Fiber-Optic Gyroscope For 6-component Planetary Seismology

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Summary

To enter a new realm of planetary exploration with an innovative ground motion instrumentation concept relying on high precision sensors based on optical interferometry, a project named PIONEERS has been submitted (April 2018) and accepted (July 2018) by European Commission through its H2020 program.

Under the leadership of ISAE-SUPAERO, gathering IPGP, ETH-Z, Royal Observatory of Belgium, LMU and iXblue, the PIONEERS team aims to **develop two innovative 6-Dof instruments for measuring ground deformation on planetary objects.**

The first instrument is a prototype of very low noise 6-Dof sensor dedicated to the imaging of the internal structure of terrestrial planets. The second one is a high TRL CubeSat version of the same instrument concept for exploration of small bodies.

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Context

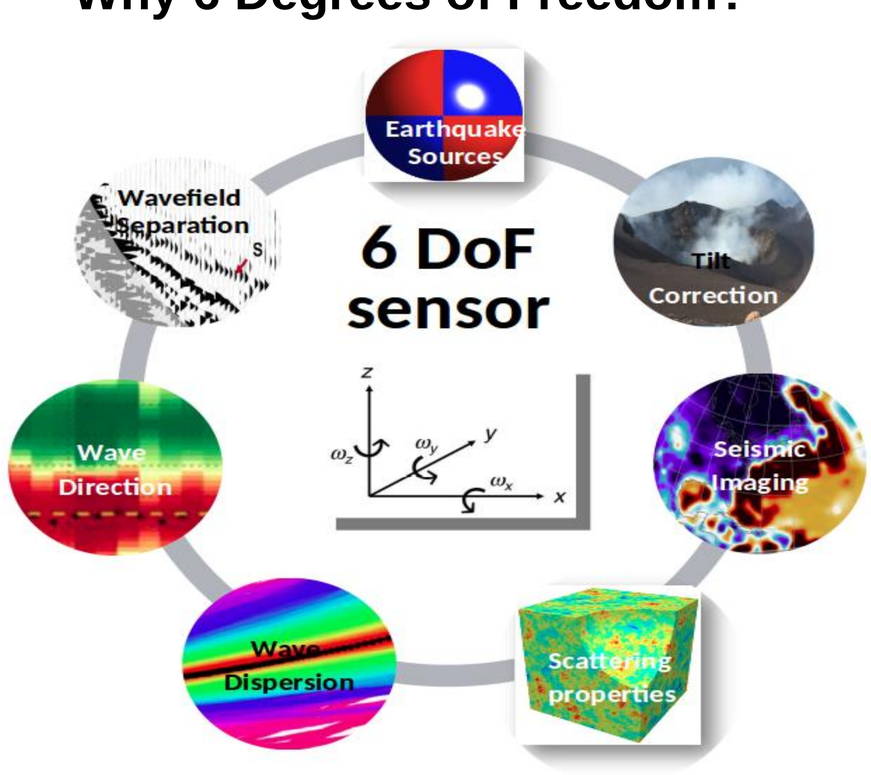
Planetary seismology is a key technique for **imaging the internal structure of planetary objects**. It targets some of the most fundamental science objectives, from the formation of planetary systems to the characterization of habitable worlds.

However, **standard methods suffer from various limitations** inherent to planetary missions, first one being that a single station is much easier to settle than an array.

Taking **benefit of the latest developments in so-called "rotational seismology"**, it appears that a single instrument able to monitor both translations and rotations of planetary surfaces would be a game changer in planetary seismology.

Indeed, in addition to perform both seismology and global rotational monitoring of the planetary object, **the measurement of 6 Degrees of Freedom (DoF) brings a significantly increased scientific return** compared to classical 3-DoF sensors.

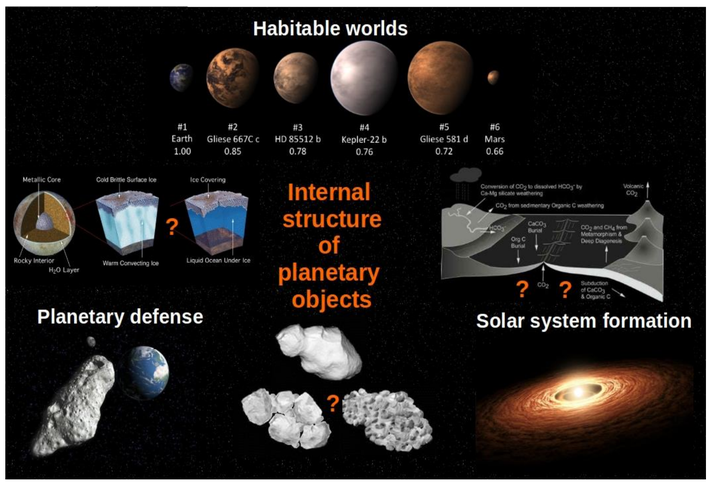
Why 6 Degrees of Freedom?



How PIONEERS's FOGs compare to others gyroscopes?

	Honeywell	Northrop	iXblue/Airbus		PIONEERS project	
	MIMU	*SIRU*	*ASTRIX 120*	*ASTRIX 200*	*EM planetary*	*PFM cubeSat*
Gyro technology	RLG	HRG	FOG	FOG	FOG	FOG
Architecture	2x3 axes	4 gyros axis cross strapped with 2 electronic	4 independent gyro channels	4 independent gyro channels	3 independent gyro channels	3 independent gyro channels
Geometrical configuration	3 perpendicular axes	Tetrahedron	Tetrahedron	Tetrahedron	3 parrallel axes	3 perpendicular axes
Sensor diameter	~150mm	~50mm	~120mm	~200mm	45mm 200mm >1000mm	~45mm
Mass	9.4 Kg	7 Kg	6 Kg	10 Kg	TBD	< 2 Kg
Power consumption	32 W	45 W	18 W	18 W	<10 W	< 10 W
Solid state	No = vibrations to avoid blind zone)	Yes	Yes	Yes	Yes	Yes
root DSP in nrad/s/√Hz	720	30	330	20	<20 ~0.1	<1000

What is the use of a better internal structure knowledge?



What are the hardware outcomes of the project?