

living planet symposium

BONN
23–27 May
2022

TAKING THE PULSE
OF OUR PLANET FROM SPACE



Meteosat Third Generation (MTG) The Flexible Combined Imager (FCI) end to end Performance

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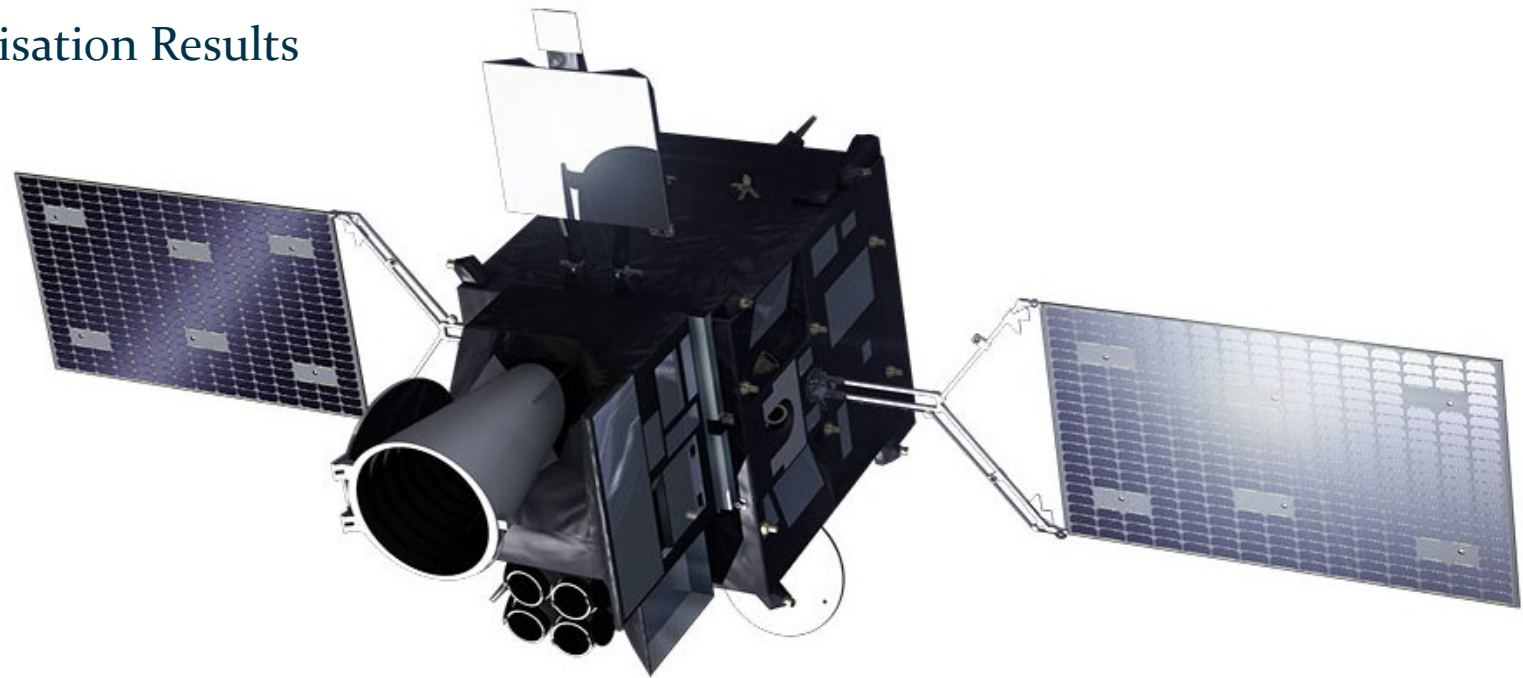
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25 May 2022

- Driving requirements
- Imaging principles
- Development Status & Performance
 - Environmental Test Results (Mechanical, thermal vacuum, auto-compatibility)
 - Performance Characterisation Results
- Conclusions



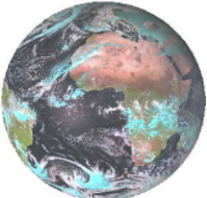
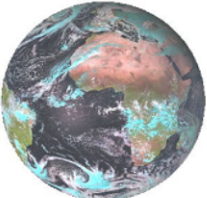
MTG FCI Driving Requirements



Parameters		Full Disc Hyper-Spectral Imagery		High Resolution Fast Imagery	
Spectral		16 channels		4 channels	
Repeat cycle		10 min		2.5 min	
SSD VNIR	SSD IR	1 km	2 km	500 m	1 km
MTF @ Nyquist		0.15 < MTF < 0.3		~ 0.3	
SNR @ $\rho=0.01$ VNIR	NEdT @ Tref IR	> 20 > 12 for VIS0.9	0.1-0.3 K 1 K for Fire	> 12	0.2 K @ IR3.8 & IR10.5
Radiometric accuracy		< 5 %	< 0.7 K	VIS0.6 & NIR2.2 < 10%	IR3.8 & IR10.5 < 1K
Lifetime & Availability		8.5 years & > 96%		8.5 years & > 96%	

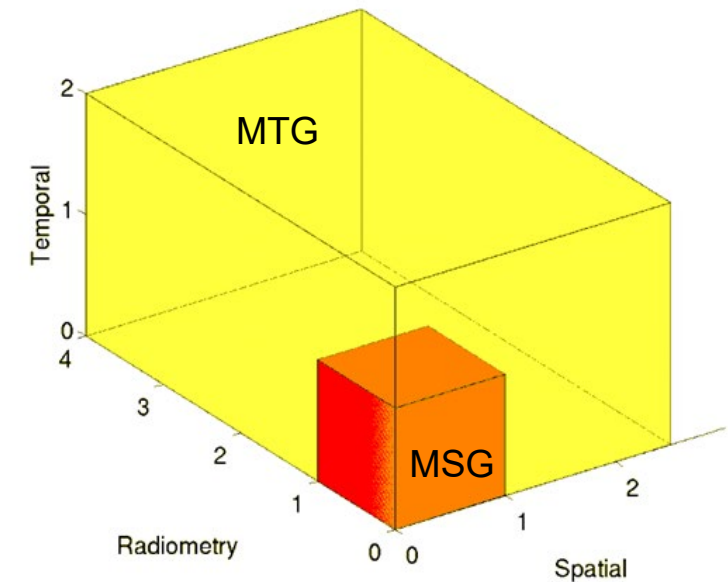


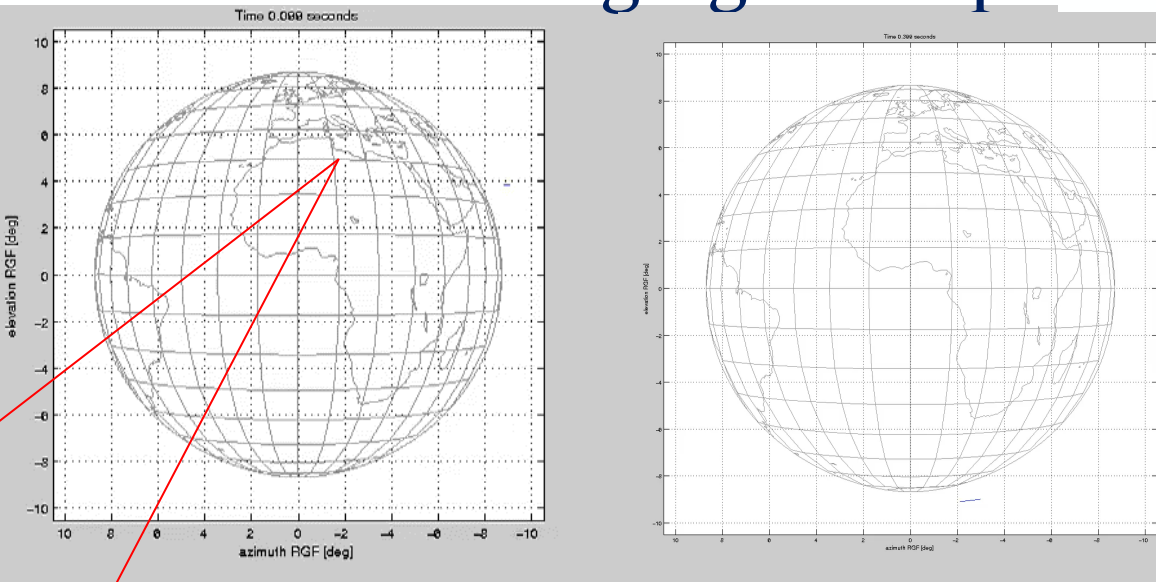
Improvements from MSG to MTG

Characteristics	MSG performance	MTG performance
Full-disk Image cycle	 15 mn	 10 mn
Spectral Channels	HRV VIS 0.6 VIS 0.8 NIR 1.6 IR 3.8 IR 6.2 (WV) IR 7.3 (WV) IR 8.7 IR 9.7 (O ₃) IR 10.8 IR 12.0 IR 13.4 (CO ₂)	VIS 0.4 VIS 0.5 VIS 0.6 VIS 0.8 VIS 0.9 NIR 1.3 NIR 1.6 NIR 2.2 IR 3.8 IR 6.3 (WV) IR 7.3 (WV) IR 8.7 IR 9.7 (O ₃) IR 10.5 IR 12.3 IR 13.3 (CO ₂)
Sampling Distance	1 km (HRV) 3 km (others)	0.5 – 1.0 km (VIS-NIR) 1.0 – 2.0 km (IR)
Telescope Diameter	500 mm	300 mm
Scan Principle	N/S scan mirror E/W spinned satellite	N/S and E/W single scan mirror 3-axis stabilized satellite

Performance Enhancements; SEVIRI to FCI

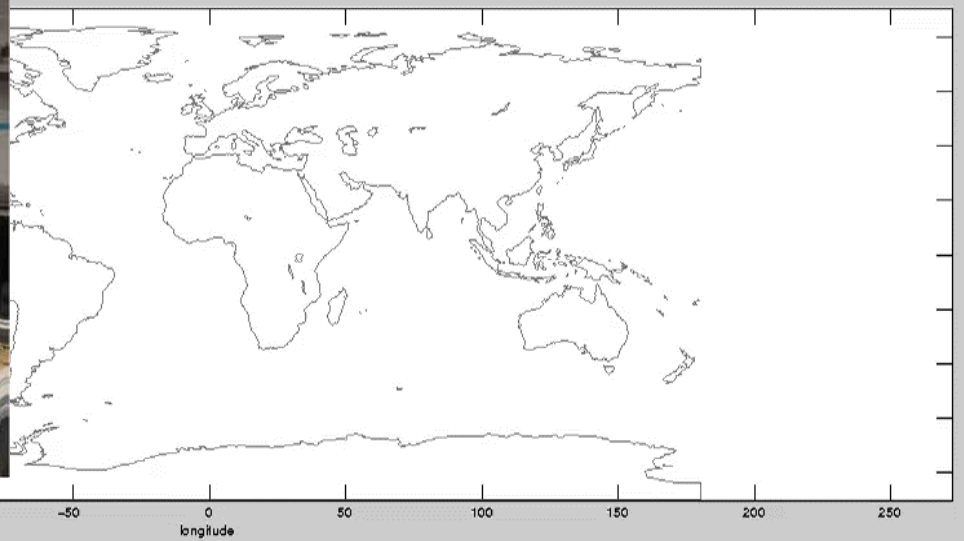
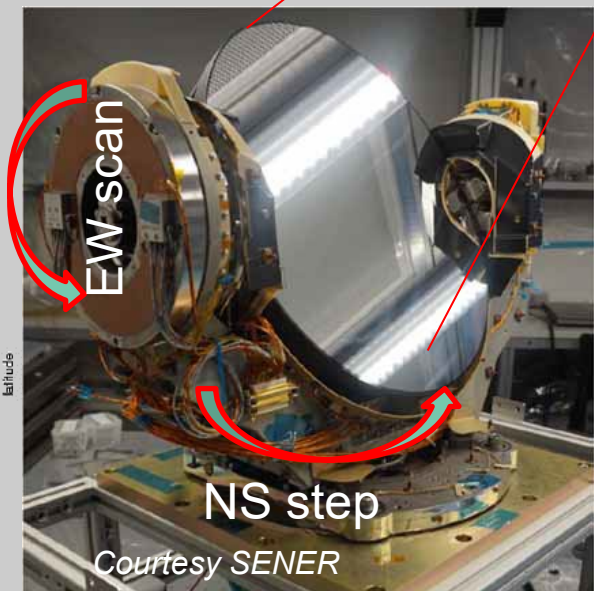
- 16 vs 12 channels
- Temporal:
 - Full disk; 10mins vs 15 mins
 - Rapid Scan; 2.5 mins vs 5mins
- Spatial:
 - VIS/NIR; 0.5-1.0 km vs 1.0 km
 - IR; 1.0-2.0 km vs 3.0 km
- Radiometry: ~4 (average for common channels)
- Spectral resolution: ~ 1.5
- Polarization Factor: ~2
- Availability 96% to 94%
- VIS On-board Calibration





Europe

Full Earth



- 3-axis stabilised satellite
- Two-axis pointing scan mechanism single-mirror with AOCS compensation for < 10 Hz
- Push-broom mode
- 1 swath = 224 km N/S
- Full Earth = 70 swaths in 10'
- Europe = 20 swath in 2.5'
- Constant speed E/W (2°/s)

FCI PFM measured budgets

- Mass ~ FCI main body 384 kg
- FCI + Electronics 444 kg
- Power ~ 585 W
- Data flow ~ 70 Mb/s
- Dimensions: 2 m x 1.6 m x 1.4 m



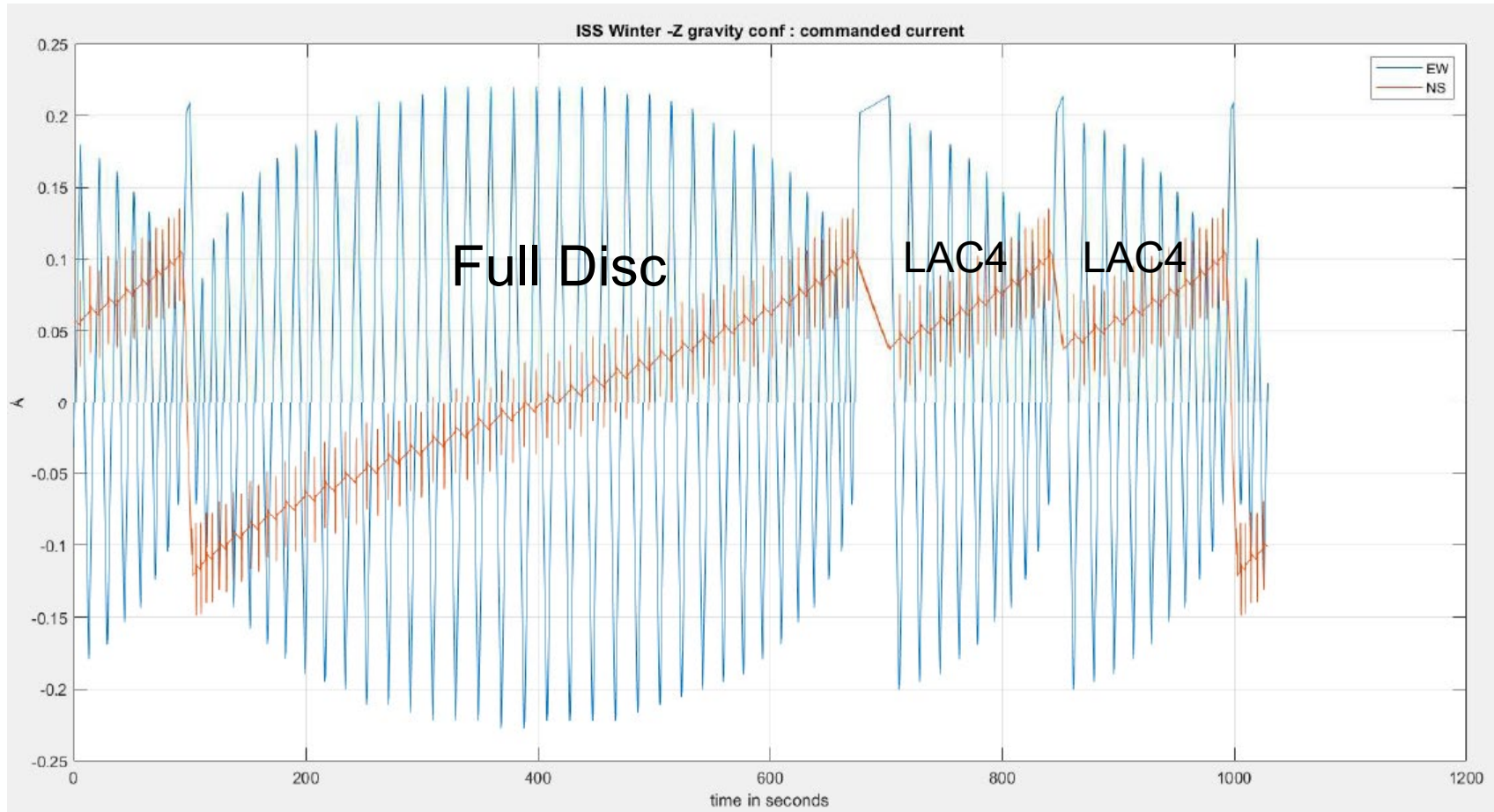
FCI Environmental Testing and Results

- Mechanical: FCI submitted to 3-axis sinus test successfully with the acoustic tested successfully at satellite level;
- Before and After => Electrical / Mechanisms / Radiometric / Optical Reference tests
- Optical LOS Test (LOS knowledge, LOS end to end dynamic pointing test)
- Thermal: TED & Scan (high precision encoder) -> pointing knowledge errors < 1 km
 - ✓ Combination of STM TB/TC,
 - ✓ OTM at Telescope Optics Assembly level and
 - ✓ FCI PFM Optical Vacuum
 - ✓ TB/TC at satellite level for qualification completeness
 - ✓ Auto-Compatibility (EMC)
- All tests are successfully completed showing:
 - ✓ **Great diurnal stability with < 1K measured**
 - ✓ **LOS stability measured < 6 micro-rad**



Imaging performance Tests (Coverage)

- Scanning profiles tested (ISS Winter Commanded Current)
- ISS Summer commanding also successfully tested (yaw flip)



FCI PFM measured budgets - Radiometry

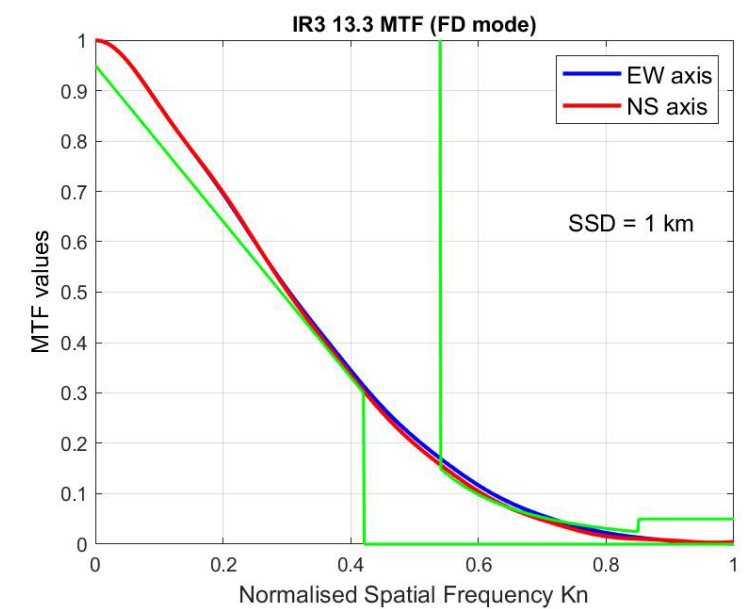
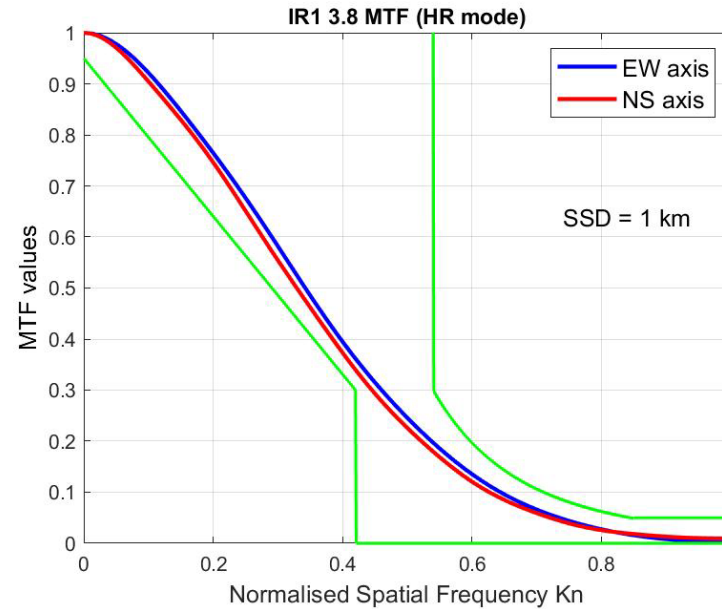
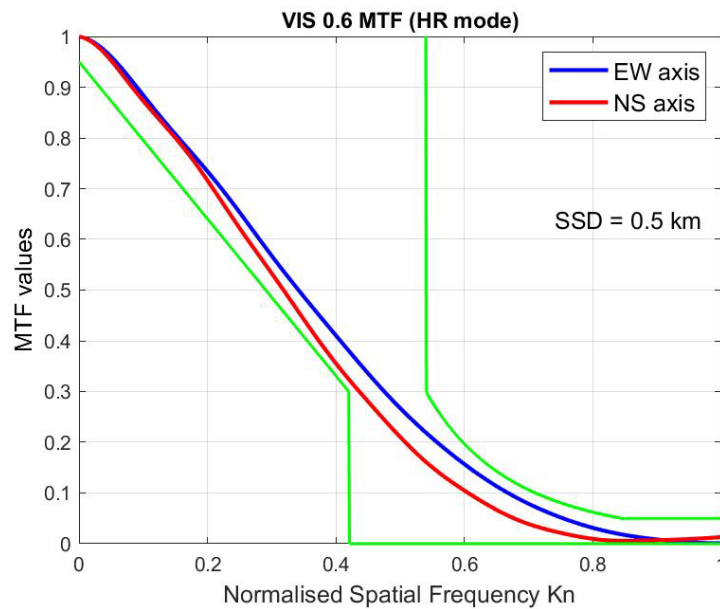
- Radiometric Test Results at FCI PFM during Optical Vacuum:
 - Successful VIS/NIR Radiometric Calibration using the on-board Metallic Neutral Density Filter (MND)
 - Successful IR Radiometric Calibration using the on-board black body
 - Successful Radiance Response (including NL and Noise)
- All channels are compliant to the Radiometric Requirements

FCI PFM Perfo test results	Radiometric Noise (SNR for solar channels)		
	PL-FCI-320	Measured SNR at the referenced radiance	Status of compliance
	Spec		
VIS0.4	25	45	C
VIS0.5	25	43	C
VIS0.6 (HR)	12	29	C
VIS0.6	30	37	C
VIS0.8	21	38	C
VIS0.9	12	40	C
NIR1.3	40	49	C
NIR1.6	30	51	C
NIR2.2 (HR)	12	8	C
NIR2.2	25	23	C

FCI PFM Perfo test results	Radiometric Noise for IR channels (NEdT)			
	PL-FCI-320		Measured NEdT at Tref (K)	Status of compliance
	Tref (K)	Spec (K)		
IR3.8 (HR)	300	0,2	0,12	C
IR3.8	300	0,1	0,04	C
IR3.8 (FA)	350	1,0		
IR6.3	250	0,3	0,05	C
IR7.3	250	0,3	0,06	C
IR8.7	300	0,1	0,02	C
IR9.7	250	0,3	0,04	C
IR10.5 (HR)	300	0,2	0,07	C
IR10.5	300	0,1	0,03	C
IR12.3	300	0,2	0,10	C
IR13.3	270	0,2	0,15	C

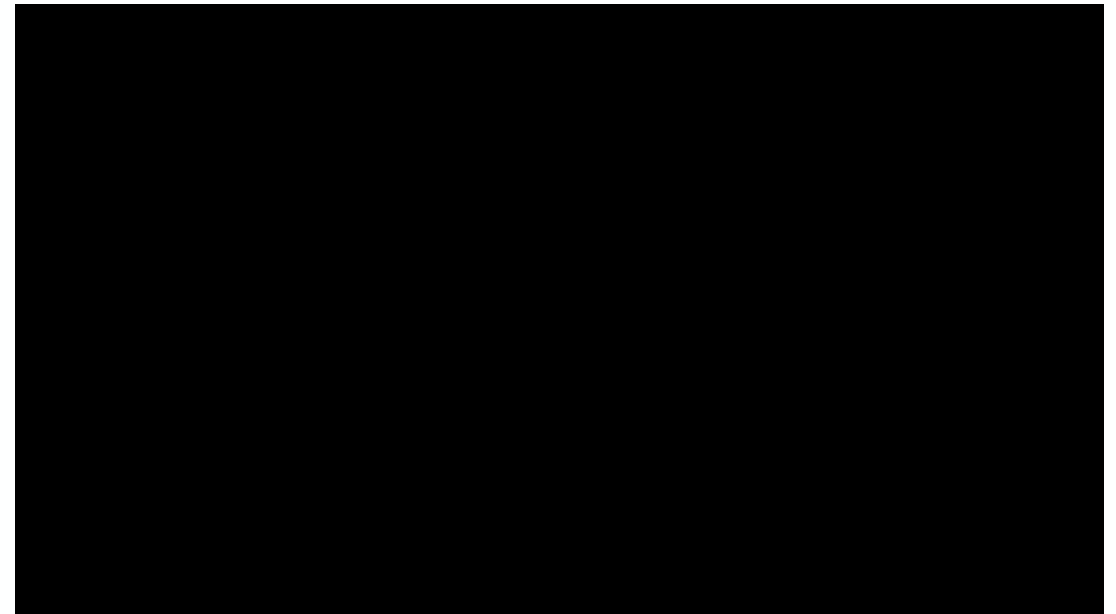
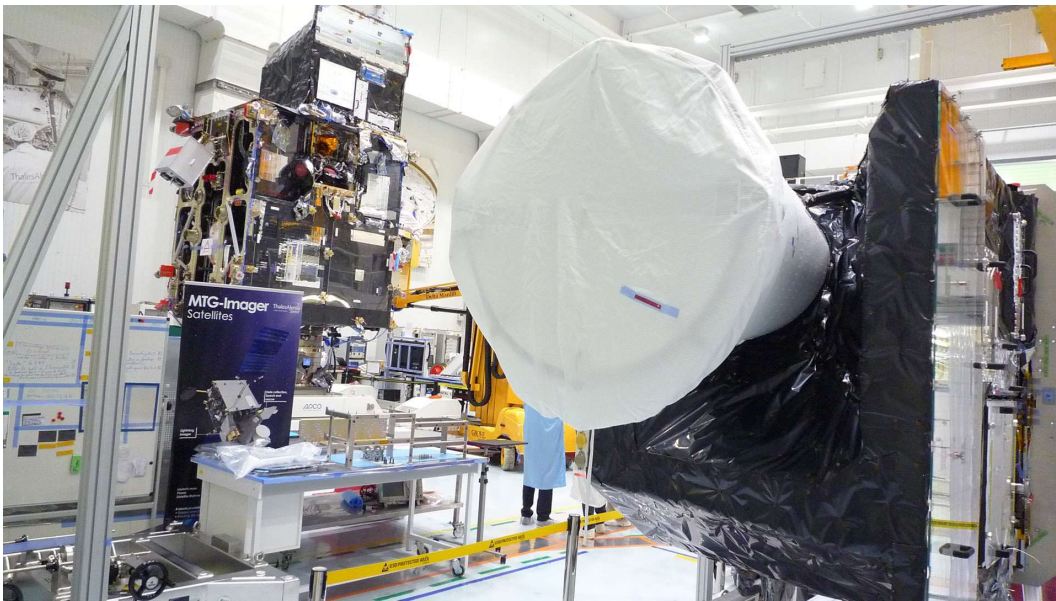
FCI PFM measured budgets – Image Geometric Quality

- Focal Length and MTF measured at FCI during Optical Vacuum:
 - Flight focus established thanks to best focus positioning with the on-board Refocusing Mechanism
 - MTF fully compliant at Level 1a for 2 km spatial sampling
 - MTF fully compliant for HR channels thanks to FIR filtering at Level 1b as required.
 - For all MTF Thermo-elastic deformation around midnight is taken into account as worst case.
- Measured MTF is in line with the prediction
- All channels are compliant to the temporal and spatial co-registration



Conclusion

- The FCI on MTG will provide continuity & enhancement of the SEVIRI mission on MSG
- The FCI PFM has been fully integrated and tested at ambient and in thermal/optical vacuum:
 - All functional and environmental tests have shown a good behavior of the instrument
 - All performance tests have shown results that are better than the prediction
 - The FCI is fully qualified, including recurrent models
- The FCI PFM has been successfully integrated onto the satellite and now MTG-I1 is getting ready for the flight



End

