Earth Tide Investigations

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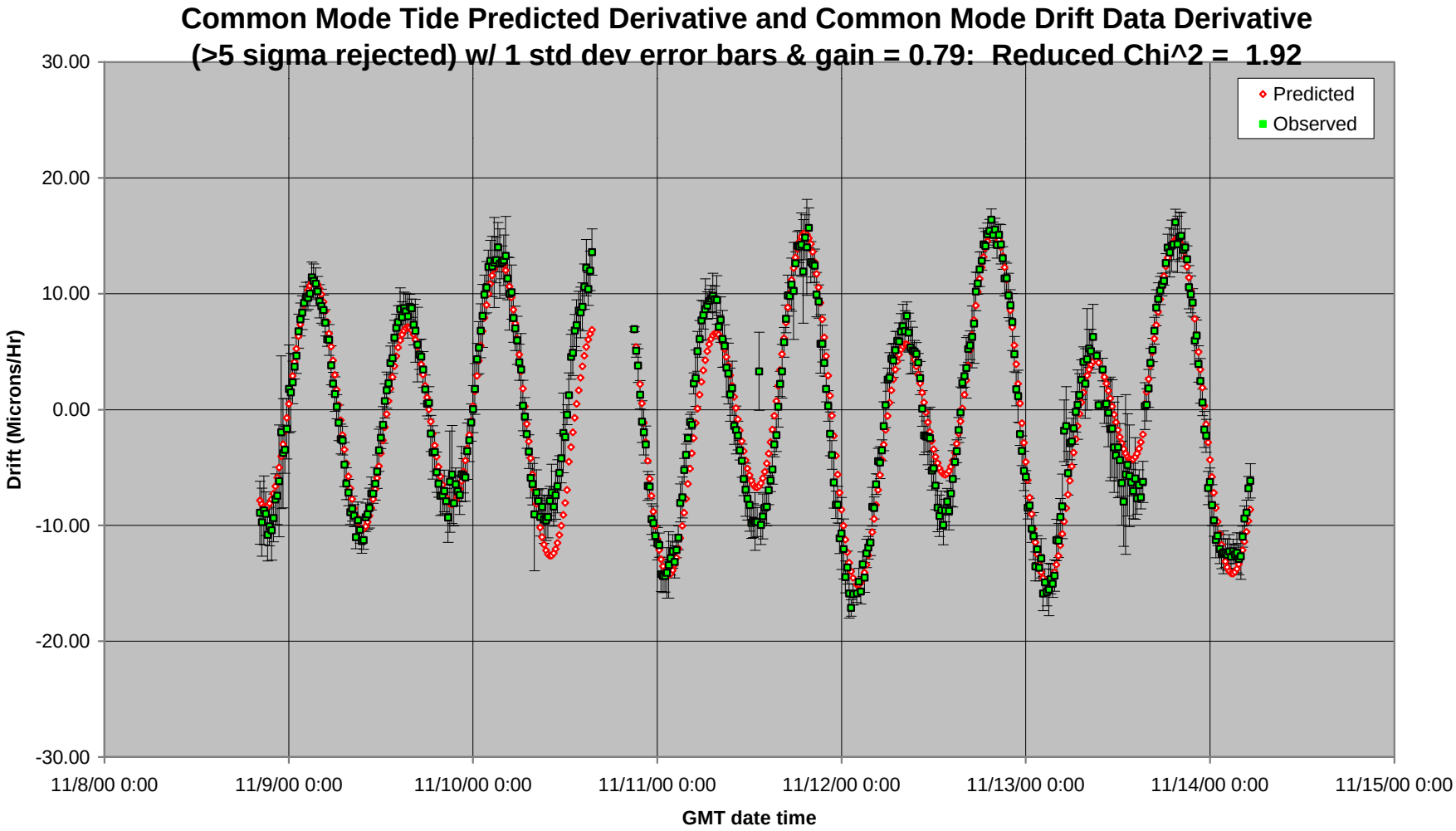
Prediction	Feedforward
3	0

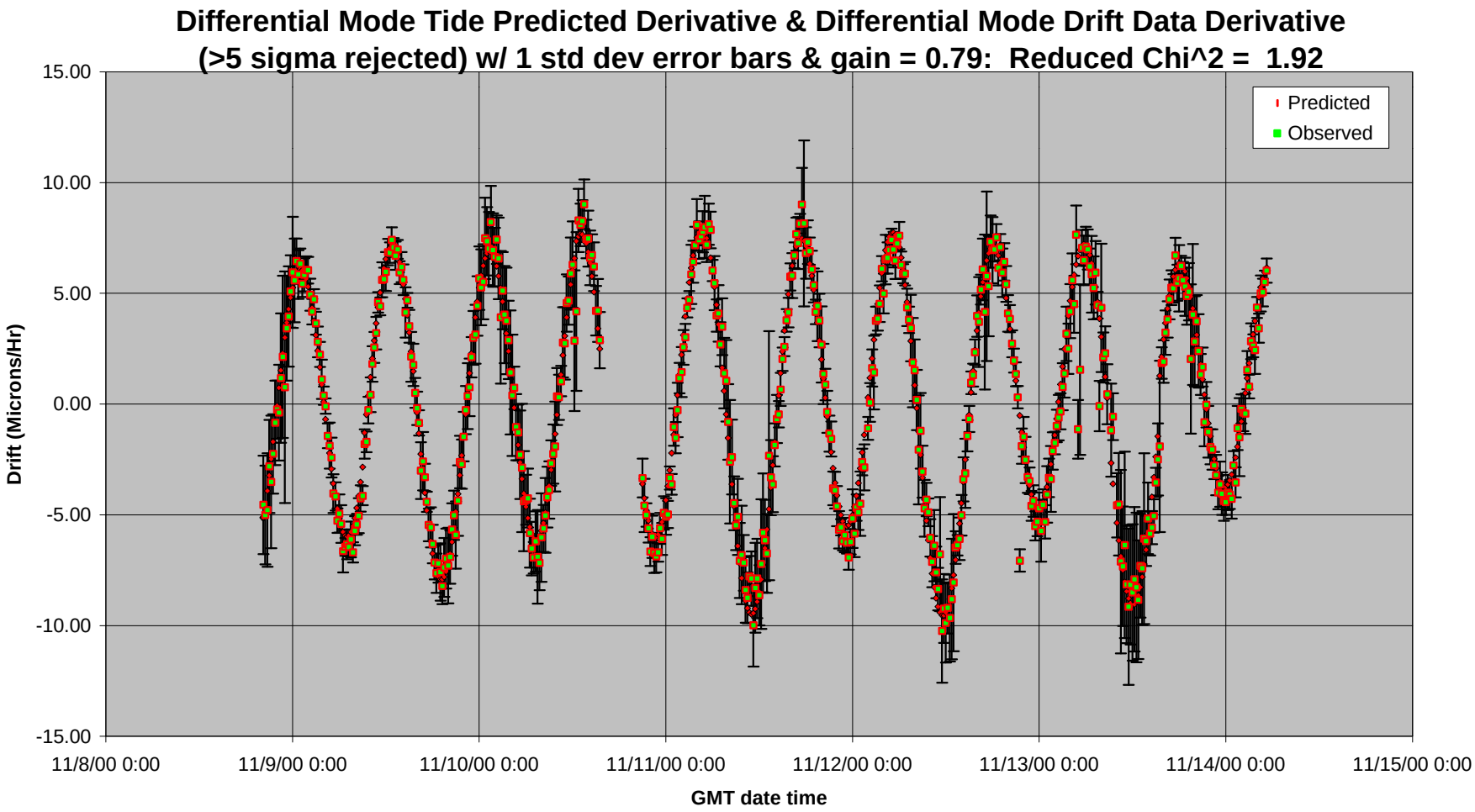
Summary of Results

- E2: Tidal Predictor ("Paladin" by Eric Morganson) shown to agree w/ WA2K recombined data to ~20%
- E3: Tidal Predictor gives qualitative agreement w/ LA4K one-arm data but another large effect is active
- E4: Data is worthless for tidal analysis
- E5: Tidal Predictor gives good agreement w/ DARM_CTRL channel of WA4K recycled data; feedforward removal of tide from CARM_CTRL ineffective (only about 2X improvement)

E2 Results

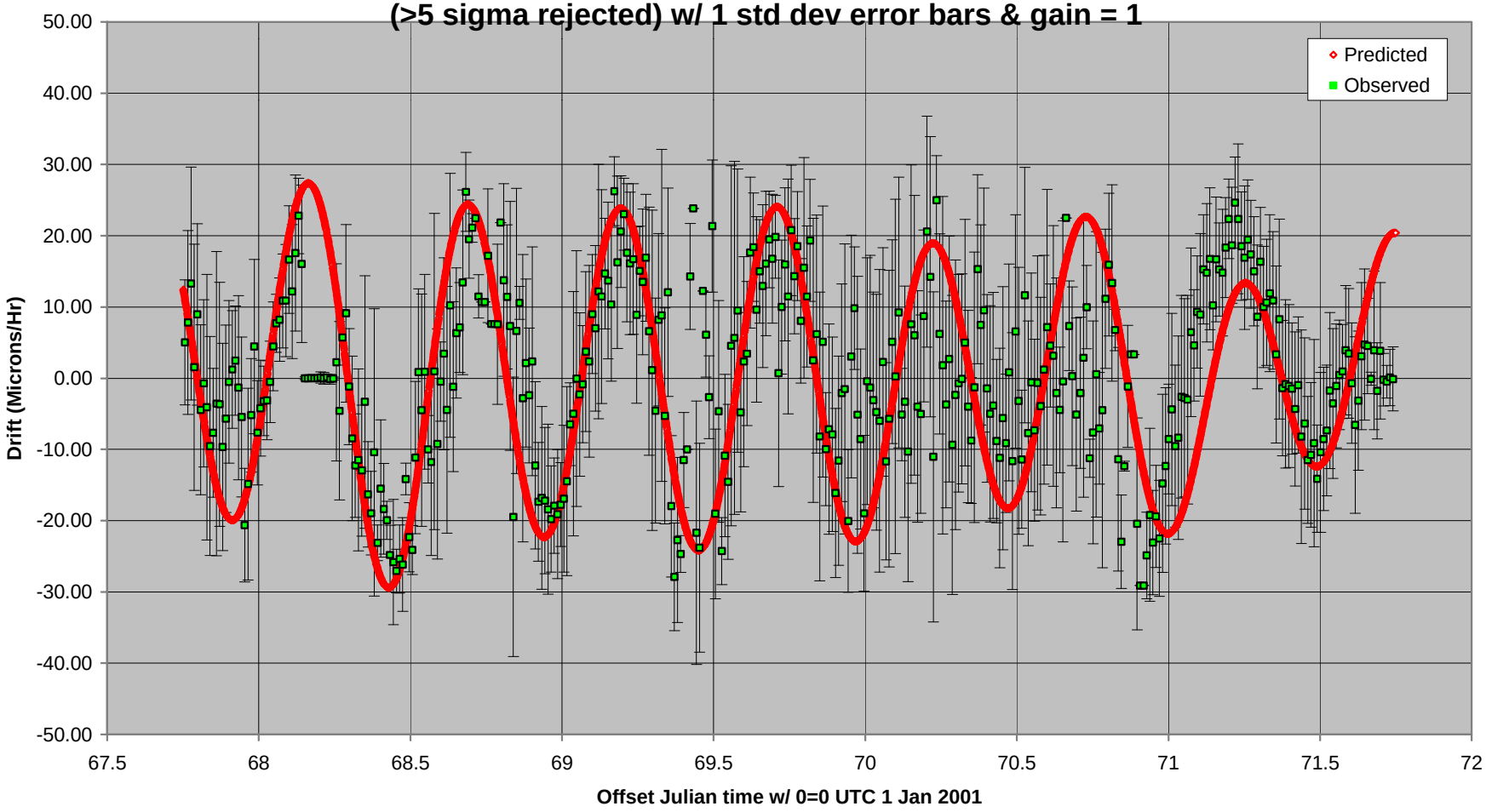
- Radkins & Raab (R&R) compared predicted tidal drifts to data; fit single "fudge factor" to reduce X^2 from 5→2 in both CARM_CTRL & DARM_CTRL
- David Strom fit a single "jump" parameter for each loss of lock to reconstruct displacements; then "fudged" both channels in agreement with R&R
- Details shown at LSC-LA in Mar01 (LIGO-G010106)
- 2001 tide tables derived for Hanford & Livingston (http://apex.ligo-wa.caltech.edu/~fjr/earth_tides/WA_tides_2001.xls or LA_tides_2001.xls)


Common Mode Tide Predicted Derivative and Common Mode Drift Data Derivative
(>5 sigma rejected) w/ 1 std dev error bars & gain = 0.79: Reduced Chi^2 = 1.92
Predicted
Observed
Drift (Microns/Hr)
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
11/8/00 0:00
11/9/00 0:00
11/10/00 0:00
11/11/00 0:00
11/12/00 0:00
11/13/00 0:00
11/14/00 0:00
11/15/00 0:00
GMT date time


Differential Mode Tide Predicted Derivative & Differential Mode Drift Data Derivative
(>5 sigma rejected) w/ 1 std dev error bars & gain = 0.79: Reduced Chi^2 = 1.92
Predicted
Observed
Drift (Microns/Hr)
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
11/8/00 0:00
11/9/00 0:00
11/10/00 0:00
11/11/00 0:00
11/12/00 0:00
11/13/00 0:00
11/14/00 0:00
11/15/00 0:00
GMT date time

E3 Results

- R&R compared predicted tidal drifts to LA4K one-arm data with qualitative agreement
- Data is poor quality (short lock sections) some days
- Odd phase shifts are observed as if earth rotation rate varied over run. Evidence for large diurnal noise?
- WA2K broken by Nisqually ‘quake


E3 LLO Xarm Tide Predicted Derivative and Common Mode Drift Data Derivative
(>5 sigma rejected) w/ 1 std dev error bars & gain = 1
Predicted
Observed
Drift (Microns/Hr)
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
67.5
68
68.5
69
69.5
70
70.5
71
71.5
72
Offset Julian time w/ 0=0 UTC 1 Jan 2001

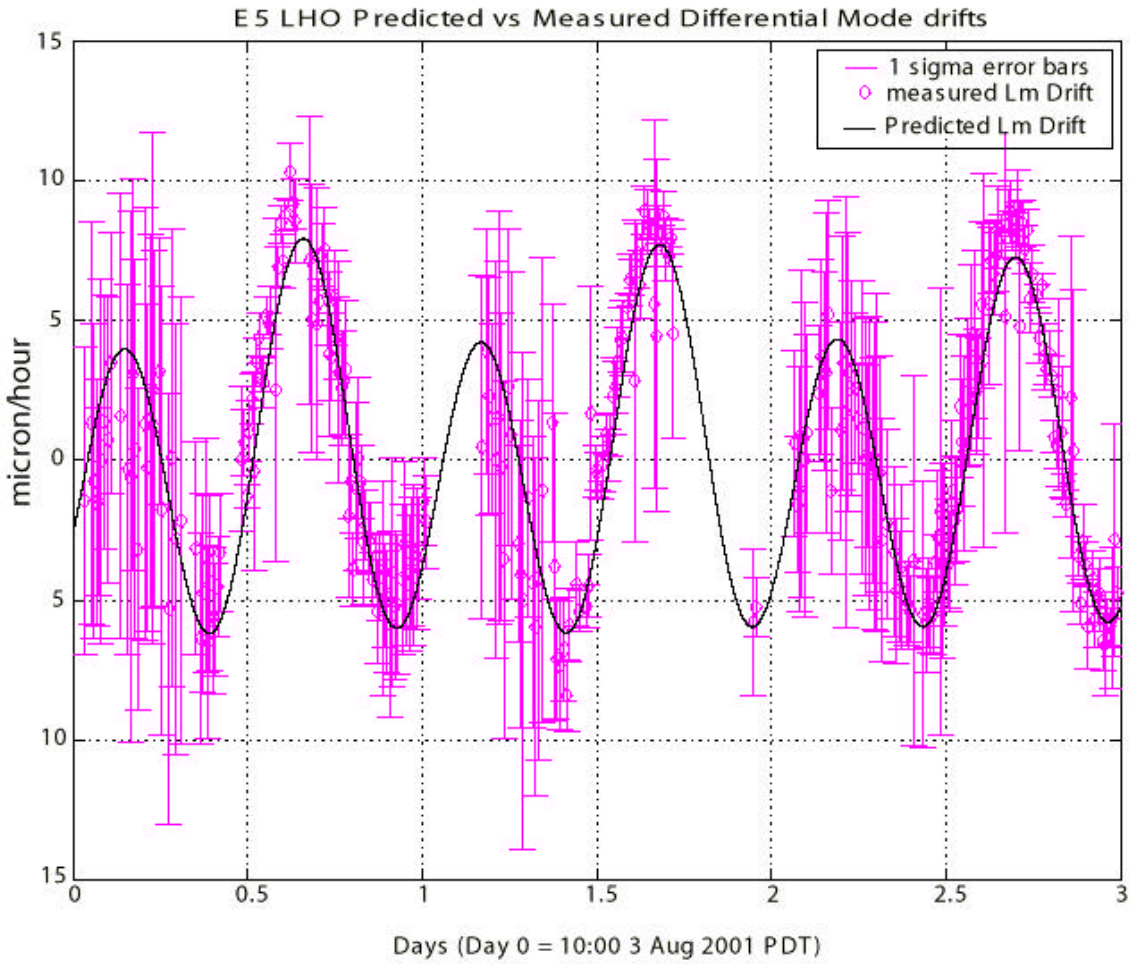
E4 Results

- Faggeddabouddit!
- LA4K locked sections are too short to be worth effort of analysis
- WA2K still broken from Nisqually ‘quake

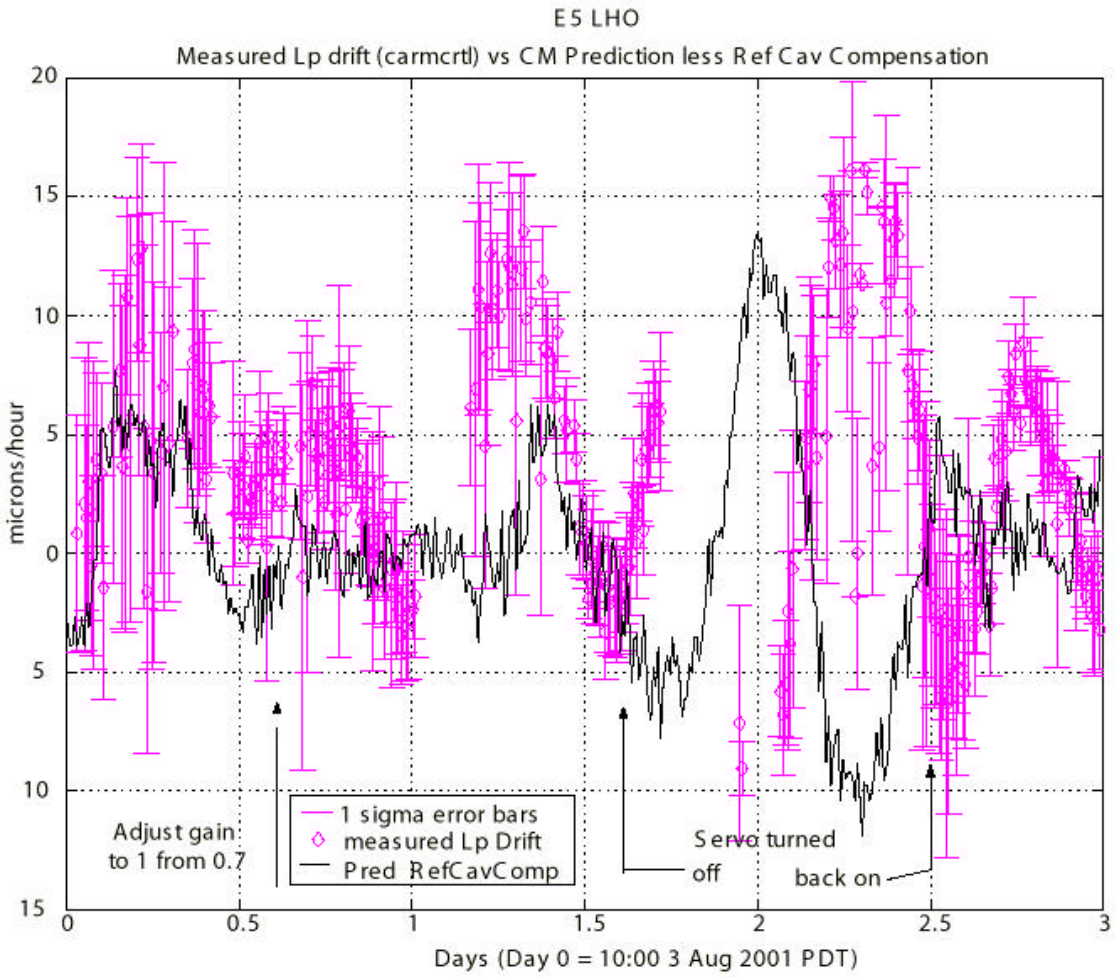
E5 Results

- LA4K down for SUS rehab; WA2K in power-recycled mode
- Attempted feedforward compensation of common-mode tide; should have left DARM_CTRL unmolested, expected big reduction in CARM_CTRL
- R&R succeed in predicting DARM_CTRL, but feedforward fails miserably
- Hardware problems prevent clean diagnosis of failed feedforward; Radkins, Savage & Schwinberg are addressing hardware issues

DARM_CTRL: Reasonable agreement when locking worked



CARM_CTRL: What we saw vs what we can account for



Application of feedforward signals made common-mode signal uninterpretable; clearly we are not controlling key parameter; believe a large problem is temperature control of reference cavity

Next Efforts

- Fix common-mode tidal actuation; stable mK control of reference cavity needed
- Repeat feedforward attempt with better actuation
- Hopefully we will get extension of locked sections and be able to fit tidal “fudge factor” and look for other influences
- Try to bring differential actuation along as resources allow