RESEARCH ON ADVANCED DISPLAYS FOR SELF-SEPARATION AND SEQUENCING AT NON-TOWERED AIRPORTS

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Paul Snow	Mind's Eye Visualizations
Keith W. Alter	NAV3D Corporation
Louis Williams	RTI International

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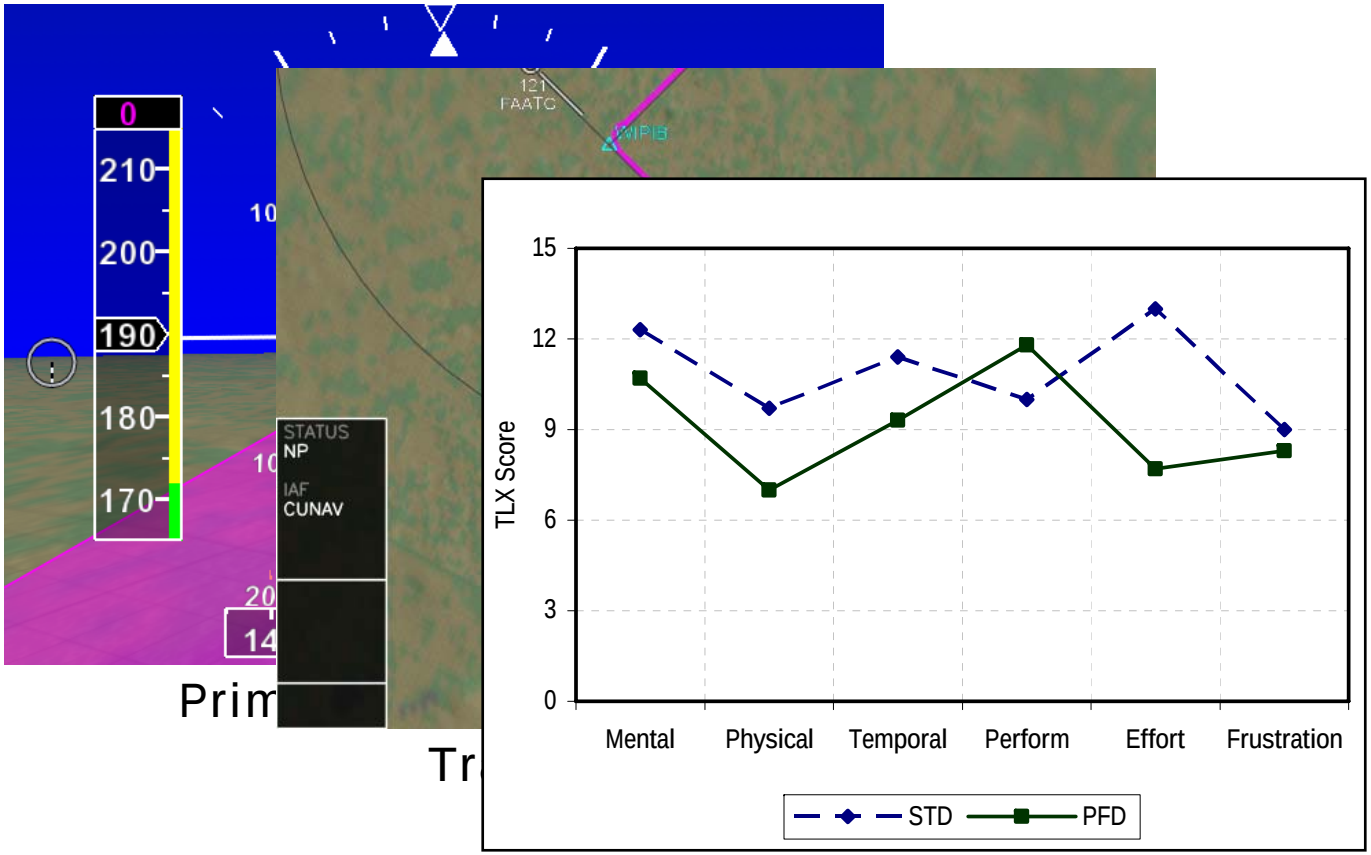
Presentation Outline



Prim

Tr

Experimental Results

Primary Flight Display

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6. 6. 2005

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20

Traffic Situation Display

Map View

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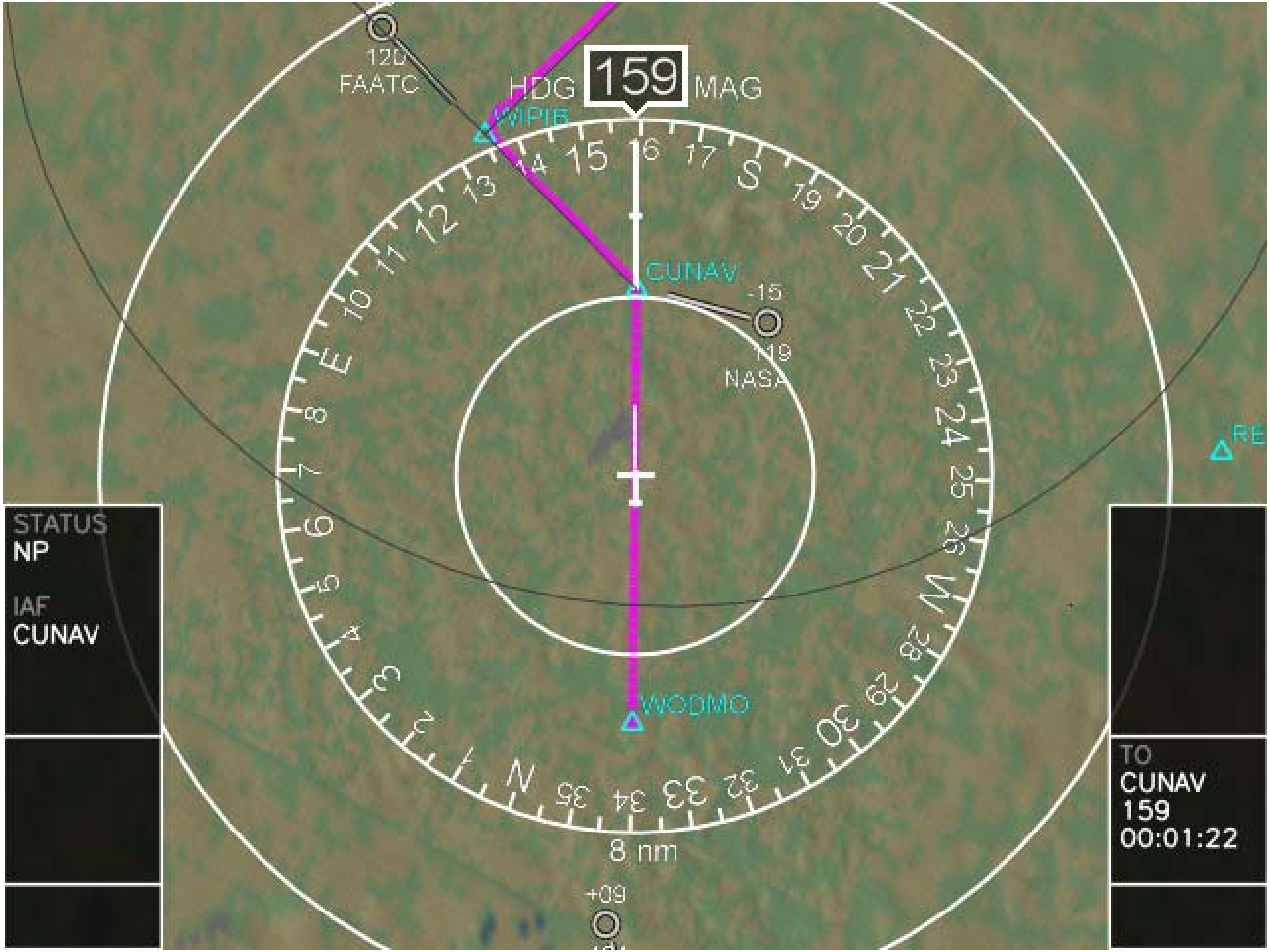

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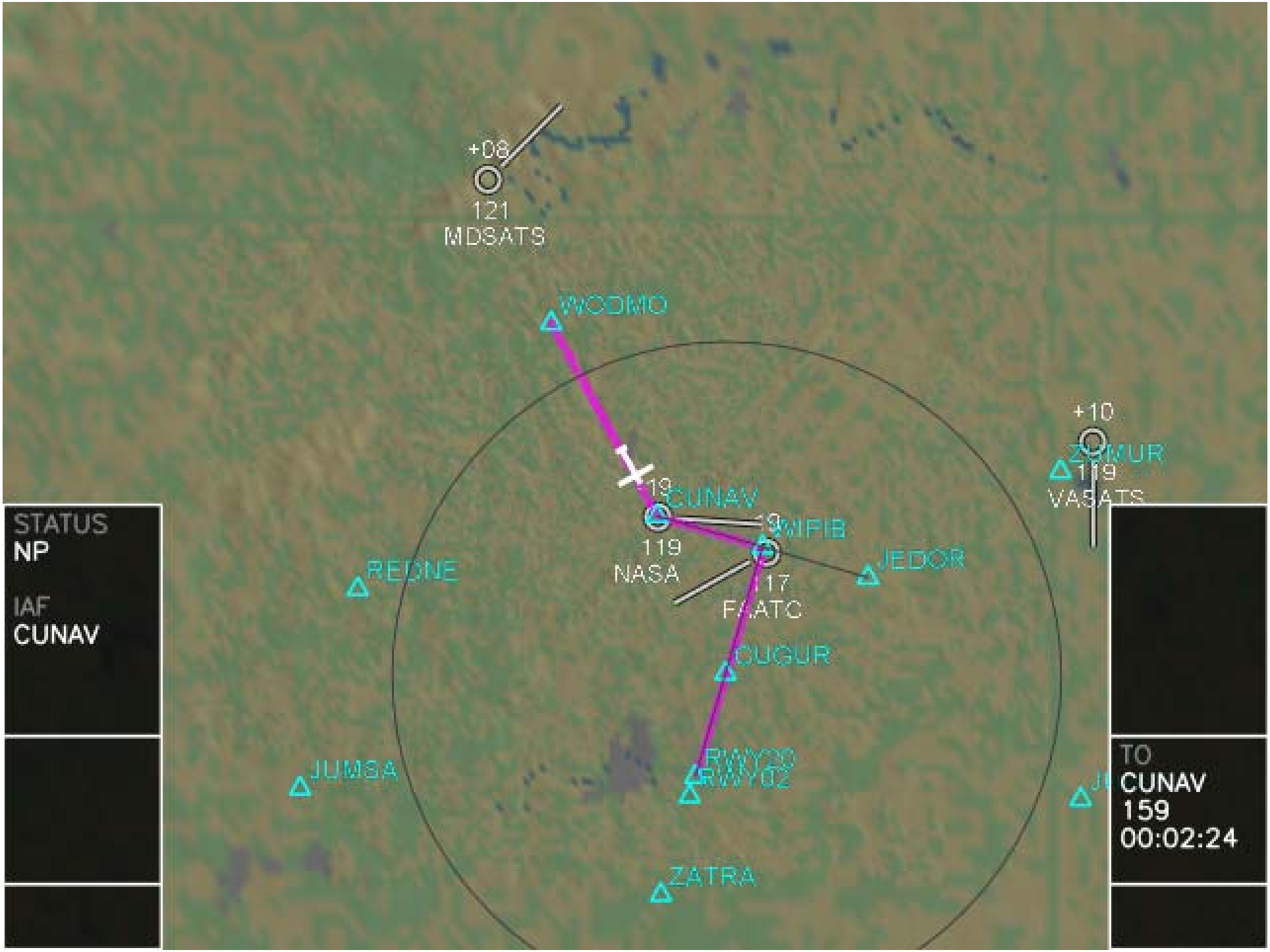
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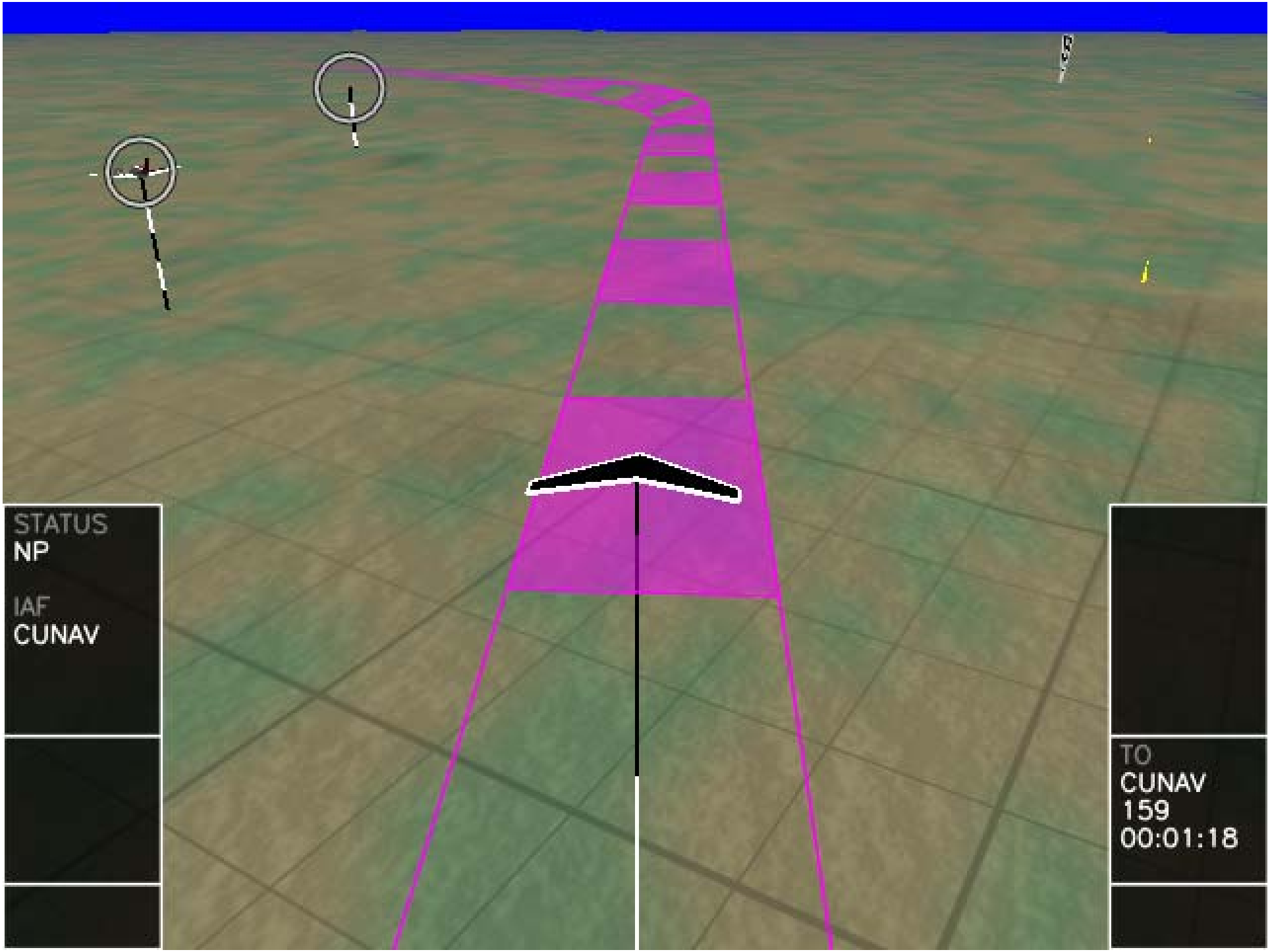
Exocentric View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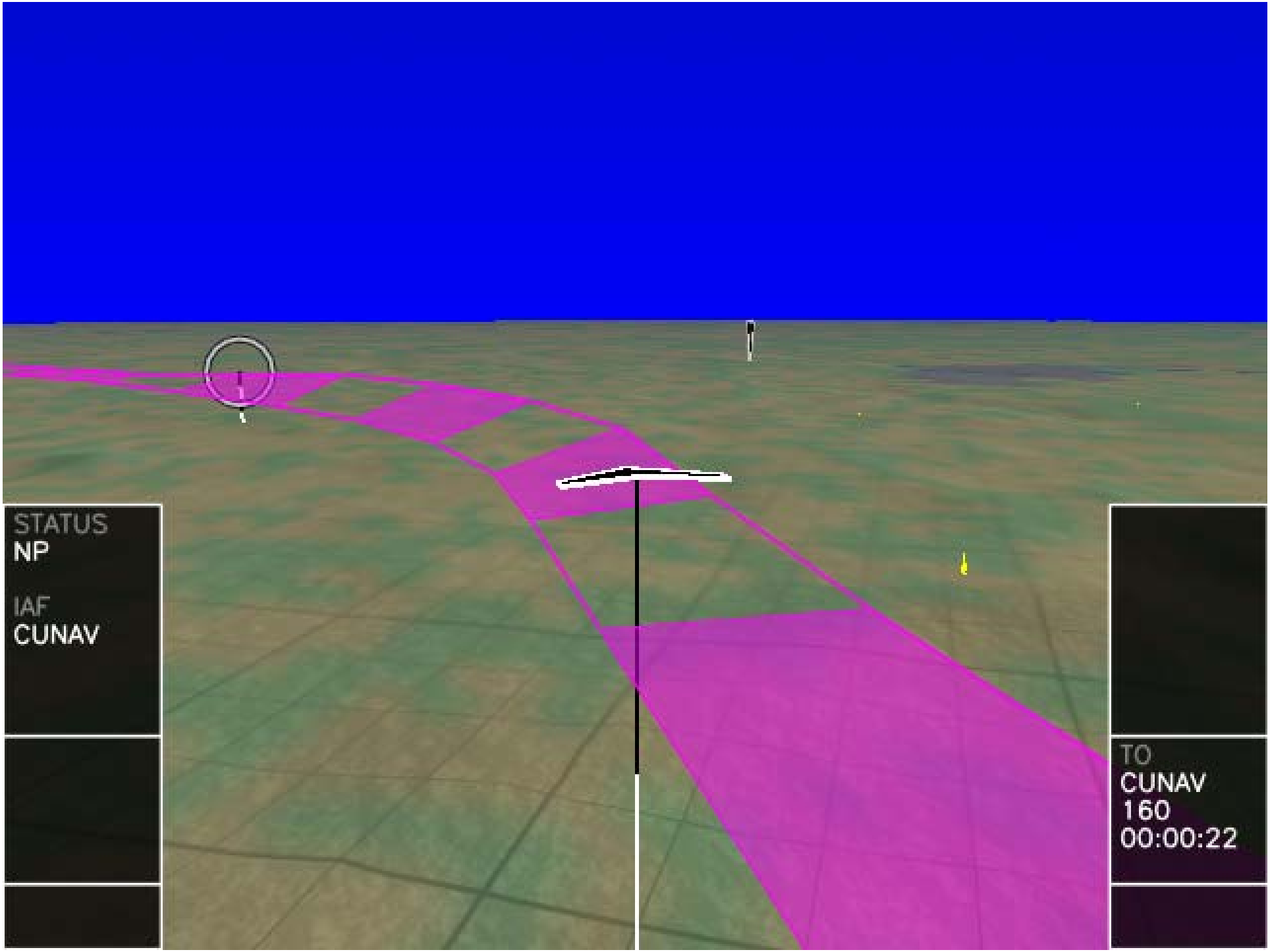
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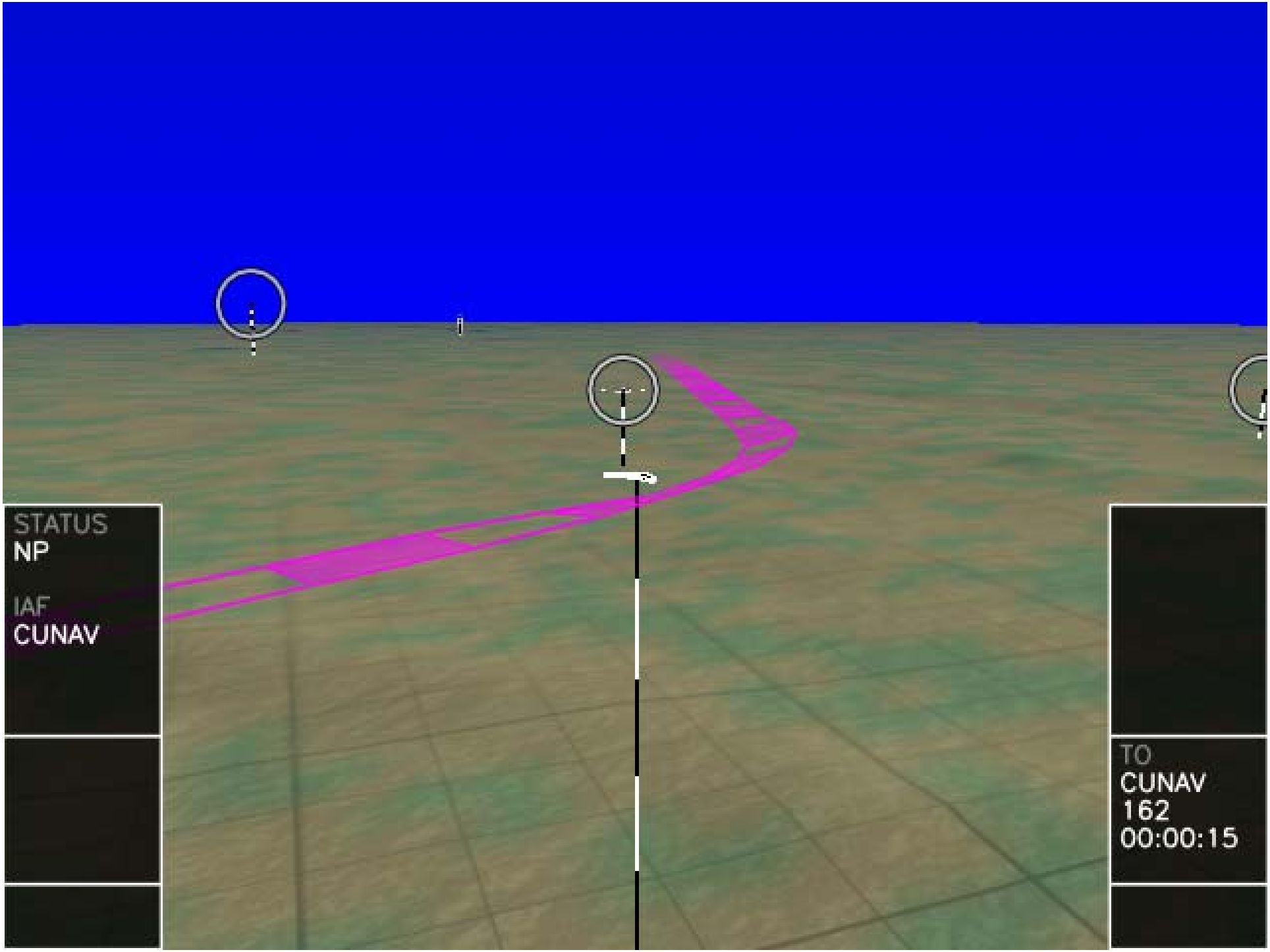
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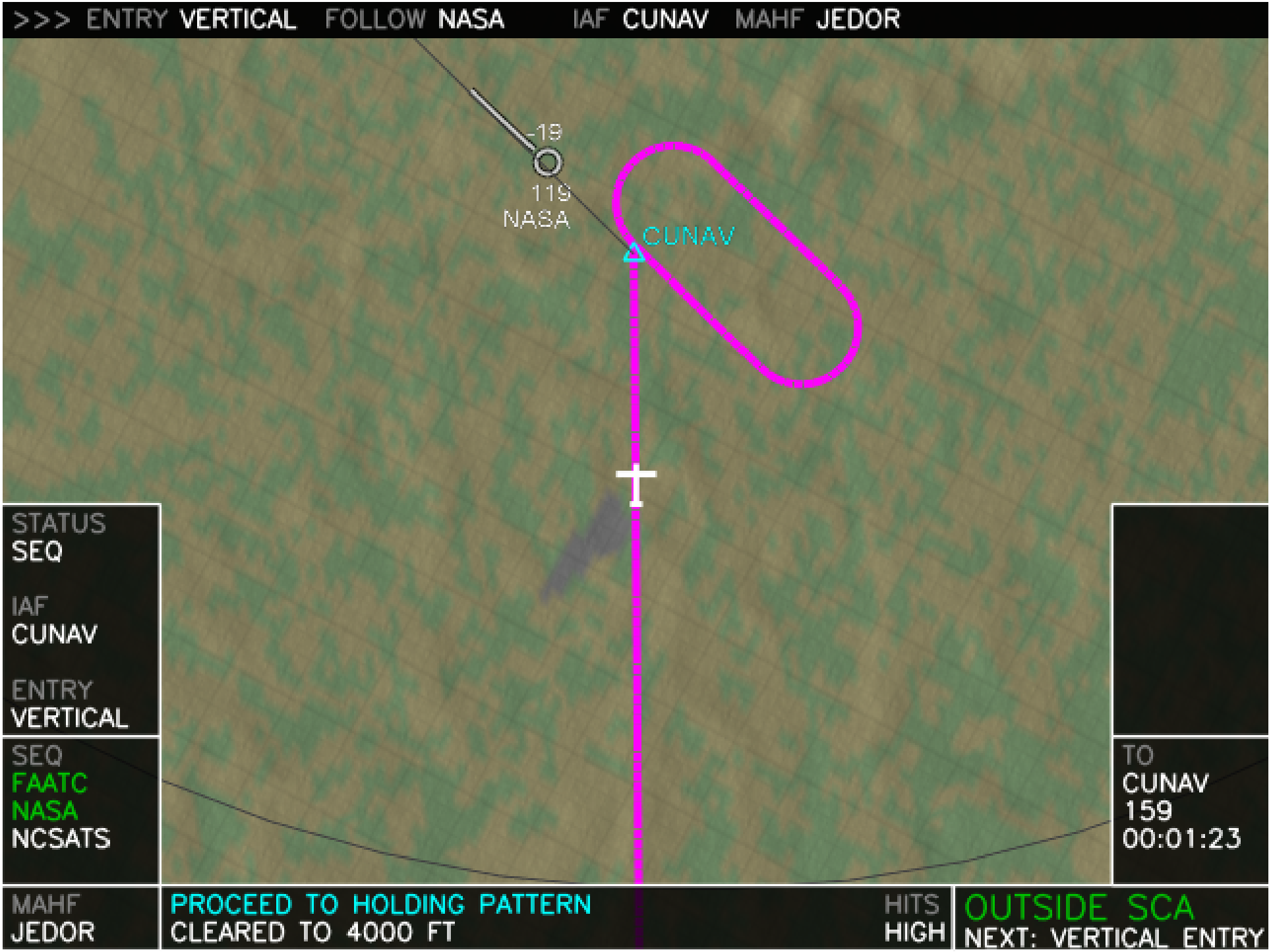
Map View Features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-19
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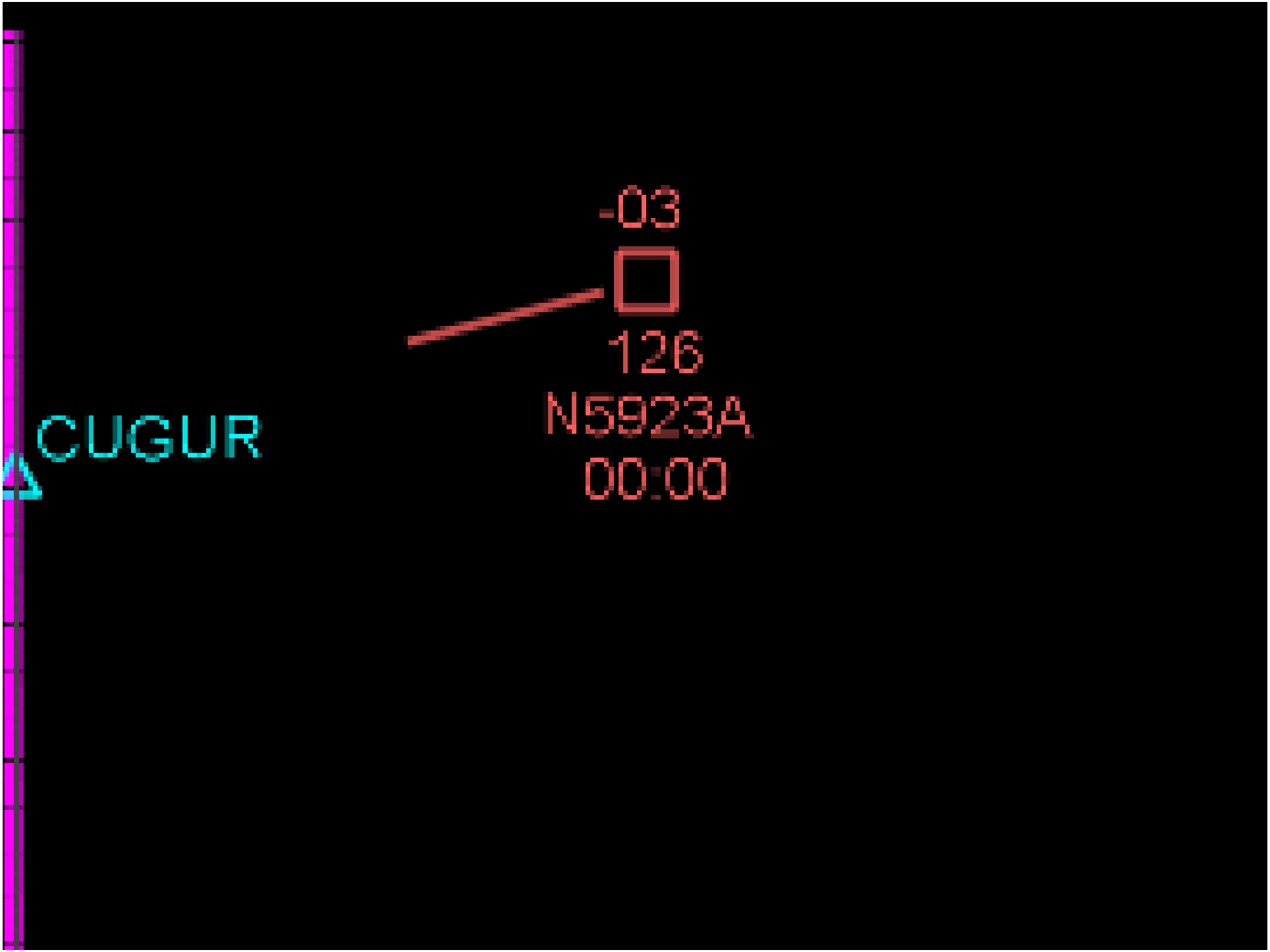
MAHF
JEDOR
PROCEED TO HOLDING PATTERN
CLEARED TO 4000 FT
HITS
HIGH
OUTSIDE SCA
NEXT: VERTICAL ENTRY

Conflict Detection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126
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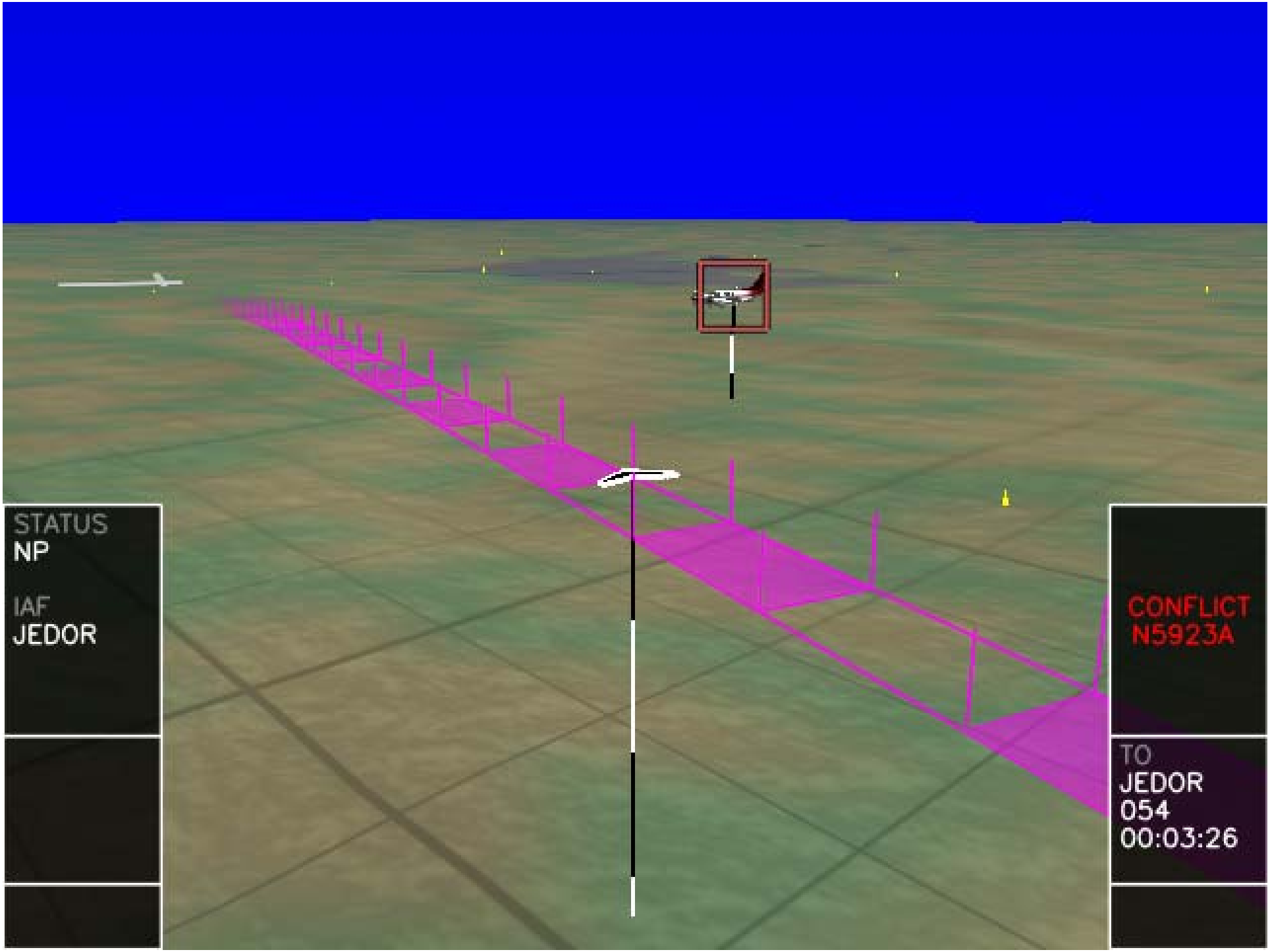
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HVO Information

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Airport Management Module message area
19
119
NASA
CUNAV
STATUS
SEQ
IAF
CUNAV
ENTRY
VERTICAL
SEQ
FAATC
NASA
NCSATS
TO
CUNAV
159
00:01:23
MAHF
JEDOR
PROCEED TO HOLDING PATTERN
CLEARED TO 4000 FT
HITS
HIGH
OUTSIDE SCA
NEXT: VERTICAL ENTRY

HVO Pilot Support

“Smart” Avionics

- If an instructor pilot were looking over your shoulder,
  - *What would he say?*
  - *How might he describe your situation?*
  - *What information would he draw to your attention?*
  - *What might he suggest regarding your displays?*

“Smart” Avionics

How do we write software that does this?

“Smart” Avionics

- We must have logical models of the following:
  - *What is the pilot doing?*
  - *What is the pilot supposed to be doing?*

Concept of Flight Segments

- To support pilot advising,
  we have found that it is useful to

- **model flights as a series of "flight segments."**

  - *Divide and conquer*
  - *Similar to pilot's mental model*

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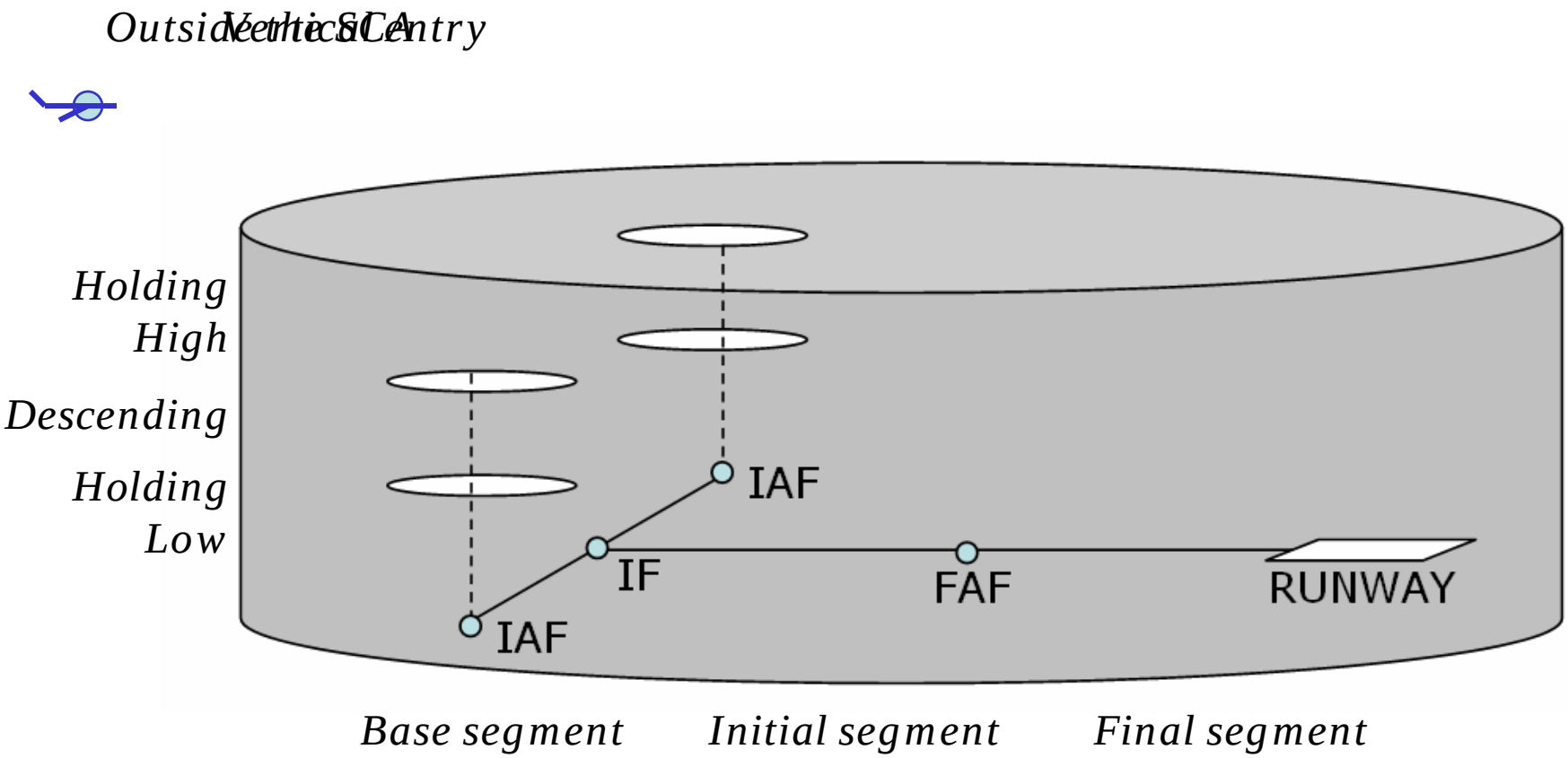
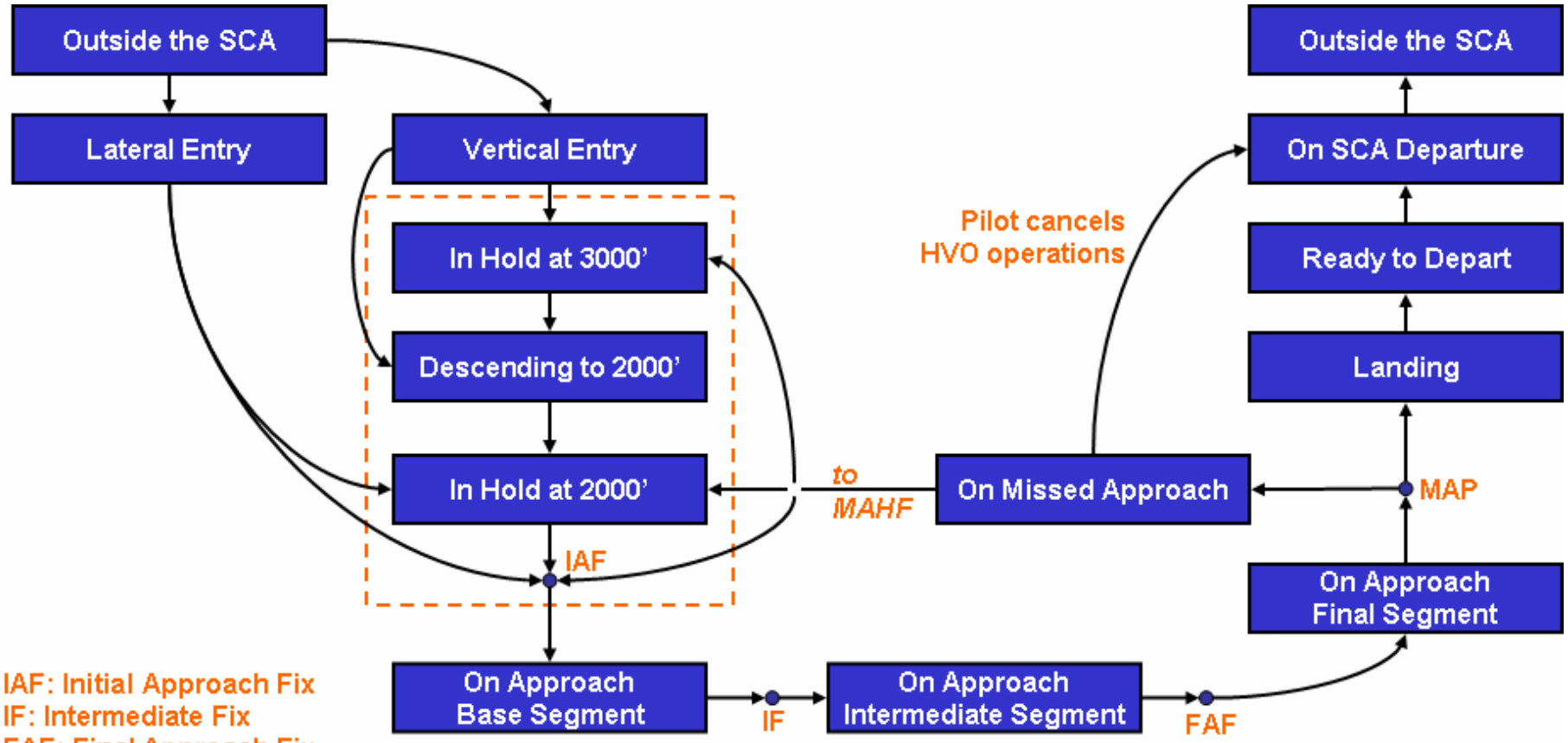
HVO Flight Segments



HVO Flight Segments



IAF: Initial Approach Fix
IF: Intermediate Fix
FAF: Final Approach Fix
MAP: Missed Approach Point
MAHF: Missed Approach Holding Fix

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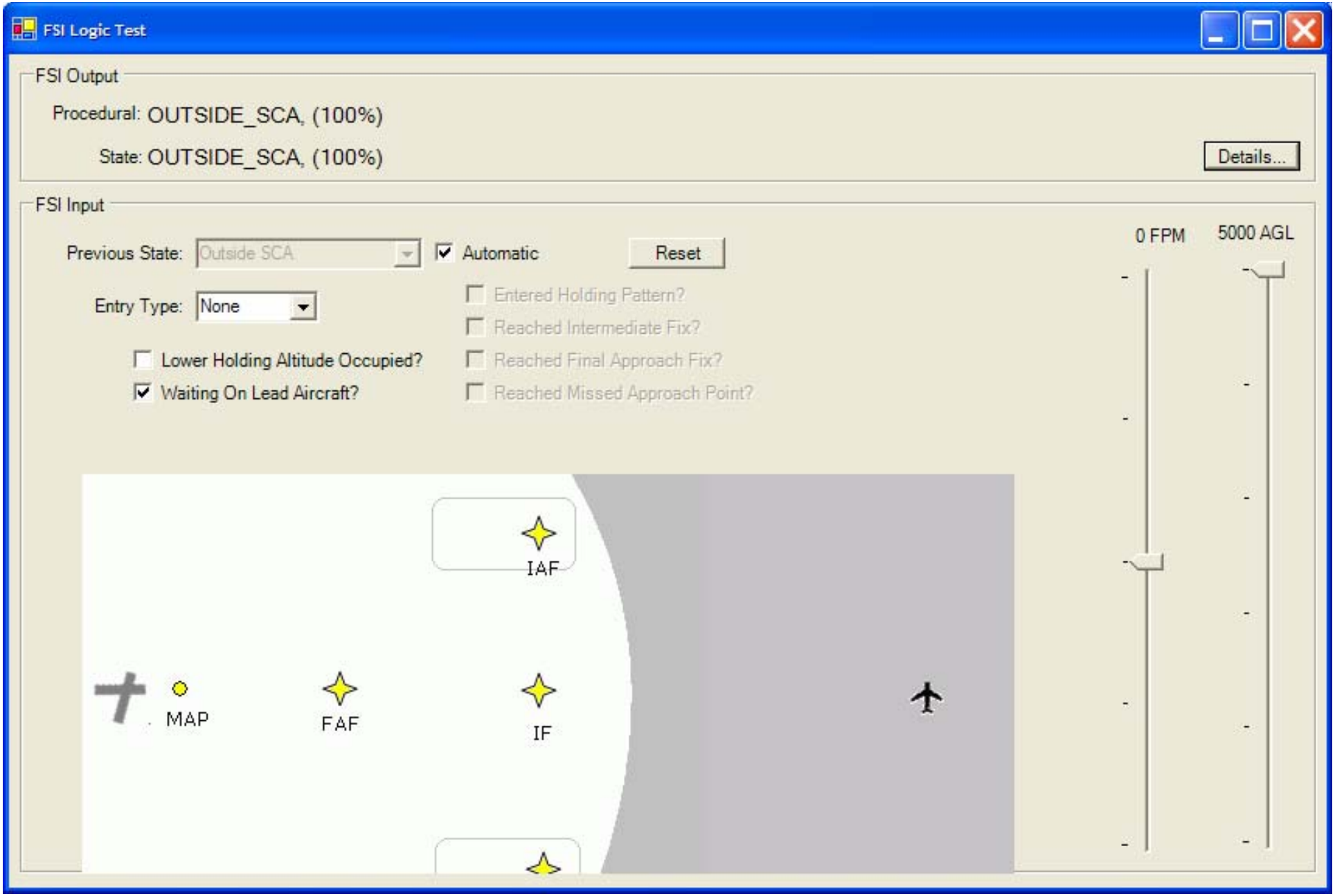

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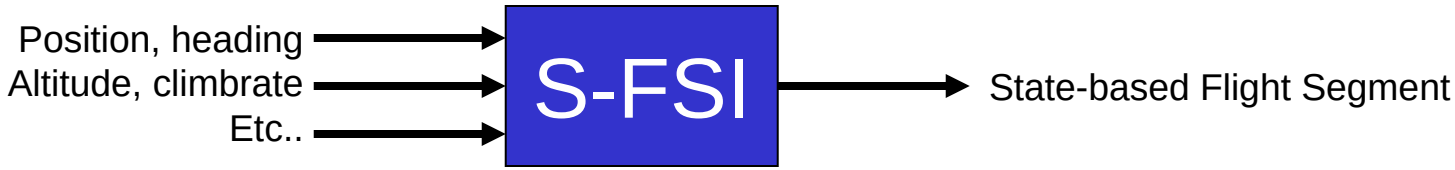
Flight Segment Identification

- What flight segment is the pilot actually flying?
  - *Based on flight data.*



- What flight segment are we supposed to be in?
  - *Based on the procedural rules.*

Display of Flight Segment Info

- How do we display the inferred flight segments?
  - *Very much an open research topic.*

Procedural Guidance

Three cases

- P-FSI and S-FSI agree.

- P-FSI reasonably follows the S-FSI.

- P-FSI and S-FSI are different and do not reasonably follow.

Path Guidance

Another Use

- P-FSI “knew” what we should be doing,
- Why not connect that to the Highway-in-the-Sky?

Pilot Advisories

Pilot Advisories Examples

- **OFF THE COURSE TO SIDLE**
- **OUT OF HOLDING PATTERN**
- **INIT APPROACH SPEED 120 KNOTS**
- **ADVISED TO SEND LANDING REQUEST**
- **CLEARED TO DESCEND TO 3000 FT**
- **CLEARED FOR APPROACH**

Flight Evaluation

Flight Evaluation

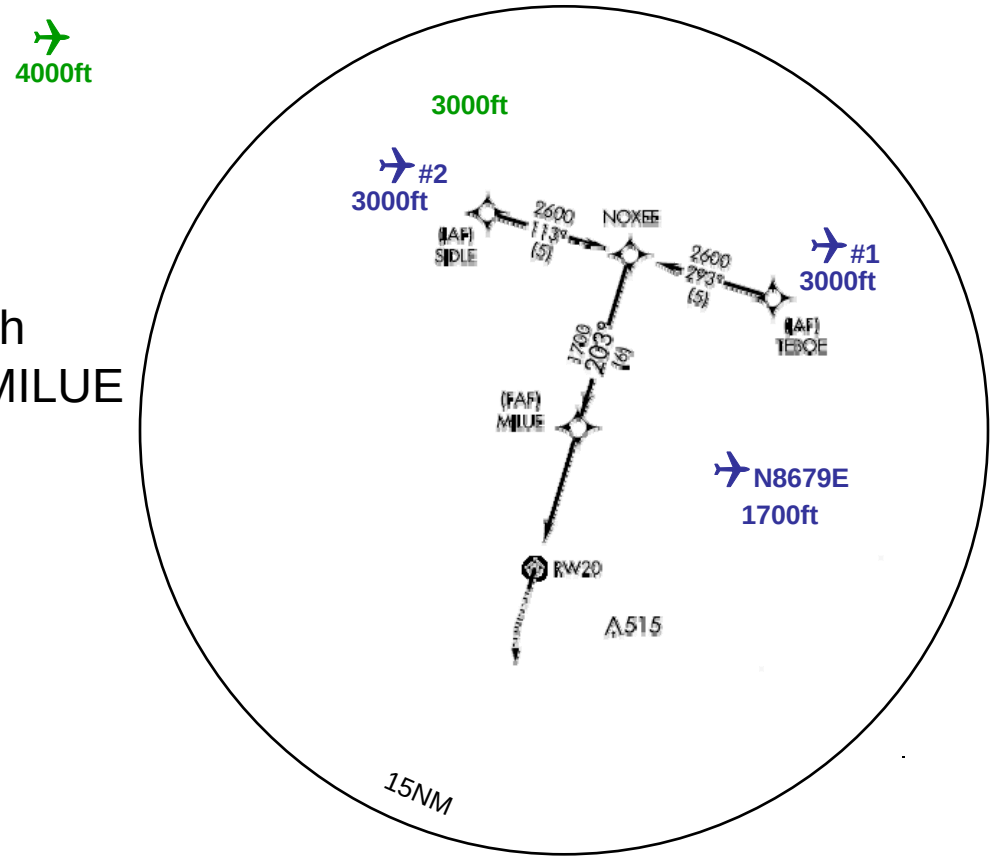
- Six experienced subject pilots started;
  Four pilot completed.

Flight Evaluation

- Determine if the PFD with Synthetic Vision System (SVS) and HITS combined with the TSD…
  - *Increases pilot Situation Awareness (SA)?*
  - *Decreases pilot workload?*
  - *Increases the accuracy of the approach?*
  - *Decision quality?*
- …over standard instruments with TSD alone.

Scenario 3 (Stray Aircraft) With PFD/HITS

- Pilot requests entry. Receives vertical entry to TEBOE, follow #2.
- #1 begins the approach
- #2 begins the approach
- Pilot descends to 3000’
- Pilot is told to begin the approach
- #4 intersects the pilot’s path at MILUE
- Pilot reacts to conflict



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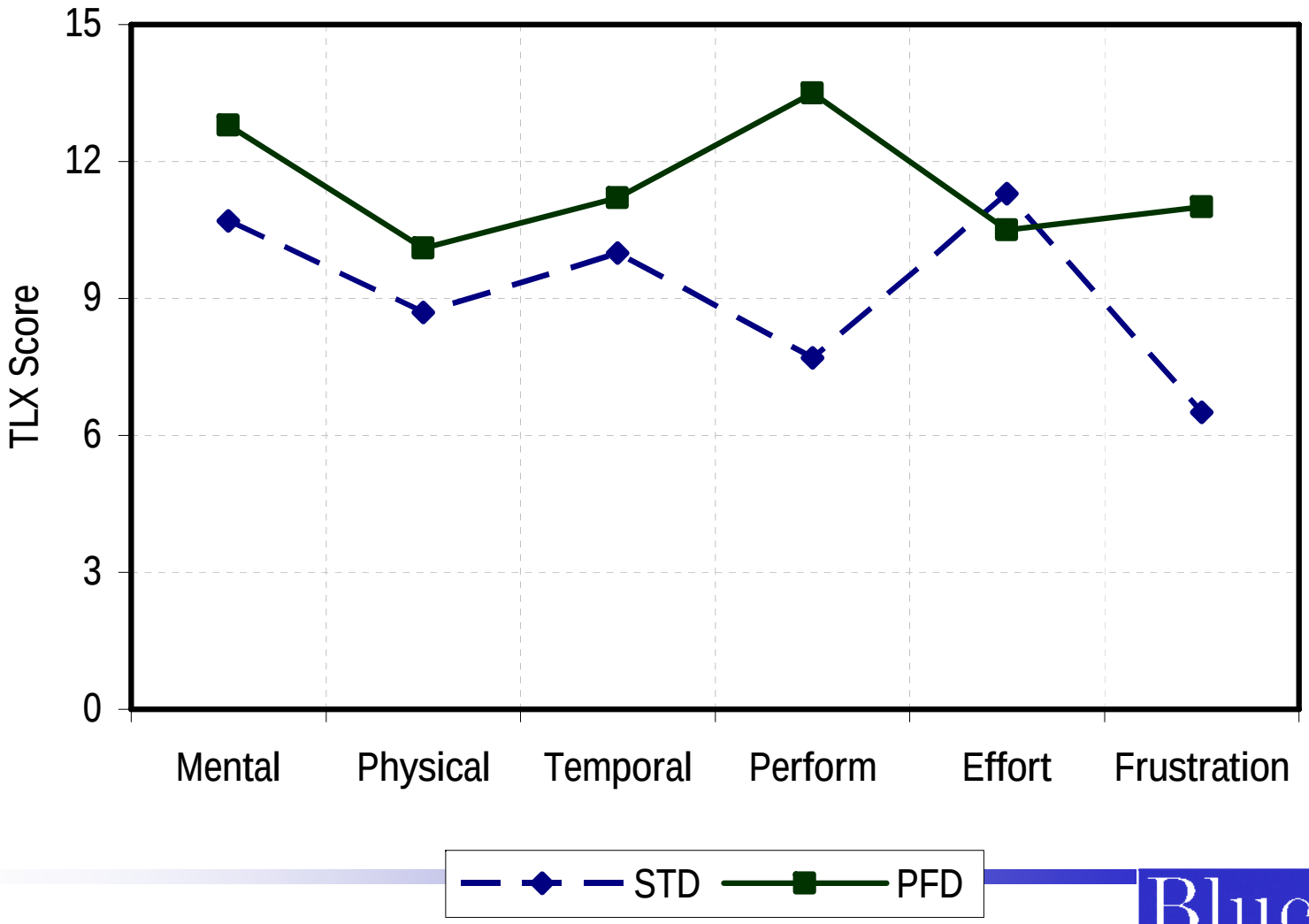
Decision Accuracy

- Did they avoid the traffic conflict?
  - *Two did; two did not.*
  - *There was a training effect.*
  - *There was a position-of-the-display effect.*

Situational Awareness

- Level 1 and Level 2
  - *No difference.*
- Level 3
  - *Better using conventional instruments.*

Pilot Workload (All four pilots)



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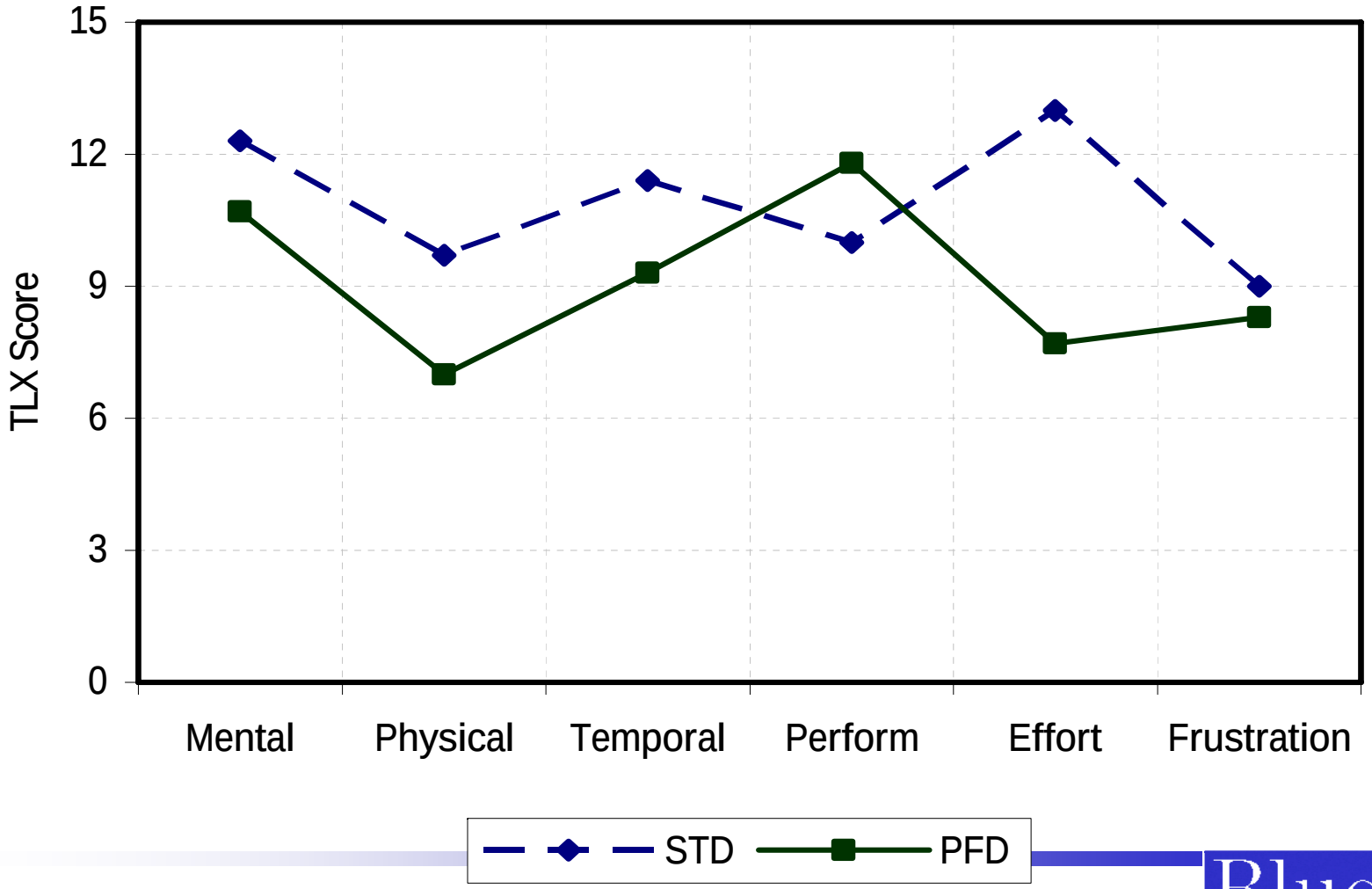
Pilot Workload (Three pilots)



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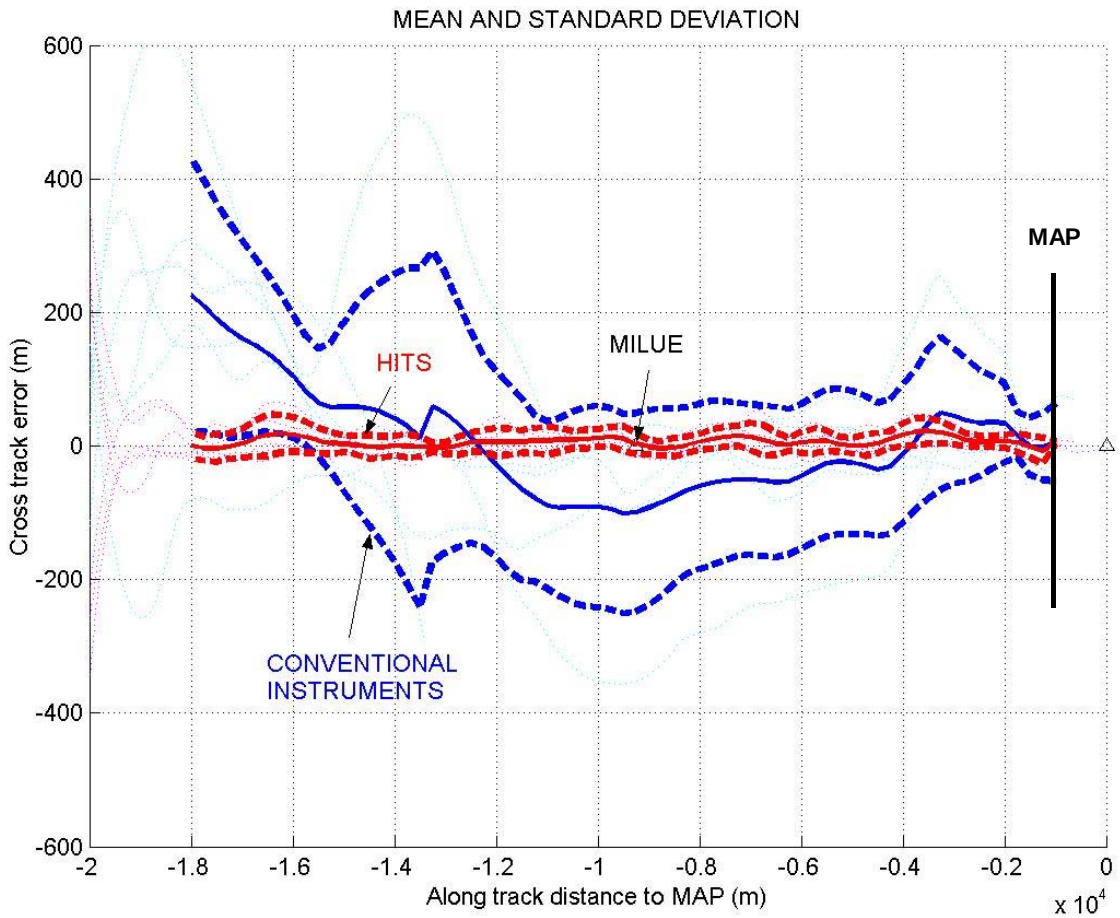
Approach Accuracy



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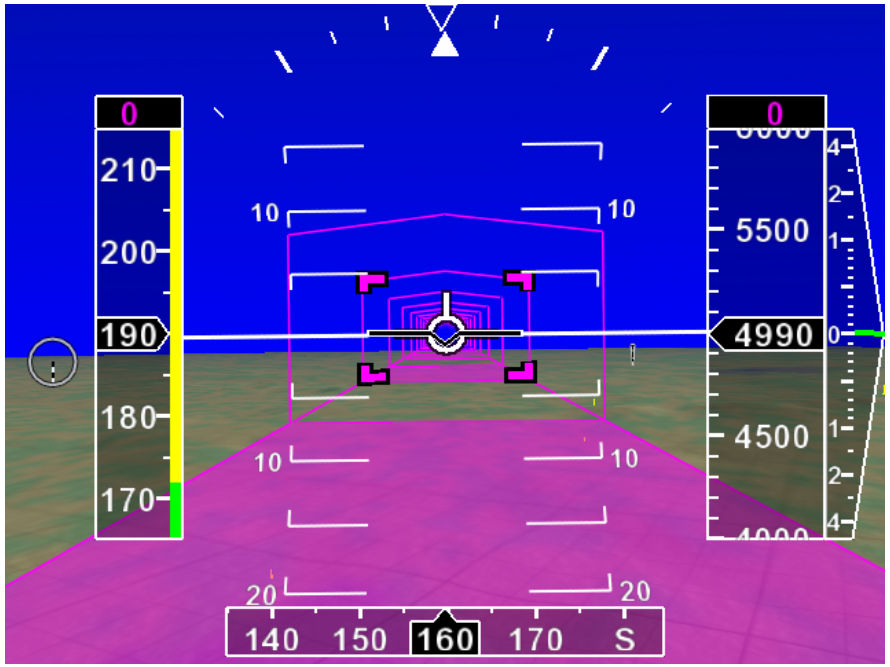
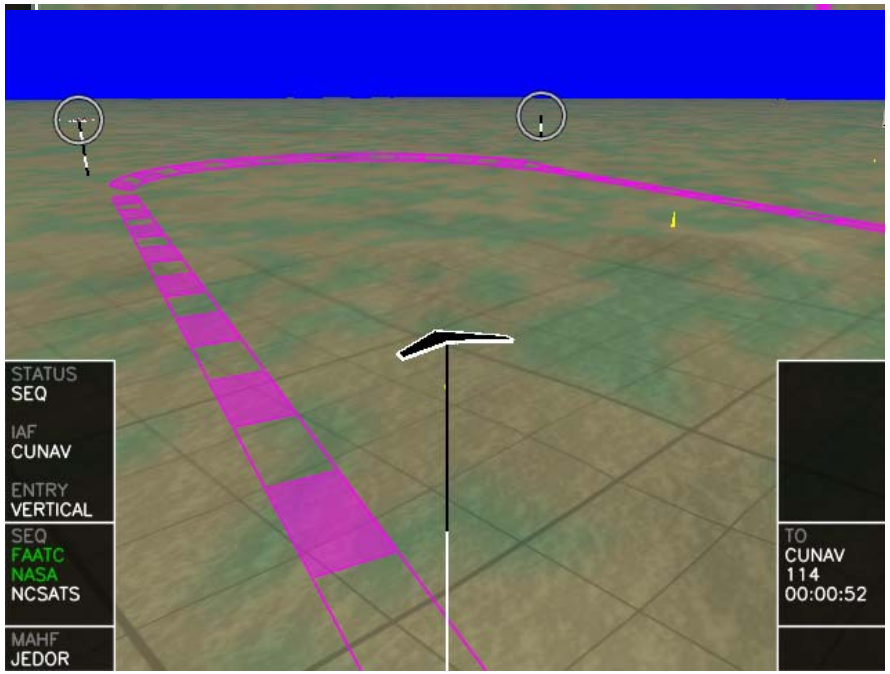
Review

- Primary Flight Display



Review

- Traffic Situation Display
  - *Map View*
  - *Exocentric View*
  - *Conflict Detection*
  - *Procedure Guidance*
  - *Pilot Advisories*
  - *Path Guidance*



Review

- Flight Evaluation
  - *Situational Awareness*
  - *Pilot Workload*
  - *Approach Accuracy*
  - *Decision Quality*