

Stella Splendida: Building the science and engineering workforce of the 21st Century

Thematic area: State of the profession

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Summary

This project, Stella Splendida, from the Latin meaning “bright stars”, aims to achieve worthwhile science at an affordable price, but also training the next generation of scientists and engineers, while they are still in school as undergraduates.

Stella Splendida project takes advantage of the rapid development of space technology, namely small satellite technology. It is a fact of modern life that currently, many colleges are able to design, build and operate small satellites. These satellites are capable of carrying telescopes of

order 10-20 cm in diameter, with no further technology development. The current state of technology and trends in the field have shown the importance of time domain measurements.

Our project's central idea is to use these small systems to make long duration, time domain measurements on the brightest stars in the sky. Each physics/astronomy department participating would be assigned a star or stars (depending on ecliptic latitude) and paired with an engineering and computer science department. They would work together to design, build, test and operate their satellite. The scientific data would be used for student research and also be sent to a centralized archive as an open community resource. Uplink/downlink capabilities would likely need to be provided by a combination of agency and industry partners, and subject to rigorous standardization.

Simply put, this project is merging of the need of developing and inspiring the best students to consider and want careers in space science and engineering and the ability of universities to build and operate space systems that accomplish these goals. *Stella Splendida* is envisioned to be a distributed space based observatory comprised of elemental telescopes, cubesats, built and operated by a university team comprised of science and engineering students

Stella Splendida: Project Bright Stars

1. Introduction

In 2019, the advancement of the USA in space science and exploration is at a cross-roads. We led mankind to the moon, but only after the USSR beat us to space with Sputnik and Gagarin. Fifty years later we are poised to be second or third back to the moon and beyond. Some of the major leaps in space science planned for the next decades similarly put at risk US leadership in many areas. This crisis is caused by large extent because we gave up our leadership in training the next generation in STEM fields, and our competitors immediately grasped the opportunity we gave them.

2. Objectives

Our project, *Stella Splendida*, will revitalize USA leadership and lead mankind into a bright future. *Stella Splendida*, from the Latin meaning literally bright stars, aims to employ worthwhile science at an affordable price as the catalyst to build the next generation of scientists and engineers, when they are still in school as undergraduates.

The project takes advantage of the rapid development of space technology, namely small satellite technology in which the USA is a world leader.

It is a fact of modern life that many colleges are able to design, build and operate small satellites. These satellites are capable of carrying telescopes of order 10-20 cm in diameter, with no further technology development. The current state of technology and trends in the field have shown the importance of time domain measurements. Systems of this size can produce first rate science, with some examples following. ASTERIA (Arcsecond Space Telescope Enabling Research in

Astrophysics), is measuring transiting planet light curves (Smith et al. 2018). In the planning stage are SPARCS (Star-Planet Activity Research CubeSat) observing low-mass stars in the ultraviolet and extreme ultraviolet, monitoring flares in these chromospherically active stars (Ardila et al. 2018). CUTE (Colorado Ultraviolet Transit Experiment) is a near-UV, 6U CubeSat telescope equipped with a spectrograph designed to monitor transiting hot Jupiters (Fleming et al. 2018).

Astronomy is a technologically limited science. These limitations come in the form of collection of light from the sky, either by aperture size or number of apertures available, detectors too limit the amount of information we can collect from the cosmos. Performing the science of astronomy in the 21st century takes some kind of collection system, a telescope, and a detector, to collect and transmute the celestial photons into information that can then be processed and turned into science. The other limitation is that of human capital, namely scientists and engineers trained to work together to produce the systems needed, pushing the frontiers of technology while also being affordable.

3. Technical: The Stella Splendida Observatory:

Our initial science objective, is the long term measurement the temporal behavior of the brightest stars in the sky. This would aid such science areas as stellar and exo-planet science. As the end goal of Stella Splendida is an open archive of fundamental science data on the behavior of stars. There will be critical performance requirements on radiometric accuracy, timing etc. The specific science requirements are to be determined by the Stella Splendida science steering committee, to be introduced later in this white paper. The performance of the project science activities, such as the calibration and its documentation, would be role of the science students prior to launch, guided by faculty.

It is perhaps an omen that there are 466 U.S. college and university departments that grant degrees in astronomy and astrophysics and that is approximately the number of naked eye resolvable stars. It is worth noting that there are over 1,000 U.S. institutions that grant engineering degrees, so partnering science and engineering students should not be an insurmountable issue. Participation is only requisite on the core ability for a college to participate, namely to be able to grant degrees in physics/astronomy, engineering, and computer science. Our aspiration is for institutions, particularly those of limited means or serving under-represented groups, to be able to participate fully. This aspiration translates into a flow down into a minimum set of resources that should be externally provided institutions to ensure uniformity of minimum playing field. Oversight would be provided by faculty members of the core departments at the institutions, with significant guidance given by the top-level project management (see below). Beyond this oversight, every aspect of the mission would be student-led and executed, providing a significant applied lesson in individual disciplines, teamwork, project management, and systems engineering.

We envision a rapid project with approximately one year for design and build and one year (minimum) of operations. This will enable Stella Splendida to attract students who can then use their participation as course and research work, both in engineering and science.

4. Operational Concept

The fundamental idea is that once the individual elemental telescopes are completed, they are delivered to the project office which has arranged for launch. Once launched the science operations, nominal and target of opportunity are performed by the university students. The data is both kept locally for student research and shipped to the Stella Splendida project office for inclusion in an open archive, creating a permanent high quality science archive.

The policies for targets of opportunity and proprietary data periods will be developed by science steering committee and ratified by the program office.

It is envisioned that these satellites will be low Earth orbit, giving them short lifetimes, so that later students can build on the experience of their predecessor peers. Moreover, low orbit lessens the challenge of disposal at end of life.

5. Technology Drivers

All of the needed technology to fulfill the science mission exists and have been demonstrated in flight.

6. Organization, Partnership and Current Status

This is admittedly a project idea very early in its formulation, so the details of the project and its management are simply not known. The Stella Splendida principals, Arenberg and O'Meara are forming the project team from colleagues based on a word of mouth campaign.

During the formulation campaign, we have begun discussions with professors of engineering at leading California colleges such as UCLA, USC, California Polytechnic and Stanford. The latter two institutions played early roles in the development of cubesats. Initial discussion with engineering partners shows an excellent match between Stella Splendida and current curriculum at these institutions. We have made invitations to other colleges and universities and are awaiting word.

We are also in the process of identifying additional science partners.

Figure 1 shows the current thinking of the organization of the project. At the top is the Project Management cell, this will include the project manager and a steering committee. Below this are two committees the Science and Engineering Policy Committees (SPC and EPC). They will be chartered with making recommendations on key project policies and requirements.

The Project management committee will be responsible for the overall project and specifically;

- Fundraising
- Arranging for launch
- Contracts management
 - With participating universities
 - Launch providers
 - Archive hosts
 - Funding organizations
- Financial operations and audits
- Overall project management
- Approval of recommended policies from SPC and EPC.

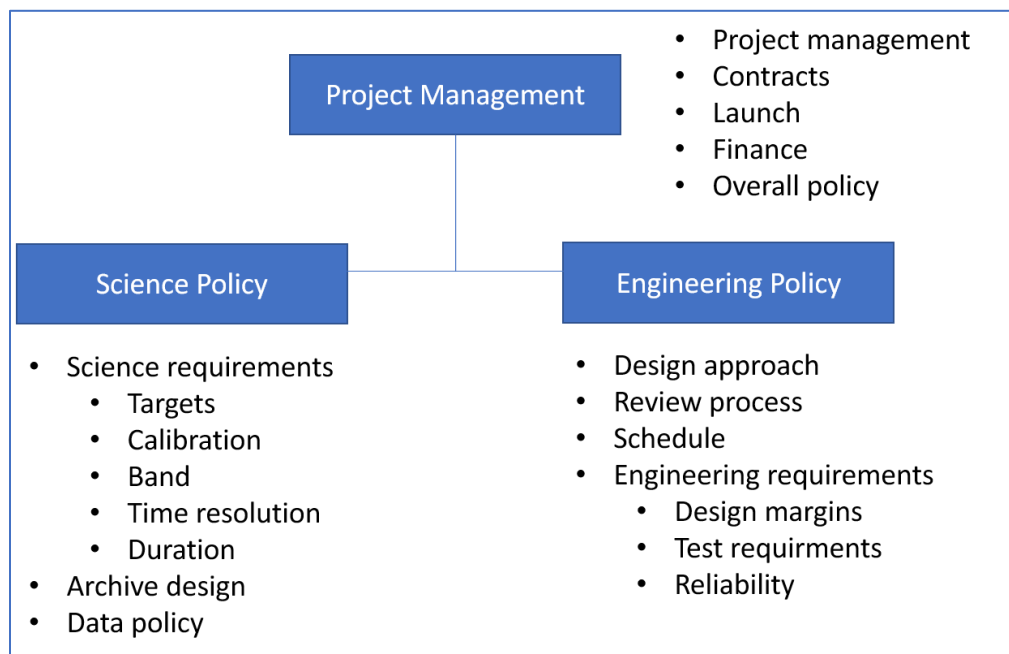


Figure 1: Organization Chart for Development

A sample of questions the SPC will consider are;

- Target selection
- Science requirements
 - Absolute calibration
 - Time resolution
 - Duration of measurement
 - Bands
- Archive design

- Proprietary data periods.

The EPC will consider such issues as;

- Design approach, namely is each university given a kit to assemble, test and operate, or a grant to develop a unique design?
- What is the proper review process
- Top level engineering requirements and practices
- Development schedule.

The committees are currently populated with members of the scientific and engineering community, from academia, industry, government and charitable realms. Namely, those listed as co-authors. We continue to recruit like-minded members of the community to help develop the needed list of items that must be answered in order to make Stella Splendida a reality. A next step is to define a uniform set of milestones and policies from the SPC and EPC, draft a notional set of requirements for institutional participation, and bring these together in a set of documents to undergo a conceptual design review by a committee drawn from academia, industry, and federal agencies. Identification of launch and funding partnerships has been initiated..

7. Funding

It is anticipated the philanthropic and small donations would provide the initial funding to develop the program and determine the annual budget. Given the likely scale of this program, a small professional staff is likely to be needed. Our goal in the formulation of this project is to determine the budget required, along with the scientific and engineering objectives.

8. Next Steps

We plan to move from ad hoc meetings to a regular set of science and engineering policy committee meetings. These meetings will produce drafts of science objective, engineering policies and plans.

We will continue to work to solidify the concept and share with the community, participation and presentation at the 2020 Winter AAS meeting.

We are in the process of organizing a 501c(3), a tax-exempt educational charity, to be able to receive donated funds and further development and establish program governance and a firm operating budget and plan.

Continue to identify universities and institutions, governmental, professional societies and individuals to participate, on the science and engineering side.

When all of the is near complete, we will then begin the search for funding, governmental, corporate as well as large and small private donors will be considered.

9. Conclusion

We believe the Stella Splendida holds great promise for scientific discovery and work force development. Stella Splendida is truly aspirational at this point, but we think that the goal of real, useful science and a future full of well trained and educated scientists and engineers from the widest set of institutions across the country is a goal worth reaching for, and significantly in the national interest, even if the details have yet to emerge.

We ask for the endorsement of the decadal committee and also hope that some of you reading this will contact us either to express the interest of your department's participation or as individuals to serve on a committee.

We thank you for your time and consideration.

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