SCIENCE IN AN OPERATIONAL SETTING

Philippa Gander
Sleep/Wake Research Centre, Massey University

Jim Mangie
Delta Air Lines

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Outline

- What to measure
- When to measure
- Interpreting the data
  - Safety Performance Indicators
- Conclusions

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What to Measure: Crew Fatigue

ICAO definition of fatigue:

A physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a crew member's alertness and ability to safely operate an aircraft or perform safety related duties.

- **Functional status (subjective ,objective)**
- **Sleep history**
- **Circadian phase**
- **Workload**

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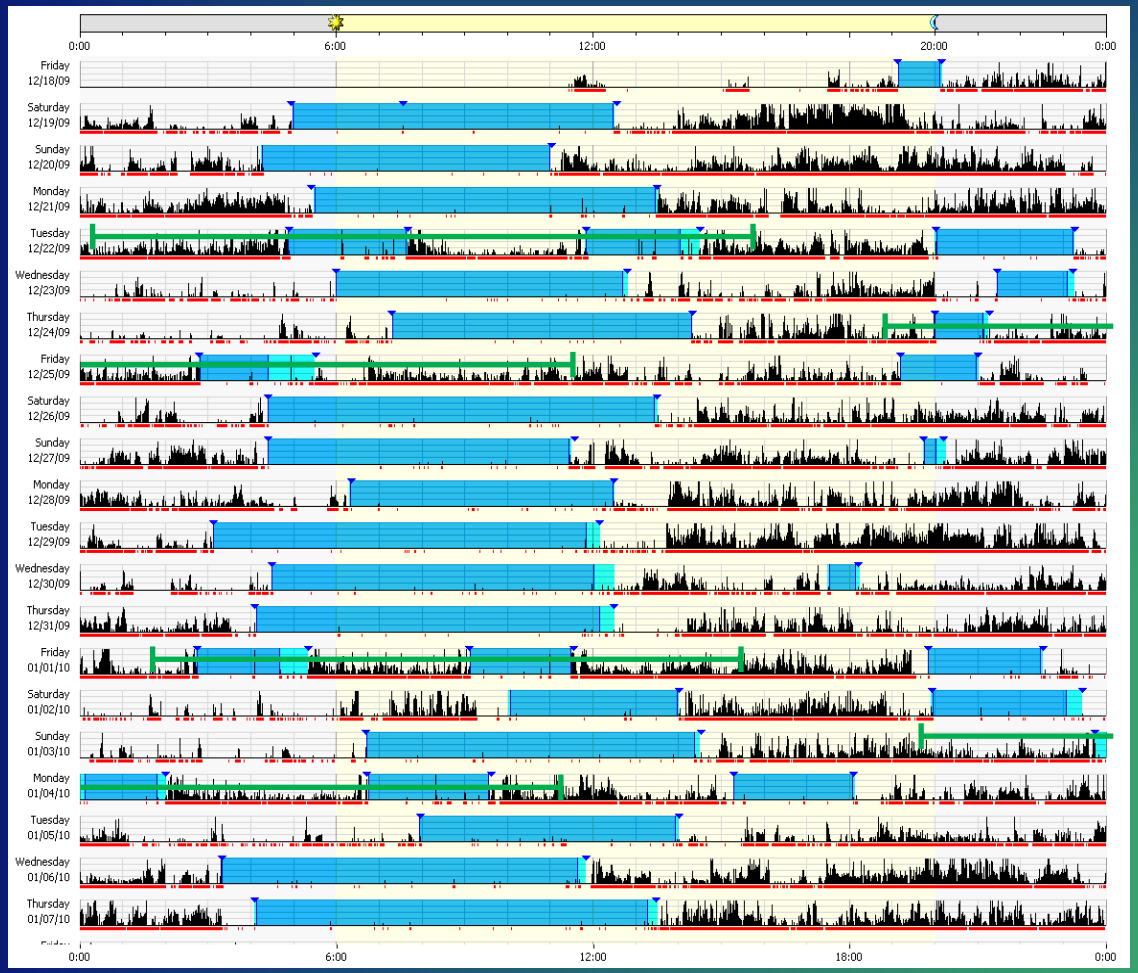
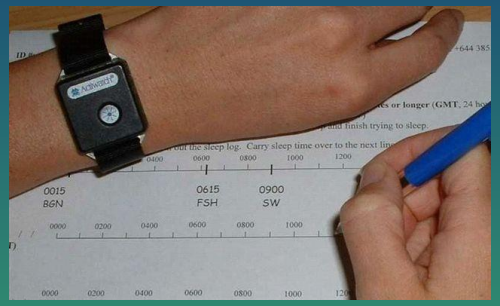
Sleep: Actigraphy and Diaries





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When to Measure Crew Fatigue

- Monitoring for FRM Processes
  - In response to a series of fatigue reports
    - to identify extent and severity of hazard
  - In response to an incident
  - SPIs to evaluate effectiveness of fatigue mitigations and controls
  - Validation of a new route
- Monitoring for FRMS Assurance Processes
  - SPIs set in FRMS Policy objectives
  - SPIs for regulatory audit

Crew fatigue measures may not always be needed

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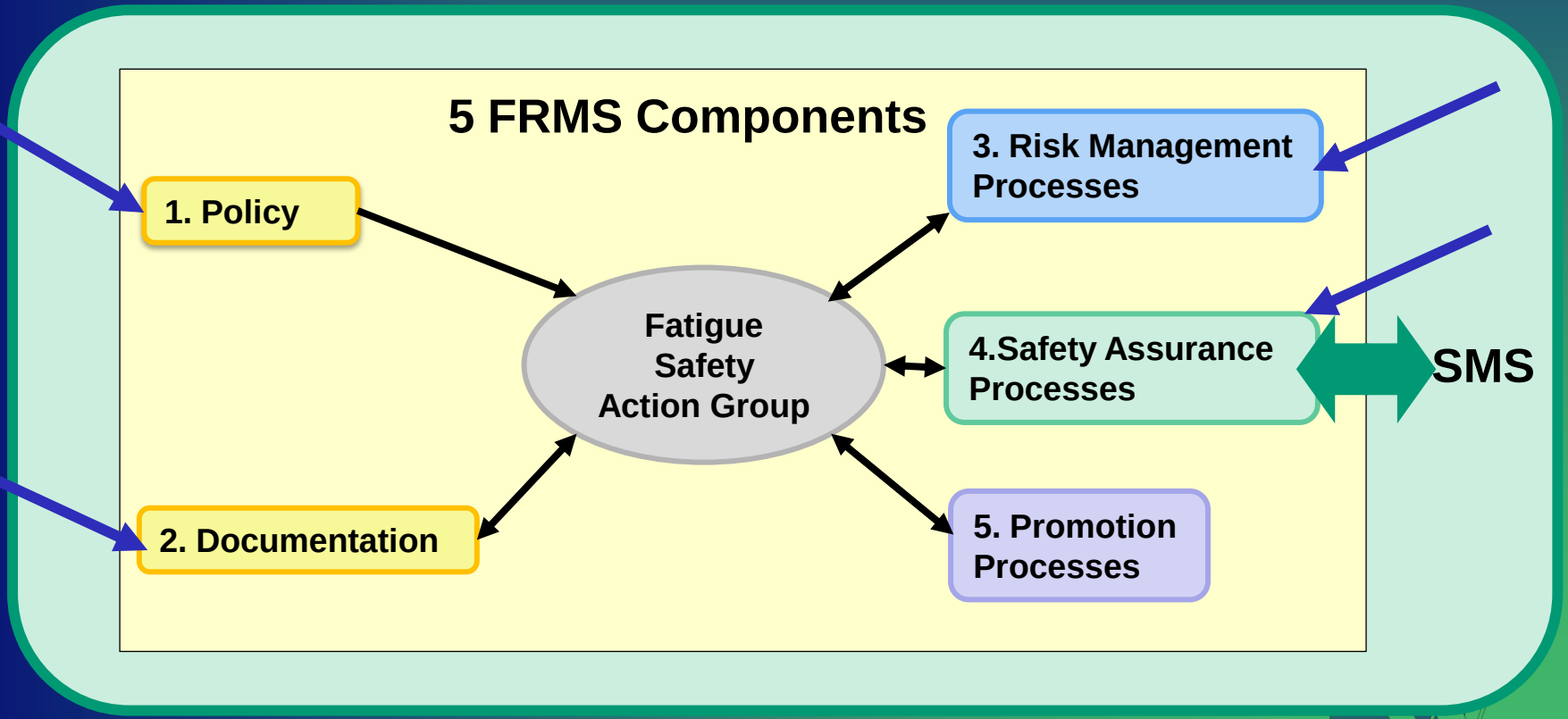
Safety Performance Indicators (SPIs)



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Safety Performance Indicators: Example

Comparing fatigue on ULR and LR flights

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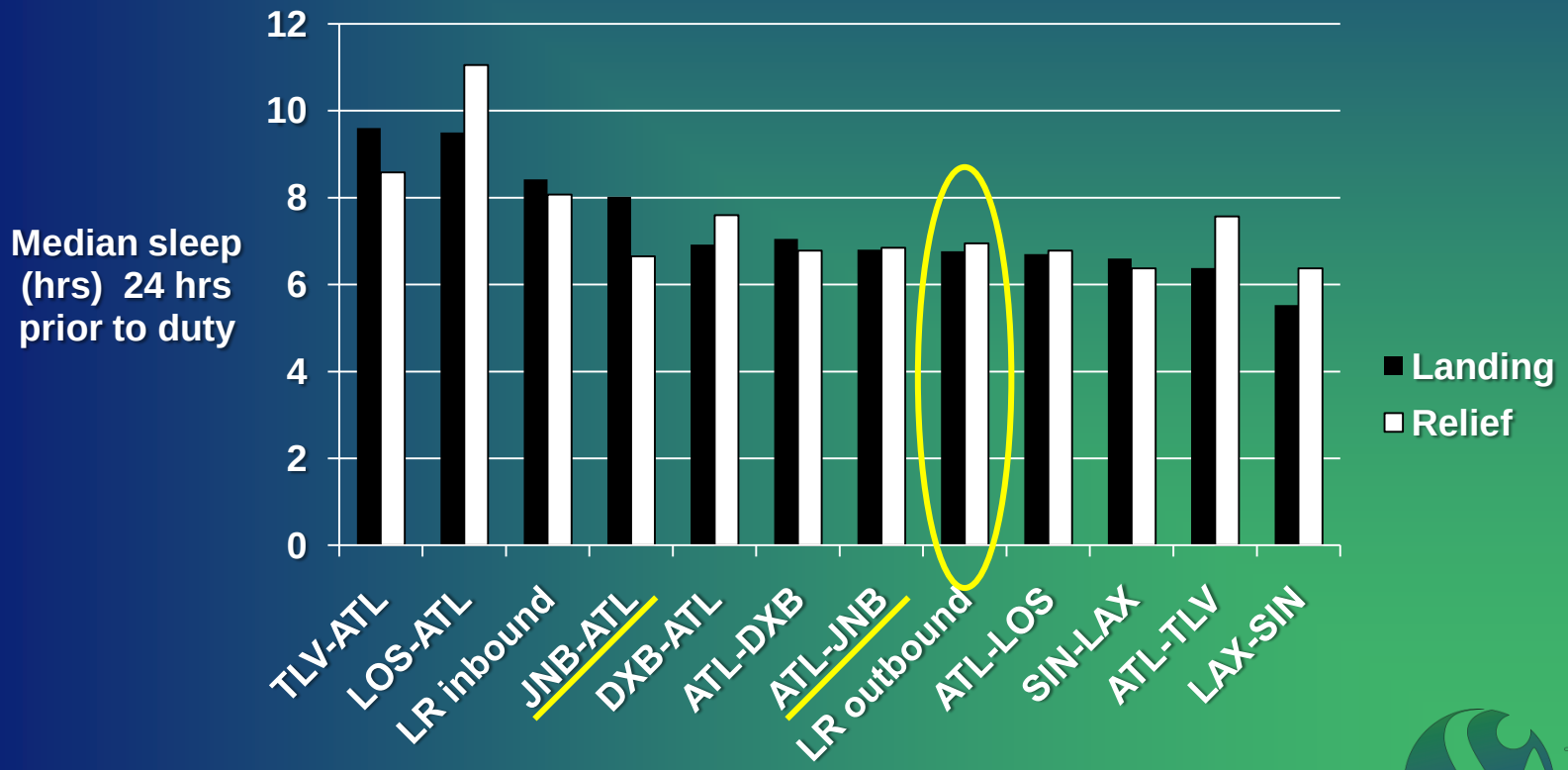
Fatigue Status at Start of Duty

SPI – sleep in the last 24 hrs



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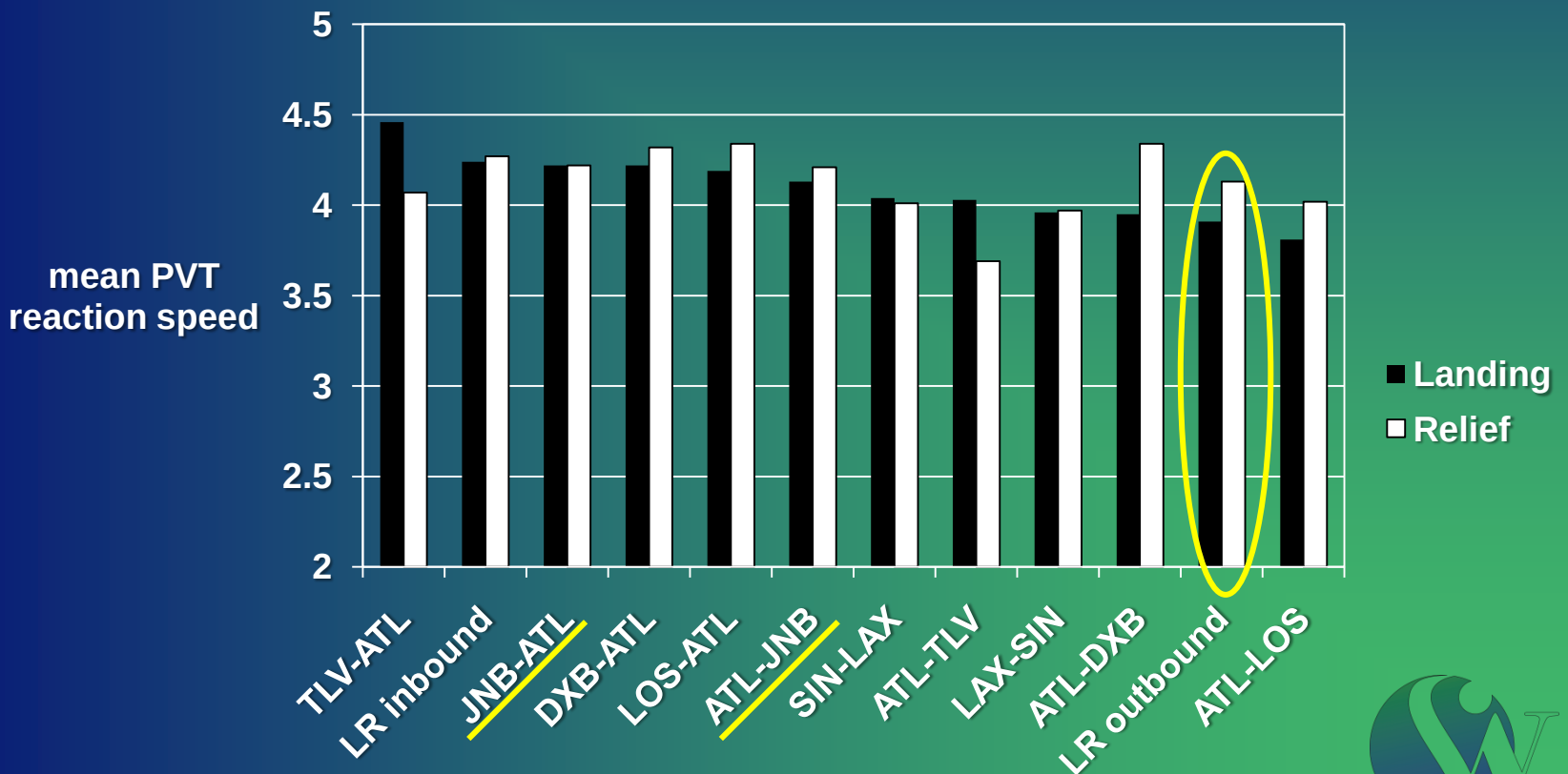
Fatigue Status at Start of Duty

SPI – mean PVT reaction speed early in flight



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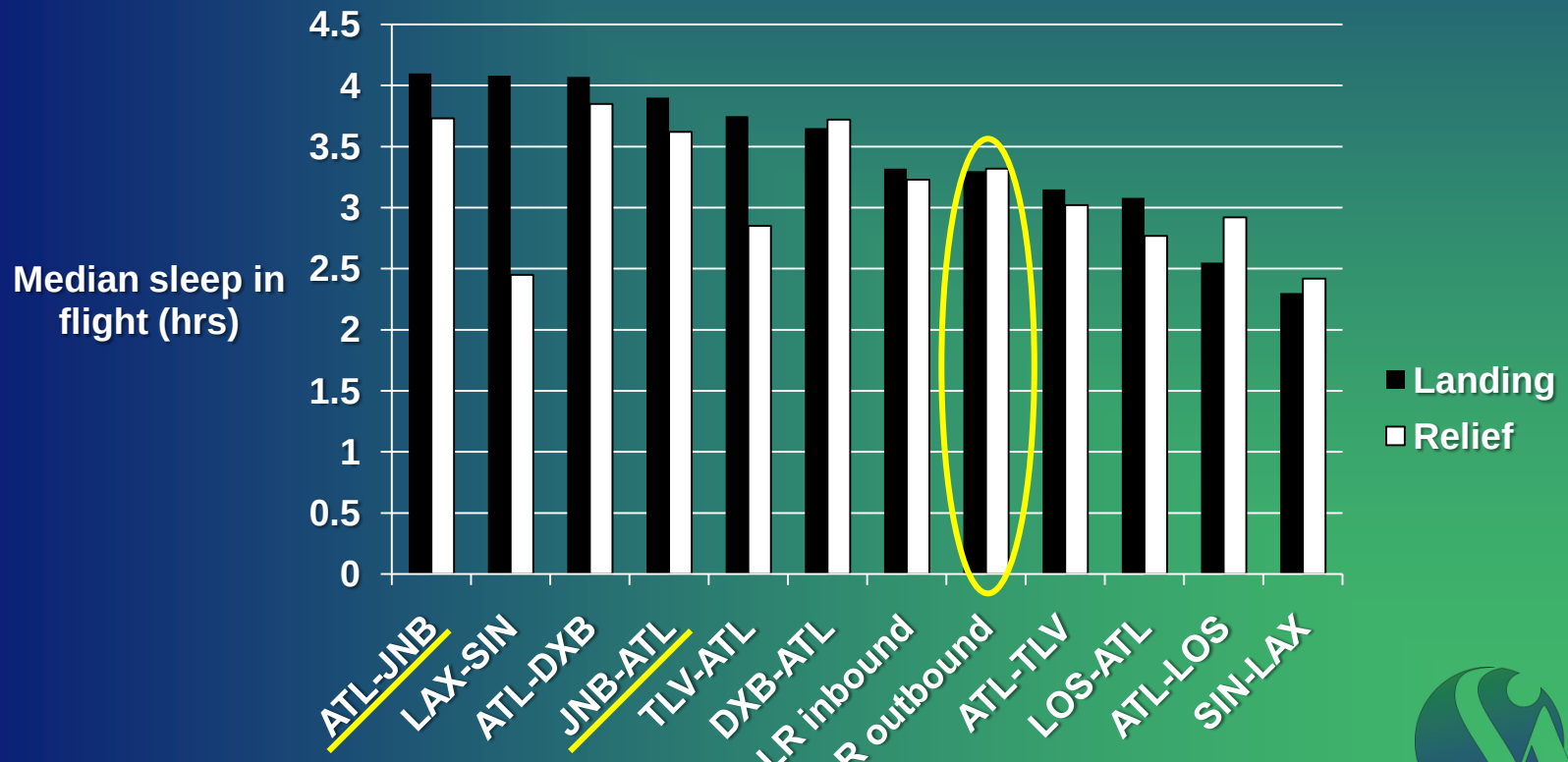
Fatigue Status at Top of Descent

SPI – median total in-flight sleep



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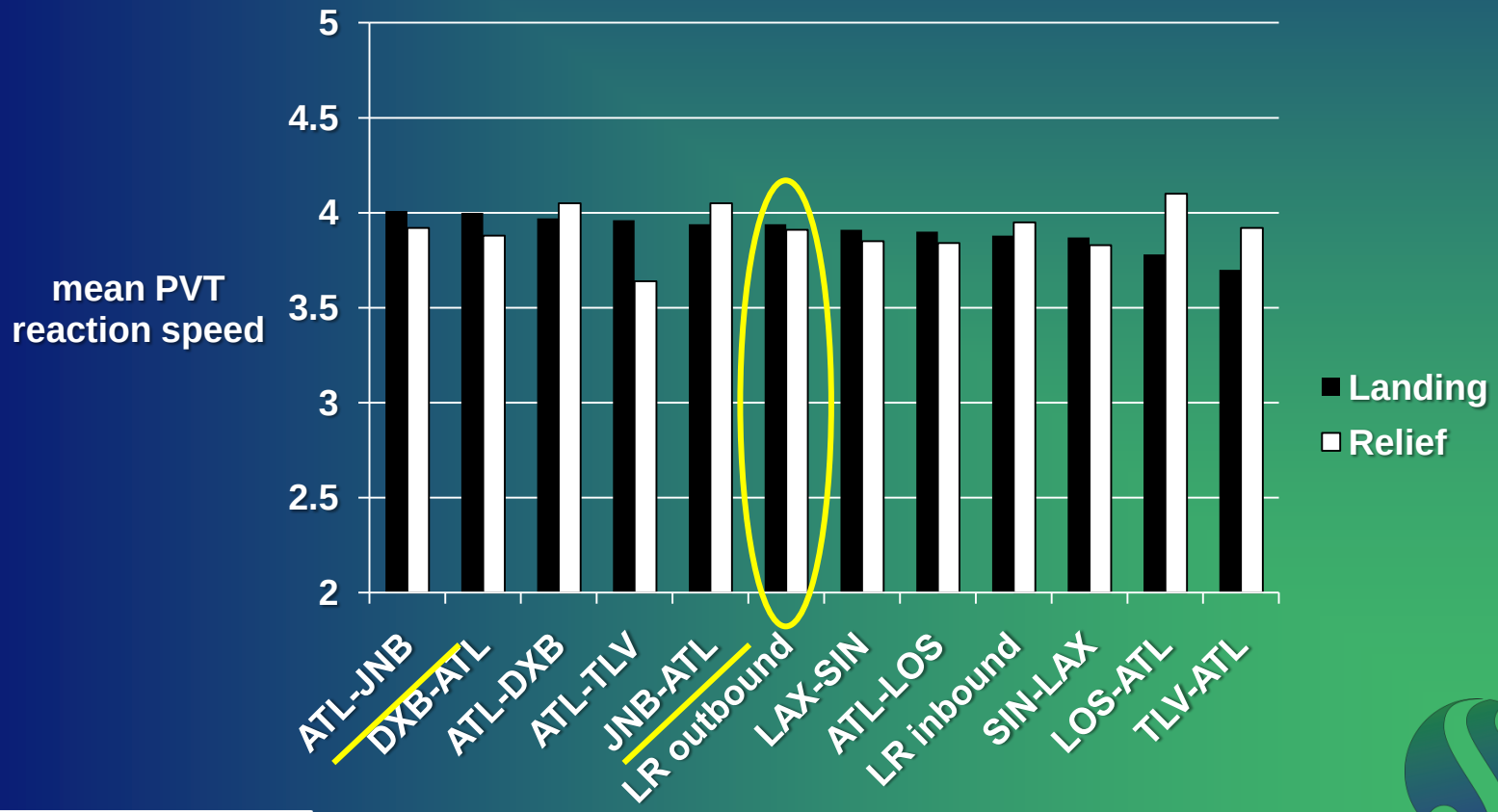
Fatigue Status at Top of Descent

SPI – mean PVT reaction speed late in flight



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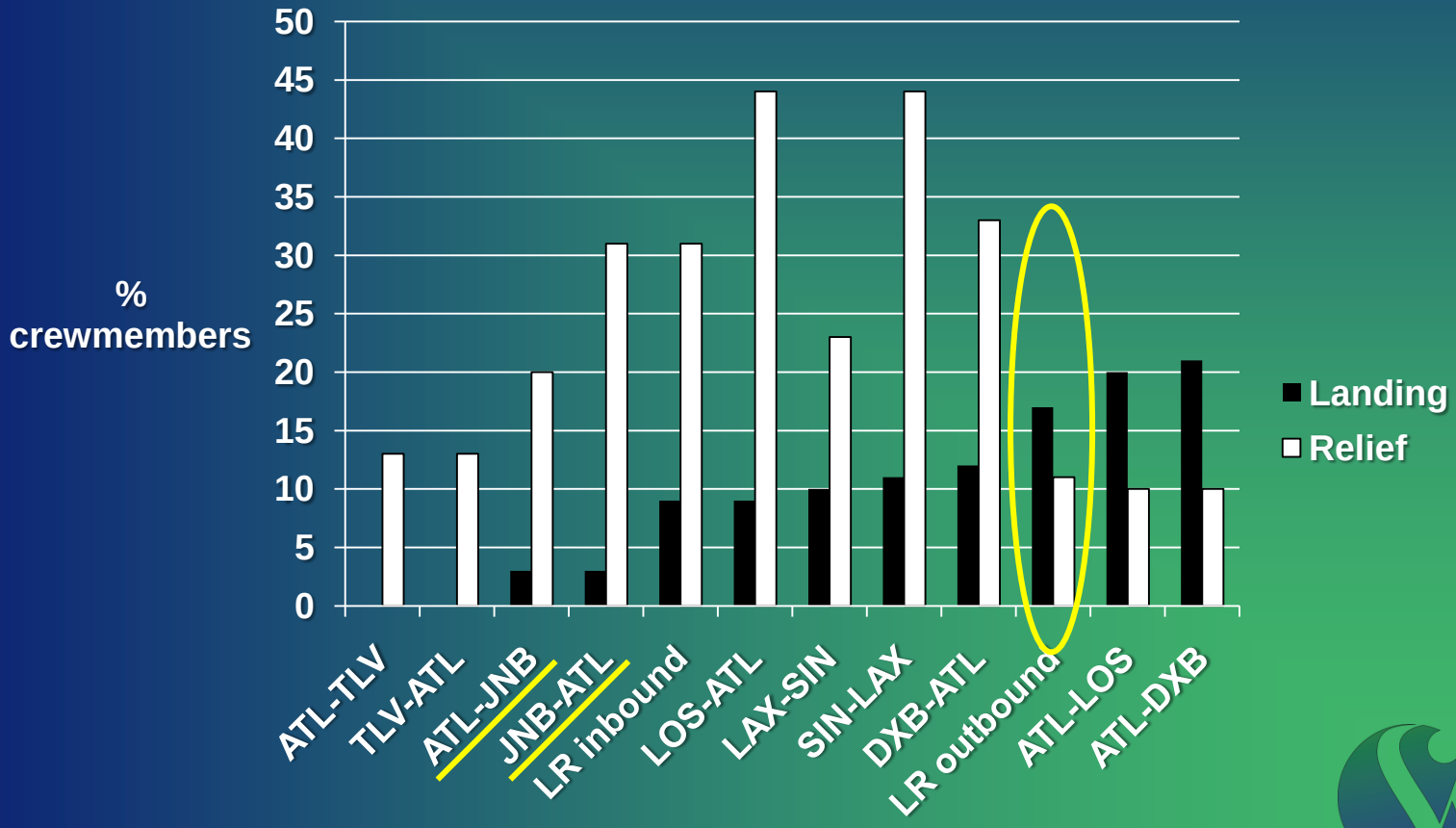
Fatigue Status at Top of Descent

SPI – % crew with KSS ≥ 7



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Operational SPIs: Examples

- Track data on number of :
  - exceedances of planned crew duty day (e.g. > 14 hrs)
  - flight duty periods ending > 30 mins later than scheduled
  - flight duty periods starting / ending within window of circadian low (WOCL)
  - reserve crew call-outs (on particular flights, at a particular crew base, etc)

Monitoring of FRM processes

Monitoring of FRMS safety assurance processes

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Conclusions

- Challenge
  - Developing in-house expertise versus using consultants ($$)
- Data sharing
  - Operators don't have to reinvent the wheel
  - Rich data source for improving fatigue science
- Needs
  - Paradigms for data sharing
  - Better indicators of fatigue-related performance impairment
  - Better fatigue measurement technologies
  - Better fatigue risk assessment (safety consequences of being fatigued in a given context)
  - Better fatigue risk controls and mitigations

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Cooperation is the key

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