JUICE - JUpiter ICy moons Explorer
GIPER Ganymede Ice PEnetrating Radar
Part I: Instrument Scientific and Technical Plan

Instrument Consortia

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Lead Funding Agency

Acme Space Agency

http://home.roadrunner.com/~tuco/looney/acme.html

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Acronyms

AO: Announcement of Opportunity
EID-A: Experiment Interface Document - Part A
EGSE: Electronic Ground Support Equipment
EM: Engineering Model
FS: Flight Spare
GIPER: Ganymede Ice PEnetrating Radar
JUICE: JUpiter ICy moons Explorer
LEO: Letter of Endorsement
LFA: Lead Funding Agency
MOC: Mission Operations Centre
PFM: Proto-Flight Model
PI: Principal Investigator
SciRD: Science Requirements Document
SHARAD: Mars SHAllow RADar sounder
SOC: Science Operations Centre
STM: Structural and Thermal Model

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Document Change Record

Table 1 – *Document Change Record for GIPER Ganymede Ice PEnetrating Radar, Part I: Instrument Scientific and Technical Plan*

Doc. reference	**Change date**	**Change Description**
GIPER-ScTch-01	December 16, 2012	1st release

Contents

1. Introduction

The GIPER instrument consortium answer to the ESA Announcement of Opportunity (AO)[1] for the L1 class JUpiter ICy moons Explorer (JUICE) mission.

1.1. JUICE Mission Overview.

ESA L1 mission selected May 2012 in Cosmic Vision programme. Expected launch date 2022. 7.5 year cruise to Jupiter. Orbit insertion 2030 around Jupiter including phase studies of Europa and Callisto. September 2032 orbit insertion around Ganymede. Nominal mission end 2033. Russian Ganymede lander.

2. Scientific Objectives

The scientific outcome of this instrument proposal is in accordance with ESA Science Requirements Document (SciRD)[2] and addresses many of the scientific investigations proposed in the ESA JUICE Assessment Study Report[3].

2.1. Introduction.

2.2. Scientific Goals.

2.3. Scientific Performance Requirements.

3. Instrument Performance

4. Technical Description and Design

The proposed instrument has been designed in accordance to ESA Experiment Interface Document - Part A (EID-A) for the JUICE mission[4].

4.1. Design Overview.

4.2. Instrument Design Elements.

4.3. Technical Resources.

4.4. Instrument Spacecraft Requirements.

This mission assumes that an altimeter instrument is included in the JUICE mission scientific instrument package. Altimeter is needed to estimate the surface clutter and surface slope. The instrument consortia will provide an Instrument Operation Manual.

5. Summary of Instrument Interfaces

6. On-ground and In-flight Test and Calibration

Functional, EMC, Thermal-Vacuum, Vibration. For Electronic Ground Support Equipment (EGSE) a Ganymede Ice PEnetrating Radar (GIPER) raw signal simulator will be developed by the instrument consortia. The raw signal simulator will be similar to the one developed for the Mars SHAllow RADar sounder (SHARAD) instrument[5] and allow testing of the signal processing chain and to develop a Ganymede transfer function considering the orbit altitude and surface clutter and sub-surface dielectric interfaces. A set of calibration files and algorithms will be send to the JUICE Science Operations Centre (SOC) for the raw to L1b data processing.

In-flight internal calibration (transmitted signal looped to receiver and data sent to ground) In-flight external calibration (unprocessed data of reflected signals from a flat surface region of Ganymede is sent to ground)

Figure 1 – *Mars Echo Generation System used on the SHARAD instrument[6]*

7. System Level Assembly, Integration and Verification

Verification by test will be the main method of verification. Vibration and thermal vacuum tests will be done at IRF in Kiruna. Shock tests may be performed at Chalmers University of Technology[7].

Table 2 – *Instrument testing for different instrument models*

Test	STM	EM	PFM	Facility
Mechanical Interface, Mass Inspection	-	-	-	
Electrical Performance	-	-	-	
Functional Test	-	-	-	
Strength Test	-	-	-	
Sine and Random Vibrations Test	-	-	-	
Shock Test	-	-	-	
Thermal Vacuum Test	-	-	-	
EMC Conducted and Radiated	-	-	-	
DC Magnetic Test	-	-	-	

7.1. **Requirements.**

7.2. **Deliverable Models.** In appliance with EIDA-R005590[4], three instrument models will be developed:

- Structural and Thermal Model (STM) - For testing of the instrument structural and thermal interface to the spacecraft
- Engineering Model (EM) - To test and verify the instruments functional and technical requirements as well as the instrument performance. If required, this unit will be refurbished as an Flight Spare (FS).
- Proto-Flight Model (PFM) - will be build using full flight standard components and tested for qualification and acceptance levels.

7.3. **System Level Testing.**

8. Flight Operations Concept

The instrument modes are inherited from the SHARAD instrument[8].

8.1. **Nominal Operations.** Operation modes: Low data rate, high data rate, calibration, receive only

8.2. **Other Modes.** Silent Modes: Off, Heating Support modes: Check/init, standby, warm-up, idle The instrument consortia will provide expert support to the JUICE Mission Operations Centre (MOC) and SOC during the payload commissioning phase and at critical operations.

9. Science Ground Segment Concept

ESA ESTRACK will be used as ground station network. A JUICE MOC established at ESOC and SOC at ESAC.

9.1. **Implementation concept for the Science Ground Segment.**

9.2. **Planning of payload operations.** During the ??? mission phases, the instrument consortia will submit science operations plans and perform maintenance and optimizations as required.

9.3. **On-Board Software Maintenance.**

10. Data Reduction, Scientific Analysis and Archival Plans

It is expected that housekeeping data and raw science data will be sent from the JUICE MOC, over internet, to the instrument team in LTU, Kiruna. To correctly remove surface clutter signals, it is required to simultaneously receive the data from the altimeter instrument. Quick-Look data analyser - to optimise efficiency and scientific return of instrument operations. L1b raw data (un-calibrated science data) analyser Data will be archived at LTU and also sent to JUICE science data archive.

11. Organization

11.1. **Management Structure.** (Please note, some of the contents in this section are fictive and should not be taken literally.)

Jan Sommer is the instrument Principal Investigator (PI). He has an extensive background studying planet geology, especially on Mars. This study will enhance our knowledge of planet inner structures, geology and provide better understanding of planet formations and evolution.

Morten Olsen is the project manager. With experience as project manager for previous successful space instruments, he will manage the project schedules and budgets.

Omair Sarwar is the technical manager. With extended engineering experience in radar systems, he will ensure that the instrument meets the performance requirements, proper instrument verification and qualification in accordance with ESA space standards.

11.2. **Budget.** ACME Space Agency is the Lead Funding Agency (LFA) for this instrument proposal. A Letter of Endorsement (LEO) has been issued ensuring funding for the project during the instrument development phase, in-flight operations and post operations activities.

References

[1] *Announcement of Opportunity for the JUICE Payload*. ESA/SRE(2012)4. 2012.
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[5] A. Giovanni and S. Giuseppe. "Raw signal simulator for SHARAD". In: *Remote Sensing in Transition*. European Association of Remote Sensing Laboratories. 2004.
[6] G. Alberti et al. "Echoes Generation Systems: SHARAD Experience". In: *Spie's Europe International Symposium, Remote Sensing Europe*. 2005.
[7] Martin Jonsson. "Development of a Shock Test Facility for Qualification of Space Equipment". MA thesis. Chalmers University of Technology, 2012.
[8] Alenia Spazio. *SHARAD SHALLOW SOUNDER Technical Concept*. Retrieved online december 15th, 2012. 2005.

Appendix A. Some Appendix