Radio and Plasma Wave Investigations (RPWI) in Japan

Radio: first Direction/Polarization, Subsurface (80kHz – 45MHz)
Wave: first Wave-Particle interaction (few – 1MHz/20kHz)
E-field: first DC E-field measurement (Langmuir probe)
Plasma: first Low-T plasma measurement (Langmuir probe)

LATEST Status (just after SWT [Sep @ ESTEC] & RPWI-Airbus [Oct @ Uppsala] meetings)

* EM1: Shipment to Europe on 8 Feb 2016
  - Development & Tests in Japan
  - First integration tests with all RPWI

* 'Software-type Wave-Particle Interaction Analyzer' (SWPIA) function for ion heating
  with MAG (B-field) & PEP (ion) teams.

* 'Passive SubSurface RADAR (PSSR)' function
  for the detection of 'ICE – WATER boundary'
  = subsurface ocean surface
  by the reflection of Jovian radiation.

Radio and Plasma Wave Investigation (RPWI) on JUICE
(Jan. 2016) -1-

Radio and Plasma Wave Investigation (RPWI) on JUICE
(Jan. 2016) -2-

Radio and Plasma Wave Investigation (RPWI) on JUICE
(Jan. 2016) -3-
Radio and Plasma Wave Investigations (RPWI)

**RPWI: Contribution from Japan**

**[PI]** Jan-Erik Wahlund
(IRF – Uppsala, Sweden)

**[Co-PI]** Y. Kasaba (Tohoku Univ.)

**<Remote sensing: Radio>**

- **[HF-System]**
  - Preamp (Tohoku/Meisei)
  - HF – Receiver (Tohoku/Meisei + IRF-Uppsala)
  - DPU: HF - Software (Tohoku/Kanazawa)

- **[HF-System]**
  - IRF-Uppsala

- **[LF-System]**
  - Software-type WPIA (Tohoku/Kyoto/Kanazawa)

- **[LP-System]**
  - Contribution to design: E/B sensor, Wave-Particle correction

**<In-situ: Wave, DC-field, Low-T plasma>**

- **[LF & LP-System]**
  - **[Science]**
    - Contribution to design: E/B sensor, Langmuir Probe (Kyoto/Kanazawa/Tohoku)

- **[Heritage]**
  - MMO/WPT-Pre Kaguya/PWS-Pre
  - RWI-Pre BBM (developed from 2012)

**<In-situ: Wave, DC-field, Low-T plasma>**

- **[Critical] Radiation, Low-T, Long herness**
  - 2.5m tip to tip x 3 pairs (8m from S/C)

**[Heritage]**

- MMO/WPT-Pre Kaguya/PWS-Pre
- RWI-Pre BBM (developed from 2012)

**Radio and Plasma Wave Investigation (RPWI) on JUICE**

(Jan. 2016)
**Radio and Plasma Wave Investigation (RPWI) on JUICE**

**RPWI: Contribution from Japan --- H/W**

- **High Radiation** (Mrad ??)
  - “Al 3.0mm + Ta 1.3mm”
  - $<100$krad

- **Long Harness** (10.5m for 50MHz)
  - To be tested in Nov. - Dec.

- **Low Temperature (30-40 K ??)**
  - LN2 (-77K) test
  - Ok above 45K!
  - Low-TEMP chamber
  - in TU & Meisei

**LN2 low temperature function and performance test** (BBM#2, 2013)

**LN2 low temperature Shock-cycle test** ‘300K <> 80K’ x 20 (BBM#4, Sep 2015)

**Thermal Vacuum Test:** +120 ~ -150degC (BBM#4, 2015)

**RFWI**

- Long Harness (10.5m for 50MHz)
  - To be tested in Nov. - Dec.

**Plasma wave receiver** (Waveform observation)

- **Pros**
  - Less attenuation ($\propto 1/f$) in the subsurface media is expected in ~1MHz.
  - Radio Source: Low-Frequency (& Wide-band) radio waves from Jupiter which continuously emitted.

**Cons**

- Jupiter-side area of the moons only (Ganymede: 7.15 day orbit around Jupiter)

**Pros**

- Radio Source: Low-Frequency (& Wide-band) radio waves from Jupiter which continuously emitted.

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- **Jupiter case: AKR by Kaguya LRS**

**Direct measurement of energy flow by Wave – Electron/Ion interaction**

- It is larger demand for the low-TLM missions!

- **Pros**
  - Radio Source: Low-Frequency (& Wide-band) radio waves from Jupiter which continuously emitted.

- **Cons**
  - Jupiter-side area of the moons only (Ganymede: 7.15 day orbit around Jupiter)

**Ice crust**

- ~150km thickness?

**Liquid Ocean**

- ~500km away
Radio and Plasma Wave Investigation (RPWI) on JUICE

[<Reflectance>]

Space ($\varepsilon_r=1$) $\Leftrightarrow$ Ice ($\varepsilon_r=3$) $\Leftrightarrow$ Liquid ocean ($\varepsilon_r=87$)

Surface echo (Space $\Leftrightarrow$ Ice)

$$R_S \sim 0.27$$

Subsurface echo (Ice $\Leftrightarrow$ Ocean)

$$R_{SS} \sim (1-0.27) \times 0.69 \times T_{ice}$$

$$\sim 0.50 \times T_{ice}$$

<Transmission in ice $\sim 150$ km>

$$T_{ice} \sim 0.25 - 0.06 @ 50$MHz$$

$$[f_{TiO2,FeO} = 1 - 10\%]$$

Ice thickness: $D>150$km

(suggested in prev. studies)

[kivelson et al. 2002; Spohn and Schubert, 2003]

<Reflectance>

PSSR (passive radar) @ 1MHz

[up to $\sim 90$km ??]

[Transmission in ice $\sim 150$ km>

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