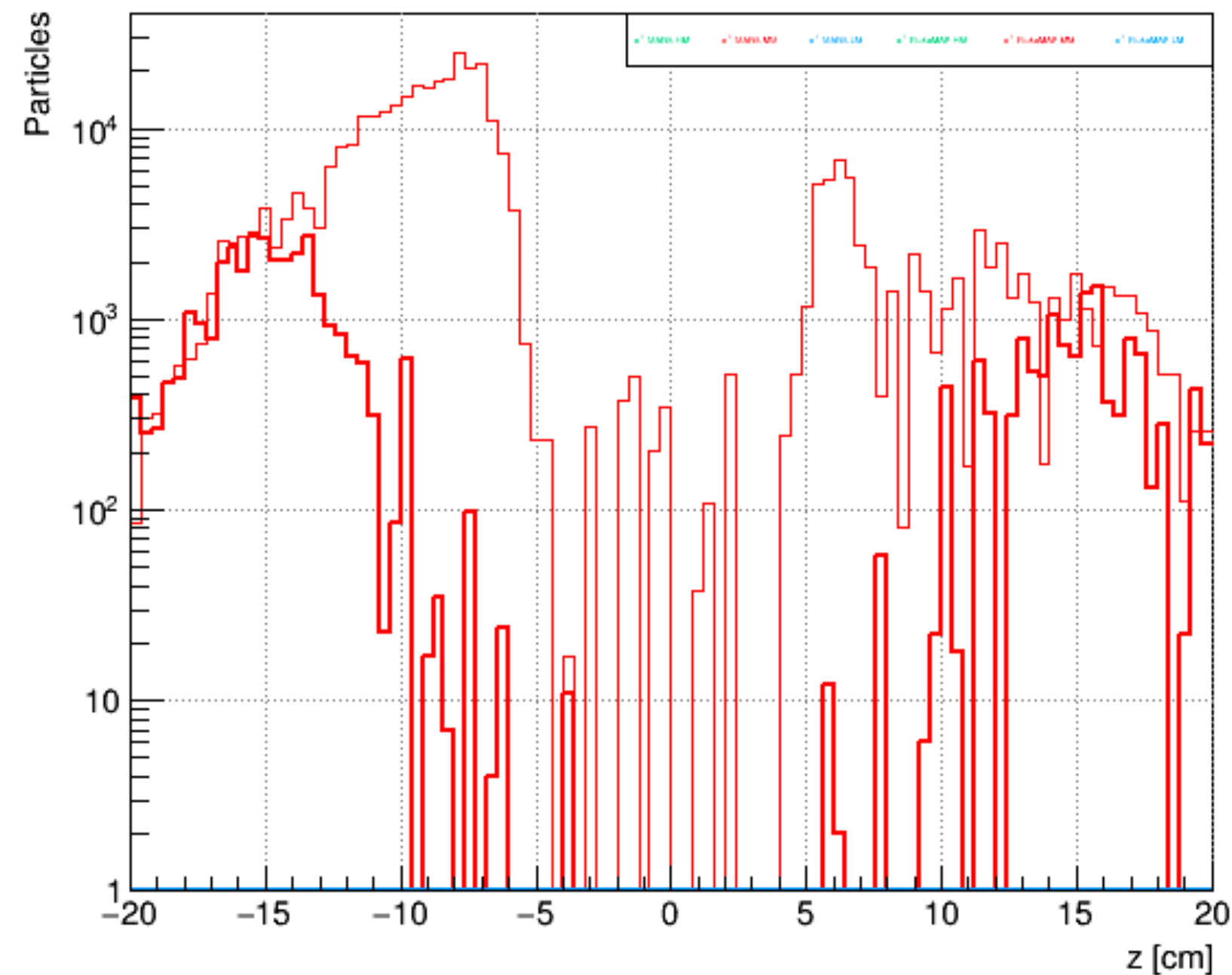
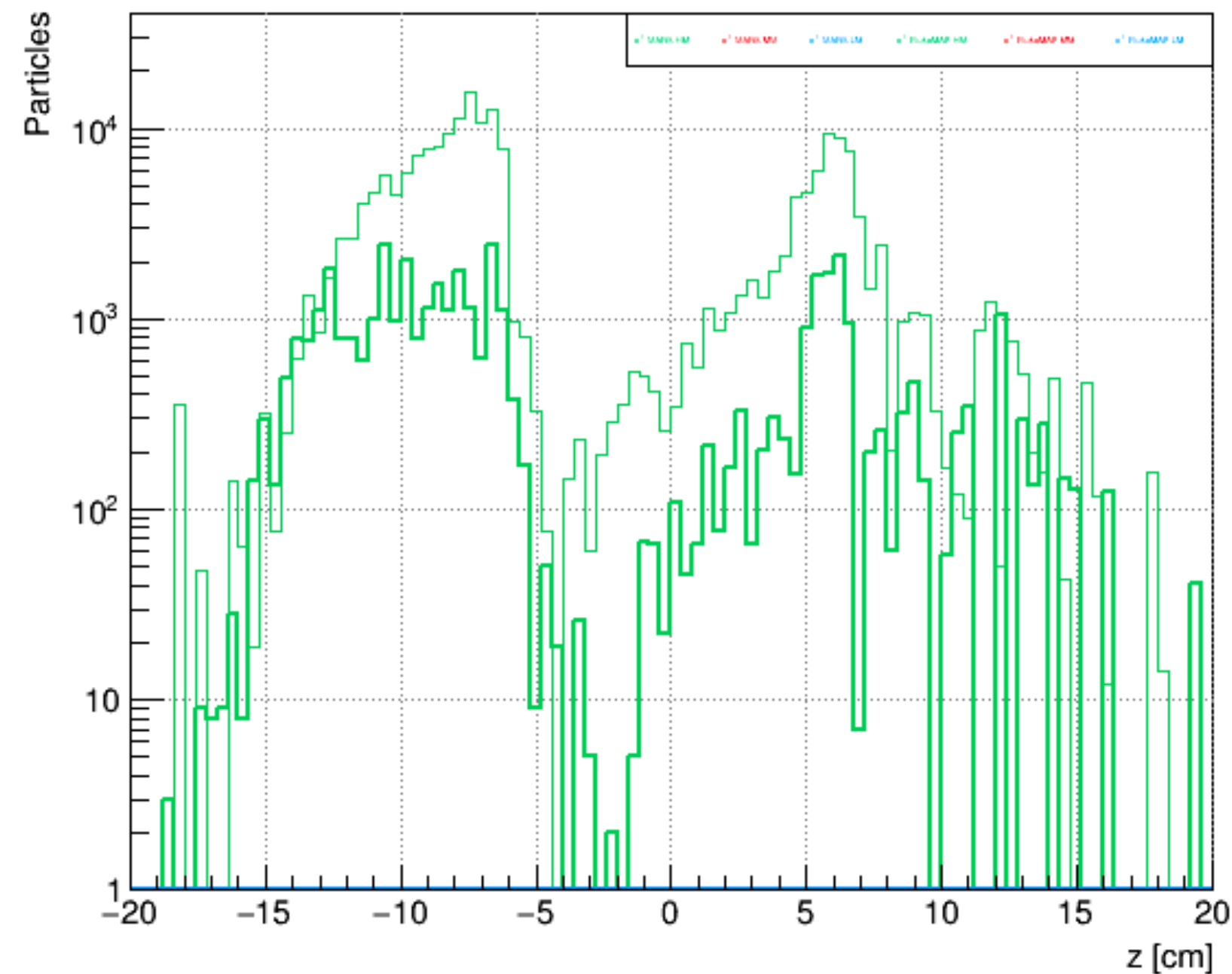
- Now checking distributions of (primary) electrons leaving hits in the tracker



Electrons from BIB + detector

DETECTOR LEVEL

- Now checking distributions of (primary) electrons leaving hits in the tracker
- Electrons at **high**, **medium** and **low** momentum (for *MARS* and **Fluka**)



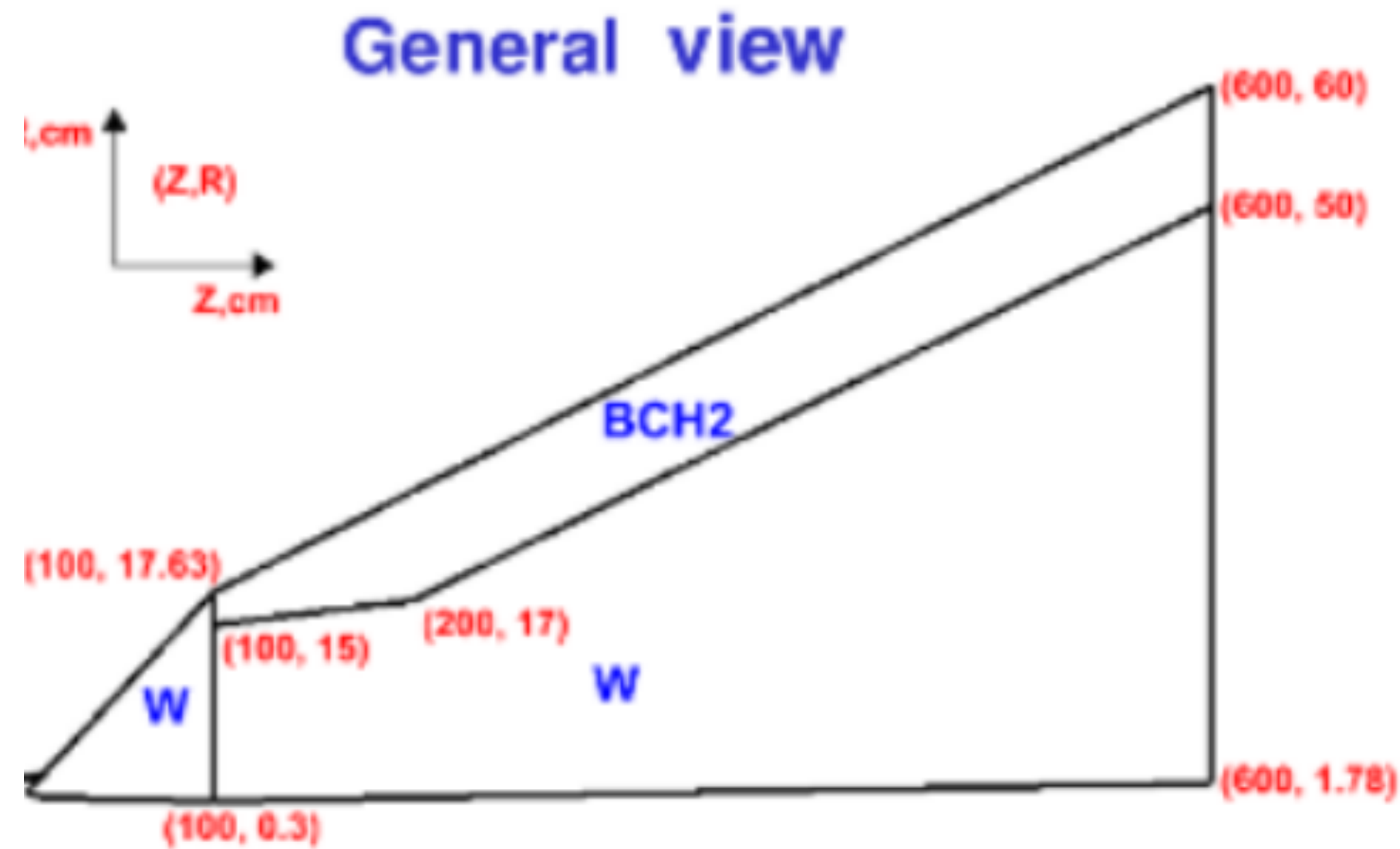
Conclusions

- So far, several considerations have been done using BIB produced by MARS
- We now have to confirm the Fluka configuration that we want to use for the ESPP
- Clear evidence of **how** Fluka is different wrt MARS → not clear **why**
- Run several checks for electrons of BIB, before and after detector simulation
- It seems that MARS produces more electrons with angle $\sim 90^\circ$ wrt Fluka
 - Beam interacting with the tip of the nozzle?
- **I think we should “accept” the overall factor ~ 2 of uncertainty in the first layers of VXD and go on with this configuration even for different center-of-mass energies**

ALMOST IMPOSSIBLE TO GET INFORMATION FROM MARS CONFIGURATION

Nozzle geometry close to IR

10⁰ nozzle geometry



W – tungsten
Be – beryllium
BCH2 – borated polyethylene

