SWTEST 2026 CONFERENCE

35th ANNIVERSARY

UltraFLEXplus Deflection and Thermal Performance

Across Multiple Interface Configurations

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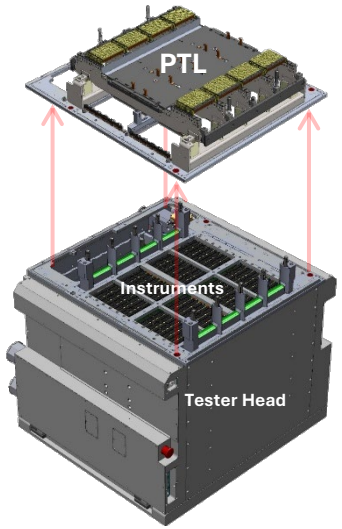
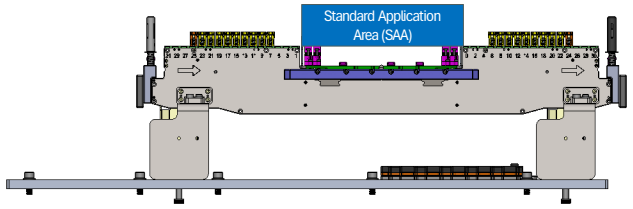
Study Background

In 2024-2025, NXP evaluated transitioning UltraFLEXplus from SPTL to UPTL and from SAA to EAA stiffener to expand application space

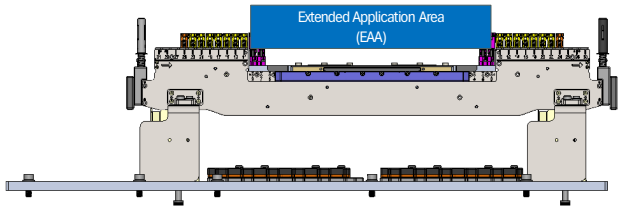
NXP UltraFLEXplus Transition Study (2024-2025)

- SPTL to UPTL (pitch translation layer)
- SAA to EAA stiffener combinations
- Goal: expand application space





SPTL (Standard Pitch Translation Layer)



UPTL (Universal Pitch Translation Layer)

The hardware variables shown on the left, combined with new **higher probe force cards**, made it apparent that it was necessary to characterize and contrast the effects of these new combinations on AOT-POT and thermal performance of NXP's current and future probe cards.

⚠ **Critical Need:** Validate interface performance across multiple configurations to ensure reliable testing

Characterization Requirements

- **AOT-POT performance**
- **Thermal stability**
- **Deflection analysis**
- **Interface compatibility**

Design Verification Goals

Objectives

- Characterize the effect of the current and new hardware configurations on mechanical and thermal deflection
- Characterize the new UltraFLEXplus High Probe Force option

Key Variables & Transitions

DEVICE TYPE	2 different devices	
PROBE FORCE	81 kg	100 kg
DIB SIZES	M18 MEDIUM	L24 LARGE
INTERFACE	SPTL STANDARD	UPTL UNIVERSAL

Test Configuration & Measurement

Deflection Measurement
AOT-POT pins at array edges

Thermal Movement
Electrical 1st touch during soak

Data Collection
Continuous monitoring during test

Test Cell and Configuration

Teradyne UltraFLEXplus

Digital/Mixed Signal Testing Platform

- SPTL: Standard Pitch Translation Layer Interface
- UPTL: Universal Pitch Translation Layer Interface

Prober

TEL Precio XL

Probe Head

TECHNOPROBE

- Technoprobe S90 SA2 XLT Flat Probe Technology
- Probe Force: 81kg and 100kg
- Pin Count: ≈40.5k probes (81kg) and 50k (100kg)

Probe Card Hardware/PCB

- Standard Application Space (SAA) Medium 18 PIB (Probe Interface Board)
- Standard Application Space (SAA) Large 24 PIB
- Extended Application Space (EAA) Large 24 PIB

Wafers

- Blanket Al/Cu for AOT-POT
- Product wafers for electrical planarity

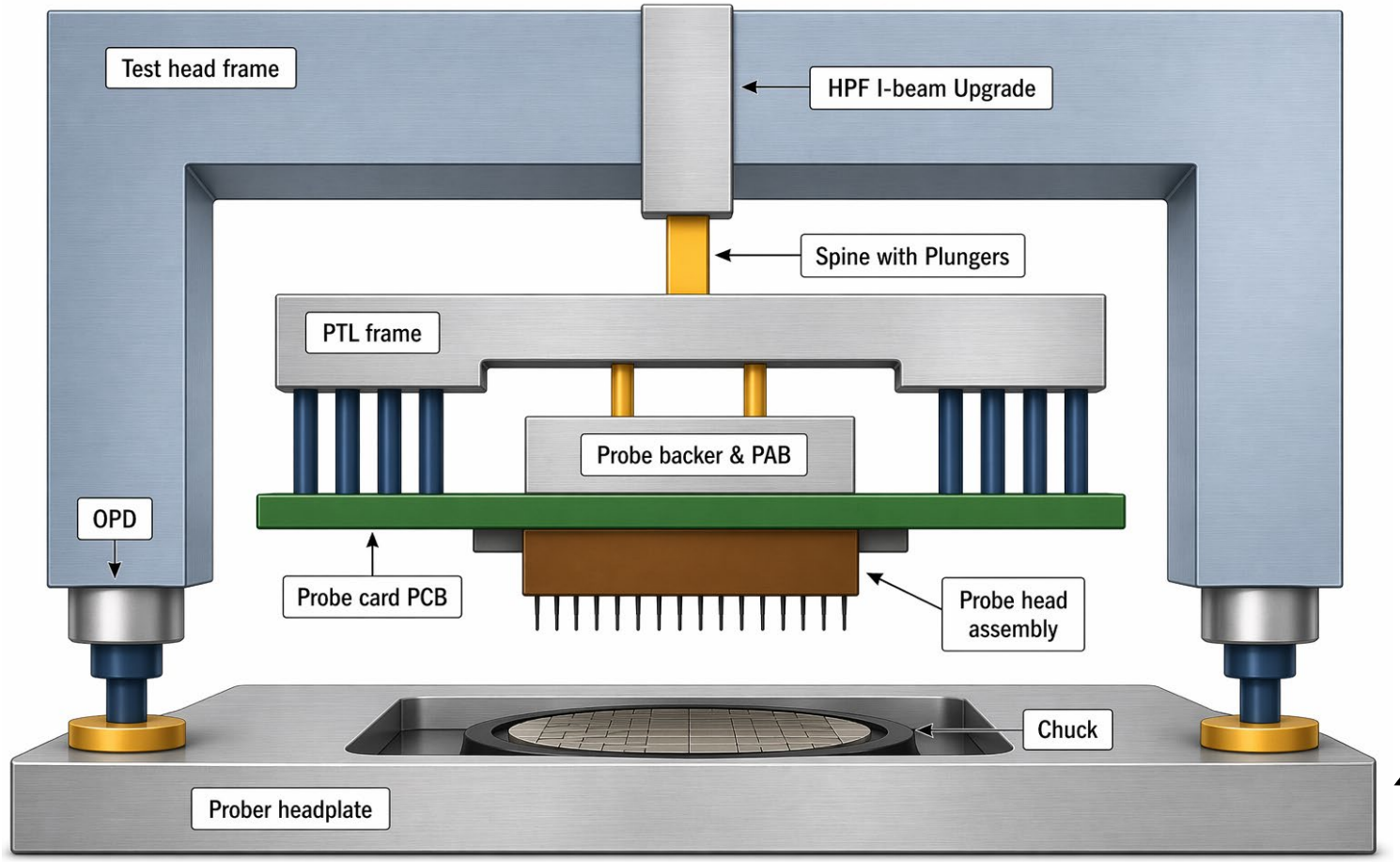
Characterization Tools

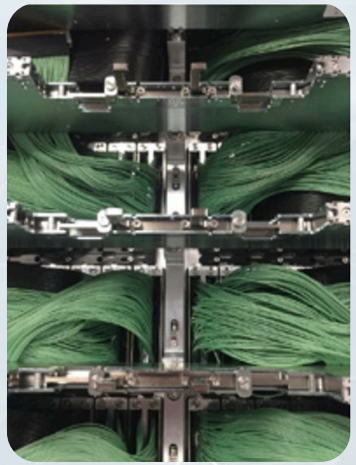
- Technoprobe AOT-POT pins
- Tester continuity program
- Fine Leveling System (FLS) planarity calibration probe card

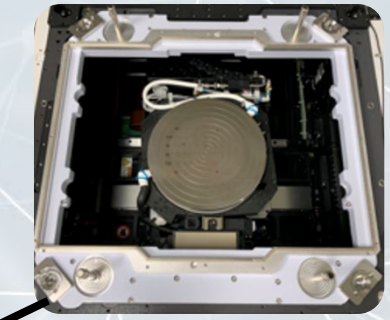
UltraFLEXplus Z-Stack Overview

Cross Section of UltraFLEXplus Mechanical Stack Up

Potential Sources of Deflection



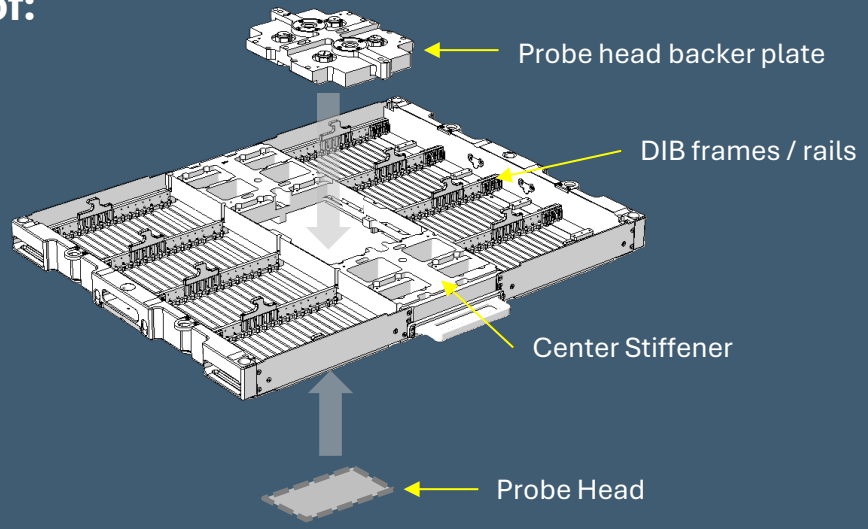


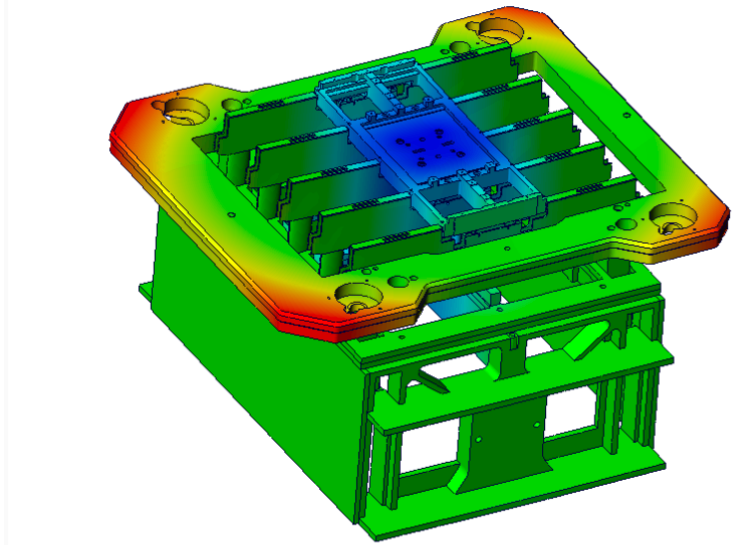


Theoretical Z-Stack Deflection w/100kg of Probe Force

Tester Interface consisting of UltraFLEXplus prober insert plate, Pitch Translation Layer and Outer and Inner Pull-Down (OPD/IPD) docking is stable.

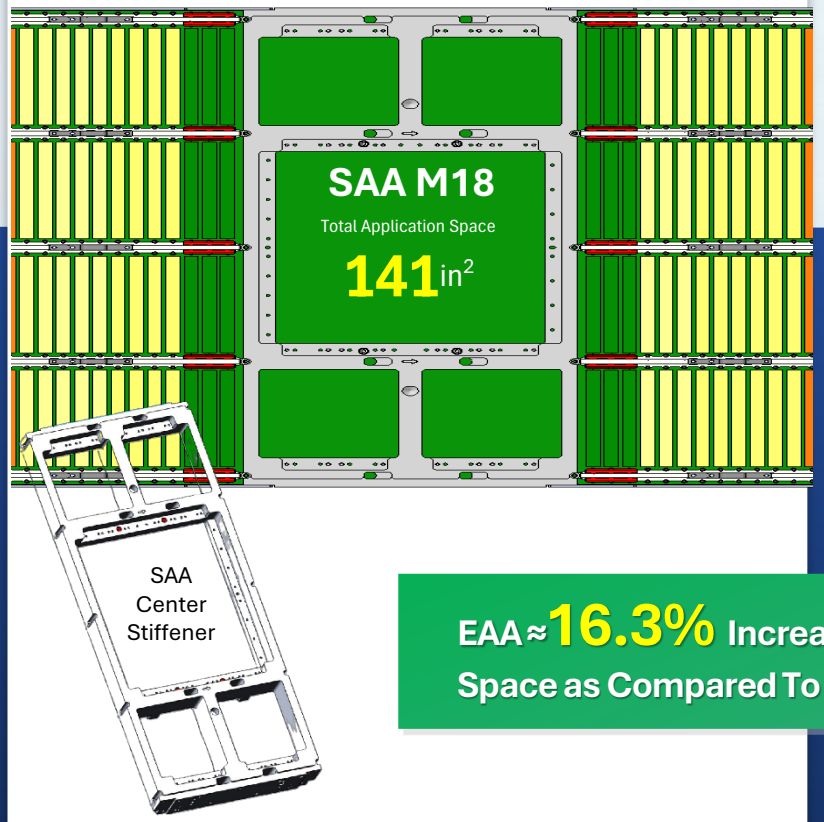
Largest contributor to interface stiffness variations driven by probe card mechanical differences in the Design and Material of:





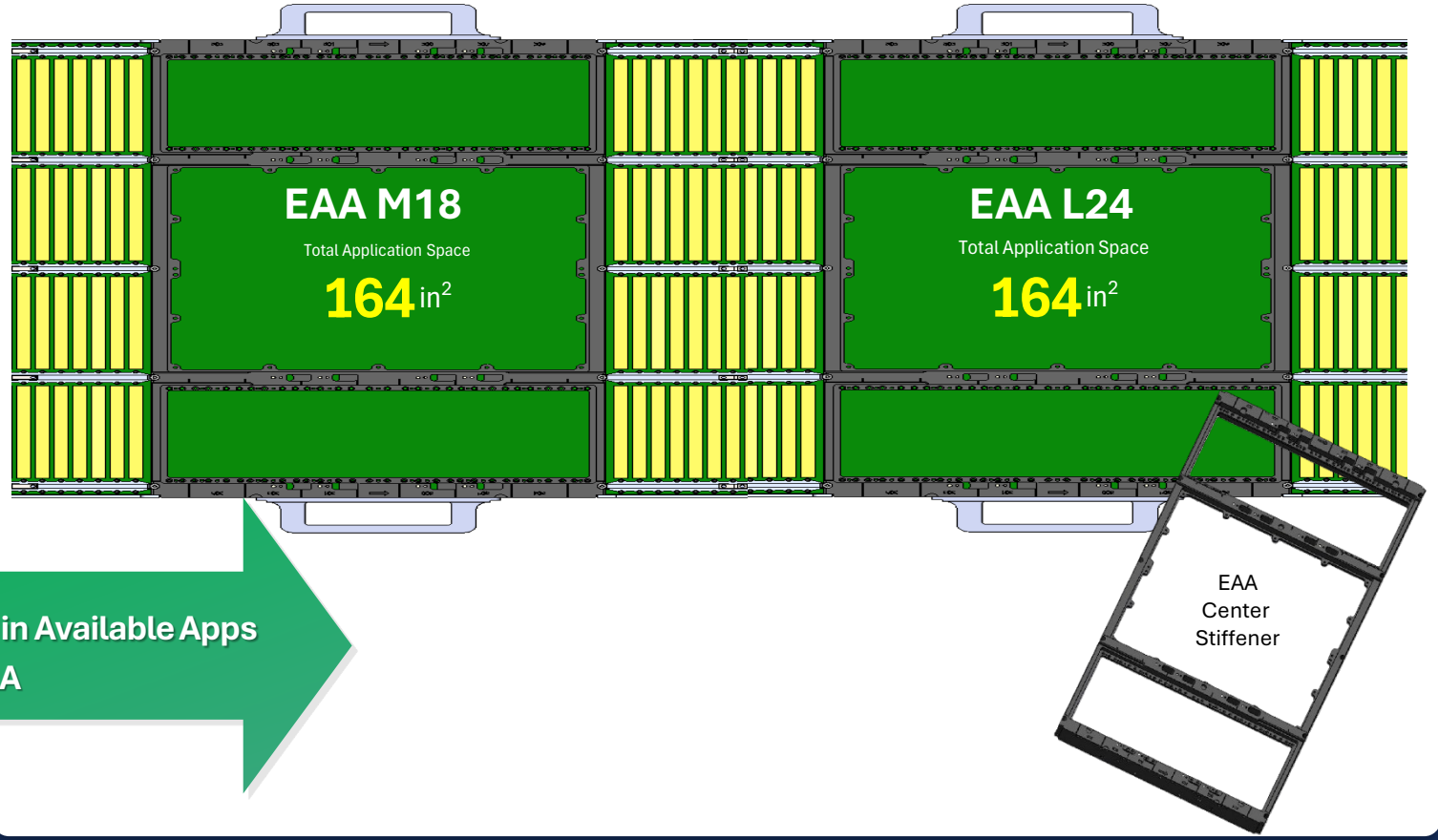
DIB Layout and Applications Space Comparison

Standard Applications Area (SAA)



EAA ≈ **16.3%** Increase in Available Apps Space as Compared To SAA

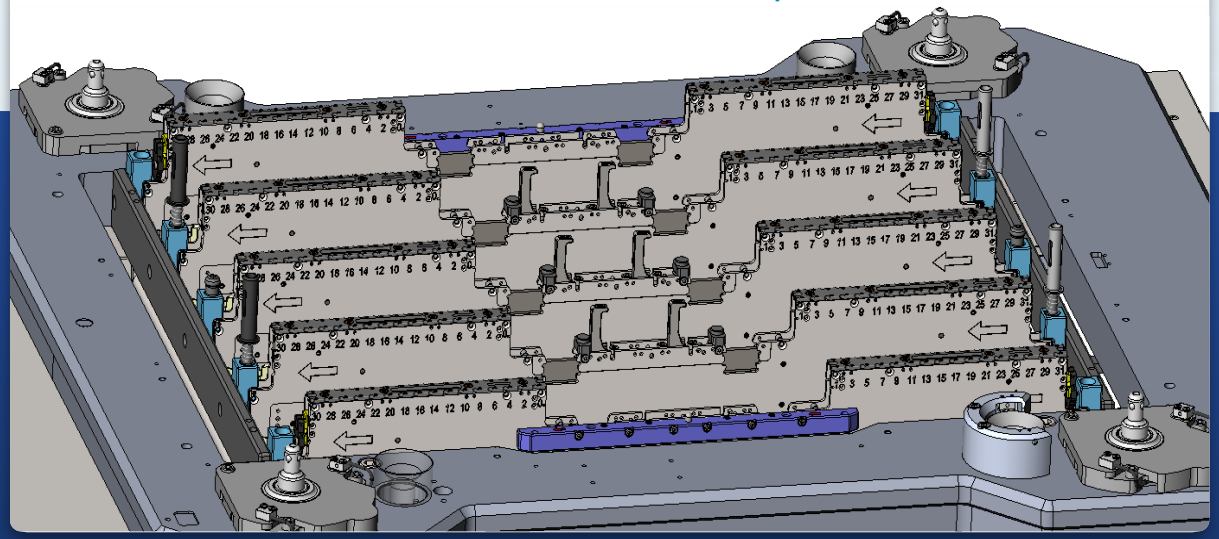
Extended Applications Area (EAA)



UltraFLEX^{plus} SPTL and UPTL Interface Comparison

Standard PTL (SPTL)

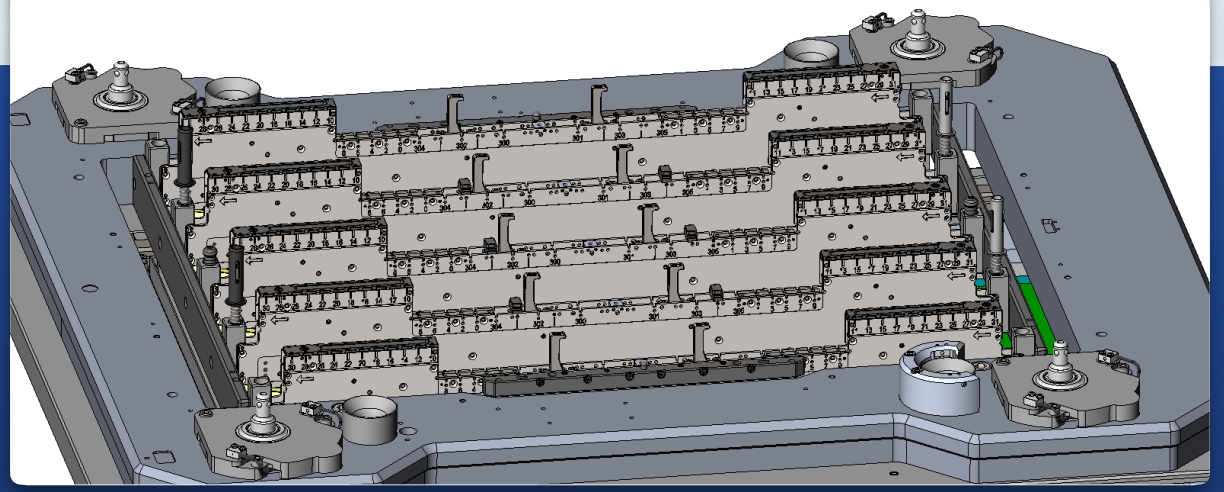
with Fixed Hard Stops



RF Hooks: 60.0mm
Hard Stop Buttons: 102.8mm

Universal PTL (UPTL)

with Fixed Hard Stops



RF Hooks: 118.0mm
Hard Stop Buttons: 162.9mm

UltraFLEXplus Probe Cards Used For DV Data Collection

SAA Stiffener

(Standard Application Area)

DUT Array	Array Size	Pin Count	Total Force
4 x 4	55 x 42mm	40.5K	81kg

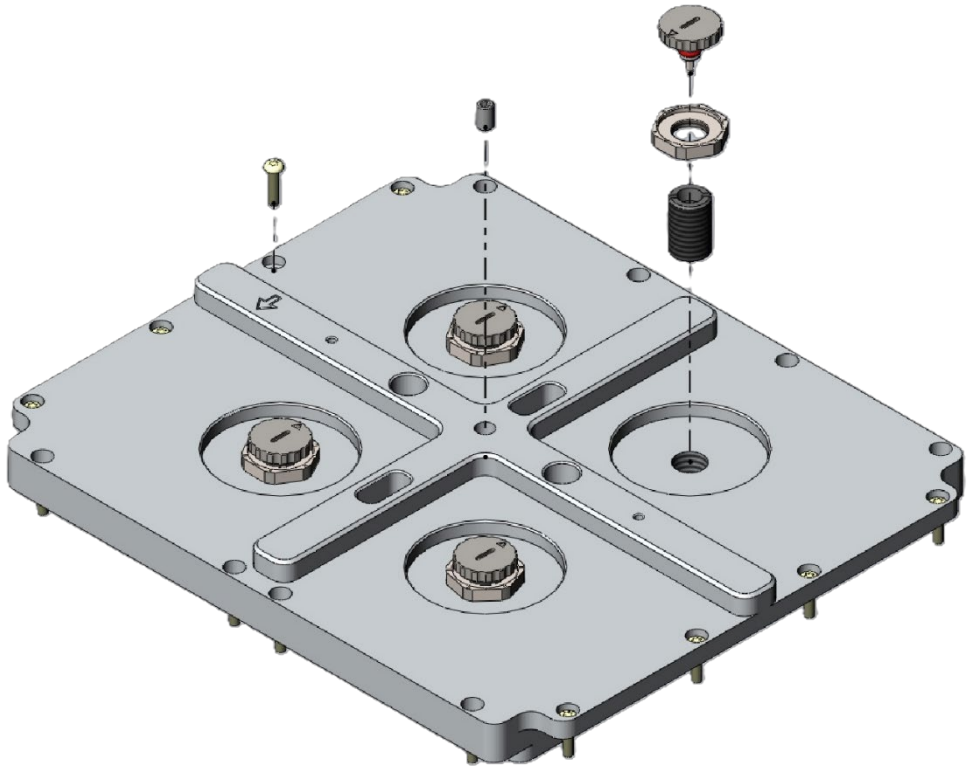
EAA Stiffener

(Extended Application Area)

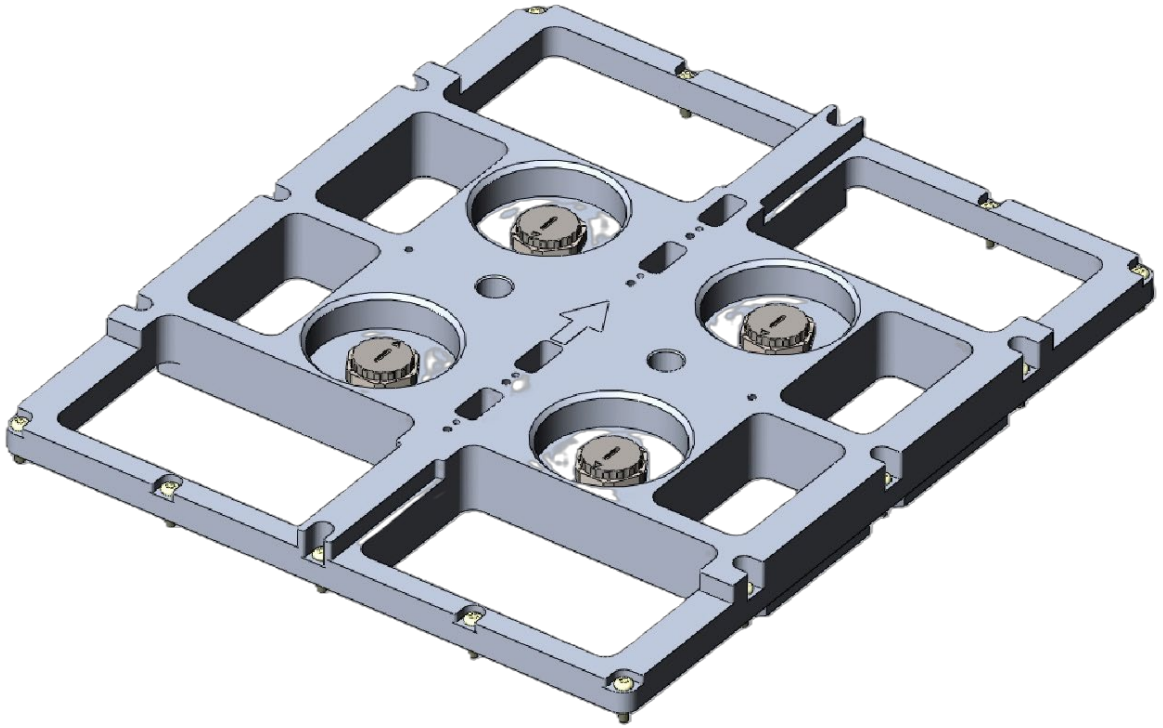
DUT Array	Array Size	Pin Count	Total Force
7 x 3	59 x 51mm	50K	100kg

UltraFLEXplus Precision Alignment Bracket (PAB)

Standard Application Space PAB



Extended Application Space PAB



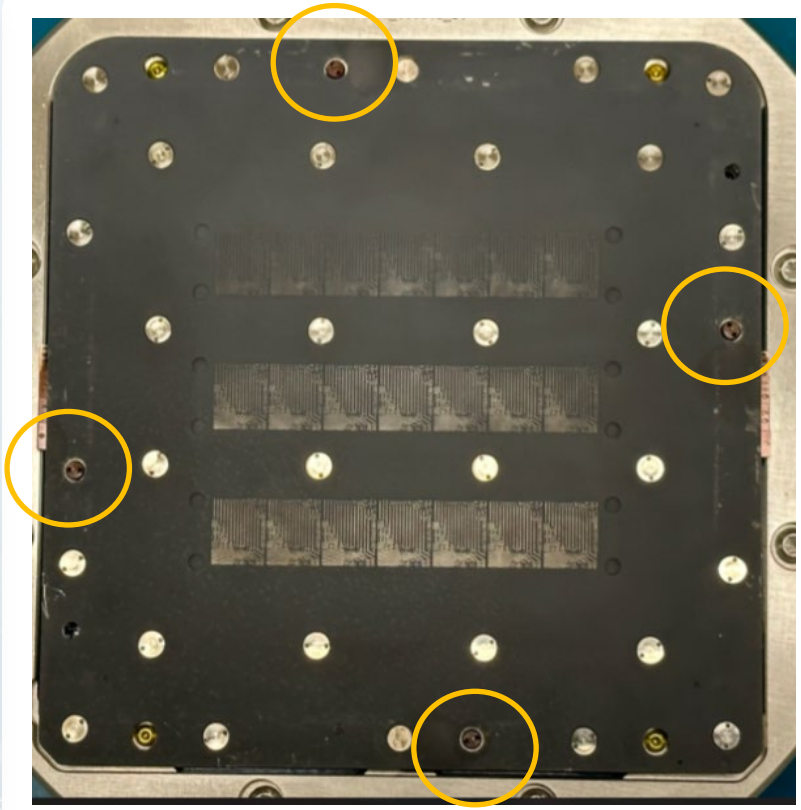
AOT-POT and Temperature Deflection Characterization
on SPTL & UPTL UltraFLEXplus Interfaces
using SAA & EAA Probe Card Hardware

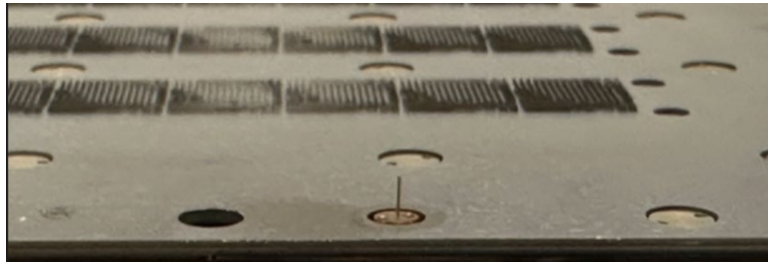
Total Overtravel Loss Using AOT-POT Methodology

- **UltraFLEXplus mechanics (True Direct Dock) does not allow for direct measurement of test head deflection**

- **Technoprobe AOT-POT pins used to measure total system loss**
  - AOT = Actual Over Travel
  - POT = Programmed Over Travel
  - 4 plunger pins are installed at the edge of array at the probe head cover locations
  - Z up to sweep thru the range of overtravel
  - Plungers "stick" when OT is applied
  - Plunger movement is measured post OT increment
  - Deflection Calculation:

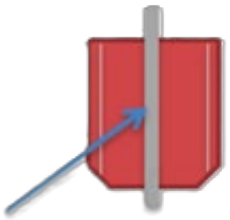
$$Total\ Overtravel\ Loss = \frac{POT - AOT}{Total\ Probe\ Head\ Force}$$



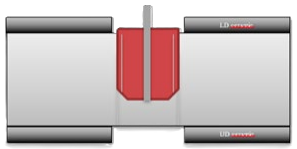


Custom made M3 set screw with center through hold and auxiliary holes on one side

Free moving "Retractable" pin



Free moving "Retractable" pin



Cross section view of the one of M3 holes with the retractable pin installed

Why Use µm/kg As A Metric???

- AOT/POT process looks at mechanical movement of the probe needle away from the wafer and is a function of the total force of the DUT array.
- Within the same tester platform and probe card stack design the variable is the total force of the probe needles
- By calculating the overdrive loss in µm/kg you can compare results across probe cards with different total loads.

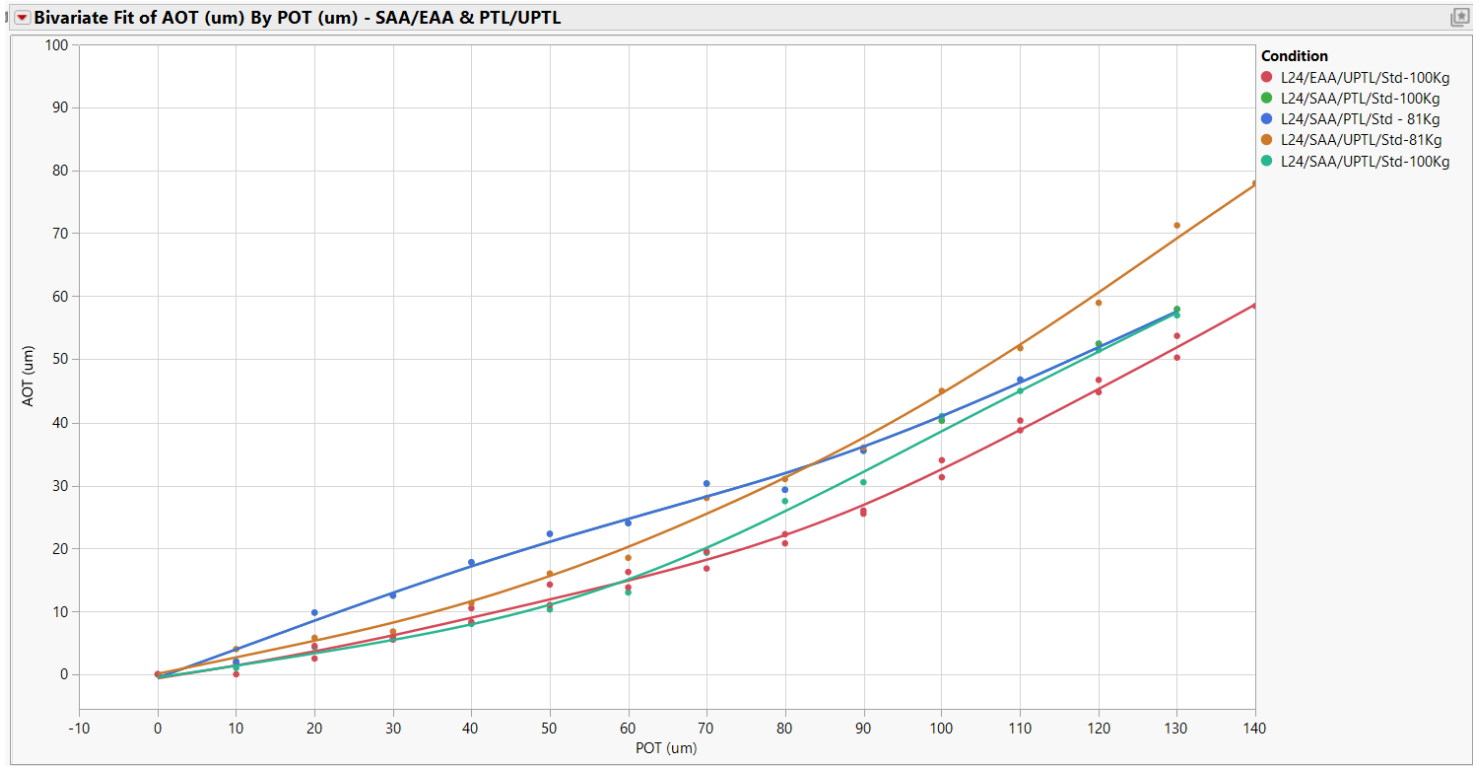
$$\frac{Total\ Overtravel}{Loss} = \frac{POT - AOT}{Total\ Probe\ Head\ Force}$$

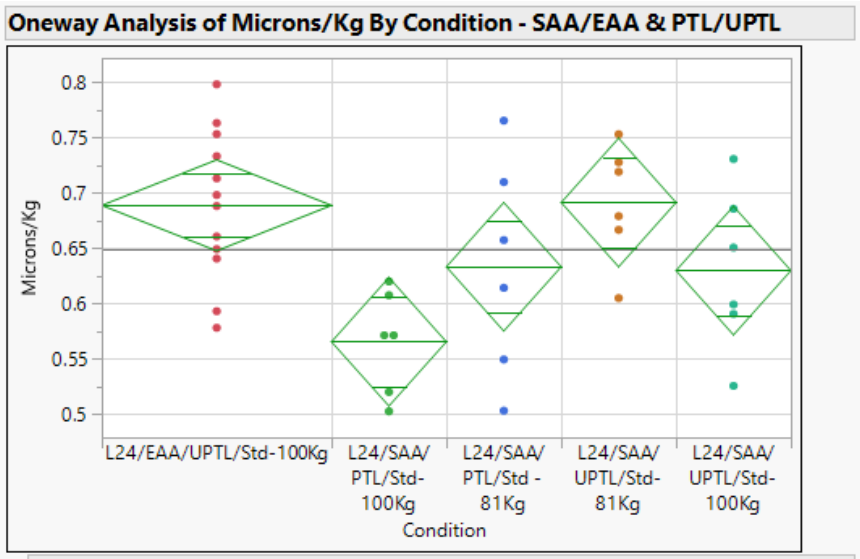
Examples using probe cards with 100kg and 81kg total probe force:

$$\frac{(100\mu m - 35\mu m)}{100kg} = 0.65\mu m/kg$$

$$\frac{(100\mu m - 37\mu m)}{81kg} = 0.63\mu m/kg$$

AOT-POT Characterization





Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
L24/EAA/UPTL/Std-100Kg	12	0.688814	0.02016	0.64770	0.72992
L24/SAA/PTL/Std-100Kg	6	0.565417	0.02851	0.50728	0.62355
L24/SAA/PTL/Std - 81Kg	6	0.633230	0.02851	0.57509	0.69137
L24/SAA/UPTL/Std-81Kg	6	0.691358	0.02851	0.63322	0.74950
L24/SAA/UPTL/Std-100Kg	6	0.629796	0.02851	0.57166	0.68793

Std Error uses a pooled estimate of error variance

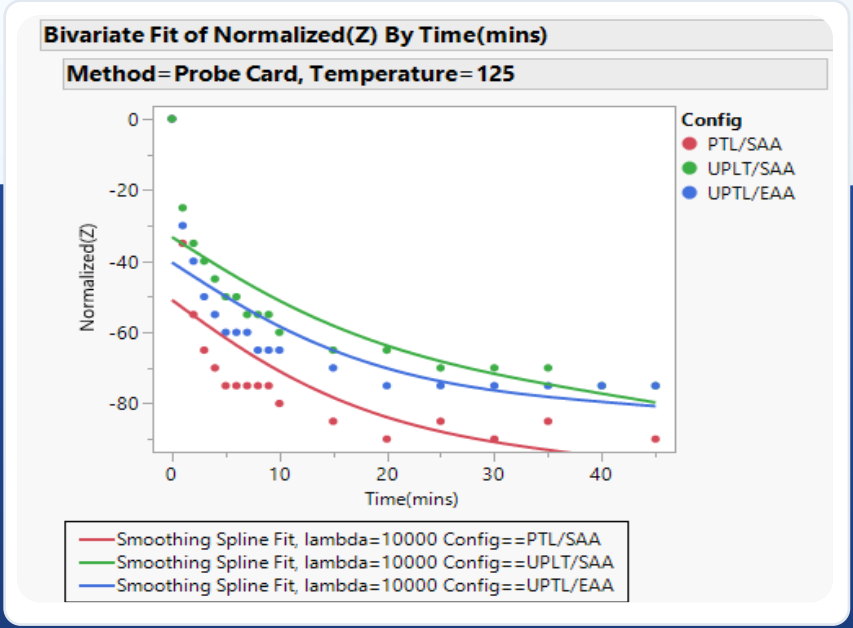
Mean Z-Stack Deflection

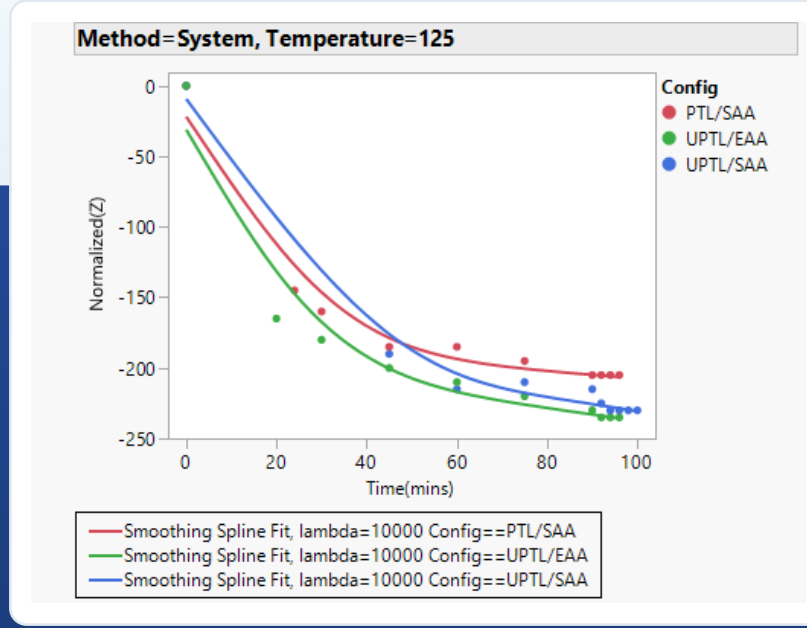
Target Spec: 0.5-0.7µm/kg

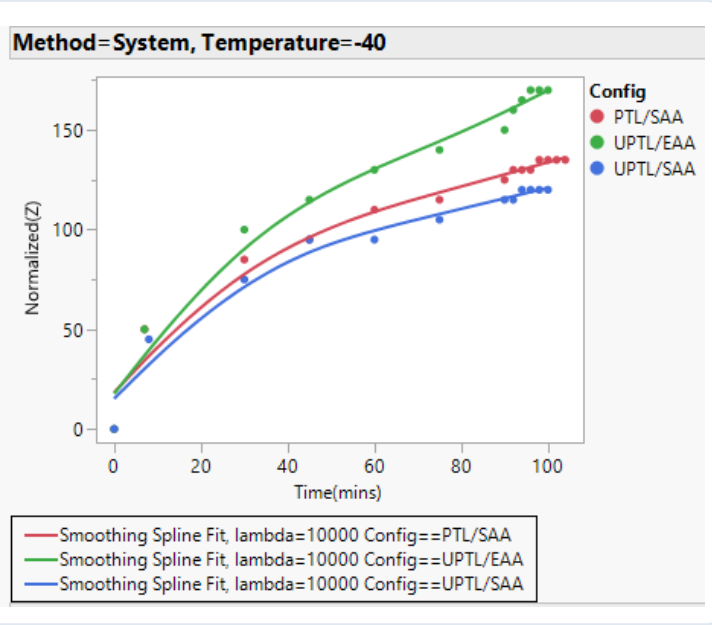
PC Config	Tester Interface	Probe Force (kg)	Deflection (µm/kg)
L24 EAA	UPTL	100	0.68
L24 SAA	SPTL	100	0.56
L24 SAA	SPTL	81	0.63
L24 SAA	UPTL	81	0.69
L24 SAA	UPTL	100	0.62

AOT-POT/Mechanical Performance not seeing a significant change due to the hardware updates.

Thermal Movement Characterization







Probe Card = Teradyne Soak Method

- Prober chuck set to 125°C @ T=0
- 12-hour stabilization of prober cavity before starting soak
- Establish 1st contact
- Soak w/80% of pins in contact
- Reestablish 1st contact
- Soak w/80% until card stabilizes

System = NXP Soak Method

- Prober chuck set to 25°C @ T=0
- Start with prober chuck at 25°C
- Measure z movement for 100 mins
- Chuck 300µm below probe card for 90 minutes

		Normalized(Z)	Normalized(Z)
Method	Config.	Max	Min
Probe Card	PTL/SAA	0	-90
	UPTL/SAA	0	-75
	UPTL/EAA	0	-75
System	PTL/SAA	135	-205
	UPTL/SAA	120	-230
	UPTL/EAA	170	-235

Result : Thermal effect not seeing a significant change due to hardware updates

Teradyne UltraFLEXplus

High Probe Force (HPF) Interface

UltraFLEXplus High Probe Force DV Goals

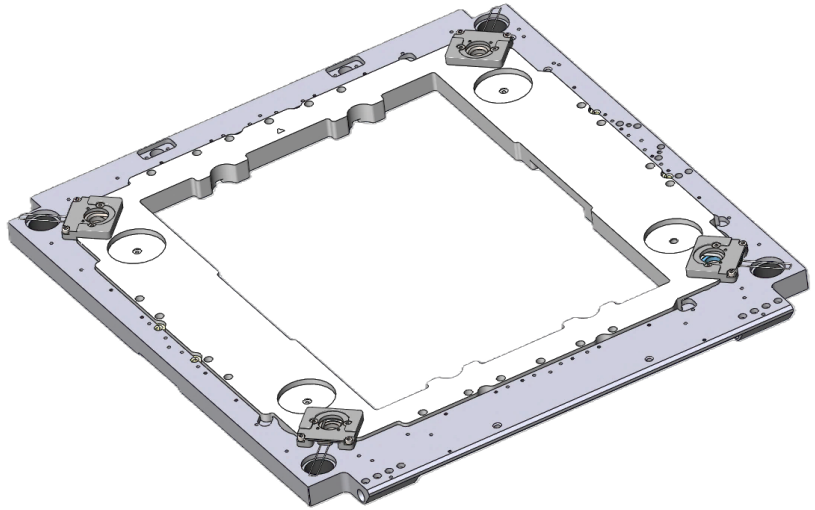
- **Characterize the UltraFLEXplus High Probe Force (HPF) Tester Interface Hardware**
  - L24/SAA probe card with 81kg probe force
  - L24/EAA probe card with 100kg probe force
- **Measure Deflection Performance to Compare Standard and High Force UltraFLEXplus Tester Interface Hardware using AOT-POT Pins**

UltraFLEXplus UltraProbe HPF Field Upgrade Kit

New Non-adjustable Hard Stop

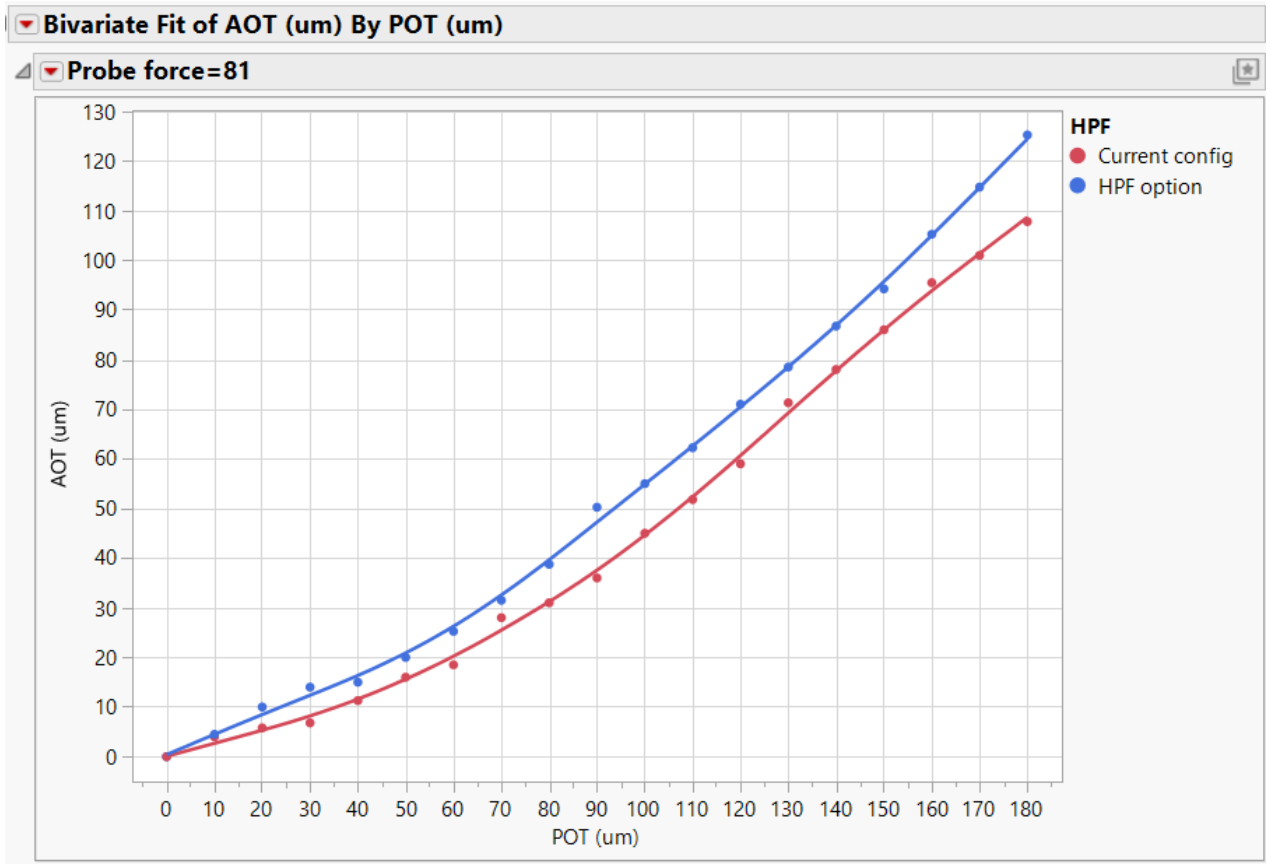
Enhanced Spine in Test Head

New I-Beam Brace on Test Head



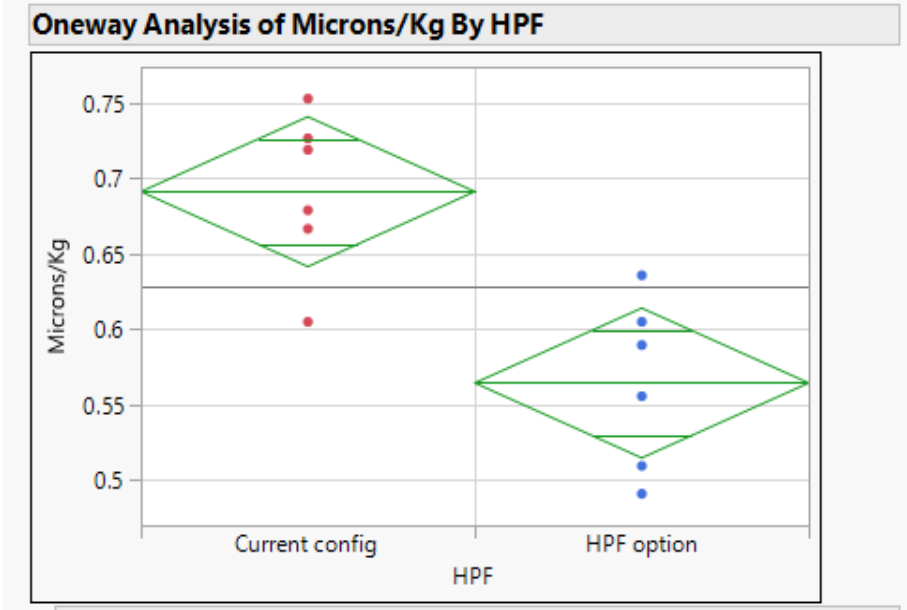
Enhanced Prober Insert with New OPD Hard Stop

AOT-POT Results – 81kg Probe Force w/HPF Kit



Target Spec
0.5-0.7µm/kg

PC Config	Tester Interface	Probe Force	Deflection
L24 SAA	UPTL	81kg	0.68 µm/kg
L24 SAA	UPTL with HPF	81kg	0.56 µm/kg



Oneway Anova

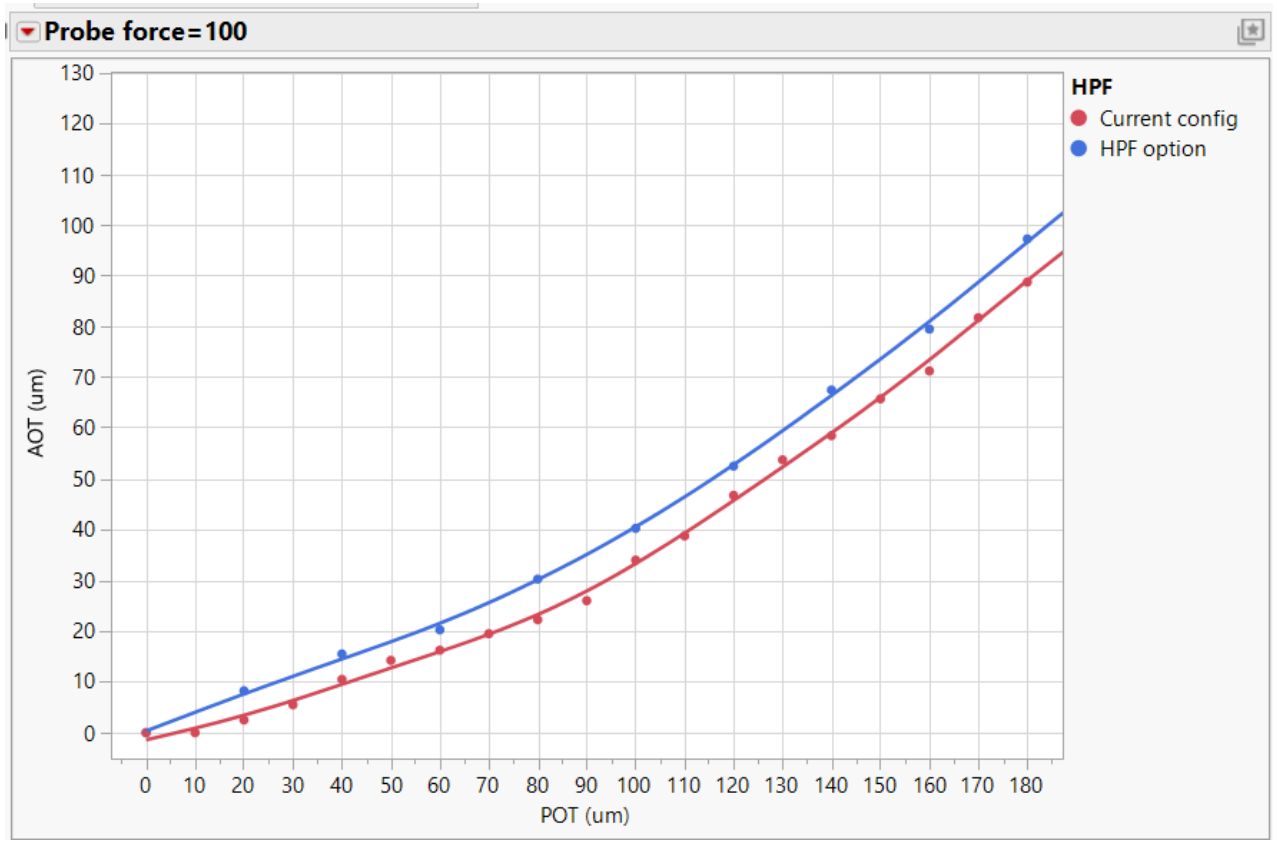
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Current config	6	0.691358	0.02232	0.64163	0.74108
HPF option	6	0.564300	0.02232	0.51458	0.61402

Std Error uses a pooled estimate of error variance

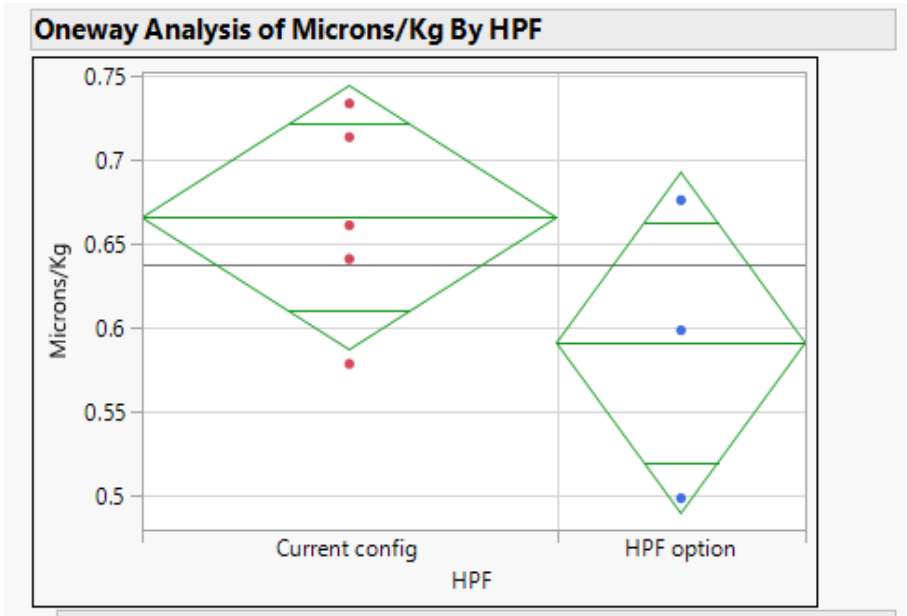
81kg Probe Card HPF option provides
0.13 µm/kg, 18% improvement

AOT-POT Results – 100kg Probe Force w/HPF Kit



Target Spec
0.5-0.7µm/kg

PC Config	Tester Interface	Probe Force	Deflection
L24 EAA	UPTL - Original	100kg	0.68 µm/kg
L24 EAA	UPTL with HPF	100kg	0.59 µm/kg



Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Current config	5	0.665165	0.03215	0.58649	0.74384
HPF option	3	0.590591	0.04151	0.48902	0.69216

Std Error uses a pooled estimate of error variance

100kg Probe Card HPF option provides
0.09 µm/kg, 11% improvement

High Probe Force DV Results

- **Mechanical results of UltraFLEXplus Standard vs. High Probe Force Interface**
- **SAA Stainless Steel stiffener 16 DUT array with 81kg Probe Force**
  - 18% improvement with High Probe Force Interface
  - 0.13 µm/kg with High Probe Force Interface
- **EAA Aluminum Stiffener 21 DUT array with 100kg Probe Force**
  - 11% improvement with High Probe Force Interface
  - 0.09 µm/kg

Mean Z-Stack Deflection

Target Spec 0.5-0.7µm/kg

PC Config	Tester Interface	Probe Force (kg)	Deflection (µm/kg)
L24 EAA	UPTL with HPF Kit	100	0.59
L24 SAA	UPTL with HPF Kit	81	0.56
L24 SAA	SPTL	100	0.56
L24 SAA	UPTL	100	0.62
L24 SAA	SPTL	81	0.63
L24 EAA	UPTL	100	0.68
L24 SAA	UPTL	81	0.69

Summary

SPTL/UPTL and SAA/EAA

Mechanical Deflection Characterization

- Technoprobe and Teradyne FEA projected 0.5 to 0.7µm/kg total deflection
- Mean of All AOT-POT data = 0.64µm/kg
- All configurations meet target spec of 0.7µm/kg
- Current deflection loss could be compensated for by using additional OD

Thermal Movement Characterization

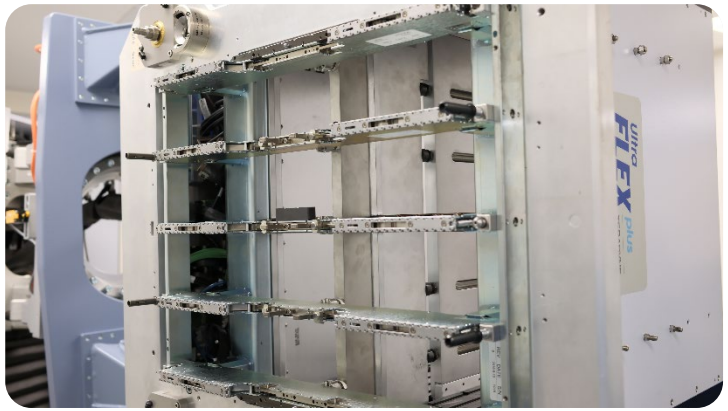
- All values are within control of NXP soak processes
- Thermal stabilization curves would allow start of probing after ≈30 minute/soak
  - Low risk for pin damage or excess bump/pad disturbance
  - Good CRES performance

Comparable Performance Between SPTL/UPTL and SAA/EAA

- Allows NXP to have Extended Application Space and Tester Instrument Flexibility with the same level of mechanical stability and thermal performance

High Probe Force Interface

The new High Probe Force Interface delivers **14.5%** average higher AOT than current interface configurations.



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Jeff Ostertag | Senior Mechanical Engineer

Denis Kang | Product Manager