evatec process systems

Challenges in the Simulation of Vacuum Processing Hardware

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THE THIN FILM POWERHOUSE

- Introduction to EVATEC
- Simulation at EVATEC
- Examples of component optimization
  - Molecular flow
  - Heating
  - Cooling
  - Microwave fields

OUR HOME

Headquarters in Trübbach, CH
Global Headcount
≈ 640

Assembly of
>40
systems simultaneously

>3000m²
application laboratory down to ISO 4 with 30 tools, 30 measurement techniques

4 BUs
Semiconductor, Advanced Packaging, Optoelectronics & Photonics

OUR HISTORY

1946
GAB
GERÄTEBAU-ANSTALT BALZERS

1960s
BALZERS

1980s
balzers

2000s
unaxis

2004
evatec process systems
Founded

2015
oerlikon systems
Acquisition

2022

THE EVATEC PLATFORM PORTFOLIO

BATCH

BAK

Family of evaporators from 0.5 to 2 metres with wide range of process sources and with “Autoload” options

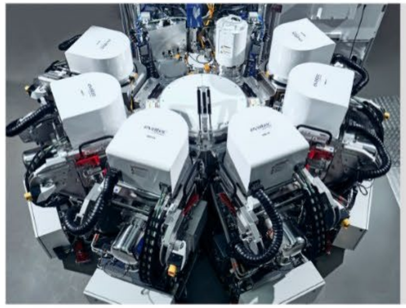
LLS EVO II

Vertical sputter for metals, dielectrics, and magnetic films

MSP 1232

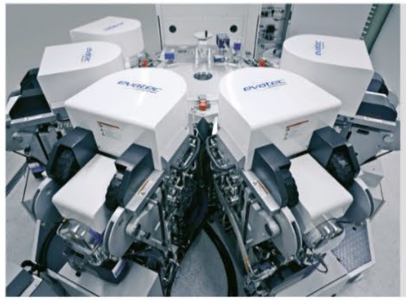
Batch sputter system for mass production of high precision optical stacks

CLUSTER



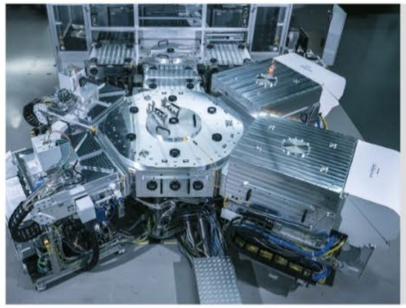
CLUSTERLINE® 200

200mm cluster platform with configuration options for single substrate or batch processing



CLUSTERLINE® 300

300mm cluster platform with configuration options for single wafer or dynamic processing in a batch module



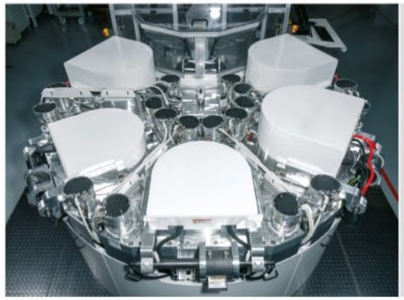
CLUSTERLINE® 600

FOPLP & IC substrate manufacturing on a cluster tool for panel handling up to 650x650mm

INLINE

HEXAGON

Your cost advantage in wafer level packaging processes



SOLARIS®

Family of platforms for fully automated high speed inline sputtering in single substrate chambers

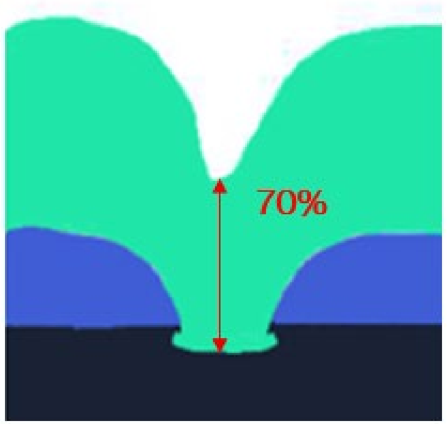
The design of vacuum processing machines require simulations in very wide technological fields for the optimization of components, like:

- Magnetic fields in process chambers, for sputtering, etching, etc.
- Molecular flow in vacuum setups
- Heating of components and substrates, optimization of heat-up rates and uniformity
- Radiative heat exchange
- Efficient cooling of components by liquids, intermediate gases or radiation
- Mechanical stability of process components under pressure and with heat loads
- Electrical field distribution of microwave and RF field in cavities
- Plasma

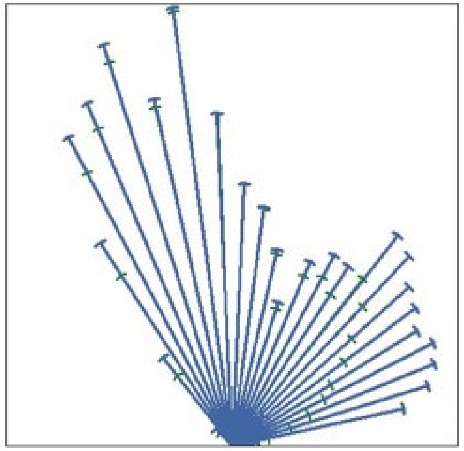
Also used:

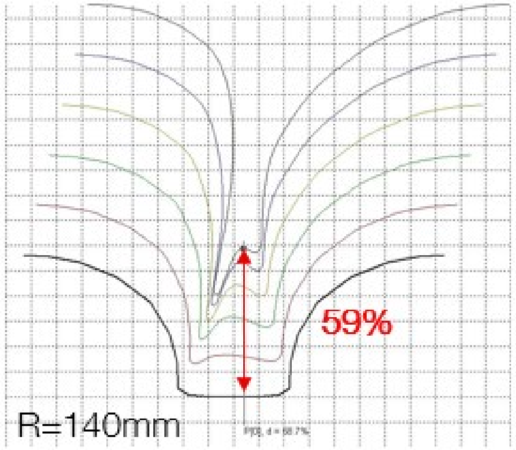
- CAD Import
- Optimization Module

Self made Software for deposition in substrate features

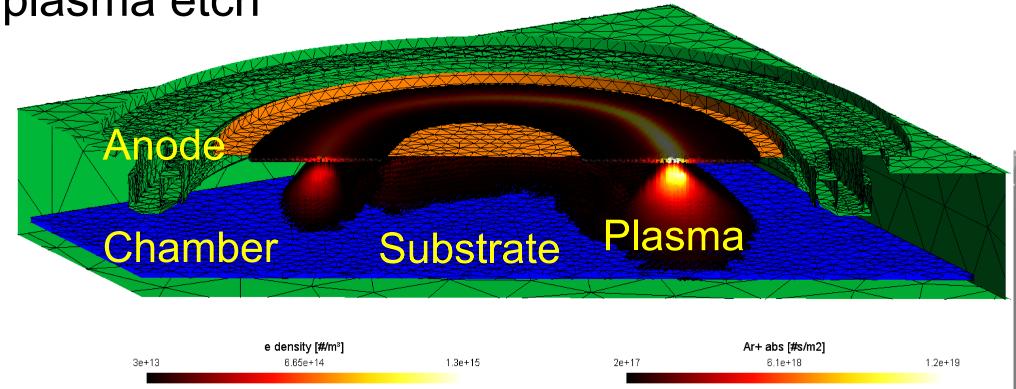


Angular distribution of incoming atoms

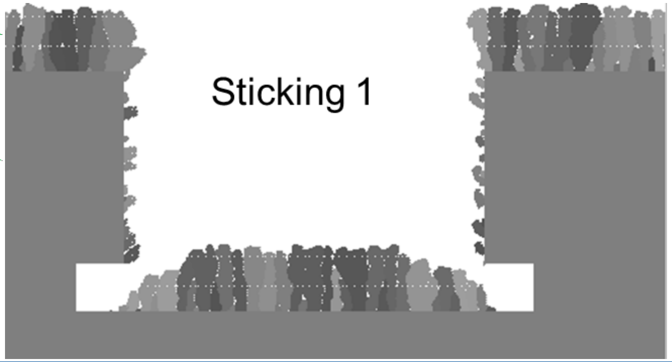


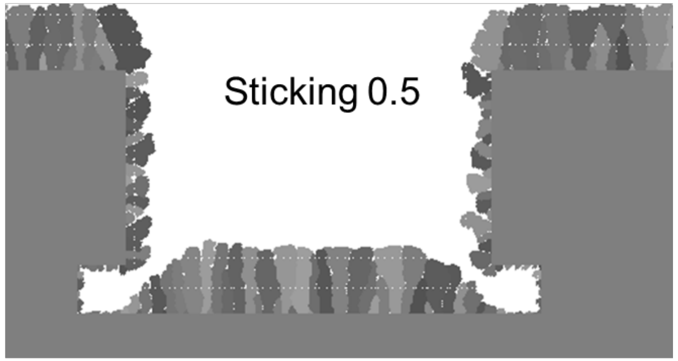


3D Particle in Cell for magnetron sputtering or plasma etch



Monte Carlo software for simulation on substrate features incl. collisions, sticking coefficients and surface diffusion

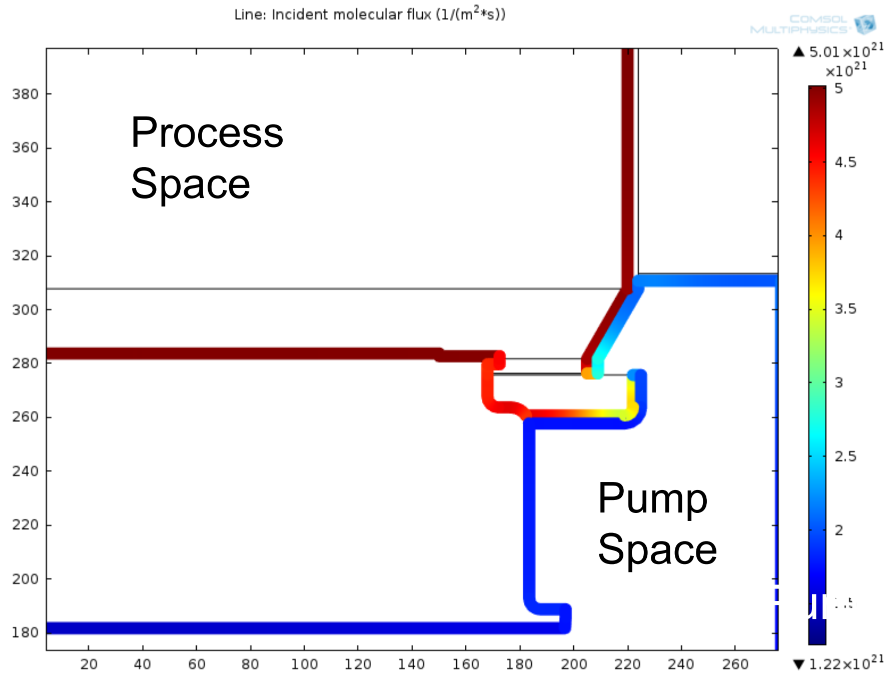


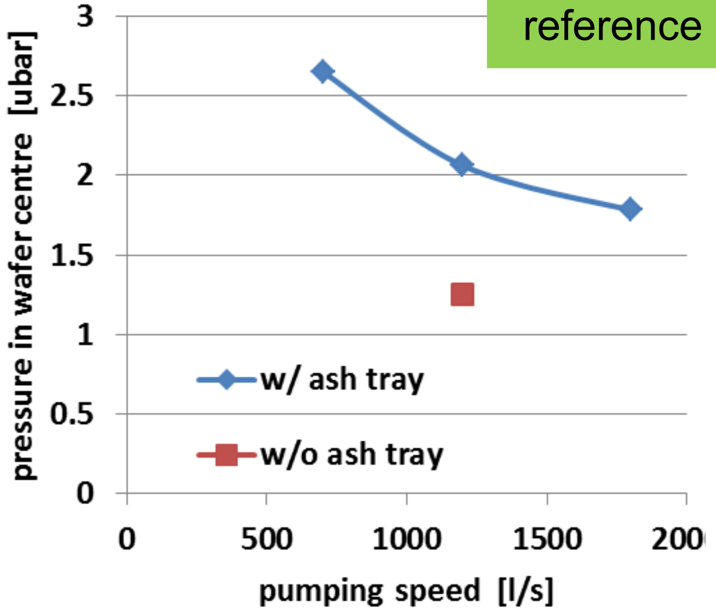


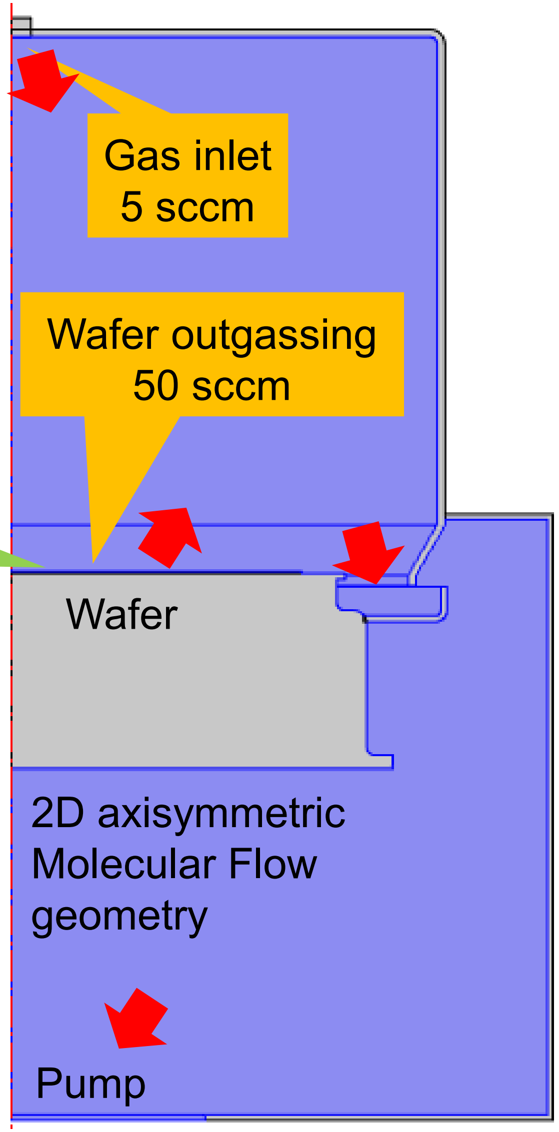
Shields are removable parts inside the process chamber.
They need to be optimized to:

a) Protect inner chamber side walls (without shields)
b) Allow a maximum pumping speed since the wafer is outgassing organics and water vapor

The limit of the applicable pumping speed is shown.
The measured pumping efficiency correlates well with the calculation.



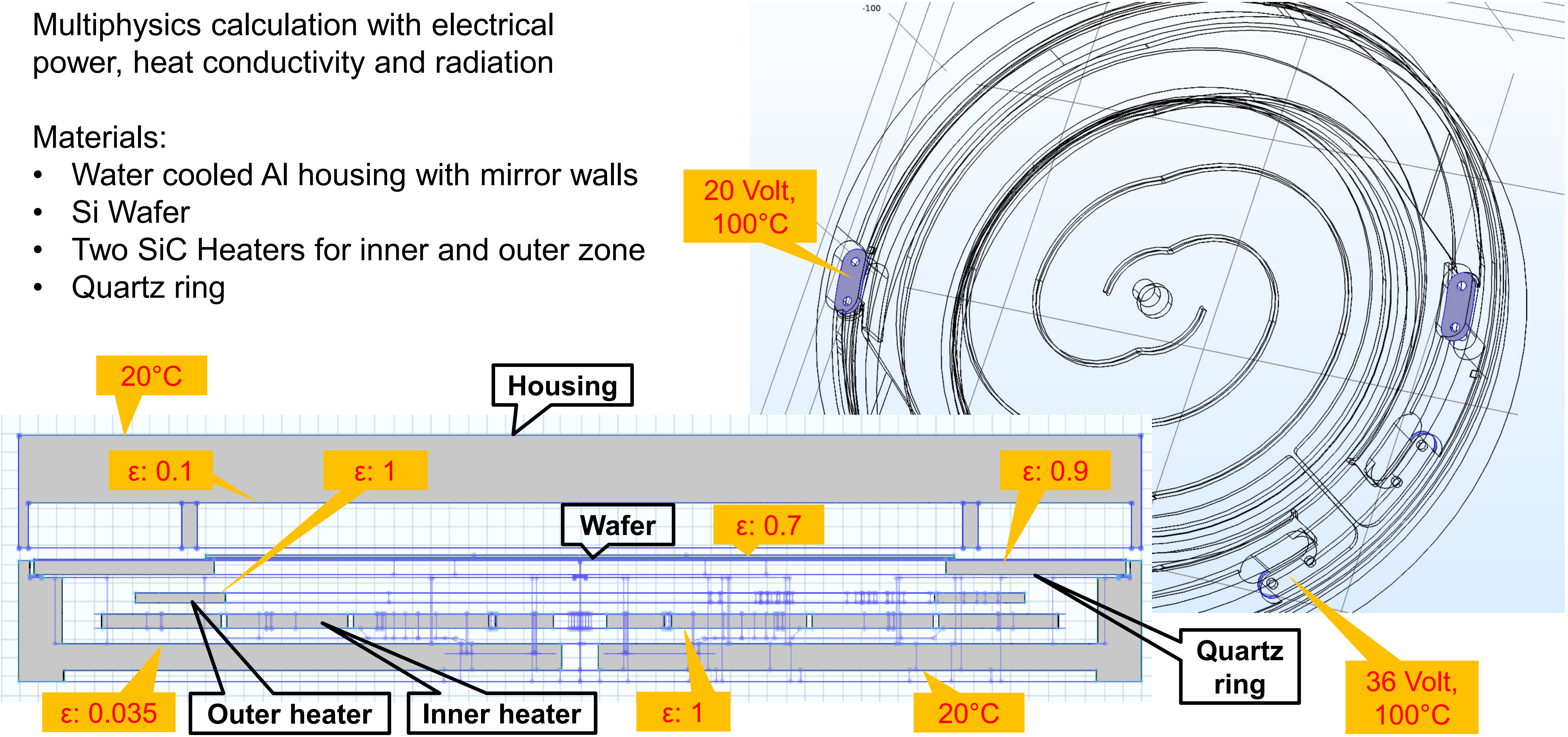




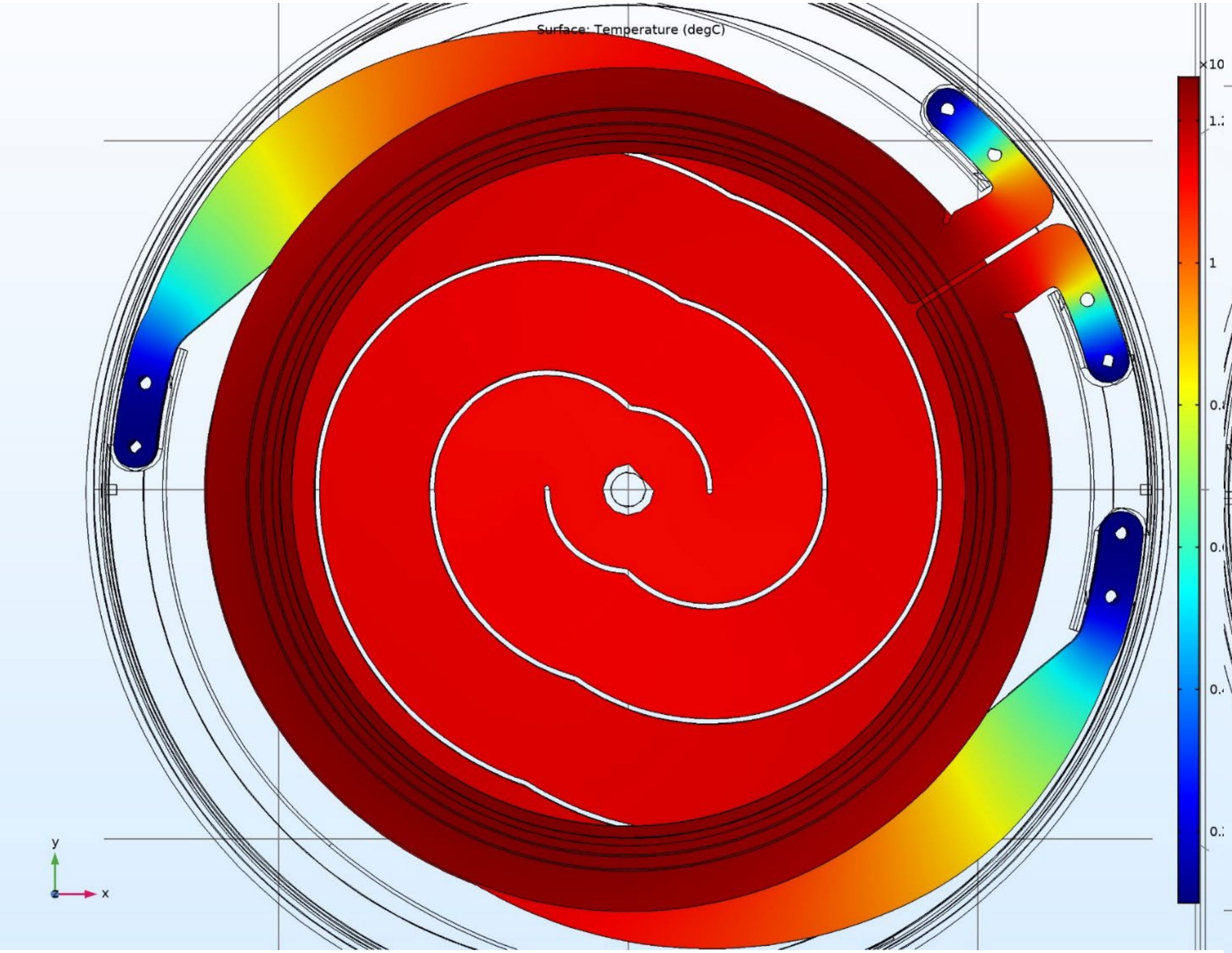
Multiphysics calculation with electrical power, heat conductivity and radiation

Materials:

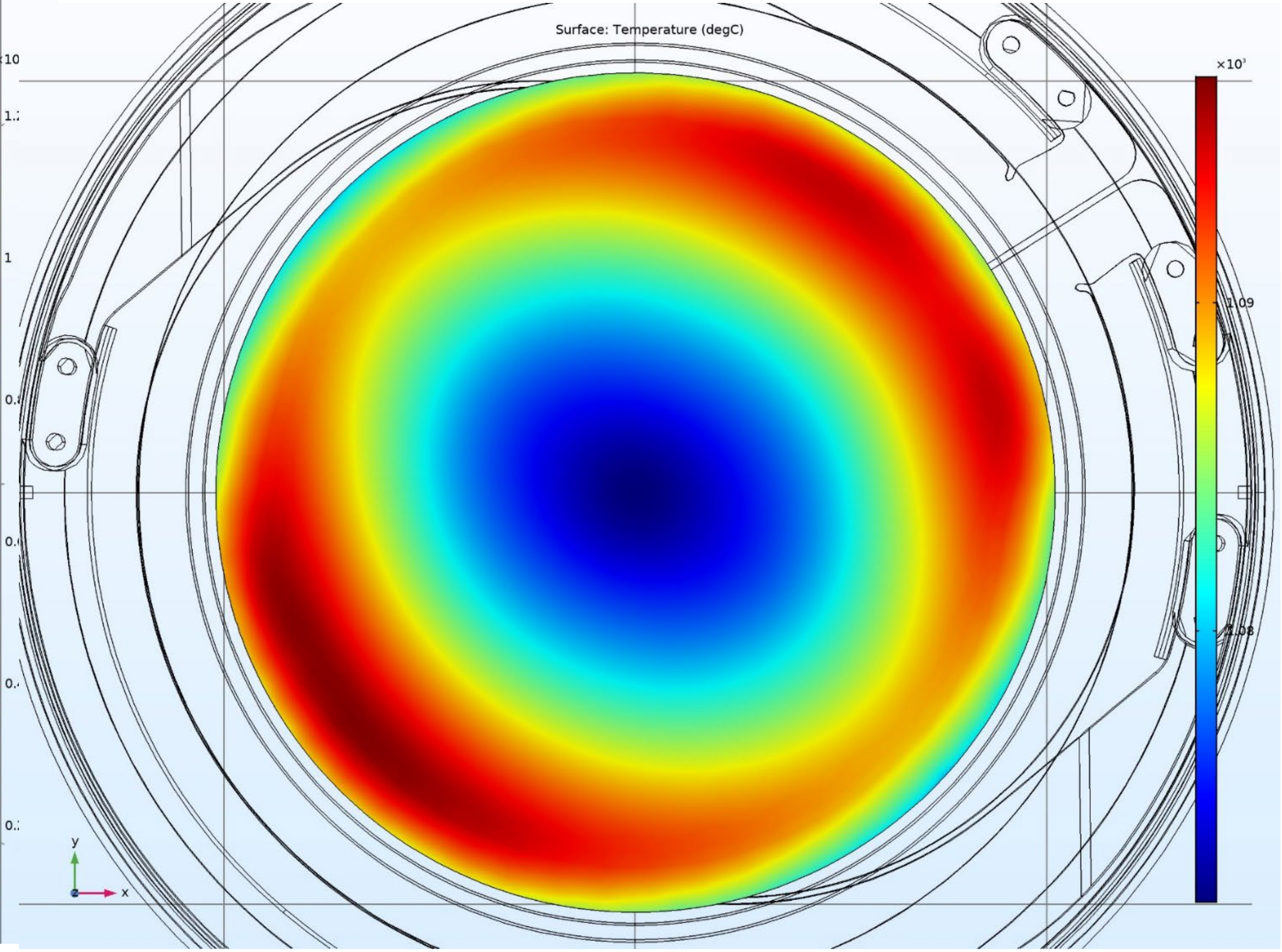
- Water cooled Al housing with mirror walls
- Si Wafer
- Two SiC Heaters for inner and outer zone
- Quartz ring



Temperature of the 2 SiC-heater circuits



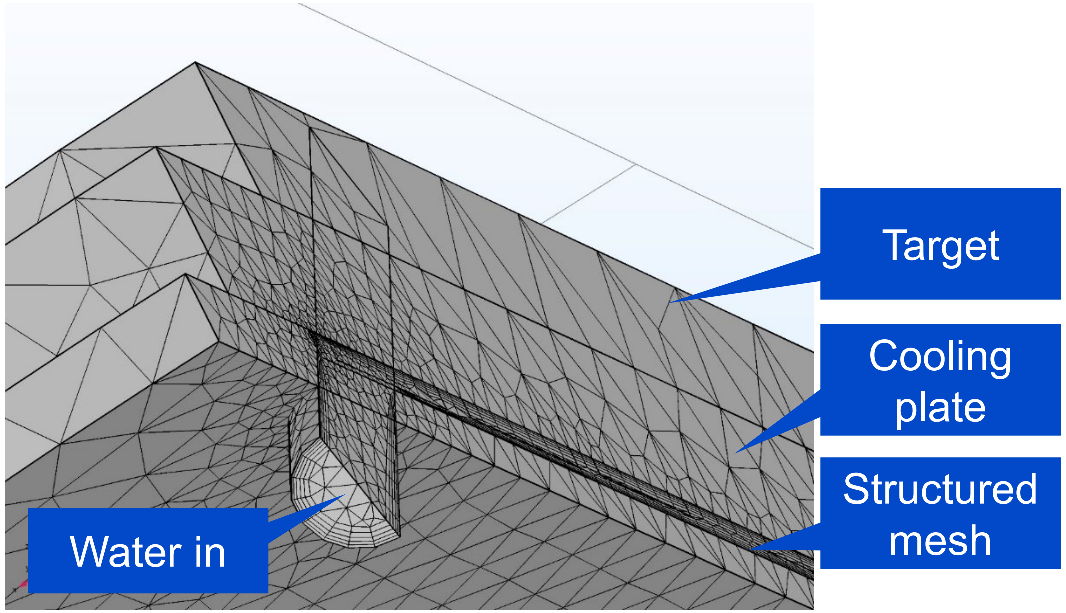
Wafer temperature: 1084±13°C

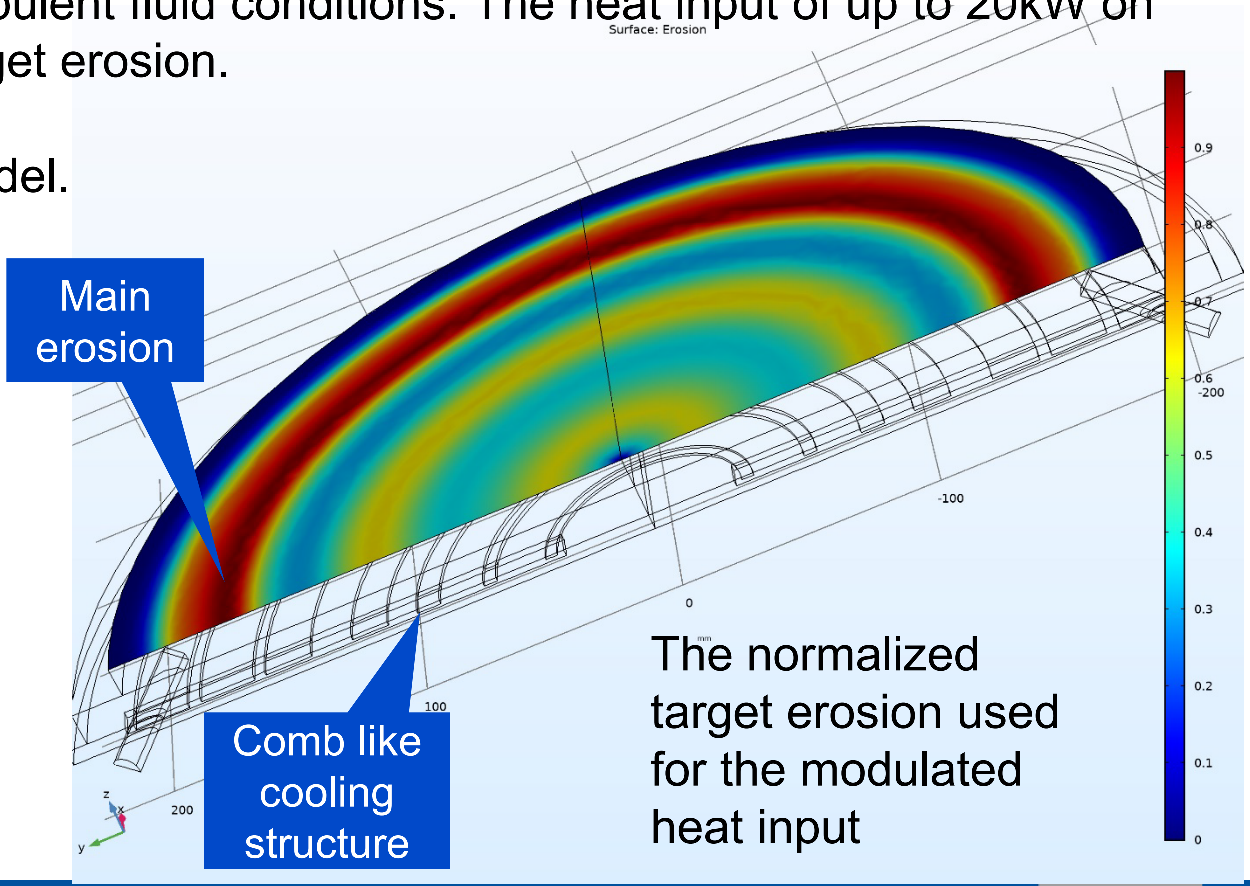


In sputtering very high heat loads of up to 320’000 W/m2 on the target must be cooled efficiently by a cooling structure as flat as possible, since magnets have to be applied at the back side of the cooling plate as close as possible. Also, the cooling plate must withstand water and atmospheric pressure.

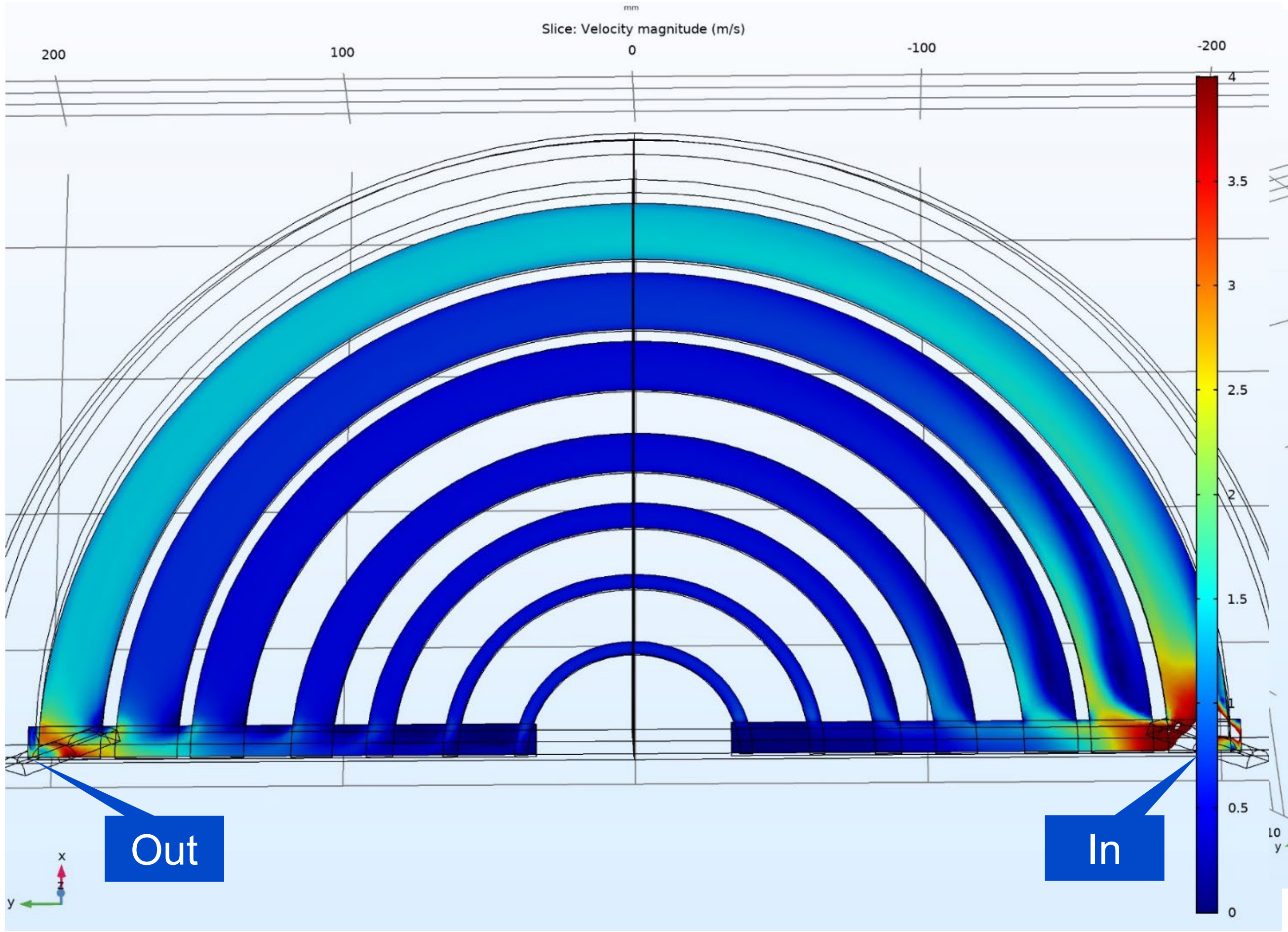
A half-model of a cooling plate is modelled with turbulent fluid conditions. The heat input of up to 20kW on the half-model is modulated with respect to the target erosion.

The heat drain is 10l/min water flow on the half-model.





Water velocity in the whole model



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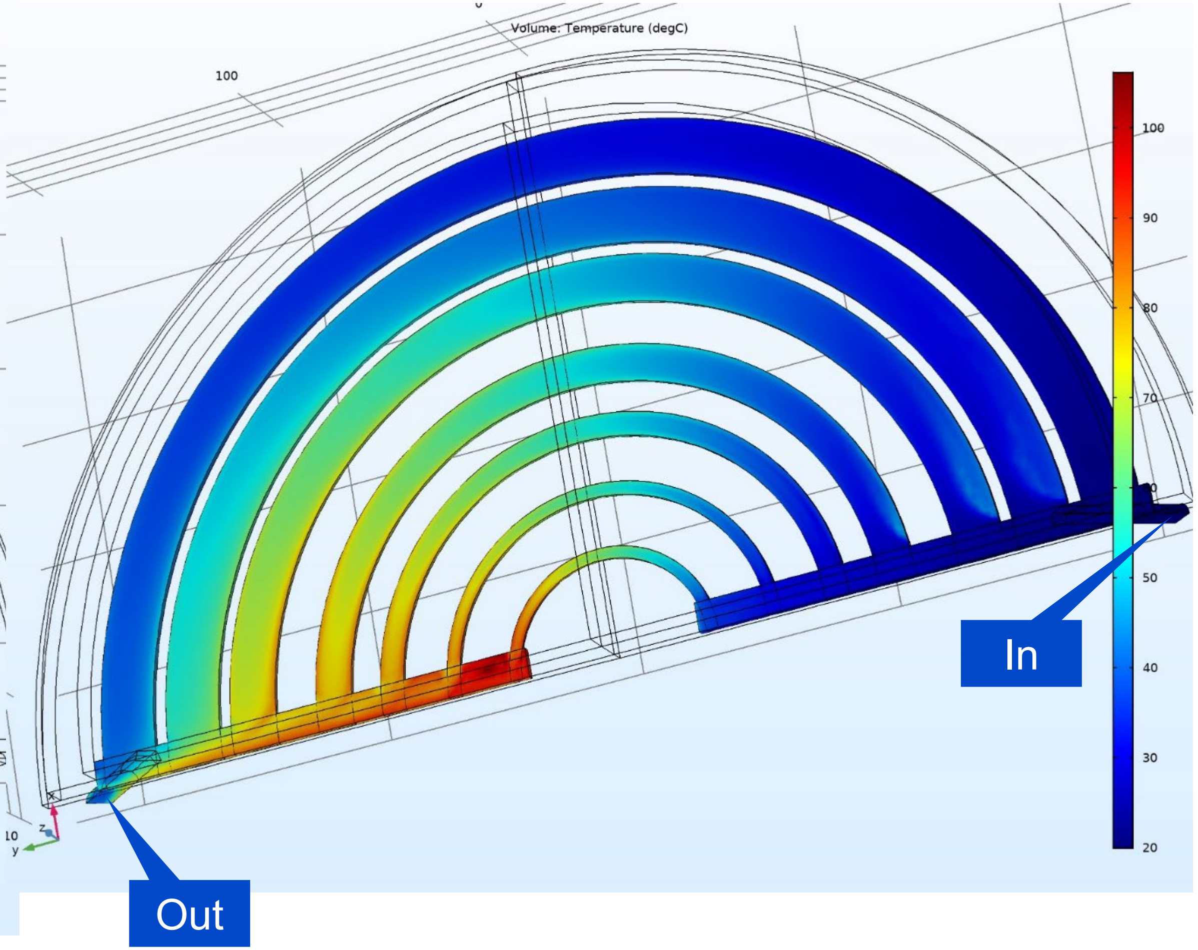
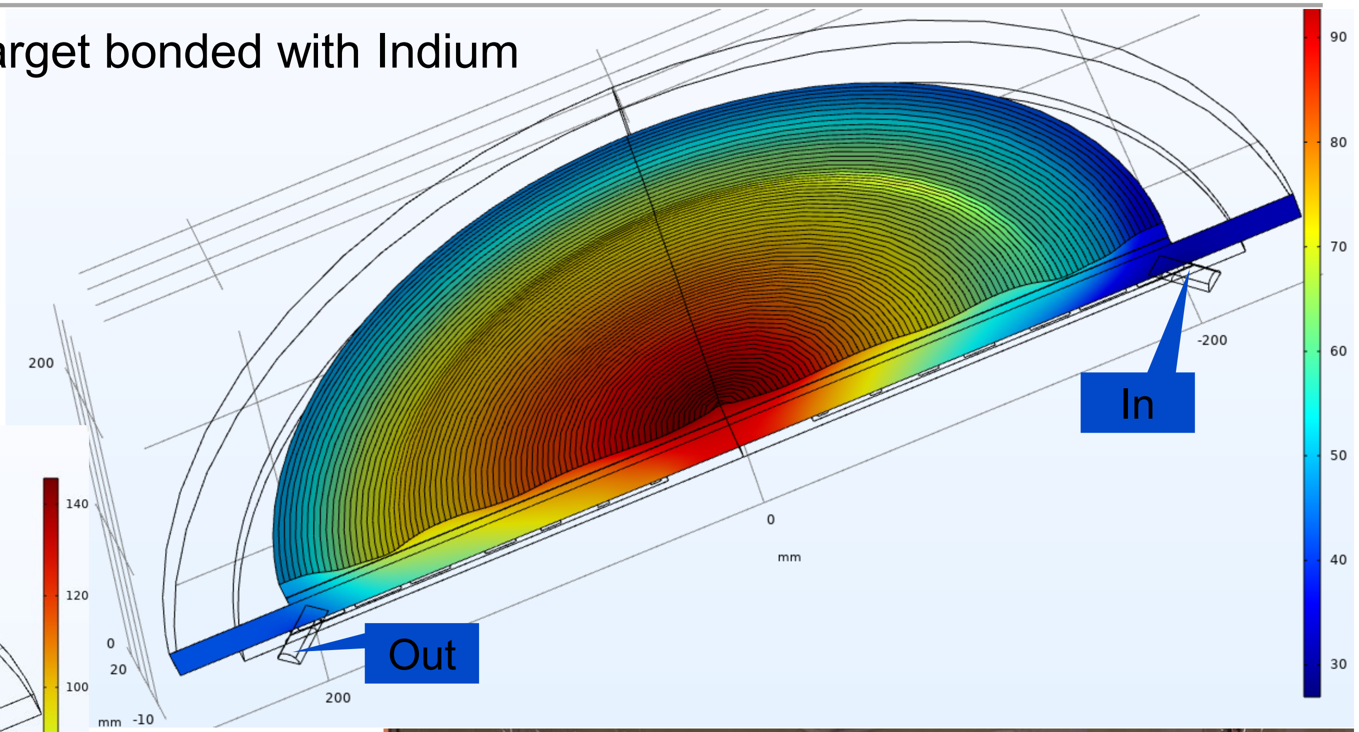
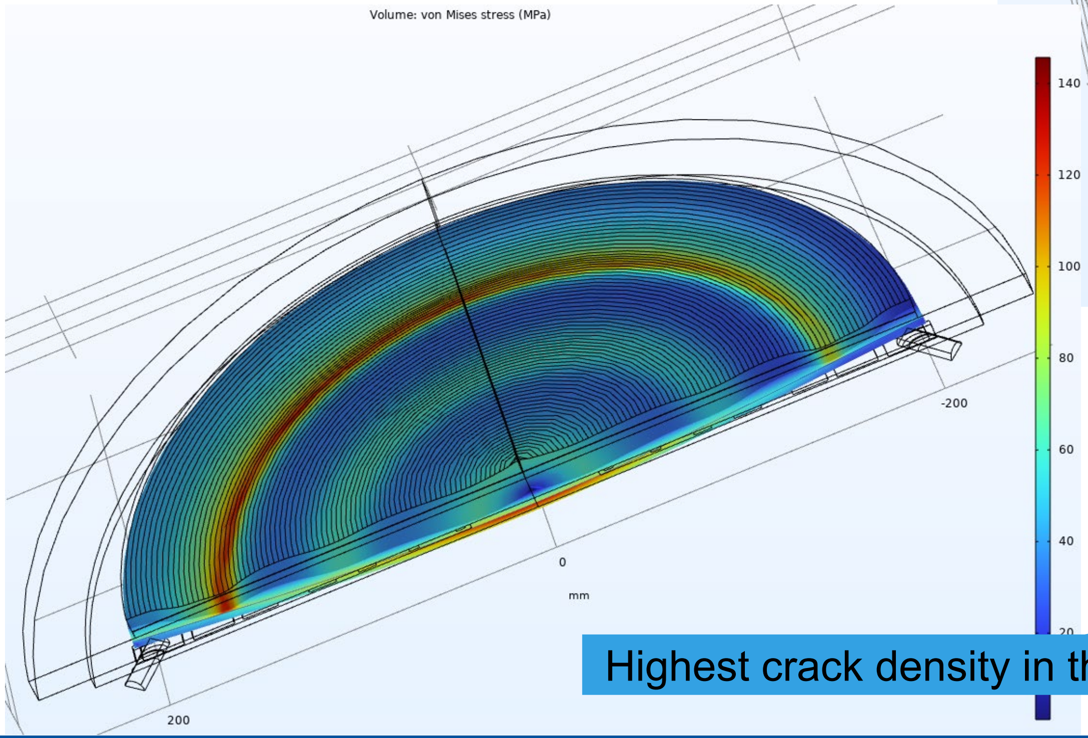
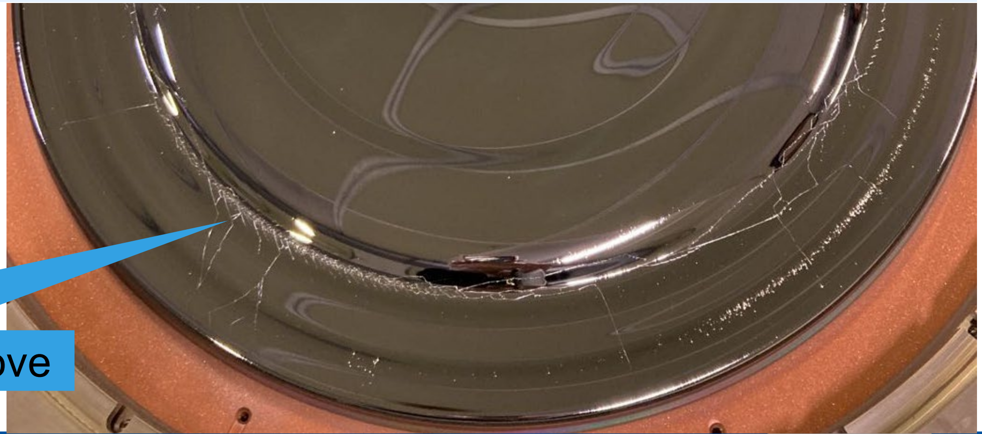


Temperature distribution of an eroded Silicon target bonded with Indium



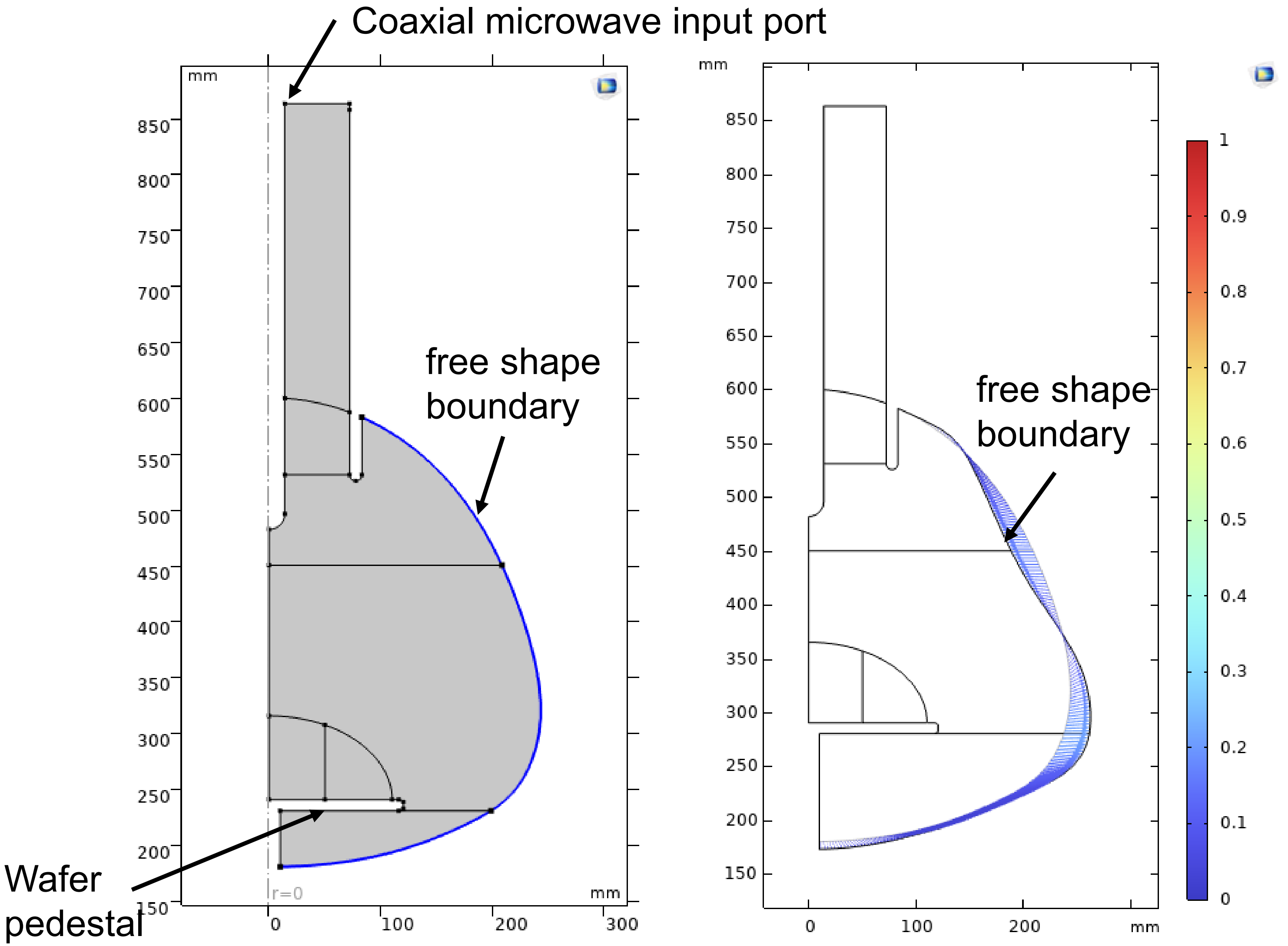
Stress distribution (Von Mises) of an eroded Si target due to thermal expansion, showing the highest stress in the deep erosion groove, where most of the cracks happened.





Highest crack density in the erosion groove

- Simulation of an axisymmetric microwave cavity
- Microwave input through coaxial port at the top of the cavity
- Optimization of cavity using the Comsol shape optimization feature
- Optimization targets:
  - Focusing of field intensity in an area above the wafer pedestal
  - Uniformity of field above wafer pedestal
  - Small cavity volume



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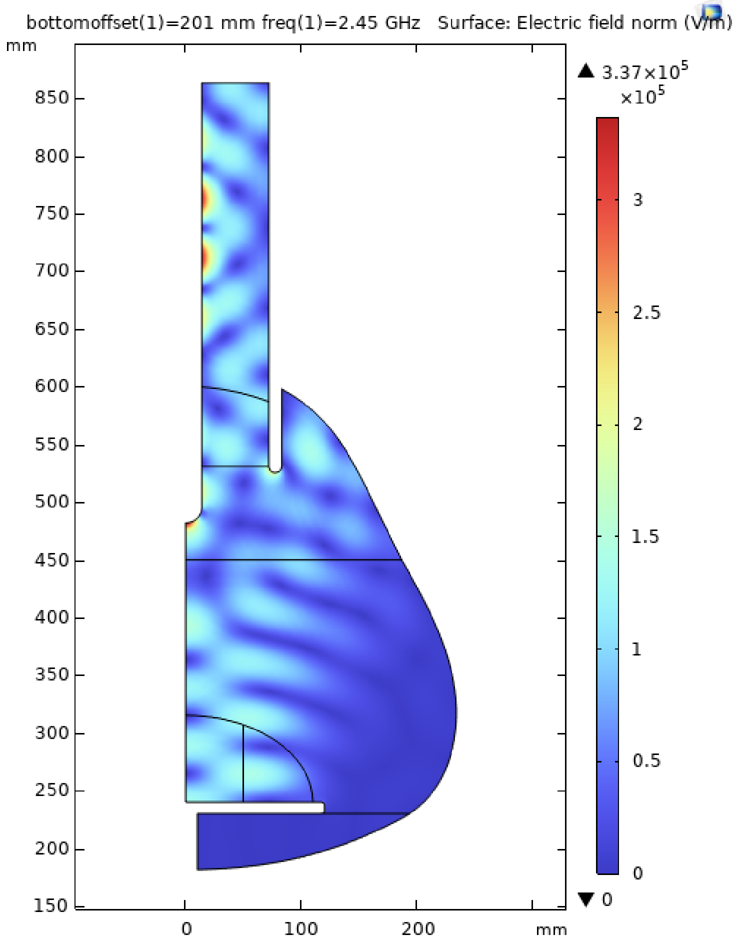
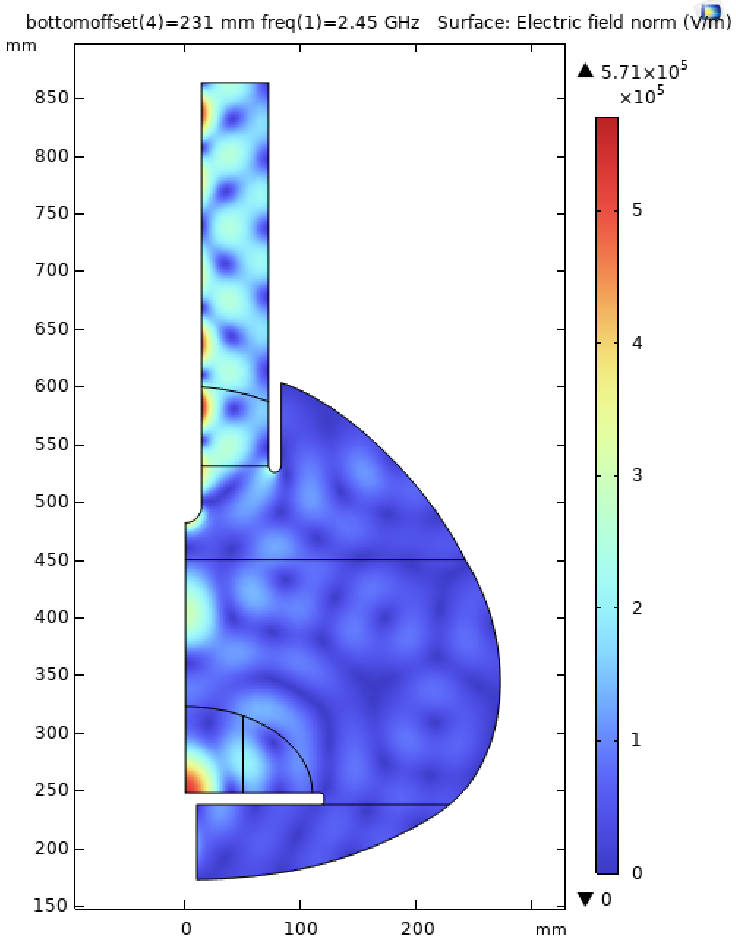
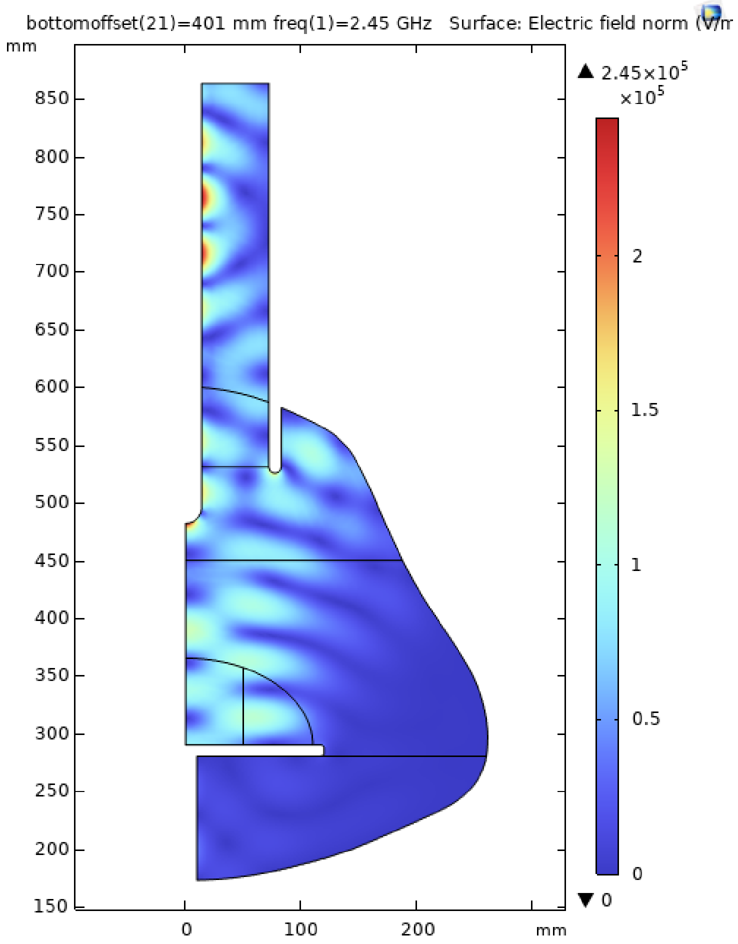
SHAPE OPTIMIZATION OF A MICROWAVE CAVITY

Electrical field distributions for different cavity shapes







Outlook: Combination with plasma simulations in Comsol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Let’s shape the future together