

Landsat 8 OLI Relative Radiometric Correction Comparison between On-Board and Vicarious Techniques

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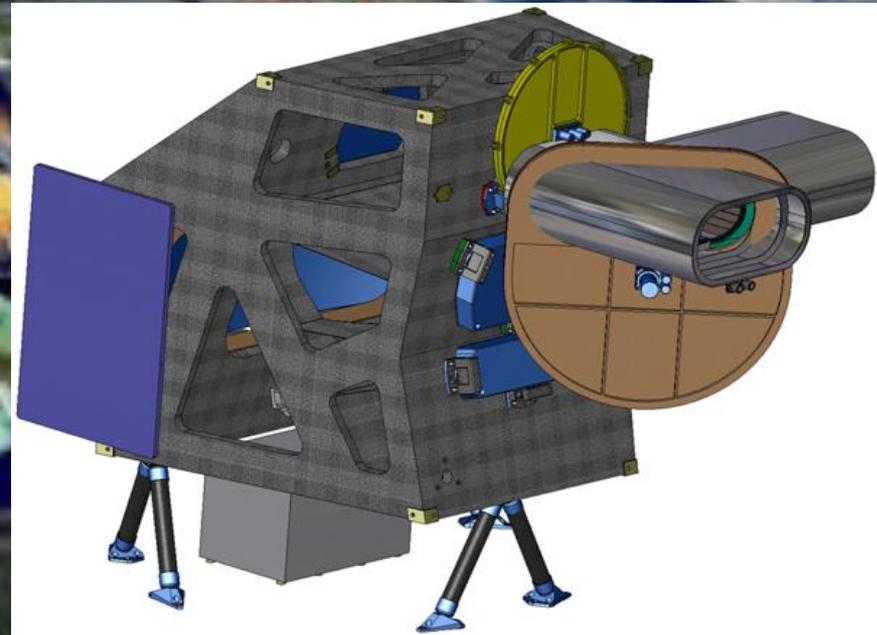


South Dakota State University
Image Processing Lab

OLI

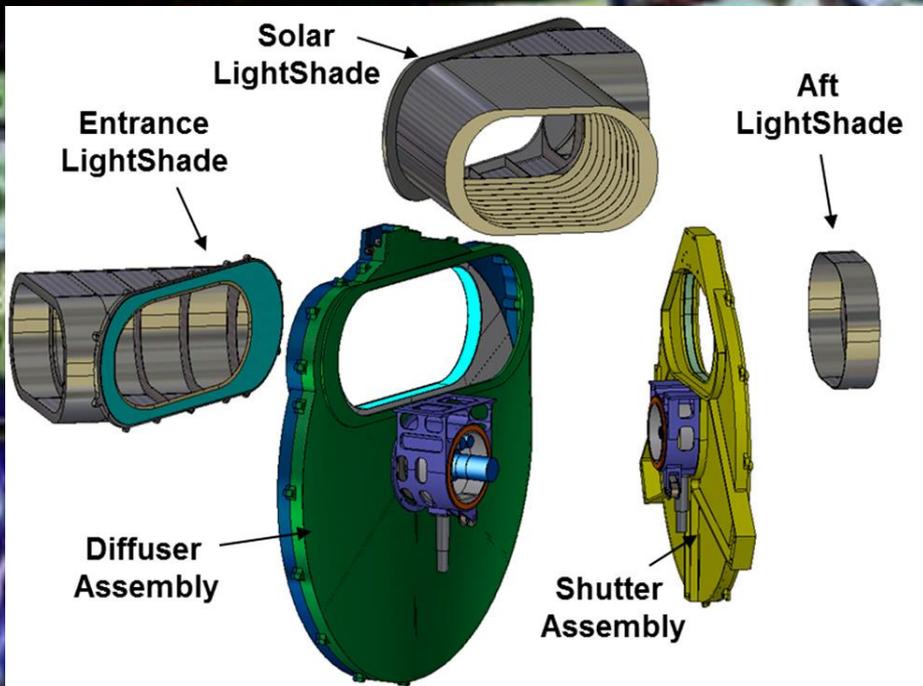
Operational Land Imager

- Built by Ball Aerospace (Contract 2007)
- Push-broom sensor, 12-bit quantization
- 5-year life span
- Collects data for visible, near and short wave infrared, aerosol, and panchromatic bands
- 725 images each day



OLI

Calibration Subsystem



- 2 lamp assemblies
- 2 Spectralon® diffuser panels
 - “Working”
 - “Pristine”
- Shutter assembly

Introduction

- Although within design specs, streaking in certain OLI bands is still discernible in Earth imagery (Blues, SWIRs)
- Three methods of characterizing detector non-uniformity:
 - diffuser (primary)
 - side slither (secondary)
 - lifetime stats (secondary, still developing)
- **Which method characterizes best?**

Test Procedure

- Apply ALL sets of relative gains to ALL test scenes
- Evaluate quantitatively + qualitatively
 - Since there's way too many individual metrics, we're focusing on scene-level metrics (mean streaking, max streak, number of streaks, mean banding**)

**banding summary omits FPM edges from calculation

Test Metrics

- Streaking

$$S_i = \frac{\left| \bar{L}_i - \frac{1}{2} (\bar{L}_{i-1} + \bar{L}_{i+1}) \right|}{\bar{L}_i}$$

- Banding

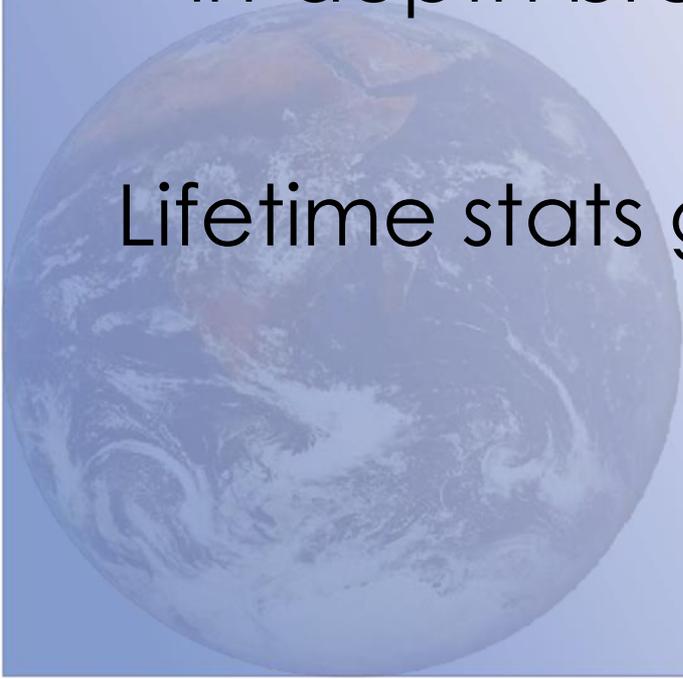
$$B_i = \sqrt{\sum_{i=n}^{n+99} \frac{(\bar{L}_i - \bar{L})^2}{99}}$$

L_i = radiance observed by detector i

Relative Gain Sets Used

- 7 diffuser-based (averaged from solar collects over respective quarters)
- 12 side-slither (Various times and sites; in-depth breakdown on next slide)

Lifetime stats gains are still in the works...



Test Scenes Used

VNIR and PAN:

- 3/14 (GRL) – **3 scenes**
- 3/16 (GRL) – **5 scenes**
- 11/7 (GRL) – **3 scenes**
- 88/113 (ANT, Dome C) – **3 scenes**

SWIRs:

- 188/46 (NER) – **16 scenes**
- 199/46 (Mali) – **9 scenes**

19 sets of relative gains applied to each image

Grand total: **741** individual work orders

SS Gain Characterization Processing Flow

Radiometric
Processing

Shift
Correction

Uniform
Frame
Selection

Even/Odd
Detector
Norm.

RelGain
Derivation

- Radiometric processing (bias removal, response linearization) using Landsat 8 Image Assessment System (IAS)
- Shift correction aligns detector data by *target* rather than *time*
- Select flat field regions in each band/collect and eliminate even/odd detector artifacts

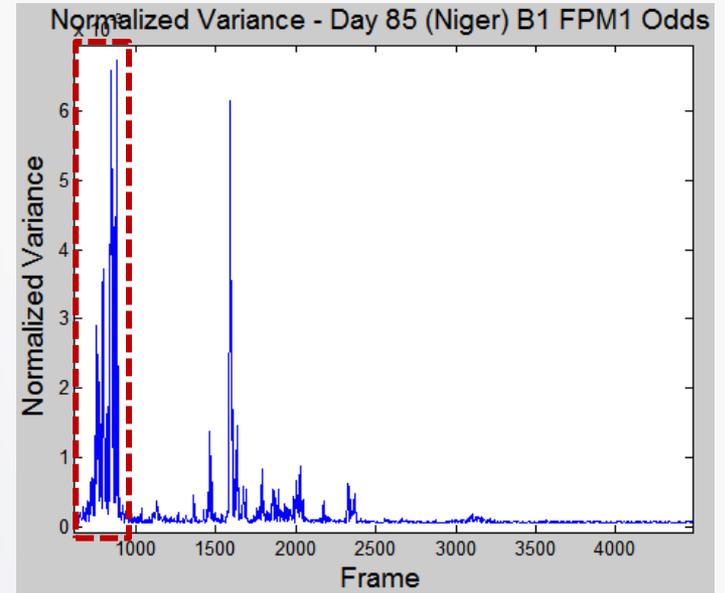
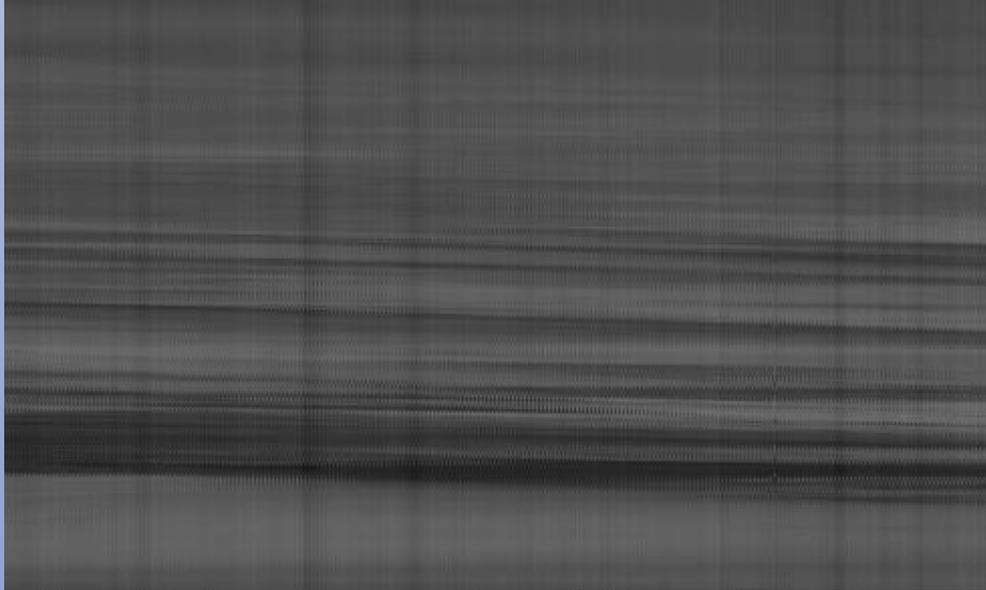
Shift Correction

A			
D	C		
G	F	A	
J	I	D	C
	L	G	F
		J	I
			L

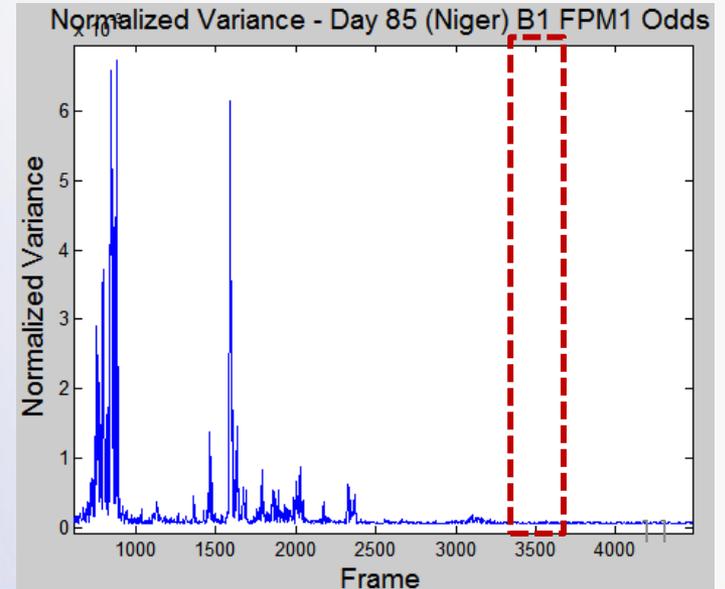
A	C	A	C
D	F	D	F
G	I	G	I
J	L	J	L

Frame Variance

'Bad' SS data



'Good' SS data

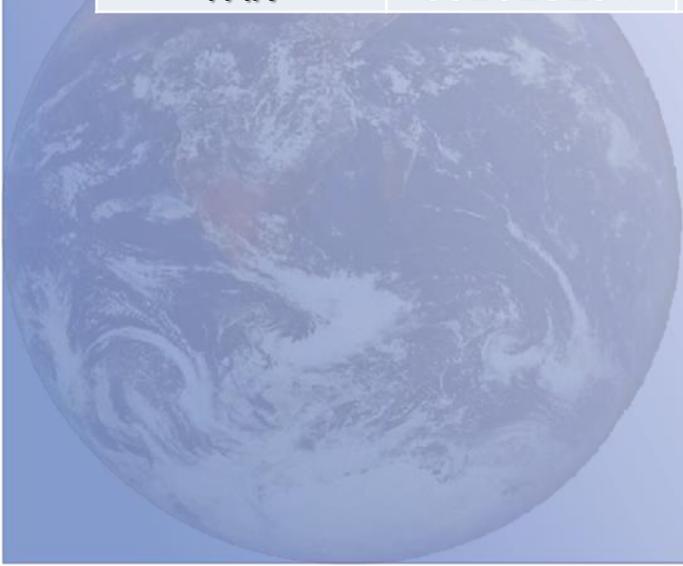


Description of SS Collects Used

Interval	Date of Collect	Location	Path	Rows
SS2013085	3-26-2013	Niger	189	45-48
SS2013095	4-5-2013	Libya/Niger	187	38-49
SS2013110	4-20-2013	Egypt	177	36-47
SS2013114	4-24-2013	Greenland	4	3-22
SS2013126	5-6-2013	Egypt	177	33-47
SS2013132	5-12-2013	Greenland	2	4-25
SS2013194	7-13-2013	Greenland	4	5-21
SS2013334	11-30-2013	Antarctica	88	103-117
SS2013350	12-16-2013	Antarctica	88	103-117
SS2014001	1-1-2014	Antarctica	88	103-117
SS2014101	4-11-2014	Niger	189	44-51
SS2014197	7-16-2014	Greenland	4	5-21

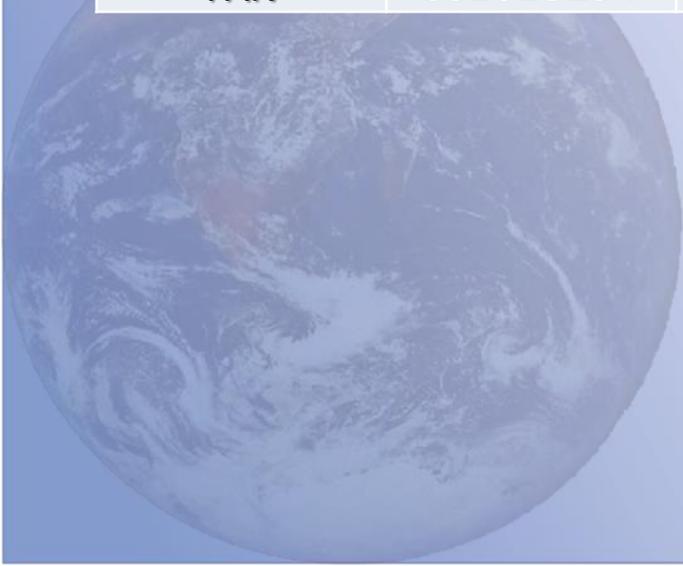
Top 5 sets for Streaking Reduction 11/7 Scene, 2013163

	1 st	2 nd	3 rd	4 th	5 th
C/A	'SS2013194'	'SS2013132'	'SS2013114'	'DIFF2013Q2'	'DIFF2013Q3'
Blue	'SS2013194'	'SS2013114'	'DIFF2013Q4'	'SS2013132'	'DIFF2014Q1'
Green	'SS2013194'	'SS2013132'	'SS2013114'	'DIFF2013Q4'	'DIFF2014Q1'
Red	'SS2013194'	'SS2013132'	'DIFF2013Q3'	'DIFF2013Q2'	'SS2013114'
NIR	'SS2013194'	'DIFF2013Q2'	'DIFF2013Q3'	'SS2013114'	'DIFF2013Q4'
PAN	'SS2013194'	'SS2013114'	'SS2013132'	'SS2014001'	'SS2013350'



Top 5 sets for Banding Reduction 11/7 Scene, 2013163

	1 st	2 nd	3 rd	4 th	5 th
C/A	'SS2013194'	'SS2013132'	'SS2013126'	'SS2013114'	'DIFF2013Q4'
Blue	'SS2013194'	'SS2013126'	'SS2013114'	'SS2013132'	'DIFF2013Q4'
Green	'SS2013194'	'SS2013132'	'SS2013114'	'DIFF2013Q3'	'DIFF2013Q2'
Red	'SS2013194'	'SS2013132'	'SS2013114'	'DIFF2013Q3'	'DIFF2013Q2'
NIR	'SS2013194'	'SS2013114'	'SS2013132'	'SS2014001'	'SS2014197'
PAN	'SS2013194'	'SS2013114'	'SS2013132'	'SS2014001'	'SS2013350'

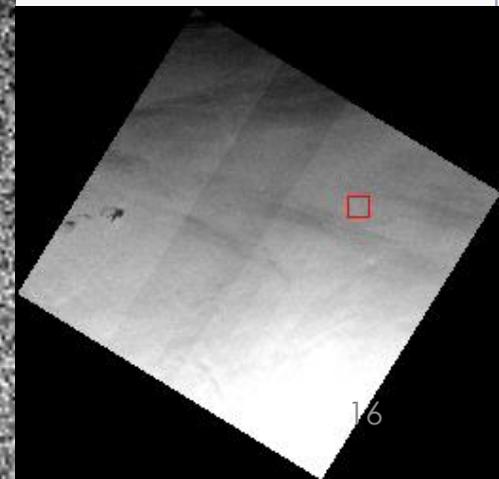
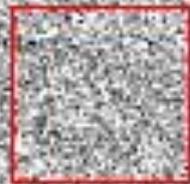


11/7 (GRL)
2013163

Coastal/Aerosol
FPM 10

SS2013194
(GRL)

Ranks:
Strk – 1st
Band – 1st

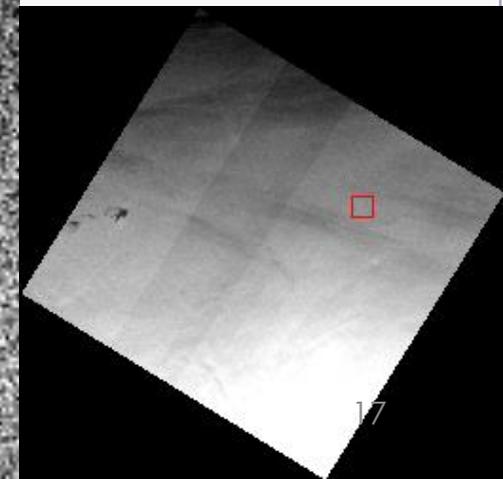
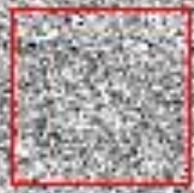


11/7 (GRL)
2013163

Coastal/Aerosol
FPM 10

SS2013132
(GRL)

Ranks:
Strk – 2nd
Band – 2nd

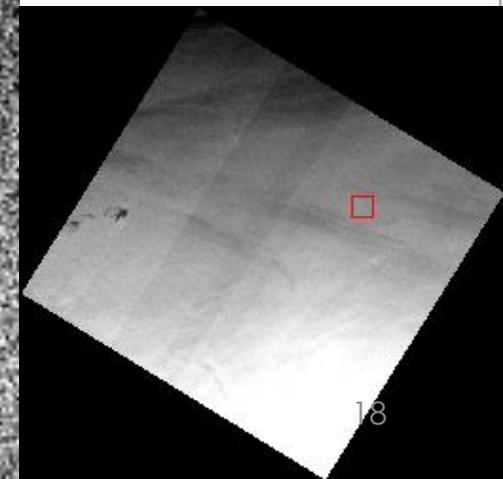
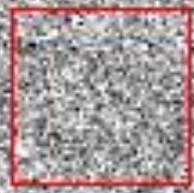


11/7 (GRL)
2013163

Coastal/Aerosol
FPM 10

SS2013114
(GRL)

Ranks:
Strk – 3rd
Band – 4th

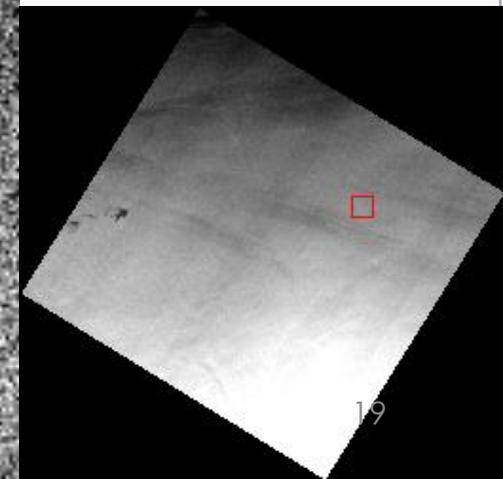
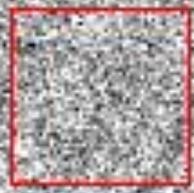


11/7 (GRL)
2013163

Coastal/Aerosol
FPM 9

Diffuser-Based
2013Q2

Ranks:
Strk – 4th
Band – Not Top 5

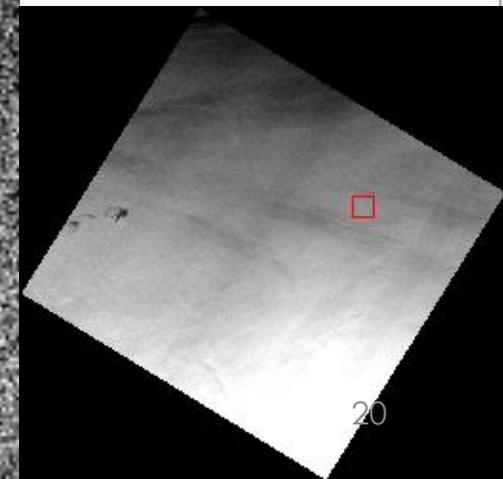
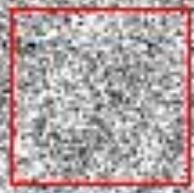


11/7 (GRL)
2013163

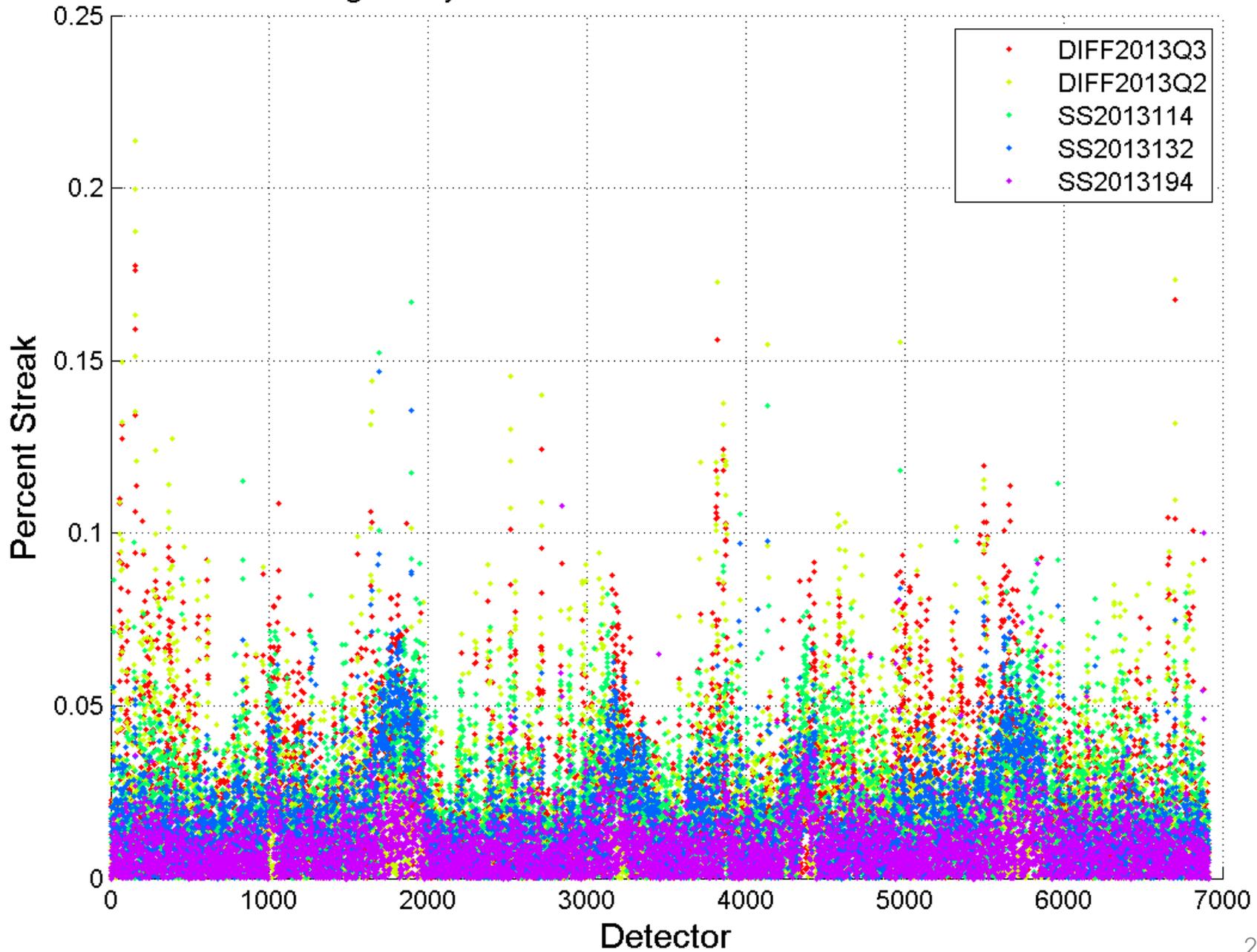
Coastal/Aerosol
FPM 9

Diffuser-Based
2013Q3

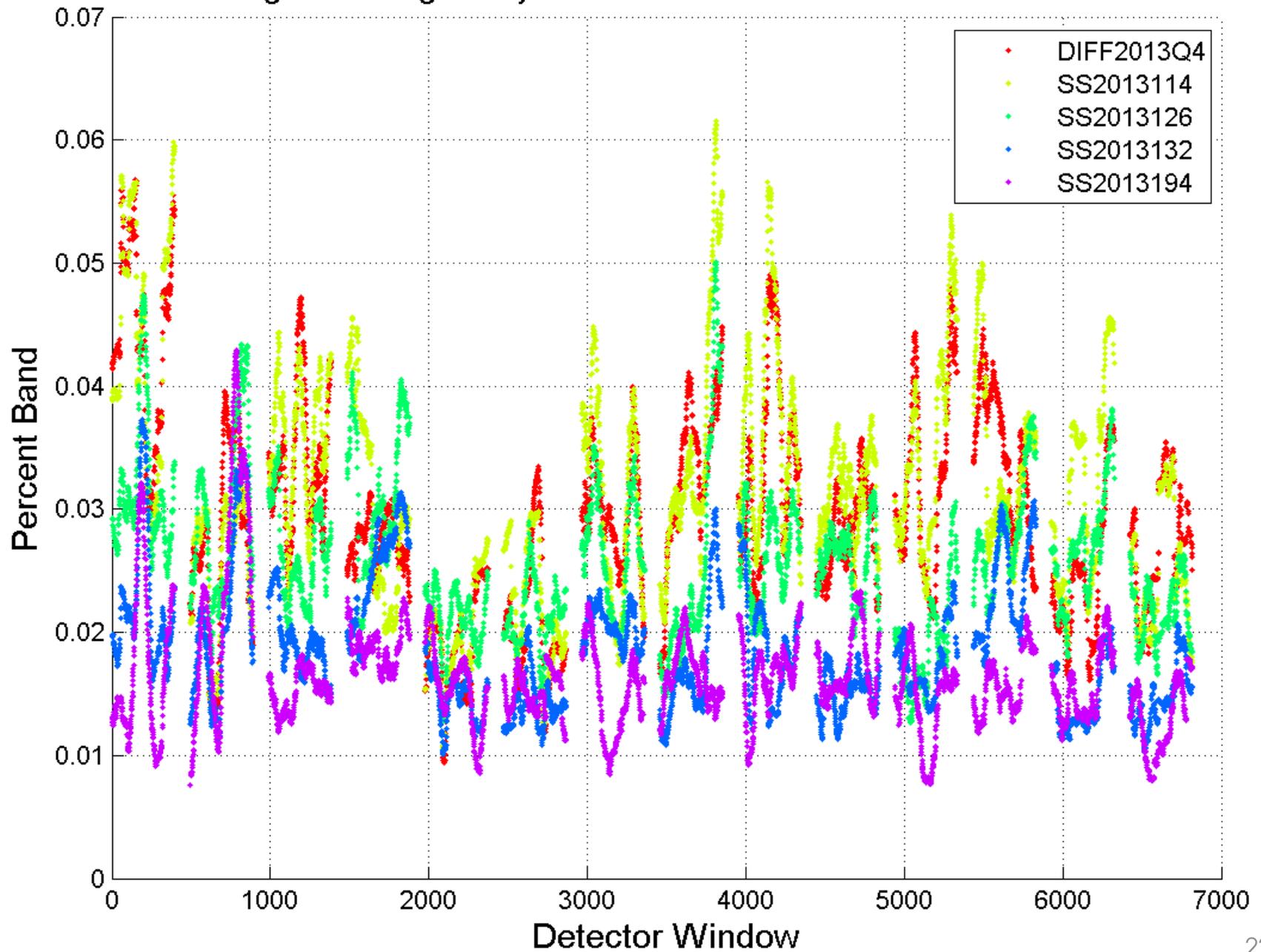
Ranks:
Strk – 5th
Band – Not Top 5



Streaking Analysis of LC80110072013163LGN00 - Band 1



Non-Edge Banding Analysis of LC80110072013163LGN00 - Band 1



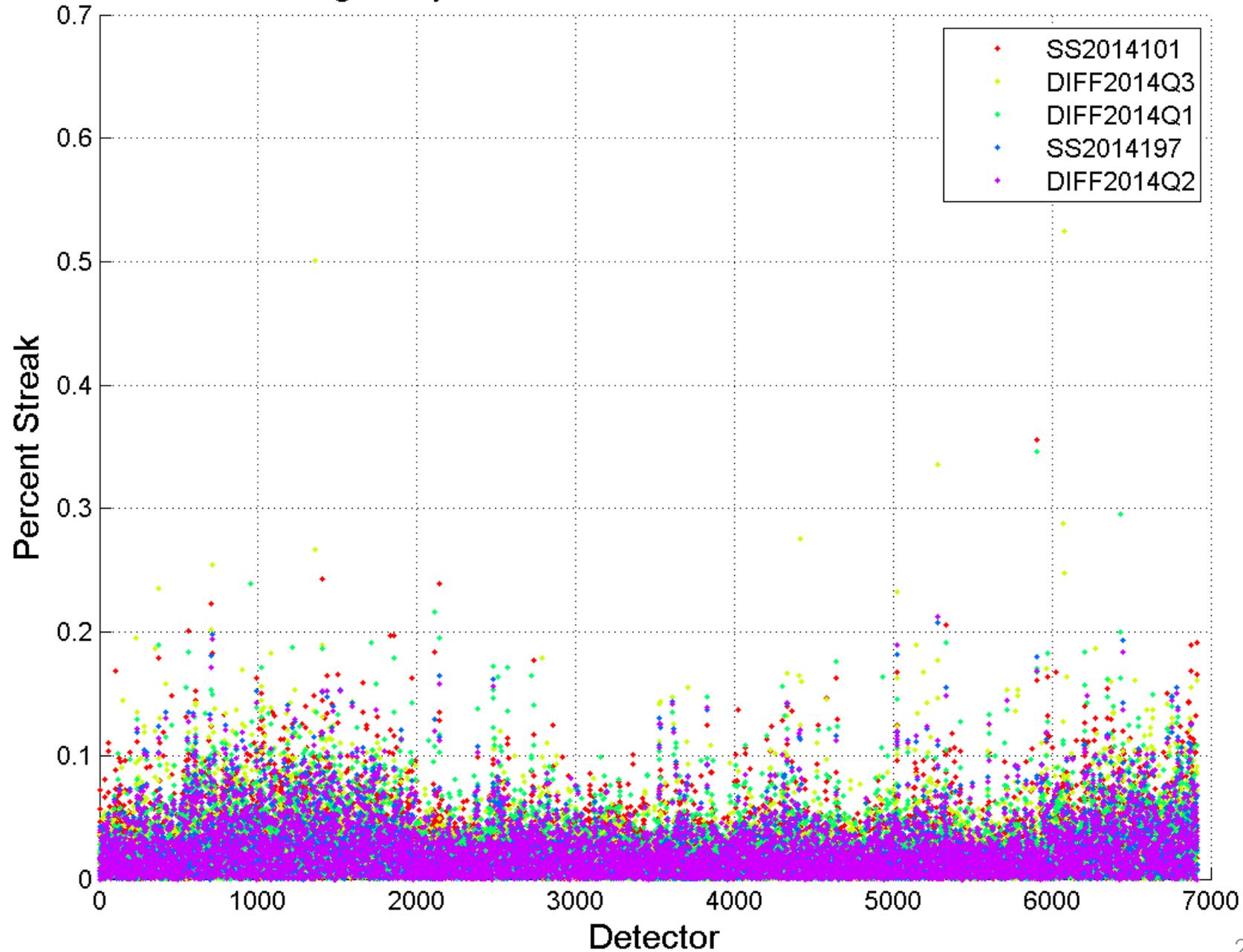
Top 5 performing relative gain sets 199/46 Scene, 2014155

Streaking	1 st	2 nd	3 rd	4 th	5 th
SWIR 1	'DIFF2014Q2'	'SS2014197'	'DIFF2014Q3'	'DIFF2014Q1'	'SS2014101'
SWIR 2	'DIFF2014Q2'	'SS2014197'	'DIFF2014Q1'	'DIFF2014Q3'	'SS2014101'

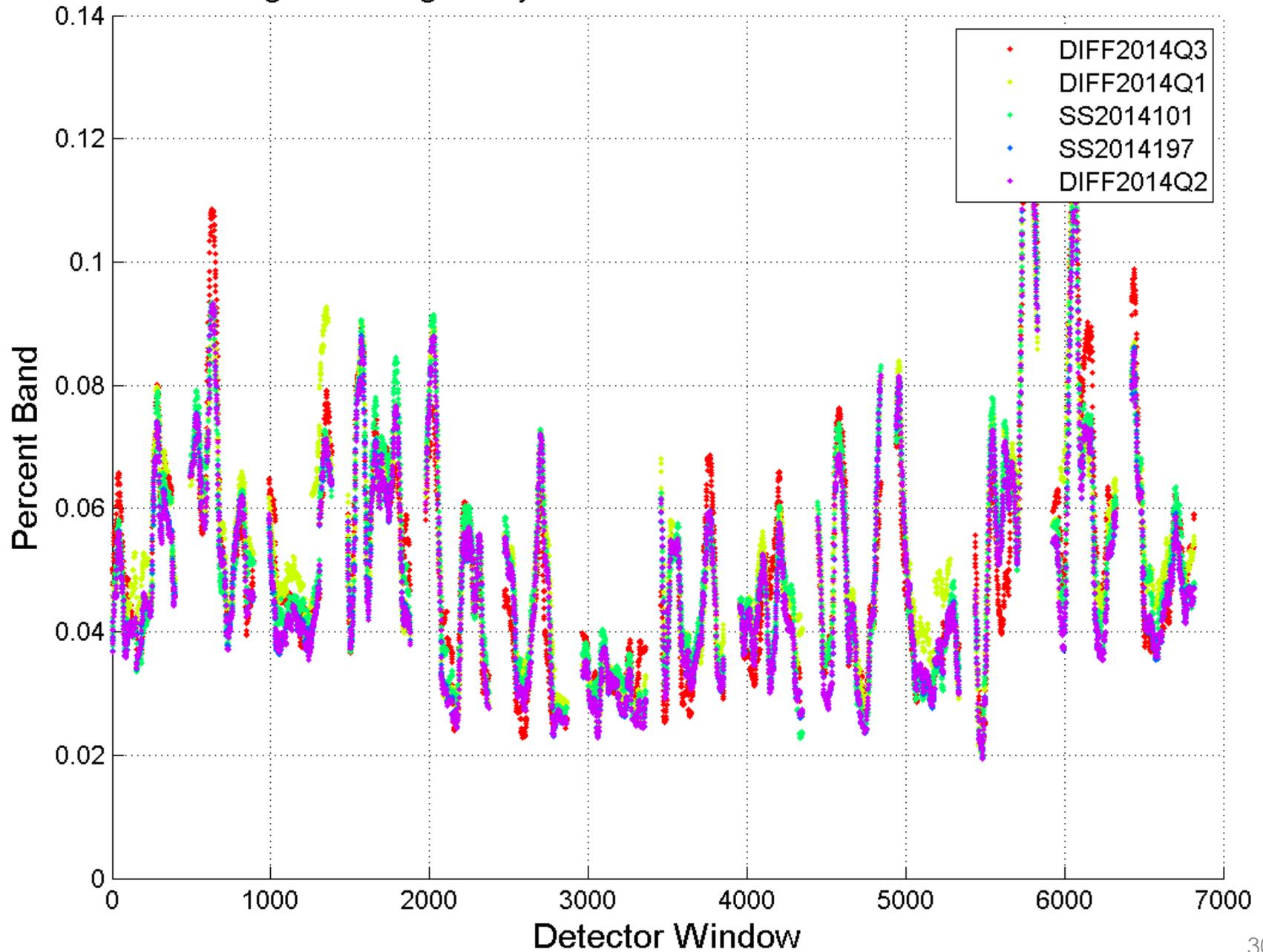
Banding	1 st	2 nd	3 rd	4 th	5 th
SWIR 1	'DIFF2014Q2'	'SS2014197'	'DIFF2014Q3'	'SS2014101'	'DIFF2014Q1'
SWIR 2	'DIFF2014Q2'	'SS2014197'	'SS2014101'	'DIFF2014Q1'	'DIFF2014Q3'



Streaking Analysis of LC81990462014155LGN00 - Band 7



Non-Edge Banding Analysis of LC81990462014155LGN00 - Band 7



Tallying up Streaking Performance...

Band	Side-Slither	Diffuser	Best Method
Coastal/Aerosol	12	2	Side-Slither
Blue	14	0	Side-Slither
Green	14	0	Side-Slither
Red	6	8	Debatable
NIR	2	12	Diffuser
SWIR 1	3	22	Diffuser
SWIR 2	3	22	Diffuser
Panchromatic	14	0	Side-Slither

Tallying up Banding Performance...

Band	Side-Slither	Diffuser	Best Method
Coastal/Aerosol	13	1	Side-Slither
Blue	14	0	Side-Slither
Green	14	0	Side-Slither
Red	13	1	Side-Slither
NIR	14	0	Side-Slither
SWIR 1	5	20	Diffuser
SWIR 2	6	19	Diffuser
Panchromatic	14	0	Side-Slither

Conclusions

1. Vicarious methods can produce detector equalization results that are competitive with on-board calibration systems.
2. SS appears to be best at characterizing relative gains at the shorter wavelengths; Diffuser best for SWIRs
3. Streaks will always be present in SWIR bands with current methodology – certain FPMs change in very short periods of time
4. The next step: Throw in lifetime stats relative gain results!