MISSION STATEMENT

The Orbiting Picosatellite Automated Launcher (OPAL) project has the following top-level objectives:

1. Develop SSDL as a laboratory.
2. Provide educational opportunities.
3. Conduct OPAL payload experiments.

1. Laboratory Development Objectives

The OPAL project will further develop SSDL by maturing the SQUIRT program, providing test opportunities for current SSDL research programs, and increasing future laboratory opportunities.

1.1 SQUIRT Program Development

As the second satellite of the SQUIRT program, the OPAL project is responsible for improving the SQUIRT foundational processes and facilities laid down by SAPPHIRE, the first SQUIRT. Specifically, the OPAL project will:

1. Identify, acquire, and maintain additional design, fabrication, and testing equipment.
2. Develop additional industry contacts and recruit mentors from industry.
3. Identify sources for parts and facilities for long-term SQUIRT usage.
4. Develop the satellite-concept-to-orbit-operations process for the SQUIRT program.
5. Provide flight heritage hardware for future SQUIRT satellites.

1.2 Current SSDL Research Development

To develop and validate innovations for improving the cost-effectiveness of space operations systems, SSDL is developing a comprehensive real-world spacecraft command and control system, named ASSET (Automated Space Systems Experimental Testbed). This system will include a number of microsatellites, a number of geographically distributed ground communications stations, a central mission control complex, and an Internet and amateur radio communications network. The primary tasks of the system include the production of mission products and the maintenance of system health. OPAL will aid in the development of ASSET by:

1. Validating primary principal investigator experimental services through the ASSET operations systems.
2. Validating the performance of the fault detection beacon system being incorporated into the ASSET operations system.

1.3 Provide Future SSDL Opportunities

As SSDL's second satellite, the OPAL project will be instrumental in demonstrating the ability of the laboratory to produce the SQUIRT satellite. A successful flight of the OPAL satellite and completion of the OPAL payload objectives will demonstrate the ability of SSDL to produce a SQUIRT satellite that performs component

qualification, spacecraft technology demonstrations, and satellite autonomy experiments.

2. Educational Opportunity Objectives

2.1 Student Educational Objectives

SSDL provides students with a world-class education and research project opportunities in the fields of space system design, technology, and operation. To continue these student opportunities, the OPAL project will:

1. Train students in the importance and practices of system engineering.
2. Train students in every aspect of a satellite project: requirements formulation, conceptual design, subsystem analysis, detailed design, fabrication, integration, test, launch, and operations.
3. Prepare students for advanced engineering and research activities in SSDL.

2.2 AMSAT Educational Objectives

SQUIRT project goals include cooperating with AMSAT-NA, the Radio Amateur Satellite Corporation, by providing reliable and efficient communications using frequency bands and formats that may be easily received and decoded by existing amateur ground stations. SQUIRT satellites parallel AMSAT's goals in education, radio experimentation and innovative utilization of the amateur radio frequency bands. To promote these AMSAT goals, OPAL will:

1. Provide the opportunity for the amateur radio community to monitor OPAL status through a beacon broadcasting system.
2. Provide the amateur radio community the opportunity to fly a picosatellite experiment of their own design aboard OPAL's picosatellite launcher payload.

3. Satellite Payload Objectives

The OPAL project has three primary payloads: the picosatellite launcher, the accelerometer testbed, and the magnetometer testbed.

3.1 Picosatellite Launcher Payload Objectives

The primary objective of the picosatellite payload is to demonstrate the feasibility of a mothership technology mission. Design trades will be conducted in the storage, deployment, and communication aspects of the mothership-daughtership mission architecture to produce a single working system. The OPAL design team will develop a mothership system capable of storing and launching at least three picosatellites. The responsibility for design and construction of the picosatellites will be given to three external agencies, with the intention of increasing external relationships for SSDL. The aim is to include one academic institution, one industrial institution, and one amateur radio community group among the external agencies. A joint responsibility will exist between the external agencies and the OPAL design team to define the operations required for communicating with the individual picosatellites. The principal investigator for the picosatellite launcher payload is the OPAL design team. In addition, the picosatellites themselves will have their own individual missions and principal investigators.

The primary objective will be accomplished by successfully executing an end-to-end proof of concept mission that incorporates all aspects of the mothership-daughtership mission architecture. For the storage and communication aspects, the minimum operational success criterion is to obtain one successful downlink of data to Earth from a picosatellite. This will demonstrate that the OPAL launcher safely secured the picosatellite prior to deployment and that the picosatellite is capable of communicating its data to the ground. For the deployment aspect, the minimum operational success criterion is the launch of a picosatellite verified through launcher telemetry.

3.2 Accelerometer Testbed Objectives

The primary mission objective of the accelerometer testbed is to characterize the functionality and operation of several commercial-off-the-shelf (COTS) accelerometers during flight in space. The following COTS devices (each representing a different sensor technology) will be tested:

1. A MEMS capacitative sensor, the ADXLO5 from Analog Devices.
2. A piezoelectric sensor, the PCB 336M27 from PCB Piezotronics.
3. An inductive sensor, the GS-11D and GS-30CT from GeoSpace Corporation.
4. A piezoresistive sensor, the NAC 103 from Lucas NovaSensor.

Characterization of the accelerometers is defined as determining short-term sensor degradation due to launch and initial exposure to the space environment and determining long-term sensor degradation due to extended exposure to the space environment. The OPAL satellite will provide a stimulation source for the accelerometers with which to monitor sensor performance. Ground testing of the accelerometer testbed will provide a set of control data with which to compare recorded flight data. The principal investigator is Prof. Tom Kenny from Stanford University.

The definition of short-term degradation and the deliverables is TBD.

The definition of long-term degradation and the deliverables is TBD.

A method to analyze the data sets will be developed jointly by the OPAL team and the principal investigator. After verification of initial data sets and their analysis by the OPAL operations team, the raw data sets will be delivered to the principal investigator for analysis within one week of data download.

3.3 Magnetometer Testbed Objectives

The primary mission objective of the magnetometer testbed is to characterize the functionality and operation of the APS533, a miniature 3-axis fluxgate magnetometer fabricated by Applied Physics Systems. Characterization of the magnetometer is defined as determining short-term magnetometer performance degradation due to launch and initial exposure to the space environment and determining long-term magnetometer performance degradation due to extended exposure to the space environment. Magnetometer performance will be measured by comparing the vector magnitude of the earth's magnetic field as measured by the sensor to the predicted vector magnitude of standard geomagnetic modeling software. The principal investigator is Jim Lockhardt from the Gravity Probe-B mission.

For determining short-term degradation, the minimum operational success criteria is to obtain three data sets, each consisting of 720 magnetometer data points taken over two consecutive orbits at evenly spaced time intervals, within one week after OPAL's launch into space. A magnetometer data point consists of the X, Y, and Z-axis field measurements, a magnetometer temperature reading, and a time stamp.

For determining long-term degradation, the minimum operational success criteria is to obtain four data sets, each consisting of 720 magnetometer data points taken over two consecutive orbits at evenly spaced time intervals. The individual data sets will be taken at one-week intervals starting after the short-term degradation objective has been completed. Upon completion of the minimum success criteria, data set collection will continue at one-week intervals for the duration of the OPAL lifetime or until the data sets are no longer deemed useful by the principal investigator.

A method to analyze the data sets will be developed jointly by the OPAL team and the principal investigator. After verification of initial data sets and their analysis by the OPAL operations team, the raw data sets will be delivered to the principal investigator for analysis within one week of data download.