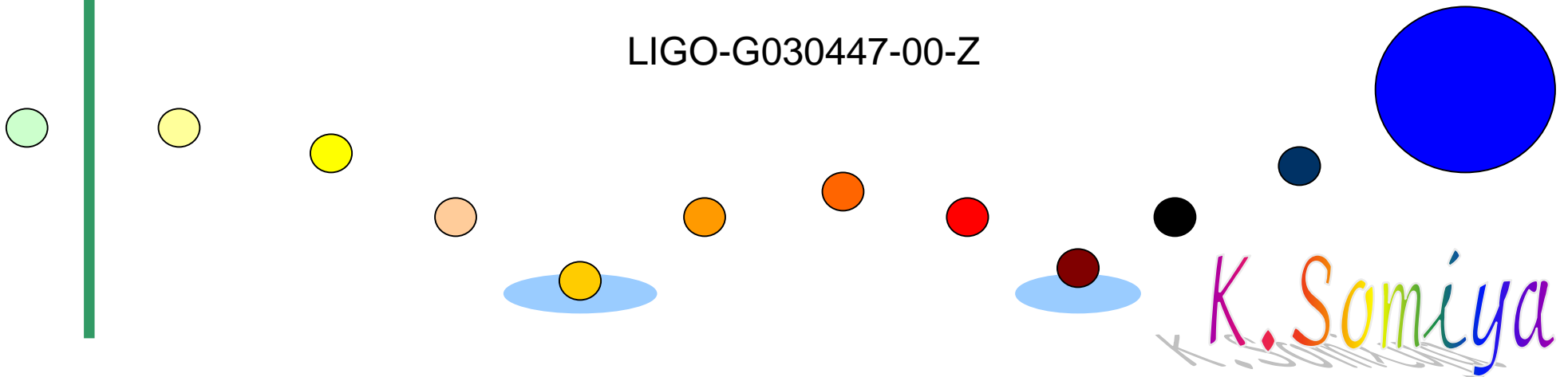


# Japan 4m RSE Experiment

**LSC Meeting @ Hannover  
Aug. 2003**

**Kentaro Somiya, Osamu Miyakawa, and Seiji Kawamura**

LIGO-G030447-00-Z



# Japan 4m RSE



Detuned RSE  
Prototype Interferometer

Built in NAO Japan  
(just near TAMA300)

500mW LASER,  
40g test masses

Vacuum chamber :  
3.4e-7 torr (w/o optics)  
1.0e-6 torr (with optics)

- Osamu came and helped us in May 2003.
- Seiji moved to Caltech for 14 months from July 2003.

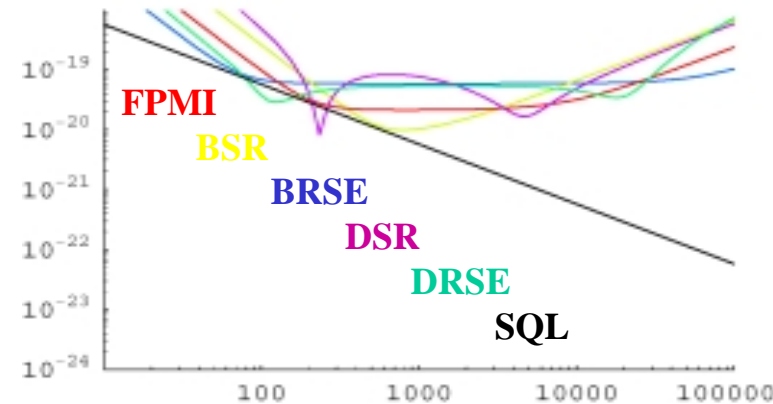
# Specialties of Japan RSE

## 1) Low-frequency control ~ THD (3<sup>rd</sup> Harmonics Demod.)

- Simple & Easy
- With DC readout, high-freq control seems better for Ad-LIGO

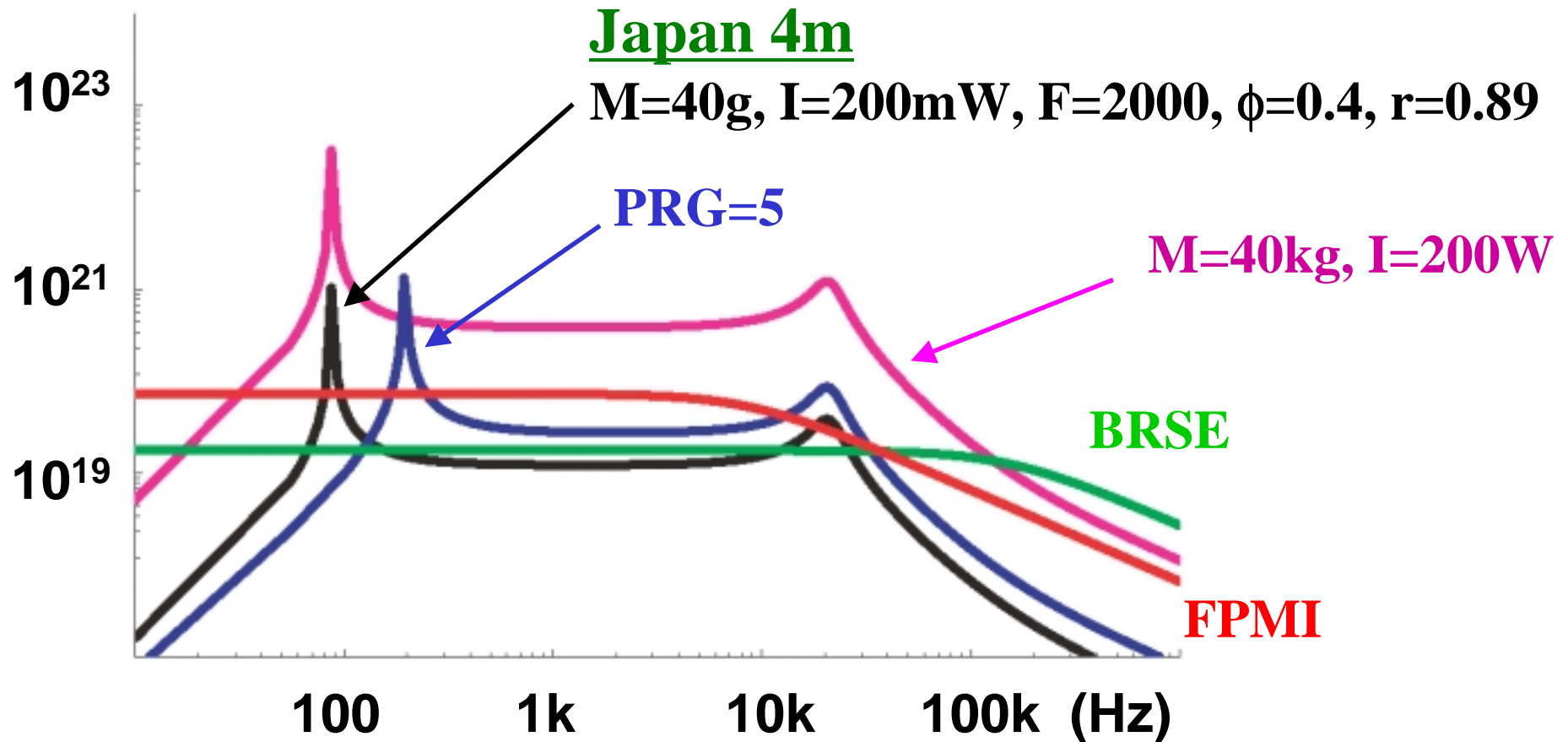
## 2) Small test masses ~ only 40g!

- Radiation pressure effect can be observed with 40g mirrors



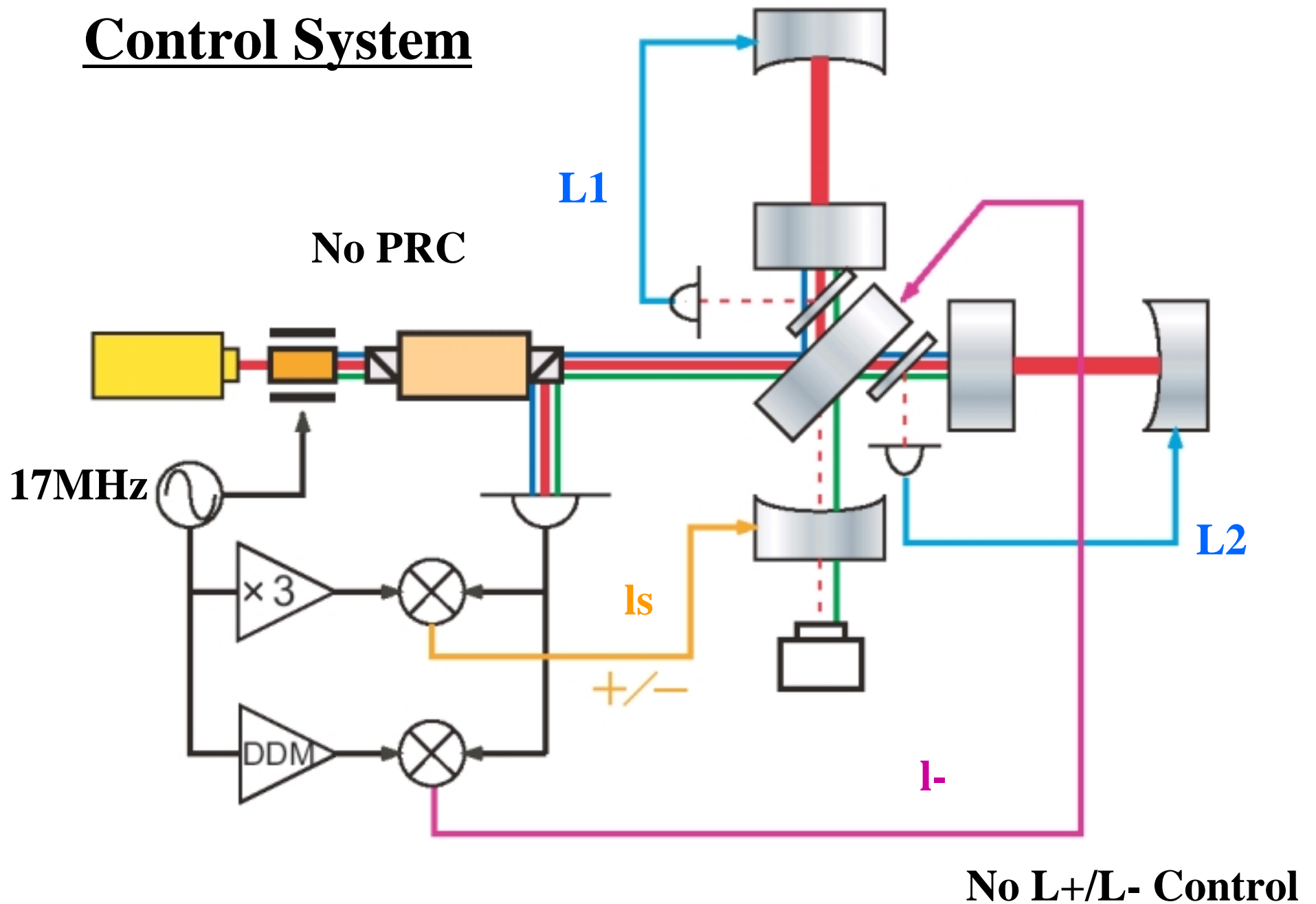
**Verification of Optical Spring**

# Transfer Function including RP Effect

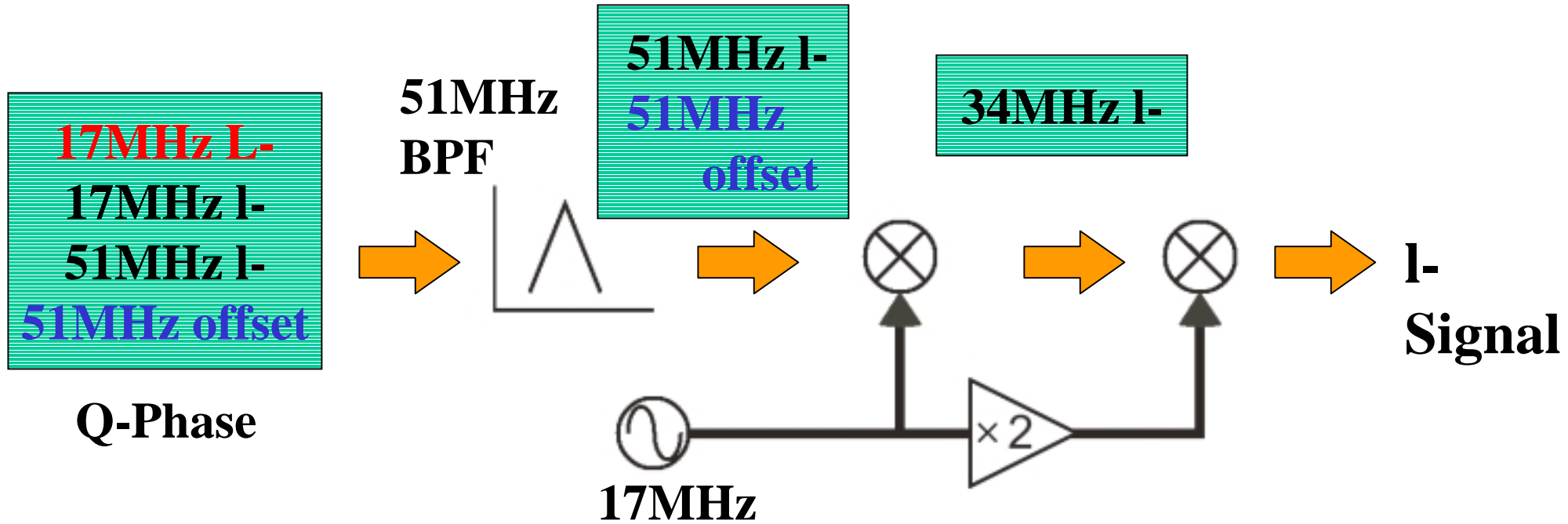


Using small mirrors is a big advantage to observe the optical spring.

# Control System



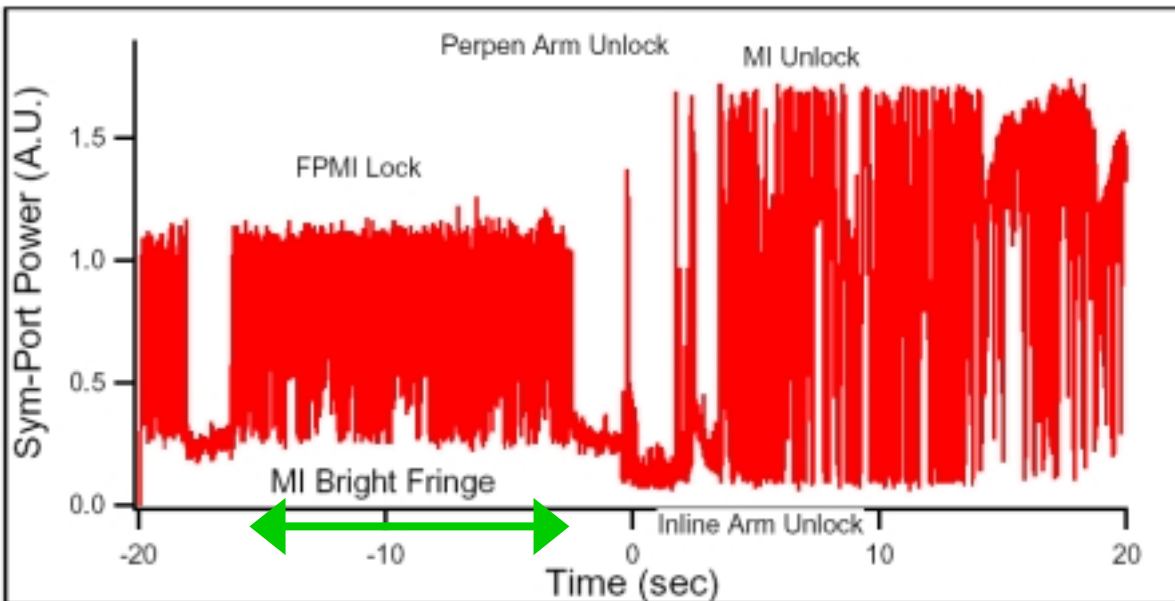
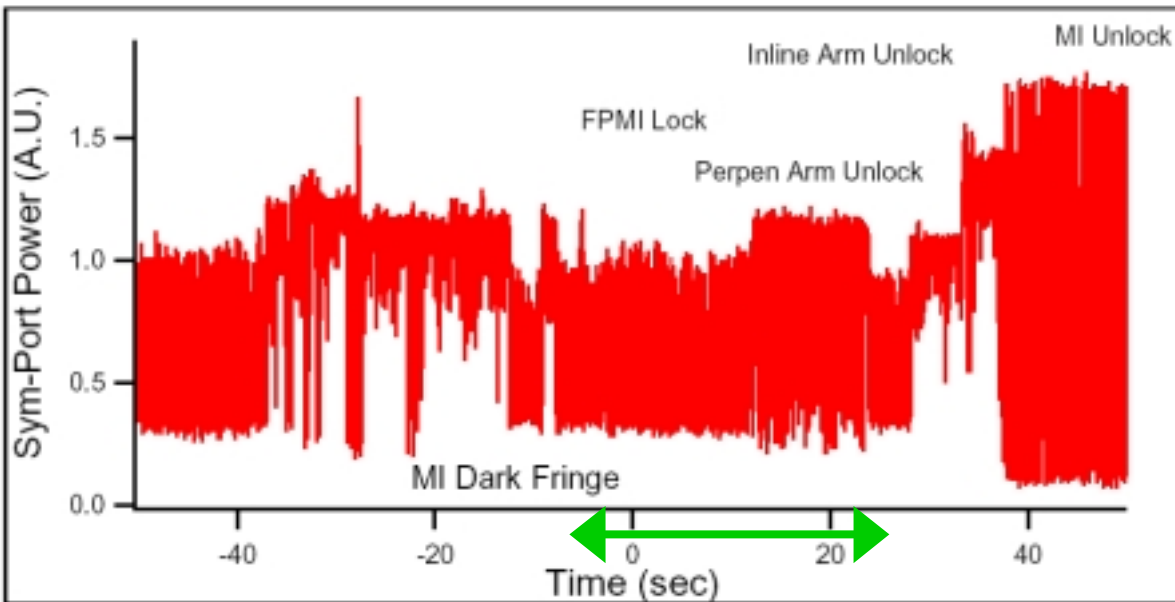
# Double Demodulation



- Polarity doesn't change after arms locked
- Offset can be removed with appropriate demo. phase

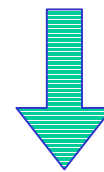
**We have installed this DDM.**

# Double Demodulation



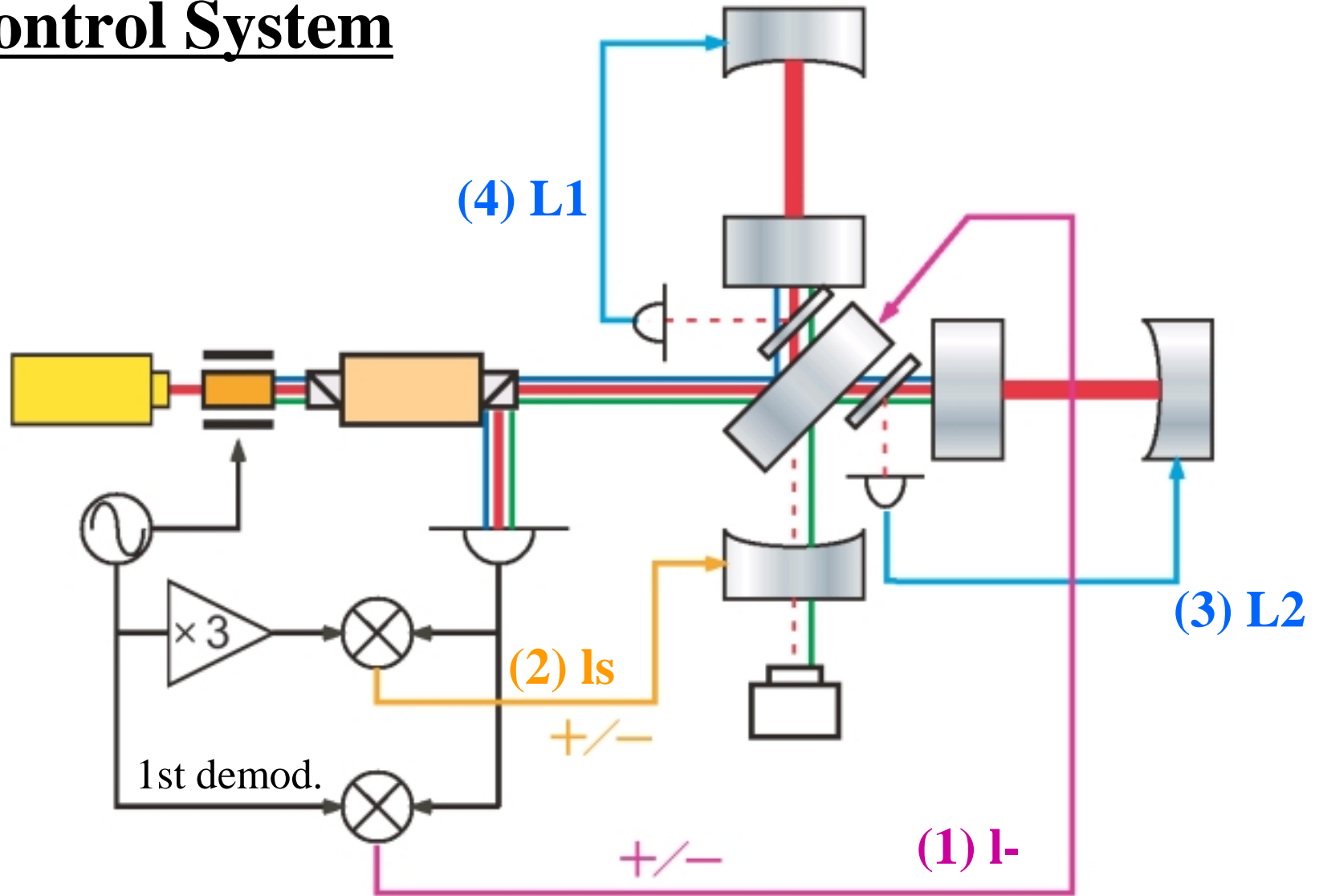
## FPMI lock with DDM

- **Not robust**
- **Lock keeps less than 1 min.**
- **Somehow polarity changes with arm cavities**



**Finally we decided not to use double demodulation for now.**

# Control System

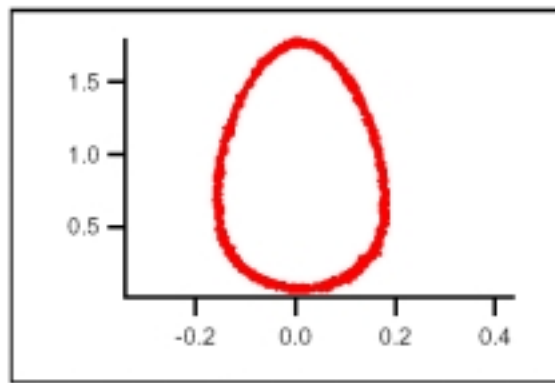


**Lock (1)  $\rightarrow$  (2)  $\rightarrow$  (3)  $\rightarrow$  (4) ( $\rightarrow$  Change the polarity of l-)**



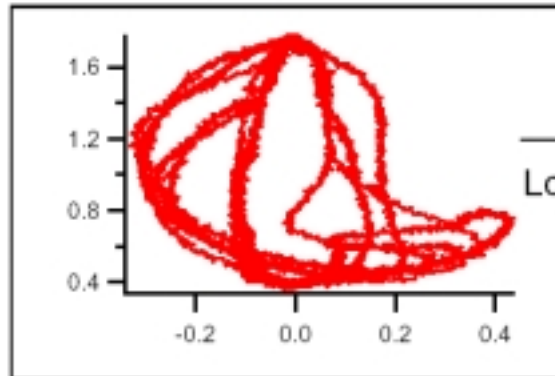
# Lock Acquisition

I- vs. BP DC Power

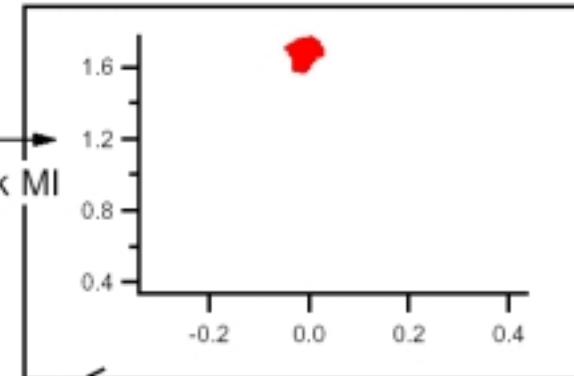


Vertical: Bright Port DC Power  
Horizontal: Error Signal of I-

Add SRM  
(Alignment has been changed.)

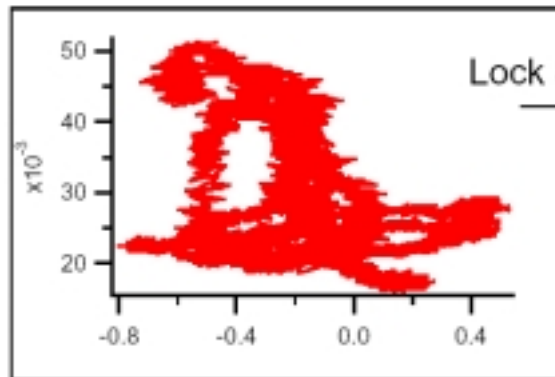


Lock MI

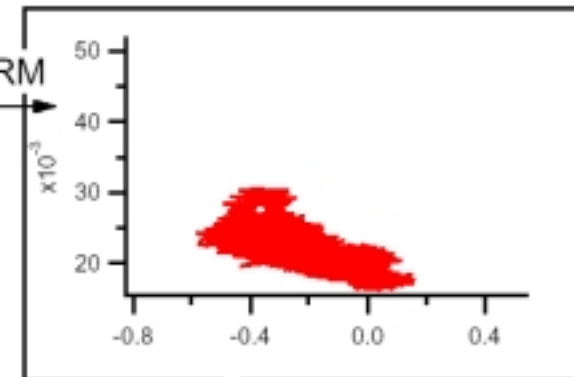


Look at SRM motion.  
(another oscilloscope)

Is vs. DP DC Power

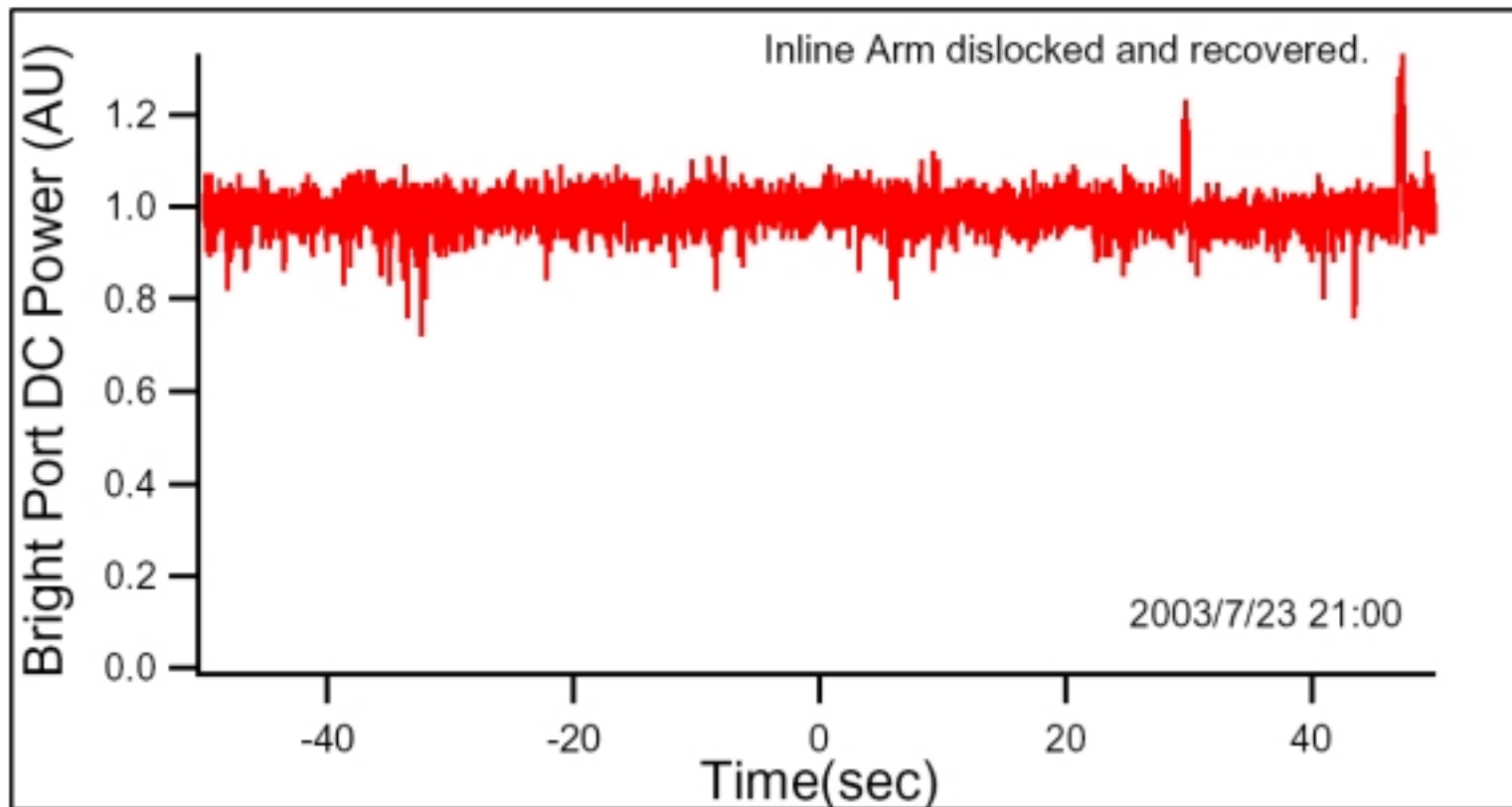


Lock SRM



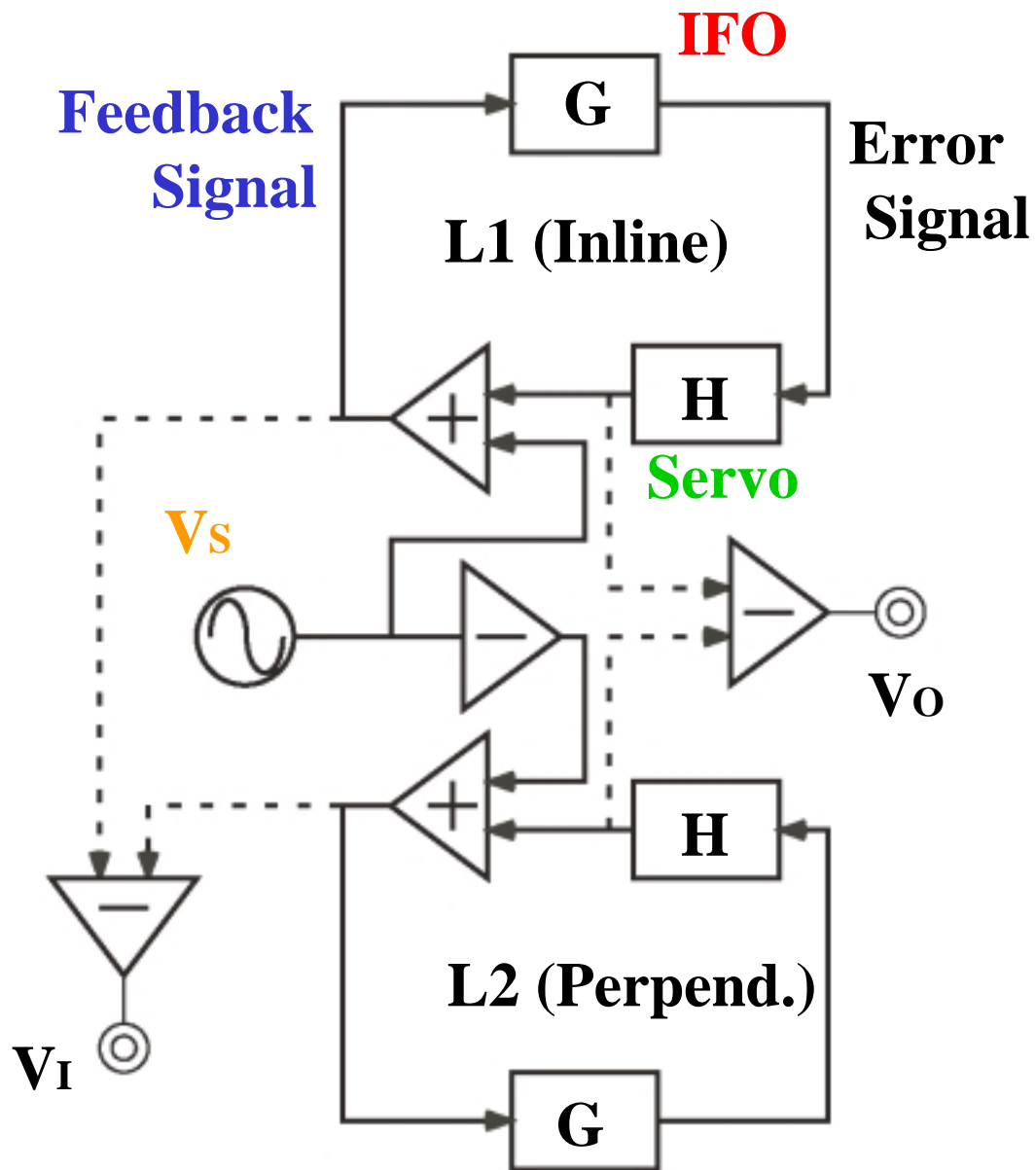
**SRMI**  
(w/o arm cavities)

# RSE Lock (with arms, without PR)



**It takes some time to lock the whole interferometer, but once locked it keeps locking as long as I want.**

# Transfer Function Measurement



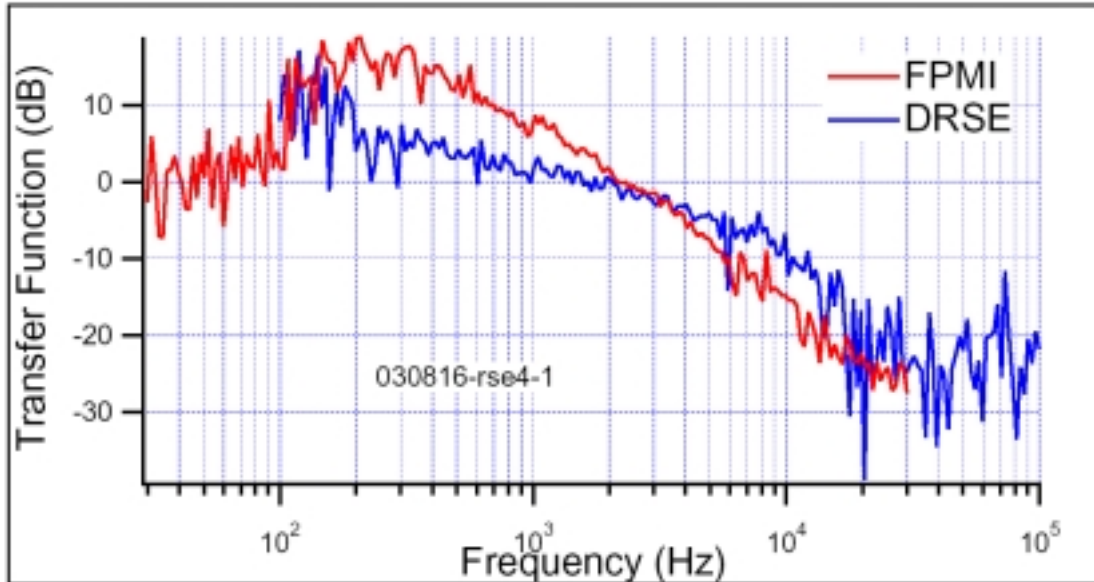
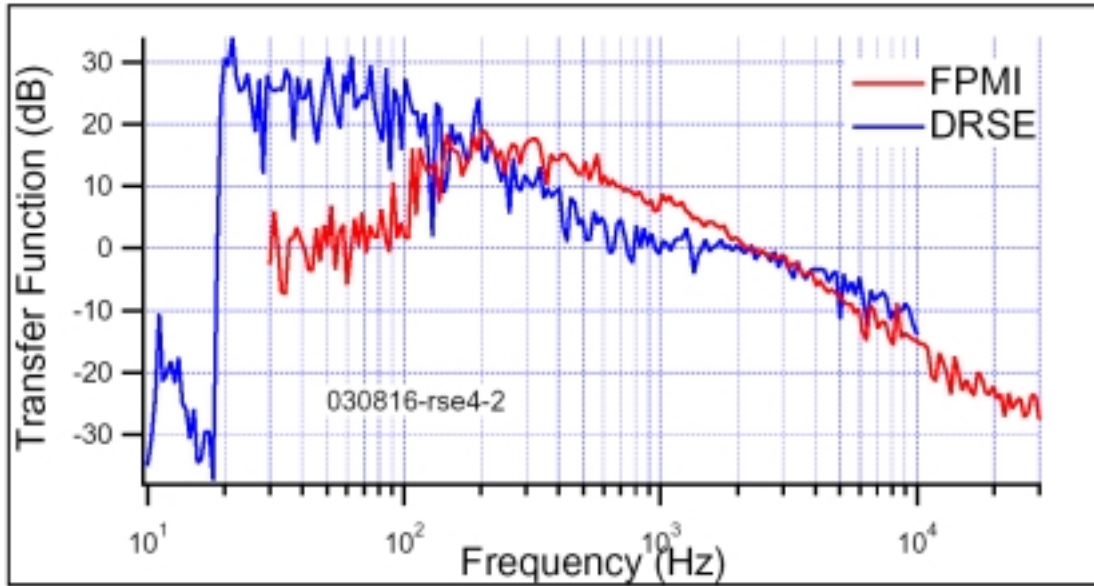
**Open-Loop Transfer Function**

$$\frac{V_O}{V_I} = GH$$

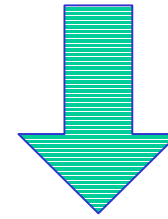
$$L^- = L1 - L2$$

**(We do not have L- port yet..)**

# Experimental Results



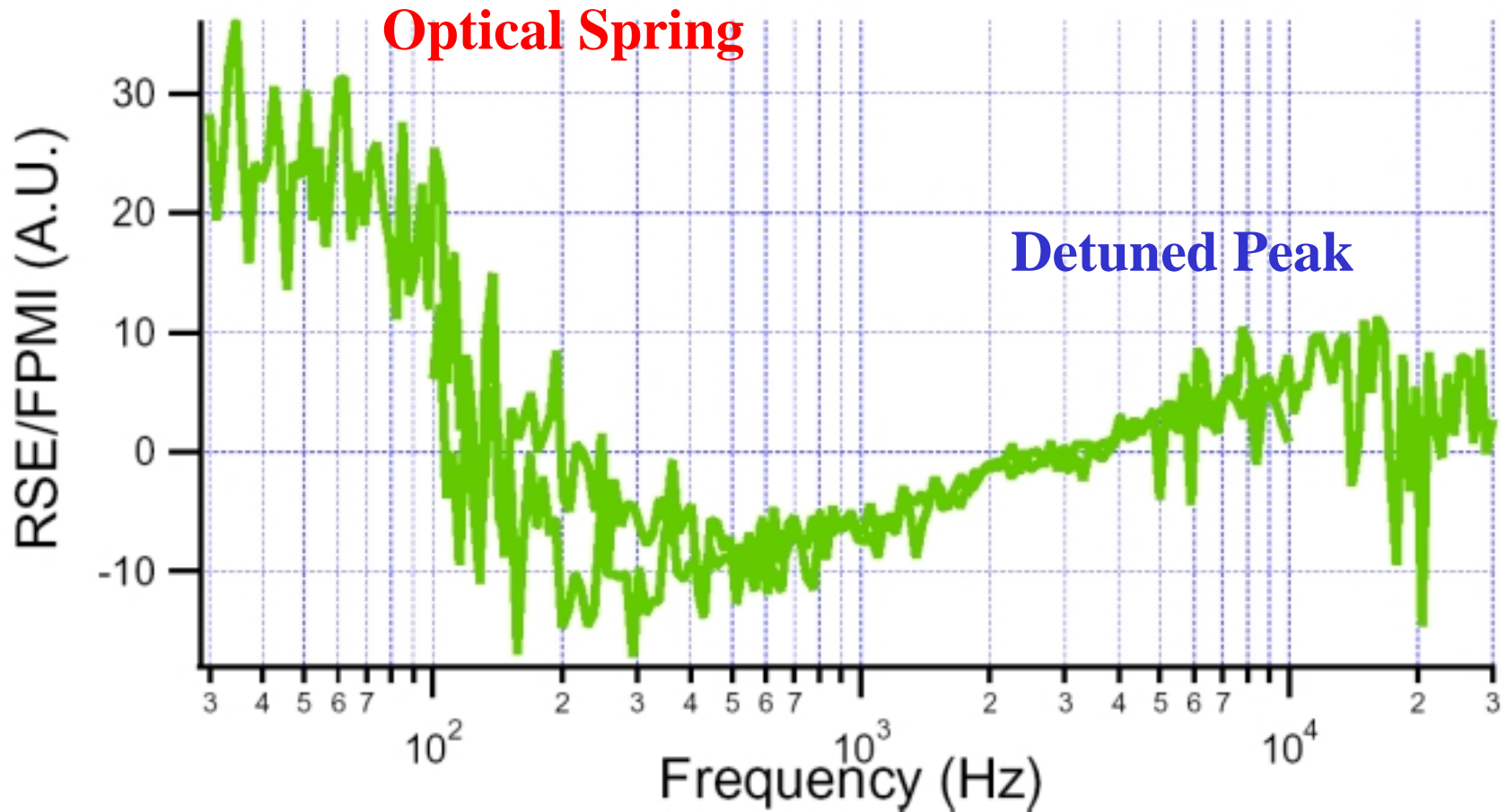
OLTF of **detuned RSE** measured in low frequency (10-10kHz) and high frequency (100-100kHz), compared with **FPMI** (20-20kHz).



**It shows differences!**

Let's take the ratio of these two.

# Relative Frequency Response (Signal Gain)



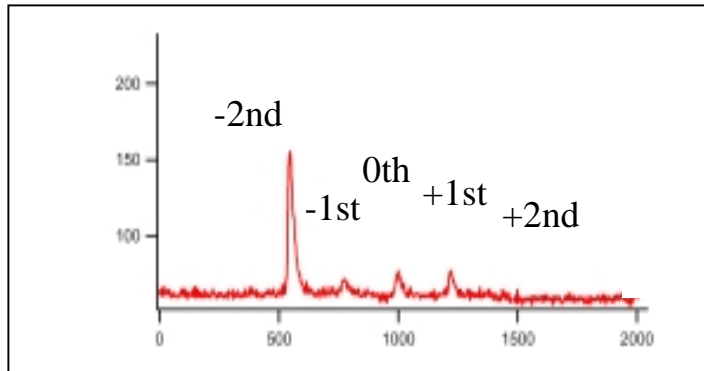
**Two peaks!!**

# Conclusion

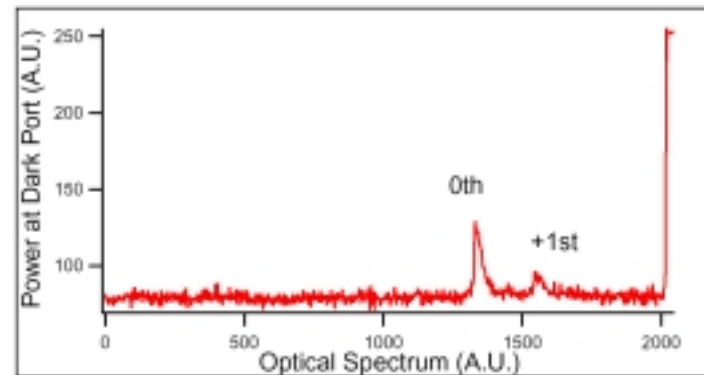
- **We confirmed the control method of DRSE with THD.**
- **We tried Double Demodulation and gave up for the present.**
- **We succeeded to lock detuned RSE with suspended masses.**
- **We measured the transfer function of L-.**
- **We can hopefully say we've observed something like an optical spring effect.**
- **There are many things to do for a better measurement.**

# To Be Improved

- **FPMI contrast should be increased.**
- **2<sup>nd</sup> harmonics should be resonant in SRC for DRSE.**



(detuned RSE w/o arms)



(locked state with arms)

- **Additional LASER injected from the end mirrors will provide more broadband TF measurement.**
- **L- detection at dark port is necessary.**

END