Integration of proposed sensor in simulations

L. Brunetti[1], J. Allibe[1], J.-P. Baud[1], G. Balik[1] , G. Deleglise[1], A. Jeremie[1], S. Vilalte[1]
B. Caron[2], A. Badel[2], R. Le Breton[2]
(LAViSta Team)

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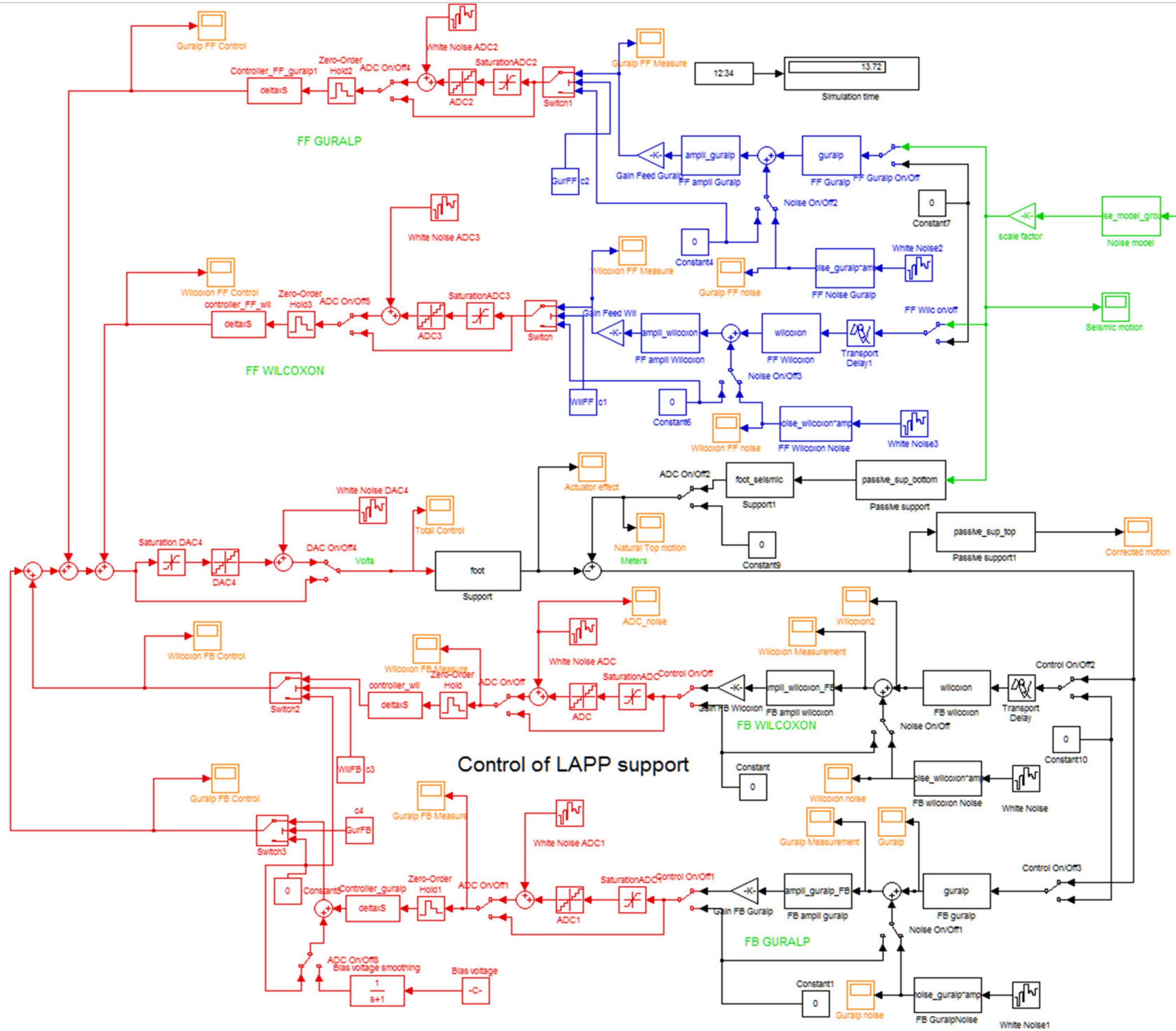
[1]: LAPP-IN2P3-CNRS, Université de Savoie, Annecy, France
&
[2]: SYMME-POLYTECH Annecy-Chambéry, Université de Savoie, Annecy, France

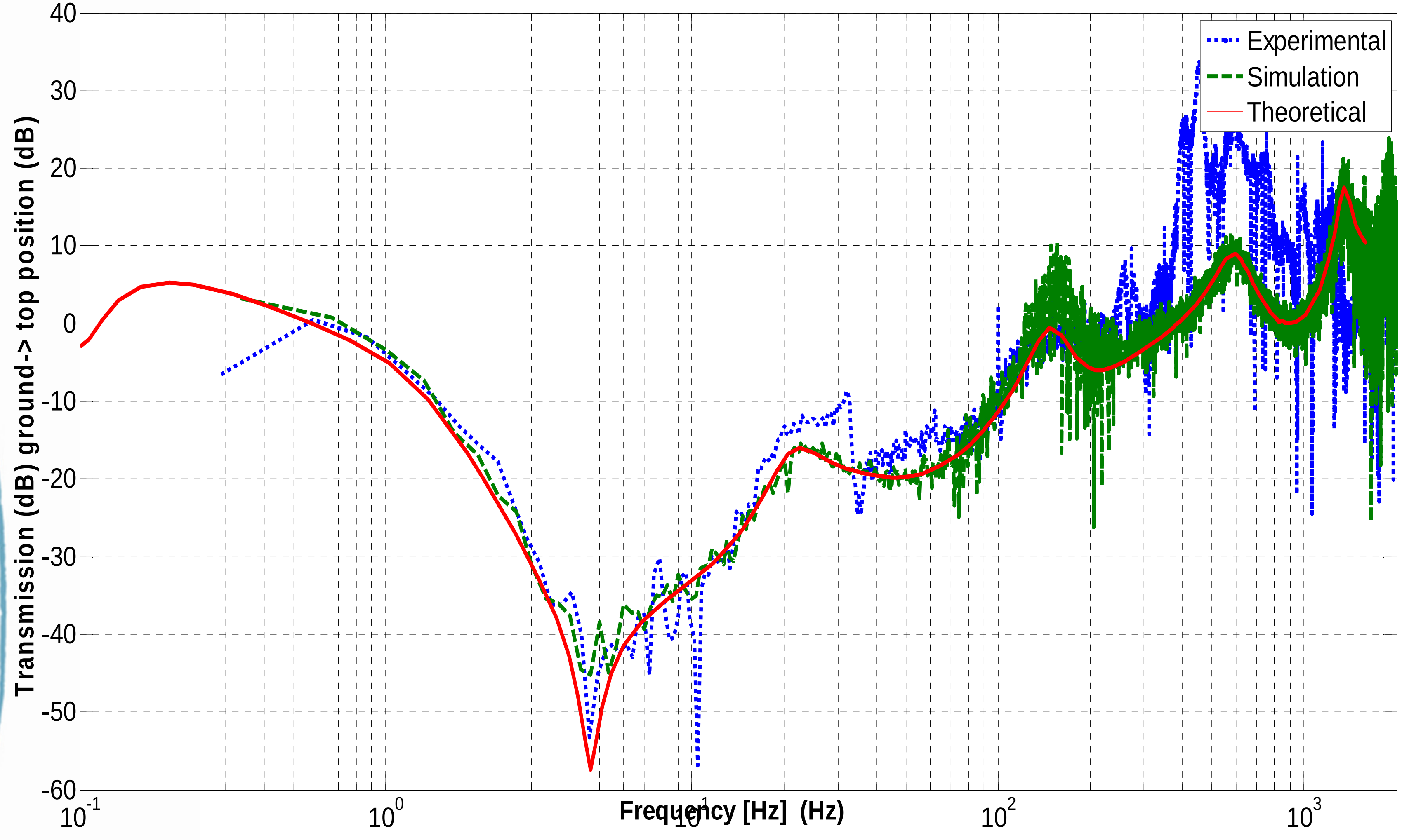
Laboratoire d'Annecy-le-Vieux
de Physique des Particules

Simulation scheme



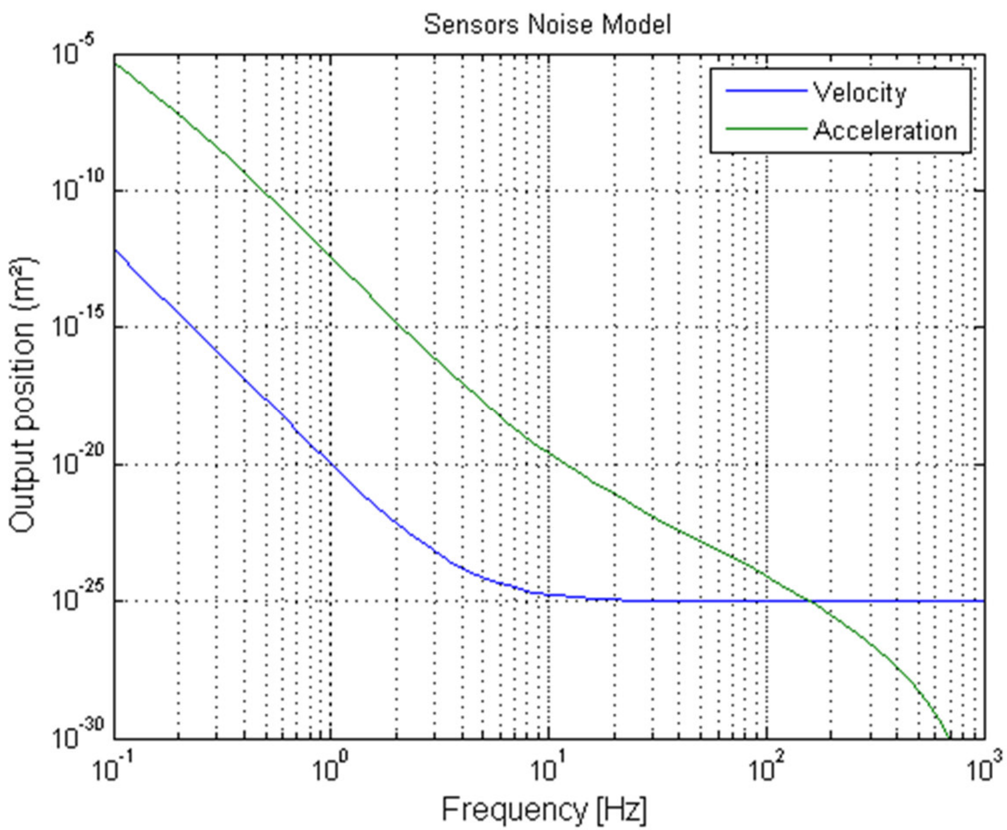
Mechanical model
4 sensors
2 FB
2 FF
Digital control
Real A/D D/A
Delays
Noises :
Sensors
A/D
D/A
Saturations

Results (Attenuation)



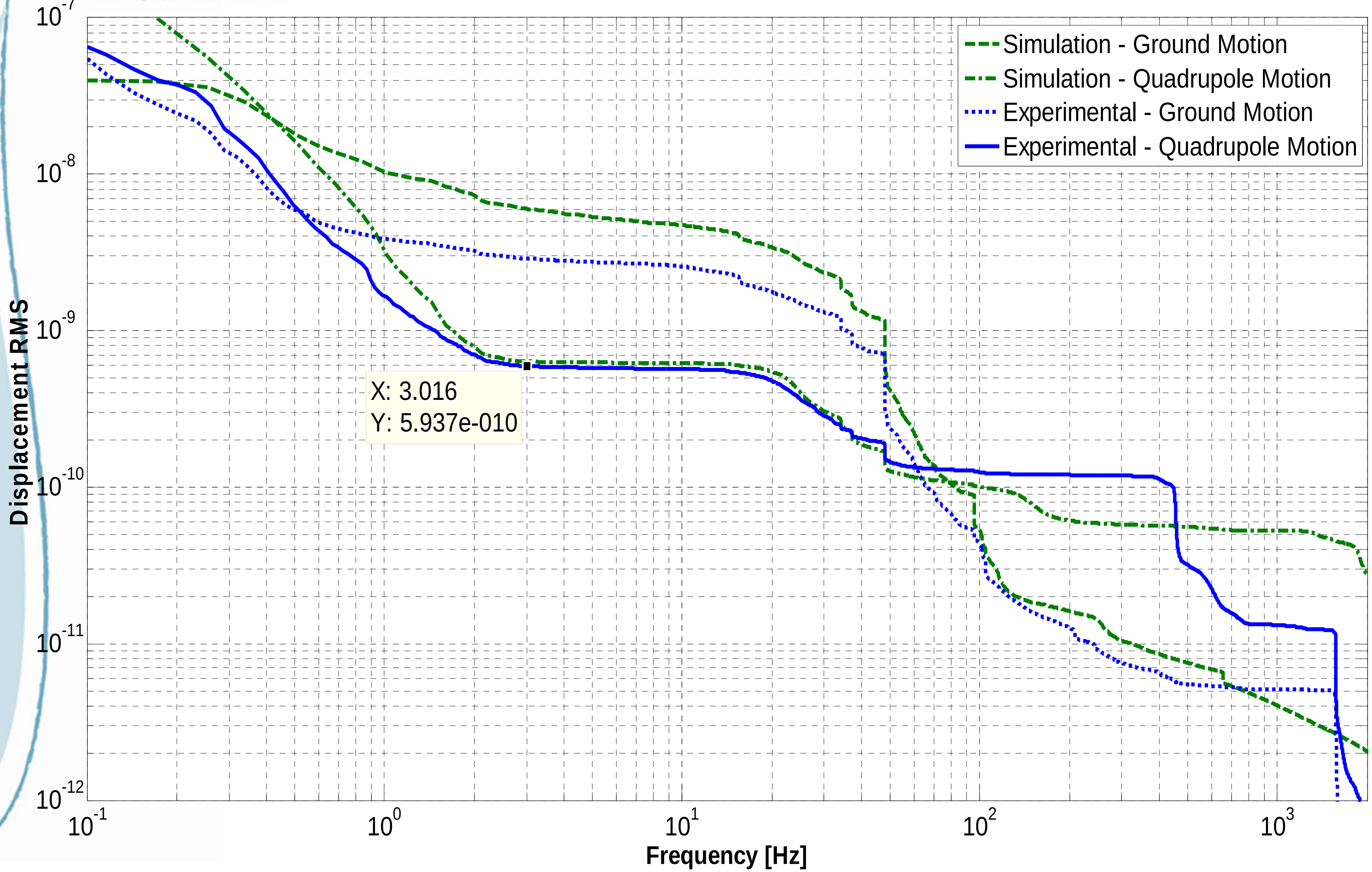
Sub-Nanometer Active Seismic Isolator Control (TBP in JIMSS)

Sensor Noise



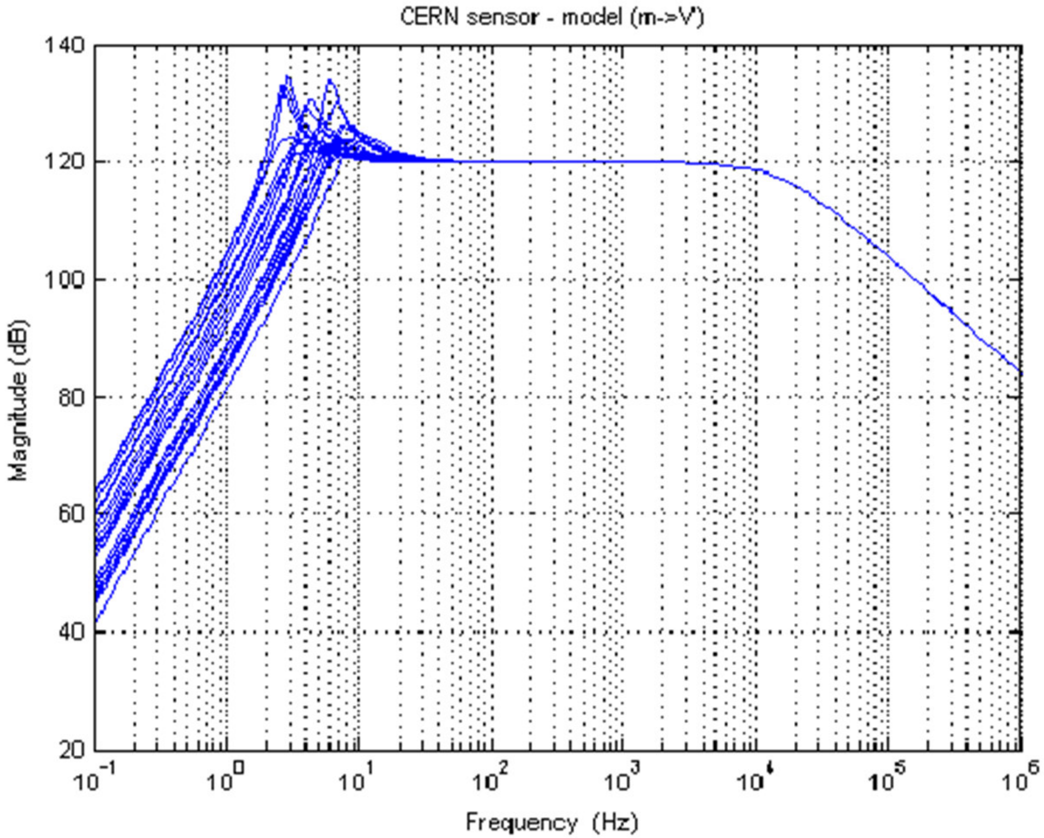
Sensor noise :
Modelled by
white Noise + linear filter

Integrated RMS



Sub-Nanometer Active Seismic Isolator Control (TBP in JIMSS)

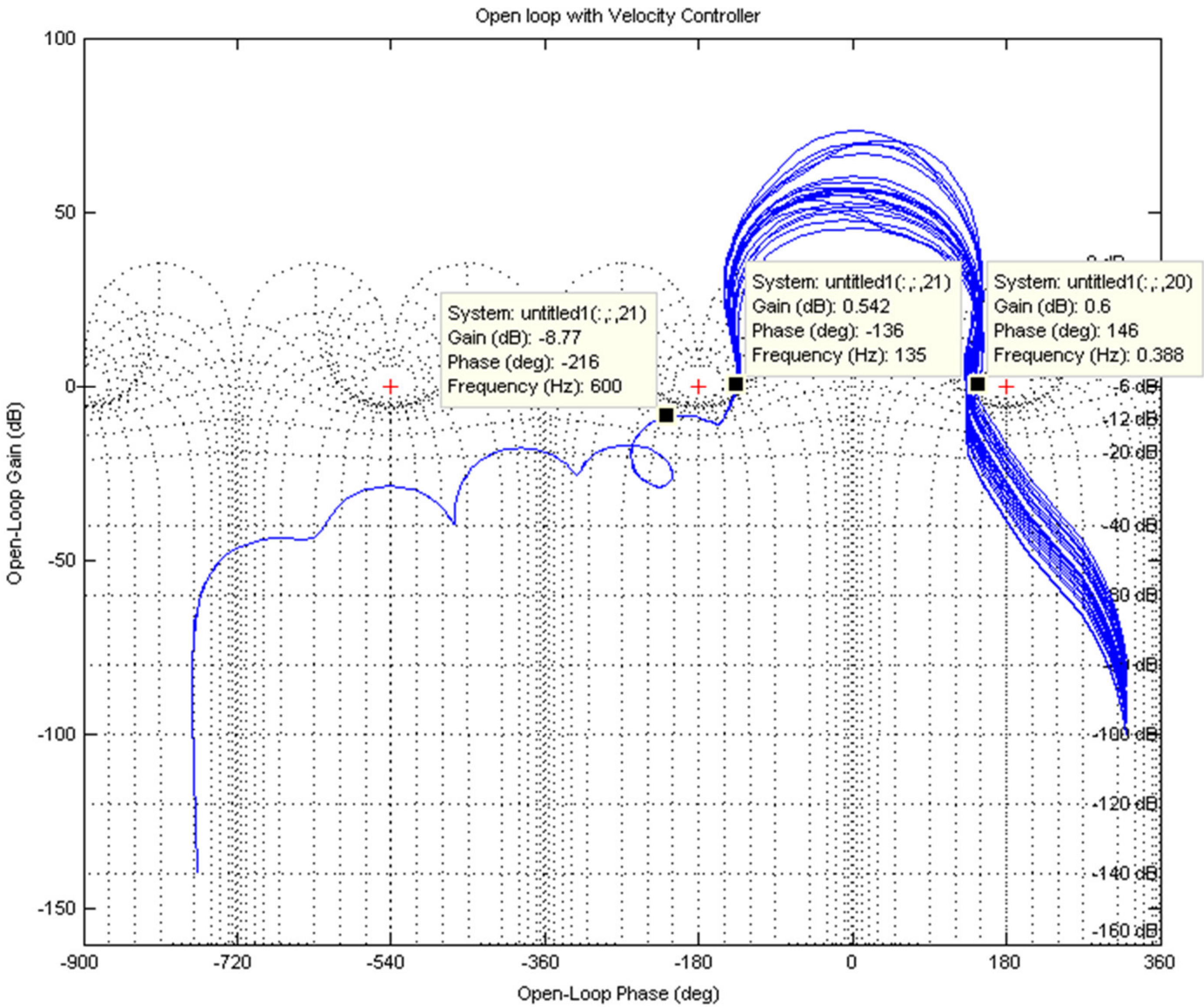
Uncertain sensor model



Resonant frequency

damping

Control loop

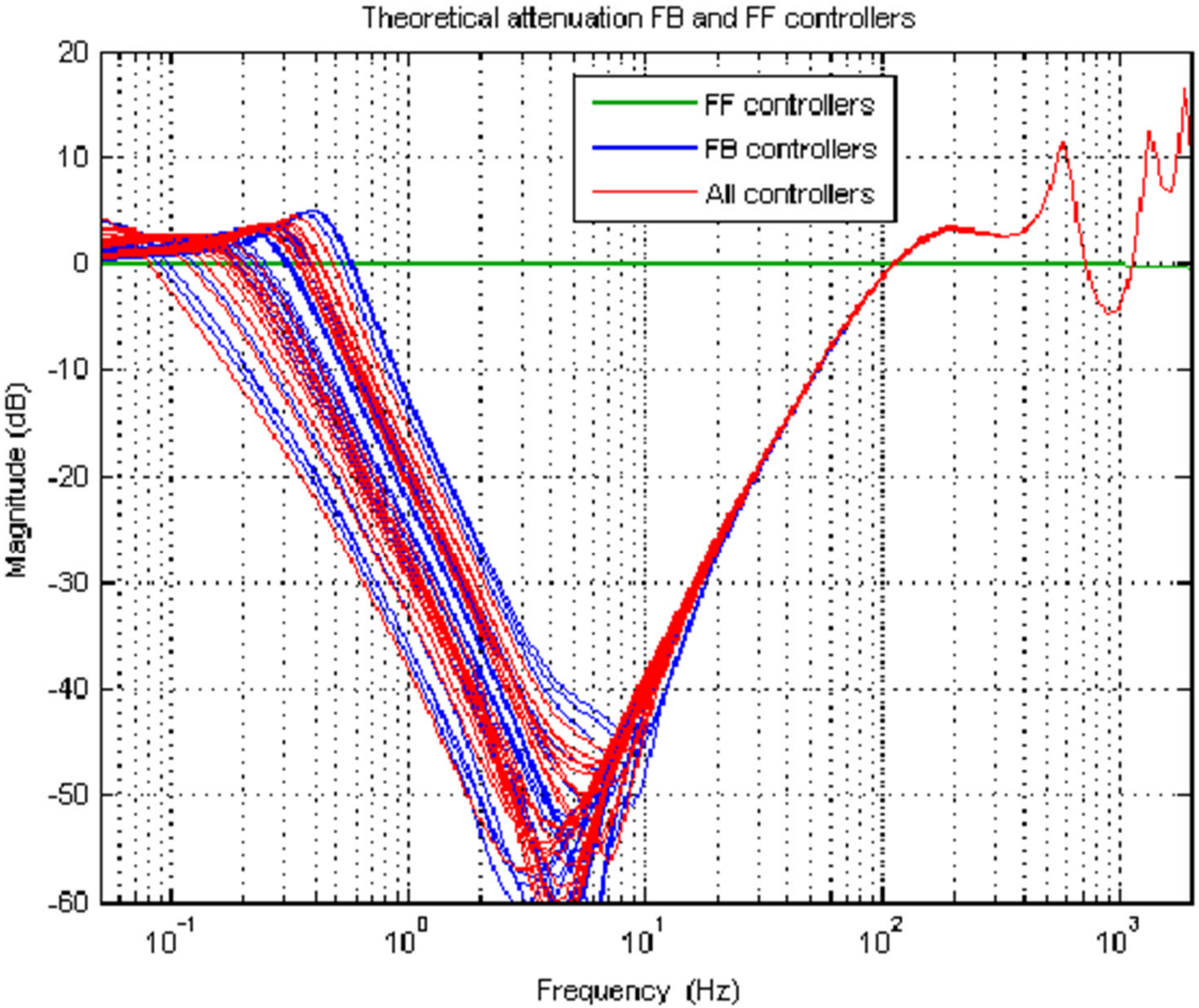


Controller must avoid :
* -180°/0dB
* + 180°/0dB
for stability

* good robustness margins
* stable with all uncertain sensor models

Controller must :
* add gain from 0.3Hz to 100Hz

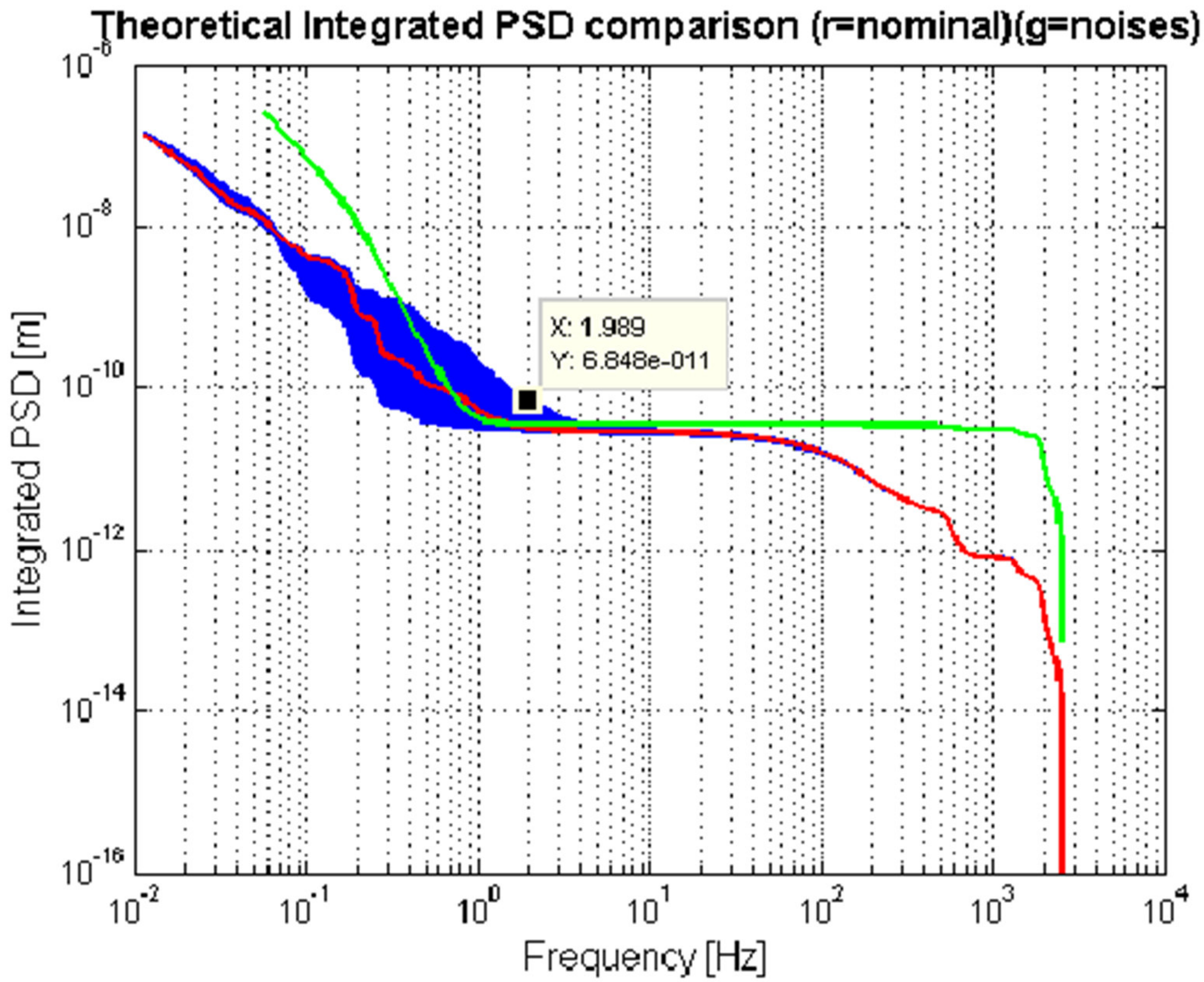
Theoretical seismic noise attenuation



Only 1 FB controller

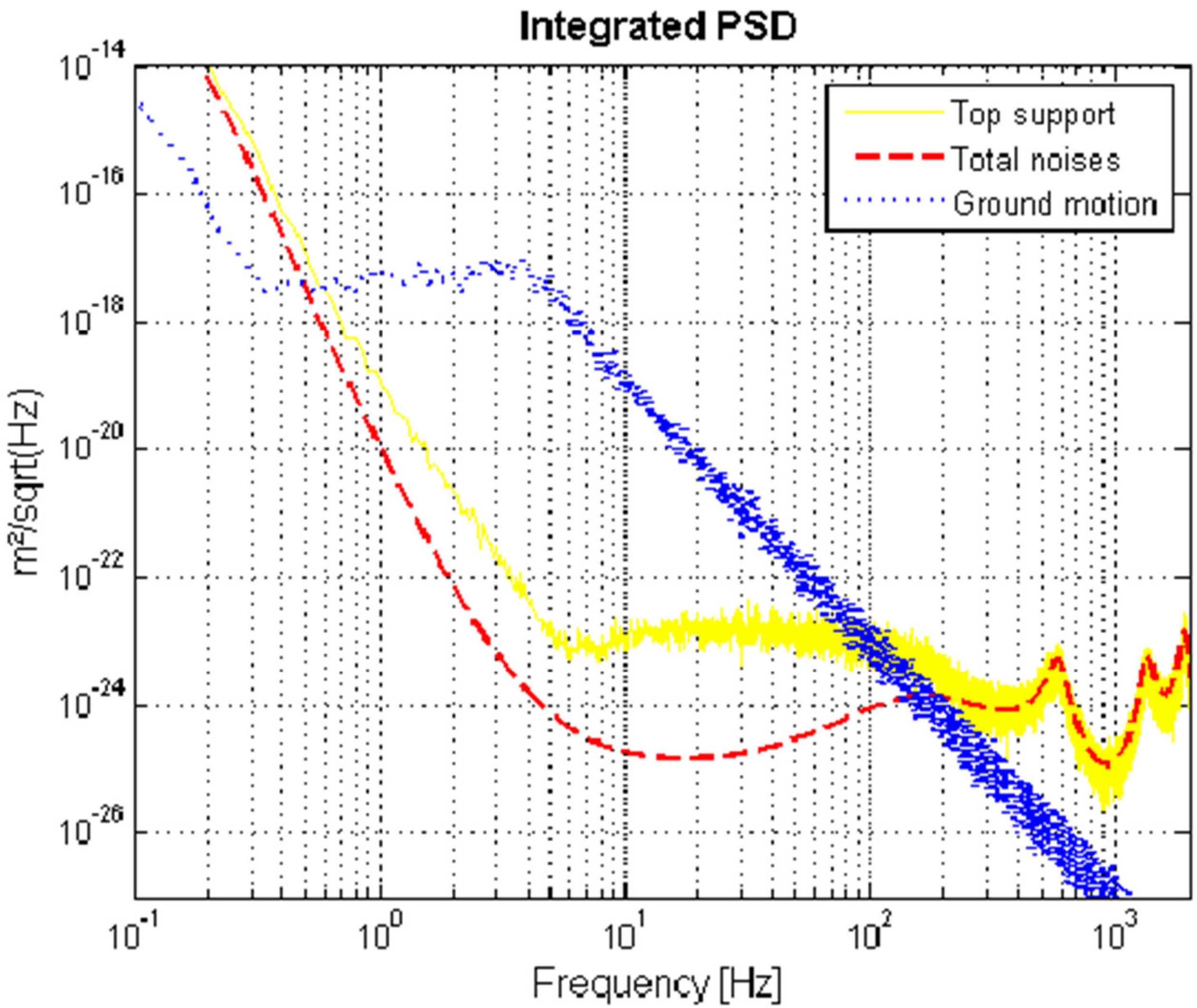
Plot for all sensor models in the uncertainty range

Integrated RMS - Analytical



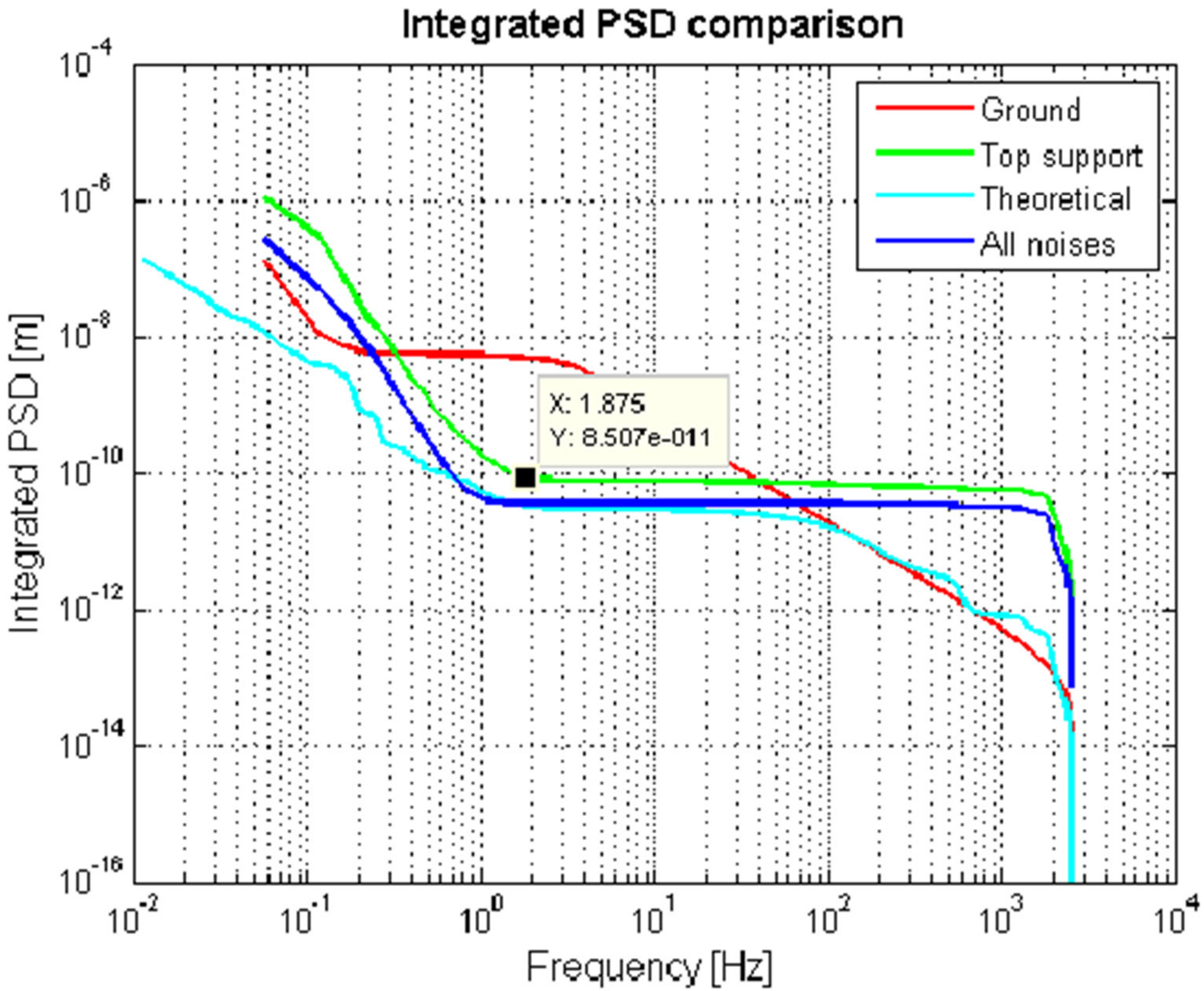
Uncertainties on sensor do not have drawbacks

Noises effects



Above 200 Hz limitation due to DAC noise

Integrated RMS : simulation



Nominal sensor
Sampling period= 0.1 ms
16 bits A/D
17 bits D/A
SNR DAC = 83 dB
SNR ADC = 97 dB
ADC = +/- 5V
DAC = +/- 15V

Sensor model

```
% sensor noise model
Re=4;
Im=6.5;
NoiseFilt= zpk([-2*pi*Re+Im*1i,-2*pi*Re-Im*1i,-2*pi*Re+Im*1i,-2*pi*Re-Im*1i],
           [-0.1 -0.1 -0.1 -0.1],sqrt(10)*1e-13);


% sensor TF
%no spurious frequencies above 600 Hz
zeta=0.25;
fc=5;
wn=2*pi*fc;
eps=0.001;%to avoid numerical problems with pure dervatives
wn_gur = ureal('wn_gur',wn,'Range',[2*pi*fc/2,2*pi*fc*2]);%uncertainty
zeta_gur = ureal('zeta_gur',zeta,'Range',[zeta/5,zeta*2]);%uncertainty
Guralp_vit=tf(1e6/wn_gur/wn_gur*[1,2*eps,eps*eps],
          [1/(wn_gur*wn_gur),2*zeta_gur/wn_gur, 1])*tf(1,[1e-5,1]);
```

Conclusion

- Previous simulations/real time tests match

- Under some modifications of the sensor model simulation succeed

- The proposed sensor model is a good candidate for LAPP support stabilisation