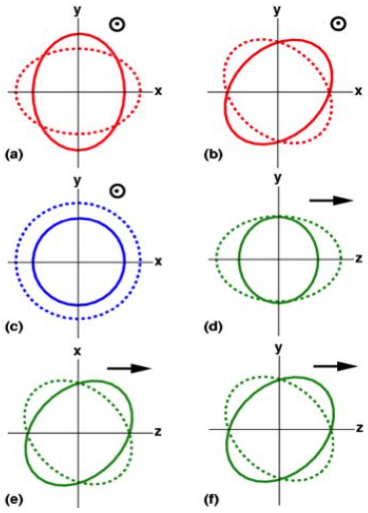

Fig. 1. A schematic view of the detector. The explosive view explains the principle of the two mode resonant transducer coupled to the spherical antenna.

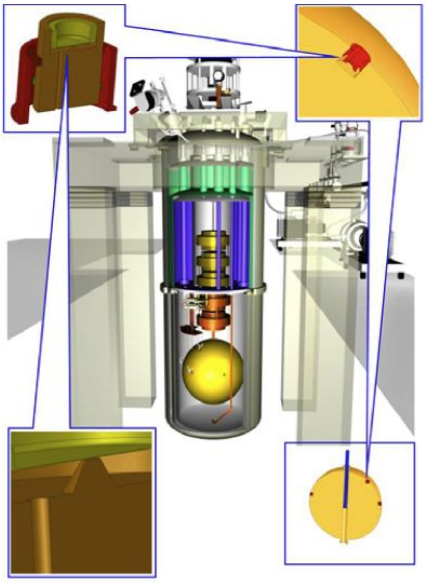

Fig. 2. A schematic view of the detector. The explosive view explains the principle of the two mode resonant transducer coupled to the spherical antenna.

because it maximizes the GW absorption (the transformation of gravitons into phonons) and is omnidirectional (it has equal sensitivity in any direction). Robert Forward, one of Weber's formers graduate students in the early 60s, was the first to realize this.

MiniGRAIL, in Leiden (the Netherlands), and SCHENBERG, in Sao Paulo (Brazil), were the first spherical antennas to go into commissioning operation. This happened in 2004 and 2006, respectively. Spherical antennas have the advantage of omnidirectionality. This means they have the same sensitivity in any direction of observation, which also implies that they are not blind to any direction. In order to accomplish this, one needs to install enough electromechanical transducers to monitor all five first mechanical quadrupolar modes of the sphere. In doing so, one can determine, in principle, the direction and polarizations of the incoming wave with a single detector. Furthermore, because they have multi-sensor (transducer) devices, their information is more complex and complete. It is possible to identify much of the noise just because it did not pass in the criterion of a quadrupolar signal. If the wave direction is determined by an observation in the electromagnetic window, monitoring the first five quadrupolar modes and the first monopolar mode of a spherical antenna will allow one to identify the six general polarizations in the weak field approximation and, so, test General Relativity and other theories of gravitation (Figure 1).

As mentioned before, spherical antennas convert part of the gravitational wave energy into mechanical oscillation of the sphere's quadrupolar modes. Then, a few transducers installed on its surface convert the mechanical energy stored in these modes into an electrical signal, which is processed, recorded and analyzed.

Transducers can be resonant or non-resonant. Non-resonant transducers can give the detector the capability to be wideband or, in other words, to have good sensitivity in a wide frequency band. However, they lose the amplification factor, which is equal to the square root of the ratio between the sphere's effective mass and the transducer sensor mass. For the SCHENBERG detector (Figure 2) this amplification factor is 10,000, because the spheres effective mass for a quadrupolar oscillation is 287 kg, and the transducer sensor mass is about 3 mg. This means that if a gravitational wave causes the SCHENBERG's spherical antenna to oscillate with a surface amplitude of 10^{-21} m, the transducer sensor mass will oscillate with an amplitude of 10^{-17} m, which facilitates the detection. In order to compensate this amplification factor loss, the non-resonant transducer must have its sensitivity increased by the same factor of 10,000, which is not easy to accomplish. However, the group involved in this research has been trying to design and construct a non-resonant transducer with sensitivity 10,000 times higher than the traditional resonant one. In the case o the SCHENBERG detector, which uses parametric transducers composed of klystron microwave cavities, the major difficulty