Cal meeting

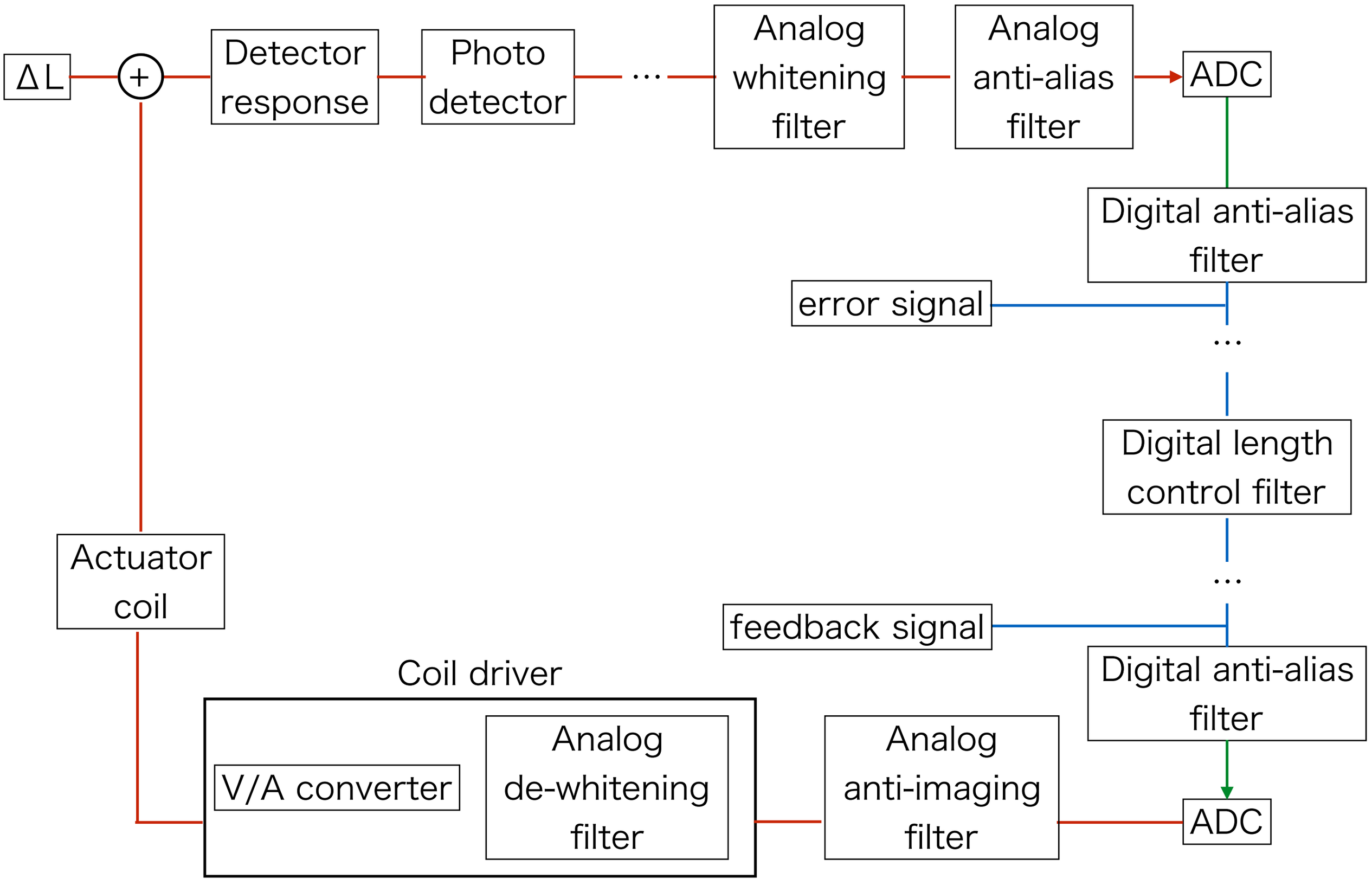
2017/07/31

Takaaki Yokozawa

Contents

- Analog circuit transfer function measurements around ADC/DAC
  - Whitening filter and High power coil driver
  - results, notice, todo
- Injection waveforms for CBC
  - Generate simulated waveform by LALInference
    - Types of waveforms(referenced by Narikawa-san’s slide)
- Injection waveforms for CW
  - makefakedata and Candidate parameters
- Writing Hardware injection memo(status)
- (I added the basic information for M1 students, please ask me if you have questions.)

(Reminder)Main MICH loop (bKAGRA phase 1)



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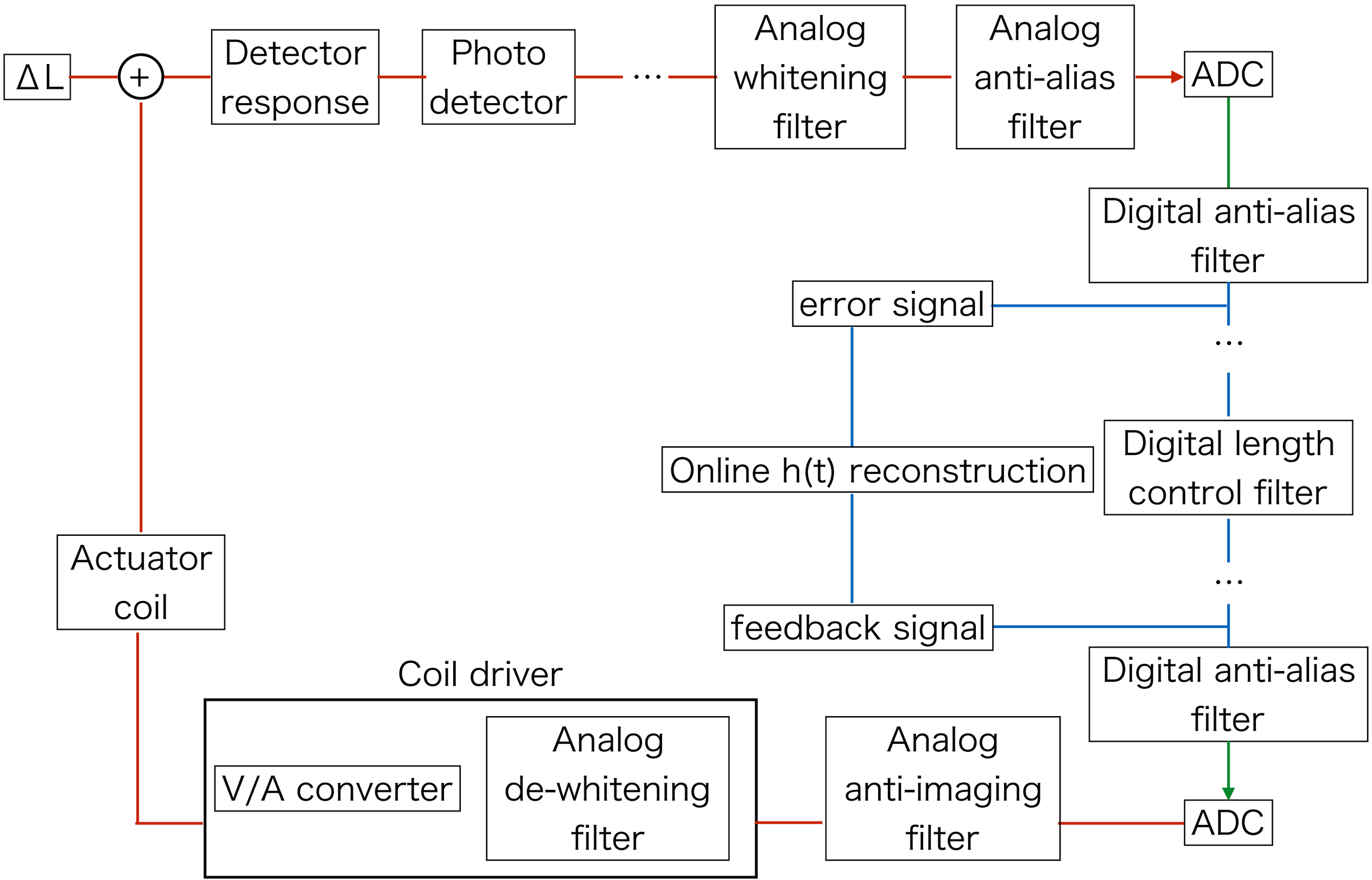

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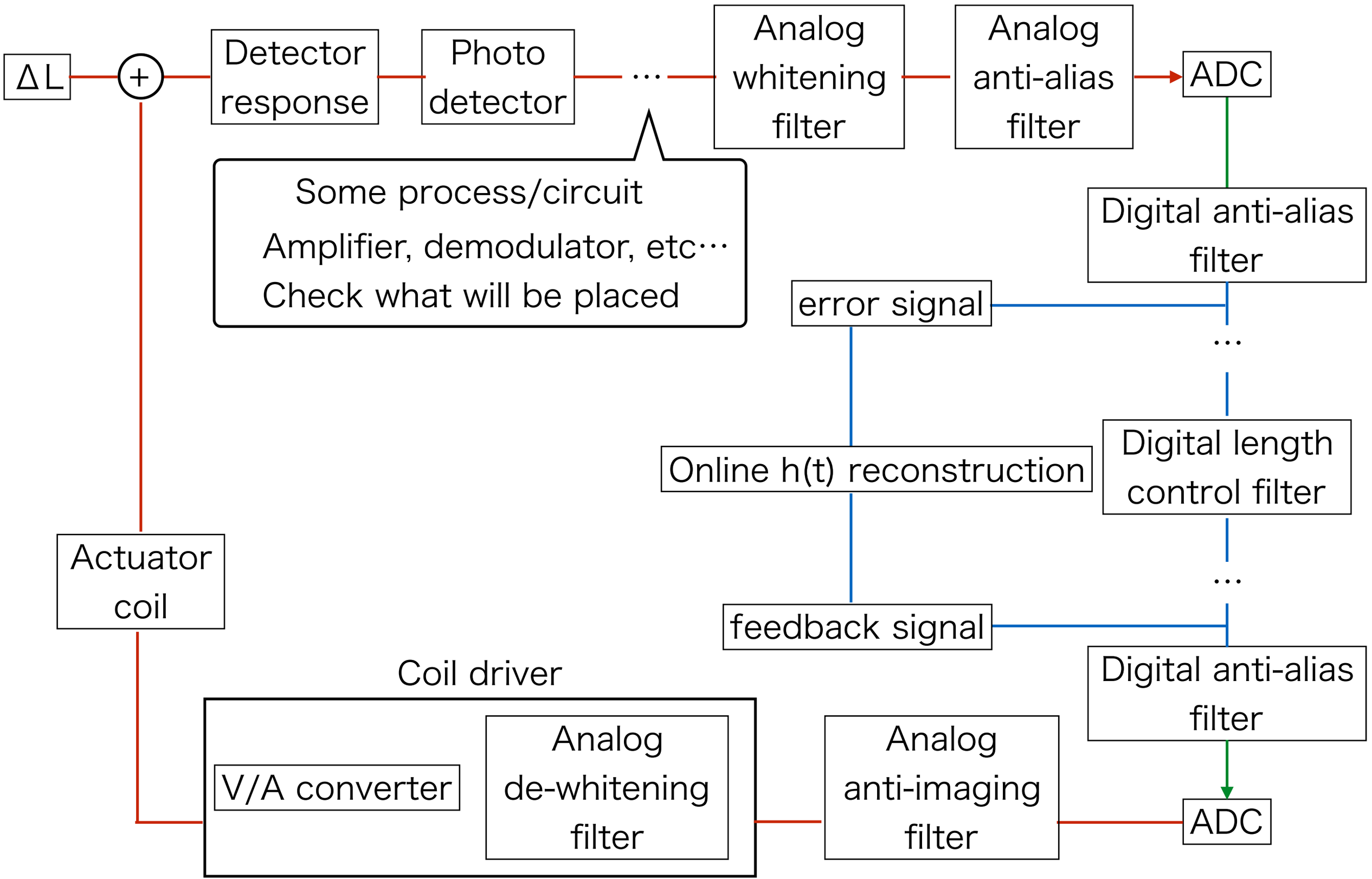

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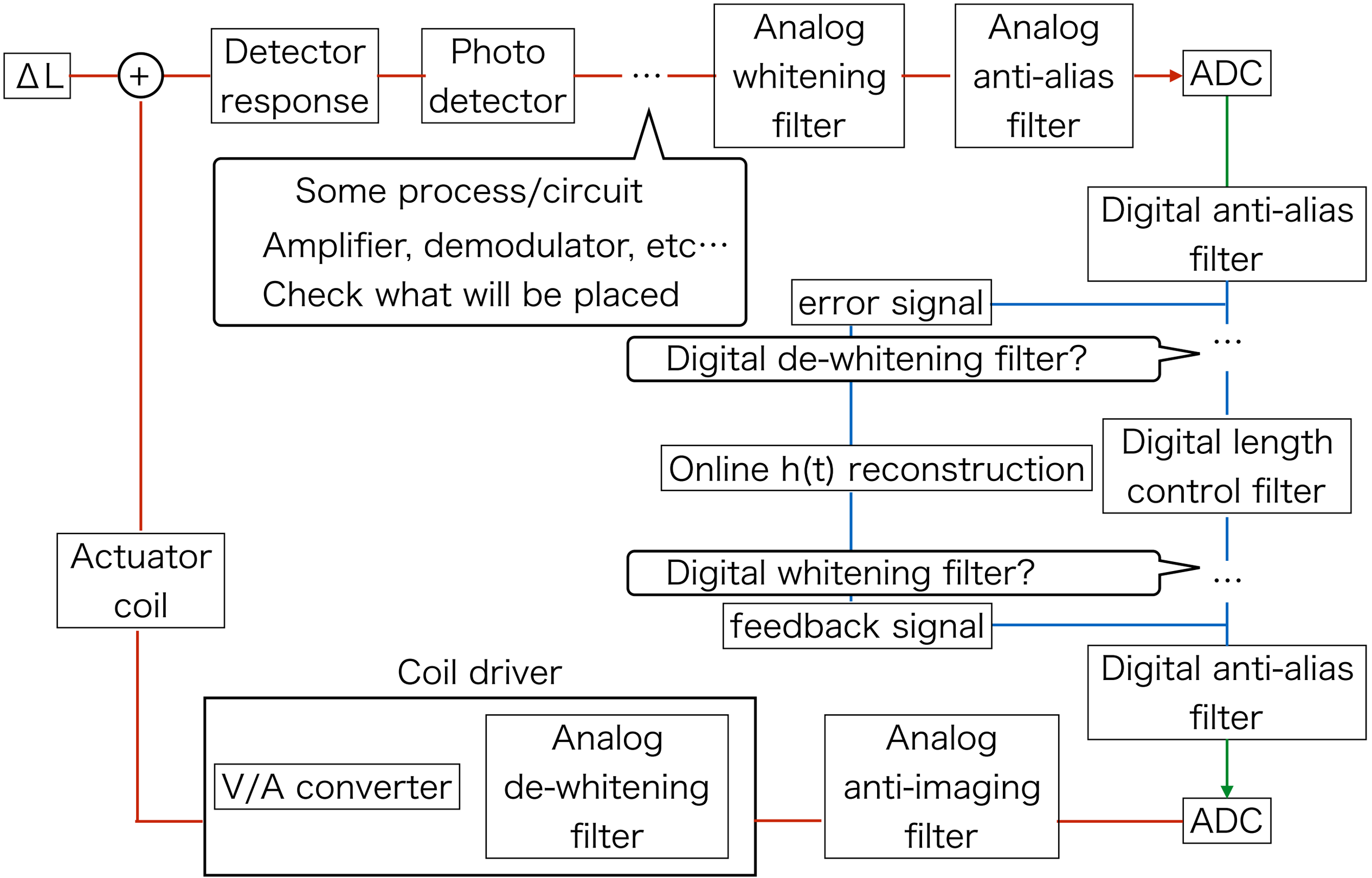

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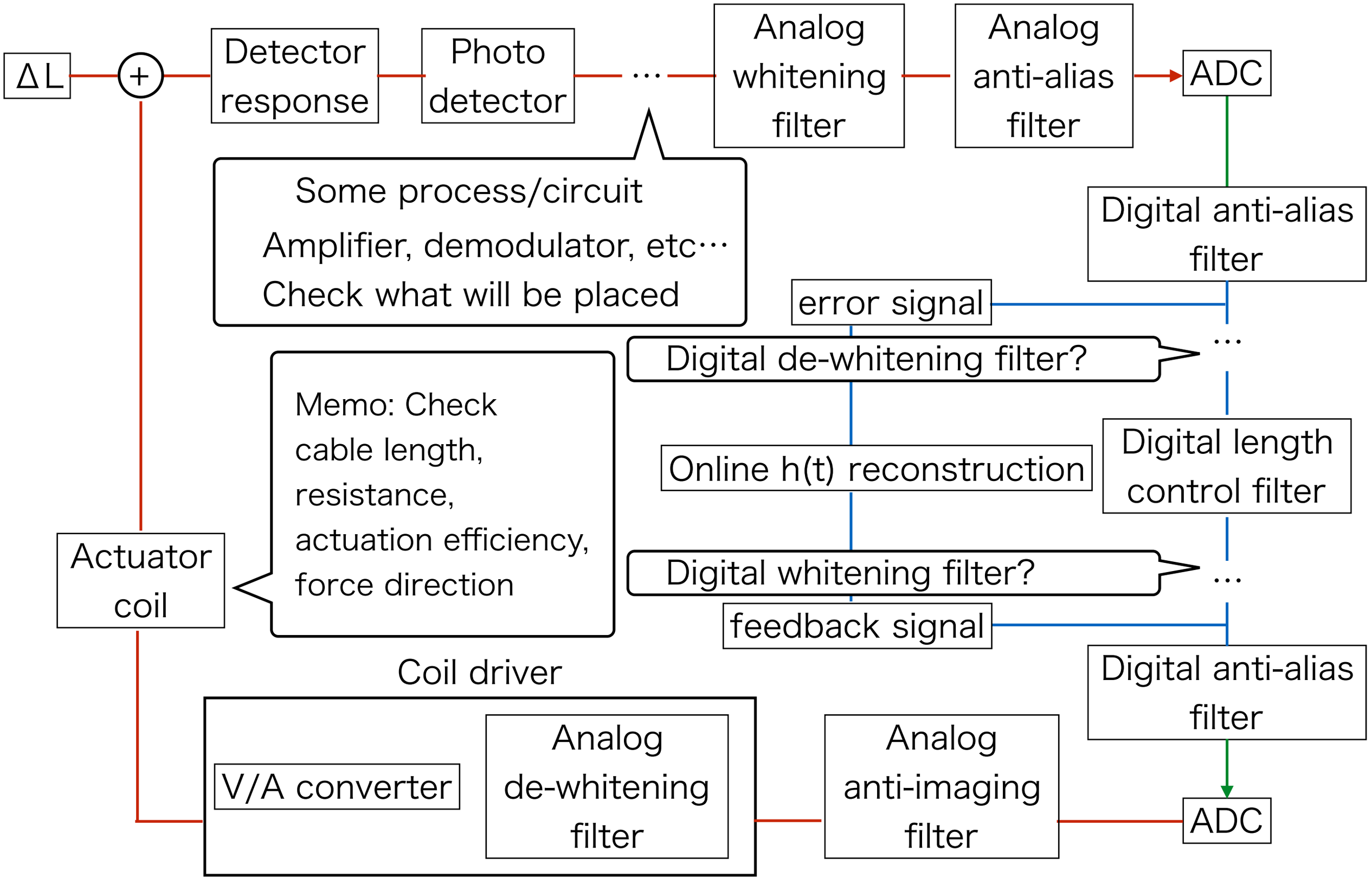
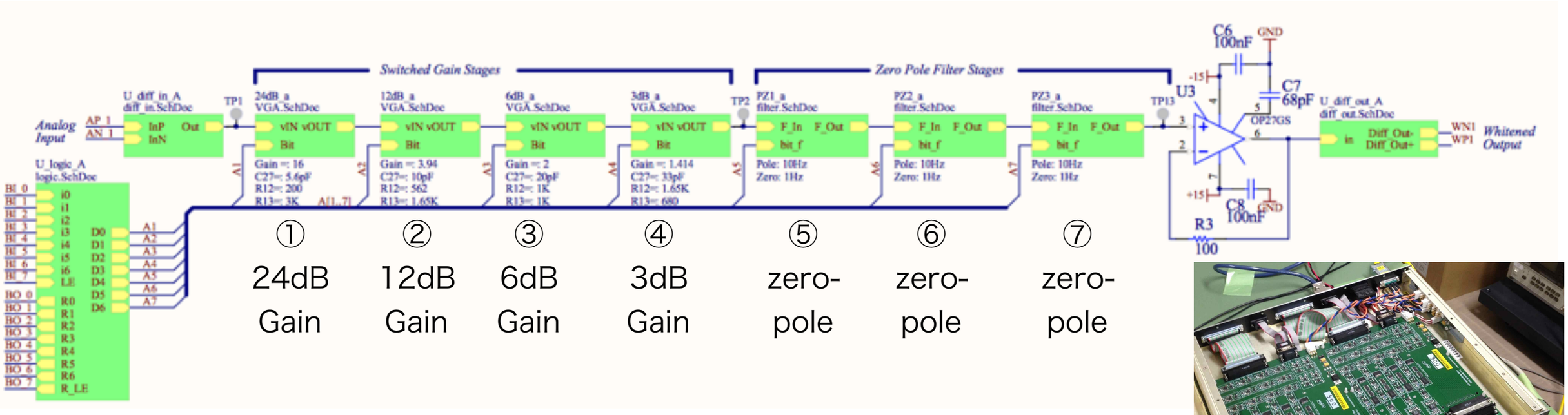
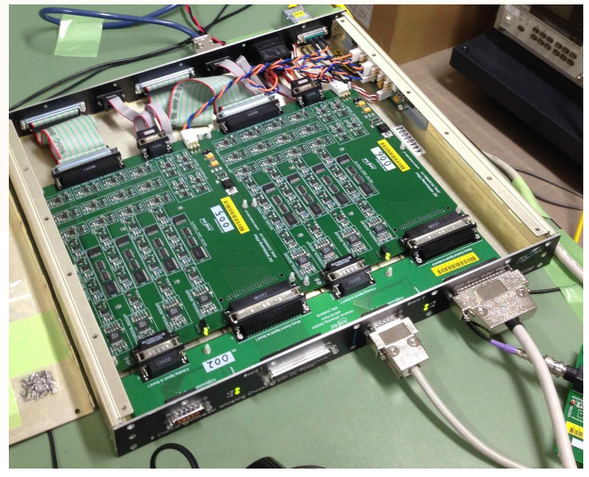


Analog Whitening filter TF measurement



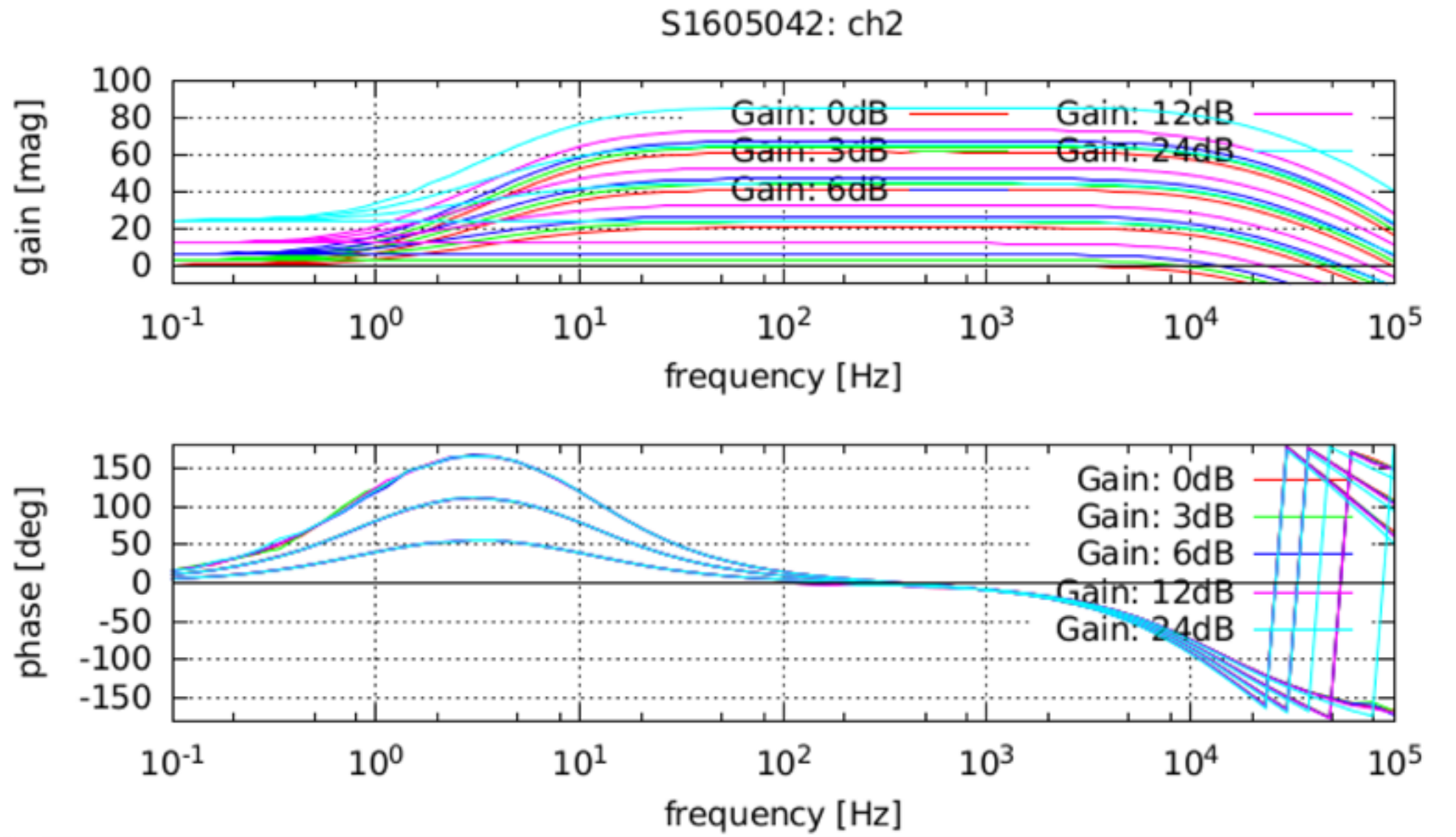


One example of measurement : S1605042, CH1

Configuration ; Gain=[0, 3, 6, 12, 24]dB, zero-pole filter=[0, 1, 2, 3]

Special thanks to Shimode-san

Analog Whitening filter TF measurement



One example of measurement : S1605042, CH1

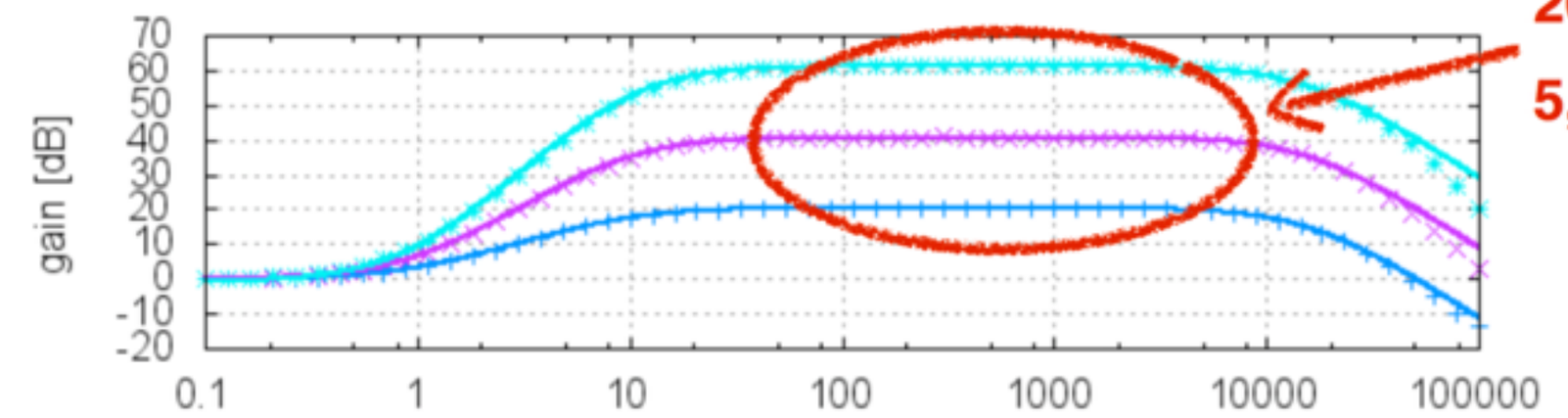
Configuration ; Gain=[0, 3, 6, 12, 24]dB, zero-pole filter=[0, 1, 2, 3]

Special thanks to Shimode-san

Already checked by Yamamoto-san, but…

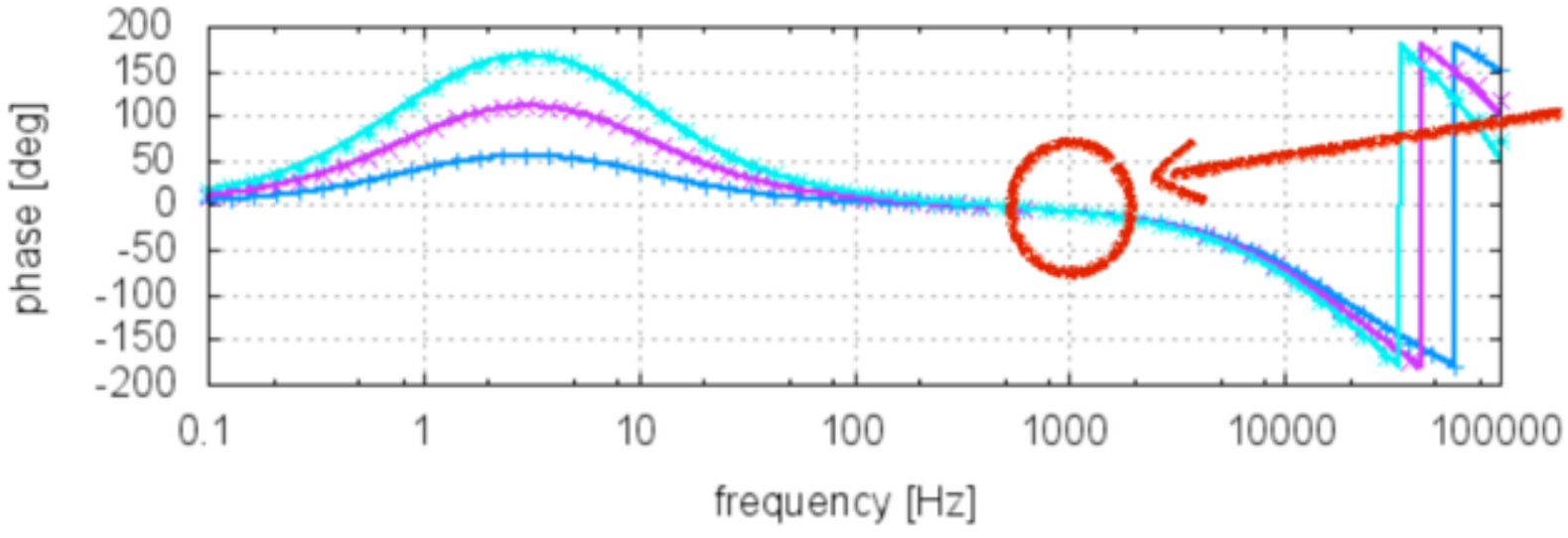
Whitening/anti-Whitening (W/aW)

f Hz		zero/pole	order
1	**0.93**	single zero	1〜3
10	**9.7**	single pole	
14k	**16.4k**	single pole	2 (fixed)
-		gain	0,3,6,12,24dB



20, 40, 60dBから

5, 10, 15%異なる

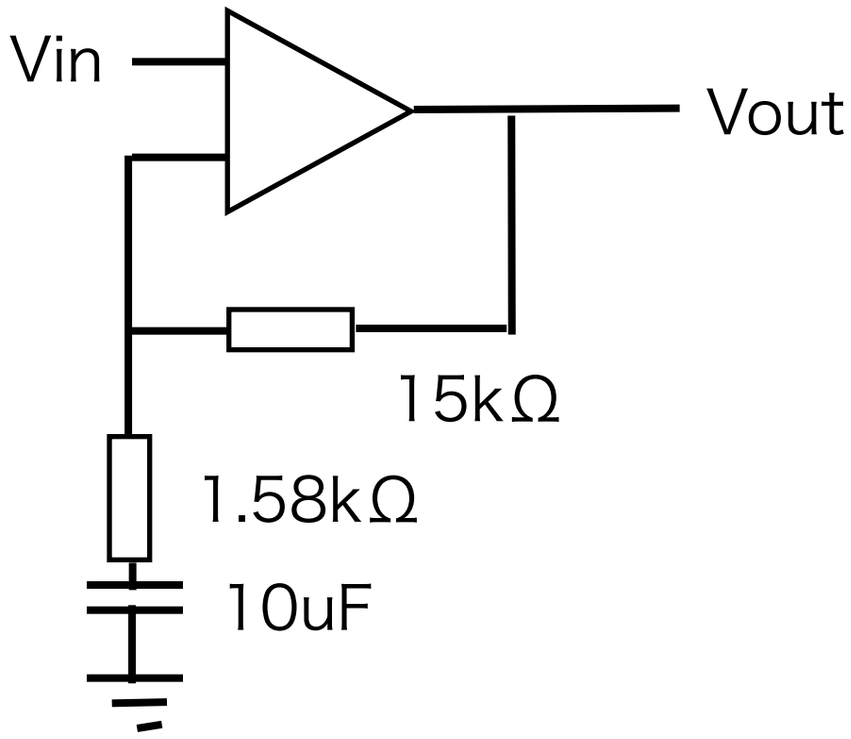


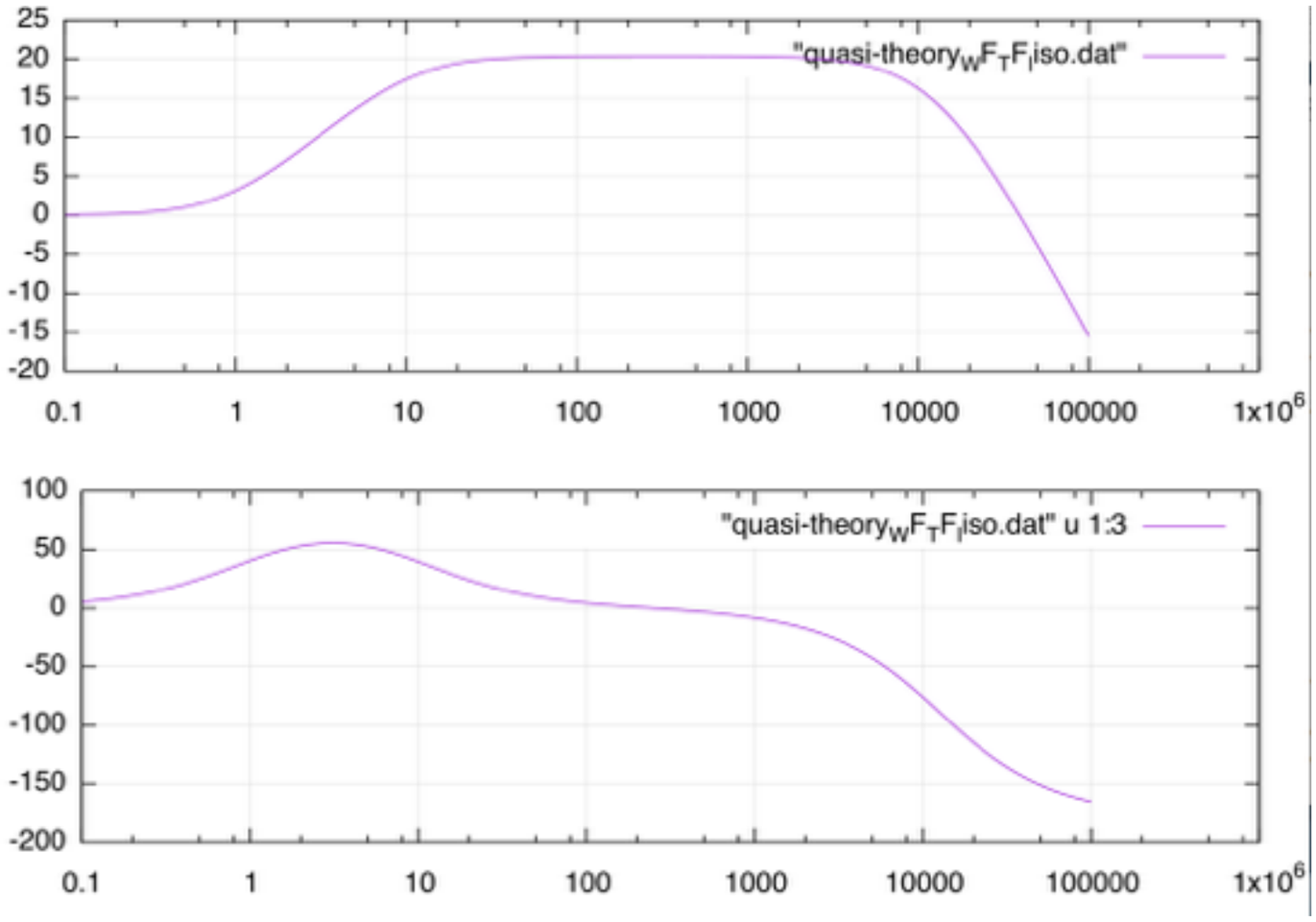
交わる点が

0 deg. でない

横澤さん、霜出さん測定

Analog Whitening filter TF measurement



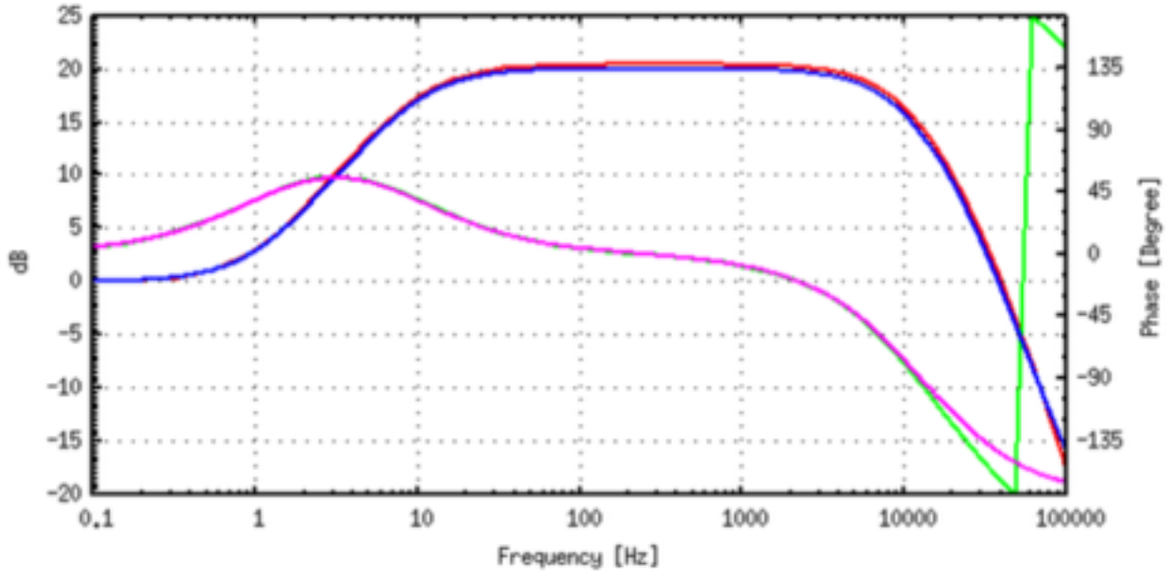


There were widely known that zero and pole frequency were 1 and 10 Hz respectively, but accurate frequency from circuit were

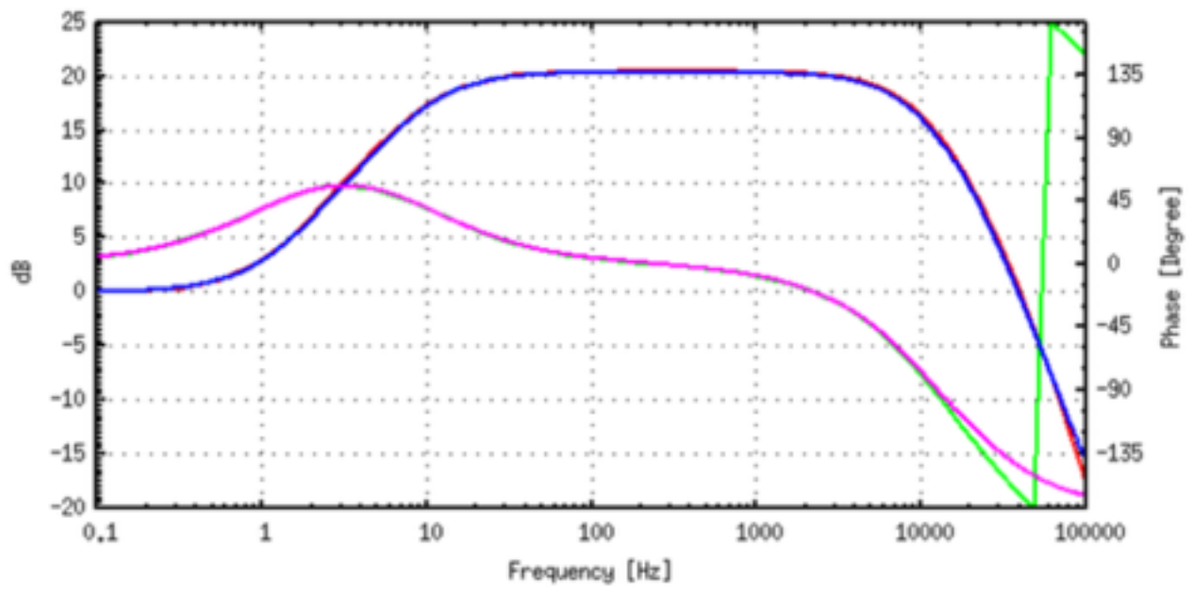
zero : 0.9599212[Hz]

pole : 10.073098[Hz]

Analog Whitening filter TF measurement



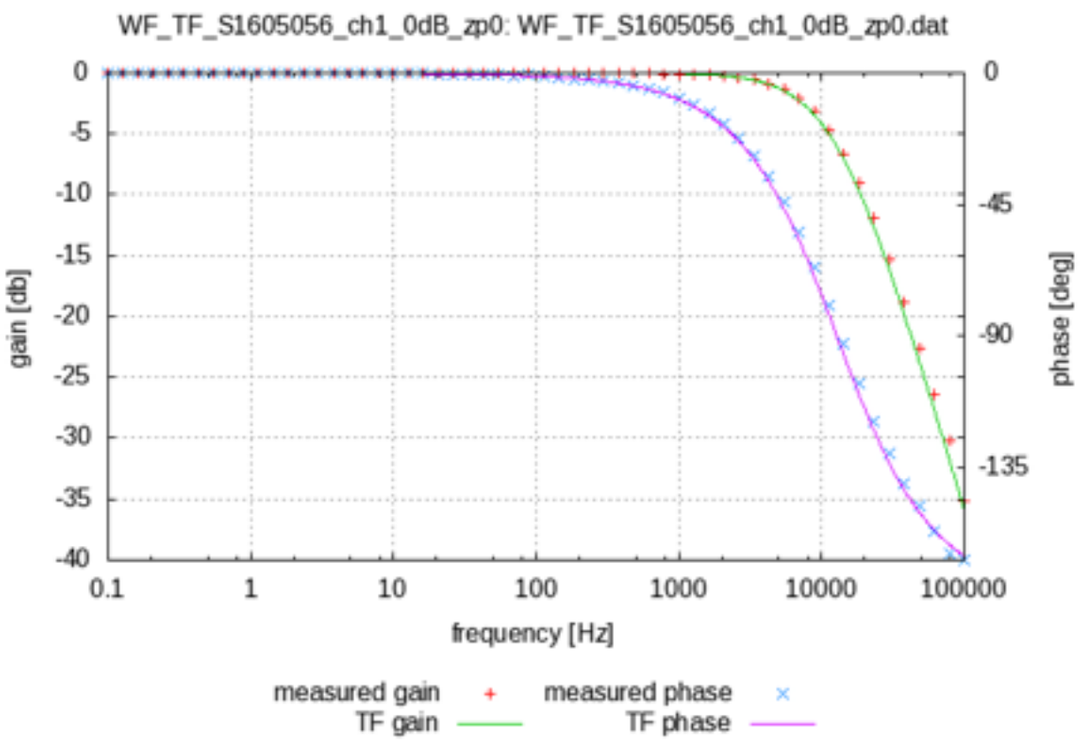
1, 10Hz zero-pole frequency

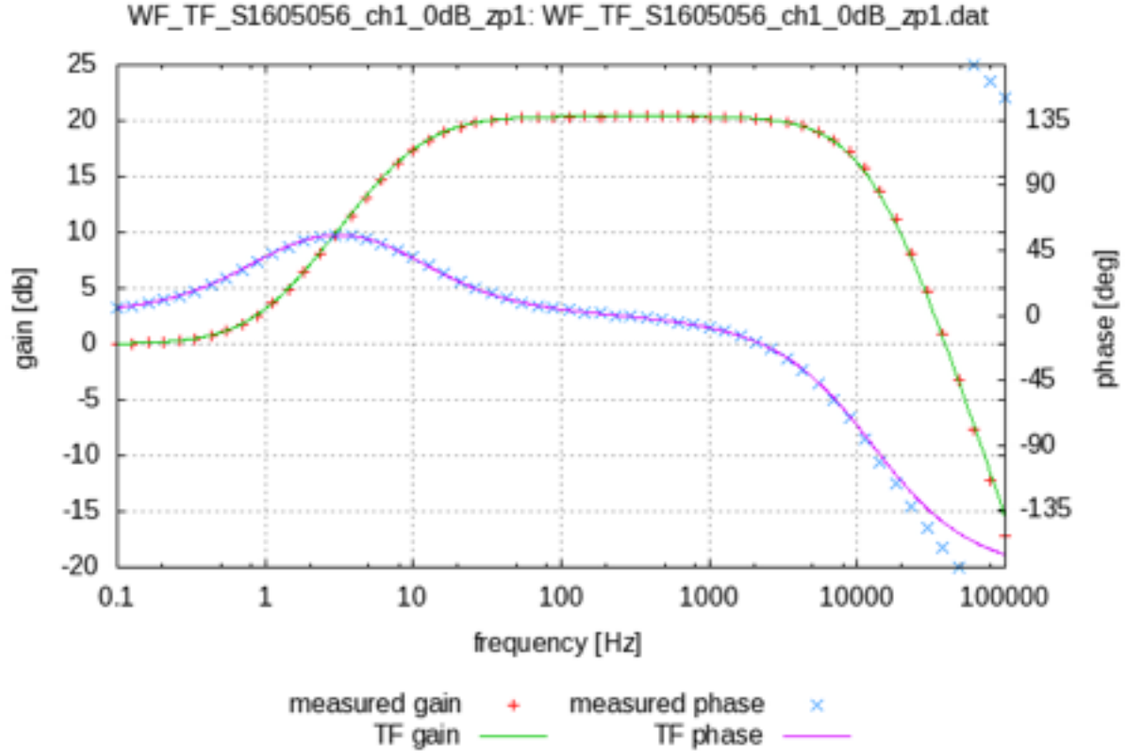


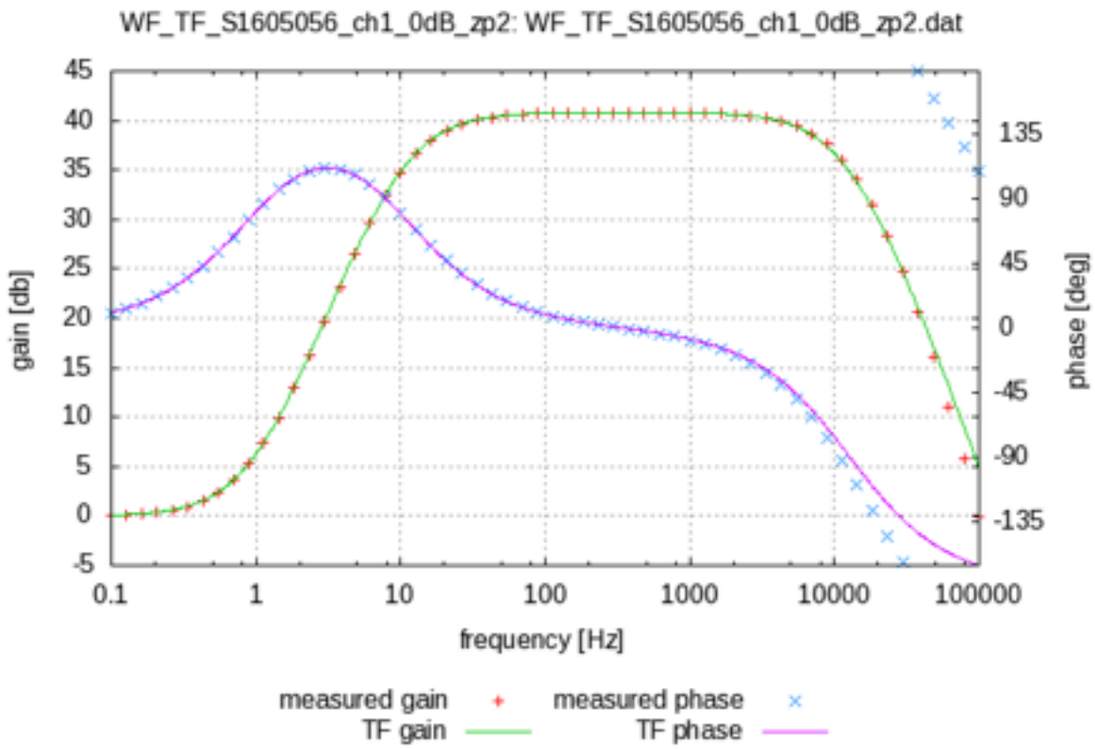
correct zero-pole frequency

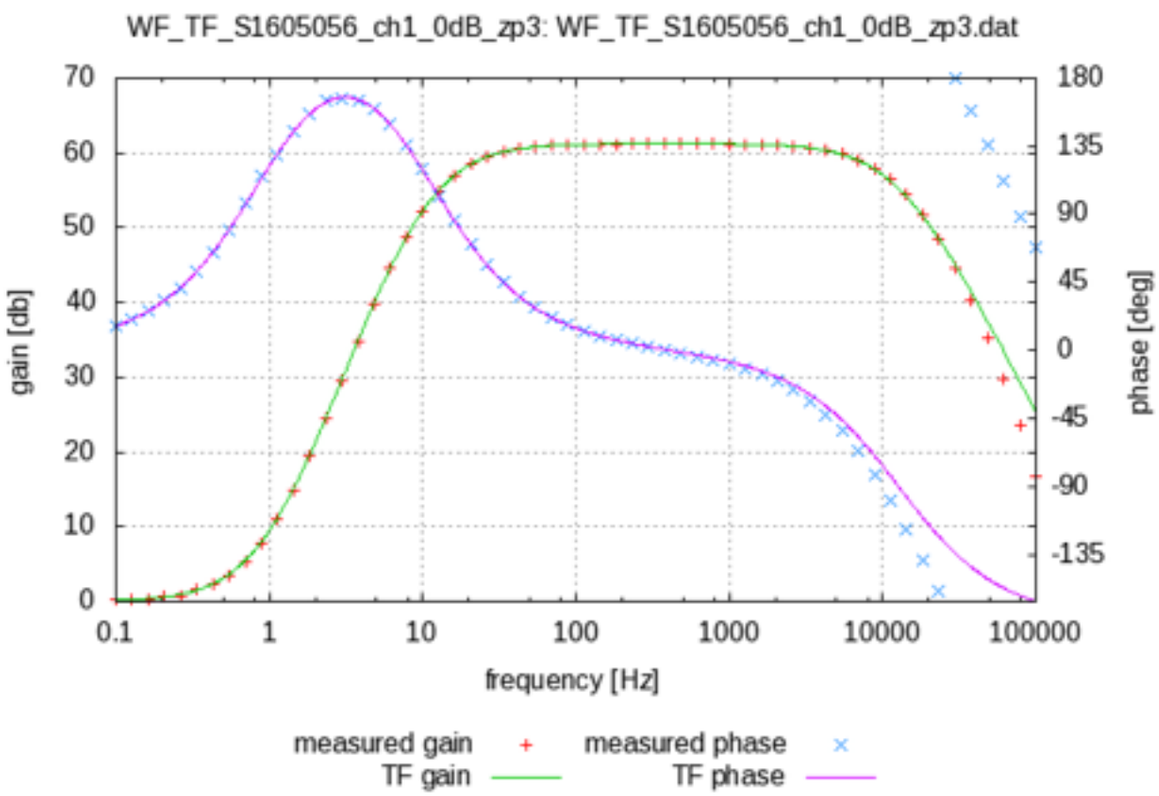
The discrepancy over 100Hz was cleared
(previously reported by Yamamoto-san)
But, it will be quite difficult to obtain theoretical value over 1,000Hz, we need to re-measure after installing to rack and make corresponding time domain filter for analog-whitening filter.

Analog Whitening filter TF measurement

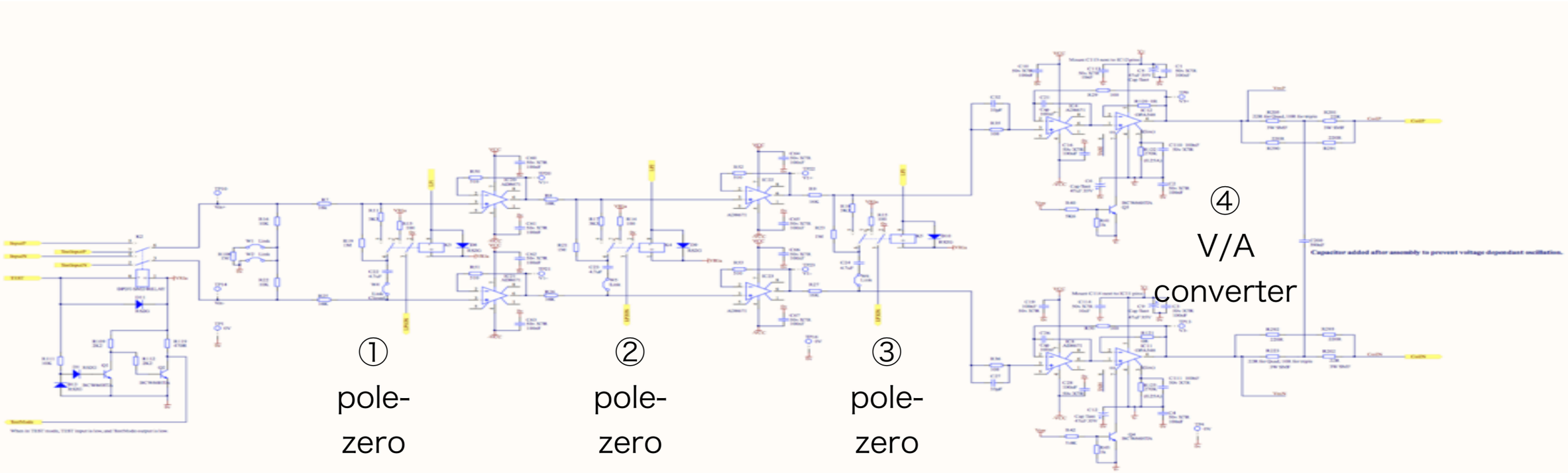






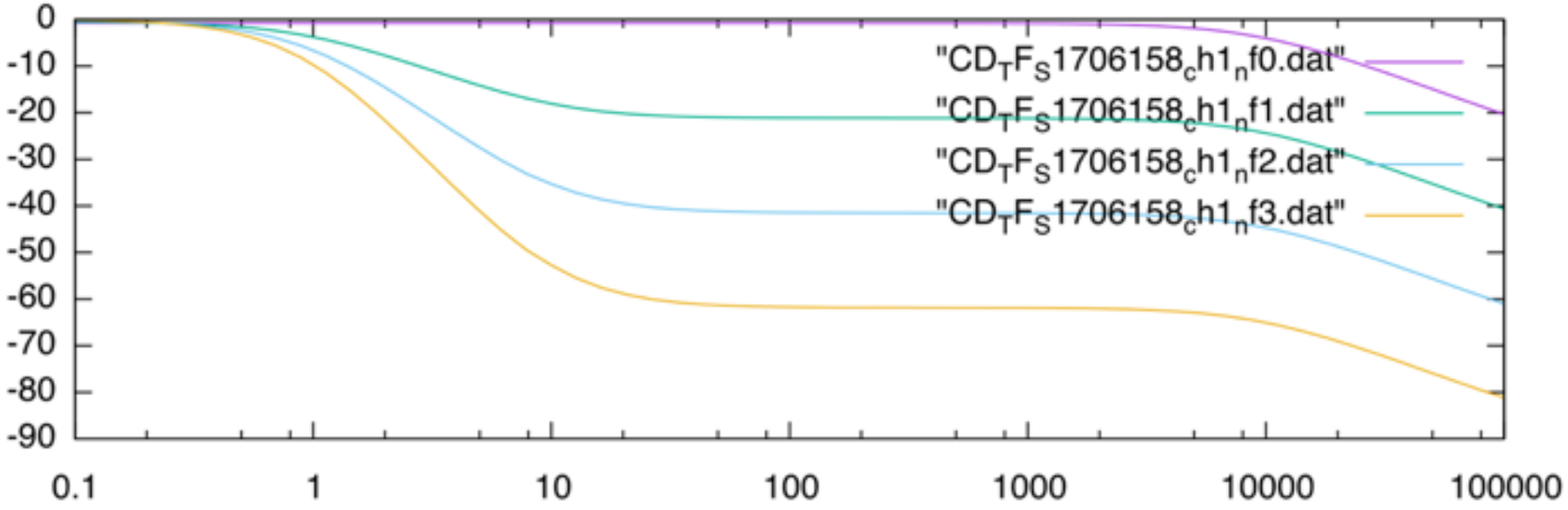


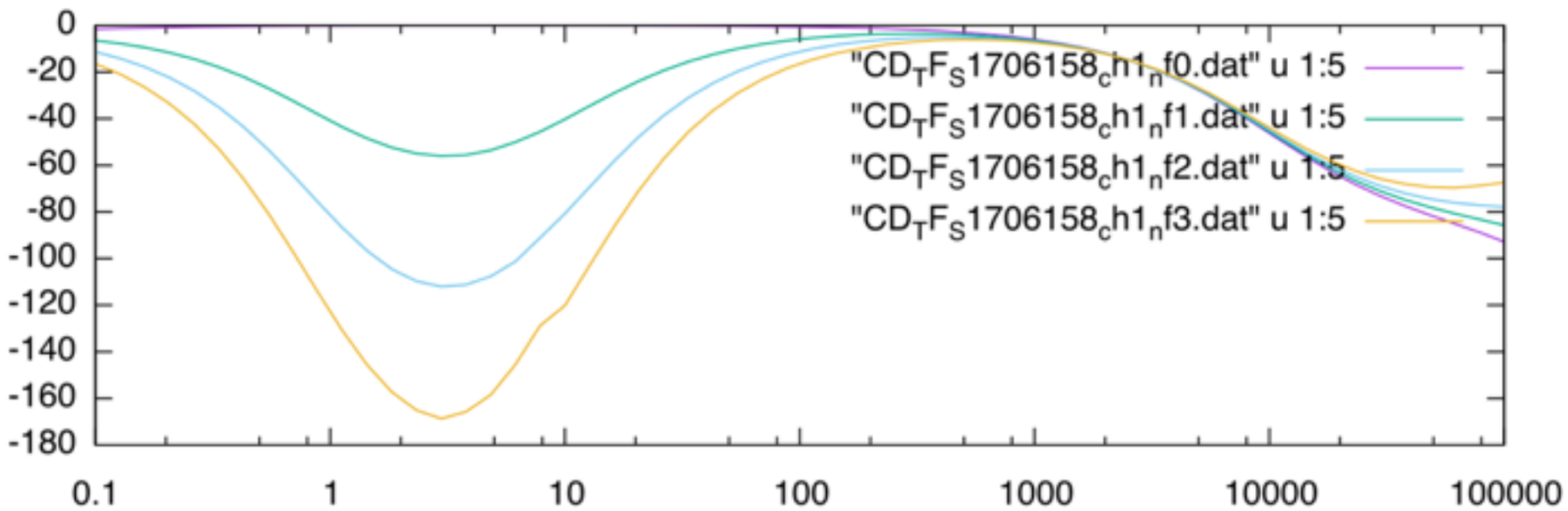
Analog coil driver TF measurement



One example of measurement : S1706158 CH1
(Check the performance of de-whitening part)

Analog coil driver TF measurement





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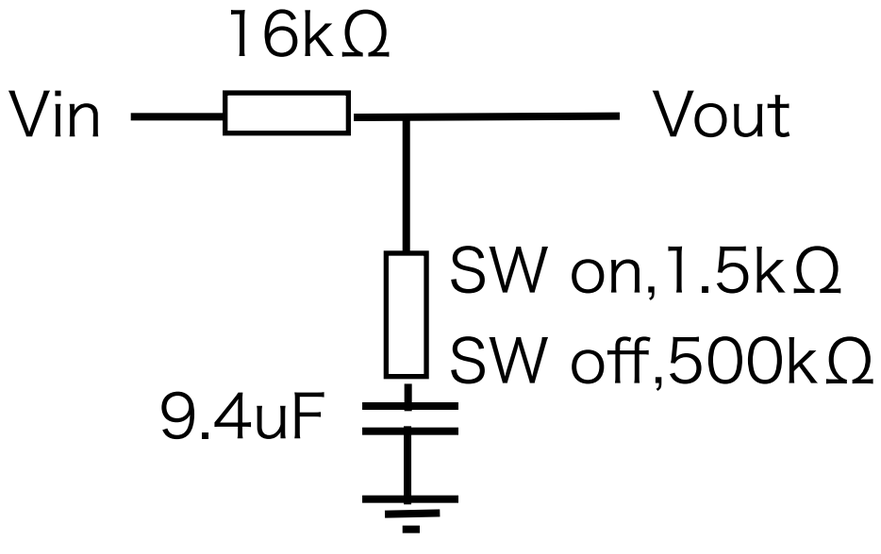
Analog coil driver TF measurement



Gain(f) for each part (SW : switch of pole-zero)

low freq. : ∞/(16k+∞) =1

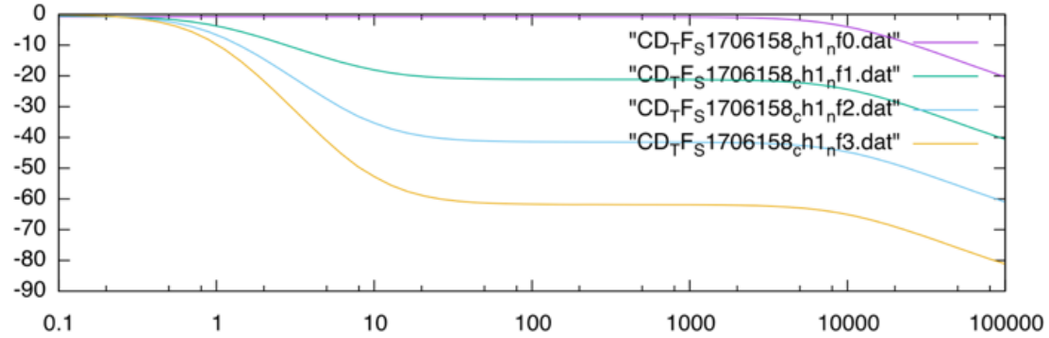
high freq. : SW off 500k/(16k+500k)=0.969

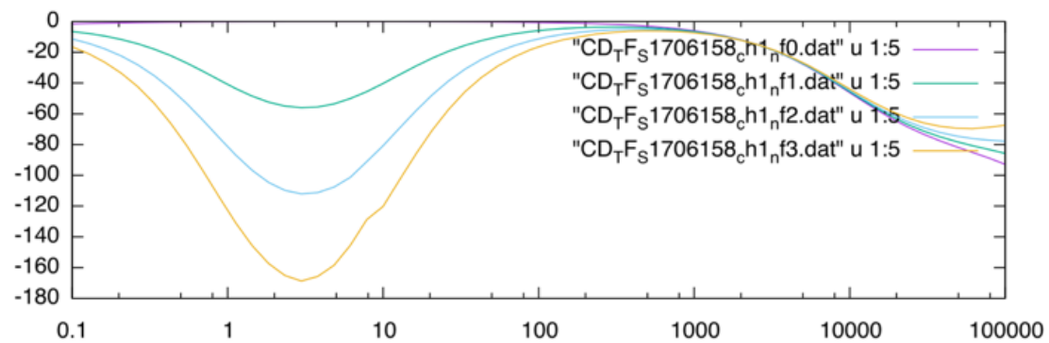
SW on 1.5k/(16k+1.5k)=0.0857

From the circuit,

pole : $1/2\pi fc + 1.5k = 16k$: f=1.17[Hz]

zero : f=1/1.5k*1/2π*1/c =11.28[Hz]





But apply tuning by my eye;

SW off : gain=0.969, no freq. dep.

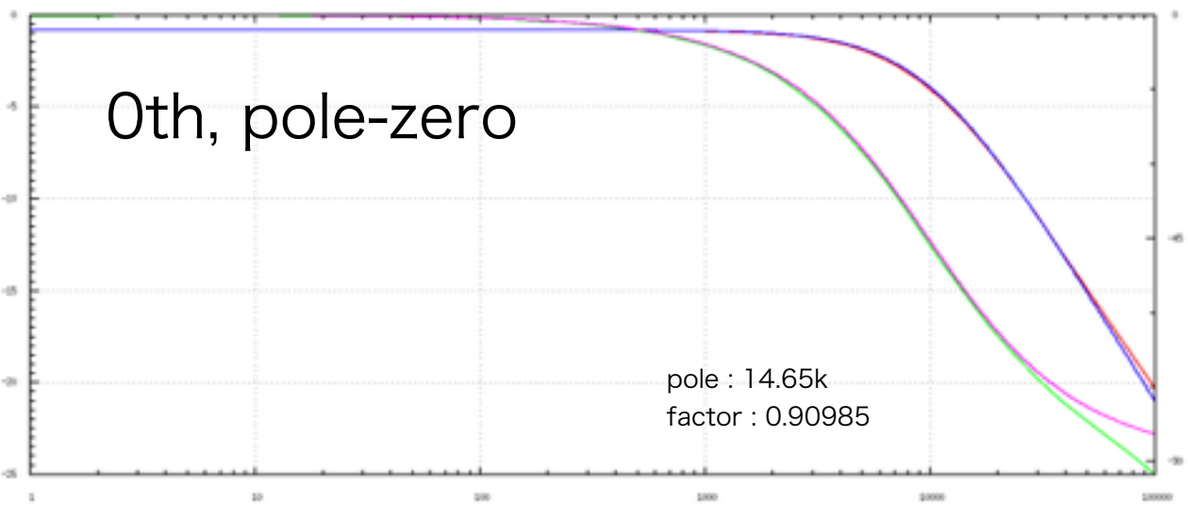
SW on : pole : 0.961[Hz]

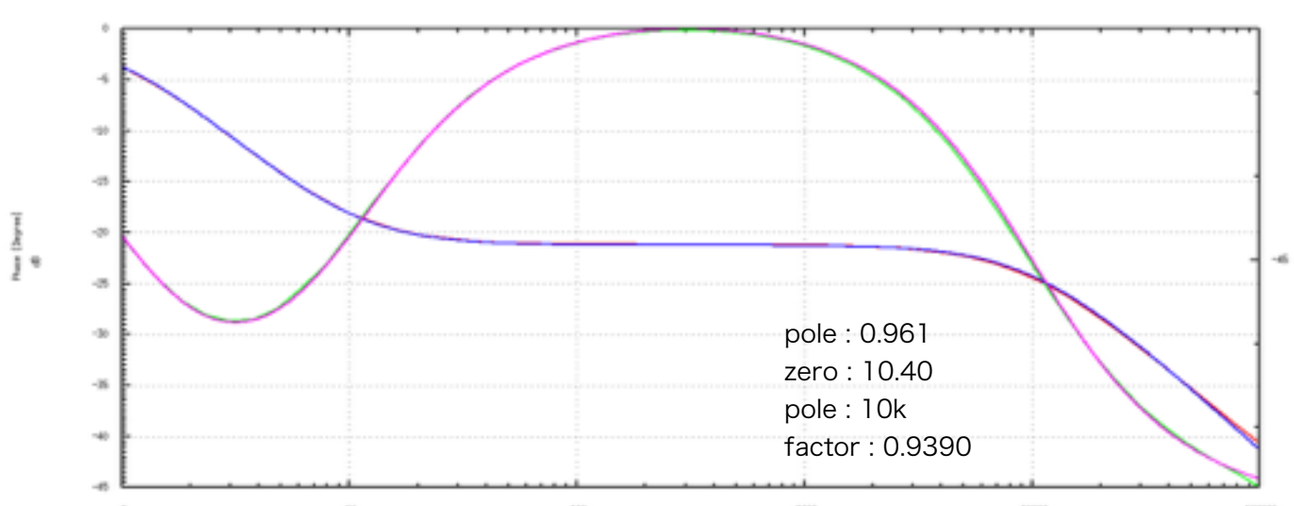
zero : 10.40 [Hz]

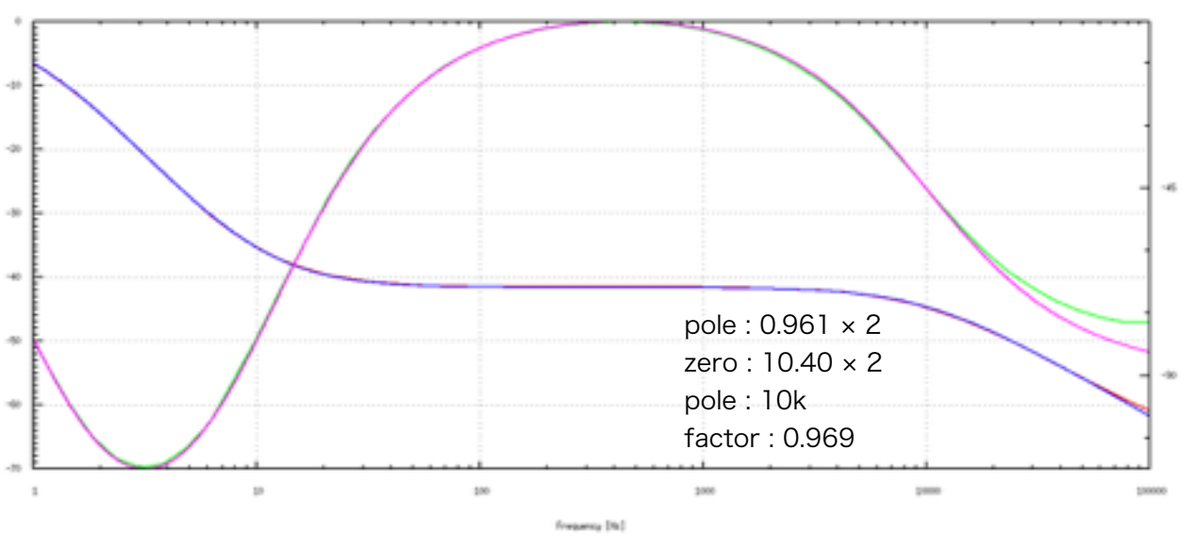
Those values are suitable.

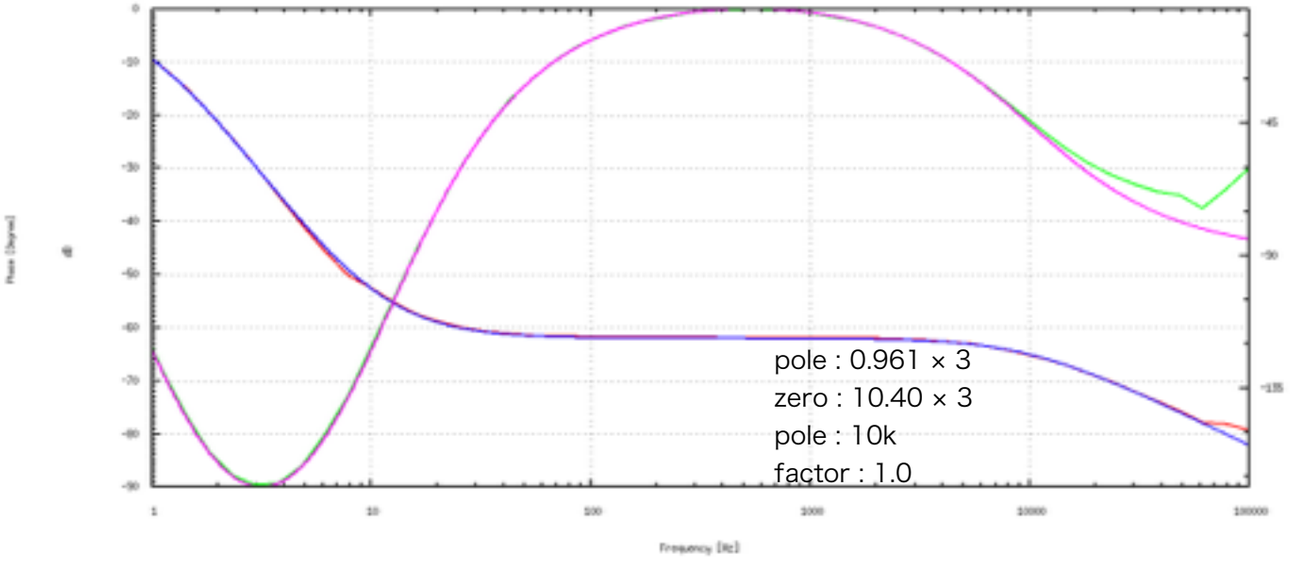
For higher frequency, the shape depends on coil resistance, need re-measurement after installing to rack.

Analog coil driver TF measurement







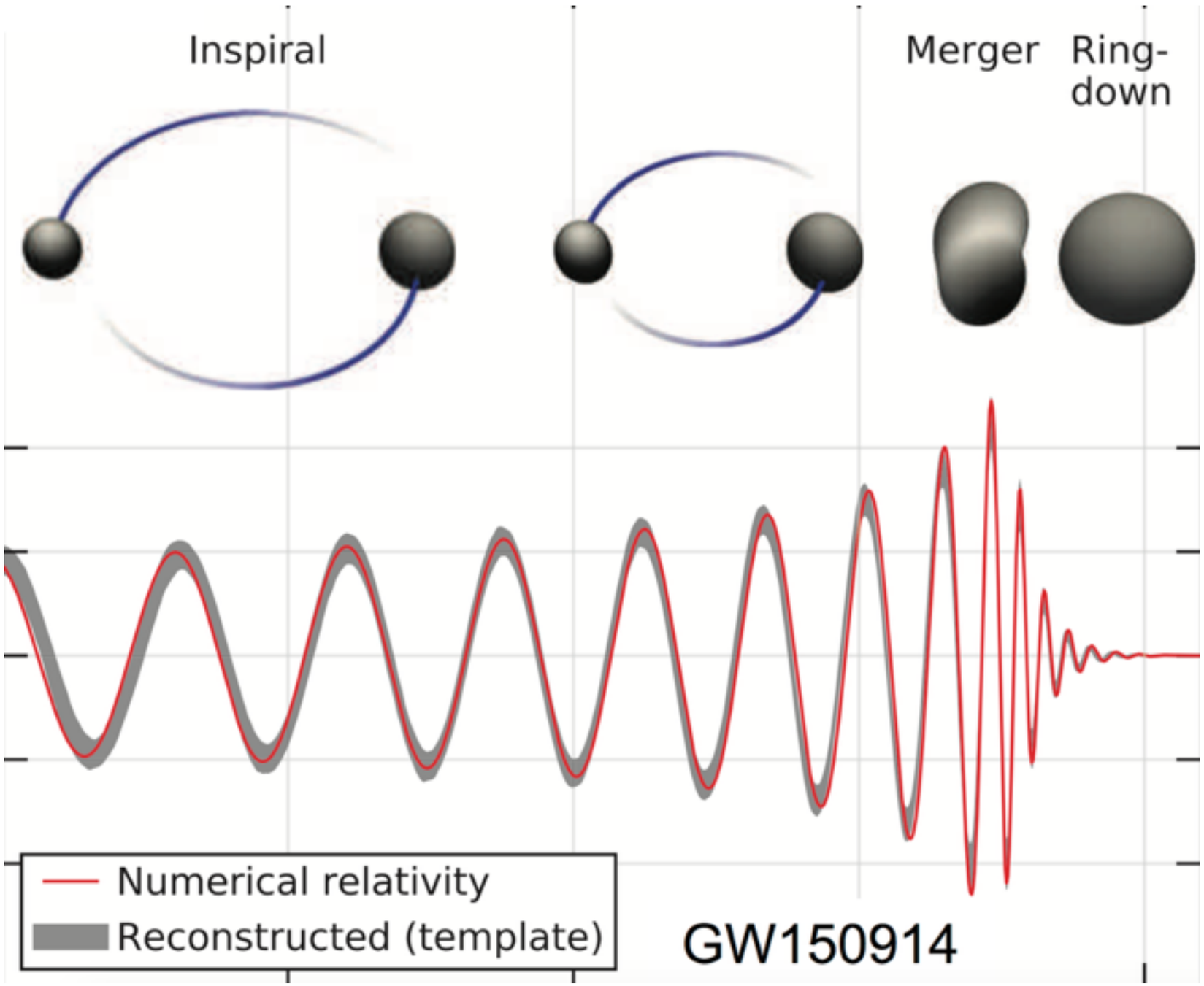


- measured gain [dB] - fitting gain [dB]
- measured phase [deg.] - fitting phase [deg.]

pole : 0.961[Hz] , zero : 10.40 [Hz] seems good agreement.(uploaded in JGWDoc)

For higher frequency, the shape depends on coil resistance, need re-measurement after installing to rack.

Injection waveform for CBC



- Inspiral
post-Neutonian approximation
(v/c<<1)
- merger/ringdown
numerical simulation/ringdown

- non-spinning waveform

$$h(t; r, m_1, m_2, t_c, \phi_c, \theta, \phi, \psi, \iota)$$

r： 距離
m_1, m_2： 質量
t_c： 合体時刻
ϕ_c： 合体時の位相
θ, ϕ： 到来方向
ψ： 偏極角
ι： 軌道傾斜角

+ spin parameter

(basic but important knowledges will be written in HWI memo)

GenerateSimulation

Code : LALInference

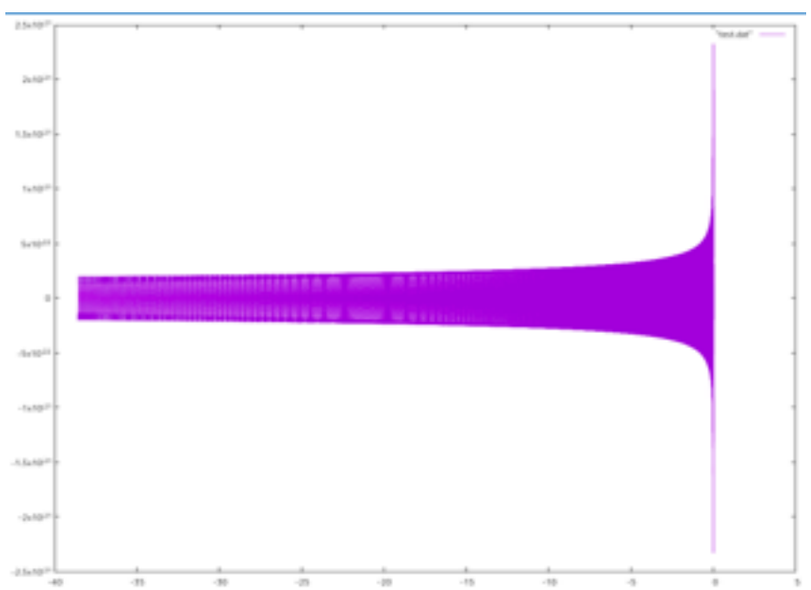
(Special thanks especially Yuzurihara-san)
This code was also used in iKAGRA hardware injection.
This will be used for BH-BH merger waveform.
(It will difficult to inject NS-NS binaries and their waveforms should be generated by numerical simulations)

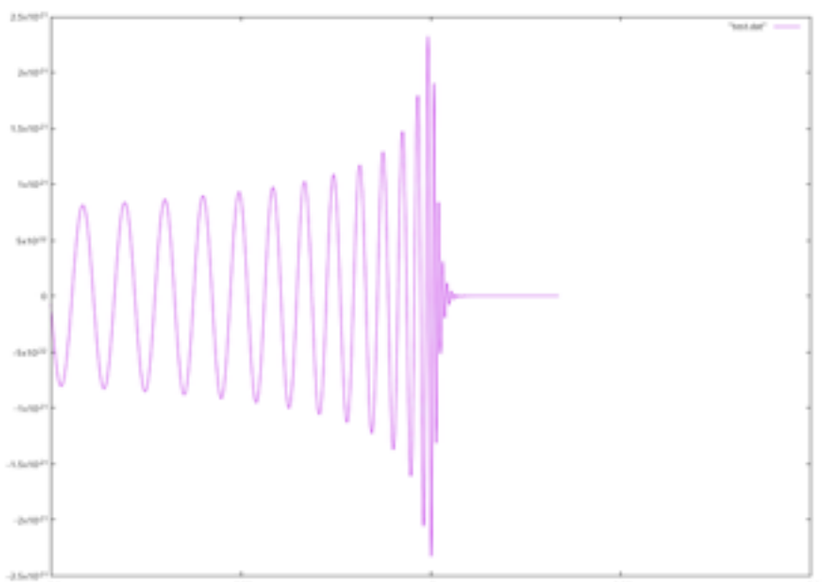
Both time domain(TD) and frequency domain. (time, h_+, h_× for TD)

Waveform type (TD);
TaylorT1, TaylorT2, TaylorT3, TaylorT4, TaylorEt
EccentricTD
IMRPhenomA, IMRPhenomB, IMRPhenomC, IMRPhenomD
EOBNRv2
SEOBNRv1, SEOBNRv2, SEOBNRv3
SpinTaylorT4, SpenTaylorT2
…
OCU student is summarizing the waveform information(for other study)

GenerateSimulation

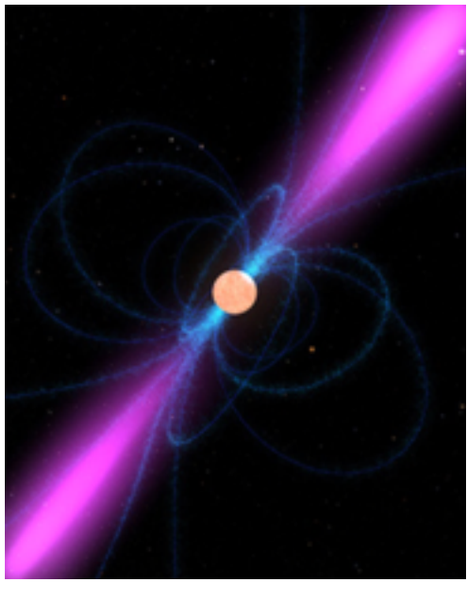
- Parameters(BH-BH merger, mains)
  - mass and spin of two objects
  - Post-Neutonian order
  - sampling frequency
  - distance, inclination angle
  - minimum frequency and maximum frequency





- SEOBNRv1
  -3.5PN
- 10-10 M
- 100Mpc
- no spin
- >10Hz

injection of continuous wave



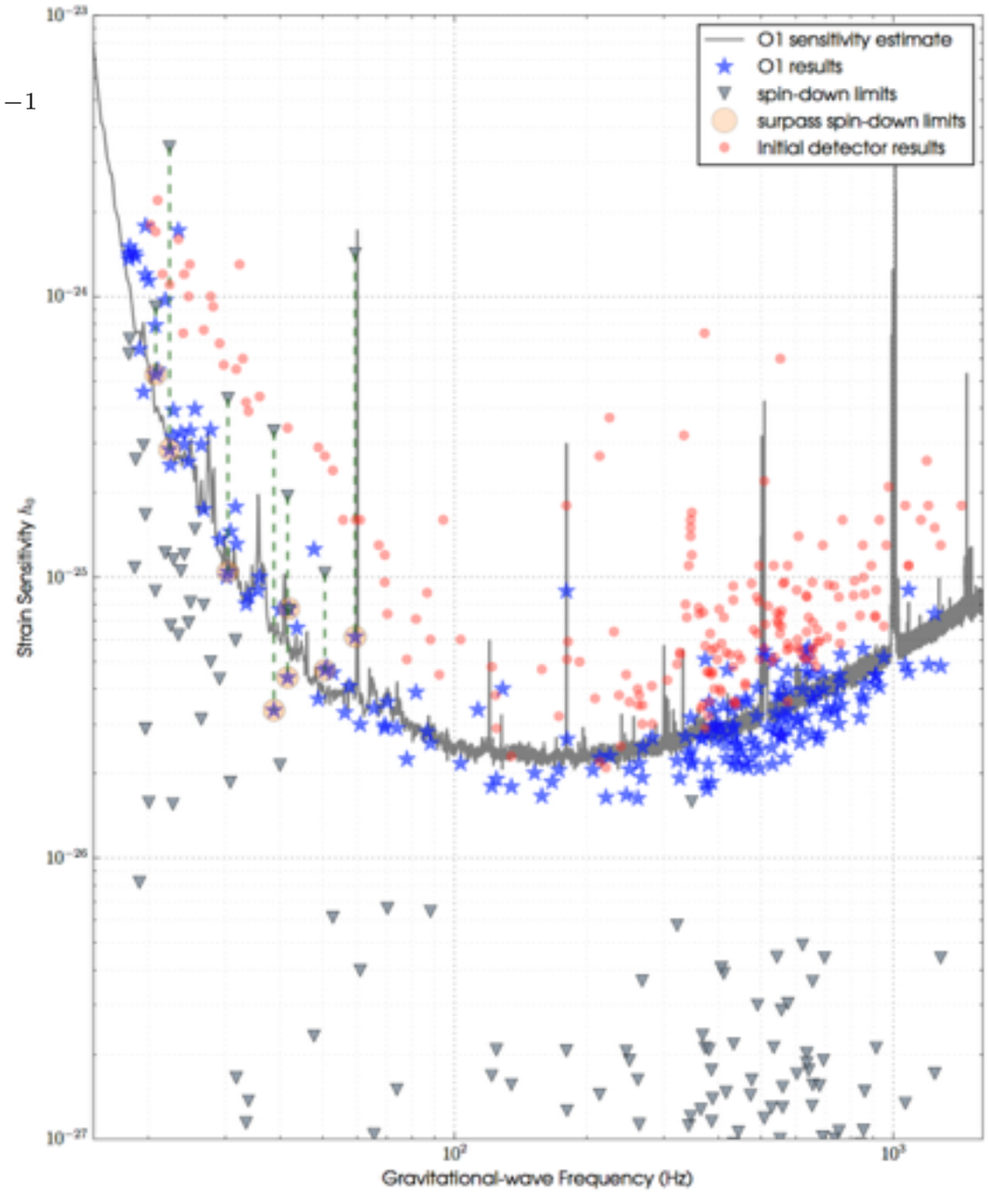
If pulser rotated rapidly and have asymmetry, they are candidate of continuous gravitational wave(CW)
noise ∝ sqrt(T), famous analysis : F-statistics

$$h(t) = \frac{16\pi^2 G}{c^4}\frac{\epsilon I_{zz} f^2}{r}$$
$$= 4.2 \times 10^{-27}\frac{\epsilon}{10^{-7}}\frac{I_{zz}}{1 -^{45} \mathrm{g/cm}^2}\left(\frac{f_0}{100\mathrm{Hz}}\right)^2\left(\frac{r}{1\mathrm{kpc}}\right)^{-1}$$

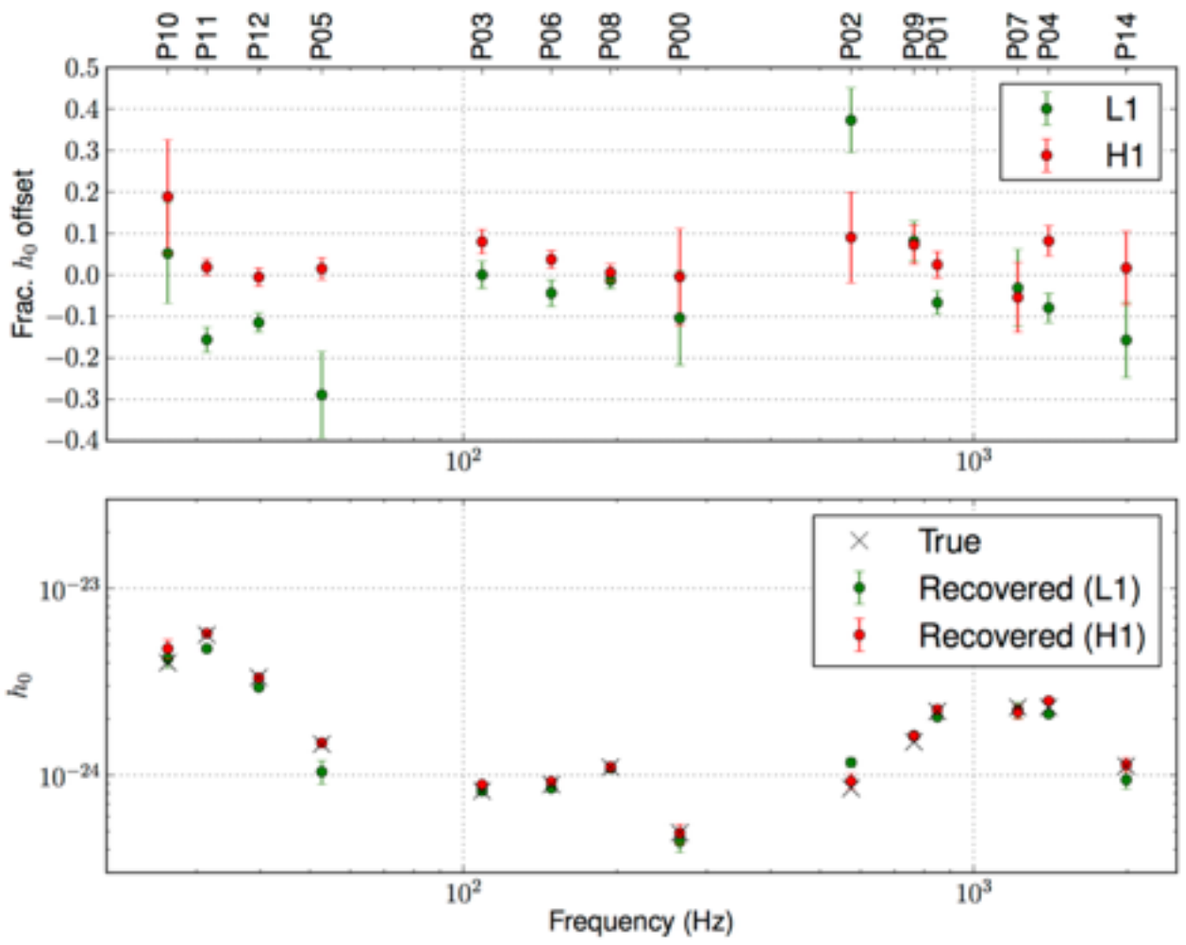
FIRST SEARCH FOR GRAVITATIONAL WAVES FROM KNOWN PULSARS WITH ADVANCED LIGO

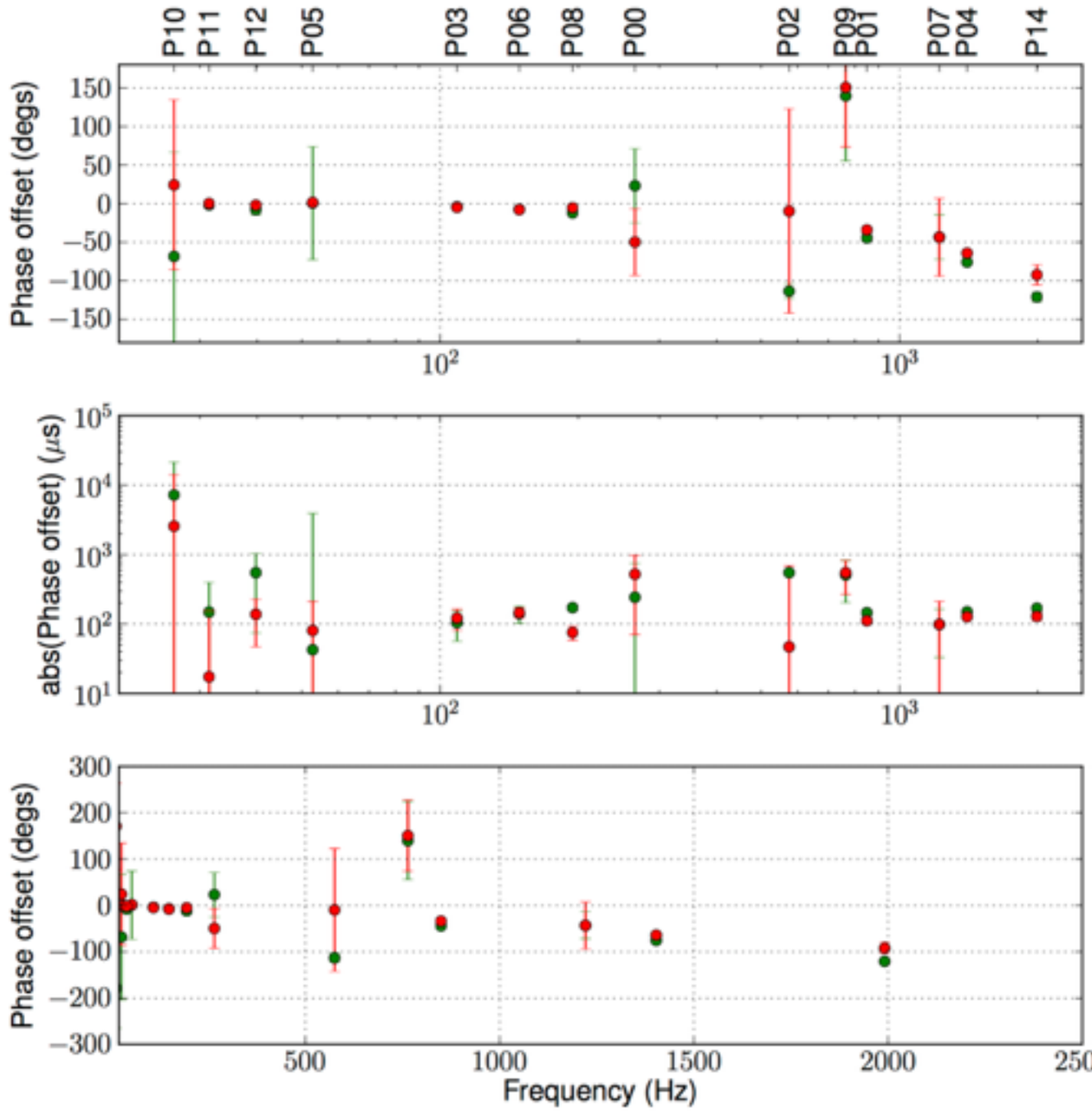
arxiv : 1701.07709

red : initial LIGO
blue : aLIGO O1
gray : spin-down limits
(assume that all spin-down was caused by GW emission,
maximum of GW emission)



injection of continuous wave





inject 15 type of CW signals
(2 signals : difficult to analyze)
amplitudes seem 1/10 of sensitivity

injection of continuous wave

Generate simulation signal :
lalapps_makefakedatav4 or v5 (LAL)
(I used this program 2 years ago (with OCU student), I continued to try to generate time domain signal)

I discussed with Itoh'san about injection signal;
(1) please avoid known pulser signal(>>0.1Hz from known pulser)
(2) 6 type of waveforms are preffered
(low, middle, high frequency with low and high noise)

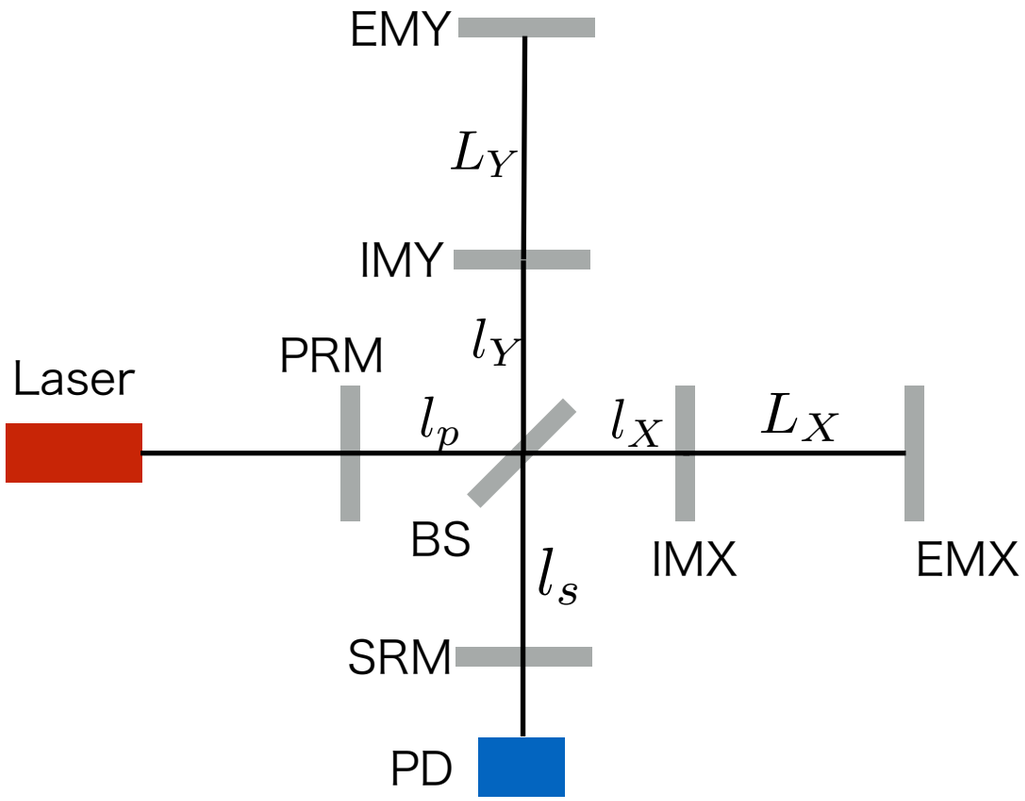
It will strongly depend on KAGRA line noise, we try to pickup 6 candidate of frequency and try to apply makefakedata
(same as LIGO frequency? Original frequency?)

Todo

- Make RT model for (cal and) hardware injection
  - visit 2 weeks to Kamioka(October) and make RT model with help of Yamamoto-san
- Finalize the injection plan
  - Discuss in December F2F meeting(especially for CW injection, this injection will be done during run)
  - Two day (before and after run) for injection test?
- Make English version of hardware injection memo (work in Obon)

backups

Length control (bKAGRA full)



DARM = $\Delta L = L_X - L_Y$

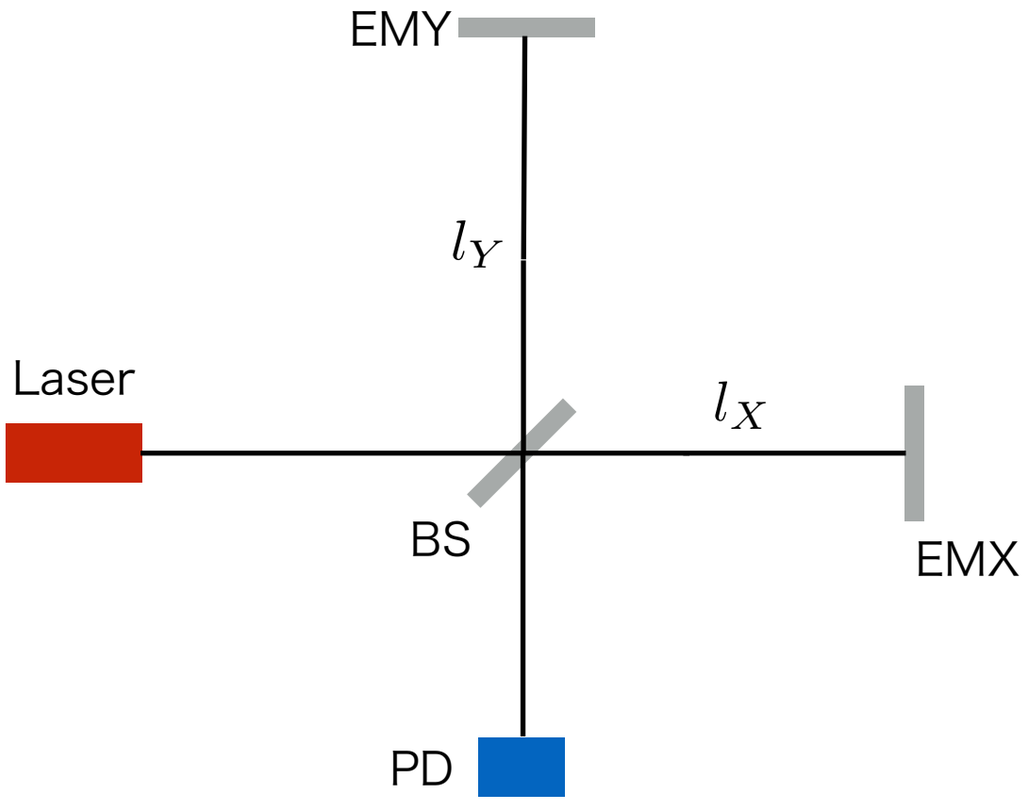
CARM = $(L_X + L_Y)/2$

MICH = $l_X - l_Y$

PRCL = $l_p + (l_X + l_Y)/2$

SRCL = $l_s + (l_X + l_Y)/2$

Length control (bKAGRA phase1)



MICH = ΔL= $l_X - l_Y$

(??) $(l_X + l_Y)/2$
は制御するのか？