

Sat Mar 27 2004 (Local)

PRC offset calibration (Andri, Valera)

We calibrated the PRC offset as follows:

- Obtained the free swinging Michelson peak to peak amplitude AS_Q=940 cts.
- Locked the simple Michelson. Drove the ITMY with 10 cts at 111 Hz. Measured the AS_Q response of 8.3e-4 cts. This gives the calibration $AS_Q/ITMY_EXC = 8.3e-4 \times \text{Lambda}/4\pi/470/10 = 1.5e-14 \text{ m/cts}$.
- Locked the power recycled Michelson to the carrier. Drove the ITMY with 300 cts at 111 Hz. Measured the PRC_IN2 response of 1.45 cts. This gives the calibration $PRC_IN2/ITMY_EXC = 4.8e-3 \text{ cts/cts}$.
- The calibration of the PRC offset is $PRC_IN2/PRC \text{ Length} = 4.8e-3(\text{cts/cts})/1.5e-14(\text{m/cts}) \times 2 = 6.4e11 \text{ cts/m}$
- Locked the power recycled Michelson to the sideband. Drove the ITMY with 300 cts at 111 Hz. Measured the PRC_IN2 response of 1.84 cts. This gives the calibration $PRC_IN2/PRC \text{ Length} = 8.1e11 \text{ cts/m}$

Therefore the PRC offset of 5000 corresponds to 7.8 nm.

- [Valera Frolov](#)

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Since we were using the carrier lock, the calibration we want is 6.4e11 cts PRC offset / meter length offset. The sideband lock calibration is just for completeness, and to correct the calibration [previously](#) posted.

- [Andri Gretarsson](#)

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We forgot to measure the prc loop ugf. The drive frequency of 111 Hz is not high enough to be out of the prc loop band. The prc loop gain correction will likely make two calibrations - ours and Brian's from two night ago - consistent with each other. The prc ugf is somewhere between 100 and 300 Hz.

- [Valera Frolov](#)

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00:08:59
Wed Mar 31
2004
(Local)

Topic: general Author: Andri Gretarsson

Wed Mar 31 06:08:59 2004 UTC

Calibration re-done

I redid the calibration using the same method as above (since we forgot previously to take the loop gain at the excitation frequency into account).

The results are as follows (reference GPS time: 764739278)

From swinging Michelson:

AS_Q cts per meter of ITMX motion on fringe
= $2 \times \pi \times (\text{peak to peak fringe height in counts}) / \lambda$
= 4.6×10^9 cts/meter

By driving ITMX_EXC with 3000 cts at 577 Hz with the Michelson locked and looking at the, the 577 Hz peak height in a power spectrum of AS_Q, the calibration of the ITMX drive is found at 577 Hz as:
Meters of of ITMX motion per count of drive at 577 Hz
= peak height in amplitude spectral density $\times \sqrt{\text{bin width}}$
/ (drive amplitude in cts / $\sqrt{2}$) / 4.6×10^9 cts/m from above
= $0.011 \text{ cts}/\sqrt{\text{Hz}} \times \sqrt{0.375 \text{ Hz}} \times \sqrt{2}$ / 3000 cts / 4.6×10^9 cts/m
= 6.9×10^{-16} meters/ct at 577 Hz

Locking the PRM on the carrier and repeating the step above gives the ratio of the PRM carrier lock response to the Michelson response. The ratio is 6.1 PRM cts/ MICH ct.

During the PRM step above, the response of the PRC loop error point was monitored by measuring the height of the resulting 577 Hz peak in L1:LSC_PRC_IN1. This signal is equivalent to the PRC offset. The peak height was 1.19 cts/ $\sqrt{\text{Hz}}$ in a bin 0.375 Hz wide. In other words the amplitude was 0.73 cts (rms).

Dividing this by the number of meters (rms) we were moving ITMX during the excitation gives us the calibration of PRC_IN1 (or equivalently PRC offset) to ITMX displacement:

cts of PRC offset per meter of ITMX motion
= $3000 / \sqrt{2}$ cts (rms) / 6.93×10^{-16} meters/ct $\times 0.73$ cts (rms) PRC offset
= 4.9×10^{11} cts PRC offset per meter ITMX motion

And multiplying by two to get the number of PRC offset counts per meter of PRC cavity length change and inverting gives

PRC offset cts per meter cavity length change = 1.0×10^{-12} m/ct

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00:14:25
Wed Mar 31
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Topic: general Author: Andri Gretarsson

Wed Mar 31 06:14:25 2004 UTC

The numbers above a right but I mistyped the last formula. It should have started with $\sqrt{2}/3000$, not $3000/\sqrt{2}$.

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00:21:34 Topic: general Author: Andri Gretarsson Wed Mar 31 06:21:34 2004 UTC
Wed Mar 31 2004 (Local) I also redid the calibration for a state 2 lock on the sideband.
The method is the same but the result is a factor of 3 different.

PRC offset per meter of cavity length change for a sidband lock in the PRM is 3.75 x 10 meters/ct.

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00:22:25 Topic: general Author: Andri Gretarsson Wed Mar 31 06:22:25 2004 UTC
Wed Mar 31 2004 (Local) BTW. the carrier PRC ugf was 110 Hz.

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21:27:14 Topic: general Author: Andri Gretarsson Sat Apr 17 02:27:14 2004 UTC
Fri Apr 16 2004 (Local) Correction: Where I said ITMX_EXC above, I meant to say ITMY_EXC

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21:37:17 Topic: general Author: Andri Gretarsson Sat Apr 17 02:37:17 2004 UTC
Fri Apr 16 2004 (Local) ...and where I said ITMX I meand ITMY.

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