MODIS Science Team Meeting
FM1 Status

NASA GSFC
Contract No. NAS 5-30800

15 December 1998

Agenda

- **Overview**

- **TV Performance**
  - Crosstalk Performance
  - Spectral Performance
  - Radiometric
  - OBC Calibrators
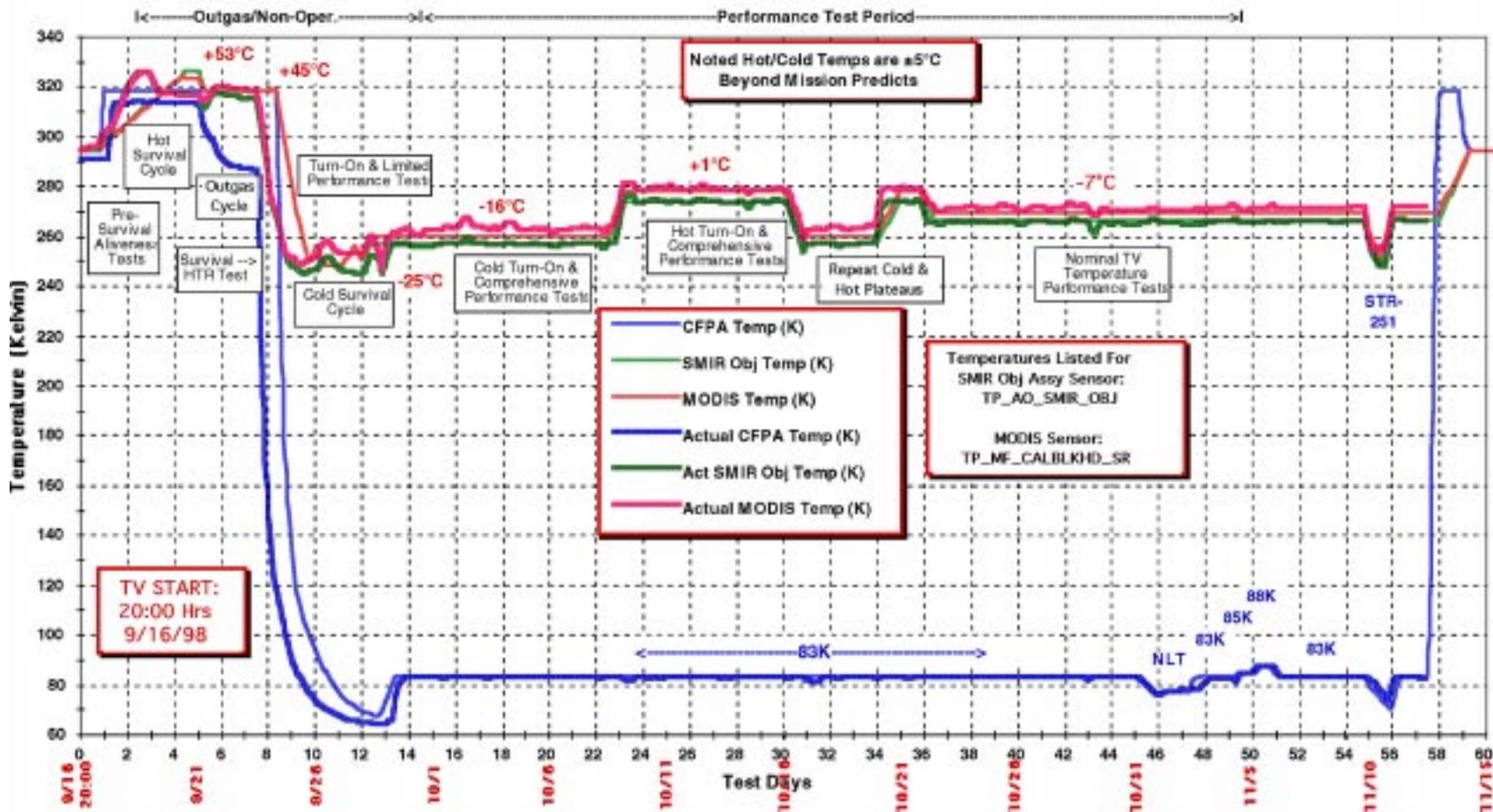
- **Ambient FM1 RVS Update**

- **Issues**

- **Summary**

FM1 Thermal Vacuum Test Has Been Completed

FM1 MODIS Instrument Thermal-Vacuum/Thermal Cycle Timeline

FM1 SWIR Crosstalk Significantly Better than PFM

Crosstalk From Band 6 Sender at Optimum Itwk/Vdet vs PFM

Legend:
- DESIRED
- PFM Nom ITWK=79
- FM1 Cold ITWK=102
- FM1 Hot ITWK=102

- PFM is Center Channel
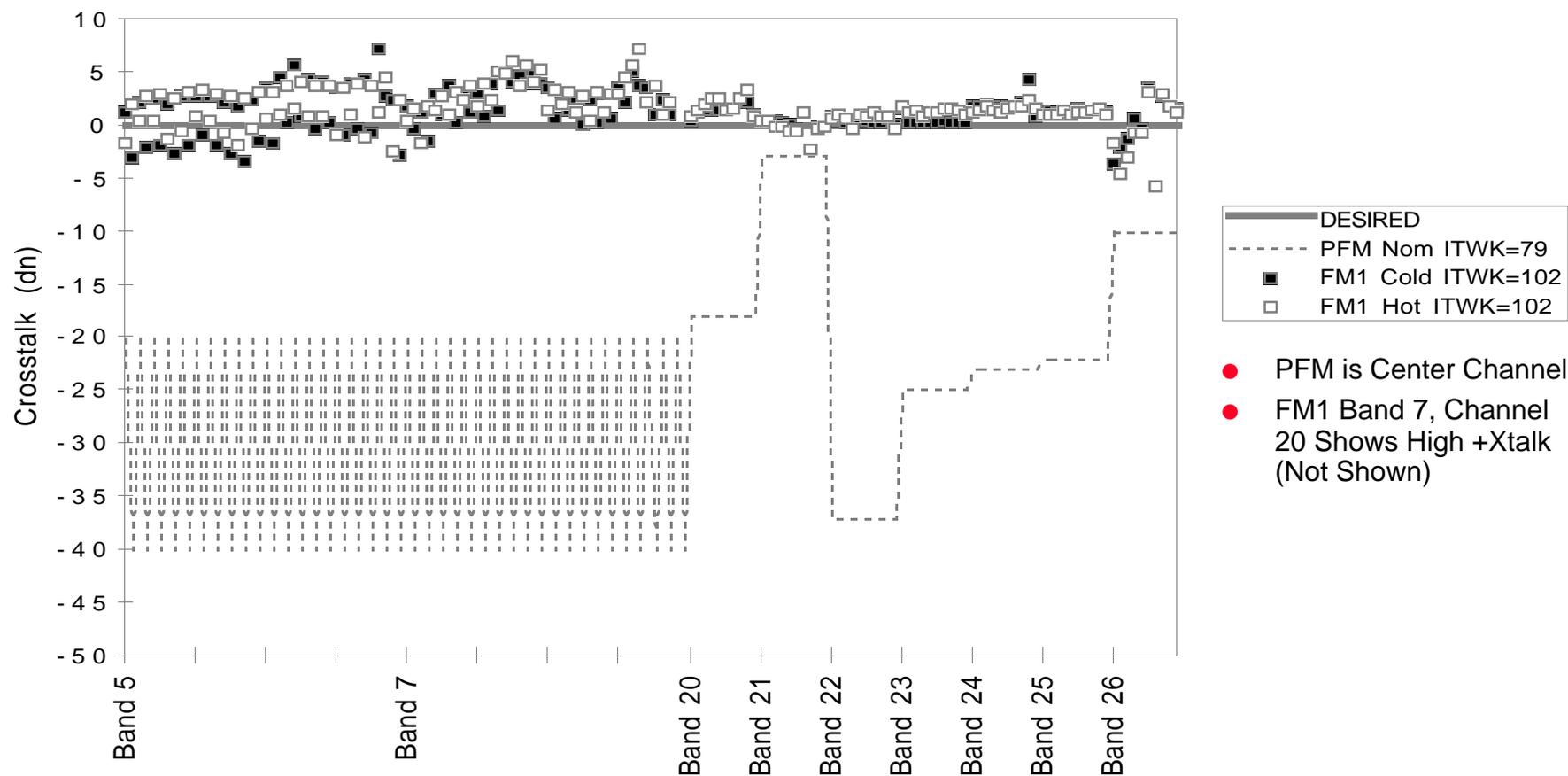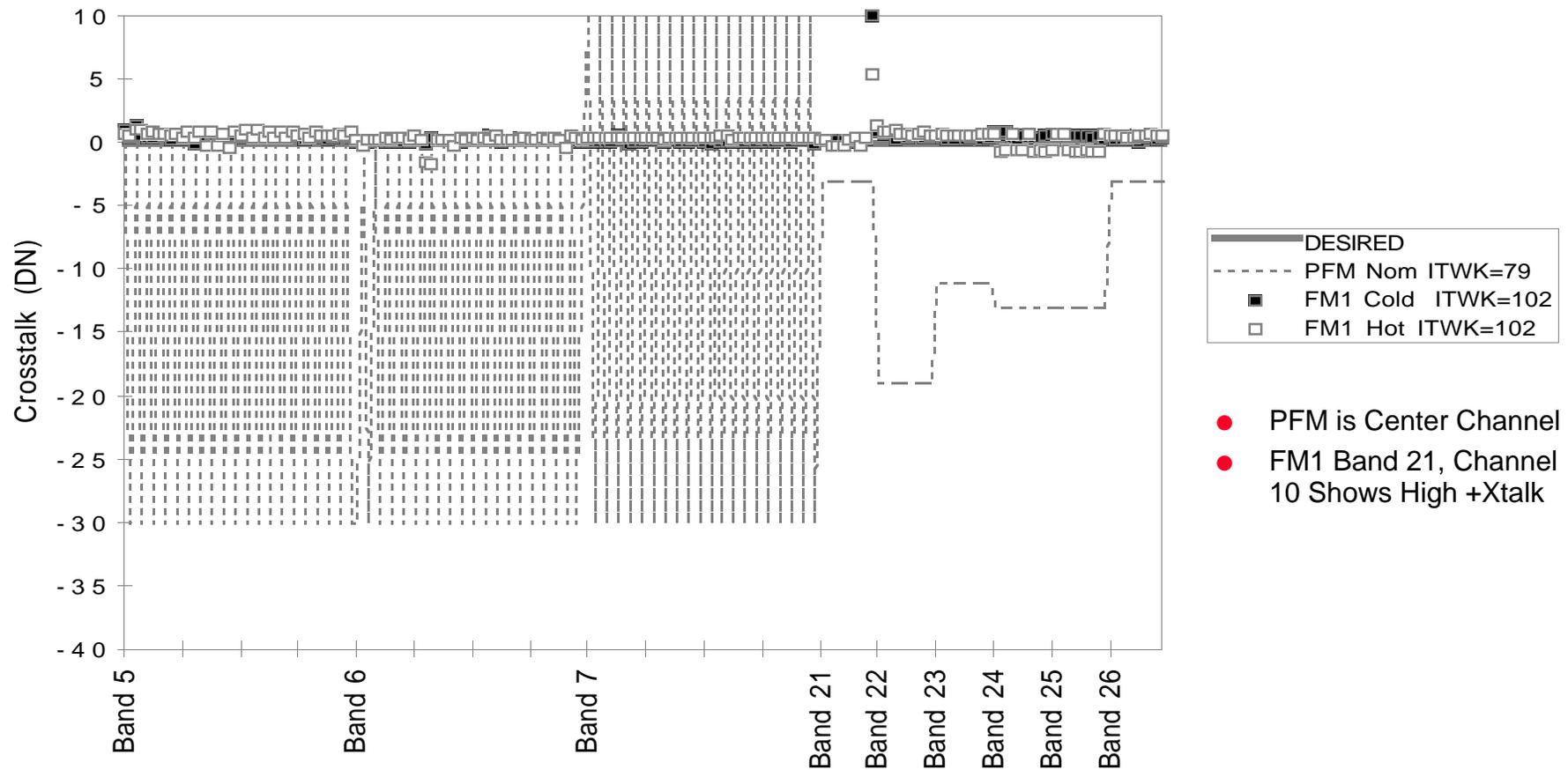- FM1 Band 7, Channel 20 Shows High +Xtalk (Not Shown)

FM1 MWIR Crosstalk Significantly Better than PFM

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Crosstalk From Band 20 Sender at Optimum Itwk/Vdet vs PFM

Legend:
- DESIRED
- PFM Nom ITWK=79
- FM1 Cold ITWK=102
- FM1 Hot ITWK=102

- PFM is Center Channel
- FM1 Band 21, Channel 10 Shows High +Xtalk

Y-axis: Crosstalk (DN), from 10 to -40

X-axis: Band 5, Band 6, Band 7, Band 21, Band 22, Band 23, Band 24, Band 25, Band 26
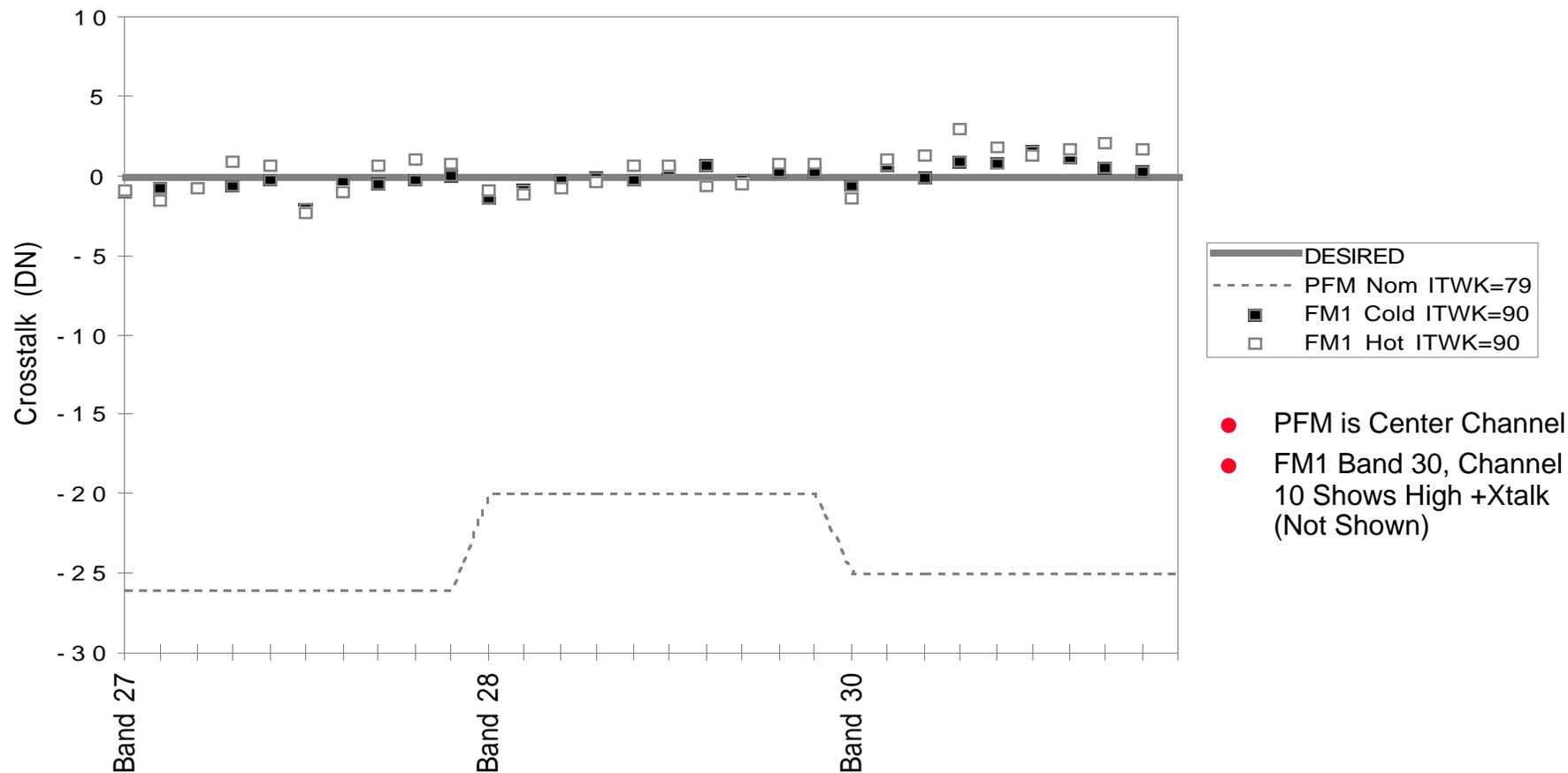
FM1 LWIR Crosstalk Significantly Better than PFM

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Crosstalk From Band 29 at Optimum Itwk/Vdet vs PFM

Legend:
- DESIRED
- PFM Nom ITWK=79
- FM1 Cold ITWK=90
- FM1 Hot ITWK=90

- PFM is Center Channel
- FM1 Band 30, Channel 10 Shows High +Xtalk (Not Shown)

Y-axis: Crosstalk (DN)
X-axis: Band 27, Band 28, Band 30

Radiometric Performance

- **Preliminary results show excellent instrument performance**

- **Many, Many RC01/RC02 data sets acquired AND analyzed**

- **SNRs/NEdTs/Linearity has been characterized, save for radiometric coefficients**

- **CPA/PRI and CPA/RDT form calibration data set**
  - Covers BOTH sides of all FPA analog signal trains

- **Redundant side not calibrated with CPB**
  - Issues remain on CPB/RDT "drift" anomaly

Primary SNRs Compliant For Reflective Bands

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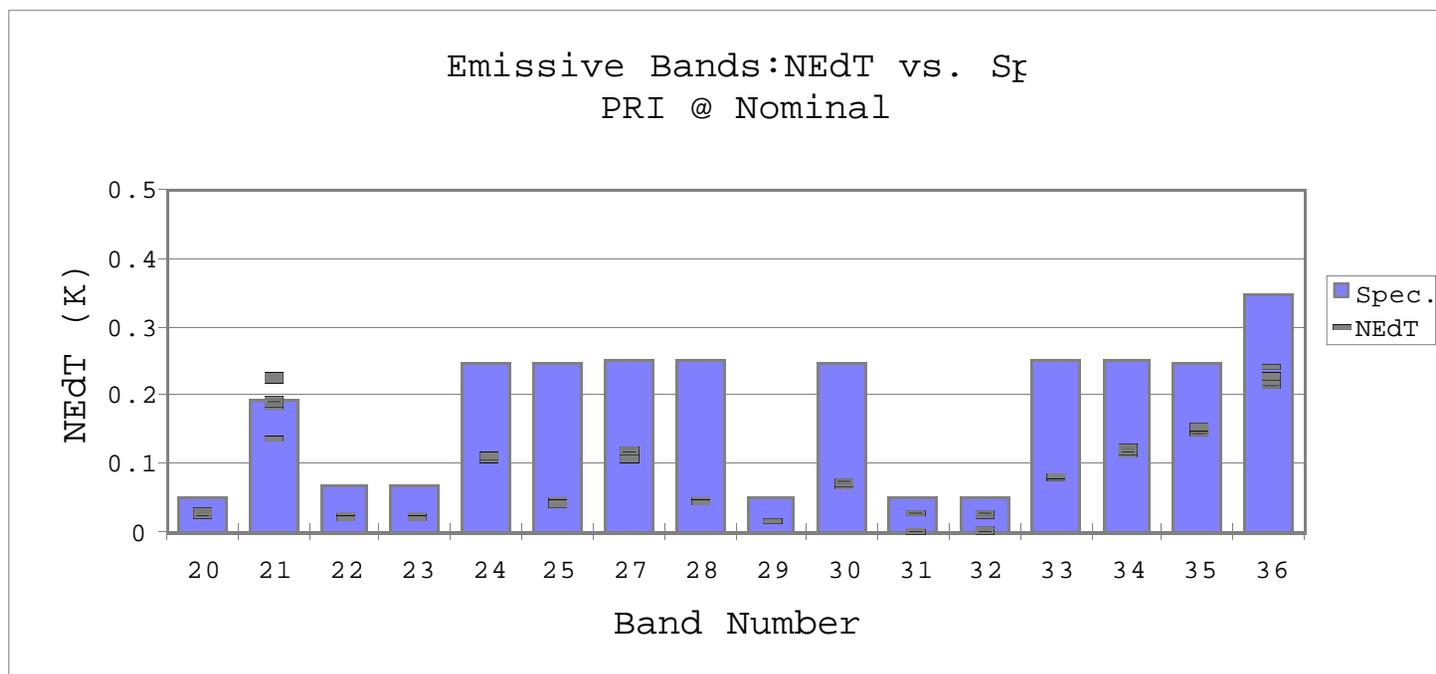**Santa Barbara**
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Reflective Bands:SNR vs S
PRI @ Nominal
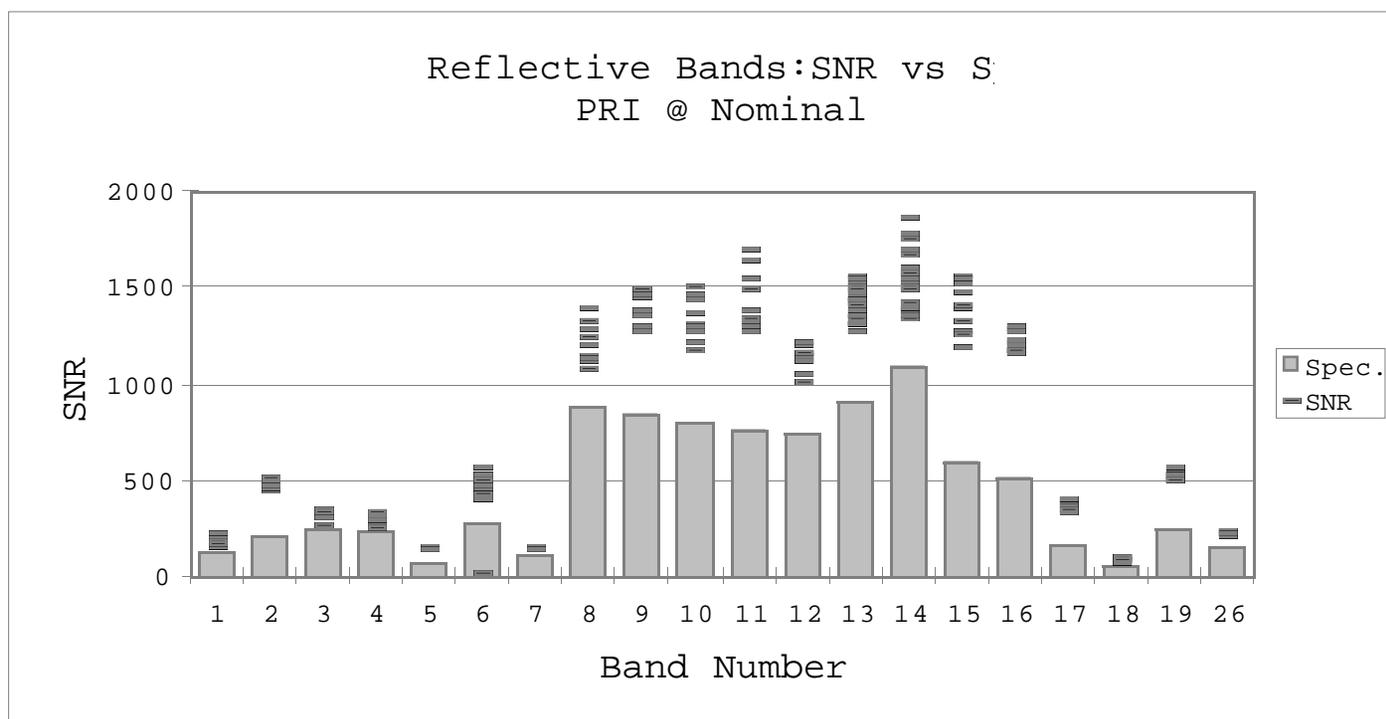
- Two failed channels for Band 6 (7 and 19) documented
  - EFR1732 (Waiver required)

Primary NEdTs Compliant For Emmissive Bands

Emissive Bands:NEdT vs. Sp
PRI @ Nominal

- Low signal on Band 21 believed to be cause of non-compliances
  - EFR1733 (Waiver required)

Spectral Performance

- **In-band data is spec compliant for most bands**

- **All Data Processed**

  — **In-Band Ambient (VIS,NIR) and TV Nominal (SW,MW,LW)**

  — **TV NLT**

    > Shifts consistent with published literature

  — **Special Collects**

    > Bands 20 and 31 vs Instrument temperature

    > Band 27 for SPMA Purge Characterization

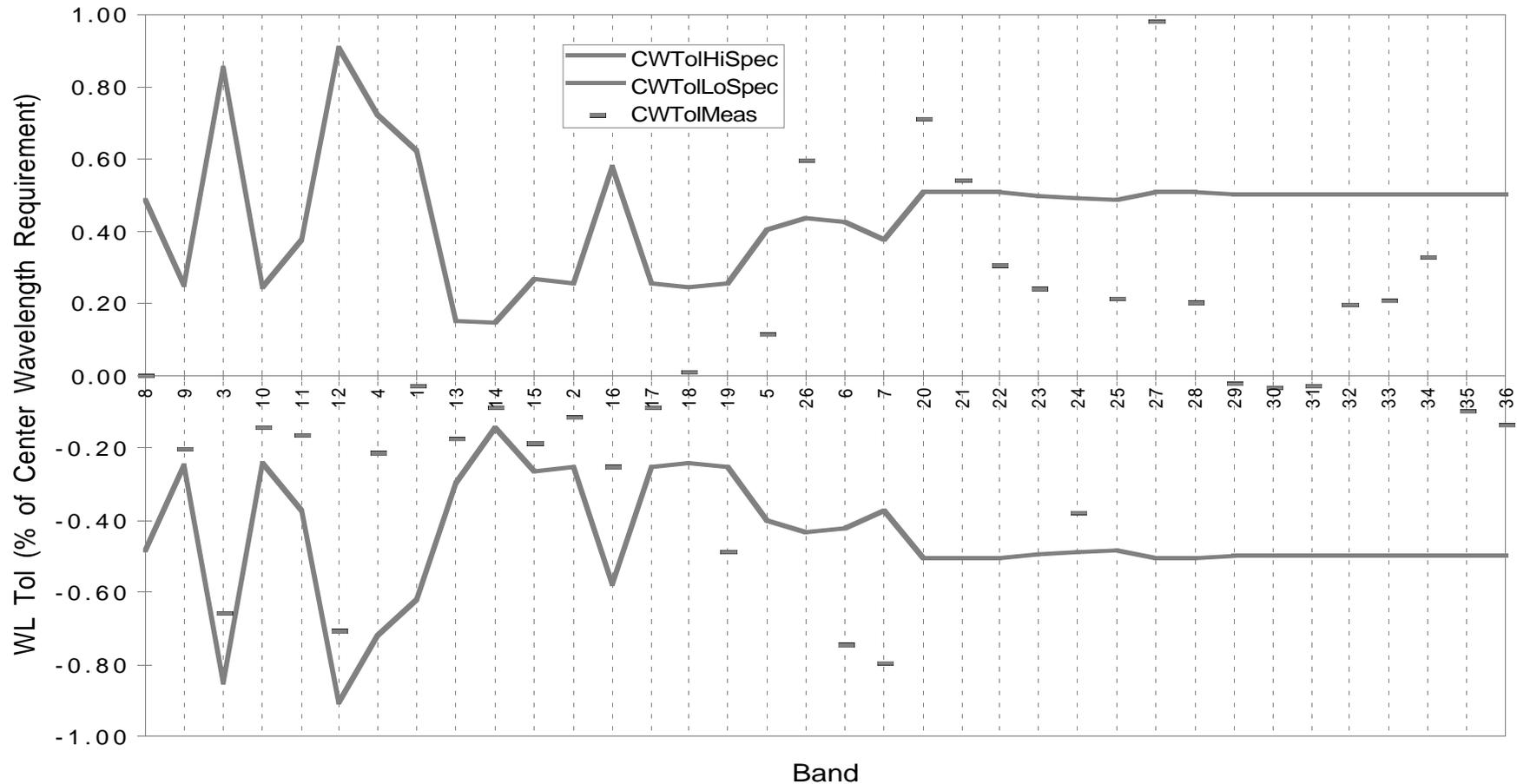   > Band 35 acquired at 2nm intervals for CO_2 characterization

Center Wavelength Requirements Achieved by Most Bands

Measured vs Spec Center Wavelength Tolerance as a Percentage of Center Wavelength Requirement

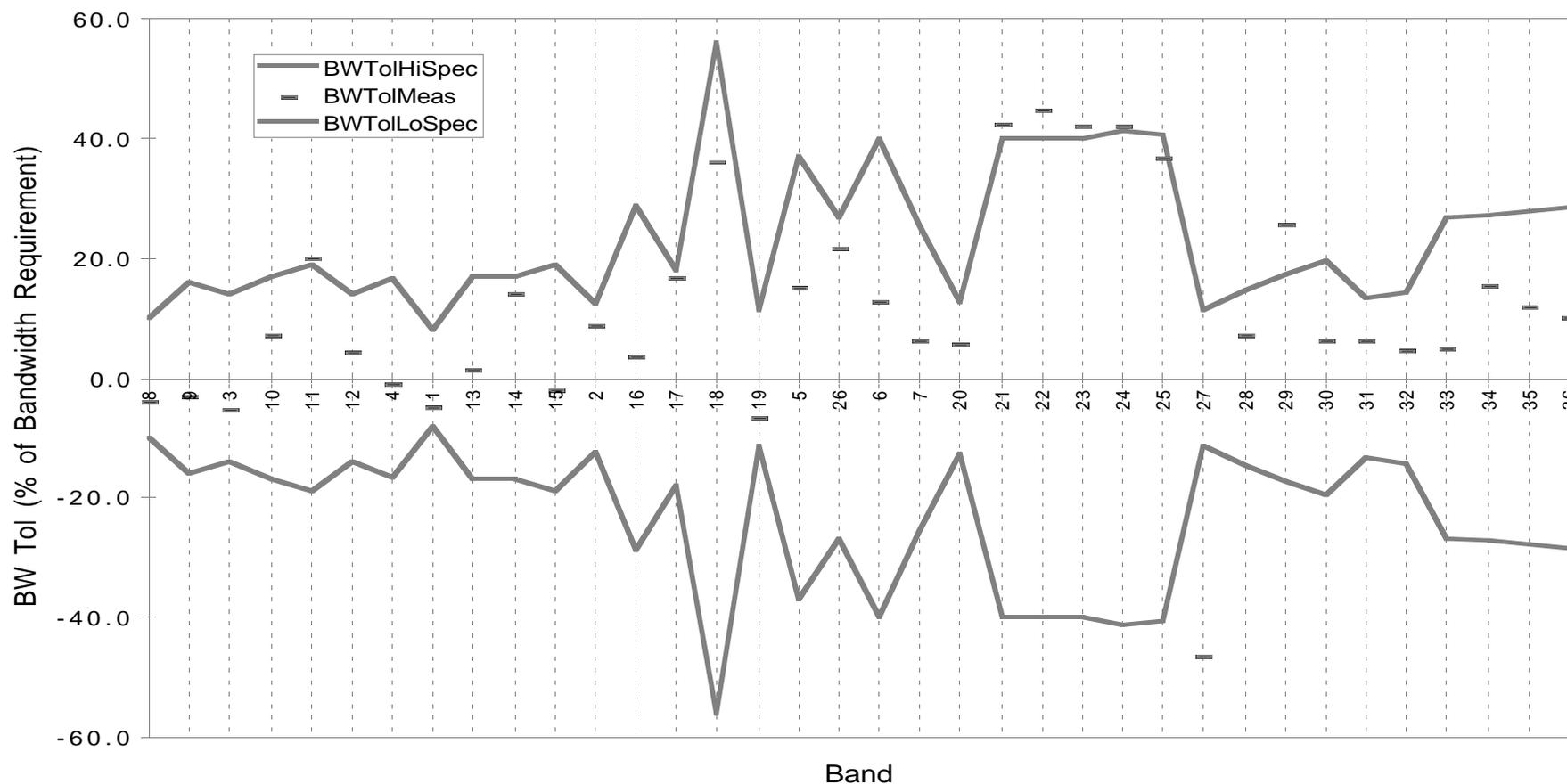Measured vs Spec Bandwidth Tolerance as a Percentage of Bandwidth Requirement

■ **All OOB data has been quiklooked**

■ **Detailed DN level reductions completed**

— **Normalizations in process**

— **Limited OOB results generated**

> 5.3 μm leak on PFM is reduced on FM1, but NOT eliminated (based on BCS results)

- Band 5 -> Approximately 3x reduction
- Band 6 -> Approximately 4x reduction
- Band 26 -> Approximately 2x reduction

> 11 μm leak on FM1 << PFM

- ~0.2%

Band 35 Out of Band Dispersive Response
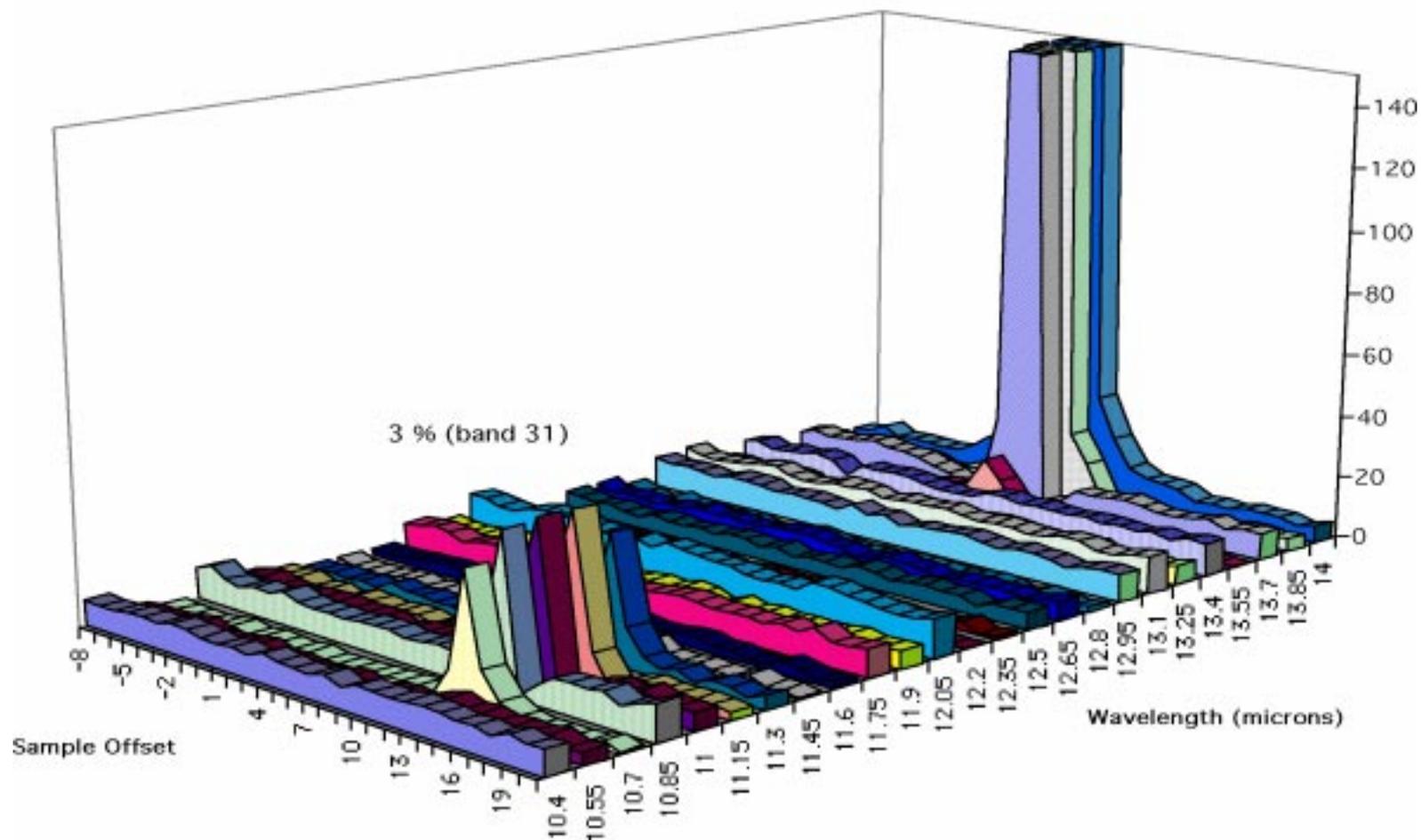
FM1 Band 35

FM1 Band 35 Out of Band Dispersive Response
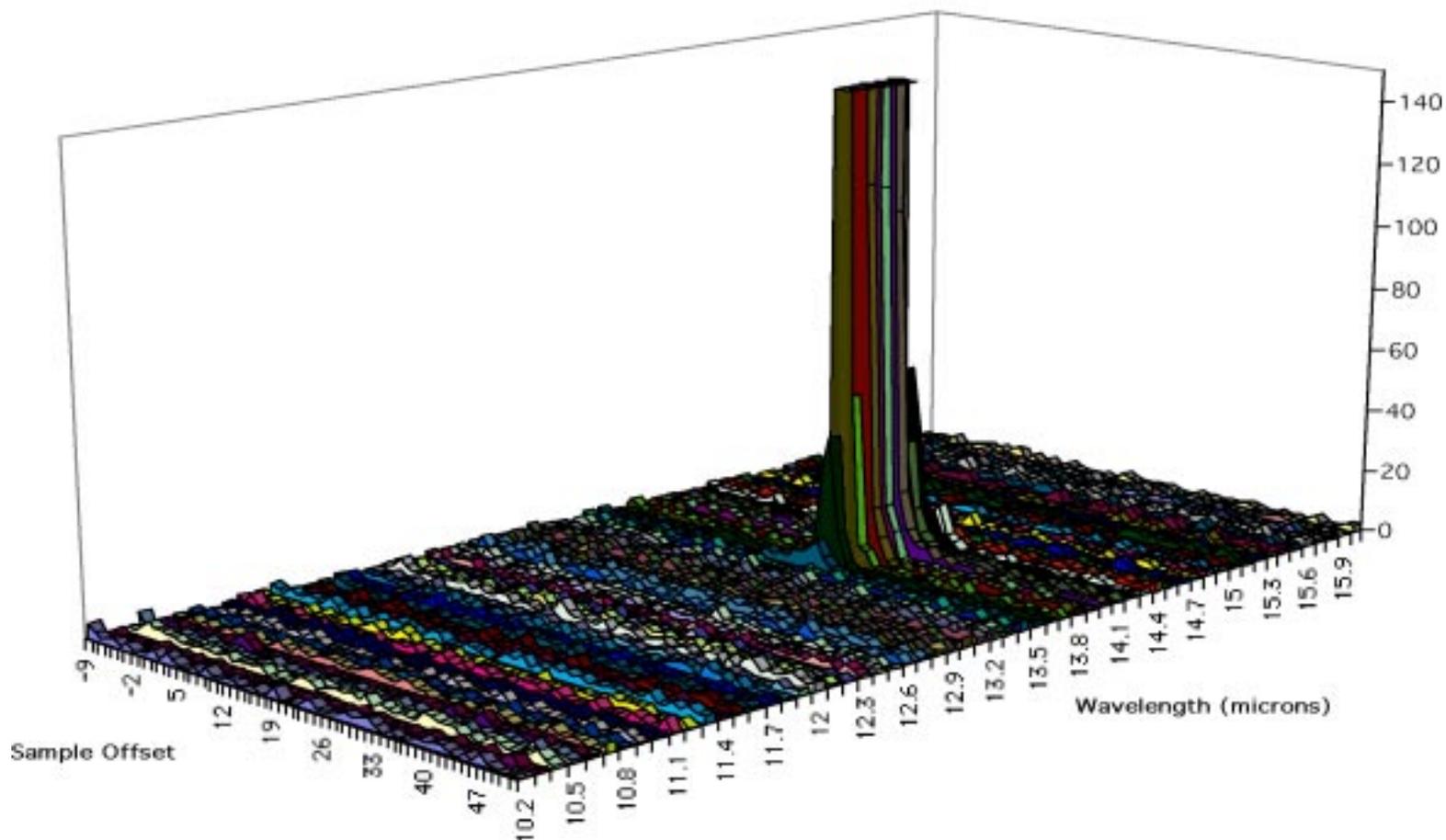
FM1 SRCA Registration Scan Direction (Nominal)

0.2 IFOV Compliance Window

FM1 SRCA Registration Track Direction (Nominal)

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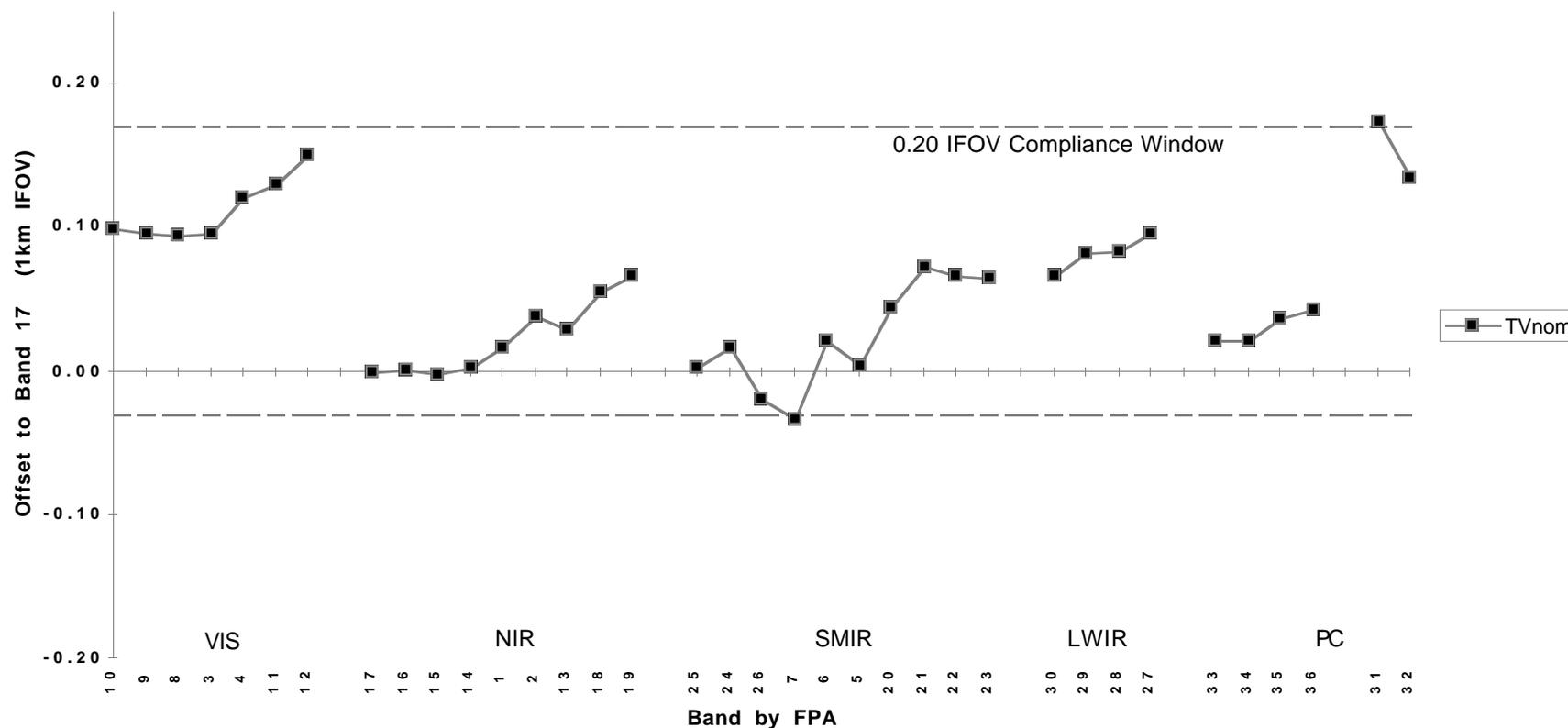
OBC BB EMITTANCE
EVALUATION NOMINAL PLATEAU

- **BCS constant temperature @ ≈285K**

- **MFI09 transition ≈ 285K used for OBC BB data set**

- **Signal levels and emitance are illustrated**
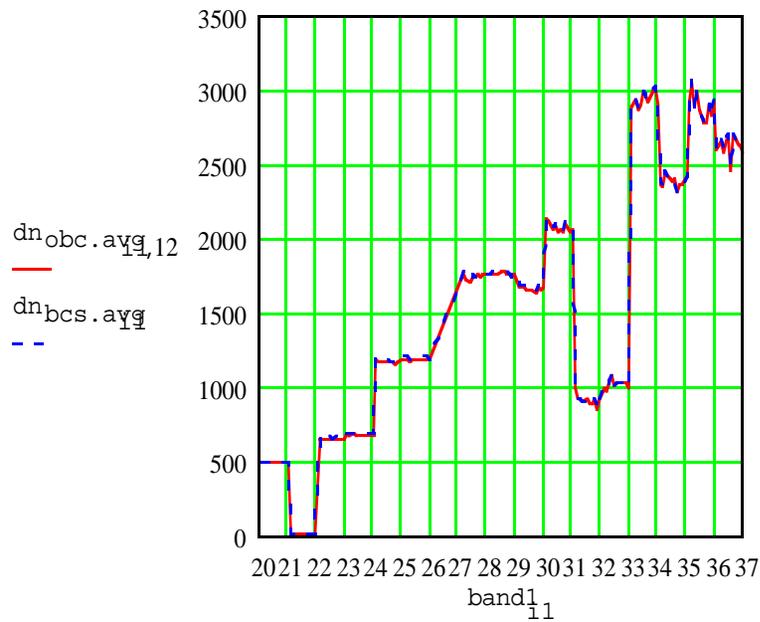
$T2_{bcs} = 285.137$ $\text{mean}\left(\varepsilon_{avg}\right) = 0.9993$

$T2_{obc} = 284.945$ $\text{stdev}\left(\varepsilon_{avg}\right) = 0.001$
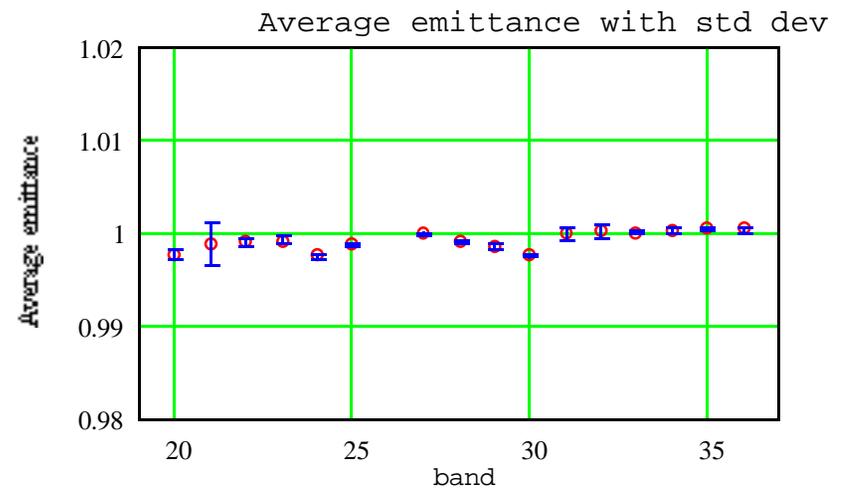
$dn_{obc.avg}_{11,12}$

$dn_{bcs.avg}_{11}$

Average emittance with std dev

- **VIS / NIR / SWIR meets 0.5 % requirement**

  — **VIS / NIR response vs scan angle results good to $\approx$ 0.2 %**

  — **SWIR response vs scan angle results good to $\approx$ 0.4%**

  — **Channel to channel uniformity better than 0.1 %**

  — **Residual to second order polynomial fit is less than 0.15 % except band 26 less than 0.3 %.**

  — **Residual for the third order polynomial are the same.**

- **FOV: No vignetting of NIR indicates field of view spec met**

■ **MWIR / LWIR does not meet internal 0.1 % requirement; however ...**

— **PL3095-N06822 alternatives - witness mirror (NPL) and on orbit measurements**

— **Bands 20 to 28 - 0.12 to 0.18 %; bands 29 & 30 - 0.3 to 0.4 %; bands 31 to 36 - 0.12 % to 0.25 %**

■ **Data reduction/analysis is continuing**

— **Acquired data includes: BCS, SVS, and OBC BB sources**

— **Channel to channel data (unsaturated) is clustered**

— **Data is much better than that acquired on PFM**

— **Reduction of all data sets not completed**

— **Data sets with BCS 320 K side A and B; BCS 310 K side A done**

— **Uncertainty assessment continues**

■ **Ratio of high bay RVS to NPL reflectance, R1**

■ **Average and standard deviation of R1 given in array "stat"**

R1 =

	0	10	26.5	38	50	60.5	65.5
20	1	1.005	1.005	1.005	1.003	1.002
22	1	1.004	1.003	1.002	1.003	1.001
23	1	1.003	1.002	1.001	1.005	1.002
24	1	1.003	1.003	1.004	1.003	1.003
25	1	1.002	1.002	1.003	1.003	1.004
27	1	1	1	1.001	1.005	1.007
28	1	1.005	1.004	1.003	1.004	1.003
29	1	1.007	1.001	0.993	0.987	0.982
30	1	1	0.997	0.995	0.998	0.998
31	1	1.004	1.002	0.998	0.996	0.995
32	1	1.003	1.002	0.998	0.998	0.998
33	1	1.007	1.004	1.002	1.004	1.004
34	1	1.007	1.006	1.004	1.005	1.008
35	1	1.008	1.007	1.003	1.004	1.007
36	1	1.009	1.008	1.004	1.006	1.011

stat =

20	1.0038	0.001
22	1.0027	0.0009
23	1.0026	0.0002
24	1.0033	0.0001
25	1.0027	0.0006
27	1.0026	0.0021
28	1.0035	0.0005
29	0.994	0.006
30	0.9976	0.0002
31	0.9988	0.0021
32	0.9999	0.0009
33	1.0041	0.0002
34	1.0061	0.0009
35	1.0059	0.0007
36	1.0078	0.0018

Ratio of SBRS RVS to NPL reflectance
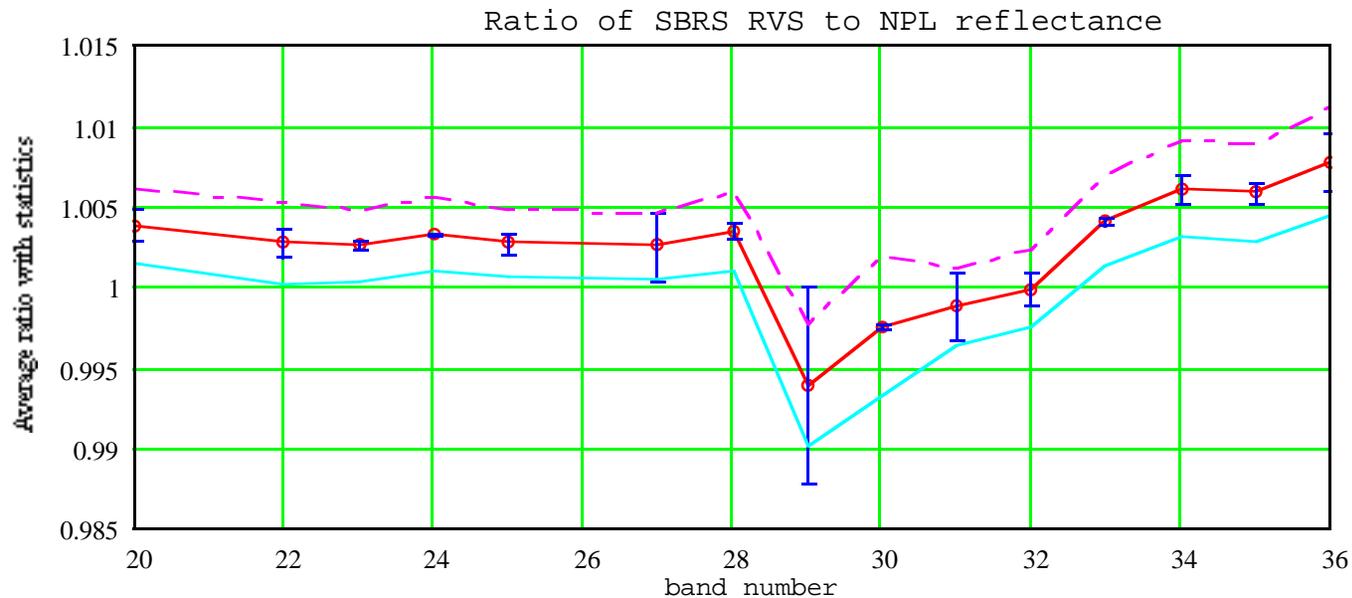
- **Middle curve is average ratio of high bay RVS to NPL reflectance.**

- **Vertical bars represent ±1 σ obtained from high bay to NPL comparison**

- **Envelope curves obtained by combining NPL and high bay estimated uncertainty in quadrature.**

—**Power supply resets**

—**PC detector response drift anomaly**

> Telemetry/science data vs LW/SM HTR, PRI/RDT crosstrap modes to the TCPs, FPA temperature, timing, and FPAs on/off

> Occurs with CPB, LW Heater, NIR FPA on, and sector timing re-synchs enabled

> Ambient diagnostics in process; Drift has been observed in ambient

—**NAD/SDD fail-safe operation**

> NAD counterweights installed improperly

> Blanket ground wire interference discovered on SDD

Summary

- **TV test yielded impressive instrument performance**

  — **Significantly reduced crosstalk observed compared to the PFM**

  — **SNR/NEdT, spectral, spatial predominantly in spec**

  — **Post-TV tests going well wrt door, PS, and PC "drift" anomalies**

- **Extremely well coordinated effort; Thanks to all who participated, including NASA/MCST**

- **Key tasks remaining**

  — **Finish ambient analyses (RVS, Stray Light)**

  — **Prepare for PSR**

    > Specifically spectral reductions, waivers, final paper

VIS/NIR/SWIR Spectral Parameters Summarized

Band	Channel	CW50%Meas	CWCentMeas	CWSPEC	BWMEAS	BWSPEC	ER1MEAS	ER2MEAS	ERSPEC	RippleMEAS	RippleSPEC
8	5	412.0	412.3	412.0	14.4	15.0	12.8	4.1	7.2	80.5%	80.0%
9	5	442.1	442.1	443.0	9.7	10.0	4.9	3.8	4.9	93.4%	80.0%
3	10	465.9	465.8	469.0	18.9	20.0	4.7	6.0	9.5	81.2%	80.0%
10	5	487.3	487.2	488.0	10.7	10.0	4.0	3.1	5.4	80.9%	80.0%
11	5	530.1	530.0	531.0	12.0	10.0	4.4	5.0	6.0	80.0%	80.0%
12	5	547.1	547.0	551.0	10.4	10.0	5.1	4.8	5.2	85.3%	80.0%
4	10	553.8	553.8	555.0	19.8	20.0	5.4	5.3	9.9	84.7%	80.0%
1	20	644.8	645.8	645.0	47.5	50.0	20.8	13.8	23.8	80.7%	80.0%
13	5	665.8	665.8	667.0	10.1	10.0	4.8	5.7	5.1	84.1%	80.0%
14	5	677.4	677.3	678.0	11.4	10.0	5.8	5.4	5.7	87.6%	80.0%
15	5	746.6	746.5	748.0	9.8	10.0	5.5	5.4	4.9	86.8%	80.0%
2	20	857.0	856.5	858.0	38.1	35.0	16.5	13.2	19.1	90.4%	80.0%
16	5	866.8	866.6	869.0	15.5	15.0	7.5	6.9	7.8	86.2%	80.0%
17	5	904.2	904.2	905.0	35.0	30.0	13.0	12.6	17.5	90.8%	80.0%
18	5	936.1	936.1	936.0	13.6	10.0	7.1	6.5	6.8	84.6%	80.0%
19	5	935.4	936.0	940.0	46.7	50.0	20.9	19.1	23.4	80.5%	80.0%
5	10	1241.4	1241.3	1240.0	23.0	20.0	14.5	13.5	11.5	80.1%	80.0%
26	6	1383.2	1381.8	1375.0	36.5	30.0	28.6	18.8	18.3	83.5%	80.0%
6	10	1627.7	1627.6	1640.0	27.7	24.6	15.7	16.2	13.9	85.8%	80.0%
7	10	2113.0	2113.5	2130.0	53.1	50.0	21.9	42.4	26.6	80.9%	80.0%

● Parameters in nm units

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Band	Channel	CW50%Meas	CWCentMeas	CWSPEC	BWMEAS	BWSPEC	ER1MEAS	ER2MEAS	ERSPEC	RippleMEAS	RippleSPEC
20	5	3776.7	3778.4	3750.0	189.6	180.0	51.0	54.5	94.8	78.7%	80.0%
21	5	3980.4	3980.2	3959.0	84.4	59.4	39.4	40.1	42.2	86.8%	80.0%
22	5	3971.0	3970.5	3959.0	85.9	59.4	38.7	30.3	43.0	82.3%	80.0%
23	5	4059.7	4059.6	4050.0	86.3	60.8	35.9	32.0	43.2	85.2%	80.0%
24	5	4447.9	4447.3	4465.0	92.2	65.0	44.2	38.3	46.1	81.1%	80.0%
25	5	4524.5	4524.5	4515.0	91.6	67.0	47.4	37.2	45.8	83.4%	80.0%
27	5	6780.7	6782.1	6715.0	192.5	360.0	181.2	169.6	96.3	80.1%	80.0%
28	5	7339.6	7341.2	7325.0	321.1	300.0	146.4	162.9	160.6	82.7%	80.0%
29	5	8547.8	8545.3	8550.0	376.3	300.0	198.4	140.9	188.2	81.6%	80.0%
30	5	9726.3	9716.2	9730.0	317.9	300.0	178.1	200.7	159.0	80.5%	80.0%
31	5	11026.8	11024.8	11030.0	530.8	500.0	269.4	267.4	265.4	80.8%	80.0%
32	5	12043.5	12039.9	12020.0	522.1	500.0	117.3	139.1	261.1	82.0%	80.0%
33	5	13362.4	13361.2	13335.0	313.9	300.0	110.8	121.6	157.0	86.9%	80.0%
34	5	13679.6	13680.9	13635.0	345.7	300.0	122.6	119.5	172.9	84.5%	80.0%
35	5	13920.5	13920.1	13935.0	335.0	300.0	114.5	117.8	167.5	81.3%	80.0%
36	5	14215.3	14209.6	14235.0	330.4	300.0	128.4	133.8	165.2	81.2%	80.0%

- Parameters in nm units

FM1 VIS Spectral Response
Bands 8, 9, 3, 10, 11, 12, 4

wavelength (nm)
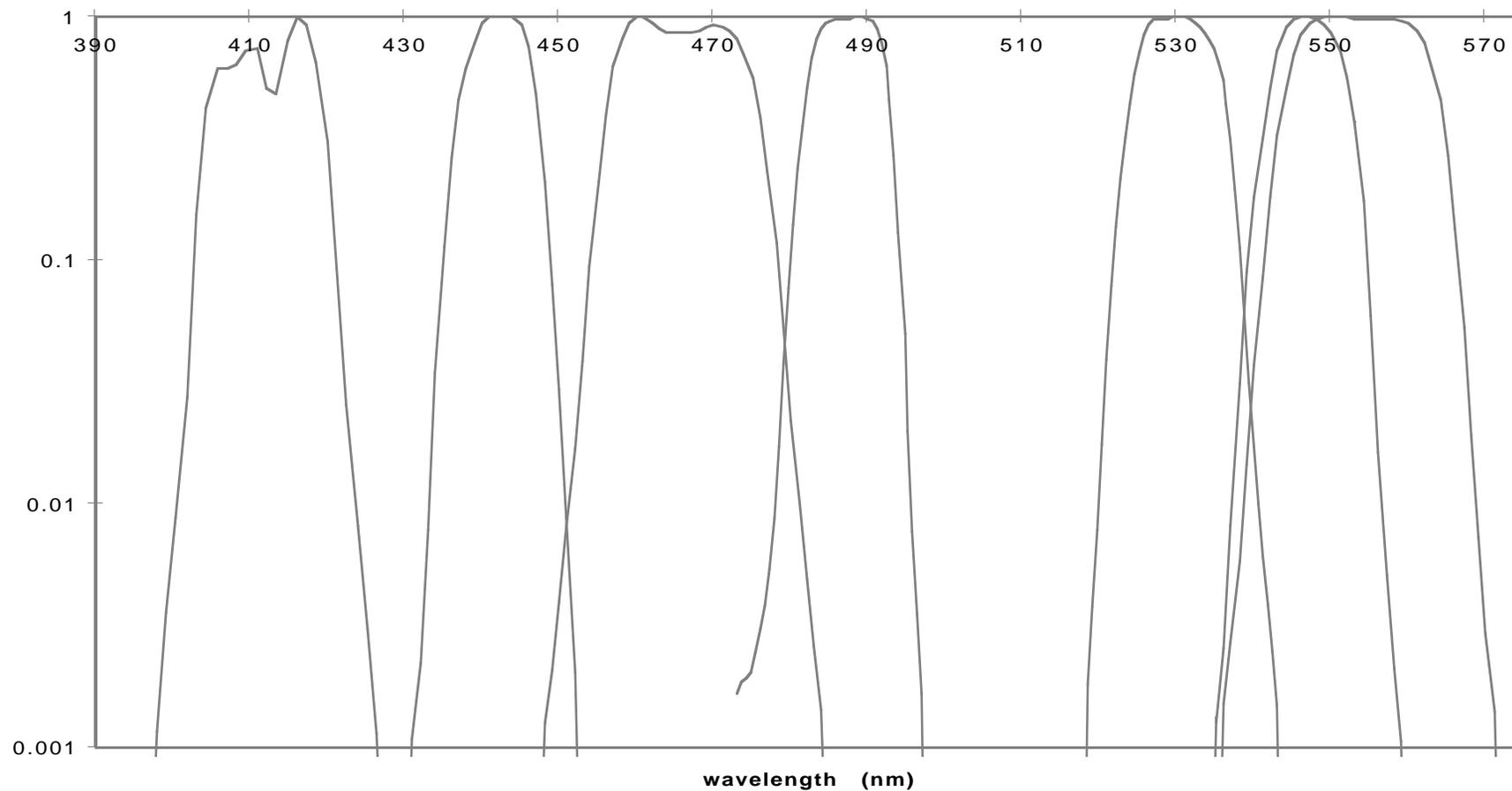
FM1 NIR Spectral Response
Bands 1, 13, 14, 15, 2, 16, 17, 18, 19
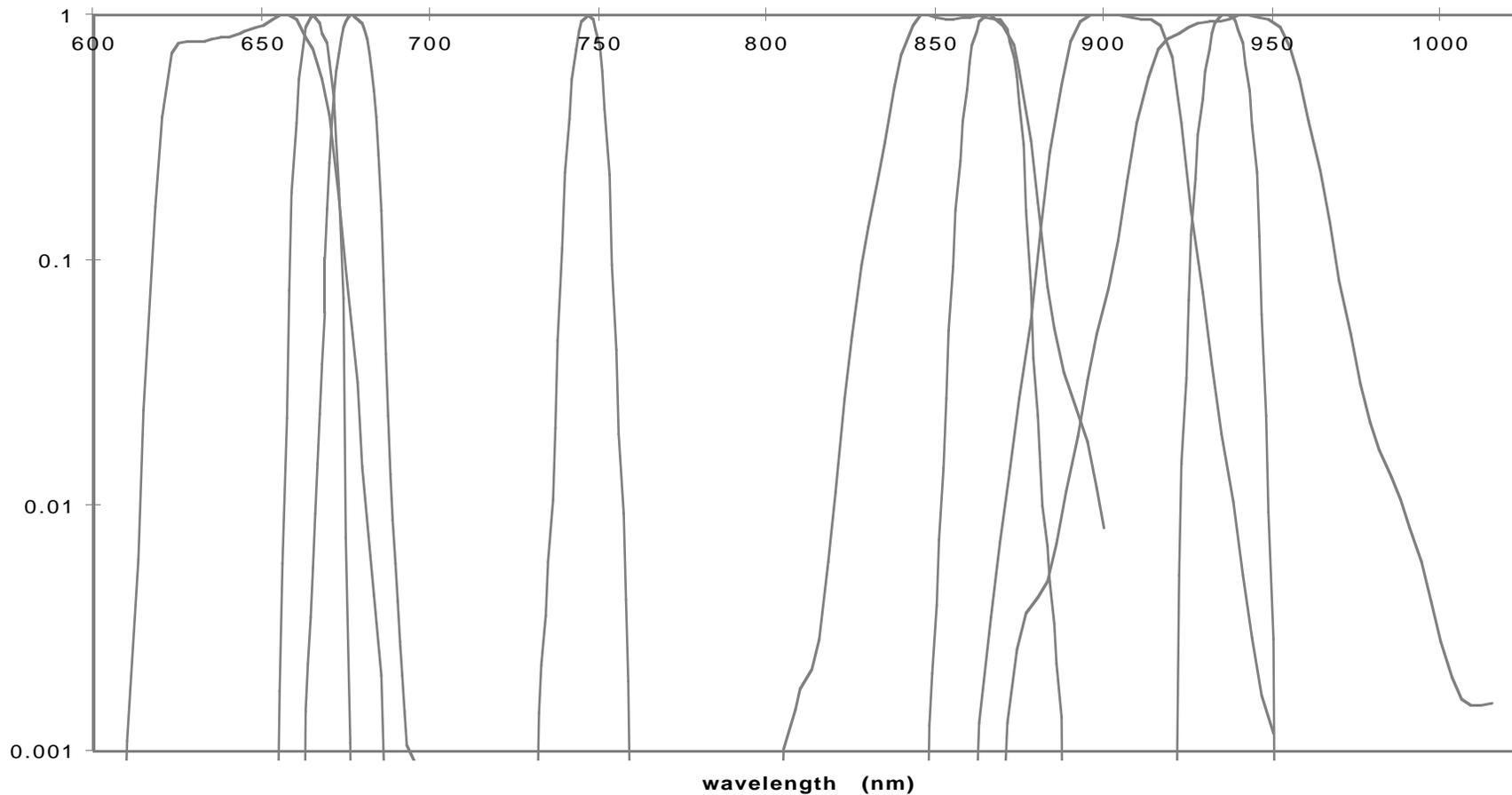
FM1 MWIR Spectral Response
Bands 20, 22, 21, 23, 24, 25
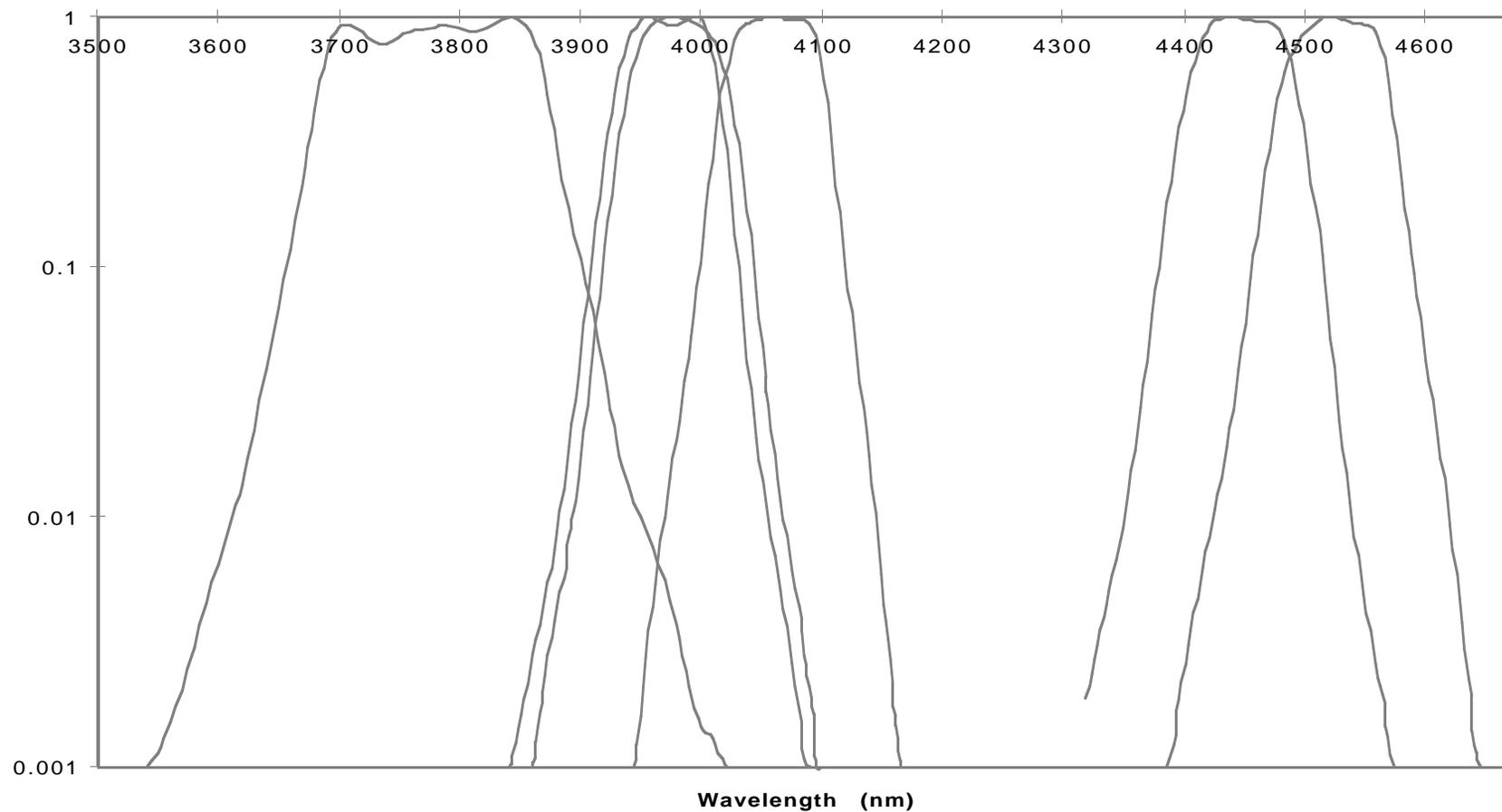
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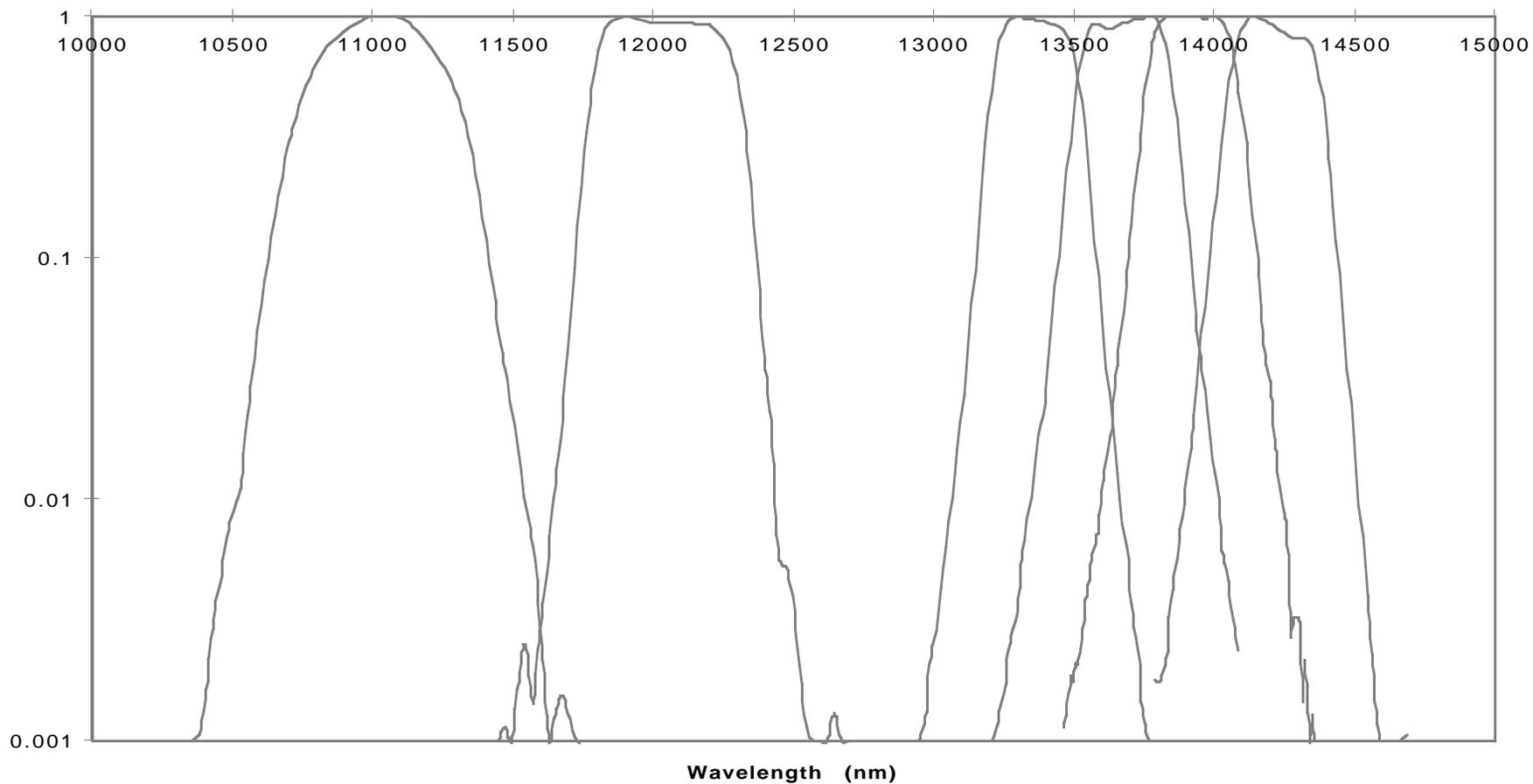FM1 PVLW Spectral Response
Bands 27, 28, 29, 30

MODIS Quarterly Management Review
10 December 1998   Slide 31
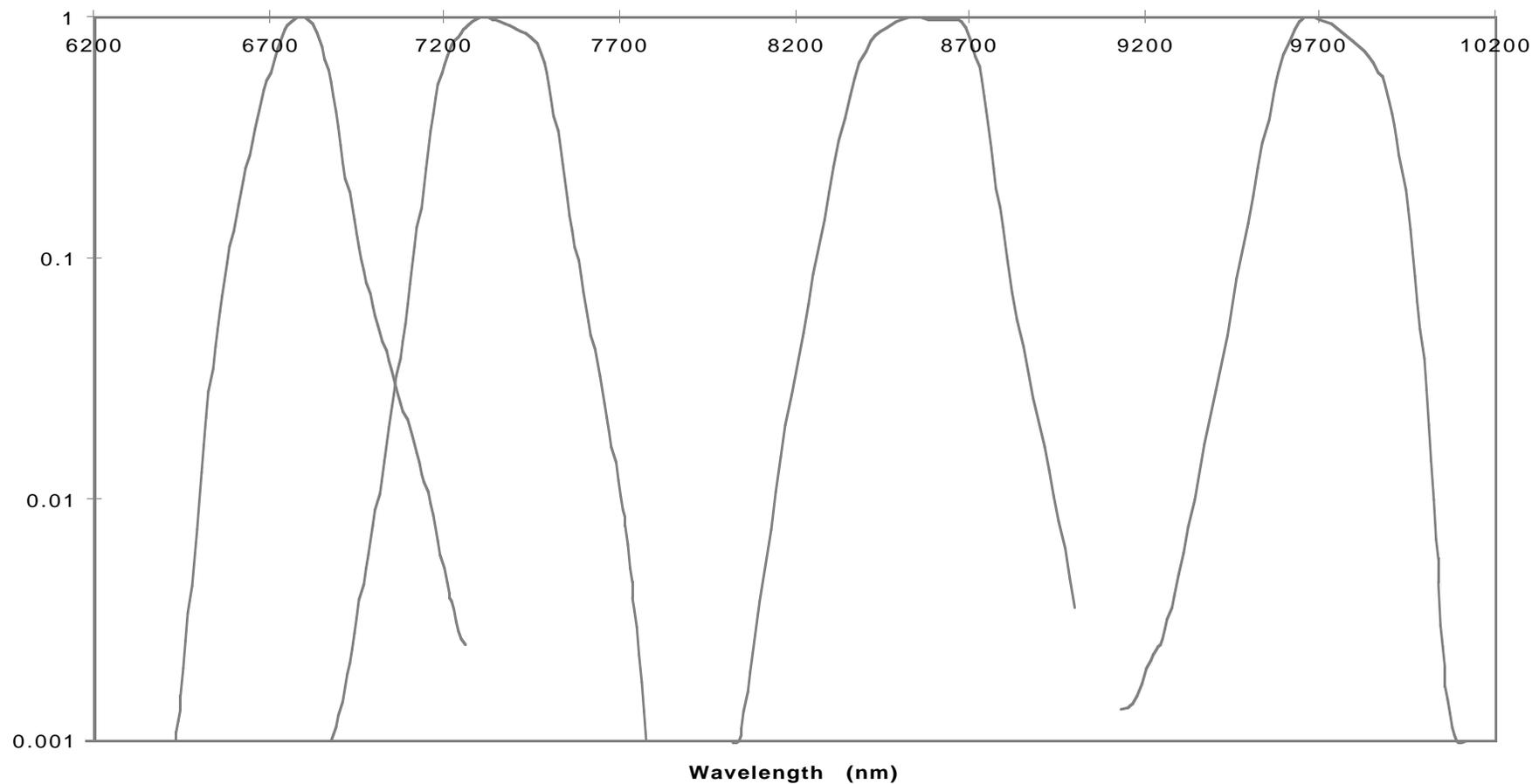
FM1 PCLWIR Spectral Response
Bands 31, 32, 33, 34, 35, 36

Wavelength (nm)

Tabulated RVS (MWIR / LWIR)

- **Tabulated normalized RVS based upon BCS 320 K, side A**

- **Scan angle and AOI given in degrees - row 1 & 2**

320	-54.5	-54	-53	-45	-23	0	10	26	38	45	50	53	54	54.5
band	10.75	11	11.5	15.5	26.5	38	43	51	57	60.5	63	64.5	65	65.25
20	1	0.997	1.000	0.997	1.001	1.002	0.997	0.998	1.000	0.996	0.995	0.997	0.999	0.995
22	1	1.001	0.999	0.999	1.000	1.001	0.997	1.000	0.999	0.999	0.996	0.994	1.000	0.993
23	1	0.997	0.998	0.998	0.998	1.000	0.995	0.998	0.998	0.995	0.998	0.998	0.998	0.997
24	1	0.997	1.000	0.996	1.000	1.001	0.997	0.997	1.001	0.998	0.997	0.999	1.000	0.997
25	1	0.997	0.998	0.997	0.997	1.000	0.995	0.997	0.999	0.997	0.999	0.999	0.998	0.997
27	1	1.002	1.002	1.000	0.998	0.997	0.995	0.999	0.998	0.998	0.997	1.000	0.996	0.999
28	1	0.997	0.996	0.996	0.996	0.999	0.993	0.994	0.994	0.988	0.991	0.990	0.991	0.987
29	1	0.995	0.991	0.988	0.986	0.979	0.973	0.964	0.942	0.934	0.926	0.925	0.922	0.922
30	1	0.989	0.983	0.985	0.981	0.977	0.968	0.968	0.952	0.955	0.948	0.946	0.947	0.944
31	1	1.001	0.999	0.999	0.998	0.994	0.988	0.984	0.978	0.974	0.970	0.966	0.971	0.965
32	1	1.001	1.000	0.999	0.997	0.993	0.986	0.979	0.971	0.966	0.962	0.958	0.962	0.955
33	1	1.000	1.000	0.998	0.993	0.985	0.976	0.961	0.948	0.938	0.933	0.926	0.928	0.919
34	1	1.000	1.001	0.999	0.993	0.985	0.975	0.959	0.944	0.935	0.930	0.924	0.926	0.915
35	1	1.000	1.001	0.999	0.992	0.985	0.974	0.956	0.941	0.931	0.927	0.920	0.922	0.911
36	1	1.001	1.002	0.999	0.992	0.984	0.974	0.954	0.939	0.929	0.926	0.918	0.919	0.908