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Remote *in situ* monitoring of weak distortions

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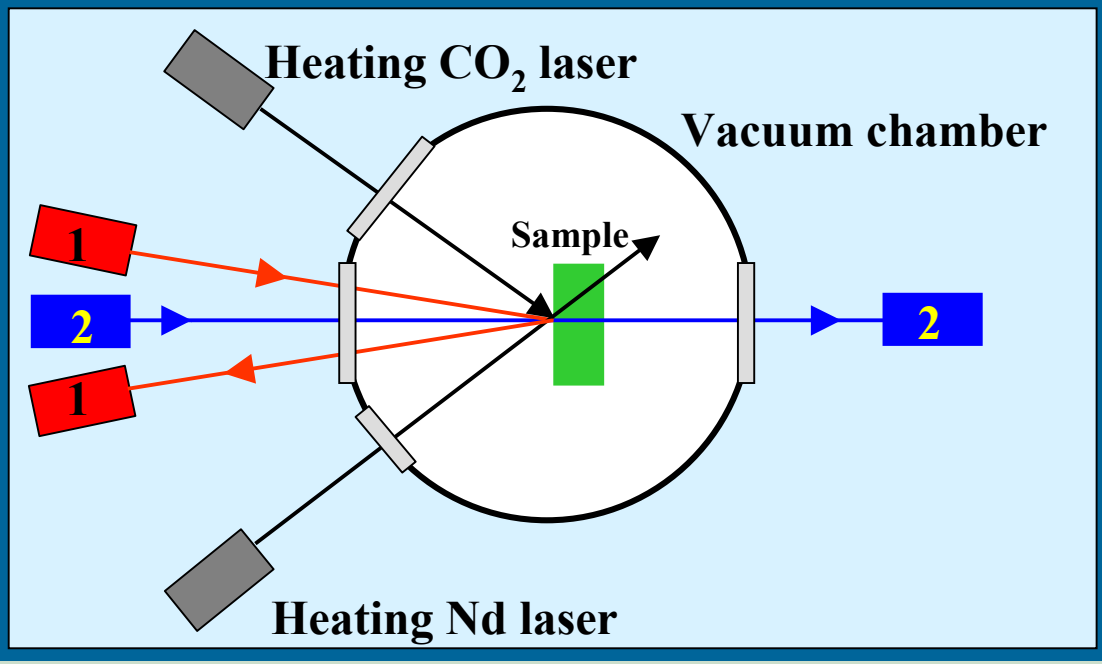
Current Research

- **Remote *in situ* monitoring of weak distortions emerging under auxiliary laser heating similarly to what is expected in advanced LIGO core optics**

- **Proposal for remote *in situ* monitoring of weak distortions of ETM.**

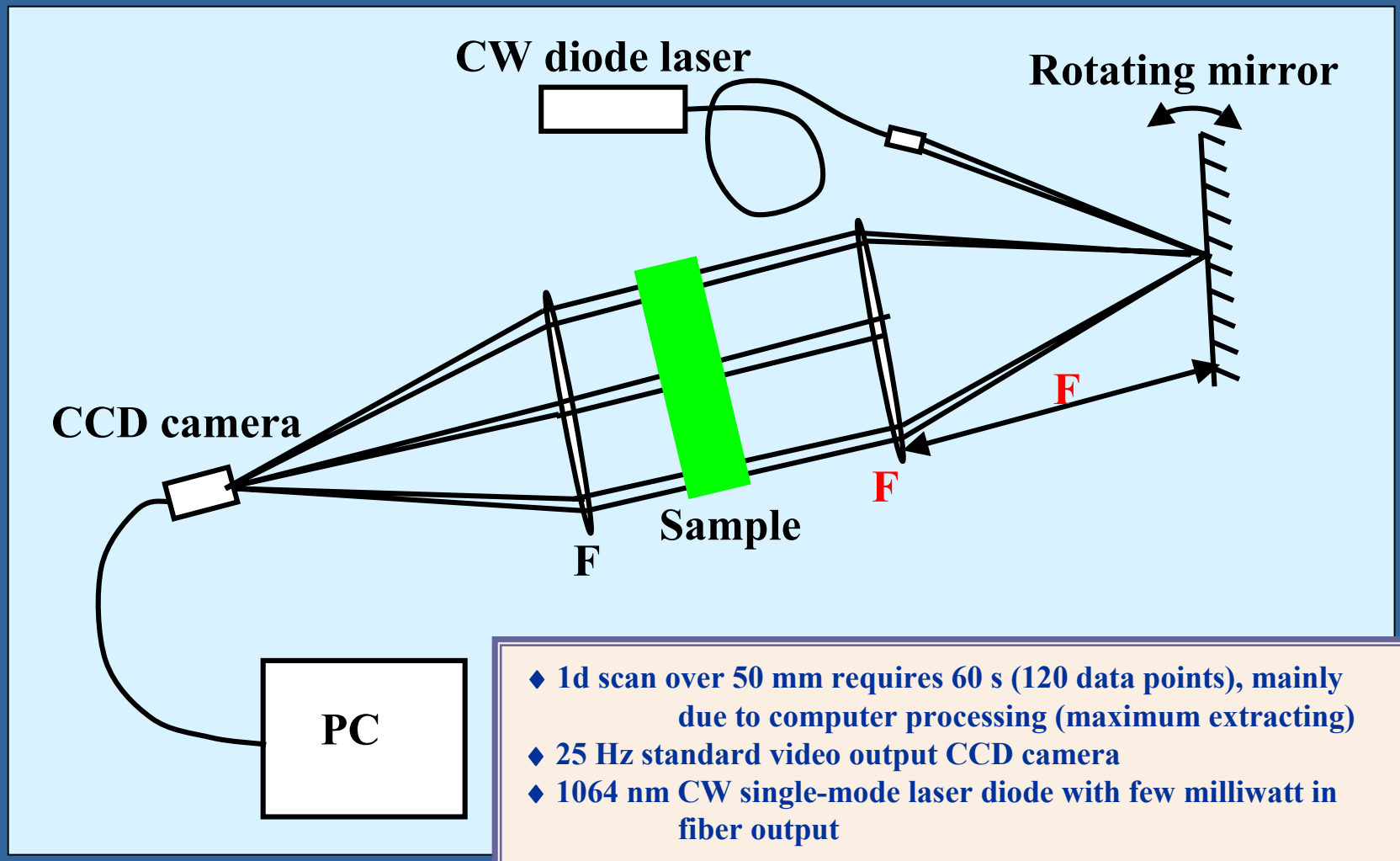
Remote *in situ* monitoring of weak distortions emerging under auxiliary laser heating



1 - WLPMI
2 - NHS and PIT

- Optical sample bulk heating by the fundamental or second harmonic of Nd:YAG laser at a power of 10-20 W
- Surface heating with the use of a CO_2 laser at power of several Watts
- Inducing contamination of a small region (characteristic size of 20-100 micron) on the optical element's surface and focusing of low-power laser radiation (<100 mW) on it

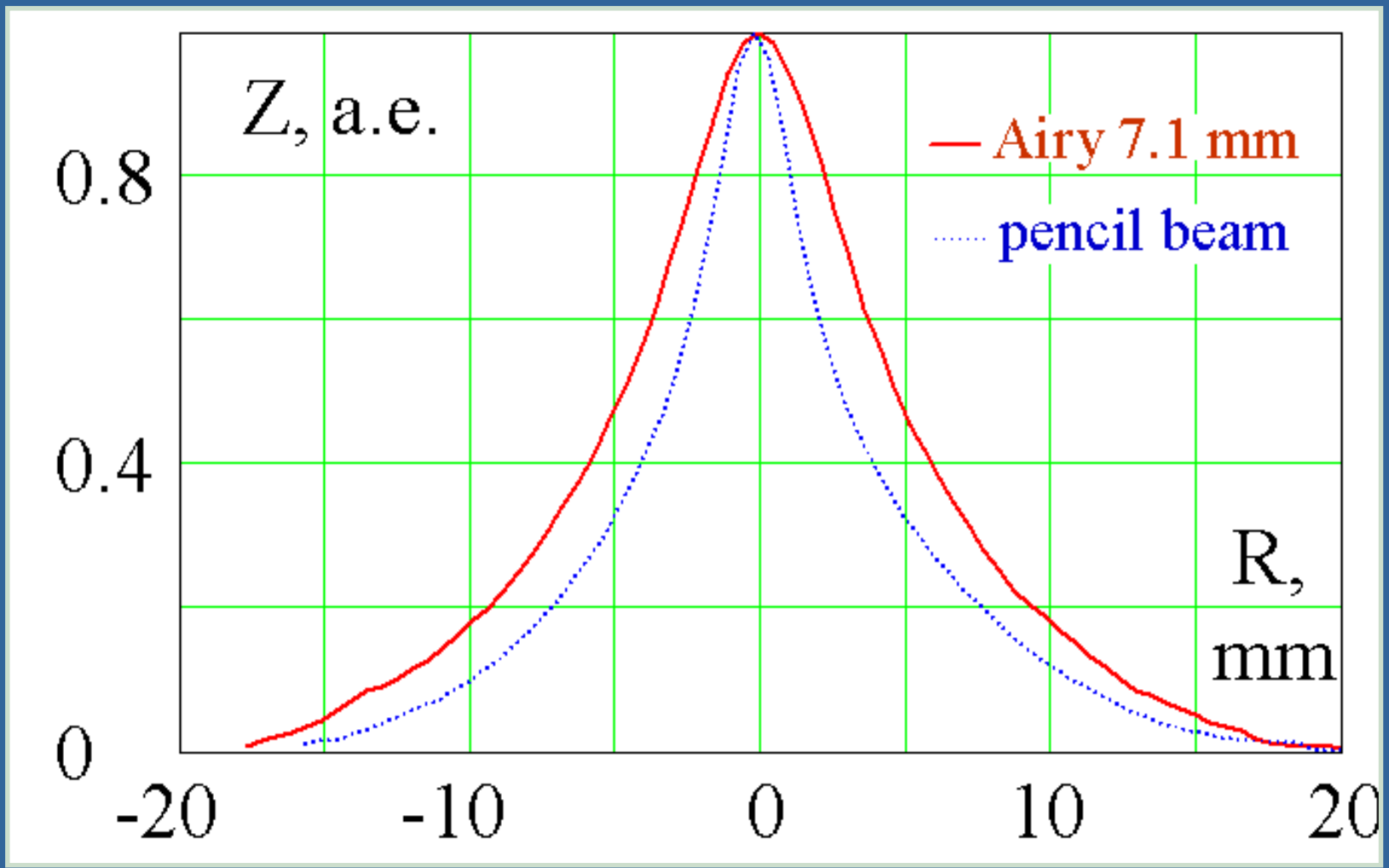
Scanning Linear HartmannTechnique



- 1d scan over 50 mm requires 60 s (120 data points), mainly due to computer processing (maximum extracting)
- 25 Hz standard video output CCD camera
- 1064 nm CW single-mode laser diode with few milliwatt in fiber output

Optical depth profile measured with scanning linear Hartmann sensor for two heating beam :

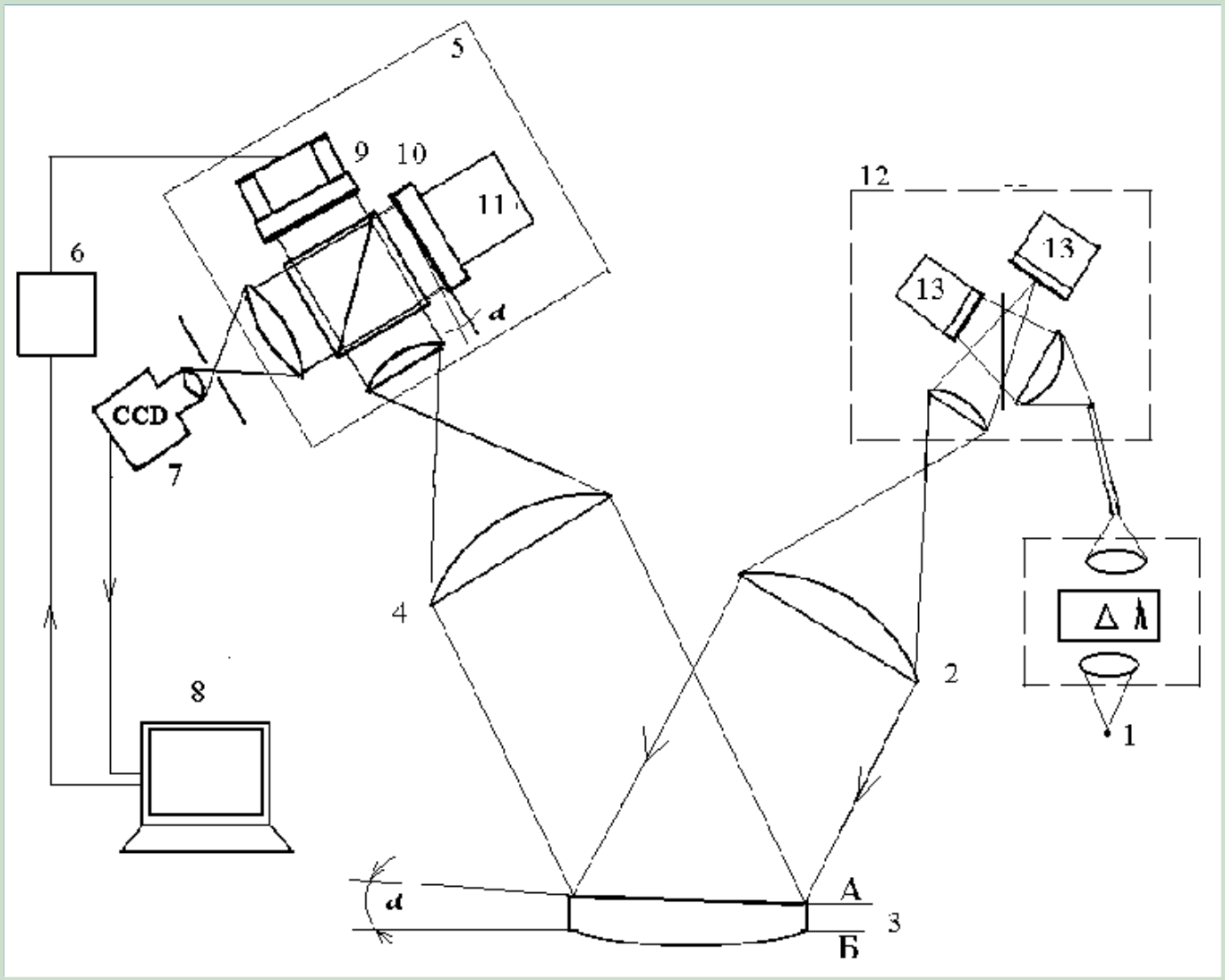
7mm Airy and 1 mm pencil structures



White Light *In Situ* Measurement Interferometer (WLISMI)

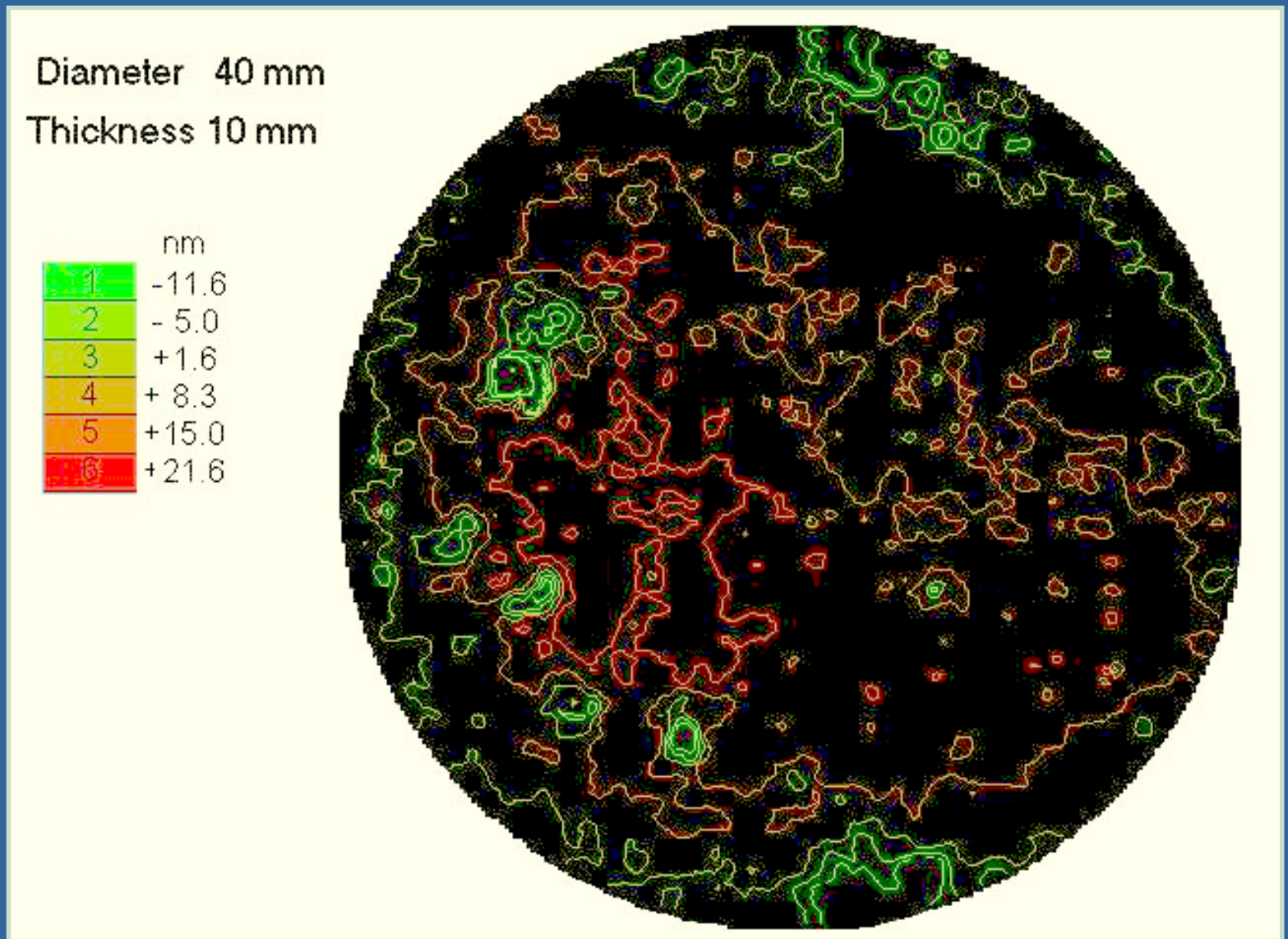
Standard interferometers	Proposed interferometers
Measurement of optical length of air spacing between two surfaces. In profilometers one of them is a sample surface, and the other is a reference surface. The problem of precise measurement of phase in the interferogram is solved by phase modulation according to a known time law.	The proposed method relies on measurements of the phase of interferogram of radiation reflected **from two surfaces of one sample** under study. The precise phase measurements are ensured by the **modulation** of the probing radiation **spectrum**. The method provides a two-dimensional pattern of a sample's **optical thickness distribution** simultaneously over the whole aperture. The method is applicable to **remote testing** of optical elements with flat, spherical and cylindrical surfaces, and also with a wedge between them.

White Light *In Situ* Measurement Interferometer. Experimental setup

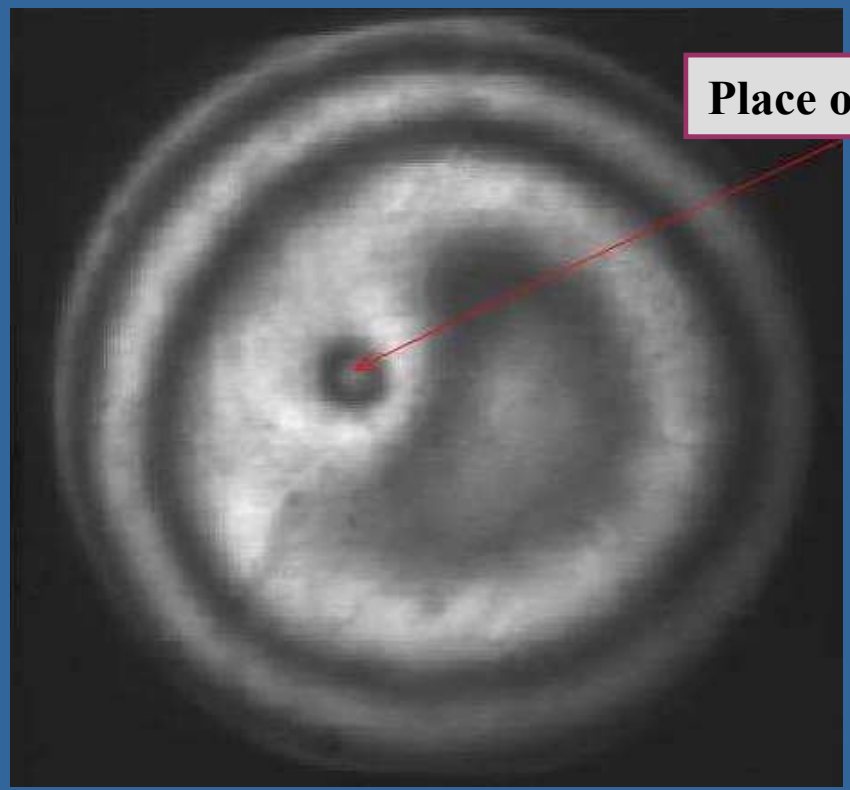


1 - light source;
2 - objective;
3 - sample;
4 - ocular;
5 - measurement interferometer;
6 - unit for synchronization and control;
7 - CCD camera;
8 - PC computer;
9 - modulating mirror;
10 - adjusting mirror;
11, 13 - motors;
12 - wave front shaper

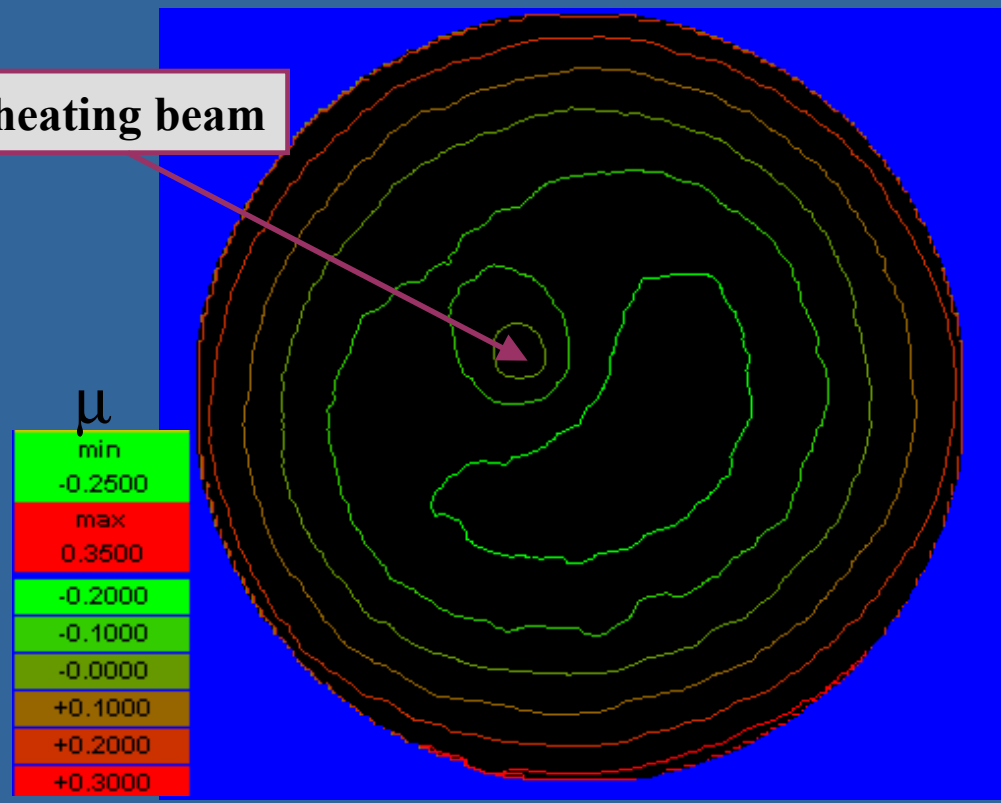
White Light *In Situ* Measurement Interferometer Phase Map



Phase map of optical sample heated by CO_2 laser



Place of heating beam

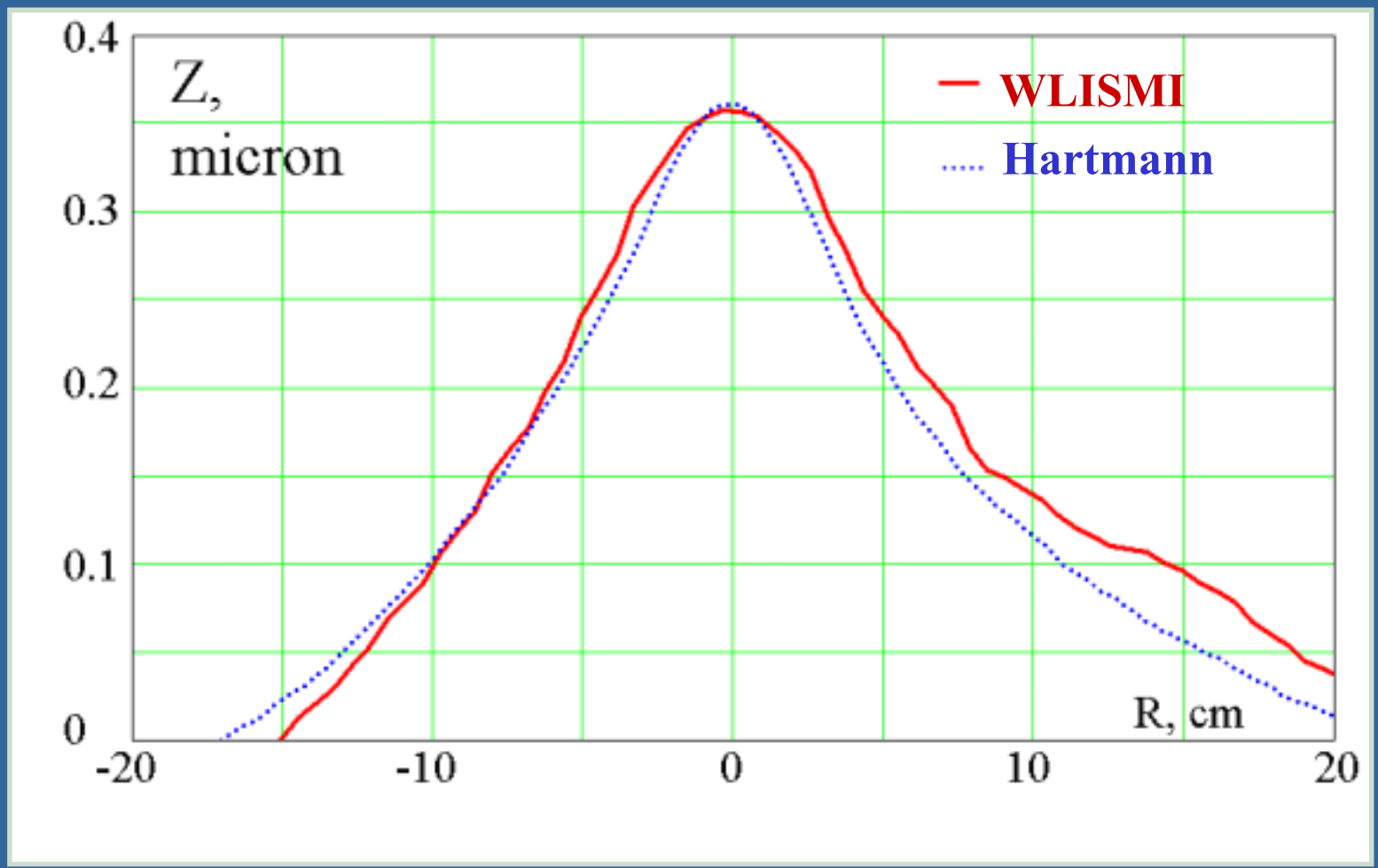


Thickness - 15 mm
Diameter - 85 mm

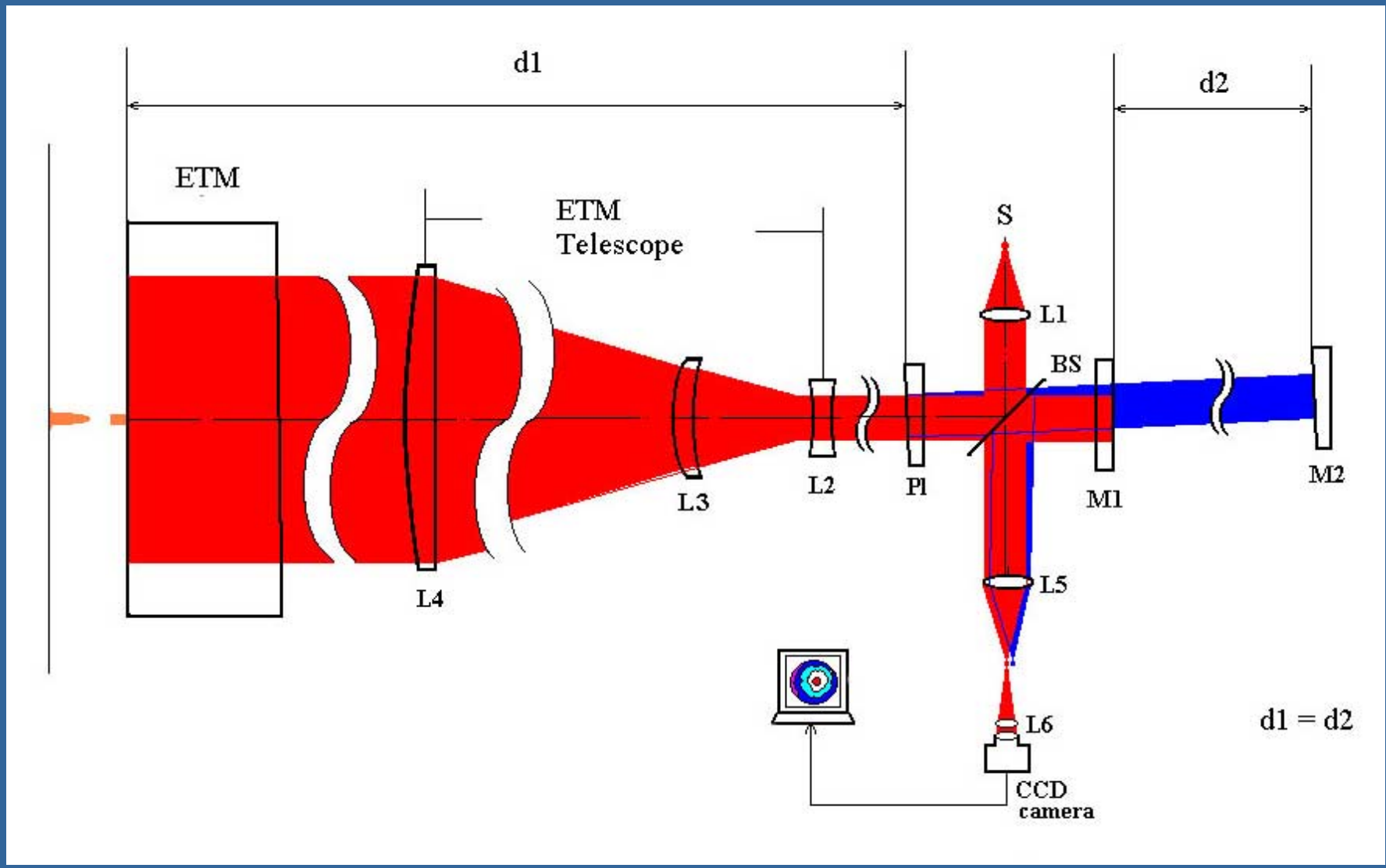
Simultaneous measurements of optical depth profiles under heating using two different techniques

CO_2 laser - 120 mW

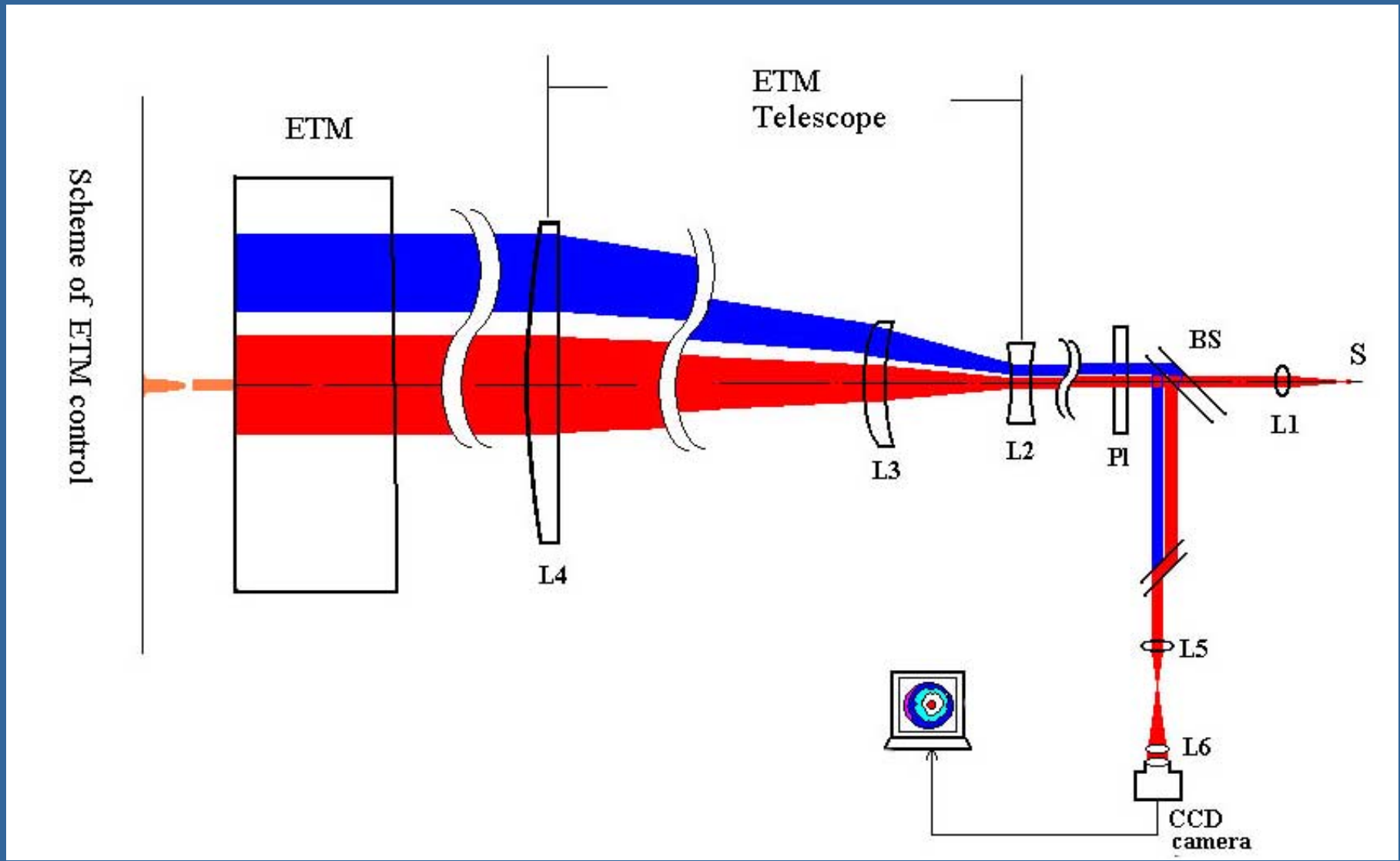
Beam size - 7 mm



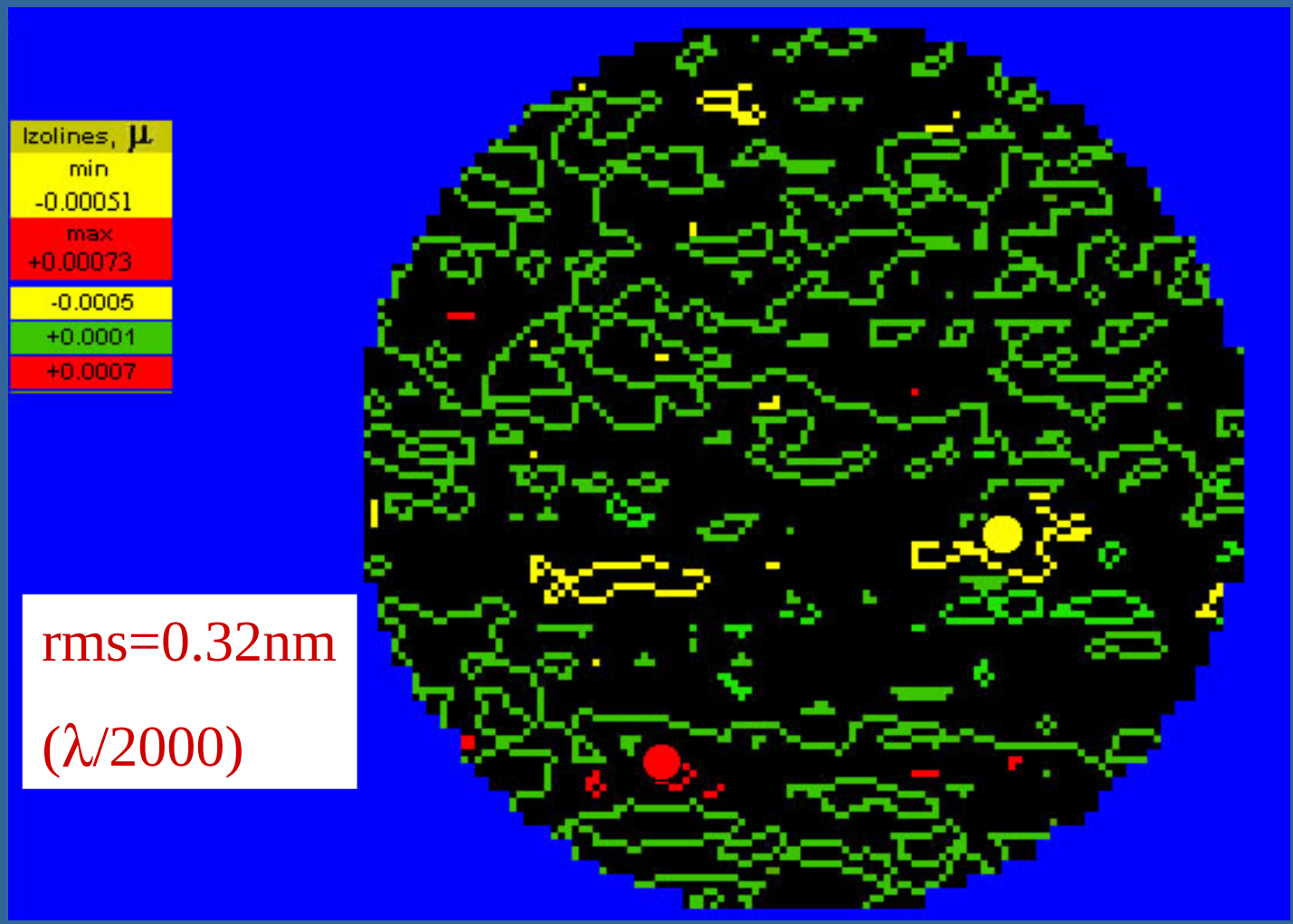
White Light *In Situ* Measurement Interferometer. How to install in LIGO interferometer?



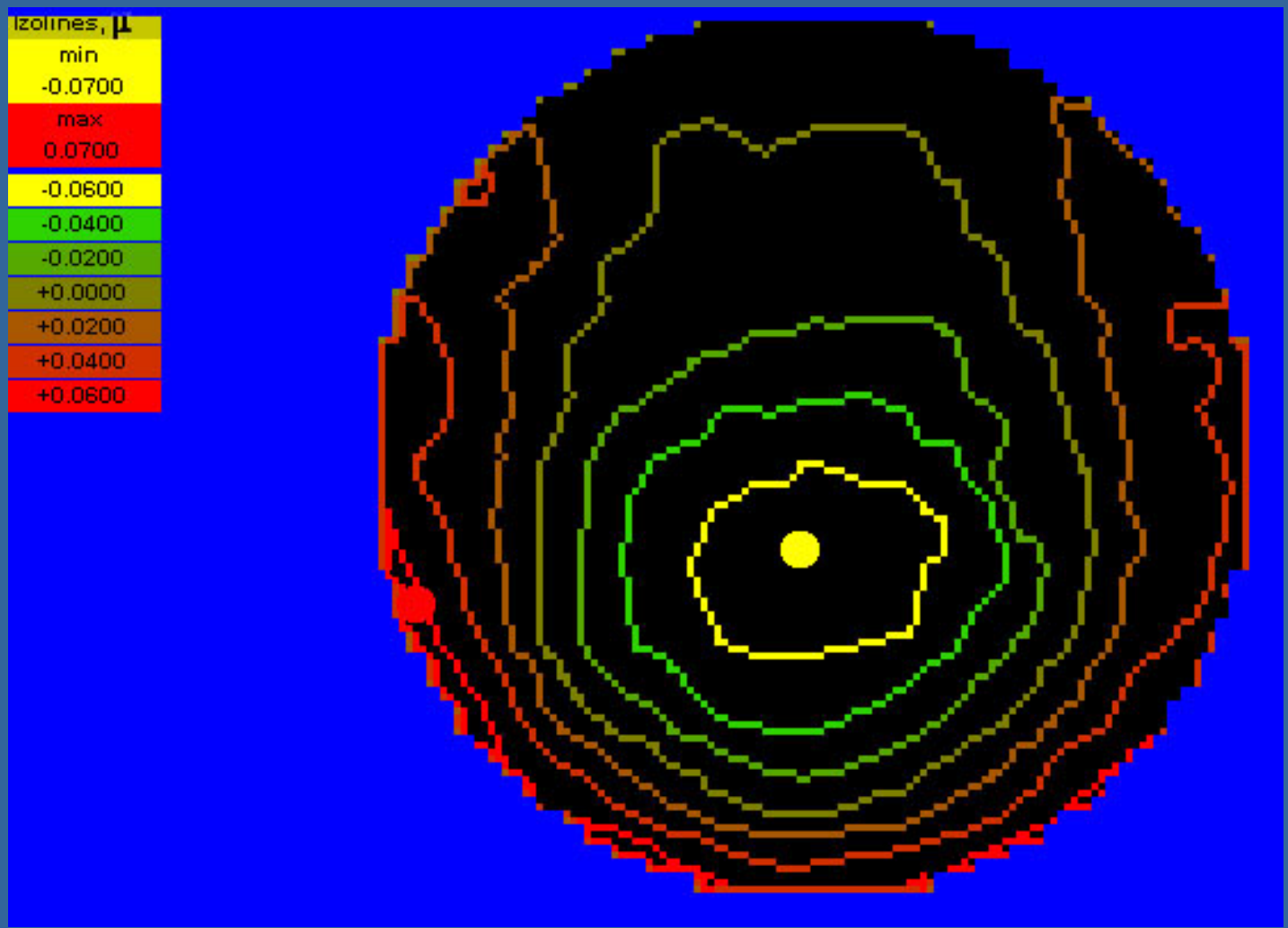
White Light *In Situ* Measurement Interferometer. How to install in LIGO interferometer?



Experimental results. No heating.



Experimental results. Heated by CO_2 laser.



Conclusion

- **LIGO-IAP Lab has been equipped with several instruments developed at IAP for High-Precision Characterization of LIGO Optical Components**

- **25 cm aperture white-light phase-modulated interferometer (WLPMI) for preliminary control of LIGO Core Optics has been implemented**

- **Simultaneous measurements of optical depth profiles under heating using two different techniques have been performed**

- **Version of WLPMI for installation on end station is tested experimentally.**