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Preliminary and remote *in situ* monitoring of weak distortions in Core Optics

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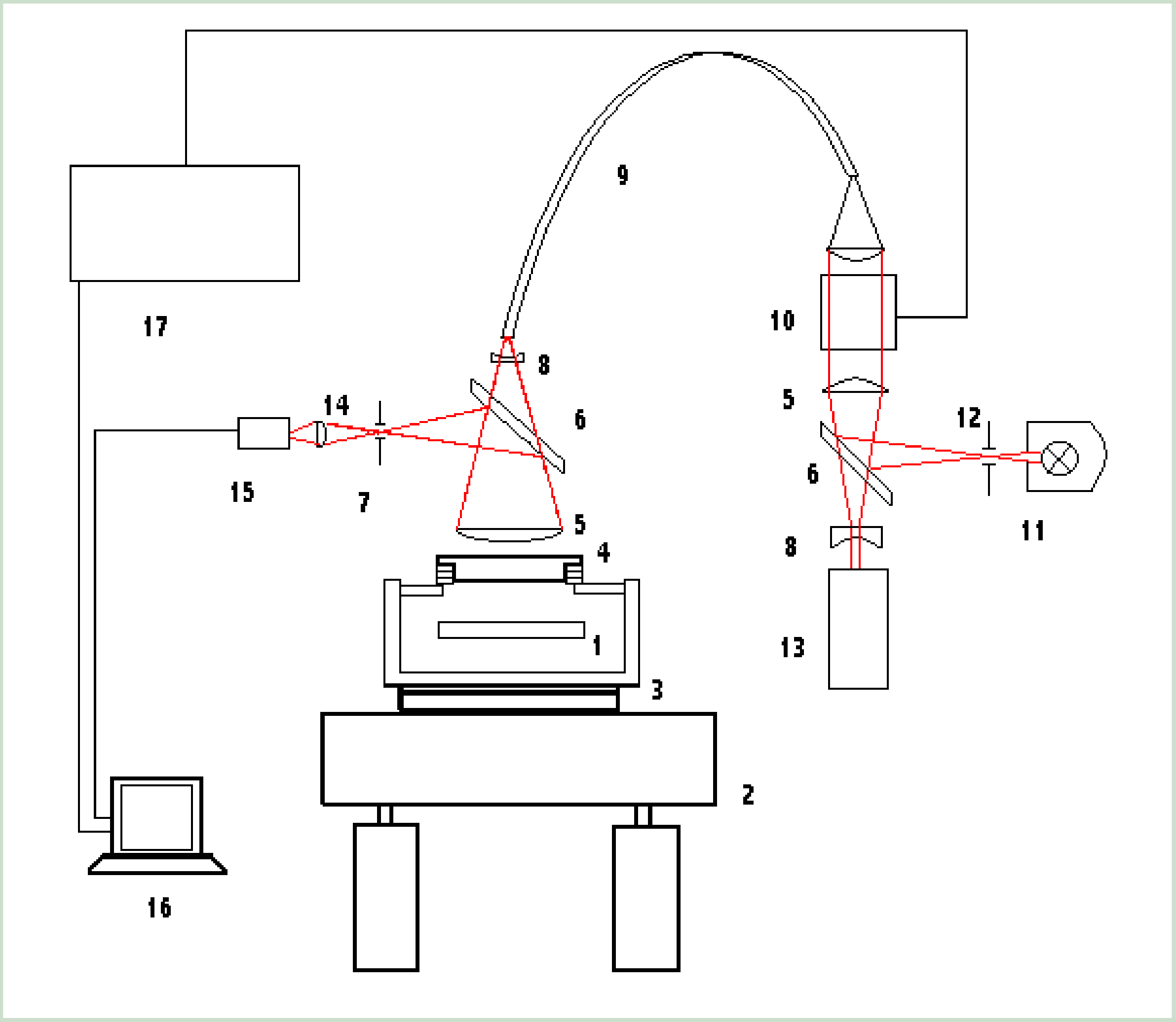
- **Preliminary monitoring of Core Optics with λ/1000 accuracy.**

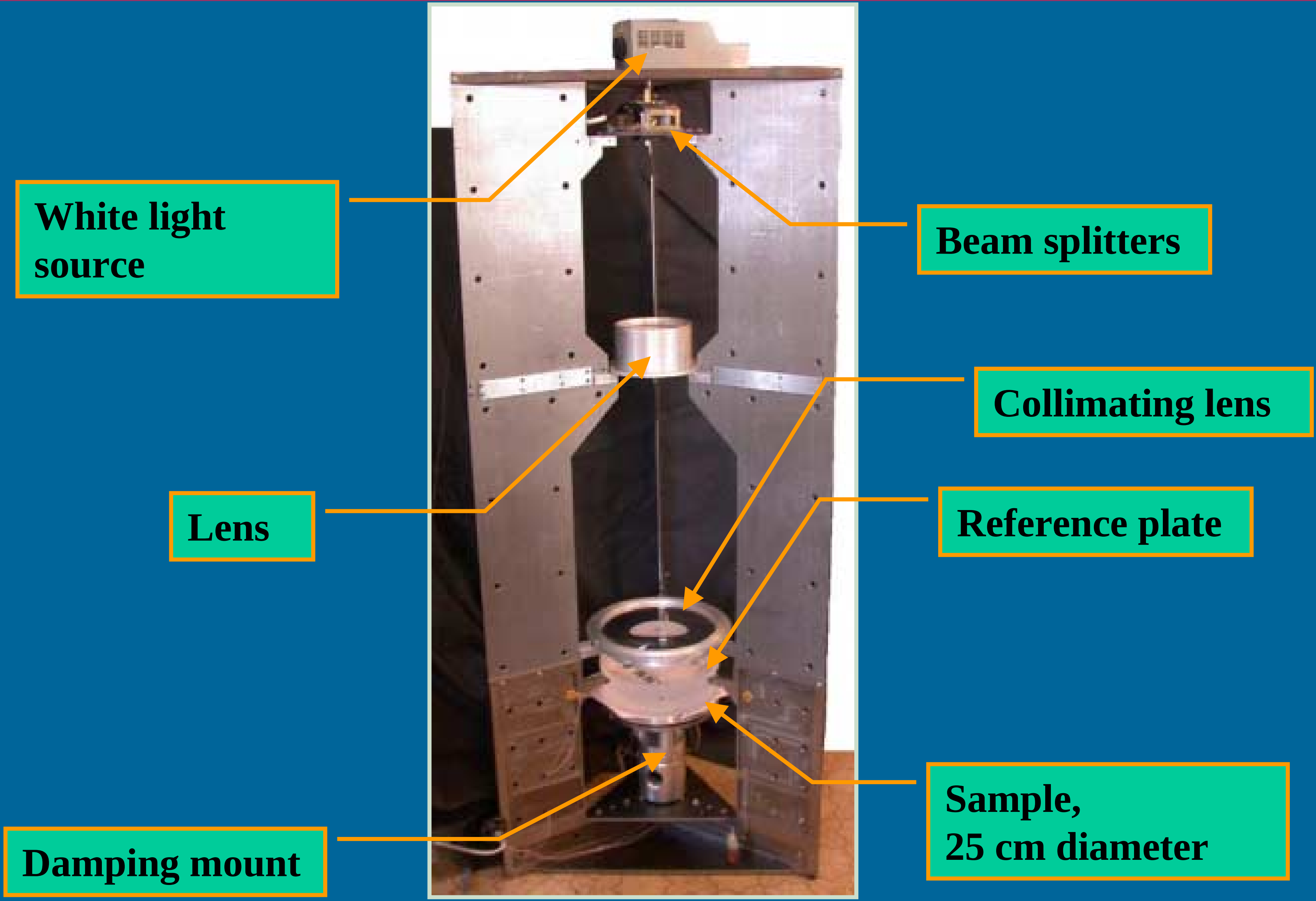
- **Remote *in situ* monitoring of weak distortions of End Test Mass.**

Large aperture white-light phase-modulated interferometer (WLPMI) for preliminary control of LIGO Core Optics

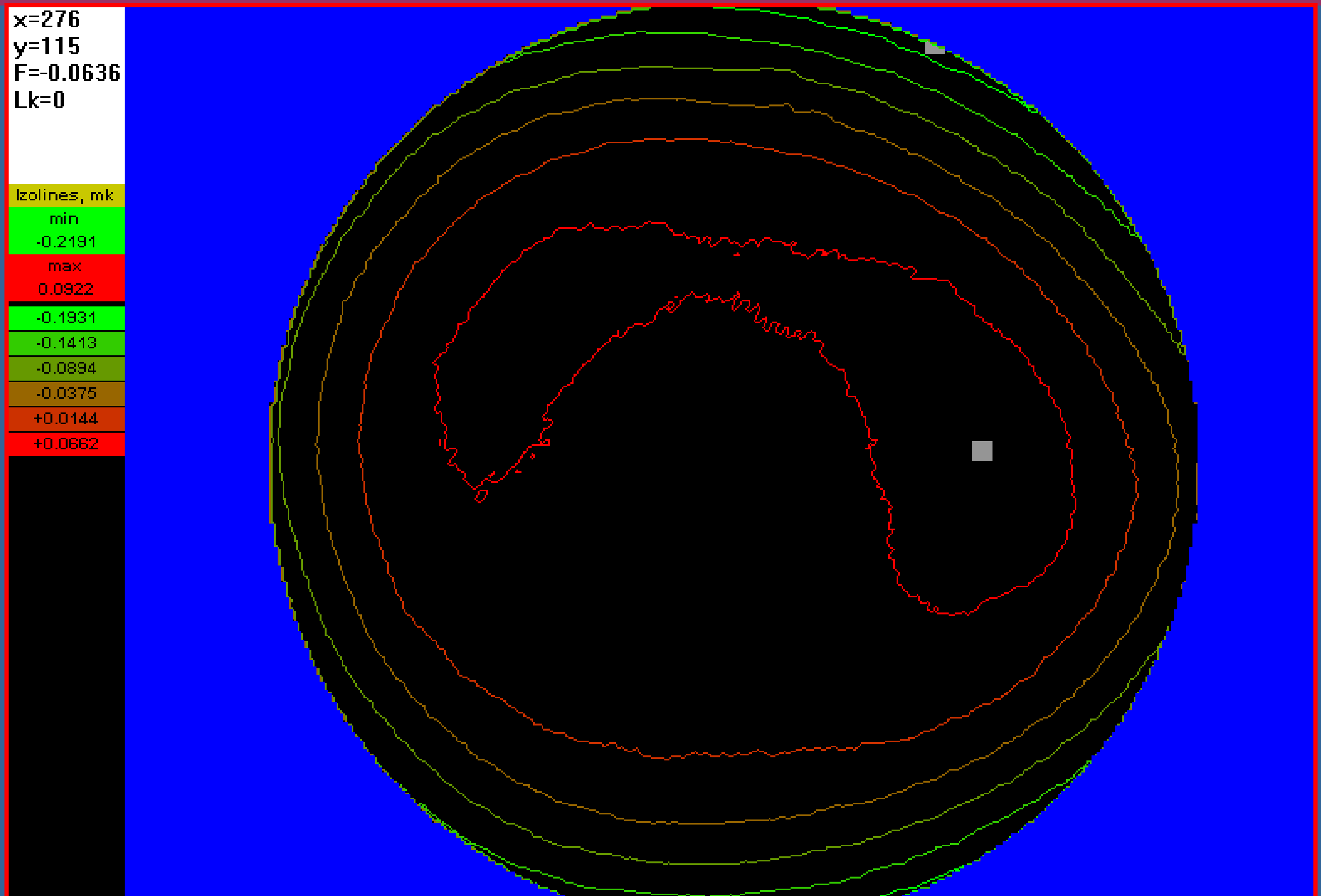


1 – sample
2 – optical table
3 – damping mount
4 – reference plate
5 – collimating lens
6 – beam splitters
7 – spatial filter
8 – lenses
9 – fiber bundle
10 – spectral modulator
11 – white light source
12 – aperture
13 – He-Ne laser
14 – projection lens
15 – CCD-camera
16 – computer
17 – control unit

Large aperture white-light phase-modulated interferometer (WLPMI) for preliminary control of LIGO Core Optics



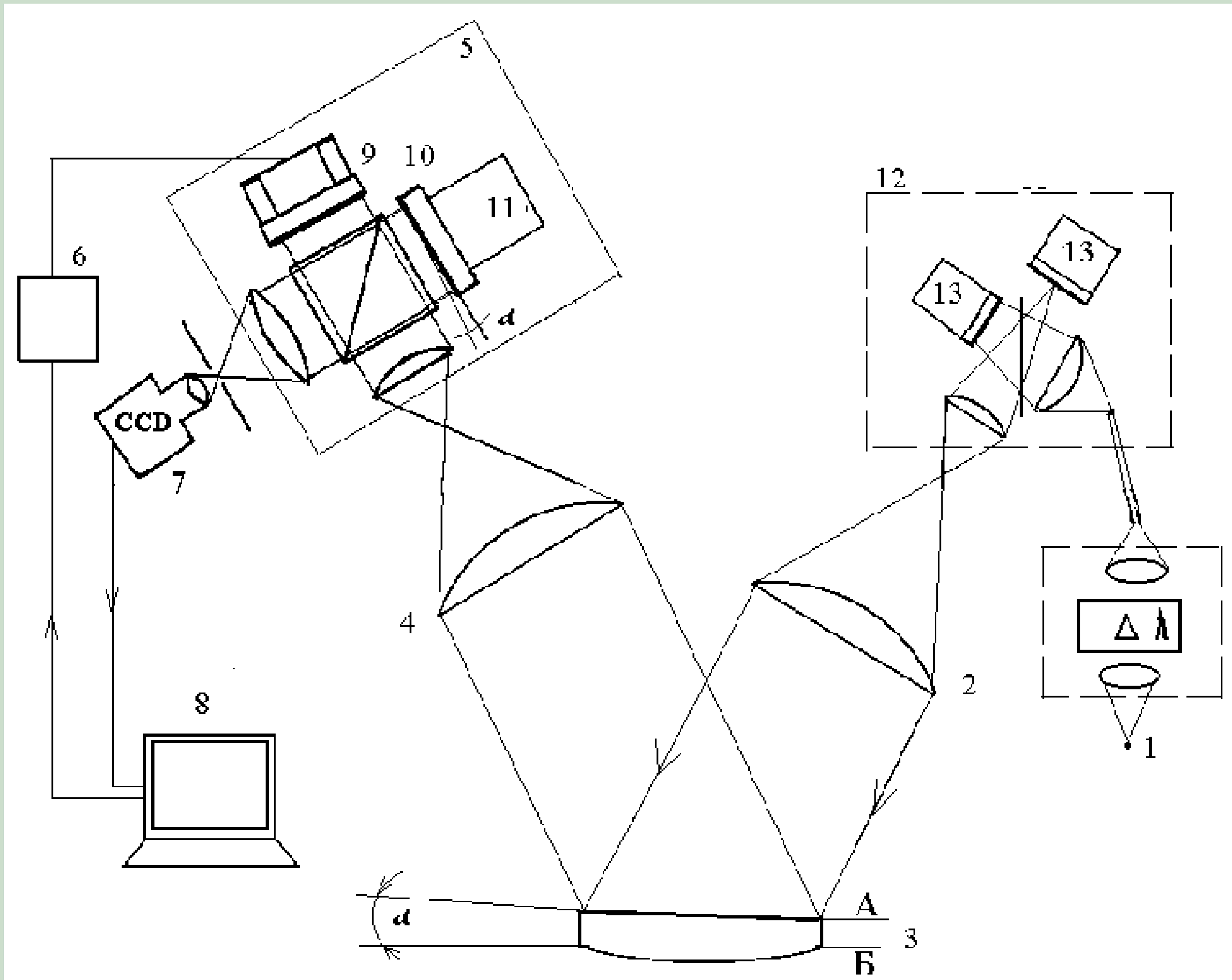
White Light Measurement Interferometer for preliminary Core Optics control.



White Light *In Situ* Measurement Interferometer (WLISMI)

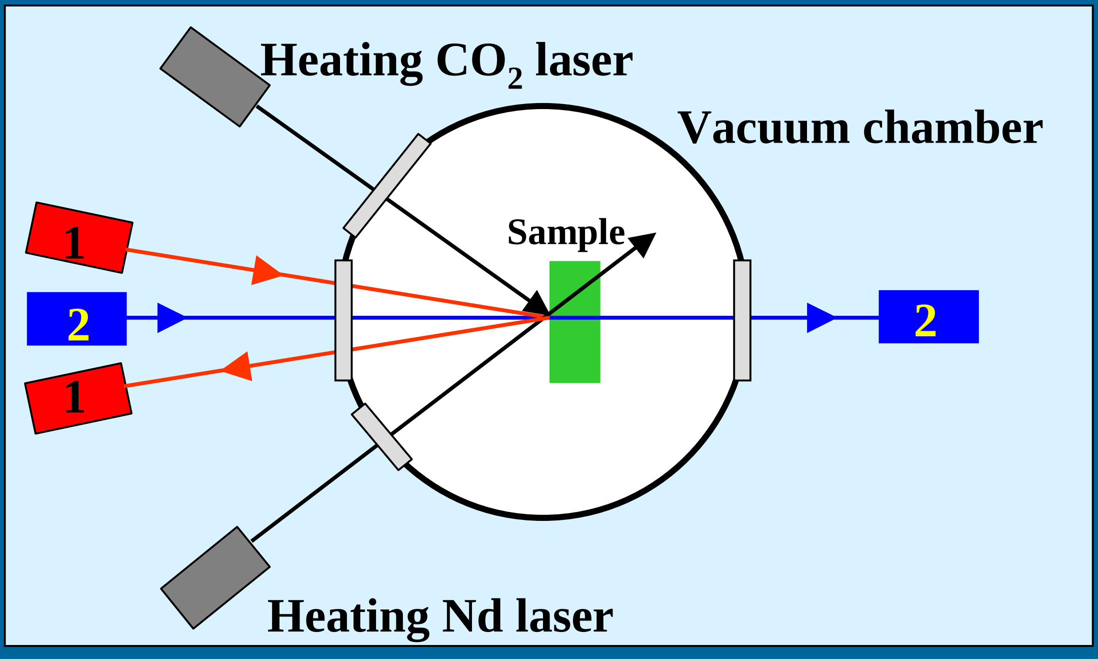
Standard interferometers	Proposed interferometers
Measurement of optical length of air spacing between two surfaces. In profilometers one of them is a sample surface, and the other is a reference surface. The problem of precise measurement of phase in the interferogram is solved by phase modulation according 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

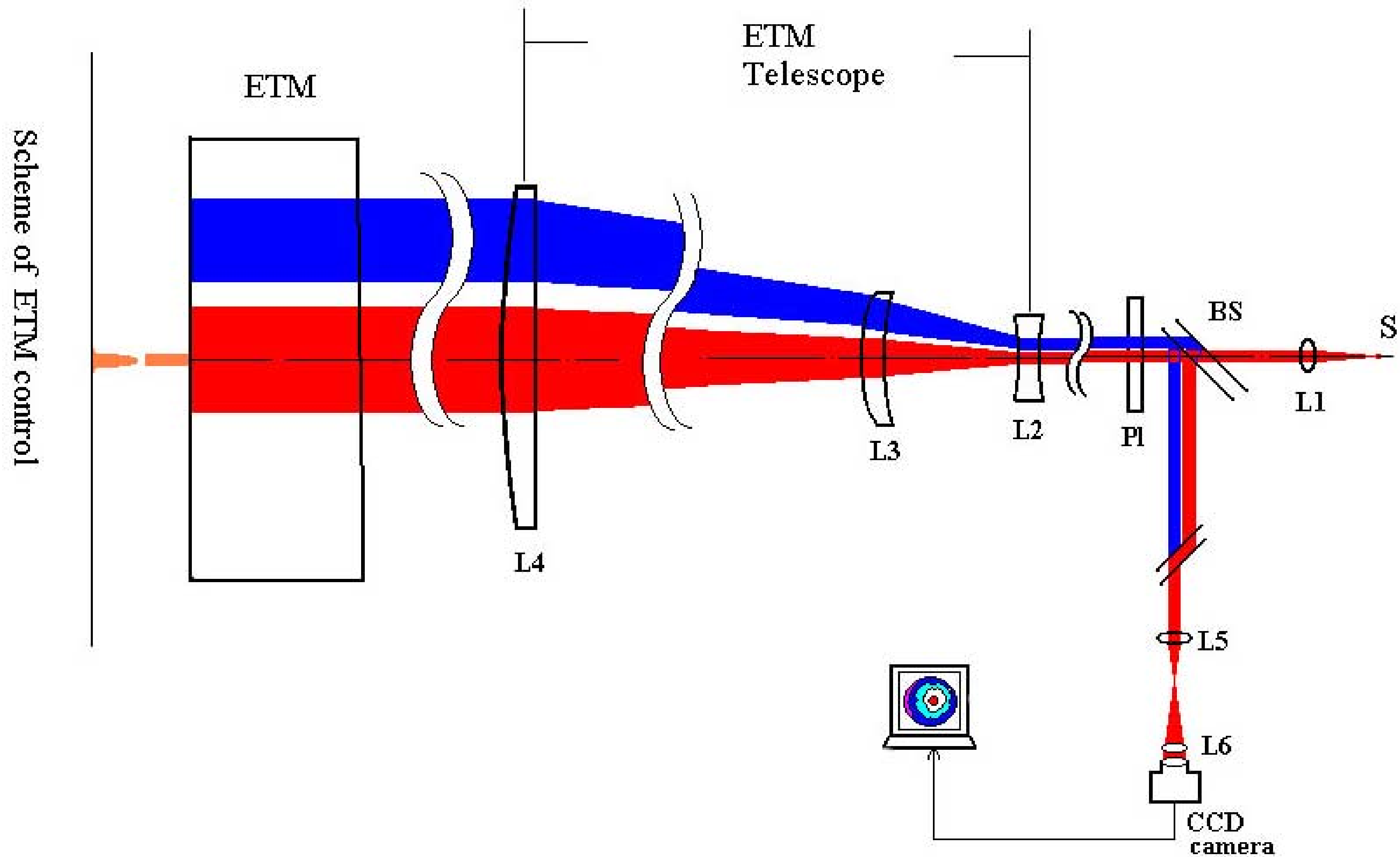
Remote *in situ* monitoring of weak distortions emerging under auxiliary laser heating



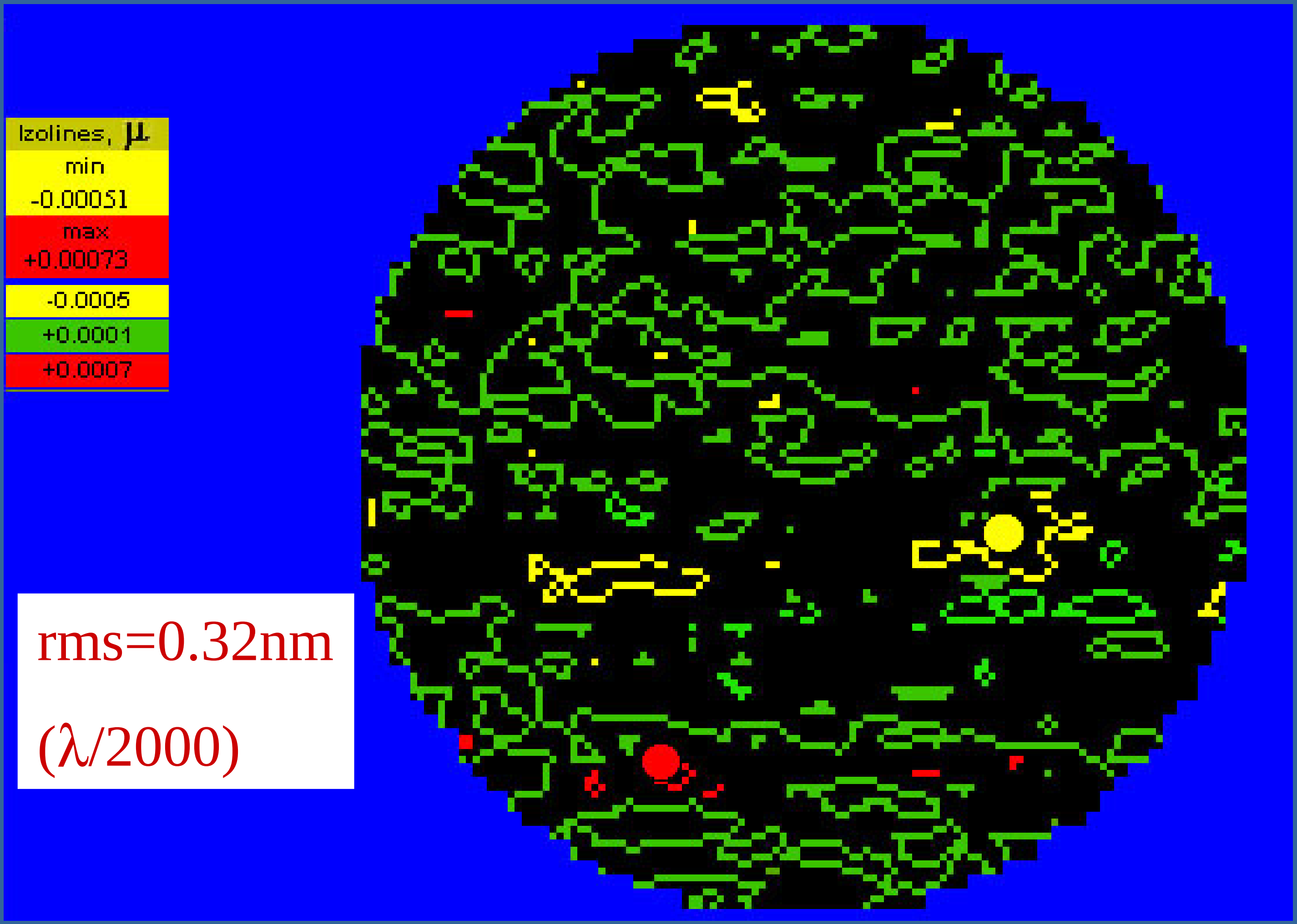
1 - WLPMI
2 - NHS and PIT

- 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

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



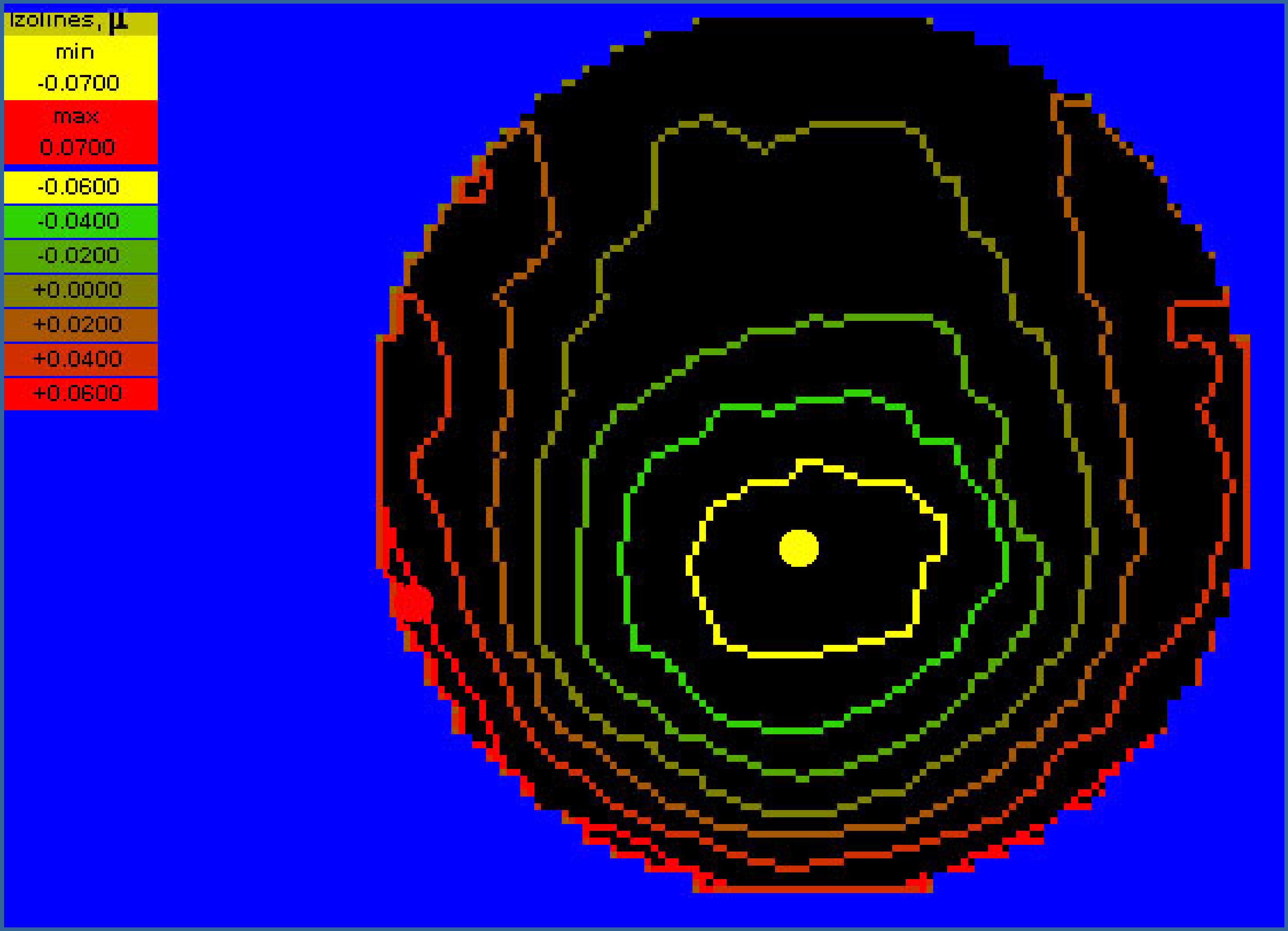
Experimental results. No heating.



rms=0.32nm

(λ/2000)

Experimental results. Heated by CO_2 laser.



White Light *In Situ* Measurement Interferometer. Important points to install it ETM of LIGO-1.

1. **Interfering beam propagate mostly on the same path. The paths are different in the vacuum chamber.**

2. **Interference pattern appears only if three following item coincide**

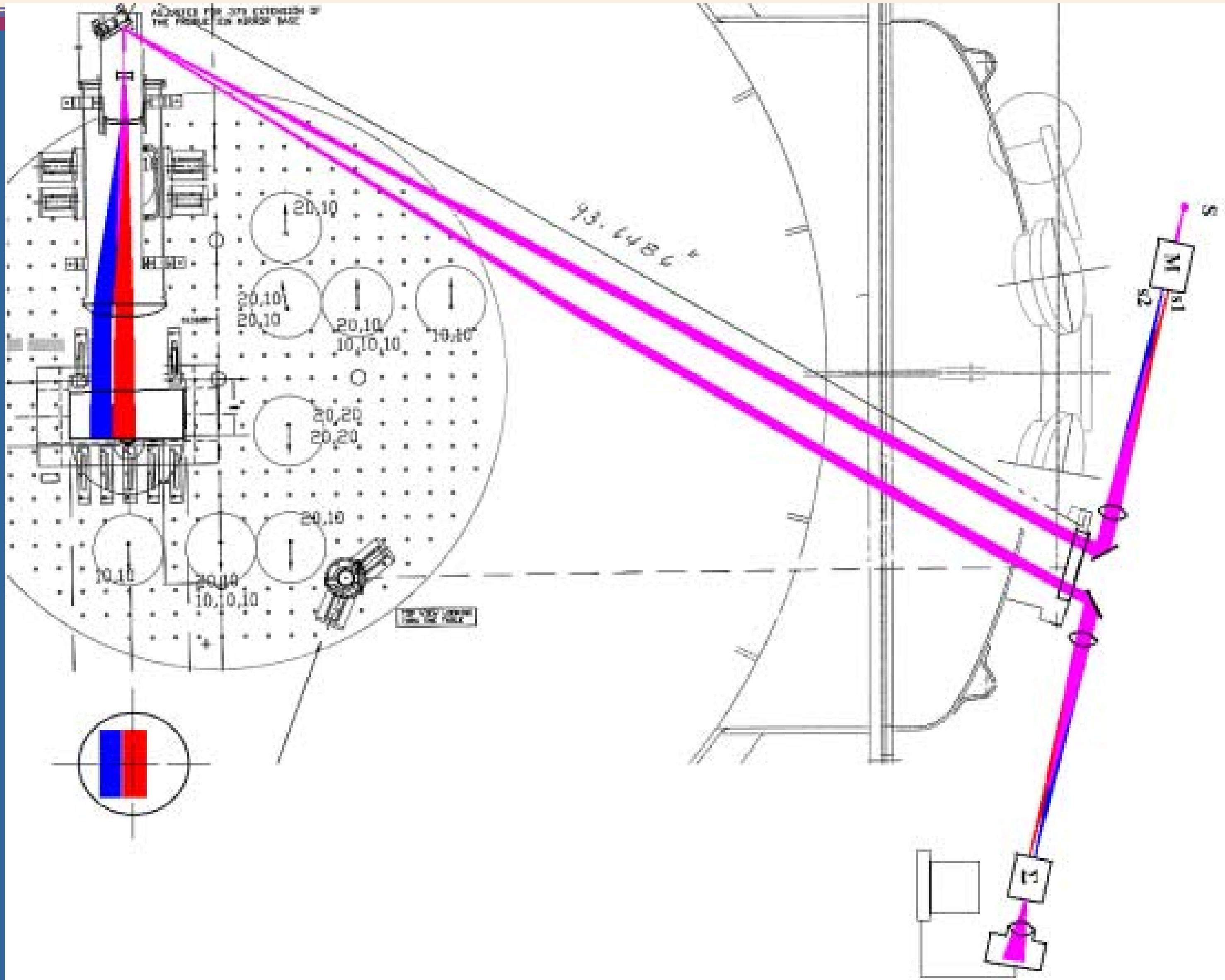
   optical paths;

   angles of beams wave front;

   planes where image of the source is related

This tripled coincidence neglects influence of Fresnel reflections on the interference.

White Light *In Situ* Measurement Interferometer. How to install in LIGO-1 interferometer?



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

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

♦ Design of WLPMI for ETM has been done.