Luftwaffe

85th ANNUAL SCIENTIFIC MEETING OF THE AEROSPACE MEDICAL ASSOCIATION 2014

THE NEW ANTI-G SUIT "G-RAFFE" – ITS POWER AND POTENTIAL

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DISCLOSURE INFORMATION

85th Annual Scientific Meeting of the Aerospace Medical Association
Speaker: Carla Ledderhos

I have no financial relationships to disclose.

I will not discuss off-label use and/or investigational use in my presentation.

INTRODUCTION


Lokheed Martin F-22 Raptor


Chengdu J-20

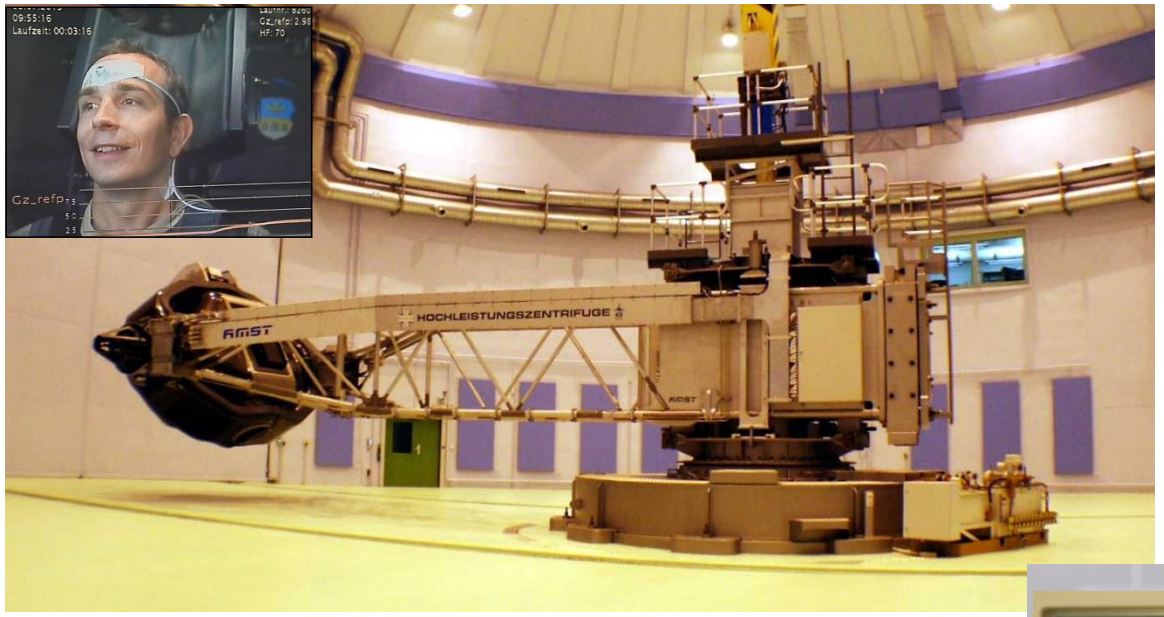
OBJECTIVE

*Evaluation of **key elements of the function** of the "G-RAFFE" suit characterizing its protective ability against G forces*

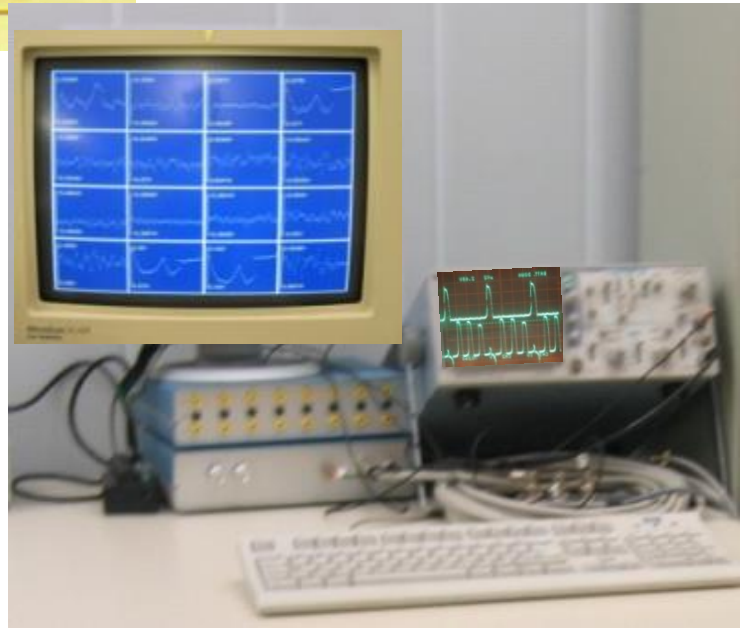
1. *Collection of **objective data** (cardiovascular function under Gz load in a human-use centrifuge)*

2. *Survey of personal, **subjective impressions** of active EF pilots*

METHODS



SETUP OF THE TEST STATION



METHODS

SUBJECTS

N = 13

85 centrifuge runs

Reflection
660, 810, 910 [nm]

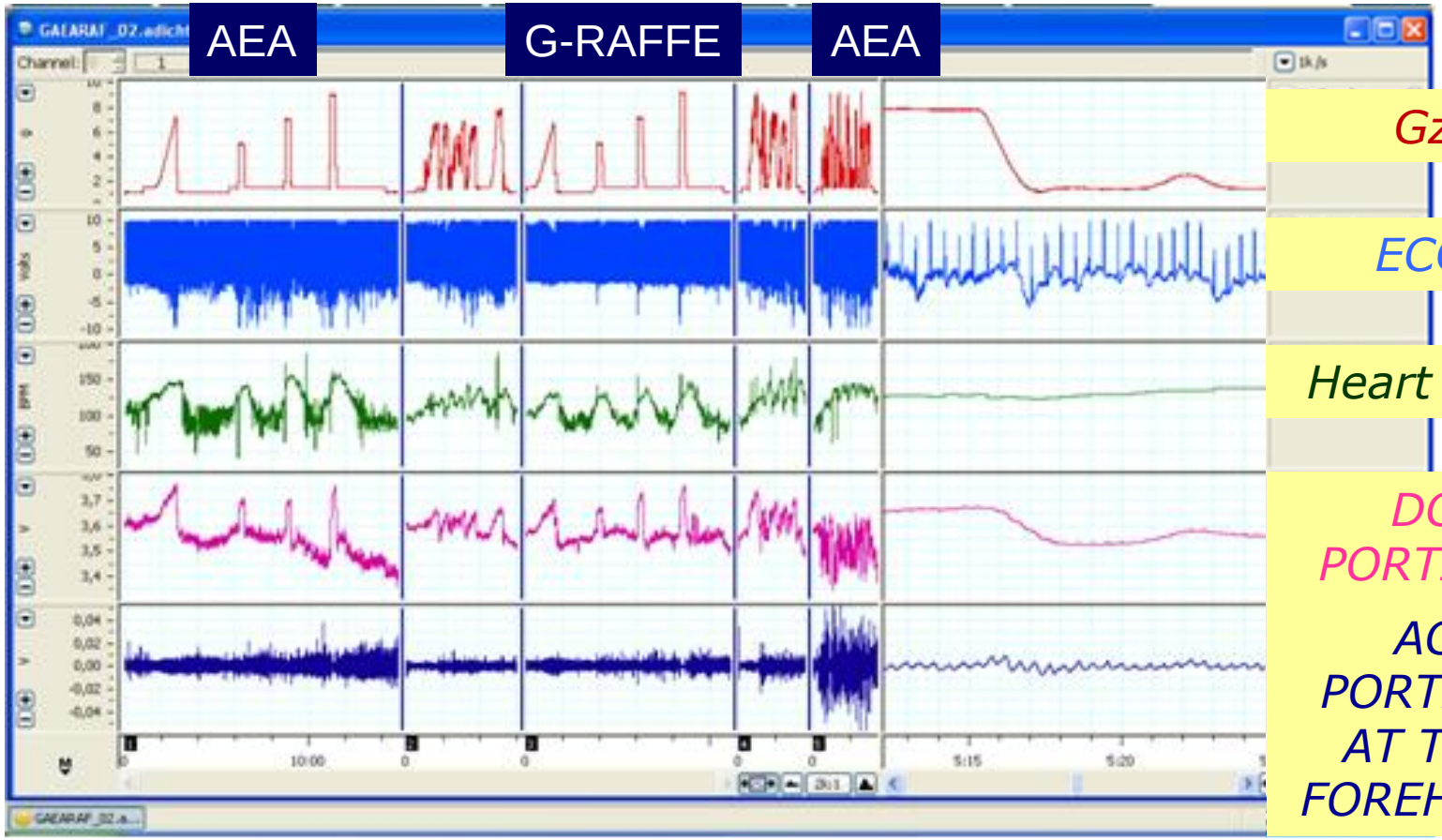
	AGE	HEIGHT	WEIGHT	SUIT
PILOTS N = 13	***31.54 ±4.63***	***177.37 ±5.50***	***79.35 ±9.81***	***AEA vs G-RAFFE***

G-RAFFE

AEA BAeS

METHODS

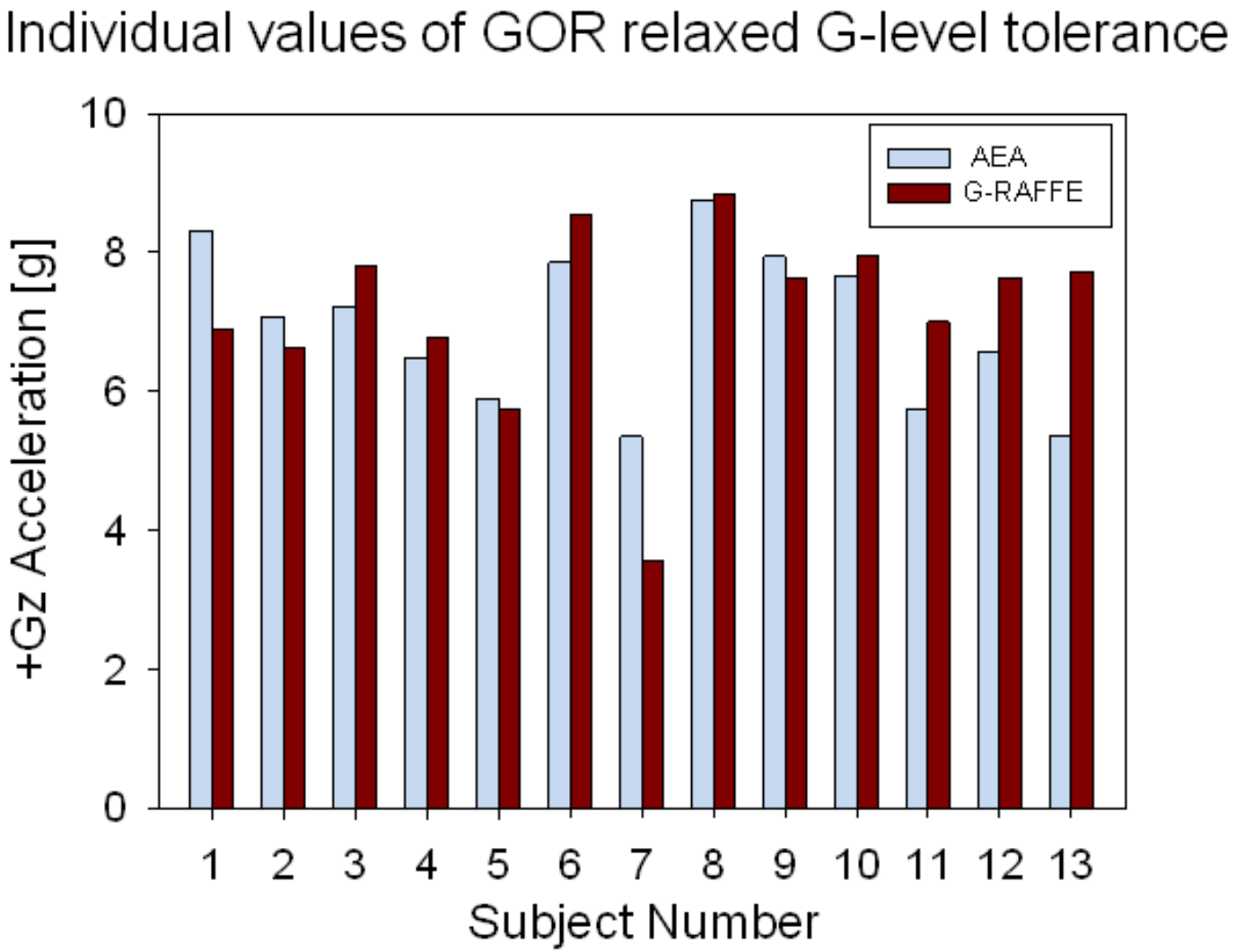
PROFILES USED



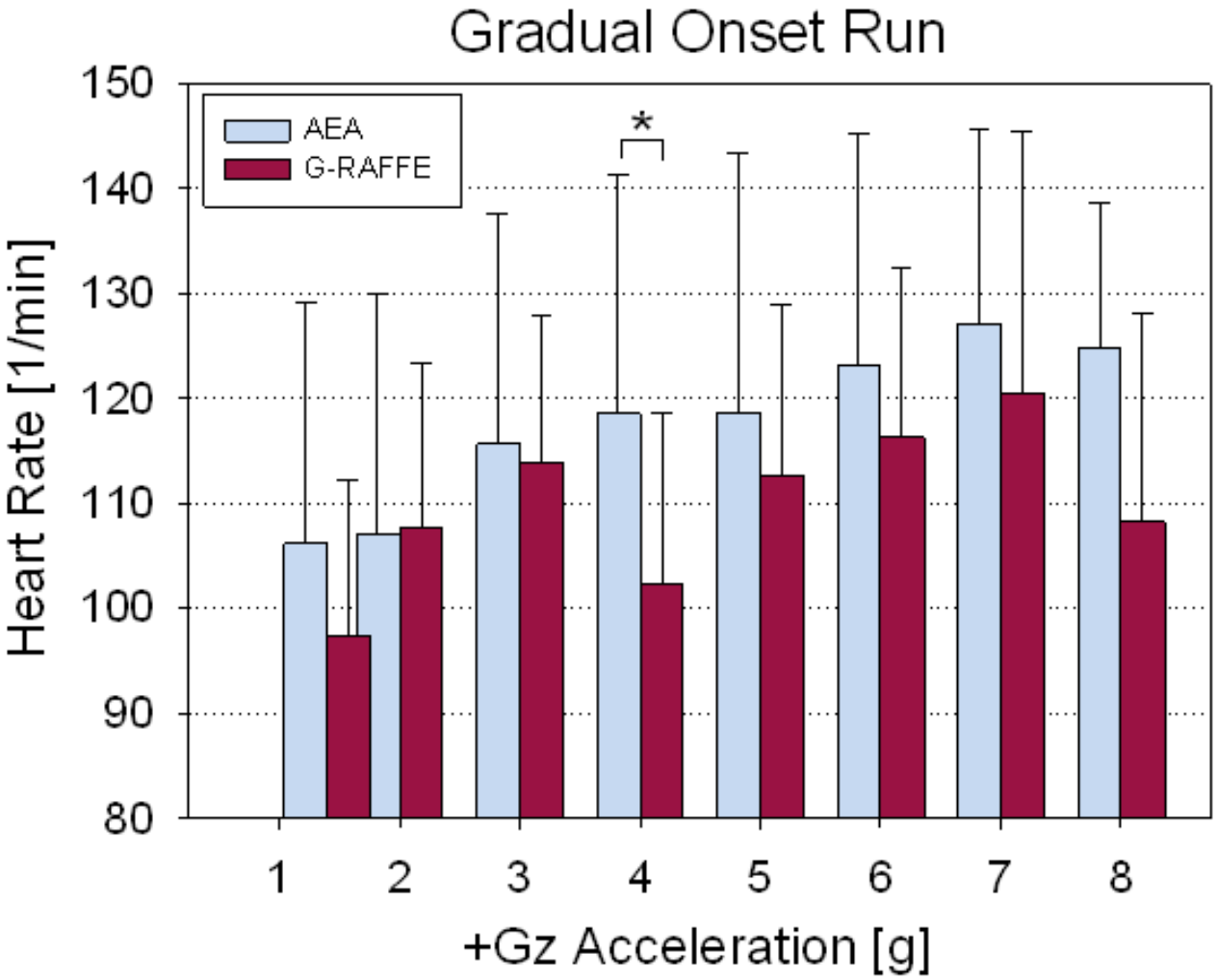
OBJECTIVE DATA

GRADUAL ONSET RUNS

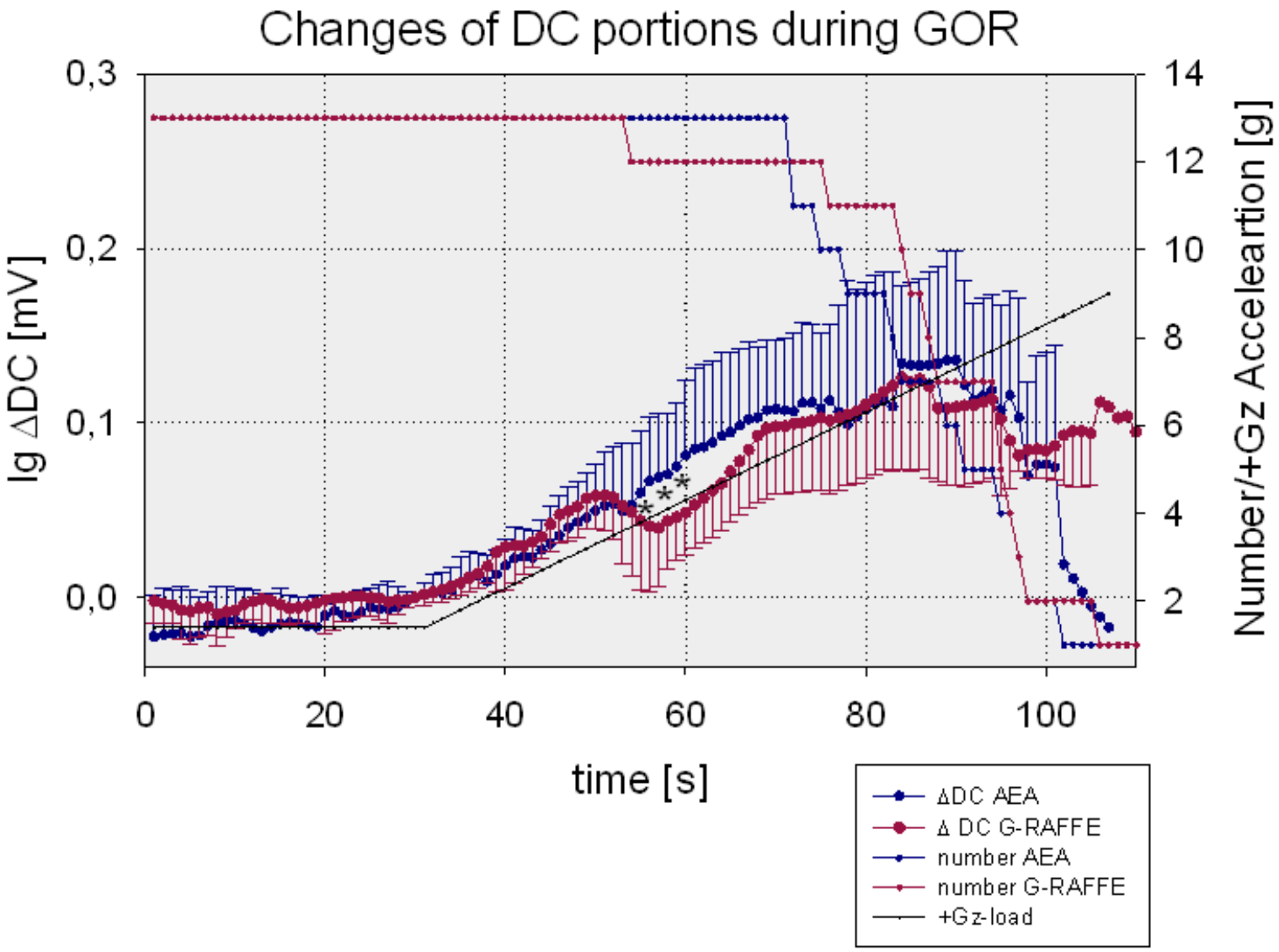
RESULTS


Individual values of GOR relaxed G-level tolerance
+Gz Acceleration [g]
0
2
4
6
8
10
1
2
3
4
5
6
7
8
9
10
11
12
13
Subject Number
AEA
G-RAFFE

RESULTS

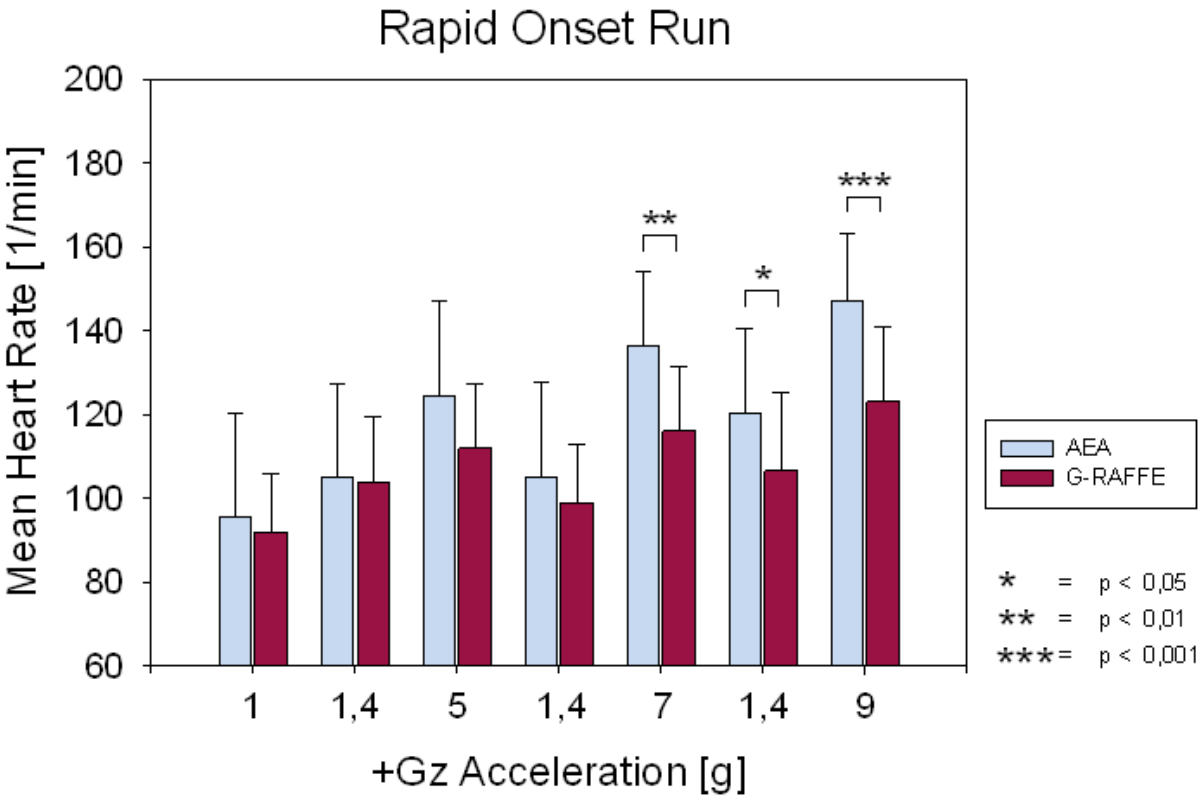

Gradual Onset Run
AEA
G-RAFFE
*
Heart Rate [1/min]
150
140
130
120
110
100
90
80
1
2
3
4
5
6
7
8
+Gz Acceleration [g]

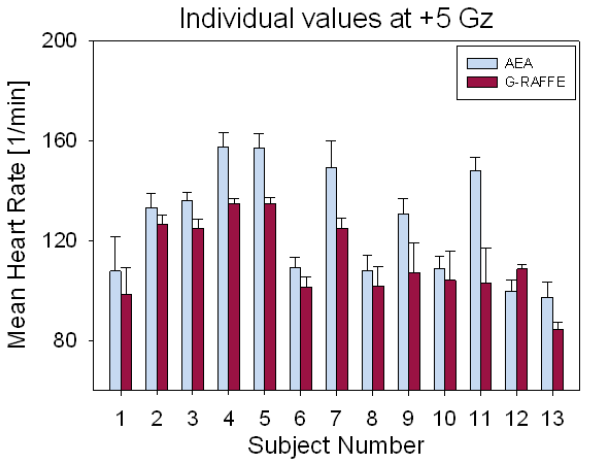
RESULTS

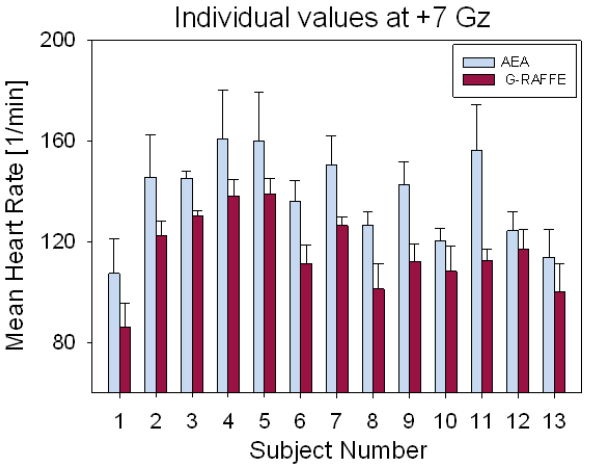

Changes of DC portions during GOR
lg ΔDC [mV]
0,3
0,2
0,1
0,0
14
12
10
8
6
4
2
Number/+Gz Acceleartion [g]
0
20
40
60
80
100
time [s]
ΔDC AEA
Δ DC G-RAFFE
number AEA
number G-RAFFE
+Gz-load

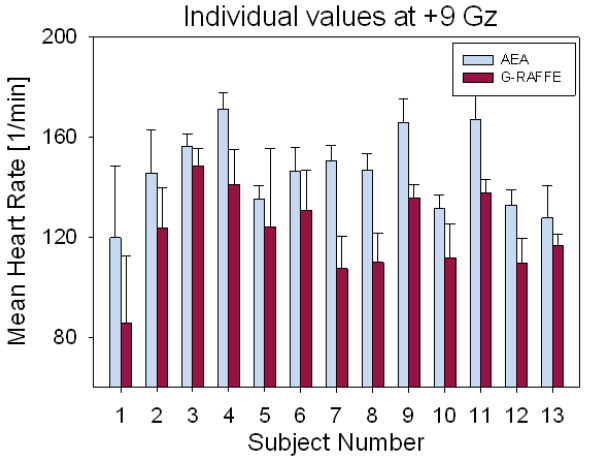
RAPID ONSET RUNS

RESULTS

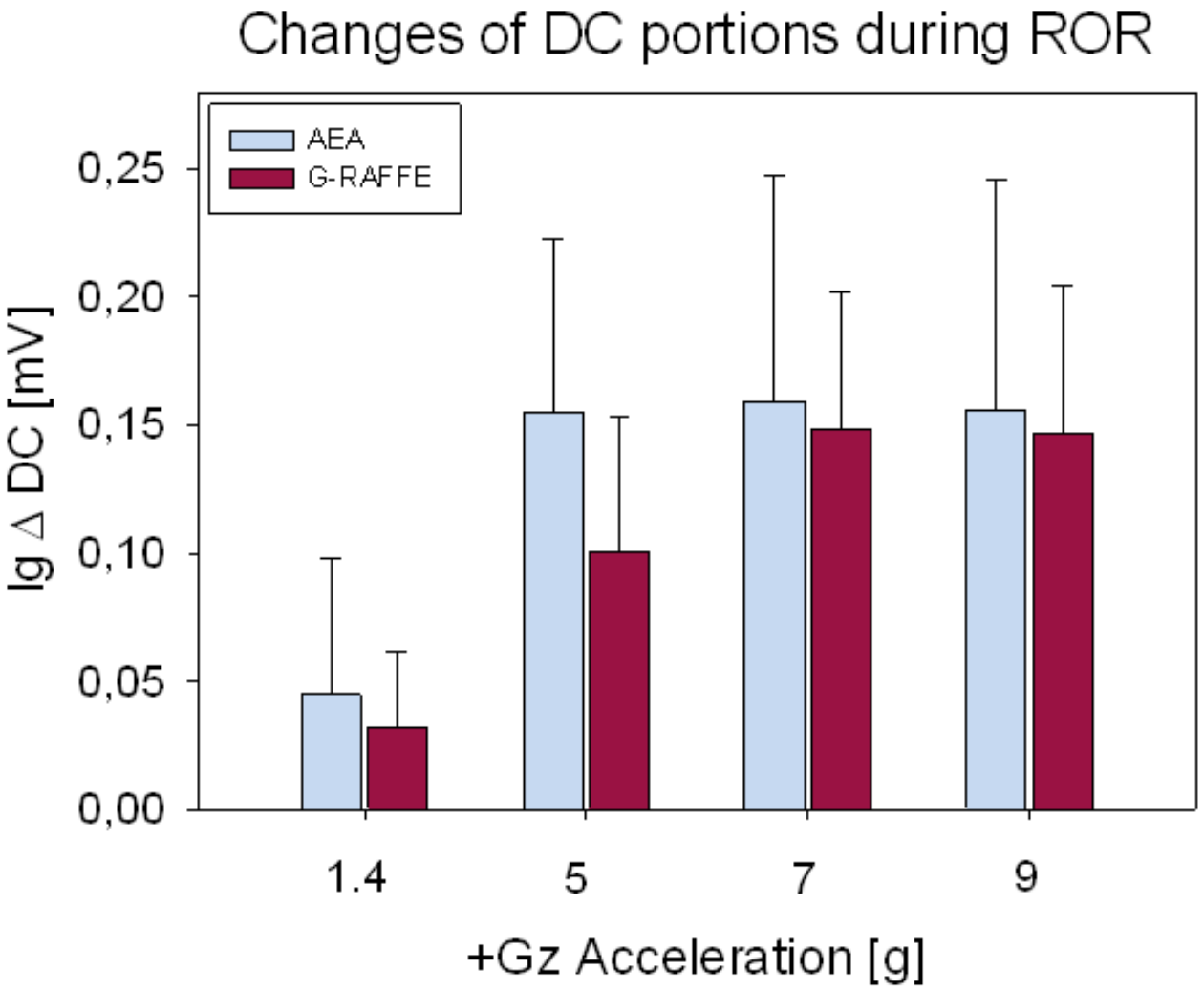

Rapid Onset Run
Mean Heart Rate [1/min]
200
180
160
140
120
100
80
60
1
1,4
5
1,4
7
1,4
9
+Gz Acceleration [g]
**
*
***
AEA
G-RAFFE
* = p < 0,05
** = p < 0,01
*** = p < 0,001


Individual values at +5 Gz
Mean Heart Rate [1/min]
200
160
120
80
1 2 3 4 5 6 7 8 9 10 11 12 13
Subject Number
AEA
G-RAFFE


Individual values at +7 Gz
Mean Heart Rate [1/min]
200
160
120
80
1 2 3 4 5 6 7 8 9 10 11 12 13
Subject Number
AEA
G-RAFFE


Individual values at +9 Gz
Mean Heart Rate [1/min]
200
160
120
80
1 2 3 4 5 6 7 8 9 10 11 12 13
Subject Number
AEA
G-RAFFE

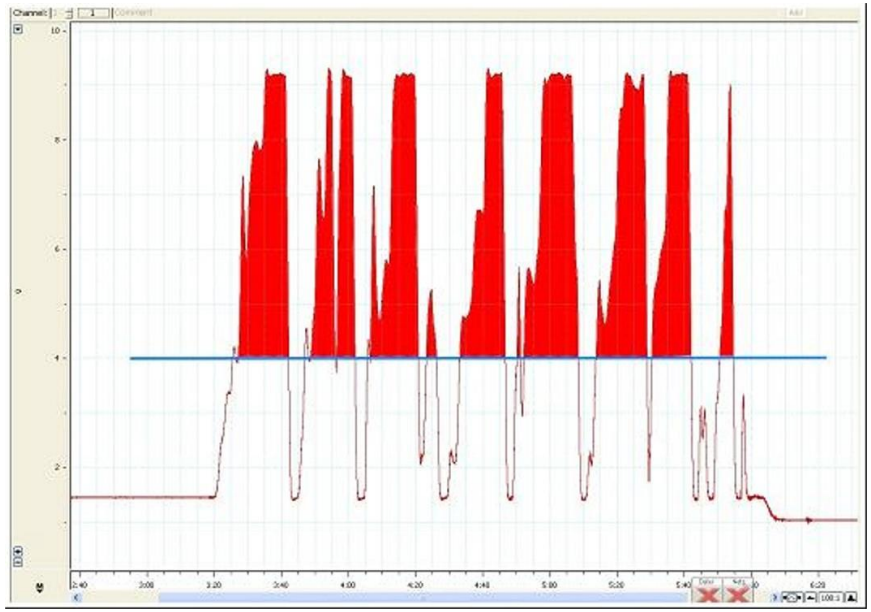
RESULTS


Changes of DC portions during ROR
AEA
G-RAFFE
0,25
0,20
0,15
0,10
0,05
0,00
lg Δ DC [mV]
1.4
5
7
9
+Gz Acceleration [g]

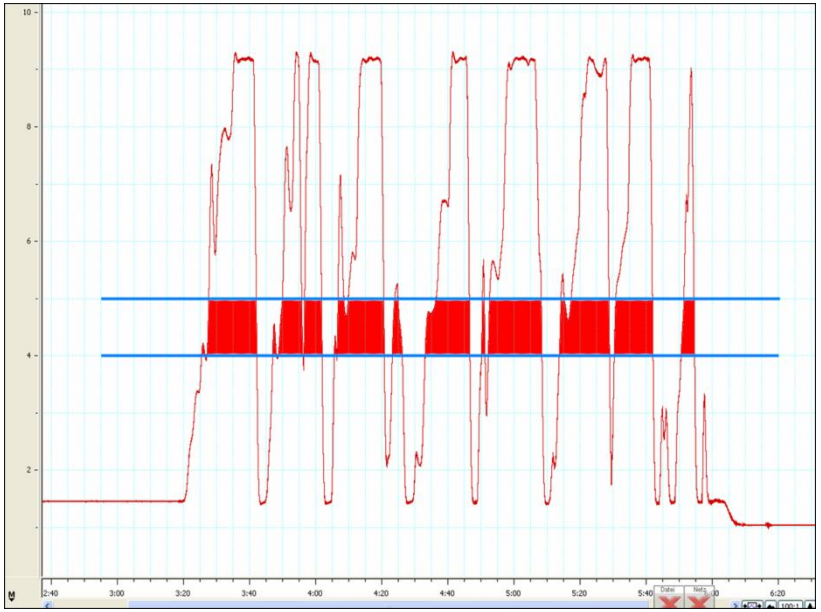
ESACM

RESULTS

DETERMINATION OF PERFORMANCE



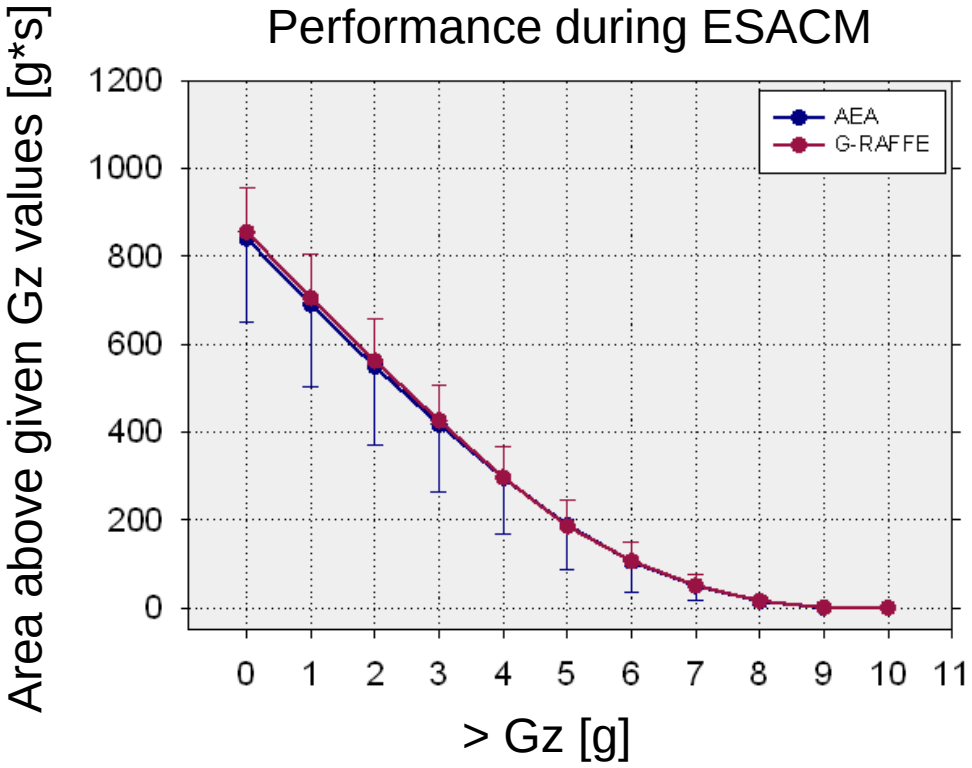
A

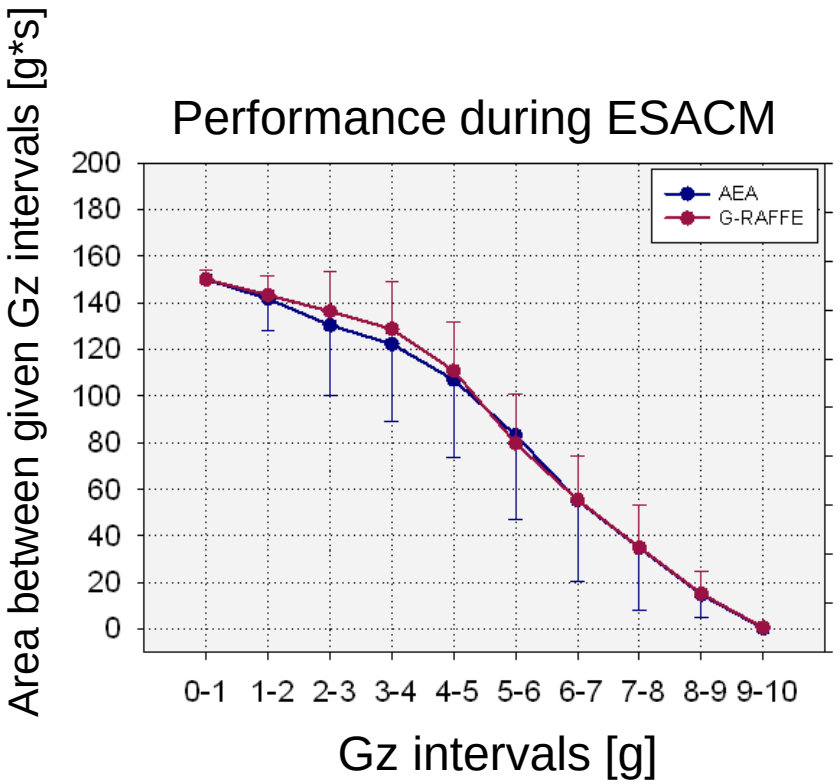


B

Example of the determination of the time integral over Gz values reached (A: area under the curve or B: area between given Gz intervals) during a centrifuge run of 150 s

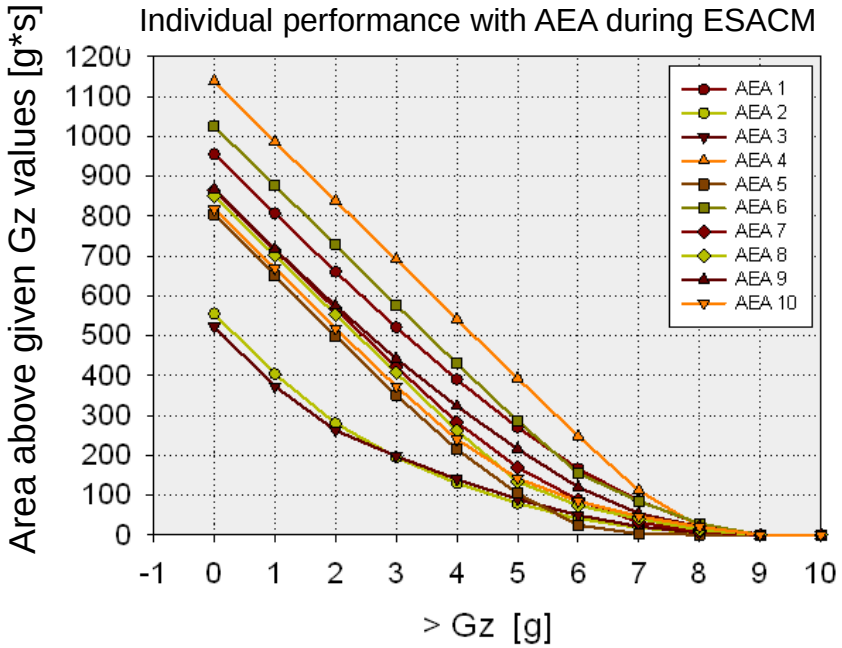
RESULTS

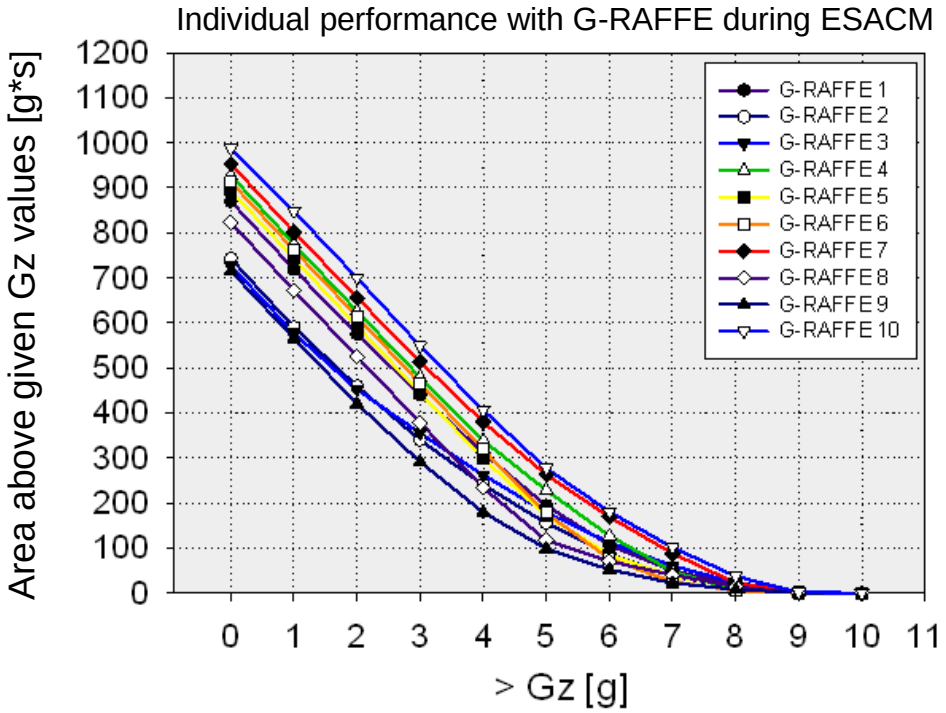

Performance during ESACM
Area above given Gz values [g*s]
1200
1000
800
600
400
200
0
AEA
G-RAFFE
0 1 2 3 4 5 6 7 8 9 10 11
> Gz [g]


Performance during ESACM
Area between given Gz intervals [g*s]
200
180
160
140
120
100
80
60
40
20
0
AEA
G-RAFFE
0-1 1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10
Gz intervals [g]

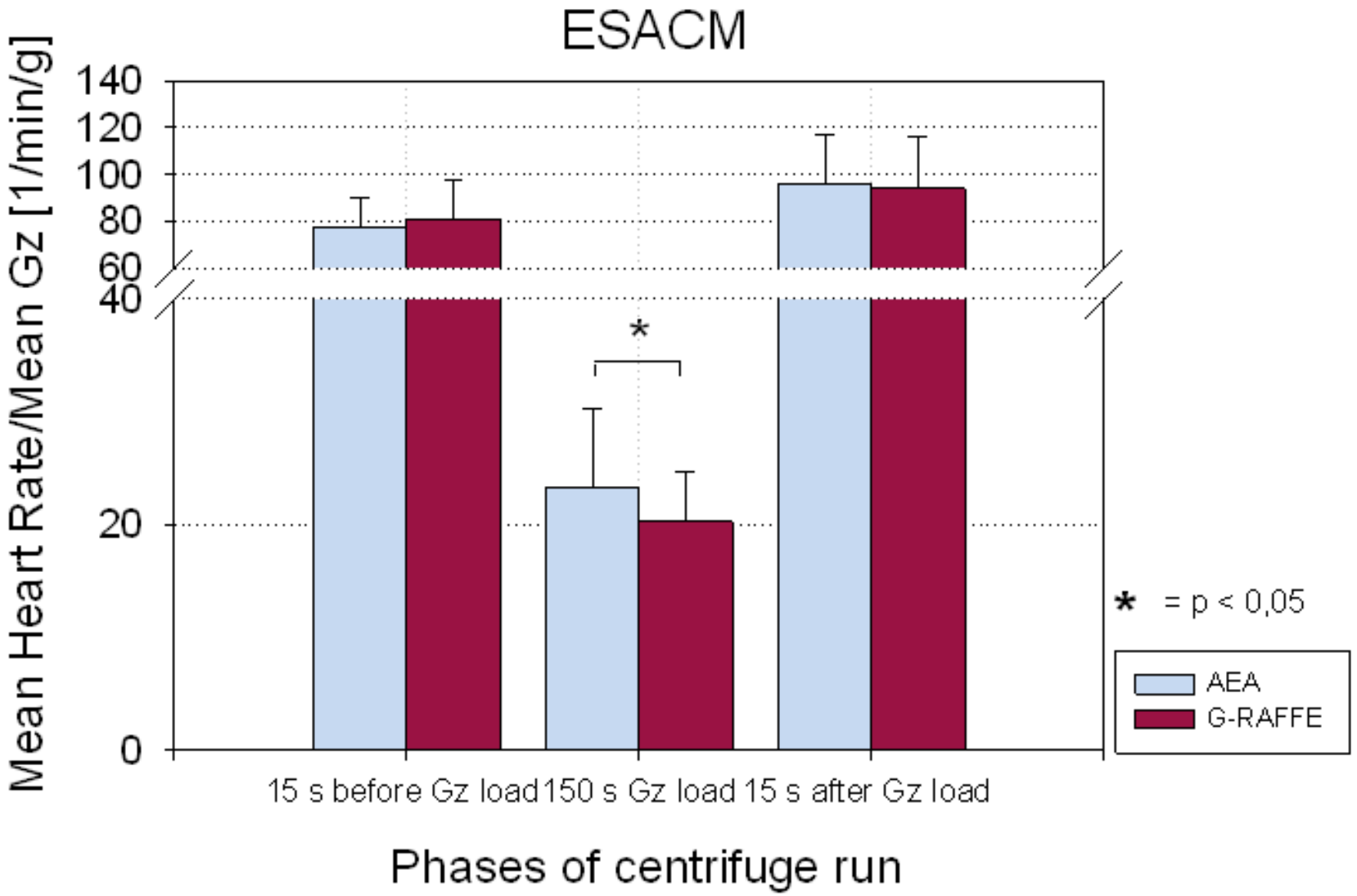
RESULTS

INDIVIDUAL PERFORMANCES DURING ESACM

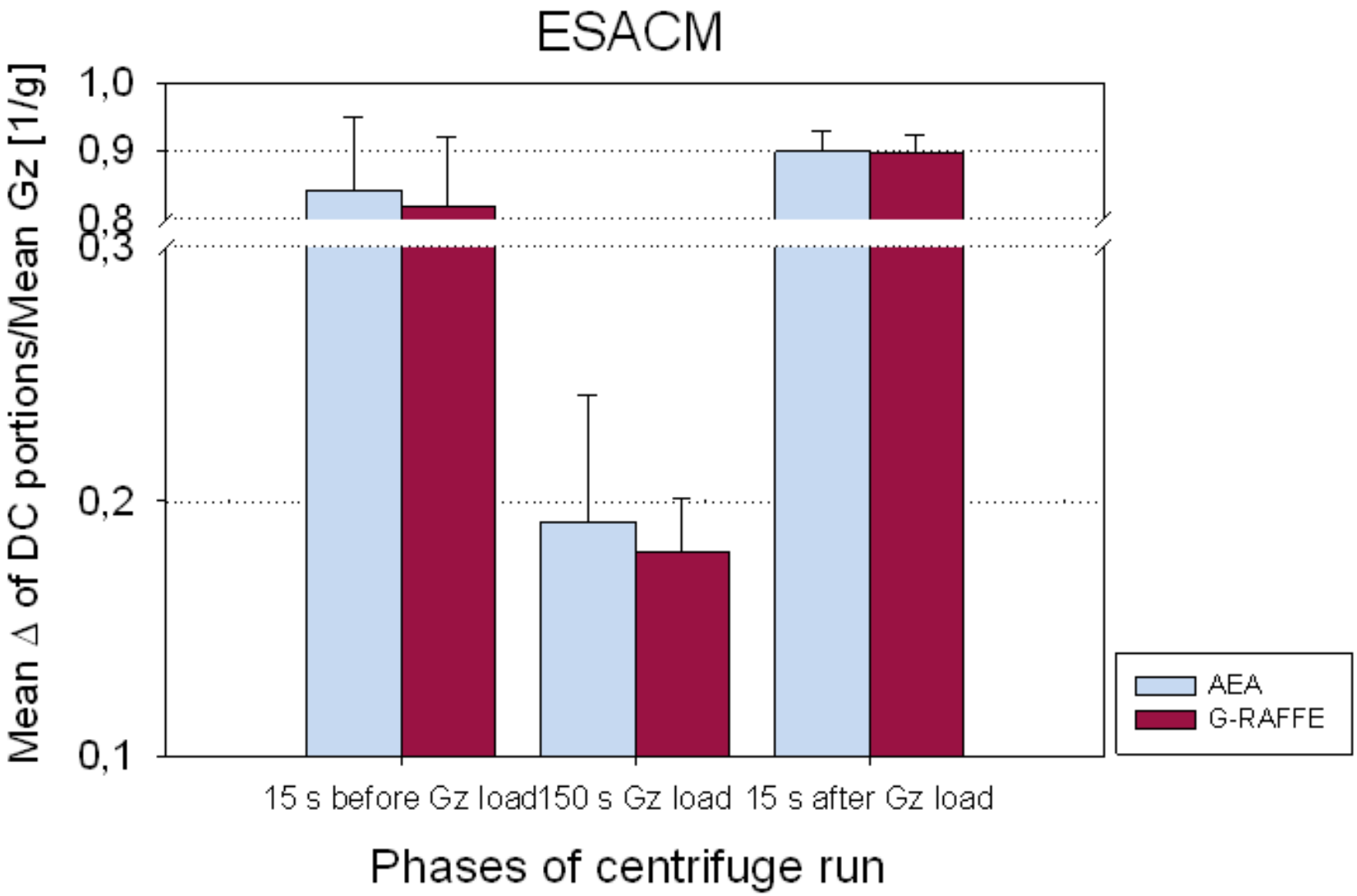




RESULTS

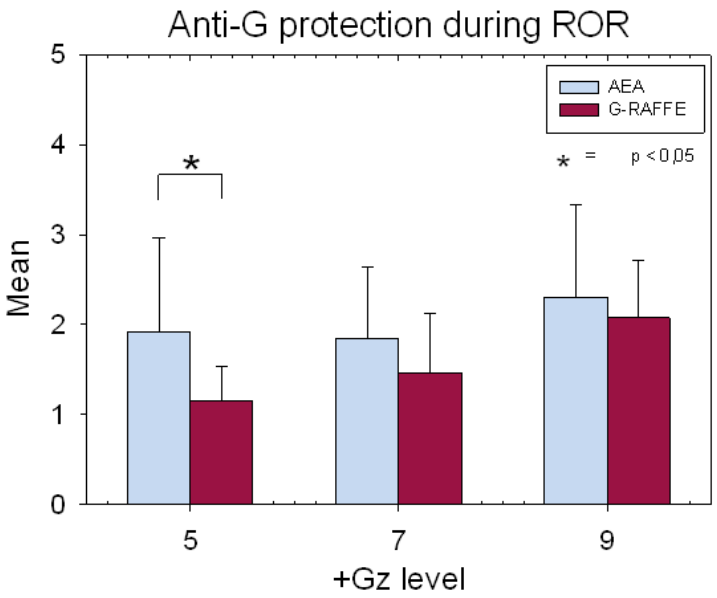

ESACM
Mean Heart Rate/Mean Gz [1/min/g]
140
120
100
80
60
40
20
0
*
* = p < 0,05
AEA
G-RAFFE
15 s before Gz load
150 s Gz load
15 s after Gz load
Phases of centrifuge run

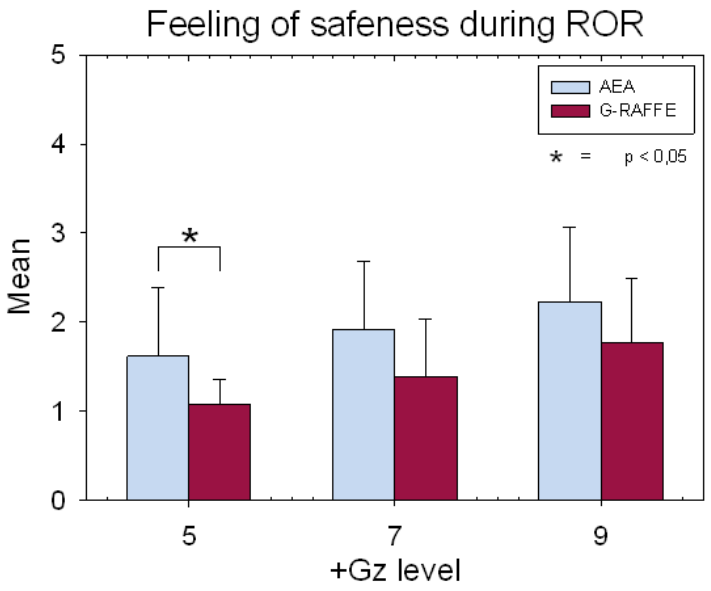
RESULTS

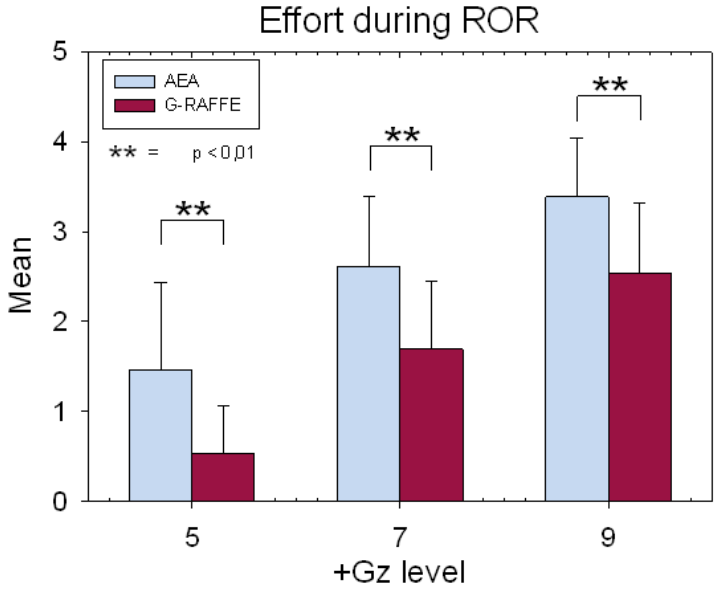

ESACM
Mean Δ of DC portions/Mean Gz [1/g]
1,0
0,9
0,8
0,3
0,2
0,1
15 s before Gz load
150 s Gz load
15 s after Gz load
Phases of centrifuge run
AEA
G-RAFFE

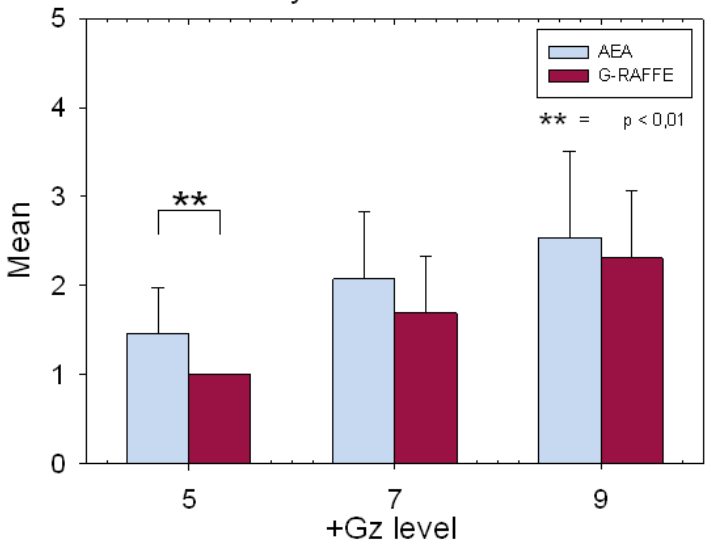
SUBJECTIVE DATA

RESULTS

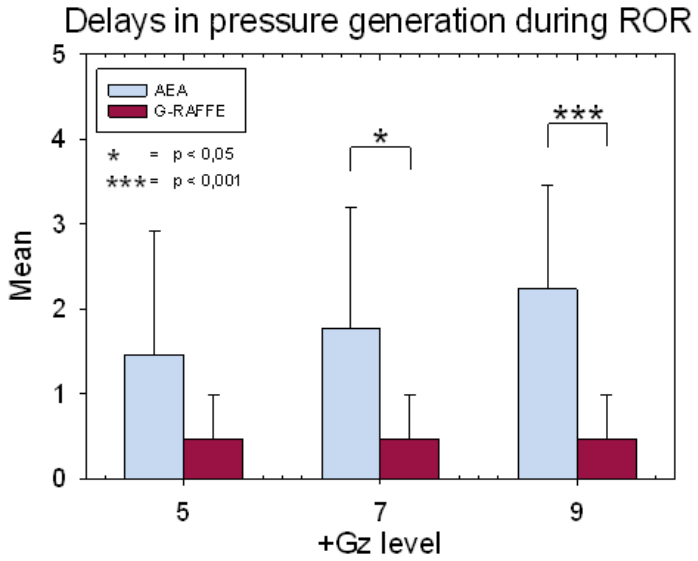

Anti-G protection during ROR
AEA
G-RAFFE
* = p < 0,05
Mean
+Gz level
0
1
2
3
4
5
7
9
*

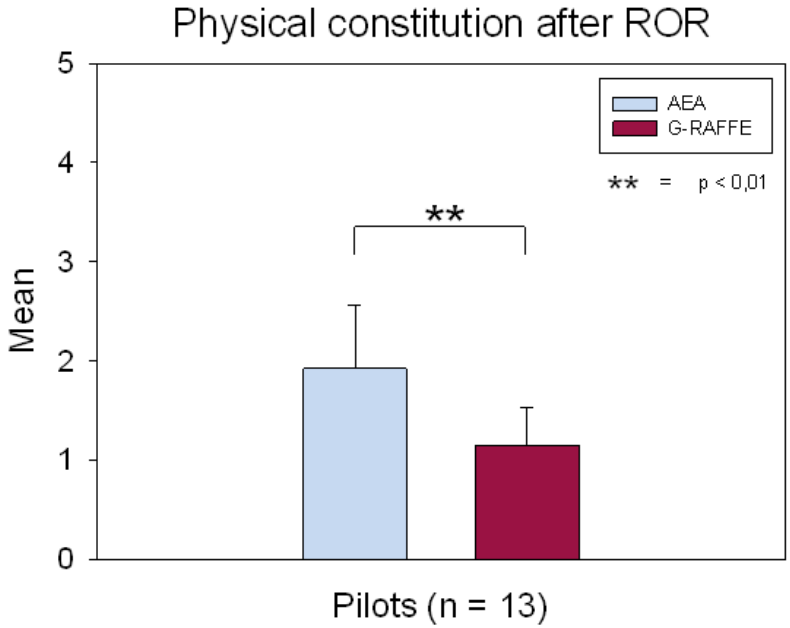

Feeling of safeness during ROR
AEA
G-RAFFE
* = p < 0,05
Mean
+Gz level
0
1
2
3
4
5
7
9
*

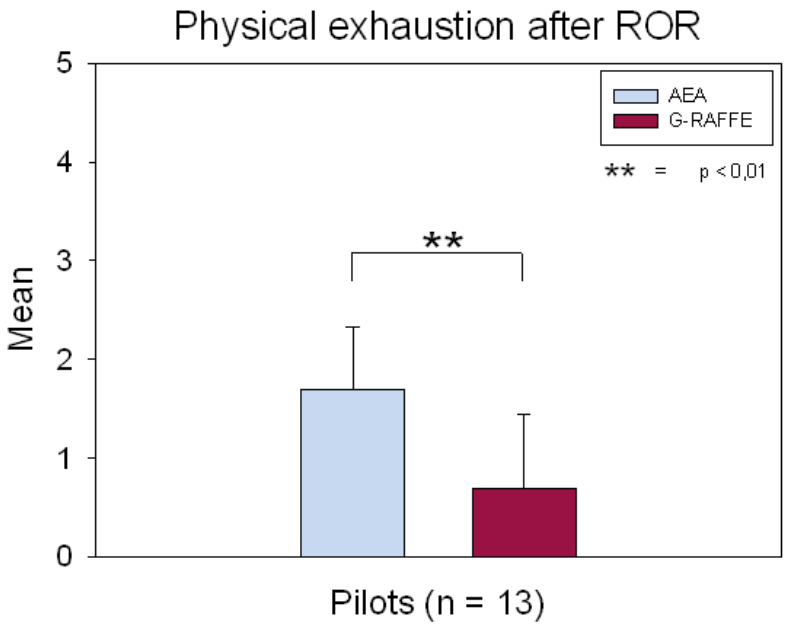

Effort during ROR
AEA
G-RAFFE
** = p < 0,01
Mean
+Gz level
0
1
2
3
4
5
7
9
**
**
**


Necessary attention for the ROR
AEA
G-RAFFE
** = p < 0,01
Mean
+Gz level
0
1
2
3
4
5
7
9
**

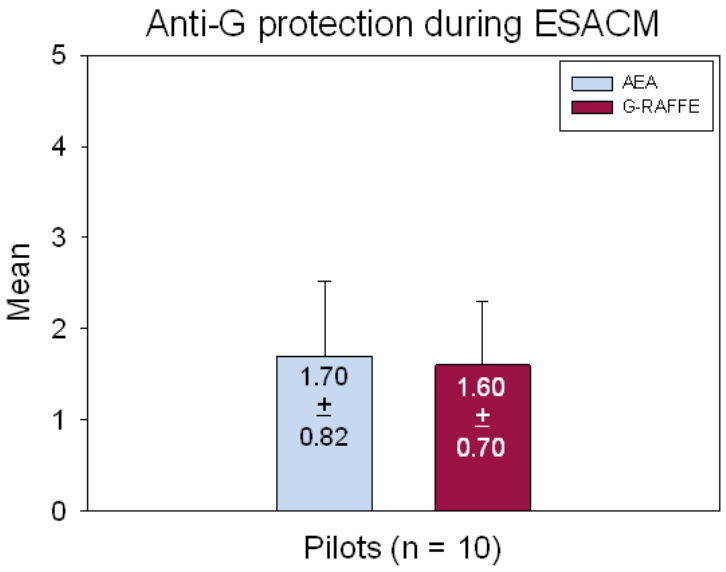
RESULTS

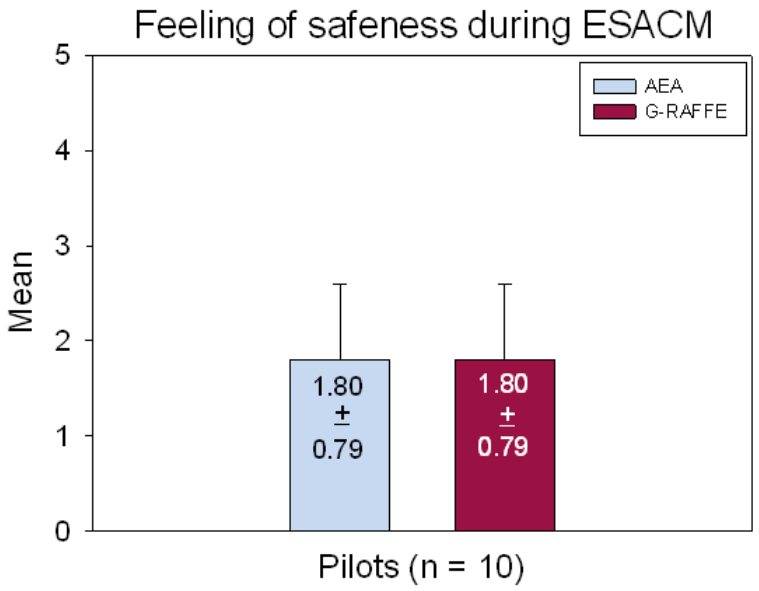

Delays in pressure generation during ROR
AEA
G-RAFFE
* = p < 0,05
*** = p < 0,001
*
***
Mean
0
1
2
3
4
5
5
7
9
+Gz level

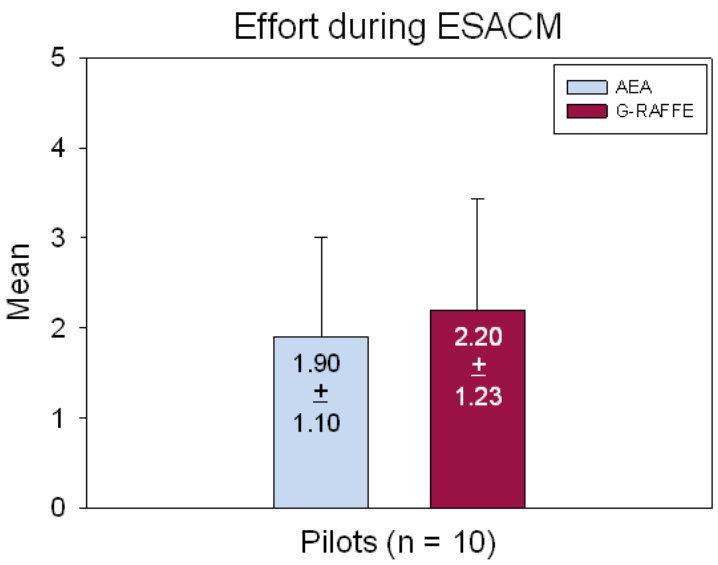

Physical constitution after ROR
AEA
G-RAFFE
** = p < 0,01
**
Mean
0
1
2
3
4
5
Pilots (n = 13)

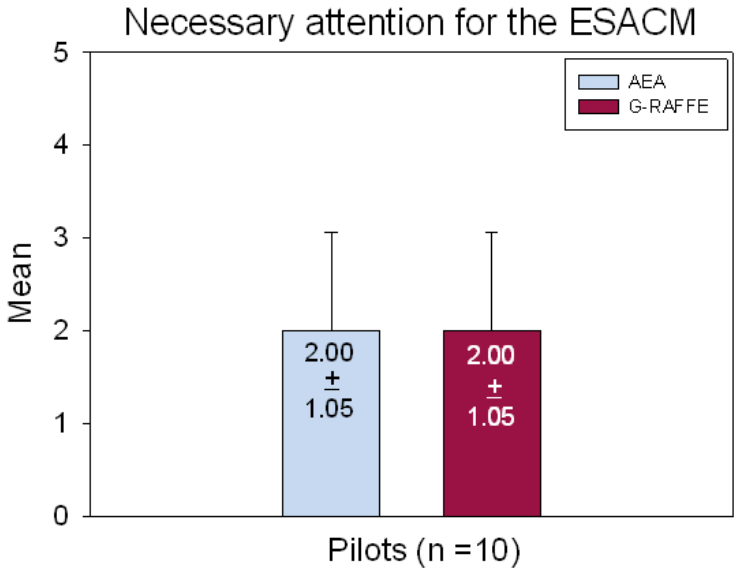

Physical exhaustion after ROR
AEA
G-RAFFE
** = p < 0,01
**
Mean
0
1
2
3
4
5
Pilots (n = 13)

RESULTS

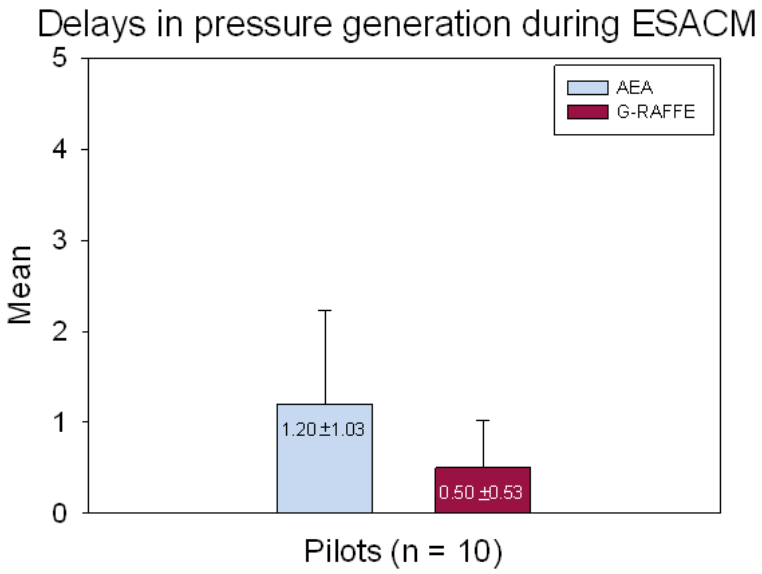

Anti-G protection during ESACM
AEA
G-RAFFE
Mean
0
1
2
3
4
5
1.70 ± 0.82
1.60 ± 0.70
Pilots (n = 10)

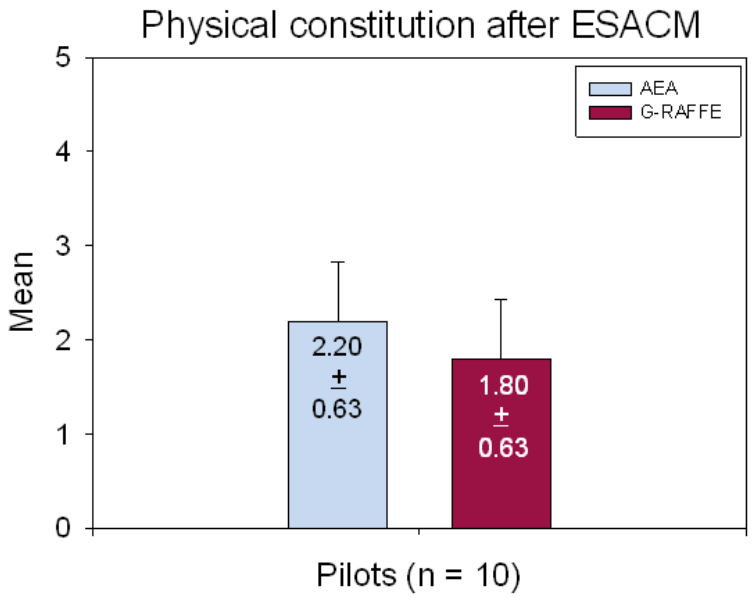

Feeling of safeness during ESACM
AEA
G-RAFFE
Mean
0
1
2
3
4
5
1.80 ± 0.79
1.80 ± 0.79
Pilots (n = 10)

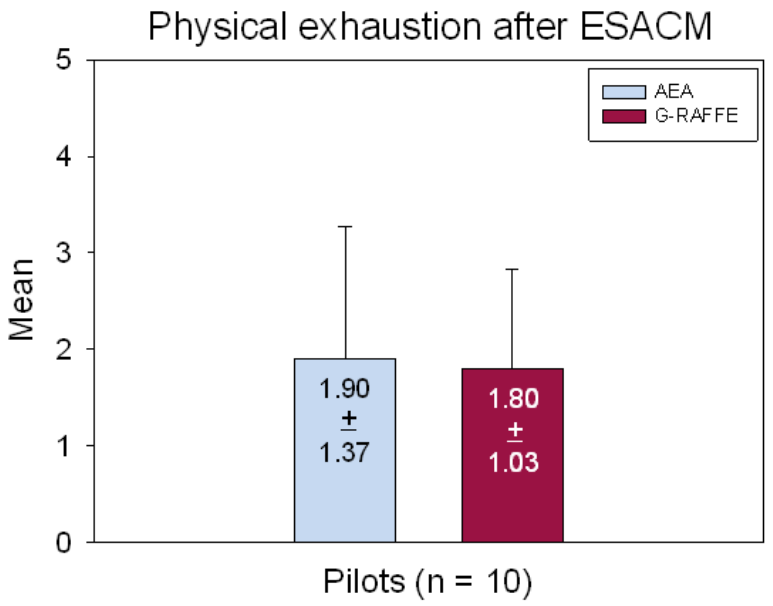

Effort during ESACM
AEA
G-RAFFE
Mean
0
1
2
3
4
5
1.90 ± 1.10
2.20 ± 1.23
Pilots (n = 10)


Necessary attention for the ESACM
AEA
G-RAFFE
Mean
0
1
2
3
4
5
2.00 ± 1.05
2.00 ± 1.05
Pilots (n =10)

RESULTS


Delays in pressure generation during ESACM
AEA
G-RAFFE
Mean
0
1
2
3
4
5
1.20 ±1.03
0.50 ±0.53
Pilots (n = 10)


Physical constitution after ESACM
AEA
G-RAFFE
Mean
0
1
2
3
4
5
2.20 ± 0.63
1.80 ± 0.63
Pilots (n = 10)


Physical exhaustion after ESACM
AEA
G-RAFFE
Mean
0
1
2
3
4
5
1.90 ± 1.37
1.80 ± 1.03
Pilots (n = 10)

CONCLUSIONS

In comparison to AEA, the "G-RAFFE" suit allowed the pilots to reach the ***same*** or a ***better performance*** even without including PBG into the protection system.

This was accompanied by a ***lower cardiovascular load*** and already occurred ***after only a very short period of familiarization*** even though the new suit had not been individually fitted to the pilots.

CONCLUSIONS

SUBJECTIVE RATING

- ***G protection*** as well as the ***feeling of safeness*** and the ***physical constitution*** felt after the runs were rated ***better***.

- ***Physical exhaustion*** and the ***effort*** necessary to fulfill the mission were rated ***lower***.

CONCLUSIONS

- Abandoning the integration of PBG into the anti-G protection system ***minimizes the potential health risk*** for the pilots.

- ***No unique AGSM*** necessary.

- As the pilots are becoming more familiar with the "G-RAFFE" suit, ***further potential of improvement*** of the performance may be expected.

Acknowledgments

- Pilots from:
  - Laage (JG 73 "S")
  - Neuburg (JG 74)
  - Nörvenich (JaboG 31 "B")
  - Wittmund (JG 71 "R")
- Team of the Flight Physiology Section of the GAF CAM in Koenigsbrueck
- iii solutions
- G-nius / Pte. Ltd. Singapore

THANK YOU VERY MUCH FOR YOUR ATTENTION!

ANY QUESTIONS ???