

Green WFS (non)progress report

Imagine no HOMs,

living in the arms, uh huh.

You may say I'm a dreamer.

But I'm not the only one.

- S. Ballmer, S. Dwyer, K. Izumi, K. Kawabe, J. Sanders, D. Sigg, and A. Staley (among others).

Not-that-inaccurate time line

HIFO-Y
(high finesse)

HIFO-X, HIFO-XY
(low finesse)

Full IFO integration
(low finesse)

“Nobody commissioned Green WFS but we don’t seem to need it” period (good old days).

“OMG mode hopping in the arm, maybe we need WFS after all, but nothing really works WTH low finesse” period.

“Maybe we don’t need it as L1 doesn’t seem to need it, wait is the initial alignment really good for SRun and long commissioning, maybe WFS is good for that, but why doesn’t it work” period.

“It’s centering stupid, see, it works!” period.

“Hey we made the centering awesomer and now it doesn’t work WTH” period

↑
We’re here.

time →

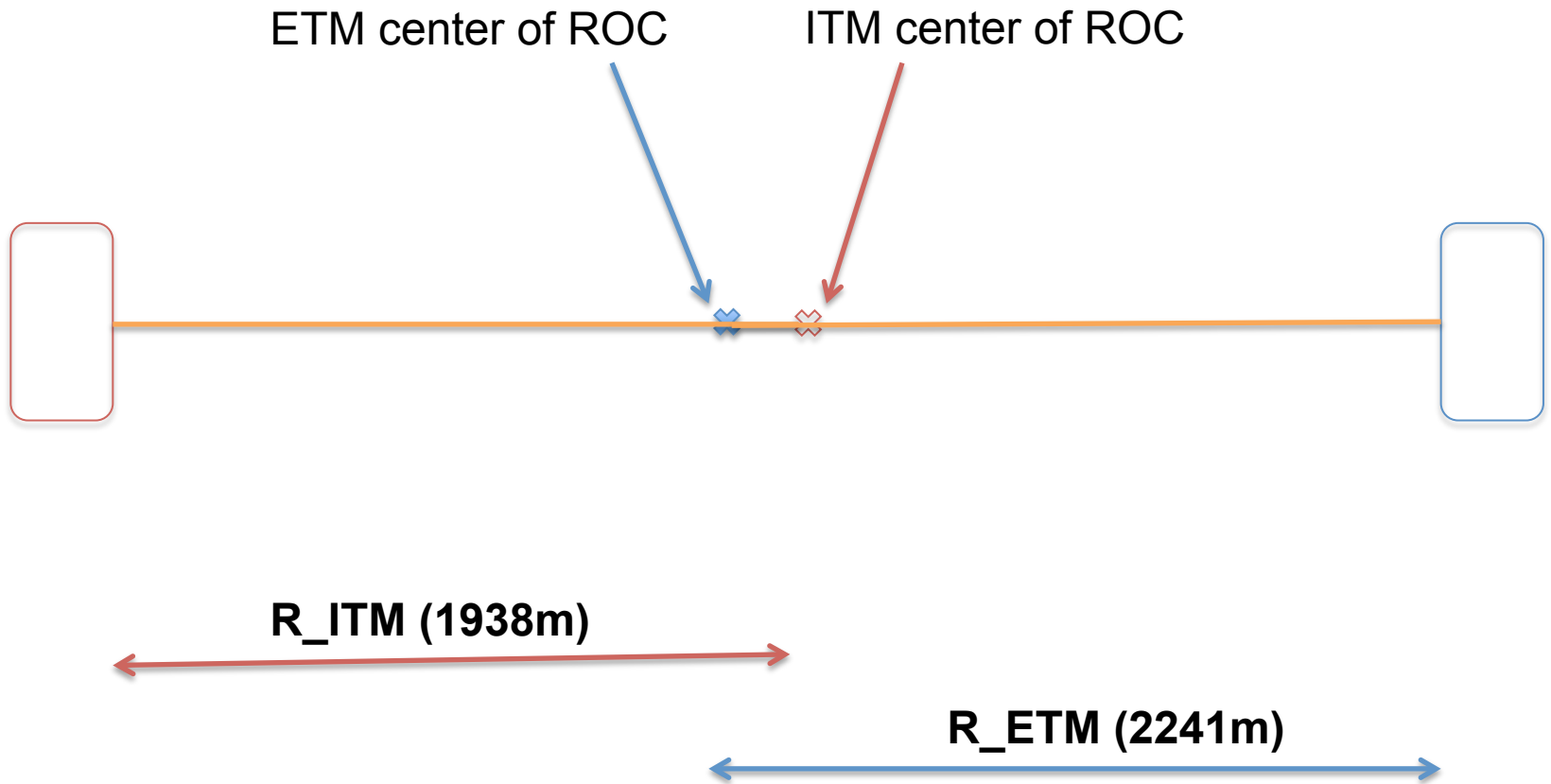
Why Green WFS 1: It should be quick

- Green light is always locked to the cavity instantly.
- Therefore, **if** Green WFS works, the arm initial alignment is a snap.
- Lock, then WFS to steer the green to the arm, offload to the arm (will be explained later).
- No need to misalign things and scan.

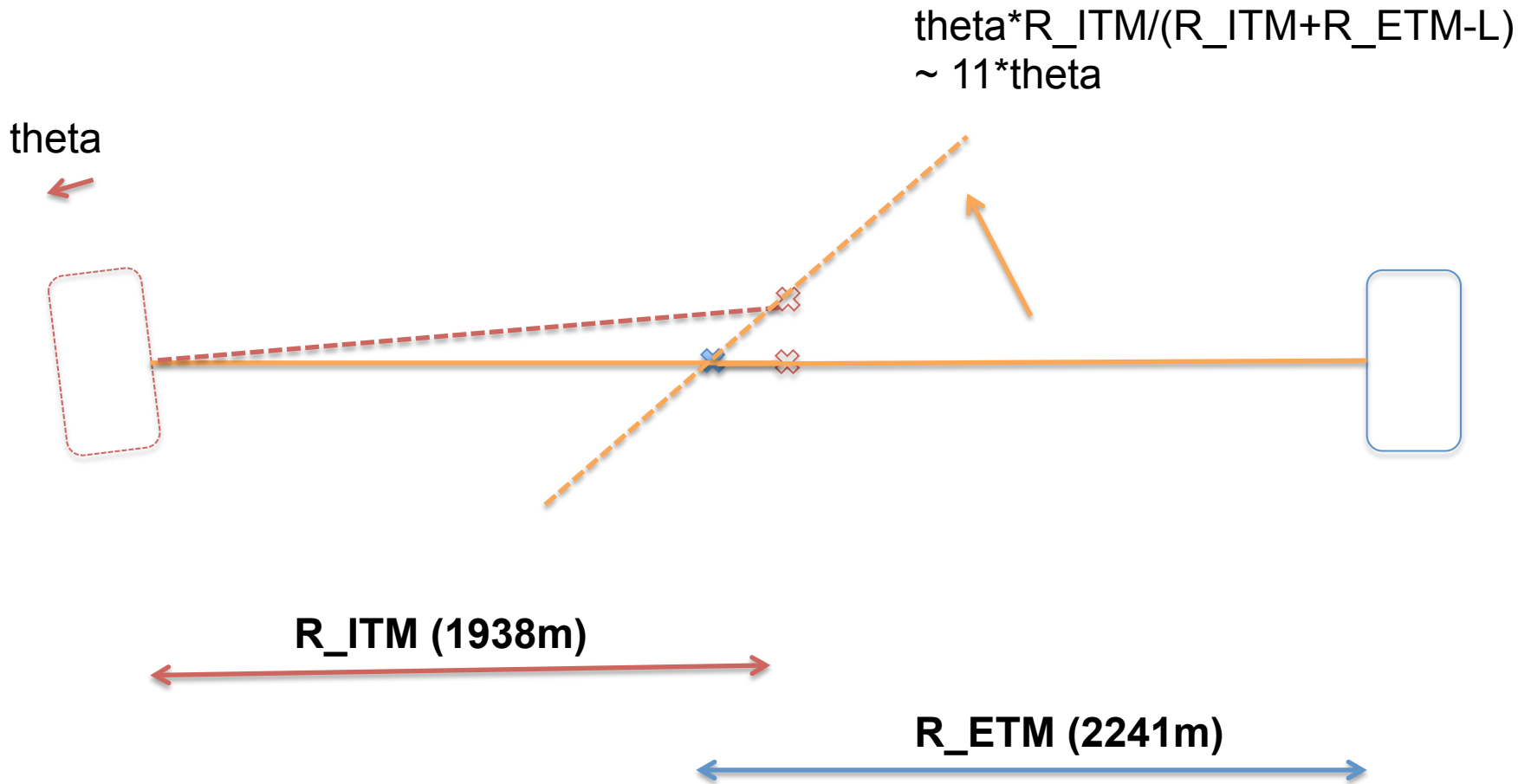
Why Green WFS 2: No arm as a reference (and still quick)

- Almost concentric arm = large geometric amplification of rotation (11 for ITM, 13 for ETM)

Geometric amplification



Geometric amplification



Why Green WFS 2: No arm as a reference (and still quick)

- Almost concentric arm = large geometric amplification of rotation (11 for ITM, 13 for ETM)
- No geometric amplification for TMS, BS, PR3

Why Green WFS 2: No arm as a reference (and still quick)

- Almost concentric arm = large geometric amplification of rotation (11 for ITM, 13 for ETM)
- No geometric amplification for TMS, BS, PR3
- In SRuns, the arm may not be a very good reference for the alignment between the long locks.

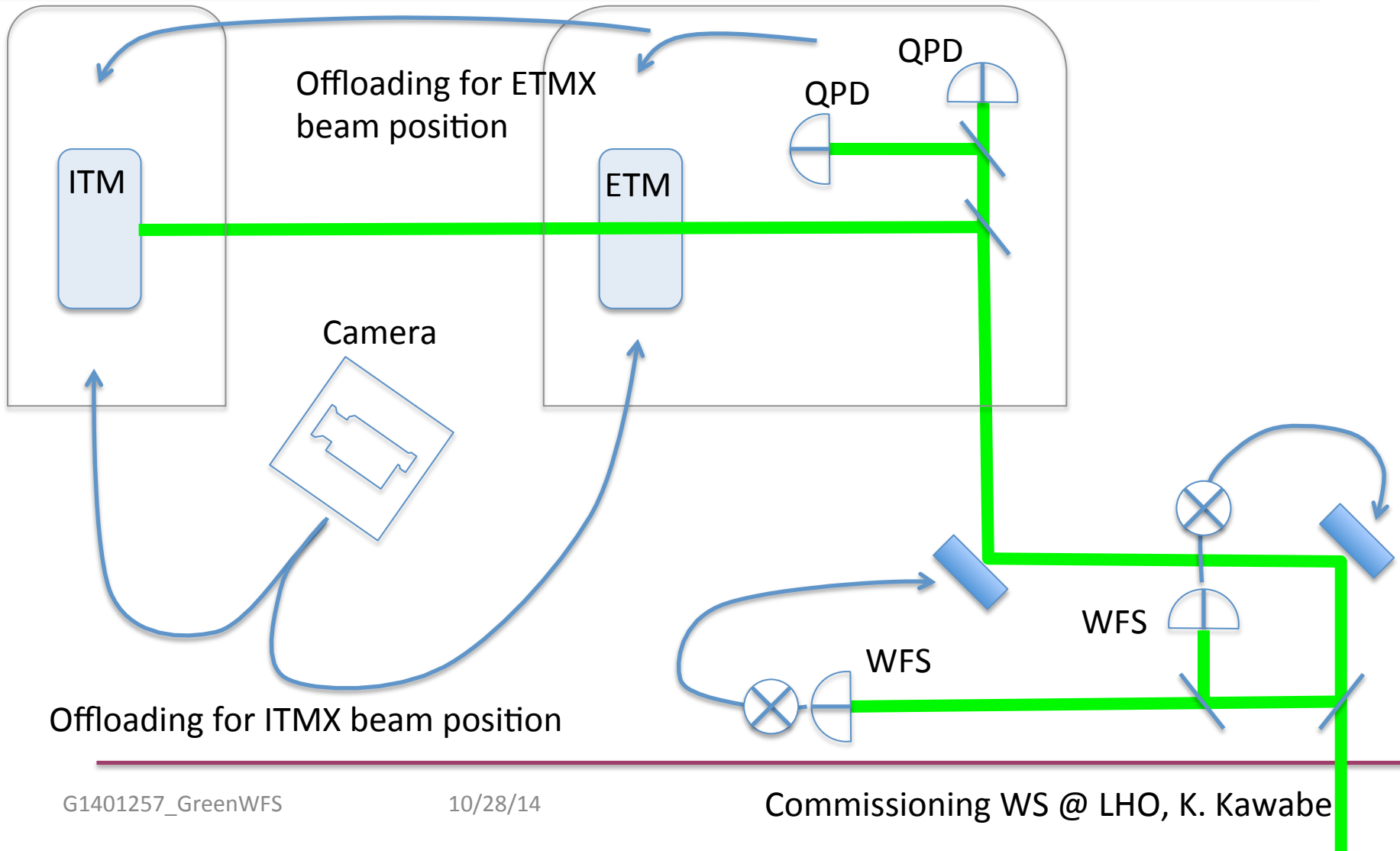
Why Green WFS 2: No arm as a reference (and still quick)

- Almost concentric arm = large geometric amplification of rotation (11 for ITM, 13 for ETM)
- No geometric amplification for TMS, BS, PR3
- In SRuns, the arm may not be a very good reference for the alignment between the long locks.
- If WFS works, we can do all sorts of offloading schemes to fix the arm to some references (e.g. ITM camera image) and it would still be quicker than fully doing baffle PD scan.

Why Green WFS 2: No arm as a reference (and still quick)

- At DC (e.g. lower than micro seismic), ETM, ITM and TMS angle drift should be on the same order for YAW (for PIT this is not apparent but let's assume that they are).
- Almost concentric arm = large geometric amplification of rotation (11 for ITM, 13 for ETM)
- In SRuns, the arm may not be a very good reference for the alignment between the long locks.
- If WFS works, we can do all sorts of offloading schemes to fix the arm to some references (e.g. ITM camera image) and it would still be quicker than fully doing baffle PD scan.
- **Note our experience using the X arm as a reference for the corner alignment: IM4 slider value changes from one initial alignment to the other by what seems like a large number.**

What we want to implement eventually



What we want to implement eventually

- WFS aligns the green beam to the arm.
- ITM beam spot camera -> offloading to the arm to fix ITM beam position.
- A linear combination of TMS green QPDs -> offloading to the arm to fix the ETM beam position.
- **Sounds** simple.

So what is not simple?

Not sure.

- At first nothing worked.
 - Demod phase changed almost daily
 - Sensing matrix changed by a huge amount each time it was measured
 - Huge error signal offset necessary
 - Never successfully closed 4DOF loops.
- Ugly beam theory.
 - Yes the beam was ugly. Spent some time realigning things, improved it somewhat, no change in the WFS behavior.
- Ghost beam theory.
 - No apparent ghost beam.
 - Tilting the ERM didn't change the beamscan measurement of the REFL beam.

So what is not simple?

Not sure, cont'd.

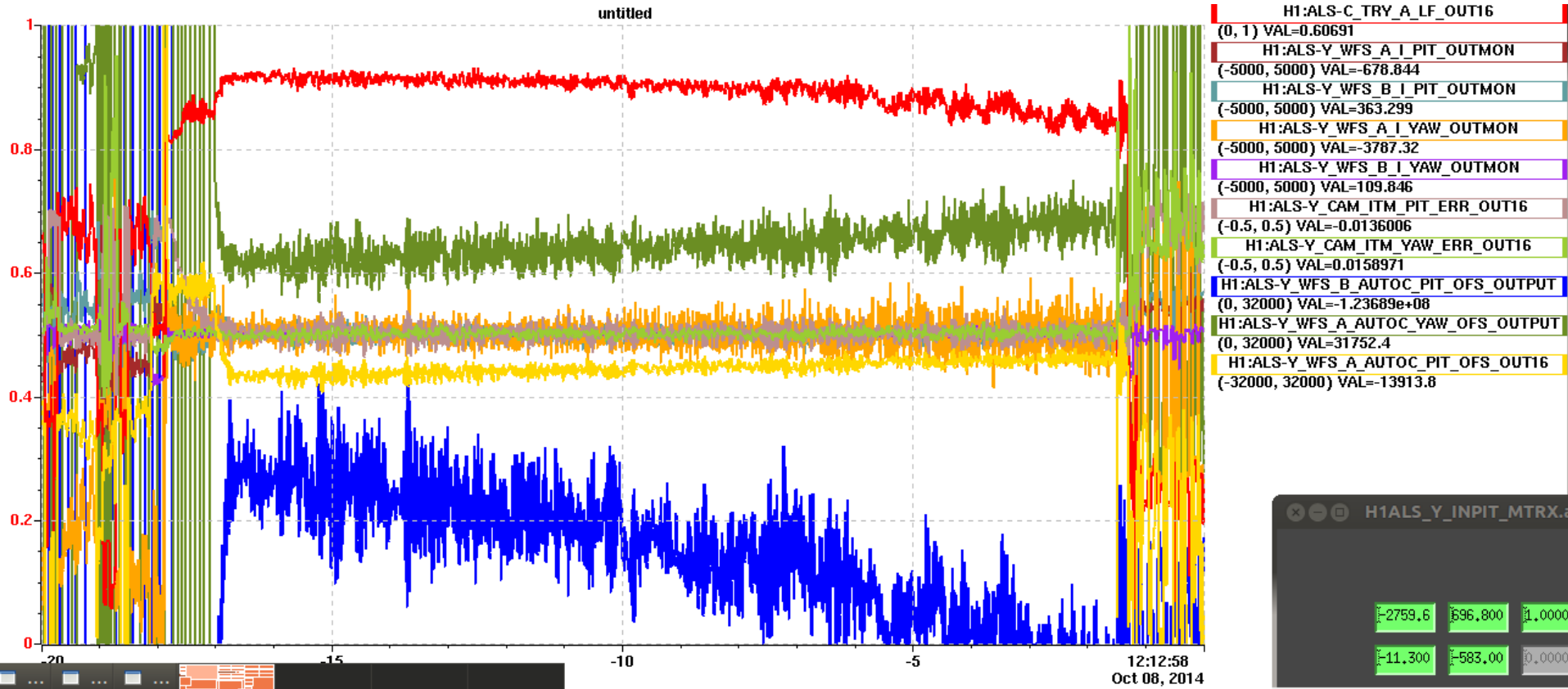
- Low finesse theory
 - Nobody made any calculation, but we know that the HOMs go into the cavity (low finesse), maybe some odd-even HOM or odd-00 type interference larger than high finesse cavity?
 - It kind of agrees with the fact that the sensing has a HUGE dependence on the WFS centering.
 - Without proper WFS centering OFFSET, there's typically no zero crossing in the error signal.

So what is not simple?

Not sure, cont'd yet again.

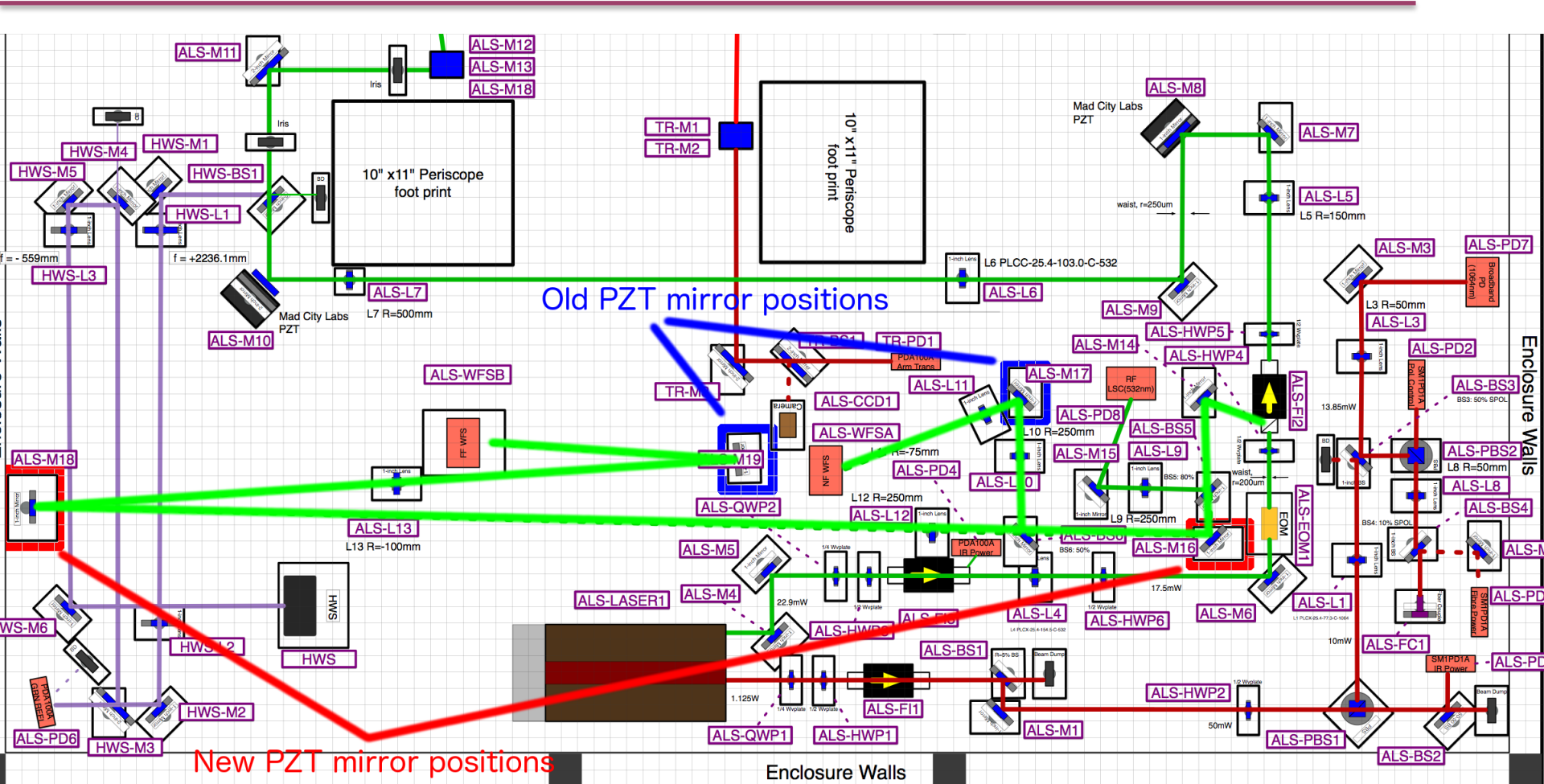
- “It’s the centering” theory.
 - Whatever the cause, we should center the WFS to have a consistent sensing matrix.
 - Implement WFS DC centering servo, give it some offset that empirically works, and we should be OK.
- This theory turned out to be a sensible one.
 - DC centering servo was implemented using MadCityLab PZTs and controllers.
 - For the first time, 4 DOF worked consistently over a few days.
 - Demod phase didn’t change.
 - Sensing matrix was consistent over a few days (no sign flip!)
 - But it was apparent that centering range was not large enough.

WFS on, ITM pos offloading on, ETM offloading not yet.



As soon as the centering feedback (blue) rails, the green trans (red) becomes ratty and eventually it loses lock.

So the PZT mirrors were shifted to get more range out.



Centering range is great now, but

- WFS doesn't behave, don't know why.
- New Ghost beam?
- New centering offset necessary for whatever reason? Sensing looks different than before.
- Demod phase is still good.
- Insert here usual excuses for not being able to spend time on this, e.g. priority VS other tasks, man power etc.
 - (But we have another student Evan now.)