

A strategy for the SOFIA instrument roadmap: Take the Pioneer on-ramp

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Enabling SOFIA to realize its full potential

- Suborbital projects are the sole means of enabling far-infrared astronomy over much of the next decade
 - Realization of a probe-class mission is unlikely before the last quarter of the new decade
 - Although the Origins Space Telescope is our community's goal, the wait for it will likely be longer ...
- Spitzer and Hershel illustrate the scientific impact that could be returned by investment in far-infrared successor missions. However, NASA mission access to the >28 micron infrared spectrum will remain limited to sounding rockets, balloons, and aircraft for many years
 - Among these suborbital options, SOFIA is the most expensive to operate, but provides the lowest risk capability to enable repeated flights of a science instrument
- SOFIA's annual operating cost is similar to that of HST but it offers ~5X less observing time
 - In order to achieve parity in scientific return to the astrophysics community, SOFIA observing projects must achieve higher scientific impact than the average orbital observatory project
 - This goal should be achievable until orbital mission access to the far-infrared spectrum is available
 - However, impactful SOFIA science does not automatically result from its unique access to this spectrum

To achieve higher impact among its projects, SOFIA must change direction in its approach to science utilization and instrument development

Maximizing scientific impact with minimum expense

- A lesson-learned by the orbital strategic missions is that large focused non-proprietary observing projects achieve both high impact and high cost efficiency
 - Initiated by Spitzer under the name “Legacy Science Projects”, and now a normal feature of strategic mission utilization, these projects are characterized by: tightly focused science objectives that cannot be met by an ensemble of General Observer (GO) projects, large investments in observing time, and immediate dissemination of results via a public archive with no proprietary period
- Strategic orbital missions achieve high impact/cost by allocating observing time to a mixture of Legacy and GO projects.
 - They have 5X more observing time per year to allocate than SOFIA
 - To achieve similar impact/cost, SOFIA should not emulate the mixture chosen by orbital missions
- SOFIA observing time allocation should be strongly weighted toward Legacy projects
 - enables SOFIA to impact broad community science investigations to a extent that GO projects typically cannot achieve
 - In this approach, the SOFIA “user community” is the broad community that uses the resulting archive

A SOFIA utilization & instrument acquisition strategy geared toward Legacy Science Projects creates a condition in which high science impact/cost can occur

A new path to achieving high impact science with SOFIA

- SOFIA instrumentation should be solicited through the Astrophysics [Pioneer Program](#)
 - Standing annual solicitation
 - PI-class instruments with the enabled science investigation as the primary selection factor
 - \$20M cost cap, 5 year projects (instrument build + science investigation)
 - Efficient (7120.8) management compatible with University PI teams
 - TRL gate requirement 6 months after project start
- The Pioneer approach ensures that every instrument investment is coupled to a specific high impact science investigation and investigator team
- Tight coupling of instrument design to a specific science investigation avoids unnecessary instrument complexity and cost
- Annual solicitation enables continuous community opportunity to propose good ideas
- Suborbital (7120.8) management approach is cost efficient and geared toward university teams
- Solicitation of instrumentation for SOFIA through the Pioneer Program could begin next year
 - Requires 5% annual investment of operating cost in the portion of the SOFIA system that does the science

Determine the destination before drawing a roadmap to it

- In order for SOFIA to realize its full potential, it must:
 - Focus on maximizing the impact of science it enables
 - Observatory utilization should be strongly weighted toward Legacy projects that offer long term impact via provision of a non-proprietary archive that supports a wide range of science
 - Instrument acquisition strategy should support the above utilization strategy
 - Avoid emulating the orbital missions in architecting these strategies
 - They have 5X more observing time to offer than SOFIA
 - Their optimal balance between GO and Legacy-class projects does not apply to SOFIA
 - The high cost and limited availability of SOFIA favors utilization that is strongly weighted toward Legacy projects
 - Follow a suborbital mission approach to instrument development
 - Every new instrument must be coupled to a specific Legacy science investigation that fully motivates the cost of the instrument and the associated flights
 - Utilize the Pioneer Program for solicitation of science instruments and management of selected projects
 - Advocate for APRA/SAT investment in technologies that enable SOFIA to produce high impact science
 - Direct detection technologies are crucial to SOFIA's ability to open new discovery space.
 - All options are TRL-4 today, and are pacing items for SOFIA instrument development (see OST Tech Dev Report)

**Put the mission objective – science impact – first in every decision
To meet this mission objective, a course correction is needed**

Observations from the HIRMES experience

- Strong science leadership is crucial to any NASA science mission
 - This leadership cannot be fully delegated to the mission operations contractor or any single individual
 - SOFIA should have a Science Working Group (SWG) that directly advises Project Management
 - The PIs of the operating and in-development instruments should be members of the SWG
 - The instrument PIs should be viewed as members of the SOFIA Project rather than contract suppliers to it
- Management of science instrument development is a challenge area for SOFIA
 - Current management approach -- for which HIRMES was the first project -- is very intrusive and cost inefficient
 - A 7120.8 approach is strongly recommended
- Development of instrument solicitations is also not well aligned with SOFIA team experience
 - Strong ApD leadership needed if the Pioneer solicitation is not used
 - The solicitation must enable Technology Readiness Level (TRL) certification by a non-advocate engineering board
 - All new instruments should be PI-class with a specific science investigation as the primary selection factor
 - SOFIA can facilitate GO use of PI-class instruments by providing data reduction pipeline and archive services outside of the PI-managed budget
 - The Facility-class “build it and science will come” approach has not been productive in terms of high impact science yield, and invites burdensome management oversight that adds cost but little value

**The roadmap should be informed by lessons learned, but must not be a continuation of the past
SOFIA must turn onto a new course to meet its mission objective**