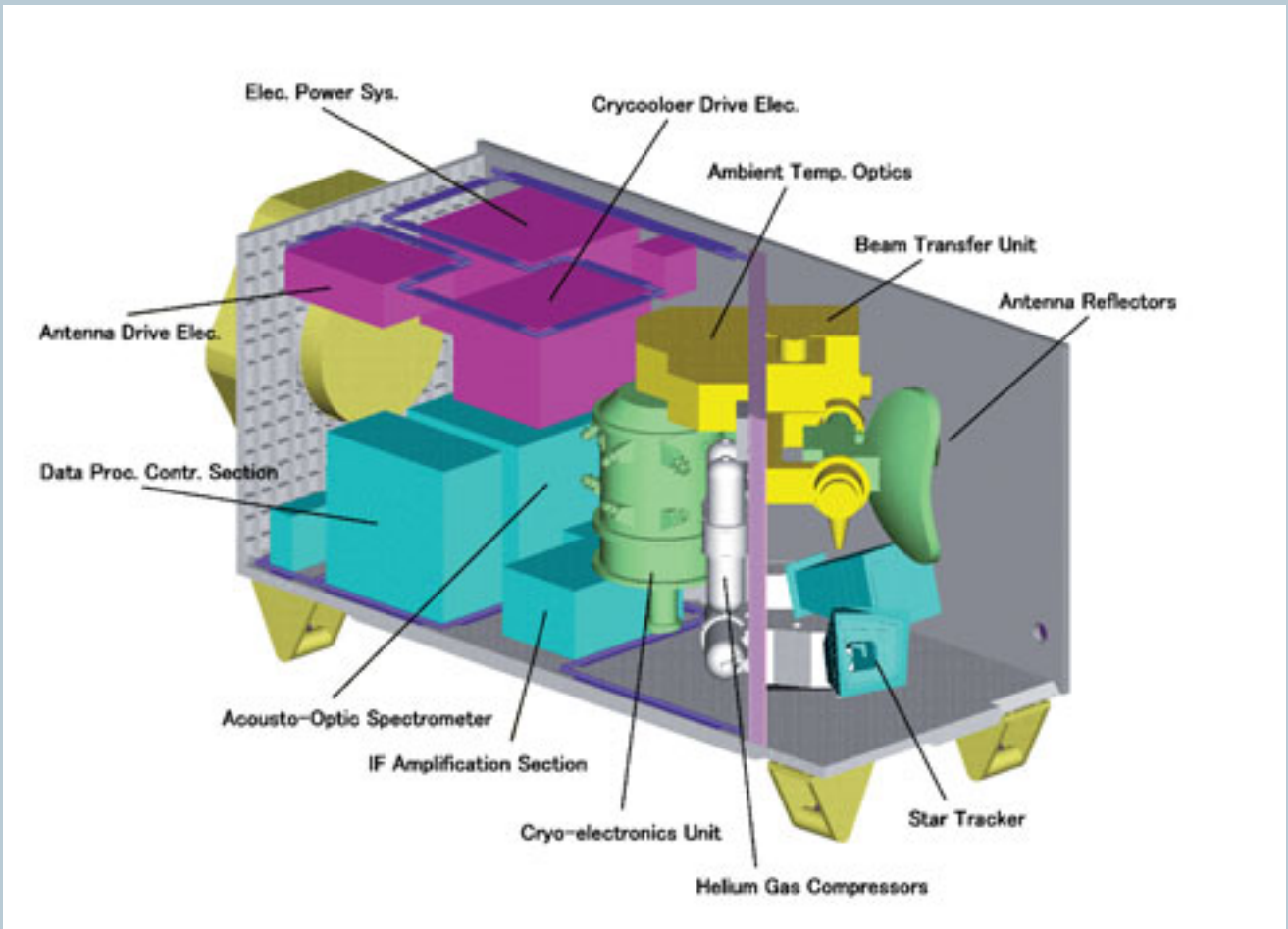
SMILES

Superconducting Submillimeter-wave Limb-emission Sounder



Mission Objectives

- Space demonstration of a submillimeter sensor technology based on a superconductive mixer and 4-Kelvin mechanical cooler
- Experiments of submillimeter limb-emission sounding of the atmosphere
- Global observation of trace gases in the stratosphere and contribution to the atmospheric sciences

Specifications

Observation Band: 640GHzBand

Target Gases: O_3, HCl, ClO, HO_2, H_2O_2, HOCl, BrO, HNO_3, SO_2,etc.

Altitude Range: 10 – 60 km

Latitude Range: 65N – 38S

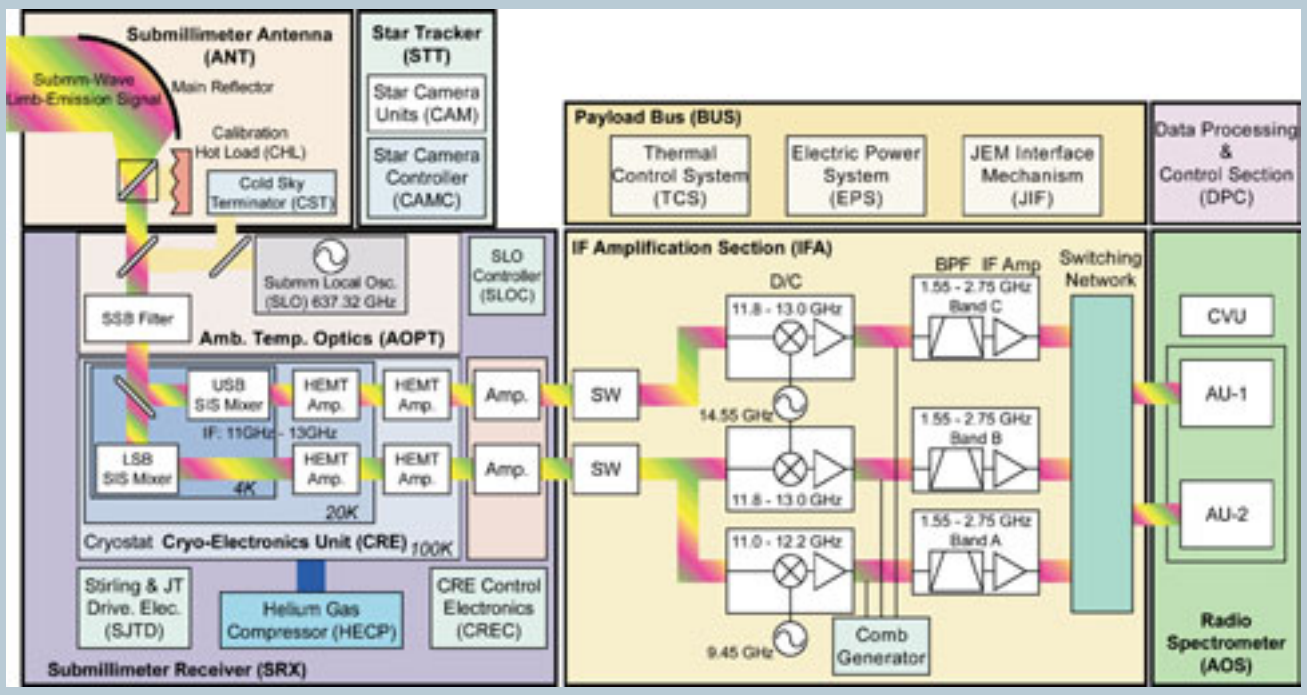
Instruments: Offset Cassegrain Antenna
SIS Mixer Receiver
4-Kelvin Mechanical Cooler
Acousto-optical Spectrometer

Frequency Resolution: 1.8 MHz

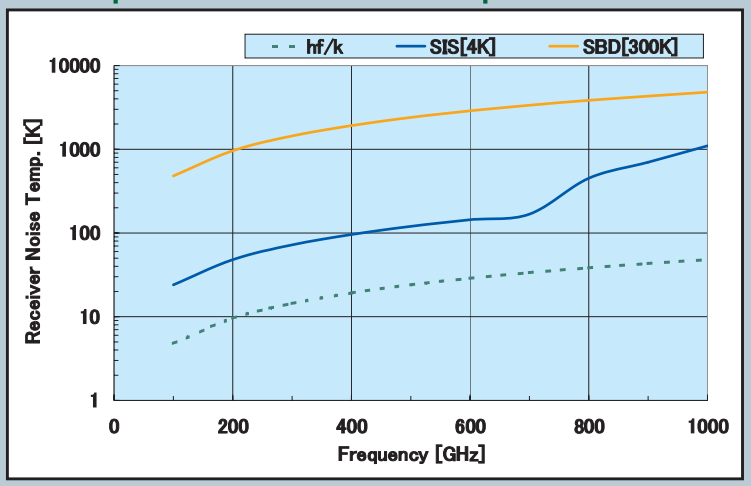
Sensitivity: 1 K(rms) in a single scan

Submillimeter-Wave Sensor Operated at 4K in the shielded cryostat

SMILES instruments are protected against the ISS environmental electric field by payload panels designed as an electric shield (shielding of 14 dB).
Cryo-electronics unit, which deals with signal at lowest power levels, are shielded more by the cryostat (shielding of 40 dB).



SIS: Superconductor-Insulator-Superconductor



Superconductive SIS mixer receivers have some 20 times higher sensitivity (lower noise) than conventional Schottky-barrier-diode (SBD) mixer receivers for frequencies less than 700 GHz. Sensitivity will be limited by the quantum limited noise (hf/k).

SMILES 640GHz SIS Reciever in the shielded cryostat

Stirling: 60-80 W (AC 15 Hz)

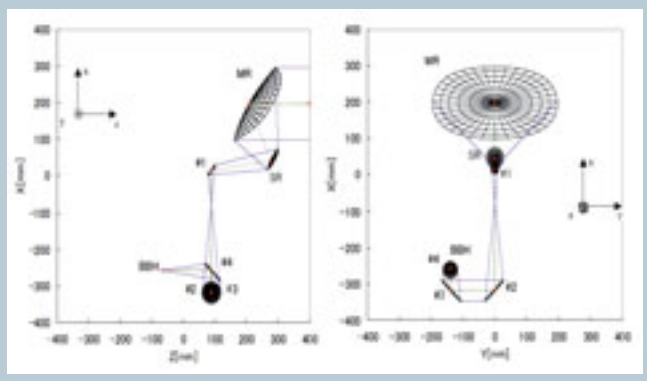
J-T Cooler: 30-37 W (AC 30 Hz)

High-Quality Subsystem

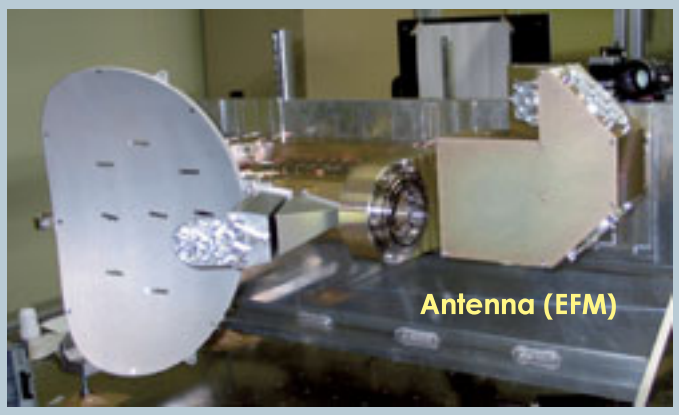
Submillimeter Antenna (ANT)

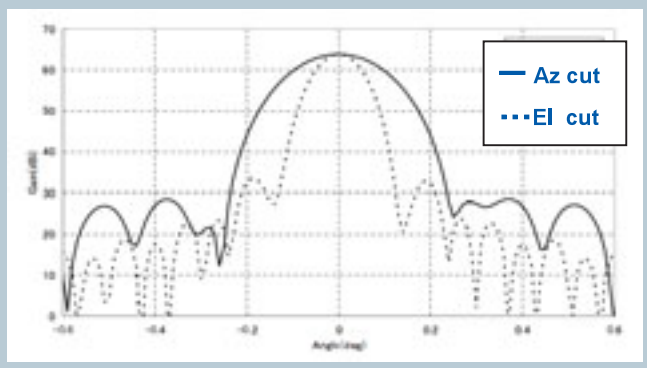
SMILES's submillimeter antenna adpots an elliptical mirror with dimensions of 40 cm in vertical direction and 20 cm in horizontal. The mirror is not so large, but it is required to be highly accurate in shape for generating a high-quality beam at submillimeter wavelengths.

Obserbation Frequency : 624.32 – 650.32GHz
Surface Accuracy : <15μm (rms)
HPBW: 0.09 deg (El) x 0.18 deg (Az)
Beam Efficiency: >0.90 (2.5*HPBW)



Submillimeter Optics



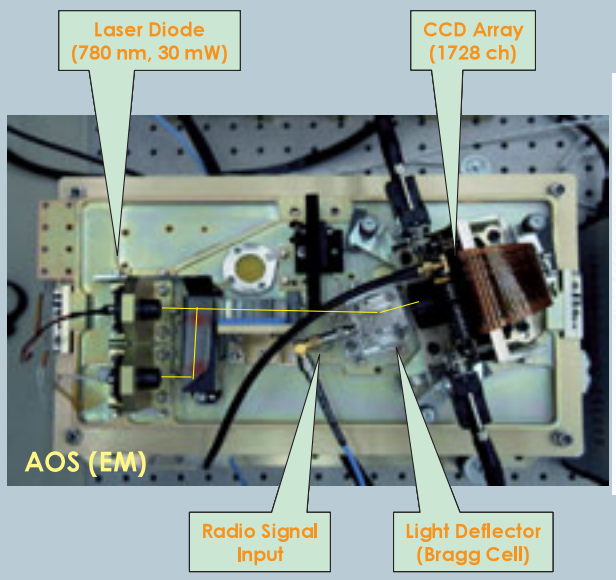


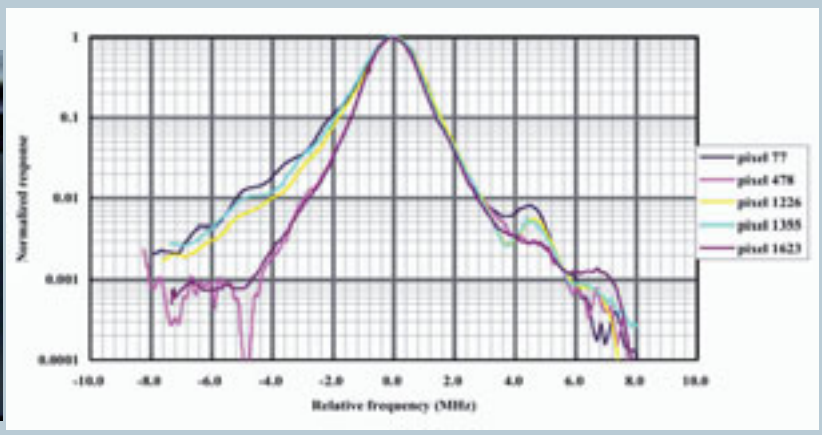
Designed Antenna Pattern (637 GHz)

Acousto-Optical Spectrometer (AOS)

SMILES is equipped with two units of AOS, each has 1,500 channels over 1,200 MHz. This enables detection of more than 20 species involved in the atmospheric spectra.

Input Frequency : 1.55 – 2.75 GHz
Frequency Resolution: 1.8 MHz (FWHM)
Channel Spacing: 0.8 MHz / channel
Unit Averaging Period: 0.47 sec

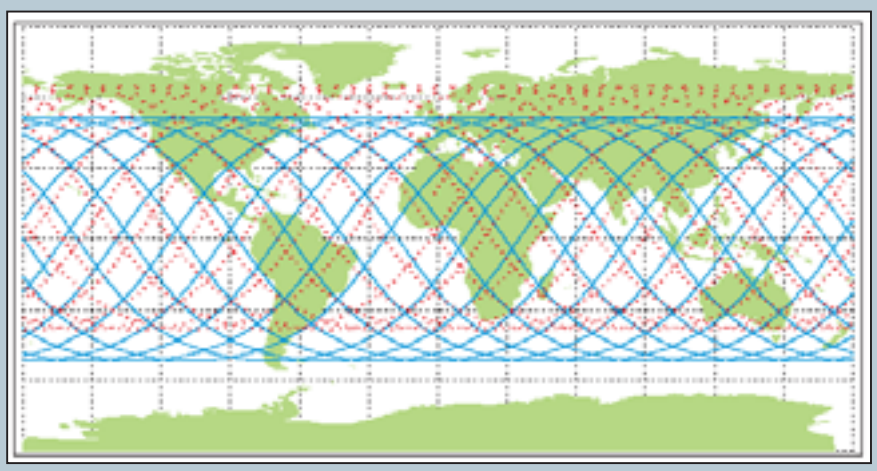




Measured Frequency resolution of the AOS(EM)

Global Data of Trace Gases with High Resolution

Global Coverage



Covered Latitudes

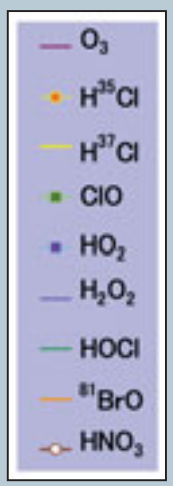
68N – 35S (ISS Yaw: +15 deg)
65N – 38S (ISS Yaw: 0 deg)
61N – 42S (ISS Yaw: –15 deg)

Trajectory for 24 Hours

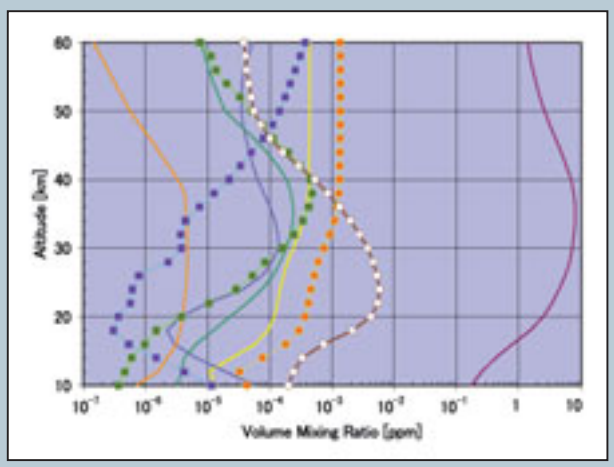
Blue: ISS-SMILES Orbit
Red Dots: Sampled Area

Major Species of SMILES

Expected altitude profile of the volume-mixing-ratio is shown for nine major SMILES species according to a typical mid-latitude model atmosphere (45N).

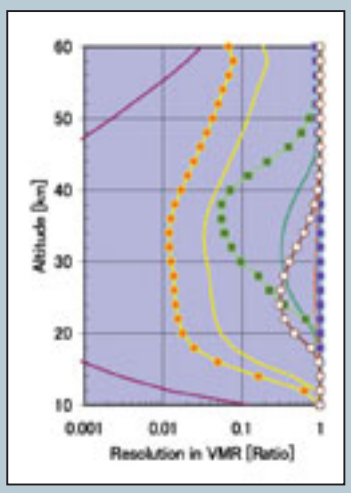


VMR

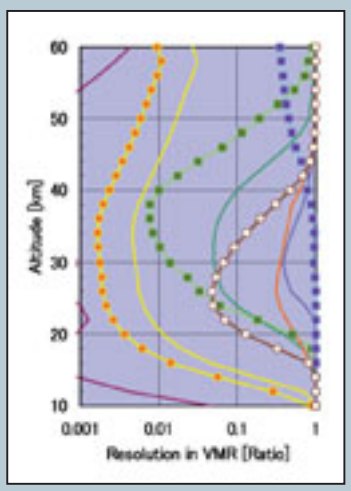


Expected Resolution of SMILES Data

Single Scan



Averaged



Resolution in VMR

Upper Right: For a single scan data available in each 53 seconds
Lower Right: For a zonal averaged data available in each day

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