ICP based Software Alignment at Lumi

Progress Report

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Software vs. Hardware Alignment

Hardware Alignment

Measurements of component positions with:

- Laser Trackers
- Theodolites
- Rulers
- etc.

Software Alignment

Determination of component positions with:

- measurement data
- cosmic rays
- etc.

Both methods give actual positions of components. **This talk is about software only.**

Shift Detector vs. Shift Data

Shift Detector

- Realistic Detector Acceptance
- Realistic scenario for Track Finder, Fitter etc.
- But need to generate MC Data again (esp. If you want multiple misaligned geometries)

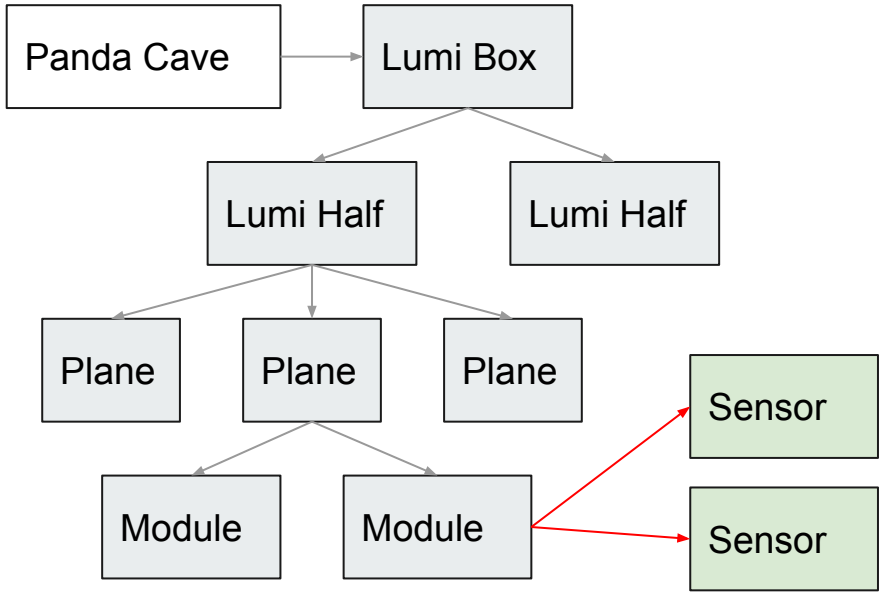
Shift Data

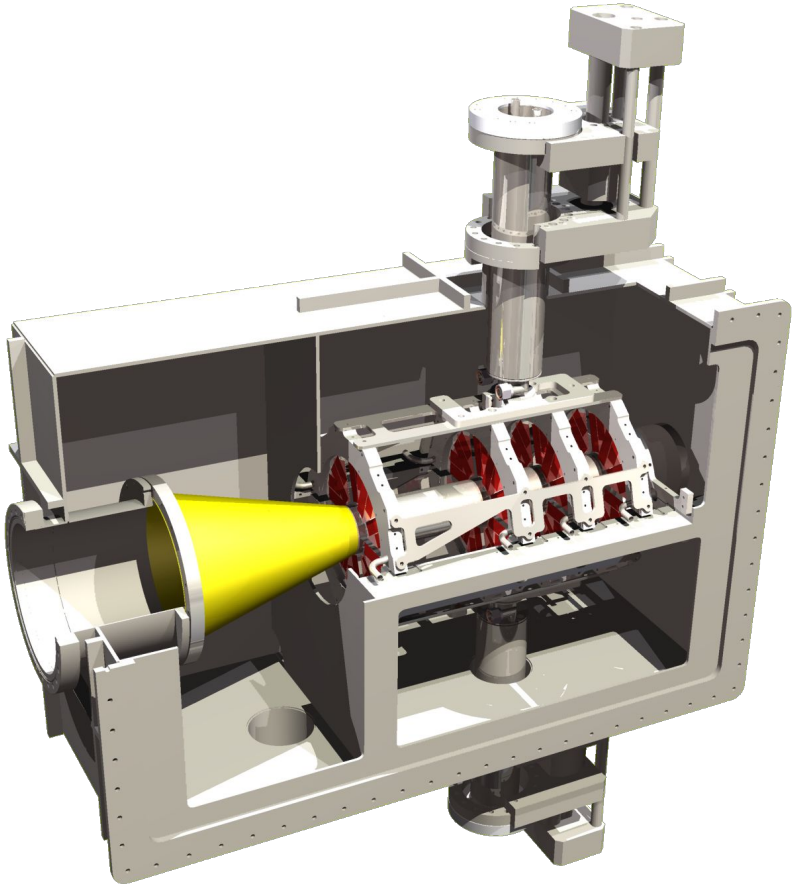
- Can use existing MC data
- Wrong detector acceptance may lead to implausible tracks:
- Don’t see some tracks that should be there
- See tracks that can’t be there

I shifted the detector components and generated new MC data on which the Software Alignment ran.

Lumi Example

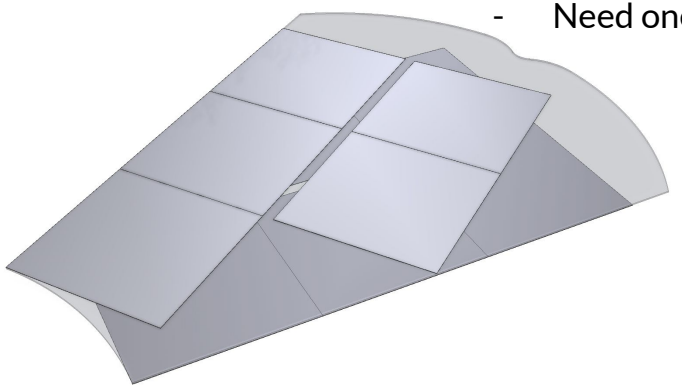
Alignable Components

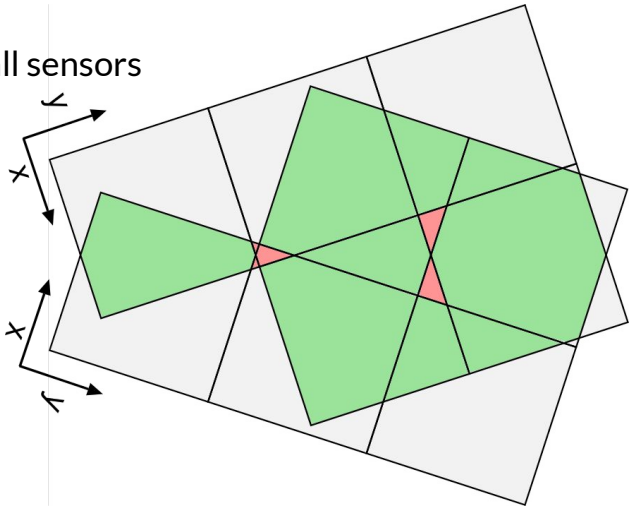




Sensor Alignment with overlapping Areas

- Use overlaps to get matrix s1 -> s2
- Go from sensor to sensor to reach all sensors
- Need one sensor as reference





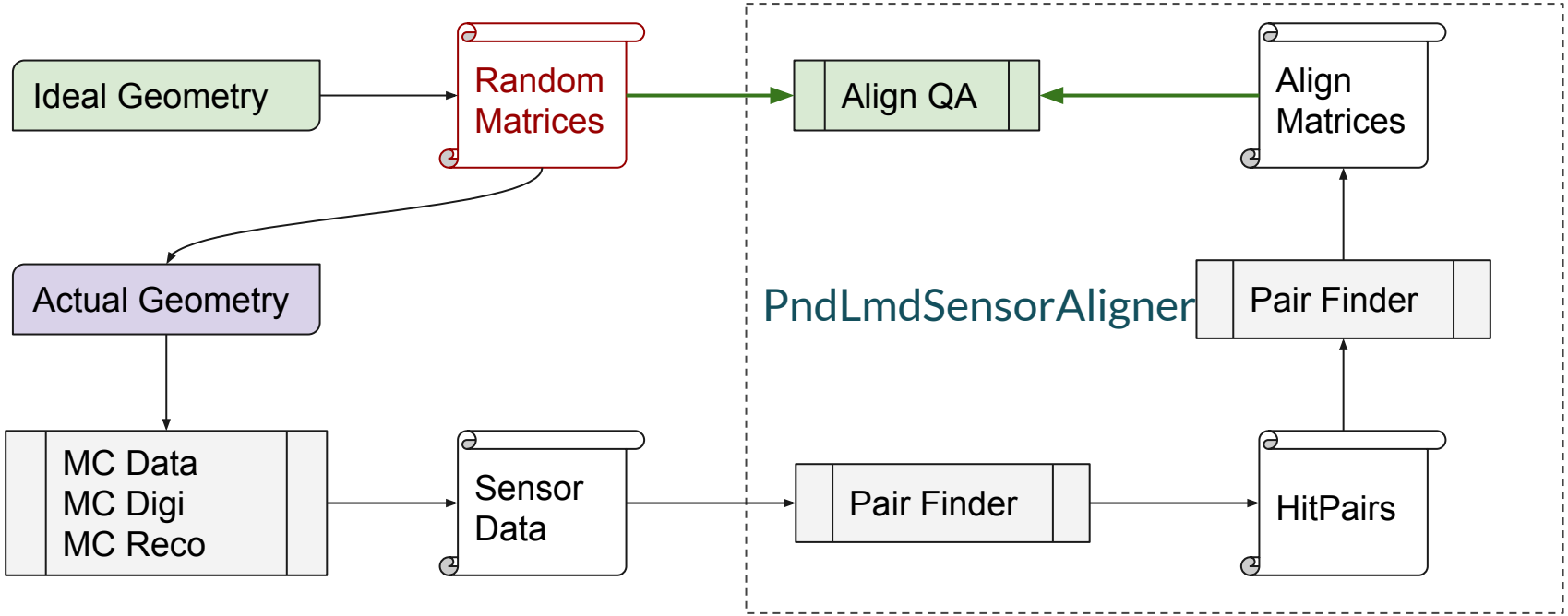
Software Parameters

- We used multiple Geometries
- We Misalign Sensors only
- We allow XY Shift and z-Rotation only
- Enough data for ~ 10^5 pairs/area

We can reach all sensors just be stepping from sensor to sensor by their overlapping areas

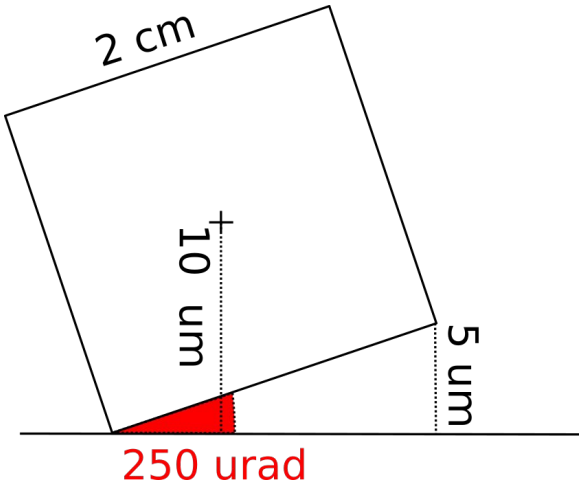
We compare the found alignment matrices with the ones provided to the simulation

Estimate Quality of Alignment



Misalign Parameters

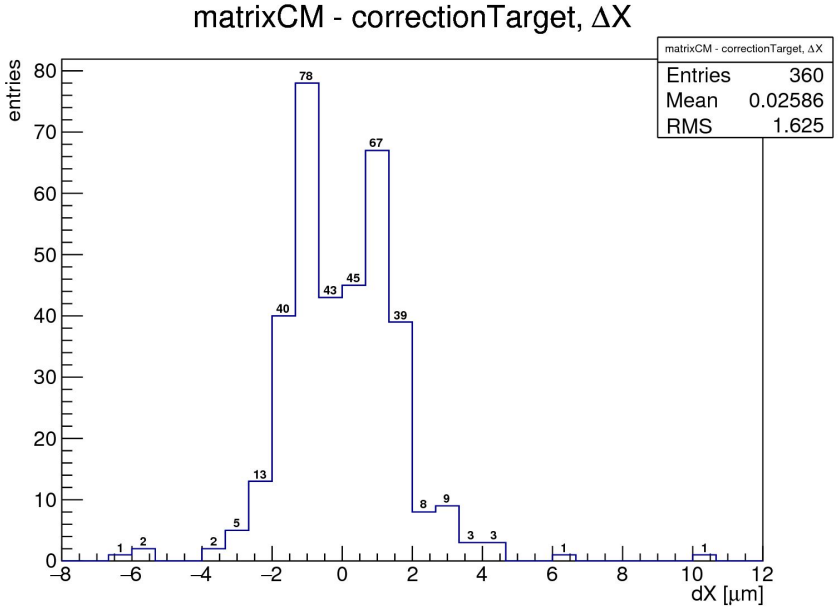
Use a fixed relation shift -> rotation

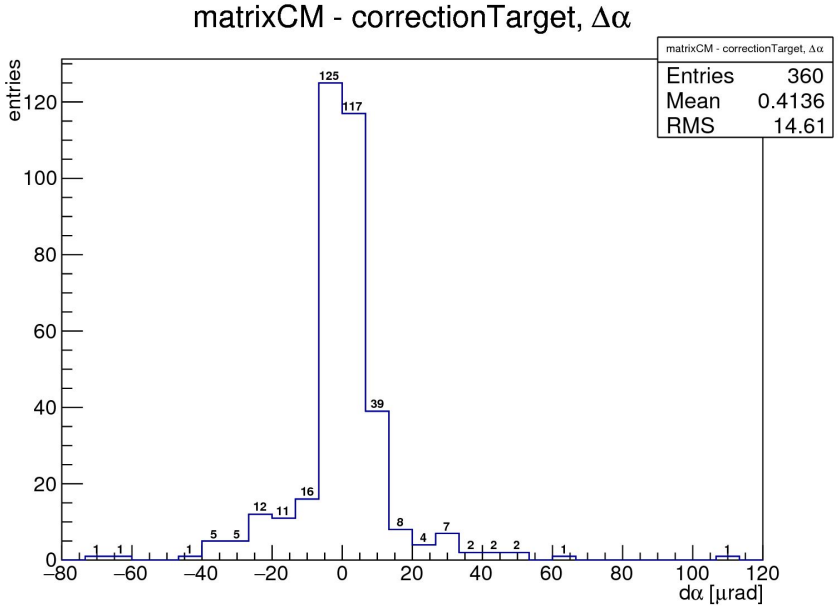


We'll use these shorthands

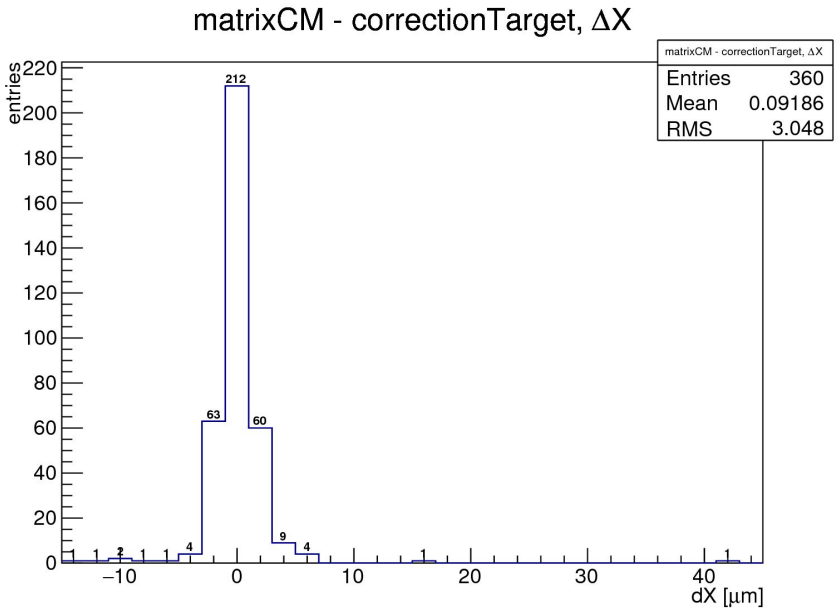
- **0μ** : perfect geometry
- **10μ** : 10μm shift, 250μrad rot
- **50μ** : 50μm shift, 1.25mrad rot
- **100μ** : 100μm shift, 2.5 mrad rot
- **200μ** : 200μm shift, 5.0 mrad rot

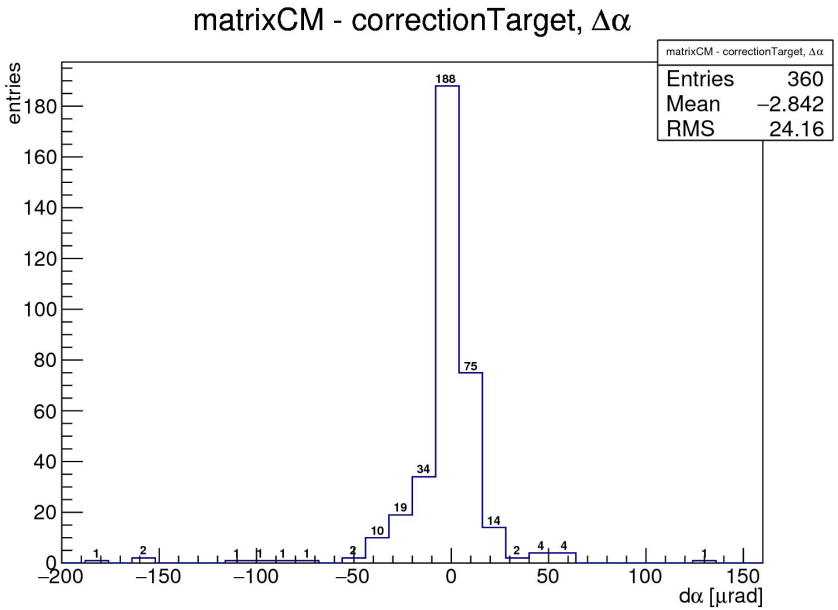
0μ - perfect geometry



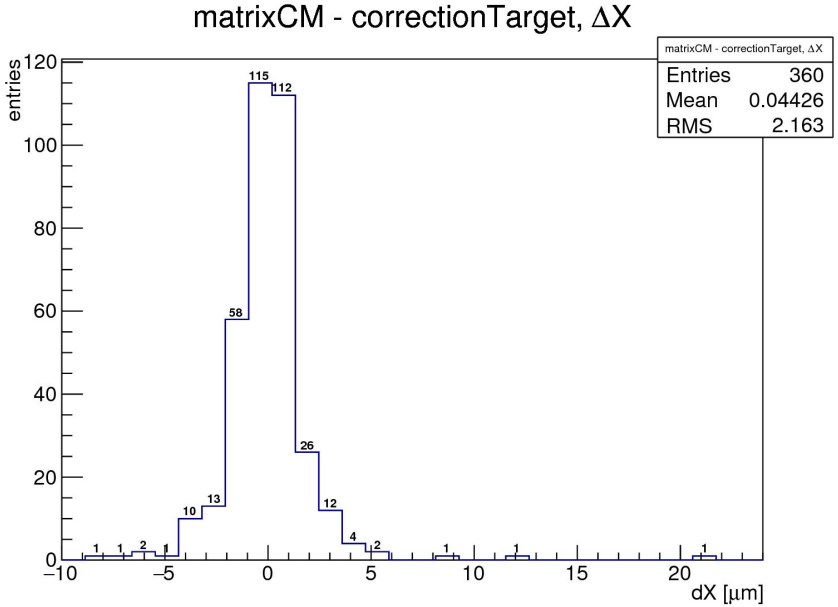


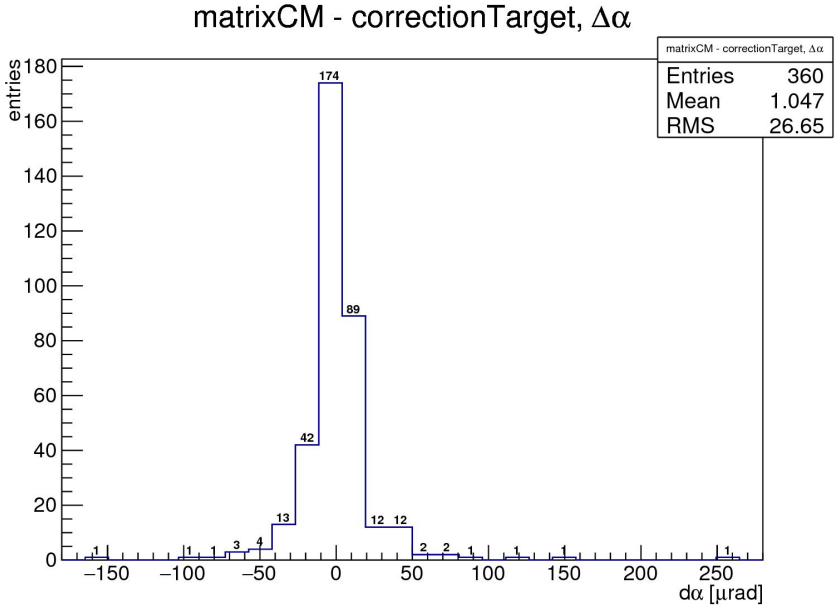
10μ - misaligned geometry



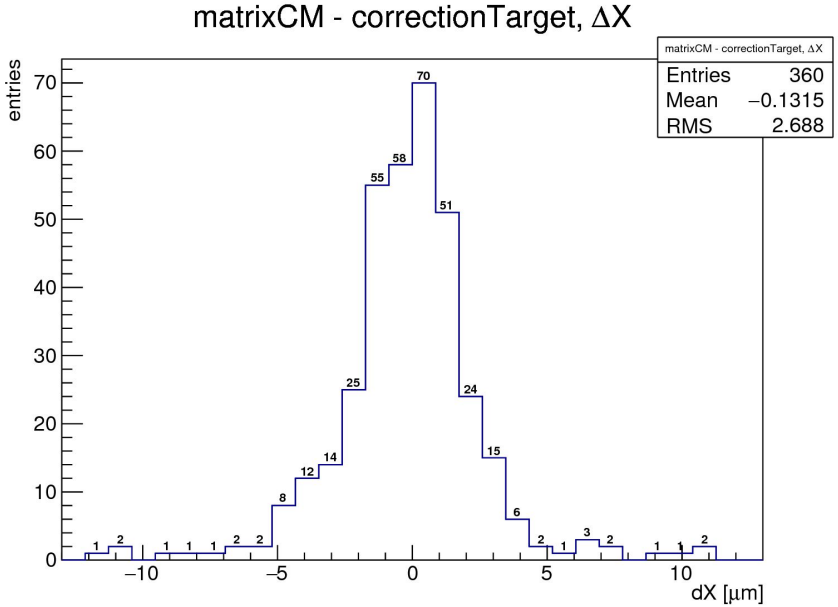


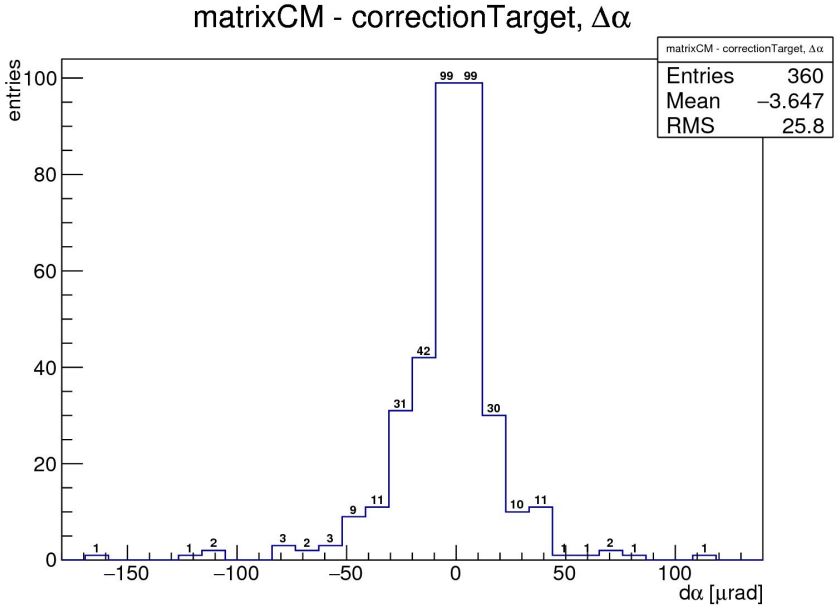
50μ - misaligned geometry



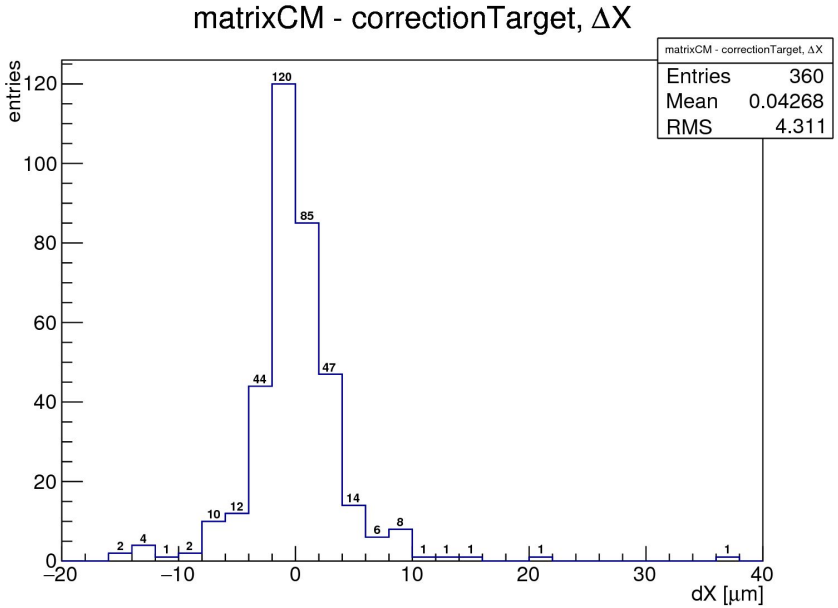


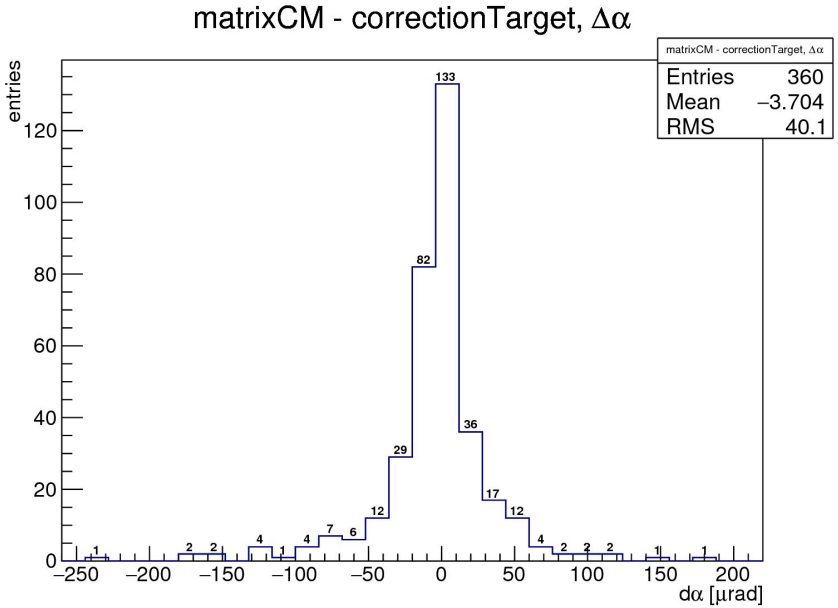
100μ - misaligned geometry





200μ - misaligned geometry





Conclusion

Software alignment using the overlapping areas of two sensors using an ICP algorithm works.

The results are consistent even when the misalignment between two sensors is large.