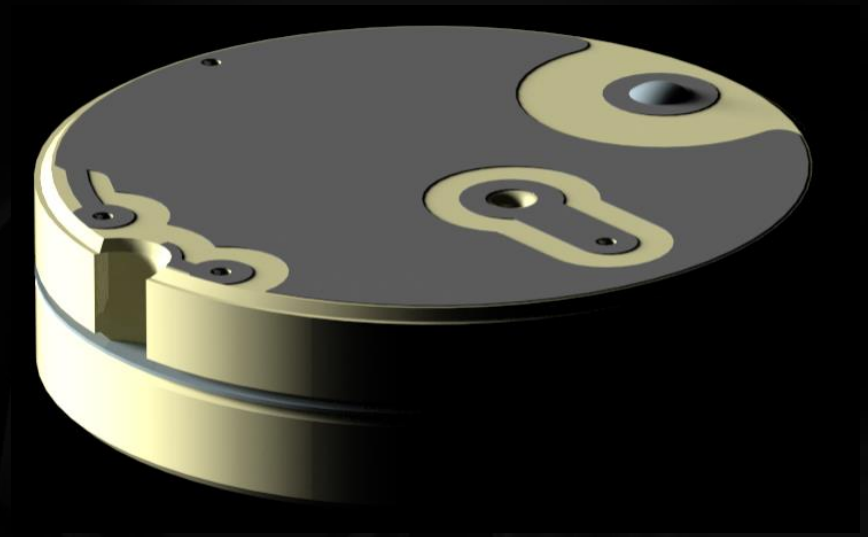
EQUIPMENT · SOFTWARE · PROCESSES
esp-engineering



LASER INDUCED SOLDERING

... AN INDUSTRIAL INSIGHT

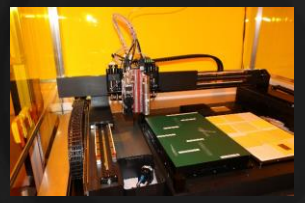
2022

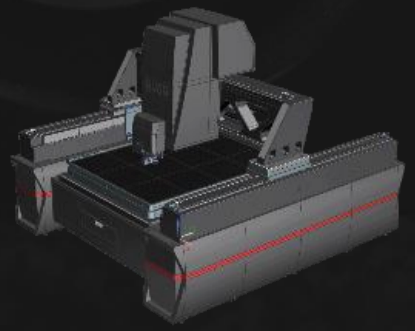
WHO WE ARE

CORE COMPETENCES

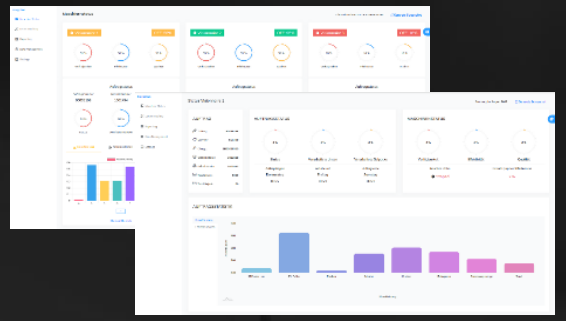
esp-engineering is an **owner-managed mechatronic** company based in **Appenzell / Switzerland**
Our core competences are related to

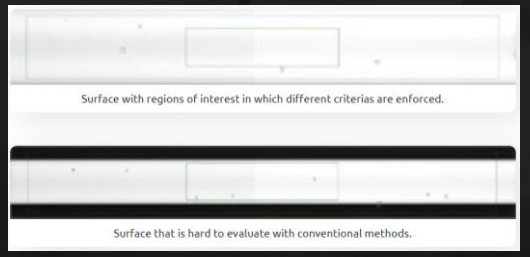
EQUIPMENT



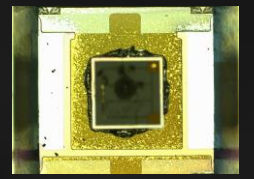


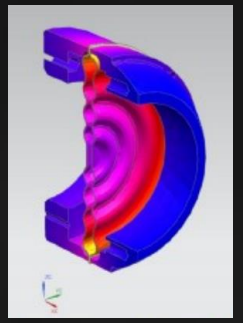
SOFTWARE

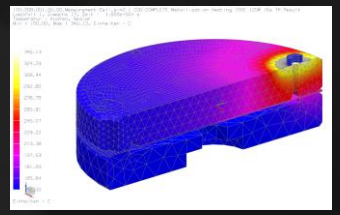




PROCESSES

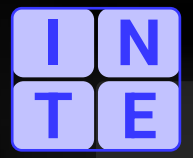






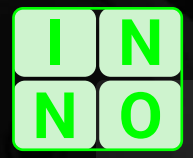
WHO WE ARE

OUR GREATEST STRENGTHS



INTERDISCIPLINARITY

We supply methodology, mechanical engineering, automation, control/regulation technology, mechatronic modules, software, risk assessment, impact analysis and after-sales service from a **single source**.



INNOVATION

We develop **customised**, individual solutions that represent the **optimum** for the customer. Where possible, we prefer sustainable **green tech** options.

PASSION

We engage ourselves value-oriented and with heart and soul from the scoping to the after-sales, from the challenge to the solution.

WHO WE ARE

TEAM

ANDREAS WALSER

CEO
FOUNDER

- Over thirty years experience in various areas from software, mechanics to electronics
- Developer to the core, always enters new and exciting areas

BJÖRN SPIESS

CTO
ELECTRICAL ENGINEERING

- More than ten years experience in automation technologies
- Passionate teacher at higher technical college

MICHAEL REICH

CTO
MECHANICAL ENGINEERING

- Over twenty years experience in mechanical design
- Combines precision, design and modularity in a unique way

DORIS WALSER

CFO / HRM

- More than ten years experience in human resources and finances
- Shapes our corporate culture with heart and soul

WHO WE ARE

LOCATION

Located in the heart of Europe…

WILDER OSTEN

… on the wild eastern part of Switzerland

… balanced between technique and nature

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9055 Bühler
Switzerland

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LASER INDUCED SOLDERING

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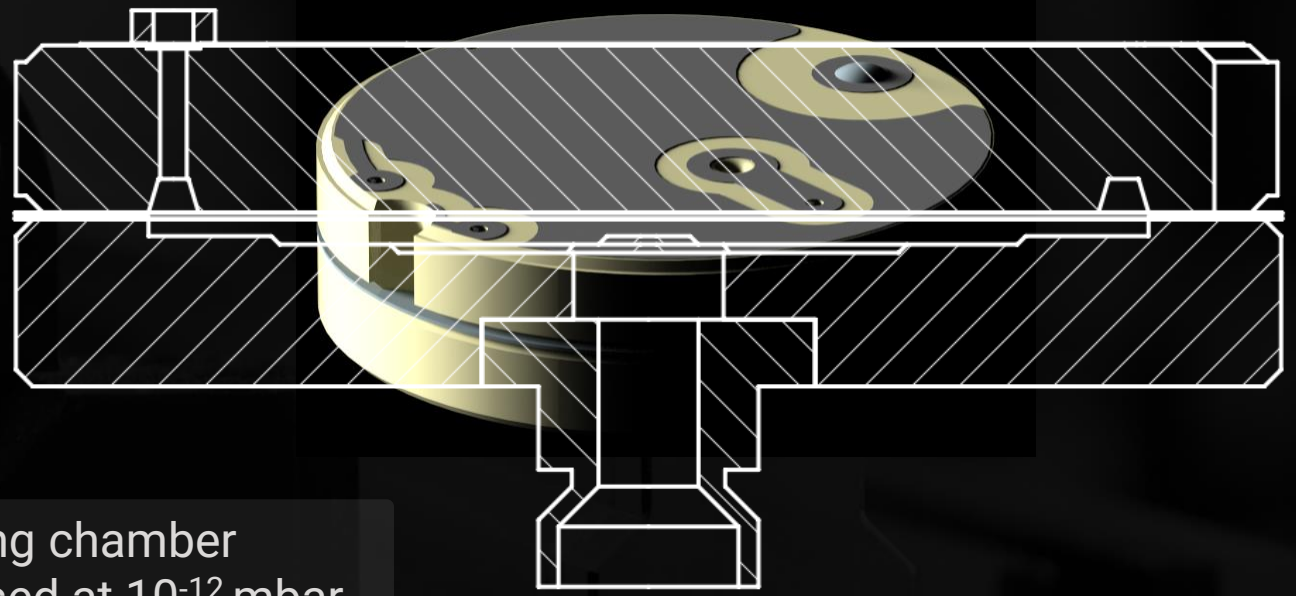
LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – WORKING PRINCIPLE

Reference chamber pressurised at 10^{-7} mbar

Capacitive measurement principle



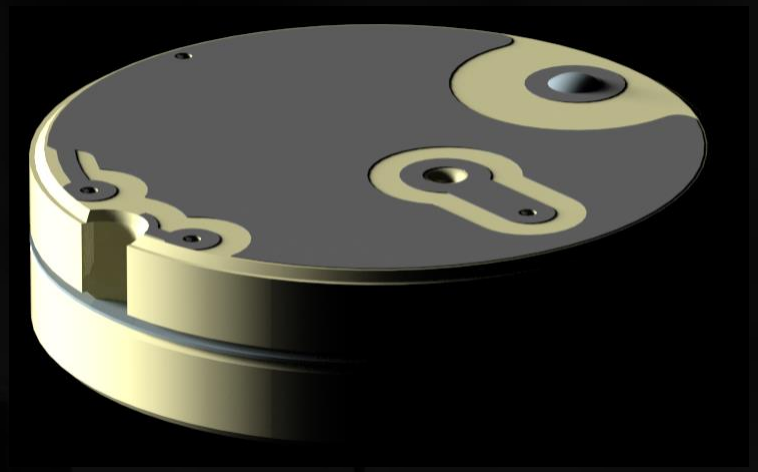
Measuring chamber pressurised at 10^{-12} mbar min

LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – REQUIREMENTS

Reduction of yield losses due to **improper solder joints**

Reduction of yield losses due to **thermomechanical stress**



Increase throughput by **cycle time reduction**

Minor changes in material surface allowed

Flux-free soldering under **high-vacuum** (10^{-7} mbar)

LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – SINGLE UNIT PROCESS

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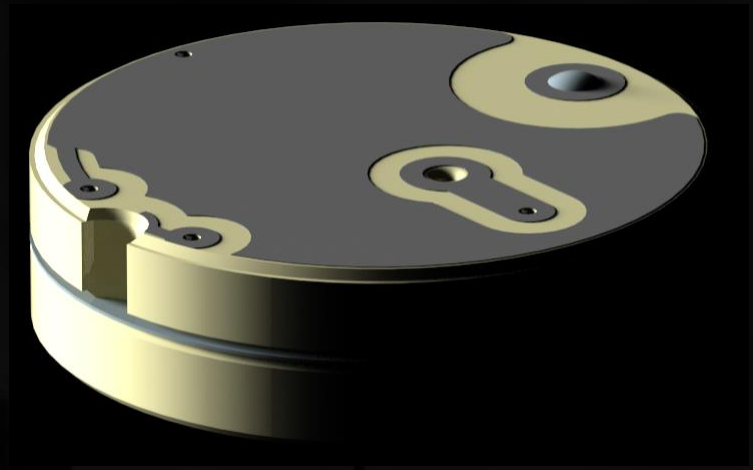
(1) Load
Surface cleaning, solder application

(2) Pre-Heating
Temperature ramp up below solidus point

(3) Soldering
Temperature increase above melting point



(4) Post-Heating
Temperature stabilisation / profile for minimal stress

(5) Cooling
Cooling down ramp, down to room temperature to minimize stress

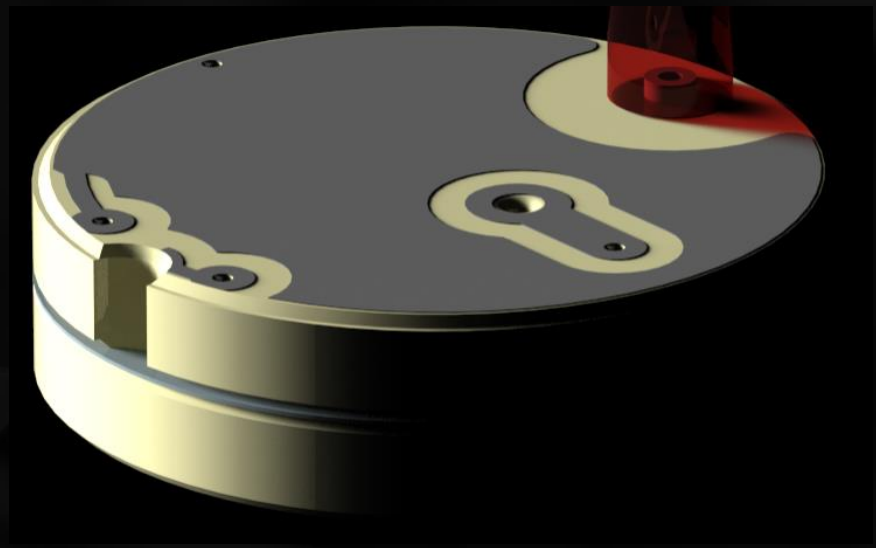
(6) Unload
Remove soldered component

LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – PARAMETERS

- Laser source
  - Wavelength
  - Power
  - Continuous and / or pulsed mode
- Optics
  - Beam shaping
  - Intensity distribution

- Assemblies / Components
  - Surfaces
    - Wettability
    - Transmission / reflection / absorption
  - Bodies
    - Coefficient of thermal expansion
    - Heat transfer
    - Shrinkage

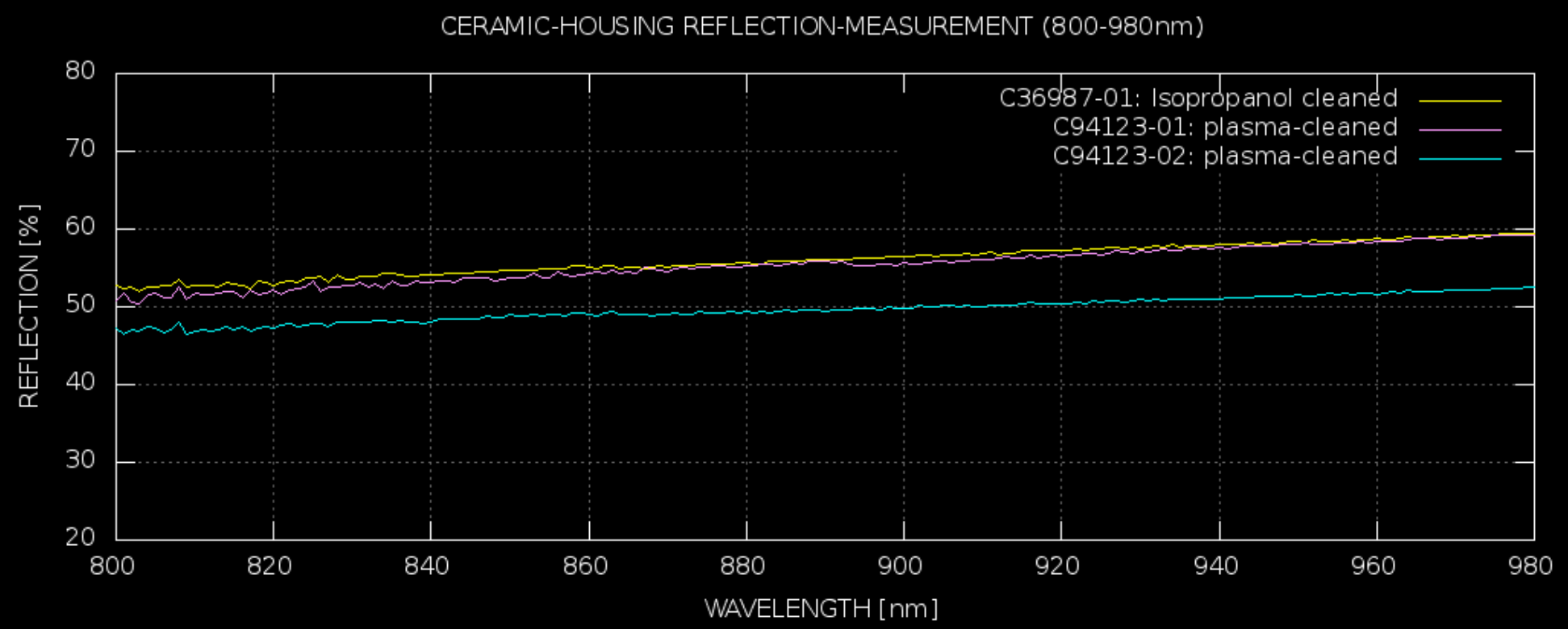


LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – MATERIALS

LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – MATERIALS



LASER INDUCED SOLDERING

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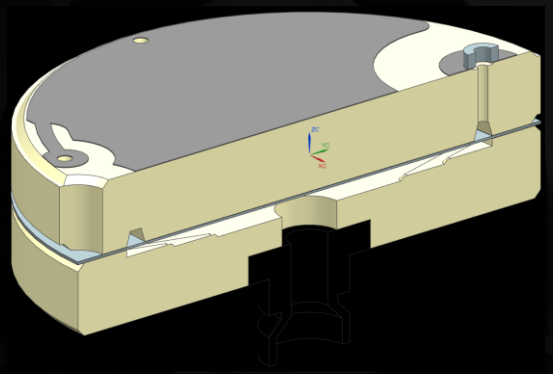
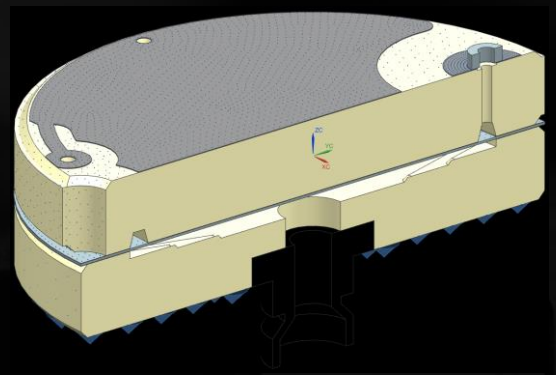
LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – SIMULATION I (MODELLING)

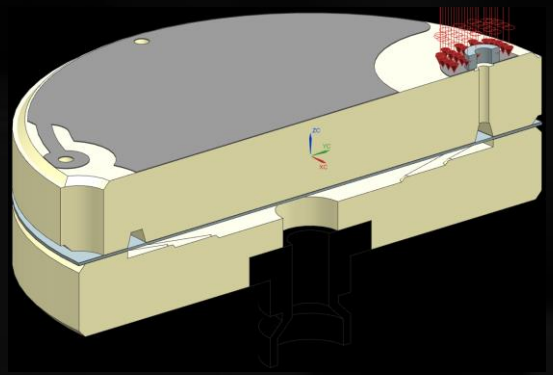
(1) Create model



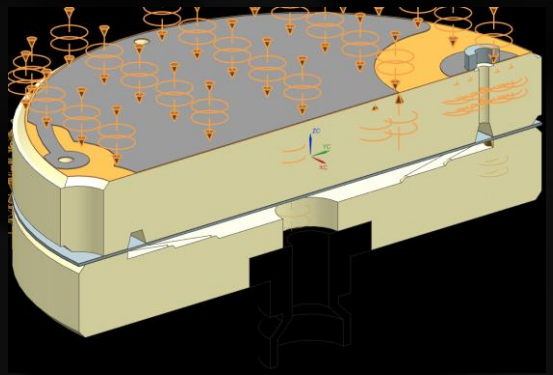
(2) Define conditions



(3) Define loads

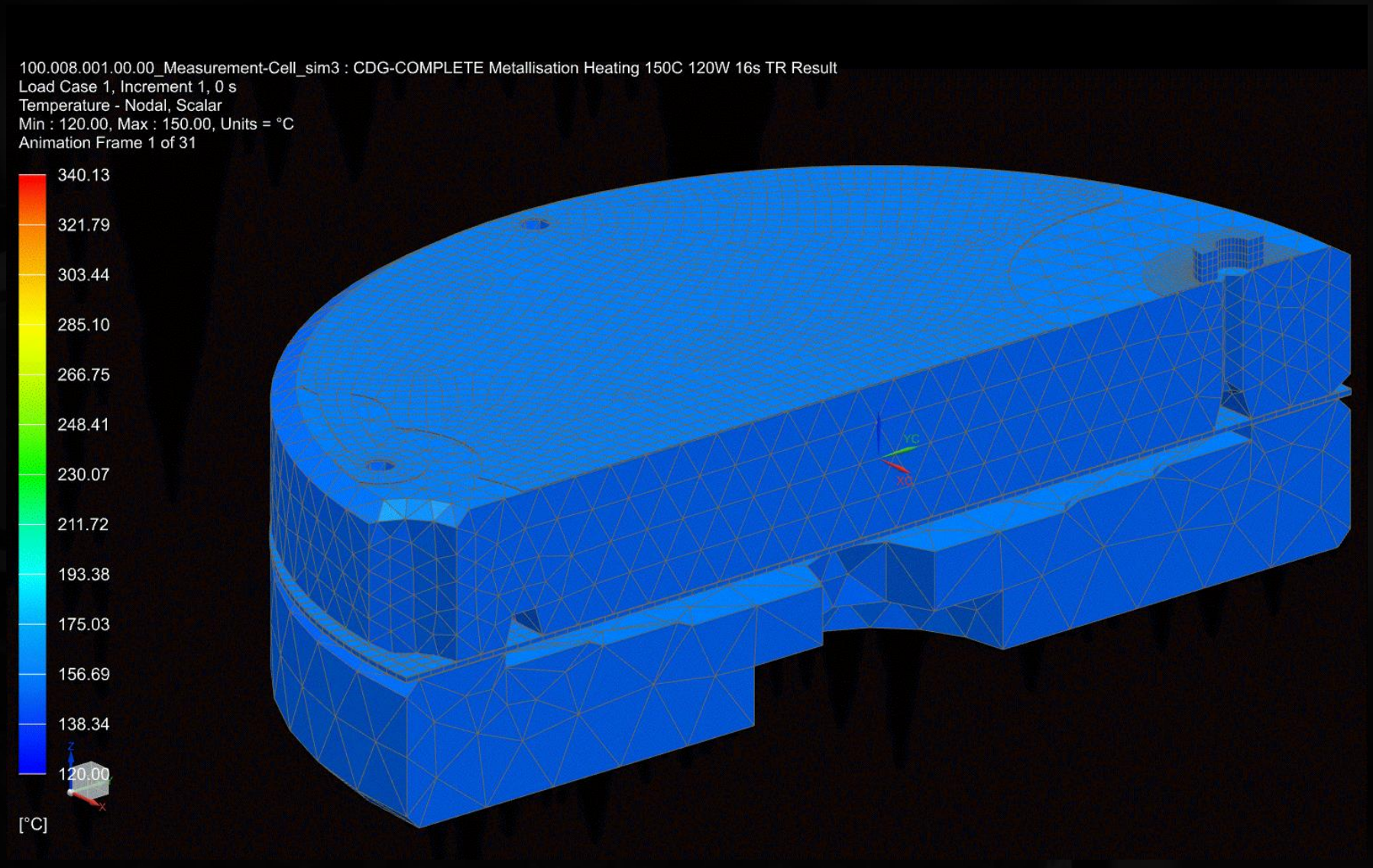


(4) Define physics



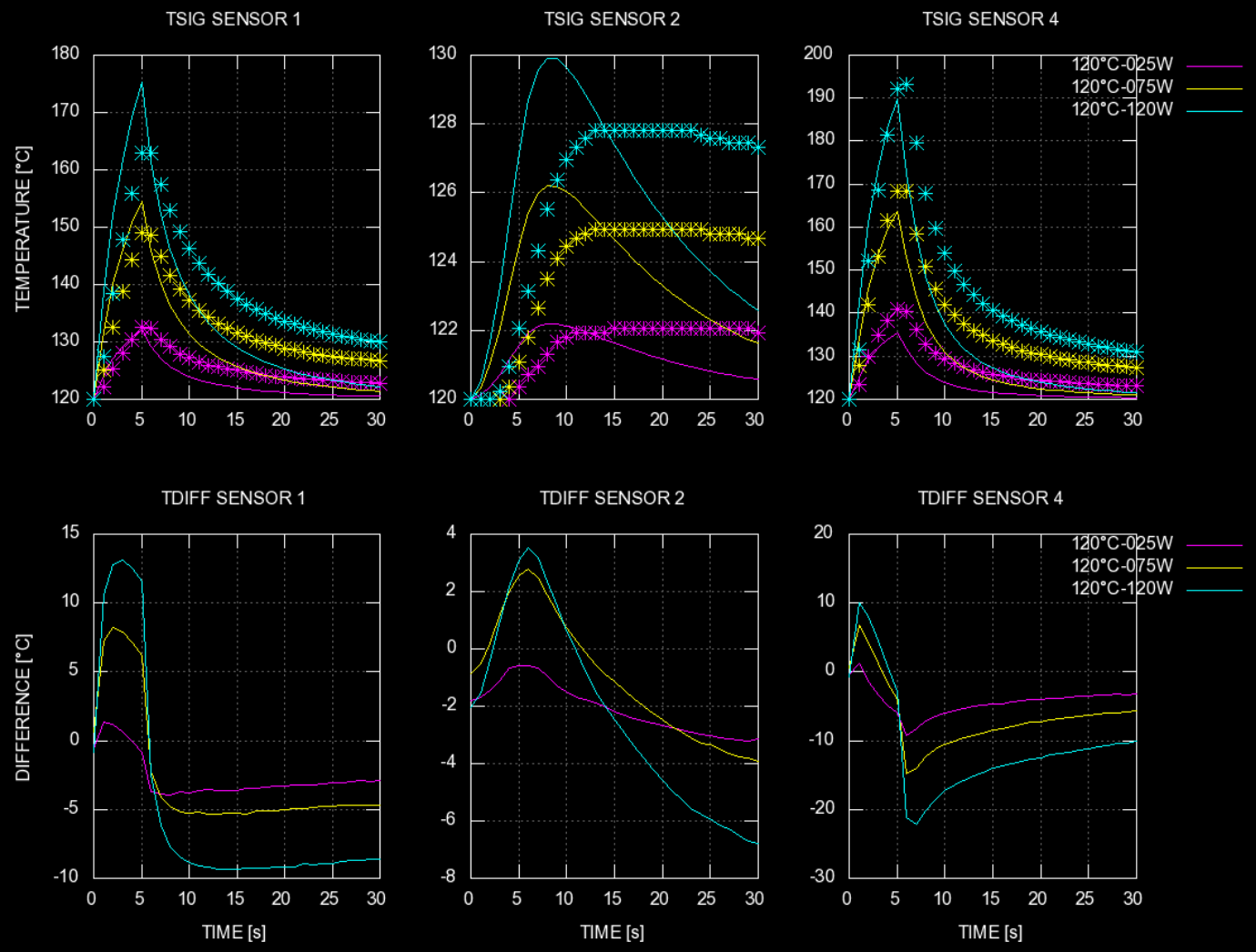
LASER INDUCED SOLDERING

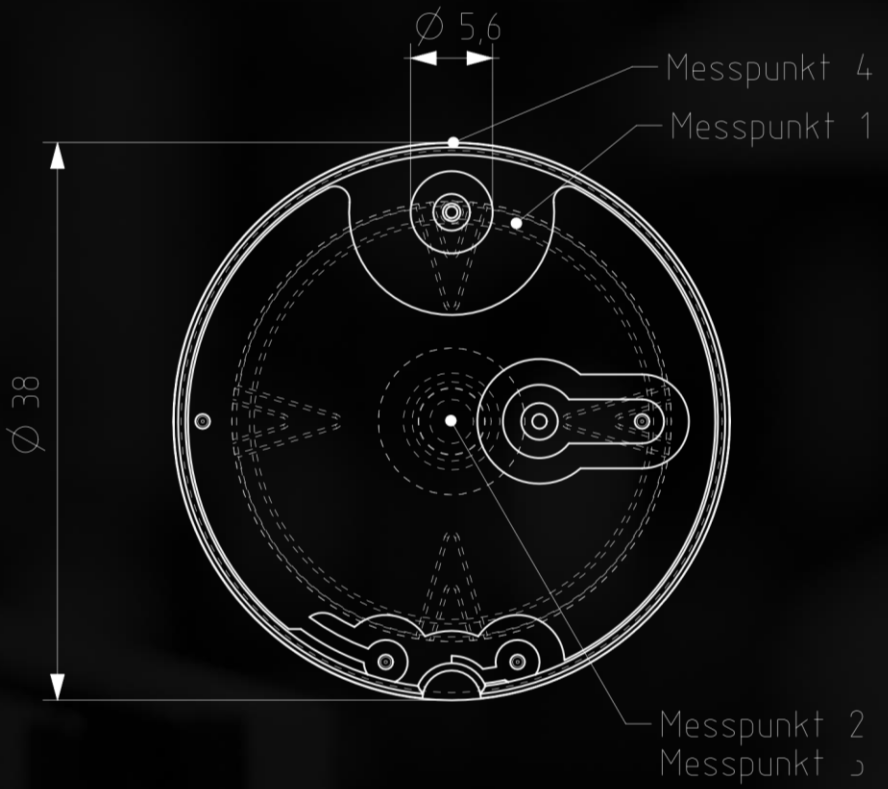
CERAMIC PRESSURE SENSOR (CPS) – SIMULATION II (SOLVING)



LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – SIMULATION III (VALIDATING)





LASER INDUCED SOLDERING

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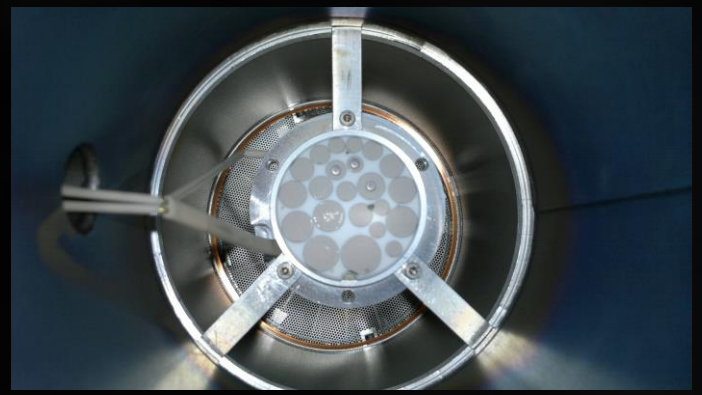
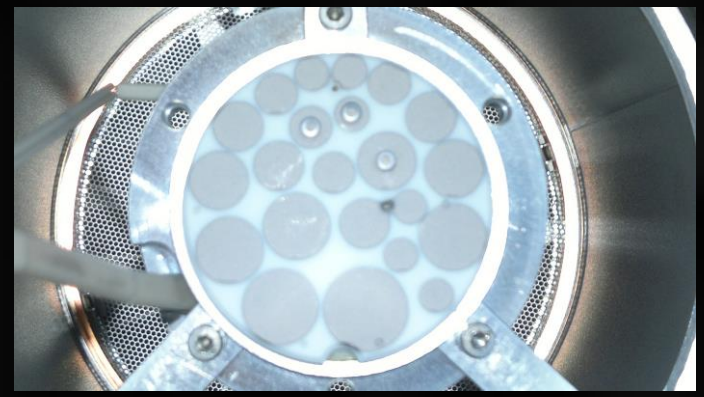
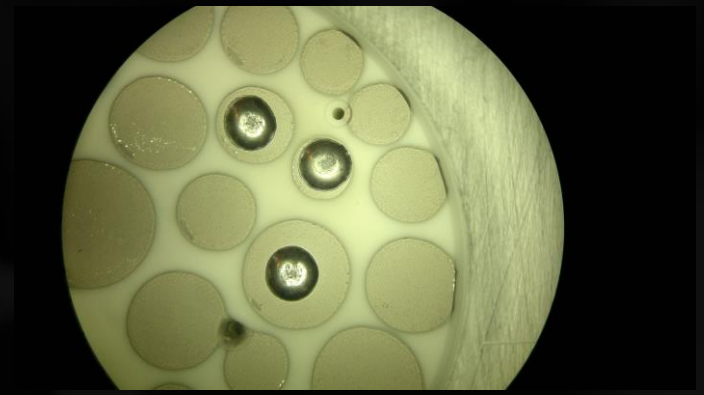
LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – REALISATION

- WETTABILITY / SOLDERABILITY
  - Evaluate different surface activation processes like plasma-cleaning
  - Laser power variation
  - Laser beam shape variation
  - Surface adaption with different coatings to increase / decrease absorption
  - Evaluate different solder materials
  - Evaluate Pre-Heating
  - N_2H_2 forming gas, prevents oxidation



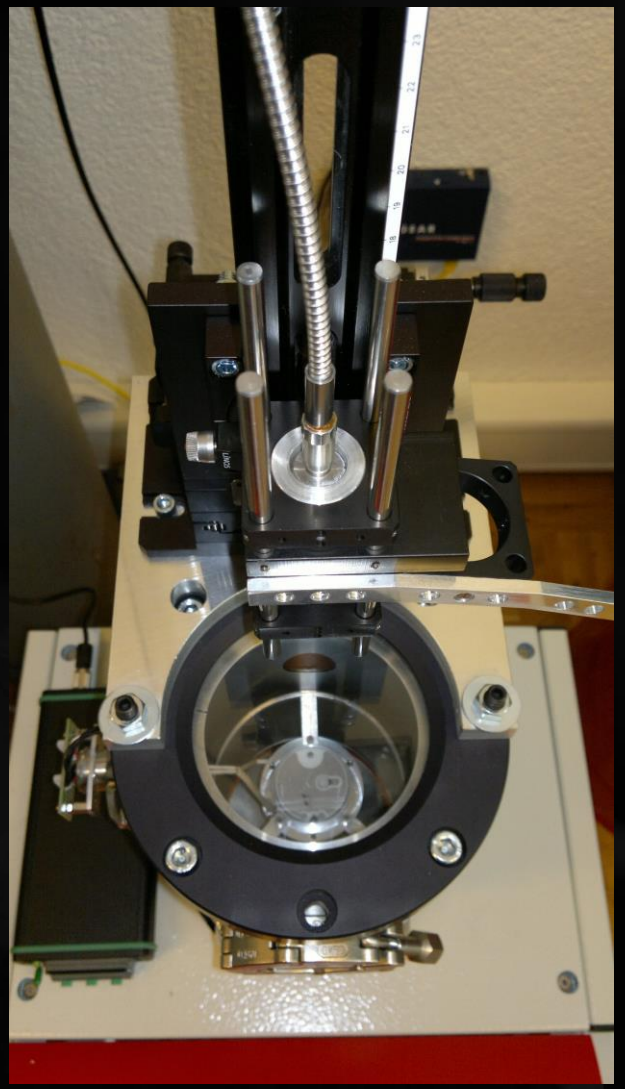




LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – REALISATION

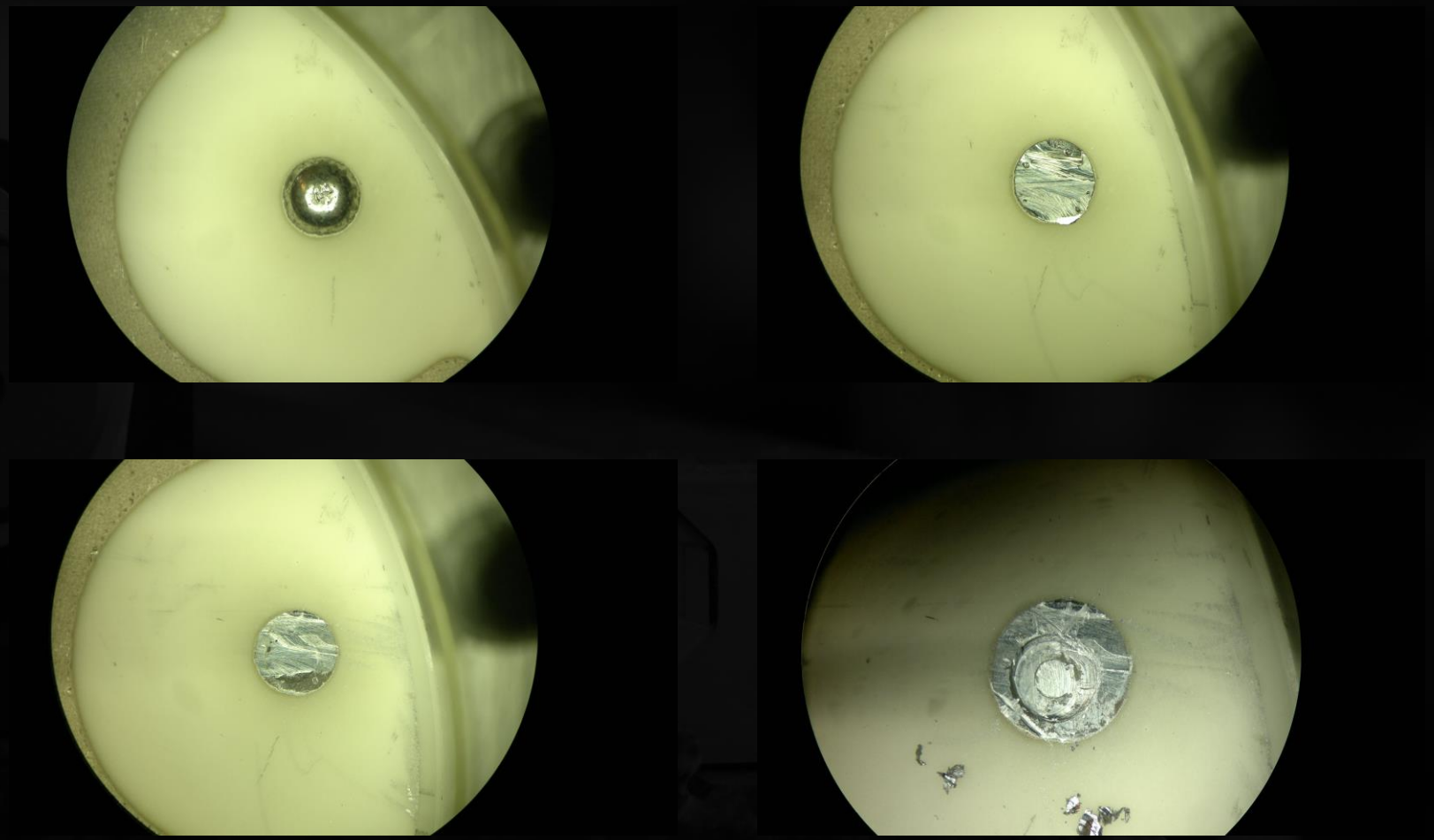
- REAL SAMPLES
  - Laser source with 150 W @ 940 nm (coupled into 400 um fibre)
  - Optics for beam shaping and collimation
  - Working distance between fibre-output and substrate 300 mm
  - Sensor under vacuum and pre-heated at 150 °C



LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – REALISATION

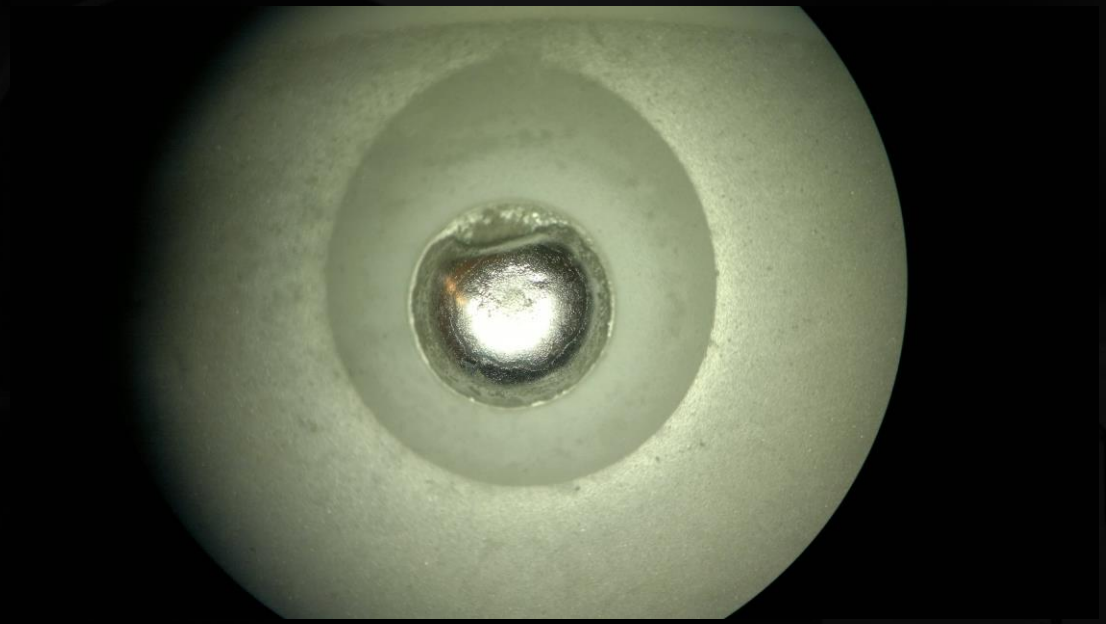
- REAL SAMPLE

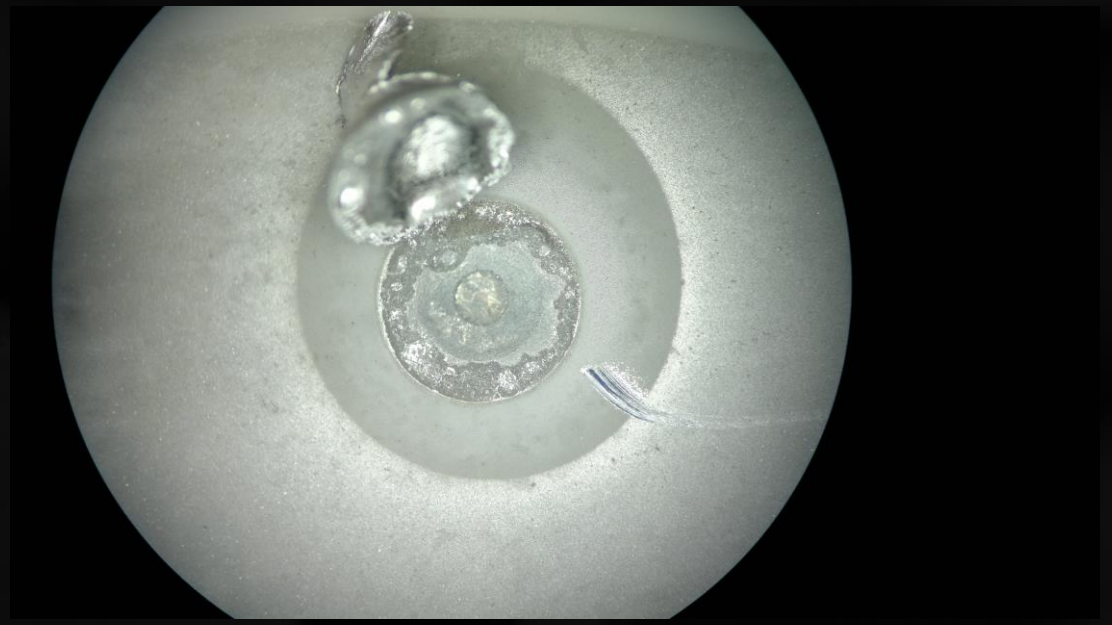


LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – REALISATION

- FAILURES
  - Bad solder joint





LASER INDUCED SOLDERING

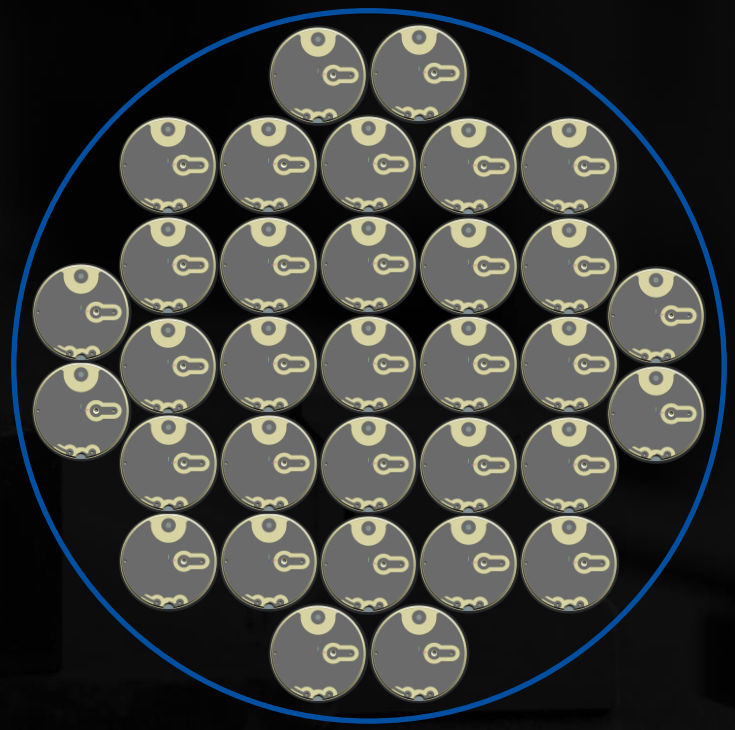
CERAMIC PRESSURE SENSOR (CPS) – REALISATION

- LARGE SCALE PROCESS

Sensors per run: 33

Vacuum chamber pressure: 10^{-7} mbar

Soldering time: 16 s per solder joint, results in 10 mins per run



LASER INDUCED SOLDERING

CERAMIC PRESSURE SENSOR (CPS) – CONCLUSION

- PROS
  - Reliable technology, suitable for various applications
  - Fast soldering process
  - Non-contact, therefore no physical stress or damage occurred during contacting
  - High repeatability
  - Flux-free or flux-base soldering, paste / wire

- CONS
  - Not all materials can be processes
  - Material- and surface-related process parameters like transmission, absorption, …
  - Laser protection guidelines must be observed