The Europa Orbiter Radar Sounder
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ABSTRACT

Recent observations of the surface of the Jovian moon Europa indicates the possibility of the presence of a vast ocean beneath the icy surface. Currently the NASA mission Europa Orbiter plans to place several instruments, including a radar sounder, in a 150 km circular orbit around this moon. The science objectives of the EO Mission are:

- Understand the surface composition, especially compounds of interest to prebiotic chemistry.
- Map the distribution of important constituents of the surface and characterize subsurface interfaces.
- Characterize the radiation environment in order to reduce the uncertainties for future missions, especially landers.

To support these science objectives, the Europa Orbiter will have the following instruments:

- An ice-penetrating radar
- A laser altimeter
- An IR-visual imager

It is well known from studies of Earth’s ice sheets that radar sounding at frequencies of tens to a few hundred MHz can be used to sound ice bodies that are many kilometers in thickness. Similarly, airborne radar sounding has proven to be a powerful tool for detecting and characterizing water bodies (both lakes and ocean) beneath these ice sheets. The Instrument Definition Team (IDT), consisting of scientists and radar system experts, issued, at the end of April 1999, a “Feasibility Study and Design Concept for Orbiting Ice-penetrating Radar Sounder”. In this draft document, the IDT defined some geophysical models for Europa surface and subsurface characteristics and provided some recommendation in terms of instrument science requirement and main characteristics. The IDT for the Europa Orbiter Radar Sounder has recommended globally distributed radar sounding “at a depth resolution of 100 m at the surface, decreasing with depth, spatial resolution at or better than the scale of major surface features,
and designed to maximize the likelihood of detection of an ice/liquid interface."

The Europa Orbiter Radar Sounder (EORS) instrument design presented here responds to the IDT recommendations. The radar would map the thickness of the icy layer with a resolution of 100 m to a depth of at least 20 km. The sounder fits into a severely mass and data rate constrained spacecraft and will operate in a high radiation environment. This paper focuses on the unique system design aspects of a 10 kg radar sounder with onboard data processing. Due to the very intense radiation environment, the mission life, after entry into orbit around Europa, is limited to about 30 days. This dictated an operational scenario for EORS that would accomplish the science goals with little or no need for feedback from Earth.

The sounder operates at a center frequency of 50 MHz which is a tradeoff between the need to have a narrow antenna beamwidth to exclude surface clutter, the attenuation characteristics of the ice, the noise environment in the Jovian system, and the allowable mass. The sounder must have a large dynamic range to cover the high returned power from the specular return from the ice surface as well as the weak expected return from an ocean many kilometers below the ice. In order to accommodate this large dynamic range, the sounder incorporates a unique modulation approach to detect both a weak return well separated from the first specular return as well a stronger return close to the specular return for a shallow ice thickness.

The antenna selected is a light weight array of three Yagi radiators each using three elements. The antenna pattern generated has a beamwidth of 22 degrees boresighted in the nadir direction to limit the surface clutter arriving to the sounder at the same time as the returns from the maximum depths of detection. In order to reduce the antenna mass a self-deploying mechanism will be used. This mechanism will make use of the self-restoring properties of fiberglass. Limitations in the onboard data storage dictated that the sounder data must be processed in real time. The processing is performed in the spacecraft computer which has a capability assigned to the sounder of about 5 Megaflops. The instrument described here fits into a very unique and constrained environment and shows how innovative system design can accomplish the mission goals.
The workshop is directed not only to scientists and research centres, but also to users who are interested in the innovations that research and technological development can offer, in particular, institutions, public bodies and companies which are responsible for land management, cultural heritage preservation or environmental protection.

**Suggested Topics**

- Earth Sciences
- Industrial and civilian applications
- Archaeology
- Humanitarian applications
- Interplanetary missions
- Electromagnetic theory, scattering models and inverse scattering
- Antennas and propagation
- Technological aspects
- RF and microwave systems design

**Preliminary Program**

The workshop will be held at the Grand Hotel Vesuvio, one of the most beautiful seafast hotel in Naples (Italy).

The conference rooms are equipped with all facilities for presentation, as well as connection to the Internet. The program will consist of four single track technical sessions. A gala dinner is planned for the evening of September 20th.

**Thursday, 20 September**

a.m.: «Spaceborne low-frequency radar systems: technological aspects and applications of new satellite systems»

p.m.: «Airborne low-frequency radar systems: technological aspects and applications of new airborne systems»

**Friday, 21 September**

a.m.:«Ground based low-frequency radars: technological aspects and applications of new ground based systems»

p.m.: «Data processing numerical modelling, inverse problems and tomography»

**Scientific Committee**

- Chairman: Prof. Sergio Vetrella, Second University of Naples (Italy)
- Prof. Ovidio Bucci, University of Naples «Federico II» (Italy)
- Dr. Charles Elachi, JPL, NASA (USA)
- Chung-Chi Lin, ESA ESTEC (The Netherlands)
- Dr. Michel Rouze, CNES (France)
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Call for Papers

Papers will be presented orally and by poster. Authors who prefer a poster presentation should notify the organisers.

An extended abstract (1000 words) should be sent before 15 February 2001 to:

EARSel Secretariat  
Atn. Mrs Madeleine Godefroy  
2 Avenue Rapp  
75340 Paris Cedex 07, France
Tel. +33 1 45 56 73 60  
Fax +33 1 45 56 73 61  
e-mail: earsel@meteo.fr

The deadline for presentation of final manuscripts is 20 September 2001.

Time Table

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Language

The working language will be English.

Registration Fee

In Italian currency LIT - 1 Euro = 1936.27 LIT

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The registration fee includes a copy of the Proceedings, coffee breaks and conference dinner. Payment should be made by bank transfer to the CO.RI.S.T.A. account (details with Preliminary Program).

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