RESULTS OF INJECTION TEST ON 15,16 FEB.

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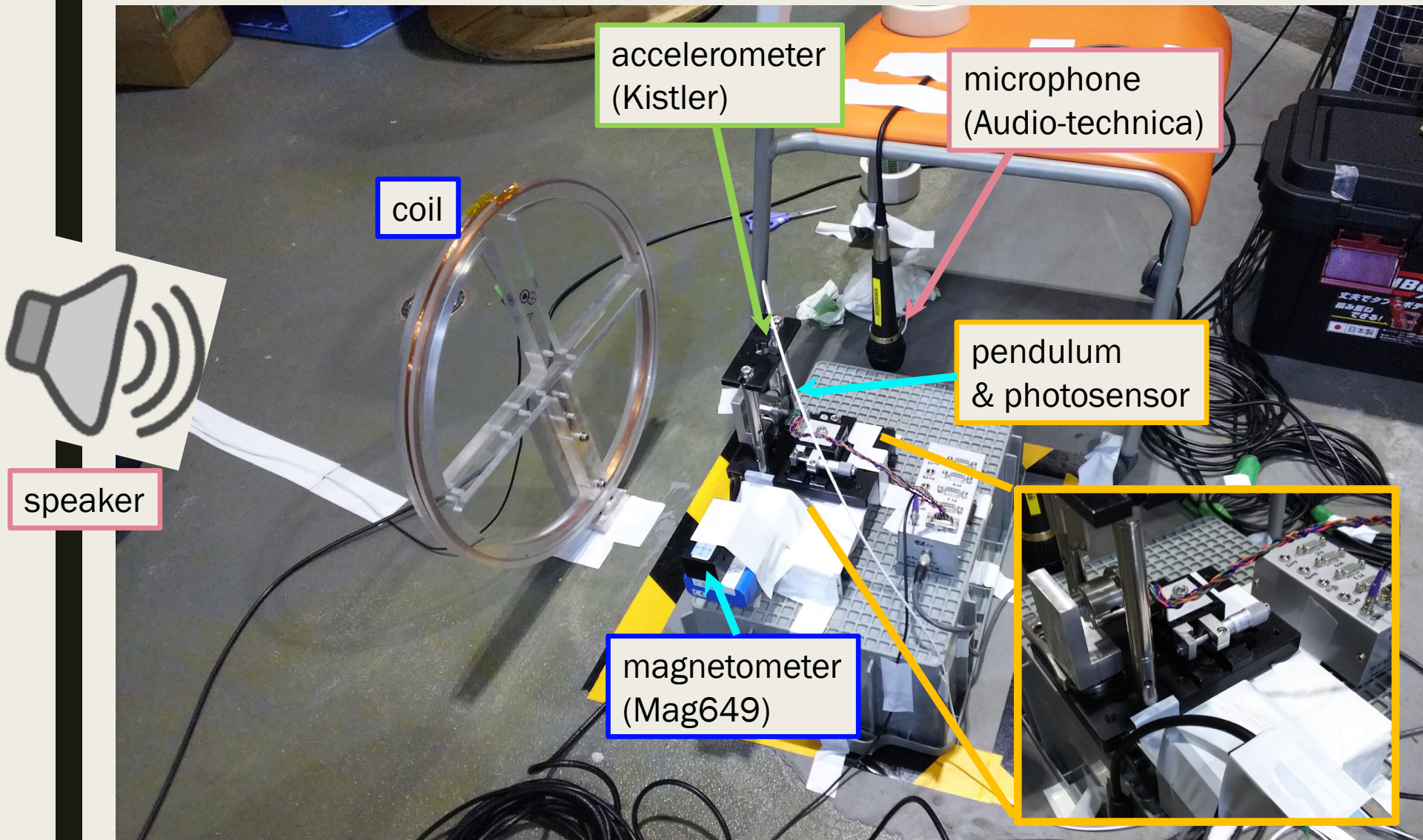
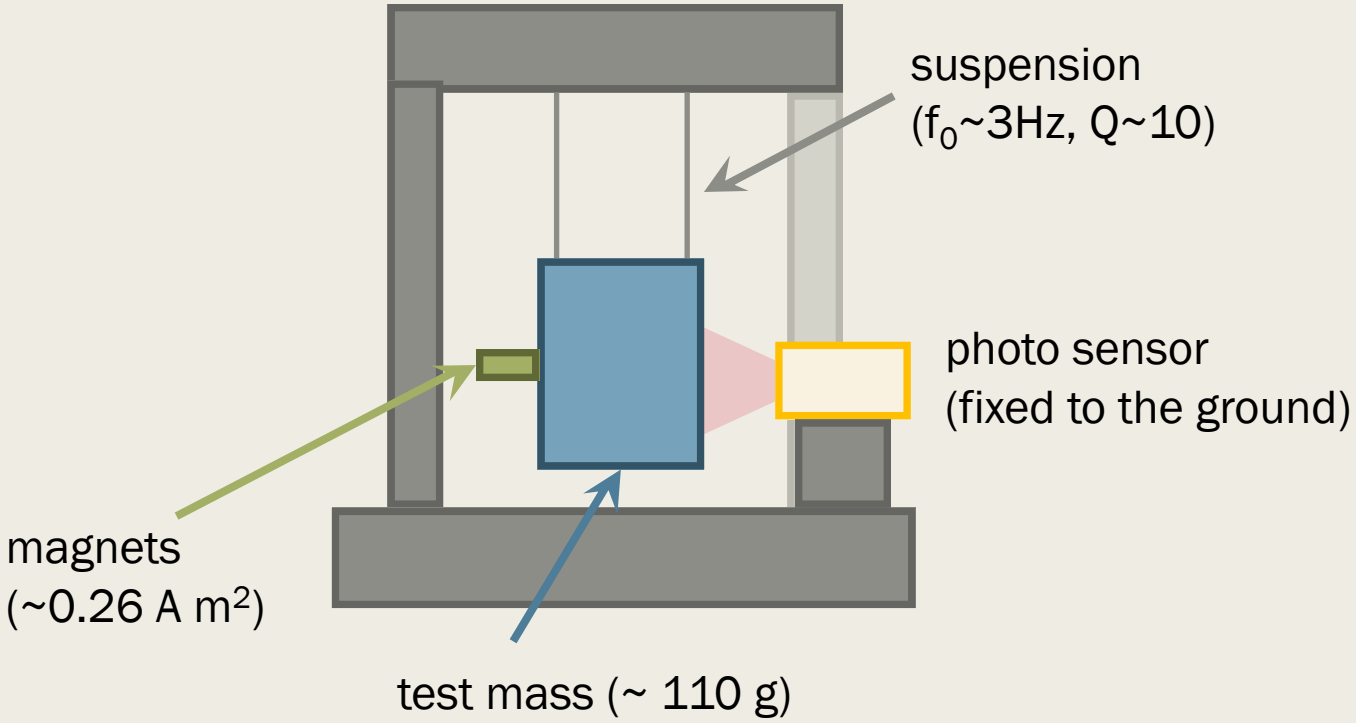
Overview of injection test

- target : simple pendulum with a photosensor
- coupling function measurement (linear transfer) & noise budget
  - *magnetic (large coil)*
  - *acoustic (speaker)*
  - *shaking (hit with screw drivers)*
- nonlinear correlation analysis

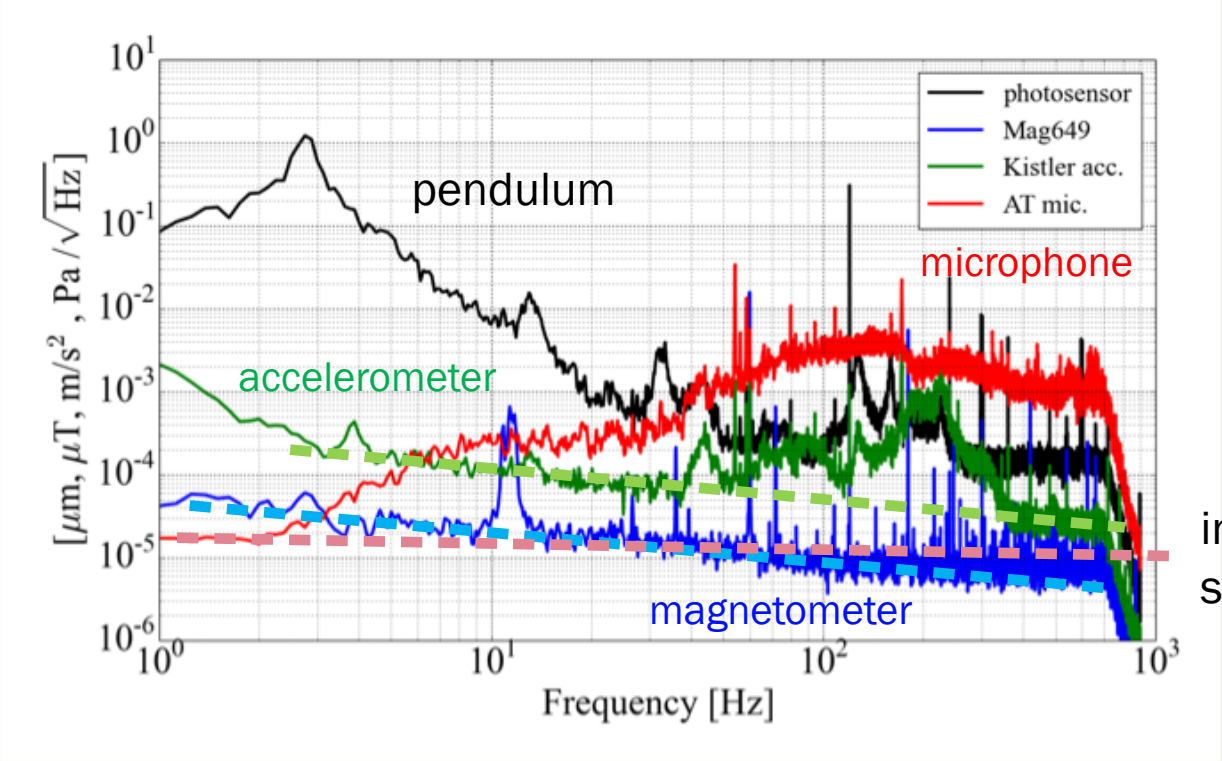
Setup


accelerometer
(Kistler)
microphone
(Audio-technica)
coil
pendulum
& photosensor
speaker
magnetometer
(Mag649)

pendulum


suspension
(f_0~3Hz, Q~10)
photo sensor
(fixed to the ground)
magnets
(~0.26 A m^2)
test mass (~ 110 g)

PSD without injection



instrumental self noise?

Coupling function measurement (injection)

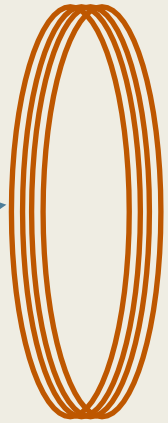
equipments

- aaa

function generator

SR560
(for broadband)

amplifier
(RMX5050a)

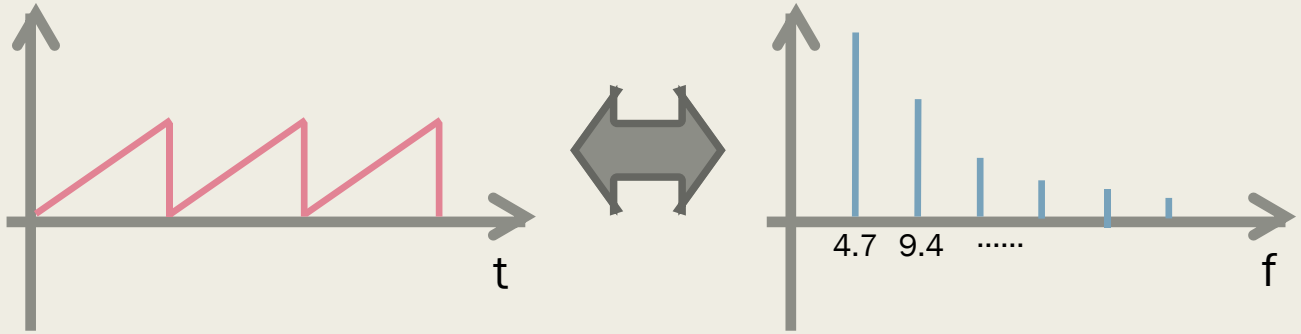


coil

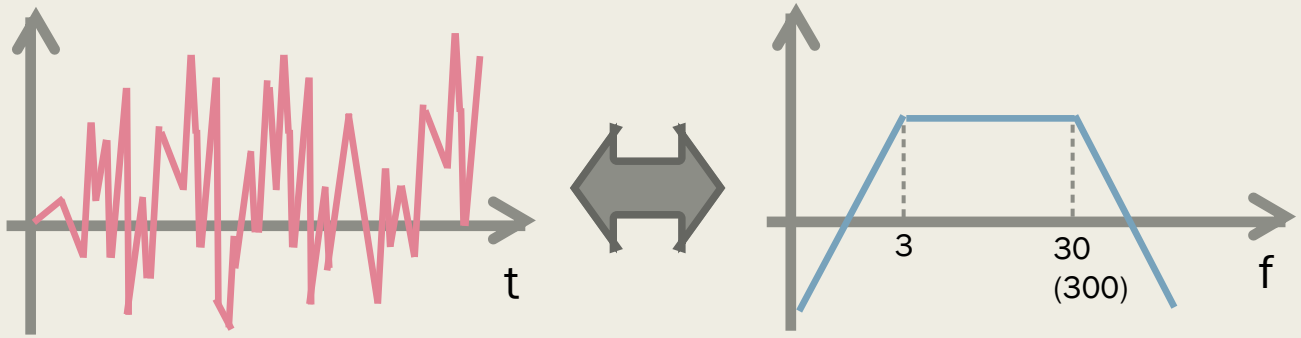
speaker

injection signal (magnetic, acoustic)

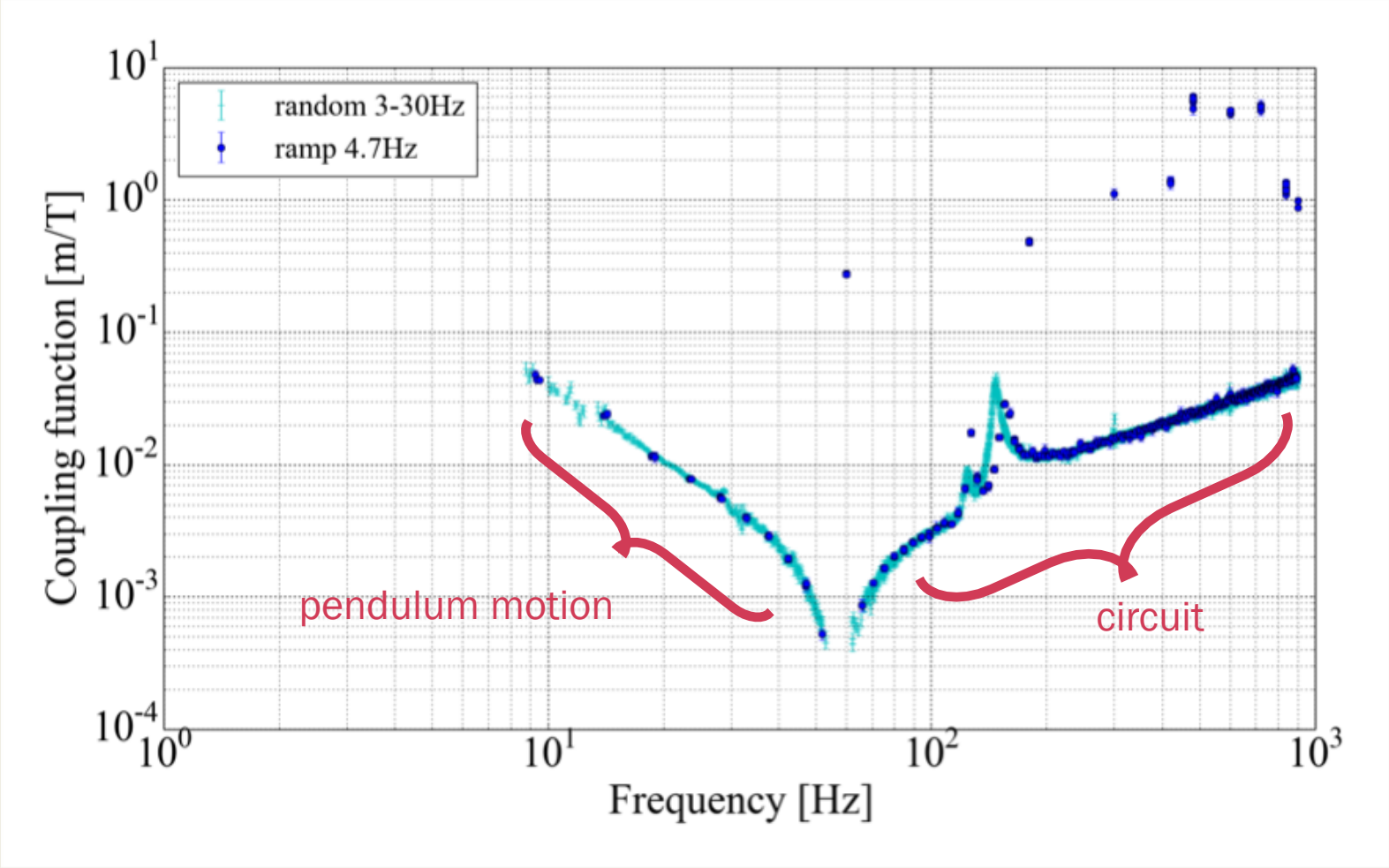
1. comb (4.7Hz ramp)



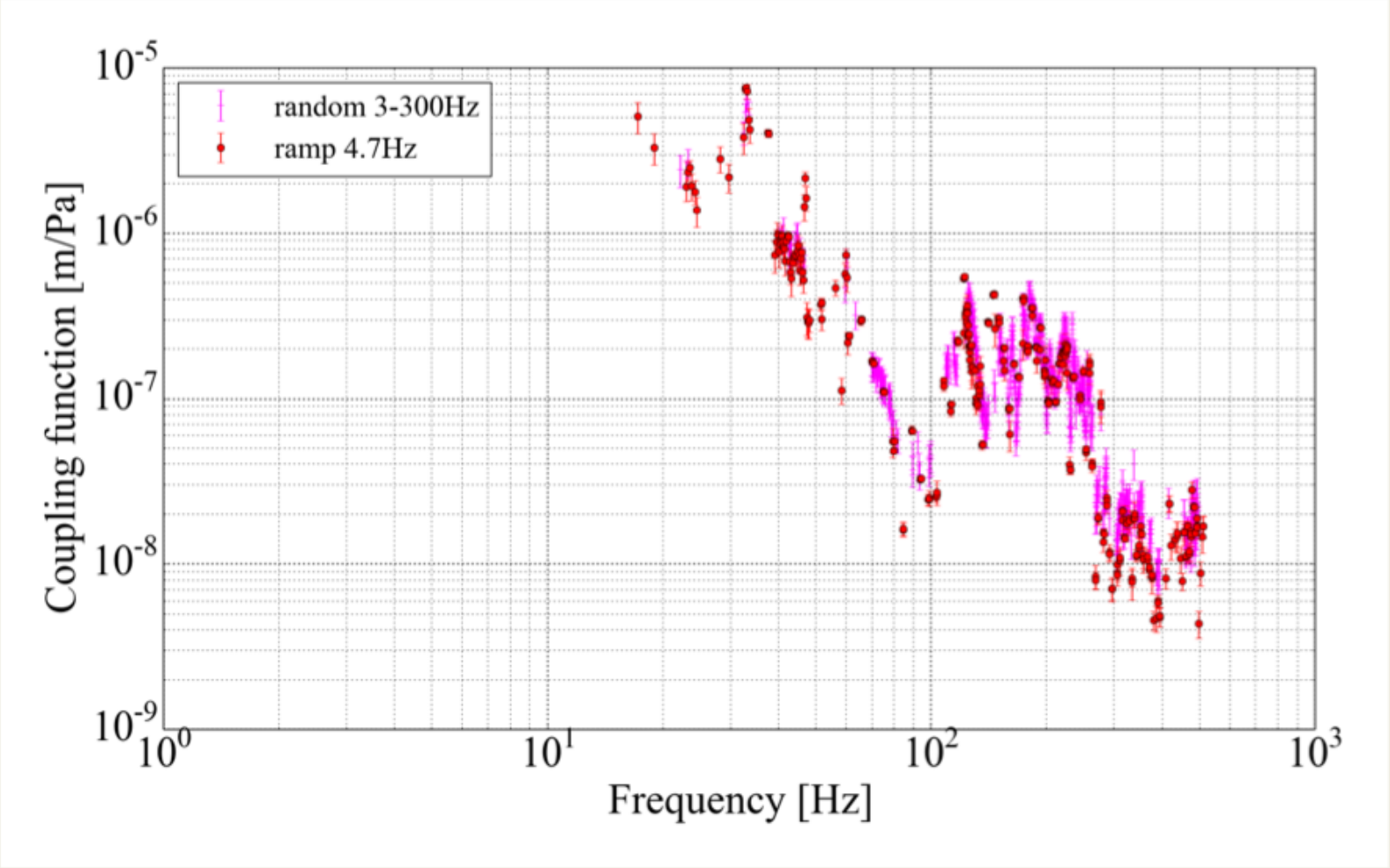
2. broad band (random: 3-30Hz for mag/ 3-300Hz for aco)



Coupling function (magnetic)

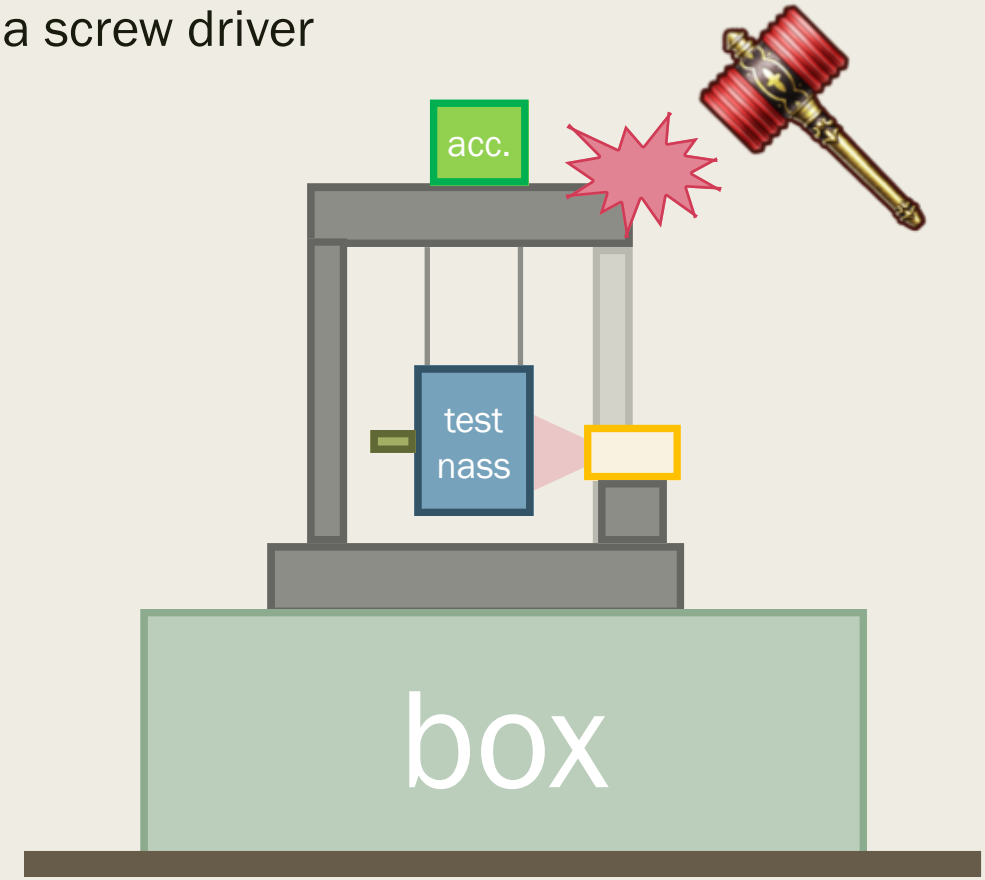


Coupling function (acoustic)

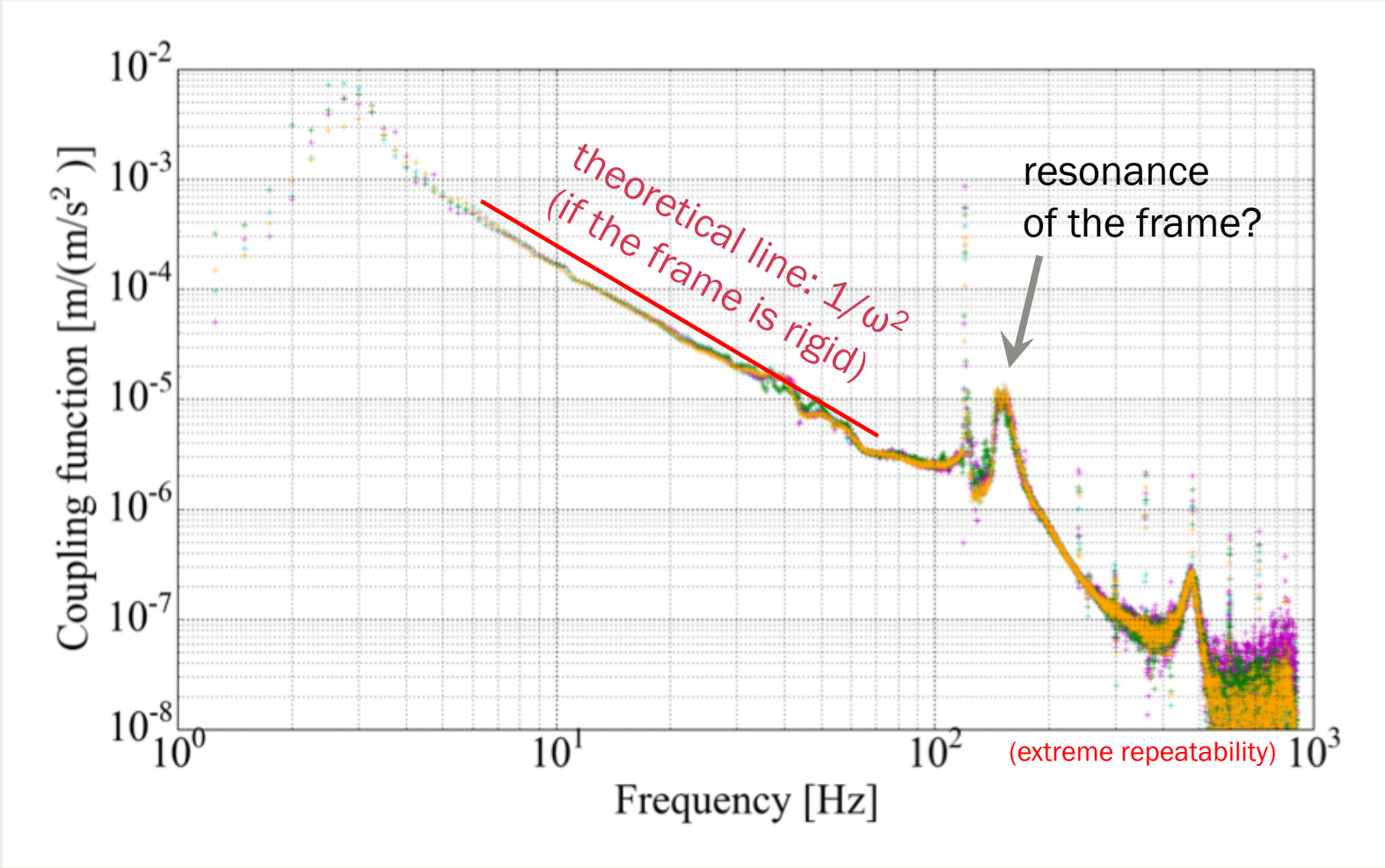


injection (acceleration)

- hit with a screw driver

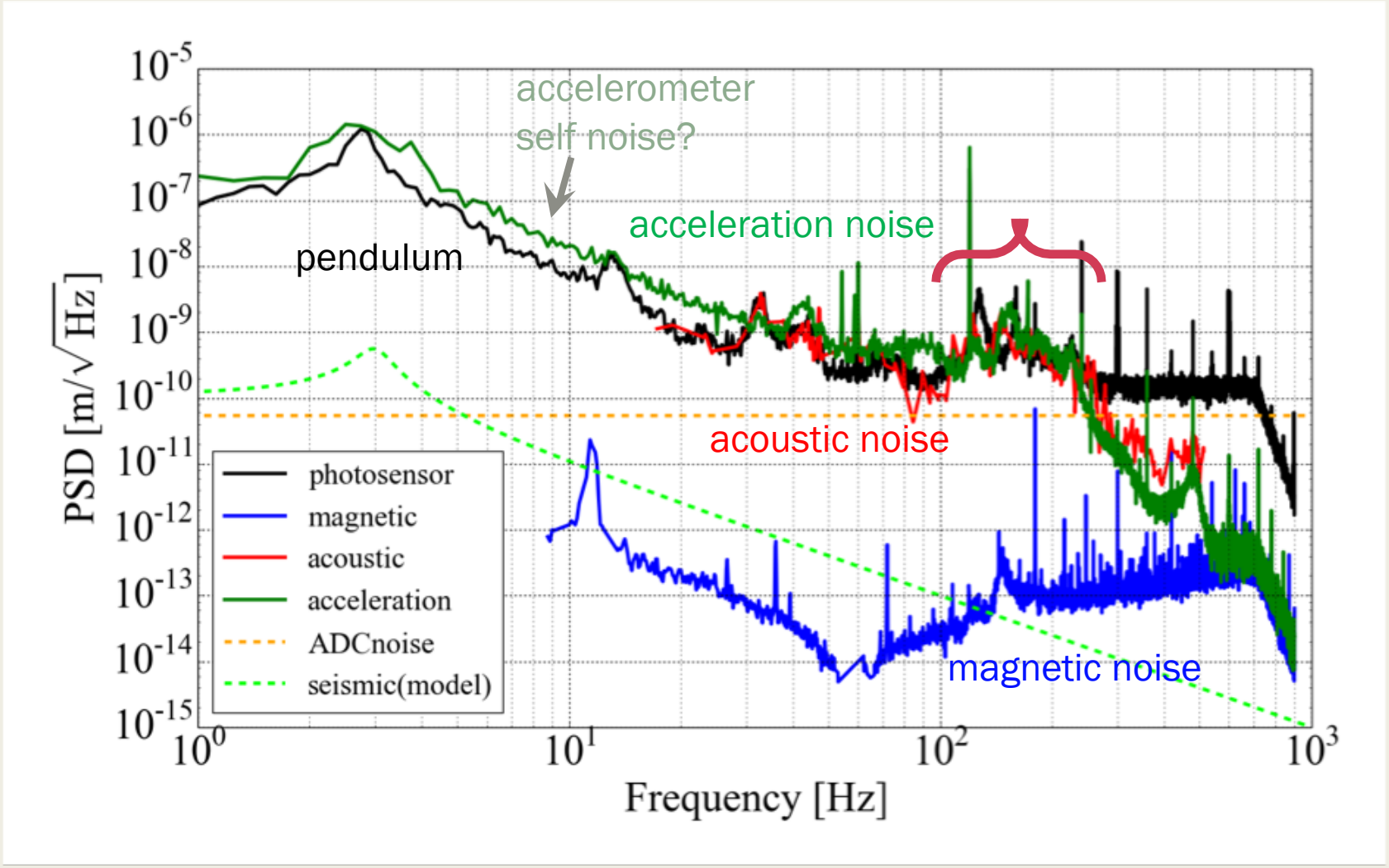


Coupling function (acceleration)

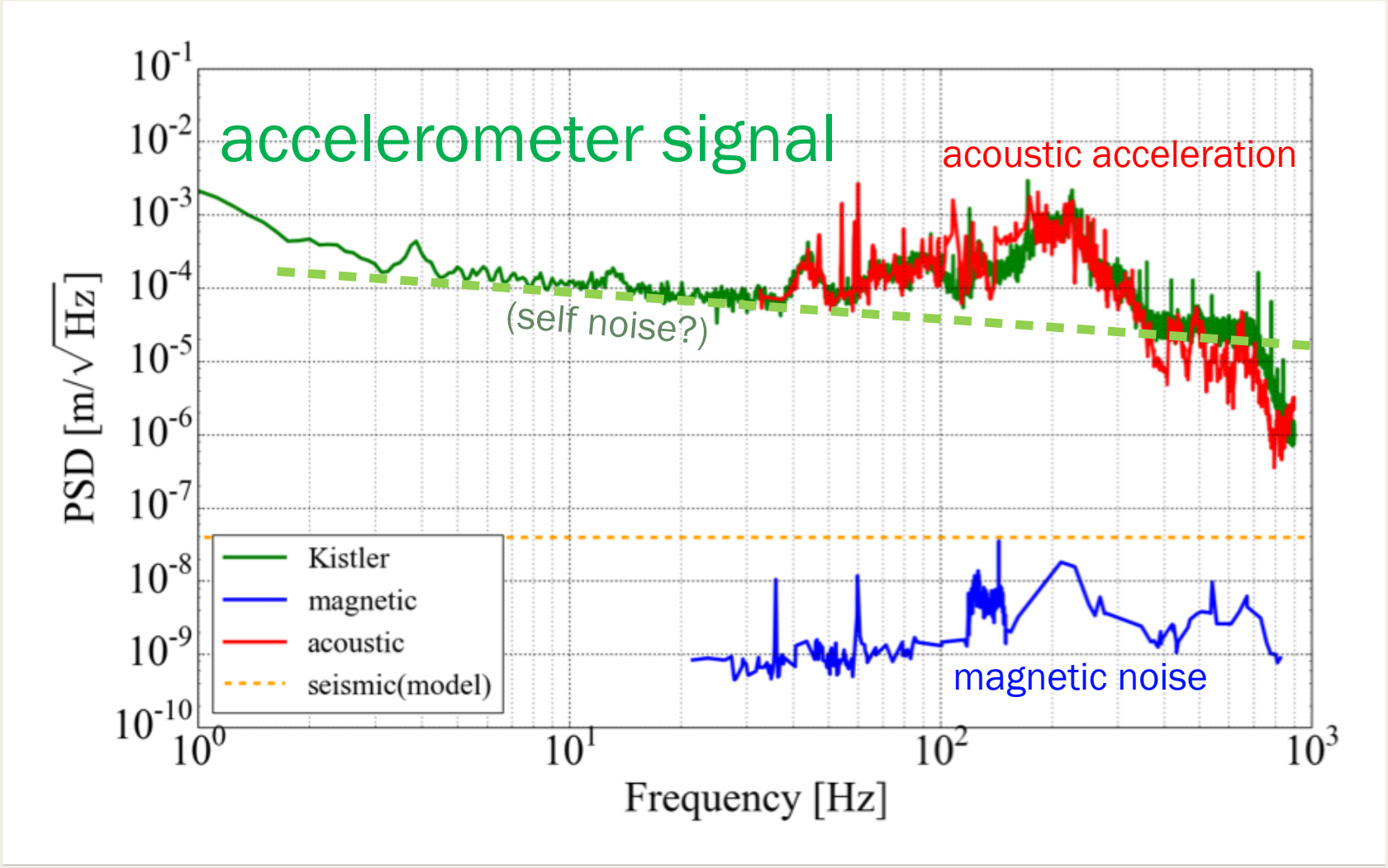


Noise budget

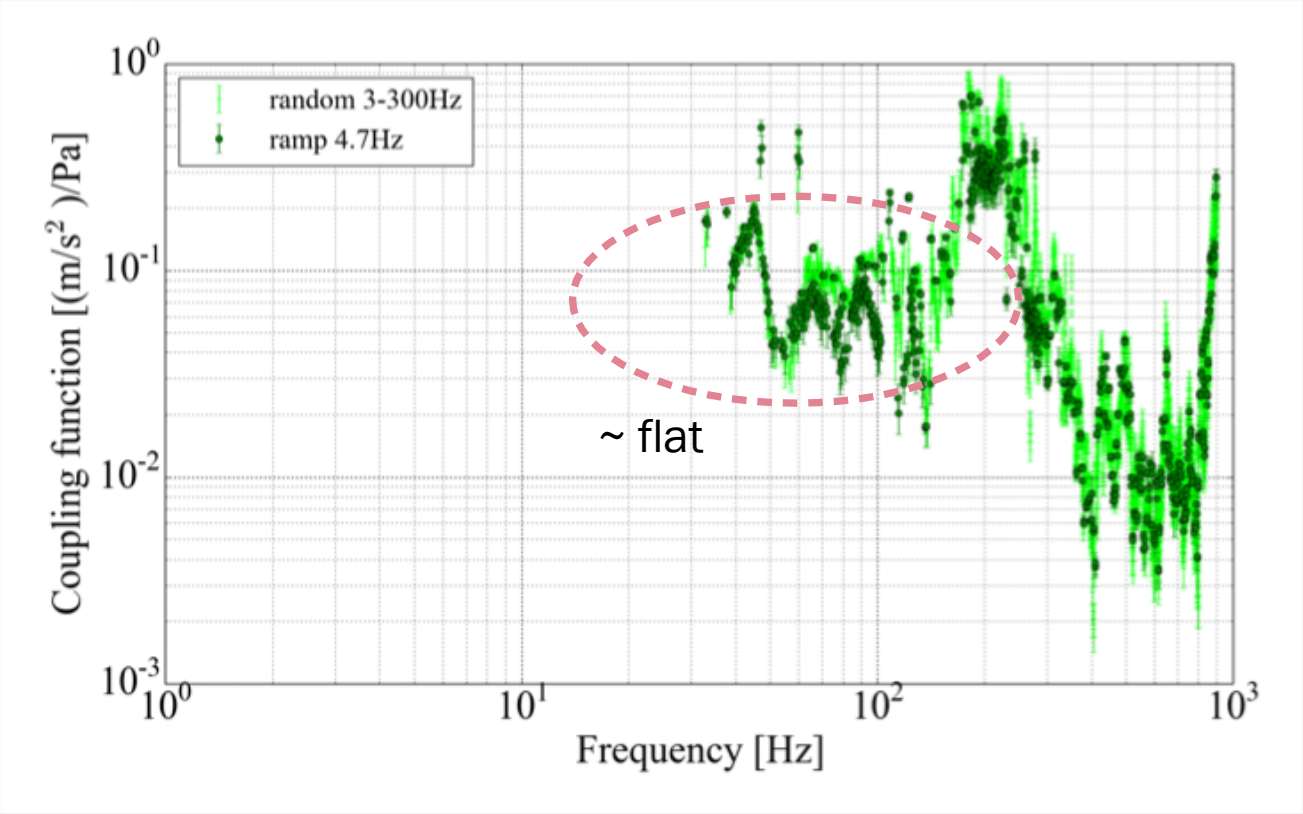
Noise budget of pendulum



Noise budget of accelerometer



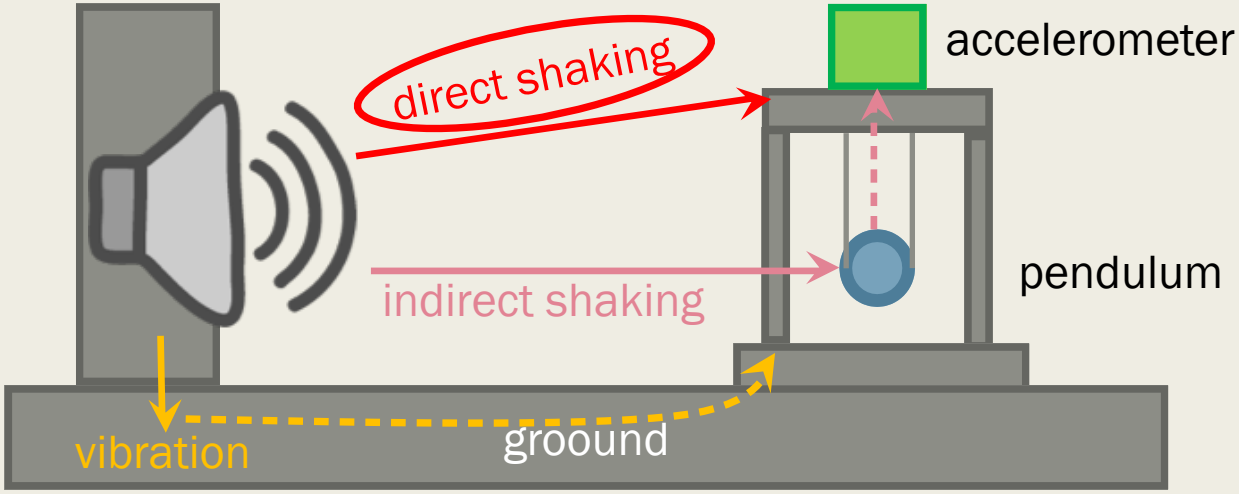
acoustic wave to acceleration



coupling function from microphone to accelerometer during speaker injection

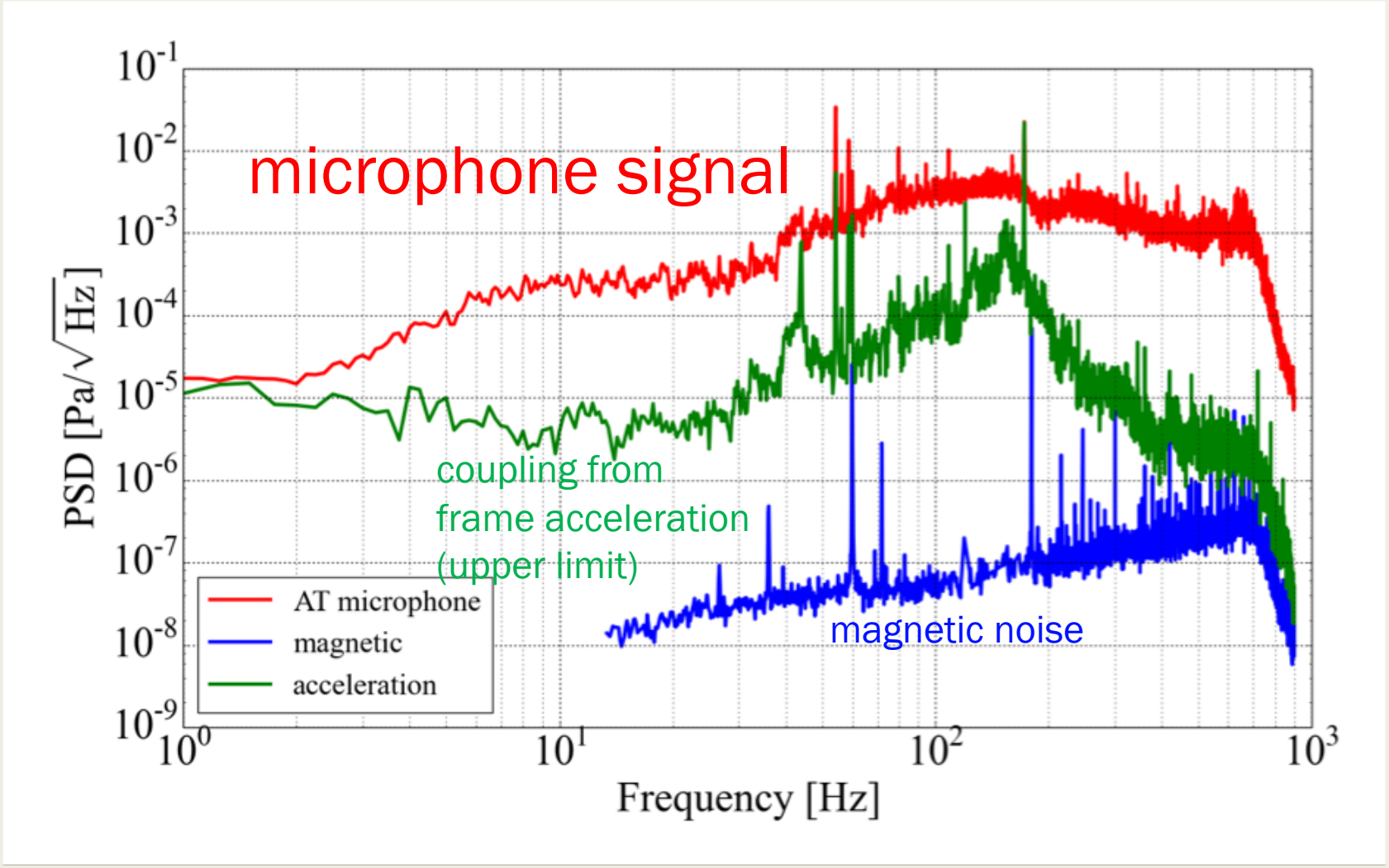
accelerometer noise

sound wave directly shakes the frame
→ (acc.) ∝ (force from sound)
(in case of indirect shaking : (acc.) ∝ (pend. motion) ∝ (force from sound)/f^2)



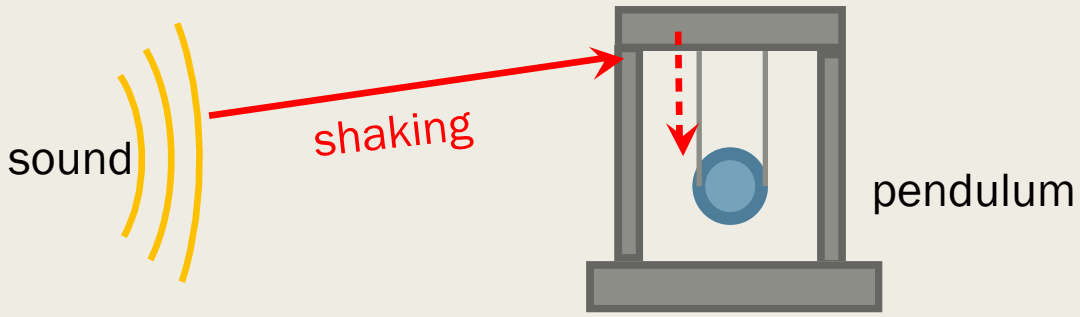
speaker vibration is not dominant during the injection
if it is dominant…
→ actual (acc.)/(sound) is less than measured coupling function (Kistler)/(mic.)
→ estimated noise (Kistler)/(mic.)×(sound PSD) will exceed accelerometer noise level

Noise budget of microphone



summary of linear analysis

- acoustic acceleration on the frame seems to be the dominant noise source @ 30-300Hz



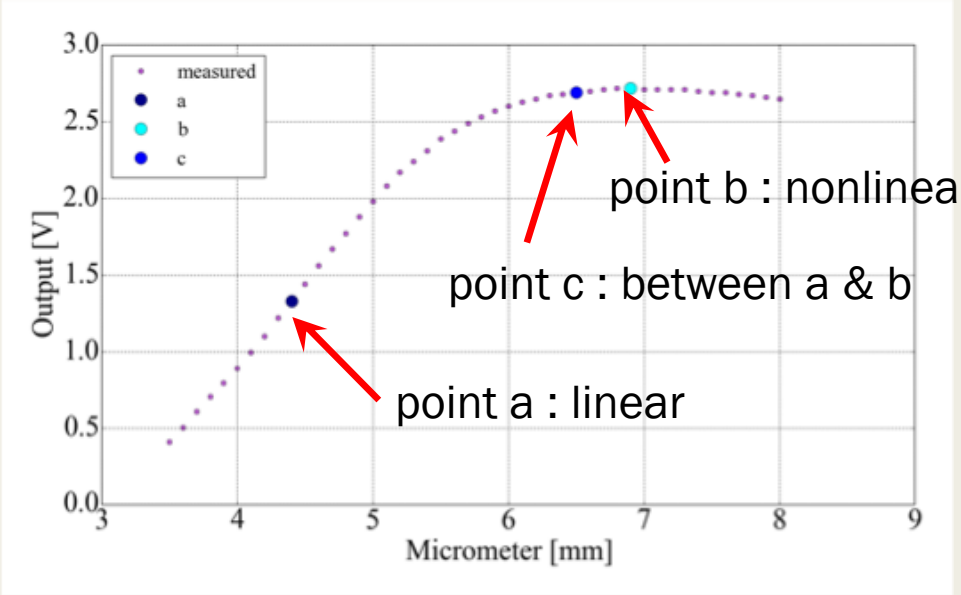
problems

- decoupling of sensor signals
  - *(e.g.) Does the microphone actually measure acoustic fluctuations? or limited by other noise?*
- better sensors (especially, microphone & accelerometer) are required to investigate lower frequency band
  - *use seismometers?*

Nonlinear injection

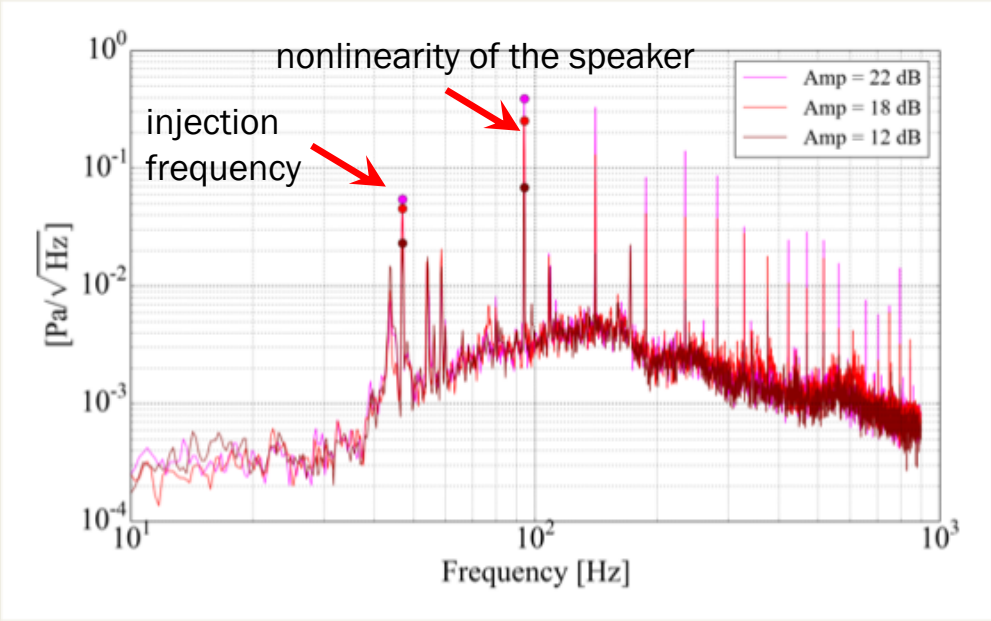
method

- change the position of the photosensor
  - *enlarge the nonlinearity of the photosensor*
- inject sinusoidal wave
  - *nonlinear signal will appear at harmonic frequencies*

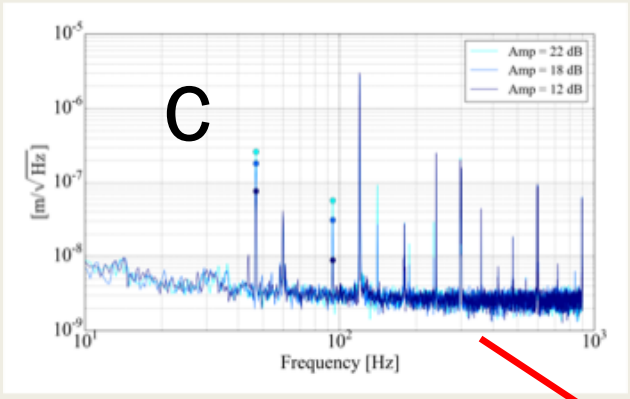


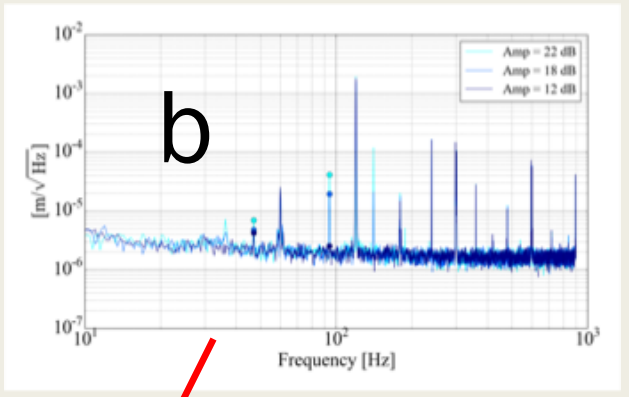
injection

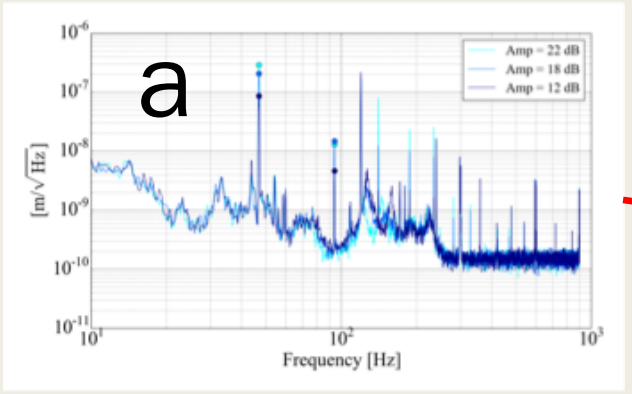
- 47Hz acoustic wave
  - *Amplifier gain = 12dB, 18dB, 22dB*
- Harmonic acoustic waves appear due to the nonlinearity of the speaker

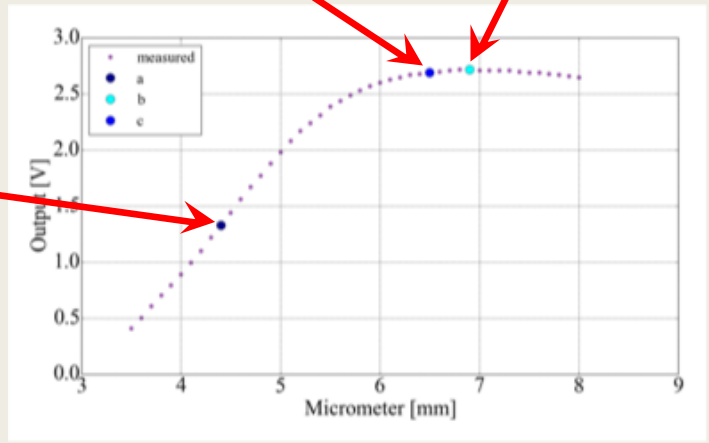


nonlinear signal of the PS



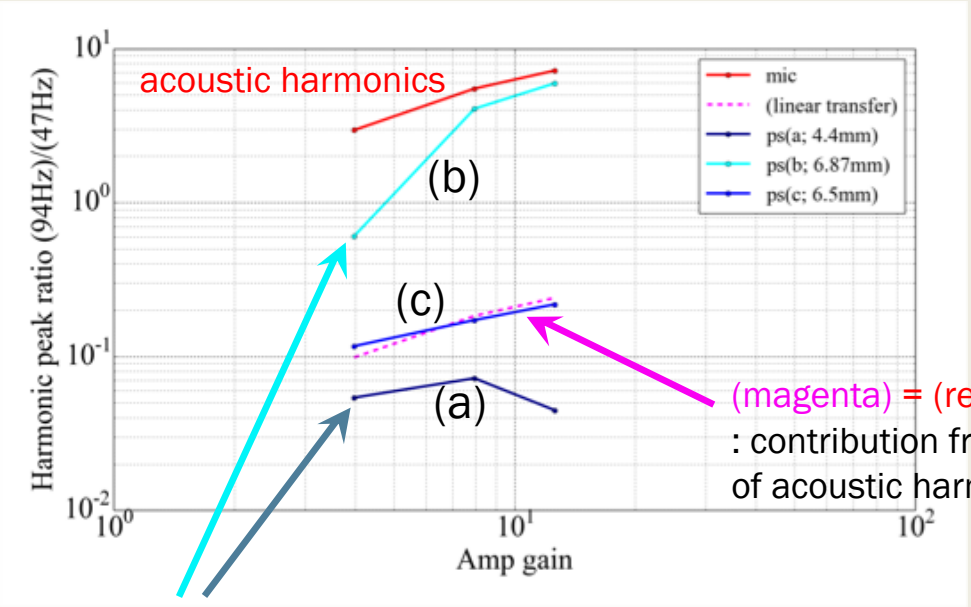




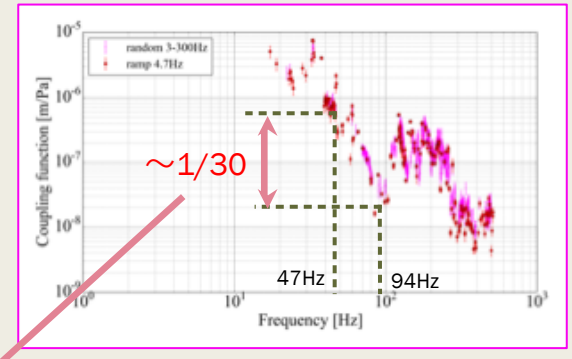


compare with linear transfer of acoustic harmonics

- nonlinear signal of the photosensor exists



microphone -> PS



(magenta) = (red)/30
: contribution from linear transfer of acoustic harmonic wave

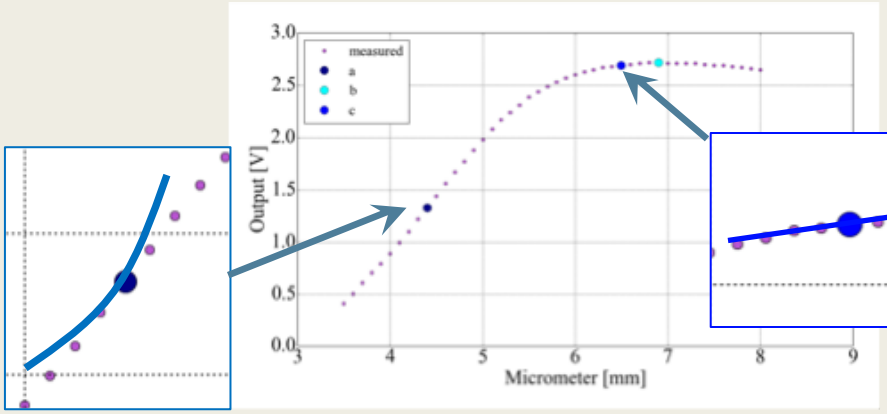
(offset from the magenta line) = (nonlinearity of the photosensor)

... why (c) is linear? (point (a) should be linear instead of (c))

summary of nonlinear injection

- nonlinear signals of the photosensor are observed
  - *let's do nonlinear correlation analysis !!*
- point (c) somehow shows linear response while (a) shows nonlinearity
  - *due to nonlinearity of the microphone?*
  - *response of the photosensor was locally linear at (c) and nonlinear at (a)?*

locally nonlinear?



locally linear?