Surface Quality Measurement of Sapphire Samples

Date and place

- 2025/7/8
- NAOJ ATC

Team

- Toshihiro Tsuzuki (NAOJ ATC)
- Yoich Aso
- Dan Chen

Measurement Setup

- Interferometer: AccuFiz
- Both standard and low-coherence laser sources were used depending on the sample shape:
  - The standard laser source was generally used. It does not impose distance constraints and allows samples to be positioned close to the instrument, minimizing air turbulence effects.
  - For samples that act as parallel plates, the low-coherence laser source was used to distinguish reflections from the front and rear surfaces. (Note: working distance ~950 mm)

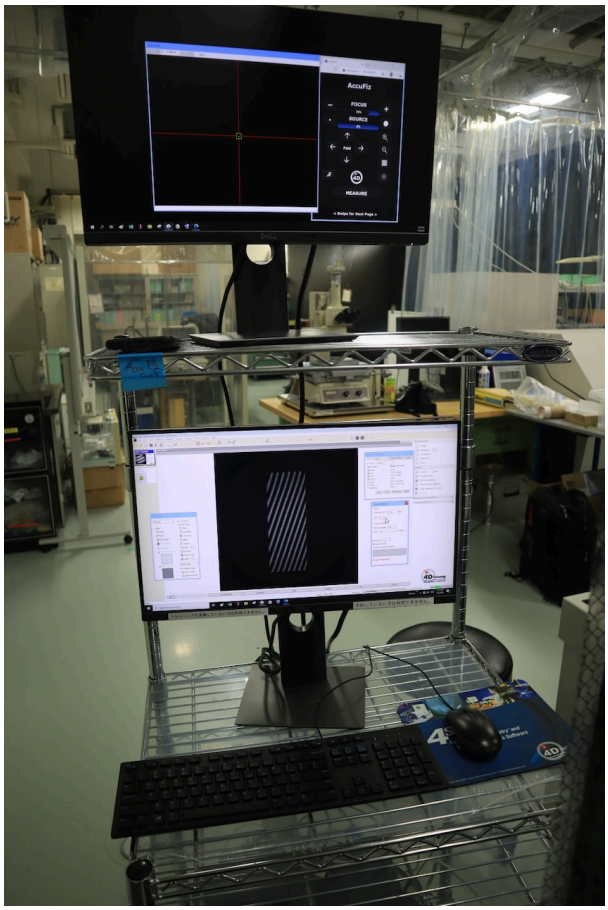
Procedure

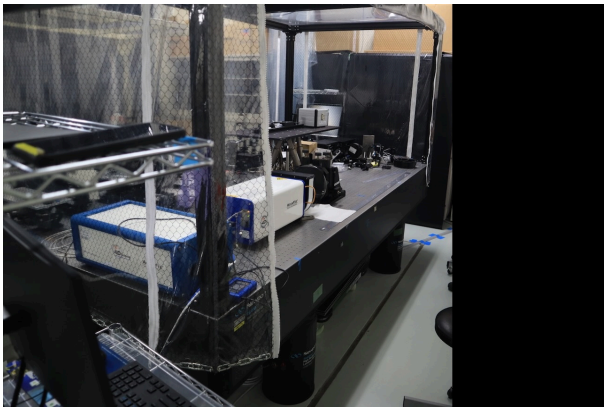
1. **Sample Mounting**
   - Samples were fixed using First Contact (Photonic Cleaning Technologies, P.O. Box 435, Platteville, WI 53818).
   - For the sapphire blade, gentle clamping from above was applied in addition.
2. **Alignment**
   - In the alignment screen, adjust the laser alignment so that the reference reflected light point aligns with the center of the green frame.
   - Adjust alignment of sample so that the sample reflected light point aligns with reference point.
   - Exposure can be modified as needed.
   - Switch the 4Sight screen to “Live Video” mode.
   - Adjust alignment of sample to minimize fringes.
3. **When using the low-coherence source**
   - Depth of measurement must be adjusted using the dial, watching the monitor while searching for fringes in the Live Video.
4. **Test Measurement**

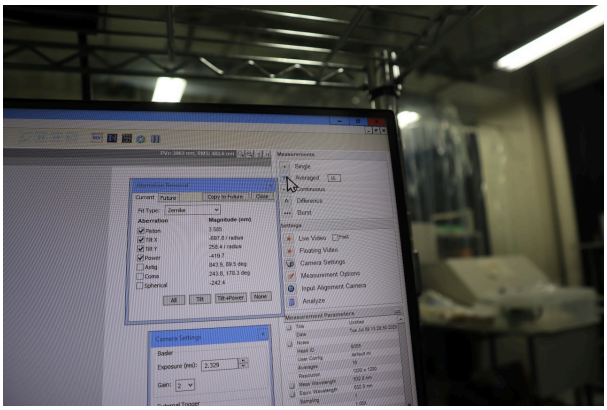
- Set “Measurements - Average” to 16, then click “Average”.
- Click “Analyze”.
- In “Aberration Removal”, uncheck “Power”.
  - This disables subtraction of the low-order spherical component in the Zernike expansion.
  - This avoids overcorrecting spherical distortion that isn't expected for these samples.
- Apply a suitable mask, excluding the outermost sample region to avoid including non-measurement areas.

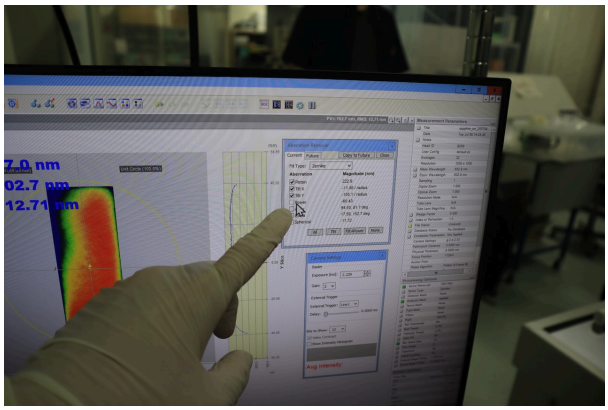
5. **Main Measurement**
   - Return to Live Video and re-align if necessary.
   - Lower curtains to minimize air turbulence.
   - Repeat averaging and analysis (Average = 32).
   - Save both the main data and screenshot images.

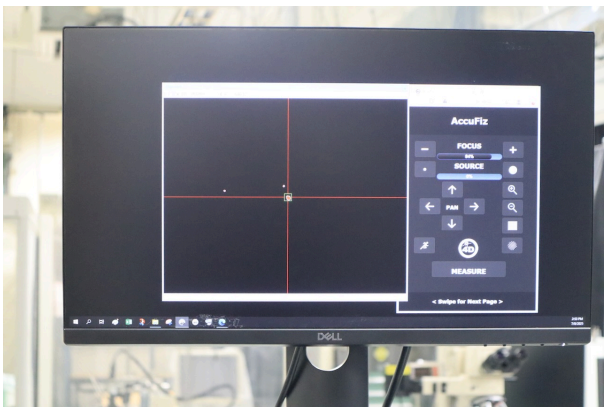
Reference Images

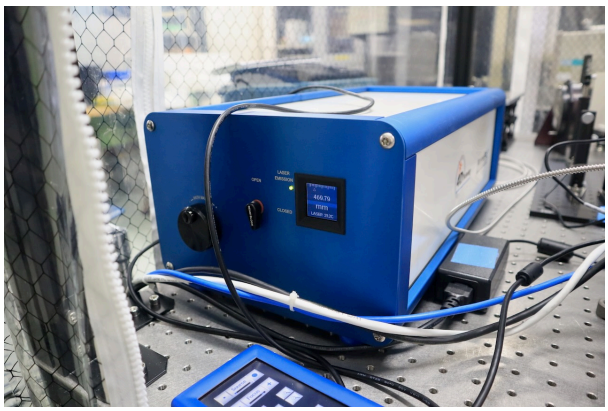






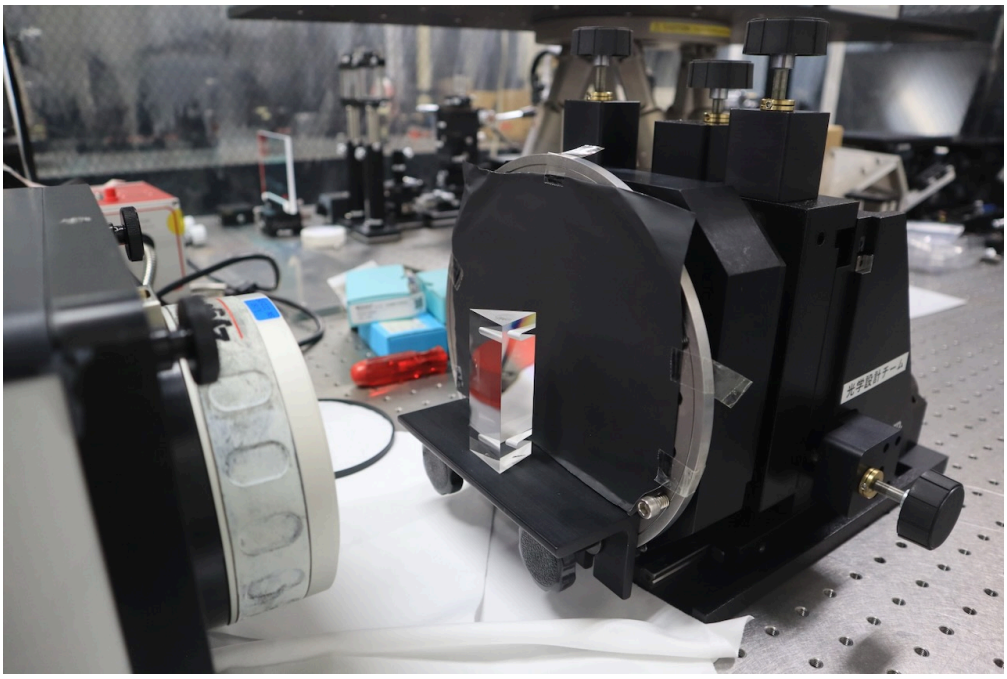




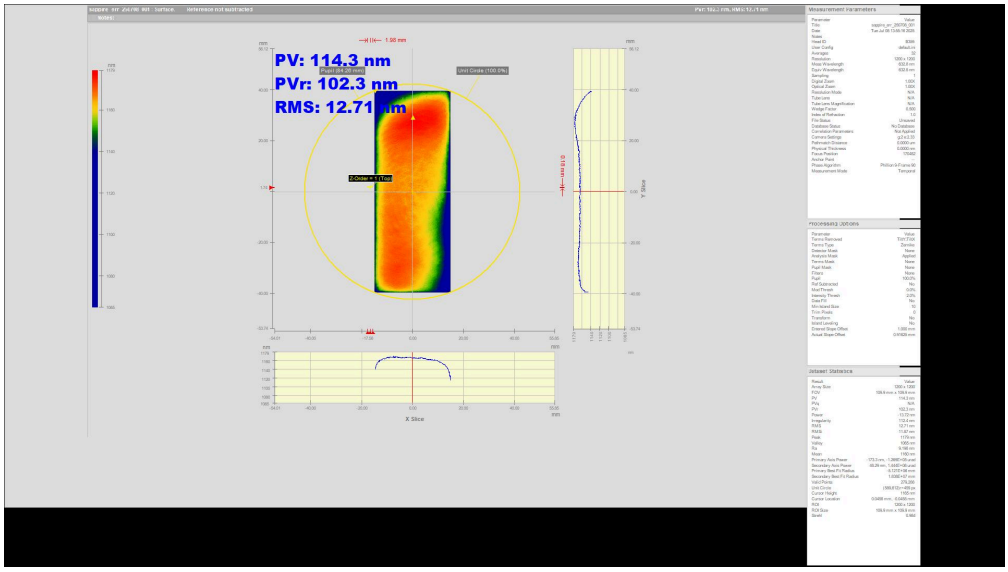


Measurement Results

Sapphire Ear (Prism)

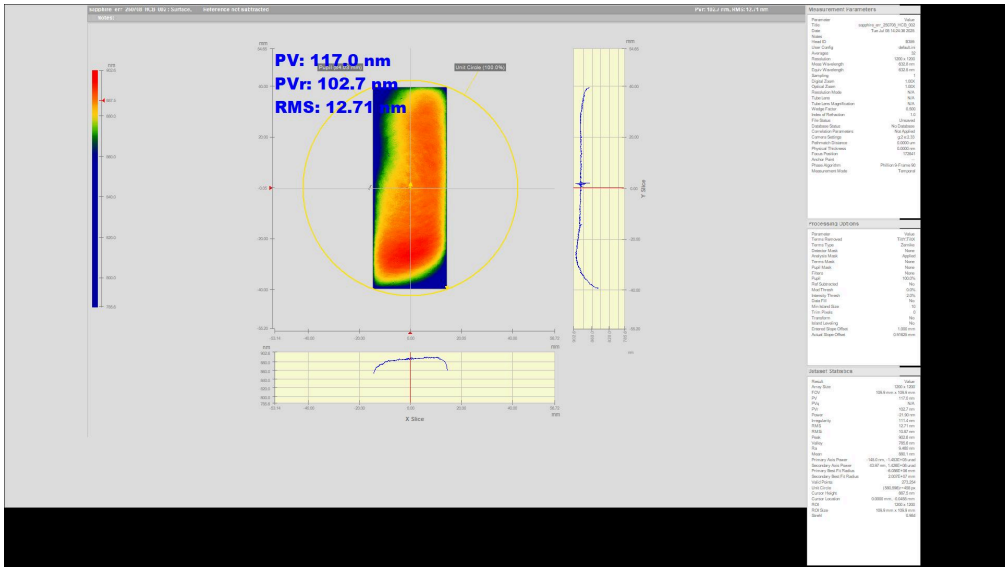


- HCB Surface (1st measurement)



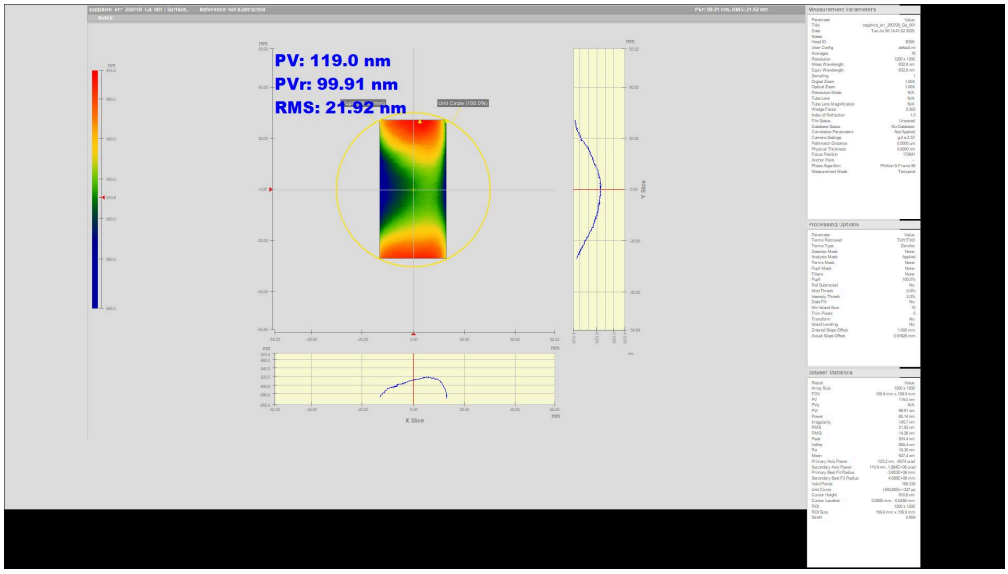
PV: 114.3 nm < $\lambda/5$ @ λ=632.8 nm
The edge appears slightly recessed, which is favorable for HCB bonding. A protrusion at edge would be problematic.

- HCB Surface (2nd measurement, flipped to test gravity effect)



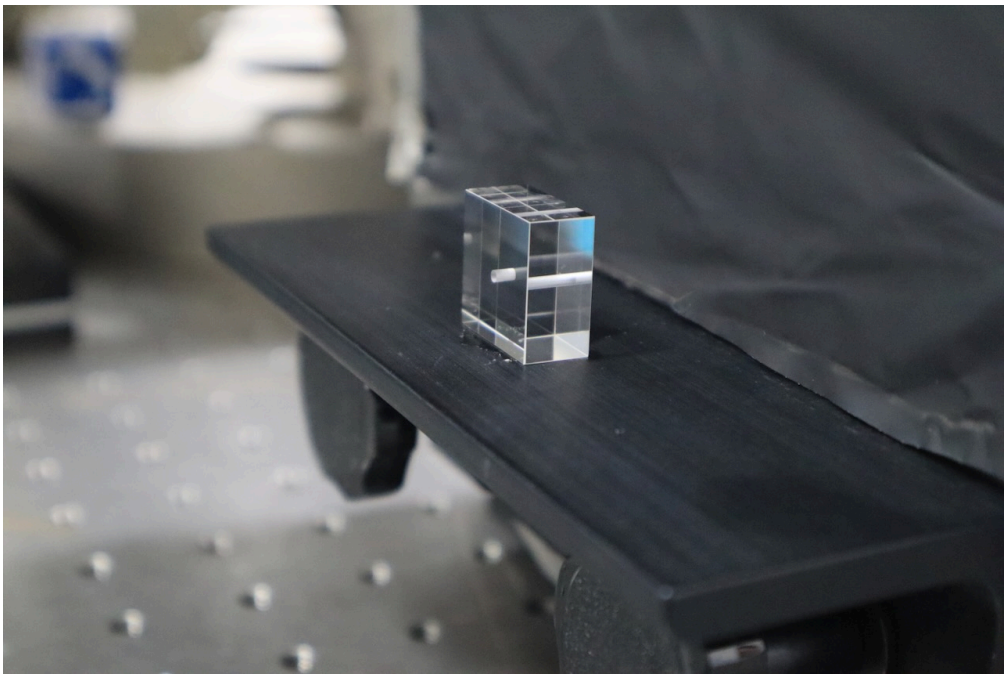
PV: 117.0 nm < $\lambda/5$ @ λ=632.8 nm
Results were consistent with the first measurement, showing an expected reversed shape.

- Ga Surface

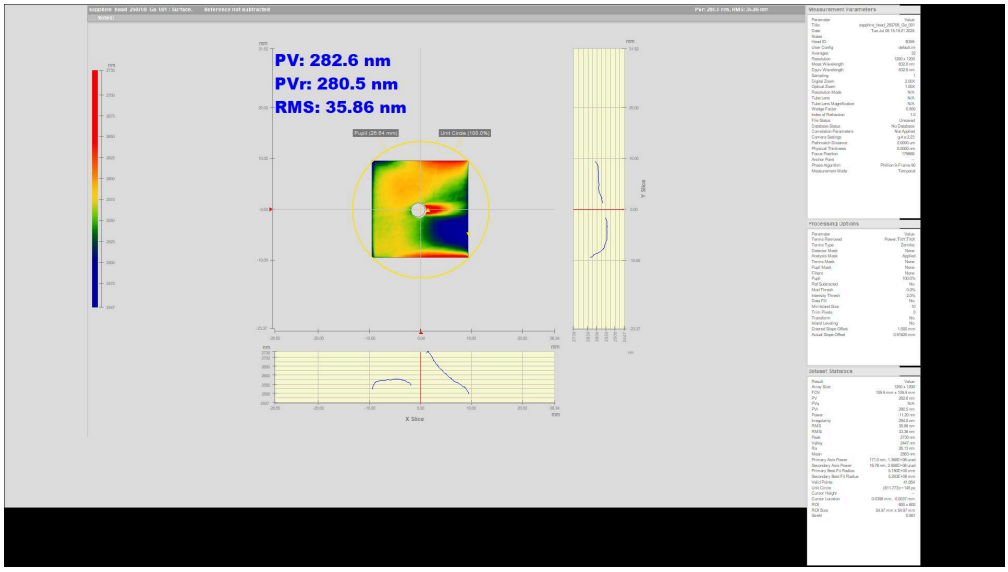


PV: 119.0 nm < $\lambda/5$ @ λ=632.8 nm
Better than expected surface quality.

Sapphire Nailhead



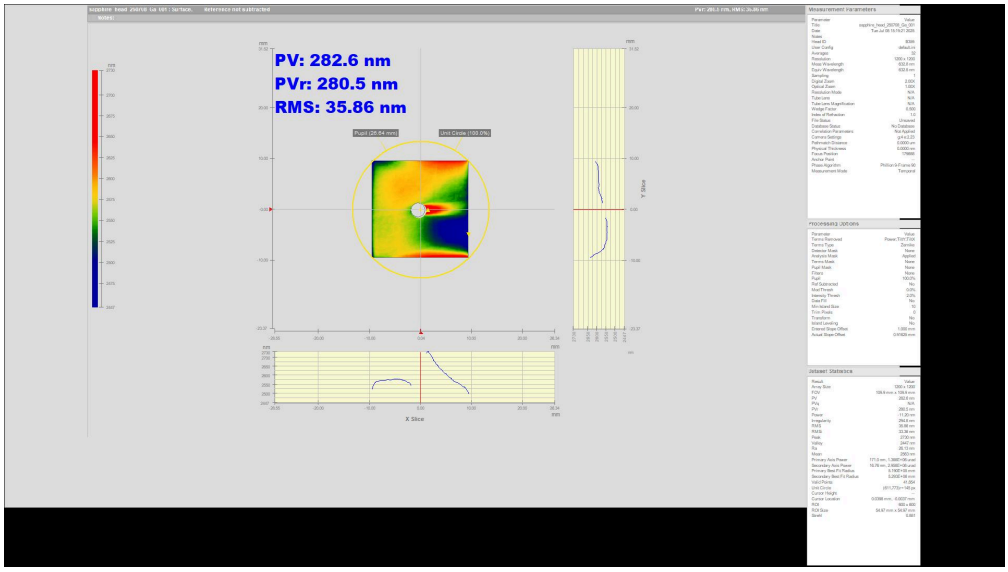
- Ga Surface A



PV: 282.6 nm < $\lambda/2$ @ λ=632.8 nm

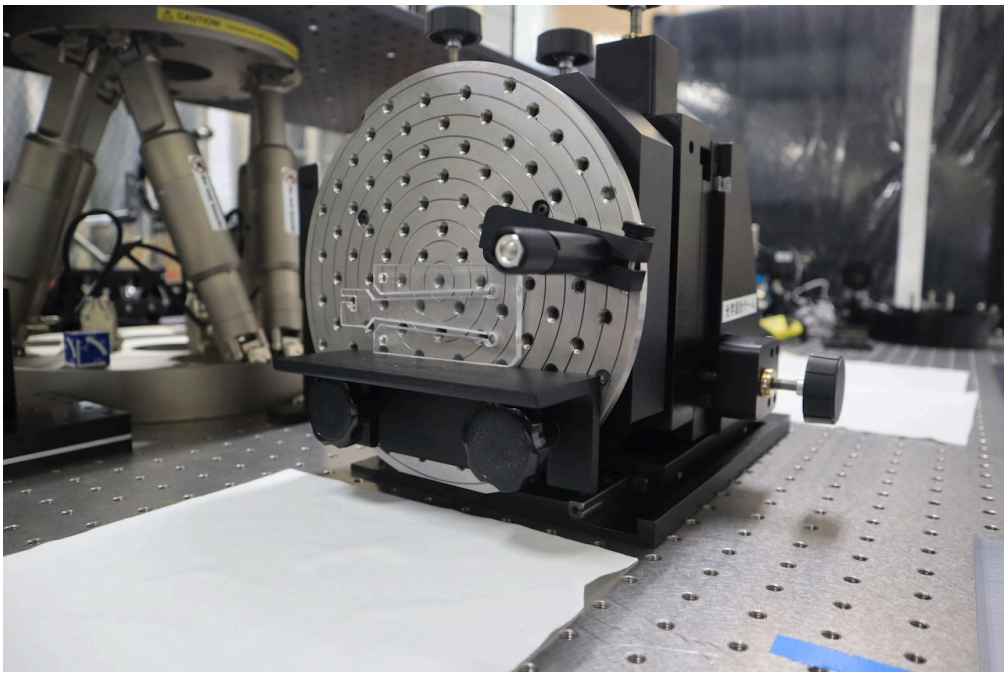
Some tail-like distortion near the central hole.

- Ga Surface B (back side of A)

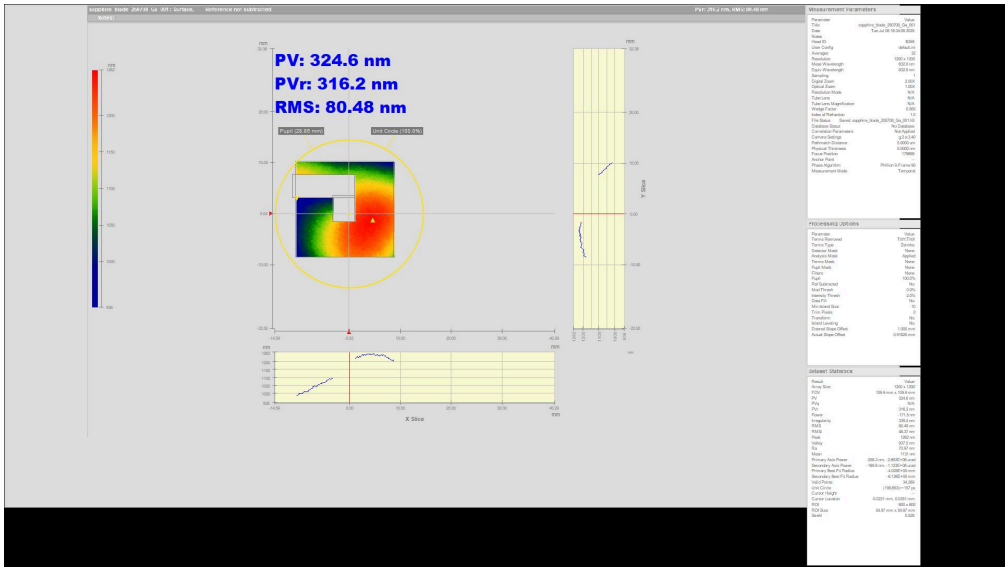


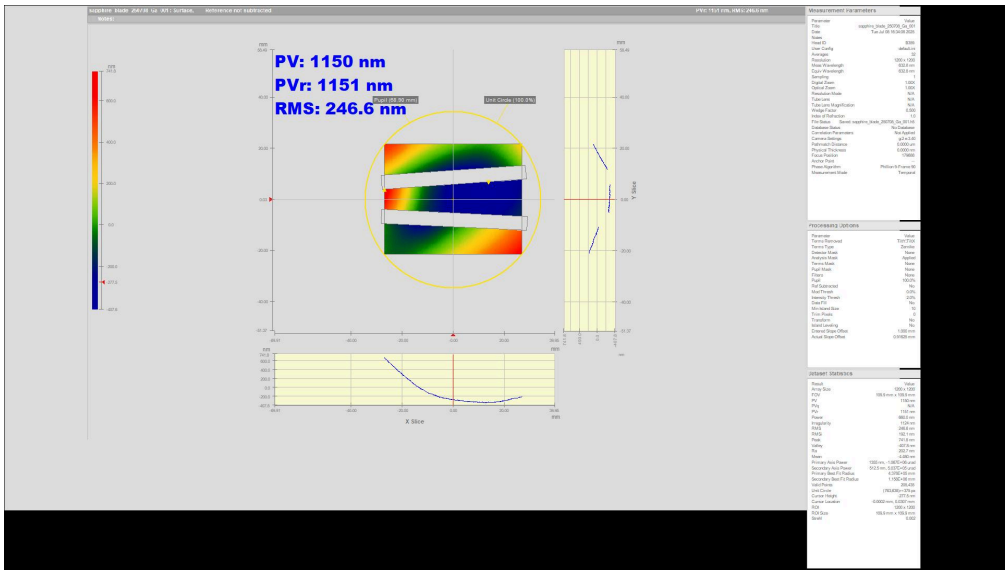
PV: 93.03 nm < $\lambda/6$ @ λ=632.8 nm

Sapphire Blade



- Surface A:

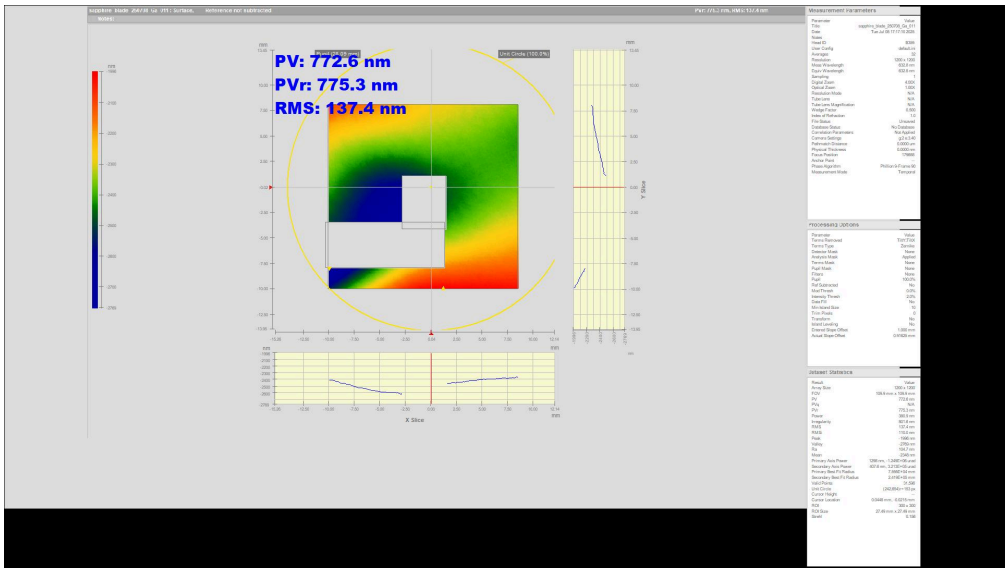


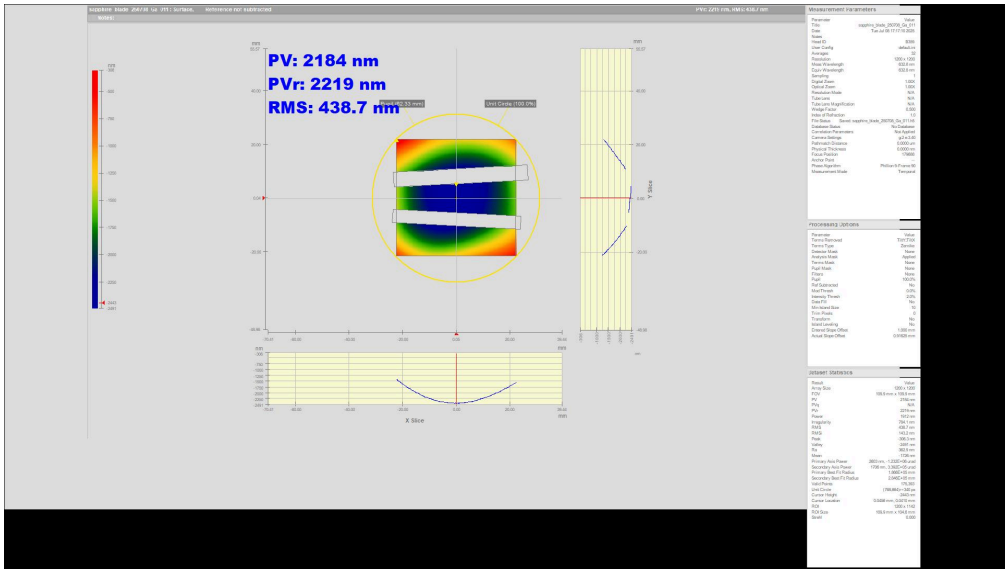


Ga region: PV = 324.6 nm < λ @ λ=632.8 nm

Other region: PV = 1150 nm < 2λ @ λ=632.8 nm

- Surface B (opposite of A):





Ga region: PV = 772.6 nm < 2λ @ λ=632.8 nm

Other region: PV = 2184 nm < 4λ @ λ=632.8 nm

Summary Table

Component	Measurement Area	PV [nm]	λ expression (λ=632.8nm)
Sapphire Ear	HCB Surface 1	114.3	PV < λ/5
	HCB Surface 2	117.0	PV < λ/5
	Ga Surface	119.0	PV < λ/5
Sapphire Nailhead	Ga Surface A	282.6	PV < λ/2
	Ga Surface B	93.03	PV < λ/6
Sapphire Blade	Surface A - Ga region	324.6	PV < λ

Component	Measurement Area	PV [nm]	λ expression (λ=632.8nm)
	Surface A - Other	1150	PV < 2λ
	Surface B - Ga region	772.6	PV < 2λ
	Surface B - Other	2184	PV < 4λ