

# Field-Off Alignment

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Norman Graf (SLAC)

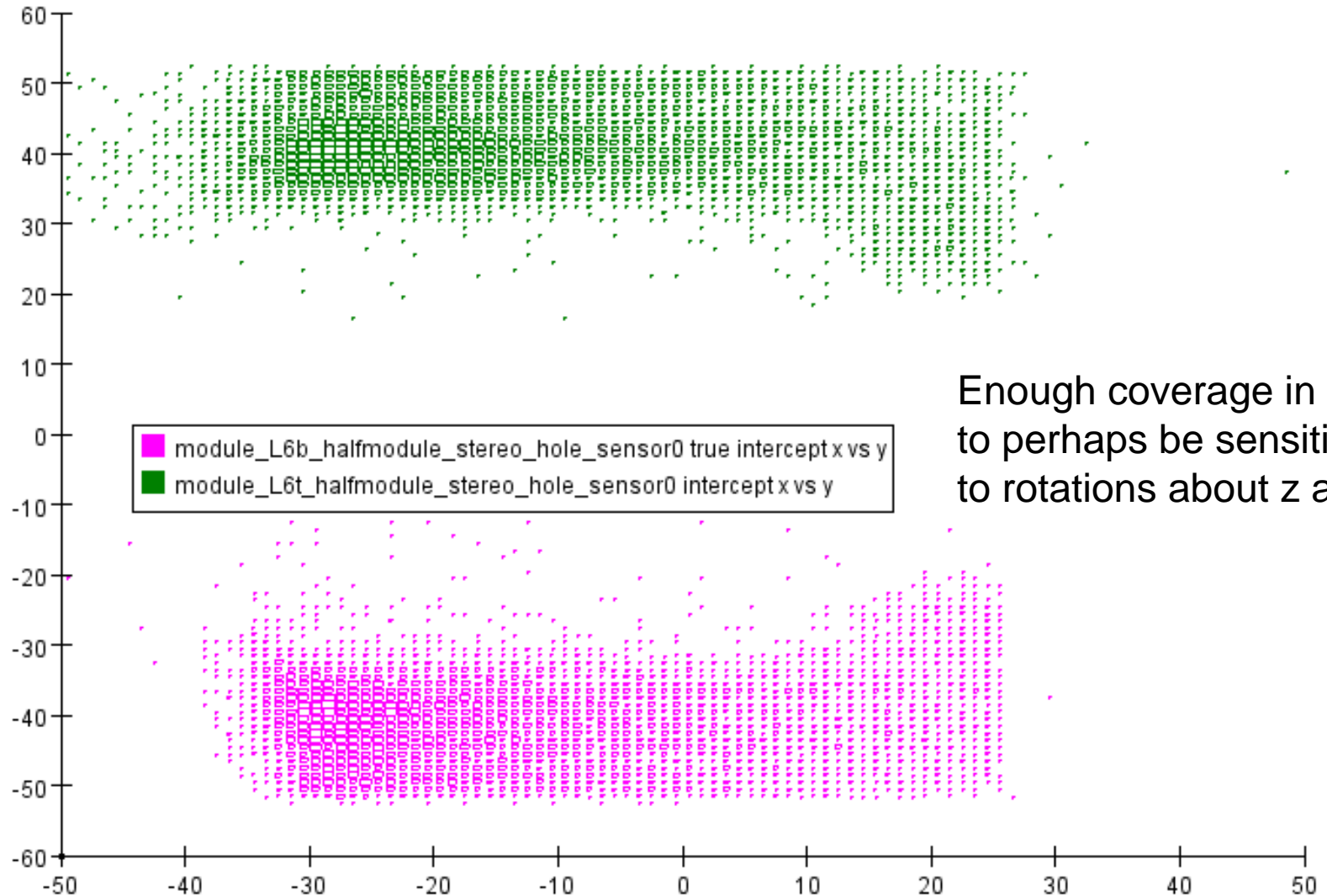
HPS SVT Meeting, 08/24/15

# Alignment Strategy

- Start simple
- Skim off clean FEE events
  - 6 hits on track
  - <20 strip clusters/event
- Fix the “target” position at (-67.23, 0.0, -2337.1)
- Pick one other sensor to fix:
  - L4t\_hole\_sensor0
  - L4b\_hole\_sensor0
- Fit straight line to target position and L4 strip hits
- Derive “true” strip residuals for remaining sensors with respect to this line

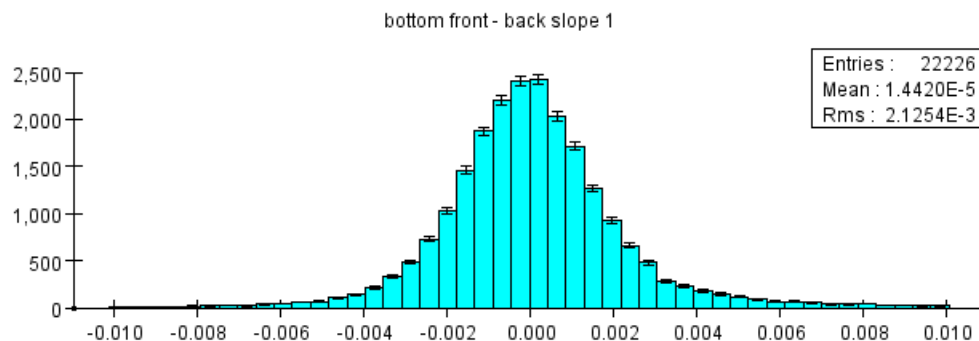
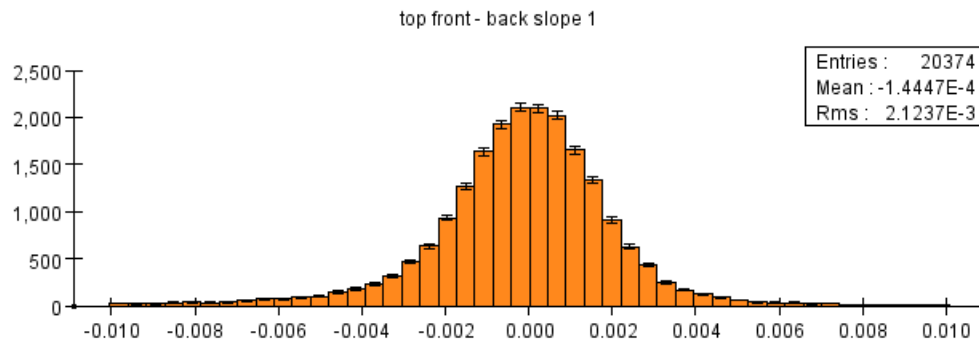
# Track Coverage in Layer 6 Axial

module\_L6b\_halfmodule\_stereo\_hole\_sensor0 true intercept x vs y - module\_L6t\_halfmodule\_stereo\_hole\_sensor0 interc...



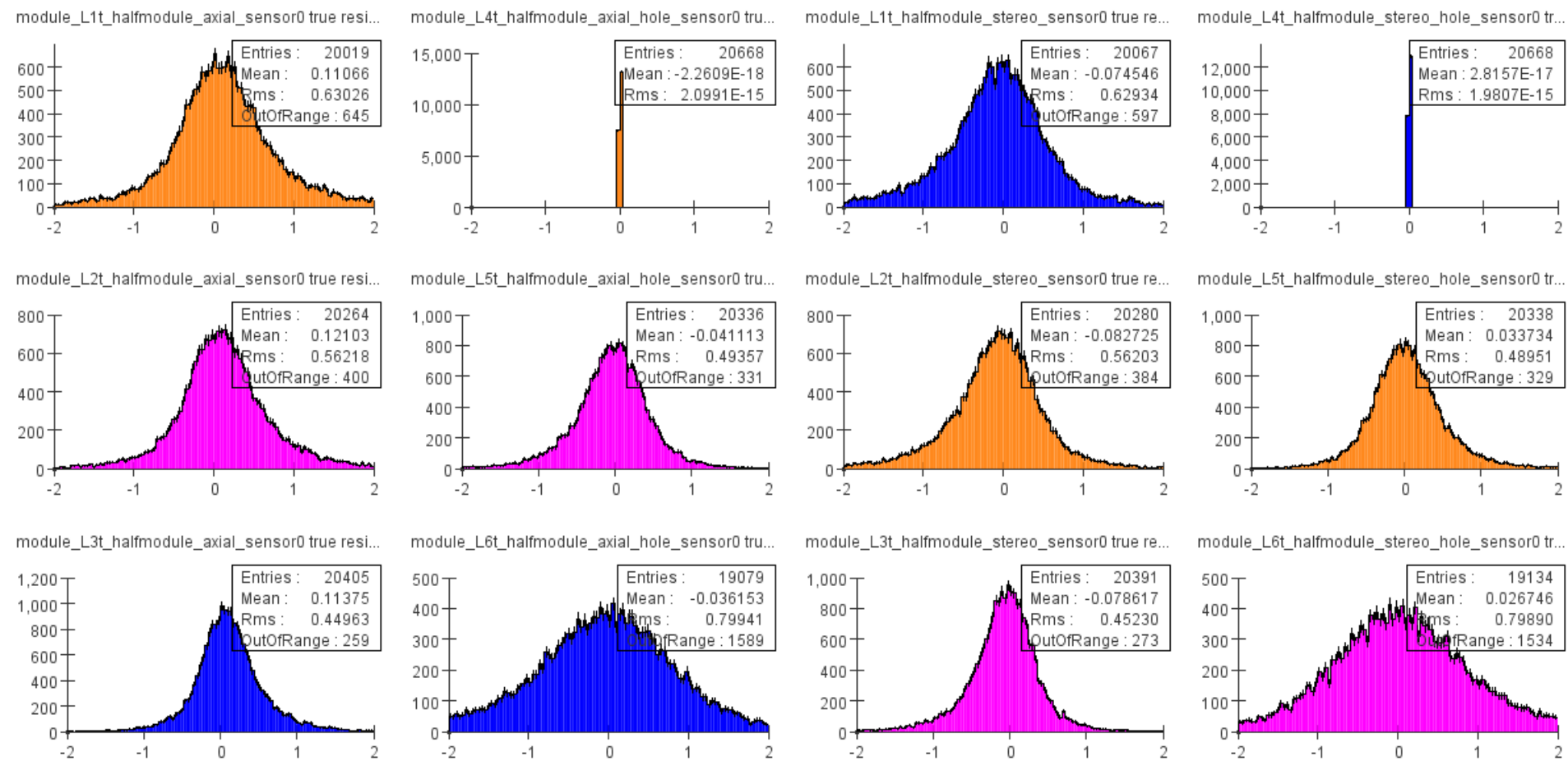
# Check for remaining opening angle

- Compare slope computed from layer 1,2,3 (front) to that computed from 4,5,6 (back)

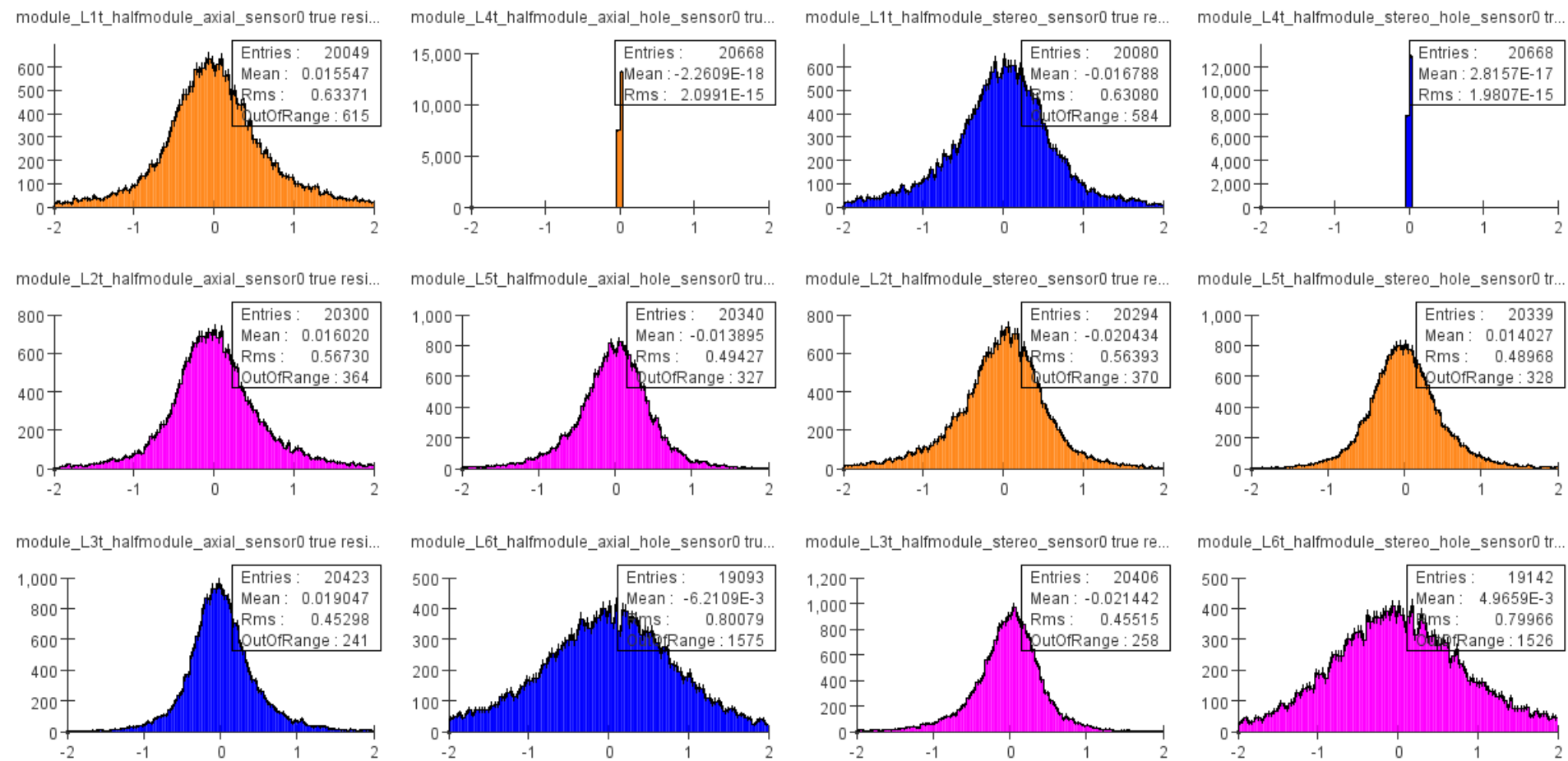


surprisingly good agreement

# Top “true” residuals (axial / stereo)

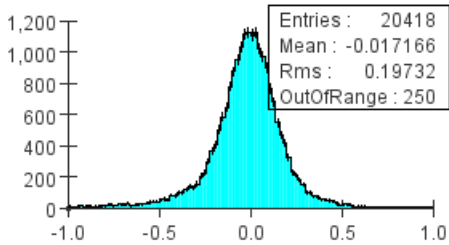


# Adjust sensors by residual offsets

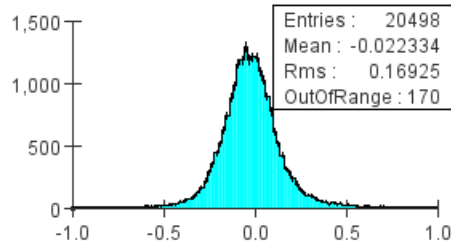


# Top Residuals axial / stereo (before)

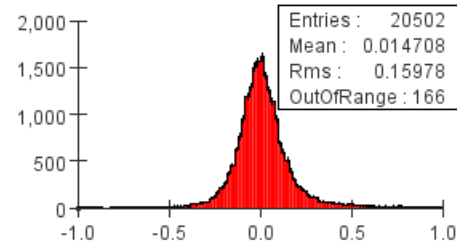
module\_L1t\_halfmodule\_axial\_sensor0 residuals



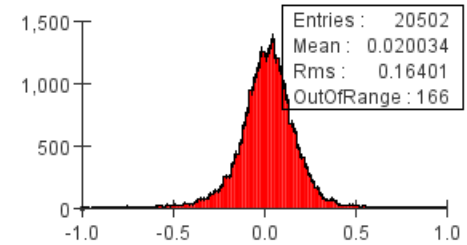
module\_L4t\_halfmodule\_axial\_hole\_sensor0 re...



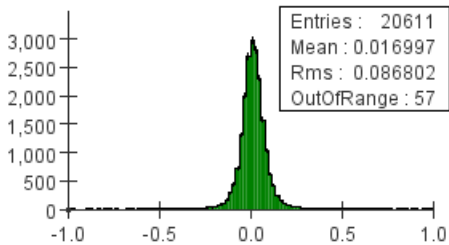
module\_L1t\_halfmodule\_stereo\_sensor0 residu...



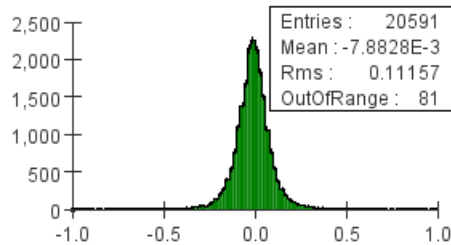
module\_L4t\_halfmodule\_stereo\_hole\_sensor0 r...



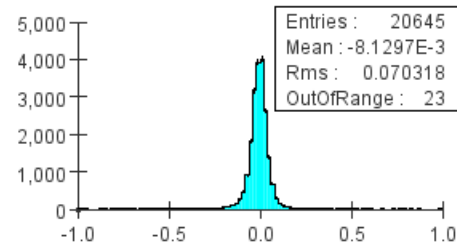
module\_L2t\_halfmodule\_axial\_sensor0 residuals



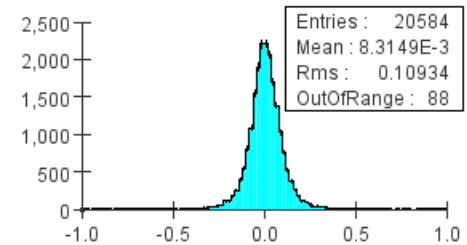
module\_L5t\_halfmodule\_axial\_hole\_sensor0 re...



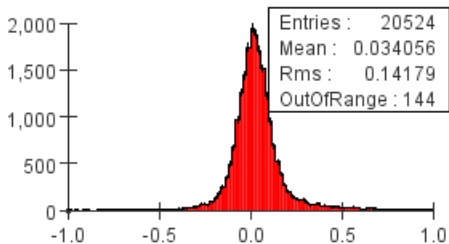
module\_L2t\_halfmodule\_stereo\_sensor0 residu...



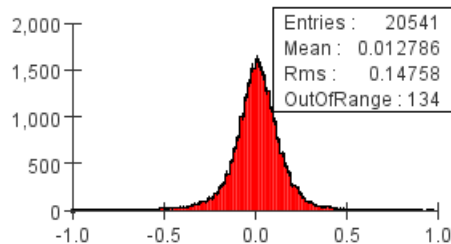
module\_L5t\_halfmodule\_stereo\_hole\_sensor0 r...



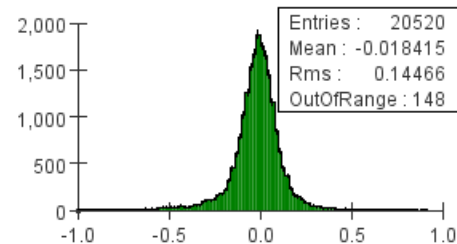
module\_L3t\_halfmodule\_axial\_sensor0 residuals



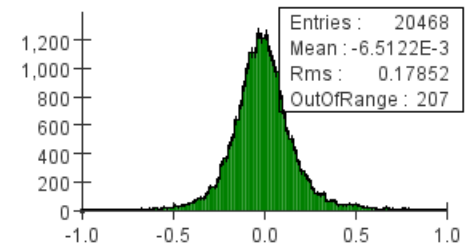
module\_L6t\_halfmodule\_axial\_hole\_sensor0 re...



module\_L3t\_halfmodule\_stereo\_sensor0 residu...

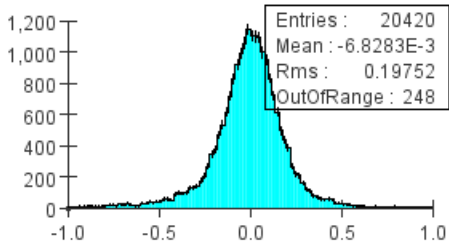


module\_L6t\_halfmodule\_stereo\_hole\_sensor0 r...

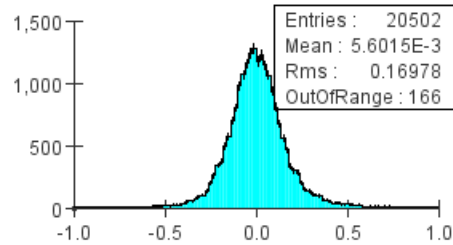


# Top Residuals axial stereo ( after )

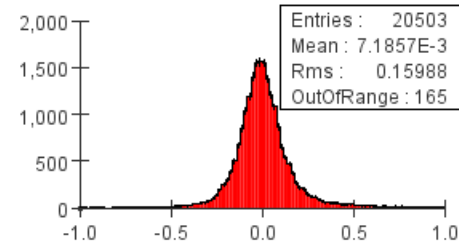
module\_L1t\_halfmodule\_axial\_sensor0 residuals



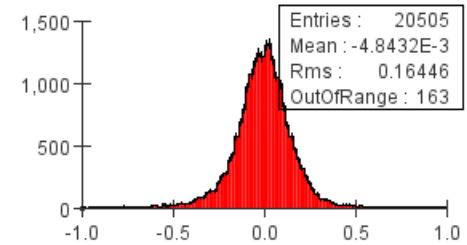
module\_L4t\_halfmodule\_axial\_hole\_sensor0 re...



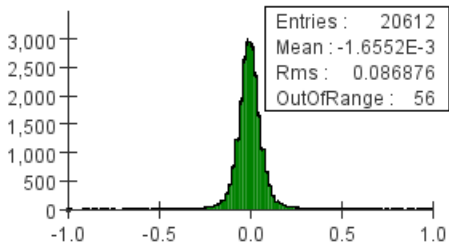
module\_L1t\_halfmodule\_stereo\_sensor0 residu...



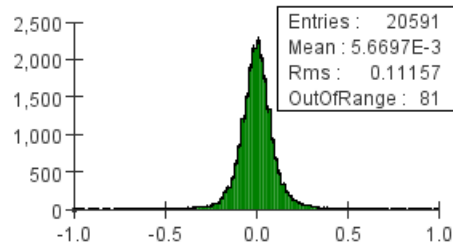
module\_L4t\_halfmodule\_stereo\_hole\_sensor0 r...



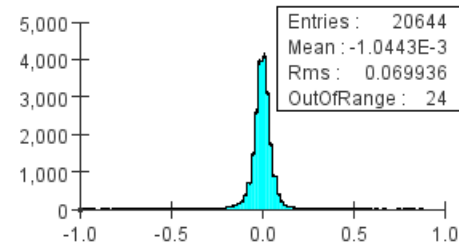
module\_L2t\_halfmodule\_axial\_sensor0 residuals



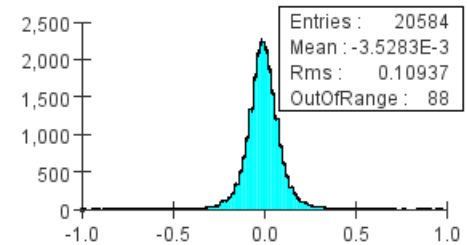
module\_L5t\_halfmodule\_axial\_hole\_sensor0 re...



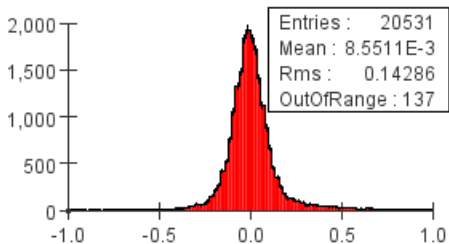
module\_L2t\_halfmodule\_stereo\_sensor0 residu...



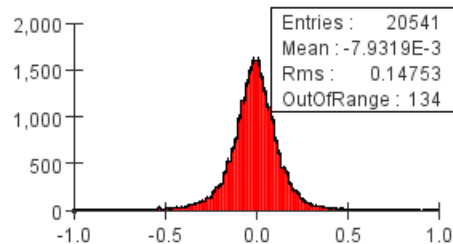
module\_L5t\_halfmodule\_stereo\_hole\_sensor0 r...



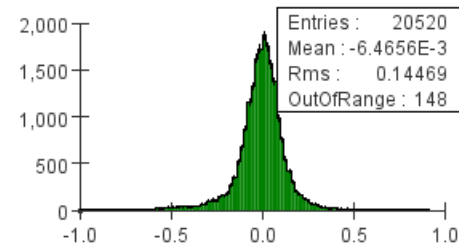
module\_L3t\_halfmodule\_axial\_sensor0 residuals



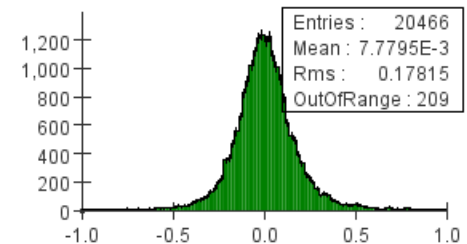
module\_L6t\_halfmodule\_axial\_hole\_sensor0 re...



module\_L3t\_halfmodule\_stereo\_sensor0 residu...

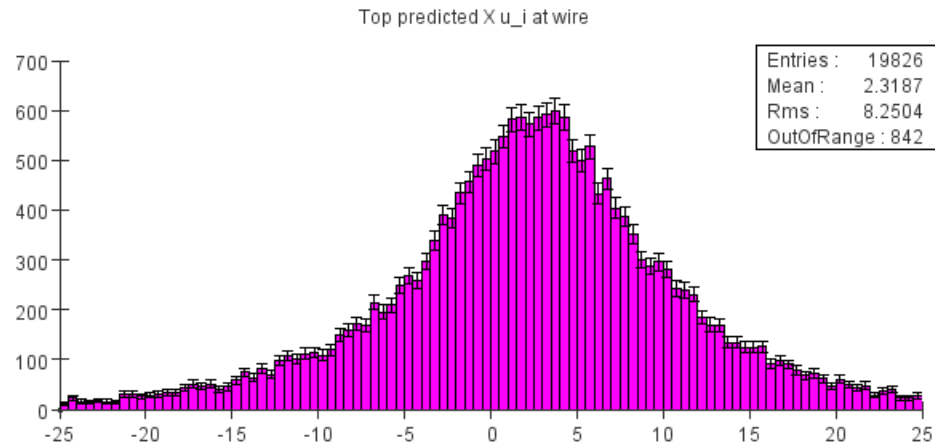


module\_L6t\_halfmodule\_stereo\_hole\_sensor0 r...

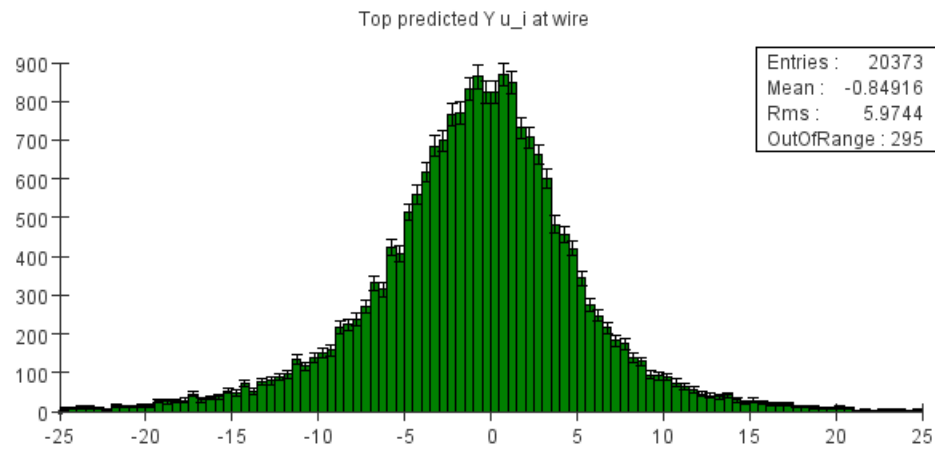




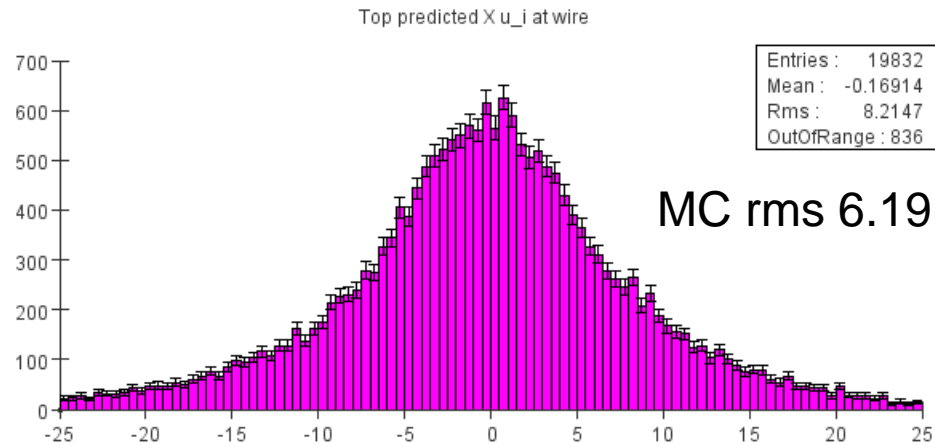
# Fit tracks and predict target position



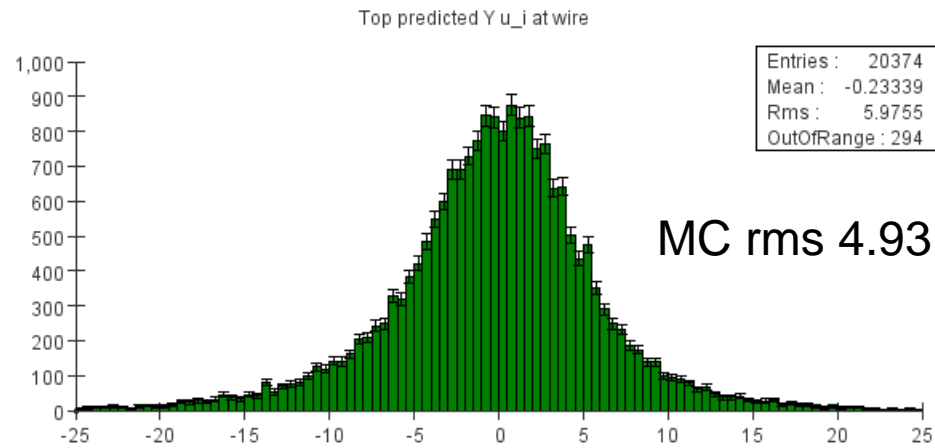
Before



# Fit tracks and predict target position

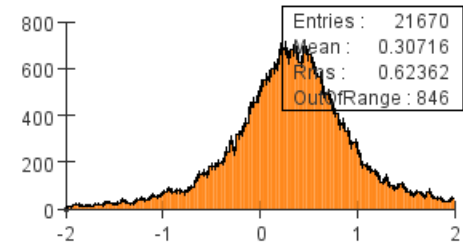


After

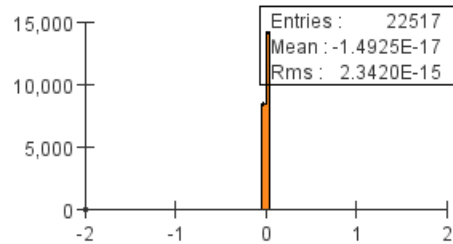


# Bottom “true” residuals (axial/stereo)

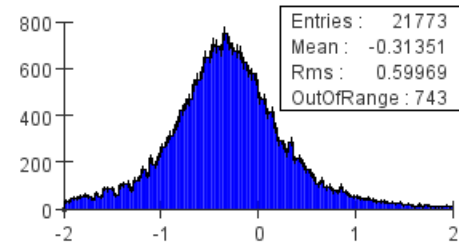
module\_L1b\_halfmodule\_axial\_sensor0 true res...



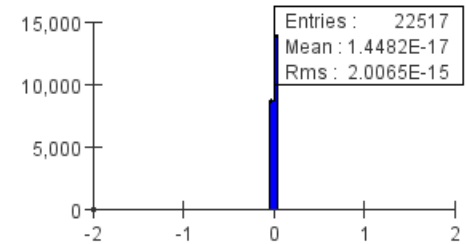
module\_L4b\_halfmodule\_axial\_hole\_sensor0 tr...



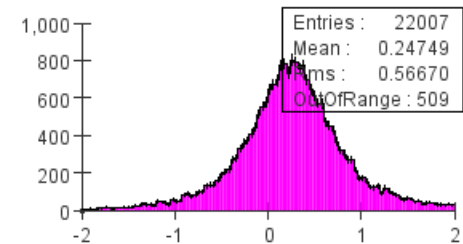
module\_L1b\_halfmodule\_stereo\_sensor0 true r...



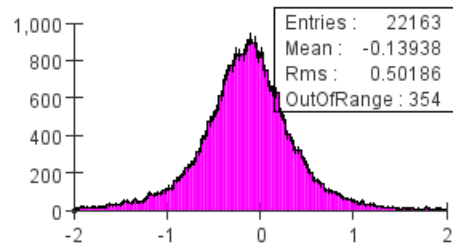
module\_L4b\_halfmodule\_stereo\_hole\_sensor0 t...



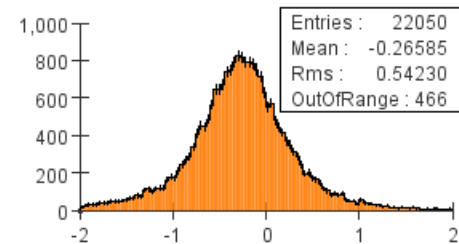
module\_L2b\_halfmodule\_axial\_sensor0 true res...



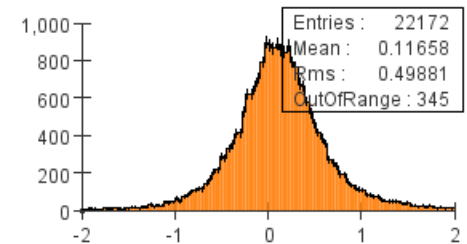
module\_L5b\_halfmodule\_axial\_hole\_sensor0 tr...



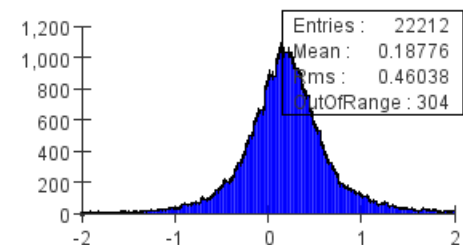
module\_L2b\_halfmodule\_stereo\_sensor0 true r...



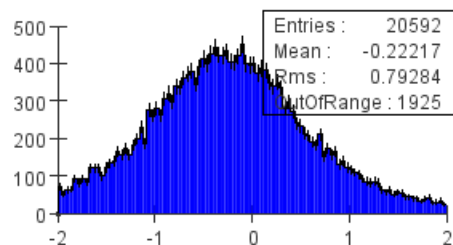
module\_L5b\_halfmodule\_stereo\_hole\_sensor0 t...



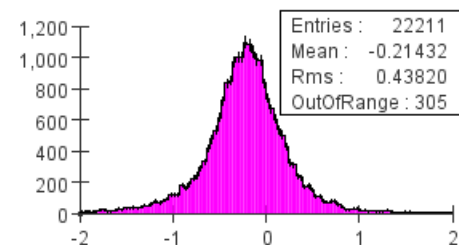
module\_L3b\_halfmodule\_axial\_sensor0 true res...



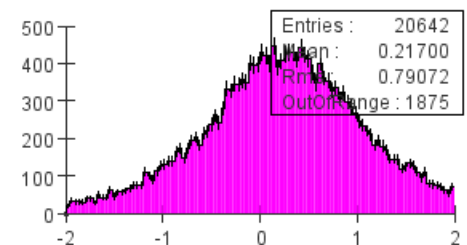
module\_L6b\_halfmodule\_axial\_hole\_sensor0 tr...



module\_L3b\_halfmodule\_stereo\_sensor0 true r...

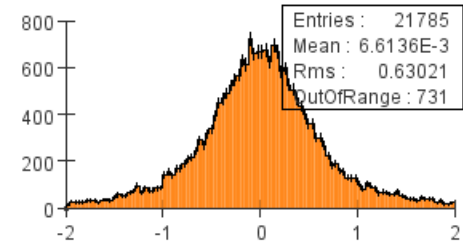


module\_L6b\_halfmodule\_stereo\_hole\_sensor0 t...

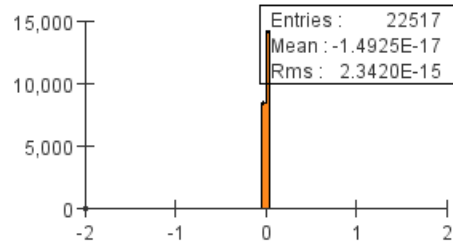


# Adjust sensors by residual offsets

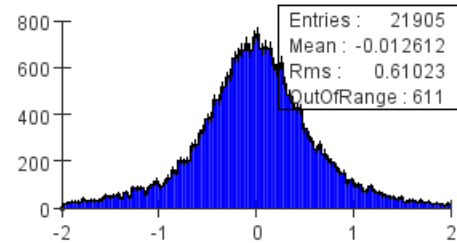
module\_L1b\_halfmodule\_axial\_sensor0 true res...



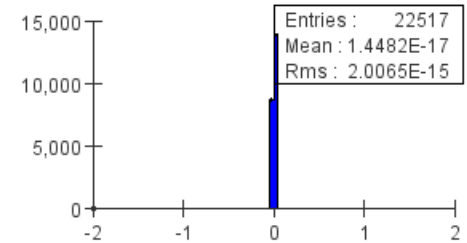
module\_L4b\_halfmodule\_axial\_hole\_sensor0 tr...



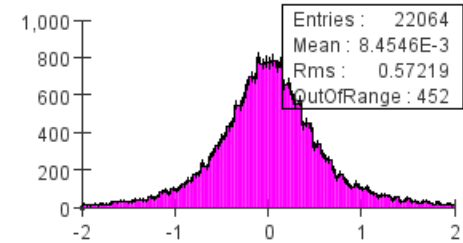
module\_L1b\_halfmodule\_stereo\_sensor0 true r...



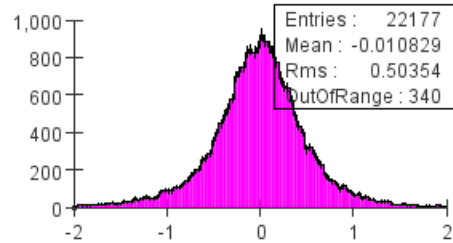
module\_L4b\_halfmodule\_stereo\_hole\_sensor0 t...



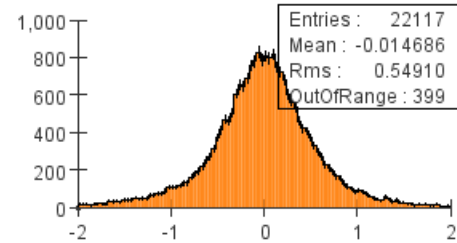
module\_L2b\_halfmodule\_axial\_sensor0 true res...



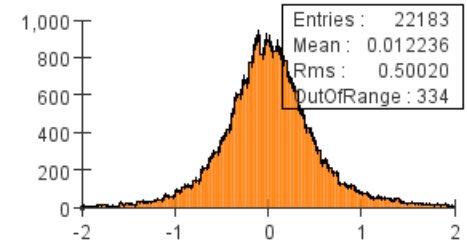
module\_L5b\_halfmodule\_axial\_hole\_sensor0 tr...



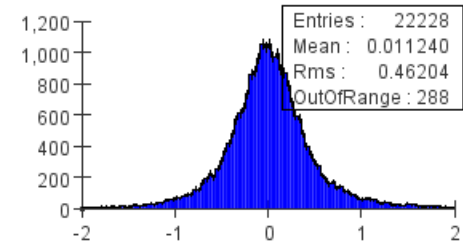
module\_L2b\_halfmodule\_stereo\_sensor0 true r...



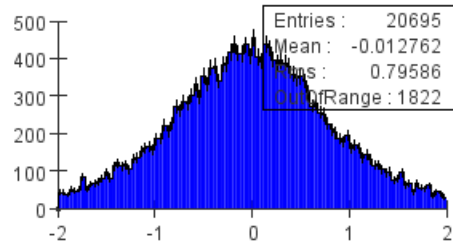
module\_L5b\_halfmodule\_stereo\_hole\_sensor0 t...



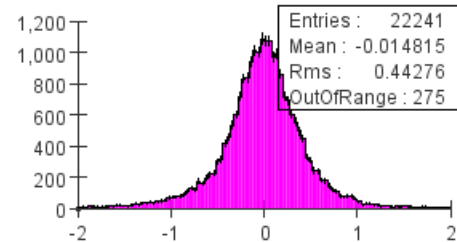
module\_L3b\_halfmodule\_axial\_sensor0 true res...



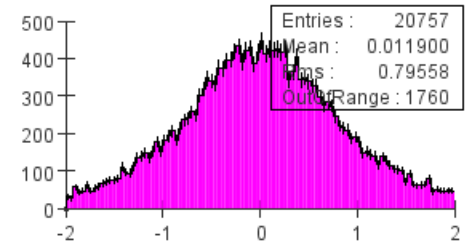
module\_L6b\_halfmodule\_axial\_hole\_sensor0 tr...



module\_L3b\_halfmodule\_stereo\_sensor0 true r...

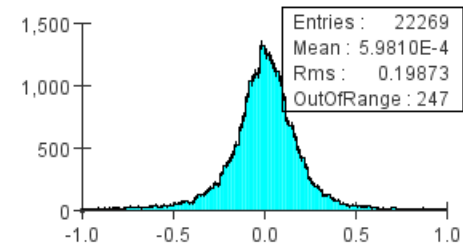


module\_L6b\_halfmodule\_stereo\_hole\_sensor0 t...

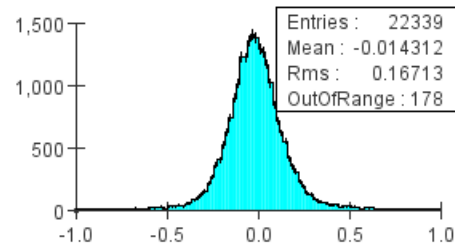


# Bottom Residuals axial/stereo (before)

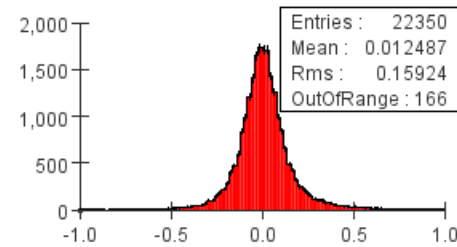
module\_L1b\_halfmodule\_axial\_sensor0 residuals



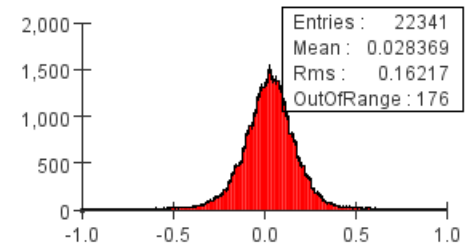
module\_L4b\_halfmodule\_axial\_hole\_sensor0 re...



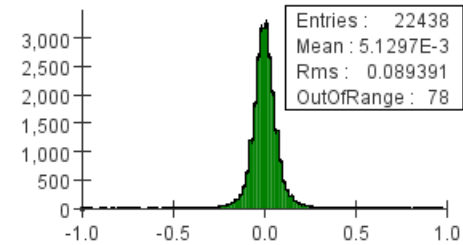
module\_L1b\_halfmodule\_stereo\_sensor0 resid...



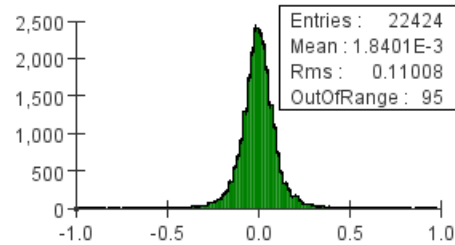
module\_L4b\_halfmodule\_stereo\_hole\_sensor0 re...



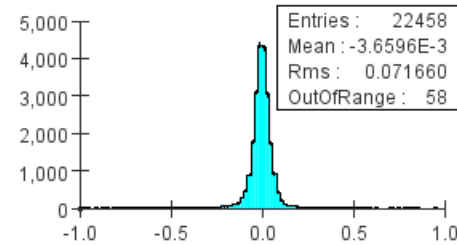
module\_L2b\_halfmodule\_axial\_sensor0 residuals



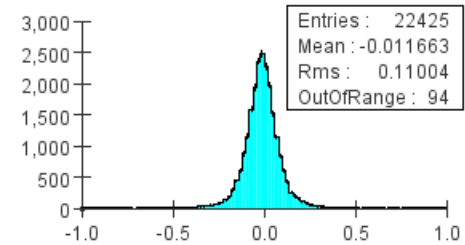
module\_L5b\_halfmodule\_axial\_hole\_sensor0 re...



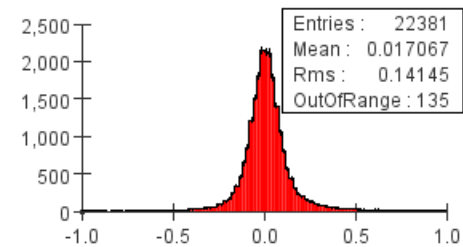
module\_L2b\_halfmodule\_stereo\_sensor0 resid...



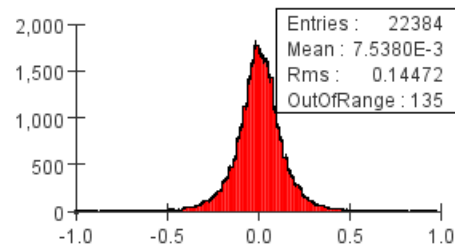
module\_L5b\_halfmodule\_stereo\_hole\_sensor0 re...



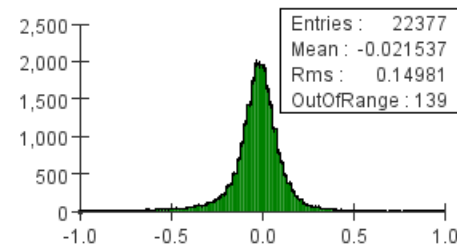
module\_L3b\_halfmodule\_axial\_sensor0 residuals



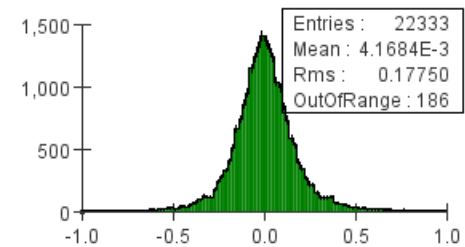
module\_L6b\_halfmodule\_axial\_hole\_sensor0 re...



module\_L3b\_halfmodule\_stereo\_sensor0 resid...

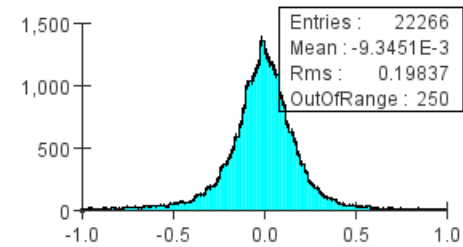


module\_L6b\_halfmodule\_stereo\_hole\_sensor0 re...

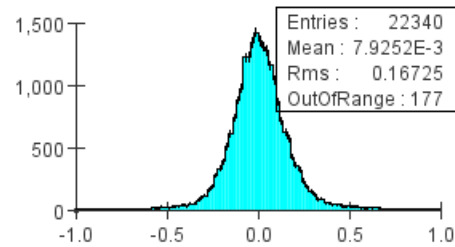


# Bottom Residuals axial/stereo (after)

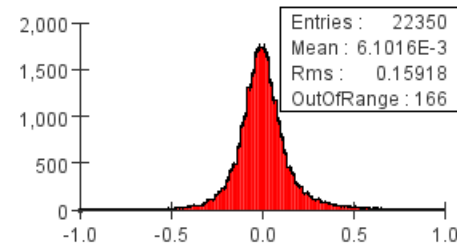
module\_L1b\_halfmodule\_axial\_sensor0 residuals



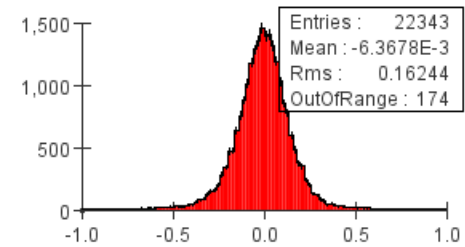
module\_L4b\_halfmodule\_axial\_hole\_sensor0 re...



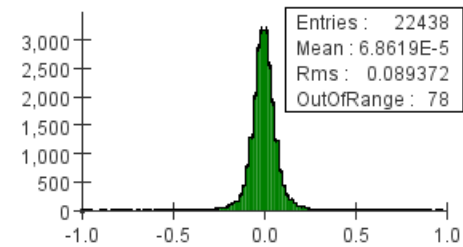
module\_L1b\_halfmodule\_stereo\_sensor0 resid...



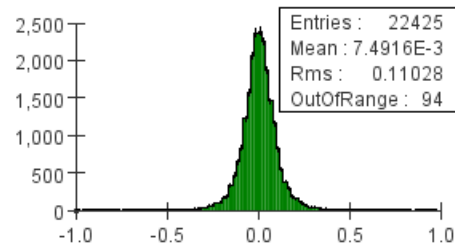
module\_L4b\_halfmodule\_stereo\_hole\_sensor0 re...



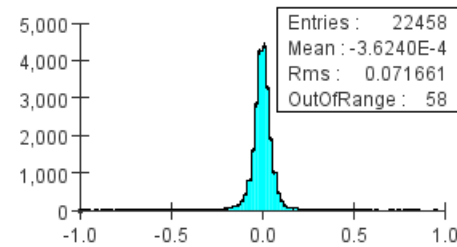
module\_L2b\_halfmodule\_axial\_sensor0 residuals



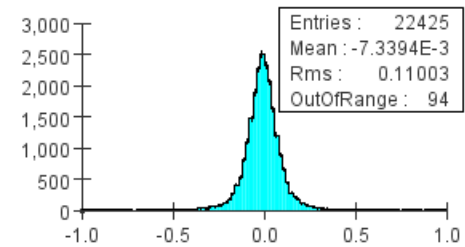
module\_L5b\_halfmodule\_axial\_hole\_sensor0 re...



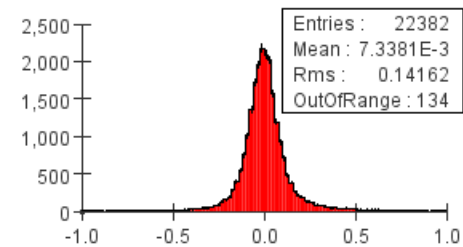
module\_L2b\_halfmodule\_stereo\_sensor0 resid...



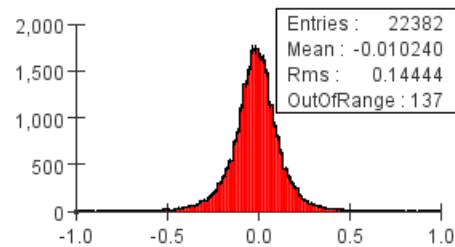
module\_L5b\_halfmodule\_stereo\_hole\_sensor0 re...



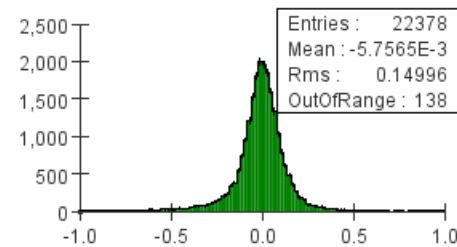
module\_L3b\_halfmodule\_axial\_sensor0 residuals



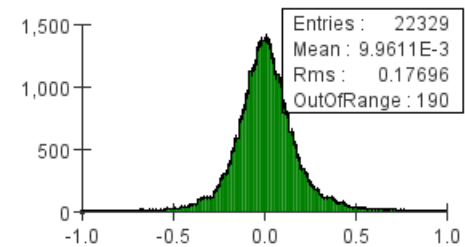
module\_L6b\_halfmodule\_axial\_hole\_sensor0 re...



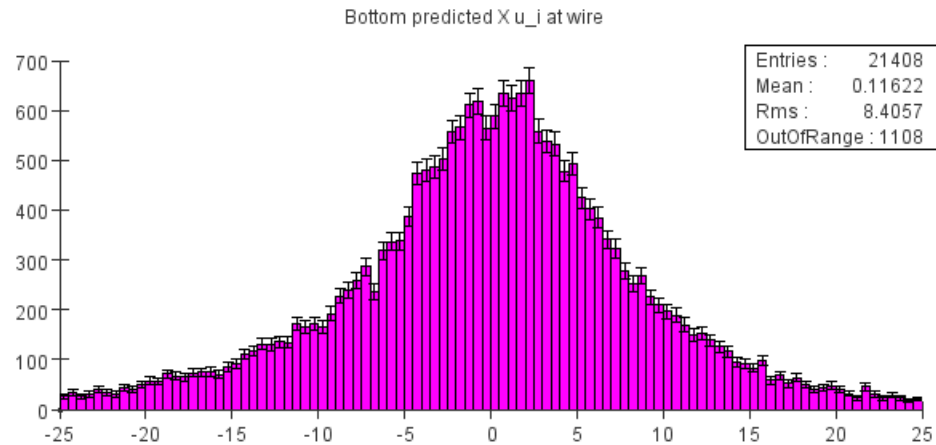
module\_L3b\_halfmodule\_stereo\_sensor0 resid...



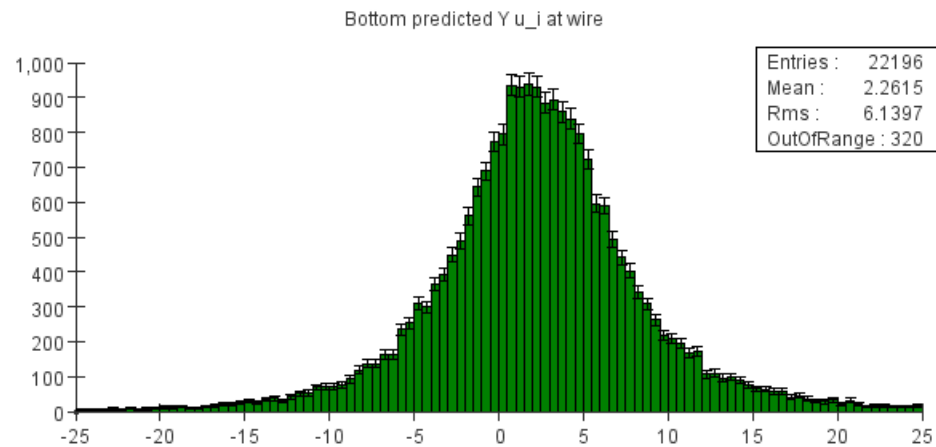
module\_L6b\_halfmodule\_stereo\_hole\_sensor0 re...



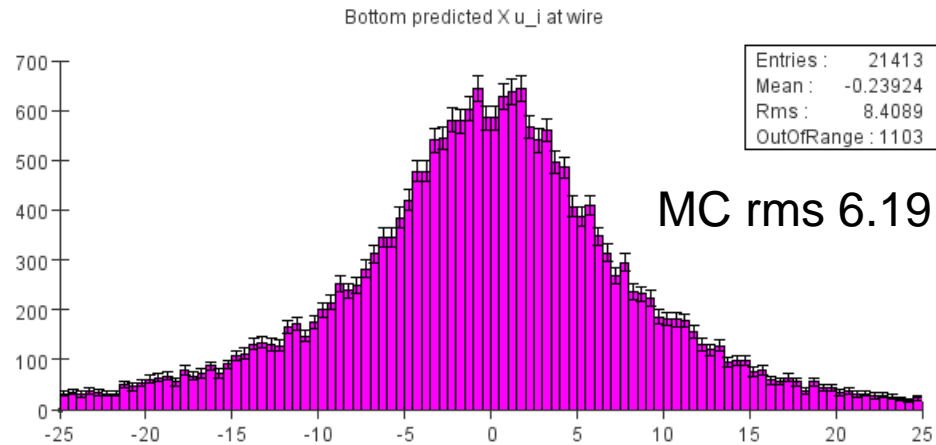
# Fit tracks and predict target position



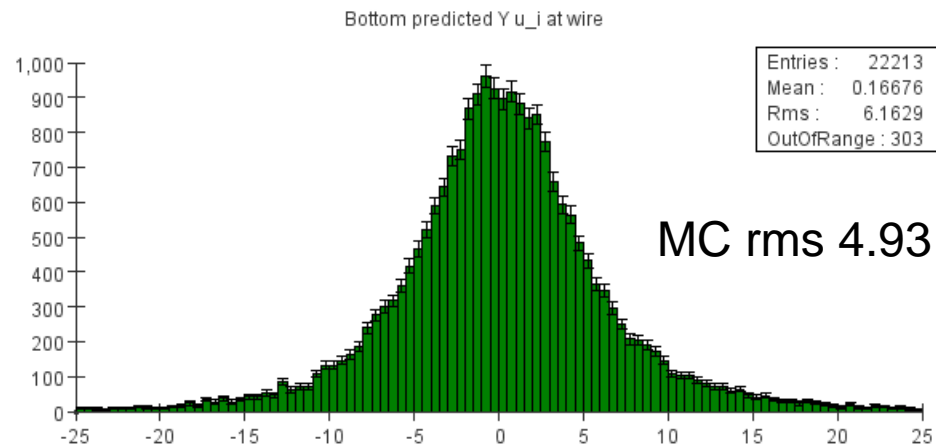
Before



# Fit tracks and predict target position



After





# MC comparisons

- Turn off field in detector

HPS-EngRun2015-Nominal-v2\_fieldOff.lcdd

- Generate single electron events:

```
/generator/select gps
```

```
/gps/particle e-
```

```
/gps/position -67.23 0.0 -2337.1 mm
```

```
/gps/energy 1.056 GeV
```

```
/gps/direction 0.02 0.008 1
```

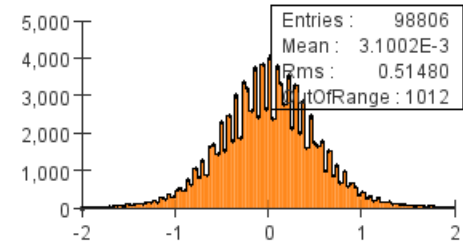
```
/random/setSavingFlag true
```

```
/lcio/fileExists delete
```

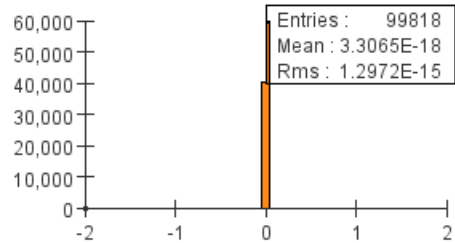
```
/lcio/PDGFlag
```

# MC “true” residuals (axial / stereo)

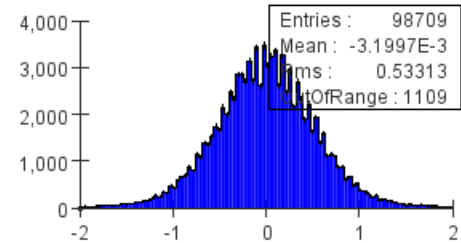
module\_L1t\_halfmodule\_axial\_sensor0 true resi...



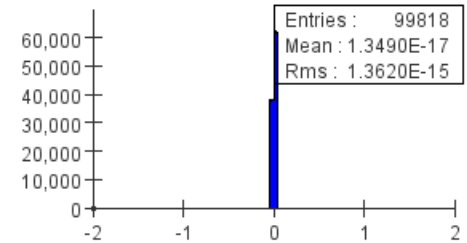
module\_L4t\_halfmodule\_axial\_hole\_sensor0 tru...



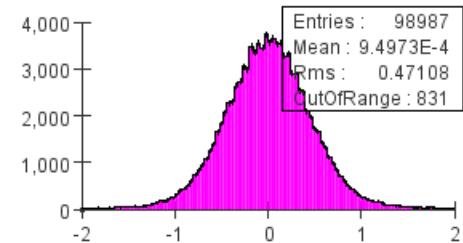
module\_L1t\_halfmodule\_stereo\_sensor0 true re...



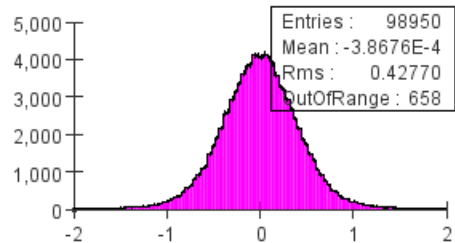
module\_L4t\_halfmodule\_stereo\_hole\_sensor0 tr...



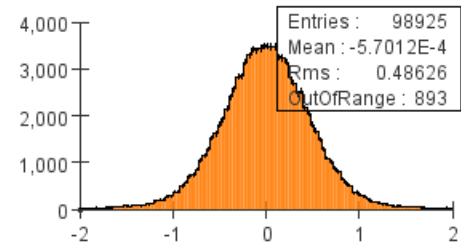
module\_L2t\_halfmodule\_axial\_sensor0 true resi...



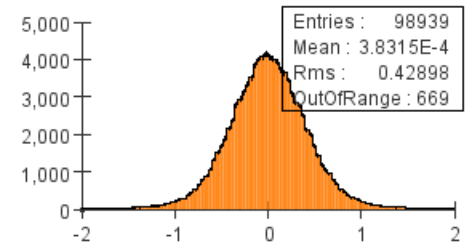
module\_L5t\_halfmodule\_axial\_hole\_sensor0 tru...



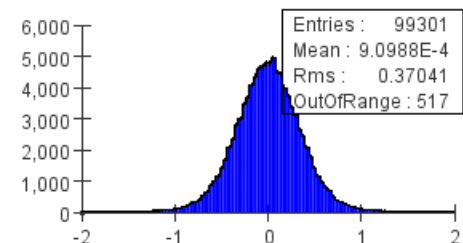
module\_L2t\_halfmodule\_stereo\_sensor0 true re...



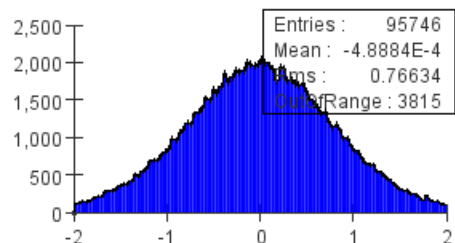
module\_L5t\_halfmodule\_stereo\_hole\_sensor0 tr...



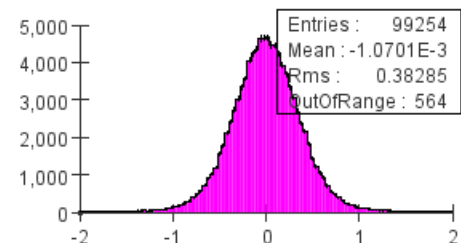
module\_L3t\_halfmodule\_axial\_sensor0 true resi...



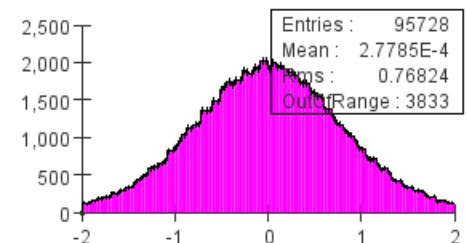
module\_L6t\_halfmodule\_axial\_hole\_sensor0 tru...



module\_L3t\_halfmodule\_stereo\_sensor0 true re...

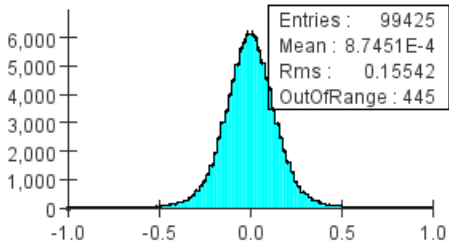


module\_L6t\_halfmodule\_stereo\_hole\_sensor0 tr...

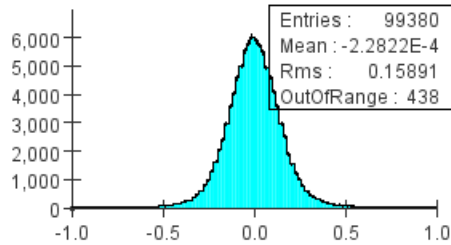


# MC Residuals axial/stereo

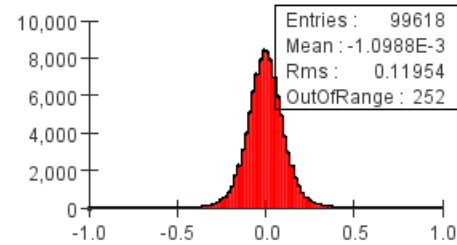
module\_L1t\_halfmodule\_axial\_sensor0 residuals



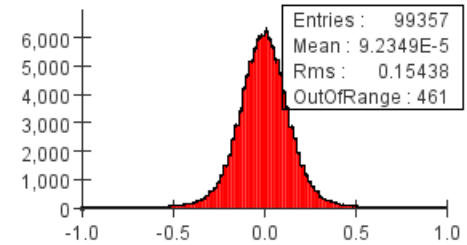
module\_L4t\_halfmodule\_axial\_hole\_sensor0 re...



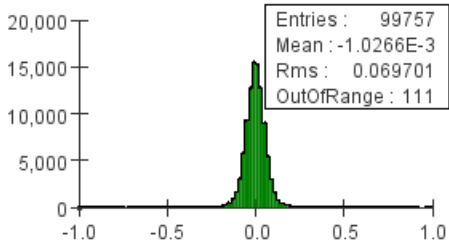
module\_L1t\_halfmodule\_stereo\_sensor0 residu...



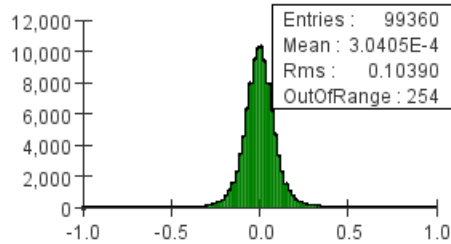
module\_L4t\_halfmodule\_stereo\_hole\_sensor0 r...



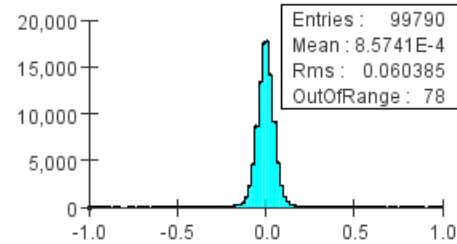
module\_L2t\_halfmodule\_axial\_sensor0 residuals



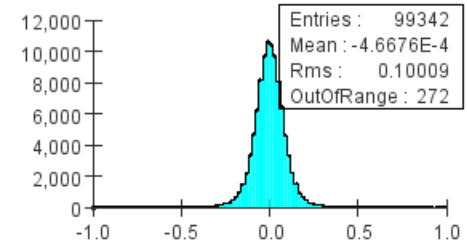
module\_L5t\_halfmodule\_axial\_hole\_sensor0 re...



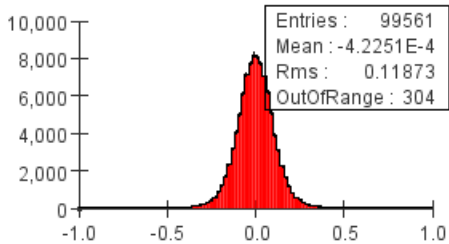
module\_L2t\_halfmodule\_stereo\_sensor0 residu...



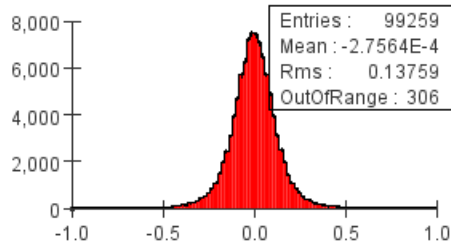
module\_L5t\_halfmodule\_stereo\_hole\_sensor0 r...



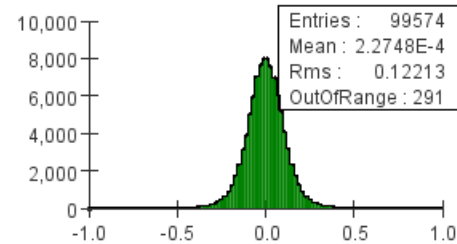
module\_L3t\_halfmodule\_axial\_sensor0 residuals



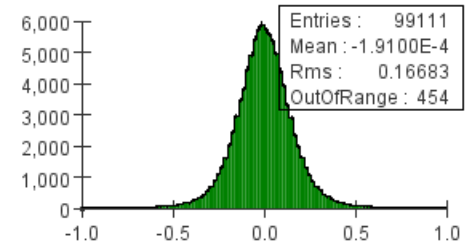
module\_L6t\_halfmodule\_axial\_hole\_sensor0 re...



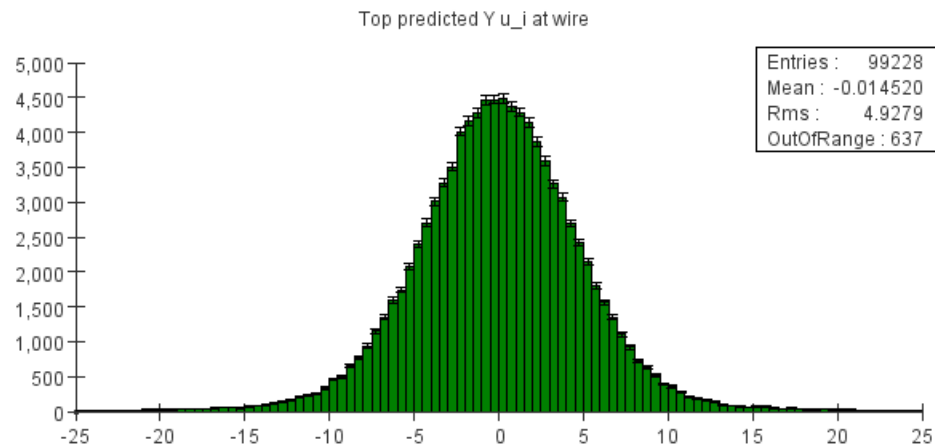
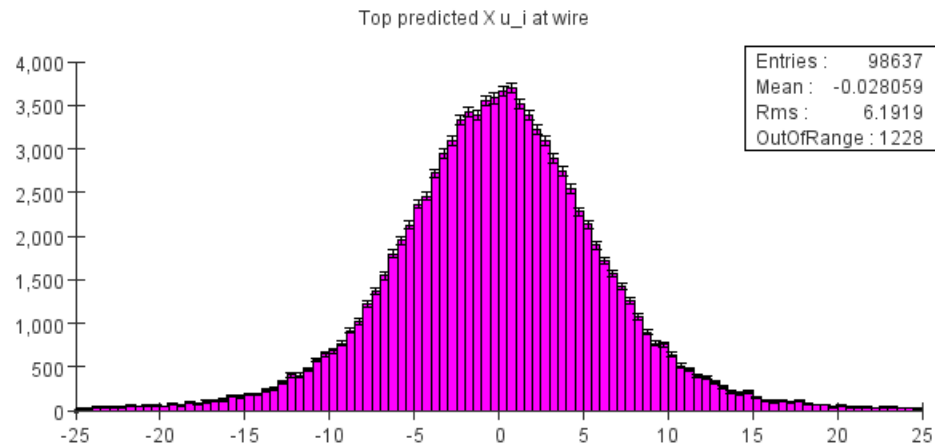
module\_L3t\_halfmodule\_stereo\_sensor0 residu...



module\_L6t\_halfmodule\_stereo\_hole\_sensor0 r...



# MC predict target position



# Current Corrections axial stereo

■ L1t	0.103	-0.063
■ L2t	0.111	-0.066
■ L3t	0.097	-0.059
■ L4t_hole	0.	0.
■ L4t_slot	0.	0.
■ L5t_hole	-0.028	0.020
■ L5t_slot	0.	0.
■ L6t_hole	-0.036	0.027
■ L6t_slot	0.	0.

consistent with  
translation of  
all three layers ?

# Current Corrections axial stereo

■ L1b	0.332	-0.327
■ L2b	0.252	-0.264
■ L3b	0.182	-0.204
■ L4b_hole	0.	0.
■ L4b_slot	0.	0.
■ L5b_hole	-0.133	0.108
■ L5b_slot	0.	0.
■ L6b_hole	-0.259	0.254
■ L6b_slot	0.	0.

consistent with  
rotation of  
all three layers ?

# Next Steps

- Keep it simple
- Chew on the results so far to understand geometry shifts
  - Quantify MC/Data comparisons
- Repeat analyses fixing other stations
- Try to understand axial/stereo shifts by constraining stations, not individual sensors
- Implement least-squares fitting for
  - translation  $\perp$  to strip direction
  - rotation about z axis ( $\gamma$ )
  - Keep it simple (don't reinvent millepede)
- Put some of the shifts into detector description
  - Run some field-on Fee events
    - check momentum and  $\chi^2$
  - Run some field-on Møller events
    - check vertex position and mass
- Finish by Friday (?)