# LASER RETROREFLECTOR ARRAY OF GEOSTATIONARY SATELLITE, ETS-VIII

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# Overview of ETS-VIII

The ETS-VIII (Engineering Test Satellite-VIII) is a Geostationary satellite which will be carried into 146 degrees East. This satellite is being developed to establish and verify the following technologies;

- 3-tons class geostationary satellite bus
- Large-scale deployable reflector (17m x 14m, Tennis court!)
- Mobile satellite communications system
- Mobile satellite multimedia broadcasting system
- Satellite positioning (includes time synchronization) using the HAC (High Accuracy Clock; Cesium) equipments

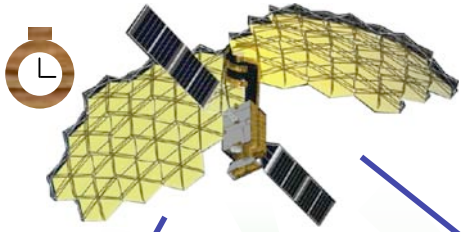
Launch date : FY2006(Tentative)
Design Life : 10 Years (Satellite Bus)
3 Years (Payload)

Orbit : Geostationary Orbit (146°E)
Weight : 3,200kg (BOL)

# Experiments using HAC(+LRRA)

Goals:

- On-board clock estimation accuracy using navigation signal <10ns
- Real time orbit estimation using navigation signal <10m (position)



Navigation Signal (L/S-band)

Navigation Signal (L/S-band)

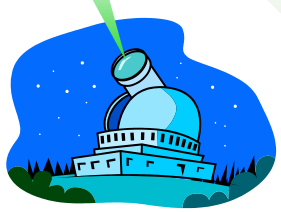
SLR

SLR

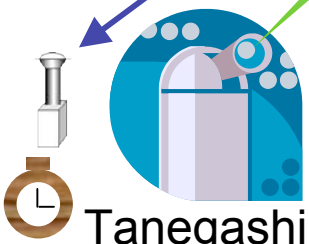
HAC Receiver

HAC Receiver

HAC Receiver



ILRS (WPLTN)

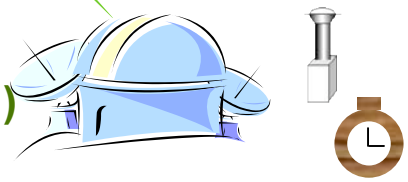


Tanegashima _GMSL_

- Estimation of ETS-VIII's orbit in real time using ETS-VIII navigation signal

SLR data is used to evaluate the result of real time estimation and post analysis using ETS-VIII navigation signal => <10m (position)

- Experiments will be performed one day every two weeks in 2006-2008(TBD)

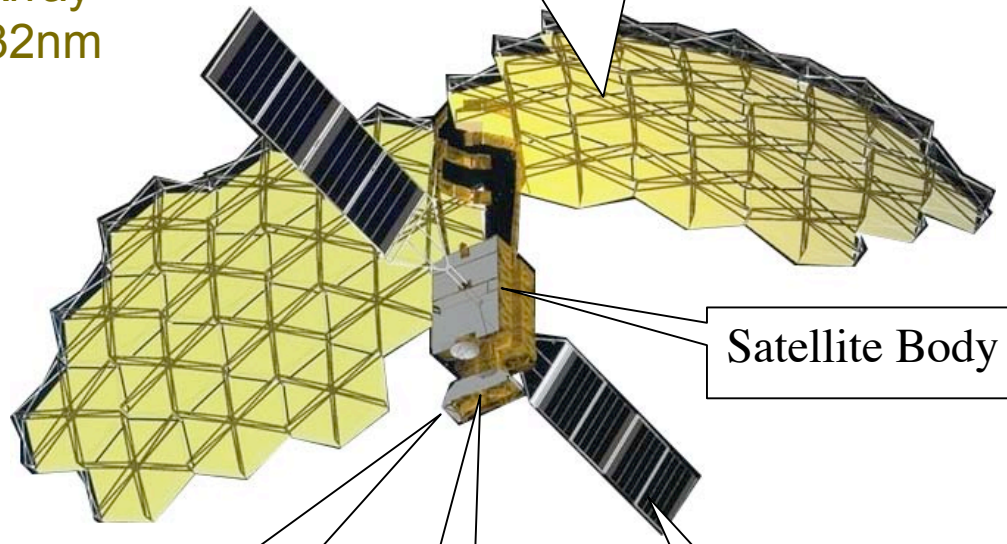


NICT-SLR_KOGL_

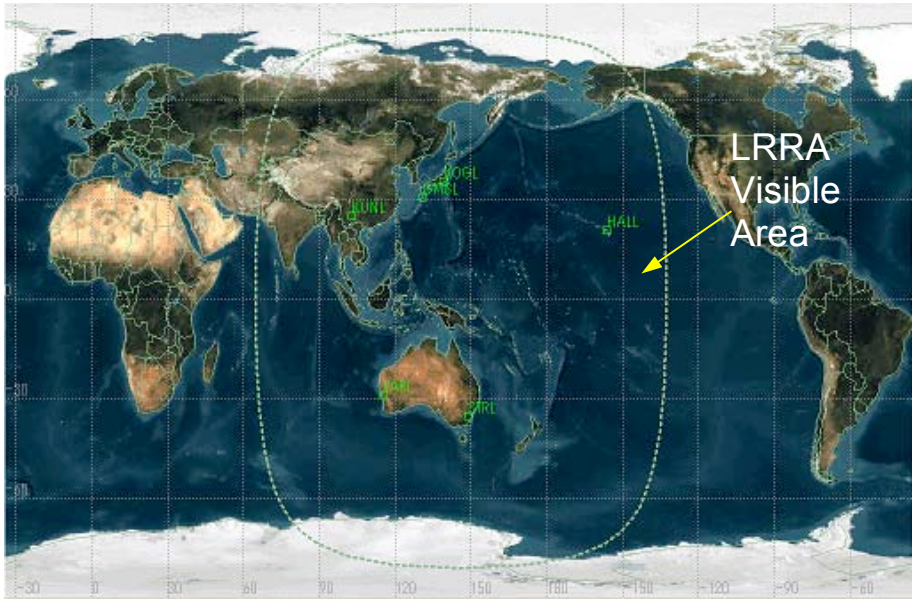
# LRRA specifications

| | |
|---|---|
| Type | Retroreflector Array |
| Wavelength | Optimized at 532nm |
| Cross Section | 1.68E8 m^2 |
| Mass | <3kg |
| Cube Diameter | 40.6mm |
| Reflectors | 36 |
| Reflectivity | >75% |

**26cm x 30cm x 5cm (within an envelope)**

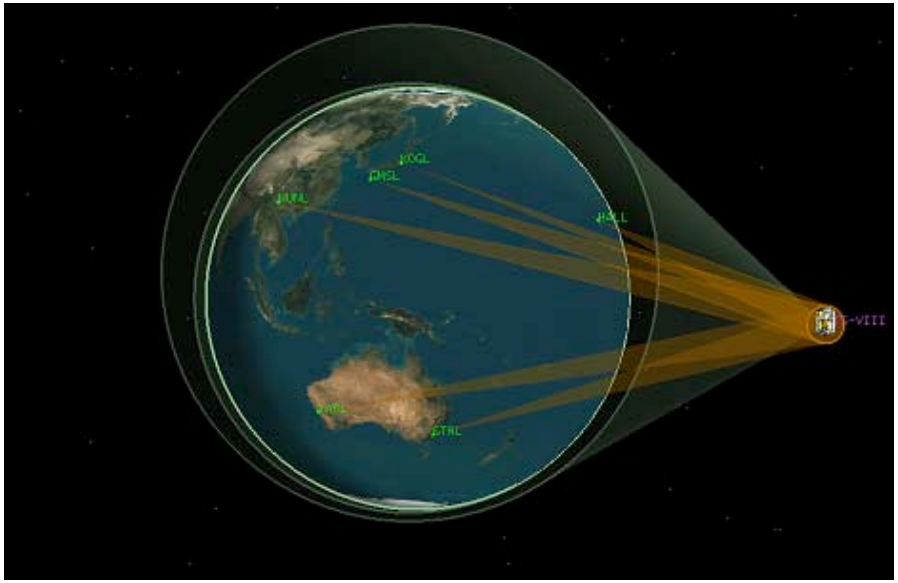


# Candidate SLR station




**It is possible to track ETS-VIII from the station of WPLTN.**

**For estimate ETS-VIII position precisely, it needs SLR data observed from other stations which consists good arrangement for orbit determination with Japanese station.**



# Example of SLR Link Budget Calcuration

The Lageos normalized signal level is approximate 0.01.

According to this result, most candidate stations are possible to get return from ETS-VIII, but we need to re-calculate link budget using more detailed parameters and also study considering other parameters such as range gate, detecting method, etc.

| Å@ | GMSL | KOGL | STRL | KUNL | YARL |
|---|---|---|---|---|---|
| Cirrus Cloud Transmission | 1 | 1 | 1 | 1 | 1 |
| Atmospheric Transmission | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Longterm Beam Spread [1Å~10$^{-6}$ rad] | 5 | 5 | 5 | 5 | 5 |
| Shortterm Beam Spread [1Å~10$^{-6}$ rad] | 20 | 20 | 20 | 20 | 20 |
| Receive Efficiency | 0.5 | 0.1 | 0.41 | 0.5 | 0.76 |
| Satellite Backscattering Cross Section [1Å~10$^{6}$ m$^{2}$] | 168 | 168 | 168 | 168 | 168 |
| Quantum Efficiency [%] | 10.4 | 15 | 20 | 20 | 15.5 |
| Receive Aperture [m$^{2}$] | 0.78 | 1.76 | 0.44 | 0.88 | 0.454 |
| Satellite Height [km] | 37000 | 37100 | 37100 | 38300 | 37100 |
| Wavelength [1Å~10$^{-6}$ m] | 0.532 | 0.532 | 0.532 | 0.532 | 0.532 |
| Transmit Efficiency | 0.5 | 0.3 | 0.41 | 0.5 | 0.95 |
| Pulse Energy [mJ] | 300 | 50 | 50 | 120 | 100 |
| Average signal level [p.e.] | 6.551 | 1.687 | 0.788 | 4.966 | 5.408 |
| Lageos normalized signal level | 0.017 | 0.016 | 0.016 | 0.014 | 0.016 |
| | GMSL | KOGL | STRL | KUNL | YARL |