



**MEDICAL CENTRE HUNGARIAN DEFENCE FORCES**

HDF MC Military Hospital is the Teaching Hospital of Semmelweis University's Faculty of Medicine

***„HRV in the air”:  
What data from top gun pilots tells us  
about physical and mental workload?***

**Hornyik, J. , Vada, G., Szabó, S., Dunai, P.**

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**Chief Flight Surgeon of Hungarian Defence Forces**

***National University for Public Servants***



**GINOP-2.3.2-  
15-2016-00007**



**„in service  
of nation”**



**MEDICAL CENTER OF HUNGARIAN  
DEFENCE FORCES, KECSKEMÉT**

ISO 9001:2008; MEES 1.0/2007; ISO 14001:2004 HÉMORI standard





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## **Military service job (especially flight) is**

**really challenging for almost every soldier (including special forces):**

**the excessive energy demands (both physically and mentally) caused  
by special deployments and missions**

**can provoke autonomic imbalance,  
POSSIBLE ROLE in acute incapacitation**

**characterized by a hyperactive sympathetic system and a hypoactive  
parasympathetic system which finally can lead to premature aging and  
diseases.**



MEDICAL C  
HDF MC Mil

# AEROMEDICAL STRESSORS

*accelerations - overloads*

*Ionizing and high  
frequency radiation*

*hypo / hyperthermia*

*noise*

*hypoxia*

*spatial disorientation*

*vibration*

*motion sickness*

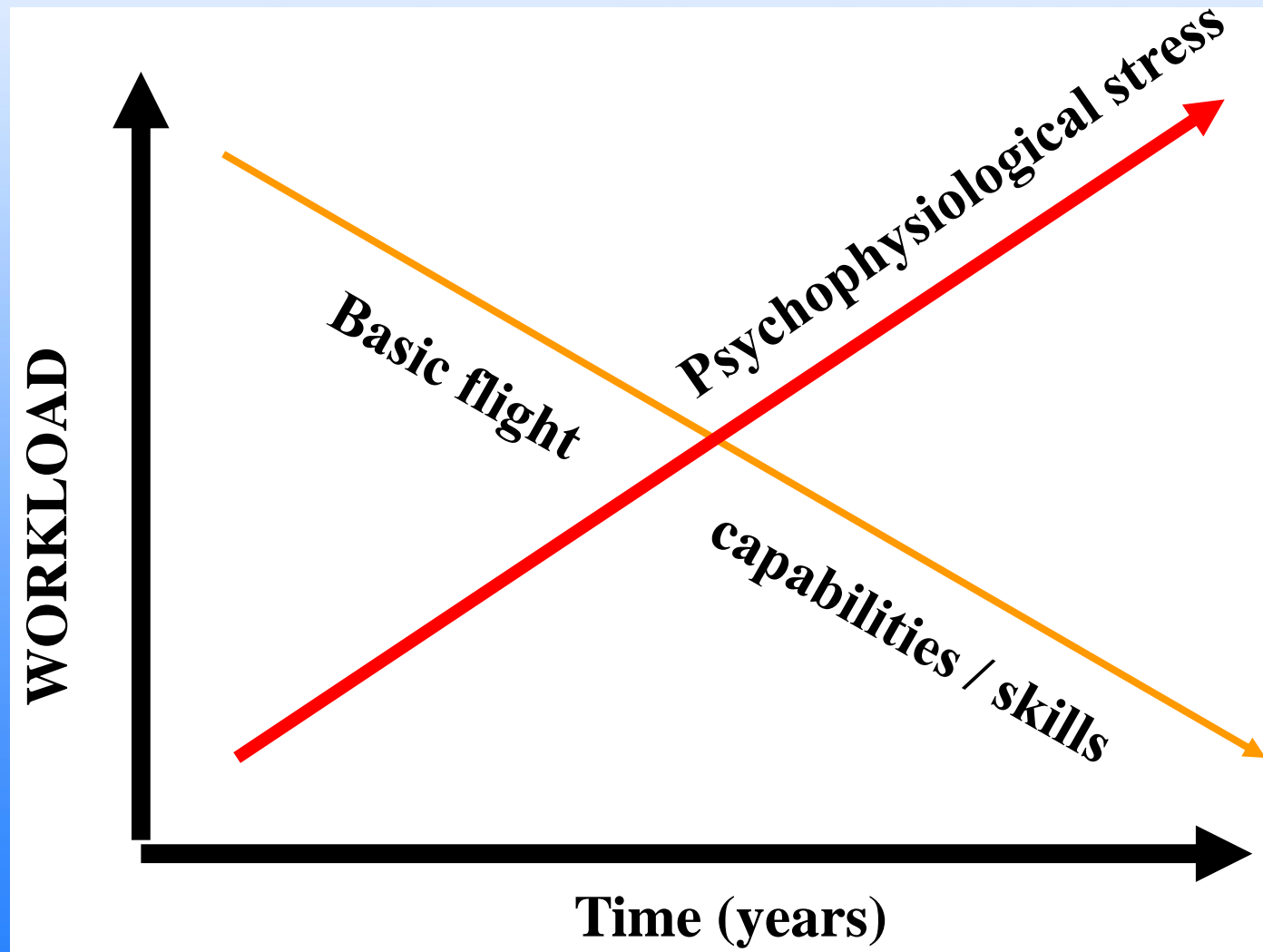




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## BEYOND THE CURVE ... - INFORMATION WAR



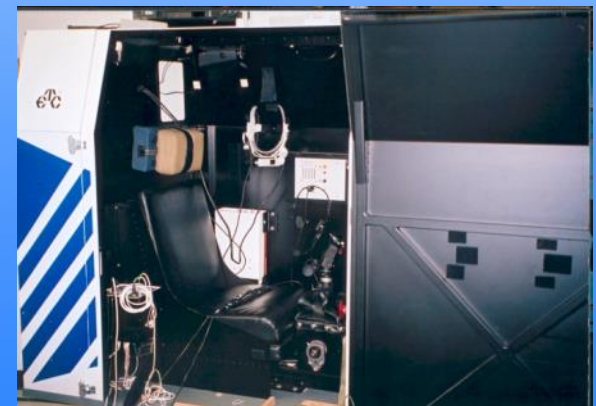
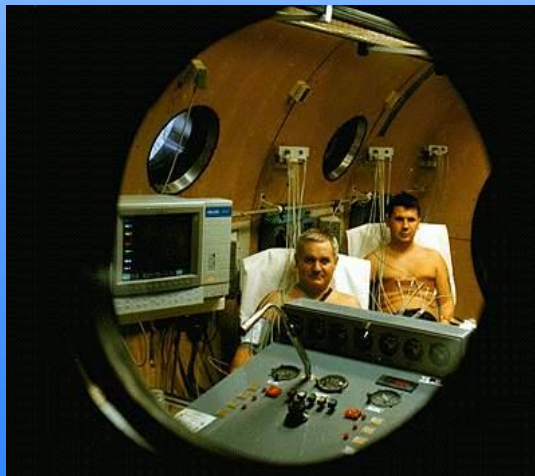
ISO 9001:2000, MIL-STD-1553, ISO 14001:2004, EN 15001 standard





# AEROMEDICAL FUNCTIONAL DIAGNOSTIC EXAMINATIONS

- ambulatory & real Holter ECG
- hypoxic tolerance exams
- orthostatic tolerance measurements
- Pressure breathing tests
- GYRO lab simulator
- centrifuge runs







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# Aeromedical aspects

*accelerations*

*psychic stress*

*physical stress*

*vibration*

*hypoxia*

*vegetative dystonia in CNS*

*change in perfusion*  
*hypoxaemia*

*Neurohumoral activation*

*CO, ectopic activity, myocardium depression*



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## Stress tolerance ? Mind set vs. skill set ?

**Ground-based  
simulation**

**Psychology  
Cognitive test battery**

**Barochamber +  
Cognitive test battery**

**Real Flight ?**

**Virtual Reality ?**

**Barochamber +  
Virtual Flight**



**1st Lt. Lea ZOLNAI**  
**1st female transport pilot on A319**

**LAB into REAL WORLD !**

# USING FIRSTBEAT BODYGUARD2 in military aviation research project

1. *As a system – simple deployable*
2. *As a software –straightforward evaluation, edition of graphs with splitters*
3. *Durability - hypoxia, G loads (G sensor up to 9 Gz-s)*
4. ***Simulation - +VR/VE technology –***
5. ***Real flight – monitoring system (with synchronized data?)***
6. *Psychic trauma (ejection – regeneration/recovery?)*
7. *Pilot work related stress (mental or physiological)*





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## **Canadian Armed Forces Fitness Study F/U 2-6 days!**

The Canadian Armed Forces (CAF) is undertaking a major research initiative with the help of Firstbeat Lifestyle Assessment. **Dr. Julie Martin** of the Directorate Fitness Team is overseeing the study that will use ***real-world measurement data*** ***investigate the physiological impact of participant's daily life*** ***and will be used to better understand fitness related topics across the CAF. (2017. March)***



## **FINNISH AIR FORCE – „hi-fi” simulator study**

***Mansikka, H, Simola, P, Virtanen, K, Harris, D, Oksama, L: Fighter pilots' heart rate, heart rate variation and performance during instrument approaches. Ergonomics. 2016 Oct; 59(10):1344-1352. Epub 2016 Mar 4***  
(The study was coordinated and funded by the Finnish Defence Research Agency) – „more complex fighter aviation scenario”



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## EU GINOP PROJECT: NIRS + VR



**NIRS: Near Infrared Spectroscopy**  
**VR: Virtual Reality**

ISO 9001:2008; MEES 1.0/2007; ISO 14001:2004 HÉMORI standard





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## JAS-39 Aircrew Equipment Assembly

Type 116E Helmet



Oxygen Mask  
127B

Survival Jacket 39

Anti-g Garment  
97C/K

Gripen Boots

**FIRSTBEAT  
BODYGUARD2**







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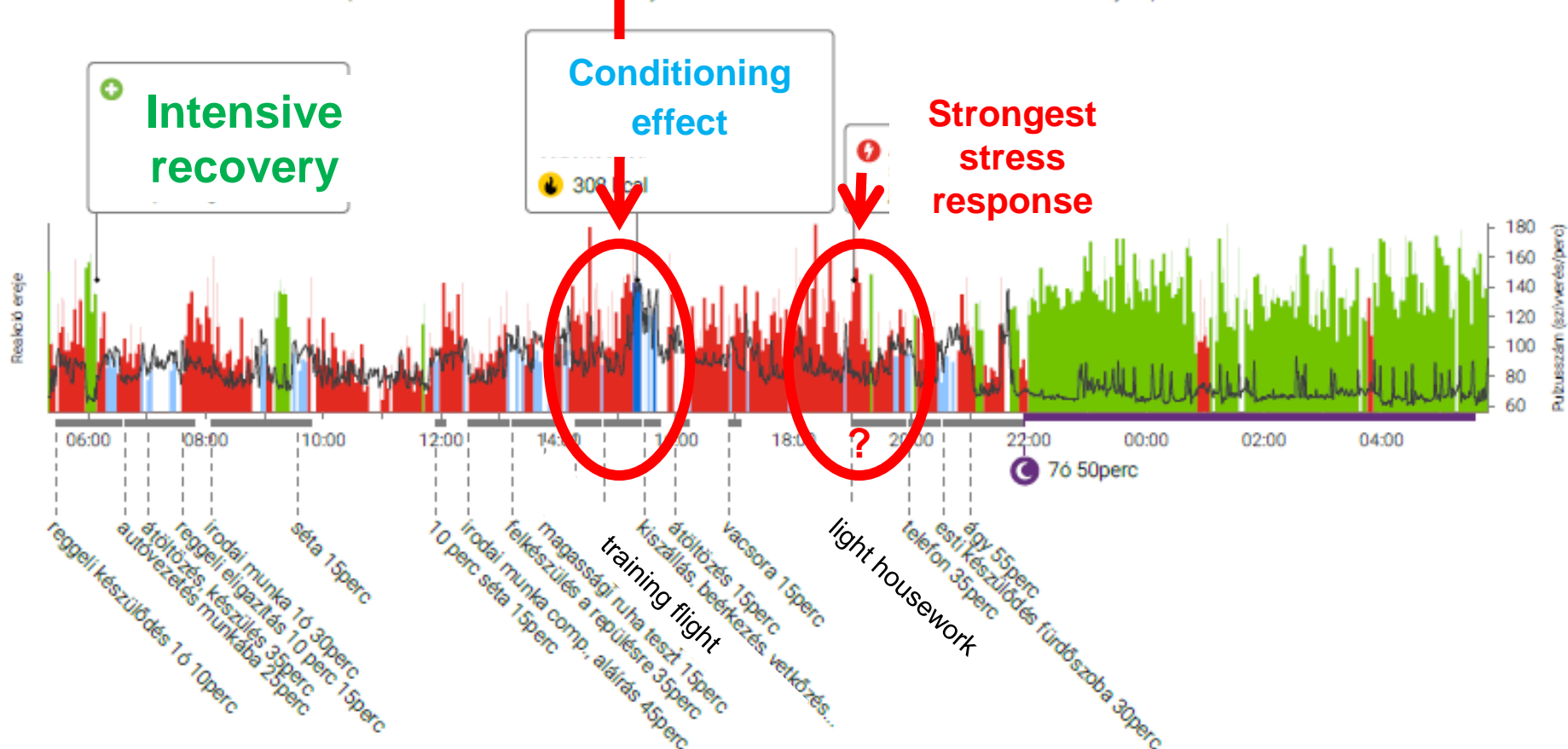
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# FIRSTBEAT BODYGUARD2 *GRIPEN fighter pilot's working day*

Flight sortie:

1. Low altitude target flight for interception 2x
2. Aerobatics up to 9 Gz

● Stressz ● Feltöltődés ● Közepes + erős fizikai aktivitás ● Enyhe fizikai aktivitás ~ Pulzusszám ~ Hiányzó pulzusszám 0%





## GRIPEN fighter pilot's working day –training flight sortie

## 2. Aerobatics up to 9 Gz

**FLIGHT:**

1. Low altitude target flight for interception 2x
2. Aerobically demanding flight for 10 minutes



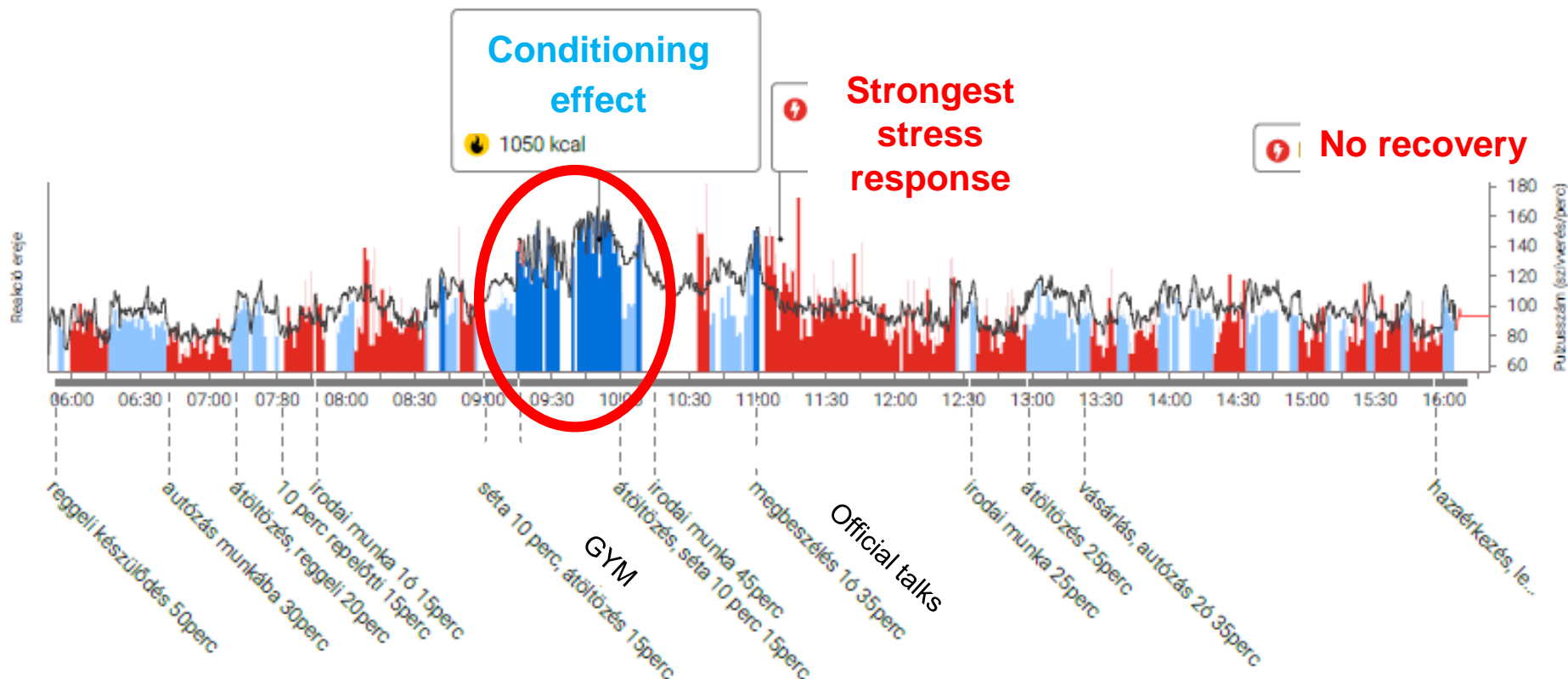


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## FIRSTBEAT BODYGUARD2

### *GRIPEN fighter pilot's working day –preparation day with gym*



***stress response / calorie expenditure***

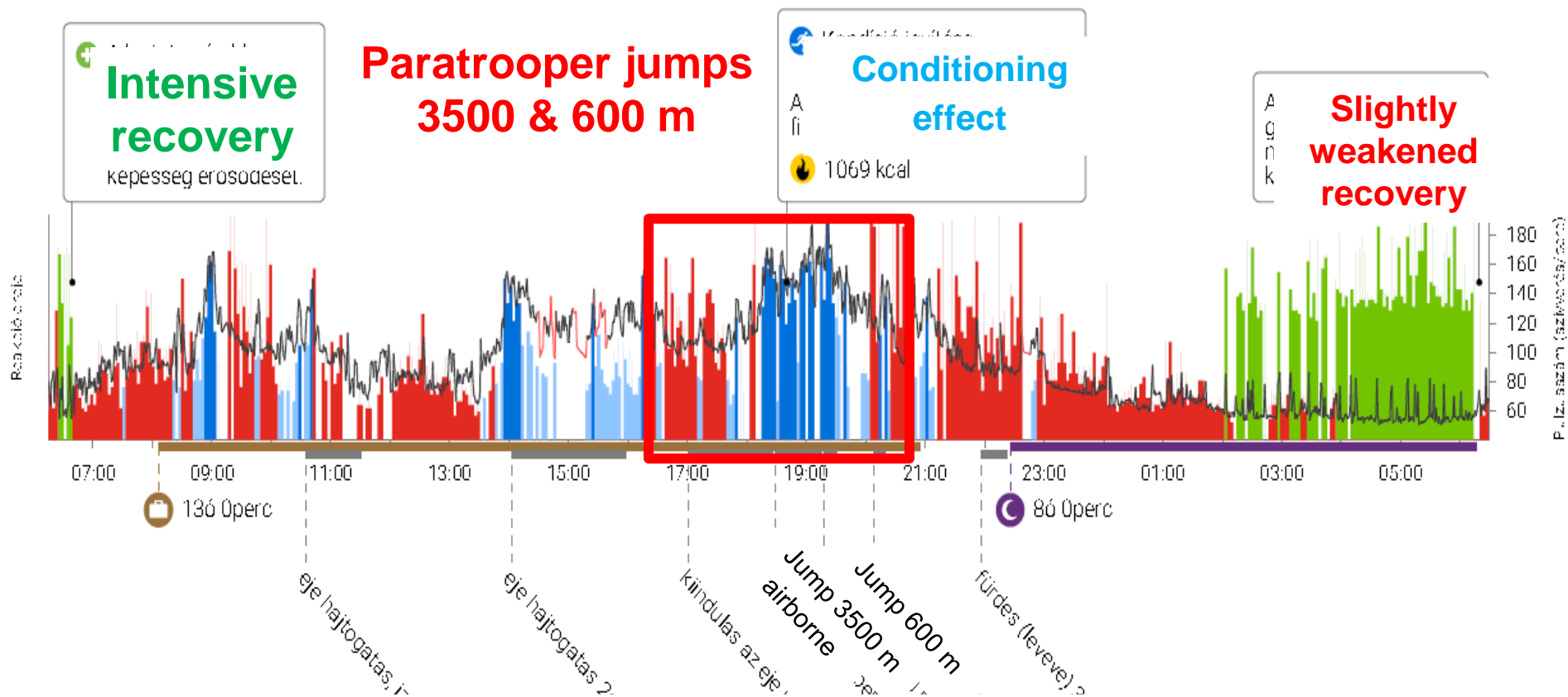


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## FIRSTBEAT BODYGUARD2 *paratrooper's working day*

● Stressz ● Feltöltődés ● Közepes + erős fizikai aktivitás ● Enyhe fizikai aktivitás ~ Pulzusszám ~ Hiányzó pulzusszám 4%



HR decrease, RMSSD and LF/HF increase during training. Krzysztof Mazurek, K., Nawoja Koprowska N., Jan Gajewski, J., Zmijewski, P., Franciszek Skibniewski, F., Rózanowski, K.: Parachuting training improves autonomic control of the heart in novice parachute jumpers. Biocybernetics and Biomedical Engineering · December 2017, DOI: 10.1016/j.bbe.2017.11.004, [www.sciencedirect.com](http://www.sciencedirect.com)

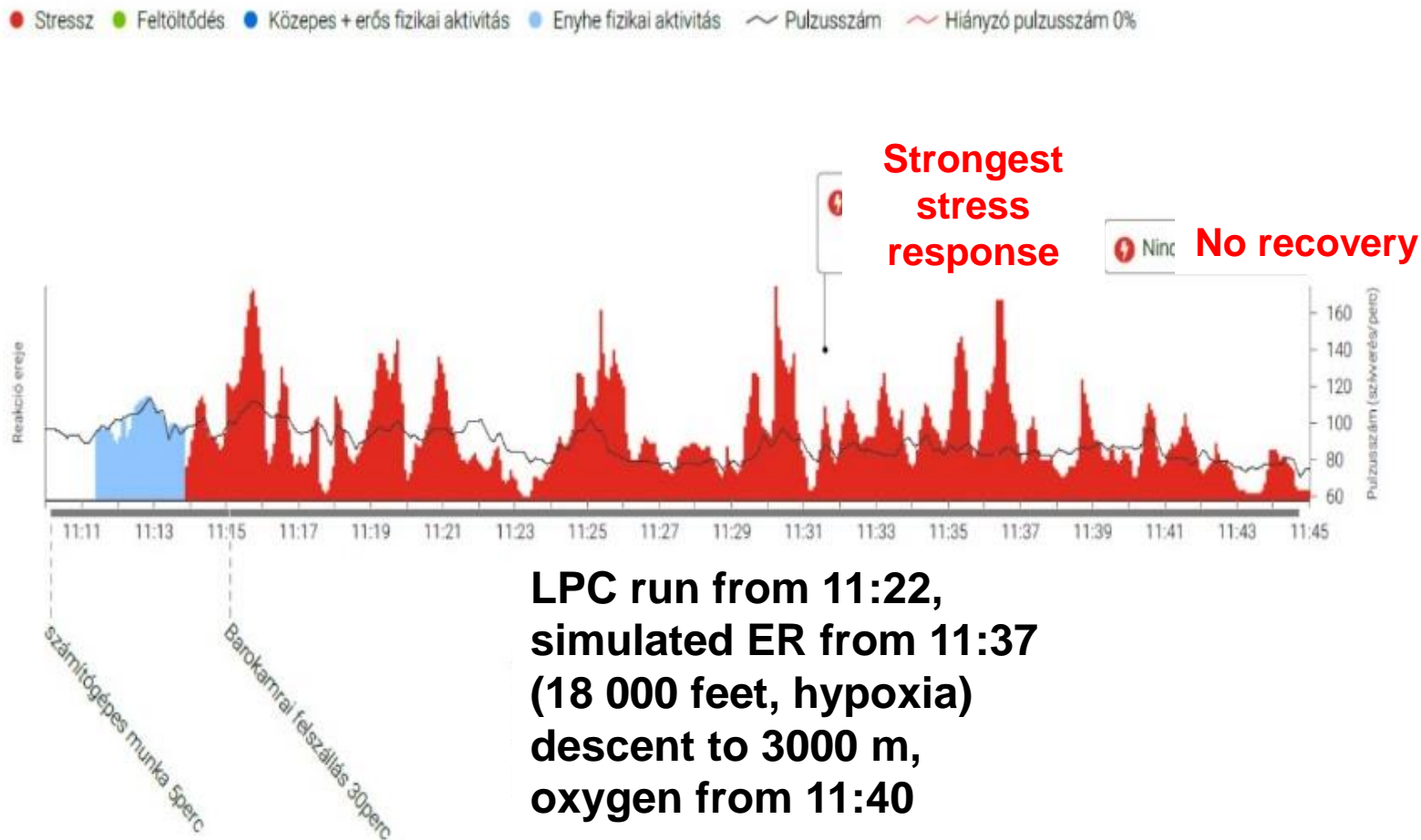


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# PULSE TREND and HRV in Low pressure Chamber (5 500 m VR flight)

## Lifestyle assessment (own registration)



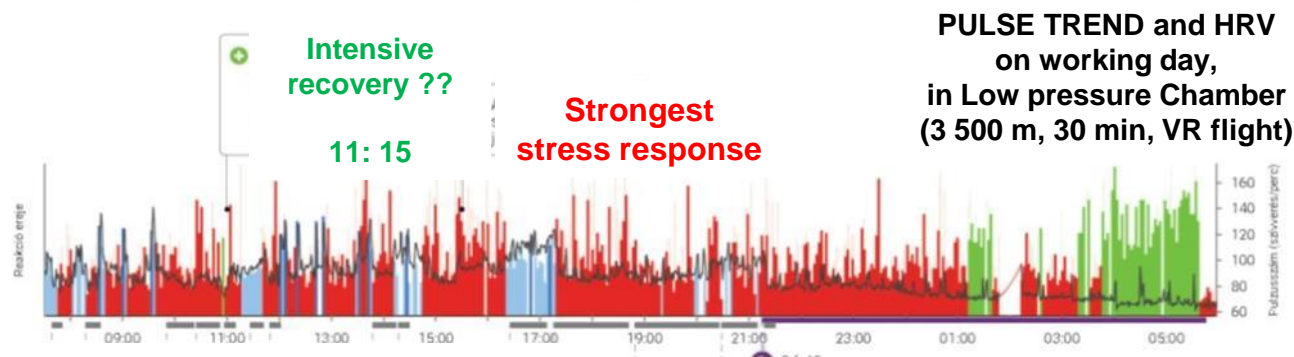


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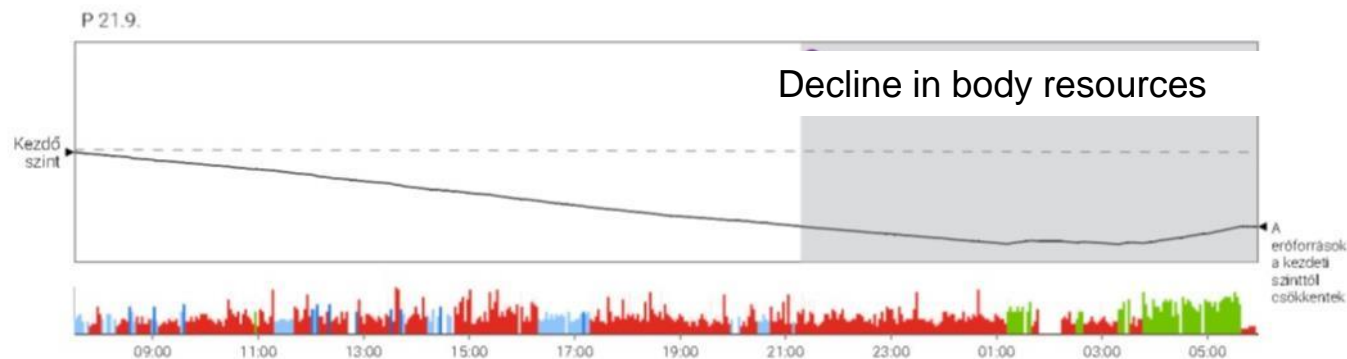
# PULSE TREND and HRV in Low pressure Chamber (5 500 m VR flight)

## Lifestyle assessment (own registration)



### Body resources

Erőforrások növekedése Erőforrások csökkenése Jelentős pihenési időszak Stressz Feltöltődés Közepes + erős fizikai aktivitás Enyhe fizikai aktivitás



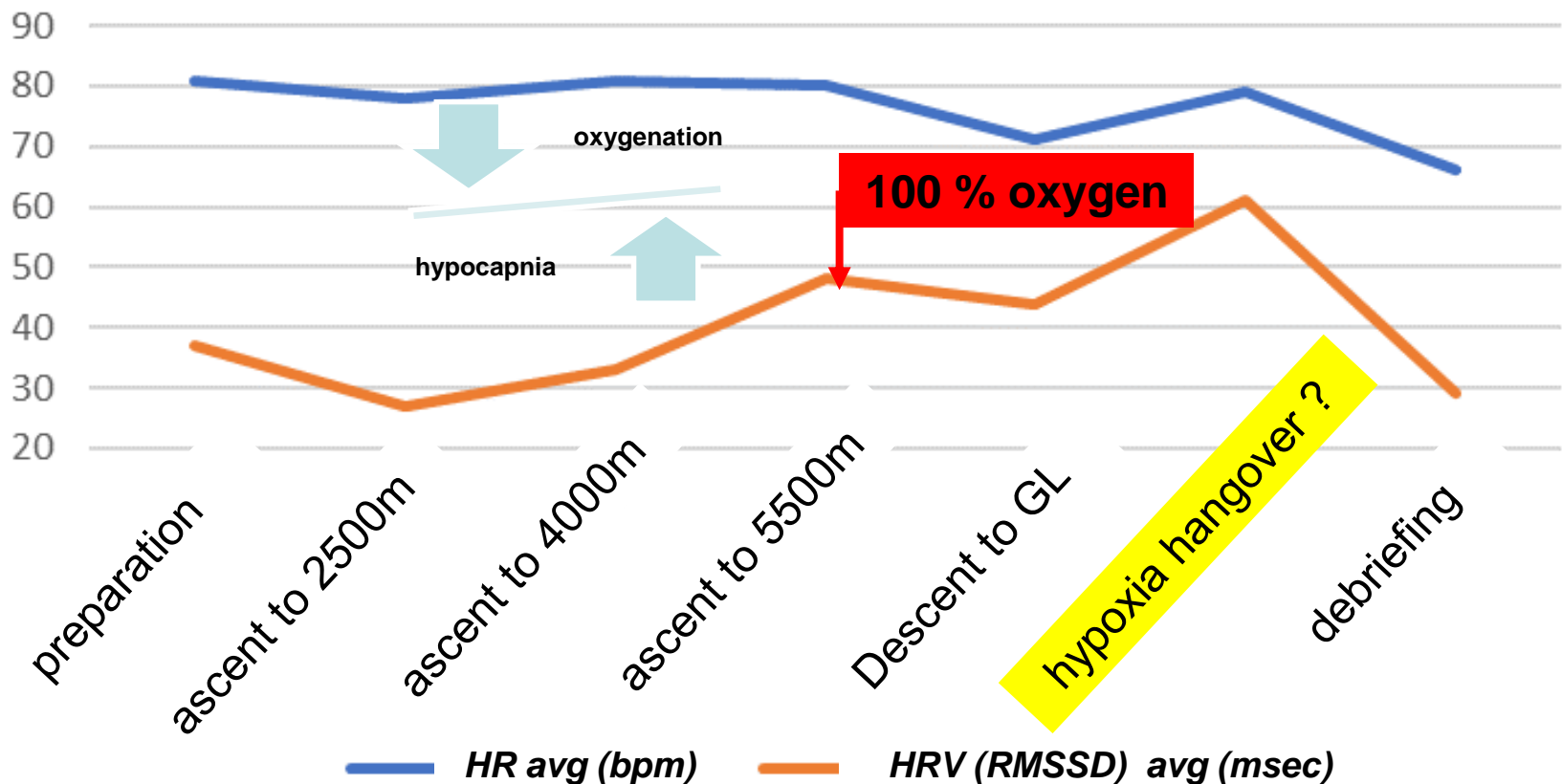


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### ANS IMBLANCE - LOWEST VALUES – LARGER BURDEN

#### HR / HRV average during LPC flight







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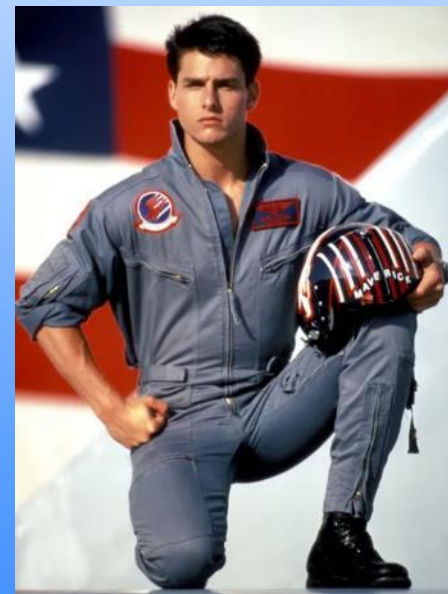
# WHO WE REALLY NEED ?



ROLAND GARROS



„GAMER”



„MAVERICK”



## CONCLUSIONS

1. continuous exhaustive military training flight missions or paratrooper's jump sorties - *destabilized vegetative tone* with increased arousal and finally can lead to psychosomatic effects of fatigue or even burnout.
2. lifestyle assessment of pilot / experienced paratrooper - compare the *real burden caused by military mission* / (civil airline flights?) and regular military physical activity and the possible recovery after sorties. Individual reactions!
3. Combined effects of hypoxia and Virtual Reality flight can be studied in *ground-based simulation settings in barochamber* or the mental effort related to combined aeromedical psychometric test batteries can be monitored as well.
4. AI (machine) vs MAN – who has the final decision? Real time monitoring and BIG DATA : HRV, + NIRS , + EEG