

***Status Update of
a LIGO Lock Acquisition
Simulation***

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LIGO-G1301126-v1

Simulation meeting Oct/04/2013

Previous Summary

see LIGO-G1300935-v2

- Transition from green to infrared sensor was achieved in CARM control.
- CARM can be locked by REFL9I directly a new concept => "Self locking"
- DRMI locked by 3fs
- SRCL is the only difficult DOF in DRMI

Today's Summary

- ▣ RFPD dark noise are newly added
- ▣ REFL is attenuated to 10 mW on each diode
- ▣ ALS acoustic bump (100Hz-1kHz) is newly added
- ▣ HSTSs (i.e. triple sus) are newly added
- ▣ DAC limiters are newly added
- ▣ CARM hand-off (i.e. self-locking) works fine

Current Sim. Settings

■ Same as before.
See Appendices for detail

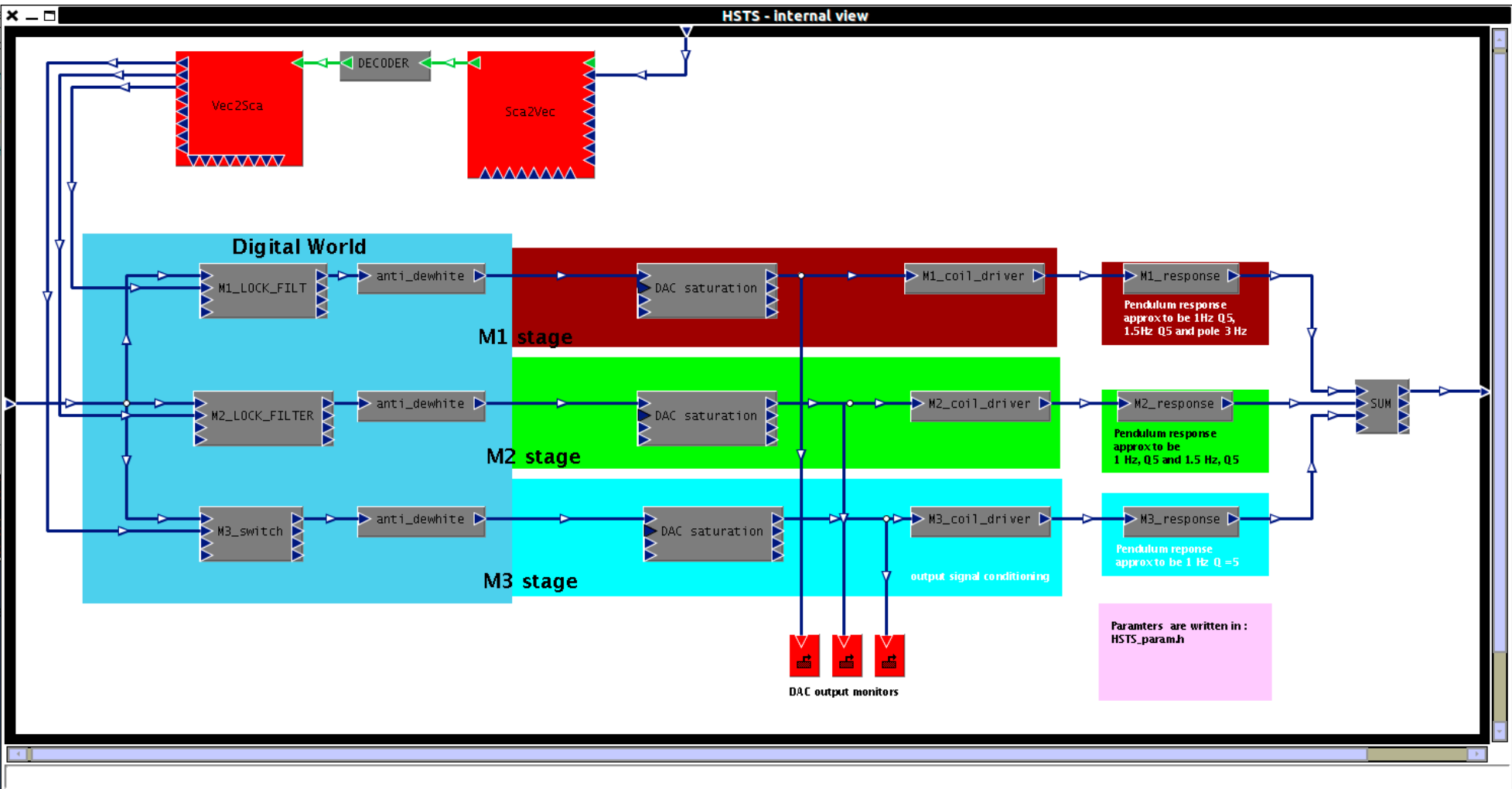
■ A few **cheating** still remain

● BS suspension is not FMBS but is HSTS

● DARM is magically locked with zero noise

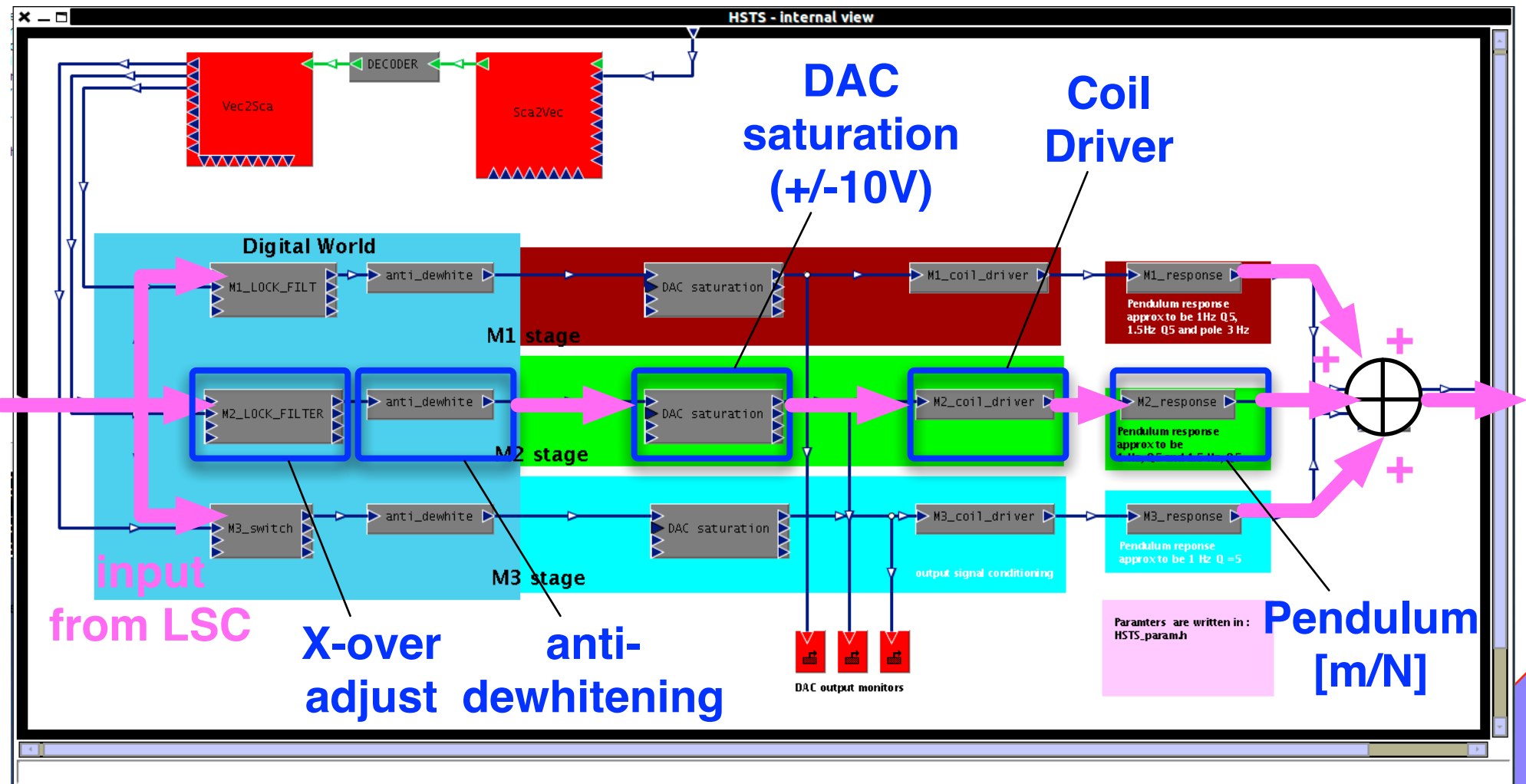
HSTS model

e2e GUI view of HSTS



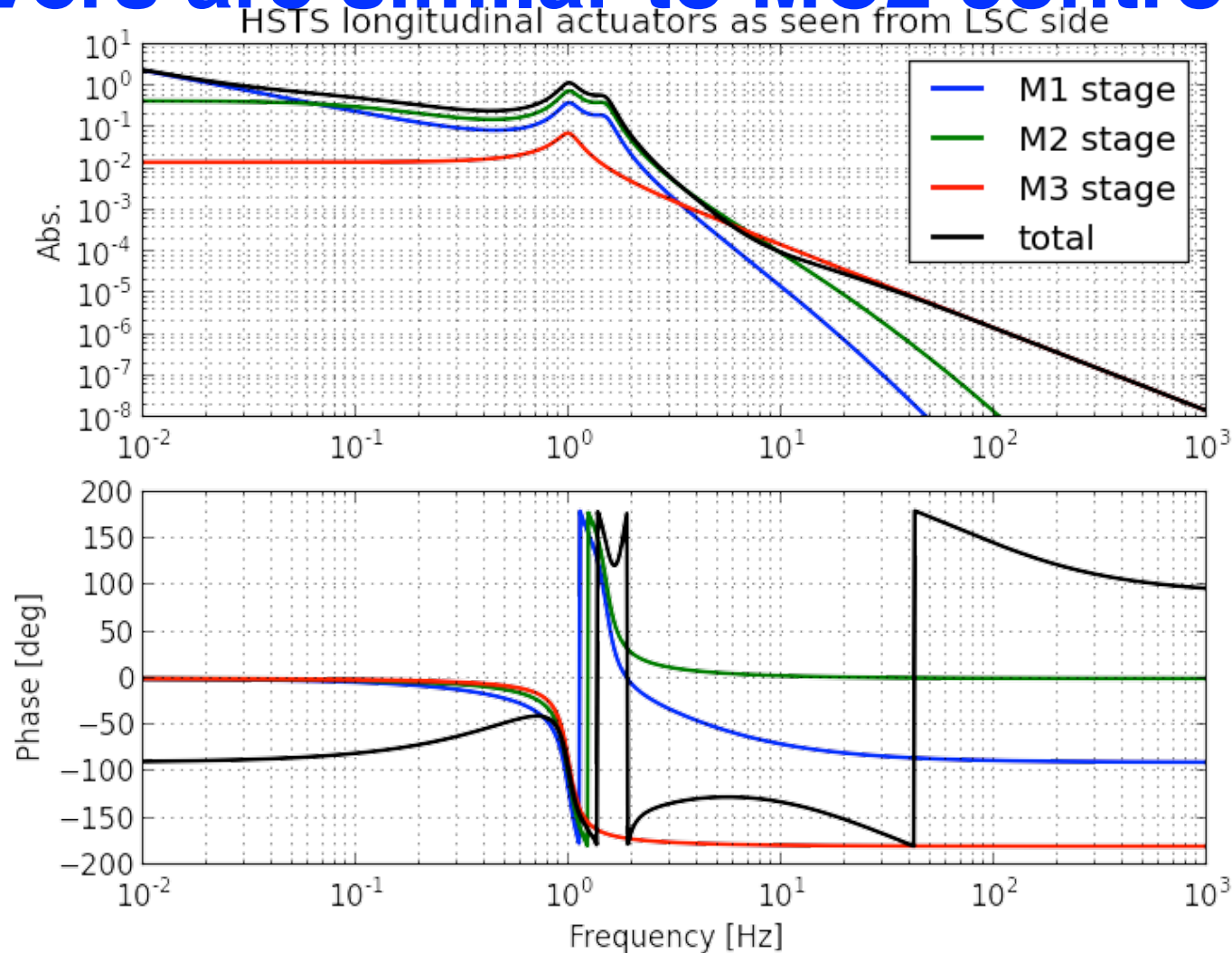
HSTS model

e2e GUI view of HSTS



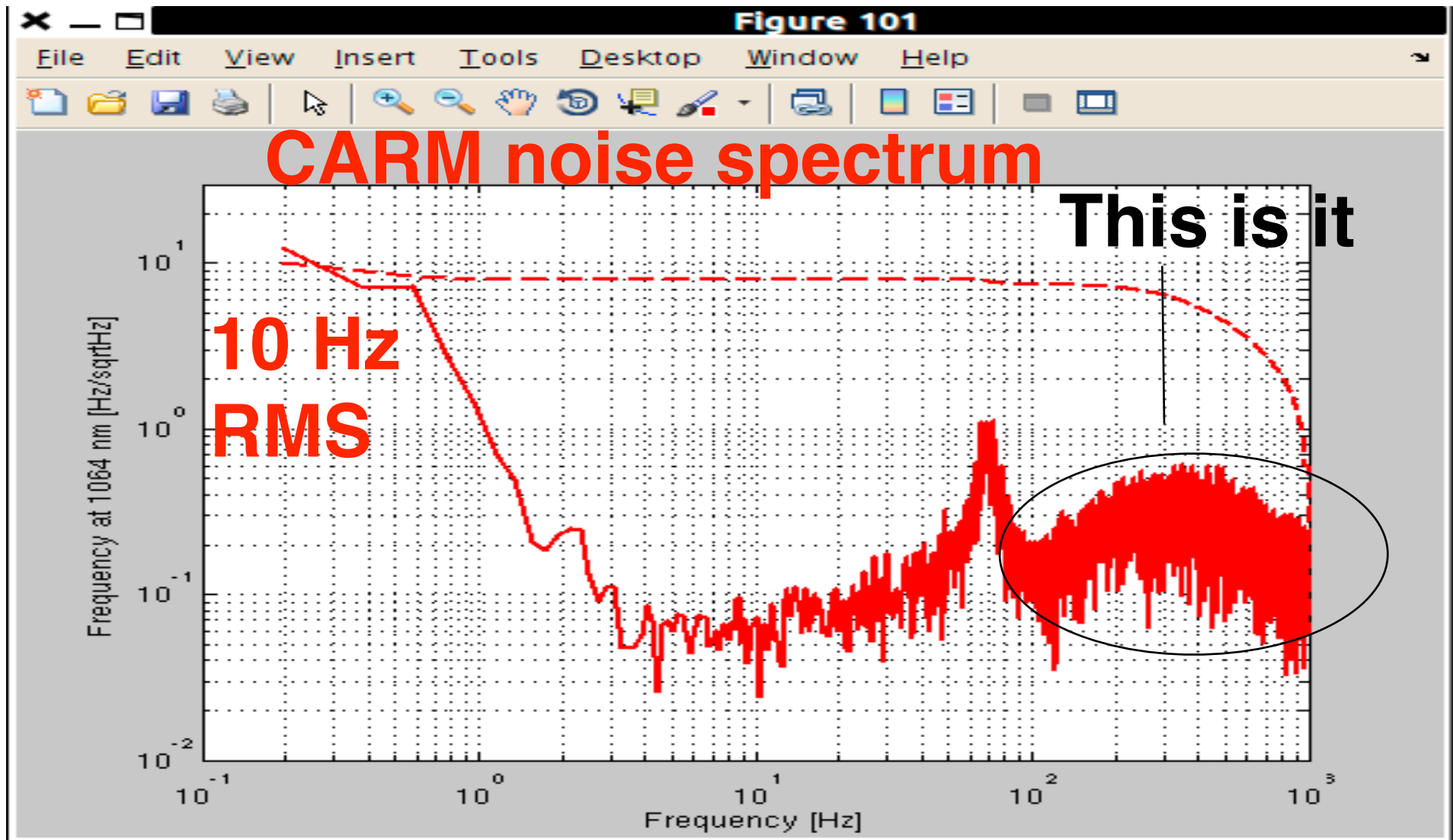
HSTS compound actuator

TFs are approximated to be simple forms
X-overs are similar to MC2 control.



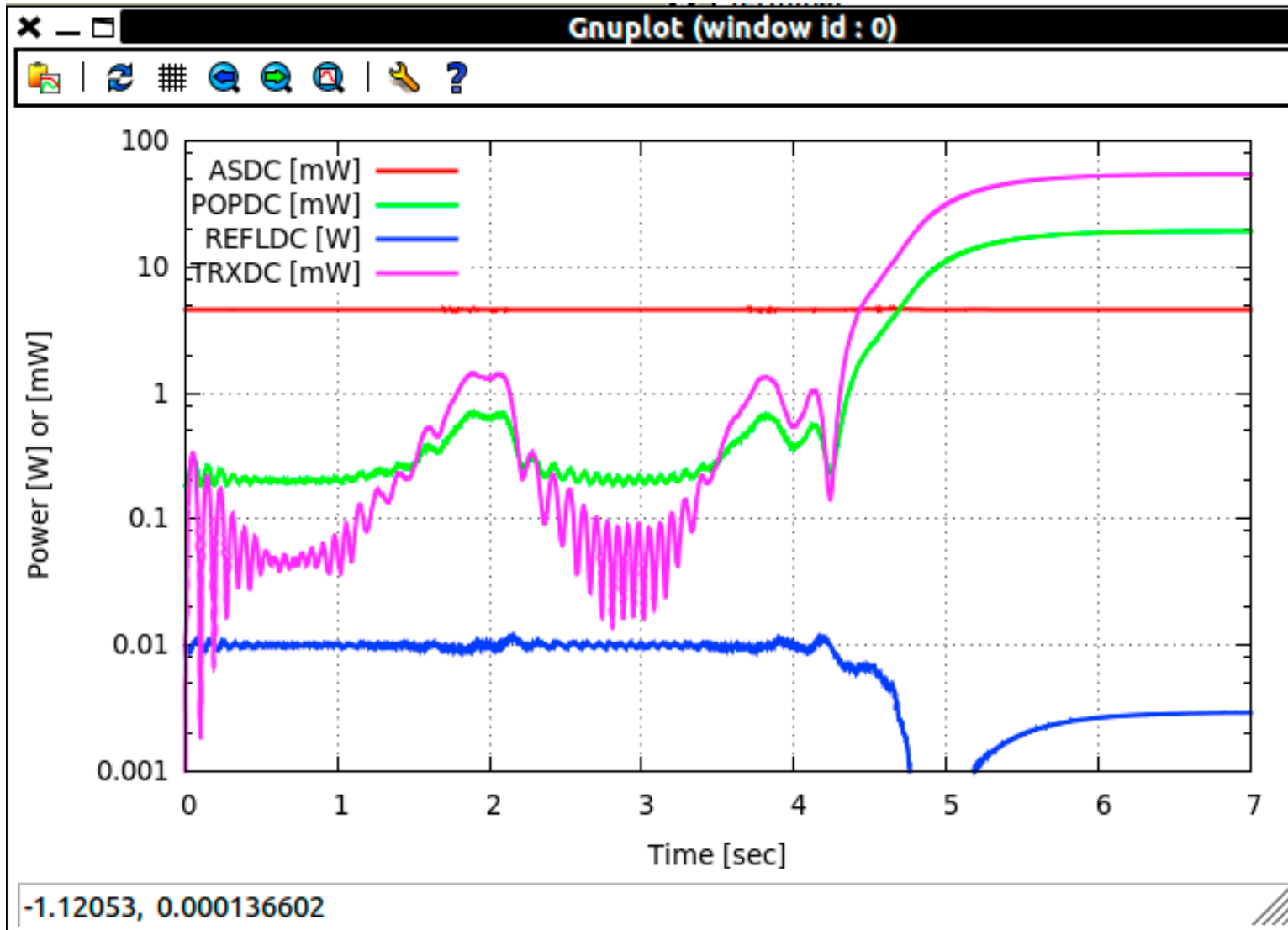
More realistic ALS noise

Noise around 100Hz - 1kHz is newly added



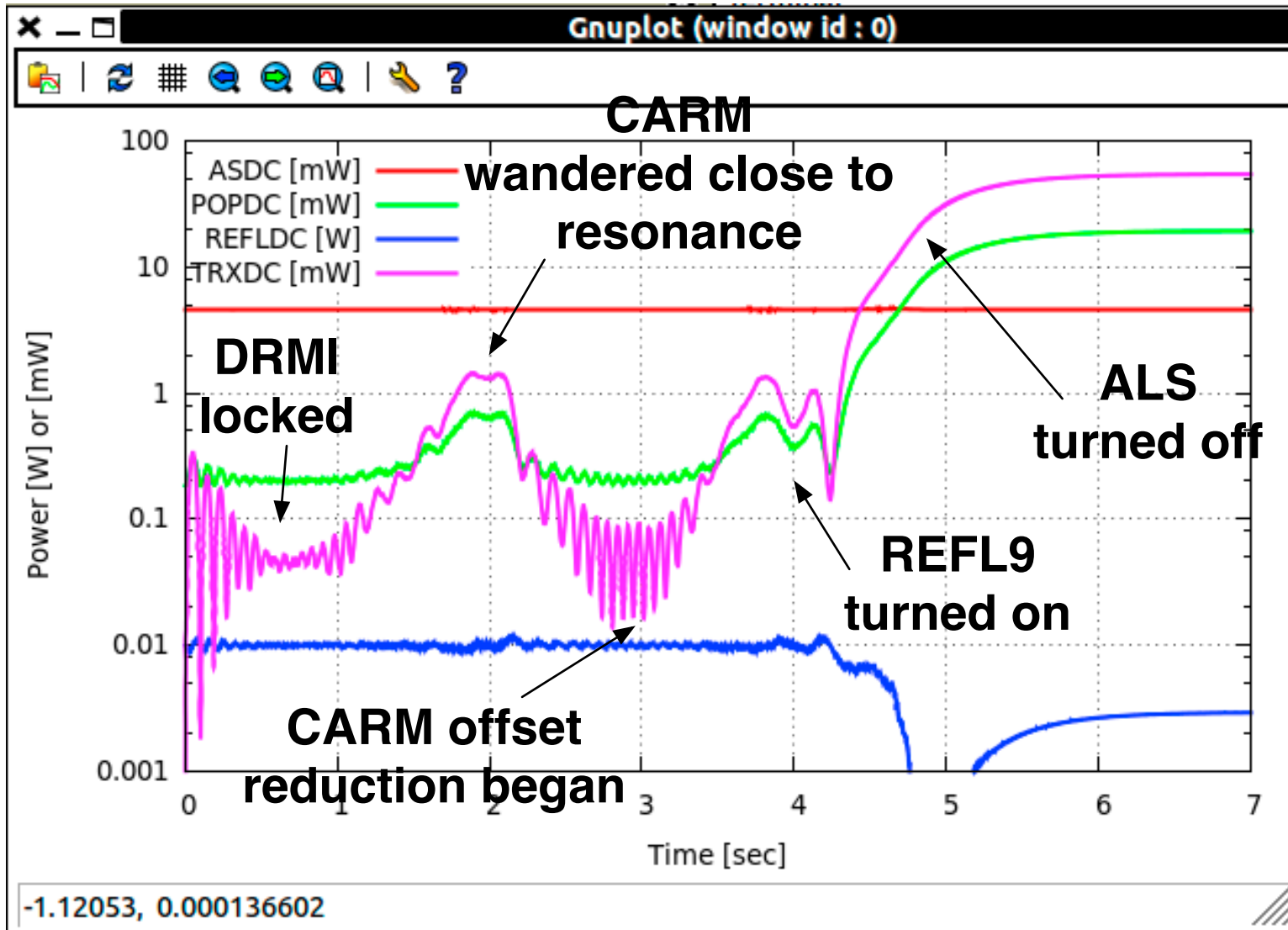
Overview

It starts from a CARM offset of 10 Hz



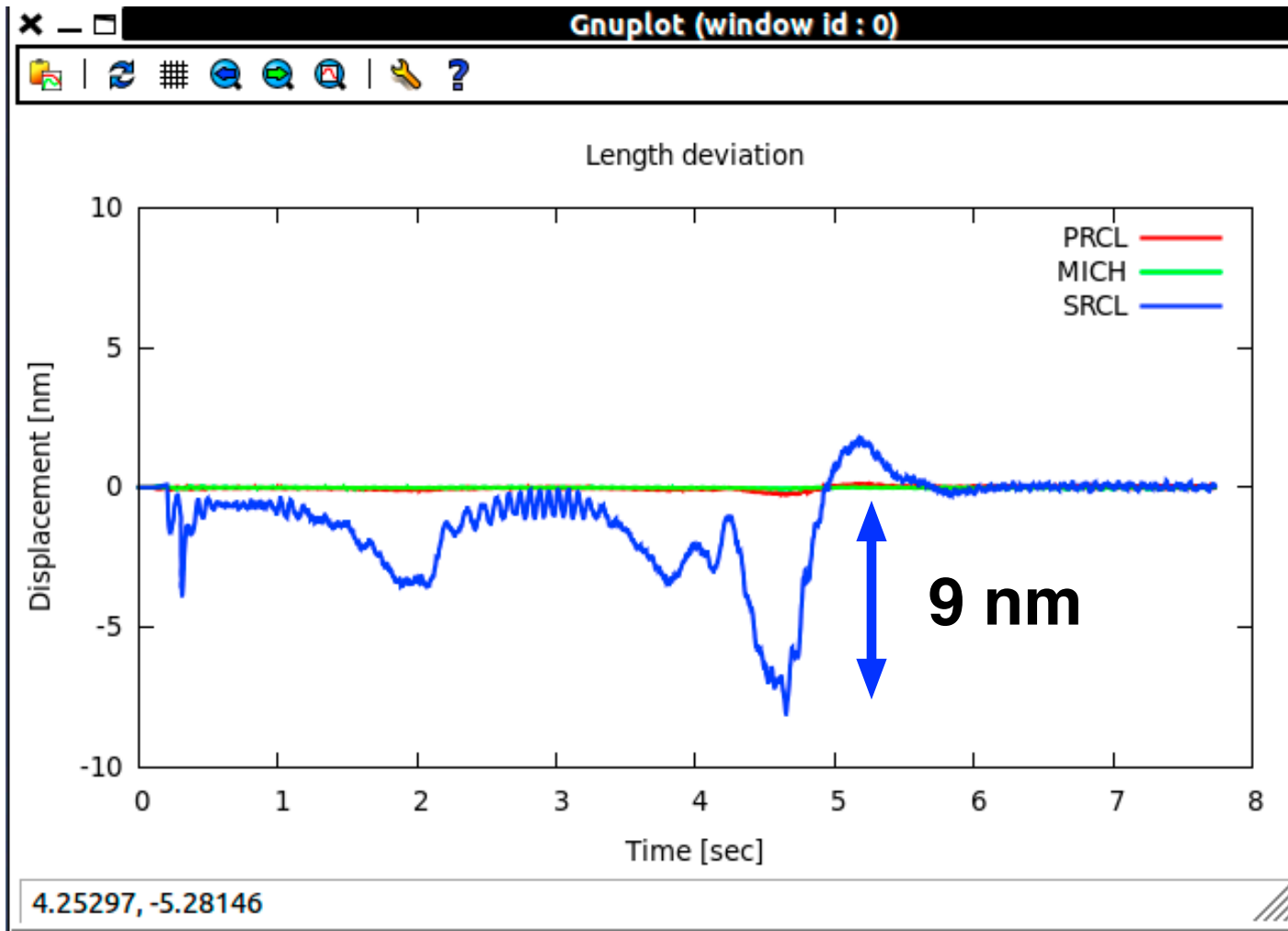
Overview

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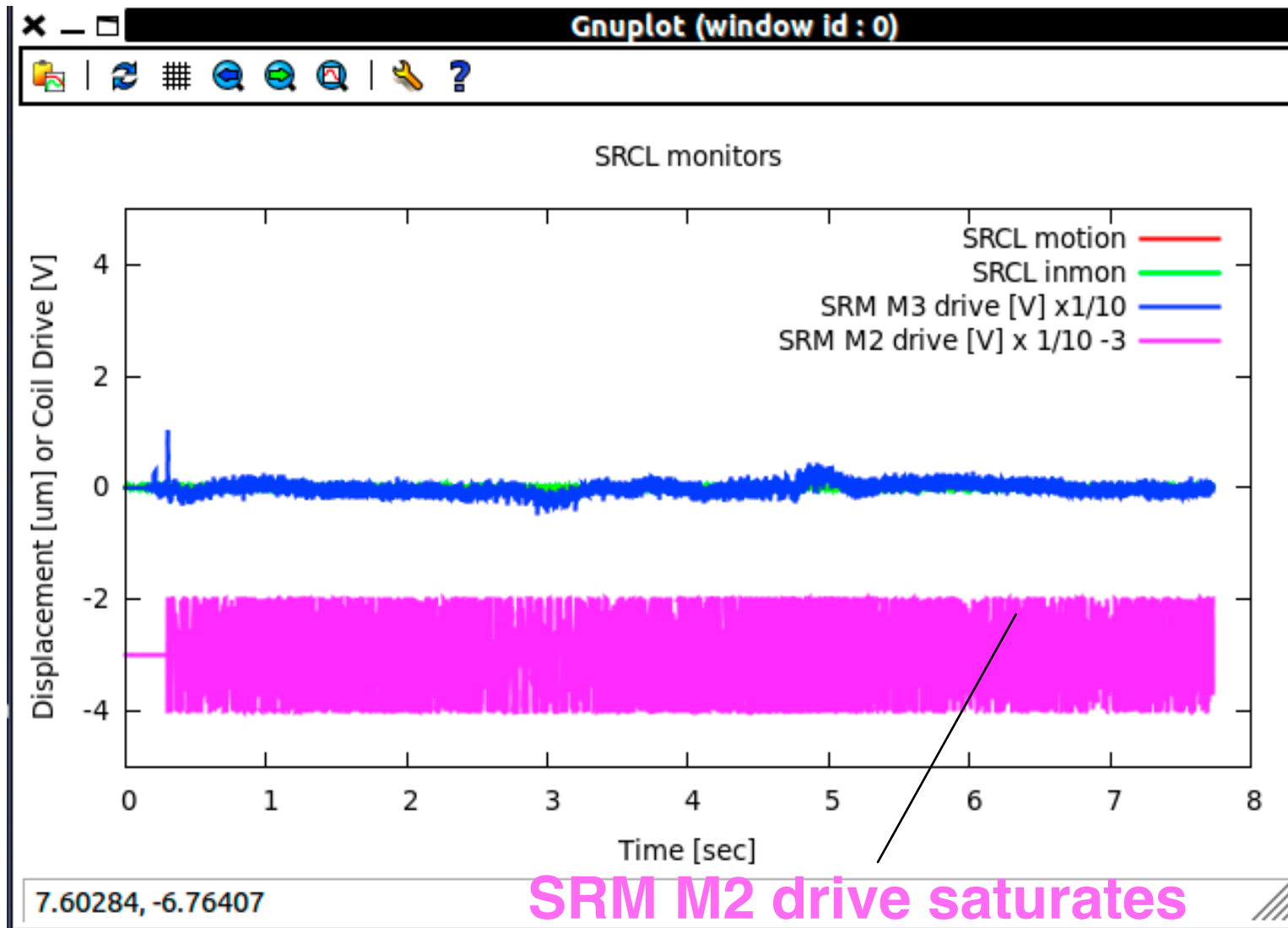
DRMI lock : OK

- Large excursion in SRCL (~9 nm max.)
- It didn't drop SRCL so far among 5 or 6 trials



Close look at SRCL

Very noisy due to the PD dark noise



ALS COMM trigger

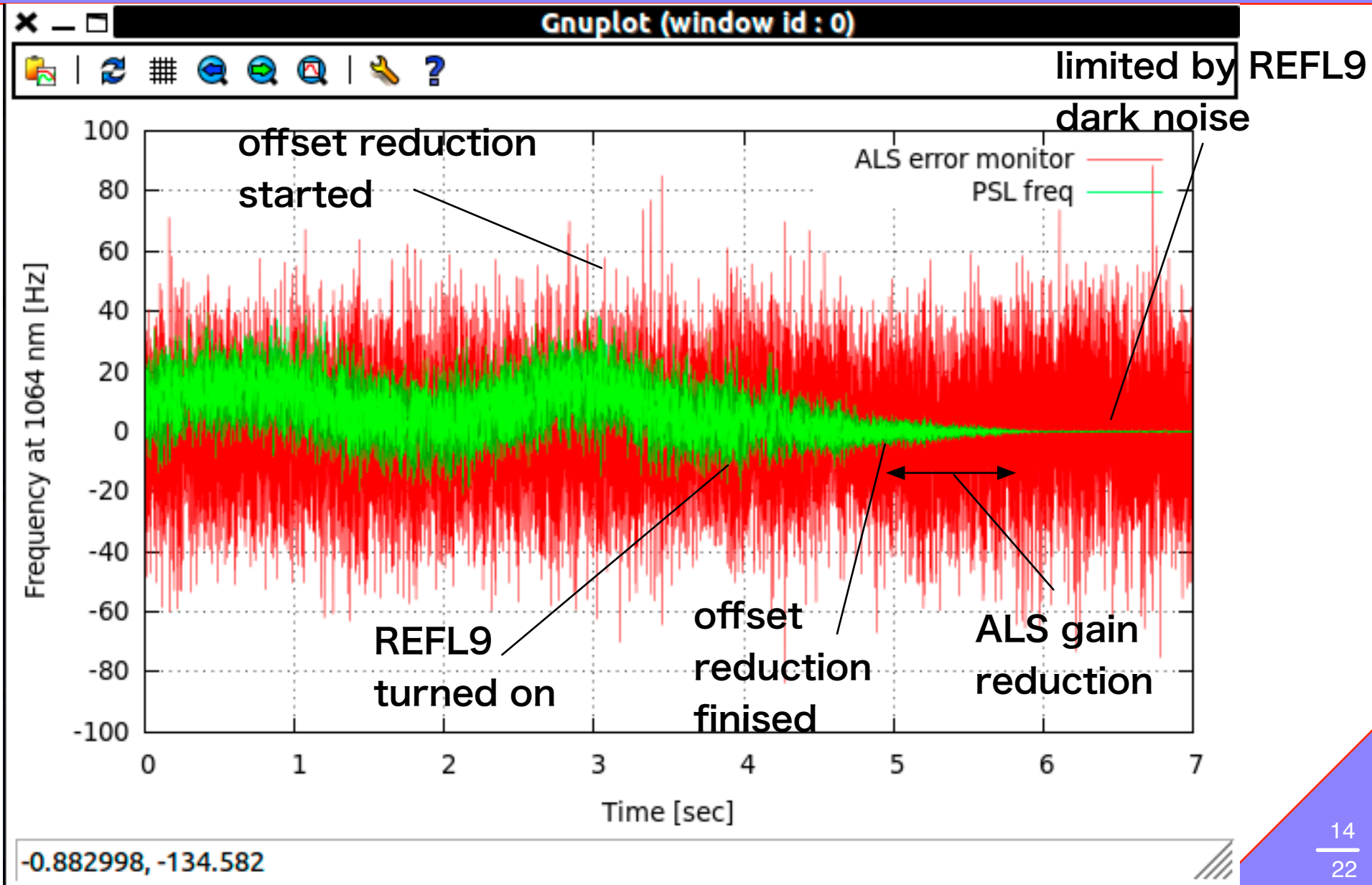
- A simple trigger was implemented to disengage ALS to stop polluting CARM
- This doesn't need to be fast.
Probably 10 msec delay is tolerable.

(CARM storage time ~ 300 msec)

*** * * what it does * * ***

```
if (TRX_DC > 30 mW)
    decrease ALS gain over 1 sec;
else
    keep working;
```

CARM in time domain



Conclusions and Plans

- ▣ SRCL excursion looks big, but still OK
- ▣ CARM hand-off works OK under the realistic noise condition
- ▣ ALS DARM noise will be included
 - This requires a noise modeling to estimate DARM noise
 - This may require ALS CARM to have higher UGF => noisier CARM.

Appendix

Important Quantities

- **Single arm full linewidth**
~ 80 Hz (or ~ 1 nm)
- **Power recycled CARM linewidth**
~ 1 Hz (or ~ 14 pm)
- **ALS CARM loop provides**
6 Hz RMS (at best so far)

DRMI lock

- 3f technique works OK so far.
- 3f can hold DRMI until the end
 - PRCL -> REFL27_I
UGF = 40 Hz
 - MICH -> REFL135_Q
UHF = 10-ish Hz
 - SRCL -> REFL135_I
UHF = 20-ish Hz

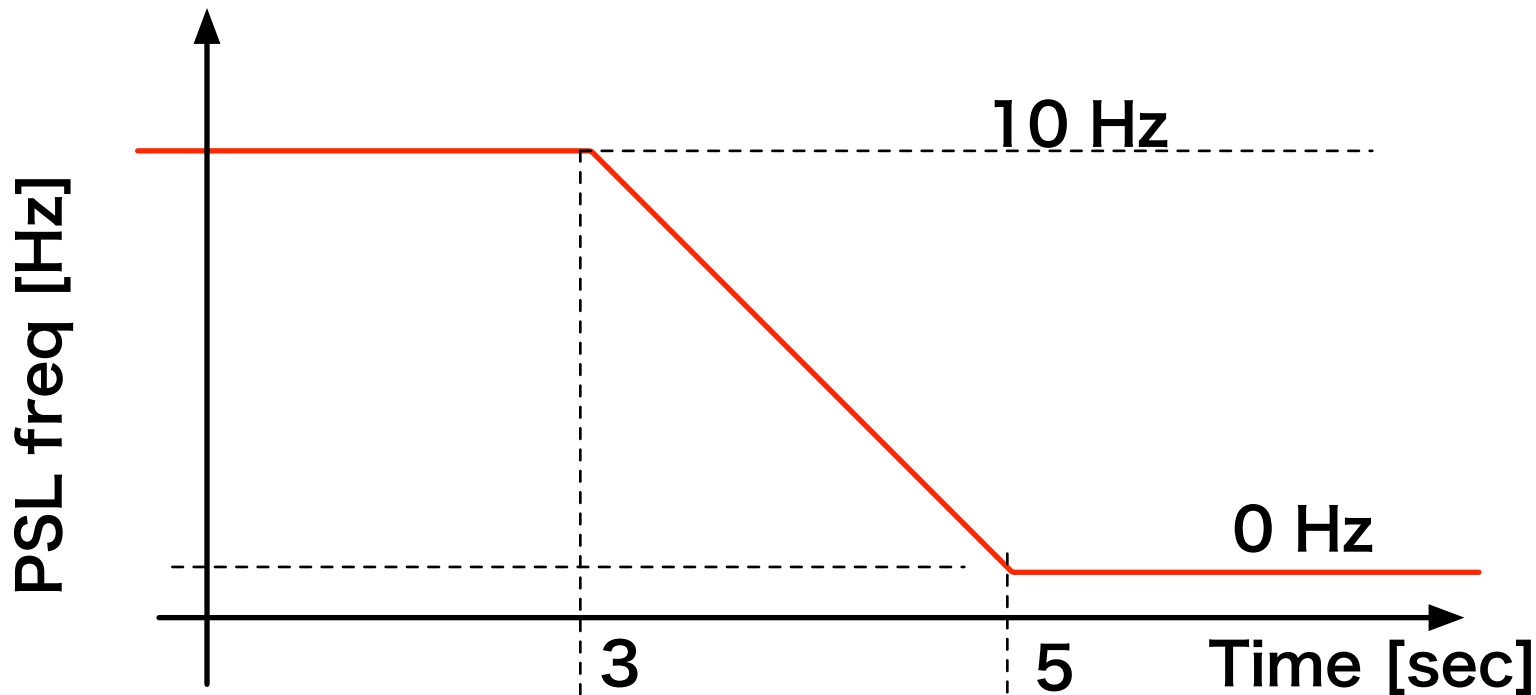
Offset reduction

CARM offset =

■ -10 Hz when $t < 3$ sec.

■ $-10 \text{ Hz} + 5 \text{ Hz/sec} \times (t - 3)$ when $t > 3$ sec

■ 0 when $t > 5$ sec



Current Sim. Settings



DRMI

locked by 3fs. Seismic noise present.



DARM

magically stays locked with zero noise



CARM

locked by ALS feeding signals back to PSL.
Sensor noise dominant (6 Hz RMS).

Sim. Settings (cntn'd)

- no radiation pressure
- no IMC or FSS
- 1 W incident on PRM
- mod. depth = 0.1 for both 9 and 45 MHz
- lower reflectivity in SRM : $T = 0.35$

RFPD dark noise

- **9MHz RFPDs (T1300387)**
 - shot noise equiv current = 1.35 [mA]
 - Responsivity = 0.8 [A/W]
- **45 MHz RFPDs (T1300387)**
 - shot noise equiv current = 1.98 mA
 - Responsivity = 0.8 [A/W]
- **f3 RFPDs a.k.a. BBPDs (D1002969)**
 - shot noise equiv current = 4 mA
 - Responsivity = 0.32 [A/W]