Attenuation Simulations and Hardware Design for the nuSol Space-based Neutrino Probe

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INTRODUCTION: The nuSol project aims to design, build, and launch a small payload which will perform several near-solar approaches in order to demonstrate the viability of a space-based neutrino detector and perform scientific measurements. Under the previous NASA Innovative Advanced Concepts (NIAC) grant work was performed to simulate basic measures of performance of the probe. Under the NIAC phase II grant, we are tasked to refine simulation and to begin measurements using prototype detectors.

PURPOSE: To determine the viability of the neutrino probe, we have been performing tests in the lab at our test stand, and I have been creating monte-carlo simulations of a simplified flight path to find best case limits for evaluating the viability of the space-flight. The lab tests are to characterize the performance of the detector before and after the target doping.

METHODS: To simulate performance, I have created a C++ code which applies the results of more detailed simulations to find the approximate neutrino counting rate during a simple elliptical flight near Venus and Mercury as well as the physical flight paths found by simulation from another member of the project. The hardware uses liquid scintillator from the NOvA experiment in a cylindrical container on our test stand to characterize the detector's performance in cosmic ray backgrounds and in radioactive decay signals that mimic our expected signals.

RESULTS: The simulated performance is promising and gives us confidence that we can meet the standards of a technology demonstration mission. Hardware development has been stalled by COVID-related delays, but we hope to be taking the post-doping measurements within two weeks of writing.

CONCLUSION: Work on the nuSol probe progresses well. The results are promising, and this contribution to the larger project to build a neutrino detector in space is on schedule for the next phases of the project.

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