

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 as 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.



EARSeL-EUROPEAN ASSOCIATION OF
REMOTE SENSING LABORATORIES



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FIRST ANNOUNCEMENT AND CALL FOR PAPERS

Workshop
Remote Sensing by Low-Frequency Radars
20-21 September 2001
Grand Hotel Vesuvio Naples (Italy)

Co-sponsored by:

Alenia Spazio
European Space Agency
Second University of Naples
University of Naples «Federico II»

With the Patronage of:

The Italian Ministry for Universities and Scientific and Technological Research
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The Workshop

EARSeL (European Association of Remote Sensing Laboratories) and CO.RI.S.T.A. (Consortium of Research on Advanced Remote Sensing Systems) are organising this workshop, whose aim is to study in depth a particular field of remote sensing: the employment of low-frequency radars.

During recent years low-frequency radars, able to operate up to the L-band, have aroused much attention among the scientific international community, due to the increasing number of applications within the field of remote sensing. The scenario has rapidly widened and includes archaeology, ecology, environment, geology and geophysics, glaciology, oceanography, planetology.

Low-frequency radars, which allow non-invasive methodologies in ground prospecting, are being more and more employed in critical surveys of soil or subsoil, such as UXO or mine detection.

Therefore, innovative radar systems coupled with the design and development of more effective data processing and numerical modelling techniques, inverse problems and tomography have become main subjects of study.

The workshop's objective is to discuss the latest technological developments, thus opening the way to future deadline conferences on this subject.

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 seafront 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 Vetrilla, Second University of Naples (Italy)

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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
Attn. Mrs Madeleine Godefroy
2 Avenue Rapp
75340 Paris Cedex 07, France
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e mail: earsel@meteo.fr

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

Time Table

Deadline for abstracts	15 February 2001
Authors notified	15 April 2001
Preliminary program	16 April 2001
Final program	30 June 2001
Deadline for papers	20 September 2001

Language

The working language will be English.

Registration Fee

In Italian currency LIT - 1 Euro = 1936,27 LIT

Before 30 June 2001

EARSeL members	non-members	students
LIT 300.000	LIT 350.000	LIT 200.000

After 30 June 2001

EARSeL members	non-members	students
LIT 400.000	LIT 450.000	LIT 250.000

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).

Hotels:

Grand Hotel Vesuvio****
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