PLASMA COMPOSITION INSTRUMENT FOR PLANETARY AND COMETARY MISSIONS. G. C. Ho[1] and G. B. Andrews[1], [1]The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723 (George.Ho@jhuapl.edu).

Introduction: Plasma exists in all space environments, whether planetary, cometary, or interplanetary space. There are two types of plasma measurement: 1) Fast plasma; and 2) Plasma composition. Fast plasma instruments measure the core plasma moments (temperature, density, and energy) in very fast time scale (~seconds or faster), while plasma composition instruments measure all of the above (at slower time scale ~minutes) plus the charge state and elemental composition of the plasma by the addition of a time-of-flight section. In almost all space missions a plasma instrument has been part of the core payload, since it measures the basic properties of the environment the spacecraft is exploring. In addition, the plasma composition measurement provides a key diagnostic tool in deciding the origins of the plasma. In interplanetary space, the plasma composition measurement can tell us whether particular plasma comes from the Sun (coronal hole or coronal mass ejection), nearby planet, or nearby comet. In a planetary mission, as demonstrated recently by MESSENGER, plasma composition measurements have not only been key to understanding of the structure of the magnetosphere, but the plasma composition has shown that materials from the planet's surface are being scoured by solar wind, magnetospheric, and physical impact processes. Most of the heavier ions in the plasma originated as neutral atoms on the surface. In a cometary mission, plasma composition measurements can remotely sense the composition of the comet tail as far out as 1.6 AU from the nucleus [1]. (Neugebauer et al., ApJ, 667, 1262-1266, 2007). When closer to the comet, plasma composition measurements provide the basic understanding of the gas jets leaving the comet and their interaction with the solar wind.

Plasms Composition: As demonstrated recently by MESSENGER, the role of low energy thermal plasma is key to many science investigations. In particular, its measurement can infer the surface composition and other key physical processes operating in many celestial bodies without ever touching the surface. A typical plasma composition instrument consists of an electrostatic analyzer (ESA) that selects the energy per charge of an ion. It is followed by post acceleration (<30 kV) into a time-of-flight (TOF) section that measures the ion velocity and energy with solid-state detectors (mass and energy).

New Approach. In this paper, we present a new ESA design that would extend the energy range of the current plasma instrument and provide higher time cadence measurement that are required for planetary and/or cometry flyover missions. The new ESA design covers a large field-of-view on a 3-axis stabilized spacecraft and can make simultaneous energy measurement over a broad range.

A preacceleration system will be used to raise the energy of low-energy particles after exit from the ESA and before entrance into a high TRL compact TOF chamber. Within the TOF chamber, the particles velocity will be measured using electrostatic mirror, thin carbon foils and micro-channel plates. And at the end of the TOF chamber, the preaccelerated ions will overcome the thin window of the solid-state detectors (SSDs) and its total energy will then be measured. The novel use of compact TOF chamber together with thin window SSDs is capable of resolving all the major species (He, C, N, O, etc.).

Challenges: The challenges to be addressed with regards to plasma composition measurements in planetary science require more capable instrument in resoure limited missions. Instruments to date have collected critical data that have helped us understand formation and physics processes in many celestial bodies. Those instruments and their data have opened a field of planetary science that needs to be further explored with more tailored/dedicated instrumentation.

References:

[1] Neugebauer M. *et al.* (2007) *ApJ, 667,* 1262–1266.