Direct Measurements of the Elemental Abundance of the Surface of Europa: an X-ray Silicon Drift Detector (SDD) for the Europa Lander

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We describe the scientific return of including an X-ray-sensitive Silicon Drift Detector (SDD) on the Europa Lander. The high radiation environment of the Jovian magnetosphere induces strong characteristic X-ray emission from the elemental constituents of the Europan surface. A sensitive X-ray spectrometer with moderate spectral resolution such as an SDD could directly and uniquely identify the elemental components and would be a strong complement to the suite of instruments considered for the Lander in the 2016 SDT. In particular, such an instrument would determine the precise elemental stoichiometry, and could detect the presence of trace elements (~to a few tens of ppm) with sufficient integration times. A table of the sensitivity of our instrument to elements from C to Ni for an assumed surface composition is shown in Figure 1. Additionally, this instrument would provide a direct measurement of the flux and spectrum of the energetic particles (protons and electrons) striking the surface thus giving a direct measure of the heat flux at the surface. The SDD sensor is TRL 9 having flown on NICER, and the electronics to operate the sensor and process the data are simple and easily extendable to the harsh radiation environment of the Europan surface. This instrument would be lightweight, low risk, low power, and use only a small fraction (<5%) of the telemetry bandwidth. The concept is also flexible in that it could be easily be integrated into any Lander configuration regardless of the rest of the science package. In this presentation, we will describe out concept, outline the potential science return, and discuss how this instrument would be a strong complement to the notional instrument suite described in the 2016 Europa Lander SDT.

Element	Energy (keV)	Concentration (ppt by mass)	Intensity (photon cm^{-2} s^{-1} sr^{-1})	Count Rate (10^{-2} cts s^{-1})	Count Rate (cts day^{-1})	Signif. (σ)
C	**0.28**	**1**	**9.87**	**0.045**	**39.0**	**0.11**
N	0.39	1	14.11	0.79	686.2	1.9
O	**0.53**	**733.81**	**13,770.7**	**1617.7**	**1.40×10^6**	**3,880**
F	0.68	1	1.92	0.441	381.1	1.1
Na	**1.04**	**39.39**	**98.76**	**38.74**	**33,473.2**	**93.0**
Mg	**1.25**	**23.5**	**72.94**	**32.87**	**28,398.1**	**78.9**
Al	1.49	1	3.51	1.73	1,494.9	4.2
Si	1.74	1	4.13	1.649	1,424.7	4.0
P	2.01	1	4.5	1.462	1,263.3	3.5
S	**2.31**	**136.64**	**718.41**	**266.91**	**230,610.0**	**641**
Cl	2.62	1	5.76	2.36	2,037.7	5.7
K	**3.31**	**2.68**	**20.51**	**9.66**	**8,345.6**	**23.2**
Ca	3.69	1	8.81	4.36	3,770.0	10.5
Fe	6.4	1	8.13	4.64	4,008.9	11.1
Ni	7.47	1	6.82	3.95	3,413.9	9.5

Figure 1: Sensitivity of X-ray fluorescence spectrometer for one day of integration. Shaded elements are derived from Galileo/NIMS. Other elements assume 1 ppt abundance.