Resonon Tasks #3 - Short and long term stability

Test included: Warm-up experiment, integration time cal and stability tests.

Not included and still to do Stray light and system response. The following tests should be done on the blue and red Resonon's.

Background:
Characterize the instrument as to ascertain the short and long term stability of the instruments as determined by monitoring of a known source of known stability, for example the NPR, NPRjr or an appropriate Optronics source. The source used must have a monitor system for stability and a known history of repeatability and performance. The Resonon instrument's temperature must be monitored and logged during the testing as well as monitoring the environmental temperature.

Experimental setup:
The setup used in performing Mark's performance tests could be utilized for the stability measurements. The setup of the instrument and the stable source should be the same for all the below experiments and well documented with logs and photos. Also the Romack f.o. bundle should be covered where it is connected to the end of the instrument. Mark said this will leak (in) ambient light if not covered.

Use FEL irradiance lamp bench from the Rochester trip and a lamp/plaque source.

- Set test up in a separate lab, undisturbed by table motions and other uses of the NPR or NPR-Jr, which are involved in other efforts (I question whether with all the activity in the RSL we'd have adequate repeatability or reproducibility just because things must be moved and so forth)

- Plaque options: 24" white plaque, or maybe we have a spare 10"

- The geometry would be 0/+/-45°, with the Resonon viewing from one side and the monitor radiometer from the other

- Monitor radiometer: VXR, or perhaps the VisFR (exists somewhere..)

- Changing levels: the Rochester bench is set up for 1/r2 so we could change the levels this way – the radiance uniformity might suffer from moving the lamp but the spectral uniformity would be superior to varying the lamp or aperture wheel setting in the OL420 setup – the spectral shape does depend on the OL420 settings

- the OL420 would be a useful cross check on the integration time stuff, but the monitor diode is unfiltered so we can't track spectral changes

- the test as written does not have the absolute responsivity test and this **needs to be added** and it would be done with NPR or NPR-Jr

- **Question from Carol:** is 50000 DN too high? I'd vote for 40,000

- **Question from Carol:** For the warmup test, to be safe should we wait several hours? How long is enough? Stephanie's thoughts: we can not wait for hours on the MOBY-C buoy so we need to see the minimum time it takes to become stable.

- Thermal Testing info: when we get to the environmental testing in the chamber, we have to use a sphere, either the OL455 that is in Hawaii or the OL420. Stephanie's thoughts: this is not covered in this document, will be covered later when we do the thermal testing and system response.

- Fiber optic holder: we could design the fiber optic tip holder so, given the distance to the source, the mounting holes are angled so all fibers point to the same target area. I'm imagining a piece of plexiglass…   the pattern would have to be small enough so all 14 fibers would view the OL420, which is the smallest diameter source (5.715cm)

- I think we should have all fibers illuminated for all the tests below.

<u>Default CCD Settings:</u>

- Speed- 100khz
- Gain = 3
- Camera CCD set temp at -75 C. Confirm the temperature set point is reached and stabilize camera for 10 minutes before taking data.
- Do not cover the camera – it needs free air flow to stay cool.
- Use integration times of 0.1 sec or greater
- Only in multi-frame mode, 11 frames
- LI or Lite = Shutter Control Normal
- BI or Dark = Shutter Control Disabled Closed

Dark/Off/BI = Background image = CCD setting to take a dark image with the CCD shutter closed On the camera settings, this is "Disable Closed". This is not the same as an ambient scan or turning the lamp off. This is a shuttered dark.

Lite/On/LI = Light Image = image with some fibers exposed to sphere with source on

Image set = A collection of associated images (light/dark/light etc.),
Image Set image sequence for "light" images, example: 11-BI, 11- LI, 11- BI   (in close succession) or 11-BI then 11-LI.

It would be good to have all the inputs be illuminated by the test sphere and whose input ends are secured in some sort of holder, which will allow us to arrange the inputs in a repeatable manner. Appropriate shutters and shielding to eliminate scattered radiation from entering the input region will have to be devised.

The instrument should be turned on an allowed to warm up and equilibrate prior to testing. This will mean that a time sufficient for the CCD temperature controller to achieve its design setting should be met and all electronics allowed to arrive at their ambient operating temperatures. The temperature should be monitored on the instrument to see if constancy is reached.

The instruments have three gain settings and if possible all three gains should be checked in each set of measurements.

I should note the times in the temperature logging program should match the times in the resonon files. I.E. "the two computers (1 logging the thermistors, and 2 controlling the Resonon) should both be set to the same time and time zone before starting. And checked daily. This should be noted on the log sheet.

Warm up Experiment:

It would be desirable to do some preliminary measurements on determining if we are using an appropriate warm up time. For example, if we start out using 10 minute warm up time, after a measurement we should turn the instrument off and let it return to ambient conditions and then use warm up times of 15 minutes and perhaps 20 minutes to ensure there are no significant differences. It might be wise to spend a day at the start determining what the minimal appropriate warm up time is so this value can be built into future use. Temperatures should be monitored and recorded for this work.

I am assuming we will be using a stable source like NPR or NPR Jr, which is used with the standard NIST procedures and with logging programs running.

1. Turn on Resonon and temperature logging program.
2. Adjust integration time so maximum value is ~50,000 counts
3. After 10 minutes from when instrument was turned on
4. Collect the following data sets with all tracks illuminated

Image set ext	**File num**	**Gain**	**Speed**	**Dark/Lite**	**Num of Frames**
warmup_10m_	01	3	2M	BI	11
warmup_10m_	02	3	2M	LI	11
warmup_10m_	03	3	2M	BI	11
warmup_10m_	04	2	2M	BI	11
warmup_10m_	05	2	2M	LI	11
warmup_10m_	06	2	2M	BI	11
warmup_10m_	07	1	2M	BI	11
warmup_10m_	08	1	2M	LI	11

warmup_10m_	09	1	2M	BI	11

5. Turn Resonon off

After the Resonon is back to room temperature.

6. Turn on Resonon and temperature logging program
7. Set integration times to match the integration times used on the 10 minute warm-up data set. Data should still be around ~50,000K.
8. After 15 minutes from when instrument was turned on
9. Collect the following data sets with all tracks illuminated.

Image set ext	**File num**	**Gain**	**Speed**	**Dark/Lite**	**Num of Frames**
warmup_15m_	01	3	2M	BI	11
warmup_15m_	02	3	2M	LI	11
warmup_15m_	03	3	2M	BI	11
warmup_15m_	04	2	2M	BI	11
warmup_15m_	05	2	2M	LI	11
warmup_15m_	06	2	2M	BI	11
warmup_15m_	07	1	2M	BI	11
warmup_15m_	08	1	2M	LI	11
warmup_15m_	09	1	2M	BI	11

10. Turn Resonon off

11. Repeat for a 20 minute warm up

12. Send Stephanie the data for analysis. Stephanie will determine which warm up time will be used for each gain and speed setting or if more data are needed. What we hope to see is that the darks and lite are stable after 10 minutes of warm up and that adding warmup time does not change the darks and lites.

13. Then repeat the whole thing (10, 15 and 20 minute warmup) for the 100K speed setting.

<u>Integration time Calibration Experiment:</u>

Calibrate the integration time, mainly so we will know for sure the shortest shutter time we should use for the rest of the data collection. We will also need this calibration to make sense of the rest of the data taken at different integration times. We would need to check the full images on this with the short integration times <100 msec because the shutter is near the image plane, the edges will be impacted more than the center of the image. The open/close delay for this shutter is about 6 msec (10% difference in total light hitting the edge of the image via the center pixels) and we also don't know how the camera firmware is timing the shutter vs readout time for short integrations. Integration time calibration is the best way to go about this.

The other way is to use a stable (and adjustable, like a 420 or the Gamma) source and start at say 1 minute integration time and work your way down to the shortest operable integration time for the Camera. All the while adjusting the source to keep the source intensity at near similar ADU on the camera. This will result in a calibration for the shutter integration time and give us an indication of the shortest integration time we really want to use to stay away from hidden issues in relating images taken at disparate integrations.

I am assuming we will be using a stable source like NPR or NPR Jr, which is used with the standard NIST procedures and with logging programs running.

1. Turn on Resonon and temperature logging program, let it warm up for X minutes
2. Adjust source (NPR/ NPR Jr) so maximum value is ~50,000 counts for each integration time
3. Collect the following data sets, 11 frames for each light and dark, with all tracks illuminated.

Image set ext	**File num**	**Gain**	**Speed**	**Dark/Lite**	**Int time (s)**
inttime1_	01	1	100K	BI	1
inttime1_	02	1	100K	LI	1
inttime1_	03	2	100K	BI	1
inttime1_	04	2	100K	LI	1
inttime1_	05	3	100K	BI	1
inttime1_	06	3	100K	LI	1
inttime1_	0 7	1	2M	BI	1
inttime1_	08	1	2M	LI	1
inttime1_	09	2	2M	BI	1
inttime1_	10	2	2M	LI	1
inttime1_	11	3	2M	BI	1
inttime1_	12	3	2M	LI	1

4. Turn Resonon off
5. Send data to Stephanie, then repeat 1-4 for integration times 240, 120, 60, 30, 20, 10, 5, 2, 1.5, 1.0, 0.75, 0.5, 0.4, 0.3, 0.2, 0.1, 0.075, 0.05, 0.025 seconds.
6. Steph will also require the NPR log file with the sphere monitor levels to account for difffering NPR radiance levels.

Stability Experiment:

I suggest a regiment of measurements beginning on day 1 that measures the source in all the channels 2 or 3 times and are recorded in the data files. I would leave the equipment on and wait about 15 minutes and repeat the measurements, keeping track of the sphere output monitor. Repeat the measurements again and record. I suggest doing this for an hour or so to get an idea of the short term stability of the system response and the repeatability of the measurements. The data should be examined for any major drift or inconsistency. For example, if three repeat measurements are done each time, we could print out a graph of the RMS differences, pixel by pixel. The same could be done for the time-separated measurements

I suggest repeating the same measurement scenario in two to three days and look for any significant differences and then do again in about 3 days. This gives us measurements over a period of a week and also a number of sets of measurements that are closely spaced. If there are no significant RMS deviations, I suggest waiting a week and repeating the measurements. One must make sure that the instrument has reached thermal equilibrium and all the appropriate temperatures are stabilized and monitored.

If the measurements seem stable and consistent after the weeks wait, we could conclude that the instruments have some stability over the two week period and we should have some idea of the RMS fluctuations. If things seem reasonable, I would repeat the measurements in a week and look at the results and compare to the previous measurements. If the results are within our expectations then I would suggest we try to characterize environmental temperature effects using an environmental chamber if available. This probably only needs to be done for 5 or so degrees above and below average room temperature but the MLML team should decide on what would be most useful for their operational needs. If temperature coefficients were non-zero and determined, then we could retroactively correct our stability data to remove any such effects.

Day 1

I am assuming we will be using a stable source like NPR or NPR Jr, which is used with the standard NIST procedures and with logging programs running.

1. Turn on Resonon and temperature logging program, let it warm up for X minutes
2. Adjust integration time so maximum value is ~50,000 counts
3. Collect the following data sets, 11 frames for each light and dark, with all tracks illuminated.

Image set ext	**File num**	**Gain**	**Speed**	**Dark/Lite**
stability1_	01	1	100K	BI
stability1_	02	1	100K	LI
stability1_	03	2	100K	BI
stability1_	04	2	100K	LI

stability1_	05	3	100K	BI
stability1_	06	3	100K	LI
stability1_	07	1	2M	BI
stability1_	08	1	2M	LI
stability1_	09	2	2M	BI
stability1_	10	2	2M	LI
stability1_	11	3	2M	BI
stability1_	12	3	2M	LI
stability1_	13	3	2M	BI
stability1_	14	3	2M	LI
stability1_	15	3	2M	BI
stability1_	16	3	2M	LI

4. Repeat every 15 minutes for an hour (15 minutes = stability1_, 30 minutes = stability2_, ...). Take a photo of the setup each time so we can see the setup and if anything changes.

5. Send data to Stephanie.

Repeat on...

6. Day 3: Repeat measurements every 15minutes to one hour and check for deviation from previous measurements

7. Day 6, 9, 12, 15, 18, 21, 24, 27, 30, 45 and 60

I am assuming that the Resonon/source setup will need to be taken down and setup for each measurement. If/when this is the case please note this in the log.