GINGER - Gyroscopes IN GEneral Relativity

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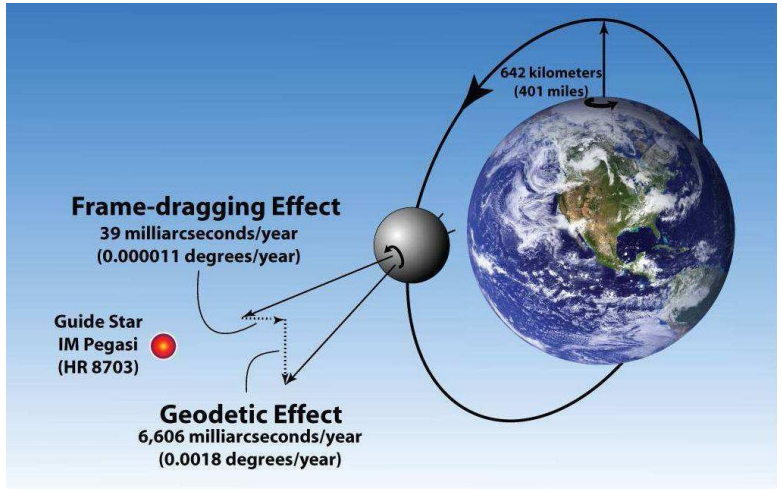
What is GINGER about?

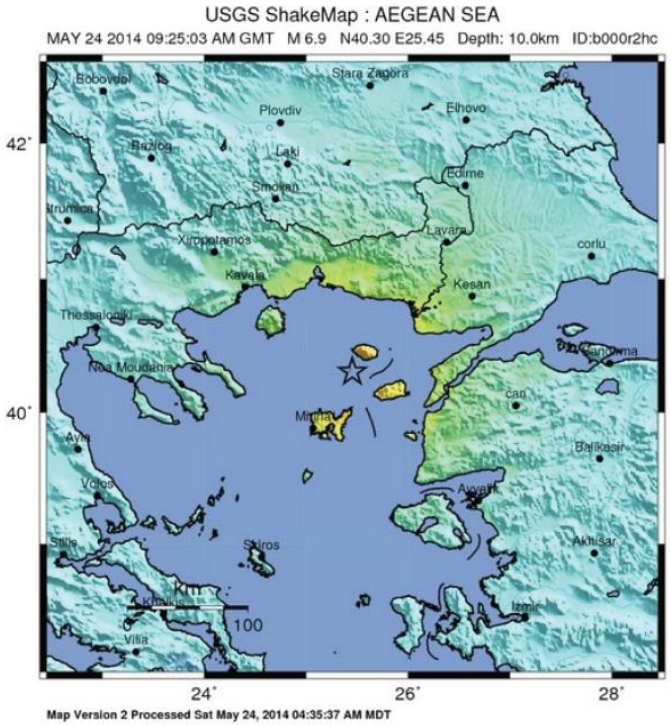
General Relativity

- De Sitter effect
- **Lense-Thirring effect**

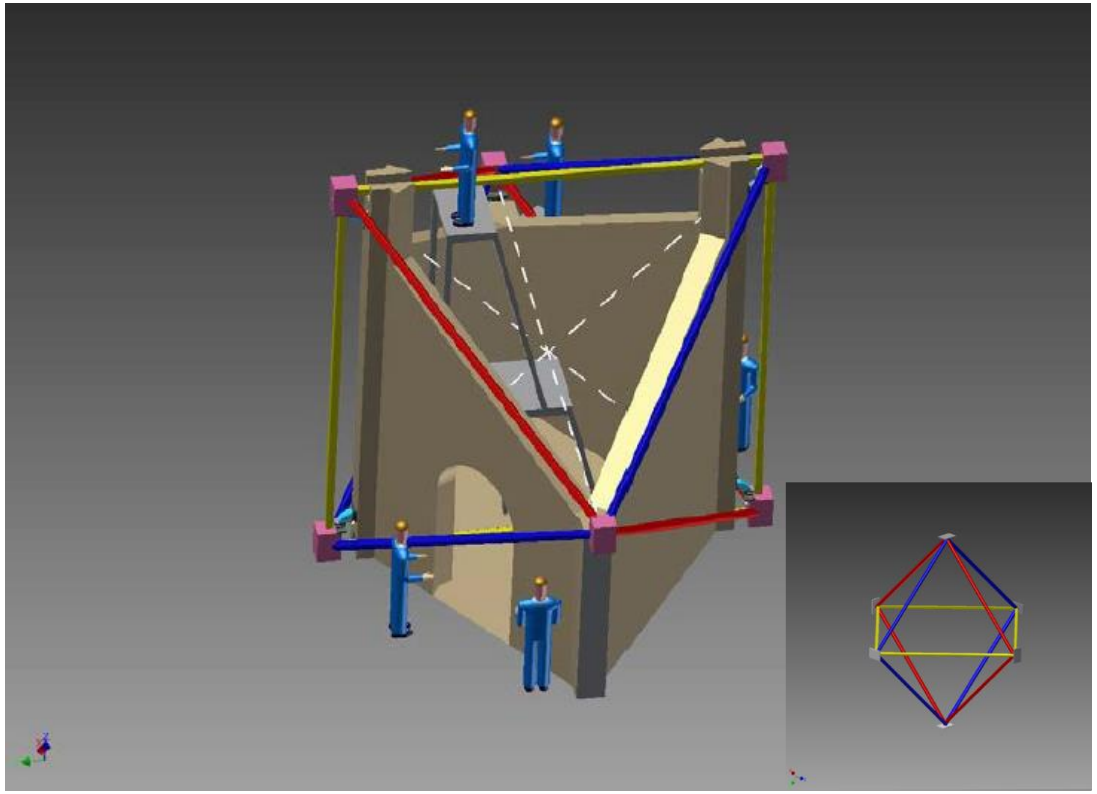


Geodesy and Geophysics

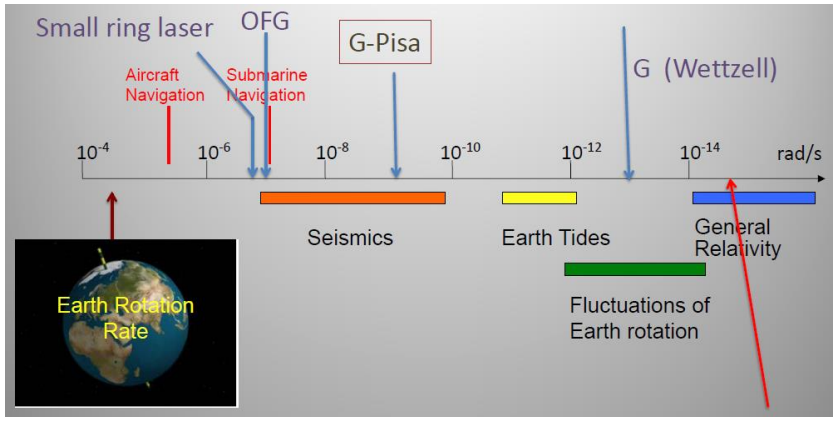
- Precise estimation of the Earth rotation (L.o.D.)
- **Seismology**



GINGER setup



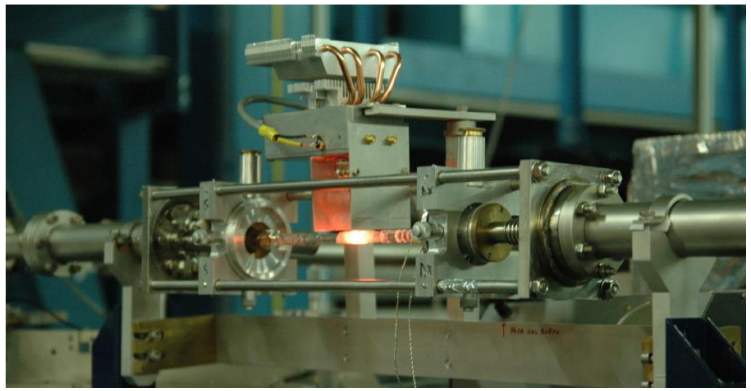
- 3 mutually orthogonal ring cavities (6-8 m side) nested in octahedral structure
- Fabry-Pérot resonators on diagonals and PZT actuators for geometry active control
- 25:1 He-Ne laser (1:1 20Ne-22Ne)

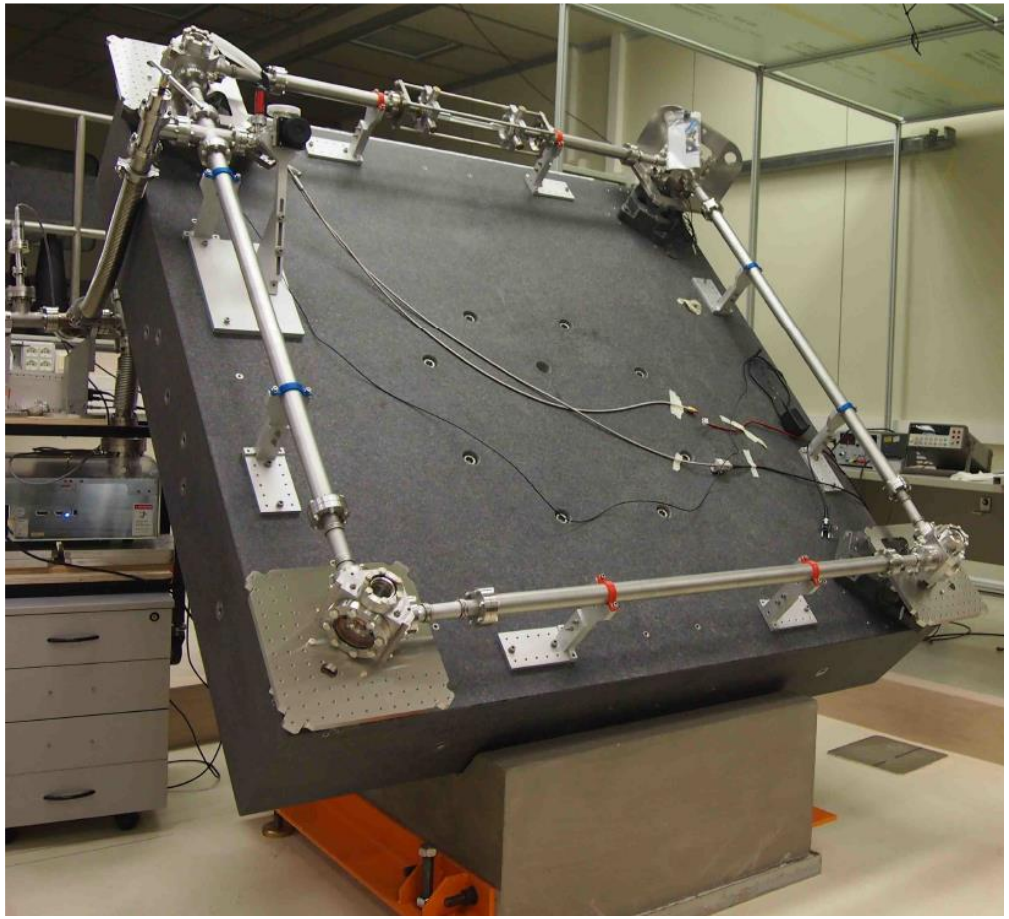


GP2

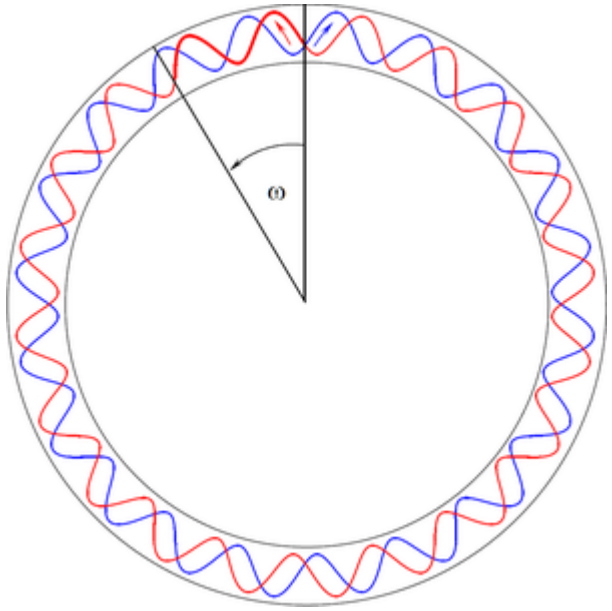
R&D for the GINGER experiment

- Square cavity (1.6 m side)
- Inclination of 47° with respect to the Earth rotation axis
- FP resonators and PZT actuators for geometry active control
- 25:1 He-Ne laser (1:1 20Ne-22Ne)



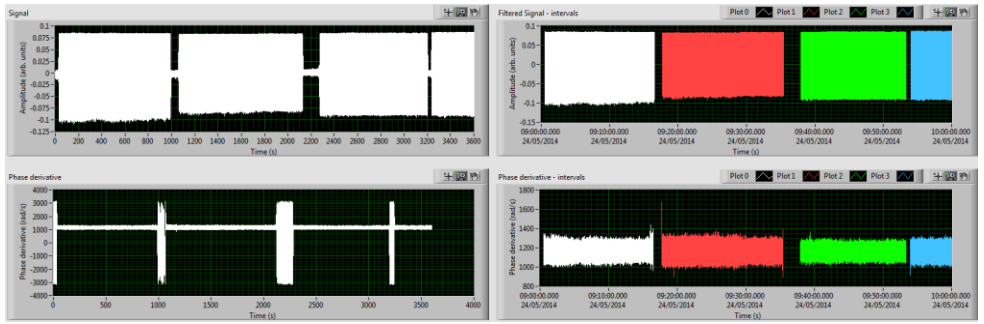


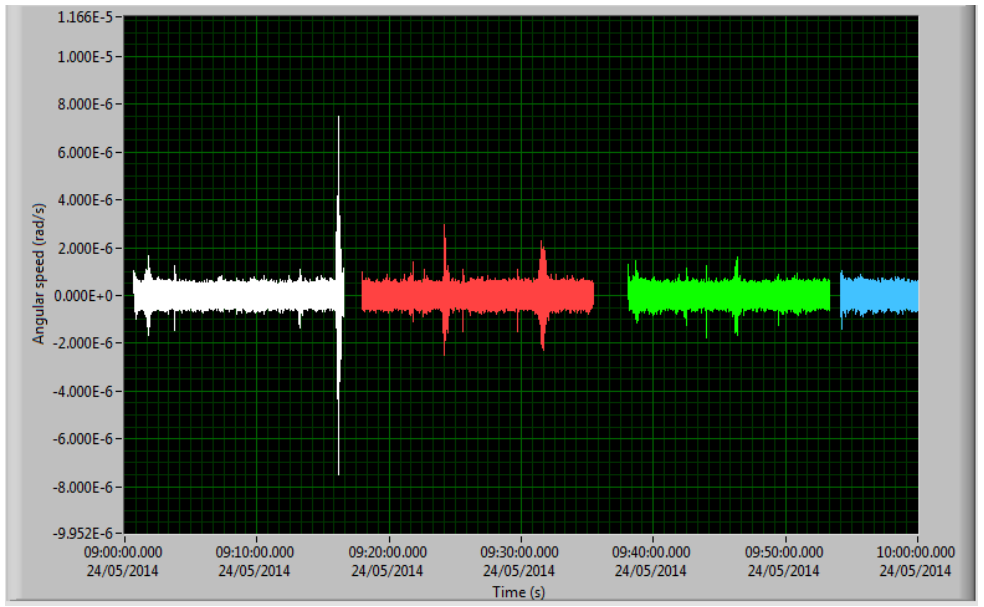
How does it work?



- The right-handed beam adjust itself to give a standing wave and the same happens for the left-handed beam
- Being the total time different for the two counterpropagating beams, also their wavelength is different
- As a result the ring laser converts time differences into frequency differences

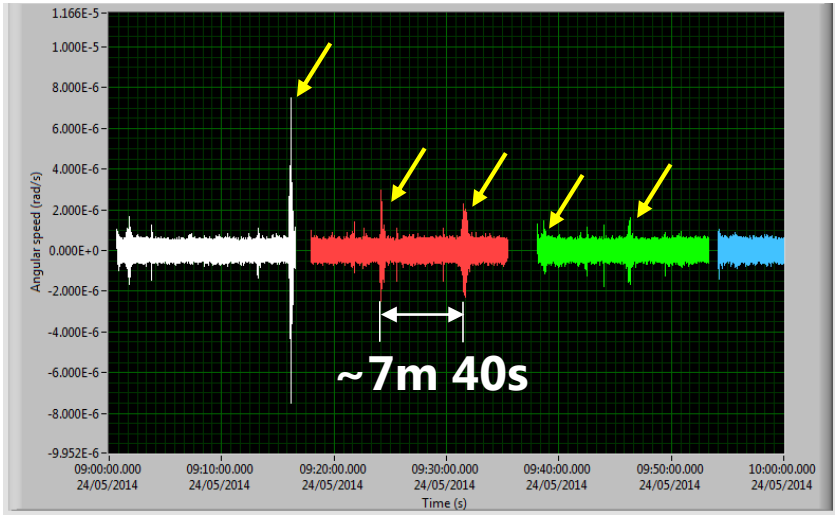
How to measure the angular speed

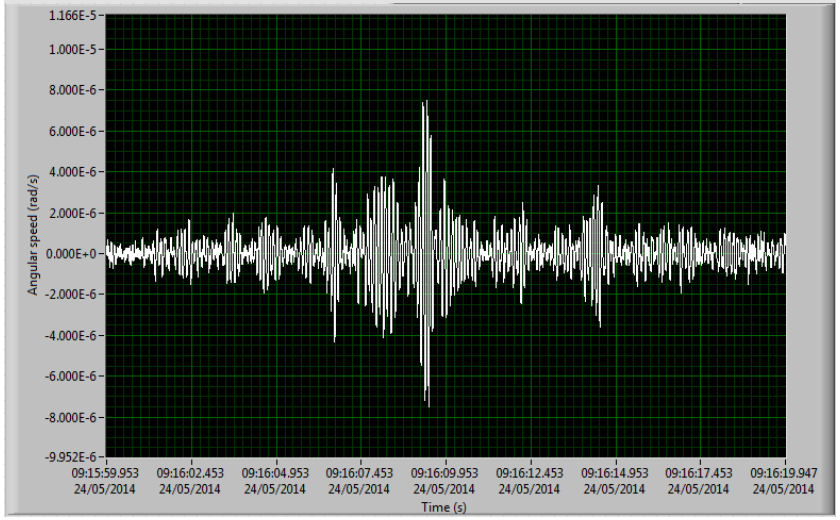


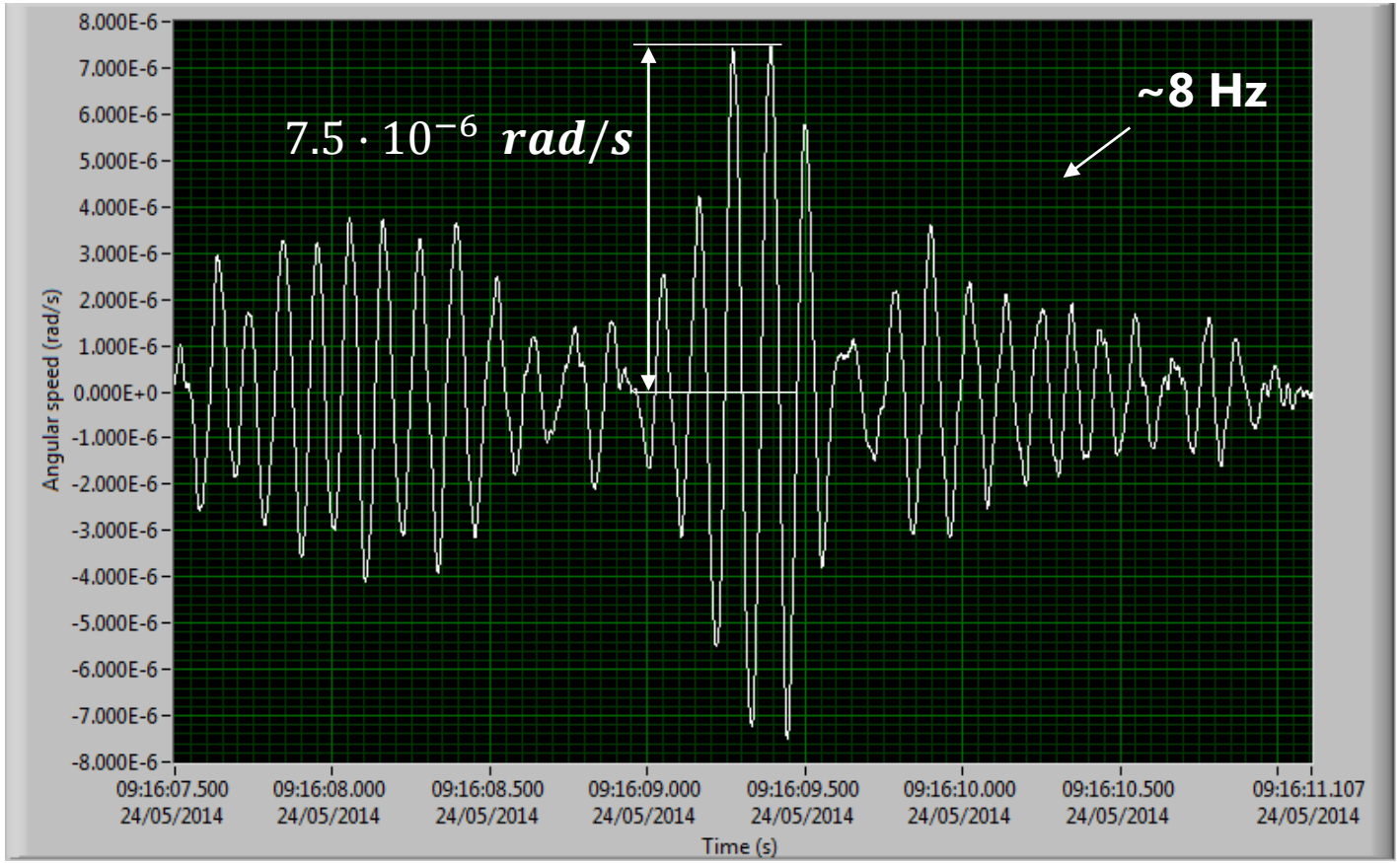


- Acquire the optical beat signal $g(t)$
- Combine the beat signal and its Hilbert transform $h(t) = H(g)(t)$ to form the analytic signal $f(t) = g(t) + ih(t)$
- Retrieve the phase ϕ between the counterpropagating laser beams from $f(t) = |f(t)|e^{-i\phi}$
- Unwrap the phase and express it in the form $\phi = 2\pi f_s t$
- Calculate $\frac{d\phi}{dt}$, which is related to Ω trough the scale factor S
- Calculate $\Omega = 2\pi \frac{l}{\lambda} \frac{d\phi}{dt}$
- Calculate the Earth angular speed by averaging the obtained Ω
- Calculate the seismic wave induced angular speed by subtracting the angular speed of the Earth

The seismic wave







Results

$$\Omega_{\oplus} = (7.30 \pm 0.03) \cdot 10^{-5}\ rad/s$$

$$\Omega_{\oplus}{}^{ref} = 7.2921150(1)\ rad/s$$


That's all Folks!