The Probe of Inflation and Cosmic Origins

A Space Mission Study Report
December, 2018

Principal Investigator:
Steering Committee:
Executive Committee:
Contributors:
Endorsers:

1 Executive Summary (2 pg, Hanany)

2 Science (31 pages)

48 pages are currently distributed as 31/17: 31 pages for science (including foregrounds and systematics), 17 for Instrument, technology, mission, technology, management and cost. References are extra. Should rebalance to 28/20?

2.1 Introduction (1.5 pgs, Hanany + (Flauger? Green? +?)

NASA suggested table of contents says Science Intro or Landscape section should include:

- State of the Art in the Field
- Compelling Outstanding Questions
- Needed Capabilities for Progress

2.2 Science Objectives (17.5 pgs)

The PICO Science Traceability Matrix (2pg, Hanany&Trangsrud) will be inserted around here. It is an 11x17 foldout, so it counts as 2 pages, which leaves 15.5 to all the rest in 2.2. Currently allocating 15 pages.

FOR EACH OF THE BELOW SUBSECTIONS:

- Introduce and elaborate on the applicable PICO "Science Objectives" from the STM table (what do they mean and why are they important)
- Observations/Measurements that enable PICO to accomplish each Science Objective (tell the data analysis story that connects the Observations column of the STM to the Science Objective column)
- Contextualize relative to sub-orbital and other space missions. *Emphasize where capabilities are unique to space.*
- Science yield estimate (be quantitative. how well will PICO do at Baseline/Required performance? at Current Best Estimate performance?)
- Include a summary plot or table which demonstrates PICO's performance against the Science Objective as written (e.g. how it discriminates between different theories)
- Perceived science impact. (The impact isn't reducing sigma on a parameter. It is about what we will learn about nature.)

2.2.1 Fundamental Physics (6 pgs, Flauger, Green)

To include: Cosmic Inflation, Particle Physics (Neutrinos and Light Relics), primordial EM fields Should address these Science Objectives from the STM:

- "Probe the physics of the big bang by detecting the energy scale at which inflation occurred if it is above 4×10^{15} GeV, or place an upper limit if it is below" [r]
- "Probe the physics of the big bang by excluding classes of potentials as the driving force of inflation" [n_s, n_{run}]
- "Determine the sum of neutrino masses, and distinguish between inverted and normal neutrino mass hierarchies" [Σm_ν]
- "Detect departures from or tightly constrain the thermal history of the universe" [N_{eff}]
- Origin of magnetic fields and cosmic birefringence

2.2.2 Cosmic Structure Formation and Evolution (4 pgs. Battaglia & Alvarez)

Should address these Science Objectives from the STM that relate to reionization + ??

2.2.3 Galactic Structure and Star Formation (5 pgs, Chuss & Fissel)

Should address these Science Objectives from the STM:

- "Determine whether the interstellar medium of our galaxy is unique by comparing the ratio of energy in magnetic field to turbulence to that in nearby galaxies."
- "Determine if magnetic fields are the dominant cause of low star formation efficiency in our Galaxy."
- "Determine whether radiative torque is responsible for the alignment of dust grains with magnetic fields"
- "Determine the influence of the magnetic field on Galactic dynamics within the Milky Way."

2.3 Measurement Requirements (2 pgs, Hanany & Trangsrud)

Some requirements derive from the science (τ = full sky) Some requirements derive from foregrounds (frequency coverage) and some from systematics (particular scan pattern)

2.4 Additional Science (2 pgs, de Zotti)

Describe science that we get for free.

2.5 Complementarity with other Measurements and Surveys (1 pg, Lawrence? Schmidt?)

Should describe complementarity with sub-orbital CMB measurements and with other surveys, both in space and on the ground. This is summary text (more detail in subsections about specific objectives)

2.6 Foregrounds (4 pgs, Clem? Jacques? Raphael? Brandon?)

The state of knowledge and known challenges; how does PICO address the challenges; forecast of performance.

2.7 Systematic Errors (3 pgs, Crill)

State of knowledge; What have we assessed in this study; what's left to be done (Crill)

3 Instrument (6 pgs, Trangsrud & Hanany)

Telescope, focal plane, cooling, readout

4 Mission (3 pgs, Trangsrud)

To be included: mission architecture, spacecraft and subsystems, orbit, attitude control and determination (Trangsrud)

5 Technology Maturation (4 pgs, O'Brient & Trangsrud)

Requirements, planned activities, schedules and milestones, estimated cost (O'Brient?)
For each technology include:

- Requirements
- Planned activities
- Schedule and Milestones
- Estimated Cost

6 Management, Risk, Heritage, and Cost (4 pgs, Trangsrud)

cost, risk, heritage (Trangsrud)

References