PIXEL Survey

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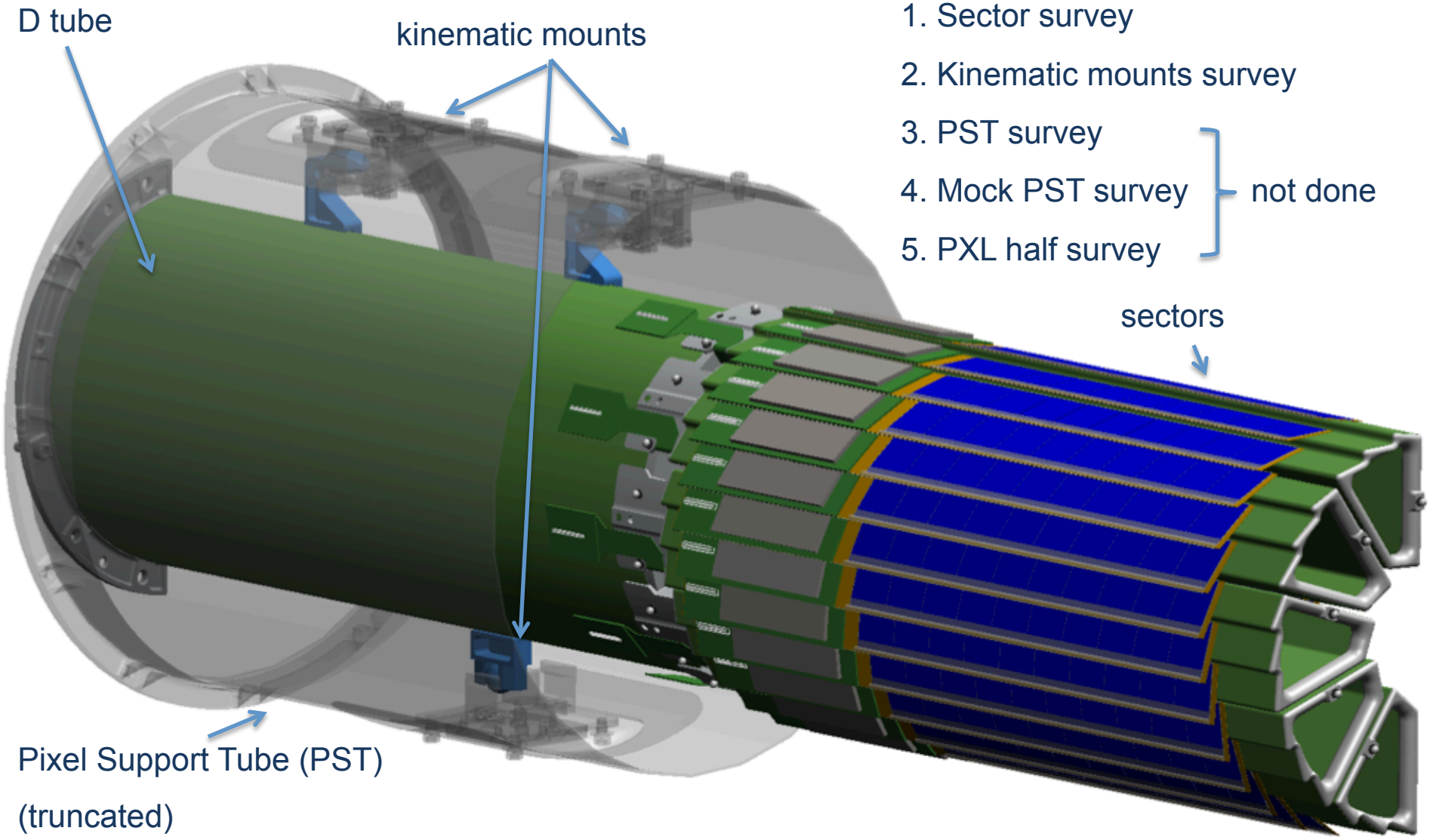
- The overall survey plan
- Sector survey results
    - ladder extension/contraction and sagging
    - sensor and sector repeatability
- DB
- Summary and to-do

Overall Survey Plan

Steps:

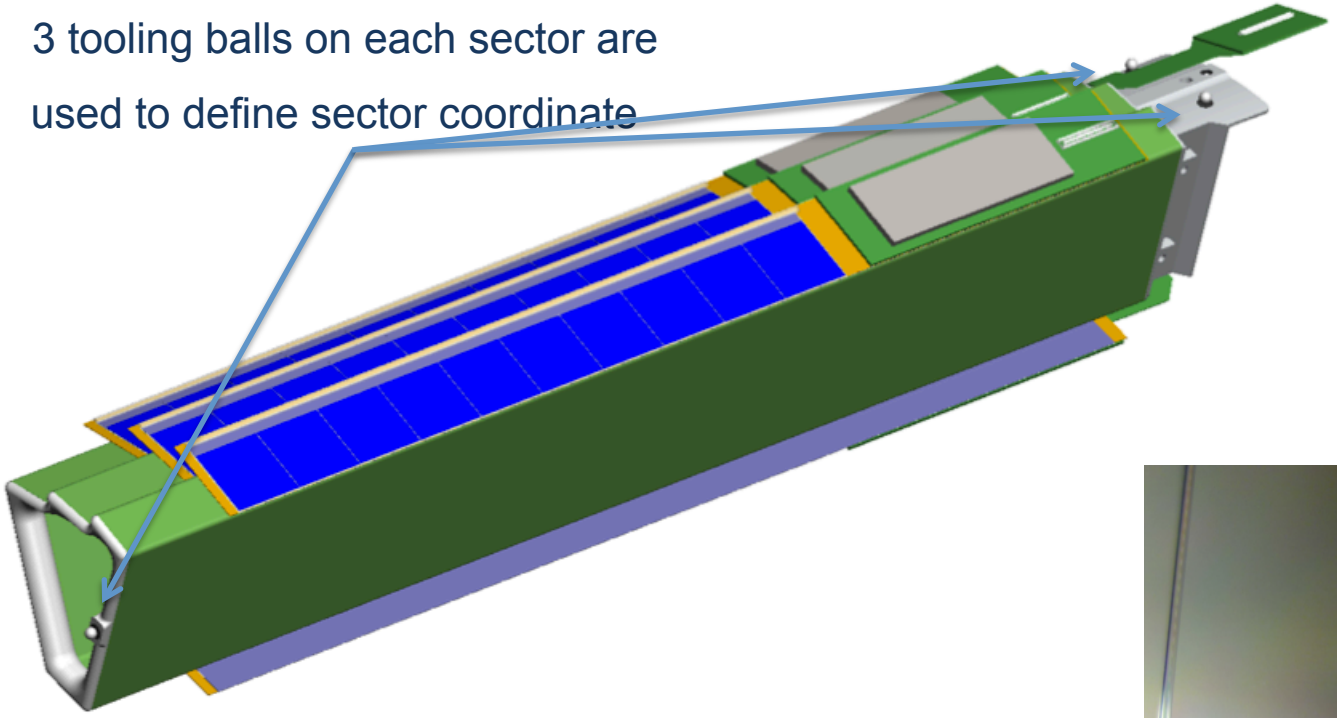
1. Sector survey
2. Kinematic mounts survey
3. PST survey
4. Mock PST survey
5. PXL half survey

not done

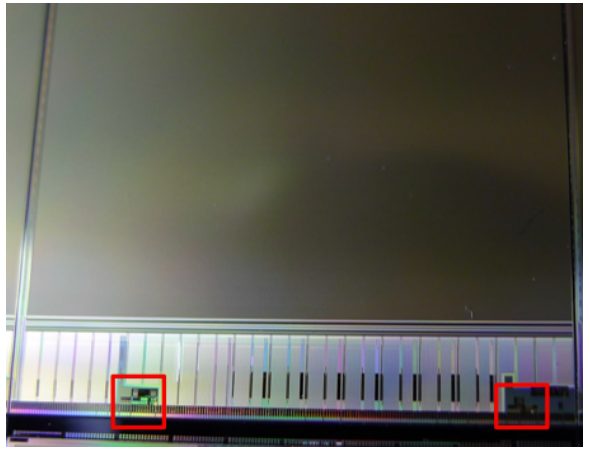


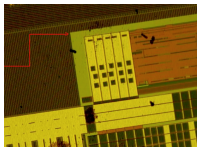
Sector Survey

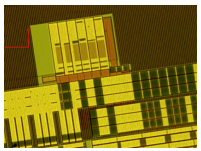
- 3 tooling balls on each sector are used to define sector coordinate



- 2 features on each chip/wafer are used to define chip local coordinate
- Each chip is scanned with 121 points to get the surface profile





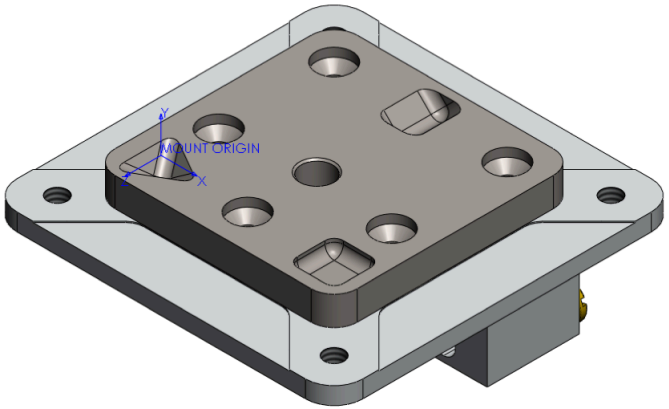


Kinematic Mounts Survey

outside

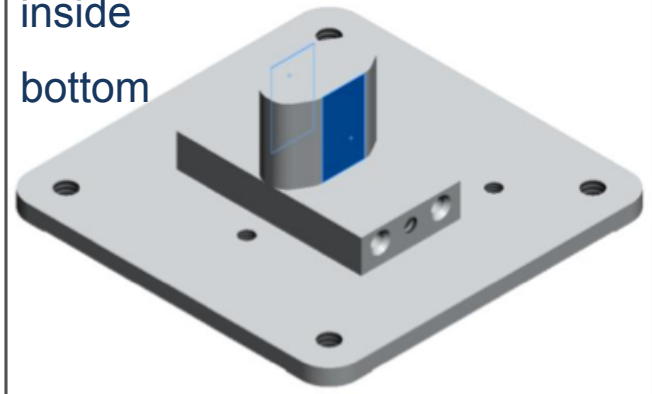
survey 3 balls with 3/2/1 dimension constrain

define coordinate



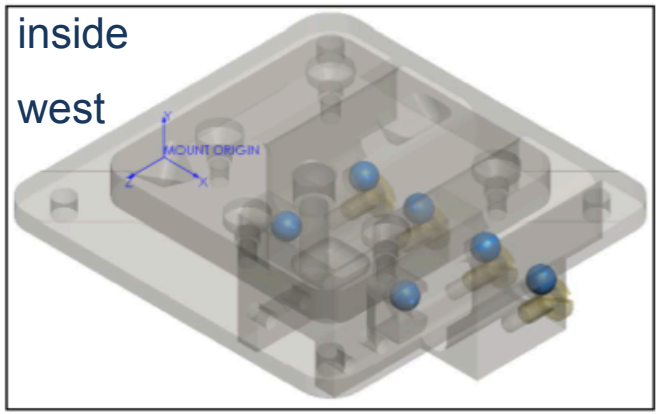
inside

bottom



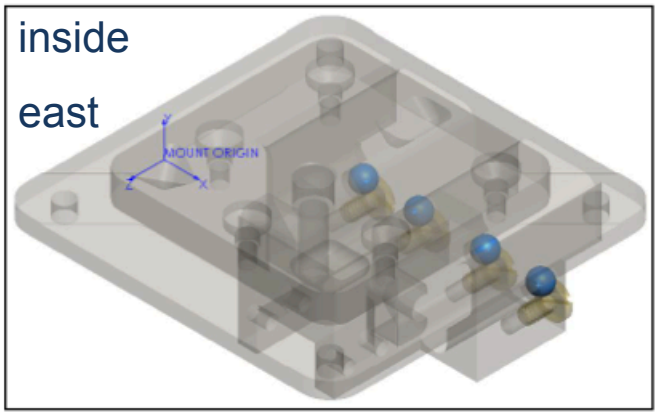
inside

west



inside

east



inside

survey balls or

surfaces that will

mount the D tubes

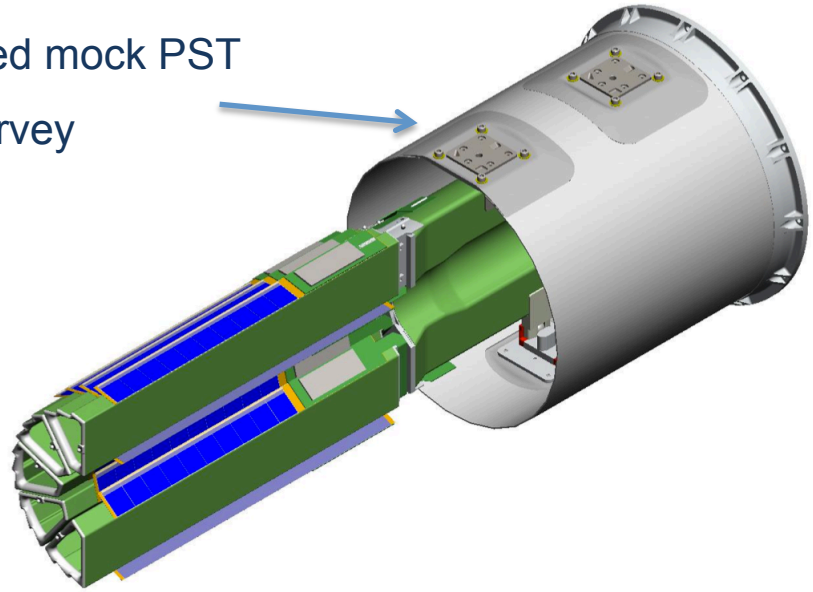
PST Survey and PXL half survey

the PST to be used in STAR

- PST Survey:

For both the PST to be used in STAR and the truncated mock PST, the positions of the 3 kinematic mounts relative to the tube will be surveyed.

the truncated mock PST used for survey

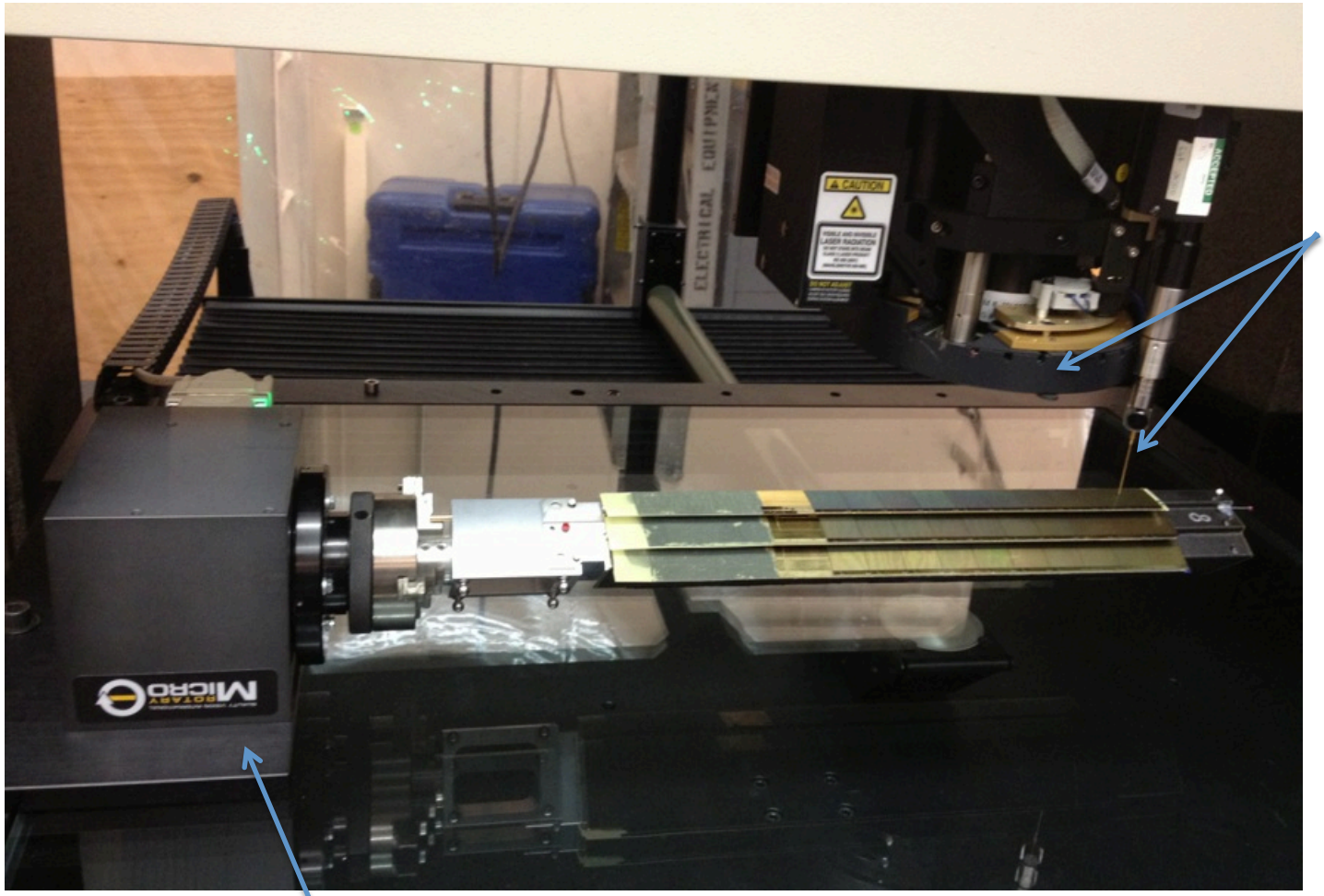


- PXL half survey:

Survey the positions of 3×5 tooling balls on 5 sectors relative to the mock PTS.

With survey of both (real) PTS and mock PTS mentioned before, the sector positions in (real) PTS can be figured out.

Sector Survey Set-up

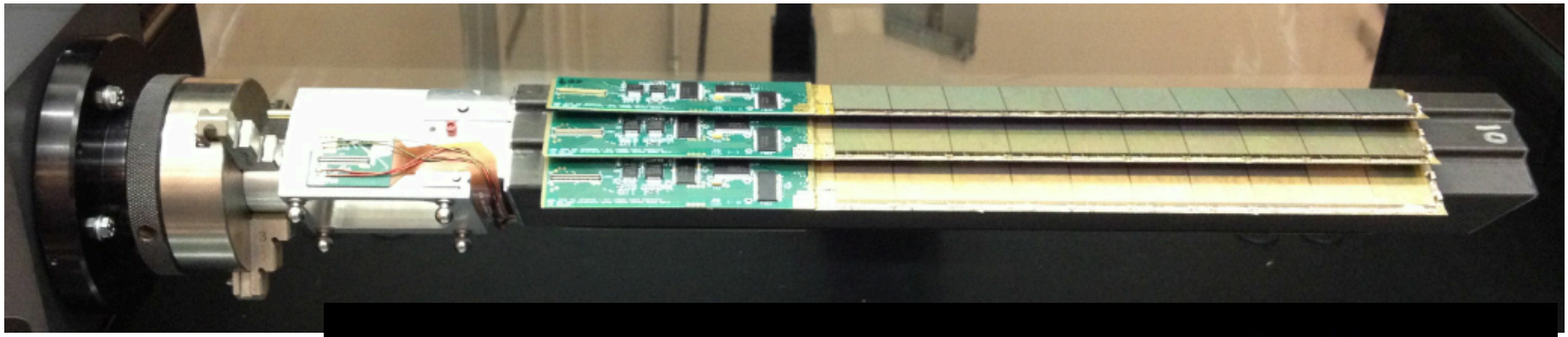


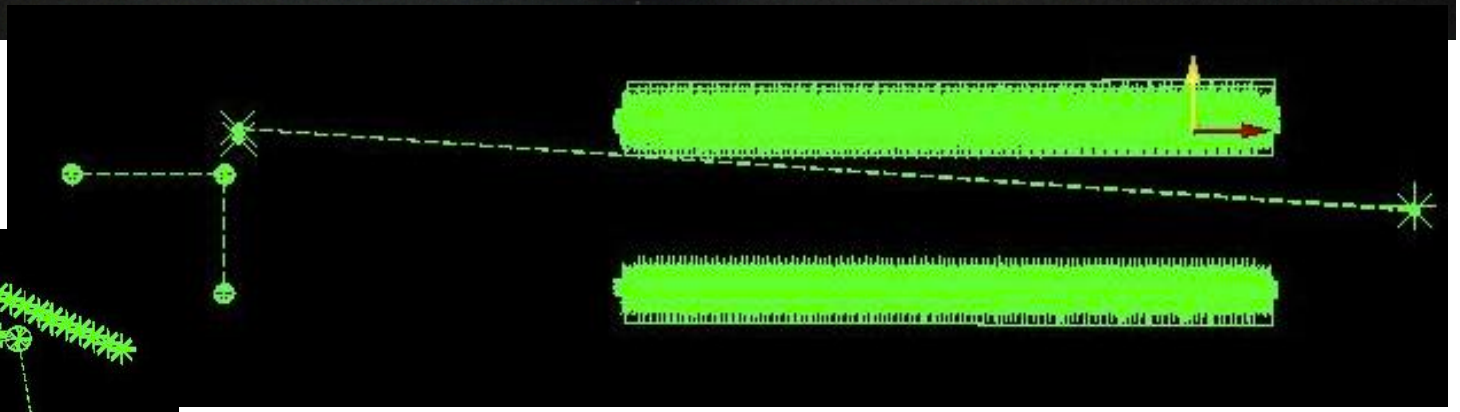
vision and stylus probes, both with µm level precision

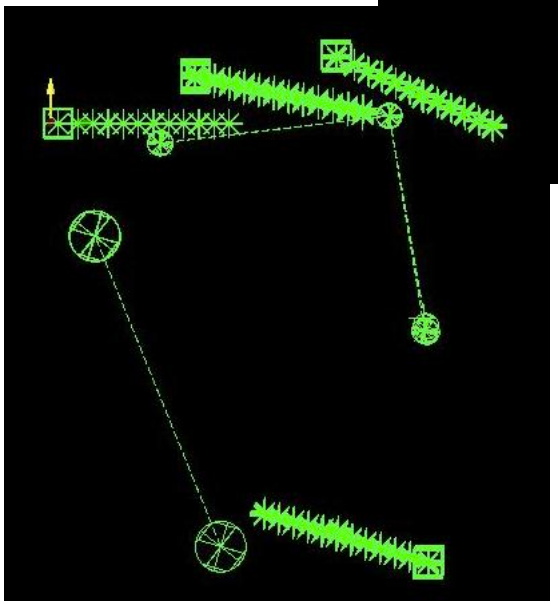
A Coordinate Measuring Machine (CMM) is used.

In order to probe different ladder surfaces, the rotary head rotates the sector to different angles

Sector Survey Results

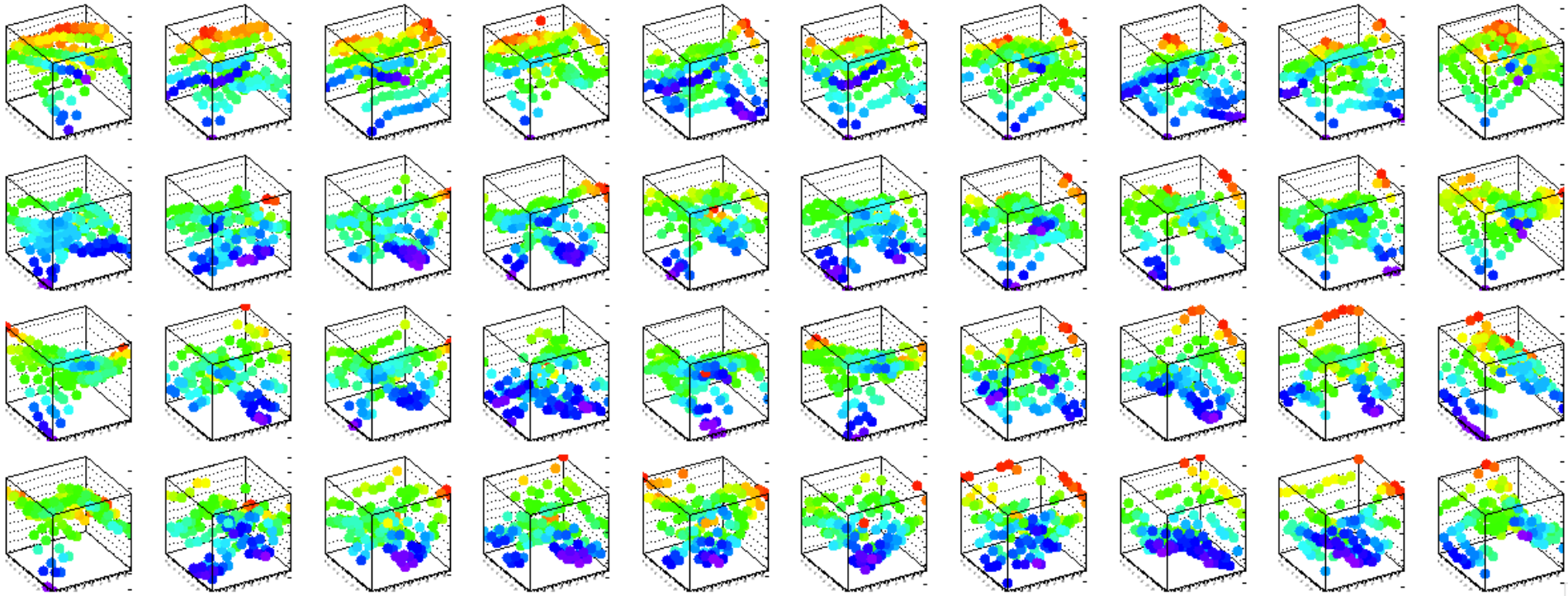






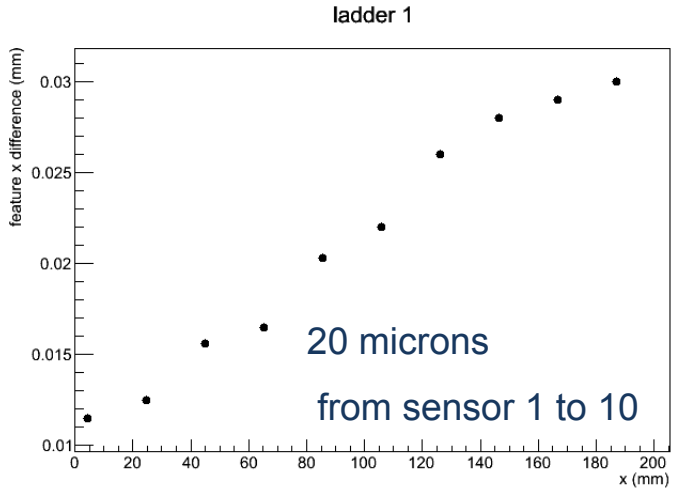
- all 3 sector has been surveyed >= 3 times

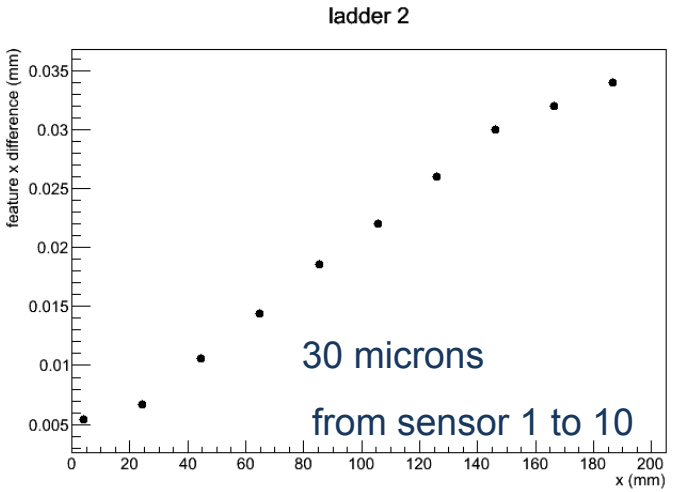
Sector Survey Results

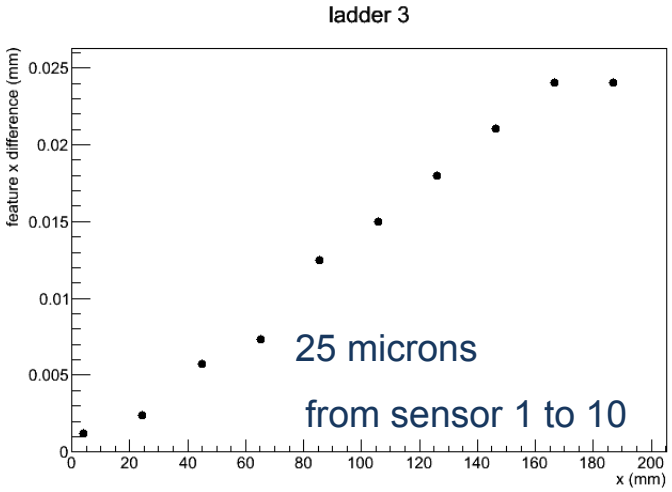


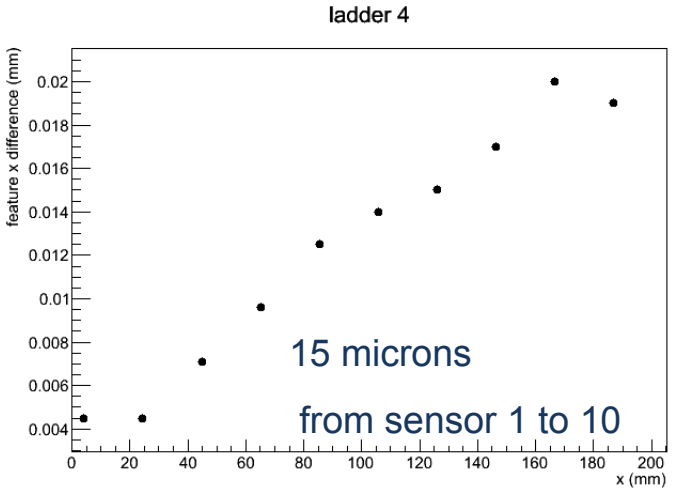
- 11 × 11 measurements on each chip, more than 5000 steps, ~7.5 hours in all
- ~1 hour with some manual work, the rest is automatic
- a maximum variation of ~50 μm in local y direction > position resolution of the PXL detector

The Ladder Extension



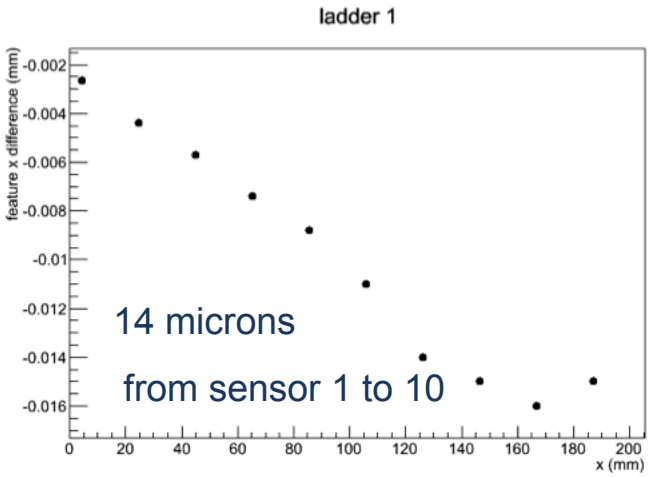


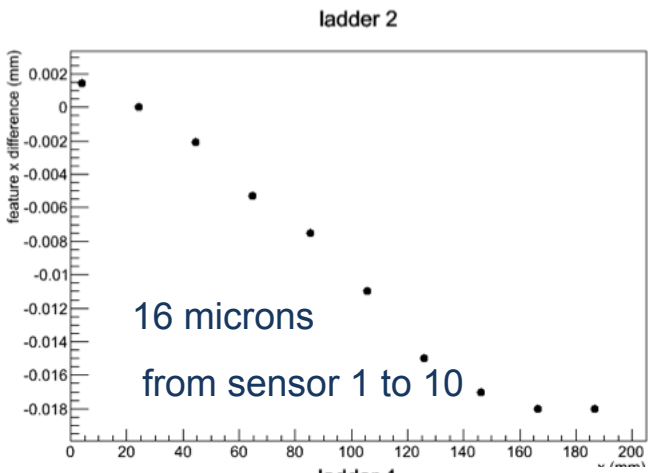


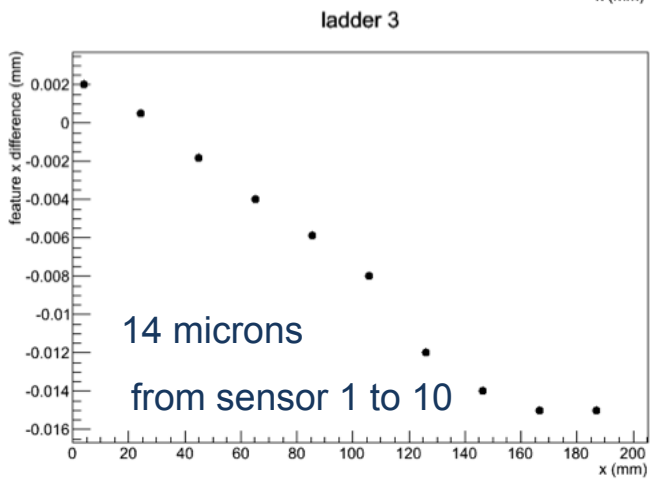


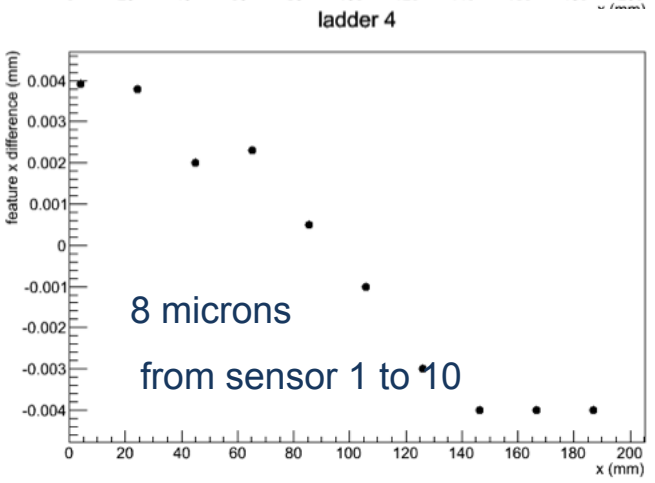
- Mar 19 - Jan 29
- Slope of difference in local x direction can not be explained by error for tooling ball measurement
- All ladders “grows” longer from Jan to Mar, but at a little different ratio (7e-5 ~ 15e-5)
- The reason still to be explored.

The Ladder Contraction



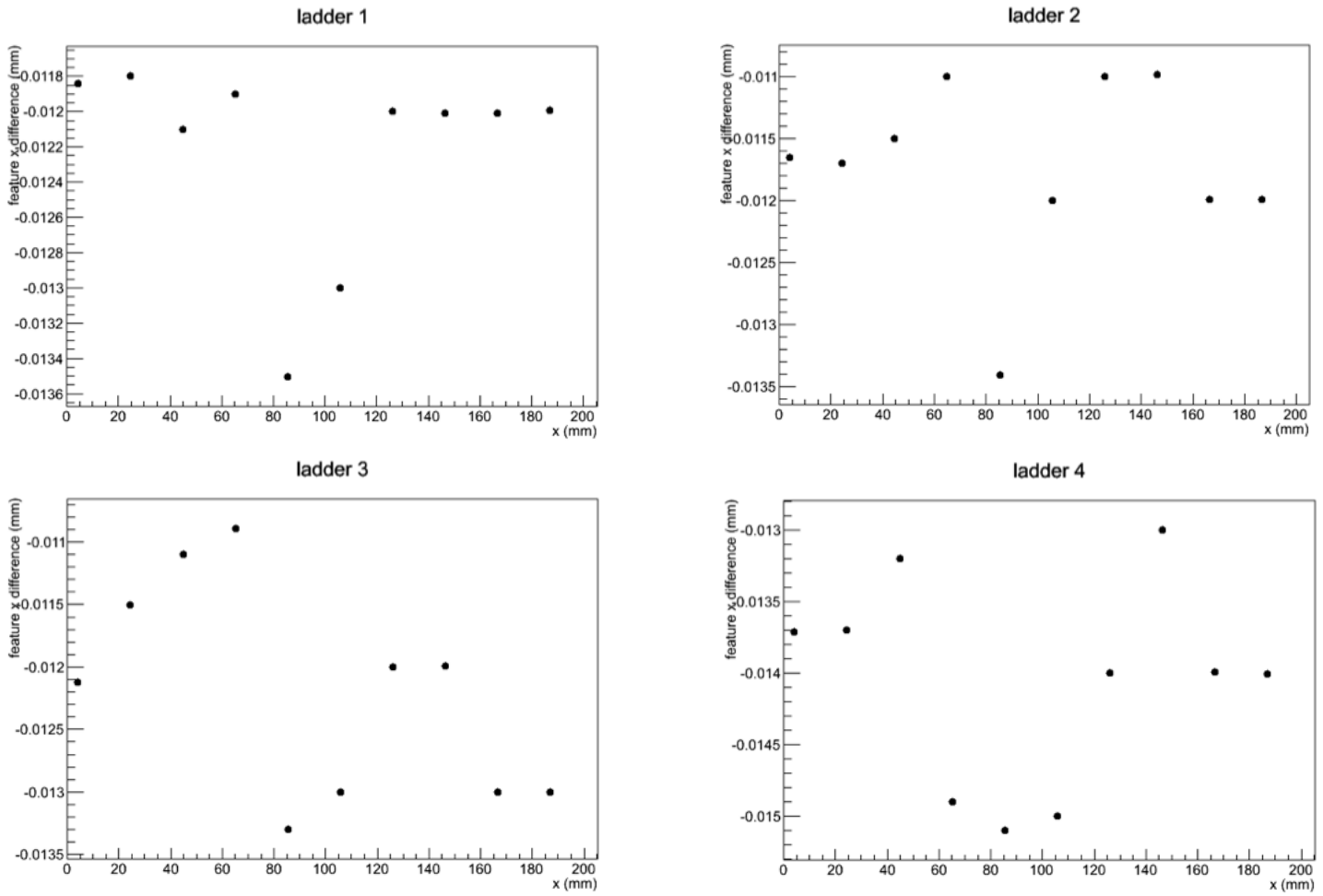






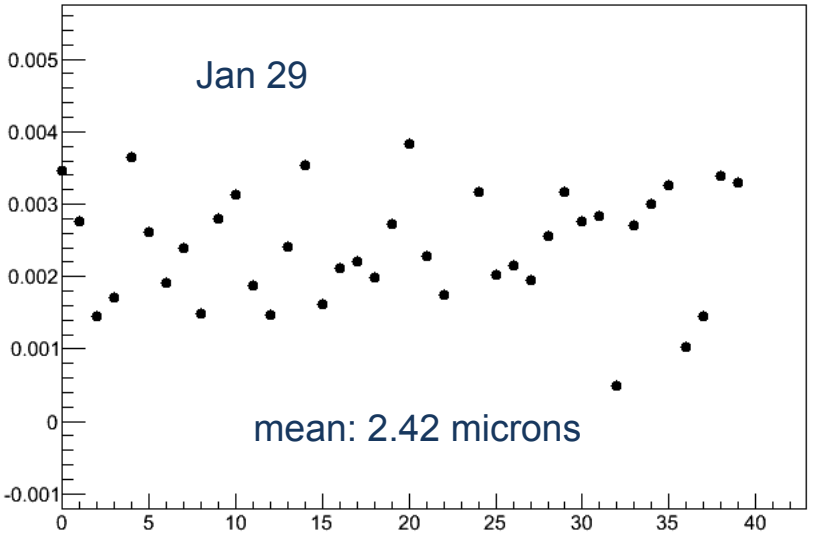
- April 05 – Mar 19, sit in a tube during the days between
- All ladders get shorter

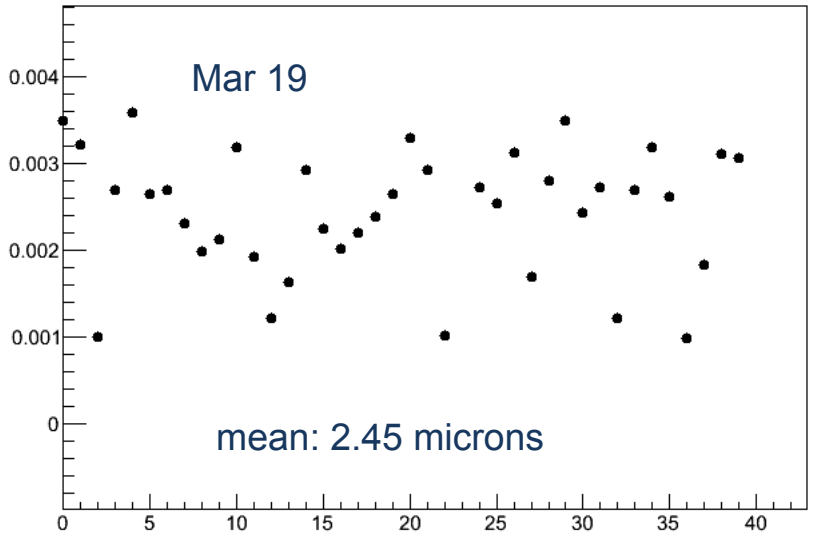
No Apparent Change with Dehydrant



- April 09 – April 05, sit in a tube with dehydrant
- No large deformation

Feature Distance within a Sensor





Measured distance – designed distance vs. sensor Id

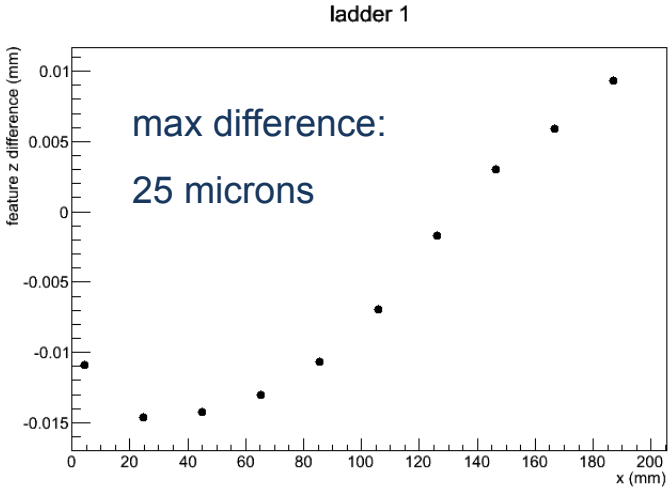
- Both measurements average at ~ 2.4 microns longer comparing with design
- → extension ratio 18e-5
- → ~ 4 microns over the sensor length
- Sensor by sensor fluctuates, this fluctuation pattern can be observed repeating between the two measurements
- The difference of the mean between the two measurements are barely noticeable << the ladder extension

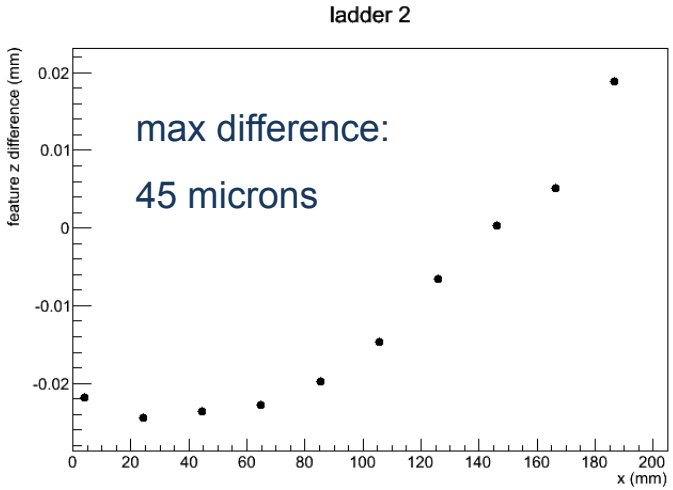
Tooling Ball Distance

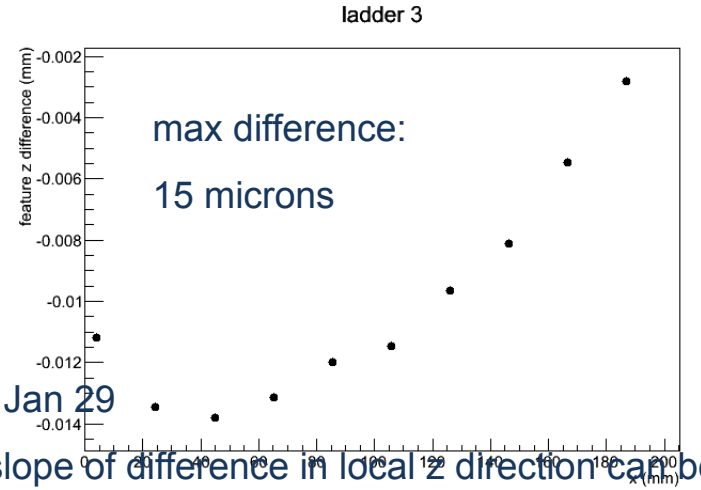
- Processing ballDistances.C("sector01_0129")...
- 385.925
- 385.924
- 385.924
- Processing ballDistances.C("sector01_0319")...
- 385.925
- 385.926
- 385.923
- root [1] .q
- Processing ballDistances.C("sector01_featureOnly_0405")...
- 385.927
- 385.927
- 385.925
- root [1] .q
- Processing ballDistances.C("sector01_featureOnly_0409")...
- 385.928
- 385.927
- 385.923

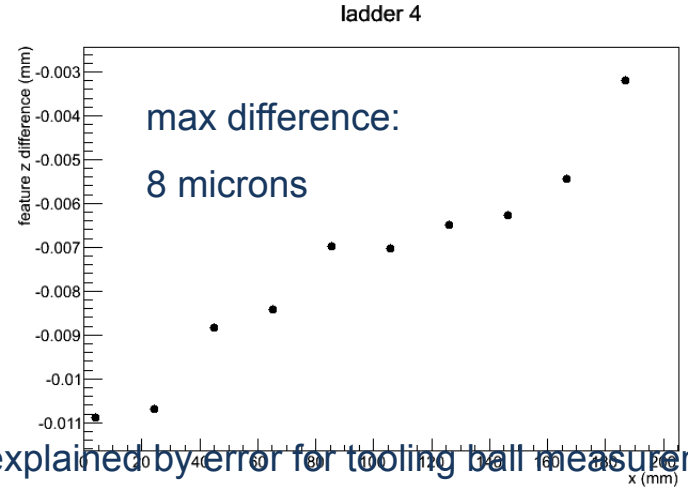
- distances between tooling balls at the 2 ends of sector
- measured 3 times per run
- changes with 2 microns << ladder extension and contraction

The Ladder "Sagging"



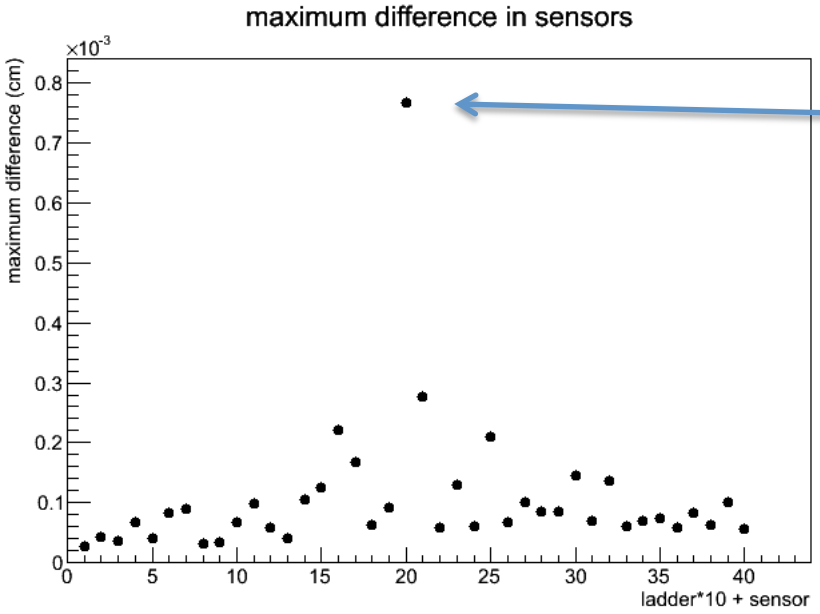




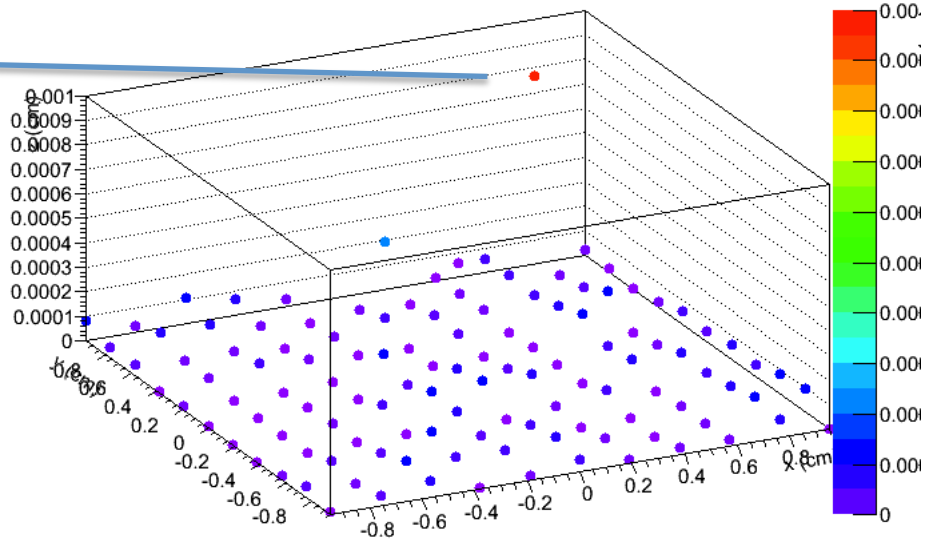


- Mar 19 - Jan 29
- A small slope of difference in local z direction can be explained by error for tooling ball measurement (several microns)
- But all 3 top ladders show similar large scale pattern, with 2nd order deformation, lowest at the middle of the ladder
- The reason still to be explored

Repeatability within Sensors



maximum (minimum difference between 4 survey runs) in different sensors



minimum difference between 4 survey runs point by point ladder 1 sensor 10

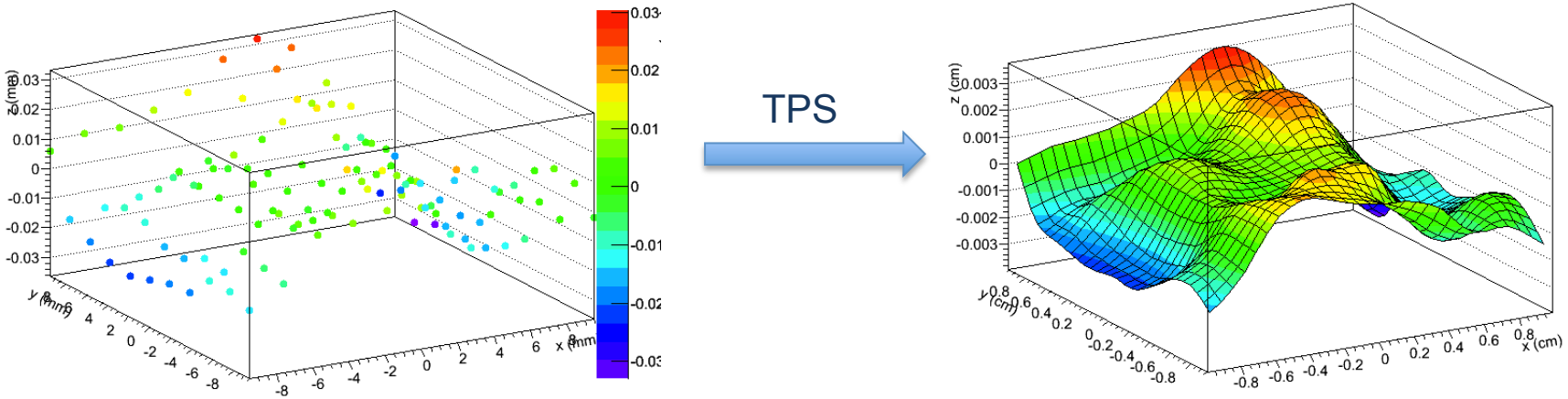
- use the average of the nearest 2 measurements out of 4, to get rid of outliers
- the nearest 2 measurements are usually repeatable within several microns

DB

- Survey results are transferred to offline geometry DB parameters
- There are more number of free parameters than needed, we minimize deviation from designed geometry at each detector level.
- From STAR global to chip, rotation + shift is the only correction.

global = tpcOnGlobal * idsOnTpc * pstOnIds * pxlOnPst * HalfOnPxl * sectorOnHalf * ladderOnSector * sensorOnLadder * sensorLocal

- Within a sensor, the surveyed profile is described by the Thin Plate Spline (TPS) method, which fill up the whole profile from the finite number of survey measurements.



Summary and To-do

- Whole pxl detector with respect to PST can be surveyed, including sensor surface fine profile.
- For the engineer run, 3 sectors are surveyed but the whole pxl survey is not done -> sector relative positions only rely on calibration.
- Sensor surface has a maximum variation of ~50 μm.
- Mysterious ladder extension/contraction and sagging is observed, to be further explored. But sector and sensor dimensions looks constant.
- One sector survey run takes ~ 8 hours.
- Each sector is surveyed no less than 3 times, using minimum difference to get rid of outlier measurements. The repeatability between 2 nearest measurements is usually several microns.
- Survey results are transformed into DB parameters and used for offline data process.

Thank you

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