Study of mp best geometries on straight tracks (run 5784)

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Straight tracks study

- Start from v4.4 geo on 2016 data with no field
- Study on run 5784 (11 stubs), about 20000 reconstructed tracks, 10 hrs run for the reconstructions
  - Now set up to run at slac (about 3 hrs)

- Alignment situation with nominal v1 geometry: bad
- Alignment situation with v4.4 (good for curved tracks): disaster
  - Mean values of u residuals as large as 8 microns (to be compared with < 0.8 microns at most for curved tracks) -> one order of magnitude larger
  - Sigmas: about 50% larger for straight tracks
- Try to apply a sequence of MP minimizations to improve the residual trends

- Strategy:
  - Keep stereo sensors fixed (in general)
  - Float u translations and w rotations for axial layers only
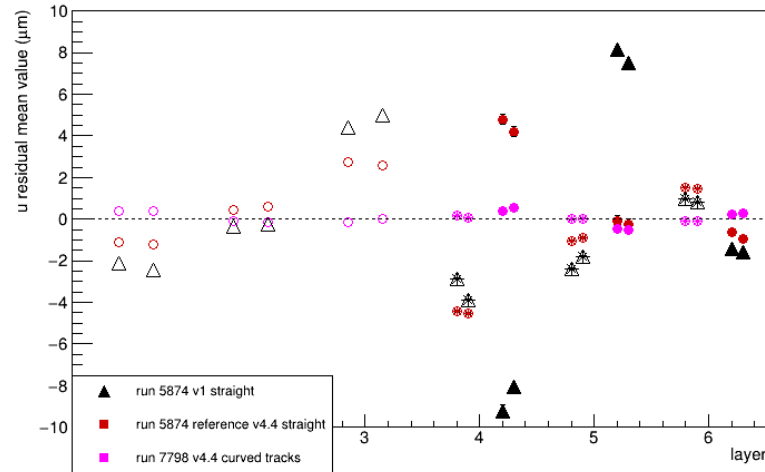- Compare the outputs of a few new geometries

Curved vs straight comparison
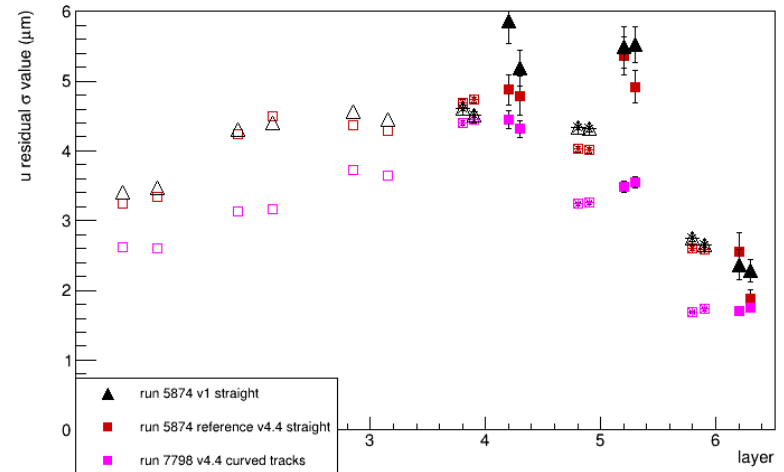
Purple: best geometry v4.4 for curved tracks
Red: same geometry for straight tracks
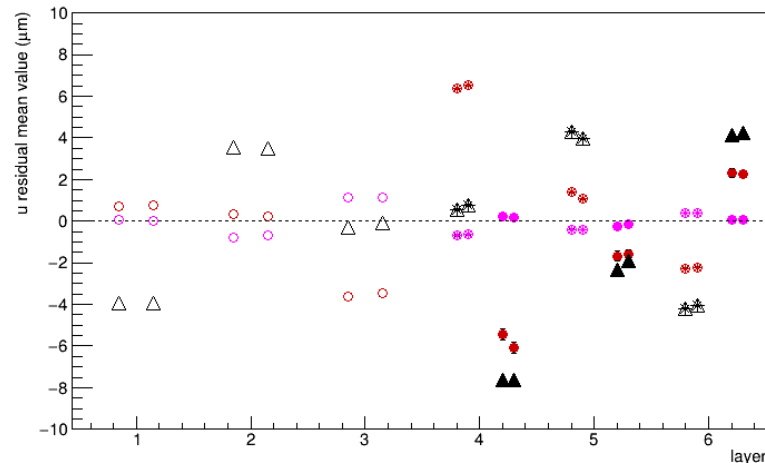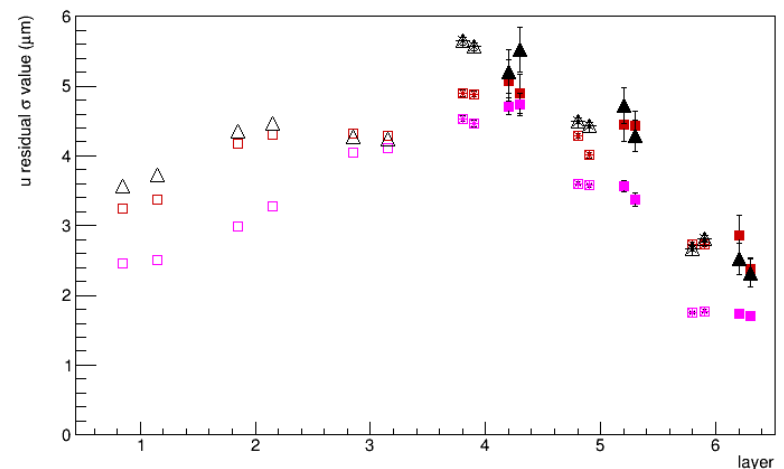Black: nominal geometry for straight tracks

Same geometry: much better u residuals for curved tracks, smaller sigmas
Mostly critical: layers 3+4 (start to float these ones…)

Millepede alignment: tested geometries

- strategies:
  - Start from v4.4 (best geo for curved tracks)
    - Reference: v4.4 with straight tracks
    - dev1 (T&B):
      - Axial 3, u trans + w rot
      - Axial 4 slot+hole, u trans + w rot
      - Then: dev2 (T&B):
        - » Axial 2, u trans + w rot
        - » Axial 5 slot+hole, u trans + w rot
        - » Then dev3 (T&B)
          - Axial 1,4,6 (slot+hole), u trans + w rot
        - » OR dev4 (T&B)
          - Axial+stereo, hole+slot, layer 4, u trans + w rot
  - Start from v1 (nominal + optical survey)
    - Reference: v1 geometry with straight tracks
    - Dev0 (T&B):
      - Same tweaks as v4.4, fixed
      - No other alignment offset
    - dev1 (T&B):
      - Same tweaks as v4.4, fixed
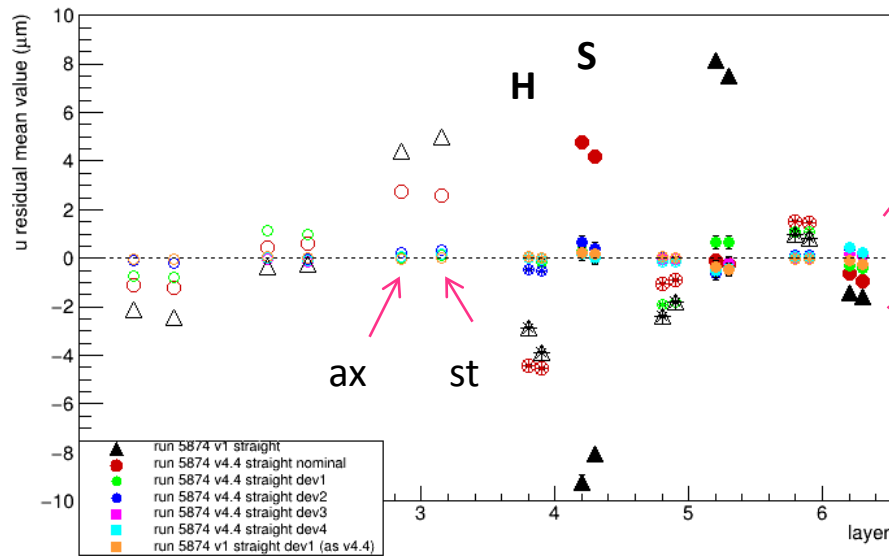   - Same free parameters as v4.4 left floating

V1-dev0 geometry, GBL residuals: very bad

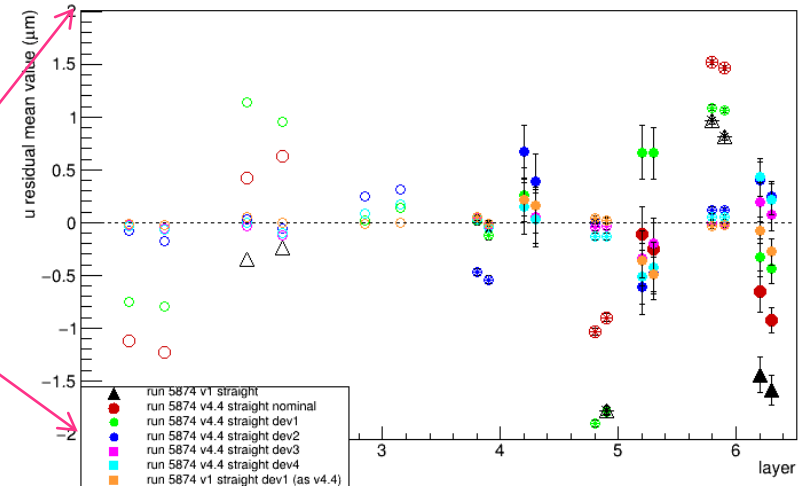Not comparable with other geometries
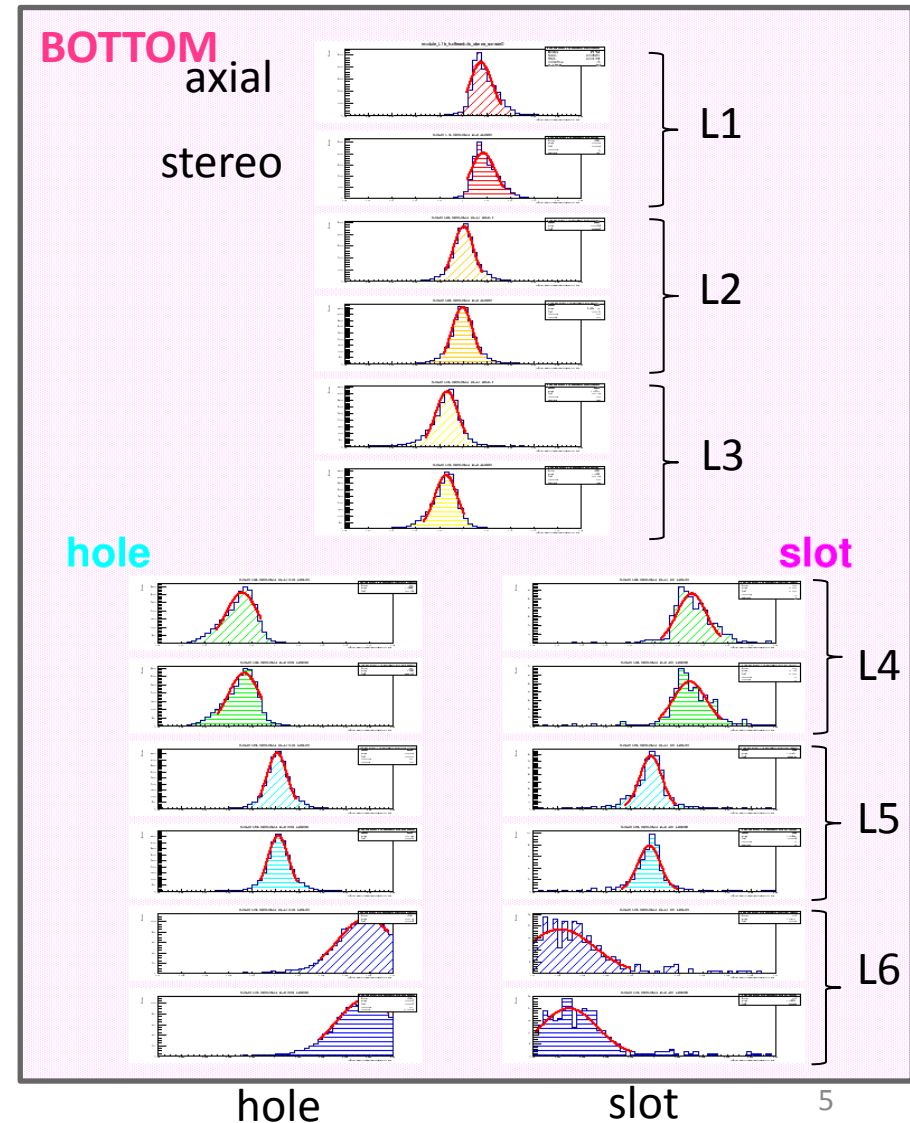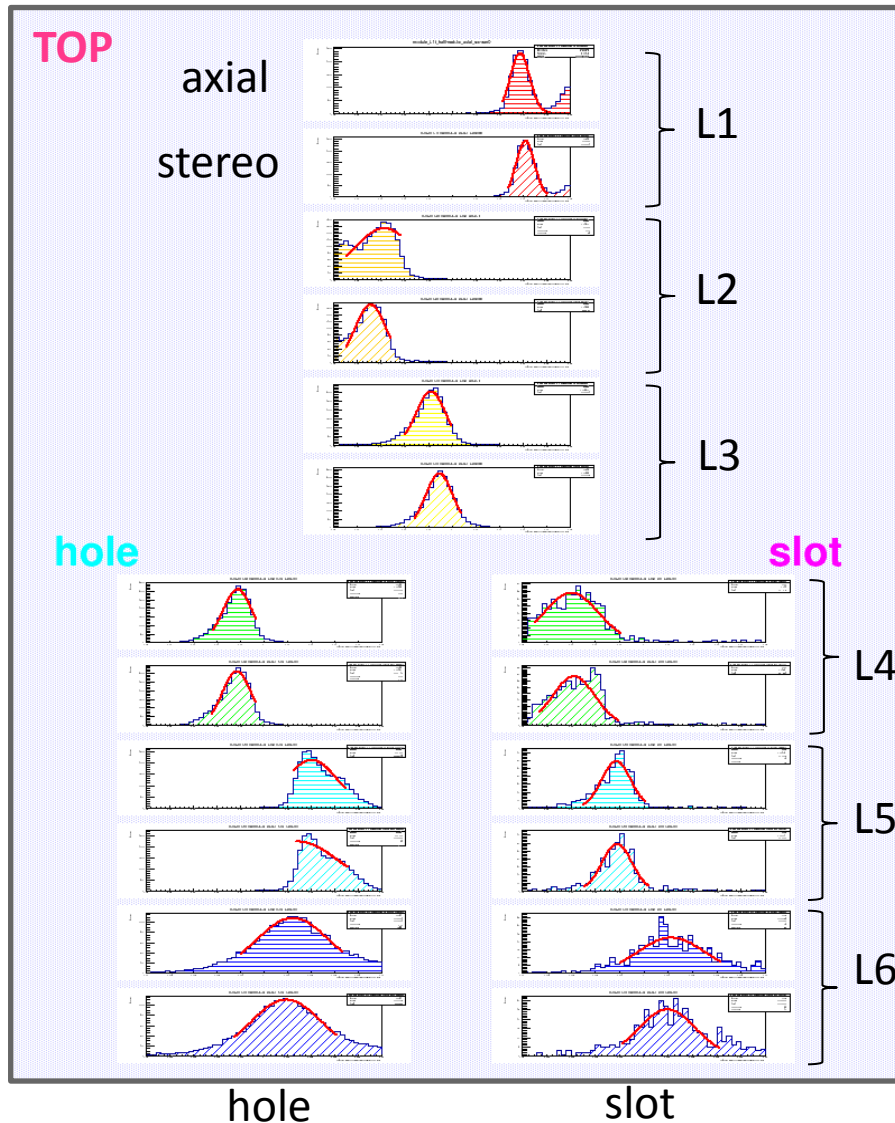
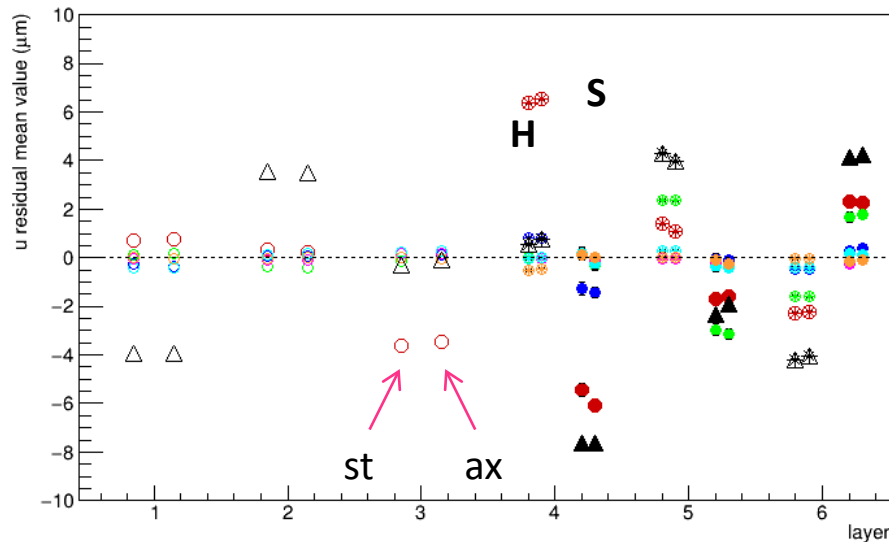# u residuals after GBL, mean

top residuals, mean value (μm)
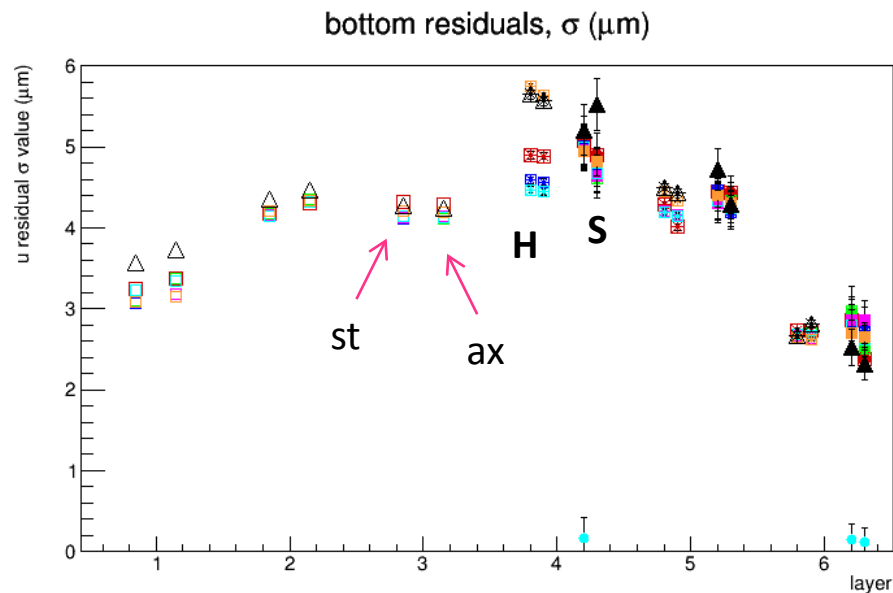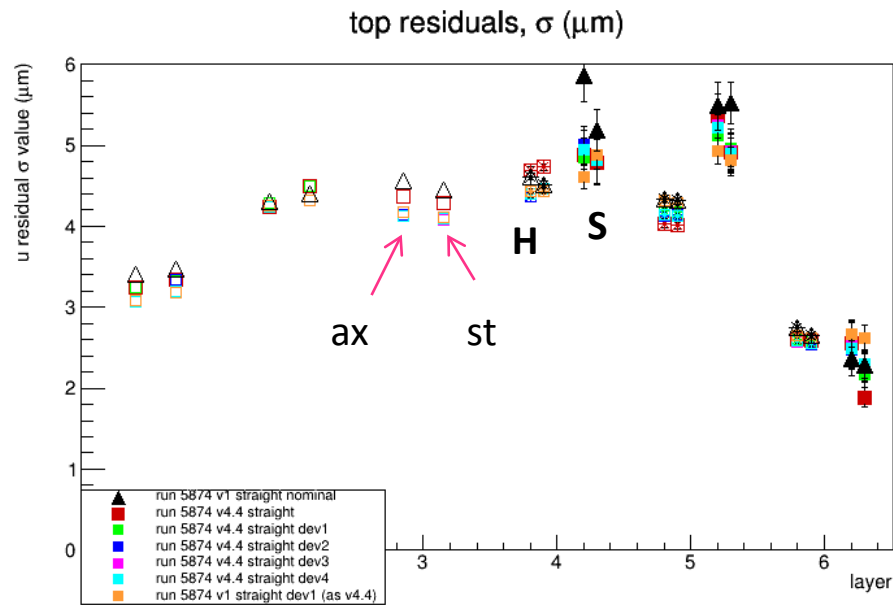

top residuals, mean value (μm)

bottom residuals, mean value (μm)

- Increasing improvement for v4.4 iterations
- Hard to distinguish dev3/dev4
  - Both rely on sensor 4 floating
    - Mostly important
    - dev3 slightly better (?)
- Very good residuals out of v1+tweaks-based alignment

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u residuals after GBL, sigma

top residuals, σ (μm)

bottom residuals, σ (μm)

- Improvement harder to be appreciated
- No wild fluctuations observed
- Sigmas mainly depend on data sample contamination (sizeable changes to be observed only on selected tracks)
- Same sort of "parabolic behaviour": smaller sigmas for limiting sensors (1+6), larger for central ones (3+4)

λ kinks, mean

top λ kinks, mean value (mrad)

bottom λ kinks, mean value (mrad)
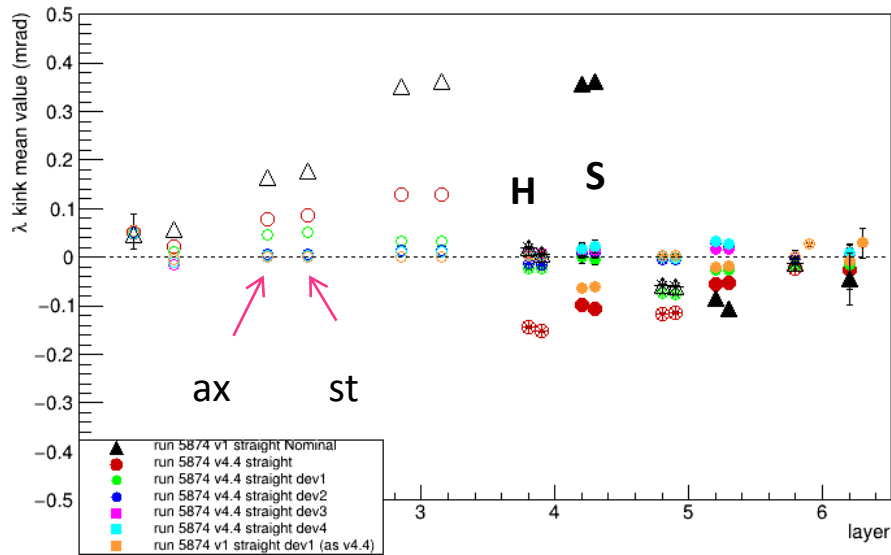
- Same level of precision as compared to curved tracks (<0.3 microns)
- Gradual improvement for the tested iterations
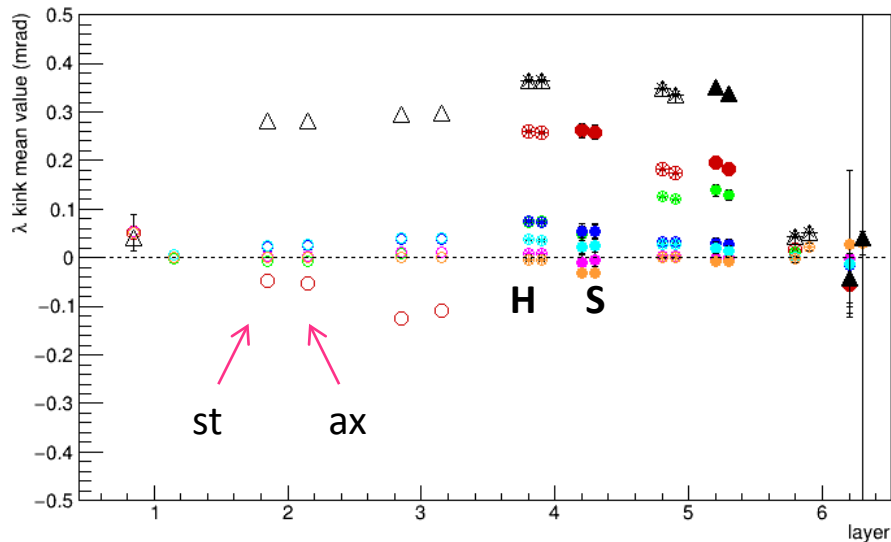
λ kinks, sigmas
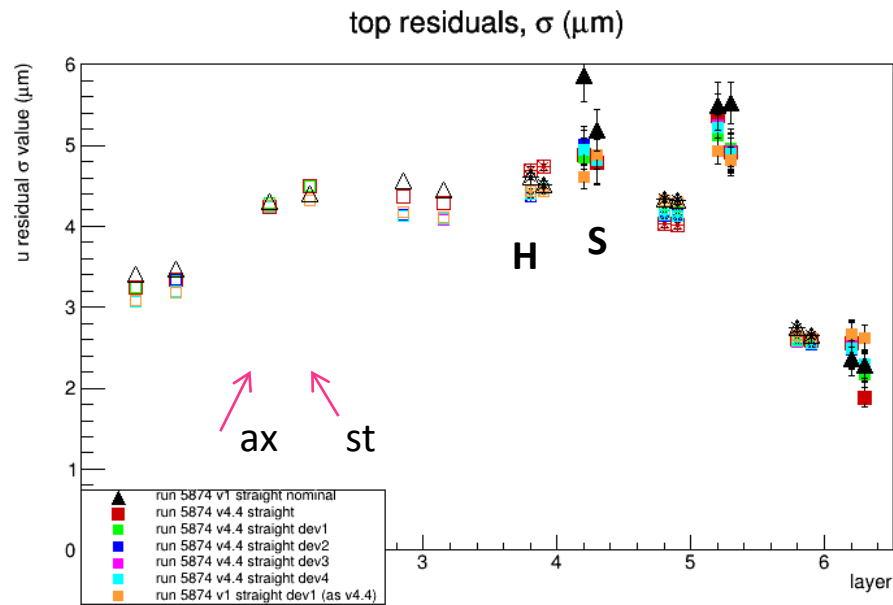
- No sensible difference
- Same level of precision as compared to curved tracks (<0.4 mrad)

φ kinks, mean

top φ kinks, mean value (mrad)

Legend:
- run 5874 v1 straight Nominal
- run 5874 v4.4 straight
- run 5874 v4.4 straight dev1
- run 5874 v4.4 straight dev2
- run 5874 v4.4 straight dev3
- run 5874 v4.4 straight dev4
- run 5874 v1 straight dev1 (as v4.4)
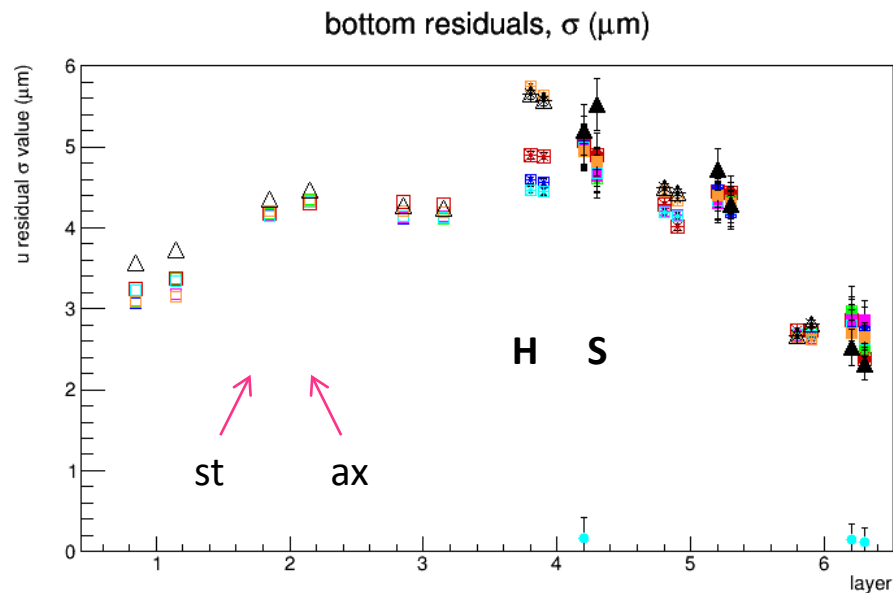
bottom φ kinks, mean value (mrad)
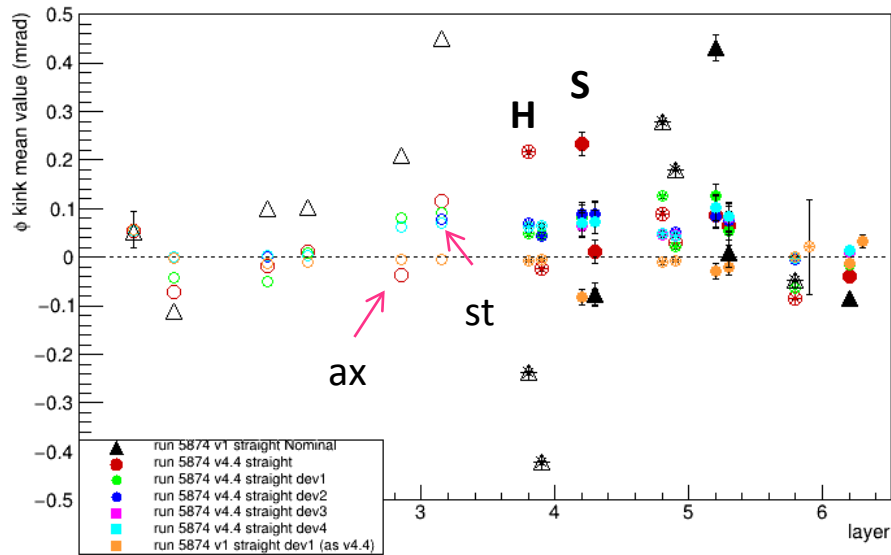
- larger fluctuations
- Precision comparable to curved tracks
- Probably the best geometry is obtained starting from scratch form dev1+tweaks
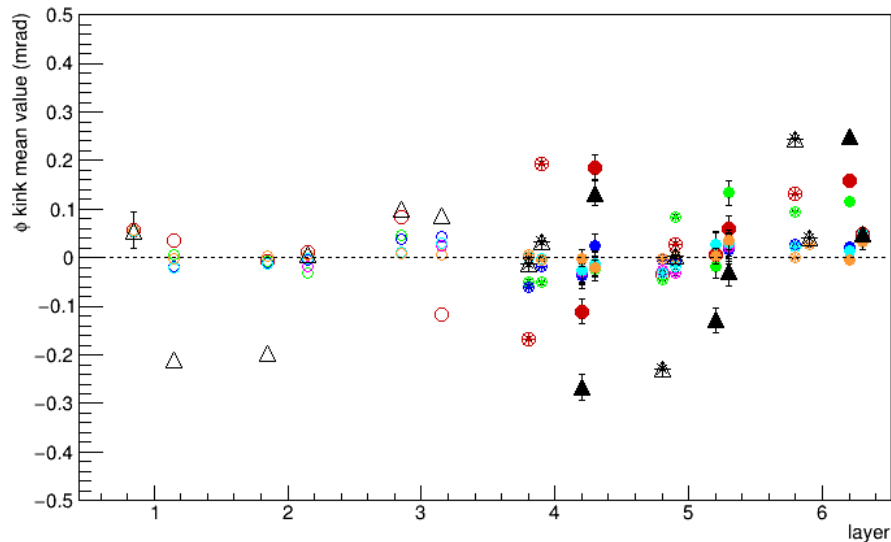
φ kinks, sigma
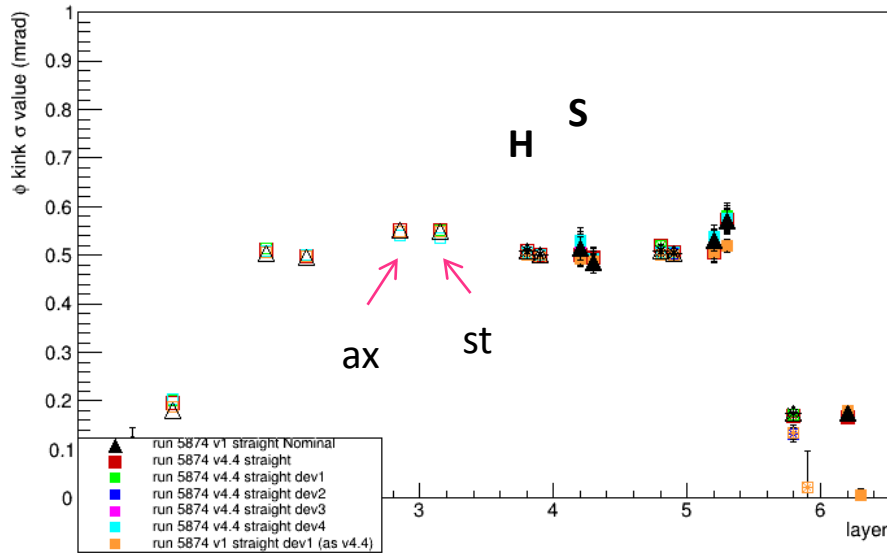
top φ kinks, σ (mrad)
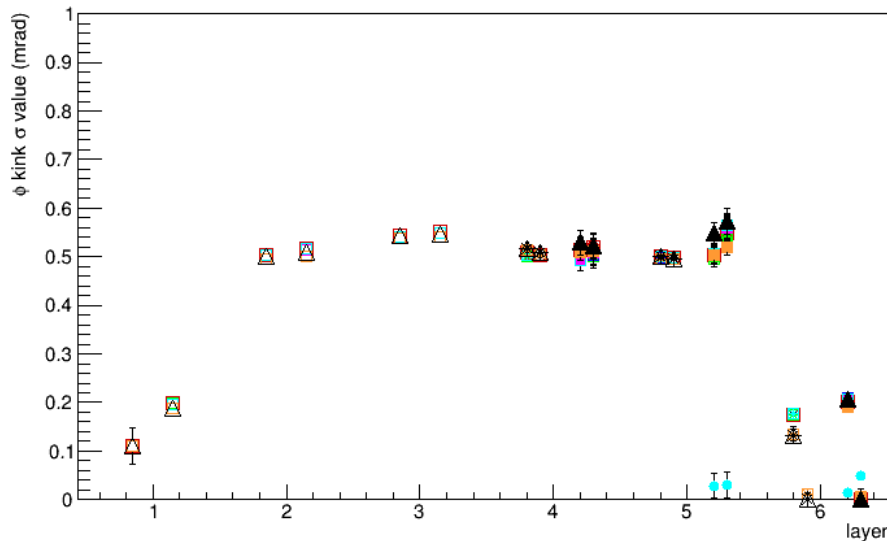
- The alternate behavior smaller sigma/first layer- larger-sigma/second layer disappears
- In this case only the axial sensor is floated, the other follows
    - Moved apart for curved tracks?
    - Almost flat (except 1-6 layers)
- Halfway value (~5 mrad)
- Sign error in the code??

bottom φ kinks, σ (mrad)

top φ kinks, σ (mrad)
bottom φ kinks, σ (mrad)
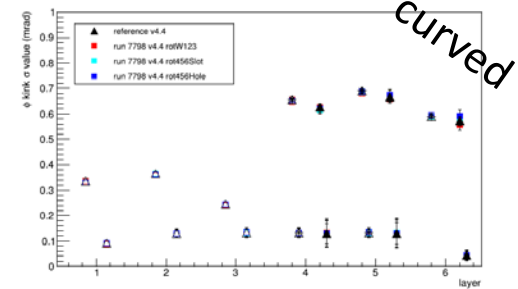
curved
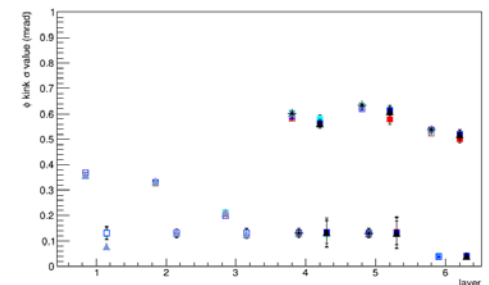
Comparison of MP offsets: TOP

Millepede corrections per sensor, top
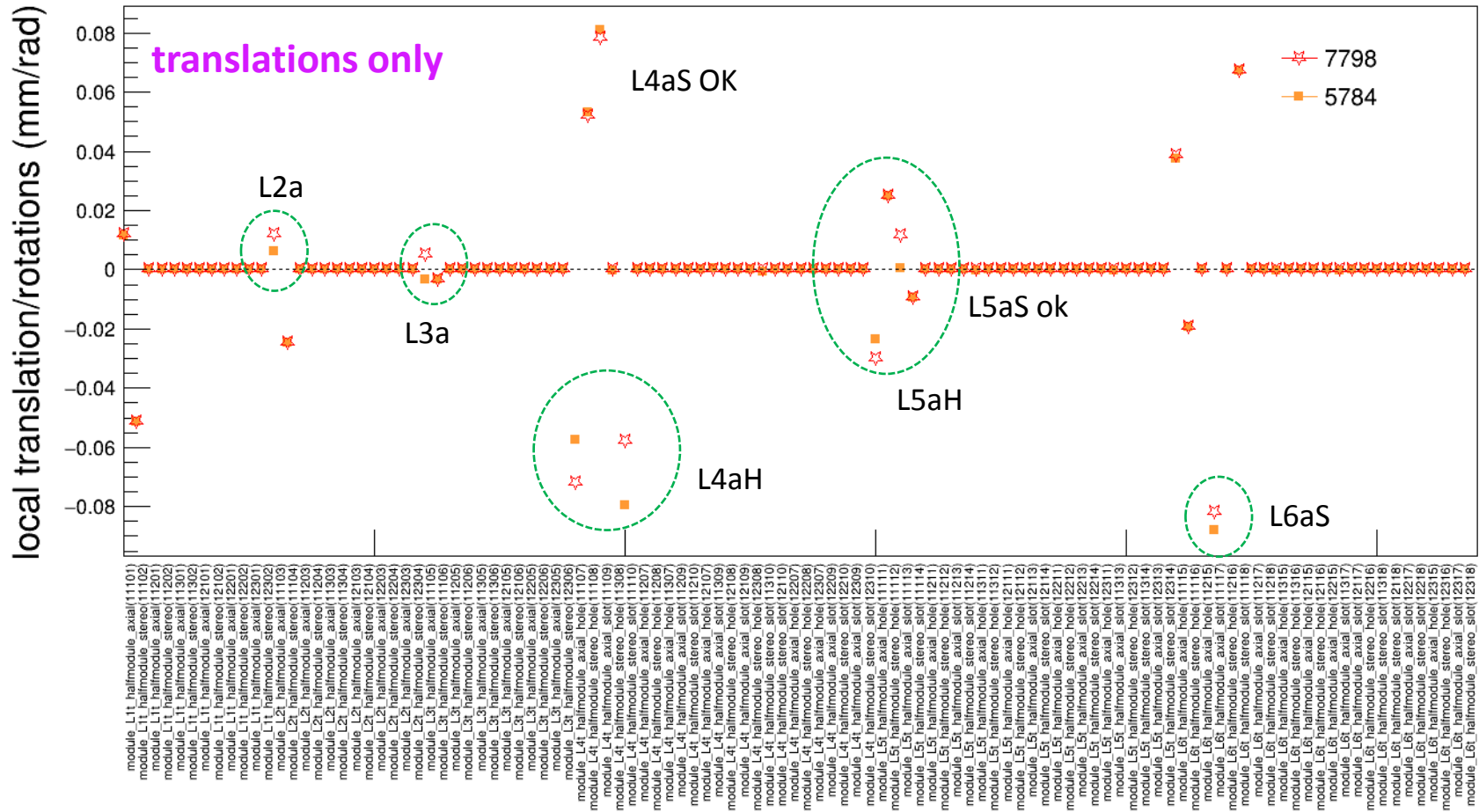
- Comparison of geometries as MP outputs starting from the same initial values and with the same floating degrees of freedom
  - V4.4 geometry vs
  - V1+tweaks + same floating parameters -> v1-dev1

Comparison of MP offsets: BOT

Millepede corrections per sensor, bottom
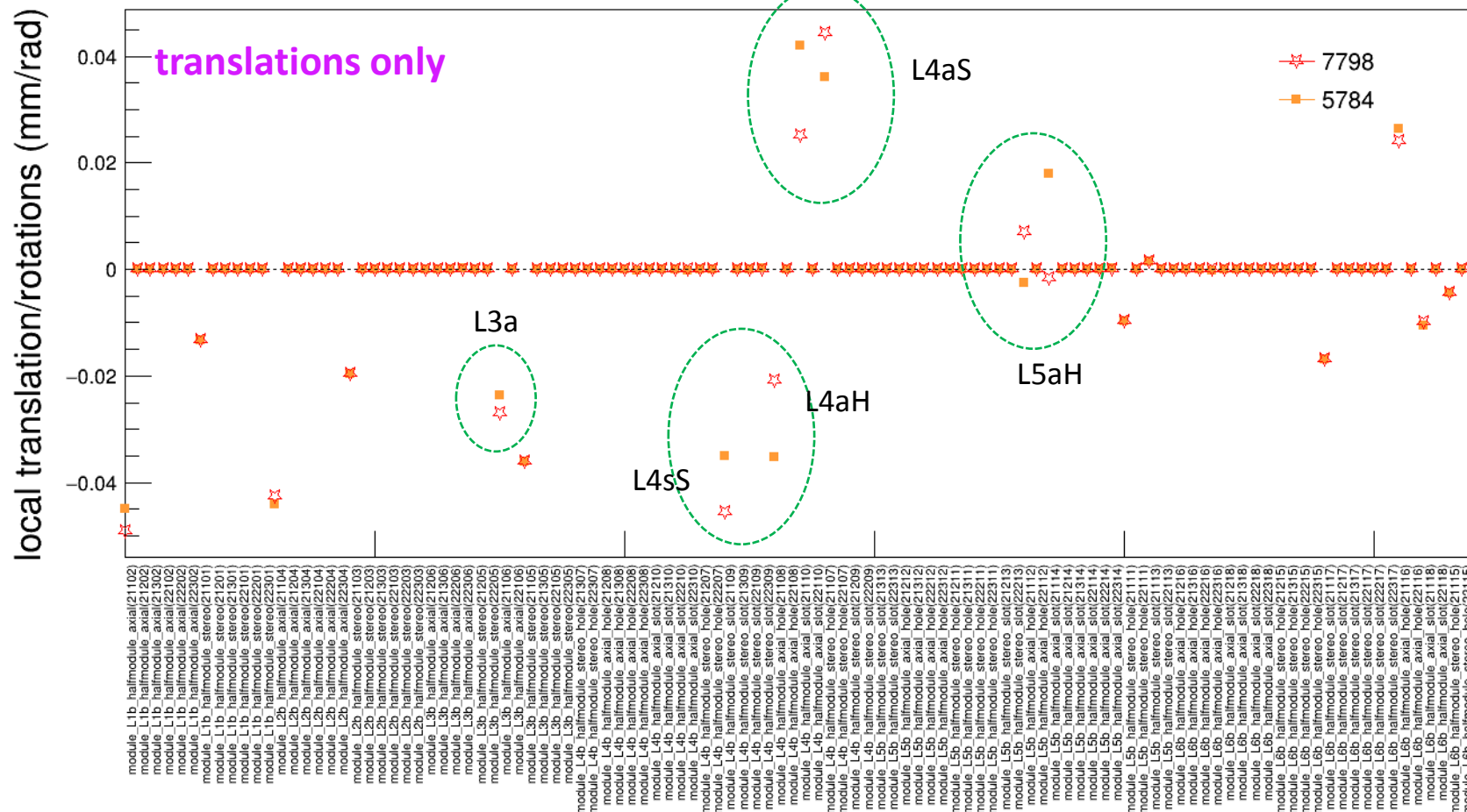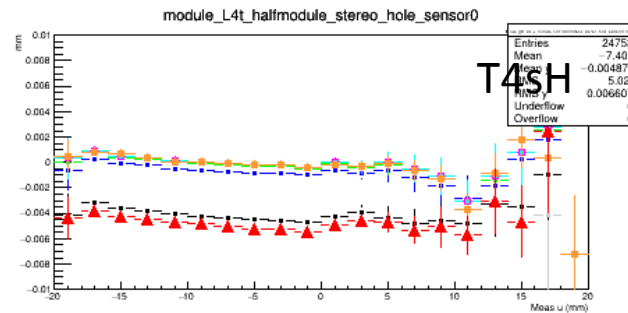
No evident systematics
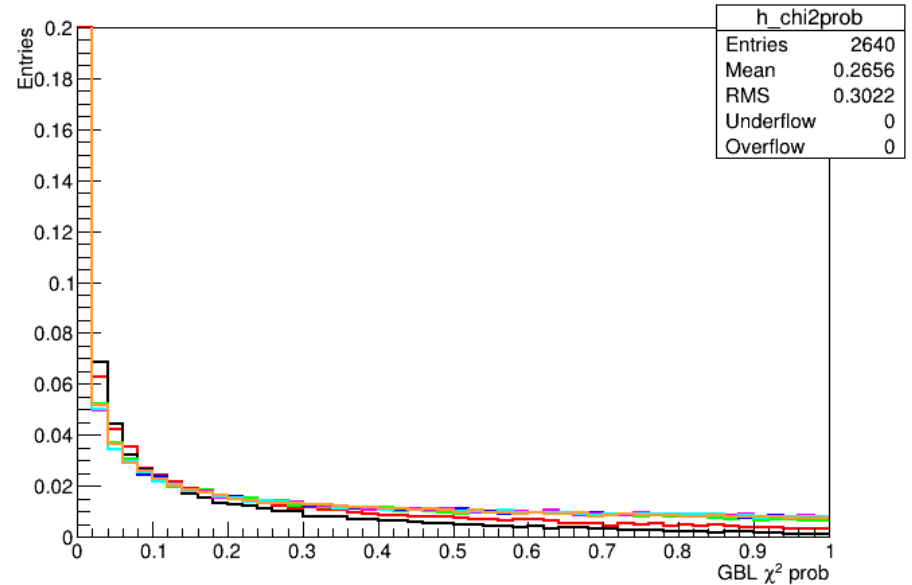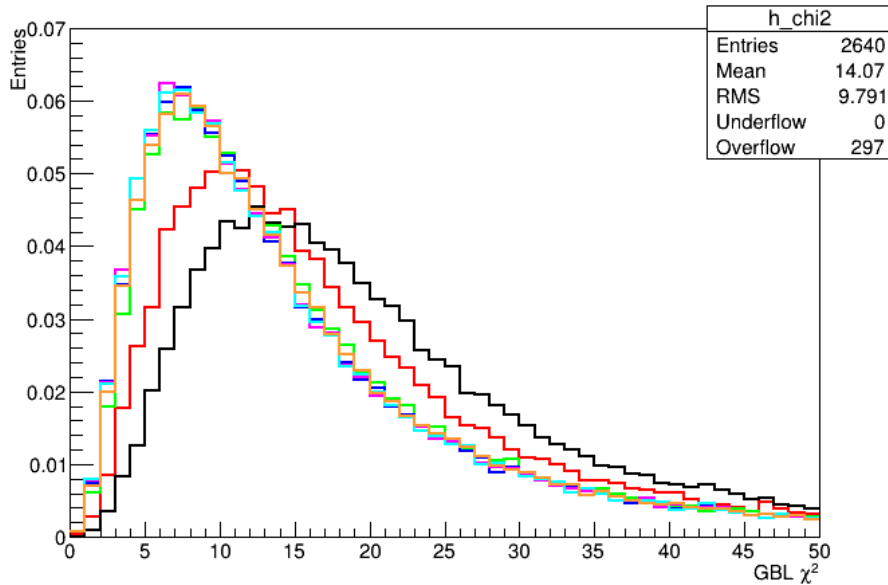
χ² distributions

(distributions normalized to 1 to compare different statistics)

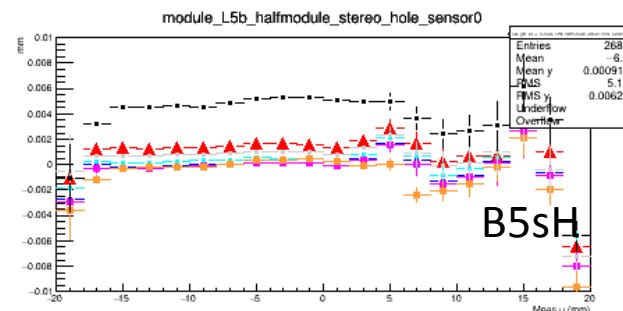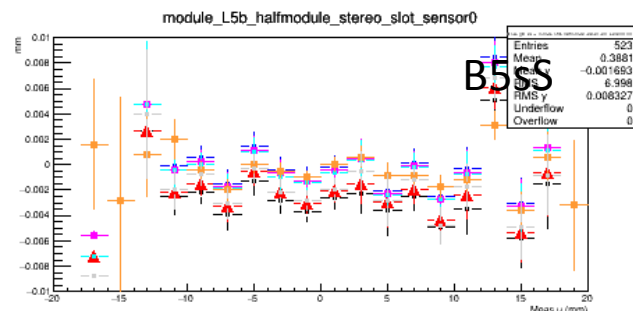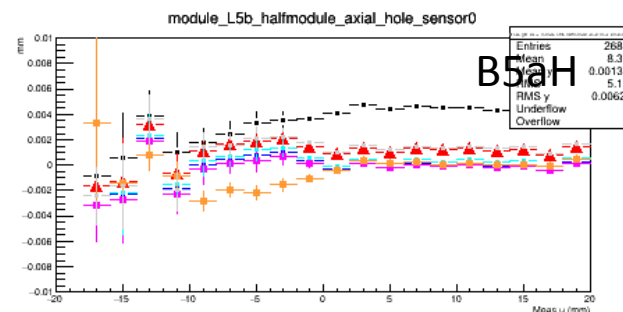# u residuals vs u profiles, layers 123
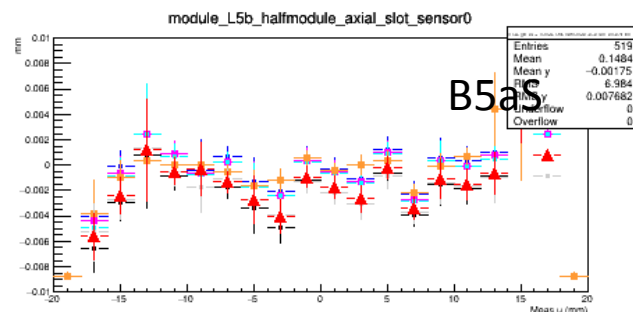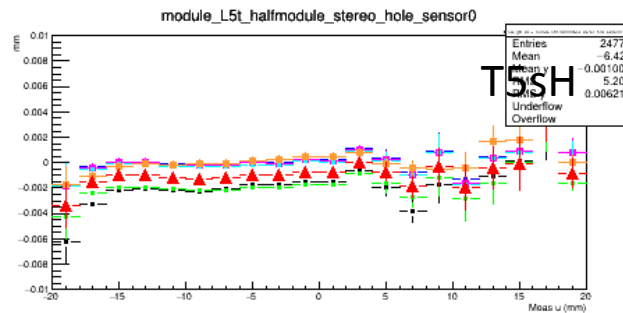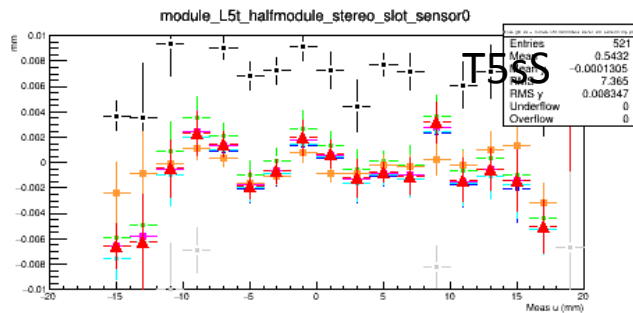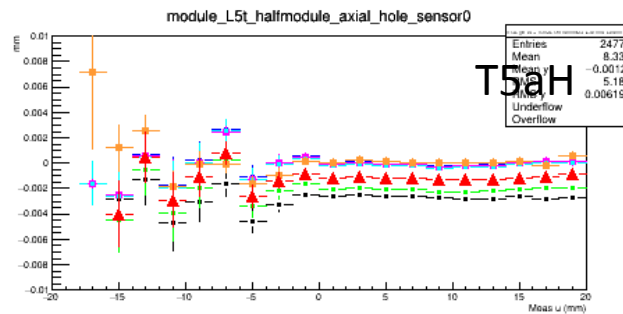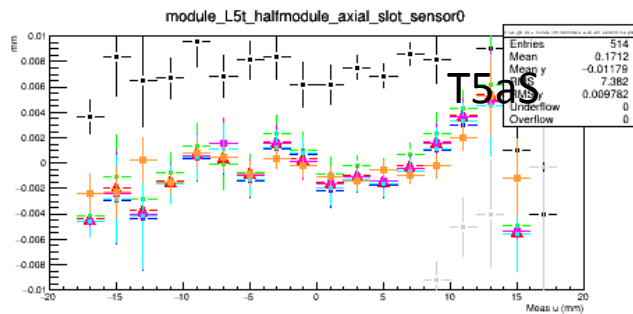
(u axis not flipped)

- Improvement for all stereo distributions
  - more aligned to zero
  - More horizontal
- Irregular trend for all axial modules
  - Border effects
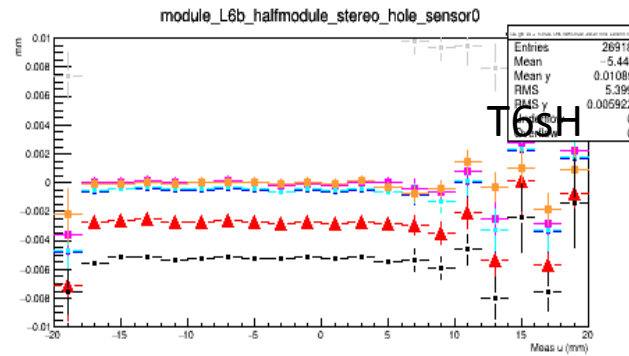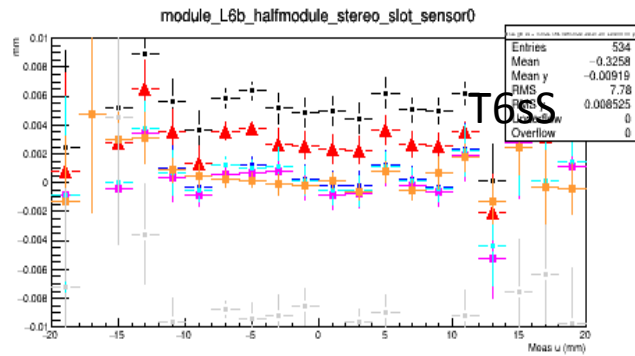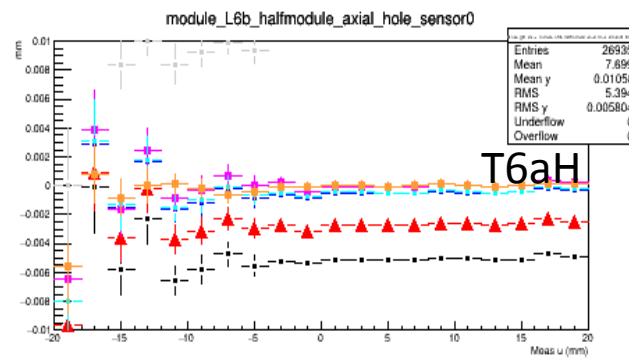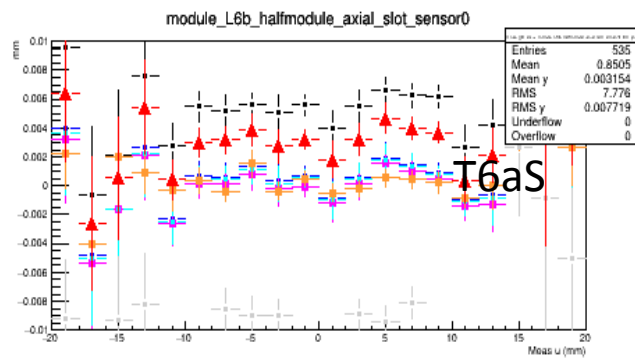 - General improvement

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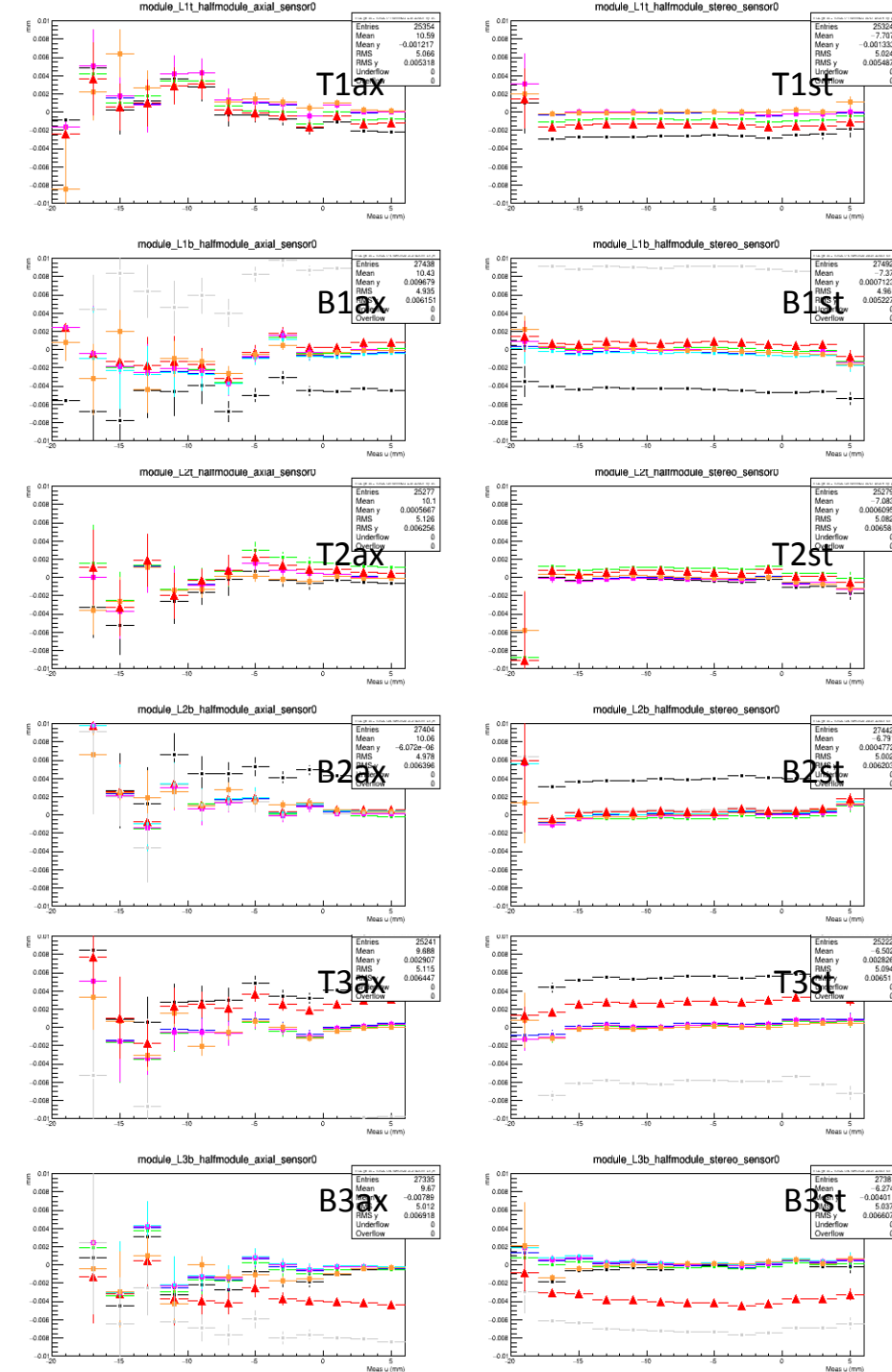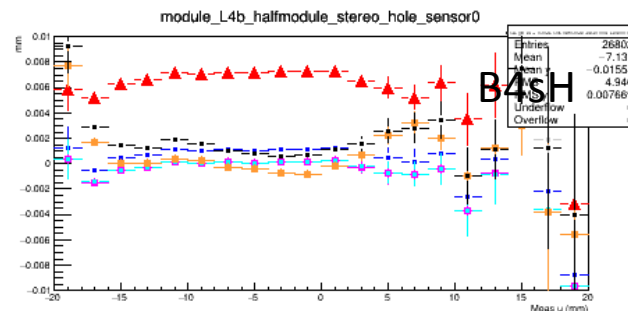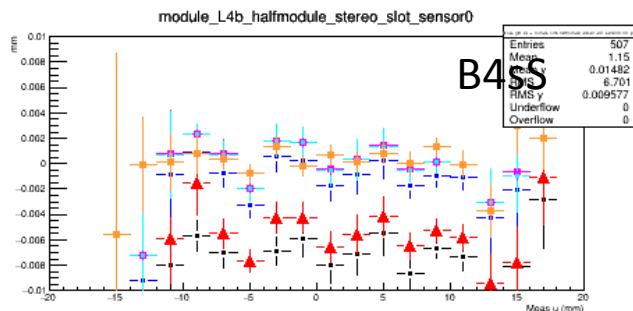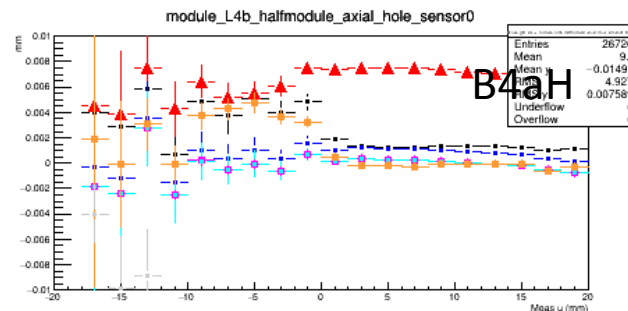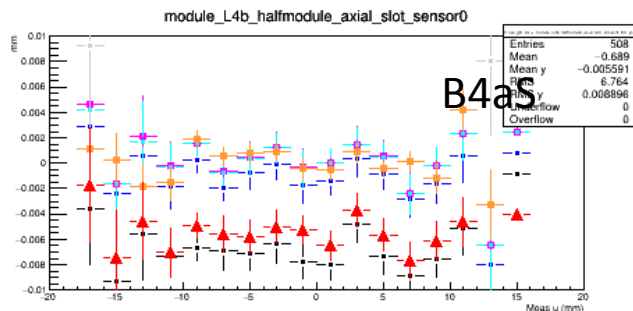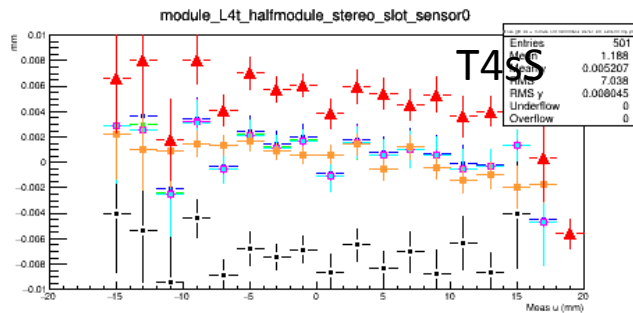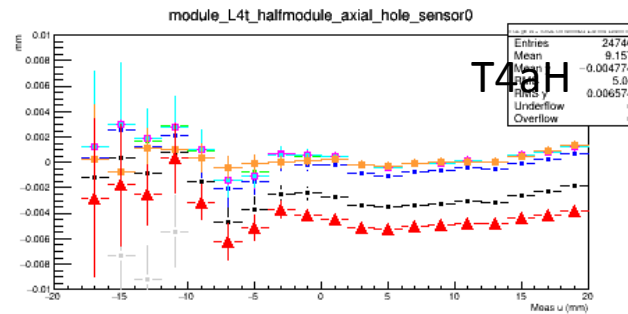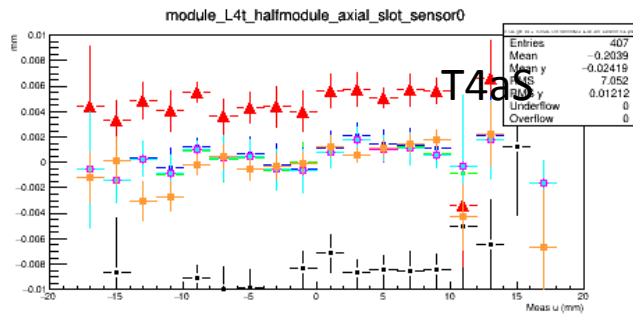
u residuals vs u profiles, layers 4

(u axis not flipped)

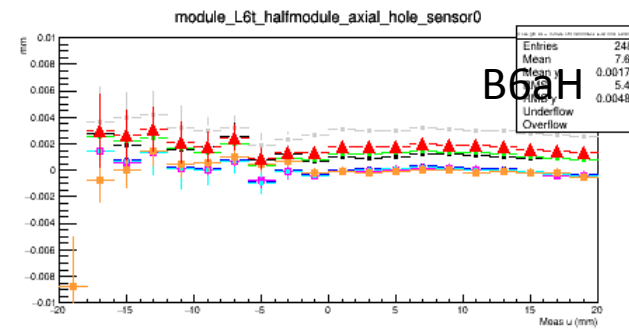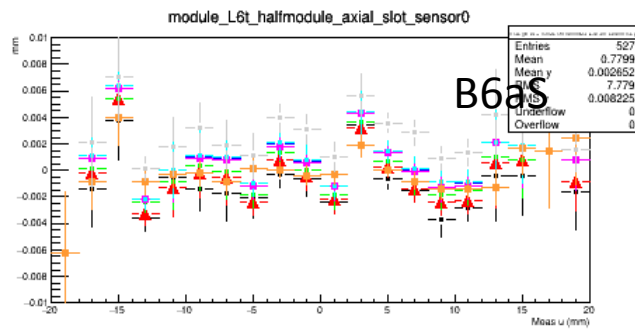- Sizeable improvement wrt to reference distribution

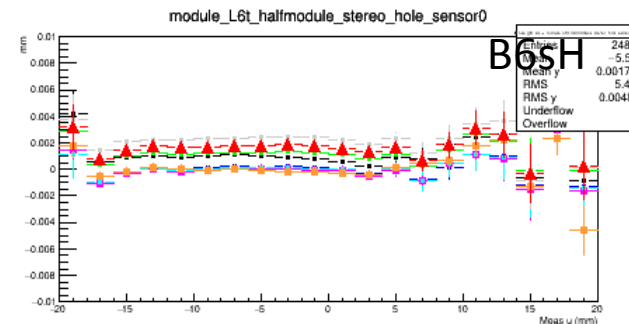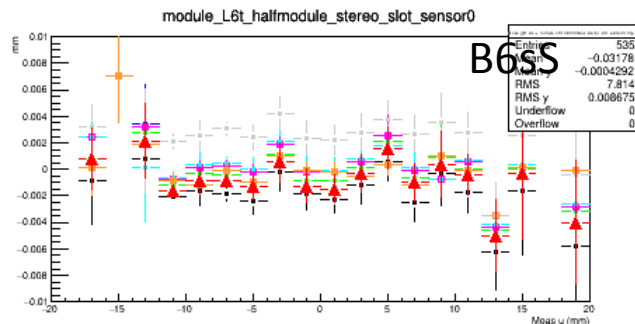# u residuals vs u profiles, layers 5

(u axis not flipped)

- Less remarkable improvement in the trend
- Some shadowing effects

u residuals vs u profiles, layers 6

(u axis not flipped)

- Some sizeable border effects

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Next steps

- A few reference geometries identified:
  - Best geo for curved: v4.4
  - Best geo for straight: v4.4-dev3 and v1-dev1
- Try best straight geo for curved tracks
- … decide next steps

- How to improve profile plots of residuals vs coordinates
  - u_res vs v plots

- Other tests: produce straight tracks best alignment floating rotations only

- Use one 2016 run to check

- Compare with MC data at the same momentum (1 GeV)