UNIVERSITÉ PARIS DESCARTES
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The science behind FRMS : the causes of fatigue

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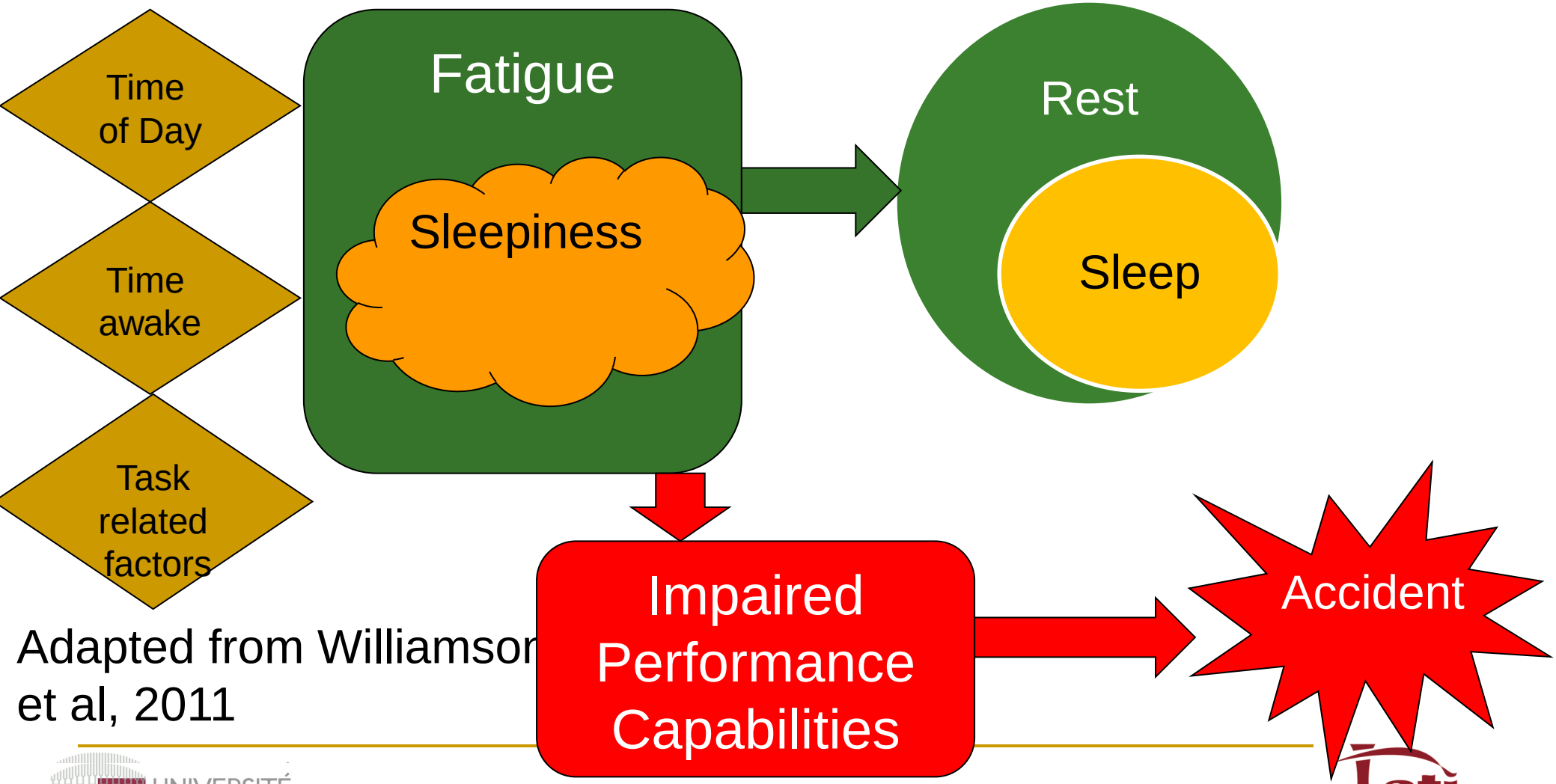
From intuition to science

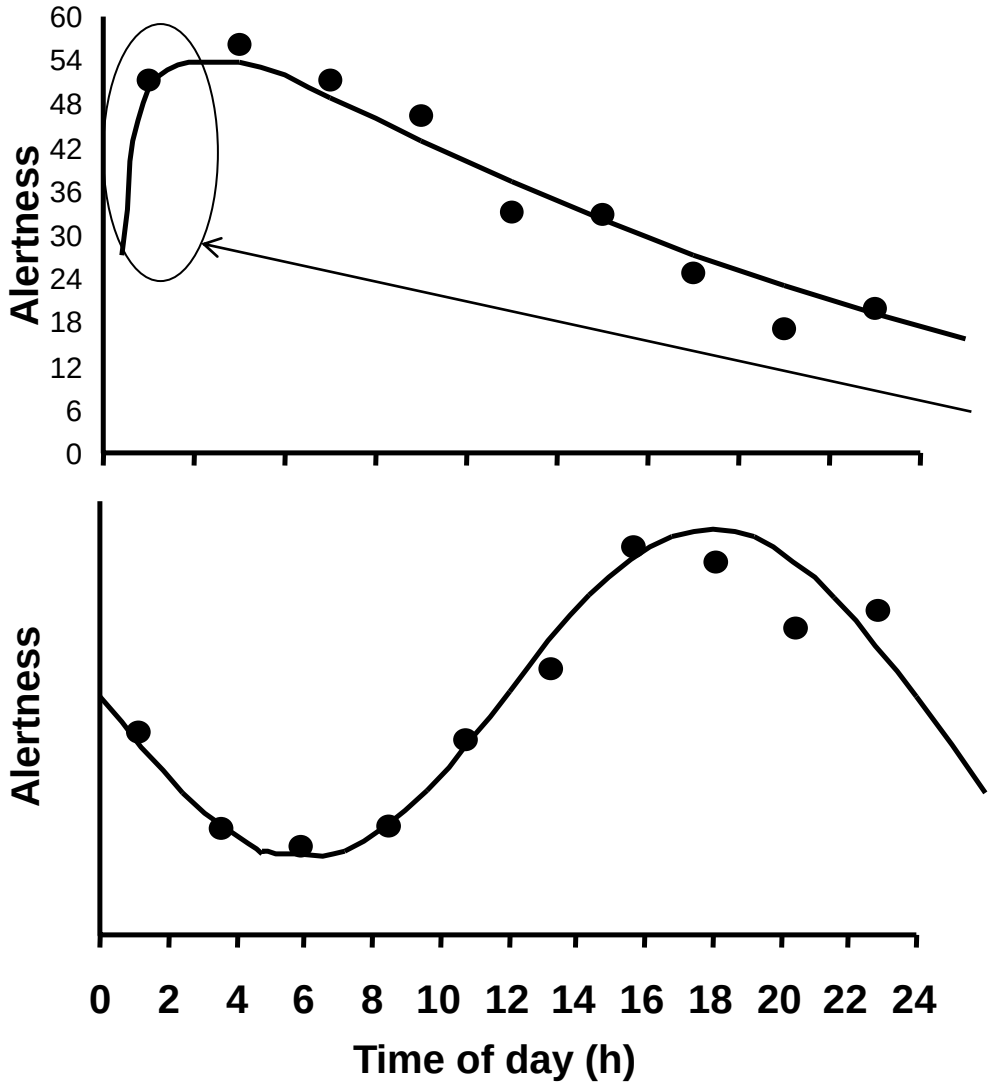
- Fatigue is not only a scientific concept, it is used in the daily life and it is a subjective experience
- Everybody has the feeling of being a “fatigue expert” based on her/his own experience
- Fatigue is linked to physiological mechanisms but the way we perceive it is linked to psychological, social and cultural factors
- The way we perceive fatigue influences the way we behave

"Fatigue is a biological drive for a recuperative rest"



Adapted from Williamson et al, 2011

Alertness components



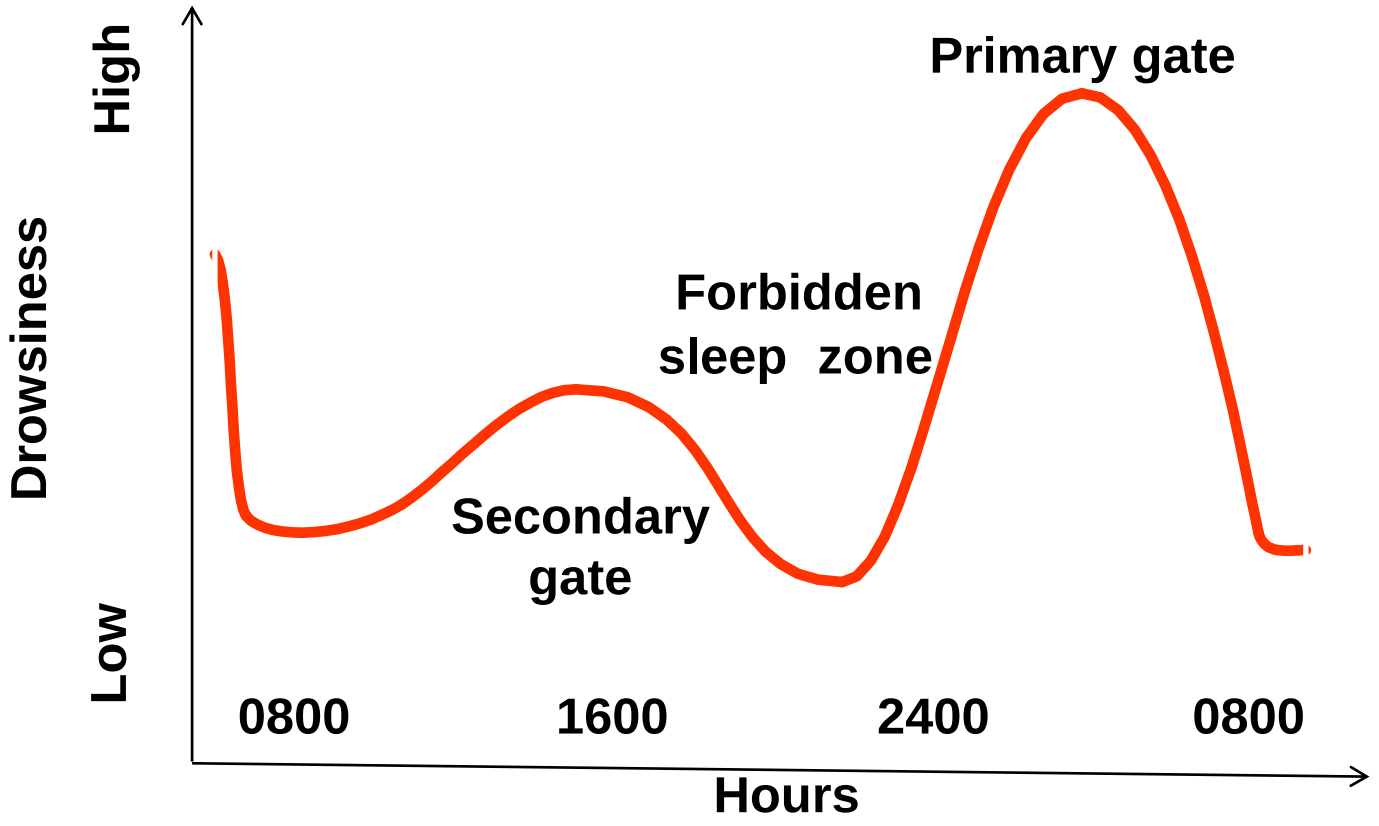
Process S (homeostasic need for sleep)

Process W (sleep inertia)

Process C

(endogeneous circadian pacemaker)

Sleep gates and forbidden sleep zone

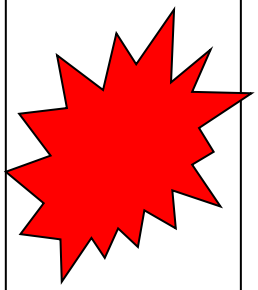


Schematic representation of time periods favoring sleep onset (taken from Stampi, 1989)

Main fatigue factors in aviation

Internal factors

- Circadian factors
- Homeostasic sleep
- Sleep inertia



Operational factors

- Irregular hours of work
- Long duty times
- Time Zone transitions

Task related factors

- Workload
- Monotony

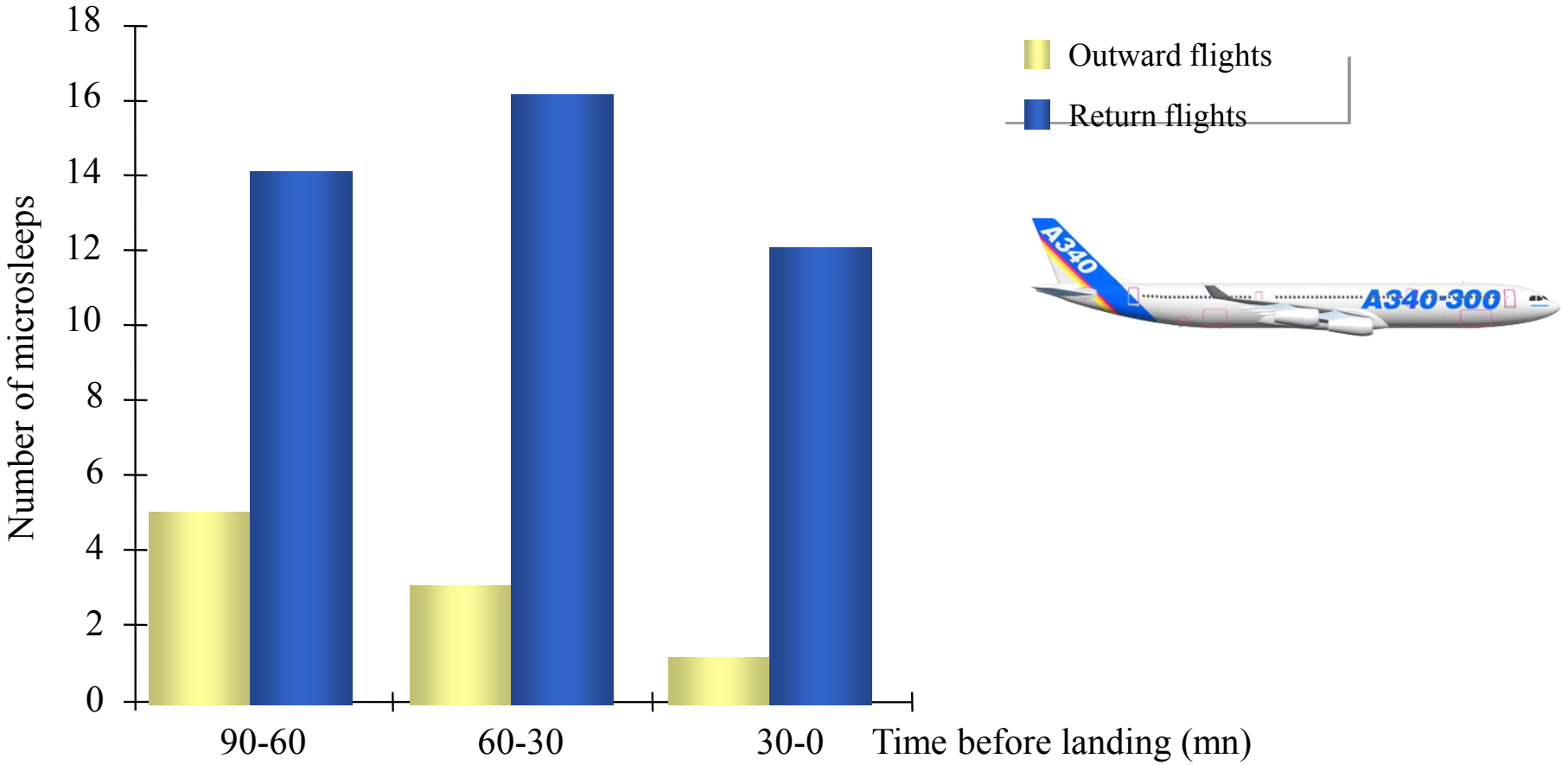
Main effects of sleep loss

- Microsleeps
- Increased reaction time
- Unstable cognitive state (more variability of performance)
- Divergent thinking is more impacted than convergent thinking

  => creative, innovative decision are more impacted than procedural decision

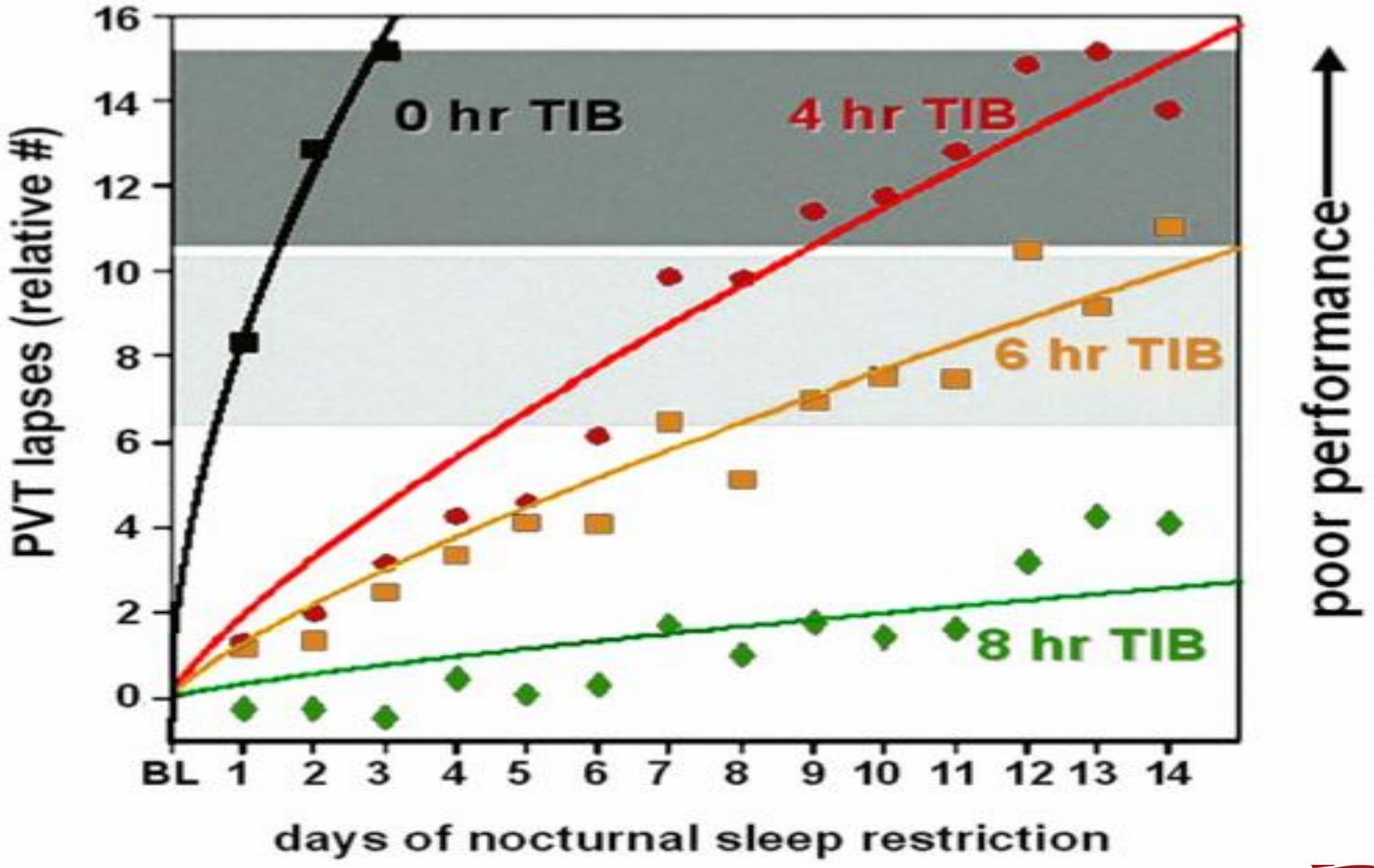
Microsleeps

Microsleeps can occur even during critical phase of a flight



Microsleeps in the last 90 mn of the flights

Chronic sleep deprivation is incidious....

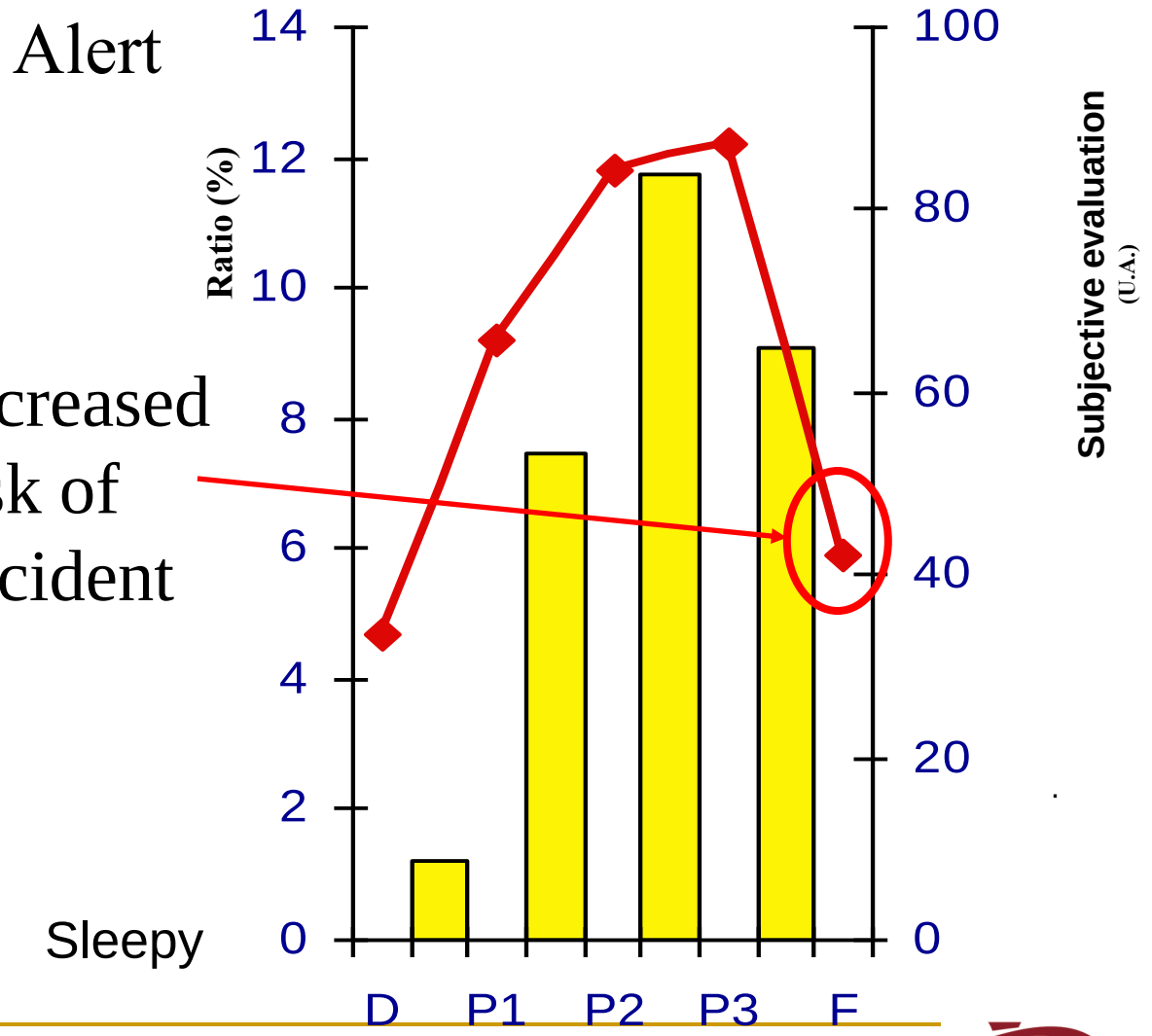


Van Dongen et al, 2003

Objective and subjective sleepiness during night driving

Objective sleepiness

Subjective sleepiness



The complexity of fatigue

- Fatigue is a normal physiological state !
- Fatigue is not only caused by the time on task but by a complex interactions of various factors
- Fatigue and the way we perceive it are influenced by a large inter-individual variability (sleep needs, chronotype,..) and by social factors
- More researches are needed to understand the complexity of the link between fatigue and safety

From science to regulation

- Science can improve the design of rules and rosters
- But the complexity of fatigue makes the design of “perfect” rules or rosters impossible
- Hours of work regulations focused on limited aspects of fatigue and cannot address its complexity while coping with operational/economics requirements
- FRMS is a promising way to better integrate the complexity of fatigue mechanisms in work schedules management