



Characterization of LIGO Input Optics

University of Florida

Thomas Delker
Guido Mueller
Malik Rakhmanov
David Reitze
Haisheng Rong
Qi-ze Shu
David Tanner
Sanichio Yoshida

Caltech

Jordan Camp
Bill Kells
Nergis Mavalvala
David Ottaway
Daniel Sigg
Stan Whitcomb

MIT

Rana Adhikari
Peter Fritschel
Mike Zucker

Presented by Haisheng Rong at
LSC Meeting 7
Hanford, 15-17 August 2000

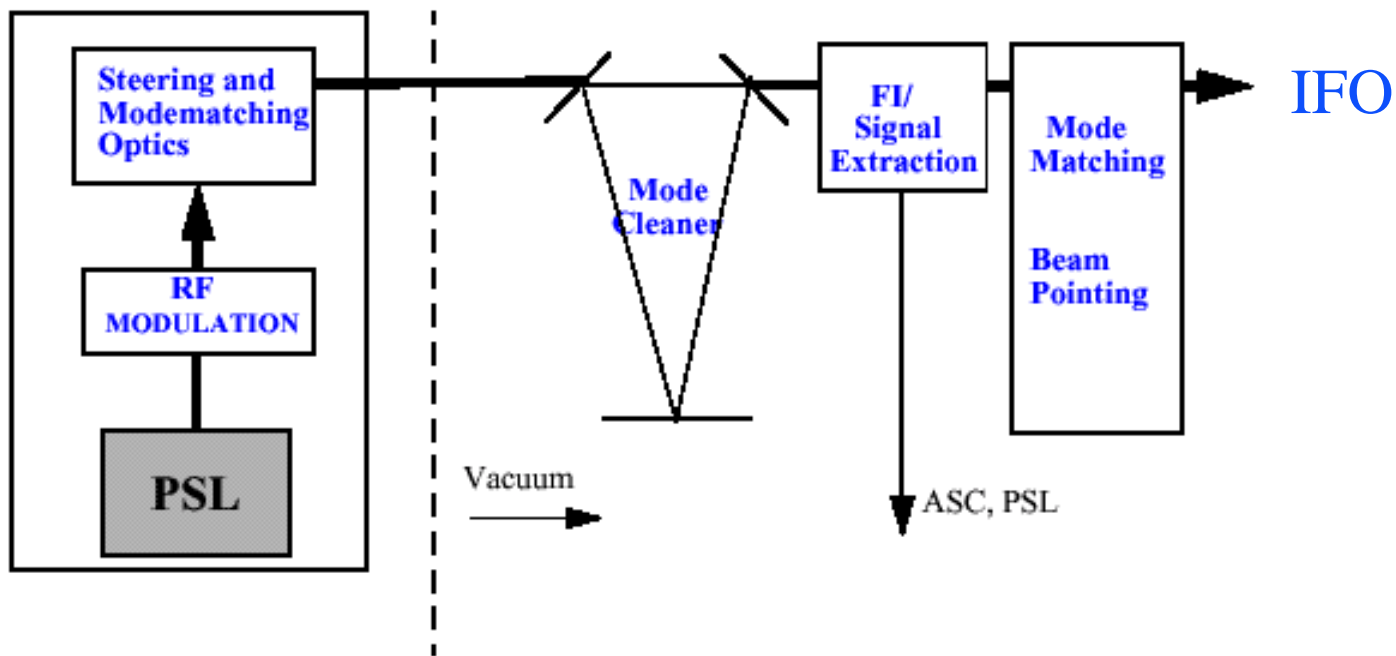
LIGO-G000296-00-D



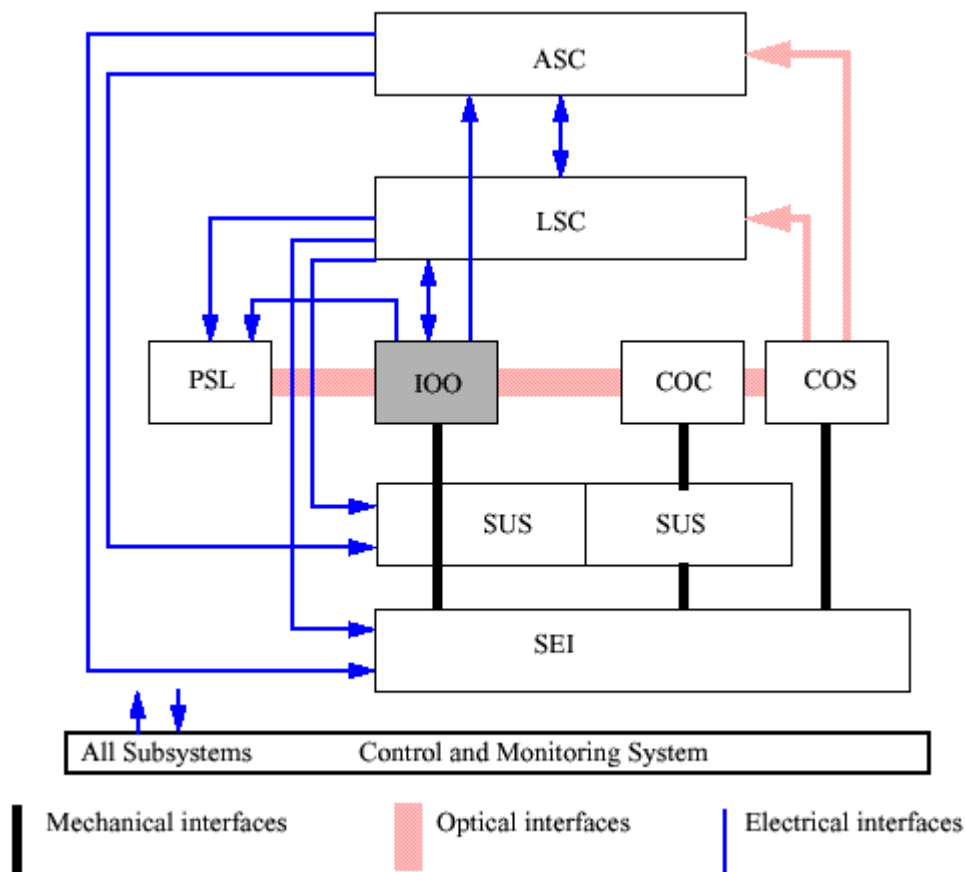
Input Optics System

- Primary Functions of the IO System
 - Conditioning of the PSL output
 - Frequency, Intensity and beam pointing stability
 - Filter high-order modes
 - Mode matching and beam delivery
 - Optical isolation
 - RF sidebands generation for IFO sensing

Input Optics Components



IO System Interfaces





Status of the IO System

- LHO 2k
 - » Operational since 08/99
 - » Major characterization measurements finished
 - » Integration with 2k IFO arm cavity successful
 - » Modification and realignment 04/00 – 05/00
- LLO 4k
 - » Mode cleaner locked in 03/00
 - » Characterization and improvement 03/00 – 06/00
 - » IO realignment 06/00 – 08/00
- LHO 4k
 - » Installation started 07/00



Characterization Measurements

- Mode Cleaner Length
 - » Measured with RF resonant side band detuning method.
 - » Uncertainty / Drift ~ 3ppm (50 μ m)
 - » Position Accuracy < 1mm
- MC Transmission
 - » 0.98 ± 0.05
- Mode Matching into the 2k Arm Cavity
 - » Power Coupling: 95%-98%



Characterization Measurements

- MC Output Beam Pointing Stability

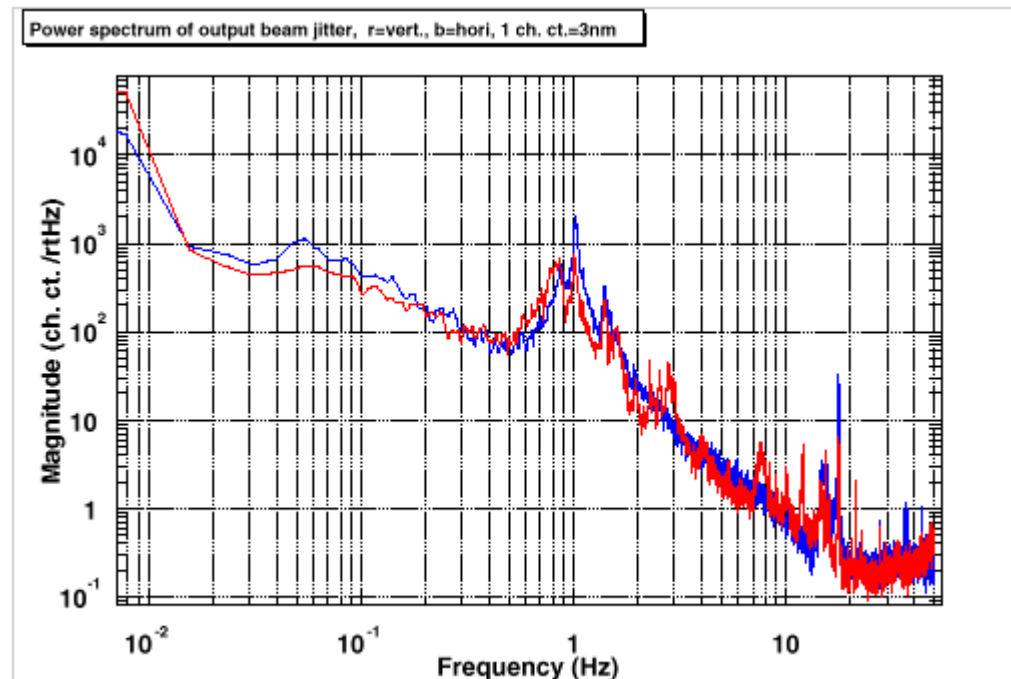
- » Long-term drift

$\sim 4\mu\text{rad/hr}$

- » Beam jitter

10^{-10} rad/rtHz

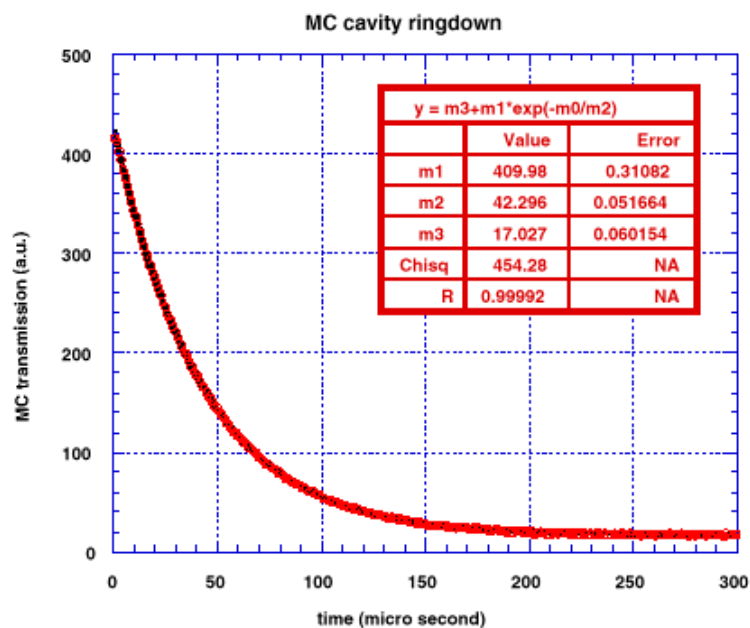
at $f > 20\text{Hz}$



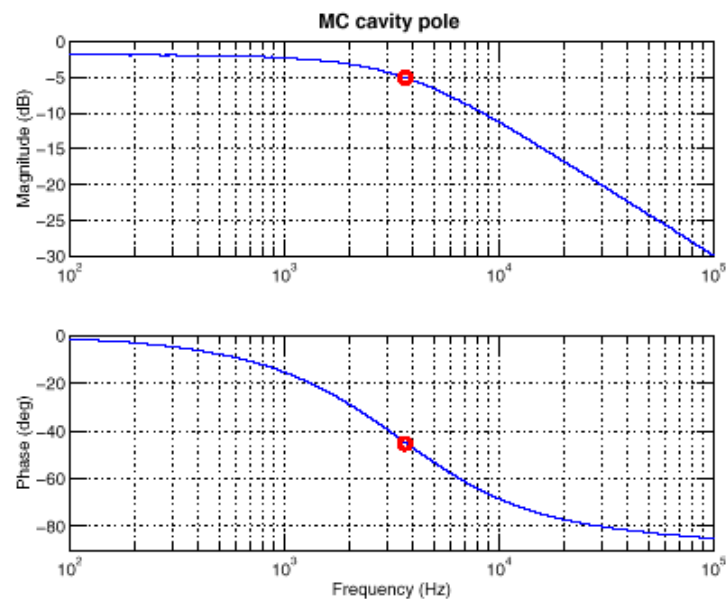
Characterization Measurements

- MC cavity linewidth measurements

Ringdown



Transfer function





Characterization Measurements

- MC linewidth measurement results

Table 1: Cavity Linewidth HWHM (kHz)

Method	09/01/99	02/16/00
Ringdown	3.68(3)	3.55(3)
X-function	3.63(3)	3.54(2)
Average	3.66(2)	3.55(2)
*Cavity losses (ppm)	148(50)	14 (50)

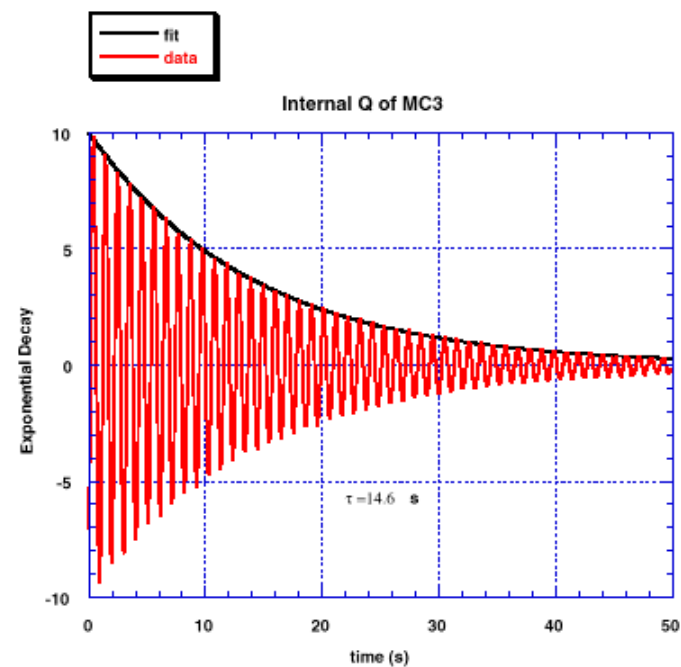
* The uncertainty in this estimate results mainly from the mirror transmission measurements

Characterization Measurements

- Internal Q's of MC mirrors

Table 2: Internal Q's of MC mirrors of LHO 2k IFO

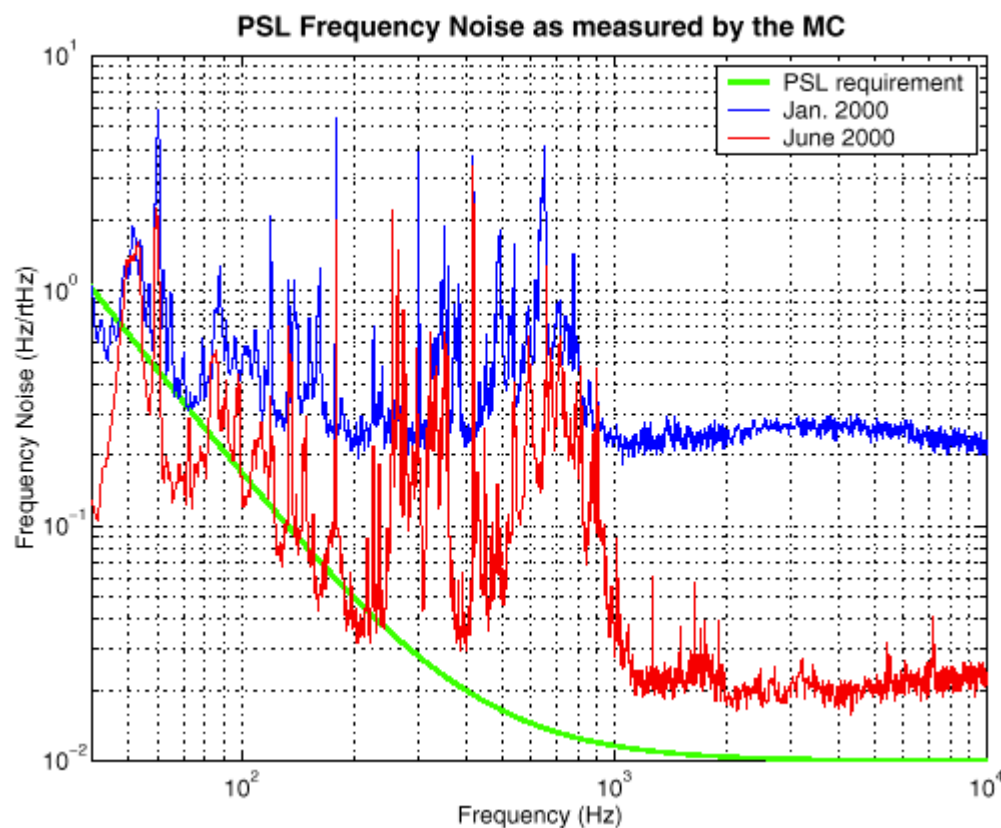
Mirrors	Frequency(kHz)	Q (10^6)
MC1	28.233	0.75
MC2	28.199	0.37
MC3	28.233	1.29





MC - a sensitive analyzer cavity

- Frequency noise of the PSL





Effect of the vertical mirror motion

- PSD of MC length control signal

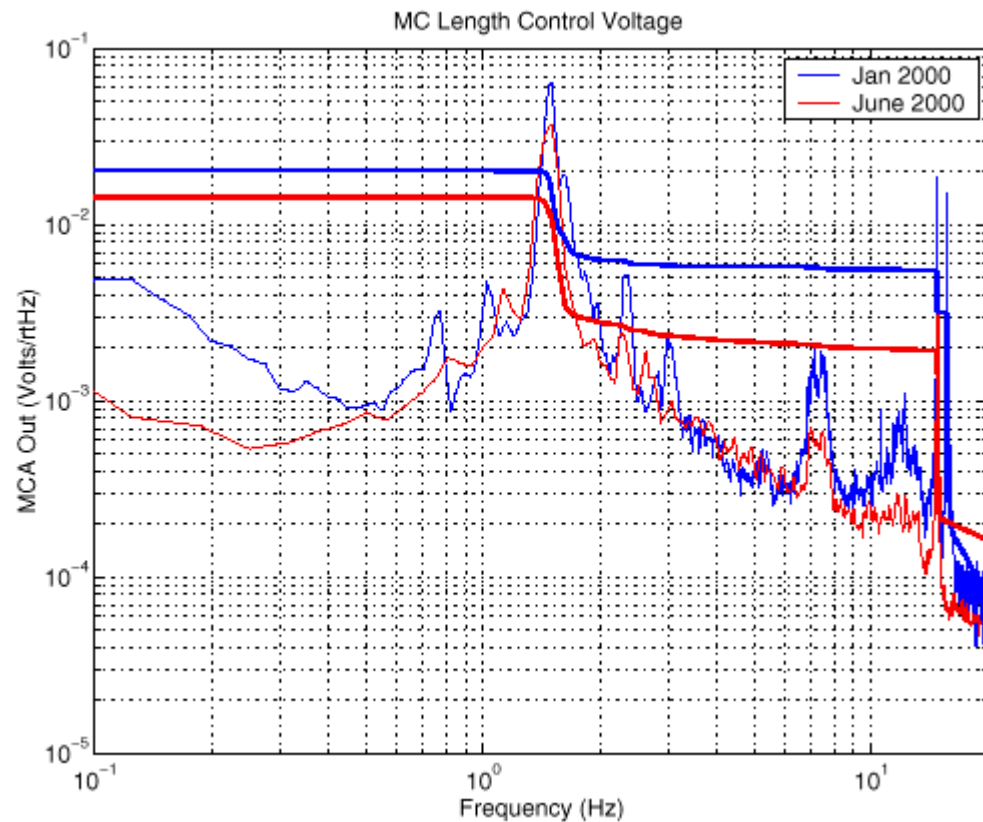
—

$\Phi = 0.62$ mrad

—

$\Phi = 0$

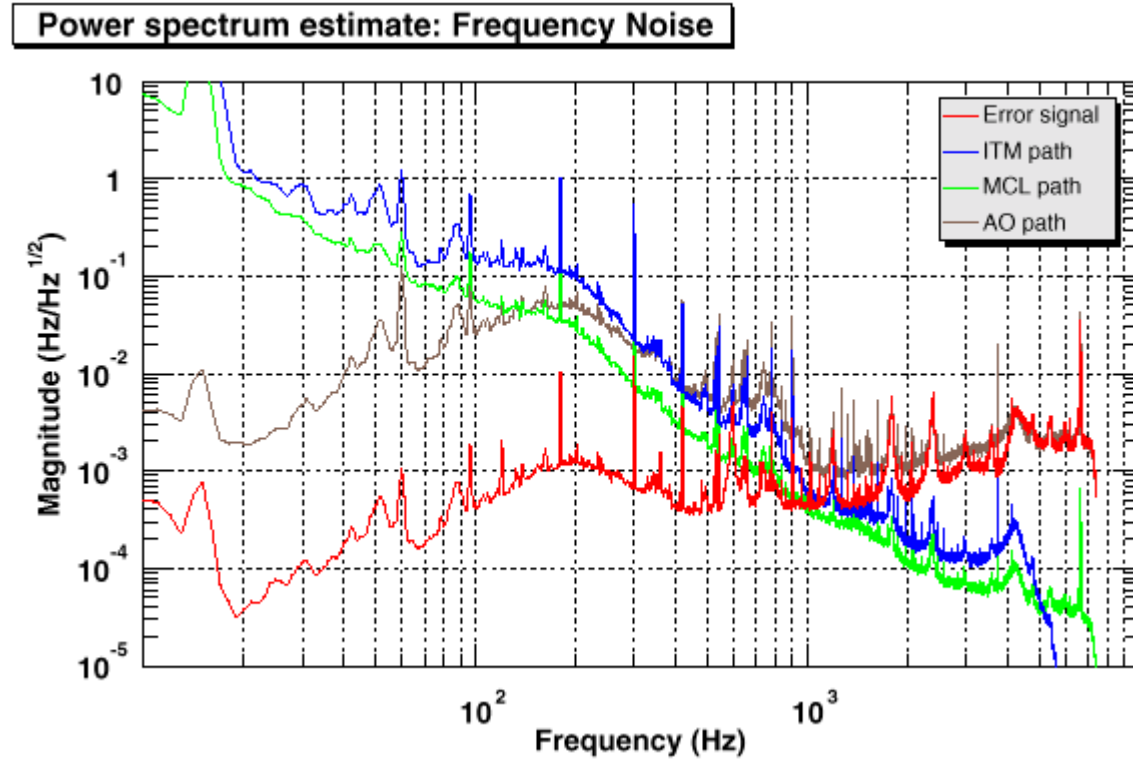
Φ : Angle of MC plane
wrt. horizontal





Frequency noise of MC output

- Frequency noise measured with 2k FP arm cavity





Coming up

- Lock MC at designed input power
 - » Scattered laser light interacts with suspension local sensors, causing angular instability
 - » Solution
 - Phase sensitive detection (coherent sensor)
 - New shadow sensors