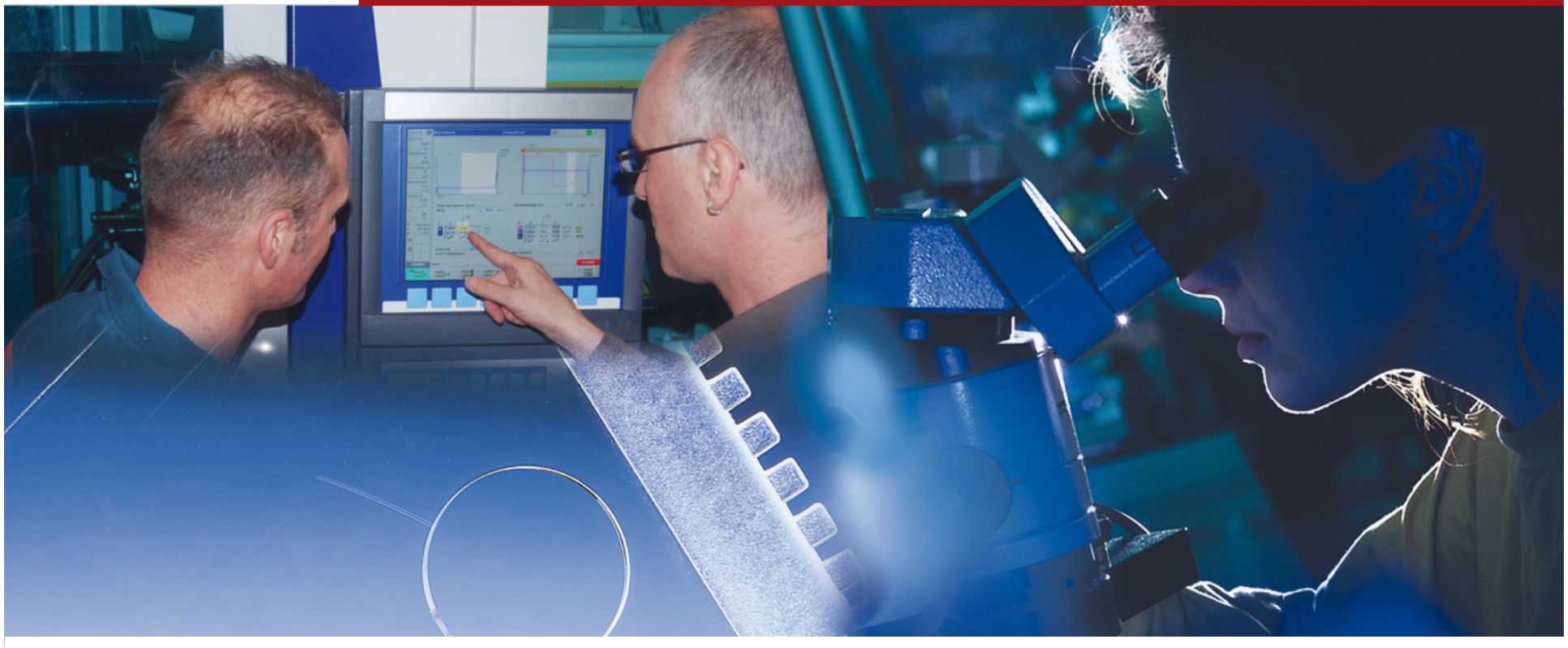
COMSOL CONFERENCE 2018 LAUSANNE

KUNSTSTOFF INSTITUT LÜDENSCHEID

Gemeinnützige KIMW Forschungs-GmbH



Simulation of CVD process in a reactor

Presenting coating on a demonstrator within the reactor

Comsol conference 2018, Lausanne, Switzerland

CVD reactor at KIMW

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Main and
Ring-nozzle Inlets

Outlet

Hollow demonstrator calculation

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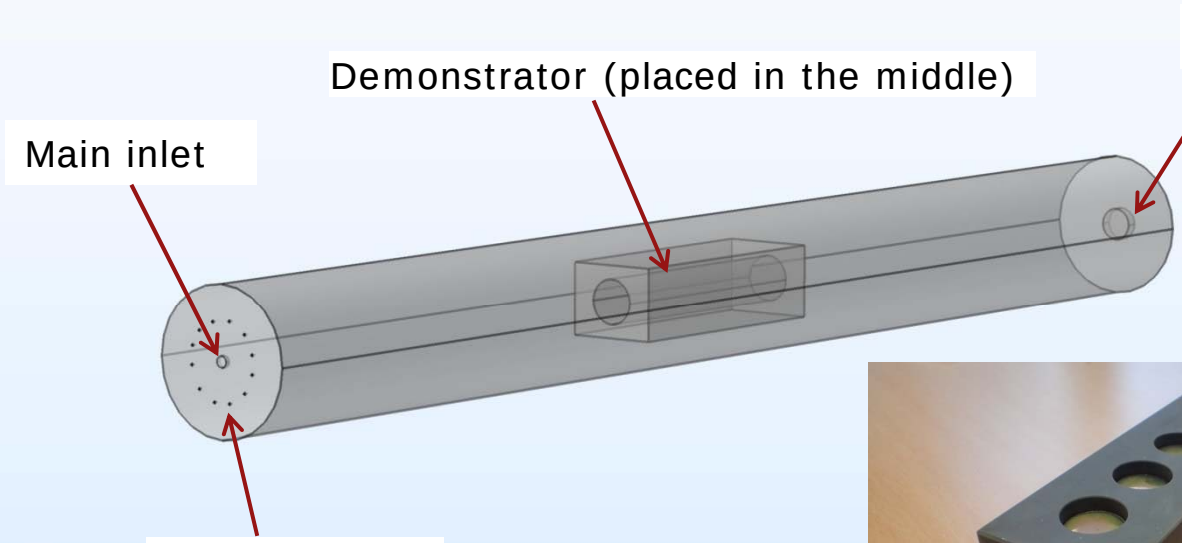
- Comsol Geometry

SCCM=450(cm³/sec), T=385(°C), P= 500(Pa)



Real Demonstrator

Equations considered for the computation

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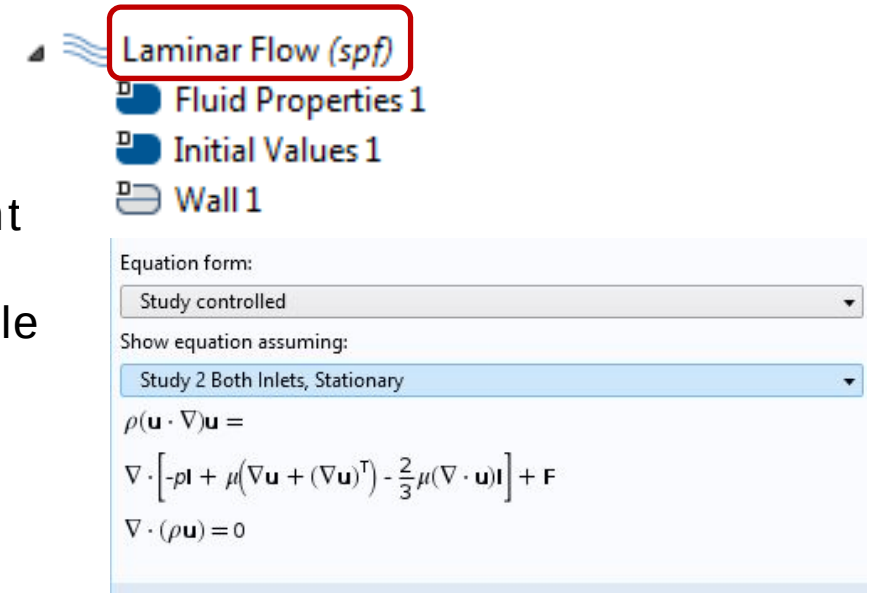
- Laminar Flow
  - Solves Navier-Stokes and continuity equations
    - Only practical for low Re numbers, i.e. Re<2000
    - Stationary or time dependent
    - Incompressible, weakly compressible, or compressible flow (Ma < 0.3)



Navier-Stokes, continuity and equation of state

$$\rho\left(\frac{\partial \boldsymbol{u}}{\partial t}+(\boldsymbol{u}\cdot\boldsymbol{\nabla})\boldsymbol{u}\right)=-\boldsymbol{\nabla}p+\boldsymbol{\nabla}\cdot\left[\mu\left(\boldsymbol{\nabla u}+(\boldsymbol{\nabla u})^{\mathrm{T}}-\frac{2}{3}(\boldsymbol{\nabla}\cdot\boldsymbol{u})\mathbf{I}\right)\right]+\boldsymbol{F}$$

$$\frac{\partial \rho}{\partial t}+\boldsymbol{\nabla}\cdot(\rho\boldsymbol{u})=0$$

$$\rho=\rho(p,T)$$

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CASE 1: Without plates

FLOW THROUGH THE REACTOR

Hollow demonstrator calculation

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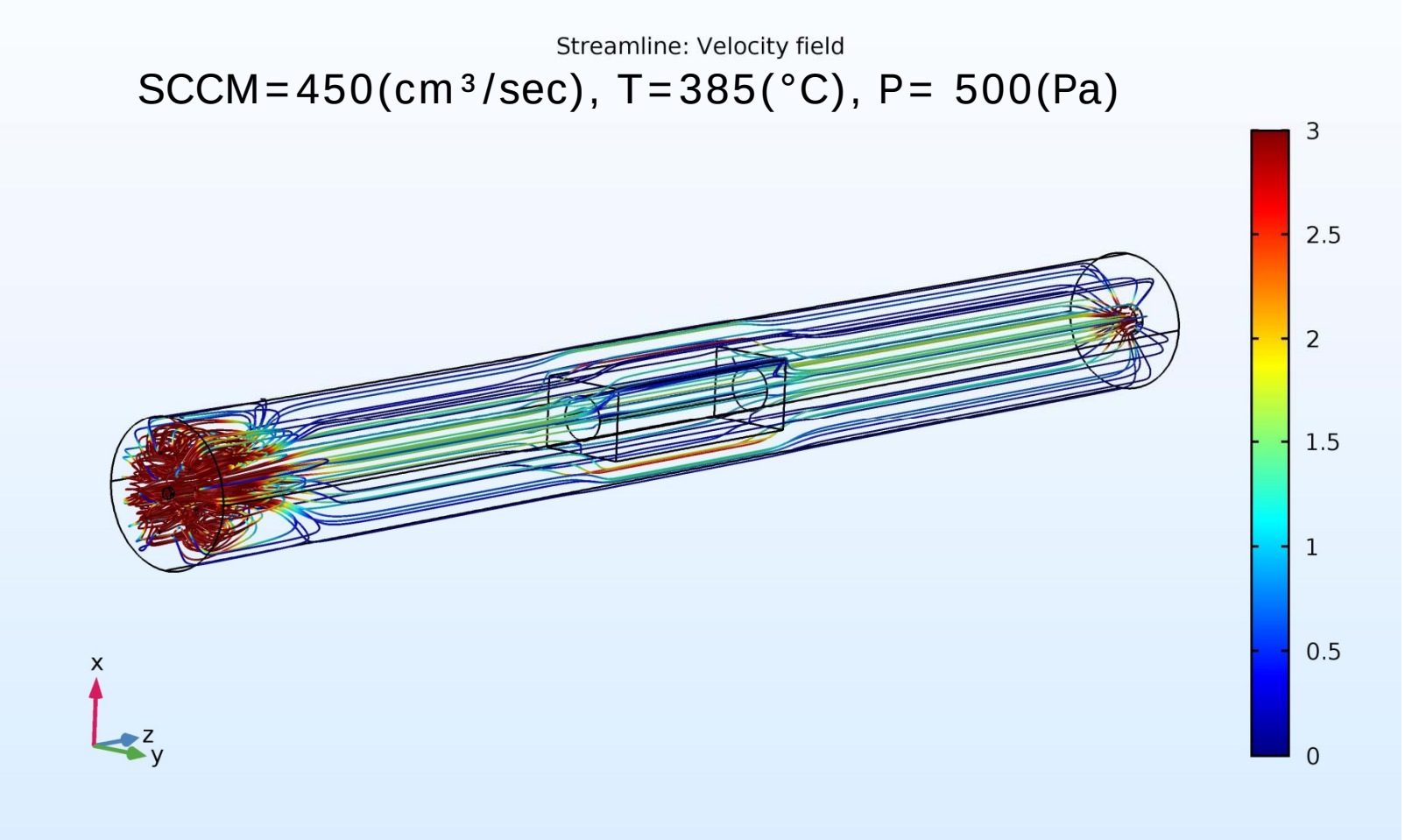
- Velocity Streamlines



Hollow demonstrator calculation

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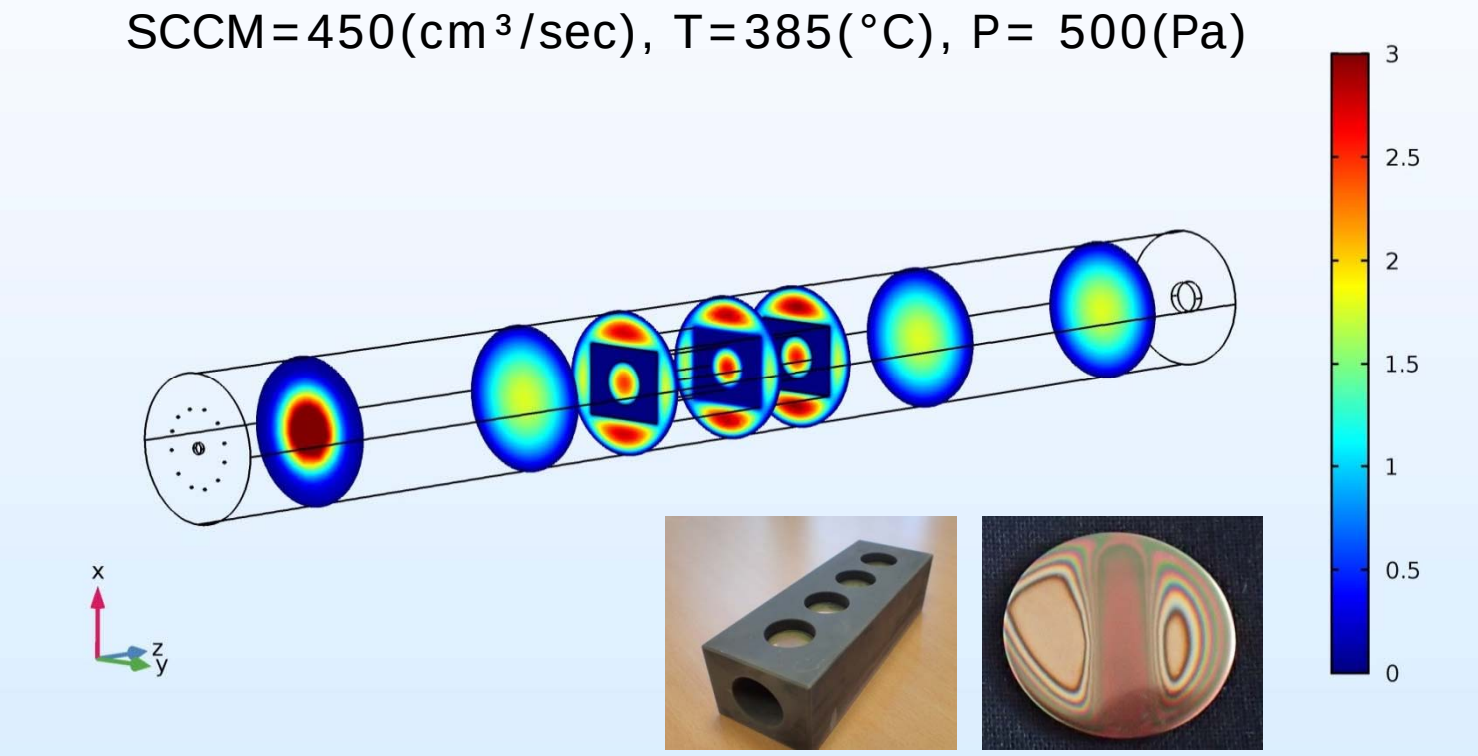
- Velocity Cut-section



- Higher velocity can be observed in the front section of the reactor because of the swirls.

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CASE 2: With plates

REDUCTION OF THE FLOW PATH

Hollow demonstrator calculation

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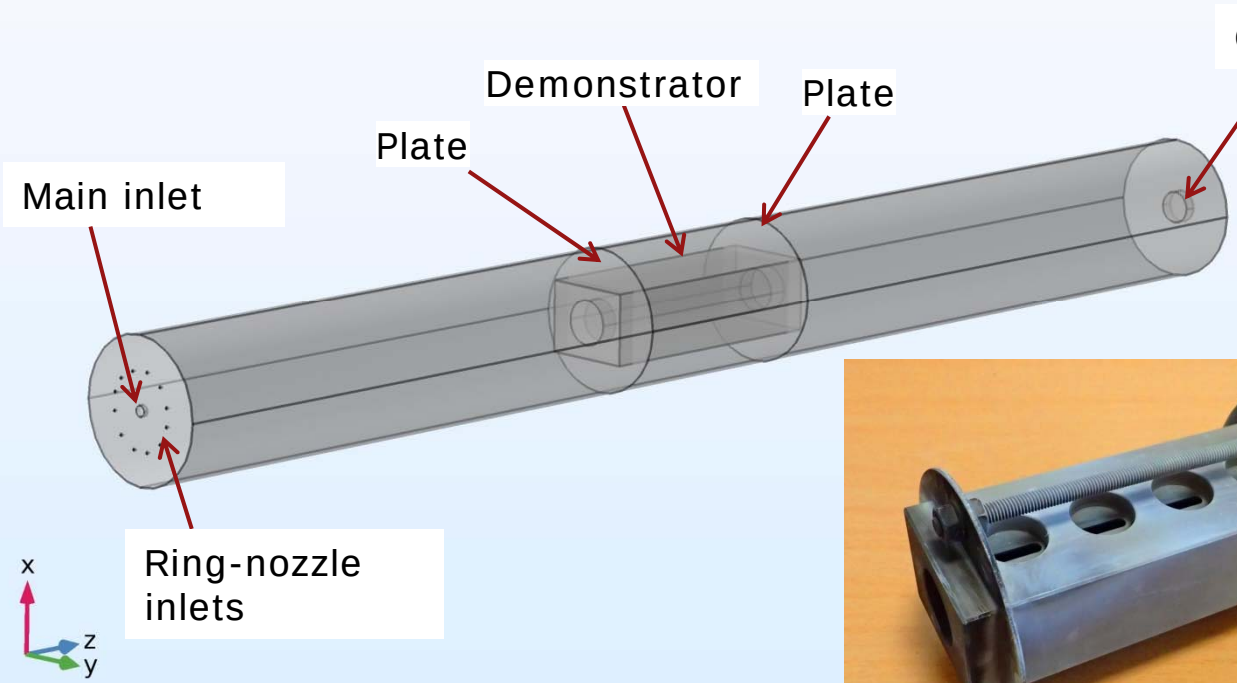
- Comsol Geometry

SCCM=450(cm³/sec), T=385(°C), P= 500(Pa)



Real Demonstrator

Hollow demonstrator calculation

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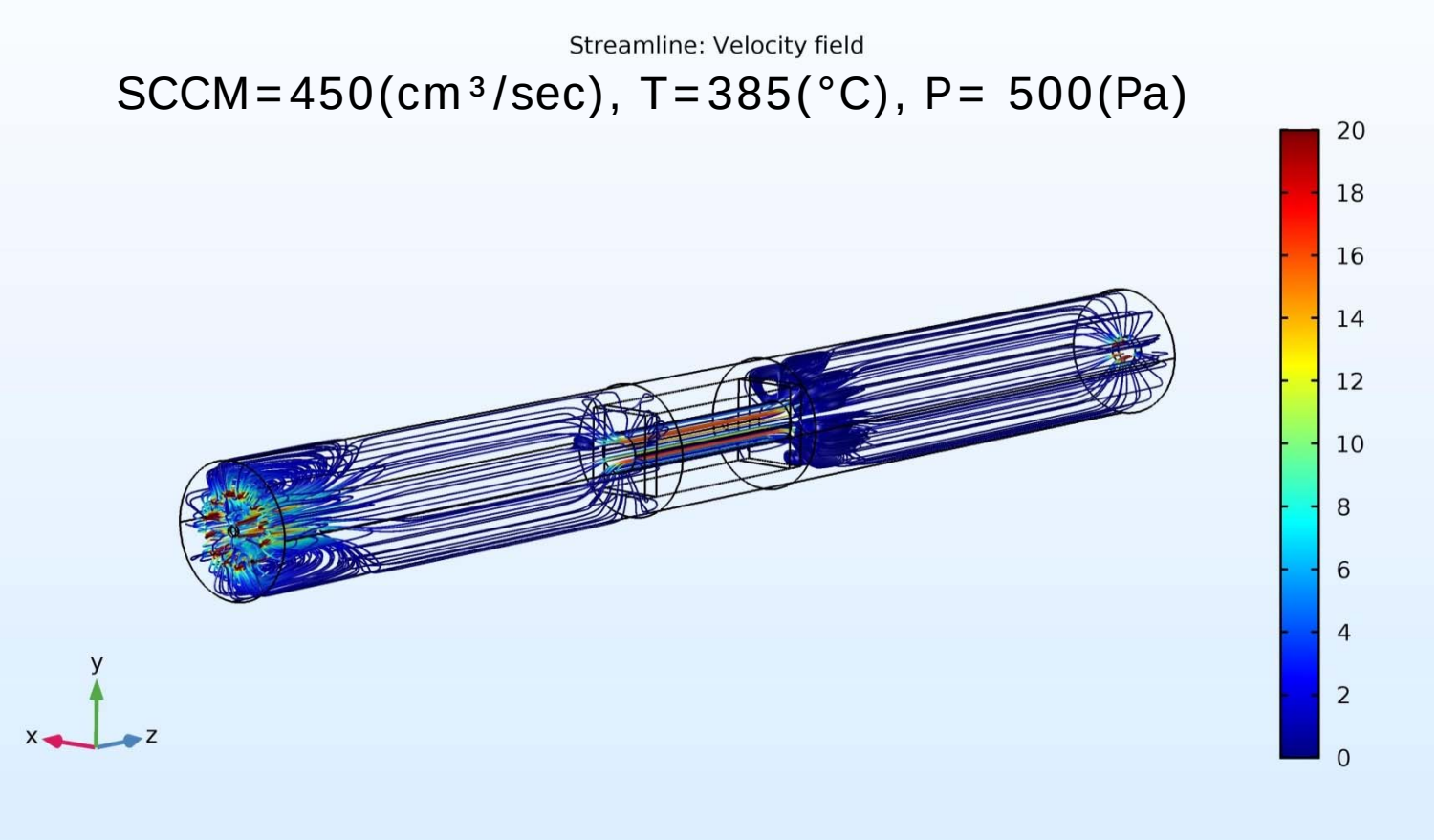
- Velocity Streamlines



Hollow demonstrator calculation

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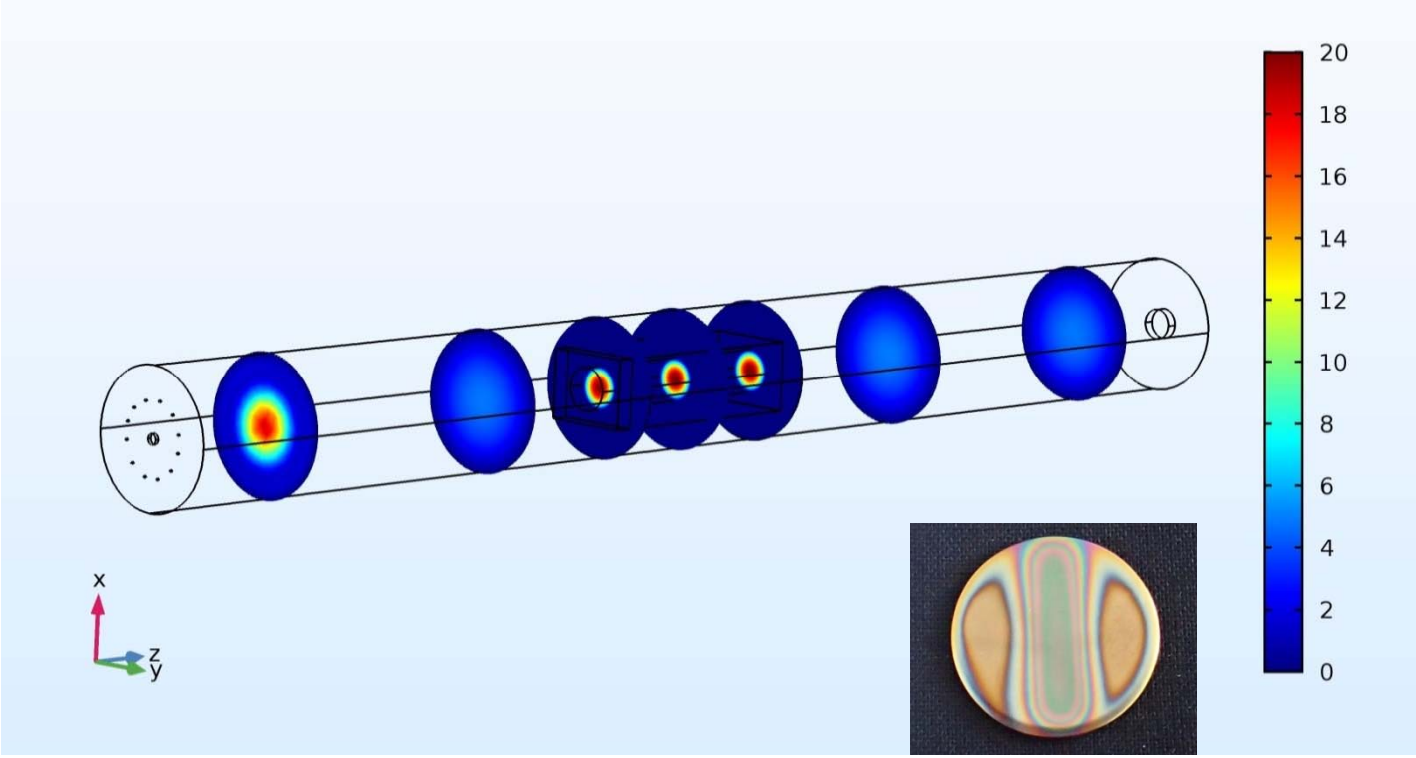
- Velocity Cut-section



- Higher velocities can be observed in the front of reactor due to swirls caused by turbulence.
- Due to the volume reduction with the help of plates, one can also clearly observe higher gas velocities within the demonstrator.

Hollow demonstrator calculation

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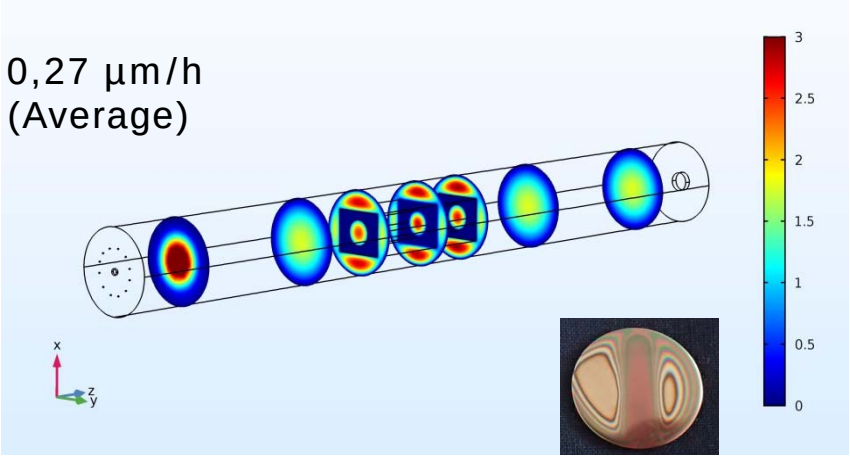
- Comparision of velocity cut-sections within reactor

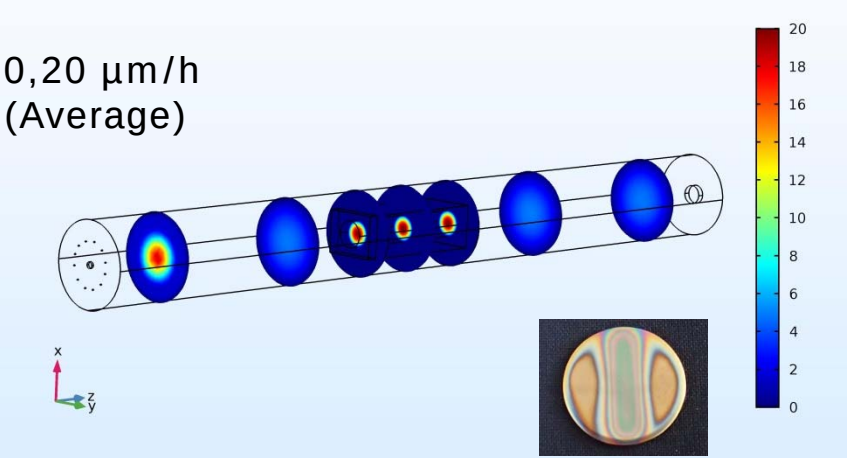
SCCM = 450, P= 500Pa, T=385°C

Without plates



SCCM = 450, P= 500Pa, T=385°C

With plates



- The simulation shows higher velocity values due to the volume reduction, so that in this case, less gas flow can be used.
- Hence an efficient, homogeneous coating could be achieved.

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REDUCED GAS FLOW THROUGH THE REACTOR

Hollow demonstrator calculation

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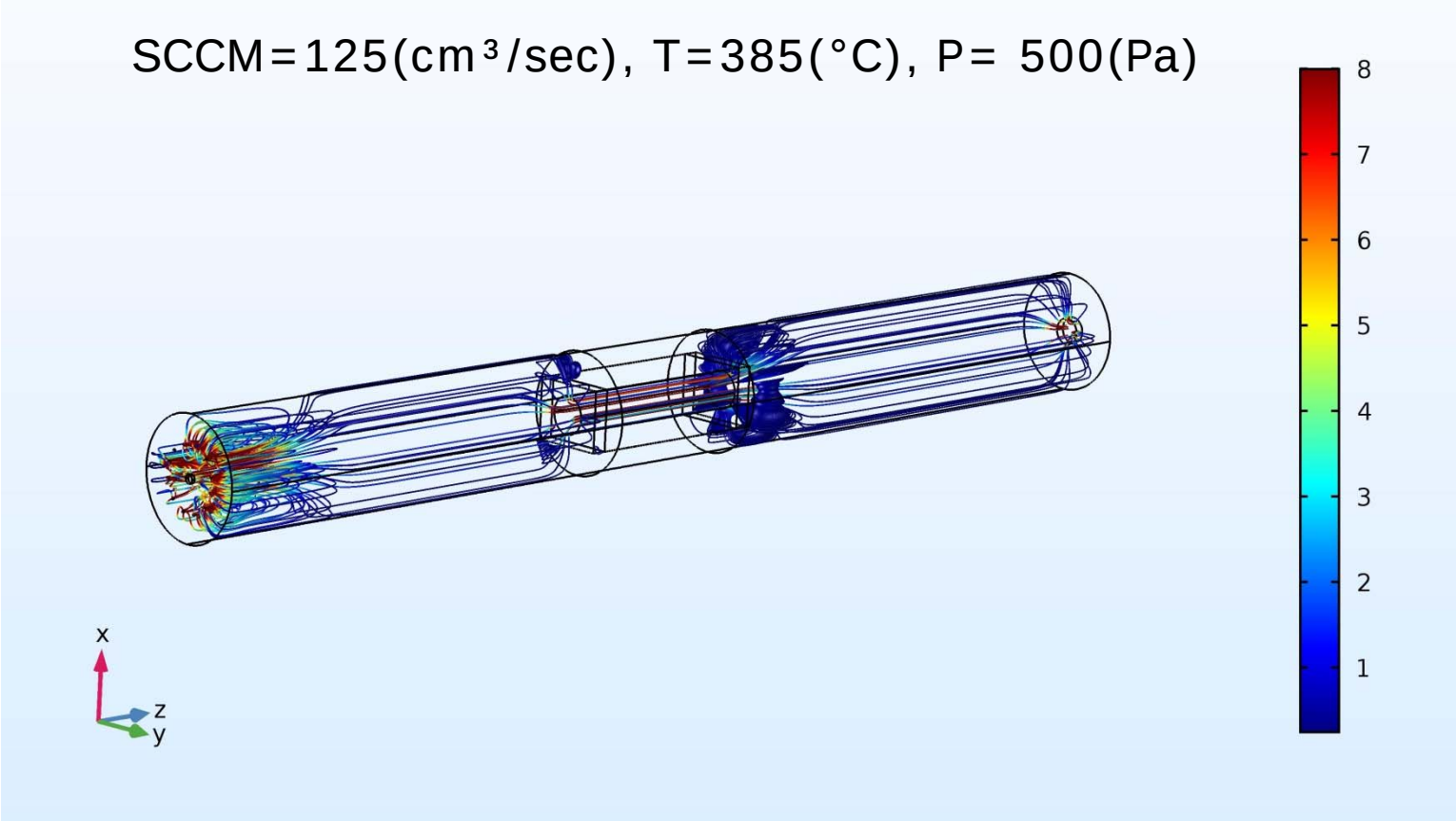
- Velocity Streamlines



Hollow demonstrator calculation

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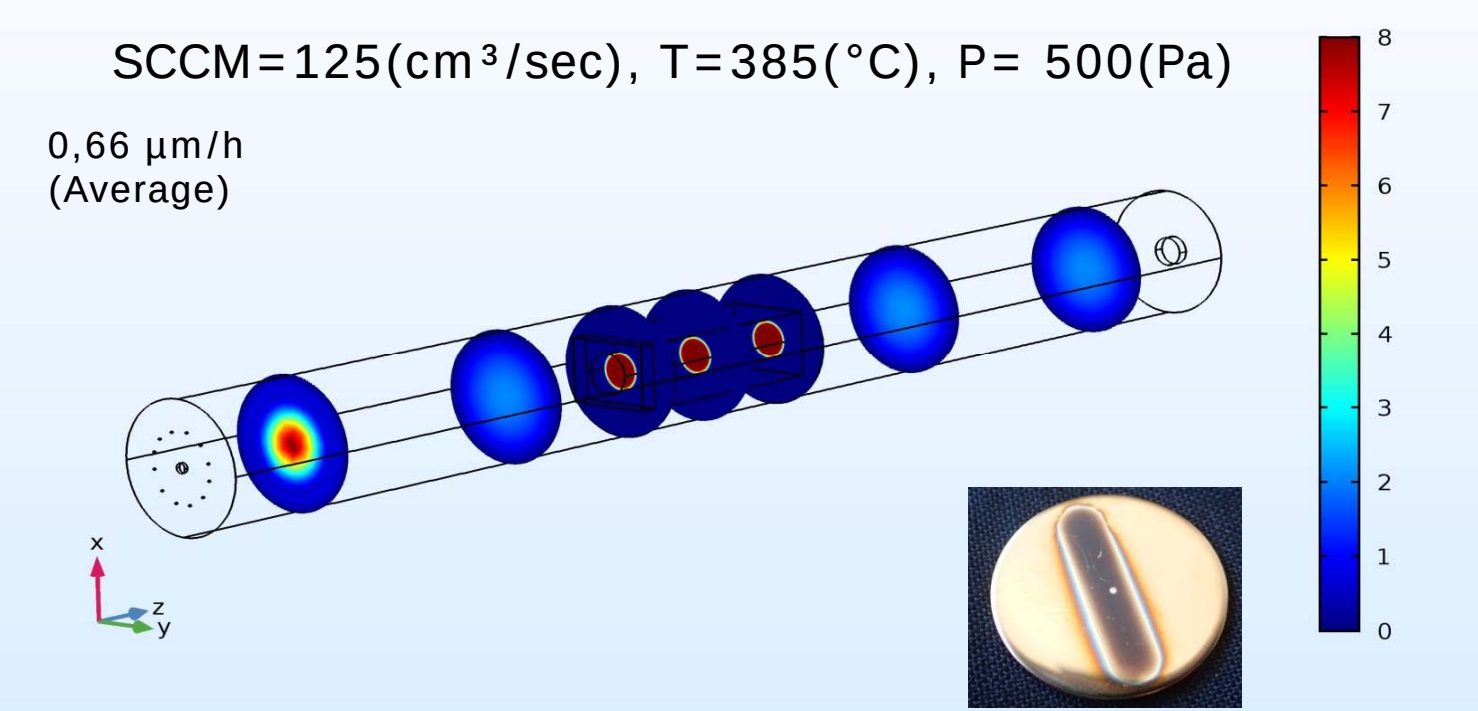
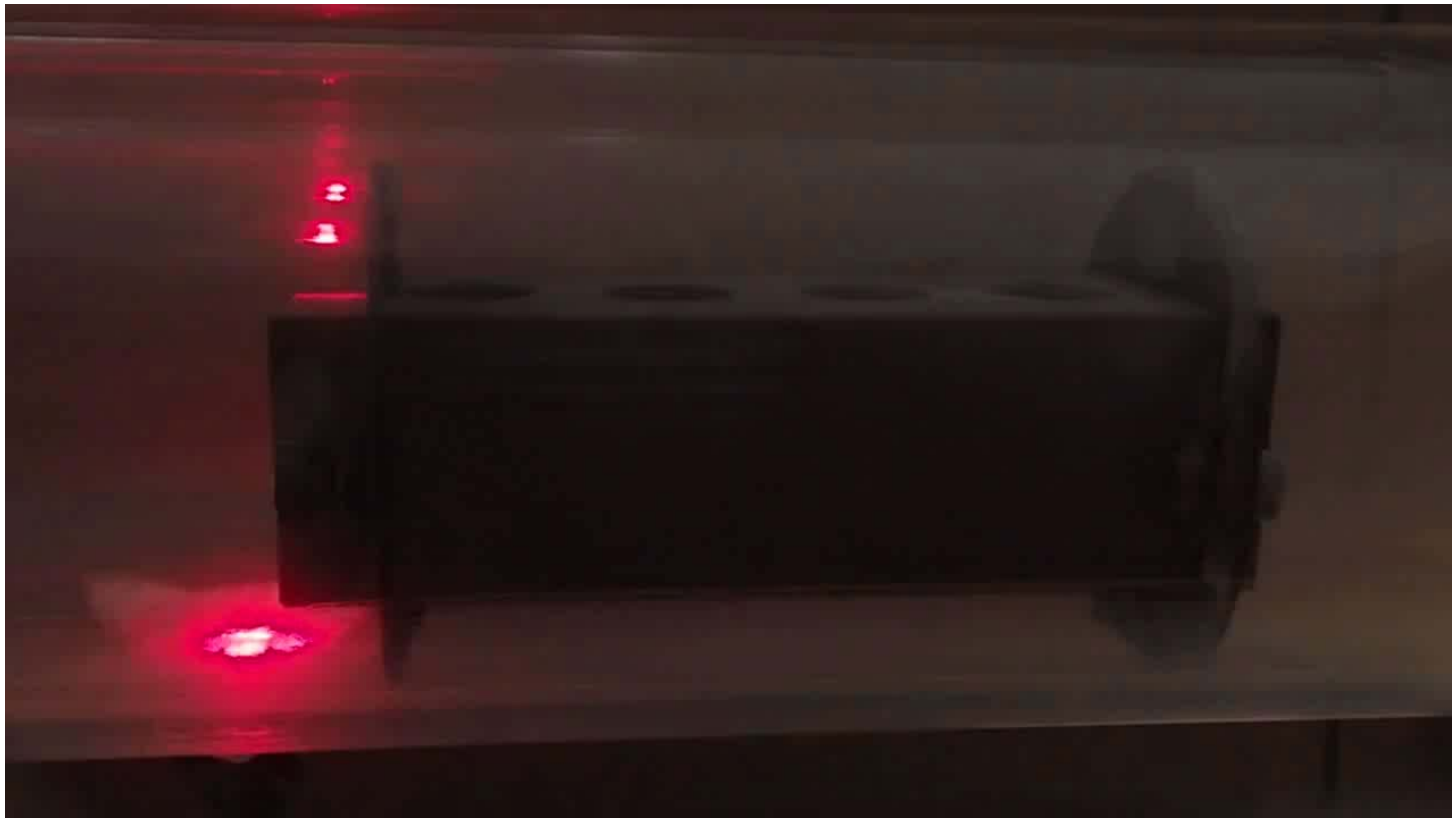
- Velocity Cut-section



- Reduced velocities are obtained from simulations with reduced SCCM.
- As the gas flow is at a slower rate a much higher coating growth rate can be obtained on the specimens.

Hollow demonstrator calculation

Hollow demonstrator calculation



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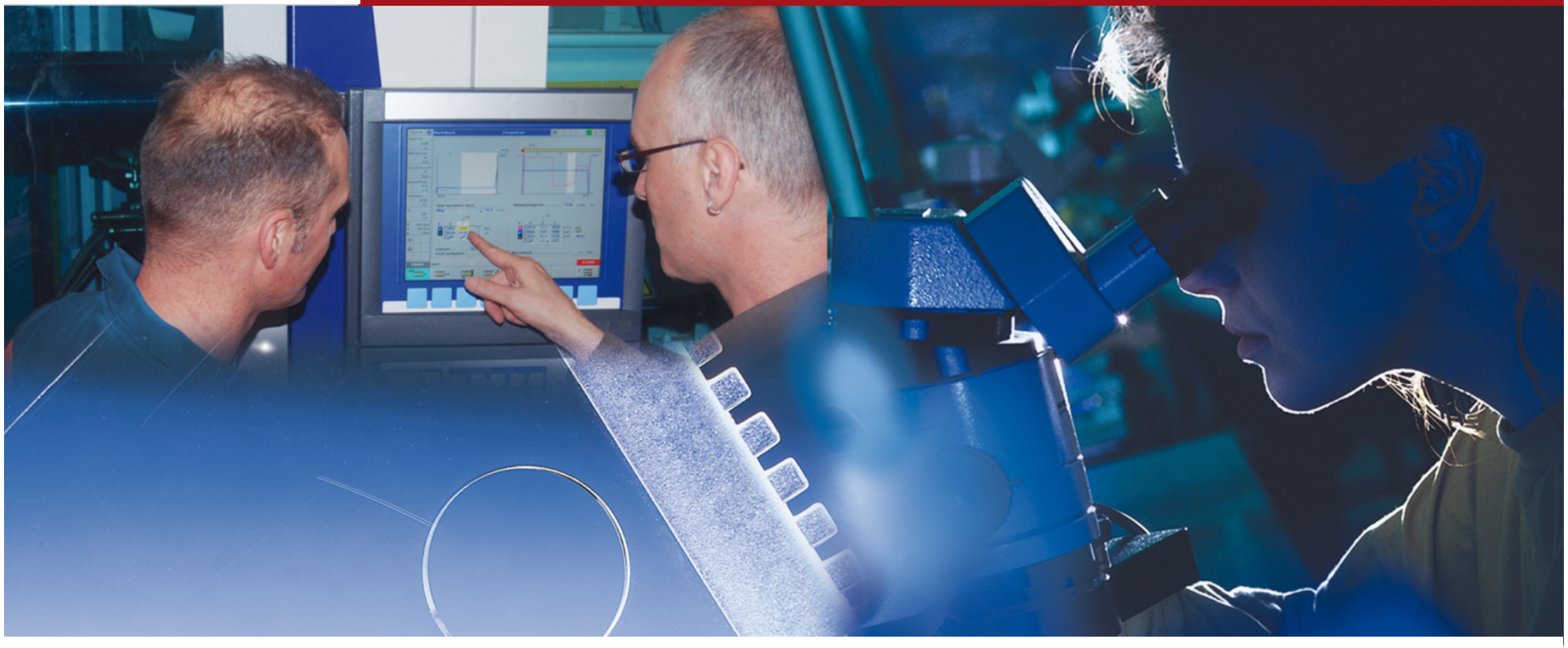

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