TWENTY-SEVENTH ANNUAL

TestConX™

Archive

DoubleTree by Hilton
Mesa, Arizona
March 1-4, 2026

Method for Characterization of Large Socket Housing Deflection

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Johnstech International

TestConX™

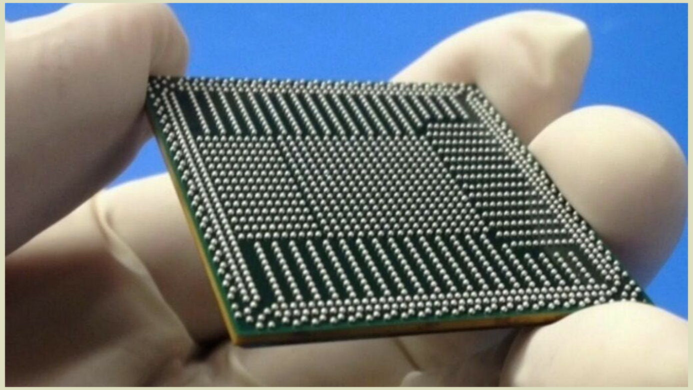
Mesa, Arizona • March 1–4, 2026

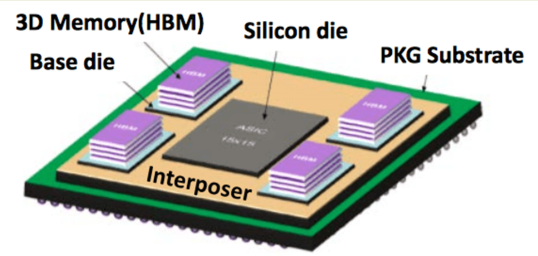
Johnstech®

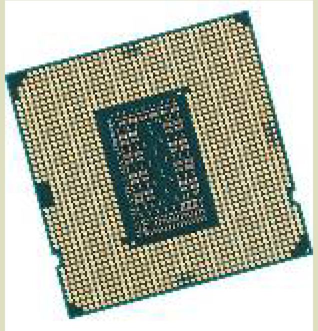
Agenda

- Components of spring probe contactor
- Preload and why it’s important
- Simulation instructions
- Interpreting the Results

Larger Packages







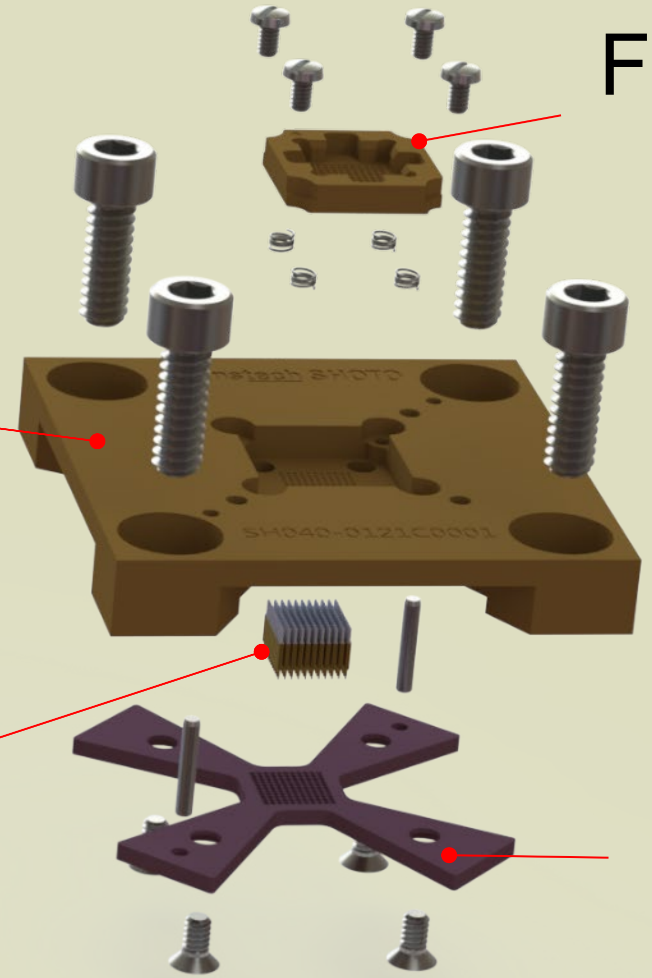
Large ball-count BGAs are used for devices requiring high I/O density, high bandwidth and high power.

As spring probe housings become more densely populated, the need for housing strength must be considered to minimize housing bowing.

This presentation will provide validated methods for simulating housing deflection, the need for spring probe pre-load and its effect on deflection.

Benefits of the Johnstech® Spring Probe series will be discussed.

Spring Probe Contactors - Features



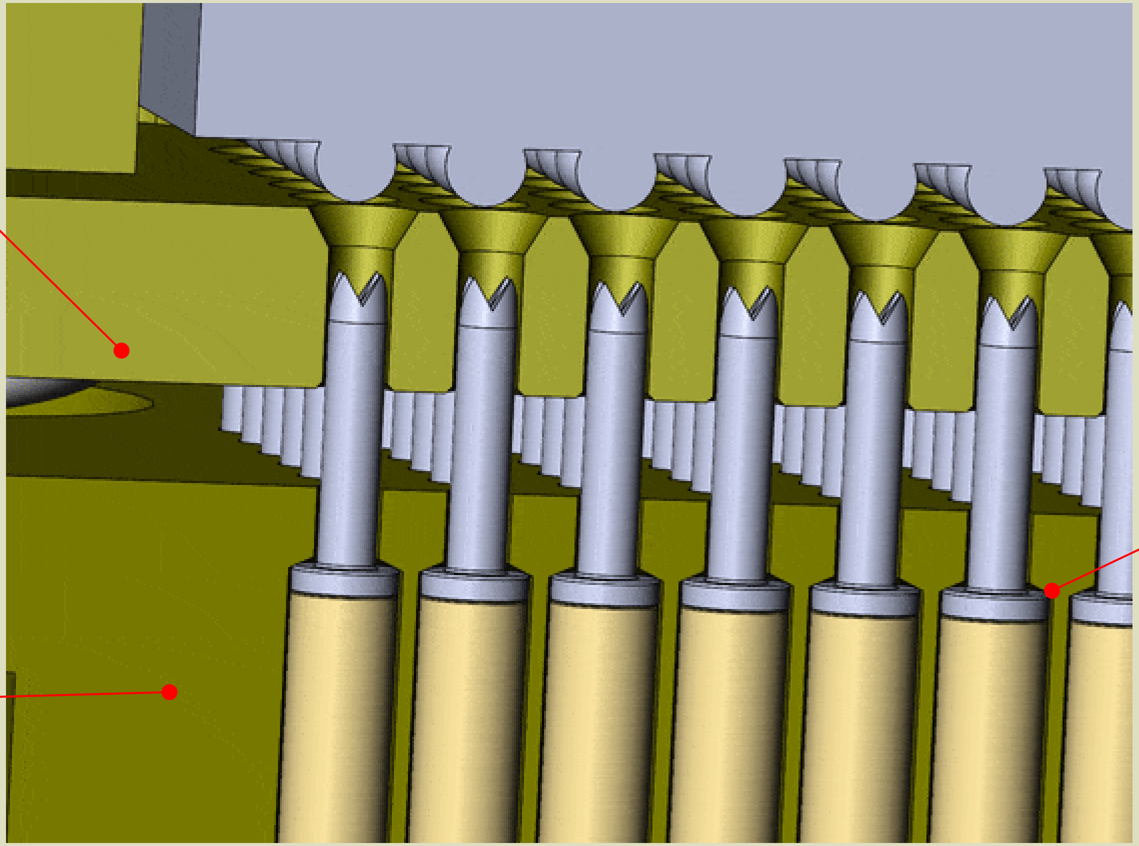
Floating Alignment Plate
FAP

Housing
HSG

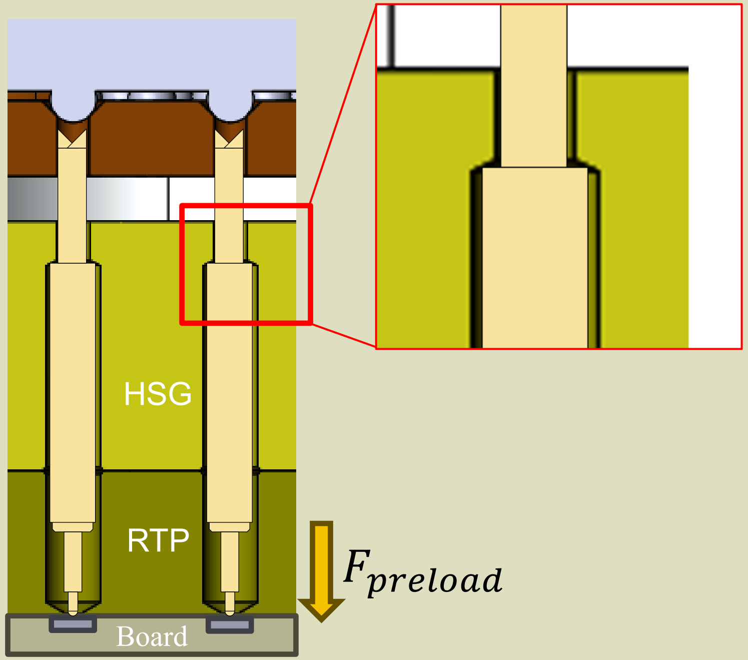
Spring Probes

Retainer Plate
RTP

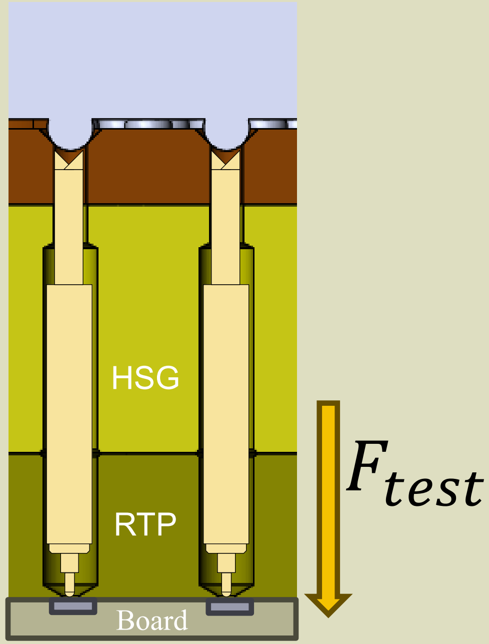
Probe Motion and Probe/Housing Interface



Properly Functioning Preload

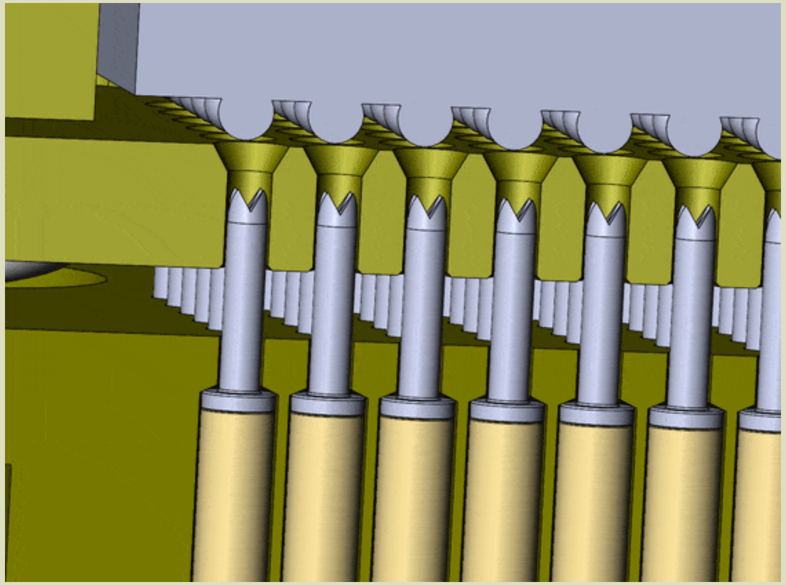


Uncompressed state
Consistent board contact is maintained to the board due to probe housing interface.

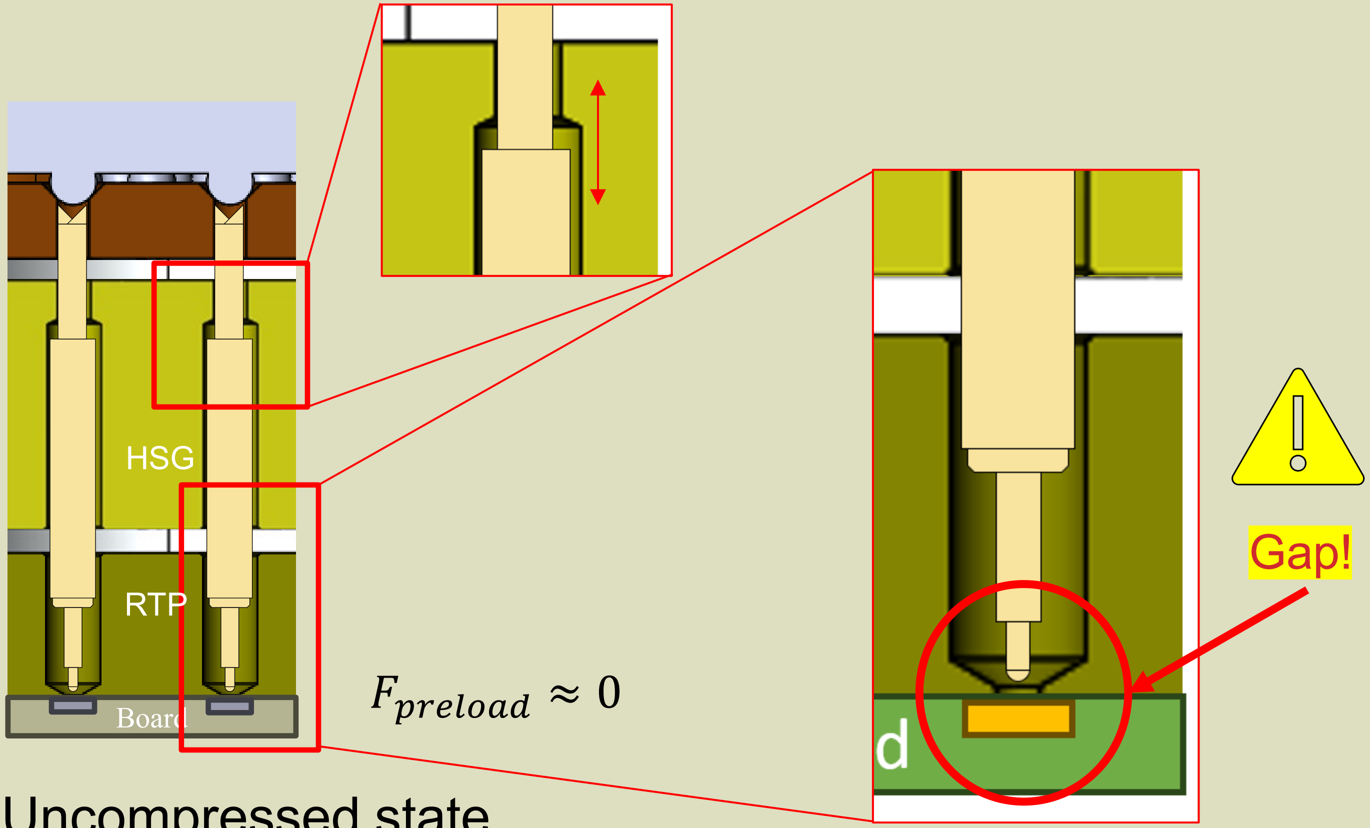


Compressed state
Board contact is maintained.

During the repeated motion between uncompressed and compressed, the probe will always remain in contact with the PCB pad.

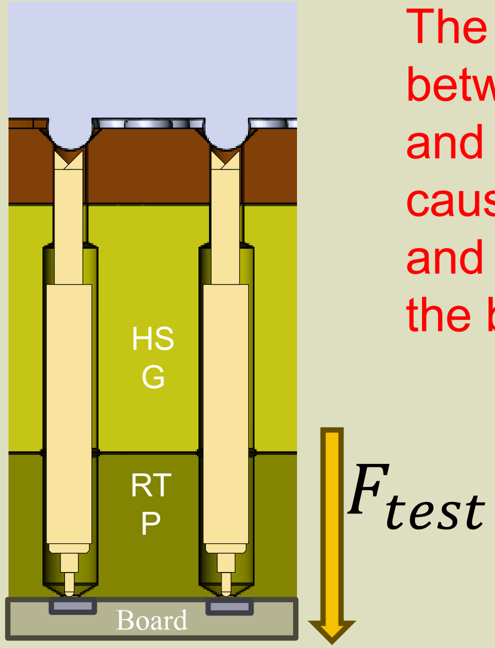


Loss of Preload Caused by Excessive Bowing



Uncompressed state

In situations where housing bow is present, the probe is not held against the loadboard and may lose contact with the PCB pad.



Board Chatter

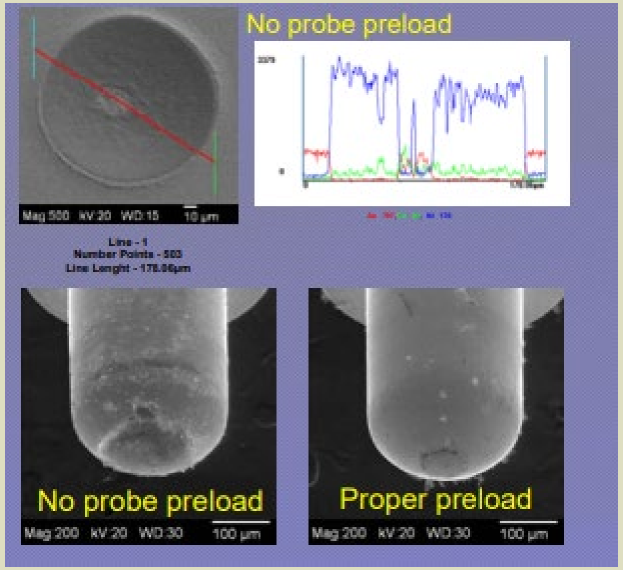
The repeated motion between uncompressed and compressed will cause the probe to make and break contact with the board.

Compressed state

Board contact is maintained.

Board Chatter Leads to Board Digging

- Probe chatter is a process where the PCB end of the probe makes and breaks contact with the PCB pad - “jackhammer”
- Board chatter can lead to early wear out of PCB pad.

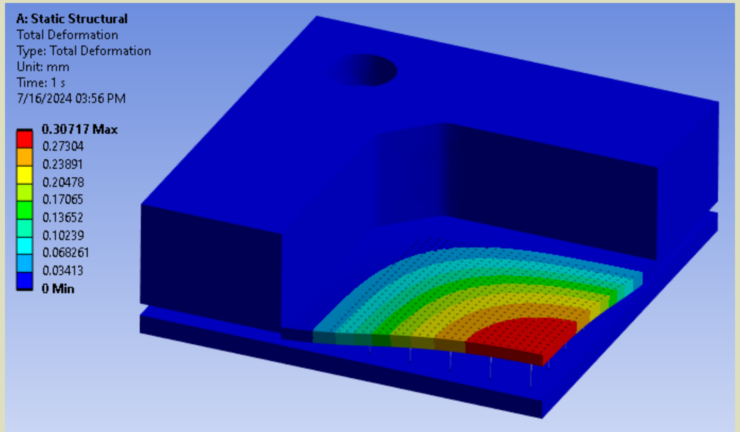


<u>Can be caused by</u>

too little preload

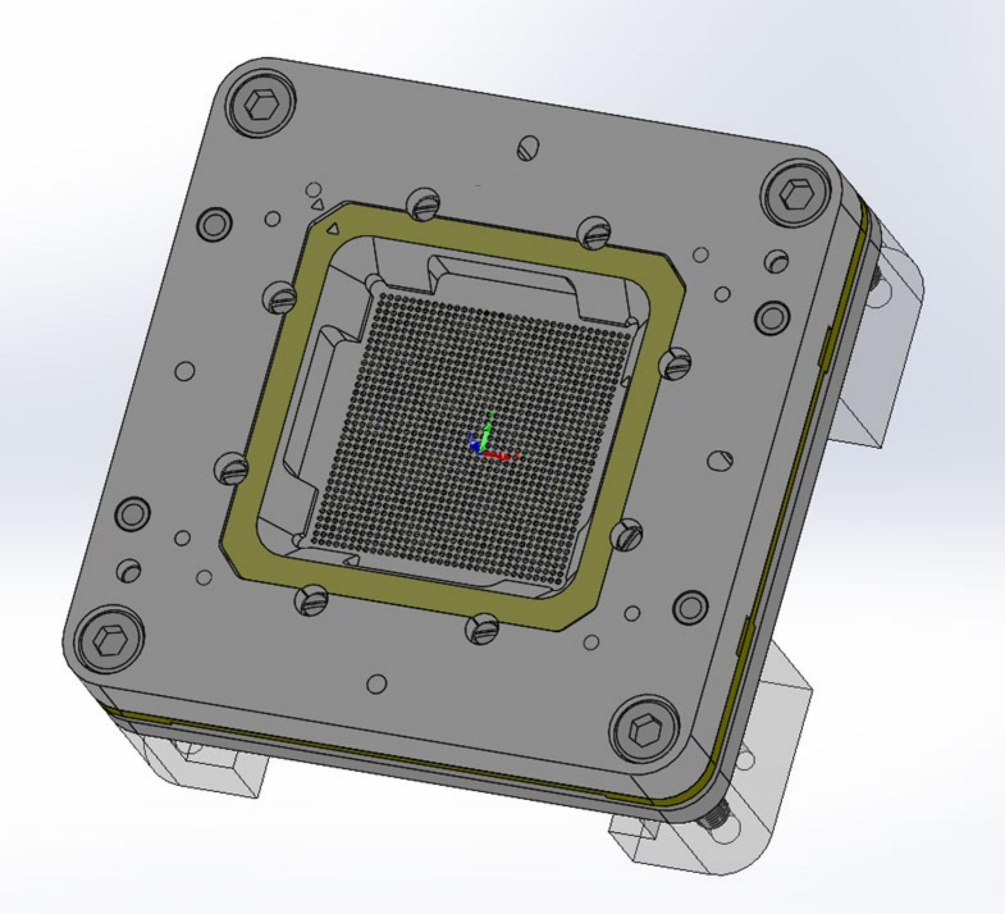
or

too much preload



Case Study with 3.0mm Test Height Spring Probe

- 1156 Probes
- 23x23 package
- Simulation Steps
  1. Simplify model
  2. Define materials and constraints
  3. Determine probe preload and spring rate
  4. Simulation deflection
- Goals:
  - Determine if the designed preload of 6 gF will be adequate.
  - Find the preload limit at which point probe chatter will occur.



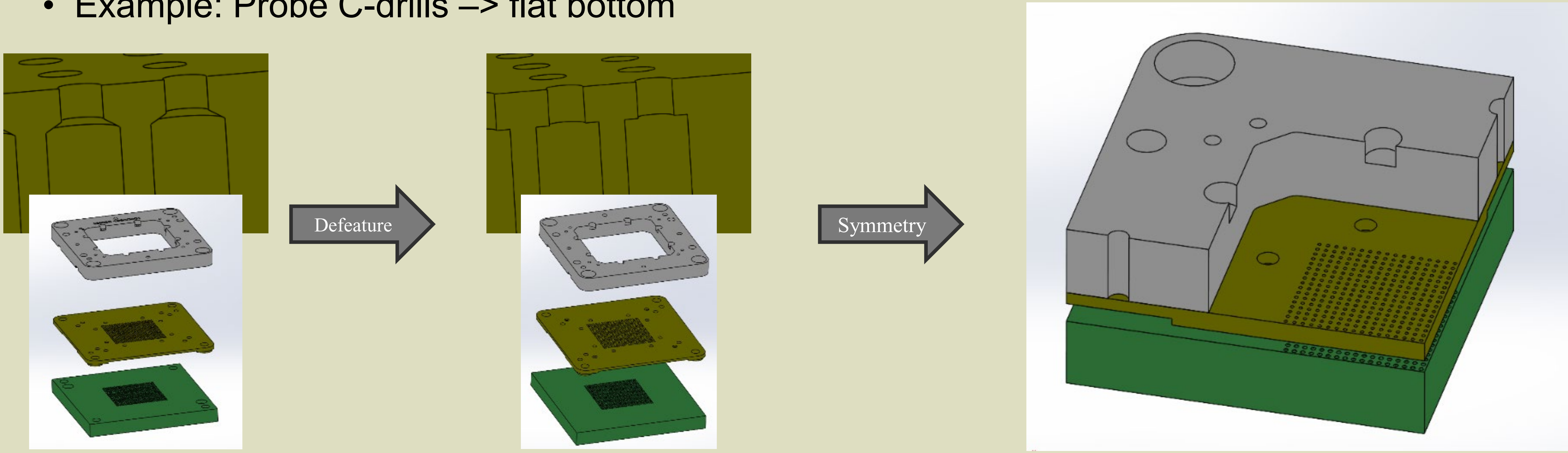
Simplify Model

Defeature

- Ignore partial array population
- Eliminate all non essential components
- Only need HSG, FRAME, PCB, Stiffener
- Example: Probe C-drills –> flat bottom

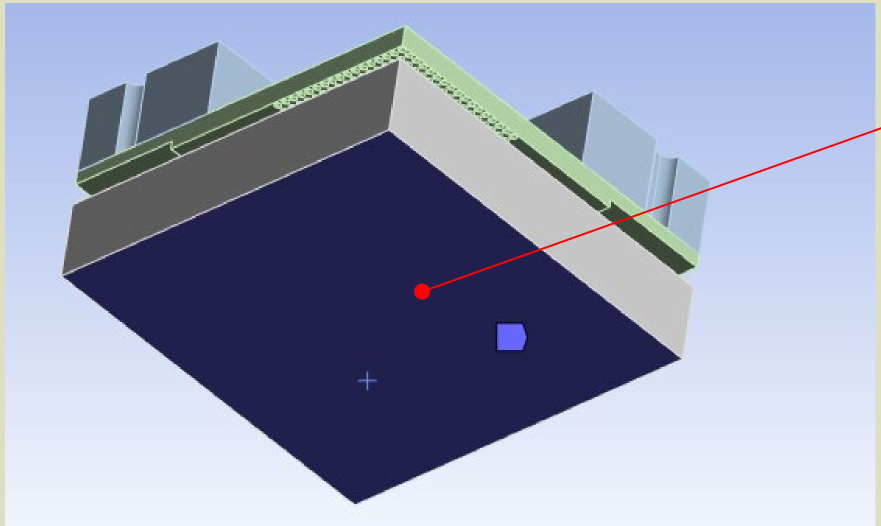
Symmetry

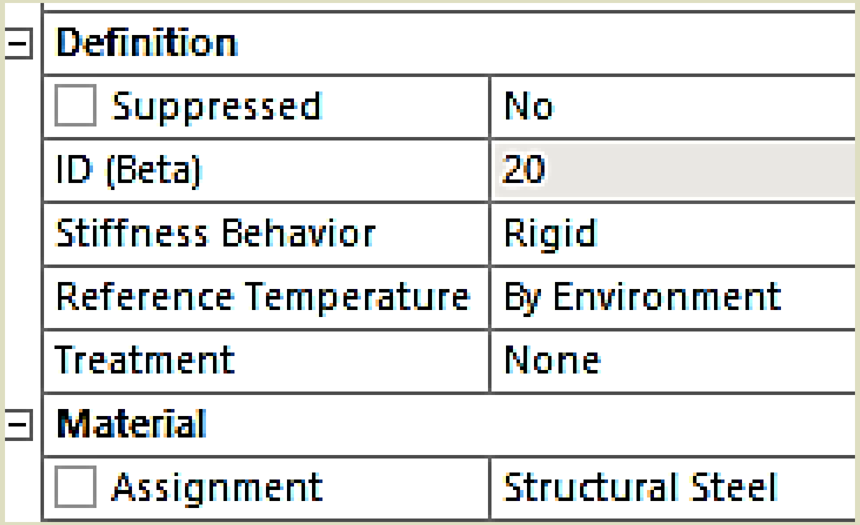
- Cut model to ¼ symmetry
- Consider even/odd arrays to ensure symmetric cuts



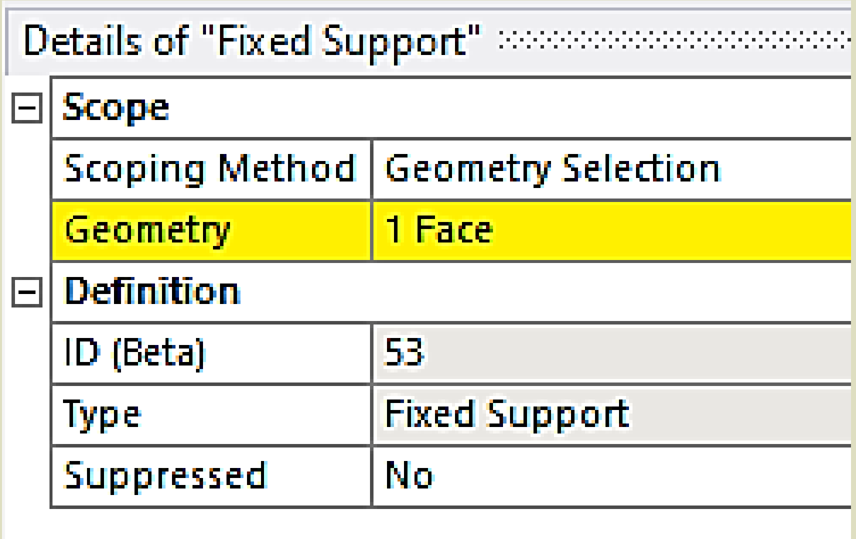
ANSYS Model Setup

- PCB part
  - Stiffness Behavior: Rigid
  - Material: Structural Steel
  - Fixed support on bottom surface





Definition	
☐ Suppressed	No
ID (Beta)	20
Stiffness Behavior	Rigid
Reference Temperature	By Environment
Treatment	None
Material	
☐ Assignment	Structural Steel

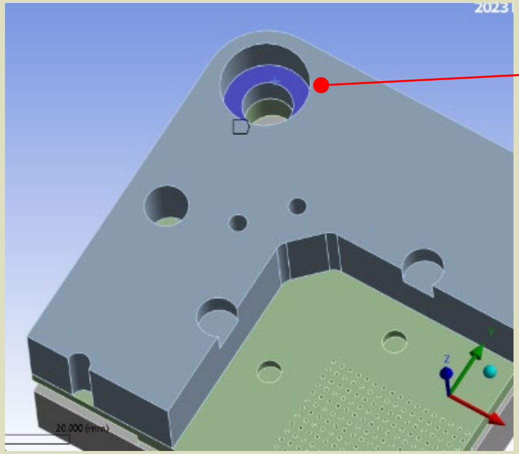


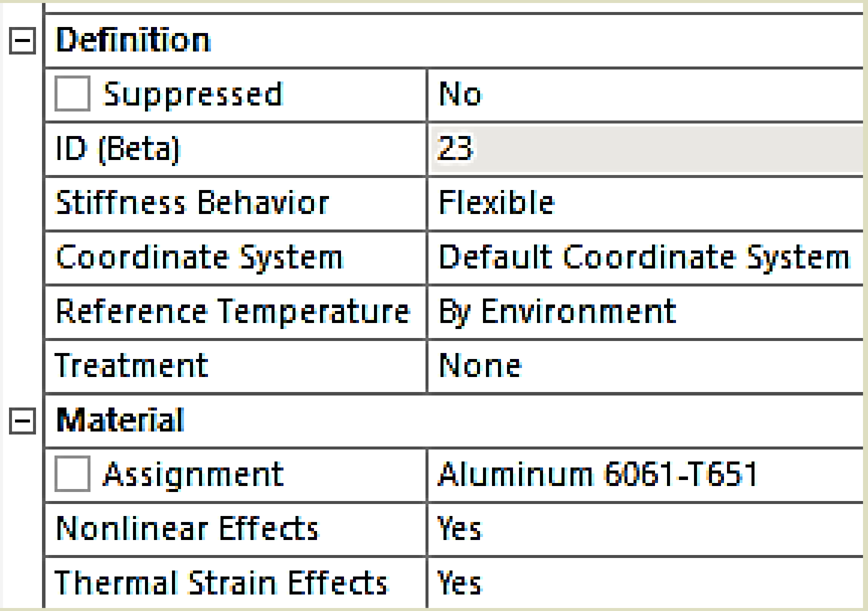
Details of "Fixed Support"

Scope	
Scoping Method	Geometry Selection
Geometry	1 Face
Definition	
ID (Beta)	53
Type	Fixed Support
Suppressed	No

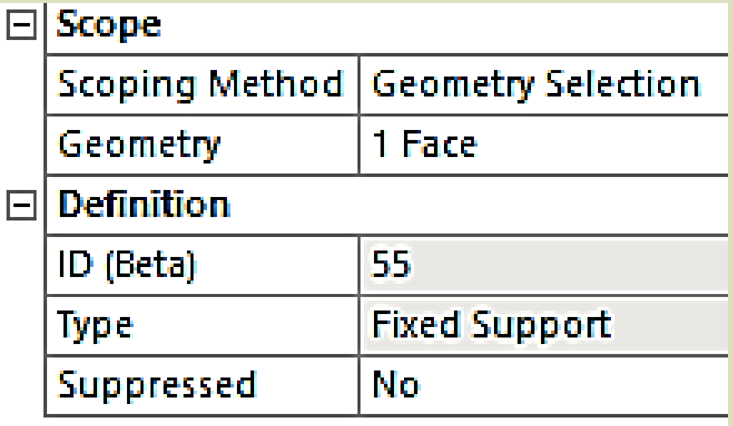
ANSYS Model Setup

- Frame part
  - Stiffness Behavior: Flexible
  - Material: 6061 Aluminum
  - Bolt hole surface: Fixed Support





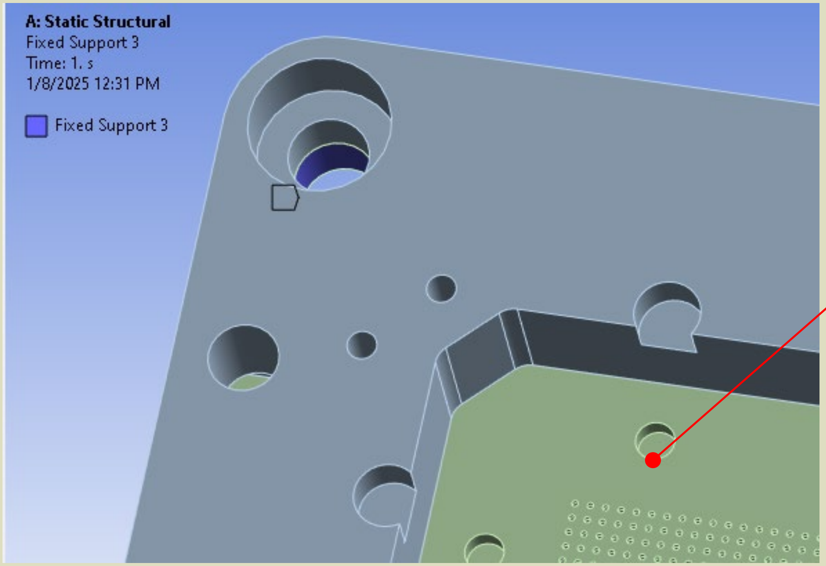
⊟ **Definition**	
☐ Suppressed	No
ID (Beta)	23
Stiffness Behavior	Flexible
Coordinate System	Default Coordinate System
Reference Temperature	By Environment
Treatment	None
⊟ **Material**	
☐ Assignment	Aluminum 6061-T651
Nonlinear Effects	Yes
Thermal Strain Effects	Yes

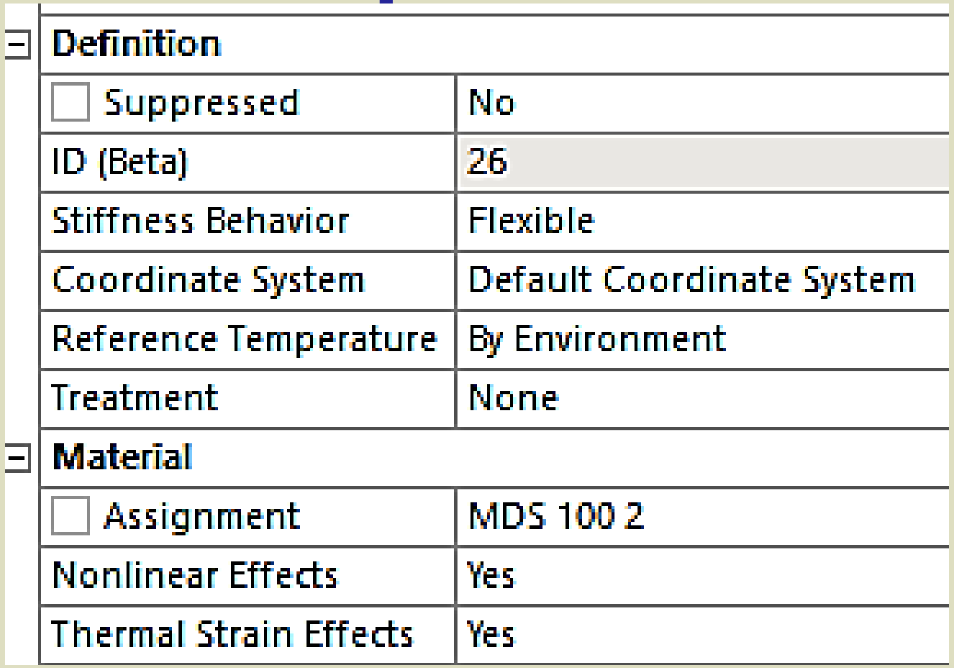


⊟ **Scope**	
Scoping Method	Geometry Selection
Geometry	1 Face
⊟ **Definition**	
ID (Beta)	55
Type	Fixed Support
Suppressed	No

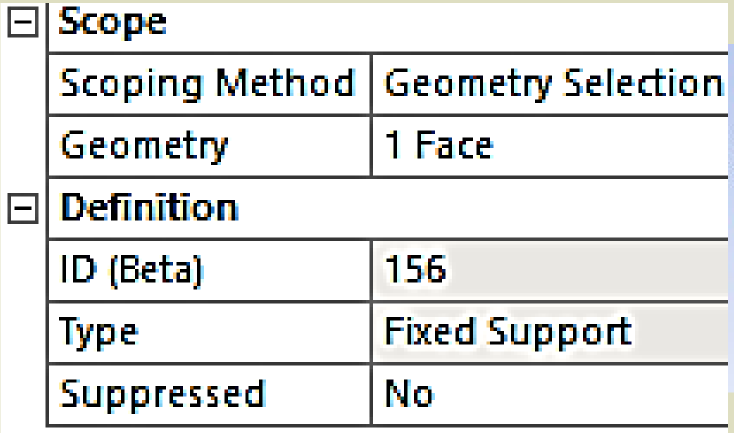
ANSYS Model setup

- Housing part
  - Stiffness Behavior: Flexible
  - Material: MDS-100
  - Bolt hole inner diameter surface: Fixed support (to prevent rigid body motion)

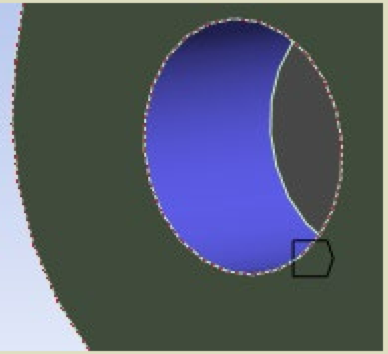




Definition	
☐ Suppressed	No
ID (Beta)	26
Stiffness Behavior	Flexible
Coordinate System	Default Coordinate System
Reference Temperature	By Environment
Treatment	None
Material	
☐ Assignment	MDS 100 2
Nonlinear Effects	Yes
Thermal Strain Effects	Yes

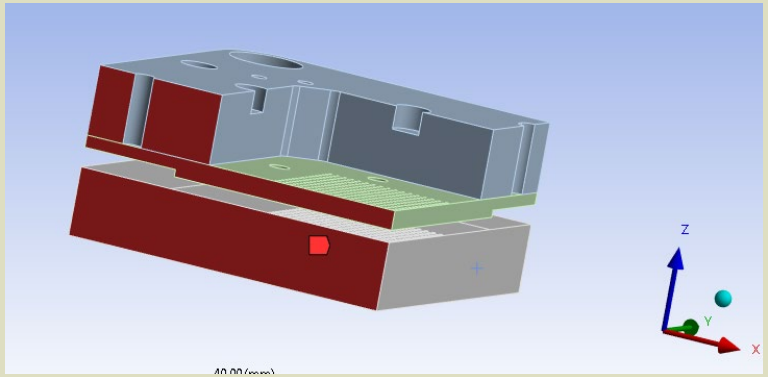


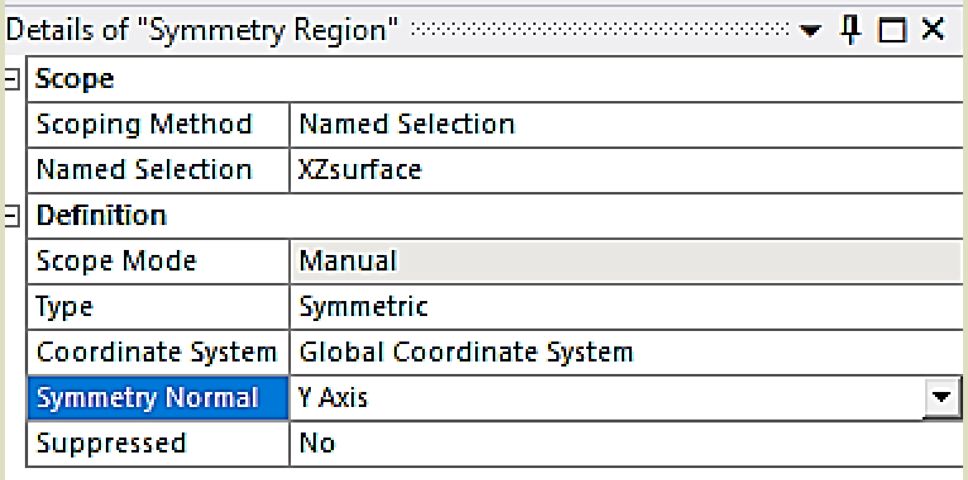
Scope	
Scoping Method	Geometry Selection
Geometry	1 Face
Definition	
ID (Beta)	156
Type	Fixed Support
Suppressed	No



Define Symmetry

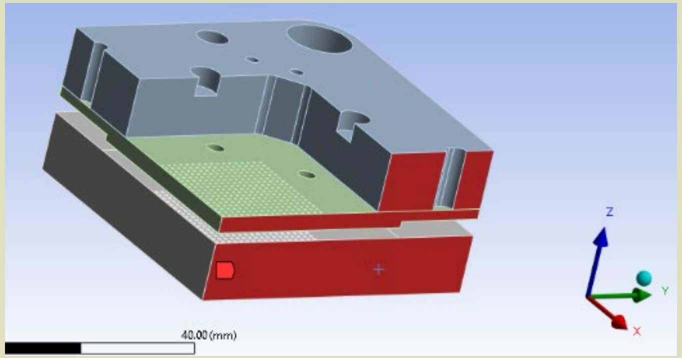
X-Z Symmetry
Plane

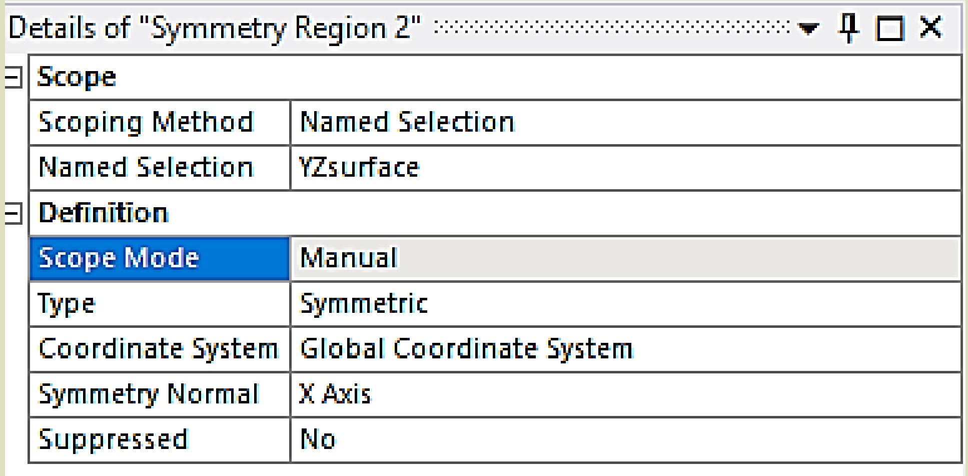



Details of "Symmetry Region"

Scope	
Scoping Method	Named Selection
Named Selection	XZsurface
Definition	
Scope Mode	Manual
Type	Symmetric
Coordinate System	Global Coordinate System
Symmetry Normal	Y Axis
Suppressed	No

Y-Z Symmetry
Plane

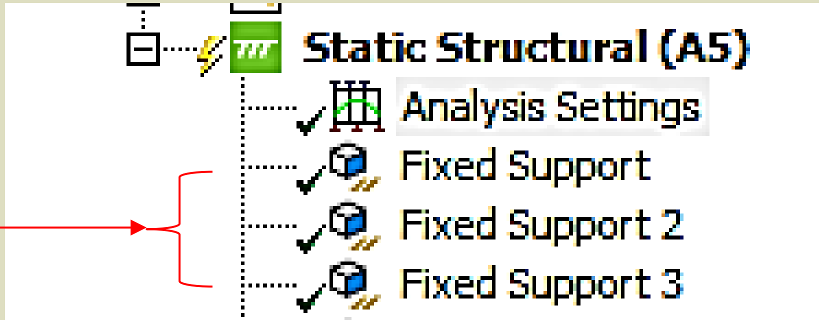



Details of "Symmetry Region 2"

Scope	
Scoping Method	Named Selection
Named Selection	YZsurface
Definition	
Scope Mode	Manual
Type	Symmetric
Coordinate System	Global Coordinate System
Symmetry Normal	X Axis
Suppressed	No

General Analysis Setup

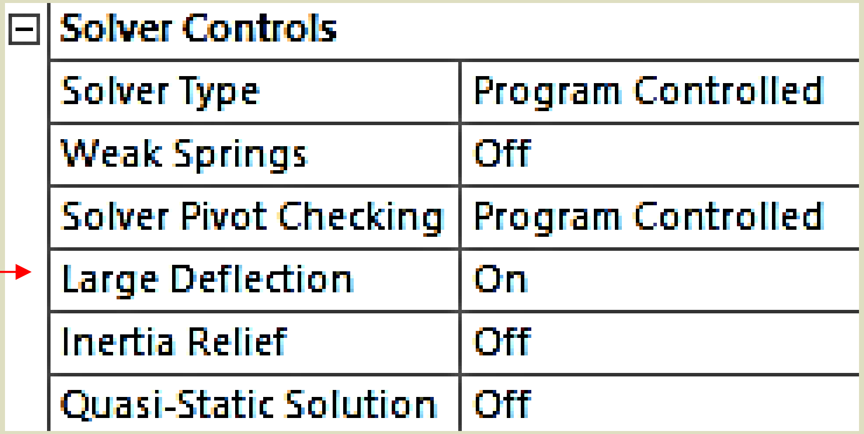
Fixed Supports
define the constraints



Static Structural (A5)
- Analysis Settings
- Fixed Support
- Fixed Support 2
- Fixed Support 3

Large Deflection: ON

(iterative analysis for accuracy)

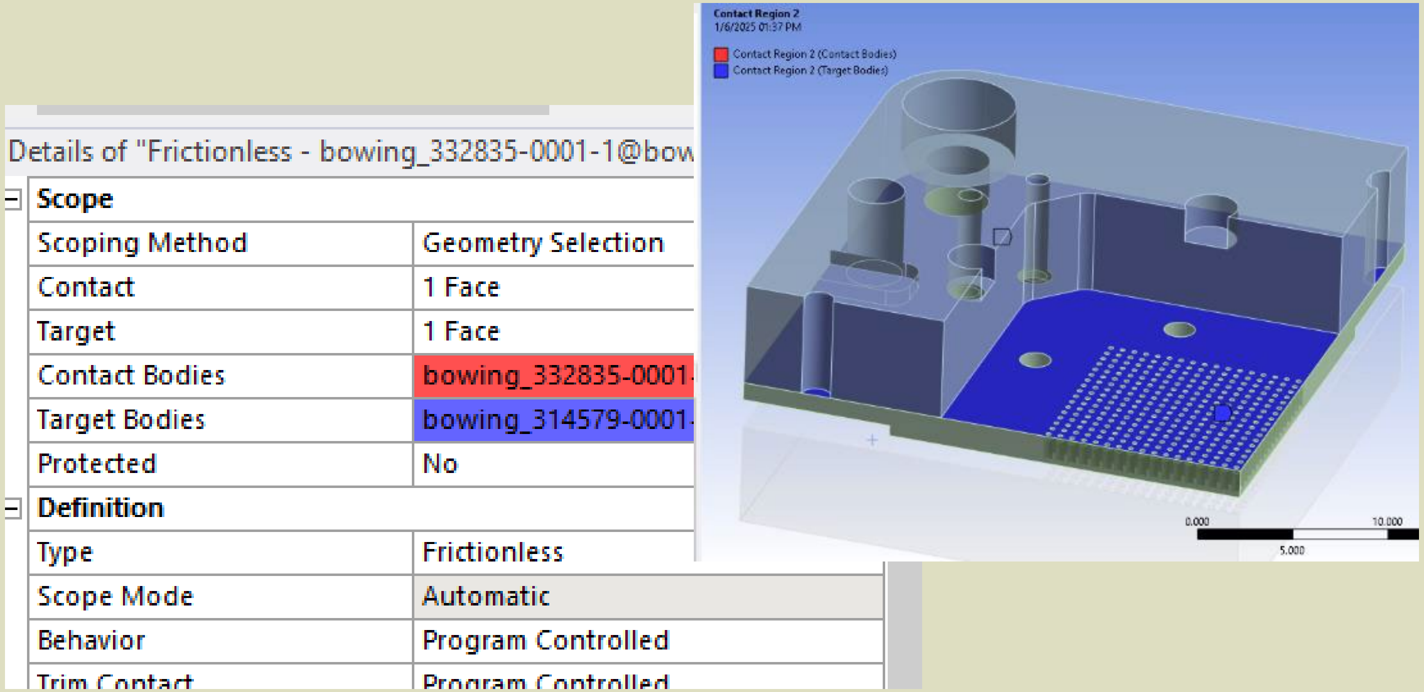


Solver Controls	
Solver Type	Program Controlled
Weak Springs	Off
Solver Pivot Checking	Program Controlled
Large Deflection	On
Inertia Relief	Off
Quasi-Static Solution	Off

Connections – Surface Contacts

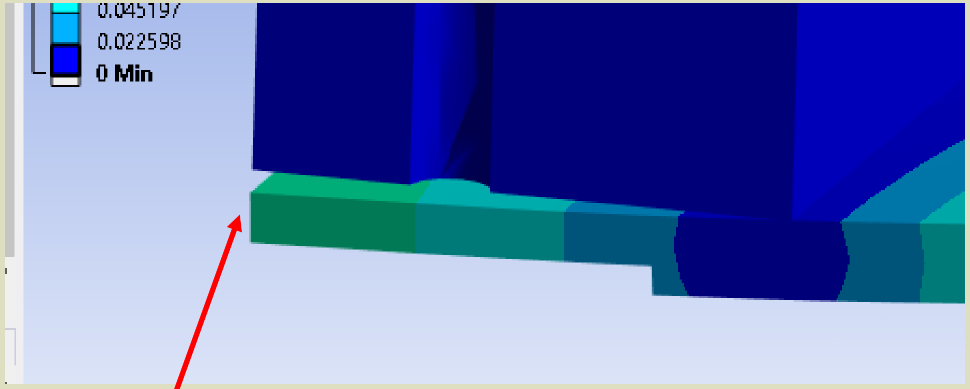
- Frame and Housing contact region: Frictionless (allows for part separation but not interference)

Note: default is bonded. Change this value from “Bonded” to “Frictionless”.



Details of "Frictionless - bowing_332835-0001-1@bow

Scope	
Scoping Method	Geometry Selection
Contact	1 Face
Target	1 Face
Contact Bodies	bowing_332835-0001
Target Bodies	bowing_314579-0001
Protected	No
Definition	
Type	Frictionless
Scope Mode	Automatic
Behavior	Program Controlled
Trim Contact	Program Controlled

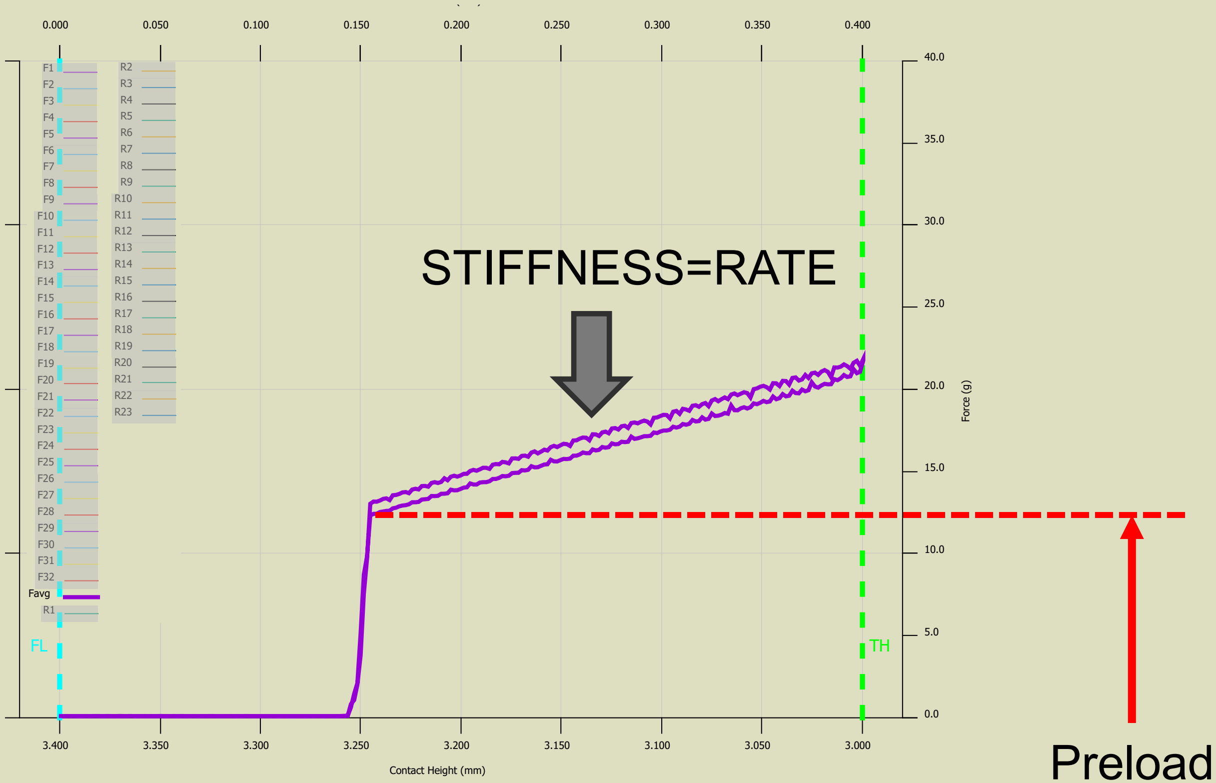


Allows for separation (based on design)

Determine the Probe Preload

Profile the spring probe to capture the spring rate k and probe preload.

$$F_x = F_{preload} + kx$$

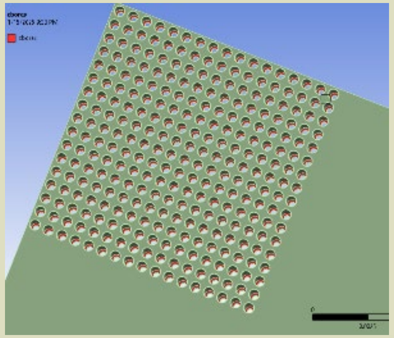


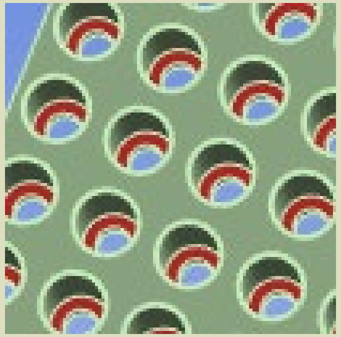
STIFFNESS=RATE

Preload force

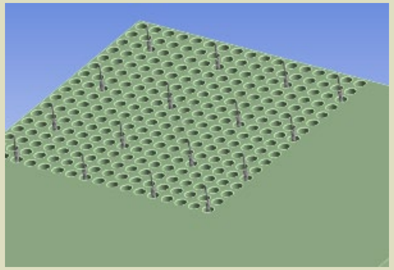
Force Application Methods In ANSYS

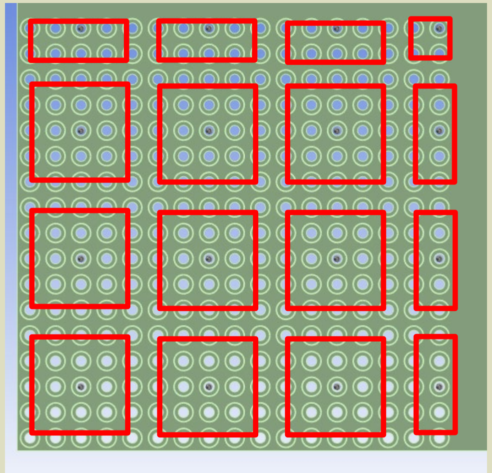
- Static Structural Force
  - Applies a single force uniformly over the selected probe-bearing surfaces
  - Quick to setup and run
  - Safe - Overstates the deflection
  - "Pass" provides approval of design
  - "Fail" requires Spring Elements Method





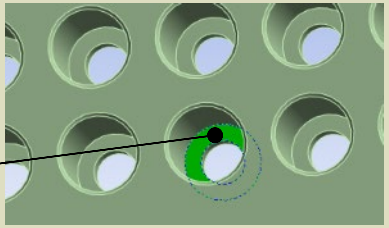
- Spring Elements Method
  - Applies spring elements between the housing and the board to simulate spring probe preload.
  - Single spring elements are spaced in maximum 5x5 arrays.
  - More time consuming
  - Accurate within 10 µm



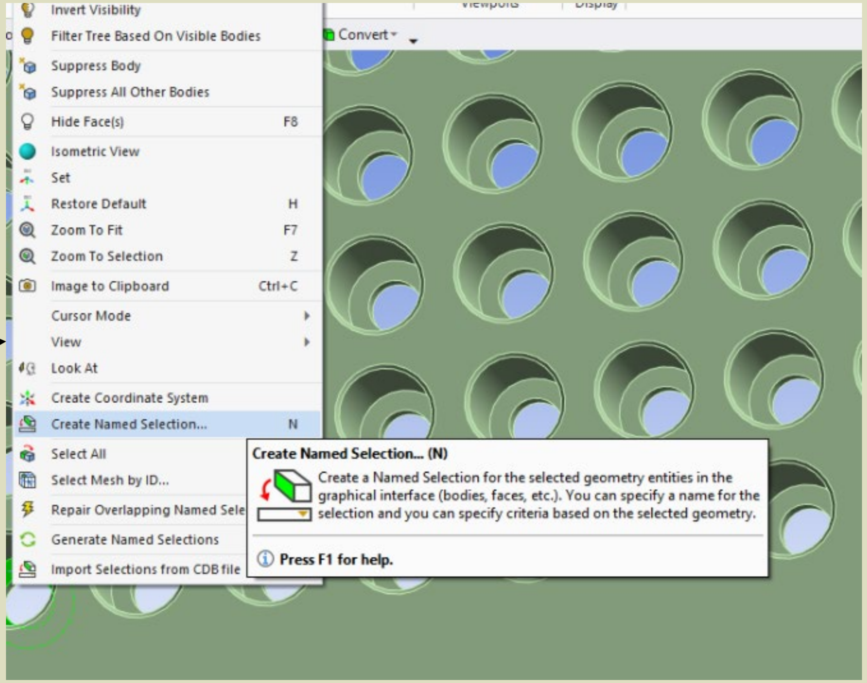


Static Structural Force Method
Step 1: Define the Probe Bearing Surface

1. Define the housing probe bearing surface by selecting a <u>single probe bearing surface</u>.



2. Right click and select “Create Named Selection”.

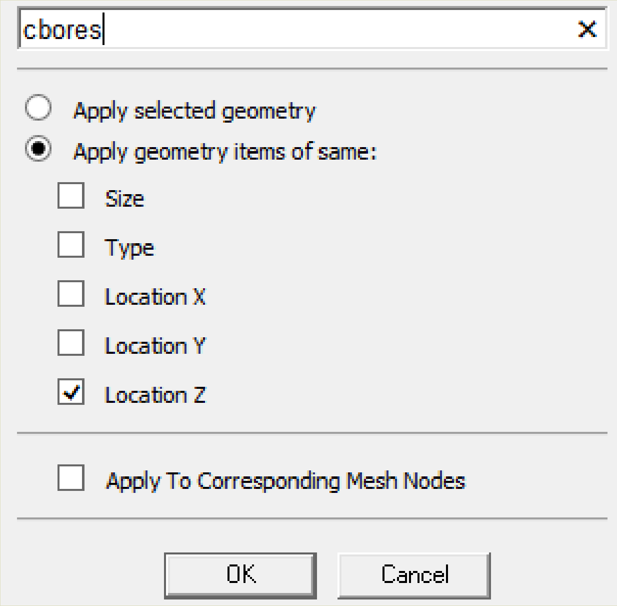


Create Named Selection... (N)

Create a Named Selection for the selected geometry entities in the graphical interface (bodies, faces, etc.). You can specify a name for the selection and you can specify criteria based on the selected geometry.

Press F1 for help.

3. Provide a name and “Apply geometry items of same: Location Z”.



cbores

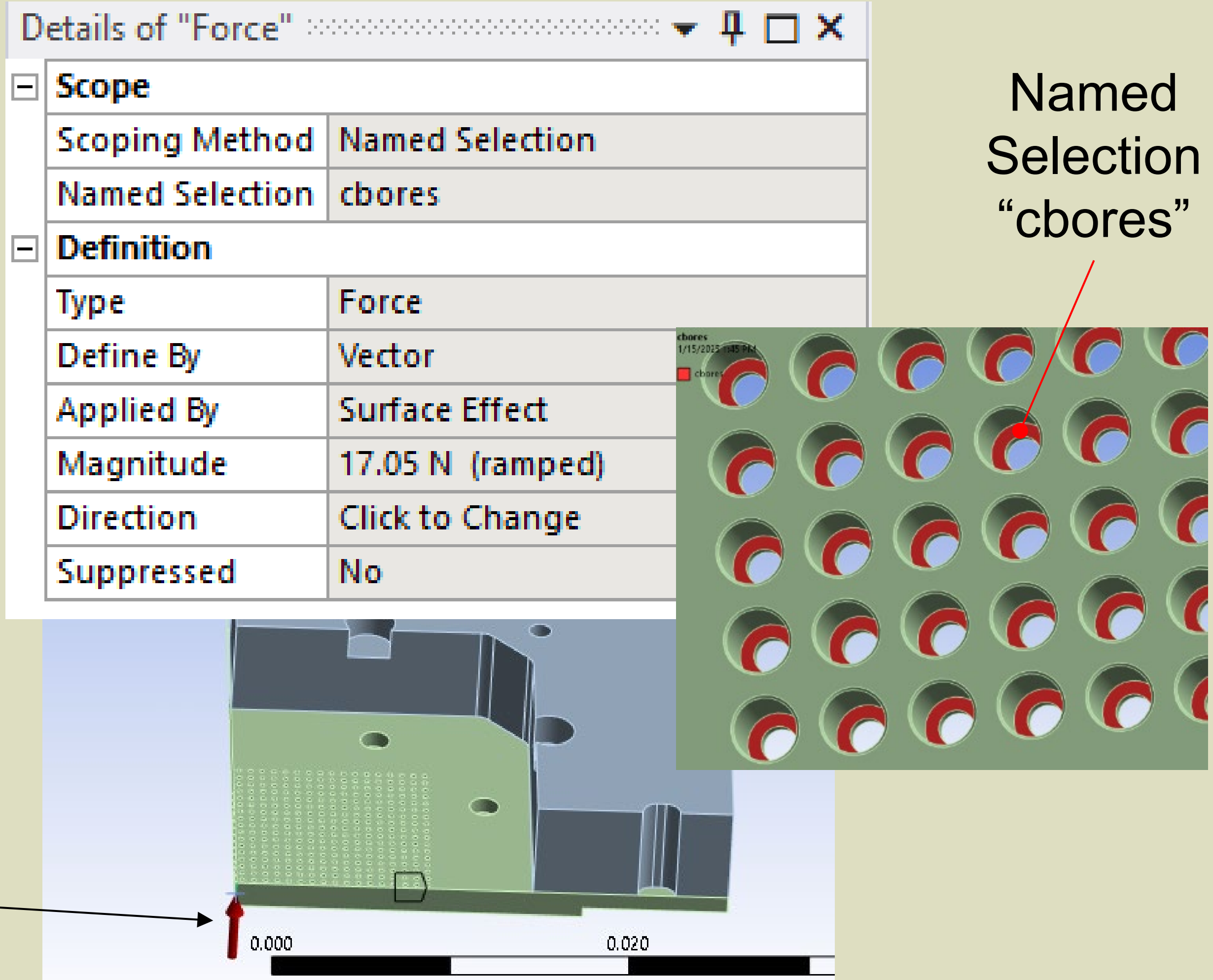
○ Apply selected geometry
● Apply geometry items of same:
  - ☐ Size
  - ☐ Type
  - ☐ Location X
  - ☐ Location Y
  - ☑ Location Z

☐ Apply To Corresponding Mesh Nodes

4. Press OK.

Static Structural Force Method
Step 2: Apply the Total Preload to the Housing

1. Right Click on Static Structural->Insert->Force
2. Scoping Method = “Named Selection” and Named Selection to be the name of probe bearing surface from Step 1.3.
3. Define by = “Vector”
4. Applied By: Surface Effect
5. Magnitude = Preload x Bores
6. Direction normal to surface of housing.



Details of "Force"

Scope	
Scoping Method	Named Selection
Named Selection	cbores
Definition	
Type	Force
Define By	Vector
Applied By	Surface Effect
Magnitude	17.05 N (ramped)
Direction	Click to Change
Suppressed	No

Named Selection “cbores”

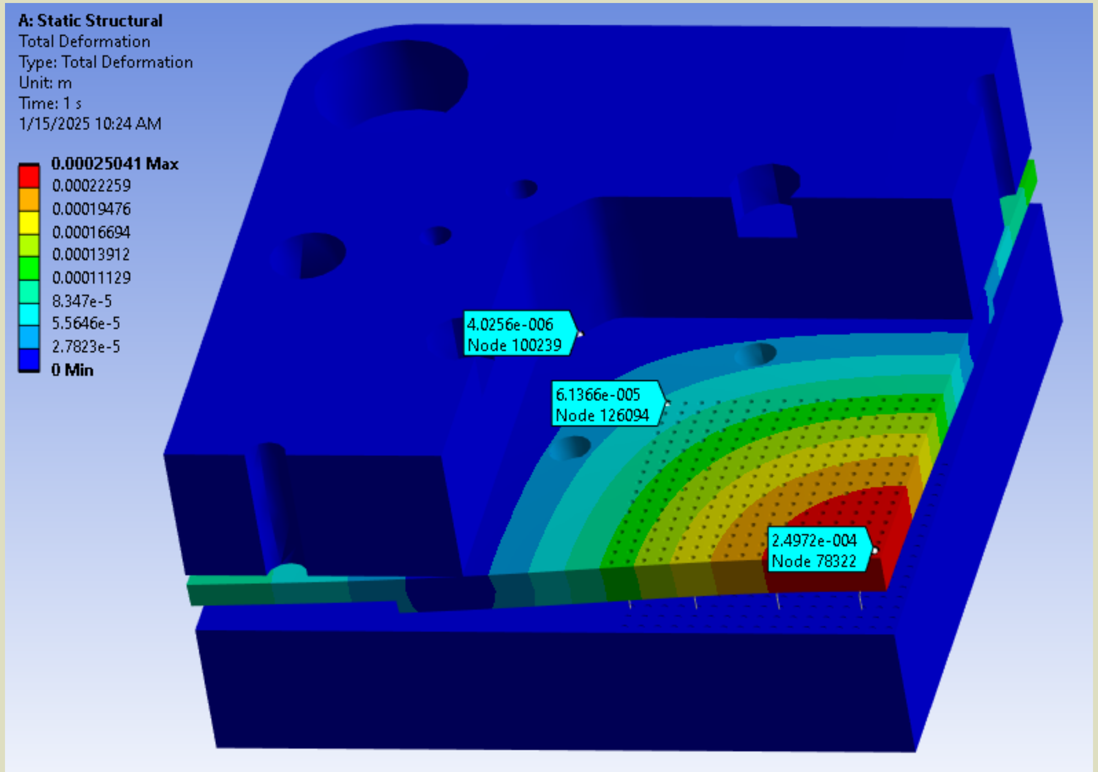
Static Structural Force Method
Step 3: Run Simulation and Probe Results

- Preload 6 gF (0.059N)
  - 289 x 0.059N = 17.05N
- Center deflection = 0.170mm

FAIL > 0.150mm deflection

Conclusion

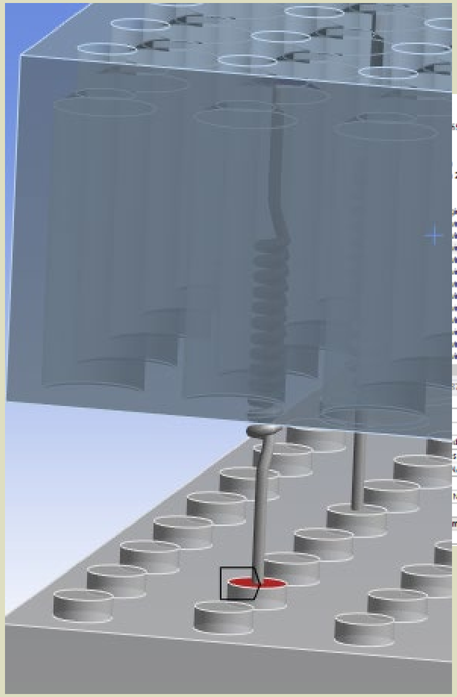
Proceed with Spring Elements Model for more accurate analysis

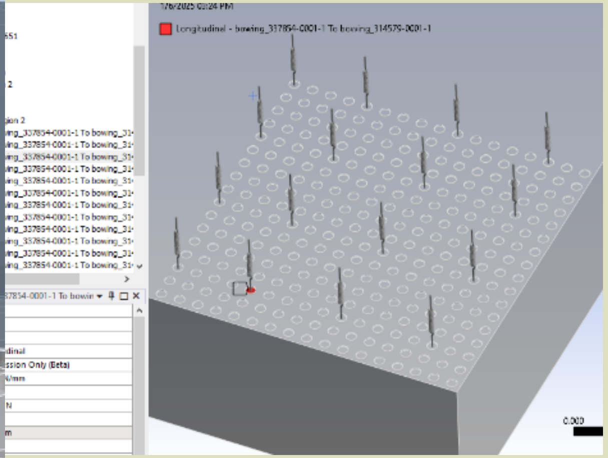


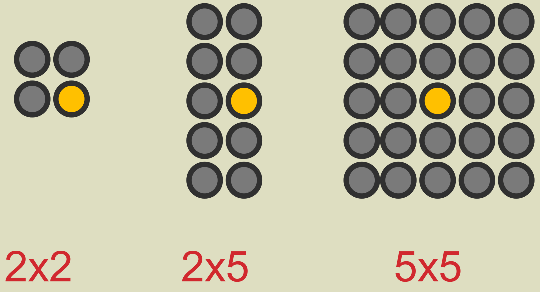
Spring Elements Model

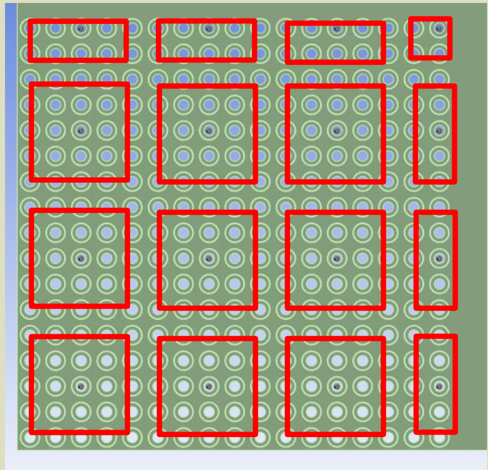
- Contact regions derived using compression-only spring elements
- Add spring stiffness constant (N/mm) and nominal preload (N)

- To save time – add elements in 5x5 arrays or smaller

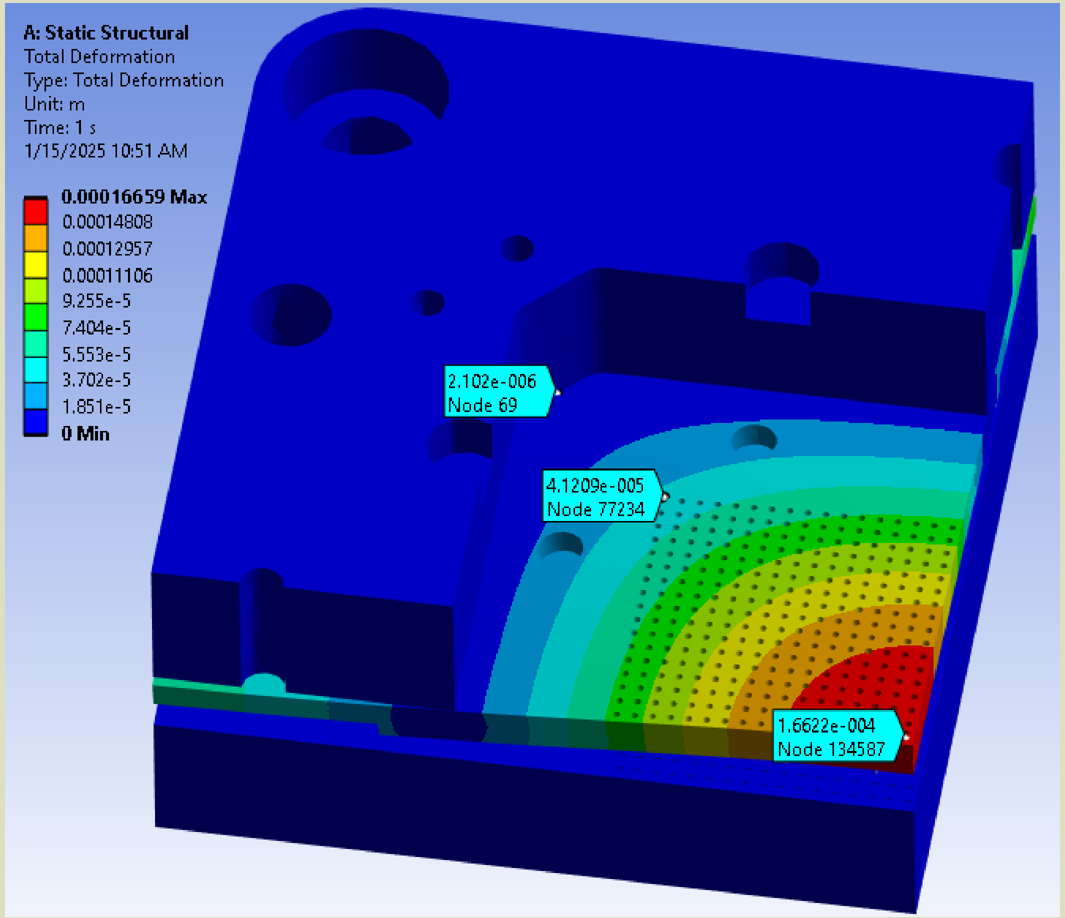








Preload = 6 gF (0.059N)



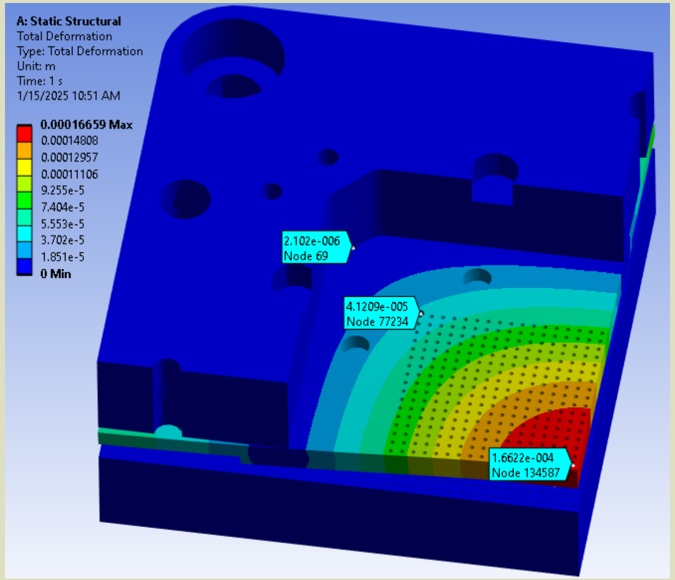
- Preload 6 gF (0.059N)
  - 5x5 = 1.47 N preload
  - 2x5 = 0.59 N preload
  - 2x2 = 0.24 N preload
- Center deflection = 0.098mm

PASS < 0.150mm

Is this simulation accurate?

Am I able to increase the preload of this probe within this design?

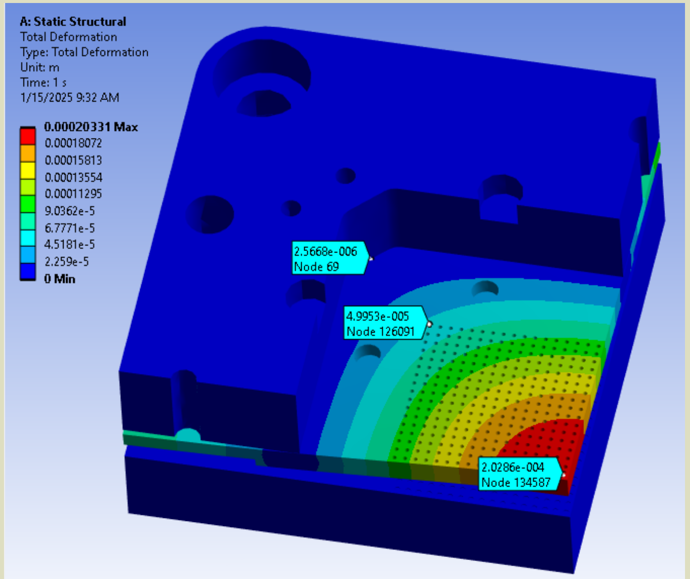
Increase Preload



- Preload 10 gF (0.098N)
  - 5x5 = 2.45 N preload
  - 2x5 = 0.98 N preload
  - 2x2 = 0.39 N preload

<u>Center deflection</u>

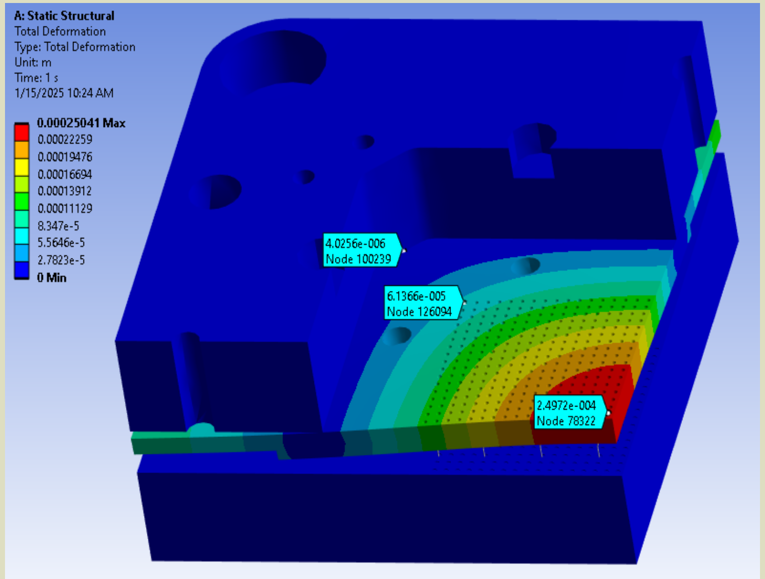
0.164mm



- Preload 12 gF (0.119N)
  - 5x5 = 2.99 N preload
  - 2x5 = 1.19 N preload
  - 2x2 = 0.48 N preload

<u>Center deflection</u>

0.200mm

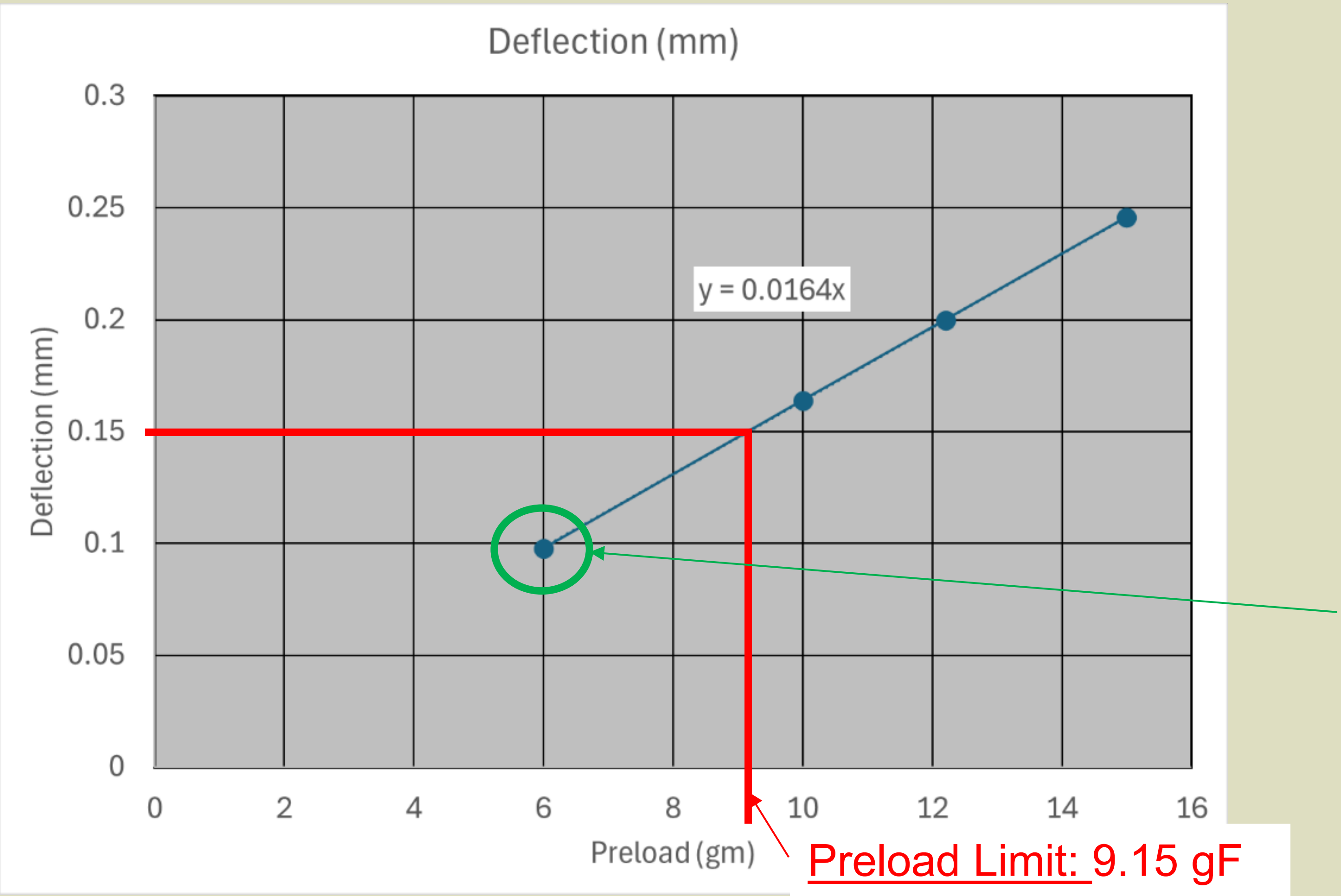


- Preload 15 gF (0.147N)
  - 5x5 = 3.68 N preload
  - 2x5 = 1.47 N preload
  - 2x2 = 0.59 N preload

<u>Center deflection</u>

0.246mm

Case Study with 3.0mm Test Height Spring Probe Conclusion

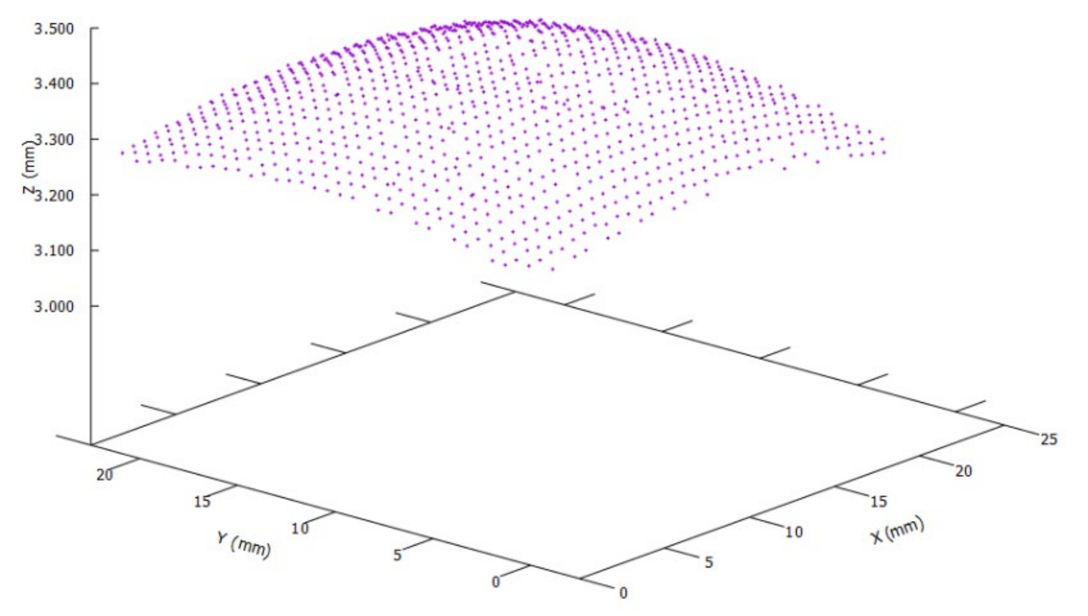


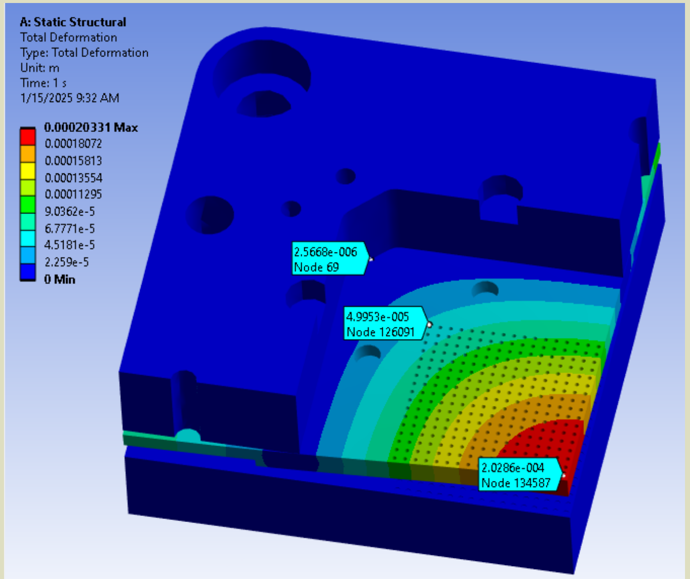
The curve crosses the 0.15mm deflection at 9.15 gF.

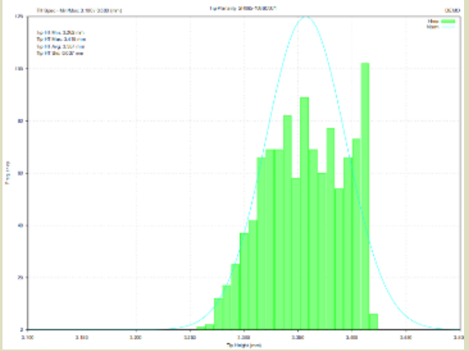
Conclusion: For this probe in a 1156 configuration, It is recommended that the preload be designed to be < 9 gF.

The selected probe with 6 gF preload is acceptable for this design.

Validation Results 3.0mm Test Height Spring Probe
9 gF Preload







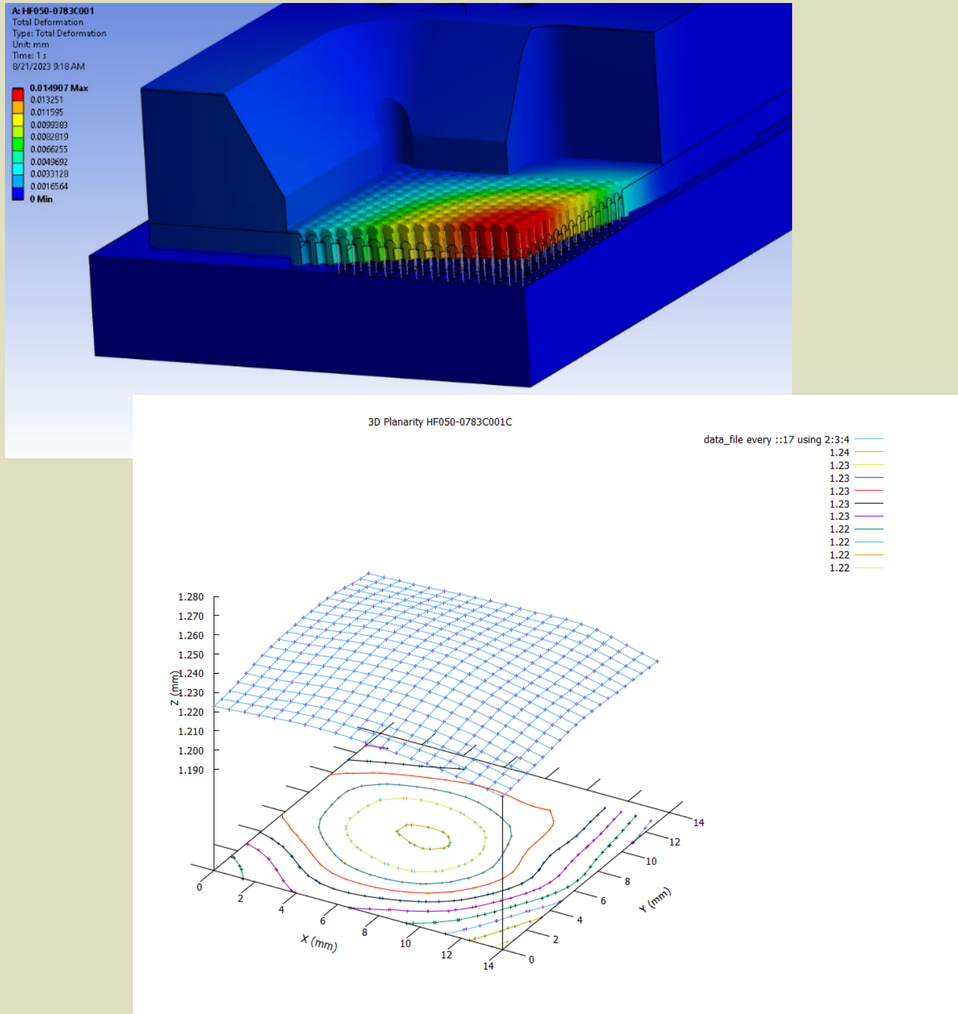
<u>Center array to corner Max-Min</u>

Measured: 0.156mm

Simulated: 0.153mm

Good match!

Validation Results 1.0mm Test Height Spring Probe

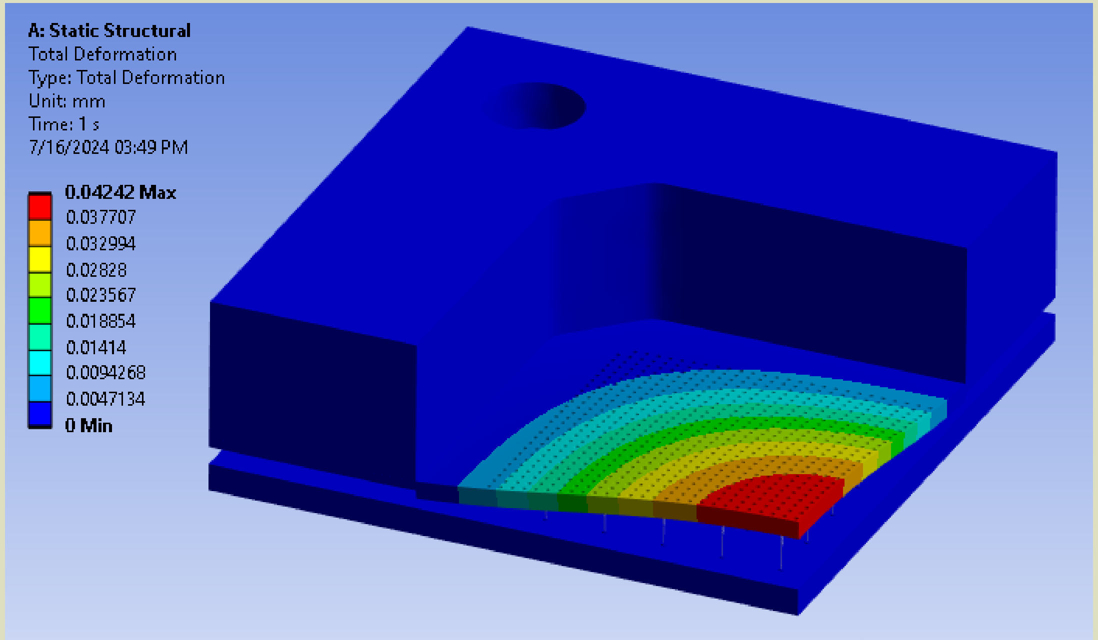


- 783 Probes
- 15x15mm package

- <u>Center array to corner Max-Min</u>
- **Measured: 0.014mm**
- **Simulated: 0.015mm**

Good match!

2.5mm Test Height High Compliance w/ High Pin Count



- 2916 Probes
- 55x55mm package
- Center deflection = 0.042mm

Even though larger arrays will inherently lead to higher deflections, the 2.5mm Test Height probe can provide extra compliance to ensure proper preload.

Summary

- For large device applications, mechanical simulations can aid in the design of the contactor with the right probe and with the right preload.
- Correctly designed preload provides consistent bias of the probe against the loadboard pad, preventing board chatter and extending board life.
- Validation of simulations provide confidence in simulation assumptions and prevents false confidence in design.

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