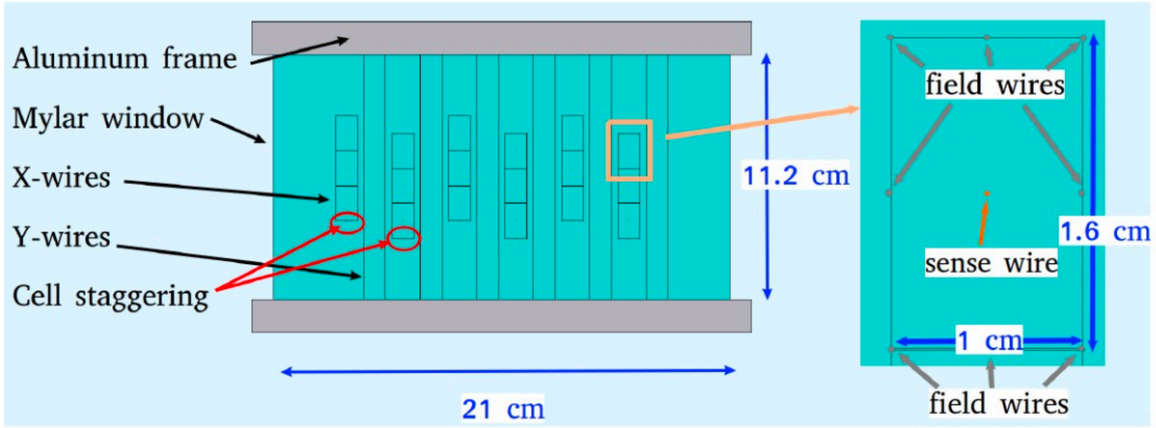
BM: the shadow of the wires

A movie by: Medusa (Milan rEsearch in Detector and nUclear Science Applications)

09/07/2024

A quick reminder on the BM detector

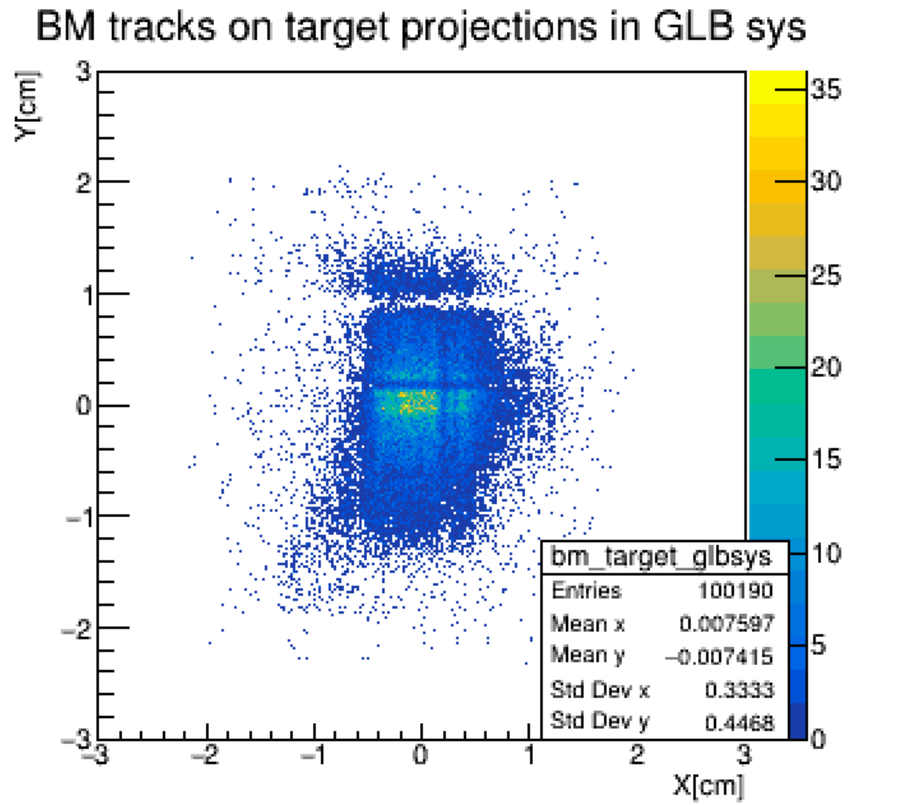


- 6 staggered layers of cells on X and Y view
- Each layer composed of 3 rectangular cells (16 mm x 10 mm)
- Contiguous BM layers of the same view are staggered by a half of a cell
- Field wire with a diameter of 90 μm
- Sense wire with a diameter of 25 μm
- A particle passing close to a cell border/center can “see” 15 field wires and 3 sense wires
- BM reference paper from FIRST:

- Abou-Haidar et al. Performance of upstream interaction region detectors for the FIRST experiment at GSI. Journal of Instrumentation, 7(02):P02006–P02006, feb 2012
-A. Paoloni, M. Anelli, E. Iarocci, V. Patera, L. Piersanti, A. Sarti, and A. Sciubba. The upstream detectors of the first experiment at gsi. Physics Procedia, 37:1466 1472, 2012. Proceedings of the 2nd International Conference on Technology and Instrumentation in Particle Physics (TIPP 2011)

An old open question:

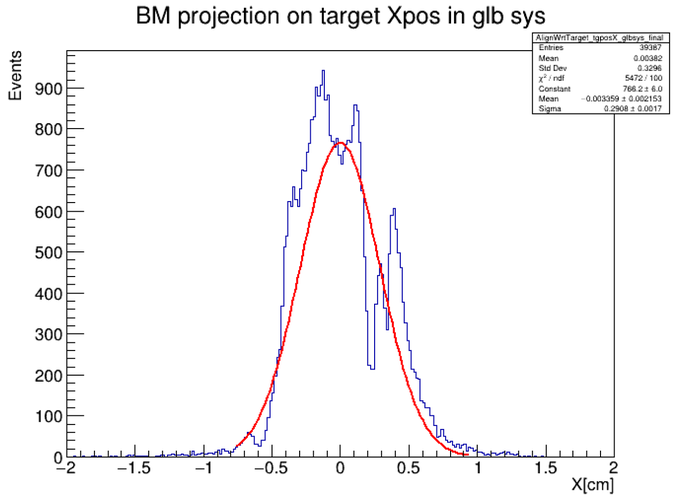
BM beam profile @ CNAO23

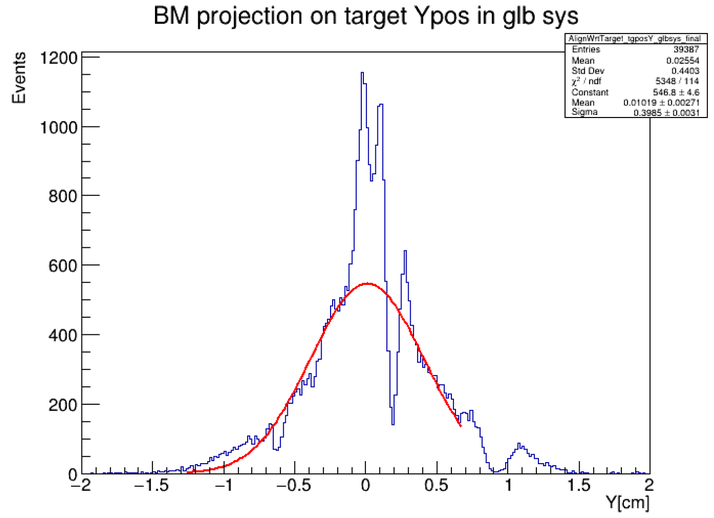


- Since we start to use the BM, we always see a grid corresponding to the BM wire positions on the beam profile measured by the BM and the other detector placed beyond the BM,

- The grid in the BM profile can be due to the BM detector itself :low efficiency at cell border, space time relation uncertainties, T0 evaluation

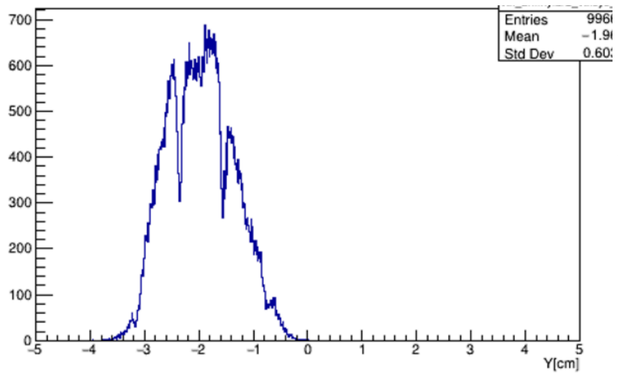
  (check the MC studies conducted in the past: https://agenda.infn.it/event/17473/contributions/37042/attachments/25830/29496/2018_12_bm_borgomale.pdf)



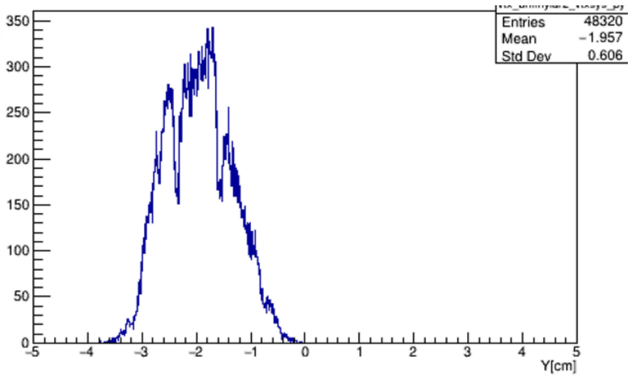


BM wire profile from other detector

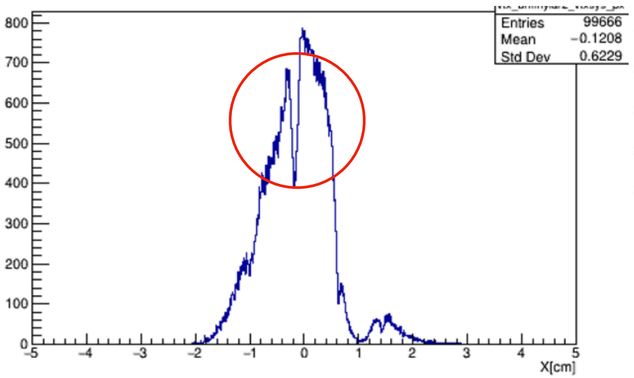
MSD beam profiles collected @ Trento with p @ 80 MeV



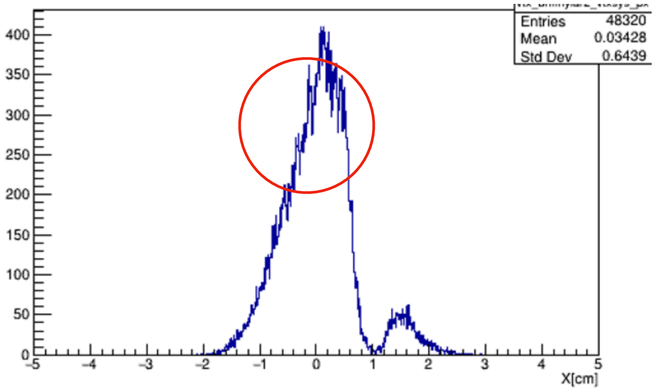
Y view, no BM tilt



Y view, with BM tilt on Y



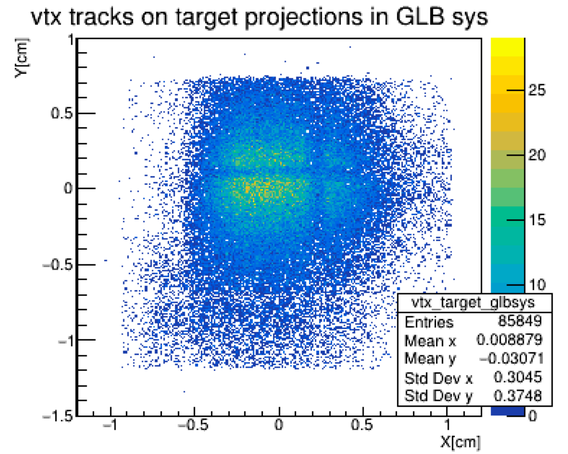
X view, no BM tilt

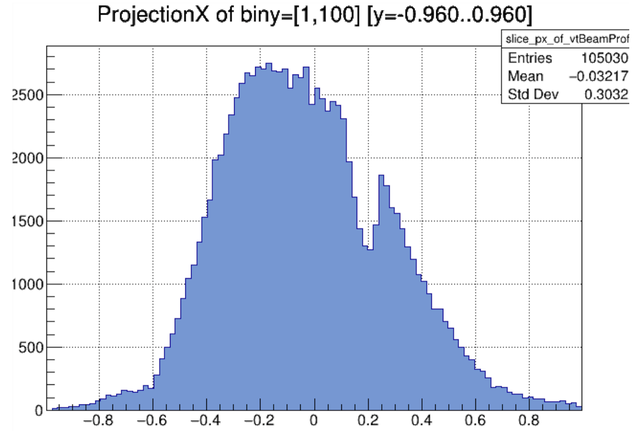


X view, with BM tilt on Y

- **The grid is reconstructed also in the other tracking detector placed beyond the BM**
- During the BM characterisation data taking conducted @ Trento with protons and with a MSD like detector, we tilted the BM on one view and the grid detected by the MSD disappeared on one view (Check here: https://agenda.infn.it/event/18616/contributions/95072/attachments/63979/77180/BM_FOOTCollaborationMeeting.pdf)
- **Conclusion: the grid is a physics effect due to the BM field wires, not something related to reconstruction**

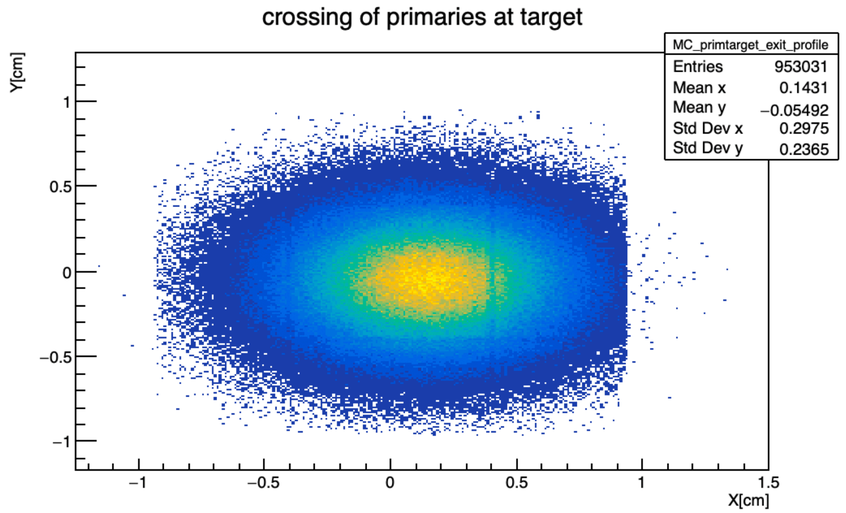
VTX beam profile @ CNAO23

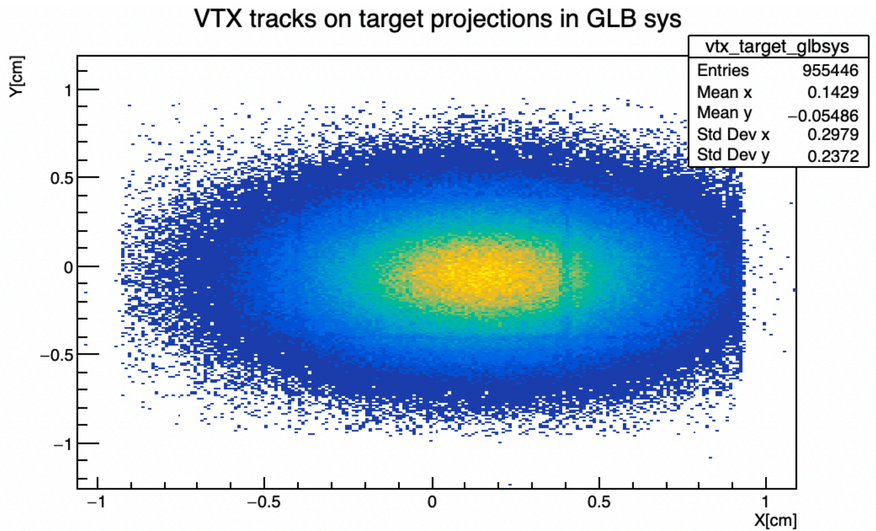




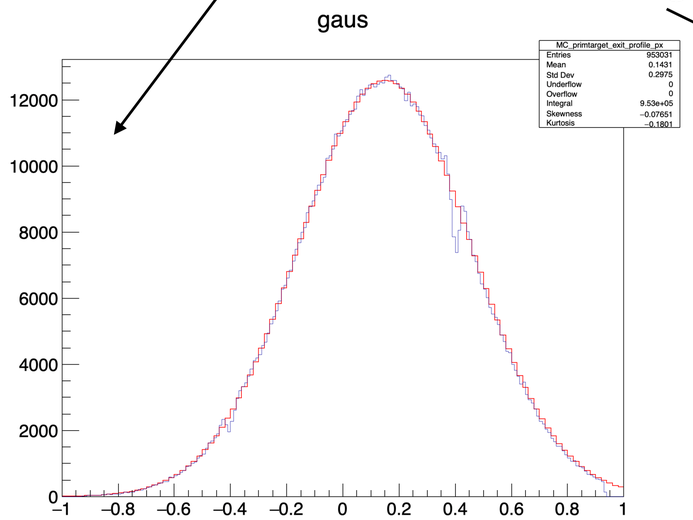
MC simulations

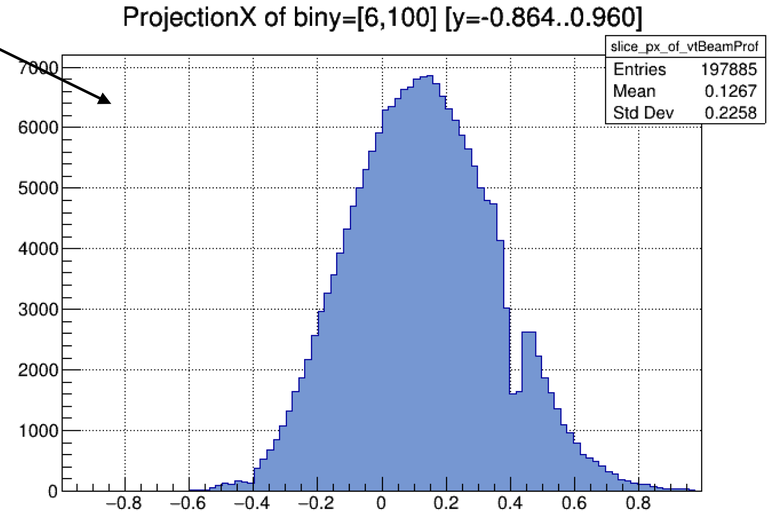
MC simulation of O @ 400 MeV/u (GSI2021)





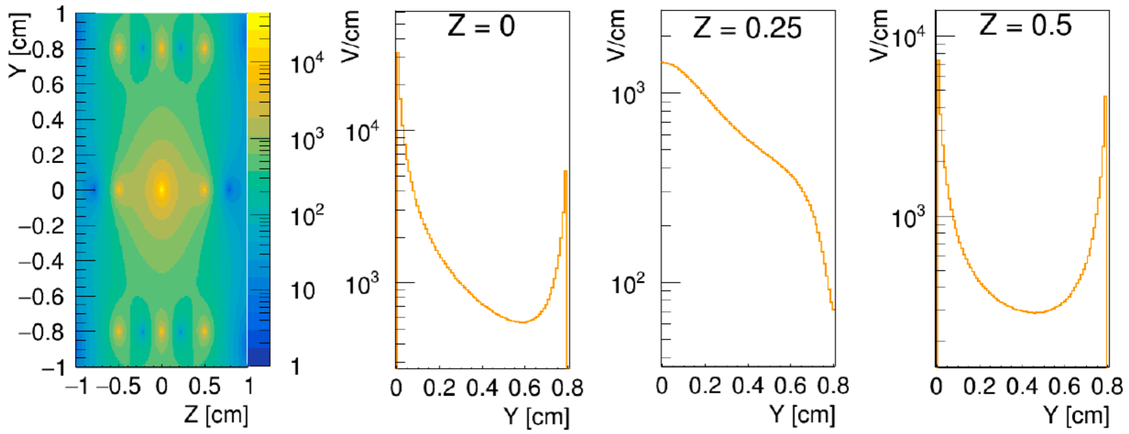
- However: the MC simulations never succeed to reproduce the grid correctly: **we can see the effect, but it is not enhanced as in data**
- No relevant effects due to the vtx reconstruction
- MC simulation missing evts in hole ~ 20%
- VTX data missing evts in hole ~ 50%

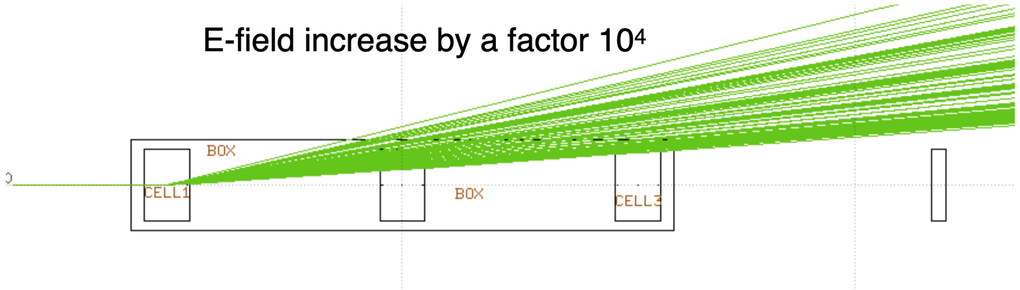




Electric field effect

Electric field map evaluated by means of Garfield++ MC simulation tool with the BM HV at 2200 V



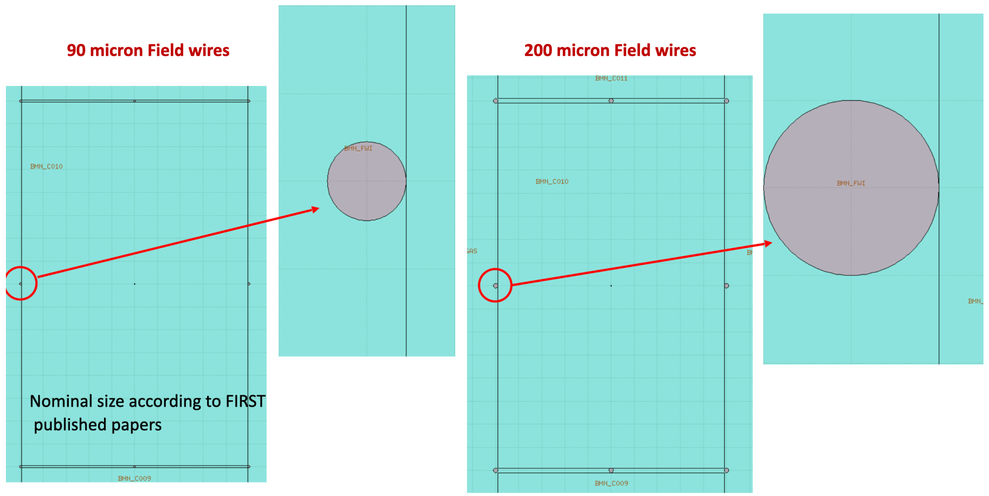


Deflection is a function of “impact parameter” of the incoming particle with respect to the sense wire

- (In the past) we tried also to displace the BM wire positions a little bit to take into account for possible wire displacement, but no effect had been seen
- We have also investigated the possibility that the high electric field close to the sense wire could contribute to the deflection of a charged particle (the field close to the field wires is less intense)
- In the space region close to the sense wire E(r) is very similar to that of a wire of radius a inside a cylindrical cathode of radius b:
  $E(r) = V/(\log[b/a]\, r) \rightarrow E(a) \sim 294$ kV/cm (b = 0.5 cm, 2a = 25 μm, V = 2200)
- This allowed to perform a MC FLUKA simulation in vacuum (trajectory calculated numerically solving differential equation with Runge-Kutta methods).
- Result: for a ^{12}C at 200 MeV/u, the maximum deflection would be of the order **~8 10^{-5} rad**
- Significative deflection could be observed only with E greater at least by a factor of thousand
- **Conclusion: the electric field does not provide any relevant effect**

A diameter that actually is a radius?

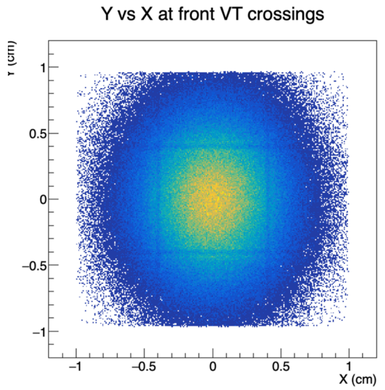
Changing diameter of Field Wires



- We increased the field wire size in the MC simulations and the beam profile seems to be more similar to data

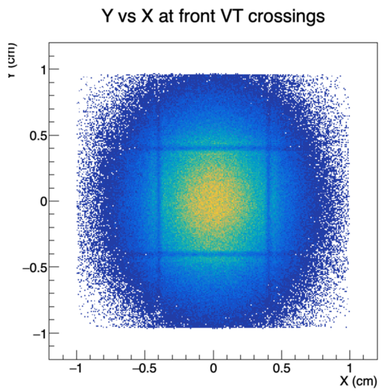
Impact point on 1st layer of VT

90 micron Field wires



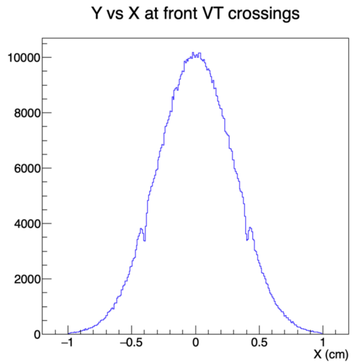
Simulation with 12CFull_MC campaign

200 micron Field wires

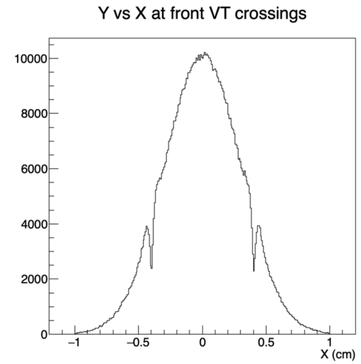


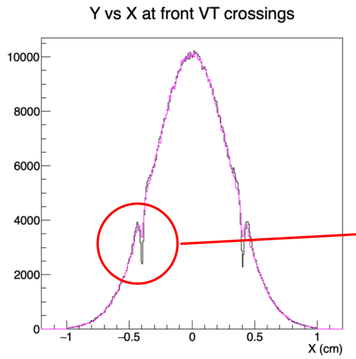
Impact point on 1st layer of VT: 1-D projection

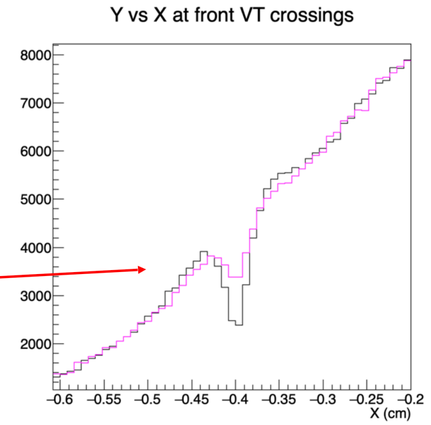
90 micron Field wires



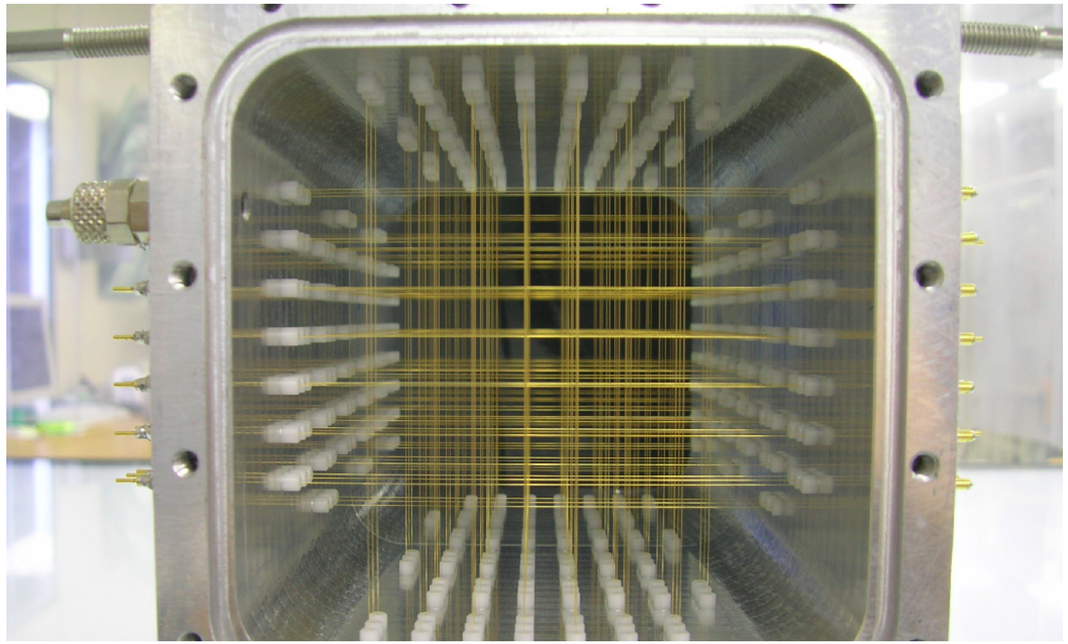
200 micron Field wires







Still an open question



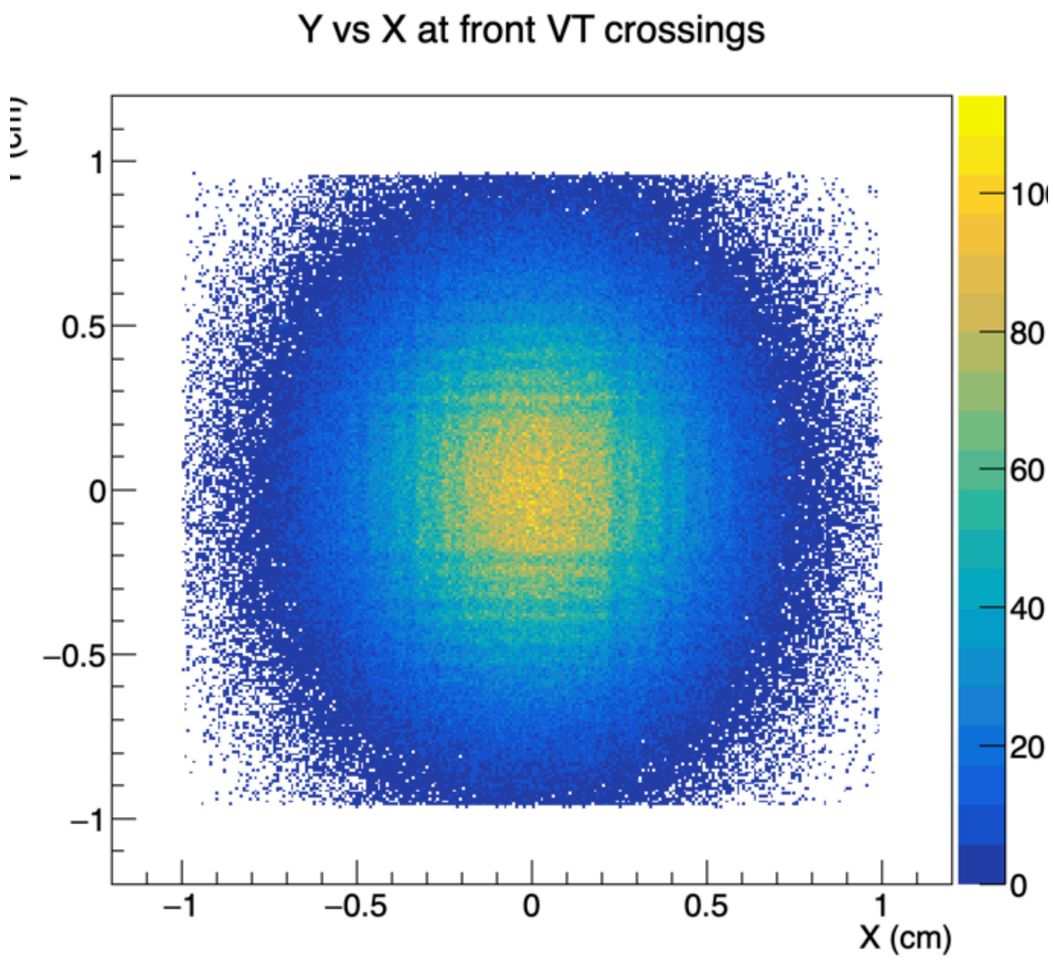
- **At the moment we do not have a definitive answer to the beam profile grid question**

- One possible explanation is that the BM field wire have a radius (not diameter) of 90 μm:
  -Maybe in the original BM paper a diameter was a radius?
  -Or maybe the BM wires had been substituted?

- Surely, the BM wires are gold plated and this is not included in the MC simulation, but the coating is of the order of 10-20 μm and it is negligible

- **We cannot (we do not want to) disassemble the detector to measure the wire size (too risky)**

Towards CNAO2024



- We would like to exclude the electric field effect experimentally: take a short run without the BM HV
- Possibility to tilt and place the BM in order to check the MCS effect on a single wire?
- Other ideas about possible causes or about other experimental test to be done?