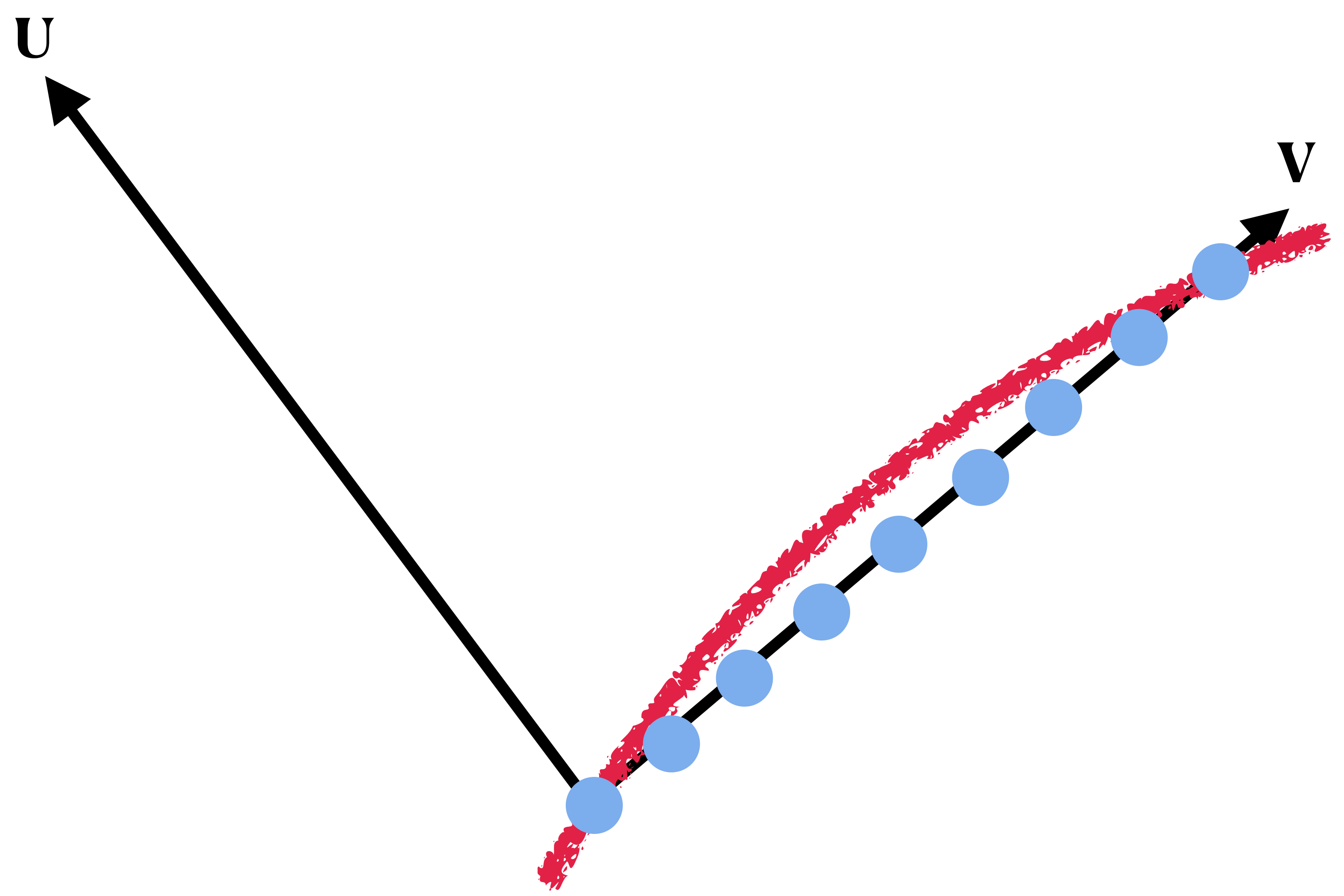
Current status of the full waveform fit in hatRecon

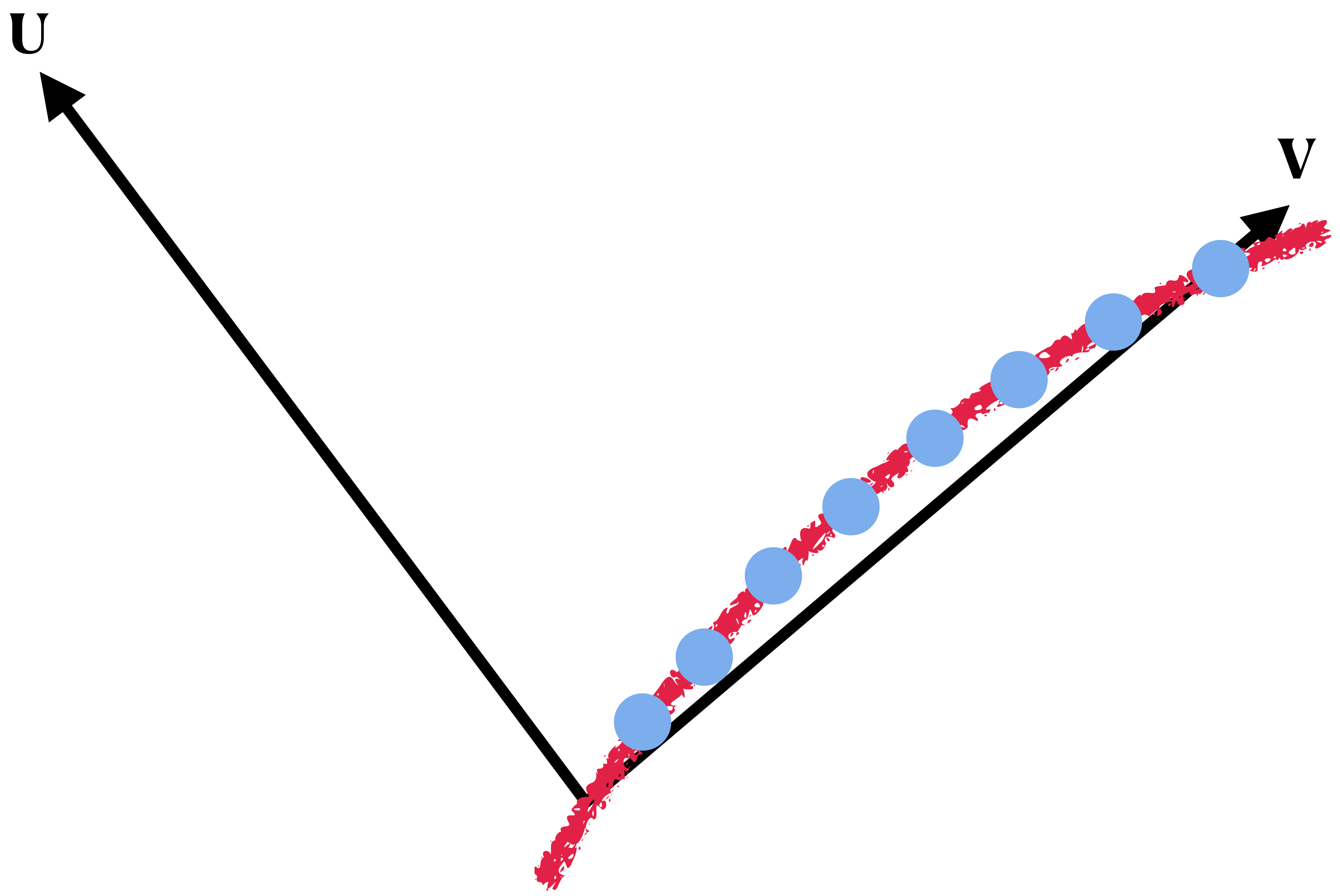
Ulysse VIRGINET - LPNHE neutrino group meeting - 07/02/2024

Reminder of the procedure

- Method proposed by P.Billoir (see his last presentation https://t2k.org/ndup/ha-tpc/meetings/2023/ha-tpc-2023-12-14/globalfit), exploiting the full waveform information

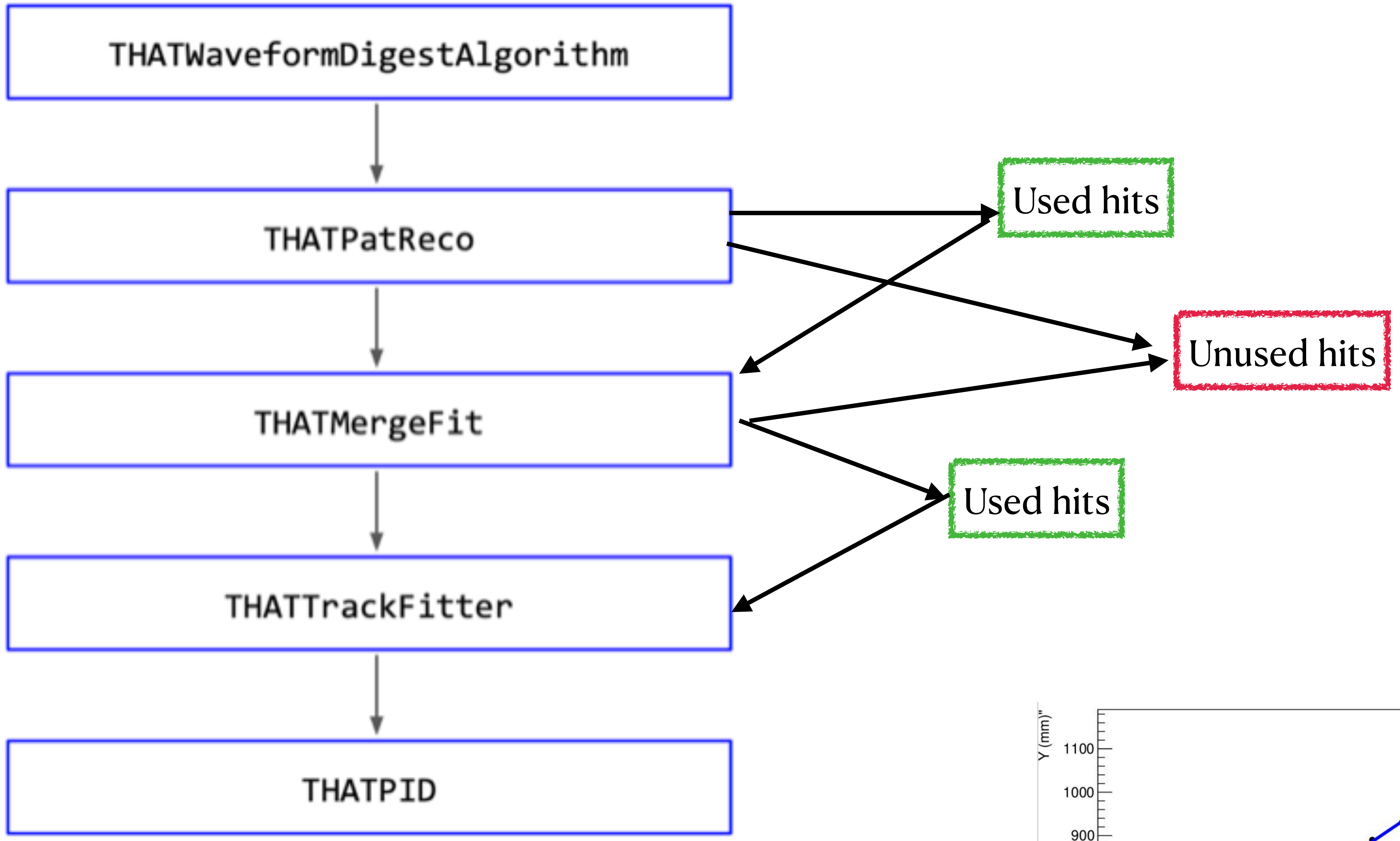
1. Use all the track hits (Qmax values) to define a (**u**,**v**) working frame
2. Put point charges (Q value is a free parameter) on the **v** axis, separated by a length Δv (5~10 mm)
3. Use the Dixit formula to predict the waveform engendered by those point charges in the surrounding pads
4. For a fixed v, move all the points along the **u** axis to minimize the χ^2 between observed waveforms and dixit-predicted ones: $\chi^2 = \sum_{i(pad)} \sum_{j(timebin)} \frac{(Q_{i,j}^{obs} - Q_{i,j}^{Dixit})^2}{\sigma_{i,j}^2}$, using Runge-Kutta method ($u_0, du/dv, q/p, t_0, dt/dv$)

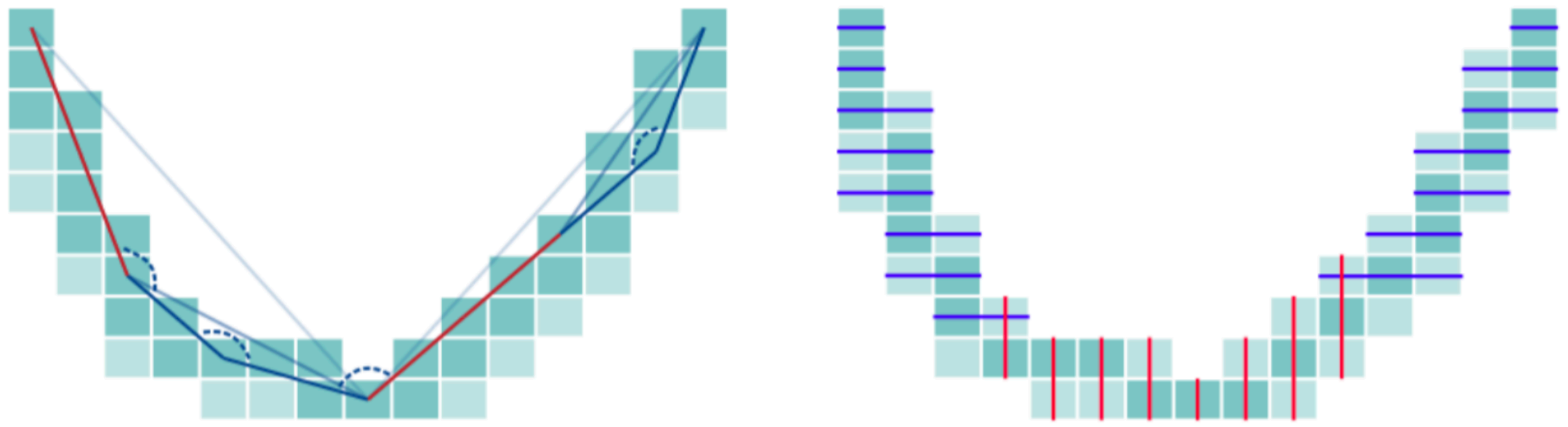


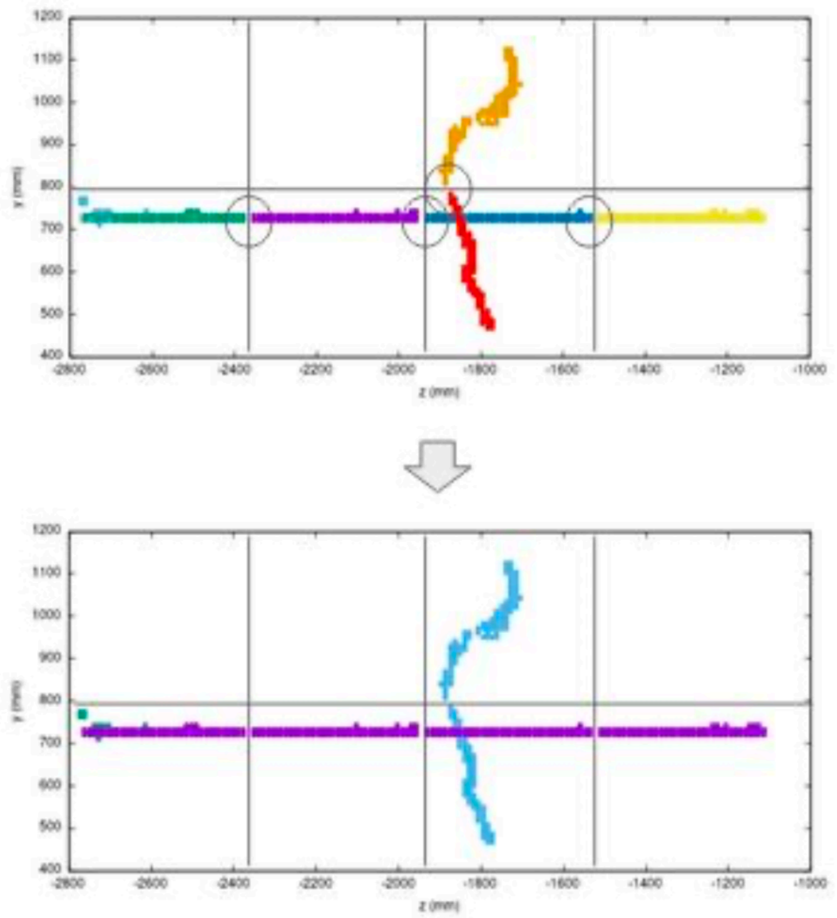


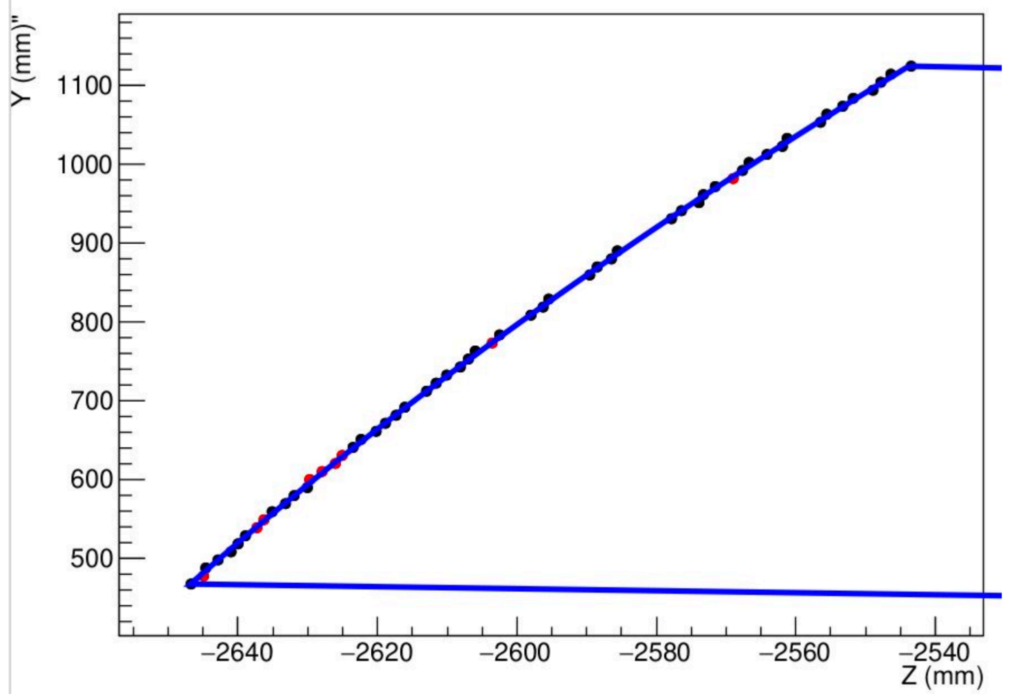
Implementation in the hatRecon software

- Standard hatRecon procedure:



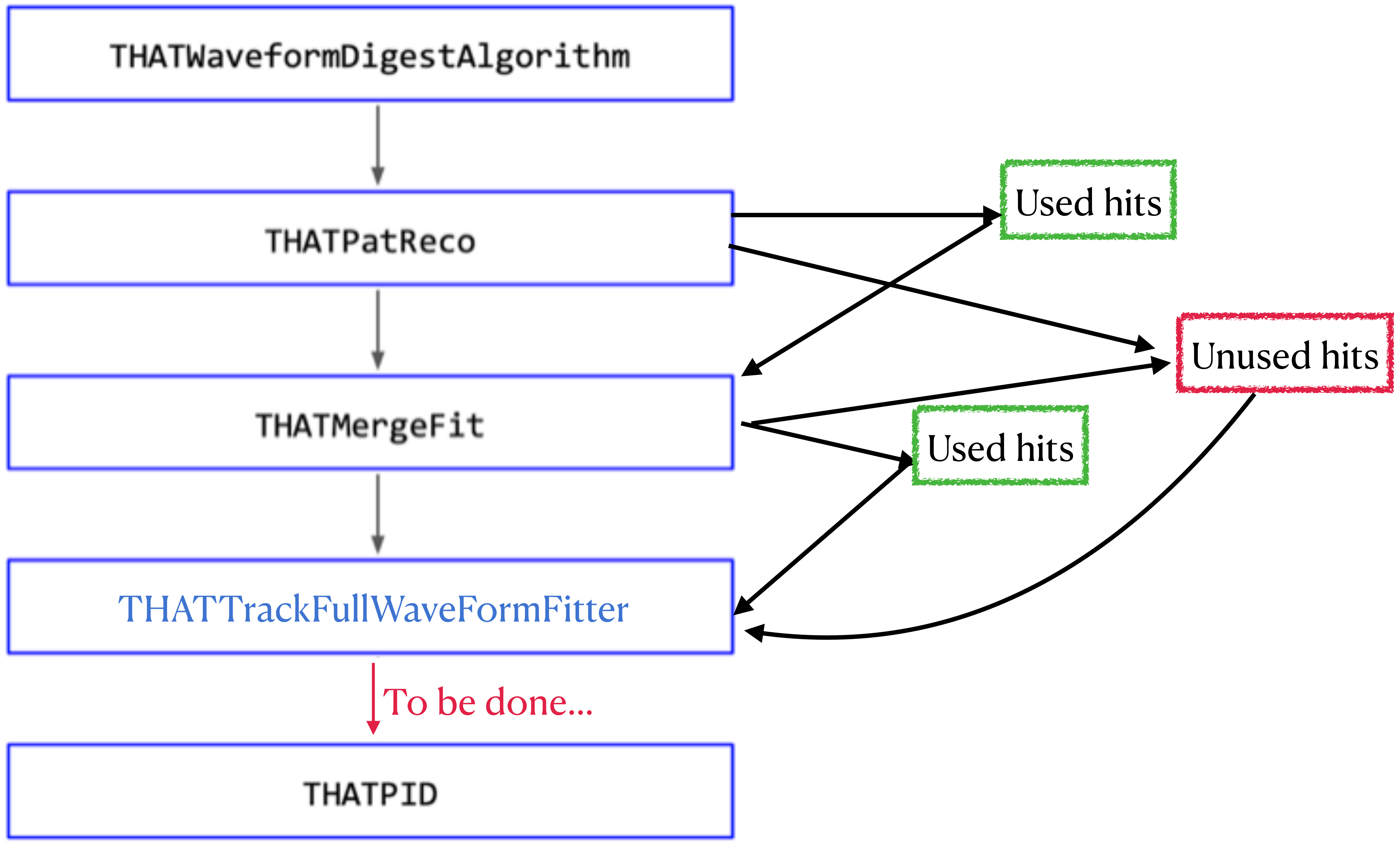


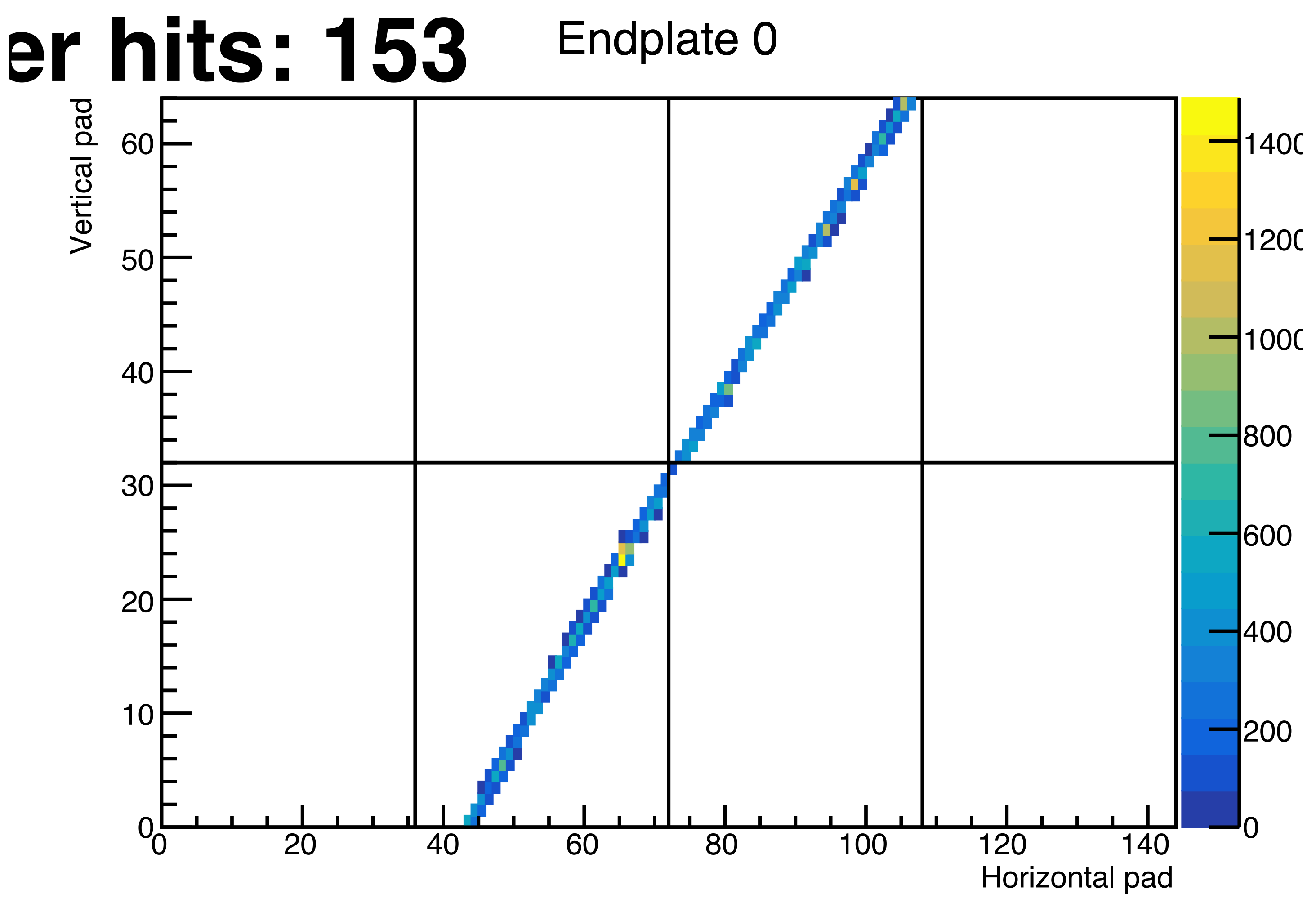


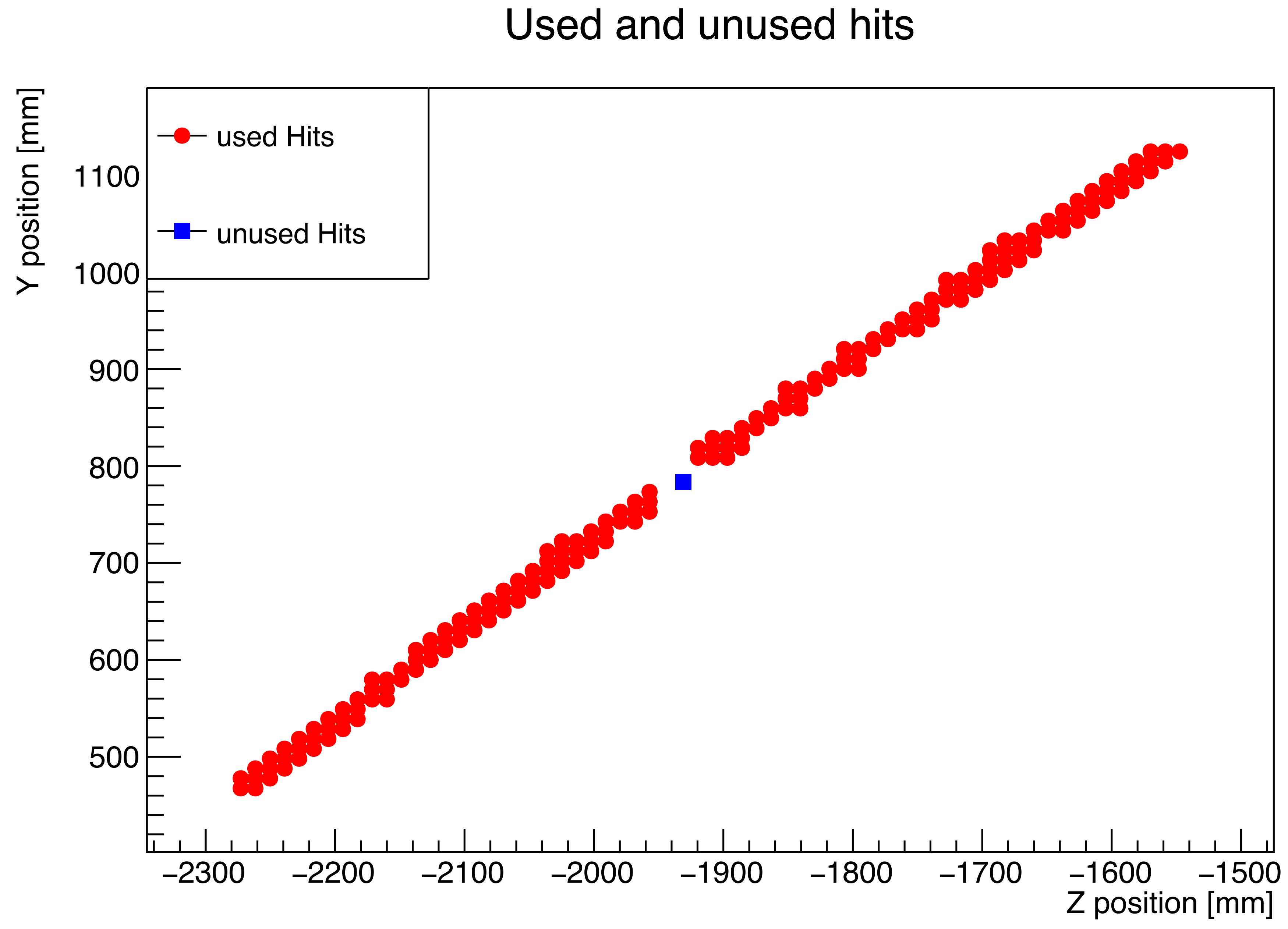


Implementation in the hatRecon software

- Global track fit hatRecon procedure:

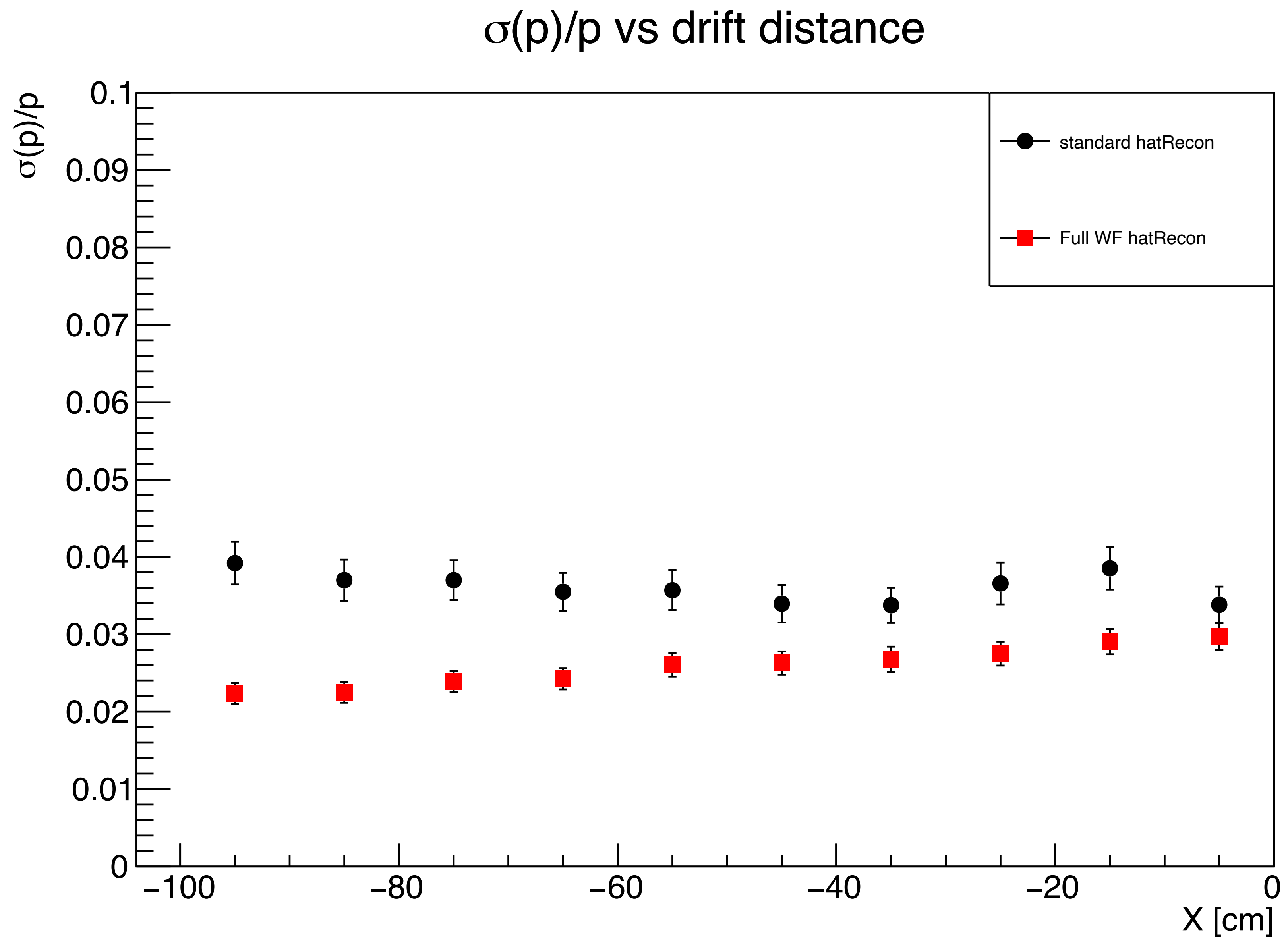




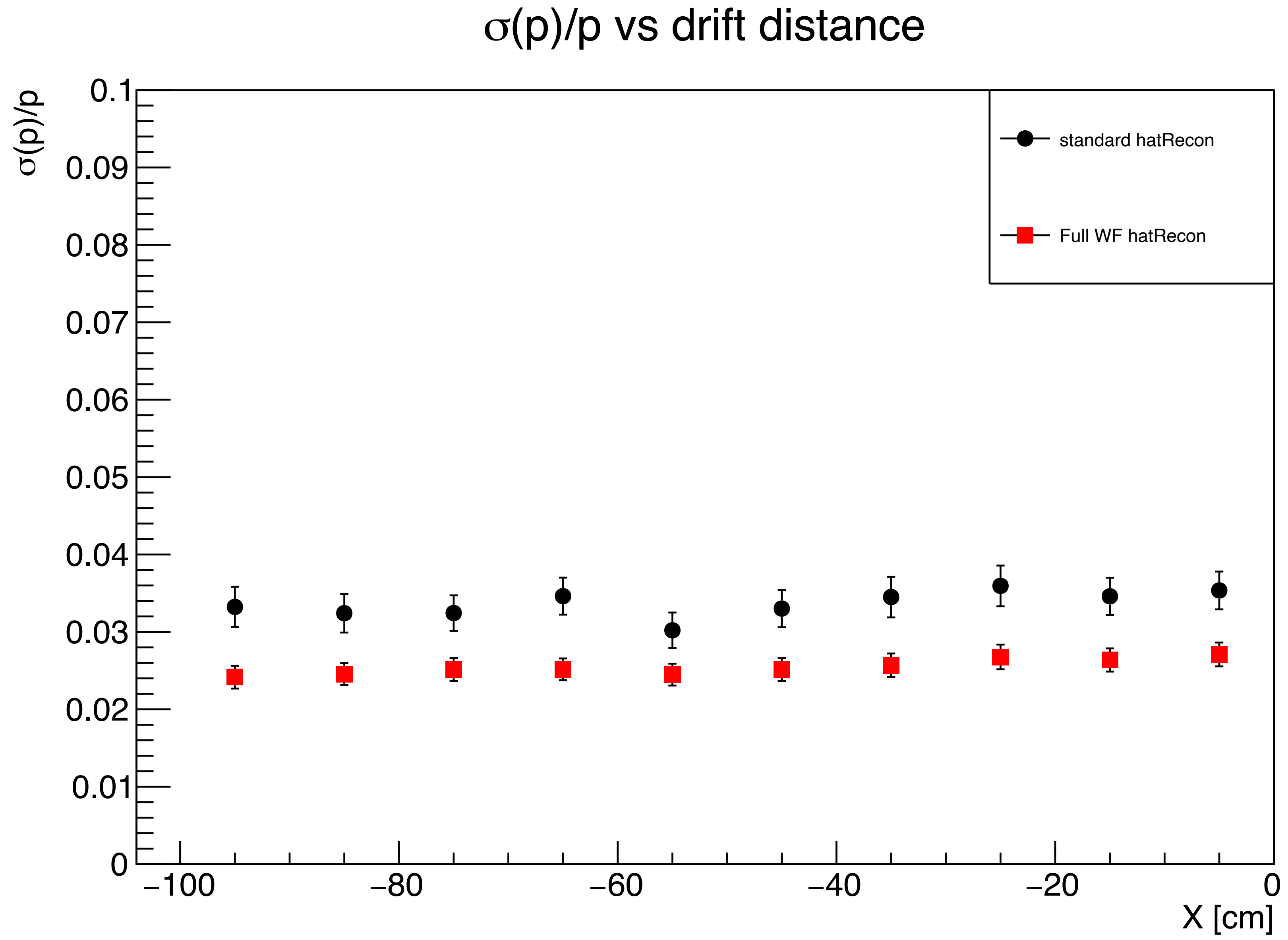


σ_p/p as a function of track drift distance for $\phi = 5.7°$

- Simulated mu+ and mu- tracks with T=700MeV, at various X (-5 to -95cm), with fixed $\phi = 5.7°$
- Samples of 1000 events per X
- Reconstructed tracks with standard THATTrackFitter and THATTrackFullWaveFormFitter
- The B field used is a uniform $B_x = 0.2T$ so no $E \times B$ effect considered here



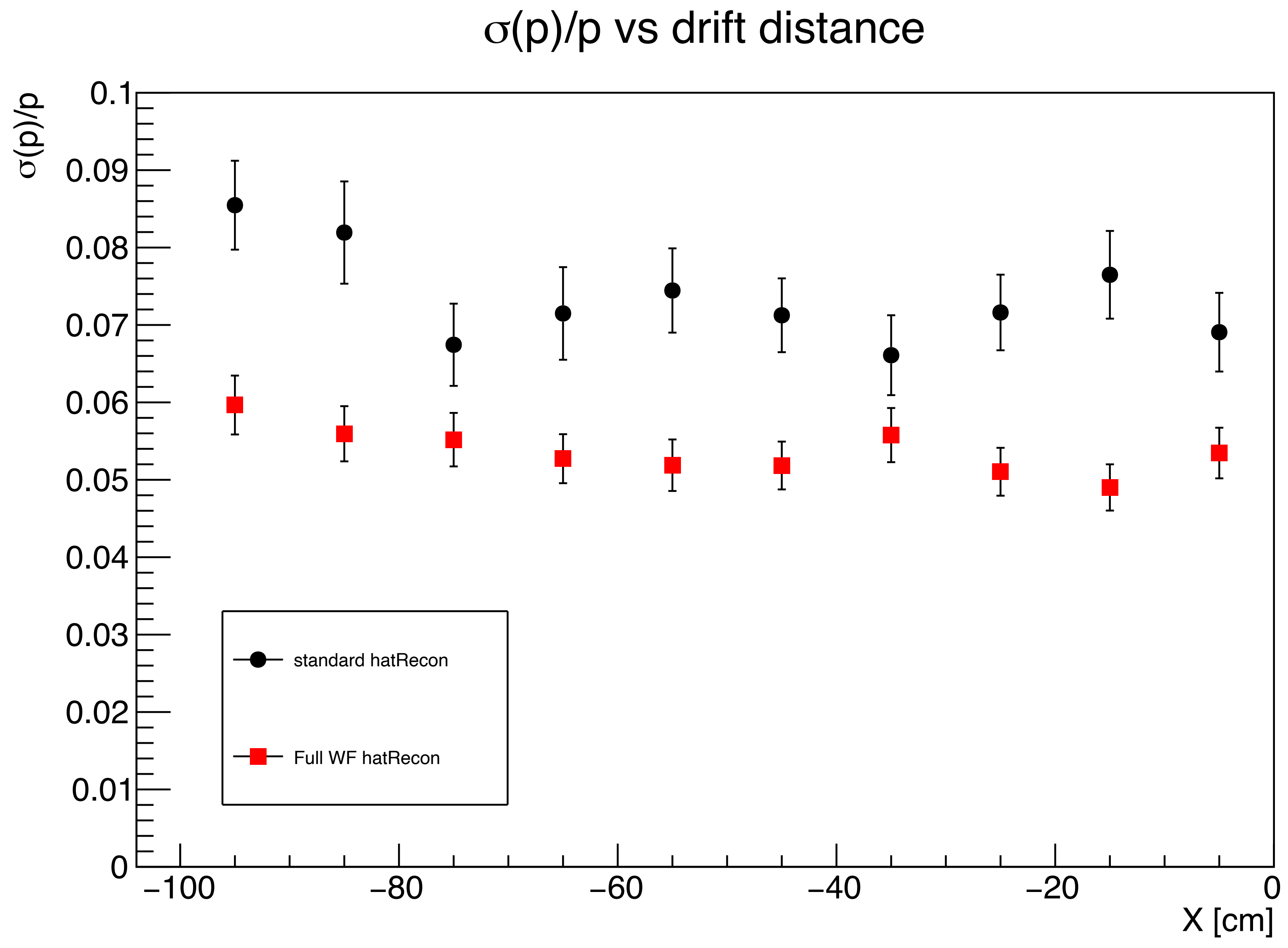
μ^-



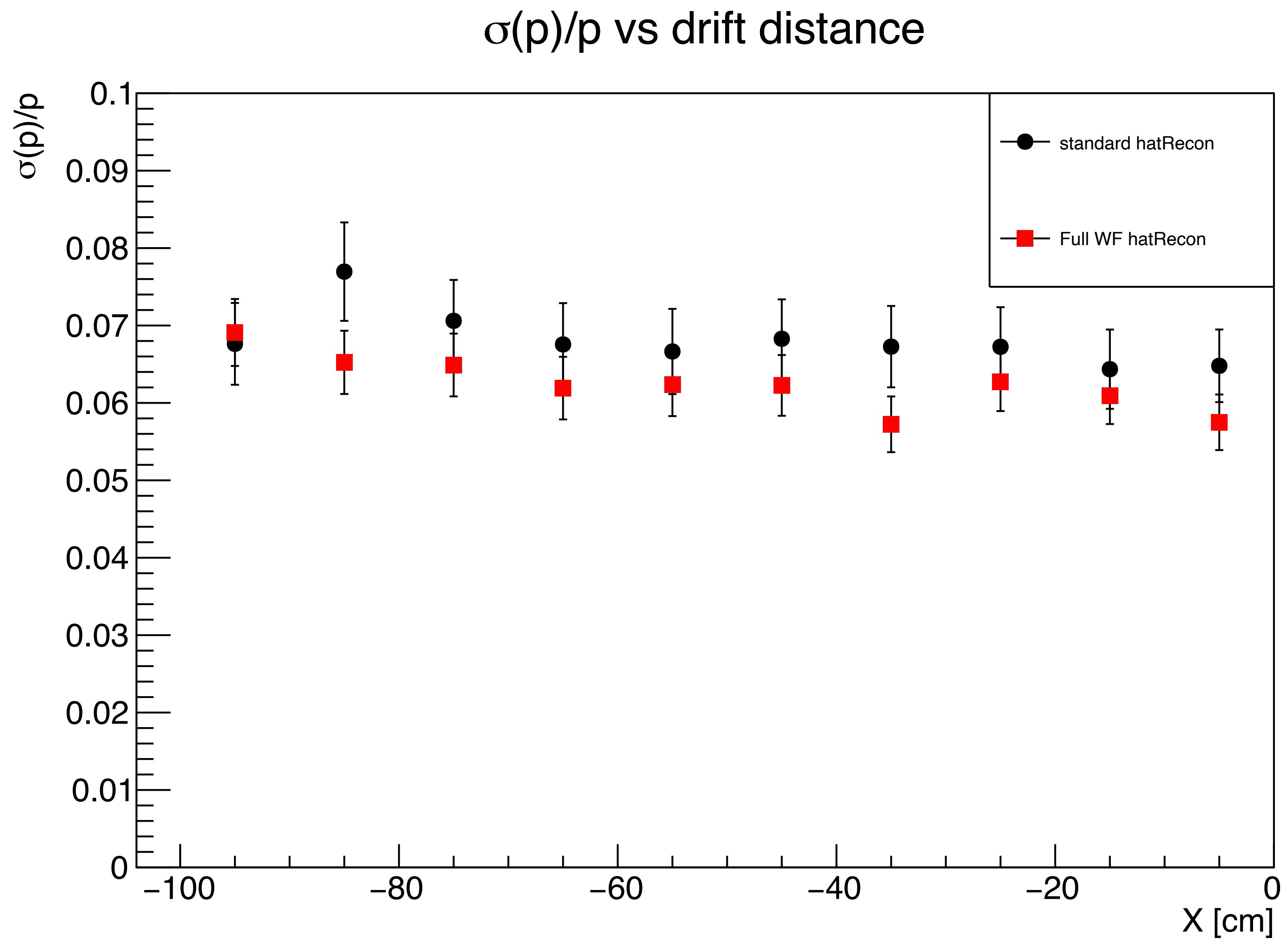
μ^+

σ_p/p as a function of track drift distance for $\phi = 45°$

- Simulated mu+ and mu- tracks with T=700MeV, at various X (-5 to -95cm), with fixed $\phi = 45°$
- Samples of 1000 events per X
- Reconstructed tracks with standard THATTrackFitter and THATTrackFullWaveFormFitter
- The B field used is a uniform $B_x = 0.2T$ so no $E \times B$ effect considered here
- Big difference between μ^+ and μ^-, could be due to alignment of diagonal configurations, need to check at $\phi = 50°$



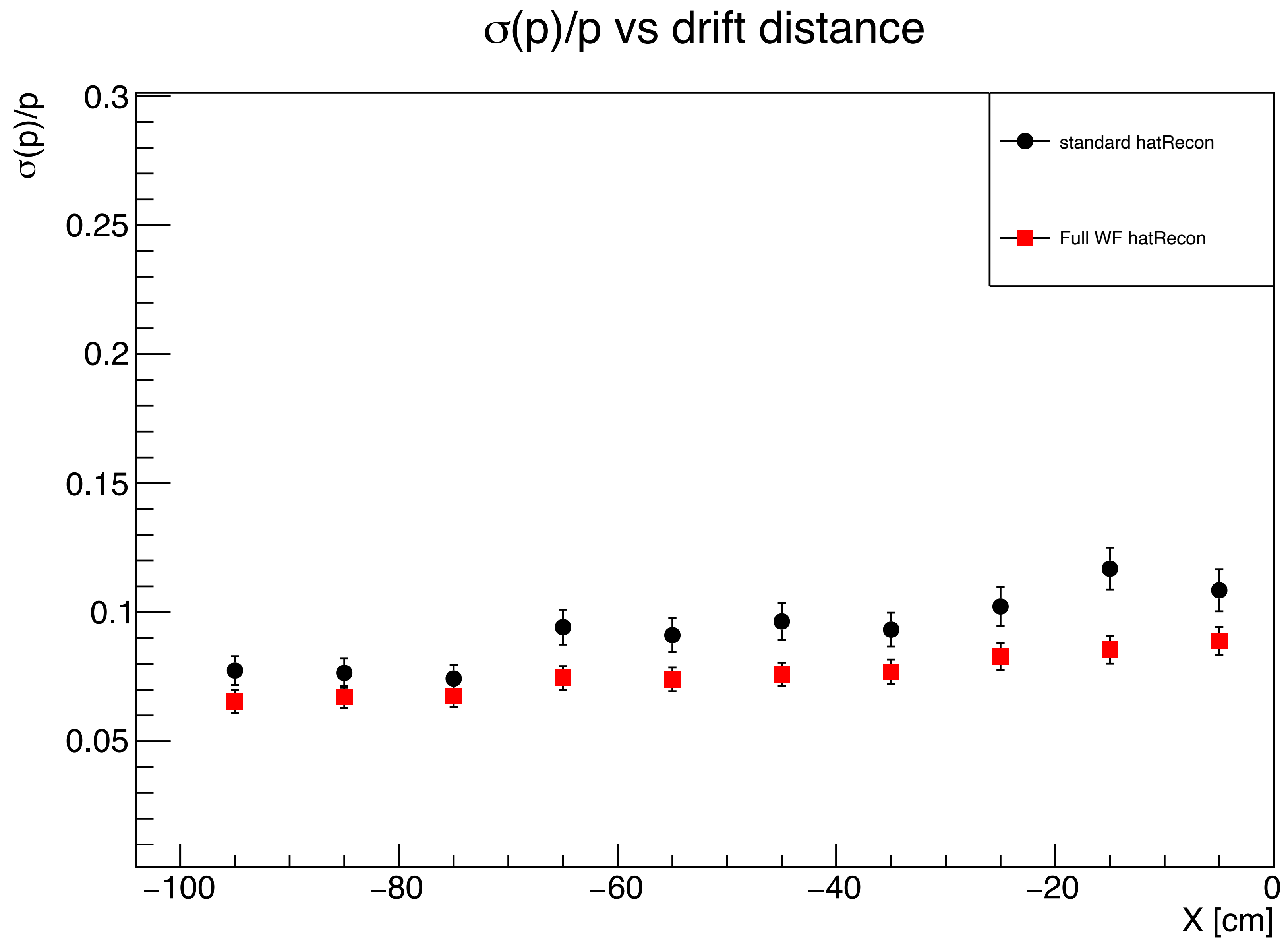
μ^-



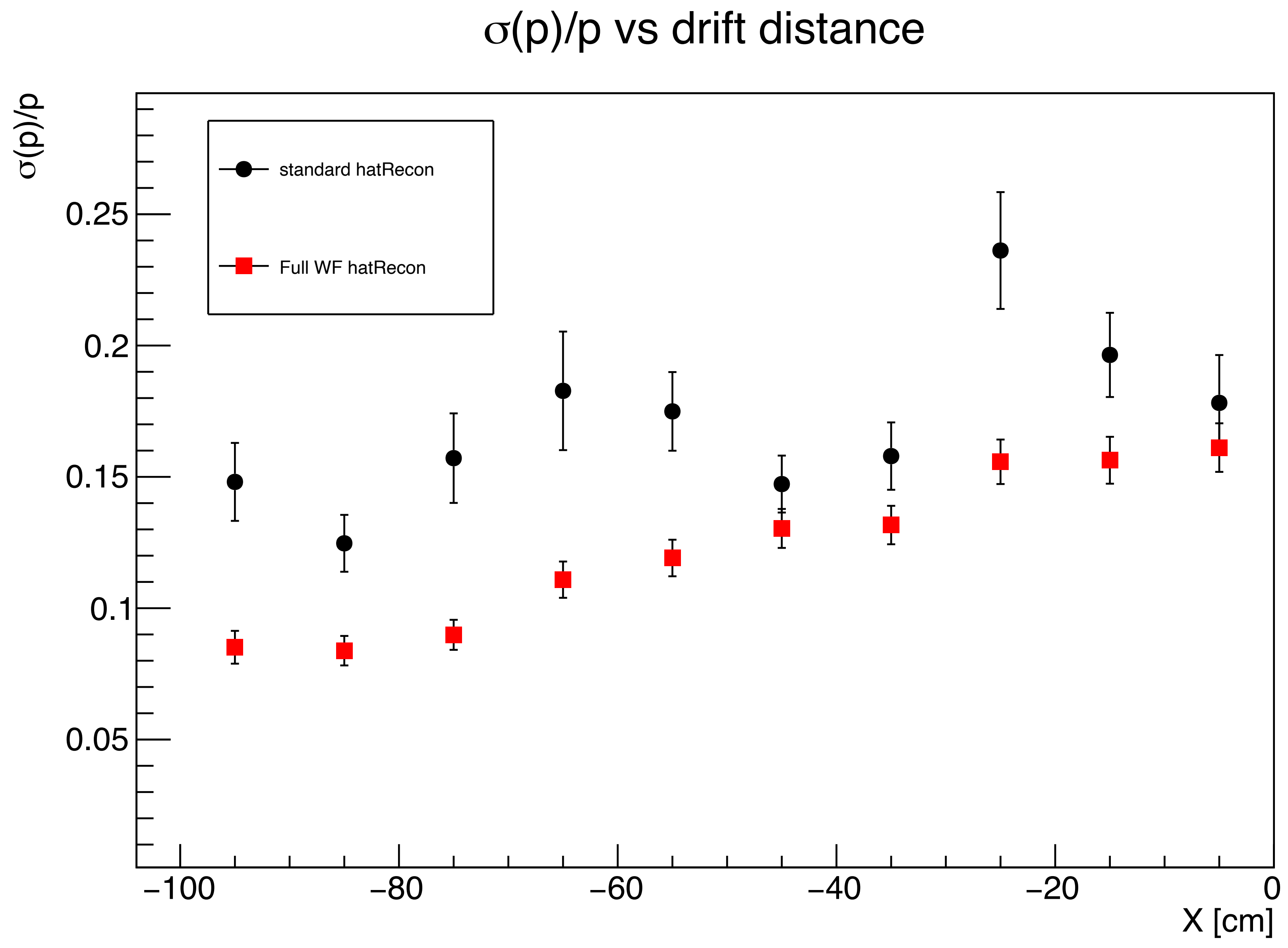
μ^+

σ_p/p as a function of track drift distance for $\phi = 84.3^\circ$

- Simulated mu+ and mu- tracks with T=700MeV, at various X (-5 to -95cm), with fixed $\phi = 84.3^\circ$
- Samples of 1000 events per X
- Reconstructed tracks with standard THATTrackFitter and THATTrackFullWaveFormFitter
- The B field used is a uniform $B_x = 0.2T$ so no $E \times B$ effect considered here
- Big difference between μ^+ and μ^-, could be due to alignment of vertical configurations, need to check at $\phi = 95.7^\circ$ for μ^+



μ^-

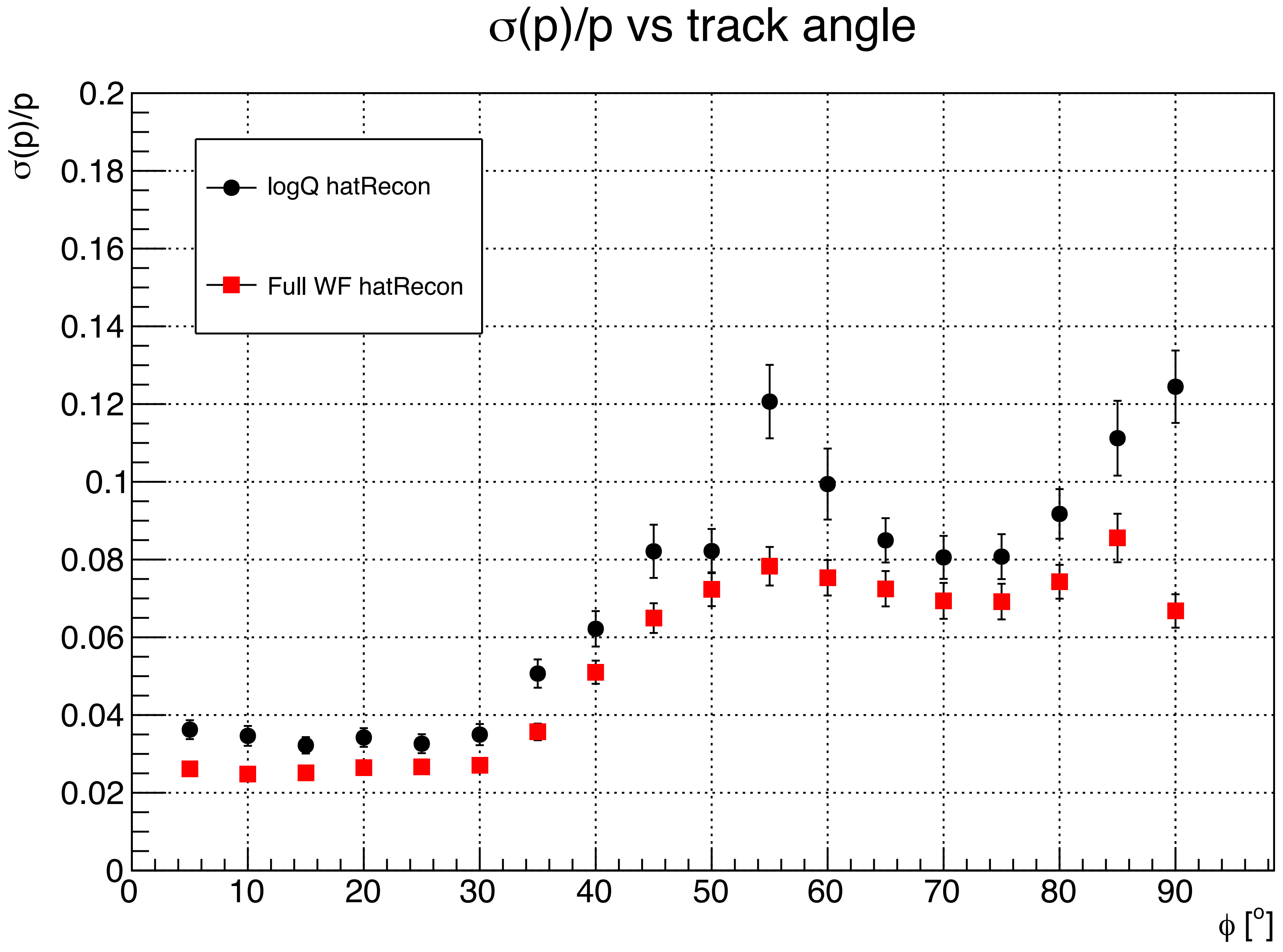


μ^+

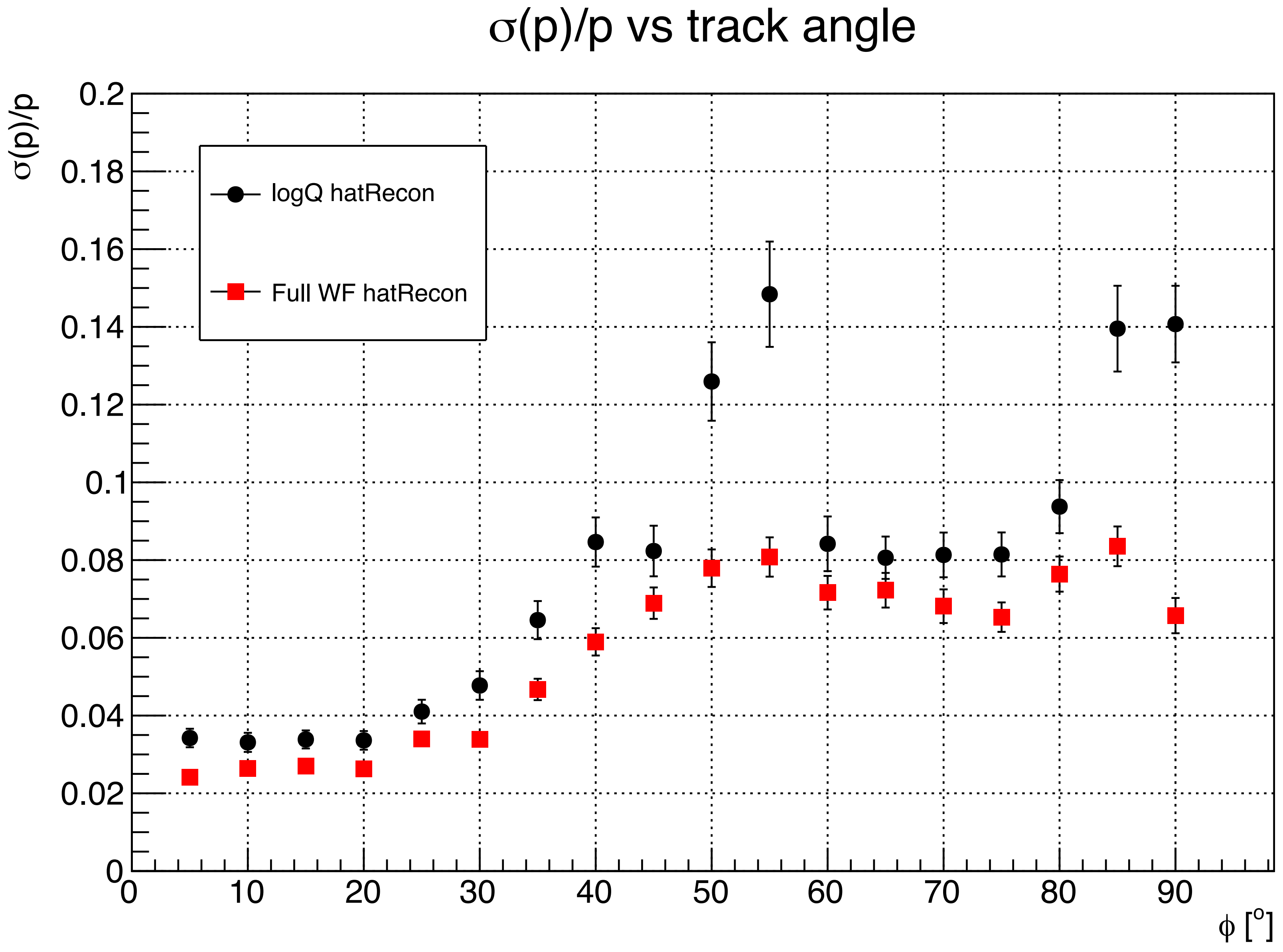
σ_p / p as a function of track ϕ angle*

- Simulated mu+ and mu- tracks with T=700MeV, at various angles (0 to 90°), with fixed X=-55cm (43cm drift distance)
- Samples of 1000 events per track angle
- Reconstructed tracks with standard THATTrackFitter and THATTrackFullWaveFormFitter
- The B field used is a uniform $B_x = 0.2T$ so no $E \times B$ effect considered here

*Track length very correlated to this angle value and $\sigma_p / p \propto 1/L^{5/2}$



μ^-



μ^+

Summary and plans

- Very promising results, momentum resolution better than what we had with logQ method
- Scan in momentum
- Non-uniform B-Field
- Create track objects to be used in the global reconstruction
- Compare efficiency and time taken by the logQ and Full WF method