SWTEST
PROBE TODAY, FOR TOMORROW
2025 CONFERENCE

High-Voltage Test: Deflection study for LuPo pressure chamber probe cards

T. I. P. S.
Technical Innovation – Physical Solutions

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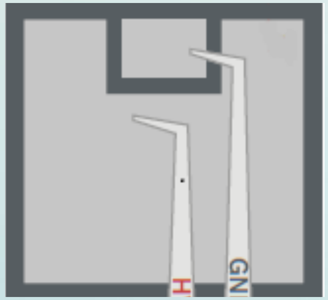
Overview

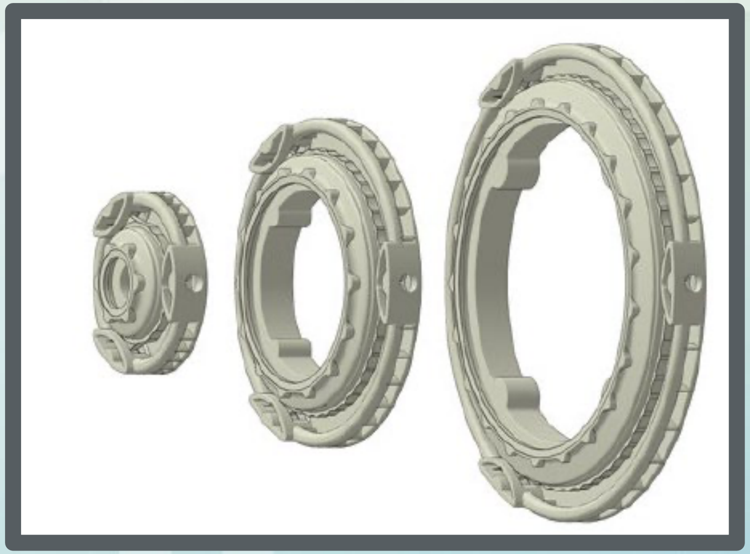
- Introduction to HV Test
- The basics
- Background
- The challenge
- Deflection effects
- System behavior
- Results
- Conclusion
- Follow-On Work

Introduction - HV test

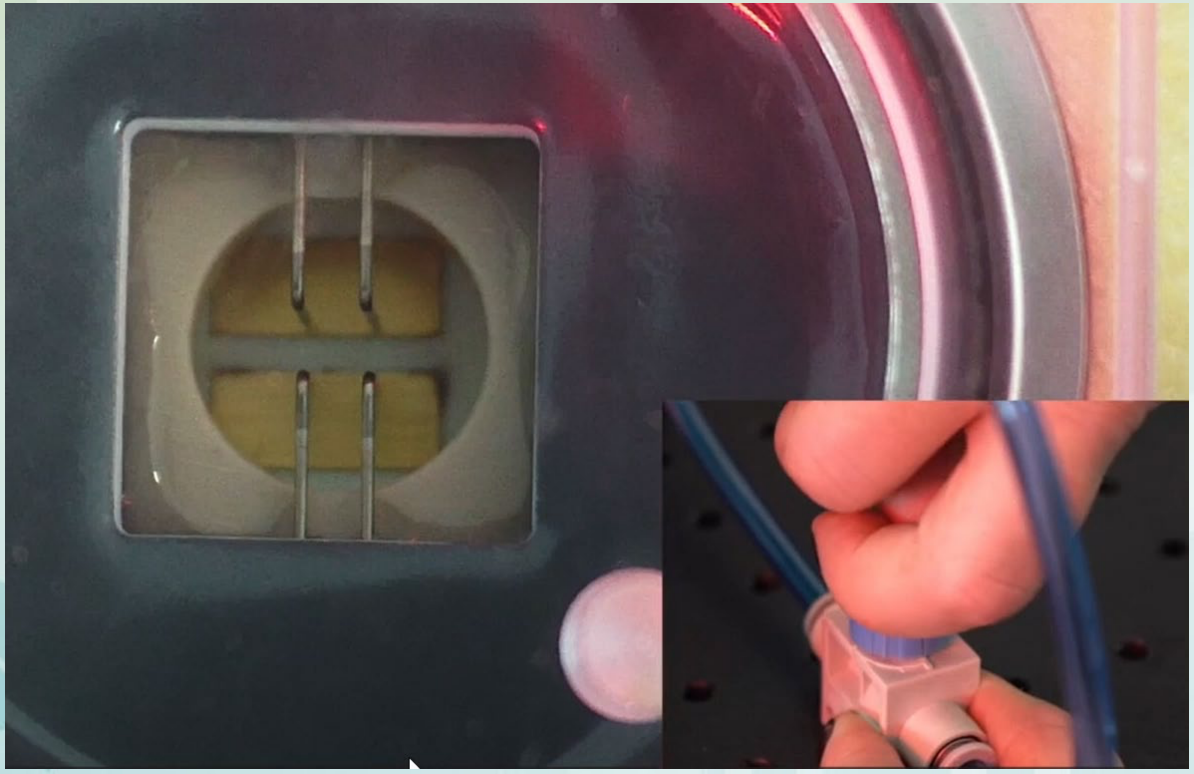
- **High voltage test:** involves applying a higher voltage than the device's intended working voltage to check for insulation resistance and leakage current.
- **How we do it?**

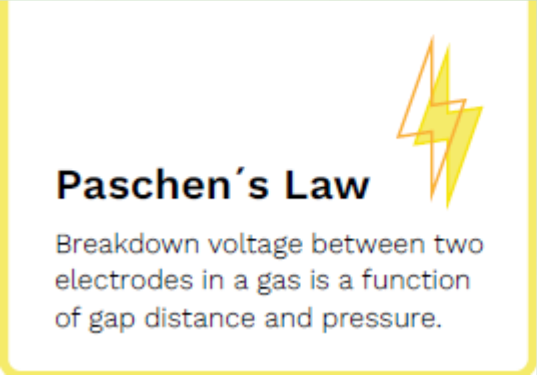


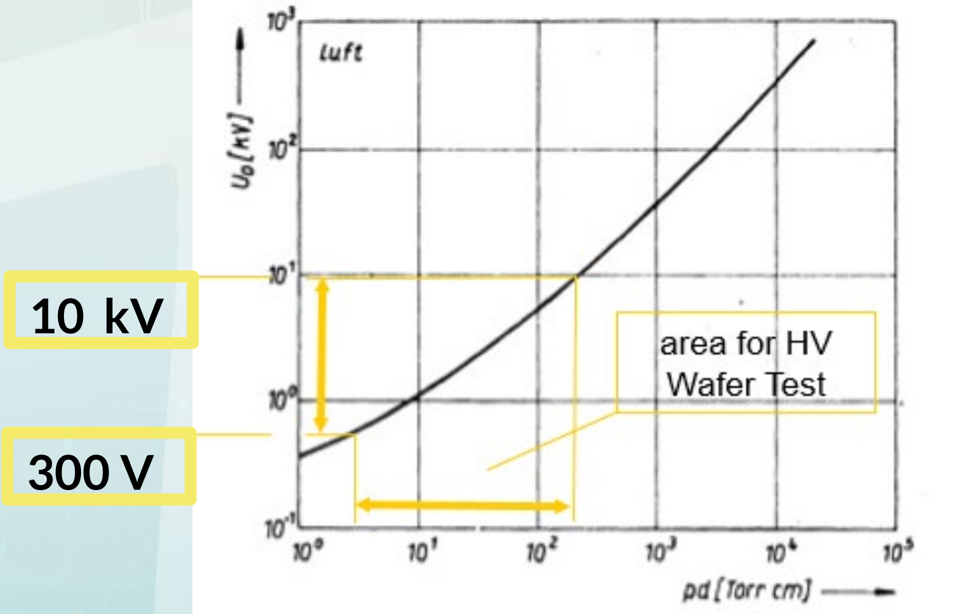
- max temperature
- max voltage



The basics





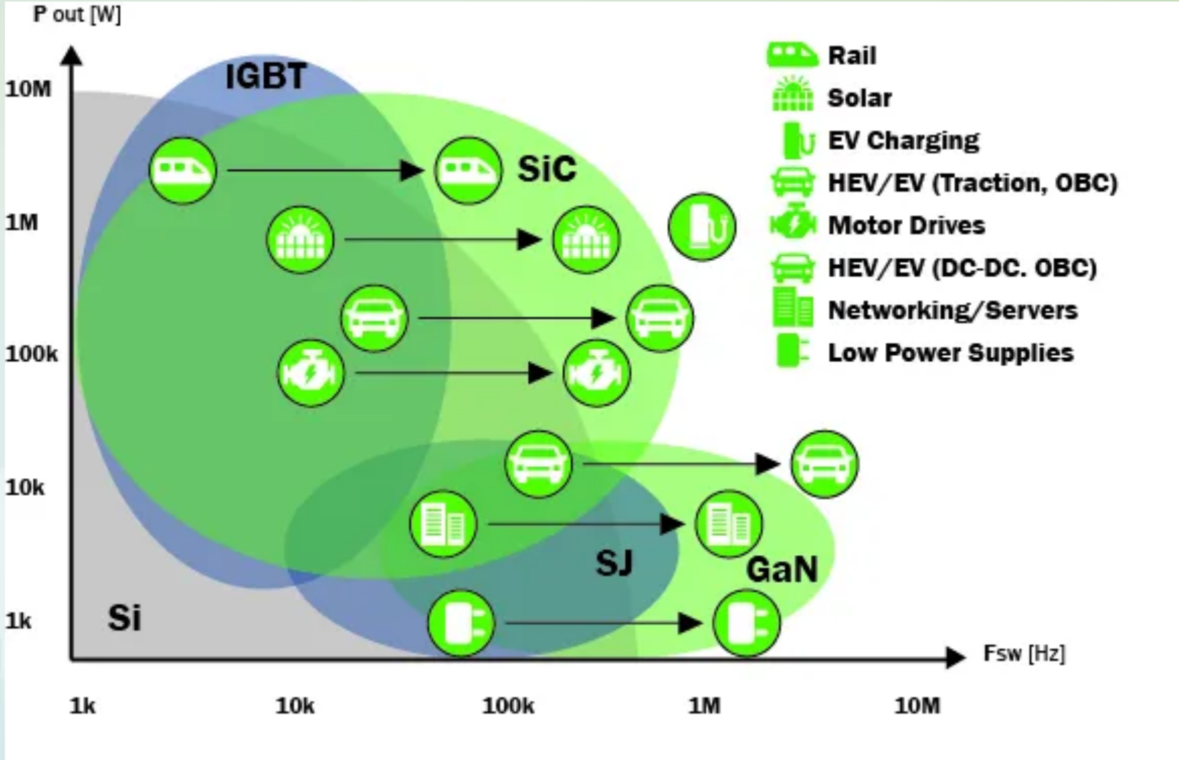


Paschen curve for air

Background

Technology transition

- **Silicon → Silicon Carbide**
  - higher breakdown voltages
  - lower on-resistance
  - exceptional thermal stability



Power capability vs switching frequency for popular high-voltage, high-current transistors and other device
(https://www.powerelectronicsnews.com/the-difference-between-gan-and-sic-transistors/)

The challenge

- Example: The chip-scale pressure chamber allows for testing under extreme conditions: **up to 180° C, 15kV, 1500A**

Smaller devices

Higher test voltage & temperature

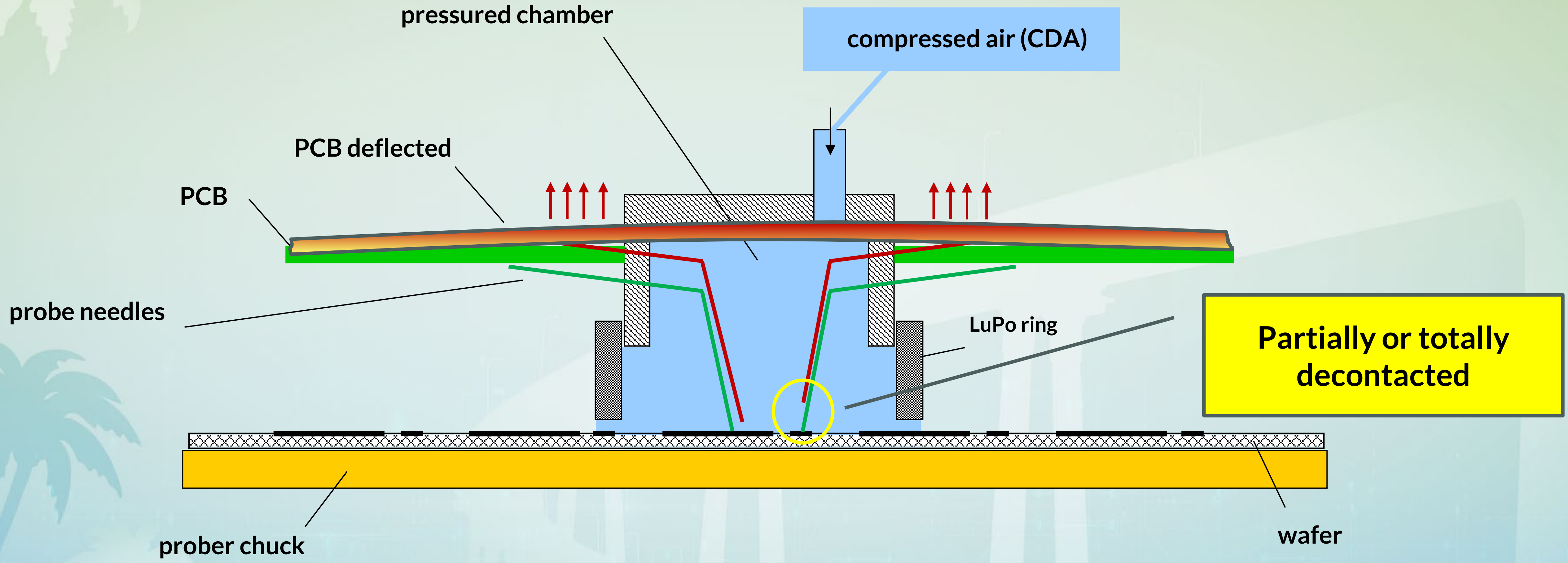
Increased chance of arching

More pressure needed

Increased deflection

- SiC chips have the ability to withstand high voltages, up to ten times higher than those usable with silicon.

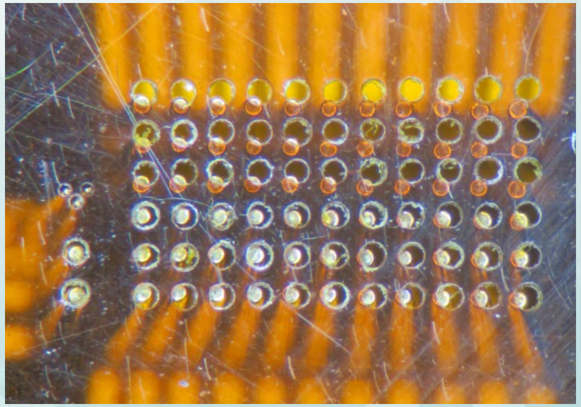
Background

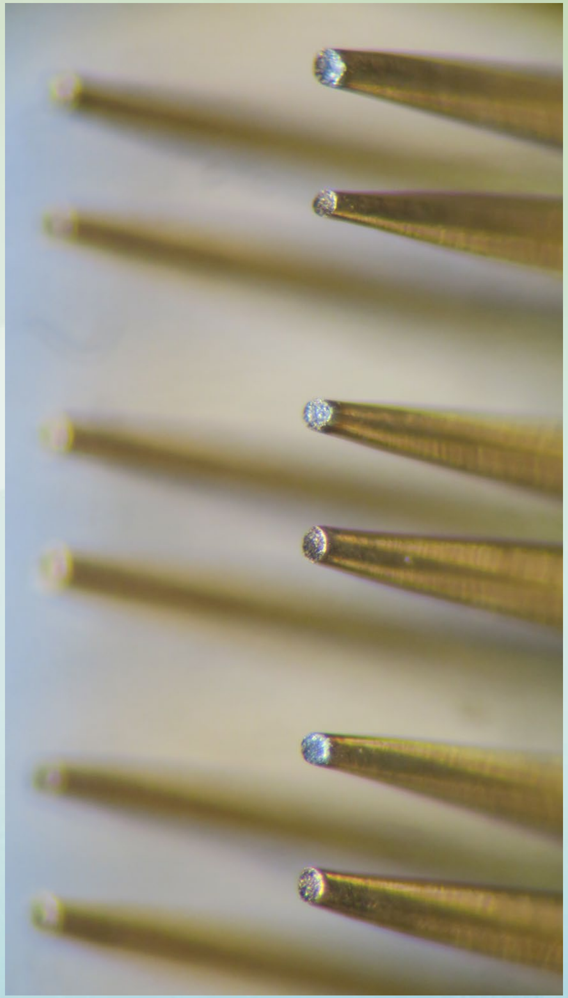


Deflection of probe card with pressure chamber

Deflection effects

- Bad CRES
- Needle tip fast wear out or burn
- Sudden overtravel
- Probe card crashing the wafer – stepping over the wafer edge



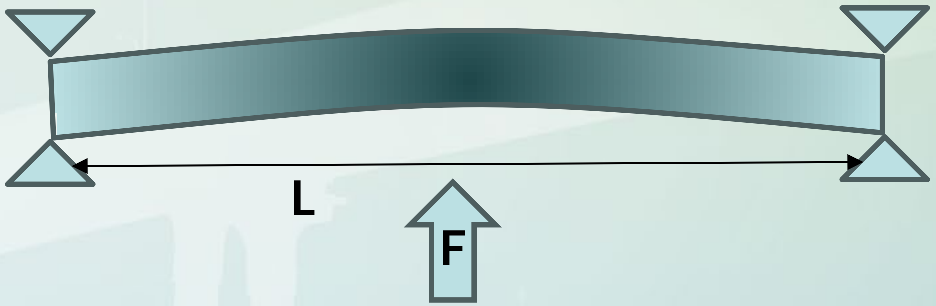


System behavior – deflection

- **What is deflection?**

  The amount of deformation that occurs in a structural element when it is subjected to a load

- **What influences Deflection?**
  - Applied force
  - Length of span between supports (clamping)
  - Modulus of elasticity and moment of inertia

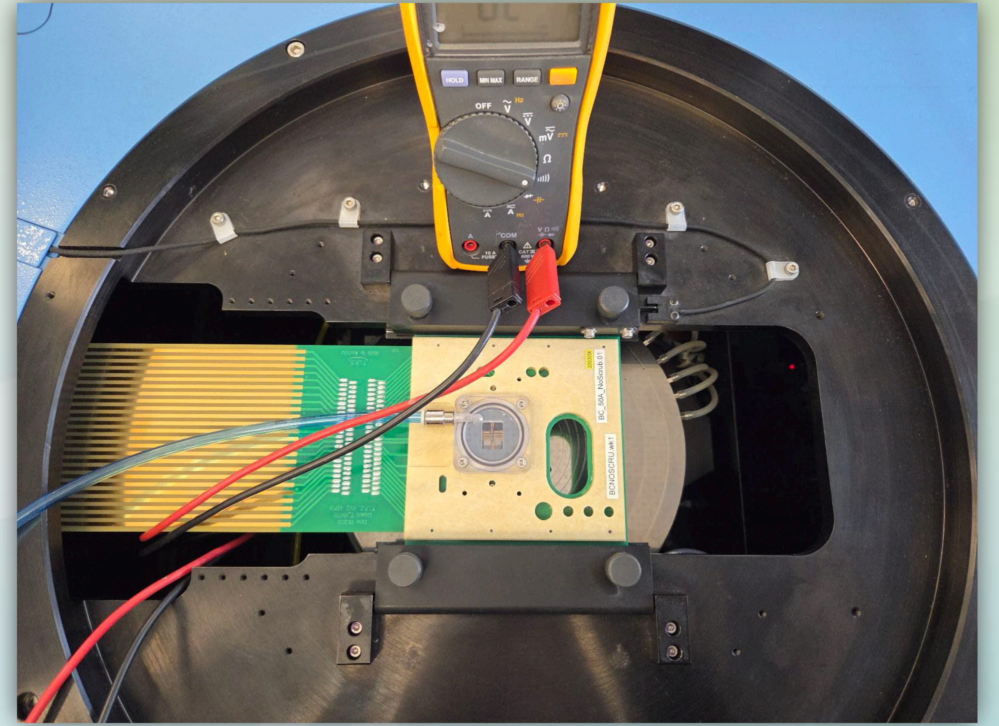


$$\delta_{max} = \frac{FL^3}{48EI}$$

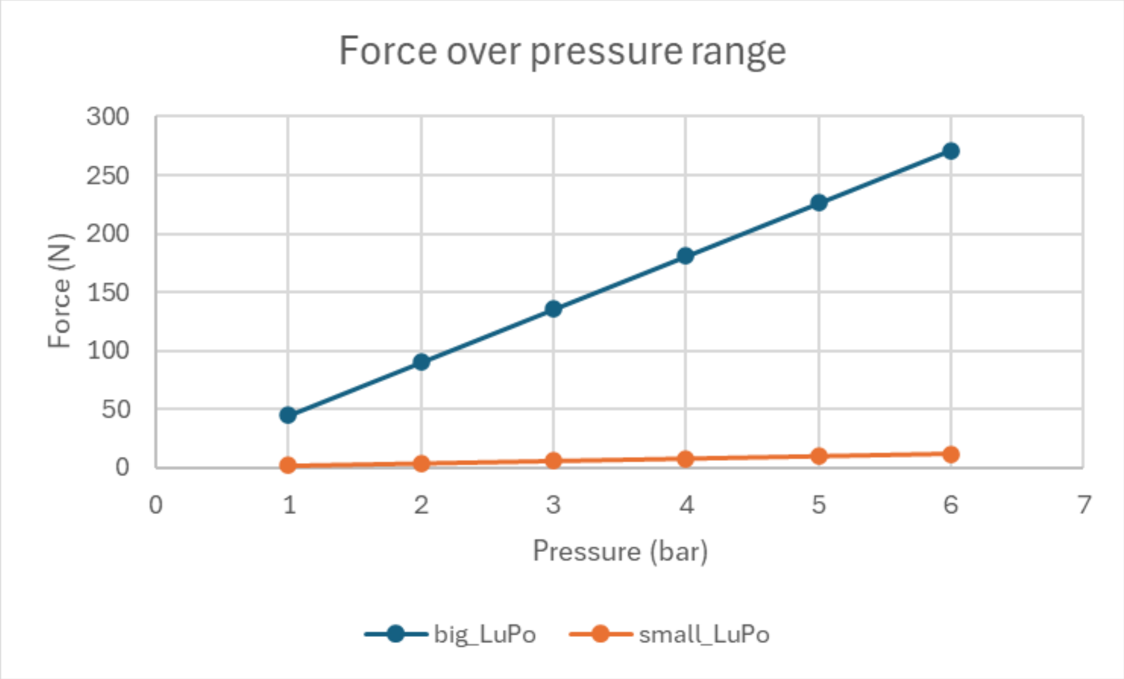
$I = \text{width} \times \text{height}^3 / 12$

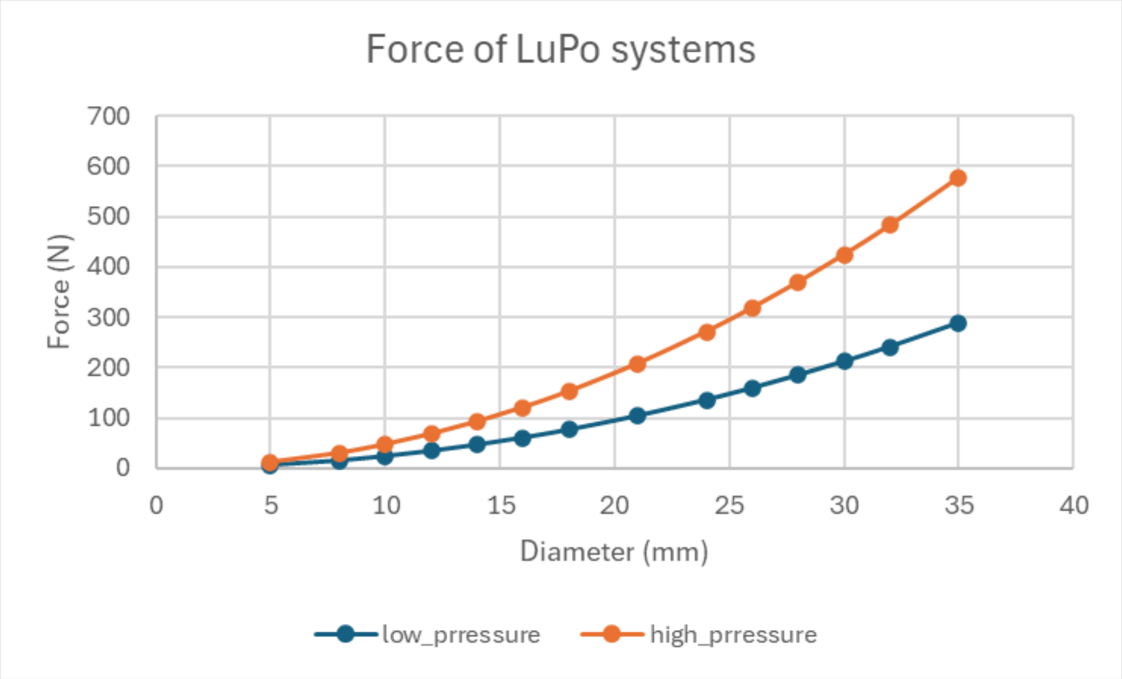
Deflection study – test setup

- TIPS HV probe card
  - 1,6mm PCB thickness
  - FR4 stiffener
- Big/small LuPo
- Low and high input pressure
- Clamping on PCB – standard clamping on Accretech prober

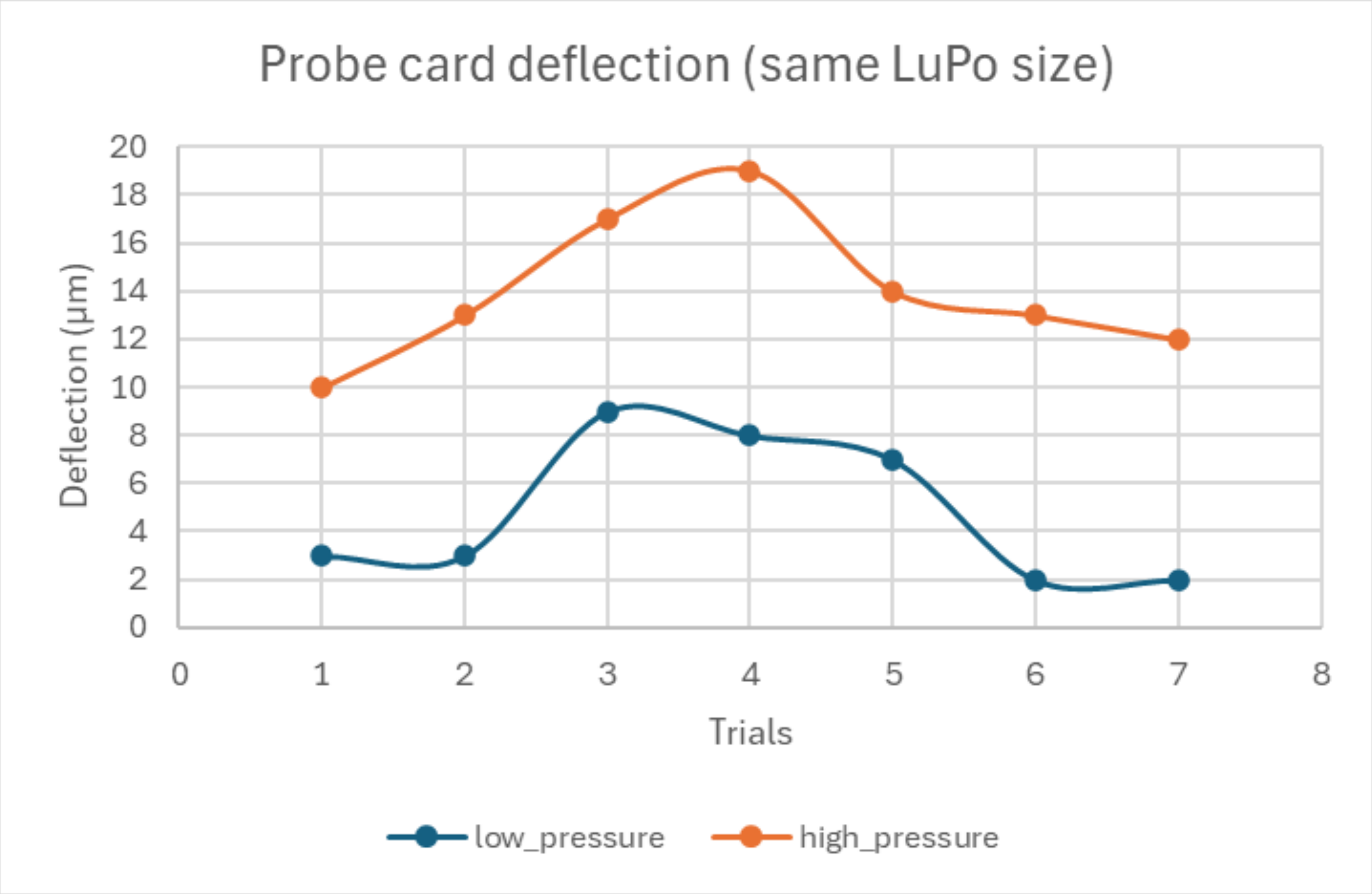


Deflection study – results





Deflection study – results

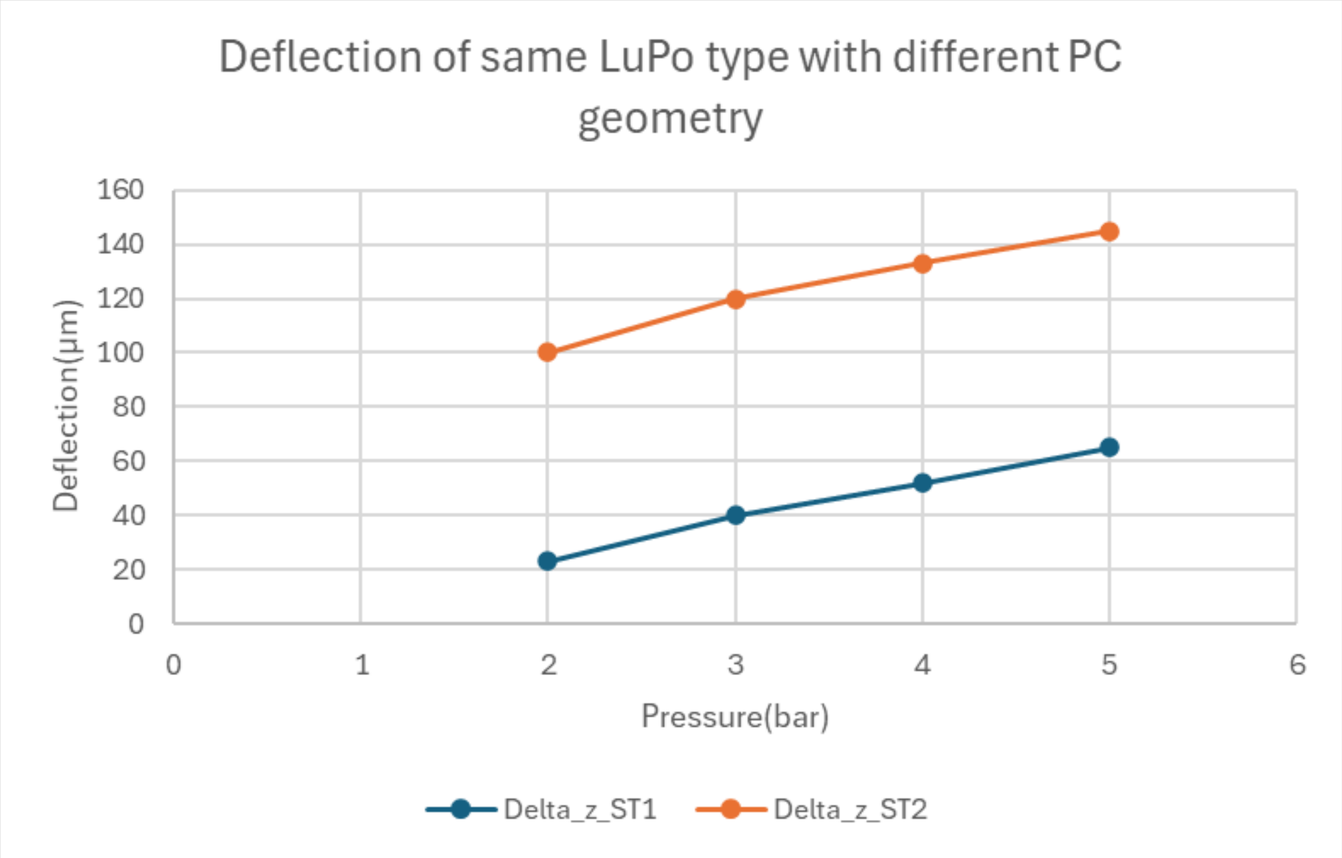


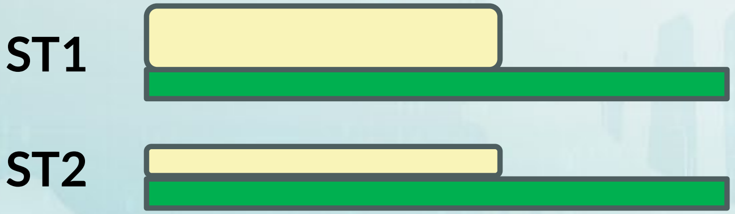
Deflection Study

- **Probe card geometry influence**

$$\delta_{max} = \frac{FL^3}{48EI} / C$$

Pressure input	Delta_z_ST1	Force_ST1	C	Mean
bar	µm	N	µm/N	
2	23	130,847334	0,04347826	0,03
3	40	153,93804	0,025	
4	52	192,42255	0,01923077	
5	65	221,285933	0,01538462	
	Delta_z_ST2	Force_ST2		
2	100	123,150432	0,01	0,01
3	120	144,316913	0,00833333	
4	133	180,877197	0,0075188	
5	145	192,42255	0,00689655	





Summary

- **Key factors:**
  - mounting method
  - input pressure levels
  - probe card geometry → the thicker the probe card, the smaller the deflection
  - overall system deflection

- **Best practices:**
  - Correct Z-zero determination or overdrive setting
  - Pressure monitoring
  - Robust probe card design

Best practices

- **Ideal set-up prober sequence where correct OVT is determined:**

System deflection + Recommended probe overtravel = Set overtravel from optical z-zero

- **Overall system deflection**
  - # of probes contribute to deflection as well
  - differences between cantilever and vertical
    - Force per probe
    - Probe count

Forecast vertical			
Lupo pressure*	Needle quantity	Overall force	Overall deflection***
bar	-	N	µm
3	3000	450	48
0	3000	300	32
3	1000	250,00	26
0	1000	100	11

* Set to zero if LuPo is already ON before first needle conatct
*** To be considered from first needle contact (one single needle)

Conclusion

High voltage testing of SiC chips needs an update!

Old

prober - probe card setups

- Probe card deflection generally present, but not considered in OD calculation
- Human intervention needed

New

prober – probe card setups

- Automated factories
- Multi-site testing / SiC testing

Rigid system

- No human intervention
- More complex design → expensive, but more efficient and reliable!

Follow-On Work

- Work on concepts for more rigid probe cards while keeping same test system structures
- Update probe card design rules to meet the new technology standards and the requests that come along

Thank you!