JUpiter ICy moons Explorer Mission (JUICE)

Update For PSS
April 4, 2013

Joan Salute
Curt Niebur
The JUpiter ICy moons Orbiter Mission

• ESA’s first Large-class mission in Cosmic Vision Program
• The JUICE mission will investigate the emergence of habitable worlds around gas giants, characterizing Ganymede, Europa, and Callisto as planetary objects and potential habitats, and will also explore the Jupiter system as an archetype for gas giants.
• JUICE will first orbit Jupiter for ~2.5 years, providing 13 flybys of Callisto and 2 of Europa, and then will orbit Ganymede for 9 months
• Launch is scheduled for 2022 with Jupiter arrival in 2030 and Ganymede orbit insertion in 2032
Model payload – 11 instruments with total mass of 104 kg

<table>
<thead>
<tr>
<th>model remote sensing package</th>
<th>model geophysical package</th>
<th>model <em>in situ package</em></th>
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<tr>
<td>Visible and Infrared Hyperspectral Imaging Spectrometer</td>
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<td>Magnetometer</td>
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<td>Ice penetrating radar</td>
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<td>Particle Package</td>
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NASA Participation in JUICE

• NASA planning to support up to $100M of contributions.
  Potential Contributions:

• NASA-funded instrument investigations led by a U.S. PI
  • Proposals to NASA were submitted on Sept. 24, 2012.
  • NASA TMC and Science Evaluations underway/planned
  • Proposals will be reviewed by NASA and ESA

• NASA-funded instrument component(s) and/or NASA-funded U.S. Co-Is on non-U.S.-led instrument(s)
  • Proposals to ESA due Oct. 15, 2012
  • Proposals reviewed by ESA and US relevant sections reviewed by NASA

• ESA and NASA will observe other’s process, share review results and collaborate on payload recommendation

• Selection expected in late January 2013
Negotiations Supporting Selection Process

- NASA and ESA observed each other’s reviews, discussed results and programmatic considerations to inform the deliberations of the ESA PRC.
- These negotiations continued as the payload and its contributors were determined.
JUICE Science Payload
Instruments announced Feb 21, 2013

<table>
<thead>
<tr>
<th>Instrument Name (type)</th>
<th>Acron.</th>
<th>Principal Investigator</th>
<th>Lead Nation</th>
<th>US participation &amp; contr. Lead*</th>
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<td>Sweden</td>
<td>APL*</td>
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JUICE Mission Status

Industry Studies
- 2 competitive studies led by Astrium SAS & Thales-Alenia
- KO mid October until end 2014
- Major milestones:
  - PRR: Sep 2013
  - SRR: Sep 2014
  - Mission adoption Nov 2014
  - KO B2/C/D: Q3 2015

Instrument milestones
- Instrument selection: Feb 2013
- KO Phase A: Mar – Apr 2013
- IPRR: Aug – Nov 2013
- IRC: Q2 2014
- Instr. confirmation: Oct 2014
- ISVR: May 2015

1. Progress meetings with industry teams typically every 6 – 8 weeks
2. Currently scheduled:
   a. PM3: end March, beg April
   b. PM4: mid May
   c. PM5: early July
Remaining TBD

• US Co-I’s on European led instruments
• European Co-I on US led instrument
JUICE-UVS Heritage
# Radar for Icy Moon Exploration (RIME)

## Main Team Members

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Institution</th>
</tr>
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<tr>
<td>PI</td>
<td>Prof. Lorenzo Bruzzone</td>
<td>Dipartimento di Ingegneria e Scienza dell'Informazione, Università degli Studi di Trento</td>
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<td>Co-PI</td>
<td>Dr. Jeffrey J. Plaut</td>
<td>Jet Propulsion Laboratory (JPL), California Institute of Technology</td>
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<td>Co-Is</td>
<td>Dr. Giovanni Alberti</td>
<td>Consorzio di Ricerca su Sistemi di Telesensori Avanzati (CO.RI.S.T.A.)</td>
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<tr>
<td>Co-Is</td>
<td>Prof. Donald D. Blankenship</td>
<td>Institute for Geophysics, University of Texas at Austin</td>
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<td>Co-Is</td>
<td>Dr. Francesca Bovolo</td>
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<td>Co-Is</td>
<td>Dr. Bruce Allan Campbell</td>
<td>Smithsonian Institution, Center for Earth and Planetary Studies</td>
</tr>
<tr>
<td>Co-Is</td>
<td>Prof. Wlodek Kofman</td>
<td>Institut de Planétologie et d’Astrophysique de Grenoble CNRS/UJF</td>
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<tr>
<td>Co-Is</td>
<td>Dr. Goro Komatsu</td>
<td>International Research School of Planetary Sciences (IRSPS), Università d’Annunzio</td>
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<tr>
<td>Co-Is</td>
<td>Prof. William B. McKinnon</td>
<td>Department of Earth and Planetary Sciences and McDonnell Center for the Space Sciences, Washington University in St. Louis</td>
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<tr>
<td>Co-Is</td>
<td>Dr. Giuseppe Mitri</td>
<td>Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale di Astrofisica (INAF)</td>
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<td>Dr. Claudia Notarnicola</td>
<td>Institute for Applied Remote Sensing, European Academy of Bolzano (EURAC)</td>
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<td>Applied Physics Laboratory, Johns Hopkins University</td>
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<td>Dipartimento di Fisica E. Amaldi, Università degli Studi Roma Tre</td>
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<td>Co-Is</td>
<td>Prof. Dirk Plettemeier</td>
<td>Radio Frequency Engineering, Technische Universität Dresden</td>
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<td>Dipartimento di Ingegneria dell’Informazione, Elettronica e Telecomunicazioni, Università di Roma “La Sapienza”</td>
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RIME: US/NASA/JPL Role

NASA is contributing to the following areas:

- Science (Co-PI and Co-Is)
- System Engineering
- Radio Frequency (RF) Subsystem
  - Receiver will be designed and built in-house at JPL
  - Transmitter and associated electronics as a subcontract to University of Iowa
- Mission Assurance
✓ RIME is based on a solid heritage from successful radar sounders operating at Mars:

• Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) on-board ESA’s Mars Express S/C.

• SHAllow RADar (SHARAD) on-board NASA’s Mars Reconnaissance Orbiter.

✓ Many of the members included in the RIME team have been involved with MARSIS and/or SHARAD.
Stas Barabash (PI)
Swedish Institute of Space Physics
Kiruna, Sweden

Peter Wurz (Co-PI)
University of Bern,
Physikalisches Institut
Bern, Switzerland

Pontus Brandt (US-Lead)
Applied Physics Laboratory /
John Hopkins University
Laurel, USA

and PEP TEAM
• TRL≥6 building on direct flight & team heritage from Galileo, Cassini, Juno, Mars Express (ASPERA-3), Venus Express (ASPERA-4), Rosetta, SOHO, New Horizons, Chandrayaan-1, IMAGE, & RBSP

US/APL contribution: Jovian Energetic Particles Investigation (JEPI)
• **Jovian Energetic Neutrals & Ions (JENI)** Global imaging of Europa/lo tori and magnetosphere combined with high resolution energetic ion measurements
• **Jovian Energetic Electrons (JoEE)** Sub-second pitch-angle distributions of energetic electrons to probe acceleration mechanisms, magnetic field topology and boundaries
Status

• New Frontiers Program Office managing projects
• Supported attendance at instrument kick offs at ESTEC
• Contracts in progress
• TAA’s complete or in progress
Back up
# JUICE Science Payload

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JUICE-UVS Science Objectives

Icy Moons

Explore the atmospheres, plasma interactions, and surfaces of the Galilean satellites
– How are their tenuous atmospheres generated, how are they distributed, and what is their composition?
– How do the atmospheres respond to changes in Jovian plasma conditions?
– What are the non-ice surface components, and are they primarily exogenic or endogenic?

Jupiter

Determine the dynamics, chemistry, and vertical structure of the upper atmosphere
– How do minor species vary with latitude in the upper and lower stratosphere?
– Is global thermospheric circulation dominated by auroral energy input?
– How do faint & diffuse auroral structures vary with changing magnetospheric conditions?

Io System

Investigate the energetics & dynamics of Io’s atmosphere, neutral clouds, and torus
– What controls the flow of mass and energy from Io’s atmosphere into neutral clouds, the torus, and eventually the magnetotail? Volcanos? Sublimation?
– How are the high-energy electrons re-energized? What do they contribute to the power emitted by the torus
– How are changing torus and inner magnetosphere conditions related to low-latitude Jovian auroras?
• RIME will address the following JUICE mission goals:
  – Characterize Ganymede as a planetary object and possible habitat
  – Explore Europa’s recently active zones
  – Study Callisto as a remnant of the early Jovian system

• RIME parameters:
  – Synthetic aperture subsurface sounding radar
  – Central frequency 9 MHz; bandwidth up to 3 MHz
  – Lateral resolution: ~0.5 km by ~5 km
  – Vertical resolution: 30 m or 90 m (in ice), selectable
  – Penetration depth: > 9 km (in ice)
PEP key points

• Meets all JUICE particle and plasma science requirements
• Combines first-ever at Jupiter energetic neutral atom global imaging with in-situ measurements
• Obtains 3D plasma flows in less than 10s probing structures of a few gyroradii
• Performs first-ever high resolution gas mass spectroscopy at icy moons to identify surface constituents
• Uses elegant modular design, well-defined and minimized interfaces to the spacecraft