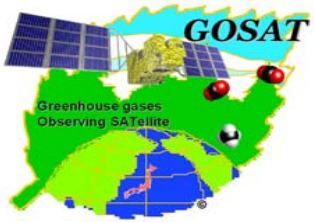

Status of GOSAT development and operation plan

Kei Shiomi, Akihiko Kuze, Hiroshi Suto,
Shuji Kawakami, Masakatsu Nakajima,
Takashi Hamazaki

Japan Aerospace Exploration Agency
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First IASI Conference, Anglet, France, 15 Nov., 2007

Contents

- Introduction
- GOSAT Satellite System
- TANSO FTS and CAI Instruments
- GOSAT Operation Plan
- Collaboration Activities
- Summary & Announcement

Introduction

- Greenhouse gases Observing SATellite
  - Monitoring the global distribution of Green House Gases (GHGs)
  - Joint project
    - Japan Aerospace Exploration Agency (JAXA)
    - Ministry of Environment (MOE)
    - National Institute for Environmental Studies (NIES)
  - Launch schedule: Dec. 2008
- Status of sensor development
  - EM integration and test: finished in Sep. 2007
  - PFM integration and test: schedule to complete in Dec. 2007

Mission Target

- To observe CO_2 and CH_4 column and profile
  - at 100-1000km spatial scale (with pointing mechanism)
  - with relative accuracy of 1% for CO_2 (4 ppmv, 3 month average) (target 1ppmV) and 2% for CH_4.
  - during the Kyoto Protocol's first commitment period (2008 to 2012).

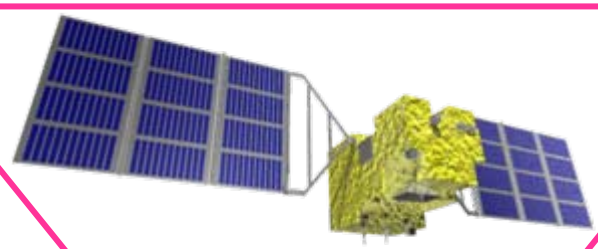
- To reduce sub-continental scale CO_2 annual flux estimation errors by half
  - 0.54 GtC/yr → 0.27 GtC/yr

Organization

MOE

JAXA

NIES



- Sensor development
- Satellite development
- H-IIA launch
- Satellite operation
- Data acquisition
- Calibration

- Algorithms development
- Data use for science
- Validation

Satellite: MITSUBISHI 三菱電機

Mission Instruments: NEC/TOSHIBA NEC東芝スペースシステム株式会社

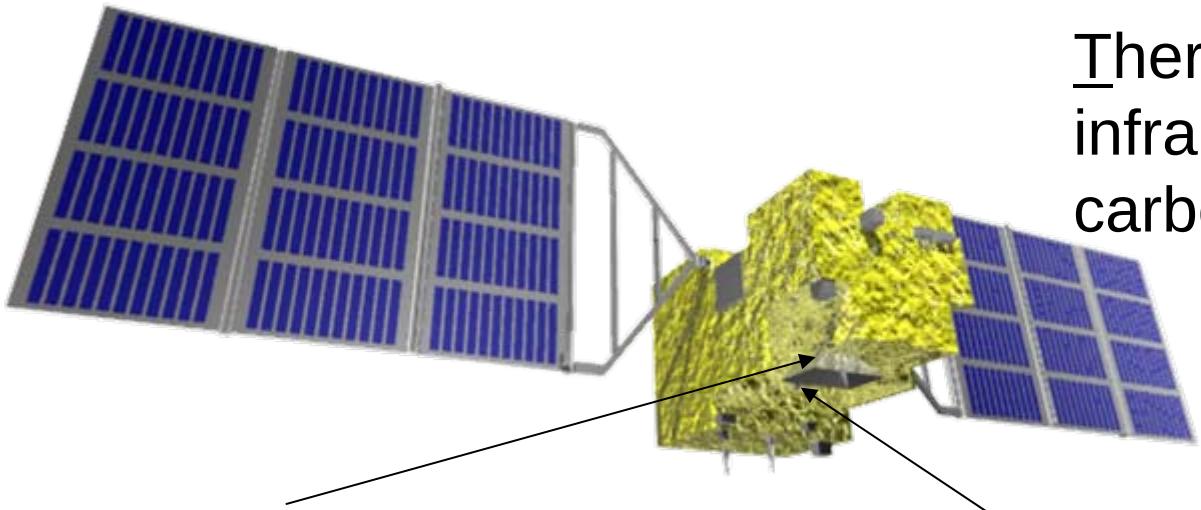
ABB


GOSAT Satellite

Satellite Specification

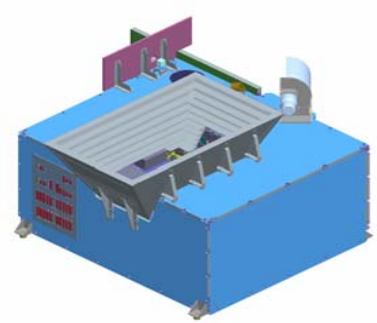
Size	Main body	3.7 m x 1.8 m x 2.0 m (Wing Span 13.7m)
Mass	Total	1750kg
Power	Total	3.8 KW (EOL)
Life Span	5 years	
Orbit	sun synchronous orbit	
	Local time	13:00+/-0:15
	Altitude	666km
	Inclination	98deg
	Re-visit	3 days
Launch	Vehicle	H-IIA
	Schedule	2008

Satellite Configuration



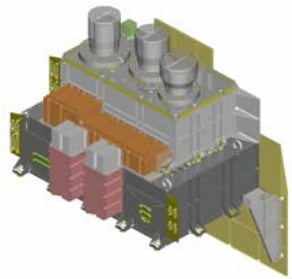
Thermal And Near infrared Sensor for carbon Observation

TANSO-FTS

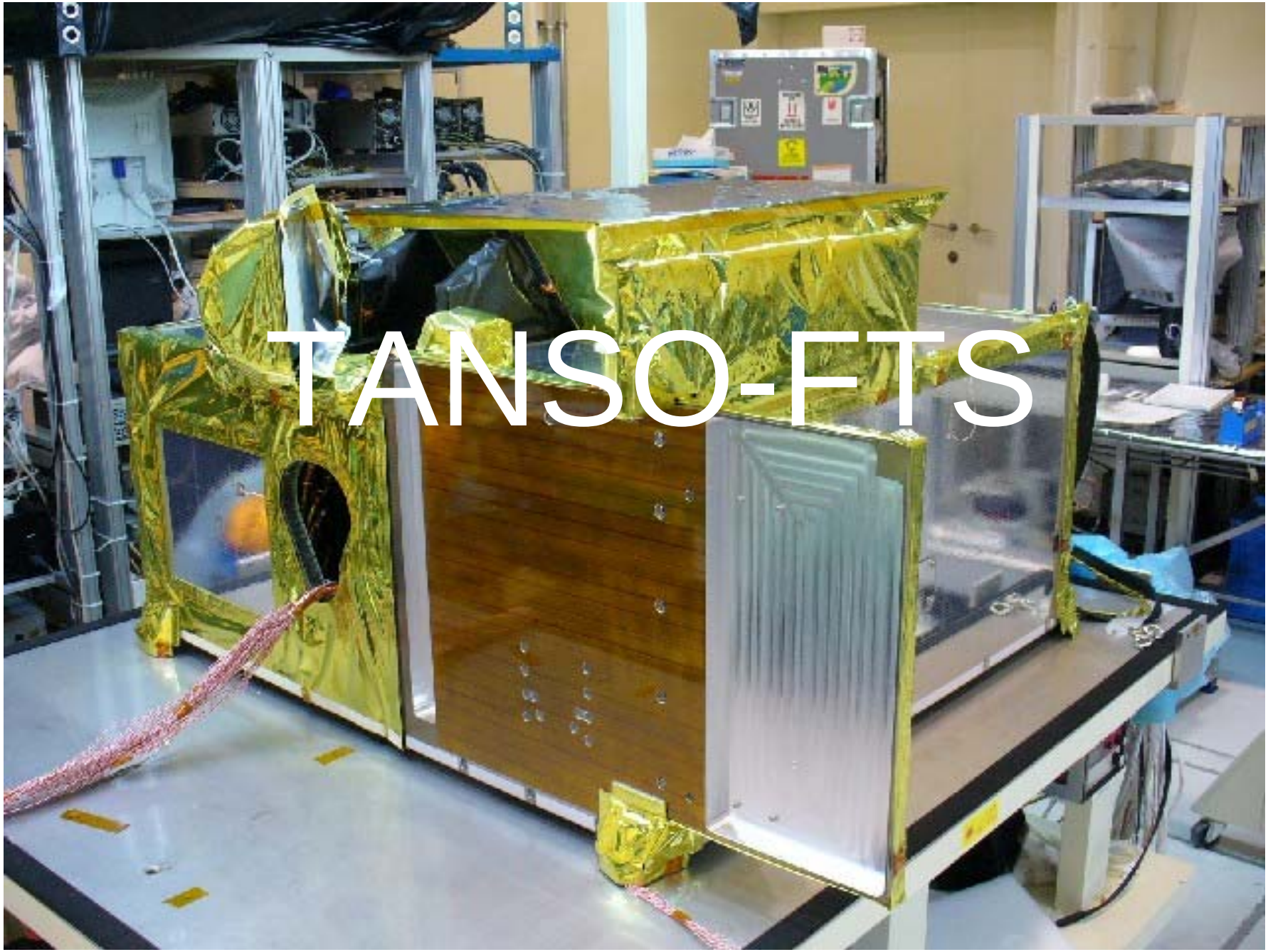


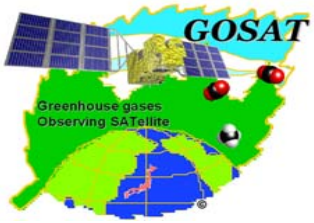
SWIR and TIR FTS

TANSO-CAI



UV, Visible, SWIR Cloud and Aerosol imager

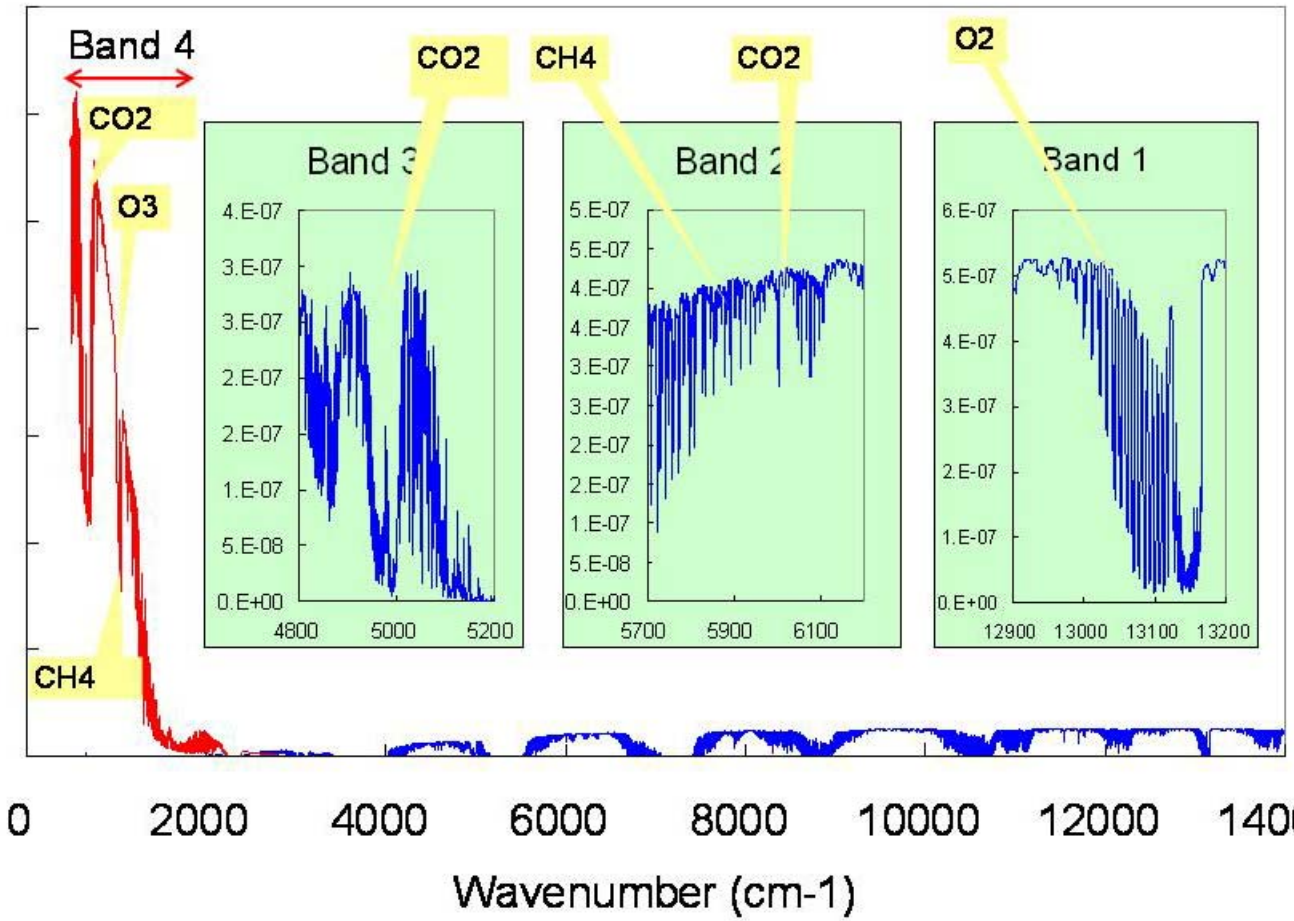

TANSO-FTS



TANSO-FTS Specifications

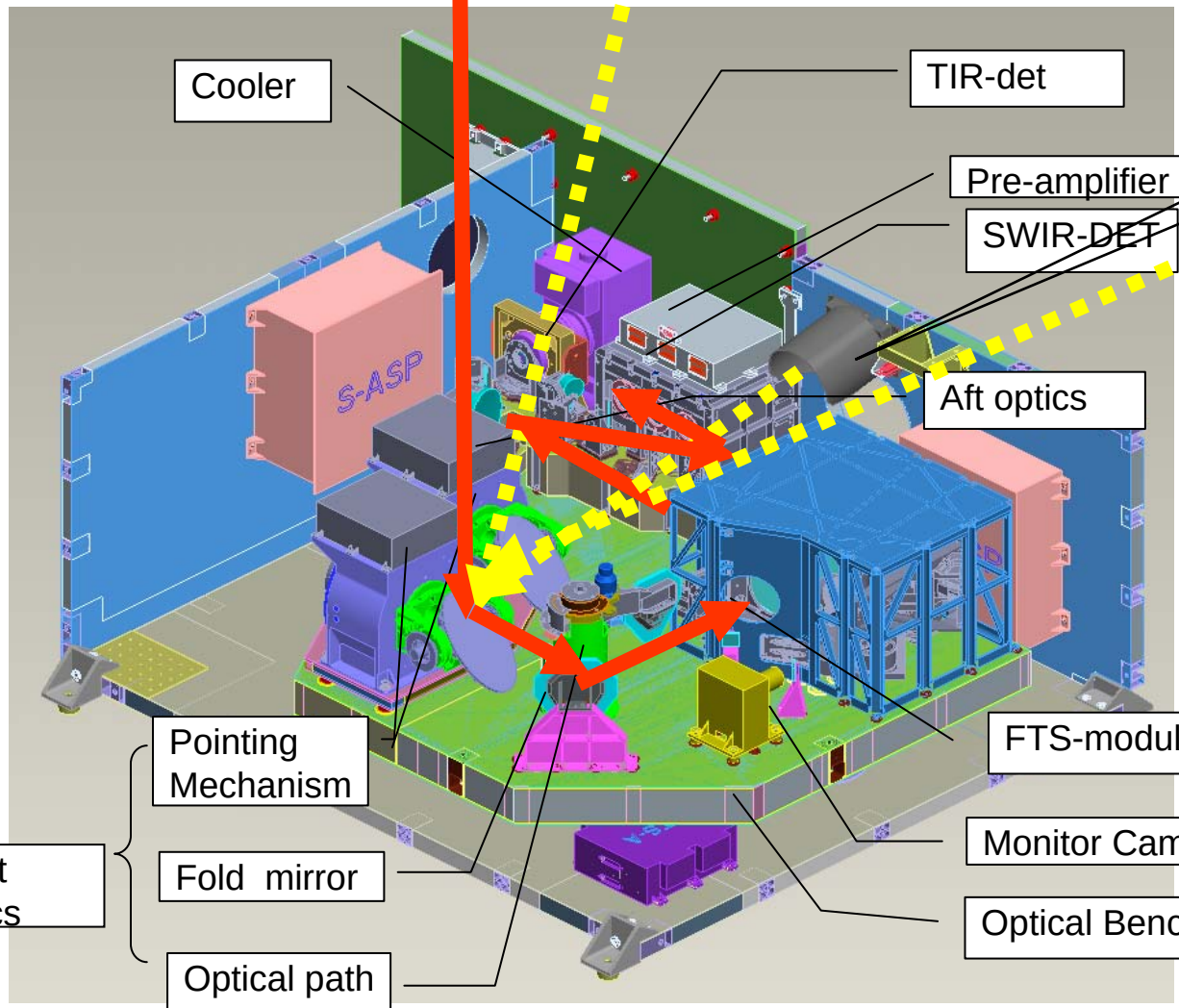
Ground Pointing Mechanism and Fore optics	Configuration	2-axes scanner (fully redundant) for ground pointing and calibration			
	Scanning	Cross Track (+/-35 °) Along Track (+/-20 °)			
	Field of view	IFOV <10.5 km 790 km (CT width) (latitude of 30 °)			
Fourier Transform Spectrometer	Speed	0.25, 0.5, 1 (Interferogram)/s			
	Spectral band	1P, 1S	2P, 2S	3P, 3S	4
	Coverage (μm)	0.75-0.78	1.56-1.72	1.92-2.08	5.5-14.3
	resolution(cm^{-1})	0.5	0.2	0.2	0.2
		0.2 cm^{-1} spacing (+/- 2.5 cm MOPD)			
	Detector	Si	InGaAs	InGaAs	PC-MCT
	Calibration	Solar Irradiance, Deep Space, Moon, Diode Laser (1.55 micron, ILS)			Blackbody, Deep space

TANSO-FTS Observation Targets

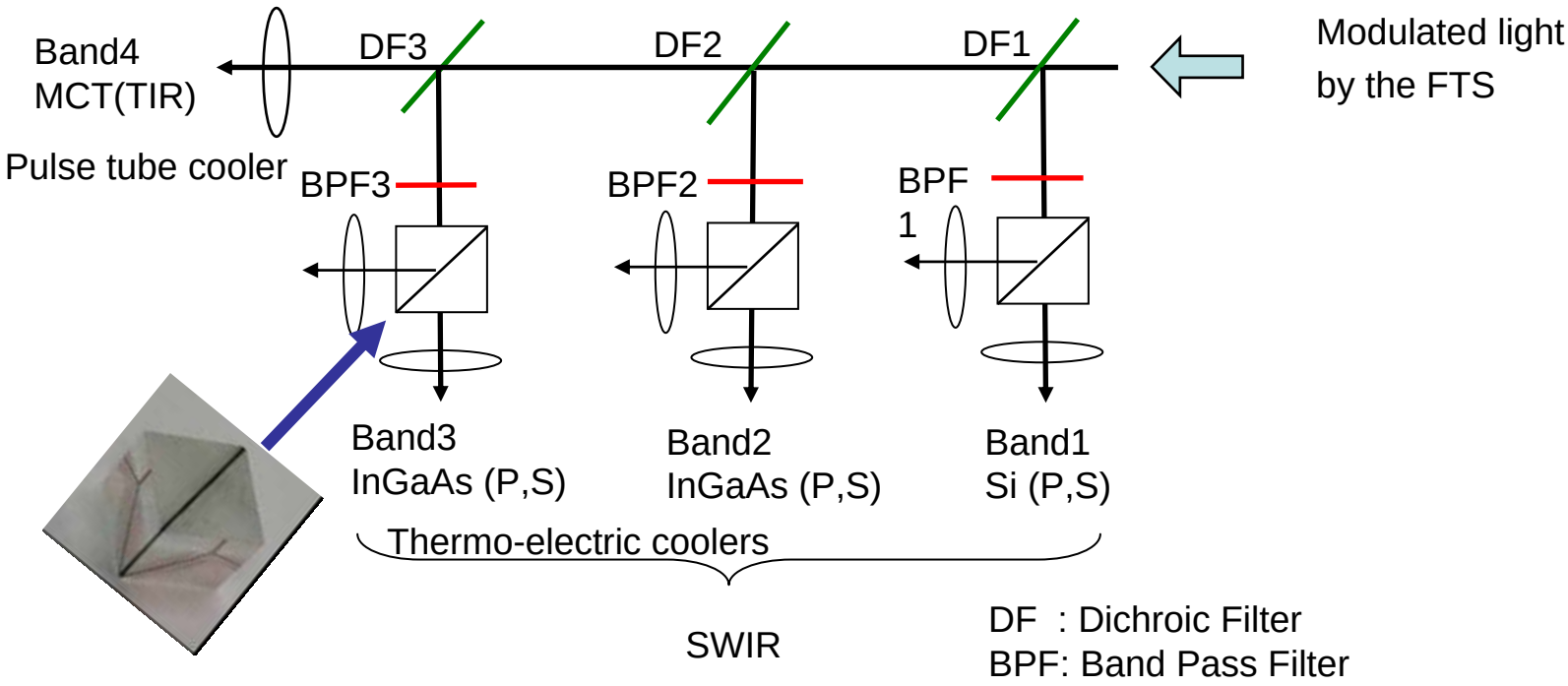


Gases	min (μm)	max (μm)	Band
O_2	0.75	0.78	1
CO_2	1.56	1.62	2
CH_4	1.66	1.67	2
H_2O	1.92	2.08	3
CO_2	1.92	2.08	3
H_2O	5.5	7.1	4
CH_4	7.0	8.2	4
O_3	9.1	10.1	4
CO_2	10.1	10.87	4
CO_2	12.8	14.3	4

TANSO-FTS Configuration



TANS-FTS Aft-Optics

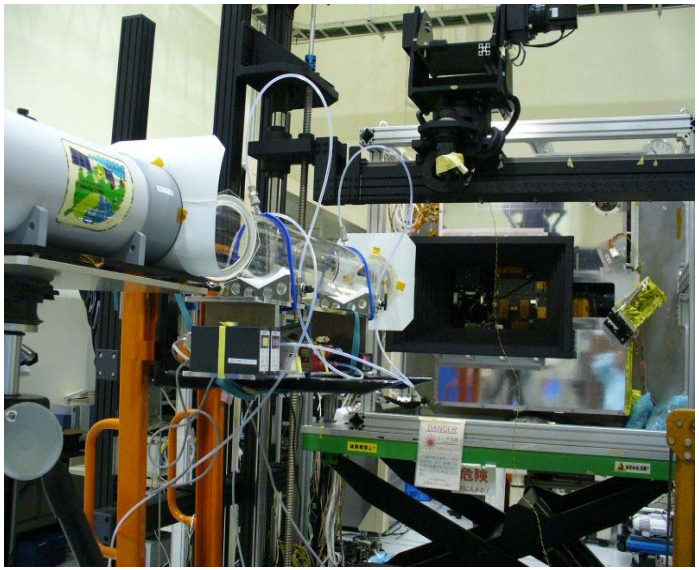


- The modulated light by the FTS is divided into four spectral bands with dichroic filters.
- The SWIR bands lights are divided into two detectors with the polarization beam splitters.
- The InGaAs detectors are cooled with thermo-electric coolers.
- The TIR light is collected on the MCT detector, which is cooled with the pulse tube cooler.

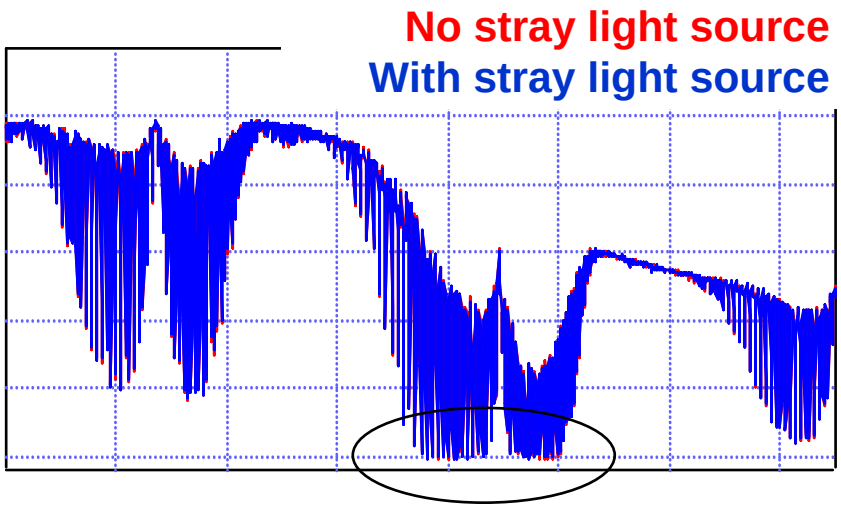
Pre-flight Test Items

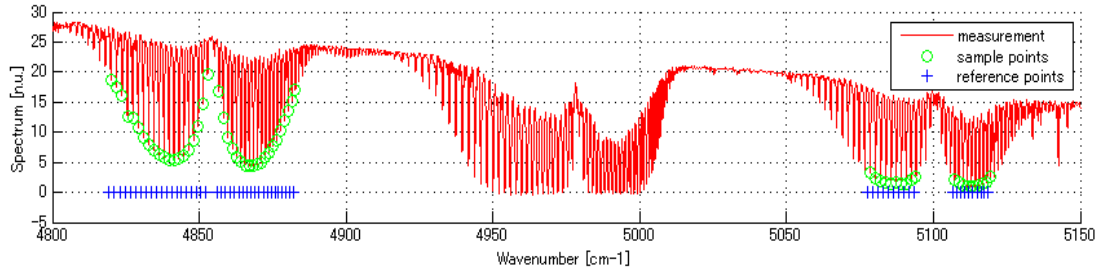
Item	Configuration
Signal to Noise Ratio	Halogen lamp Integrating Sphere (SWIR) Large Aperture Cavity Blackbody in TVT (TIR)
Instrument Line Shape Function (shape and wavelength)	Ar lamp Integrating Sphere and Tunable diode laser
Radiometric Response (Non liner correction if exists)	Fix Point Blackbody and Integrating Sphere Large Aperture Cavity Blackbody (TIR)
IFOV (Response distribution within a pixel if exists)	Collimator with Alignment test
Diffuser BRDF	Spherical Distributed Detectors
Onboard Laser temperature dependency	Wavelength meter
Response Stability	Halogen lamp Integrating Sphere and light source monitoring radiometers
Stray Light	Halogen lamp Integrating Sphere and CO_2 cell
Micro-vibration	Ar lamp Integrating Sphere and Shaker

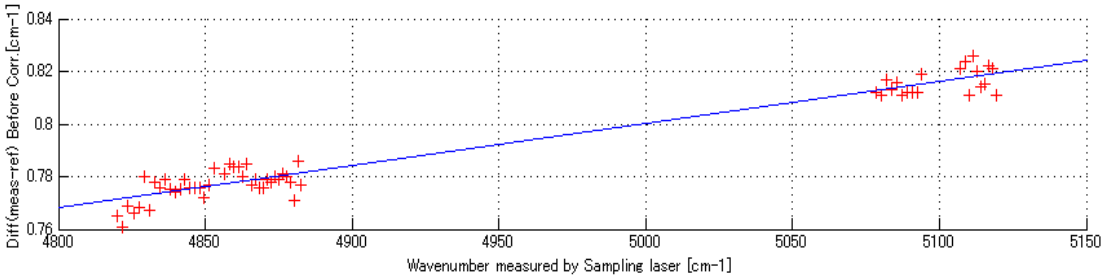
CO2 cell measurements

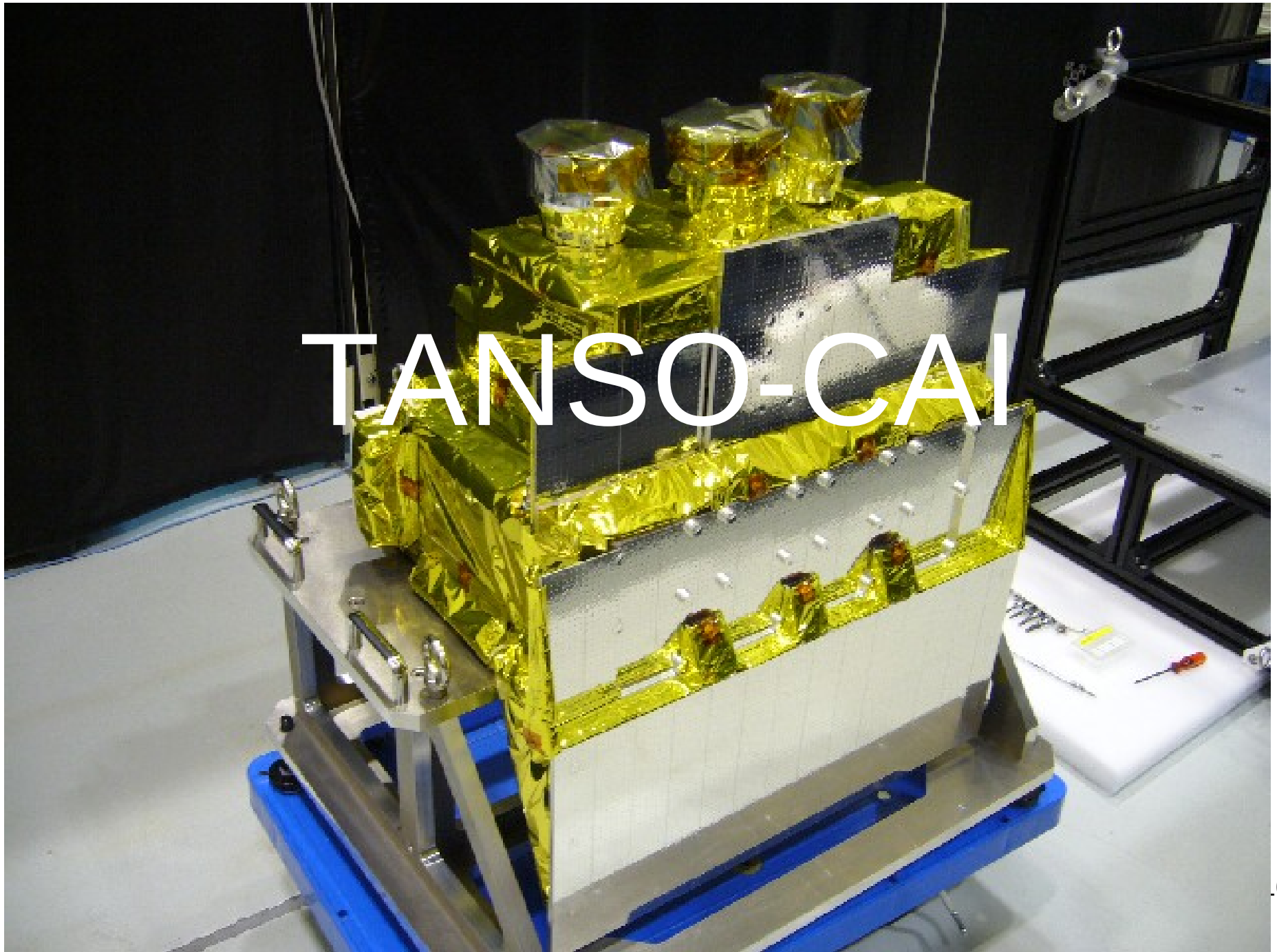


- Stray light
  - Stray light effect far from FOV
  - Measurement of saturated CO_2 absorptions whether no change or going-up
  - No significant AC stray light
- Spectral calibration
  - Laser wavelength precision ~10^{-6}
  - Spectral accuracy ~ $4x10^{-3}$ cm^{-1}







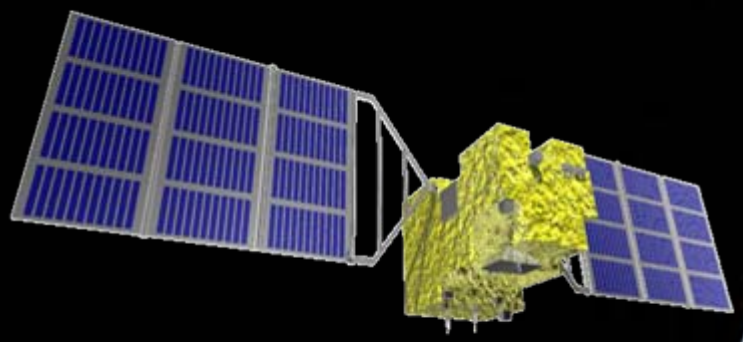

TANSO-CAI

TANSO-CAI

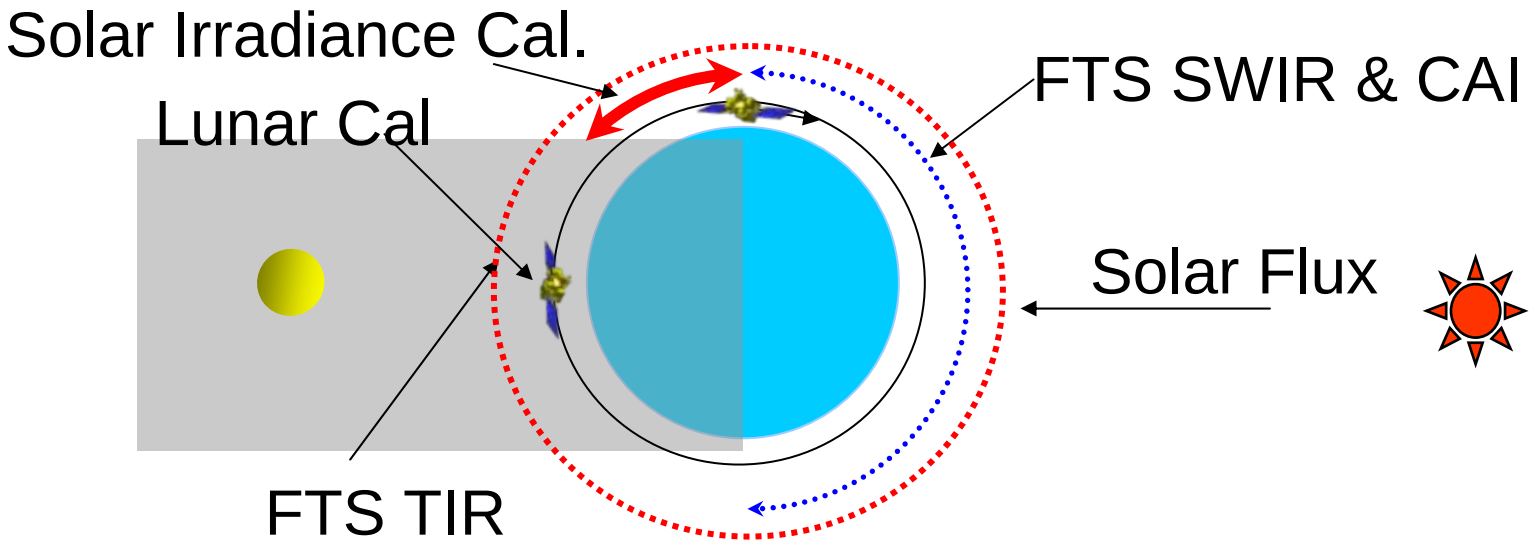
- TANSO-CAI is operated together with TANSO-FTS
  - detect aerosol spatial distribution and cloud coverage
  - retrieve scattering spectral characteristics of aerosol

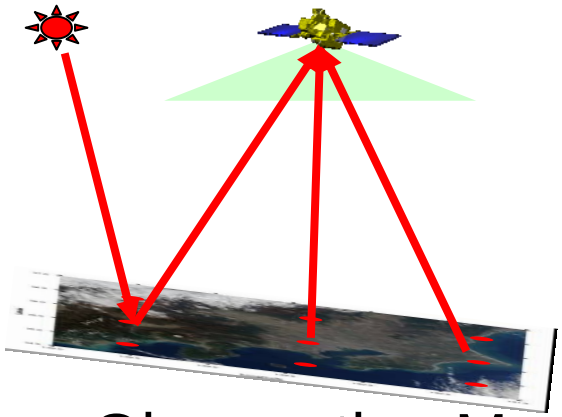
Band No.	Observation Band (nm)	Center Wavelength (nm)	Spatial Resolution (IFOV) (km)	FOV (km)	No. of Pixels (cross track)
1	372-387	380	0.5	1000	2000
2	667-680	678	0.5	1000	2000
3	866-877	870	0.5	1000	2000
4	1560-1640	1620	1.5	750	500

GOSAT Operation Plan

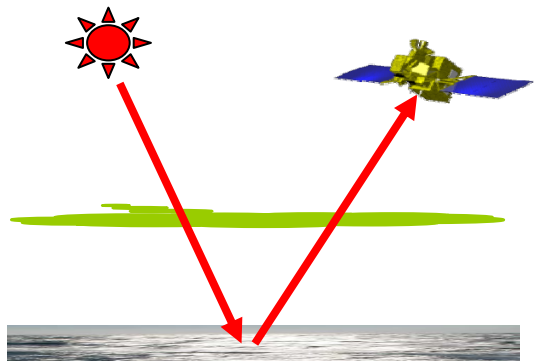


Operation Modes



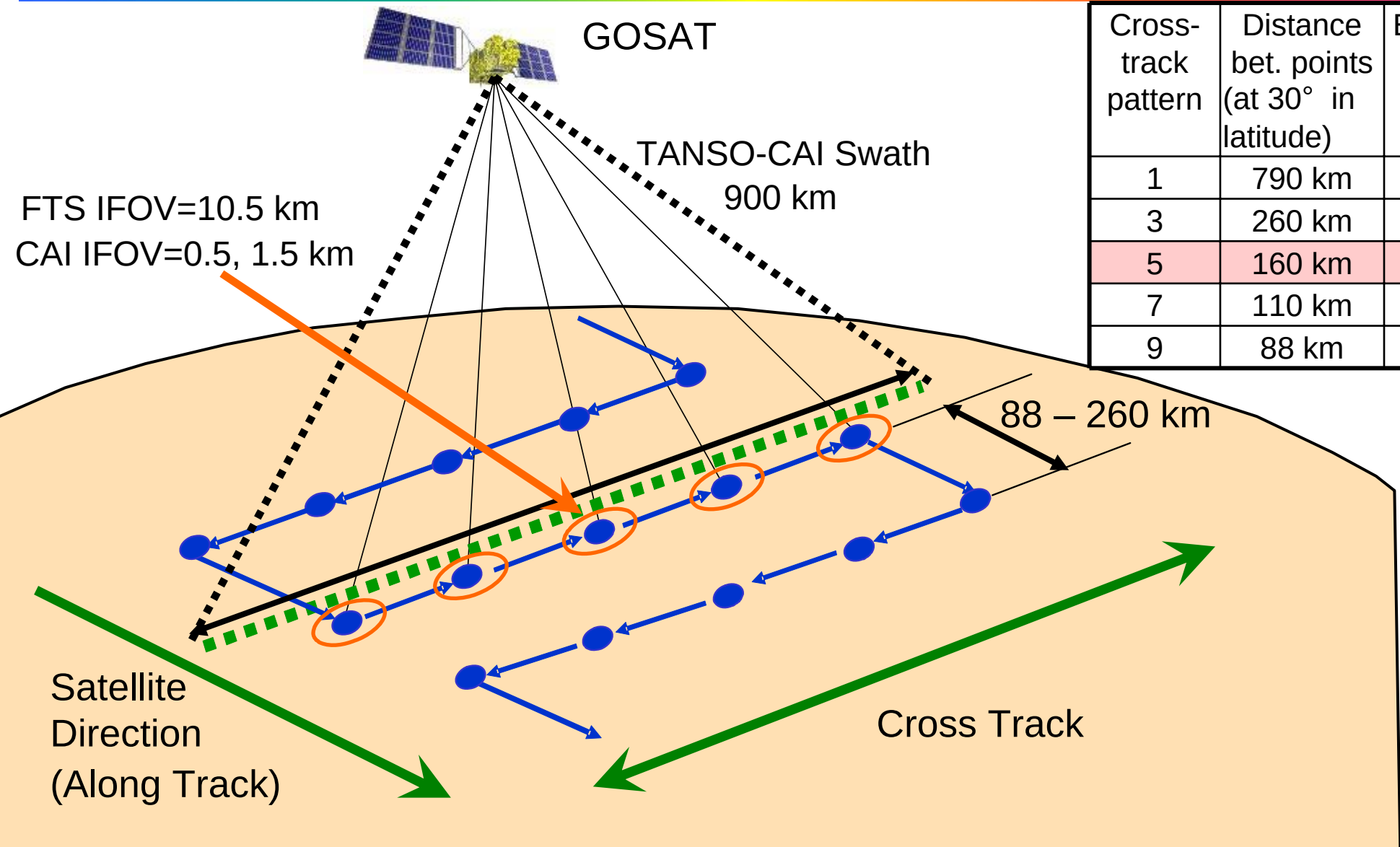


Observation Mode
(Dayside land & Nightside)



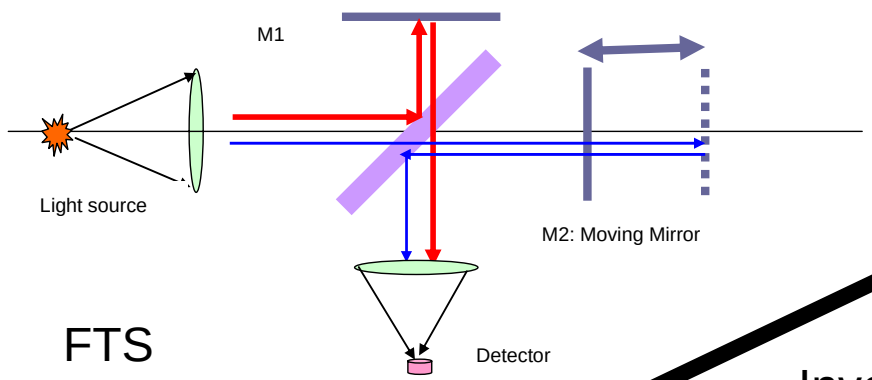
Sun Glint Pointing Mode
(Dayside ocean)

Pointing and Foot prints

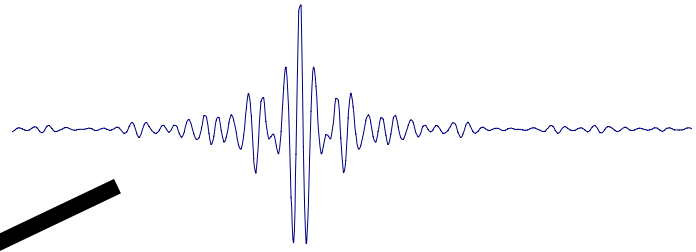


Cross-track pattern	Distance bet. points (at 30° in latitude)	Expo-sure (s)
1	790 km	4x3
3	260 km	4x3
5	160 km	4
7	110 km	2
9	88 km	1

TANSO-FTS Data Flow



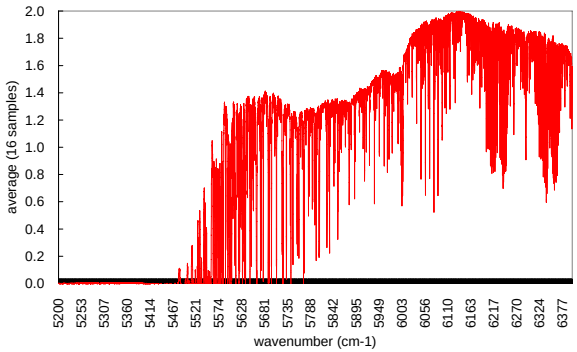
FTS



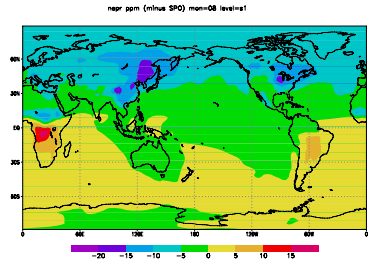
ground

Interferogram (L1A)

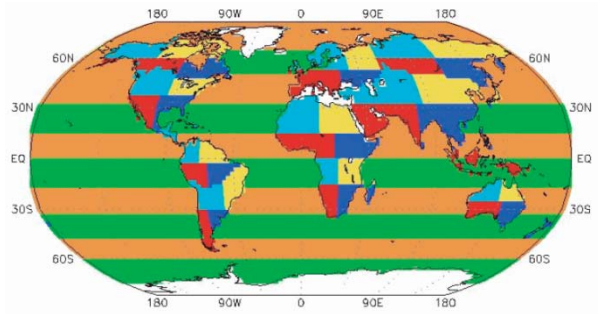
Inverse FFT



Spectra (L1B)

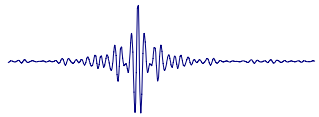
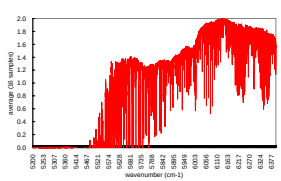
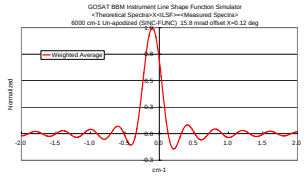
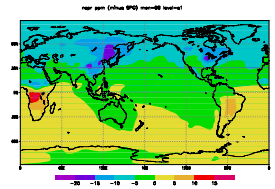
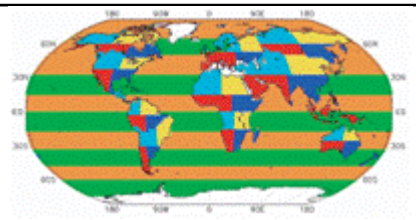


Column and profile for each exposure (L2)
Global distribution (L3)



Source and sink of 64 area (L4)

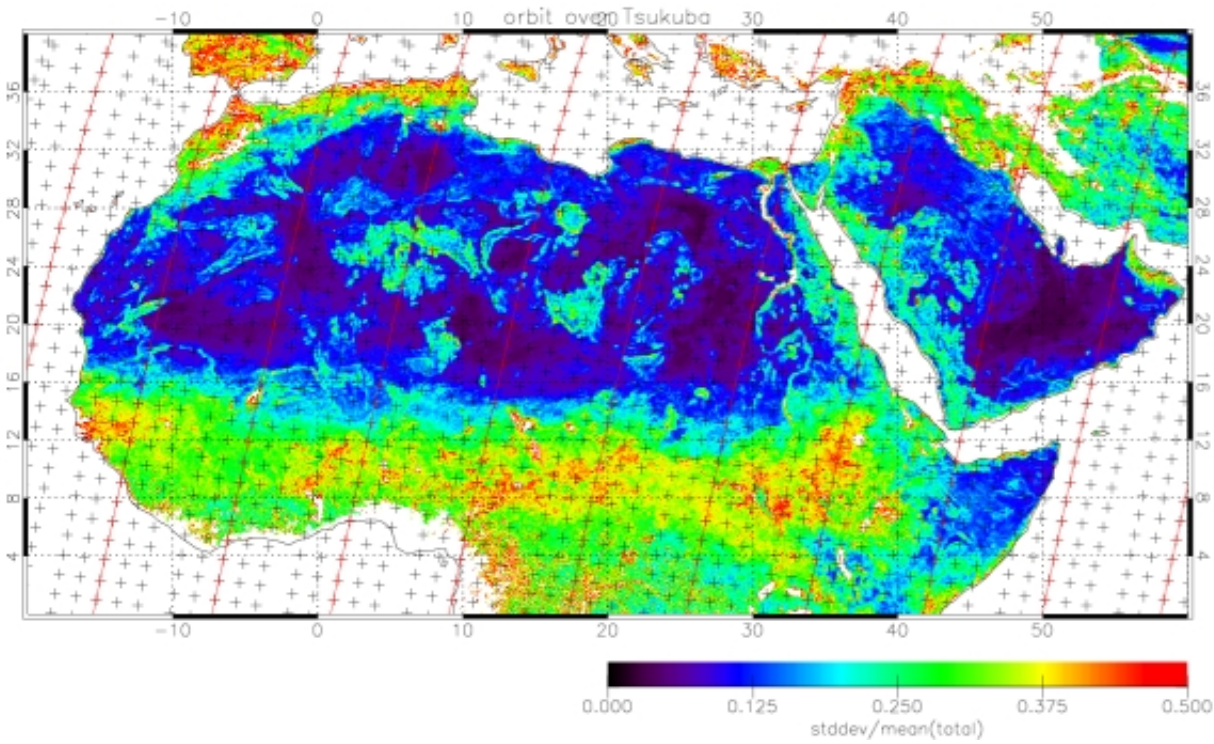
Data Distribution of TANSO-FTS

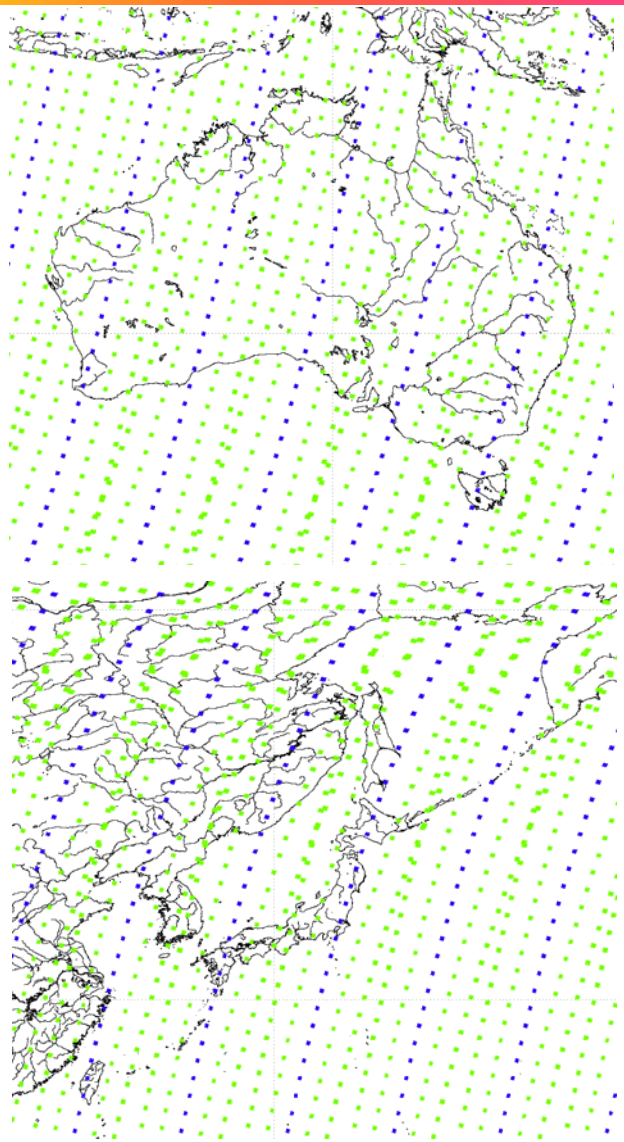
L1A HDF5 format		Interferogram
L1B HDF5 format	 	(TANSO-FTS-SWIR) Earth Albedo: Measured spectra ((raw spectra) by (Instrument line shape)) divided by solar irradiance measured by onboard solar diffuser (TANSO-FTS-TIR) Spectral radiance ILSF (Instrument Line Shape Function) is also provided.
L2 HDF5 format	$XCO_2 = 8 \times 10^{21}$ molecule/cm^2 (sample) $XCH_4 = 4 \times 10^{19}$ molecule/cm^2 (sample)	(SWIR) Column amount using differential absorption (TIR) vertical profile
L3 NETCDF format		Global distribution of CO_2,CH_4 (every 3 days and monthly mean)
L4 NETCDF format		Source and sink distribution of 64 area

Data Distribution of TANSO-CAI

L1A HDF5 format	Raw digital data Parameters for geometrical and radiometric calibration
L1B HDF5 format	Calibrated radiance Geolocation resampling
L2 HDF5 format	Physical parameters of cloud property (amount, coverage) and aerosol property (type, particle size, optical thickness)
L3 HDF5 format	Global distribution of radiance cloud and aerosol (every 3 days)

Preparation of Post-launch Cal/Val





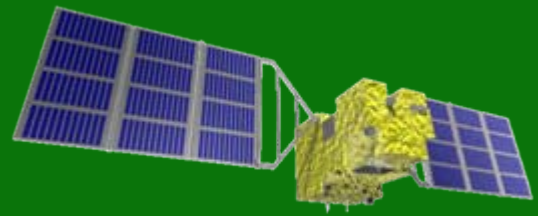
- Scene selection for
  - Radiance comparison with other similar sensor and DB simulation
  - Geolocation
  - Cal/Val locations

Master Schedule

- Operation phase and Data release
  - Launch date: Dec., 2008
  - Initial operation: L~L+6 M
    - Initial check-out
    - Cal/Val phase
  - Normal operation: L+6 M~
    - L1 release: L+6 M~
    - L2 release: L+9 M~
  - Nominal lifetime: 5 years

- Research announcement and Science plan
  - 1 year before launching

Collaboration Activities

	GOSAT (JAXA)	OCO (NASA)
		
Spectrometer	Fourier	Grating
Spatial coverage	Mechanical pointing	Imaging
Spectral coverage	Wide with single spectrometer	Limited 3 spectral channels
Target	CO_2, CH_4	CO_2
Validation and pre launch calibration	Common target	
Data base	Share	

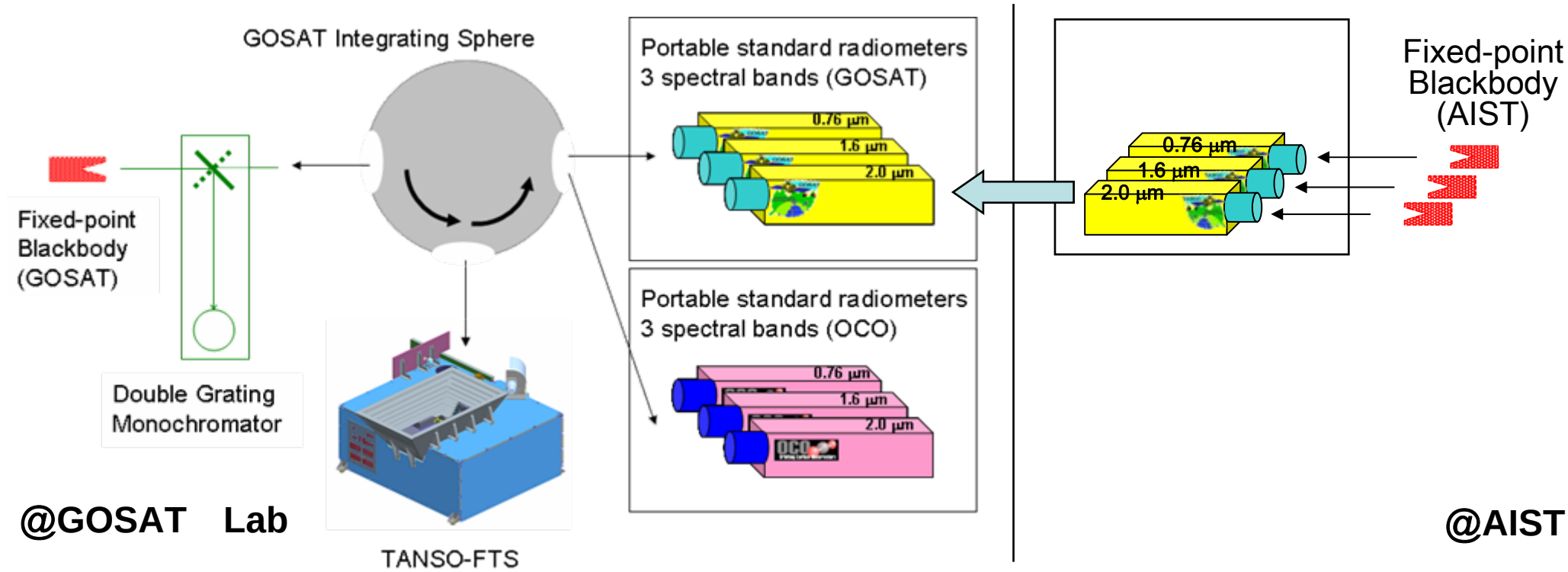
Collaboration items with OCO

JAXA
Japan Aerospace Exploration Agency

- Cross calibration in PFT
  - Intercomparison with calibrated standard radiometers and integrating spheres
- Data exchange
  - Line parameters
  - Cal/Val datasets of ground-based measurements (ex. Solar spectra, CO_2 column and profile)
  - Observation data
- Activities

  Cal/Val experiments (ex. Park Falls, Railroad Valley)

Methodology of Cross Calibration



- Preparatory experiment : Aug., 2007
  - The GOSAT standard radiometers and integrating sphere are evaluated by comparison with AIST standard light sources.
- X-cal at JPL : Feb, 2008
- X-cal in Japan : 2008

Collaboration with AIST

Summary & Announcement

- Summary
  - The satellite and sensor EM test has been completed. Currently, the PFM is integrated and will be characterized.
  - We prepare the post-launch operation plan of GOSAT.
  - We collaborate with OCO group for some items and activities have started.

- Announcement
  - Research announcement has been prepared and will be released soon. The GOSAT science plan will be distributed.
  - Please apply the Cal/Val activities of L1/L2, various data application of L1/L2 and more higher data for your purposes. Welcome to GOSAT project!

Advantage of GOSAT

- Simultaneous observations of SWIR and TIR spectra
  - SWIR target is dayside over land and ocean with sun glint tracking.
  - TIR target is dayside and nightside.
- Cloud and aerosol observation with higher resolution than FTS

- Other topics
  - Polarization
  - Other trace gases
  - Cloud property by simultaneous observation of UV-TIR
- Different local time observation of IASI(9:30), and GOSAT(13:00)
- But, the same place observation together and comparison