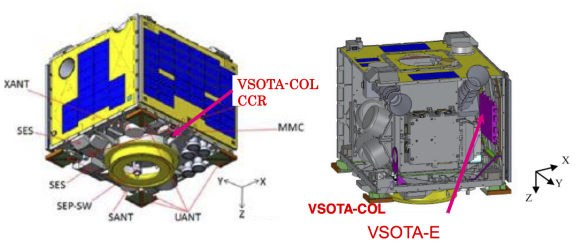
Collaboration of ranging and optical communication mission RISESAT

Toshihiro Kubo-oka [1], Hiroo Kunimori [1], Tetsuharu Fuse [1], Hideki Takenaka [1], Morio Toyoshima [1],
Toshinori Kuwahara [2], Kazuya Yoshida [2], Yoshihiro Tomioka [2], Kazufumi Fukuda [2], Junichi Kurihara [3] and Yukihiro Takahashi [3]
[1] NICT, [2] Tohoku University, [3] Hokkaido University

RISESAT

Rapid **I**nternational **S**cientific **E**xperiment **SAT**ellite

One of "HODOYOSHI" Small Satellite Series
Under Development by Tohoku University



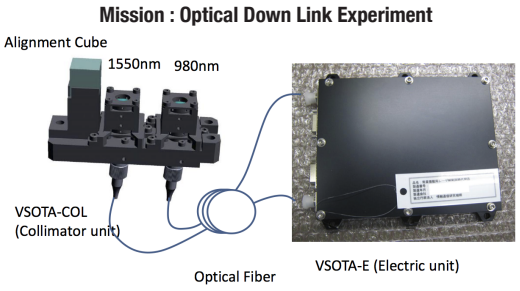
Specifications of RISESAT

Size and Weight		Attitude Control	
Size	W 500 x D 500 x H 500 [mm]	Method	3-axis stabilization
Weight	less than 55 kg	Pointing Accuracy	
Orbit			< 0.1 [deg] (requirement, 3s)
Type	Sun Synchronous		< 0.04 [deg] (objective, 3s)
Altitude	500 - 900 [km]	Pointing Stability	< 6 [arcsec/s]
Inclination	approx. 98 [deg]	Sensors	Star Sensor, FOG, Magnetometer, GPS Receiver, Sun Sensors
		Actuators	Reaction Wheels, Magnetic Torquers

VSOTA

Very **S**mall **O**ptical **TrA**nsmitter

Mission : Optical Down Link Experiment

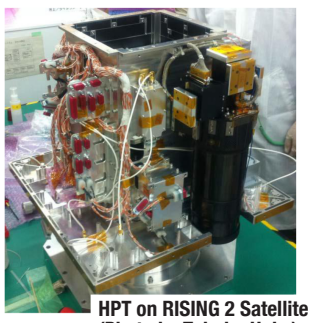


Optical Source

	TX1	TX4
Wavelength [nm]	980	1550
Power [mW]	270	40
Modulation Speed [Mbps]	10	10
Beam Div. [mrad]	3.5	1.3
Polarization	Arvitrary	Linear

High Precision Telescope (HPT)

- Science Instruments
  developed by Hokkaido & Tohoku Univ.
  for Earth and Planetary Observation
- Diameter : 100 mm
- Focal Length : ~1000 mm
- GSD : 5m @ 700km altitude
- LCTF Filter : 420-700 nm, 650-1050 nm
  with 1nm resolution

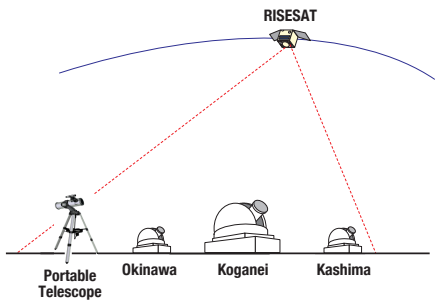


HPT on RISING 2 Satellite
(Photo by Tohoku Univ.)

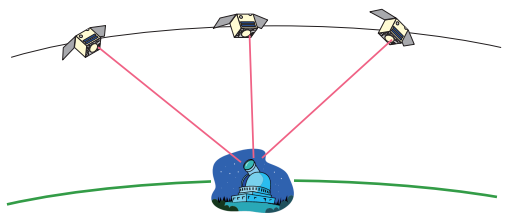
Corner Cube Reflector

- Aid to maintain pointing of ground station
- Range data for orbit accuracy improvement

Optical Downlink Experiment

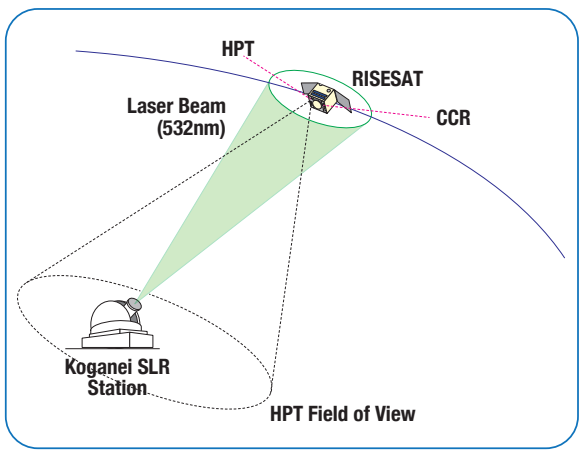


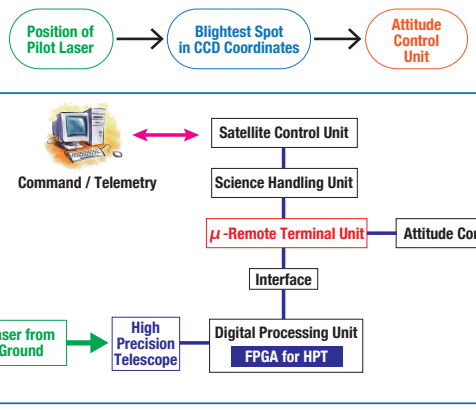
No Gimals and No Moving Parts!



Optical Transmission Direction
controlled only by "Body Pointing"

Assessment of Body Pointing Accuracy Using Pilot Laser





Optical Ground Station Parameters - existing Laser Ranger at Koganei -

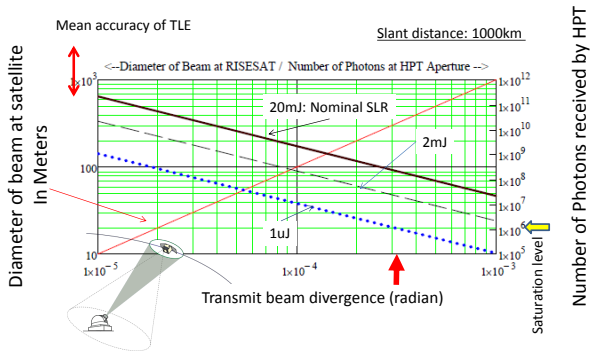
Parameters	Value
Wavelength of Pilot laser (SLR)	532 nm
Pulse width 1/e2	50 ps
Repetition Rate	20 Hz
Energy per pulse	20 mJ
Transmit optical efficiency	0.6
Atmospheric efficiency (One way)	0.5
Pointing LOSS factor (Efficiency)	0.135
Diameter of Receiving Telescope	1.5 m
Receiving optics efficiency including spectral filter	0.2
Quantum efficiency of SLR receiver	0.2

Corner Cube Retro Reflector (CCR) Parameters

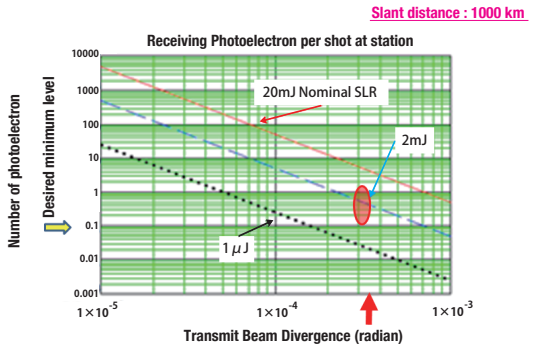
Parameters	Value
CCR clear aperture diameter	28 mm
CCR Reflectivity	0.8
Refractive index of CCR fused silica	1.45
Dihedral Angle offset	1.4 arcsec
Incident angle of CCR	neary 0 deg

Results : Number of Photon on Instruments

Number of Photons Received in HPT Aperture



Receiving Photoelectron reflected by CCR on RISESAT



Discussion

- Number of photons received by each instruments
  → too much difference by law of One way link (1/R2) ,
  and that of Two way link (1/R4)
- Shall we do independently one-way HPT and CCR
  using a different energy level of laser setting.
- Can we do simultaneously ?
  → Yes
  We could feasible by combination of:
  – Less sensitive HPT by setting LCTF intentionally offset wavelength
  – Larger CCR (e.g. twice the diameter) makes one order magnitude more returns on ground SLR receiver.
  – Variable repetition rate 20Hz-kHz several μJ ranging laser introduced