1. Executive Summary

1.1 Overview of the SMILES mission
1.2 Scientific targets
1.3 SMILES observations
1.4 Launch schedule
1.5 Functional tests
1.6 Summary
**JEM/SMILES Mission and History**

(JEM/SMILES: Superconducting Submillimeter–Wave Limb–Emission Sounder designed to be aboard the Japanese Experiment Module on ISS)

Collaboration project of **JAXA** (Japan Aerospace Exploration Agency) and **NICT** (National Institute of Information and Communications Technology) to demonstrate superconductive mixer and 4–K mechanical cooler for the submillimeter limb–emission sounding in space and to observe atmospheric minor constituents in the stratosphere

**Overview**

**Apr. 1997**: Selection as the ISS Japanese Experiment Module (JEM) Exposed Facility 1st stage Utilization Mission

**Dec. 1998**: Mission Definite Review

**Sep. 2001**: Preliminary Design Review

**Mar. 2003**: Interim Appraisal of the JEM Exposed Facility 1st stage Utilization Mission

The SMILES instrument is now ready for launch.
SMILES Science Team is set in ISS Science Project Office in Institute of Space and Astronautical Science, JAXA.
Block Diagram of JEM/SMILES

Overview
JEM/SMILES Payload

Major Design Parameters

- RF: 640 GHz band
- Spectral Coverage: 1200 MHz x 2
- Antenna: 40 cm x 20 cm
- Weight: < 500 kg
- Mission Life: 1 year
Mechanical Cooler and SIS Mixer

- **Mechanical Cooler**
  - Two-stage Stirling and J-T
  - Cooling Capacity:
    - 20mW @4K, 200mW @20K, 1000mW @100K
  - Power Consumption: <300 W
  - Mass: 90 kg

- **SIS Mixer**
  - RF: 640 GHz
  - IF: 11–13 GHz
  - Junction:
    - Nb/AlOx/Nb, ~7 kA/cm²
  - RF Matching:
    - PCTJ with Integrated Circuit
  - Fabricated at Nobeyama RO
## Development Schedule

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Subsystems</td>
<td>△ PDR</td>
<td>△ CDR1</td>
<td>△ CDR2</td>
<td>△ (△) PQR</td>
<td>△ HTV-TF</td>
<td>PDR</td>
<td>CDR1</td>
<td>CDR2</td>
<td>HTV-TF</td>
</tr>
<tr>
<td>Support Subsystems/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payload Bus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Handling Facility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science Research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Validation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overview</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **PFM Fabrication/Functional Test**
- **EM Fabrication/Functional Test**
- **PFM Integration/Proto-Flight Test**
- **DHF Development**
- **DHF Operation**
- **Science Research**
- **Validation Planning / Experiment**
Not only in the polar latitudes, but also in the mid- and lower latitudes, ozone depletion is critical whole the globe. The recovery is estimated around 2060–2070, but there is very big uncertainty in association with the Cl and Br chemistries (WMO, 2006).

Model results for the future Antarctic ozone amount calculated from chemistry-climate models (WMO, 2006)
Chlorine and Bromine in the Stratosphere

**Our quantitative understanding of how halogenated very short-lived substances contribute to halogen levels in the stratosphere has improved significantly since the 2002 Assessment, with brominated very short-lived substances believed to make a significant contribution to total stratospheric bromine and its effect on stratospheric ozone. (WMO Ozone Report, 2006)**
Scientific targets of SMILES

1. Inorganic Chlorine chemistry
   - ClO to HCl ratio (O₃ trend in the US)
   - HOCl production (O₃ trend in the LS)
   - Global ClO (background ClO)
2. Bromine budget (very short-lived source gas)
3. HOₓ budget (HOₓ dilemma)
4. Cirrus clouds (Het. reactions & rad. budget)
5. O₃ isotope (mass independent chemistry)
6. UT/LS mixing (O₃ flux)
BrO measurements suggest that in addition to long-lived source gases (halons and methyl bromide), very short-lived ($\tau < 6$ months) source gases likely contribute to $Br_\gamma$ by about 5 pptv. This difference can be important for $O_3$ in the LS. (Salawitch et al., 2005)
The background ClO\textsubscript{x} level is important to quantify the in-situ O\textsubscript{3} loss at mid-latitudes. However, its global distribution has not been observed with high precision.

SMILES provides global ClO distribution with high precision. Furthermore, measurements of ClO, HCl, HOCl, and HO\textsubscript{2} can provide important insights into the Cl\textsubscript{y} chemistry.
**Partitioning within Cly in US**

Inclusion of the reaction (2) results in a better agreement with observed [ClO]/[HCl] ratio (balloon) and O\textsubscript{3} trend in the upper stratosphere.

SMILES [ClO]/[HCl] measurements can be utilized further systematic test on Cly partitioning.
**Submillimeter limb–emission sounding and global observation**

- High sensitivity in detecting atmospheric limb emission of the submillimeter wave range (640GHz)
- Vertical profiling (~3km) from JEM/ISS with latitudinal coverage of 65N to 38S

→ Measurements on several radical species crucial to the ozone chemistry (normal O$_3$, isotope O$_3$, ClO, HCl, HOCl, BrO, HO$_2$, H$_2$O$_2$)
Error estimation for the mid-latitude case based on the single scan measurement.
**Launch schedule**

**1st phase utilization of JEM Exposed Facility**

- **Superconducting Sub millimeter-wave Limb-Emission Sounder (SMILES)**
  - SMILES will be launched by HTV in 2009

- **Monitor of All-sky X-ray Image (MAXI)**
  - MAXI will be launched by Shuttle 2J/A

- **Space Environment Data Acquisition (SEDA)**
  - SEDA-AP will be launched by Shuttle 2J/A

- **Engineering Model**
  - Solar flare induced neutron detected by BBND in US Lab “Destiny”
Launch schedule of experiment facilities for the 1st phase JEM utilization

<table>
<thead>
<tr>
<th>FY 2008</th>
<th>FY 2009</th>
<th>FY 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>March 11, 2008</strong></td>
<td><strong>June 1, 2008</strong> JEM ELM-PS</td>
<td><strong>FY 2010 HTV#2 launch</strong></td>
</tr>
<tr>
<td><strong>JEM ELM-PS</strong></td>
<td><strong>JEM-Exposed Facility &amp; ELM-ES</strong></td>
<td></td>
</tr>
<tr>
<td>In the ELM-PS</td>
<td>On the ELM-ES</td>
<td>In Pressurized Logistics Carrier (PLC) of HTV</td>
</tr>
<tr>
<td>SAIBO Rack</td>
<td>SEDA-AP</td>
<td></td>
</tr>
<tr>
<td>Ryutai Rack</td>
<td>MAXI</td>
<td></td>
</tr>
<tr>
<td>Both rack were installed in ELM-PS at NASA Kennedy Space Center.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FY 2009</th>
<th>FY 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FY2009 (June 13)</strong></td>
<td><strong>HTV#1 launch</strong></td>
</tr>
<tr>
<td>JEM-Exposed Facility &amp; ELM-ES</td>
<td></td>
</tr>
<tr>
<td>On the Unpressurized Logistics Carrier (ULC) of HTV.</td>
<td></td>
</tr>
<tr>
<td>SEDA-AP</td>
<td>SMILES</td>
</tr>
<tr>
<td>MAXI</td>
<td>HREP</td>
</tr>
<tr>
<td>US Utilization</td>
<td></td>
</tr>
</tbody>
</table>

HREP: US Utilization

Development is completed
Functional test
Results from functional test – 1

Noise Temperature

Antenna Pattern

- 4.5K - red
- 4.3K - green
- 4.1K - blue
Results from functional test – 2

Molecular Detection

Functional tests
Interface testing with JEM–EF

- Telemetry communication between SMILES and operation system through JEM–EF was successfully demonstrated.
**Level 2 Data processing system**

- **Level 2 Data processing**
  - Convert emission spectra (Level1B data) into vertical profiles
  - Near–real–time processing (53sec./scan)
  - Automatic processing (without operators)
Summary

- JEM/SMILES will make measurements on several radical species crucial to the ozone chemistry with high-sensitivity observations.
- The SMILES instrument is now ready for launch in Tanegashima.
- SMILES will be scheduled for the launch using HTV in 2009 September.