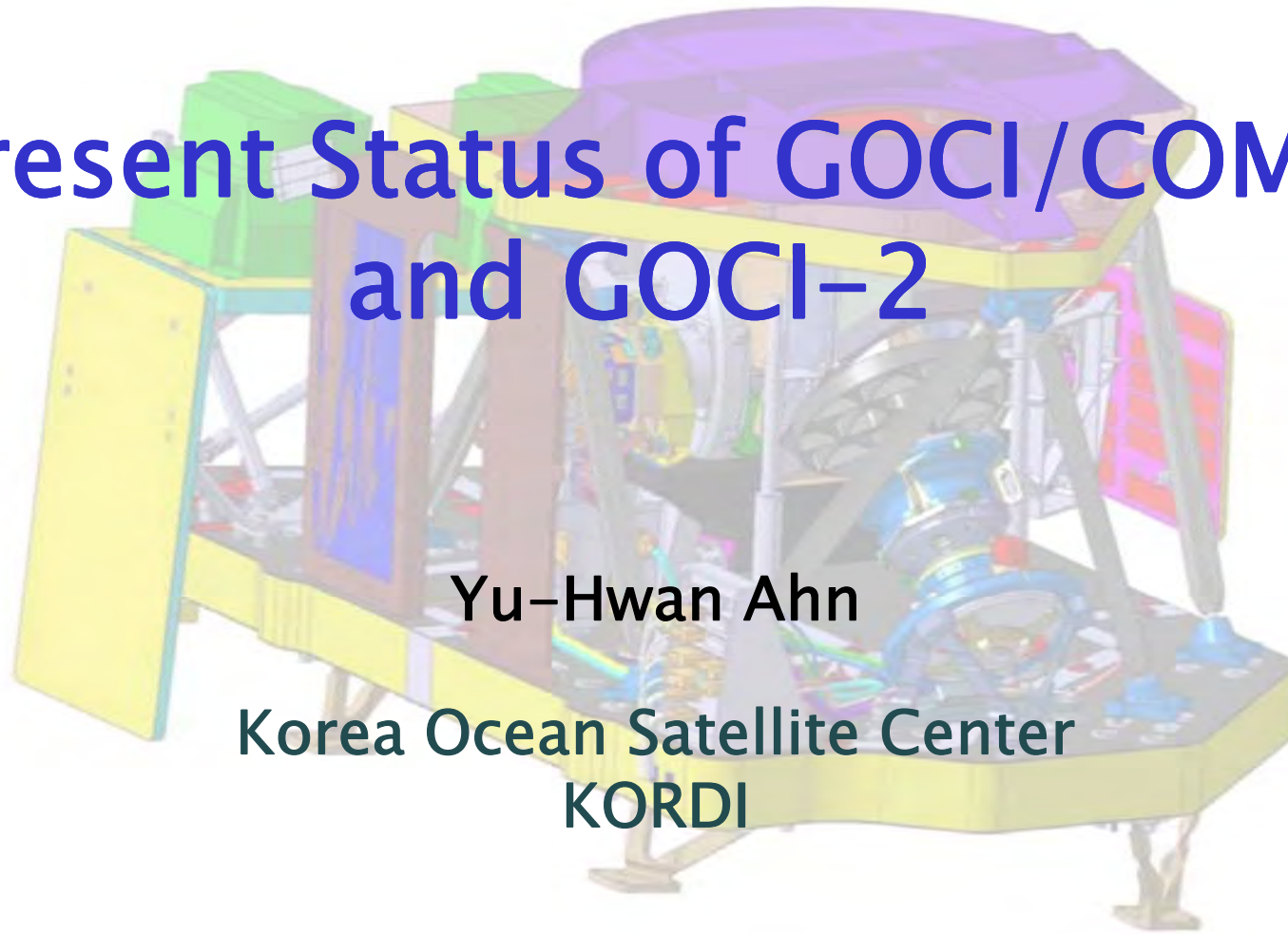
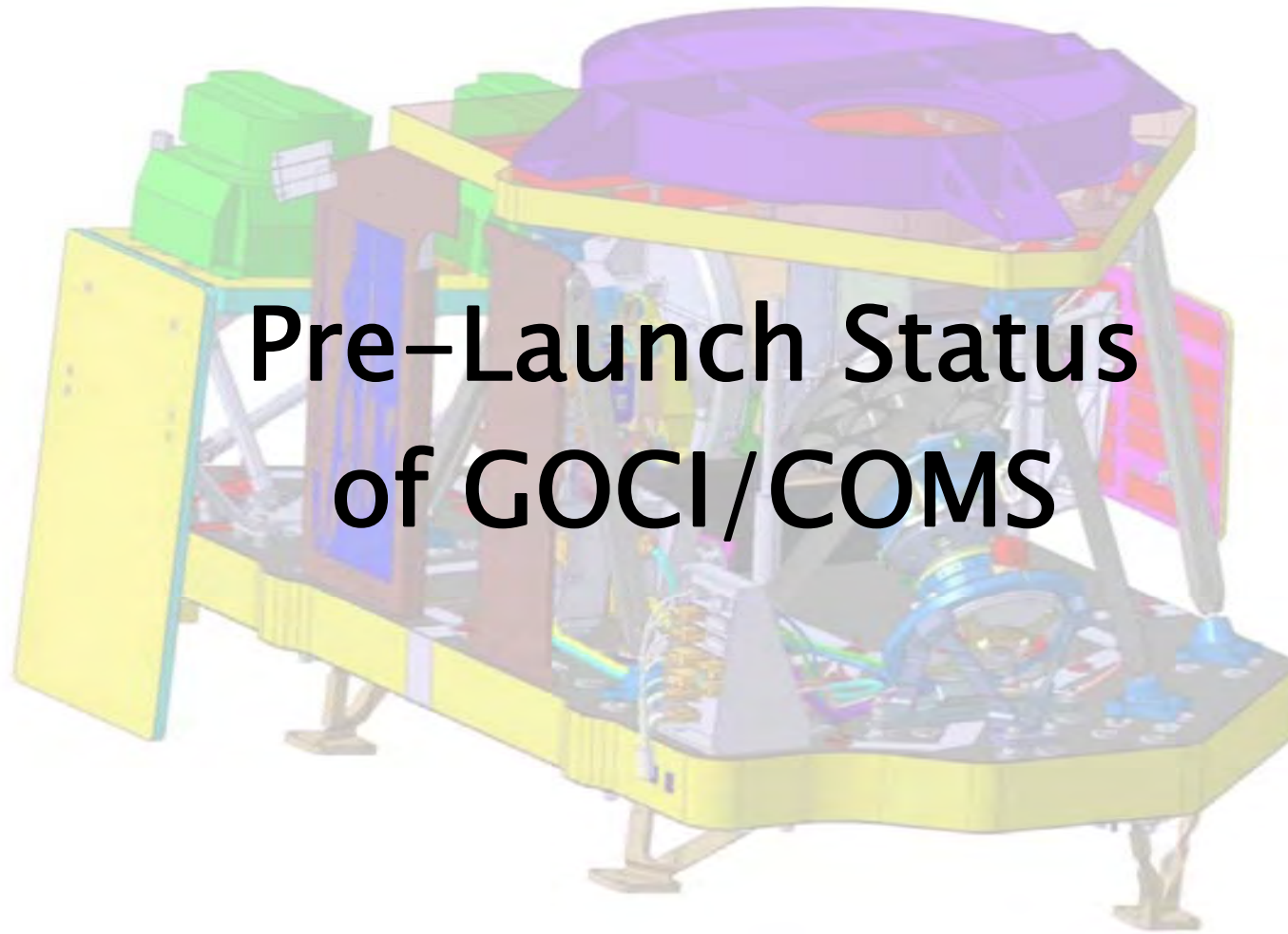


# Present Status of GOCI/COMS and GOCI-2

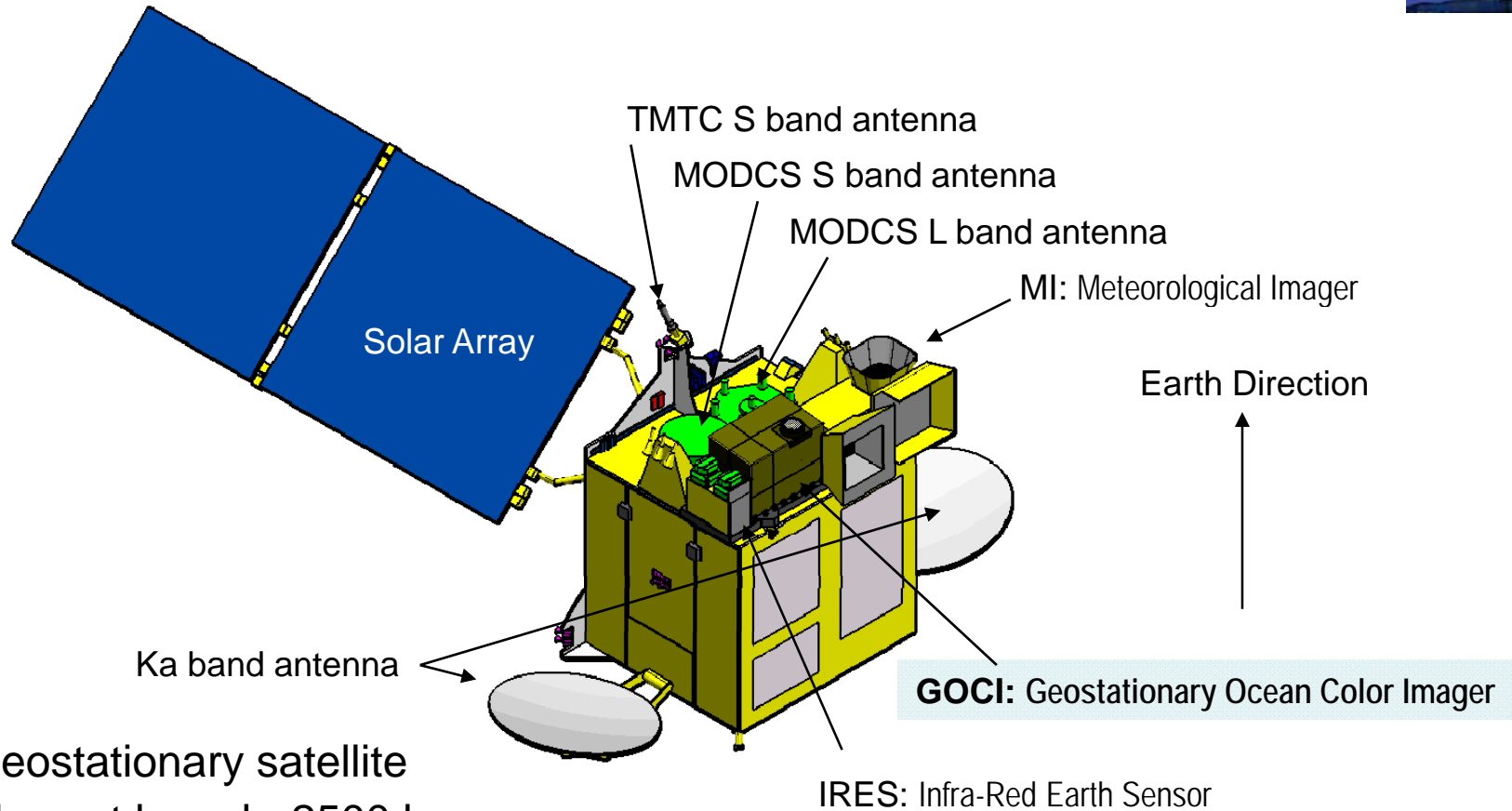
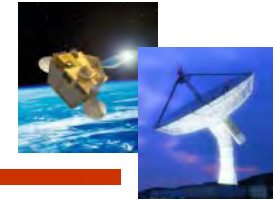


Yu-Hwan Ahn

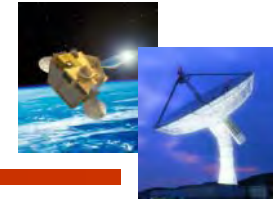
Korea Ocean Satellite Center  
KORDI



# Pre-Launch Status of GOCI/COMS

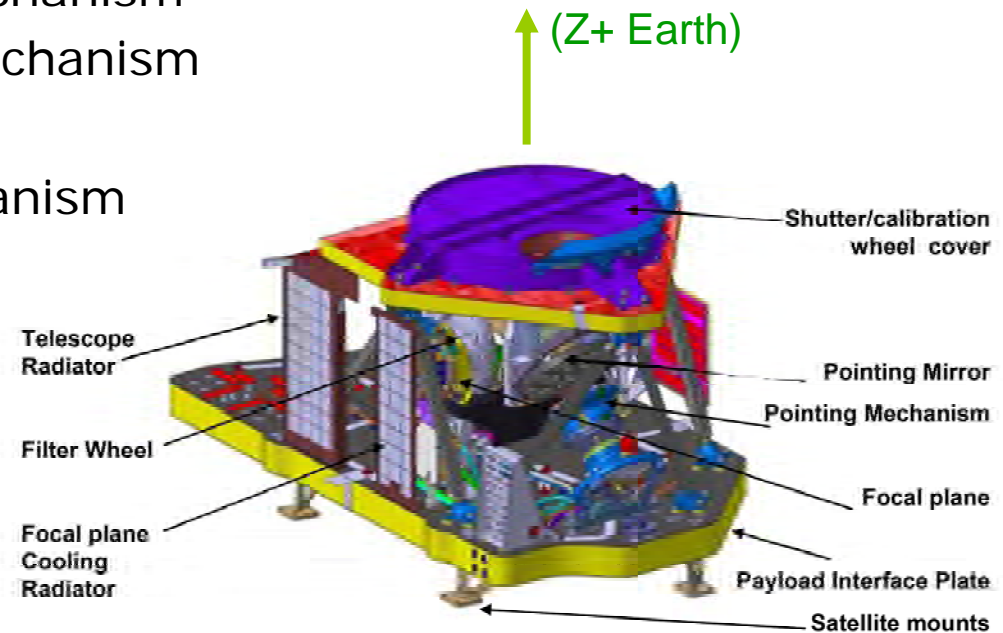
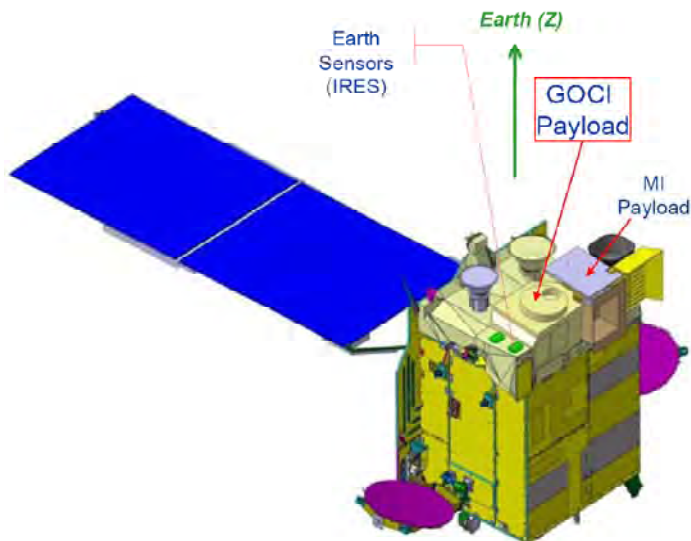


- Geostationary satellite
- Mass at launch: 2500 kg
- Design life time: 10 years
- Operational life: 7.7 years from launch
- Launcher: Ariane 5



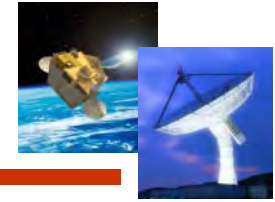
## ◆ Overview of GOCI Instrument

- Shutter wheel & Mechanism
- Pointing Mirror & Mechanism
- Optics
- Filter wheel & Mechanism
- Detector & FEE
- PIP
- IEU



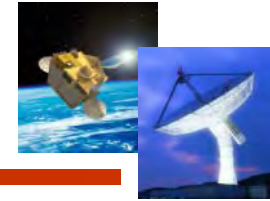
<b>Volume</b>	<b>1.39m x 0.89m x 0.85m</b>
<b>Mass</b>	<b>&lt; 84kg (including IEU)</b>
<b>Power</b>	<b>&lt; 100W (including thermal control)</b>

# KORDI Issues–Radiometric Calibration



- **Number of bad sensor pixels**
  - => Not meeting Radiometric Requirements
    - KORDI's Request : should be reduced to **0.01%** , not 0.1%.
    - Status : 0.01% **confirmed** by Test Results
- **2<sup>nd</sup> Diffuser (Diffuser Aging Monitoring Device) size**
  - KORDI's Request : DAMD should be identical to solar diffuser to monitor the aging.
  - Status : **Small sized** (half of diameter) 2<sup>nd</sup> diffuser is implemented replaced from calibration plate.





- Accuracy requirement : < 4%  
 -> lower than **3.8%** (Solar calibration only)

GOCI Radiance Calculation Equation

$$\tilde{L} = \frac{1}{T_{int}} \frac{\bar{S}}{\tilde{G}} \left[ 1 - \frac{\tilde{b} \bar{S}^2}{\tilde{G}^3 + 3\tilde{b} \bar{S}^2} \left( 1 + 3 \left( \frac{\tilde{b} \bar{S}^2}{\tilde{G}^3 + 3\tilde{b} \bar{S}^2} \right)^2 \right) \right]$$

Identification of error sources

- On-ground characterization parameters
  - ✓ Diffusion factor of SD
  - ✓ FMD of DAMD
- In-orbit operation environment
  - ✓ Reflectivity variation of pointing mirror
  - ✓ Gain variation during one day
  - ✓ Offset variation during one slot imaging
  - ✓ System noise (SNR)
  - ✓ SD aging factor estimation error
  - ✓ DAMD aging
- GOCI radiometric model error
  - ✓ Simplification of nonlinearity due to dark current

Analytic calculation of estimation error

**Derivation error propagation coefficients** from radiance equation

&

**Error source estimation** from On-ground test results achieved at GOCI level and equipment level

Then

Calculation of radiance estimation error using propagation coefficients and error

Validation of analytic method through GOCI simulation model

Simulation of **Sun radiance acquisition** with GOCI for single pixel (using GOCI simulation model)

&

Simulation of **Sea radiance acquisition** with GOCI for single pixel (using GOCI simulation model)

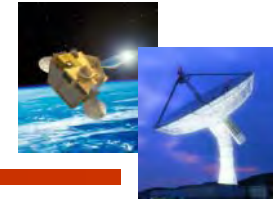
&

**Radiance calculation** using simulated GOCI signals

↓

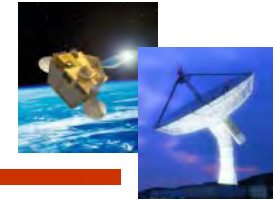
Extraction of radiance estimation error using simulation results (1000 times)

Comparison between analytical result and simulated result



- GOCI has shipped to Korea in Nov. 24, 2008





- GOCI has been successfully integrated into COMS in KARI / Korea
- GOCI/COMS final ground test campaign is on going in KARI.



+/-Y wall Panel Harness



-Y wall Coupling



MODCS Panel Coupling



Top Floor Flatness Measuring



Closure Panel Closing



Closure Panel Closing



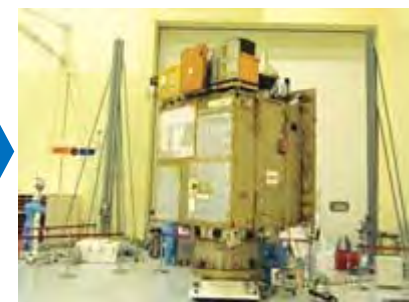
Propulsion Leak Test



Battery Panel Coupling

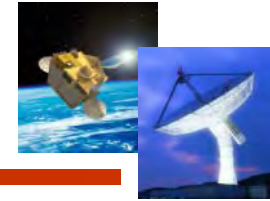


GOCI integration

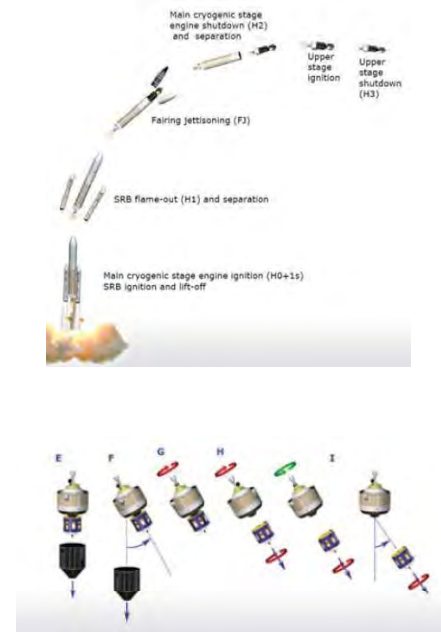
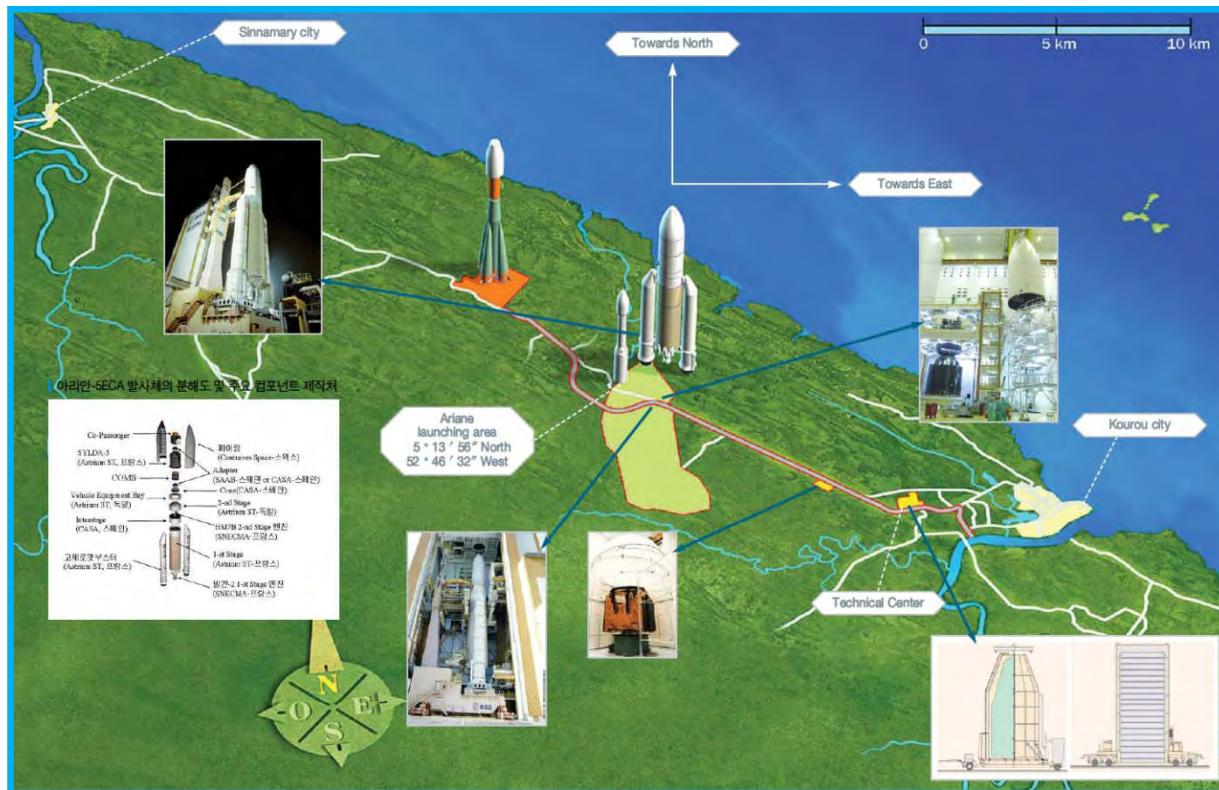


GOCI/COMS Final Test





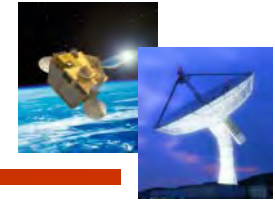
- Launch Schedule : Nov. 2009
- Launch Vehicle : Ariane-V (ESA)
  - Location : Kourou Space Center, French Guiana





# GOCI-2

(2010 -2016)



## Multiple purpose GEO satellite(A &B)

## COMS

---

-	
Meteorological satellite (MI-2)	Communication payload
Ocean payload (GOCI-2) 60M\$	Meteorological payload
Atmospheric chemistry payload	Ocean payload(GOCI)
	-

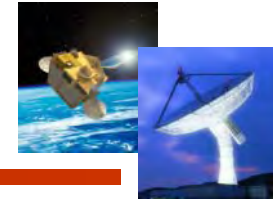
- Data Collection System(DCS ?)

=> Confirmed by Ministries

Under evaluation for funding / National scientific committee

# KORDI GOCI-2 Mission Requirements

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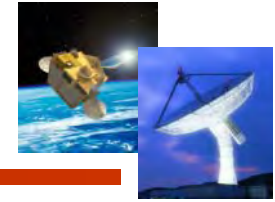
- Main Mission
  - Succession and expansion of the GOCI-1 missions
- Newly assigned Mission to GOCI-2
  - Establishment of Ocean Observation System to monitor long-term climate change **with Full Disk Observation.**
  - Environment Monitoring for the efficient management of coastal waters **with High Resolution(GSD 250m) Local Area Observation.**





# **GOCI-2**

## **User Requirements and Feasibility Study**

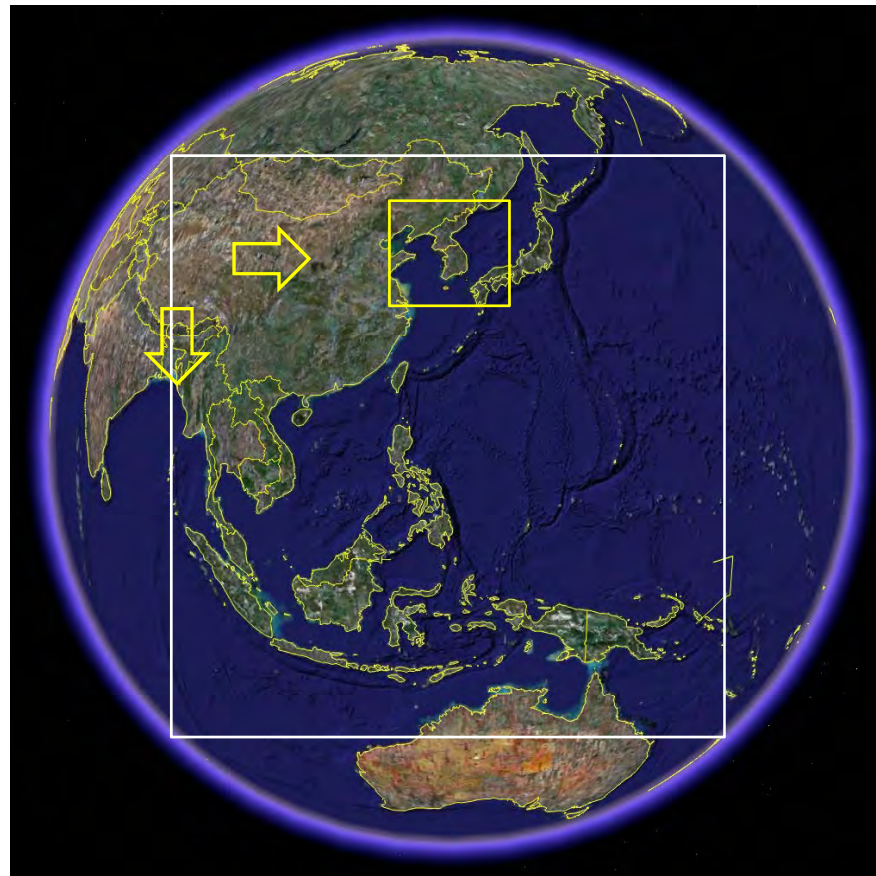


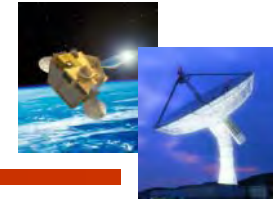
- **Key Requirements**

- Spectral Band : 13 bands (cf. GOCI = 8 Bands)
- Resolution(GSD) : 250m & 1km (cf. GOCI = 500m)
- Temporal Resolution : every 1 h & 12-24h
- Observation Coverage
  - Local Area(GOCI Coverage) – GSD: ~250m
  - Full Disk Coverage – GSD: ~1000m
- Nighttime Observation
  - Additional Panchromatic Filter
    - Panchromatic Filter (400~900nm)
    - Dedicated Low Noise Detector for Nighttime Observation



- Monitoring of the Global/Local ocean environment



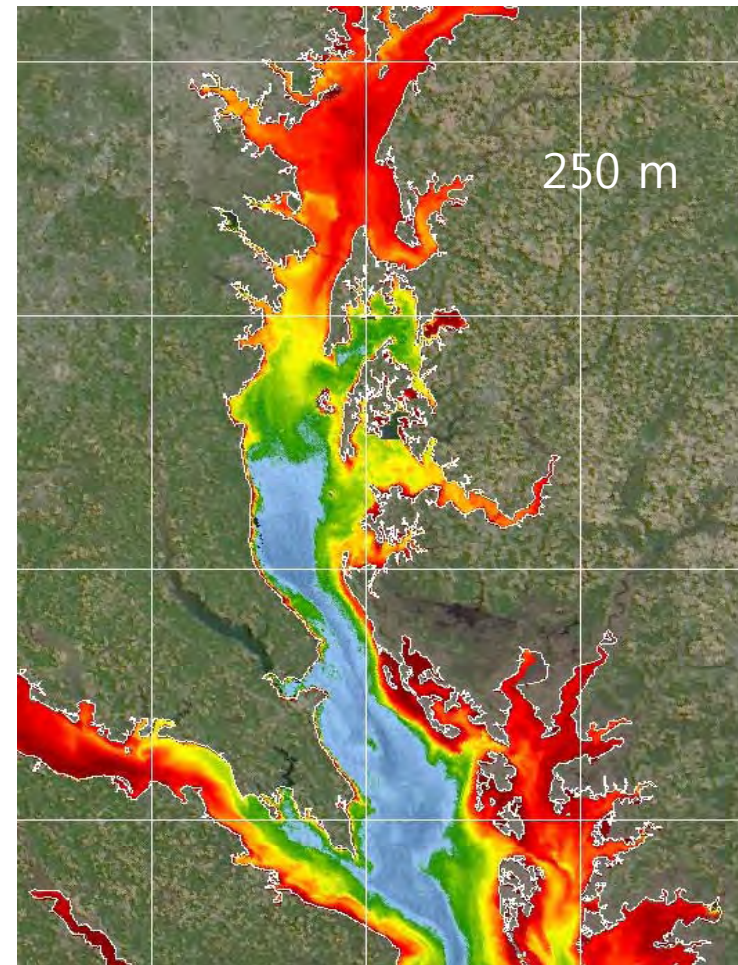
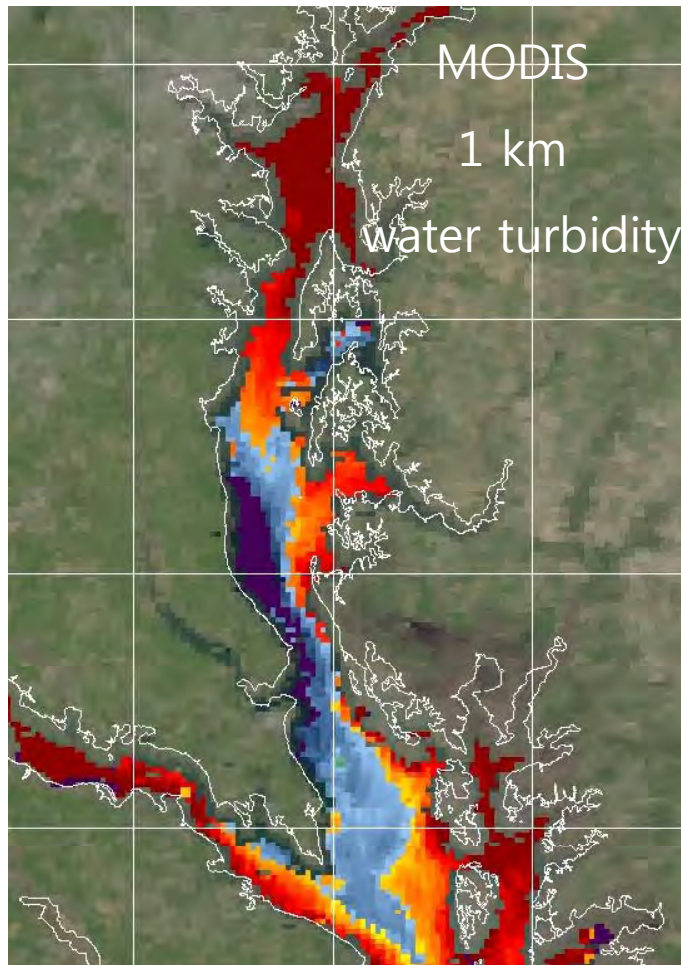
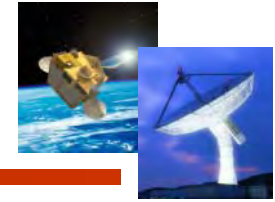


- Comparison with GOCI

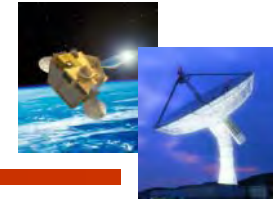
	GOCI	GOCI-2
Orbit type	GEO	GEO
# of Bands	8	13
Spatial Resolution	500m x 500m	250m x 250m 1km x 1km
Coverage	Local Area (Korean Peninsula)	Local Area & Full disk
SNR	~1000	~ 1500
Temporal Resolution	1 Hour	1 Hour 12-24H



# KORDI Technical Analysis for Resolution



=> Due to low spatial resolution, ocean contamination by land signal can't be applicable.



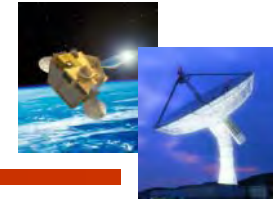
- Spectral Bands Requirements
  - 13 Bands (GOCI : 8 Bands)
  - Nighttime Observation, Enhanced Atmospheric Correction Accuracy

Radiance : W/m<sup>2</sup>/um/sr

Band	Heritage	Band Center	Band width	Nominal Radiance	Maximum Ocean Radiance	Saturation Radiance	Maximum Cloud Radiance	NEdL	SNR	Primary use
1	GOCI-B1	412nm	20nm	100.0	150.0	152.0	601.6	0.100	1000	Yellow substance and turbidity
2	GOCI-B2	443nm	20nm	92.5	145.8	148.0	679.1	0.085	1090	Chlorophyll absorption maximum
3	GOCI-B3	490nm	20nm	72.2	115.5	116.0	682.1	0.067	1170	Chlorophyll and other pigments
4	(KGOCI)	520nm	20nm							Red Tide
5	GOCI-B4	555nm	20nm	55.3	85.2	87.0	649.7	0.056	1070	Turbidity, suspended sediment
6	(KGOCI)	625nm	20nm							SS & Red Tide
7	GOCI-B5	660nm	10nm	32.0	58.3	61.0	589.0	0.032	1010	Baseline of fluorescence signal, Chlorophyll, suspended sediment
8	GOCI-B6	685nm	10nm	27.1	46.2	47.0	549.3	0.031	870	Atmospheric correction and fluorescence signal
9	GOCI-B7	745nm	20nm	17.7	33.0	33.0	429.8	0.020	860	Atmospheric correction and baseline of fluorescence signal
10	(KGOCI)	765nm	20nm							Aerosol Properties, Atmospheric Properties
11	GOCI-B8	865nm	40nm	12.0	23.4	24.0	343.8	0.016	750	Aerosol optical thickness, vegetation, water vapor reference over the ocean
12		905nm	40nm							Atmospheric Properties, Cloud Properties
13		650nm	500nm	6.5E-6						Night Band (Night time fishing boat activities)



- 5 additional bands and Full Disk Coverage
  - Technical impact
    - Long integration time
    - Increased Data : 9 times larger than GOCI
    - Increased data transmitting rate : **9 times larger than GOCI**
  - Solution
    - Data communication band : L-band to X-band
      - => **X band : about 23 time faster than L-band**
      - > **Feasible**
      - \* GOES-R(X-Band) : 140Mbps (A. Krimchansky et. al, 2006)
      - \* GOCI(L-Band) : 6.2Mbps , MI(L-Band) : 2.6Mbps
      - => **Required transfer rate : ~ 60Mbps**



- How to accomplish the resolution with GSD 250m

- Solution with modifying GOCI design

- Reduced CCD Pixel Size : 14.81 -> 7.0 $\mu$ m

(B. Zhukov, et. Al, 2005)

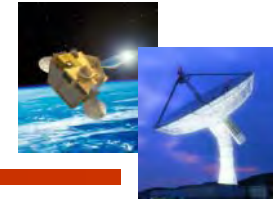
- Heritage: BIRD satellite- 7 $\mu$ m pixel size CCD [payload: WAOSS-B]

- Increased Aperture Size (14cm -> 30cm )

- To compensate SNR & MTF degradation due to reduced pixel size and increasing light gathering power

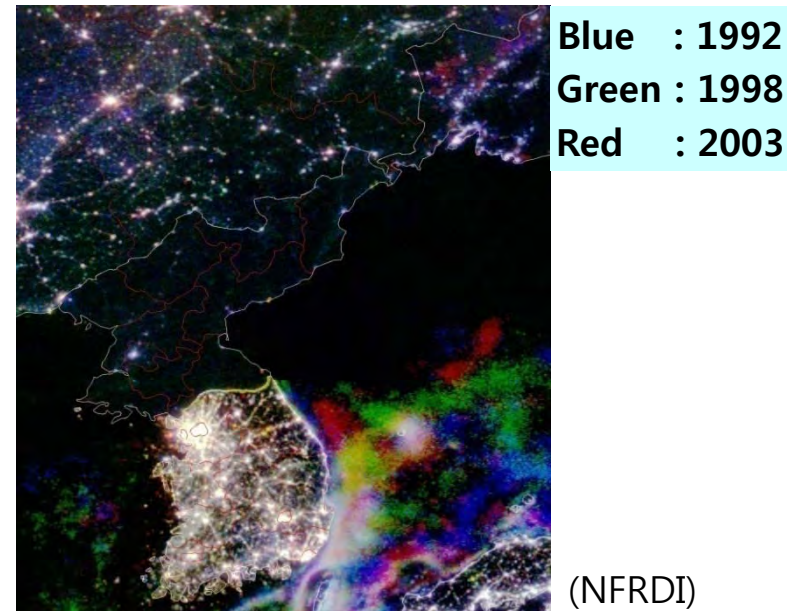
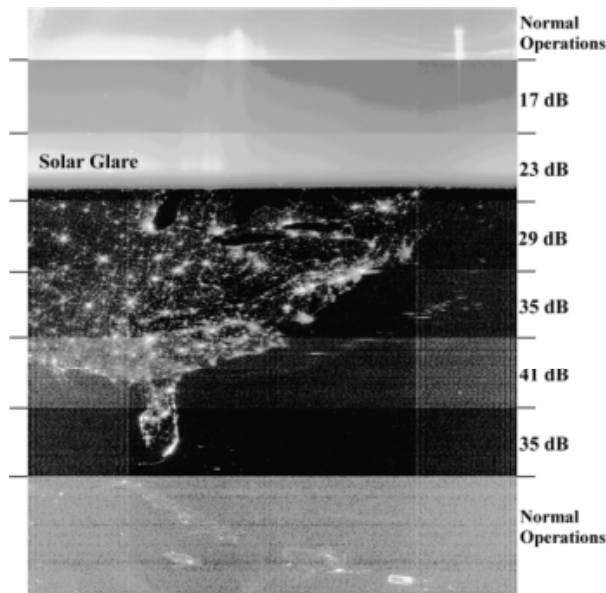
구분	KAI-16000	GX-20	WFC3	GOCI
Company	Kodak (Japan)	Samsung (Korea)	E2V (UK)	E2V (UK)
Type	CCD	CMOS	CCD	CMOS
Pixel	4,872×3,248	4,672×3,104	2x2051x4096	1,415x1,431
Pixel Size	7.4 $\mu$ m×7.4 $\mu$ m	5.0 $\mu$ m×5.0 $\mu$ m	15.0 $\mu$ m×15.0 $\mu$ m	14.81 $\mu$ m×11.53 $\mu$ m
Detector Size	36.1×24.0mm	15.6x23.4 mm	62.1x61.4mm	18.1x22.1 mm
Spectral Range	400~900nm	400~900nm	200~1000nm	400~900nm

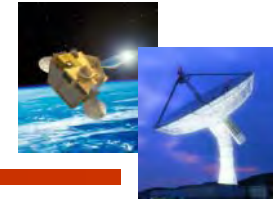




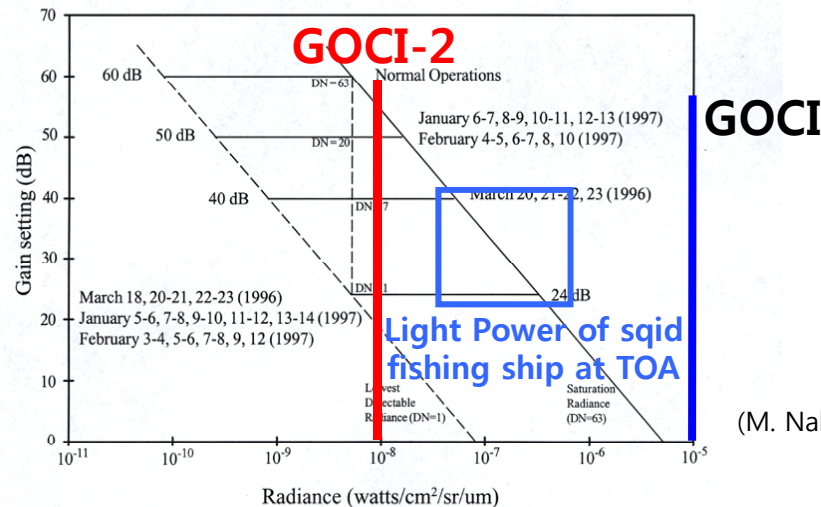
- **Nighttime Observation**

- 1 band observation (Panchromatic Filter ;400~900nm)
- Light energy required : ~ 1000 time /GOCI

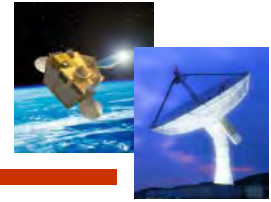




- How to increased Light gathering power and efficiency
    - Panchromatic Filter (400–900nm) : (~15 times)
    - Increased Max. Integration time (only 1 band / 5 times)
    - Increased Electronic gain in amplifier(2 time)
    - High S/N CCD (2 times lower NEdL)
    - Larger Aperture size (4 times)
- => 1200 times higher incident power / Feasible



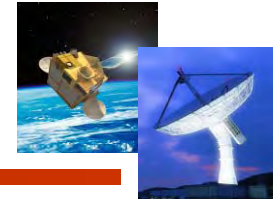
(M. Nakayama & Ch. D. Elvidge, 1999)



# Preliminary Design of GOCI-2

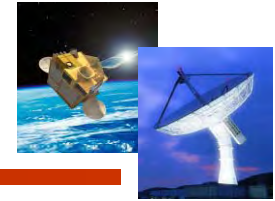
**: Is it possible to fabricate FOV-selectable(Local Area, Full Disk) Ocean Sensor?**

# KORDI GOCI-2 Pre Design : 3 Options



- **Key Issue :**
  - > How to fabricate the optical system which offers FOV selection function **for Local Area and Full Disk Observation?**
- **Option 1 : Modified GOCI Design**
- **Option 2 : WFOV with additional optics (2D frame)**
  - ZORO Type Telescope (Korean Design)
- **Option 3 : WFOV with scanning (1D push broom)**
  - ABI(Advanced Baseline Imager) Type Imager

# KORDI Option 1. Modified GOCI Design

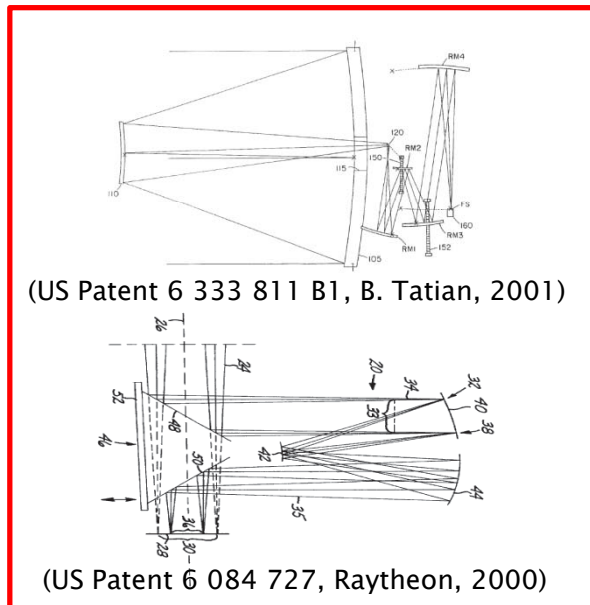


- **Technical Requirements for Full Disk (WFOV)**

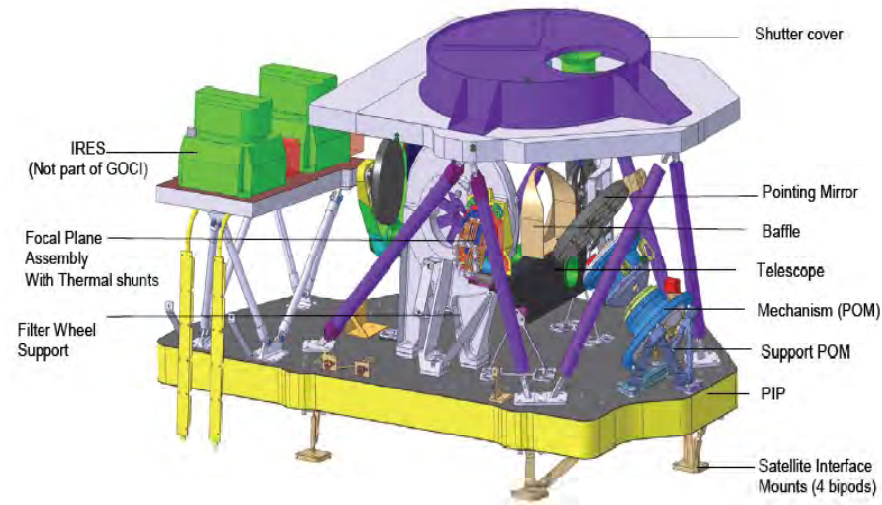
- > Relay Optics with Beam Splitter
- > Larger Aperture Size, etc.

GOCI has no space for additional optics(Relay Optics, Beam Splitter, etc.)

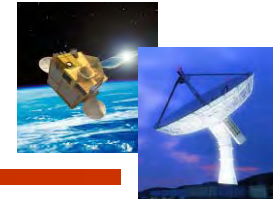
**Re-Design is required for Full Disk Observation.**



Feasible Design for FOV switching optics



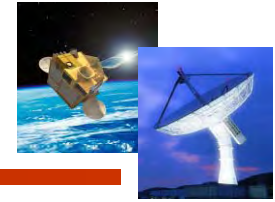




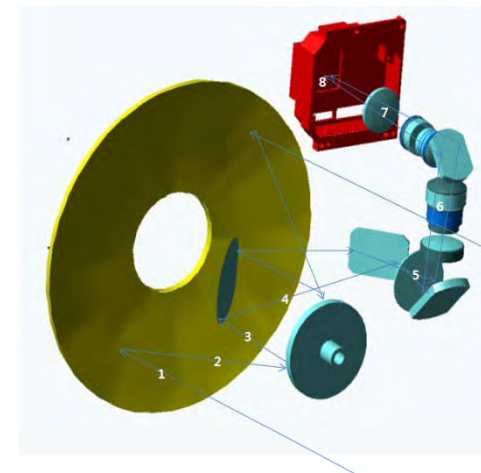
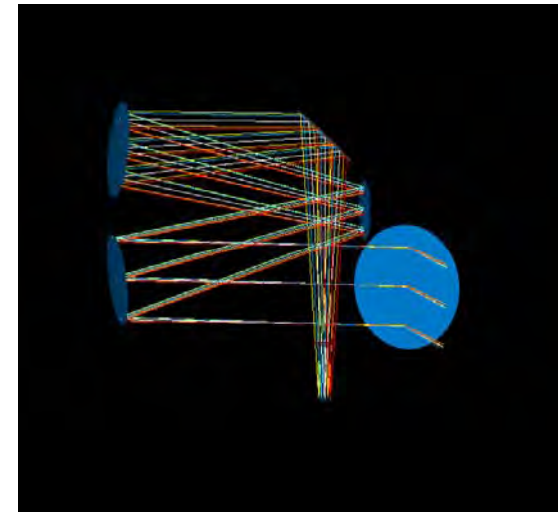
- ZORO type Reflective Telescope
  - Simultaneous NFOV & WFOV Observation
  - Front-end Reflective Telescope + Relay Optics

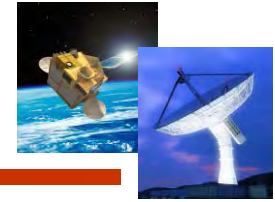
Type	Wavelength	Focal Plane (diagonal)	FOV	EFL	f/# (EPD)
Narrow Visible	500-750nm	43.33mm	1.27°×0.84°	1630mm	5.1 (320mm)
Wide Visible			3.7°× 2.2°	670mm	10.0 (67mm)



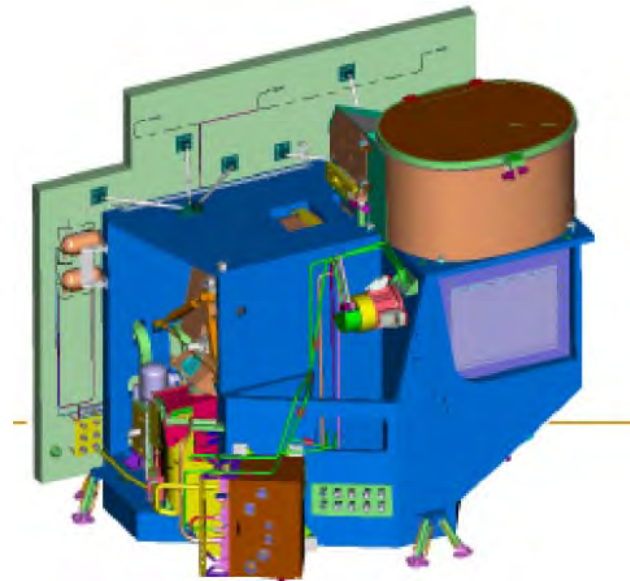


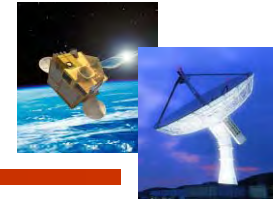
- **GOCI:**
  - 500 m in spatial resolution
  - Aperture of 140 mm in diameter
  - 14 microns in pixel size
  
- **GOCI-2 ZORO Type (draft)**
  - 150-250m in spatial resolution
  - Aperture of 300 mm in diameter
  - 7 microns in pixel size





- **Full Disk observation with scanning**
  - One of the most feasible solution for Full Disk acquisition
    - 16 bands in Visible and IR
    - SNR : 300
    - FPA : 1D Push Broom
    - Aperture : 27 cm





1. GOCI-2 will have full disk coverage with higher resolution and 5 more bands than GOCI.
2. By the result of the tentative study, all user requirements are feasible.
3. Detailed feasibility study and system design will be followed.
4. For the Full Disk Coverage, dedicated optical design is Required.
5. All of GOCI-2 Pre designs have a possibility to be selected as GOCI-2 Design.
6. In-depth technical feasibility study and trade-off will be followed.



# **GOCI-1 data distribution policy**



# KORDI GOCI Data Characteristics

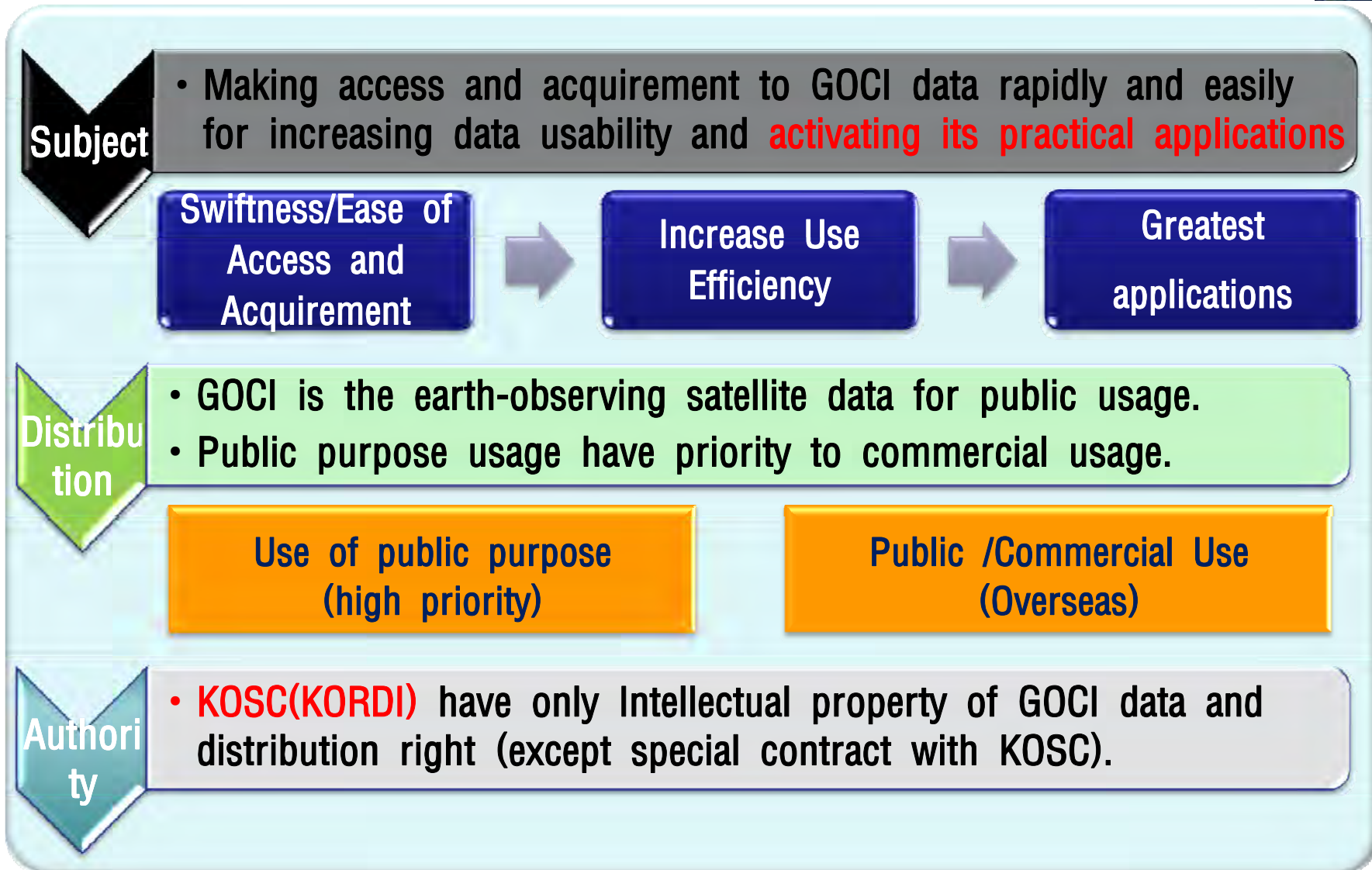


	Data Type	Related S/W	Description	size	Distribution
IMPS	GOCI RAW	GDAS & IMPS/DM	Received packet data from satellite	769MB	X
	GOCI L0	IMPS/DM	Slot Image data + Dark Calibration Data	634MB	X
	GOCI L1A	IMPS/PMM	Radiometric corrected data in IRCM	994MB	X
	GOCI INRSM input file	IMPS/PMM	INRSM input data same as L1A	994MB	X
	GOCI INRSM output file	IMPS/INRSM	INRSM output data. Whole image data with geometric correction	994MB	X
	GOCI L1B	IMPS/PMM	Rearranged whole image data including header information	~994MB	O
GDPS	GOCI L1B region	GDPS/GOCI Regional Data Generation Module	L1B subscened data to pre defined regions	994MB~	O
	GOCI L2	GDPS/L2 Generation Module	Bio/physical data applied ocean analysis algorithm	~3.5GB	O
	GOCI L2 region	GDPS/GOGI Regional Data Generation Module	L2 subscened data to pre defined regions	~3.5GB	O
	GOCI L2 LRIT	GDPS/Sample Image Generation Module	Three kinds of GOCI small image data for LRIT distribution (CHL, SS,DOM)	10MB	O
	GOCI L1B/L2 Browsing image	GDPS/Browsing Image Generation Module	Very small insight image data for searching/browsing L1B/L2 in GDDS (200x200, 1000x1000)	40KB 1MB	O

**\*\*KOSC Data Management System Data Size**

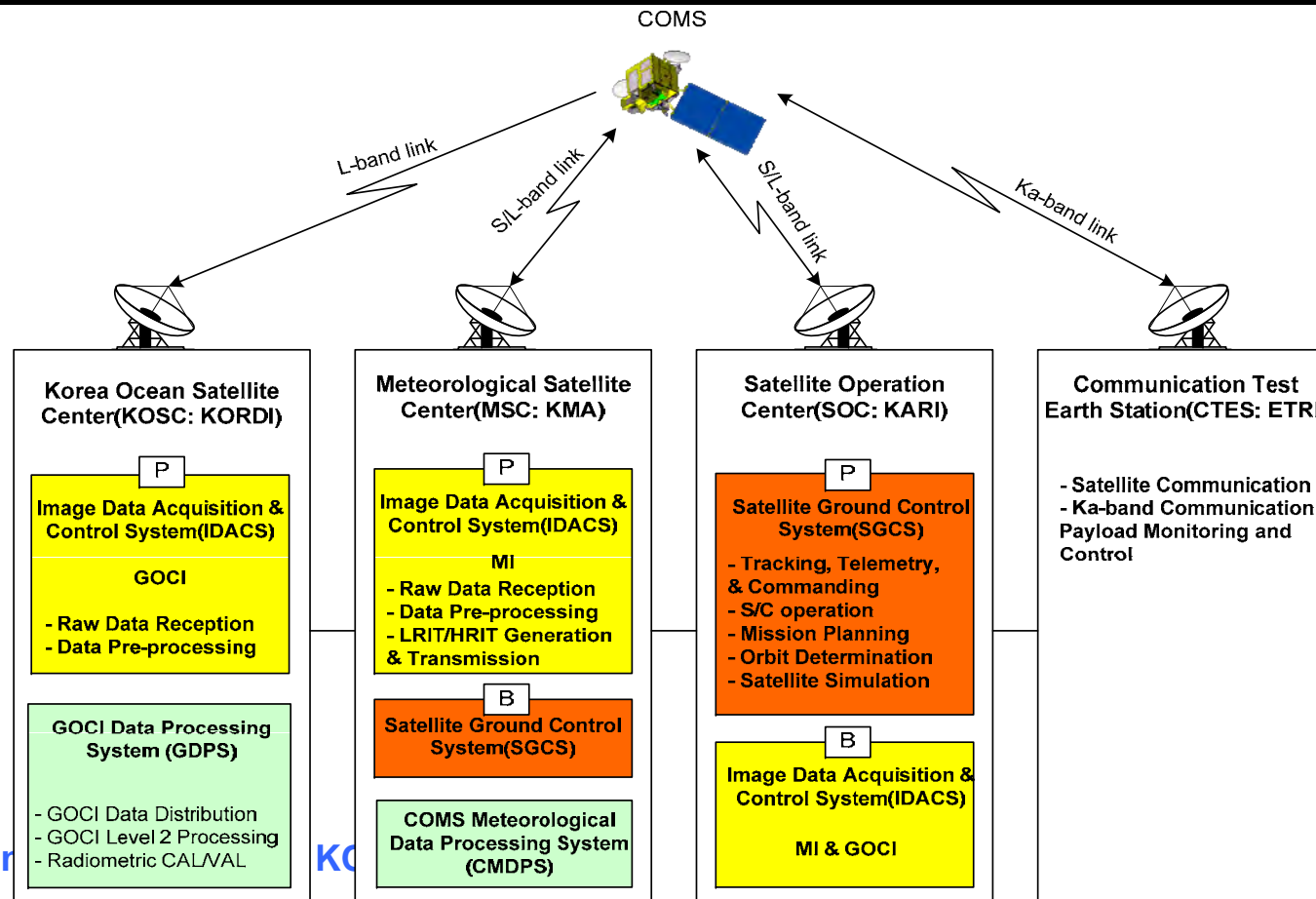
one-time :11.4GB / one-day : 114GB / one-month: 3.4TB / one-year: 41.64T

# Fundamental concept of GOCI distribution





	Korea Ocean Satellite Center (KOSC:KORDI)	Satellite Operation Center (SOC:KARI)
Major Subject	<ul style="list-style-type: none"> <li>- Mission scheduling</li> <li>- Satellite data receiving and archiving</li> <li>- Standard data processing service</li> <li>- Sensor optical calibration</li> </ul>	<ul style="list-style-type: none"> <li>- Satellite Operation (mission and orbit determining)</li> </ul>
Minor Subject	<ul style="list-style-type: none"> <li>- data backup and distribution of L1b later</li> <li>- Cal/Val of L2 - User support/training</li> </ul>	<ul style="list-style-type: none"> <li>- data backup of before L1B(limited)</li> </ul>





## Public purpose distribution

### Domestic users

- **Free distribution** : public interest & research (except commercial purpose)
- **Distribution data type** : **GOCI L1B ~ Level 2**
  
- **Data access** : Online distribution(possible offline request)
  - Near real time distribution : at least within 2 hours
- **Redistribution is not authorized except national institutes(NFRDI)**



## Public purpose distribution

### Foreign users

- **Free distribution** : Research (PI registration) & public interest
- **Commercial distribution** : industry, case of regular data service & processing
- **Distribution data type** : **GOCI L1B ~ Level 2**
- **Data access** : Online distribution (possible offline request)

**Delayed mode distribution** : within 1-3 days (to avoid line traffic)

- **Redistribution** is not authorized (except special contract with KOSC/KORDI)
- **Direct receiving station** : Possible with mutual agreement between 2 countries