Kaon LT Meeting

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Offsets optimization

- Shift in missing mass observed mostly in high ϵ settings.
- Parameters for optimization:
  - htheta_offset, hphi_offset, hdelta_offset
  - hpcentral_offset, hthetacentral_offset, h_oopcentral_offset

$$\begin{bmatrix} x'_{\text{tar}} \\ y_{\text{tar}} \\ y'_{\text{tar}} \\ \delta p \end{bmatrix} = \begin{bmatrix} \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \end{bmatrix} \begin{bmatrix} x_{\text{fptar}} \\ x'_{\text{fptar}} \\ y_{\text{fptar}} \\ y'_{\text{fptar}} \\ \tilde{x}_{\text{tar}} \end{bmatrix} + \begin{bmatrix} \texttt{htheta\_offset} + \texttt{h\_oopcentral\_offset} \\ 0.0 \\ \texttt{hphi\_offset} \\ \texttt{hdelta\_offset} \end{bmatrix}$$

$$p_{\text{central}} = p_{\text{central}} \cdot (1 + \texttt{hpcentral\_offset})$$
$$\theta_{\text{central}} = \theta_{\text{central}} + \texttt{hthetacentral\_offset}$$
$$\phi_{\text{central}} = \phi_{\text{central}} + \texttt{hphi\_offset}$$

- ok to set htheta_offset $= 0$ and hdelta_offset $= 0$.

First Test

Parameters

- Parameters for optimization (HMS + SHMS)
  - ~~htheta_offset~~, hphi_offset, ~~hdelta_offset~~ (2)
  - hpcentral_offset, hthetacentral_offset, h_oopcentral_offset (6)
  - δE_{beam} (5) $\rightarrow$ ignore for now

Data

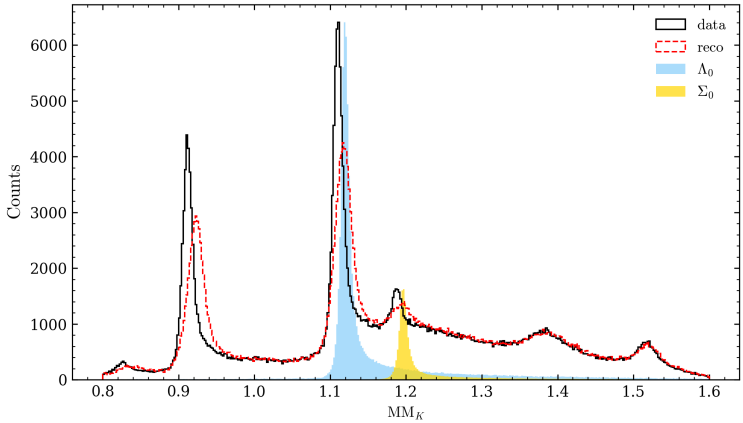
- only for $Q^2 = 3.0, W = 3.14$ settings
- PID and coincidence time cuts applied, i.e. the trimmed replayed data files.
- No further background cut (e.g. heavy gas cherenkov hole cut) applied for now.

optimization

- keep hphi_offset $= 0$ for now.
- global parameters $\rightarrow$ 6 parameters to optimize
- use Λ^0 peak only

$$\chi^2 = \sum_i^{N_{\text{setting}}} \frac{(M_{\text{MM}}^{\text{data}} - M_{\text{MM}}^{\text{sim}})^2}{\sigma_i^2}$$

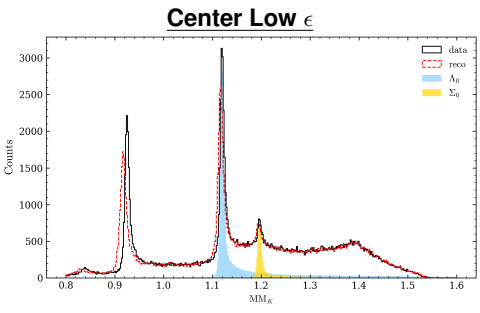
First Test Result

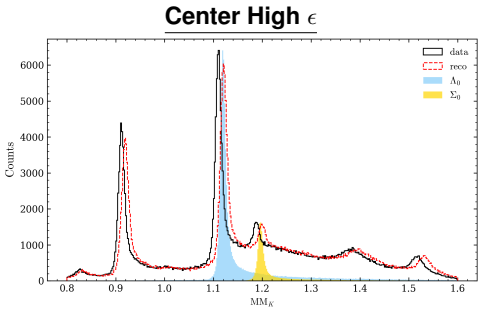


- shifted missing mass peak but in the cost of resolution.

Second Test

- same data as before
- add `hphi_offset` back to optimization (10 parameters to optimize).
- include 2 peaks ($K^+ + \Lambda^0$, $K^+ + \Sigma^0$) in the χ^2 calculation.

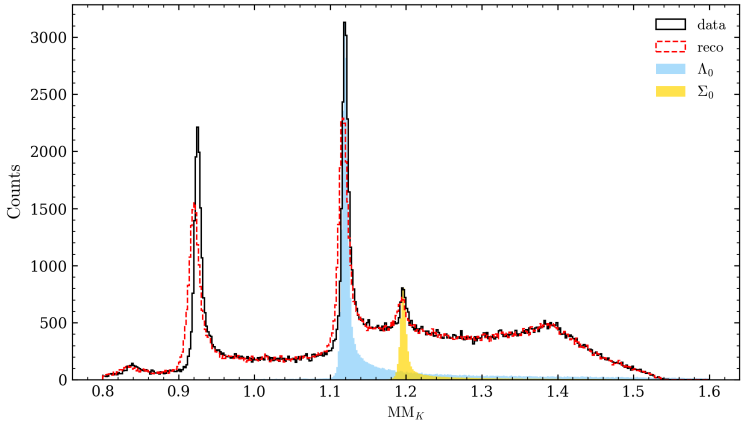




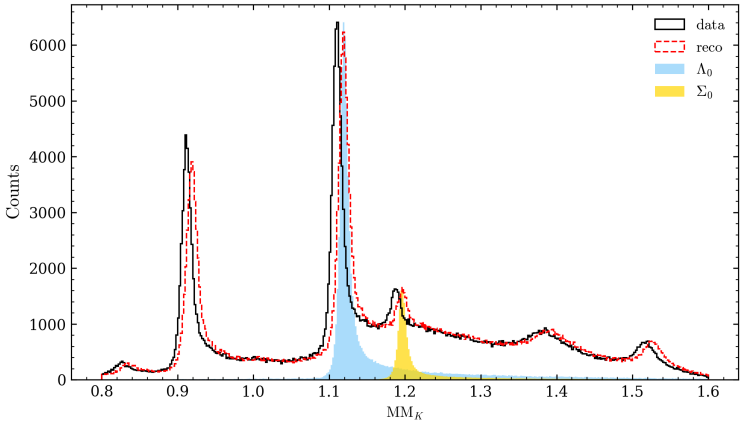
Third test

- All replay data so far turn off hphi_offset.
- fix central kinematics offsets to the original values
  - hpcentral_offset $= -0.1$, hthetacentral_offset $= 0.001$, h_oopcentral_offset $= 0.00251$
  - spcentral_offset $= -0.2$, sthetacentral_offset $= 0.0011$, s_oopcentral_offset $= -0.00011$
- optimize only the hphi_offset (2 parameters to optimize).

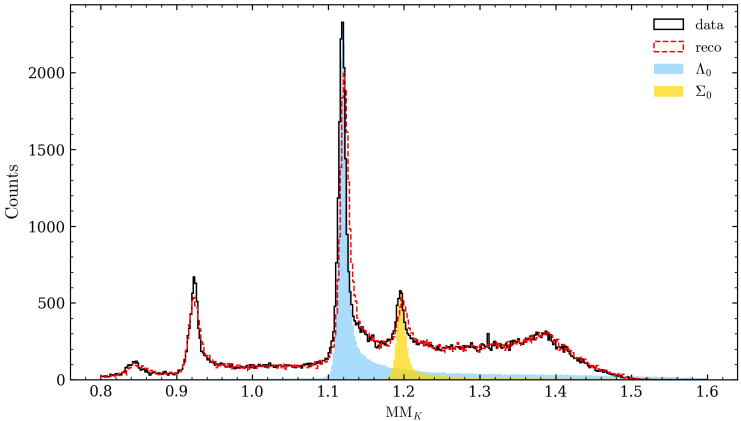
Third test result - center low ϵ



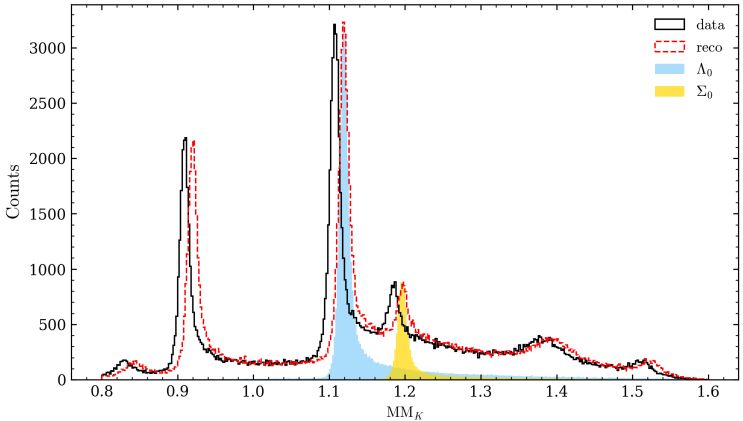
Third test result - center high ϵ



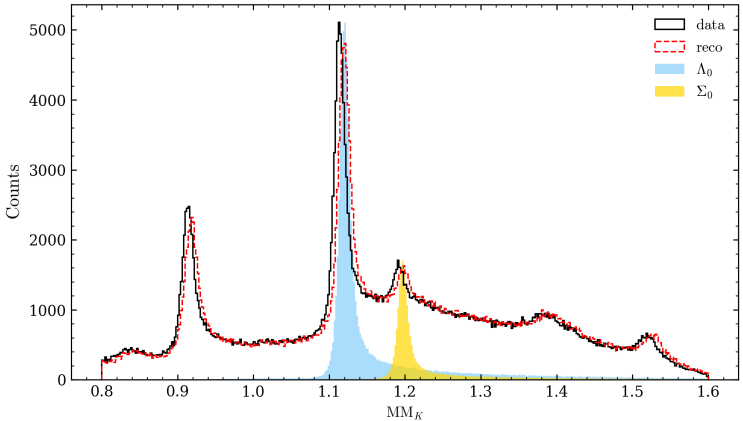
Third test result - left low ϵ



Third test result - left high ϵ



Third test result - right high ϵ



Third test result - Summary

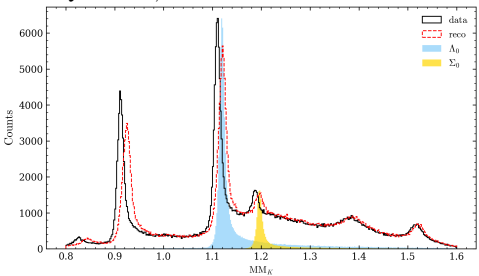
- All peaks shifted to the right place for all settings.
- need to improve peak fitting method.

Source	$\mathbf{hms}\ \delta\phi$	$\mathbf{shms}\ \delta\phi$
Best Estimate	2.88$\times 10^{-3}$	-5.18$\times 10^{-3}$
NPS Original	-4.95$\times 10^{-3}$	-8.68$\times 10^{-4}$
Junaid (Meeting Note)	2.8$\times 10^{-4}$	—

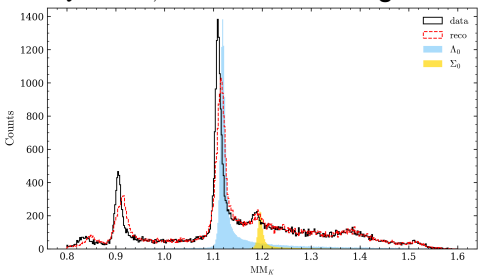
Forth test

- same optimization strategy as the third test
- use both $Q^2 = 3.0, W = 3.14$ and $Q^2 = 4.4, W = 2.74$ settings

$Q^2 = 3.0, W = 3.14$ **Center Low** ϵ



$Q^2 = 4.4, W = 2.74$ **Center High** ϵ



Clarification

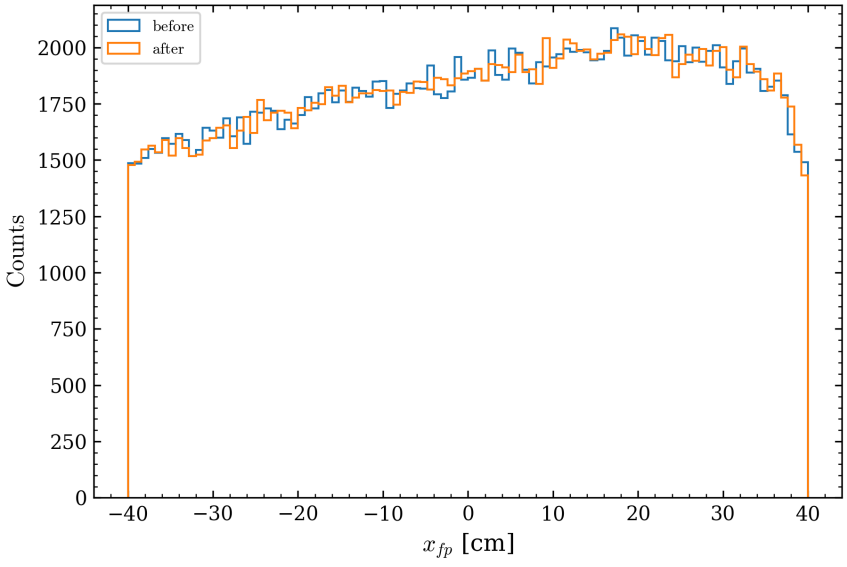
- so far, offsets are applied by directly modifying the input in SIMC, e.g. $\theta \to \theta + \delta\theta$. No explicit offset parameter.
- `recon_hcana.C` ran after `SIMC` but,
  - only `soopcentral_offset` applied.

Procedure

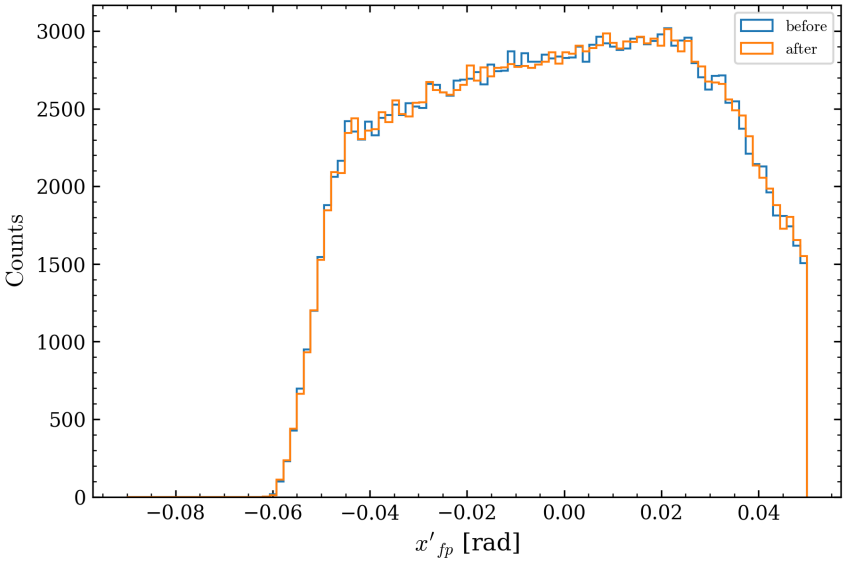
- run replay without any offsets $\rightarrow$ take the focal plane + x_{tar}
- run SIMC without any offsets $\rightarrow$ take the focal plane + `fry`
- while True:
  - generate offsets (same for data and SIMC)
  - reconstruction : `fp` + offsets $\rightarrow$ `COSY` $\rightarrow$ kinematics
  - compare data and SIMC for mm peak or missing energy if `Heep`

- Only work if offsets has little effect on the focal plane variables in `SIMC` ...

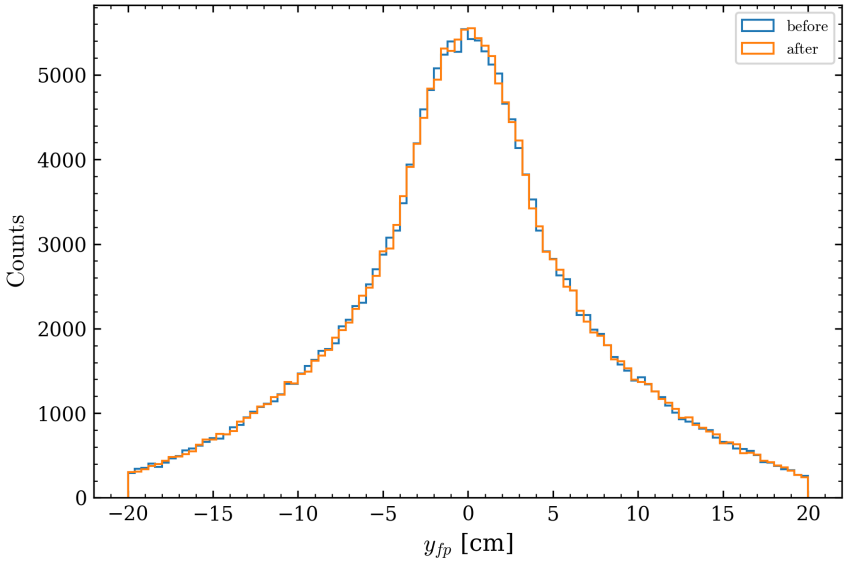
Focal Plane


before
after
Counts
2000
1750
1500
1250
1000
750
500
250
0
−40
−30
−20
−10
0
10
20
30
40
x_{fp} [cm]

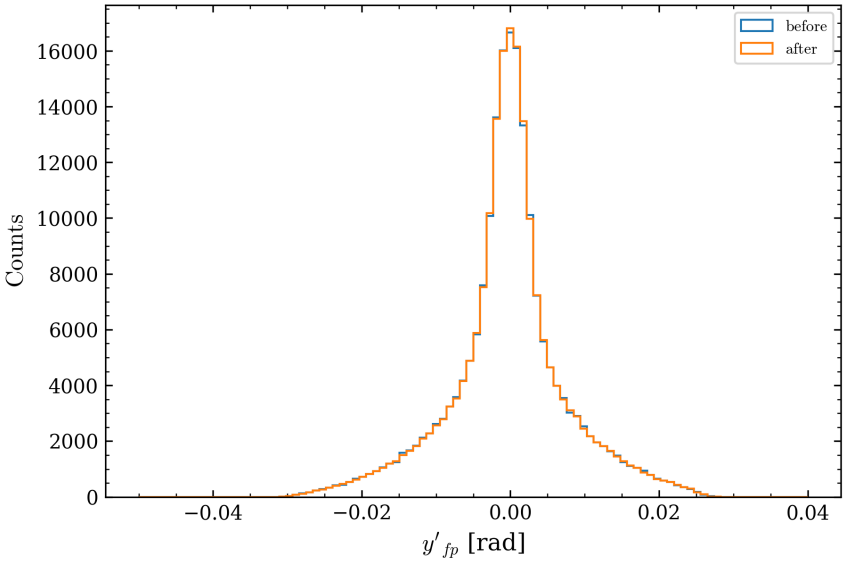
Focal Plane


before
after
Counts
3000
2500
2000
1500
1000
500
0
−0.08
−0.06
−0.04
−0.02
0.00
0.02
0.04
x'_{fp} [rad]

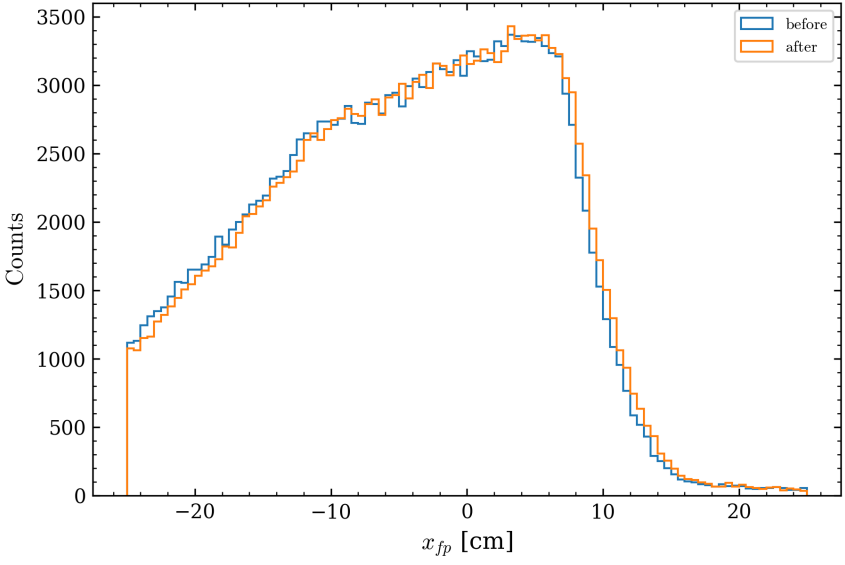
Focal Plane


before
after
Counts
0
1000
2000
3000
4000
5000
−20
−15
−10
−5
0
5
10
15
20
y_{fp} [cm]

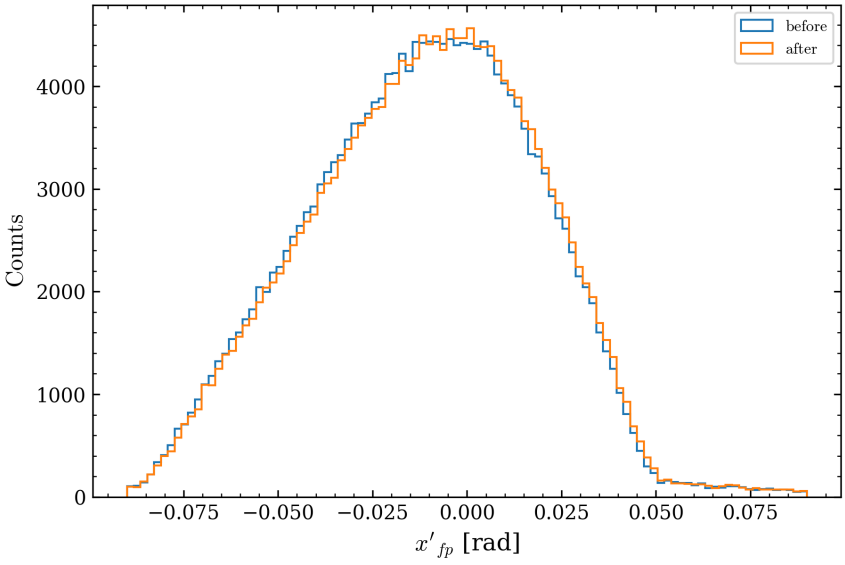
Focal Plane


before
after
Counts
16000
14000
12000
10000
8000
6000
4000
2000
0
−0.04
−0.02
0.00
0.02
0.04
y'_{fp} [rad]

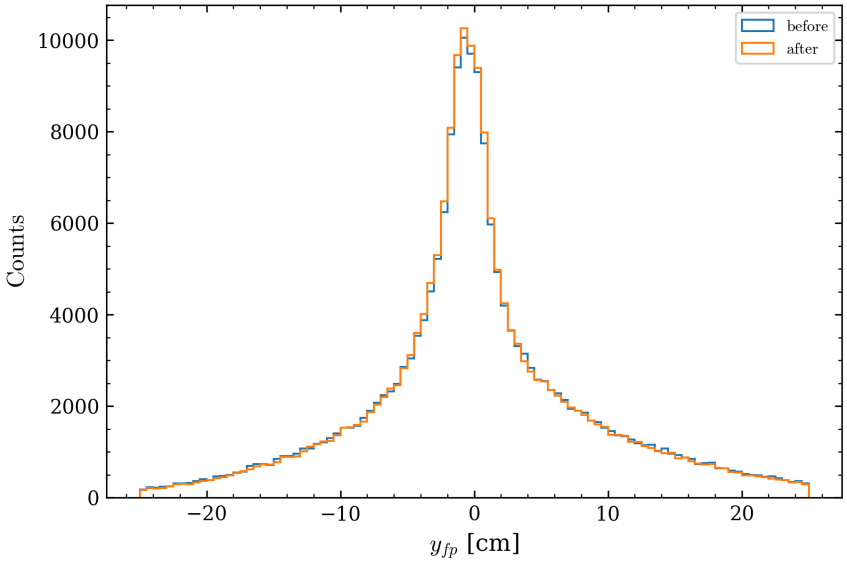
Focal Plane


before
after
Counts
3500
3000
2500
2000
1500
1000
500
0
−20
−10
0
10
20
x_{fp} [cm]

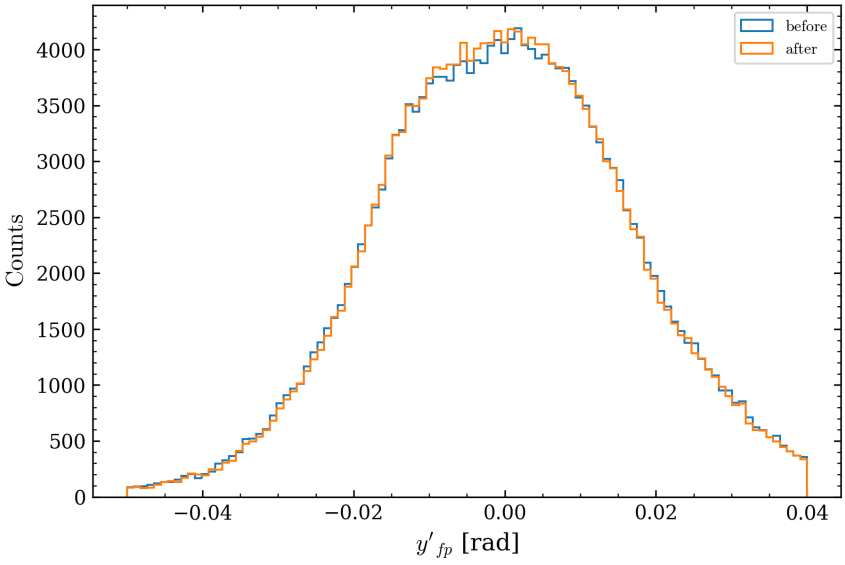
Focal Plane


before
after
4000
3000
2000
1000
0
Counts
−0.075
−0.050
−0.025
0.000
0.025
0.050
0.075
x'_{fp} [rad]

Focal Plane


before
after
Counts
10000
8000
6000
4000
2000
0
−20
−10
0
10
20
y_{fp} [cm]

Focal Plane


before
after
Counts
0
500
1000
1500
2000
2500
3000
3500
4000
−0.04
−0.02
0.00
0.02
0.04
y'_{fp} [rad]