Development of an Extraterrestrial Organic Analyzer (EOA) for Highly Sensitive Organic Detection on a Kinetic Penetrator. Z. Duca[1*], G. Tan[1], T. Cantrell[1], M. Van Enige[1], M. Dorn[1], M. Cato[1], S. Foreman[2], P. Putman[3], J. Kim[2], R. Mathies[4], and A. Stockton[1†]. [1]Georgia Institute of Technology, GA, USA, [2]Texas Tech University, TX, USA, [3]Sierra Lobo, OH, USA, [4]University of California, Berkeley, CA, USA ([*]zduca4@gatech.edu, [†]astockto@gatech.edu).

Introduction: Quantitative, compositional, and chiral analysis of small organic molecules *in situ* provides important information for studying planetary formation and evolution, and, more excitingly, also can provide signatures of past or present life. EOA, with microchip capillary electrophoresis (µCE) and laser-induced fluorescence (LIF) detection, is the only technique currently ready for space flight that has the resolution, selectivity, and sensitivity to provide these analyses. Through both in-lab [1,2] and field [3] testing, µCE-LIF has demonstrated the capability to provide highly sensitive (sub parts-per-trillion, or pptr) automated quantitative compositional chiral analysis of multiple organic compound classes [4], including polycyclic aromatic hydrocarbons (PAHs) [5], amino acids [6], aldehydes and ketones [7], carboxylic acids [8], thiols [9], and amines [10]. Lander or fly-by missions have largely been the focus for the development of µCE-LIF, as proposed in the Mars Organic Analyzer (MOA) and the Enceladus Organic Analyzer.

Here, we show the continued development of the microfluidic and LIF subsystems for a kinetic impactor mission. Preliminary results have shown promising sustainability of microdevices during a 50000g impact, indicating that µCE-LIF is a valid *in situ* technique for this extreme planetary mission format.

Instrument Development: Programmable microfluidic architechtures enable automated, complex microfluidic manipulation on-chip, including mixing, dilutions, fluorescent derivatization, and transfer [11]. Recently, we have shown that microdevices retain functionality of their pneumatically-actuated monolithic membrane microvalves after 10+ years in storage [12].

However, the survival of these microvalves during a high g impact is not proven. The pneumatic microvalves use a compressible fluid for actuation, which could be succeptible to bursting at sudden high pressures induced upon impact. Hydraulically-actuated microvalves that use incompressibile fluids to control valve acuation may not experience these issues. Early tests show that these hydraulic valves function properly and can replace the pneumatic valves for high impact or high pressure (e.g. deep ocean) missions.

The precision optics of LIF can be succeptable to high impact collisions and has never been developed for these high g conditions. Proper permanent alignment of components is essential for absolute sensitivity, and optical stack placement and material bonding properties must be optimized. Recent modeling data has shown that in order to reduce internal mechanical stress ideal placement of the optical components is directly in the center of the microdevice (Figure 1). By placing proper support underneath the structure, the mechanical strength of the microdevice is not exceeded. Indium bump bonding will be used in the optical stack to permenantly and precisely weld non-glass/glass connections. Glass/glass conections will be made using a Schott Glass bonding technique to create a continuous glass construction, avoiding any possible optical interferences.

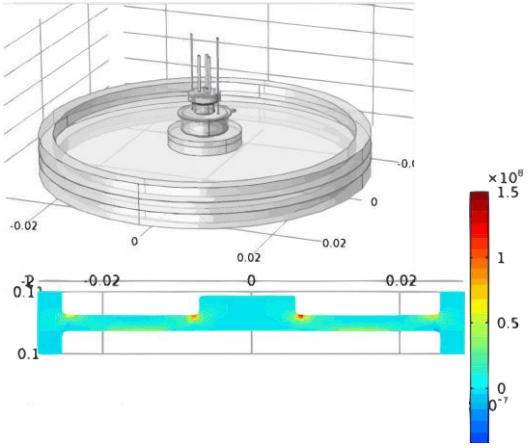

Figure 1: Structural (top) and stress (bottom) model of a centered optical stack without support structures.

Summary and Conclusions: This work shows the low-TRL development of EOA's LIF and microfluidic subsystems for future planetary impact penetrator missions. With correct structural decisions and optimizations, EOA can survive a 50,000g impact, making it the only current optical instrument with this capability.

References:

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