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Performance of the CONSERT instrument operating as a bi-static RADAR sounder during the Separation-Descent-Landing phase of the ROSETTA mission

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1 Introduction

The *Comet Nucleus Sounding Experiment by Radiowave Transmission*[3], short "CONSERT", is an experiment aboard the ESA spacecraft Rosetta en route to comet 67P/Churyumov-Gerasimenko. After observing and mapping the comet nucleus, the Philae landing unit will descend onto it in November 2014.

The CONSERT instrument will sound 67P using radiowaves, yielding data for an estimation of several of the comet's properties, amongst other, the mean permittivity, the mean absorption and the volume scattering coefficient of the comet nucleus.

The performance of using CONSERT as a radar sounder in the "classical" sense, i.e., as separate sender and receiver units in orbit around the object to be sounded, during the Separation-Sescent-Landing (SDL) phase of the Rosetta mission will be evaluated, using a simulation approach based on the method of Physical Optics[1] which allows to include the complete radiation characteristics of CONSERT's antenna systems of both Rosetta and Philae[5].

2 Modeling

In order to achieve a meaningful worst-case estimation, two different cometary models were used, namely the Lamy shape model A1[4], and the so-called CHIMERA2 model[2]. The CHIMERA2 shape model is based on Lamy A1, and adds surface features extracted from an observation of the comet 81P/Wild2 onto the Lamy A1 shape model. The orbitography used for the simulations was provided by Science Operation and Navigation Center (SONC) at Centre national d'études spatiales (CNES), using the Lamy A1 shape model for the planning.

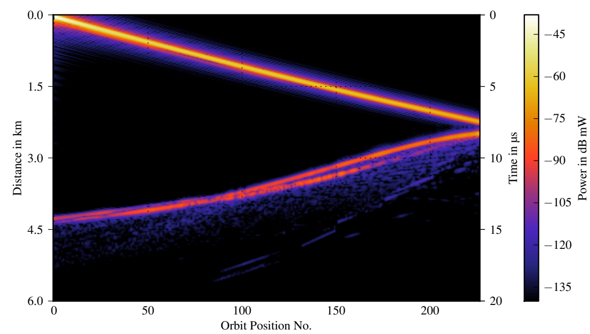

Figure 1: Radargram of Lamy A1 w./ $\varepsilon_r = 2$, including the line-of-sight propagation path.

3 Simulation Results

The results of our simulations aim to evaluate the influence of the direct line-of-sight propagation path on the received signal, the SNR w. r. t. the expected background noise level, and finally the possibility to reconstruct a profile of the dielectric permittivity around the landing site.

Background noise. The background noise level is estimated to be around -95 dB mW. Figure 1 presents a radargram containing the line-of-sight propagation path as well as the echoes coming from the Lamy A1 cometary model. It can be seen that the echoes from the surface are above -95 dB mW beginning around orbit position no. 100, and below -105 dB mW only for a few orbit positions. CONSERT's on-board processing at Rosetta's side can improve the SNR by 30 dB, giving a big enough safety margin for successful data retrieval.

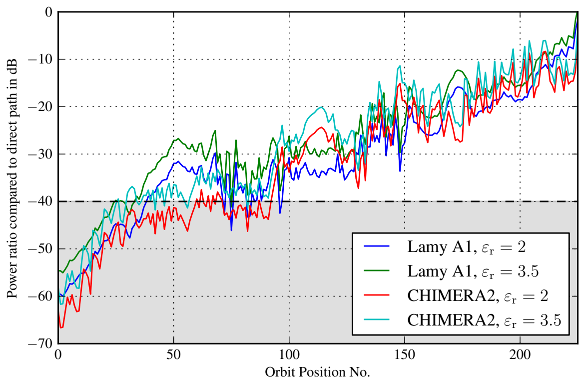

Figure 2: Power ratio of the line-of-sight path vs. strongest surface echo.

Processing dynamic range. As can be seen from figure 2, for both cometary models considered, with an assumed homogeneous permittivity distribution of $\varepsilon_r = 2.0$ and $\varepsilon_r = 3.5$, the power ratio between the line-of-sight propagation path and the power of th surface echoes is above -40 dB for a vast majority of orbit positions, the dynamic range of CONSERT's signal processing.

4 Conclusions

The results presented in the previous section allow to conclude that CONSERT operation during the SDL will yield scientifically useful data, thereby contributing to the experiment's main objectives.

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