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Korea's First Satellite for Satellite Laser Ranging

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Introduction to SaTReC

Overview

- SaTReC was
  - ✓ Founded in 1989 as Korea's first research organization dedicated to education and research in satellite engineering, space science and remote sensing
  - ✓ Selected in 1990 as an Engineering Research Center by the Korea Science and Engineering Foundation, which marked the beginning of space activities in Korea

- SaTReC developed
  - ✓ Korea's first two satellites: KITSAT-1, KITSAT-2
  - ✓ Korea's first earth observation satellite: KITSAT-3 (13.5m Multi-spectral GSD)
  - ✓ Korea's first space science satellite: STSAT-1 (Other names: KITSAT-4 or KAISTSAT-4)

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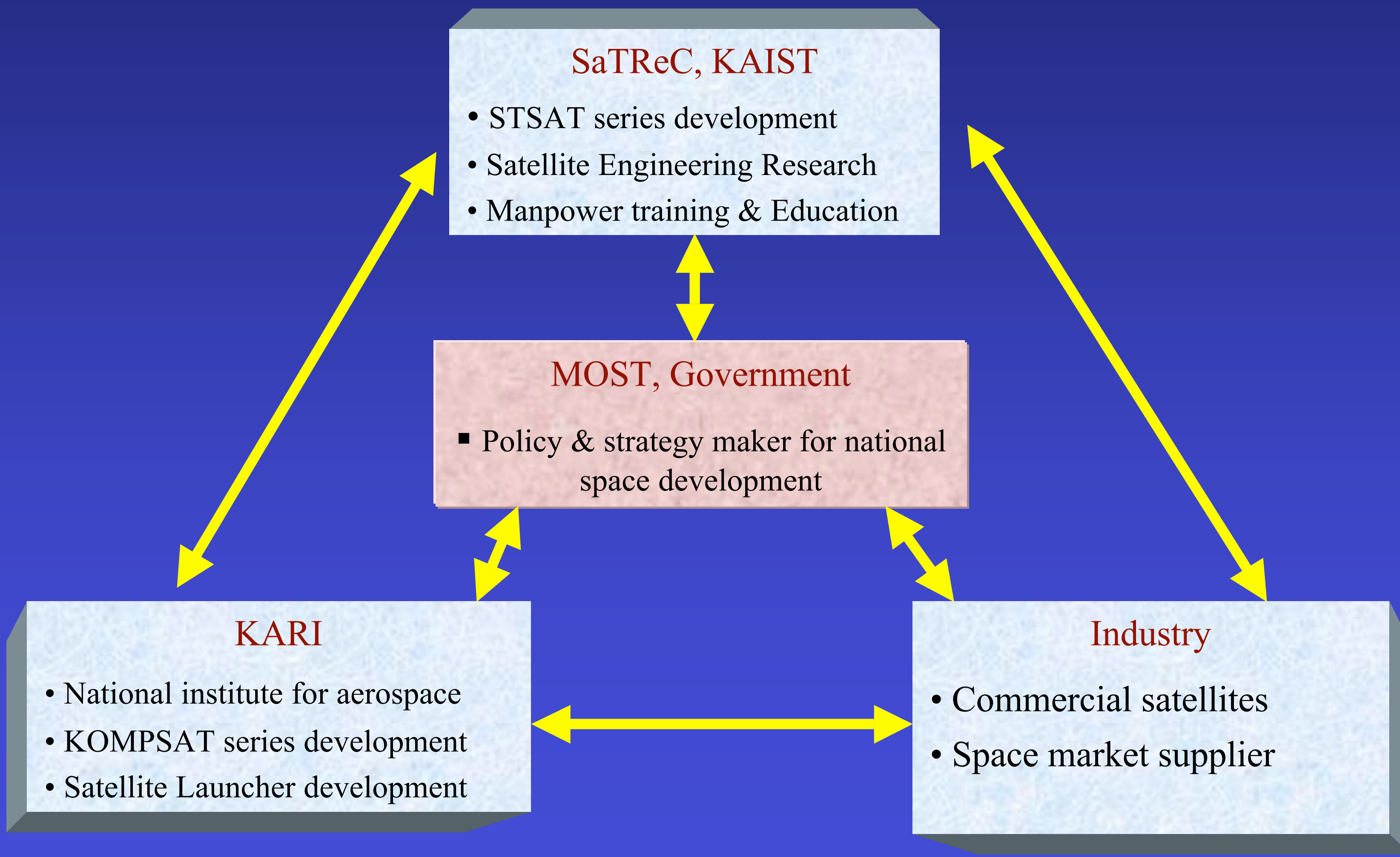
Introduction to SaTReC

One of three majors in Korea’ Space Devel.



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Introduction to SaTReC

Brief History

- ❑ 1989 Established
- ❑ 1990 KITSAT-1 Initiation (Surrey Univ., U.K.)
- ❑ 1992 KITSAT-1 Launch
- ❑ 1993 KITSAT-2 Launch
- ❑ 1995 Opened Overseas Laboratories in UCL, U.K. (Optical Camera, SAR)
- ❑ 1999 KITSAT-3 Launch
- ❑ 1999 SaTReCi spin-off
- ❑ 2003 STSAT-1 (KITSAT4 or KAISTSAT4) Launch
- ❑ 2004 STSAT-2 Development
- ❑ 2005~2007 STSAT-2 Launch (Planned)

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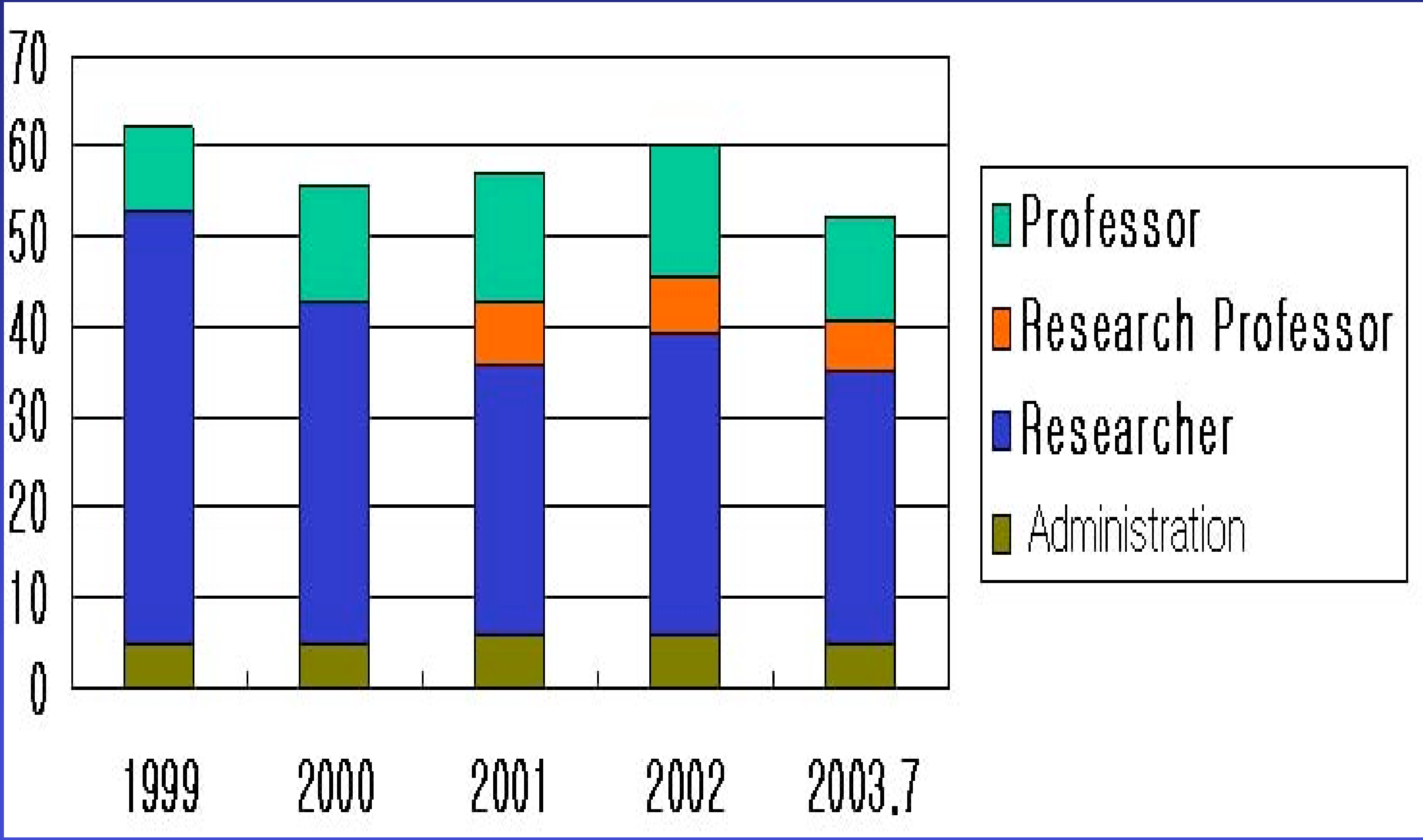
Introduction to SaTReC

Manpower



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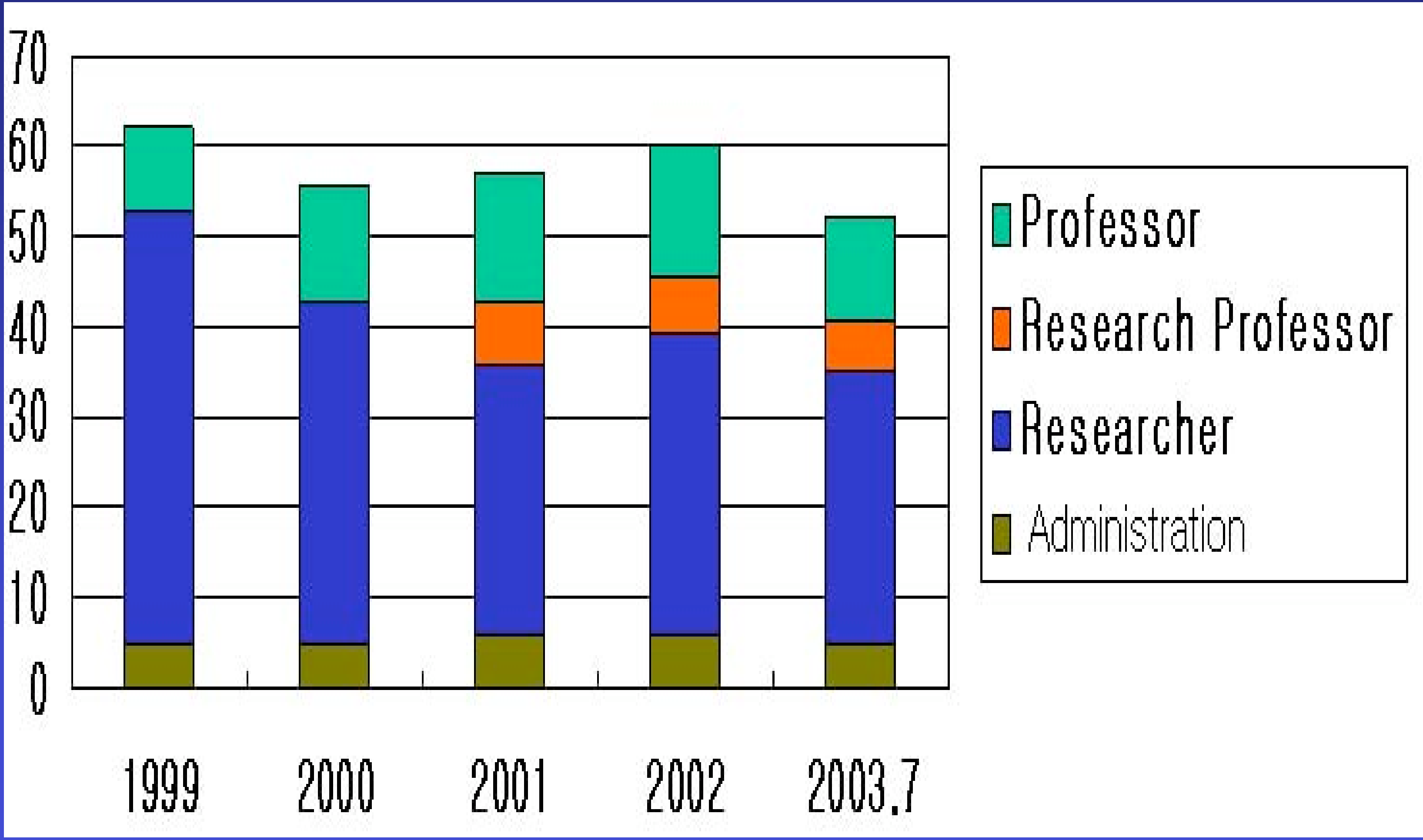
Manpower



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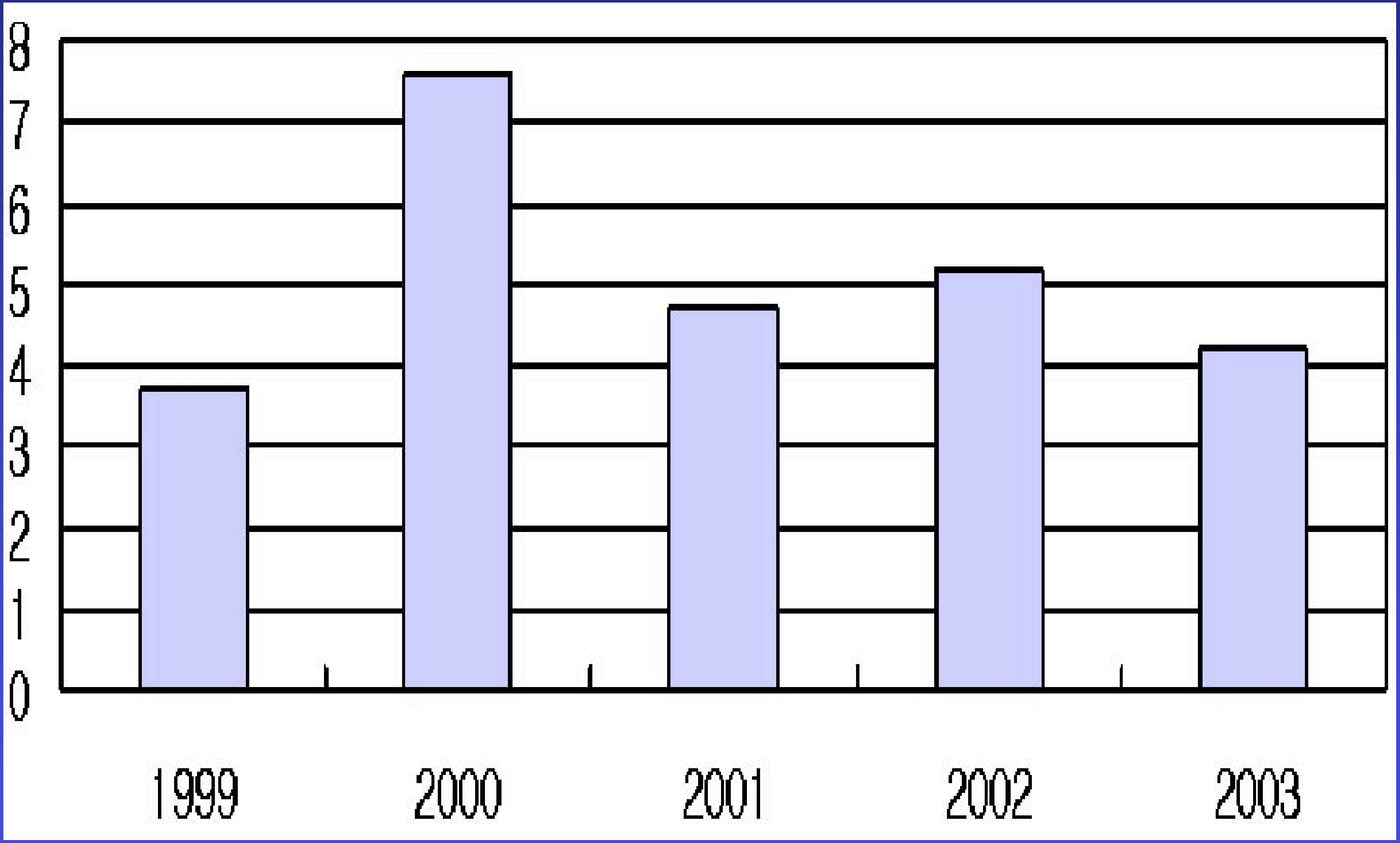
Annual Budget

(Unit: Million US $)



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Facilities

Electronics Assembly
and Test Area (200 sqm)

Attitude Control Simulator

Environment test facility

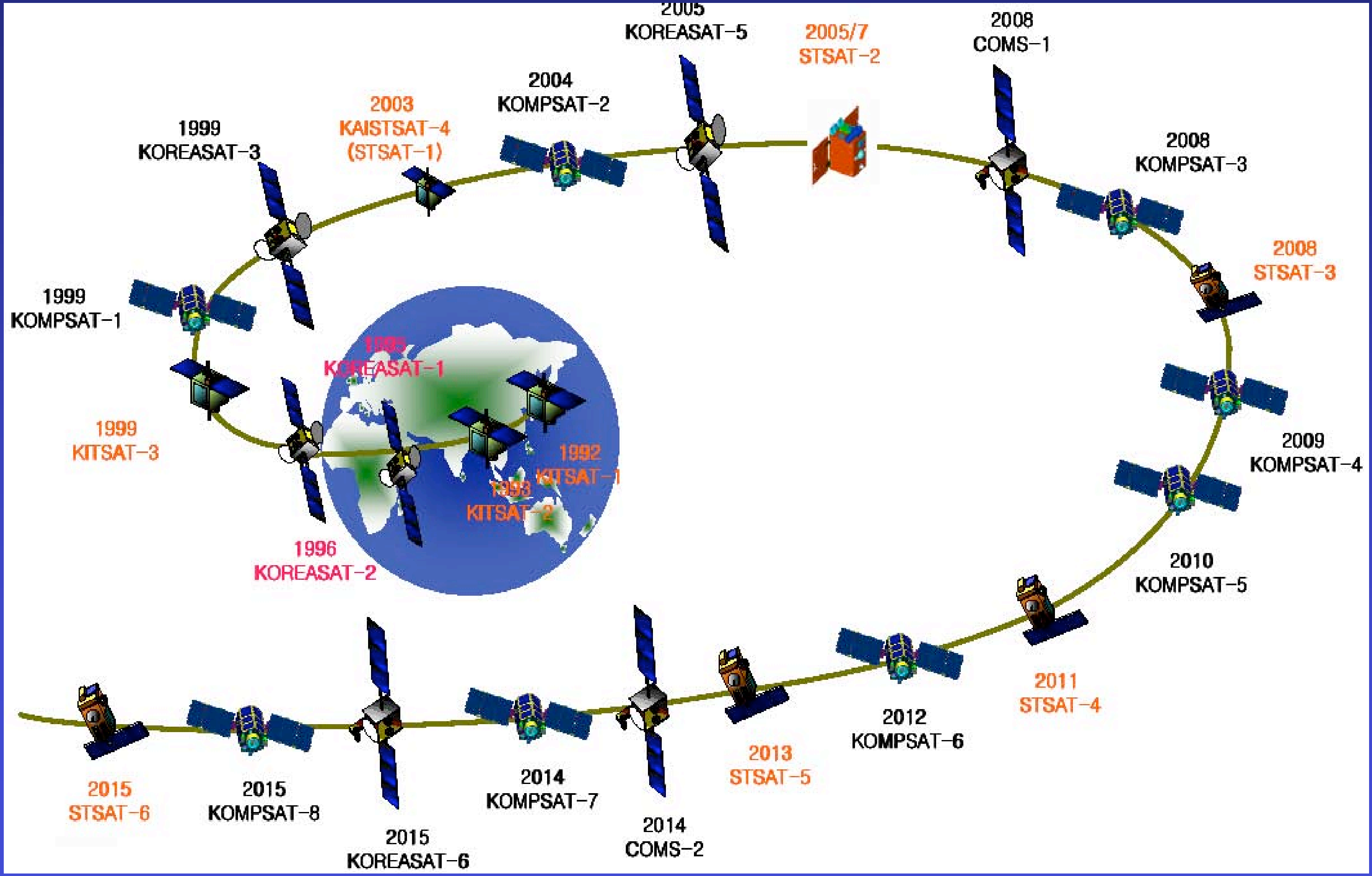
KITSAT/STSAT
Ground Control

Clean Room for Integration &Test
(cleanness : 100,000, 150 sqm)

13m S/X Band
+ 3m S-Band
+ 1 VHF/UHF antenna

Introduction to KITSAT/STSAT Series

Korea's Long Term Plan For Space Devel.



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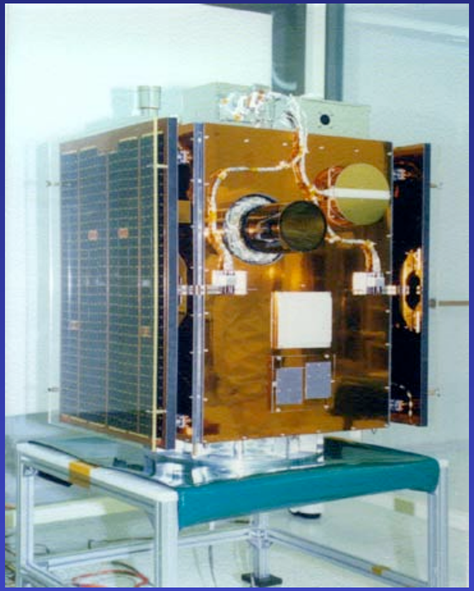
Introduction to KITSAT/STSAT Series

KITSAT Series



KITSAT-1 (1992)

- Technology Acquisition
- Manpower Training
- Jointly Developed with the University of Surrey, UK

KITSAT-2 (1993)

- New Payloads
- Use of Korean Components
- Developed by SaTReC and Tested in Korea

KITSAT-3 (1999)

- Development of a Unique Small Satellite System
- Engineering Test for Key Technologies
- Advanced Payloads

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Introduction to KITSAT/STSAT Series

KITSAT Series

	KITSAT-1	KITSAT-2	KITSAT-3
Launch Date	92. 8. 11	93. 9. 26	99. 5. 26
Mass	50 kg	50 kg	110 kg
Dimension	352*356*670	352*356*670	495*604*837
Altitude	1300 km	820 km	730 km
Power	30 Watt	30 Watt	180 Watt
Lifetime	5 Yrs	5 Yrs	3 Yrs
Camera Type	Area Frame	Area Frame	Linear Pushbroom
Camera GSD	4 km/400 m	2 km/200 m	13.8 m (3 Chs)
Solar Panels	Body-fixed	Body-fixed	Deployable
Com System	VHF/UHF	VHF/UHF	VHF/UHF/S/X
D/L Data Rate	9.6 kbps	9.6 kbps	3,300 kbps
Attitude Control	Gravity Gradient	Gravity Gradient	3-Axis Stabilized
Control Accuracy	< 5 deg	< 5 deg	< 0.5 deg
Actuators	G-G Boom Magnetorquers	G-G Boom Magnetorquers	Reaction Wheels Magnetorquers

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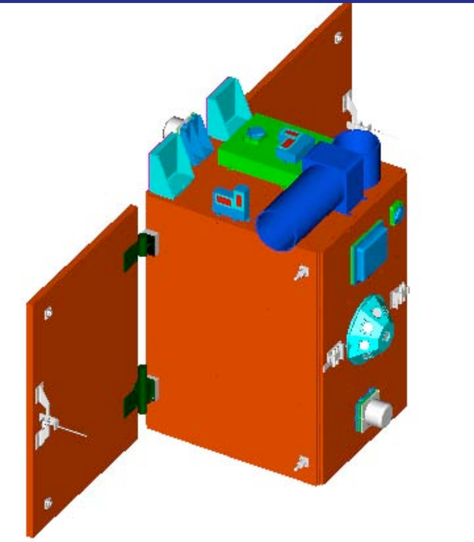
Introduction to KITSAT/STSAT Series

STSAT Series



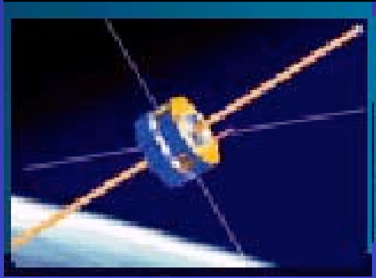
STSAT-1 (2003)

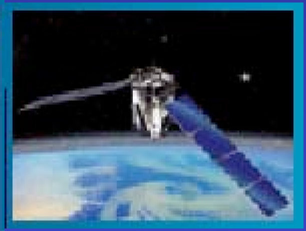
- Development of High Performance Micro-Sat
- Space Astronomy (FIMS)
- Engineering & Technology Demonstration

STSAT-2 (2005/2007)

- Sun Observation
- Satellite Laser Ranging
- Engineering & Technology Demonstration

- Nano satellites
- Light weight technology
- Advanced attitude control





•IR sensor

•Hyper-spectral sensor

•Radiometer

•SAR sensor

STSAT-3(2008)~STSAT6

* Detailed missions have been fixed yet.

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STSAT2

Mission Summary

Item	Specification
Sponsor	Ministry of Science and Technology of Korea
Expected life	2 years
Primary application	Satellite Engineering Experiments Solar Imaging at Lyman-α (0.121μm)
Primary SLR Application	Precise orbit determination
Launch date (planned)	Dec. 2005 (by KSLV-1)
Orbit	Elliptical
Inclination	80°
Perigee	300km
Eccentricity	0.082435
Period	102.998 minutes
Attitude control	3-axis stabilization, 0.15° pointing accuracy
Weight	90kg (Platform + Payloads)

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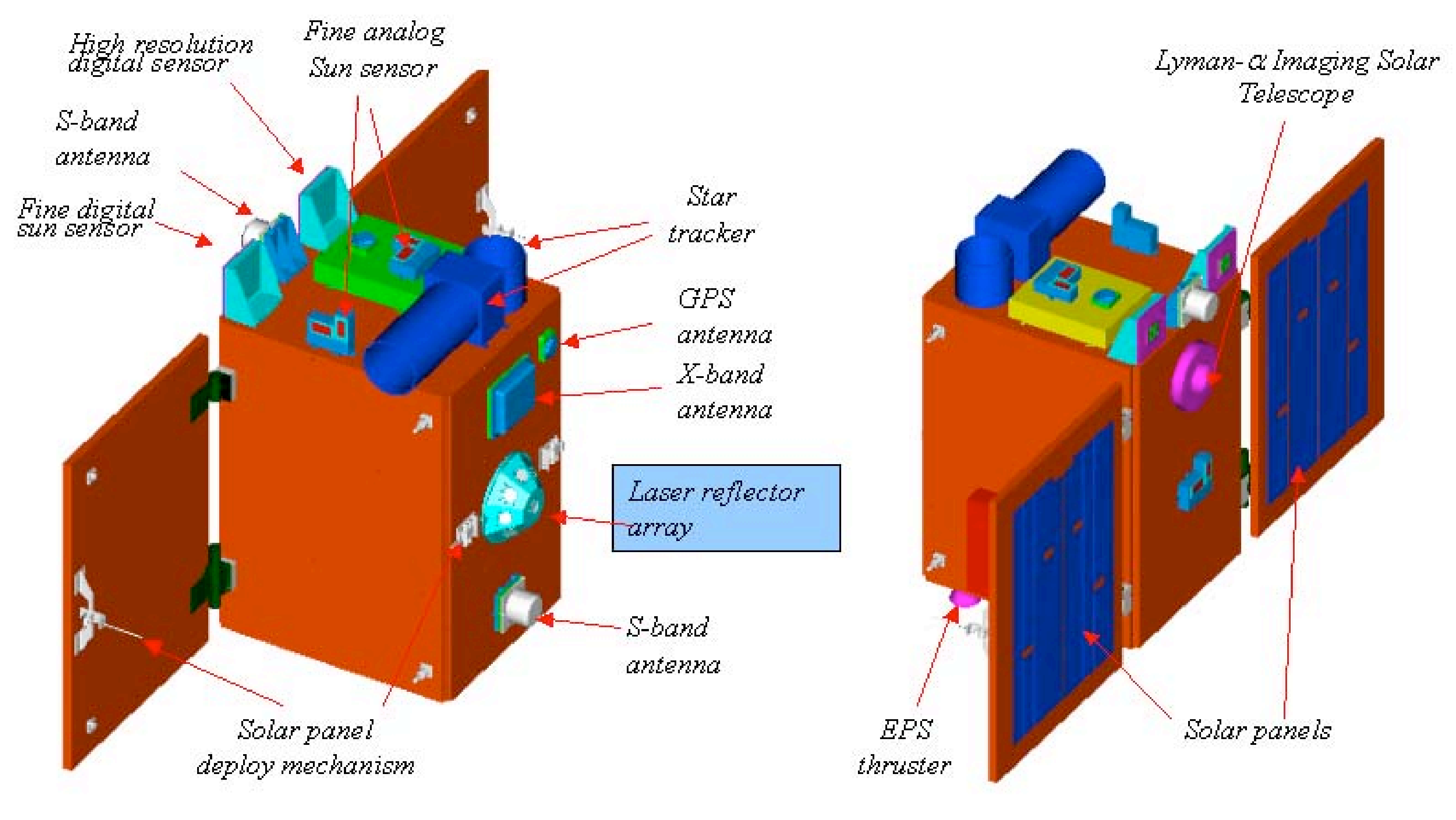
STSAT2

Preliminary Design



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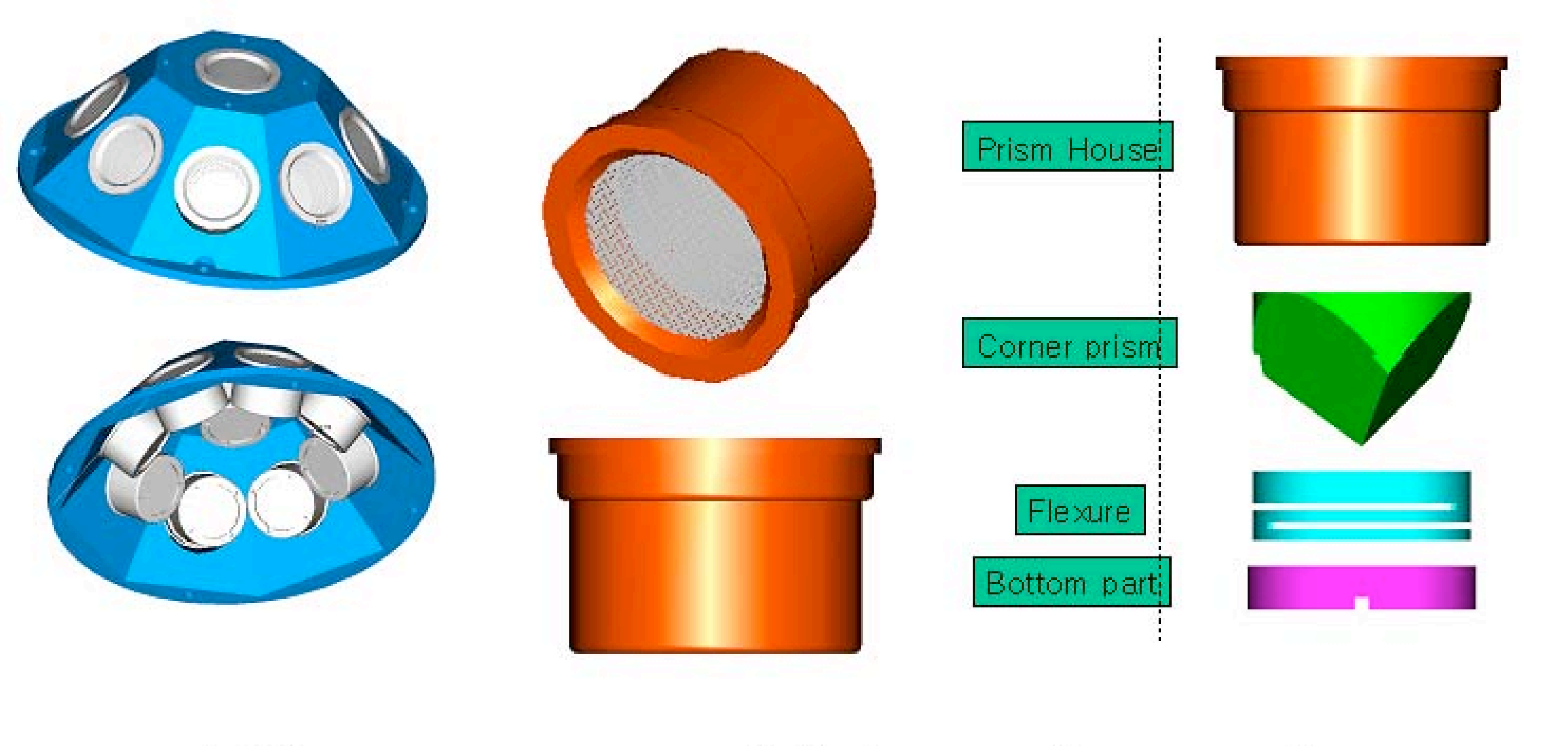
LRA for STSAT2

Design

- LRA (Laser Retro-reflector Array) is a payload for STSAT2, which consists of an array of 9 retro-reflectors and mechanical housing. The payload might have additional single retro-reflectors or LRA with its on mechanical structures depending on the geometry of the STSAT2 and its operational modes.



a) LRA b) Single retro-reflector assembly

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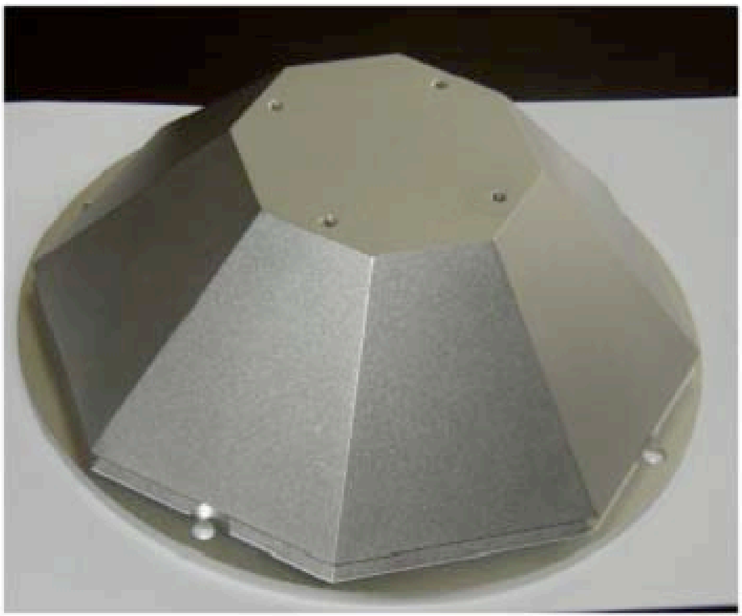
LRA for STSAT2

Manufactured

- LRA for STSAT2 was developed through the international collaboration between SaTReC, KAIST, South Korea and Shanghai Astronomical Observatory, China.



〈With protection cover〉

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〈Without protection cover〉

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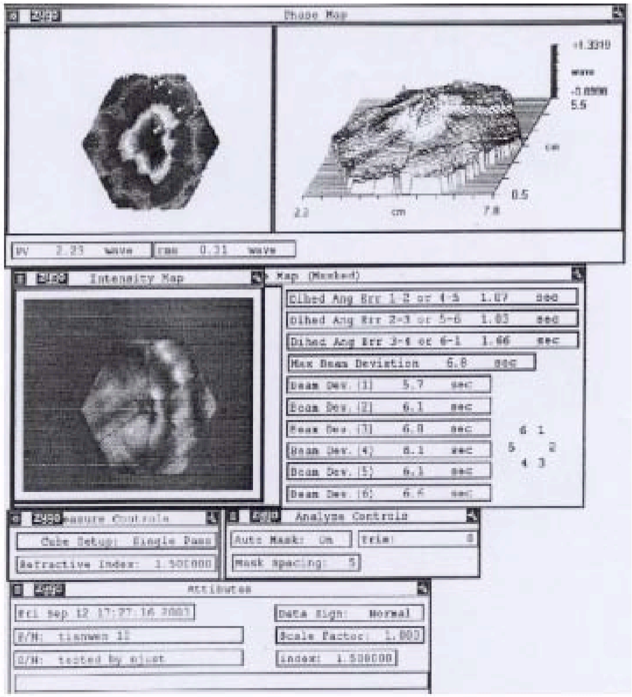
LRA for STSAT2

Optically Tested



〈Test results of single reflector〉

No.	Divergence (arcsec)	Note
1	10.3	
2	11.9	
3	10.0	
4	9.0	
5	10.0	
6	10.0	
7	9.8	
8	10.7	
9	12.5	

〈Test results of single reflectors〉

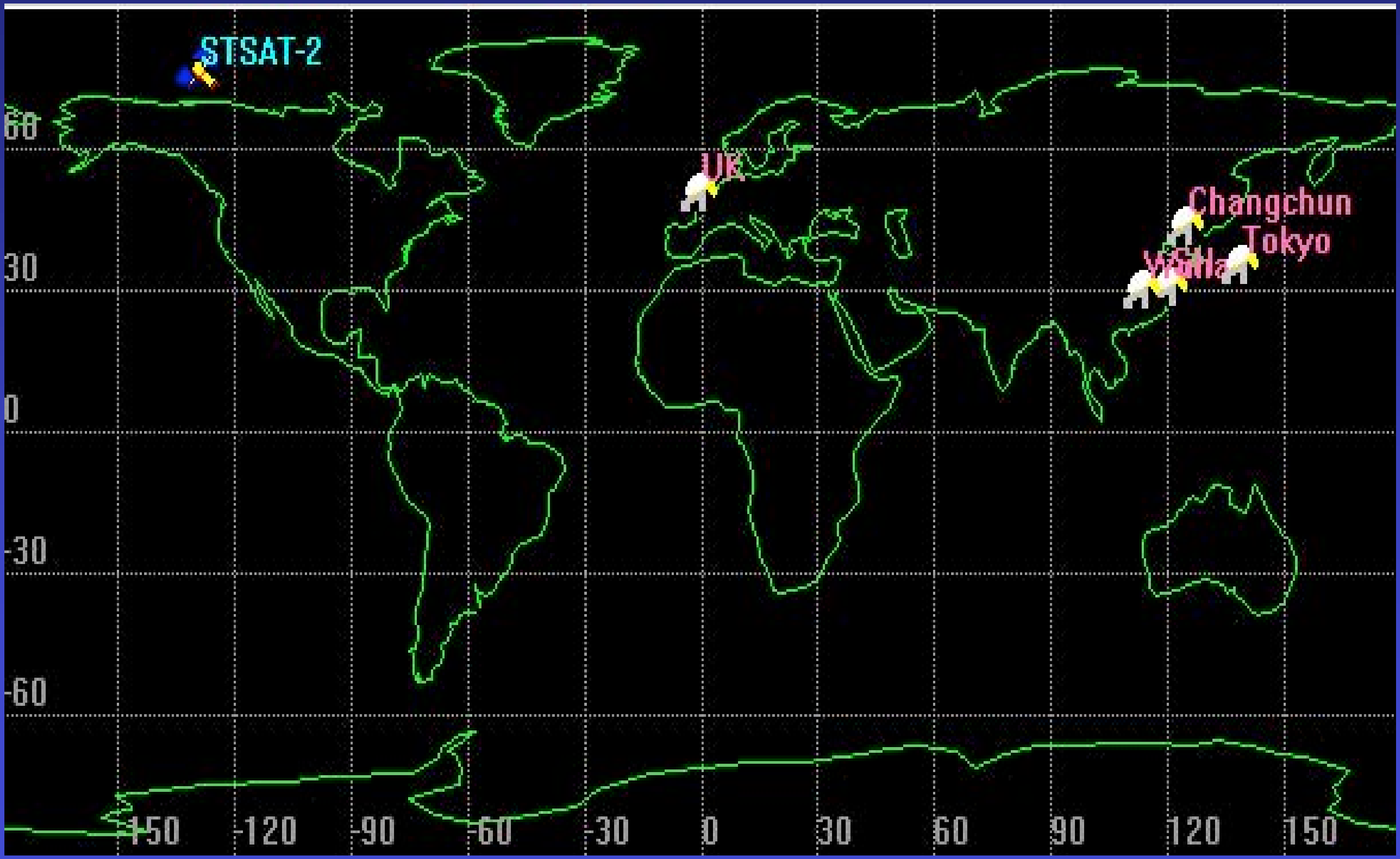
SLR for STSAT2

SLR Stations

- No Korea SLR Stations
- So far we contacted China SLR Network, U.K. Herstmonceus, Japan CRL.
  - Special thanks should go for China SLR network for their kindness.
- We are planning to apply the ILRS service. (The launch date is still in doubt!)

SLR for STSAT2

Contacted SLR Stations



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SLR for STSAT2

Safety Issues

- A question over whether the laser could damage optical sensors on STSAT2.
- In general, all remote sensing payloads have large aperture lens es that could focus the received laser power onto one pixel of a sensor with potentially damaging results.
- Satellite systems potentially affected
  - LIST, Star tracker, Sun sensor ← damage to CCDs
  - Solar Panel ← damage from partial illumination or shading, l aser intensity itself does not damage solar panel.
- Worst case considered: Maximum laser power, lowest altitude, minimum attenuation

SLR for STSAT2

Safety Issues

Sensor	Filter	Wavelength (nm)	Atten. factor at 532nm	Foucs (mm) /F no	Aperture	Pixel Size/ Array	Energy From Laser	Energy Density
LIST	Band-pass filter (Lyman-α)	121.6 (Bandwidth:1)	0.05	939.6 / 12.3	76.2mm	24µm 512×512	30nJ	5.2 mJ/cm^2
Star Tracker		Visible band	0.95	101mm /2.0	50mm	13µm 1024×1024	62nJ	37 mJ/ cm^2
Digital Sun sensor	Pin-hole (100 µm)	880nm (Bandwidth: 20)	1e-5	NA		25µm 512x512	2.6nJ	0.4 mJ/cm^2

• CCD breakdown voltage: 0.3 J/cm^2, CCD noticeable morphological damage at above 0.7 J/cm^2.

• Surrey carried out CCD damage experiment with a laser of 5400 times higher power than the predicted worst case. The experiment shows that the camera was not damaged even w ith that high power.

Note.

1. Energy from sun and laser are calculated at 532nm wavelength with 50ps of SLR laser pulse width.
2. Laser ªÁaePówer 50mJ with 50 ps pulse width at 0.532□m, Beam divergence=30'', Atmospheric Transmission =0.5, Altitude=300km, Transmission coefficient of launching telescope=0.7
3. Following Beam size at 300km = 1495m^2, Energy density=33.4 □J/m^2

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SLR for STSAT2

Contact Time (Predicted)

Location	Total number of contacts per 1 year			Average Contact time(min)/ contact
	Elevation angle > 30deg	Duration >1min.	Observable	
Wuhan, China	675	601	189	4.65
Herstmonceus, UK	523	483	483	5.74
Tokyo, Japan	726	651	191	4.8

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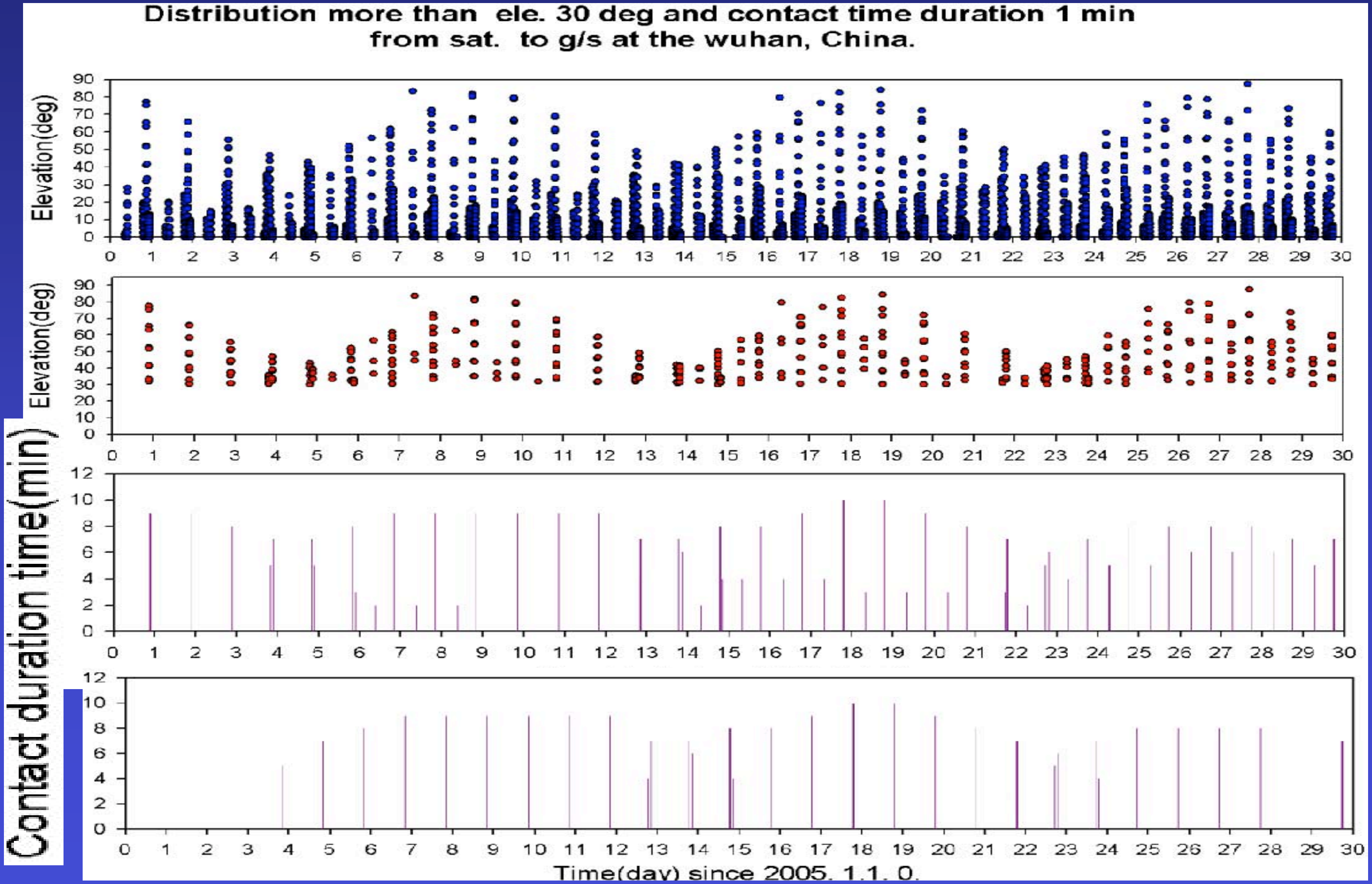
Contact Time (Predicted)



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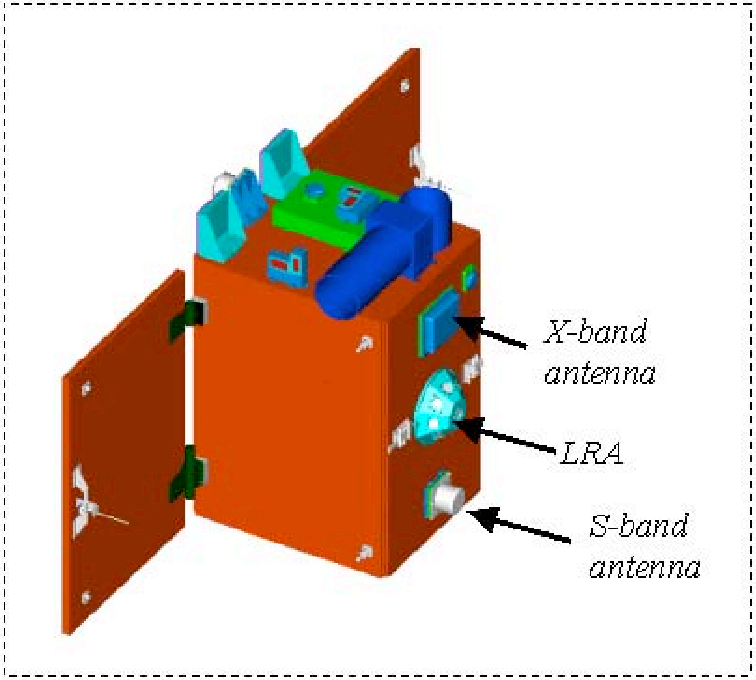
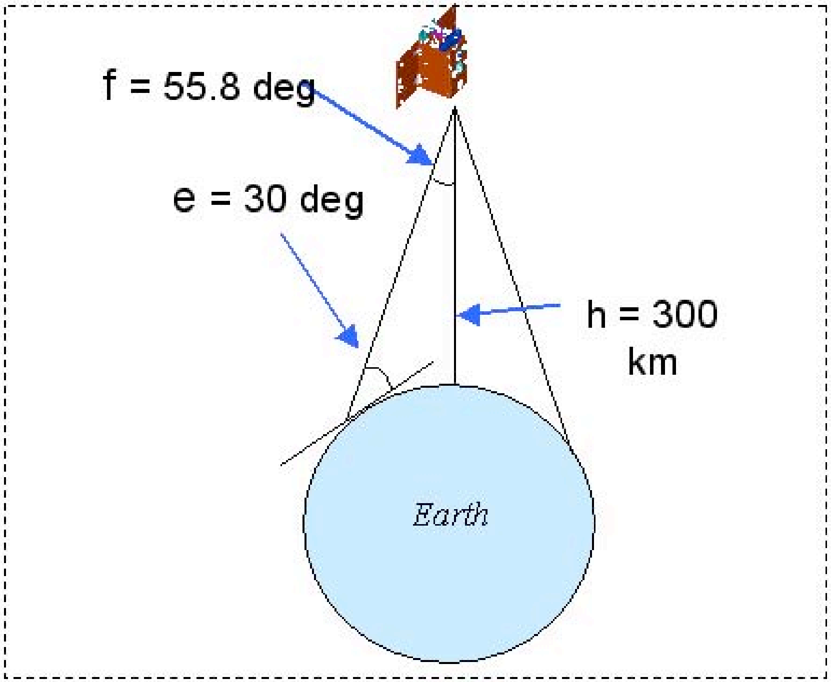
SLR for STSAT2

Line of Sight or Contact ability

- For communication, STSAT2 will always earth-point the ground station at Daejo n
- LRA and S-band, X-band antenna are on the same plane of STSAT

→ All SLR stations around Daejon always will be in LRA's optical field of view (60°)





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Thank You.