Universal MEMS Seismometer

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New Science Enabled:

The UMS is the first high sensitivity seismometer that:
- Will be deployable in extreme environments
- Will be deployable on rough landers and impactors, thus enabling deployment of a low cost seismic sense network
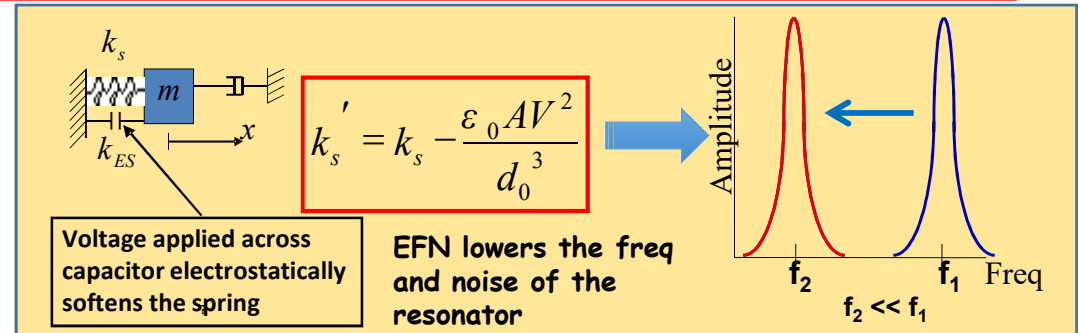
Target Bodies:
all future rocky moon / planet missions (e.g. ocean worlds landers, Europa lander, Venus in-situ explorer)
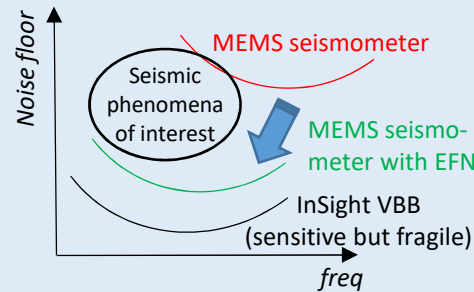
Key Capabilities:
- High sensitivity (noise floor <$2m/s^2/\sqrt{hz}$, bandwidth: 0.2-20hz)
- Extreme temperature (+300C to -200C) tolerant
- High Shock (up to 29,000g's) tolerant
- High radiation tolerance
- Gravity / tilt insensitive
- No sensitivity to external magnetic fields

Key Advantages over State of the Art:

$$k_s' = k_s - \frac{\varepsilon_0 A V^2}{d_0^3}$$

Voltage applied across capacitor electrostatically softens the spring

EFN lowers the freq and noise of the resonator

$f_2 \ll f_1$

... this enables turning a high frequency, low sensitivity micro seismometer into a low frequency, high sensitivity device that is still high shock tolerant and extreme environment robust:

MEMS seismometer

Seismic phenomena of interest

MEMS seismo-meter with EFN

InSight VBB (sensitive but fragile)

... this, and the small size and power of such devices, enables seismic science to be performed on any lander (including rough landers and penetrators)

DS2 penetrator probe

Requirement		Sensor				
		InSight VBB[15]	InSight SP[14]	MET[17]	Silicon Audio[18]	UMS
Performance	Sensitivity (m/s²/√hz)	1e-10	2e-9	2e-8	2e-8	2e-9
	Bandwidth (hz)	0.1-1	0.1-10	0.8-80	0.2-200	0.2-20
Environment	Temperature					
	Radiation					
	Gravity / tilt					
	Magnetic Field					
	Atmosphere					
Deployment	Soft lander					
	Rough lander					
	Penetrator deployment					

Path Forward:
- TRL advancement from 2-4 under PICASSO
- Pursue follow on NASA follow on funding (PSTAR, MATTISE, ColdTech, HotTech…)
- Pursue reimbursable funding (paper study currently funded by Chevron to determine benefits for oil and gas industry)

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Planetary Instrument Concepts for the Advancement of Solar System Operations (PICASSO)