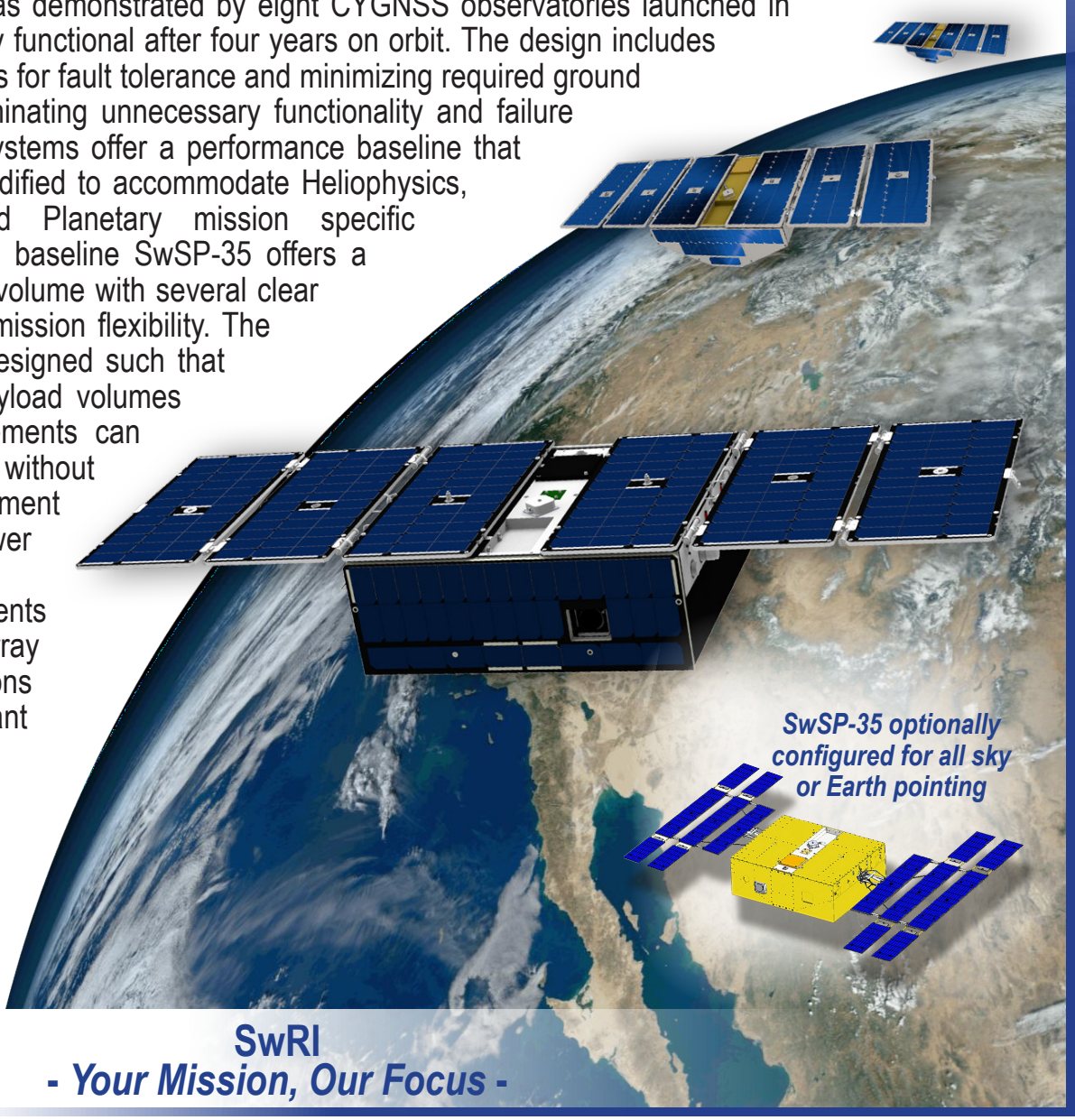
Advanced Science, Applied Technology

SwSP-35 Spacecraft

Rapid IV Spacecraft Catalog

Southwest Research Institute® (SwRI®) is a not-for-profit, independent, world-class developer of space flight hardware and missions, with a 4-decade history of successfully developing and delivering flight designs at all system levels from mechanisms and avionics boards to complete missions. We are an industry leader in mission design and management, flight avionics, instruments, and small S/C design and assembly, with full lifecycle capabilities. Our approach begins with understanding the mission objectives and progresses to the completion of innovative, unbiased, mission-centric designs. This approach, in conjunction with our heritage cost-controlled processes, was demonstrated by the successful development of the eight Cyclone Global Navigation Satellite System (CYGNSS) S/C constellation having met all science requirements and presently operating in extended mission.

SwRI's Rapid Spacecraft Development Office (RSDO) Rapid IV Core S/C, the 35 kg SwRI Spacecraft Platform (SwSP-35), is a natural evolution of the CYGNSS S/C. The SwSP-35 is based on a single-string architecture with functional and selective redundancy included for critical areas to increase system reliability while maintaining cost effectiveness. Mission design lifetime is >2 yrs as demonstrated by eight CYGNSS observatories launched in Dec 2016 and fully functional after four years on orbit. The design includes automated features for fault tolerance and minimizing required ground operations by eliminating unnecessary functionality and failure points. S/C subsystems offer a performance baseline that can be readily modified to accommodate Heliophysics, Astrophysics, and Planetary mission specific requirements. The baseline SwSP-35 offers a standard payload volume with several clear fields of view for mission flexibility. The S/C structure is designed such that larger external payload volumes and mass requirements can be accommodated without significant development effort. Payload power provisions meet Rapid IV requirements while solar array and battery options support a significant array of payloads. Observatory pointing capability is included to accommodate a wide range of mission scenarios and modes.



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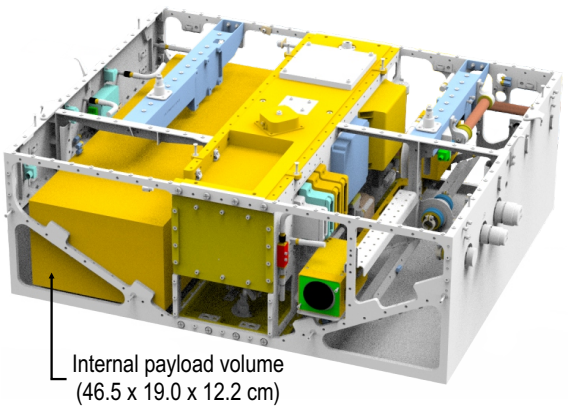
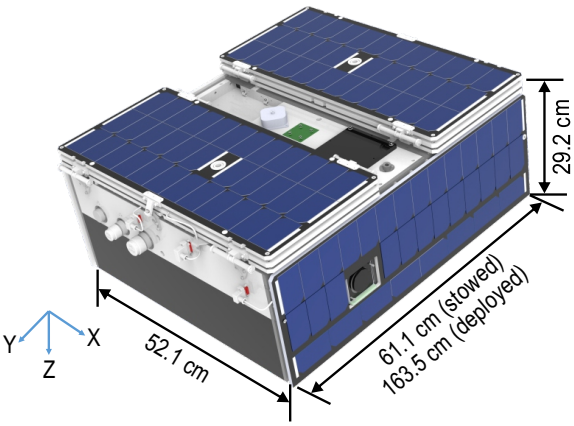
Baseline SwSP-35 Spacecraft Characteristics		
Mission Life		>2 yrs @ Ps > 0.89; TID: 5 krad (2 RDM)
Orbit Compatibility		400 – 700 km; all inclinations
Structure		Machined Aluminum
S/C Mass		23.4 kg
Internal Payload Mass		11 kg (max)
Thermal Control		Heaters, MLI, surface finishes
Electrical Power		Peak Power Tracking
Battery	Type & Capacity	Li-ion; 8.4 Ahr
	DOD	30%
Solar Array	Type & Size	Fixed; 0.7 m^2
	Deployment	One time deployed dual wings
	Cell Type	Triple junction with AR coating
	Cell Efficiency	30% (BOL)
Available Payload Power		>22 W (max orbital average)
Communications	Uplink	S-band; selectable to 128kbps
	Downlink	S-band; selectable to 4.5Mbps
Command Processing	Formatting	CCSDS; BCH; COP1
	Processing	Real-time, conditional, and/or time based
Data Handling	Payload interface	RS422, SpW, LVDS, others
	Formatting	CCSDS; AES-256
	Storage	>16 GB
Autonomy		Deterministic on-board event response
Fault Management		Autonomous response, background SEE scrubbing and recovery
Pointing Type		3-axis stabilized ; nadir, geo-location, solar, or inertial pointing
Knowledge	Performance	0.03 deg (3σ RSS)
	Star Tracker	Dual; 6 arc-sec (1σ)
	IMU	3 axis; 0.33 arc-sec (1σ)
	Magnetometer	10 nT
	Sun Sensor	6 DOF;
Control	Performance	0.07 deg (3σ RSS)
	Reaction Wheels	3 axis; 0.015 N·m·sec
	Torque Rods	1.5 Am^2
Orbit Knowledge	Position	10 m
	Velocity	25 cm/sec

SwSP-35 Internal Layout



Stowed SwSP-35 compatible with all ELV& VCLS launch vehicles



Integrated Observatory mass with maximum internal payload: 34.4 kg

The SwSP-35 S/C platform is designed and implemented to maintain the safety of the Observatory without ground intervention. The design maximizes fault tolerance by eliminating unnecessary functionality and failure points by employing a simple architecture and a simple operational scheme. S/C elements perform many autonomous functions allowing the S/C to operate with minimal routine commanding to accomplish operations. In areas where modifications may be necessary on-orbit, parameters allow modification by ground personnel during the course of the mission.

Structures and Mechanisms – Machined Al primary structure is used for the avionics bay as the core of the SwSP-35; all other components are mounted to this backbone with structural extensions included to accommodate the Al honeycomb-based solar arrays and payload assemblies. Observatory mechanisms are limited to heritage solar array deployment devices and 3-axis reaction wheels. Two “z-fold” solar array wings perform a one-time deployment into a permanently held position planar along the zenith side of the Observatory.

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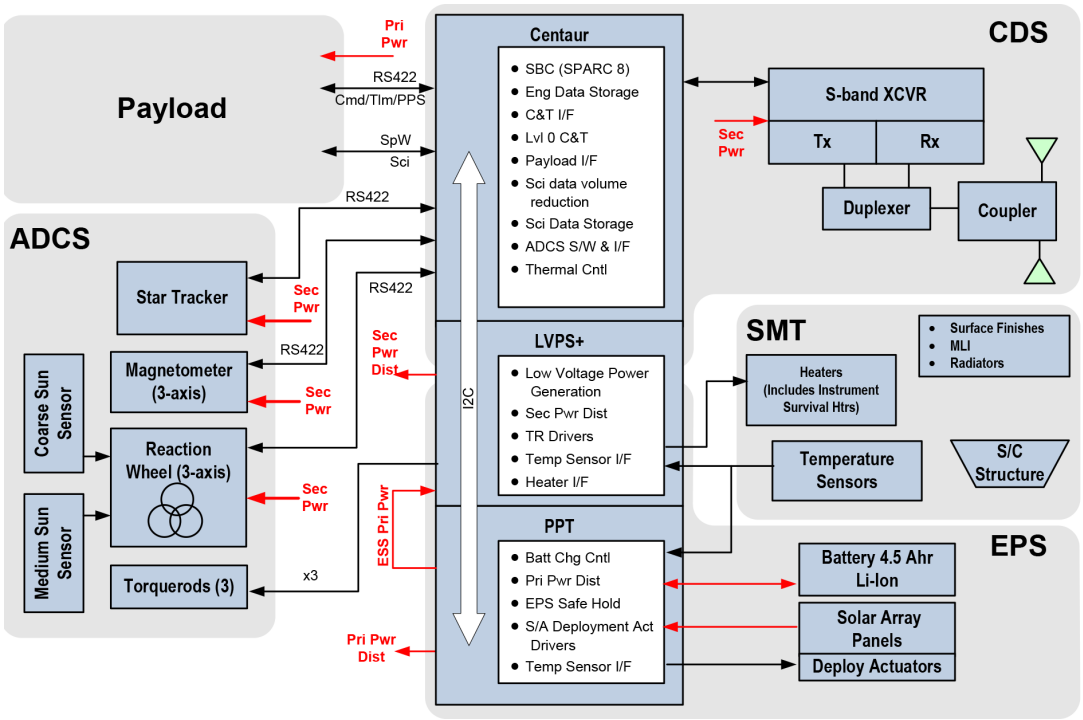
Electrical Power - The EPS is designed to perform battery charging without interrupting payload data acquisition. It is based on a 28 Vdc primary power bus with electrical power generated by an 8-panel solar array. When stowed, the Z-fold design of the fixed solar array allows the solar cells to face outward, to power the S/C in Safe mode before solar array deployment.

Communications and Data Handling - S/C uplink and downlink S-band communication links provide operational interfaces to the Observatory. The Communications and Data Handling subsystem also contains the S/C control processor with the associated Flight Software necessary to manage operations of each of the S/C subsystems and the payload. Data is stored as CCSDS packets in the on-board non-volatile data storage buffers. Hardware adds Virtual Channel and related formatting as data is pulled from the Buffers for downlink.

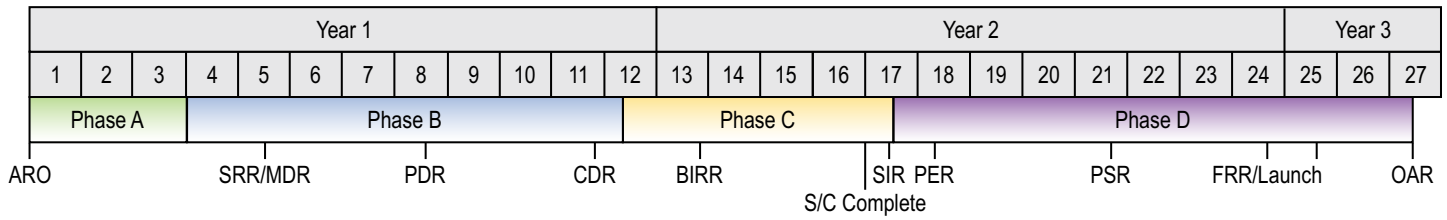
Attitude Determination and Control - The SwSP-35 ADCS is a 3-axis, star tracker/reaction wheel design. A magnetometer and 3-axis electromagnetic torque rods provide for reaction wheel momentum desaturation. The full featured ADCS software supports nadir, geo-location, solar, or inertial pointing mission pointing scenarios.



Mission specific optional capabilities include:

- Mission Concept Development
- Mission PM, SE, and SMA
- External Payload accommodation to 50 kg
- S/C Structure Size Expansion
- Solar Array Capability Increase
- Solar Array gimbal
- Battery Capacity Increase
- Payload Data Processing
- Increased data storage of >1 TB
- Downlink Rate Increase; X-band or Ka-band
- Gryphon AVE KI-55 encryption/decryption
- High Performance Pointing
- Pointing Agility Increase
- Solar Electric Propulsion
- Access to space; Rideshare or Primary payload
- Mission Operations

SwSP -35 S/C ready for delivery in 16 months, fully integrated & tested SwSP-35 Observatory delivered on-orbit in 26 months



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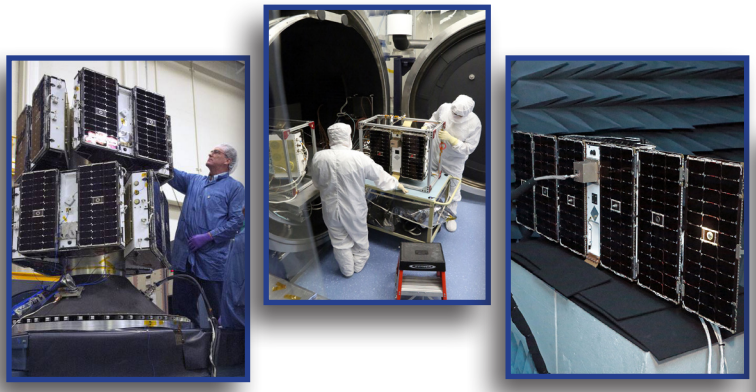
The SwRI Spacecraft Manufacturing Facilities co-located in San Antonio, TX, includes all development and production infrastructure required for the design, production, assembly, integration, and test of avionics, instruments, S/C, and fully integrated SwSP-35 observatories. Our facilities accommodate customer payload needs from initial delivery, through integration with the S/C and integrated system-level testing.

SwRI integration facilities include over 9000 sq-ft of cleanroom space, including two 950 sq-ft ISO 7 (Class 10k) and two 500 sq-ft ISO 6 (Class 1k) cleanroom. The mirrored facilities are configured to allow SwSP to perform commercial/civil projects in parallel with classified projects. Multiple 7.5 ton overhead cranes with 30 ft hook height and a transition bay allow transport of flight hardware to adjacent environmental test bays for thermal vacuum, acoustic, vibration, and EMC/EMI testing without ever leaving the building.

The SwRI Mission Operations Center (MOC), located in the Boulder CO SwRI offices, uses a straight forward approach to manage ongoing and future SwSP-35 Observatory(s) for NASA. The facility is specifically designed to efficiently manage spacecraft constellations. Support for mission operations stages available to NASA include: Launch and Observatory deployment, Commissioning, and Science Operations.



SwRI's Multi-Mission Operations Center is specifically designed for SmallSat constellations

SwRI's S/C AI&T Facility provides end-to-end S/C AI&T capabilities under one roof

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