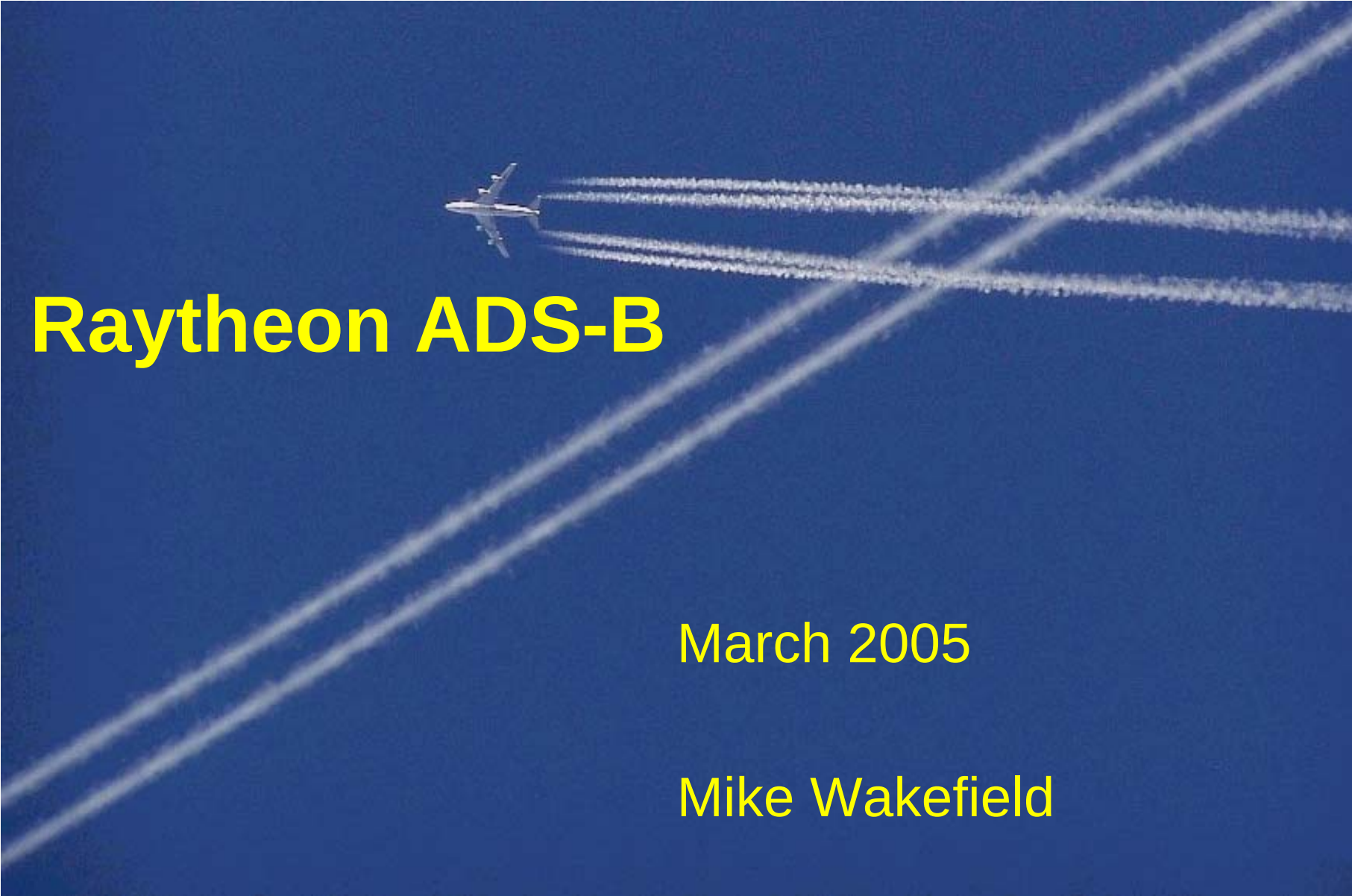




# Raytheon ADS-B

March 2005

Mike Wakefield

# Core Communication, Navigation, Surveillance/ Air Traffic Management (CNS/ATM) Product Lines

**Raytheon**  
Systems Limited

## Communication



SATCOM



Air/Ground  
Communications

## Navigation



Space-Based  
Augmentation  
Systems(SBAS)



Ground-Based  
Augmentation  
Systems(GBAS)

## Surveillance



Primary/Secondary  
Surveillance



Surface Movement



ADS-B

## ATM

En Route, Terminal,  
Tower, Surface



STARS



AutoTrac/TracView



AutoTrac III

## Meteorology



Terminal Doppler  
Weather Radar



Integrated Terminal  
Weather System

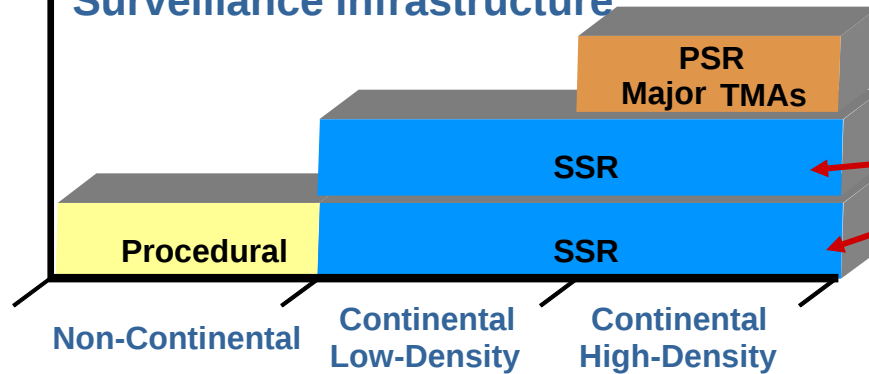
## Simulation and Training



FIRSTplus®System

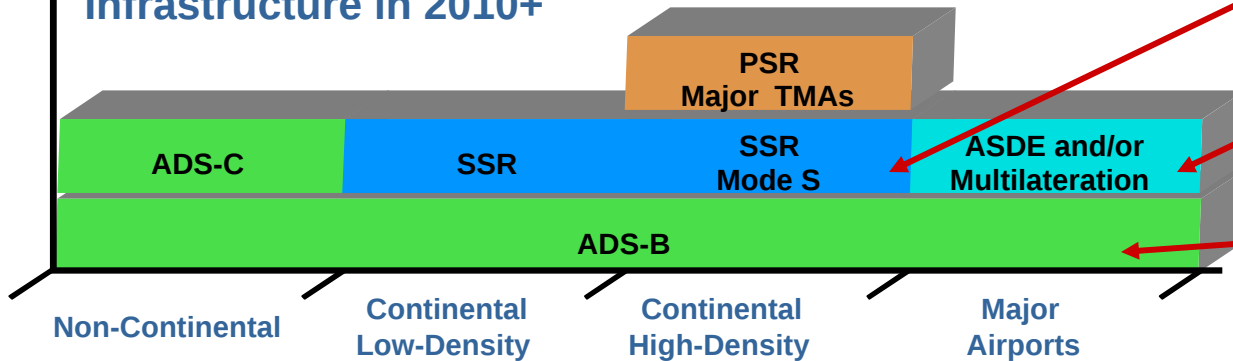
# ECAC/EUROCONTROL ATM 2000+ and EATMP

## Today's Surveillance Infrastructure



Dual-redundant  
SSR in all medium  
and high density  
airspace

## Future Surveillance Infrastructure in 2010+



Single SSR coverage

Multilateration at  
major airports

ADS-B for all  
airspace

# Advanced Surveillance Solutions

## Mode S provides:

- Selective addressing
- Unique addressing to relieve Mode 3/A code shortage
- Identity retention in stacks
- 25ft height readout
- FRUIT reduction
- Enhanced Surveillance
- Reduced R/T workload

## ADS-B provides:

- Lower cost surveillance
- Improved surveillance accuracy
- Gap filling capability
- Identity retention in stacks
- 25ft height readout
- FRUIT reduction
- Enhanced Surveillance
- Capability for delegation of responsibility from ground to air

**MSSR Mode S and ADS-B are complementary**

# ADS-B Development

**Raytheon is developing ADS-B on 1090 ES because:**

- 1090 MHz receiver and decoder expertise
- Evolutionary step from Mode S
- Easiest technology to implement
- Minimises aircraft equipage cost
- ICAO recommendation for initial global application
- Being procured by ANSPs for operational use



# 1090 MHz Environment

However, 1090 MHz band is already congested with:

- Replies to SSR (Modes 3/A, C, S, Mode 4...)
- TCAS communications (Mode S, SSR whisper-shout)
- TACAN/DME interrogator transmissions
- Plus out of band interference - PSR, DME...

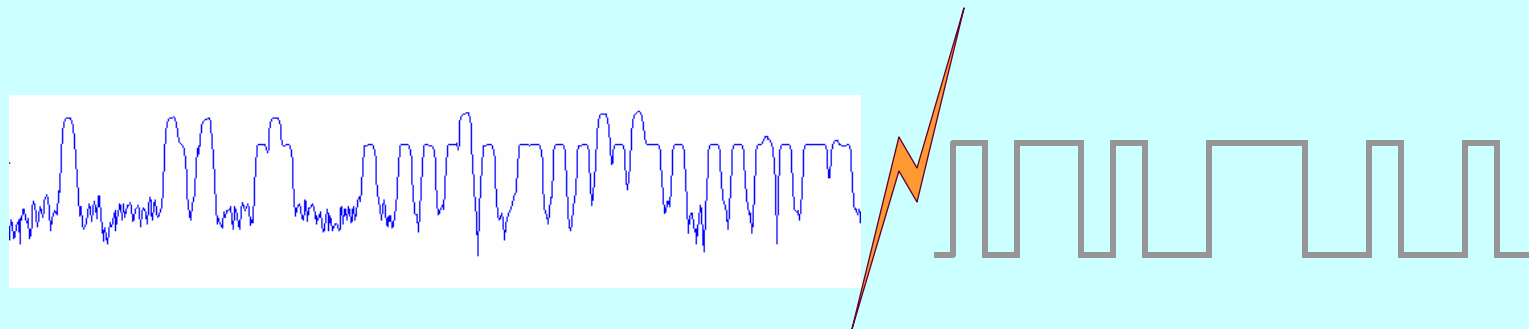
This provides an increasingly  
challenging RF environment.

**ADS-B must meet traffic demands today  
and in the future**



# The Decoder is Key...

- For ADS-B on 1090 MHz the decoder is the critical enabler
- We have concentrated our development efforts on new decoding techniques
- The result is a revolutionary new decoder designed specifically for the demanding requirements of ADS-B



# Raytheon Decoder

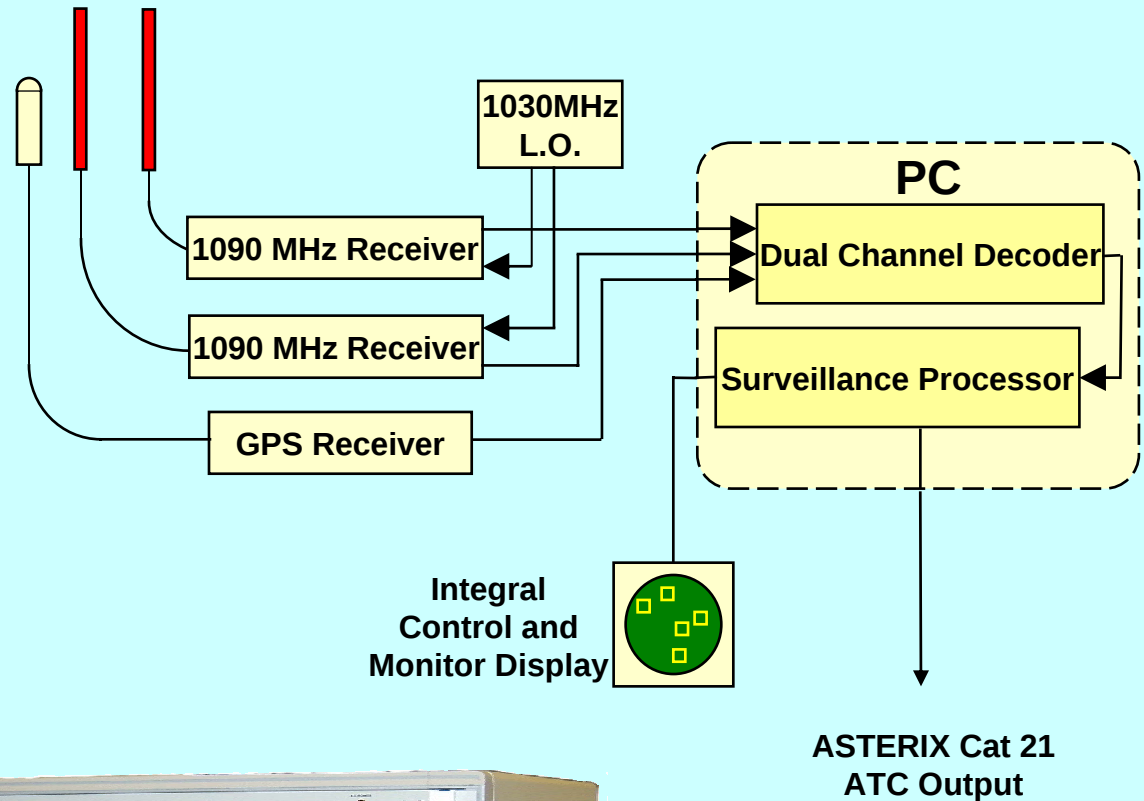
**The Raytheon decoder features:**

- **A 16 MHz or higher sample rate to provide better pulse discrimination**
- **An algorithm not limited to a particular sample rate but may be optimised to suit specific conditions**
- **Enhanced error correction to provide greater probability of detection in a high FRUIT environment**
- **High integrity data output**

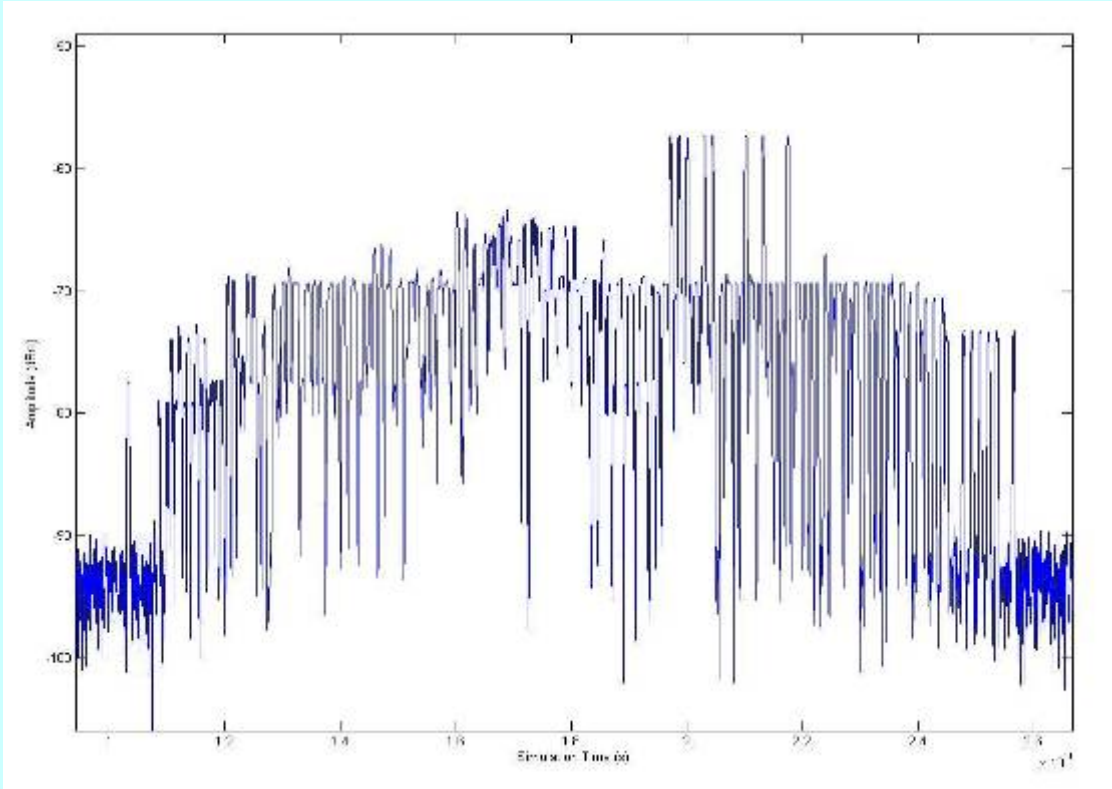
**Designed for use in all airspace types and to support projected traffic beyond 2020**

# ADS-B Demonstrator

- Dual receiver/decoder channels
- Standard receivers from Condor MSSR
- Decoder implemented in Xilinx FPGAs on a PCI card
- Host PC outputs ASTERIX Cat 21 ADS-B data and drives PPI display program in Windows XP
- Four systems for operational field trials



# Successful Decoding with FRUIT



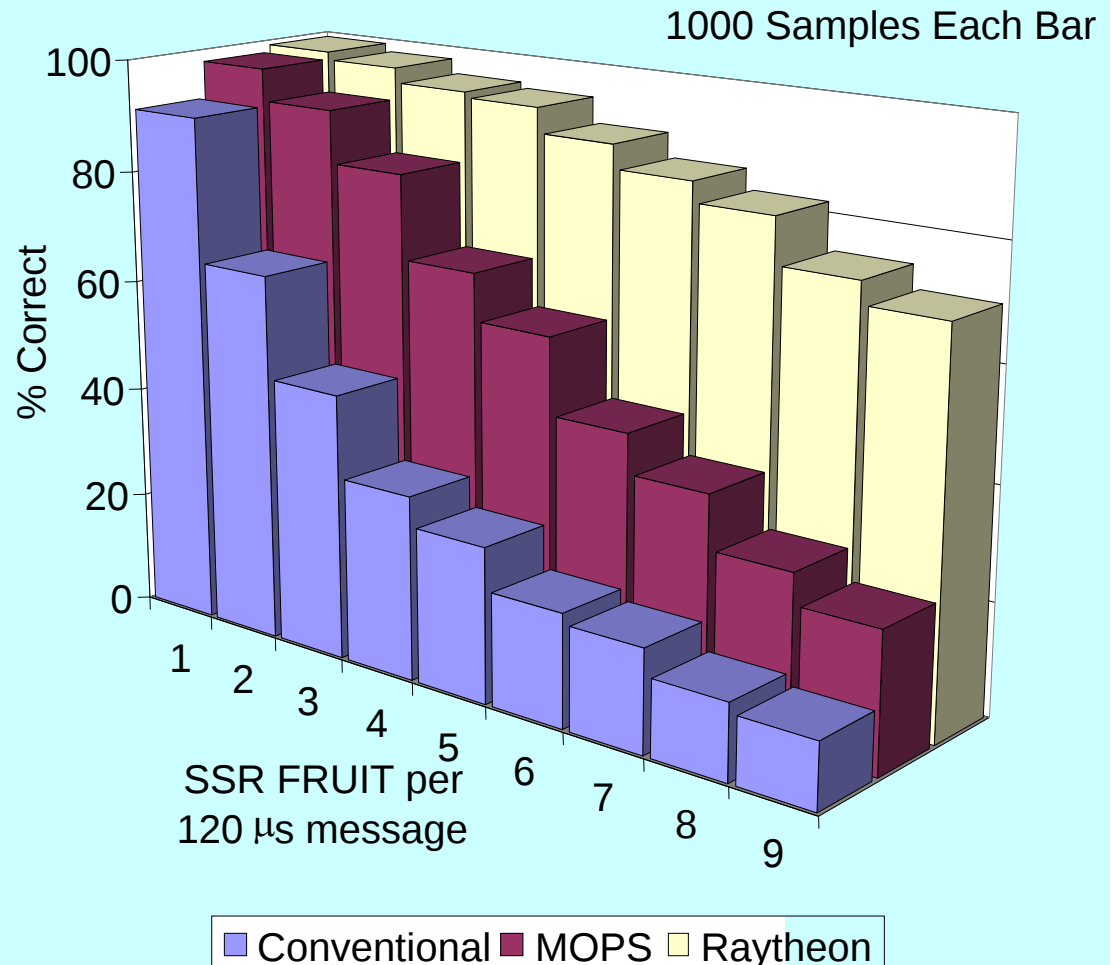
**This ADS-B 1090 ES transmission was successfully decoded in the presence of 17 overlapping messages**

**- 2 short Mode S responses and 15 SSR FRUIT replies**

# Raytheon Decoder Results

In the presence of 4 SSR replies overlapping the ADS-B message:

- The Raytheon decoder was able to achieve a higher level of decoding success
- 82% fewer failures than the RTCA MOPS model
- This increase in performance is due to improvements in preamble detection, decoding, and error correction.



**Results are now being confirmed by independent FAA trials**

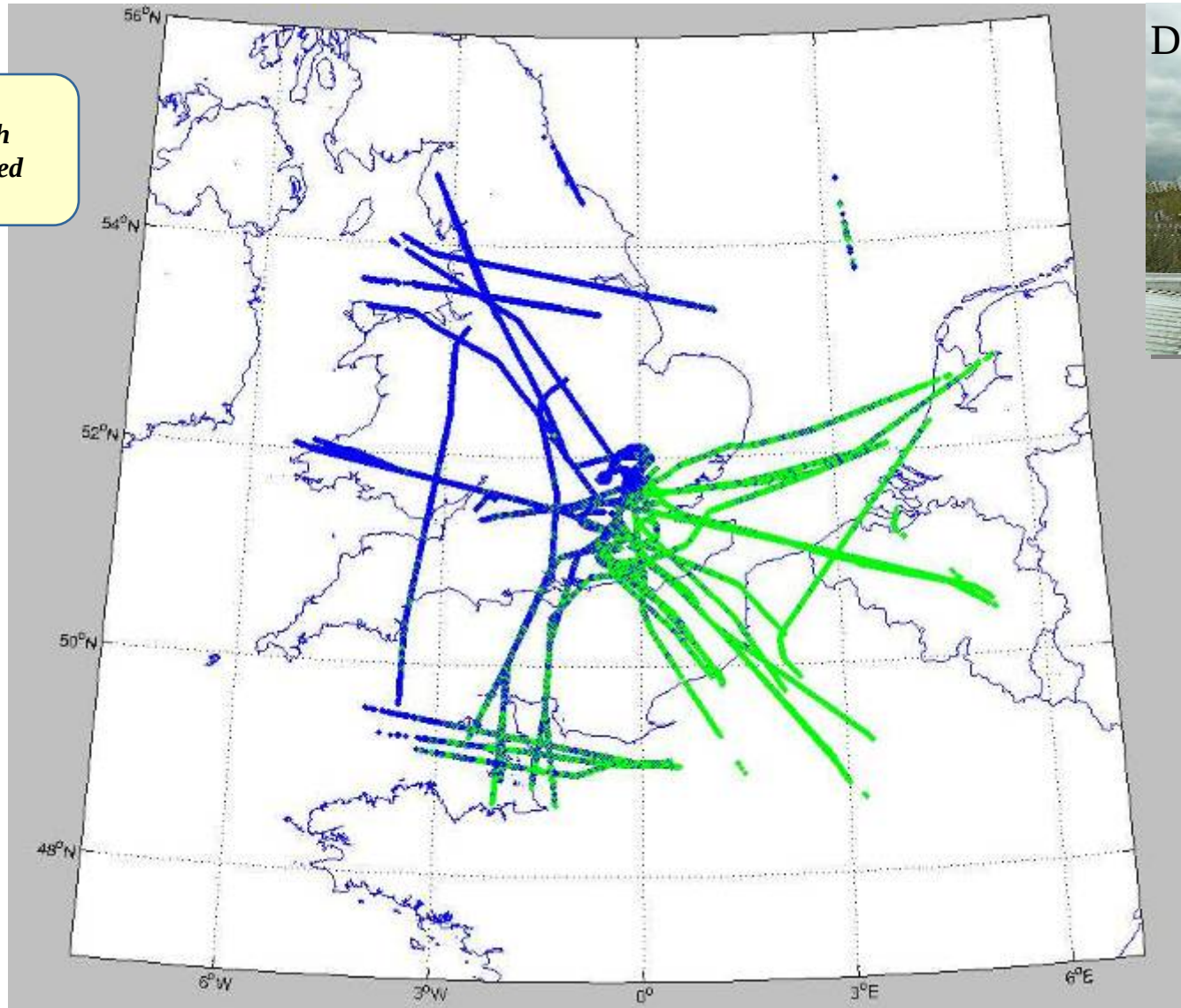
# ADS-B Field Trials

- Operational field trials have been conducted in different environments
- Trials in:
  - UK
  - Singapore
  - Mongolia
  - Canada
  - Germany
  - Ireland
  - USA



# ADS-B Coverage from Harlow

*Track colour  
indicates which  
antenna was used  
for detection*



Dual Antenna

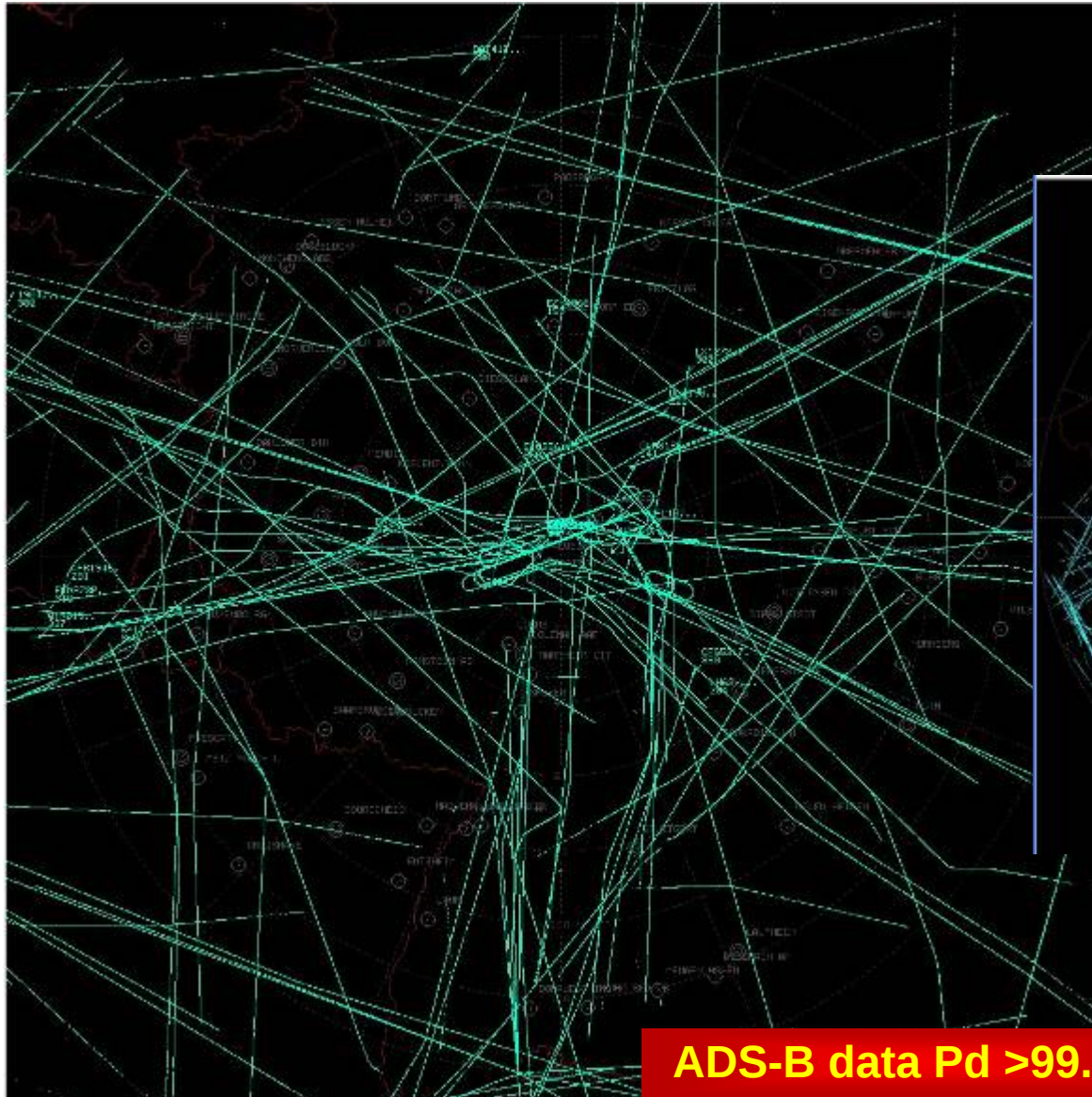


# Frankfurt (Götzenhein) Trial

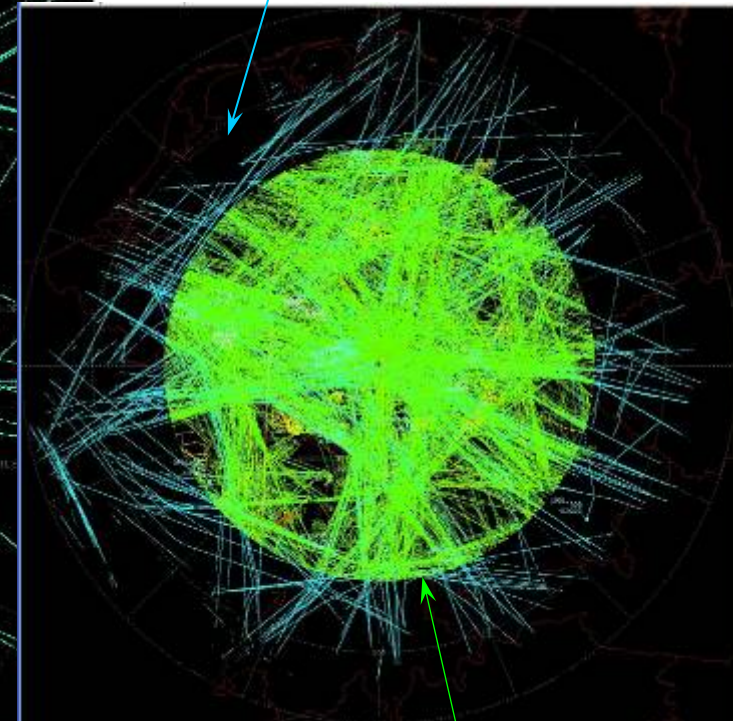


**At Götzenhein the ADS-B antenna elements were positioned either side of the tower for 360° coverage.**

# Frankfurt (Götzenhein Radar Site)



ADS-B data only limited by  
terrain screening



Radar data gated to 150nm

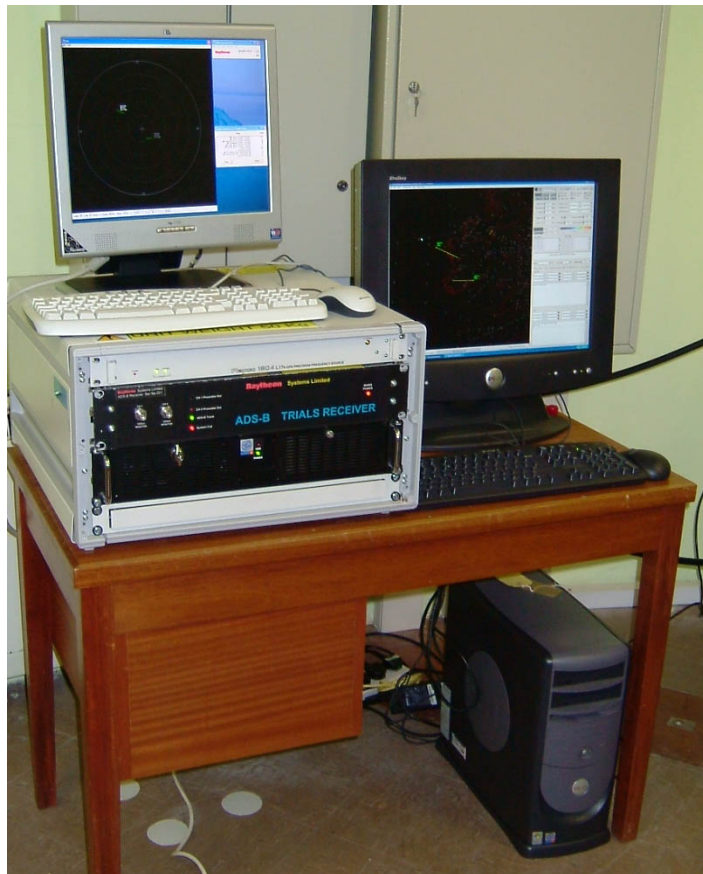
**ADS-B data Pd >99.8%**

# Frankfurt (Götzenhein) Trials

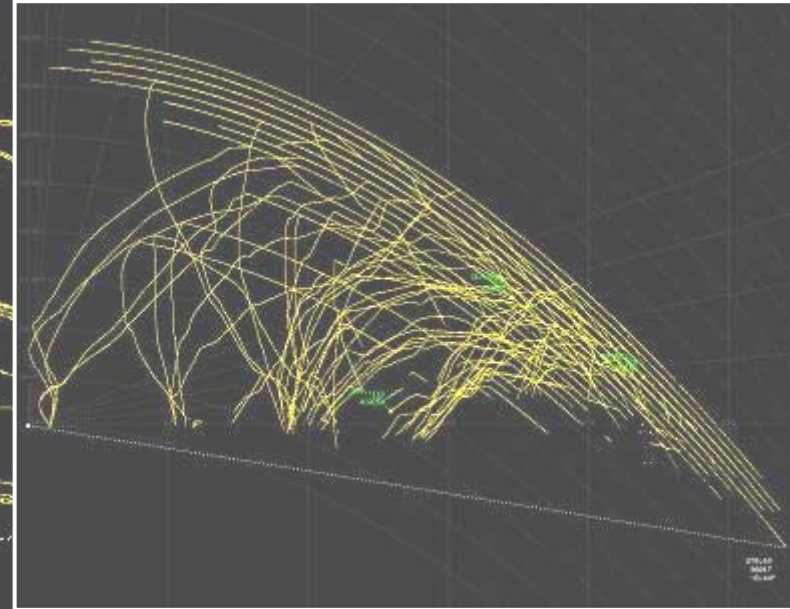
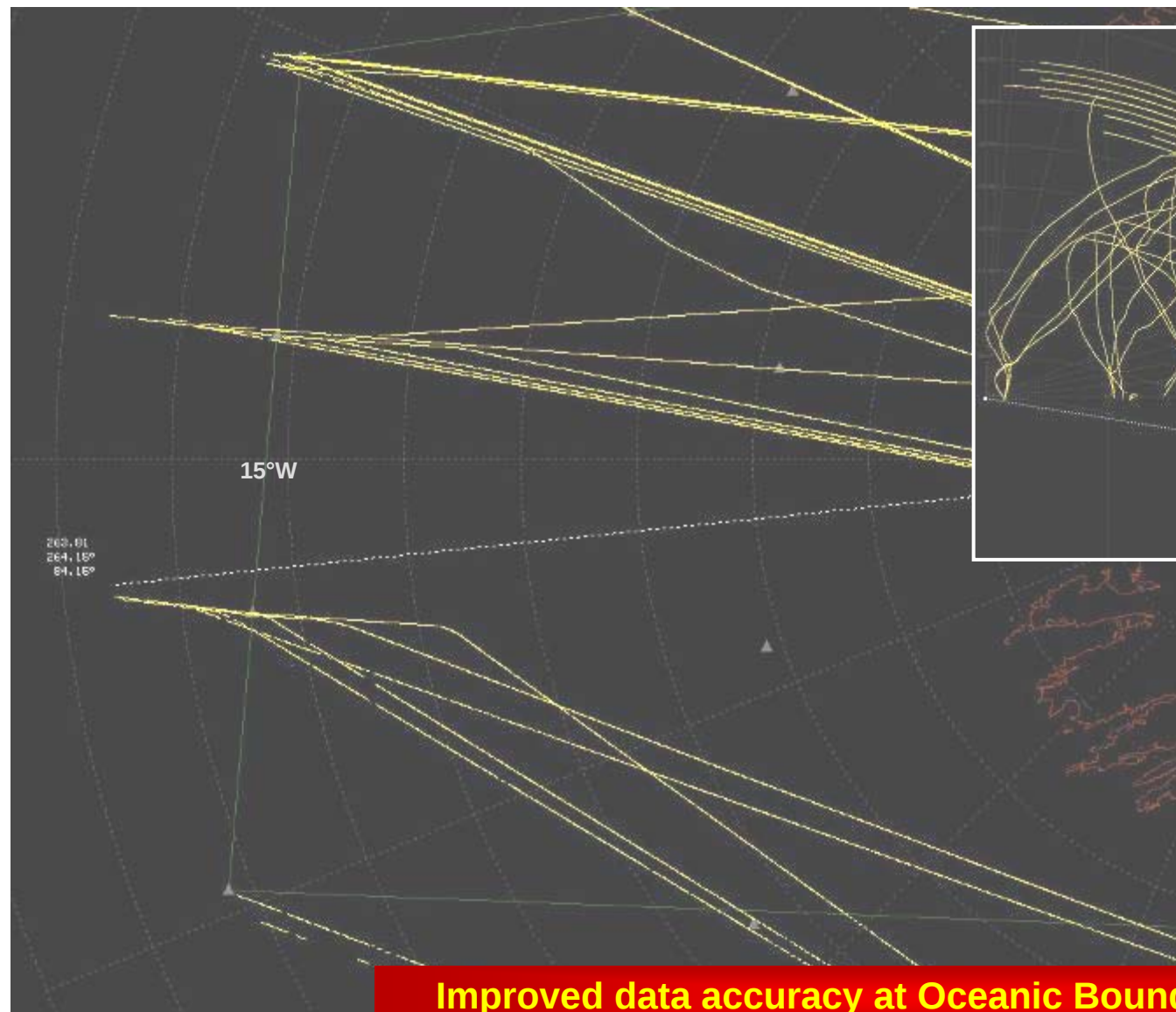
- This site was chosen because the Frankfurt location has been evaluated as the region with the highest FRUIT density world-wide. (By DFS/FAA trial)
- An independent ADS-B evaluation, carried out by Intersoft, gave excellent Pd results.
  - Evaluated as a Terminal application (100 Nm) with a 4 second update rate the Pd was >99.8%
  - Evaluated as a En-route application (150 Nm) with a 6 second update rate the Pd was >99.6%

# ADS-B Equipment at Shannon

- The site was chosen to evaluate long range surveillance from a low FRUIT density location.



# Ireland (Shannon)

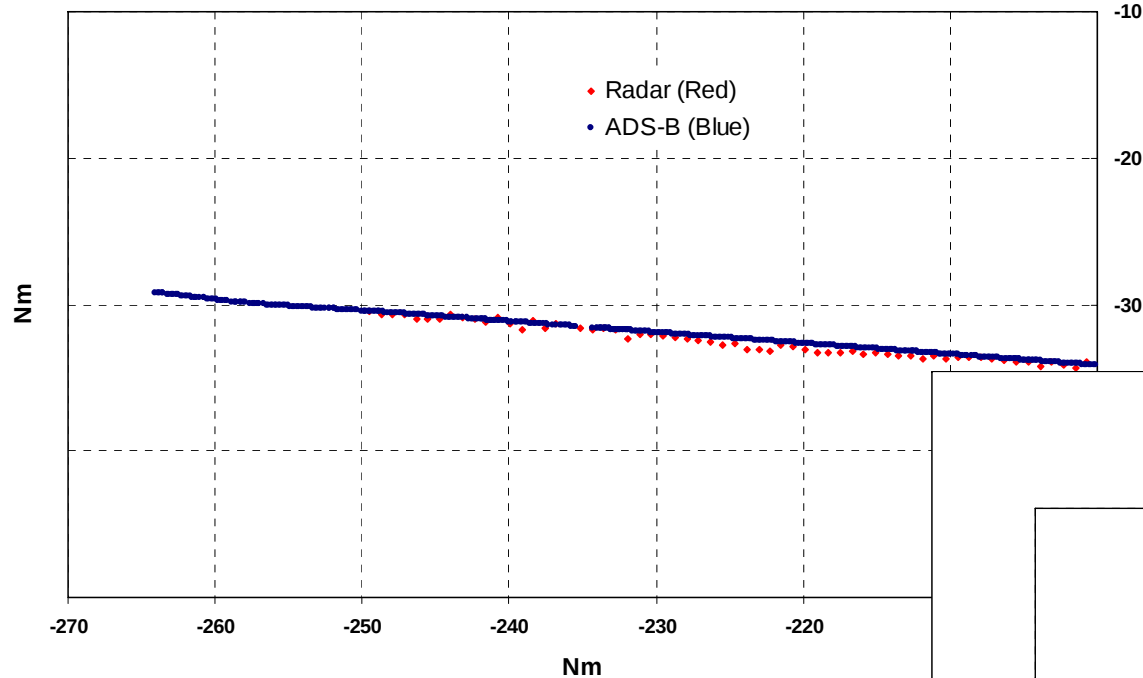


**ADS-B coverage to 260 NM**

**Improved data accuracy at Oceanic Boundary, 15°W**

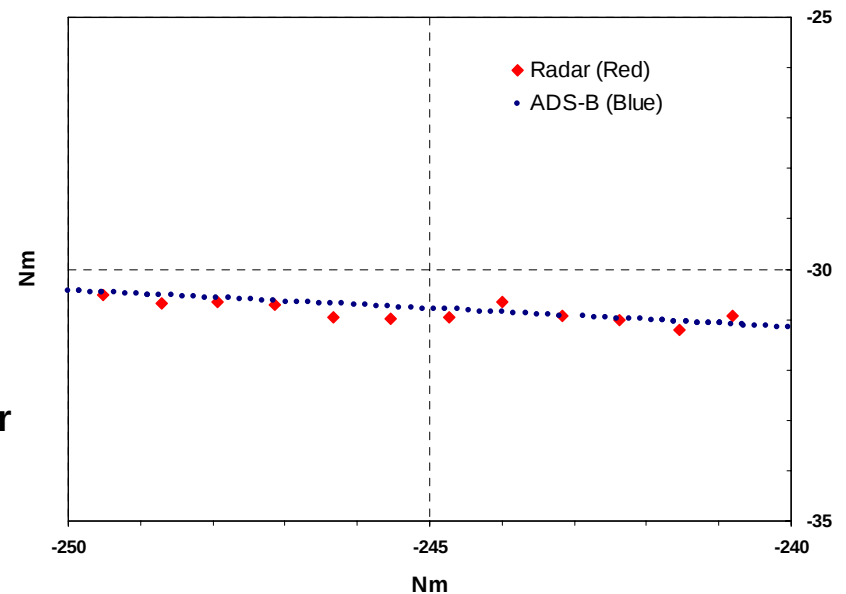
# Radar vs ADS-B Comparison

Woodcock Hill - Radar vs ADS-B (DLH401)



The ADS-B track was consistently being acquired before the radar

Woodcock Hill - Radar vs ADS-B (DLH401)  
(Expanded View)



The expanded view shows the higher position update rate from ADS-B

# Raytheon ADS-B

- 
- **Advanced surveillance solution**
  - **Complements MSSR Mode S**
  - **Revolutionary decoder designed specifically for demanding requirements of ADS-B**
    - Developed for challenging RF environment but suitable for all traffic intensities
    - Can be optimised to specific customer requirements
  - **Proven in operational field trials**

**Tomorrow's surveillance today**