Lunar Calibration Activities at USGS-EROS

03/02/2023

Sandra Preaux, KBR

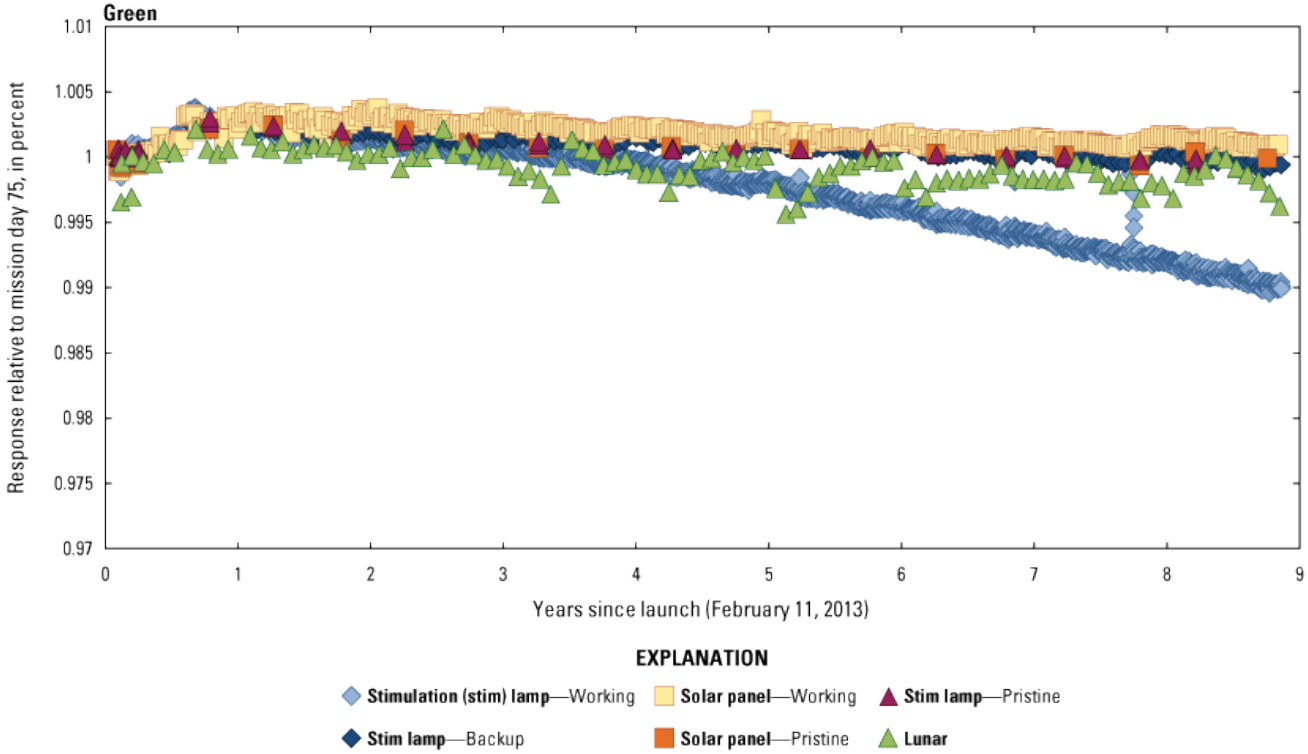
KBR, Inc., contractor to the U.S. Geological Survey (USGS)
Earth Resources Observation and Science (EROS) Center, Sioux Falls, SD 57198, USA.
Work performed under USGS Contract 140G0121D0001.

U.S. Department of the Interior
U.S. Geological Survey

Landsat 8 Radiometric Stability from 2021Q4 Report

Lunar roughly follows, but high variability make it less useful

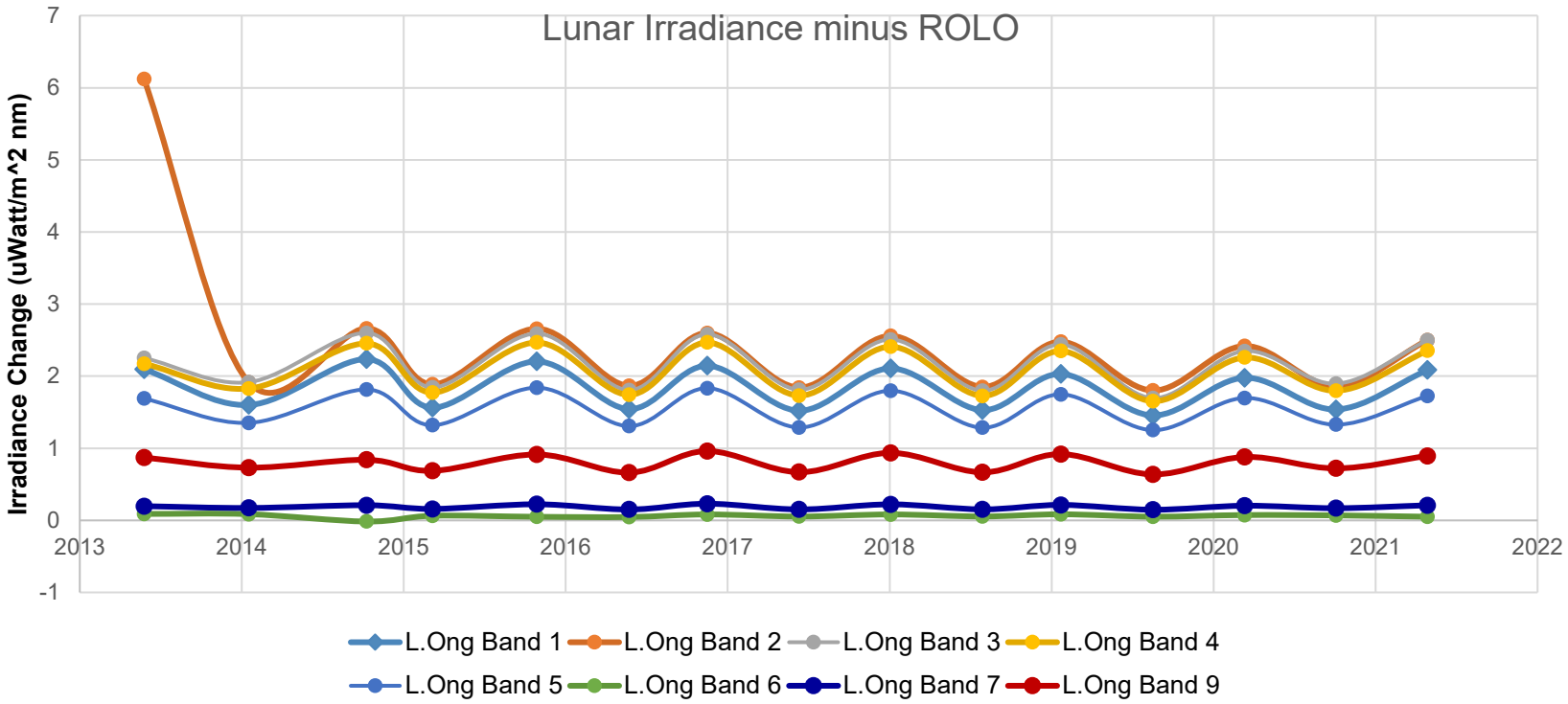
If we dig, perhaps we can reduce the variability and increase the usefulness of these lunar collects



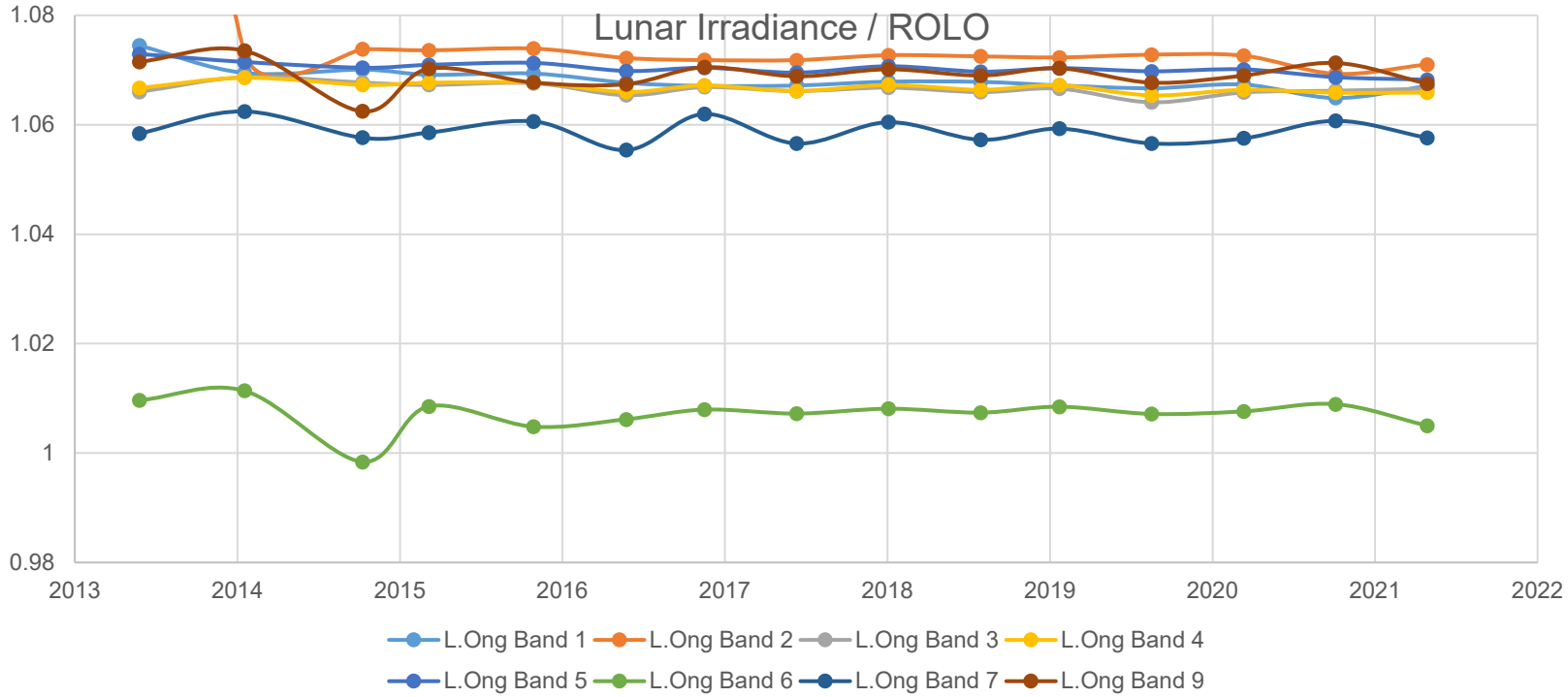
Oscillation in Difference Between ROLO and OLI

Values from L. Ong

L. Ong OLI difference from L. Ong ROLO



L. Ong OLI ratio to L. Ong ROLO



Confirm Annual Nature of Oscillation and Relation to Apparent Lunar Diameter

Examine Lunar Apparent Diameter & Oversampling in L1R images

- A set of L1r images from near the peak and trough times of the difference between OLI & ROLO found by L. Ong
- Detector offsets are applied to each image
- A moon mask is created for each image using a threshold of 10x the mean background
- Across and along diameters are found as the longest row or column in the moon mask
- This is compared to the expected lunar apparent diameter computed from the angular lunar diameter as seen from L8 at the observation time (provided by T. Stone) and the IFOV from the CPF file

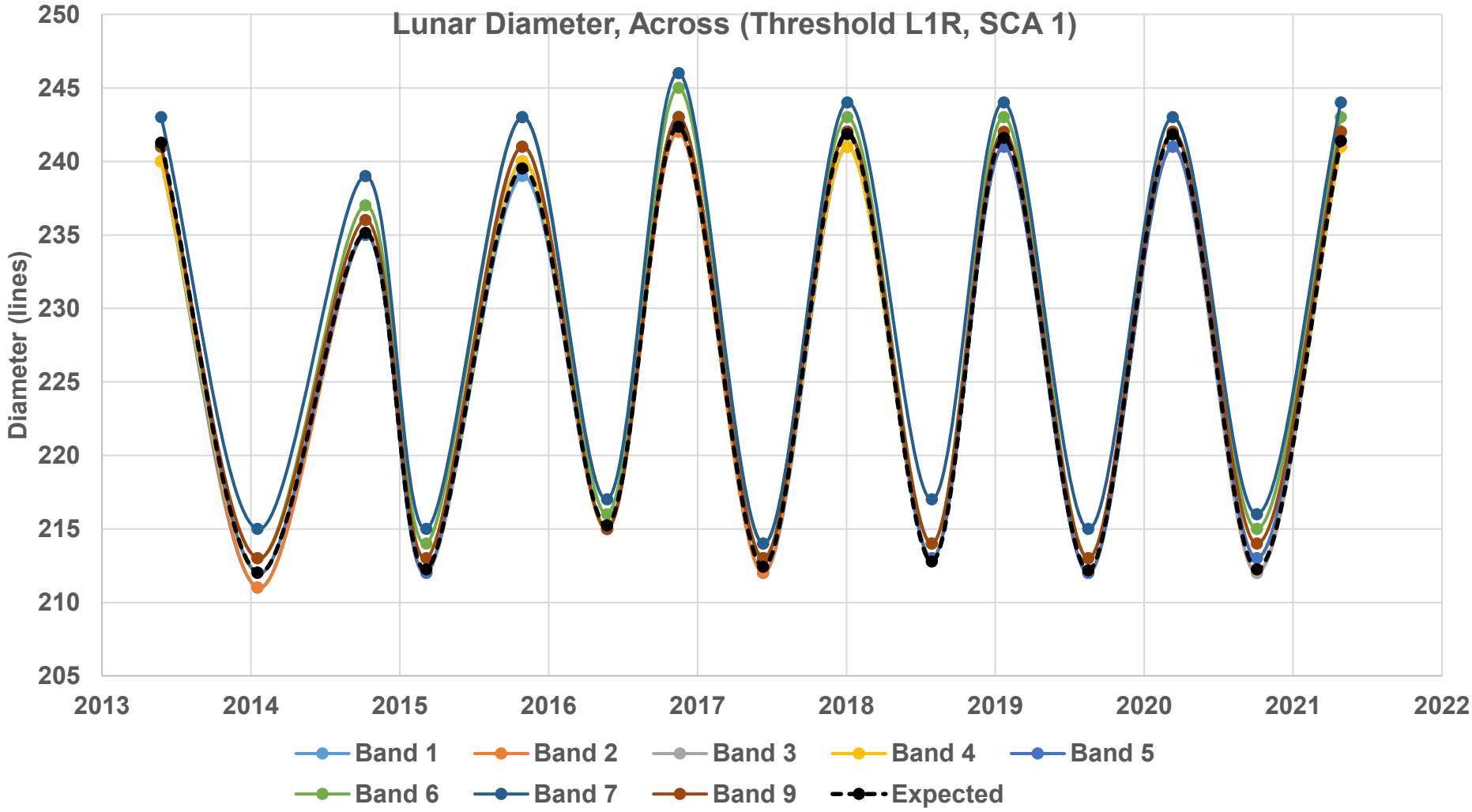
Across Track Lunar Diameter in Pixels for Peaks & Troughs in OLI - ROLO

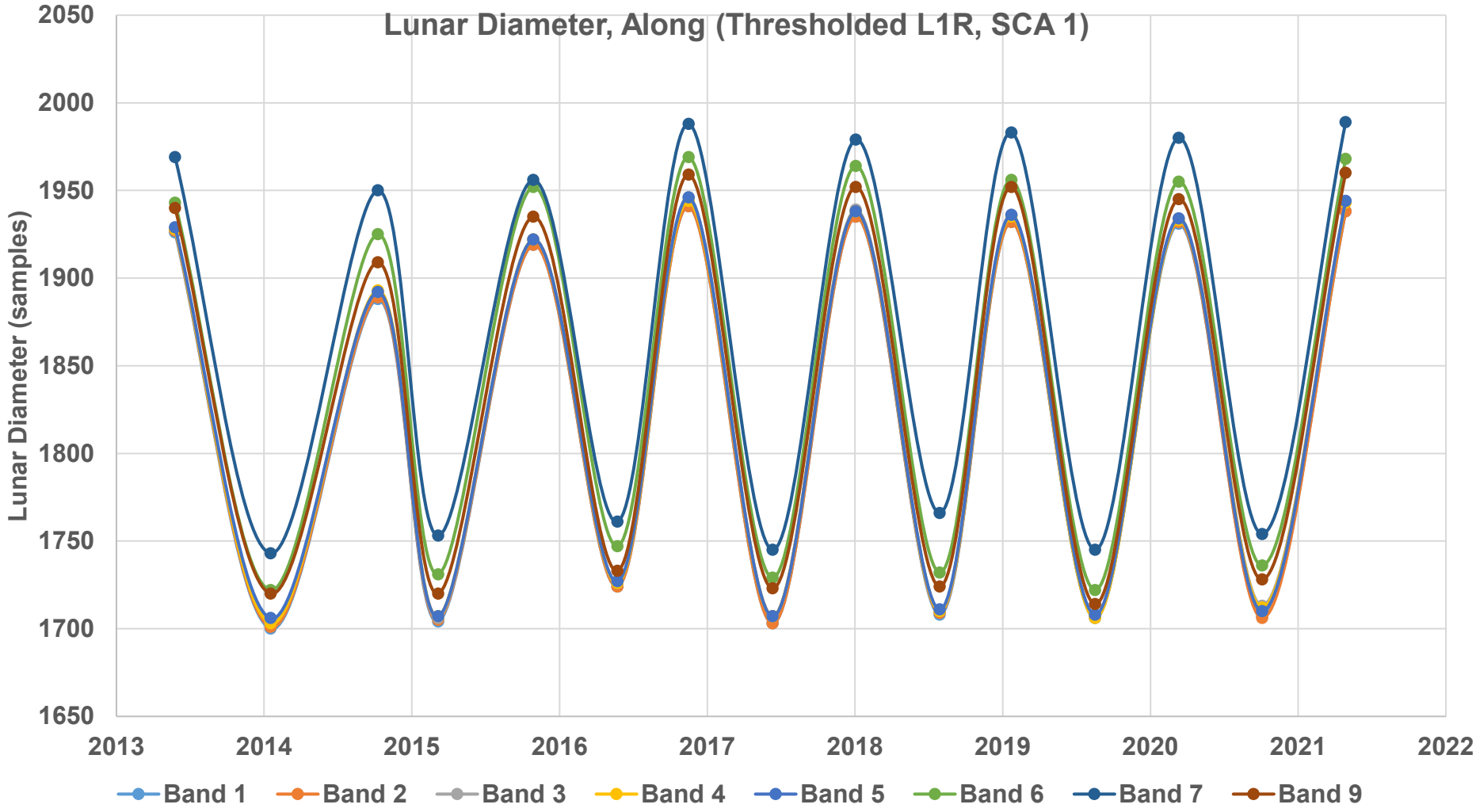
PEAKS					
Date	SCA	moon_pix	along_diam	cross_dia	os_center
2013145	1	363705	1928	240	8.033
2014281	1	349118	1892	235	8.051
2015300	1	361220	1922	240	8.008
2016319	1	370211	1946	243	8.008
2018002	1	367168	1939	242	8.046
2019021	1	365930	1936	241	8.033
2020070	1	365860	1934	241	8.025
2021117	1	367199	1944	241	8.066

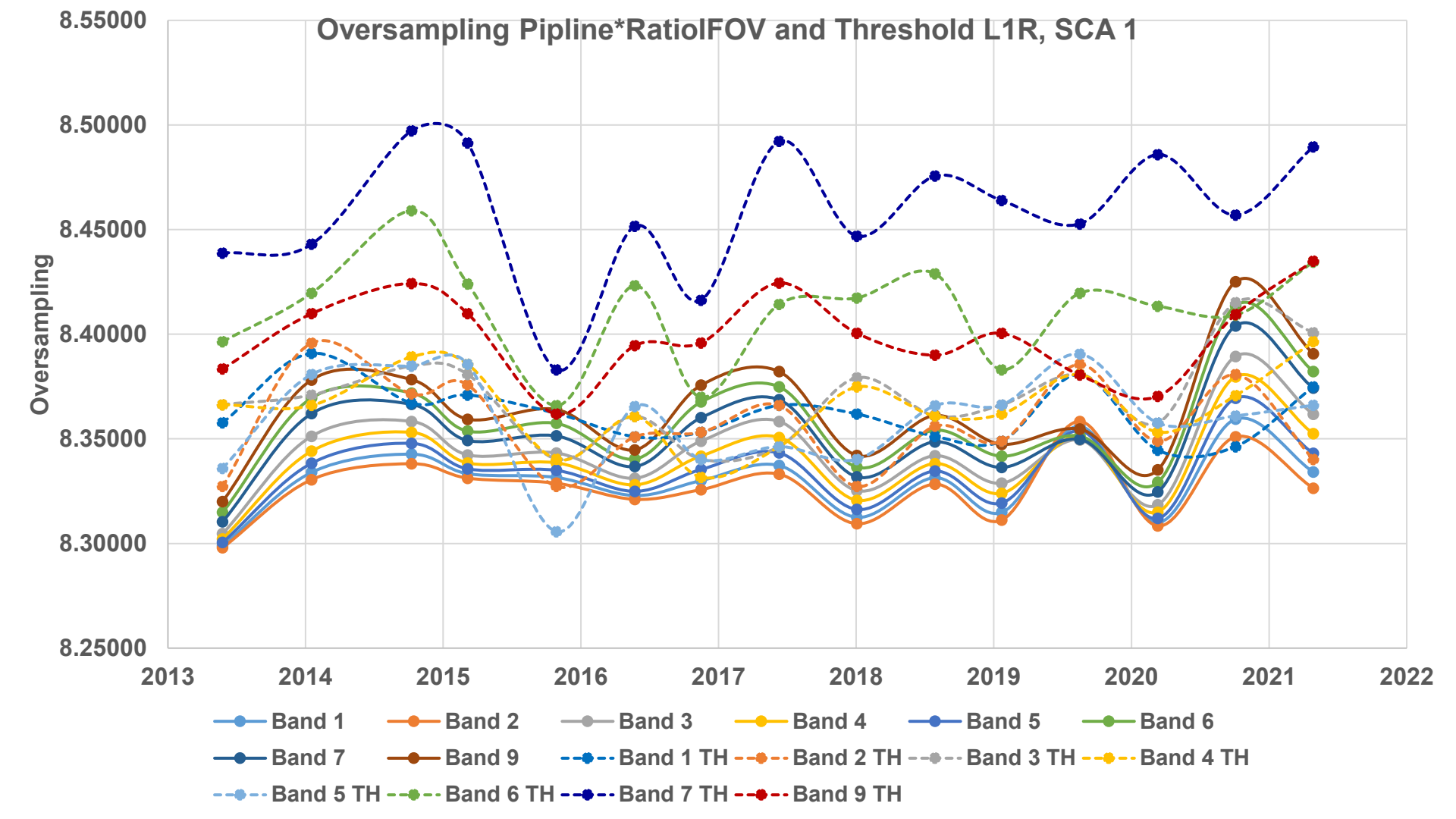
L1G Band 1

TROUGHS					
Date	SCA	moon_pix	along_diam	cross_dia	os_center
2014016	1	283065	1704	212	8.038
2015065	1	283111	1706	212	8.047
2016143	1	290587	1726	215	8.028
2017161	1	284110	1707	213	8.014
2018209	1	285002	1710	213	8.028
2019228	1	283250	1706	212	8.047
2020276	1	285478	1713	212	8.08

L1G Band 1


Lunar Diameter, Across (Threshold L1R, SCA 1)
Diameter (lines)
250
245
240
235
230
225
220
215
210
205
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Band 1
Band 2
Band 3
Band 4
Band 5
Band 6
Band 7
Band 9
Expected


Lunar Diameter, Along (Thresholded L1R, SCA 1)
Lunar Diameter (samples)
2050
2000
1950
1900
1850
1800
1750
1700
1650
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Band 1
Band 2
Band 3
Band 4
Band 5
Band 6
Band 7
Band 9


Oversampling Pipline*RatiolFOV and Threshold L1R, SCA 1
Oversampling
8.55000
8.50000
8.45000
8.40000
8.35000
8.30000
8.25000
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Band 1
Band 2
Band 3
Band 4
Band 5
Band 6
Band 7
Band 9
Band 1 TH
Band 2 TH
Band 3 TH
Band 4 TH
Band 5 TH
Band 6 TH
Band 7 TH
Band 9 TH

Challenges with Oversampling from Threshold

- Terminator location
- 1 line or sample precision limit
- Stray light
- Shear during collect

Why is the moon different sizes in different bands and different FPMs?

The image size depends on the distance and orientation to the focal plane

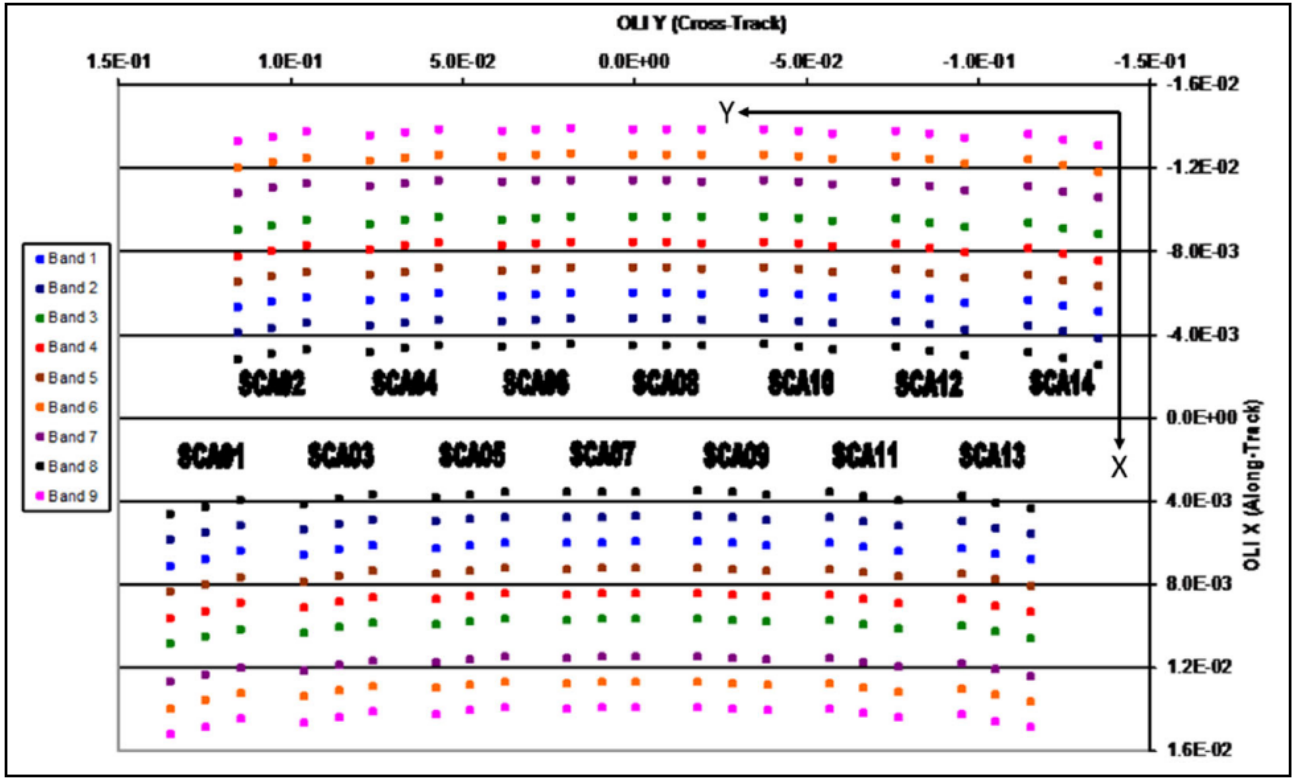
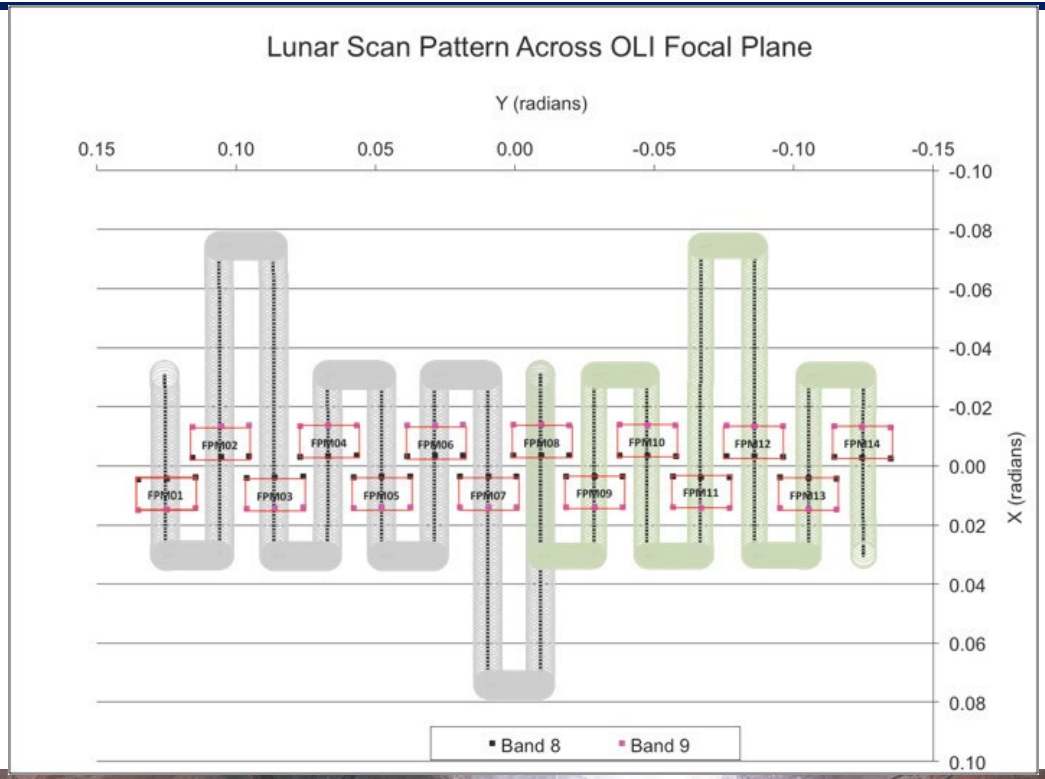
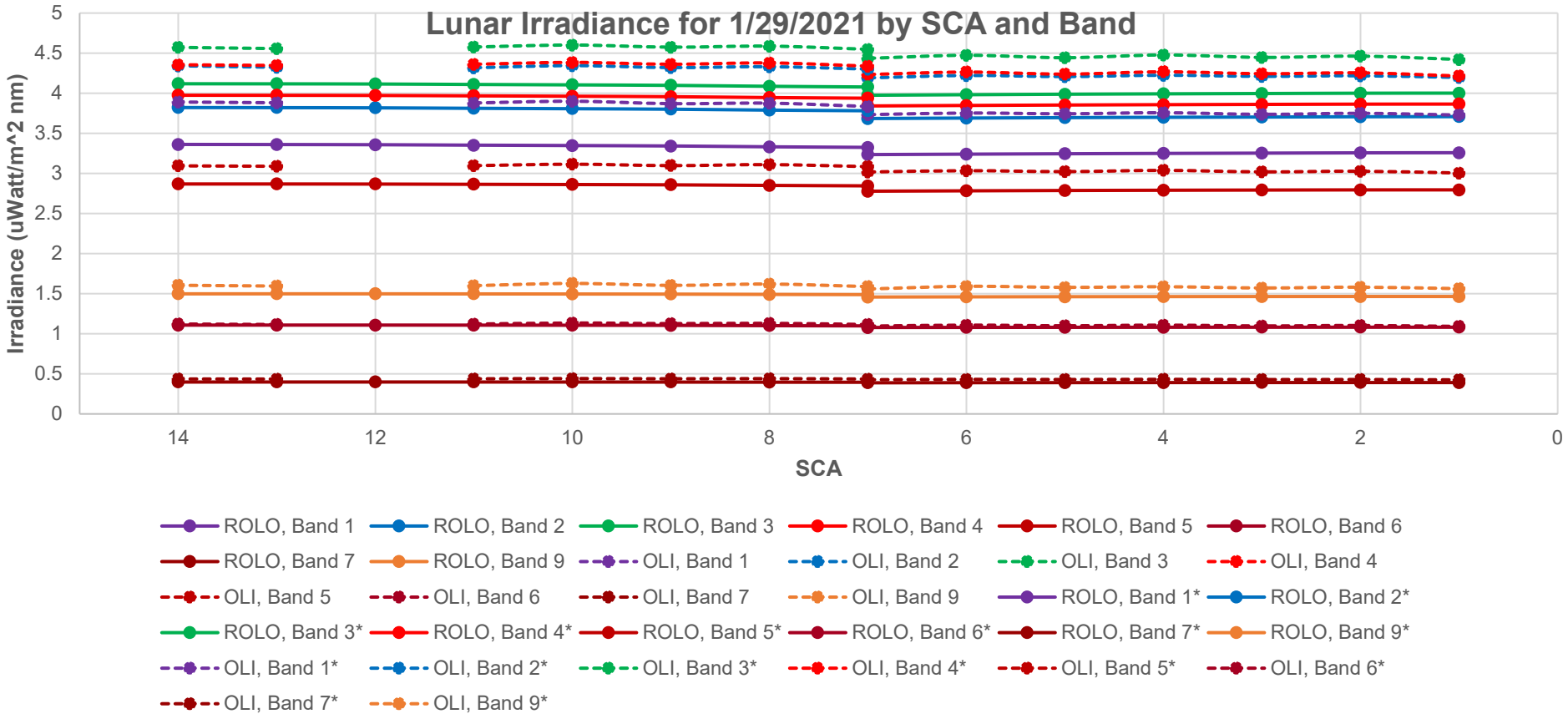


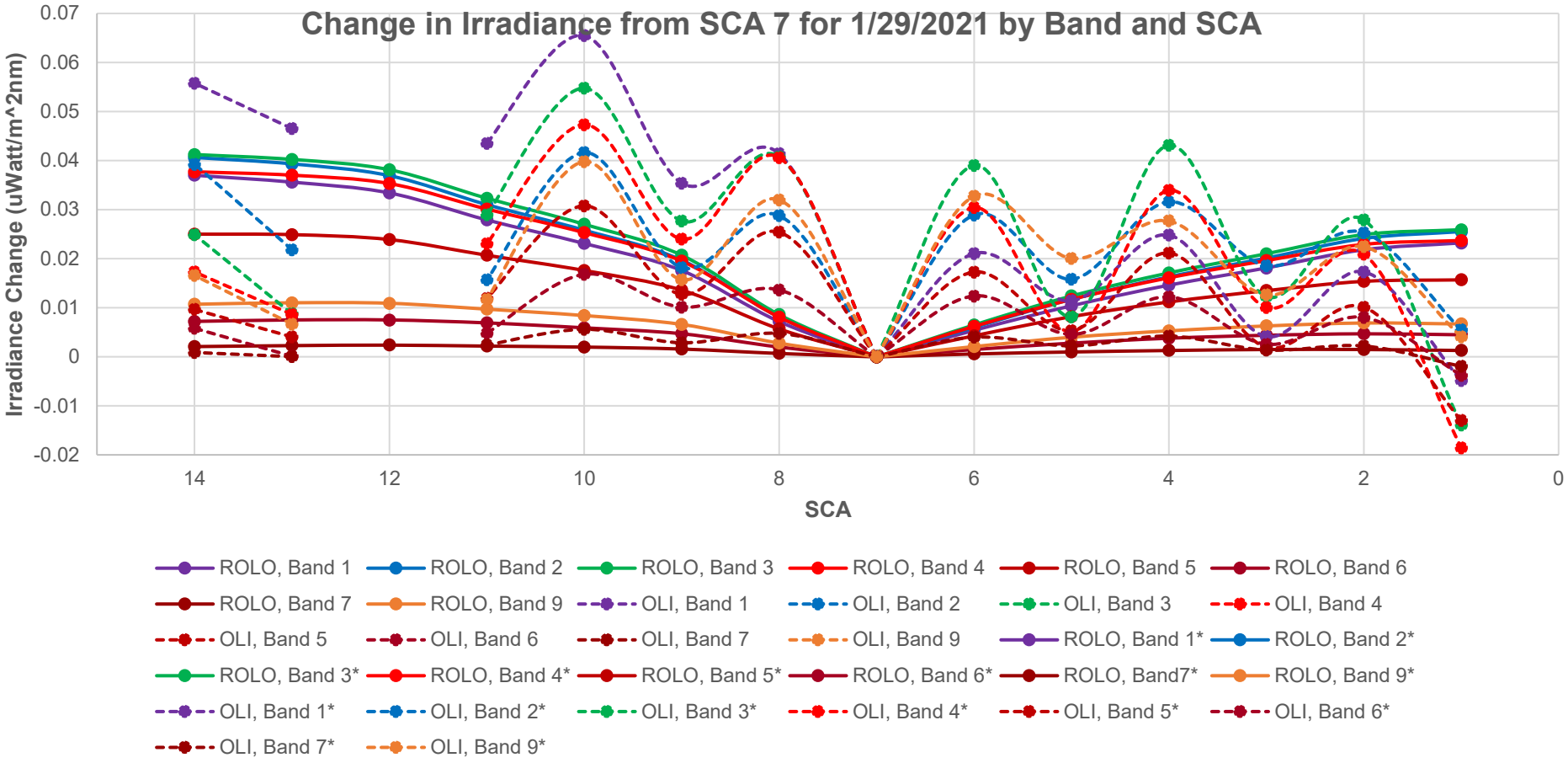
Figure 4-1. OLI Line-of-Sight Coordinate System

Variation in ROLO (From T.Stone), LIM and OLI (L. Ong and Pipeline) across Bands and FPMs

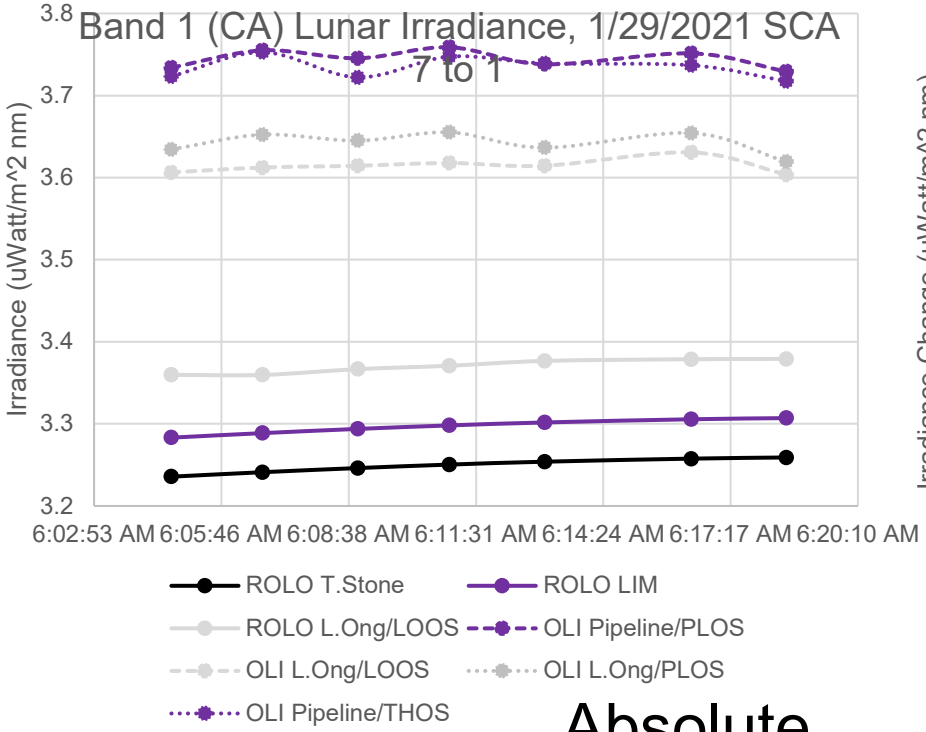
OLI Lunar Collect Pattern



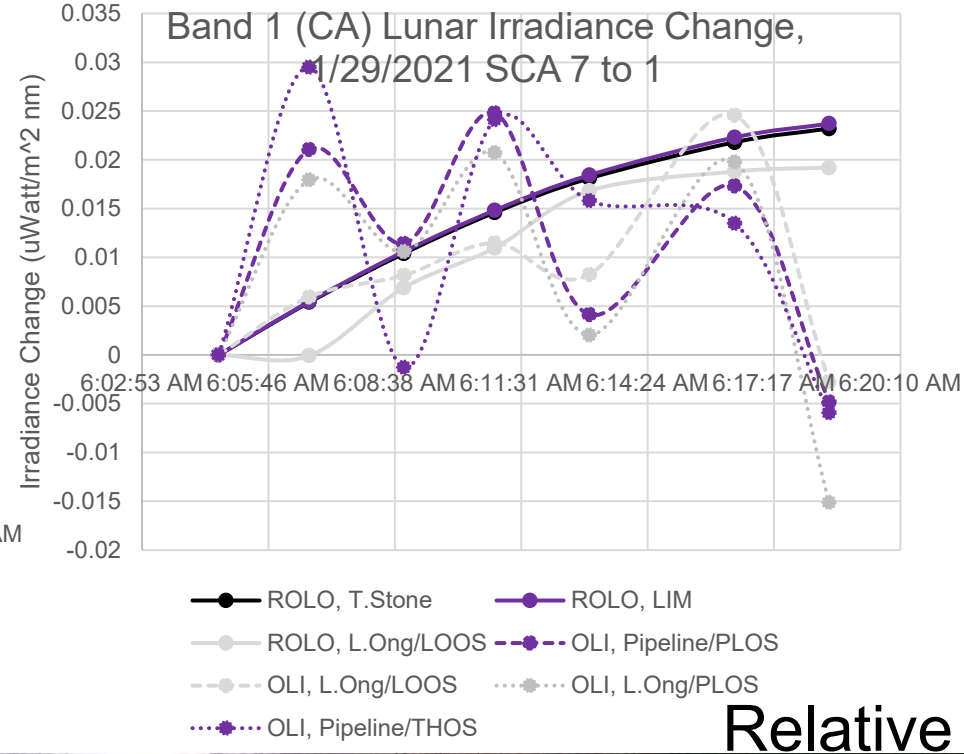

Lunar Irradiance for 1/29/2021 by SCA and Band
Irradiance (uWatt/m^2 nm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
14
12
10
8
6
4
2
0
SCA
ROLO, Band 1
ROLO, Band 2
ROLO, Band 3
ROLO, Band 4
ROLO, Band 5
ROLO, Band 6
ROLO, Band 7
ROLO, Band 9
OLI, Band 1
OLI, Band 2
OLI, Band 3
OLI, Band 4
OLI, Band 5
OLI, Band 6
OLI, Band 7
OLI, Band 9
ROLO, Band 1*
ROLO, Band 2*
ROLO, Band 3*
ROLO, Band 4*
ROLO, Band 5*
ROLO, Band 6*
ROLO, Band 7*
ROLO, Band 9*
OLI, Band 1*
OLI, Band 2*
OLI, Band 3*
OLI, Band 4*
OLI, Band 5*
OLI, Band 6*
OLI, Band 7*
OLI, Band 9*


Change in Irradiance from SCA 7 for 1/29/2021 by Band and SCA
Irradiance Change (uWatt/m^2nm)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
14
12
10
8
6
4
2
0
SCA
ROLO, Band 1
ROLO, Band 2
ROLO, Band 3
ROLO, Band 4
ROLO, Band 5
ROLO, Band 6
ROLO, Band 7
ROLO, Band 9
OLI, Band 1
OLI, Band 2
OLI, Band 3
OLI, Band 4
OLI, Band 5
OLI, Band 6
OLI, Band 7
OLI, Band 9
ROLO, Band 1*
ROLO, Band 2*
ROLO, Band 3*
ROLO, Band 4*
ROLO, Band 5*
ROLO, Band 6*
ROLO, Band7*
ROLO, Band 9*
OLI, Band 1*
OLI, Band 2*
OLI, Band 3*
OLI, Band 4*
OLI, Band 5*
OLI, Band 6*
OLI, Band 7*
OLI, Band 9*

ROLO lunar irradiance comparison for 1/29/2021

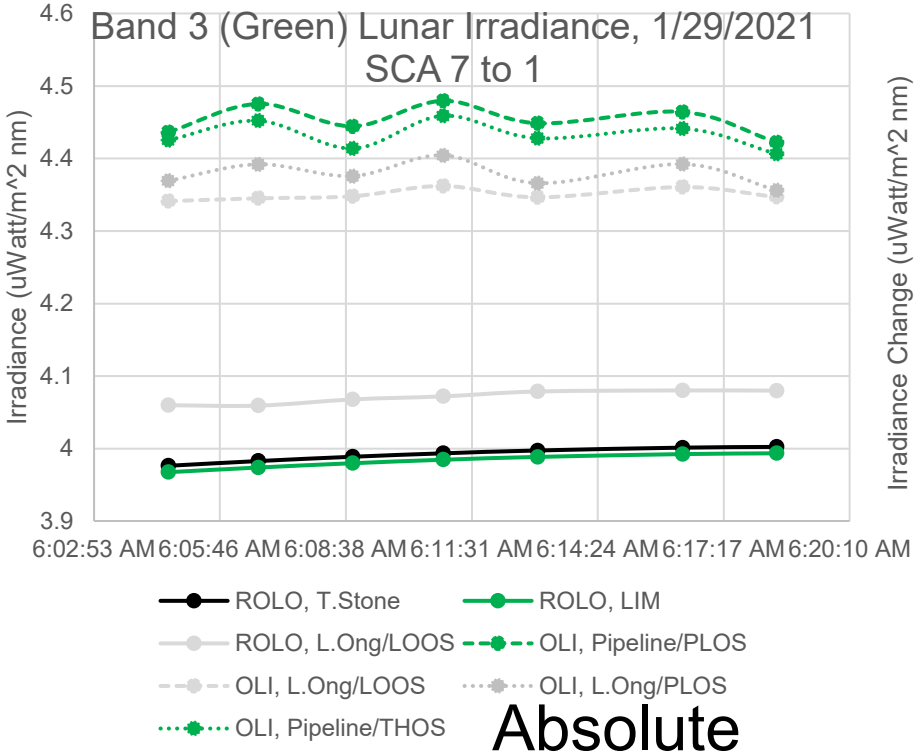


Absolute

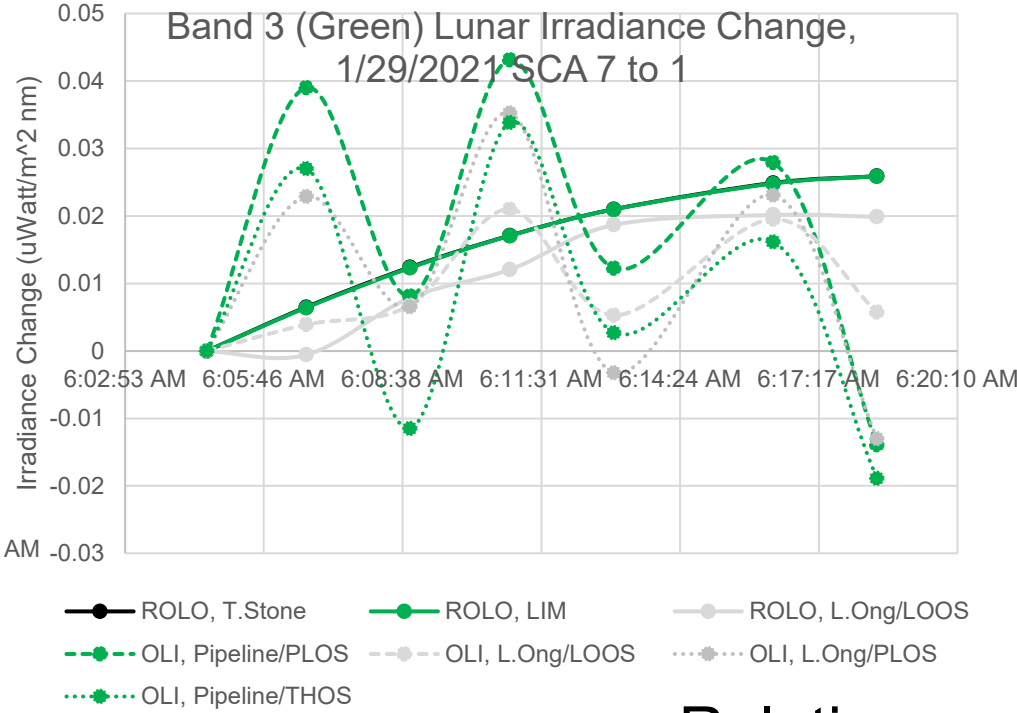


Relative

ROLO lunar irradiance comparison for 1/29/2021



Absolute



Relative

OLI Image Processing Plan

1. **Document & Diagram Pipeline Code with specific attention to LOS and IFOV parameter sourcing,**
2. **Ensure proper estimate of oversampling factor**
   1. Work with geometry cal/val to update pipeline code to properly apply LOS and IFOV specific to FPM and Band and any other necessary parameters,
   2. Verify against lunar l1g to l1r mapping from geometry cal/val
3. **Verify step 2 corrects OLI/LIM annual cycle & the issues with scan pass direction and systematic variation with FPM and Band**
4. **Automate Pipeline Code with consideration of flexibility for L8, L9 and others**

Backup Slides