

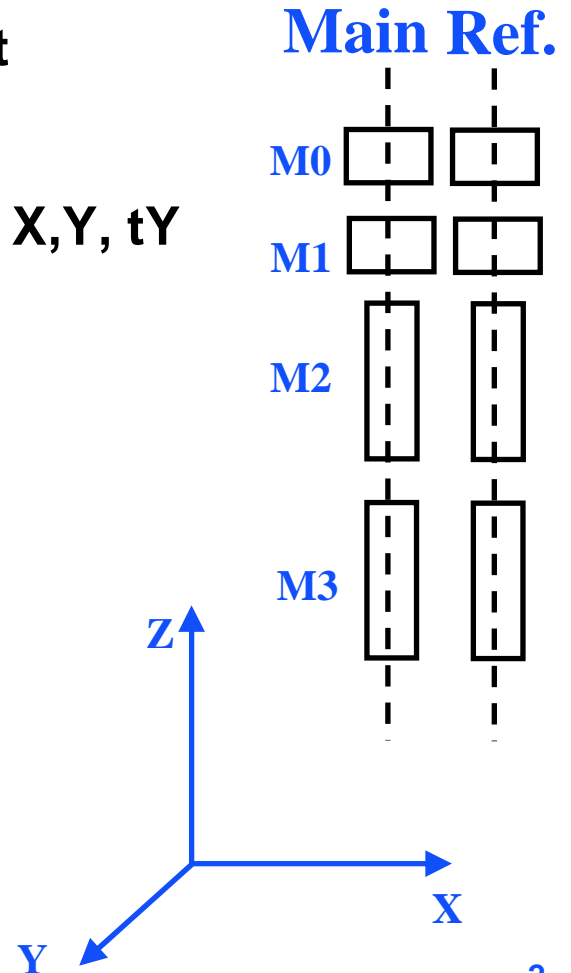
Updating report for FP cavity with AdLIGO parameters on E2E

Osamu Miyakawa, Hiroaki Yamamoto

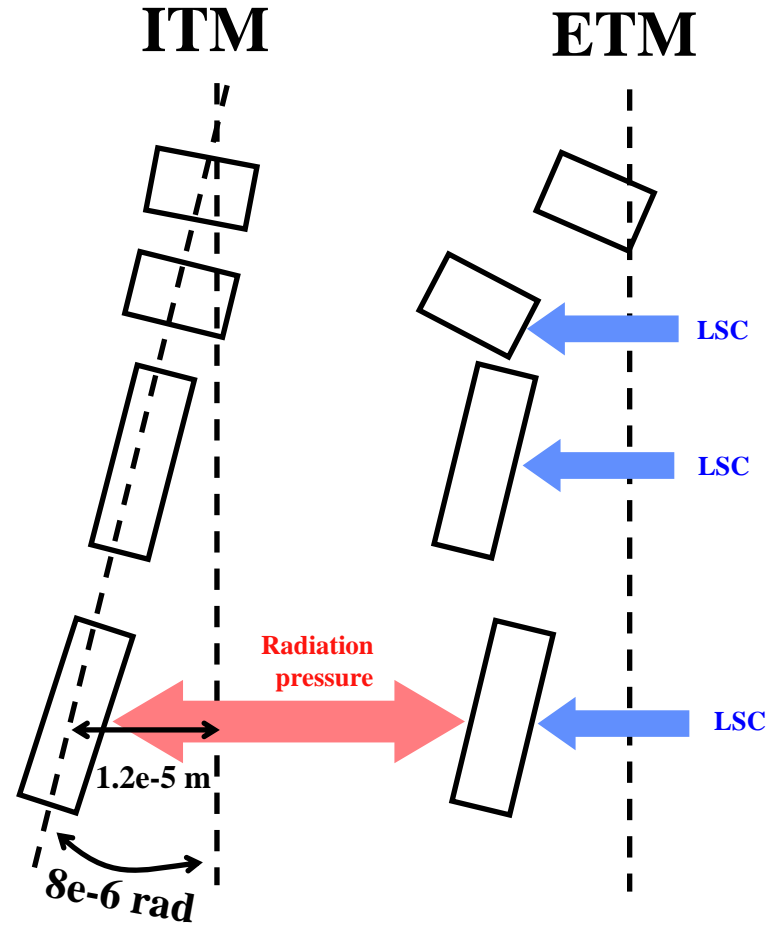
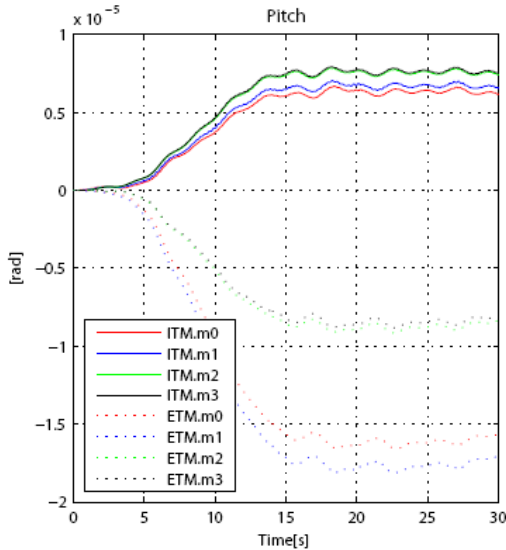
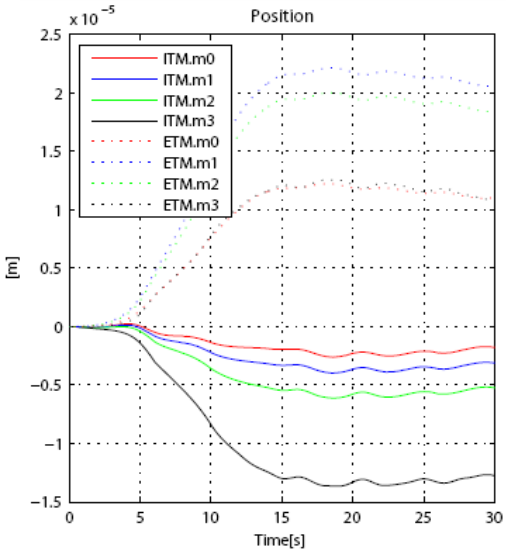
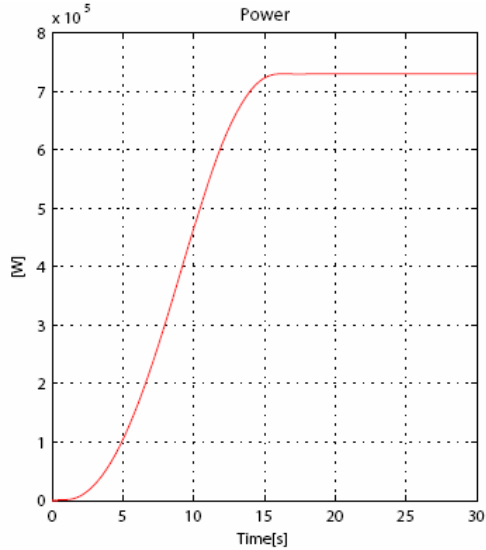
07/26/2006 Advanced LIGO meeting

- **Is it possible to acquire lock with radiation pressure?**
- **Is it possible to control alignment with radiation pressure?**
- **Optical spring in ASC?**
- **Do we need test mass actuator for ASC? both ETM and ITM?**
- **Is the actuator dynamic range enough?**
- **Noise performance?**

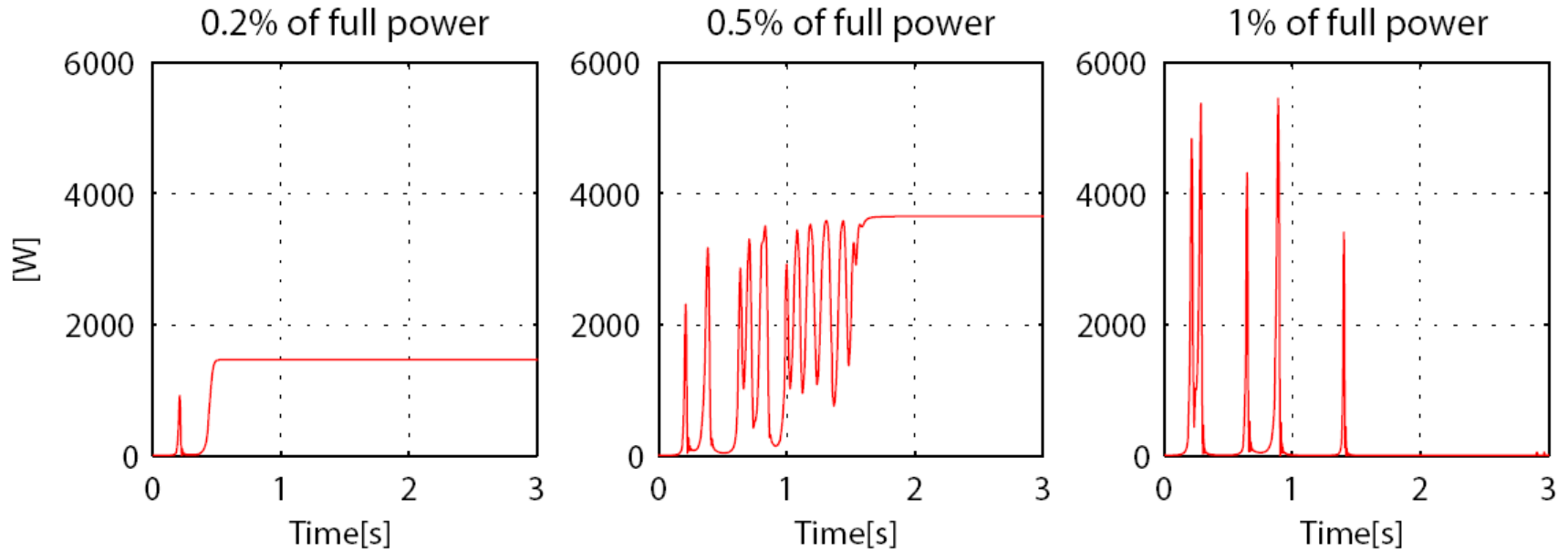
- AdLIGO Quad suspension (Mark's model 03/31/2006)
- Radiation pressure on length and alignment
- Shot noise and radiation pressure noise
- Seismic motion and optical table motion on X,Y, tY and tZ (length, side, pitch and yaw)
- Local damping (6 DOFs of M0)
- Length control for M3 through M1, M2, M3
- M3 alignment control through M2
- WFS



Quad suspension with radiation pressure (length)

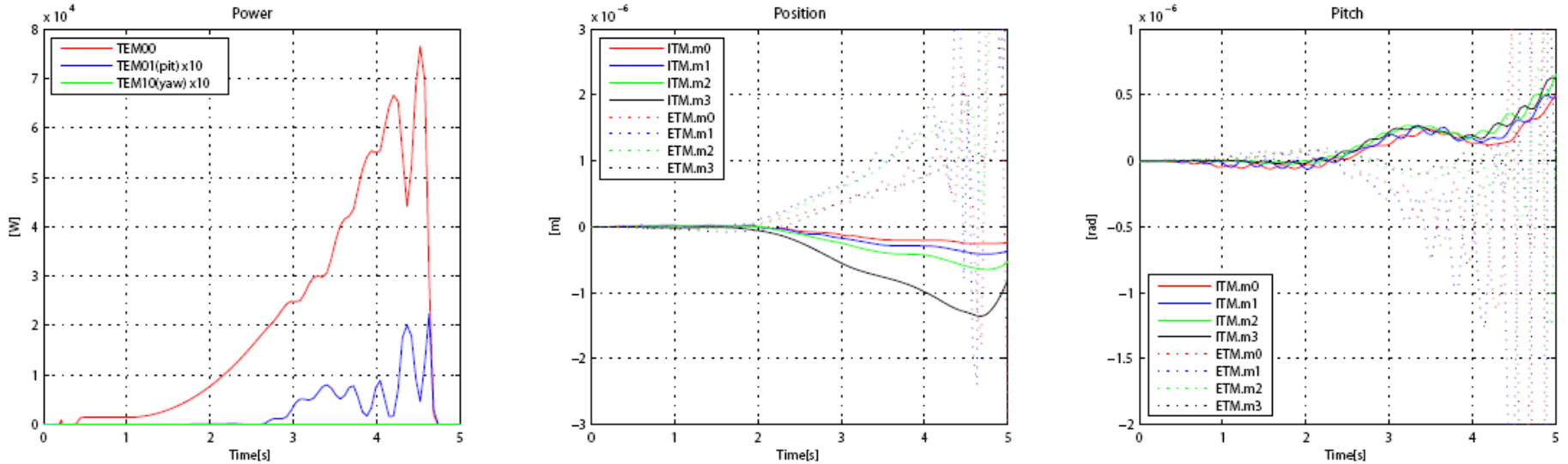


Lock acquisition with radiation pressure



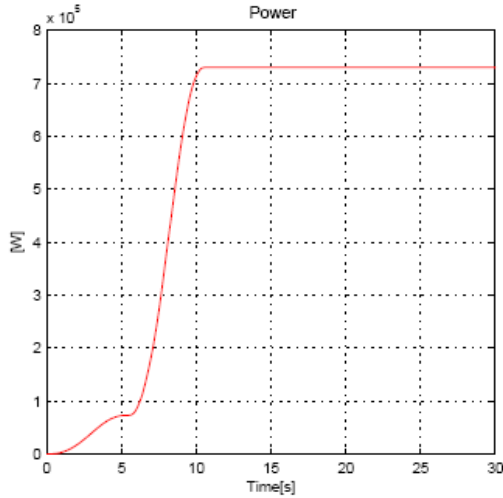
- **60nm/sec** :enough slow to acquire lock for LSC only
- **Full power** : 0.7MW
- **Lock can be acquired with less than few kW**

Alignment instability with no ASC

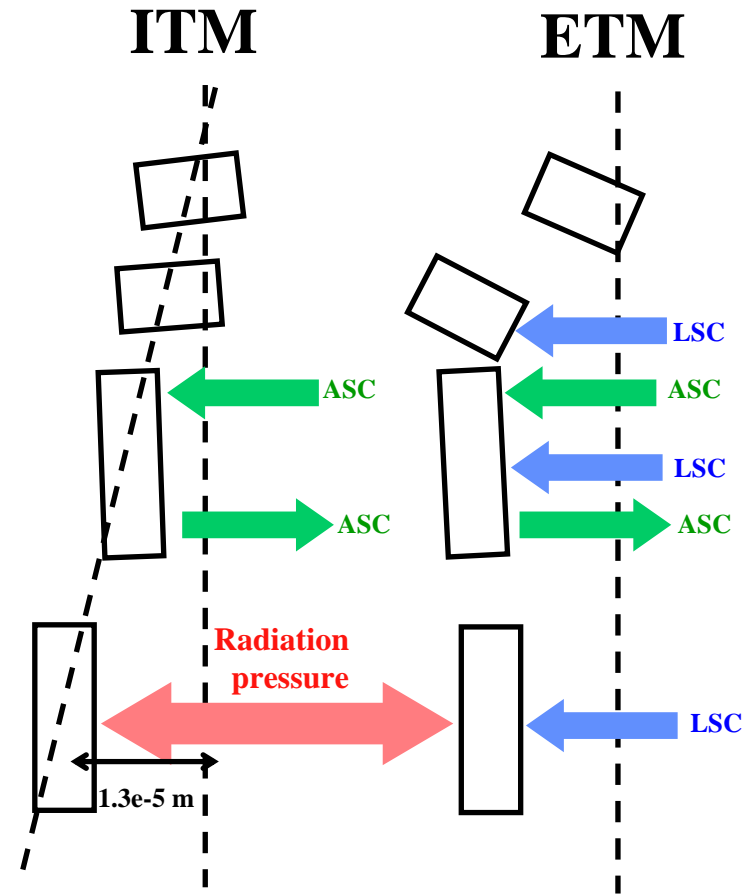
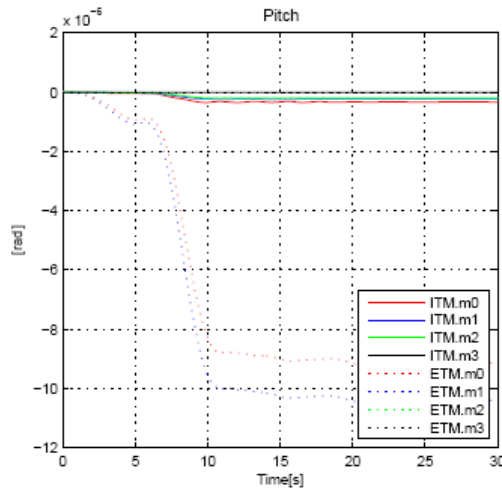
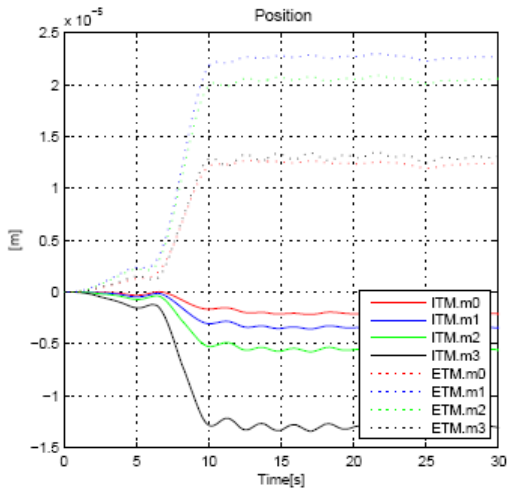


- Pitch motion due to Radiation pressure breaks lock with 10%(70kW) of full power if there is no ASC

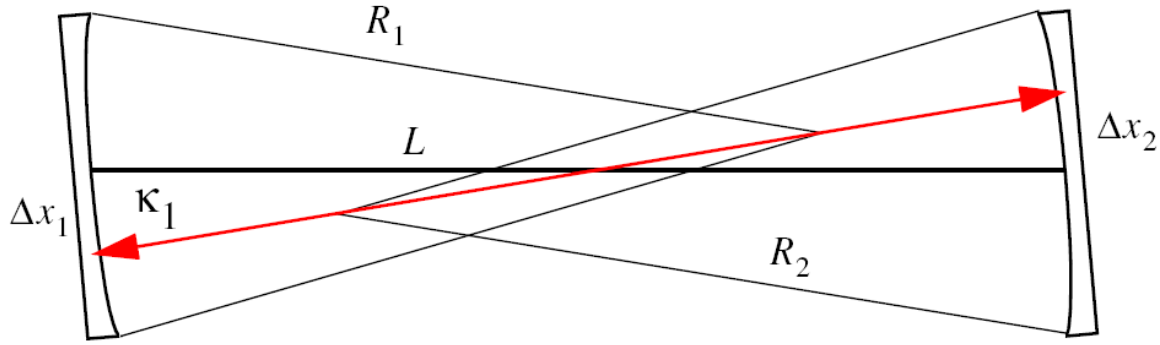
Test mass alignment control through M2 with radiation pressure



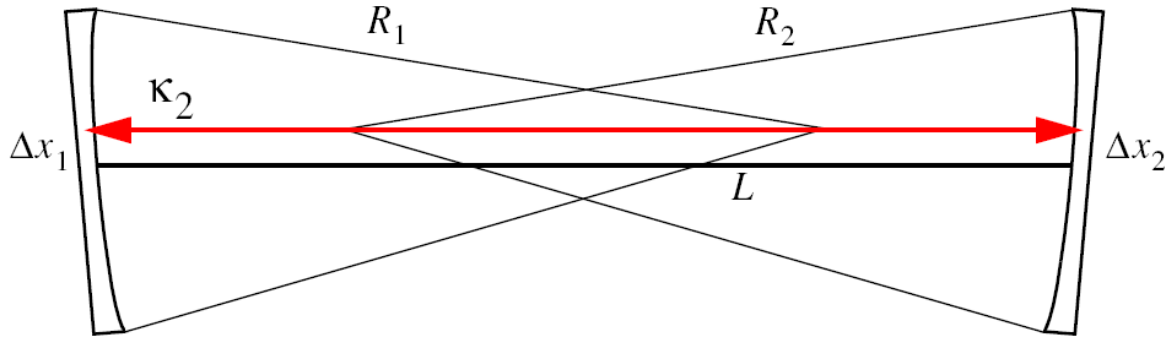
- Control M3 through M2
- f^3 filter
- Boost at 2Hz
- 10Hz control band width



Two modes of optical instability



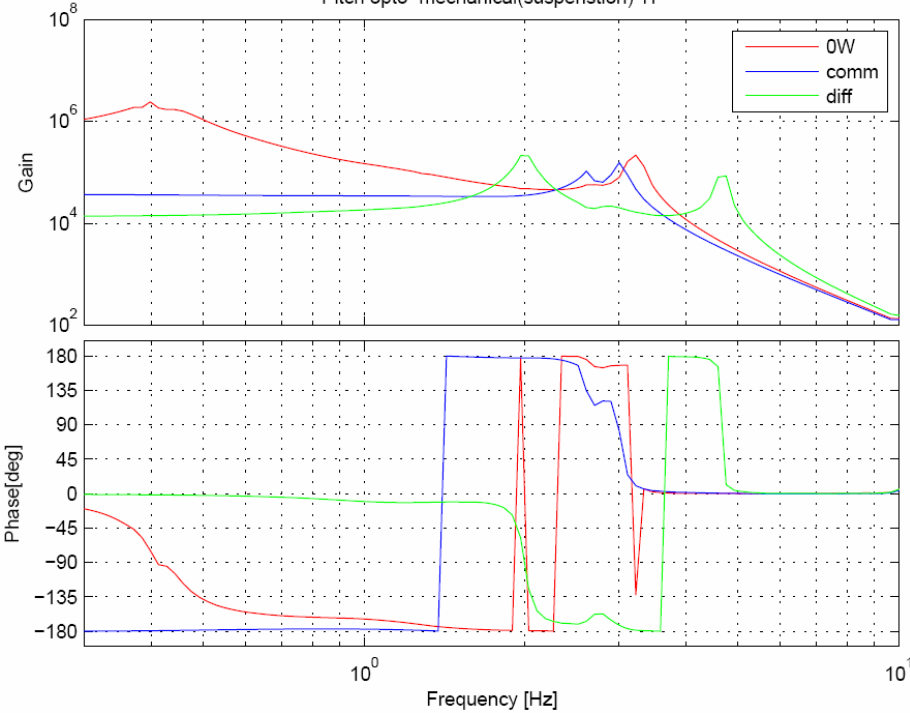
Differential : stable -> spring



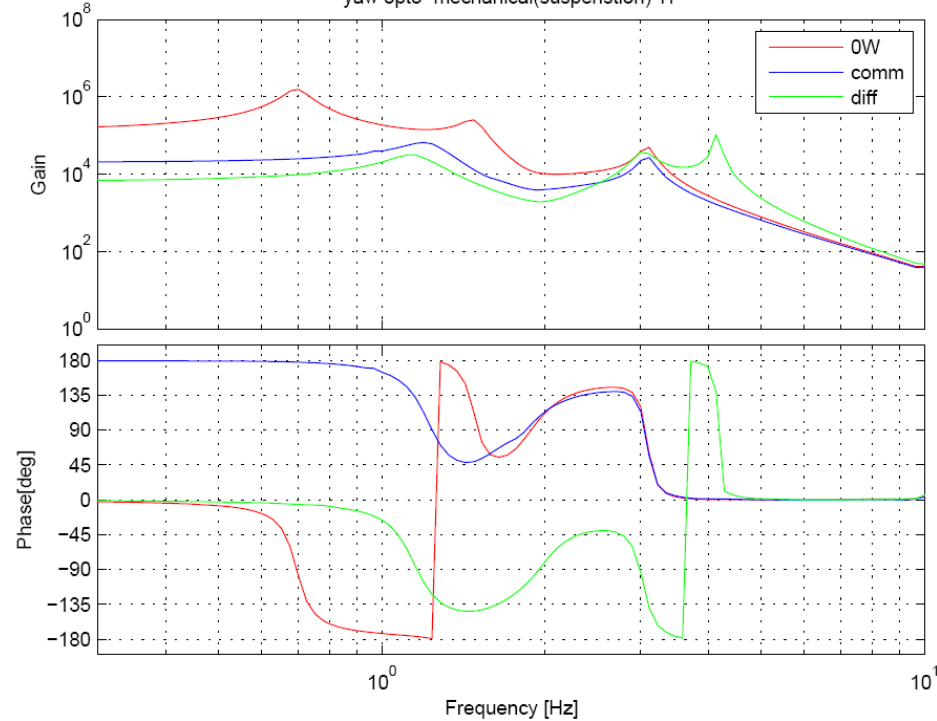
Common : unstable -> no spring

Opt-mechanical (suspension) TF

Pitch opto-mechanical(suspension) TF



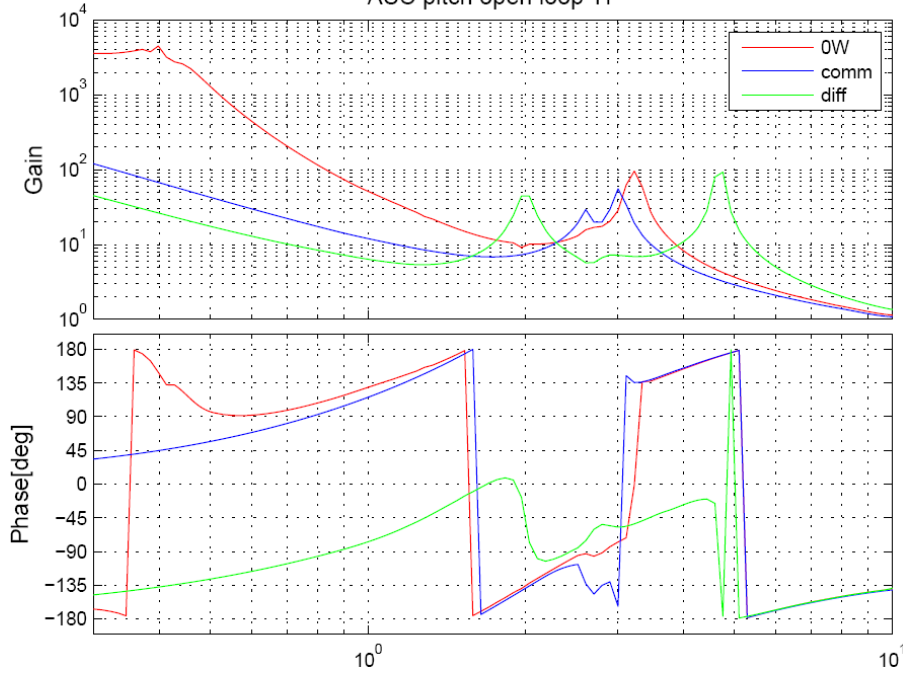
yaw opto-mechanical(suspension) TF



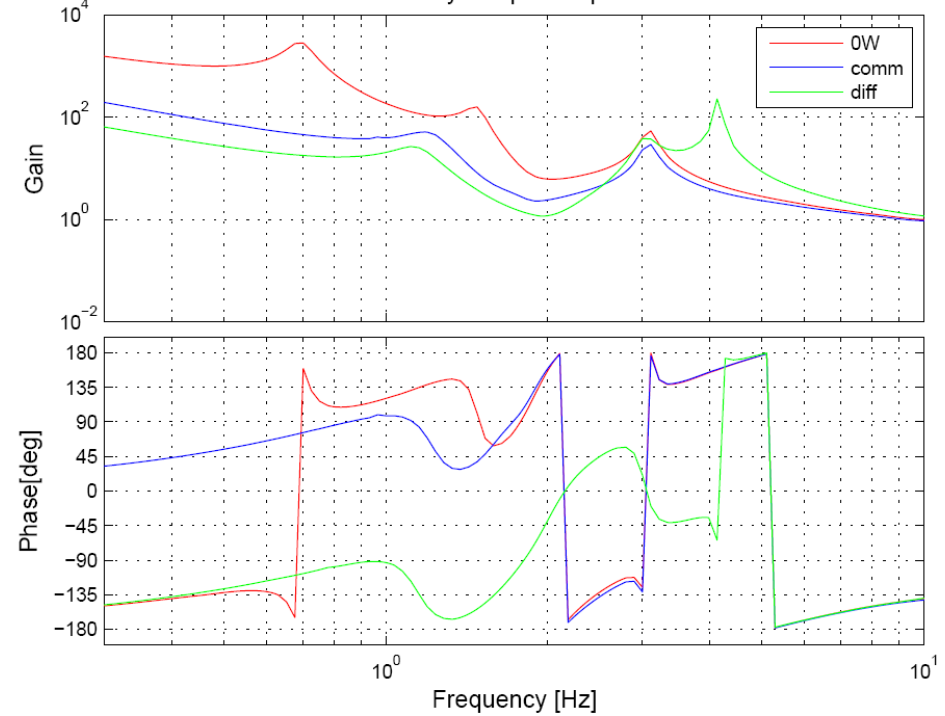
- Calculated in time domain
- Low frequency peak is suppressed
- Optical spring in differential mode at 4.5Hz for pitch and 4.1Hz for yaw

Open loop TF of ASC

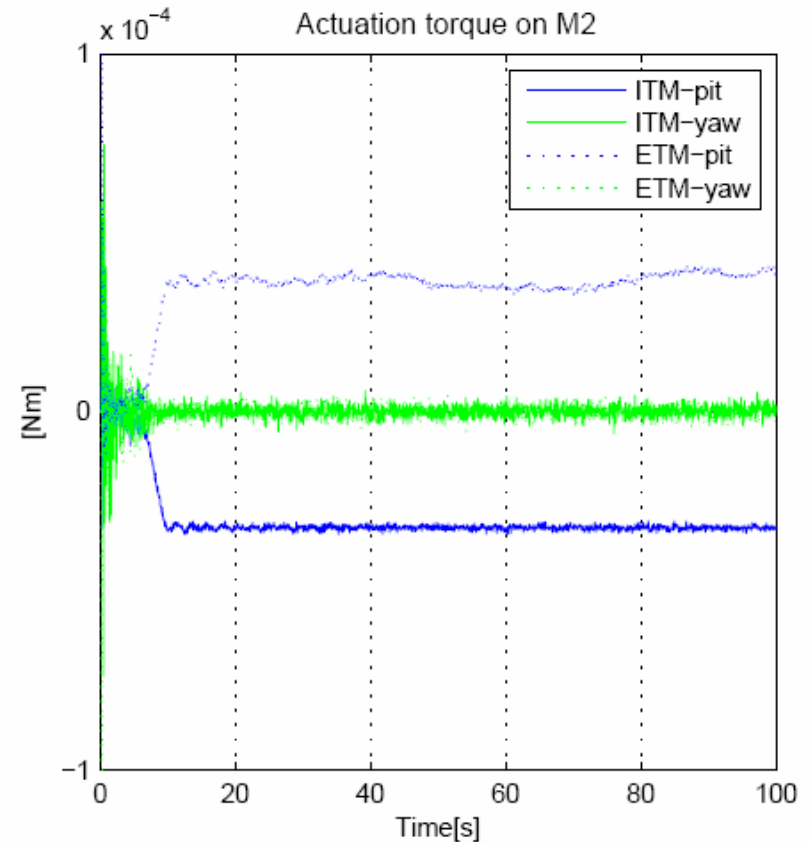
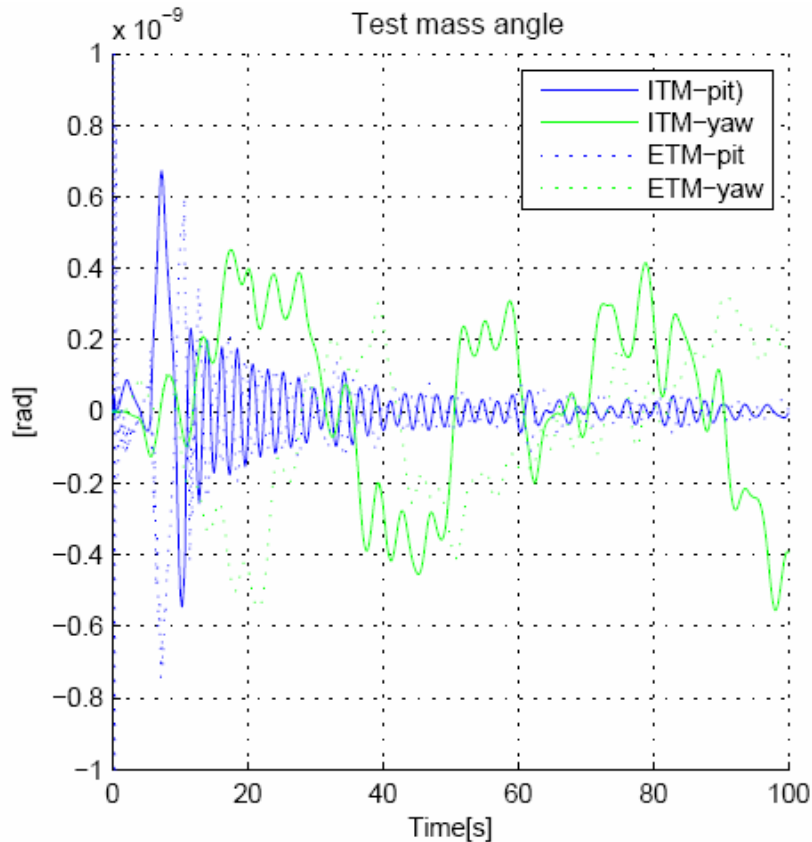
ASC pitch open loop TF



ASC yaw open loop TF

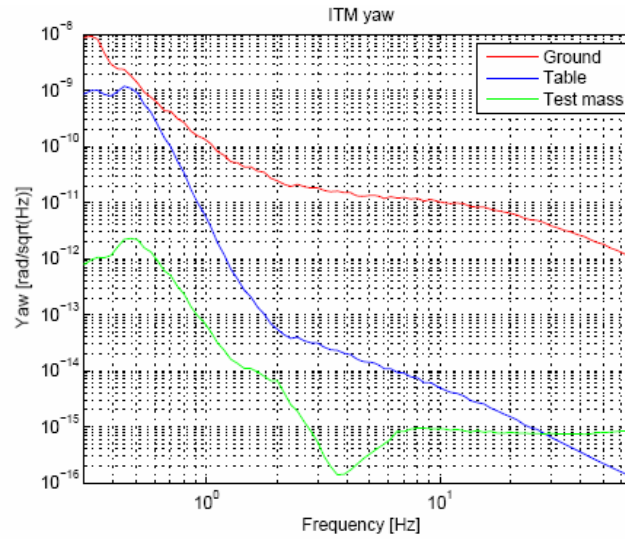
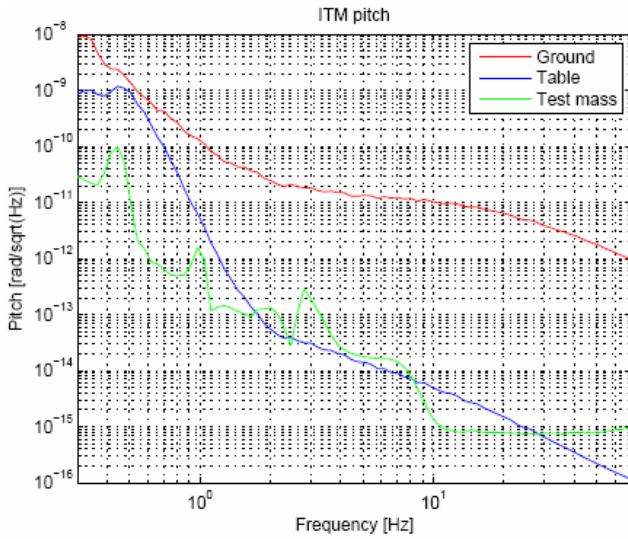


- **10Hz control band width**
- **Gain in low frequency is suppressed a lot by radiation pressure**

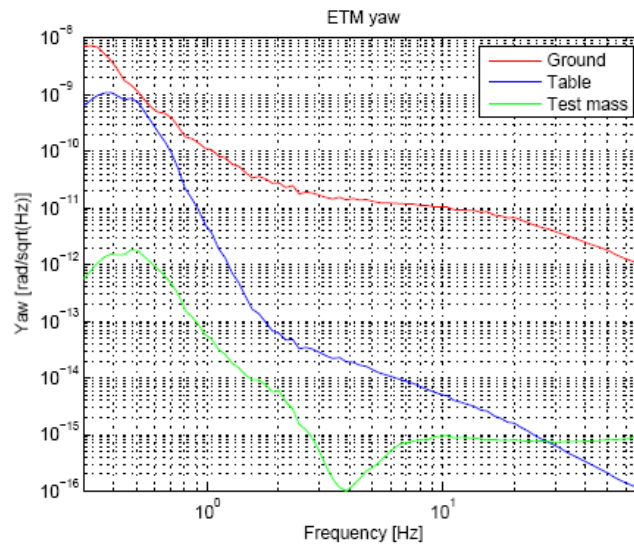
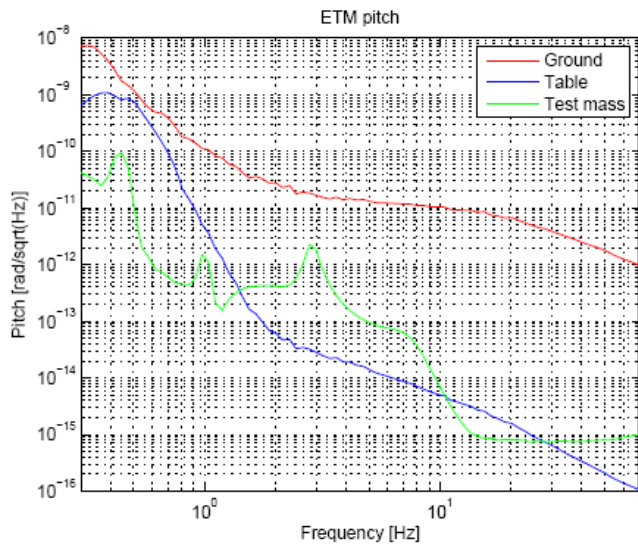


- Residual RMS: $<10^{-9}$ rad (depends on servo)
- Actuation torque(force): 3×10^{-4} Nm (1×10^{-3} N) on M2 OSEM (max 20mN)

Noise performance in spectra



- Depends on seismic noise model
- Length to pitch coupling is not ignorable
- High frequency is limited by shot noise



- Is it possible to acquire lock with radiation pressure? *Yes, with less than few kW*
- Is it possible to control alignment with radiation pressure? *Yes, with 10Hz control band-width*
- Optical spring in ASC? *Yes, 4-5Hz*
- Do we need test mass actuator for ASC? both ETM and ITM? *No, penultimate mass actuator enough*
- Is the actuator dynamic range enough? *Yes, 1mN of 20mN*
- Noise performance? *< 10⁻⁹ rad*