E990
THE HOLOMETER
MP7 & 8

Status Report

Fermilab All Experimenter’s Meeting
December 3, 2012
Bobby Lanza for the Holometer
The Holometer Instrument

- Two nested power-recycled Michelson interferometers
- Optimized to detect a fundamental Planck scale uncertainty in the position of all objects

Output Intensity $\sim |L_1 - L_2|^2$
for $|L_1 - L_2| \ll 1$

$\lambda = 1064\text{nm}$

$1\text{kW}$ circulating power
Two Interferometers Now Constructed

One set of arms is inside an old Fermilab meson beam tunnel.

The other arms extend outside to a remote hut housing the end mirrors.

Vacuum service vessels housing beamsplitters

1e-8 torr; low hydrocarbons
SEISMIC ISOLATION
Seismic Noise as Measured by Interferometer

Differential Arm Length Noise

Low frequency noise
Easily suppressed by Control system

Beamsplitter Mechanical Resonance

4"
Seismic Isolation installed in interferometer and tested

Passive Seismic Isolation

- 40 lb + 60 lb steel plates
- Viton balls
- Beamsplitter 3” diameter
- Power recycling mirror
- 12”
Seismically Driven Beamsplitter Motion Suppressed

Differential Arm Length Noise

x10 suppression of RMS motion around beamsplitter resonance
OPTICAL POWER BUILDUP
Predicted Power vs. Arm Length Difference

Optical Power at Each Location

- [Watts]
  - 0.0
  - 0.2
  - 0.4
  - 0.6
  - 0.8
  - 1.0

- [Watts]
  - 0
  - 500
  - 1000
  - 1500
  - 2000
  - 2500
  - 3000
  - 3500

- [Watts]
  - 0
  - 0.2
  - 0.4
  - 0.6
  - 0.8

Mirror displacement [nanometers]

1

2

3

laser

laser
Measured Resonant Cavity Power Buildup

Modulating arm length difference and cavity resonance frequency by actuating end mirrors

Searching Through 2D Phase Space

Max Power Buildup

T0=09/11/2012 06:23:22.100036
Locked to Max Power Buildup

Time Series

Interferometer Output
Cavity Power Buildup

Arbitrary Units

Time (s)

T0=09/11/2012 03:52:45.141601
Power Recycling Summary

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<thead>
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<tbody>
<tr>
<td>Expected</td>
<td>78 ± 24</td>
<td>1.5 ± 0.2</td>
<td>117 ± 39</td>
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<tr>
<td>Measured</td>
<td>79 ± 2</td>
<td>1.5 ± 0.2</td>
<td>119 ± 16</td>
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- This is exactly as expected for this power recycling mirror

- Installing 99.9% reflectivity power recycling mirror will allow us to reach 1kW.
Power Recycling Images

No Power Recycling

Interferometer Output

End Mirror Transmission

Power Recycling
Status / Schedule

• **Completed:**
  
  • **MECHANICAL:**
    • Two interferometers constructed
    • Ground noise discovered; solution installed and tested in one interferometer
  
  • **OPTICS:**
    • Achieved maximum power build-up using low-reflectivity mirrors: 100 watts

• **Next Steps:**
  
  • Install beam splitter isolation in other interferometer (*this month*)
  • Further vibration isolation at end stations: designed and out for bid
  • Install high reflectivity optics
  • Stable operation at 1kW
The Holometer Team

- Fermilab:
  - A. Chou (co-PI, project manager), H. Glass, C. Hogan, C. Stoughton, R. Tomlin, J. Volk, W. Wester, A. Sippel

- MIT LIGO:
  - M. Evans, S. Waldman, R. Weiss

- UChicago:
  - S. Meyer (co-PI), B. Lanza, L. McCuller, J. Richardson

- U Michigan LIGO:
  - D. Gustafson

- Northwestern
  - J. Steffen

- Vanderbilt University
  - B. Kamai