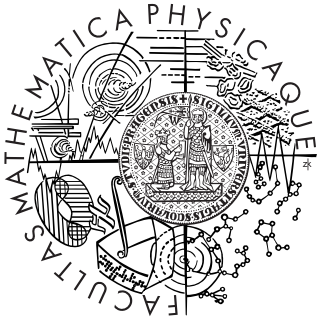

The VXD alignment

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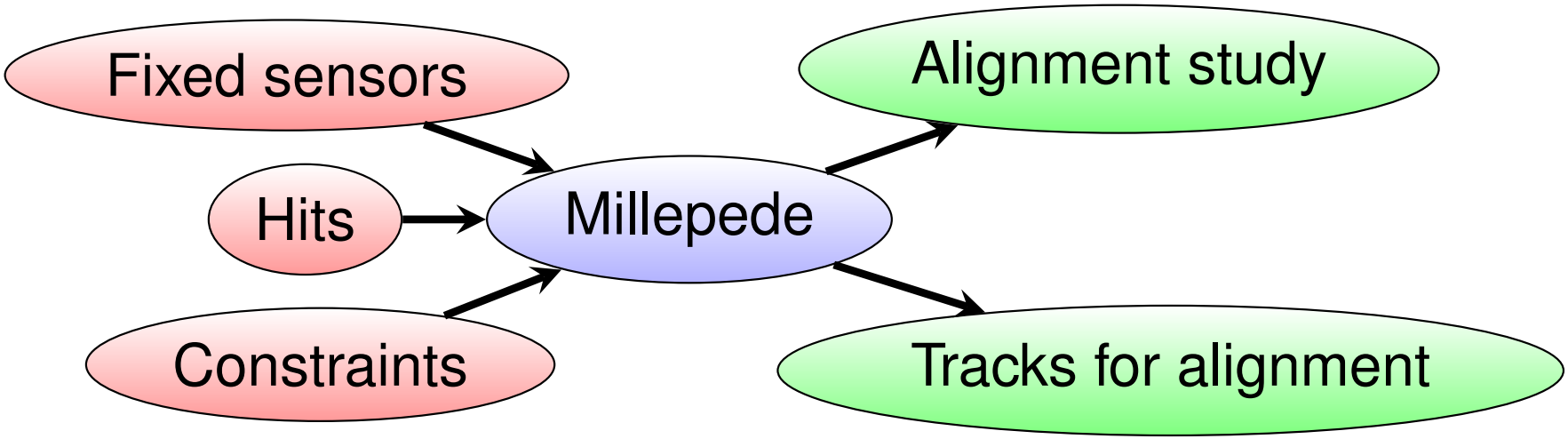
January 11, 2016

Outline

Millepede algorithm



- **Constraints** fix the otherwise undefined degrees of freedom corresponding to global translations and rotations of VXD. They are realized by requiring that the sum of alignment correction per each parameter (projected to global system) is zero. We use them because otherwise we would need to fix some sensor.
- **TrueHits** are MC simulation objects, they are the records of passage of simulated particles through a sensor.
- **Clusters** are reconstruction objects. They represent reconstructed hits based on fired pixels or strips.

Validation of Millepede algorithm

Tracks used for alignment:

- Physics process with high counting rate
- Cosmic-ray muons

Alignment study:

- Convergence of alignment parameters of sensors
- The study of choice of samples and inputs
- The shift of 3^{rd} layer

Procedure

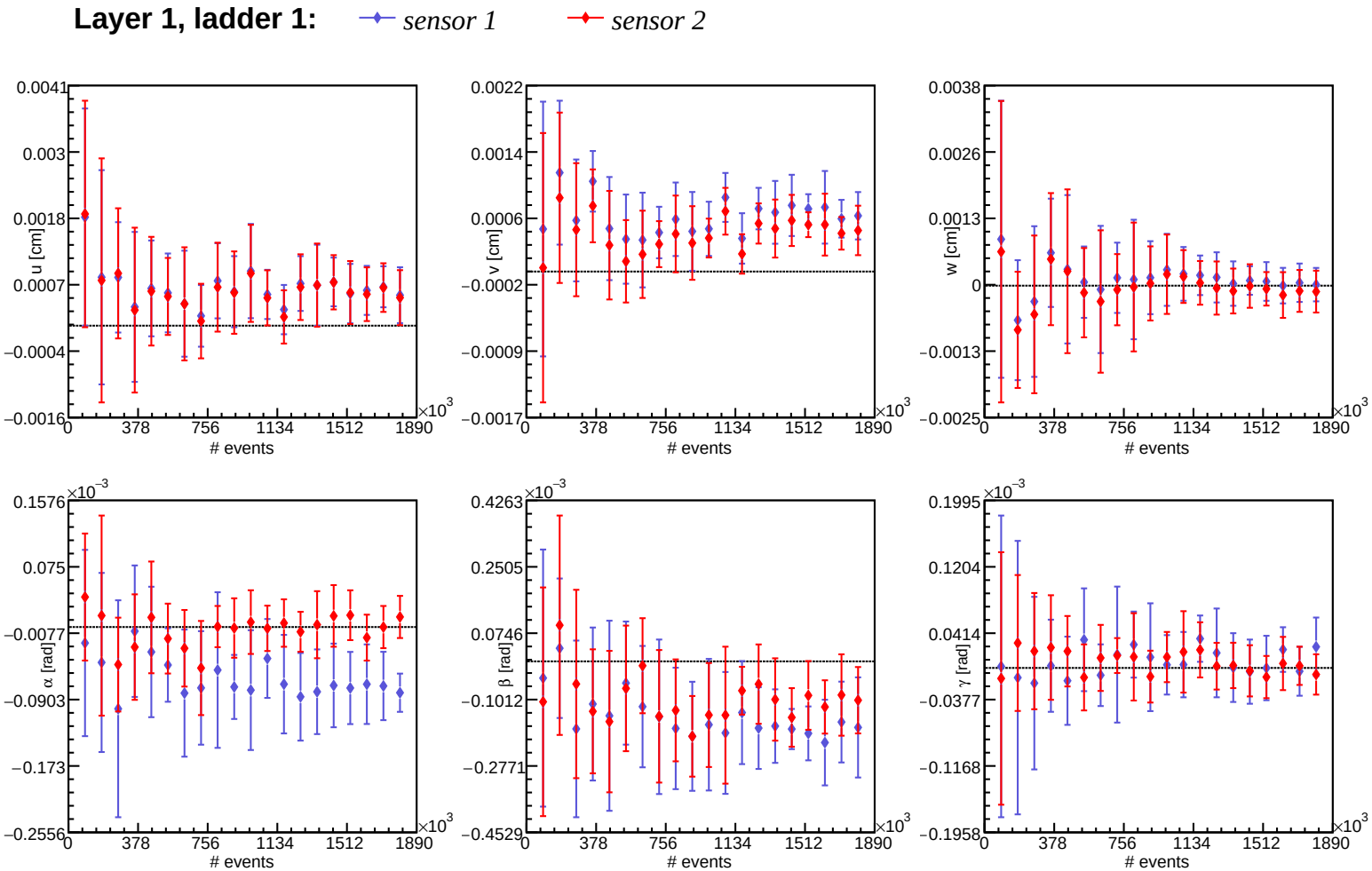
- Generation of samples:
  1. Muons generated from IP by ParticleGun (90 000 events)
  2. Upsilon(4S) (60 000 events)
  3. Cosmics generator (60 000 events)
  4. Pair of muons from $Z^0 \rightarrow \mu^+ + \mu^-$ (30 000 events)
- Merging of 20 samples
- 10 independent simulations ($\sim$ 200 samples)
- Outputs:
  - Mean value with standard deviation (std)
  - Standard deviation of Millepede algorithm (std_mille)

Geometry of sensors and parameters

- All sensors at ideal position (without misalignment)
- Using constraints
- Local parameters for each sensor:
  1. Shifts: u, v, w
  2. Rotations: α, β, γ
- Mean value as bias (difference between ideal and calculated position)

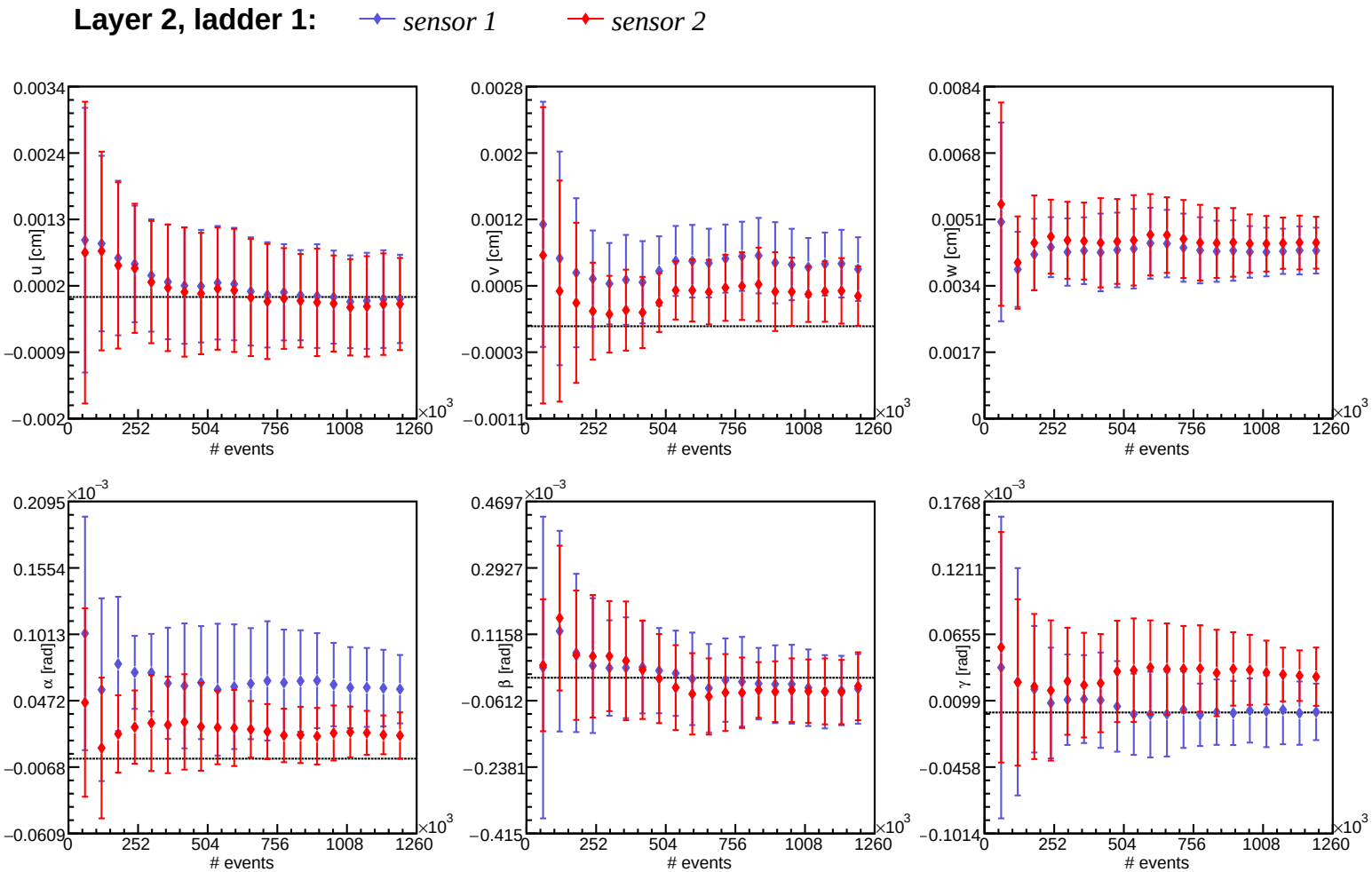
Layer ID	*Ladders*	*Sensors*	*Parameters*
1	8	$2 \cdot 8$	$2 \cdot 8 \cdot 6$
2	12	$2 \cdot 12$	$2 \cdot 12 \cdot 6$
3	7	$2 \cdot 7$	$2 \cdot 7 \cdot 6$
4	10	$3 \cdot 10$	$3 \cdot 10 \cdot 6$
5	12	$4 \cdot 12$	$4 \cdot 12 \cdot 6$
6	16	$5 \cdot 16$	$5 \cdot 16 \cdot 6$
	65	212	1 272

Using ParticleGun by TrueHits



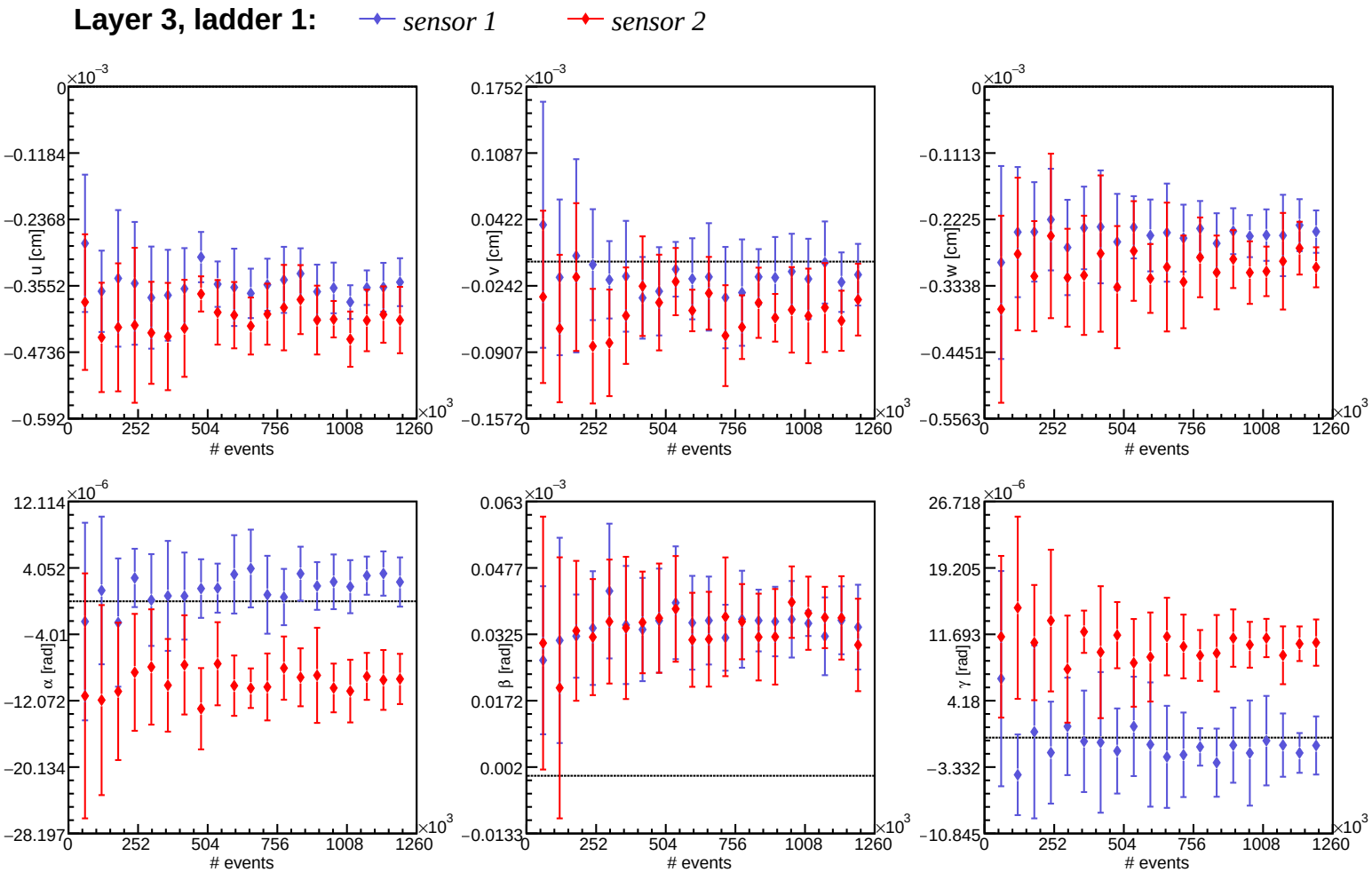
The samples do not converge to expected values.

Upsilon by TrueHits



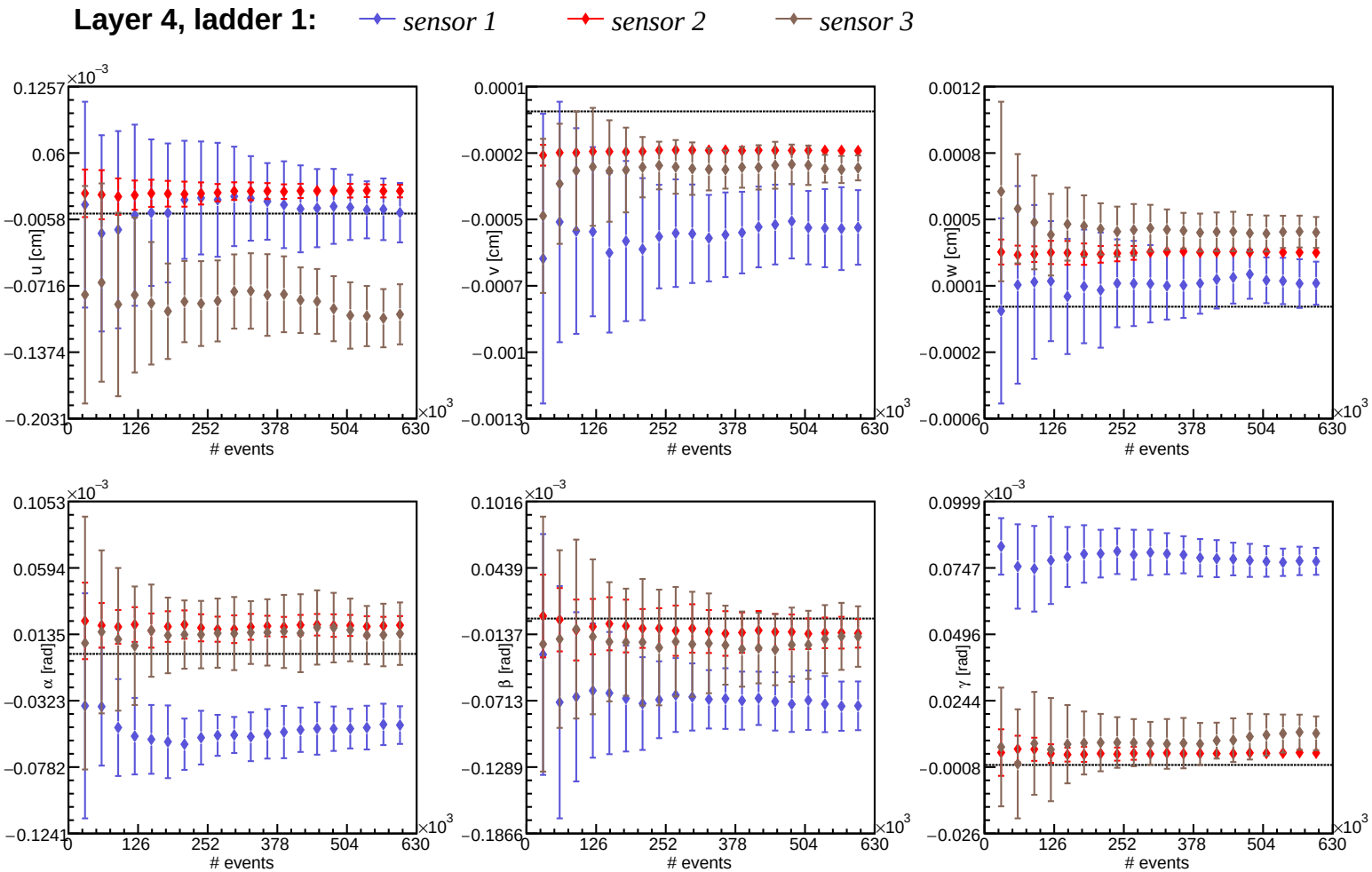
The samples do not converge to expected values and Upsilon's values are similar as ParticleGun.

Cosmics by TrueHits



The samples do not converge to expected values and Cosmics's values are smaller than ParticleGun.

MuonPairs by Clusters

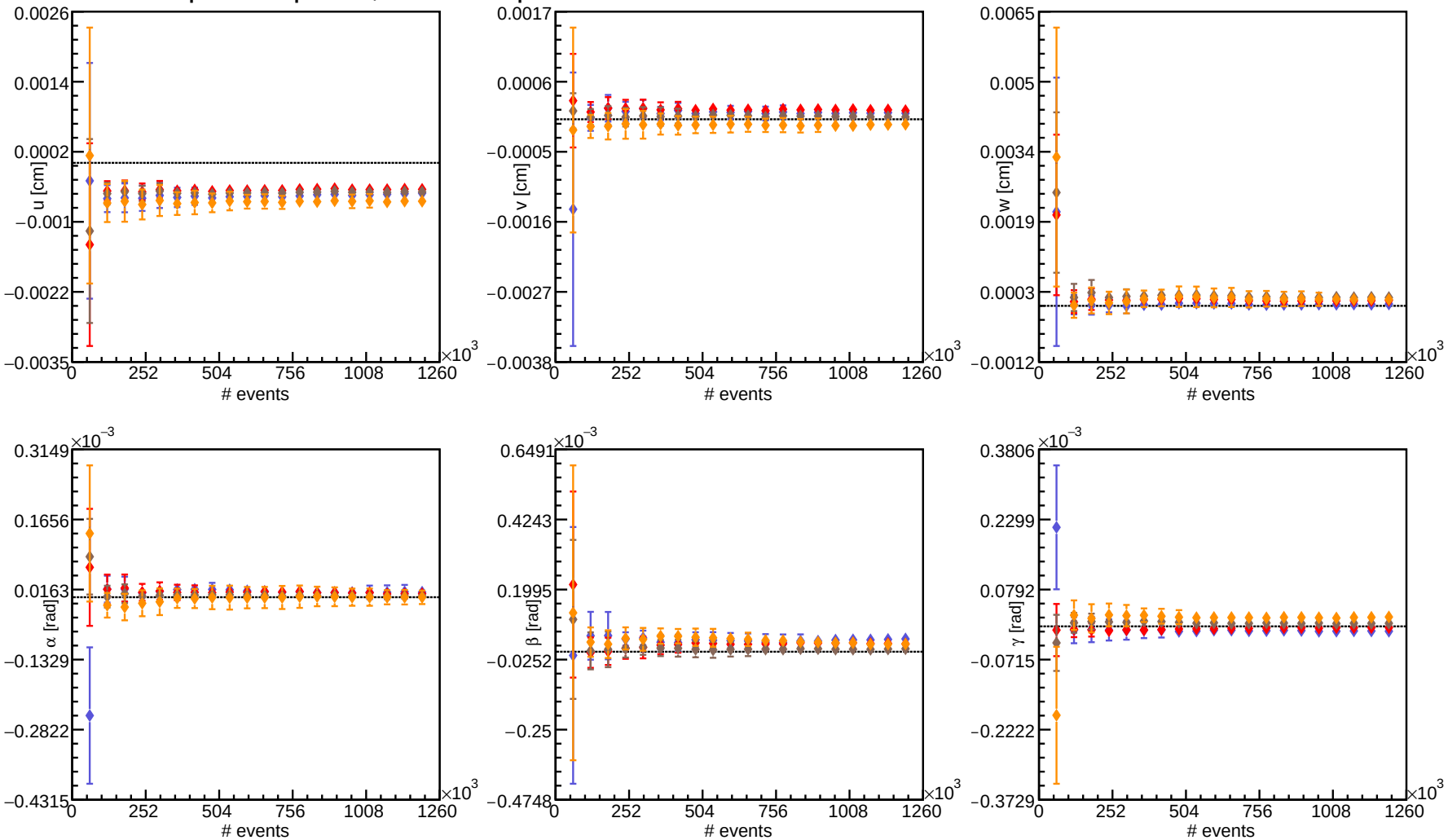


The samples do not converge to expected values and MuonsPairs's values are different as Upsilon or Cosmics.

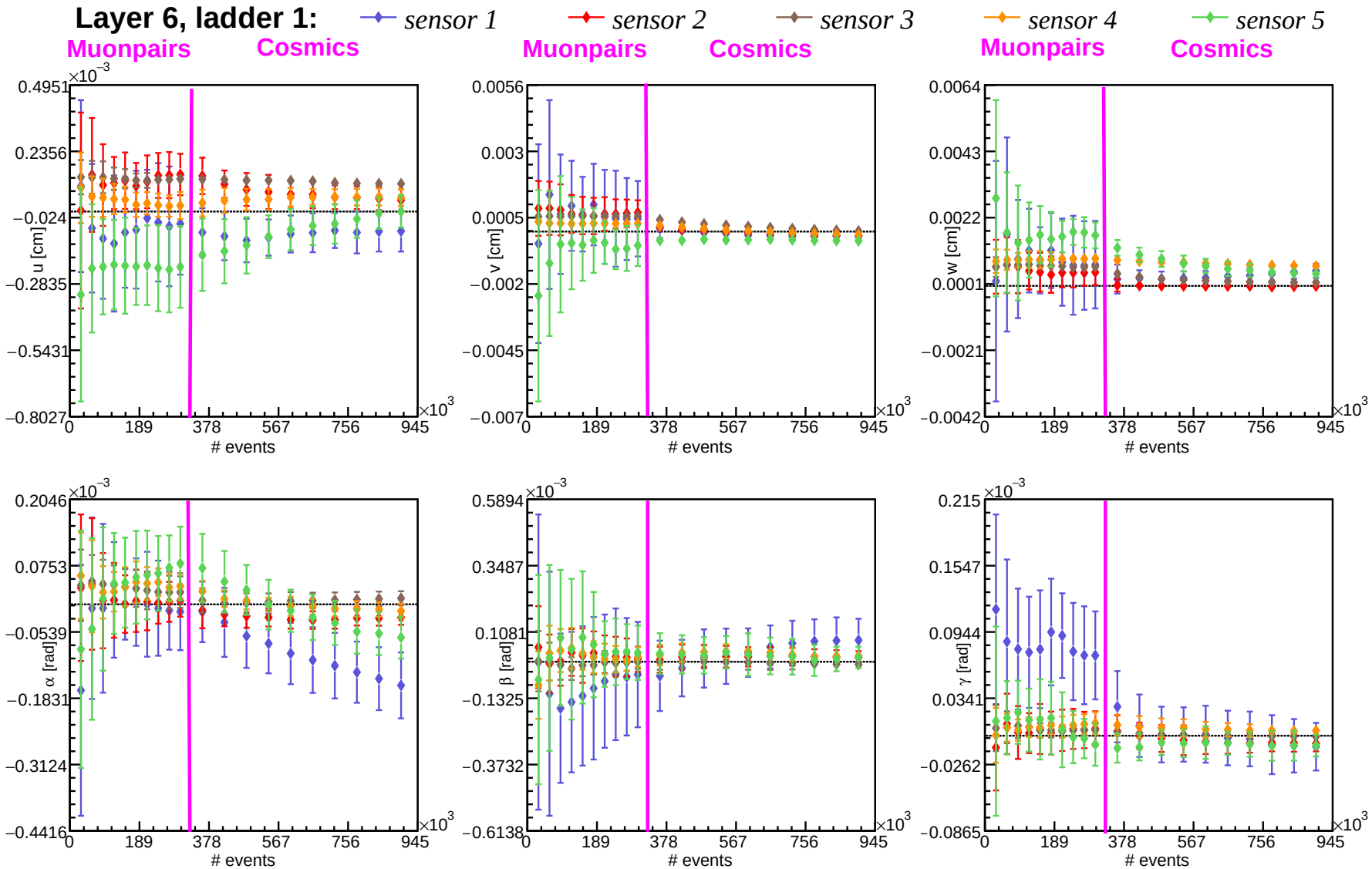
Uspilon and Cosmics by TrueHits (ZigZag)

Layer 5, ladder 1: *sensor 1* *sensor 2* *sensor 3* *sensor 4*

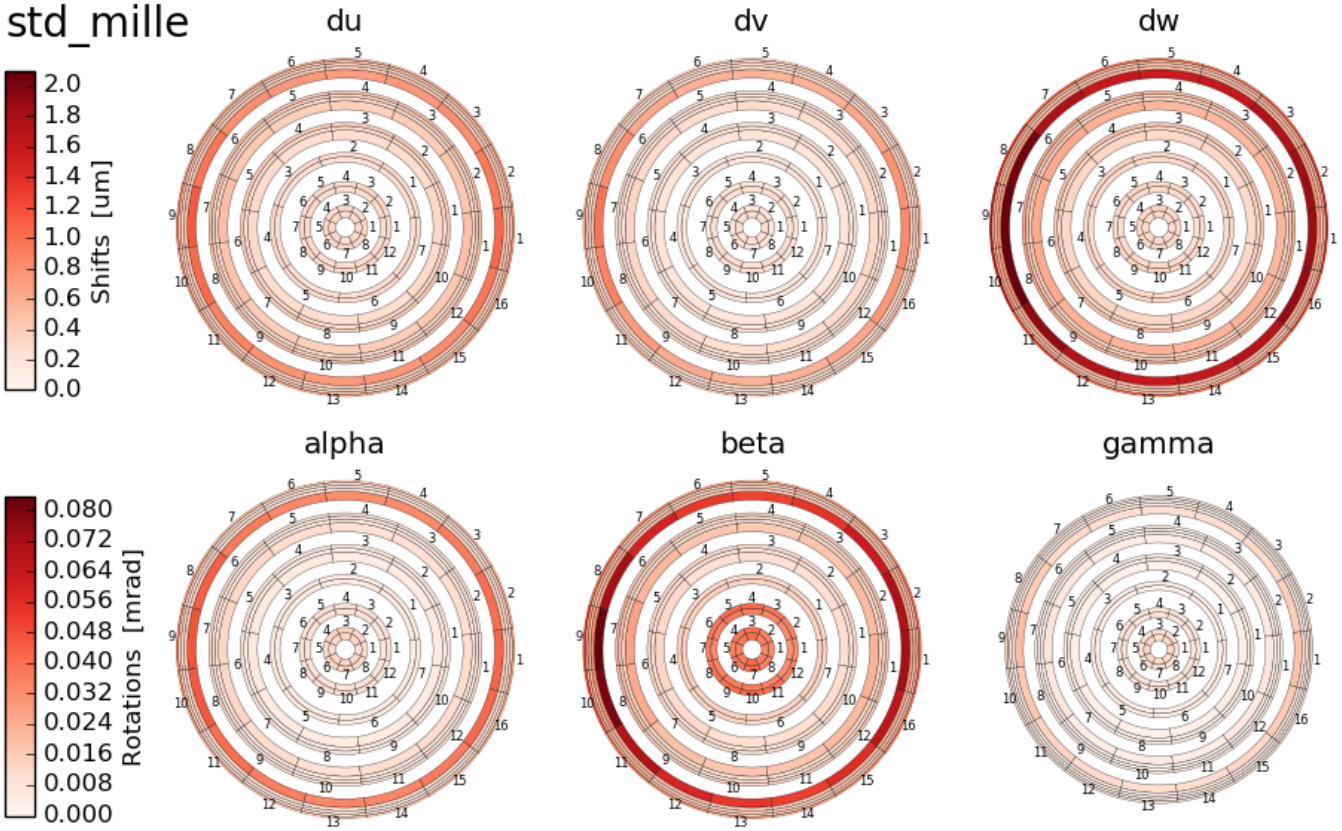
odd sample -> Upsilon, even sample -> Cosmics



MuonPairs and Cosmics by Clusters

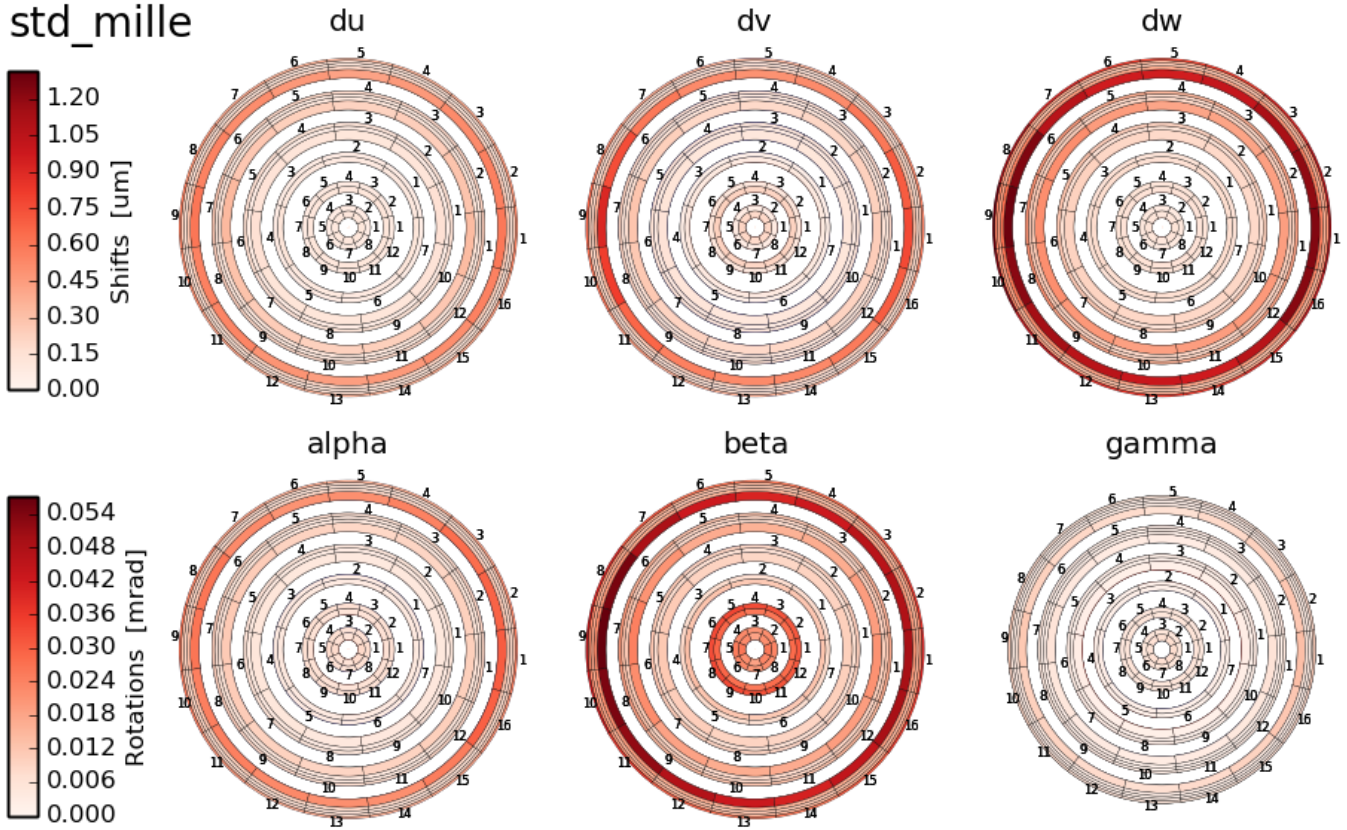


Upsilon and Cosmics by Cluster



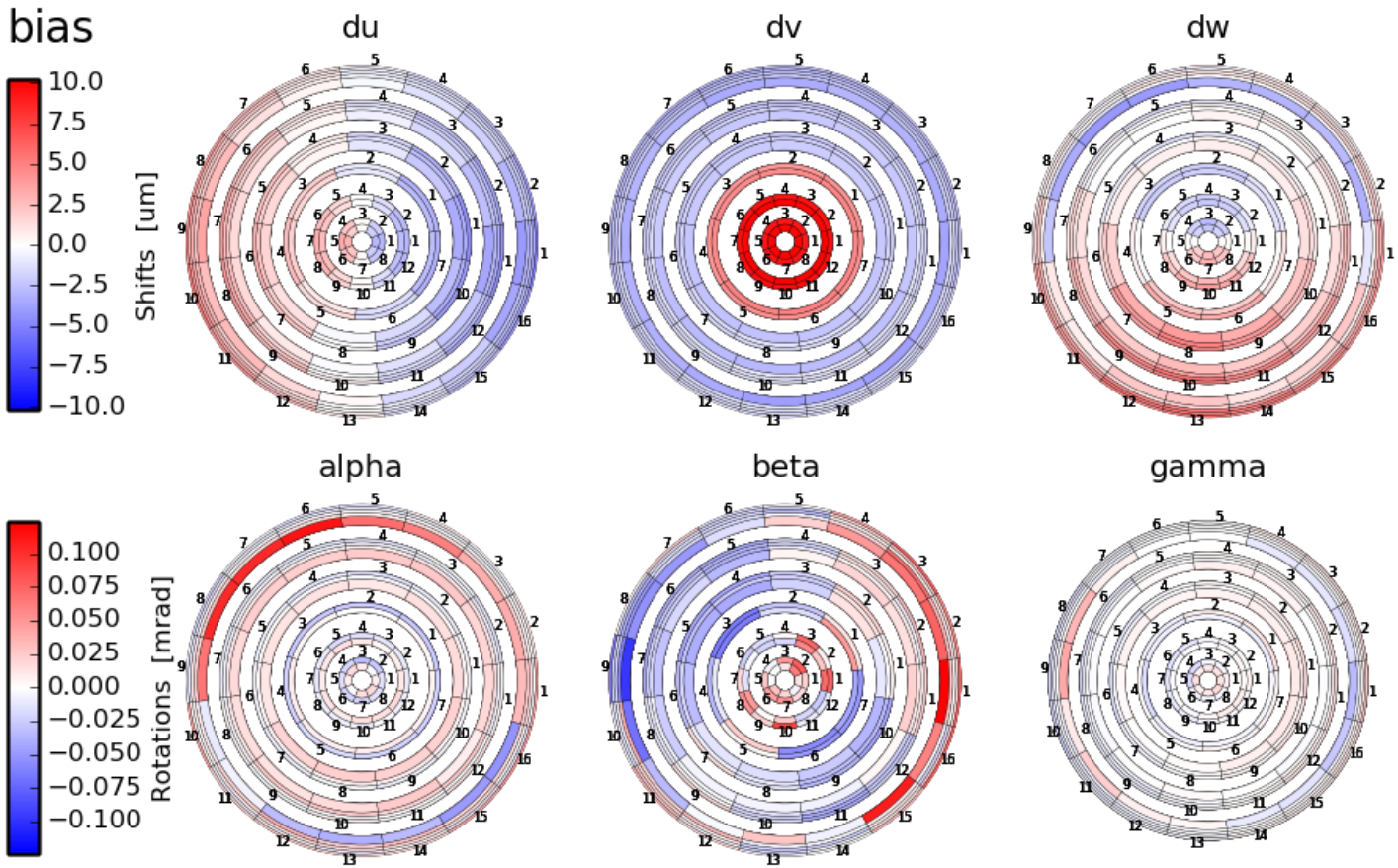
The standard deviation of rotations is smaller than MuonPair.
and the wedge sensors have the highest deviation.

MuonsPair and Cosmics by Cluster



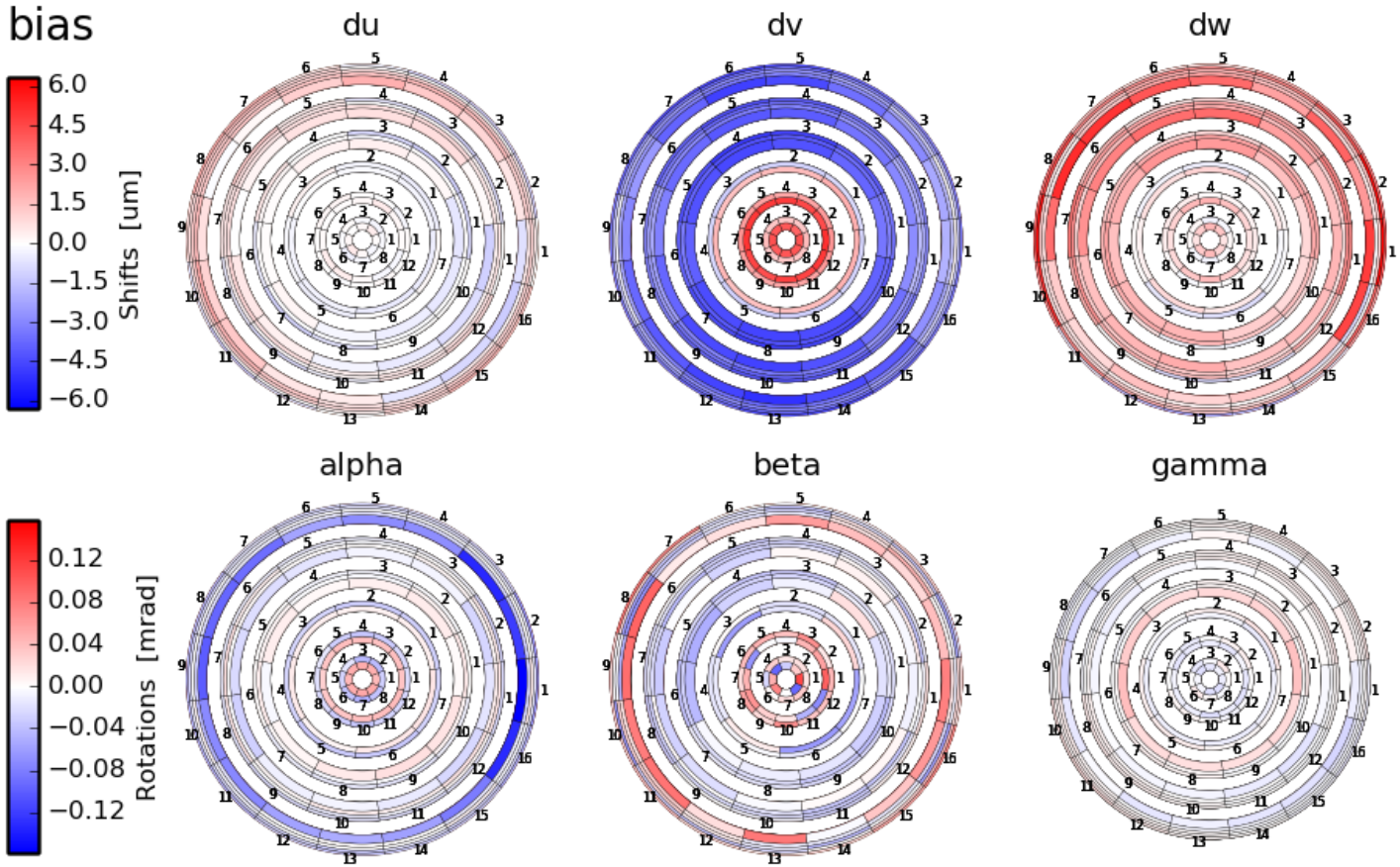
The standard deviation of shifts is smaller than Upsilon and the wedge sensors have the highest deviation.

Upsilon and Cosmics by Cluster



The range of rotations is shorter than MuonPair.

MuonsPair and Cosmics by Cluster



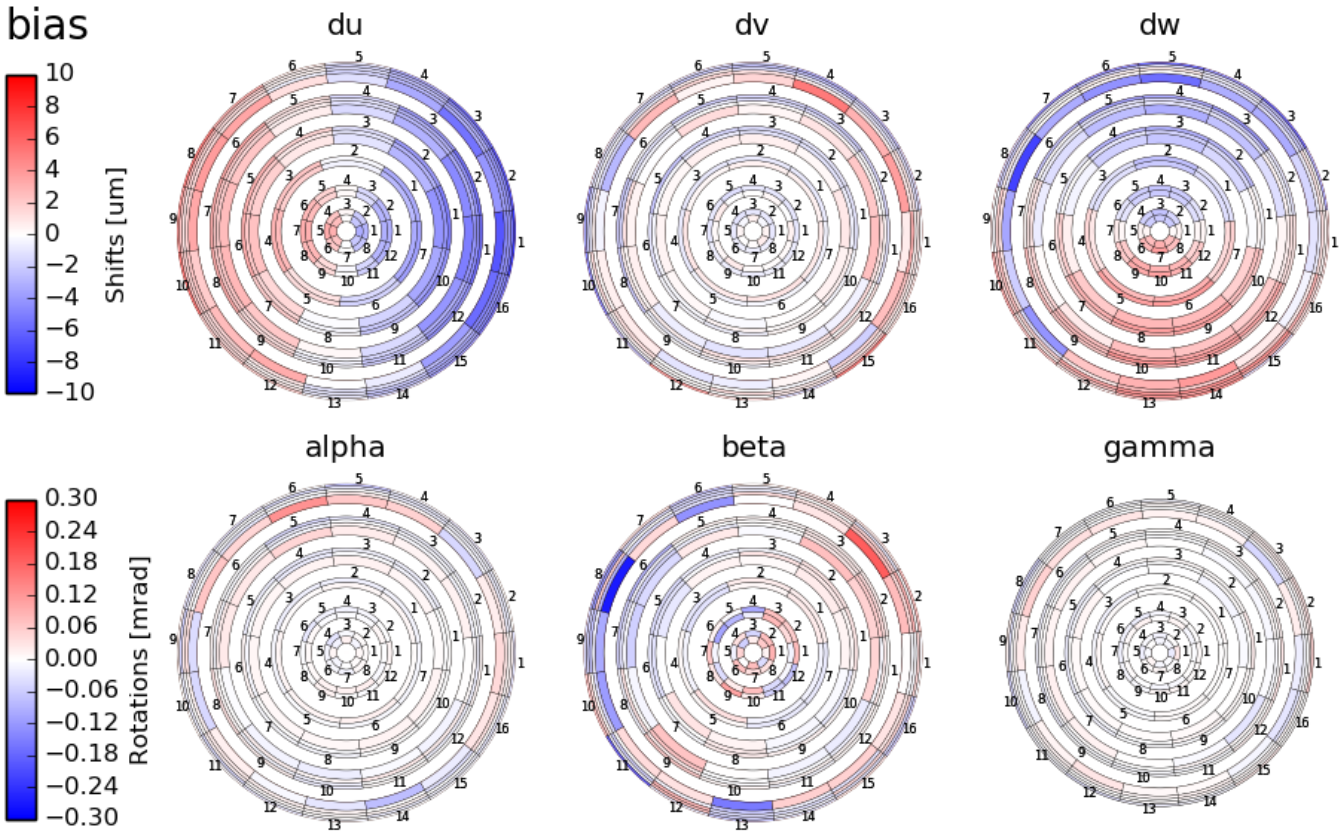
The range of shifts is shorter than Upsilon.

The shift of 3^{rd} Layer

The study of shift:

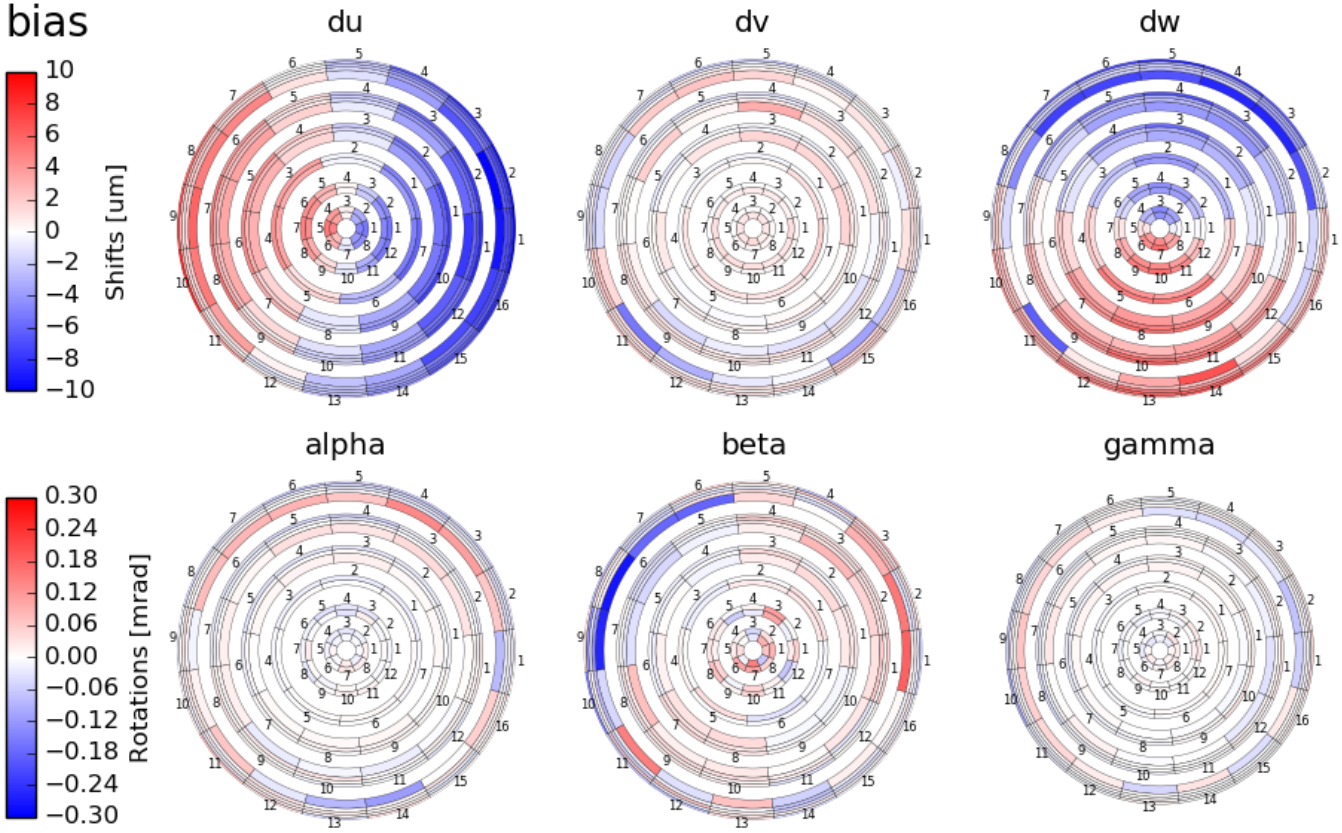
- Layer: 3^{rd}
- Sensors: all
- Position:
  - Before: 37.99 *mm*
  - After: 38.99 *mm*
- ParticleGun and Cosmics by TrueHits
- Bias of rotations: (-0.27, 0.27) *mrad*
- Standard deviation:
  - Shifts: (0, 2.26) μm
  - Rotations: (0, 0.084) *mrad*

Before the shift



Bias of shifts are in range (-7.72, 7.72)

After the shift



Bias of shifts are in range (-9.99, 9.99)
The change are connected with u and w coordinate.

Status

Recommendations

- Mixture of samples

The shift of 3^{rd} layer

- Worse result at u and w coordinate

The best result

- Shifts (by mixture of Muons and Cosmics):
  - Mean: (-6.34, 6.34) μm
  - Standard deviation: (0, 1.31) μm
- Rotations (by mixture of Upsilon and Cosmics):
  - Mean: (-0.124, 0.124) *mrad*
  - Standard deviation: (0, 0.084) *mrad*

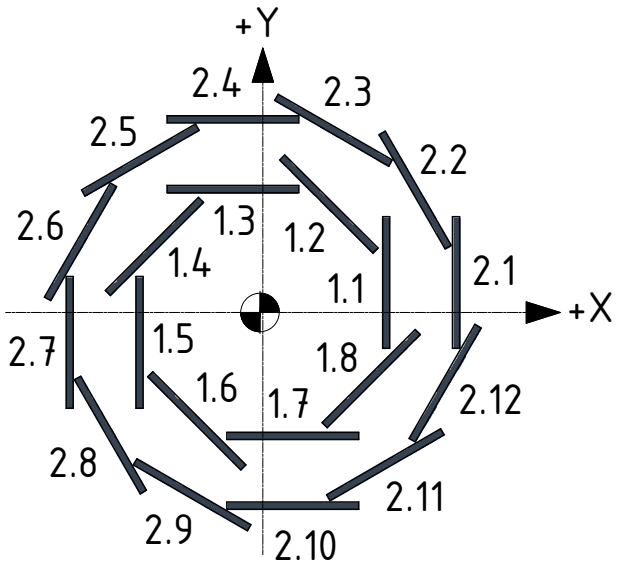
Plans

- Combination of three types samples
- Comparison between Clusters and TrueHits
- Changing constraints for fixed CDC wires

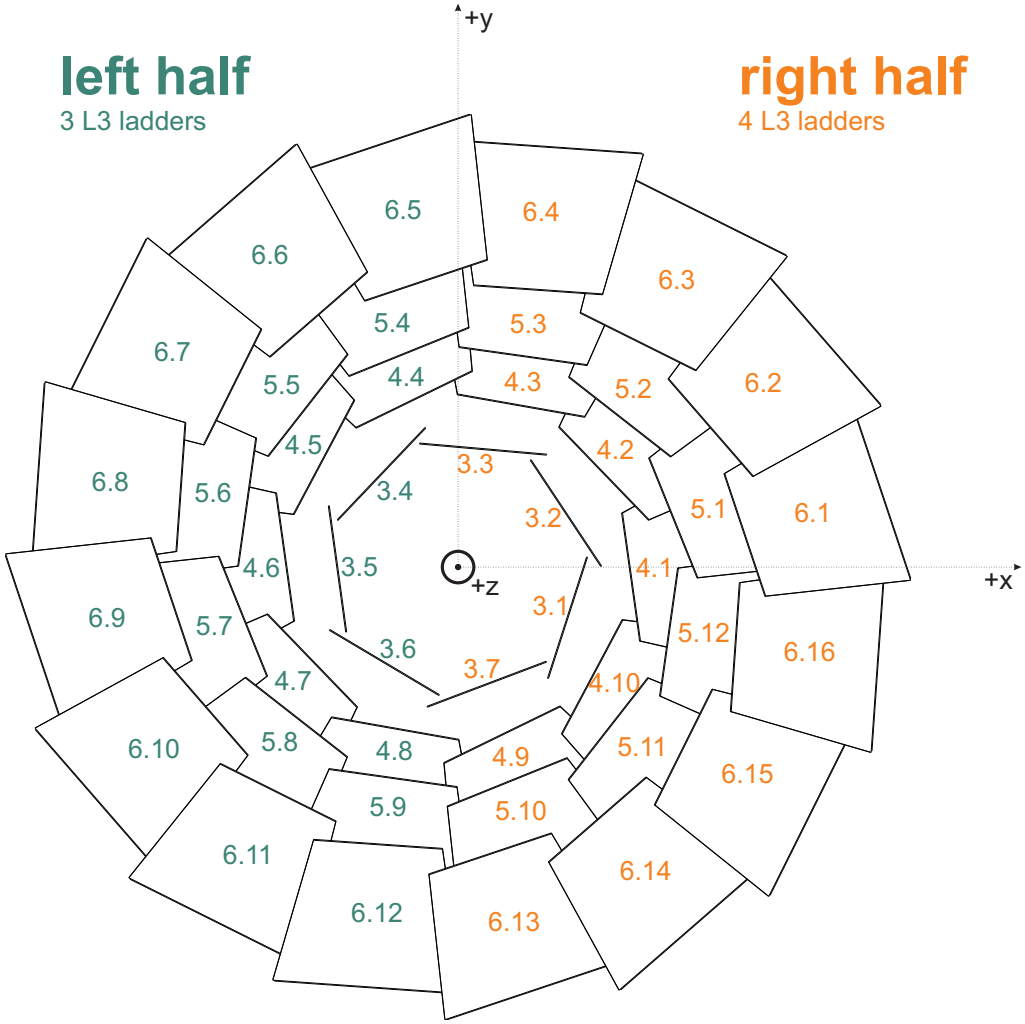
The study of impact to tracking parameters

Backup

The ladder numbering of VXD

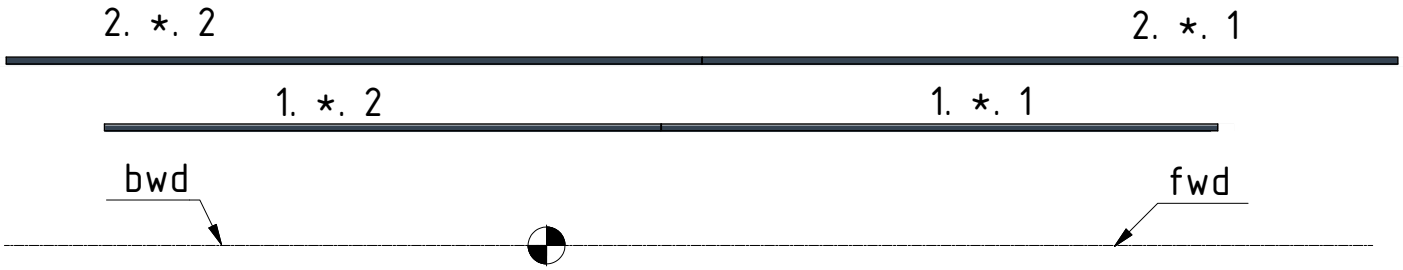


The PXD

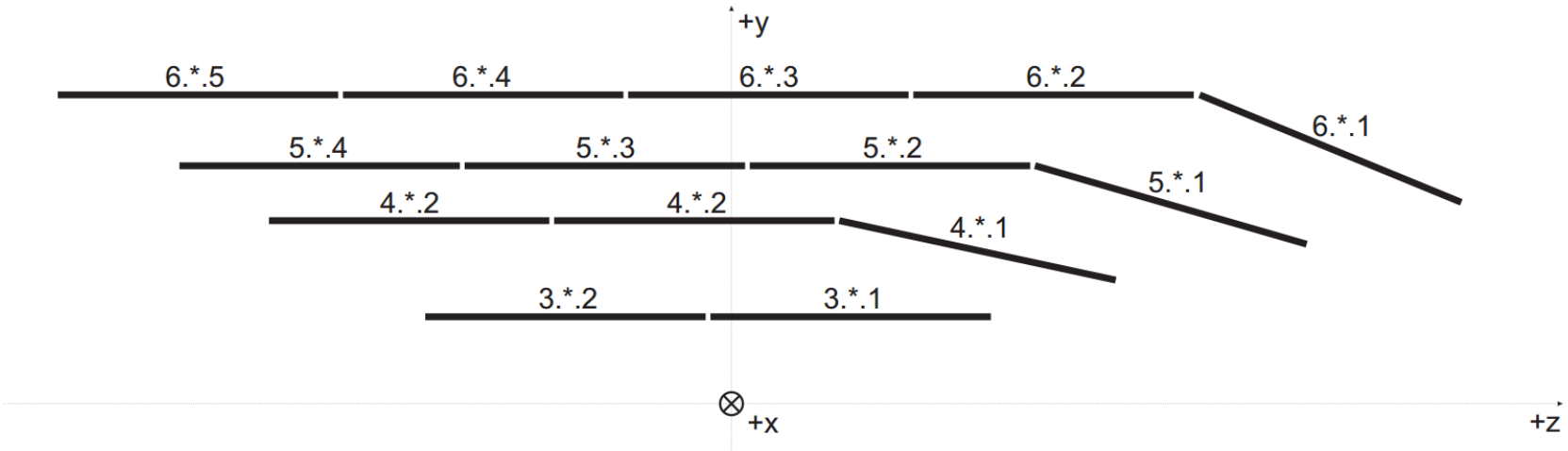


The SVD

The sensor numbering of VXD

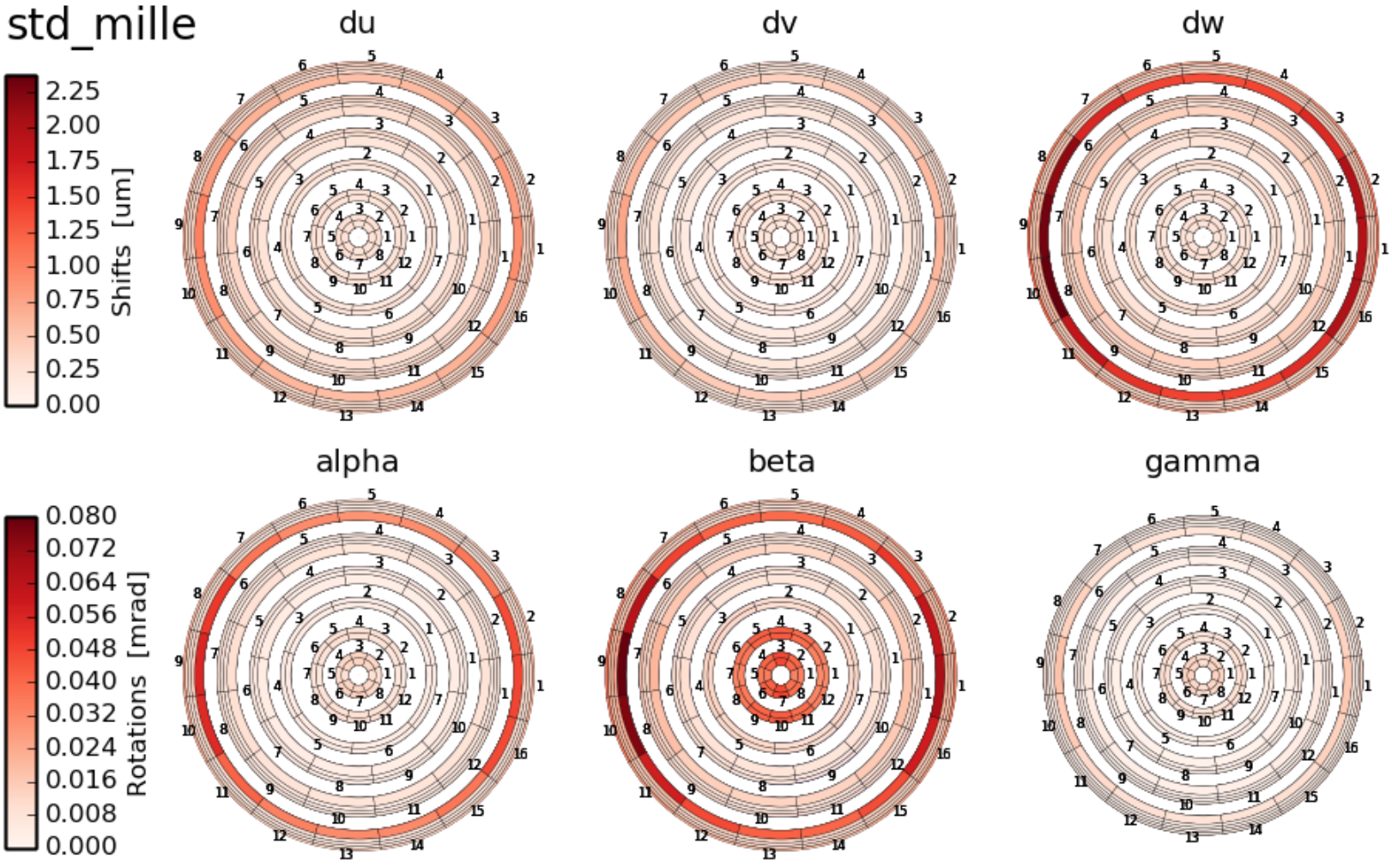


The PXD

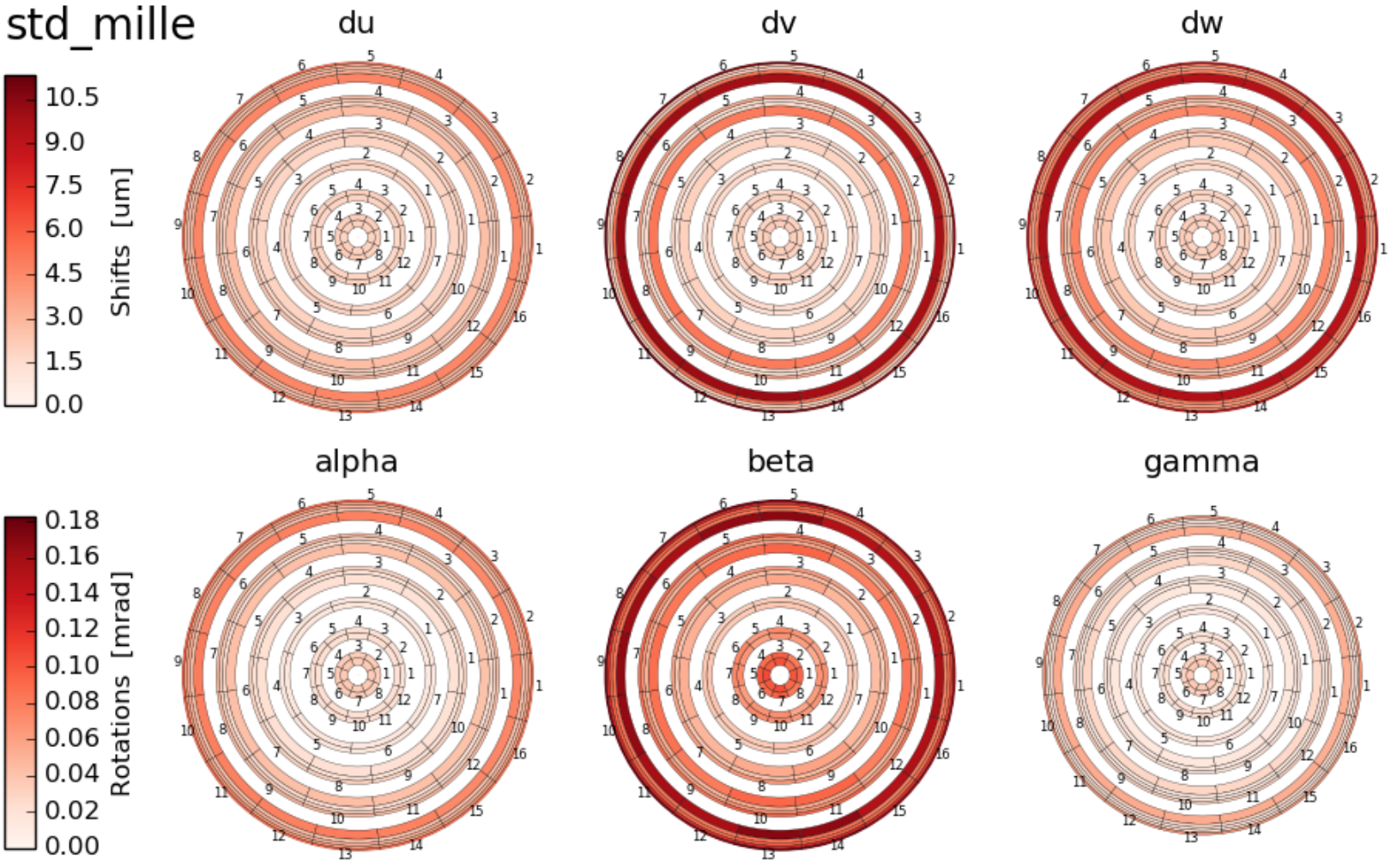


The SVD

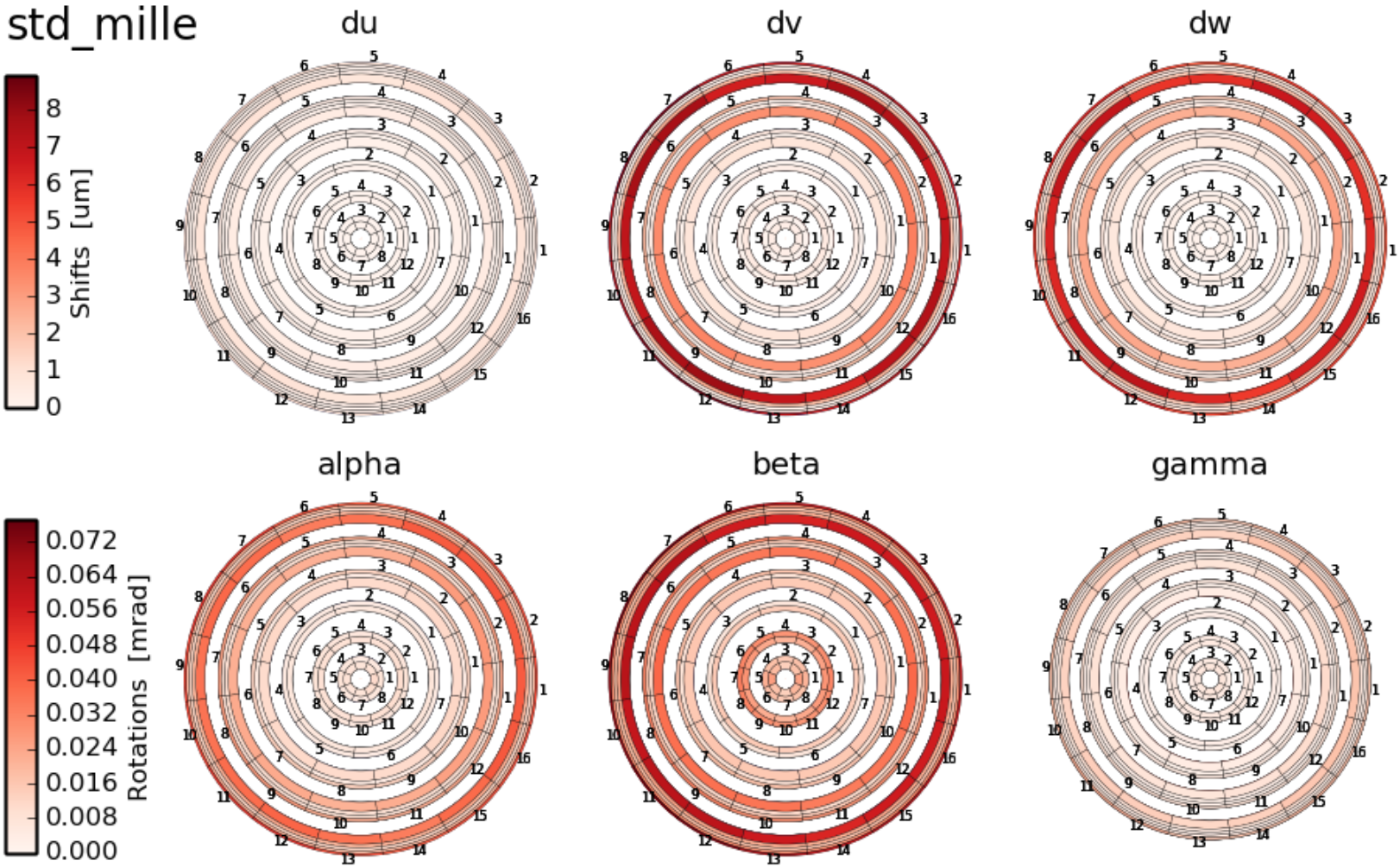
Cosmics by Cluster



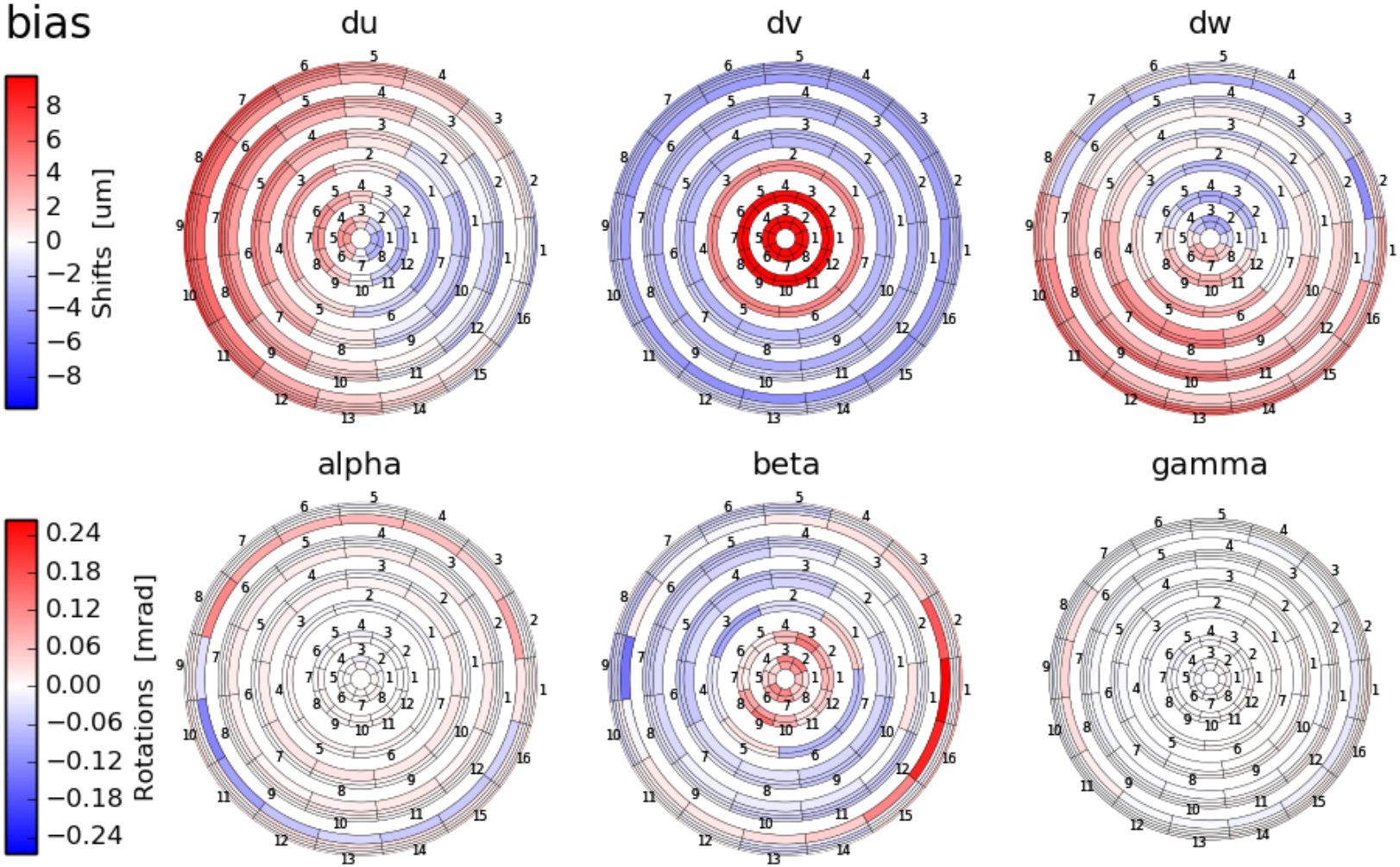
Upsilon by Cluster



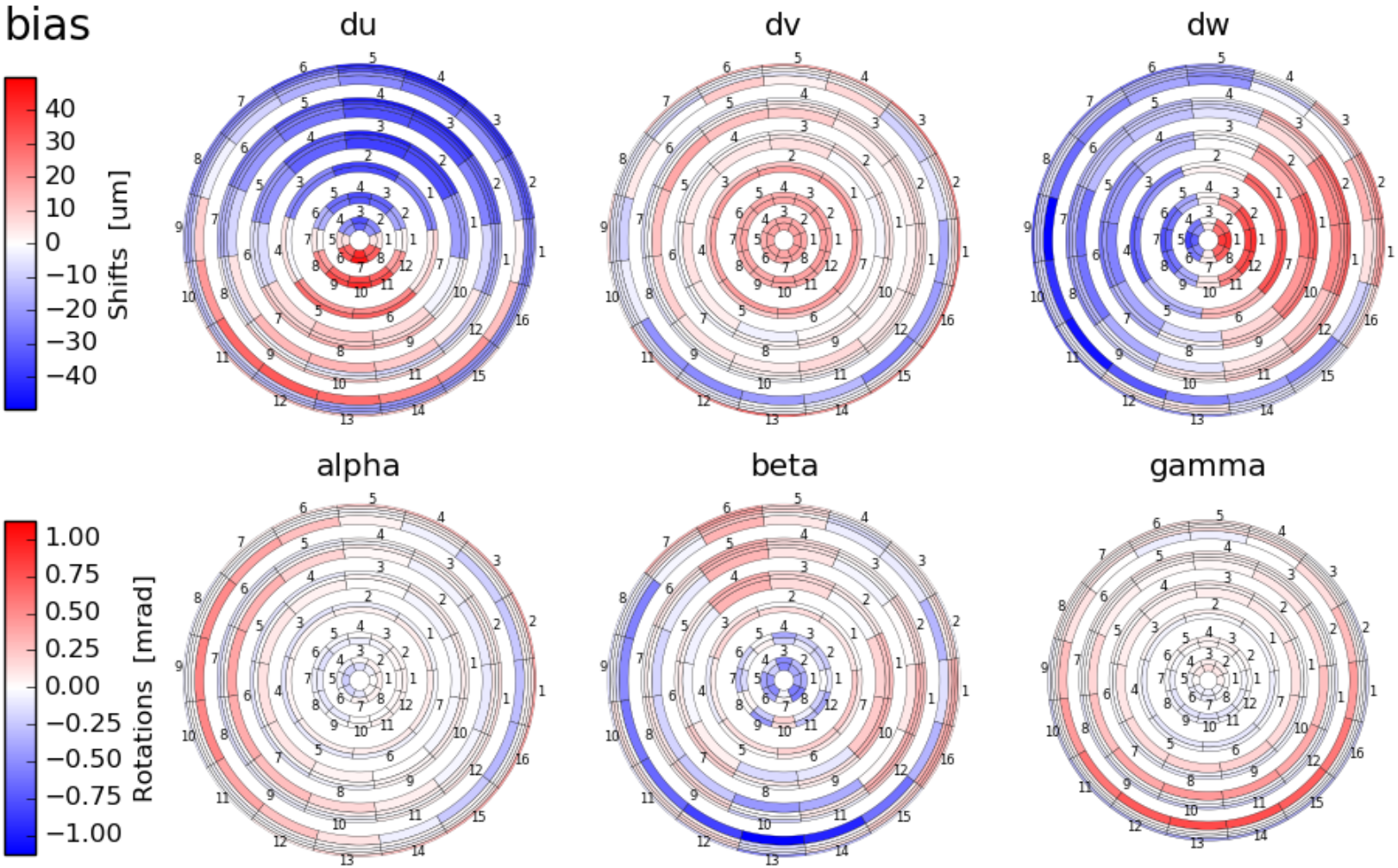
MuonPairs by Cluster



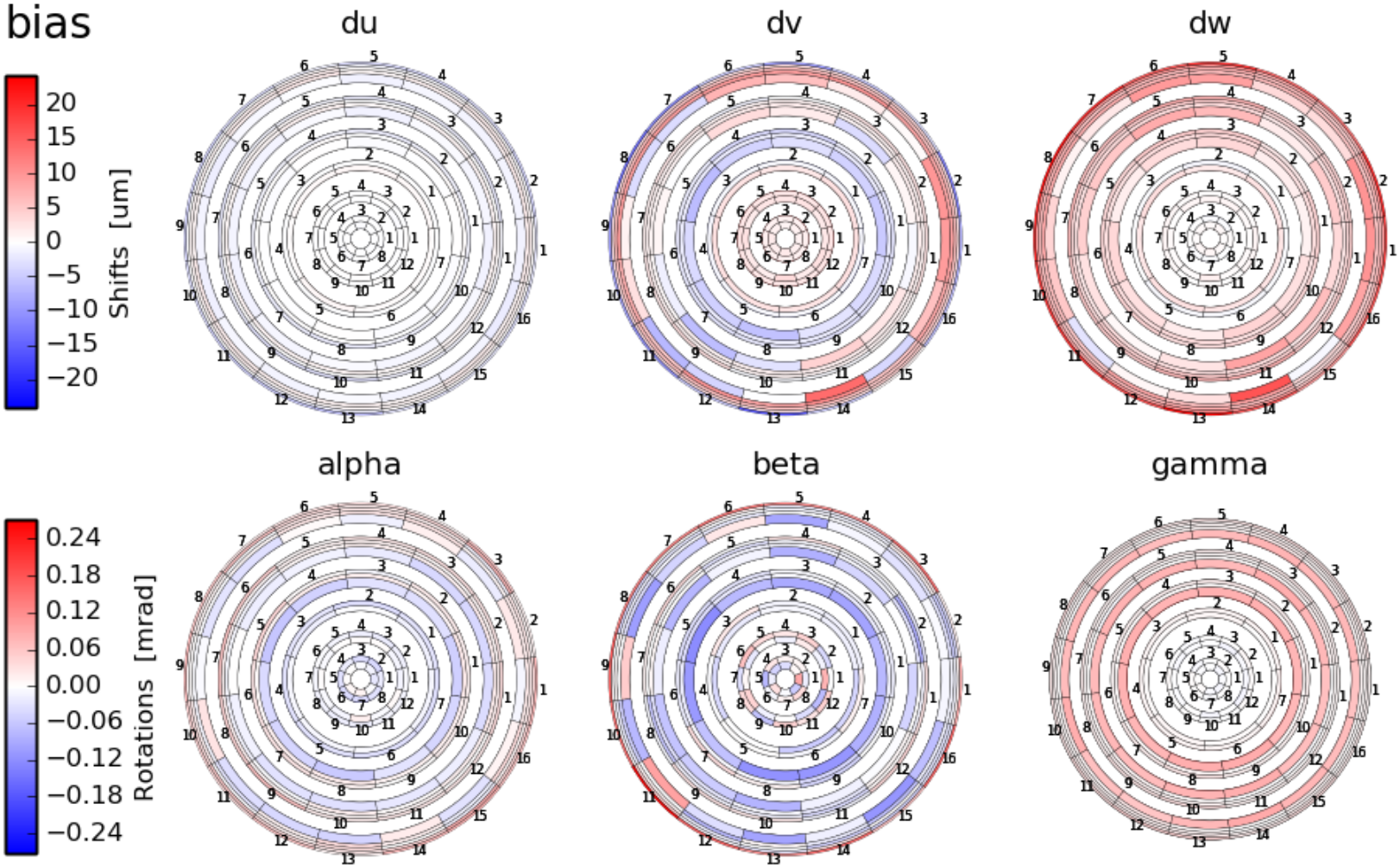
Cosmics by Cluster



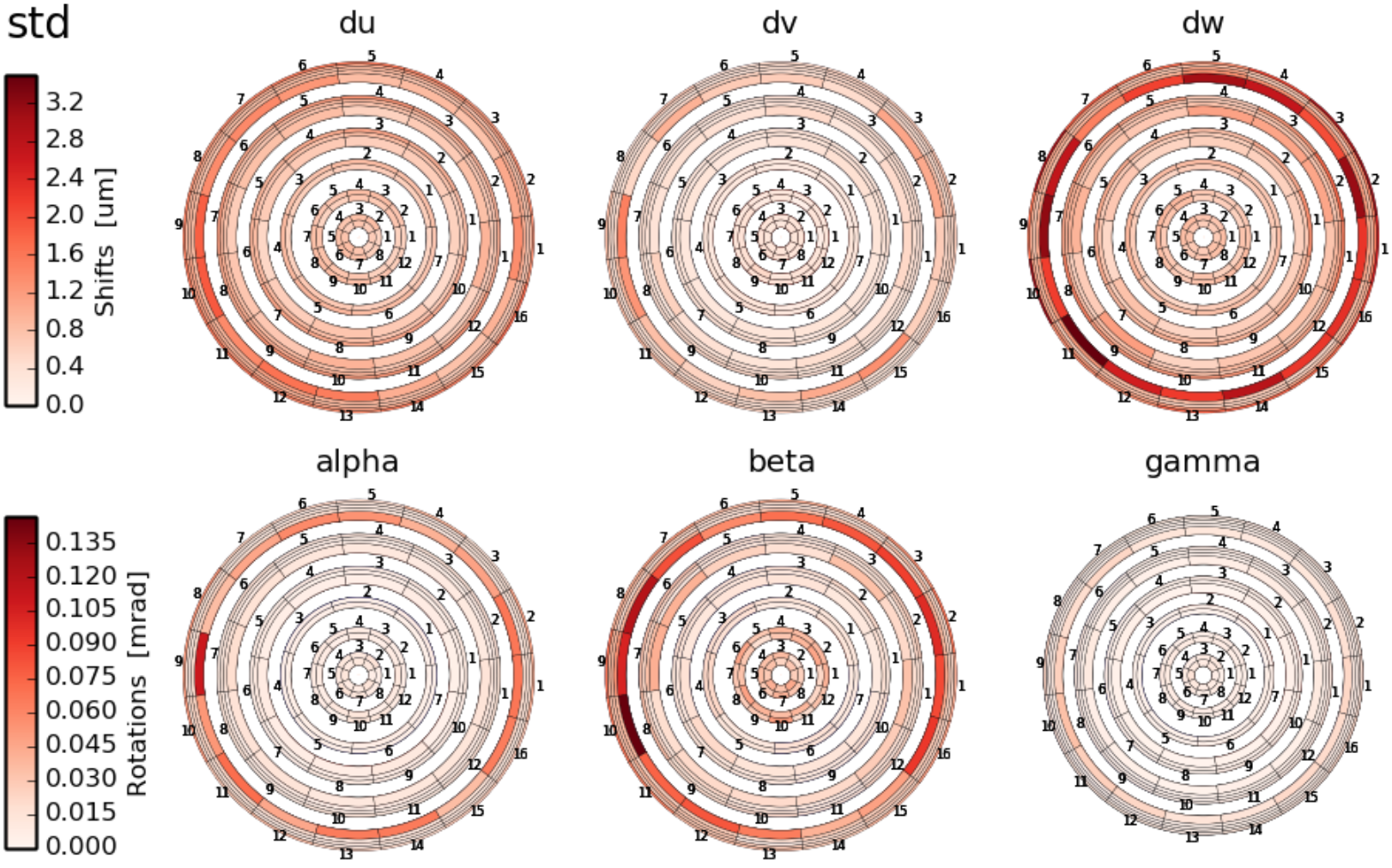
Upsilon by Cluster



MuonPairs by Cluster



Upsilon and Cosmics by Cluster



MuonsPair and Cosmics by Cluster