RAIDS Update

The Remote Atmospheric and Ionospheric Detection System aboard the ISS *October 9, 2009*

Figure 1: RAIDS launched aboard the H-II Transfer Vehicle on the maiden voyage of Japan's new H-IIB rocket from Tanegashima Space Center on September 10, 2009 at 17:01:46 UT. (Photo credit: JAXA)

Figure 2: The unmanned H-II Transfer Vehicle carrying HREP, the Japanese SMILES payload, and supplies rendezvous with the space station on September 18, 2009. (Photo credit: NASA)

Mission Highlights

The RAIDS experiment has been installed on the JEM Exposed Facility aboard the ISS and is undergoing its initial check-out and commissioning. Seven sensors have been powered, with the EUV spectrograph awaiting completion of its planned outgassing period before activation. All sensors are functioning as expected and returning live science telemetry to the Payload Operations Control Center (POCC) at NRL. The sensors were initially operated with dust covers closed to perform dark count and noise characterization. On October 5, first motion of the RAIDS scan head from its stowed position deployed all dust covers and readied the sensors for first light. Live video coverage of this initial scan was obtained from two of the ISS cameras to allow the RAIDS team to monitor this activity and verify successful deployment. All seven sensors on the scan head were turned off during this maneuver, but the FUV imager remained powered and collected first light spectral limb profiles. On-orbit testing is proceeding well with no significant anomalies. Normal operations are scheduled to commence on October 24 after a required Sun-avoidance shutdown around October 19-22.

This newsletter presents H-II Transfer Vehicle (HTV), HREP (HICO-RAIDS Experiment Payload), and RAIDS mission highlights and includes some images to keep you current with RAIDS mission activities. Enjoy!

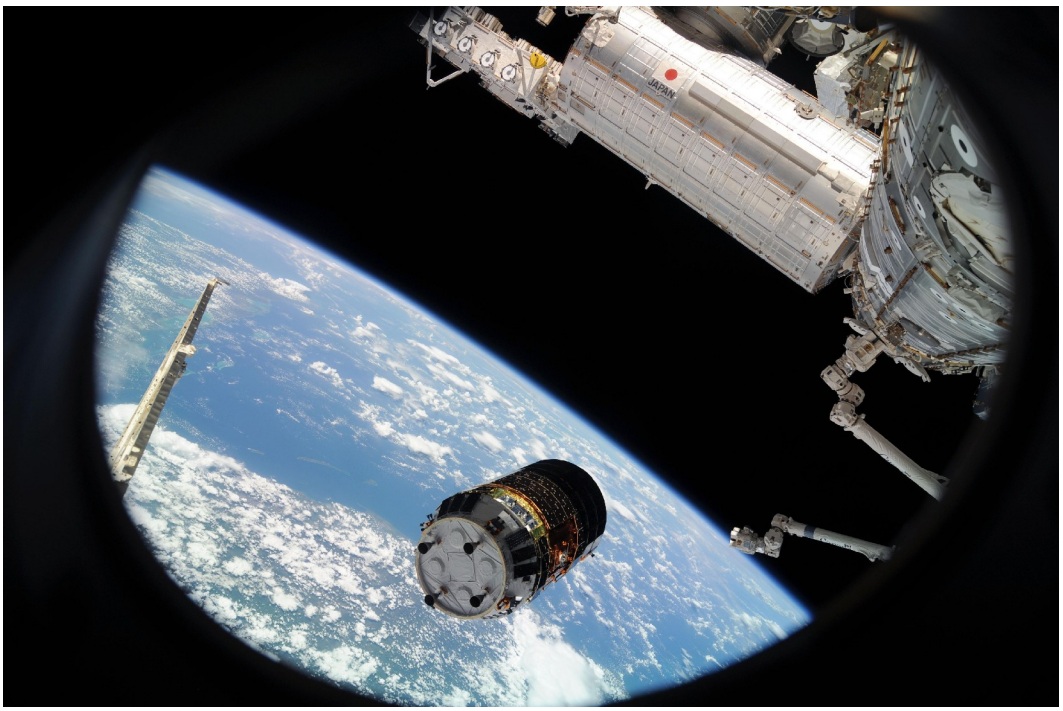
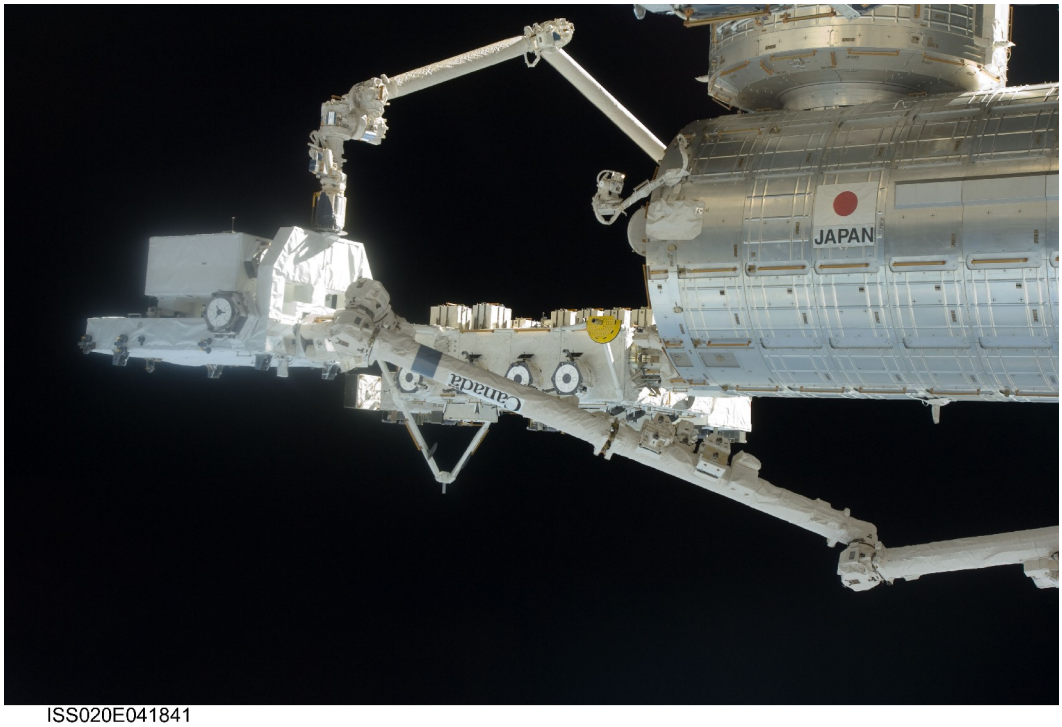


Figure 3: Immediately after launch, the unmanned HTV began several days of free flight and test maneuvers before approaching the space station. On September 18, astronaut Nicole Stott used the Canadarm2 space station manipulator to grapple and dock the HTV to the Harmony module. In this view the Japanese Experiment Module (JEM) and its Exposed Facility (JEM-EF) are visible at the top. (Photo credit:NASA)



ISS020E041841

Figure 4: The Experiment Pallet holding HREP and Japan's SMILES payloads was removed from the HTV with the main station arm, and then transferred to the JEM's robotic arm. The Experiment Pallet was secured to the JEM-EF on September 23 to prepare for payload installation the following day. (Photo credit: NASA)

ISS020E041972

Figure 5: Astronauts use the JEM manipulator arm to transfer HREP from the Experiment Pallet to its operating location on September 24. The ISS main solar arrays rotating in the background indicate that the Sun is below the station and to the right. The many large ISS structures generate substantial scattered light even when HREP is shaded from the direct Sun. (Photo credit: NASA)

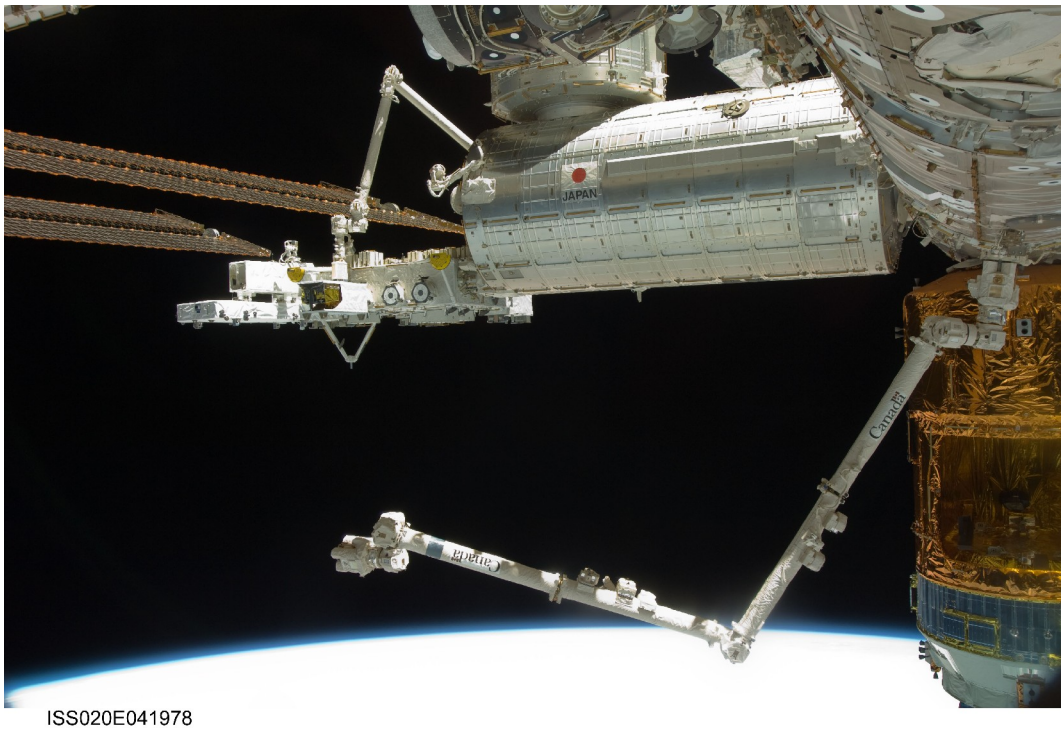


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Figure 6: HREP is installed onto the JEM-EF. The RAIDS experiment can be seen in gold thermal blanketing viewing aft from the open end of HREP. The empty HTV is in the lower right foreground. (Photo credit: NASA)

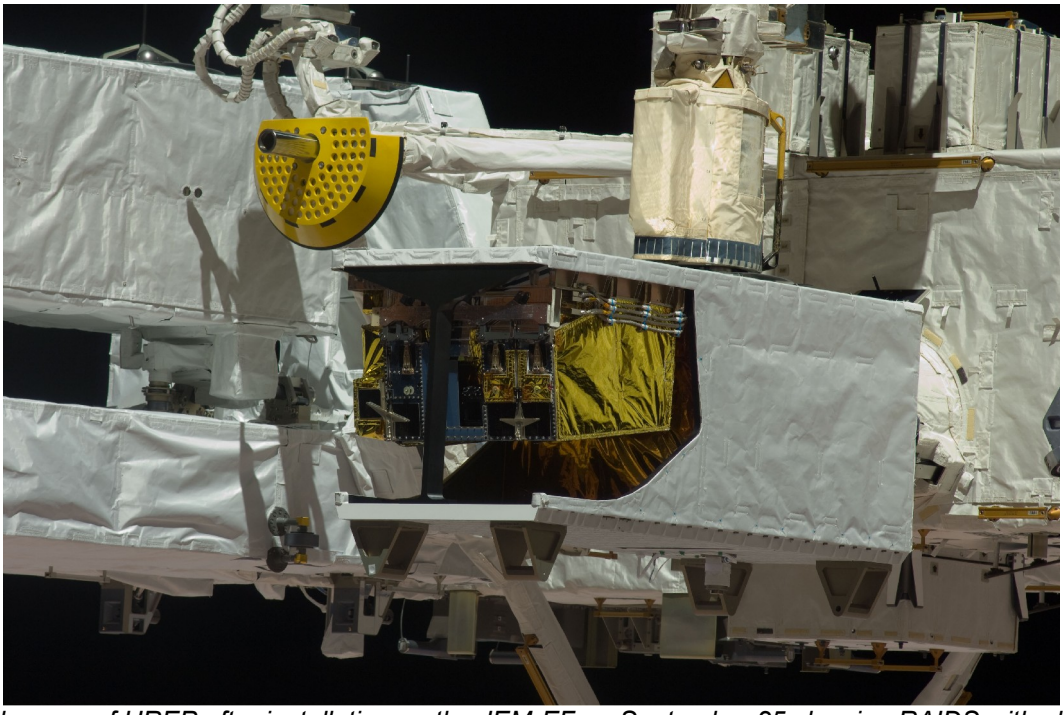

Figure 7: Close-up of HREP after installation on the JEM-EF on September 25 showing RAIDS with all dust covers closed. In the background on the left sits the Experiment Pallets with the SMILES experiment still attached. (Photo credit: NASA)

Figure 8: During the RAIDS first motion and deployment the Space Test Program arranged for live video coverage of the activity. This image is a video frame capture taken just seconds after all dust covers opened and RAIDS began a limb scan. All sensors were turned off during deployment except for the non-scanning FUV imaging spectrograph.(Video credit: NASA)

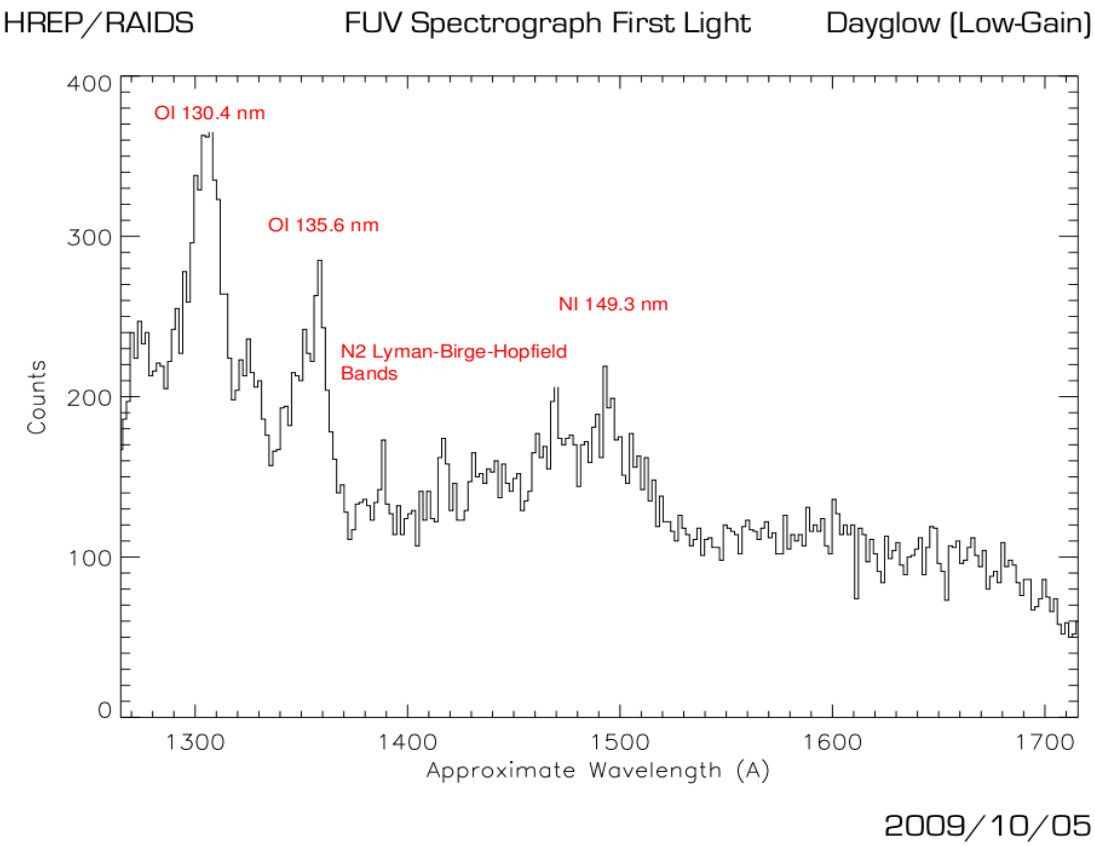

Figure 9: During the time of RAIDS deployment the FUV spectrograph was operating in conservative low-gain mode. Spectra from the dayside pass were co-added to produce this initial dayglow spectrum from RAIDS, showing the major thermospheric emission features. As RAIDS enters normal science operations, the FUV sensor detector high voltage level will be boosted for optimal gain.

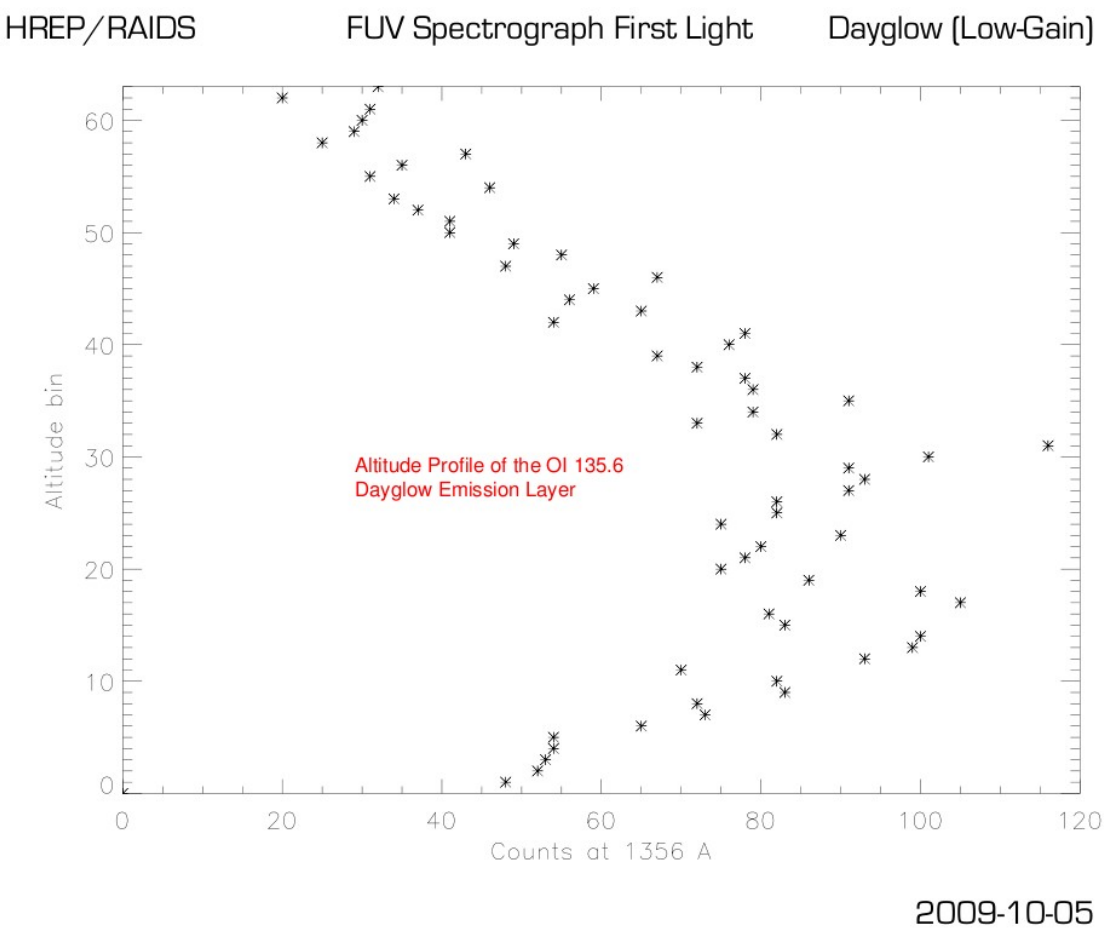

Figure 10: This plot shows the averaged vertical profile of OI 135.6 nm emission during the dayside pass. This indicates that the FUV spectrograph slit is imaging the peak of the thermospheric airglow layer. The FUV sensor is an imaging spectrograph which does not scan and is not steerable. Due to the sensor's limited 4.1˚ vertical field-of-view and uncertainty about the ISS operating attitude, a considerable number of trade-offs had to be evaluated to optimize the probability that the sensor would image the emission peak. This is a particularly gratifying image that shows the payoff of the Instrument Team's hard work.

On-orbit Check-out Progress

The on-orbit checkout for RAIDS is proceeding well, albeit at a very demanding pace for the small Instrument Team. The schedule below is somewhat less aggressive than the original Check-out plan, based upon the experience gained during the first two weeks of HREP/RAIDS check-out. The shaded items are completed through October 7.

RAIDS Commissioning Activities (as-run and planned)

MisnDay	Date	Event	Activity	Description	Notes
1	09/24/09 Thu	1	HREP Install	HREP installed at EFU#6	
1	09/24/09 Thu	2	HREP Surv Pwr	HREP EFU#6 survival power ON	MSFC/PRO and JAXA coordination
1	09/24/09 Thu	3	HREP On	Turn on HREP Operational Power	Monitor IIU boot (Verify proper boot); Monitor thermal configuration (verfy thermal configuration); Send IIU no-op command(verify command link)
1	09/24/09 Thu	5	RAIDS On	HREP/RAIDS activation and heater configure	Turn on RAIDS FMP, Monitor RAIDS Boot, Turn on RAIDS Heater Bus (monitor thermal states)
3	09/26/09 Sat	7	RAIDS EUV Door	RAIDS EUV detector outgassing	Open the EUV detector door to vent detector into the cavity (with dust door shut). ENSURE: EUV detector temperature is above 0C(+margin) to allow H2O? liberation and grating is warm. At least 7(?) days of outgassing complete.
3	09/26/09 Sat	15	RAIDS Noise Trending	RAIDS Sealed detector noise trending	Power all sealed-tube sensors to trend temperature, noise performance, and search for potential light leaks. No spectral scanning. If no light leaks observed when HREP is in sunlight, 3 days is sufficient for noise trending. Sensor data must be collected.
5	09/28/09 Mon	15B	RAIDS Noise Trending	RAIDS Sealed detector noise trending, with NIR scanning	Activate NIR spectrometer scanning and place NUV at 385nm to characterize light leak spectrum.
6	09/29/09 Tue	15C	RAIDS Noise Trending	RAIDS Sealed detector noise trending, with NIR scanning	Cold start of RAIDS, then activate NIR spectrometer scanning and place NUV at 385nm to characterize light leak spectrum.
12	10/05/09 Mon	27	RAIDS 1st Motion	RAIDS deployment and FUV first light	Deployment + First Light for FUV. Protect NIR/Vis, NUV, MUV sensors from accidental Rayleigh scattering damage, start the scan mechanism, deploy RAIDS. FUV does not need to be turned off. Successful deploy, door indicators show open and returned to stow
13	10/06/09 Tue	36A	RAIDS Sensors part 1	First Light NIR	Turn on NIR and monitor signal at high altitude from nightside into dayside.
13	10/06/09 Tue	33	RAIDS Safing Test	Test of RAIDS sun-avoidance safe-mode and recovery	Scan RAIDS down to disk to test sun-avoidance mode, set instruments to Mode 0 (all instruments off). Return to stand-by state.

MisnDay	Date	Event	Activity	Description	Notes
14	10/07/09 Wed	13	MSFC Low Power Test a	MSFC/ POD low power command test	MSFC/PRO sends to the "HREP Low Power Mode" Commands and HREP verifies status
14	10/07/09 Wed	14	MSFC Low Power Test b	HREP return to operations test	HREP commands ICU and RAIDS power on (event 3&4)
14	10/07/09 Wed	34	RAIDS Platform Test 1	Test of platform turn-around point (max-alpha)	Set max-alpha point and test with scan of platform
15	10/08/09 Thu	36	RAIDS Sensors	RAIDS First Light photometers, MUV, NUV, NIR	Turn on photometers, scan MUV, NUV, NIR, and monitor signal at high altitude from nightside into dayside.
16	10/09/09 Fri	37	RAIDS Low Limits	Low altitude limit search	Identify the lowest altitude the NIR/Vis sensors can safely measure w/o damage. Start high, and work low. Angle for maximum safe count rate determined for the most sensitive sensors (NIR/Vis). ESTIMATED 7 COMMAND WINDOWS REQUIRED DAILY (ALTERNATING ORBIT
18	10/11/09 Sun	41	RAIDS EUV On	RAIDS Power ON EUV sensor	Execute 14+ days after Event 7 (EUV Detector outgassing).
18	10/11/09 Sun	39	RAIDS Alt Limit Set	Set low altitude scan limit	Implement low altitude angle limit with reverse bit using nominal scan. (Minimum altitude scan angle determined.) Can defer to Tues 10/13/09.
18	10/11/09 Sun	42 & 38	RAIDS EUV Limb scans & RAIDS Low Scan	Collect limb-scan data with EUV	RAIDS EUV On, Status of all other sensors determined by results of low-altitude limit search (Event 37) FUV at optimal HV setting (Level 6). Verifies on-orbit low altitude angle limit scan performance with reverse bit. Can defer to Tues 10/13/09.
21	10/14/09 Wed	35A	RAIDS Scan Mode	Scan mode testing	Test default scan modes 1,2—nothing fancy here
21	10/14/09 Wed	40	RAIDS Sequencer Test	Sequencer functional test	RAIDS Test Sequencer functionality according to 1992 test plan. Validate table upload, day/night, and 5-entry Mode 2. Spectrometers should be on.
22	10/15/09 Thu	43A	RAID Normal Ops Preview	RAIDS test normal operating mode	Precautions taken until sun sensors can be fully evaluated at next apparition within scan field of view. Evaluate data for possible ops mode adjustments.
27	10/20/09 Tue		Sun Avoidance Safing Likely	Sun-Safe RAIDS	Set instruments to Mode 0 (all instruments off), can RAIDS down to disk/
28	10/21/09 Wed	44	RAIDS Sun Sensor	Sun sensor testing	Sun Sensor Threshold setting, Set safing overrides.
28	10/21/09 Wed	35B	RAIDS Scan Mode	IIU Script Testing	Use No-op commands to test scripting upload, starting, waiting, looping, and stopping. Works wiith only FMP running.
29	10/22/09 Thu		Sun Safe Recovery	Recover from Sun-safe to prepare for Normal Ops	Return RAIDS to stowed position
29	10/22/09 Thu	43B	RAID Normal Ops	RAIDS enter normal operating mode	Precautions taken until sun sensors can be fully evaluated at next apparition within scan field of view

RAIDS Science Data Preview

The current check-out schedule projects RAIDS will transition to initial science operations during a "preview" period from October 15-19. This operating mode will obtain a continuous series of stepped limb scans covering five discrete altitudes. The RAIDS scan platform will position itself to point at each altitude for 25 seconds while the spectrometers make complete spectral scans. The actual values of those five altitudes depend upon the outcome of the low altitude scan limit search (event 37 above), but a baseline set of altitudes would be 105, 120, 135, 150, and 180 km. After a few days of operations, the sensors will be shut down and put into a sun-safe mode while the Sun passes through the sensor fields-of-regard on October 20–21. RAIDS will return to normal operation and resume its spectral scans at the five chosen altitudes after this time. By completing these full spectral scans, the RAIDS science team expects to achieve all minimum mission objectives in about 30 days.

In preparation for the transition to normal operations, we propose that the Science Team hold a **one-day virtual meeting on or about Tuesday, October 20 (exact date to be finalized next week)**. This allows the team a few days of preview observations to assess instrument performance and evaluate original mission objectives in light of these data. To avoid complications due to slips in the instrument checkout schedule and their impact on travel plans, a virtual meeting by telecon is recommended and distributed viewgraphs will be made available. However, anyone that is willing and able to travel to NRL is certainly welcome to attend in person. The goal of the meeting is to familiarize the whole Science Team with the nature and quality of the RAIDS data, evaluate the experiment operating modes and develop plans to optimize them to meet the RAIDS science objectives, and discuss data distribution and processing logistics for the near-term.

Figure 12: The RAIDS, HICO, and HREP Teams during mission operations in the POCC.

Figure 11: The NRL RAIDS Instrument Team in the POCC during spectrometer and photometer first light activities on October 8.

RAIDS Instrument Team for Mission Operations Support

Naval Research Lab, Washington, DC

- Scott Budzien, Principal Investigator
- Andy Stephan, Project Scientist
- Ken Wolfram, Electrical Engineer
- Don McMullin, System Engineer

The Aerospace Corporation, El Segundo, CA

- Rebecca Bishop, Aerospace PI
- Andy Christensen, Senior Scientist
- Paul Straus, Senior Scientist
- Jim Hecht, Senior Scientist

RAIDS/HICO is integrated and flown under the direction of the Department of Defense Space Test Program. RAIDS was built jointly by the Naval Research Laboratory and The Aerospace Corporation.