Calibration of data in the time domain

(or how to generate 1800s long SFTs from time domain data)

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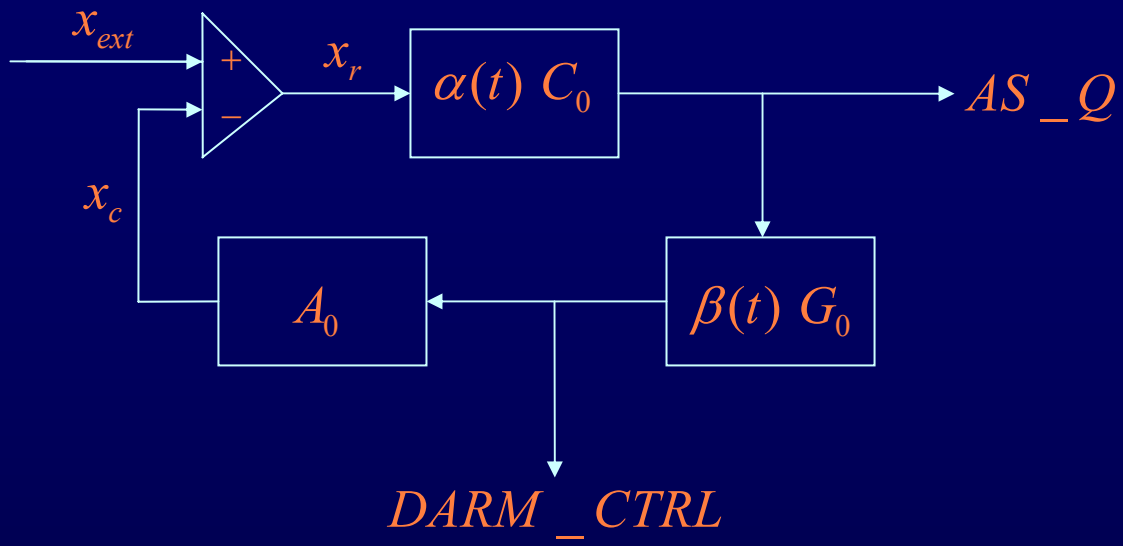
LIGO-G030628-00-Z



We reconstruct the strain from the residual and control motions:

$$x_r(f_c) = x_{ext}(f_c) - x_c(f_c)$$

$$\Rightarrow x_{ext}(f_c) = x_r(f_c) + x_c(f_c)$$

$$x_{ext} = \frac{1}{\alpha(t)\,C_0}\,AS\_Q + A_0\beta(t)G_0\,AS\_Q$$

$$DARM\_CTRL$$

Need to construct digital filters for the inverse sensing function $1/\alpha(t)C_0$, the servo $\beta(t)\ G_0$, and the actuation function A_0

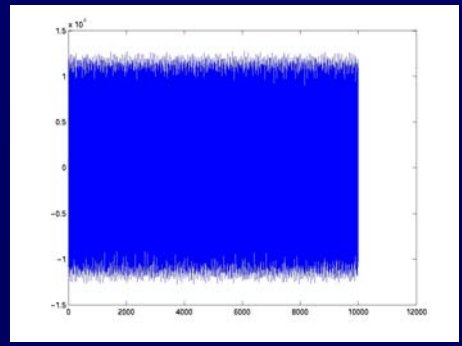
H1:

-Sensing function

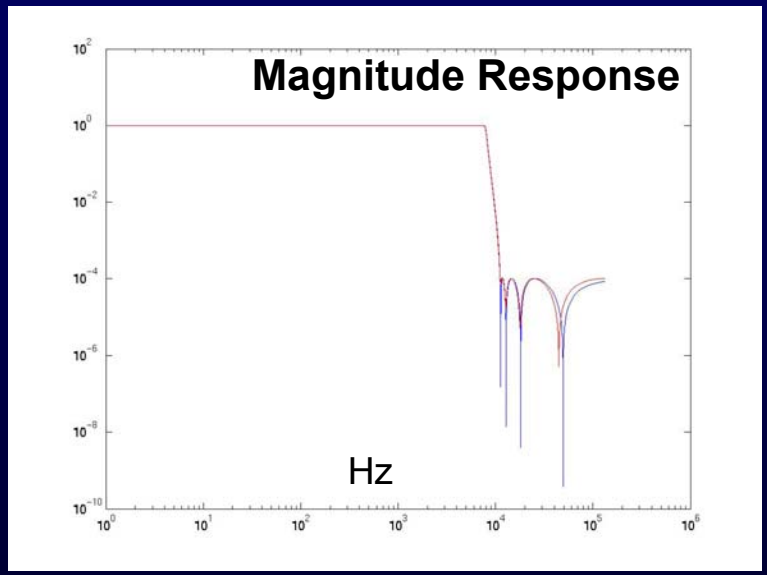
-Consists of a cavity pole at 84.8 Hz, an anti-aliasing 8th order elliptic filter at 7.5KHz, a pole at 100kHz and an electronics gain.

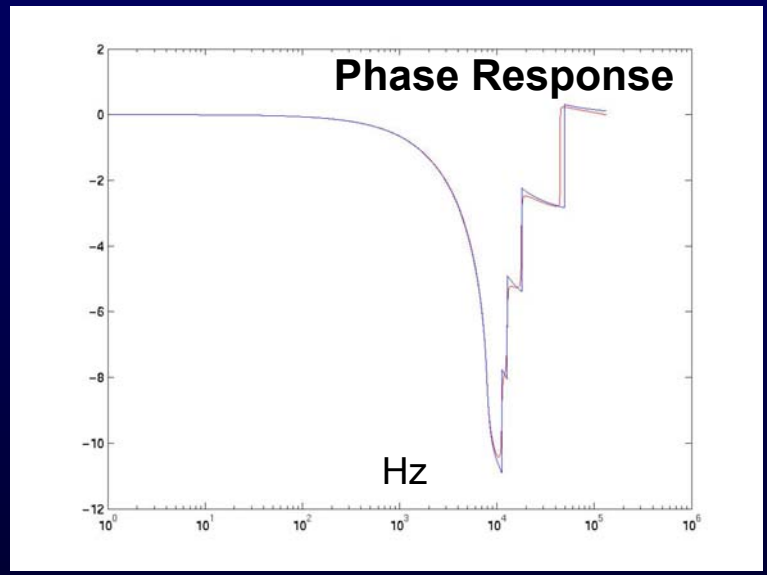
-Inverse of sensing function (a zero) is unstable: to stabilise it a pole is added at 100kHz, and up-sampled AS_Q is filtered through it

-Inverse of 8th order elliptic filter is tricky …
impulse response is no good:

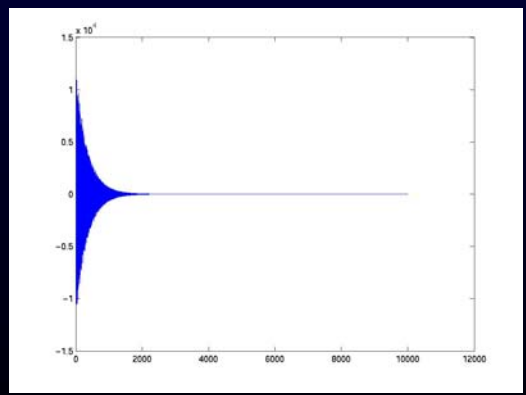


Needs some fixing:





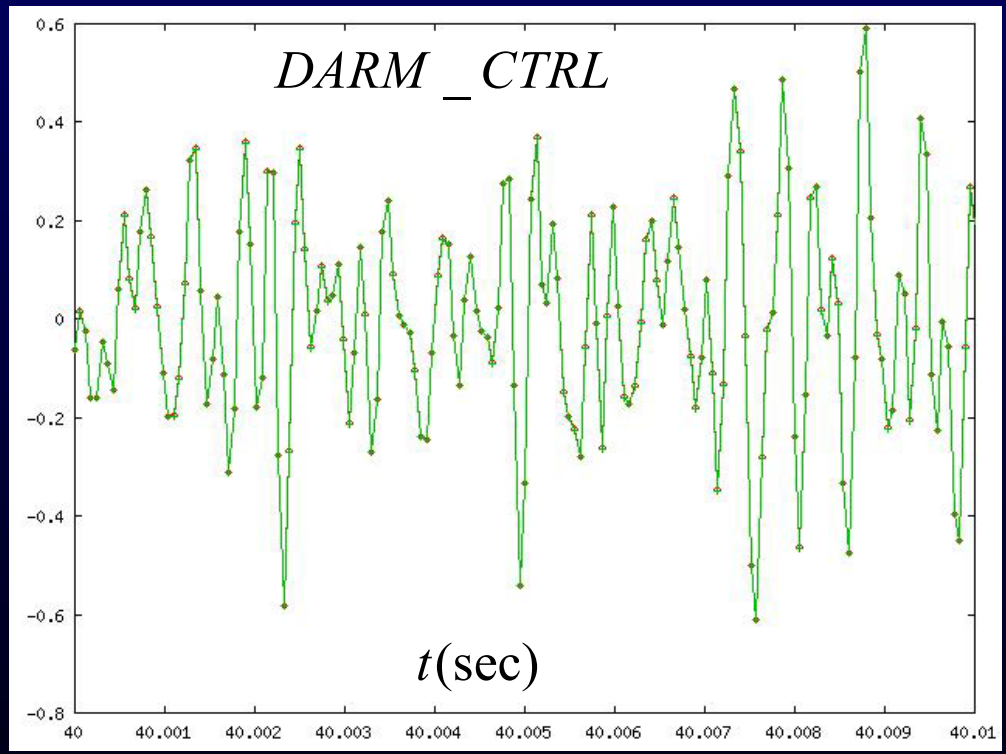
New impulse response:



-Servo

-Consists 11 2nd order digital filters

-Only had problems with the first filter: a double pole at 0Hz which we moved to 1.6Hz



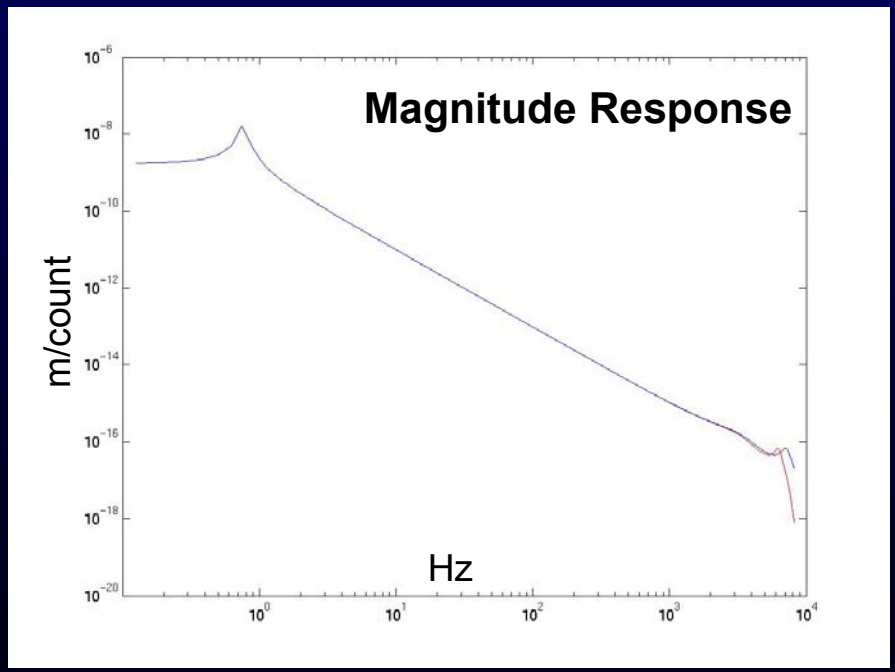
Green is frame DARM_CTRL

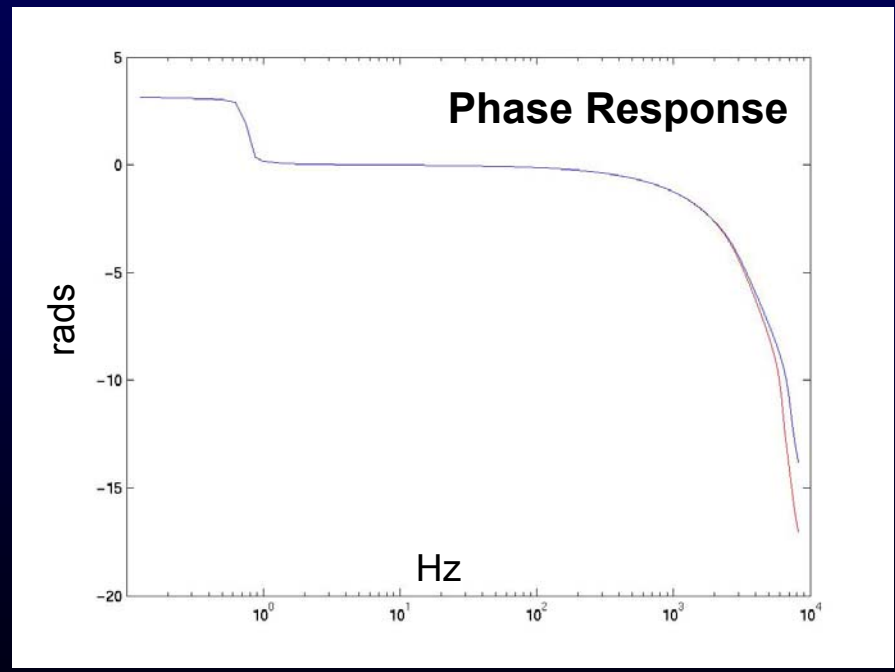
Red is AS_Q filtered through $\beta(t)\, G_0$

-Actuation

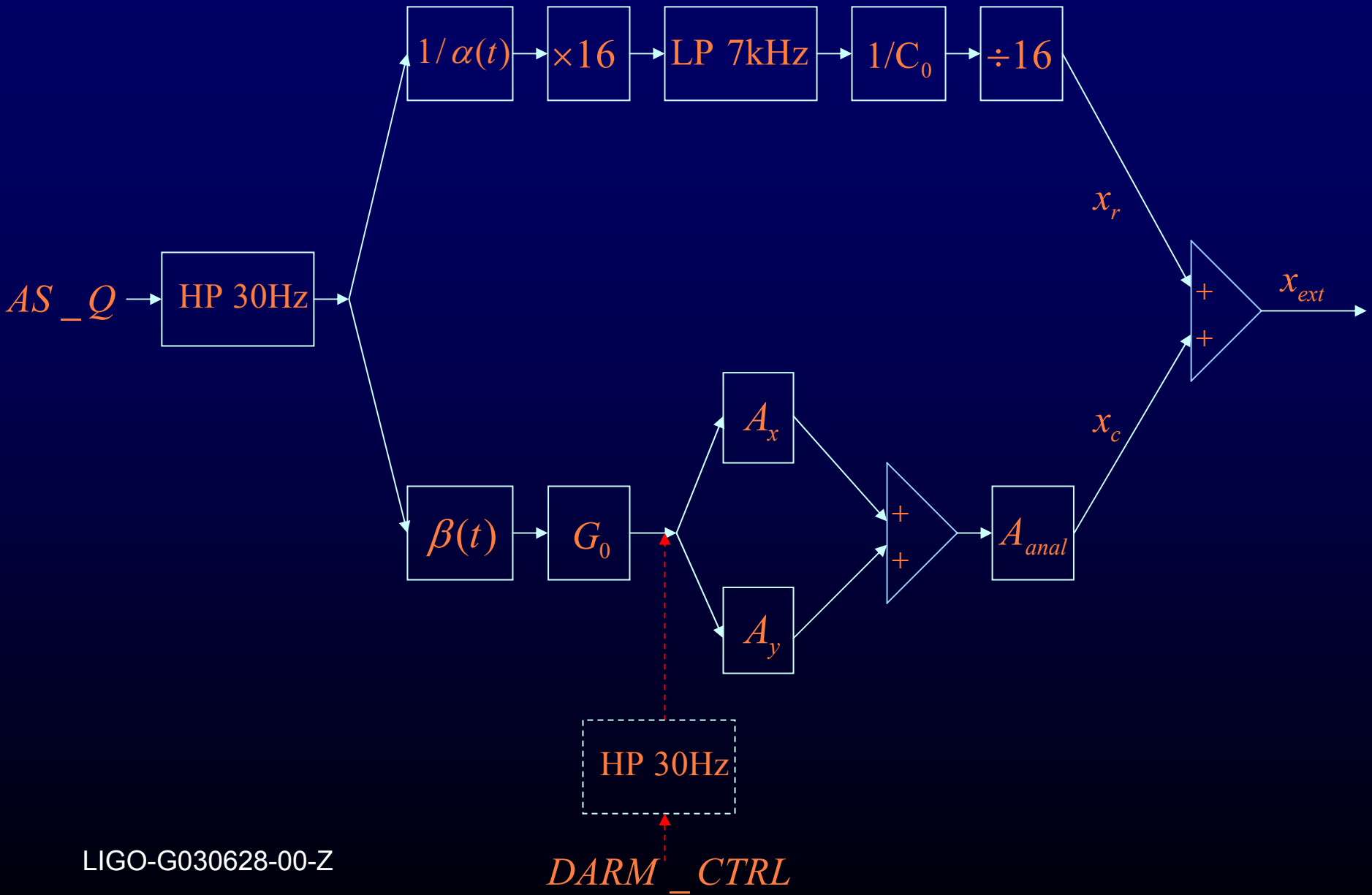
-Consists 13 2nd order digital filters (7 for x-arm, 6 for y-arm), pendulum transfer function, anti-imaging 4th order elliptic filter at 7.5kHz, time delay Pade filter and snubber

-The analog part of this filter was digitised using a bilinear transformation at 16384x2Hz (!)





Signal Processing Pipeline



Conclusions

-All elements of pipeline are in place but still need extensive testing and validation

-Would appreciate feedback (HP frequency? Accuracy?…)