

e2e modeling of seismic isolation

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Motivation

- Lock acquisition design in progress
- Angular instability is a major issue of AdvLIGO
- Table yaw source unidentified

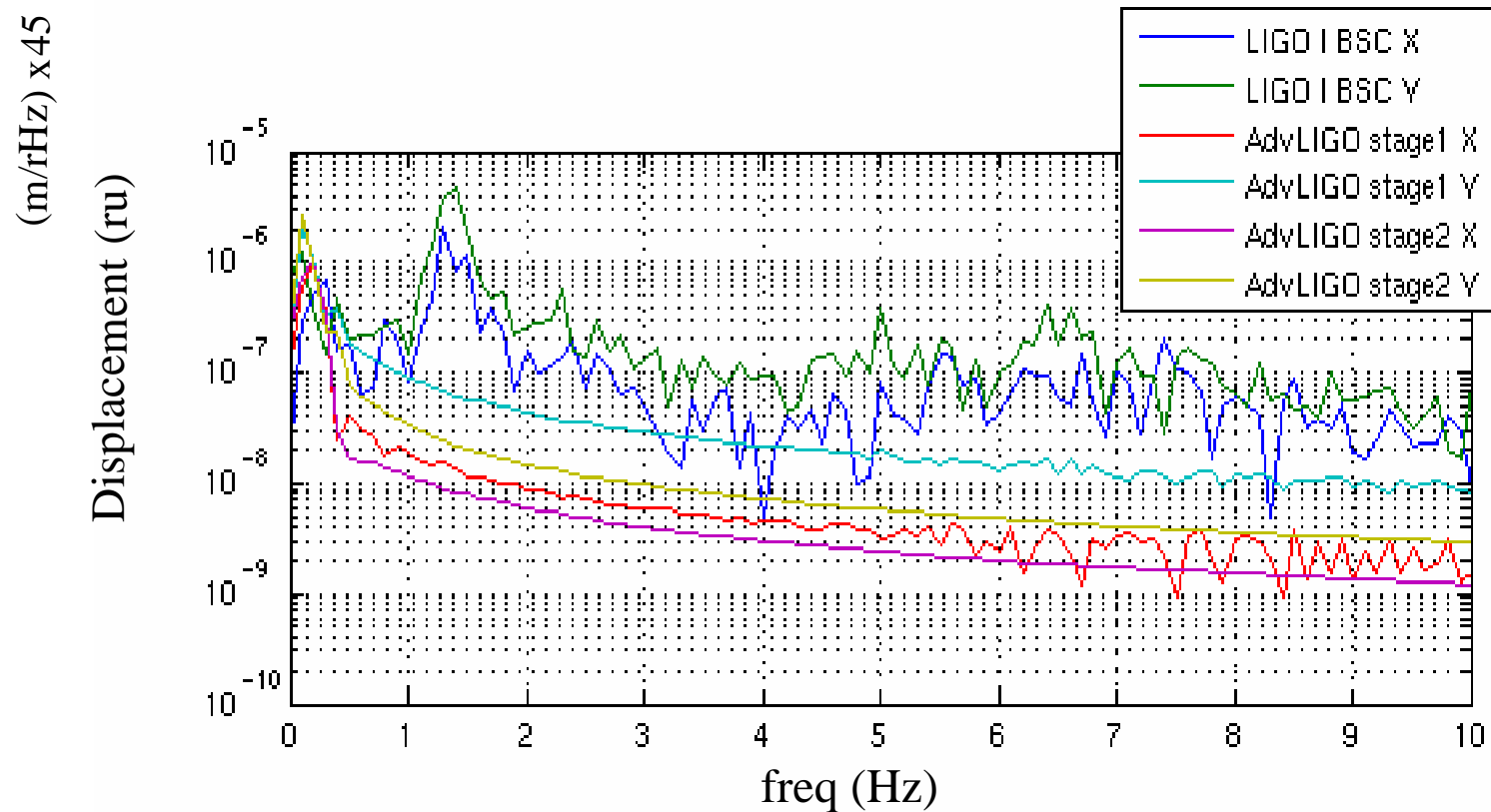
Outline

- Status report on AdvLIGO e2e seismic models
- Study on table top yaw motion

Status

	Available	Under development
BSC (help needed!)	- simple parameterized model	- Full-Dimension model by Active SEI group - Impulse response confirmed - Low freq response not understood
HAM (help needed!)	- simple parameterized model	- Soft HAM model by HAM SAS group
Quad sus Triple sus (BS) Triple sus (MC)	- State Space matrix w/ and w/o violin modes	- Model structure damping

AdvLIGO stage1&2_x, y and LIGO I BSC x, y



DAQ floor X at LLO HAM1 as gnd_x, gnd_y inputs

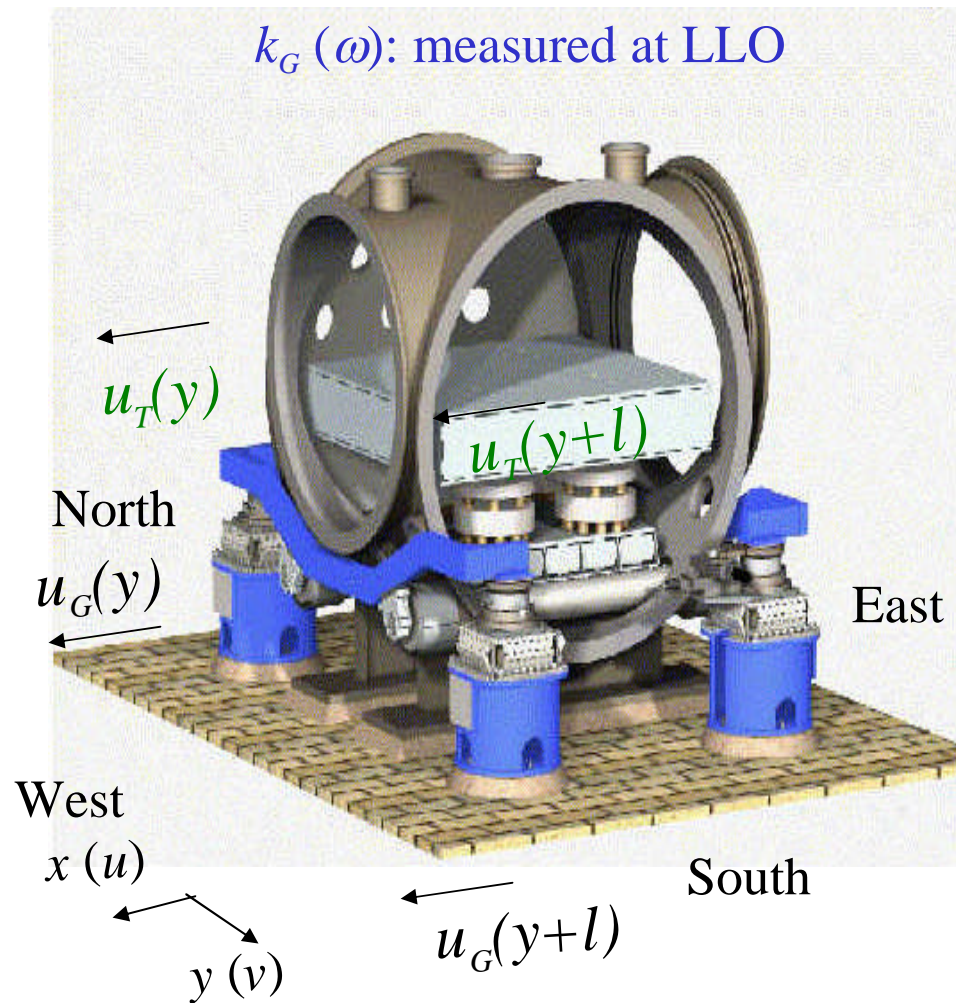
LIGO I HAM and ground/table Yaw

$$\begin{aligned} \text{Ground yaw} &= \frac{1}{2} \left(\frac{\partial u}{\partial y} - \frac{\partial v}{\partial x} \right) \\ &= \frac{1}{2} \{ ik_1 u(y,t) - ik_2 v(x,t) \} \\ &= ik_G \{ \boxed{u(y,t)} - v(x,t) \} \end{aligned}$$

$$\begin{array}{ccc} u_G - u_T \text{ xfer} & & v_G - v_T \text{ xfer} \\ \downarrow & & \downarrow \\ i\phi_1 u(y,t) & & i\phi_2 v(y,t) \end{array}$$

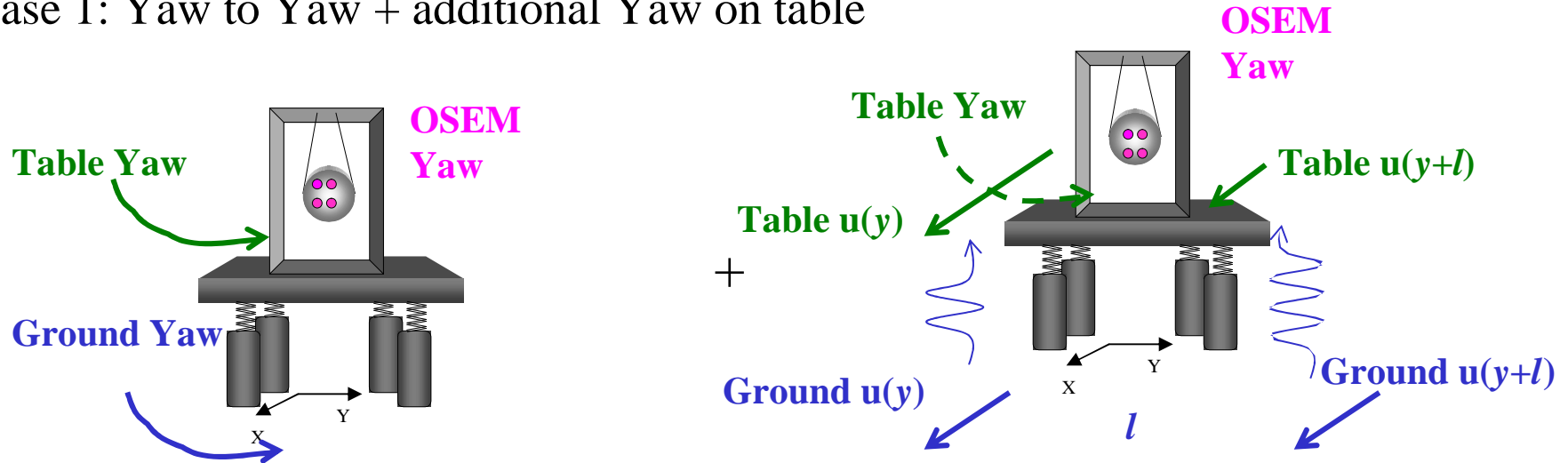
ϕ_1, ϕ_2 : additional phase delay due to different u-u (v-v) transfer rate between north and south (east and west)

$$\text{Table yaw} = ik_{T1} u_T(y,t) - ik_{T2} v_T(x,t)$$

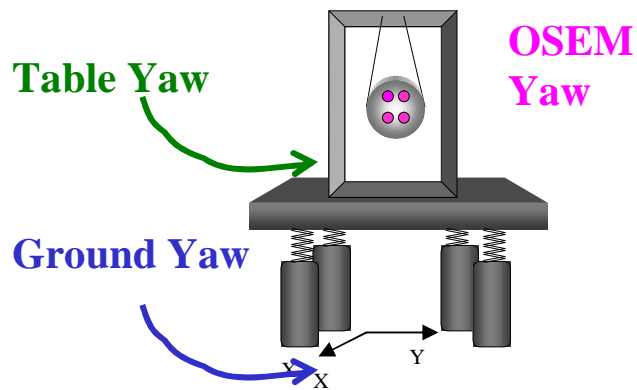


Two scenarios for table Yaw

Case 1: Yaw to Yaw + additional Yaw on table

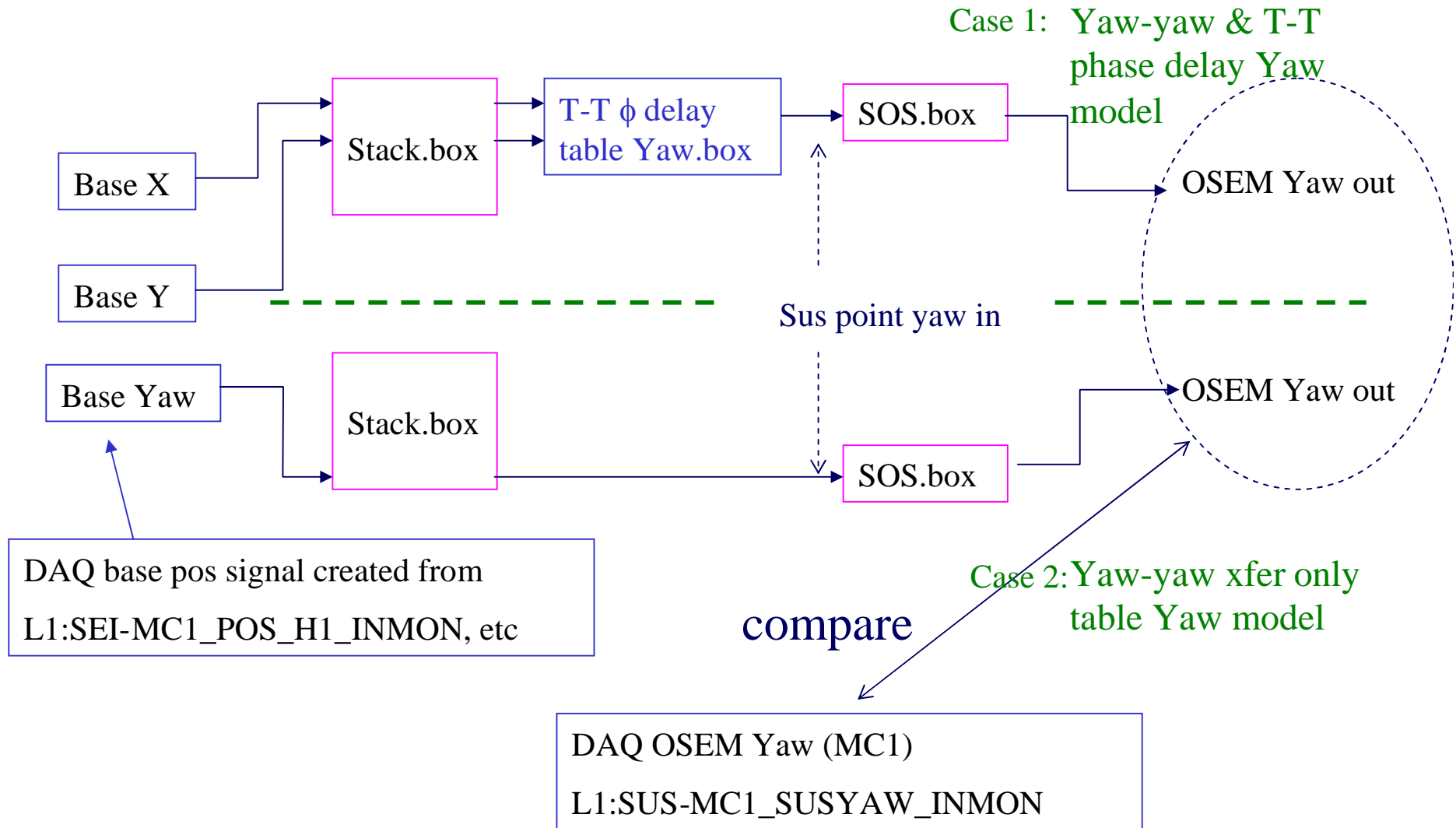


Case 2: Yaw to Yaw only

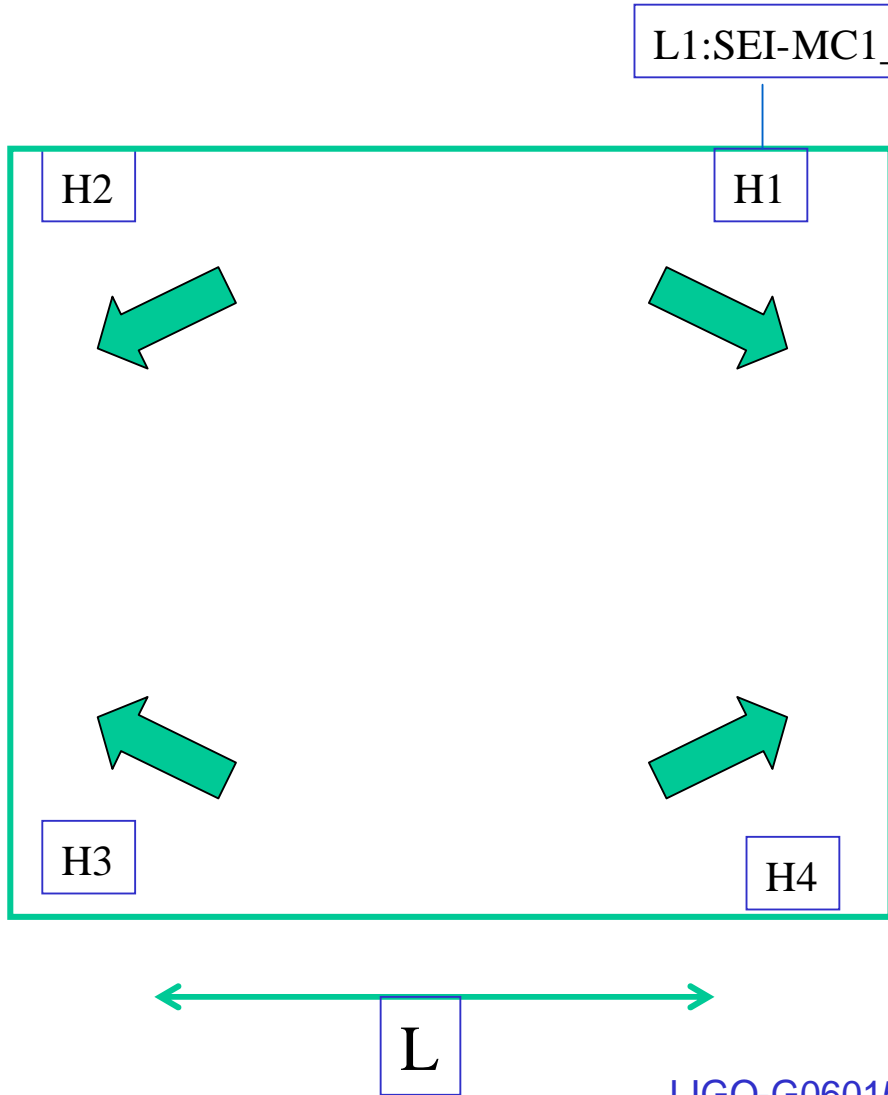


Compare resultant SOS OSEM yaw with DAQ OSEM yaw

Ground (base)table yaw models



L1:SEI-pos_H sensors

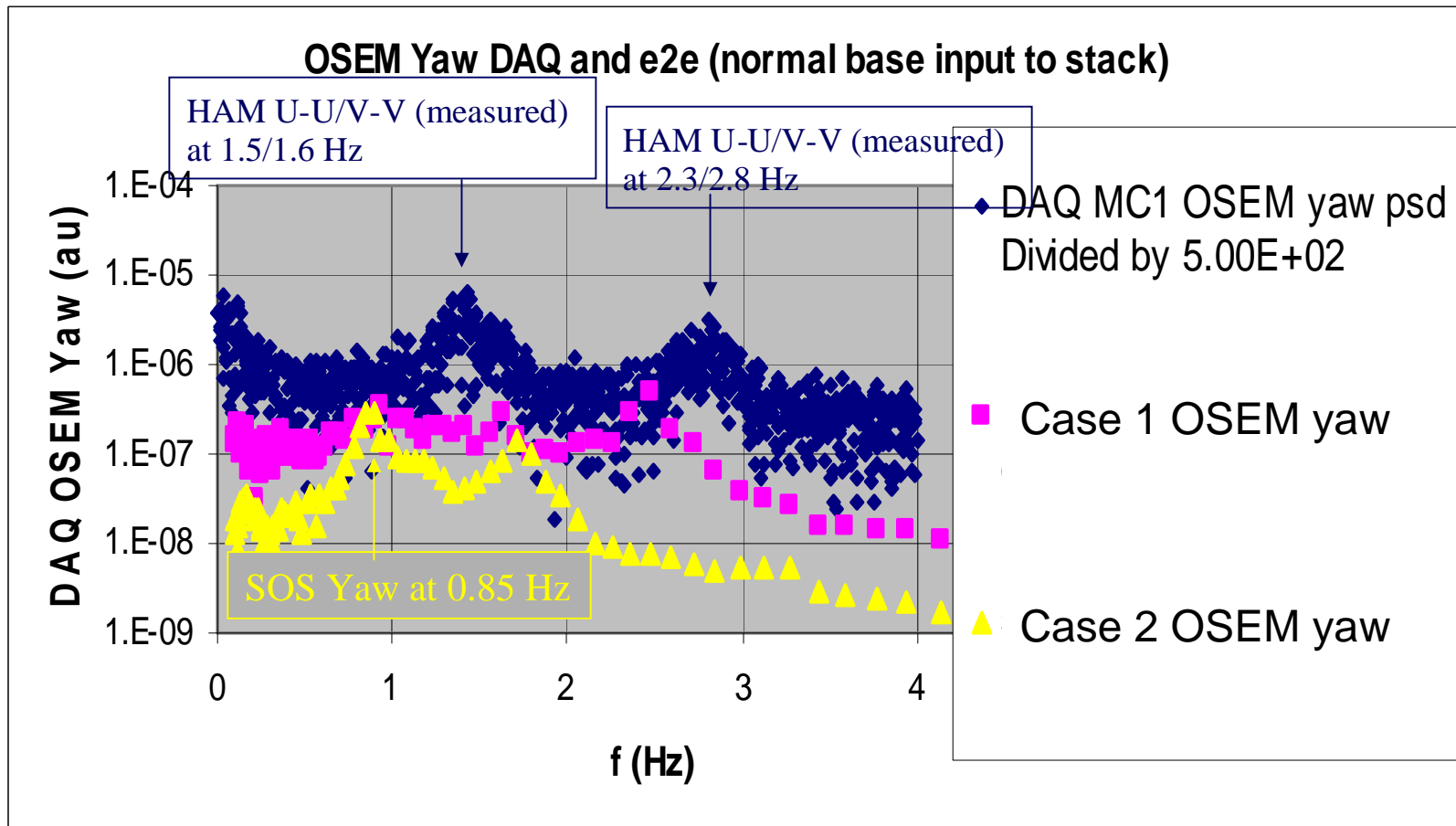


$$X=(H1-H2-H3+H4)/4*\cos30^\circ$$

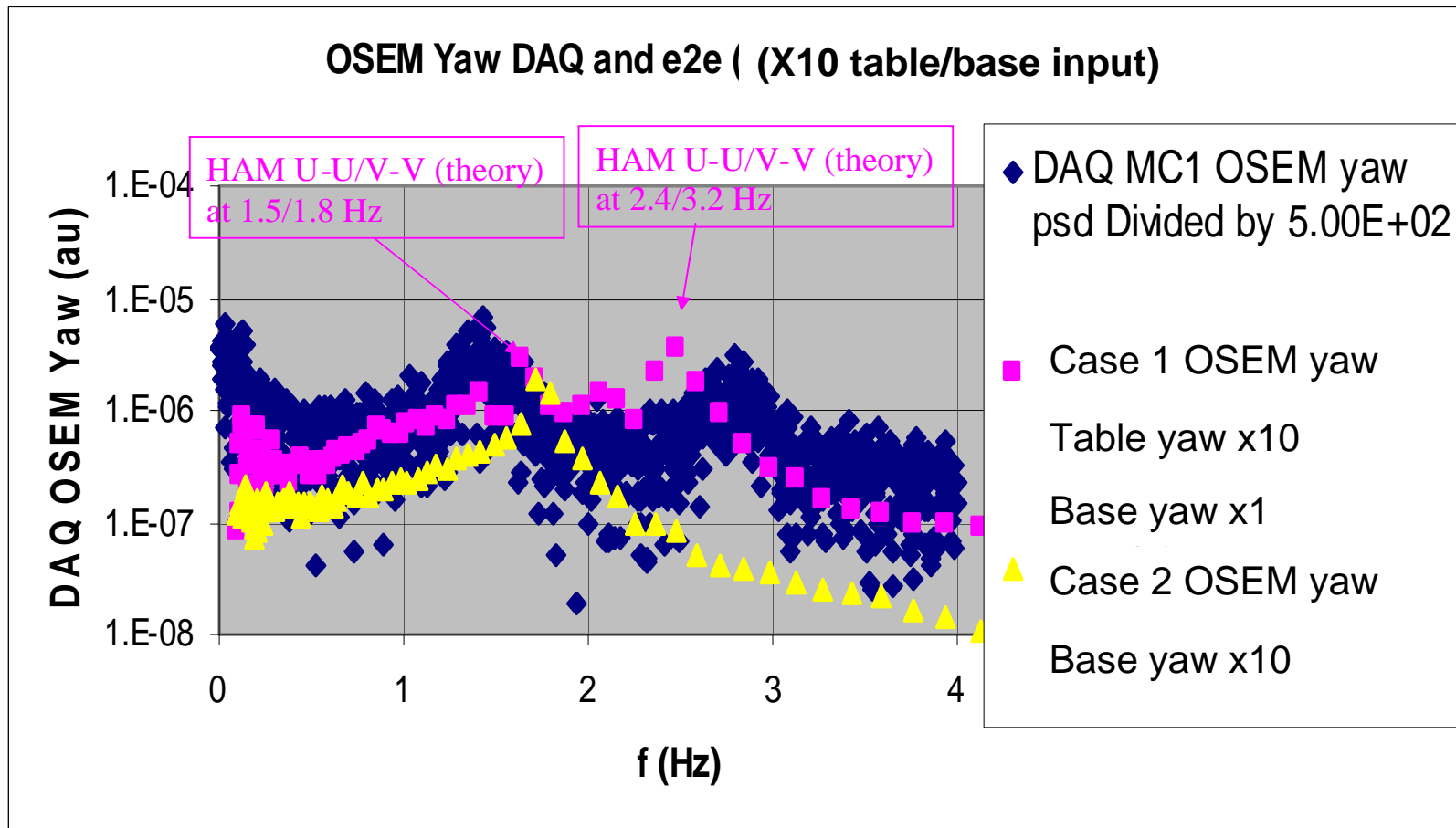
$$Y=(-H1-H2+H3+H4)/4*\sin30^\circ$$

$$\text{Yaw}=(-H1+H2-H3+H4)/4L$$

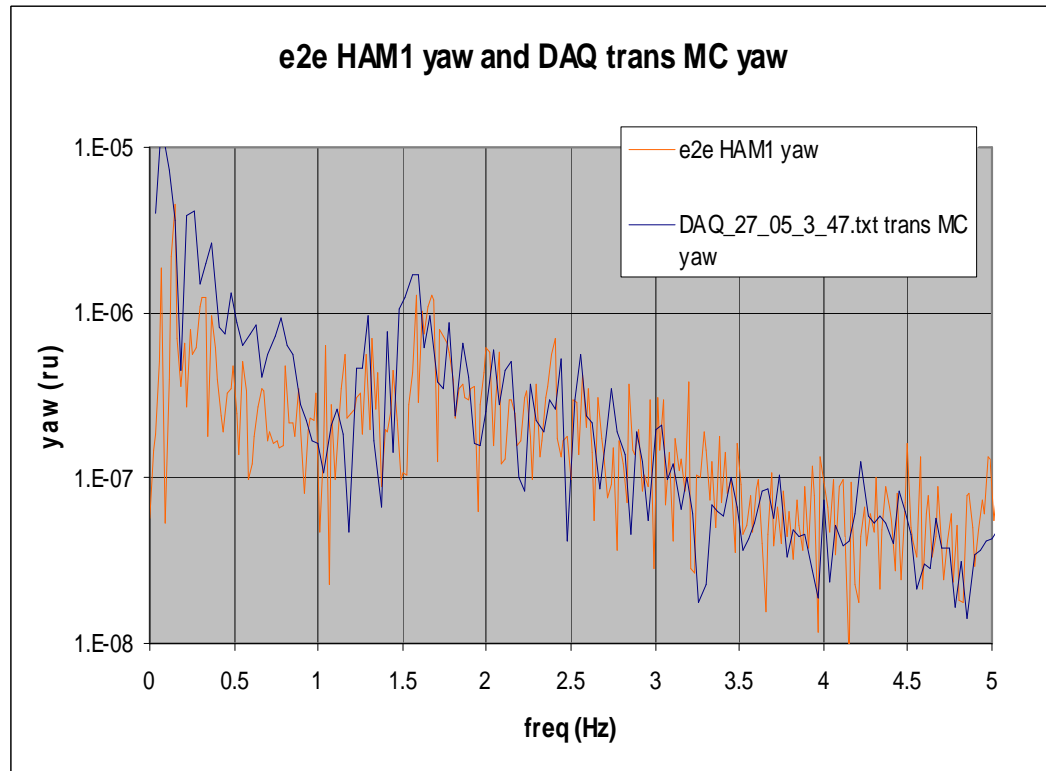
OSEM Yaw DAQ and e2e (1)



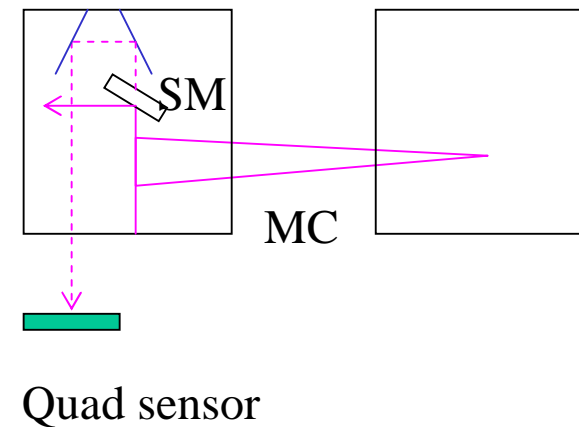
OSEM Yaw DAQ and e2e (2)



e2e HAM1 table yaw & DAQ MC trans Yaw



Folding mirrors



MC trans quad sensor for HAM table yaw monitor?

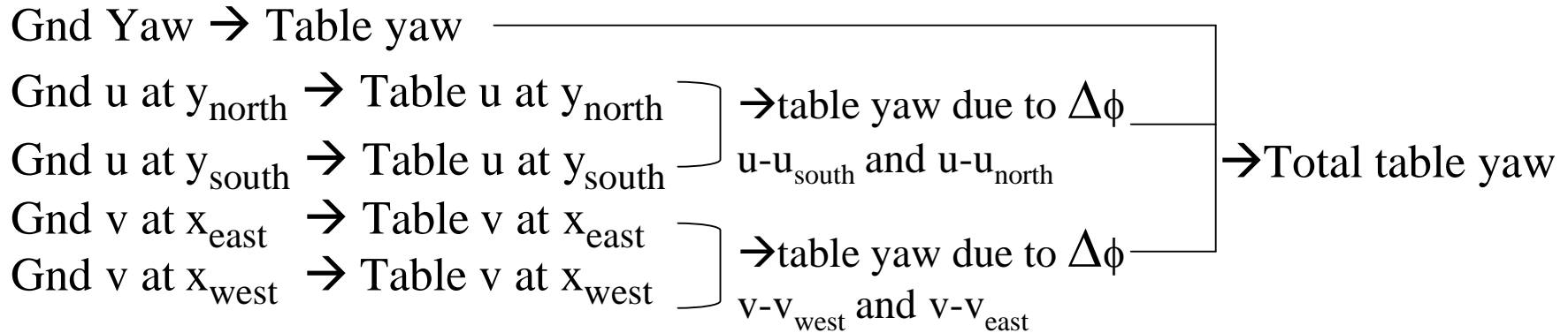
Acknowledgment

- SGW group for various advices
- Big thanks to
 - Brian Lantz for BSC SS matrix
 - Shyang Wen for ground signal
- Virginio Sannibale and Valerio Boschi for HAM model
- Mark Barton for SUS models
- NSF: PHYS-0354942
- LLO: DAQ signals

Thank you.

Two scenarios for table Yaw

Case 1: Yaw to Yaw + additional Yaw on table



Case 2: Yaw to Yaw + additional Yaw on table
Gnd Yaw \rightarrow T

Compare result
DAQ OSEM y_i accelerometer

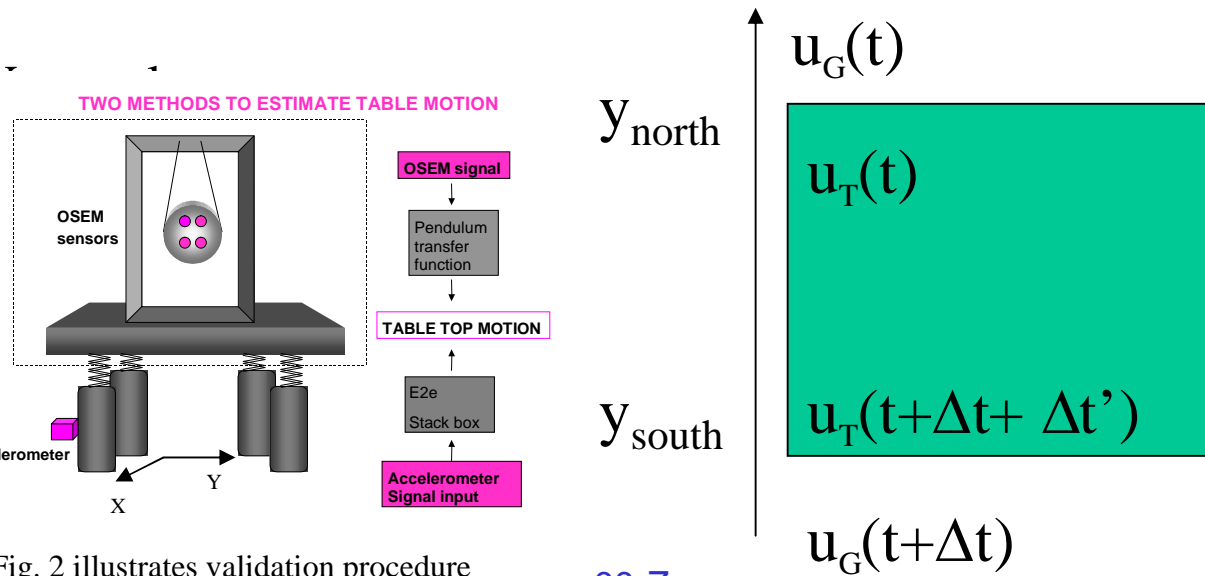
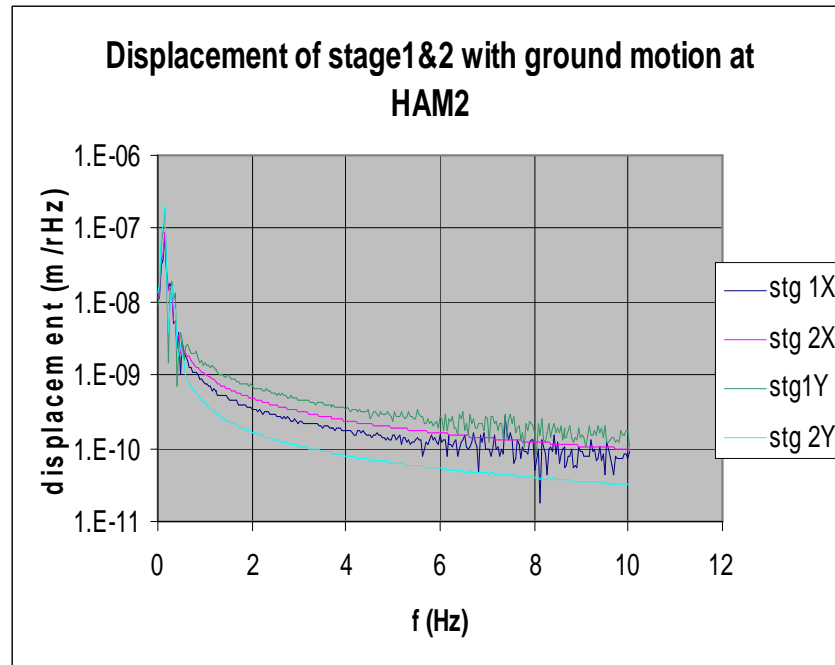
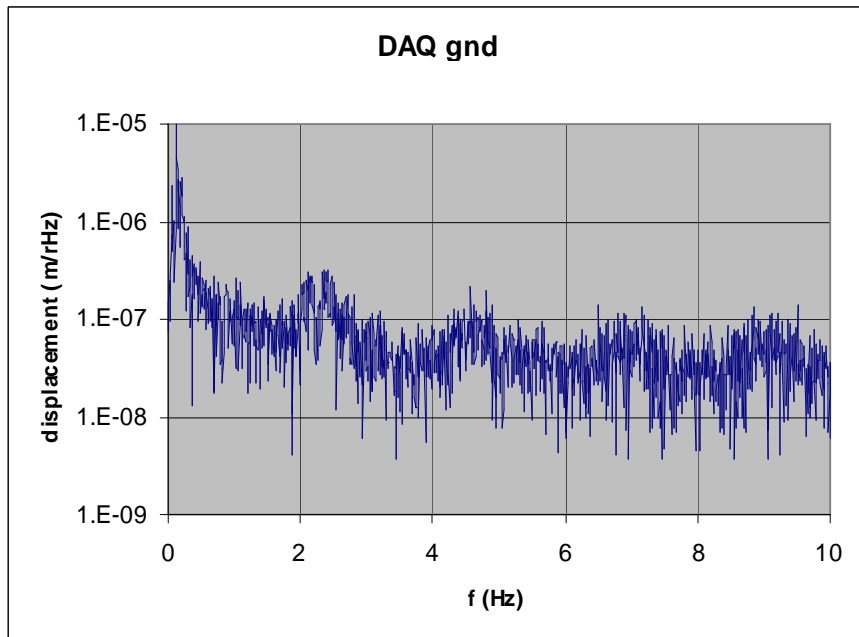


Fig. 2 illustrates validation procedure

Ground & AdvLIGO BSC psd



OSEM gain tests

