

# Evaluation of green light PPG in Heart Rate Variability parameters

Yuka Maeda<sup>1</sup>, Masaki Sekine<sup>2</sup>, Toshiyo Tamura<sup>2</sup>, Koichi Mizutani<sup>1</sup>

1 University of Tsukuba

2 Osaka Electro-Communication University

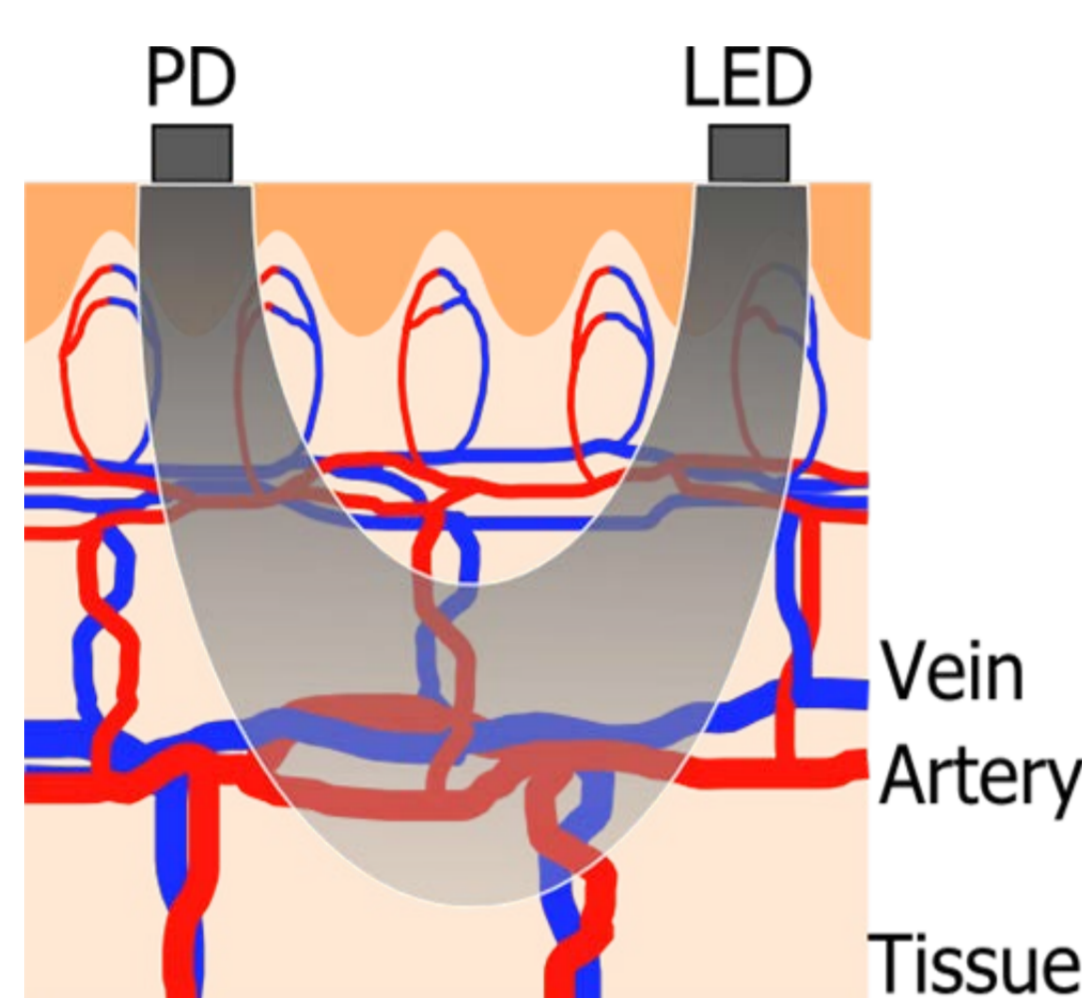
## Introduction

- Heart rate variability (HRV) gives important information on autonomic nervous system's regulating function.
- Pulse rate variability (PRV) obtained from infrared photoplethysmography (PPG) is also used as an acceptable alternative.
- Recently green light has been widely used in PPG measurement from advantage of motion artifact robustness.
- The green light PPG is more suitable for daily monitoring than the conventional infrared light. PRV obtained from green PPG might provide advantage in measurement opportunity.
- Although the green light will not reach deeper tissue, compared with infrared light. This difference have possibilities to affect the PRV parameters.
- The aim of this study is to evaluate the accuracy of PRV parameters obtained from green light PPG.

## PPG

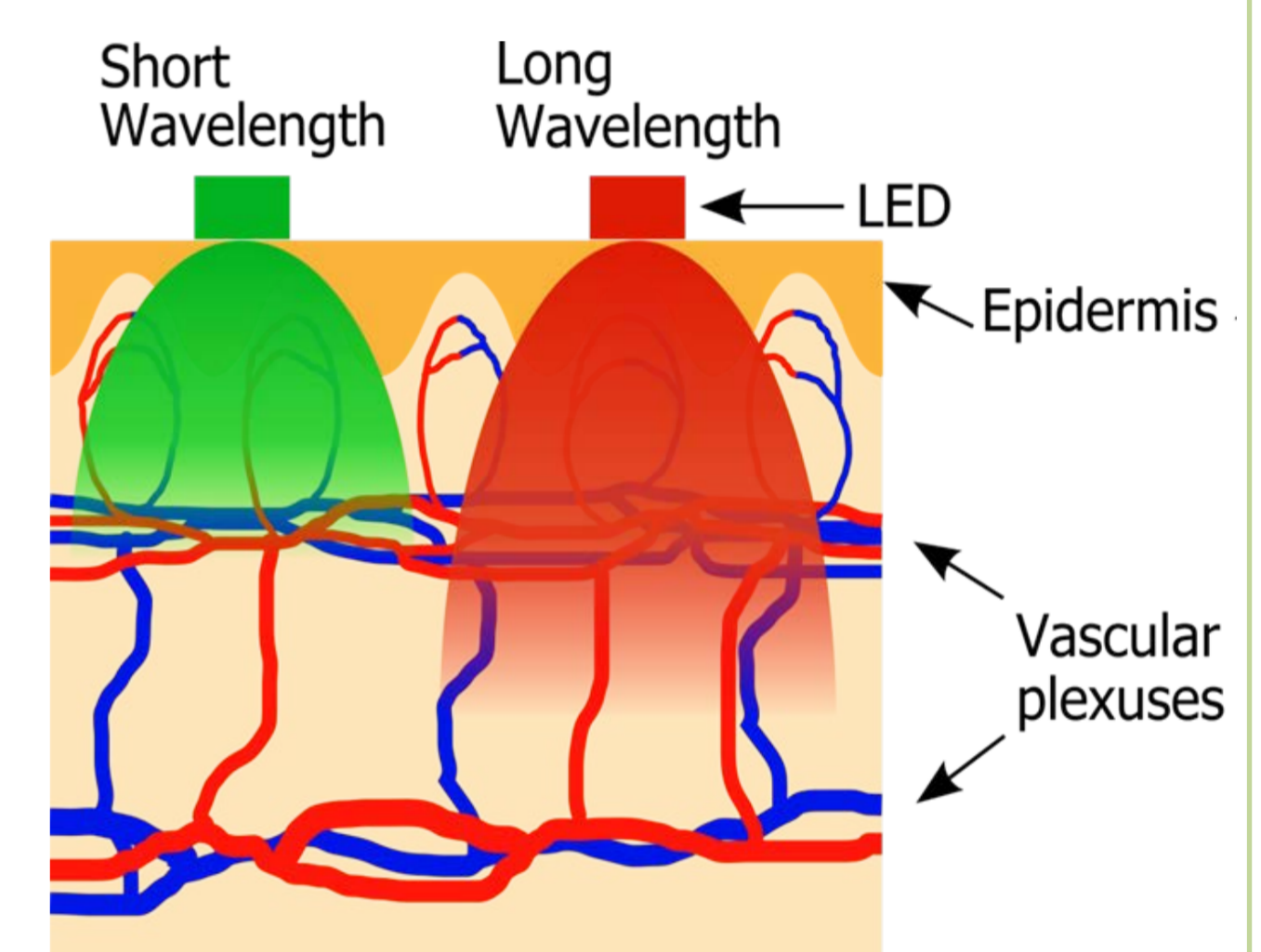
### PPG sensor

- PPG sensor consists of LED and Photo detector.
- In this study, reflected type sensors were used.



## Light source

- Infrared is commonly used as light source.
- The penetration depth of light is dependent on its wavelength.
- We could measure the PPG signals which reflected in different depths.
- The effect of light source wavelength on PRV parameters is not clarified.



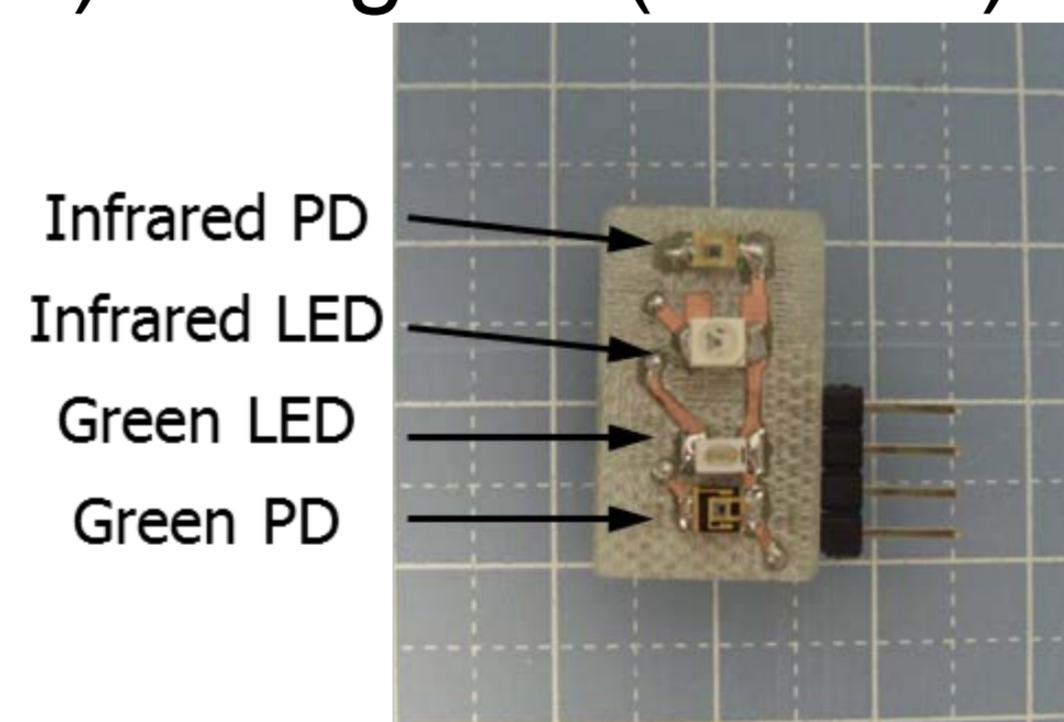
## Subjects and Method

### Subjects

- Seven healthy volunteers with no indications of peripheral circulatory problems (age  $21.5 \pm 1.0$  years)
- This study was approved by IRB at the University. The experimental procedure was explained, and written informed consent was obtained from all subjects.

### PPG sensor

- Two pairs of LED and PD were mounted on sensor. The wavelengths were infrared(880nm) and green(525nm).
- The size of transmitter was designed to 22mm long, 13mm wide, 5mm thick and 1.5g weight.



### Measurement

Following signals were measured simultaneously for 2 min. The sampling frequency was 1024Hz.

- ECG (BIOVIEW-2000, NEC)
- Green PPG (located on fingertip)
- Infrared PPG (located on fingertip)

### Evaluation

#### HRV, PRV

- The heart rate and pulse interval were calculated by peak detection using thresholds. The standard deviation of data collection was used to determine threshold.

#### Correlation coefficient

- The relationship between the HRV and PRV was compared, and the correlation coefficient was calculated

#### SDNN

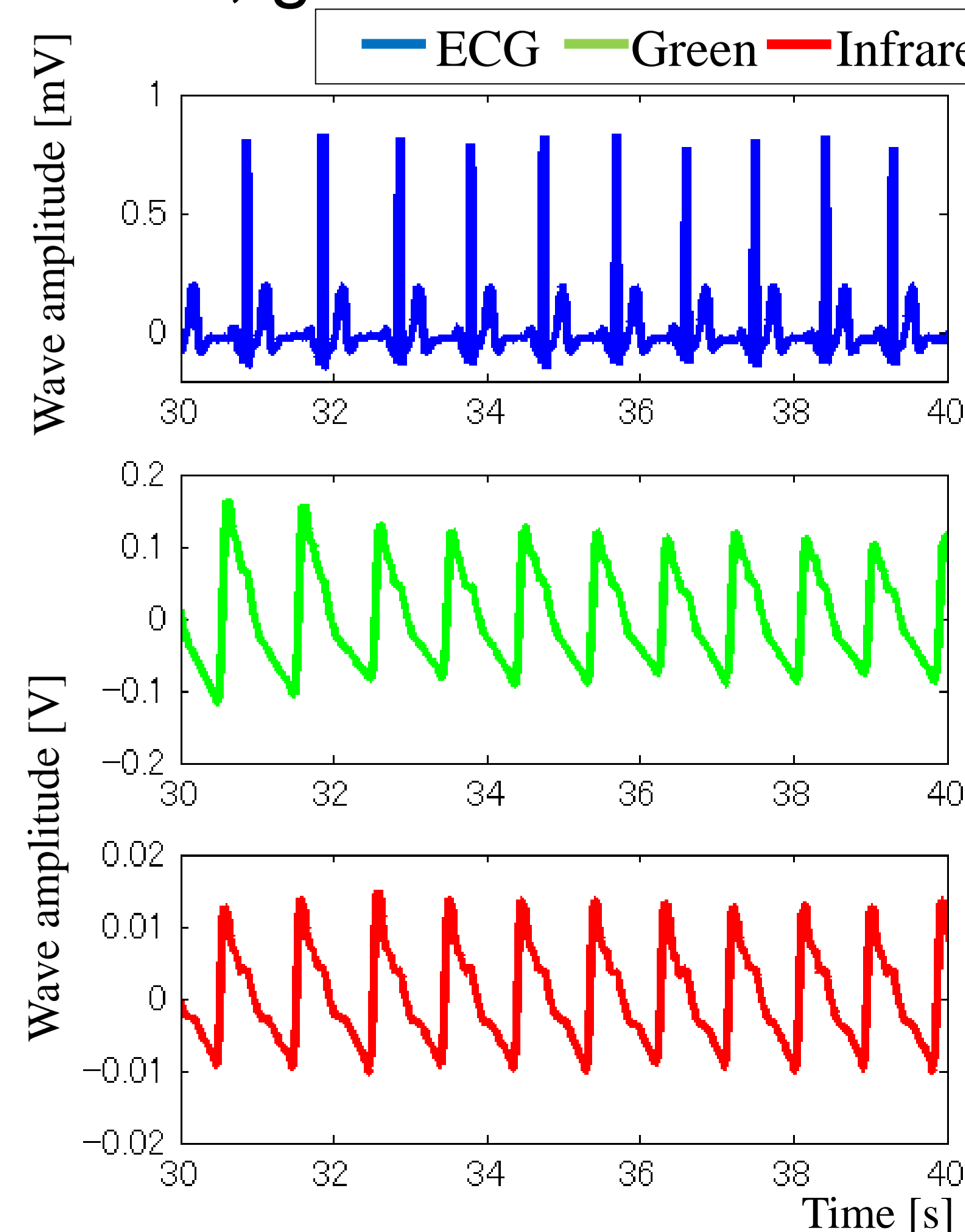
- A standard deviation of the normal-to-normal (NN) intervals.

#### Relative power

- LF and HF power spectral were calculated by HRV and PRV, respectively. Relative power was the ratio between PRV-power spectral and HRV-power spectral.

## Result

### ECG, green and infrared PPG



### The correlation coefficient (n=7)

Green:  $0.995 \pm 0.003$  IR:  $0.984 \pm 0.016$

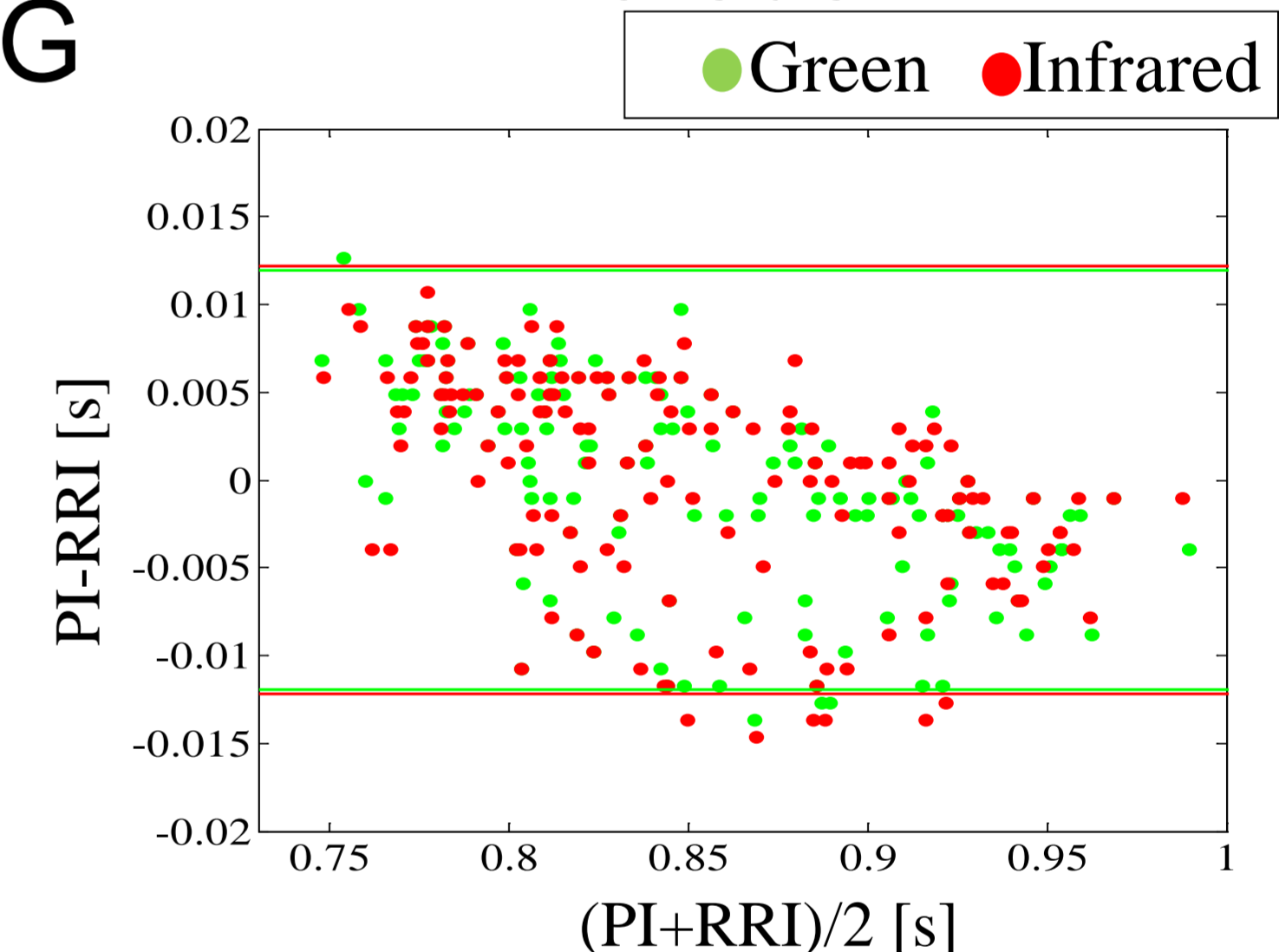
### SDNN (n=7)

HRV:  $0.050 \pm 0.014$  Green:  $0.050 \pm 0.015$  IR:  $0.051 \pm 0.015$

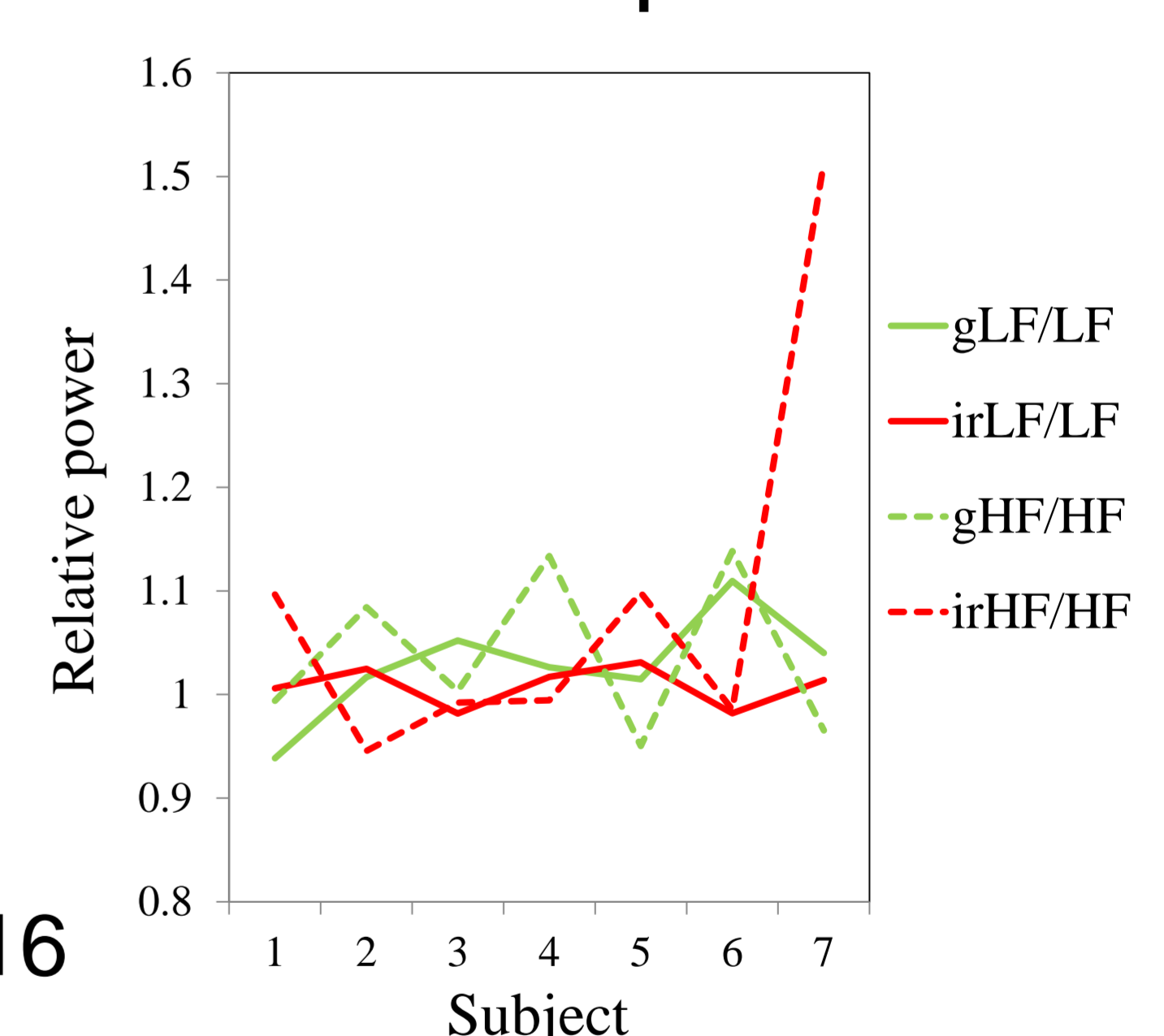
### Relative power (n=7)

Green LF:  $1.03 \pm 0.05$  Green HF:  $1.03 \pm 0.08$   
IR LF:  $1.01 \pm 0.02$  IR HF:  $1.09 \pm 0.20$

### PRV versus HRV



### Relative power



## Discussion & Conclusion

This study examined the accuracy of PRV parameters obtained from green PPG, compared with infrared one.

The results suggested PRV obtained from green light PPG was closely correlated with HRV in a rest position.

Therefore green PPG would be an alternative along with infrared PPG in a rest position.