

Ondes gravitationnelles et détection des séismes

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on behalf of the
APC/IPGP/INFN/Univ-Nice
« E-GRAAL » and « PEGASEWS »
Collaboration

The “big picture”

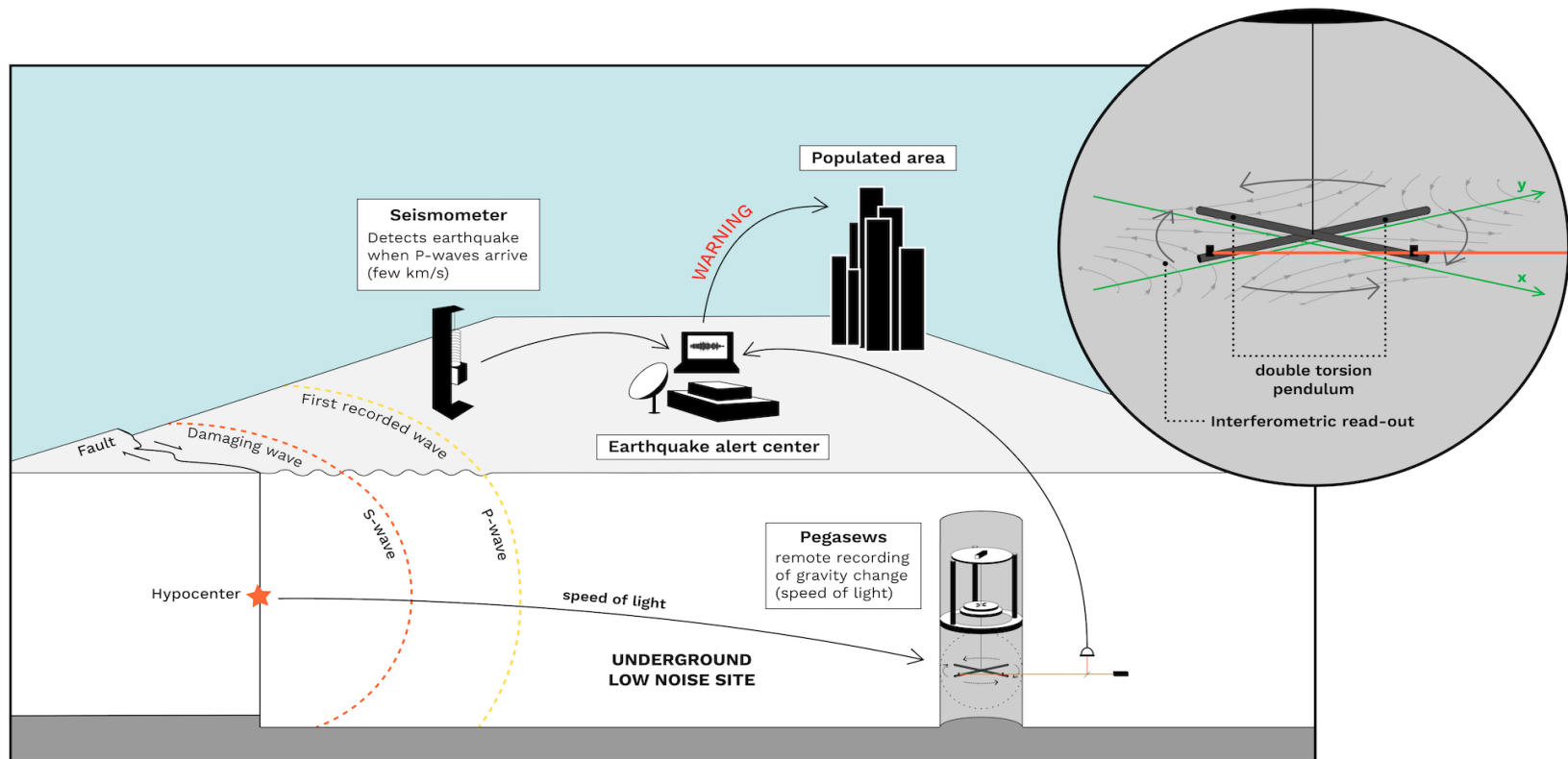
Seismic disturbances are a noise for gravitational-wave detectors and a signal for geophysics

- How geophysics experience and instrumentation can contribute to GW science? **Geophysics→GW**
- How GW experience and instrumentation can contribute to geosciences and their applications?
GW→Geophysics

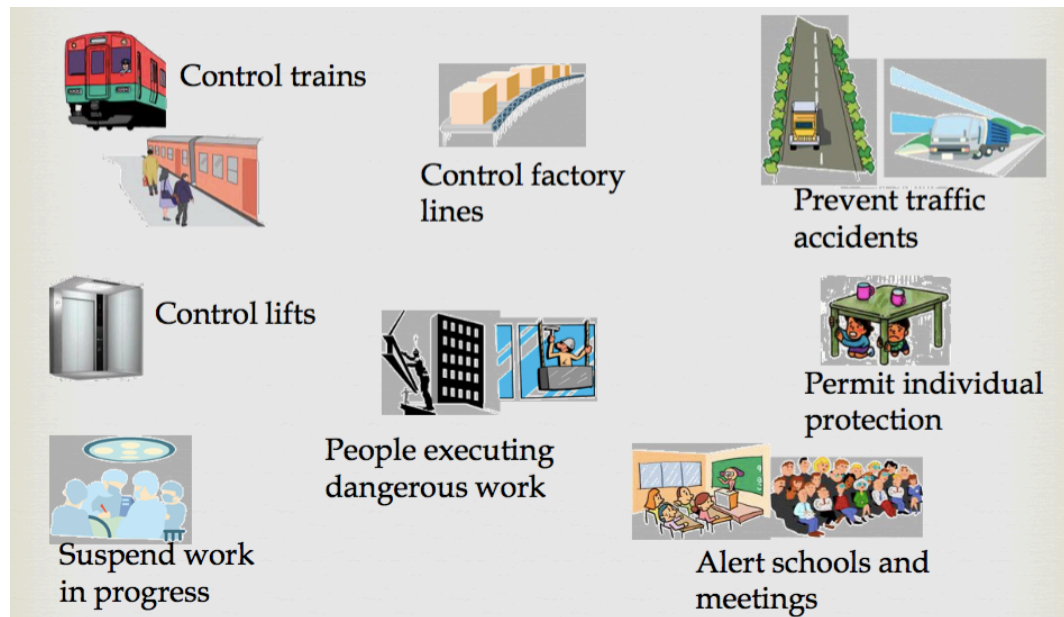
Prompt gravity signals from earthquake

- Detection of the prompt earthquake gravity perturbations (before the arrival of the seismic waves)
- A new messenger
 - To improve the current earthquake early-warning systems
 - To open a new field: the « speed of light seismology »

New earthquake early warnings



Potential benefits of a gravity-based early warning system



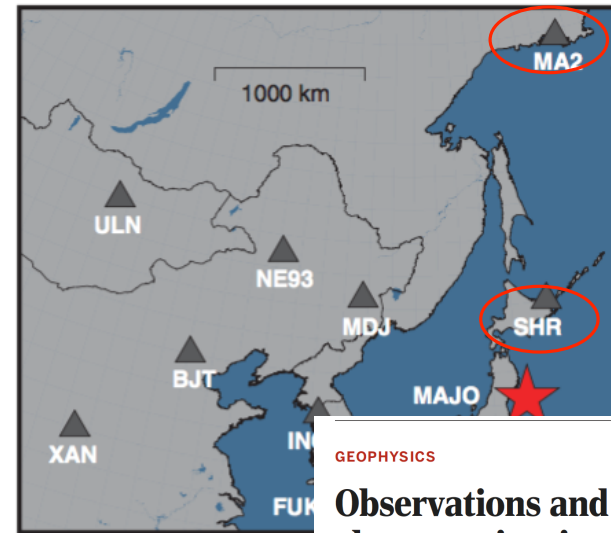
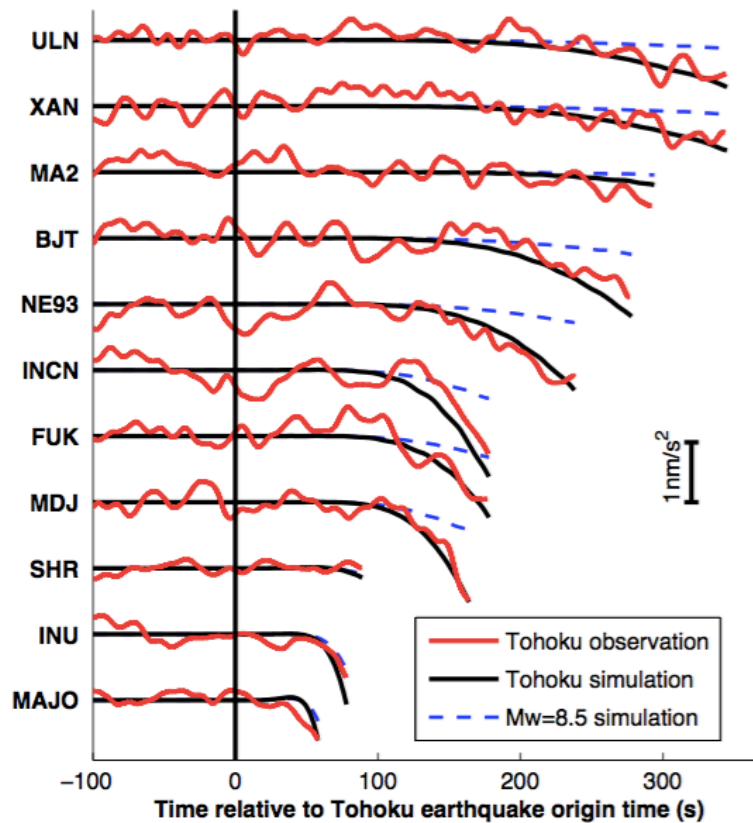
- Increase of available time for warning
- Reduction of the blind zone
- Quicker estimation of the magnitude

Research on going since 2012

Funding by Labex UnivEarthS and ANR

- Modeling of the signal (2 publications)
- Search of a gravity signal in the existing data (3 publications)
- Current instruments limitation → Requirements of future instruments (1 publication)
- Feasibility study of new detectors (1 publication in preparation)
- Impact of local gravity noise (also called Newtonian noise) (1 publication)
- Detailed study of the detector
- Realization of new detectors (ERC synergy project submitted)

Gravity signal from the Tohoku earthquake

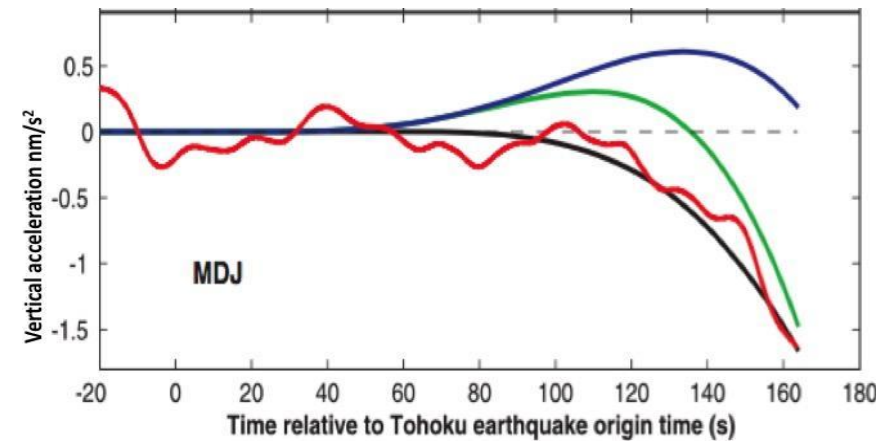
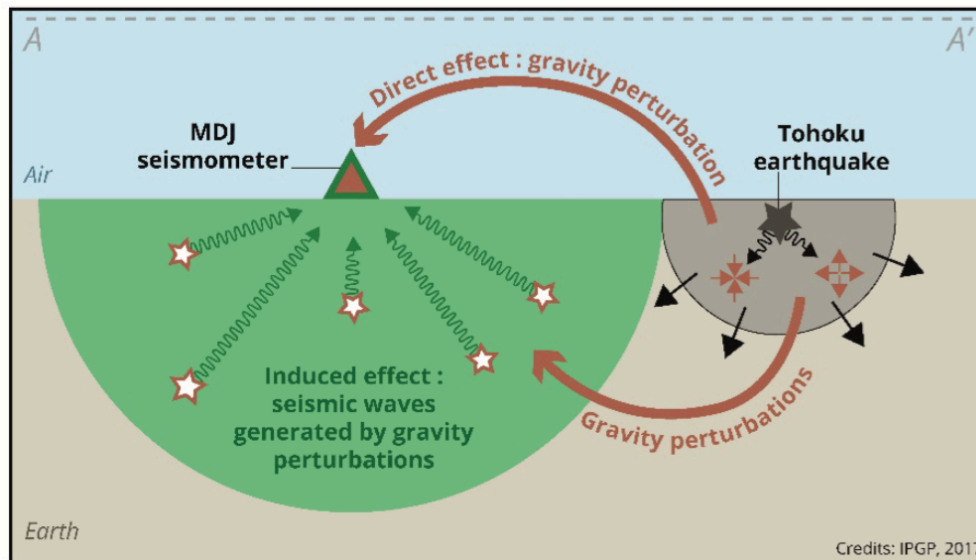


GEOPHYSICS

Observations and modeling of the elastogravity signals preceding direct seismic waves

Martin Vallée,^{1,*} Jean Paul Ampuero,² Kévin Juhel,¹ Pascal Bernard,¹
Jean-Paul Montagner,¹ Matteo Barsuglia³

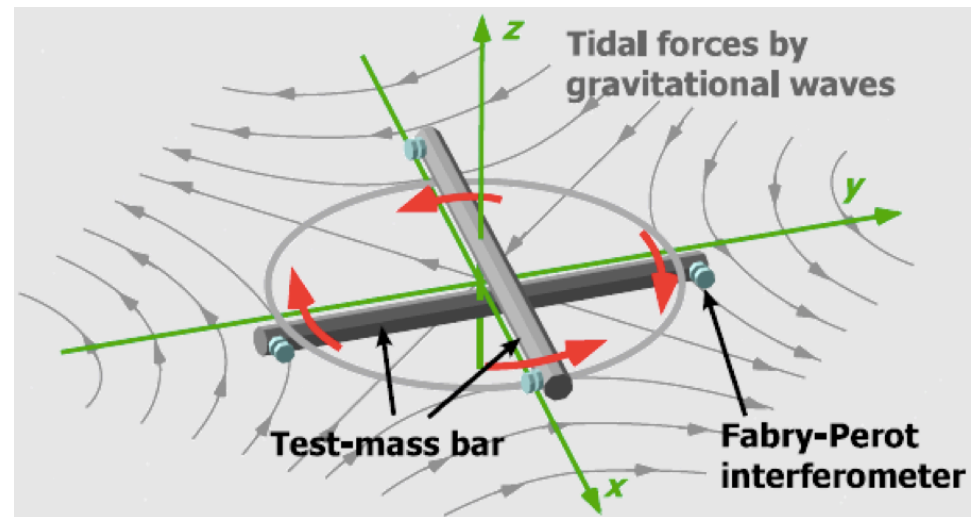
The limitations of seismometers and gravimeters: seismic noise and cancellation effect



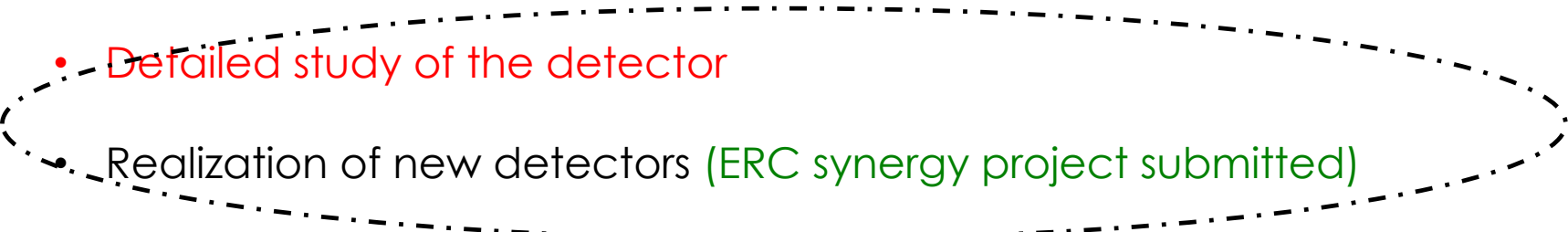
Tohoku 2011: lessons learned

- Signal in seismometers and gravimeters
 - Can detect gravity signals for $M \sim 8$ in > 60 sec
 - Signals limited by seismic noise and cancellation effect
- More sophisticated signal processing possible but **intrinsic limitation**
- In order to detect $M \sim 7$ in ~ 10 seconds new instruments are necessary
 - strainmeters with seismically isolated test masses
 - Measurement of gravity strain instead of gravity acceleration

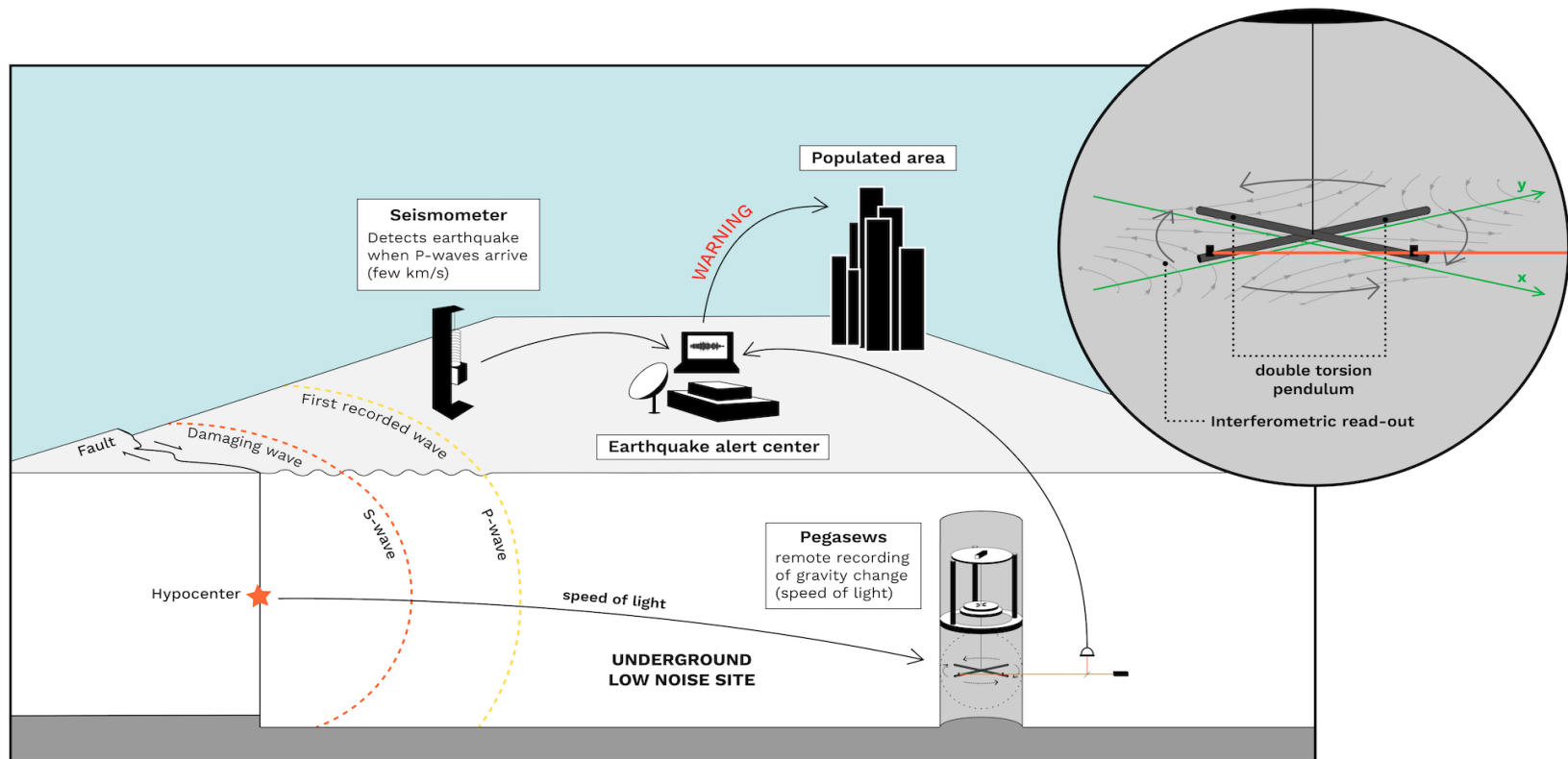
Gravity strainmeters



Our path

- Modeling of the signal (2 publications+1 being finalised)
 - Search of a gravity signal in the existing data (3 publications)
 - Current instruments limitation → Requirements of future instruments
 - (1 publication)
 - Feasibility study of new detectors (1 publication in preparation)
 - Impact of environment: local gravity noise (1 publication)
 - Detailed study of the detector
 - Realization of new detectors (ERC synergy project submitted)
- 

New earthquake early warnings



Summary and some concluding remarks

- Gravity signals from earthquake: a new messenger for geophysics
- Potential impact in earthquake early warning systems, but new instruments necessary
- Technologies and experience from gravitational-wave research – a spin-off with a societal impact
 - Precision optics interferometry and stabilized lasers
 - Suspension systems
 - Electronics (analog and digital)
 - Data analysis algorithms
- Current funding, through Labex 2020 (possibly 2021-2022) à post-doc APC-IPGP
- Instrumentation development needs a collaborations and ressources
- ERC synergy (answer in fall 2020)
- Synergies with LISA and Einstein Telescope (detection at low frequency)