Matthew Wilkinson
matwi@nerc.ac.uk

SGF, Herstmonceux in-sky safety system testing using ADS-B

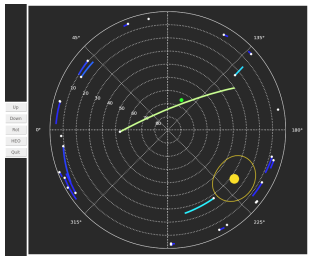
The Space Geodesy Facility, Herstmonceux, uses a radar transceiver to instantly inhibit SLR laser firing in order to prevent the illumination of aircraft. The radar is an important part of in-sky safety at the SGF and it has operated reliably since the facility began laser ranging. The newly installed SBS-3 ADS-B receiver provides real-time updates of nearby aircraft locations and offers the opportunity to test the radar sky coverage.

Radar safety system

A 150cm diameter antenna dish, mounted on an alt-az mount, tracks with the SLR telescope and is enclosed in a second smaller dome. An X-band transceiver produces 25kW, 9410MHz pulses of duration 0.9 microseconds at a maximum rate of 750Hz. An electronic system, built in house, processes the returning reflection signals to detect objects in the beam path, out to a range of approximately 40km. This detection signal is used to instantly stop SLR laser fires. The correct operation of the radar is checked regularly by the SLR observer.

ADS-B receiver and l2pserver

The SGF relies on the radar for its in-sky safety along with the further precautions of an observer plane-spotter located alongside the SLR telescope and an ADS-B system. A SBS-3 ADS-B receiver was installed at the SGF in 2013. It decodes the incoming signals broadcast from nearby aircraft and feeds this raw data to the 'l2pserver' program (available to download http://sgf.rgo.ac.uk/operations/adsb.html) via TCP/IP. Two clients in routine use at the SGF connect to this server. The first displays the aircraft overhead and the second provides audible warnings of aircraft approaching the laser beam. The ADS-B system in operation at the SGF has proved to be very useful to the SLR observer.



Radar tracking aircraft using ADS-B

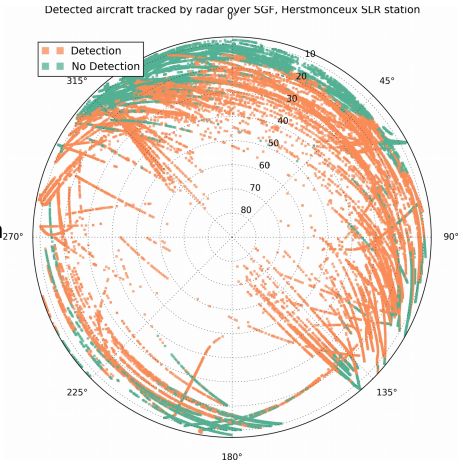
A new client program 'l2pradar' developed at the SGF, Herstmonceux connects to l2pserver and selects a nearby aircraft from those listed. It uses the real-time positions and velocities broadcast by the aircraft to predict its azimuth and elevation trajectory across the sky. The program sends commands to drive the radar to the predicted position at a rate of 5Hz. The actual radar position is monitored in real-time through feedback from the encoders and small adjustments are made to the predict ahead time. Finally, the radar detection status is recorded.

The radar is able to consistently track aircraft passing over the SGF using the real-time ADS-B updates. The pointing accuracy can be lost at high elevations when tracking fast moving aircraft.

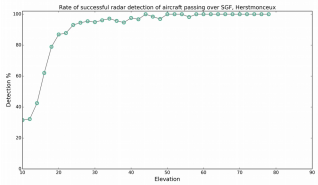
Testing the radar sky coverage

The radar must perform well in all directions above the SLR operational minimum elevation of 30° in daytime and 25° at night. To test this the recorded ADS-B positions were compared with the radar encoder feedback and the pointing was deemed to be on target if these values agreed within 0.5° on both axes. The radar has a field of view of approximately 3°.

A dataset was collected on a series of aircraft passing over the SGF over a number of days in September 2016. The transceiver has a triggering threshold, which is sometimes adjusted according to sky conditions and was set at a fixed level for this experiment. Aircraft that were not detected at all were removed as this may be as a result of inaccurate ADS-B broadcast data. The detection status of the radar was then plotted on a sky polar plot (above right).



The probability of detection was calculated from the dataset at 2° elevation bins and is plotted to the right. Aircraft were detected with a >90% success rate above 25° elevation and a >95% success rate above 40°.



Feasibility of optical aircraft detection

It was also possible to use the ADS-B feed to drive the SLR telescope on aircraft. Mounted on the SLR telescope is a uEye USB camera and lens, with a field of view of approximately 5°.

Aircraft were clearly visible from the camera images and this will allow the collection of a variety of test frames to investigate the advantages of, and help to develop, an optical aircraft detection system.