NASA AATT HITS Program
(Helicopter In-flight Tracking System)

FAA Safe Flight 21 En Route and Oceanic Applications

May 21, 2003

Briefing to:

NASA ICNS Conference

ATM Surveillance Systems Sessions

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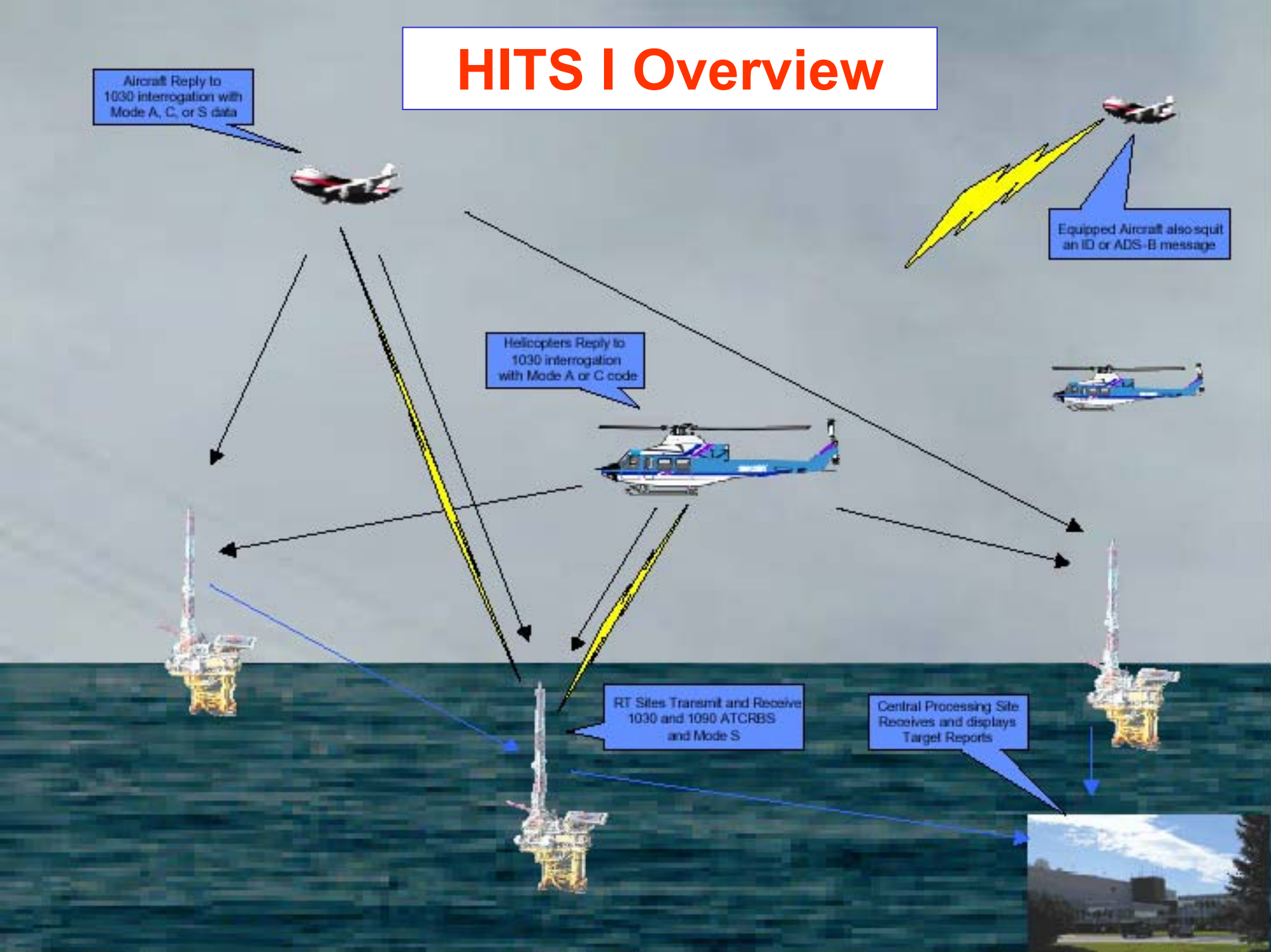
Surveillance and Assessment Division (DTS-53)

HITS I Overview

- **Period: 2001 and 2002**
- **Participants: NASA, Volpe, Sensis**
- **Function: Surveillance using 2 technologies:**
  - Wide Area Multilateration (WAM)
  - Automatic Dependent Surveillance – Broadcast (ADS-B)
- **Purposes:**
  - Engineering 1: WAM concept validation
  - Engineering 2: Effectiveness of WAM and ADS-B over water
  - Operational: Test acceptability of WAM as helicopter flight following system

HITS I Overview



HITS I Coverage

Coverage areas

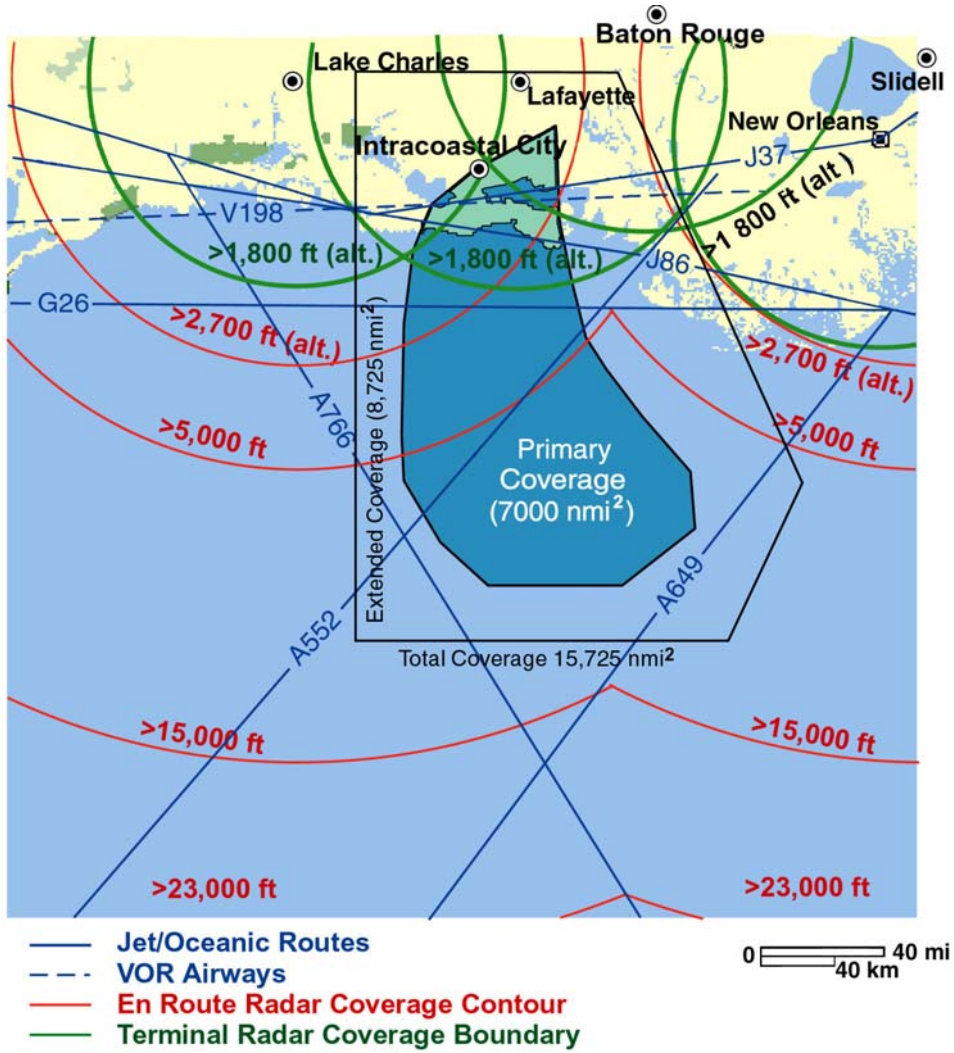
- "Primary" (containing ground sites) — 7,000 nmi² above 100 ft altitude
- "Extended" — 8,725 nmi² above 1000 ft
- Additional at higher altitudes

En route radars

- Lake Charles
- Slidel

Terminal radars

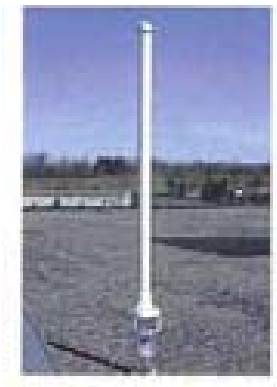
- Lafayette
- Lake Charles
- Baton Rouge
- New Orleans



HITS Ground Equipment

Remote Sites
On and Off-shore

Electronics Cabinet
(24”x18”x42”)



DME Antenna

AS-177B Omni Antenna
(6.5”x20”)

Central Site
PHI, Lafayette, LA

Target Processor

Maintenance and Display Terminal

Offshore Platform Examples

Evaluation Methodology and Criteria

- **Factory and Site Acceptance Test**
  - Interrogation Modes
  - Multiple ATCRBS Processing
  - Target Capacity
  - Overload Processing
  - Data Latency
  - RU Clock Calibration
  - Transponder Occupancy
  - Continuous Certification
- **Controlled Flight Testing**
  - Coverage Volume
  - Probability of Detection and Probability of False Target
  - Position Update Rate
  - Target Report Accuracy
  - Target Resolution
  - Mode A Code Reliability and Validation
  - Mode C Code Reliability and Validation
  - SPI Pulse

NASA Langley B-757
Sept. 11, 2002 Test

NASA Langley's B-757 test aircraft
NASA Langley Research Center 12/18/1998 Image # EL-1999-00108

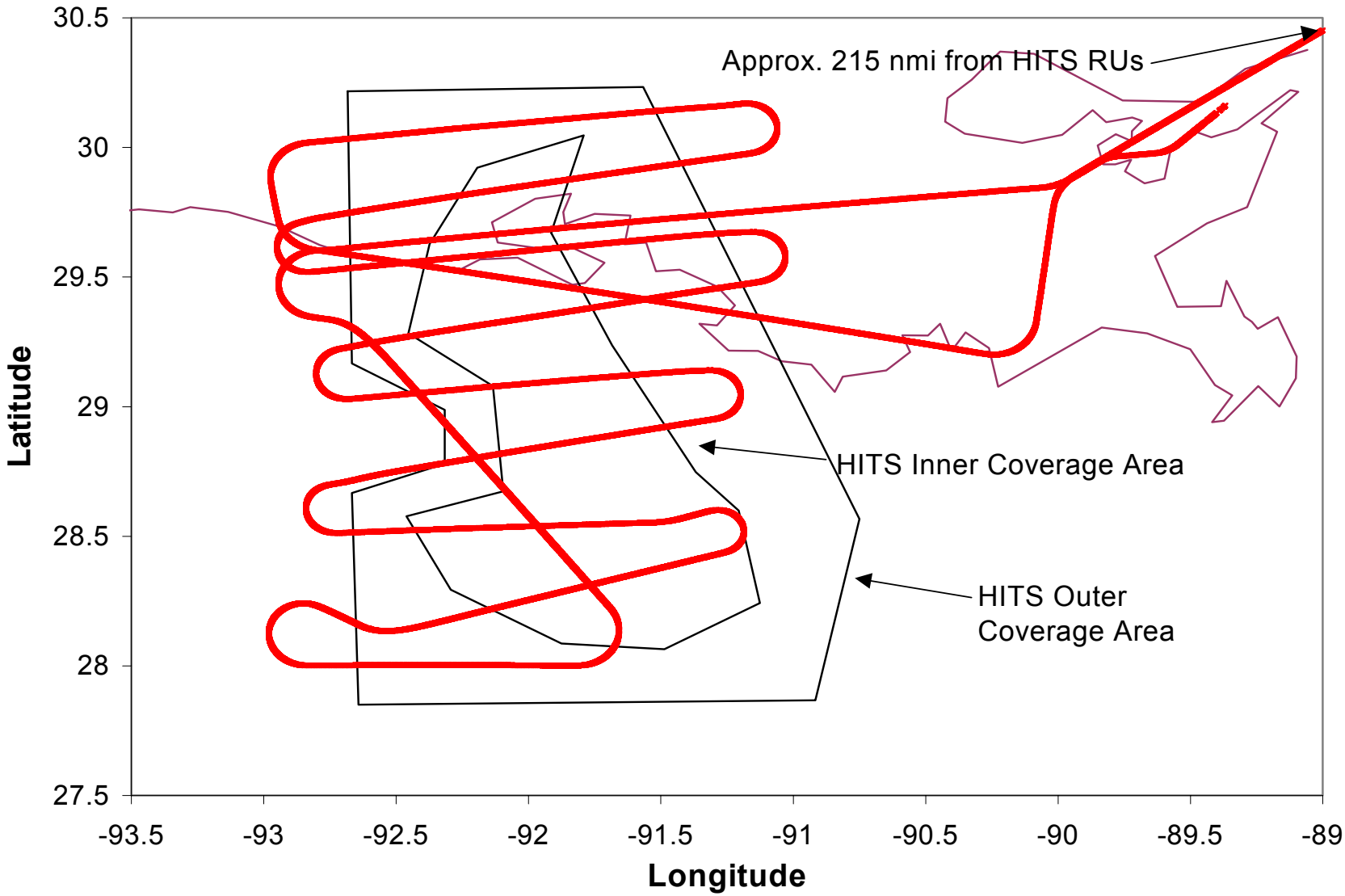
- **Boeing 757-200**
- **Tail #: N557NA**
- **Flight ID: NASA557**
- **Mode S Address**
  - A71A99 (Hex)
  - 10951321 (Dec)
  - 51615231 (Oct)
- **Initial System Flight Test**
  - Mode A Code: 3613

Langley flight and support team

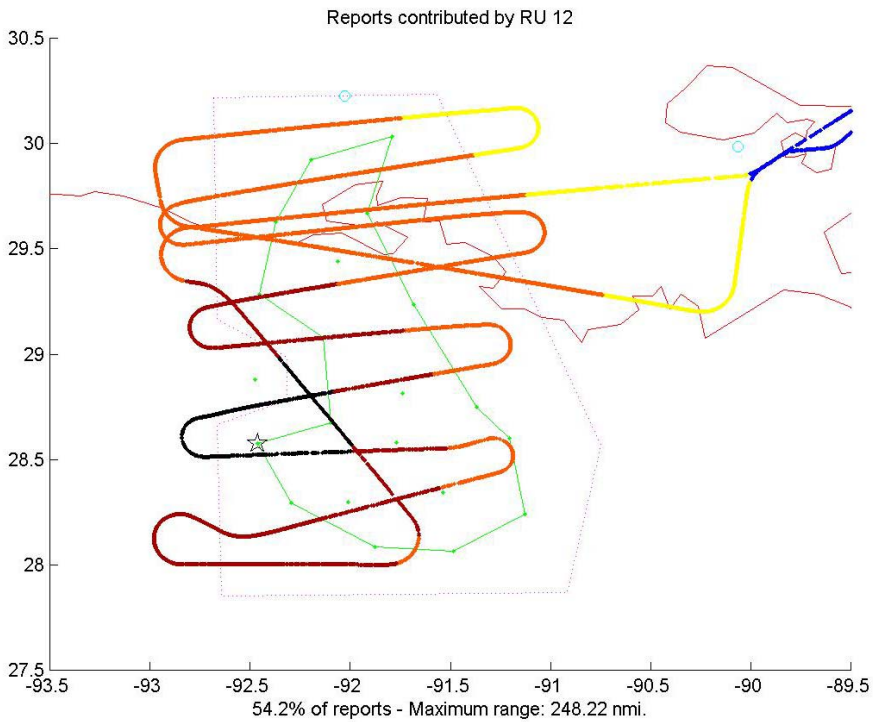
–Gerald Brown	– Lucy Crittenden
–Kevin Dutton	– Charles Howell
–Harry Verstynen	– Mike Wusk

NASA B-757: ADS-B Data

Aircraft at FL280 on 9/11/02



Individual Remote Unit ADS-B Receive Performance

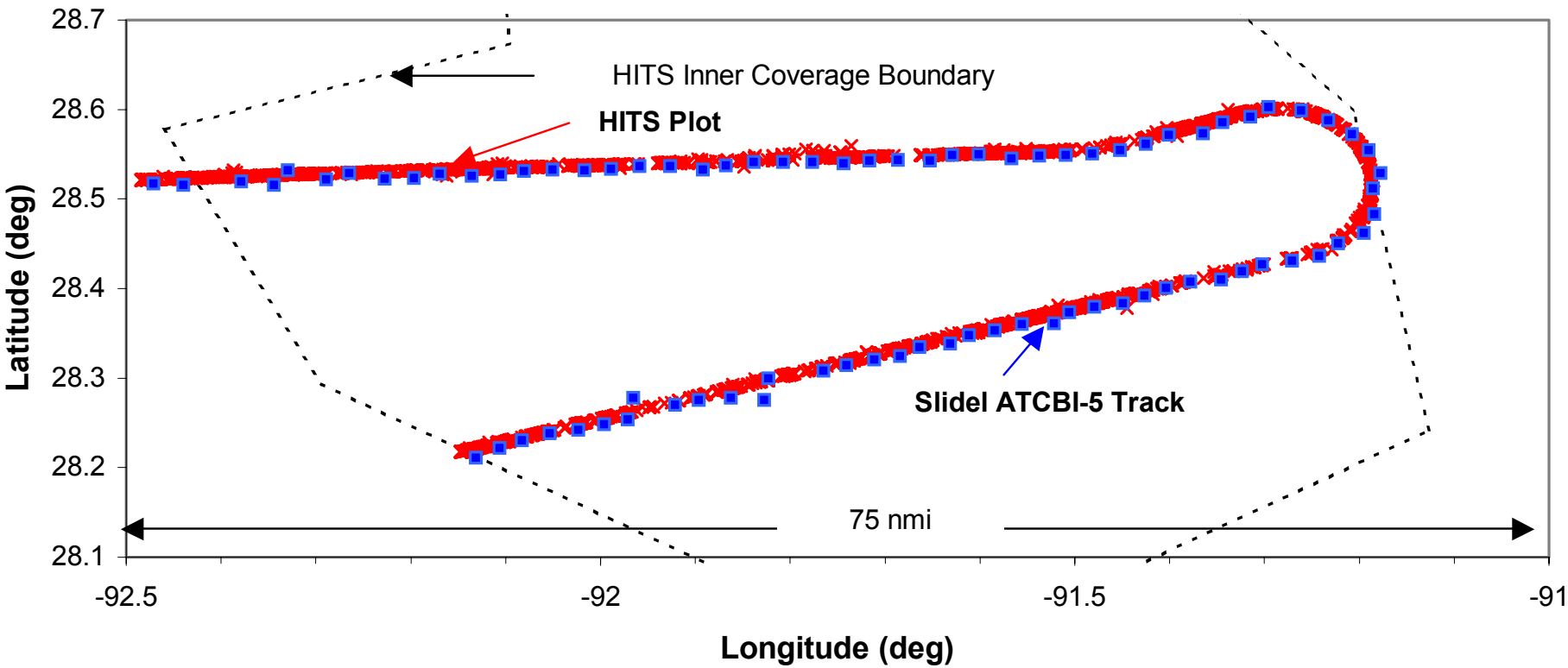


Update interval performance for RU 12

	Ranges	Max. Update	95% PDF
	<= 25 nmi.	8.76 sec.	2.58 sec.
	<= 50 nmi.	15.49 sec.	2.51 sec.
	<= 100 nmi.	15.49 sec.	2.16 sec.
	<= 150 nmi.	15.49 sec.	2.11 sec.
	<= 200 nmi.	15.49 sec.	2.16 sec.

Reliable Reception to 200 NMI

Radar / WAM Comparison
Sept. 11, 2002 / Flight Segment 2



Flight Test Aircraft (ATCRBS)
Sept. 17-18, 2002 Tests

Volpe Piper Aztec Flight Team
- Jack Giurleo, Pilot
- Alan Yost, Co-Pilot
- Jon Parmet, Engineer

PHI Bell 206 Flight Team
- Robert Cao, PHI Pilot
- Chris Daskalakis, Volpe Engineer
- Rob Huether, Volpe Staff

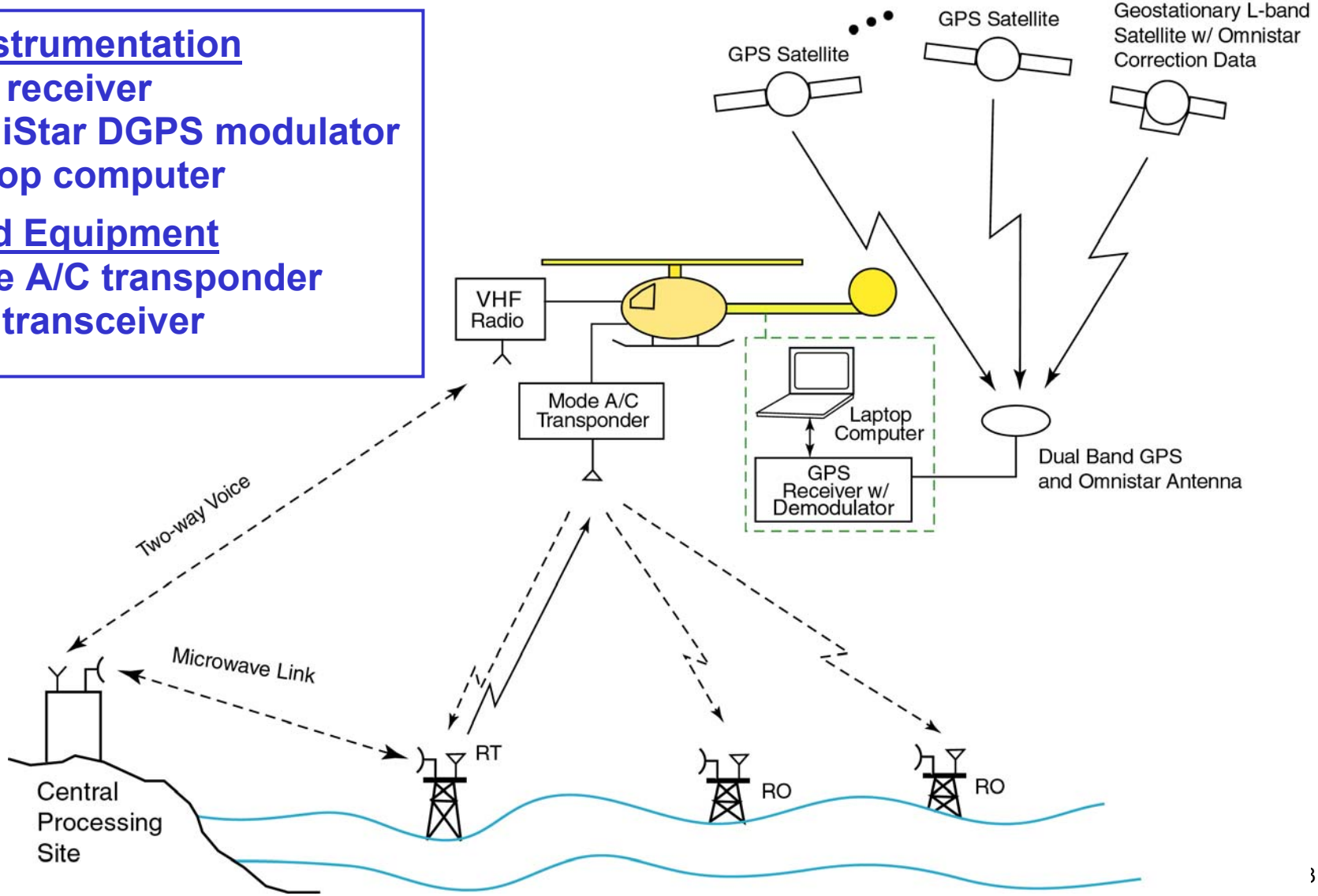
Airborne Data Collection System
Volpe Piper and PHI Bell 206

HITS Instrumentation

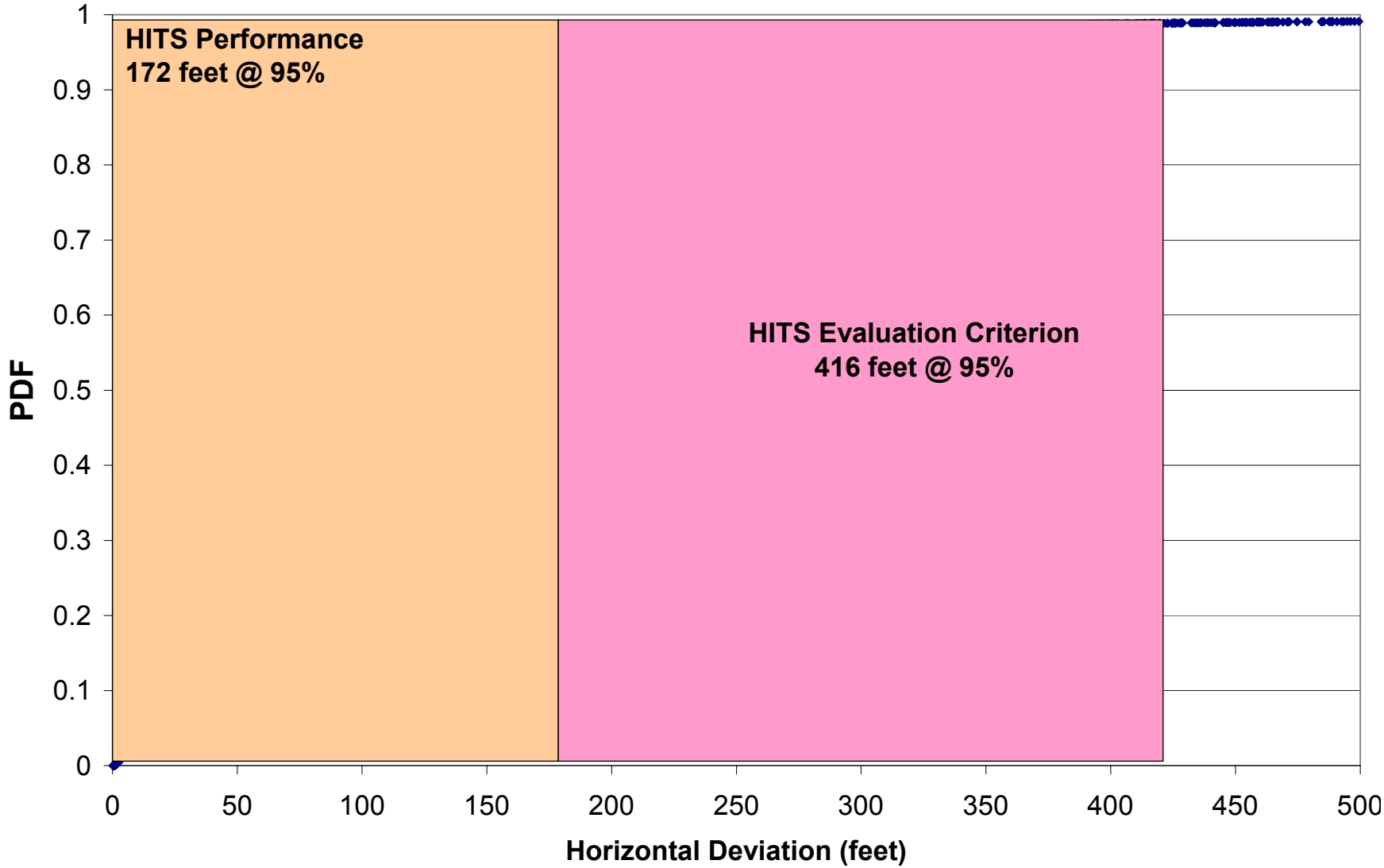
- GPS receiver
- OmniStar DGPS modulator
- Laptop computer

Installed Equipment

- Mode A/C transponder
- VHF transceiver

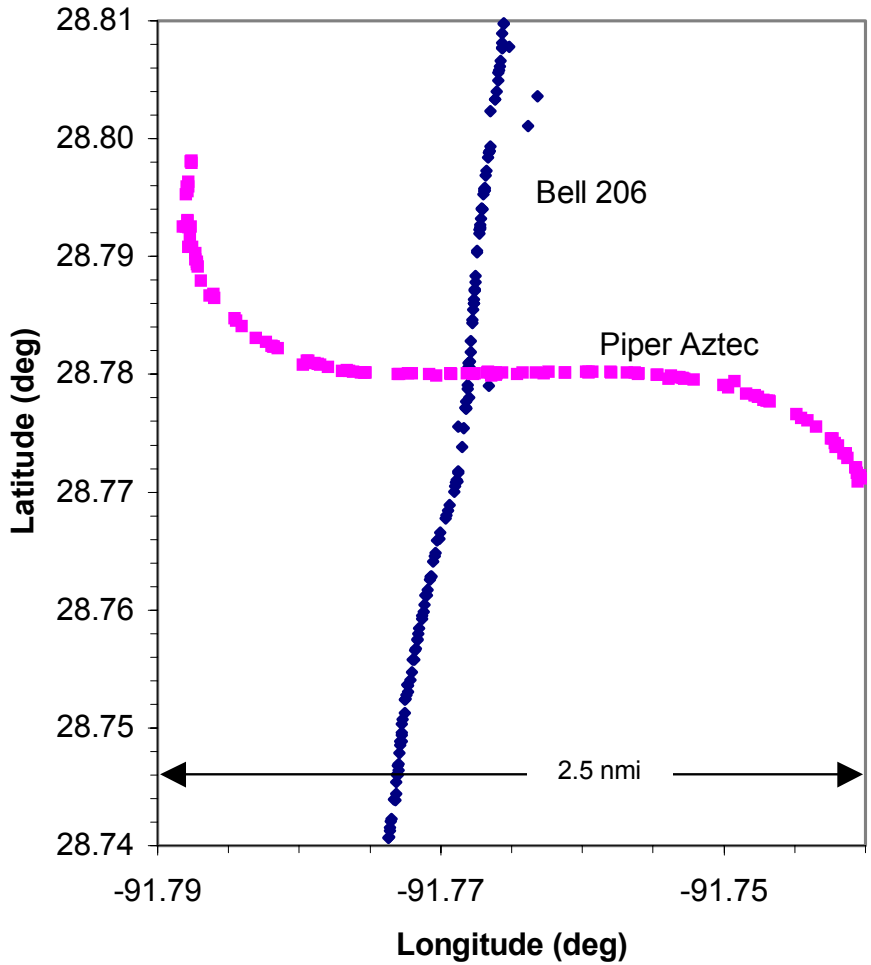


WAM Horizontal Position Error
(HITS) – (DGPS)



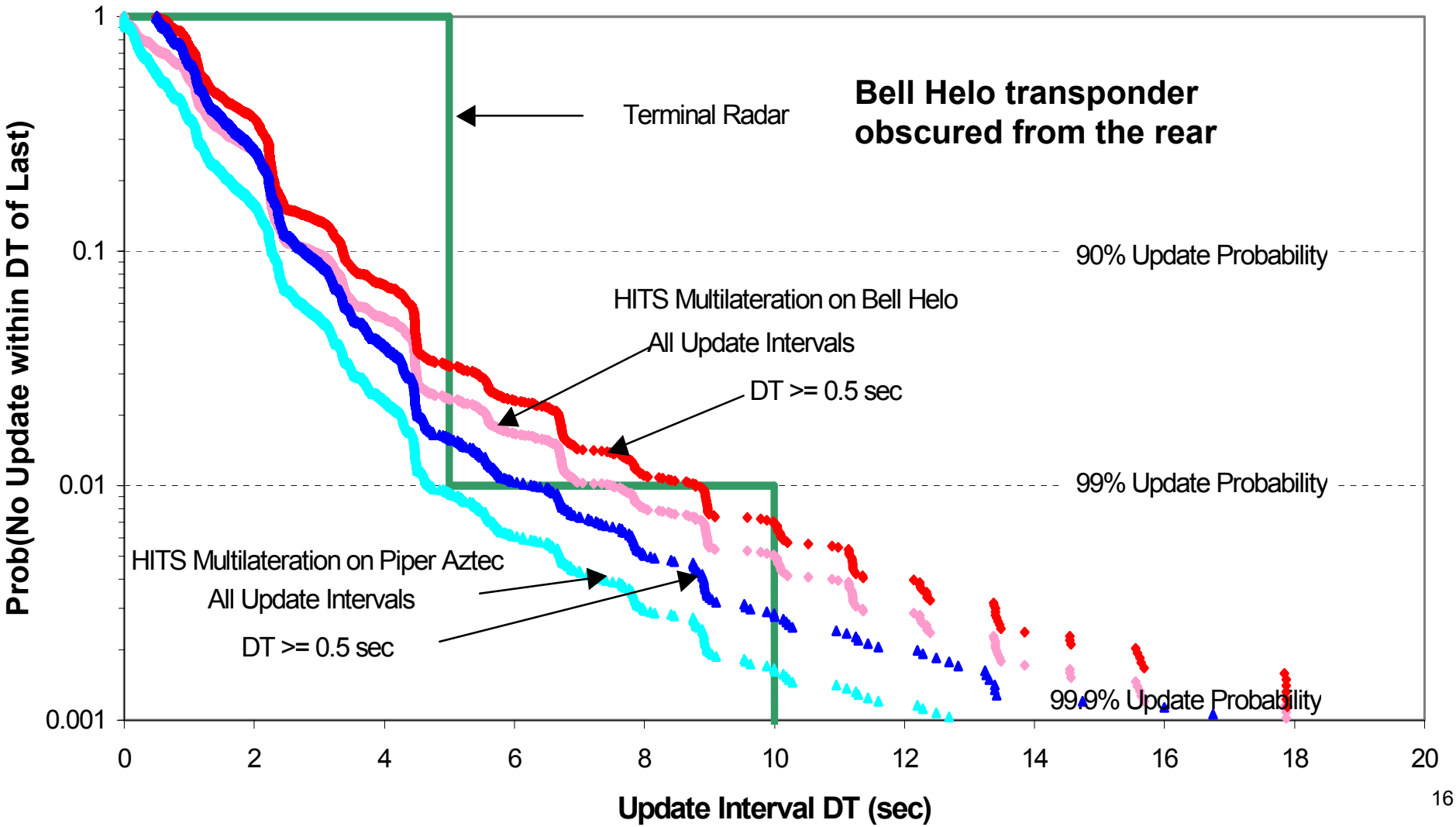
Piper Aztec/Bell 206 Long Ranger Target Crossing Scenario

Sept 18, 2002



- Targets separated 500 feet vertically
- Both target report sequences were continuous
- No Mode A code swaps
- Two Mode C swaps

WAM Position Update Interval
Breakdown by Aircraft
Sept 17-18, 2002

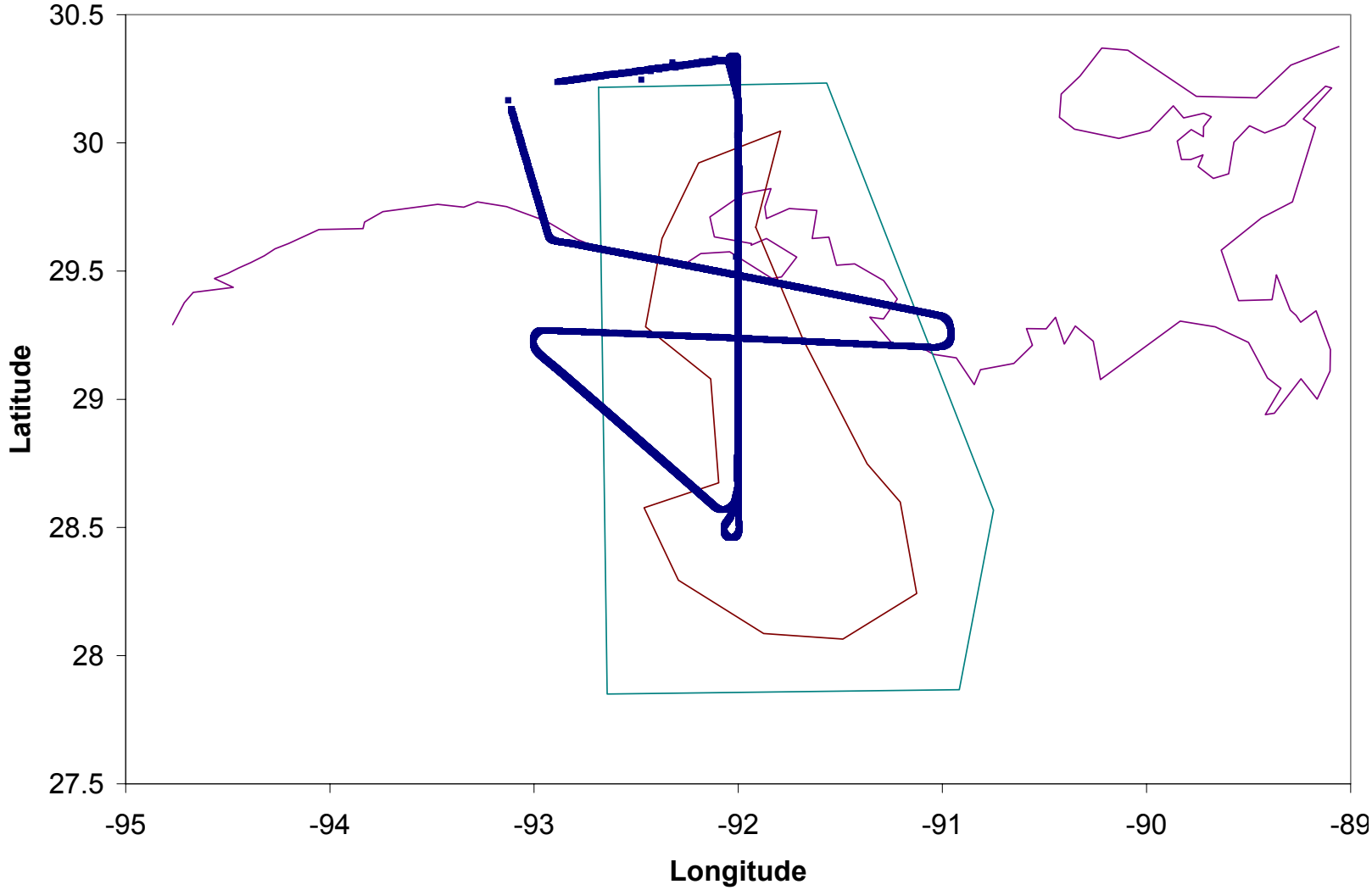


FAA Tech Center Aircraft
Convair 580 Turbo-prop

- Tail #: N49
- Mode S Extended Squitter Transponder
  - A60DBE (hex)
- Discrete Mode A codes during tests
  - AM: 4714 (octal)
  - PM: 4774 (octal)
- Truth system: On board GPS with post processing differential corrections

Purpose: Verify system changes and corrections

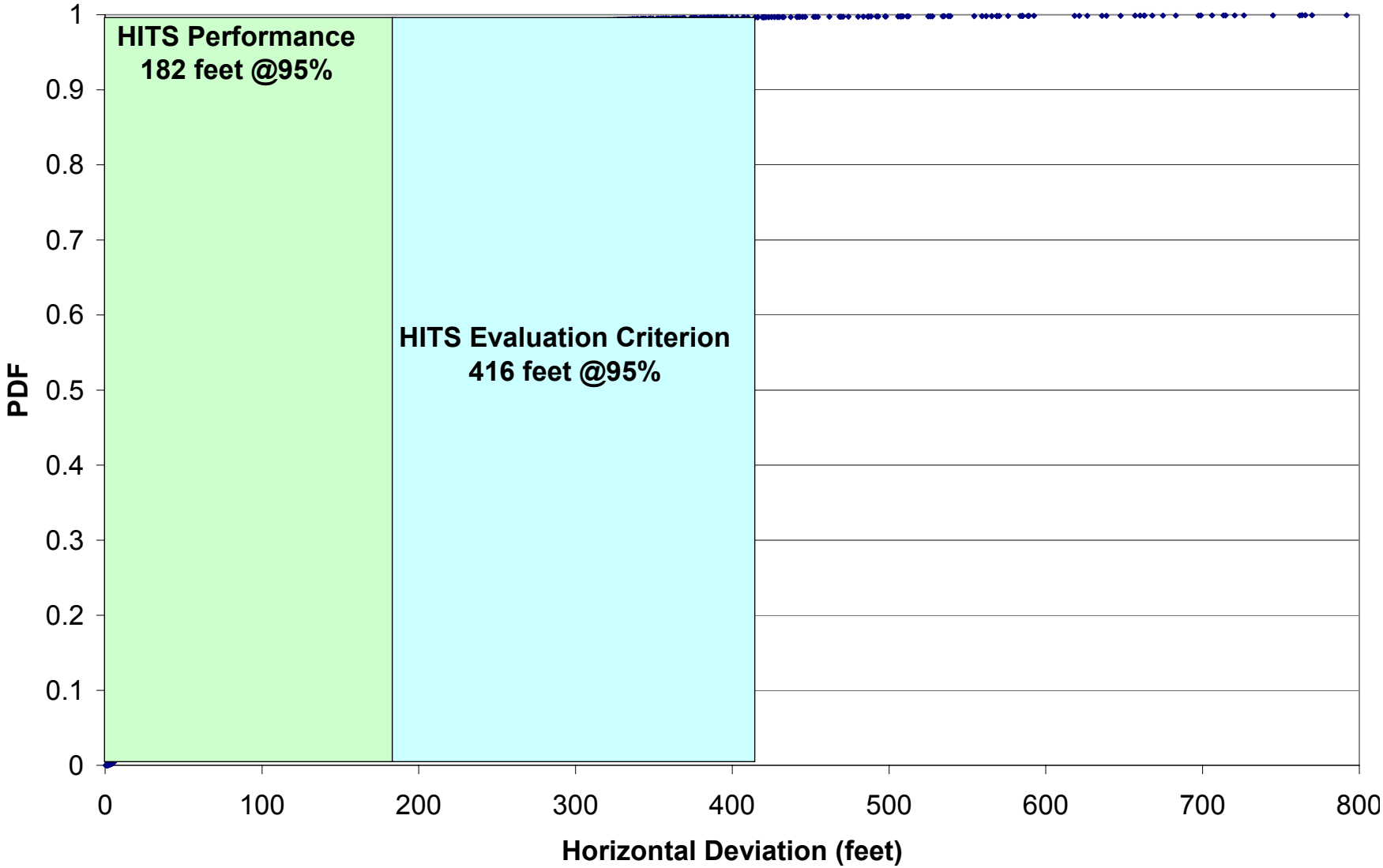
Convair 580 Multilateration Track
1/28/03 Morning Flight / Depart & Arrive LCH



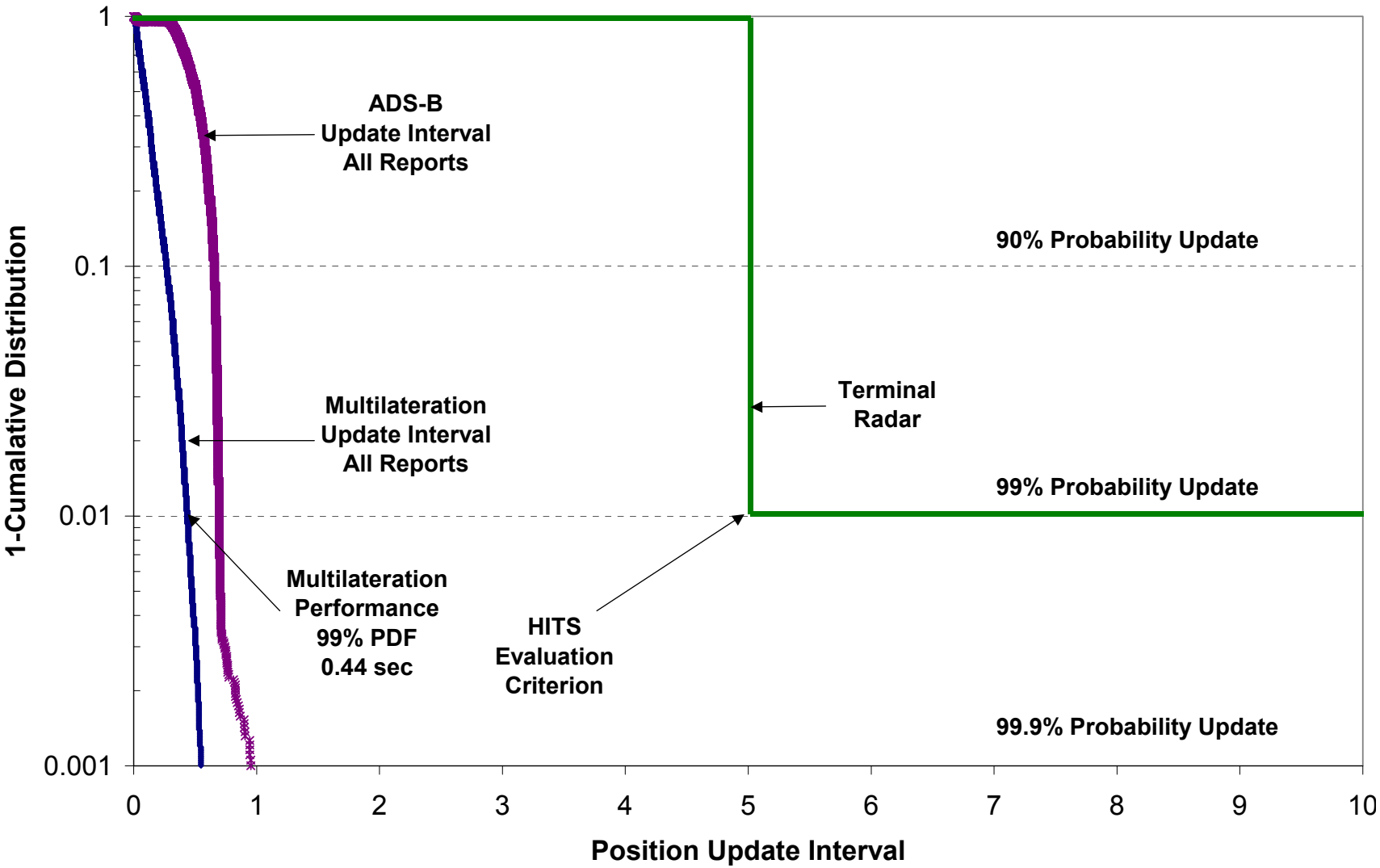
WAM Positional Accuracy 1/28/03

(HITS Multilateration) – (non-differential GPS)

All 6 Segments / Baro Altitude > 20k ft



WAM Update Interval
Position Reports
January 28, 2003



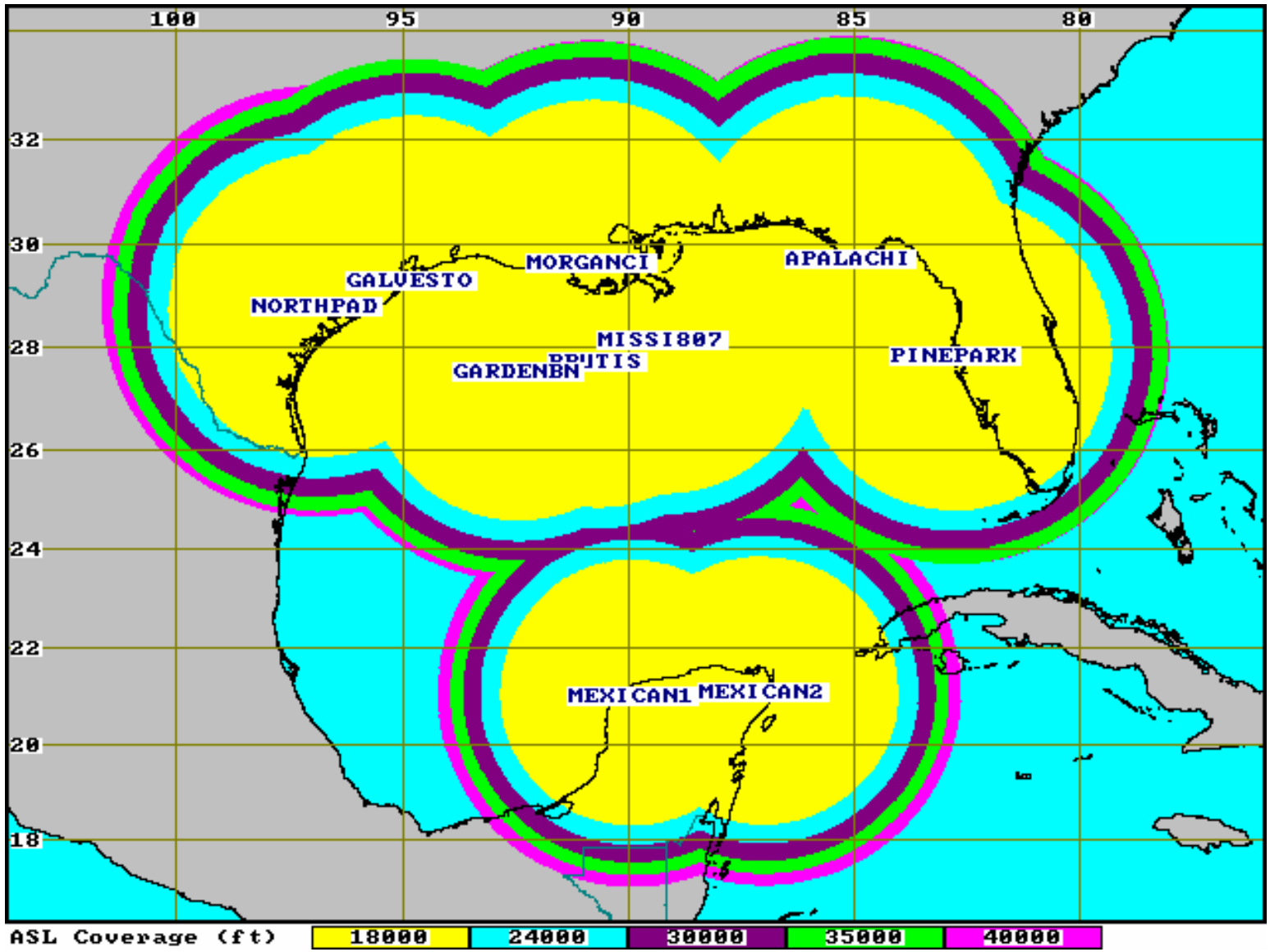
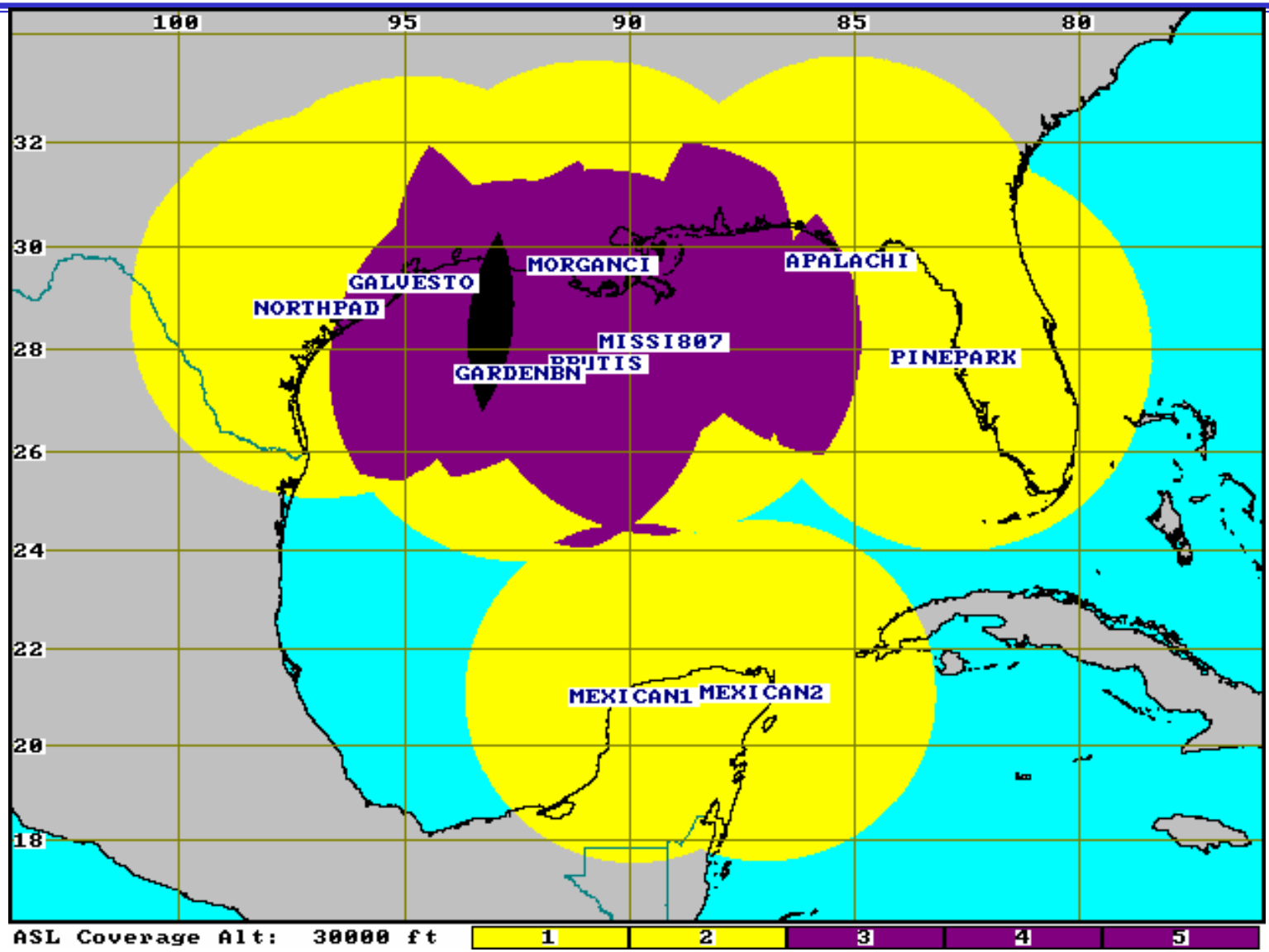
As good as radar?

- **Wide Area Multilateration**
  - Very close, for Mode S extended squitter transponder equipped aircraft tested
    - False target rate exceeds criterion
      - Likely correctable by software change
    - High interrogation rate
      - May require reduction
  - ATCRBS performance good, especially Target Resolution
    - Mode C performance needs improvement
      - Competing w/Transponder Occupancy requirement
      - Results from Sept 17 – Sept 18 flight testing degraded by Bell 206 Long Ranger
    - False target rate exceeds criterion
      - Likely correctable by software change
- **ADS-B**
  - Provided reliable detection (60 nmi)
  - Results indicate that, with reasonable receiver and antenna improvements, 200 nmi reliable range can be achieved (Gulf of Mexico
  - Few software corrections identified

HITS II Overview

- **Period: 2003 and 2004**
- **Participants: NASA, FAA, Volpe, Sensis**
- **Functions: Surveillance using 2 technologies:**
  - Automatic Dependent Surveillance – Broadcast (ADS-B)
  - Wide Area Multilateration (WAM)
- **Purposes:**
  - Operational 1: Demonstrate continuous surveillance between U.S. (central Gulf coast) and Mexico (Yucatan)
  - Operational 2: Test validity of WAM for terminal area helicopter operations
  - Engineering 1: Demonstrate effectiveness of ADS-B over very wide area (400,000 nmi^2)
  - Engineering 2: Test WAM over very wide area

ADS-B Coverage Overview with Mexican Radars



ADS-B and WAM Coverage @ FL 300 with Mexican Radars