

Integration of a SBS-3 ADS-B receiver in to the SGF, Herstmonceux aircraft safety system

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Introducing the SBS-3 from Kinetic

- Two 8MHz bandwidth tuners covering 27-980 MHz.
- Sockets for a wideband antenna and a dedicated 1090MHz ADS-B antenna.
- Onboard decoding of ADS-B, AIS, ACARS.
- Full speed 100M ethernet interface and USB connectivity.
- Raw binary data output.
- Published API for third party integration.
- Compatible with Plane Plotter & Ship Plotter.



www.kinetic-avionics.com

SBS-3 raw data stream

The SBS-3 decodes the 1090 MHz binary broadcasts from nearby aircraft.

The unit can provide this data to the user in two ways:

1. Through the 'BaseStation' software provided and maintained by the manufacturer with the unit connected to a PC over the network or via USB.

This software translates the binary messages and calculates aircraft positions and velocities.

It also provides these aircraft positions and velocities in text format on a TCP/IP port.

2. As a stand-alone unit providing the raw binary data stream on a TCP/IP port.

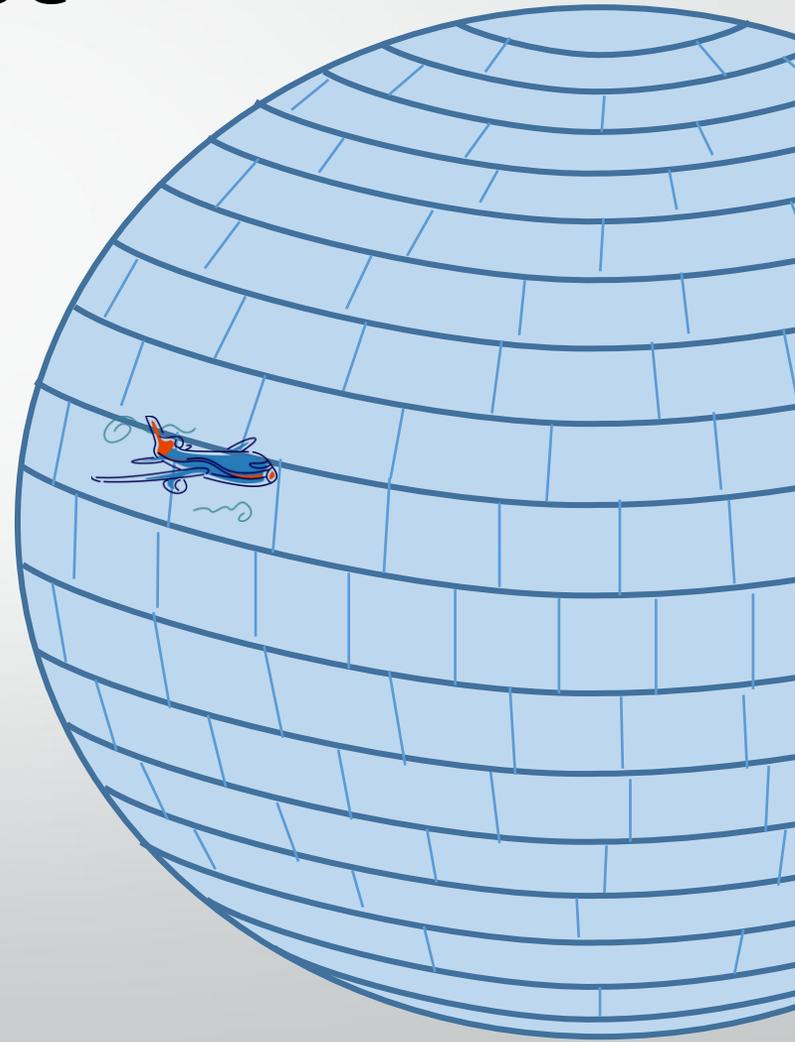


Development of a stand-alone solution

- It was decided to attempt to interpret the raw data stream. This would require more work and research but would result in greater understanding and a simpler end solution.
- Altitudes and velocities could be read from the binary code.
- Latitudes and longitudes had to be calculated from the Compact Position Reporting (CPR) data format used.

The ADS-B technique

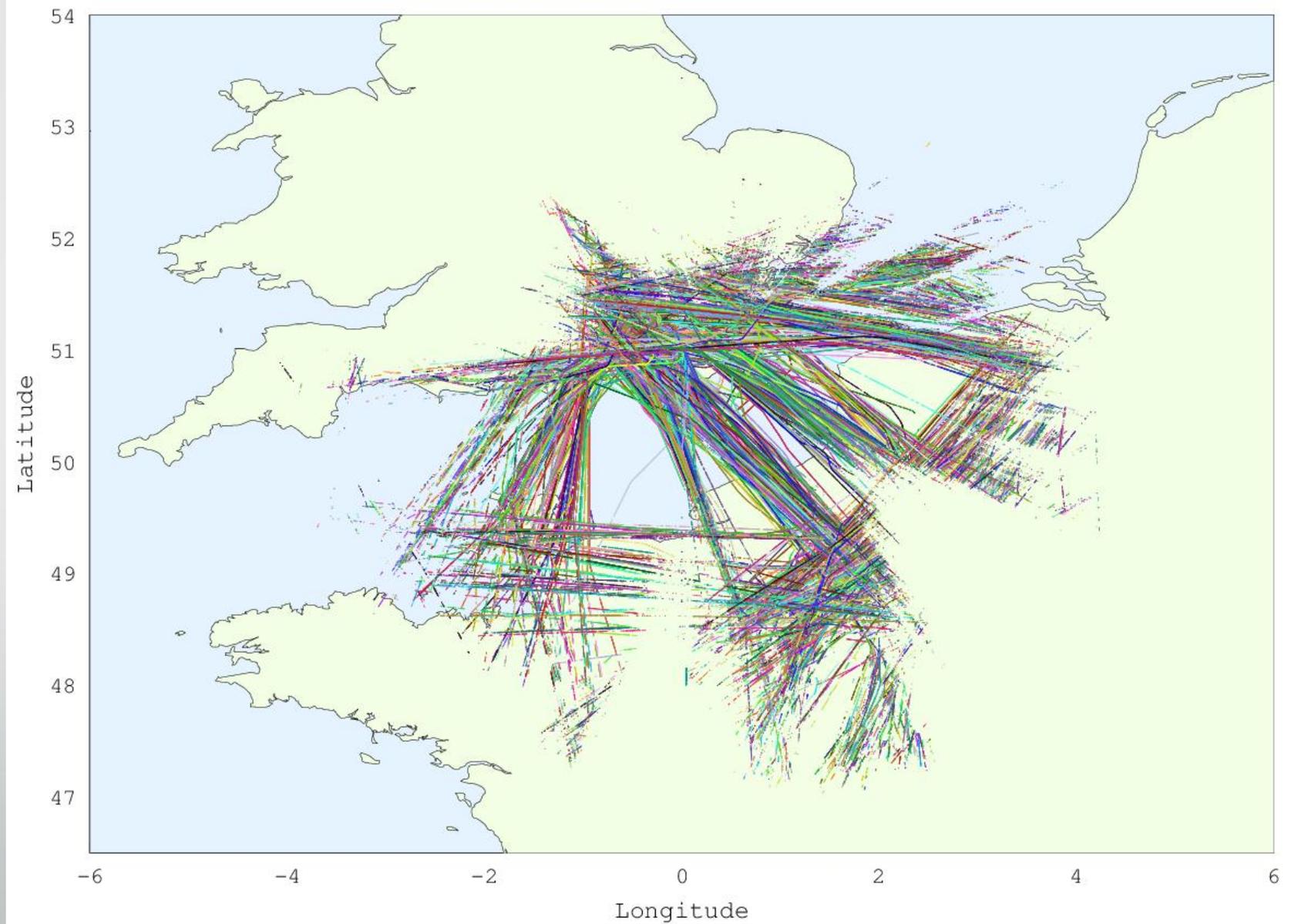
- Aircraft broadcast their GPS positions twice a second using the CPR format.
- The Earth's surface is divided up into zones by 60 latitudes and evenly spaced longitude lines. Each zone contains 2^{17} latitudes and 2^{17} longitude indexes.
- The aircraft broadcasts these indexes but not the zone. This must be determined using an additional 'odd' position message that uses 59 latitudes and up to 59 longitudes.



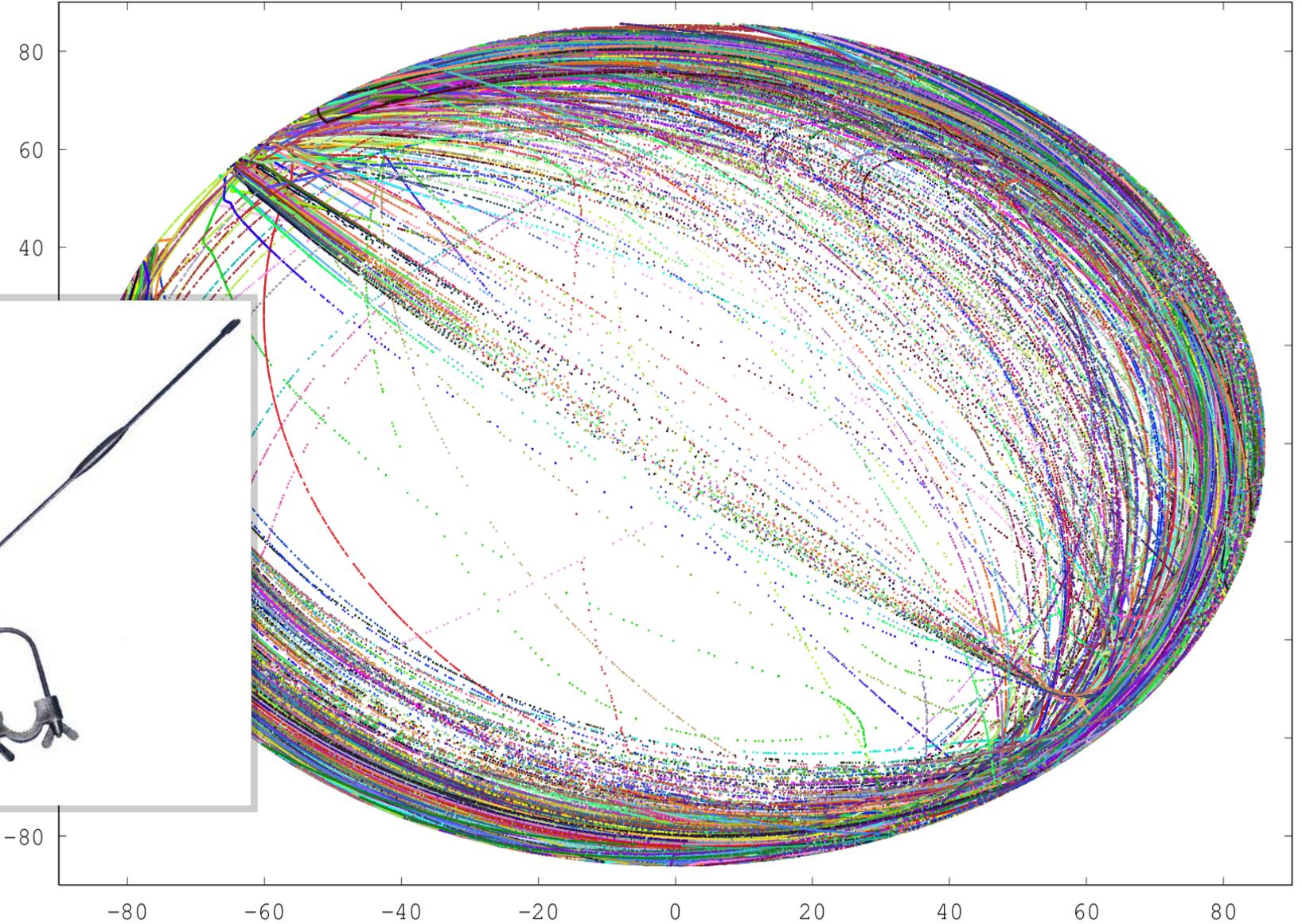
Positional results

- Our results derived from the raw messages now agree exactly with the data from the BaseStation package.
- And fortunately they agree with aeroplanes in the sky.
- The latitude, longitudes and altitudes are converted to azimuth and elevations for Herstmonceux, SGF.

Aircraft ADS-B tracks over Herstmonceux

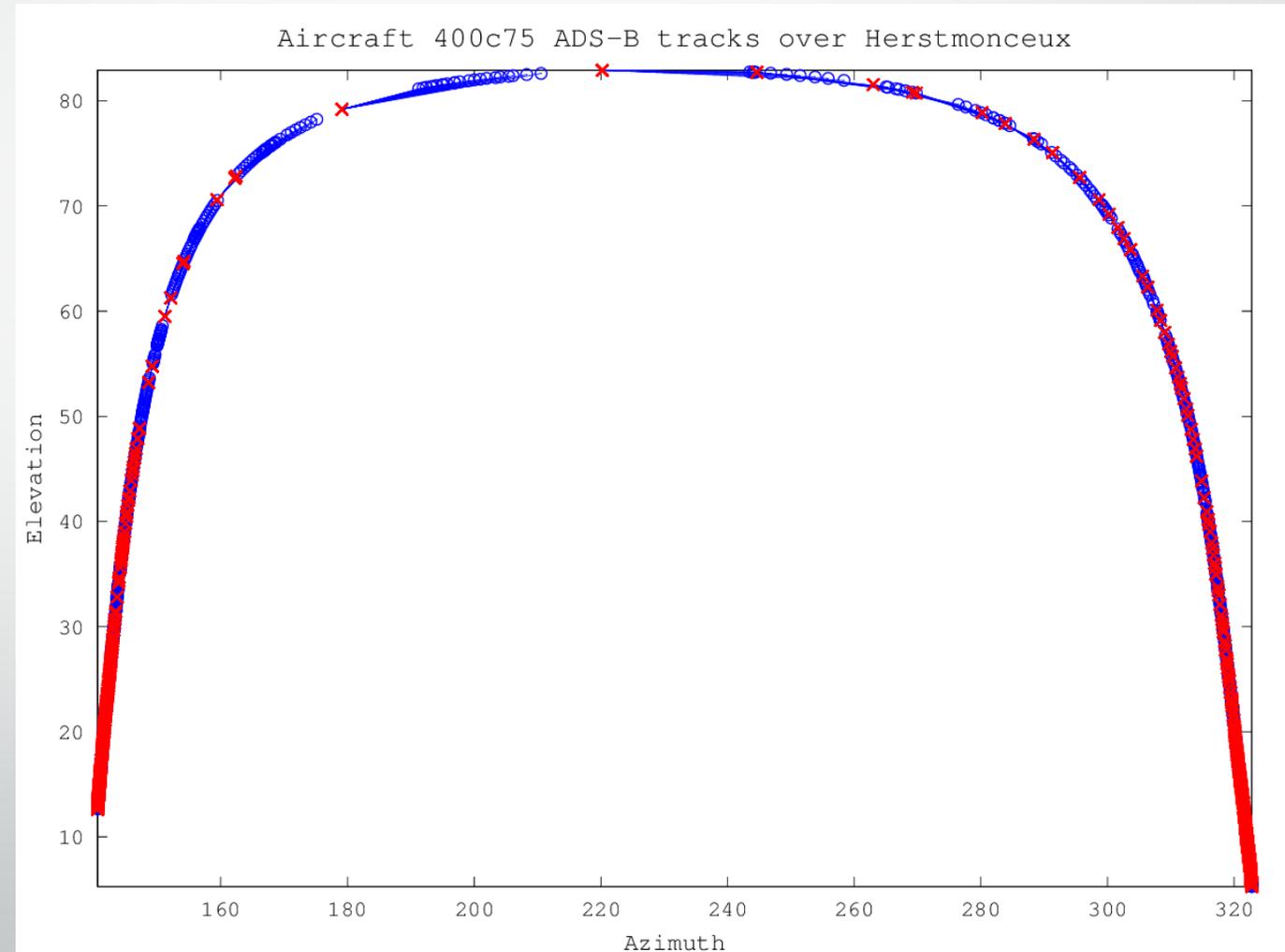


Aircraft ADS-B tracks over SGF, Herstmonceux



Predictions and warnings

- Predictions are required for a safety system.
- Separate ADS-B broadcasts contain north, east and altitude velocities.
- These are used to predict possible aircraft-laser collisions 10 seconds in advance.

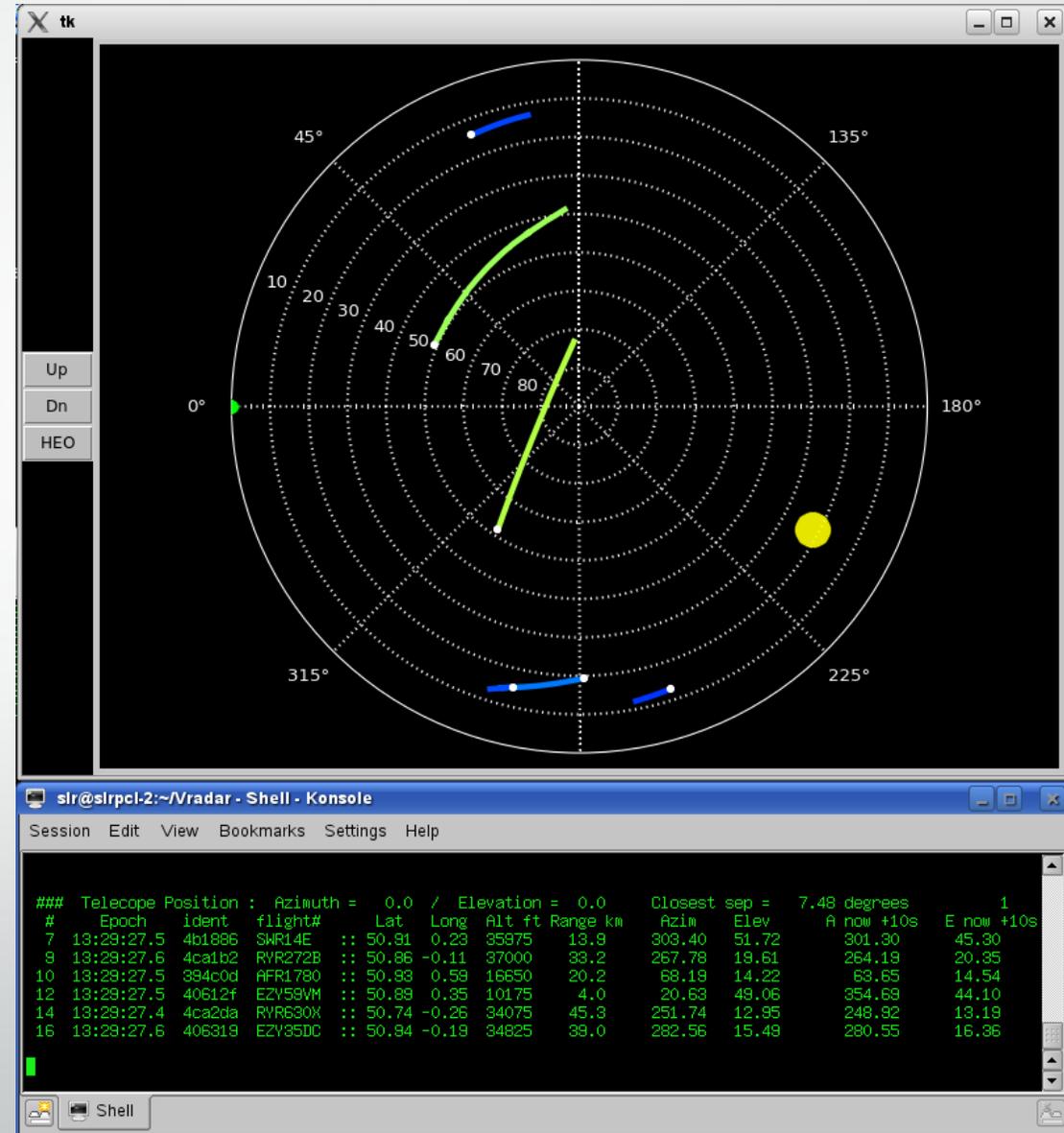


ADS-B TCP/IP server

- A TCP/IP server was built to allow multiple streams of the position and velocity results.
- An additional connection to this server is made by the SLR ranging system to provide real-time laser telescope positional updates.
- This server runs continuously and has been extremely stable and reliable.
- Applications can connect to this server and use the data independently.

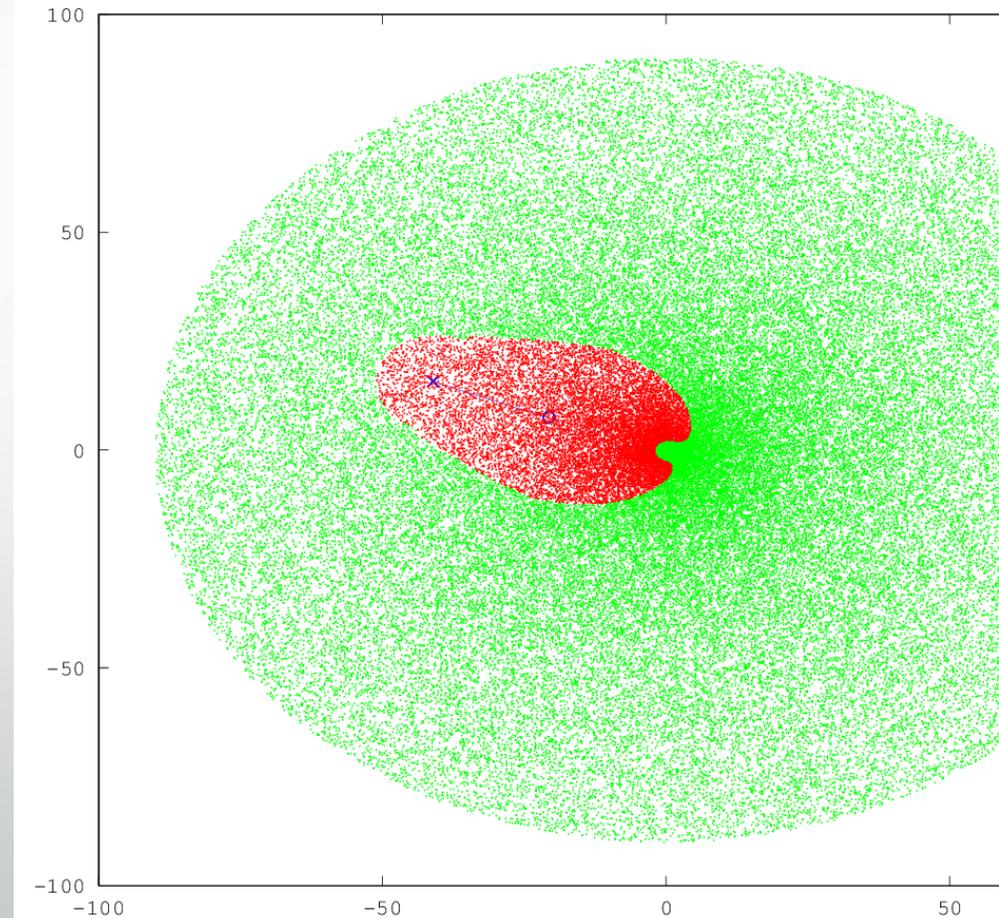
Applications

- The SGF has built two applications using this data stream:
 1. A real-time visual sky plot display in Python showing the planes above the Herstmonceux horizon along with the laser firing position.
 2. An alarm system that gives an audible warning to the observer of approaching aircraft.



Approaching aircraft alarm

- By predicting 10 seconds ahead, the client gives an audible warning to the observer should an aircraft be approaching the laser beam.
- A higher pitch warning is also included using a 2 second prediction.
- The SGF radar safety system gives an audio warning when it shuts the laser off and these alarms coincide very well.



Conclusions

- The SBS-3 is a reliable ADS-B receiver.
- This ADS-B system has shown to be able to alert the observer to oncoming aircraft and agrees with the radar safety system at about 1 degree.
- While the results have been impressive, this only applies to those aircraft carrying ADS-B systems, which at present is not all commercial flights and does not include light aircraft, gliders or hot air balloons.

Future activities

- The collision warnings will be added to our SLR system as an extra layer of safety and be allowed to shut off the laser automatically.
- An application to test our safety radar by tracking aircraft to confirm full sky coverage is planned.
- An antenna upgrade will be researched to give better coverage at high elevations.



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Welcome to the NERC Space Geodesy Facility

The Space Geodesy Facility operates multiple geodetic techniques to make a major contribution to the formation of a highly-precise global reference frame and supports satellite missions to study the dynamic Earth.

Located near to the village of Herstmonceux in East Sussex, the NERC Space Geodesy Facility (SGF) is actively supporting geodetic and geophysical science.

The SGF makes range observations that enable orbit determination for scientific satellite missions that study the oceans, ice sheets, land mass, gravity field and climate of the Earth in order to better understand the processes at work.

The SGF is part of the International Laser Ranging Service (ILRS) and International GNSS Service (IGS) networks. It was appointed by the ILRS as one of the eight ILRS Analysis Centres and awarded by the Global Geodetic Observing System (GGOS) the status of 'New Technology SLR Site'.

The SGF is a Research Facility of the Natural Environment Research Council (NERC) with additional funding from the Ministry of Defence.



Space Geodesy Facility

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Hardware Overview

Hardware in operation at the SGF is listed below.

GNSS sites

The HERS site uses a Septentrio PolaRx3 receiver and a Leica AR25 antenna. HERT uses a LEICA GRX1200GGPRO receiver with a Leica AT 504 GG choke ring antenna.

Digital Levelling

The levelling run uses a Leica DNA03 digital level that, once adjusted to make its bubble level, scans a barcode on a staff and can measure height difference to 0.3mm.

Lidar

The backscattered light from SLR laser frings is recorded by a Hamamatsu PMT. A National Instruments data acquisition card samples the PMT at a rate of 100Mhz to collect data through the atmosphere.

Absolute Gravimeter

The Micro-g LaCoste FG-5 in the SGF basement was upgraded at the end of 2012 to a FG-5X with an extended dropping chamber, new dropping mechanisms and upgraded electronics.

Virtual Radar

A Kinetic SBS-3 is being tested at the SGF which listens to the ADS-B broadcasts from planes and acquires their instantaneous positions.

Meteorological station

The temperature, pressure and humidity at the SGF is recorded by a met device and house in a Stevenson screen 3m above ground on the HERS tower.

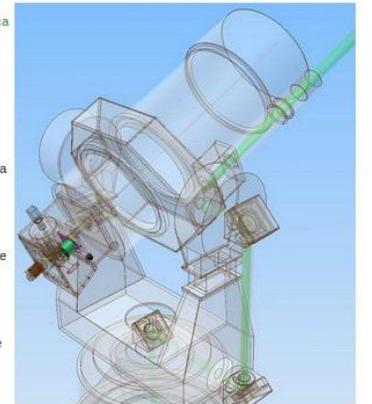
Photometer

To observe variable brightness, due to spinning of the geodetic spheres or tumbling of inactive satellites, the light from the second telescope port can be sent to a Hamamatsu photometer.

Seismometer

The site hosts a British Geological Survey broadband seismometer (HMNX) that automatically contributes in realtime to BGS British Isles seismic network.

Maser



<http://sgf.rgo.ac.uk>