Mould-integrated mechatronic fixture for error compensation in injection over-moulding of optoelectronic devices

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Outline

1. Initial situation and motivation
2. Claims of the research
3. Development of concept
4. Motion and thermal analysis
5. Conclusion and Outlook

1. Initial situation and motivation

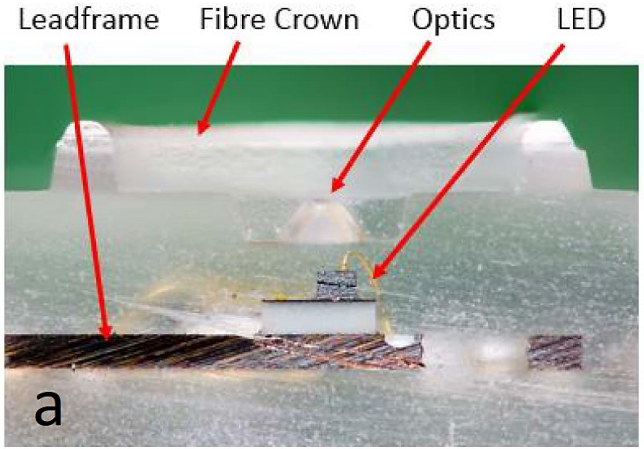
Geometric tolerances

Compensation and Alignment

Higher productivity

Reproducible optic characteristics

Miniaturization and function integration

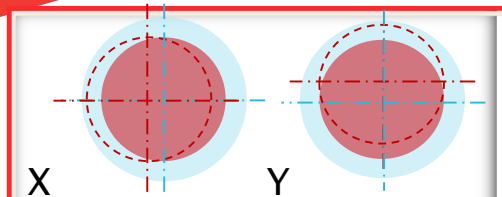


source: http://www.floimproject.eu

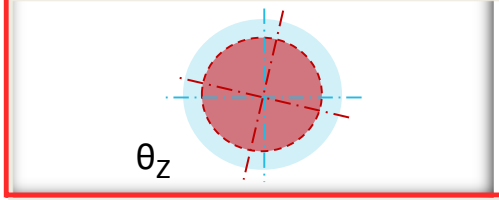
Expectations

- Development of kinematic and design concept
- Realization and mould integration

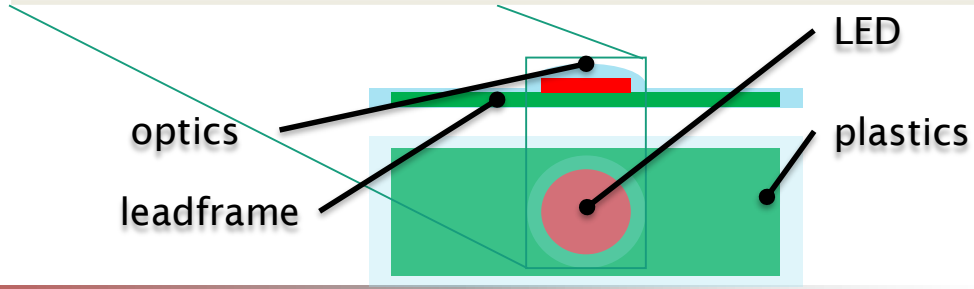
2. Claims of the research project



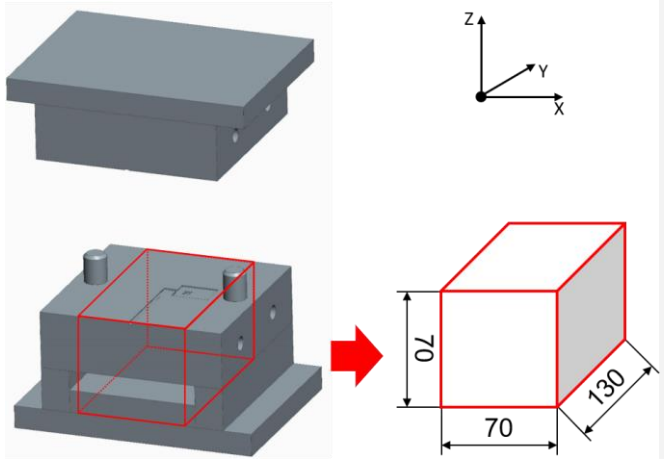
max. translatory travel:
min ±200 µm
positioning accuracy:
0.1 µm



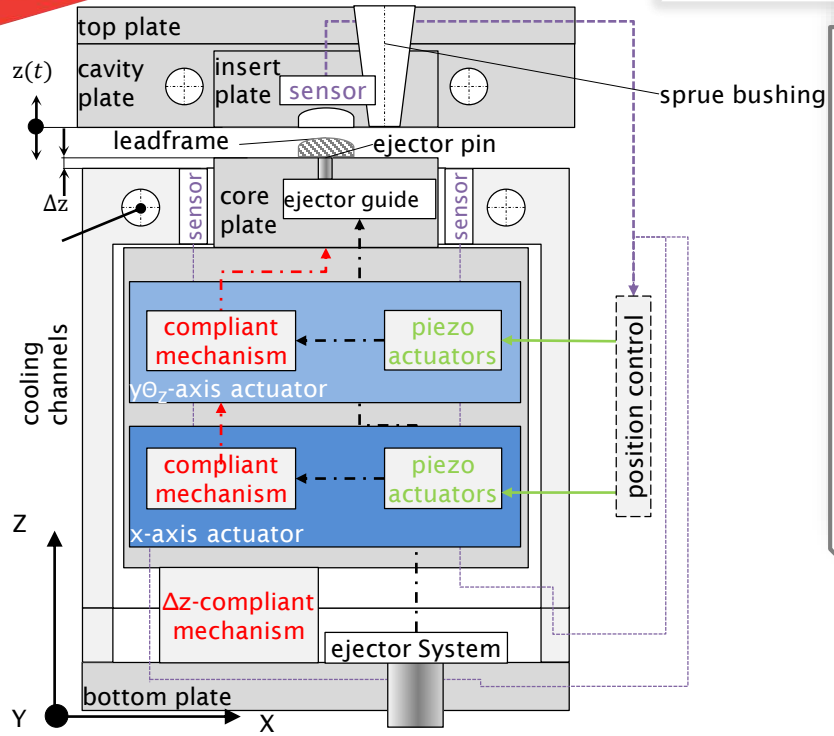
max. rotatory angle:
1.8°
positioning accuracy:
0.01°



Installation space (micro-injection-tool)

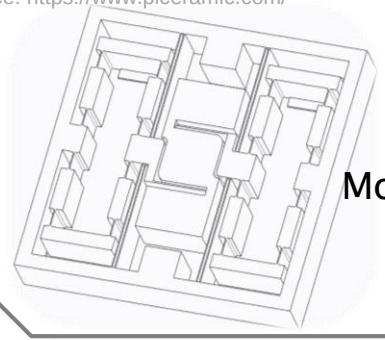


3. Development of concept



source: https://www.piceramic.com/

Movement generated by piezo actuators

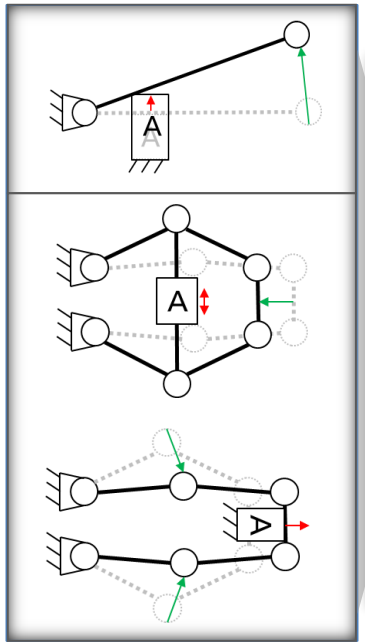


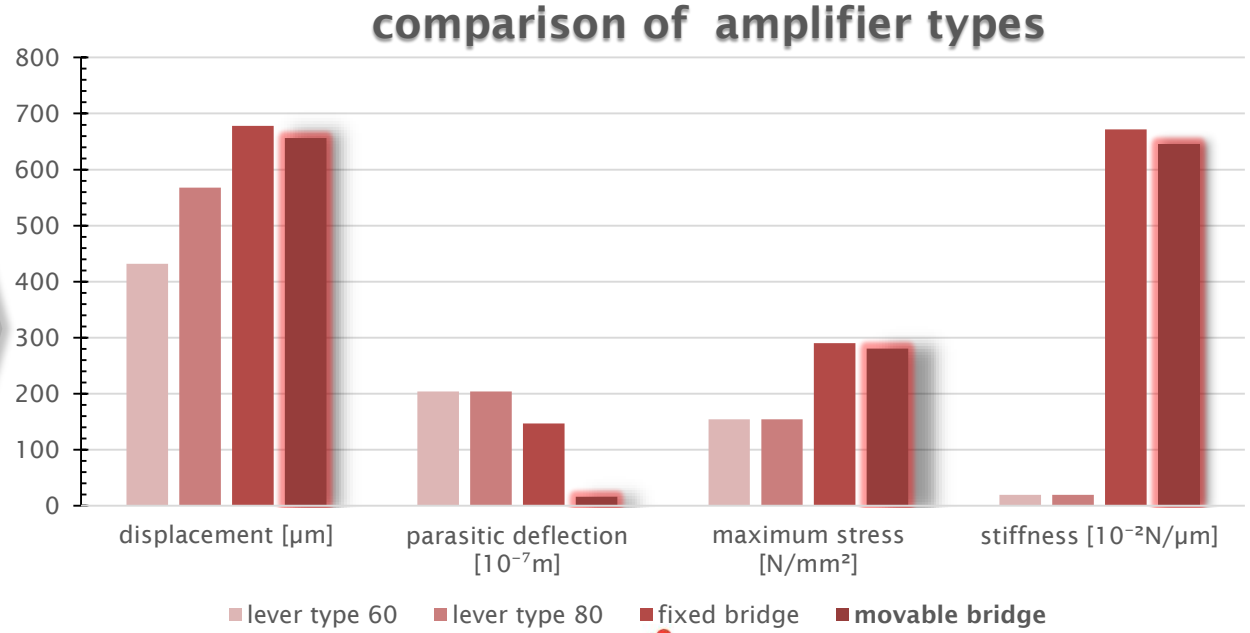
Movement transmitted by flexure joint mechanisms

3. Development of concept

Analysis of rigid body mechanism

Amplifier Types: Lever, Bridge

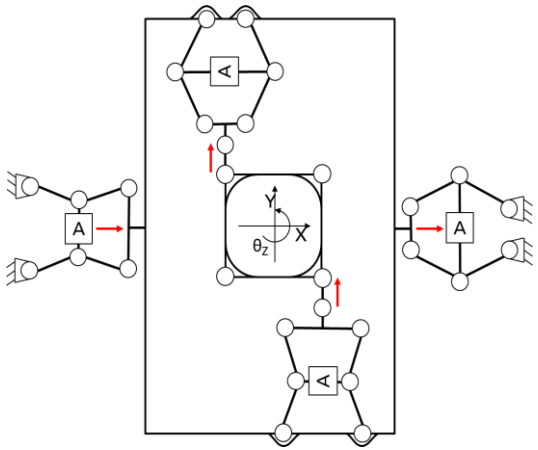




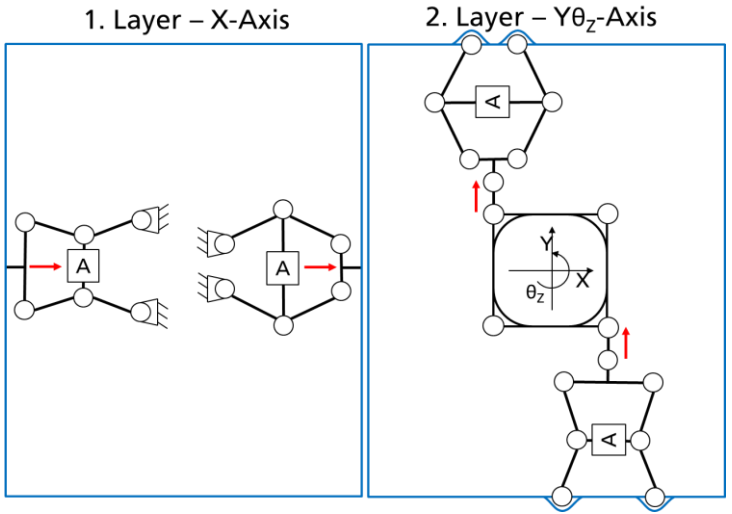
3. Development of concept

Analysis of rigid body mechanism

Arrangement of single amplifiers to fulfill the motion task

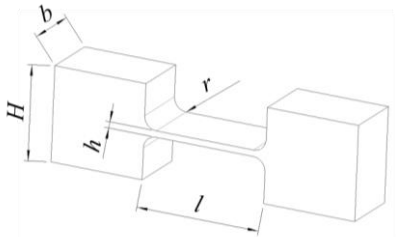


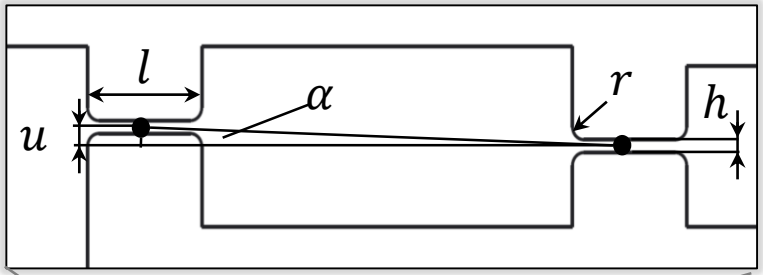
Splitting the axes to reduce the installation space

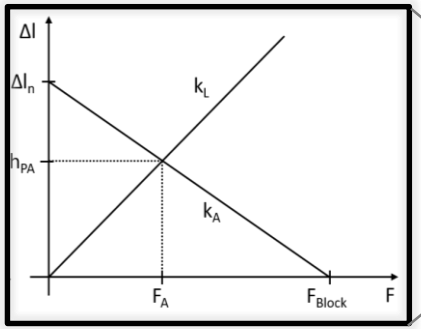


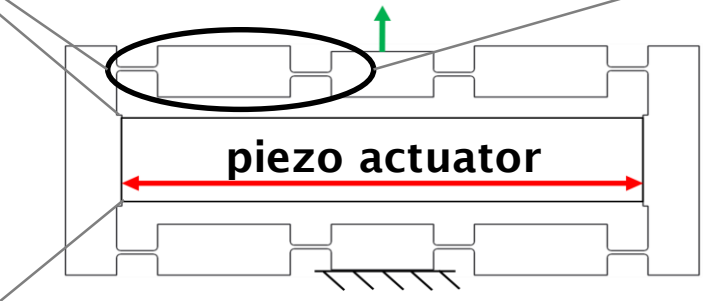
3. Development of concept

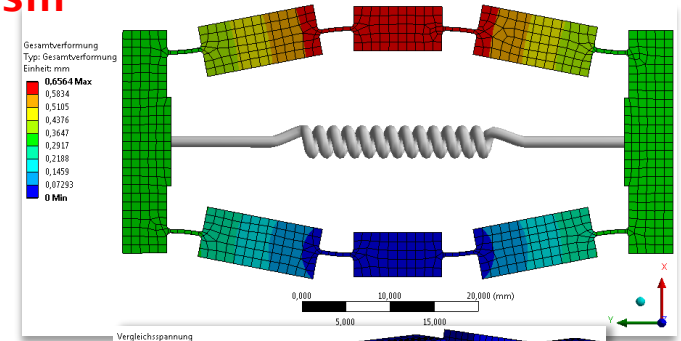
Synthesis and optimization of compliant mechanism

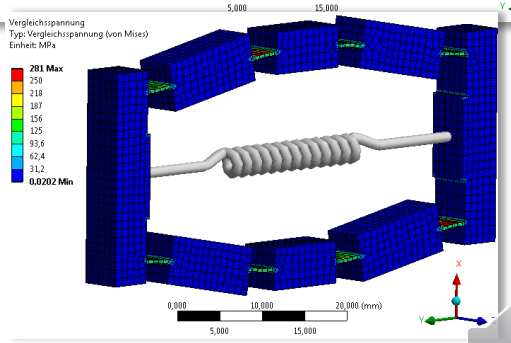












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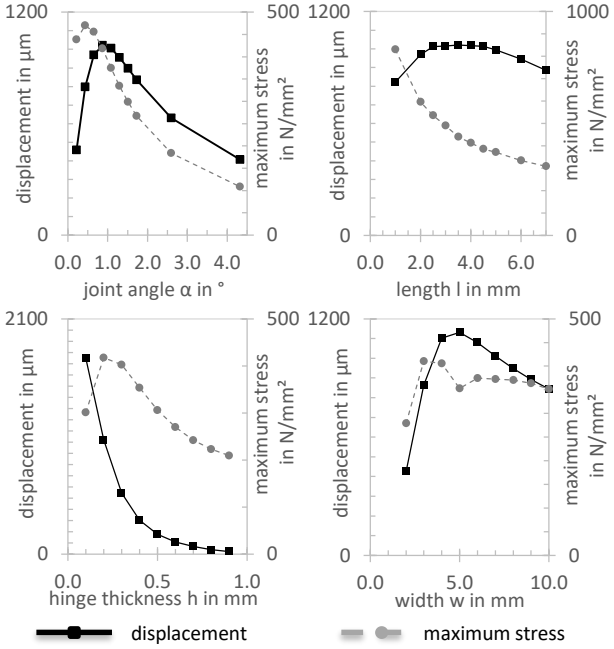
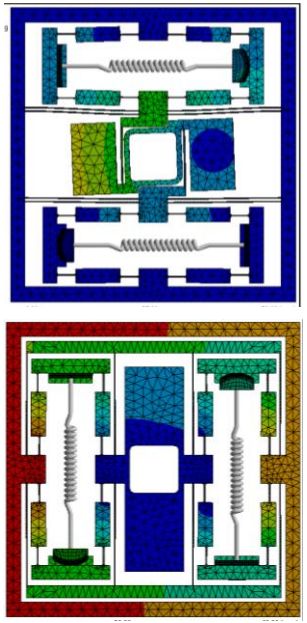
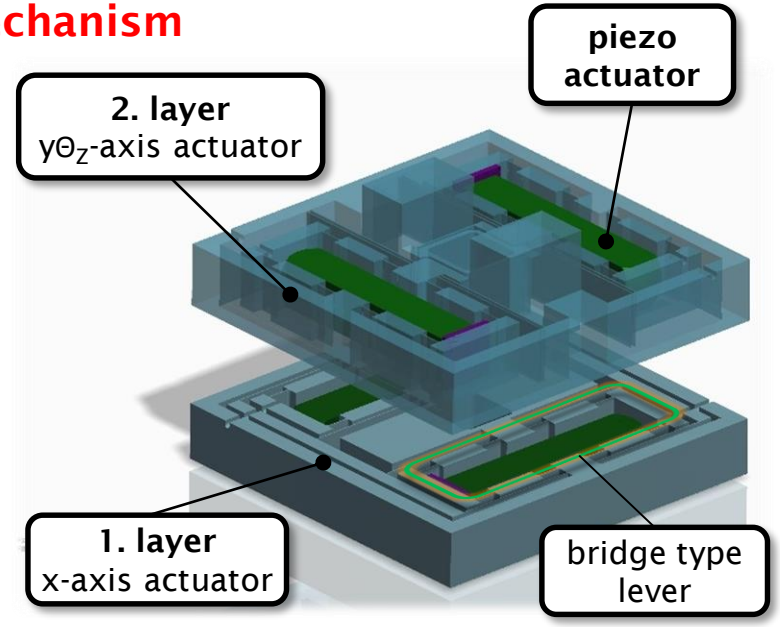
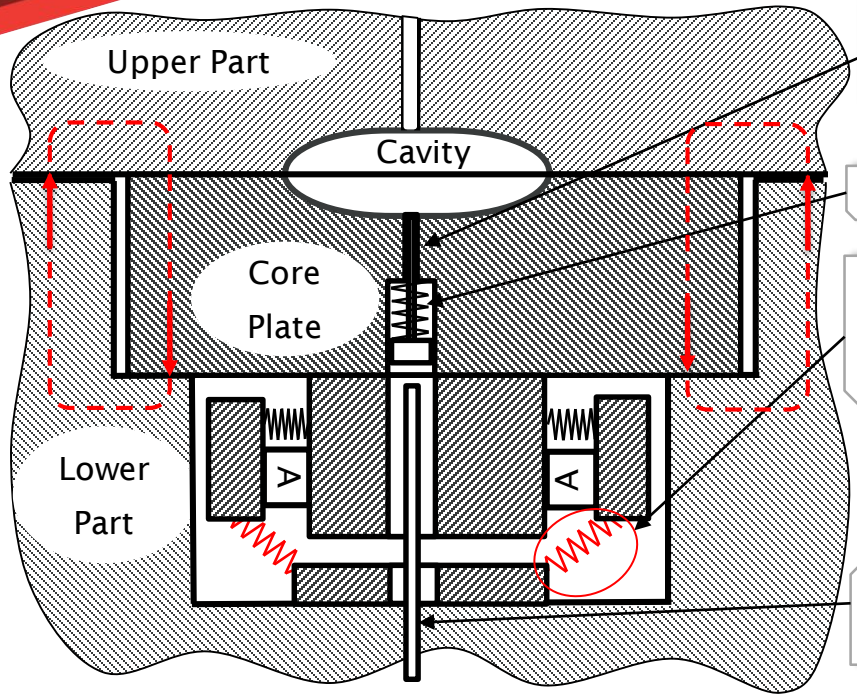
Synthesis and optimization of compliant mechanism







3. Development of concept

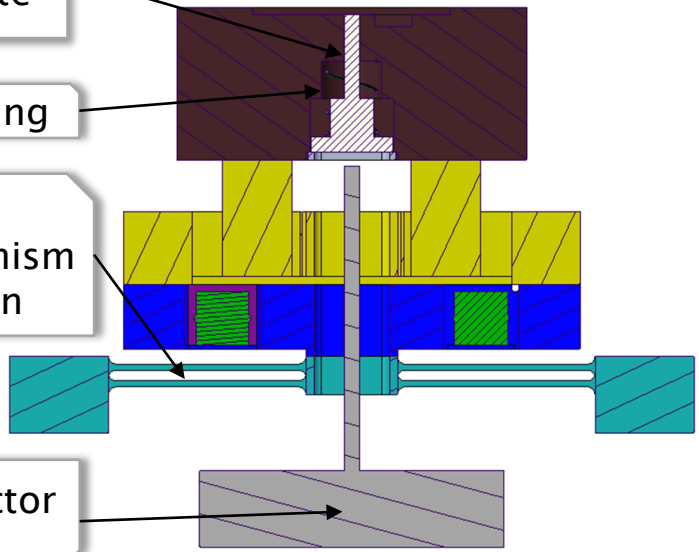


additional ejector pin in cavity plate

compression spring

additional compliant mechanism for Z-translation

conventional ejector pin in mould

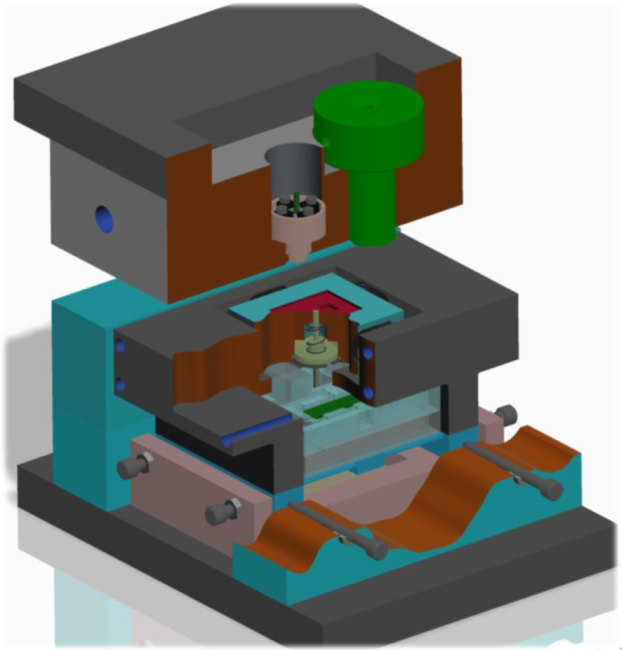


3. Development of concept

Design of concept

- 3 capacitive sensors on cavity plate
- 1 absolute system in upper part
- Alignment of the device in the mould by 8 fine adjustment screws

source: https://www.meusburger.com/



Modular mould concept

Injection moulding tool with standard components:

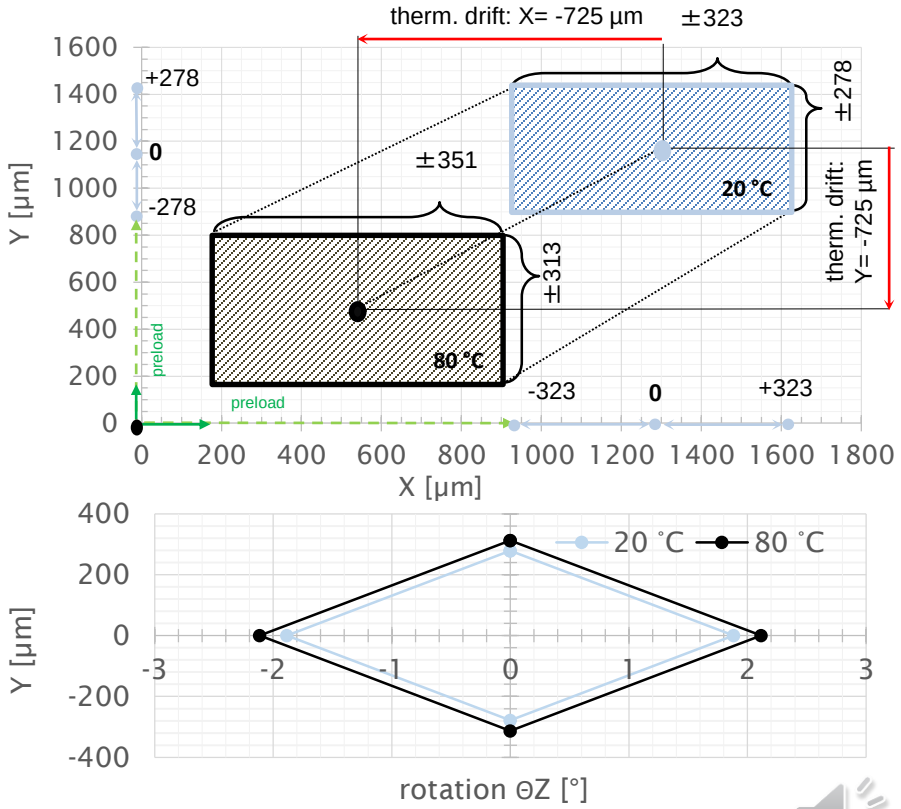
- ✓ Plates and risers
- ✓ Guidance and Ejector system
- ✓ Fasteners

4. Motion and thermal analysis

Results of FE-Simulation

Motion	Value
Travel X	±350 µm
Travel Y	±310 µm
Angle Θ_Z	±1,88°
parasitic motion in X-axis	0,02 µm / 0,0004°
parasitic motion in Y-axis	0,08 µm / 0,007°

Temperature dependency:
Maximum travel depends on the temperature
→ If temperature increases, maximum travel decreases by about 0,5 µm/K
→ Constant temperature during operation is assumed



5. Conclusion and Outlook

Design of concept

- Compliant mechanisms allow high-precision positioning
- Parameter optimisation increases deflections and reduce parasitic movements
- Highly compact systems can be integrated into an injection moulding tool

Outlook

Realisation of the actuator system, commissioning and measurements of the adjustment ranges during operation

Benefits

- Active error compensation inside the mould
- Additional assembly steps are not necessary
- Production of the electronic components can become more cost-effective