

Subject: Annual Reort PO: 15-PO-400-0000316869
Date: Monday, July 31, 2017 at 11:39:07 AM Eastern Daylight Time
From: David Arnold
To: Pearlman, Michael R. (Mike)
Attachments: Reports .doc, Reports .pdf

Hi Mike,

Annual Report
David Arnold Task for SAO
for the Period July 1, 2016 - June 30, 2017.

The primary task has been simulations to develop a design for the LARES-2 satellite. The design goal is to minimize cost and manufacturing time, maximize cross section, and reduce systematic range errors to below one millimeter by minimizing the effects of manufacturing imperfections in the cubes, polarization, loss of total internal reflection, irregular diffraction patterns, range variations with incidence angle on the satellite, range variations with velocity aberration, and degradation of range accuracy due to thermal effects. There were 43 reports prepared relative to various options for the design including:

- Coated vs uncoated cubes
- Optimum cube size
- Optimization for cross section
- Dihedral angle offset
- Orientation of the cubes
- Satellite diameter
- Number of cubes
- Asymmetry of the range correction due to polarization
- Ring geometry vs close packing of cubes
- Accommodating the separation system

A ray tracing and diffraction calculation has been done using a temperature matrix computed in Italy. A transfer function was computed using using measured dihedral angle offsets in a set of 10 uncoated 1.0 inch COTS cubes. Systematic range errors are expected to be on the order of a half millimeter.

New studies of LAGEOS-2 have been done including:

- The actual coordinates and orientation of the LAGEOS-2 cube corners
- Asymmetry of the range correction due to polarization
- Histogram of the return pulse
- Studies of centroid, constant fraction, and first photoelectron detection systems
- Effect of pulse length, number of photoelectrons, and receiver rise time.
- LW20 paper (Potsdam): "Lageos-2 Polarization Asymmetry".

Upgrades were made to various compute simulations programs. New pre and post processing software was developed to analyze the data in different ways.

TRANSFR (Transfer function program for computing centroid and cross section)
The program has been updated to use both the group and phase index of refraction for better range accuracy.

RETURN (computes return pulse shape) and LRSS (Laser Receiving System Simulation using pulse shape from RETURN)
LRSS has been recompiled and tested on the MacBookPro. Various upgrades and new analysis software have been developed. The programs work in tandem to study the effects of transmitted pulse length, number of photoelectrons, detector rise time, and type of detection system (centroid, constant fraction, first photoelectron).

THERMAL2 (thermal analysis of a cube corner)
The program has been recompiled and tested on the MacBookPro in preparation for doing thermal studies of the LARES-2 cube corners.

RAYTRACE (ray tracing of a cube corner with thermal gradients using a temperature matrix computed by program THERMAL2)

The program has been recompiled and tested on the MacBookPro.

DIFRACT(Thermal) (computes diffraction pattern using phase matrix computed by program RAYTRACE)

The program has been recompiled and tested on the MacBookPro.

THERMAL2(Rings) (thermal analysis including a crude model of the retaining rings)

The program has been recompiled and tested on the MacBookPro.

The attached file lists reports giving the results of the analyses.

Best,

David Arnold

From: Mike Pearlman <mpearlman@cfa.harvard.edu>

Date: Monday, July 3, 2017 at 12:14 PM

To: David Arnold <david-arnold2006@earthlink.net>

Subject: Re: Invoice PO: 15-PO-400-0000316869

David,

I will need a report from you covering the the period 7/1/16 - 6/30/17. I need to give something to NASA.

Entitled

Annual Report

David Arnold Task for SAO

for the Period July 1, 2016 - June 30, 2017.

Make it succinct. Break it up into the different tasks that you did. Include the update of software and the capability added. Include LARES and what the goal was and what you achieved.

Okay?

Mike