LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO -
CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Technical Note **LIGO-T1500062-v7** 2019/03/03

Pcal End Station Power Sensors Responsivity Ratio Measurements Procedures and Log

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END STATION: ....LHO....X..... DATE: ...11th June 2019

PEOPLE DOING THE WORK: ..Niko,....Dripta,....Rick,....Lawrence.....

Before (or after) going to the End Station

- Check the calibration of the Keithley Model 2100 voltmeter using the Martel Calibrated Voltage source (the same one that will be taken to the end station.
  - – 4 V with Martel = ...-4.0001..... V on Keithley 2100 DVM
  - – 2 V with Martel = ...-2.0001..... V on Keithley 2100 DVM
  - 0 V with Martel = ...0.0001..... V on Keithley 2100 DVM

Items to take to the end station for the measurements:

- Working Standard
- PD Satellite Box (blue box), D1300368
- Long (25') and short (6'-10') 9-pin D-sub cables
- BNC cable
- Martel calibrated voltage source and charger
- IR-only laser glasses

Before starting the measurements

- Disable excitations on the Pcal MEDM screen.
- Check that ETM is pointed properly. Check Pcal beam locations at the Rx sensor (photograph spot locations on white card).
- Open **gpsclock**
- Open **StripTool** and display the following sensor outputs. Always verify that signals are stable before recording time series.
  - **(IFO):CAL-PCAL(END)_TX_PD_VOLTS_OUTMON**
  - **(IFO):CAL-PCAL(END)_RX_PD_VOLTS_OUTMON**
  - **(IFO):CAL-PCAL(END)_WS_PD_OUTMON**
  - **(IFO):CAL-PCAL(END)_OFS_PD_OUTMON**

Calibration measurements and log

Preliminary measurements

Calibrate the Working standard channel

- Connect **Martel Calibrated Voltage Source** to INPUT 1 on the ***BNC to DB9*** module. Note: use negative polarity.
- Record 15 seconds of data for each input voltage.
  - - 4 V = -3.996 volts and GPS Start Time 1244304668
  - - 2 V = -1.998 volts and GPS Start Time 1244304640
  - 0 V = 0.00013 volts and GPS Start Time 1244304593

Record Optical Follower Servo settings

- Offset: 3.7 volt
- Gain: 41 dB
- OFS PD: -3.868 volt

Record Working Standard temperature

- Measure sensor voltage at Interface Module **WS PD MON** BNC output ising a voltmeter.
  - GPS time: .....
  - WS PD MON: ..... volts
- Convert to degrees Celsius by dividing by 0.90909, multiplying by 100, and subtracting 273.15.
  - WS PD temperature: .....deg. Celsius.
  - WS PD temperature: .....deg. Farenheit.

Time Series Measurements

- Connect Peal Blue Box PD MON output to INPUT 1 on the ***BNC to DB9*** module.

Measurement 1:

- Block the OUTER beam with a razor blade dump in the Tx module.
- Place the WS in the INNER beam in the Tx module.

WS in the INNER beam in the Tx module.			
GPS Times		Readings from MEDM screen	
Start Time #1	1244304993	TxPD	2.5499 volt
Duration	240 seconds	WSPD	-2.2713 volt
End Time #1	5233	OFSPD	-3.694 volt

Measurement 2:

- Move the block to the INNER beam in the Tx module.
- Move the WS to the OUTER beam in the Tx module.

WS in the OUTER beam in the Tx module.			
GPS Times		Readings from MEDM screen	
Start Time #2	1244305295	TxPD	2.5529
Duration	240 seconds	WSPD	-2.2806
End Time #2	535	OFSPD	-3.6961

Measurement 3:

- Leave the WS in the OUTER beam in the Tx module with the INNER beam blocked.
- Close the shutter in the Tx module.

WS in the OUTER beam in the Tx module. Shutter CLOSED.			
GPS Times		Readings from MEDM screen	
Start Time #3	1244305575	TxPD	0.0054
Duration	60 seconds	WSPD	-0.0005
End Time #3	635	OFSPD	-0.01004

Measurement 4:

- Leave the block in the INNER beam in the Tx module.
- Open the shutter in the Tx module.
- Replace the Rx sensor with the WS in the Rx module.

WS in the Rx module. INNER beam blocked in the Tx module.			
GPS Times		Readings from MEDM screen	
Start Time #4	1244 306 000	TxPD	2.5478
Duration	240 seconds	WSPD	-2.2511
End Time #4	240	OFSPD	-3.6924

Measurement 5:

- Move the block to the OUTER beam in the Tx module.

WS in the Rx module. OUTER beam blocked in the Tx module.			
GPS Times		Readings from MEDM screen	
Start Time #5	1244 30		2.5441
Duration	240 sec		-2.2373
End Time #5		PD	-3.6851

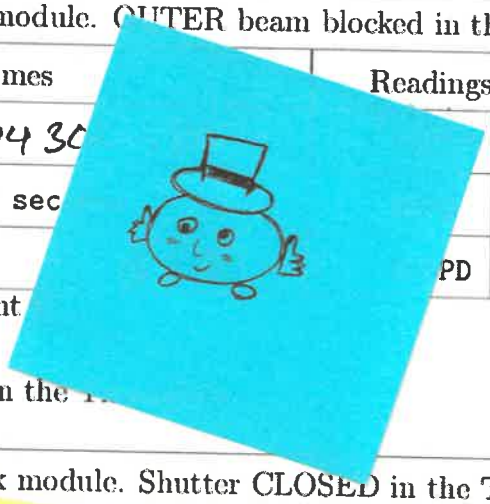
subsubsection*Measurement

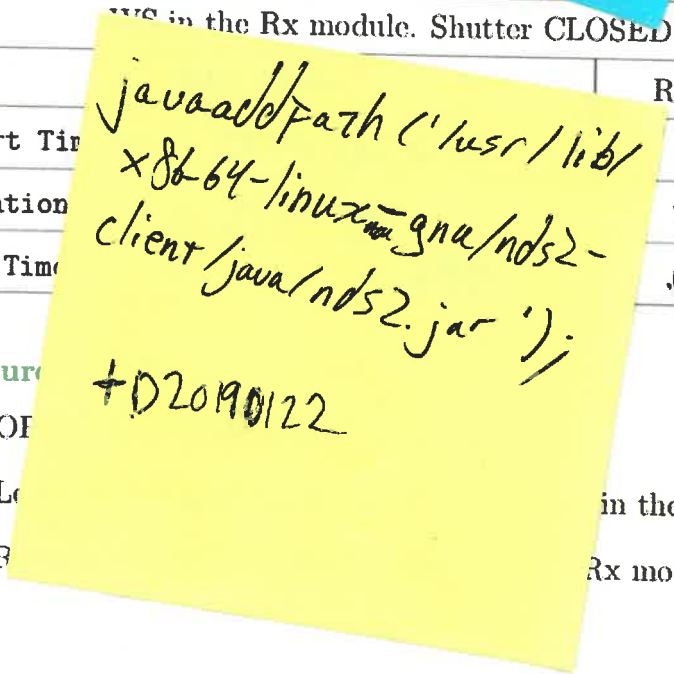
- CLOSE the shutter in the

WS in the Rx module. Shutter CLOSED in the Tx module.			
		Readings from MEDM screen	
Start Tim		TxPD	0.0053
Duration		WSPD	-0.0010
End Time		OFSPD	-0.0091

Measure

- OF
- L in the Tx module.
- R Rx module.





OUTER beam blocked in the Tx module. Rx sensor in the Rx module.			
GPS Times		Readings from MEDM screen	
Start Time #7	1244306990	TxPD	2.5449
Duration	240 seconds	RxPD	-0.0068
End Time #7	~~5307~~230	OFSPD	-3.6856

Measurement 8:

- Move the beam block to the INNER beam in the Tx module.

INNER beam blocked in the Tx module. Rx sensor in the Rx module.			
GPS Times		Readings from MEDM screen	
Start Time #8	1244 307430	TxPD	2.5449
Duration	240 seconds	RxPD	1.6168
End Time #8	670	OFSPD	-3.6855

Measurement 9:

- CLOSE the shutter in the Tx module.

Shutter CLOSED in the Tx module. Inner beam blocked.				
GPS Times		Readings from MEDM screen		
Start Time #9	1244 307 ~~745~~846	TxPD	~~2.5449~~	0.0057
Duration	60 seconds	RxPD	~~3.2332~~	0.0004
End Time #9	~~8~~906	OFSPD	~~-3.6849~~	-0.0096

When measurements are finished.

- Remove the beam block from the INNER beam in the Tx module.
- OPEN shutter in the Tx module.
- Set shutter control to *Remote* on interface module.
- Re-enable excitations on the Pcal MEDM screen (if applicable).
- Check that ETM is pointed properly. Check Pcal beam locations at the Rx sensor (photograph spot locations on white card).

- Analyze the data and upload results to the SVN.
- Make aLog entry, append image of beam spots at the Rx module, add pointer to measurements results in the SVN.

Data Retrieval and Ratio calculations

Data Acquisition, Plots and Report

1. Make sure the SVN directory
   `/ligo/svncommon/CalSVN/aligocalibration/trunk/Projects/PhotonCalibrator/scripts/pcalEndstation`
   is installed in the machine where you are trying to do the calibration calculation. A description of the Photon Calibrator SVN directory structure and instructions for checking out the whole Pcal repository can be found in `LIGO-T1500095`.

2. Execute the command `svn update` to make sure you have the latest version of the scripts.

3. Execute the command `kinit albert.einstein@LIGO.ORG` to establish connection to the external data server. This will be required for obtaining data later.

4. Open the `parametersforScript01.m` script in Matlab.
   (a) Enter the appropriate calibration date, location and GPS times.
   (b) Make sure the `workingcopy_location` has the appropriate path to the `PhotonCalibrator` directory,
   e.g. `/ligo/svncommon/CalSVN/aligocalibration/trunk/Projects/PhotonCalibrator/`

5. Run `Script01_pcaldateandtime.m` in Matlab.
   (a) It will create a folder named `DYYYYMMDD` in the appropriate directory, e.g. `/ligo/svncommon/CalSVN/aligocalibration/trunk/Projects/PhotonCalibrator/measurements/LHO_EndY`
   (b) It also creates a matlab file named `DYYYYMMDD_time.m` in this folder; it contains the GPS time information.

6. Open the `parametersforScript02.m` script in Matlab.
   (a) Enter the appropriate calibration date and location (interferometer and end station). This is typically the same as for first parameter file.
   (b) Again, make sure the `workingcopy_location` path is correct.

7. Run `Script02_pcalDataandResults.m` in Matlab.
   (a) This will fetch the data from the server and write it as .txt files in the folder.
   (b) It also generates plots of the ratios and saves the plots to the same folder, in addition to displaying them on the screen. Make sure the plots are satisfactory before closing them.
   (c) It will generate files, `DYYYYMMDD_Ratio.mat` and `DYYYYMMDD_Results.mat`, that contain the calibration results.

8. In the Matlab command window run the following command.
   `pcalPublishReport('ifo_arm', 'outputFilename')` where

(a) `ifo_arm` = `LHOX`, `LHOY`, `LLOX` or `LLOY`.

(b) `outputFilename` is

- `''` (quotes with an empty string will return the default .pdf filename)
- `XXXXX.pdf` with `XXXXX` being the desired .pdf output filename

Commit the new files to the SVN

1. In the terminal window, execute the following commands (Refer to T1500095 for details) from the
   `.../PhotonCalibrator/measurements/end_station`
   folder (Refer to T1500095 for details.)

   - `svn add DYYYYMMDD`
   - `svn commit -m "message, e.g.  person committing files"`
   - `svn update`

2. Also make sure that the changes made to the scripts in the `pcalEndstation` folder are committed to the svn in a similar manner.

DCC Update

1. Upload the generated report to the T-document filecard in the DCC as a new version.

2. Update the `LIGO-T1500622` filecard by adding a link¡ under the proper interferometer and end station¡ to the new `DYYYYMMDD` folder in the SVN repository.