Black Box Alignment (BBA): first test with mCBM data 2024 and beyond

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Black Box Alignment (BBA)

41st CBM Collaboration Meeting link

- Use reconstructed in pre-aligned setup (mechanical, optical etc.) tracks

- Shift construction elements to minimize track χ^2
  - shifts
  - step of shifts
  - precision
  - reference units

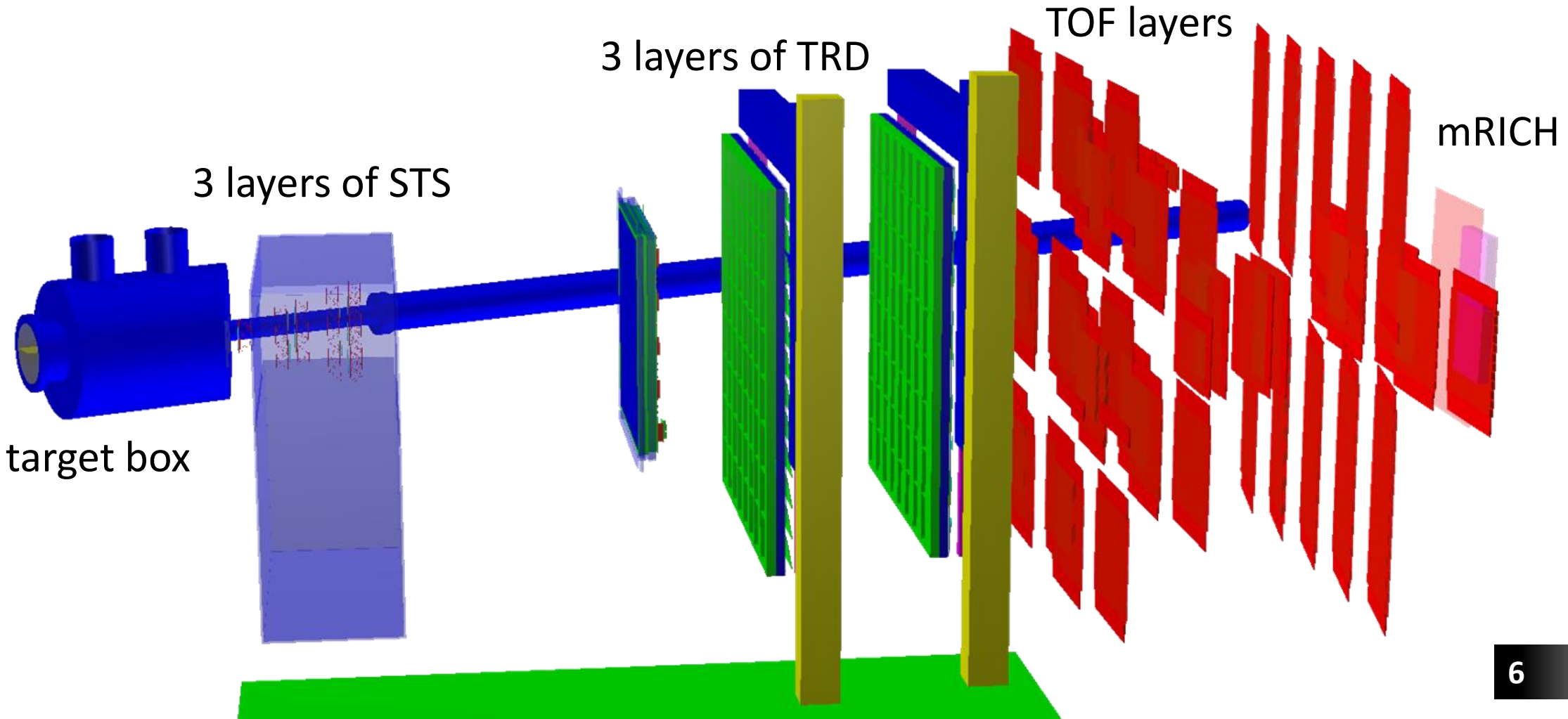
- Possible to run several times with different settings to tune alignment

Outline

- MC simulations for mCBM
- mCBM data 2024 run 2984
- first test for STS misaligned units
- Next steps

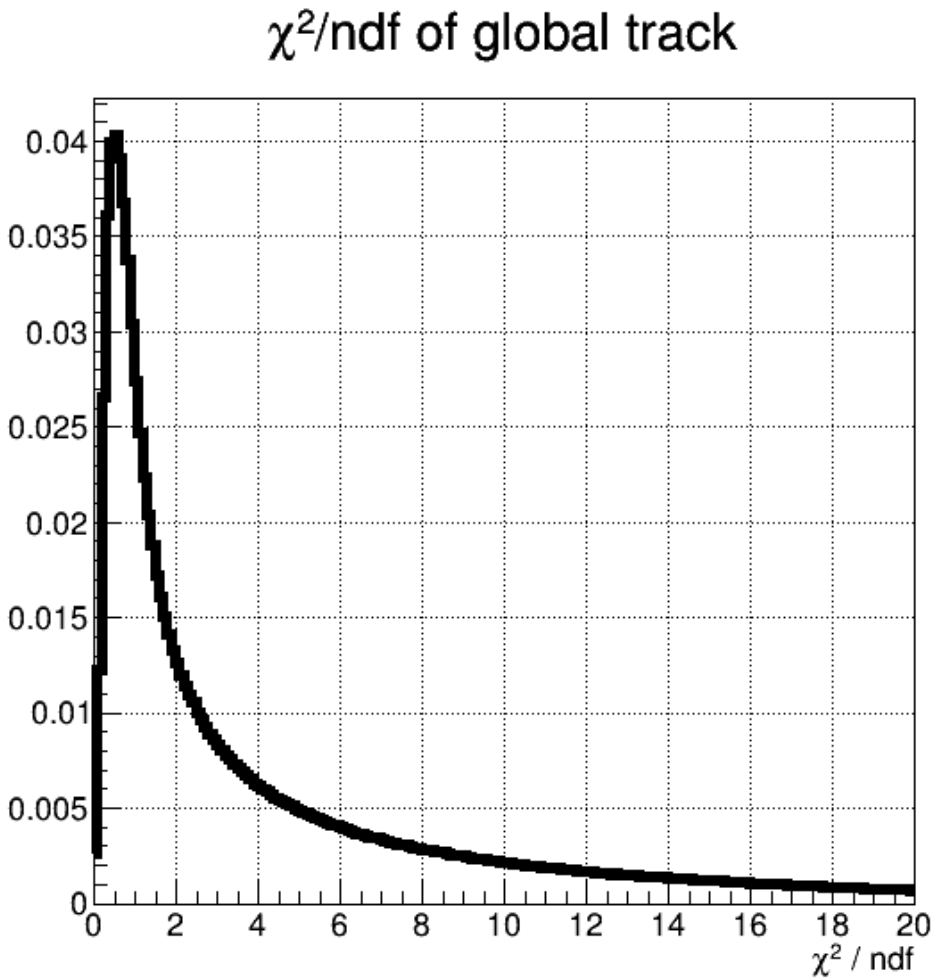
2024 geometry in CBMROOT

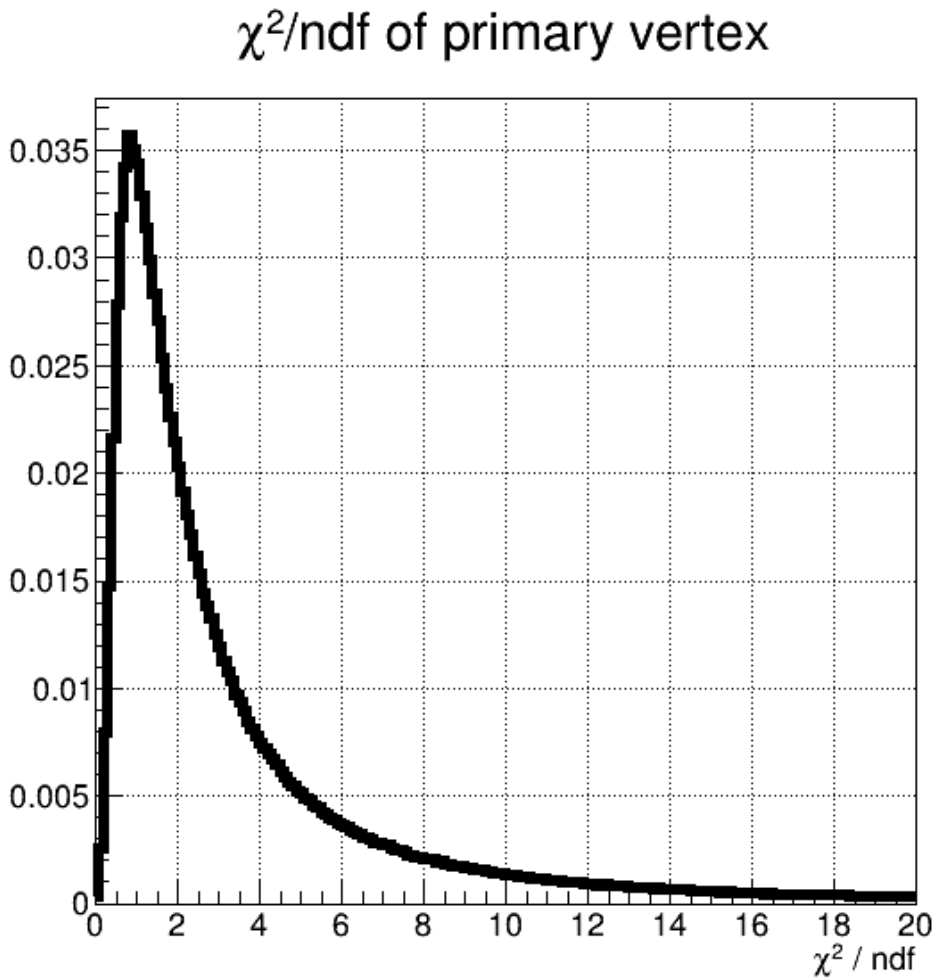
mcbm_beam_2024_05_08_nickel



QA check with MC

MC: mbias UrQMD Ni+Ni @ 1.93A GeV





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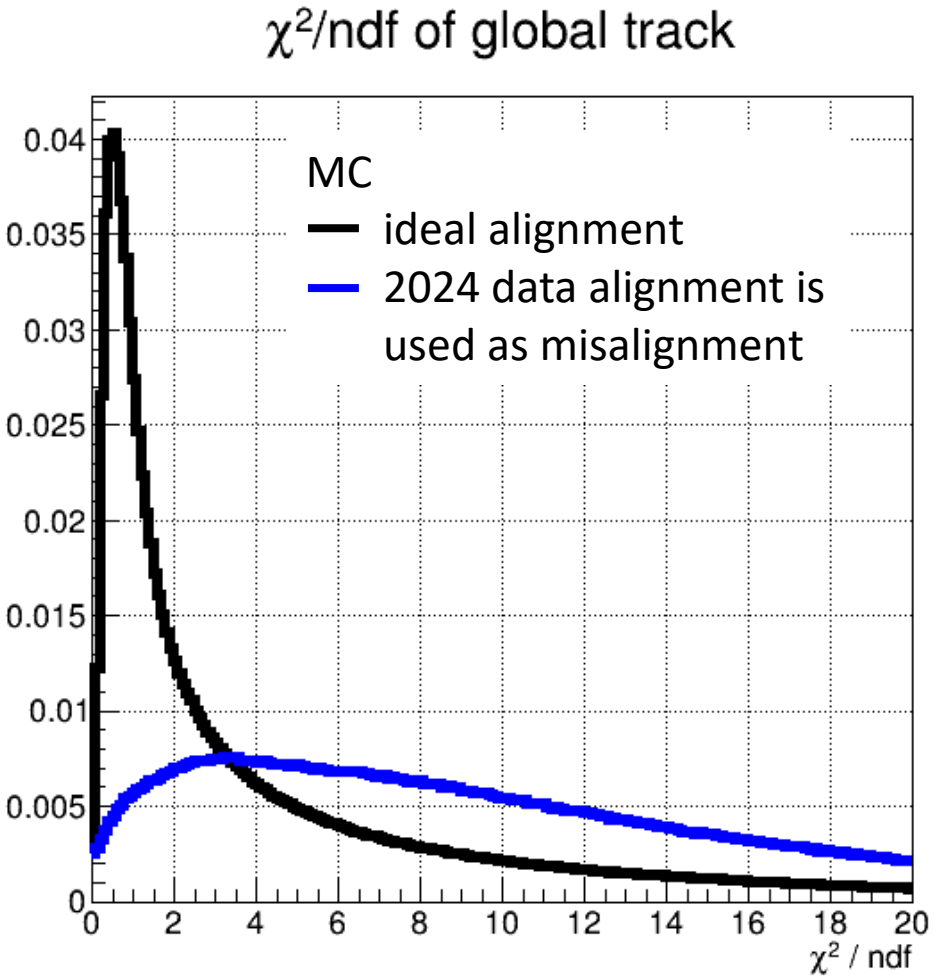
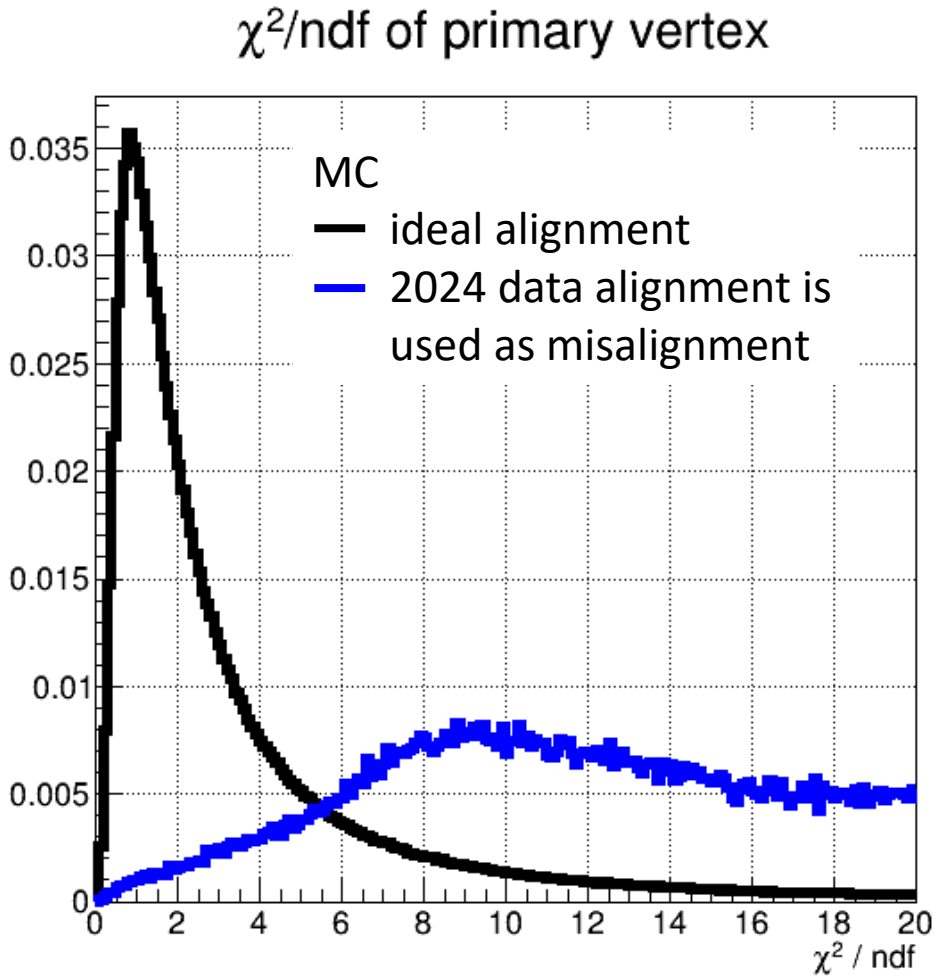


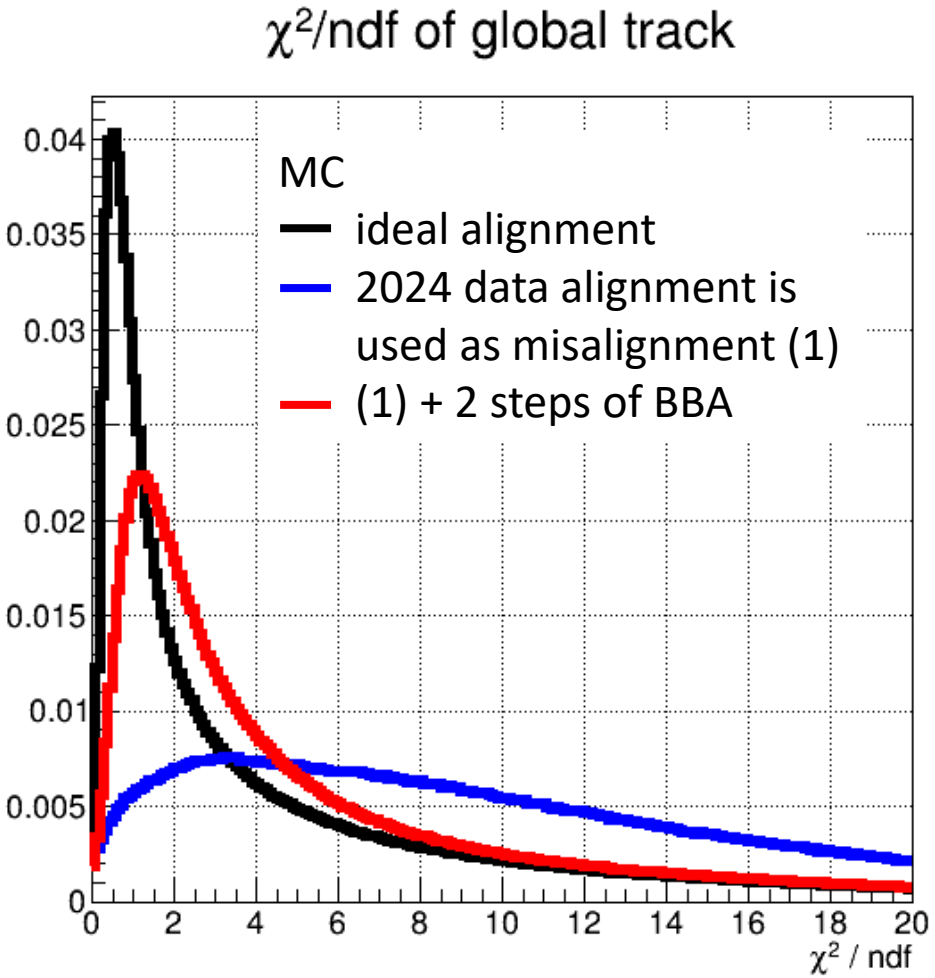


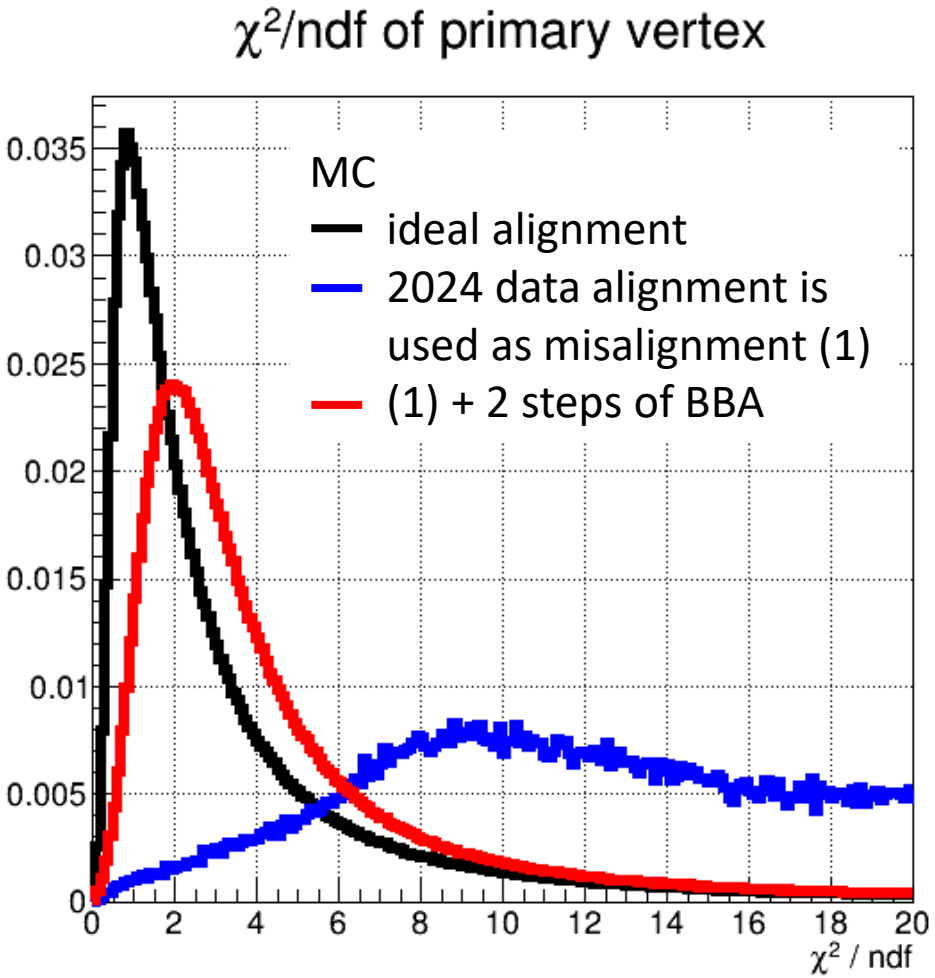
BBA working scheme for test with mcbm2024 data

- Run track reconstruction without alignment
- BBA reference detectors: first station – STS0, last station – TOF last station/layer
- Run BBA with fixed Z positions of all detectors/sensors (first step)
- Run track reconstruction using first BBA output
- Run BBA with fixed Z positions of first and last stations (second step)
- Run track reconstruction using second BBA
- Shift full setup to have primary vertex in (0, 0, 0)

QA check with MC

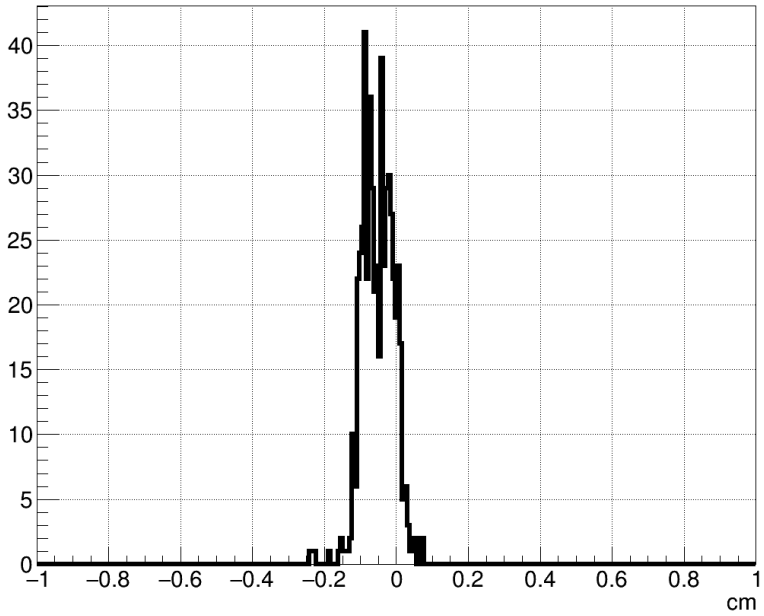
MC: mbias UrQMD Ni+Ni @ 1.93A GeV



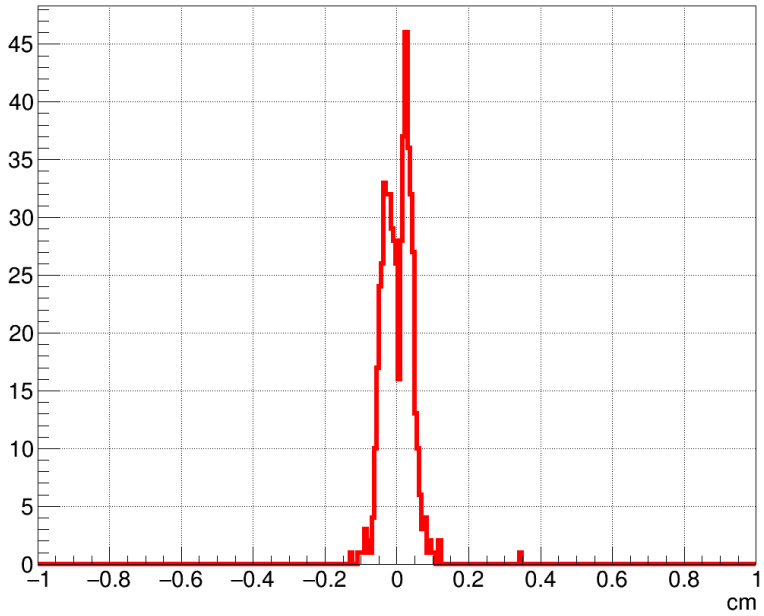


X residuals: STS station 0

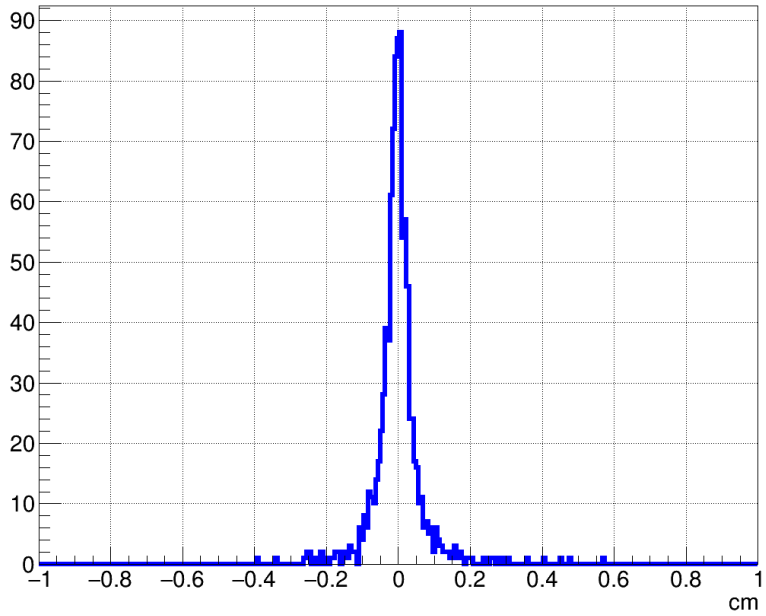
Before BBA



First BBA step

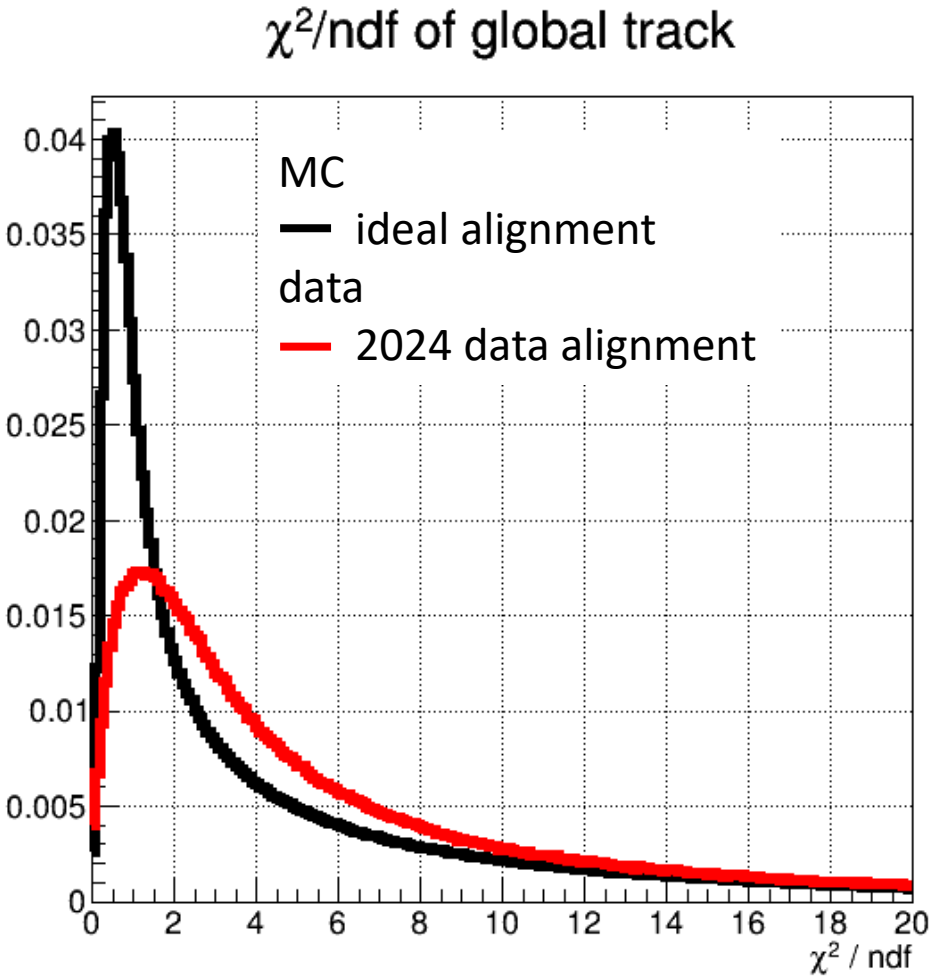


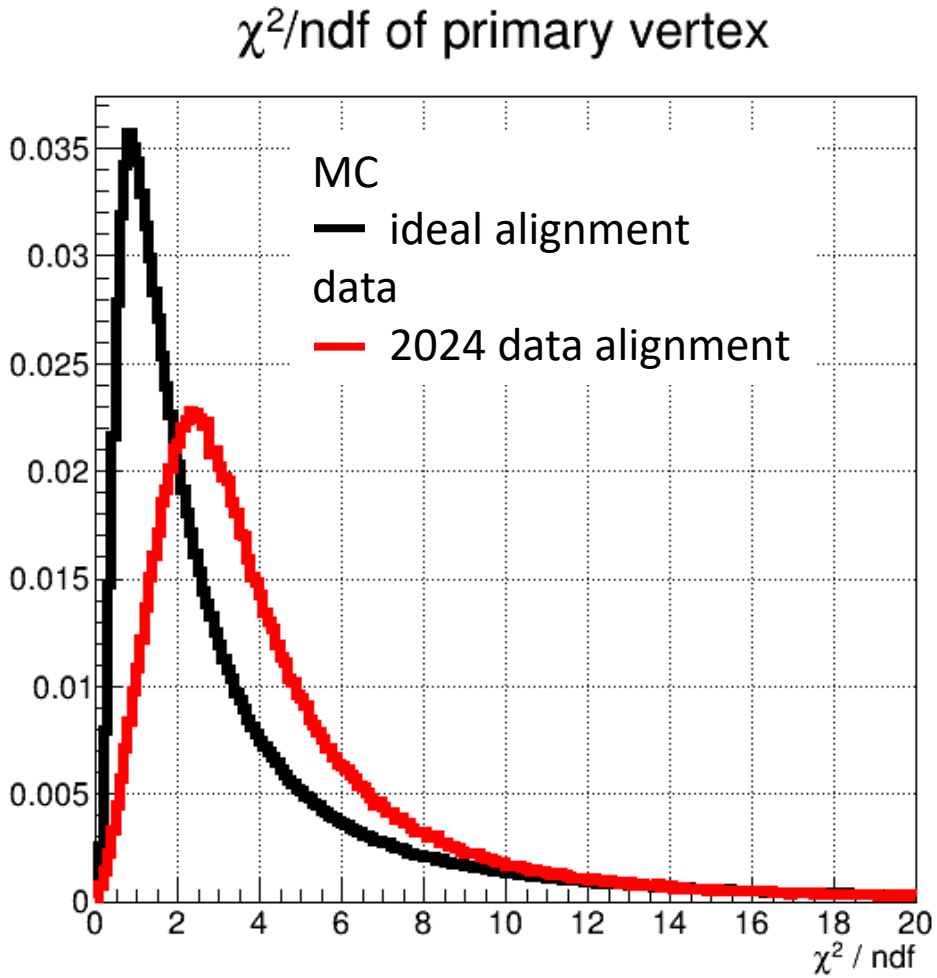
Second BBA step



QA check

MC: mbias UrQMD Ni+Ni @ 1.93A GeV
data: run 2984





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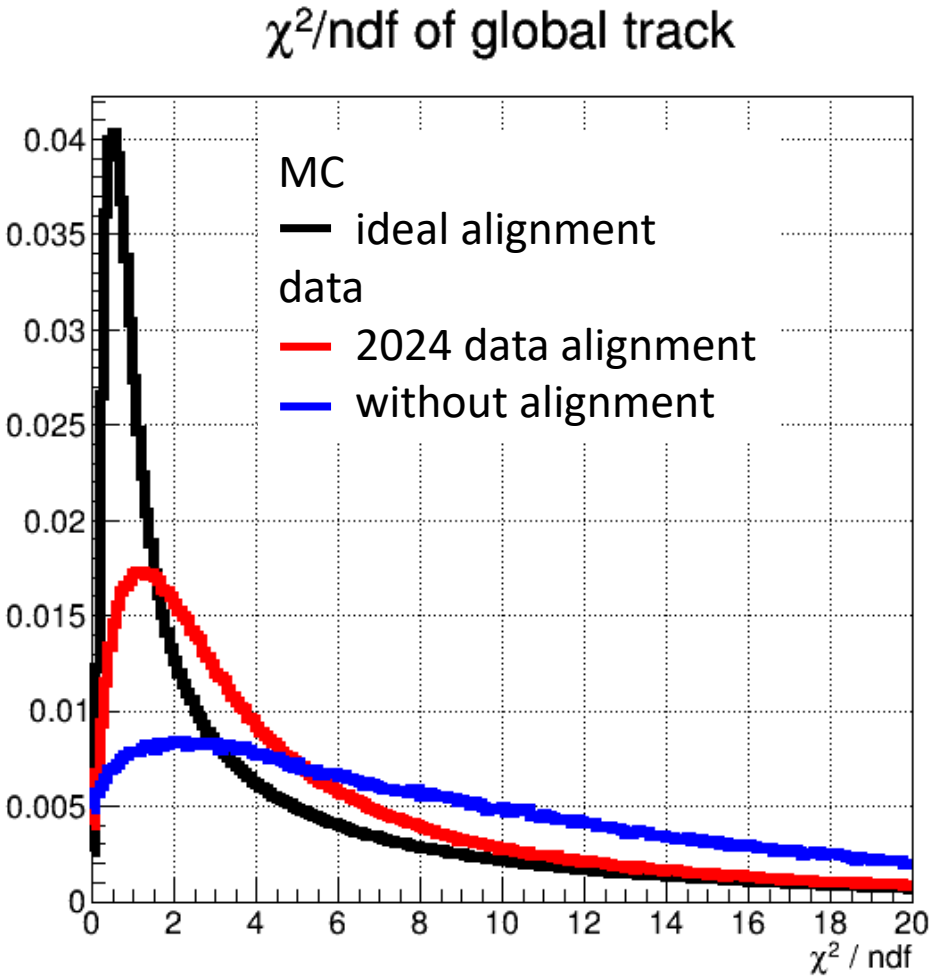
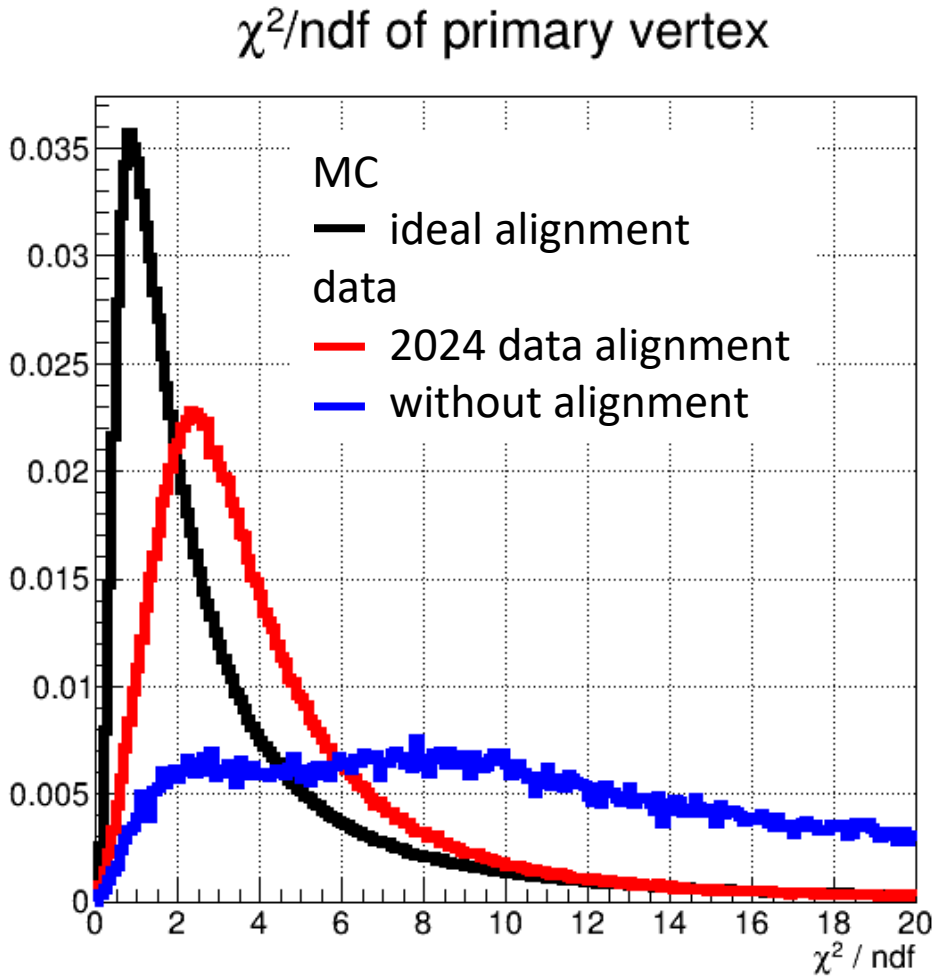
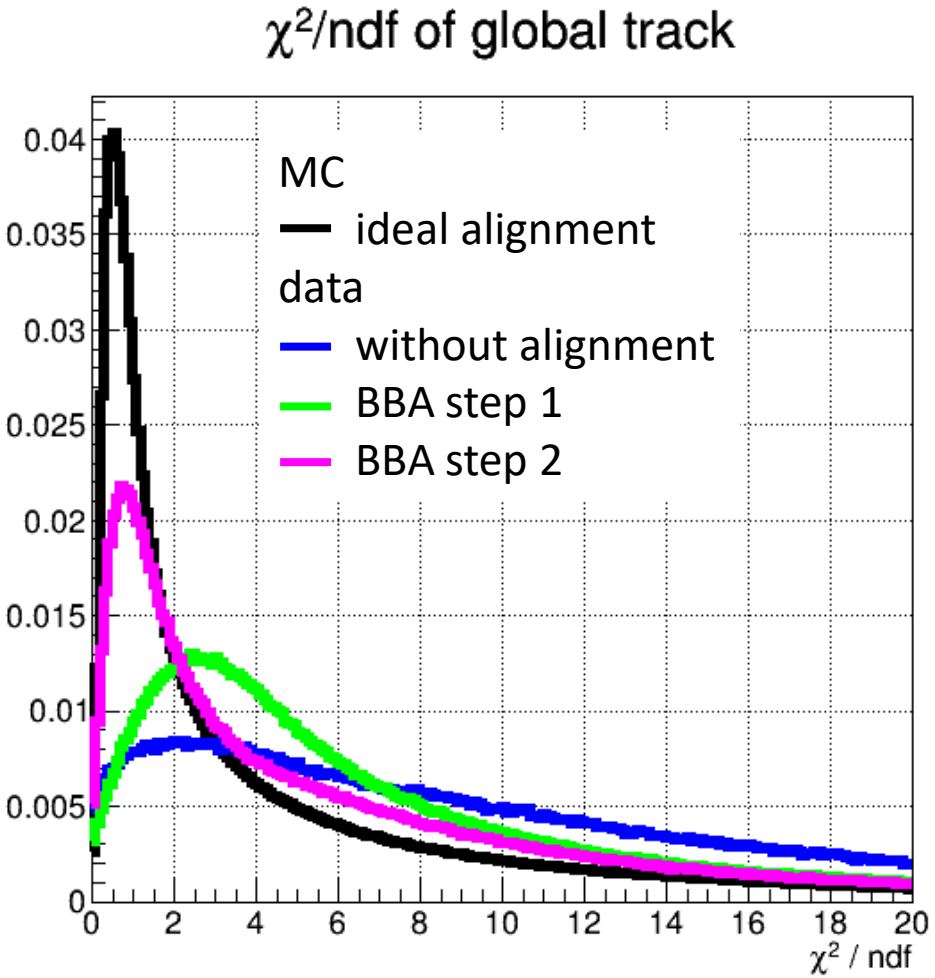
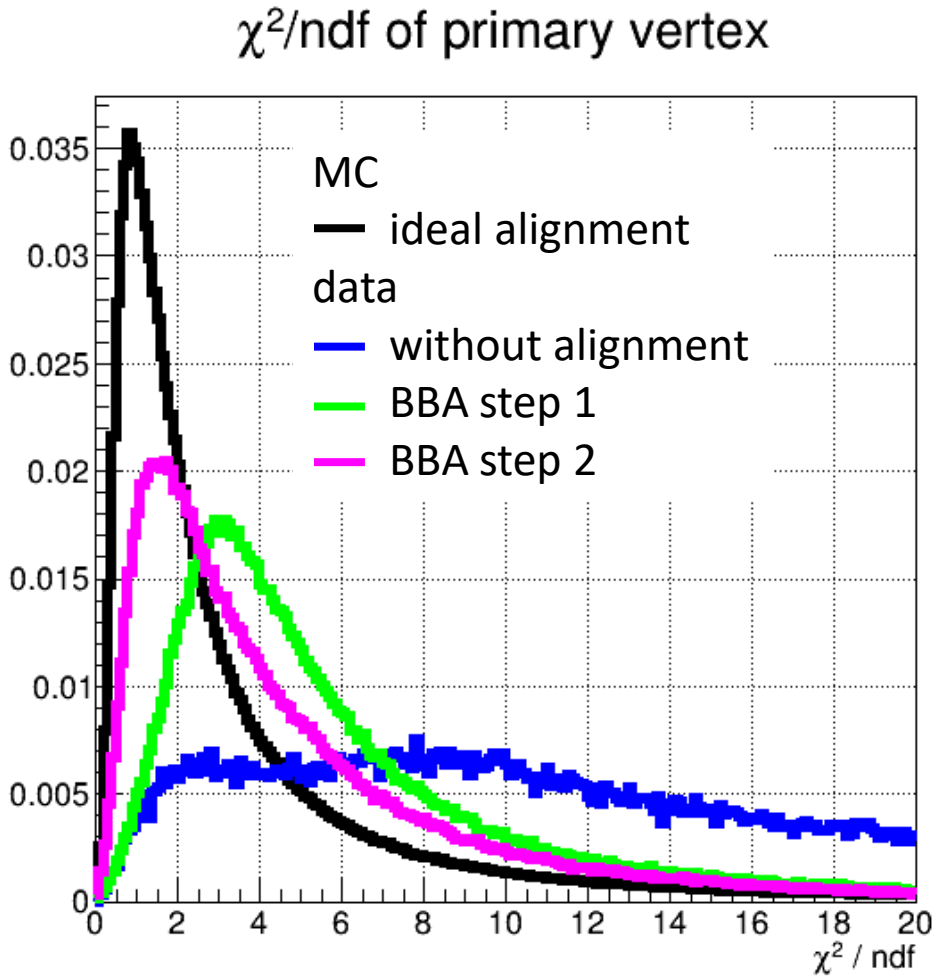




QA check

MC: mbias UrQMD Ni+Ni @ 1.93A GeV
data: run 2984





QA check

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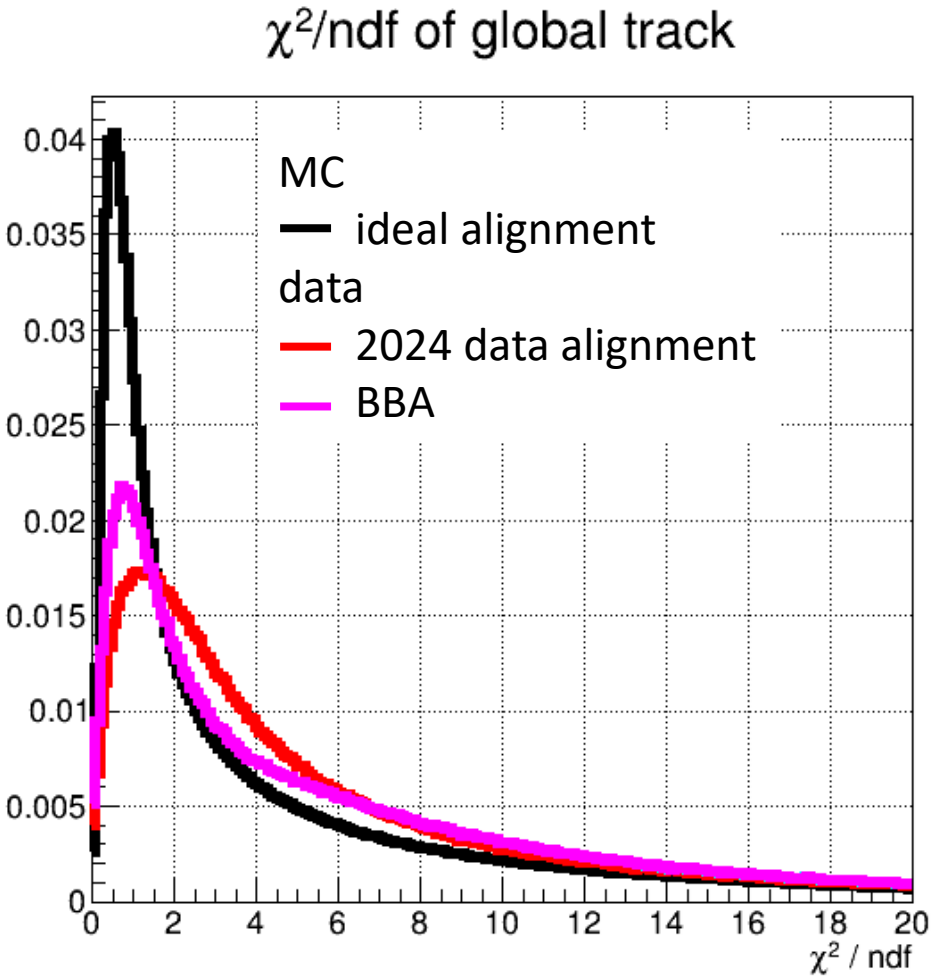
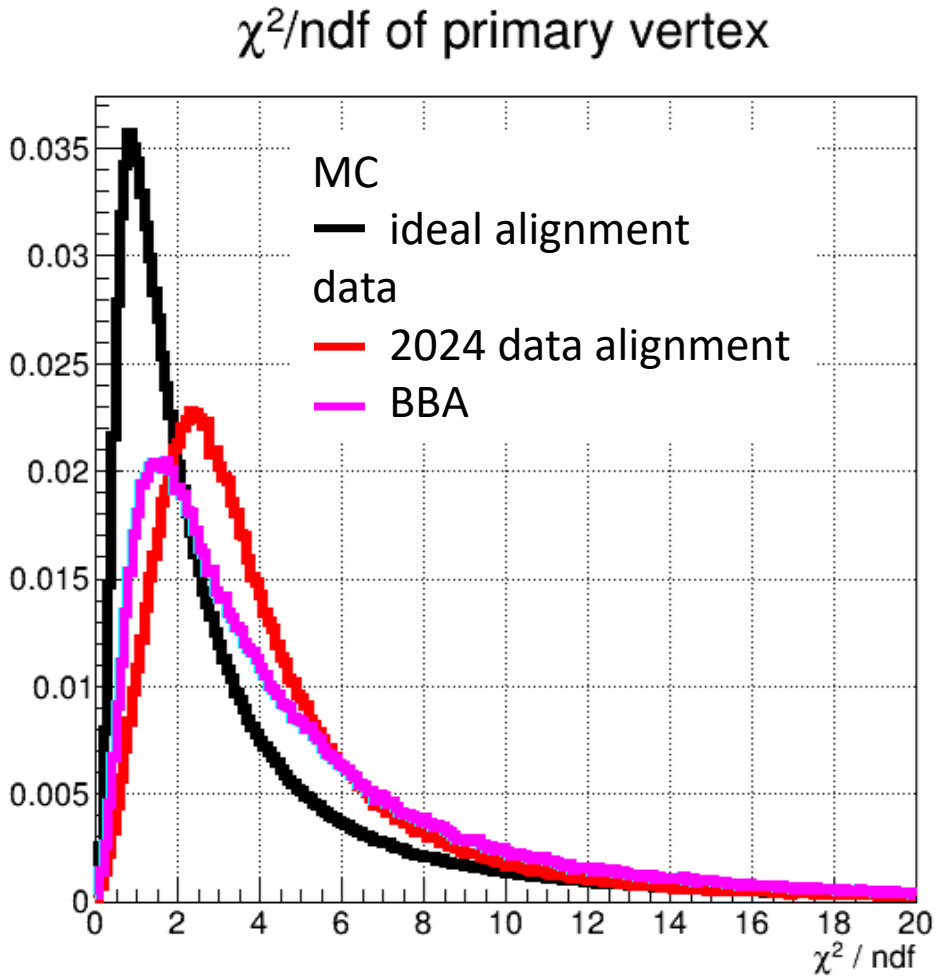
data: run 2984





Reconstructed target position

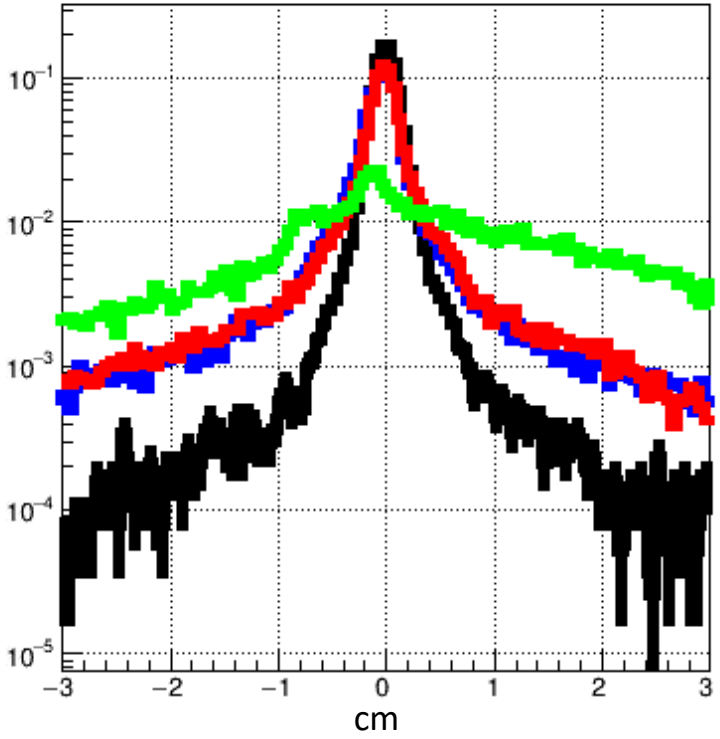
conditions: STS+TRD+TOF

$\chi^2_{vertex} / ndf < 4$

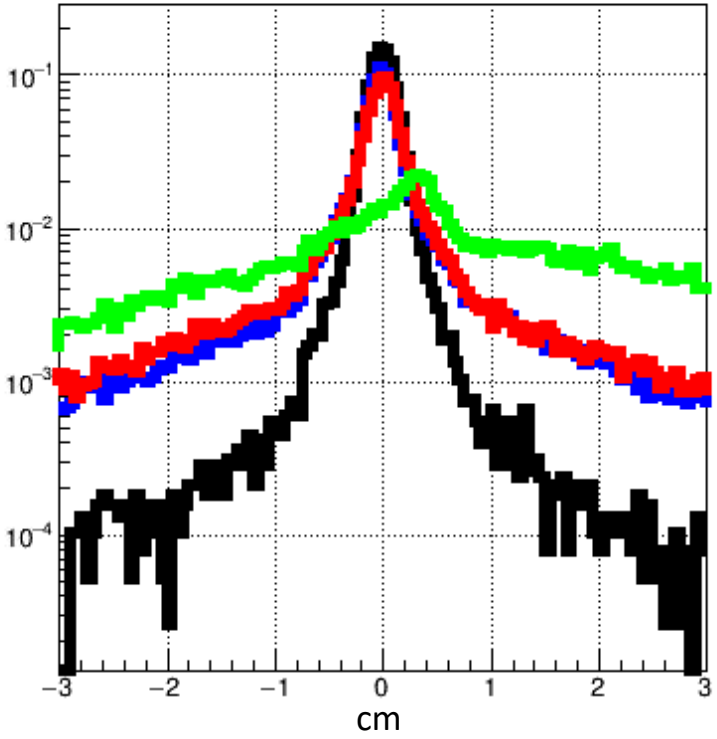
MC (event-by-event):
- ideal alignment

data:
- 2024 data alignment
- without alignment
- BBA

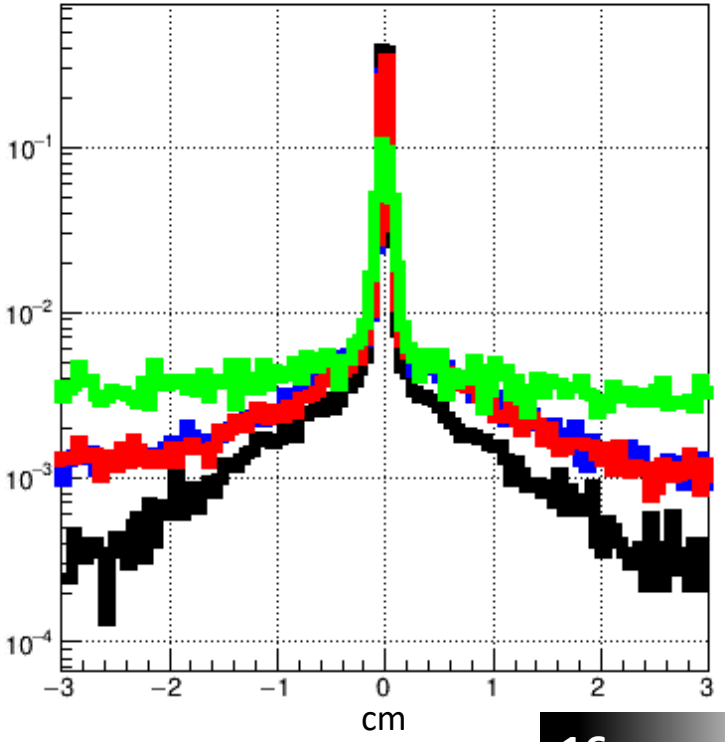
X_{vertex}

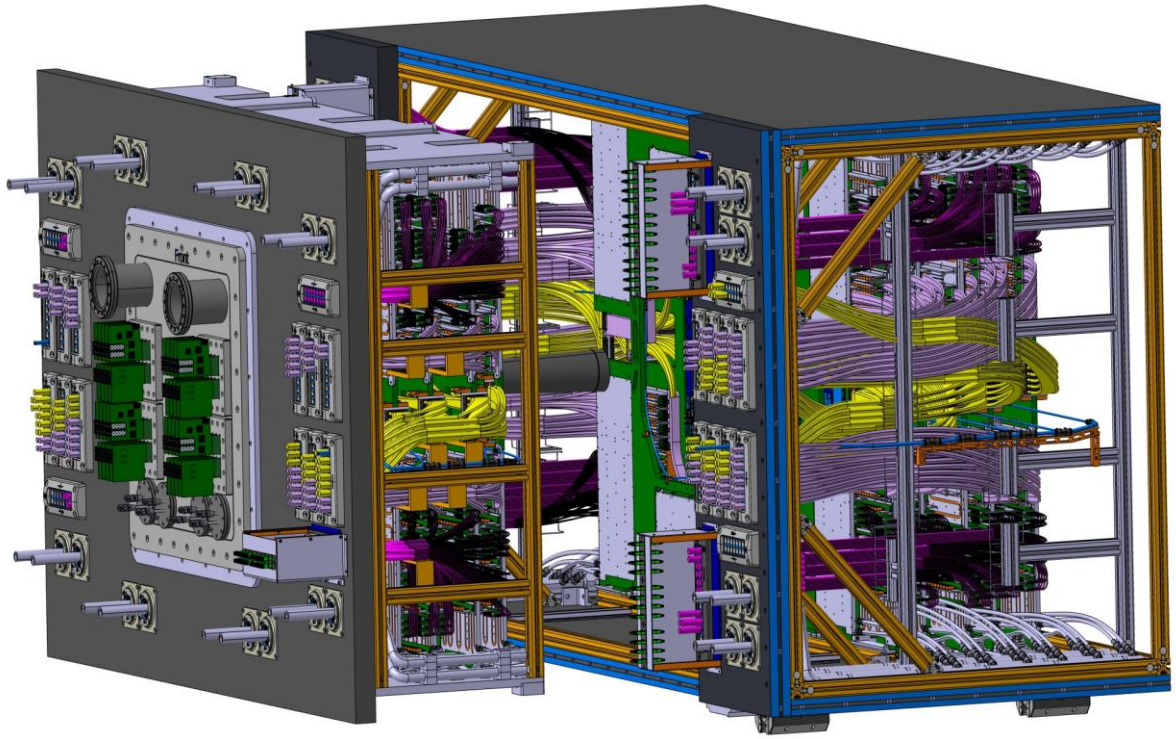


Y_{vertex}



Z_{vertex}





STS alignment using BBA

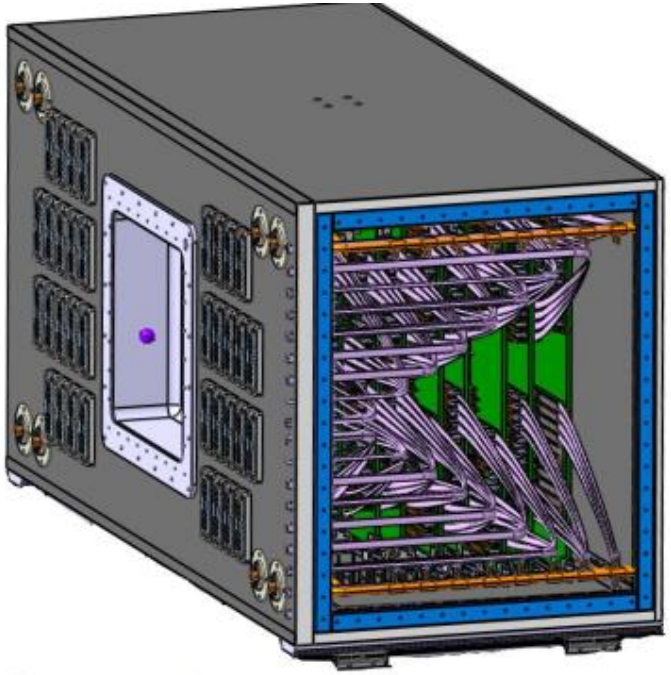
https://indico.gsi.de/event/23010/

https://indico.gsi.de/event/23066/

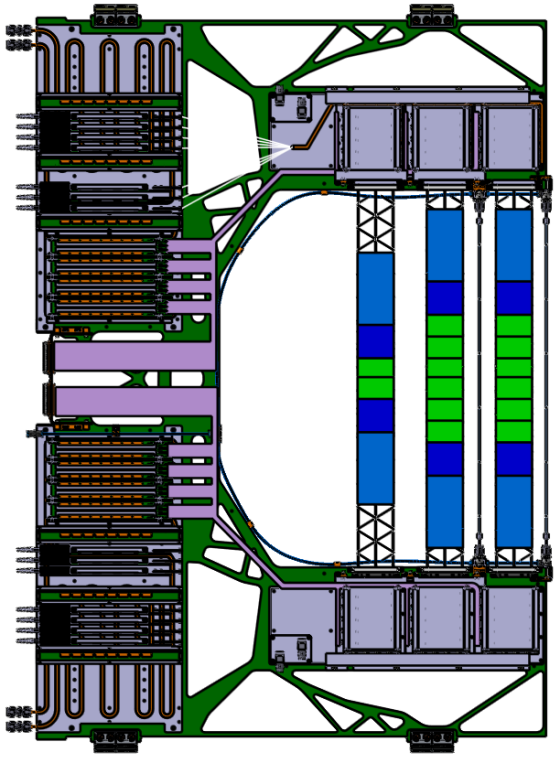
https://indico.gsi.de/event/23163/

STS: ~100 µm misalignment for each construction element

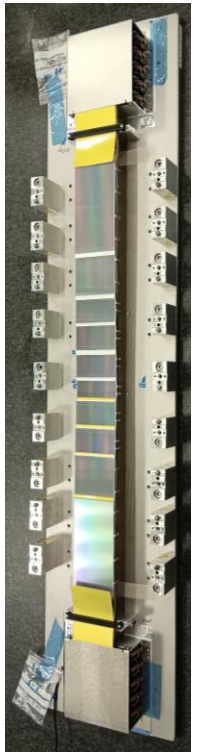
STS
(1)



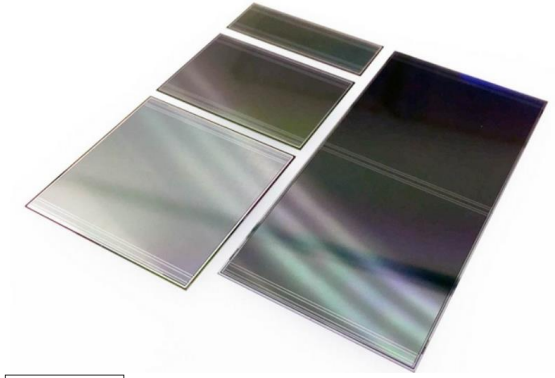
Units
(20)



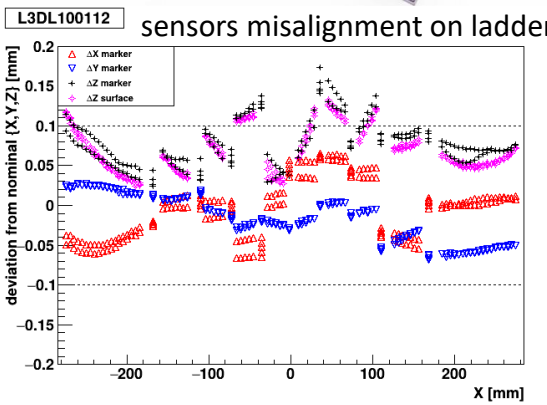
Laddrers
(106)



Sensors
(876)

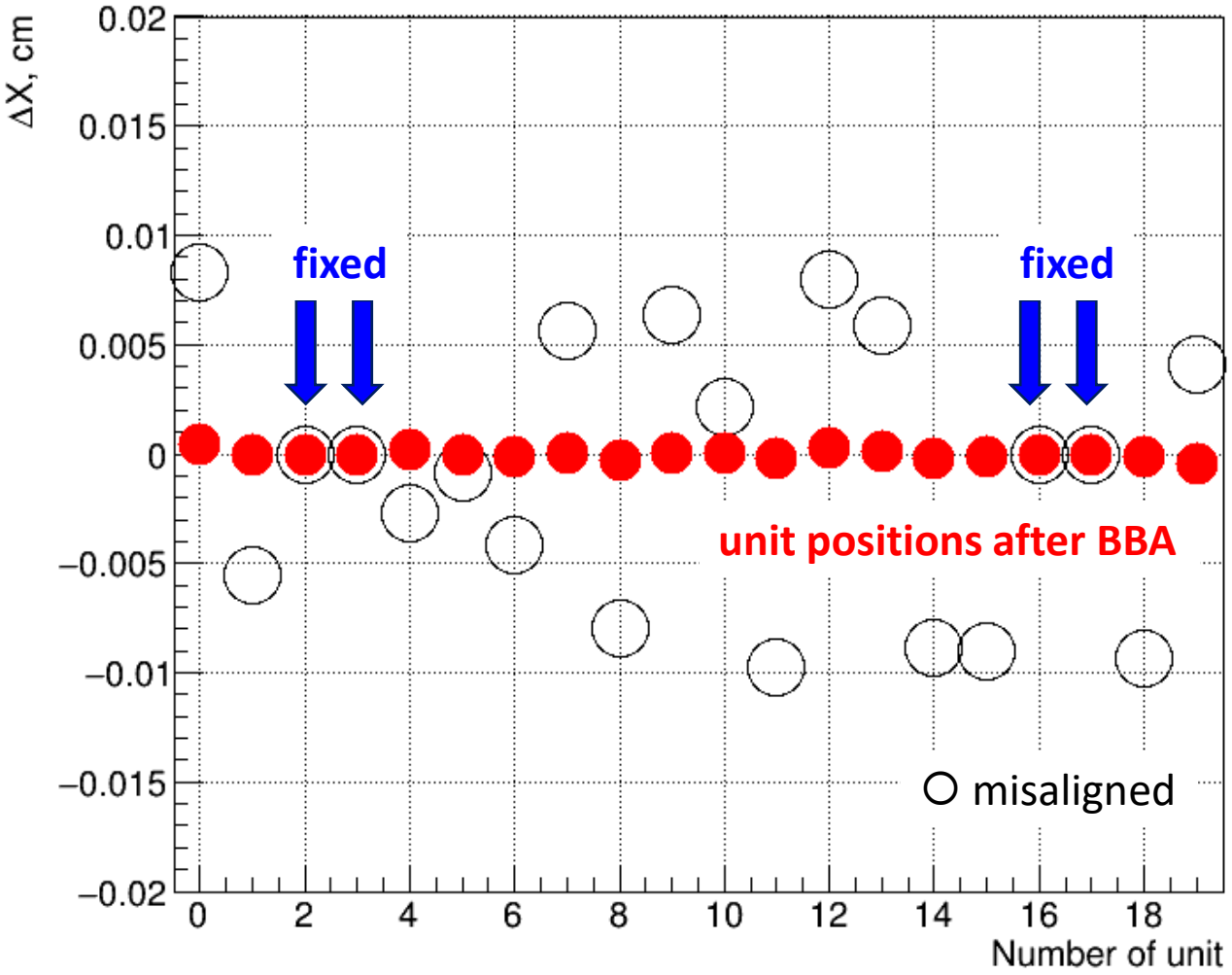


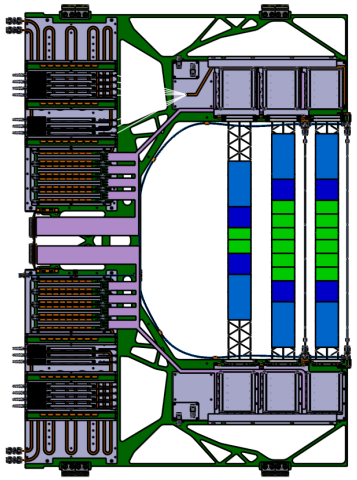
sensors misalignment on ladder



Fast test: misaligned units in X plane

MC: mbias DCMQGSM-SMM Au+Au @ 12A GeV/c





100 μm misaligned units
gRandom->Uniform(0.01*(-1.), 0.01);

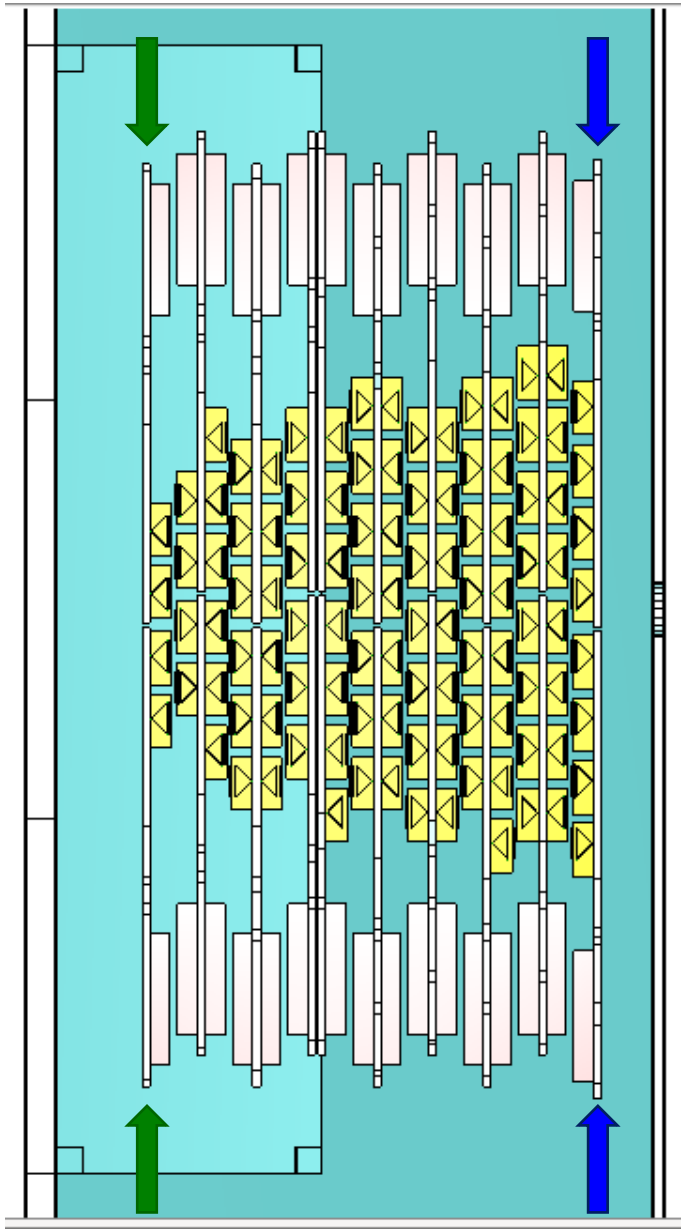
BBA settings:

- boundary ± 100 μm
- minimum step 1 μm

BBA run

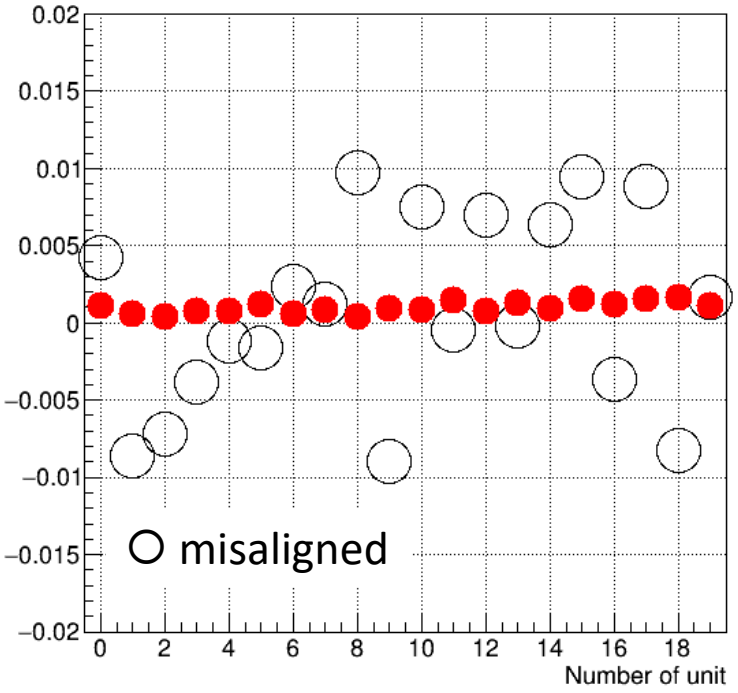
- BBA settings:
  - boundary ± 100 µm
  - minimum step 1 µm
- BBA scheme:
  - X alignment
    - step 1 – units 0 and 1 are fixed
    - step 2 – units 18 and 19 are fixed
  - XYZ alignment
    - step1
    - step 2

track reconstruction

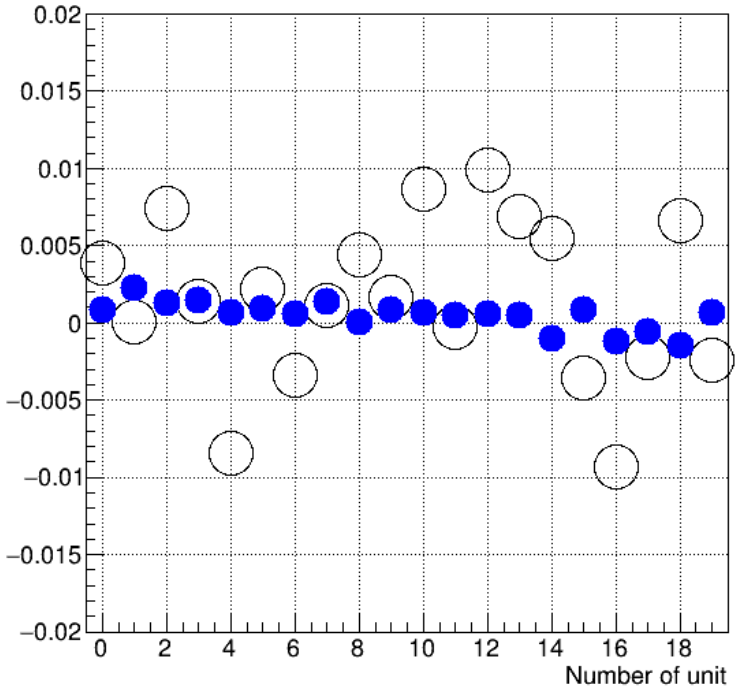


STS unit alignment

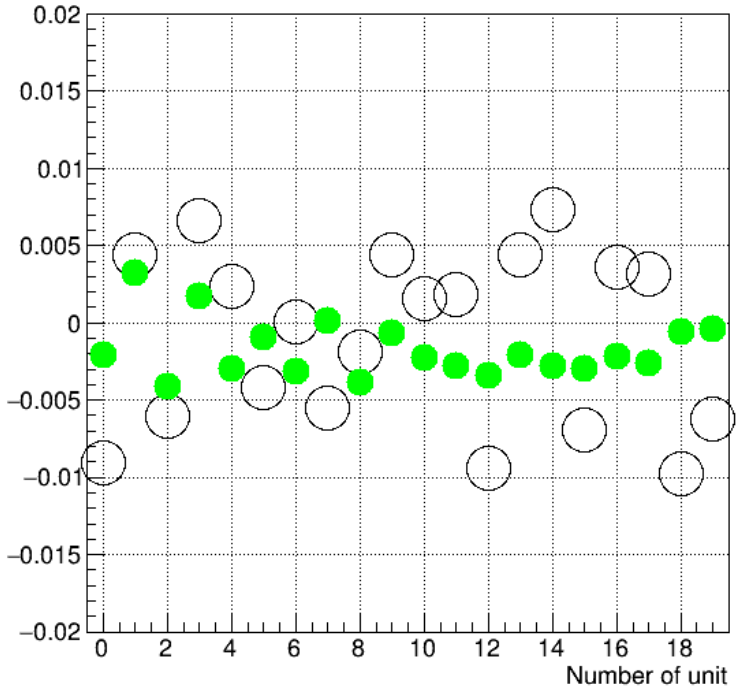
● X alignment



● Y alignment



● Z alignment



Next steps

- Include angle alignment
- Add other detectors
- Optimize for high statistics
- Speed up the code
- …