17th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Orbit Determination and Propagation (9)

Author: Mr. Matteo Losacco
Politecnico di Milano, Italy

Dr. Pierluigi Di Lizia
Politecnico di Milano, Italy
Dr. Mauro Massari
Politecnico di Milano, Italy
Dr. Germano Bianchi
INAF - IRA, Italy
Dr. Giuseppe Pupillo
INAF - IRA, Italy
Dr. Andrea Mattana
National Institute for Astrophysics, Italy
Dr. Giovanni Naldi
National Institute for Astrophysics, Italy
Mr. Claudio Bortolotti
INAF - IRA, Italy
Dr. Federico Perini
INAF - IRA, Italy
Dr. Luca Lama
INAF - IRA, Italy
Mr. Marco Schiaffino
INAF - IRA, Italy
Mr. Mauro Roma
INAF - IRA, Italy
Mr. Andrea Maccaferri
INAF, Italy
Dr. Alessio Magro
Malta
Mr. Denis Cutajar
Malta
Mr. Josef Borg
Malta
Mr. Fabio Monaci
Italian Air Force , Italy

SPACE SURVEILLANCE WITH THE MULTIBEAM RADAR SENSOR BIRALES

Abstract

The number of manmade objects orbiting the Earth has dramatically increased during the last decades, posing a serious risk for space-based activities. Consequently, an international effort is being devoted to

improving the performance of optical and radar sensors for space objects monitoring. This work presents the results of observation campaigns performed using the Italian bistatic radar sensor BIRALES (BIstatic RAdar for LEo Survey).

BIRALES sensor is composed by the Radio Frequency Transmitter (RFT) of the Italian Joint Test Range of Salto di Quirra in Sardinia (Italy) and part of the Northern Cross (NC) radiotelescope located in Medicina (Bologna, Italy) as multibeam receiver. The RFT consists of a 7 meters parabolic antenna equipped with an RF transmitter able to radiate a 10 kW power in the 410-415 MHz band. The NC is made of two perpendicular arms: the East-West arm is a 564 m long cylindrical-parabolic reflector antenna, whereas the North-South arm is an array of 64 cylindrical-parabolic antennas. The receiving part currently uses eight antennas of the NS arm, each equipped with four receivers, and it is able to synthetize up to 32 simultaneous beams. This configuration will be expanded up to 32 NS antennas with 128 simultaneous beams by the middle of 2020.

The innovative multibeam configuration of the receiver offers the possibility of estimating the track of detected objects within the receiver field of view by analyzing the beams illumination sequence. The task is complicated by the peculiar geometrical configuration of the receiver, that determines a complex gain pattern in which each single beam presents multiple gain peaks (main gain lobe, grating lobes, and side lobes). Every time a beam is illuminated, therefore, the identification of the gain lobe responsible for the beam illumination is not straightforward. The ambiguities introduced by the presence of multiple gain lobes per beam are solved with a tailored trace definition algorithm, that progressively prunes all possible illumination sequences and identifies the most likely one. The obtained trace estimate is then used with the available Doppler shift and slant range measurements to perform initial orbit determination.

The paper presents the results of some survey and tracking observation campaigns performed using BIRALES sensor. A detailed description of the dedicated orbit determination algorithm is offered. Then, the performance of the sensor is assessed both in terms of observation capabilities and orbit determination accuracy.