Activity on Optical Space Communications in NICT

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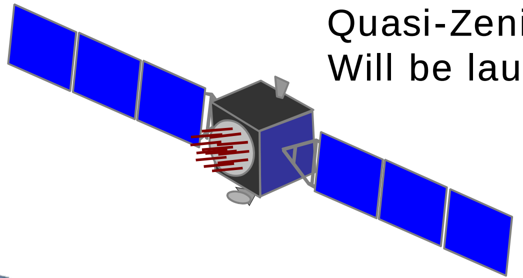
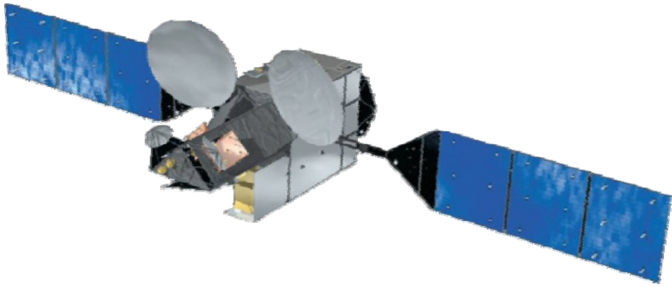
Satellite Projects related to NICT

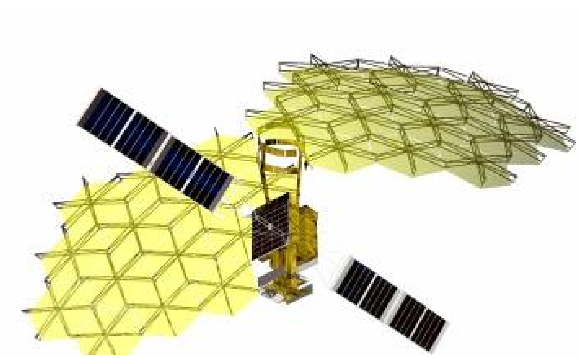


Quasi-Zenith Satellite
Will be launched in 2010

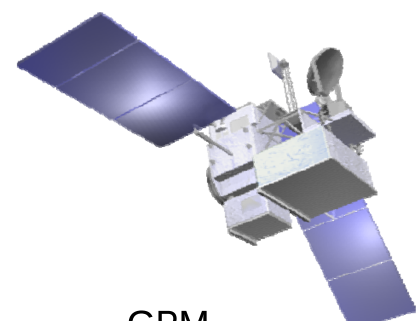


Wideband Internetworking Satellite (WINDS)
Launched on Feb. 2008

EarthCARE
Will be launched in 2013

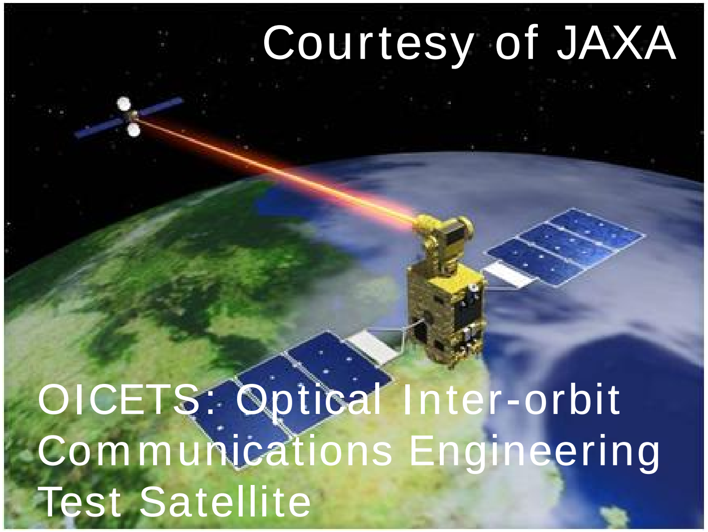


Engineering Test Satellite 8 (ETS-8)
Launched on Dec. 2006

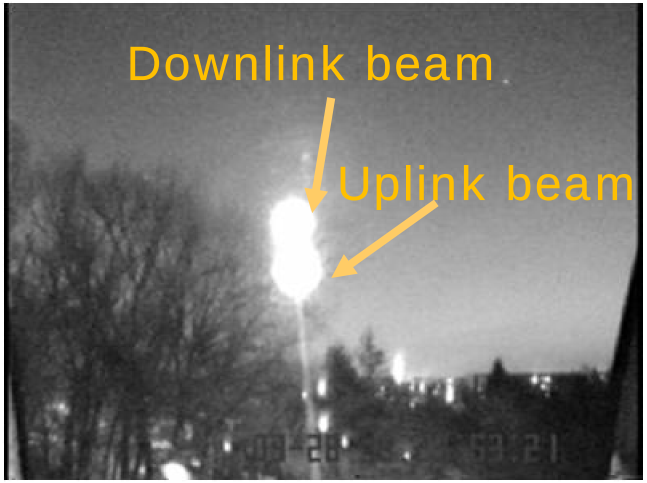


GPM
Will be launched in 2013

Laser communication demonstrations

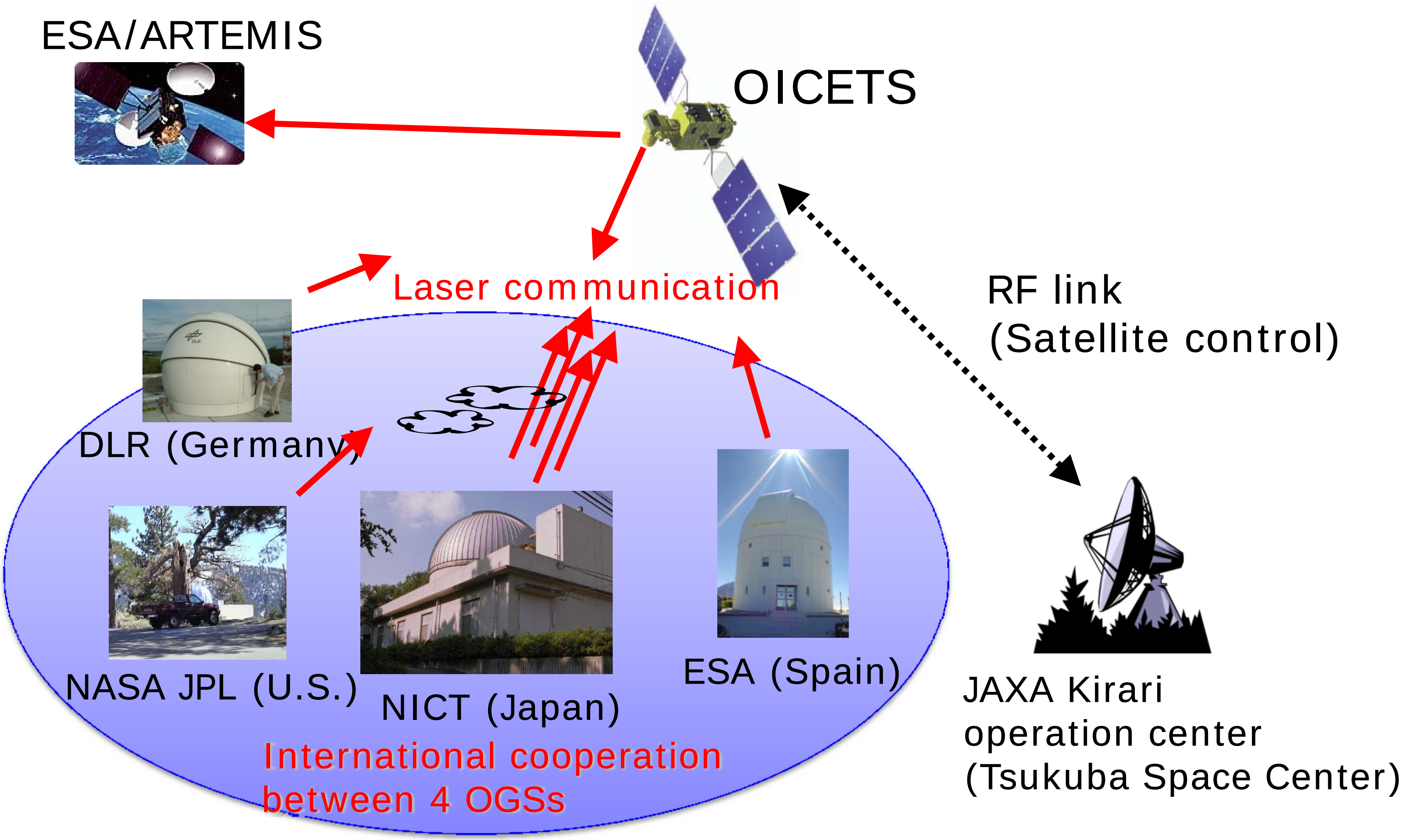


Launch Date	23rd Aug. 2005
Launch site	Baikonur Cosmodrome in the Republic of Kazakhstan.
Orbit inclination	97.8 deg
Eccentricity	0
Size	9.4 m× 1.8m ×3.1 m
Weight	570 kg

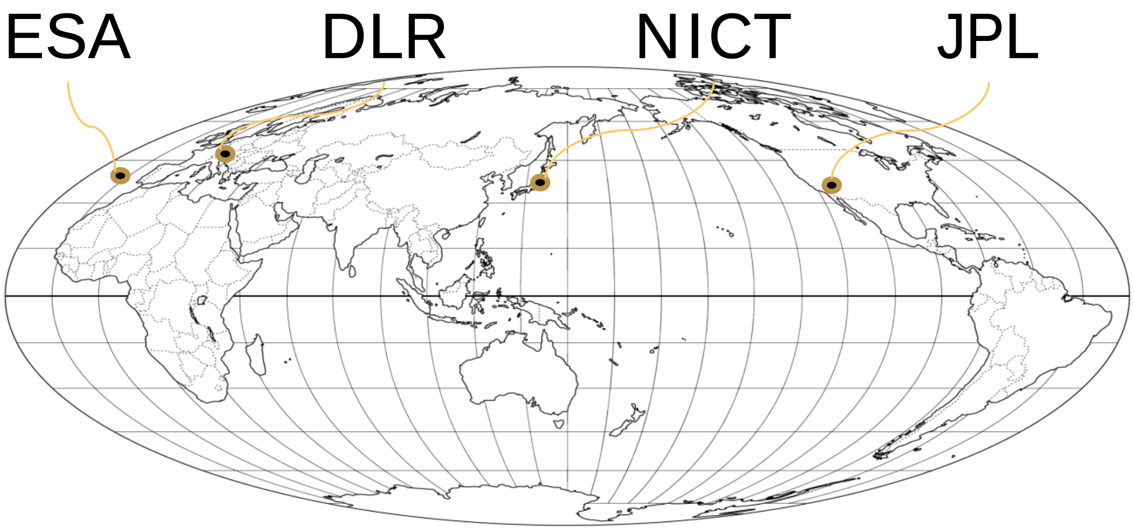


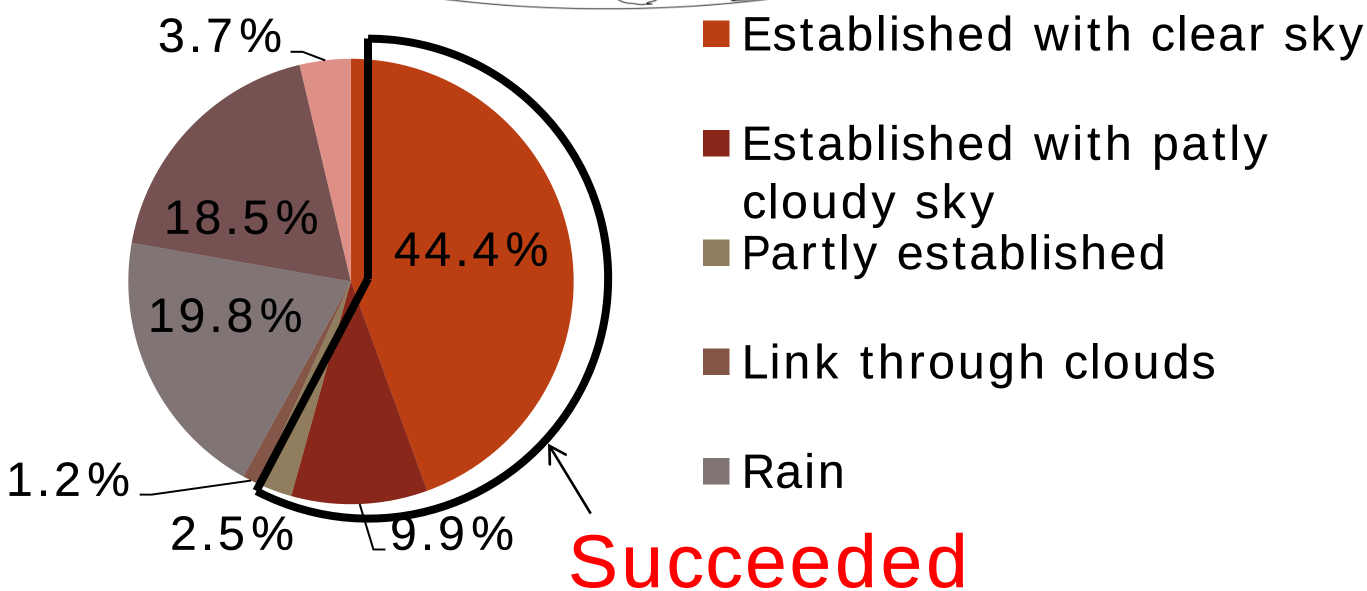
NICT National Institute of Information and Communications Technology

International Joint Experiments using OICETS

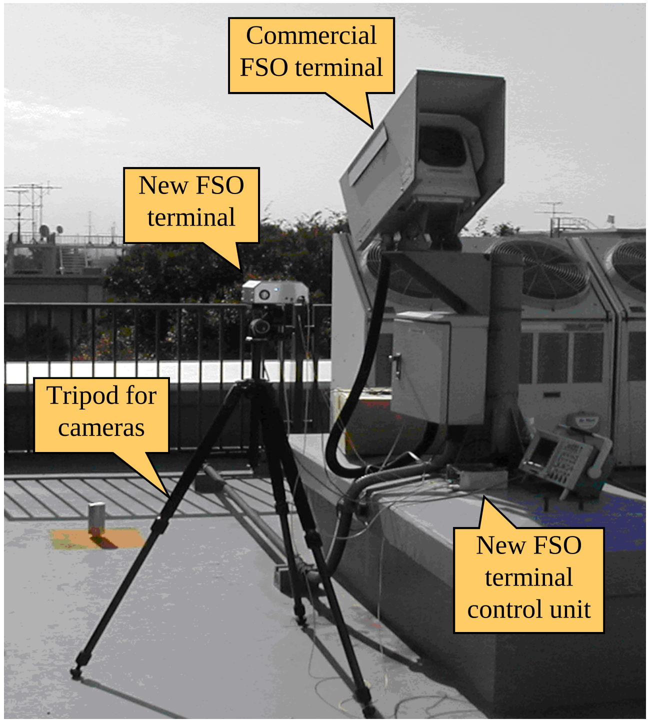


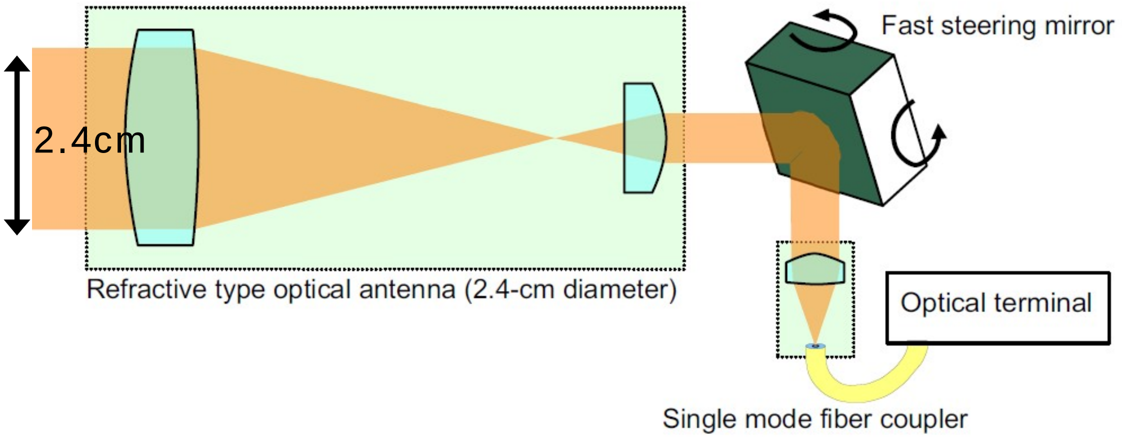
Trials with 4-OGS: April 2009 – Sep. 2009





New FSO terminal design and principle



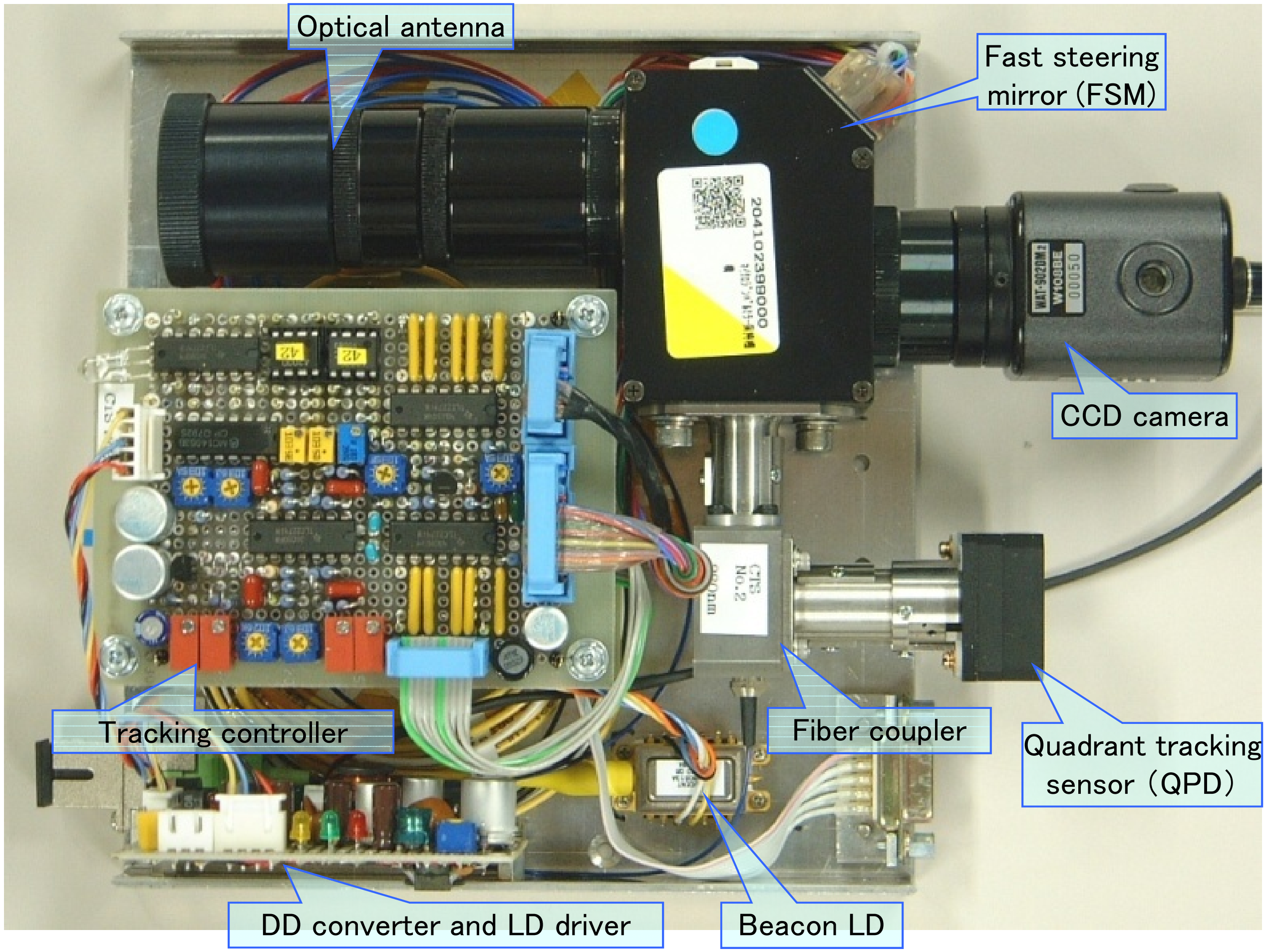


Principle of new FSO terminal

- Minimizes the coupling loss between free-space laser beam and the single mode fiber
- Minimizes the beam divergence using diffraction limited optics
- Remove the angle of arrival fluctuation due to atmospheric turbulence and vibration of the terminal support
- No optical-electrical conversion allows us to achieve low cost and low power consumption (24-hour operational by using eight AAA batteries)

Overview of the new FSO terminal

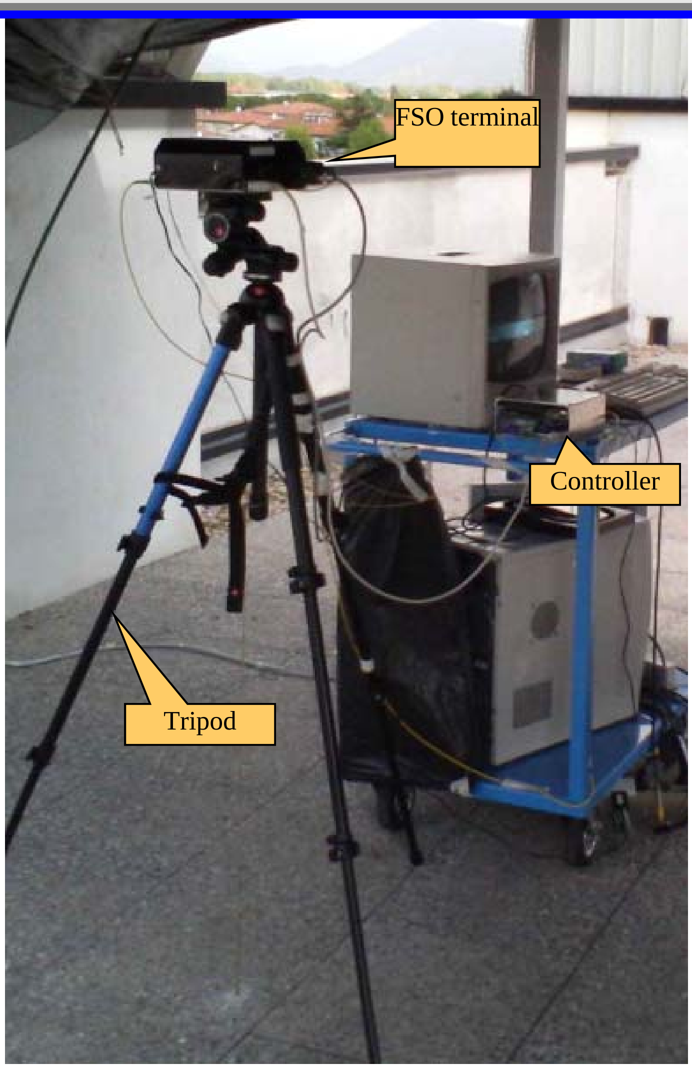
Internal layout of the new FSO terminal



Major specifications

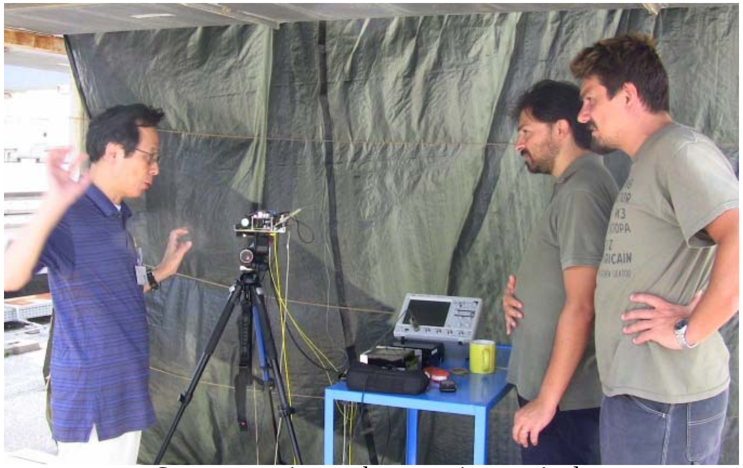
- Direct couple to SMF (compatible to DWDM, CATV transmission)
- Refractive telescope with 24mm aperture
- Tracking response time: 200ms
- Tracking bandwidth: 5kHz
- Tracking sensor FOV: 100mrad.
- Tracking area: 1.2degrees
- Internal signal loss: -3.7dB
- Beacon sensitivity: -41.3dBm (dynamic range: 17dB)
- Power consumption: 12V (unregurated), 1W, without CCD camera
- Weight: 930g without dust cover.

Terminal operation at the rooftop of CEIIC

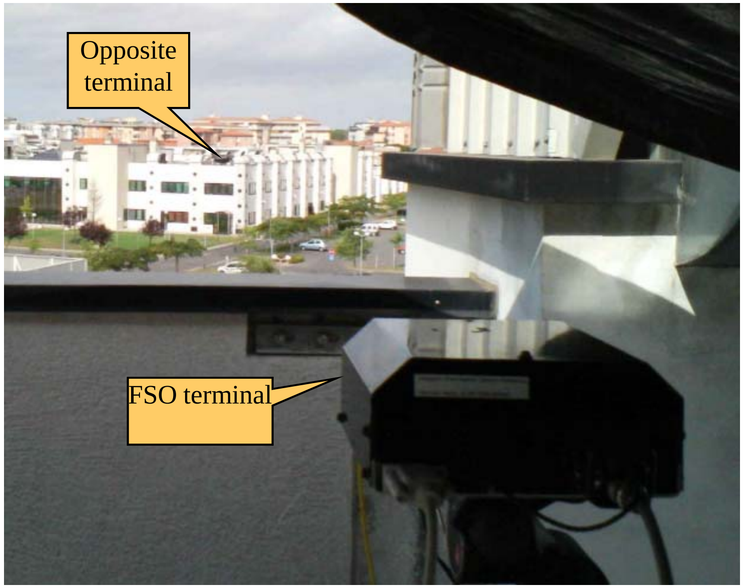


Setting at the FSO terminal 1 at the rooftop of CEIIC building

(The communication equipment and measurement system is located at the first floor of the building. The input/output optical signal was connected via a single mode fiber.)



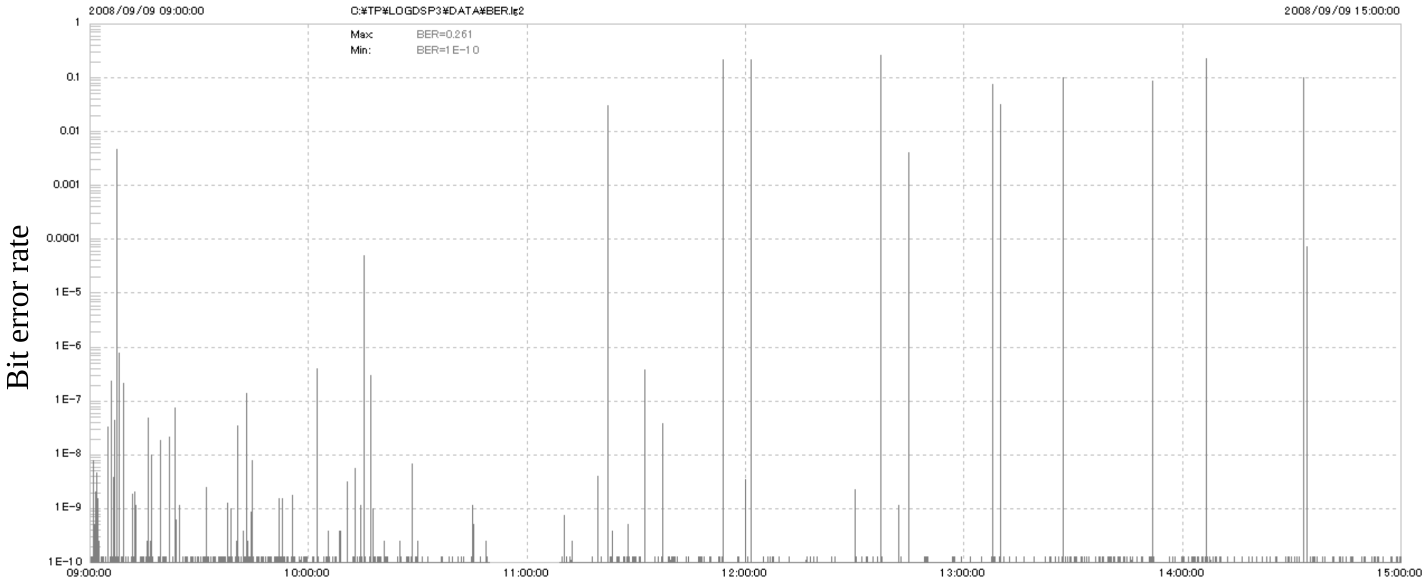
Setup operation at the opposite terminal

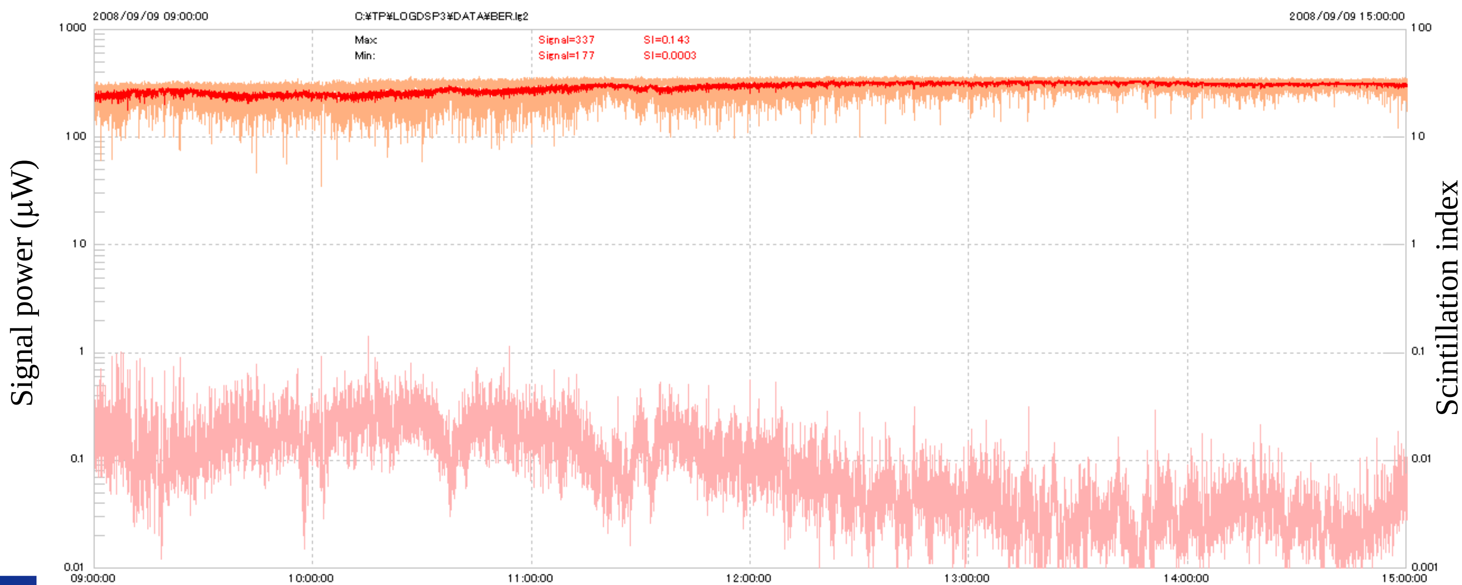


View from CEIIC terminal 1 to the opposite terminal

(Link distance is 210m)

Link performance of DWDM transmission at Pisa





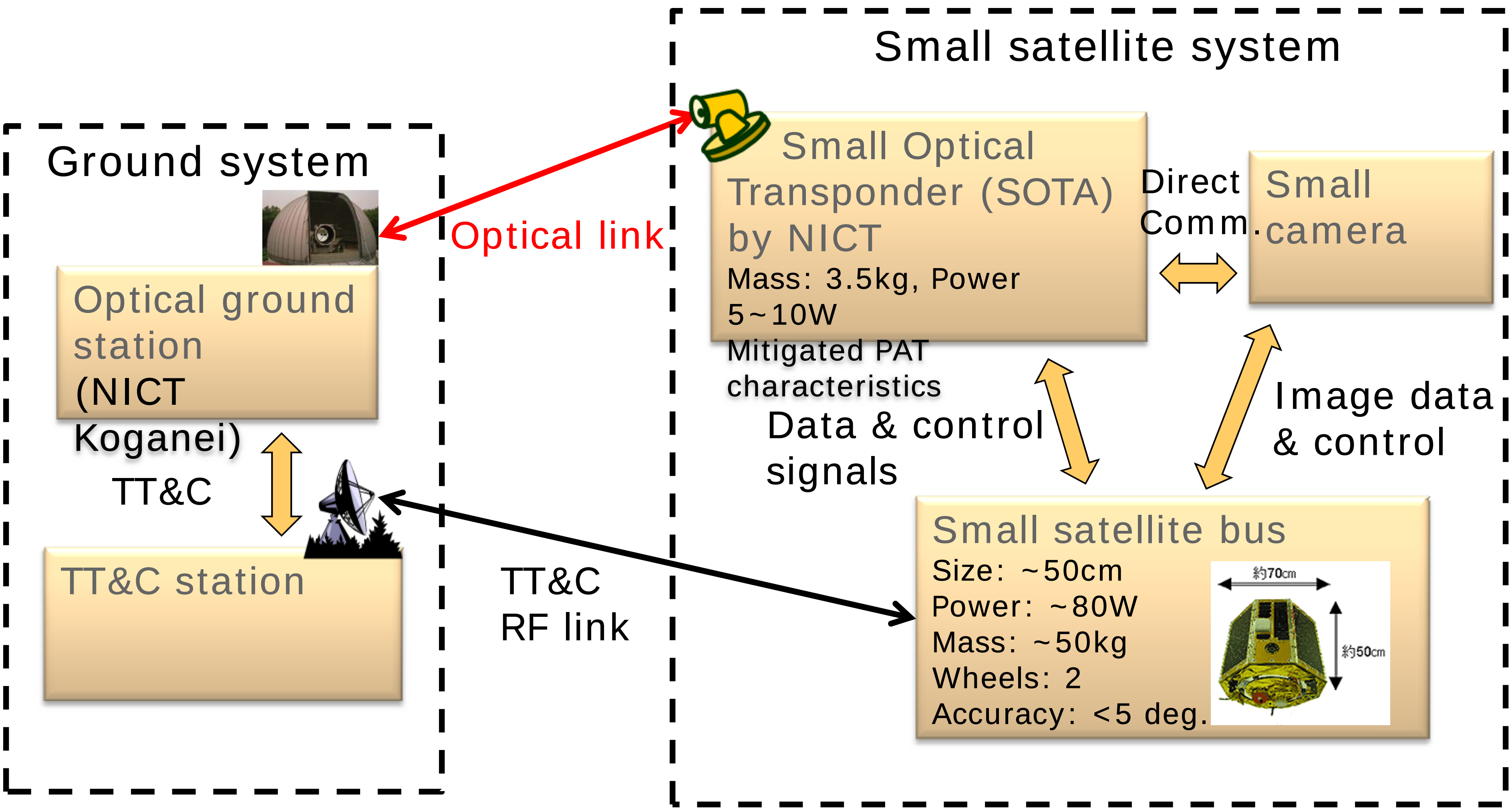
- Upper graph shows BER measurement data from 2008/9/9 9:00 to 15:00
- More than 99.9% availability with less than 10^{-9} BER achieved under the daylight condition.

* BER statistis: nBer=112256

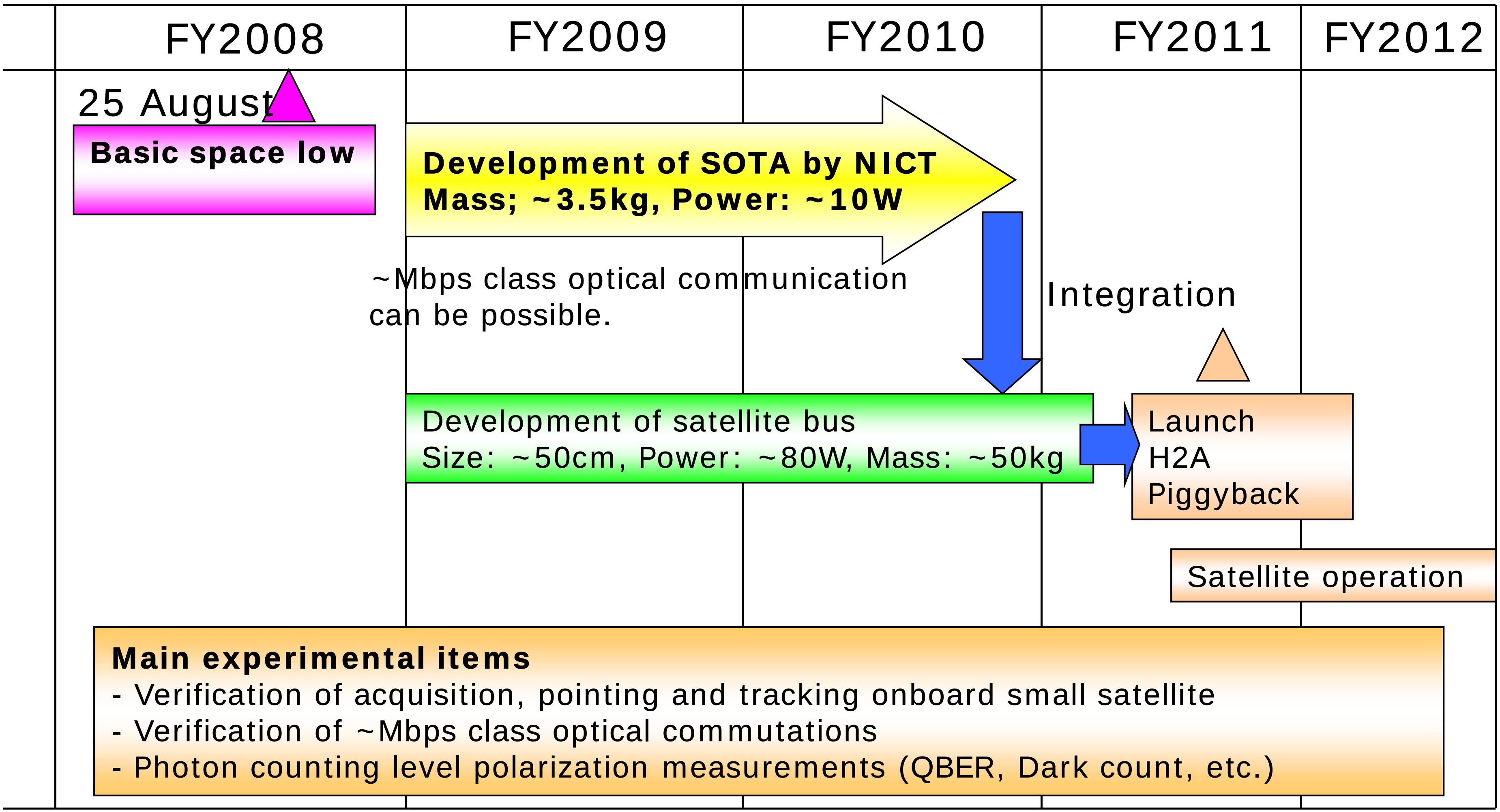
log(BER)	Probability	Cumulative
-1,	0.00005,	0.00005
-2,	0.00004,	0.00009
-3,	0.00002,	0.00011
-4,	0.00001,	0.00012
-5,	0.00012,	0.00024
-6,	0.00004,	0.00028
-7,	0.00007,	0.00035
-8,	0.00010,	0.00045
-9,	0.00027,	0.00071
-10,	0.99929,	1.00000

- Lower graph shows the signal intensity with the min/max and average value
- Lower trace shows the corresponding scintillation index.

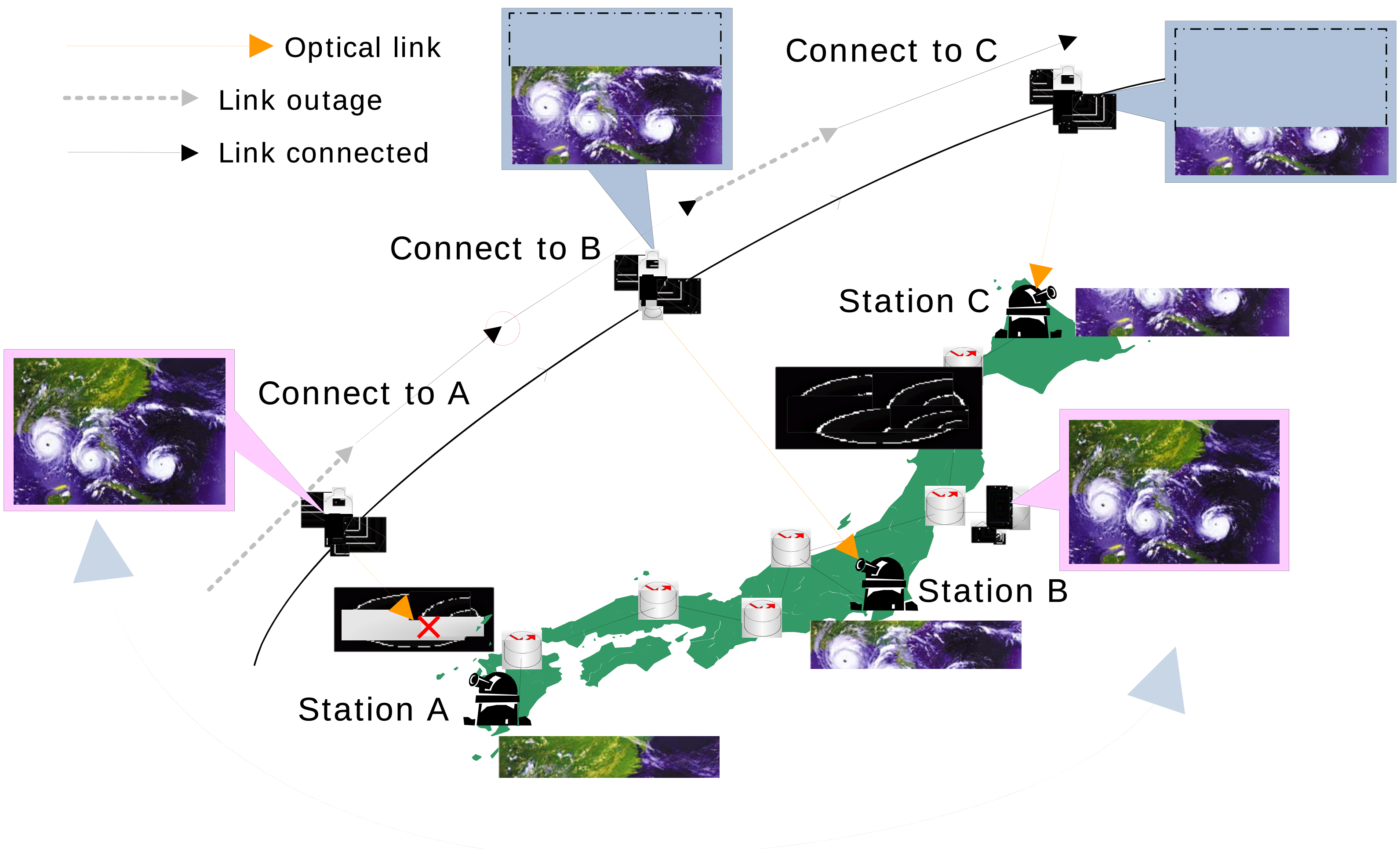
Optical Communication terminal for Small Satellite



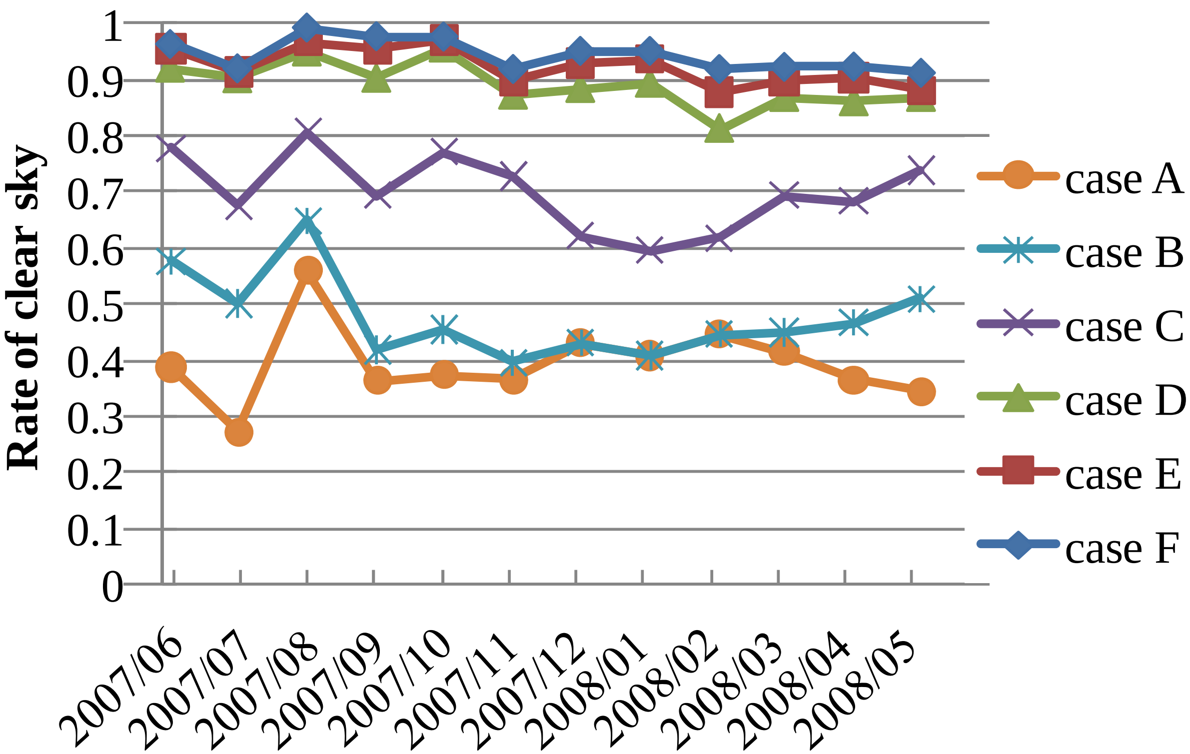
Schedule for Optical Satellite Project



Broadband Optical Downlink



Clear Sky Probability by using Multiple Stations

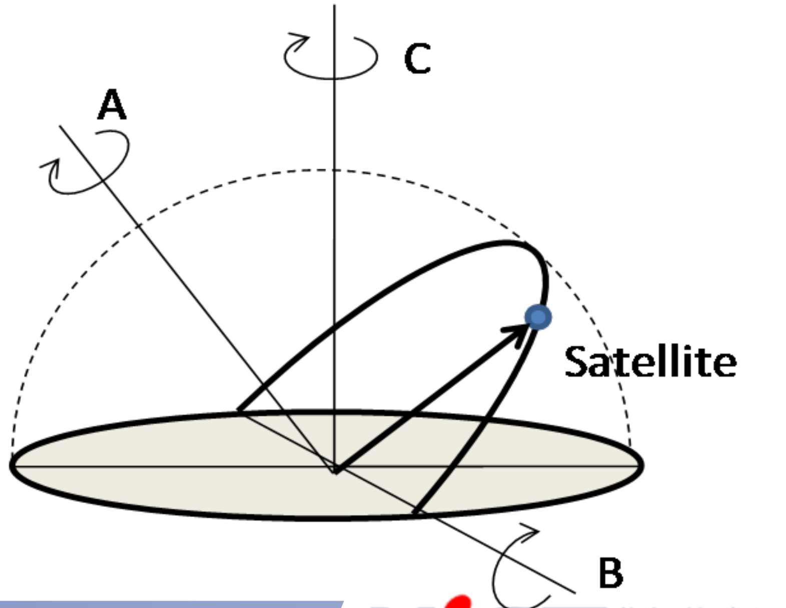


case	A	B	C	D	E	F
Tokyo	○	○	○	○	○	○
Sapporo		○	○	○	○	○
Fukuoka			○	○	○	○
Naha				○	○	○
Sendai					○	○
Osaka					○	○
Asahikawa						○
Kagoshima						○

case	A	B	C	D	E	F
Ave	0.39	0.48	0.70	0.89	0.92	0.94
Max	0.56	0.65	0.81	0.96	0.97	0.99
Min	0.27	0.40	0.60	0.81	0.88	0.91
Diff.	0.29	0.25	0.21	0.14	0.09	0.08

Transportable Optical Earth Station

Items	values
Aperture diameter	0.2 m
Max. angular velocity	5 deg/s
Min. operation angle	0.5 asec
Field-of-view	0.5 deg
Weight	150kg
Height	1.1m
Partition number	4



Summary

- Research areas in NICT cover both Satellite communications and Earth observations.
- 1.2 Gbps of transmission rate by WINDS was realized. However, data transmission rate using radio waves will be limited by the frequency allocations for the satellite communications.
- NICT focused on optical space communications as a breakthrough for the multi-gigabit transmission for the satellite.
- Satellite – Earth optical communication was carried out by using OICETS successfully.
- 1.28 Tbps of free-space laser communication link about 210m of distance was carried out.
- Optical satellite communication project by using small satellite have been started in NICT.
- For the optical feeder link, clear sky probability of 99% will be realized by using more than five optical earth stations in Japan.