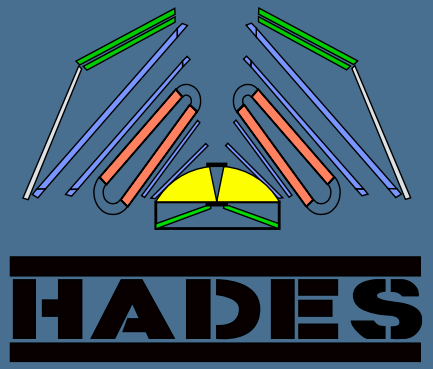
# Update on the reconstruction of $\eta$' in p+p collisions at 4.5 GeV

Lena M. Albohn - VIII HADES physics analysis meeting – 24.06.2026

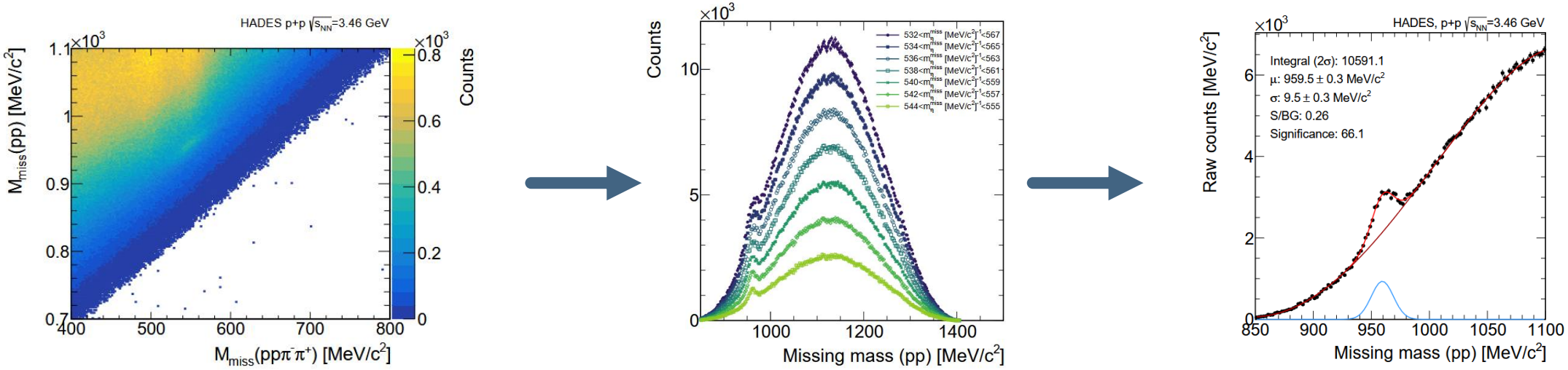



# Reminder

- Reconstruction of the $\eta'$ via the following channel

$$p\ p \rightarrow p\ p\ \eta' \rightarrow p\ p\ \pi^+\pi^-\eta$$

- Two protons and two pions are measured directly, $\eta$ is found via missing mass




- Data sample: Feb22 p+p gen4 full statistics at 4.5 GeV (full target run)

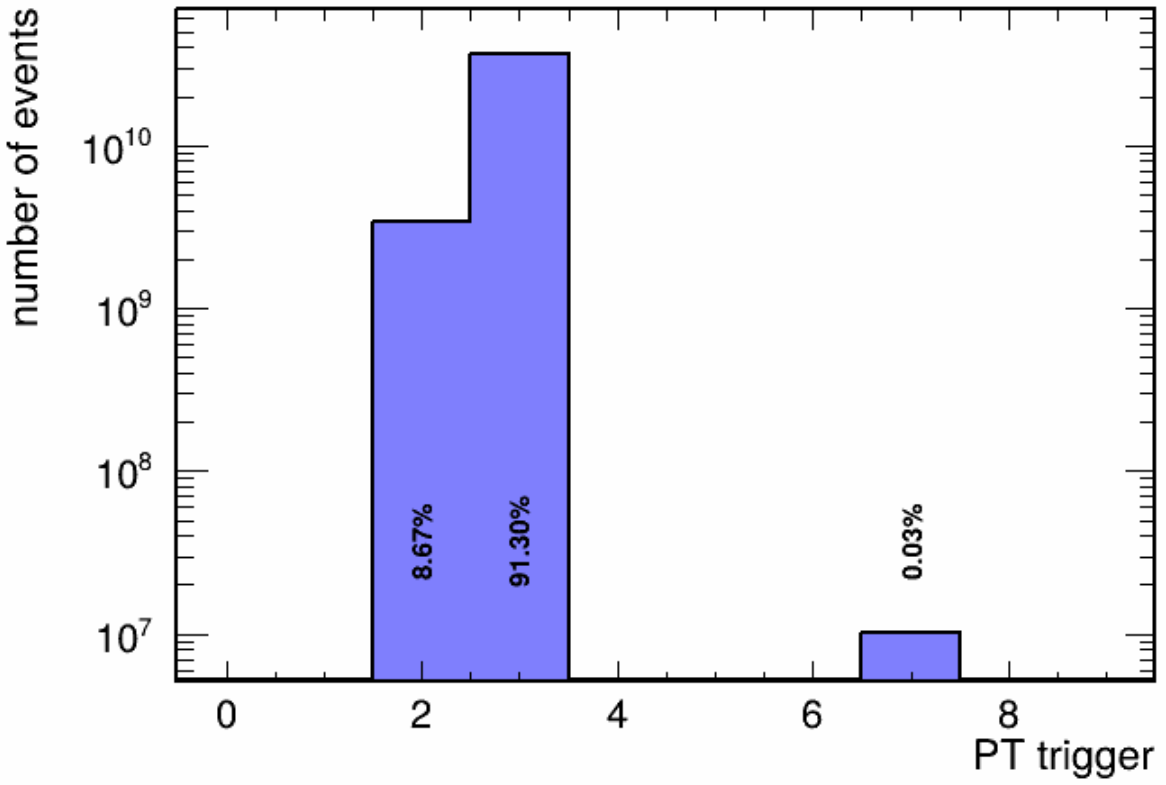
# Outline

- event selection
- candidate selection
  - applied corrections
  - hadron selection
  - particle identification
- conclusion

# event selection

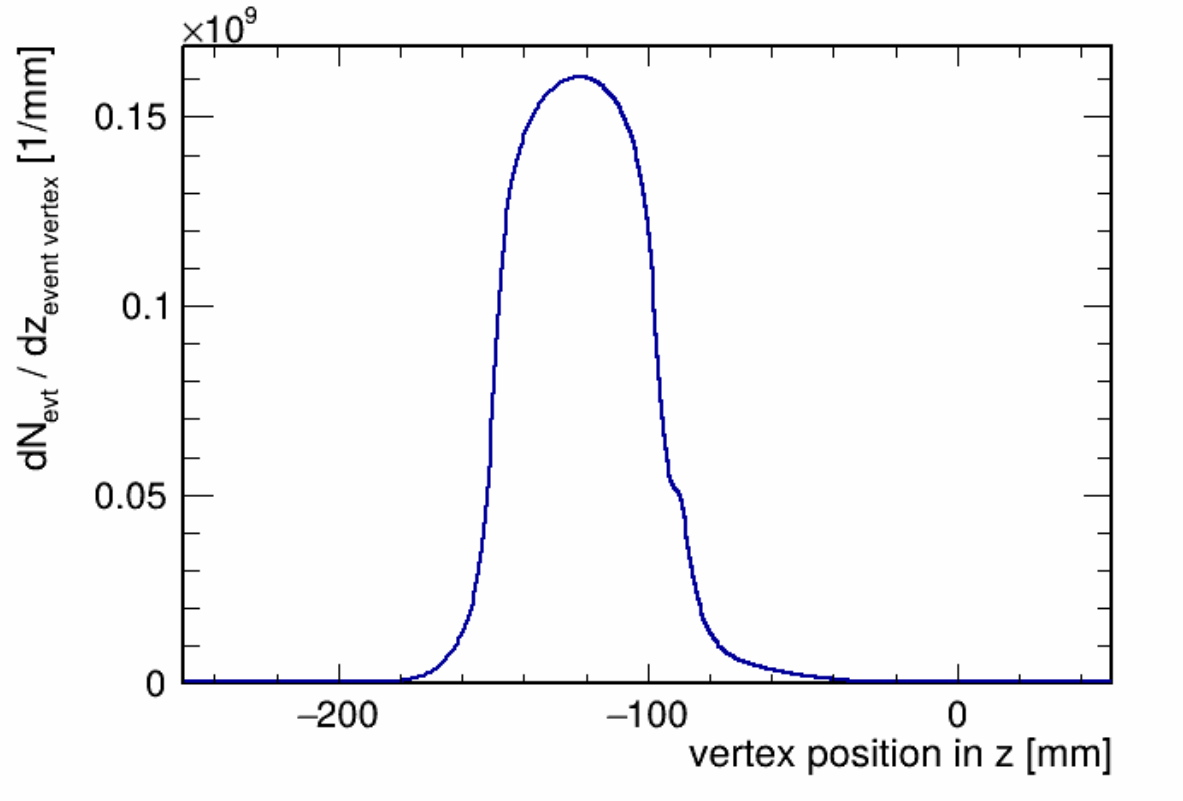
# EVENT SELECTION

- trigger cut: PT3 events only



# EVENT SELECTION

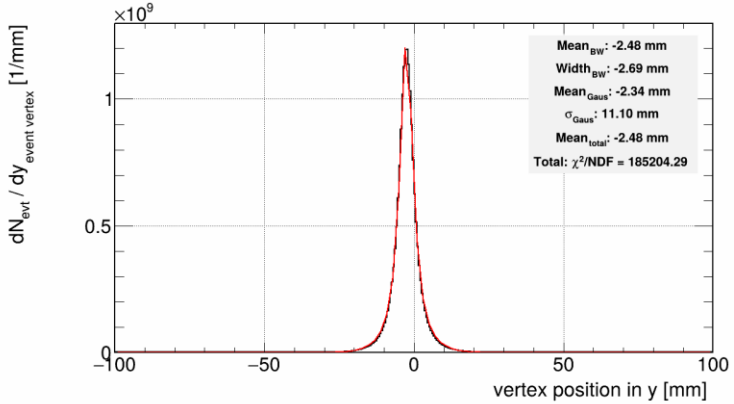
- trigger cut: PT3 events only
- vertex cut:
  - $z >$ -1000 mm

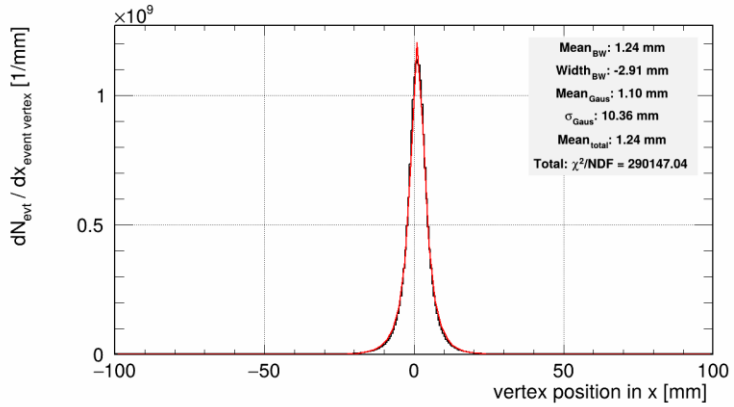


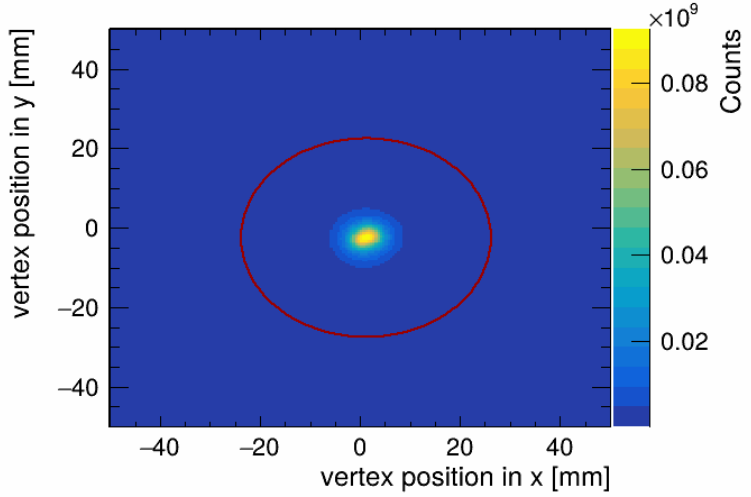
# EVENT SELECTION

- trigger cut: PT3 events only
- vertex cut:
  - $z >$ -1000 mm
  - 25 mm radius around xy peak position

→ $1.8 \cdot 10^{10}$ events for further analysis



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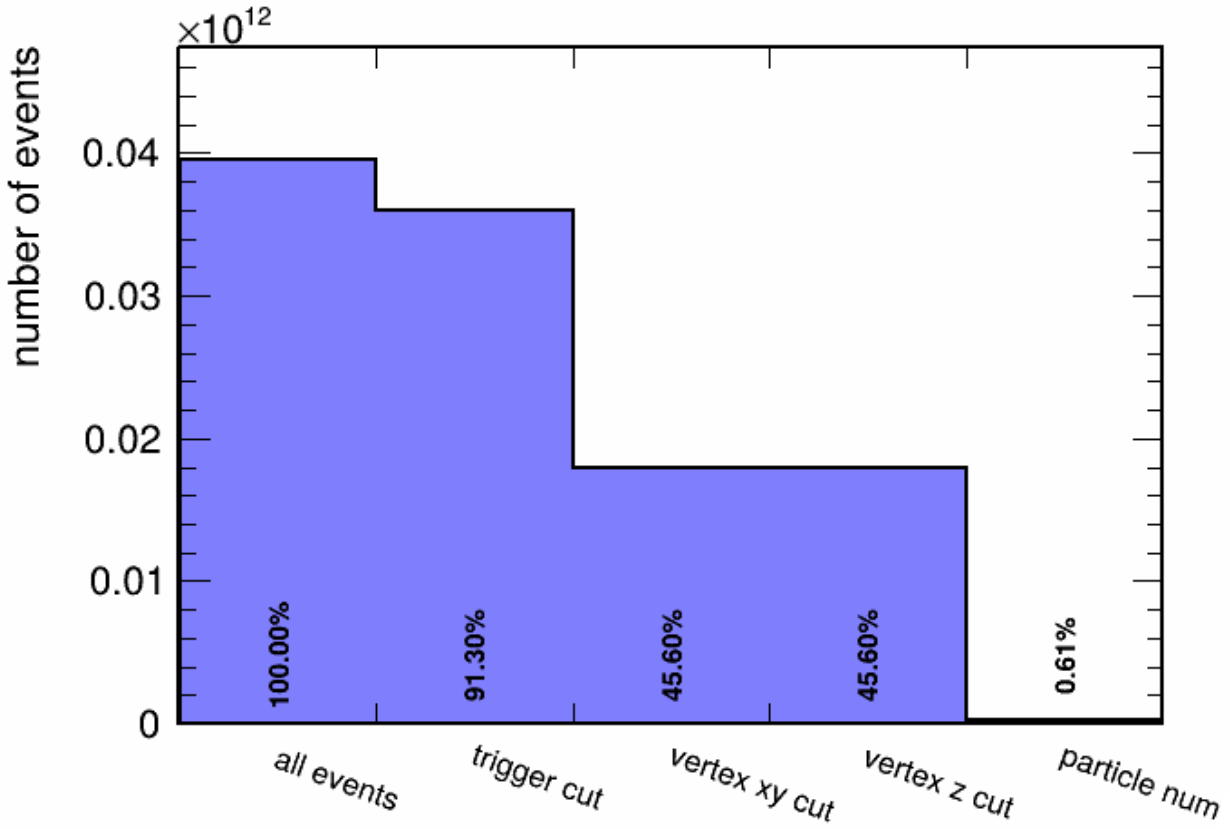
- min number of particle types
  - $\geq 2$ p
  - $\geq 1\ \pi^+$
  - $\geq 1\ \pi^-$



# candidate selection

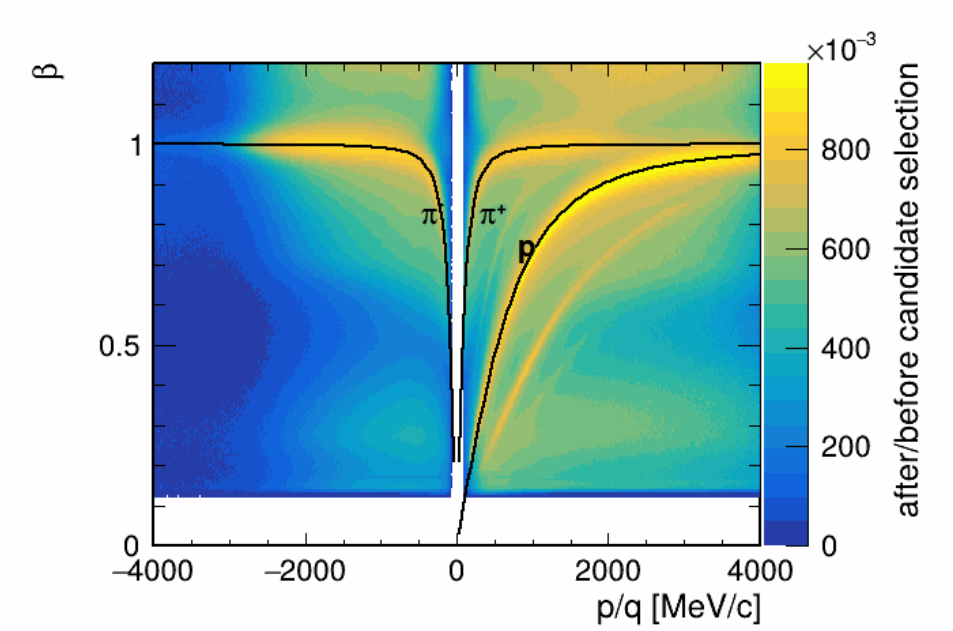
# APPLIED CORRECTIONS

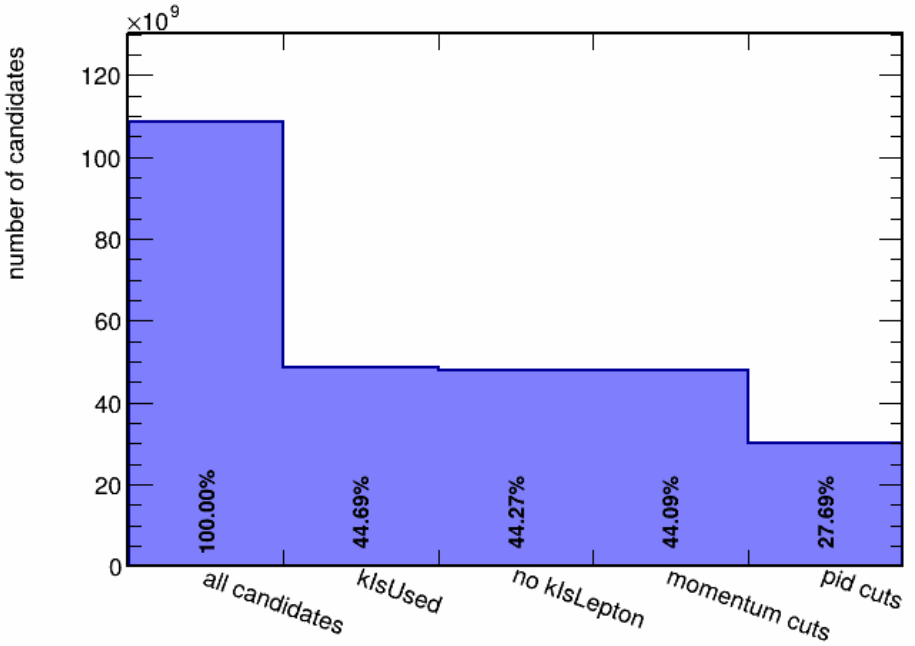
- correct order of application is under discussion, currently the following order is used:
  1) beam tilt correction
  2) magnetic field correction
  3) energy loss correction
- swapping beam tilt and magnetic field correction has no significant impact on reconstructed $\eta'$
  - position and width of the $\eta'$ peak are identical
  - numbers of reconstructed $\eta'$ vary by 0.5 %

→ Is there a correct order of application for these corrections?

# HADRON SELECTION

- kIsUsed
- !kIsLepton
- orginal momentum: $p_{\mathrm{org}} \leq 4000$ MeV/c
- momentum: $\mathrm{p} \geq 80$ MeV/c

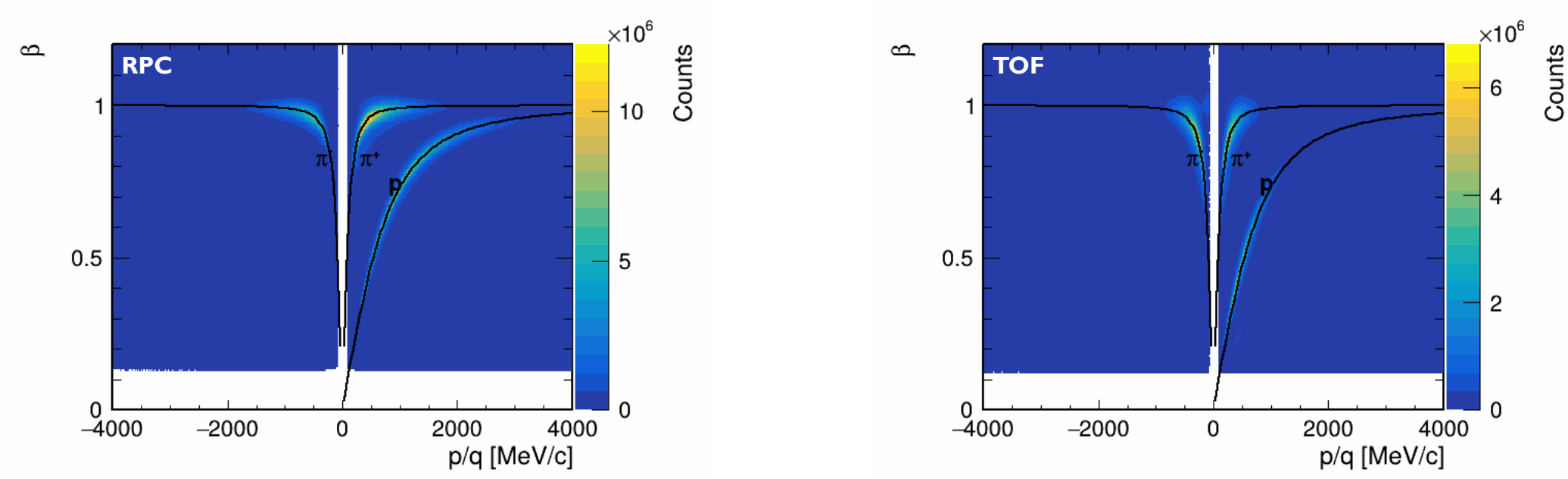



→ particle identification cuts are explained on the next few slides

# PARTICLE IDENTIFICATION

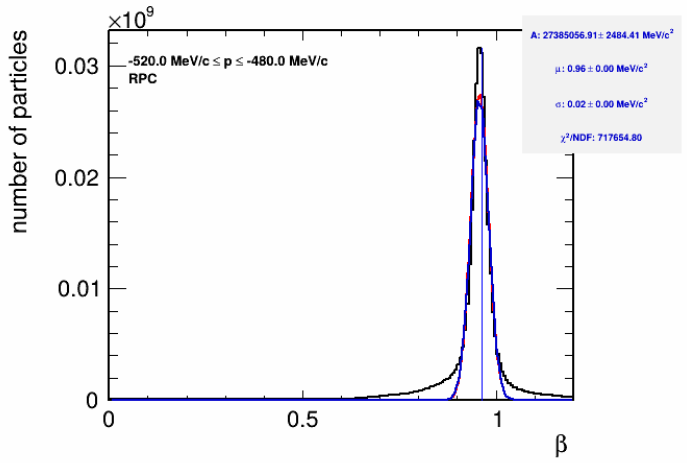
- positions of different particle types in the $\beta$-$p$-spectrum don‘t follow the expected lines exactly
- additional differences in the resolution between TOF and RPC



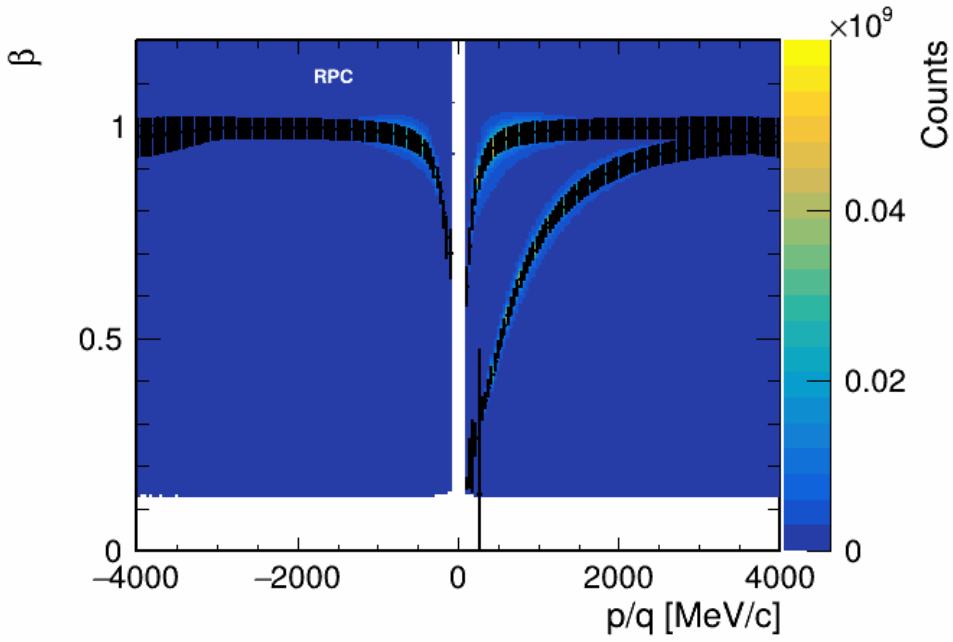

- therefore, a momentum and detector dependent PID cut is calculated and applied

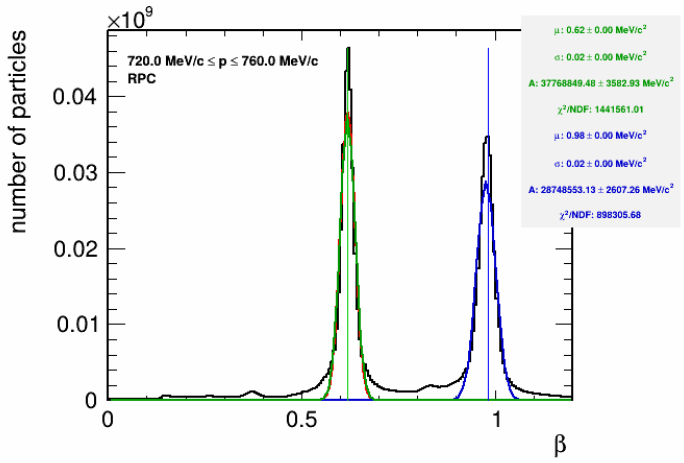
# PARTICLE IDENTIFICATION

- $\beta$-$p$-spectrum is divided into momentum bins of 40 MeV/c width
- projection on the $\beta$ axis for each momentum bin
- resulting peaks in the $\beta$ distribution are fitted with gaussian functions
- mean $\mu$ and standard deviation $\sigma$ are saved to be used for the PID cut
- final cut: $\mu \pm 1.5\ \sigma$




**RPC**



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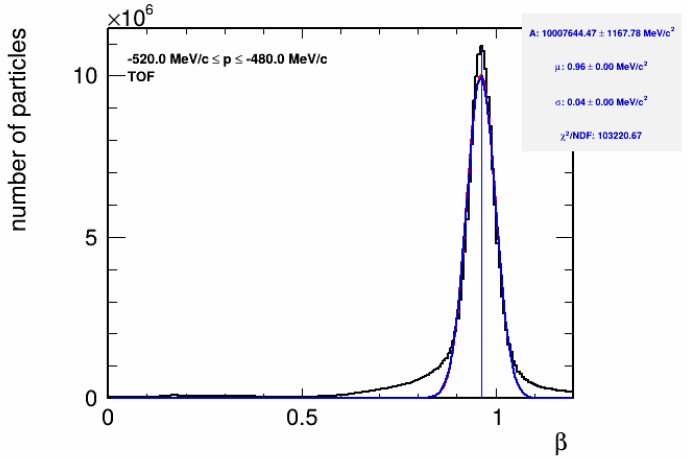
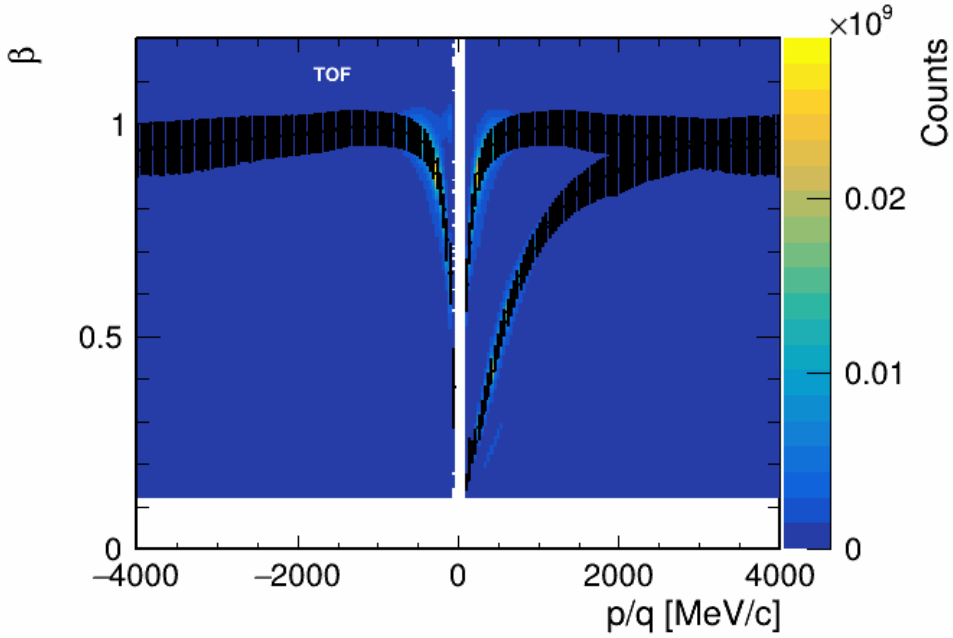
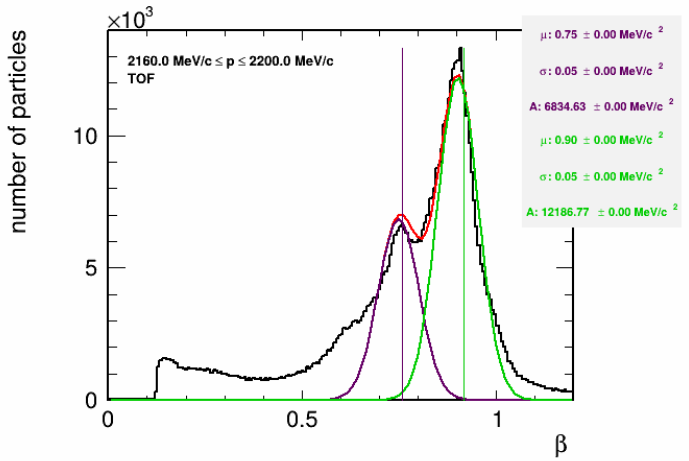
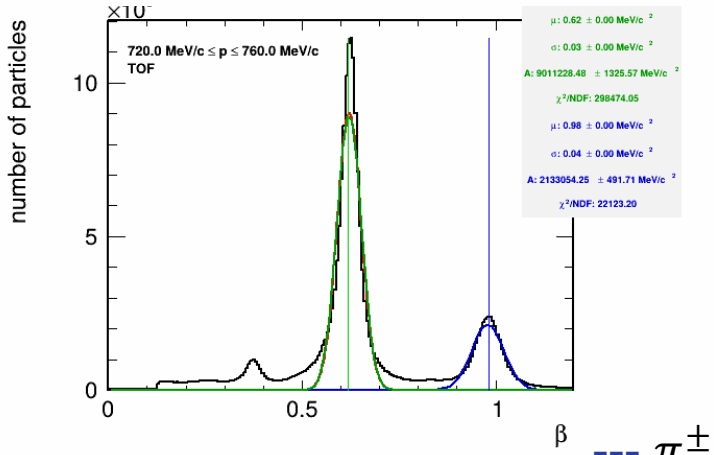


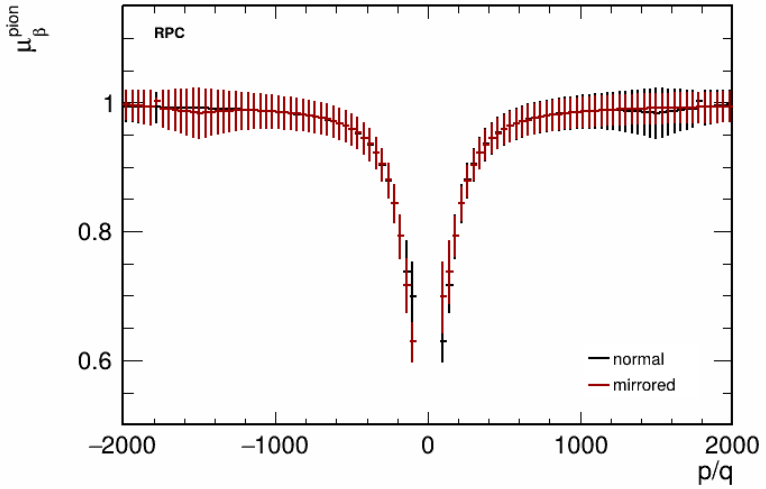



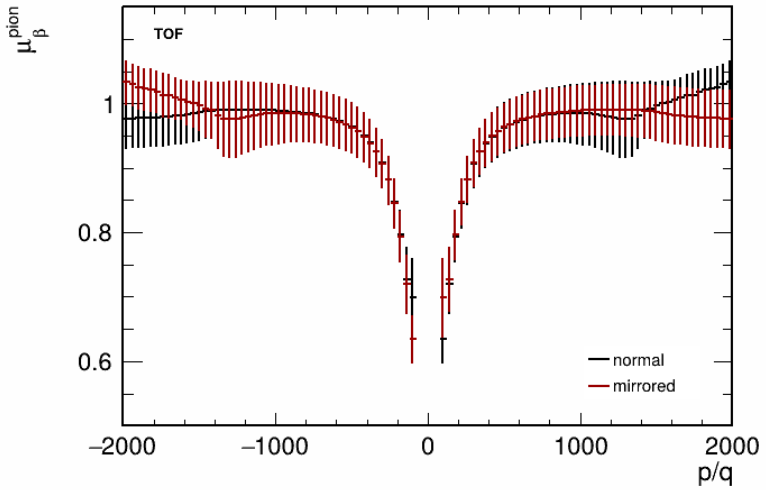

**TOF**

$\pi^{\pm}$
$p$
$d$

# PARTICLE IDENTIFICATION

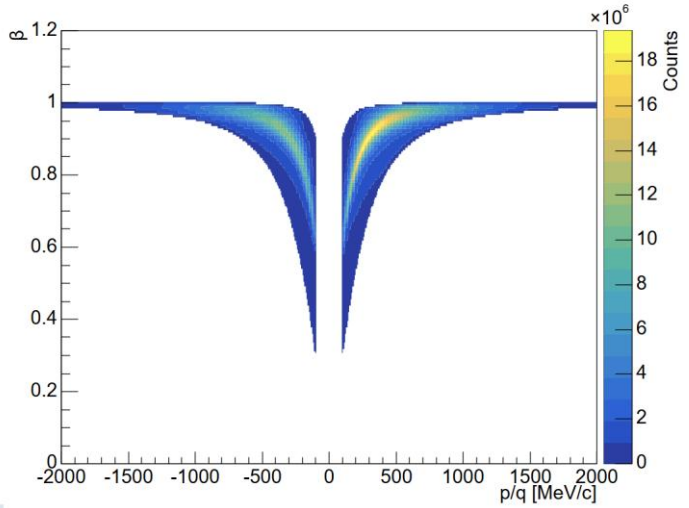
- compare calculated $\mu$ and $\sigma$ for $\pi^+$ and $\pi^-$
  → should be the same
- for high momenta, the peaks of protons and pions start to overlap
- use $\mu$ and $\sigma$ from $\pi^-$ for $\pi^+$ at high momenta
  - RPC: $p \geq 1000$ MeV/c
  - TOF: $p \geq 500$ MeV/c

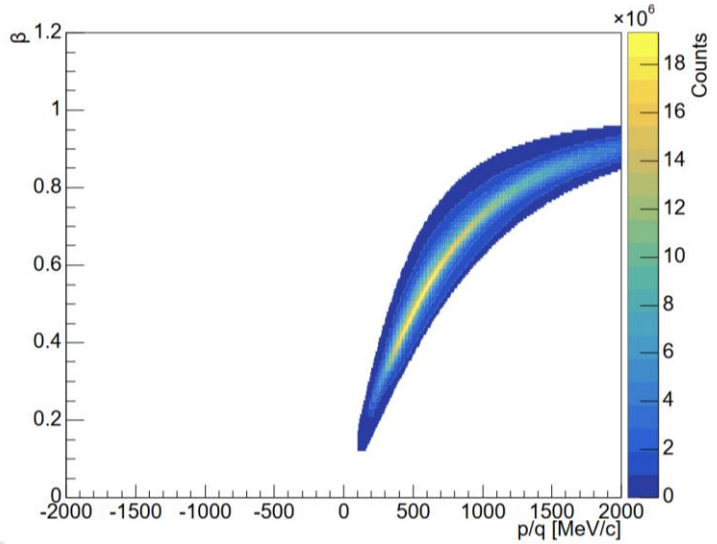


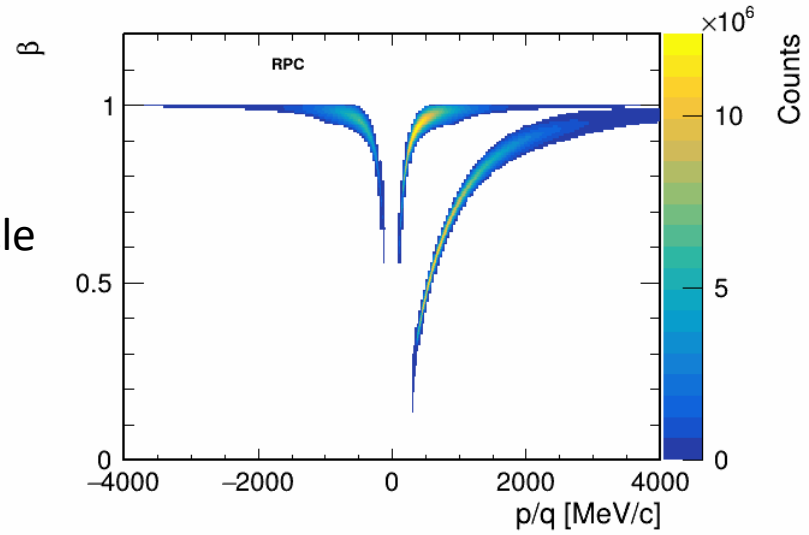
# PARTICLE IDENTIFICATION

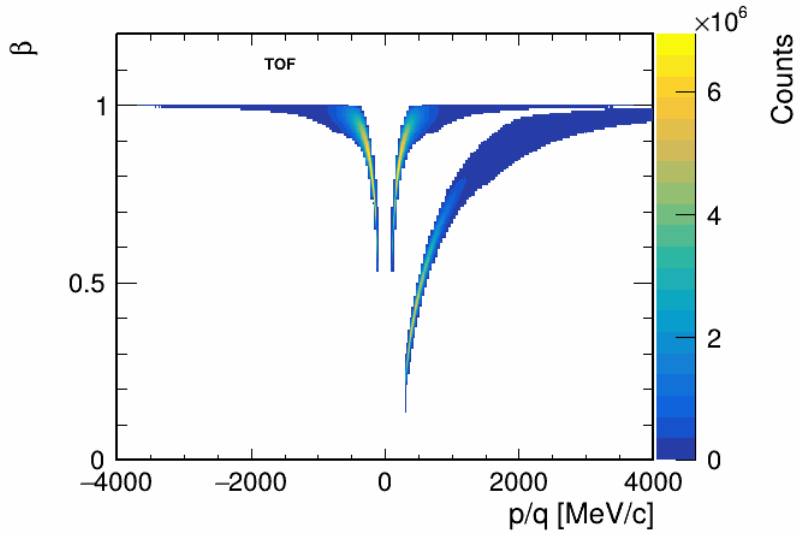
previous particle identification cuts




current 1.5$\sigma$ particle identification cuts



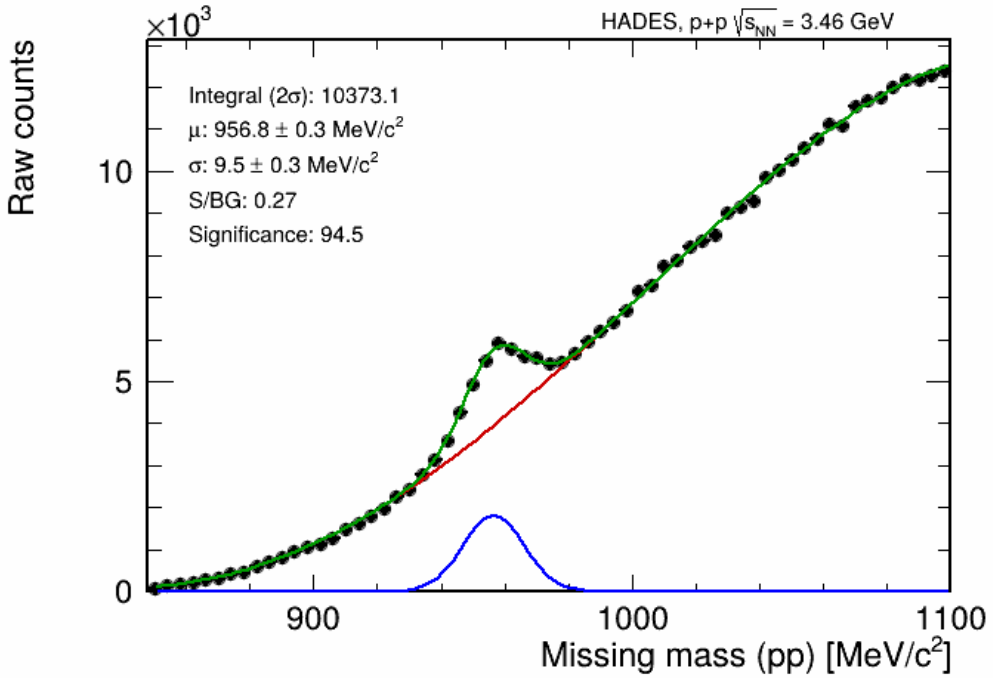



# CONCLUSION

- now working with gen4 data
- improved event selection and candidate selection
  - Cuts on event vertex
  - Momentum and detector dependent particle identification
- currently working on doing a kinematic refit with a missing $\eta$ mass

**Next Steps:**

- calculating detector errors with white simulations
- finishing the kinematic refit




# THANK YOU FOR YOUR ATTENTION!