

The Fizeau System Instrument at ALBA Optics Laboratory

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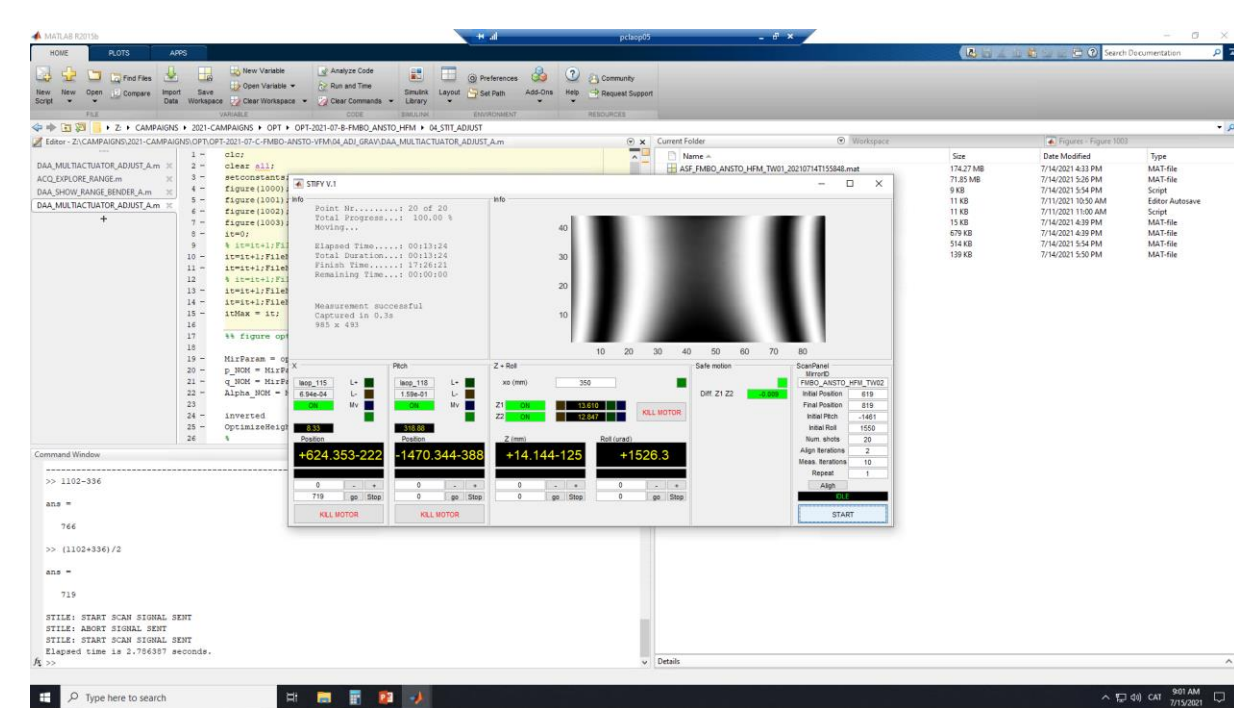
Abstract

ALBA optics laboratory has recently acquired a new Zygo Verifire HD Fizeau interferometer. The instrument has been integrated with a positioning stage to allow stitching measurements of long x-ray optical elements. The mechanical set up comprised of four axes allows for automatic positioning and alignment of the interferometer aperture with respect to the surface under the test (SUT). The longitudinal movement range allows for scanning of X-ray mirrors up to 1500 m long. The positioning platform includes two angles, roll and yaw, and two translations, vertical and longitudinal translations. The longitudinal translation is a custom designed linear stage. The yaw rotation is based on a sine arm mechanism. The vertical and roll motions are combined in a single stage, closely integrated around the main linear stage. The system reaches repeatabilities better than 1 μm or 1 μrad for all axes. System is mounted on top of a vibration isolated optical bench in the clean room of the laboratory. The control software of the instrument allows direct control of every individual axis, and allows selecting the center of rotation for both roll and yaw. The system includes inclinometers and autocollimators to control the relative orientation between the interferometer and the SUT. The positioning system is integrated with the software of the interferometer, and includes features for automatic alignment of the interferometer with respect to the mirror, or for automatic stitching acquisition with selectable parameters. System allows for full three-dimensional characterization of the optical surface of mirrors and gratings, and provides height map reconstructions with accuracy in the order of 1 nm, for flat or curved surfaces with lengths up to 1500 mm.



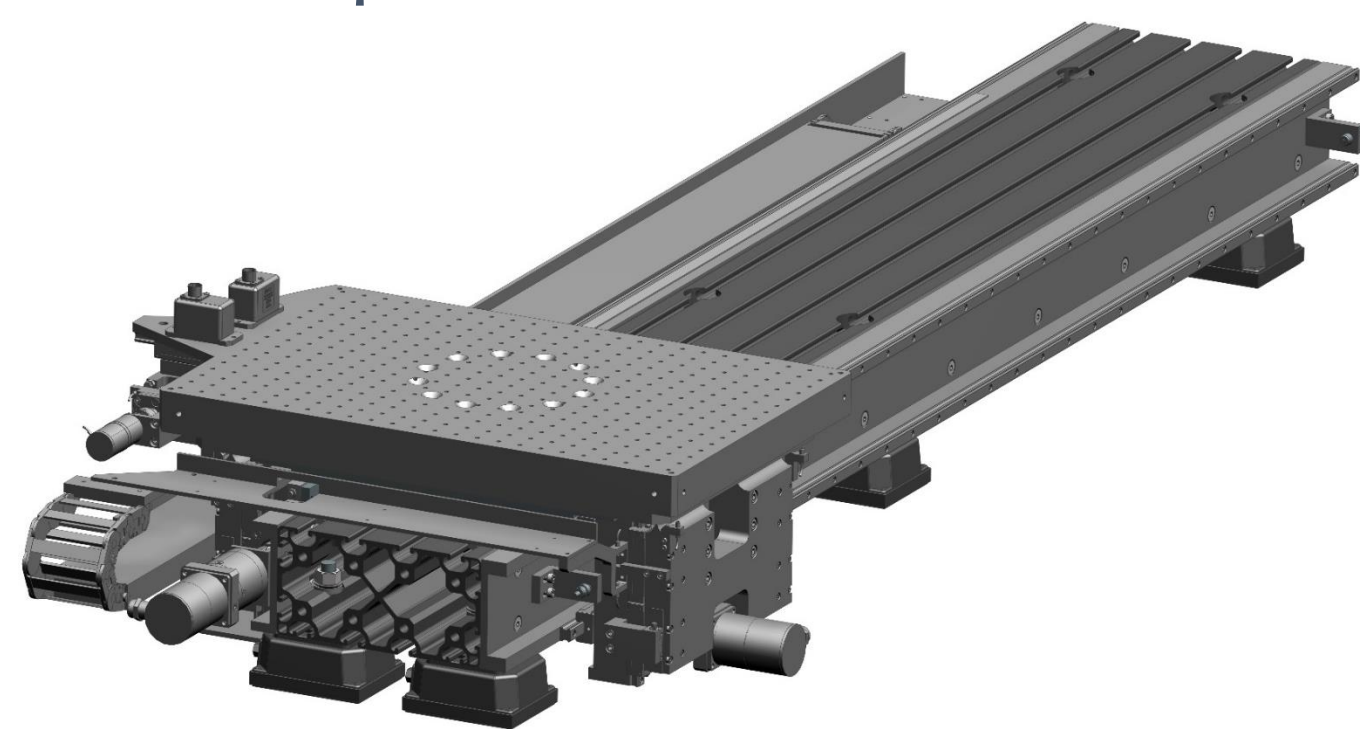
FIGEAU INTERFEROMETER

Zygo Verifire HD Fizeau interferometer
Accurate Optical Surface measurement



CONTROL SYSTEM

Automatic Instrument to optics alignment
Automatic measurement positioning



POSITIONING STAGE

4 DOF'S, up to 1,5 m longitudinal range
Optical aperture & stitching positioning

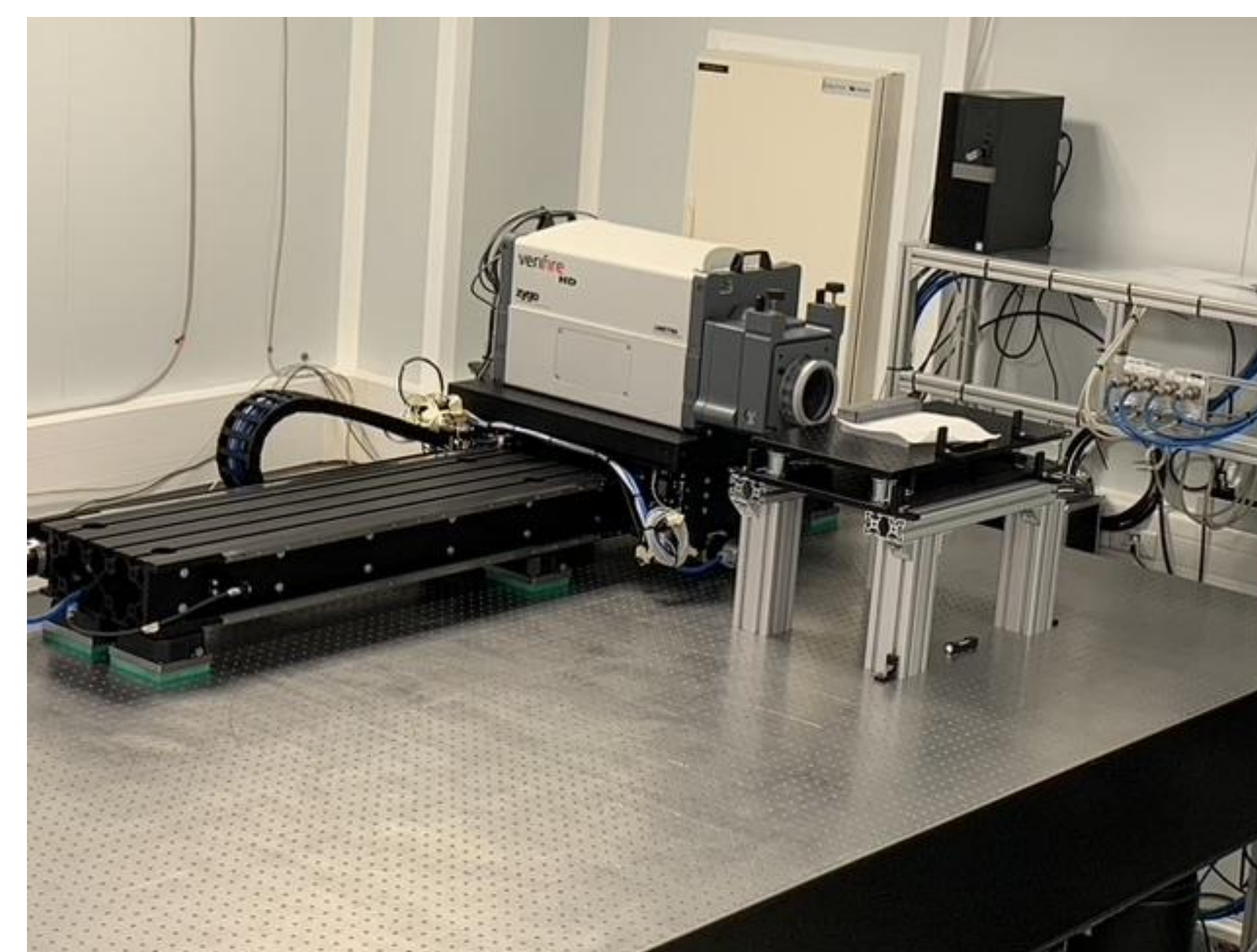


ISOLATION BENCH

Vibration isolation by means air bench
Clean Room enviroment stability

INTEGRATED SYSTEM

The measurement system is based on the integration of several elements giving to the instrument the adequate environment and tools to perform functional and accurate measurements. These are (i) a stable environment of the optical laboratory and the (ii) vibration isolation table and also the (iii) positioning stage with up to 1,5 m longitudinal scan range for stitching measurements, (iv) the control system and the measurement processing algorithms. All these factors enable acquisition and functional data analysis allowing determination of the main optical parameters of the optics under tests, and resulting in high resolution map reconstruction of the optical surface measured.



Fizeau Interferometer

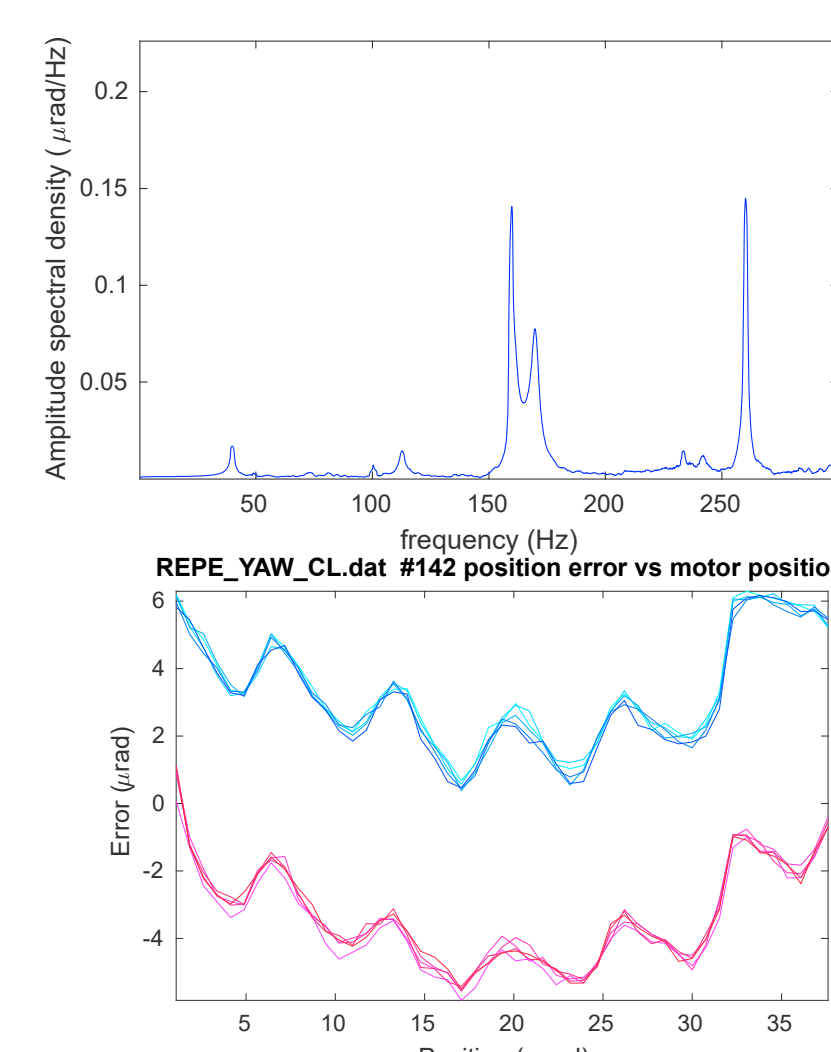
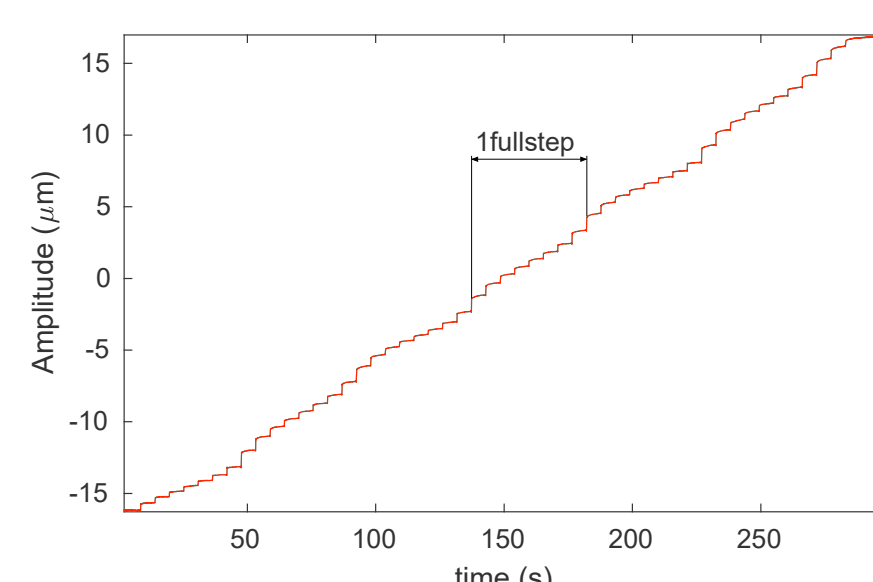
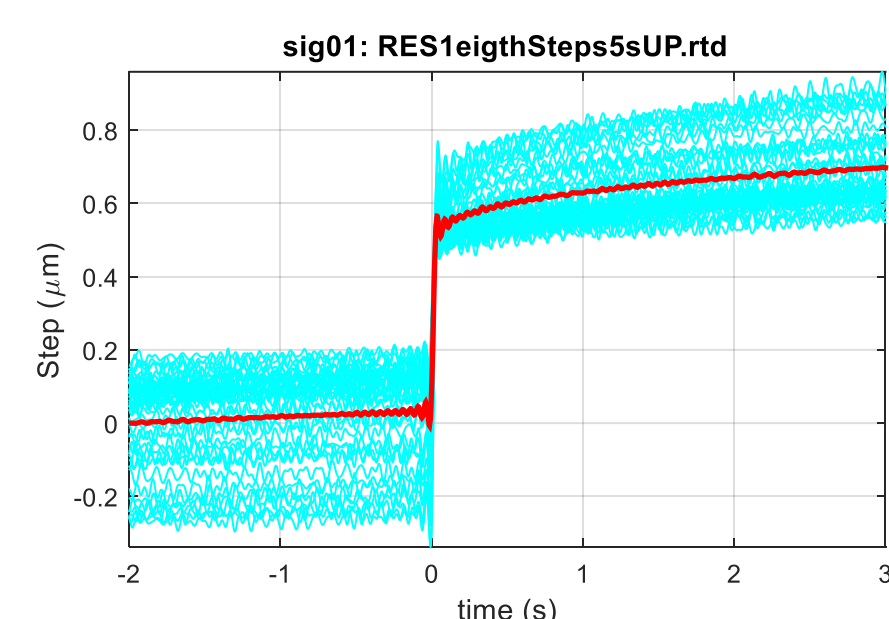
Clean Room

Isolation Bench

Positioning Stage

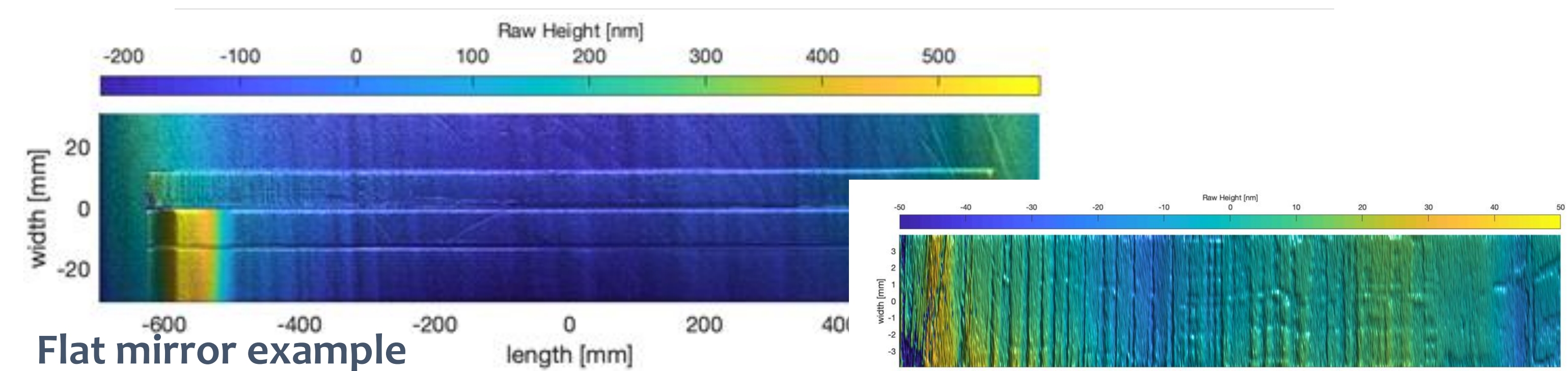
Instrument Controls

Data processing software



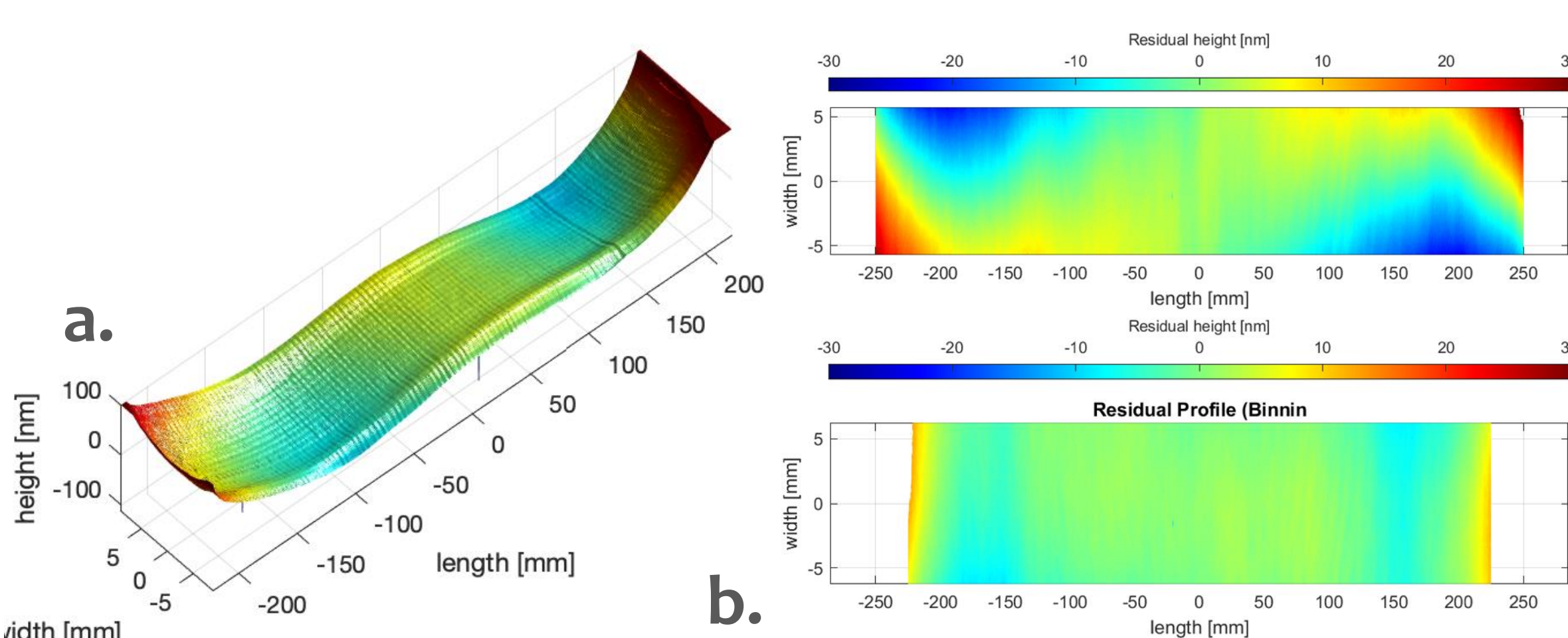
Positioning Stage metrology

Longitudinal positioning resolution about 0,7 μm .
Repeatabilities well below 1 μm (Long. 0,84 μm)

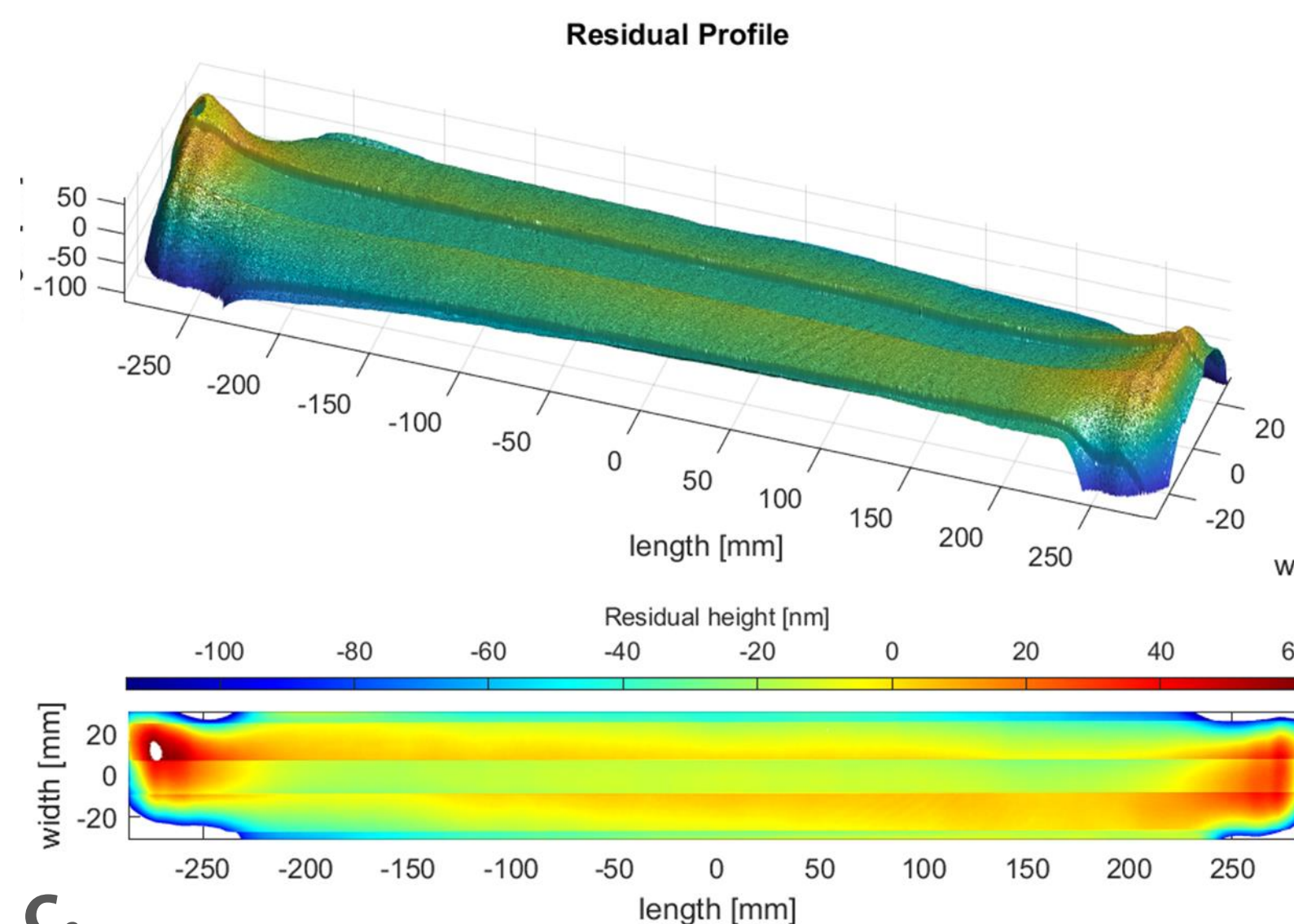


Flat mirror example

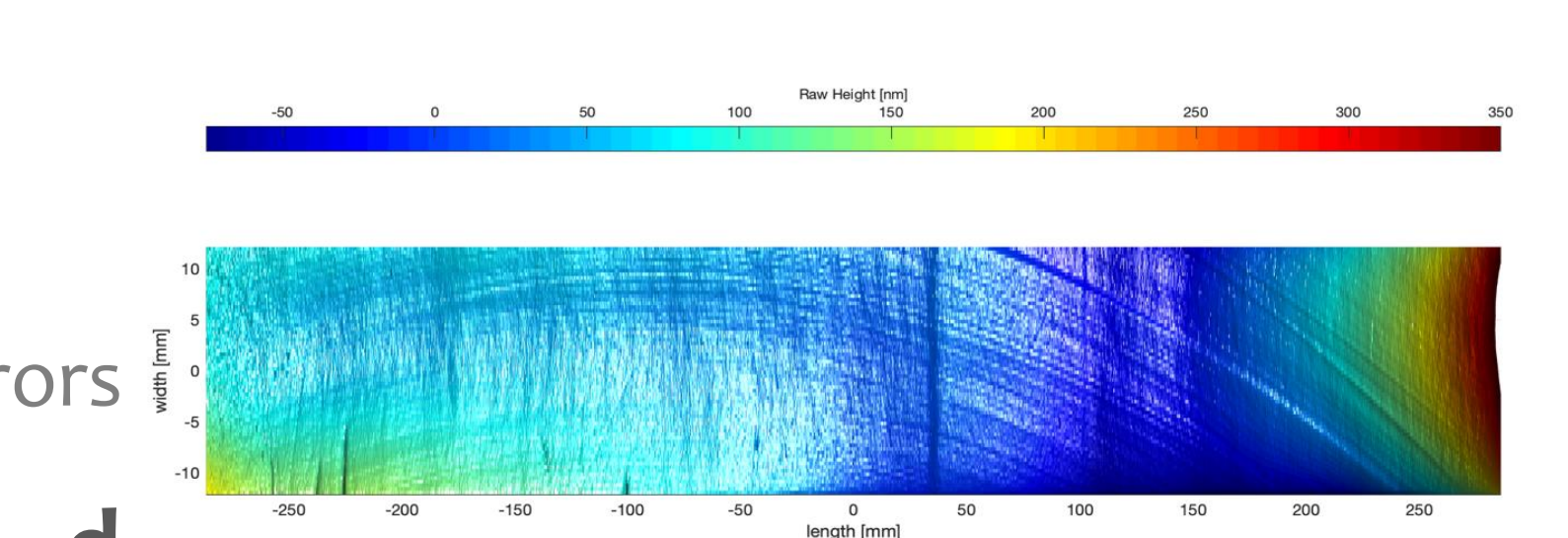
2D surface reconstruction of a 1,4m long flat mirror with spatial resolution of 0,09 mm, after the numerically calculated gravity sag subtraction. The high resolution measurement allows to distinguish even IBF passes during polishing overlapping (striation height of ca 5 nm).



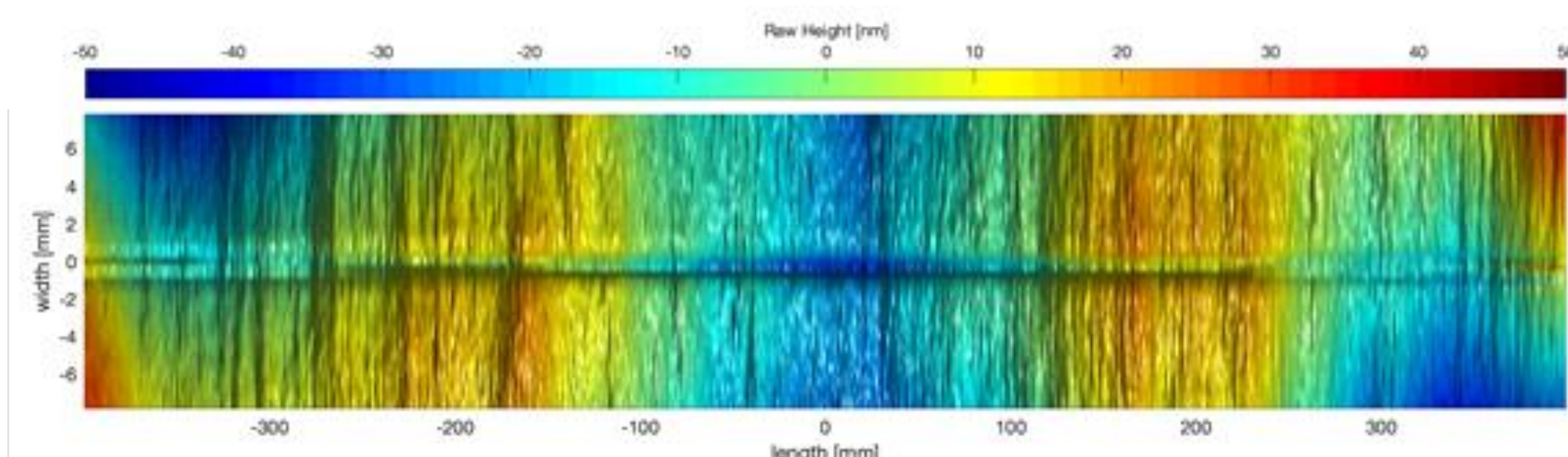
b.



c.



d.



Mirror with bender metrology example

Surface reconstruction of a 800 mm flat mirror at the nm level, after the the best fit meridional cylinder substruction. The measurement provides assessment of the sagittal radius of curvature and of the sagittal slope error

Examples of Surface map reconstruction

- Periodic, pattern, errors due to the IBF polishing mirrors
- Example of Twist correction for a 500 mm long mirror
- Effects of the clamps on the mirror
- Characterization of some features for traditional polished mirrors

Conclusions

- The ALBA optics laboratory metrology capacity has been promoted with acquisition of a new Fizeau Interferometer
- The Instrument have been integrated mechanically and with a control system synchronized with the Instrument control interface allowing the automatic alignment of the interferometer to the optical surfaces of SUT
- Data analysis software allow for a quick extraction of the main optical parameters of the optical surface being measured with high precision and resolution. This enables highly detailed surface map reconstruction of the measured optics, even able of not only measuring the optical parameters but also surface errors and features of the polishing process, clamping, mounting deformations, etc...

Acknowledgments

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References

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