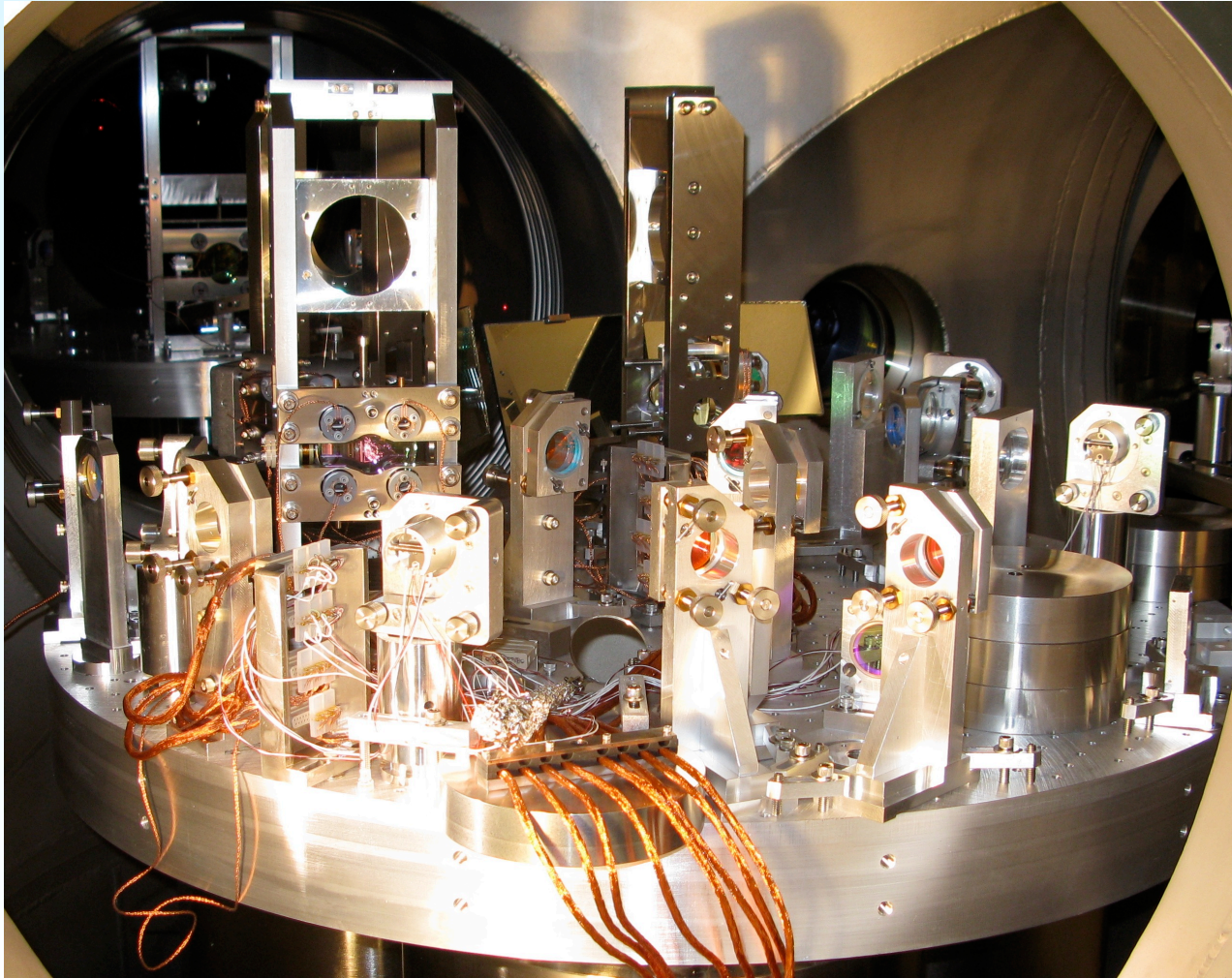


40m upgrade status



Koji Arai (Caltech)

LVC meeting @Arcadia Mar 15, 2010

LIGO-G1000323-v1

Introduction

40m prototype IFO@Caltech

Dual Recycled Fabry-Perot Michelson

Control prototype of the aLIGO IFOs

Upgrade of the 40m

Change of the optical parameters

Renewal of the systems

This talk

- **Overview of the upgrade**
- **Advanced technologies**
- **Upgrade status**

Upgrade of the 40m prototype IFO

Purpose of the upgrade

"Making the 40m IFO system more relevant to aLIGO"

- Testbed for the aLIGO IFO technologies

LSC, IFO responses / Noise couplings

Tuned/detuned comparison

Green laser injection for arm length stabilization

aLIGO CDS

- Development of advanced interferometer techniques

Simulated plant for S/W development & system diagnoses

Adaptive noise cancellation

IFO configuration

- New test masses (1.35kg -> 0.24kg)

Larger RP effect

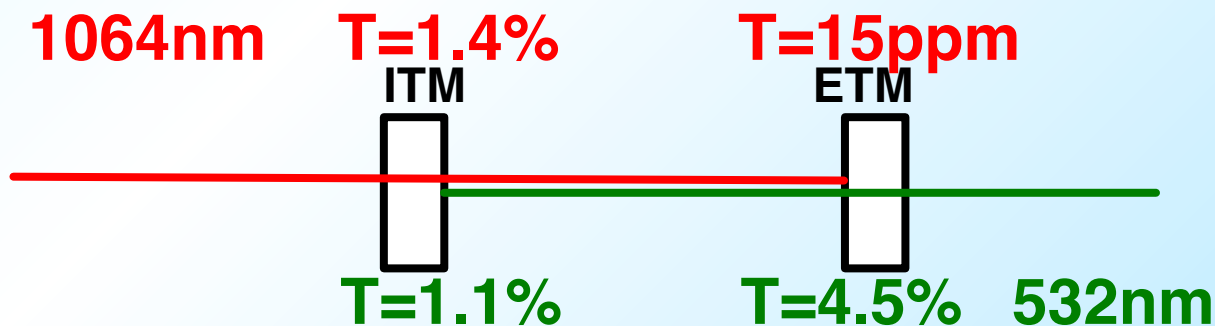
Use of SOS (Small Optics Suspension)

Finesse matched to the aLIGO design

$F = 1250 \rightarrow 450 @ 1064\text{nm}$

Dichroic coating for green locking

$F = 100 @ 532\text{nm}$



IFO configuration

- **Lower f_{mod} (33/166MHz \rightarrow 11/55MHz)**
Yields longer PRC/SRC

$$L_{\text{PRC}}=6.77\text{m} \quad / \quad L_{\text{SRC}}=5.41\text{m}$$

\rightarrow Folded by ANU TTs
(eddy current damping passive suspended)

Measurement of the cavity lengths planned
 \Rightarrow **Poster: A. Stochino**

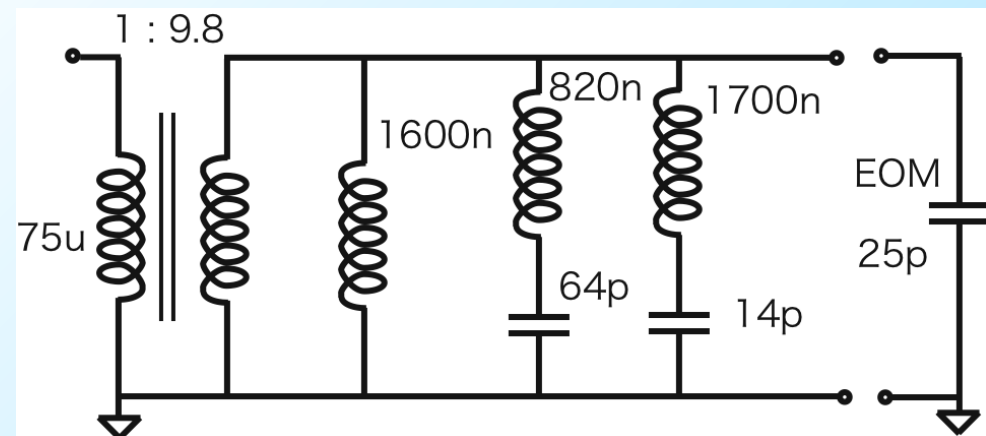
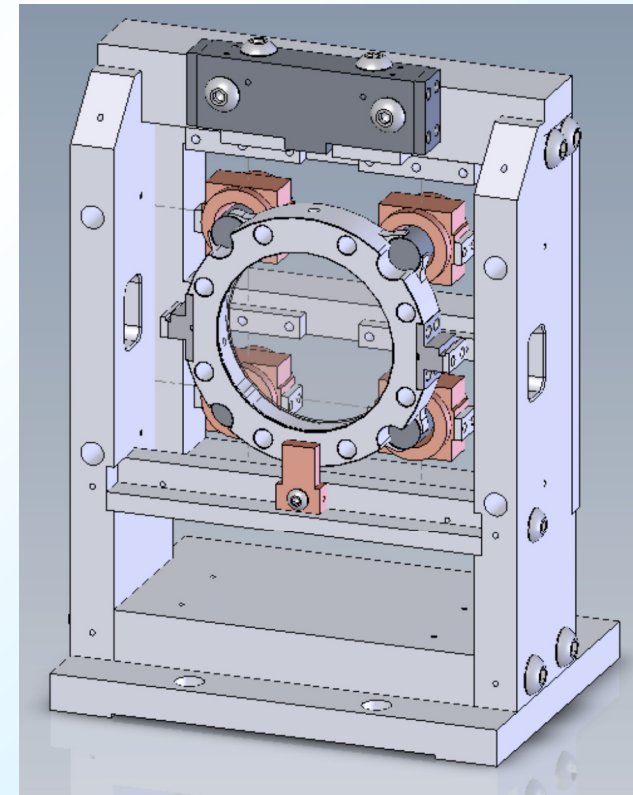
3f demodulation for lock acquisition

Modulation:

No Mach-Zehnder

Multiple Resonant EOM
already in hand

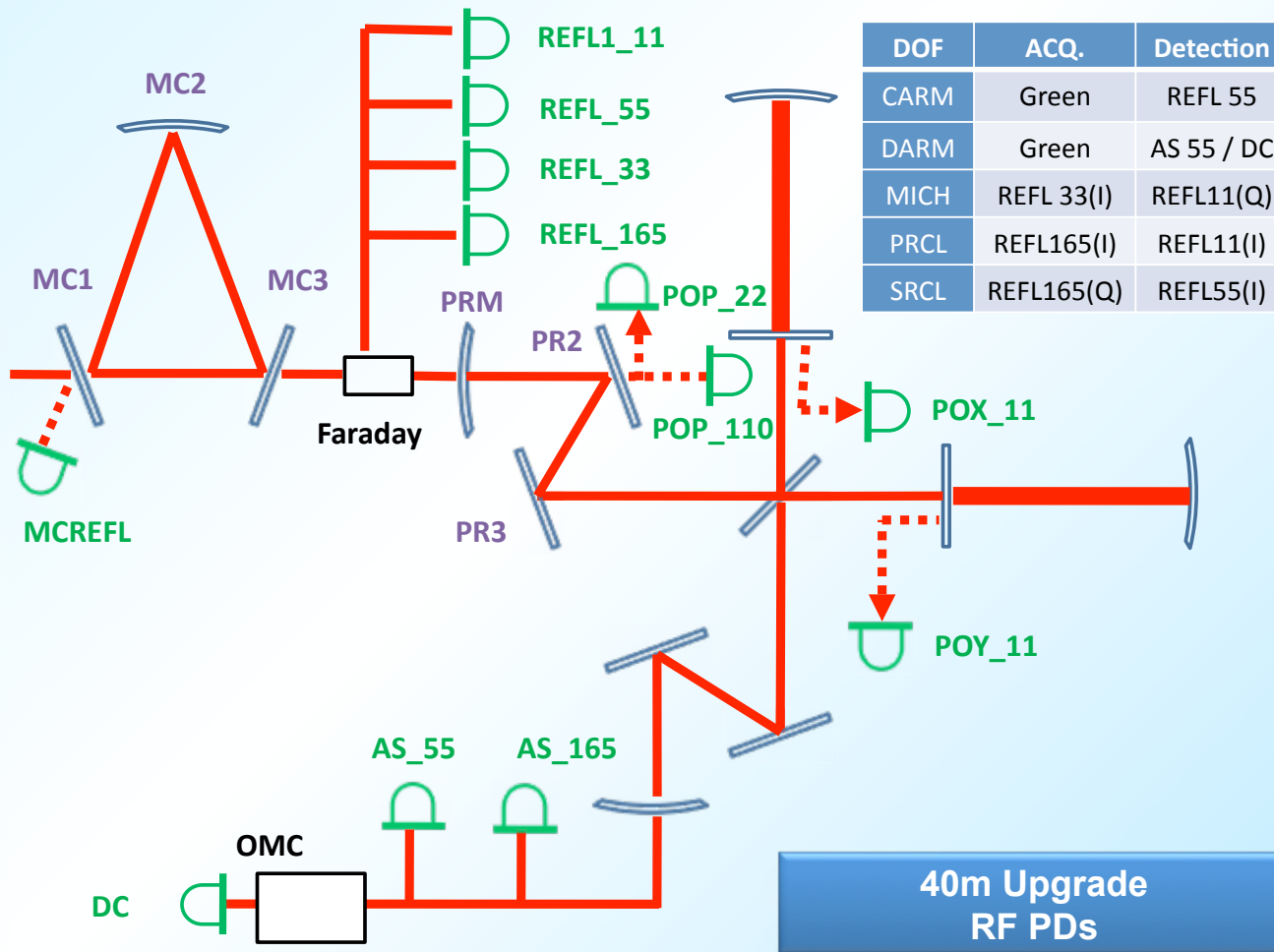
Poster: K. Izumi \Leftarrow



Signal extraction

Planned photodetector arrangement

Detection frequency: 11, 22, 33, 55, 110, 165MHz

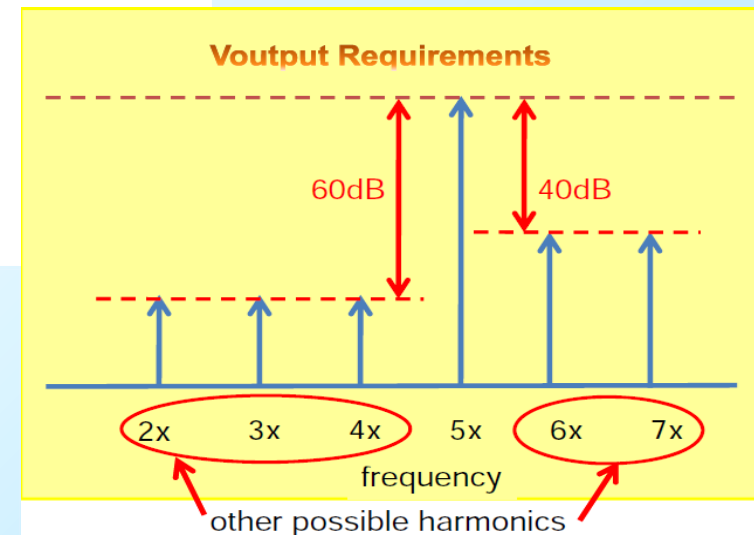
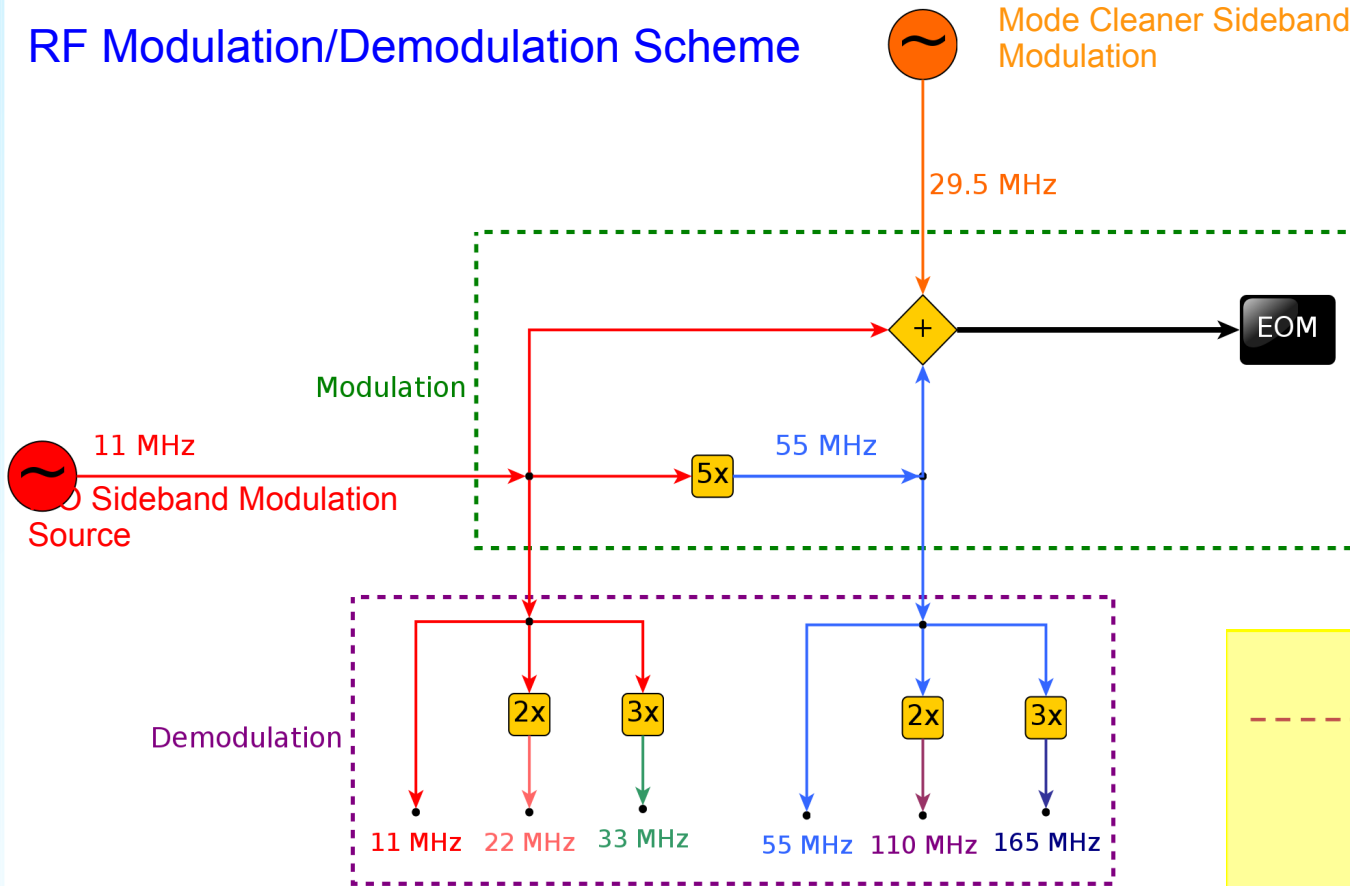


The PDs are currently being refurbished

Signal extraction

Local oscillator generation

RF Modulation/Demodulation Scheme



**Harmonics levels of the multipliers
=> specified not to cause unwanted
IFO signal couplings**

Vertex Green Locking

=> Poster: A. Brooks
D. Yeaton-Massey

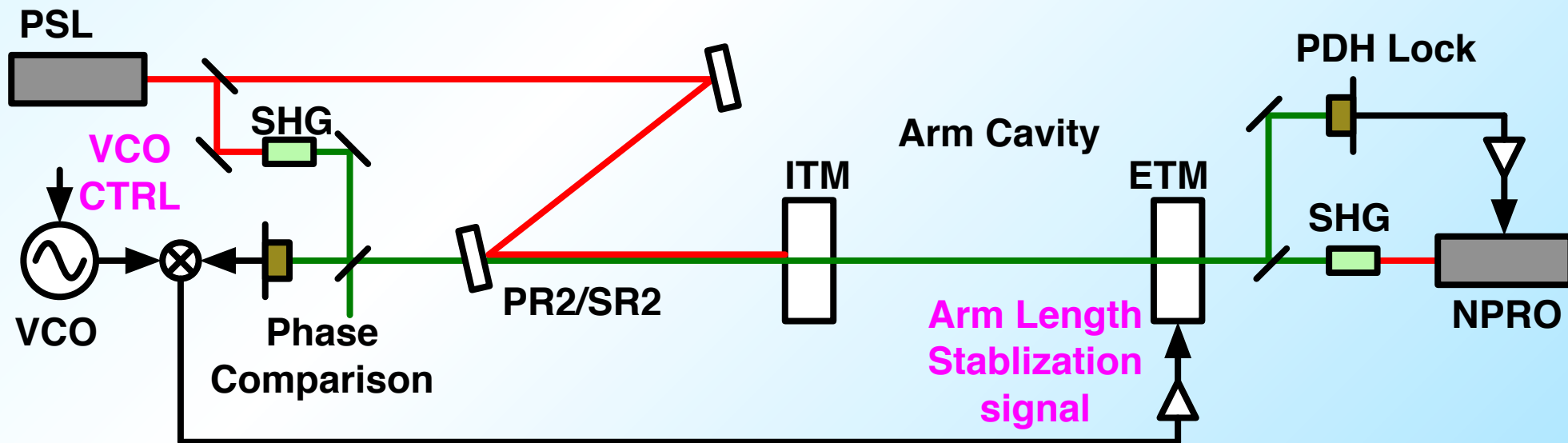
Arm length stabilization with aux. green beam

Inject green beams from each end

Beating at the vertex

=> longitudinal fluctuation info of the arms

Demonstrating the scheme prior to the aLIGO implementation



New CDS

aLIGO CDS

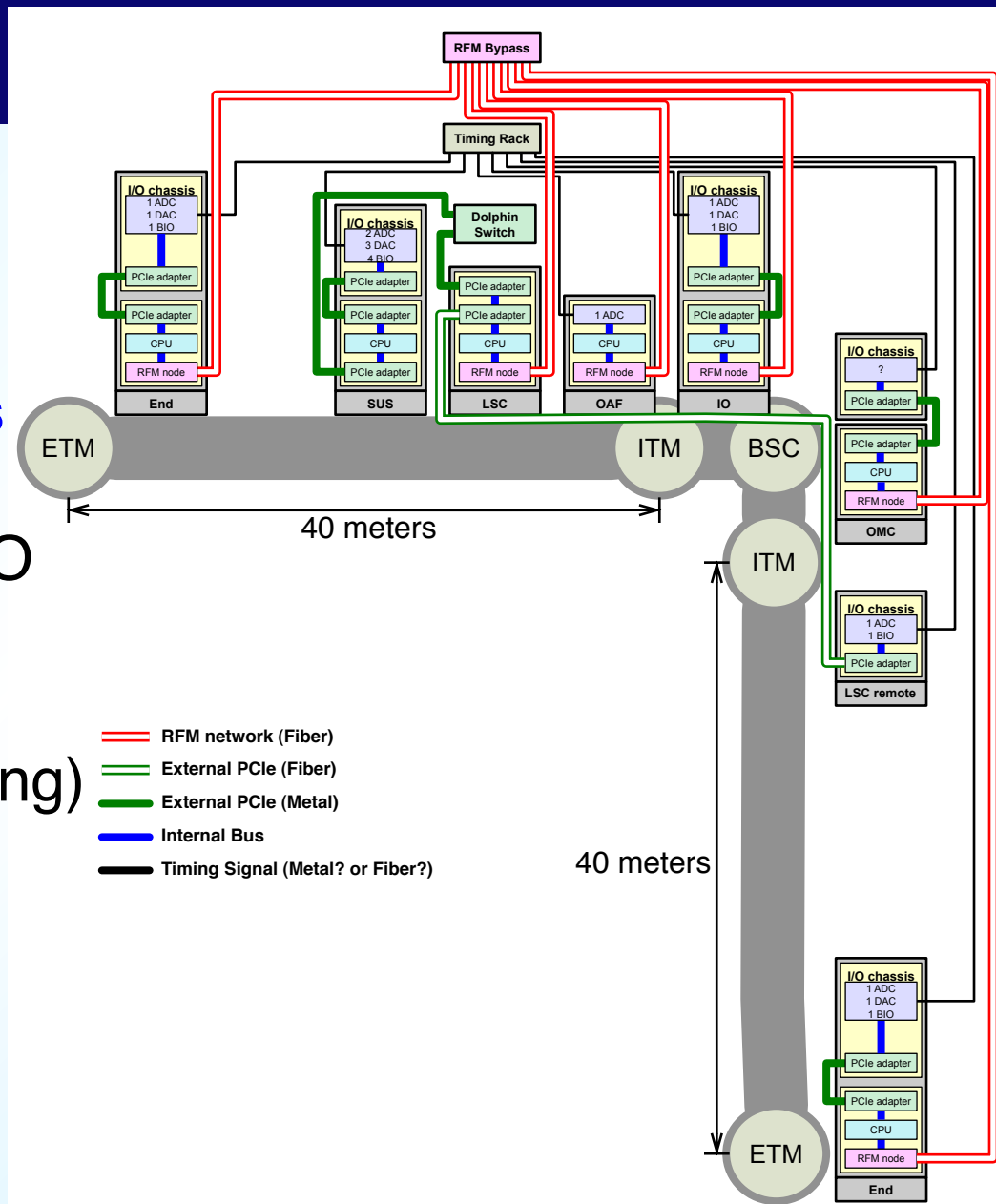
- Distributed processors connected by PCIe / RFM
- Distributed ADCs/DACs/DOs

=> Topologically similar to aLIGO
=> Provides the opportunities for comprehensive test (functions, codes, noise, timing)

Successful test of ETMY

- Local damping
- Transmon
- Arm lock through RFM

Integration on going

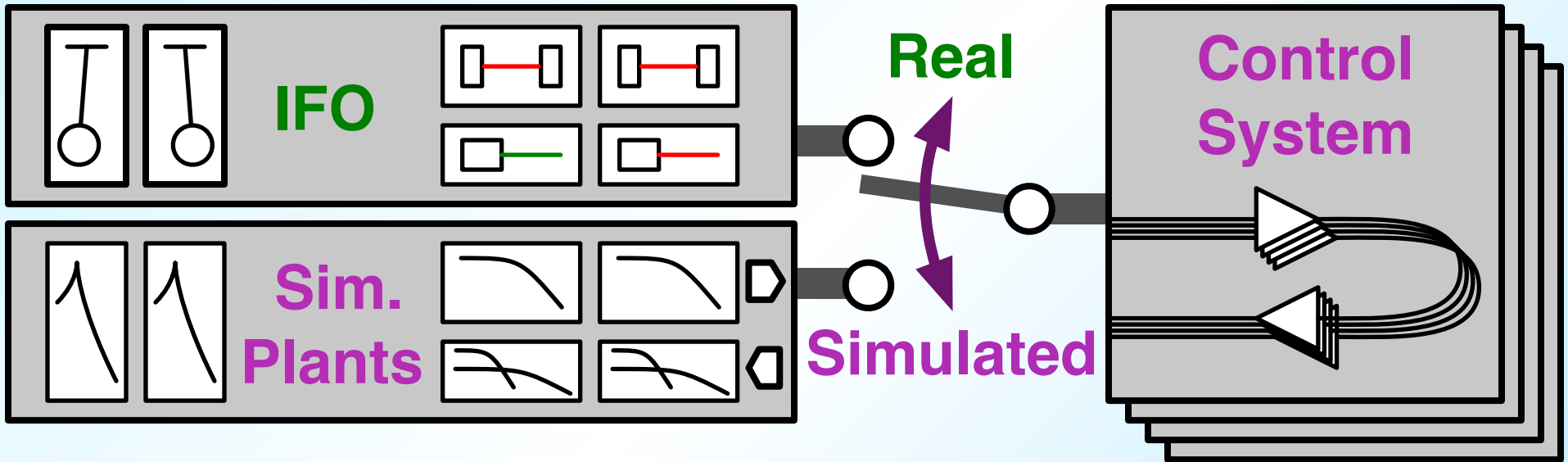


... and tricky

Simulated plant

Realtime process to simulate the hardware response

Suspension / dual recycled ifo / lasers / ...



Development of the RCG codes / algorithms / scripts

without using real hardwares / sacrificing the IFO time

separate the software problems from the hardware ones

enables the noise modeling

Need to figure out how to realize this in a unified way

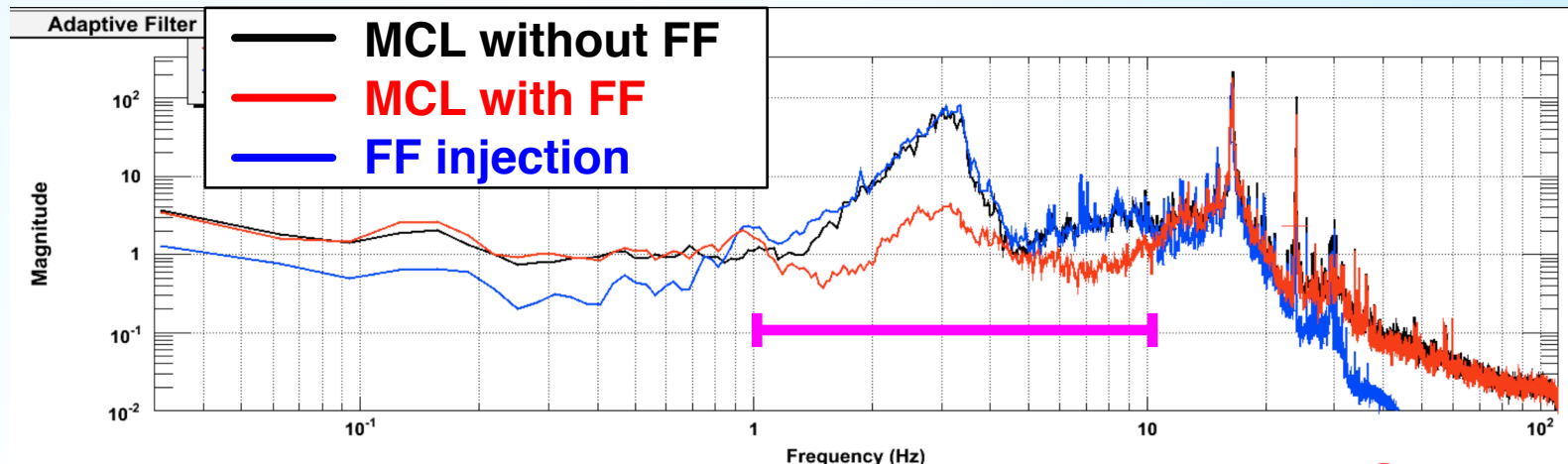
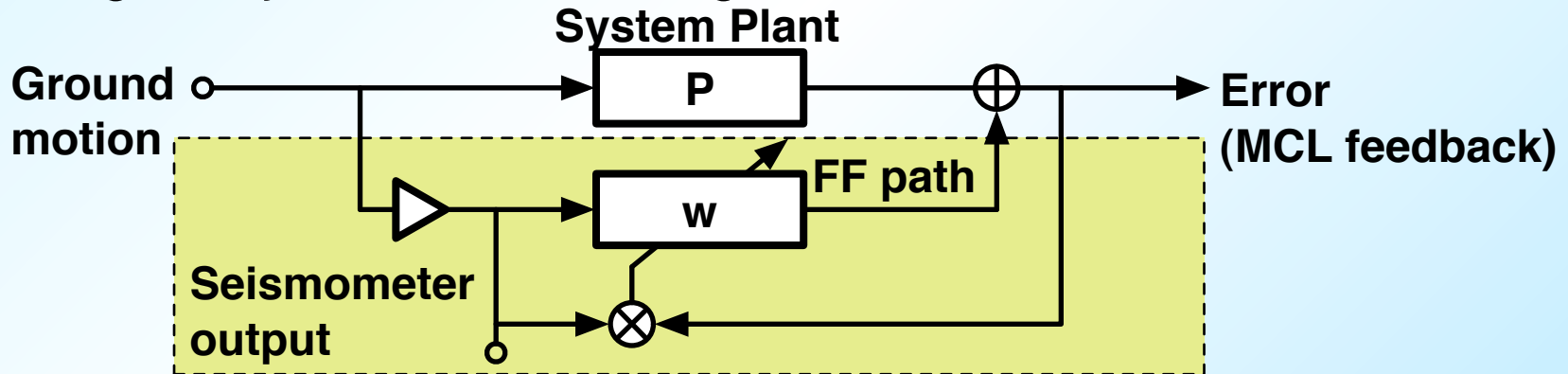
Adaptive noise cancellation \Rightarrow Poster: J. Driggers

Feedforward with adaptive wiener filtering

Demonstrated with Mode Cleaner

MC2 Length control signal

Seismic signal injection to MC1 length with FIR filter



Plan to extend this technique to the main IFO

Status / Plan

New ITMs / SRM / temporary PRM delivered

- Purchasing for new ETMs on going

Suspensions for ITMs ready

- Another 2 SOSs, 5 TTs in hand

Vacuum manifold vented in the end of Feb.

- Working on the input optics

Green laser optics installation

- Installation begins right after this meeting

RF / CDS upgrade continues in parallel

Summary

40m interferometer

Control prototype for the aLIGO interferometers

Upgrade in progress

Making the 40m IFO system more relevant to aLIGO

Providing a testbed for aLIGO hardwares

Development of advanced technologies

Items being upgraded

Signal extraction / control => optics / RF system upgrade

Green beam injection => installation begins soon

New CDS / simulated plant => ETMY test

Adaptive noise cancellation => preliminary demonstration