



 **EGO** EUROPEAN  
GRAVITATIONAL  
OBSERVATORY

The quest for  
gravitational waves



# Gravitation: EU Excellence

- **Kepler, Ticho Brahe, Copernicus**
- **Galileo, Newton**
- **Einstein, Eötvös**
- **Amaldi & the resonating antennas**
- **The era of interferometers:**
  - GEO600 & VIRGO in EU**
  - LIGO in USA, TAMA in Japan**

**An active field:**

**Advanced detectors (VIRGO, LIGO, GEO600)**

**LCGT in Japan**

**IndIGO in India**

**Australia**

...



# EGO in synthesis



EGO:  
French-Italian  
Consortium to support &  
operate VIRGO

and  
promote cooperation  
on Gravitational  
Waves physics  
in Europe





# EGO/VIRGO

## A large infrastructure :

- 3 km long arms:  $\Delta L / L = 10^{-21}$
- 60 ha of land;  $\sim 150000 \text{ m}^3$  of buildings
- The largest high vacuum system in Europe :  $7000 \text{ m}^3$   
 $P \approx 10^{-9} \text{ mbar}$
- High tech optics
- Several class 10 clean rooms ;  $15000 \text{ m}^3$  thermo  
stabilized to  $\pm 0.2 \text{ }^\circ\text{C}$
- 600 kW electrical power
- 24h/24h data taking; 1 TB/day collected





# EGO / VIRGO

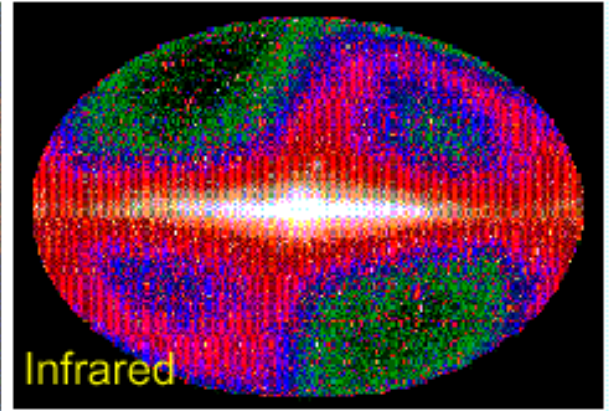
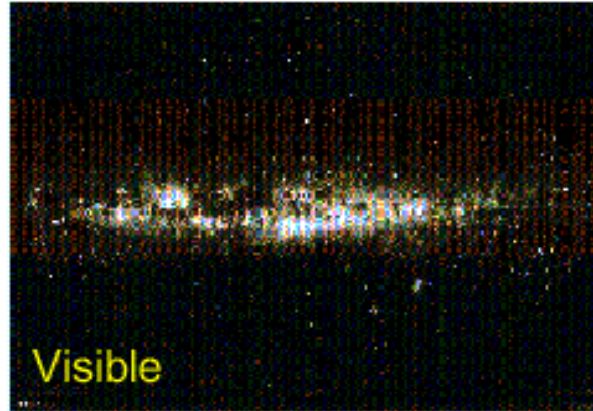
- ❑ LAPP – Annecy
- ❑ NIKHEF – Amsterdam
- ❑ RMKI - Budapest
- ❑ INFN – Firenze-Urbino
- ❑ INFN – Genova
- ❑ INFN – LNF
- ❑ LMA – Lyon
- ❑ INFN – Napoli
- ❑ OCA – Nice
- ❑ LAL – Orsay
- ❑ APC – Paris
- ❑ LKB - Paris
- ❑ INFN – Padova-Trento
- ❑ INFN – Perugia
- ❑ INFN - Pisa
- ❑ INFN – Roma 1
- ❑ INFN – Roma 2
- ❑ POLGRAV - Warsaw



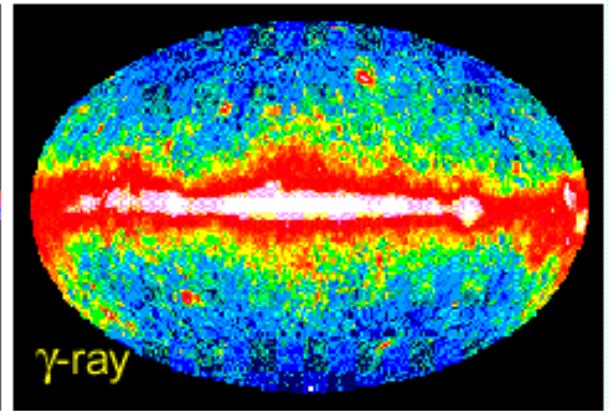
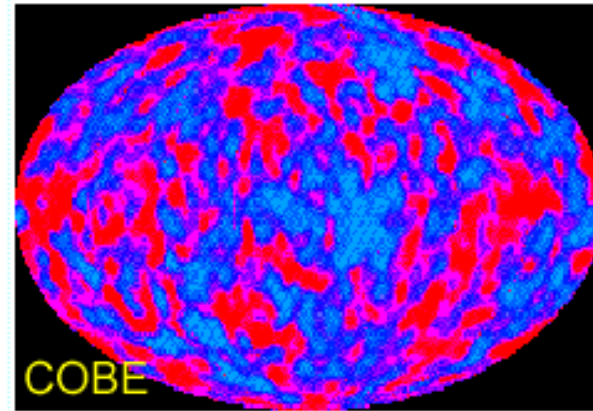


# The Scientific Motivation

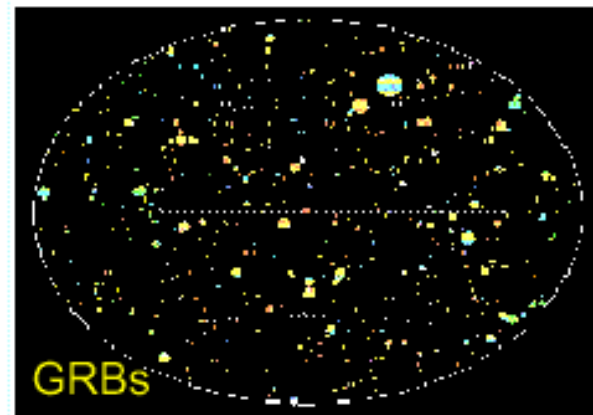
The Universe has been studied essentially through EM radiation.



GWs have a different origin.

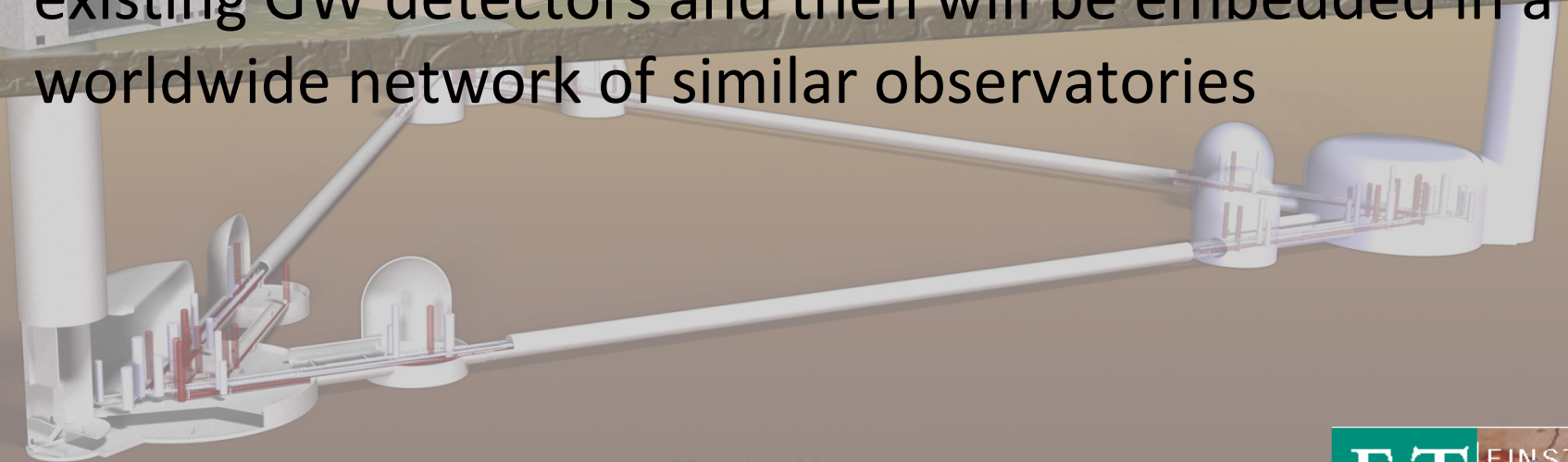
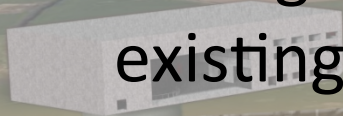


A view complementary to the results of CERN & ESO



# Einstein Telescope

- ET will be a 3<sup>rd</sup> generation GW observatory
  - Science targets on Cosmology, General relativity. Astrophysics and fundamental physics, completing the multi-messenger observation of the Universe
  - ET will be a large European research infrastructure that, during the first years of its life, will collaborate with the existing GW detectors and then will be embedded in a worldwide network of similar observatories





# ET: the research infrastructure

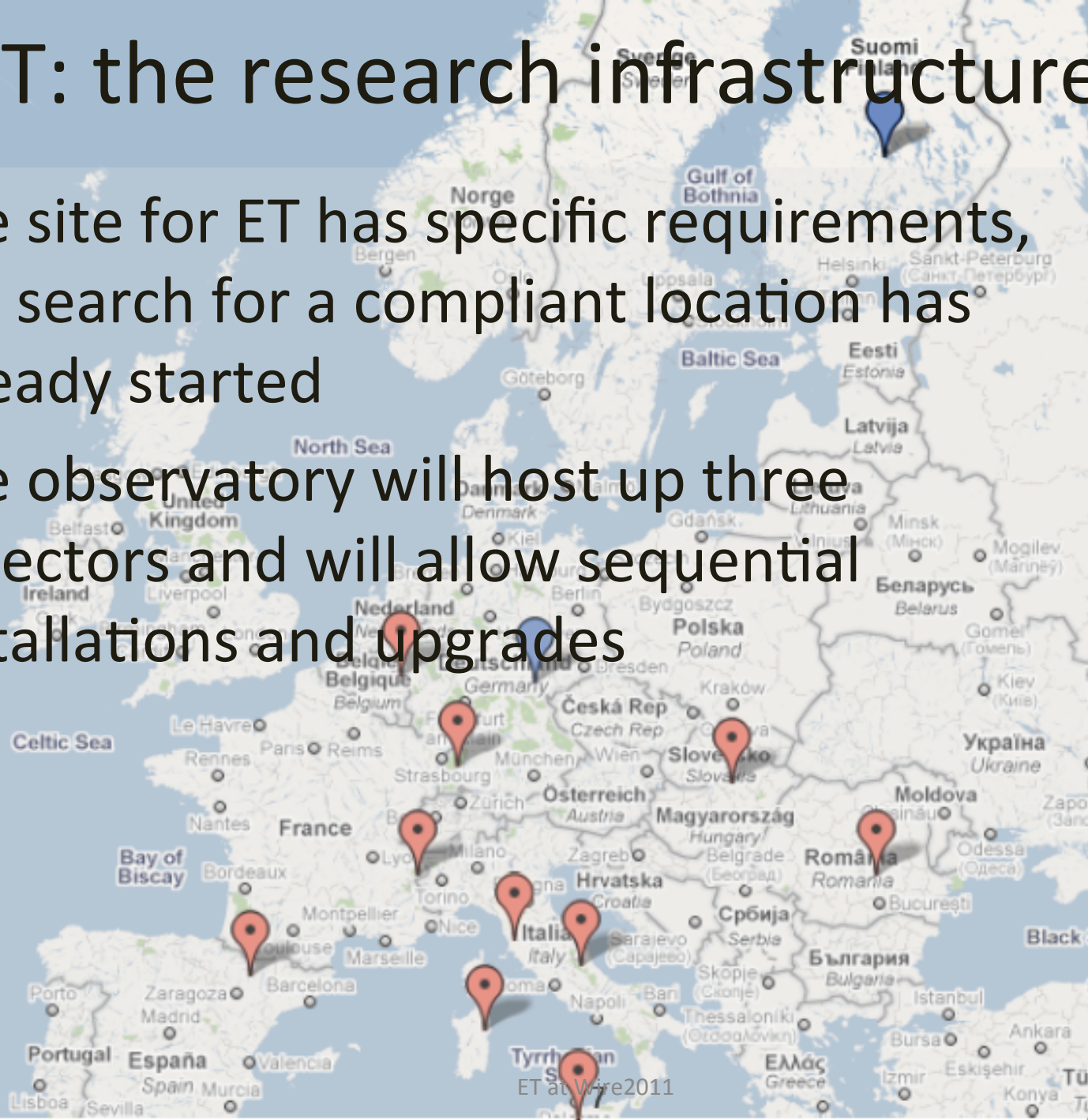


Data collected from these sites



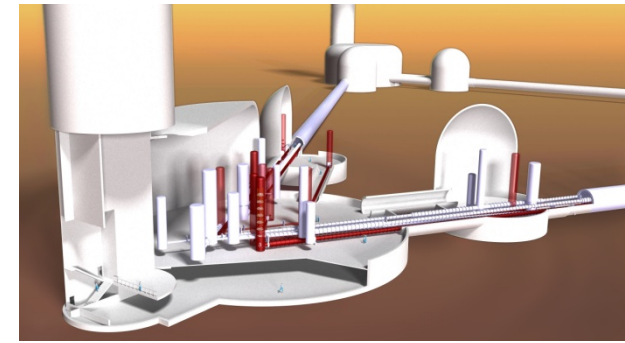
3rd party data obtained and analyzed from these sites

- The site for ET has specific requirements, the search for a compliant location has already started
- The observatory will host up three detectors and will allow sequential installations and upgrades





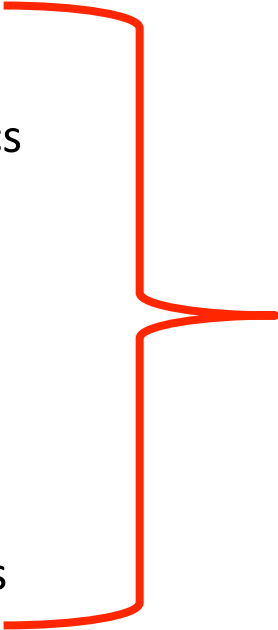
# ET network



- ET will be located in Europe
- Initially it will collaborate with the second generation GW detectors, then it will use the technologies tested in that apparatuses
- National laboratories are studying and developing the technical solutions for ET and performing the data analysis



# ET: technology developments

- To improve the sensitivity of the GW detectors at the level requested by ET a huge technology development program is required, with intense know-how exchange with the industries:
    - Cryogenics
      - Low vibration noise cryo-coolers
    - Precision mechanics
      - Seismic noise filtering
    - Optics
      - Low absorption silicon and silica optics
      - Very low scattering polishing
      - High quality dielectric coatings
      - Nanotechnologies for coatings
      - Quantum optics
      - Simulation
    - Lasers
      - High power, low noise 1064 nm lasers
      - Low noise 1550 nm lasers
- 

Mirrors & Lasers  
ASPERA-Industries  
workshop  
21-22 October 2011  
EGO/Virgo site



# Present of GW research in Europe

- There is a scientific case
- There are scientific and technological competencies, developed locally in Laboratories
- There are research infrastructures, thanks to the vision of National Agencies
- There are industries which have produced the high-tech components, acquiring know-how to be spent on the market
- There are first class World-wide technology transfers and/or spin-off from EGO/VIRGO and GEO600: (a) mechanics (IT), (b) lasers (DE), (c) mirrors (FR & DE)
- The two EU interferometers started one week ago to explore the sky together, in a scientific run with the highest sensitivity ever reached
- The National scientific communities have demonstrated to be able to cooperate on a common project (the Einstein Telescope)
- There is a well consolidated management (EU grants, EU projects, science and technology workshops, R&D, training)

# An EUROPEAN STRATEGY for GW?

A paradigmatic case?

- ✧ EGO & GEO600
- ✧ A multi-sited Research Infrastructure?
- ✧ Lead 3<sup>rd</sup> Generation Interferometers?
- ✧ Local & Global

The virtuous quadrilateral:







**ADVANCED VIRGO**