

Progress report

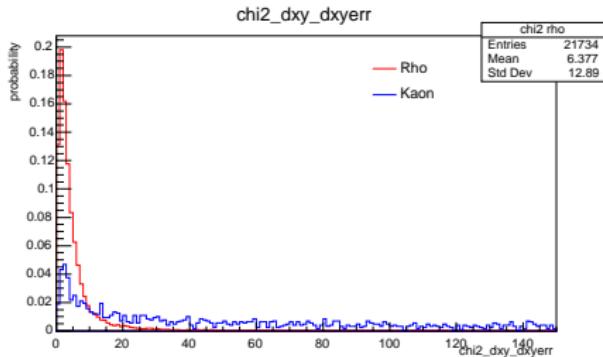
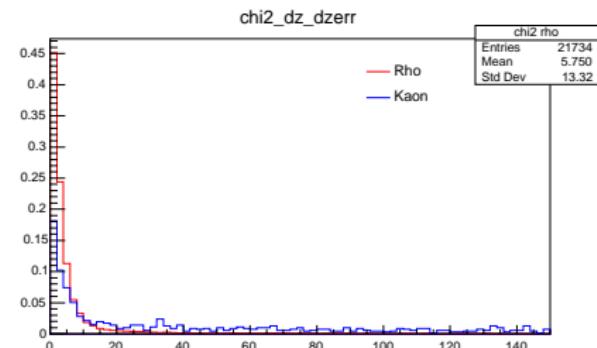
Jan Loder

Helsinki Institute of Physics

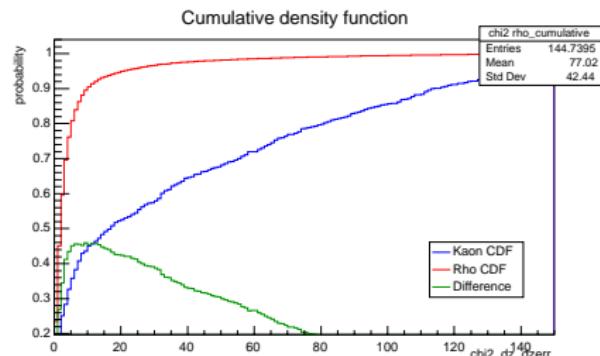
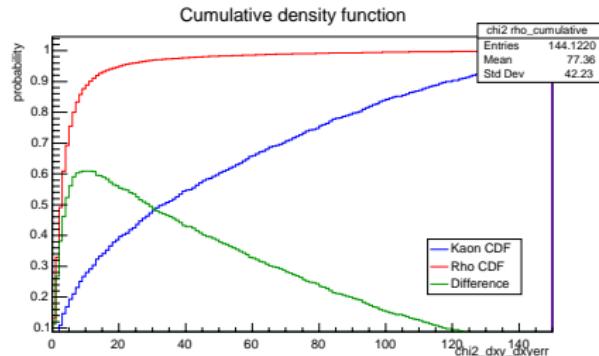
12 August, 2025

"Pure" Kaon and Rho χ^2 variables of TOTEM4

- χ^2 values from uncut 2D invariant mass histogram in interval $\mu \pm 0.5\sigma$ in x and y
- Normalised to histogram area, for comparability \Rightarrow probability density function for χ^2 distributions

 χ^2_{dxy}  χ^2_{dz}

Where to place optimal cut?

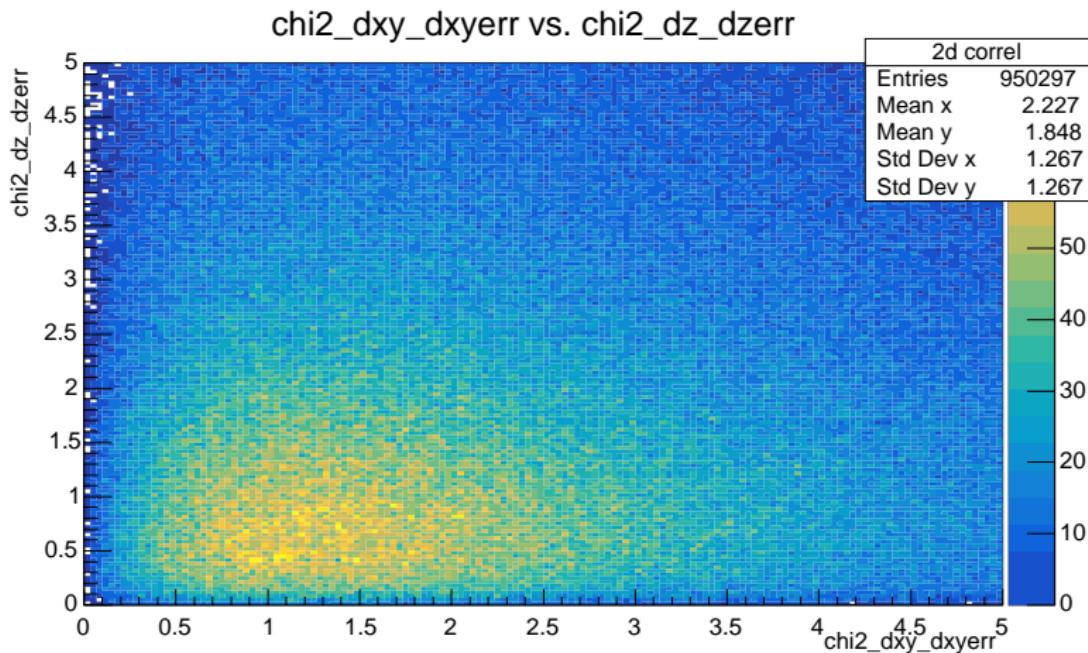


$$\chi^2_{\text{dxerr}}$$

$$\chi^2_{\text{dzerr}}$$

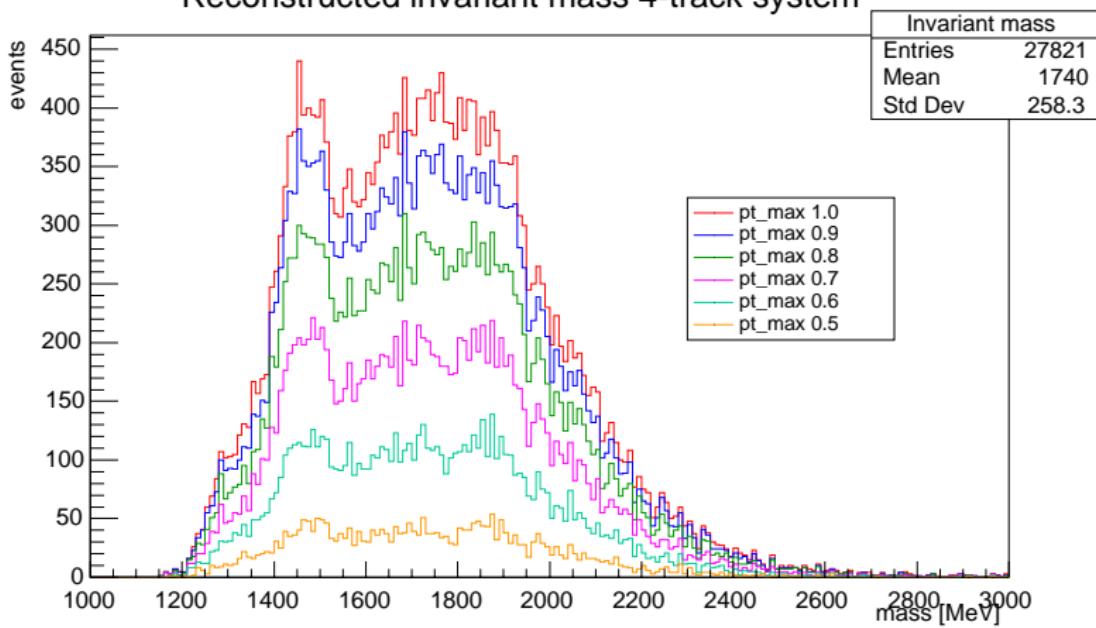
- I tried hypothesis tests, but Rho and Kaon distributions overlap too much
- Put the "optimal" cutoff at maximum of difference of CDFs
 $\Rightarrow \chi^2 \sim 10$

Correlation between dxy and dz?



Effect of p_T cuts on TOTEM4

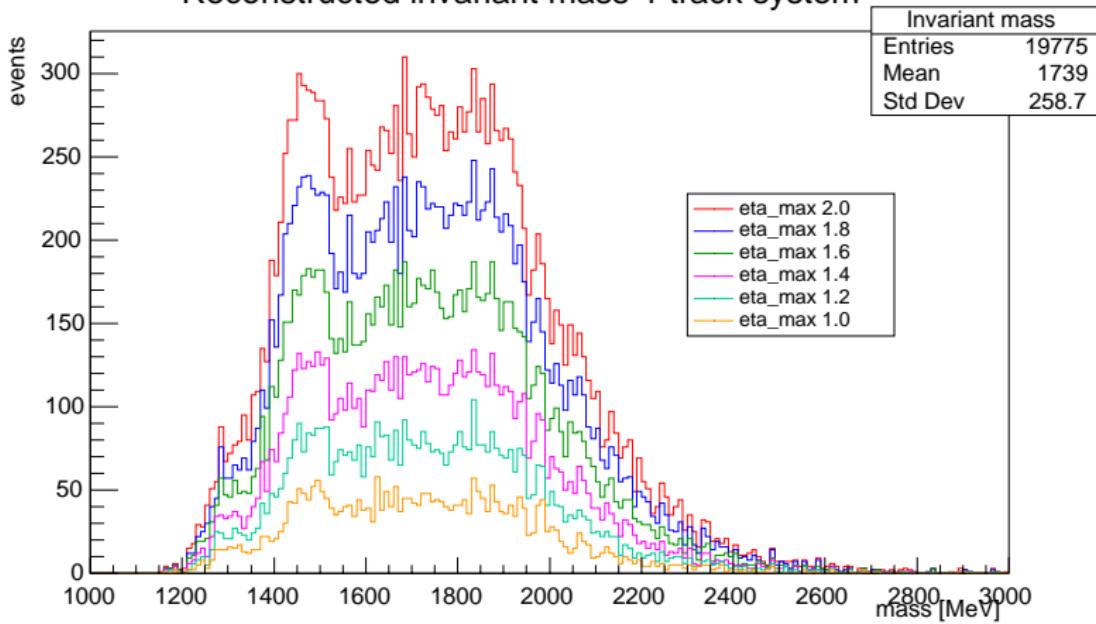
Reconstructed invariant mass 4-track system



$$|\eta| < 2, \chi^2_{zPV, dxy, dz} < 10, \chi^2_\rho < 20$$

Effect of η cuts on TOTEM4

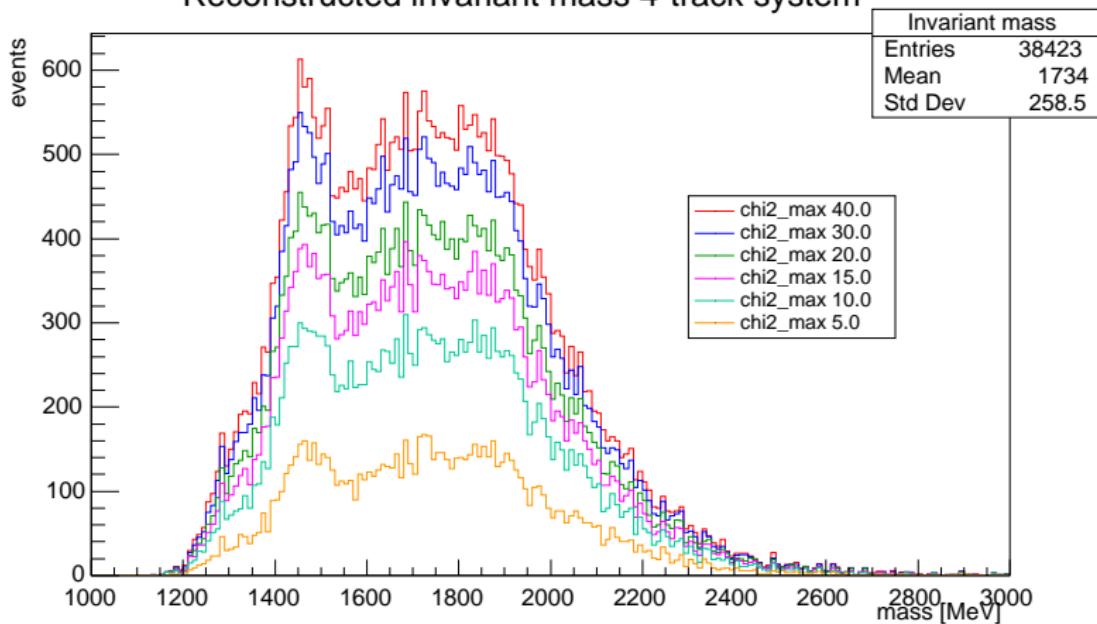
Reconstructed invariant mass 4-track system



$$p_T < 0.8 \text{ GeV}, \chi^2_{zPV, dxy, dz} < 10, \chi^2_\rho < 20$$

Effect of coarse $\chi^2_{zPV,dxy,dz}$ cuts on TOTEM40

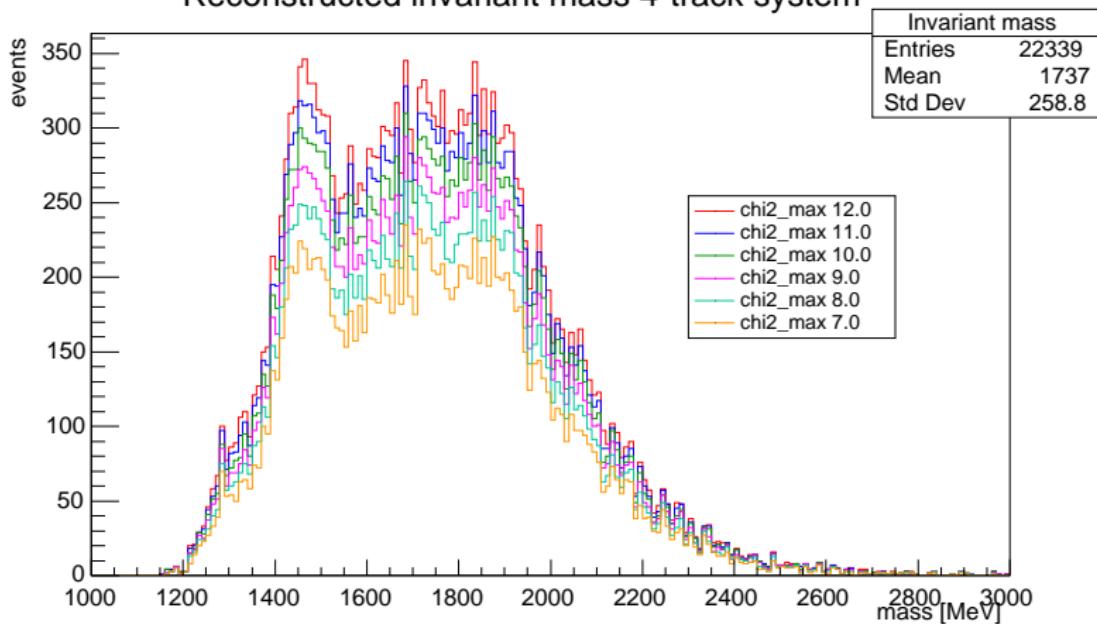
Reconstructed invariant mass 4-track system



$$p_T < 0.8 \text{ GeV}, |\eta| < 2, \chi^2_\rho < 20$$

Effect of fine $\chi^2_{zPV,dxy,dz}$ cuts on TOTEM40

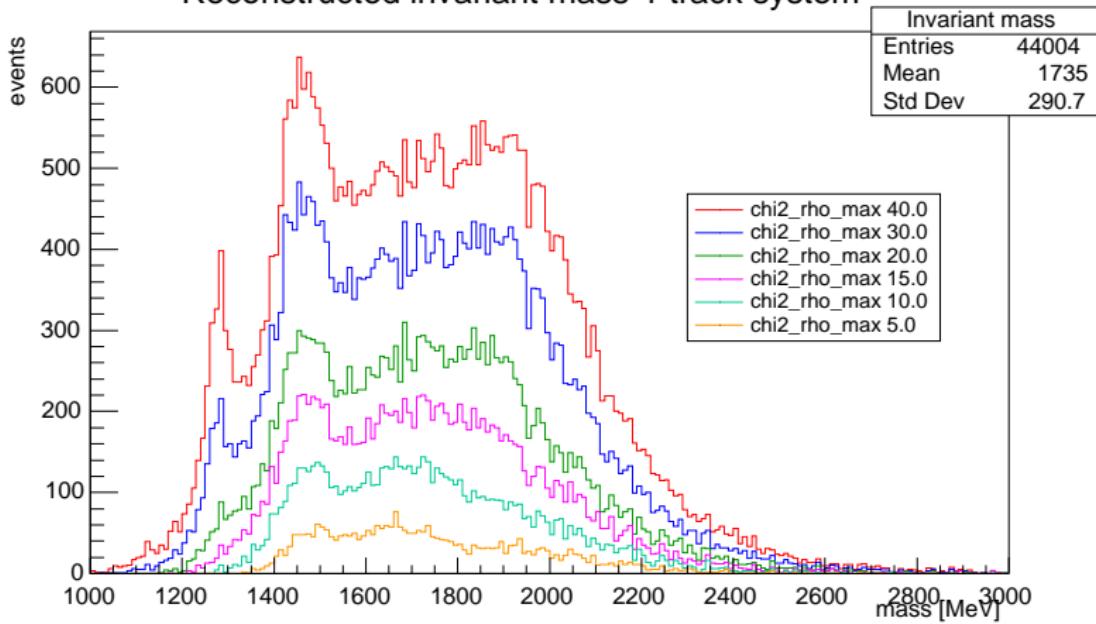
Reconstructed invariant mass 4-track system



$$p_T < 0.8 \text{ GeV}, |\eta| < 2, \chi^2_\rho < 20$$

Effect of coarse χ^2_ρ cuts on TOTEM4

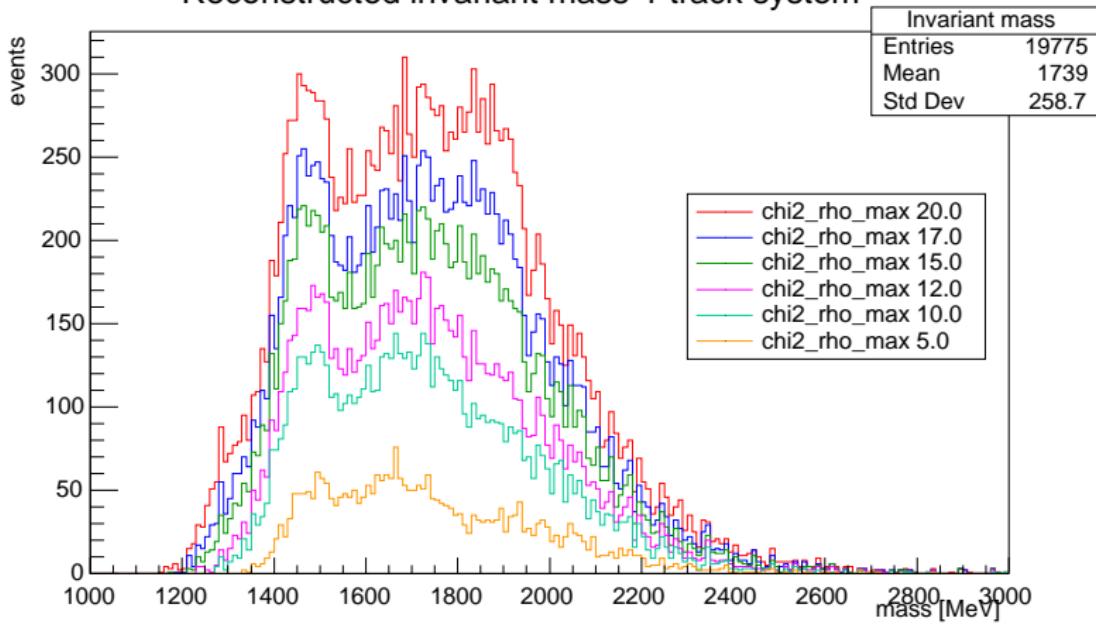
Reconstructed invariant mass 4-track system



$$p_T < 0.8 \text{ GeV}, |\eta| < 2, \chi^2_{zPV, dxy, dz} < 10,$$

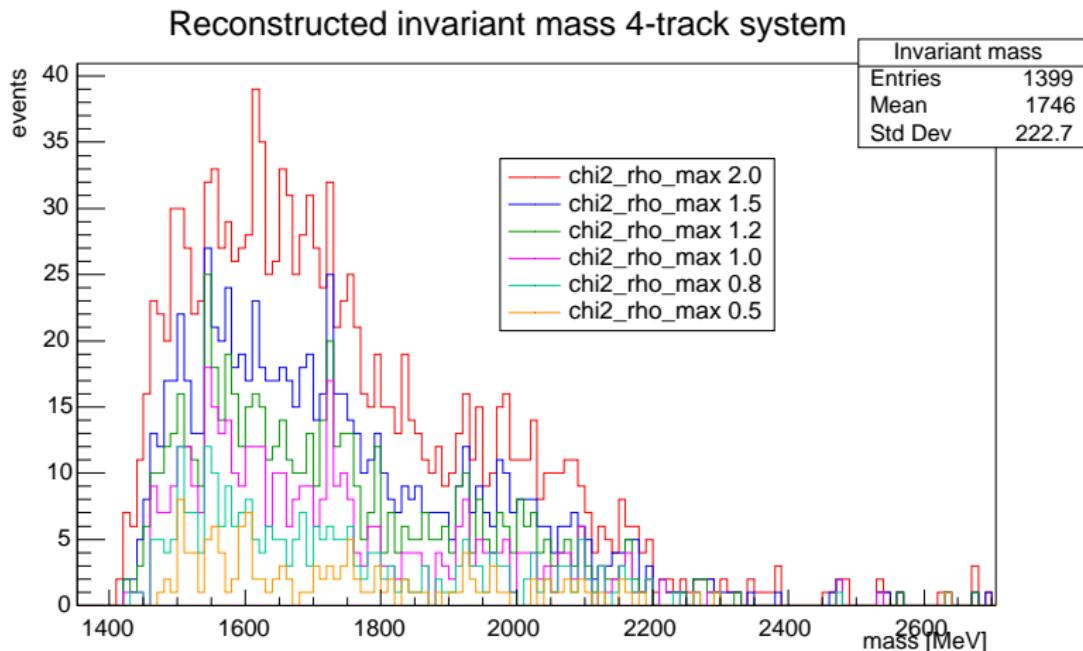
Effect of fine χ^2_ρ cuts on TOTEM4

Reconstructed invariant mass 4-track system



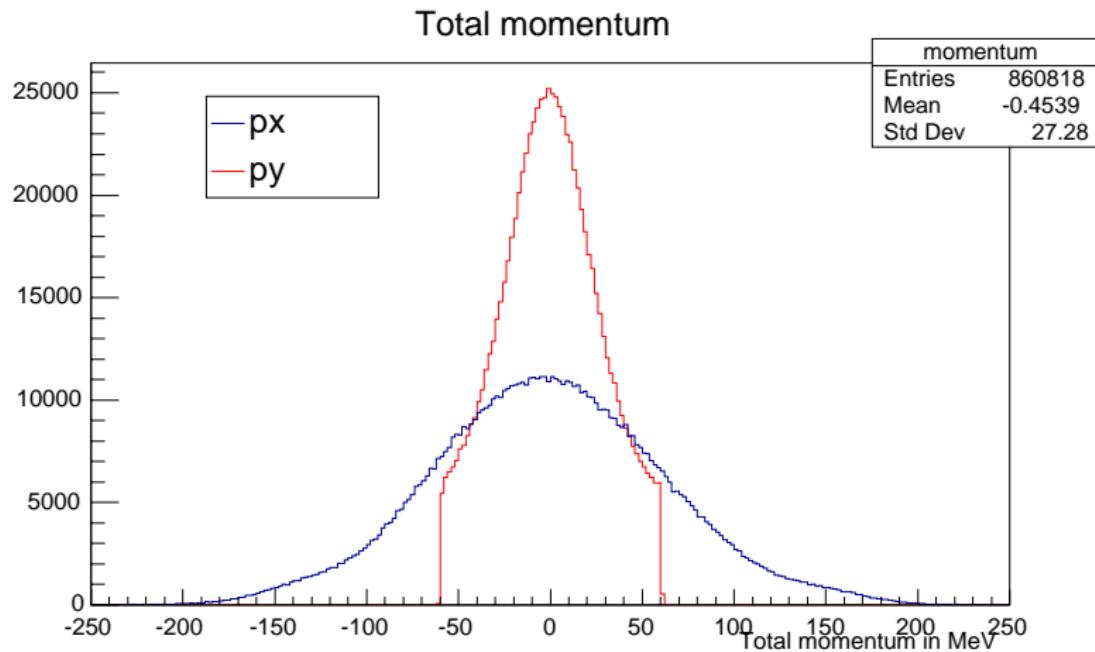
$$p_T < 0.8 \text{ GeV}, |\eta| < 2, \chi^2_{zPV, dxy, dz} < 10,$$

Effect of hyperfine χ^2 cuts on TOTEM4

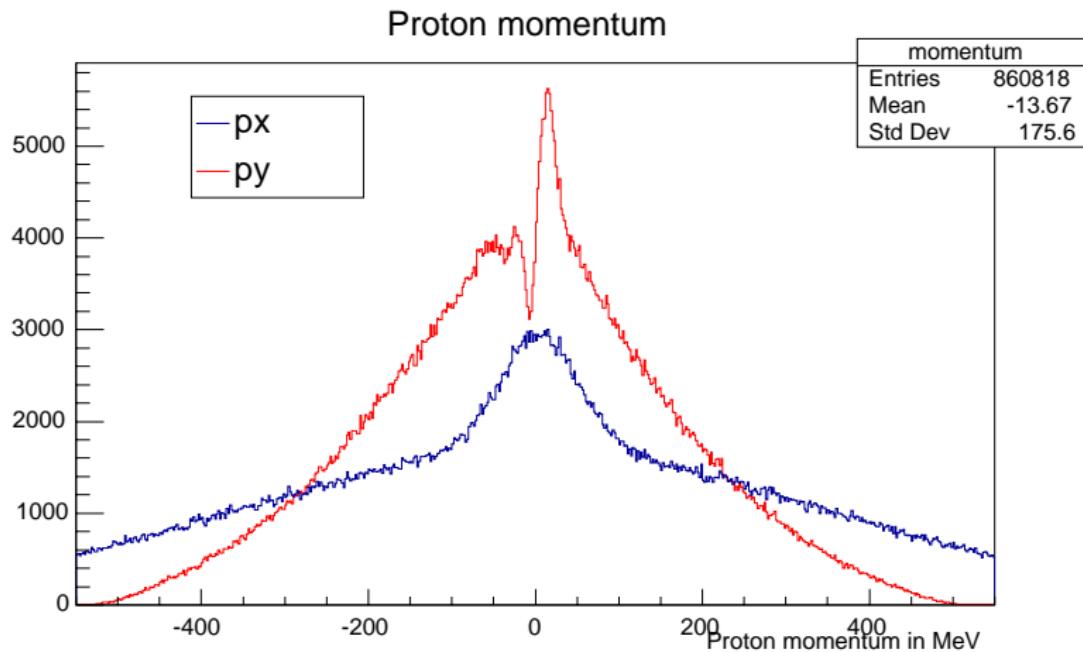


$$p_T < 1.2 \text{ GeV}, |\eta| < 2, \chi^2_{zPV, dxy, dz} < 15,$$

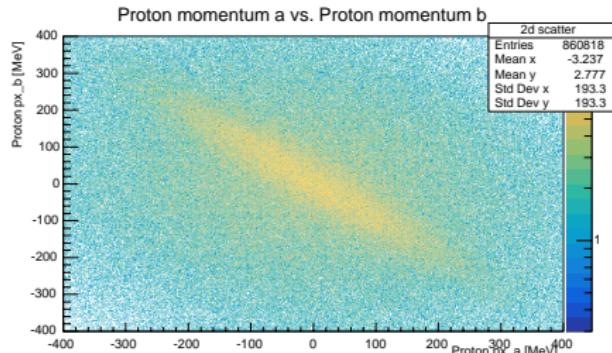
Momentum distribution TOTEM4



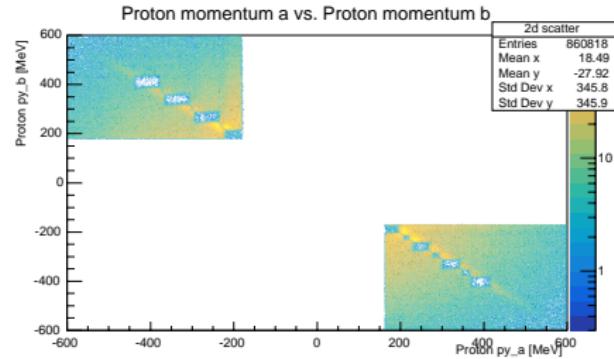
Momentum distribution TOTEM2



Proton momentum correlation in TOTEM2



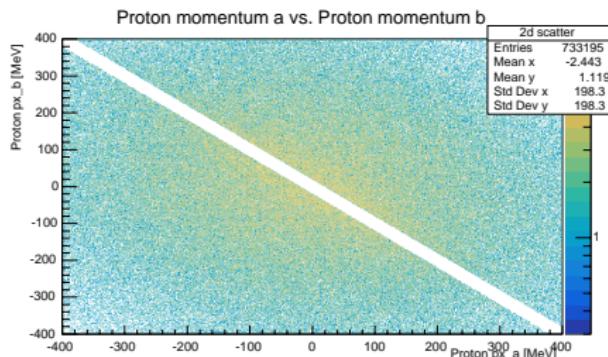
x-direction



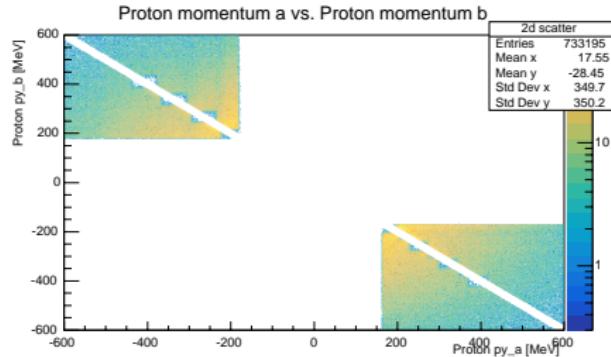
y-direction

Proton momentum correlation

- Only looking at x and y -direction
- Demand $|pr_p_x^a + pr_p_x^b| < \text{cutoff} \ \&\& \ |pr_p_y^a + pr_p_y^b| < \text{cutoff}$
otherwise reject



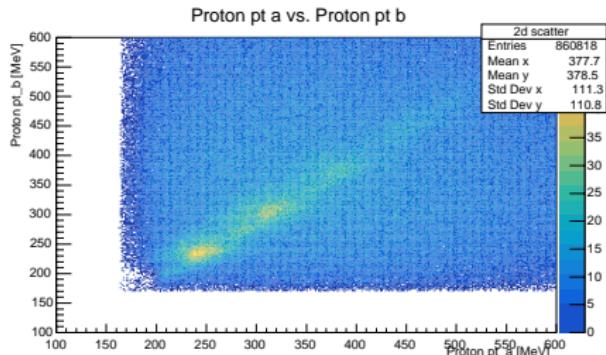
x -direction



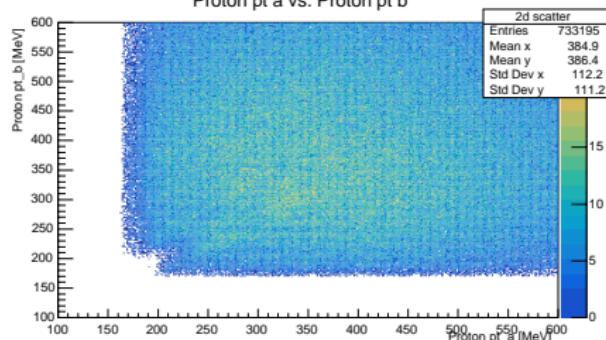
y -direction

- Through experimenting we find cutoff= 20 MeV works best

Transverse momentum correlation



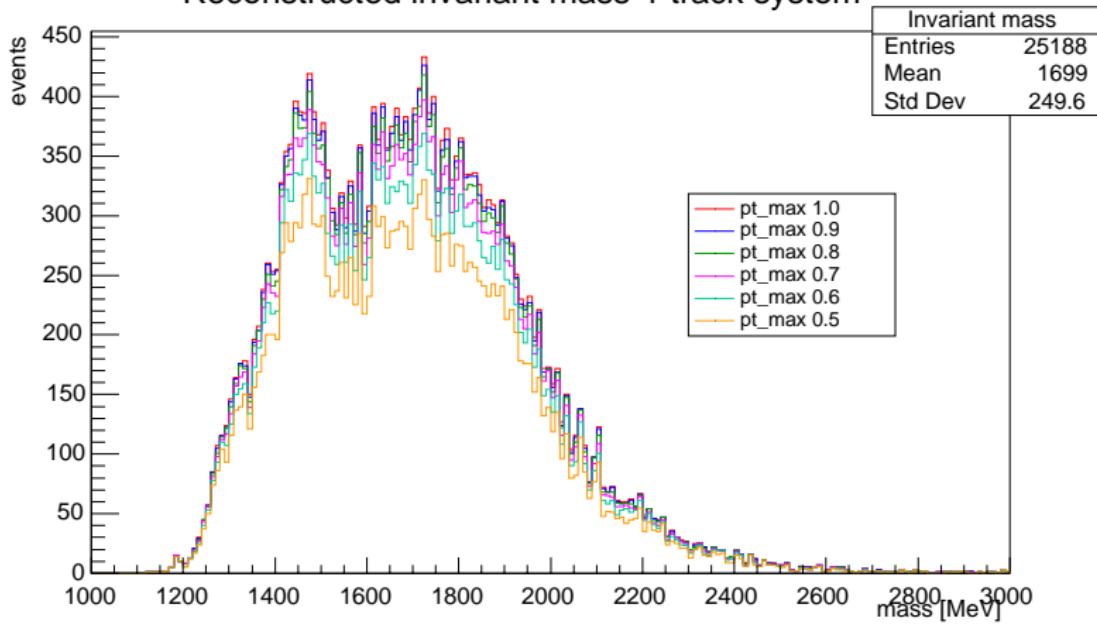
No veto



Veto 20 MeV

Effect of p_T cuts on vetoed TOTEM2

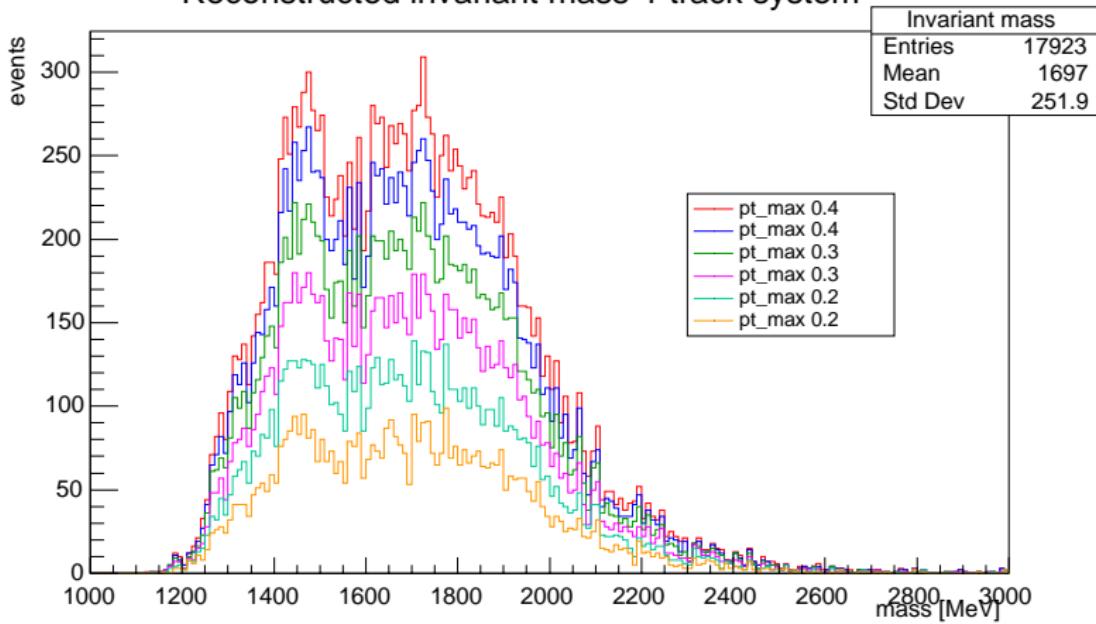
Reconstructed invariant mass 4-track system



$$|\eta| < 2, \chi^2_{zPV, dxy, dz} < 10, \chi^2_\rho < 20$$

Effect of fine p_T cuts on vetoed TOTEM2

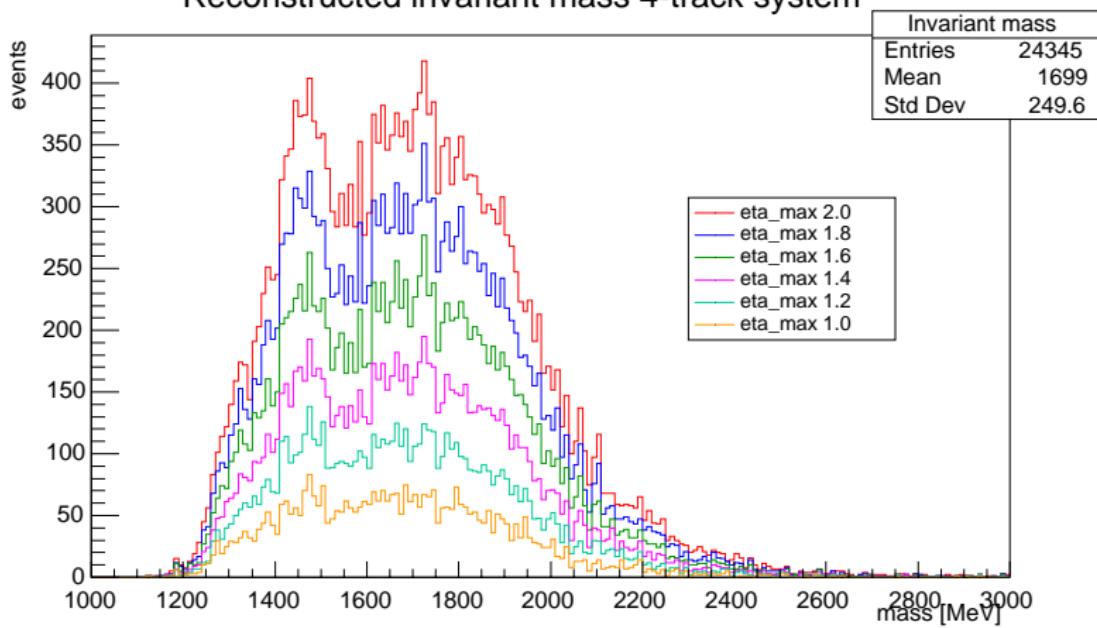
Reconstructed invariant mass 4-track system



$$|\eta| < 2, \chi^2_{zPV, dxy, dz} < 10, \chi^2_\rho < 20$$

Effect of η cuts on vetoed TOTEM2

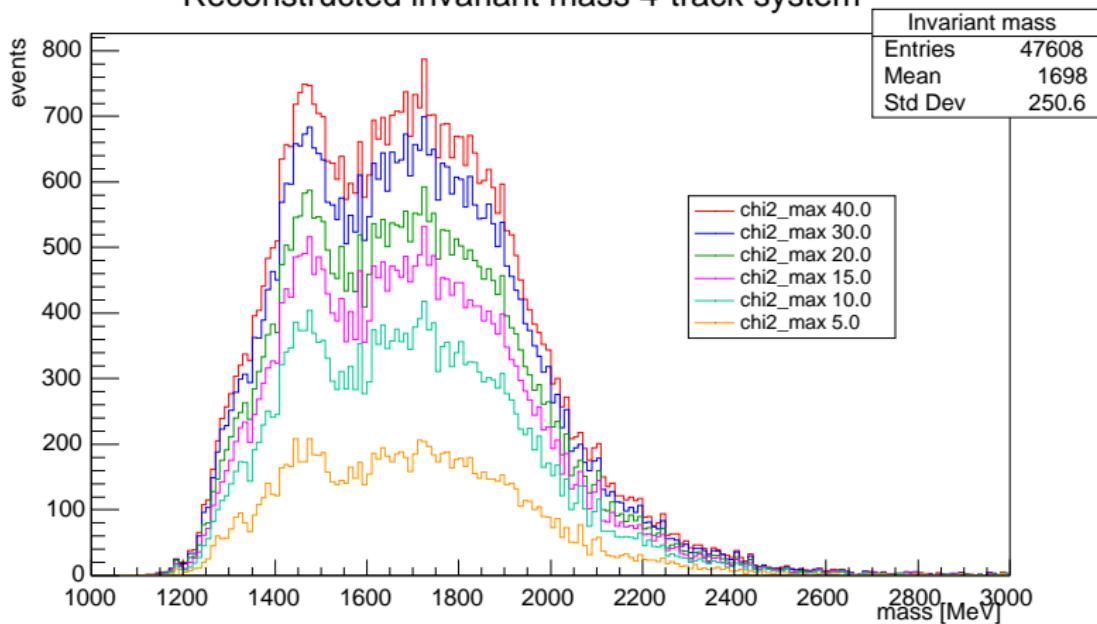
Reconstructed invariant mass 4-track system



$$p_T < 0.8 \text{ GeV}, \chi^2_{zPV, dxy, dz} < 10, \chi^2_\rho < 20$$

Effect of coarse $\chi^2_{zPV,dxy,dz}$ cuts on vetoed TOTEM20

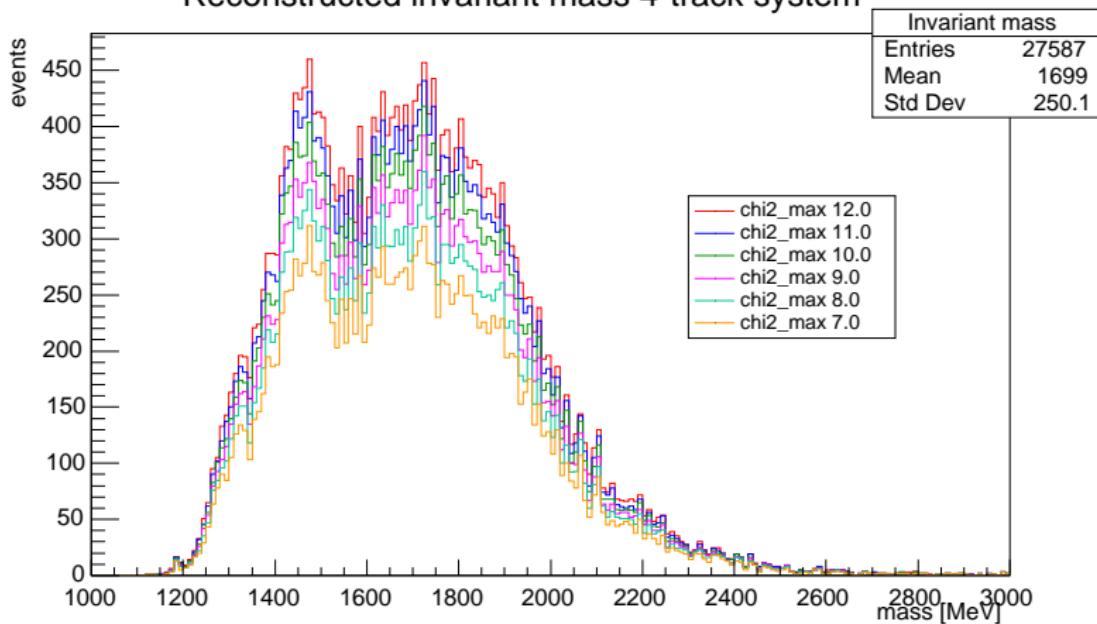
Reconstructed invariant mass 4-track system



$$p_T < 0.8 \text{ GeV}, |\eta| < 2, \chi^2_\rho < 20$$

Effect of fine $\chi^2_{zPV,dxy,dz}$ cuts on vetoed TOTEM20

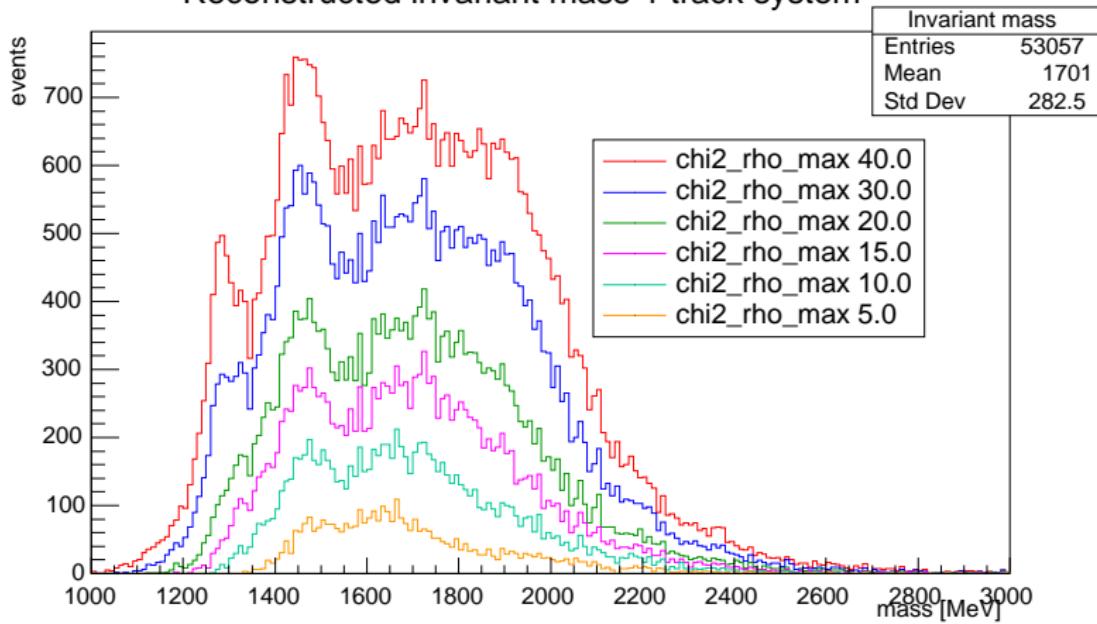
Reconstructed invariant mass 4-track system



$$p_T < 0.8 \text{ GeV}, |\eta| < 2, \chi^2_\rho < 20$$

Effect of coarse χ^2_ρ cuts on vetoed TOTEM2

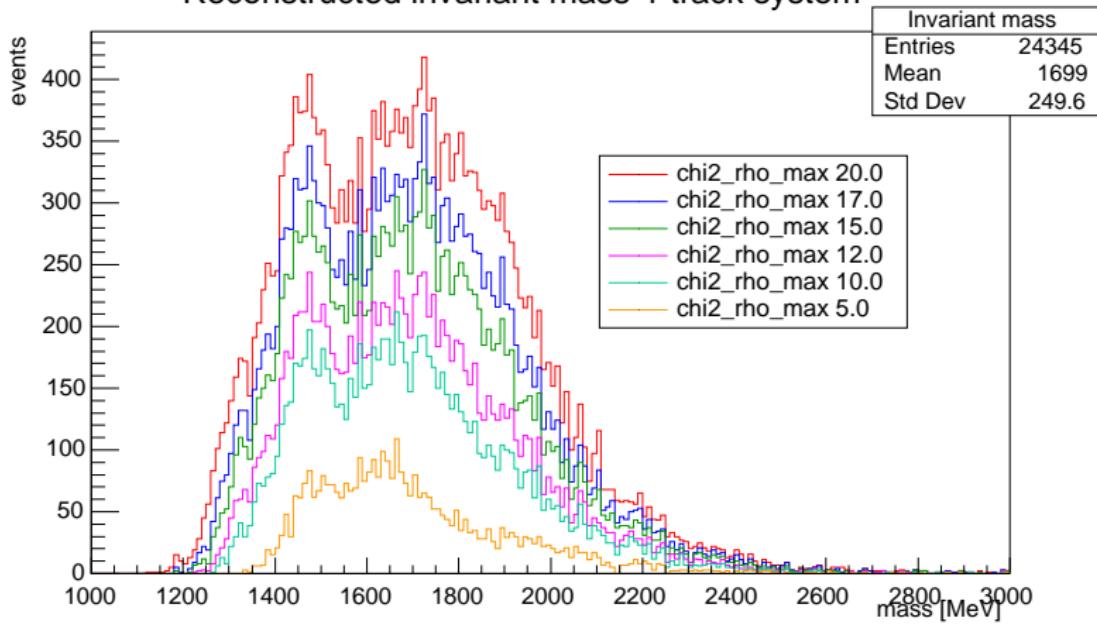
Reconstructed invariant mass 4-track system



$$p_T < 0.8 \text{ GeV}, |\eta| < 2, \chi^2_{zPV, dxy, dz} < 10,$$

Effect of fine χ^2_ρ cuts on vetoed TOTEM2

Reconstructed invariant mass 4-track system

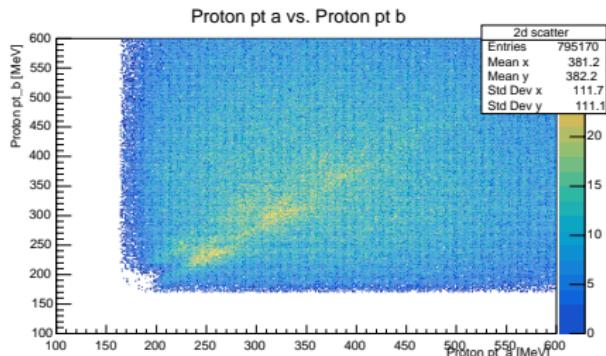


$$p_T < 0.8 \text{ GeV}, |\eta| < 2, \chi^2_{z\text{PV},dxy,dz} < 10,$$

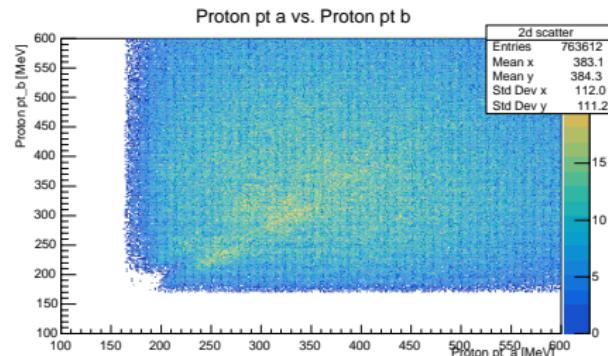
Thanks for your attention!

Questions are welcome.

Backup: Finding veto cut

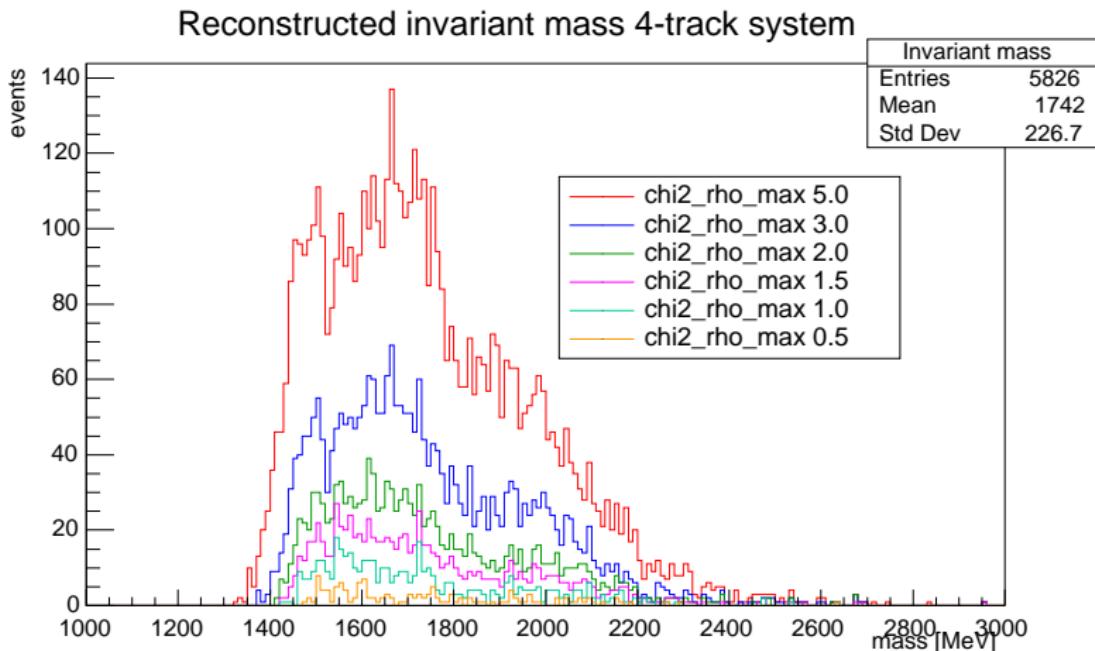


cutoff 10 MeV



cutoff 15 MeV

Backup: Effect of superfine χ^2_ρ cuts on TOTEM4



$$\rho_T < 1.2 \text{ GeV}, |\eta| < 2, \chi^2_{zPV, dxy, dz} < 15,$$