



Predicting Sleep/Wake Behaviour in Operational Settings

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InterDynamics

Background:

- Not Researchers
- We specialise in Decision Support Solutions – in particular we provide a full suite of Fatigue Risk Management software and services
- In 2000 we implemented research by Adam Fletcher and Drew Dawson as FAID[®]
- In 2016 we implemented research by David Darwent, Drew Dawson and Greg Roach as FAID Quantum

Bio-mathematical Models

Ground Rules:

- There is no unit or absolute measure of fatigue
- The sleep needs and responses to sleep deprivation vary significantly between people
- An individual's alertness, sleepiness and/or fatigue, is better predicted if actual hours of sleep are known

Bio-mathematical Models

Ground Rules:

- For a practical decision support tool to function it must be driven from available data, and in the work environment, actual sleep data is usually not available for past events and not available for future events

Bio-mathematical Models

Ground Rules:

- The model must be good enough to predict the relative fatigue response of the average person to a pattern of work hours such that patterns of work with higher fatigue exposure may be identified, enabling appropriate risk management assessment and responses

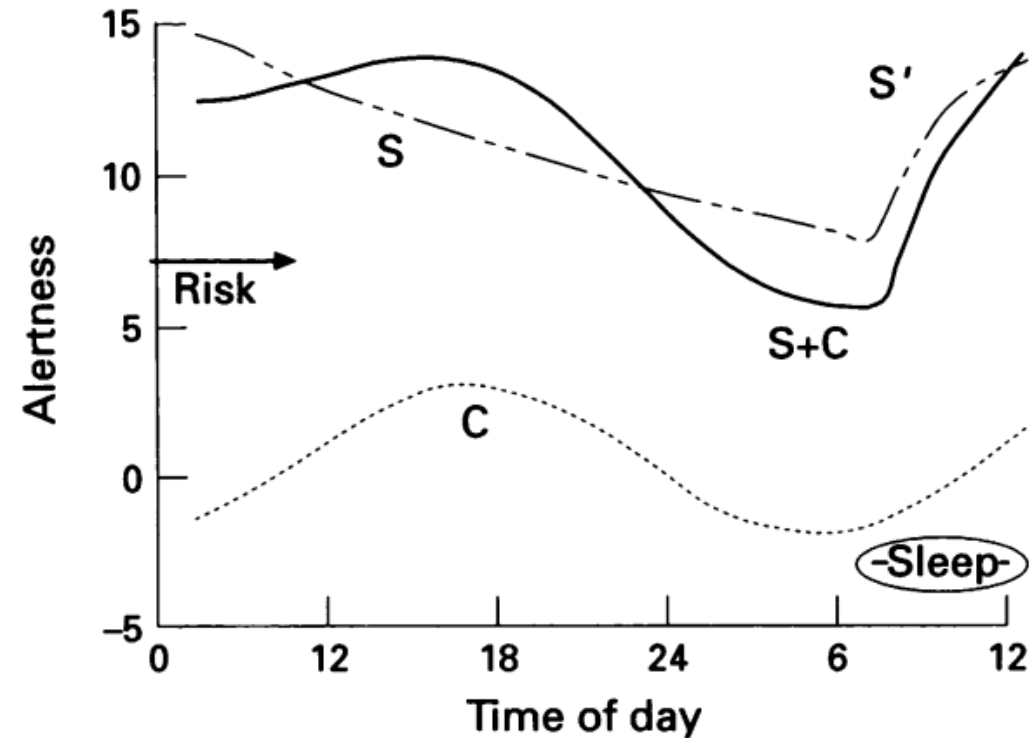
Three/Two Process Model of Alertness

Torbjörn Åkerstedt (1995 – on)

Process C - Circadian

Process S - Time awake

Process W - Sleep inertia



FAID

Adam Fletcher, Drew Dawson (1995 – 2000)

Australian rail based research. 55,000 hours of data from train drivers.

- Duration of work & breaks
- Time of day of work & breaks
- Work history from preceding 7 days
- Biological limits on recovery sleep

FAID

Model:

- Each hour of the day has a weighing factor for work periods and for non-work periods (C and S processes)
- Scores for each of the past 168 hours are accumulated using a linear weighting with most recent most influential. (Partially S and Work load?)

FAID

Quick benchmarks:

- Monday to Friday: **9am to 5pm**
 - 40-hour standard work week
 - Peak **FAID Score 40**
- Monday to Friday: **11pm to 7am**
 - 40-hour work week
 - Peak **FAID Score ~95**

FAID Quantum

David Darwent, Drew Dawson (2010 – 2016)

Australian rail and aviation based research. 15,000 days of work/sleep data. Half is long haul aviation with 1/3 of that West bound, 1/3 East bound and 1/3 Northward. The remainder is regional aviation and rail.

Half this data was used to parameterize a sleep prediction algorithm. The remaining half used to validate the parameterized algorithm.

FAID Quantum

Accident Analysis and Prevention 45S (2012) 6–10



Contents lists available at [SciVerse ScienceDirect](#)

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap



A model of shiftworker sleep/wake behaviour

David Darwent*, Drew Dawson, Gregory D. Roach

Centre for Sleep Research, University of South Australia, GPO Box 2471, Adelaide, South Australia 5001, Australia

FAID Quantum

Model:

- FAID Quantum predicts amount and timing of likely sleep from work/rest data

FAID Quantum

The sleep predictor accuracy (non-transmeridian):

- Model outputs had 85% agreement (15% error rate) with observed sleep and wake times
- Intra-individual agreement between serial episodes of sleep behaviour in matched rest periods was similarly robust (90%), but nonetheless associated with an intrinsic level of behavioural variation in the order of 10%
- The scope for improvement in the sleep predictor model is minor (i.e., $15 - 10 = 5\%$)

FAID Quantum

The sleep predictor accuracy (transmeridian):

- Model outputs had ~82% agreement (~20% error rate) with observed sleep and wake times
- Intra-individual agreement between serial episodes of sleep behaviour in matched rest periods was ~80%, but based upon a small dataset for pilots who had completed the same flight sequences/break length sequences

FAID Quantum

Model:

- From the predicted sleep or user supplied sleep data Karolinska Sleepiness Scale (KSS) scores are calculated utilising the Three/Two Process Model

Karolinska Sleepiness Scale

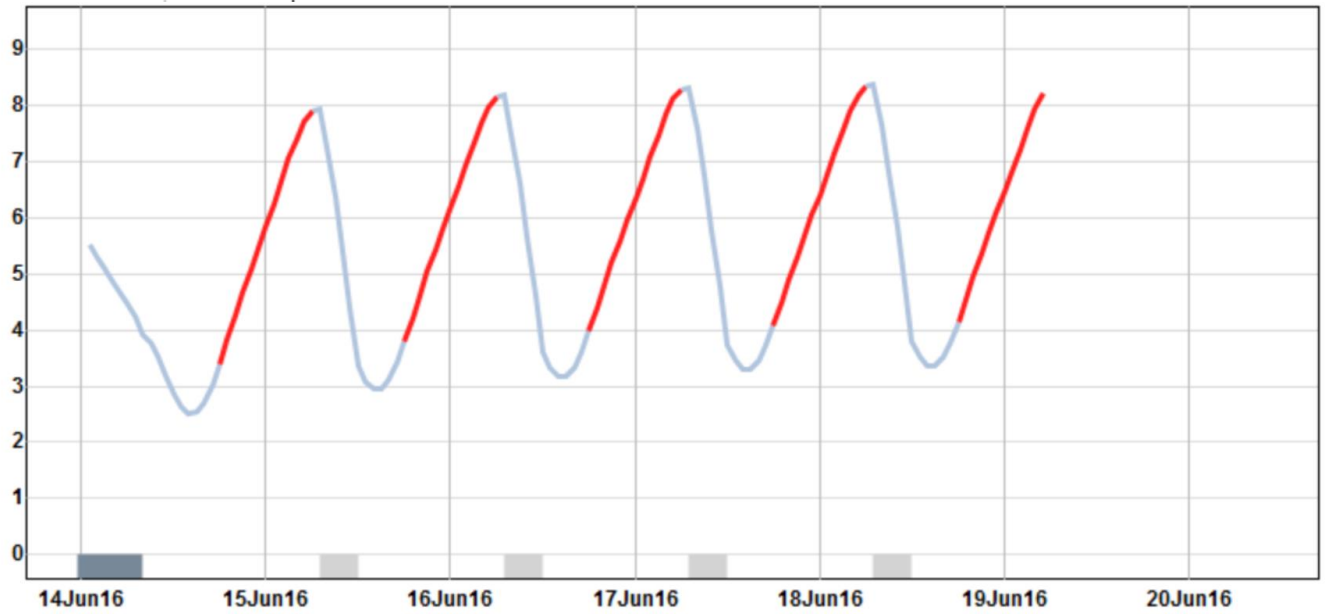
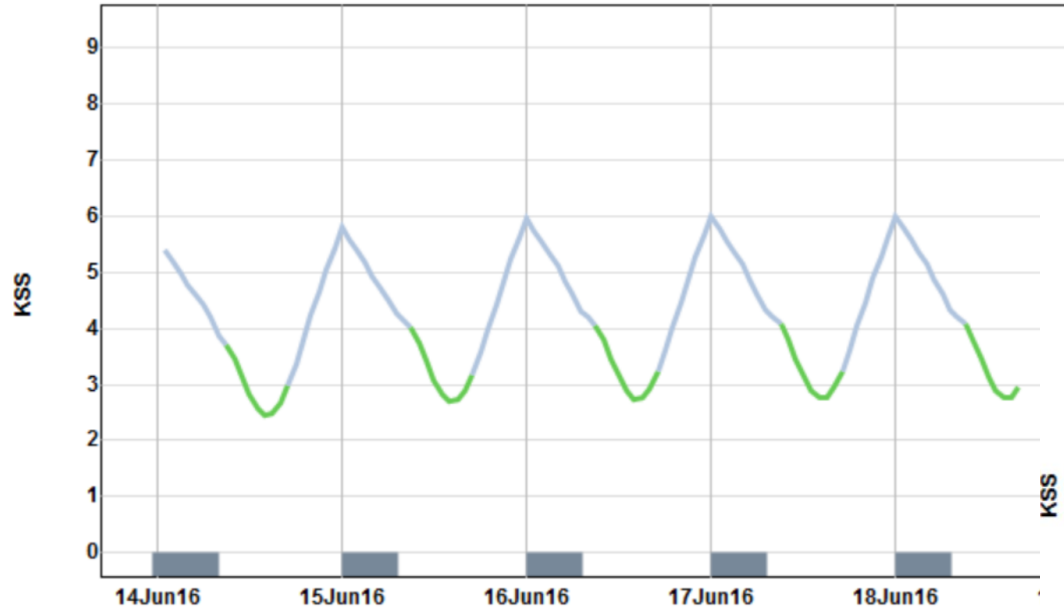
9. Extremely sleepy, fighting sleep
8. Sleepy, some effort to keep alert
7. Sleepy, but no difficulty remaining awake
6. Some signs of sleepiness
5. Neither alert nor sleepy
4. Rather alert
3. Alert
2. Very alert
1. Extremely alert

FAID and FAID Quantum

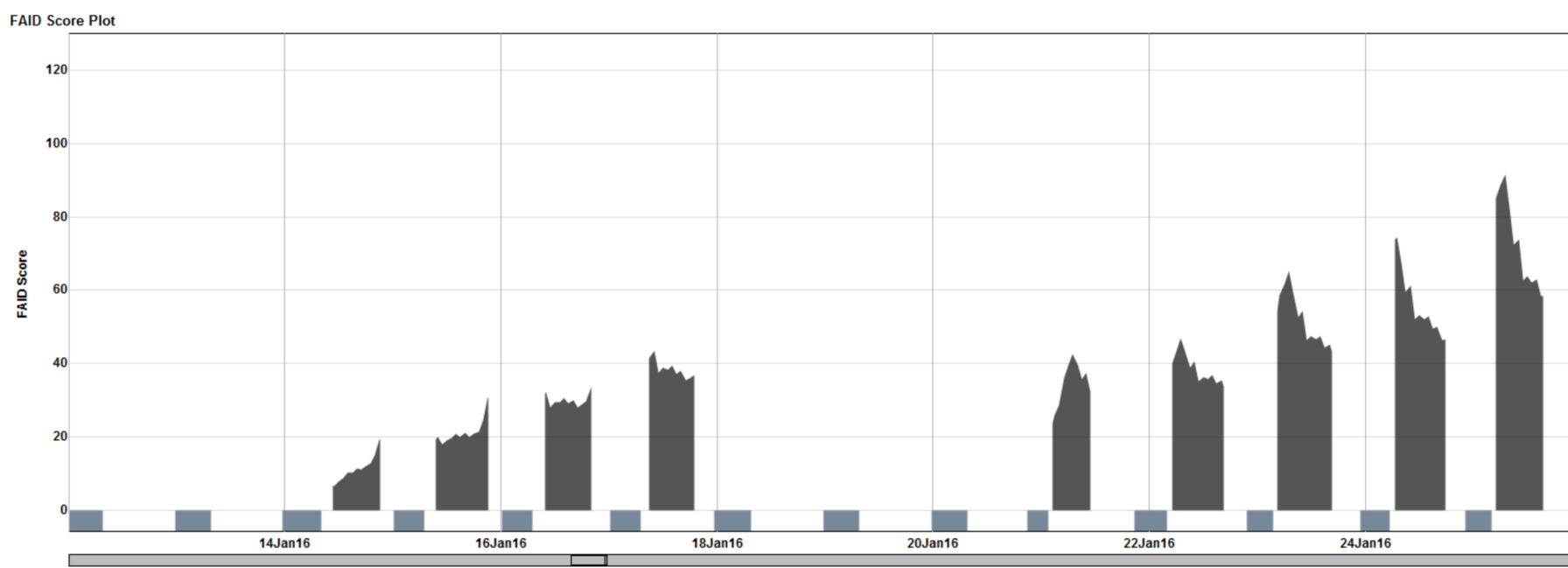
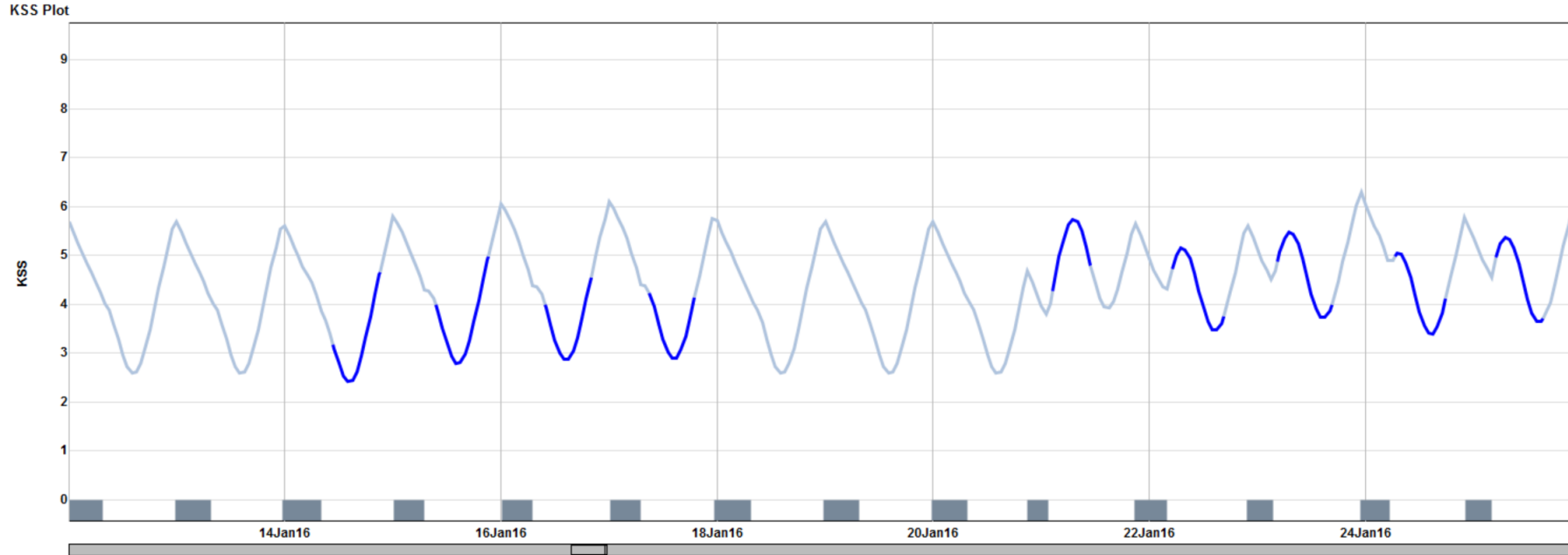
Quick benchmarks:

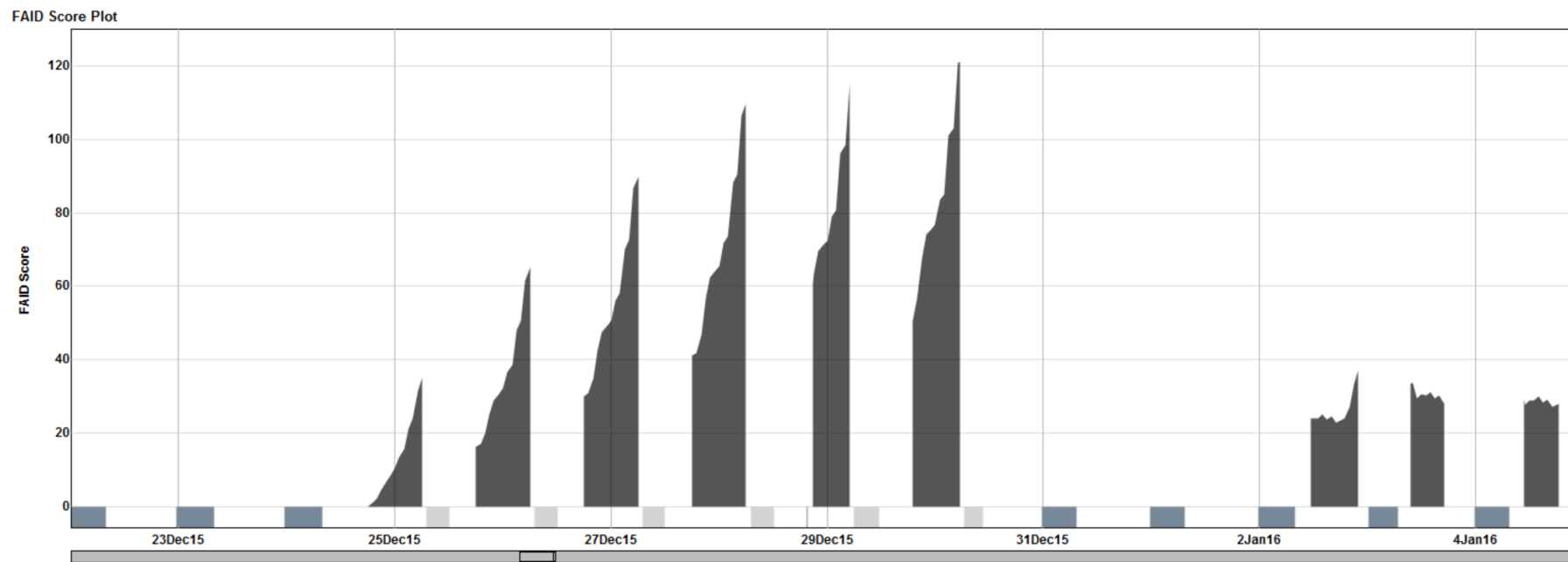
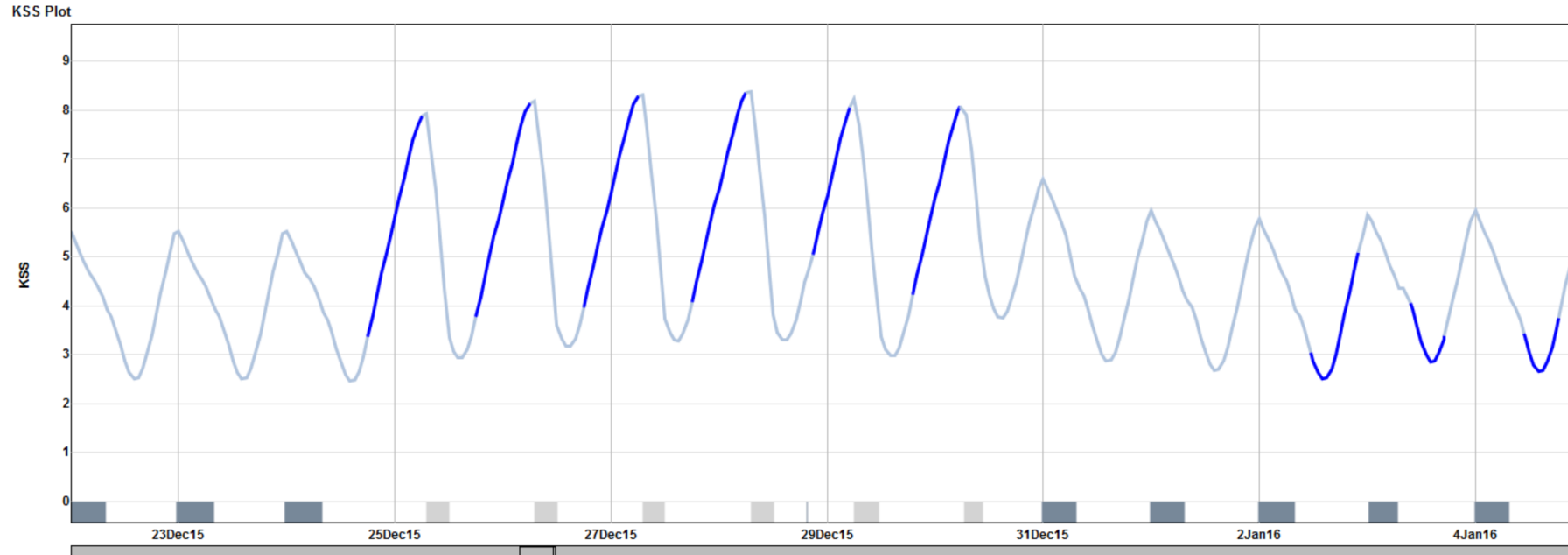
- Monday to Friday: **9am to 5pm**
 - 40-hour standard work week
 - Peak **FAID Score 40**
 - Peak **KSS 4.1**
- Monday to Friday: **11pm to 7am**
 - 40-hour work week
 - Peak **FAID Score ~95**
 - Peak **KSS 8.4**

FAID Quantum Benchmark plots



FAID and FAID Quantum comparison plots





FAID and FAID Quantum

Additional features:

- Circadian adaption
- Augmentation

InterDynamics Fatigue Risk Management Solutions



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