IEEE SW Test Workshop

Semiconductor Wafer Test Workshop

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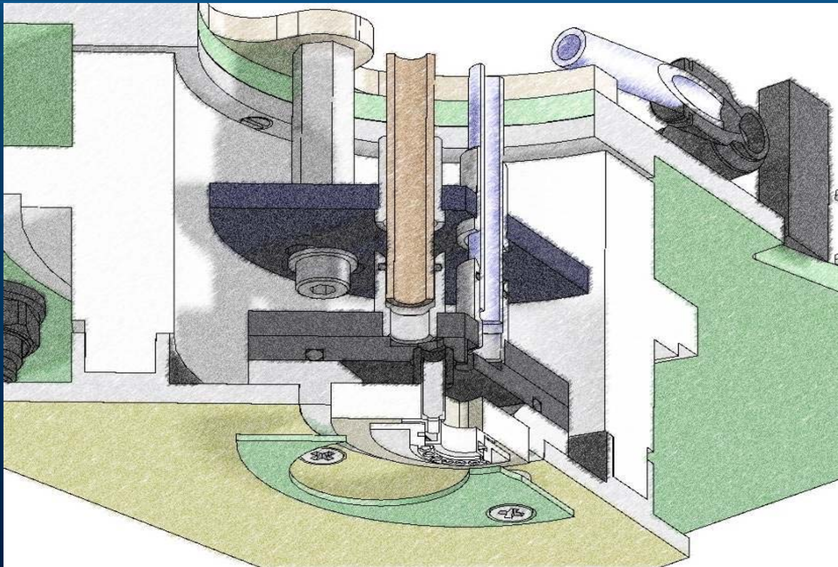
"Fusion Cuisine"

Hybrid Technologies to address MEMS sensors, Magnetics and High Voltage Probing



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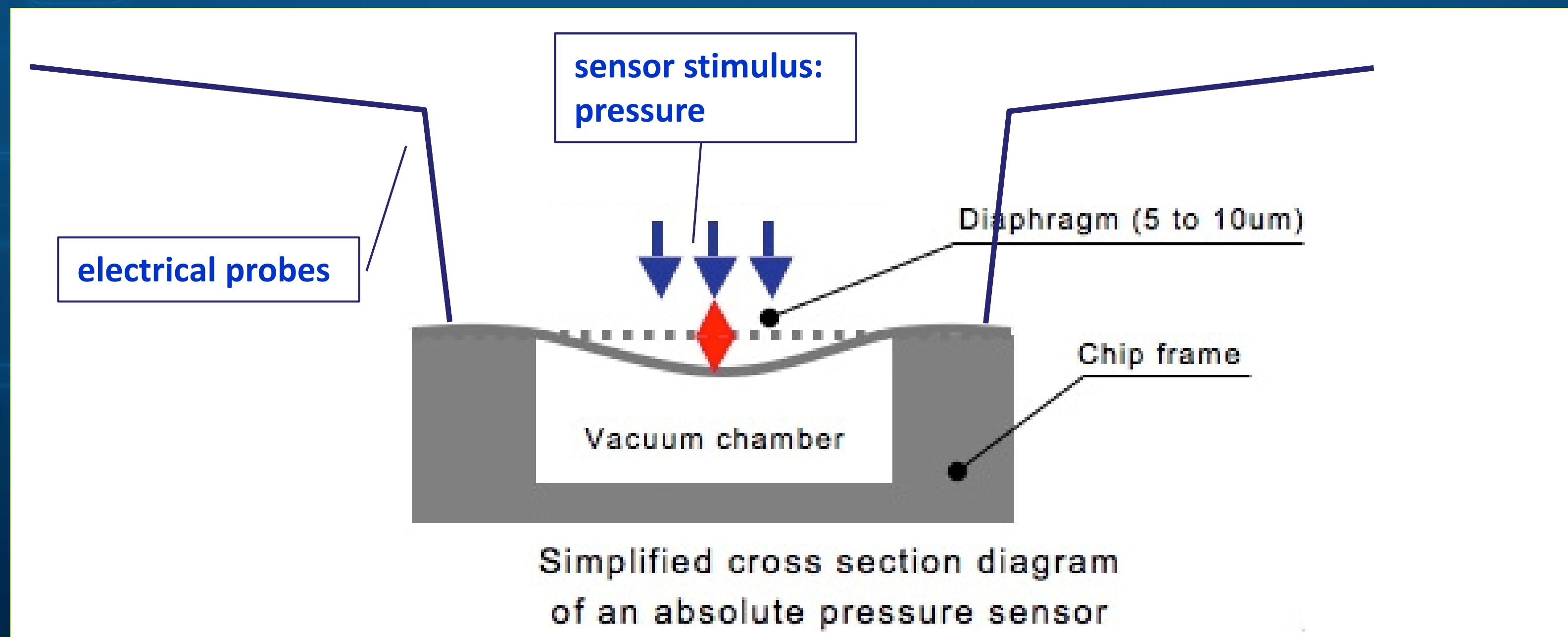
Overview

- Probing Sensors
- Pressure Sensors
- Pressurized Probe Cards
- "Vertical Cantilever Probes"
- Vertical "LuPo" Probe Head
- Magnetic Sensors
- Rotary Magnet Probe Card
- Summary

Probing Sensors

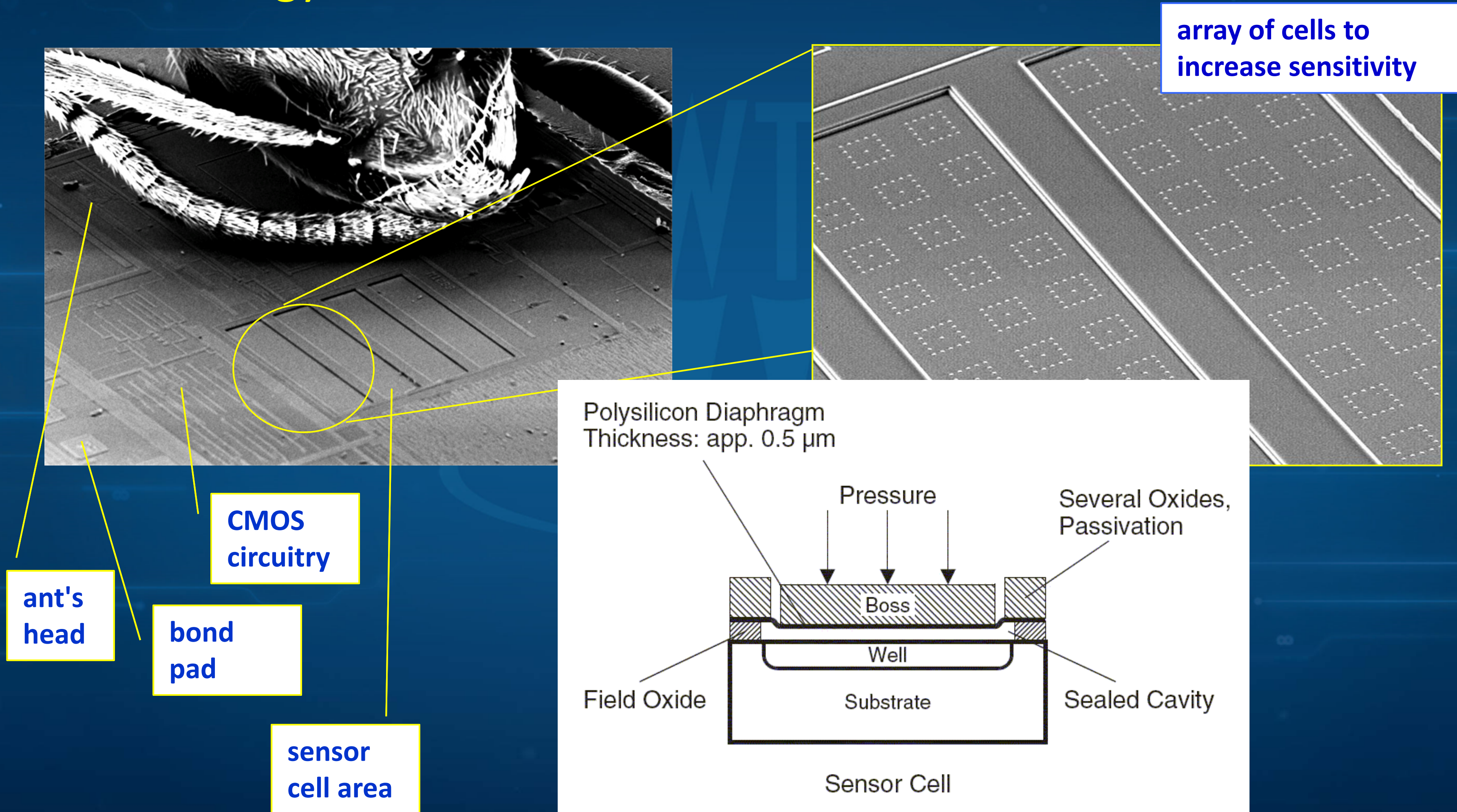
- besides electrical contact to the sensor device (probes...) the sensor element has to be stimulated:
  - pressure
  - magnetic field
  - light, radiation, humidity....



Simplified cross section diagram of an absolute pressure sensor

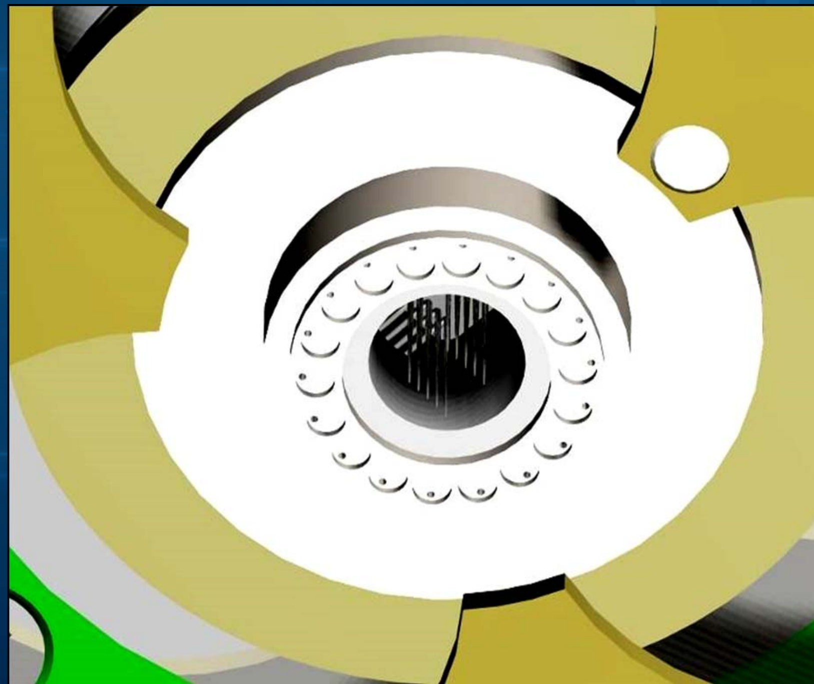
MEMS Pressure Sensors – the D.U.T.

- Technology: surface micro machined sensor cell



Probing MEMS Pressure Sensors…

- signal capture through electrical probes
- stimulation of sensor cells by applying air pressure

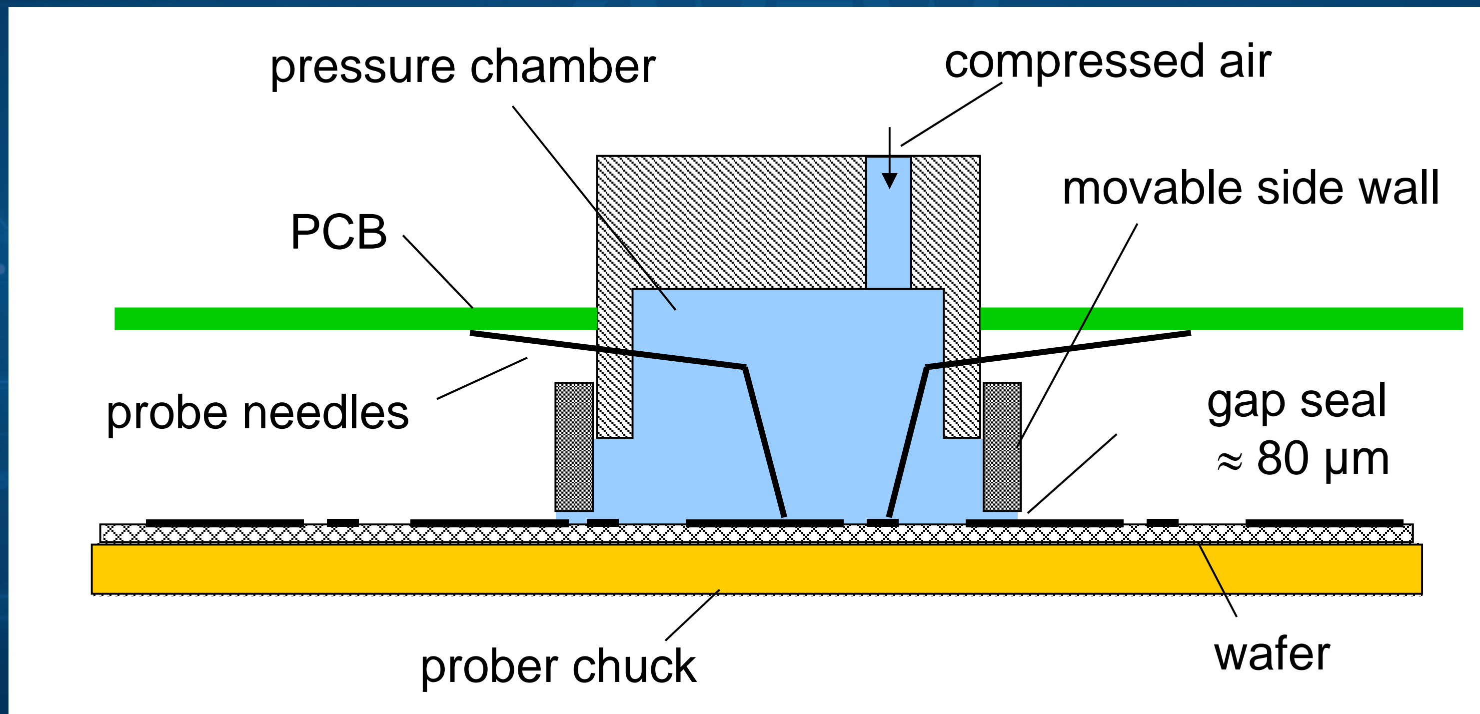


"Fusion" of a chip-scale pressure chamber + "Vertical Cantilever" probe card.....

"LuPo" – Luftpolster Probe Card

"LuPo-ABS" Probe Card

- "LuPo-ABS": Luftpolster – Air Bearing Seal

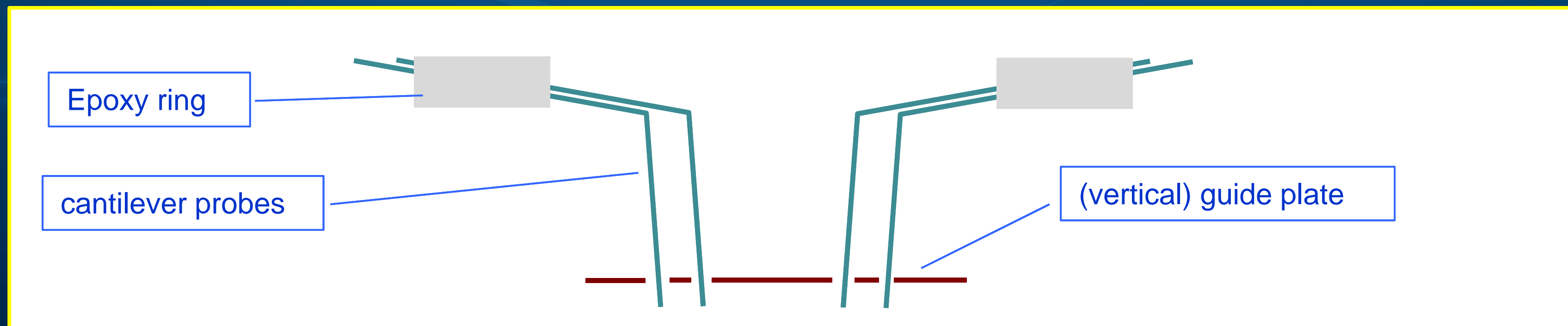


principle setup of "NoTouch" – gap seal pressure chamber probe card

"Vertical-Cantilever" Hybrid

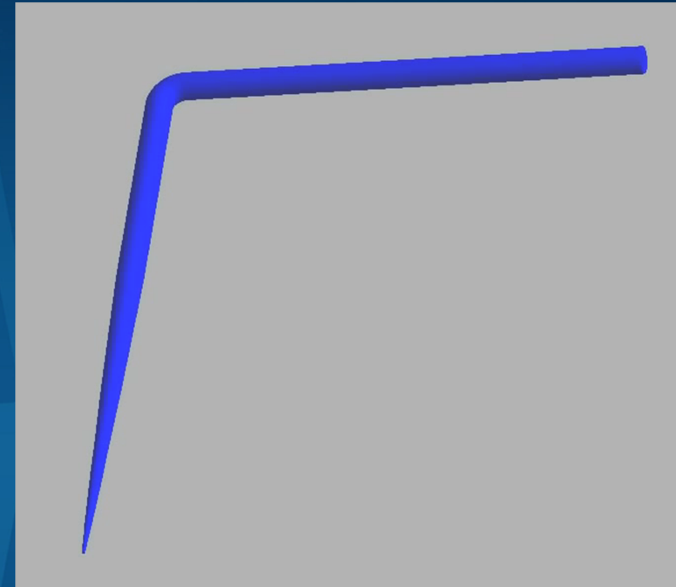
- "Long" probe tips needed to comply with constraints imposed by pressure chamber geometry
- Scrub behavior depends on friction on probe tips on pad surface, sometimes not well predictable
  - "skating", e.g. on Pt pad surface, pad edge damage
- Solution: "Hybrid" of Cantilever probes with guide plate known from Vertical probe card technologies

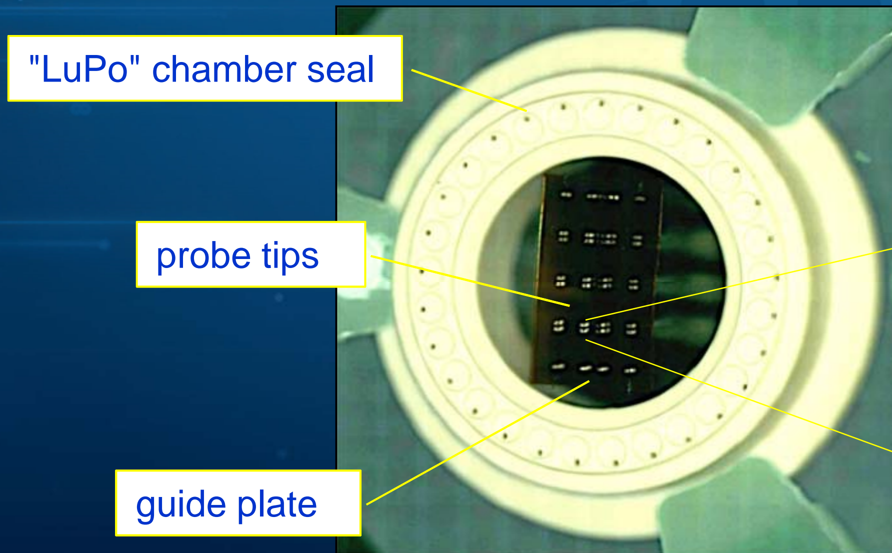
-> "Vertical-Cantilever Probe Card"

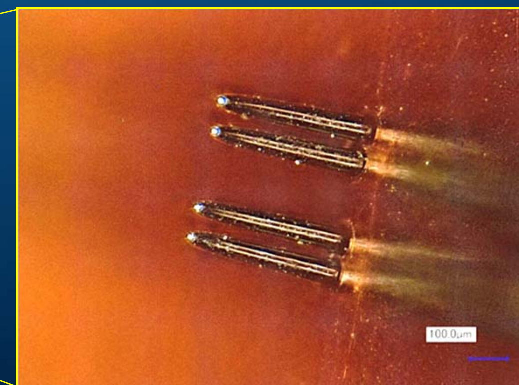


Vertical-Cantilever Probes

- Probe geometry for "stubbing" contact geometry
  - optimized through FEM simulation
- Integration into "LuPo" pressure chamber

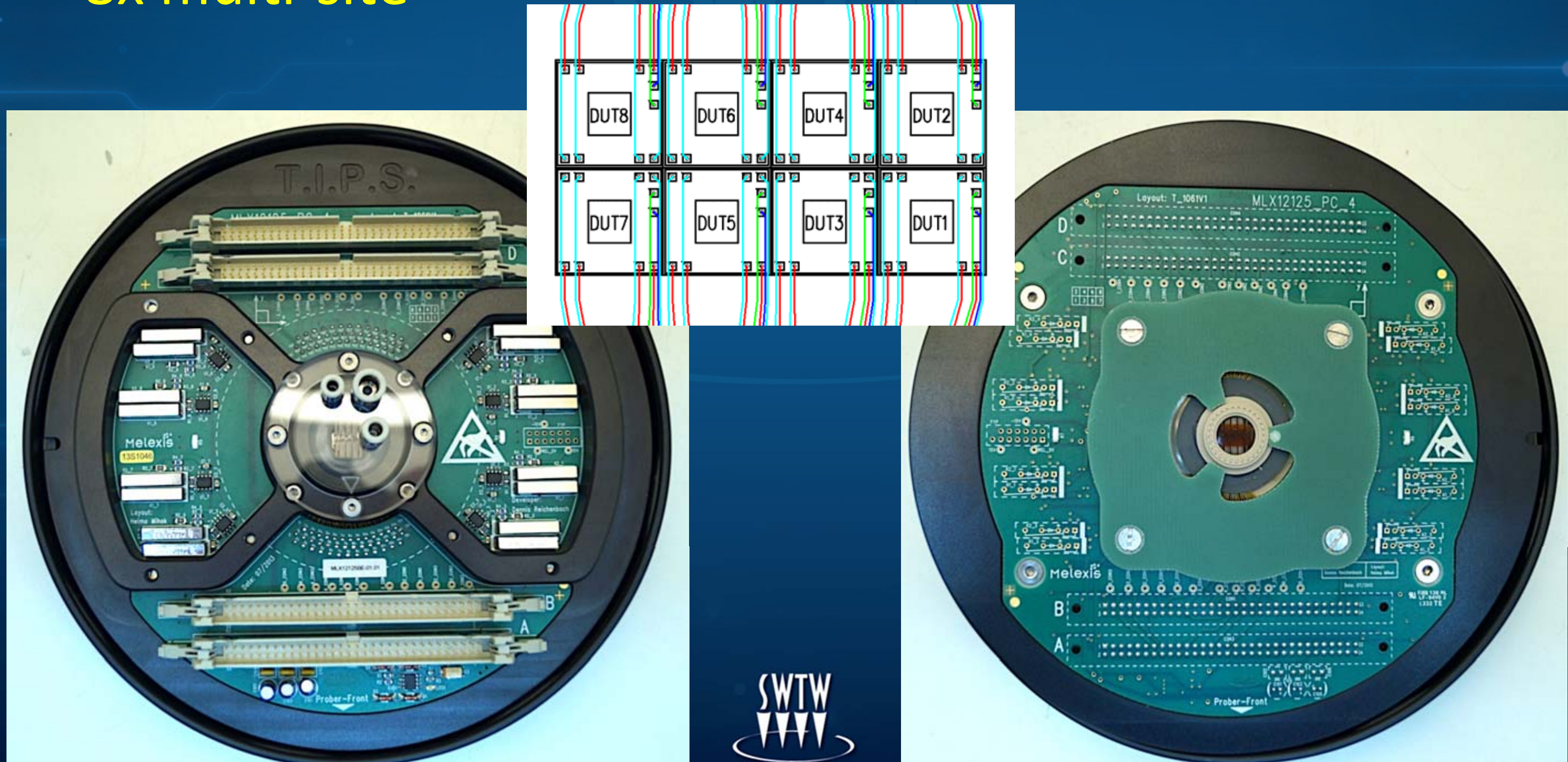




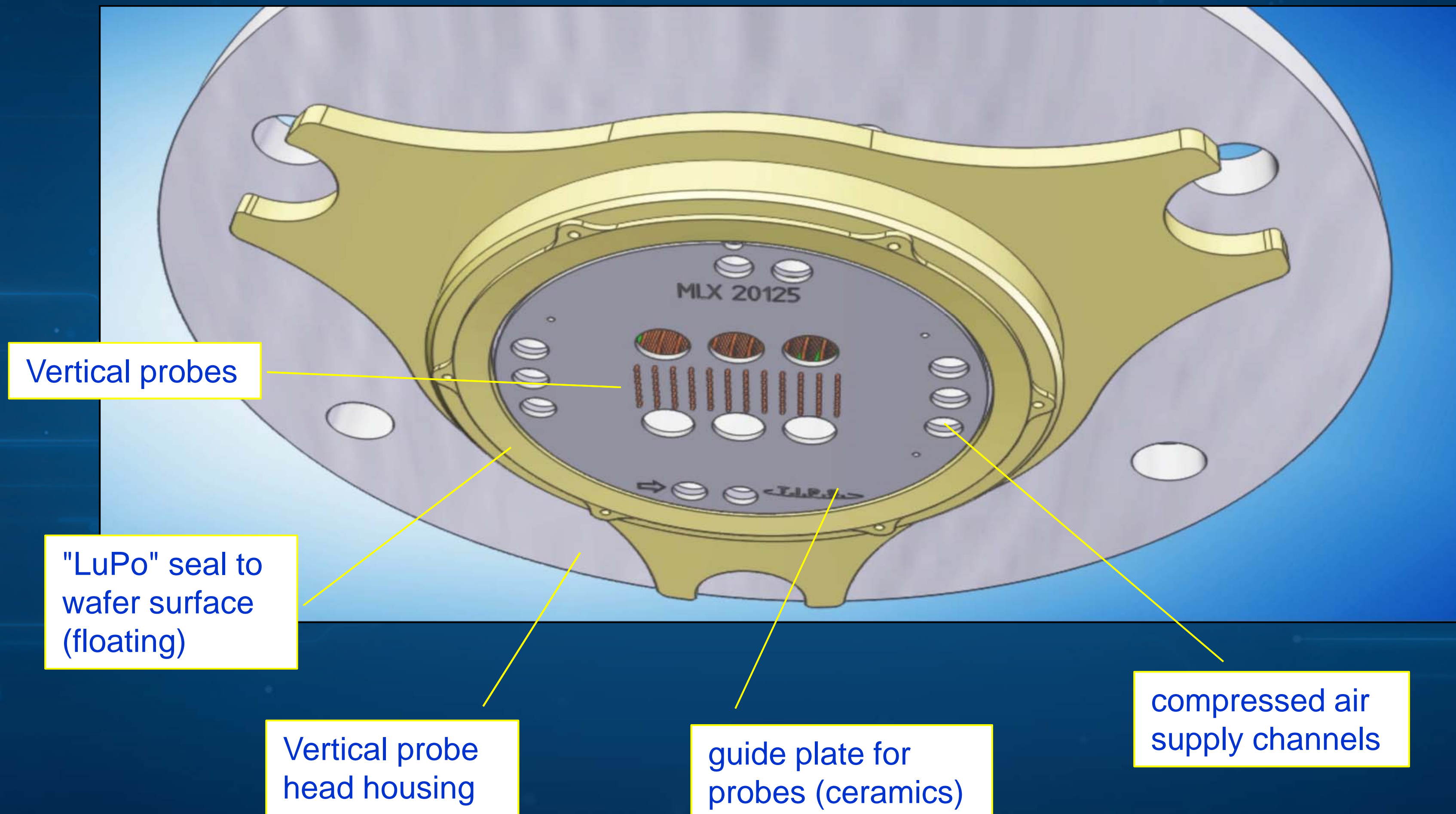


"Vertical-Cantilever" - Example

- Automotive-grade pressure sensor
- Paliney probes chosen for contacting of Platinum pads
- 8x multi-site



Vertical "LuPo" Probe Card



Vertical "LuPo" Probe Card

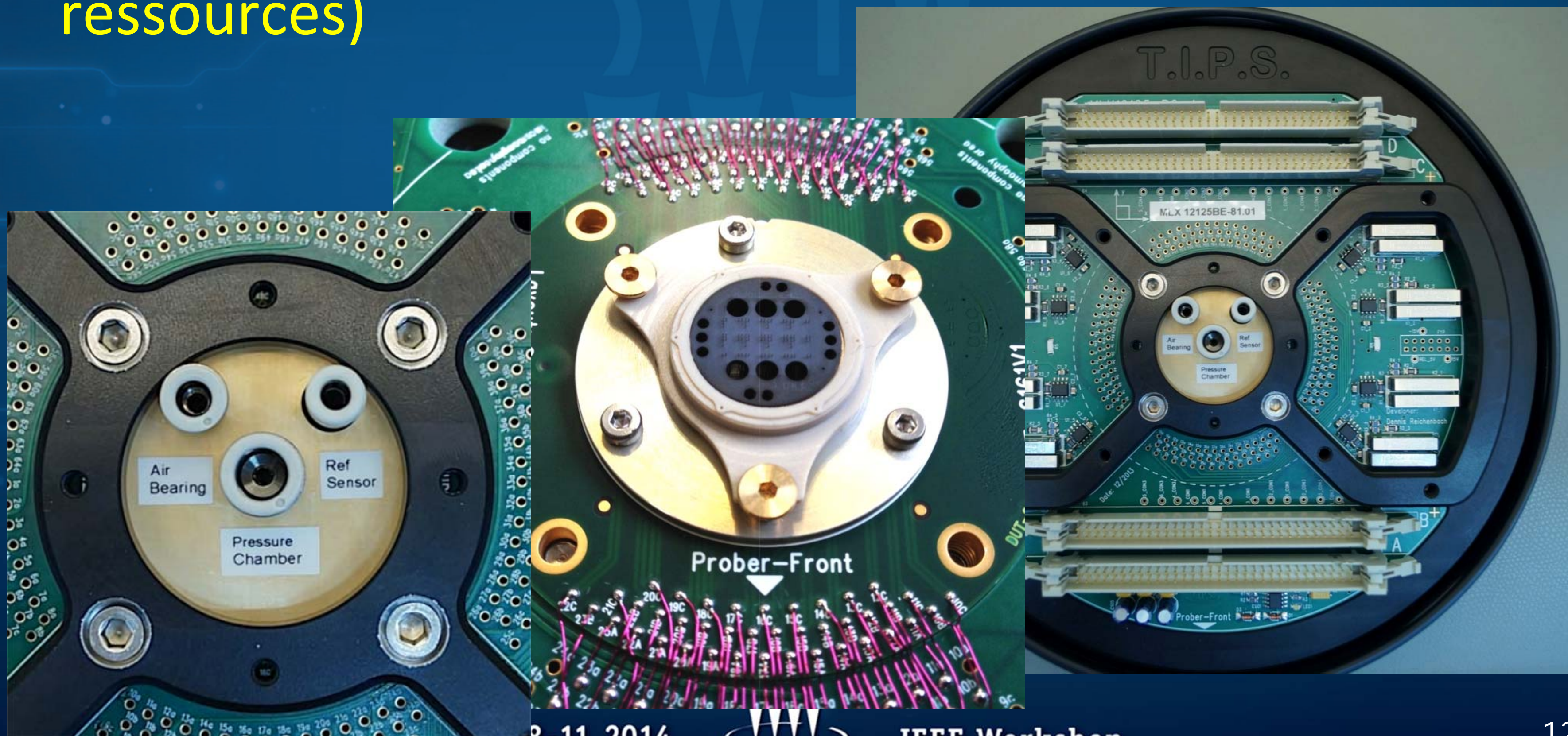
- Challenge:
  - apply advantages of Vertical buckling beam technology to pressure sensors probing

-> "Hybrid" of Vertical probe head (buckling beam configuration) with "LuPo" pressure chamber !

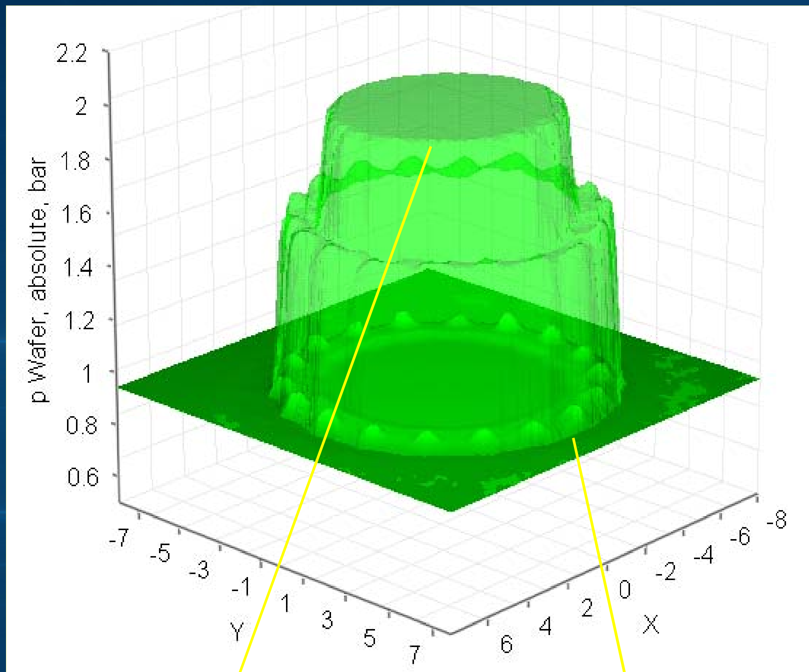
- integration of functionalities:
  - Vertical probe head housing serves as guide plates mount + part of pressure chamber + compressed air guide
  - MLO interposer serves as electrical connector + compressed air guide
- New concept for mounting and replacing vertical beams developed

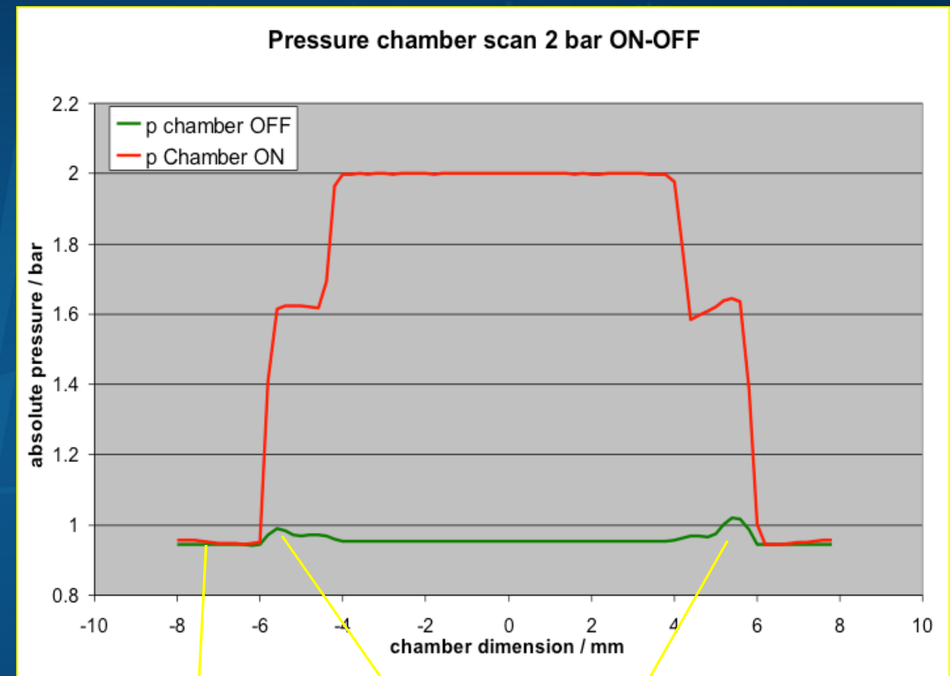
Vertical "LuPo" - Example

- automotive-grade pressure sensor (same as for Vertical-Cantilever)
- 8x multi-site (capable of 32x – limitation here: tester ressources)



"LuPo-ABS" - Lab Characterization





homogenity of pressure inside chamber ("hat top") better than **0.05 %**

High precision wafer level sensor calibration feasible!

air bearing structure – gap seal

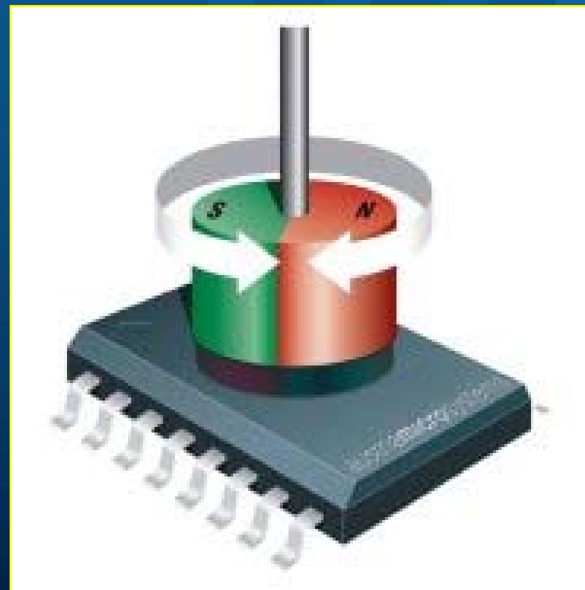
outside of chamber

gap seal region

2-D pressure scan of LuPo chamber (diameter 8 mm), undertaken with micro static pressure probe mounted to prober chuck

Magnetic Sensors

- various effects from Physics used to measure magnetic field strength: Hall, GMR...
- single- and multi-axis sensors
- requirements for variation of the magnetic field in strength and/or direction



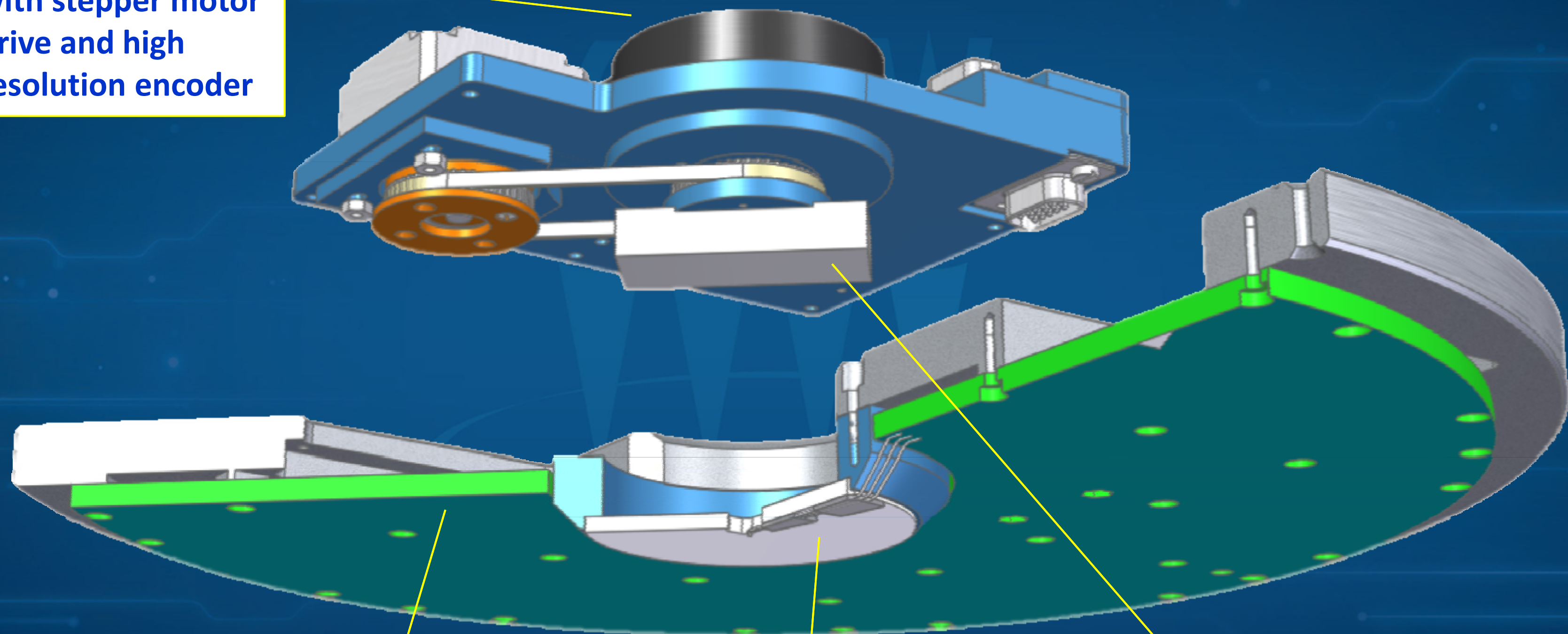
2-D rotary magnetic sensor IC

picture courtesy: austriamicrosystems

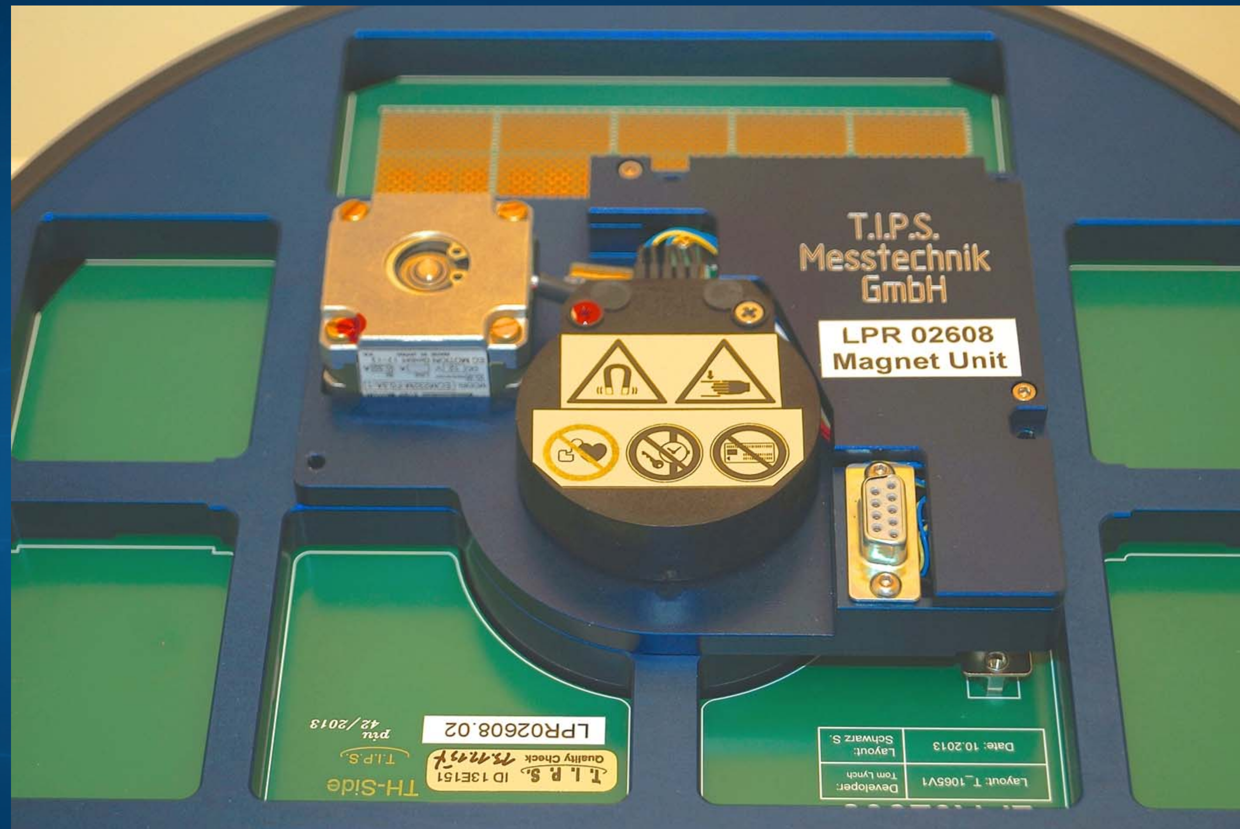
Magnetic Sensor Probe Card

- customer request: wafer probe card for production test of an angular magnetic sensor
- 0.5° precision rotational positioning of magnetic field vector in the wafer plane required
- **-> "Fusion" of high precision angular positioner with high strength Neodymium magnet integrated into probe card**
- challenges: non-magnetic design of probe card (except magnet itself of course)
  - stiffener
  - screws....
- Design of angular positioner to fit within probe card space constraints
- Communication of angular motion control unit with tester

Magnetic Sensor Probe Card



Magnetic Sensor Probe Card



- 0.1° angular precision and repeatability
- 50 mT field strength in the wafer plane

Summary

- Wafer probing of sensor devices poses the additional challenge of "stimulating" a sensor element
- "Fusion" of various technologies allow the design and manufacture of robust production probe cards:
  - micro contacting technology
  - custom PCB and mechanical design design
  - motion control
  - pressure application
  - magnetics design
  - FEM simulation
  - ...

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THANK YOU!