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COMPACT GEOPHYSICAL INSTRUMENTATION FOR ASTEROID EXPLORATION

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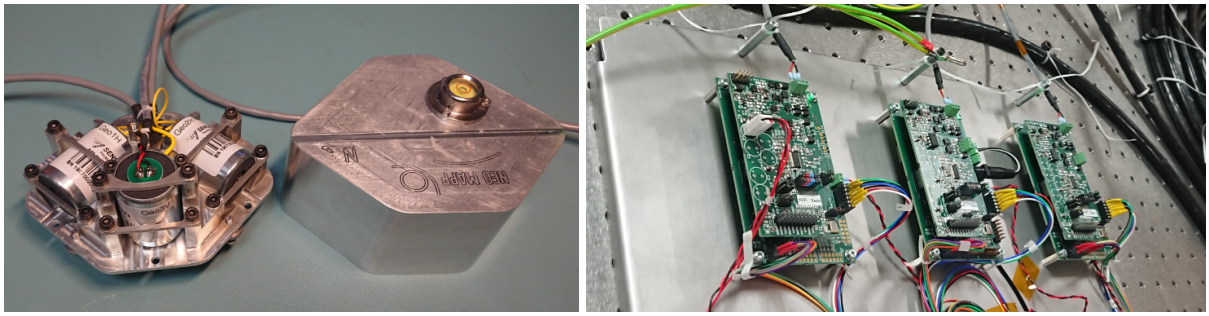
ABSTRACT

Understanding the internal structure of asteroids is key for science, planetary defense and future in-situ resource utilisation. In the framework of two European Commission Horizon 2020 projects (PIONEERS and NEO-MAPP), we are developing two complementary in-situ geophysical instruments, designed specifically to fit inside a small asteroid lander and function in the challenging environment of the asteroid surface.

The first of these instruments is a compact, low pass, low power seismometer (Fig 1a). This seismometer consists of three geophones that will each measure the ground motion along one axis, and dedicated analogue and digital electronics that are developed at ISAE-SUPAERO (Fig 1b). The commercial sensors contain no active electronics and were designed to withstand extreme environments (e.g., terrestrial boreholes). The compact seismometer can image an asteroid's internal structure by measuring ground motion generated by either natural seismic sources (micro-meteoroid impacts, thermal cracking, tidal quakes, … [1]) or artificial sources (such as the Hayabusa SCI-2 impactor [2]).

The second instrument is a 6 Degrees of Freedom (DoF) instrument that combines MEMS accelerometers and fiber optic gyroscopes. The 6 DoF instrument makes precise measurements of the asteroid's rotational dynamics. This includes the capability to measure forced librations and the decay of excited rotation states such as the free librations, both of which constrain the internal structure [3]. The 6 DoF instrument can precisely measure the landing dynamics in order to probe the mechanical surface properties [4], and could also be used to study the internal structure during active seismic experiments.



(a) (b)

Figure 1. (a) Compact seismometer containing three geophones. (b) Breadboard of the acquisition electronics, developed at ISAE-SUPAERO as part of the NEO-MAPP project.

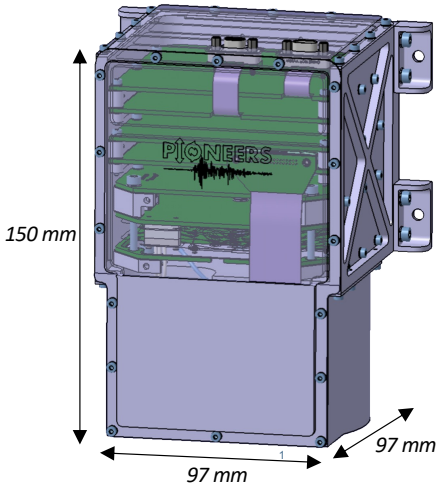


Figure 2. The 6 Degrees of Freedom PIONEERS instrument.

This presentation will discuss the design, status and complementary nature of these two compact instruments. These geophysical instruments, capable of precisely monitoring dynamical changes during the close encounter with the Earth in addition to measuring tidal force-induced seismicity, would be ideal for inclusion in a small lander to a target like asteroid Apophis.

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Comments: Oral presentation preferred, will be attending in person.