Prototype HysplRI-TIR (PHyTIR) Test Results

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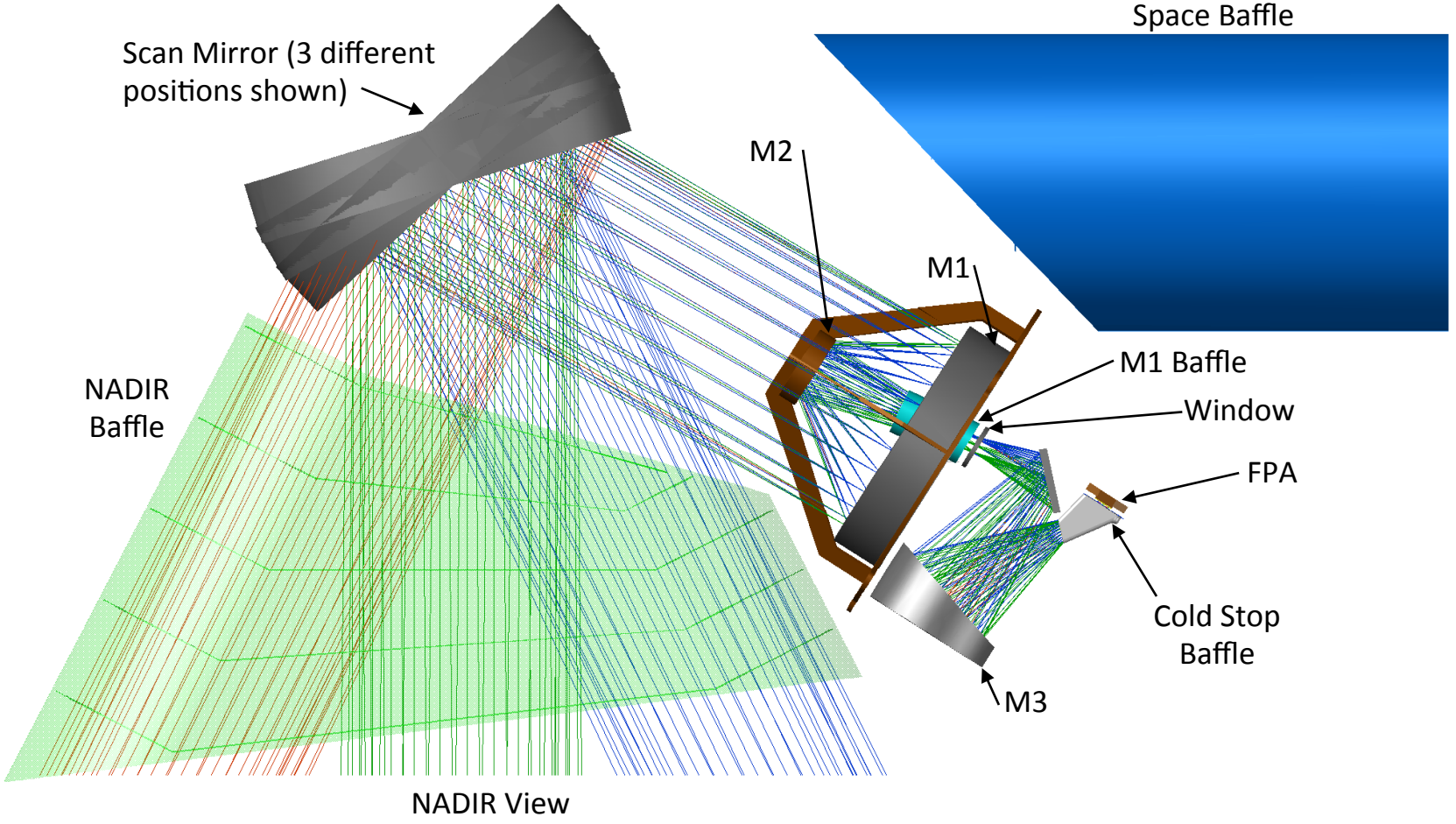
Optical Prescription

- Optical Prescription: Three-Mirror Anastigmat Telescope with Scan Mirror



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Optical Prescription

PHyTIR Optical Design Parameters	
Effective Focal Length*	415.3mm
Speed	F/2
Aperture Size	207.7mm
Pixel pitch	40µm
IFOV	96.308µrad (single pixel)
FOV	1.4126° (along track scanning)
Dwell time	32µs
Spectral coverage	3.5µm to 12.5µm
Optical $MTF_{Nyquist}$	50% polychromatic, all fields (no spider)
Scan mirror rotation rate	14.15rpm (double sided scan mirror)
Altitude*	623km
FOV*	51° (cross track scanning)
Cross track pixels*	9287
Swath*	596km
Swath overlap*	10% along track pixels

* HyspIRI-TIR specific

- PHyTIR optics consists of 6 reflecting surfaces, 4 transmitting surfaces. (5 mirrors, 2 windows)

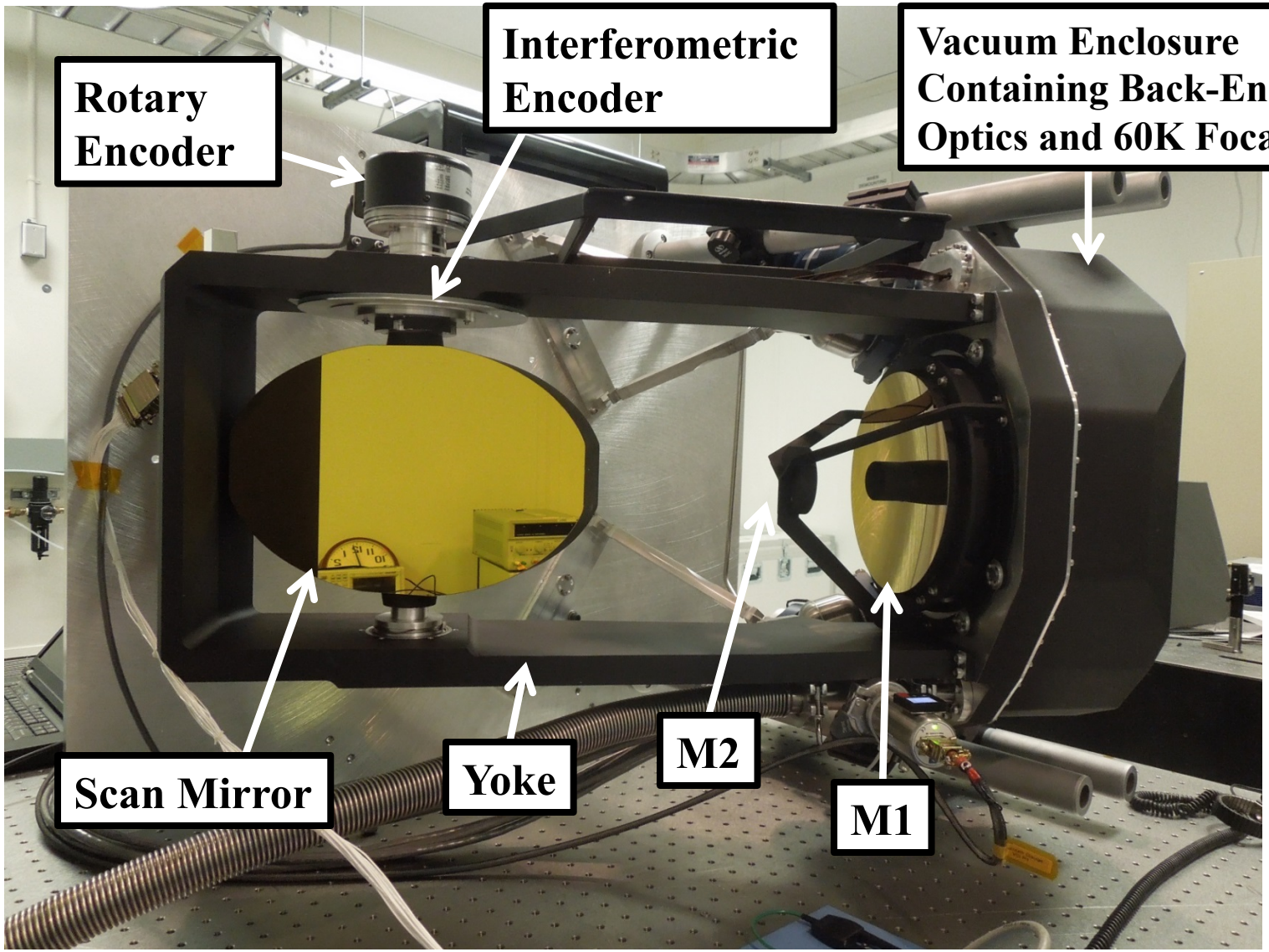
- Optics and baffles will operate in an ambient environment (approximately 295K).

- Focal plane assembly (including cold stop) will operate at 60K.

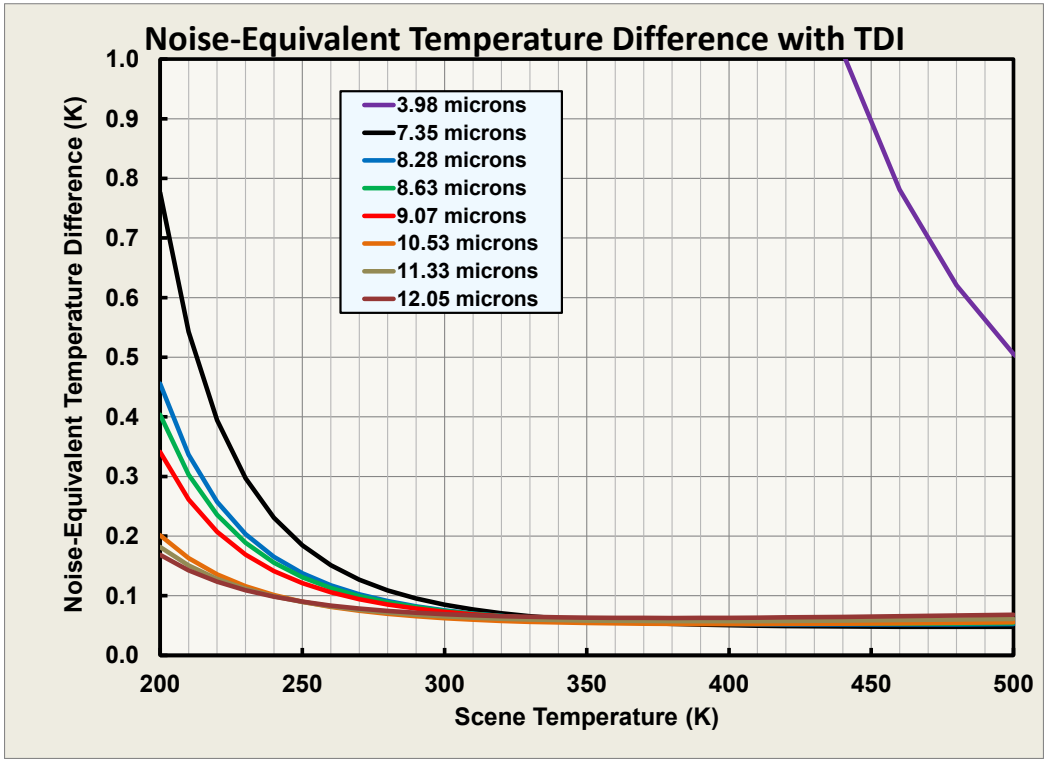
- All reflective optics are aluminum with optical surfaces overcoated with protected gold (> 98% reflectance). Transmissive window will use BBAR coated ZnSe (τ > 95%). Non-optical, baffles and contact surfaces will be coated with appropriate thermal coatings.

- Cold stop to be polished aluminum facing focal plane and black facing optics.

PHyTIR Prototype



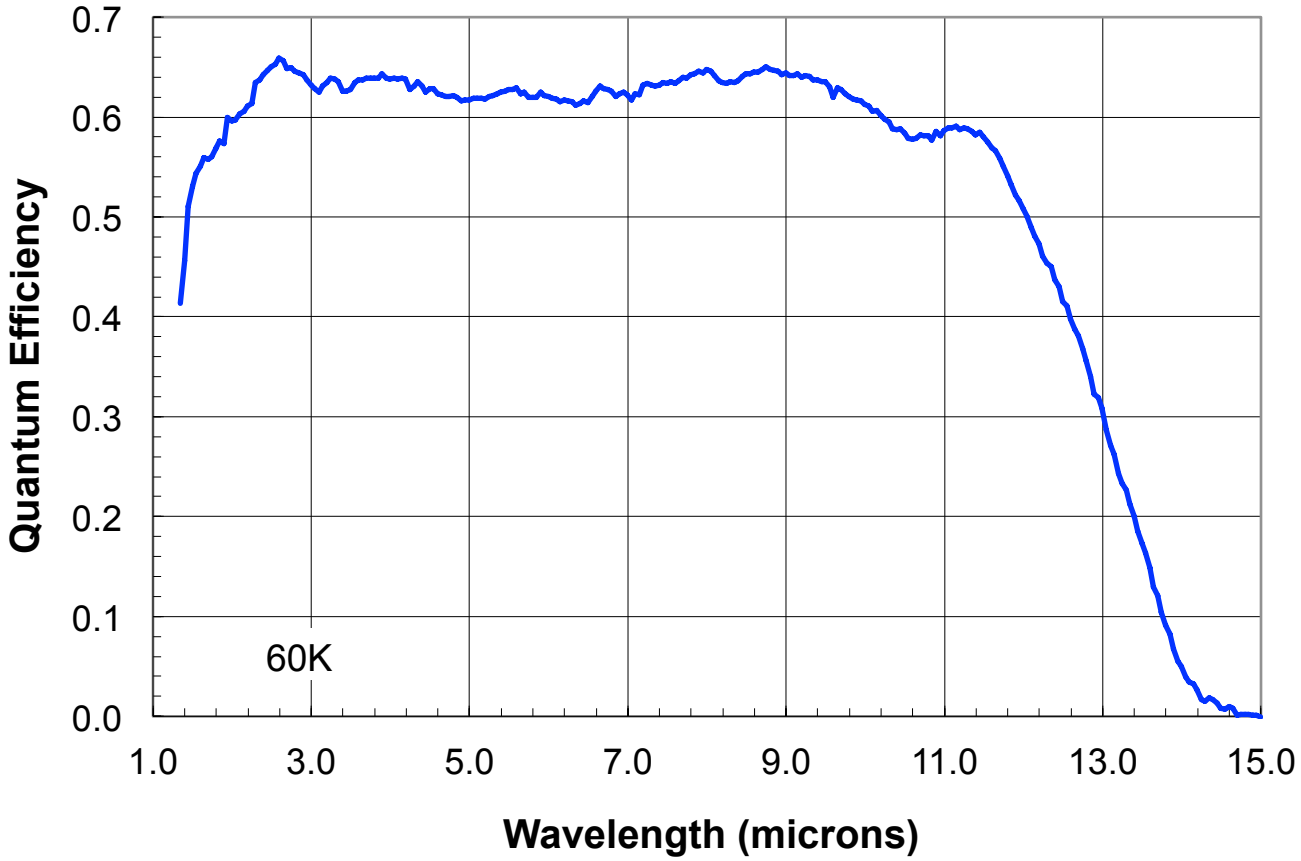
Baseline Calculated Performance



HyspIRI-TIR Focal Plane Model Assumption Summary							
	Wavelength (μm)	Bandwidth (μm)	Well Size (Me-)	QE	Read noise (e-)	Dark Current (e-)	Optics Transmission (%)
Band 1	3.98	0.015	6.79	0.7	876	235	0.5
Band 2	7.35	0.32	6.29	0.7	876	235	0.63
Band 3	8.28	0.34	6.55	0.7	876	235	0.63
Band 4	8.63	0.35	6.63	0.7	876	235	0.63
Band 5	9.07	0.36	6.65	0.7	876	235	0.63
Band 6	10.53	0.54	8.8	0.7	876	235	0.63
Band 7	11.33	0.54	8.3	0.7	876	235	0.63
Band 8	12.05	0.52	7.5	0.7	876	235	0.63

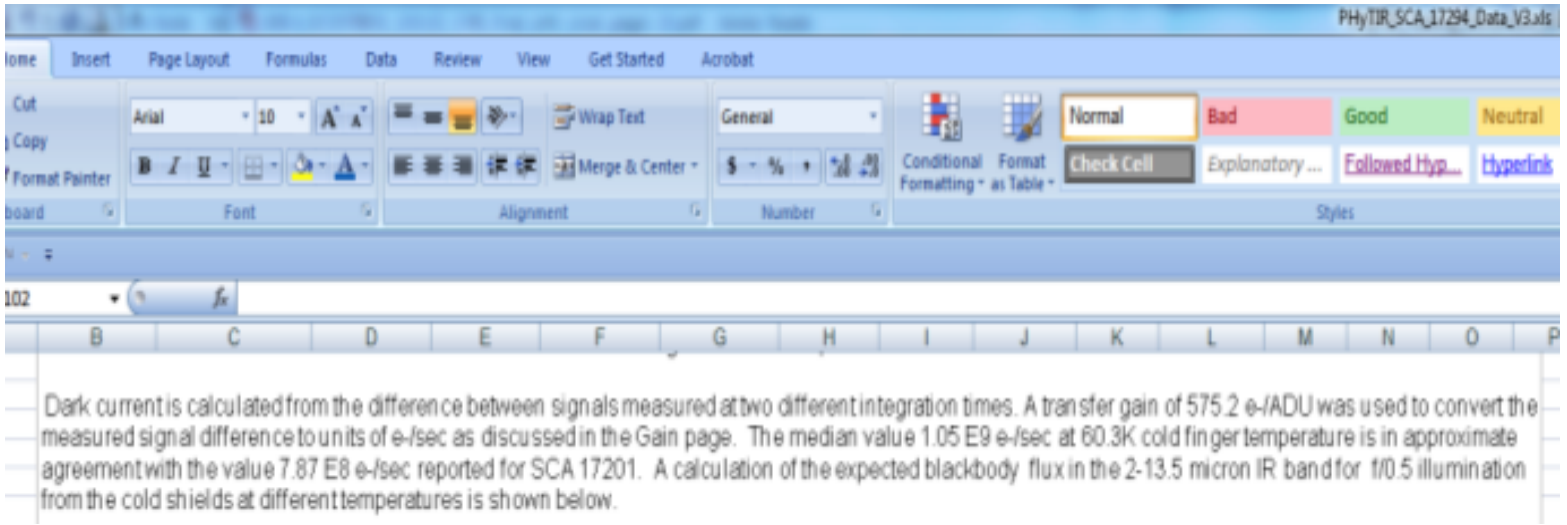
PHyTIR test results

Measured Quantum Efficiency



This plot shows QE measured on a Process Evaluation Chip (PEC) detector fabricated on the same MBE layer as the SCA detector array.

Measured Focal Plane Dark Current



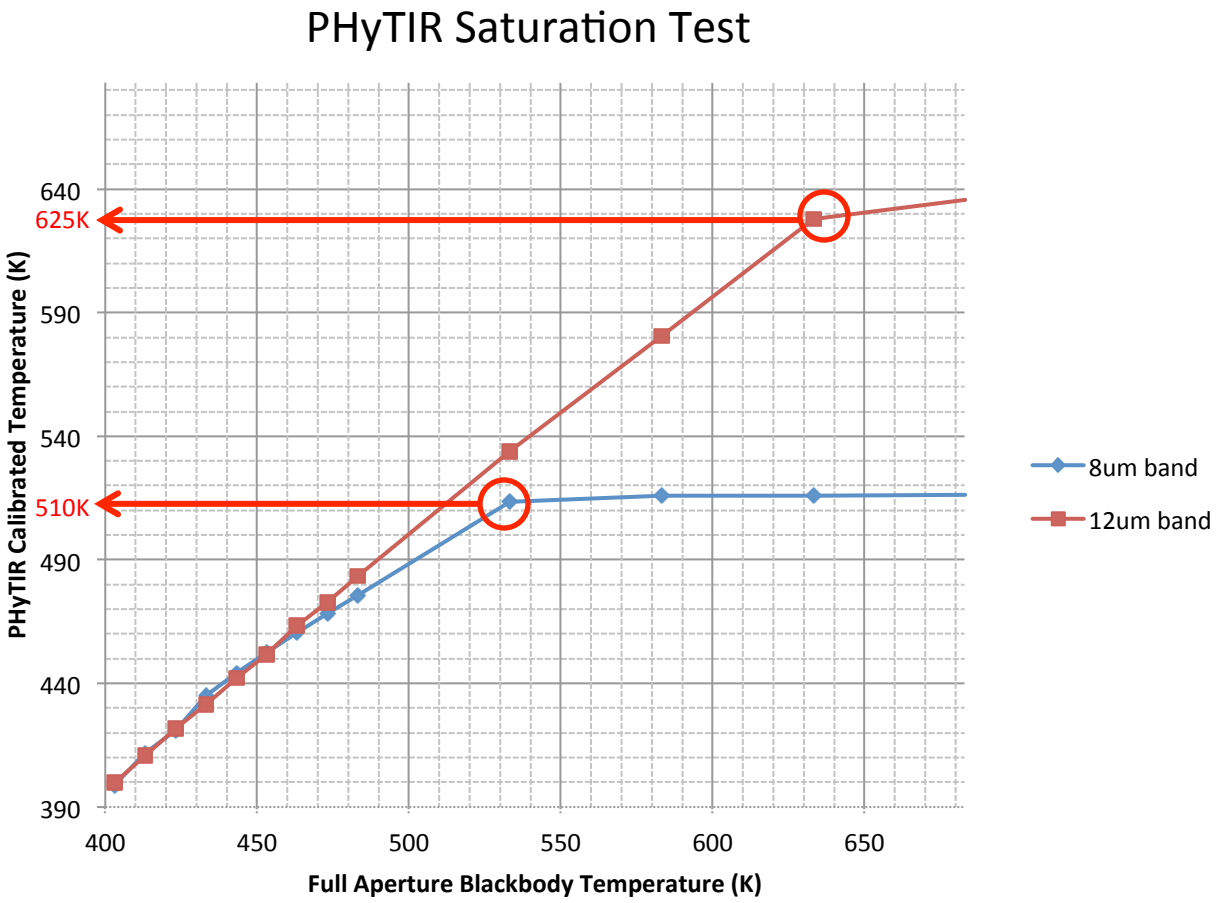
The dark current was measured to be ~183e- which exceeds the performance of the current baseline estimate of 235e-

Measured Focal Plane Well Size

HyspIRI-TIR focal plane array well depth measrement									
Parameter	**Band 1**	**Band 2**	**Band 3**	**Band 4**	**Band 5**	**Band 6**	**Band 7**	**Band 8**	**units**
System Transfer Gain	574.2	550.5	550.5	573.5	574.0	733.3	705.5	656.6	e/adu
Rail to Rail Signal Swing	10825	10825	10825	10825	10825	10825	10825	10825	ADU
Rail to Rail Well Depth	6.22E+06	5.96E+06	5.96E+06	6.21E+06	6.21E+06	7.94E+06	7.64E+06	7.11E+06	e

The well depth was measured by taking the signal difference between a saturated and a starved frame multiplied by the gain is the well depth in electrons. The values are within the range expected for the HyspIRI-TIR array. Both Band 6 and 7 have the significant increase expected.

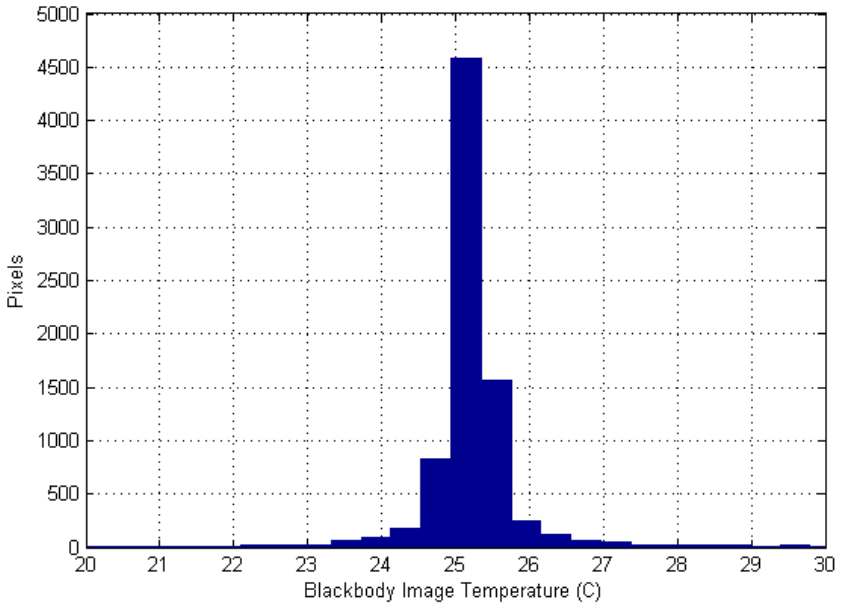
System measurement: Saturation temperature



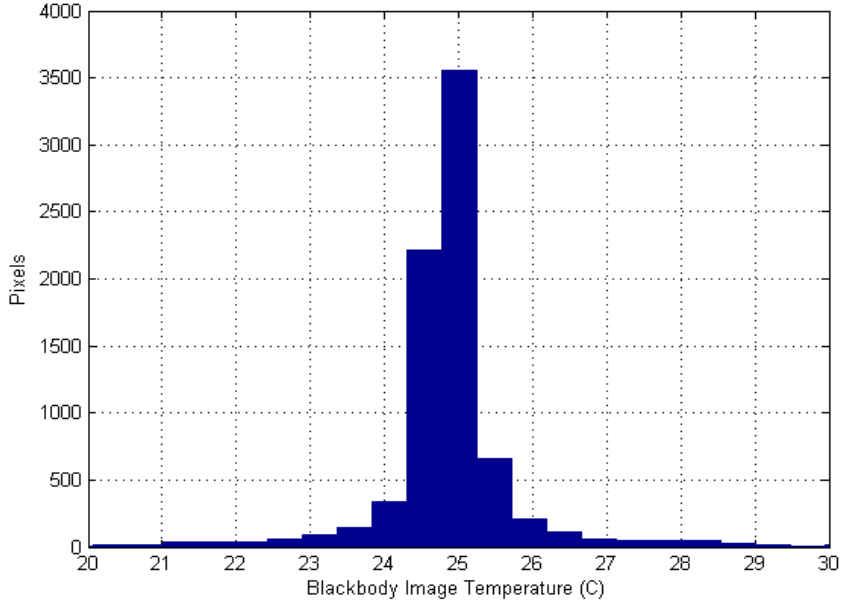
Demonstrates that long-wavelength bands (8 and 12 µm in PHyTIR) do not saturate below 480 K, as required.

System measurement : Noise equivalent delta temperature (NEΔT)

8 µm
(32 cols x 256 rows)



12 µm
(32cols x 256 rows)



Pixel temperatures retrieved in each band with 25 C blackbody, 10 minutes after calibration at required readout speed. PHyTIR would normally be calibrated every 2 seconds. Demonstrates yield (99.8 % response) within columns needed to define a spectral band and that PHyTIR meets S:N specification.

System measurement : Noise equivalent delta temperature (NEΔT)

test temp range: 8C to 48C , temporal SNR determined using single pixel over 256 integrations.									
FPA 60k, SHELL < 200K									Comments
	12 μm band				**8μm band**				
Gain	**ADU**	NEΔT			**ADU**	NEΔT		$\Delta\tau_{noise}$	
125	32.2484	2108.632	mk		57.5	1182.609	mk	1.7	12.37 bits total over full dynamic range
250	151.719	500.9261	mk		274.6875	276.678	mk	1.9	
375	279.0458	301.0259	mk		501.7813	**167.4036**	mk	2.1	
500	402.8105	223.4301	mk		724.1875	124.2772	mk	2.25	
625	532.6	**180.2478**	mk		958	100.2088	mk	2.4	
750	663.5425	156.7345	mk		1.20E+03	86.71725	mk	2.6	
875	791.7059	136.4143	mk		1.38E+03	78.27221	mk	2.7	
1000	915.2353	120.1877	mk		1.50E+03	73.11399	mk	2.75	

Detail for previous slide. Demonstrates that gains are available that meet required signal to noise at single pixel level. Required is < 200 mK.