



German Air Force Center of Aerospace Medicine

RECORDING HUMAN HEMODYNAMICS
DURING PARABOLIC FLIGHTS
USING PHOTOPLETHYSMOGRAPHY

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PARABOLIC FLIGHTS



Airbus A300 Zero-G directly before reaching the 0-g phase

- Parabolic flights present one of the few possibilities to simulate alternating gravity conditions under laboratory-type conditions.
- The special parabolic trajectory allows for approximately 22 seconds of zero-g, preceded and followed by a hyper-g phase.
- Parabolic flights are excellent for examining rapid hemodynamic changes in humans under alternating accelerations.

Picture: https://bilder.t-online.de/b/61/32/23/90/id_61322390/610/tid_da/



INTRODUCTION

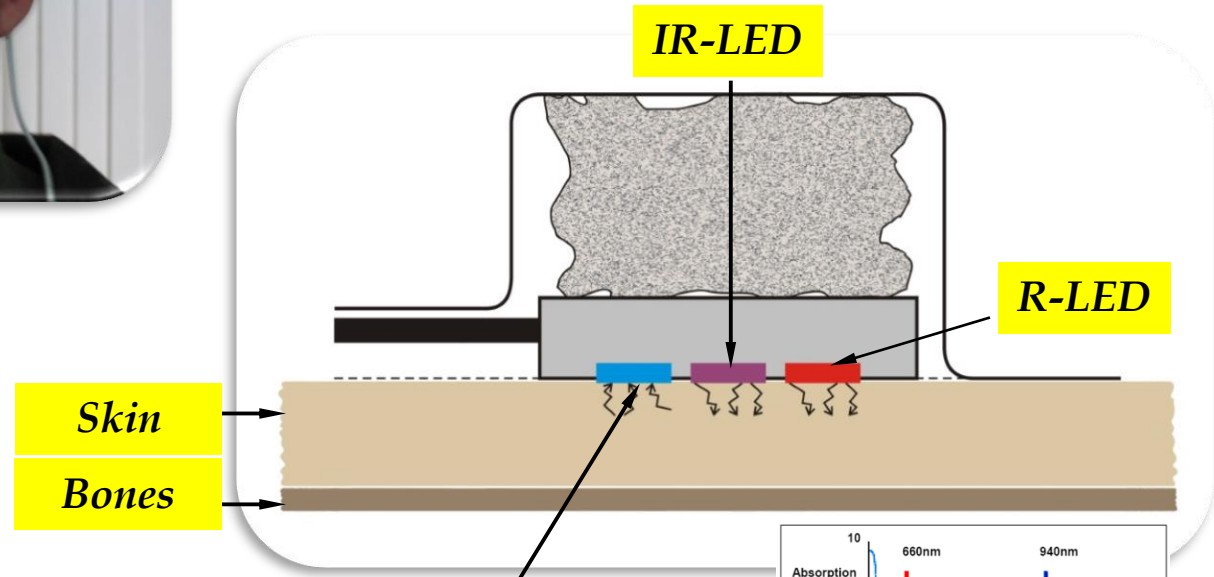


PULSOXIMETRY

Takuo Aoyagi, 1972

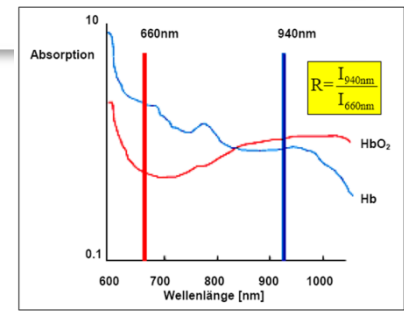
PHOTOPLETHYSMOGRAPHY

Hertzmann, 1930s



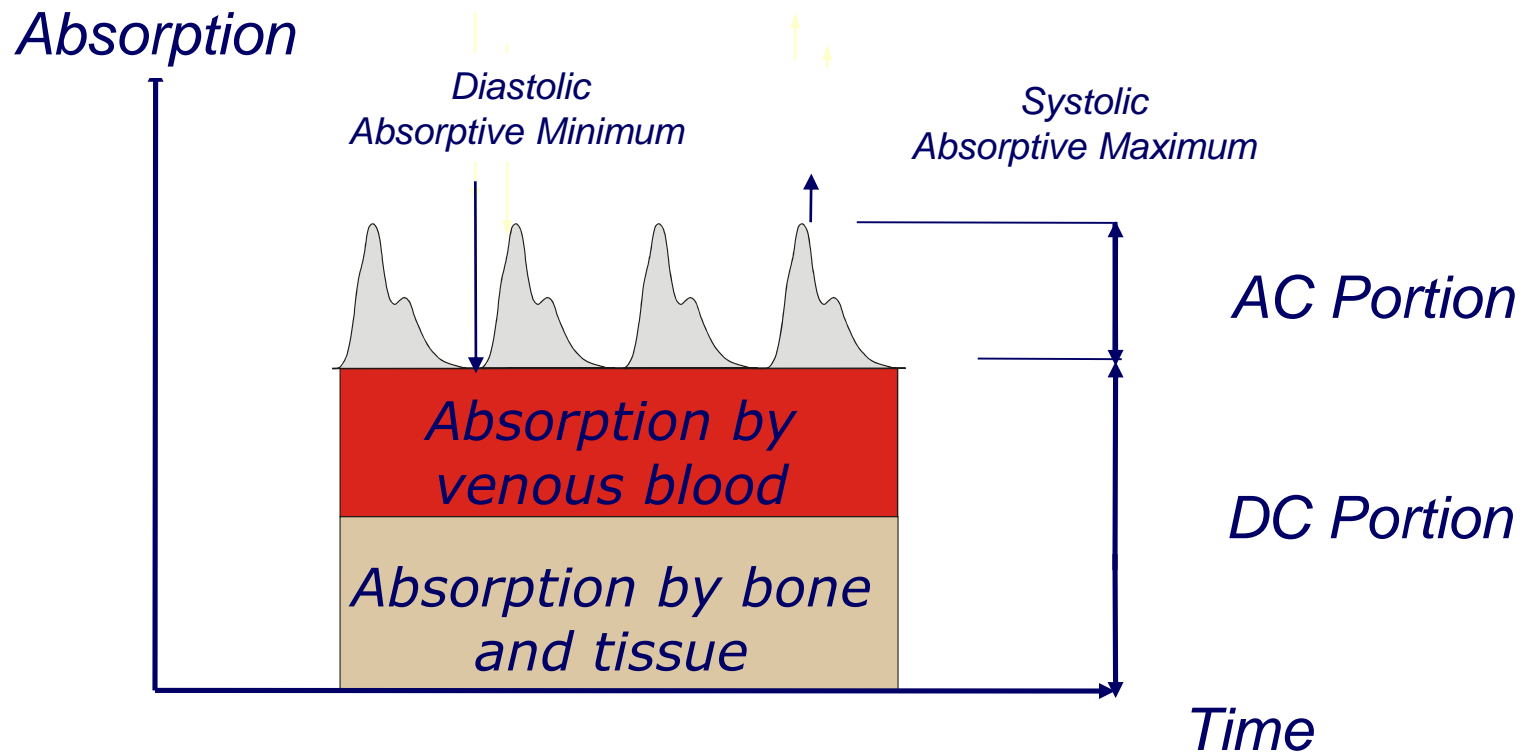
Photodetector

$$SaO_2 = \frac{[O_2-Hb]}{[O_2-Hb] + [Hb]}$$



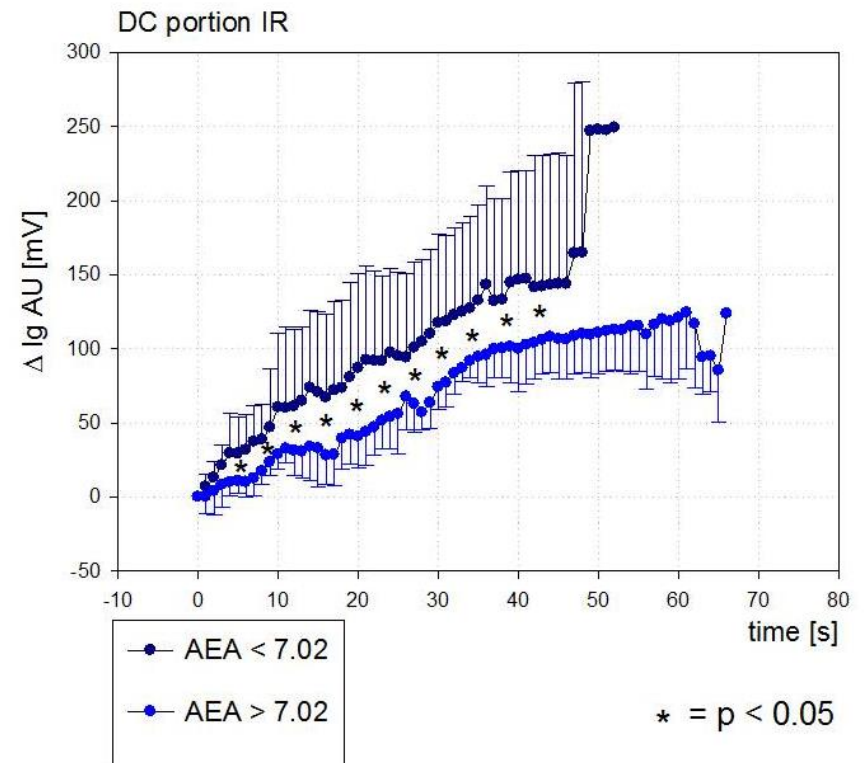
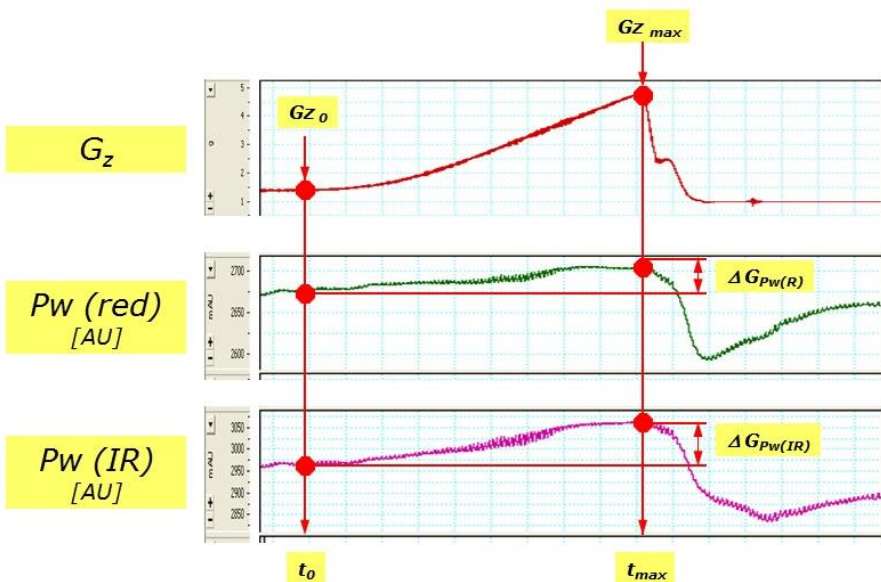


COMPONENTS OF THE PPG SIGNAL





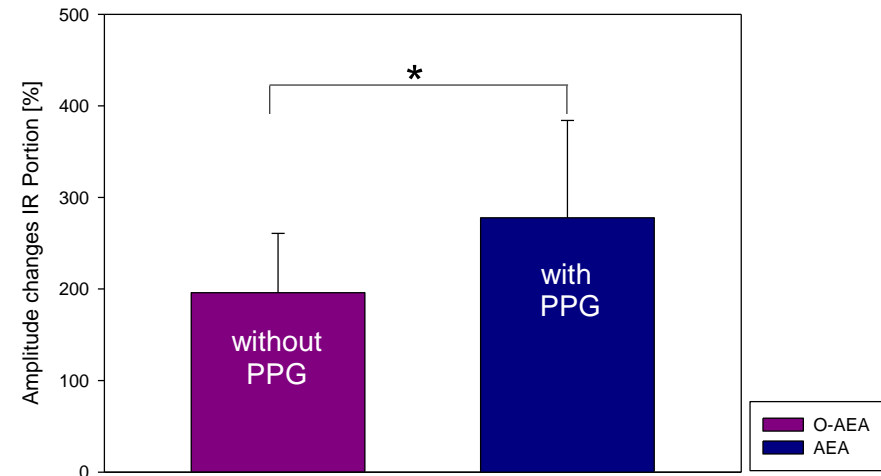
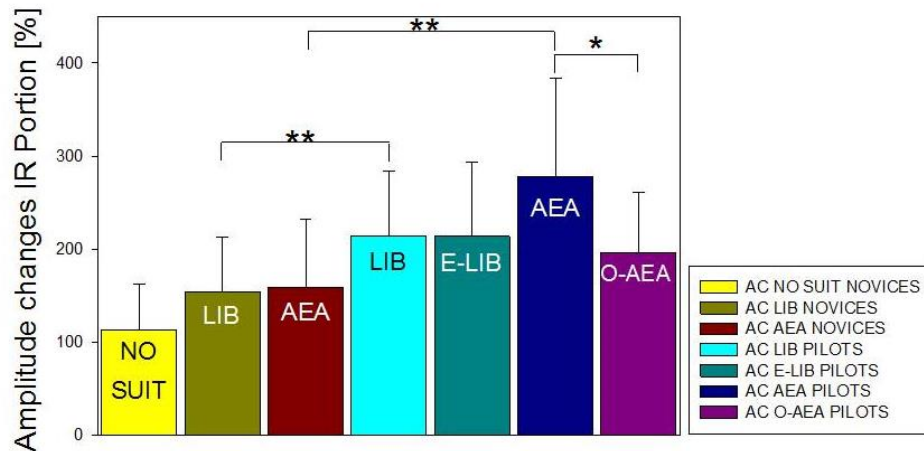
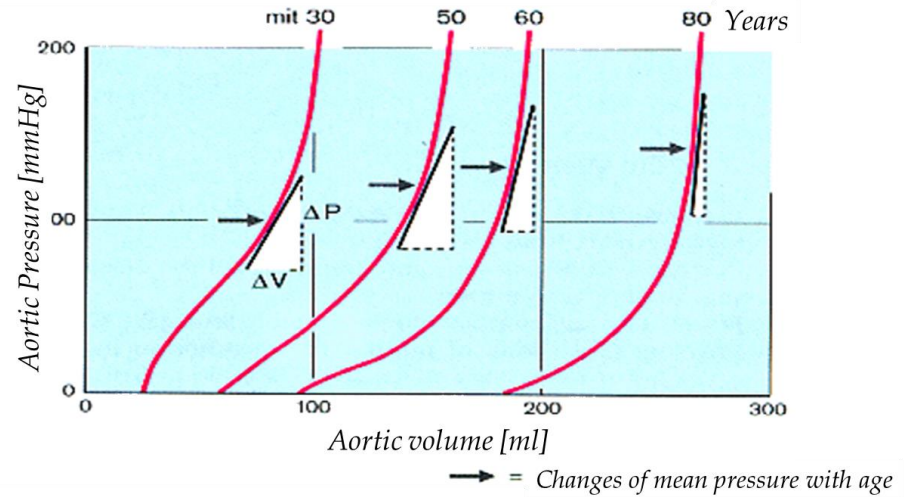
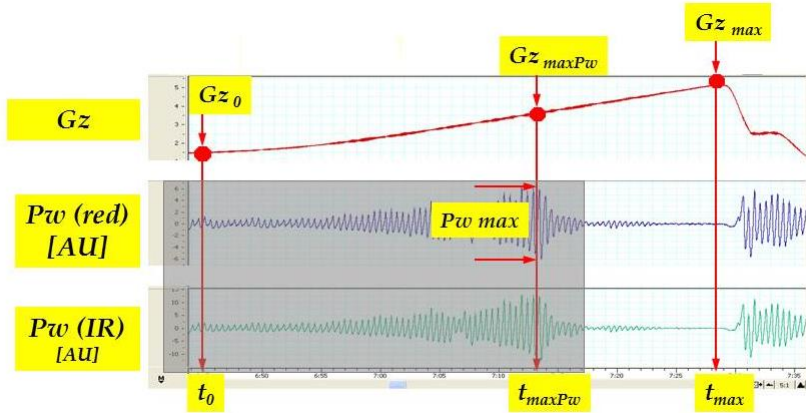
QUANTITATIVE EVALUATION OF THE DC PORTIONS OF THE PULSE WAVE DURING CENTRIFUGE PROFILES





INTRODUCTION

QUANTITATIVE EVALUATION OF THE AC PORTIONS OF THE PULSE WAVE



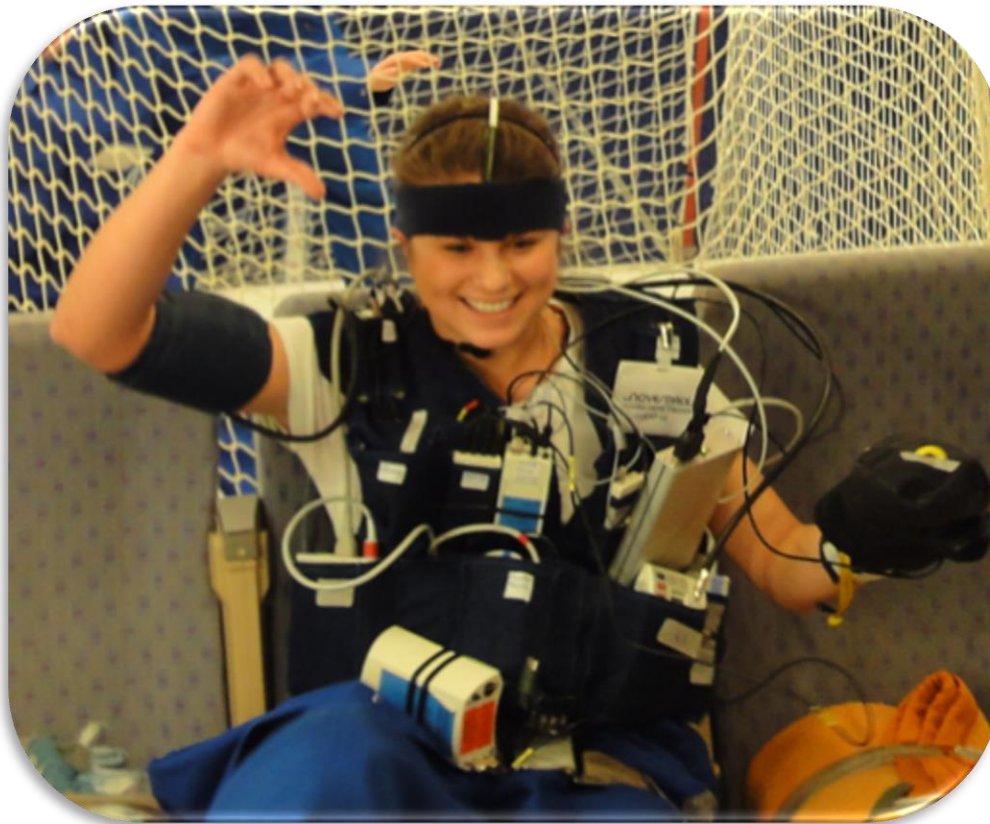


OBJECTIVES OF THE STUDY

- Continuously record the pulse wave during parabolic flights using photoplethysmography;
- derive DC portions (= PPG_{DC}) and AC portions (= PPG_{AC});
- draw conclusions about blood volume distribution and changes in cardiac contractility.



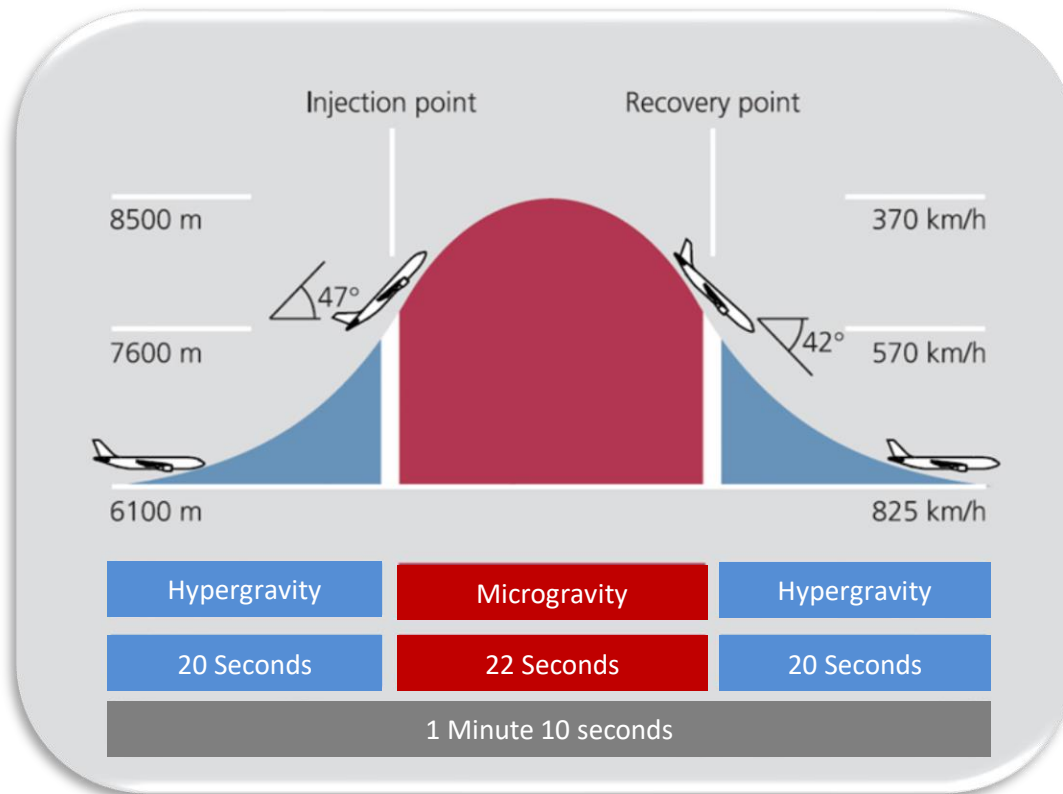
SUBJECTS



- ✓ $N = 26$
- ✓ *11 women, 15 men*
- ✓ *Age: 33 ± 9 years ($MW \pm SD$)*
- ✓ *valid medical*



EXPERIMENTAL PROCEDURE

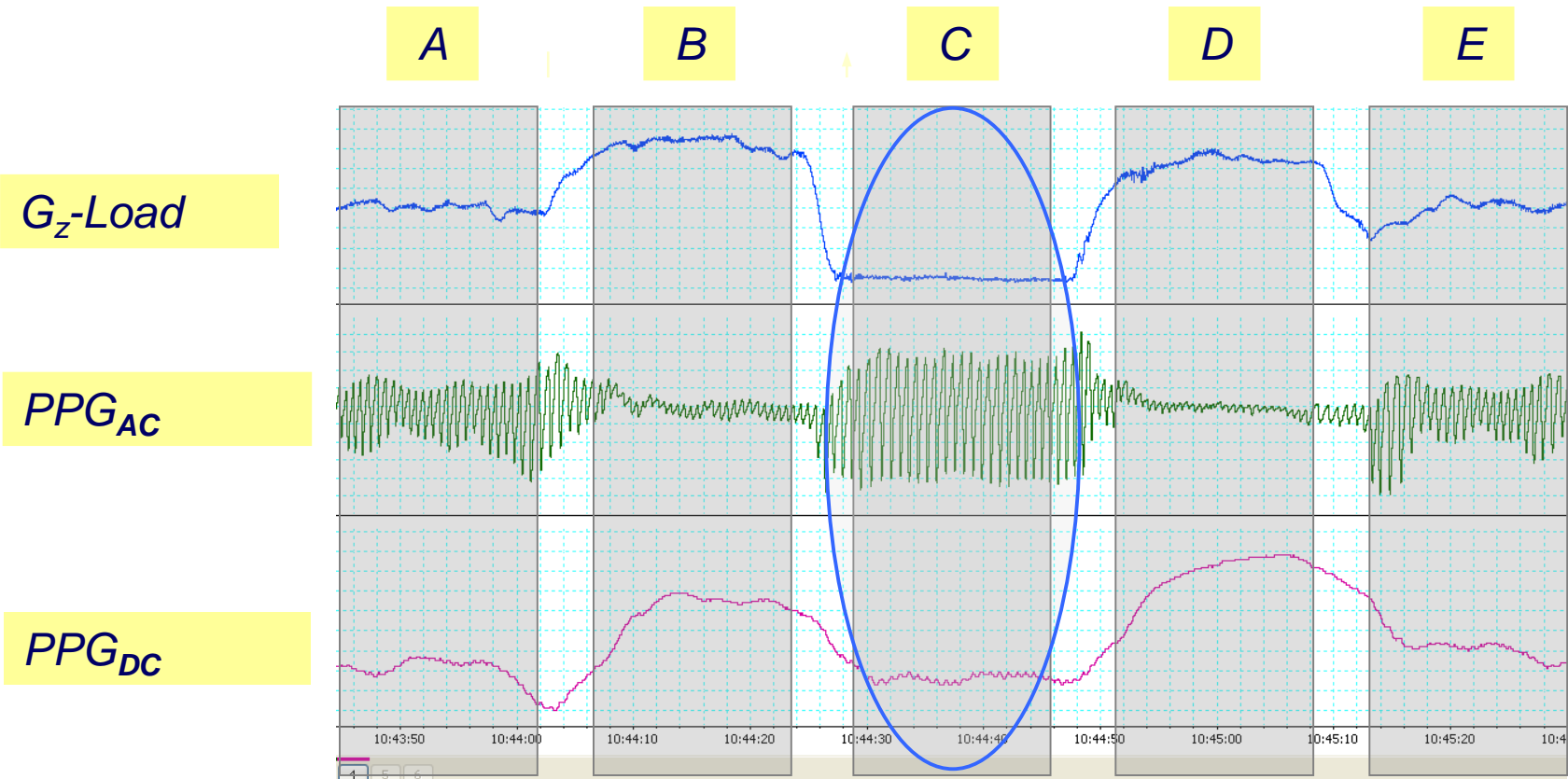


Phases of parabolic flight

- Each subject underwent:
- 31 parabolas including
3 different activity levels:
- no load (NL),
 - physical load (PL -50 W),
 - mental load (ML).



DATA ANALYSIS





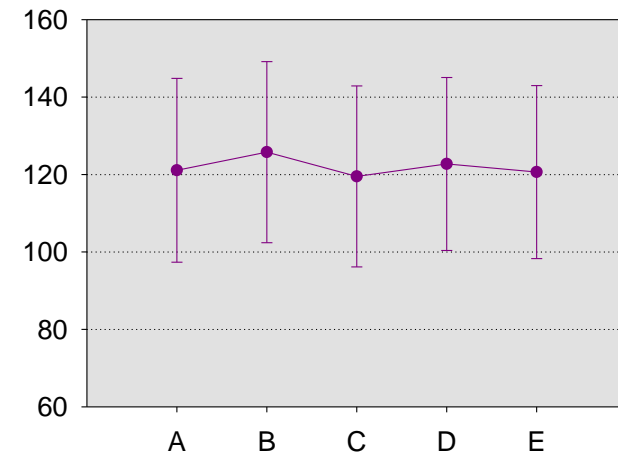
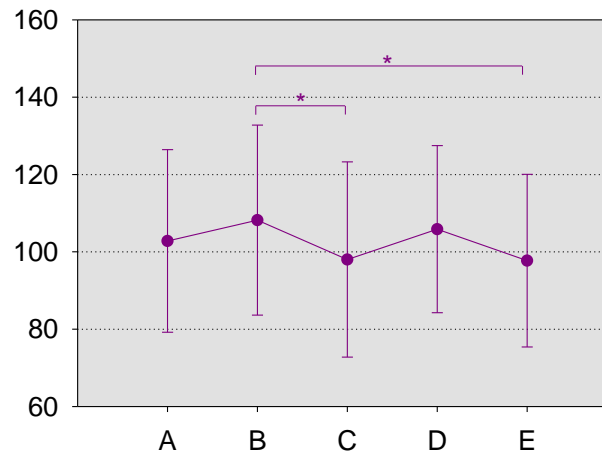
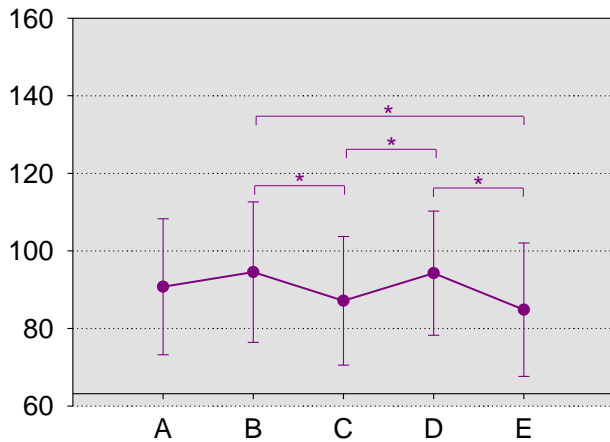
RESULTS

HR [bpm]

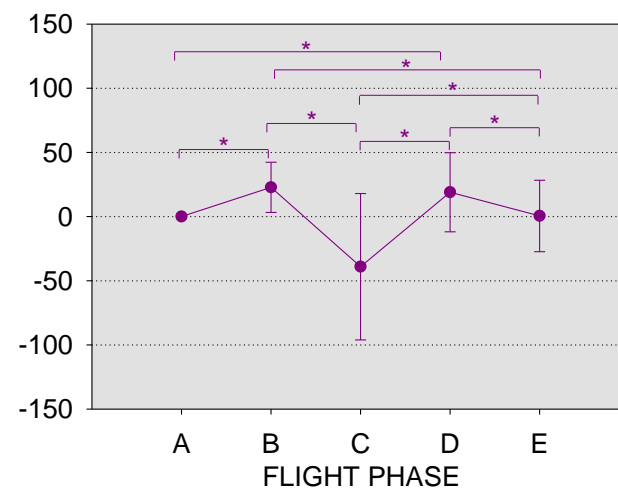
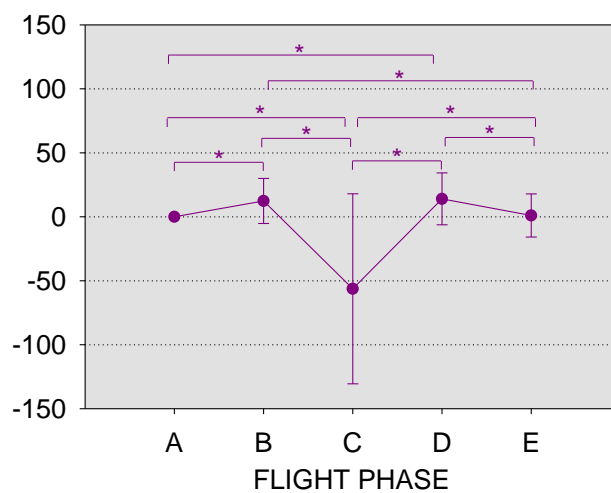
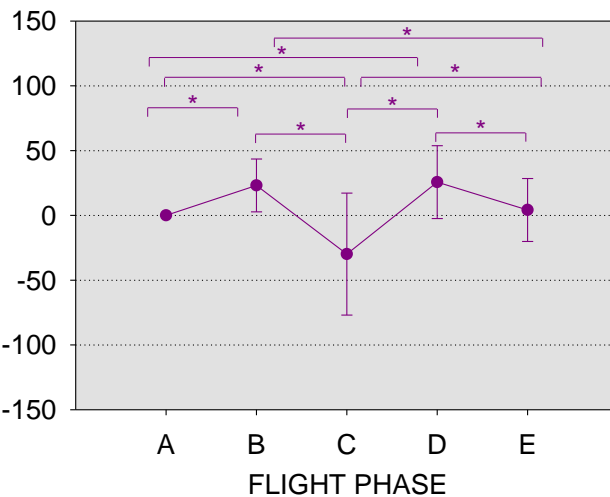
NL

ML

PL



PPG_{DC} [AU]



* = p<0.05



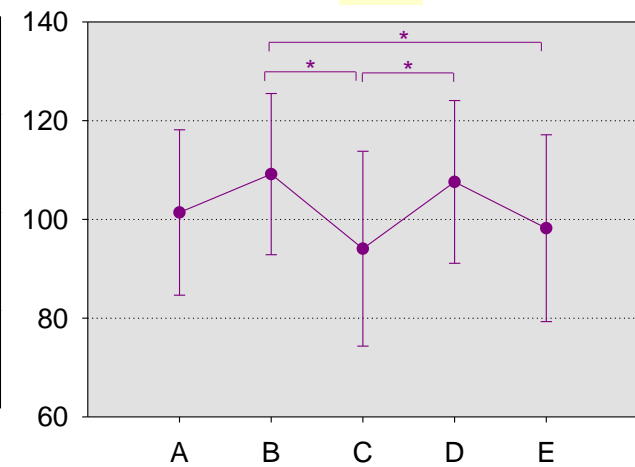
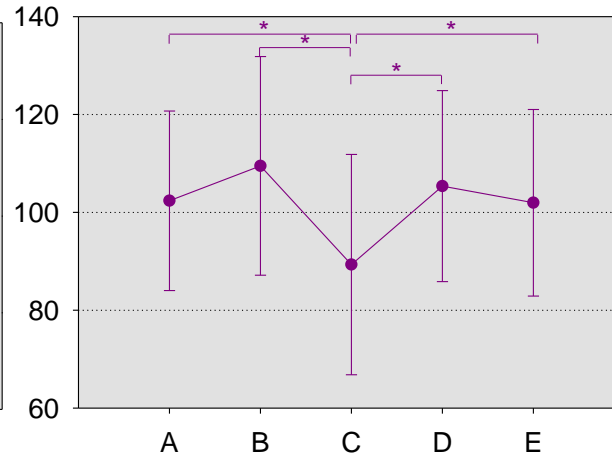
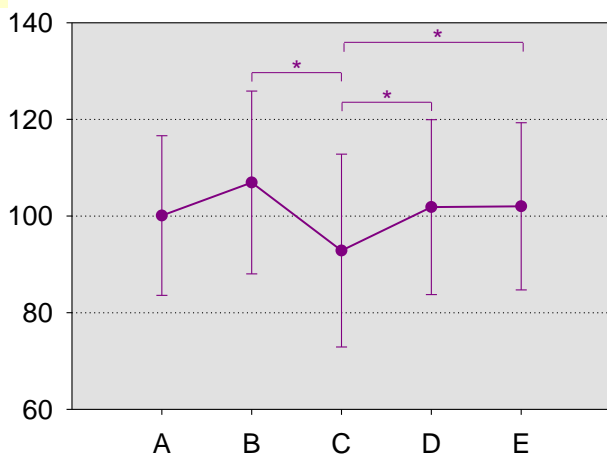
RESULTS

CNAP [mmHg]

NL

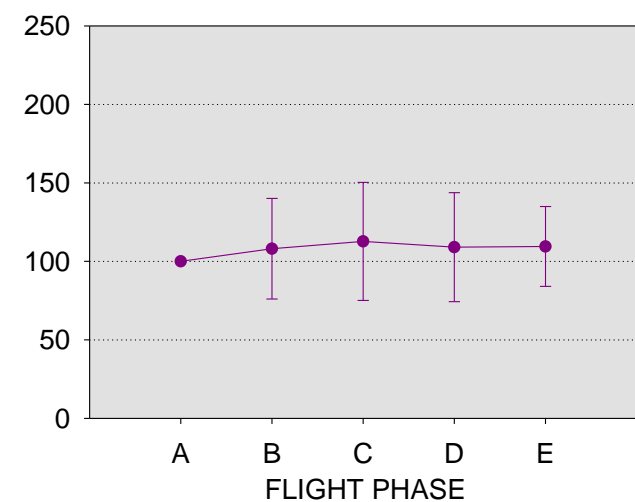
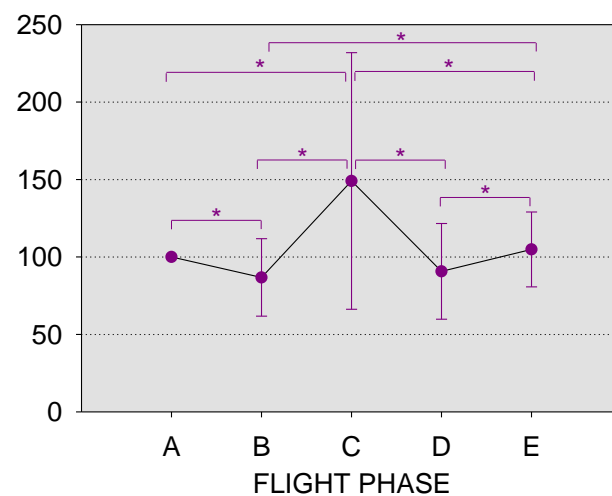
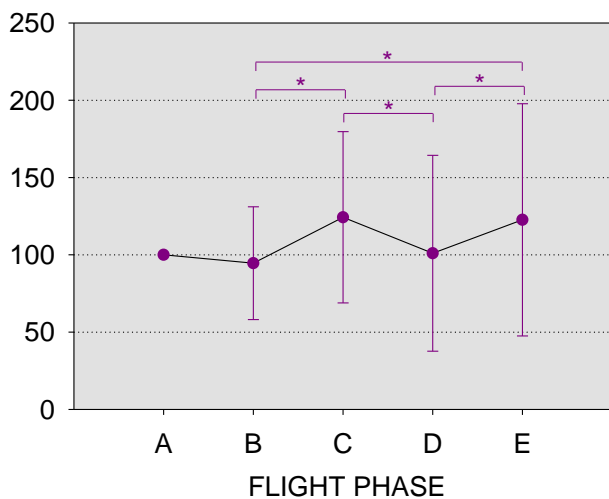
ML

PL



PPG_{AC} [AU]

* = p<0.05





SUMMARY

- The PPG method is an easy-to-use, low-cost method without wearing effects on the test persons.
- In flights with alternating accelerations, PPG enables relevant information and noninvasive data generation to describe the instantaneous state of the circulatory system.
- Our findings confirm that filtered PPG reflects the changes of blood volume distribution and cardiac contractility known from earlier studies on parabolic flights using other methodological approaches.



THANK YOU VERY MUCH FOR YOUR ATTENTION!

