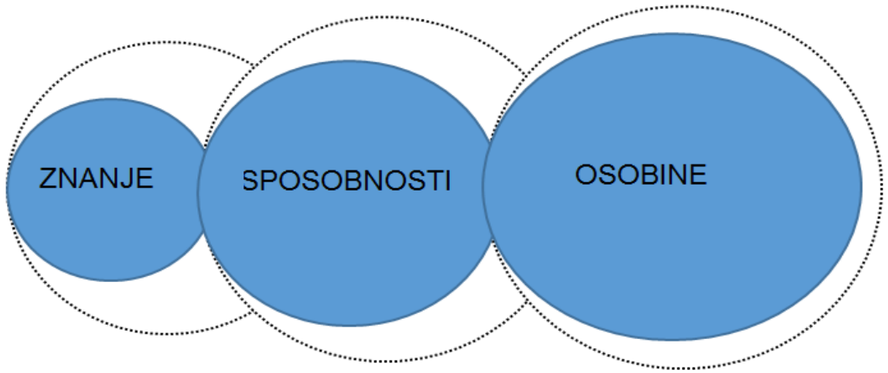
# Rafale F3R Fighter Jet - New Croatian Aircraft

# Inicijalne karakteristike pilotskih kandidata

**POTREBAN JE ODREĐENI NIVO ZNANJA, SPOSOBNOSTI I OSOBINA**

**Kod kandidata je najmanji moguć utjecaj na osobine, te je bitna visoka razina poželjnih osobina *na* samom početku procesa selekcije i obuke.**



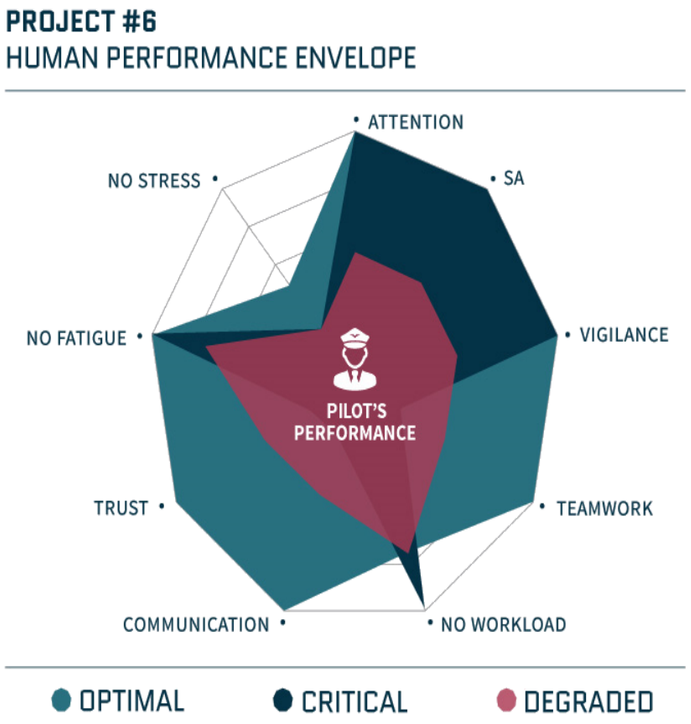

# Što može znanost?

Znanost može proizvesti nove metode i alate :

- kojima se mogu pospješiti procesi selekcije i obuke
- za veću održivost borbenih sposobnosti i otpornost pojedinaca izloženih borbenim traumama i stresu
- "*Ne preživljavaju najjači, niti najinteligentniji pojedinci u vrsti već oni koji su najsposobniji prilagoditi se promjenama*." - Charles Darwin

# Relevant Former EU Future Sky Safety Project Illustration "Project #6: Human Performance Envelope"

**Human Performance Envelope** project proposes a variety of physiological, speech/voice processing, oculometric and neurometric approaches in order to evaluate the factors/axes of the Human Performance Envelope




| | WL | Stress | Fatigue | SA | Attention | Vigilance | Teamwork | Comm. | Trust |
|---|---|---|---|---|---|---|---|---|---|
| ECG | X | X | X | X | X | X | | | |
| EEG | X | | X | X | X | X | | | |
| EMG | X | X | X | | | | | | |
| EOG | X | X | X | X | X | X | | | |
| fNIR | X | | | X | X | | | | |
| GRS/EDA | X | X | X | | | | | | |
| Respiratory activity | X | X | X | | | | | | |
| Eye-tracking | X | X | X | X | X | | | | X |
| Subjective measures | X | X | X | X | | | | | |
| Primary / secondary task | X | | X | X | X | | | | |
| Expert observation | X | | | X | X | | X | X | X |
| Communication analysis | | X | | X | | | X | X | |
| Seat sensors | X | X | | | | | | | |
| Voice analysis | X | X | | | | | | | |
| Pressure / grip sensors | | X | | | | | | | |
| Polygraph sensor | | X | | | | | | | |
| Electrochemical sensors | | X | | | | | | | |

Silvagni, S., Napoletano, L., Graziani, I., Le Blaye, P., & Rognin, L. (2017). Concept for human performance envelope. https://www.futuresky-safety.eu/wp-content/uploads/2015/12/FSS_P6_DBL_D6.1-Concept-for-Human-Performance-Envelope_v2.0.pdf

# Relevant Former U.S. Project Illustration: Applied Neuroscience in Defense Setting Sense Technologies

## Off Body

- **Eye tracking/ Oculometrics**
  - Vigilance, Arousal, Trust, Cognitive Load, Fatigue
- **Cardiac Activity**
  - Stress, Team Synchronicity, Cognitive load, Arousal
- **Voice Patterns**
  - Stress/Anxiety, Team Synchronicity
- **Facial Expressions**
  - Emotional/Affective State
- **Thermal Imaging**
  - Workload, Stress/Anxiety
- **Interface Pressure Sensors**
  - Stress/Anxiety, Cognitive Load
- **Metrics of Mission Performance**
  - Cognitive Load

## On Body

- **Galvanic Skin Response**
  - Stress
- **Cardiac Activity**
  - Stress, Team Synchronicity, Cognitive load, Arousal
- **Respiration**
  - Cognitive Load, Arousal
- **Skin Temperature**
  - Workload, Stress/Anxiety
- **EEG**
  - Cognitive load
- **EMG**
  - Stress/Anxiety
- **fNIRS**
  - Cognitive Load
- **Accelerometers**
  - Team Synchronicity, Arousal

## Biomarkers

- **Brain Derived Neurotrophic Factor**
  - Memory/Learning
- **Neuropeptide Y**
  - Memory/Learning, Stress Resilience
- **Cortisol**
  - Anxiety
- **Orexin A**
  - Vigilance, Arousal
- **Oxytocin**
  - Interpersonal Trust, Anxiety
- **Epinephrine**
  - Anxiety, Arousal
- **Norepinephrine**
  - Anxiety, Arousal
- **DHEA**
  - Anxiety, Emotional State
- **Cytokines**
  - Inflammation/stress

EUROPEAN DEFENCE FUND

EUROPEAN UNION

# EPIIC

Enhanced Pilot Interfaces & Interactions for New Generation Fighter Cockpits

## SELECTED PROJECTS EUROPEAN DEFENCE FUND (EDF) 2021

| | |
|---|---|
| CALL TITLE: | Avionics and advanced air combat |
| TOPIC TITLE: | Enhanced pilot environment for air combat |
| DURATION OF THE PROJECT: | 36 months |
| TYPE(S) OF ACTIVITIES: | Studies |
| ESTIMATED TOTAL COST: | € 77,769,904.62 |
| MAXIMUM EU CONTRIBUTION : | € 74,999,974.60 |

# LIST OF ORGANISATIONS

| Countries | |
|---|---|
|  | University of Zagreb FER |
|  | Terma, Aalborg University |
|  | **Thales**, Dassault Aviation |
|  | ADS GmbH, Diehl Aero, ESG, Rockwell Collins, HAT.tec |
|  | University of Patras |
|  | Leonardo |
|  | INSTA |

| Countries | |
|---|---|
|  | NLR |
|  | Gmv PT |
|  | Incas |
|  | Indra, ADS SAU, Tecnobit |
|  | SAAB Aerospace, |
|  | EASN, Phasya |
| | |

# Proračun FER-a u okviru EDF EPIIC projekta : 432 025 eura, raspoloživ od 1.1.2023.

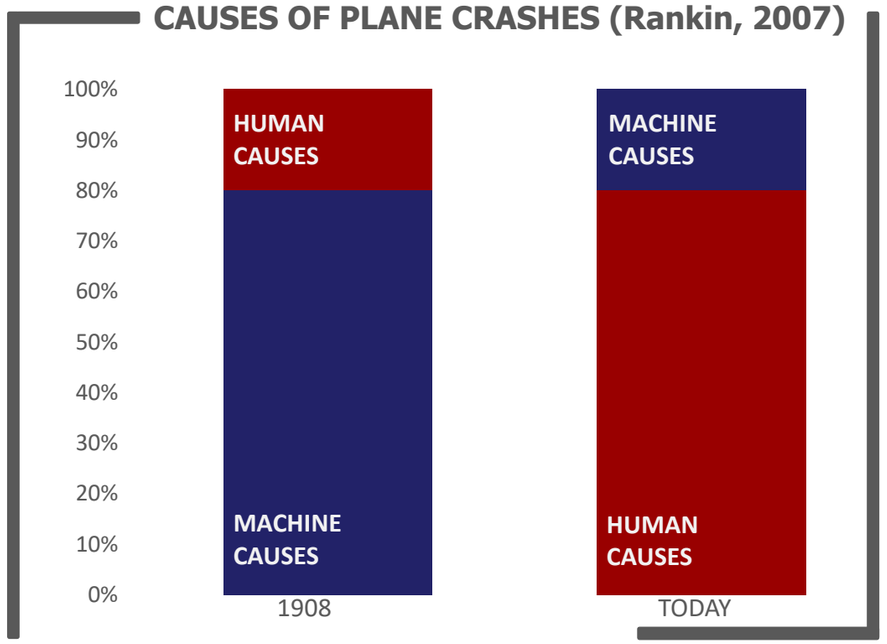
| | | | |
|---|---|---|---|
| 21 | ... | ... | ... |
| 22 | Sveuciliste U Zagrebu Fakultet Elektrotehnike I Racunarstva | HR | 432025.00 |
| 23 | Insta Ils Oy | FI | ... |
| 24 | Almadesign Conceito E Desenvolvimento De Design Lda | PT | ... |
| 25 | Next2u Srl | IT | ... |
| 26 | Totalforsvarets Forskningsinstitut | SE | ... |
| 27 | Empordef Tecnologias De Informacao Sa | PT | ... |
| | Total | | 74999974.60 |

# Human Factors in Military Aviation

Human factors refer to environmental, organisational and job factors, and human and individual characteristics, which influence behaviour at work in a way which can affect health and safety (Health and Safety Executive).

- Human factors research goals (Wickens et al., 2004):
  - Reducing error,
  - Increasing productivity,
  - Enhancing safety,
  - Enhancing comfort.
- Croatian Air Force Accidents:
  - Mi-8 helicopter crash (Jul. 2007)
  - Clash of two MiG-21 fighters (Sep. 2010)
  - MiG-21 fighter crash (Aug. 2014)
  - Kiowa Warrior helicopter crash (Jan. 2020)
  - School plane crash (May. 2020)

→ Objectivized assessment of stress and cognitive resilience in the early phases of pilot selection




→ 60-80% plane crashes are caused by human factors


Rankin, W. (2007). MEdA investigation process. *Boeing Commercial Aero*.
Wickens, C. D., Gordon, S. E., Liu, Y., & Lee, J. (2004). *An introduction to human factors engineering* (Vol. 2). Upper Saddle River, NJ: Pearson Prentice Hall.
Health and Safety Executive: Introduction to human factors, available at: https://www.hse.gov.uk/humanfactors/introduction.htm.

# Human Factors in Military Aviation

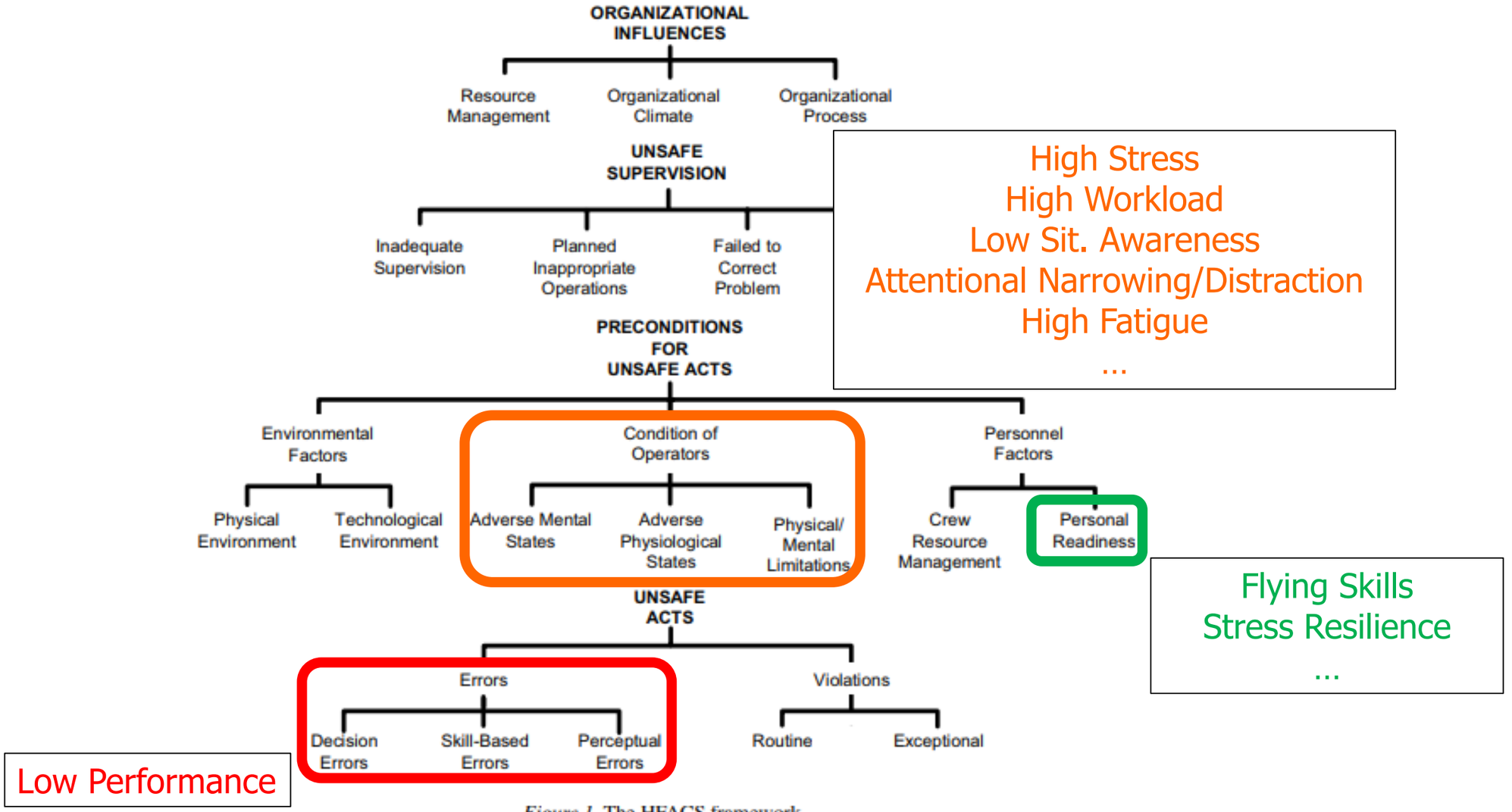
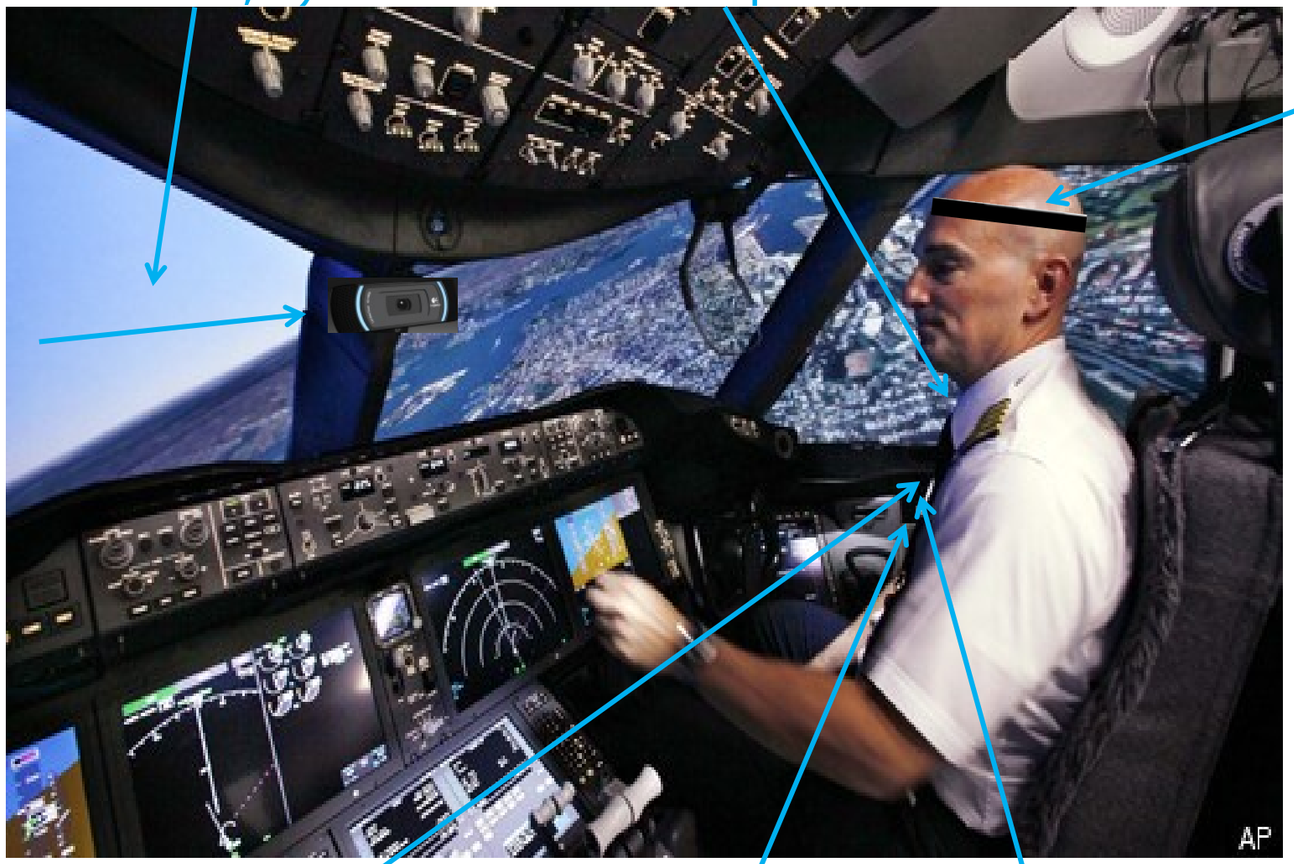



*Figure 1*. The HFACS framework.

Shappell, S., Detwiler, C., Holcomb, K., Hackworth, C., Boquet, A., & Wiegmann, D. A. (2007). Human Error and Commercial Aviation Accidents: An Analysis Using the Human Factors Analysis and Classification System. *Human Factors*, *49*(2), 227-242. Link. Cited by 515.

# Multimodal Estimation of Pilot's Mental States




# EDF EPIIC Project

**WP7&8 – Crew monitoring system**

## WP7 – Crew monitoring sensors and physiological states

**Goal:** have "sensors and physiological models" for efficient crew monitoring in combat aircraft.

**Tasks**:

- Task 71 – Identification and definition of the raw physiological states and parameters in cockpit fighter environment
- Task 72 – Study of relevant sensing technologies (external, wearable and head-located)
- Task 73 – Raw physiological state computing and database
- Task 74 – Crew Monitoring Sensors demonstrations

## WP8 – Crew states identification algorithms

**Goal:** identify the crew ability to perform its mission via the detection of degraded crew states.

**Tasks**:

- Task 81 – Crew states identification principles
- Task 82 – Identification and definition of relevant crew states
- Task 83 – Identification and definition of relevant parameters to be measured
- Task 84 – Development of models
- Task 85 – Assessments and demonstrations
- Task 86 – Definition of a standardised crew physiological and interactions database

# EDF EPIIC Project

## WP7&8 – Crew monitoring system

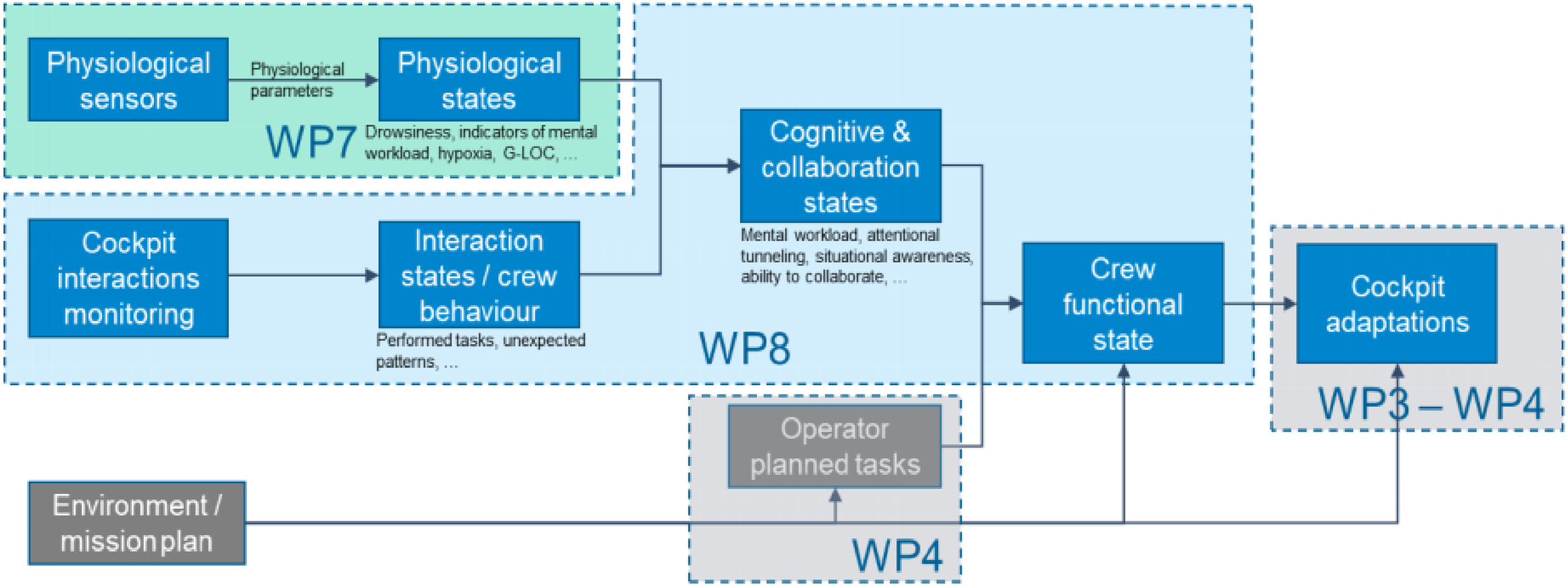



*Figure 11 - Overall architecture of the CMS*

# EDF EPIIC Project

## WP7&8 – Crew monitoring system

**Stress resilience** as a research interest of University of Zagreb

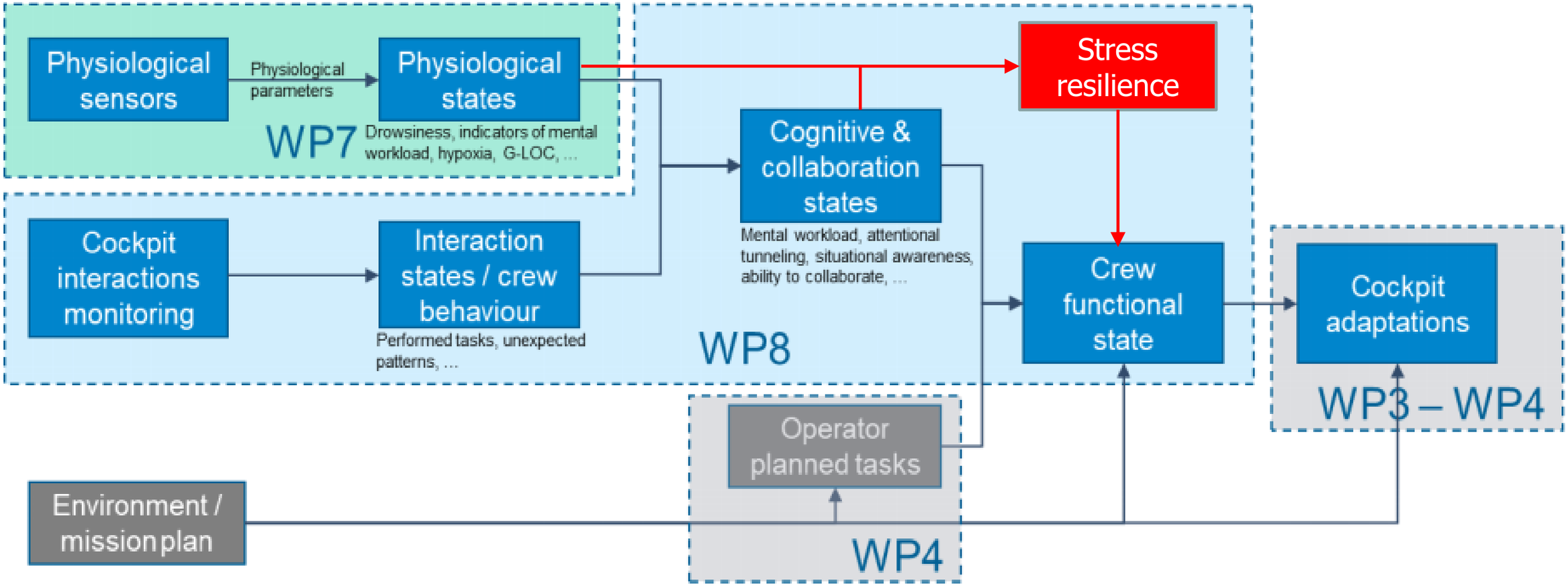



*Figure 11 - Overall architecture of the CMS*