Graz Experience with HEO Ranging

Georg Kirchner, Franz Koidl
Institute for Space Research
Austrian Academy of Sciences

Introduction

During the last few years, we have spent some effort to optimize the efficiency of the Graz SLR system; we installed a new dichroic mirror (which has to transmit the green laser photons with > 95%, independent of polarization); we removed several obsolete lenses, mirrors and telescopes from the laser bench (e.g. we are using now the natural divergence of 1.6 mrad of the laser beam, and a few meters on the laser bench, to increase the laser beam diameter); we remove the wavelength filter in front of the C-SPAD automatically during night time (this is done by the PC: It issues the command, checks that the filter is really out of the beam path, and corrects the measured time-of-flight accordingly).

Results

All this resulted in significantly – about a factor of 10 - increase of return rates, especially from higher satellites. From LAGEOS (1 & 2) we now get several 100 returns per second, day and night (fig. 1); at an elevation of 60°, we get an average of > 200 returns per second. Because our system needs about 1000 returns to reach the maximum accuracy (about 0.2 mm) we can get a complete Normal Point within about 5 seconds (without acquisition time, initial mount movements etc.).

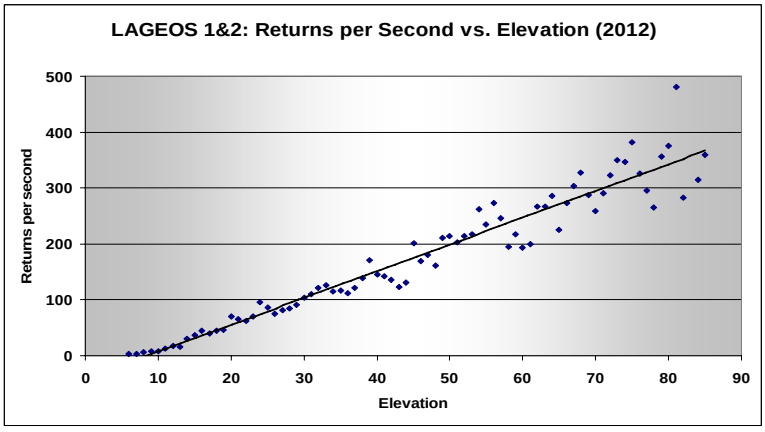

Fig. 1: Lageos return rates 2012

At 60°, we get >200 returns / s:

Asusming that we need 1000 pts to achieve the limit resolution of 0.2 mm for the Graz system, a NP can be created in 5 s

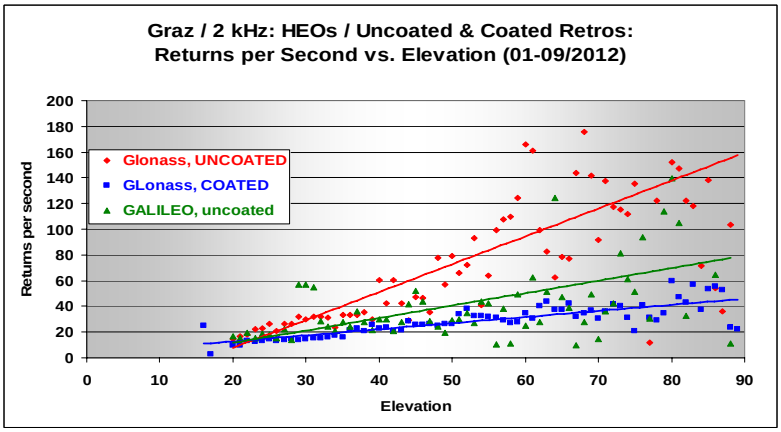

Fig. 2: HEO return rates 2012

Uncoated retro-reflectors show significantly higher return rates

Similar improvements could be achieved for the HEO satellites (fig. 2). The biggest effect here is the possibility to achieve a HEO Normal Point – with about 1000 observations - within much less than the proposed 5-minute NP interval (after acquisition). Taking acquisition time, mount motion time, and collecting at least 1000 points, we end up at less than 1 minute (night time) resp. less than 2 minutes (day time) for an average HEO NP (fig. 3). This allows to collect NPs of several different HEO satellites within the same 5-minute bin, using fast pass switching, and will allow to track not only the complete set of GLONASS (which we do already), but also all GALILEO satellites, once they are launched…

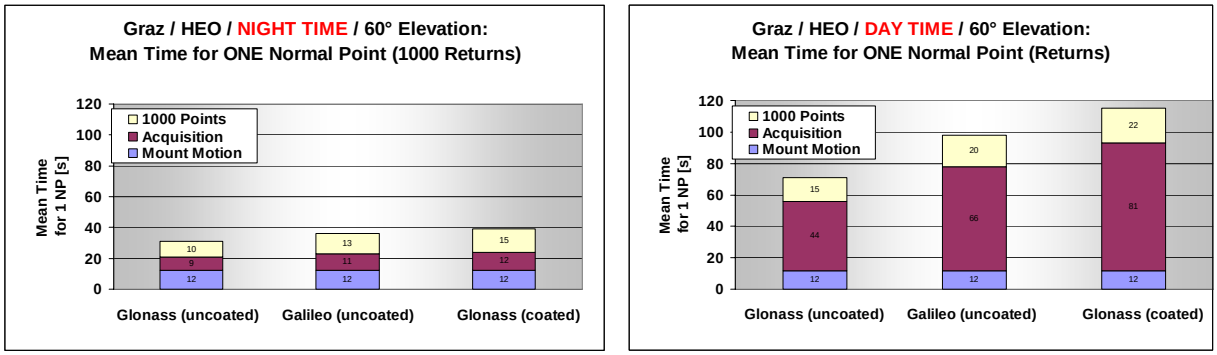

Fig 3: Mean Total Time for 1 NP for HEO satellites during night (left) and day (right)

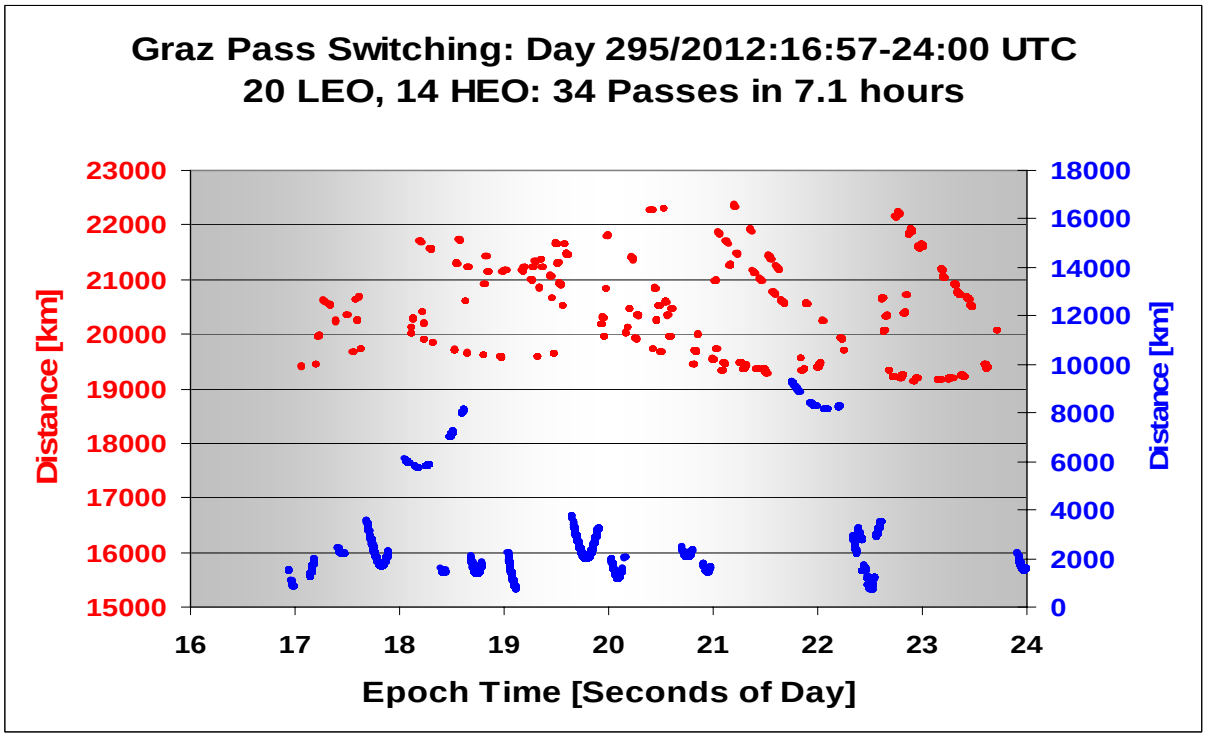

Fig. 4: A successful pass switching period: 34 passes tracked within 7 hours in Graz