

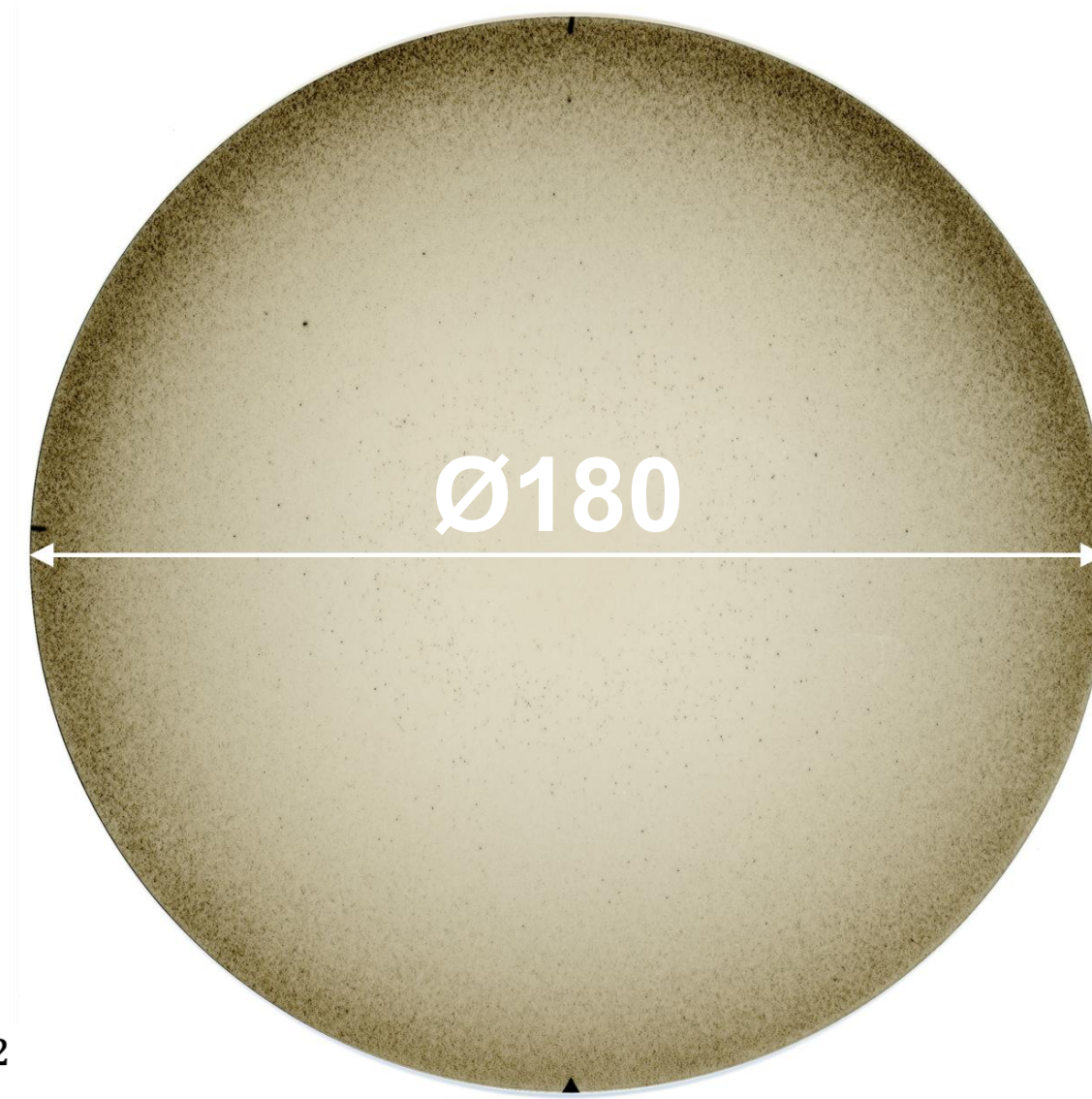
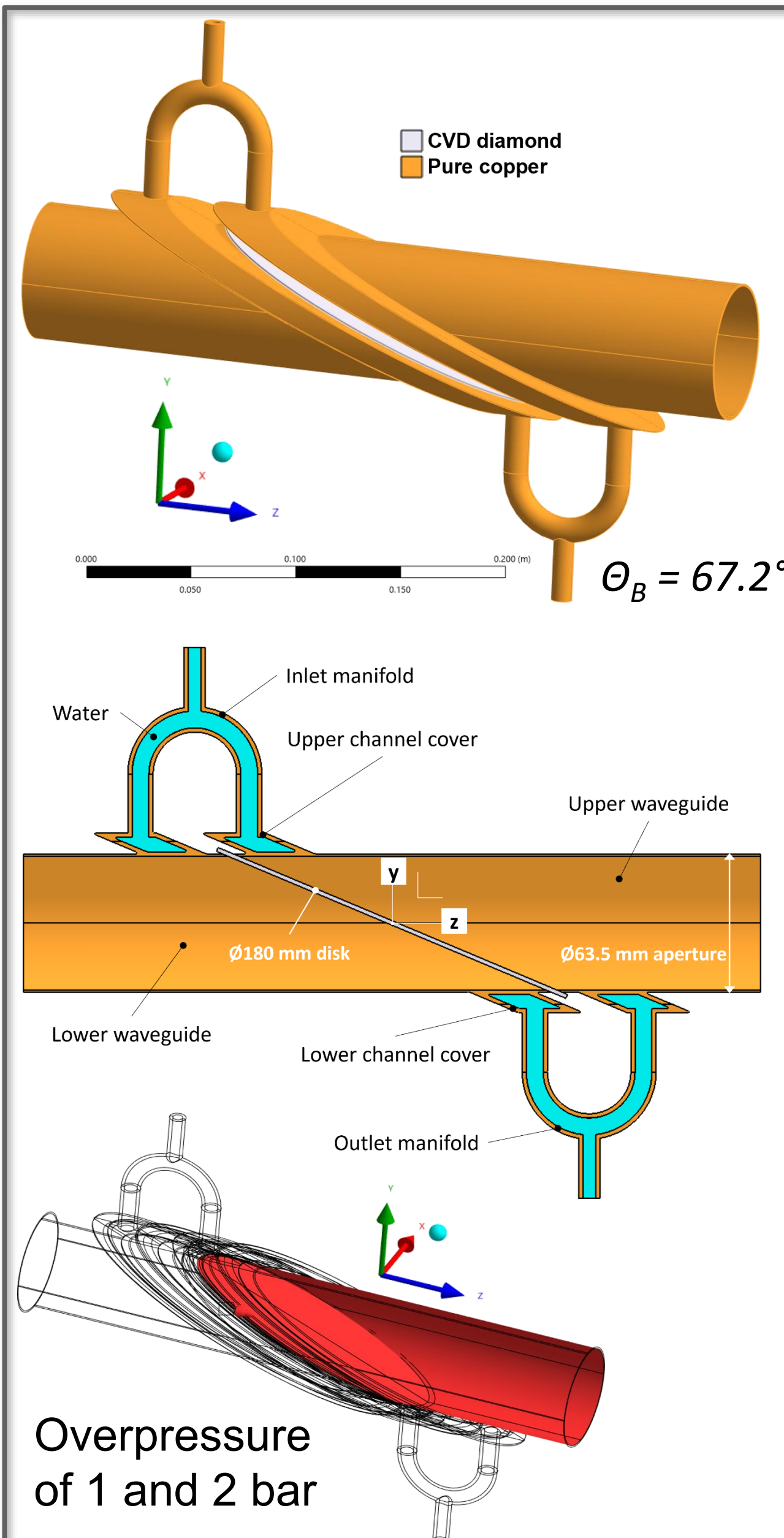
Brewster-angle window: design verification with the largest diamond disk to date and experimental loss tangent distribution

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Methods



Polished growth side

$$P_{abs} = \frac{P_{beam} 2 \pi v \sqrt{\epsilon_r} \tan \delta t}{c \sin(\theta_B)}$$

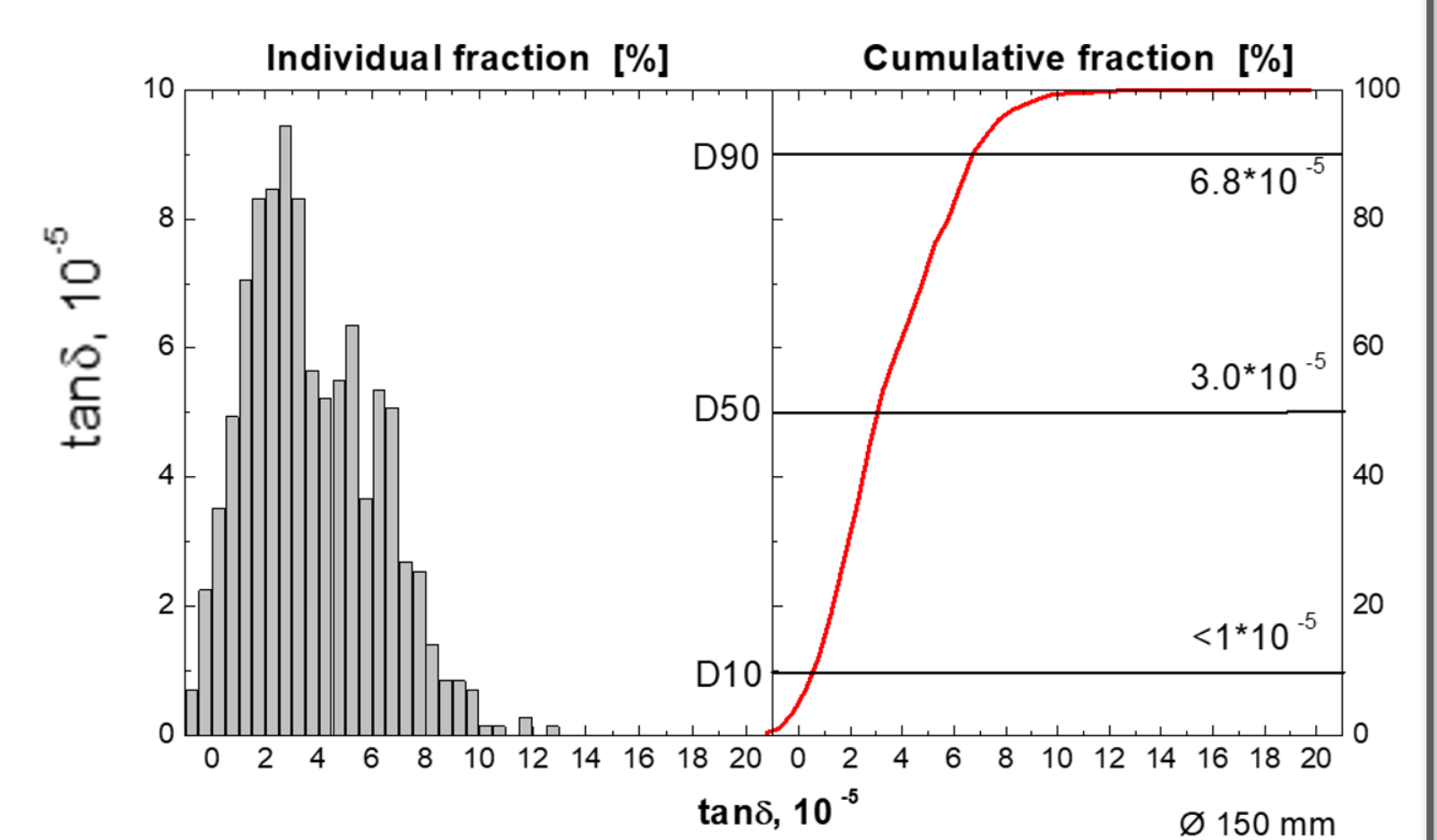
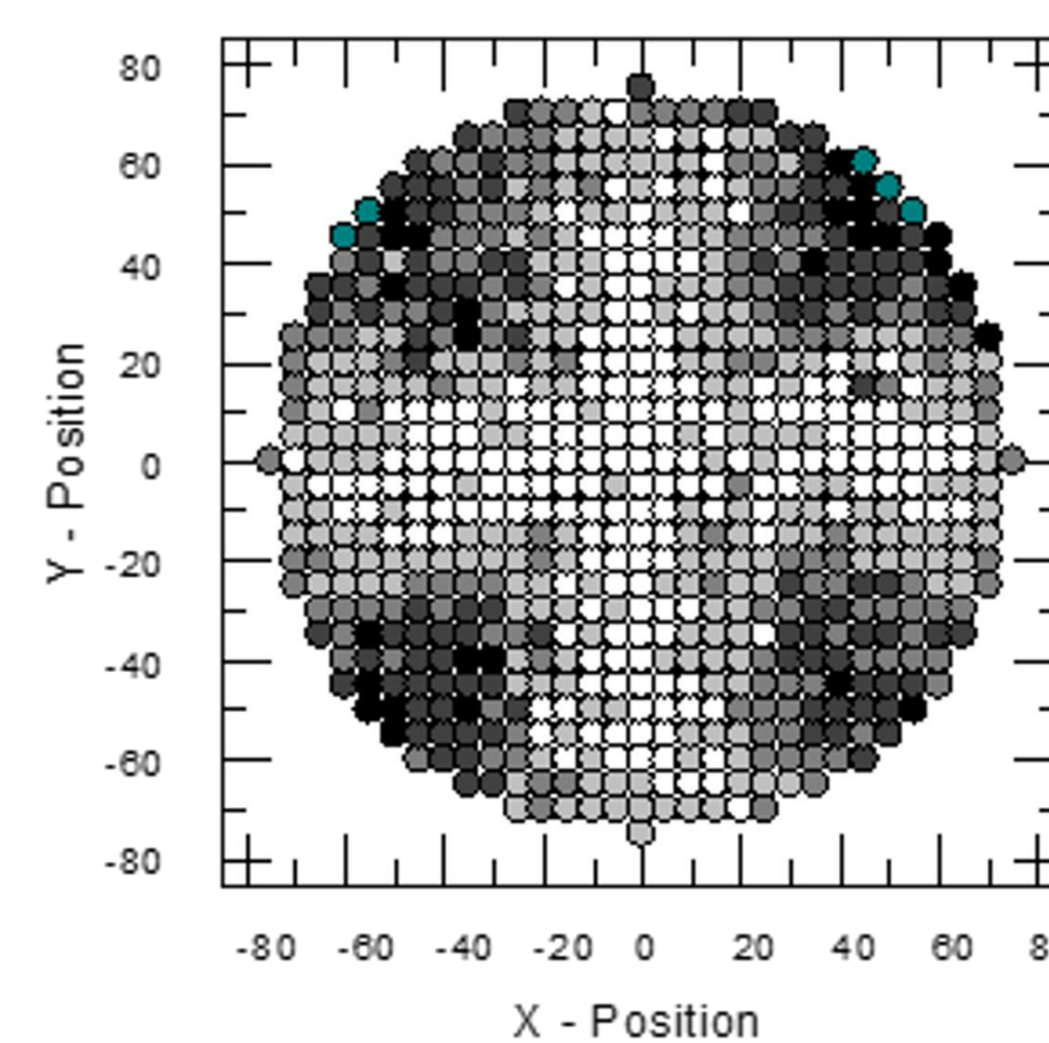
$$q'''(r) = \frac{2 P_{abs}}{k \pi w_0^2 t} e^{-2 \frac{r^2}{w_0^2}}$$

$$q'''(r) = \frac{N}{k} [J_0(x)]^2$$

$$x = 2.405 r/a$$

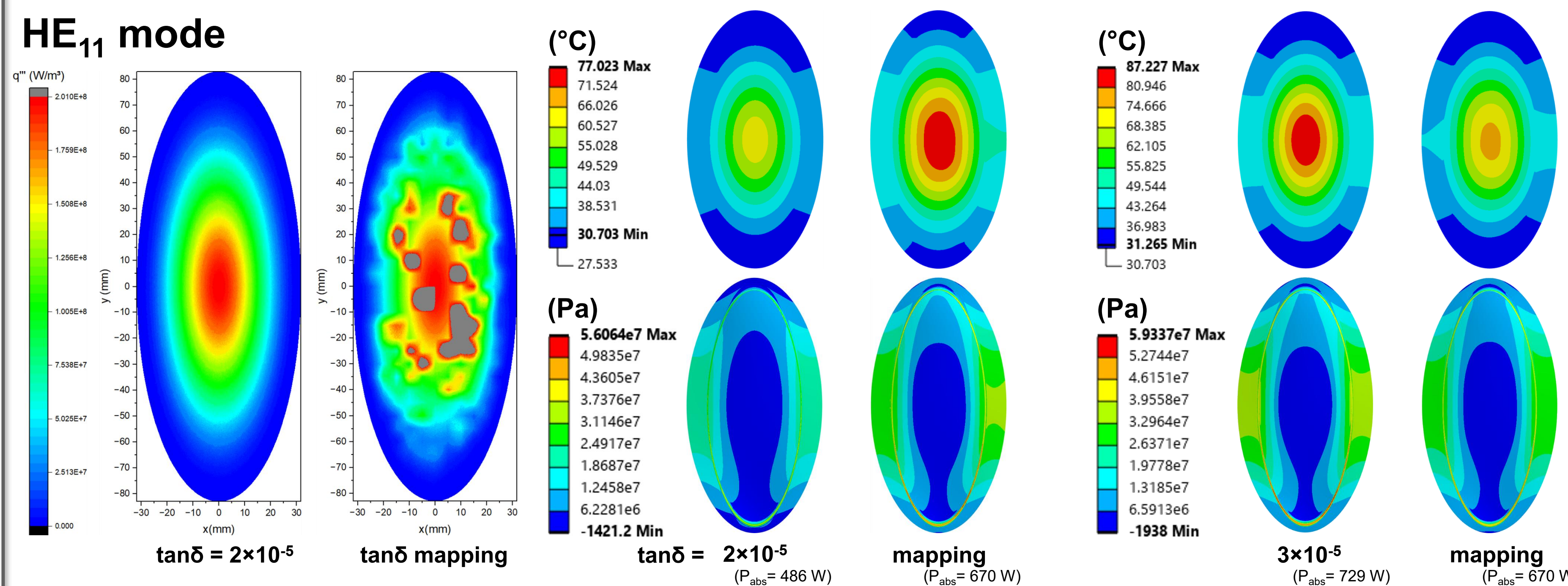
- 2 MW CW at 204 GHz, Ø180 mm, 1.1 mm disk
- HE₁₁ and Gaussian beam profiles on the torus and gyrotron sides
- Comparative analyses using tanδ distribution and uniform values (2×10⁻⁵ and 3×10⁻⁵)
- Custom-developed macro for integrating the measured tanδ maps into the analyses
- Design verification with a conservative tanδ distribution (additional 1×10⁻⁵ margin)
- Normal operating conditions: thermal loads, gravity and 10 bar coolant pressure

- Compact, high-performance window concept for frequency-steering 2 MW CW gyrotron operations
- Development of the largest free-standing optical grade disk manufactured to date (Ø180 mm)
- Thickness of ~1230 μm at center and 1100-1150 μm at edge
- Experimental mapping of dielectric losses (loss tangent, tanδ) over Ø150 mm disk area
- First implementation of measured spatial tanδ distribution in coupled thermo-structural analyses
- Verification of the window under normal operating (NO) conditions and accidental overpressure scenarios
- Impact assessment of tanδ distribution input compared with the conventional uniform tanδ value over the disk area



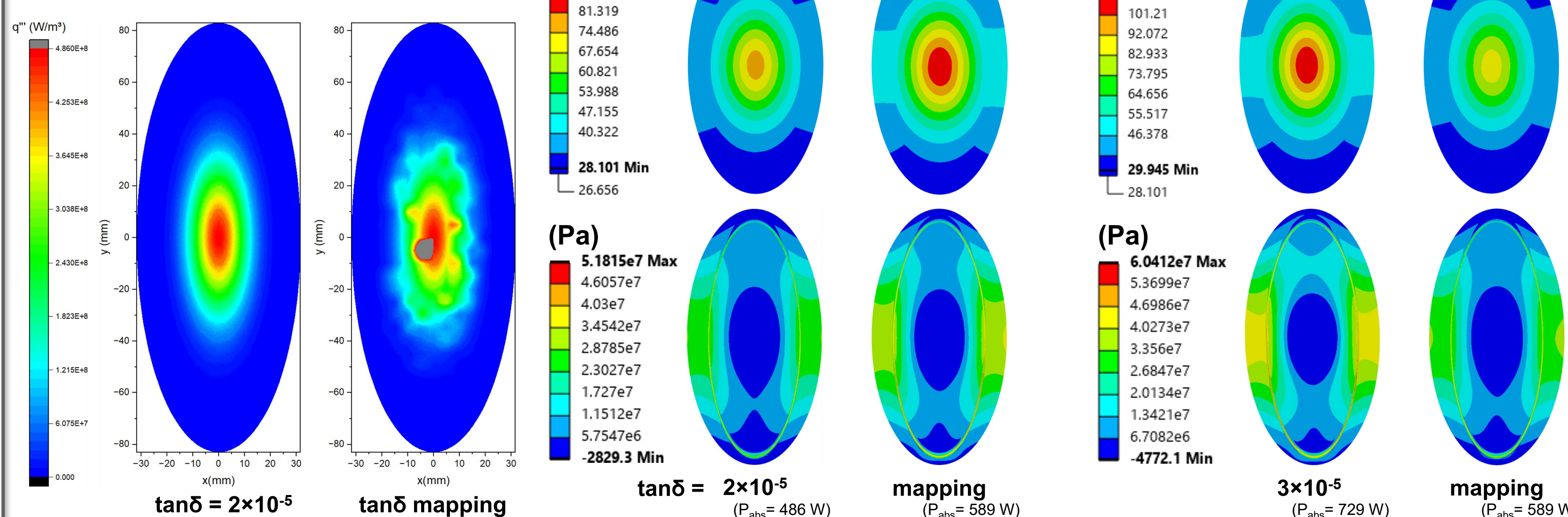
Results

Comparative analyses

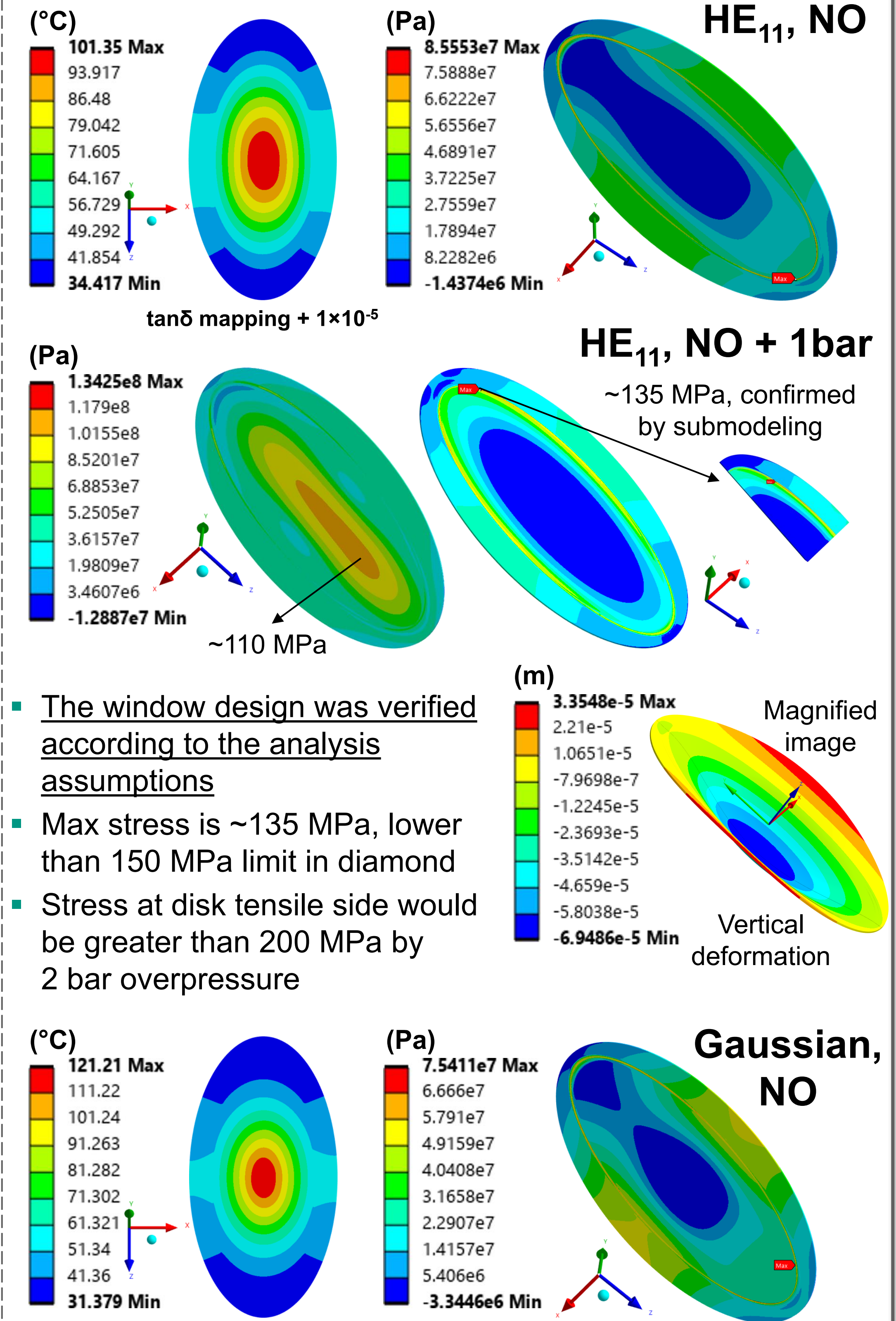


The measured tanδ distribution in the disk shall be used as input for the analyses to obtain a more realistic assessment of the window performance

Gaussian mode



Design verification



- The window design was verified according to the analysis assumptions
- Max stress is ~135 MPa, lower than 150 MPa limit in diamond
- Stress at disk tensile side would be greater than 200 MPa by 2 bar overpressure