SWTEST

PROBE TODAY, FOR TOMORROW

Evaluation of a MEMS Solution for Kelvin Probing on Bumps 180µm and Smaller

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Overview

- Background & Motivation
- Issues with Kelvin Probing on Bumps
- Pin and Probe Head Design
- Evaluation Plan
- Results
- Summary & Next Steps

Background and Motivation

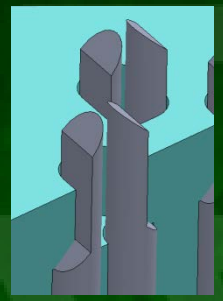
- **Wafer Level Chip Scale Packages (WLCSP) are used when space is at a premium, as in mobile and wearable electronic products**

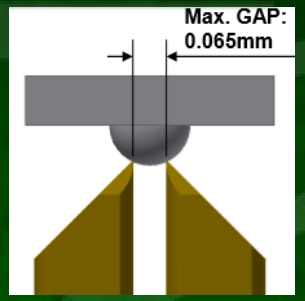


- **Wafer-level test (a.k.a. sorting or multiprobe) is usually the last electrical testing done on WLCSP devices**
- **The test plans for power management devices include RdsON and related measurements, and these tests require Kelvin contacts for accuracy**
  - Kelvin contact – two pins, Force and Sense, contact the DUT in the same location, but the two pins should not contact each other
- **As WLCSP bumps continue to shrink, landing two pins on the same bump becomes a big challenge**

Kelvin Probing on Bumps

- Commonly implemented with wedge tip pogo pins



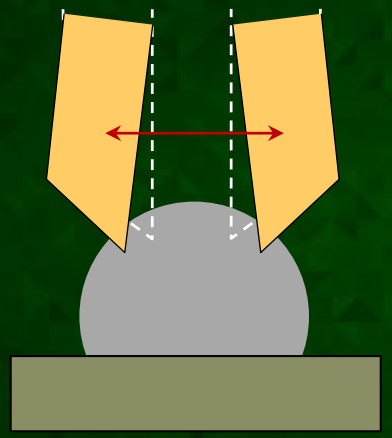


- But, as the bump diameter decreases below 200µm, the pin landing area curves more sharply, and it becomes more difficult for the pins to land consistently

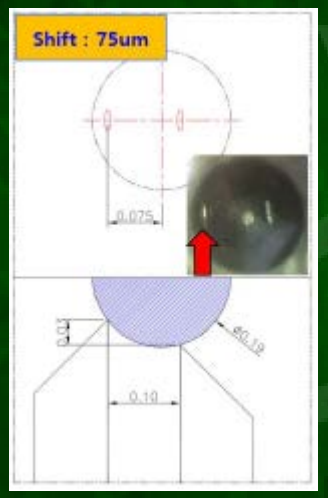
What Can Go Wrong

- **Probe spreading, shifting and rotation**

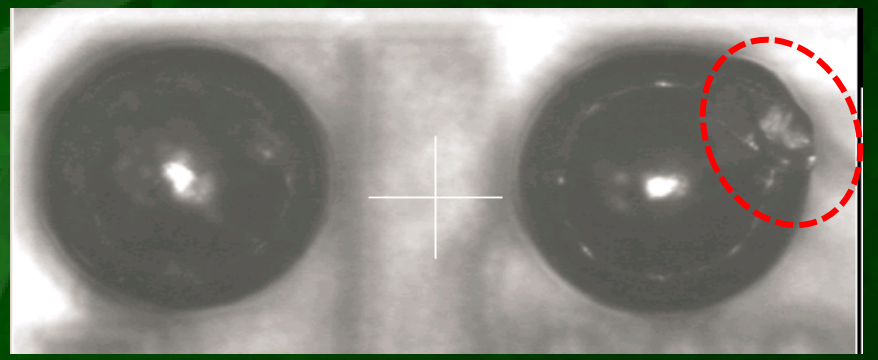
Probe Spreading



Probe Shifting



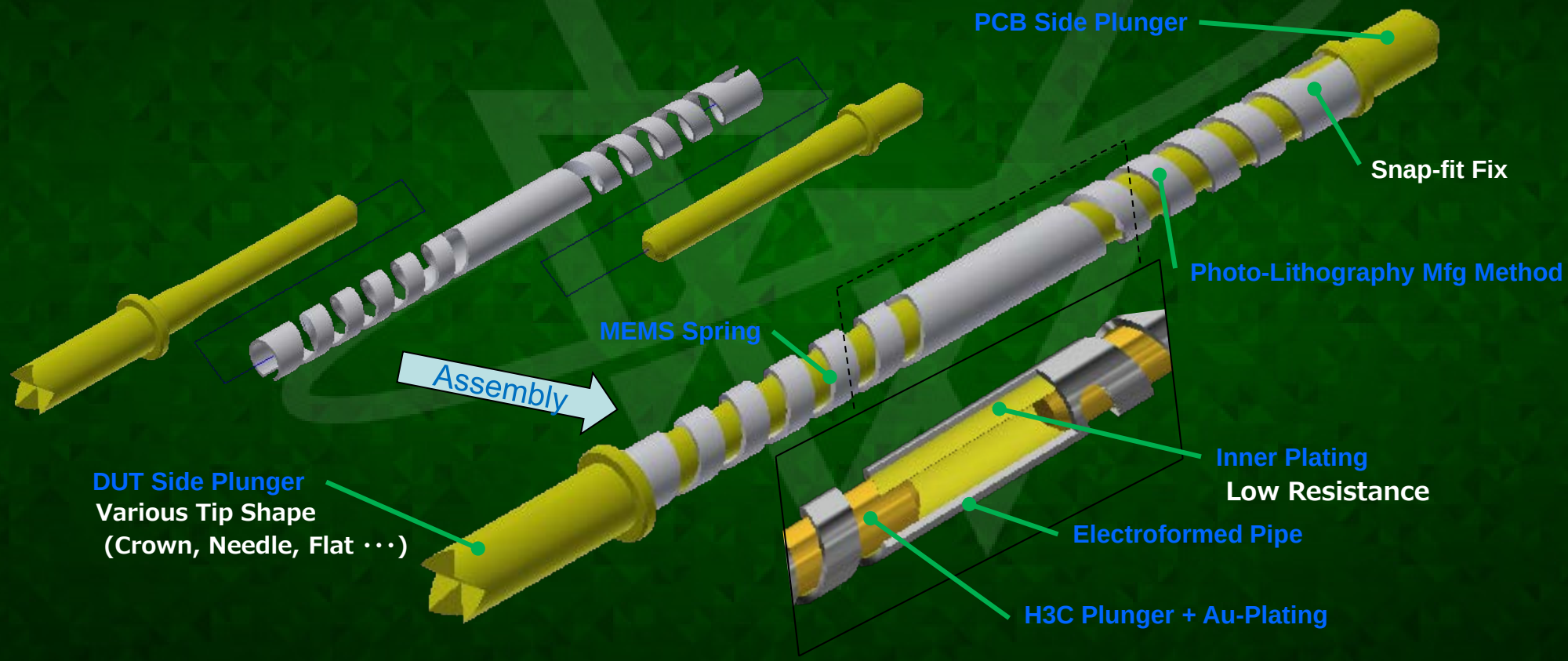
Pin Rotation



→ **Something different is needed for sub-200µm bumps !**

MEMS Spring Pin

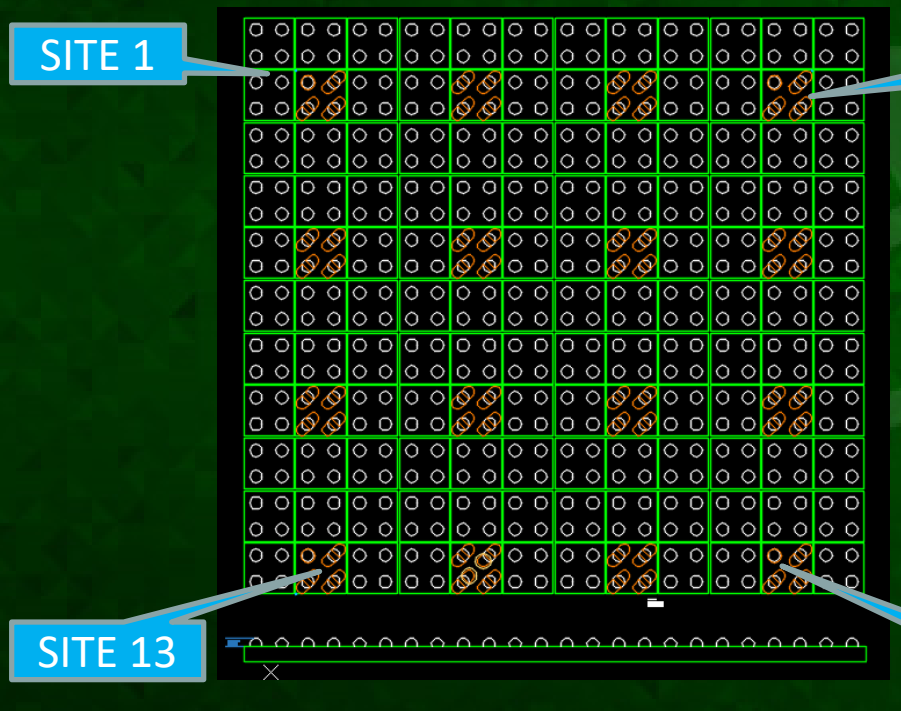
- Simple structure with spring and snap-fixed two plungers
- Low resistance and high current capacity

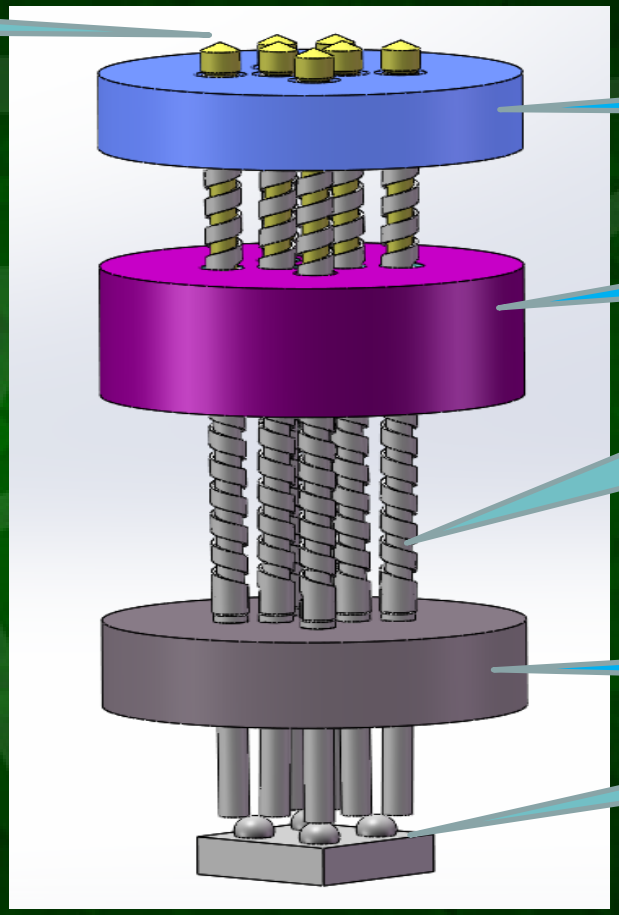


Probe Head Schematic – single site

PCB contact point

Tester side view

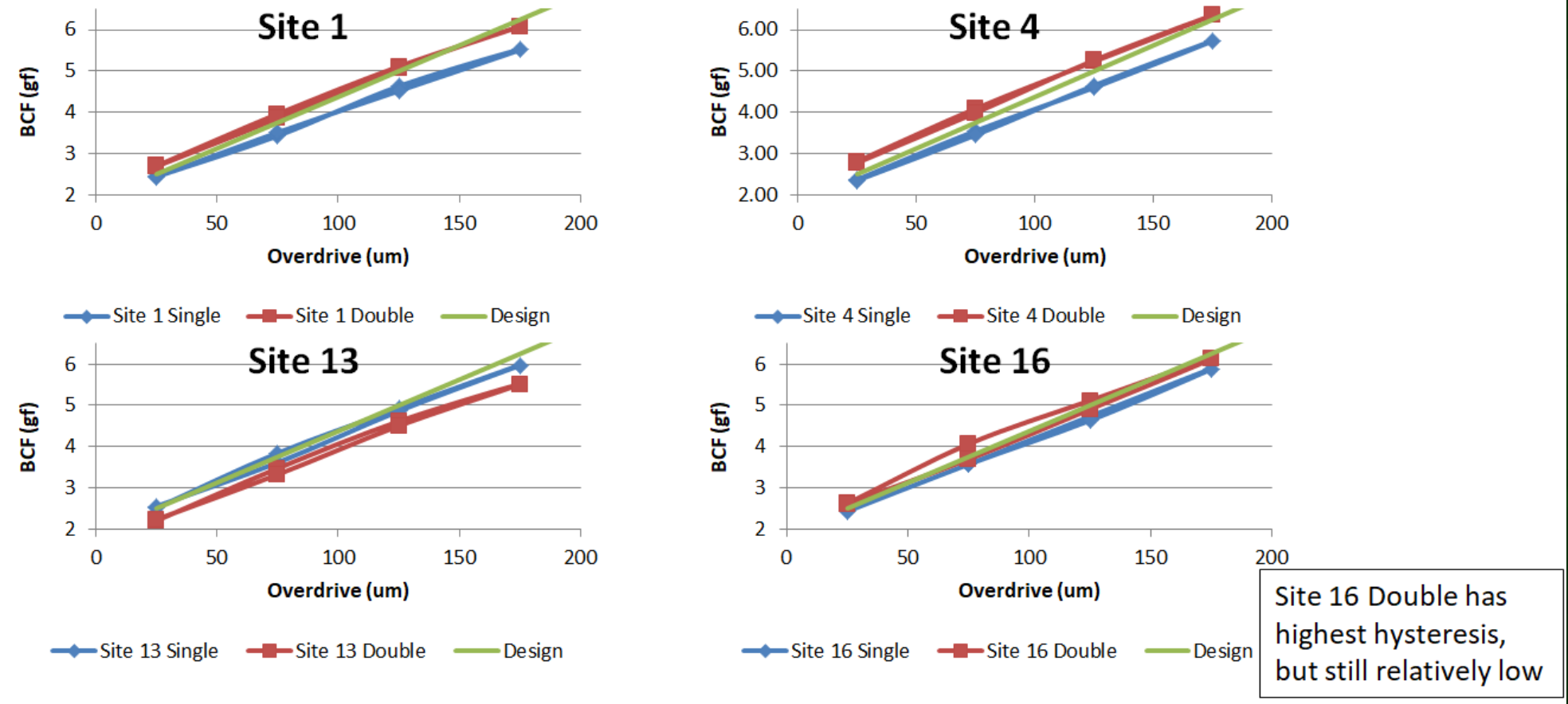




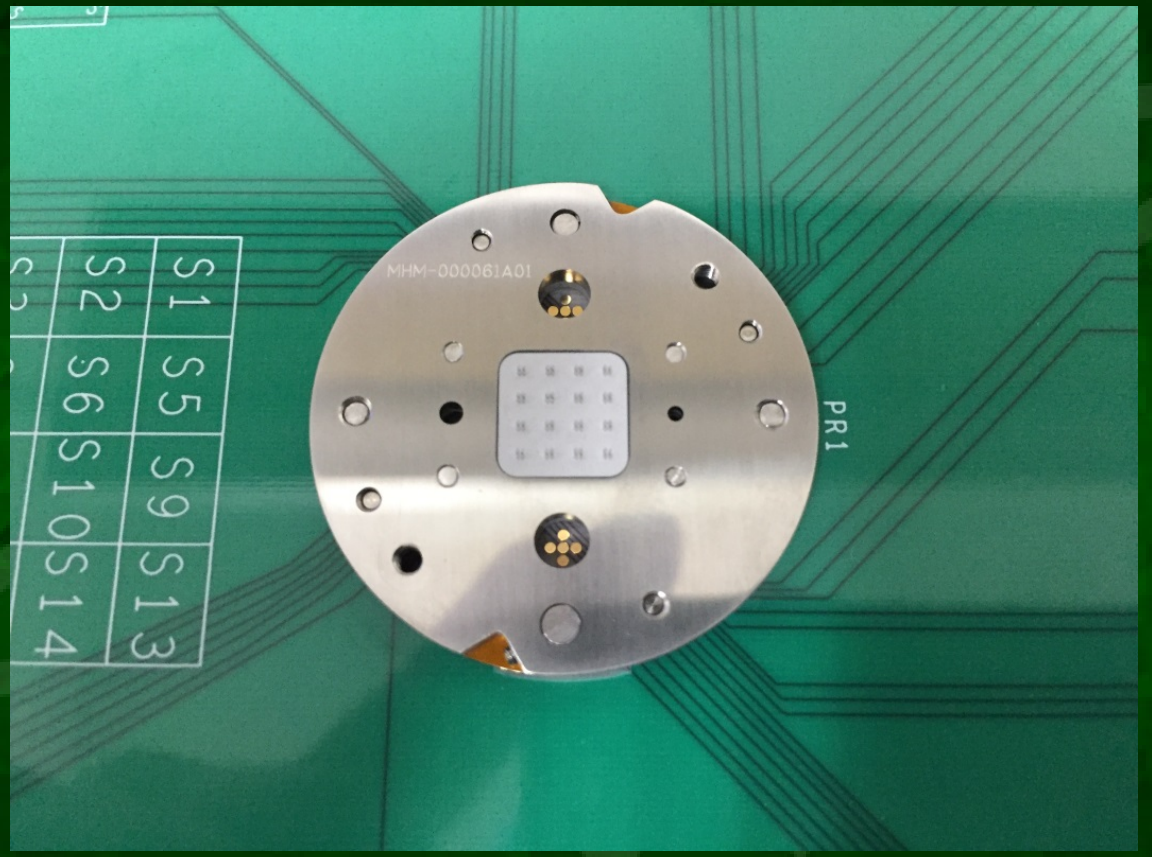
Probe head was built with 16 sites, spaced layout

Balanced Contact Force (BCF) by Site

Data collected after 5,000 touchdowns



Probe Head

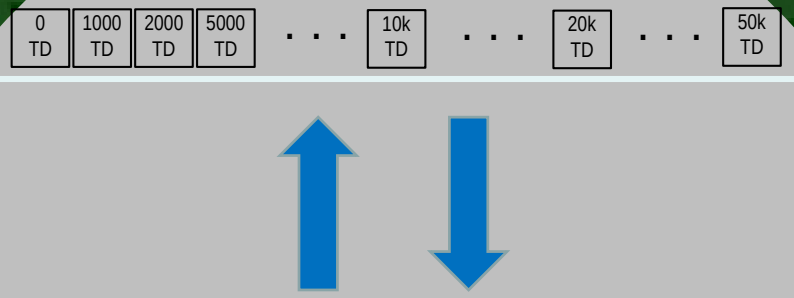


No screw heads on wafer side of probe card

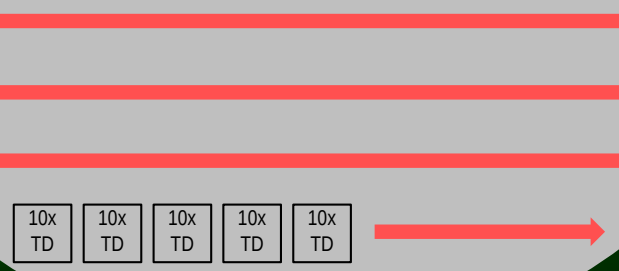
Test Plan

‘Snapshot‘ Area: Jump to this area of the wafer for a single touchdown every 1,000 TDs – intervals increased to 10k as the evaluation progressed

This created a periodic ‘snapshot’ of the probe marks as touchdowns accumulated on the probe head



‘Sandbox’ Area: run repetitive touchdowns in this area of the wafer
10 – 20 TDs per die

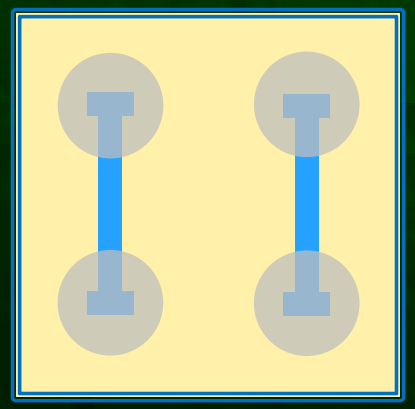


Small Bump Test Chip

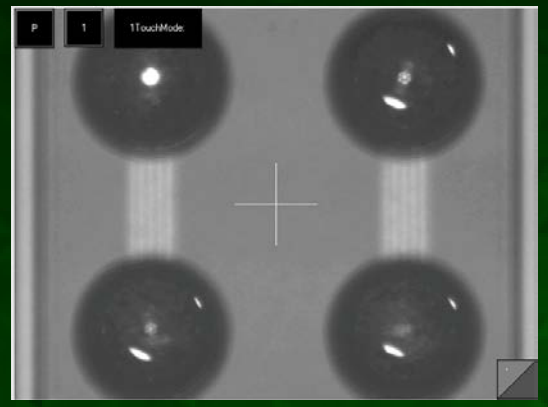
< 1mm^2 die

2 x 2 bump array

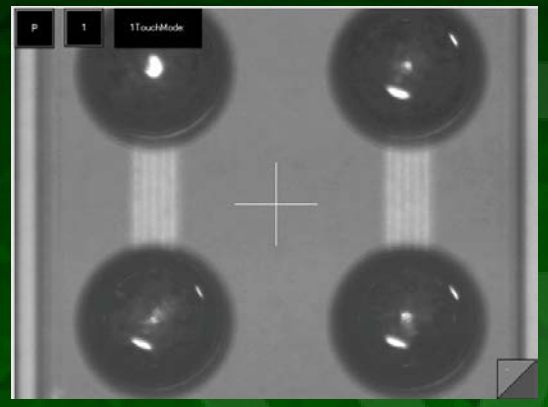
~ 180,000 die per wfr



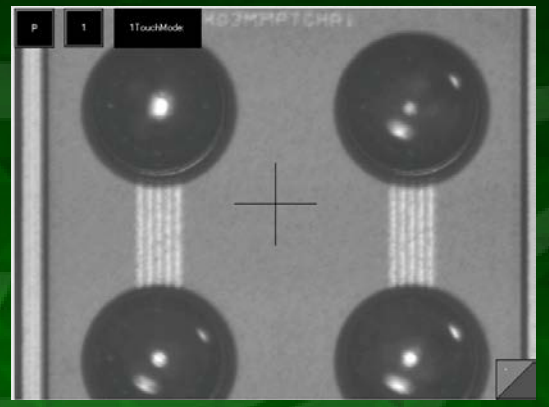
Probe Marks vs. Touchdowns



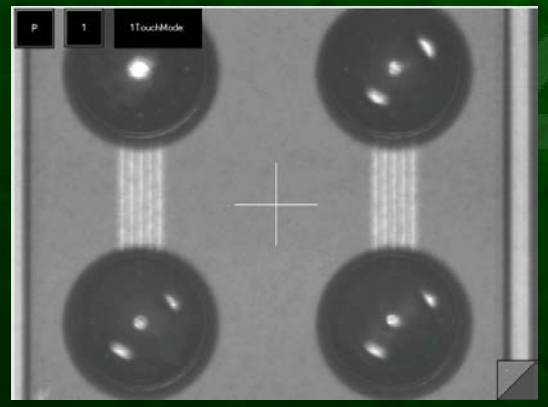
1000 TDs



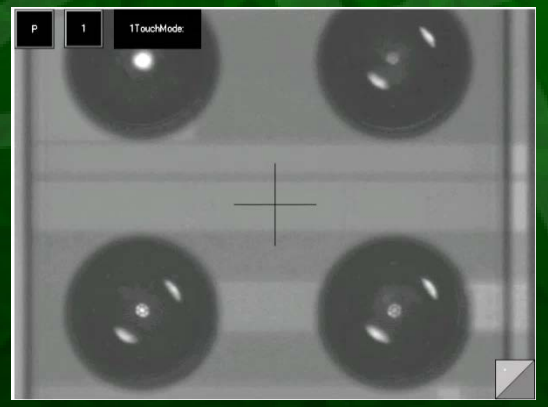
2000 TDs



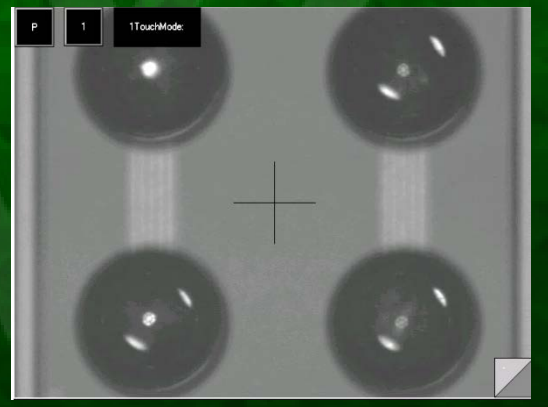
5000 TDs



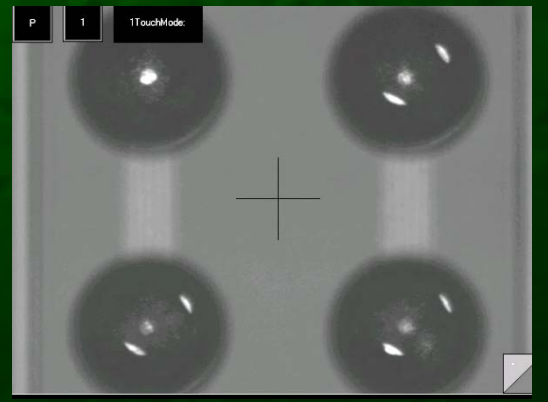
10k TDs



20k TDs

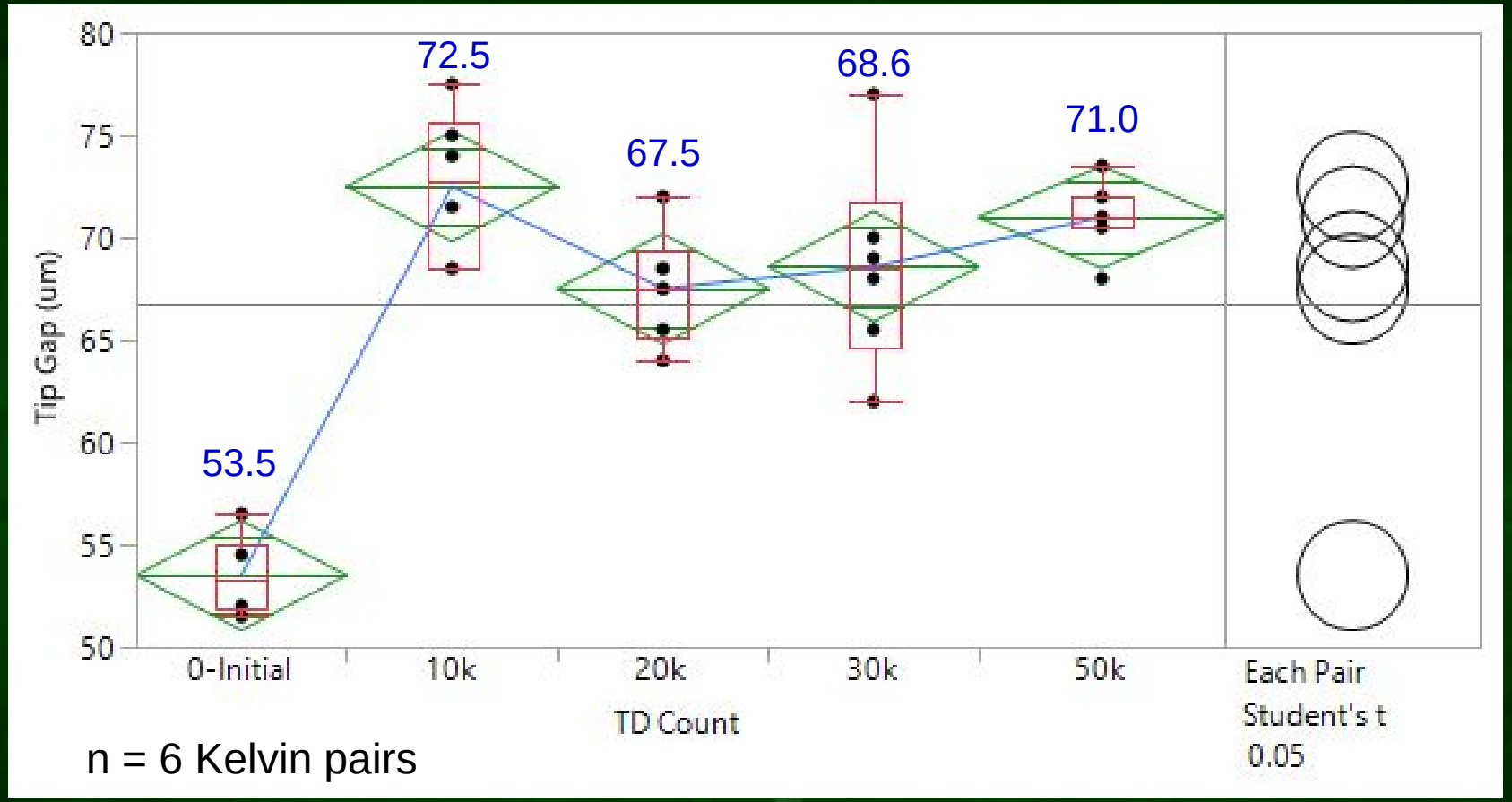


30k TDs



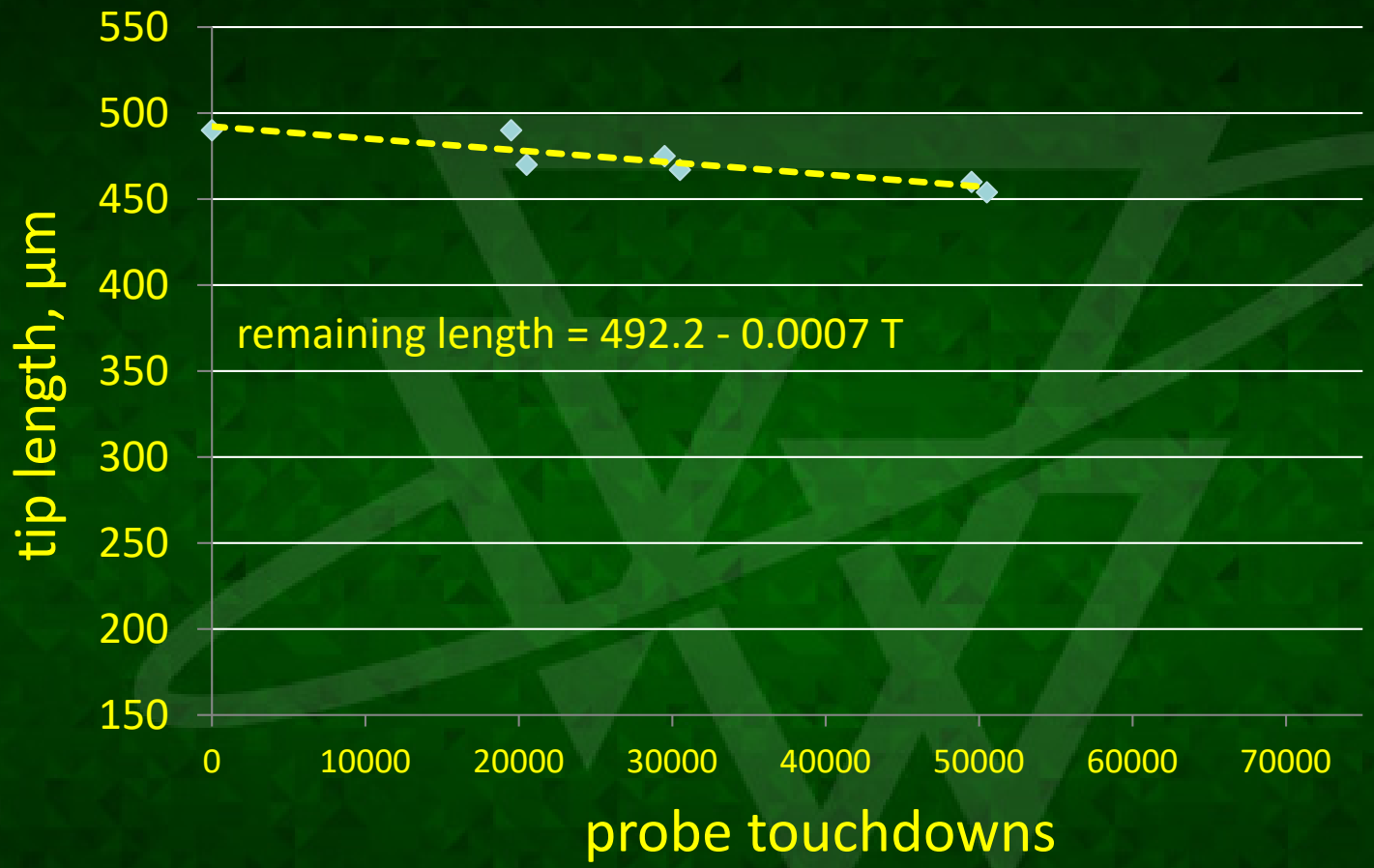
50k TDs

Kelvin Pin Gap vs. Touchdowns



Average gap size increased about 15µm from 0 to 10k TDs, then levelled off

Estimated Pin Lifetime



With the measured wear rate through 50k touchdowns and an end-of-life tip length of 150µm, projected pin lifetime is *a minimum* of 500k touchdowns

Summary & Next Steps

- **The P200 MEMS pin and probe head shows consistent probe marks out to 50,000 touchdowns on < 200µm diameter bumps**
  - No probe marks observed within 10µm of the bump edge
- **Average Kelvin gap size increased by ~15µm from 0 to 10k TDs, but then stayed level from 10k to 50k TDs**
- **Based on pin wear to 50k TDs, estimated pin lifetime is at least 500k touchdowns**
  - CRES data (when available) may provide an opportunity to reduce cleaning frequency and extend pin life

- **Continue to monitor probe marks and Kelvin gap size out to (at least) 200k touchdowns**
- **Add contact resistance (CRES) monitoring to the evaluation**
  - Will CRES be an indicator of probe position on the bump?

    e.g. higher CRES = probe has slid to bump edge

Acknowledgements & Thanks

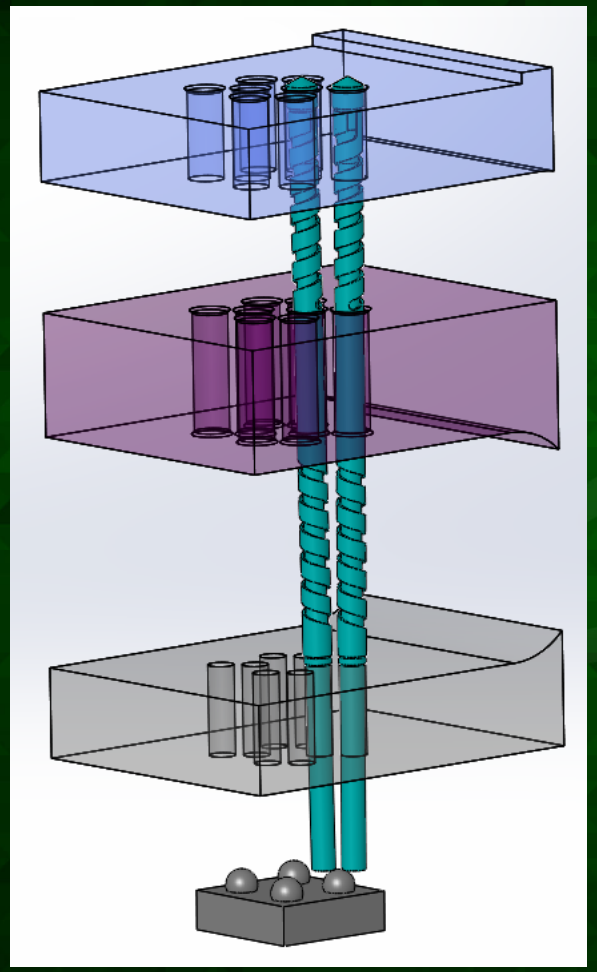
Nidec – SV TCL Carmen Tomsu, Fidencio Pena, Tien Phan, Alan Truong, Steven Pham, Norihiro Ohta, Yusuke Yokota

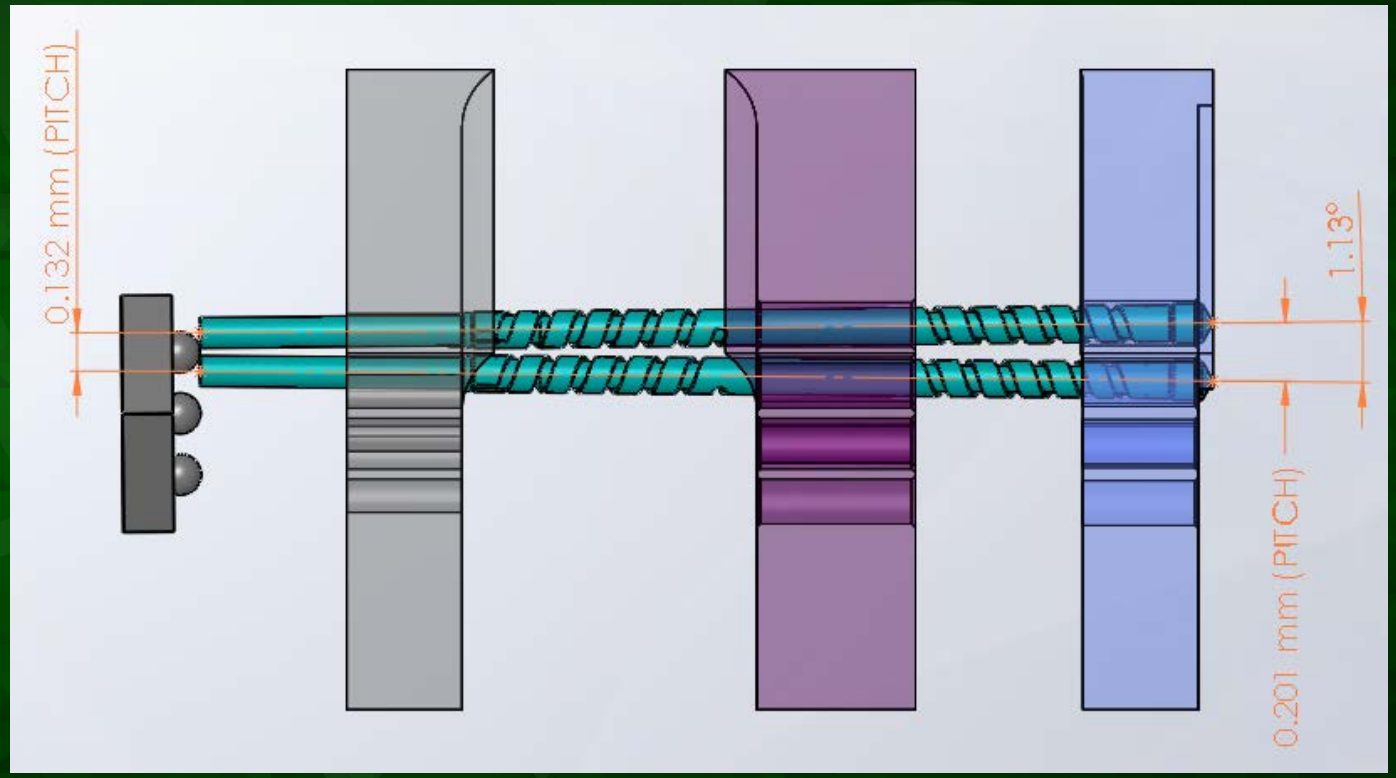
Texas Instruments Mike Morris, Khurram Aziz, Qiao Chen, Mark Vu, Doug Shuey, Brandon Mair

Q & A

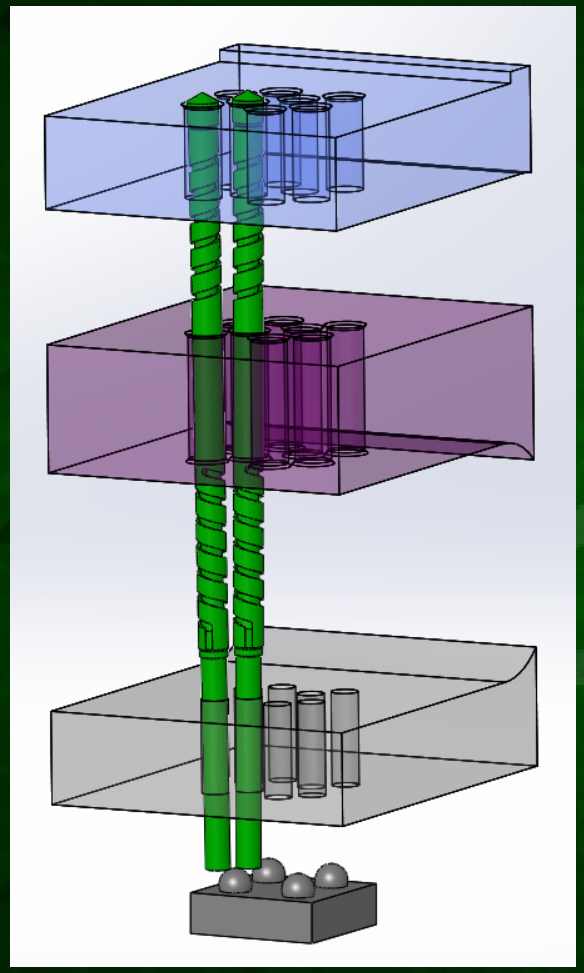
Backup Slides

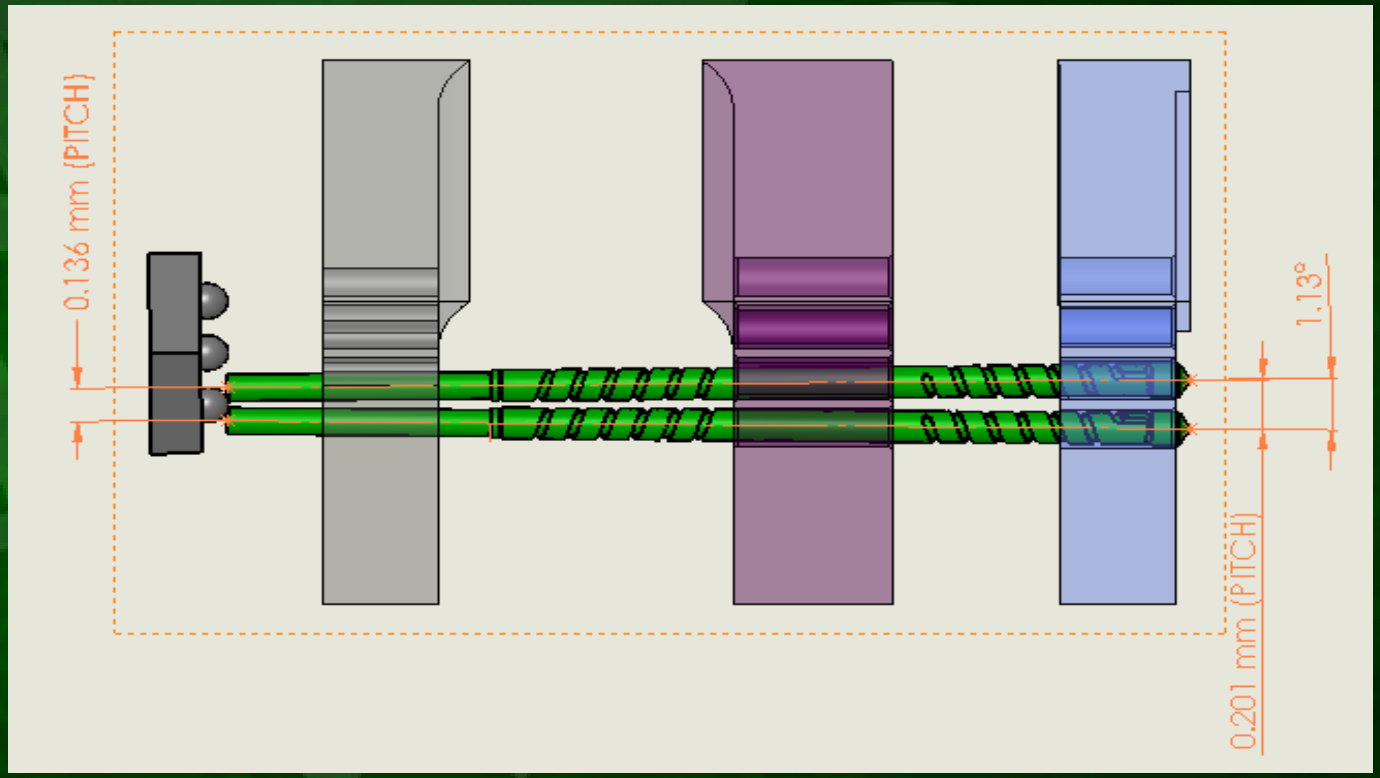
Probe Head with Preload





Recommended Overtravel – 180µm





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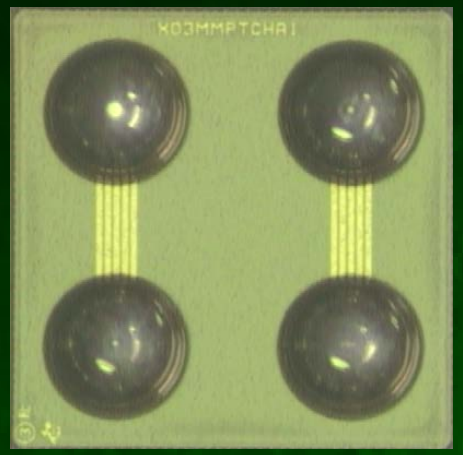

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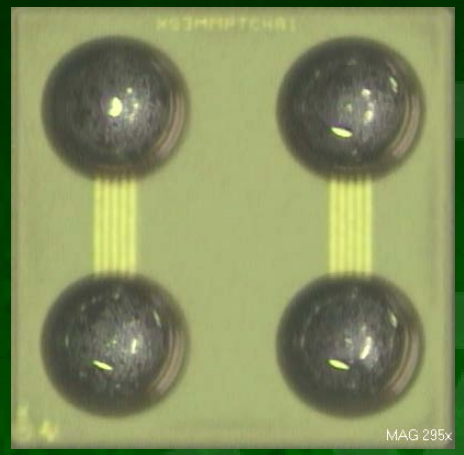

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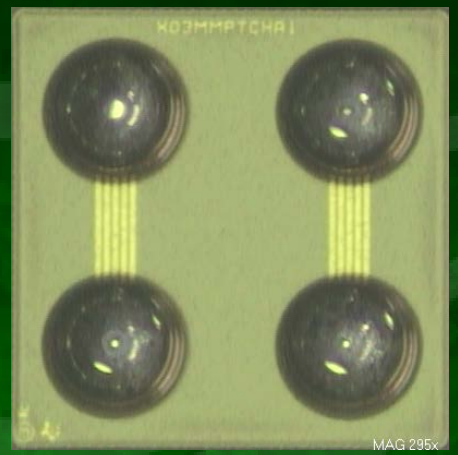

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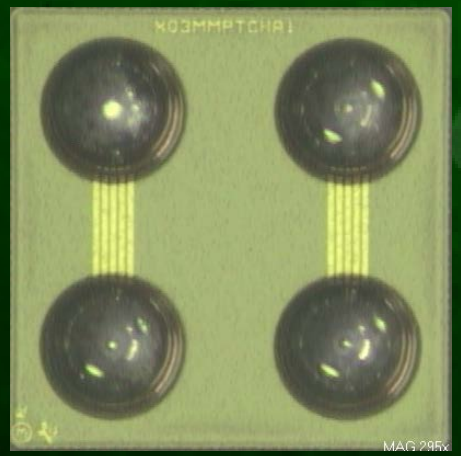

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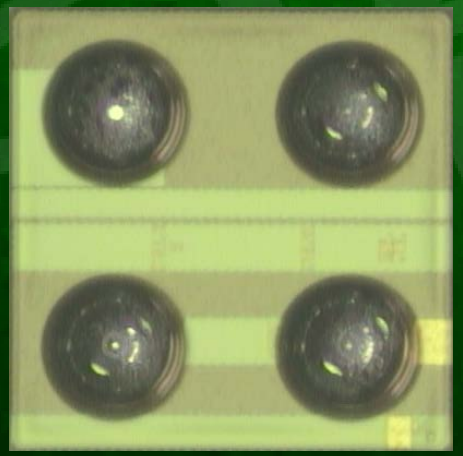
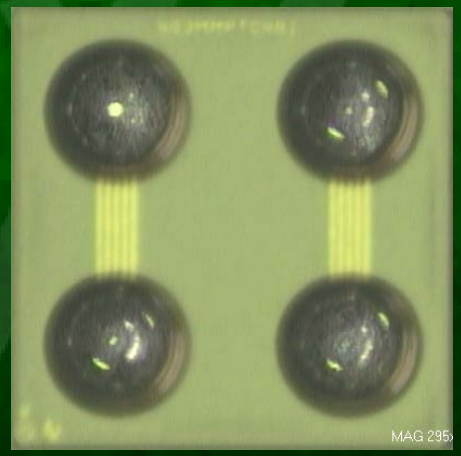
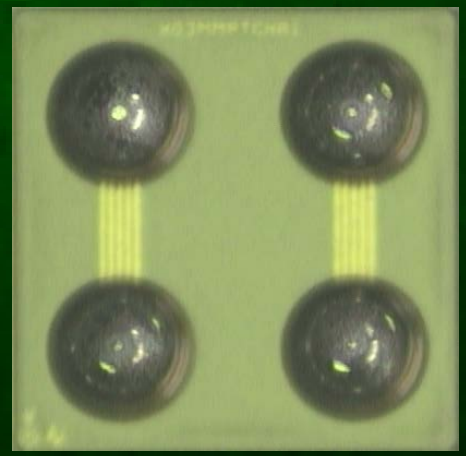


20k TDs



30k TDs



50k TDs