Supplement to the ORS-SQRD Science Plan
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Required Data
Optional Data

Experiment	Level 0 Objectives	Level 1 Objectives	Attitude / Pointing / Orbital Requirements	Preferred CONOPS	Measurement Timeline Start	End	Measurement Location	Sensor Type	Quantity	Sensor Part Number	Meas. Axes X	Y	Z	Units	Range Min	Range Max	Resolution	Bandwidth [Hz]	Sampling rate [Hz]	Data bits per sample	Comments	Ground Validation Method (These steps need to be included in the ground test plan)
CSD																						
	Measure the dynamic launch environment of a 6U payload inside the CSD.	Measure random vibration loads at bus during launch	none	Launch	Engine ignition	Final stage burn-out	n/a	Accelerometer	2	PCB Piezotronics 356A01	x	x	x	g	-50	+50	0.1	2,500	5,000	TBD	launch vibe trigger is TBR 8 g's for TBD duration. This will be refined pending input from the ORS office.	TBD
		Measure shock during all related events	none	Launch	All staging, fairing events, and all dispensing events (TBR)	All staging, fairing events, and all dispensing events	n/a	Accelerometer	1	PCB Piezotronics 356A01	x	x	x	g	-1000	+1000	1	3-10,000	30,000	TBD	The timing of each launch vehicle shock event will be refined pending input from the ORS office.	TBD
		Measure bus ejection/separation loads	none	Launch	Engine ignition	10 seconds after payload dispensed	n/a				x	x	x	g	-5	5	0.01	100	300	TBD		Ground test data collection of spacecraft-CSD ejection event
		Measure temperature from launch through separation	none	Launch	Engine ignition	10 seconds after payload dispensed	n/a	6 axis LVS IMU	1	Analog devices ADIS16445 Set to +/-62 degrees	n/a	n/a	n/a	C	-40	70	1	1	0.1	TBD		T-vac test data collection
	Measure separation/ejection performance of a 6U payload inside the CSD in the space environment.	Measure rotation rates before during and after separation	none	Orbit Insertion	Just prior to separation	10 seconds after payload dispensed	n/a				x	x	x	deg/sec	-50	50	0.5	100	300	TBD		Ground test data collection of spacecraft-CSD ejection event
		Illuminate adjoining structures during separation for camera	none	Orbit Insertion	Just prior to separation	100 seconds after payload dispensed	+/-z faces	Light	4	LED MFRM MCL053SWC-YH1 (Multi-comp)	n/a	n/a	n/a	none	none	none	non	none	none	TBD	Illuminate the inside of the CSD	Ground test images of spacecraft-CSD ejection event
		Capture images before, during and after dispensing	none	Orbit Insertion	Just prior to separation	100 seconds after payload dispensed	+ z face	Camera	2	C4224-136	n/a	n/a	n/a	none	none	none	5 megapixels	none	0.5	TBD	Capture one image every 2 seconds	Ground test images of spacecraft-CSD ejection event
		~~Capture video before, during and after separation~~	~~none~~	~~Orbit Insertion~~	~~Just prior to separation~~	~~100 seconds after payload dispensed~~	~~+z face~~				~~n/a~~	~~n/a~~	~~n/a~~	~~none~~	~~none~~	~~none~~	~~video~~	~~none~~	~~20~~	~~TBD~~	~~Maximum FPS~~	~~Ground test images of spacecraft-CSD ejection event~~
		Measure intermittency of loopback in flight disconnect	none	Launch	Just prior to engine ignition	10 seconds after payload dispensed	n/a	Voltage divider	1	Custom Voltage Divider	n/a	n/a	n/a	A	0	0.02	0.005	10,000	10,000	TBD	Detect open circuit, duration and quantity, may be reported as histogram	Confirm data collection during ground checkout
		Measure intermittency of payload inhibit switches	none	Launch	Just prior to engine ignition	10 seconds after payload dispensed	n/a	Voltage divider	1	Custom Voltage Divider	n/a	n/a	n/a	A	0	0.02	0.005	10,000	10,000	TBD	Detect open circuit, duration and quantity, may be reported as histogram	Confirm data collection during ground checkout
SPA																					The functioning of the SPA electronics will be demonstrated by the functioning of the spacecraft in general. Further to this each SPA unit will generate HK data providing currents, voltages and temperature. This data will be part of the nominal spacecraft housekeeping data and will therefore not create any surplus data. It will also not be required that specific experiments are designed for the SPA electronics.	
	Exercise SPA electronics for long duration in a space environment.	Measure OBC (on-board computer) latentcy throughout the mission (TBC)	none	none	at OBC start-up	never	inside bus	none	none	none	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		Confirm data collection during ground checkout and boot-up
		Measure OBC health status throughout the mission (TBC)	none	none	at OBC start-up	never	inside bus	none	none	none	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		Confirm data collection during ground checkout and boot-up
HaWK Array																						
	Measure the deployment performance of the HaWK array during deployment in the space environment.	Measure 6 DOF deployment dynamics at the spacecraft interface.	Spacecraft should make a best effort to de-tumble to a rate les than 10 degis prior to deployment. Spacecraft TLE data is required at the time of all deployment events.	Deploy immediately after spacecraft has de-tumbled	5 seconds prior to deployment actuation	60 seconds after deployment actuation	as close to array gimbal as possible	6 axis LVS IMU	1	same IMU as used on LVS	x	x	x	g	-5	5	0.01	100	300	TBD	Also gather IMU temperature data as needed to calibrate acceleration measurement	TBD
		Measure 3 DOF shock loads at the spacecraft interface during deployment			5 seconds prior to deployment actuation	60 seconds after deployment actuation	as close to array gimbal as possible	Accelerometer package from CSD launch shock measurement	1	PCB Piezotronics 356A01	x	x	x	g	-200	+200	0.1	3-300	1,000	TBD		TBD
		Capture array deployment video			5 seconds prior to deployment actuation	240 seconds after deployment actuation	in full FOV of array and boom	Camera (from high data rate experiment)	1					MP			5		30		Capturing the full FOV of the array is preferred but a partial image is also useful	TBD
	Measure health and performance of the HaWK array over time in the space environment and demonstrate value of the SPA network to optimize inbound current.	Measure array current and voltage			At the start of array gimbal algorithm	eclipse	take the measurement at the input to the power management system	none	6 Strings	none	n/a	n/a	n/a	V and mA	0 V 0 mA	14 V 43 mA	+/- 5%	none	1	TBD	Measure the current and voltage from each of 6 strings. Each string is 14 V and peak power for each string is approximately 6 Watts	TBD
		~~Demonstrate current optimization through array gimbal algorithm:~~			~~Enter Illumination mash orbit:~~	~~eclipse~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~	~~degrees~~	~~0~~	~~90~~	~~+/- 5~~	~~none~~	~~2~~	~~TBD~~	~~This objective may be accomplished with a solar tracking algorithm. AAS C: responsible for the algorithm~~	~~TBD~~
		Command 180 degree gimbal rotation	As close to solar normal as possible. Spacecraft TLE data is required at the time of all measurements.	This array performance check should be performed constantly whenever in solar illumination.	Start gimbal articulation common	After step count indicates 180 degree motion	Spacecraft command needed	none	none	none	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Gimbal command and control details will be provided in an ICD	TBD
		Count gimbal rotation steps			At the start of array gimbal algorithm	eclipse	Within gimbal	step counter provided	1	TBD	n/a	n/a	n/a	step count	TBD	TBD	+/- 1	none	1	TBD	Gimbal command and control details will be provided in an ICD	TBD
		Confirm gimbal limit switch activation signal			At the start of array gimbal algorithm	eclipse	Within gimbal	limit switch provided	1	TBD	n/a	n/a	n/a	TBD	TBD	TBD	TBD	none	TBD	TBD	Gimbal command and control details will be provided in an ICD	TBD
		Capture images of array			5 seconds prior to array gimbal command	5 seconds after final array gimbal command	in full FOV of array and boom	Camera (from high data rate experiment)	1					MP			5		1			TBD
		Measure Gimbal dynamic loads during operation and idle			60 seconds prior to array gimbal command	60 seconds after final array gimbal command	as close to array gimbal as possible	6 axis LVS IMU						g	-5	5	0.01	100	300			TBD
		Measure change in spacecraft attitude during array gimballing																				TBD
SIMPLE Boom																					These methods are suggested to measure deployment success of the boom. First, sense the change in magnetic field with the spacecraft magnetometer. Second is measure the change in magnetic field with the SMILE magnetometer. These may require a special calibration of the integrated spacecraft and magnetometer. Third, sense changes in spacecraft gravity gradient induced libration rates prior to and after boom deployment. A change is expected due to the mass moment of inertia change due to the boom deployment.	
	Measure the deployment performance of the SIMPLE boom in the space environment.	Measure boom deployed length and change in spacecraft attitude due to deployment.	Spacecraft rotation rate should be minimized prior to deployment, less than 10 degree/sec/sec0 is desired but not required. Spacecraft TLE data is required at the time of deployment. All data should be time stamped.	Prefer to deploy as soon as possible, within 24 days after separation is desired. Deploy soon after HaWK for stabilization.	5 SMILE magnetometer data samples and 5 spacecraft magnetometer data samples gathered one-time in the orbit 5 seconds prior to deployment. Measure spacecraft libration rates with IMU one-time 5 seconds prior to deployment.	5 SMILE magnetometer data samples and 5 spacecraft magnetometer data samples gathered one-time in the orbit 5 seconds after to deployment. Measure spacecraft libration rates 5 seconds after deployment.	n/a	Magnetometer and 6-axis LVS IMU	n/a	Analog devices ADIS16445 Set to +/-62 degrees	x	x	x	gm-mm^2 deg/sec	n/a	n/a	+/- 200 0.1	n/a	n/a	TBD		Spacecraft C.G. predicted using CAD. Total spacecraft mass is measured. Boom first motion test is required after all launch loads testing is completed.
		Measure time required to sever burn wire and the 6 DOF spacecraft deployment dynamics effects			5 seconds prior to deployment actuation	420 seconds after deployment actuation	as close to array gimbal as possible	6 axis LVS IMU	1	Analog devices ADIS16445 Set to +/-62 degrees	x	x	x	g	-5	5	0.01	100	300	TBD		Burn-wire component T-vac testing--COMPLETE
		Measure 3 DOF shock loads during deployment			5 seconds prior to deployment actuation	420 seconds after deployment actuation	as close to array gimbal as possible	Accelerometer package from CSD launch shock measurement	1	PCB Piezotronics 356A01	x	x	x	g	-50	+50	0.1	3-300	1,000	TBD		none
		Capture video of boom deployment			5 seconds prior to deployment actuation	420 seconds after deployment actuation	in full FOV of array and boom	Camera (from high data rate experiment)	1	Camera from high data rate experiment				none	none	none	5 megapixels	none	30		Capturing the full FOV of the boom is preferred but a partial image is also useful	Test images to be collected in ambient.
	Measure the structural health and behavior of the SIMPLE boom over time in the space environment.	Capture images of boom	Sunlit to illuminate boom	A single boom image should be collected immediately after deployment and once per week thereafter until mission end			in full FOV of array and boom	Camera (from high data rate experiment)	1	Camera from high data rate experiment				none	none	none	5 megapixels	none	1		Capturing the full FOV of the boom is preferred but a partial image is also useful	Test images to be collected in ambient.
SMILE																						
	Measure the vector magnetic field and auroral currents of the Earth along the orbital velocity vector in the aurora regions.	none	Polar orbit is preferred. Spacecraft TLE data is required for all measurements. All other data should be time stamped.	Prefer to start collecting data as soon as possible and continuously throughout the mission duration. Data collection for 15 minutes in the auroral zone is particularly important.	as soon as possible	never	tip of SIMPLE boom	SMILE magnetometer	1	SMILE Magnetometer	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10	64	Sampling rate is 10 Hz. Each data sample includes four data sets, three 20 bit samples and one 4 bit counter. The signal also includes a temperature signal. To the extent possible within the constraints of the mission, magnetic cleanliness should be pursued. Limit the use of magnetic material (steel, iron, nickel, etc). Limit the area of the current loops (non twisted pairs for current-carrying harness).	TBD
Dosimeter	*Measure ionizing dose radiation as a function of spacecraft altitude and attitude.*	none	Spacecraft altitude and inclination angle is desired. All data should be time stamped.	Collect a dosage reading once every 10 minutes throughout the life of the mission.	as soon as possible	never	Shielded inside the bus but positioned close to the bus outer wall	Dosimeter board	1	n/a	n/a	n/a	n/a	Volts	0 (0V)	0xF (3.3V)	8 bit x2	100K	1/6000	16	SPA-1 interface, each sample is 2 x 8 bits of data, sample once a minute is preferred, once every 10 minutes is threshold. This experiment has on board data storage to allows buffering and downlinking flexibility.	Data Should match a validation curve
Iridium Radio	*Establish the orbital and ground station parameters by which to successfully communicate to an orbiting Iridium and Orbcomm terrestial radio through the respective commercial space communications*	Iridium communication operations		Collect measurement four times daily	end of mission	Six months after first communications	Will be received via email	1.6 GHz patch antenna	1	Q9602 by Iridium	n/a	n/a	n/a	n/a	N/A	N/A	N/A	Identified in Sensor type section	N/A	minimal data to prove communications	These radios can be tested by sending and receiving simple messages from a CPU with an internet connection, no groundstation is required to test. The plan for these radios is to utilize the Iridium radio to provide the spacecraft with a GPS signal. Over the six months, we will record repeating transmissions from the radio as the circle to characterize the weakness in this systems capability to receive from the ground and transmit to the ground. Primary limitations on duration for these tests would probably be cost of operation (per byte costs are high)	While the system is sitting at Ames, we will transmit to and receive from the modem. Clear view of the sky will be required.