



Joint 5<sup>th</sup> ASAS TN2 Workshop & 2<sup>nd</sup> FLYSAFE Forum



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# Experiments on the Impact of Wind on ASPA-S&M Manoeuvres

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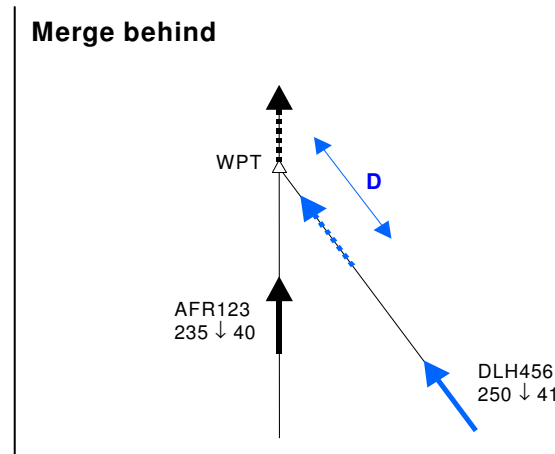
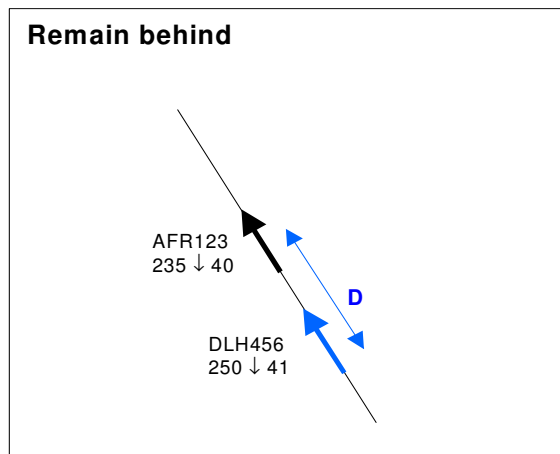
- **Sequencing and Merging (S&M) overview**
- **S&M in the FLYSAFE context**
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## S&M Overview (1)

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- **Purpose:** to ensure more consistent aircraft spacing, potentially increasing capacity and reducing controller workload
- **Controller** instructs aircraft to establish and maintain spacing from target aircraft
- **Responsibility for separation remains with controller**
- **Two basic manoeuvre types** defined by the Requirements Focus Group (RFG)

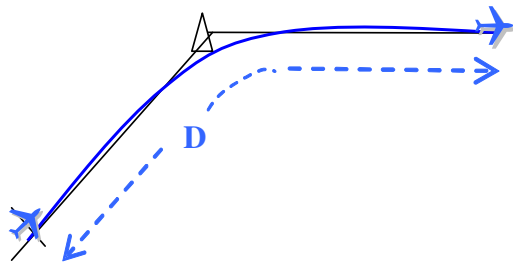


- **Variations** may be formed by adding vector instruction at start of manoeuvre



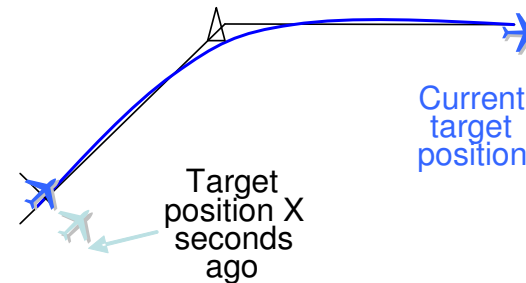
## S&M Overview (2)

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**Distance-based spacing** for a remain behind situation

= D (the distance along the common route between own-ship and target aircraft)



**Time-based spacing** for a remain behind situation

= Time difference between when the target aircraft passed a point in space, and when own-ship passes the same point



## S&M in the FLYSAFE Context

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- **ASPA-S&M is part of the NG-ISS “Traffic” functionality**
- **Implemented in previous projects for manual speed control**
- **Developed in FLYSAFE for automatic (FMS) control**
  - Supports distance and time spacing
  - Speed control is linear, with pulse-inputs for rapid reaction to accumulating divergences
  - Algorithm does not predict future impact of wind



## Impact of Wind

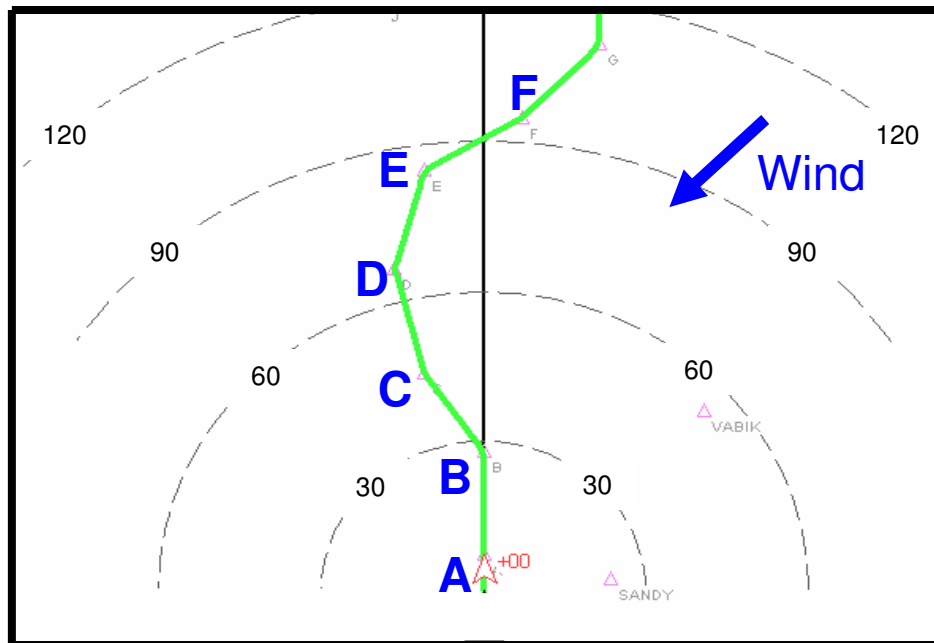
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- **Route with turns; constant target airspeed; steady wind**
- **Using RFG definitions of distance and time spacing, would expect behaviour to differ**
- **Distance spacing**
  - Target aircraft groundspeed will change as a result of turn
  - To maintain distance spacing, instructed aircraft must change airspeed
- **Time spacing:**
  - Uses position of target X seconds ago
  - No gross change in airspeed required to maintain spacing



## Experimental Results

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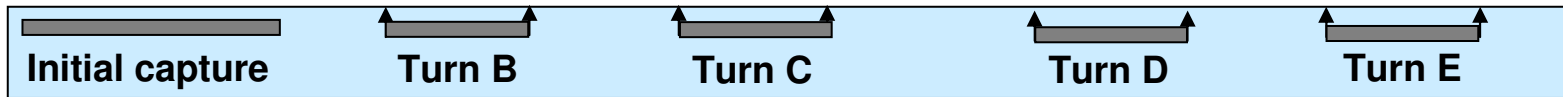
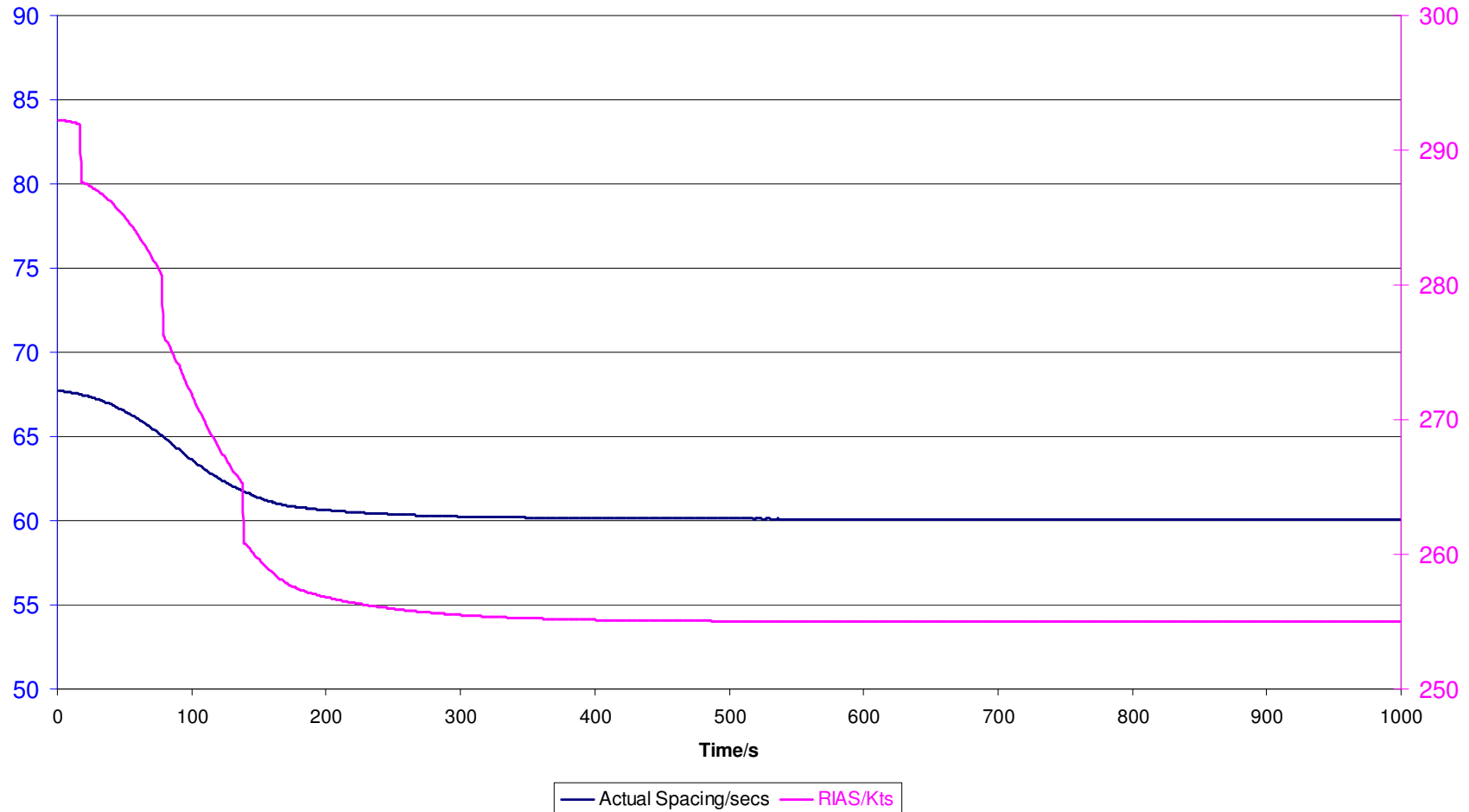
- Route A to F
- Aircraft in “Remain Behind”
- Wind speeds 0, 50, 100, 150kts

### The following graphs show:

- Achieved spacing as a function of time
- Recommended speed, RIAS, (not actual speed) as a function of time
- “Route summary” along the time axis

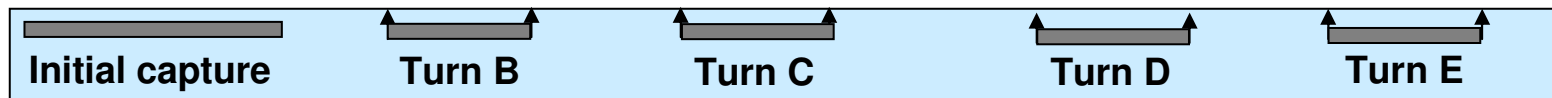
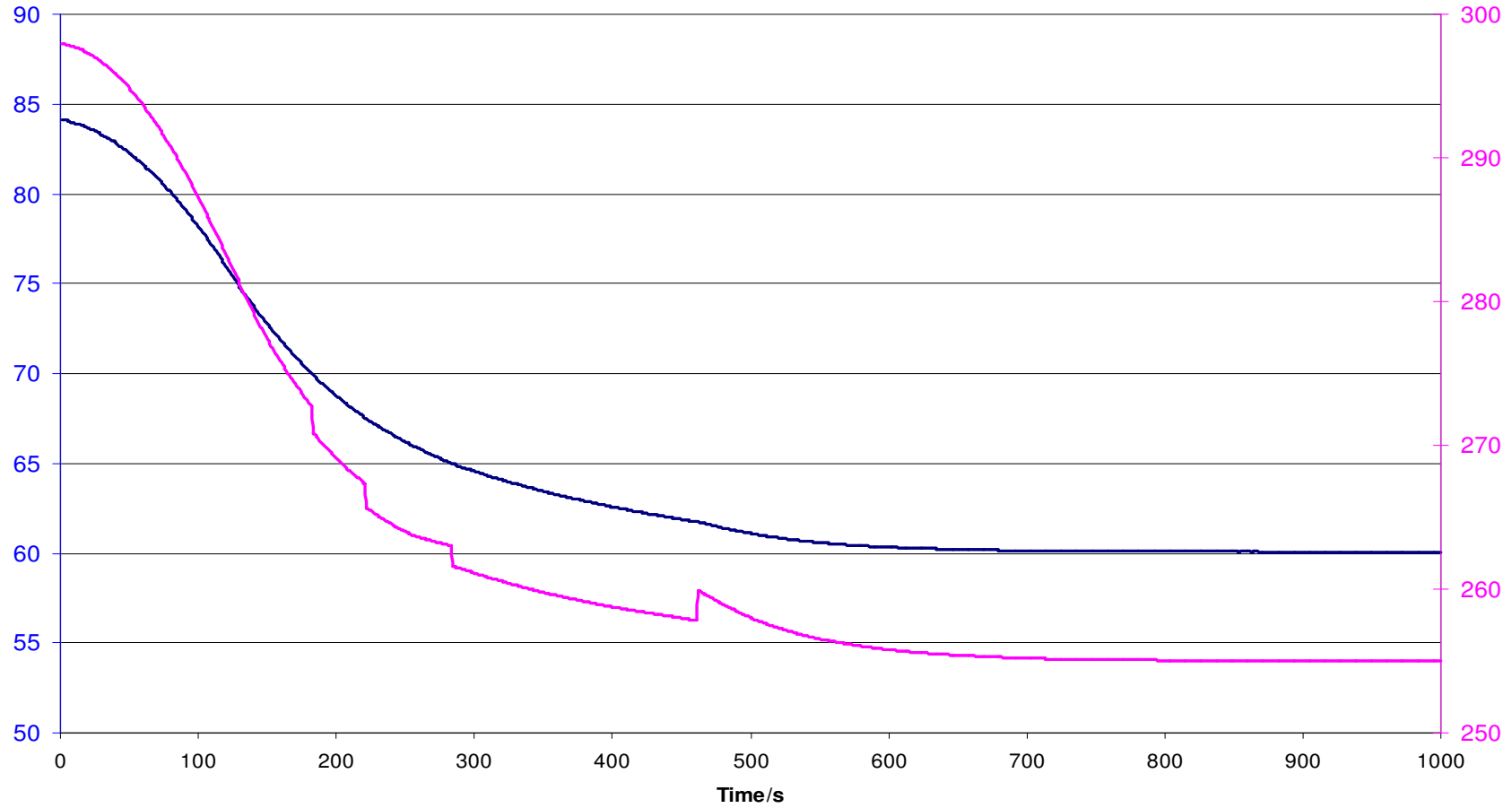


# Time spacing: 60secs, No Wind



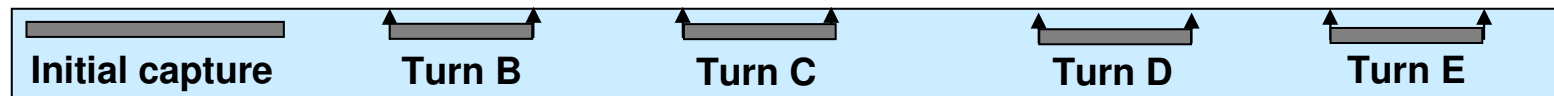
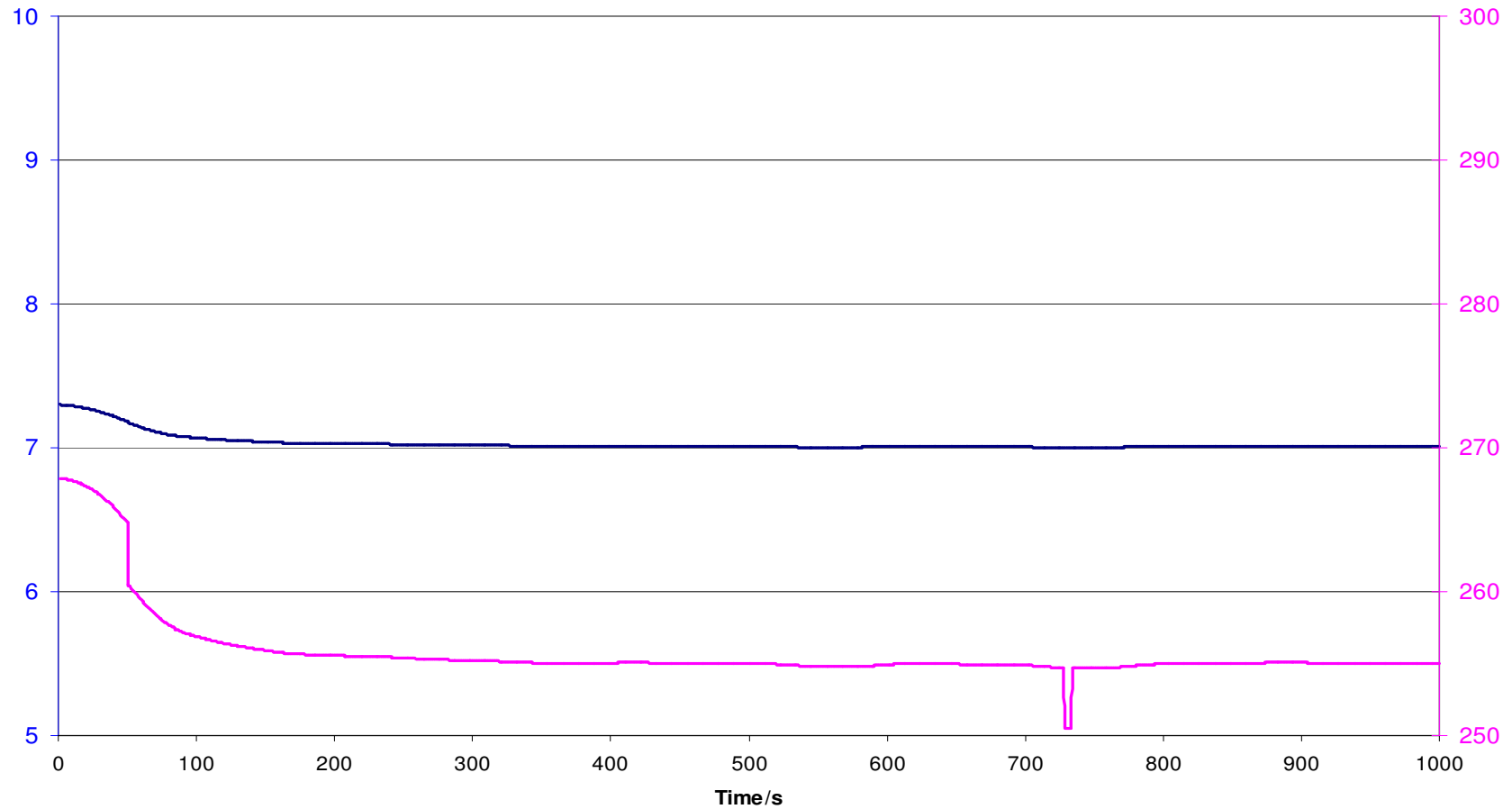


# Time spacing: 60 secs, Wind 100 Kts



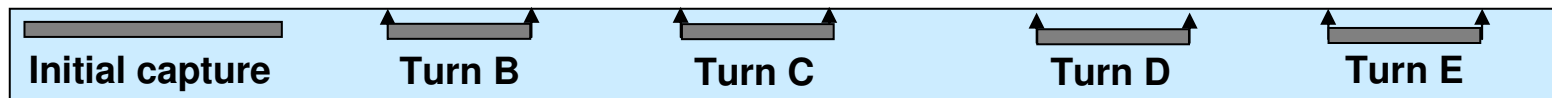
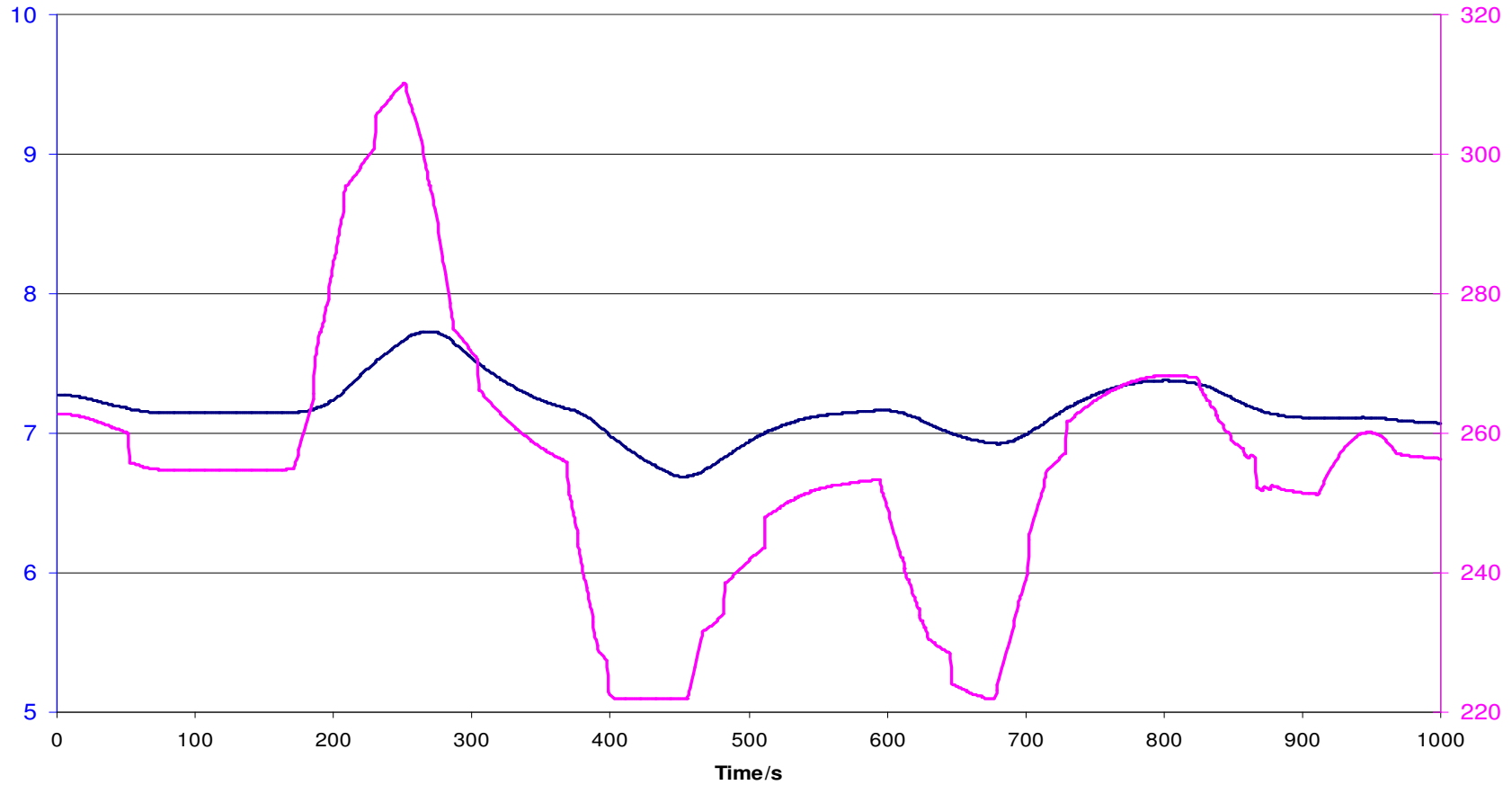


# Distance spacing: 7Nm, No Wind





# Distance spacing: 7Nm, Wind 100Kts





## Conclusions

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- **Distance spacing** is more sensitive to wind than time spacing
  
- **Wind impact is seen in the severity of the speed adjustments required to maintain distance spacing**
  - Speed demands can exceed actual aircraft performance, potentially leading to manoeuvre termination
  - Wind of 150kts resulted in manoeuvre termination for distance spacing, whereas time spacing was stable
  
- **ATC Time spacing instructions** must respect wind effects to ensure separation limits are not infringed at turns into wind



# List of Abbreviations

**BAE SYSTEMS**

<b>ASAS</b>	<b>Airborne Separation Assistance System</b>
<b>ASPA-S&amp;M</b>	<b>Airborne SPacing Application – Sequencing and Merging</b>
<b>FMS</b>	<b>Flight Management System</b>
<b>NG-ISS</b>	<b>Next Generation – Integrated Surveillance System</b>
<b>RFG</b>	<b>ASAS Requirements Focus group</b>
<b>RIAS</b>	<b>Recommended Indicated Air Speed</b>



## Contacts

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