



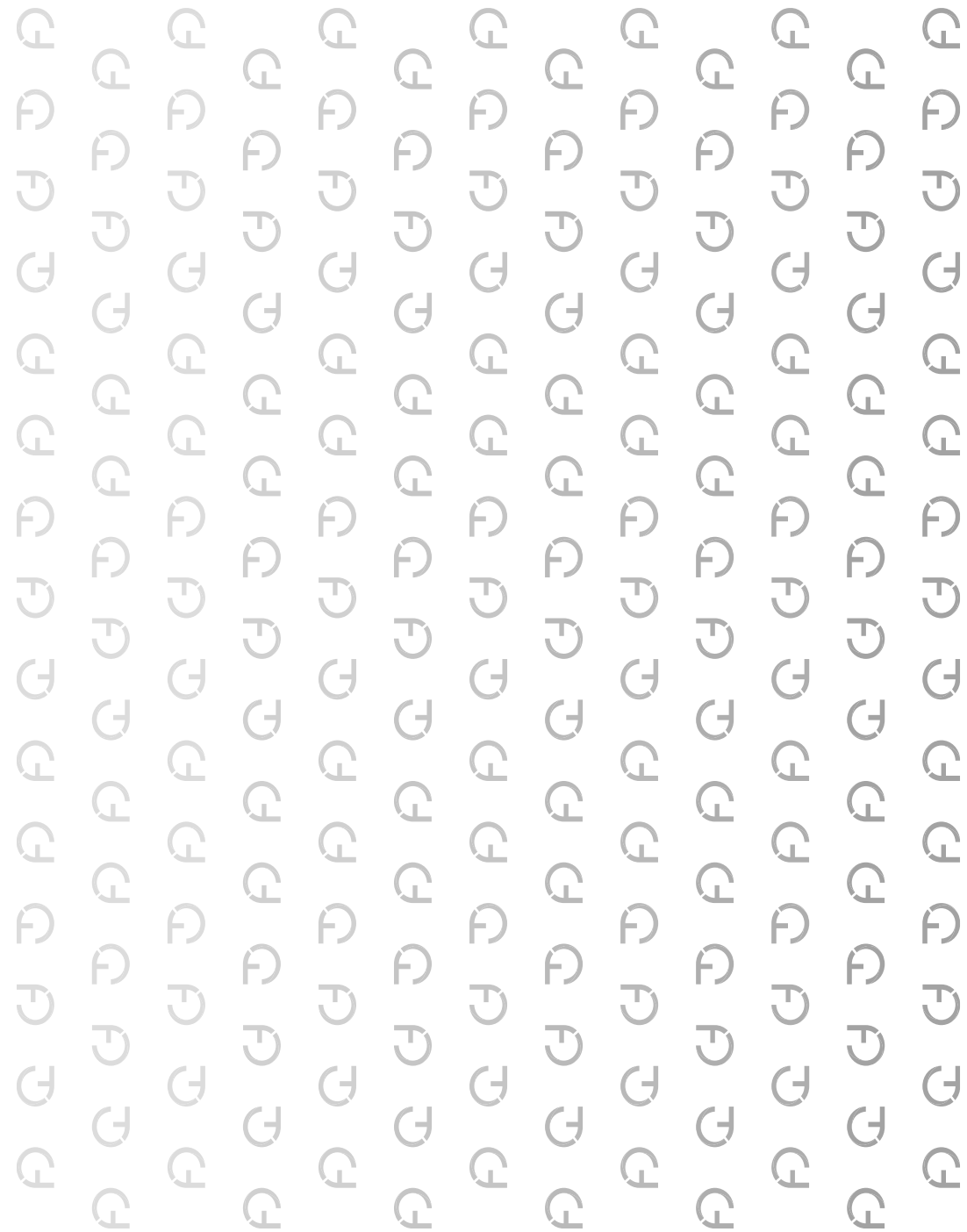
Glass 3D micro-manufacturing for monolithically integrated quantum devices

Dr. Casamenti Enrico

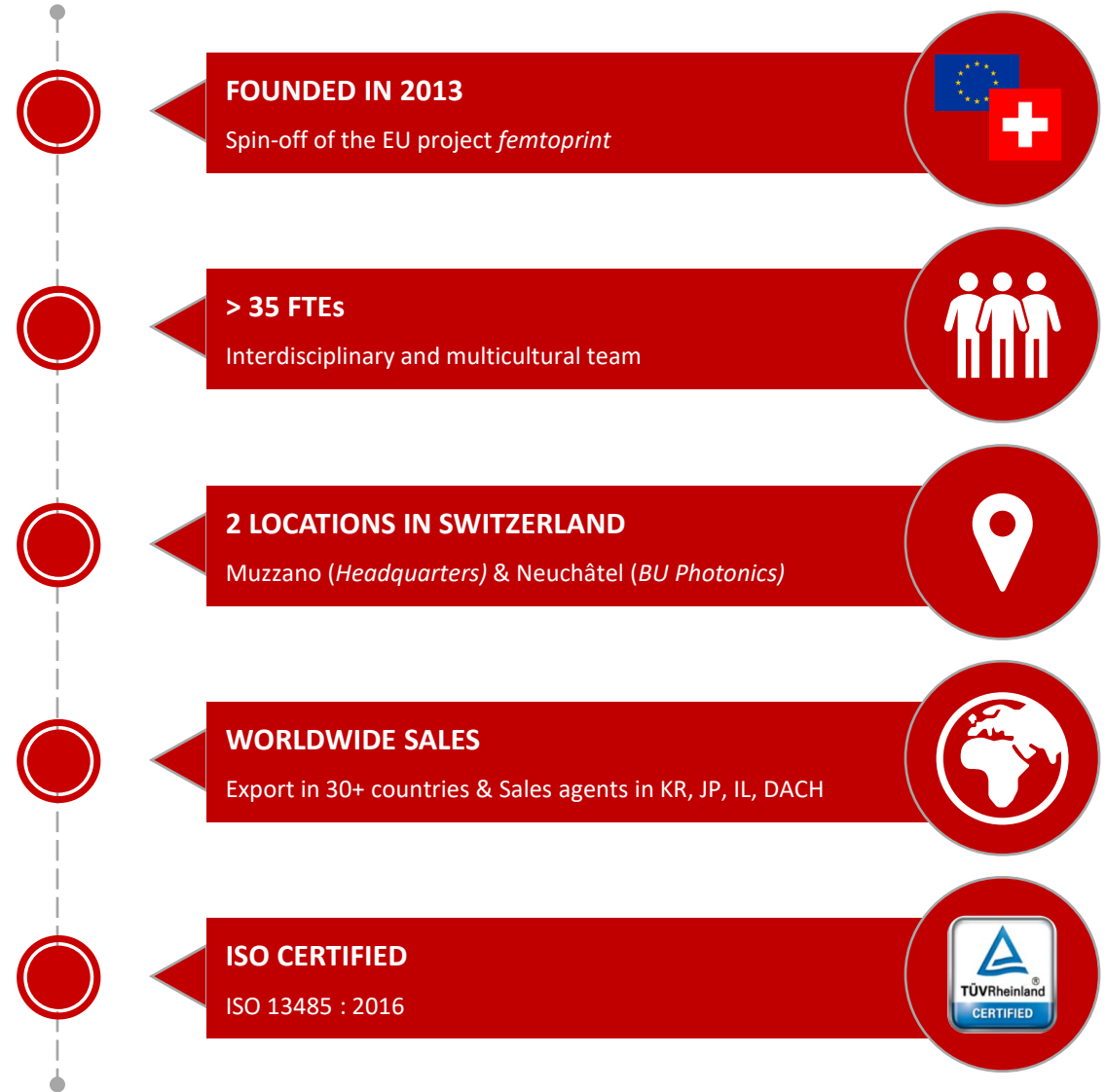


Quantum Metrology and Quantum Sensors
Online Event, February 27th, 2023

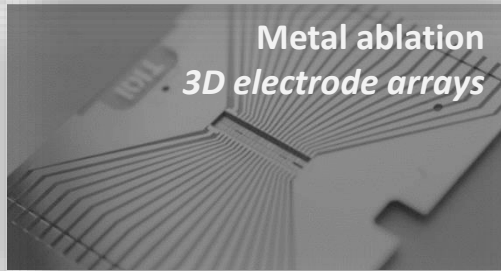
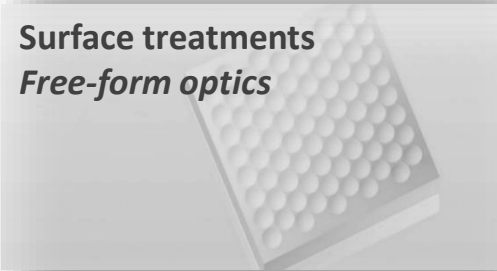
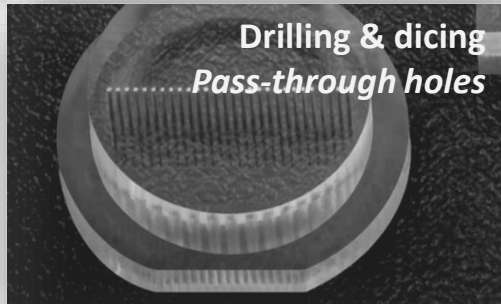
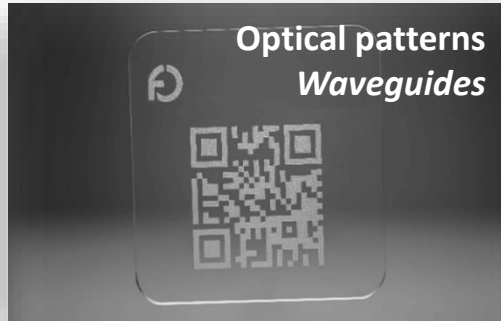
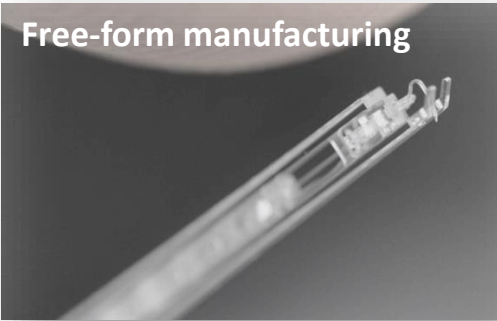
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FEMTOprint is a Swiss high-tech **Contract Development & Manufacturing Organization (CDMO)** specialized in high-precision **3D microfabrication in glass.**



CAPABILITIES



PERFORMANCES*

RESOLUTION
AND
TOLERANCES

- Process resolution $\sim 1 \mu\text{m}$
- XY tolerances $\pm 1 \mu\text{m}$
- Z tolerance $\pm 2 \mu\text{m}$

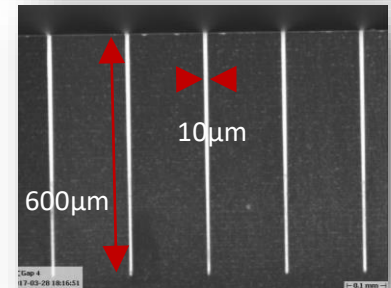
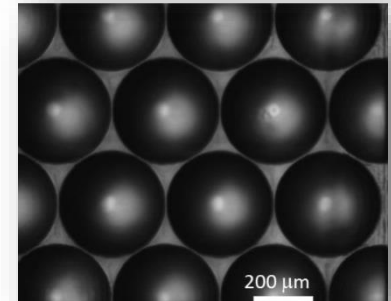
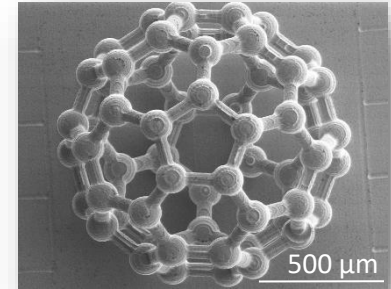
SURFACE
QUALITY

- Patterned surface $Sa \sim 150 \text{ nm}$
- Surface treatment $Sa < 20 \text{ nm}$

ASPECT RATIO

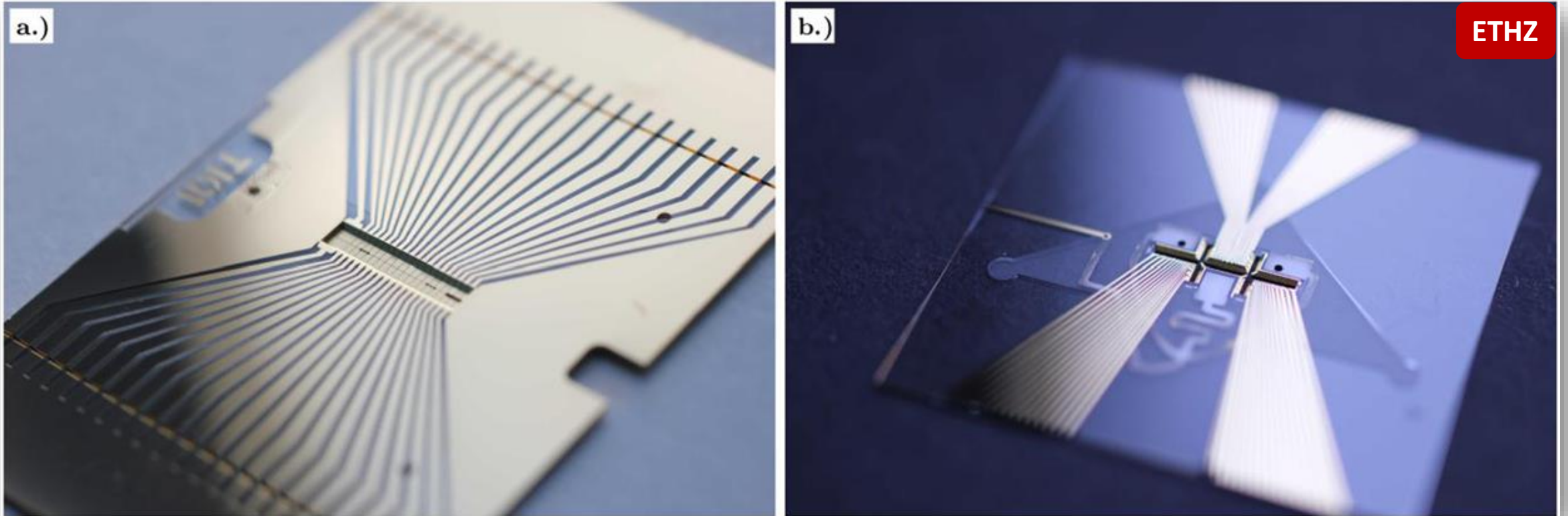
- Channel aspect ratio $> 1:500$
- Bulk height up to 30 mm
- Working area up to 300 mm \varnothing

*in SiO₂



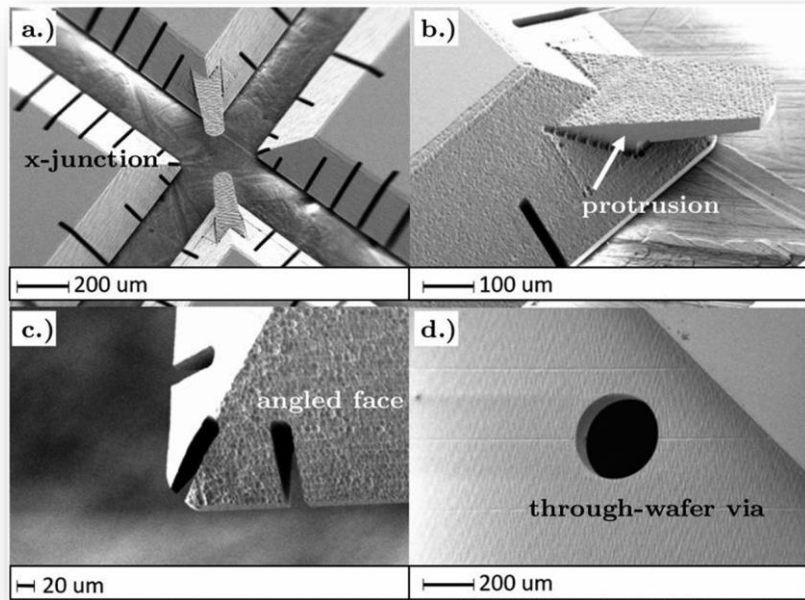
Glass 3D ion traps

Quantum computing + Precision measurements and frequency standards (e.g. Atomic clocks)

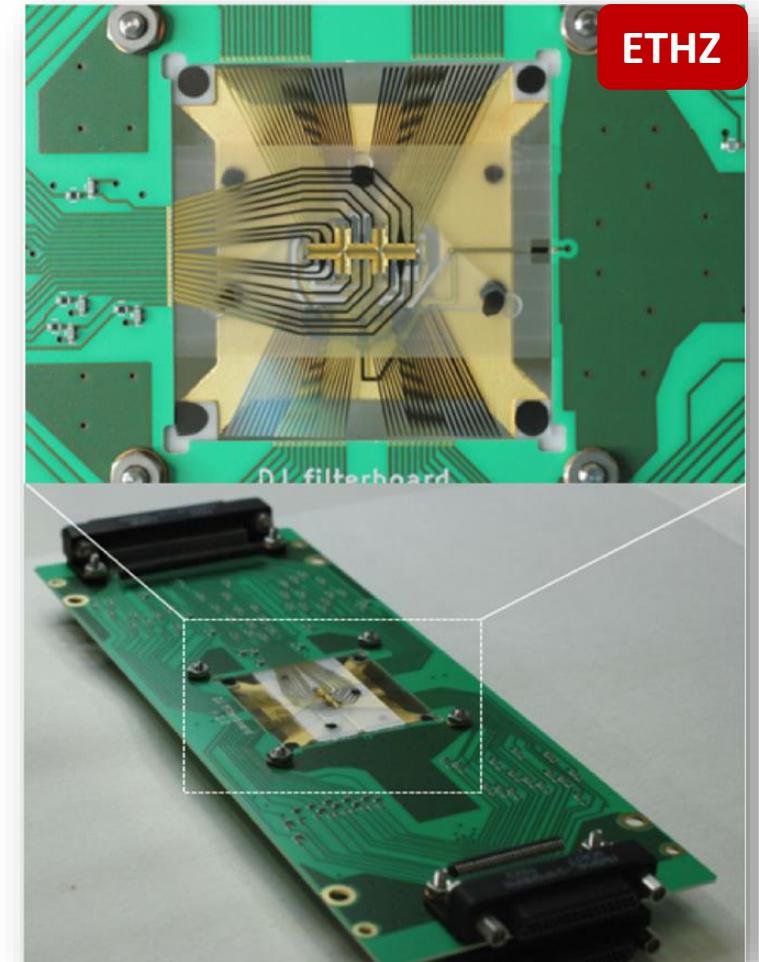
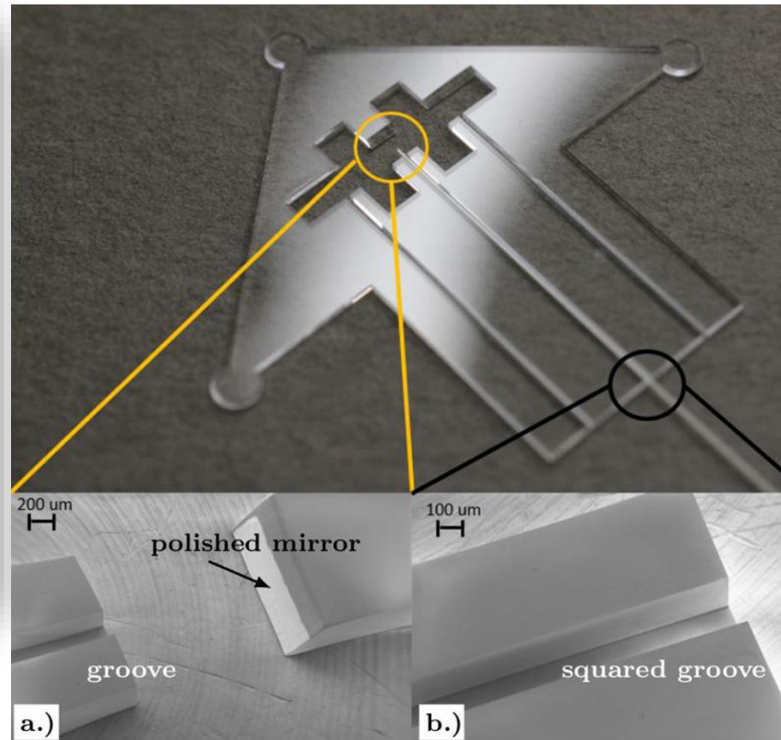


S. Ragg, et al., **Segmented ion-trap fabrication using high precision stacked wafers**, Rev. Sci. Instrum. **90**, 103203 (2019);

Glass 3D ion traps



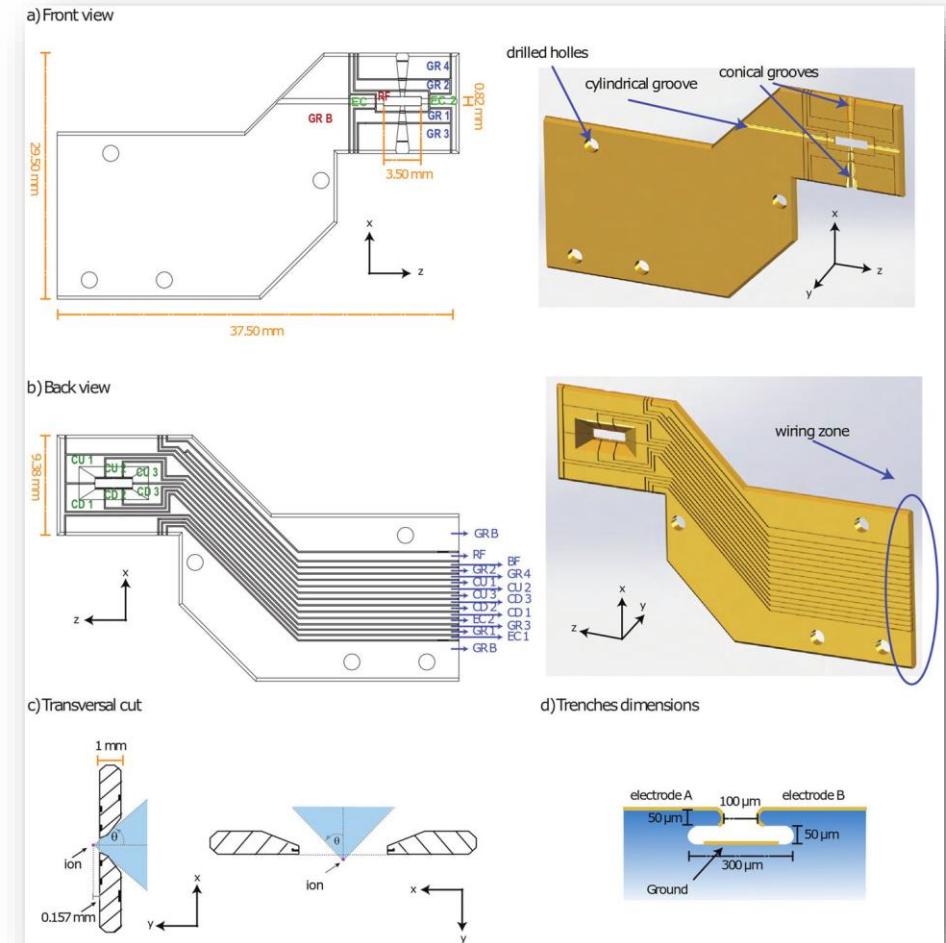
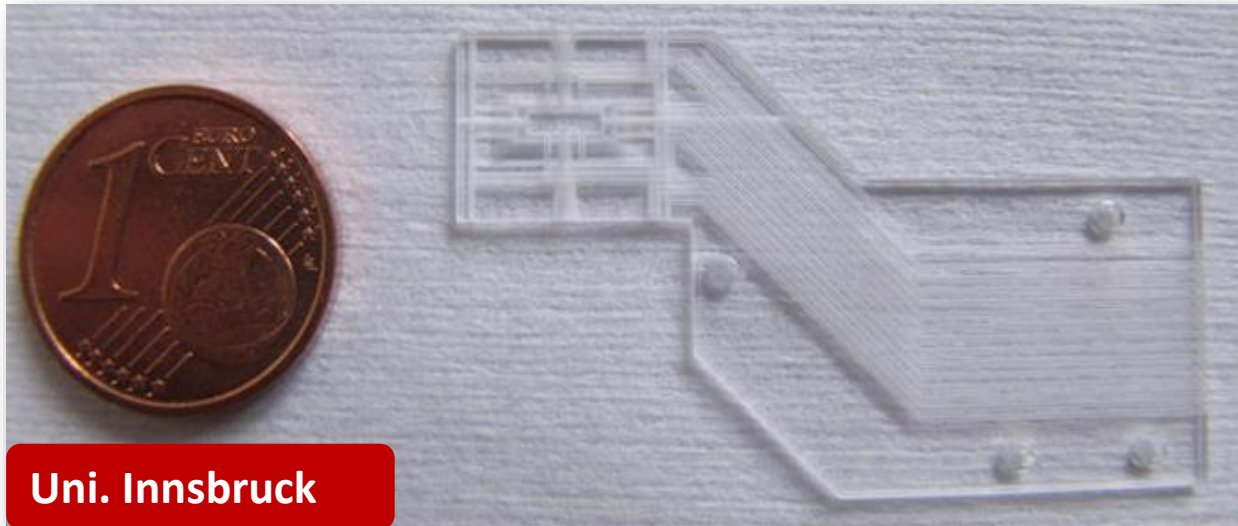
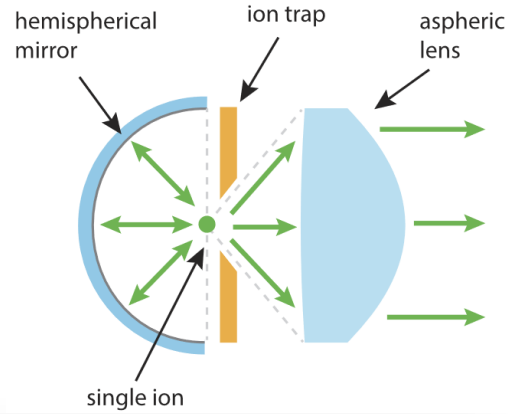
- Ad-hoc 3D features
- Surface smoothing
- Optical integration
- Multi-layers self-assembly with micrometric precision
- Metallization (possibility of masking)



S. Ragg, et al., **Segmented ion-trap fabrication using high precision stacked wafers**, Rev. Sci. Instrum. **90**, 103203 (2019);

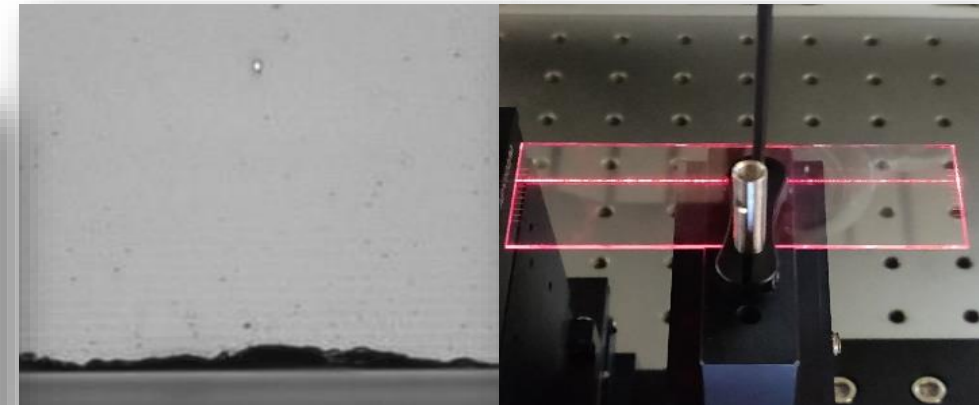
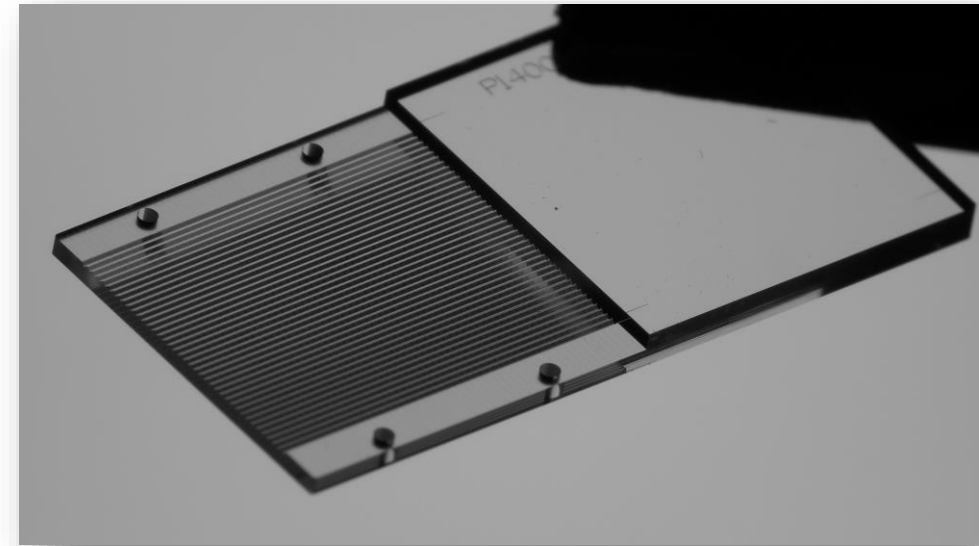
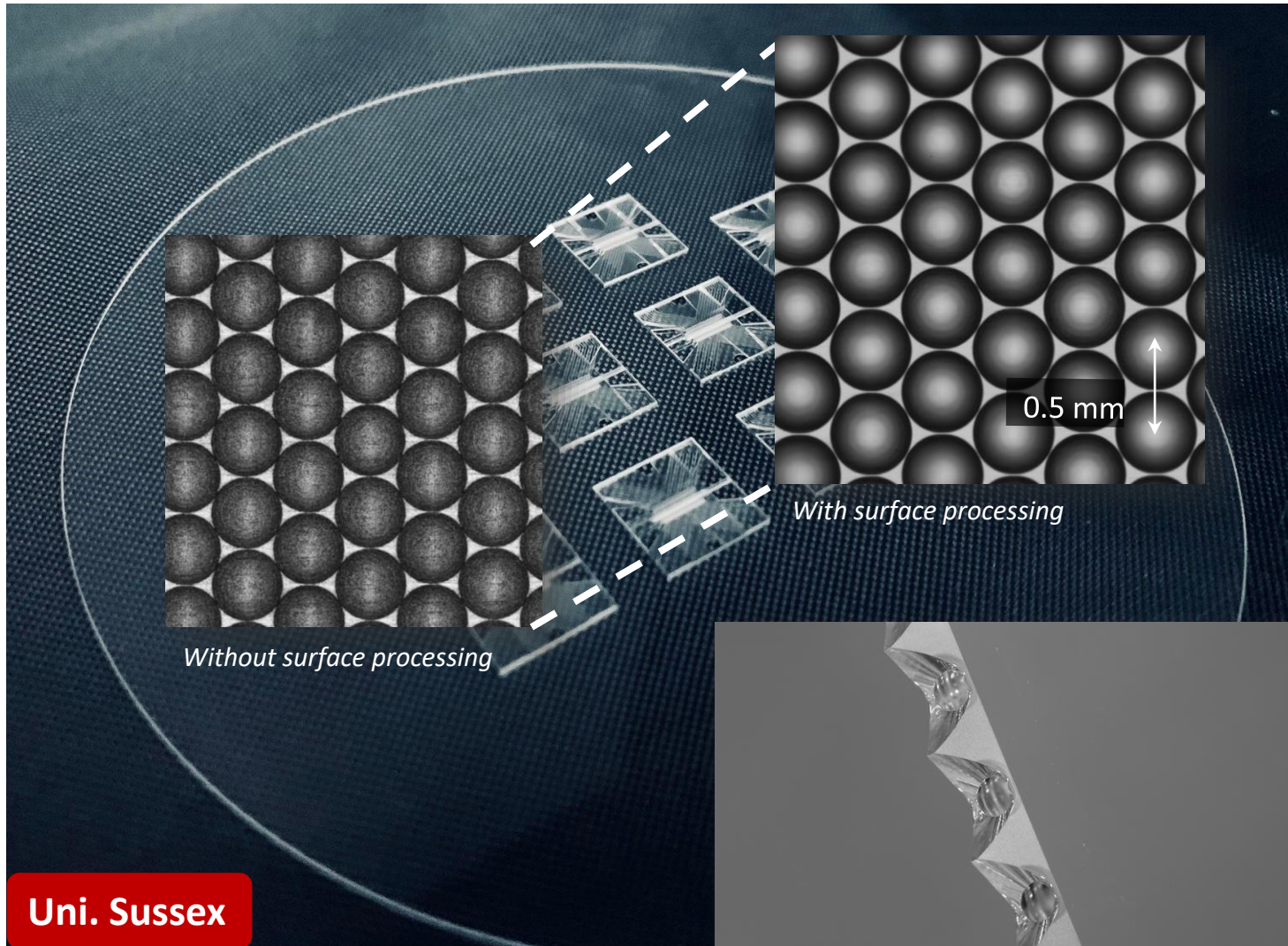
Glass 3D ion traps

Study the inhibition and enhancement of spontaneous emission of trapped Ba^+ ions.



G. Araneda, et al., **The Panopticon device: An integrated Paul-trap–hemispherical mirror system for quantum optics featured**, Rev. Sci. Instrum. 91, 113201 (2020);

Wafer scale + Optical integration



WHAT CAN WE DO FOR YOU?

- 3D printing of monolithically integrated glass micro-devices: from feasibility & fast prototyping to pilot & volume production
- Combine dedicated know-how in optics & photonics with full control over fabrication processes and production systems
- Provide solutions for integrated devices:
 - High precision 3D micro-manufacturing of glass;
 - Integration of mechanical & electrical functionalities;
 - Packaging & assembly (incl. Welding and high precision 1D & 2D fiber arrays);
 - Co-packaged miniaturized optics and micro-optics.

WHAT CAN YOU DO FOR US?

- Design, Metrology, Functional testing
- Requests for fast-prototyping, pilot manufacturing, and mastering/tooling services
- Collaboration on the development & manufacturing of
 - ion traps;
 - application specific quantum systems;
 - miniaturized & micro- optical components, devices, and systems;
 - multifunctional glass micro-systems.



FEMTOPRINT®

3D PRINTING FOR GLASS MICRODEVICES

*Thank
you!*



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