Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PPS01-P01 Room:Convention Hall Time:May 21 18:15-19:30

Instrument overview and Japanese contribution to the development of Submillimetre Wave Instrument (SWI) aboard Jupiter

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The Submillimetre Wave Instrument (SWI) is a very high spectral resolution, dual band (600 and 1200 GHz) instrument proposed to form part of the scientific payload instruments for the JUpiter Icy Moons Explorer (JUICE) mission. It will measure atmospheric temperature, winds, water vapor, methane and numerous other molecules with its high-resolution spectrometers on Jupiter, Ganymede, Callisto, Europa and Io.

The SWI is a passive heterodyne microwave spectrometer sensitive for radiation in the two frequency bands of 530-601 GHz and 1082-1271 GHz. Radiation is received through a submillimetre telescope with 30 cm aperture diameter, providing a spatial resolution of 400 and 200 arcseconds (FWHM) at 600 and 1200 GHz, respectively. Two independent double sideband receivers are used to obtain simultaneous observing capability in the two frequency bands. Each receiver is connected to its own high-resolution chirp transform spectrometer (CTS), providing a total bandwidth of 1 GHz at 100 kHz resolution. To allow a larger bandwidth coverage at lower resolution for surface emission measurements of Jupiter's satellites, SWI is equipped with two autocorrelation spectrometers (ACS) (5 GHz bandwidth, programmable 256, 512, 758 or 1024 channels) and two continuum detectors (5 GHz bandwidth) as well. For radiometric calibration, the SWI instrument uses an internal blackbody as hot reference load and the cold sky as external cold reference load. The hot reference load is coupled into the beam internally via a calibration flip mirror. The cold sky is viewed by turning away the telescope from Jupiter respective the satellite under investigation.

Japanese team is responsible for the development of telescope unit consisting of antenna, scanning mechanism, and actuator control for SWI. In this poster, current idea and design of the telescope unit are briefly summarized.

The telescope consists of an off-axis parabolic primary mirror together with a hyperbolic secondary mirror (Cassegrain configuration). It is very similar to the design of the telescope for the MIRO instrument onboard of the Rosetta spacecraft. However, the surface accuracy of the primary reflector for SWI needs to be at least twice as good than for the MIRO reflector, because SWI observes in band 2 within a frequency range with approximately half the wavelength than at 557 GHz.

The actuator control electronics will control the movements of the 3 mechanisms (rotation of primary mirror, tilt of telescope sub-unit and movement of the calibration flip mirror). Radiation hard components will be used.

The design of the scanning mechanism is critical and thus still preliminary. The requirement is to have a pointing step size of less than 30 arcseconds, but to achieve a pointing knowledge of 5 arcseconds. To save mass the baseline approach is not to use an appropriate absolute angular encoder, but instead to aim mechanically for a 5 arcsecond step size and then to count steps relative to a single reference position. A dedicated test model for just the mechanism will be built to demonstrate the feasibility of this concept and to move the decision point for including an angular encoder (adds additional mass) as far as possible towards early phase of the instrument development phase.

Keywords: Jupiter, submillimeter sounder, JUICE