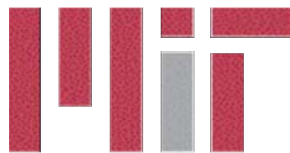




Noise Abatement Arrival Procedures at Louisville International Airport

Prof. John-Paul Clarke
Georgia Institute of Technology



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The Team

□ Noise Abatement Procedures Working Group (NAPWG) has the following members:

- ❖ MIT (lead) -> Georgia Tech (lead)

- ❖ Boeing

- ❖ FAA

- ❖ NASA

- ❖ Louisville Regional Airport Authority

- ❖ UPS



□ Gets assistance from others as appropriate



Introduction

- **Operational procedures are a cost effective means of achieving near- and medium-term noise and emissions reductions**
 - ❖ Especially true in the case of arrivals
- **The ideal arrival procedure is one where the aircraft descends continually at idle thrust from cruise to landing**
- **However, because the airplane is a glider in this situation, its future trajectory is very susceptible to variances in FMS logic, pilot technique, aircraft weight, and wind**



Challenges and Overview

- **Therefore, the challenges in develop such procedures are to:**
 - ❖ Develop procedures that positively leverage on the capabilities of the FMS
 - ❖ Determine the initial separation that ensures (for a given variation in pilot technique, aircraft weight, and wind) that the separation will not fall below the minimum throughout the arrival

- **In this presentation, I will present the results of two flight tests at Louisville Airport that were conducted to address these challenges**



2002 Flight Test: Overview

□ Objectives:

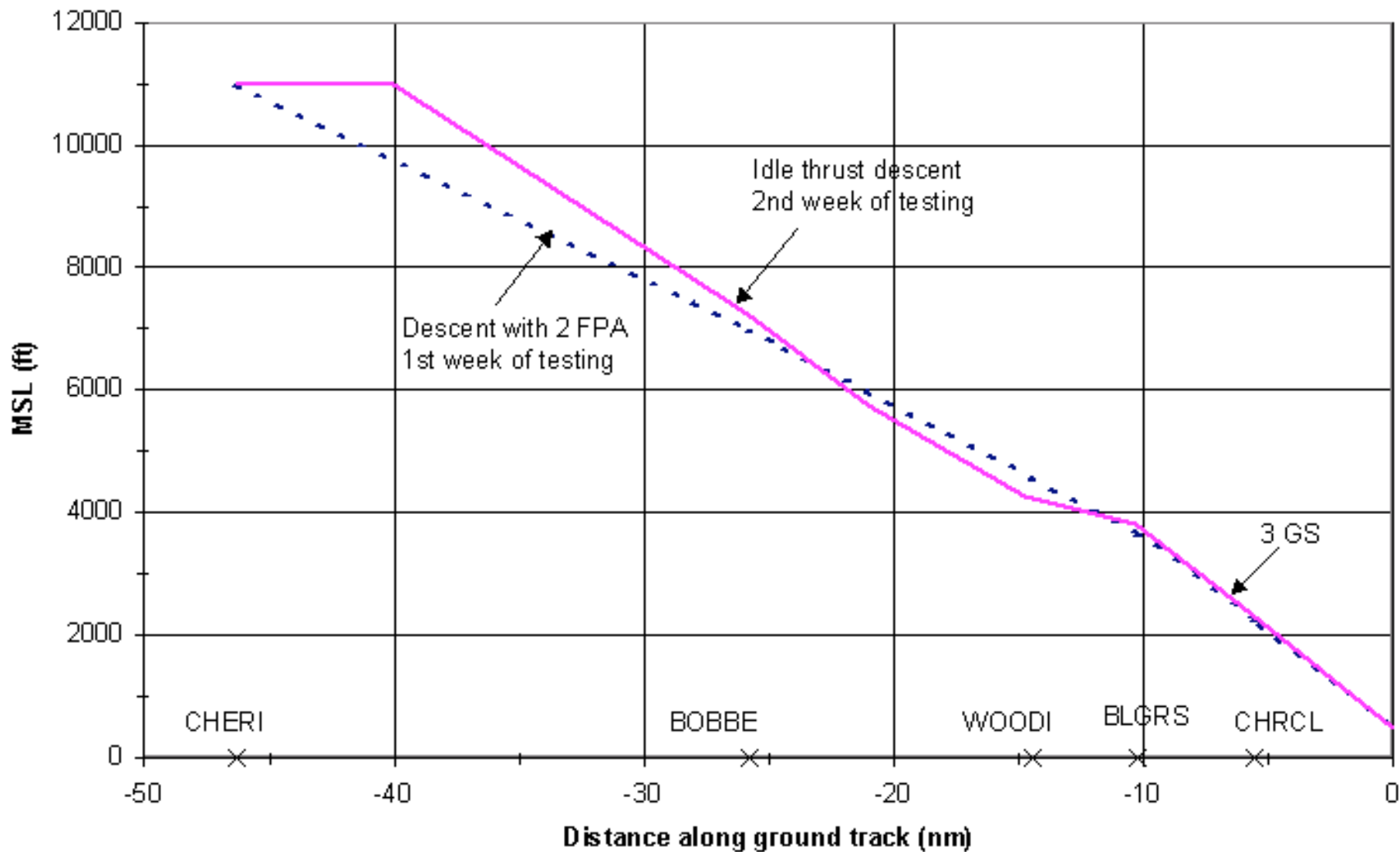
- ❖ Design CDA procedure for SDF TRACON
- ❖ Measure “real-world” benefits of CDA procedure
- ❖ Identify FMS issues that limit benefits or introduction

□ Research Approach:

- ❖ Fly two consecutive B767-300 aircraft along the same lateral path each night over a two-week period
 - First aircraft using conventional approach
 - Second aircraft using CDA approach
- ❖ Measure noise and archive flight data
- ❖ Determine noise, emissions, fuel burn, time savings

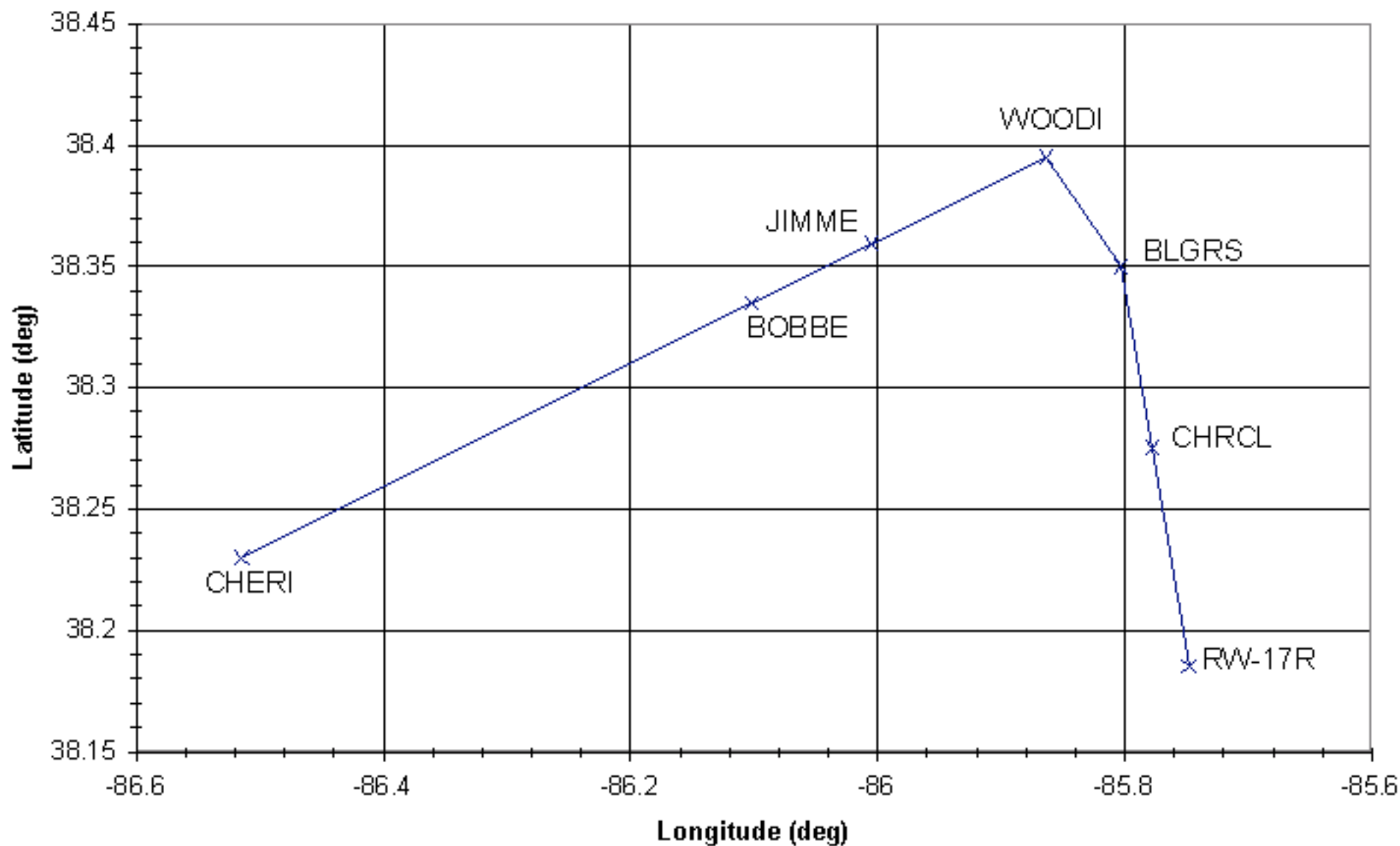


2002 Flight Test: "Design" Profile



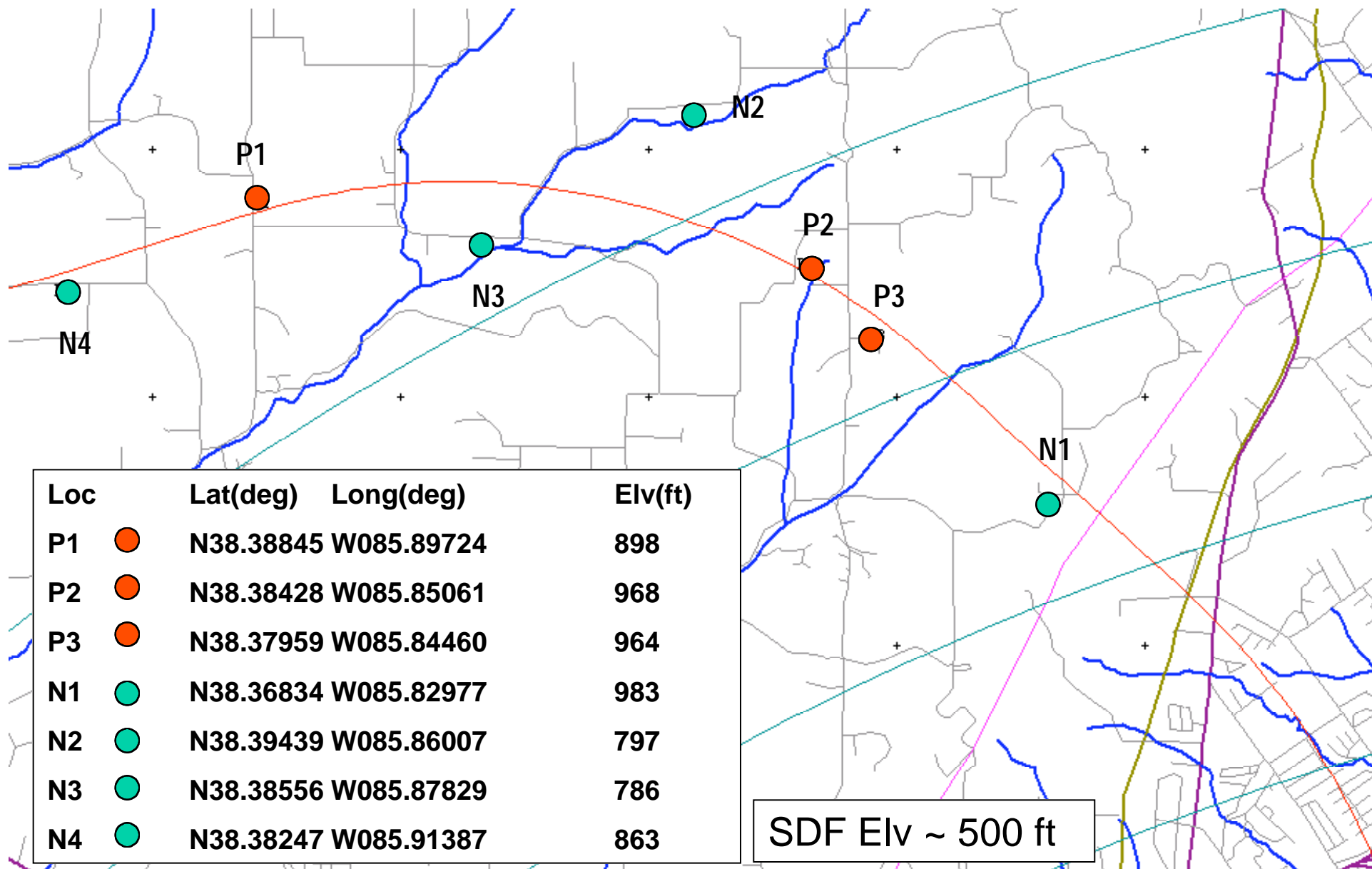


2002 Flight Test: Waypoints



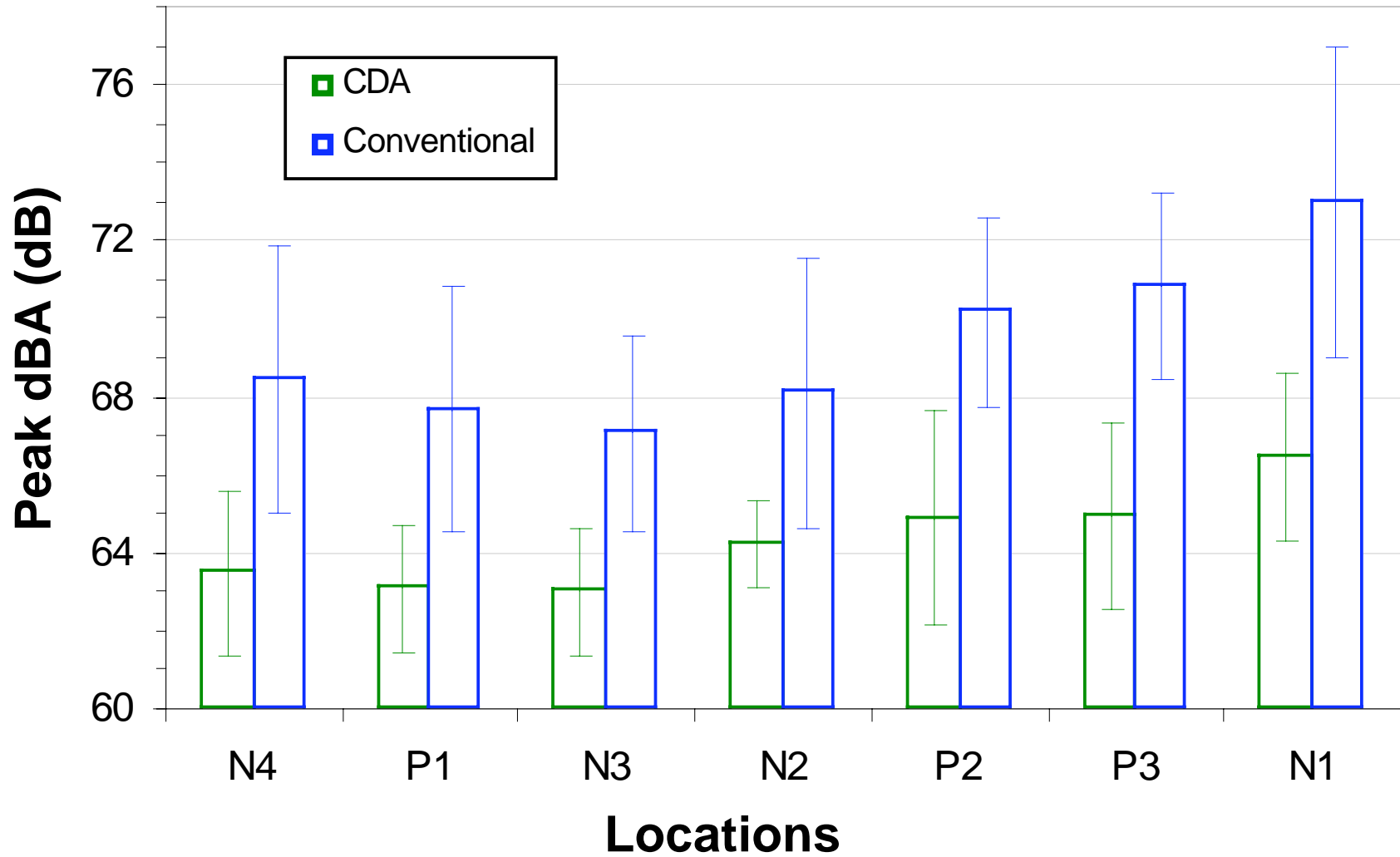


2002 Flight Test: Noise Monitors





2002 Flight Test: Noise Reduction





2002 Flight Test: Summary

□ Environmental and economic benefits:

- ❖ Up to 6 dB noise reduction (7.5 to 15 NM)
- ❖ 30% reduction in NOx (below 3,000 ft.)
- ❖ 500 lb. fuel burn reduction
- ❖ 100 sec. flight time reduction

□ FMS issues:

- ❖ Auto-throttle engages (with high thrust) if pilots are tardy in extending flaps/gear or if unexpected wind caused aircraft to slow more quickly than expected
- ❖ Auto-pilot responds by decreasing descent rate to arrest acceleration thus taking aircraft off desired path



2004 Flight Test: Overview

□ Objectives:

❖ Design CDA procedures for 17R and 35L that:

- Begin at cruise altitude
- May be used in daily operation
- Are FMS operational procedures
- Correct FMS issues identified in 2002

❖ Conduct flight test to:

- Validate new design tools
- Demonstrate consistency of procedure
- Provide data required for operational acceptance
- Validate noise, emissions, fuel burn and time savings



2004 Flight Test: Overview

□ Research Approach:

- ❖ Determine waypoints, corresponding altitude and speed restrictions, and pilot procedures
 - Analytical analysis
 - Simulator studies (at Boeing, NASA and UPS)
 - Beta flight tests (conducted by management pilots)
- ❖ Determine initial separation required to ensure that the minimum separation is never violated
 - Monte-Carlo simulator studies (at MIT)
- ❖ Conduct flight test over two-week period in September with 12 to 14 aircraft each night
 - Measure noise and archive flight data
- ❖ Determine noise, emissions, fuel burn, time savings



2004 Flight Test: Summary

□ **Flight test successfully completed**

- ❖ 126 aircraft planned over 10-nights
 - 125 aircraft performed as (or close to) expected
 - 2 of 125 aircraft given short vectors to improve spacing
 - 1 aircraft performed a visual approach
- ❖ Noise data collected on 9 of the 10 nights;
 - Late switch in direction of operation prevented noise measurement team moving to other side of airport.
- ❖ CDA and non-CDA aircraft successfully mixed on one night.



2004 Flight Test: Summary (cont'd)

□ Demonstrated (for the first time at the aggregate level) the environmental benefits of CDA in real-world operations:

❖ Noise impact significantly reduced

- Lower per aircraft noise levels
- Impact concentrated in narrow corridors

❖ Local emissions significantly reduced

- CO below 3,000 ft reduced by 12.7% (B-767) and 20.1% (B-757)
- HC below 3,000 ft reduced by 11.0% (B-767) and 25.1% (B-757)
- NOx below 3,000 ft reduced by 34.3% (B-767) and 34.4% (B-757)



2004 Flight Test: Summary (cont'd)

□ Demonstrated (for the first time at the aggregate level) the economic benefits of CDA in real-world operations:

❖ Economic costs significantly reduced

- Fuel to fly last 180 nm to runway reduced by 364 lbs/flight (B-767) and 118 lbs/flight (B-757)
- Time to fly last 180 nm to runway reduced by 147 secs/flight (B-767) and 118 secs/flight (B-757)

□ Demonstrated CDA use in realistic nighttime operations

□ Report available!



Next Steps

- ❑ **Get Louisville procedure approved for daily use with West Coast arrivals**
 - ❖ UPS currently developing package for submission
- ❑ **Develop guidelines for procedure design**
 - ❖ Leverage insights from 2004 flight test
- ❑ **Develop criteria and determine priority for wider implementation of CDA**
 - ❖ Analyze noise impact data, radar data and structure of airspace to determine airports where introduction of CDA will provide greatest benefits



Next Steps

□ **Develop controller tools required for implementation in higher traffic**

- ❖ Develop rule-based algorithm (using MIT Monte-Carlo Simulator) for setting initial separation
 - Based on current aircraft types and weight, and wind
- ❖ Design and test algorithms and displays that help controllers estimate the future state of CDA aircraft
 - Results of preliminary subjective study indicates that graphical display of velocity history improves prediction capabilities of test subjects

□ **Evaluate controller tools**

- ❖ Conduct controller-in-the-loop study