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The Radio & Plasma Wave Investigation (RPWI) for JUICE

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1. Introduction

We present the Radio & Plasma Waves Investigation (RPWI) selected for implementation on the JUICE mission. RPWI consists of a highly integrated instrument package that provides a whole set of plasma and fields measurements. The RPWI instrument has outstanding new capabilities not previously available to outer planet missions, and that would address many fundamental planetary science objectives. Specifically, RPWI would be able to study the electro-dynamic influence of the Jovian magnetosphere on the exospheres, surfaces and conducting oceans of Ganymede, Europa and Callisto. RPWI would also be able to monitor the sources of radio emissions from auroral regions of Ganymede and Jupiter, and possibly also from lightning activity in Jupiter's clouds. Moreover, RPWI will search for exhaust plumes from cracks on the icy moons, as well as μm-sized dust and related dust-plasma-surface interaction processes occurring near the icy moons of Jupiter.

1.1 Consortium

The RPWI consortium consists of experienced international teams who provide a long heritage record from several previous ESA/NASA/JAXA missions and a track record of collaboration with each other. The team also includes members who are experts in numerical modeling of all relevant physics and Jovian space environments to enhance the science return from the investigation. The team includes members from the following research organizations:

Swedish Institute of Space Physics (IRF), Uppsala, **Sweden**
Royal Institute of Technology (KTH), Stockholm, **Sweden**
Laboratoire de Physique des Plasmas (LPP), Palaiseau cedex, **France**
LESIA-Observatoire de Paris, Meudon Cedex, **France**
CNRS-LPC2E, Université d'Orléans, Orléans cedex, **France**
CNRS-IRAP, Université Paul Sabatier 9, Toulouse Cedex 4, **France**
Université de Versailles Saint-Quentin (LATMOS), Guyancourt, **France**
Space Research Centre of the Polish Academy of Sciences, Warsaw, **Poland**
Institute of Atmospheric Physics, Prague 4-Sporilov, **Czech Republic**
Astronomical Institute, Prague 4-Sporilov, **Czech Republic**
Imperial College London, London, **UK**
University of Sheffield, Sheffield, **UK**
Space Research Institute, Graz, **Austria**
University of Cologne, Cologne, **Germany**
Tohoku University (and Toyama Prefectural University), Sendai, **Japan**
Kyoto University, Kyoto, **Japan**
Kanazawa University, Kanazawa, **Japan**
ISAS/JAXA, Kanagawa, **Japan**
Nagoya University, Nagoya, **Japan**
Space Science Laboratory, Berkeley, **USA**
University of Iowa, Iowa City, **USA**
Johns Hopkins University, Baltimore, **USA**
NASA Goddard Space Flight Centre, Greenbelt, **USA**
Boston University, Boston, **USA**
University of Michigan, Ann Arbor, **USA**

2. RPWI Science Objectives

RPWI has put special efforts into the design in order to have the capabilities:

- To determine the properties, dynamics and the electrically conducting state of the cold plasma (<100 eV, and possibly dusty) that originates from the ionization of the dense exospheres of the icy Galilean moons, and its effect on these moons icy surfaces;
- To determine the electro-dynamic coupling via electric currents, Alfvén waves, electric acceleration structures and plasma waves that transfer energy and momentum between different particle populations in Ganymede's magnetosphere as well as in the induced

magnetospheres of Europa and Callisto, and the induced fields coupling to their conducting sub-surface Oceans;

- To determine the state and dynamics of the Jovian magnetosphere, and how this variable and rotating magnetosphere transfer energy and momentum to the space environments around the icy Galilean moons, with special emphasis on the mechanisms of the electro-dynamic coupling in this interaction;
- To determine the location of source regions of the radio emissions within the Jovian domain and to determine the properties of those emissions, such as polarization, to characterize the source regions;
- To use a closely integrated and substantial theory support tailored to enhance the understanding of the RPWI observations in both specific and broad contexts.

RPWI therefore focus, apart from cold plasma studies, on the understanding of how, through electro-dynamic and electromagnetic coupling, the momentum and energy transfer occurs in the space environments encountered by JUICE and with the icy Galilean moons.

"If it is electrified and wiggles, its ours!"

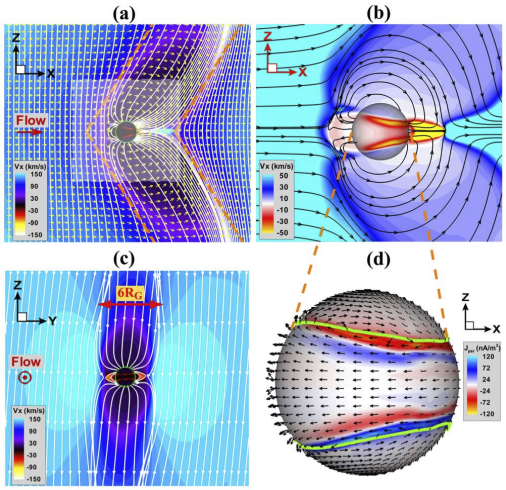

Figure 1: The Jovian magnetospheric flow induces, among other physical effects, an auroral current system in Ganymede's mini-magnetosphere with strong field-aligned currents on auroral magnetic flux tubes to/from the surface. The resulting currents in the partially conducting ionosphere near the surface close these currents and the dynamics of the whole system due to variations in the upstream co-rotation flow can couple to a conducting sub-surface Ocean and the magnetic field variations will certainly superimpose on the signatures of possible existing sub-surface Ocean currents (Jia et al., 2008).

3. RPWI Instrument

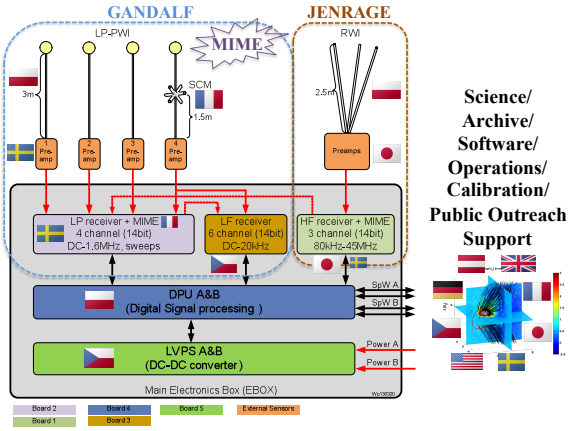

Figure 3: Current baseline configuration of RPWI. The sensors consist of 4 Langmuir probes (LP-PWI) for determination of the vector electric field up to 1.6 MHz and cold plasma properties (including active measurements by LP sweeps and mutual impedance sounding) up to 1.6 MHz, a tri-axial search coil magnetometer (SCM) for determination of the vector magnetic field up to 20 kHz, and a tri-monopole antenna system (RWI) for monitoring of radio emissions (80 kHz – 45 MHz).

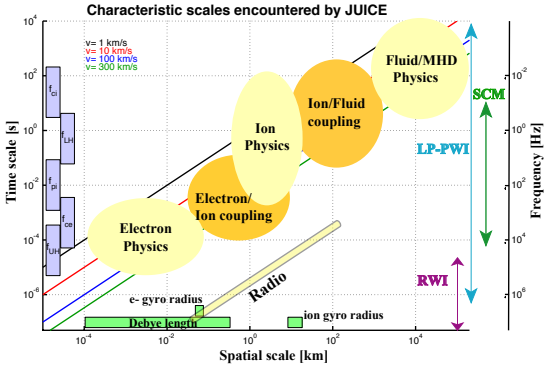

Figure 4: The RPWI instrumentation covers all possible expected encountered physical processes near Jupiter's icy moons. The JMAG (another PI instrument) will cover the low frequency magnetic vector measurements.