Update on the TANSO-FTS-2 Instrument for GOSAT-2

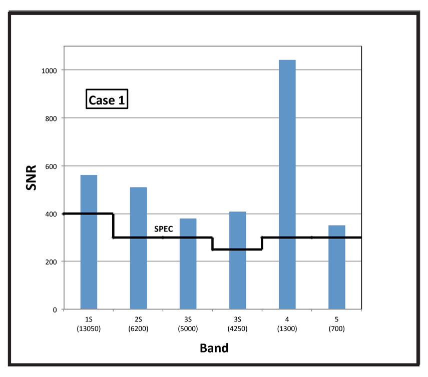
Ronald Glumb, Peter Mantica, Alan Bell, Christopher Ellsworth, Lawrence Suwinski, and Jeremy Dobler. Harris Space and Intelligence Systems. Fort Wayne, Indiana, USA.

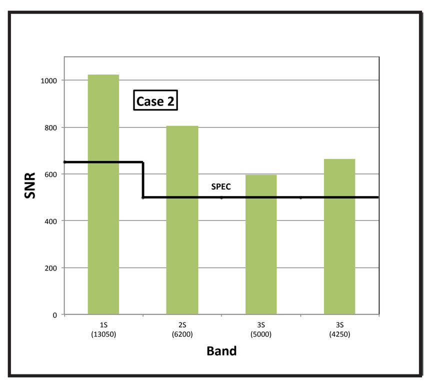
GOSAT-2 Provides Improved Measurements of Greenhouse Gases

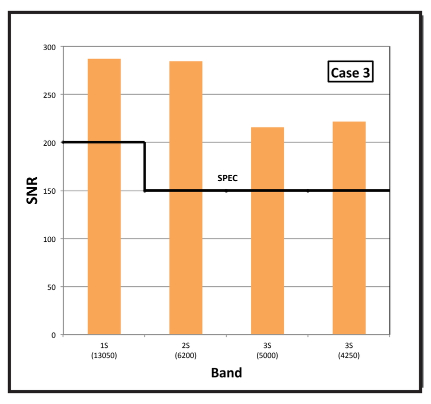
TANSO-FTS-2 is a primary instrument aboard Greenhouse gases Observation Satellite-2 (GOSAT-2). It measures high-resolution spectra of upwelling earth radiance in 5 spectral bands (left) to extract concentrations of greenhouse gases (CO^2, CH^4) and artificial emission sources (CO). The development of TANSO-FTS-2 is being performed under a subcontract by Mitsubishi Electric Corporation, the GOSAT-2 prime contractor of Japan Aerospace Exploration Agency (JAXA) GOSAT-2 Project.

Band	Microns	Wavenumbers	Resolution	Mission Purpose
1	0.755 - 0.772	12,950 -13,250	0.2 cm^{-1}	Total column oxygen; used to derive total column mass
2	1.563 - 1.695	5900 - 6400	0.2 cm^{-1}	Total column carbon dioxide and methane
3	1.923 - 2.381	4200 - 5200	0.2 cm^{-1}	Total column carbon dioxide, moisture and carbon monoxide
4	5.56 - 8.45	1183 - 1800	0.2 cm^{-1}	Methane and moisture
5	8.45 - 14.29	700 - 1183	0.2 cm^{-1}	Teperature profile, carbon dioxide

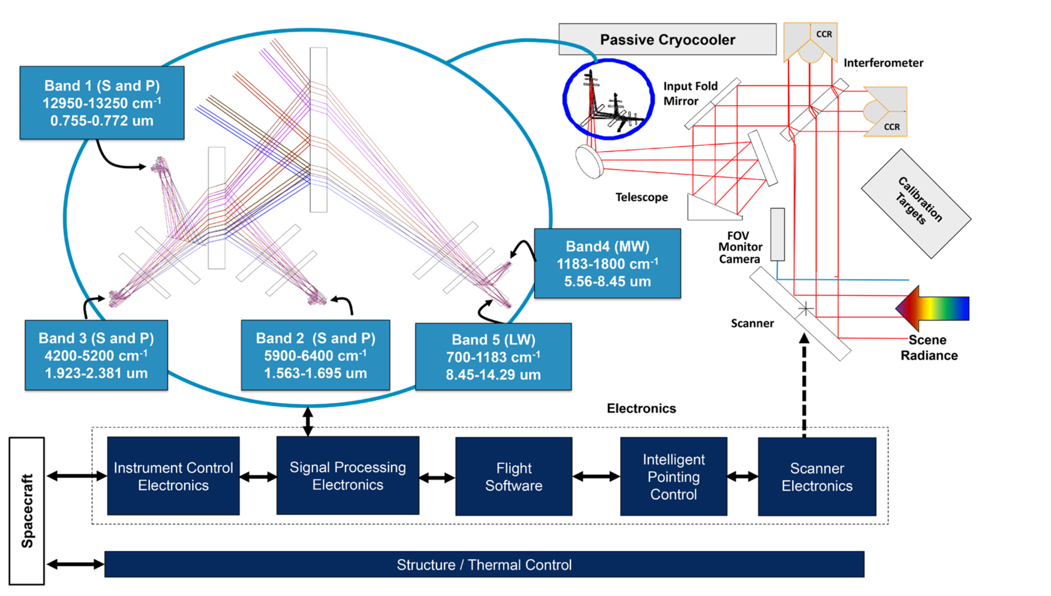
Requirement	Required Value	Projected Value
Nominal Orbital Altitude	613 km	613 km
Nominal Orbital Inclination	97.84 degrees	97.84 degrees
Scanner Cross-Track Range	±35 degrees	±35 degrees
Scanner Along-Track Range	±40 degrees	±40 degrees
Image Motion Compensation	Yes	Two-Axis
Scan Pattern	Commandable	Commandable
IFOV 50% Diameter at Nadir	≤9.7 km	9.7 km
Spectral Bands	See Table	See Table
SNR Levels	See Figures	See Figures
Interferogram Collect Time	4.0 sec	4.0 sec
ILS FWHM (Band 1/Band 2)	≤0.4/≤0.27cm-1	0.310/0.256
ILS Calibration Target SNR (Band 1/Band 2)	≥300/>300	2550/1340
Calibration Uncertainty (Bands 1-3), 1-Sigma	≤3%	2.45%
Calibration Uncertainty (Bands 4-5), 1-Sigma	≤0.3K	0.270K
Band-to-Band Registration	≤5%	3.91%
Polarization (Band 1)	≤34%	26.08%
Polarization (Band 2)	≤38%	32.40%
Polarization Extinction Ratio	≥33:1	49:1
Solar Cal Target Reflectivity at EOL	≥90%	95.3%
Pointing Accuracy, deg, 3-sigma	≤0.24/0.24/0.39	0.17/0.14/0.10
Pointing Stability Over 4 sec, 3-sigma	≤0.0778 deg	0.01 degrees
Intelligent Pointing Camera FOV at Nadir	≥46 x 27 km	46 x 27 km
IP Camera Max Rate for 10 sec	5 frames/sec	5 frames/sec
Average Power (Operational)	≤220W	187.2 W
Peak Power (Operational)	≤350W	277.1 W
Science Data Rate, Band 1 Operational	≤635 kbps	478 kbps
Science Data Rate, Band 2-5 Operational	≤320 kbps	220 kbps
High Rate Telemetry Data Rate	≤600 kbps	411 kbps
Mass	≤225 kg	218.8 kg
Reliability after 5 Years on Orbit	≥0.85	0.87

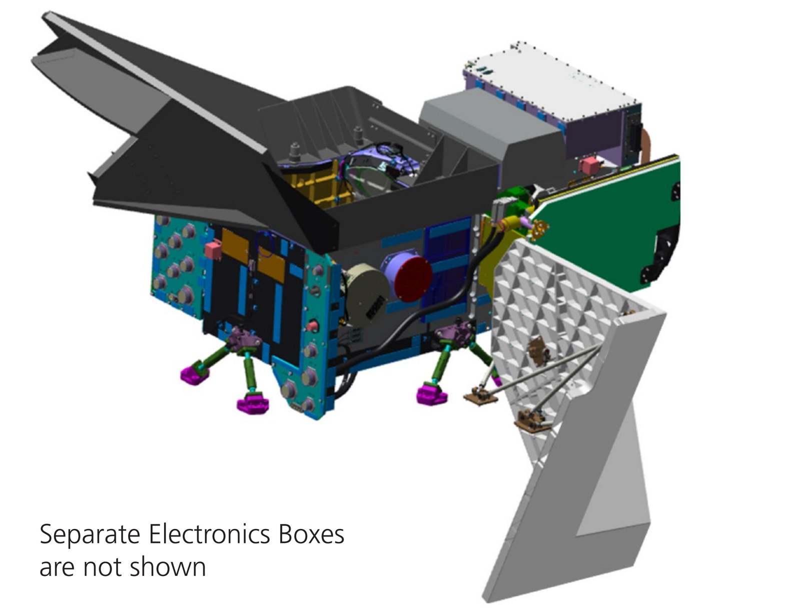


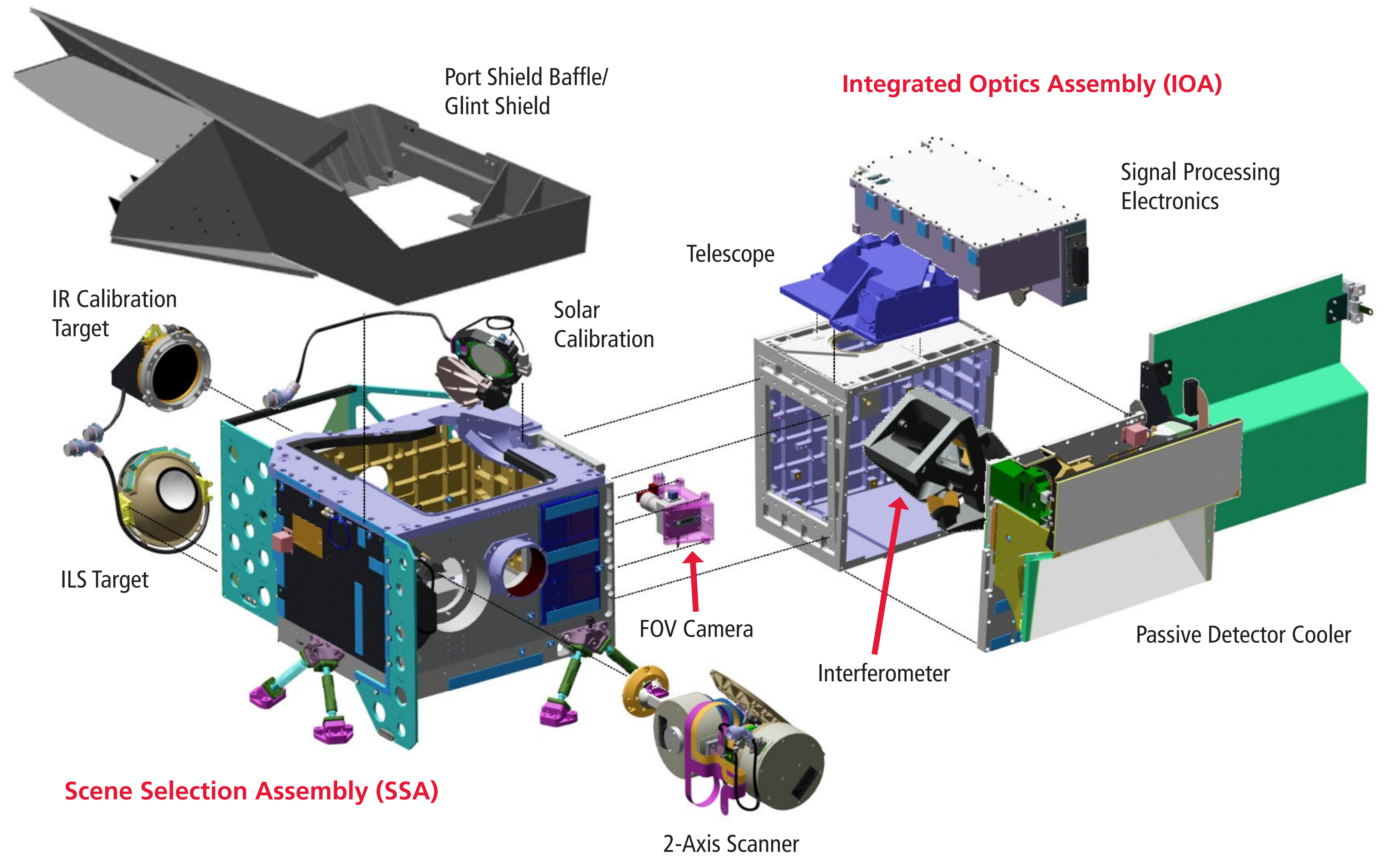




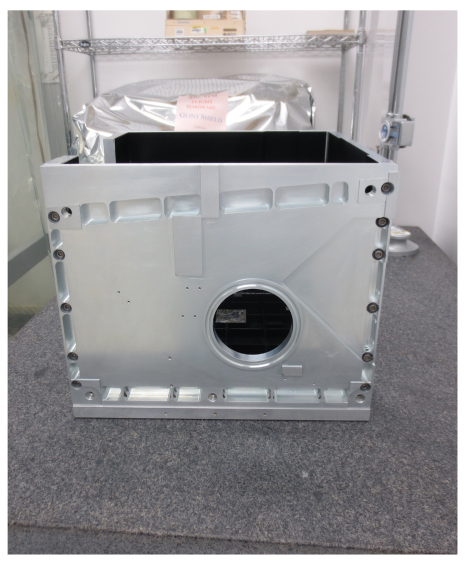
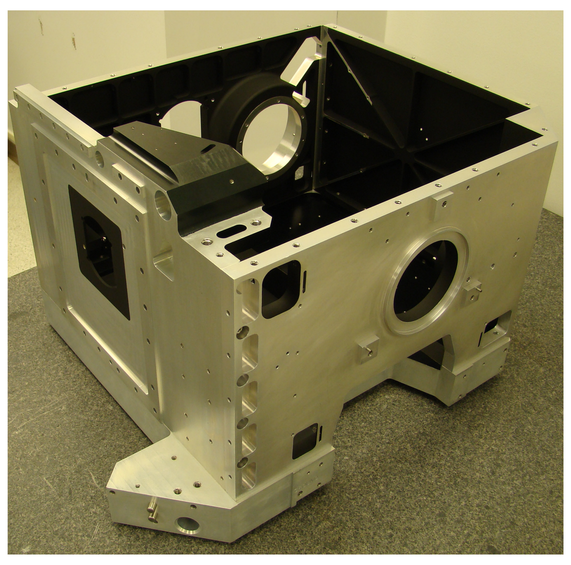
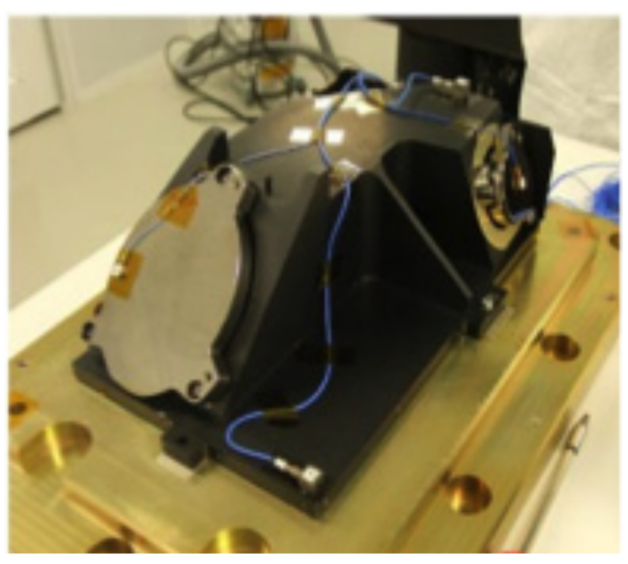
FTS-2 Instrument Provides Five Hyperspectral Infrared Bands with Excellent Signal to Noise

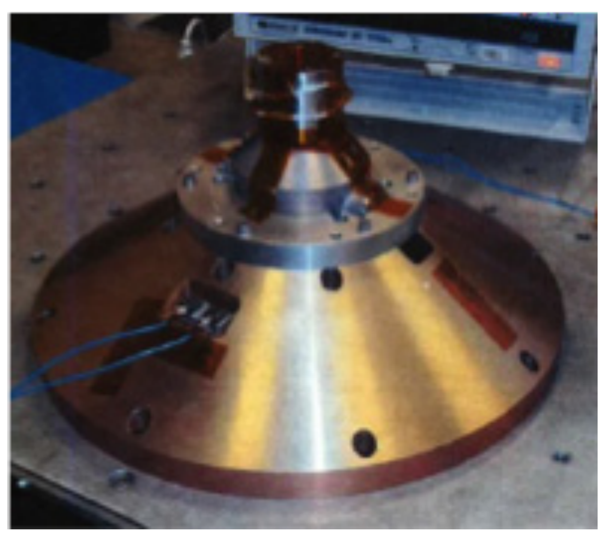
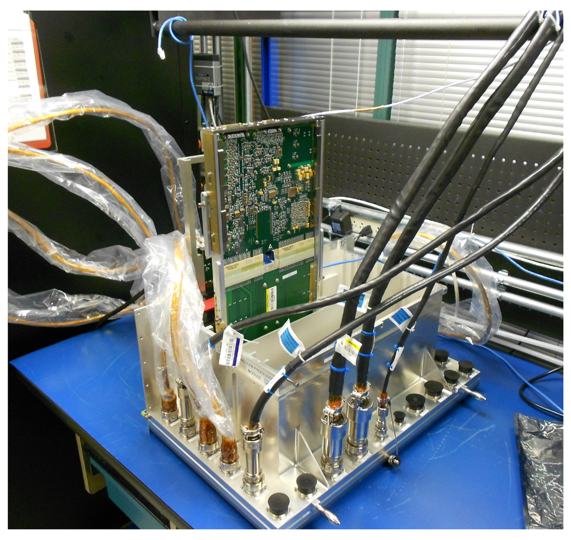






Key Components of the FTS-2 Instrument Have Been Completed

Top Row (Left to Right): FOV Monitor Camera, Integrated Optics Assembly Structure, Scene Selection Assembly Structure, Telescope
Bottom Row (Left to Right): Spectralon for Solar Calibration Target, Chassis for Command and Control Electronics Unit, Scanner Optical Encoder, Circuit Card Assemblies

Intelligent Pointing Significantly Increases Data Yield

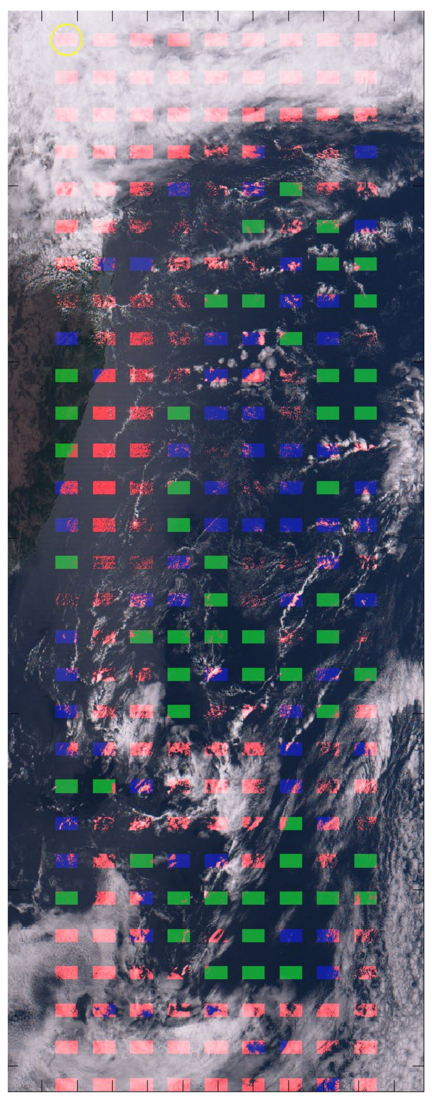
- (green) = Already Clear at Center of FOV
- (blue) = IP Provides Clear View Via Repoint
- (red) = Cloudy FOV (No IP Improvement)

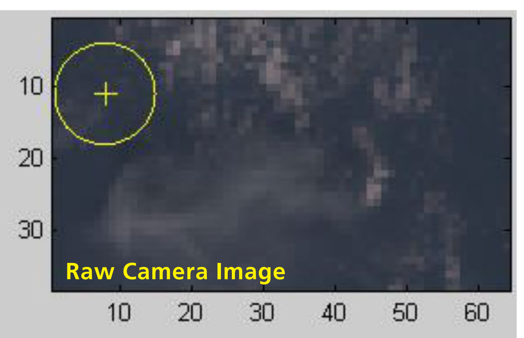
Intelligent Pointing (IP) uses a high-resolution RGB camera to identify cloud-free regions near the commanded LOS position.

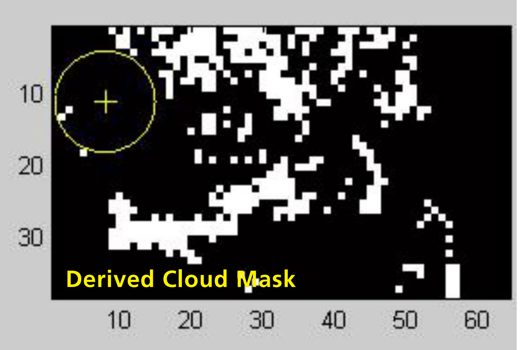
As shown in the right-most images, onboard processing uses the raw camera image to create a cloud mask, and then determines via a convolution the least cloudy area of the FOV (images at right). The instrument LOS is then shifted to the cloud-free region before the interferogram is collected.

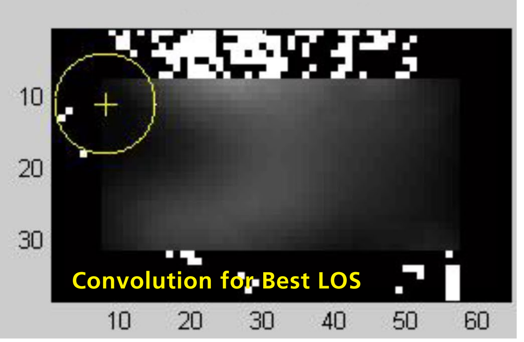
In the left-most example region, the percentage of usable cloud-free data collects increases from 20% (green locations) to 46% (green plus blue locations), which is a 2.3X improvement.

Globally, IP is expected to provide about a 2X improvement in cloud-free data yield.









Design Features Enable Improved Mission Performance for GOSAT-2

GOSAT-2 Design Feature	Mission Benefits
– CrIS-Based Passive Detector Cooler	– Inherently reliable, achieves temperatures needed for IR detectors
– New Intelligent Pointing Function	– Detects cloud-free areas and repoints scanner in real-time to maximize the number of cloud-free measurements
– Highly Accurate and Stable Scanner	– Minimizes scene-induced interferogram fluctuations during data collects
– Very Linear Signal Outputs	– Minimizes radiance errors due to nonlinearity effects
– Interferometer Improvements	– More stable laser metrology laser outputs and more stable ZPD position
– Target for ILS Characterization	– Accurate on-orbit ILS characterizations in two spectral bands
– Multiple Spectralon Surfaces in Solar Calibration Target	– Excellent knowledge of solar calibration target radiances over life
– Flight-Proven High-Emissivity Infrared Calibration Target	– CrIS-based target provides emissivity >0.995 and temperature errors <100mK for precise calibration of infrared data
– Stabilized Optical Temperatures	– Most of instrument is actively temperature controlled to provide enhanced calibration accuracy
– Stable Scanner Performance Over Life	– Significant motor torque margin, full outgas of components, robust EMI shielding, reprogrammable servo coefficients
– Improved Solar Calibration Accuracy	– Glint shield prevents earth radiance or spacecraft glints from impacting solar calibration accuracy
– ILS Target Uniformity	– Integrating sphere ensures very good uniformity for best ILS calibration
– Minimized Scanner Disturbances to Interferometer	– Scanner peak torques avoid zero-velocity points of interferometer turnaround, which is most sensitive for ZPD shifts
– Negligible Stray Light During Calibration	– Baffles ensure no stray light impact to calibration
– Improved Telemetry for IR Calibration	– Large number of accurate temperature sensors provide improved calibration corrections
– Fixed Rate Sampling	– Simplifies onboard processing while ensuring low-noise performance

**= Exelis, now part of Harris Corporation*