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FORMATION FLYING TECHNIQUES FOR THE VIRTUAL TELESCOPE FOR X-RAY OBSERVATIONS

Abstract

The Virtual Telescope for X-Ray Observations (VTXO) is a proof of concept mission being developed to demonstrate a Phase Fresnel Lense (PFL) based space telescope. The PFL promises to provide several orders of magnitude improvement in angular resolution over current state of the art x-ray optics. However, the PFL requires a very long optical path, for VTXO the optical path is estimated to be on the order of 0.5km and will likely grow larger for follow on designs with a larger aperture. Since these path lengths are not feasible on a single spacecraft, the proposed solution is to use two separate spacecrafts, one with the lense, and the second with the detector. These two spacecrafts will then fly in a formation approximating a single rigid telescope.

In order to achieve this task, the two spacecrafts must maintain formation approximately 0.5km apart, with centimeter level control, and sub millimeter level knowledge requirements. Additionally, for the telescope to achieve sufficient exposure time, the system must keep the telescope axis pointed at a fixed target on the celestial sphere for durations on the order of a few hours.

VTXO's system architecture calls for two 6U CubeSats to operate in a highly eccentric Earth orbit with one of the spacecraft's traveling on a natural keplarian orbit. The second spacecraft will then fly on a so called "pseudo" orbit which will maintain a fixed offset relative to the celestial sphere during observations. Observations with this system will occur near apogee where differential forces on the spacecrafts are minimal which in turn minimizes fuel consumption. The "pseudo" orbit where the second spacecraft is located is not quite a stable orbit requiring small continuous propulsion to maintain formation.

This paper and presentation will overview VTXO's system architecture, additionally it will look in depth at the formation flying techniques, including fuel consumption, and methods for establishing, and maintaining the formation. Beyond its use in X-ray astronomy, these formations flying techniques should eventually contribute to the development of a distributed aperture telescope, providing images orders of magnitude better than anything that currently exists.