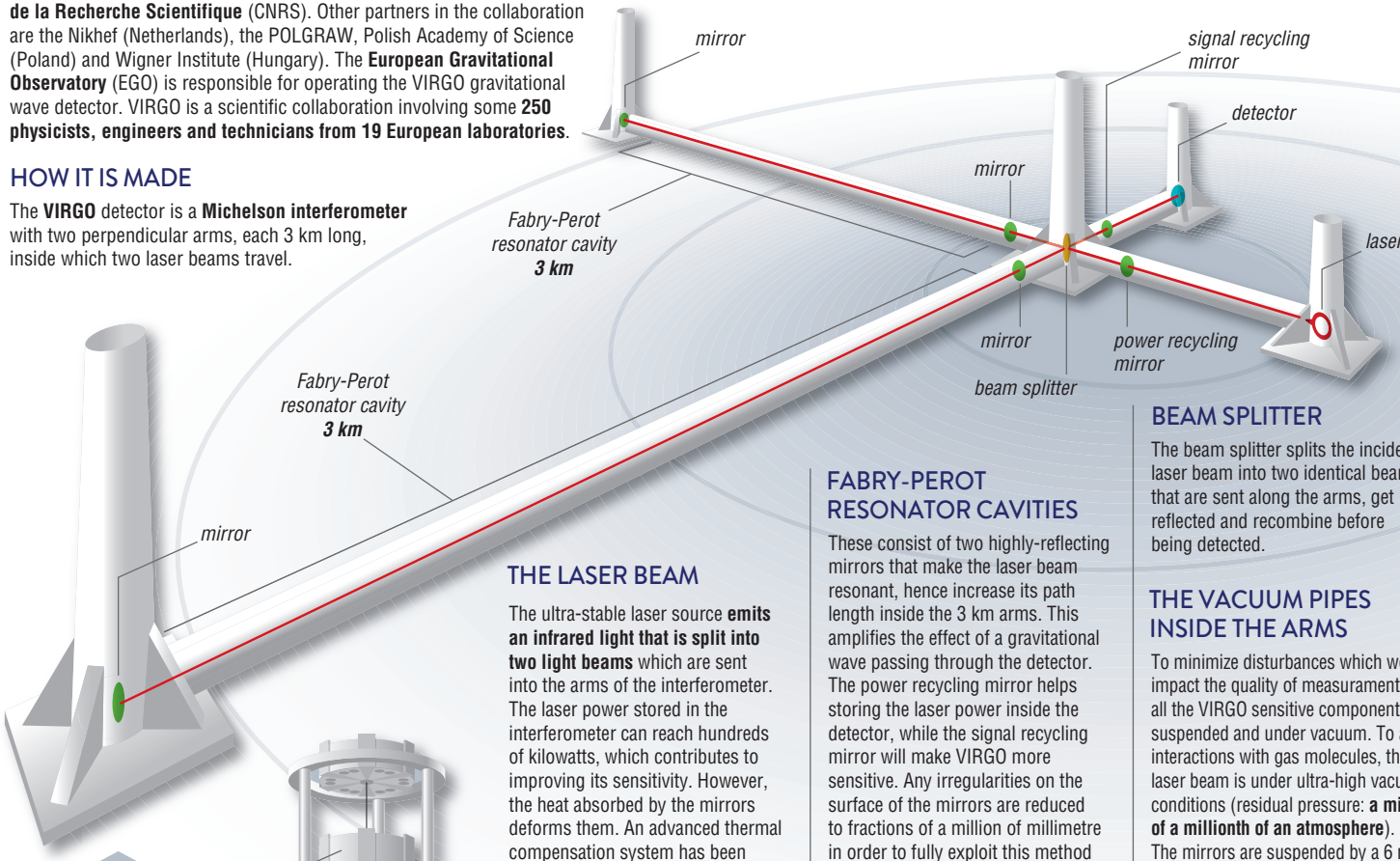
VIRGO

VIRGO is the interferometer for gravitational waves located at Cascina, near Pisa in Italy, set up by the **Italian Institute for Nuclear Physics** (INFN) and the **Centre National de la Recherche Scientifique** (CNRS). Other partners in the collaboration are the Nikhef (Netherlands), the POLGRAW, Polish Academy of Science (Poland) and Wigner Institute (Hungary). The **European Gravitational Observatory** (EGO) is responsible for operating the VIRGO gravitational wave detector. VIRGO is a scientific collaboration involving some **250 physicists, engineers and technicians from 19 European laboratories**.

HOW IT IS MADE

The **VIRGO** detector is a **Michelson interferometer** with two perpendicular arms, each 3 km long, inside which two laser beams travel.



THE LASER BEAM

The ultra-stable laser source **emits an infrared light that is split into two light beams** which are sent into the arms of the interferometer. The laser power stored in the interferometer can reach hundreds of kilowatts, which contributes to improving its sensitivity. However, the heat absorbed by the mirrors deforms them. An advanced thermal compensation system has been developed to control these effects.

FABRY-PEROT RESONATOR CAVITIES

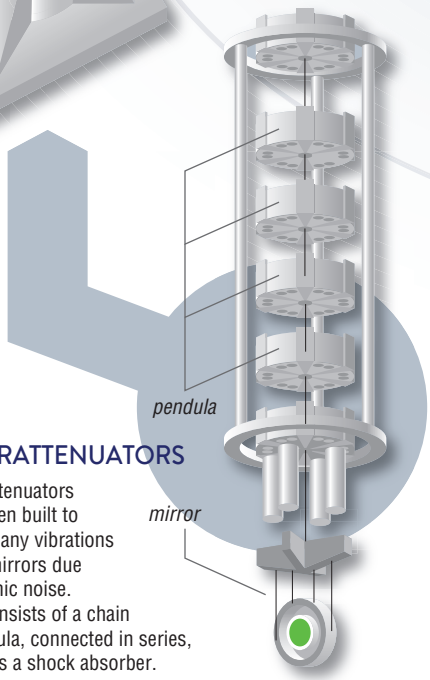
These consist of two highly-reflecting mirrors that make the laser beam resonant, hence increase its path length inside the 3 km arms. This amplifies the effect of a gravitational wave passing through the detector. The power recycling mirror helps storing the laser power inside the detector, while the signal recycling mirror will make VIRGO more sensitive. Any irregularities on the surface of the mirrors are reduced to fractions of a million of millimetre in order to fully exploit this method of trapping light in the optical cavites.

BEAM SPLITTER

The beam splitter splits the incident laser beam into two identical beams that are sent along the arms, get reflected and recombine before being detected.

THE VACUUM PIPES INSIDE THE ARMS

To minimize disturbances which would impact the quality of measuraments, all the VIRGO sensitive components are suspended and under vacuum. To avoid interactions with gas molecules, the laser beam is under ultra-high vacuum conditions (residual pressure: **a millionth of a millionth of an atmosphere**).
The mirrors are suspended by a 6 m long active suspensions (superattenuators).

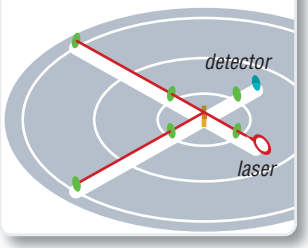


SUPERATTENUATORS

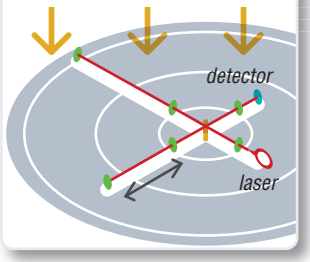
Superattenuators have been built to prevent any vibrations of the mirrors due to seismic noise.
They consists of a chain of pendula, connected in series, acting as a shock absorber.

HOW THE INTERFEROMETER WORKS

When they come out of the arms, the two laser beams are recombined (with opposite phases) so that no light reaches the detector.



When a **gravitational wave** passes through the interferometer it produces an infinitesimal variation (much smaller than the diameter of atomic nucleus) in the length of the two arms (one arm lengthens while the other shrinks).



These variations induce a change in the interference pattern detected: the measured signal is proportional to the gravitational wave amplitude.