SSD Alignment Issues

and a few comments from GvN about the IST

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The IST

STAR HFT

- **Who:**
  - **Bob Soja has expressed interest, probably combination of him and GvN will do the survey**
- **What:**
  - **Targets will be the 4 corners of the active area of each module**
  - **Mounts on MSC need to be surveyed at LBL**
- **When:**
  - **Winter 2013**
- **Where:**
  - **In the clean room**
- **Why:**
  - **Survey will give position of silicon sensor active area with respect to the mounting points provided on the MSC**
- **How:**
  - **Optical survey machine at BNL (already exists)**
- **Schedule:**
  - **expect to be able to survey 2 staves per day, so 14 days for mounted staves plus spares**

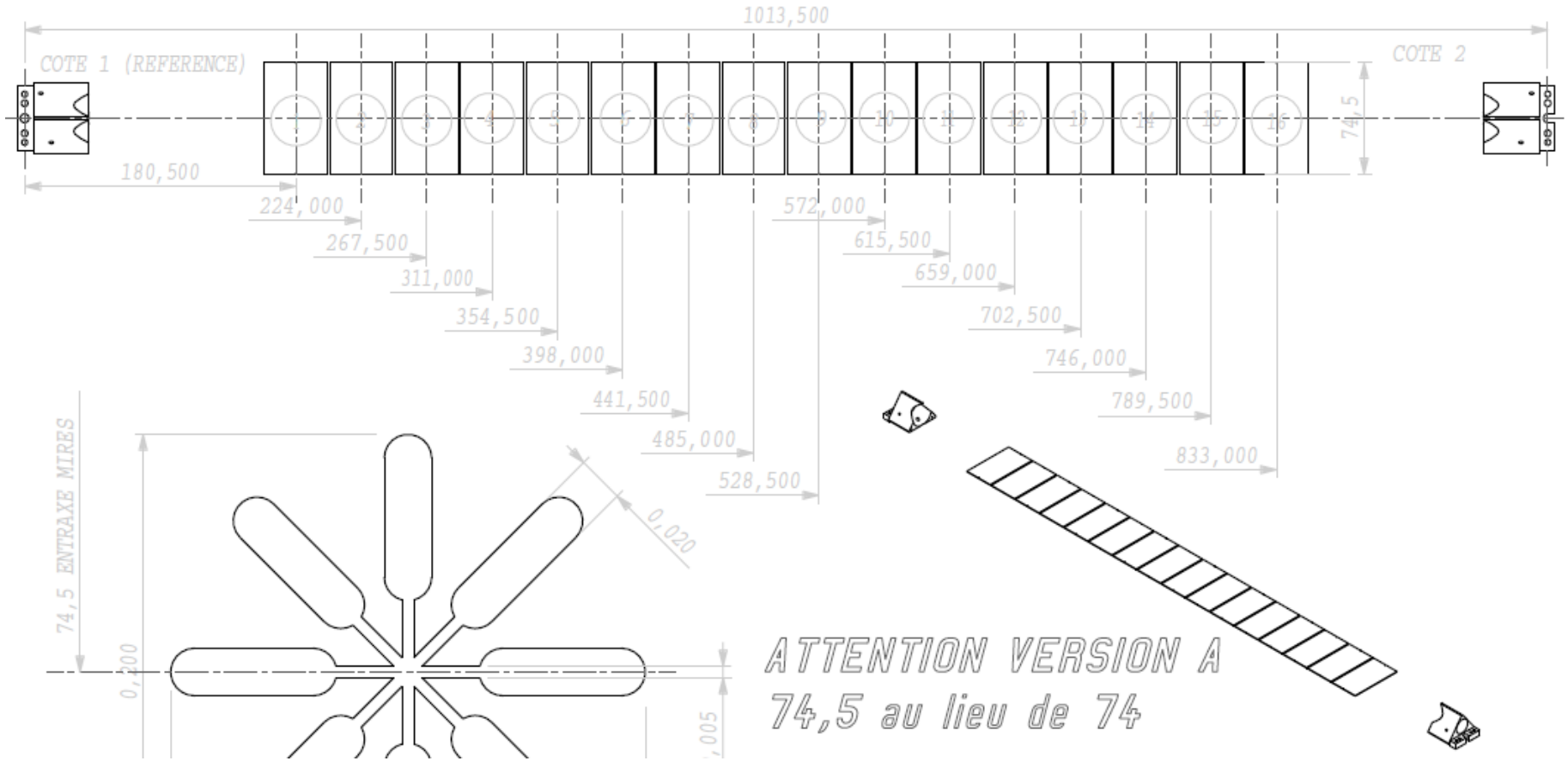
The SSD

- **Who:**
  - **Bob Connors is the expert. Joe Silber. Howard Matis has done good work but now we are looking for new legs on this project.**
- **What:**
  - **Multiple targets on each Si module, measure relative to pin on end**
  - **Mounts on OSC need to be surveyed at LBL**
- **When:**
  - **Fall & Winter 2013**
- **Where:**
  - **LBL shops**
- **Why:**
  - **Survey will give position of silicon sensor with respect to the mount points on the OSC**
- **How:**
  - **Optical survey machine at LBL (already exists)**
- **Schedule:**
  - **expect to be able to survey 2 ladders per day, so approximately two weeks to do all 20 ladders**

SSD: Prior Survey Data

- The SSD ladders were previously surveyed
- Data were recorded as delta offsets from a theoretical model
  - The “model” has recently been located in the archives
- Ladders were found to have a curvature in (local) Z direction
  - it was *assumed* that this is permanent feature (not gravity)
- It is not clear that we have all of this information available today
  - The good news is that new things turn up every day
  - however, existing databases for the SSD/SVT in the STAR code include the sum of many effects and do not preserve the primary records on how the total sum was achieved
- Even if we had complete records, it is worthwhile to check the previous results … looking for errors or changes that might coincide with the installation of the new electronics

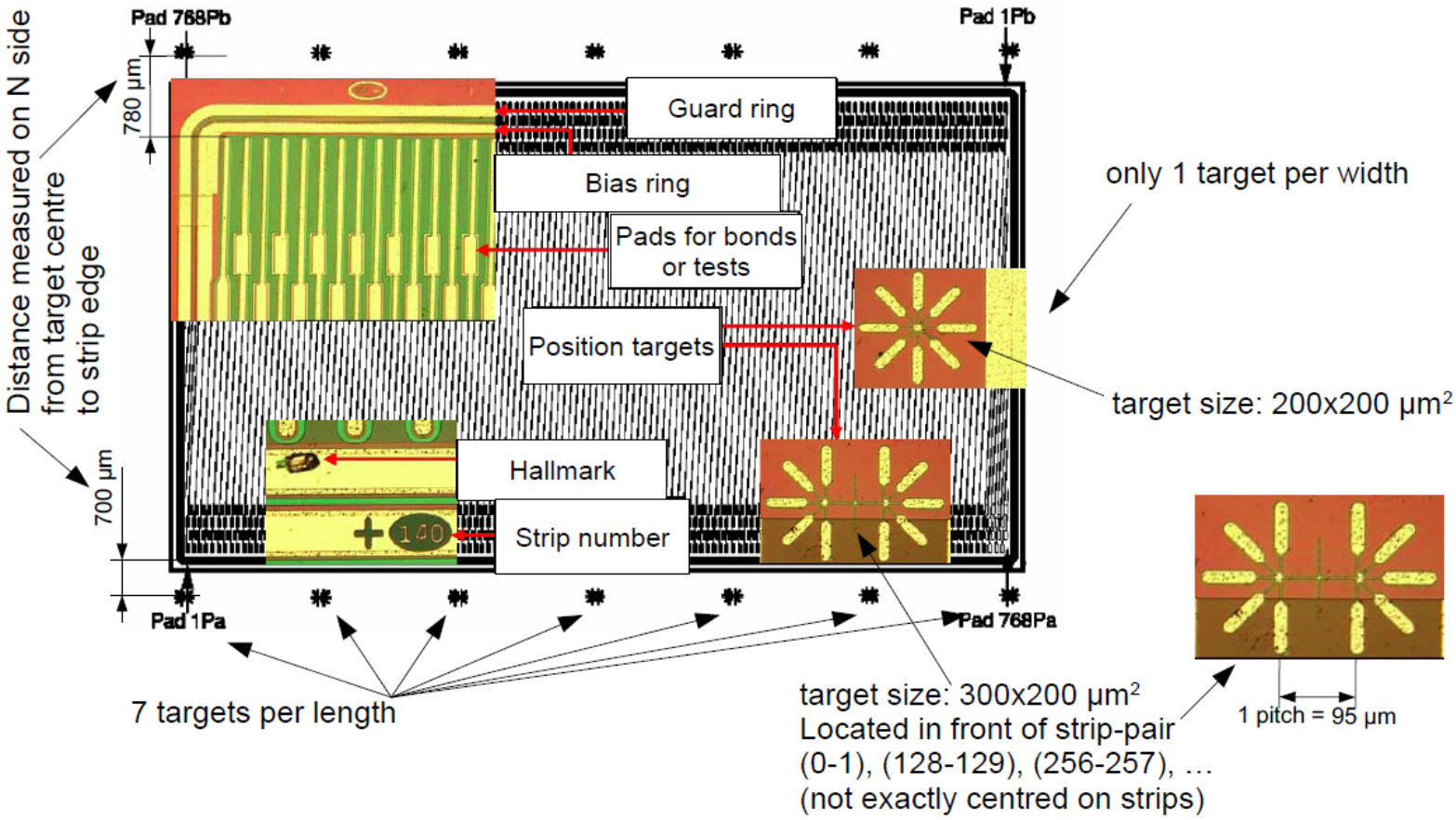
The Theoretical Geometry Model



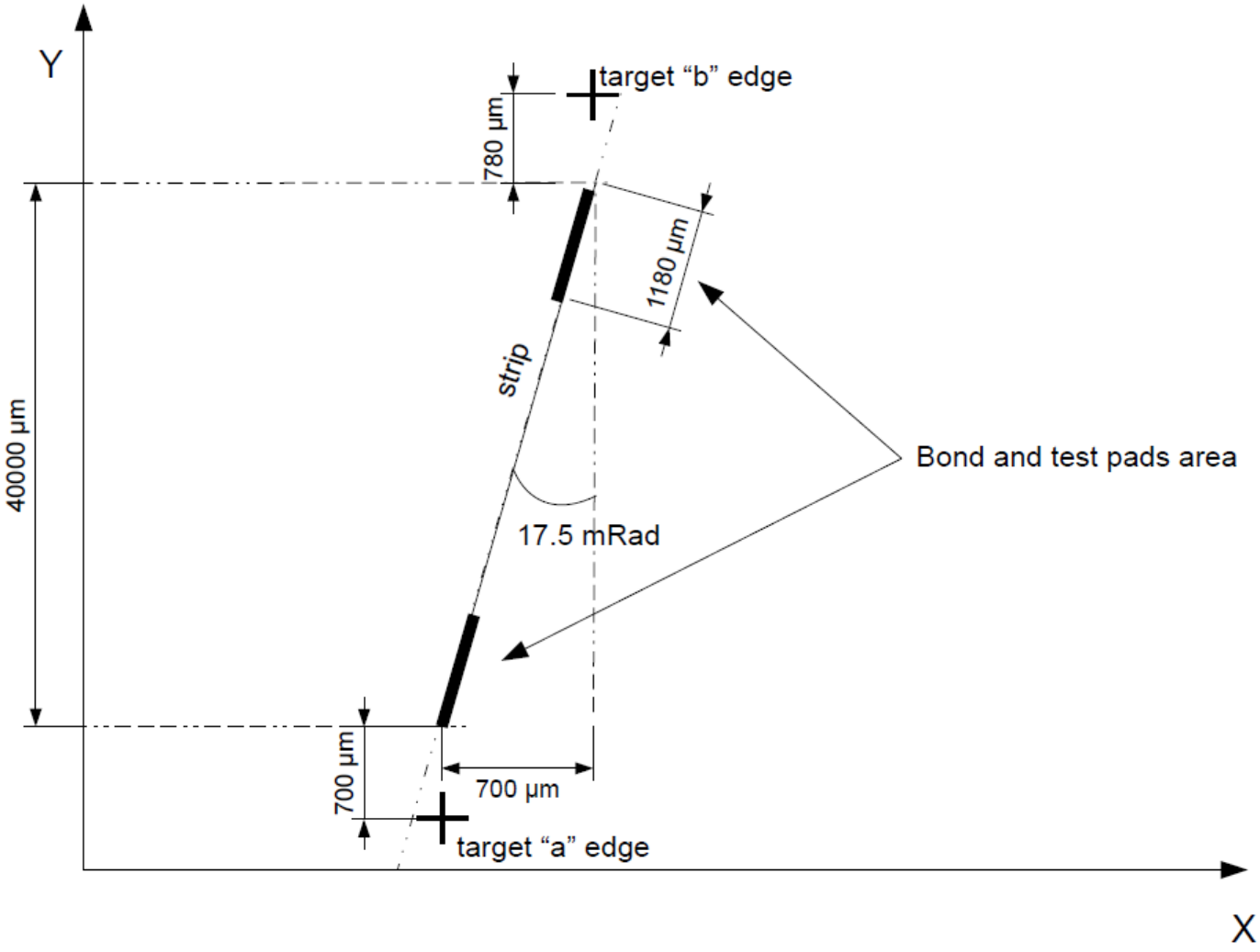
- **Two “single” star targets, one on each end**
  - **visible on front and back**
- **Fourteen “double star” targets, seven on each side**
  - **visible only from the front side**

What do we know?

STAR-SSD sensor geometrical specification,
according to documents used to order the sensors and measurements.
J.Baudot 2012/04/02, updated 2012/04/20



Detail on Module structure



Coordinate system parallel to the detector edges

Precision needed from the survey camera

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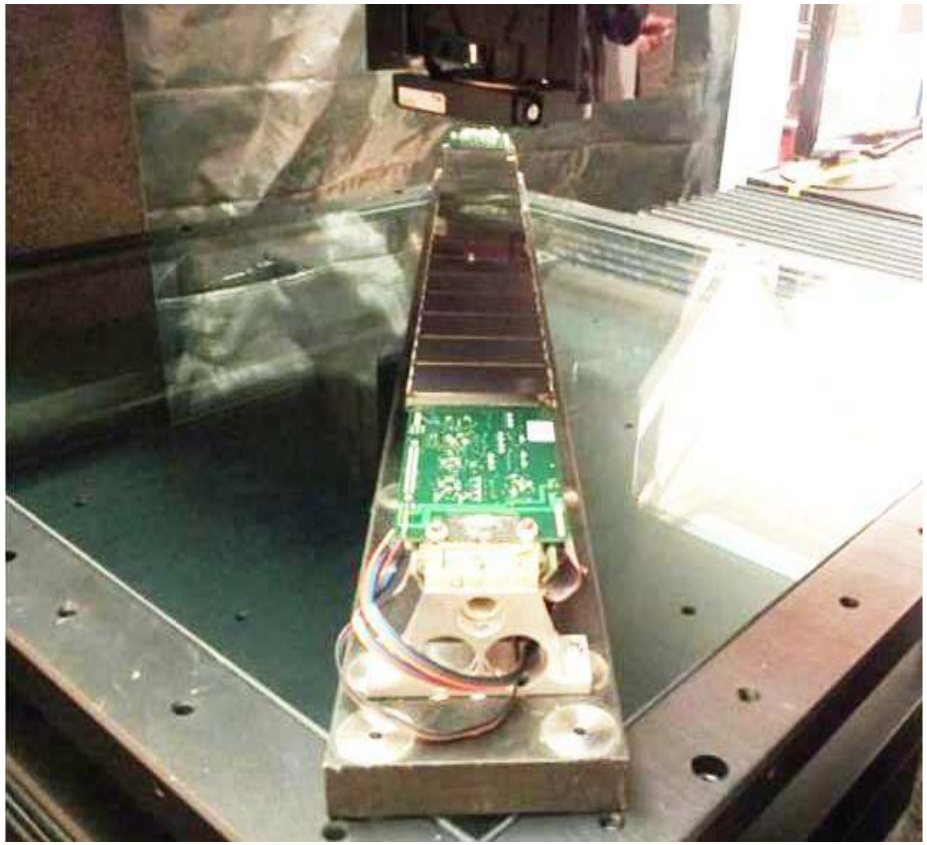
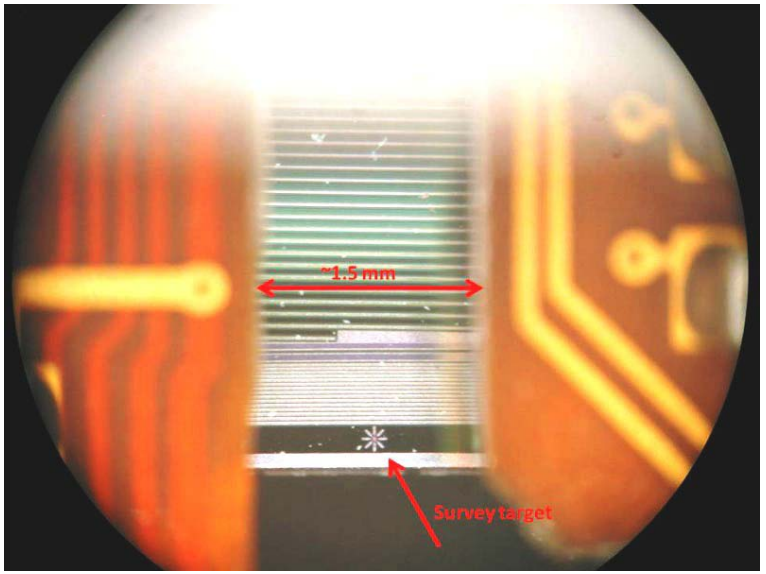
- The SSD is built from 4 cm long strips
  - 95 μm pitch
- Double sided
  - Opposite sides crossed at an angle of 35 mR
- Intrinsic resolution of the detector
  - 30 μm in r-Phi direction
  - 800 μm in Z direction
- It would be nice to match the r-Phi resolution of the detector but, frankly, this is not necessary
  - Proper functioning of the HFT system requires ~200 μm resolution at the SSD
- Therefore, heroics are not required. We will take whatever comes for "free" on the survey machine
  - 30 – 50 μm (???)
  - (Spiros says we can do 10 μm, offline, with tracks)

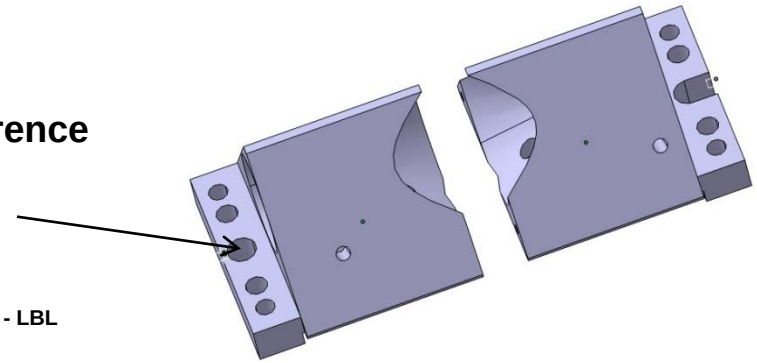
Pictures

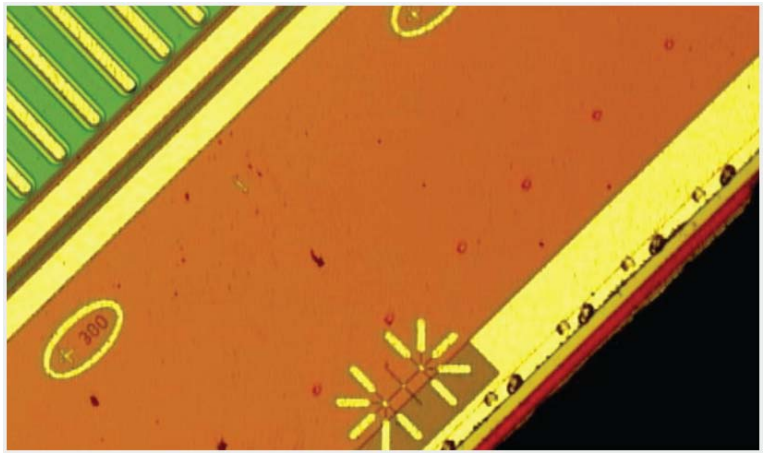




Target on end of wafer (backside)

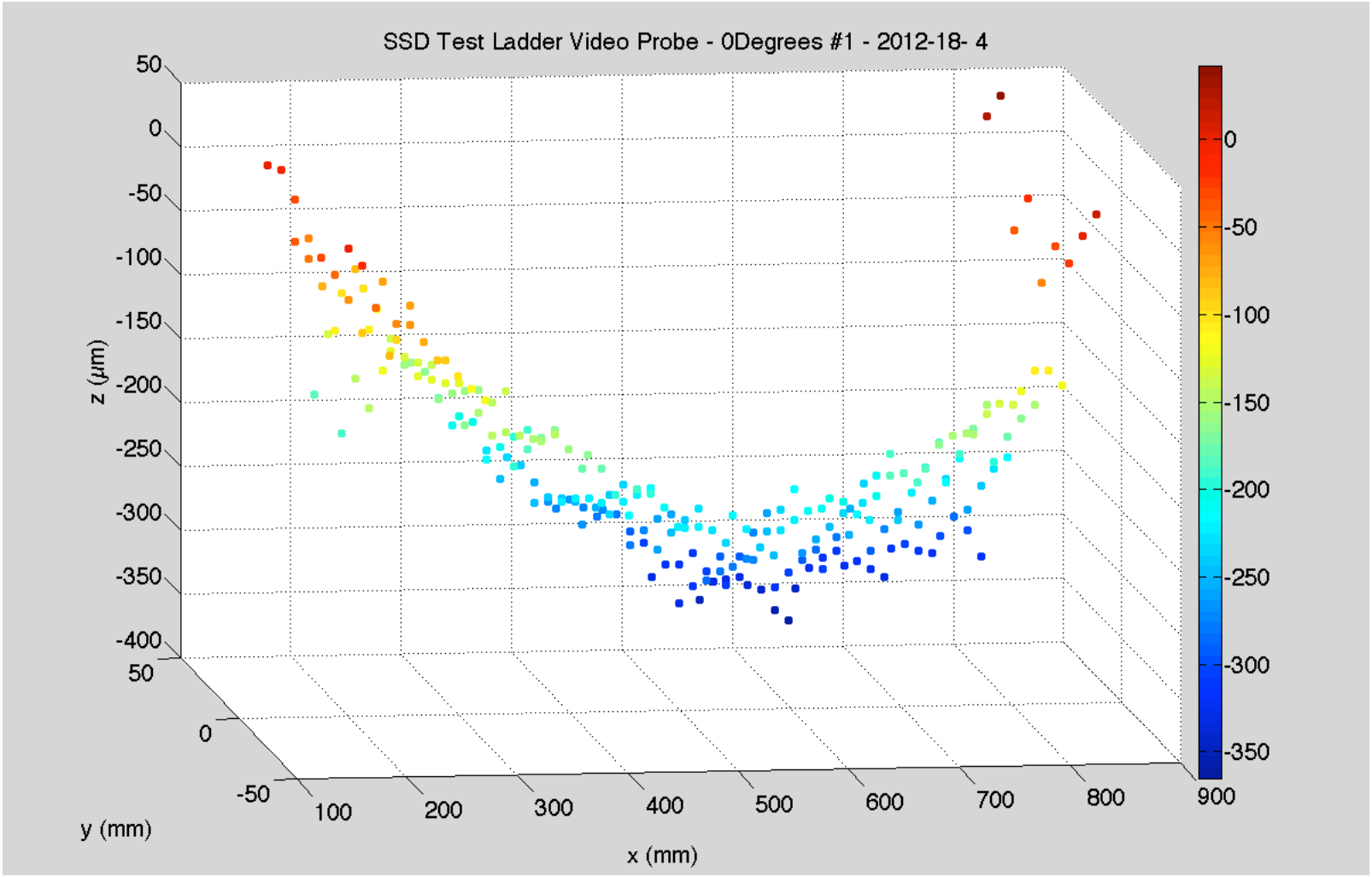
Reference point





Targets on edges of wafer (front)

New Ladder 0 survey (courtesy of H. Matis)



Ladder 0 has a built in curvature in Z, probably permanent, due to construction techniques … to be checked!

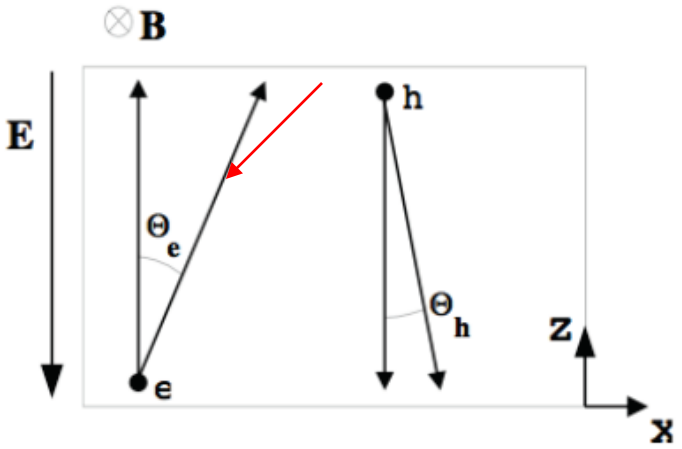
To do

Philosophy: start from the module and work outwards

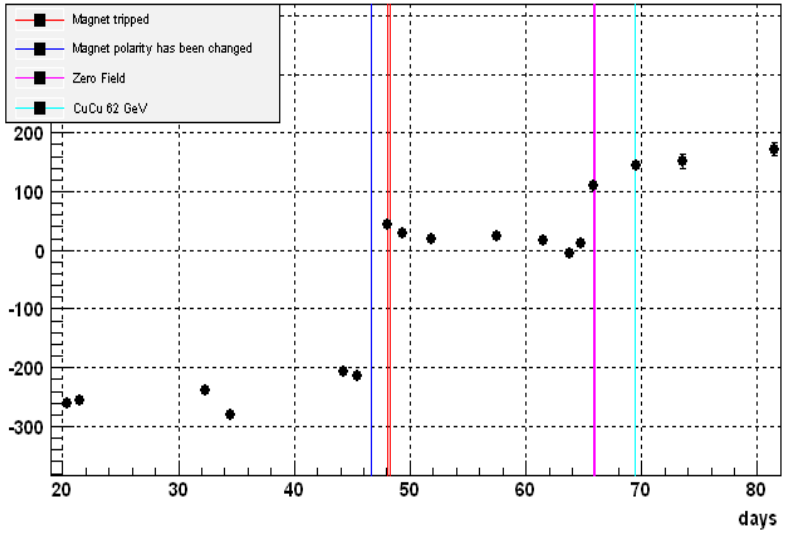
- **Measure location of strips relative to targets (one wafer)**
- **Measure location of targets on wafers relative to pin (all)**
- **Repeat for all ladders**
- **Check gravity sag on one ladder (this can be done on Zeiss)**
  - **Assume that 0° and 90° are sufficient to characterize sag**
  - **Repeat 90° measurement on all ladders if necessary**
- **Record and manage data**
- **Design, glue, and survey location of mounts on OSC**
- **Develop mathematical transforms from strip to target to pin to OSC mount to STAR Global Coordinate system**
- **Record and store in STAR qualified DB**

The Lorentz Force affects the SSD

- **Lorentz effect :**
  - **Trajectory of electrons/holes are modified due to the combination of the STAR magnet B-field and the SSD wafer E-field (vxB)**



- **Observation from data :**
  - **Shift in <z> direction of the order of 200 μm depending on the B-field orientation.**
  - **Oops. Not all shifts explained by sign and Mag of B. (?)**



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Lorentz Effect Corrections … already in code

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- **Values from CMS**
  - θ_L = 21° for electrons and θ_L = 8° for holes
  - T =280 K and V_{bias} = 40 V *http://arxiv.org/pdf/physics/0204078v2.pdf*
- **Normalized to STAR B-Field**

$$tan(\theta_L^{STAR}) = \arctan(\tan(\theta_L^{CMS}) \times \frac{B^{STAR}}{B^{CMS}})$$

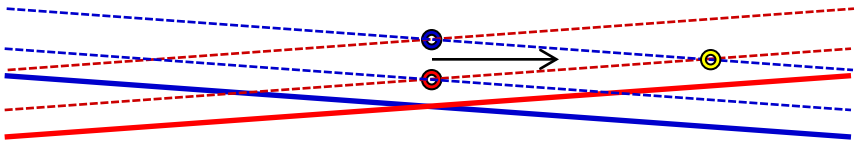
θ_e = 4.4 °
θ_h = 1.6 °

$$\Delta(x) = \tan(\theta_L^{STAR}) \times d$$

Δx = 12 μm for electrons
Δx = 4.2 μm for holes

d = drift distance along the E-field (d =150 microns , half-thickness of the wafer)

Thus the anode and cathode strips will experience different distortions on the two sides of the detector. When reconstructed, this leads to a distortion in the Z direction approximately equal to $\tan(\theta_e - \theta_h)*d / \tan(\theta_{ac})$ or about 210 μm.



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Summary

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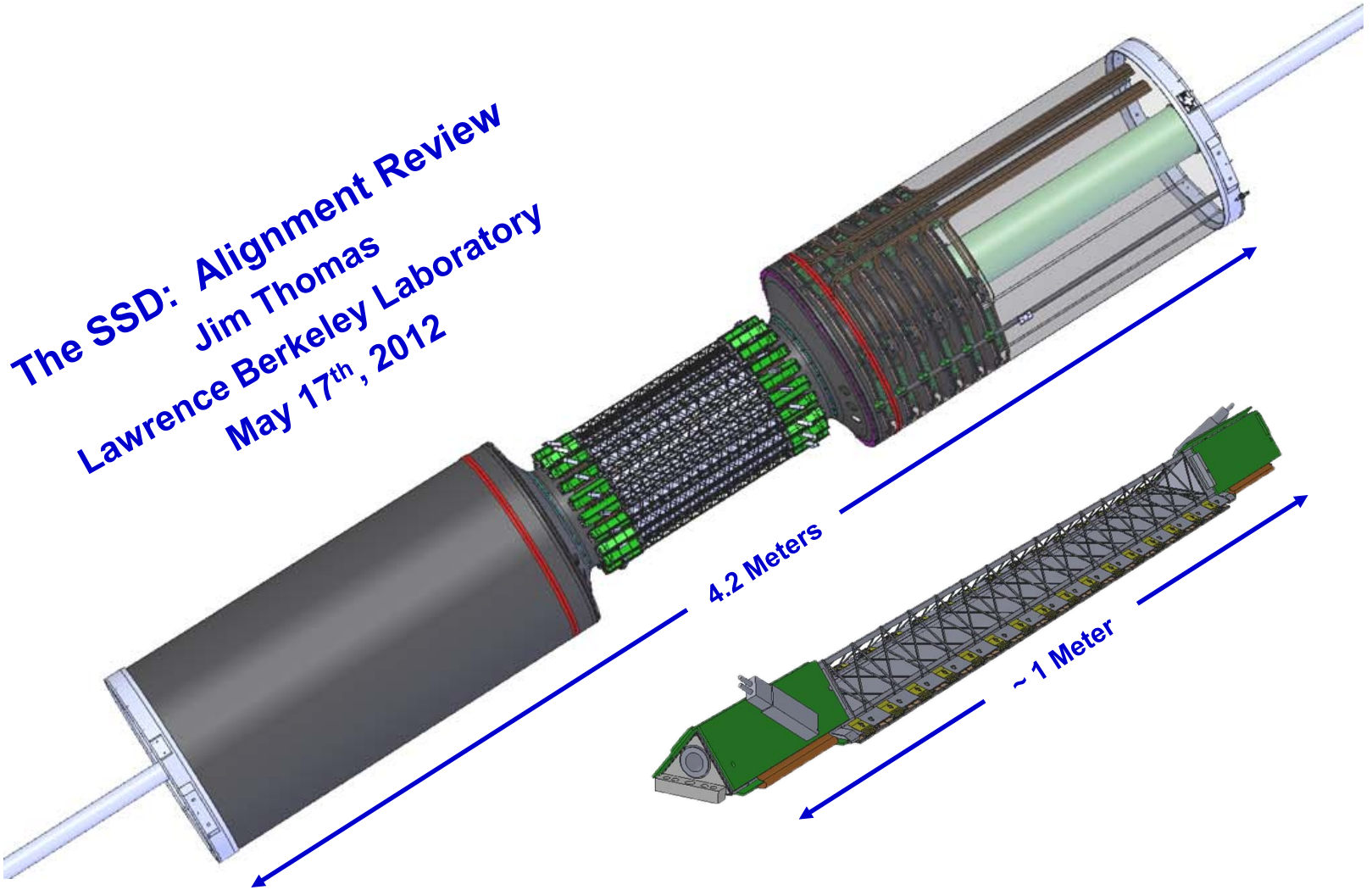
- A prior survey for the SSD was done in 2001
- Much of this information has been recovered, but not all
- LBL has a seemingly easy to use survey machine
- We propose to resurvey all of the ladders
- Targets are available on both sides of each wafer
- A well defined reference point exists on each ladder
- Preliminary data has already been collected
- Some software already exists from the last time the SSD was used in STAR
  - As with all archeology projects, a curse as well as a blessing

Backup Slides

The SSD


The SSD: Alignment Review
Jim Thomas
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May 17th, 2012
4.2 Meters
~ 1 Meter