

The background features a dark blue gradient with technical diagrams. On the left, a large circular scale is visible with numerical markings from 150 to 260. To the right, there are several circular diagrams with arrows indicating clockwise rotation. A horizontal white line is positioned near the top of the slide.

# FATIGUE RISK MANAGEMENT

WHERE ARE WE, AND WHERE ARE WE GOING?

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INTERNATIONAL AEROSPACE MEDICINE CONGRESS

BOGOTA COLOMBIA

4 APRIL 2019

# DISCLOSURES

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- No conflicts to declare
- No off-label use
- Contracted to Virgin Australia, IATA
- All opinions are my own



# CHARLES LINDBERGH



First non- stop  
transatlantic flight

May 1927    33.5 hours

“My mind clicks on and off... I try letting one eyelid close at a time....

My eyes jump to the altimeter... I'm at 1600 feet.

The turn-indicator leans over the left - the airspeed drops - the ball rolls quickly...”

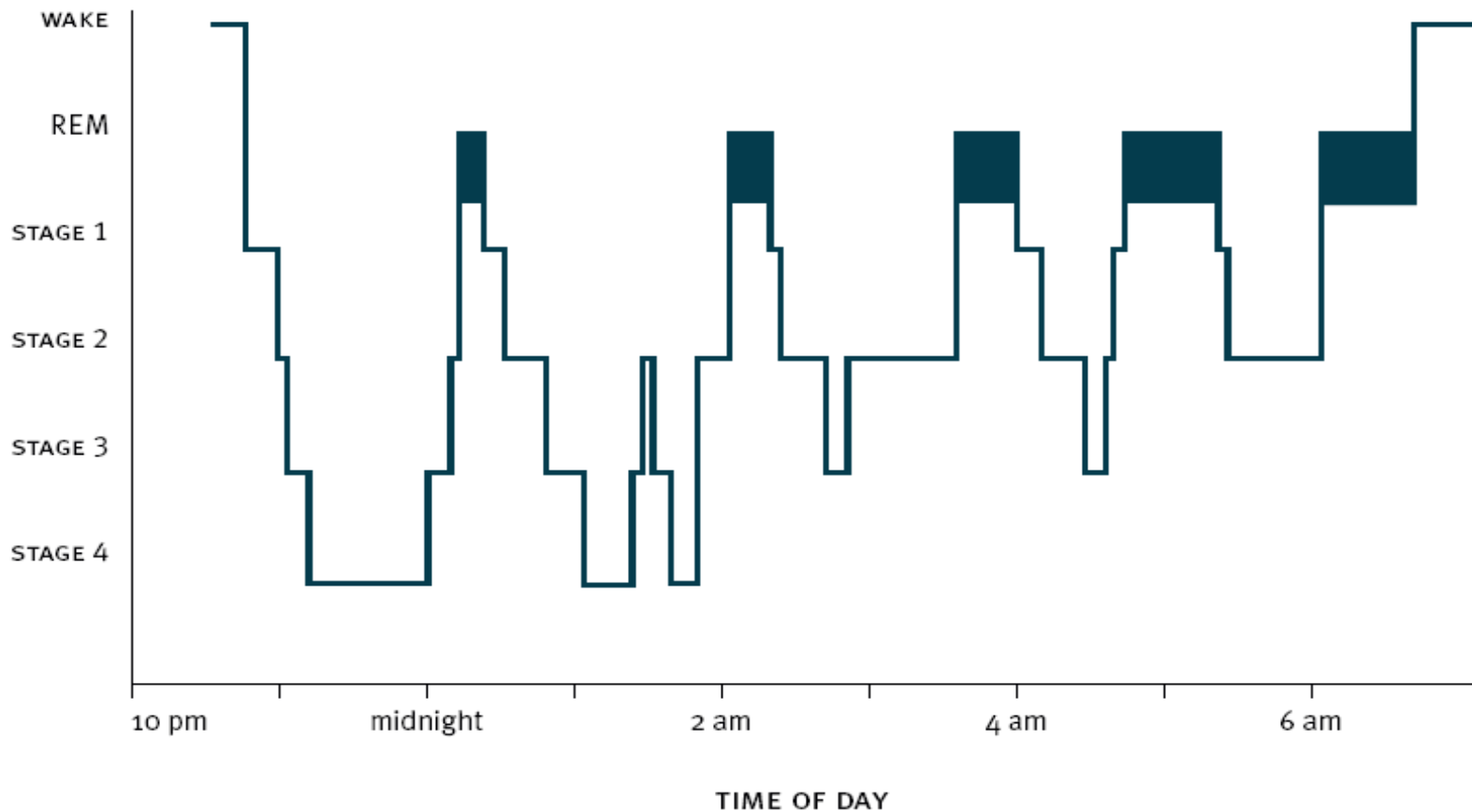
# Fatigue and safety



American MD-82 Little Rock  
Epps Challenger Birmingham  
Corporate J-31 Kirksville  
Med-Air Learjet 35 San Bernadino  
Kalitta DC-8-61F Guantanamo Bay  
Colgan Air Q400 Buffalo  
Air India Express 737 Mangalore

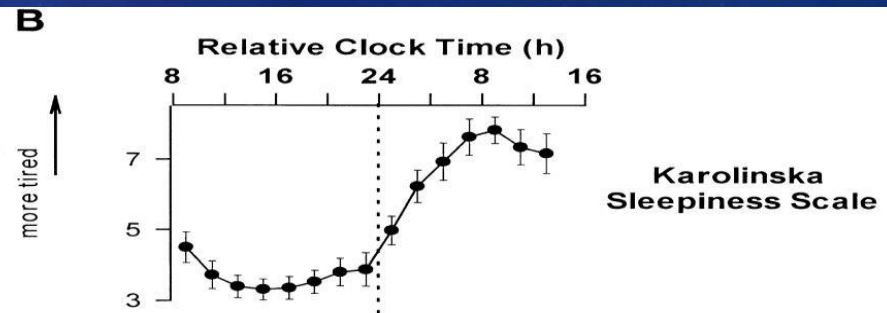
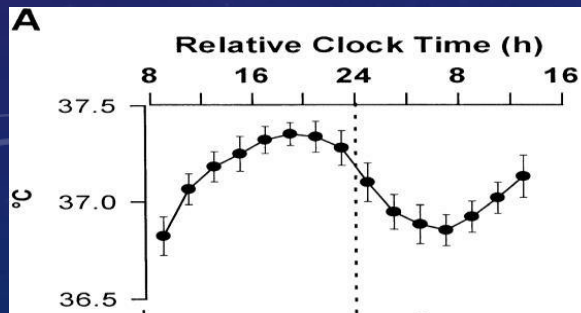
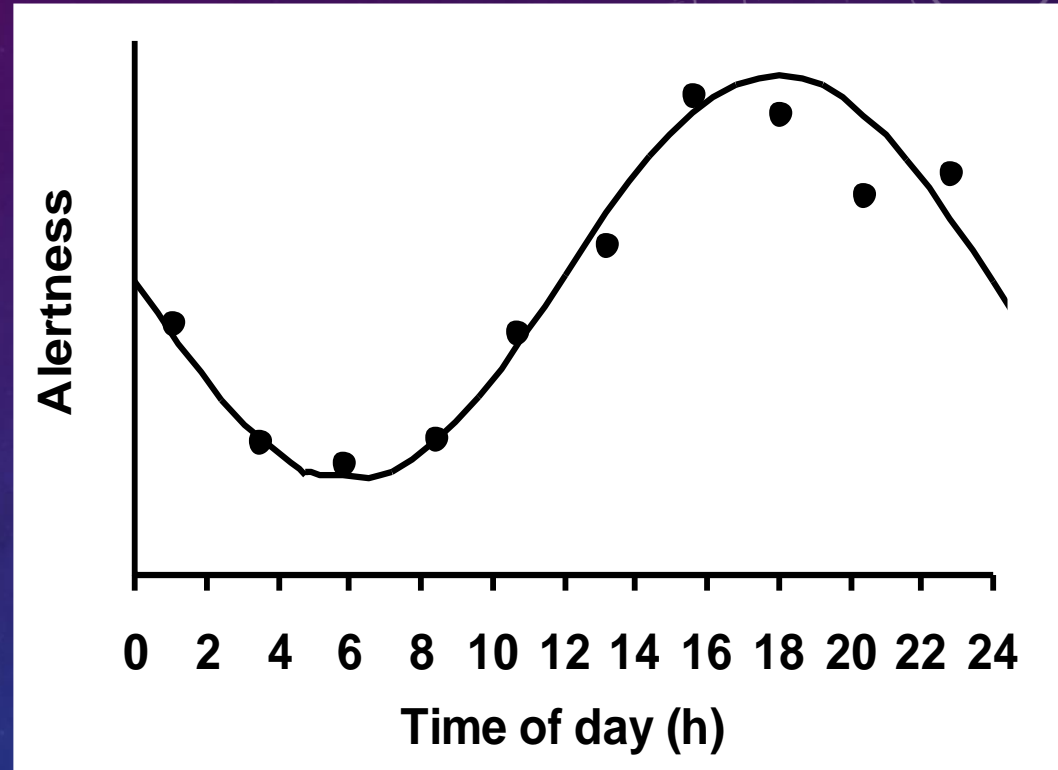
# WHAT CAUSES FATIGUE?

## 1. Sleep-related factors (acute/chronic)



# WHAT CAUSES FATIGUE?

## 2. Circadian factors



# WHAT CAUSES FATIGUE?

## 3. Task-related factors: workload, environment





# WHAT DOES FATIGUE DO TO PERFORMANCE?

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- Less vigilant
- Variable with overall slower reactions
- Forgetfulness
- “Tunnel vision”
- Poor decision-making
- Apathy
- Mood changes
- Diminished communication
- ASLEEP

# SAFETY EFFECTS IN OTHER SETTINGS

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Residents on extended shifts ( $\geq 24$  hours) vs. day shifts had more:

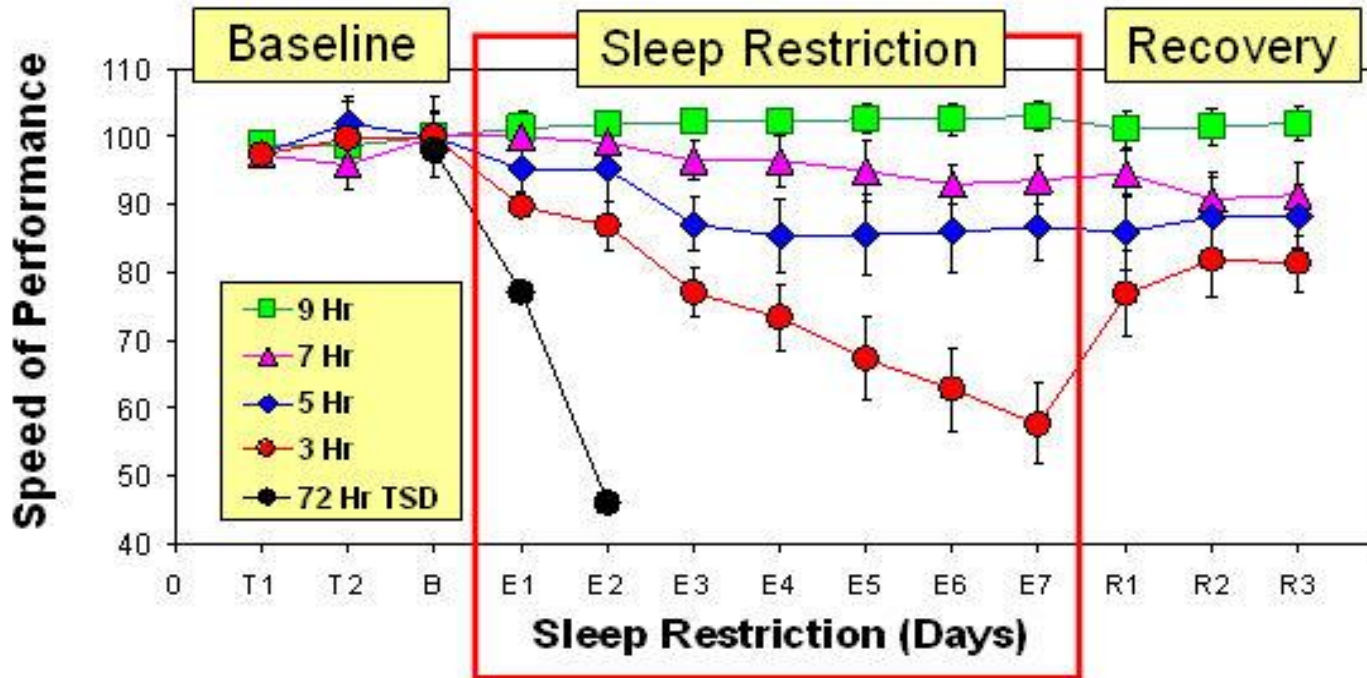
- significant medical errors, attention failures, and fatigue-related preventable adverse events resulting in fatality
- percutaneous injuries
- crashes, near misses, and falling asleep while driving

Survey of 2737 residents.  
2006; Ayas et al., PLoS 2008

Barger et al., NEJM 2005,

# Sleep Loss Degrades Performance

## Chronic, Partial Sleep Restriction Degrades Performance



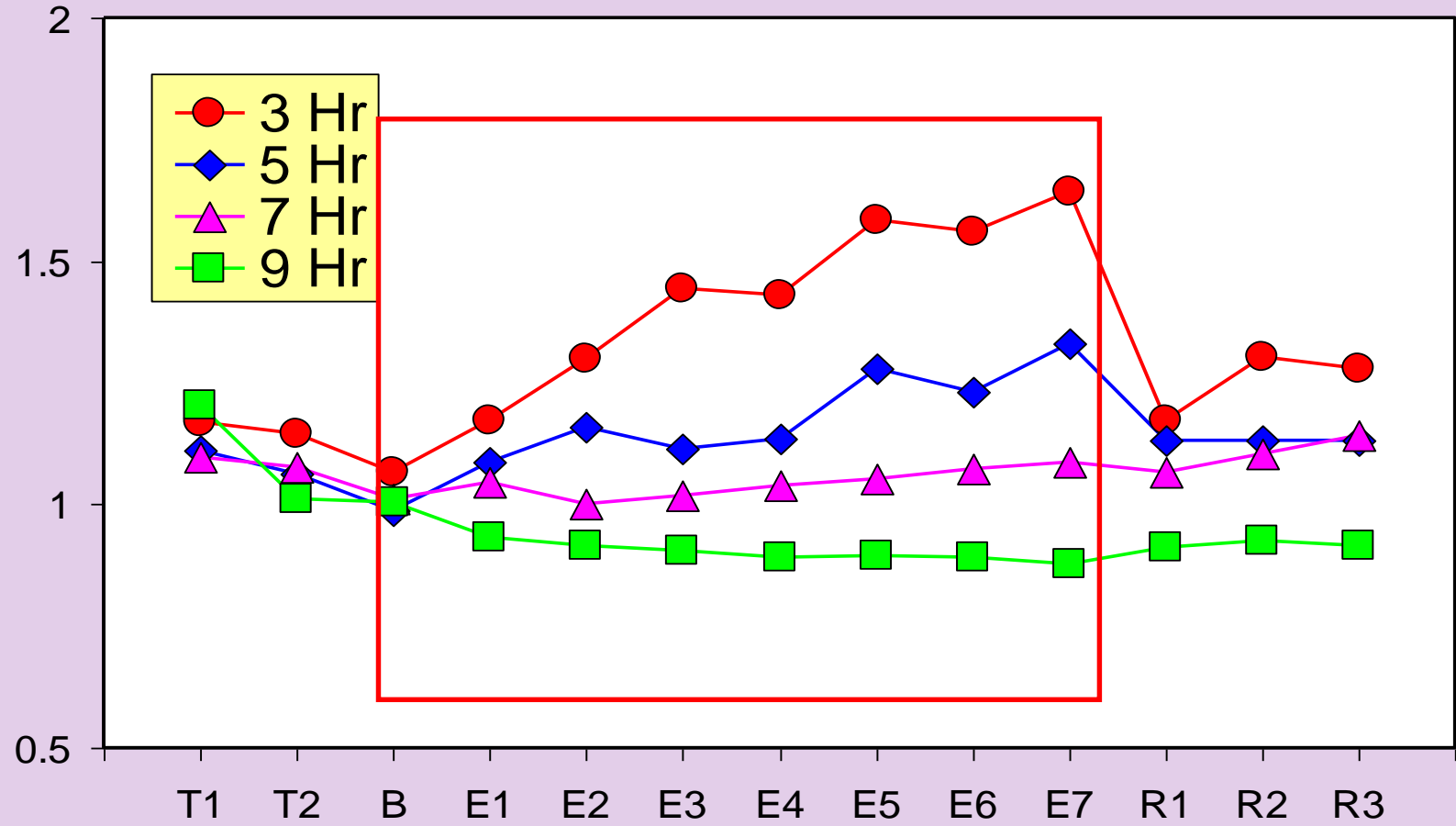
Belenky et al, J. Sleep Res. 2003



Psychomotor  
Vigilance  
Task (PVT)

# DRIVING SIMULATOR – LANE DEVIATION

Deviation of Lane Position

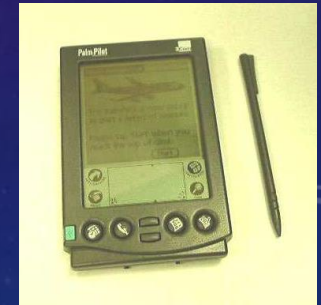


Day

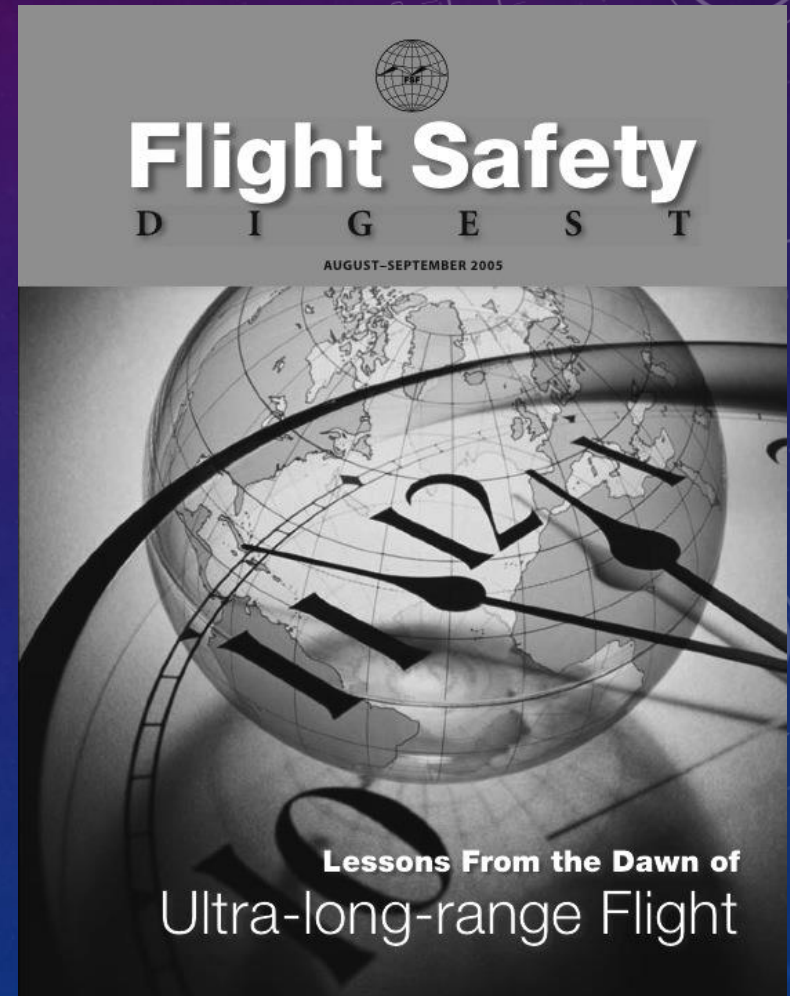
# PHASE 1 - STUDIES

Air New Zealand –  
subjective ratings and PVT

Easyjet  
– LOSA



# PHASE 2 - ULR



# Phase 3: Other studies

## Top of Descent Survey

Last descent of duty day

Self rated fatigue (SP, VAS)

Three months

>9000 responses

Three parts of operation



AIR NEW ZEALAND

### PILOT ALERTNESS REPORT FORM

Forms to be completed immediately prior to Top of Descent on last leg of duty period.

Report Time (UTC)

Time (UTC) at Top of Descent

Name the Sectors operated this duty period.

Please circle "How you feel" at Top of Descent

1. Fully alert, wide awake
2. Very lively, responsive, but not at peak
3. OK, somewhat fresh
4. A little tired, less than fresh
5. Moderately tired, let down
6. Extremely tired, very difficult to concentrate
7. Completed exhausted

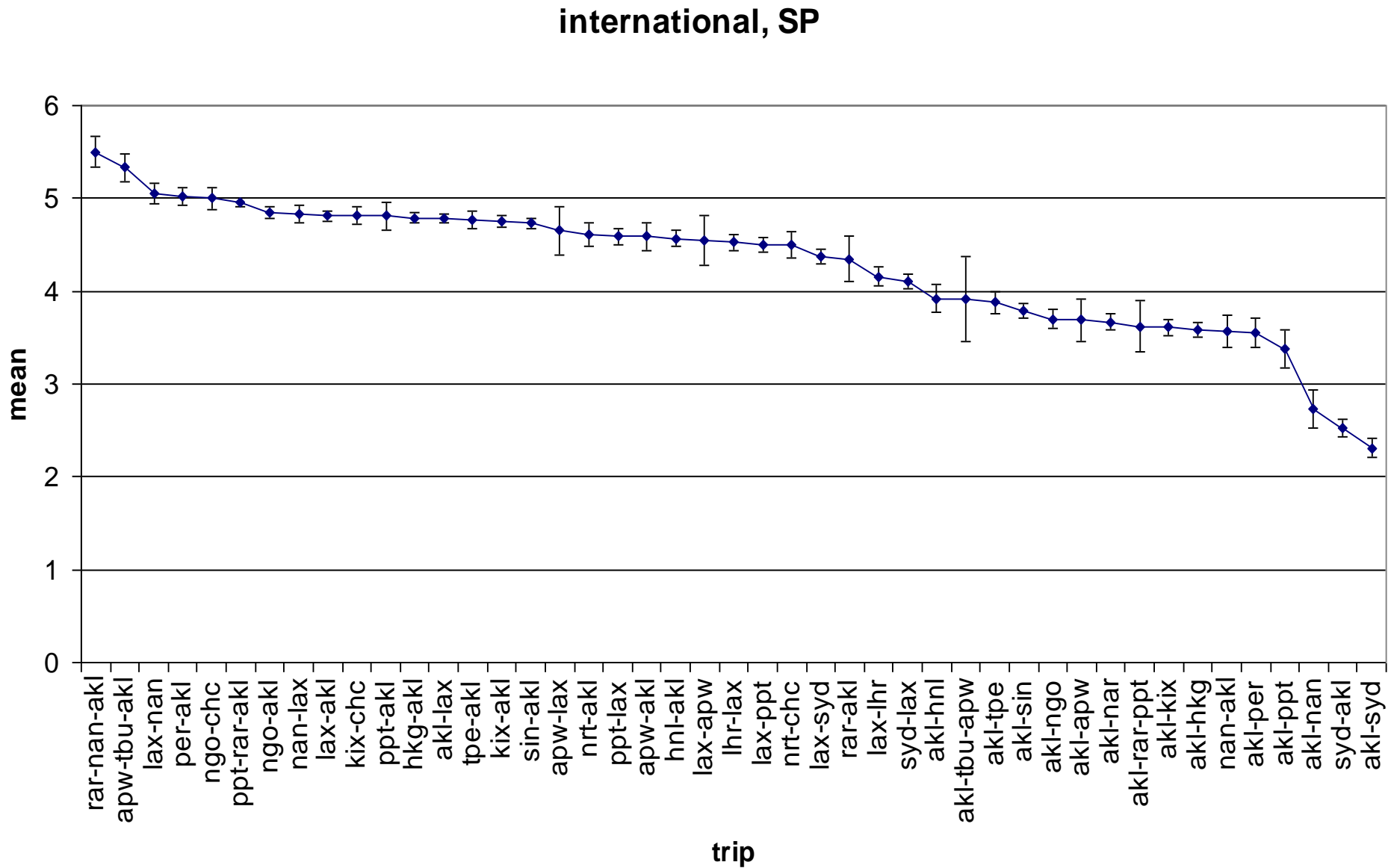
Please mark on the line below

Alert

Drowsy

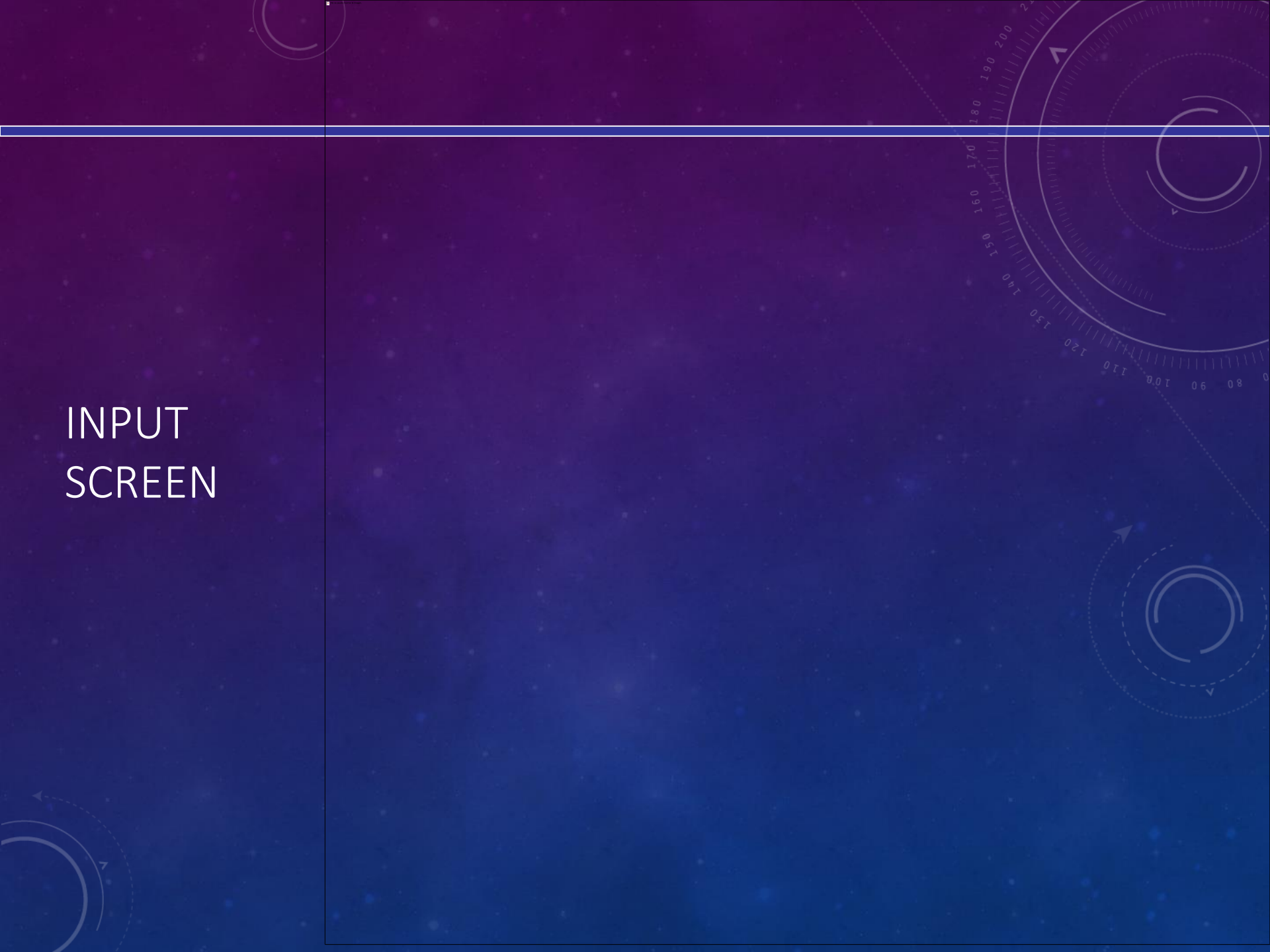
Please place in brown envelope

# Top of descent survey results (Longhaul)

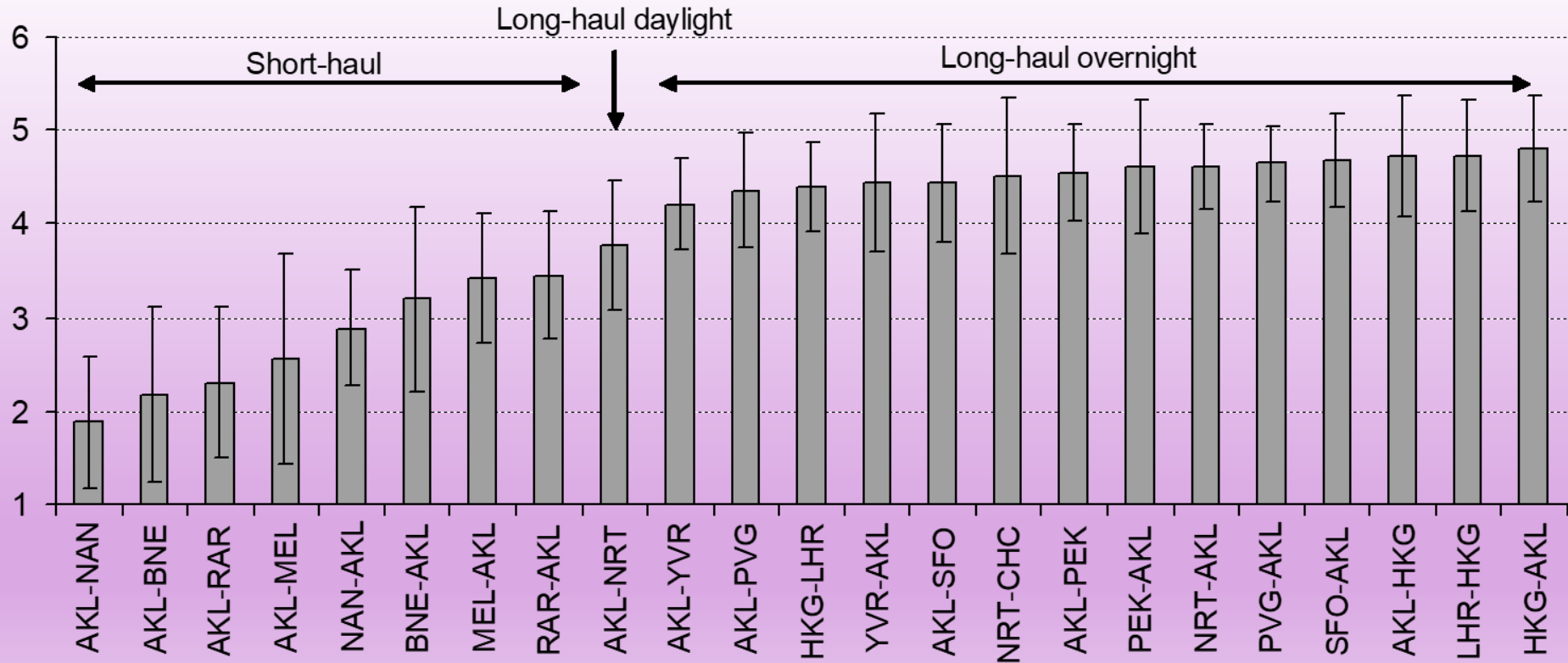




# INPUT SCREEN

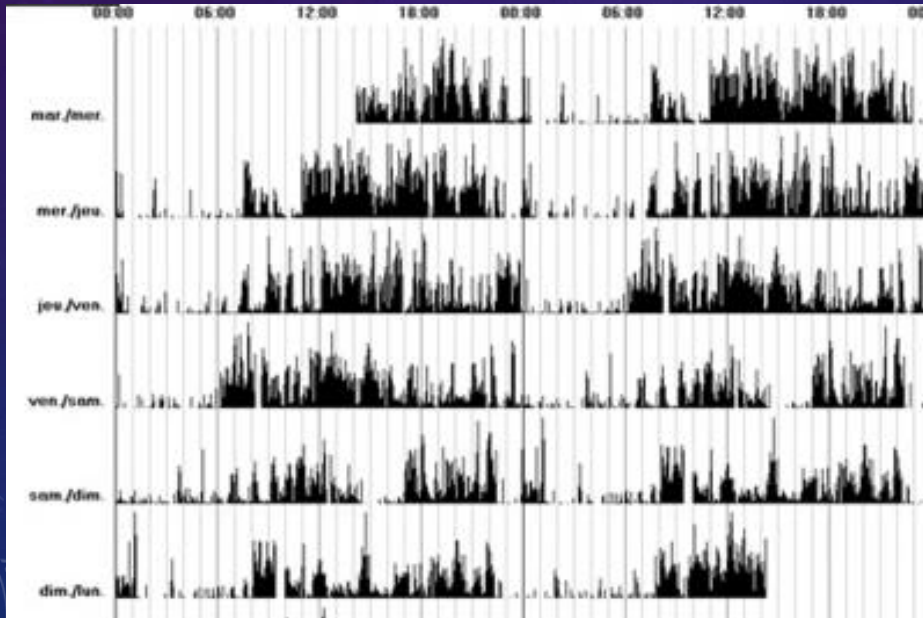
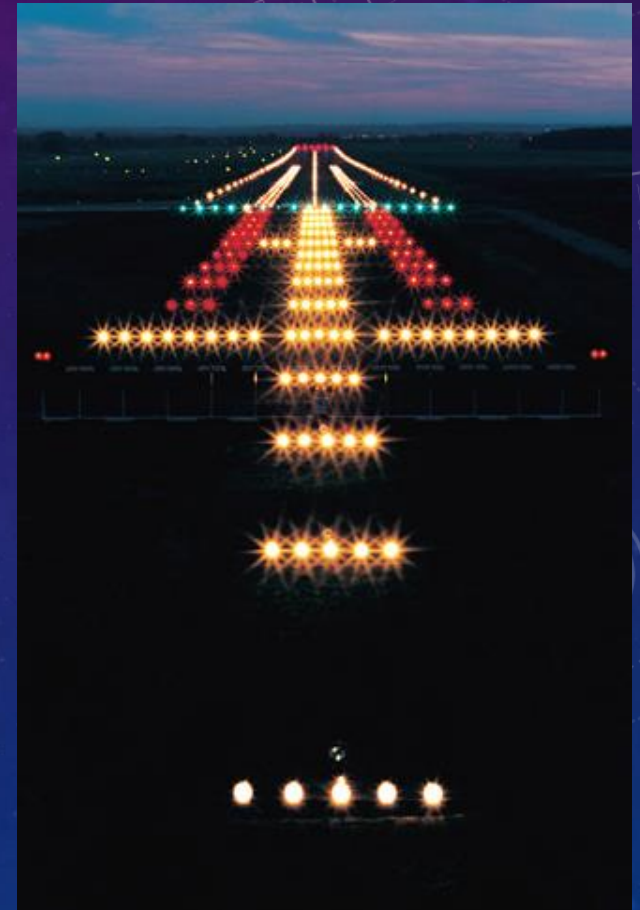


# SAMN-PERELLI SCORES BY SECTOR



Short < Long (p < 0.001)

# ACTIWATCH, SIM STUDIES



# Phase 4: 2009 ICAO Task Force on FRMS



Over 40 participants –  
States, Operators,  
Scientists, Organisations

Produced ICAO  
Standard and  
Implementation Guide  
2010

# FRMS APPROACH – DATA-DRIVEN

## Guía de Implementación OACI

1- FRMS – Política y **documentación**

2- **Procesos** de evaluación de riesgo en fatiga

Identificar amenazas de fatiga

- Reactivo, proactivo, **predictivo**

Identificar riesgos de fatiga

Intervenciones para controlar el riesgo de fatiga

3- FRMS – Procesos de **garantía** de seguridad

Incluyendo medidas de efectividad

4- FRMS – procesos de **promoción** – entrenamiento, educación

# 5. FATIGUE MODELS

Based on combination of at least 2 processes - circadian and sleep components

Several available

BAM

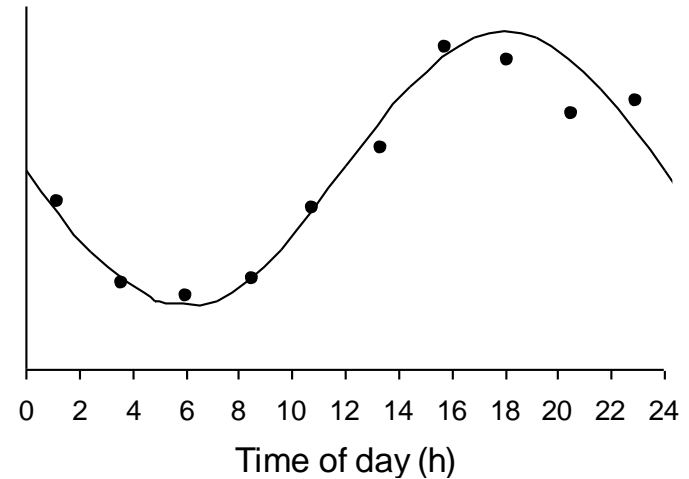
CAS

SAFE

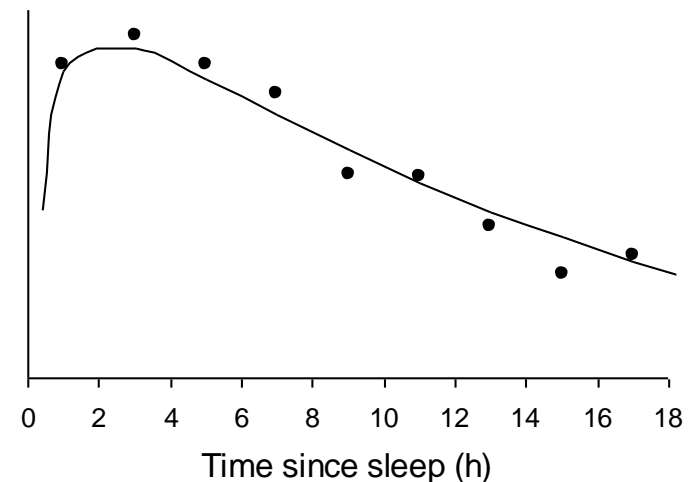
FAID

SAFTE/FAST

Alertness

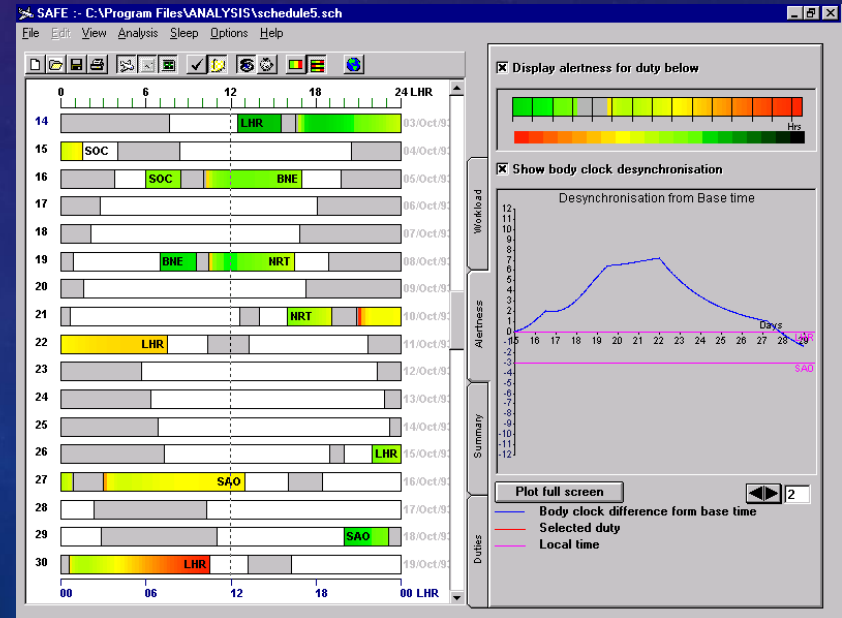
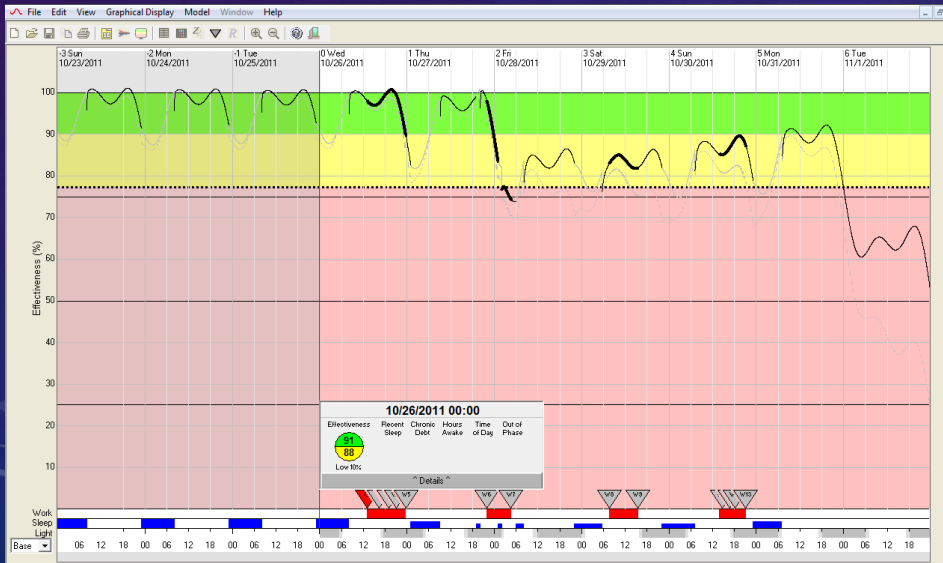


Alertness

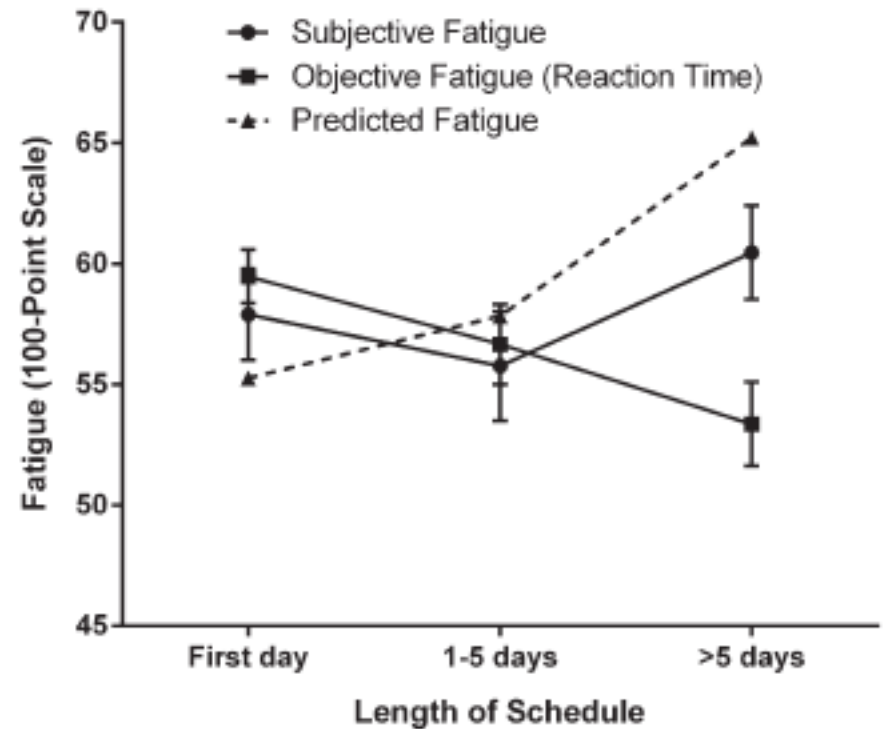
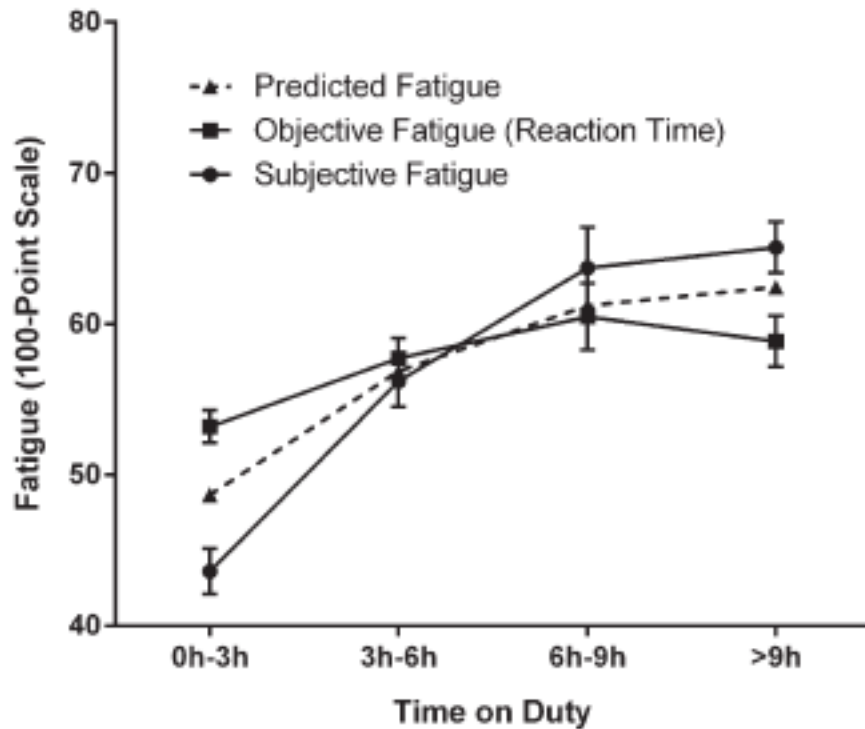


# CHALLENGES WITH MODELS

VALIDATION  
STANDARDS  
Over Reliance - EDUCATION  
Accuracy – MORE DATA



# IN-FLIGHT MEASURES VS MODEL PREDICTIONS



Powell DMC, Spencer MB, Petrie KJ  
of a bio-mathematical fatigue model

Comparison of in-flight measures with predictions  
Aviat Space Envir Med 2014 85:1177-84



## BOEING STUDY (THOMAS 2015)

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- no single measurement device was found to reliably indicate fatigue levels with enough granularity.....
- a learning model was constructed that was able to accurately categorize ..... data with a success rate greater than 95%.

# PHASE 6 – REGULATION REVIEW

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## Regulations for FRMS – USA FRMP

### Review of FTLs

USA

EU

Australia

Argentina

etc etc

The background features a dark blue gradient with faint, light blue technical diagrams. On the left, a large circular scale is visible with numerical markings from 160 to 260 in increments of 10. Several circular arrows and dashed lines are scattered across the scene, suggesting a technical or engineering context.

# FATIGUE RISK MANAGEMENT

WHAT ARE PHASES 7 AND 8?

# 1. What about safety?

How much fatigue = how much effect on safety?



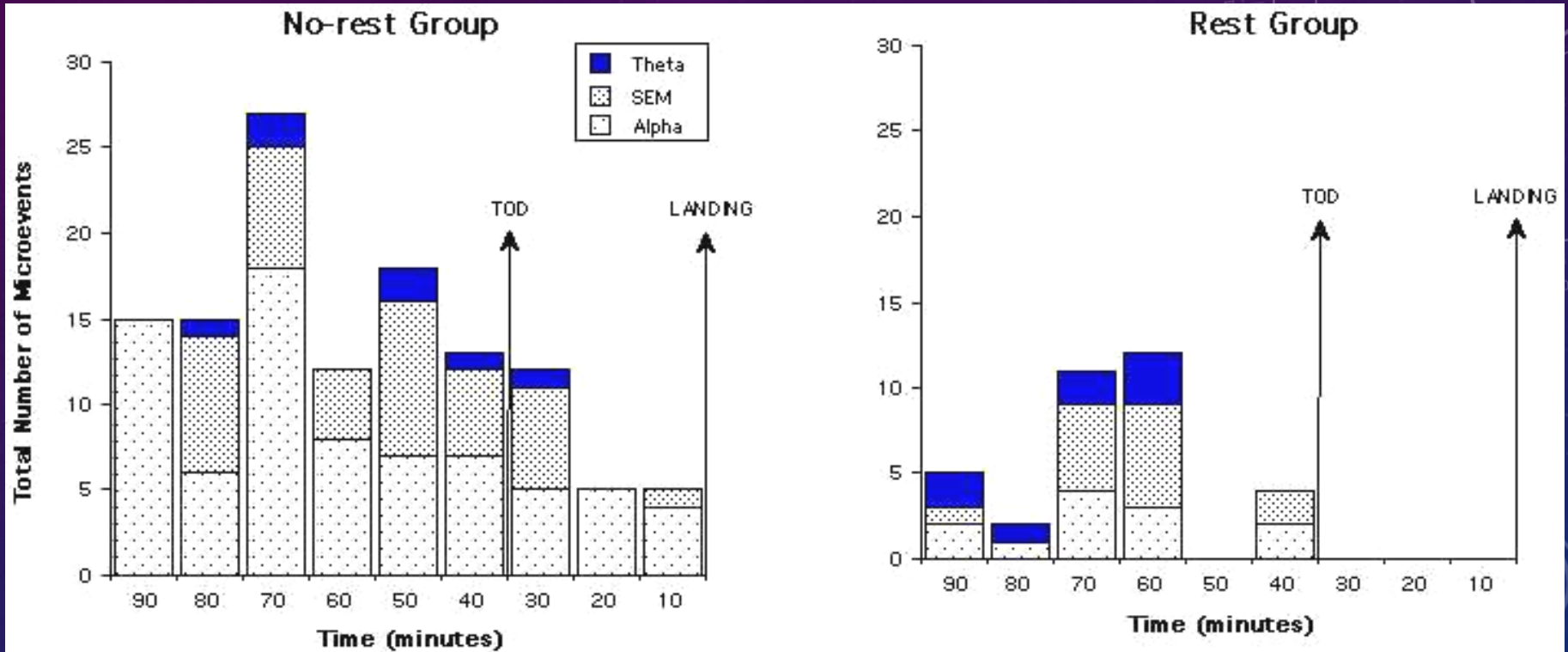
## FEW STUDIES TO DATE

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- easyJet – LOSA
- Qantas – simulator study
- Thomas – LOSA compared to sleep 24h\*
- French regional airlines – FOQA
- Other FOQA work
- MORE WORK NEEDED – FOQA, LOSA?

Thomas MJ, Ferguson SA. Prior sleep, prior wake, and crew performance during normal flight operations. *Aviat Space Environ Med* 2010 Jul;81(7):665-70.

## 2. COCKPIT NAPPING



**A 26-min nap improved subsequent physiological alertness and performance, especially during descent and landing**

# ASMA 2009

- **Given the scientific evidence** that cockpit napping is safe and highly effective, as well as clear indications that the general public appreciates the value of cockpit napping, **we take exception to the current prohibition on in-seat cockpit napping** in civil aviation, and instead recommend that **in-seat cockpit naps up to 45 min in duration be permitted** in U.S. commercial flight operations

Caldwell JA, Mallis MM, et al, Aerospace Medical Association Aerospace Fatigue Countermeasures Subcommittee of the Human Factors committee. *Fatigue countermeasures in aviation*. Aviat Space Environ Med 2009; 80:29–59.

# GUÍA DE IMPLEMENTACIÓN OACI

1- FRMS – Política y **documentación**

2- **Procesos** de evaluación de riesgo en fatiga

Identificar amenazas de fatiga

- Reactivo, proactivo, predictivo

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Intervenciones para controlar el riesgo de fatiga

3- FRMS – **Procesos de garantía de seguridad**

**Incluyendo medidas de efectividad**

4- FRMS – procesos de **promoción** – entrenamiento, educación



# Questions?



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