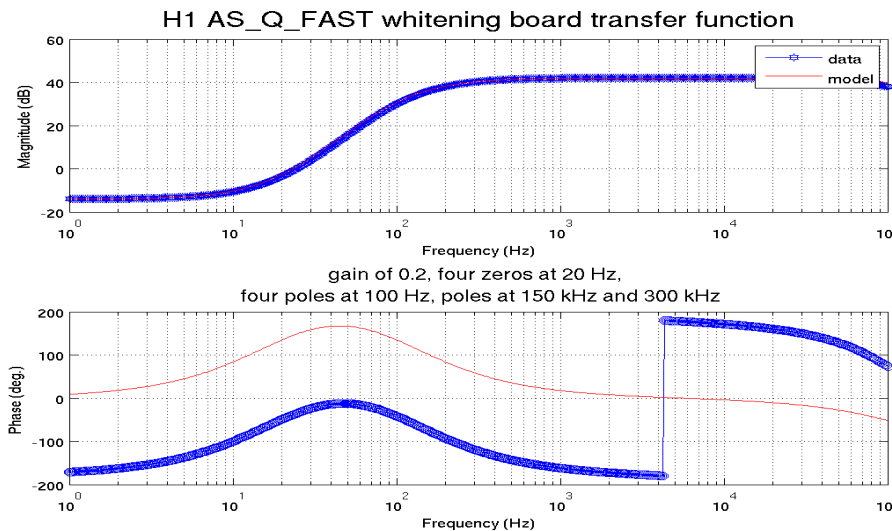
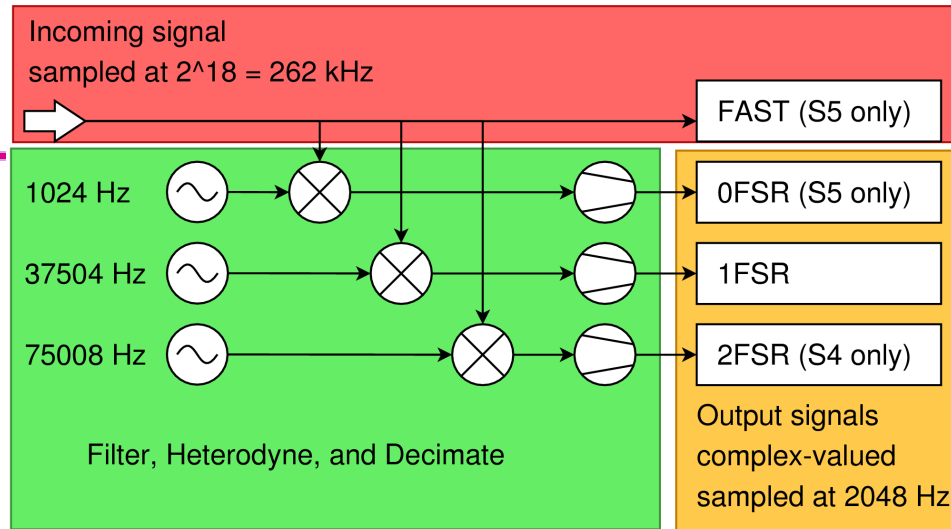


Calibration of Fast Channels

- Hardware configuration in S4
- Calibration measurements
- Generating a response function for the Fast Channels
- Calibrated spectra
- S4 FSR Calibration currently under review (Rick et al)
<http://apex.ligo-wa.caltech.edu/~rick/Calibration/HFcalibration>



- ### Differences between AS_Q/Fast
- AS_Q whitening gain(12dB in H1)
 - AS_Q anti-aliasing filter
 - ASPDs dig. gains before ADC
 - 2^{16} cts/20V in ADC in AS_Q
 - Its own whitening (on the left)
 - x2 at the Demod monitor points
 - 2^{16} cts/4V in ADC

Fast Channels in S4

- 2 ASPDs (AS3 & AS4)
- Fast Channels(not archived)
 - H1:DAQ-FAST_CH1_SHORT (AS3_I_FAST)
 - H1:DAQ-FAST_CH2_SHORT (AS3_Q_FAST)
 - H2:DAQ-FAST_CH0_SHORT (AS4_I_FAST)
 - H2:DAQ-FAST_CH1_SHORT (AS4_Q_FAST)

Heterodyned Channels

- LSC-AS3_I_1FSR
- LSC-AS3_Q_1FSR
- LSC-AS3_I_2FSR
- LSC-AS3_Q_2FSR
- LSC-AS4_I_1FSR
- LSC-AS4_Q_1FSR
- LSC-AS4_I_2FSR
- LSC-AS4_Q_2FSR

Time series rotation and summation

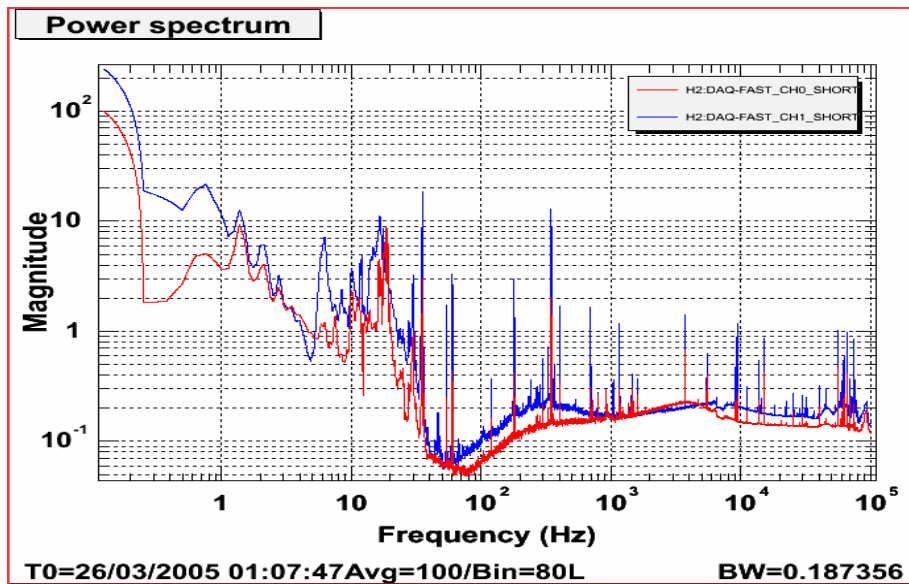
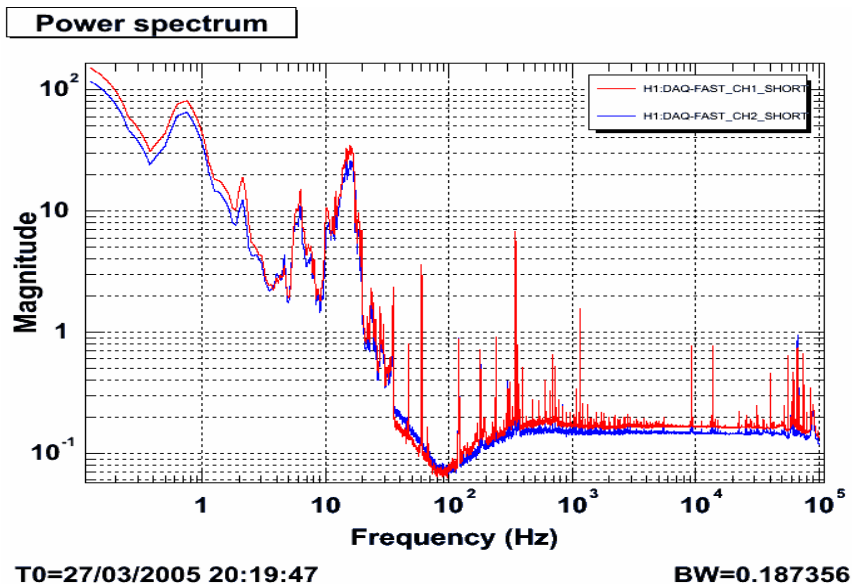
$$AS3 = AS3_I \sin(\varphi) + AS3_Q \cos(\varphi)$$

$$AS4 = AS4_I \sin(\theta) + AS3_Q \cos(\theta)$$

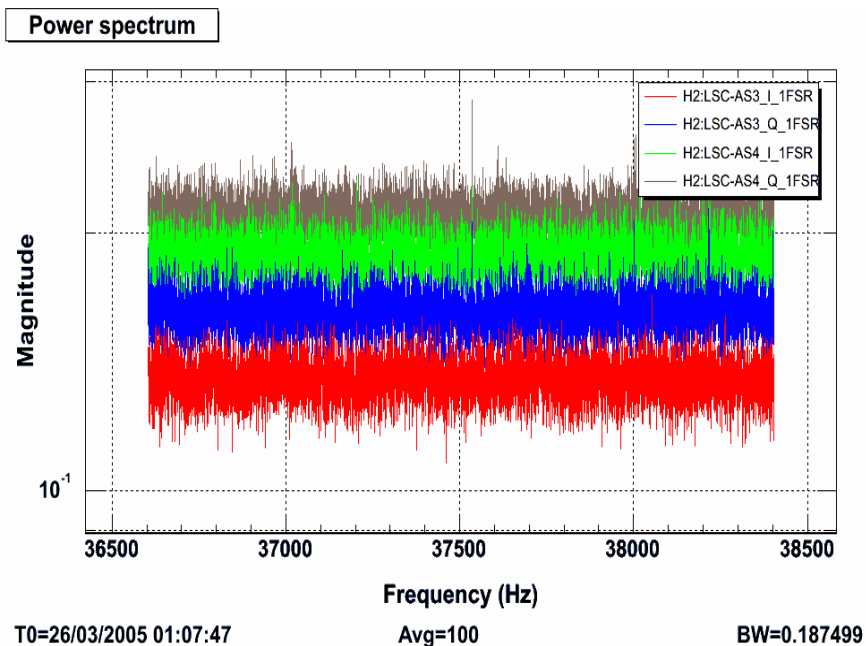
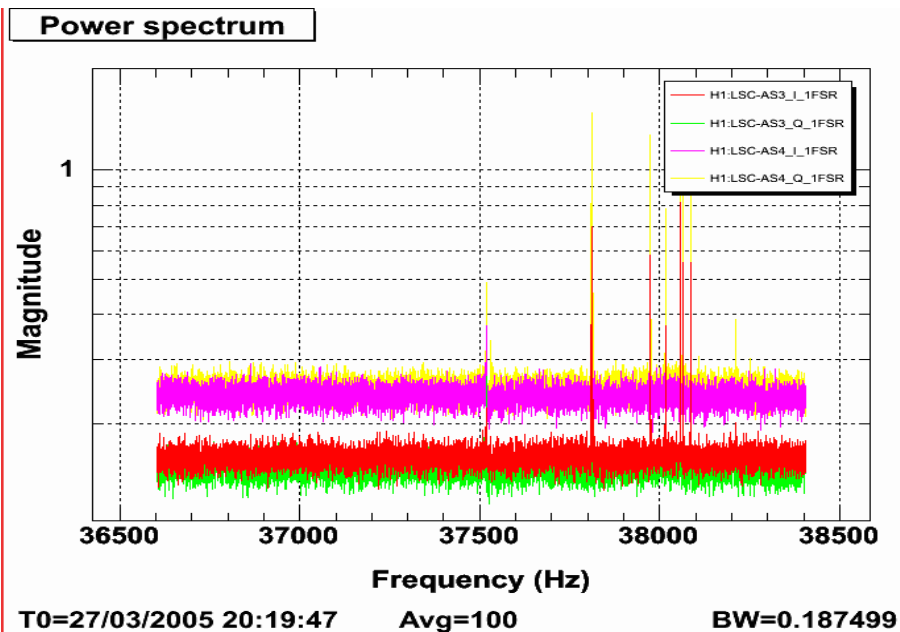
$$AS_Q = (n3 AS3 + n4 AS4) / 2$$

Fast spectra in S4 (Feb. 22 – March 23 2005)

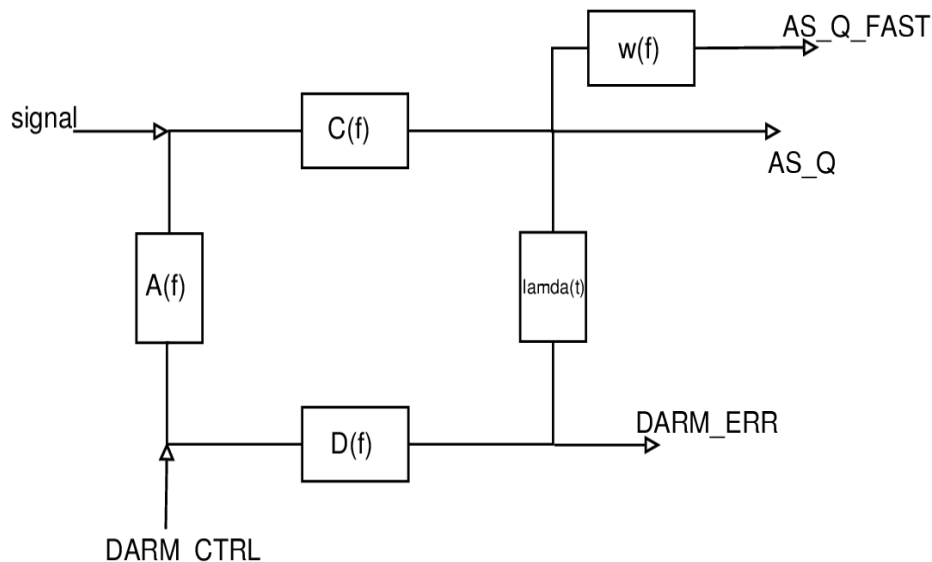
- 2 measurements on March 11 and March 27 2005 (AS3 only)



Heterodyned spectra



Block Diagram / AS_Q_FAST response



$$R(f)_{\text{fast}} = (1+G'(f))/C'(f) / w(f)$$

where

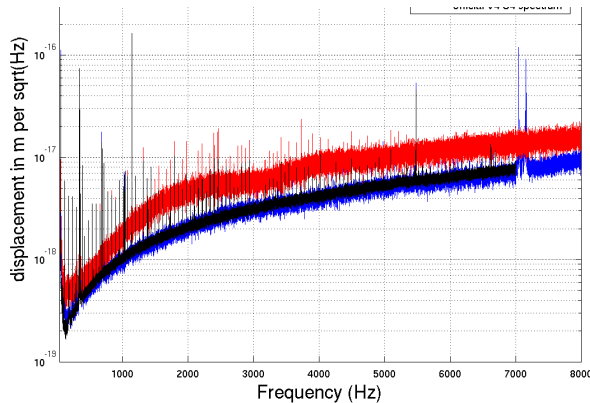
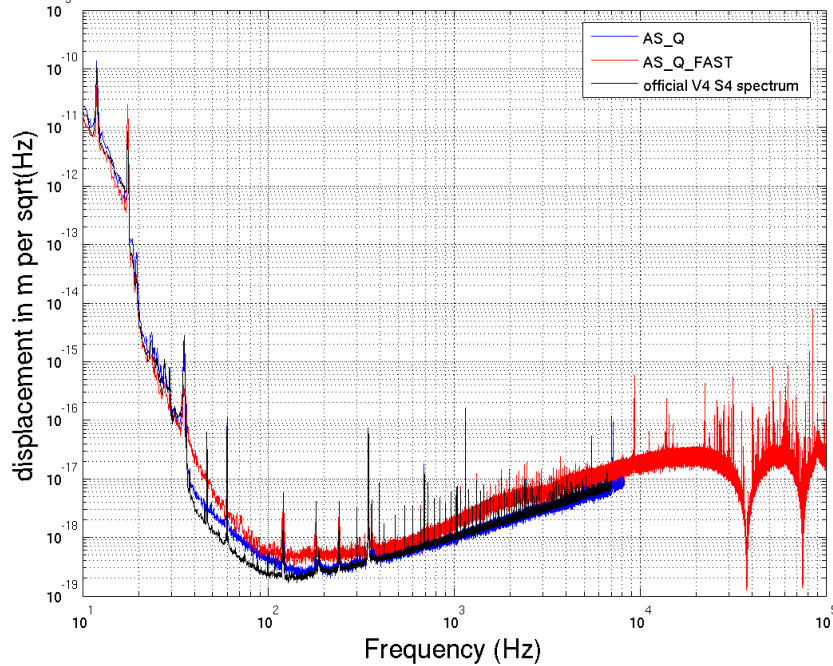
$$C'(f) = C(f) * \text{time_delay}$$

$$G'(f) = A(f) * D(f) * C'(f) * aa * k$$

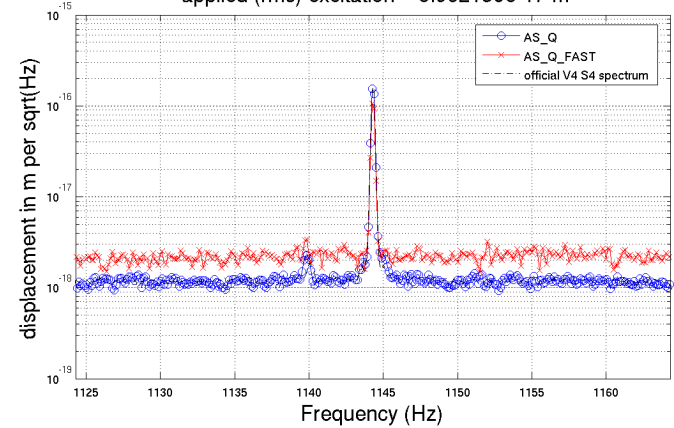
$w(f)$ the whitening filter

H1 : March 11 2005

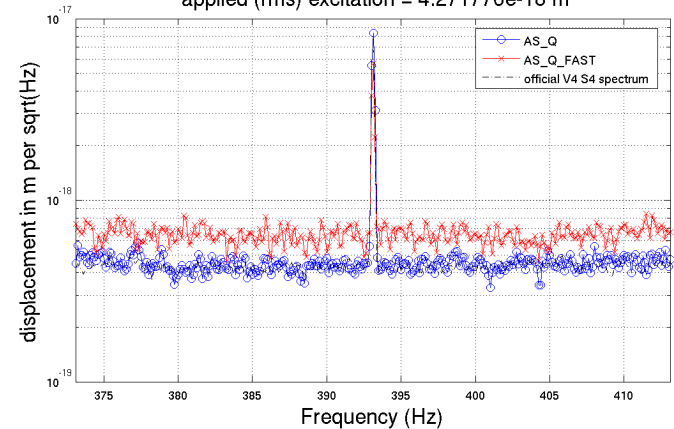
Calibrated spectra of 2005-03-11 21:39:43 (794612396)



Calibrated spectra of 2005-03-11 21:39:43 (794612396), calibration line at 1144.3 Hz
 integrated amplitude for AS_Q = 7.437136×10^{-17} m,
 integrated amplitude for AS_Q_FAST = 5.153493×10^{-17} m,
 integrated amplitude from official spectrum = 7.841362×10^{-17} m,
 applied (rms) excitation = 8.962150×10^{-17} m

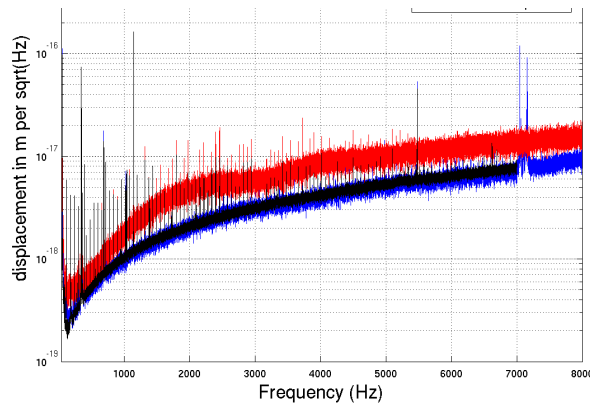
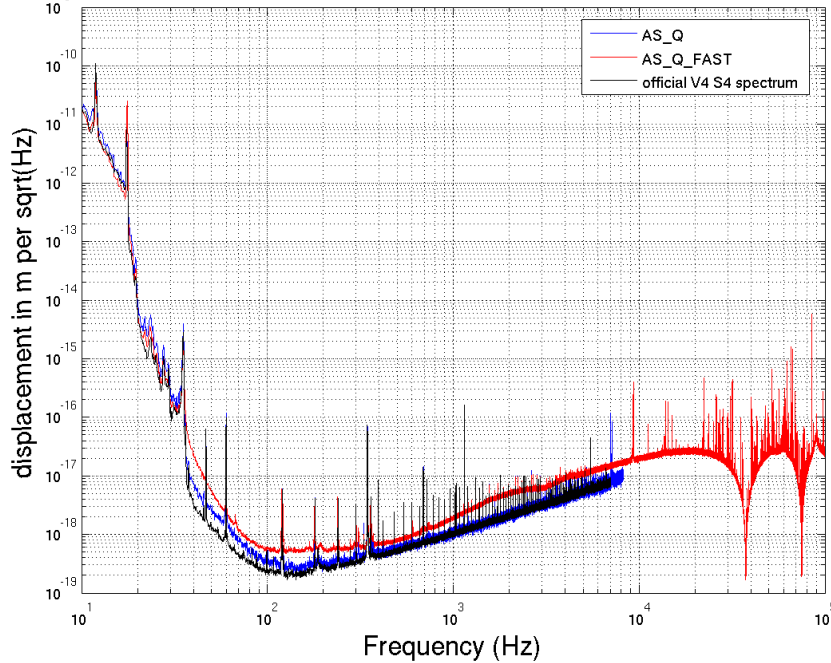


Calibrated spectra of 2005-03-11 21:39:43 (794612396), calibration line at 393.1 Hz
 integrated amplitude for AS_Q = 3.727068×10^{-18} m,
 integrated amplitude for AS_Q_FAST = 2.597801×10^{-18} m,
 integrated amplitude from official spectrum = 3.743552×10^{-18} m,
 applied (rms) excitation = 4.271776×10^{-18} m

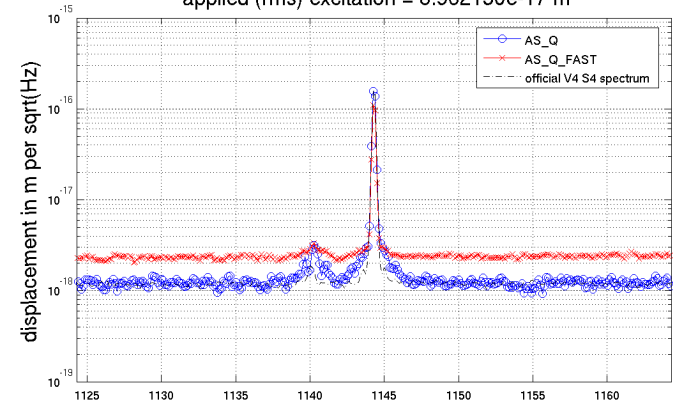


H1: March 27 2005

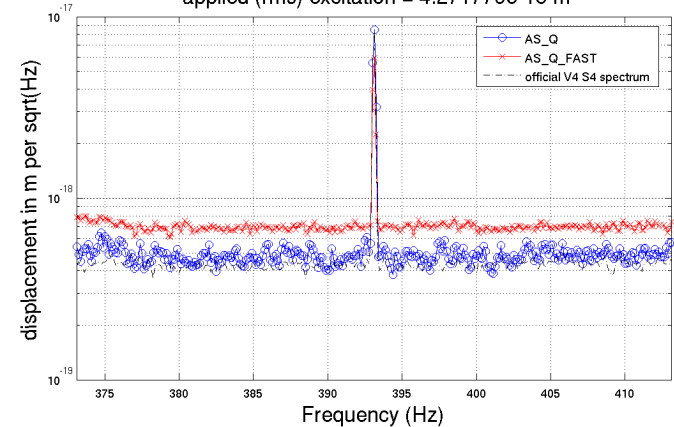
Calibrated spectra of 2005-03-27 20:19:47 (795990000)



Calibrated spectra of 2005-03-27 20:19:47 (795990000), calibration line at 1144.3 H
 integrated amplitude for AS_Q = 7.544061×10^{-17} m,
 integrated amplitude for AS_Q_FAST = 5.295310×10^{-17} m,
 integrated amplitude from official spectrum = 7.841362×10^{-17} m,
 applied (rms) excitation = 8.962150×10^{-17} m

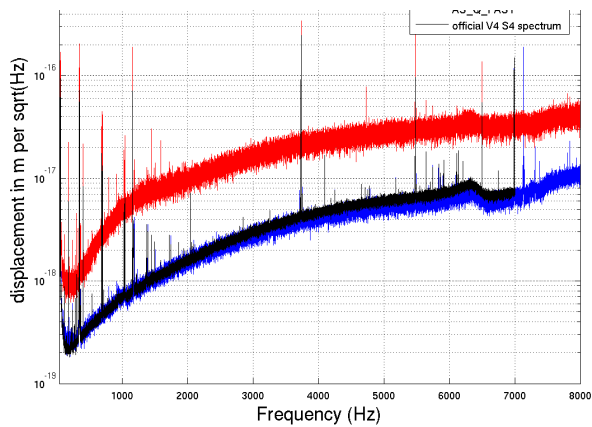
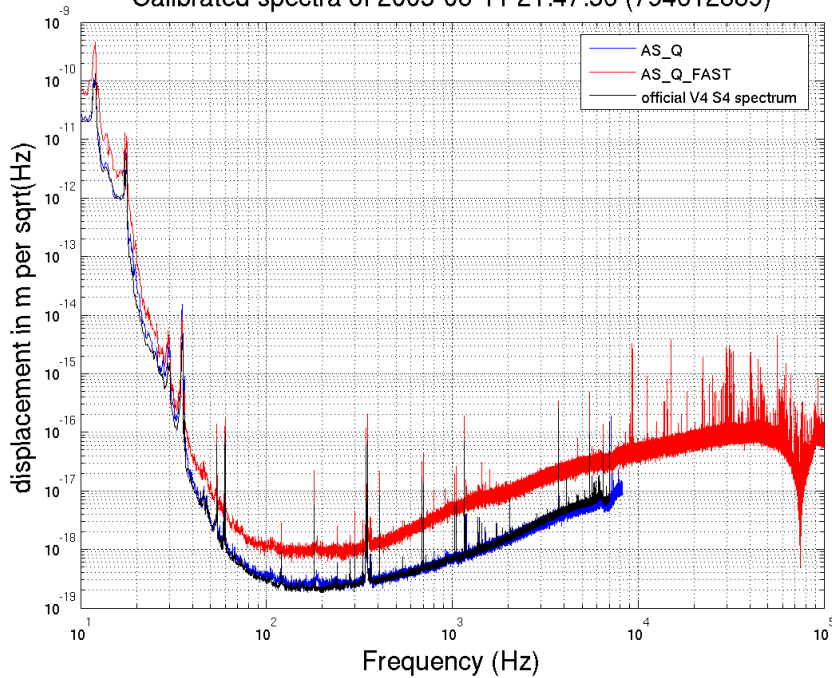


Calibrated spectra of 2005-03-27 20:19:47 (795990000), calibration line at 393.1 H:
 integrated amplitude for AS_Q = 3.784739×10^{-18} m,
 integrated amplitude for AS_Q_FAST = 2.725831×10^{-18} m,
 integrated amplitude from official spectrum = 3.743552×10^{-18} m,
 applied (rms) excitation = 4.271776×10^{-18} m

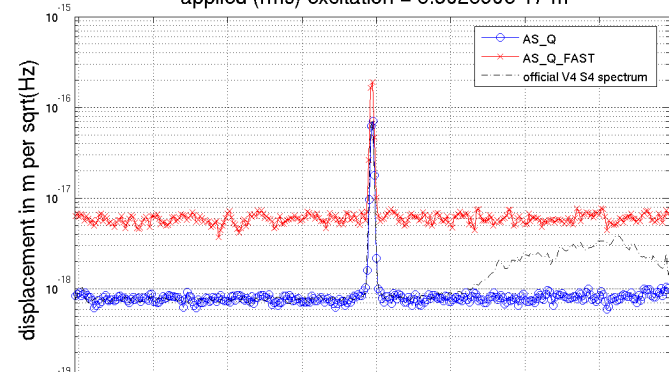


H2: March 11 2005

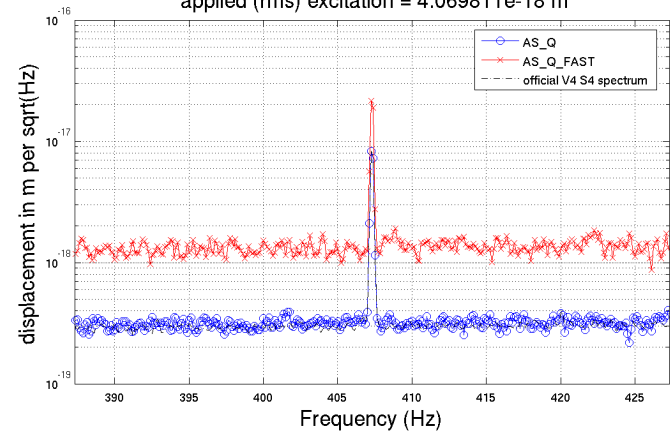
Calibrated spectra of 2005-03-11 21:47:56 (794612889)



Calibrated spectra of 2005-03-11 21:47:56 (794612889), calibration line at 1159.7 Hz
 integrated amplitude for AS_Q = 3.401380×10^{-17} m,
 integrated amplitude for AS_Q_FAST = 9.102334×10^{-17} m,
 integrated amplitude from official spectrum = 3.439733×10^{-17} m,
 applied (rms) excitation = 3.502390×10^{-17} m

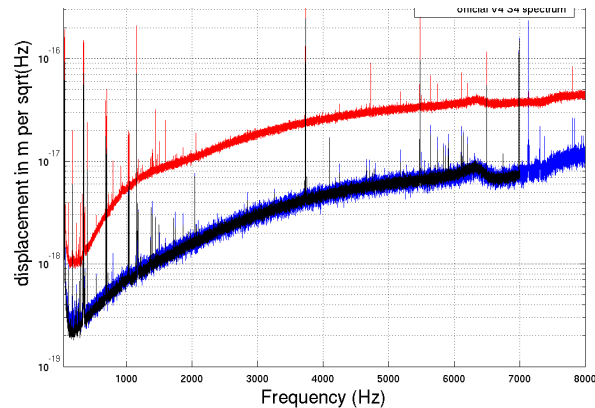
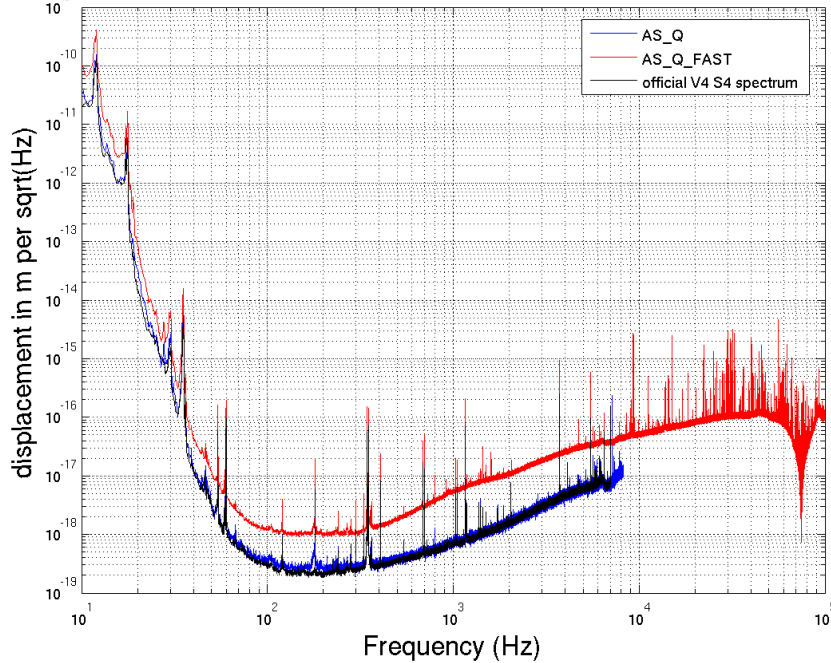


Calibrated spectra of 2005-03-11 21:47:56 (794612889), calibration line at 407.3 Hz:
 integrated amplitude for AS_Q = 3.983484×10^{-18} m,
 integrated amplitude for AS_Q_FAST = 1.041711×10^{-17} m,
 integrated amplitude from official spectrum = 3.999059×10^{-18} m,
 applied (rms) excitation = 4.069811×10^{-18} m

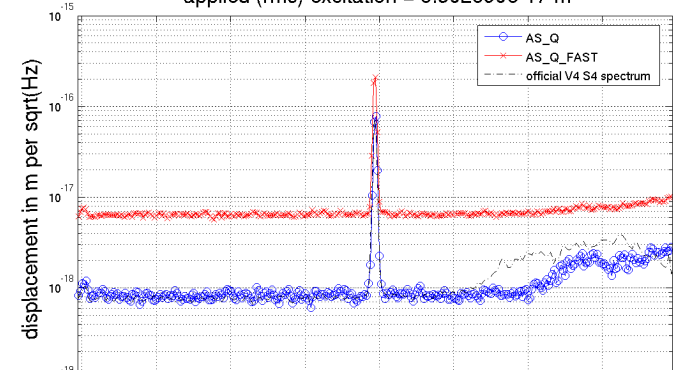


H2: March 26 2005

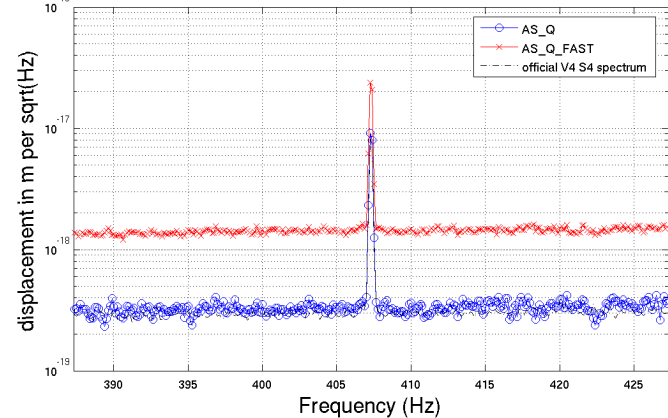
Calibrated spectra of 2005-03-26 01:07:47 (795834480)



Calibrated spectra of 2005-03-26 01:07:47 (795834480), calibration line at 1159.7 Hz
 integrated amplitude for AS_Q = 3.740194×10^{-17} m,
 integrated amplitude for AS_Q_FAST = 1.004805×10^{-16} m,
 integrated amplitude from official spectrum = 3.439733×10^{-17} m,
 applied (rms) excitation = 3.502390×10^{-17} m

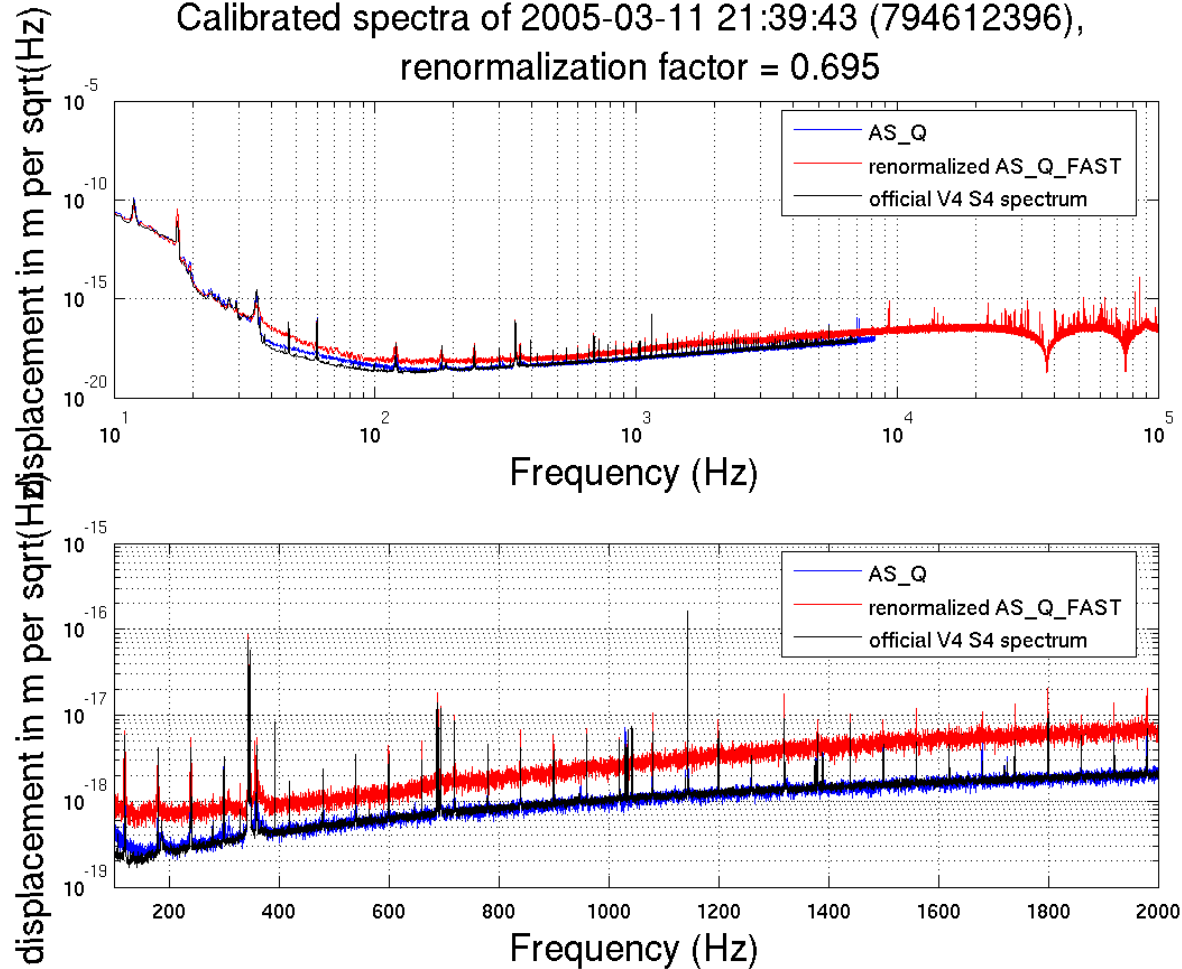


Calibrated spectra of 2005-03-26 01:07:47 (795834480), calibration line at 407.3 Hz
 integrated amplitude for AS_Q = 4.386246×10^{-18} m,
 integrated amplitude for AS_Q_FAST = 1.159224×10^{-17} m,
 integrated amplitude from official spectrum = 3.999059×10^{-18} m,
 applied (rms) excitation = 4.069811×10^{-18} m



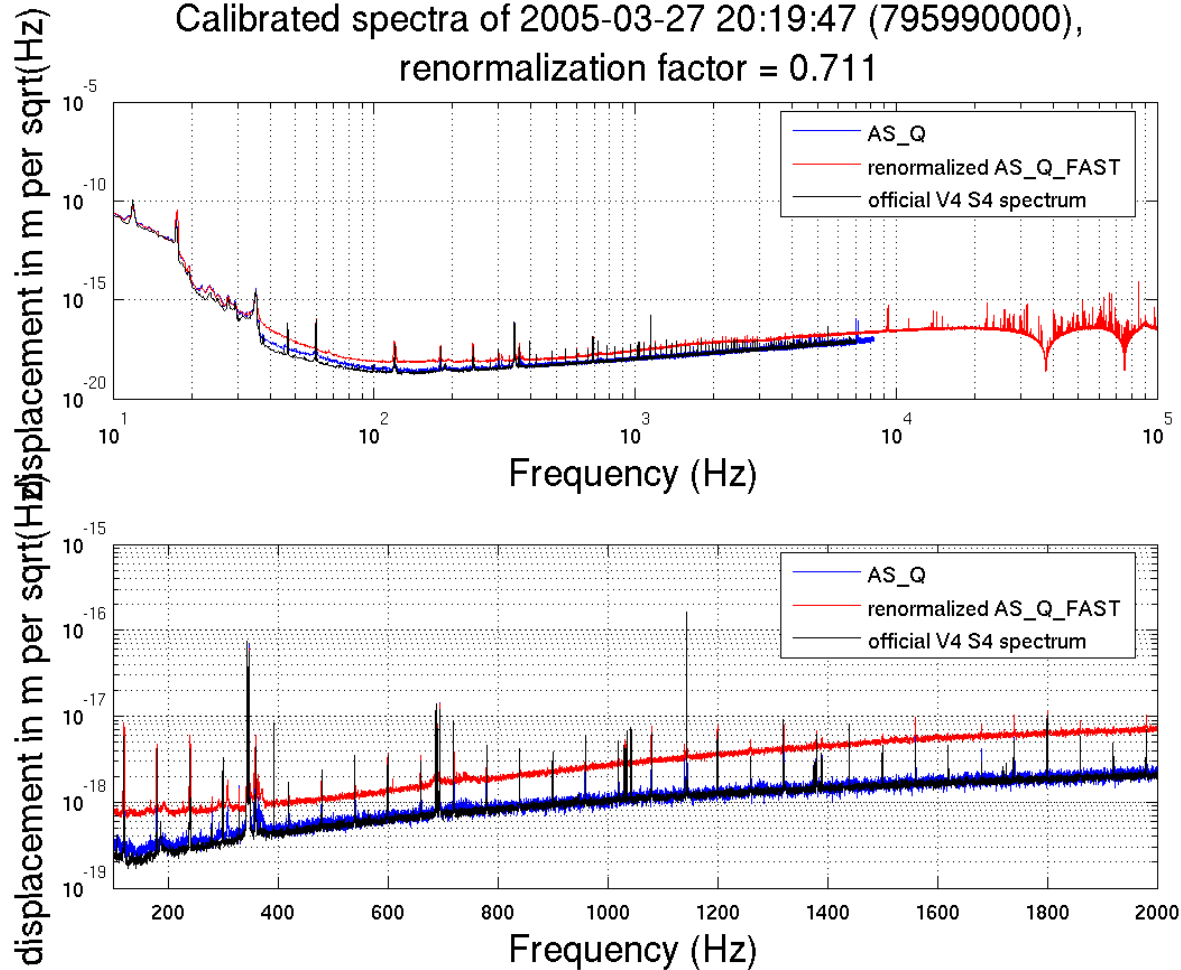
H1: March 11 2005 (renormalized)

Calibrated spectra of 2005-03-11 21:39:43 (794612396),
renormalization factor = 0.695



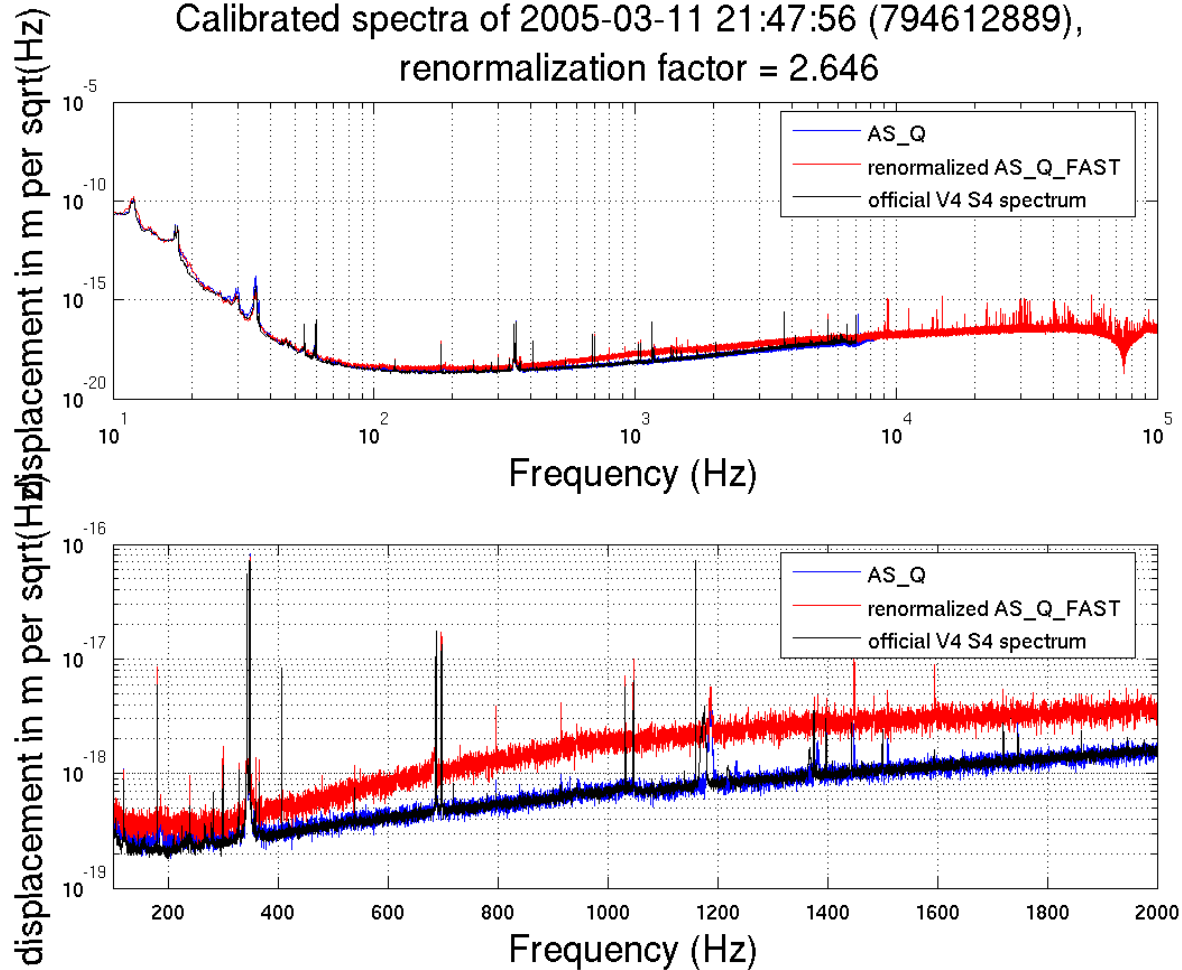
H1: March 27 2005 (renormalized)

Calibrated spectra of 2005-03-27 20:19:47 (795990000),
renormalization factor = 0.711

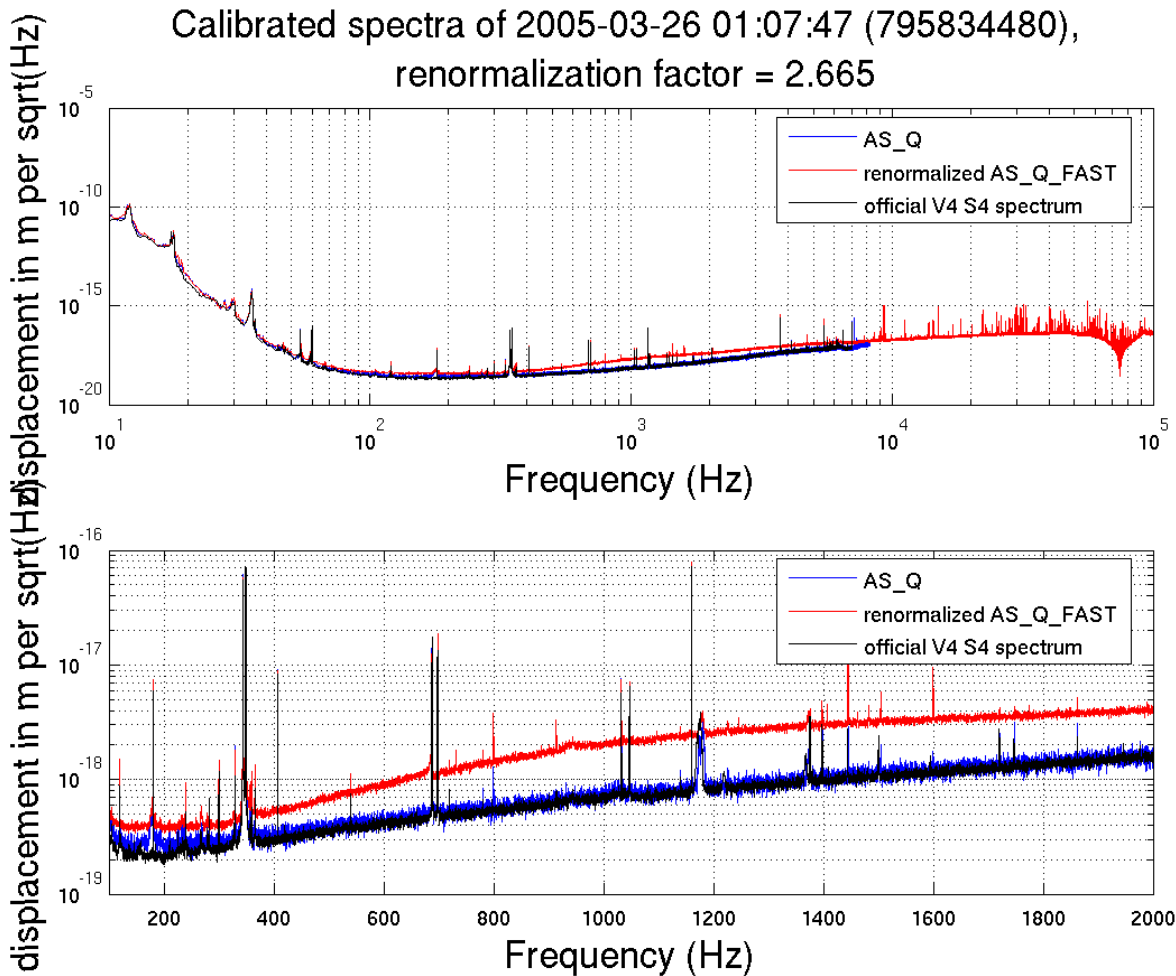


H2: March 11 2005 (renormalized)

Calibrated spectra of 2005-03-11 21:47:56 (794612889),
renormalization factor = 2.646



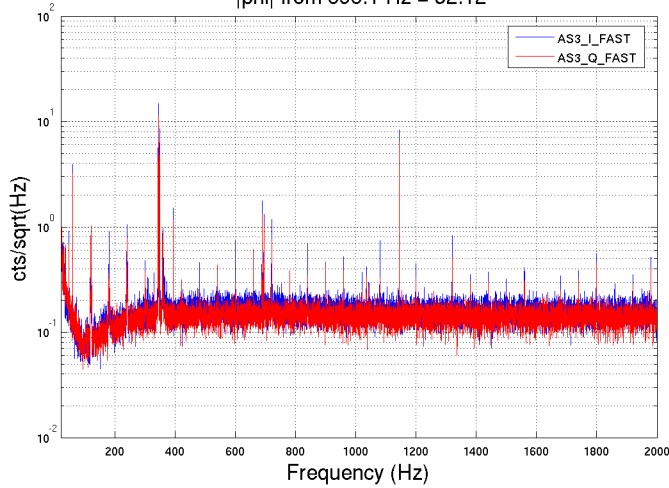
H2: March 26 2005 (renormalized)



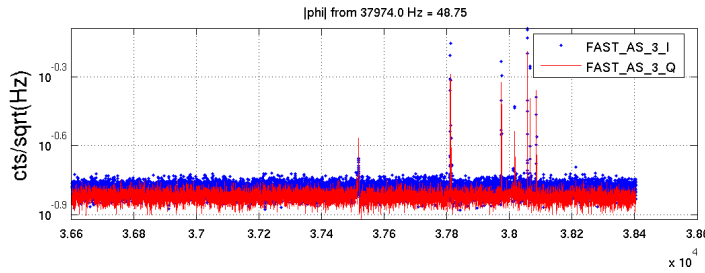
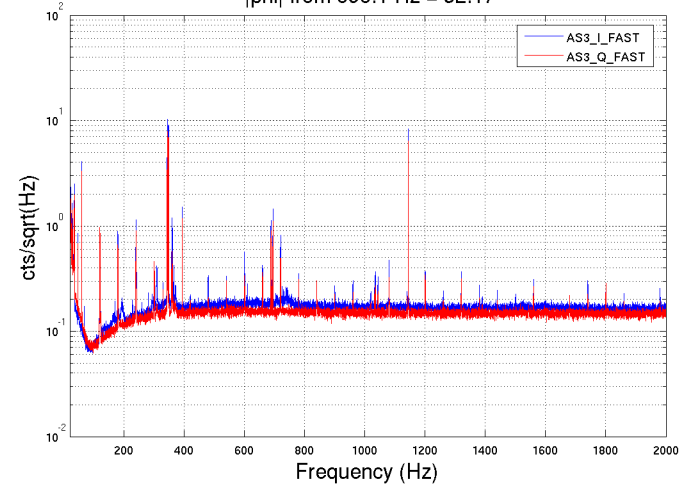
Rotation angles (Demod phases)

H1 AS3Ifast and AS3Qfast spectrum of 2005-03-11 21:39:43 (794612396),
 $|\phi|$ from 1144.3 Hz = 52.75,
 $|\phi|$ from 393.1 Hz = 52.12

H1

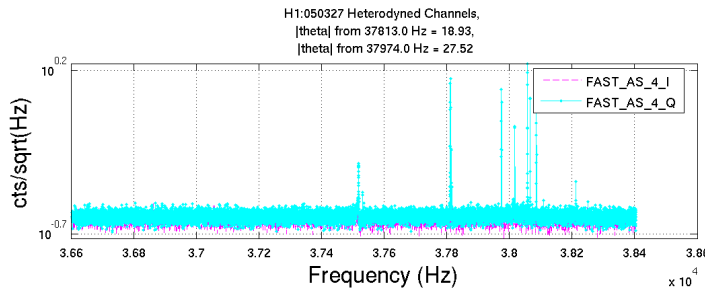


H1 AS3Ifast and AS3Qfast spectrum of 2005-03-27 20:19:47 (795990000),
 $|\phi|$ from 1144.3 Hz = 52.48,
 $|\phi|$ from 393.1 Hz = 52.17



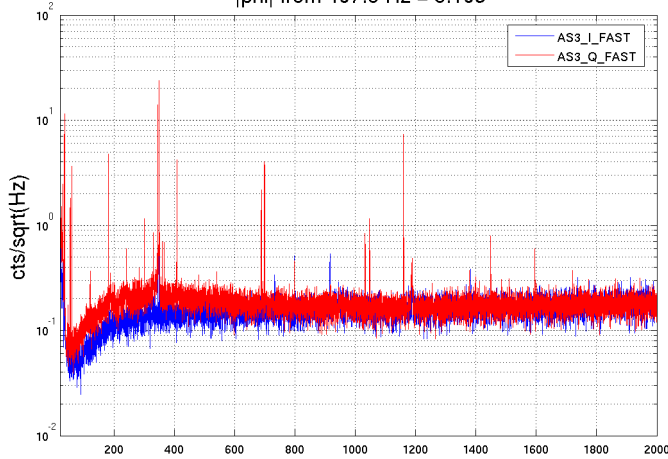
$$|\varphi| \sim 52.4 \quad (51.4)$$

$$|\theta| \sim 18.9 \quad (17.2)$$

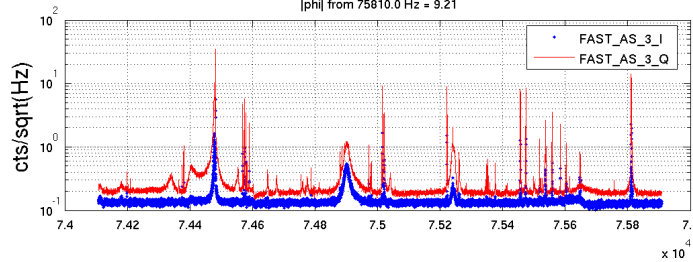


H2

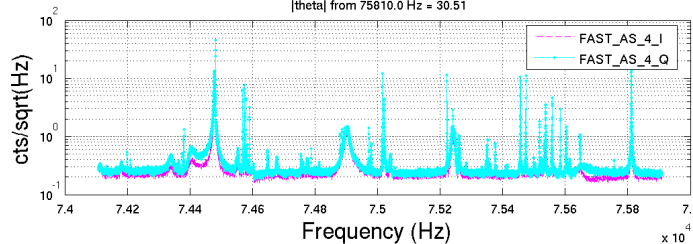
H2 AS3Ifast and AS3Qfast spectrum of 2005-03-11 21:47:56 (794612889),
 $|\phi|$ from 1159.7 Hz = 7.835,
 $|\phi|$ from 407.3 Hz = 8.105



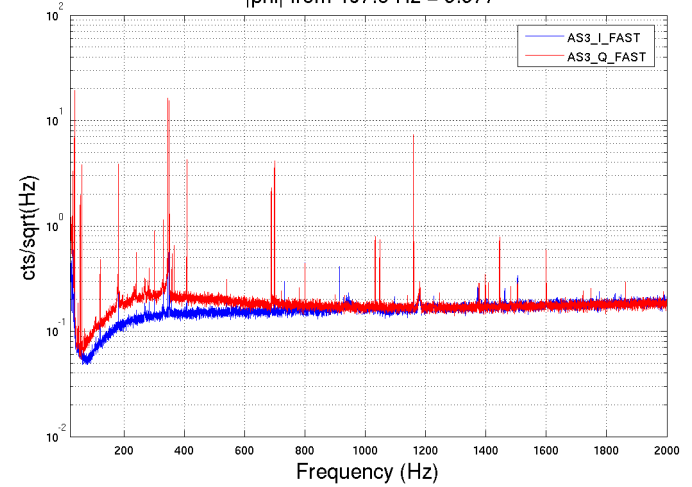
H2:050326 Heterodyned Channels,
 $|\phi|$ from 75222.0 Hz = 9.668,
 $|\phi|$ from 75810.0 Hz = 9.21



H2:050326 Heterodyned Channels,
 $|\theta|$ from 75222.0 Hz = 30.36,
 $|\theta|$ from 75810.0 Hz = 30.51



H2 AS3Ifast and AS3Qfast spectrum of 2005-03-26 01:07:47 (795834480),
 $|\phi|$ from 1159.7 Hz = 9.632,
 $|\phi|$ from 407.3 Hz = 9.977



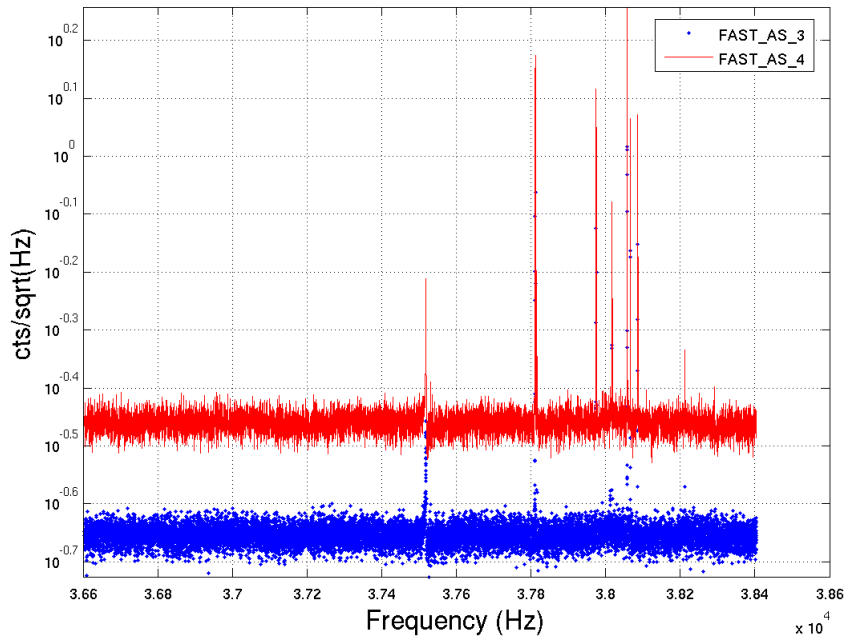
$$|\phi| \sim 8.88 \quad (175)$$

$$|\theta| \sim 30.36 \quad (27)$$

n3 / n4 ASPDs weights

H1

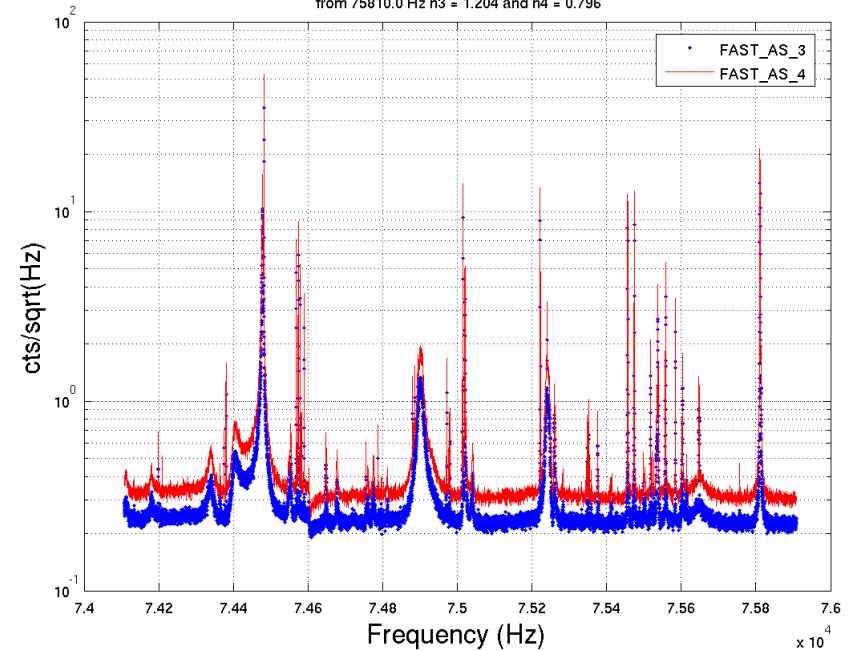
H1:050327 Heterodyned Channels,
 from 37813.0 Hz n3 = 1.264 and n4 = 0.736,
 from 37974.0 Hz n3 = 1.232 and n4 = 0.768



n3 ~ 1.25
 n4 ~ 0.75

H2

H2:050326 Heterodyned Channels,
 from 75222.0 Hz n3 = 1.194 and n4 = 0.806,
 from 75810.0 Hz n3 = 1.204 and n4 = 0.796



n3 ~ 1.2
 n4 ~ 0.8

H1 Fast Channel shot noise measurement in S4

Shotnoise/Darknoise displacement spectra of 2005-01-12 23:51:46
 with 30mA into ASPD4 with lamp and 1.5mA under normal operation (2W)

