

# International Collaboration Optical Test and Development

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# International Collaboration Optical Test and Development

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- Collaboration with VIRGO

- ››Alain Brillet - Material Development and Specification

- ››Jean-Marie Mackowski - Surface Characterization

- ››Claude Boccara - Absorption, Birefringence, Wavefront Distortion

- Vincent Lorient

- Jean-Baptiste Daban

- ››Frederic Cleva - Absorption



# Material Development and Specification

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## VIRGO/Orsay - Alain Brillet

- VIRGO involved in development of low absorption (SV) Heraeus glass
  - ›› Not ready at the time for commercial release
  - ›› Better understanding/process control now than at the time of the LIGO material contracting
  - ›› Could possibly use SV for future LIGO optics
- Review and comment on LIGO material specifications
  - ›› specifying absorption in terms of OH content
  - ›› For Heraeus glass  $< 300\text{ppm OH}$  implies  $< 5\text{ppm/cm}$  absorption at 1064 nm



# Surface Characterization

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## VIRGO/IPN Lyon - Jean-Marie Mackowski

- LIGO assisted in characterization of VIRGO microroughness measuring instrument
  - ›› Pathfinder optic polished at General Optics, coated at REO - results were similar to those obtained during pathfinder metrology
  - ›› Smaller substrates polished at General Optics
- Shared LIGO IR Interferometer specification



# Birefringence, Surface Roughness, Wavefront Distortion, Absorption

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VIRGO/ESPCI - Boccara, Loriette, Daban  
VIRGO/Orsay - Cleva

- Provided a characterized LIGO pathfinder optic A002 for inter-comparison
- Provided 27 samples of various Fused Silica (Corning, Heraeus)



# Birefringence

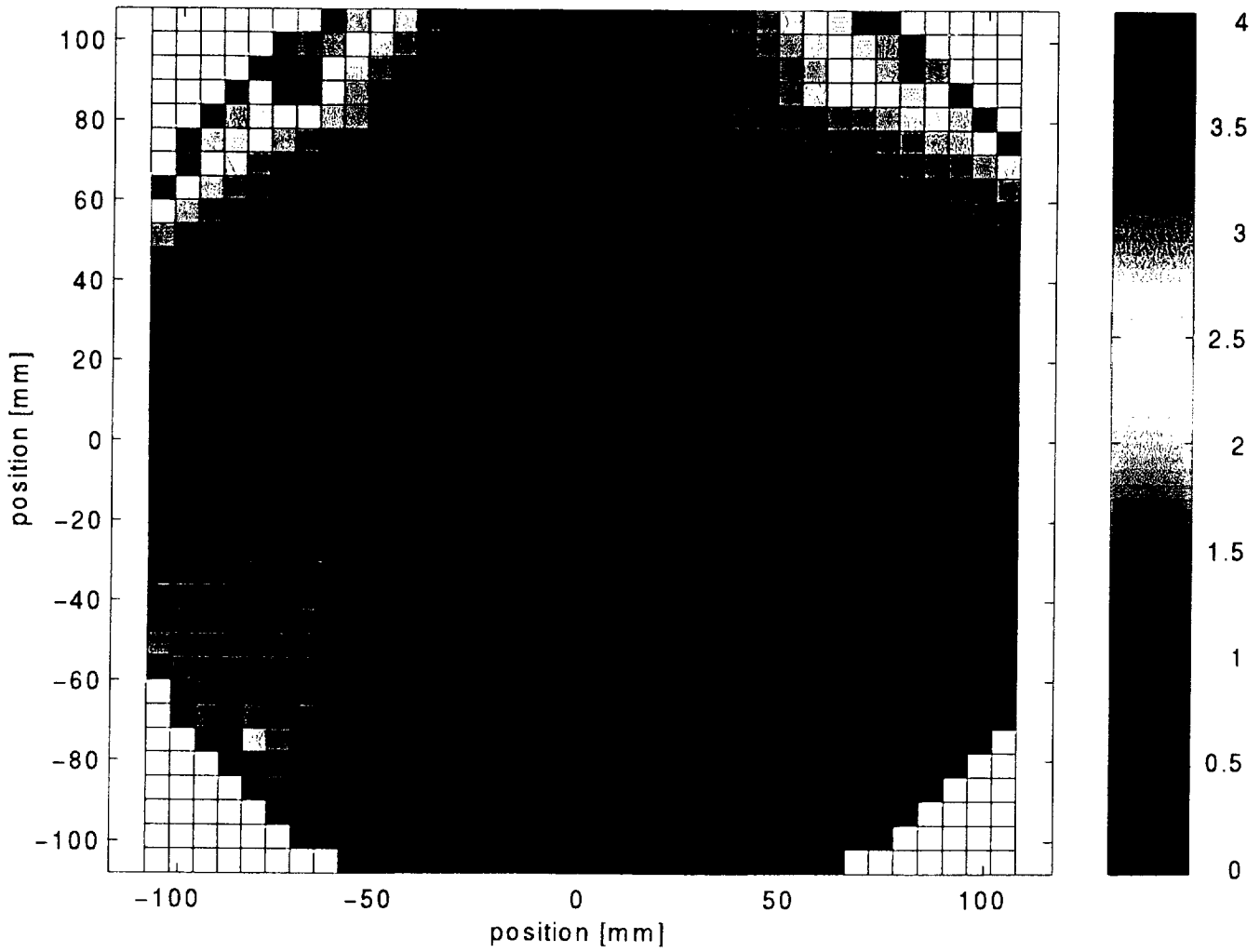
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## VIRGO/ESPCI

- Found to be induced by mounting/gravity (does not follow substrate rotation)
  - ›› LIGO pathfinder A002 measured, ranges between 0 and 18 mrad when mounted in a “V” support.
  - ›› Even mounted in this configuration the birefringence is found to be within the LIGO specification

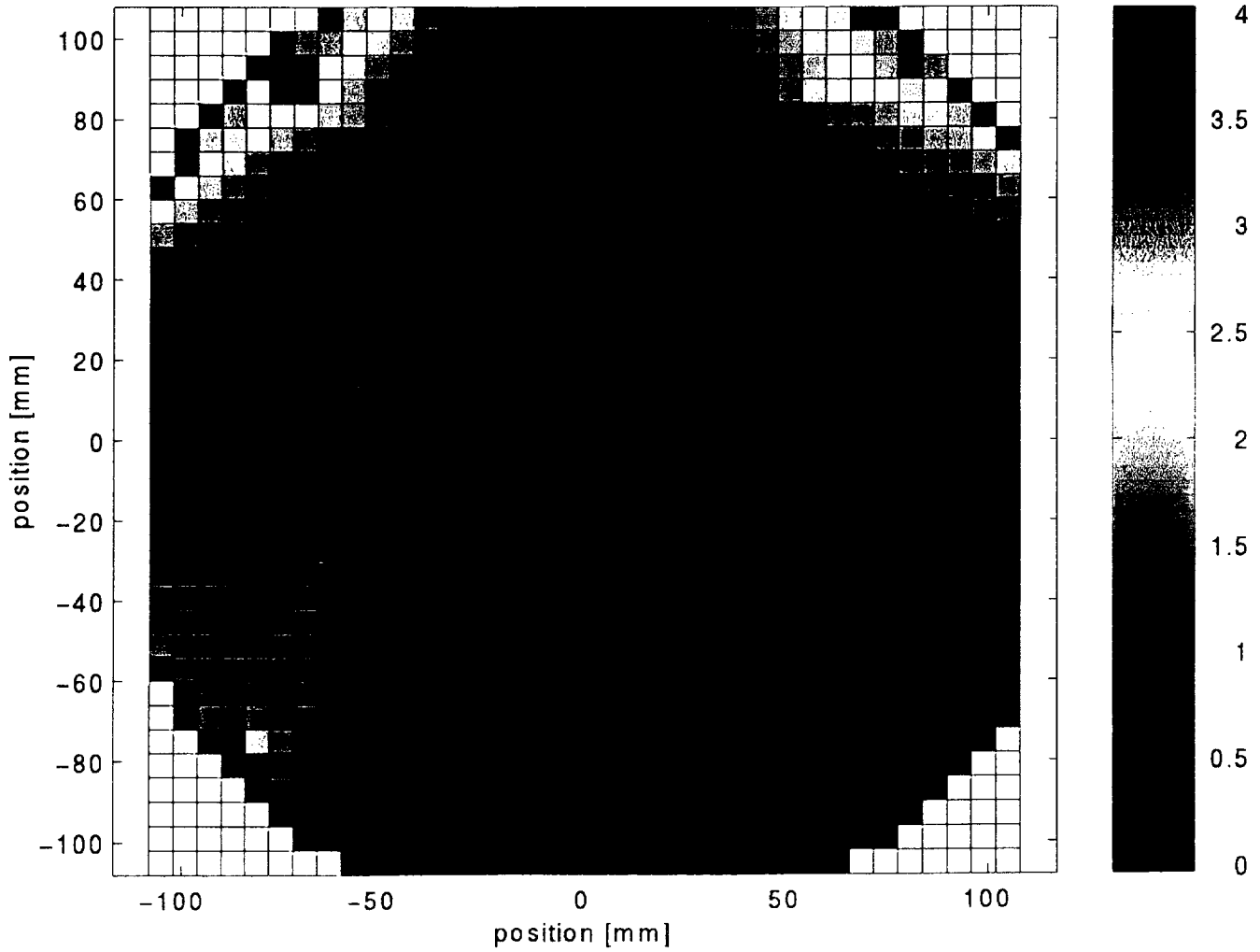


LIGO PathFinder birefringence amplitude [mrad] S-POL (BILIG34)



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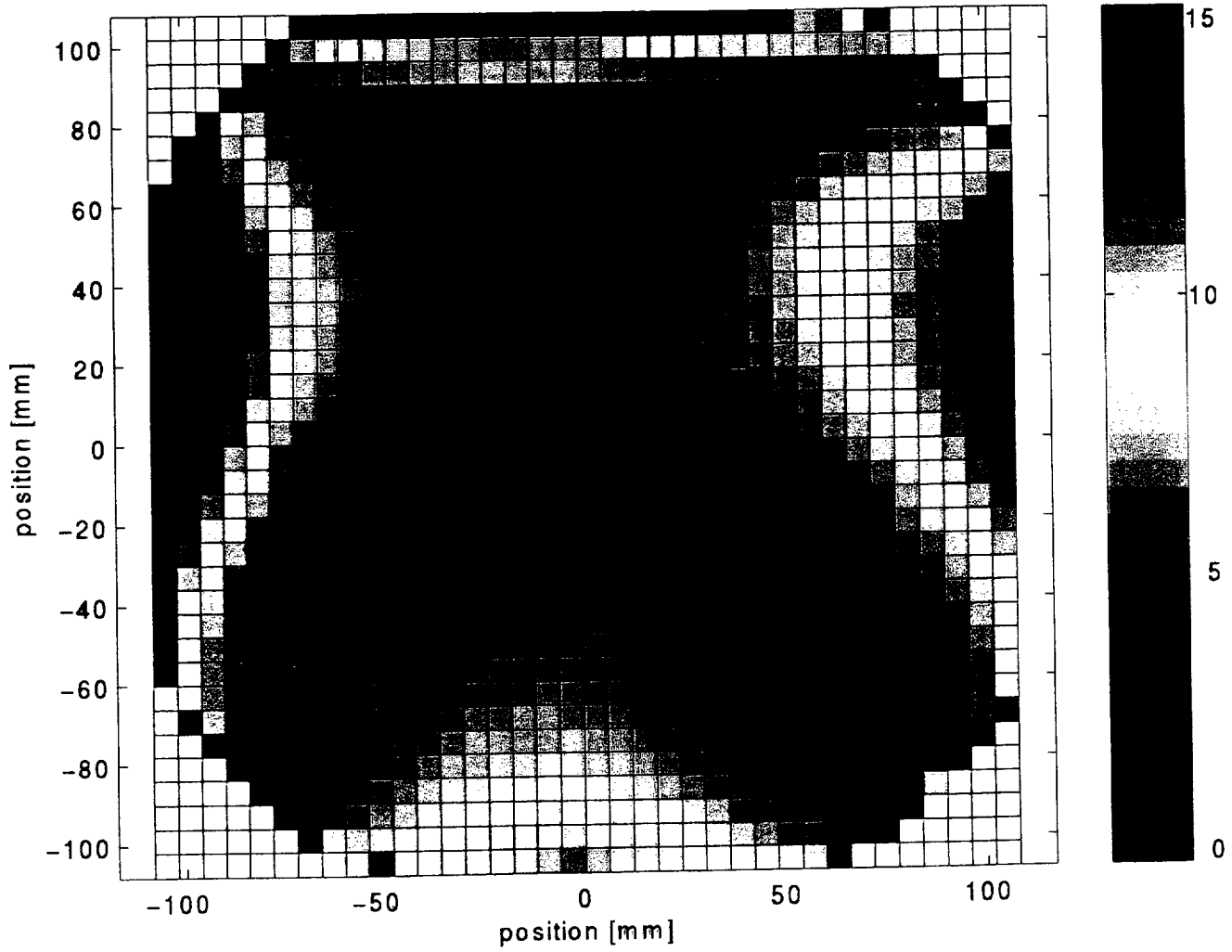
LIGO PathFinder birefringence amplitude [mrad] S-POL (BILIG34)



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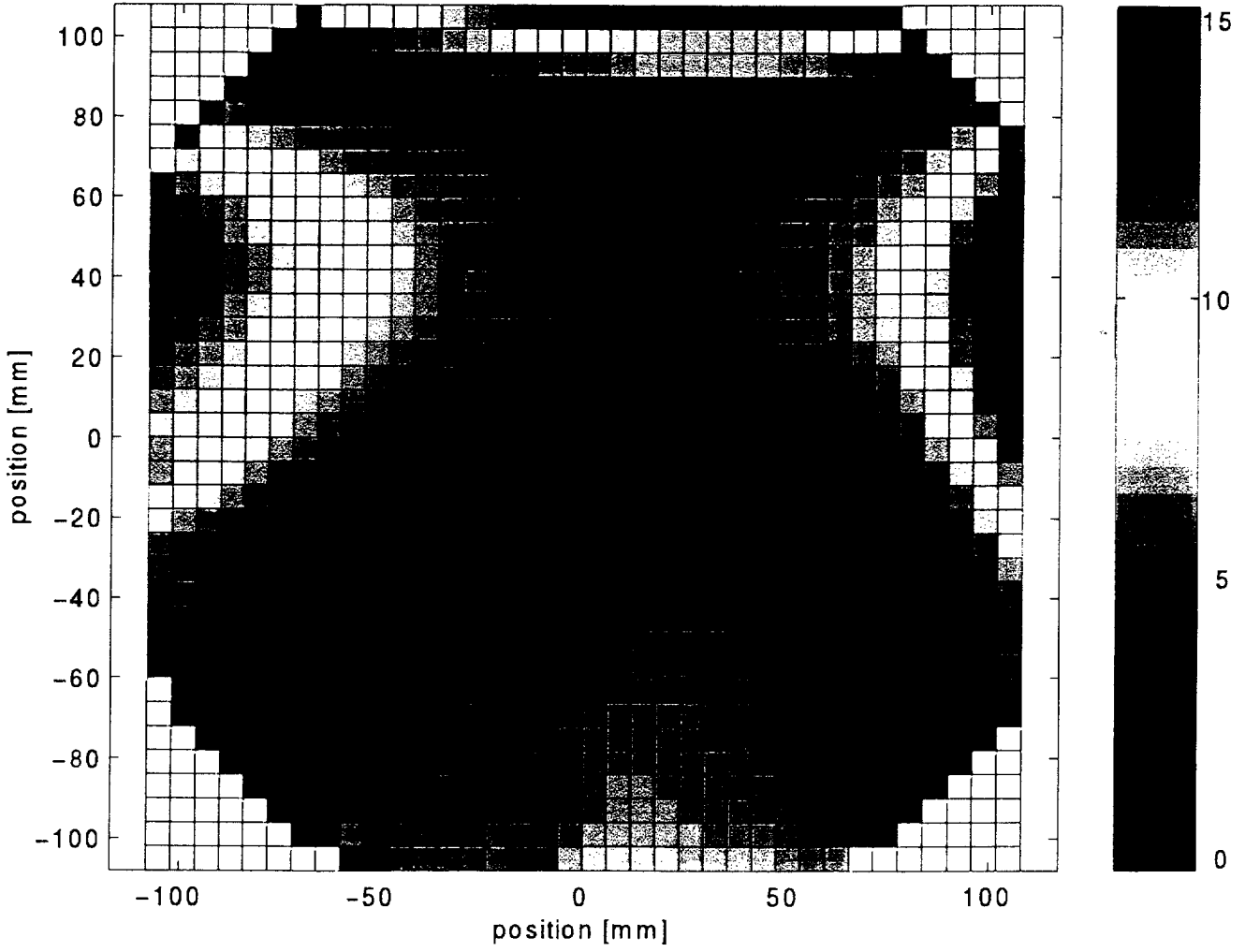


LIGO PathFinder birefringence amplitude [mrad] (BILIG34)



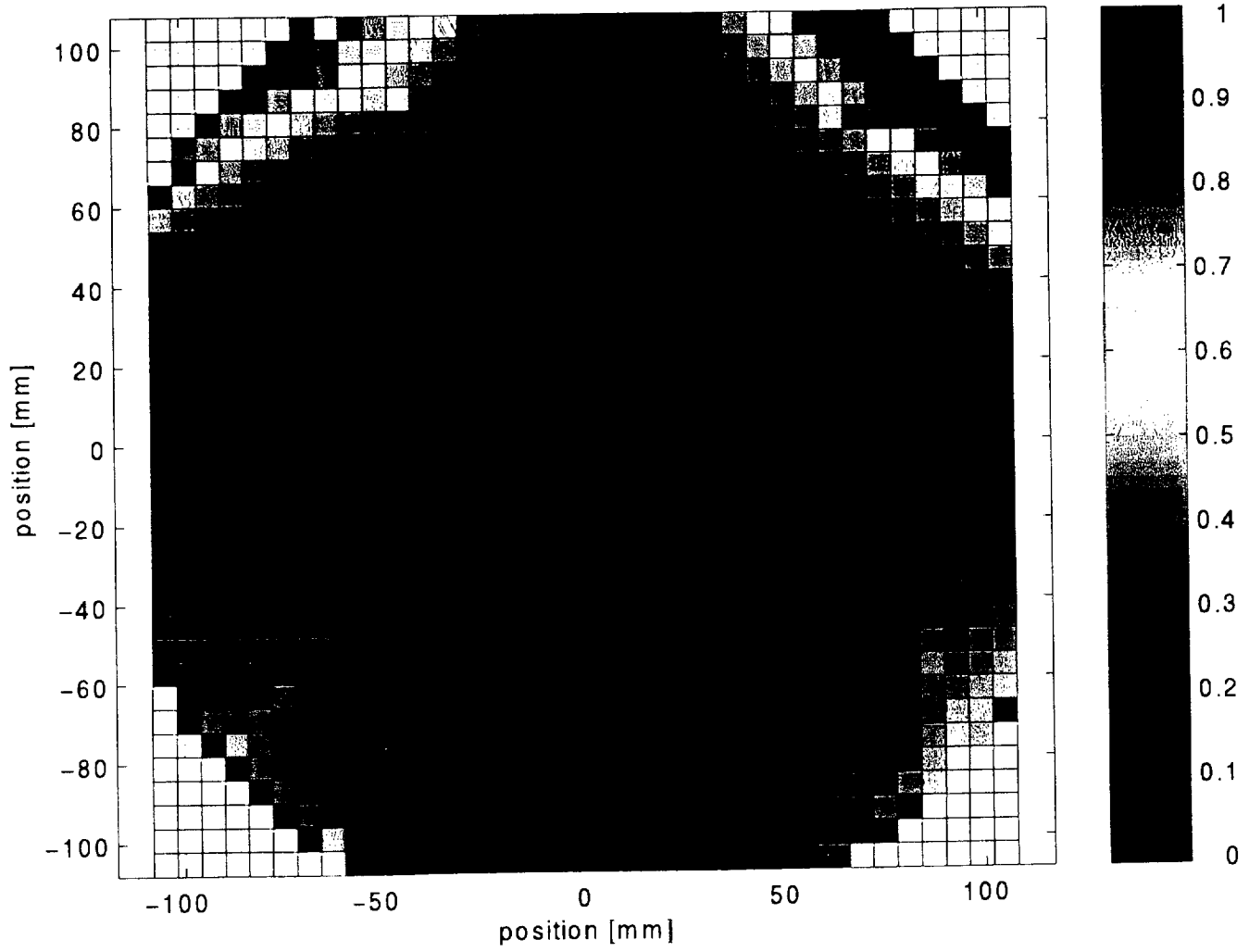
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LIGO PathFinder birefringence amplitude [mrad] (BILIG78)



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LIGO PathFinder birefringence amplitude [mrad] S-POL (BILIG78)



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# Surface Roughness

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## VIRGO/ESPCI

- Interferometric Microscope
- A002 measured
  - ›› 3.0 nm rms
- Compare to
  - ››CSIRO measurement ~2.7 nm rms
  - ››REO measurement ~3.0 nm rms



# Wavefront Distortion

## Optical thickness homogeneity

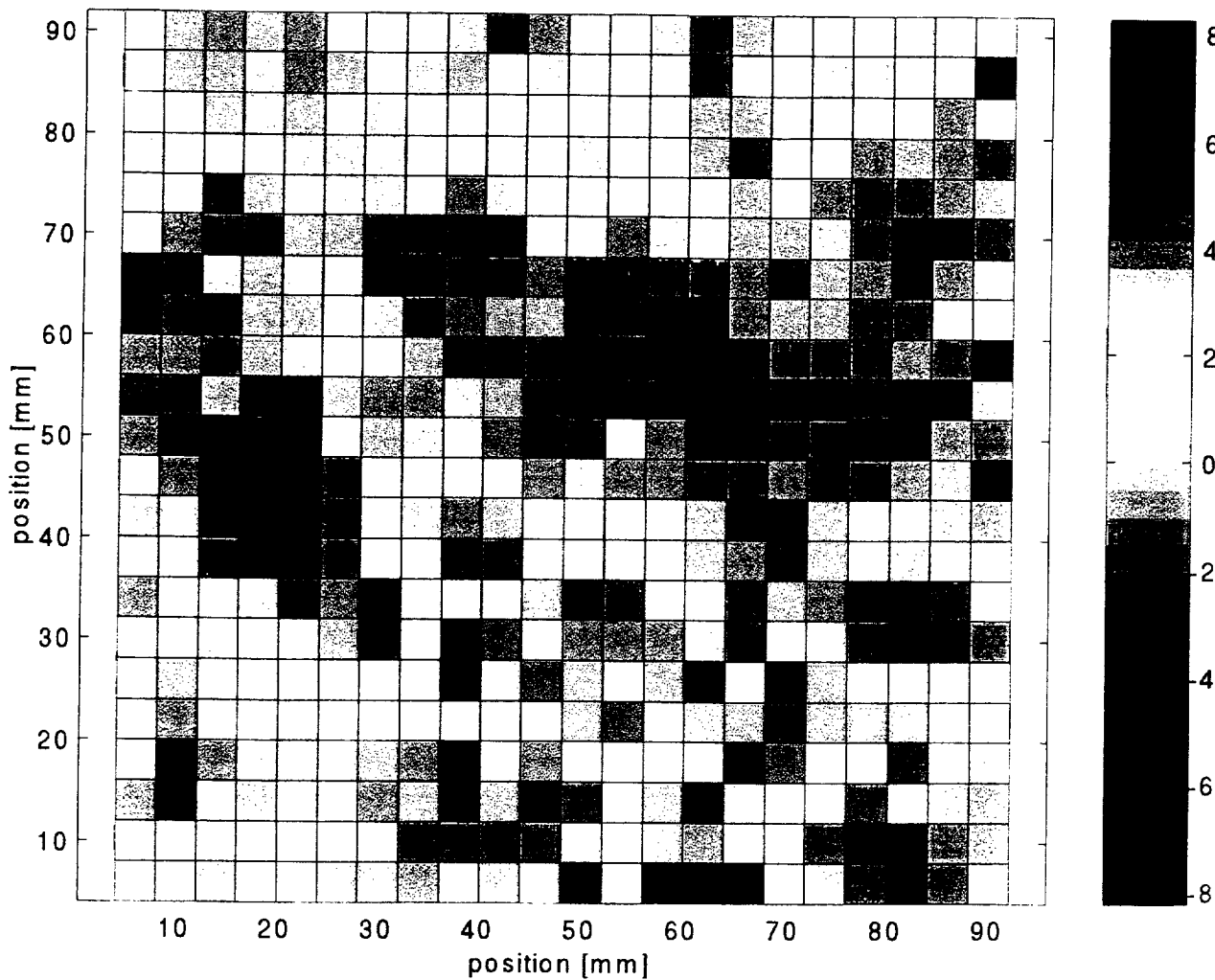
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### VIRGO/ESPCI

- Slope Measurement Technique
  - ›› Raw Peak to Valley - 36 nm
  - ›› Corrected Peak to Valley - ~10 nm
  - ›› rms - 2.7 nm



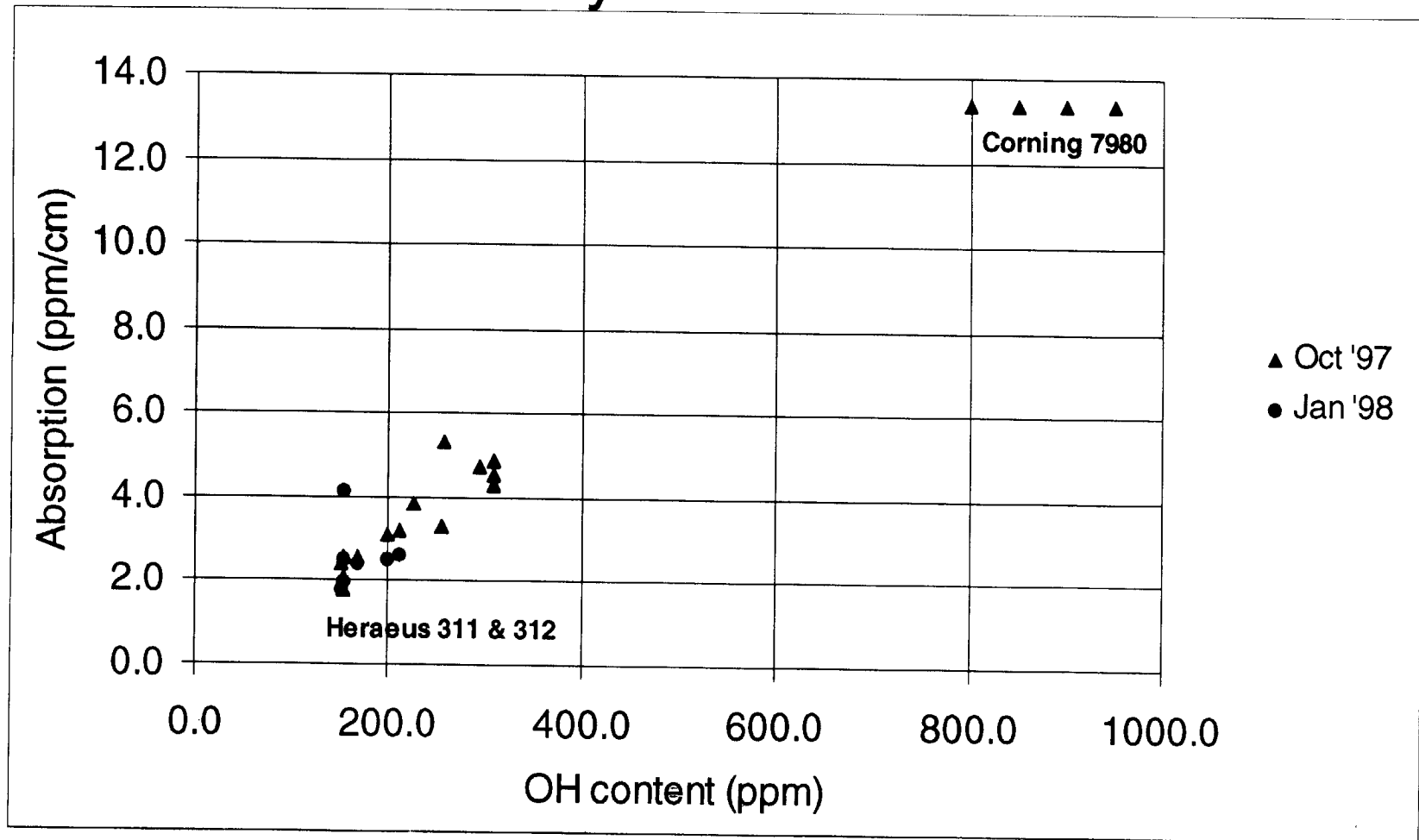
LIGO PathFinder optical thickness [nm] (EPLIGO6)



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# Absorption

## VIRGO/ESPCI & Orsay



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Including SV glass

$$\text{abs (ppm/cm)} = 1.2 \times 10^2 \text{ OH (ppm)}$$

V. Laxiette.

# Heraeus Suprasil fused silica absorption vs. OH content

