# AN UPDATE ON MICRO-PENETRATORS FOR IN-SITU SUB-SURFACE INVESTIGATIONS OF EUROPA

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**Abstract**

In-situ elements are essential to significantly extend orbital observations to justify the large mission costs. They can provide ground truth, and new exploration capabilities, particularly for direct detection of astrobiologically significant material, and indirect habitability determination. They can also provide key seismic interior body and chemical investigation of the subsurface material.

We propose a payload of 2 penetrators for Europa, to provide redundancy, and improved science return, including enhanced seismic performance and diversity of sampling regions. Each penetrator would be capable of achieving the above science goals with a modest payload of around 2kg. The total mass for such a penetrator system including the spacecraft attachment and descent module is estimated to be around 13kg, though a considerable degree of flexibility with payload and total mass is possible.

The cold, icy and rough nature of much of the surface of Europa provides a challenge for securing a low risk impact, for which considerations of site selection and surface gardening effects will be presented. This will also include effects on penetrator impact forces, penetration depth, likelihood of ricochet, and communications. Penetrator shape options, including anti-ricochet techniques, and their consequent effects on science measurement feasibility will also be presented.

It is intended that these studies will be performed in concert with EJSM JGO and UK MoonLITE developments, as progressions from last year's highly successful 300ms$^{-1}$ impact tests into dry sand targets but extended into icy impacts, and to include high radiation environment and planetary protection. Since last year we have also welcomed a number of European science and hardware contributors, and we also would welcome US involvement.