

# HARP Manual v1.0

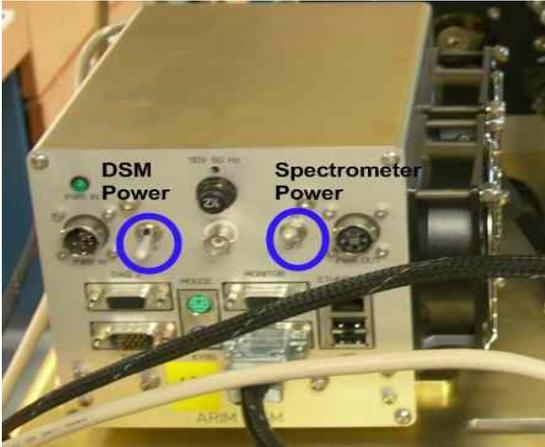
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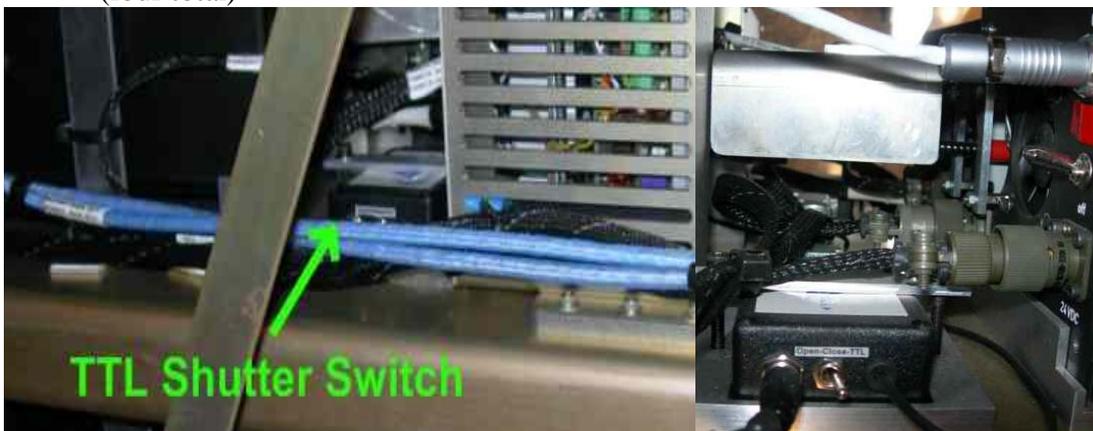
## I. Quick Reference Checklists

### A. HARP Spectrometer Preflight Checklist

- 1) Power on rack, power switch on black Tripplite power strip –red button behind metal guard. Check that all DSM power switches are on (2 per box for a total of 12 switches). The HARP DSM's are designed to automatically start data collection after bootup.



- 2) Make sure spectral irradiance caps have been removed from light collectors.
- 3) Allow LabVIEW to start all six spectrometers, check for spectra on all. VPN requires several minutes or more to establish contact with laptop.
- 4) Stop HARP LabVIEW software
- 5) Check calendar date on computer (*not* set by IRIG! All six spectrometers)
- 6) Use IRIG button on LabVIEW main menu to sync computer clock to IRIG time (all six spectrometers).
- 7) Check integration times and dark current frequency and sample count are correct (integration times all six, dark current on the four spectral irradiance).
- 8) Check setup in parameters to see that the shutter is active for spectral irradiance spectrometers (VIS and NIR, four total)
- 9) Check shutters are switched to TTL mode on spectral irradiance spectrometers (four total)



- 10) Move non-flight data to OLD directory for each instrument (six total).
- 11) Pump down spectral irradiance light collectors (two total)

- a. Valve and Swage attachment located on top and aft outboard edge of rack
  - b. Remove Swagelok cap (finger tight)
  - c. Attach hand pump (finger tight)
  - d. Open Valve
  - e. Pump to 20 (or more) if possible
  - f. Close Valve
  - g. Remove hand pump
  - h. Replace Swagelok cap
- 12) Power up Stabilized Platforms as described in Enviscope procedures

## B. In Flight Checklist

- 13) During flight check for flashing red LED (all six spectrometers) on front panel of DSM. LED will toggle between lit and unlit every scan if working and freeze if computer freezes. If frozen, wait 1 minute for self-correction software to clear errors. Cycle power on any spectrometer which appears not to be collecting spectra.



- 14) Monitor Stabilized platforms for correct motion (*restart procedure*)

### C. HARP Postflight Checklist

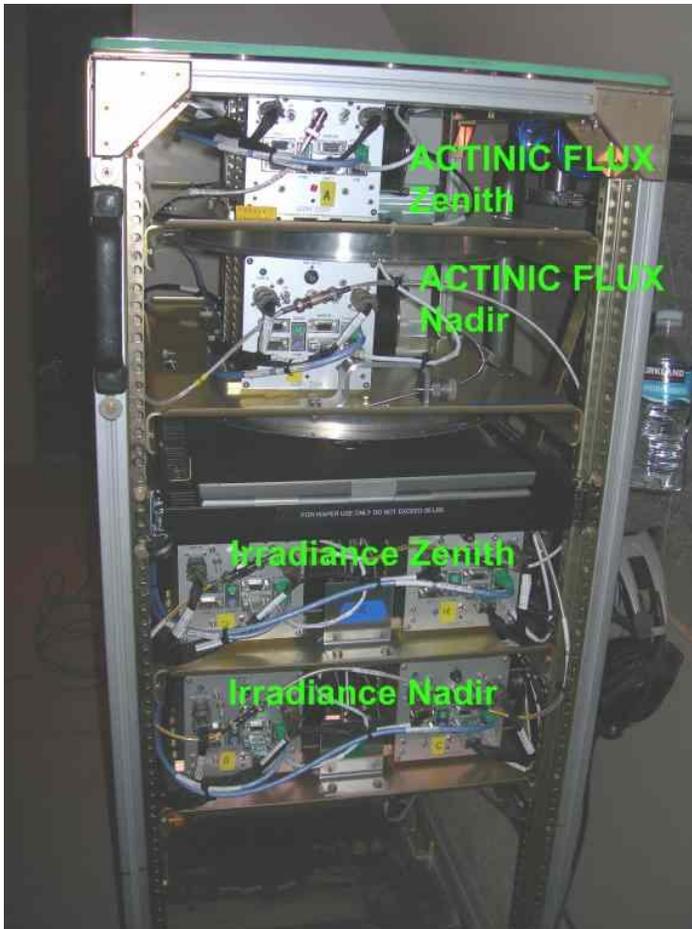
- 1) Create flight folder (yymmdd\_[Flight ID]\_[Instrument ID] and move all flight data to folder.
- 2) Copy data from DAT directory to memory stick or laptop (six total).
- 3) Shutdown computers via VPN link
- 4) Power off main rack power.
- 5) Place cap on nadir spectral irradiance (zenith, if possible).

## II. Description of Instruments

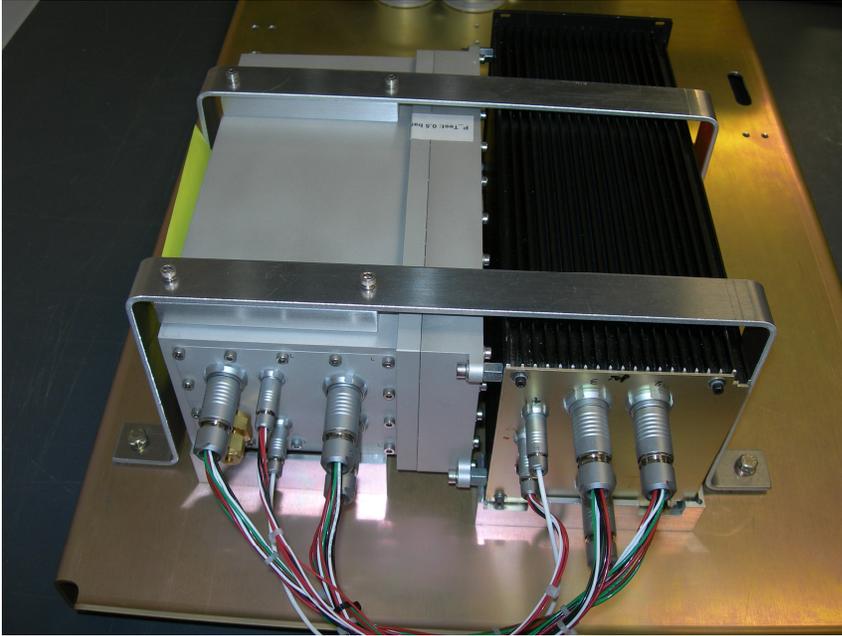
The HARP instrument package consists of six spectrometers for the measurement of actinic flux and spectral irradiance. Each spectrometer is controlled with a PC-104 based Data-Sampling-Module (DSM) with wiring specific for each type of spectrometer. The spectrometers are:

- Zenith Actinic Flux
- Nadir Actinic Flux
- Zenith Irradiance – NIR
- Zenith Irradiance - visible
- Nadir Irradiance – NIR
- Nadir Irradiance – visible

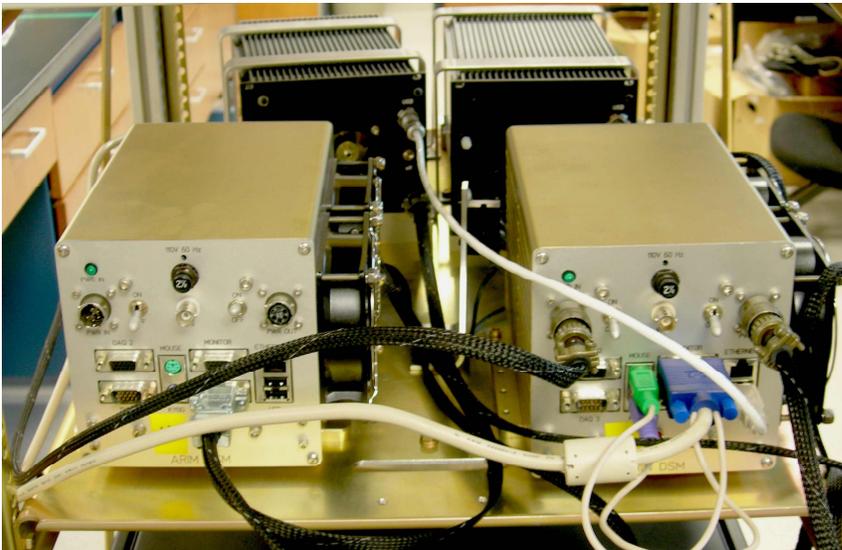
The spectrometers and DSM's are distributed on four shelves on the HARP rack. Each actinic flux system is on its own shelf. The irradiance zenith (NIR and VIS) and nadir (NIR and VIS) systems are contained on two separate shelves with their respective spectrometers and DSMs.



Harp Instrument Rack



Actinic Flux System – CCD/optics in silver box, electronics in black box



Irradiance System – NIR and VIS spectrometers share shelf, the black boxes each contain optics and electronics. The two DSMs are in front

In addition, the optical heads for the irradiance system are mounted on computer controlled stabilized platforms to maintain a parallel orientation to the ground regardless of airplane movement. The stabilized platform's control systems run independently of the spectrometer control systems. All computer systems can be controlled via internet through the rack's Ethernet switch and a laptop computer with a VNC connection.

The **actinic flux** systems have a zenith optical collection head located on the top of the tail and a nadir optical collection head below the fuselage.



Nadir and Zenith Optical Collectors

The actinic flux heads transmit light to the spectrometers via fiber optic cable run from 1) the tail down to the rear of cabin and 2) through the underbelly to the port side of the cabin. These fiber optic runs from head to cabin are designed to be a permanent installation on the GV. **The fibers are considerably more brittle than standard fiber optics used on the aircraft. Therefore, extra care should be taken to ensure the fibers are not damaged.** These two fibers are enclosed by PFA tubing to protect these fiber runs.



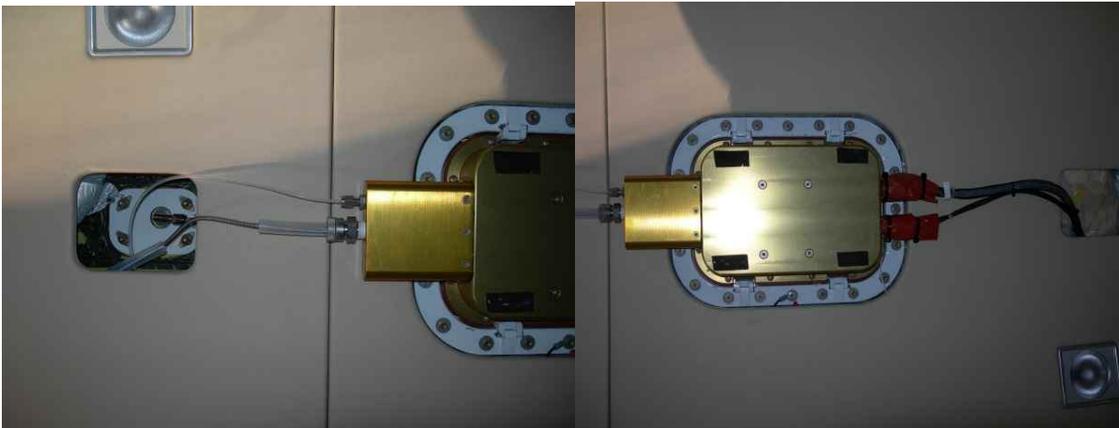
Zenith Fiber: Bare fiber entering cabin, Routed behind galley to protect fiber union



Nadir Fiber: Entering cabin in port service tray, Fiber union in service tray

The two permanent fibers will be coupled to in-cabin fibers to complete the connection to the spectrometers - with routing determined by the location of the HARP instrument rack for each particular mission.

The **spectral irradiance** systems consist of a nadir and zenith optical head mounted on stabilized platforms and a fiber running from each head that splits and is fed into two spectrometers (one in the visible and one in the near IR range). The zenith optical head and stabilized platform are mounted in the zenith viewing port with the optical fiber, purge line, and platform control cables being routed under the ceiling panels to the HARP rack.



Fiber and purge line entering ceiling on Zenith Platform, Cables entering ceiling

The nadir stabilized platform is installed in the nadir viewing port with the cables and fiber entering the cabin and run to the HARP rack along the service tray. The irradiance fibers do not always have the protection of the PFA tubing when routed through the cabin. When not in use, the Zenith irradiance fiber may be stored under the ceiling panel because the glue and tubing used to create a seal in the stabilized platform is too large to pass easily through the tubing run down to the service tray.

Six individual **DSM's** with PC-104 architecture control the HARP spectrometers. These consists of a standard PC104 motherboard, a Diamond Systems A/D card that also has digital switching outputs, a Brandywine IRIG card to receive a timestamp from the aircrafts GPS timing computer, and two power supplies – one for the PC104 stack and one for the spectrometer. (Specs are listed in the Appendix)

The DSM are powered by standard 60Hz 110V and provide the spectrometers and control electronics with their power through a 28V DC power supply that is individually switched by the switch on the faceplate on the DSM. The spectrometer itself has an additional relay to control power via software – this is used to ensure proper conditions for powering the sensitive spectrometer unit. Temperature sensors and RH sensors (Actinic flux only) are monitored via the A/D card and active regardless of the spectrometer's status.

The **stabilized platforms** are controlled via a separate computer system and control box, which receive data from an iMAR GPS/INS system mounted on the bottom of the HARP rack. The iMAR unit requires a unprocessed GPS signal from the aircraft's GPS antenna to function properly. The platforms will need to be initialized and calibrated prior to every flight according to the startup instructions provided in a separate manual.

### **III. VNC interface connection**

As an alternative to using a direct connection via a monitor, mouse and keyboard to control the HARP DSM's and the stabilized platform computer, the user can access the HARP package computers via a VNC connection using a laptop connected to the HARP rack's Ethernet Hub (currently a separate network from the aircraft network) . The user's computer should have its IP address set to 192.168.1.10 (Do not obtain IP address automatically) and a VNC Viewer such as TightVNC installed. The HARP computers startup with a VNC client running and are preset to the following IP address (no password is required):

Zenith UV	192.168.1.1
Nadir UV	192.168.1.2
Zenith NIR	192.168.1.3
Zenith VIS	192.168.1.4
Nadir NIR	192.168.1.5
Nadir VIS	192.168.1.6
Platform CPU	192.168.1.100
iMar Nav Unit	192.168.1.199 (only for maintenance)

Often, the VNC software will not update the all the graphics on the display screen for the remote computer in real time – it is necessary to click on the VNC window to force a display update.

#### IV. Routine Maintenance (Actinic Flux Only)

The Actinic Flux CCD spectrometers need to be run in a low humidity environment. The LabVIEW software has a safeguard that only powers the spectrometer when the boxes have a RH of below 10 %. The CCD box should be purged with dry N<sub>2</sub> when the RH in the box approaches 8%.



Purge Port for Actinic Flux Instrument

To purge the CCD box:

- Ensure spectrometer power switch is off.
- Run the LabVIEW program, RH Monitor .
- Insert a 1/16" tubing into the brass purge port on the rear panel and purge with N<sub>2</sub> at 20-40 PSI. **Do not seal the port**, as the port is both the input and output. The RH should begin dropping immediately.
- Monitor the RH level in the LabVIEW program - Run N<sub>2</sub> for approximately 20 minutes after RH reaches a constant value.
- Remove the tubing and immediately close the port.

#### Routine Maintenance (Irradiance Only)

Both irradiance heads should be pumped down before each flight as described in the Pre-Flight Checklist:

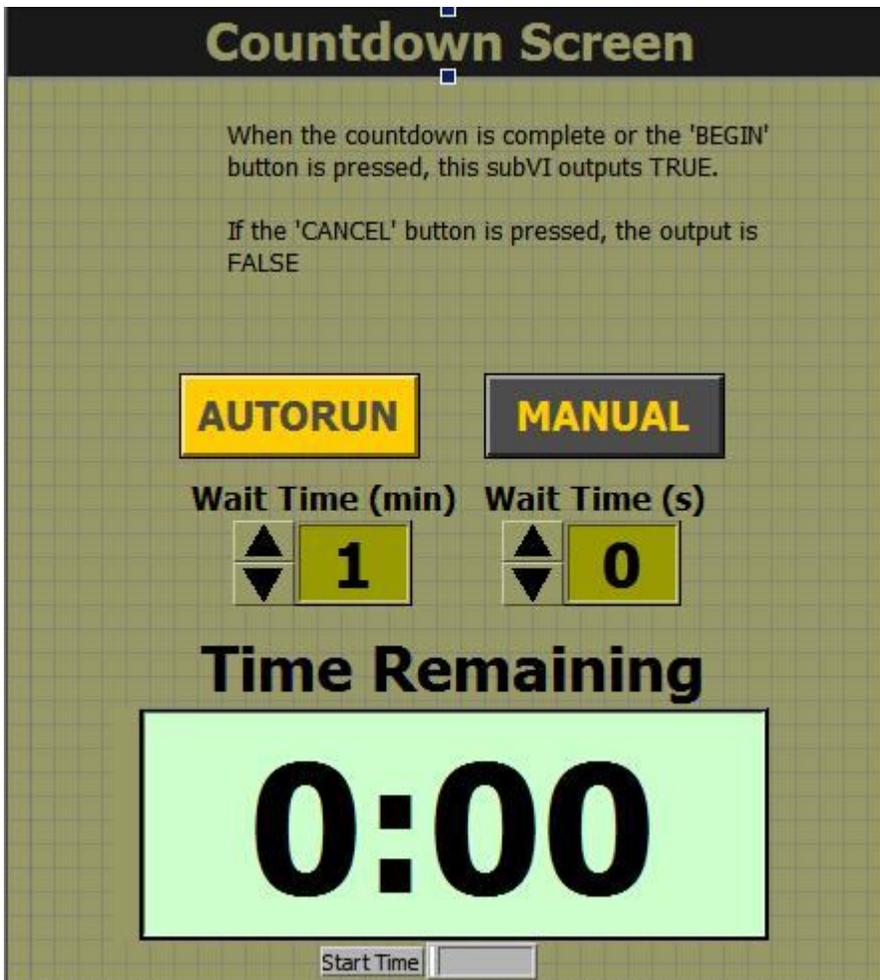
- a. Valve and Swage attachment located on top and aft outboard edge of rack
- b. Remove Swagelock cap (finger tight)
- c. Attach hand pump (finger tight)
- d. Open Valve
- e. Pump to 20 (or more) if possible
- f. Close Valve
- g. Remove hand pump
- h. Replace Swagelock cap

## V. Spectrometer Control Software (LabVIEW)

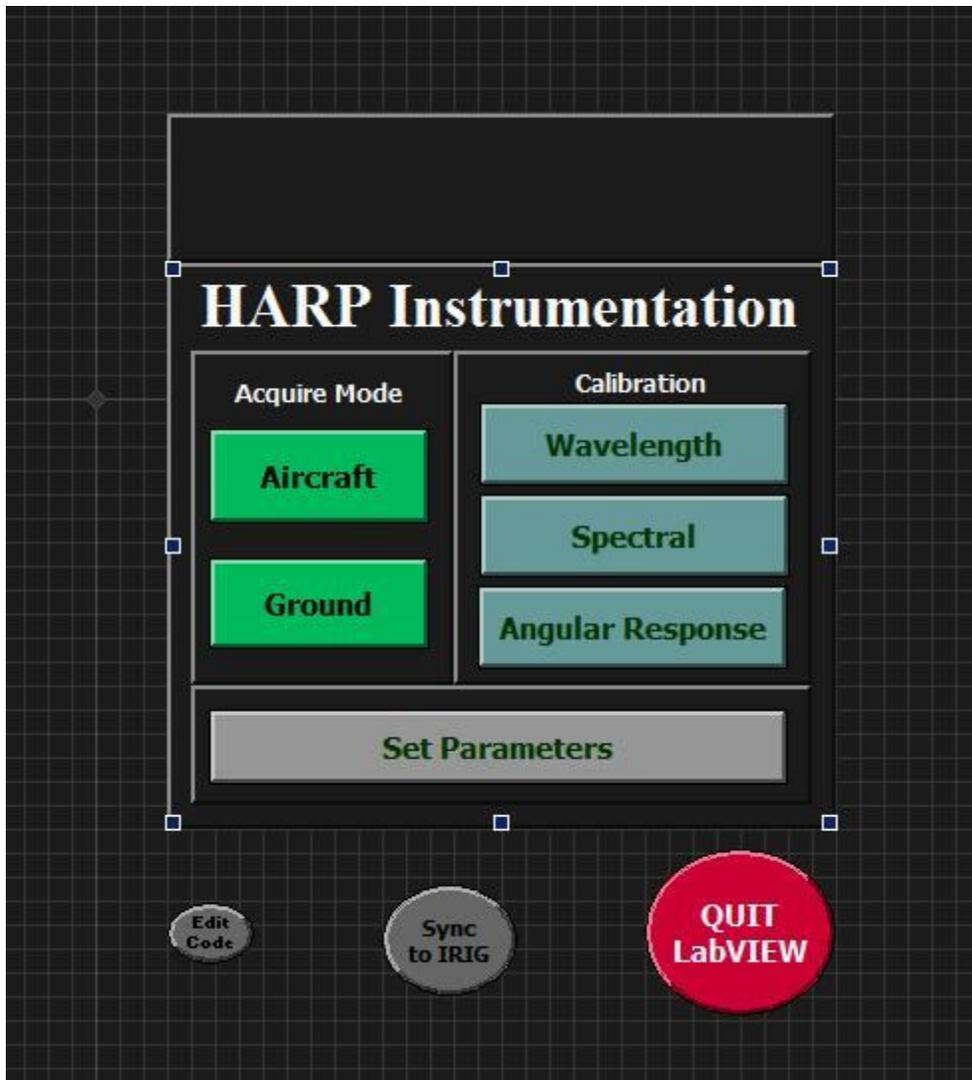
The HARP spectrometer control software is a LabVIEW program that will start data acquisition automatically when there is a shortcut to the HARP program in the Windows Startup folder. The LabVIEW control software is the same for all six instruments, with the specific type of spectrometer and other options selected with the “Set Parameters” function. To run other computer functions, or other LabVIEW programs, the user should exit from data acquisition.

### Startup

After a short countdown, the program will automatically start flight data acquisition in ‘autorun’ mode, unless the user selects ‘manual’ mode on the countdown screen.



When manual is selected, the user is presented with the HARP main menu:

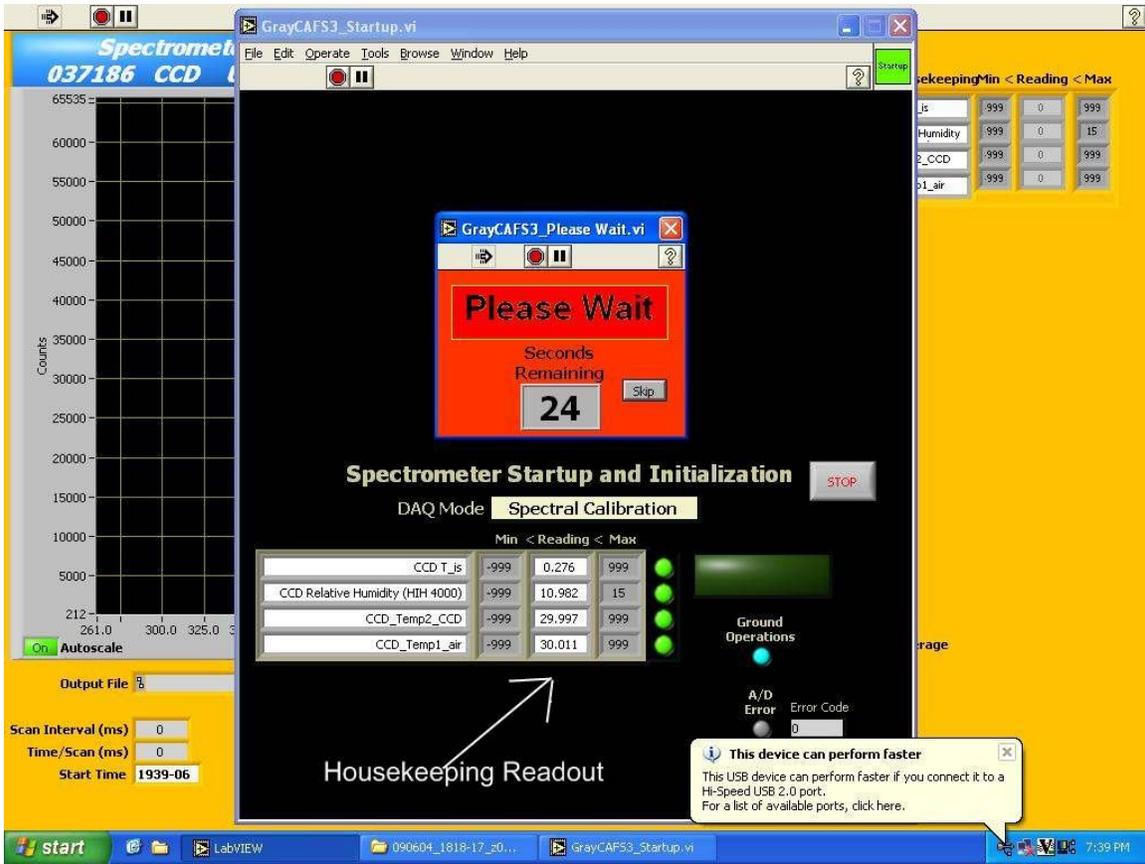


### Data Acquisition Modes

-**Flight** – Default data acquisition mode. Can be started by the user at any time from the Main Menu or will start automatically upon Windows boot-up with no user present. In Flight mode, the data display is disabled to improve efficiency, but can be toggled on/off by pressing the “Show Data” button

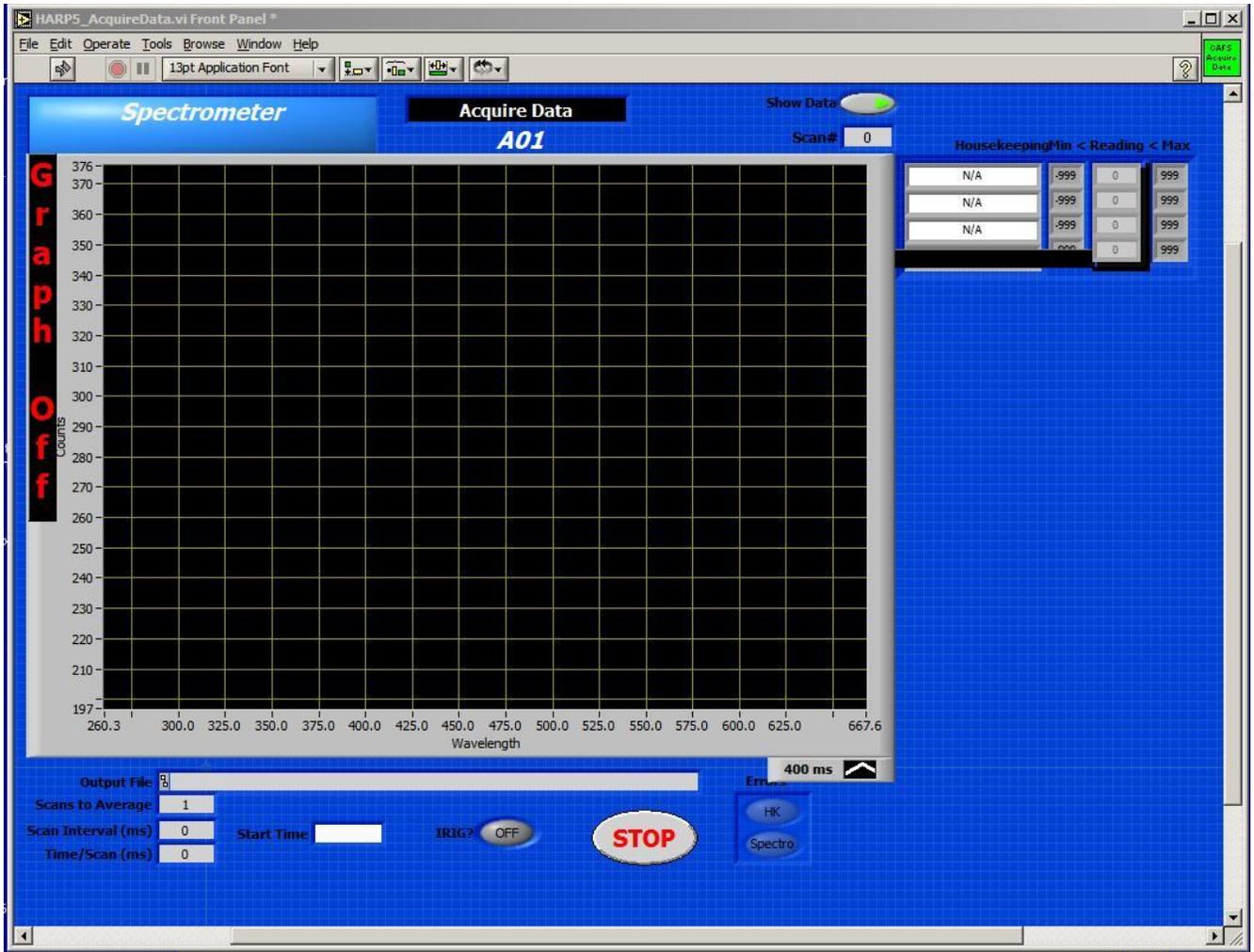
-**Ground** – currently the same as Flight Mode, with data display enabled by default.

The data acquisition routine starts with a check of the housekeeping variables to ensure they are within an allowable range. These ranges can be checked or modified with the Set Parameters function. The actinic flux systems monitor both internal humidity and temperatures, while the spectral irradiance systems monitor temperatures only. The system will only power the spectrometers when the housekeeping values ranges are met. If the actinic flux systems do not meet the humidity requirement, the spectrometer boxes should be purged with N<sub>2</sub> gas (see section Routine Maintenance).



If the housekeeping tolerances are met, the HARP program then powers the spectrometers (provided that the DSM power output switch is also on). It may take up to 30 seconds to establish USB communications to the spectrometer and its control hardware. This wait is necessary any time the spectrometer power is reset.



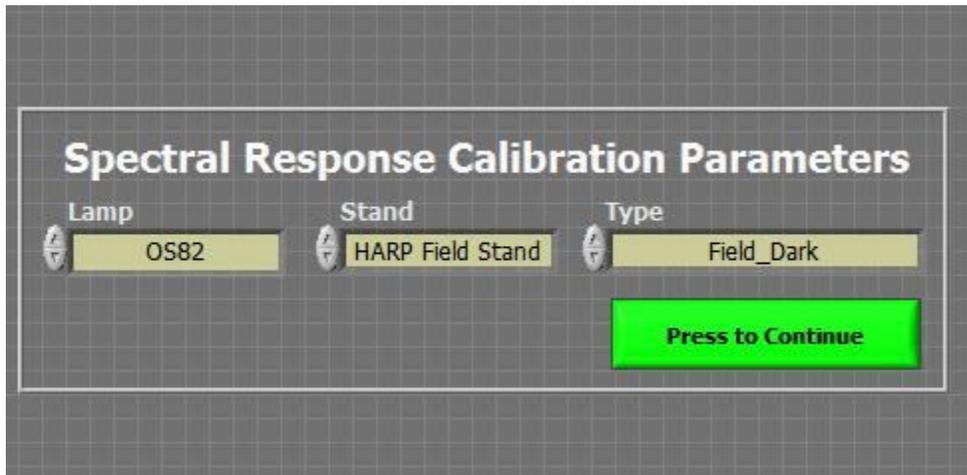


The Data acquisition screen is the same for Flight, Ground, and Calibration Modes. The HARP program continuously monitors the Housekeeping Variables and will suspend data acquisition if they move outside tolerances. The graph of the raw data can be toggled on and off with the show data switch. The HARP spectrometers are designed to run automatically in flight mode upon boot-up of the DSM. It will run without a user and without a keyboard and monitor connected. The DSM box has a red indicator LED that toggles on/off after each successful scan. If the indicator is not flashing with a frequency equal to the scan frequency (typically 2-10 seconds, see Set Parameters), the system is likely hung up. Wait 1 minute to allow the software to clear any errors, then restart if necessary. Wait ~5 min after restart for the data acquisition to begin.

Spectral data and housekeeping data is saved to a new directory in the specified data path each time the CCD is powered or reset. Both IRIG and CPU timestamps are logged to the data files. All data will be saved to a directory in the folder c:\missionname\Dat\, in a separate folder for each session labeled with the start date, start time, instrument ID, and integration time (e.g. C:\2007TC4\Dat\070717\_1243-40\_z01\_400\). The subfolder contains all the spectral data and housekeeping data for that session, if the system requires a restart, the data for a flight will be in separate folders. Please see Post-Flight

Instructions and Data Processing for requirements on organizing the output data for processing.

**Spectral and Wavelength Calibrations** use the Data Acquisition Interface described above and require the user to log information on the calibration lamp and type. See Calibration Procedures, [page X](#), for detailed instructions on performing field calibrations.



Depending on the type of calibration, the HARP program will display a countdown timer to allow the required lamp to warm-up. If multiple calibrations are performed on the same lamp, in succession, this countdown can be bypassed.

After completion of a calibration, the program will return to the main menu.

**Angular Response Calibrations** of the optics must be performed in the NCAR/ARIM primary calibration lab at FL0.

**Set Parameters** – this function allows the user to set parameters controlling the data acquisition routine.

**Set Parameters** Software Version  
HAPP4

Project Directory: C:\2008GrayCAFStest

Project Name: ARCTAS testing

Comments: ARIM lab

Latitude (dec deg): NA

Longitude (dec deg): NA

Altitude (m): NA

Head ID: none      Optic Location (X): z

Fiber ID: none      Instrument ID (XX): 01

Spectrometer S/N: 037186 CCD UV-VIS

Zeiss Coefficients:

0	251.026
1	0.809232
2	-1.16701E-5
3	-2.18704E-8
4	0

	Acquire Data	Spectral Calibration	Wavelength Calibration
Number of Scans	Unlimited	10	10
Time/Scan (ms)	3000	—	—
Scans To Average	2	10	10
Integration Times	400	400	600
Type '-1' to remove excess rows	0	0	0
	0	0	0
	0	0	0

Calibration Lamp List      Spectrometer Settings

Calibration Field Stand List      Housekeeping Settings

Diamond Base Address: 380

IRIG Base Address: 300

Shutter: Activate      # Scans Between Darks: 5

Deactivate      # Consecutive Darks: 2

**Press to Save Parameters**

On a flight to flight basis, the only parameters that should be changed are scan number/integration time(s). The integration time(s) should be chosen so that the instrument count rate never saturates. This will vary depending on the type(s) of fiber optics used or whether there are colored glass filters to filter parts of the spectrum. Expected solar zenith angles and environmental conditions should also be considered. The time/scan parameter sets a regular time grid for the software to start a scan – integration time and number of hardware averages for each integration time should be set to fall within the time/scan. The software also allows for multiple integration times in each scan.

Project Directory and other information should be filled out for each mission. Longitude, latitude, and altitude are not necessary parameters for aircraft based data - these parameters are obtained from the IRIG feed.

The spectrometer S/N should match the installed hardware system – the software uses the settings from spectrometer setting tab to initialize the different types of spectrometers. These settings should not be changed unless the DSM is moved from spectrometer to spectrometer – note that spectral irradiance DSM's and actinic flux DSM's are wired somewhat differently and cannot be interchanged.

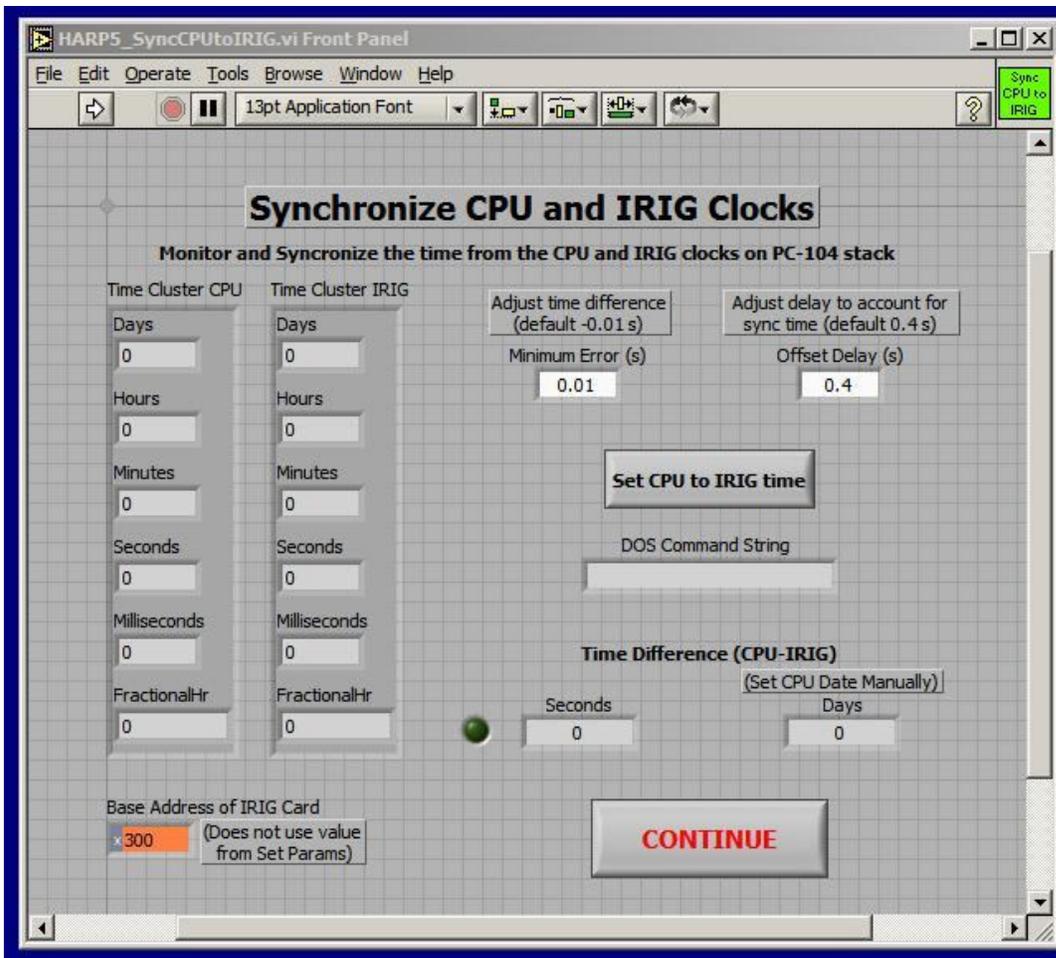
Calibration Lamp List contains a listing of all calibration lamps to be used. New calibration lamps should be added to this list.

Calibration Field Stand contains a listing of all field stands lamps to be used. No new calibration stands are expected to be added at this time.

Diamond and IRIG addresses should not be changed.

The spectral irradiance systems use a shutter to perform in-flight dark calibrations. The Shutter toggle should be **activated** for the Irradiance Systems and **deactivated** for the Actinic Flux systems.

**Sync to IRIG** – this function changes CPU time to match the IRIG time. Please note that the date (day, month, year) are not kept by IRIG so the CPU date must be set manually by the user using the Windows clock. The software logs two timestamps – IRIG and CPU time. In the event that the IRIG timestamp is unavailable, an accurate CPU timestamp is very desirable.



The HARP software logs both the CPU and IRIG time to its data files, but the CPU clock should be synchronized to the IRIG time before each flight – if IRIG signal is lost for any reason during flight, the CPU timestamp needs to be as accurate as possible to match the timestamps across the instruments.

## VI. Data Processing – Actinic Flux

HARP actinic main Path: 'C:\HARP\Matlab\HARP\_actinic\Flux\HARP\_Main\_v2.m'

Data output from the HARP LabVIEW data acquisition software is in binary format. The HARP Matlab processing software applies the instrument sensitivity – which is derived from the primary calibrations in the ARIM lab and from the secondary field calibrations – and the spectrometer specifications for wavelength assignments for each pixel.

### -File Organization

Data should be organized into a separate folder for *each* flight and *each* spectrometer. If an instrument ran smoothly for the entire flight, this folder will contain one subfolder:

```
C:\2007TC4\Dat\070717ScienceFlight2_UV_Z\070717_1243-40_z01_400\
```

If the spectrometer was reset for any reason, there will be multiple subfolders:

```
C:\2007TC4\Dat\070717ScienceFlight2_UV_Z\070717_1243-40_z01_400\  
C:\2007TC4\Dat\070717ScienceFlight2_UV_Z\070717_1447-42_z01_400\  
C:\2007TC4\Dat\070717ScienceFlight2_UV_Z\070717_1512-08_z01_400\
```

The processing software must be given data organized in the manner to correctly combine multiple data sessions.

### -Running the Processing Program

The MATLAB program 'CAFS\_Main\_v2.m' takes parameters from a driver file and outputs the results to the Results directory of the mission specified in the driver file. To avoid overwriting processed data, these results are written to a new subfolder each time the processing program is run. The file path of the driver file is specified by the DriverPath variable in the MATLAB and is the only user changed input in MATLAB.

```
DriverPath =  
'C:\jvdata\2007TC4_DC8\txt\flx\TC4_DC8_entire_mission.dvr';
```

The HARP processing Drive File:

```

TC4_DC8_mission_new.dvr - WordPad
File Edit View Insert Format Help

%%CONSTANT DIRECTORIES
missionDir C:\jvdata\2007TC4_DC8\
-----
%%CONSTANT PARAMETERS
zeissSN_Z 044120
zeissSN_N blank
pcalDist 50
epr 0
lastDarkWvl 290
slEndWvl 297
cntSaturation 64000
wvlExcelStart 297
wvlExcelEnd 422
createOutputsFlags [1 1 1 1]
outDirNameComment TC4_DC8_mission
-----
% Calibration and Flight History
NumFlights 2
-----
Flight 1
% 070717
% Zenith parameters
rundataZ 1
dataDirZ 070717_SF1
darkDirZ 070716_1825-04_z01_OS87_400
SensDirz 070716_z01_400
timeSrcZ 1
intTimeZ 400
logCommentZ TC4_DC8_SF1
% Nadir parameters
rundataN 0
dataDirN blank
darkDirN blank
SensDirN blank
timeSrcN blank
intTimeN blank
logCommentN blank
-----
Flight 2
% 070721
% Zenith parameters
rundataZ 1
dataDirZ 070721_SF2
darkDirZ 070716_1825-04_z01_OS87_400
SensDirz 070716_z01_400
timeSrcZ 1
intTimeZ 400
logCommentZ TC4_DC8_SF2
% Nadir parameters
rundataN 0
dataDirN blank
darkDirN blank
SensDirN blank
timeSrcN blank
intTimeN blank
logCommentN blank
-----

```

A template driver file is provided with the software.

### Driver Fields for Mission

<b>missionDir</b>	directory for each mission - must end with “\”
<b>zeissSN_Z</b>	serial number for each instrument
<b>zeissSN_N</b>	serial number for each instrument
<b>pcaldist, epr</b>	unused at this time (primary cal related)
<b>lastDarkWvl</b>	uses all wvls below this to calculate in-flight background <b>should be set to 290</b>
<b>slEndWvl</b>	unused at this time (cal related)
<b>wvlExcelStart</b>	first wavelength to output (if valid pixel)
<b>wvlExcelEnd</b>	last wavelength to output (if valid pixel)
<b>createOutputsFlags</b>	should be set to [1 1 1 0]

**outDirNameComment** Used in name of Results Subfolder for processing run  
**NumFlights** integer number of flights to process

#### Driver Fields for each Flight

**runDataZ** 1 = run data, 0 = don't run  
**dataDirZ** flight data directory  
**darkDirZ** dark calibration data directory  
**SensDirZ** sensitivity file  
**timeSrcZ** select time source 1 for IRIG, 2 for CPU  
**intTimeZ** integration time for data/dark files  
**logCommentZ** Used in name of each Flight Subfolder in Results SubFolder

All fields need to be complete for the driver file to load properly. To run data for just one instrument, set either RunDataZ or RunDataN to 0.

For each flight, the user must specify:

- a data directory
- a dark calibration file with the same integration time as the data file
- a sensitivity file (instructions on creating a sensitivity file below)
- the Time Source – should be 1 for IRIG unless IRIG failed
- the Integration Time
- a Name for the individual flight Subdirectory

Actinic Flux Results are saved in Tab delimited format and Matlab format, with a corresponding log file detailing pertinent instrument and processing parameters. Tab delimited raw counts data and housekeeping data are saved in the data folder along with the original binary data files.

#### **-Creating Sensitivity Files from Field Calibrations**

Calibration tools path: 'C:\HARP\Matlab\HARP\_actinic\Cals\'

The MATLAB program 'DialogMakeSensitivityFullGUI.m' is used to create the instrument sensitivity file used in Actinic Flux processing above. It requires data from a set of calibrations done in the field – spectral, dark and straylight – using the field calibration lamps provided by and calibrated by the ARIM group. ARIM also provided a flux calibration file for each field lamp specific to the field stand configuration used on HIAPER.

The program will prompt the user to select, using a GUI, a mission directory and then a spectral calibration file. Based on the spectral calibration selected, the user will then be prompted to select an integration time, stray light file, dark cal file, and Oriol file (this is the calibrated flux file for the field lamp created with the ARIM calibration system). An error box will pop up if there are no appropriate cal files found. Check that there is a complete set of dark, stray, and Oriol files for the lamp, instrument, and integration time specified by the chosen spectral calibration file.

#### **-Notes on Calibrations and Choosing Integration Times**

At a minimum, a set of calibrations must be performed before each mission, as the fiber configuration and placement of the HARP rack can change each install, which will have an effect on the overall sensitivity of the actinic flux instruments. If possible, calibrations should be performed between every flight to ensure the instruments sensitivity does not change and that there is no damage to the system. In particular, this is necessary to confirm throughput on the irradiance instruments optical heads which have been damaged in the past.

The sensitivity file is time independent, so the integration time for calibrations can vary from the in-flight integration times. However, the dark characteristics of each instrument change at different integration times. Thus, a dark calibration is necessary at each integration time used in flight to correctly process the data. For the actinic flux system, performing one thorough calibration (with longer integration times and more averaging) after install, then performing shorter calibrations between flights is sufficient for the actinic flux system if tail access (zenith instrument) is limited.

### **-Other**

To track instrument sensitivity (from individual spectral calcs), the Matlab program 'DialogSensitivityPlot.m' has been provided. The GUI will prompt the user for mission directory and instrument ID (which have the form of z01, n02, z03, n04, z05, n06), and will then will let the user select which sensitivity files to track. Hold CTRL to select multiple files.

## VII. Irradiance Processing (MATLAB)

Irradiance Path: 'C:\HARP\Matlab\HARP\_irradiance\Main\HARP\_irradiance.m'

Also provided is a MATLAB routine to convert the output from the four Irradiance Instruments into a single spliced spectrum for each the Nadir and Zenith Stabilized heads.

The data format and processing is very similar to the Actinic flux program. The Irradiance processing also runs from a simple driver file. The user must specify a data folder and response file for both the NIR and VIS data, as well as specify the integration time and serial number for each spectrometer. The program will not work unless both VIS and NIR data is specified. The serial numbers assignments are:

Zenith VIS = 044118  
Nadir VIS = 044119  
Zenith NIR= 044839  
Nadir NIR = 044840

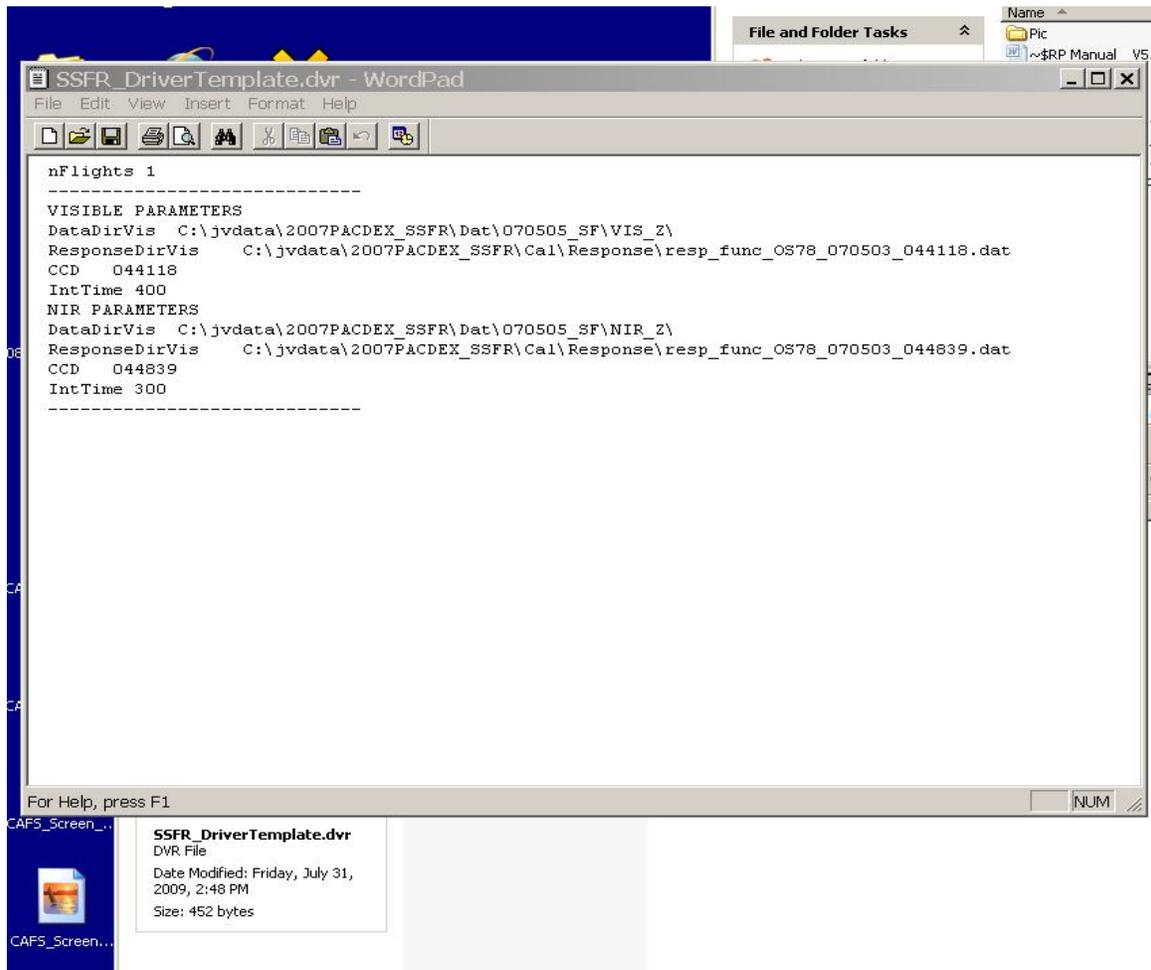


Fig. Driver file for HARP irradiance – typically located in [MissionDir]\txt\ folder

Remember that the data directory will contain the subdirectory or subdirectories created by the instrument. It will not run properly if the binary data is placed directly in the data directory specified in the driver file. The program will automatically combine data in subdirectories of the given data directory. The HARP irradiance instruments automatically open and close shutters at a regular interval in flight to take dark scans. The Labview program writes these in the binary data directory and the MATLAB code automatically handles the dark subtraction. Output is a tab delimited text file written in the Results subfolder of the mission directory, with the timestamp being seconds after midnight on the start date .

## Creating Irradiance Response Files

Calibration tools for irradiance: 'C:\HARP\Matlab\HARP\_irradiance\Cal\'

The irradiance response files are created from a field and dark calibration for each of the paired spectrometer systems using the Matlab program 'CreateResponseFromBinaryField.m'. For both the VIS and NIR systems, the user must specify the Spectra Cal Data Path, the Dark Cal Data Path, the Field Lamp File (provided by ARIM, from a primary calibration in the ARIM lab), the spectrometer serial number, the integration time, and the output file name/path. The secondary lamp files have a suffix of .S2 and a filename of the form 'OS77\_zen\_z04\_nir\_044839\_from\_1018.s2' denoting the secondary lamp used, the instrument name, the instrument serial number and the NIST traceable primary lamp used in the ARIM lab.

```

1  DataPathVIS = 'C:\jvdata\2007PACDEX_SSFR\Cal\Field\070503_2100-00_z03_OS77_400';
2  DarkPathVIS = 'C:\jvdata\2007PACDEX_SSFR\Cal\Dark\070503_2100-00_z03_OS77_400';
3  FieldLampFileVIS = 'C:\jvdata\2007PACDEX_SSFR\Cal\Lamp\OS77_zen_vis_from_1018.s2';
4  zeissSN_VIS = '044118';
5  intTimeVIS = 400;
6
7  DataPathNIR = 'C:\jvdata\2007PACDEX_SSFR\Cal\Field\070503_2100-00_z04_OS77_300';
8  DarkPathNIR = 'C:\jvdata\2007PACDEX_SSFR\Cal\Dark\070503_2100-00_z04_OS77_300';
9  FieldLampFileNIR = 'C:\jvdata\2007PACDEX_SSFR\Cal\Lamp\OS77_zen_nir_from_1018.s2';
10 zeissSN_NIR = '044839';
11 intTimeNIR = 300;
12
13 ResponseFileVIS = 'C:\jvdata\2007PACDEX_SSFR\Cal\Response\RespFromFieldBin_070503_2100-00_z03_OS77.ascii';
14 ResponseFileNIR = 'C:\jvdata\2007PACDEX_SSFR\Cal\Response\RespFromFieldBin_070503_2100-00_z04_OS77.ascii';
15
16
17 Parameters for creating the Response functions
18
19 %% Load Data
20 guiDat.type = 'DarkSub';
21 guiDat.cntSaturation = 64000;
22 guiDat.createOutputsFlags = [0 0 0 0]; %data output in tabbed format only
23 guiDat.fileComment = 'PACDEX';
24 guiDat.timeSrc = 2; %CPU time
25 guiDat.wvlExcelStart = 280;
26 guiDat.wvlExcelEnd = 600;
27

```

Fig. Matlab program to create irradiance instrument response functions

The output is an single column ascii text file with the response – the wavelength assignments are provided for each spectrometer in the ‘wavelength’ folder of the sample data. The output filename has the form:

RespFromFieldBin\_070503\_2100-00\_z04\_044839\_OS77.ascii

## VIII. Calibrations

The following components are required for calibrations and should be stored in the silver box provided by ARIM:

Field Stand

Black Cloth cover for Stand

Oriel Power Supply

Calibrated Osram Lamps

Jelight Power Supply

Mercury Lamp

Post to hold Mercury Lamp

2” square WB 360 optical glass filter

5/32” ball driver

3 10-32 screws to attach stand to aircraft

Ethanol and Wipes to clean optical head

Adapter for stabilized platforms (with other screws, size?)

A laptop connected via a long Ethernet cable to the HARP ethernet hub on board is recommended to control instruments from the exterior of the aircraft during calibrations.

### Clean Optical Head

Wipe head with ethanol on Kimwipe. Follow with a dry Kimwipe to remove streaks. Be careful - Ethanol can dissolve the black paint finish on the actinic flux shadow ring and weaken the sealing o-ring.

### Attach the Field Stand

The field stand is designed to attach directly to the shadow ring on the actinic flux systems. Use the three 10-32 screws to secure the stand to the aircraft.

The two lamp leads should be inserted into the socket with **the gray writing on the lamp facing the optical head.**

Gently rock the lamp back and forth so that both leads touch the back of the sockets. The lamp must be perpendicular to the socket base. Only one lamp at a

time should be removed from its labeled box, as they are indistinguishable, but have different spectral outputs.

Enclose Field Stand with black cloth cover

Make sure cover is secured tightly to block out all exterior light and that the power cord(s) are accessible. Attach white cord to Oriel Power supply.

Operating the Oriel Power Supply

The Oriel Power supply delivers a highly consistent power level to the Osram lamp during the spectral calibrations. It takes five minutes for the supply and bulb to heat up and reach equilibrium. In extremely cold ambient conditions, a longer warmup and insulation may be necessary.

To start a spectral calibration

1. Turn on the lamp power supply with the orange switch behind the protective shield.
2. Press the **METER/ITEM SELECT** key to check the current setting. It should be set to 10.20 Amps. If not, you will have to reset it using the procedure below.
3. Press the **Lamp On** button. The amp reading on the display should begin to rise.
4. Note the OS lamp used and start time in the logbook.
5. Ensure that the power supply reaches/stops at 10.20 Amps – we noticed that the outlets on the RAF scissors lift, used to calibrate the Zenith Actinic Flux system located on the tail, cannot deliver enough current if any other electrical device (such as a laptop) is drawing power from the lift's power supply. Calibrations are invalid if the current is not 10.20A
6. Wait 5 minutes before beginning the calibration to allow the lamp to heat up. The LabVIEW program has a built in 5 minute timer to allow for this warm-up time.

See Actinic Flux Calibration Procedure and Irradiance Calibration Procedure below for instructions on each method.

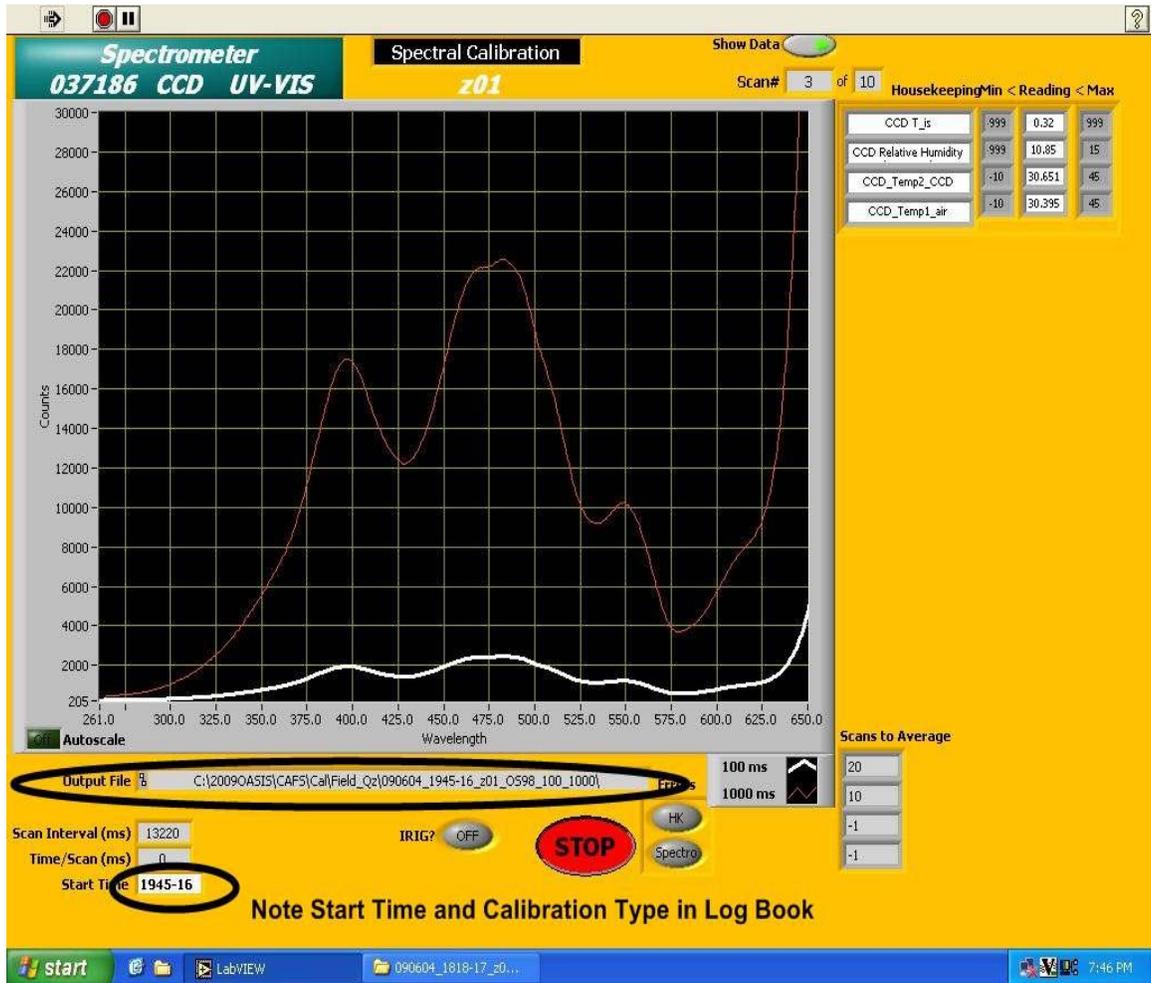
Turning off Oriel PS

1. Turn off the lamp by pressing **LAMP OFF/SETUP** on the power supply.
2. If all calibrations are complete, allow current to ramp down to zero before turning off the power supply via the orange switch – **turning off the power supply without turning the lamp off first can damage the calibrated lamp**
3. Open cloth cover to allow lamp to cool.
4. When lamp is cool (~5min), remove the lamp using the plastic sheath (without touching it) and place it in the appropriate box.

**Actinic Flux Calibrations**

The Actinic Flux systems require three types of calibrations scans with each lamp – spectral, stray light, and dark. Time permitting, doing the calibrations with multiple lamps will ensure that measured sensitivity changes are not due to changes in an individual lamp’s output. Integration times (set in Set Parameters) in the 500-1000ms range are recommended along with 10 scans and 10 hardware averages.

- Ensure no optical filters are inserted in the stand.
- Ensure black cloth is secured tightly to block out all outside light
- Turn on Lamp on Oriel PS
- Select ‘spectral’ from Main Menu of HARP software in LabVIEW
- Enter Lamp ID and Calibration type as ‘Field’ on pull down menus
- Allow 5 min countdown timer to elapse, wait for spectrometer to start
- Log Start Time, Type and Lamp used
- Verify shape of spectra and check for saturation
- Program will return to Main Menu when complete



Spectral Calibration Above. Spectra shape affected by colored glass filter type. Multiple Integration times used in this calibration.

## Stray Light Field Calibrations

- Slide 2" glass optical filter into filter holder on field stand – be careful as stand will be hot. Optical gloves may be used
- Ensure black cloth is secured tightly to block out all outside light
- Select 'spectral' from Main Menu of HARP software in LabVIEW
- Enter Lamp and Calibration type as 'Field\_Stray'
- If lamp already on, skip 5 minute countdown
- Log Start Time, Type and Lamp used
- Program will return to Main Menu when complete
- Turn off the lamp by pressing **LAMP OFF/SETUP** on the Oriel PS.

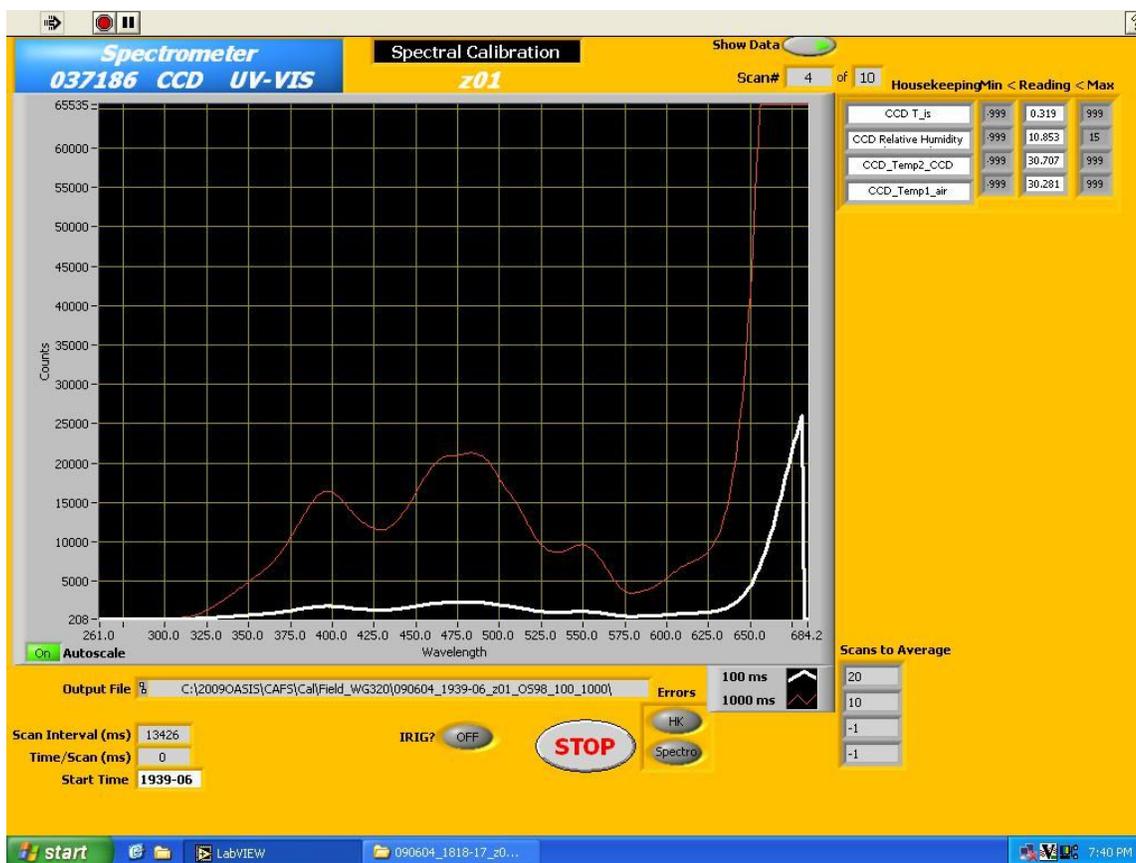


Fig. Stray Light Calibration. Cutoff filter removes light below ~320nm

## Dark Calibration

- Wait for Lamp current to ramp down to zero.
- Ensure black cloth is secured tightly to block out all outside light
- Select 'spectral' from Main Menu of HARP software in LabVIEW
- Enter Lamp and Calibration type as 'Field\_Dark'

- Skip 5 min countdown
- Log Start Time, Type and Lamp used
- Program will return to Main Menu when complete

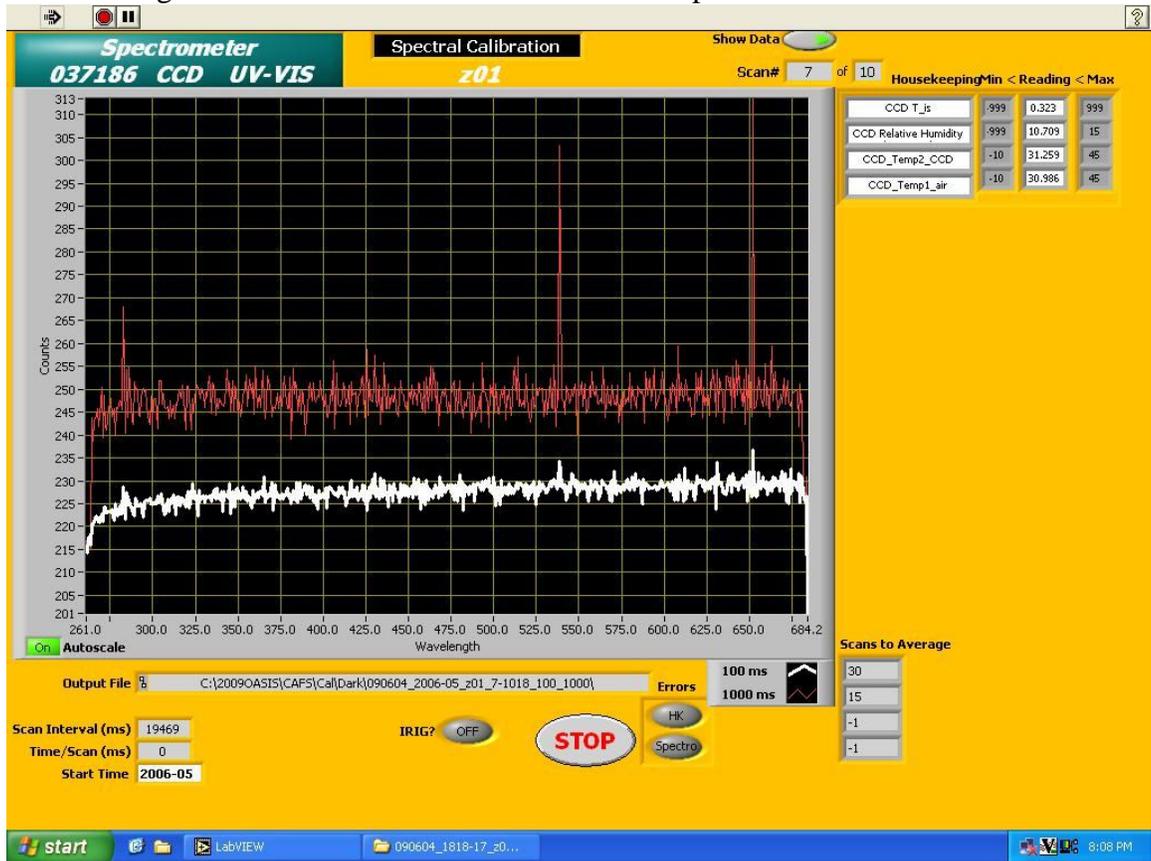


Fig. Dark Scan has pixel by pixel structure

If finished with lamp, wait for lamp to cool and remove filter and lamp. The stand may still be at a high temperature.

The set of calibrations will be used together by the 'SensitivityFromCal.m' Matlab program to create a instrument sensitivity used in data processing.

### Spectral Irradiance Calibrations

The Spectral Irradiance systems require only two types of calibrations scans with each lamp – spectral and dark. The dark will be performed automatically at the end of the spectral scan because the shutter will close. Time permitting, doing the calibrations with multiple lamps will ensure that measured sensitivity changes are not due to changes in an individual lamp's output.

The stand is the same used as in the actinic flux cals, but with an extension at the optical head end that connects to the stabilized platform. The stabilized platform should be in the Home position (refer to the Enviscope manual).

### Spectral Field Calibrations

- Make sure no optical filters are inserted in the stand.
- Ensure black cloth is secured tightly to block out all outside light
- Turn on Lamp on Oriel PS
- Select 'spectral' from Main Menu of HARP software in LabVIEW
- Enter Lamp and Calibration type as 'Field' on pull down menus
- Allow 5 min countdown timer to elapse, wait for spectrometer to start
- The calibration will run 1 dark scan, the set number of spectral scans, followed by the remainder of the dark scans. [This is a "feature"]
- Log Start Time, Type and Lamp used.
- Verify shape of spectra and check for saturation
- Program will return to Main Menu when complete

### Wavelength Calibration

To perform a wavelength calibration, a mercury lamp and the Jelight power supply are used. Slide the Hg lamp into the post holder and then attach the post to the stand at the silver. The lamp should be as close to the head as possible.

- Ensure black cloth is secured tightly to block out all outside light.
- Plug HG lamp into black Jelight PS and turn on.
- Start "Wavelength" calibration from Main Menu. Wait for 2 minute countdown to elapse to allow light to warm up.
- Log Start Time, Type and Lamp used
- Check to ensure count level for 297 peak is greater than 1000 counts. If not, reposition the lamp or increase integration time in Set Parameters.
- Program will return to Main Menu when complete.
- Turn off Jelight power switch and remove lamp and post.

*Reminder: The mercury lamp and post must be removed to perform a spectral calibration.*

## Appendix A– DSM Specifications

**Case** – Parvus PRV-1191-02, DuraChassi 5x5 PC/104 Enclosure, <http://www.parvus.com/products/ProductPage.aspx?ProductID=64>

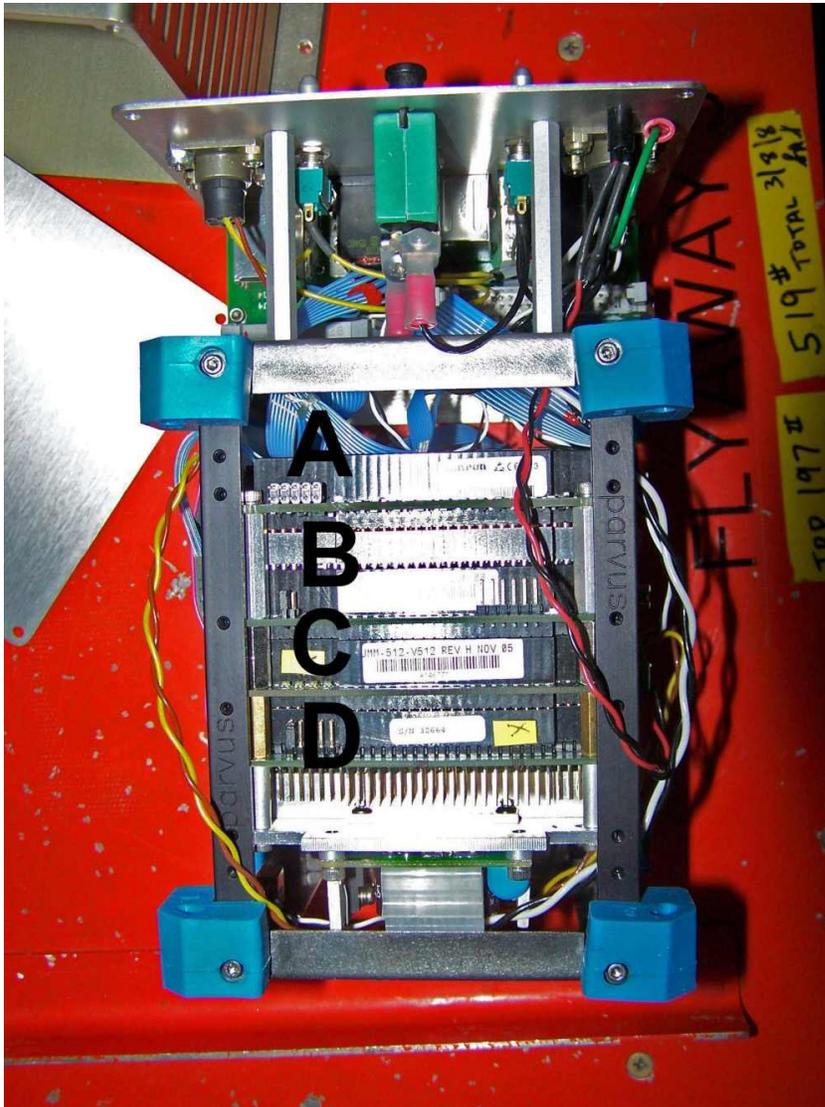
### PC 104 cards:

**A.** CPU Motherboard – Kontron MOPSlcd7, 700MHz Pentium III, <http://us.kontron.com/support/?productId=43>

**B.** A/D – Diamond Systems DMM-32X-AT, Analog I/O PC/104 Module with Advanced Automatic Autocalibration, <http://www.diamondsystems.com/products/dmm32x>

**C.** CPU Power Supply – Diamond Systems JMM-512-V512, 50 Watt PC/104 DC/DC Power Supply, <http://www.diamondsystems.com/products/jupitermm>

**D.** IRIG B – Brandywine PC104-SG-P2, Synchronizable Clock FOR PC/104 BUS, <http://www.brandywinecomm.com/products/p67/BusLevelPluginBoards/PC104SG>



PC 104 stack