EX LUNA, SCIENTIA - THE LUNAR OCCULTATION OBSERVER (LOCO) NUCLEAR ASTROPHYSICS MISSION CONCEPT

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Introduction: The Moon is a unique location for experimental astrophysics. It's dense regolith and lack of an appreciable atmosphere are just two of the characteristics that can be leveraged to address key challenges in high-energy astrophysics. The long-term goal of our program is the development of a next-generation mission capable of surveying the Cosmos in the nuclear γ-ray regime (~0.1-10 MeV), and the Moon enables a unique approach to this endeavor.

The *Lunar Occultation Observer* (LOCO) [1, 2] is a new γ-ray astrophysics mission concept having unprecedented flux sensitivity, high spectral resolution, excellent spatial resolution, and very uniform sky coverage. It meets or exceeds the capabilities required of the next-generation nuclear astrophysics mission, and is therefore capable of addressing multiple high-priority science goals such as Galactic nucleosynthesis, supernovae & novae, orbital geochemistry of the Moon, etc.

Occultation Imaging: LOCO will be a pioneering mission in high-energy astrophysics: the first to utilize the moon as a scientific platform, and the first to *successfully* employ occultation imaging as the *principle* detection method. This is a powerful, yet relatively simple, approach to imaging in regimes where traditional imaging approaches are inappropriate, complex, or cost prohibitive [3, 4].

Specifically, LOCO will utilize the *Lunar Occultation Technique* (LOT) [5] - the temporal modulation of source fluxes from lunar orbit as they are repeatedly occulted by the Moon. The encoded temporal modulation is used to image the sky thereby enabling spectroscopic, time-variability, point- & extended-source analyses. The benefits of this concept derive from the innovative imaging technique and lack of a lunar atmosphere & magnetosphere, and maximize performance relative to other Earth-orbit endeavors.

Status: A preliminary feasibility study has been completed and fundamental performance capabilities of the LOCO concept have been evaluated. Techniques for image reconstruction of astrophysical point-sources [5], as well as spatially extended sources, have been developed. Detailed mission design, as well as detector evaluation and prototyping, is now ongoing.

Open issues relate primarily to *implementation* rather than *development*, and are the focus of our current efforts. Ongoing development tasks include refinements to analysis techniques, detector prototyping and design, as well as spacecraft and mission architecture planning.

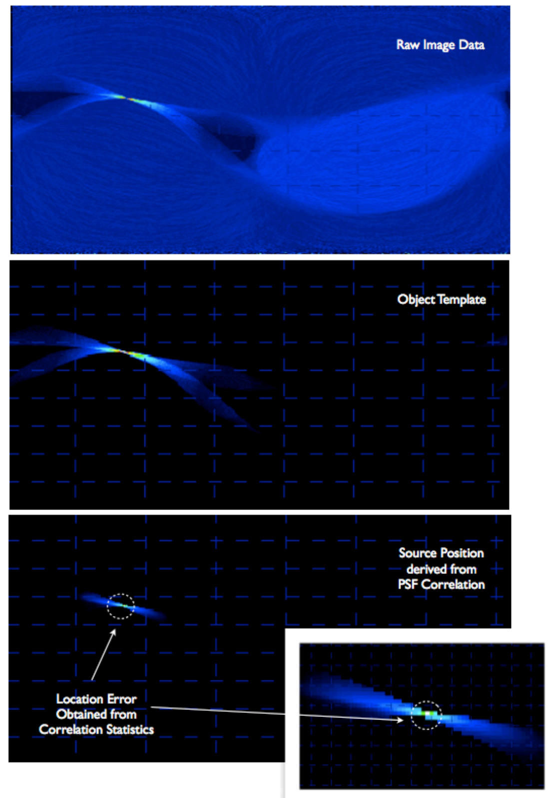

Figure 1. Occultation image generated for one configuration of the LOCO concept. Shown are the raw lunar limb projections simulated for 1 day of lunar orbit (top), an occultation object template (middle), and a correlation image for a hypothetical astrophysical source at the position of the Crab Nebula (bottom, inset).

Summary: LOCO is a nuclear astrophysics mission concept whose goal is to probe the Cosmos and study the ``fires of creation". We will report on the motivations for this mission, the estimates of science return, the concept's cost-effectiveness and scaleability, as well as implementation tradeoffs.

References: [1] R.S. Miller (2008), IEEE Trans. Nucl. Sci. 55, 1387. [2] R.S. Miller (2008), SPIE Conf. Proc, 6686. [3] B.A. Harmon, et al. (2002), ApJ Supp., 138, 149. [4] S.E. Shaw, et al. (2004), A&A, 418, 1187. [5]R.S. Miller & D. A. Gregory (2010), Nucl. Instr. Meth. A, submitted.