Parallel Session

Operational Evidence of Fatigue: Flight Operations

Sleep and Psychomotor Performance during Commercial Ultra-Long Range Flights

Leigh Signal, Ph.D.
Massey University

14:45 - 15:10

June 17, 2008

Presented at the FAA Fatigue Management Symposium: Partnerships for Solutions; Vienna, VA: June 17-19, 2008

Leigh Signal, Ph.D.
Biography

Dr. Leigh Signal is a Senior Research Fellow and the Associate Director of the Sleep/Wake Research Centre, Massey University, New Zealand. Leigh initially trained as Commercial Pilot. She has completed a Masters Degree in Industrial and Organizational Psychology and a Doctorate in Public Health, which investigated strategic napping in the Air Traffic Control environment. Her current research focuses on understanding the factors that influence sleep and the circadian biological clock and, in turn, how these physiological processes influence waking functioning, particularly for individuals working in the aviation industry. She conducts research in both laboratory and applied settings.

Sleep and Psychomotor Performance during Commercial Ultra-Long-Range Flights

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Research School of Public Health
Massey University

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Background

- **Ultra-long-range = planned flights in excess of 16 hours (duty periods of 18-22 hours)**
- **CAAS task force validation programme**
  - » SIA applied to operate SIN-LAX non-stop using A340-500
  - » Task force established (CAAS, SIA, ALPA-S)
  - » Prediction of flight crew alertness (QinetiQ/ECASS)
  - » Update of model using existing SIA long-range flights (QinetiQ/ECASS)
  - » CAAS Air Operator Certificate Requirements (Chapters 2 and 4, Appendices C1 and C2)
  - » ULR data collection SIN-LAX-SIN (ECASS and Massey University)

Overview of Studies

2004	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
SIN-LAX-SIN Diary study	X	X				X				
SIN-LAX-SIN PSG study			X		X					

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Measures

Sleep

- **Polysomnography (PSG)**
  - » "Gold standard" measure
  - » Brain activity (EEG)
  - » Eye movement (EOG)
  - » Muscle tone (EMG)
- **Actigraphy and sleep diary**

Performance

- **Psychomotor Vigilance Task (PVT)**

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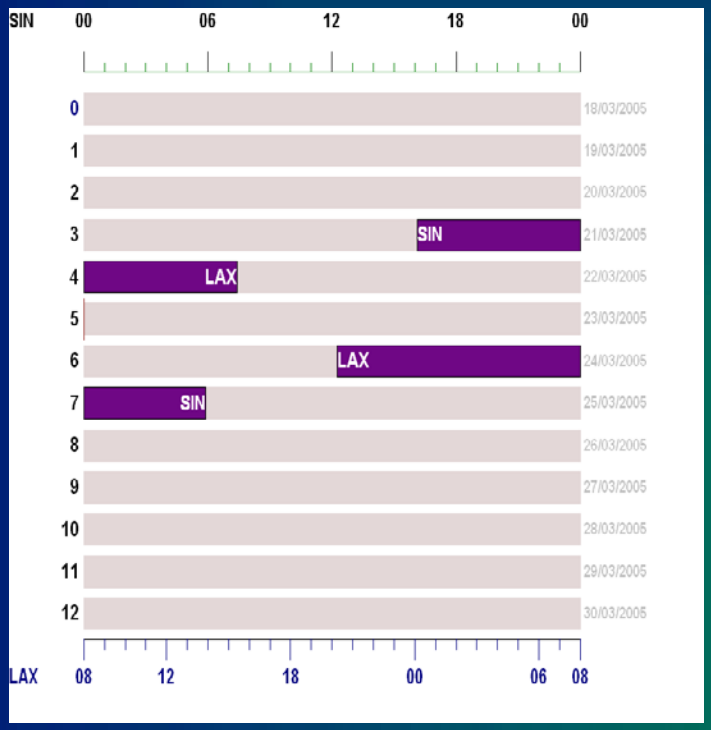
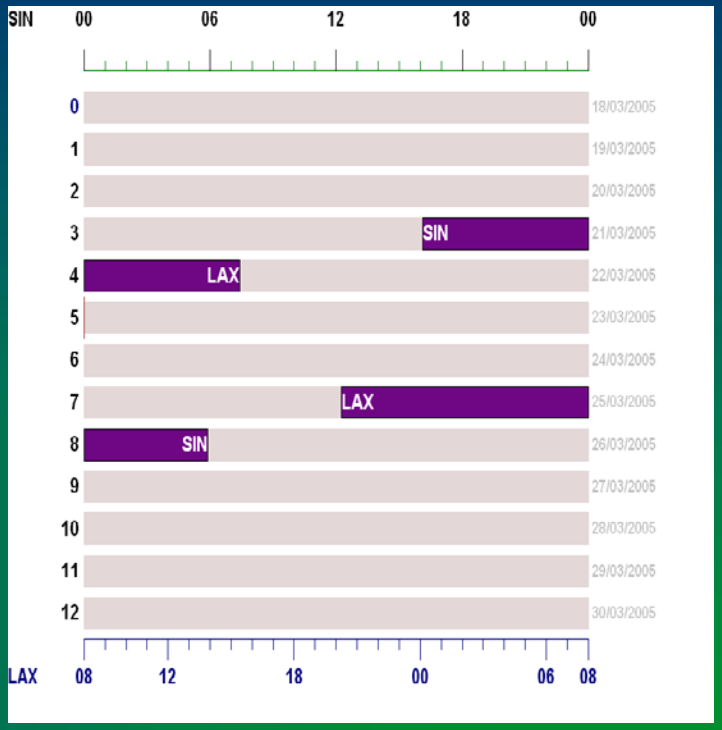
SIN-LAX-SIN Schedule



Four day pattern (two-day layover)



Five day pattern (three-day layover)

SIN-LAX = 15:30 (15:06-16:03)

LAX-SIN = 17:00 (16:12-18:02)

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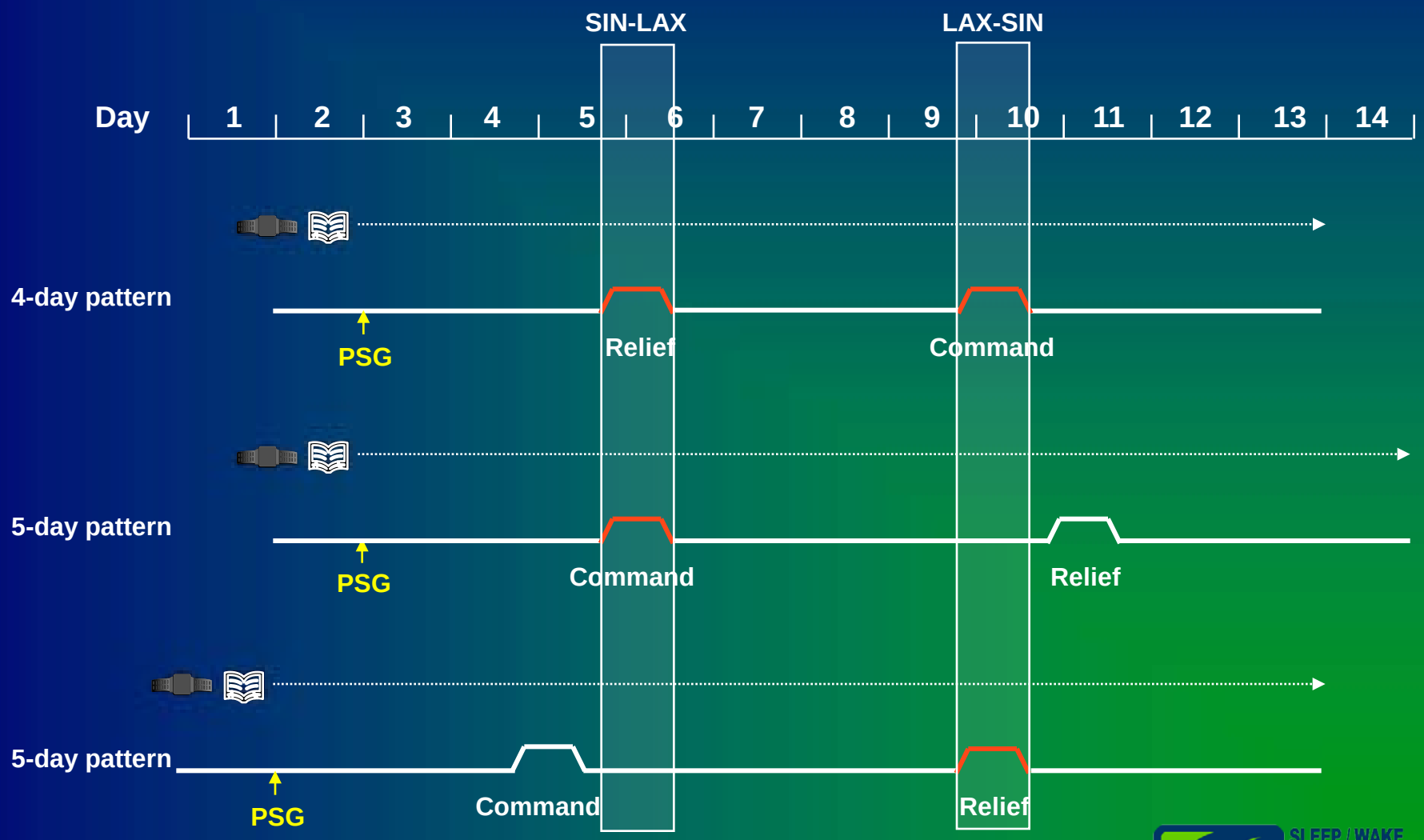
Data Collection



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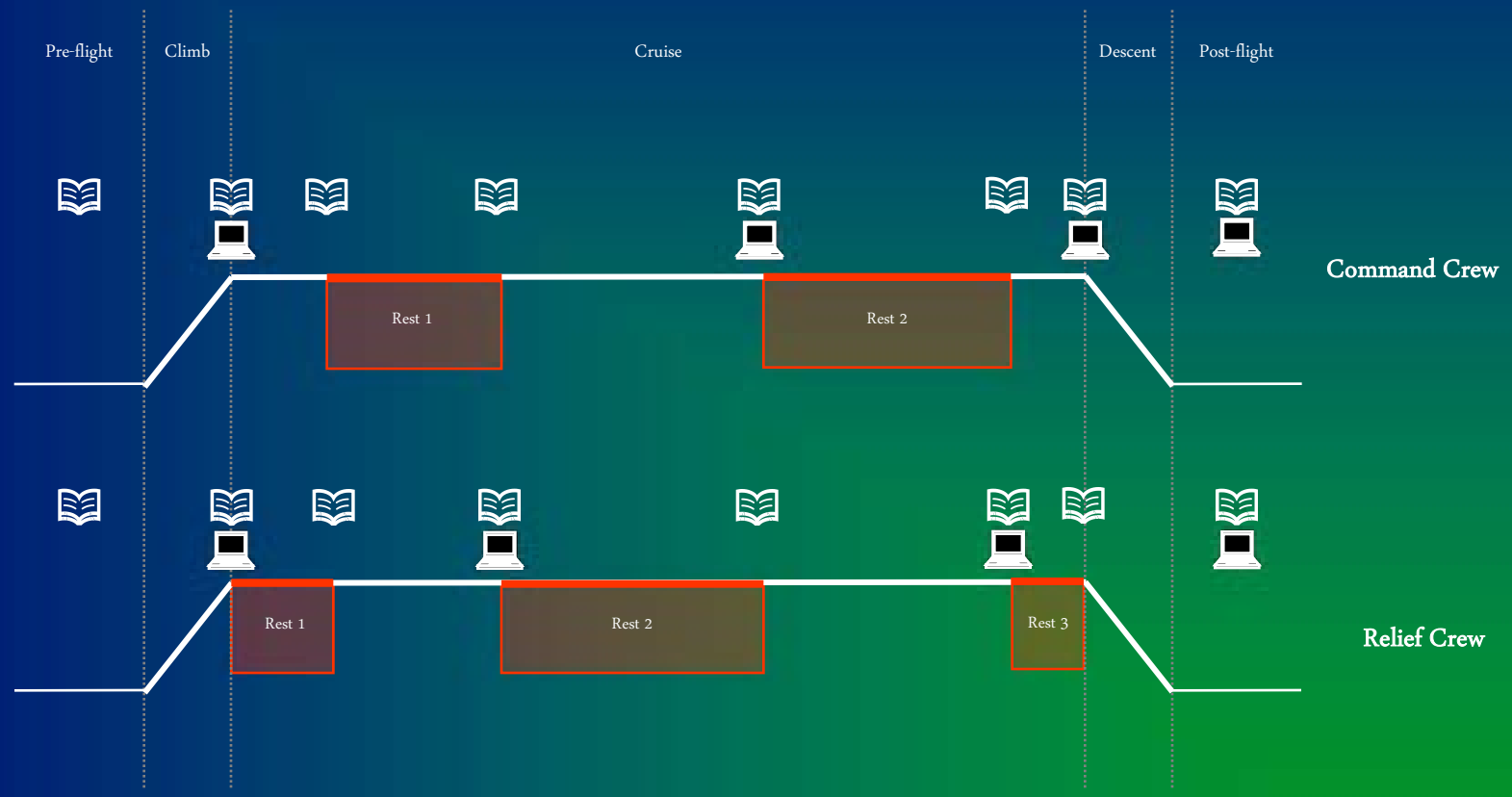
In-Flight Data Collection



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Crewmembers

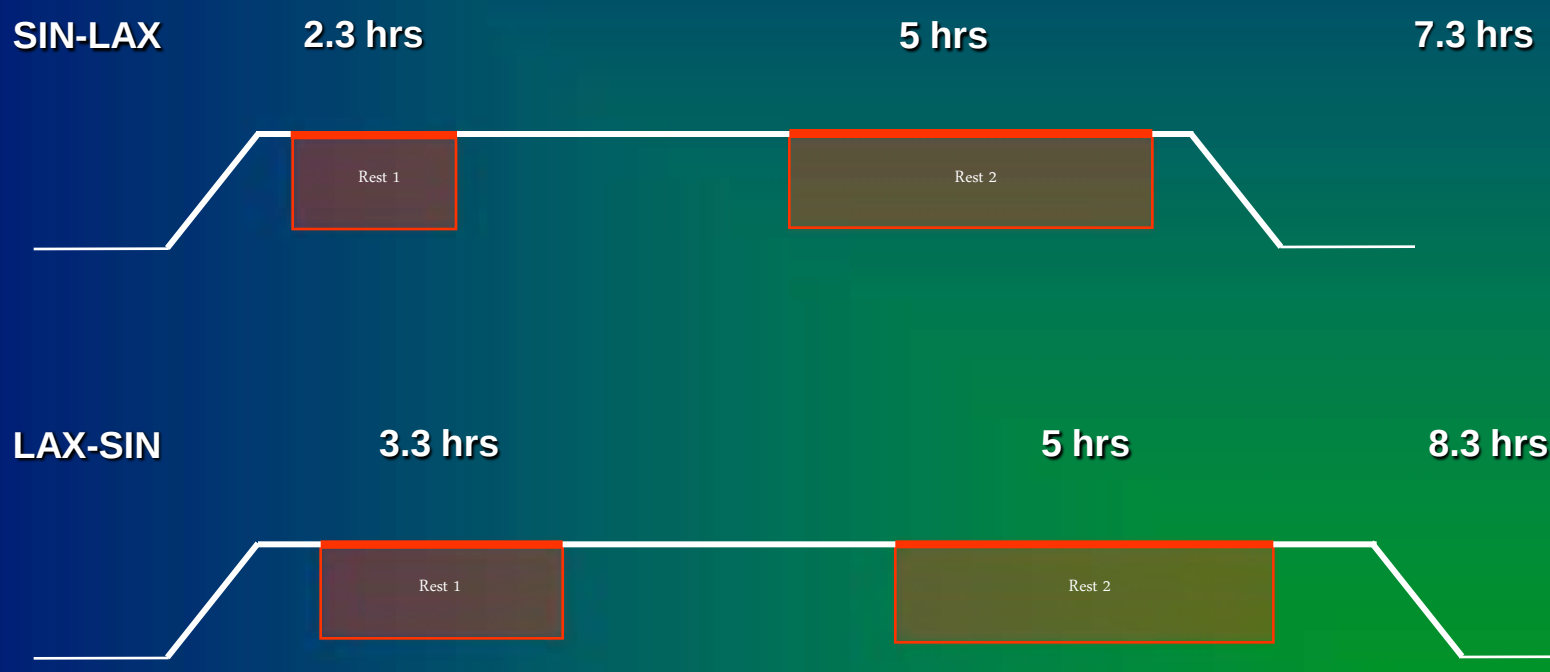
- 23 Captains, 18 First Officers (6 participated twice)

	Median	Range
Age (yrs)	44	29-58
Flight time (hrs)	10,500	800-20,000
LR (yrs)	6	0-32
ULR (mths)	2.1	0-5.1

Data Analysed

	Number of data sets
PSG SIN-LAX	43
PSG LAX-SIN	45
PVT SIN-LAX	30
PVT LAX-SIN	29

In-Flight Rest Command Crew



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In-Flight Rest Command Crew

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In-Flight Rest Command Crew

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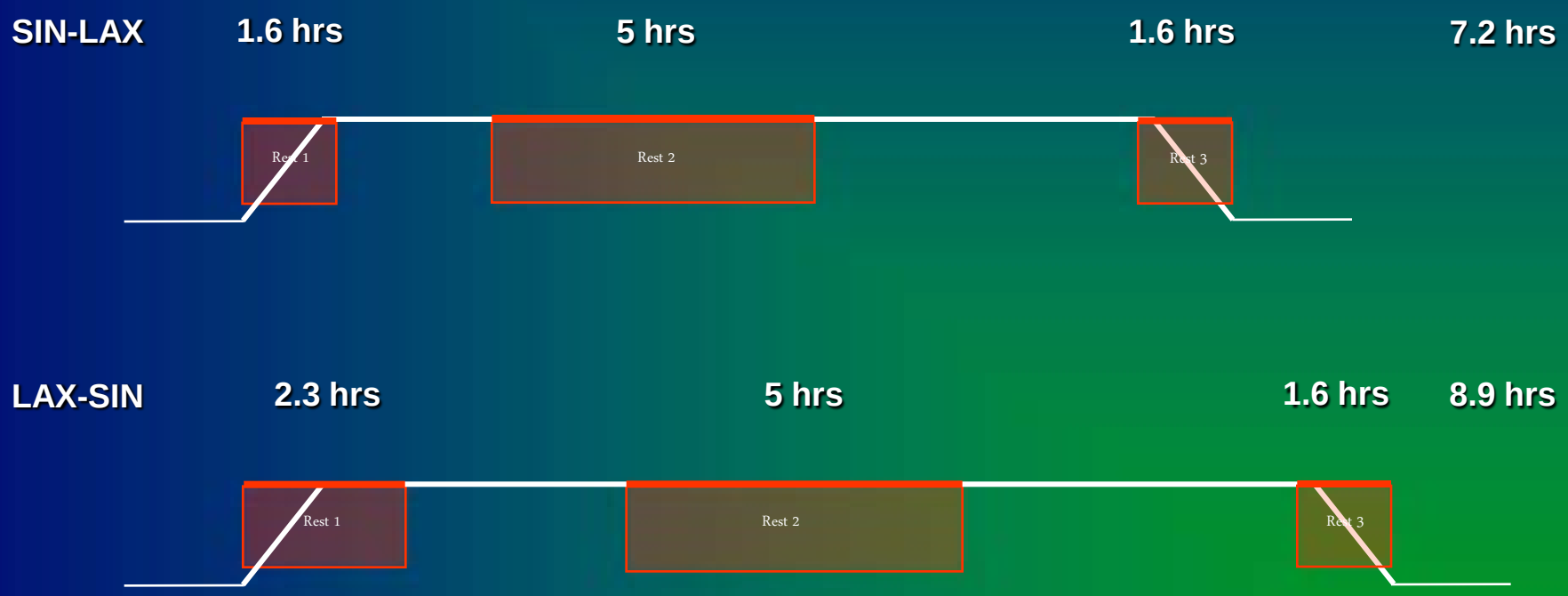
In-Flight Rest Relief Crew



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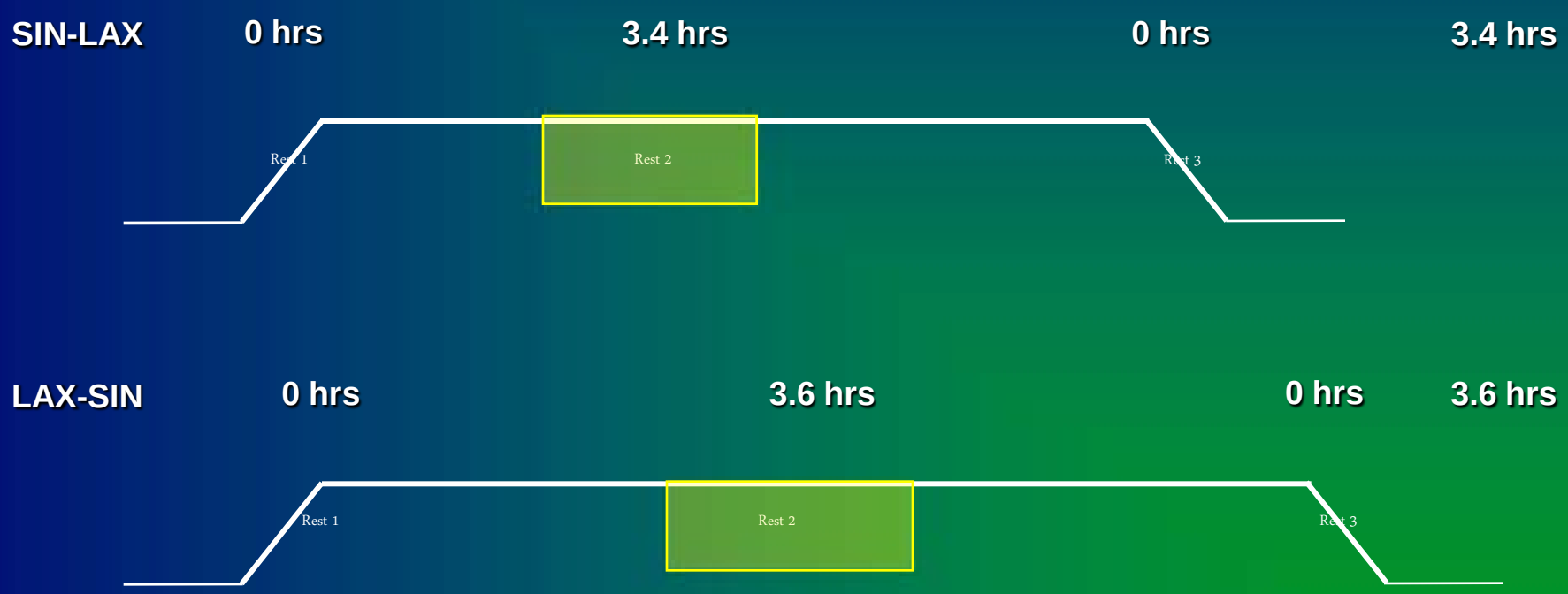
In-Flight Rest Relief Crew



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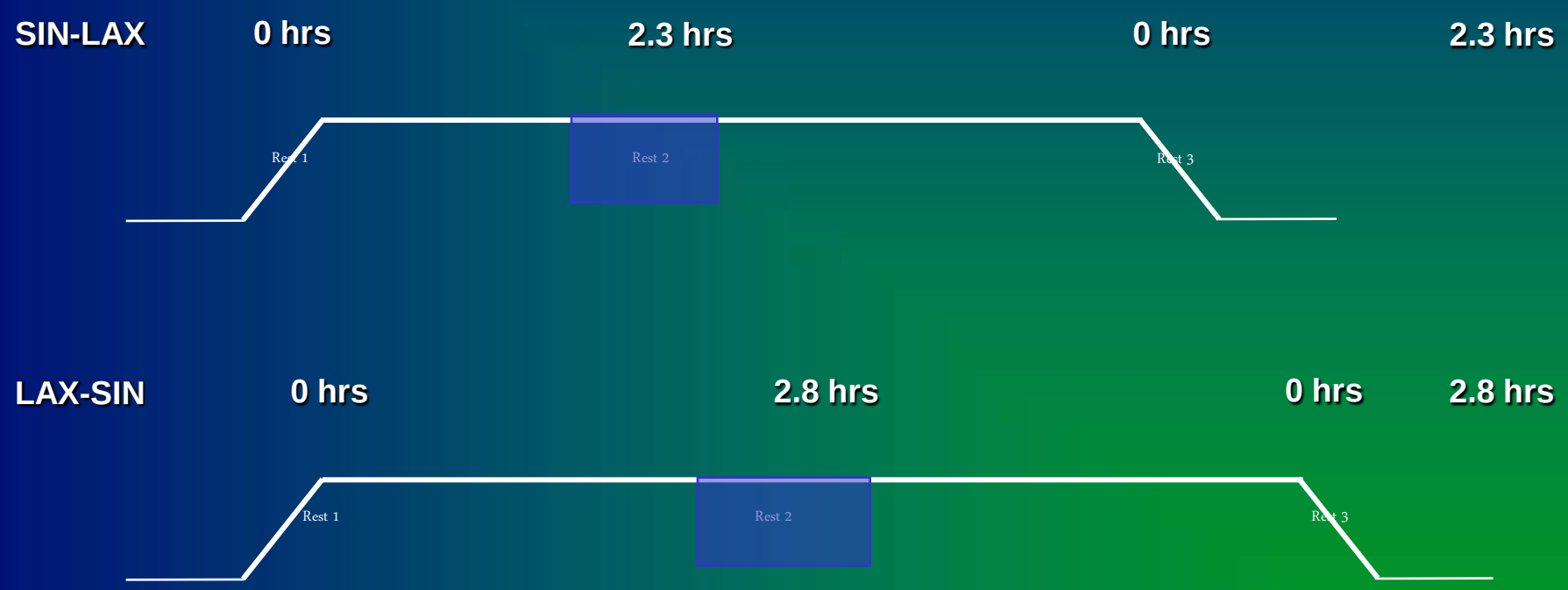
In-Flight Rest Relief Crew



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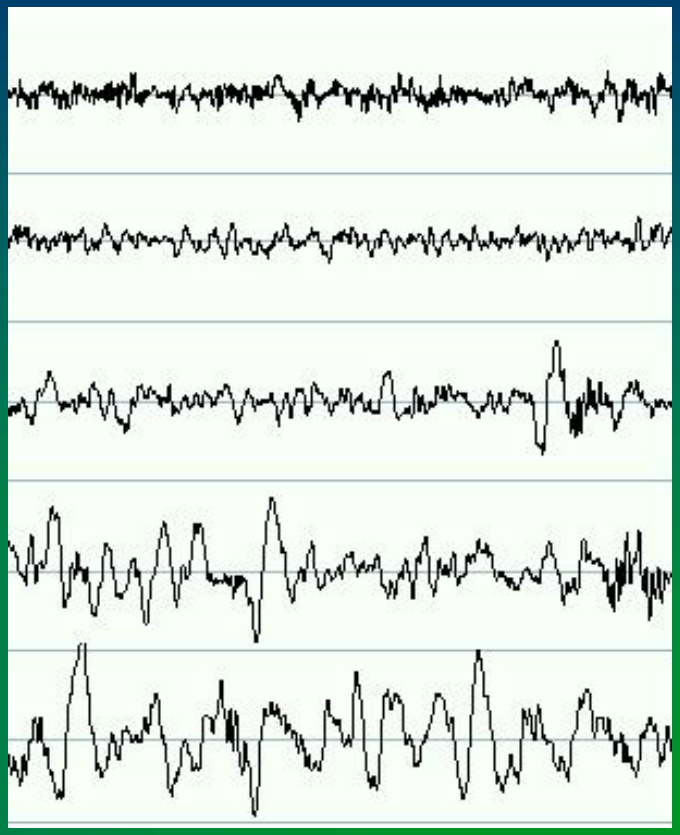
Sleep Structure

- Latencies range widely (1-84 min)
- Most sleep NREM S1 and S2
- Long rest opportunity (second rest)
  - » More efficient sleep, more SWS, more REM
- Crew sleeping twice tend to obtain more sleep
  - » Main crew 4 hrs vs. 3.2 hrs
  - » Relief crew 3 hrs vs. 2.5 hrs
- Amount of sleep in 2nd rest not reduced by sleeping in first rest



Adaptation vs. In-Flight Sleep

- Comparison made between longest in-flight sleep and adaptation night sleep

	Adaptation	SIN-LAX	Adaptation	LAX-SIN
Sleep Latency (mins)	10	16	10	13
Sleep Efficiency (%)	87	73	85	77
Wake (%)	13	27	15	23
Awakenings (/hr)	7	7	7	6
Arousals (/hr)	23	22	23	23

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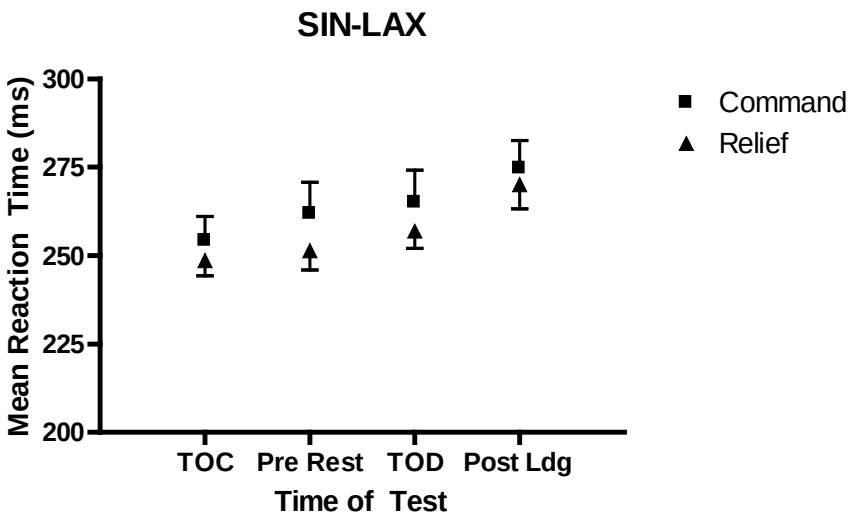
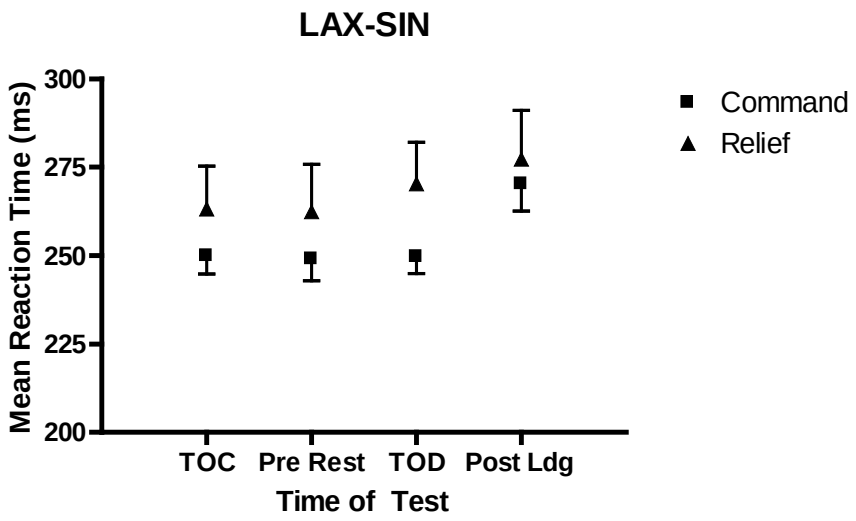
Psychomotor Performance





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Summary

- **In-flight rest opportunities**
  - » All flight crew slept at least once in-flight
  - » Large individual variability in total sleep obtained
  - » Relatively low utilisation of short rest opportunities
  - » Sleeping twice not a disadvantage
  - » Important to measure how rest opportunities are used and how much sleep is actually obtained.
- **Multiple measures required to determine functional status of flight crew**

Acknowledgements

- SIA flight crew
- SIA management
- CAAS
- ALPA-S
- Researchers from DLR
- Researchers from ECASS