JUICE instrument workshop

9-11 November 2011

Agenda

1. Schedule
2. Darmstadtium
3. Presentations
4. Conclusions

Instrument Workshop 9 – 11 November 2011 at ESOC / Darmstadtium

Agenda:

Day 1:

Joint Session

09:30	Welcome and introduction
09:45	Mission concept summary
10:30	Radiation Environment Update
11:15	ESA-instrument collaboration
11:45	Shared Resources: an introduction
12:15	Resources Discussion and Q&A
12:50	Issues in modelling of radiation effects in the Jupiter environment (G. Santin)
13:30	Lunch
14:30	Computational Tools for Spacecraft Electrostatic Cleanliness and Payload Analysis (A. Hilgers)
15:10	Issues in (very) rad-hard systems: an ESA perspective on use of COTS and space grade electronics in JUICE mission. (G. Furano)
15:50	Break
16:20	Electronic radiation hardening - technology demonstration activities (V. Ferlet-Cavrois)
17:00	DARE+ (Design Against Radiation Effects) ASICs for extremely radiation hard & harsh environments (B. Glass)
17:30	Front-end readout ASIC technology study and development test vehicles for front-end readout ASICS (R. Jansen)
18:00	Payload Data Processing Technologies for JUICE (R. Trautner)
18:30	End

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Agenda: Darmstadtium!!!

Day 2:

Parallel Sessions

Room A: Germanium 2

09:00 Issues in modelling of radiation effects in the Jupiter environment – G. Santin
10:30 Break
10:50 Electrostatic charging – A. Hilgers
13:00 End

Room B: Helium 2

09:00 DARE + radiation design library – B. Glass
10:30 Break
10:50 Front-end ASIC Development I – R. Jansen
13:00 End

13:00 Lunch

Parallel Sessions

Room A: Germanium 2

14:00 Issues in (very) rad hard systems – G. Furano
15:30 Break
16:00 Electronic radiation hardening - technology demonstration activities - V. Ferlet - Cavrois
18:00 End

Room B: Helium 2

14:00 Front-end ASIC development II – R. Jansen
15:30 Break
16:00 Payload Data Processing Technologies for JUICE – R. Trautner
18:00 End

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Day 3: Darmstadtium

Instrument Session I

09:00 – 09:15 The Doppler Spectro Imager (DSI-ECHOES) for EJSM/JGO: a dedicated instrument for Jovian internal structure and atmospheric study
09:15 – 09:30 High Resolution Camera Study for the JUICE mission
09:30 – 09:45 Radiation design of a plasma particle package for the JUICE Mission
09:45 – 10:00 Radiation Design of Ion Mass Spectrometers
10:00 – 10:15 Geodesy in the Jovian System with the Radio Science Instrument (RSI)
10:15 – 10:30 Science Enabling ASICs and FEEs for the JUICE and JEO Missions
10:30 – 10:45 Low-energy neutral detection from JUICE
10:45 – 11:00 CIRIS – A Compositional InfraRed Interferometric Spectrometer for investigation of icy satellites and Jupiter's atmosphere
11:00 – 11:15 BREAK

Instrument Session II

11:15 – 11:30 Global ENA Imaging of the Europa Torus, the Giant Magnetospheric Accelerator and Their Interaction with the Moons
11:30 – 11:45 Planetary Radio Interferometry and Doppler Experiment (PRIDE for the Jupiter Icy Satellite Explorer (JUICE) mission
11:45 – 12:00 Sub-Surface radar instrument for the JUICE mission
12:00 – 12:15 Magnetometer Concepts for EJSM / Jupiter Ganymede Orbiter
12:15 – 12:30 Instrument Study of the Ganymede Laser Altimeter (GALA) for the Jupiter Icy Moon Explorer (JUICE)
12:30 – 12:45 Update of the Wide Angle Camera for JUICE
12:45 – 13:00 Visible and InfraRed Hyperspectral Imaging Spectrometer (VIRHIS) for JUICE
13:00 - 14:30 LUNCH

Instrument Session III

14:30 – 14:45 ORTIS, the ORbiter TeraHertz Infrared Spectrometer
14:45 – 15:00 Status of the Sub-millimeter Wave Instrument
15:00 – 15:15 Dust telescope for JUICE
15:15 – 15:30 Progress on the JuMMP investigation and development of the miniaturised plasma analyser for the JENI sensor
15:30 – 15:45 Thermal Plasma Sensors Study for the JUICE mission
15:45 – 16:00 Radiation Hard Electron Monitor

16:00 Splinter & workshop summary
16:15 End of workshop

Workshop

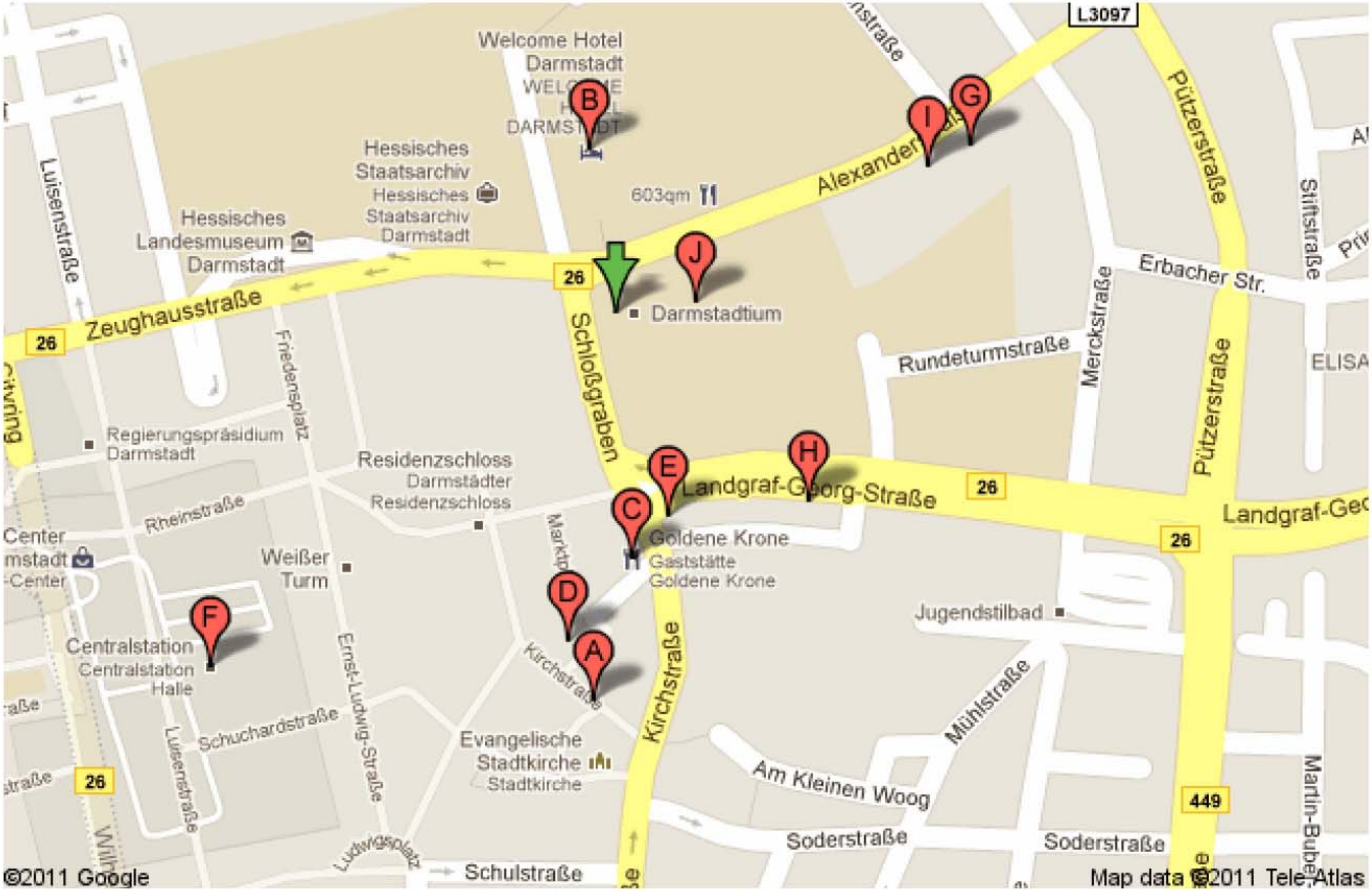
1. Lunches:
    a. Day 1: @ ESOC at own expenses
    b. Day 2 and 3: lunch outside Darmstadtium; list of restaurants below at own expenses
2. Diner:
    a. No joint diner arranged

3. Wireless:
    a. ESA-public
    b. Encryption Disabled
    c. EAP: disabled
    d. SSID: esa-public
4. Questions or problems: ask us

Restaurants

List of Restaurants in the area of Darmstadtium
Closest to venue:
J. Calla
Schloßgraben 1, 64283 Darmstadt, Germany
+49 6151/1019660 calla□darmstadt.de
****
Other:
D. Darmstädter Ratskeller Hausbrauerei GmbH
Marktplatz 8, 64283 Darmstadt, Germany
+49 6151/26444 ratskeller□darmstadt.de
E. Restaurant Asia□Kim
Holzstraße 2, 64283 Darmstadt, Germany
+49 6151/9515888
G. Bayrischer Hof
Alexanderstraße 33, 64283 Darmstadt, Germany
+49 6151/24550 +49 6151/295211 (Fax) bayrischer□hof□da.de
H. El Cid
Landgraf□Georg□Straße 19, 64283 Darmstadt, Germany
+49 6151/295136
I. Pizzeria da Nino
Alexanderstraße 29, 64283 Darmstadt, Germany
+49 6151/24220

Restaurants



Instrument Workshop Announcement
9 – 11 November Goals

1. Technical discussion with instrument study teams
2. Update on latest mission profile
3. Critical items to be taken into account during development
    a. Modelling of the radiation environment
    b. Radiation mitigation approach in the Definition Phase (A/B1)
4. Platform for instrument study teams to share status and experience
    a. Discussion of common issues/difficulties
    b. Possibilities of resource optimization by sharing (combined functions for redundancy, etc)
    c. Short presentations from instrument study teams solicited – abstract required
5. Exchange with ESA technical personnel working on ongoing development activities with potential applications/benefits to instrument study teams

ESA-instrument Collaboration

1. Schedule
2. Framework
3. Responsibilities
4. EID-A and EID-B
5. Radiation design/analysis interaction
6. DPU / datarate

Next Steps: Plans for Reviews and Milestones

1.	New issue of Yellow Book ready	Nov 2011
2.	ESA internal review	Nov/Dec 2011
3.	Evaluation of reformulated mission by ESA advisory bodies (SSEWG)	Dec 2011/Jan 2012
4.	SPC Down-selection	Feb 2012
5.	If down-selection successful –	
	a. ITT for industrial Phase A/B1	Q2/2012 (tentative)
	b. Issue of instrument AO	Q2/2012 (tentative)

External Framework

1. **General**
2. Implementation as part of ESA mandatory programme
3. ESA contribution comes completely out of the science budget
4. **Payload**
5. Payload provided by Principal investigators
6. Payload funding by national funding agencies or by international partners
7. Letter of Agreement has to be signed after AO

Responsibilities (1)

1. ESA is responsible for:
   a. Overall mission design
   b. Procurement of JUICE s/c (without P/L)
   c. Integration of P/L into s/c
   d. System testing
   e. Launch
   f. Cruise operations until S/C delivery to Jupiter system
   g. JUICE mission and science operations
   h. JUICE data acquisition and distribution to Principal Investigators

Responsibilities (2)

1. Customer is the scientific community, Principal Investigators
    a. Responsible for P/L development of the JUICE s/c
    b. Responsible for data products
    c. Archiving

Experiment Interface Documents

Experiment Interface Document A to be provided by the Agency

Experiment Interface Document B to be provided by each instrument team after payload selection as a result of the Announcement of Opportunity

Additional Documents available for the AO:

- Mission Requirements Document
- Radiation Environmental Specification
- Overall environmental specification
- Payload Definition Document (model payload)
- ECSS standards

EID-A

The main purpose of the set of Experiment Interface Documents (one EID-A, common to all instruments and the EID-Bs, one for each instrument) is to ensure that:

- The Principal Investigators (PIs) design, procure, build, qualify, test and calibrate their instruments in line with the technical and programmatic requirements and constraints defined in the EID-A.
- The JUICE Prime Contractor designs, builds and verifies the spacecraft such that the instruments can be successfully integrated and tested into the system, in line with the instrument interface definitions and resources provided in the EID-Bs.
- The spacecraft can be successfully launched and operated to achieve the scientific objectives of the JUICE mission in line with the instrument driven requirements detailed in the EID-A.

EID-A

1. The EID-A, together with its related documents, defines the interface, the design, the operational, the verification, the management and the programmatic requirements applicable to each instrument.
2. The EID-A also specifies the spacecraft performance requirements and the resources allocated to each instrument.
   Specific instrument driven requirements applicable to the spacecraft, namely EMC, cleanliness and pointing requirements are also specified in the EID-A.
3. The EID-A is a living document and will be updated with each major milestone in the project. The EID-Bs will be updated according to the same milestone based process as well

EID-Bs

- Each EID-B, in response to the instrument technical requirements of the EID-A, specifies in detail the instrument interface information.
- Each EID-B defines the specific technical agreements between the ESA JUICE Project Office and each JUICE Principal Investigator.
- Once the EID-A and the EID-Bs have reached a satisfactory level of maturity, they will be placed under formal configuration and change control.

EID-A possible structure

The EID-A could be structured as follows:

1. Chapter 1: General introduction.
2. Chapter 2: Payload related key persons and points of contact.
3. Chapter 3: Synthetic description of the mission, the spacecraft and the payload.
4. Chapter 4: Interface and design requirements and resources.
5. Chapter 5: Radiation environment and analyses
6. Chapter 6: Planetary Protection
7. Chapter 7: Operations description and requirements.
8. Chapter 8: Verification requirements.
9. Chapter 9: Product Assurance requirements.
10. Chapter 10: Management Requirements.
11. Chapter 11: Instrument driven requirements; namely: EMC, pointing, cleanliness, applicable to the spacecraft and/or to the instruments.
12. Chapter 12: Related and informative documents.

Radiation

The radiation environment of the Jovian system specifies the need for a different approach in radiation analyses and instrument design.

Already in a very early phase after the announcement of the payload for the mission, the instrument teams need to send a 3D detailed model of their instrument to be included in the first spacecraft / payload overall radiation sector analyses. This process will be continuous to ensure the most efficient accommodation of spacecraft and payload subsystems and minimizing the total amount of shielding.

In the instrument proposal for the AO already a first analyses of the radiation seen by each subsystem of the instrument is needed with its related shielding mass.

Radiation II

- In the current phase 0/A the shielding mass has been calculated by the three industrial contractors based on a simple geometry taking into account all model payload boxes and applying shielding to them such that inside the boxes a certain TID is seen.
- Part of the total shielding mass calculated by the contractors will be part of the instruments and therefore each instrument proposal shall already give a first assessment of how much shielding the instrument needs and how it is applied.
- Certain parts of payload will have higher TID tolerance compared to what was calculated by the contractors and some will have lower radiation hardness capability. Shielding will be reduced or increased accordingly.

Radiation III

ESA project team

- Current idea is to have one person in the ESA project team dedicated to radiation issues for payload and spacecraft

- Preferred parts list

Resource sharing: an introduction

Resource sharing

Combining instruments or combing parts of instruments by sharing resources will not be dictated by the Agency.

Instrument teams should decide themselves whether this sharing of resources is an interesting option.

Resource sharing could be part of the instrument proposal as an appendix for example

Payload Definition Document

JGO Model Payload

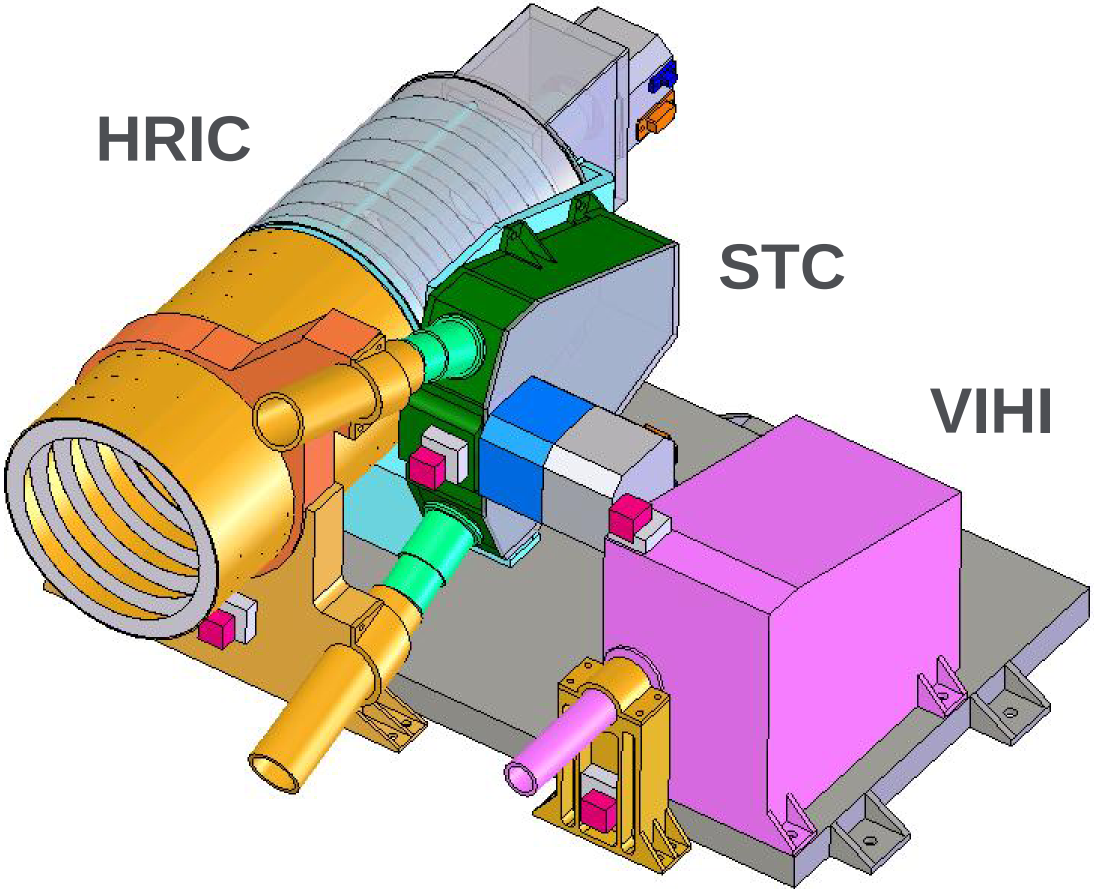
Instrument	Acronym	High level description
High Resolution Camera	HRC	Spectral range: 350–1050 nm, 12 filters, IFOV: 0.005 mrad
Wide Angle Camera	WAC	Wide: 12 filters Framing, IFOV: 2 mrad
Plasma Package (includes part of INMS)	PLP	Plasma Analyzer Electrons: 1 eV – 20 keV, Ions: 1 eV – 50 keV Particle Analyzer: Electrons: 15 keV – 1 MeV Ions: 3 keV – 5 MeV, ENA: 10 eV – 10 keV Thermal plasma number density (Te < 10 eV)
Radio and Plasma Wave Instrument	RPWI	Plasma Wave: electrons, ions Electric & magnetic field vector, QTNS
Magnetometer	MAG	Dual tri-axial fluxgate sensors
Visible and infrared Hyperspectral Imaging spectrometer	VIRHIS	Pushbroom imaging spectrometer with two channels with scan system, Spec. range: 400–5200 nm, Spec. res: 2.8 - 5 nm
Submillimeter Wave Sounder	SWI	2 channels: Spec. range: 550–230 μm FOV: 0.15° – 0.065°
Radio Science Instrument plus Ultrastable Oscillator	JRST & USO	2-way Doppler with Ka-Band transponder & Ultra-stable Oscillator
Ultraviolet Imaging Spectrometer	UVIS	EUV and FUV + MUV grating spectrometers Spectral range: 50–320 nm
Laser Altimeter	LA	Single Beam @ 1064 nm, 10 m spot @ 200 km 175 Hz pulse rate
Subsurface Radar	SSR	Single frequency: 20–50 MHz, Dipole antenna: 10 m

Resource sharing

- One mission to Jupiter every 30 years
- Resources are scarce due to:
  - low temperatures
  - low solar irradiance
  - high radiation environment (high energy electrons)
  - large distance, restricted datarate

- To get the most out of the mission sharing of resources could be one option to optimise number of instruments for payload
- resource sharing / integrated payload approach also efficiently uses mass for shielding

Resource sharing: example



HRIC: 400 – 900 nm,
4 ch., 5m/px @ 400 km
STC: 500 – 900 nm,
3 col. , < 110m @ 400 km
VIHI: 2000 – 4000 nm

Overall mass 7.6 kg including mass of optical bench, PDU and contingency (20%)

Peak power (for simultaneous operation of two channels) is 24.5 W including PDU and contingency (10%)

SIMBIO-SYS Camera System (info from 2006)

Resource sharing

1. Resource sharing has been tried on BepiColombo and has been partly implemented (Symbio-SYS and SERENA).
2. Resource sharing has been studied by ESA under a number of contracts to identify potential benefits, but also to identify problems.
3. Resource sharing has been used a number of pre-phase A studies in missions with extremely low resources to minimise overall mass

Resource sharing: potential benefits

Integrate:

- Alignment requirements
- Thermal controls
- Common subsystems
- Front end electronics

Reduce:

- Mass
- Envelope
- Power
- AIV

European Space Agency

Resource sharing: potential problems

1. Integrated approach leads to the fact that the majority of effort comes early in the design process
2. Flexible design in early stages, but inflexible in later stages
3. Thermal issues are more important compared to standard payload approach
4. Shielding mass can be optimised using integrated approach, but this needs to be fixed quite early in the process and not much flexibility left in later stages

Resource Sharing Discussion

Discussion