Lowering Barriers to Near-Space Heliophysics with B-SSIPP

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Abstract
The Balloon-borne SwRI Solar Instrument Pointing Platform (B-SSIPP) is a test platform to enable novel solar measurements in near-space, and reduce barriers for new instrumentation. We report on the successful flight of B-SSIPP under a World View balloon on 1-Nov-02019, and on implications and future plans for the platform now that the technology has been successfully demonstrated.

Performing novel solar remote sensing from space and near-space has been and remains far more difficult than comparable measurements from the ground. This is because ground observations are supported by observatories: facilities that provide a conditioned environment and a stable, pointed beam to a controlled instrument environment (typically an optical table). By contrast, flight missions typically use "point designs" that, to a large degree, integrate all aspects of both the instrument and the observatory supporting it.

With the wave of low-cost ballooning and rocketry, engineering of "point design" missions can easily dominate the cost of a novel measurement. B-SSIPP lowers that barrier by providing an observatory environment, with a stable, pointed beam entering a thermally controlled, human accessible, configurable space for a novel prototype instrument. The B-SSIPP concept is specifically designed for low cost, scalability, reconfigurability, and rapid re-flight in its final form.

The current test flight demonstrates the system concept and key low cost and accessibility features, and enables development of a 75cm class platform to track the solar magnetic field, trace energy through the solar chromosphere, and provide facility observatory access to the solar physics and educational communities.

B-SSIPP Concept
B-SSIPP is a self-contained balloon gondola with a two-stage solar pointing system. Coarse pointing uses in-flight measured characteristics of the flight train to assemble a stable responsive control law with only a single low-power stepper motor driving twist. Fine pointing uses a telescope-in-loop feedback system. The solar beam enters a 4" Maksutov-Cassegrain telescope via an elliptical tip/tilt mirror. Four photodiodes pick off the solar limb at prime focus, driving mirror position and allowing most of the beam to propagate untouched through a physical hole, to the instrument itself on a general-purpose optical table. Command, control, and homeostasis use an on-board network of microcontrollers, one or more of which control the instrument and acquire data. B-SSIPP is battery-powered with endurance over 8 hours.

B-SSIPP History and Flights
B-SSIPP flew with partial success in Sep 2016, but did not complete all tests due to a command link failure. In 2017, the initial unit was destroyed in a lab fire. A new unit was built to incorporate lessons from Flight 1, and flew in Nov 2019. The second flight was fully successful.

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B-SSIPP launched under a World View envelope on 1-Nov-2019, achieving 97,000 ft altitude and observing the Sun in the spectroscopic "g-band".