

# SPIN

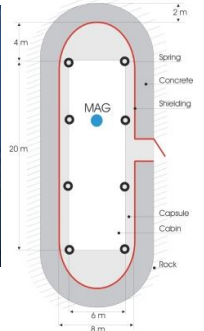
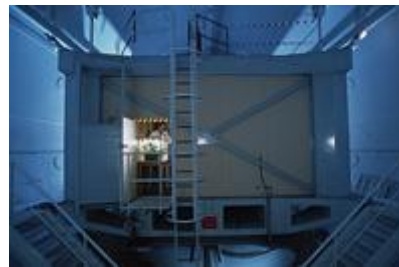
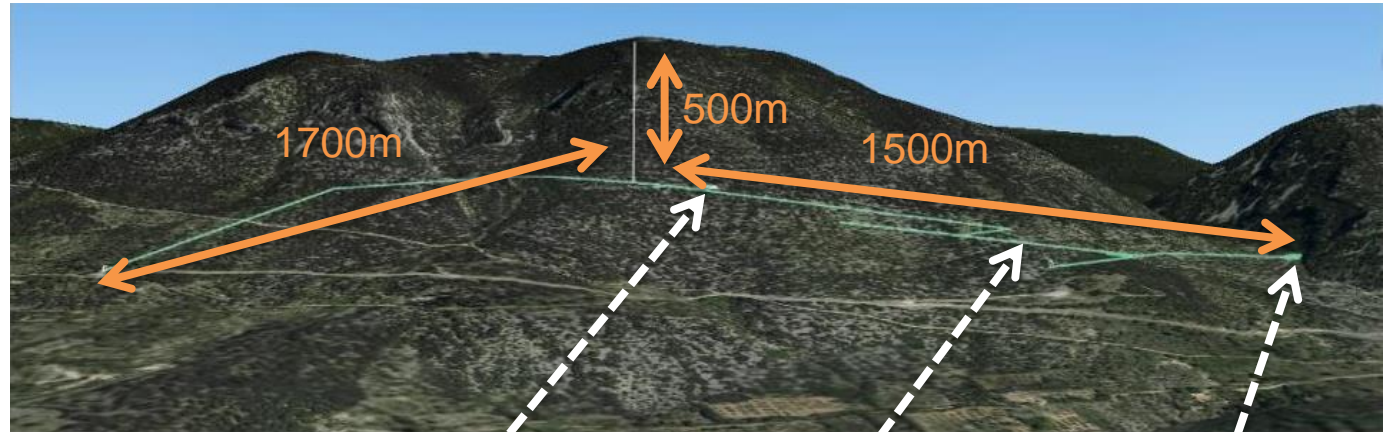
## MONITORING A RESTLESS EARTH

<http://spin-itn.eu>

# Partner: LSBB (Laboratoire Souterrain Bas Bruit), France



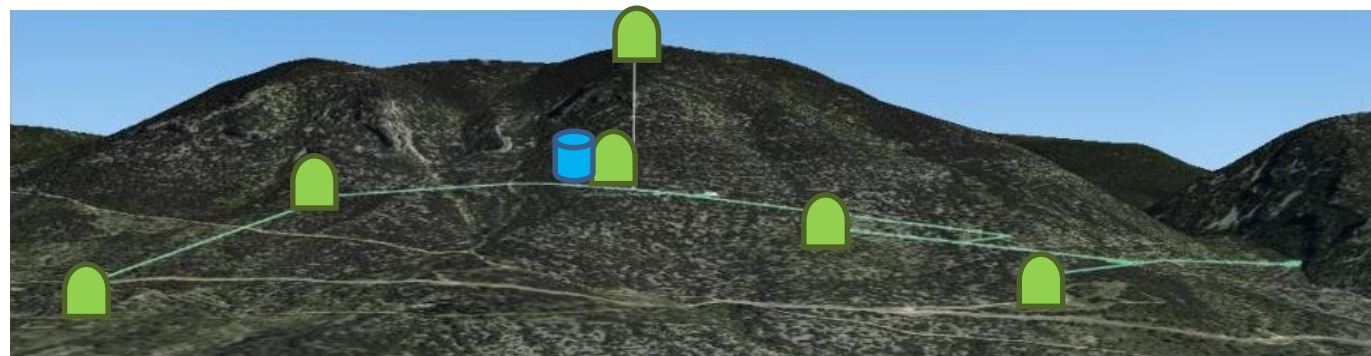
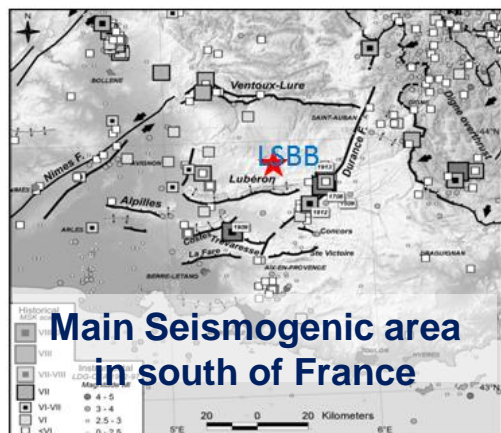
- Researchers involved in SPIN: **Stéphane Gaffet** (CNRS-LSBB)
  - ESR1.1 (6DoF measurement),
  - ESR2.2 (field deployment design consideration)
  - ESR3.3 (Intersectoral Supervisor & field deployment data set)



## ■ Infrastructure

- **Ground & underground based fully equipped facility**
- **Access to surface** in a regional natural park and **access to depth** (4 km long gallery)
- Boreholes for instrumentation from surface and galleries
- EM Shielded Capsule 28 m × Ø8 m at 518 m depth

# LSBB Underground Research Laboratory in a low noise environment



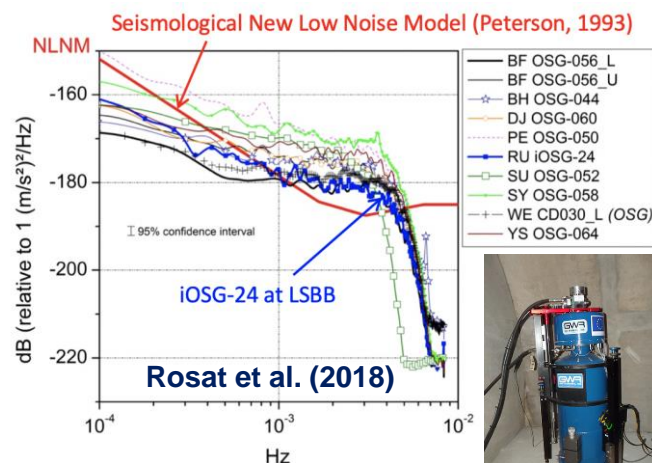
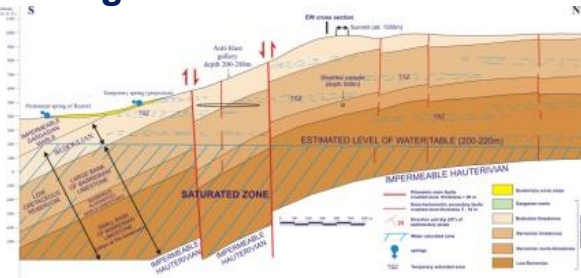
## Superconducting gravimetry

One of the quietest sites in the world



## 3D dense STS2 Array

## Urgonian Carbonate Platform

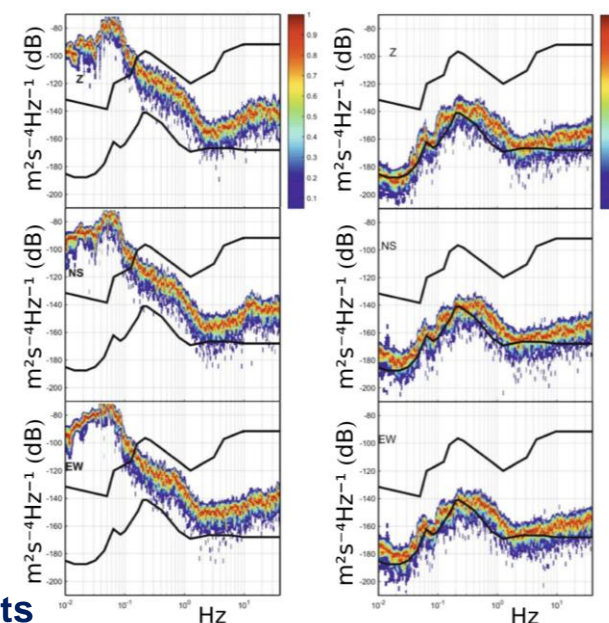


## Low-noise seismic properties

Seismic noise PSD for three compared to Peterson's noise models (black lines).

Tohoku-Oki EQ

Quiet day



## Environment

- Low anthropogenic noise (within the Regional Nature Park of Luberon)
- A well known Urgonian platform in the main perimediterranean hydrogeological reservoir
- Major Seismogenic Region South of France

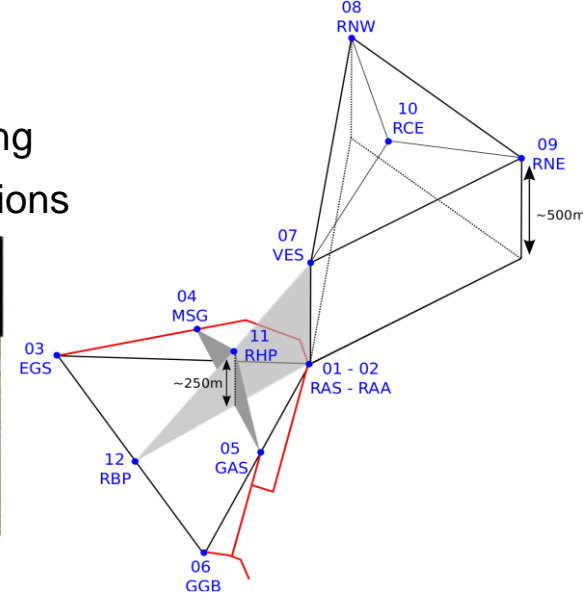
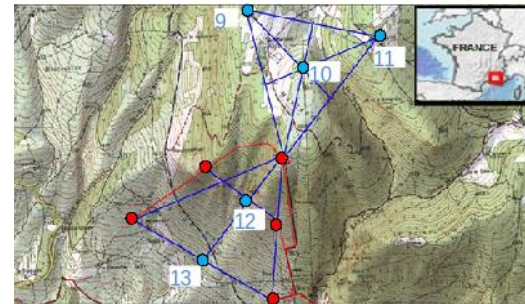
## An unique multi-scale Research Infrastructure for ultra-sensitive science

Open to everyone respecting the environment necessary to other experiments



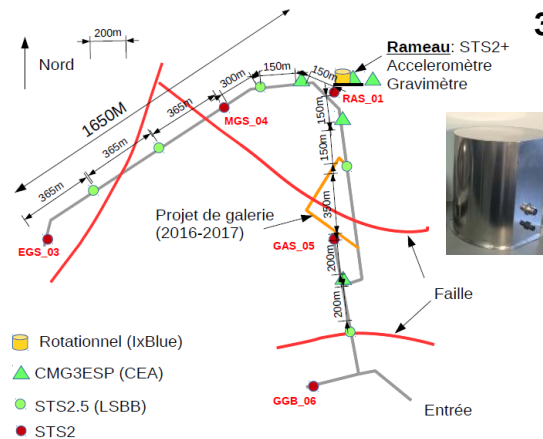
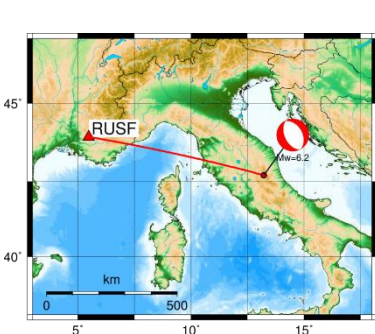
# What are major projects with links to SPIN?

- CEA-LSBB Research agreement on Dense 3C seismic antenna processing
  - Upgrade of the LSBB Broad-Band Seismic array with 5 surface Stations
  - 3C array processing (Labonne 2016)
  - Array Derived Rotation measurement (Rusch 2020)

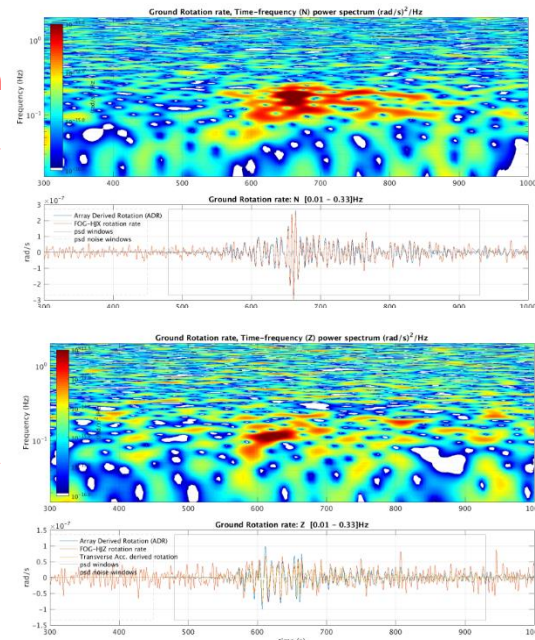
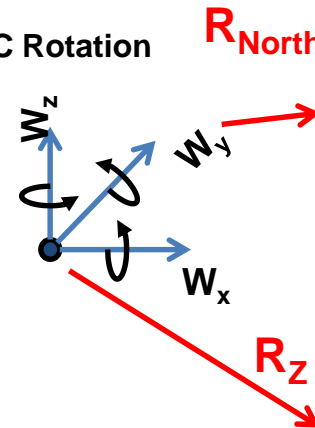


## What new/original instrumentation types are you using?

- Test of a BlueSeis3A prototype (2016 Oct.)



3x1C Rotation

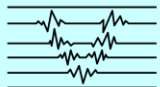


### The Norcia EQ:

- Magnitude: 6.5
- Epicentral distance: 650km
- RZ:  $10^{-7}$  rad/s, RN:  $3 \times 10^{-7}$  rad/s; Noise level:  $40 \text{ nrad/s/Hz}^{0.5}$

## Which instrumentation is necessary to address your scientific issues?

- Installation of Seismic Gyroscopes for direct rotation motion measurement



**SPIN** MONITORING A RESTLESS EARTH

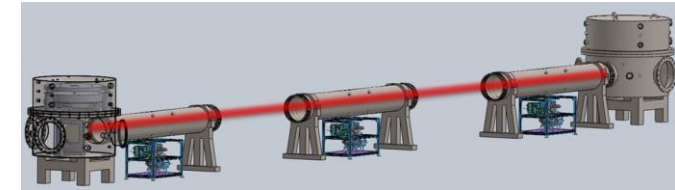
SPIN Workshop 1, 2021 -- Tutzing, Germany

# Any new aspect on the horizon?

## The MIGA Project: Atomic interferometer for gravitation gradient investigation

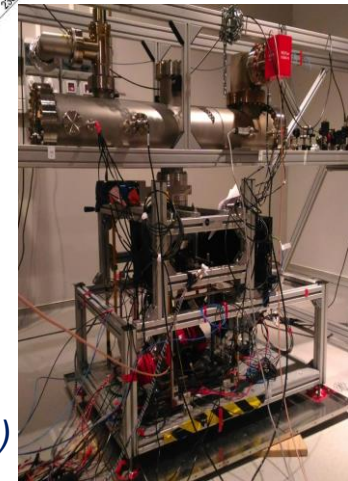
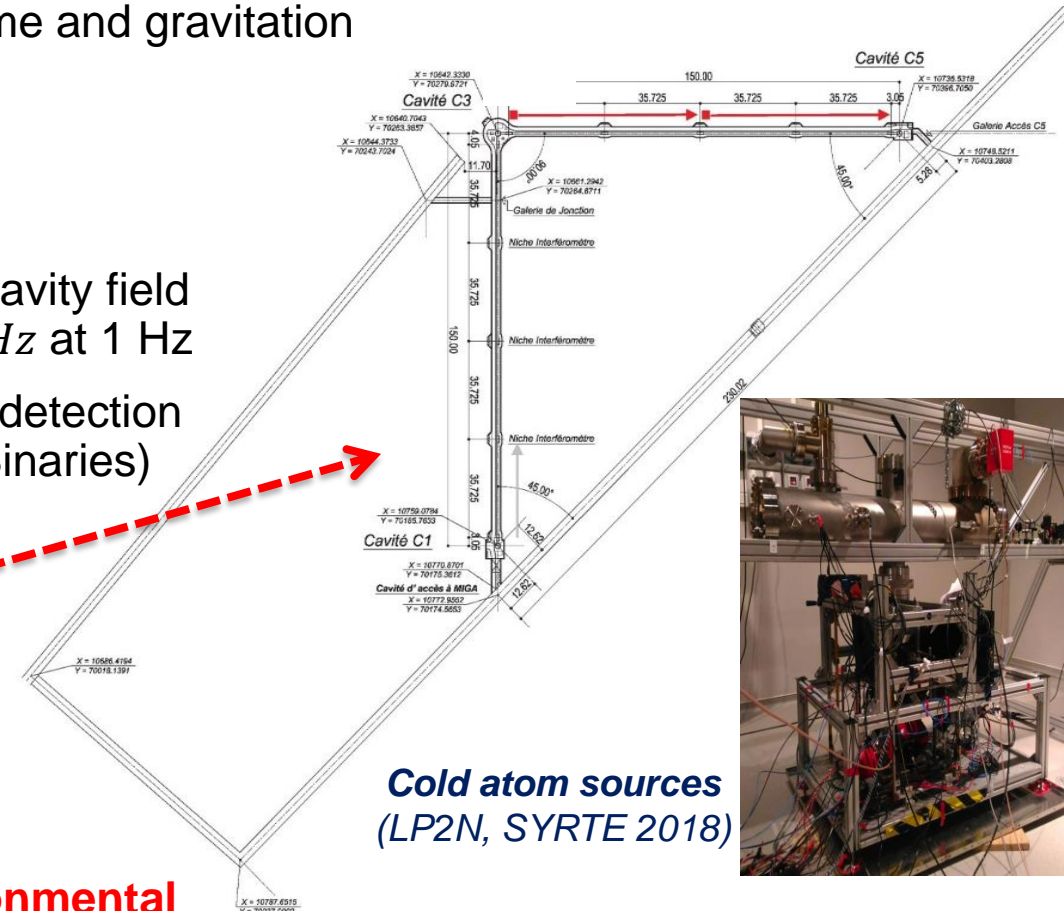
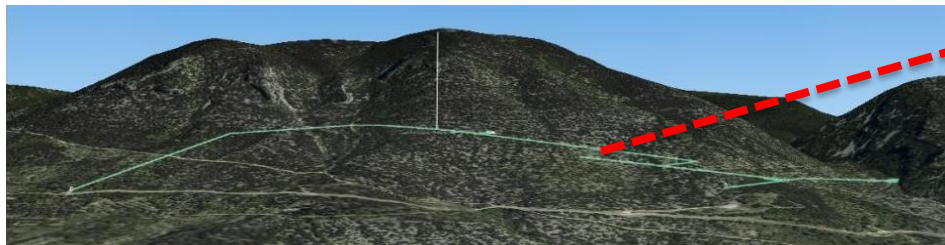
### Matter wave - laser based Interferometer Gravitation Antenna

- building the first laser-based atomic interferometer to study variations of the strain tensor of space-time and gravitation (<https://www.miga-project.org>)



### New metrology for interdisciplinary issues

- Very small changes in local to regional gravity field  
Gravity gradient sensitivity  $\sim 10^{-13} \text{ s}^{-2}/\text{Hz}$  at 1 Hz
- Low frequency Gravitational Wave (GW) detection (0.1 – 10 Hz) in astrophysics (Compact Binaries)



### Explore the instrumentation and the environmental conditions of the future underground GW Observatories