Evaluation, Design, Commissioning and Certification of a ±15° Reduced/Raised Coverage Localizer

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Content

- Design

- Operational Requirements

- Supporting Technical Validation

- ICAO Standardization

- Conclusions

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Evaluation, Design, Commissioning and Certification
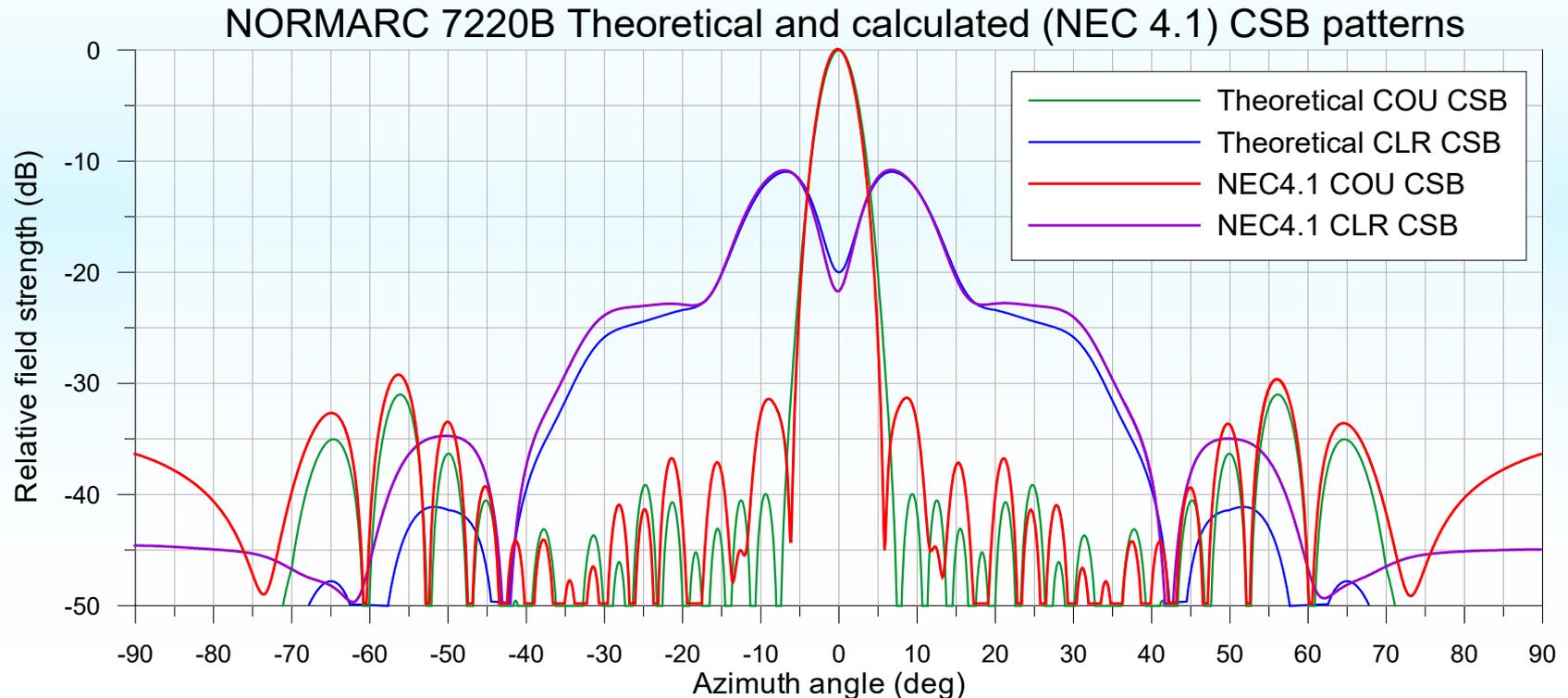of a $\pm 15°$ Reduced/ Raised Coverage Localizer

Design Goals

- 100% compatible with existing airborne equipment

- The main lateral coverage region, ±15° shall be 100% compliant with existing ICAO Annex 10 specifications.

  - 25NM within ±10° 2000'
  - 17NM from ±10° to ±15° 2000'

- Outside the main lateral coverage region and out to ±35° there must be no false courses or low clearance

Design Goals

- The Clearance CSB field strength shall have a large negative gradient from $\pm 10°$ to $\pm 15°$
  - Reduction of field strength by approx. 8dB

- From $\pm 15°$ to $\pm 35°$ the Clearance signal field strength shall be reduced further, but shall be sufficient to suppress the effect of CSB course side lobes.
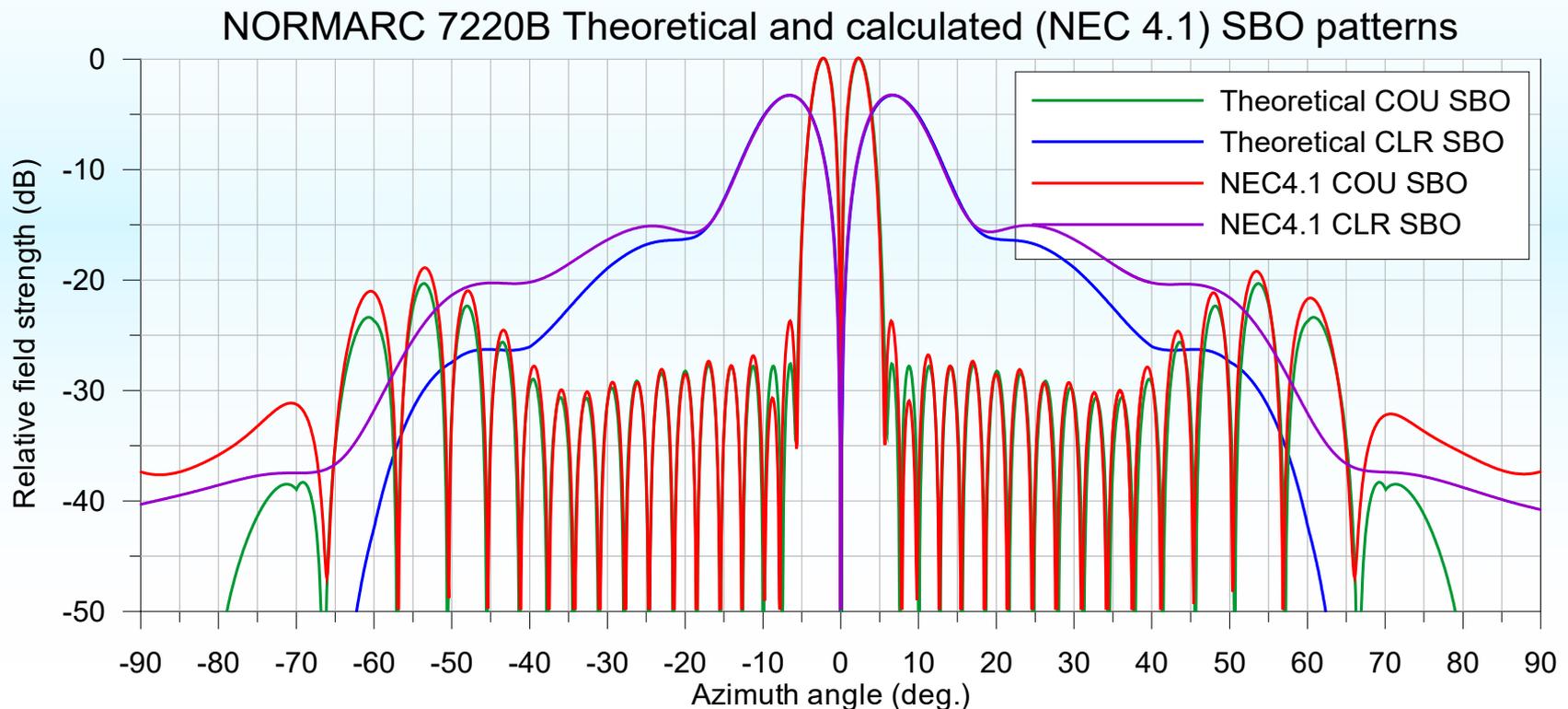
The design (CSB)

- The theoretical CSB patterns
- CSB patterns calculated with mutual coupling

NORMARC 7220B Theoretical and calculated (NEC 4.1) CSB patterns

Legend:
- Theoretical COU CSB
- Theoretical CLR CSB
- NEC4.1 COU CSB
- NEC4.1 CLR CSB

Y-axis: Relative field strength (dB)
X-axis: Azimuth angle (deg)

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The design (SBO)

- The theoretical SBO patterns
- SBO patterns calculated with mutual coupling

NORMARC 7220B Theoretical and calculated (NEC 4.1) SBO patterns

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The design (DDM/SDM)

NM7220B computed DDM/SDM pattern (CS=4°)
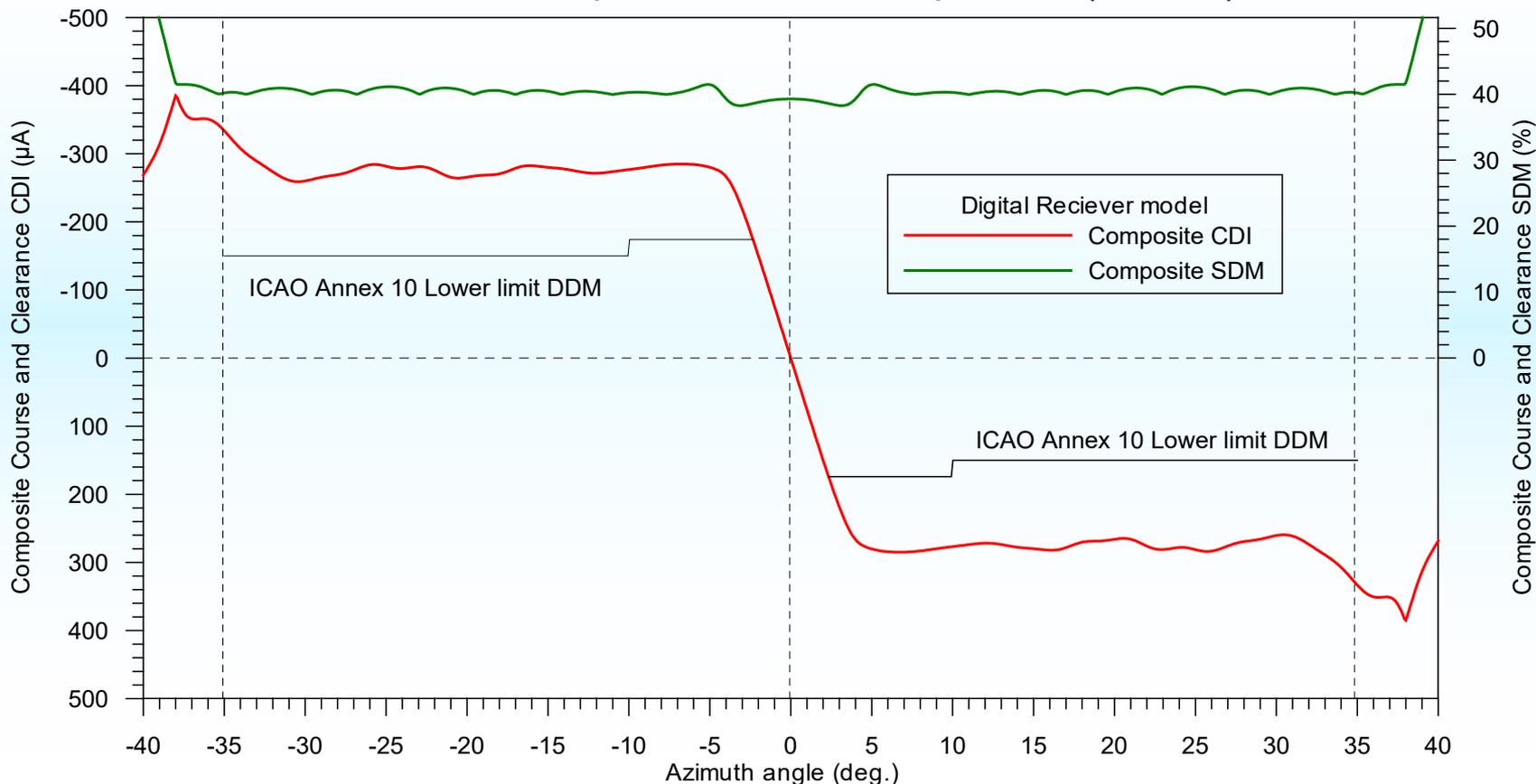
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Operational Localizer Coverage Requirements to Support Intercept

- **Avionics (Automatic Flight Control Systems)**
  - *Extend use of standardized linear region* to support reliable intercept without overshot…

- **PANS-ATM**
  - Vectoring requirements for intercept

- **PANS-OPS**
  - Procedure design requirements for intercept lead to IF (2NM minimum)
    - worst case scenario (high speed / large angle)
  - Basic ILS Surface Splay

- **Piloting**
  - Need to arm AFCS LOC Intercept Mode – *follows* receipt of ATC clearance to intercept

$\pm 5°$

$\pm 5°$

$\pm 15°$

$\pm 15°$

Requirements to Support Intercept

SWISS EMS Flight Data

ILS LOC offset angle at timepoint of APPROACH MODE ARM activation

Intercept Vector

Intercept Lead

LOC   RWY   FAP   IF   AFCS

15°
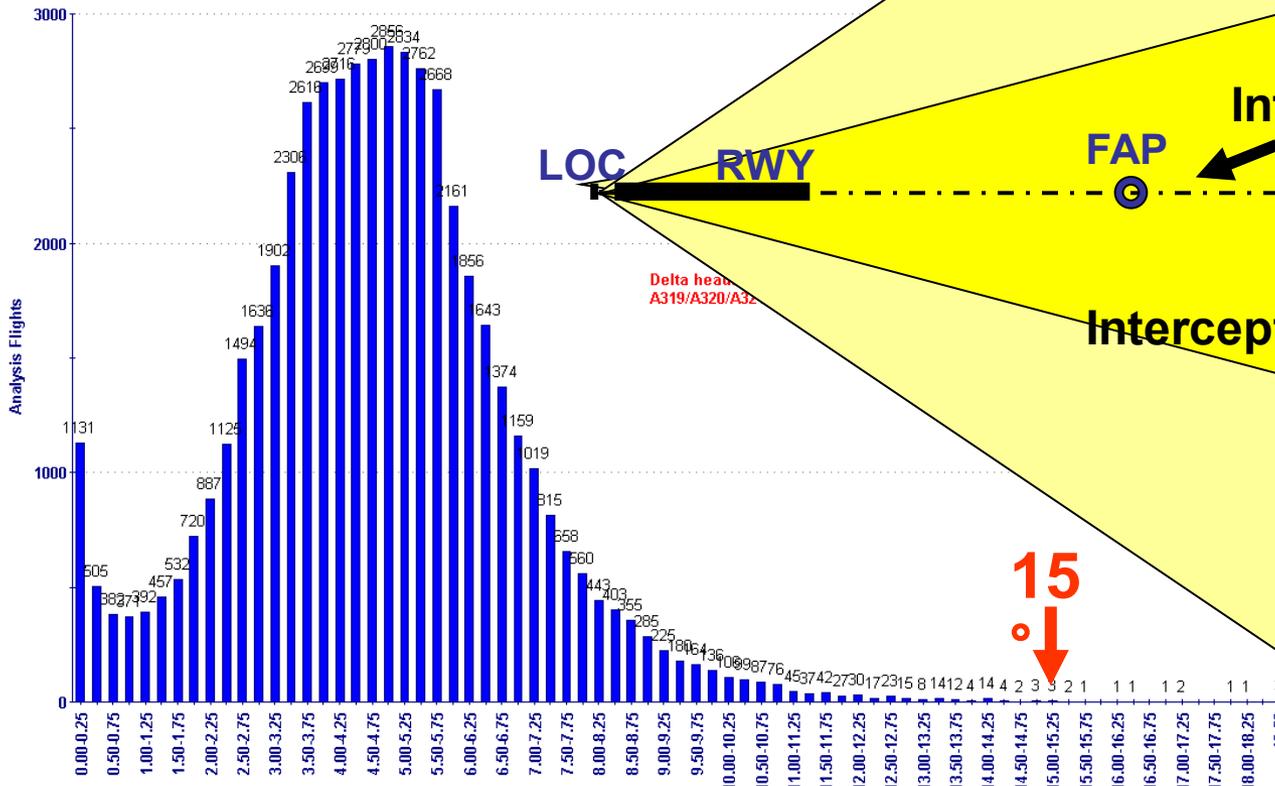
P116: LOC offset angle at APPROACH MODE ARM (degrees, abs value based on GC navigation)

Analysis processed at 8:28 AM Jan 19, 2006

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Requirements to Support IDENT

- IDENT is *key driver* for LOC Coverage
  - Without IDENT, Pilot shall not descend on Glidepath (NAV responsibility hand-over)
- **Taskload** study confirmed that IDENT *within* formal coverage remains possible (high workload / fast geometry)
- Operational reality is that IDENT is *expected to be* available at **FL100**
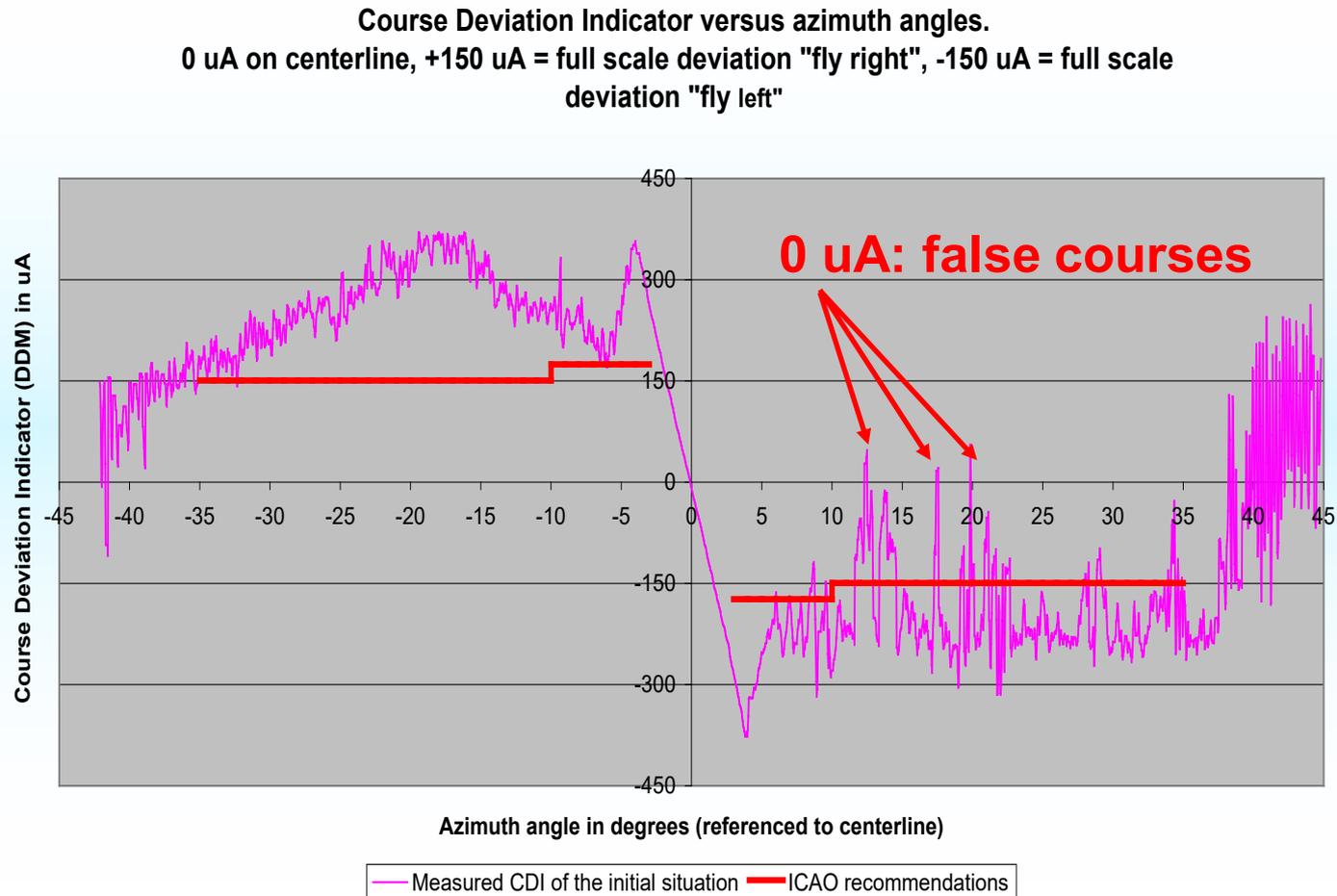 - Check for Approach
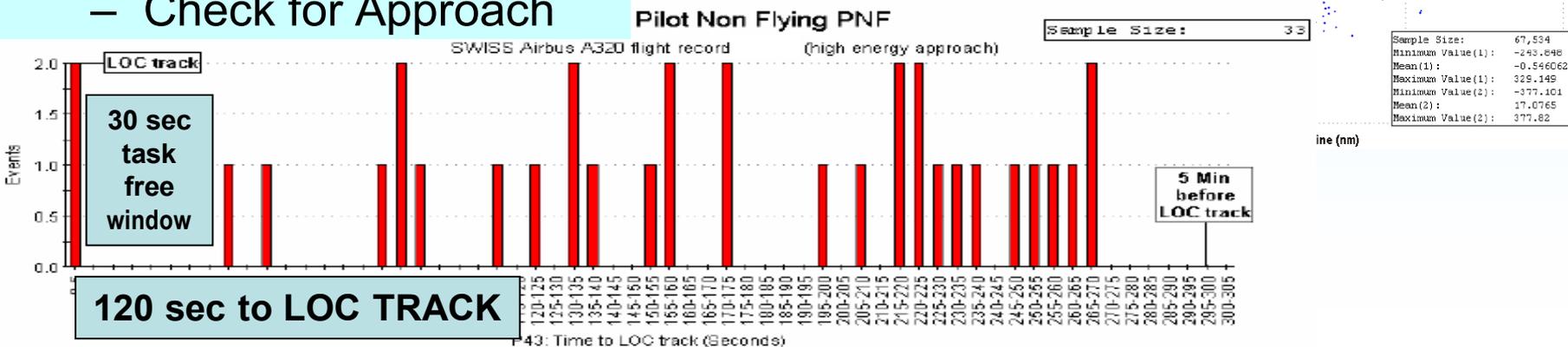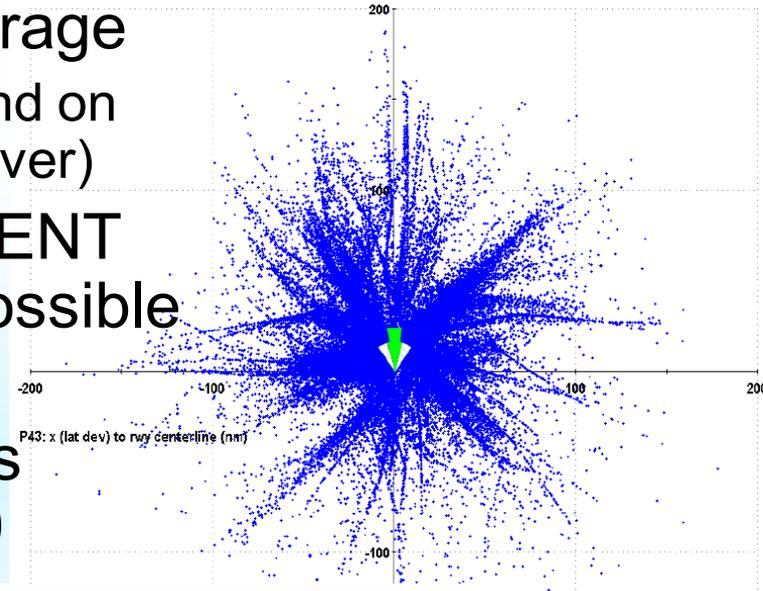
X/Y deviation from LOC antenna axis when ILS is activated

P43: x (lat dev) to rwy center line (nm)

Sample Size:	67,534
Minimum Value(1):	-243.848
Mean(1):	-0.546062
Maximum Value(1):	329.149
Minimum Value(2):	-377.101
Mean(2):	17.0765
Maximum Value(2):	377.82

ine (nm)

Pilot Non Flying PNF
(high energy approach)
SWISS Airbus A320 flight record

Sample Size: 33

30 sec task free window

120 sec to LOC TRACK

5 Min before LOC track

P43: Time to LOC track (Seconds)

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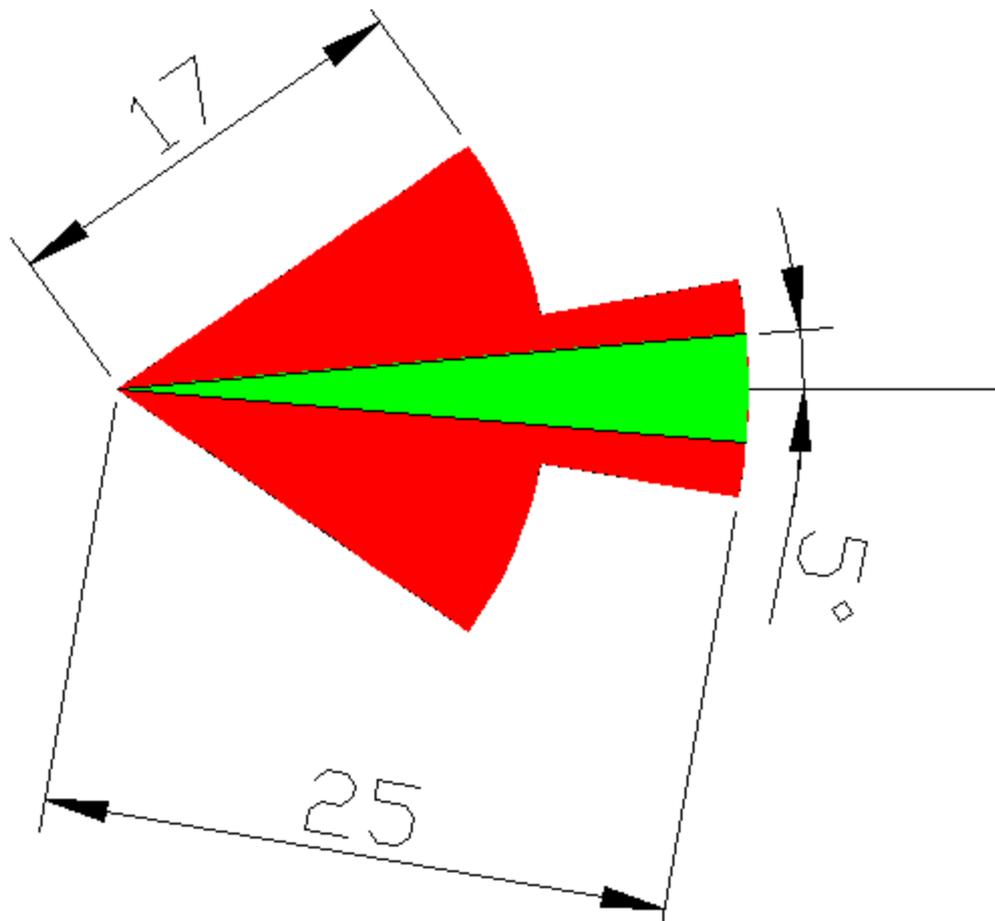of a ±15° Reduced/ Raised Coverage Localizer

- Signal reflections on a building in the Clearance domain, producing,

- Clearance / Clearance Interference and

- False courses measured by the flight check

Course Deviation Indicator versus azimuth angles.
0 uA on centerline, +150 uA = full scale deviation "fly right", -150 uA = full scale deviation "fly left"

0 uA: false courses

Course Deviation Indicator (DDM) in uA

Azimuth angle in degrees (referenced to centerline)

— Measured CDI of the initial situation ▬ ICAO recommendations

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Supporting Technical Validation
An Initial Restricted Coverage of +/- 5°

- Restriction of the operational coverage: +/- 5° at a range of 25 NM

- Outside +/- 5° , possible false courses

- The replacement project of the ILS 16 Zurich had to be launched

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Supporting Technical Validation
The Replacement Study

- The solution consists in:
  - reducing the incident signal on the building,
  - thus consequently reducing the reflected signal,
  - and finally the amplitude of the Clearance / Clearance interference.

- Reducing the Clearance incident signal means modifying the Clearance radiating antenna diagram.
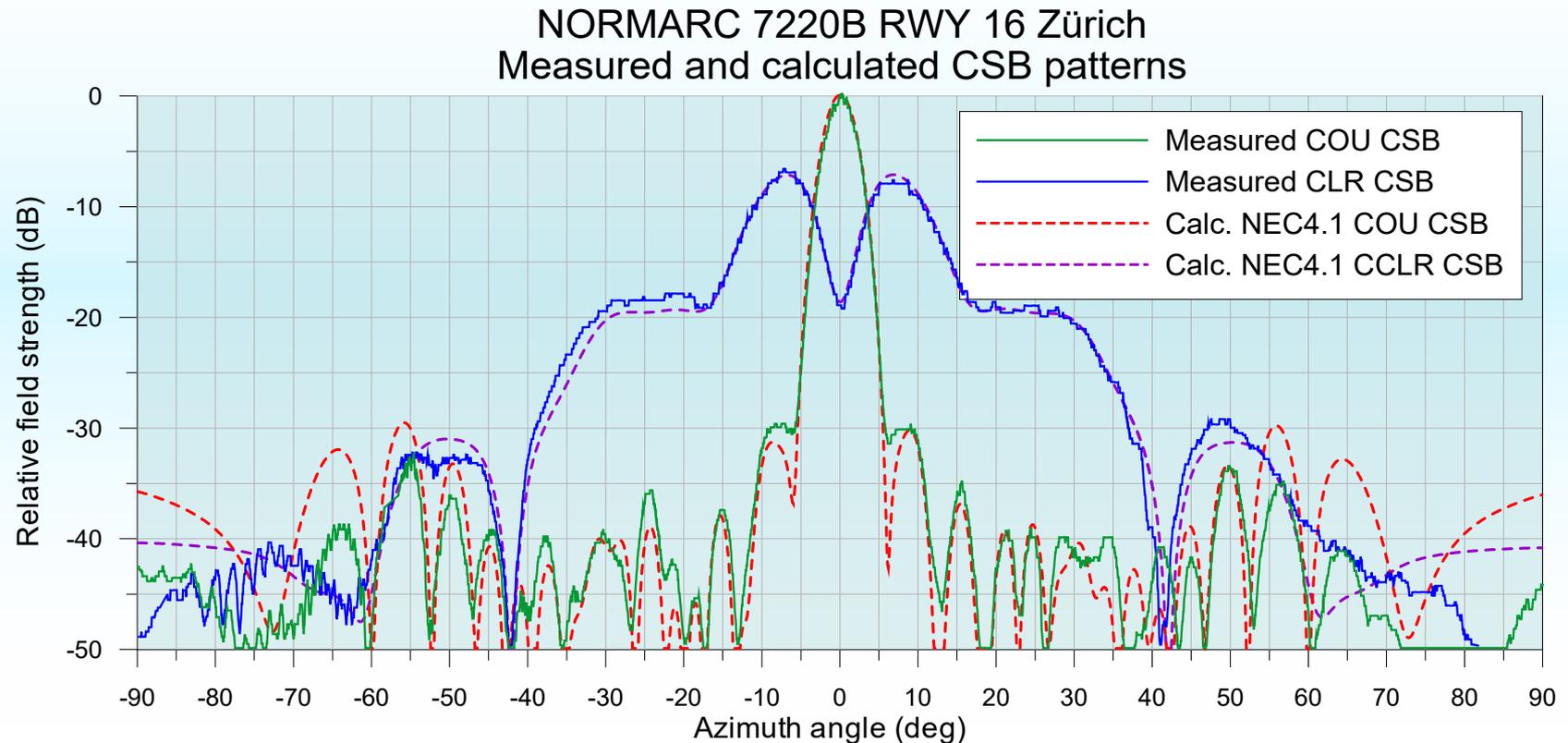
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Supporting Technical Validation
The Chosen System

- The reduced/raised coverage localizer at Zurich Airport Runway 16:

- The NM 7220B from Park Air Systems

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Supporting Technical Validation Flight Check Results. CSB Patterns

- Very good correlation between the measured and simulated CSB patterns

NORMARC 7220B RWY 16 Zürich
Measured and calculated CSB patterns

Evaluation, Design, Commissioning and Certification
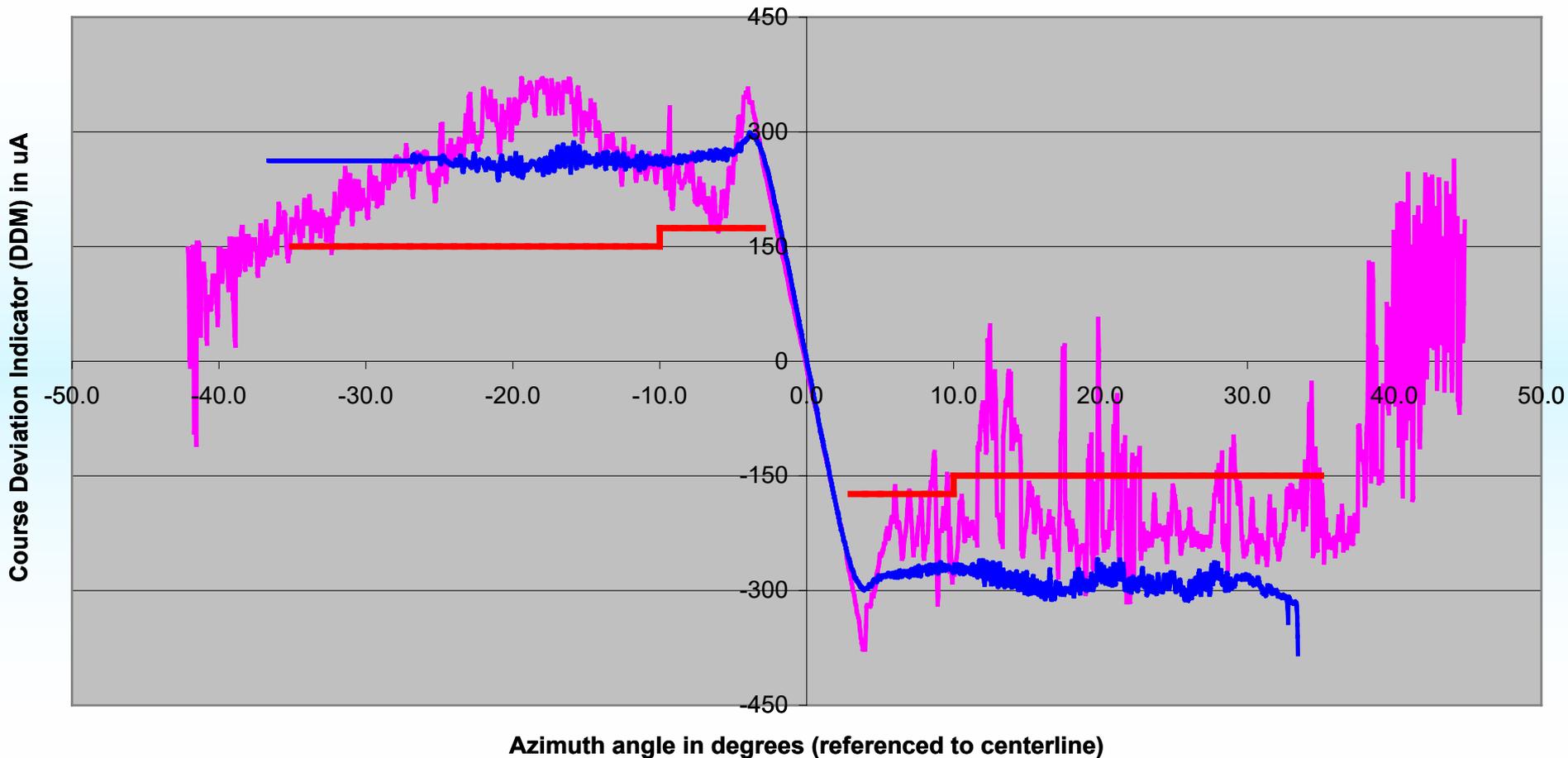of a ±15˚ Reduced/ Raised Coverage Localizer

Supporting Technical Validation
Flight Check Results. SBO Patterns

- Very good correlation between the measured and simulated SBO patterns

NORMARC 7220B RWY 16 Zürich
Measured and calculated SBO patterns
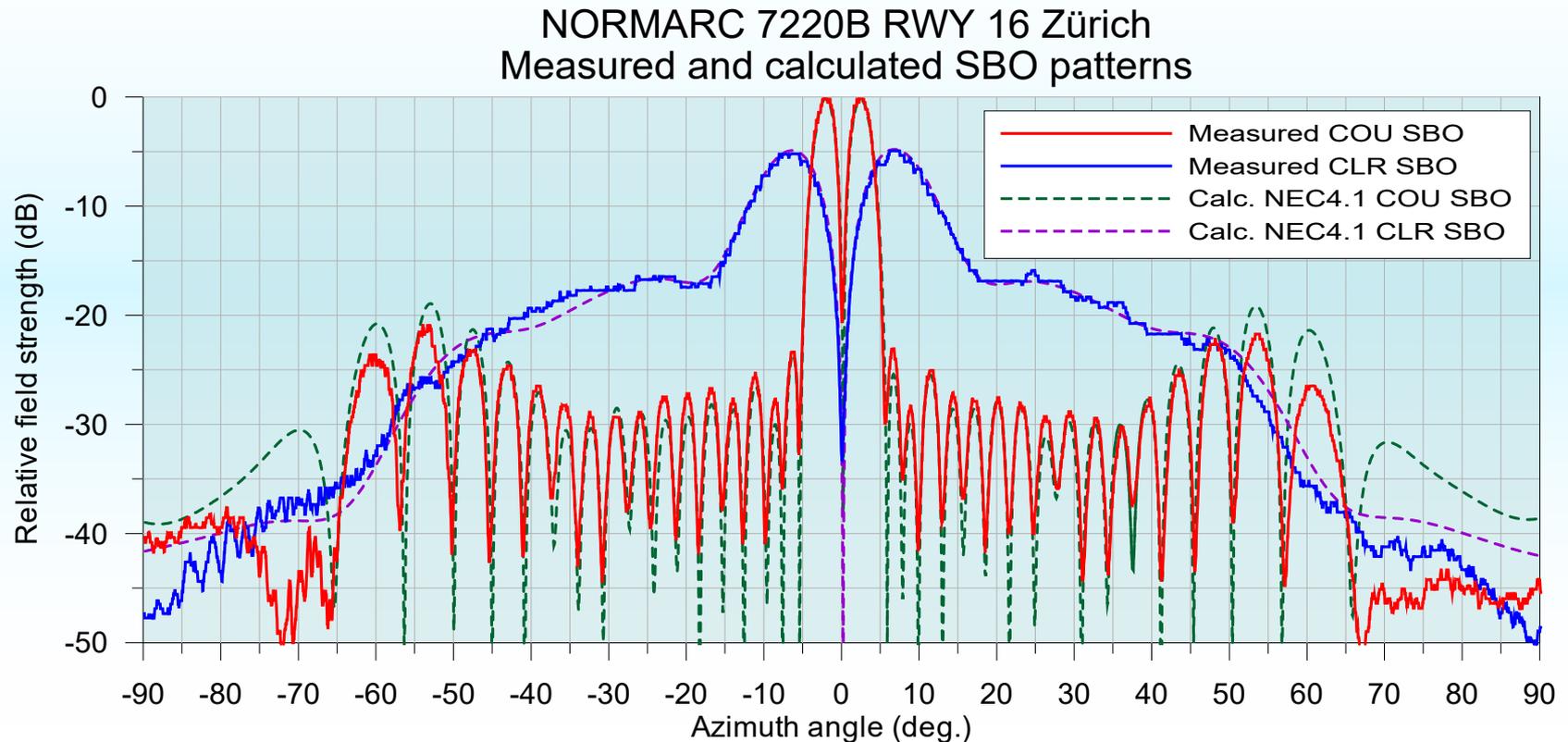
Supporting Technical Validation
Flight Check Results. DDM Profiles

- Comparison between the initial and final situations

Chart: Course Deviation Indicator (DDM) in uA vs. Azimuth angle in degrees (referenced to centerline)

Legend: Measured CDI of the initial situation — ICAO recommendations — Measured CDI of the final situation

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Supporting Technical Validation
Flight Check Results

RF-Level (in Blue), SDM (in Green) and DDM (in Auburn) Profiles of the Reduced Coverage System at a Range of 17 NM

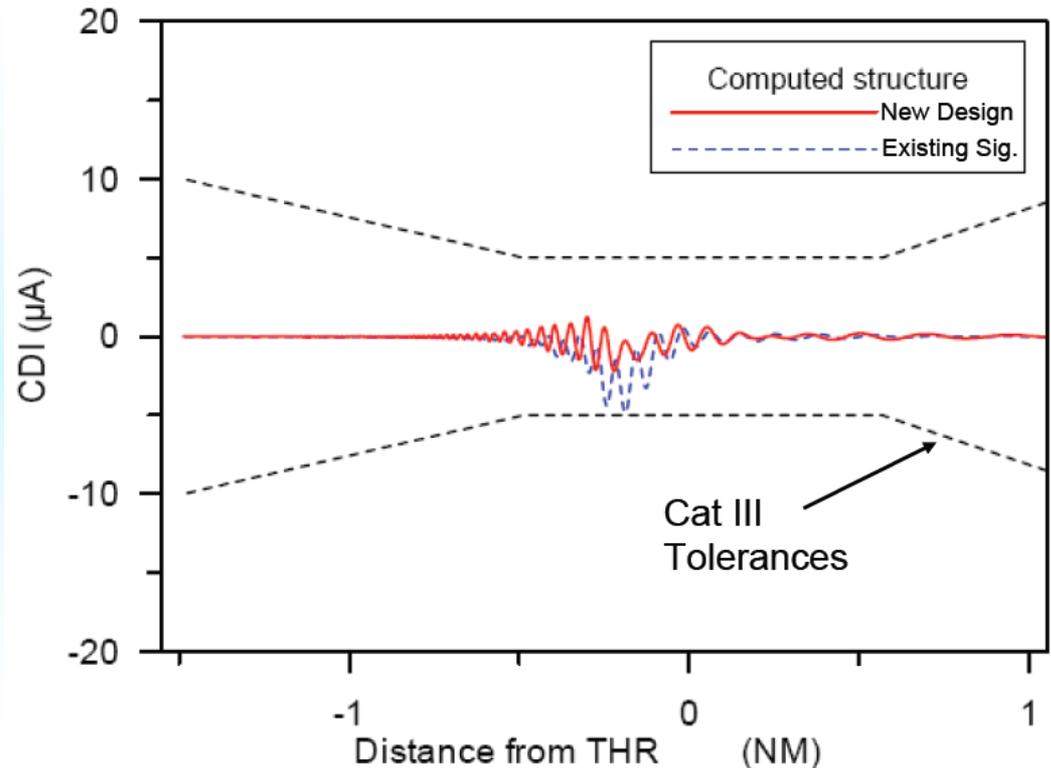**The problem is solved: no more false course.**
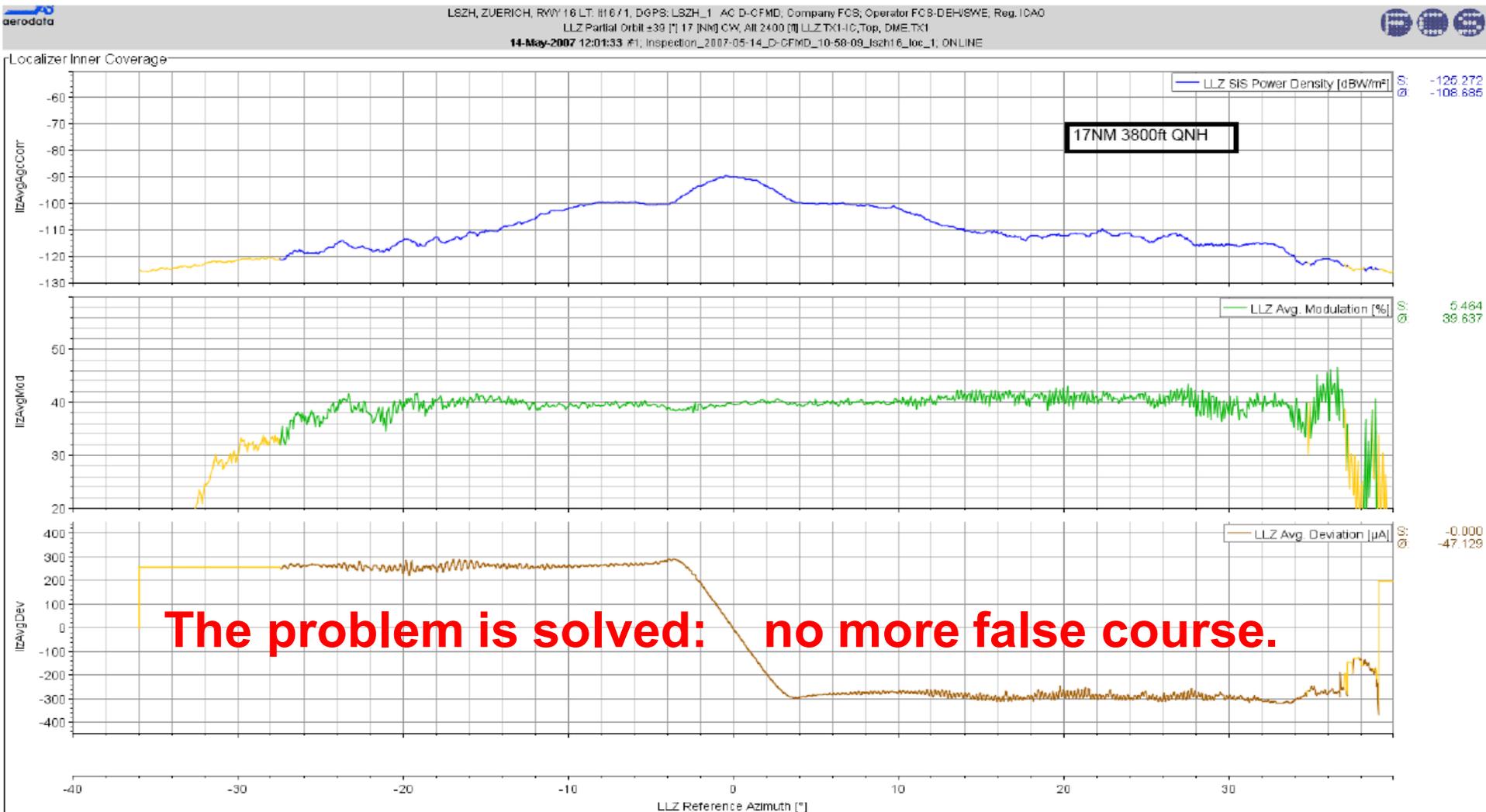
Supporting Technical Validation Flight Check Results. IDENT

- By flying the standard and published IFR approach procedures, the "flyability" of the standard interception and the availability of the IDENT have been assessed

- The IDENT is receivable and useable if the line of sight conditions (i.e. no screening effects due to topographic obstacle) are respected

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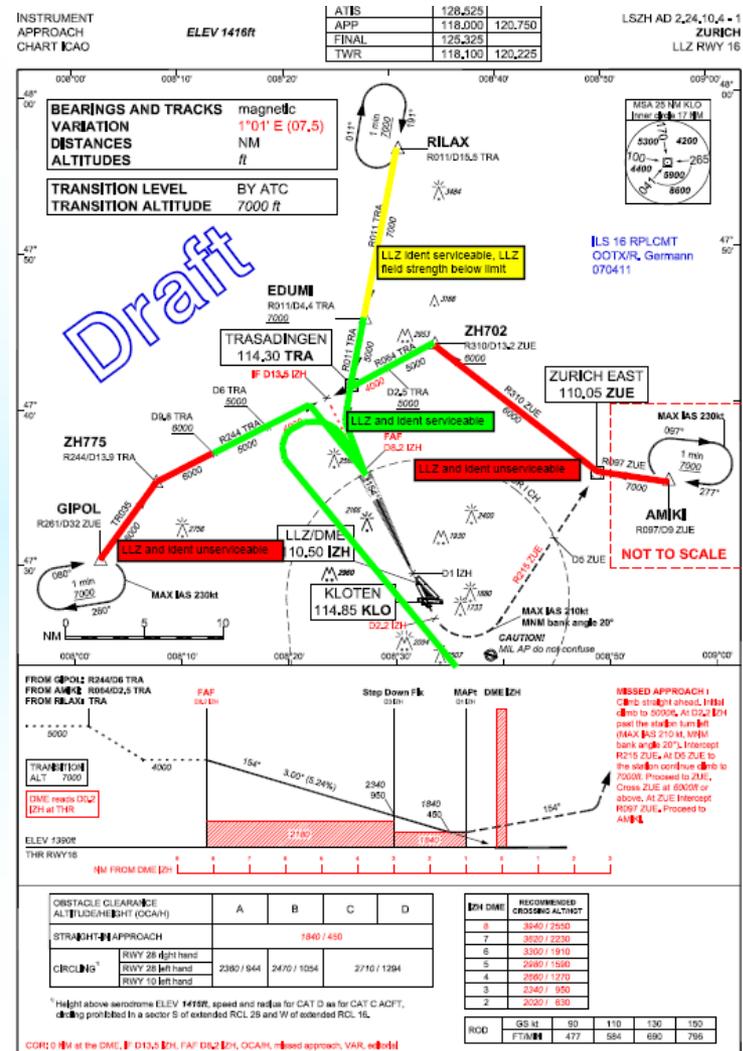
Clearance – Course Benefits Simulation

- Most critical hangars or buildings tend to be near 12 to 15° from LOC C/L

- New clearance design shifts clearance peak inward to $\pm$7-8°

- Achievable improvement at one difficult site was demonstrated through site-survey and simulation

Evaluation, Design, Commissioning and Certification
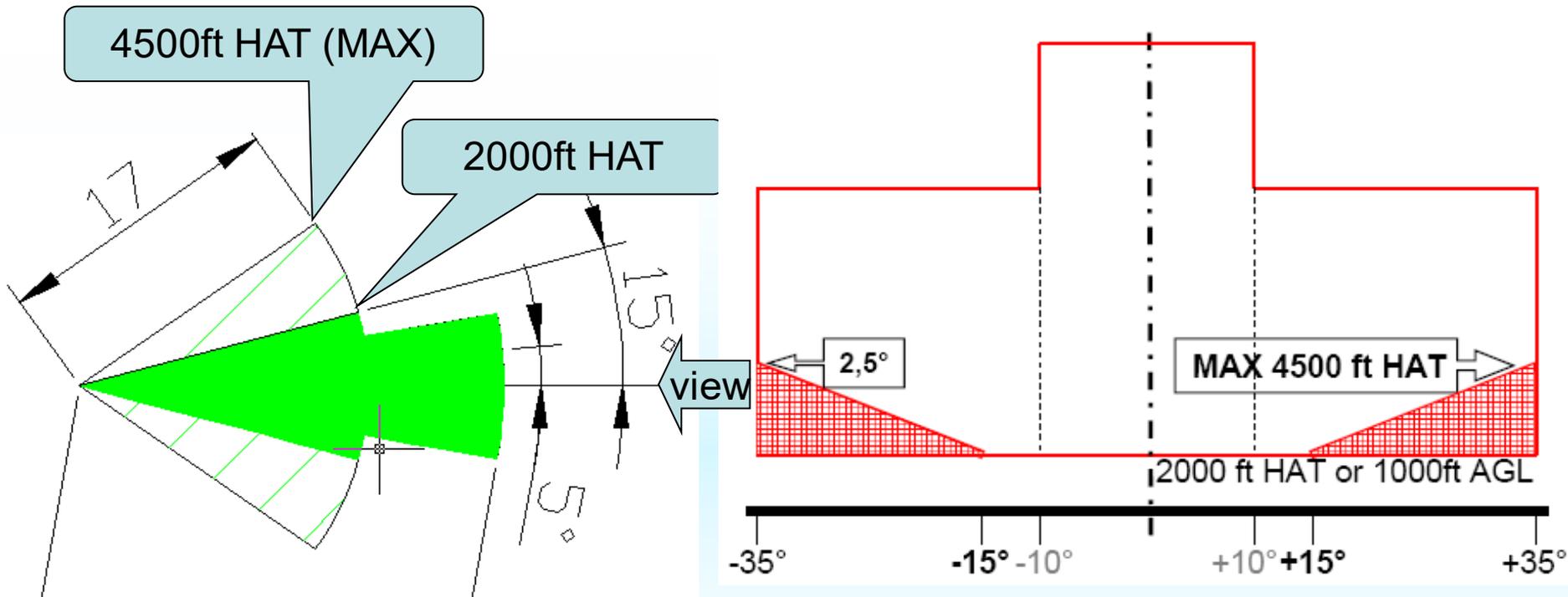of a $\pm$15° Reduced/ Raised Coverage Localizer

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ICAO Standardization (1/2)

- Current "Solutions" in difficult requirements typically just limit declared coverage
  - No solutions by design (until now)
  - Coverage requirements restrain operationally optimal solution (best coverage where needed)
  - Relaxation of angular limits rejected due to various concerns
- Alternative:
  - Relaxation of lower coverage boundary up to limit
  - *If operational requirements permit*
    - Instrument Flight Procedure needs to be supported
    - Minimum vectoring altitudes only in line with *lowest operational use* (e.g., can be higher, depending on local practice)
    - Does not work everywhere, but more so with use of CDA
- Coordinated with ICAO OPS Panel, NSP agreement sought by fall 2008 (published amendment ca. 2010)

ICAO Standardization (2/2)

4500ft HAT (MAX)

2000ft HAT

17

15°

5°

view

2,5°

MAX 4500 ft HAT

2000 ft HAT or 1000ft AGL

-35°   -15° -10°   +10° **+15°**   +35°

- Current proposal as *preferred version* of reduced / raised lower coverage
- New guidance seeks to foster dialogue between operational and technical ANSP staff

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Conclusions (1/2)

- The $\pm 15°$ Reduced/Raised Coverage Localizer has solved the Clearance / Clearance interference on a difficult site: Zurich RWY 16.

- The operational and technical experience accumulated has demonstrated that it has been used and operated like any other conventional system.

Conclusions (2/2)

- It can also solve Course / Clearance interference in case of a bad course structure caused by Clearance reflections on obstacles located outside the $\pm 15°$ region (or even $\pm 12°$)

- It represents a major safety improvement compared to conventional ILS with coverage restrictions.

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Thanks for your attention

Any questions?