An accelerometer for spaceborne application with interferometric readout: LIG layout, the optoelectronic board and the phasemeter

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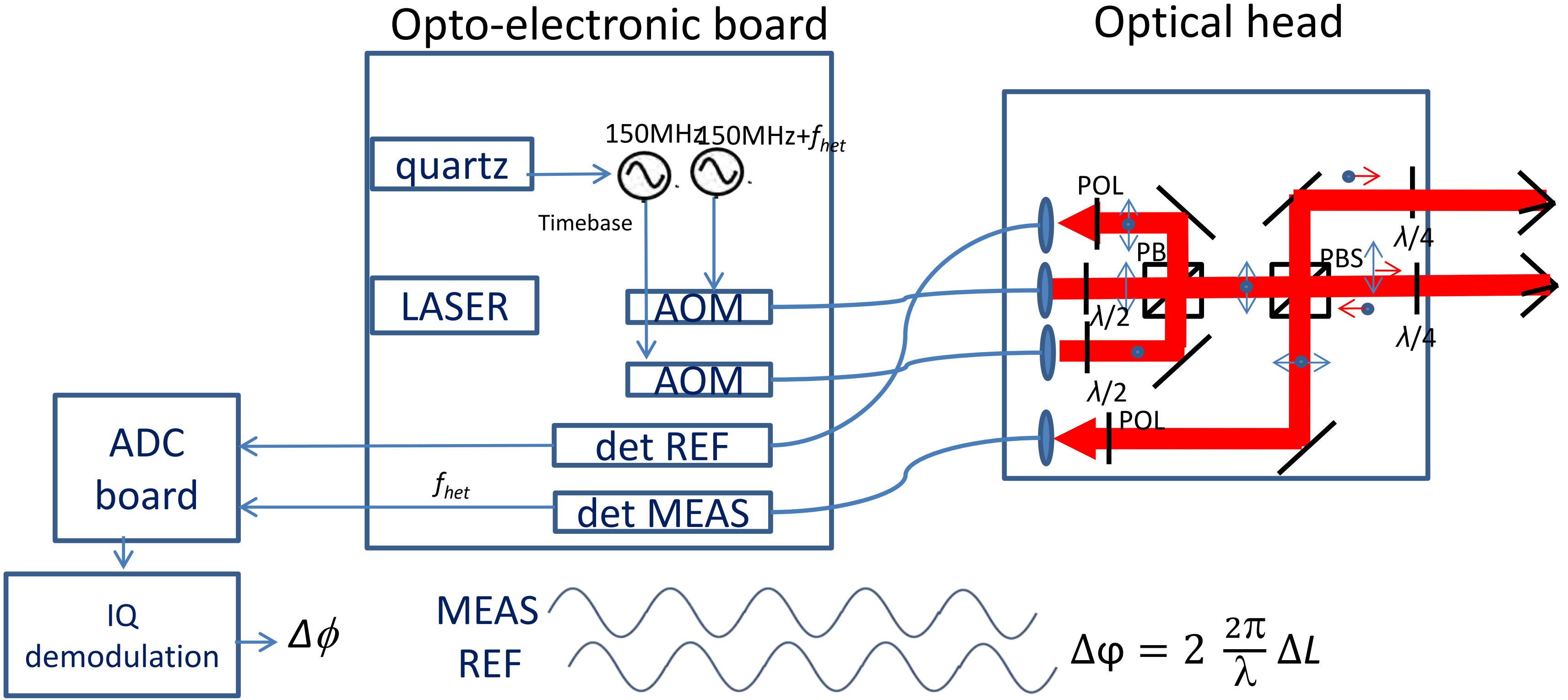
SETUP of LIG

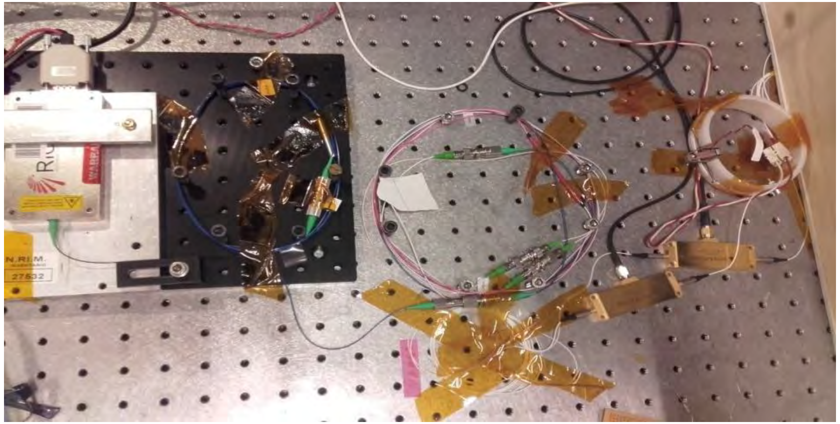


$$\Delta\varphi = 2\,\frac{2\pi}{\lambda}\,\Delta L$$

Laser characterization

The frequency noise of the laser $S_{\nu}(f)$ couples to the interferometer noise $S_L(f)$ through the equation proportional to the interferometer unbalance L_o: $S_L(f) = S_{\nu}(f)\,\frac{L_o}{\nu_o}$

λ = 1064 nm in coincidence of Nd:YAG laser
P = 10 mW
Linewidth = 10 kHz
Possibility to tune the frequency
PM fiber
Low phase noise free running



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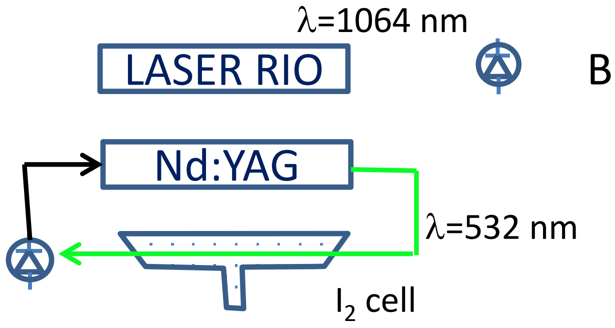
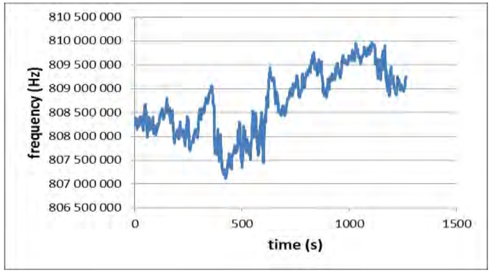


Beat note time series



INRIM Nd:YAG locked to iodine transitions at 532 nm has a relative stability of about 10^{-13} at 1 second and $S_\nu(f) < 10^3\ \mathrm{Hz}/\sqrt{\mathrm{Hz}}$

SI second

LASER RIO

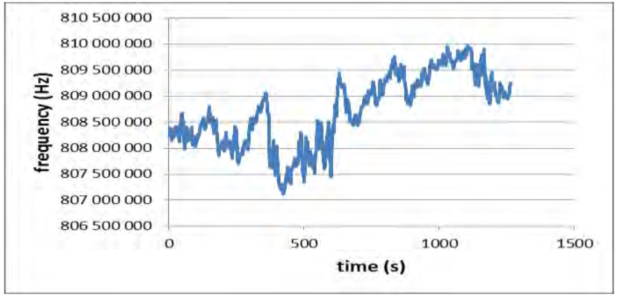
λ=1064 nm

→ Optical comb

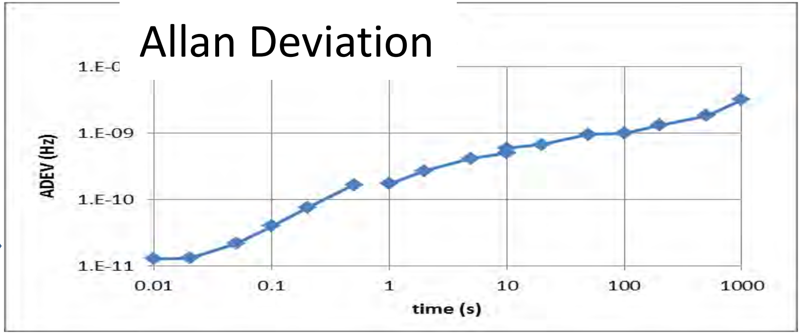
INRIM optical comb has a stability of $3\cdot10^{-13}$ at 1 s and accuracy 10^{-13}

Laser characterization

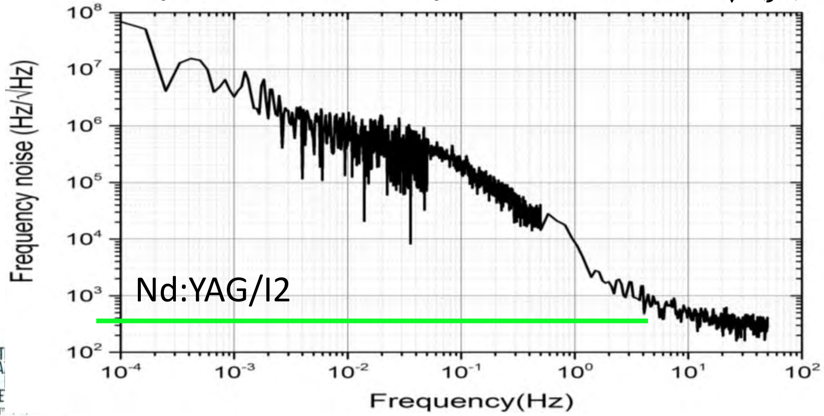
Beat note time series



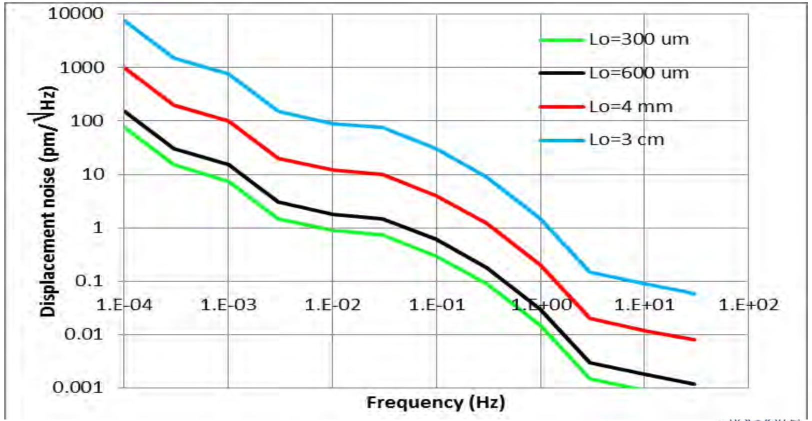
Allan Deviation



Power Spectral Density (measured) $S_\nu(f)$



Power Spectral Density (simulated) $S_L(f)$



Opto-electronic board

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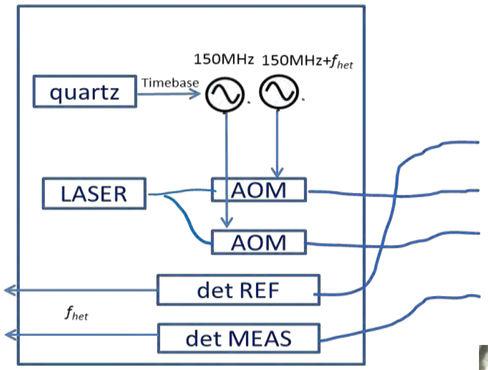
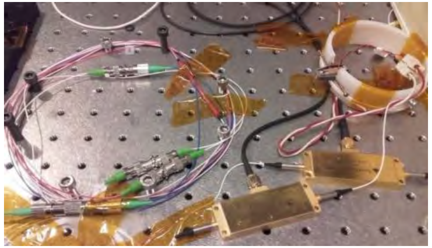
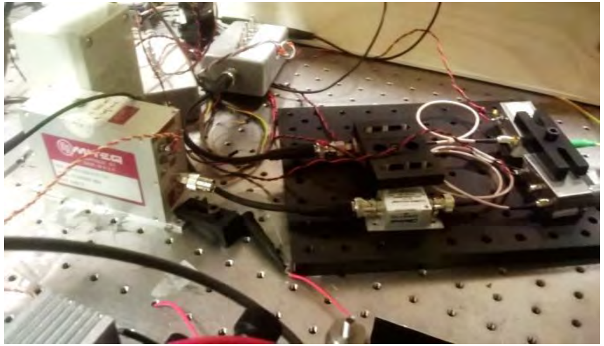
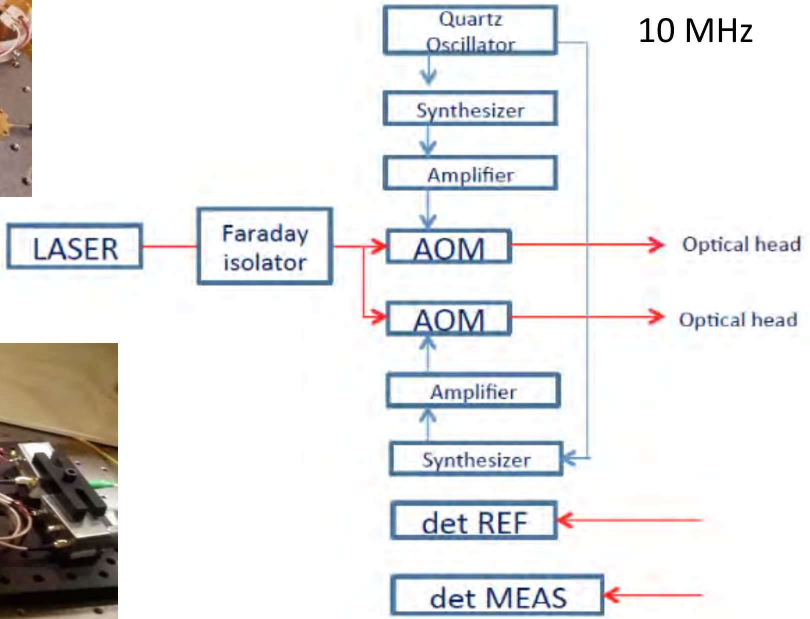




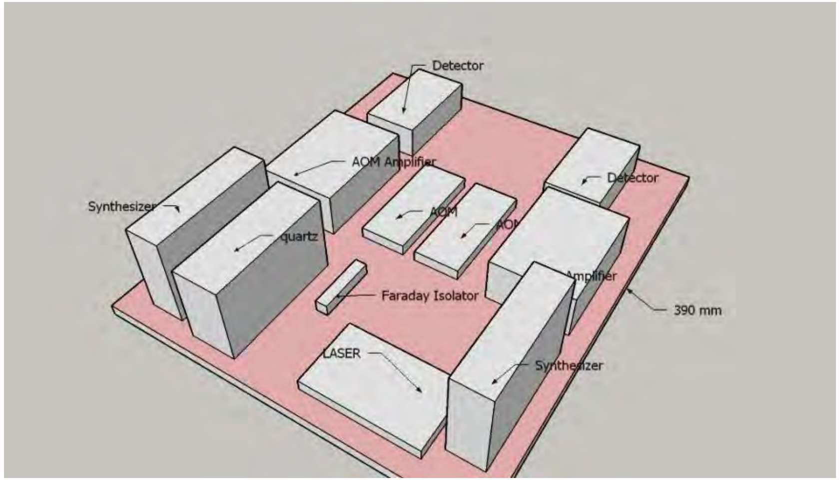


Opto-electronic flow chart



Opto-electronic board

3D view of the Opto-electronic board
39 cm x 32 cm board.
The total mass about 2.35 kg.
Pmax = 40W (using standard components not optimized for space).

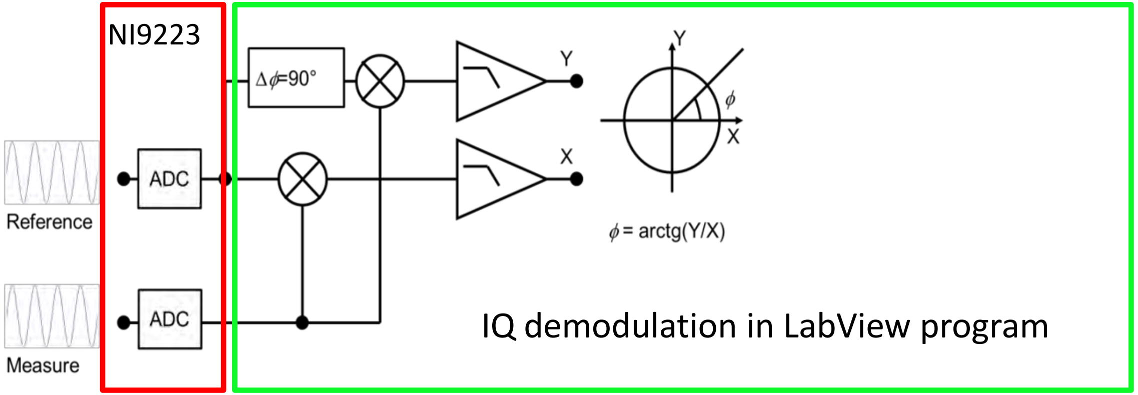


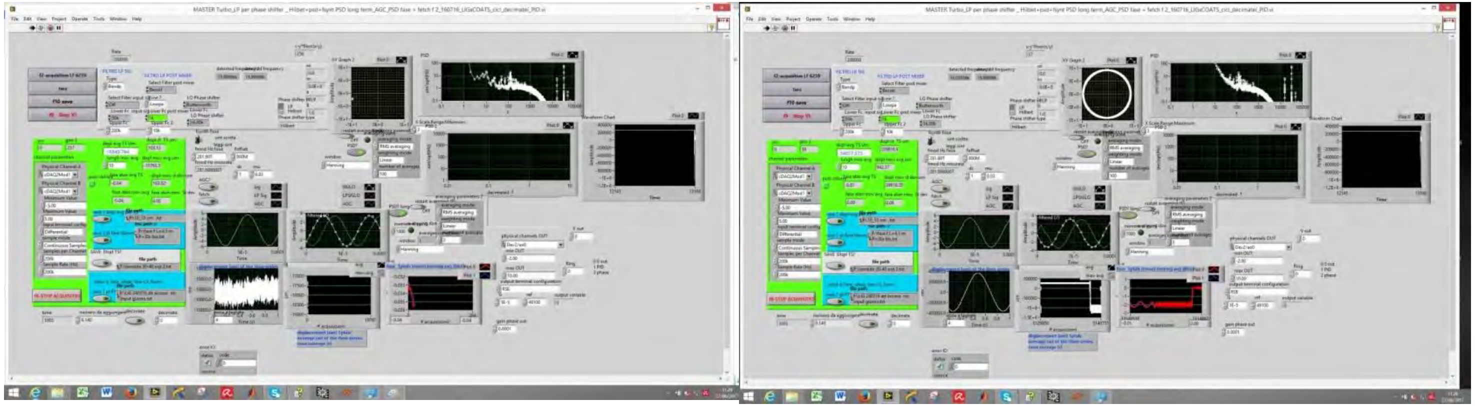
Opto-electronic devices

Digital Phase meter

ADC obtained with Analog to Digital Converter ADC (NI9223) with sampling rate up to 1 Msample/s with 16 bits of vertical resolution. IQ demodulation implemented in a Labview program

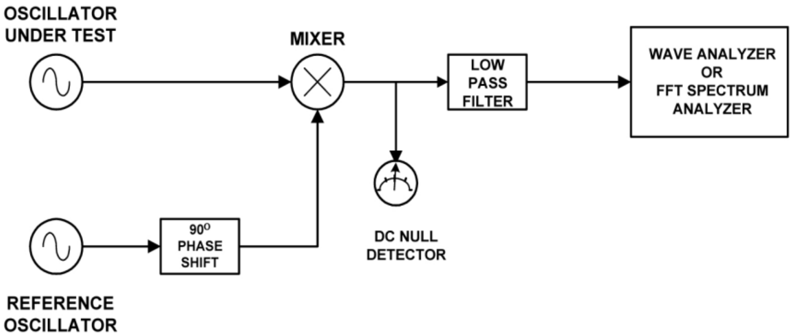
Signals at the heterodyne frequency
5 kHz < f_{het} < 100 kHz





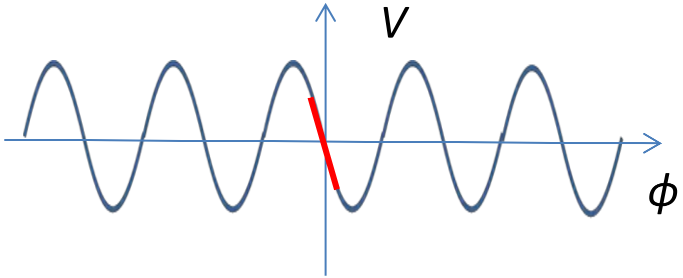
Digital Phase meter

Alternative technique based on mixers



PRO
Higher heterodyne frequency, up to some GHz
Higher bandwidth
Phase directly in voltage, it could be used as error signal to close a loop
CONS
The amplitude noise is measured as phase noise
The transfer function depends on the signals ampltude and must be measured

Mixer transfer function



Comparison of different digital phase meters