100mJ,1Hz Nd:YAG laser using Laser ALTimeter (LALT) for SELENE lunar orbiter

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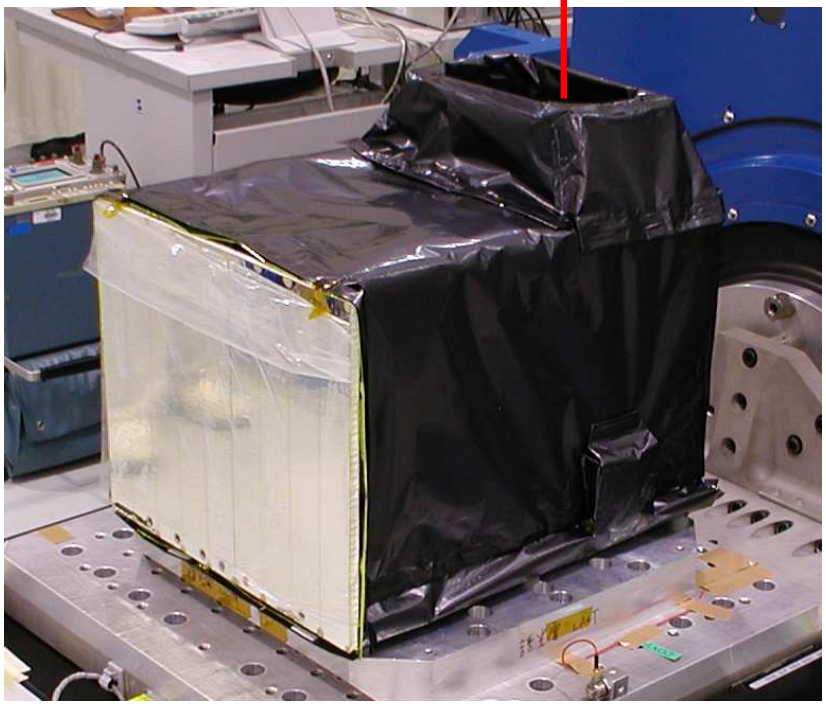
Overview of LALT

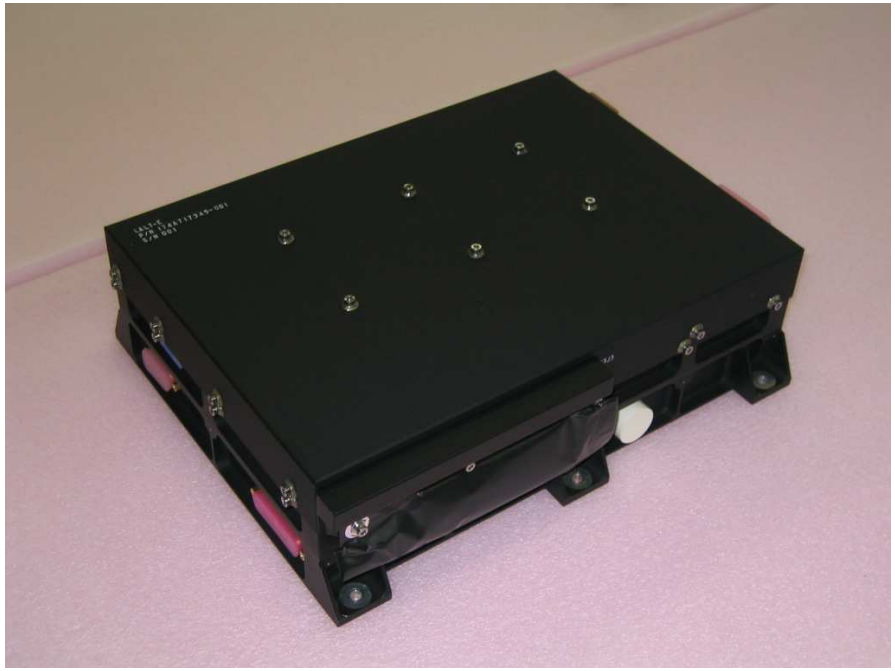
Wavelength	1,064 nm
Ranging distance	50 to 150 km
Pulse repetition rate	1 Hz or 0.5Hz
Laser Output Energy	100 mJ
Pulse Width	17 nsec
Receiver diameter	100 mm
Receiver field of view	1 mrad
Transmitting beam divergence	0.4 mrad
Ranging accuracy	+/- 5 m
Weight	
Transmitter/Receiver	15 kg
Control Electronics	4 kg

Structure of LALT (1)

Lunar surface



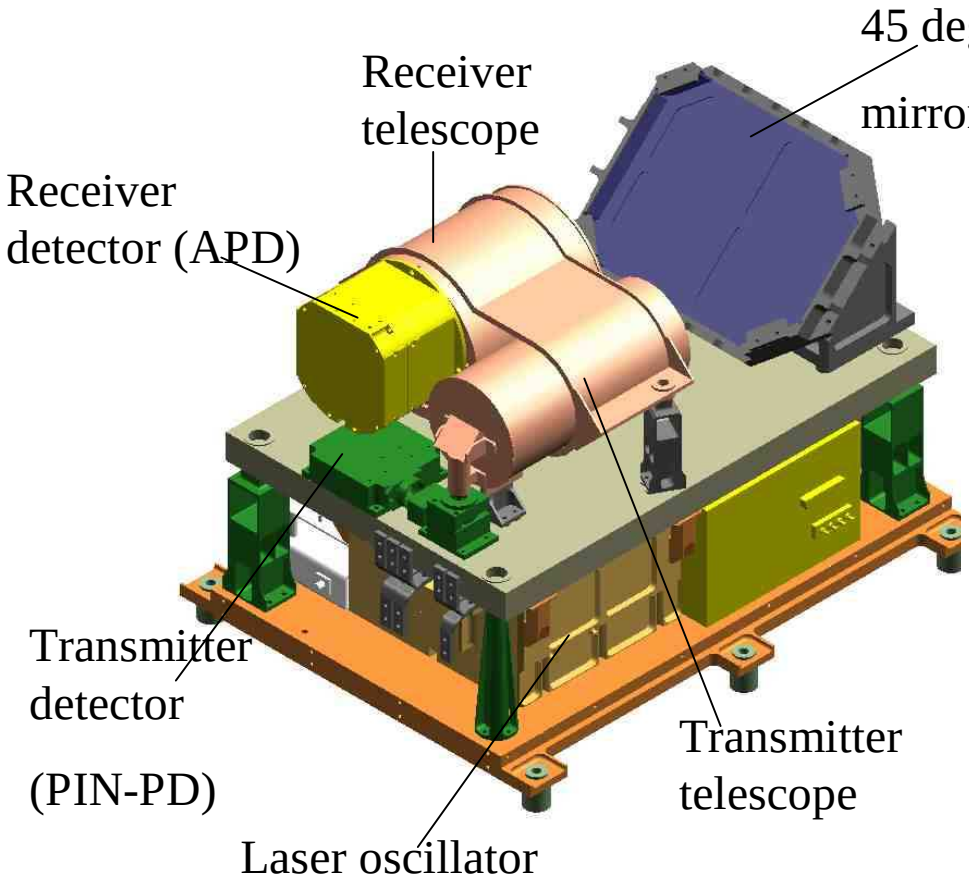
Laser Transmitter/Receiver:LALT-TR



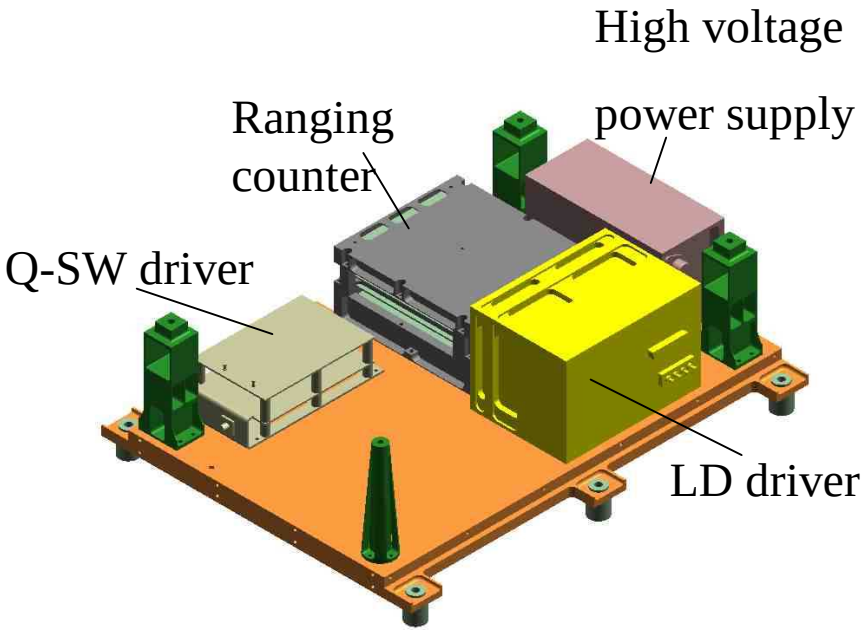
Control Electronics:LALT-E

Structure of LALT(2)

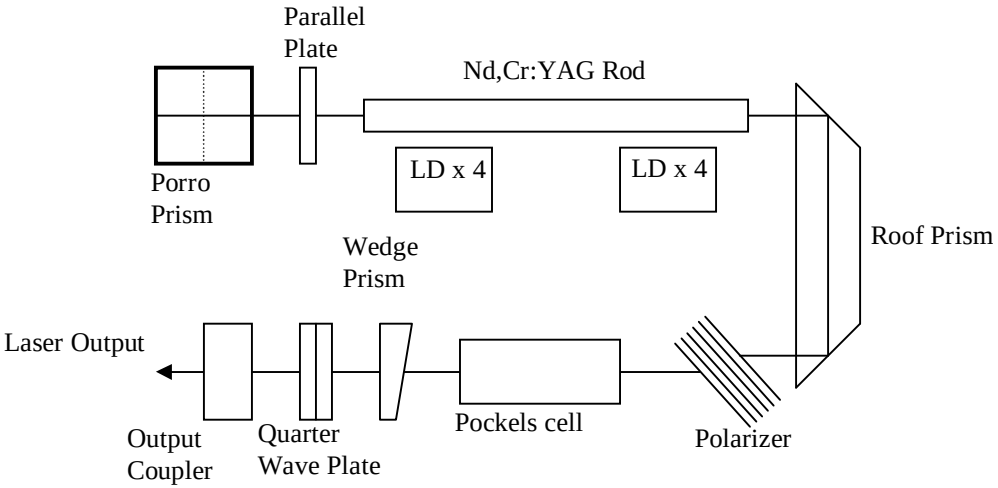
NEC

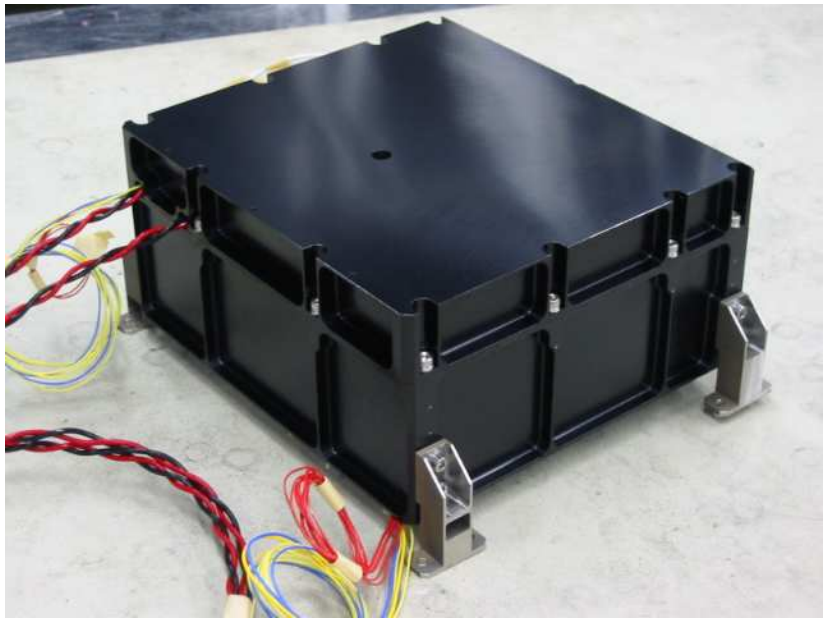


LALT-TR



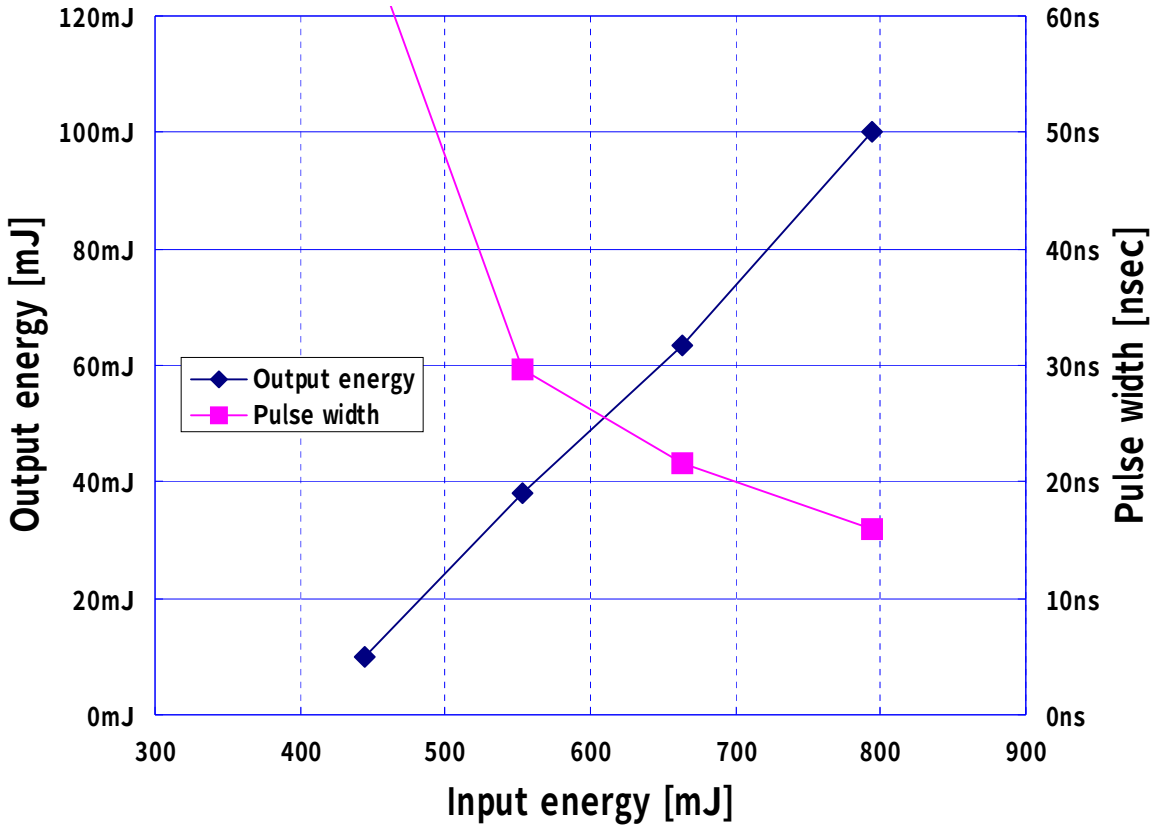
Structure of Laser Oscillator





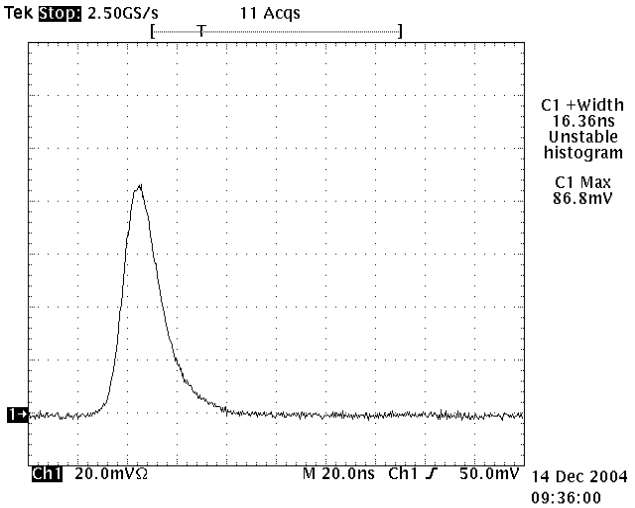
Wavelength	1.064mm
Pulse Repetition Frequency	1Hz
Output Energy	100mJ
Pulse Width	17nsec
Size	150 x 170 x 83mm
Weight	1.6 kg

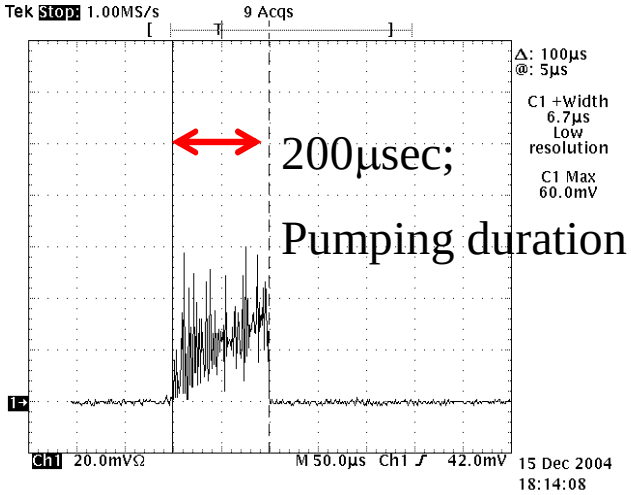
Characteristics of Laser Oscillator



(Atmospheric Temperature and Pressure)

Result of 1st thermal vacuum test





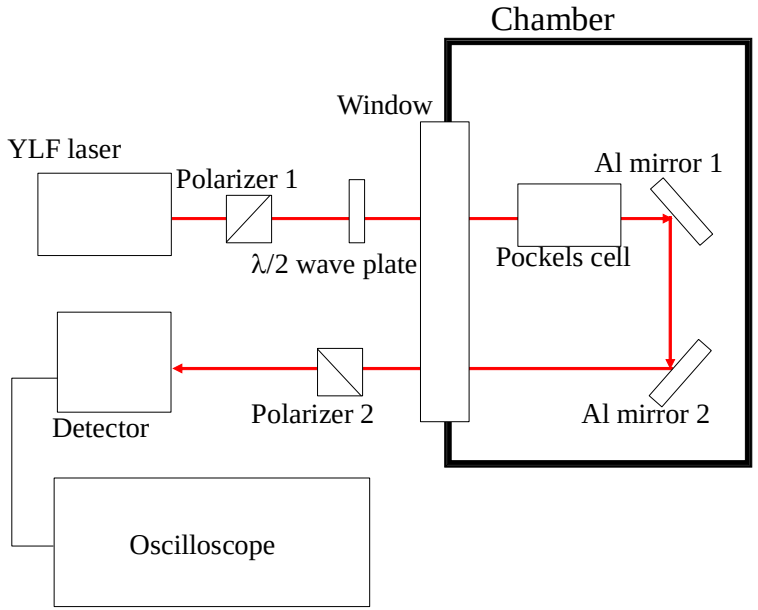
Laser pulse wave form .

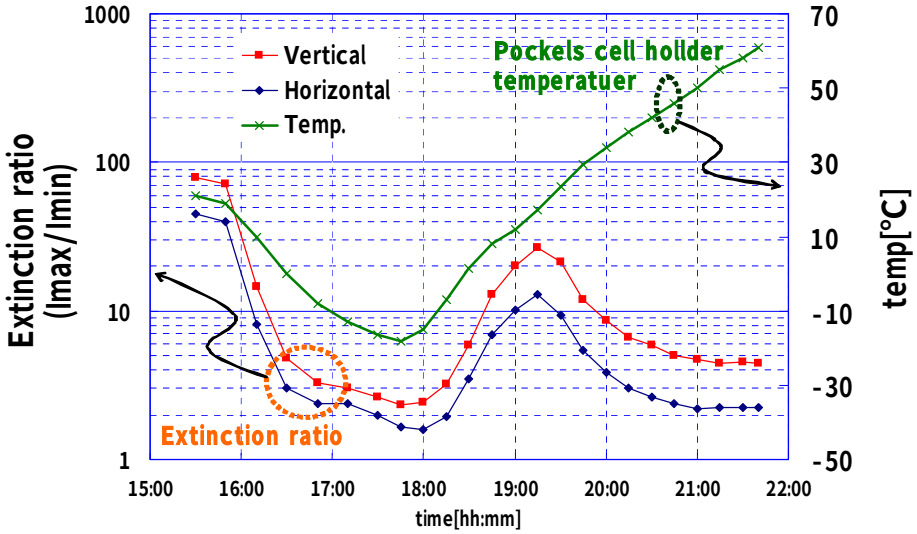
(normal conditions)

Wave form in vacuum after the low temperature test ;

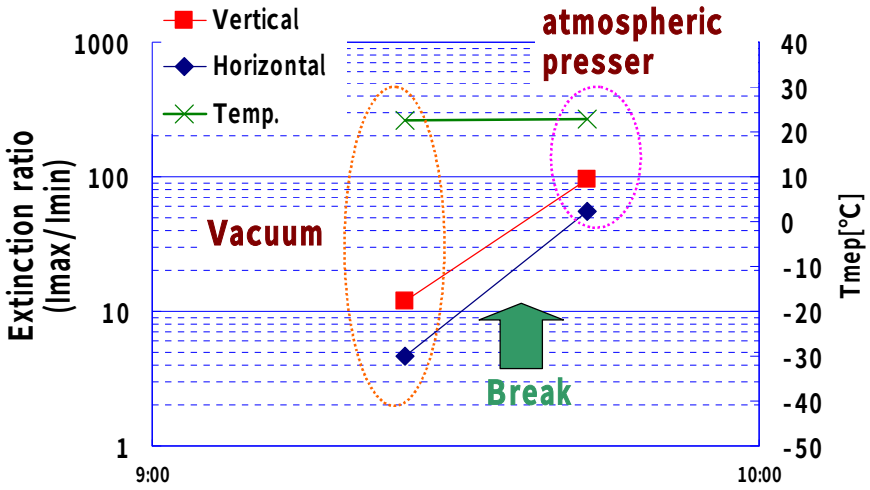
Free running oscillation for bad extinction ratio of pockels cell($LiNbO_3$)

Characteristics of Pockels cell in thermal vacuum





The extinction ratio of the pockels cell was measured by using YLF laser. The directions of polarization of YLF laser can change (vertical and horizontal) by the λ/2 wave plate. The maximum and minimum of the transmission beam detected the peak of transmission beam.



Design change of LALT-TR

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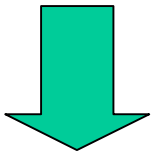
*the heater was added to a laser oscillator

*Storage temperature (in vacuum) of a laser oscillator was changed:

before : -30deg ~ +60deg



currently : +20deg ~ +37 deg

Conditions of the environmental test for LALT-TR

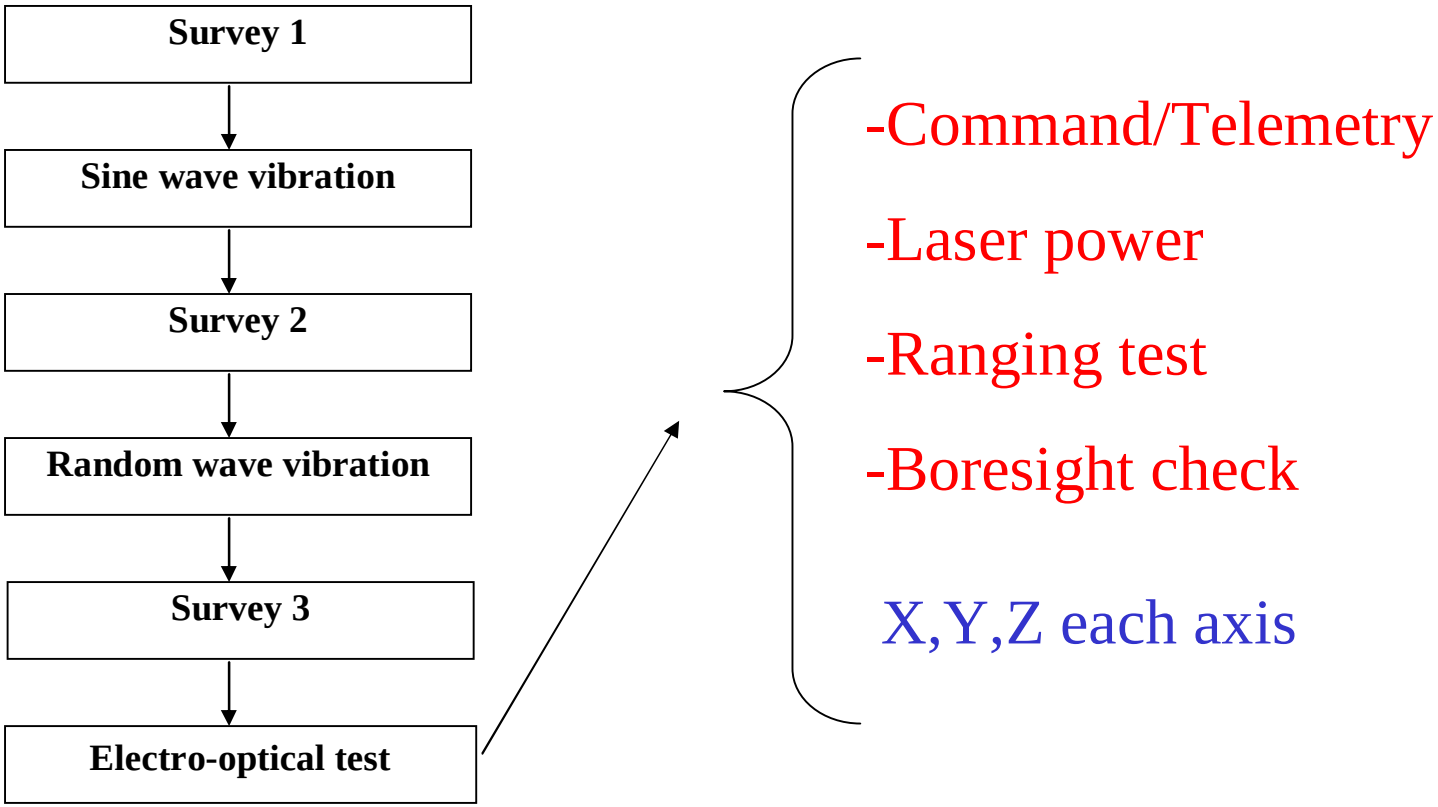
Vibration test

Sweep-Sine vibration	X,Y-axis	5 to 50 Hz, 12.5G
		50 to 100 Hz, 7.5G
	Z-axis	5 to 100 Hz, 12.5G
Random wave vibration	X,Y-axis	8.54Grms
	Z-axis	12.49Grms

Thermal vacuum test

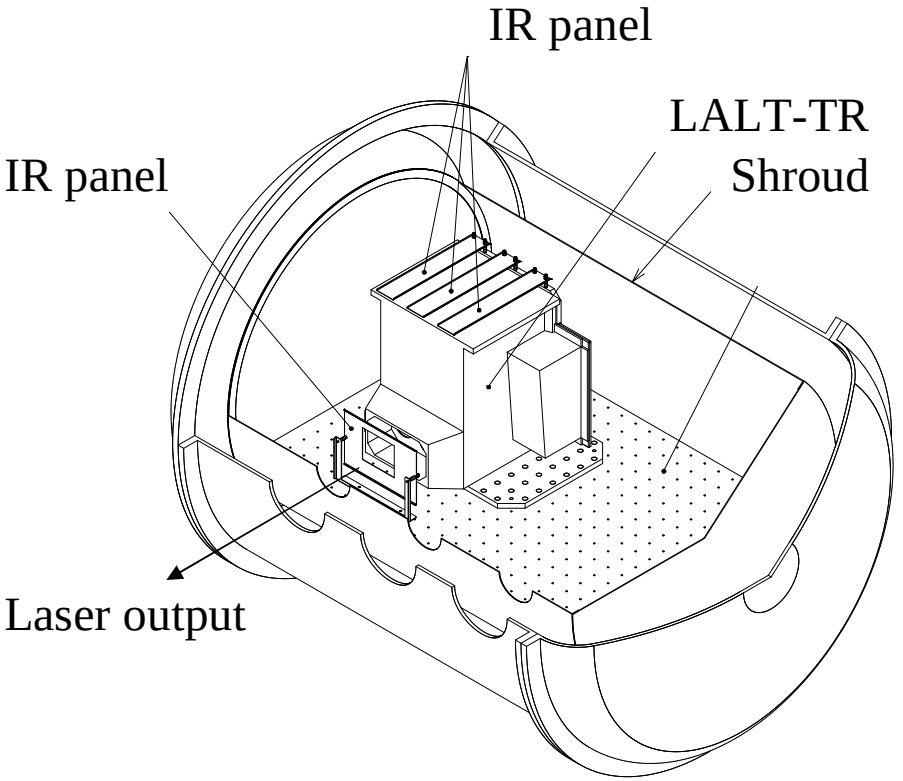
Low temperature	-26deg (@base plate)
High temperature	+47deg (@base plate)
Degree of vacuum	133x 10^{-5} Pa

Vibration test procedures



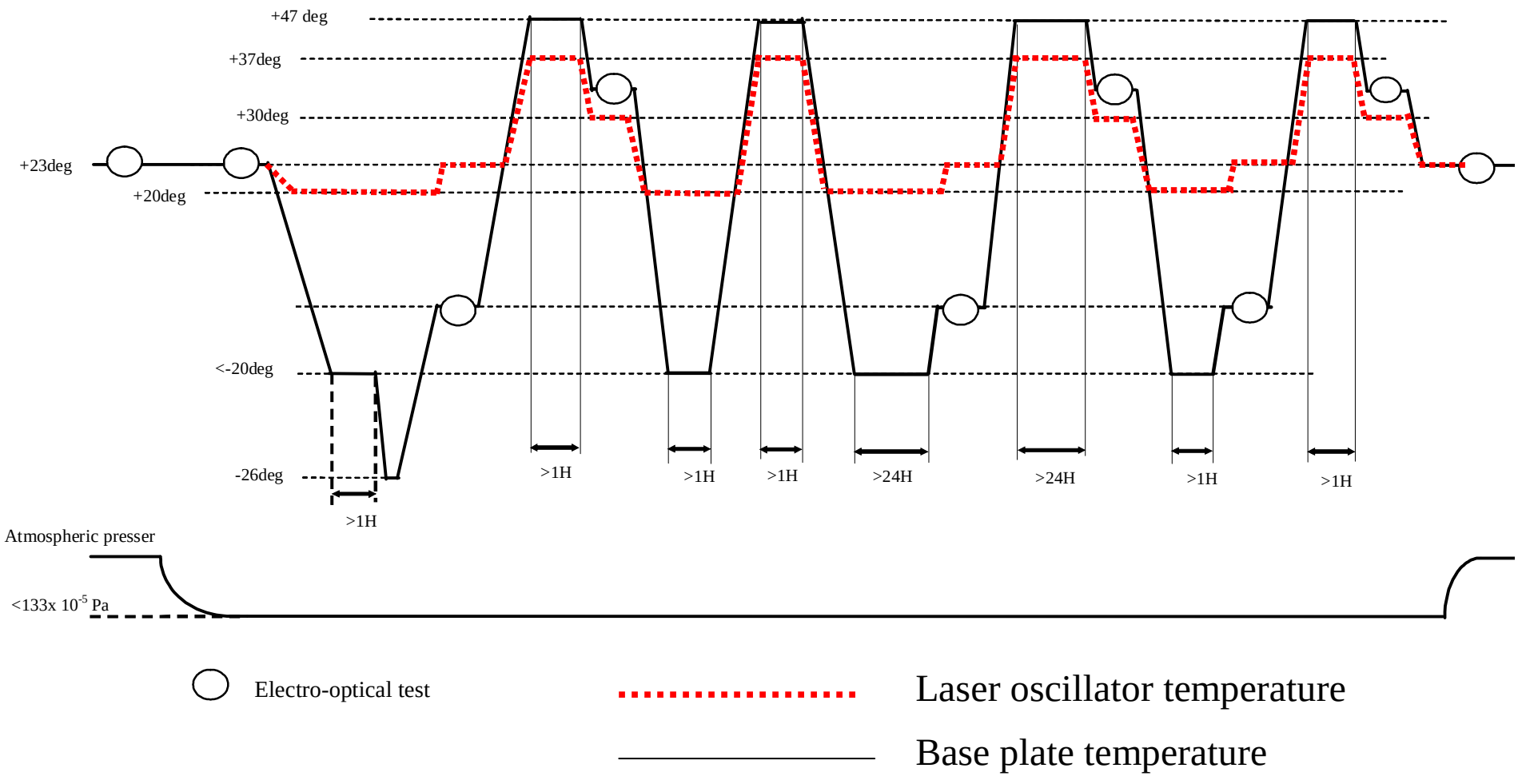
Thermal vacuum test (LALT-TR)

Vacuum chamber

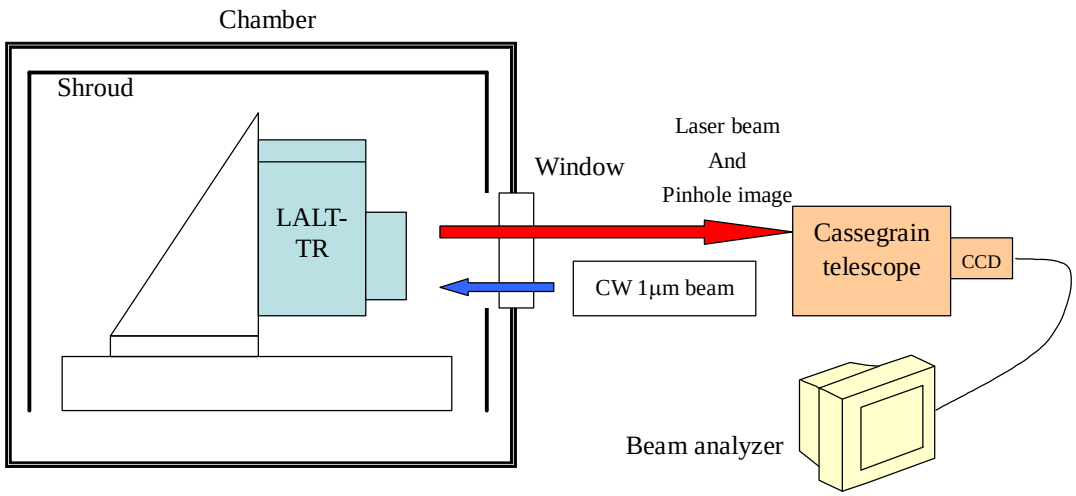


LALT-TR is surrounded by the shroud which liquid nitrogen was used for. An IR panel is installed in the aperture and the beside LALT-TR.

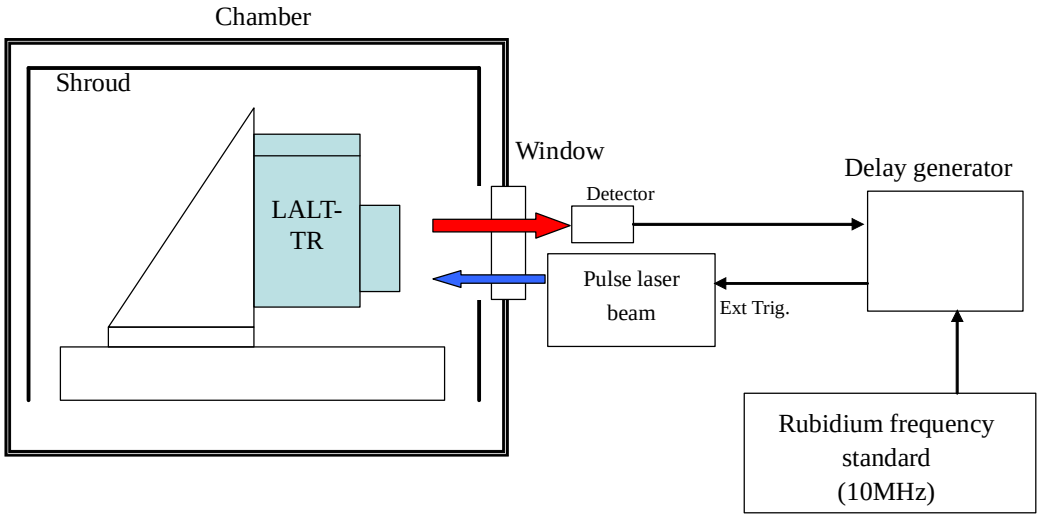
Thermal vacuum profile (LALT-TR)



Thermal vacuum test configuration

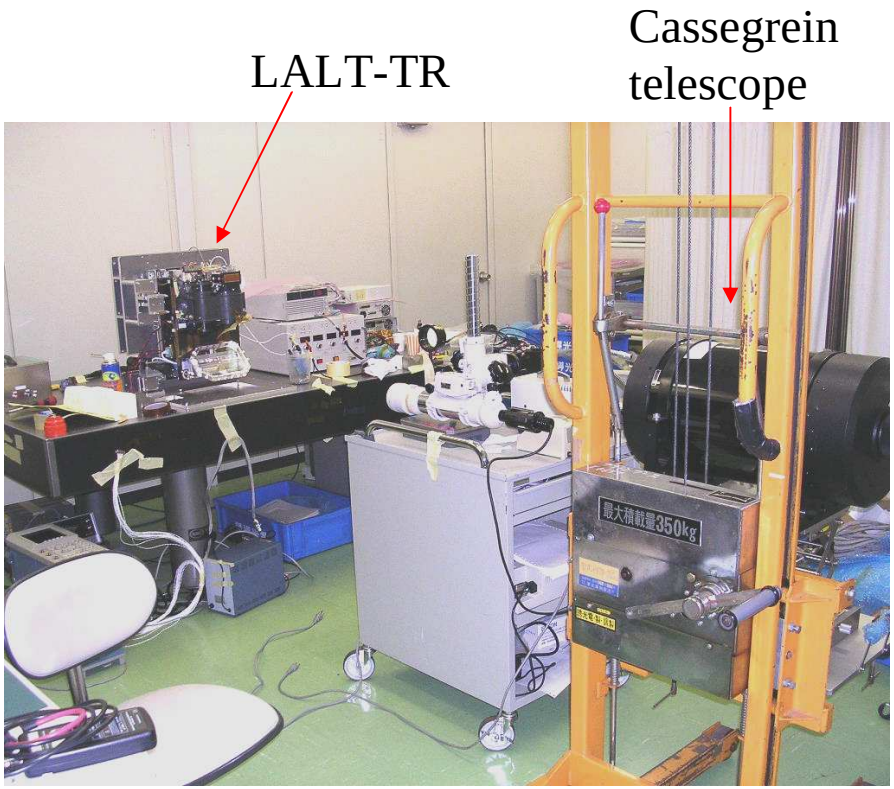


A Cassegrain telescope is placed in front of LALT-TR. The pinhole of the receiver telescope in LALT-TR is lighted with a 1μm CW-laser. The image of the pinhole and the transmitting beam are monitored by a CCD camera to observe the boresight.



A frequency standard signal is connected to delay generator. Ranging distance is changed by the timing delay generator.

Boresight alignment



LALT-TR is placed in front of the Cassegrain telescope to adjust the boresight alignment .

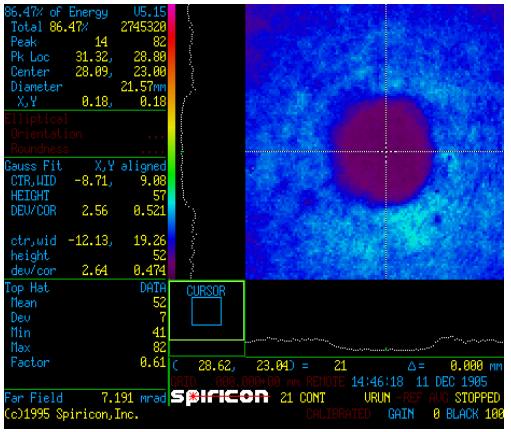
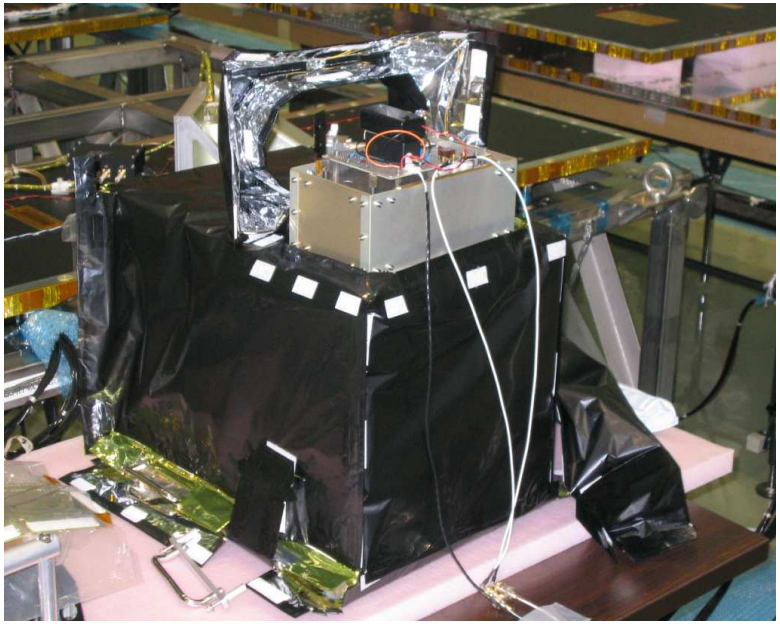


Image of the Receive telescope pinhole

Image of the transmitter laser beam (far field pattern)

Ranging simulation



LALT-TR which attached the head of the ranging simulation equipment for ranging test.

In the ranging simulation, the equivalents distance is changed by the timing delay generator. And a laser wave form is monitored by the oscilloscope.

Targets ranging

Targets are the wall of building, steel tower, and the range calibration target in factory. Ranging distance are 5.1km, 8.3km and 0.45km, respectively.

Conclusion

Laser oscillator

Measurement results in normal conditions

Output energy 100mJ/pulse @ 794mJ input energy

Pulse width 17nsec @ 794mJ input energy

In environmental tests (Thermal vacuum, Vibration)

Laser Output fluctuation 10% or less

Laser altimeter (LALT)

Proto-flight test for LALT-TR/E was finished in Apr. 2006

LALT is being installed to SELENE