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A Flight Procedure Design Method for RNP to xLS with Shallow Segment

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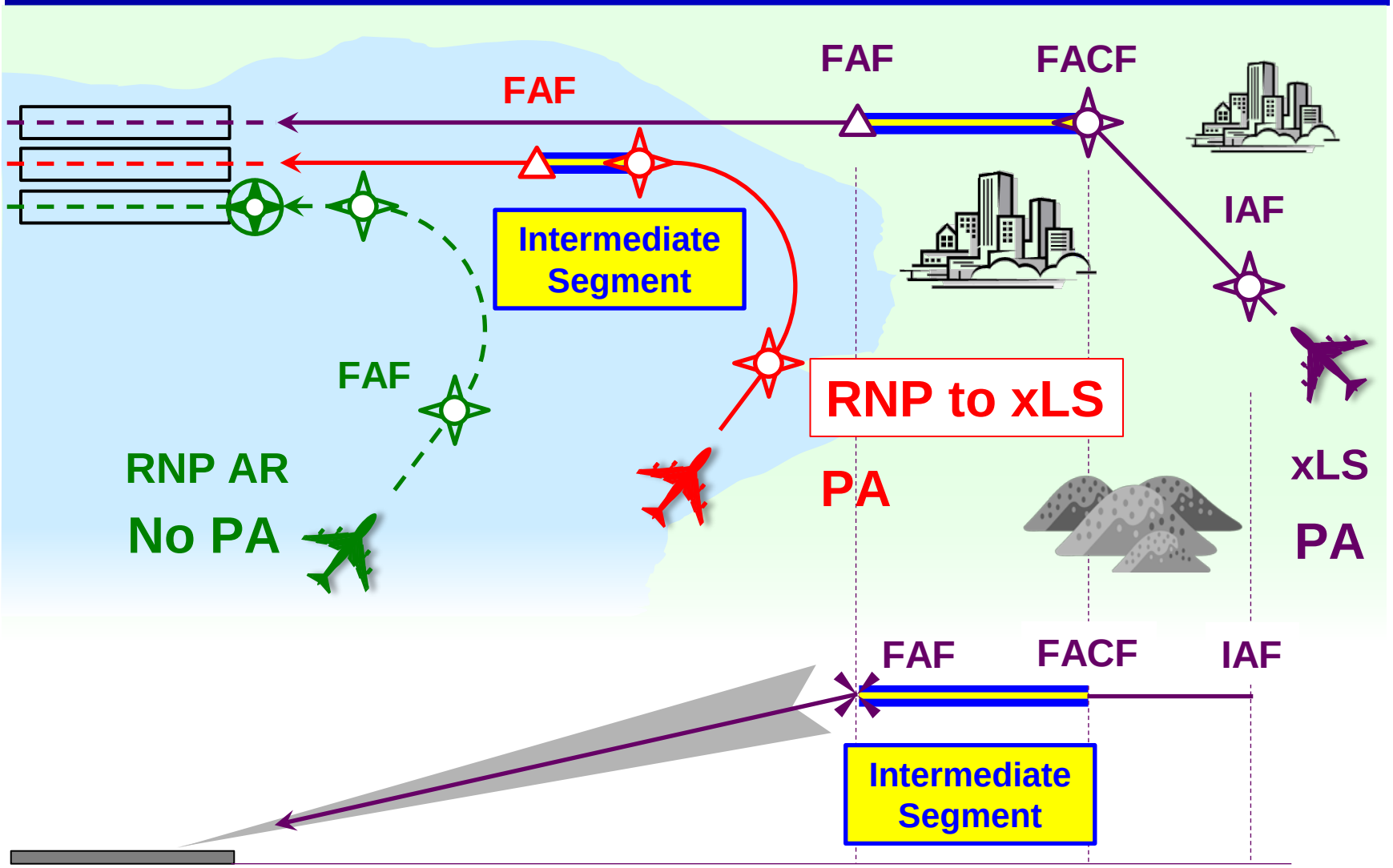
Outline

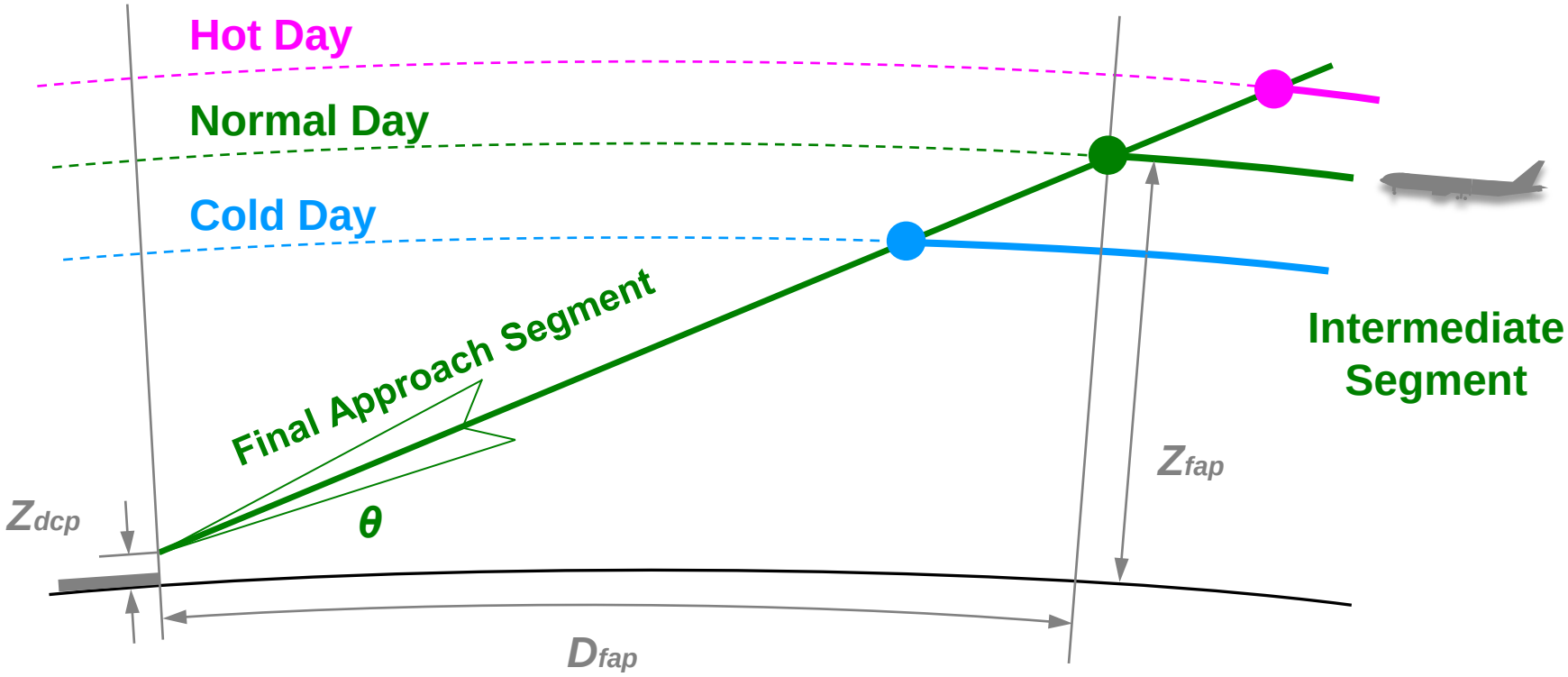
1. Background
2. “RNP to xLS” Procedure Design Assumption & Method
3. Full-Flight Simulator Trials
4. Summary

1. Advantage of RNP to xLS



1. Glideslope Intercept Altitude

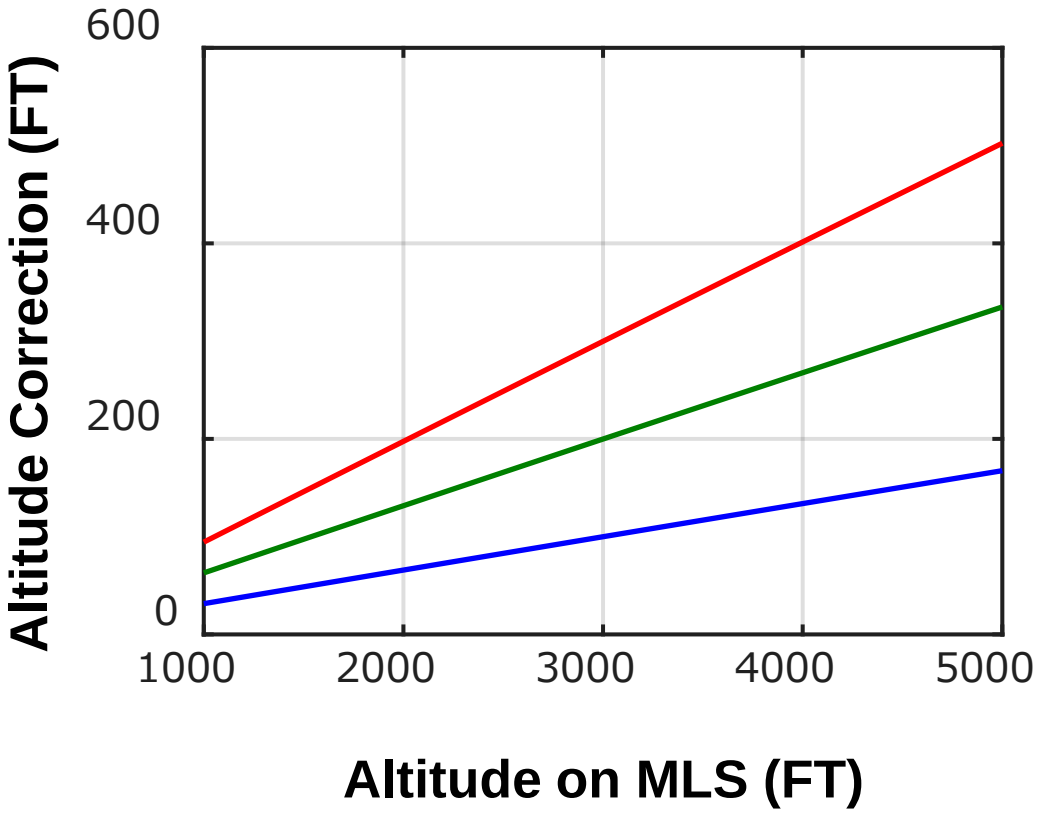
- **Intermediate Segment used barometric altitude while final approach segment depends on geometric altitude.**



1. Temperature Correction

International Standard Atmosphere (ISA)

Temp 15°C at Mean Sea Level, Lapse rate ~ –2°C per 1,000 ft



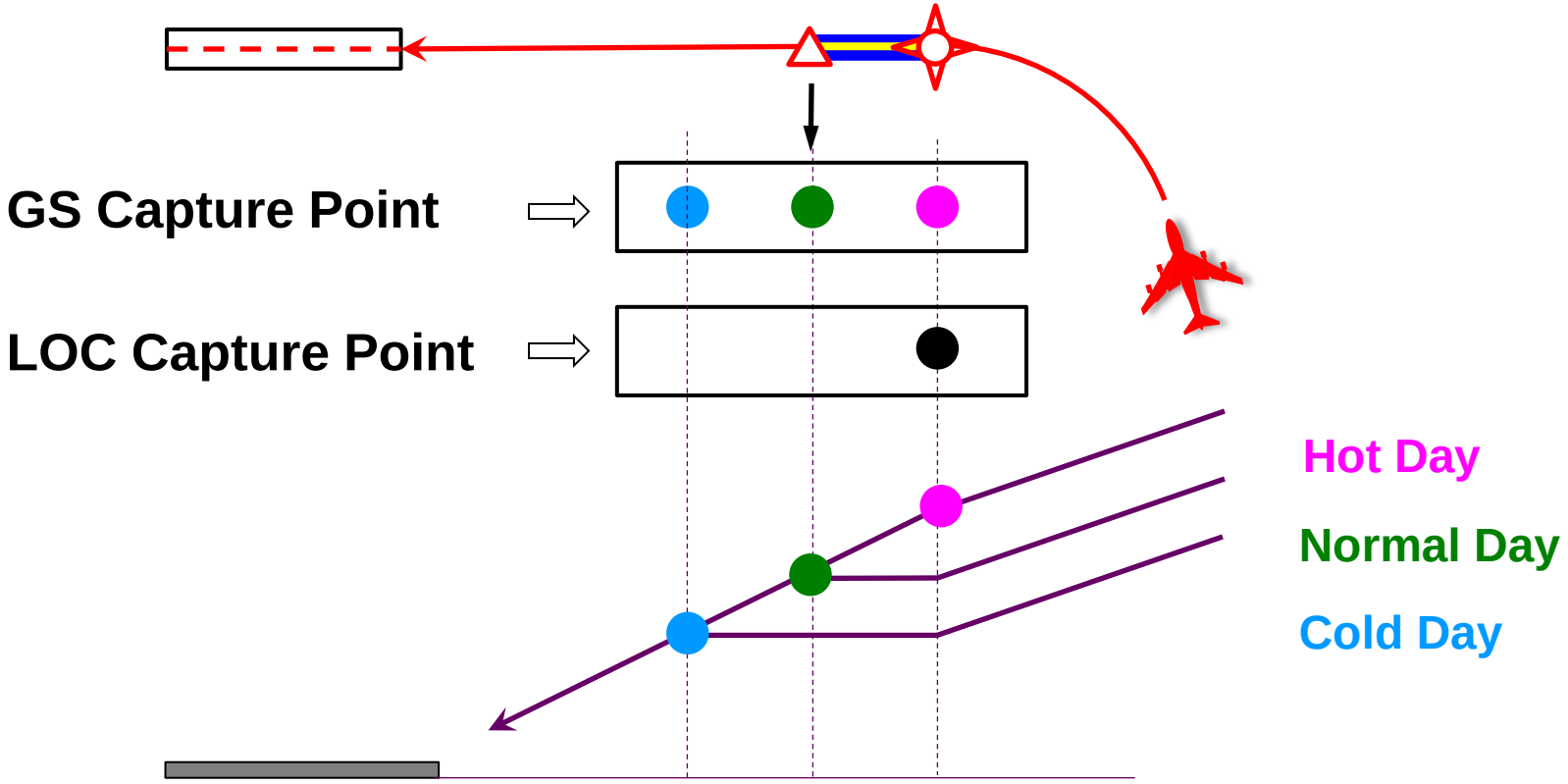
ΔISA = 30°C 10.2 %

ΔISA = 20°C 6.8 %

ΔISA = 10°C 3.4 %

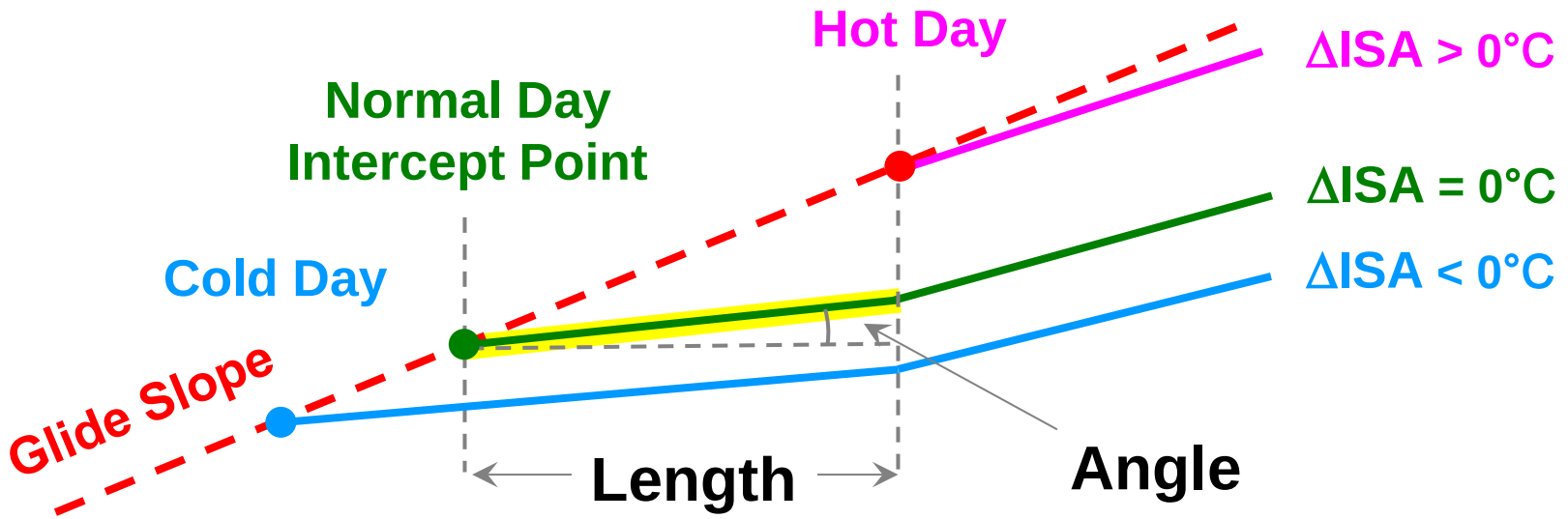
1. Difficulty of Procedure Design

- **GS should be captured after capturing LOC.**
  - ✓ **For short intermediate design, GS capture may happen before LOC capture.**



1. Shallow segment

- **FAA PARC reported RNP to xLS procedure design using Shallow Intermediate Segments**
  - Improving flight efficiency: Long level segment decrease it.
  - Considering capture condition and guideline.



Discussing more detail, and optimum design method

2. Assumption of procedure design

1. ARINC 424 compliance

424-19 (2008)

- "All such approach procedures **must begin at the FACF**"
- "The rules of coding GLS approach procedure are understood to be identical to those of LOC coding"

424-20 (2011)

- "The final approach coding of **GLS** instrument approach procedures **does not require the coding of a FACF** waypoint"

ARINC 424-19 specification are supposed

All type of aircraft does not support 424-20

2. Hottest day temperature ⇨ ΔISA = 30°C 113°F MSL

2. Assumption of procedure design

3. Glideslope & Localizer capture timing

Type A aircraft allows Glideslope capture before Localizer capture	**Type B aircraft inhibits Glideslope capture before Localizer capture**

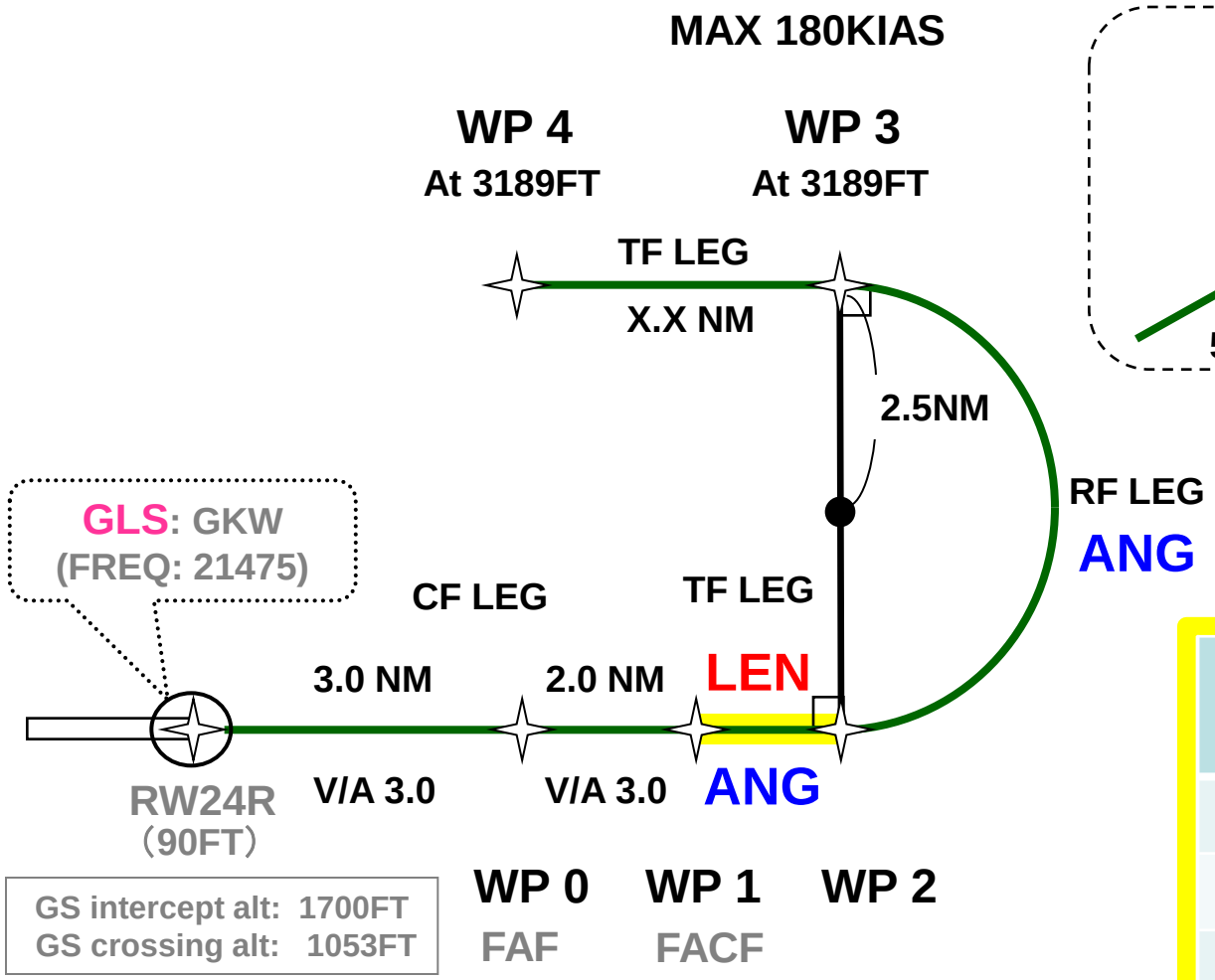
Type A aircraft are supposed ⇦ Critical

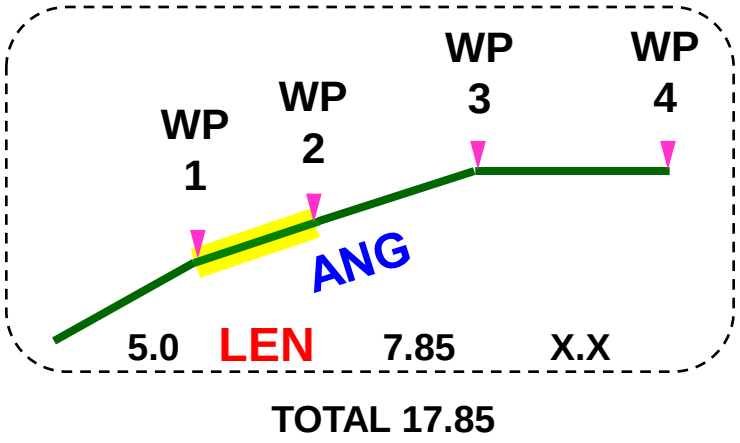
4. Glideslope pointer exceed one dot

Pilots need a buffer for pushing APP switch

5. Glideslope capture boundary ⇨ a half dot

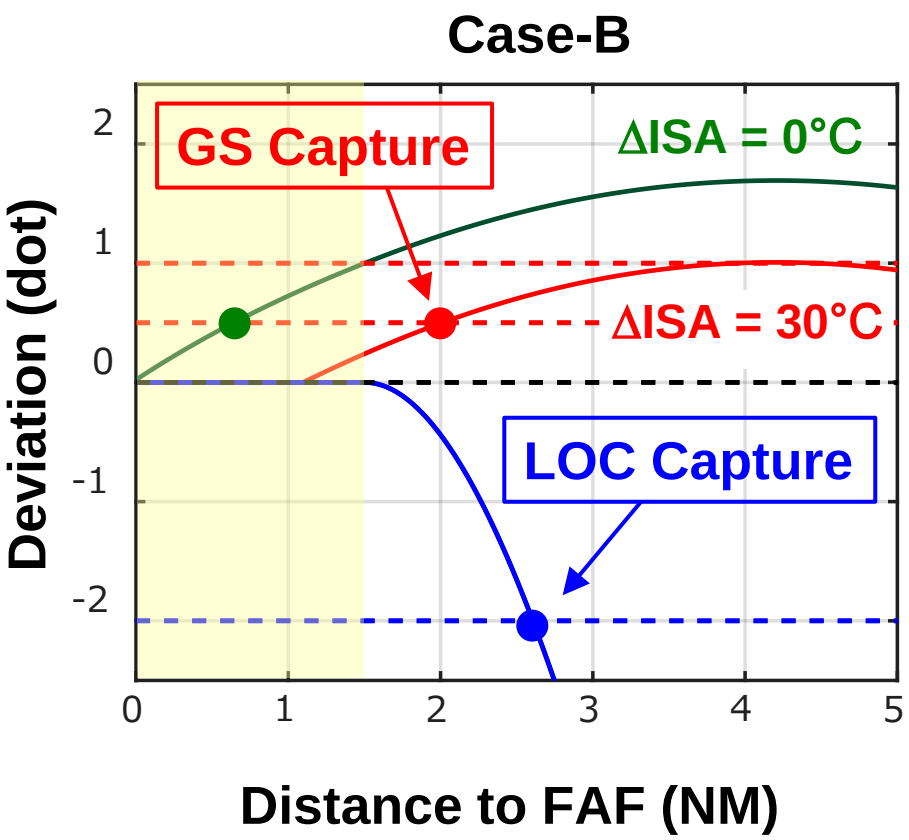
2. Procedure design

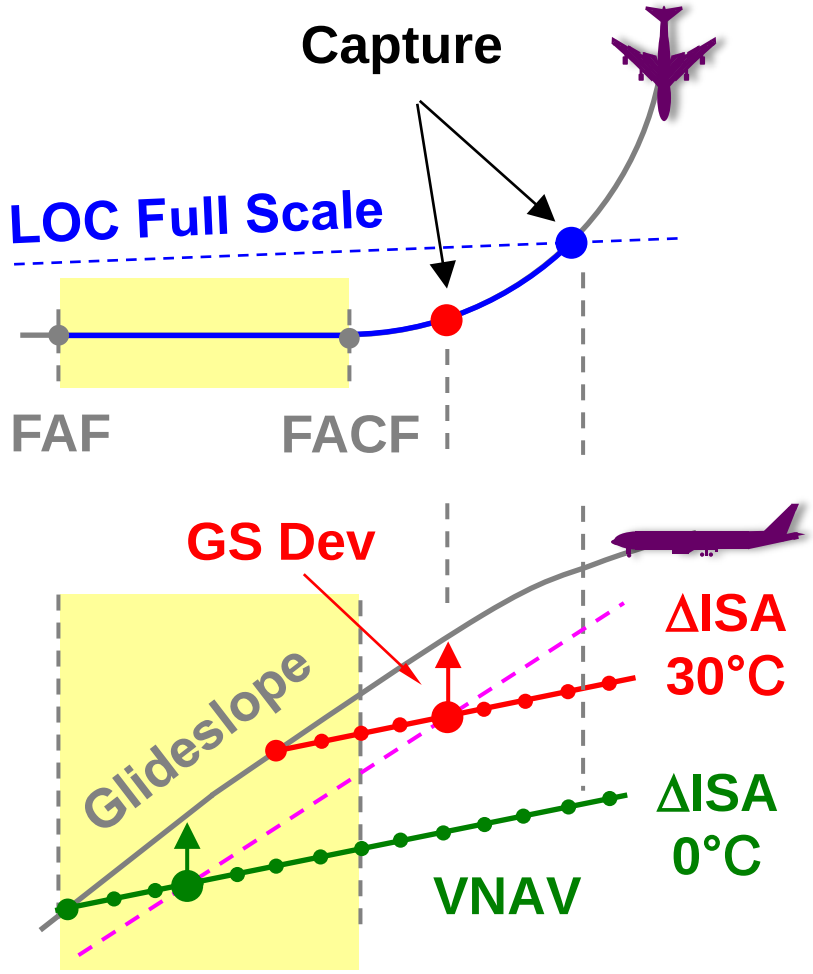




	LEN (NM)	ANG (deg)
A	1.0	1.4
B	1.5	1.5
C	2.0	1.6

2. Deviation & Capture points





2. Calculation of ANGmax

Iteration Algorithm

Given LEN, others

ANG = ANG + Δ

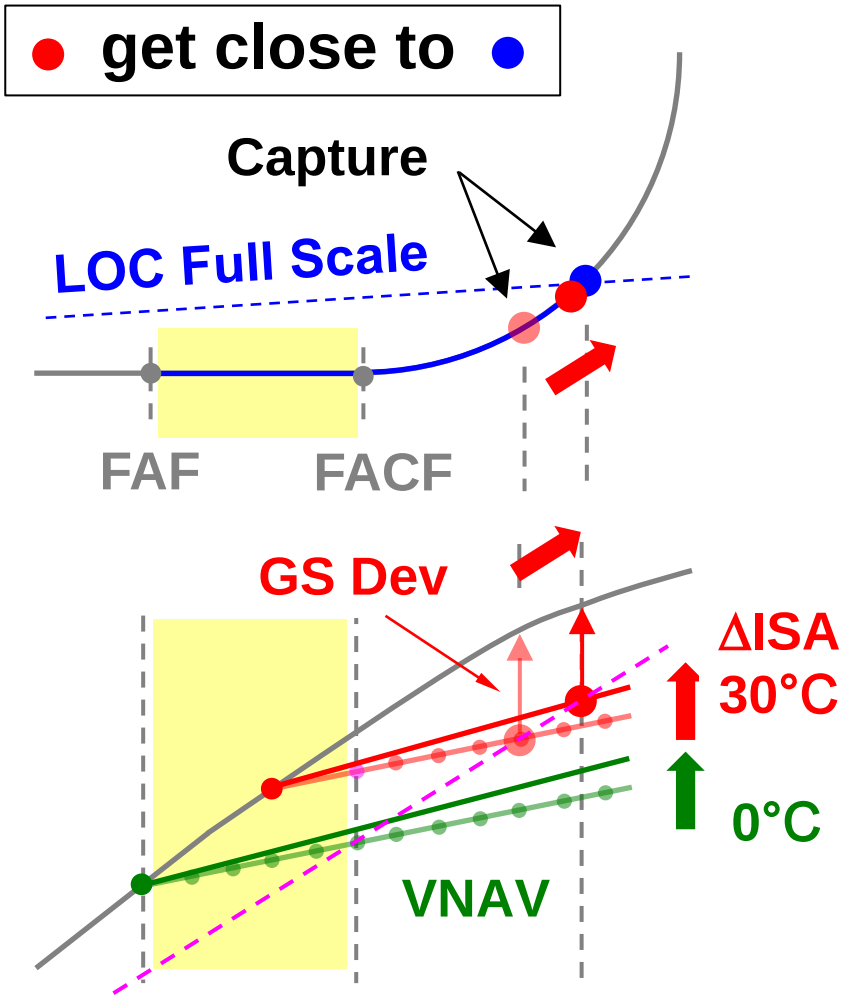
Calc

FAA ORDER 8260.58A, PANS-OPS

IF dist(●) < dist(●)
& Max GS > 1.0 dot

Output ANGmax

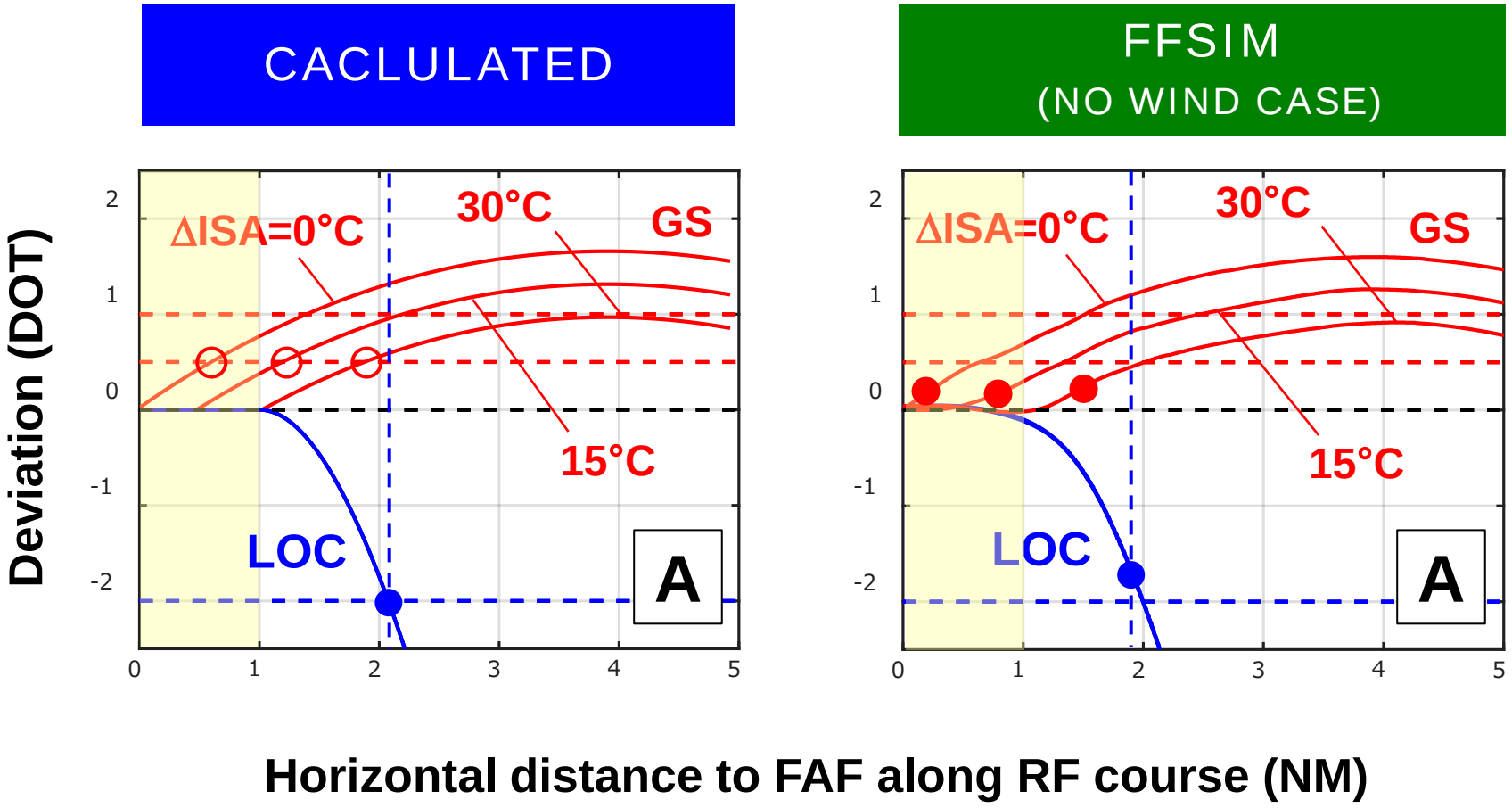
dist (●) : distance along RF to ● from FAF



3. Simulator Trials

- Standard procedures based on **ARINC 424** specification were coded by NAV database provider
- FMS vender checked the database quality, and converted to FMS loadable database
- Flight simulations with **variable temp** were conducted in ANA flight training center

3. Comparison with FFSIM

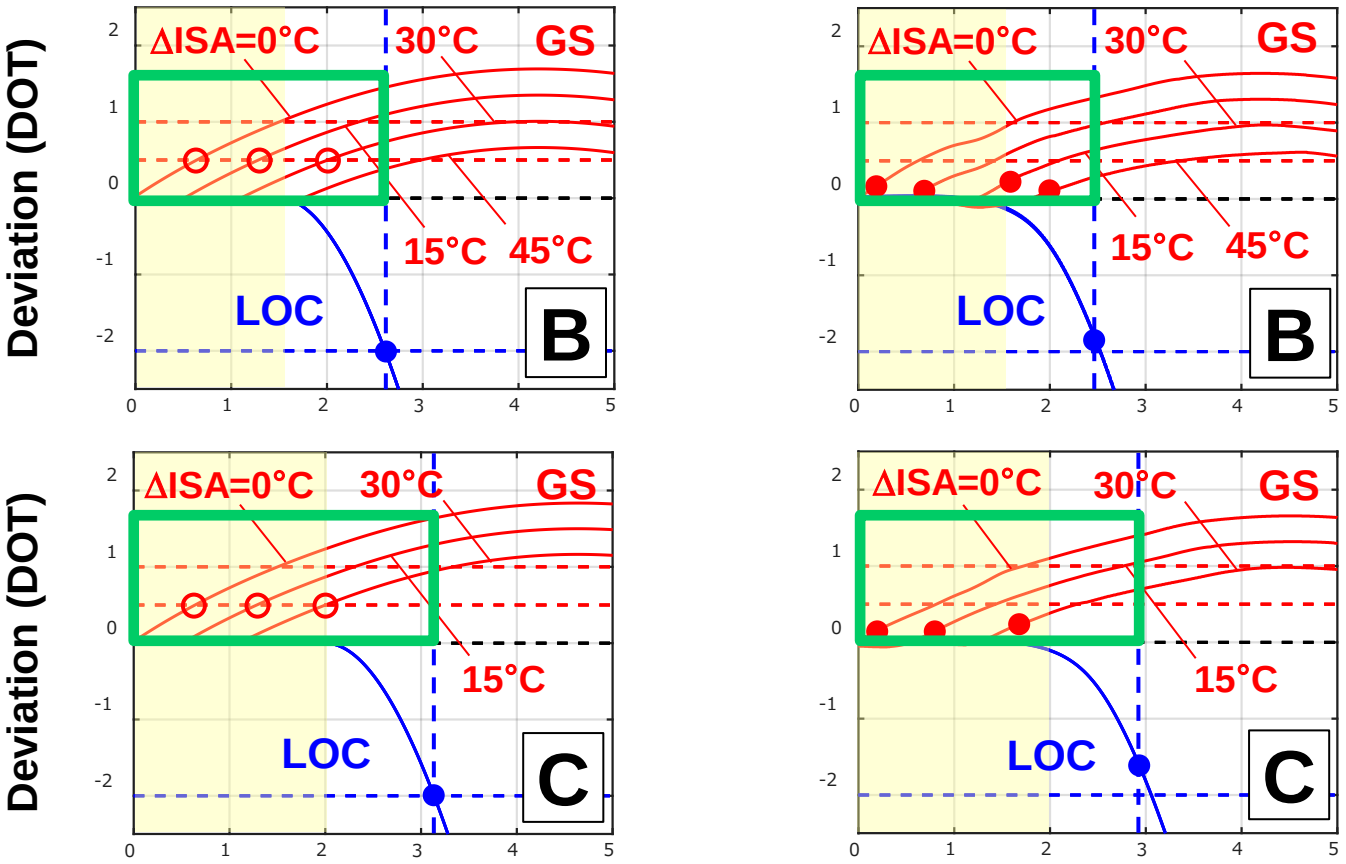


Horizontal distance to FAF along RF course (NM)

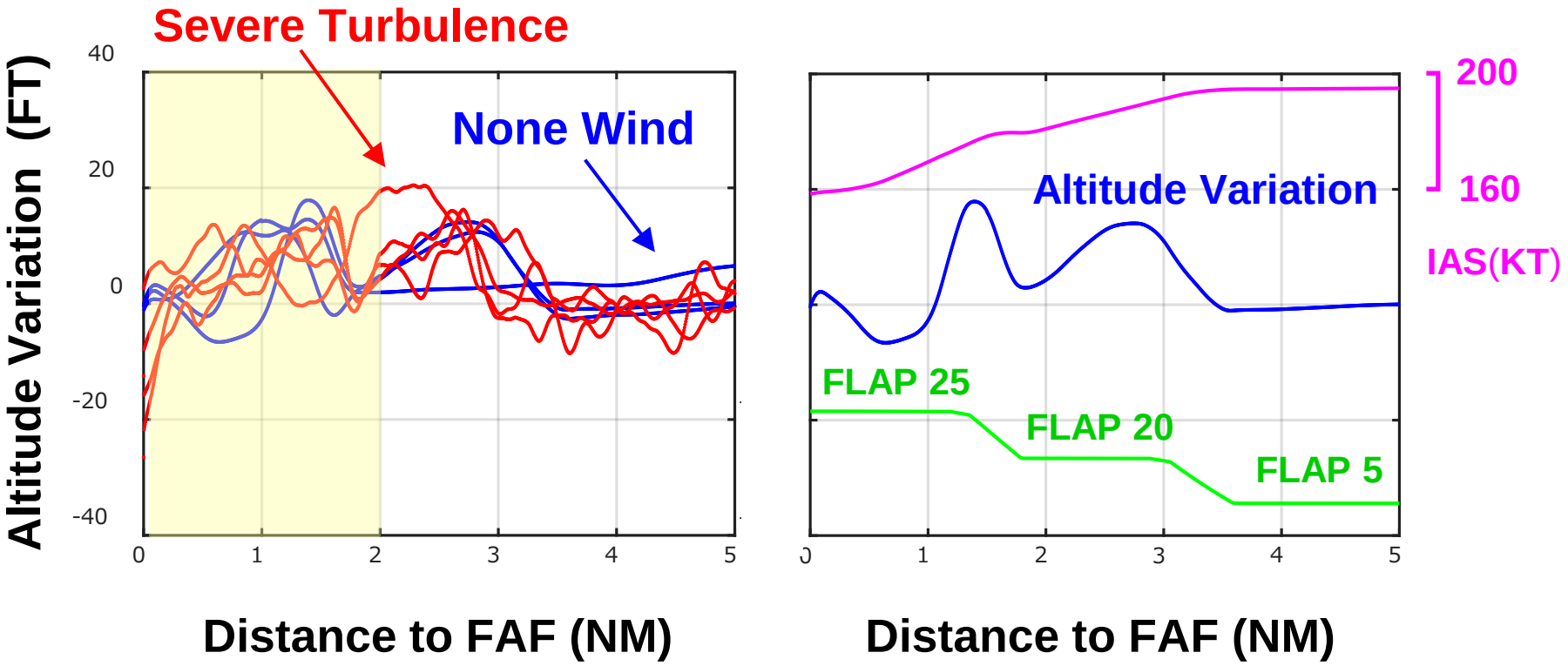
3. Comparison with FFSIM

CACLULATED

FFSIM
(NO WIND CASE)

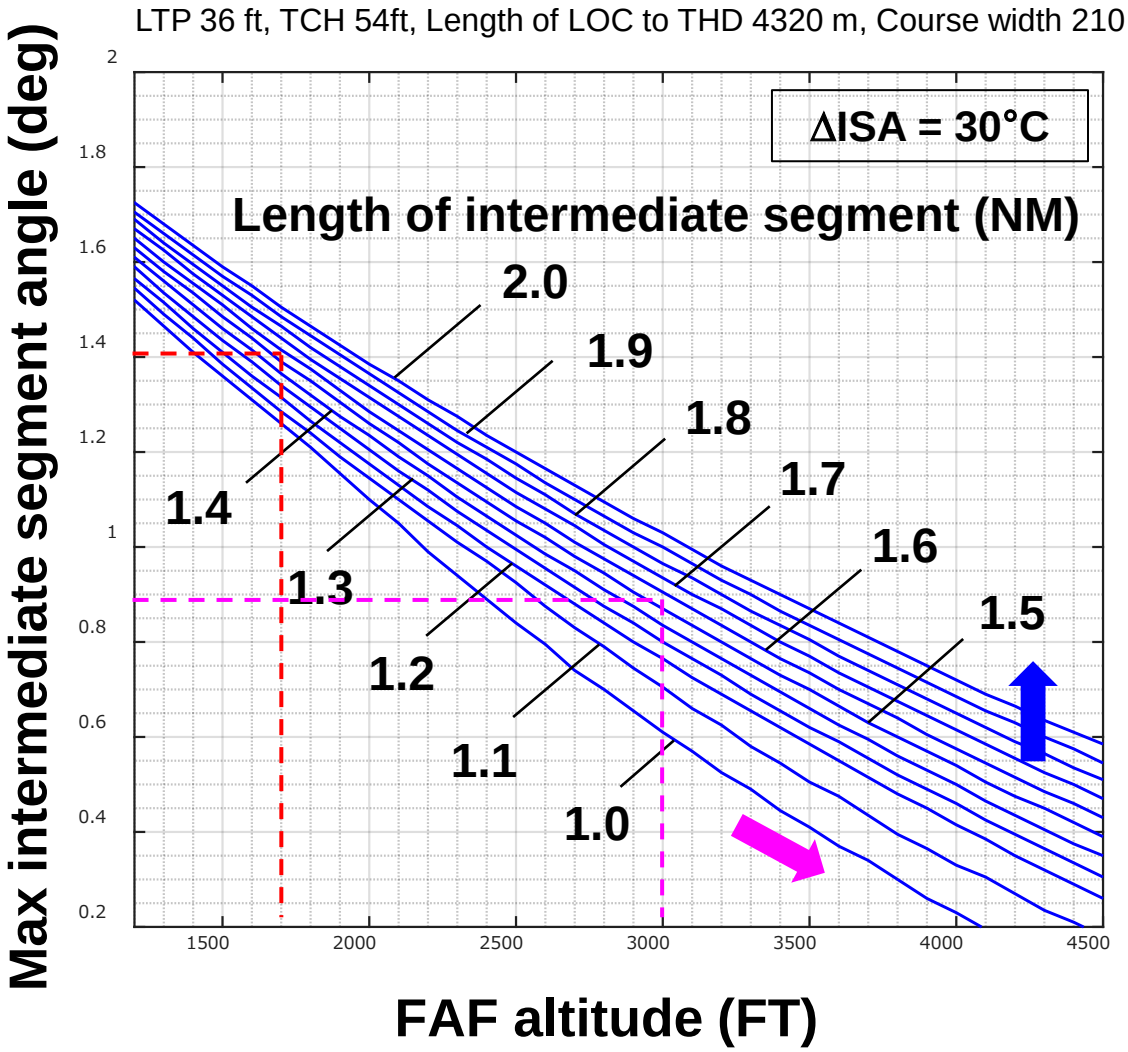


3. Altitude Variation before FAF



- **Altitude Variation is affected by the Flap Extension, and not exceed +20 FT even severe turbulence condition**

4. Intermediate LEN .vs. ANG



Additional assumption
By FFSIM experiments

+50FT (20FT + Margin)

- **Direct Proportion**
  LEN .vs. ANG
- **Inverse Proportion**
  FAF ALT. vs. ANG

5. Summary

- Development of RNP to xLS procedures with shallow intermediate segment were discussed
- The design method of shallow intermediate segments were proposed based on the assumptions
- Full flight simulator trials confirmed that the method enables to design procedure even in the high temperature condition
- Findings also revealed altitude variations required a buffer
- The revised algorithm will enable the development of the procedures design criteria

Thank you for your attention !

Quoted from :

Sonosuke Fukushima, Ryota Mori, Shinji Saitoh,

"*Geometric Approach for RNP Transition to xLS Procedure Design,*"

36th Digital Avionics Systems Conference, Sept. 2017.