

Amplitude Interferometer Research for Geosynchronous Earth Orbit (GEO) Space Situational Awareness (SSA)

Statement of Objectives (SOO)

20 August 2014

Overview

The overall objective of this effort is to explore the capabilities of current and future amplitude interferometer telescope array technology in regards to its application to Space Situational Awareness (SSA) at Geosynchronous Earth Orbit (GEO). Astronomical interferometry currently supports general scientific advancements such as: advancing humanity's knowledge of the physical universe, asteroid characterization, star and planet formation, physics of stellar evolution, and observations of galaxies. As such, it is the express desire that this effort continue to encourage science, technology, engineering and mathematics (STEM) advancement for the next generation of researchers, while also answering a number of key overarching technology questions regarding the suitability of interferometry for Department of Defense and Air Force SSA. Those questions include, but are not limited to the following:

Overarching Technology Research Questions (OTRQ)

- What is the effective optical resolution on GEO targets as a function of:
 - Object brightness?
 - Object extent and structure?
 - Data processing techniques including bootstrapping methods with a single dish telescope?
- Can the optical data be combined with Radio Frequency (RF) interferometry data to create fused SSA products?
 - If so, how?
 - If so, how much of an improvement is made from the fusion?
- Can the products (either individual or fused) be sufficiently accurate and timely to support for spacecraft operator decisions?

Objectives

The objective of this effort is to conduct research into the viability of using ground based optical amplitude interferometry as a timely method for GEO space situational awareness. Therefore, a fully functional telescope array may be required to conduct the necessary research. Additionally, this effort should demonstrate technology risk reduction of amplitude interferometry for potential technology transition to a space based array.

Project Structure

Proposals should be developed to phase the work in a manner that produces incremental capability and research with each period of additional work. Specific technology questions and characterizations should be accomplished in the current period which builds upon the work of previous period(s). Each period must have specific measurable objectives with capability demonstrations. These objectives and demonstrations will become the exit criteria at the end of each period.

Basic Effort

This effort will begin with an initial “Basic effort” consisting of approximately \$5M with a period of performance of approximately one year. The Basic Effort should address, but not be limited to, answering the following specific subset of the OTRQs:

- What is the effective object brightness of GEO targets that can be observed, as a function of the number of telescopes in the array?
- What data processing techniques, to include bootstrapping methods, are required?
 - Are the data processing techniques based on the number of telescopes in the array?
 - Will changes to those techniques be required as additional telescopes are added to the array? If so, what are those changes?
- Can the optical data be combined with Radio Frequency (RF) interferometry data to create fused SSA products? If so, how?
 - What are the improvements of the fused products compared to the products from the optical-alone and RF-alone products?

Periods of Additional Effort

Before the completion of the Basic Effort’s period of performance, the Government may pursue four periods of additional effort. Each period may have a similar funding profile as the Basic Effort of approximately \$5M. The Government shall extend the overall period of performance after any preceding period(s) of additional effort. These period(s) may run sequentially or concurrently with the Basic Effort. The additional periods should also address the OTRQs, but the specific questions that can be answered in each period should be detailed in the proposal. The specific goals would then be solidified and agreed upon by all parties approximately 9 months after award of the Basic effort or current period of additional effort.

Additional Proposal Requirements

All Proposals must also address the following questions:

- Current optical interferometry capabilities in regards to SSA
 - What is the baseline and what is currently possible?

- Define key design features and at which period of work those features can be demonstrated.
- The process for demonstrating capability at each phase must be detailed.
- For each phase of the proposal, the anticipated resolution of the system and time required to resolve images of GEO satellites must be defined. Each phase must be supported with the calculations to support the anticipated resolution and time to resolve images.
- The capability of supporting general astronomy scientific advancement must be described.
- What hardware/equipment will be used to conduct the research?
 - Do you currently have the hardware/equipment?
 - If not, what necessary hardware/equipment will need to be procured?
 - What are the technical details?
 - Where is the site? What telescopes will be used? What physical configuration mechanism is used? What beam relay system/combiner system is used? Is the hardware/equipment currently operational?
 - Are there any improvements needed to conduct this research?
 - If so, what? How much will it cost? What is the timeline for improvements?

This effort is anticipated to be awarded as a cooperative agreement, and as such, the proposal must detail the contribution to public purpose. The proposal will also need to provide a vision of how the capability will be utilized. Proposals need to define how the recipient will collaborate with external researchers; such as the US Government, national research organizations, and academic institutions. It is anticipated that collaboration with researchers will continue from the point of initial capability throughout the period of performance. Detail the specific relationship with the Department of Defense for SSA with respect to data collection and targeting. The Government expects to be able to obtain SSA data on targets the Government defines once the Amplitude Interferometry research capability has been fully completed as well as lessons learned.