IEEE SW Test Workshop

Semiconductor Wafer Test Workshop

**Rod Doe**

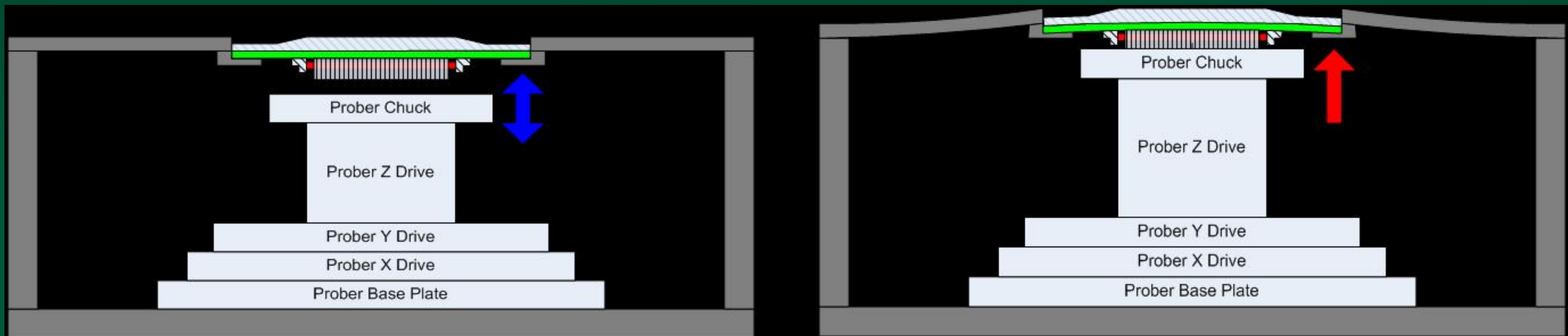
# Challenges of 300mm probe

RUDOLPH TECHNOLOGIES

# Overview of Presentation

- Problem statement / Goals of study
- Review the design of experiments (DOE)
- Review probe card data collected on a PCA
- Review results of empirical deflection study
- Summary

# Problem Statement: Test Cell Deflection Is Unknown




- Programmed prober overdrive is not equal to actual probe card overdrive

- Actual overdrive of the probe card is a function of …
  - The force produced by the probe card (# of pins)
  - Stiffness of the system

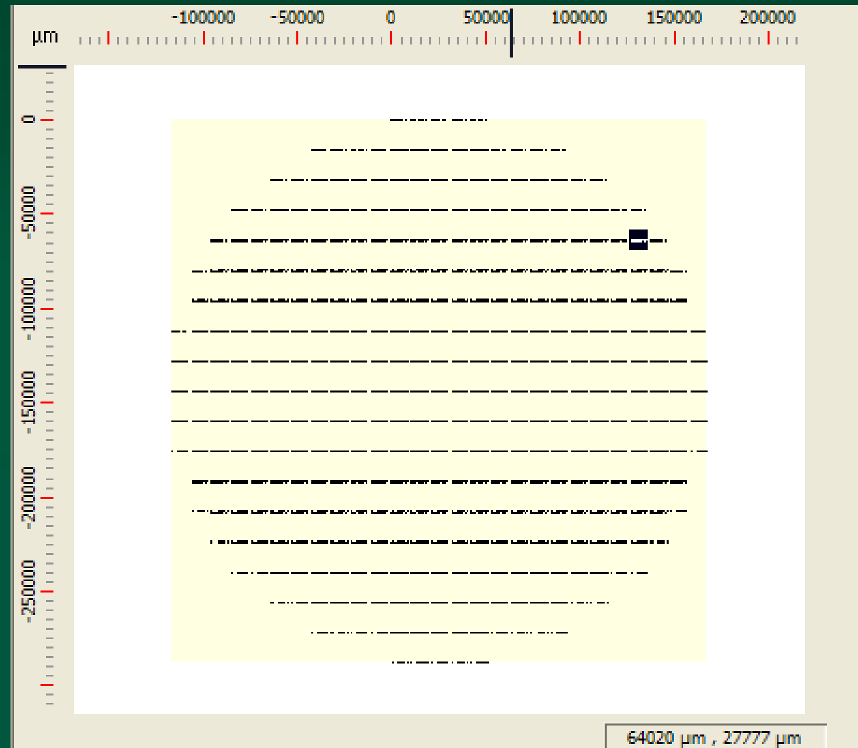
- Z drive encoders compensate for subset of deflection.

- Goal is to produce consistent robust scrubs at any load

# DOE: Analysis of Deflection

1. Measure 300mm Probe Cards on a Probe Card Analyzer (PWX)
   - Measure unloaded planarity
   - Measure loaded planarity
   - Measure scrub distance
   - Analysis of deflection
2. Conduct Clay Study of Deflection Analysis in a Test Cell
   - Experiment setup in test cell
   - Directly measure deflection (clay study method)
   - Analysis of deflection

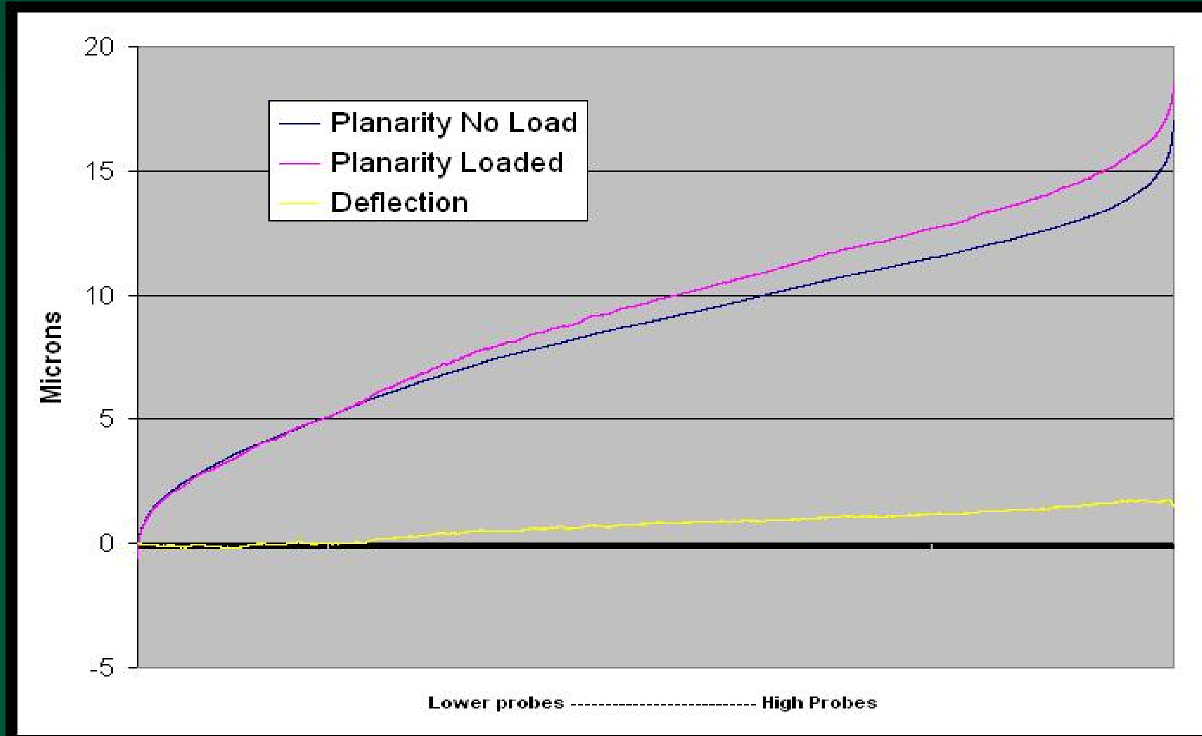
# Probe Card Properties




- 300 mm : One touch probe card
- ~ 6000 probes

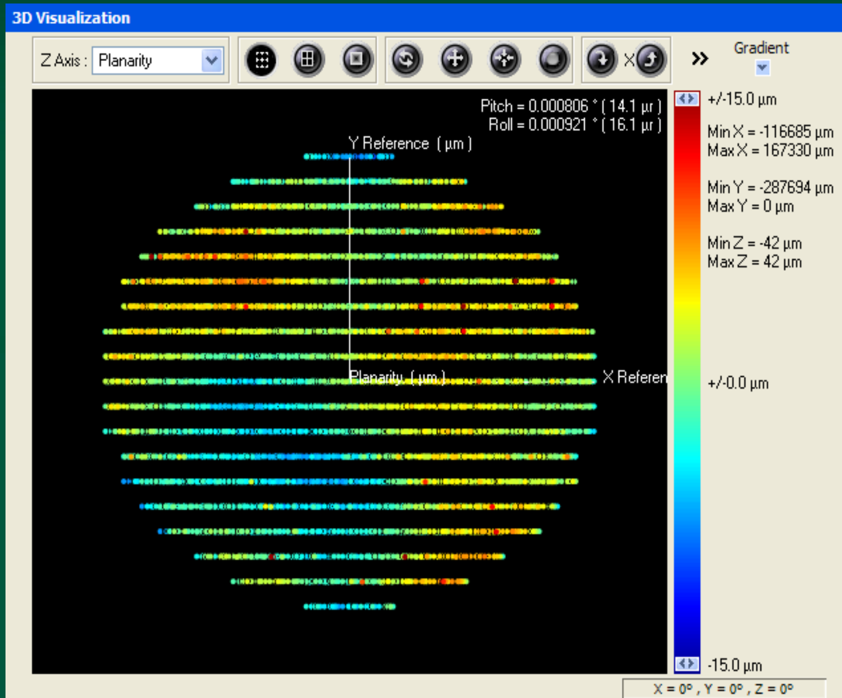
# Probe Card Analyzer Data Overview

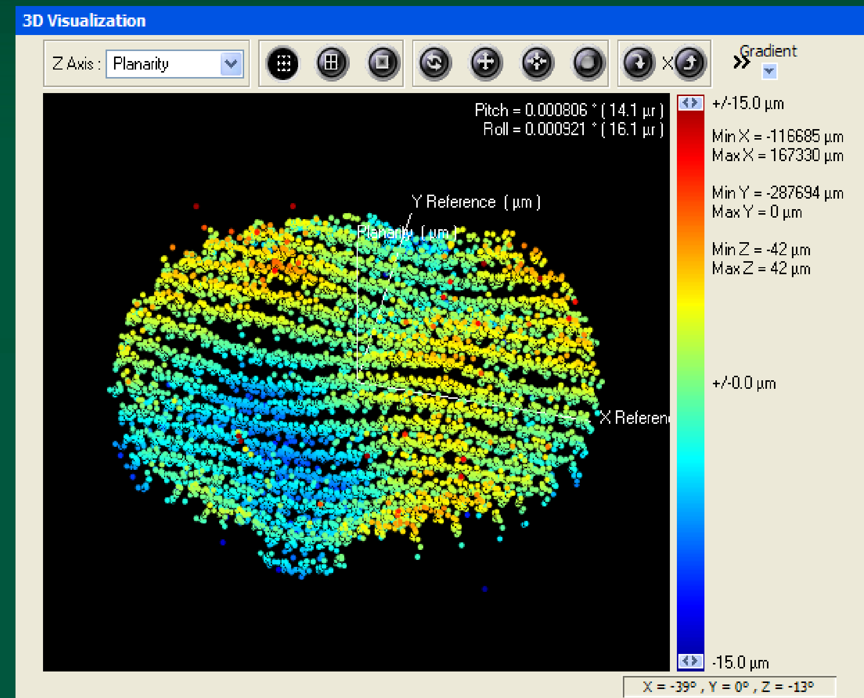
# Expectations: No Load Planarity vs. Loaded Planarity




- No load low probes = Loaded low probes
- Higher probes separate because of load

# PCA Data: Probe Card 1: Planarity - No Load

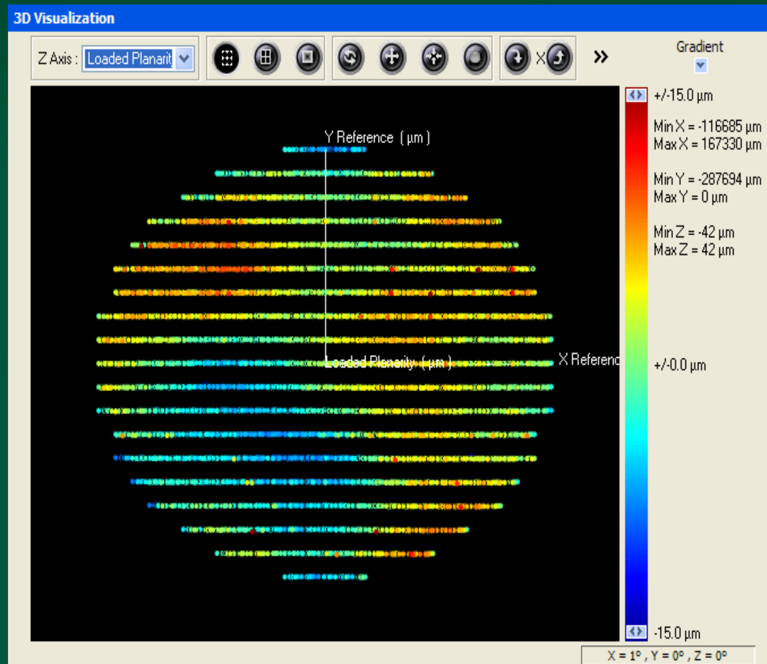


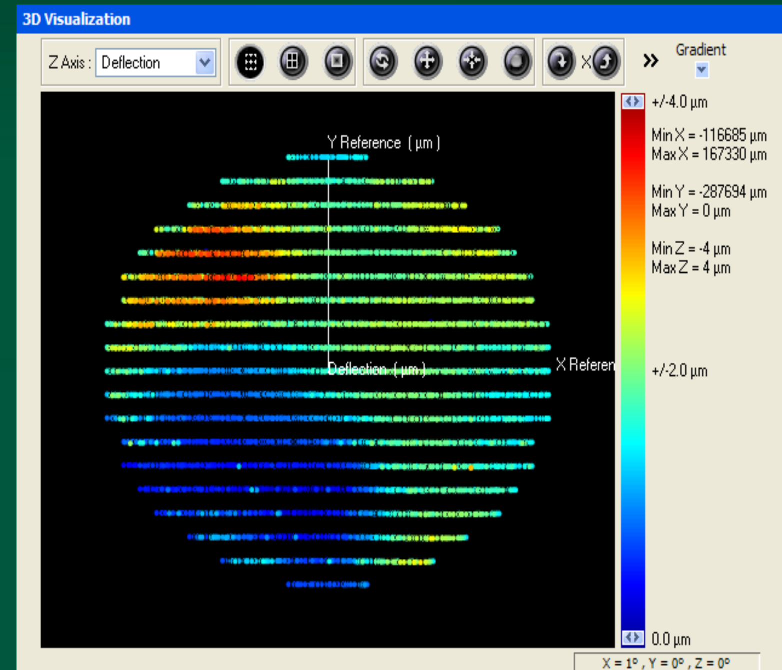

Planarity of probes free hanging (No Load) +/- 15 microns

# Probe Card 1: Planarity

## Loaded Planarity

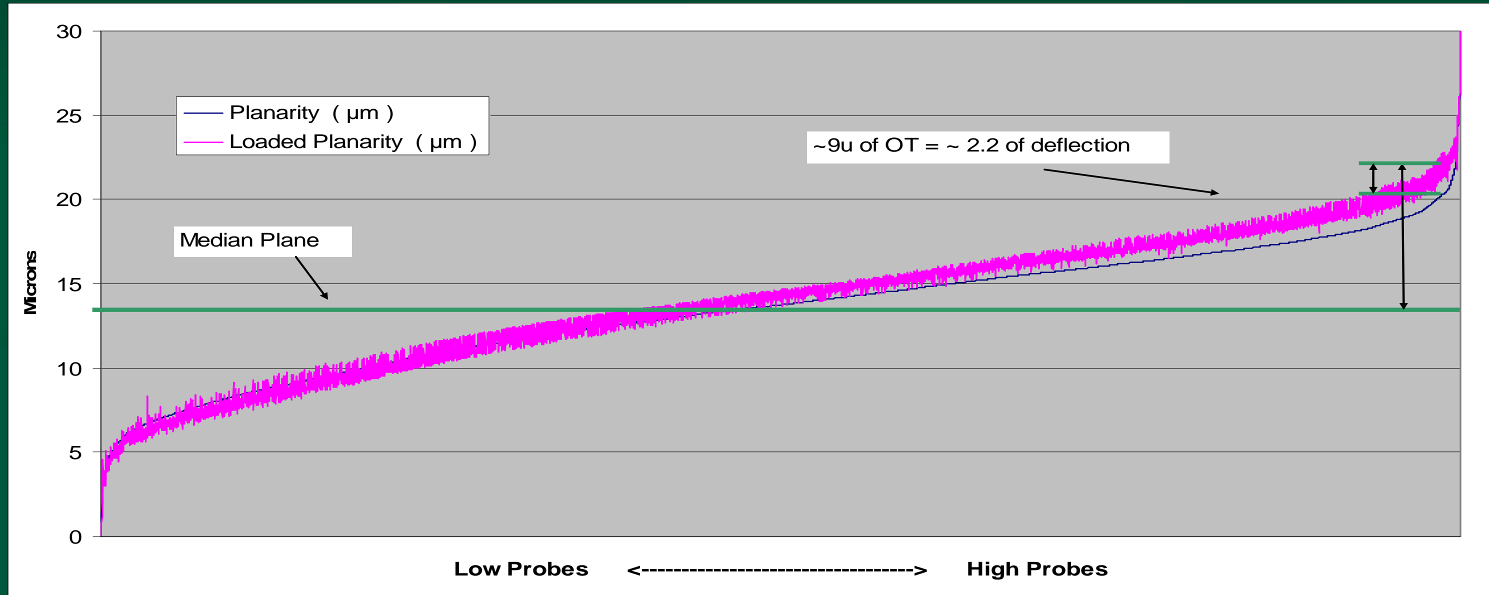



## Deflection



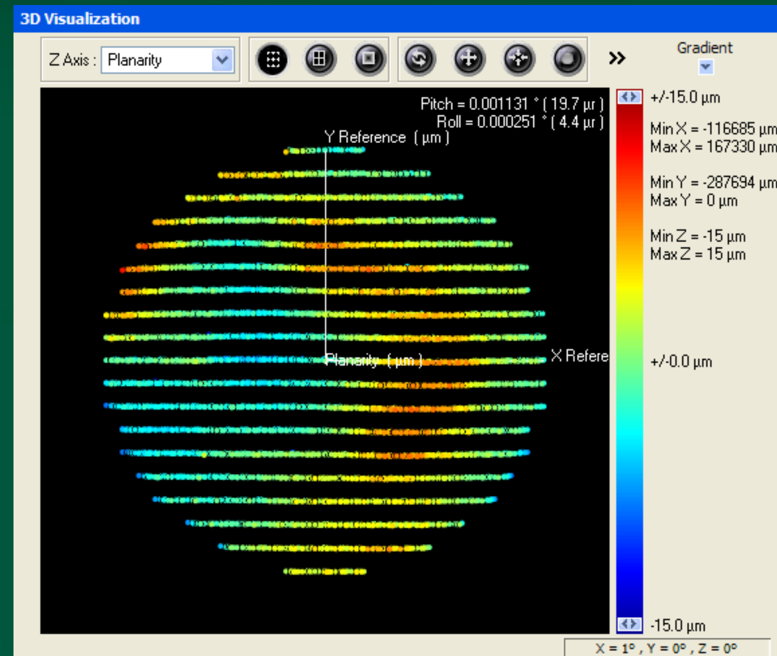

- Deflection of probe card from no overtravel until all probes are touching ~ 4 microns
- Low probes showing no deflection
- High probes drift up as the probe card is overtraveled

# Probe Card 1: Deflection Graph




- Deflection of probe card ~ 3 microns (When all probes are touching)
- Low probes showing no deflection
- High probes drift up as the probe card is overtraveled
- Extrapolate to 80 microns of OT , actual = 62 microns

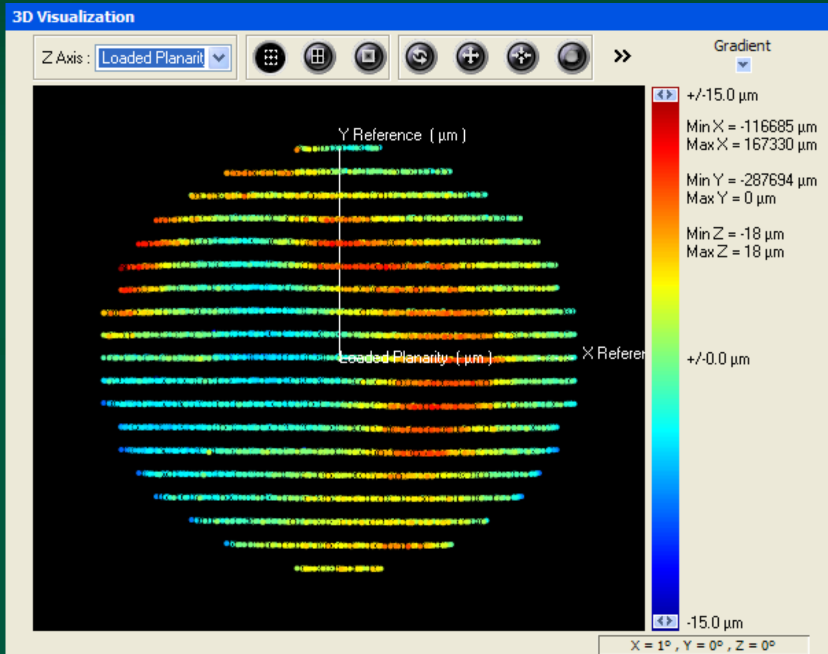
# PCA Data – Probe Card 2: No Load



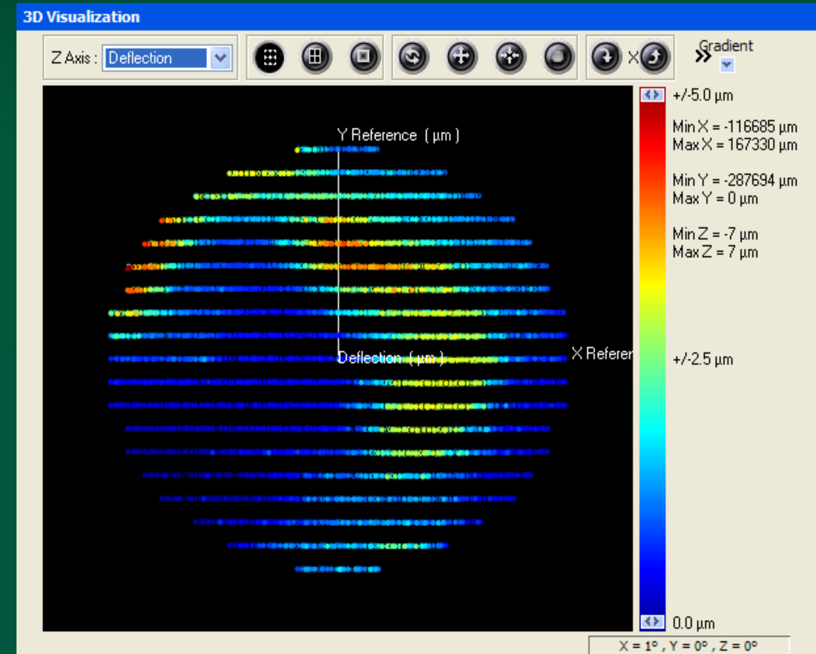

Planarity of probes free hanging (No Load) +/- 15 microns

# Probe Card 2 - Loaded

## Loaded Planarity

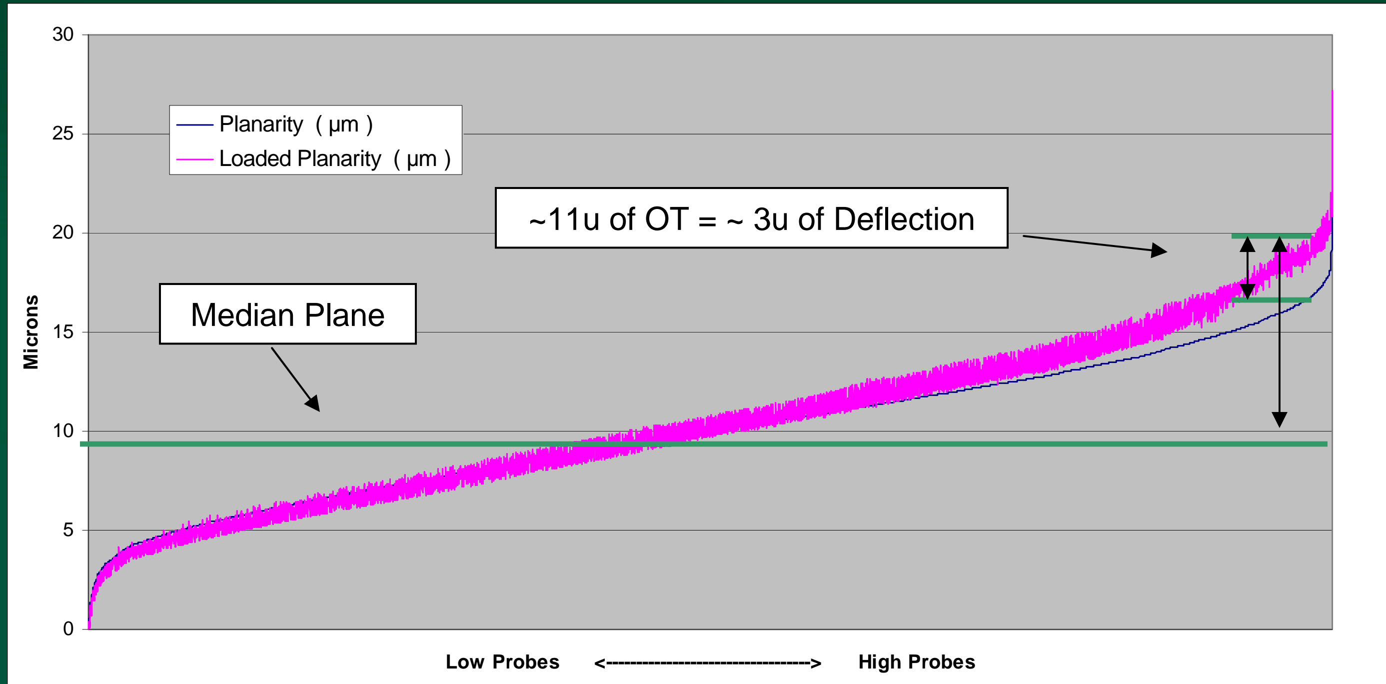



## Deflection




- Deflection of probe card from no overtravel until all probes are touching ~ 5 microns
- Low probes no deflection
- High probes drift up as the probe card is overtraveled

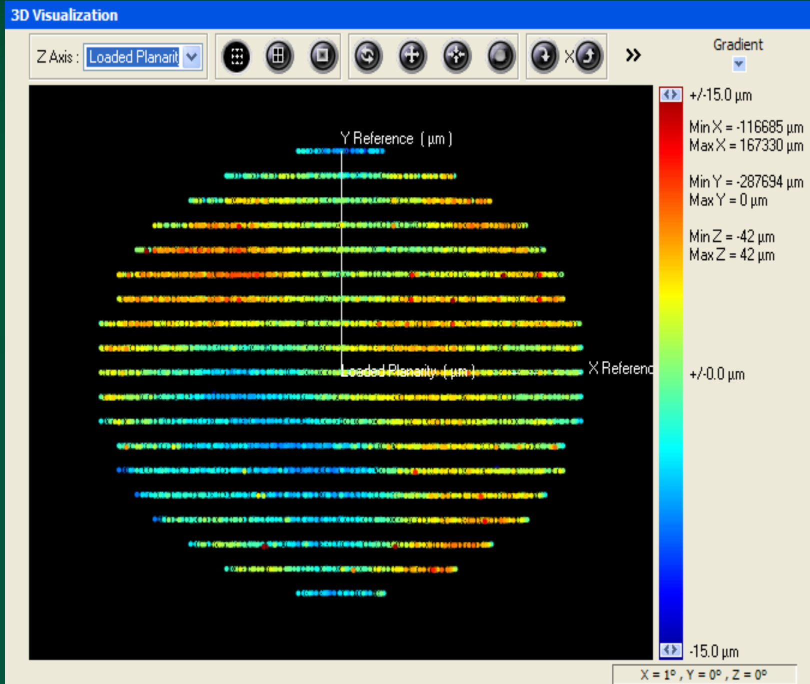
# Probe Card 2:  Deflection Graph



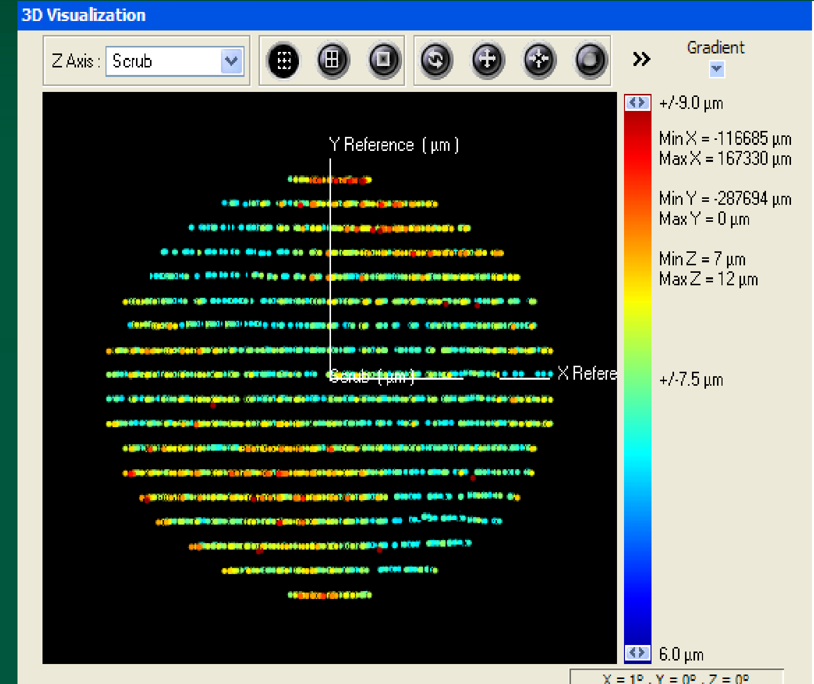

- Deflection of probe card from no overtravel until all probes are touching ~ 5 microns
- Low probes show no deflection / High probes drift up as the probe card is overtraveled
- Extrapolate to 80 microns, actual = ~ 59 microns of overtravel

# PCA: Probe Card 1 - Scrub Length

## Loaded Planarity



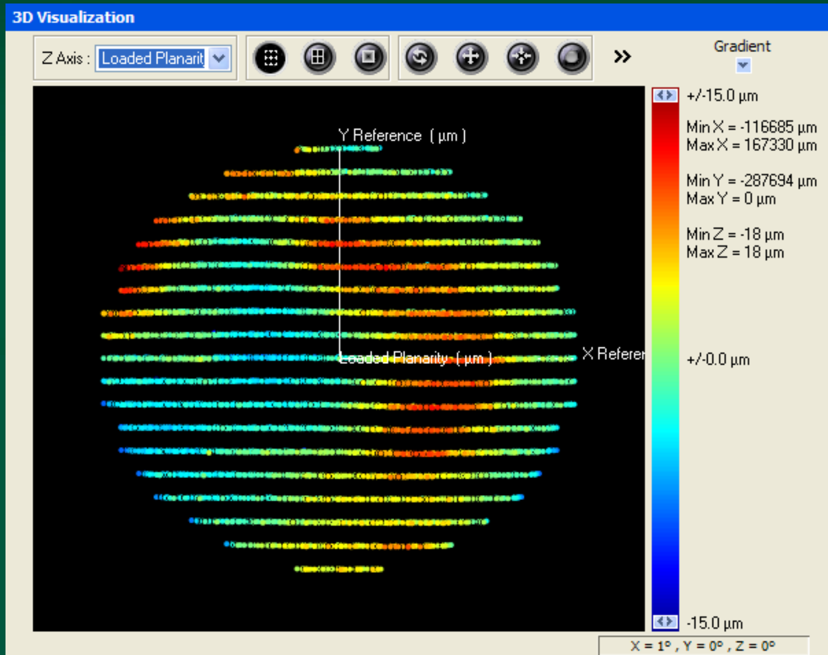

## Scrub Length



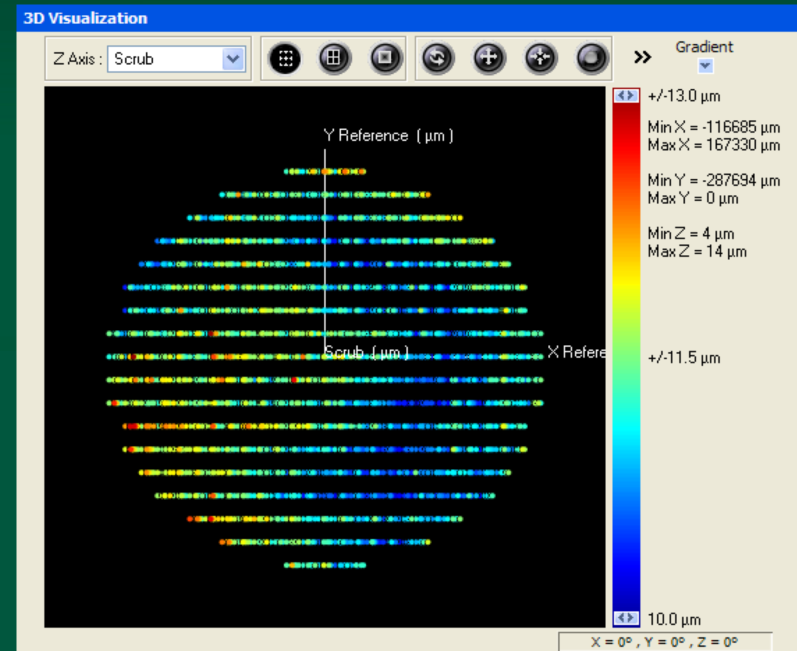

- Low probes scrub the farthest
- High probes scrub the least

# Probe Card 2 – Scrub Length

## Loaded Planarity




## Scrub Length




- Low probes scrub the farthest
- High probes scrub the least

# Probe Card 3 Multiple OT - Scrub Lengths produced

6
5
4
3
2
1
0

Microns

Scrub 60 OT
Scrub 47 OT
Scrub 31 OT
Scrub 15 OT

Probe closest to center <---------- Radius ----------> Probes closest to edge

- Probes in the center were highest but probes actually produce an even distribution of scrub lengths.

# PCA Data – Card Bowing

Scrub Length relative change (Microns)

4
3
2
1
0
-1
-2
-3
-4

Probe closest to center <---------- Raduis ----------> Probes closest to edge

Card does not show any significant change in relative scrub length as a function of overtravel (No bowing of the card)

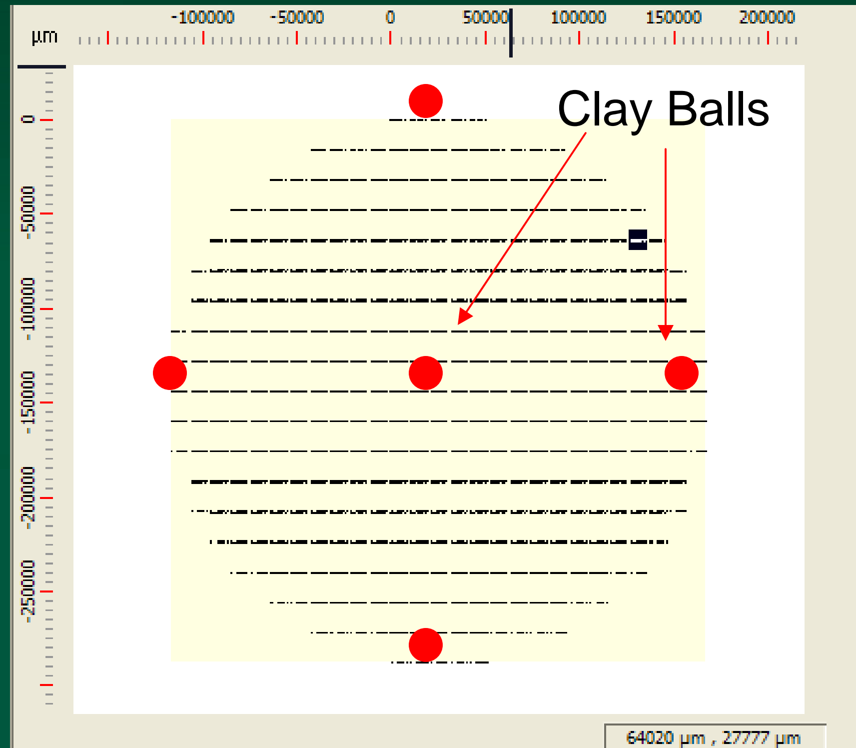
# Probe Card Summary

- **Loaded Planarity vs. Unloaded Planarity**
  - Overall planarity range ~15u
  - Both cards showed similar planarity signatures between unloaded and loaded states
  - Similar deflection rates for both cards (3-4 microns)
- **Scrub length at multiple overtravel levels**
  - Scrub lengths mirrored planarity signatures
  - Scrub lengths showed no significant signature change relative to overtravel load (No bowing of card)

# Clay method for measuring actual overdrive

- Place multiple pieces of clay on the probe card.
- Have prober overdrive to multiple overdrive positions.
- Measure the height of the clay balls after each overdrive.
- The clay ball compression shows the actual overtravel of probe card vs. programmed overdrive.

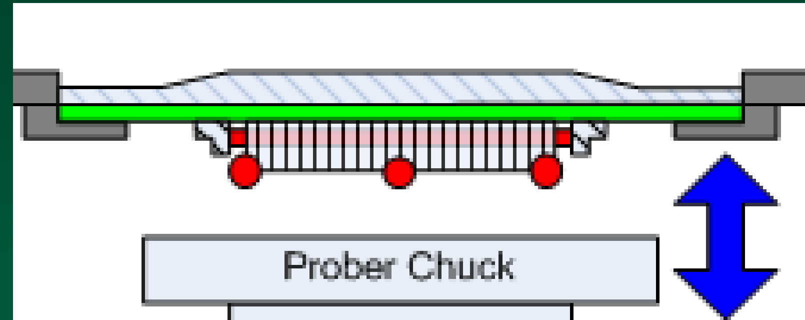
# Probe Card: Clay Balls



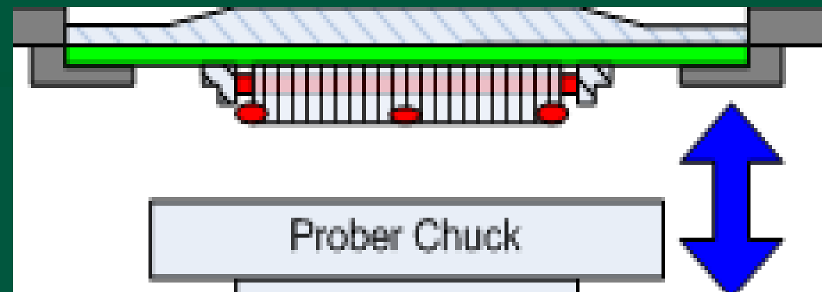

**Place multiple clay balls on the probe card**

# Wafer Data: Clay Study

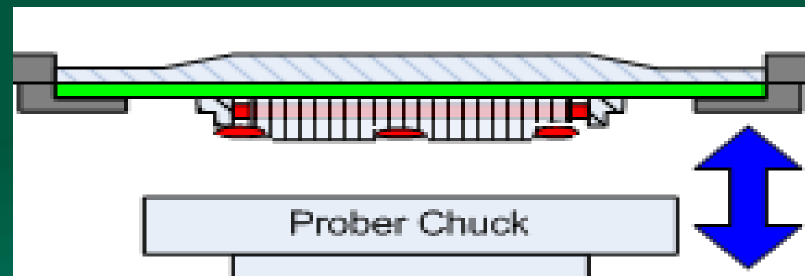
Initial State of Clay Balls




Measure After Zero Overtravel




Measure After XX Overtravel




SWTW

# Wafer Data: Clay Study



Deflection amounts similar to PCA deflections

# Summary

- Two models of deflection analysis presented
  - Probe Card Analyzer
  - Clay model analysis
- Both models showed very similar deflection signatures
- Loaded Planarity deflection extrapolation model on Probe Card Analyzer shows strong correlation to standardized Clay model deflection analysis
- Use of Loaded Planarity deflection analysis model enables test cell optimization without resultant spent wafers

# Questions?