Alignment of Multi-Sensored Data:
Adjustment of Sampling Frequencies and Time Shifts

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11 September 2019, CinC Singapore

Outline

1. Experimental Data

2. Adjustment of Time Shifts

3. Correction of Sampling Frequencies
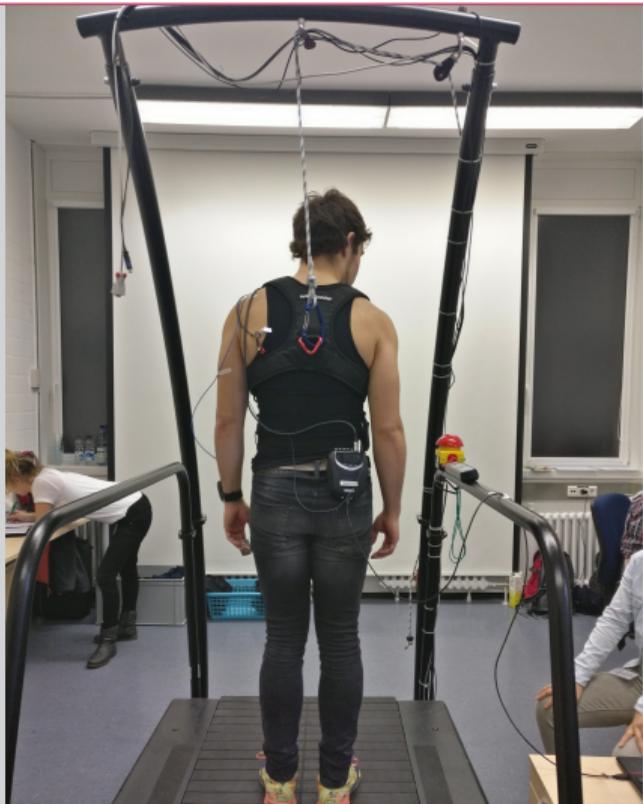
1. Experimental Data

Research Team

Experimental Setup
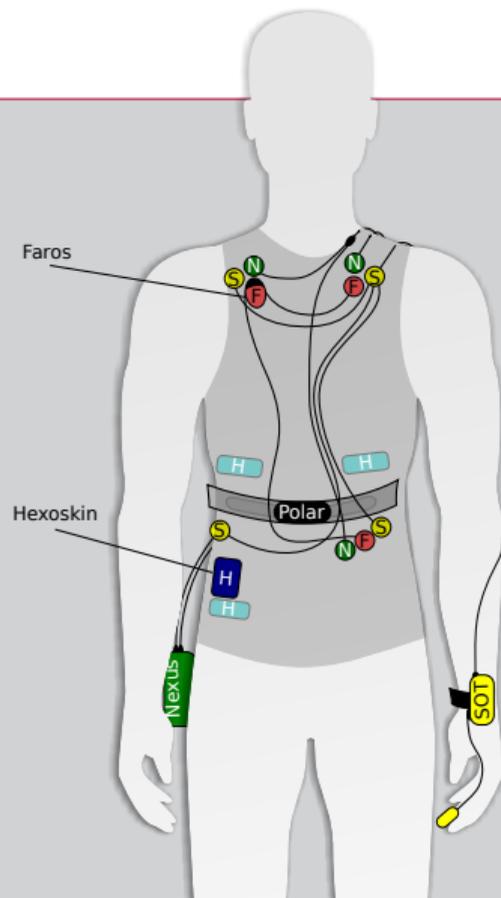

- 5 min standing rest
- 5 min walking on treadmill (1.2 m/s)
- cognitive test (2-back audio test)
- 5 min walking on treadmill (1.2 m/s, 15% gradient)

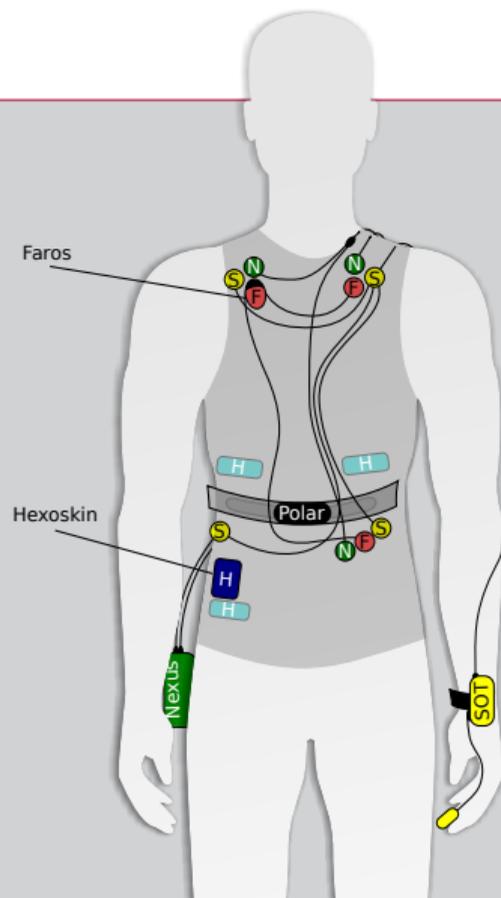In between: NASA Task Load Index to measure individual strain

Experimental Setup

- EMotion Faros 360° | 1000 Hz
- SOMNOtouch NIBP | 512 Hz
- NeXus-10 MKII | 8192 Hz
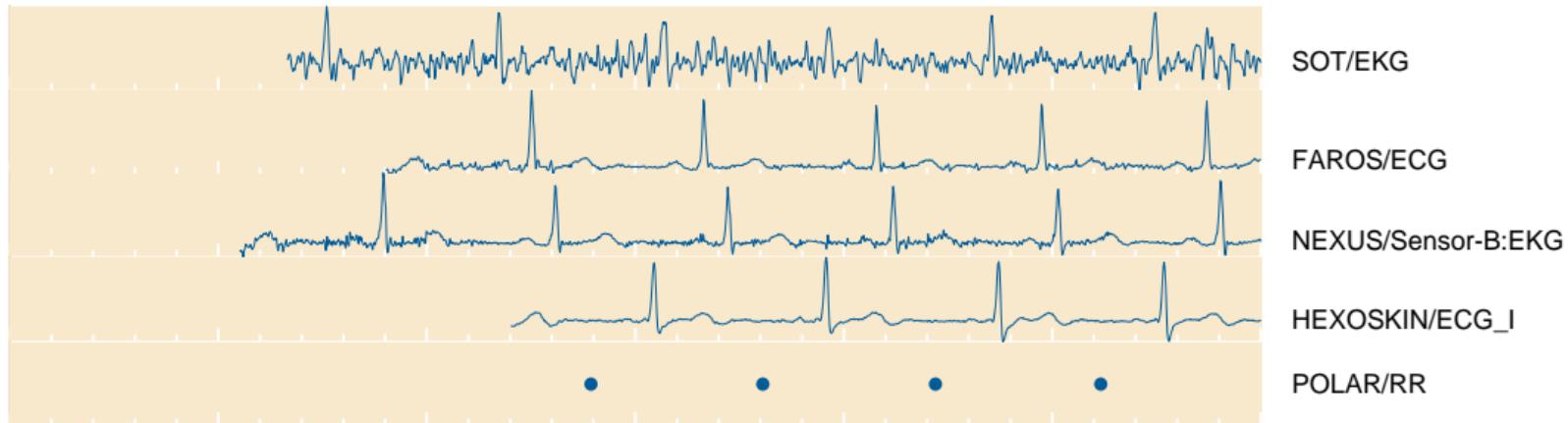- Polar RS800 Multi | 1000 Hz
- Hexoskin Smart Shirt Hx1 | 256 Hz

Experimental Setup

- ▶ EMotion Faros 360° | 1000 Hz
- ▶ SOMNOtouch NIBP | 512 Hz
- ▶ NeXus-10 MKII | ~~8192 Hz~~ 8000 Hz
- ▶ Polar RS800 Multi | 1000 Hz
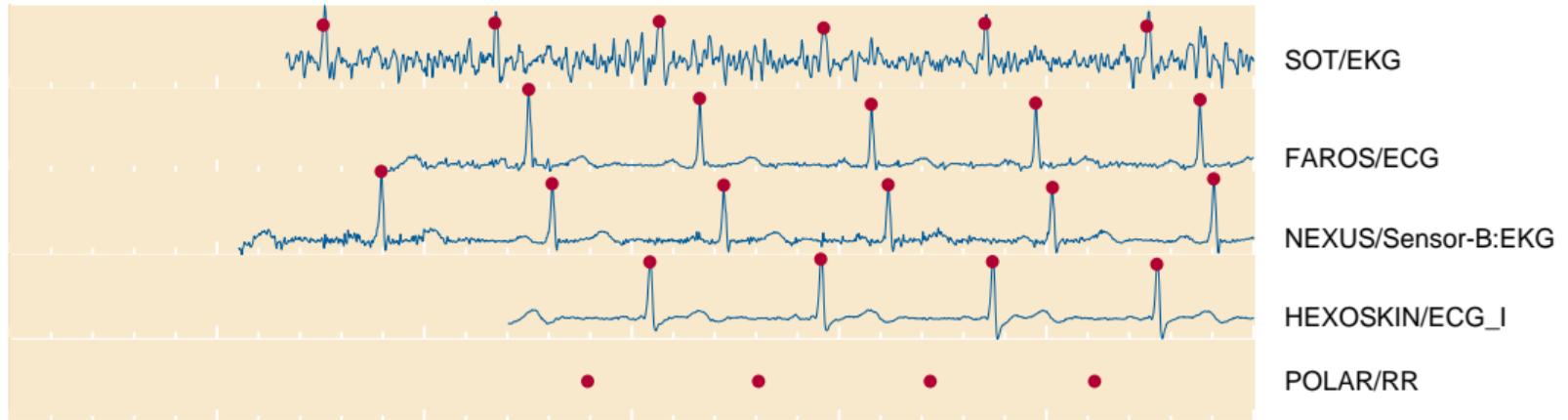- ▶ Hexoskin Smart Shirt Hx1 | 256 Hz
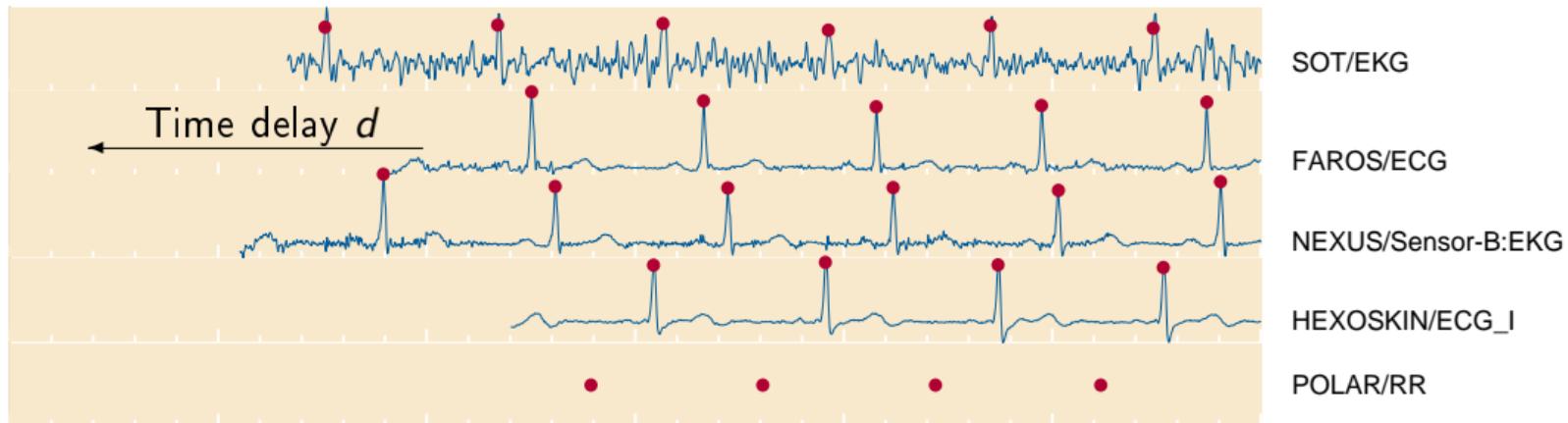
2. Adjustment of Time Shifts

Offset in the Beginning of Measurements

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$$\sum_i |s_i| \approx 0$$
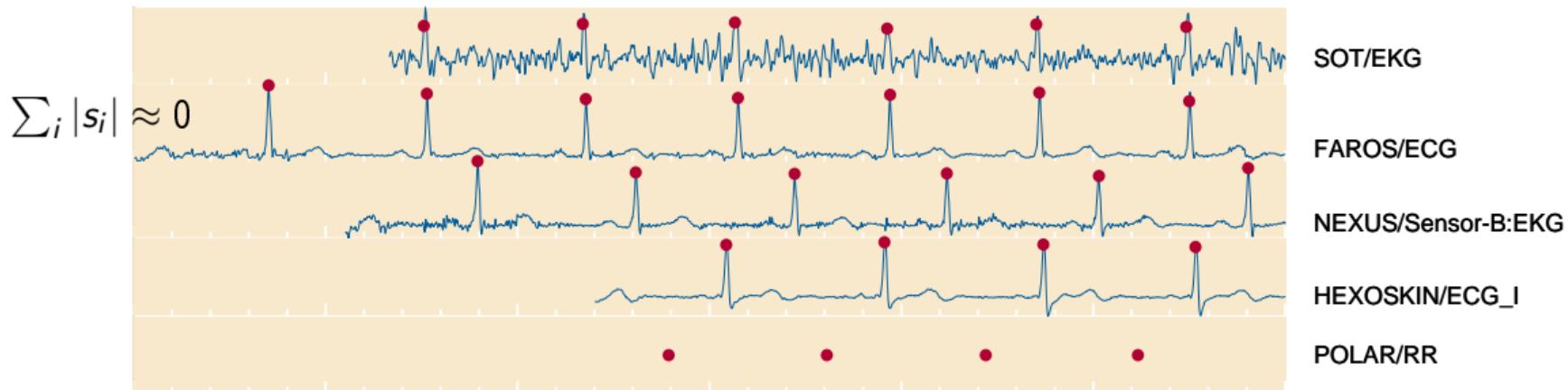
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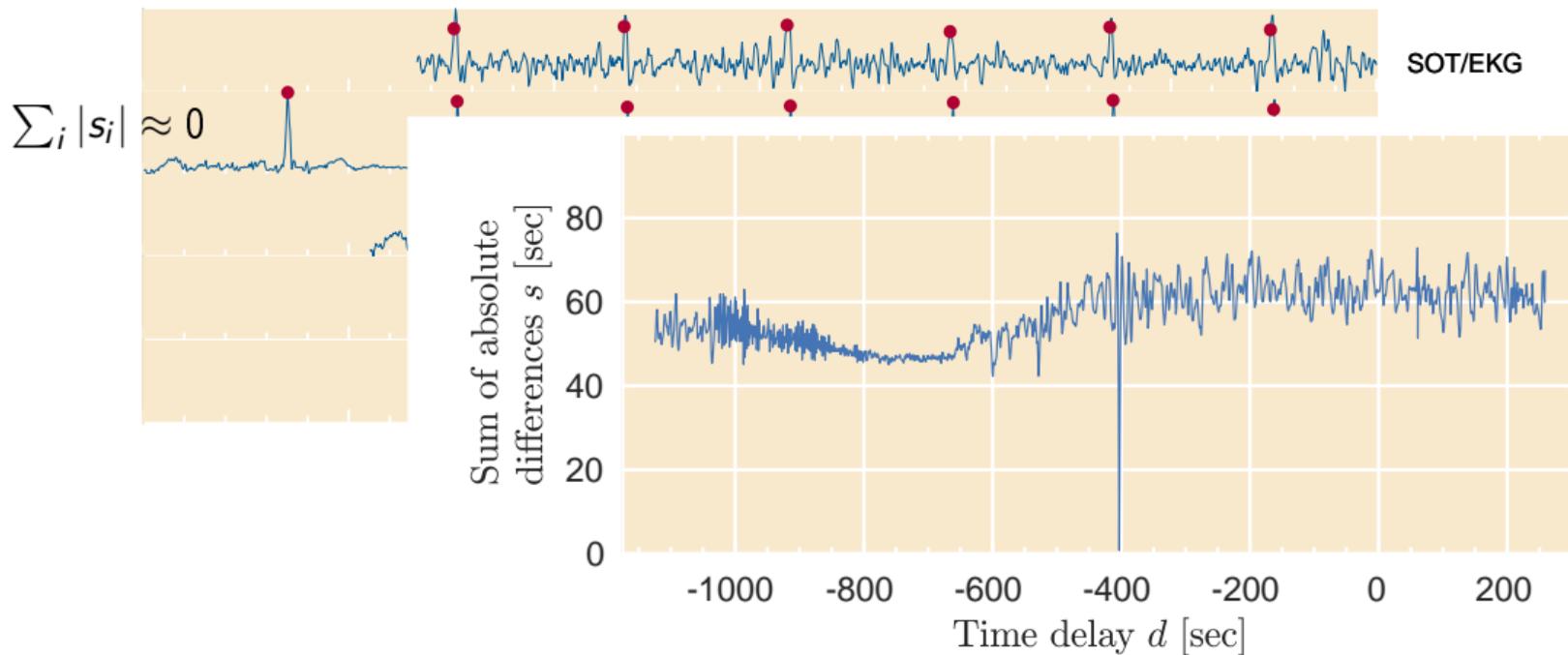
3. Correction of Sampling Frequencies

Linear Adjustment of Sampling Frequencies

▶ Pairwise differences s_i are linear decreasing or increasing with time

Linear Adjustment of Sampling Frequencies
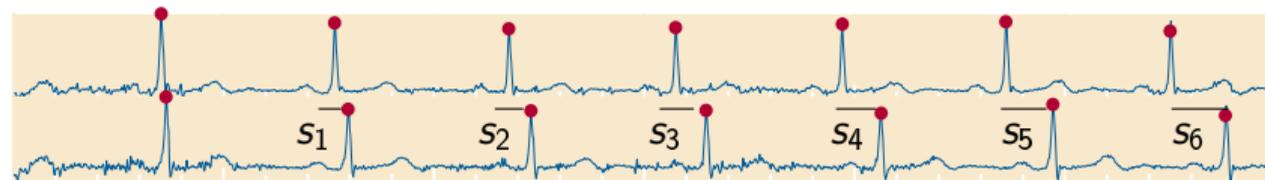
Linear Adjustment of Sampling Frequencies

$$\hat{f}_s = f_s \cdot (1 - \text{'Slope of robust regression fit'})$$

d=0.177-0.000204*t

Linear Adjustment Factors

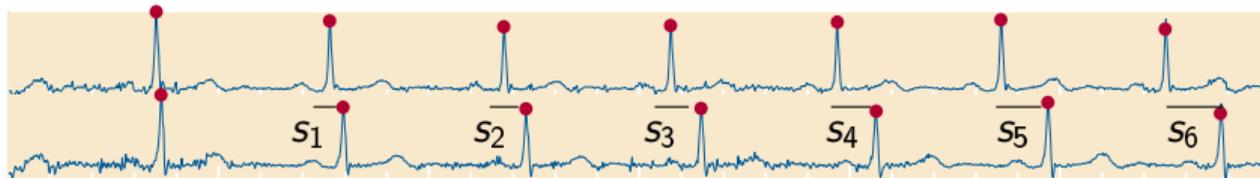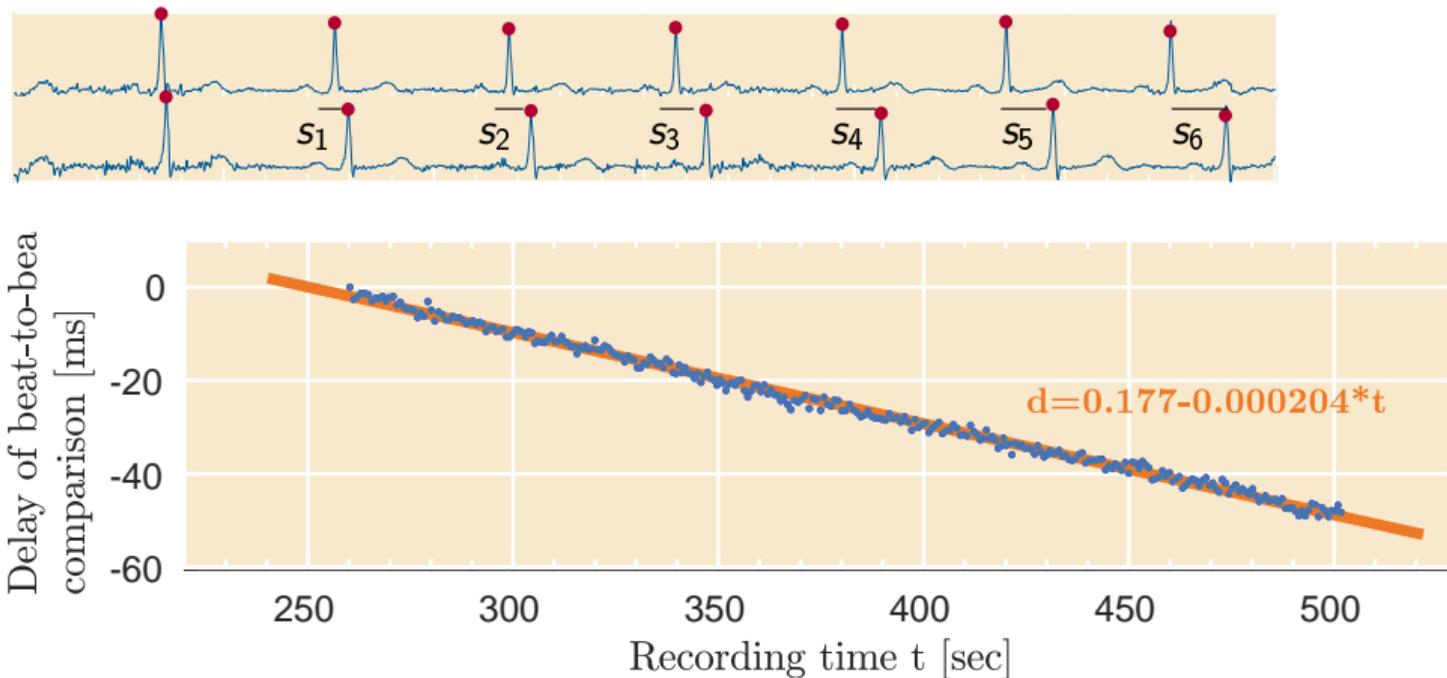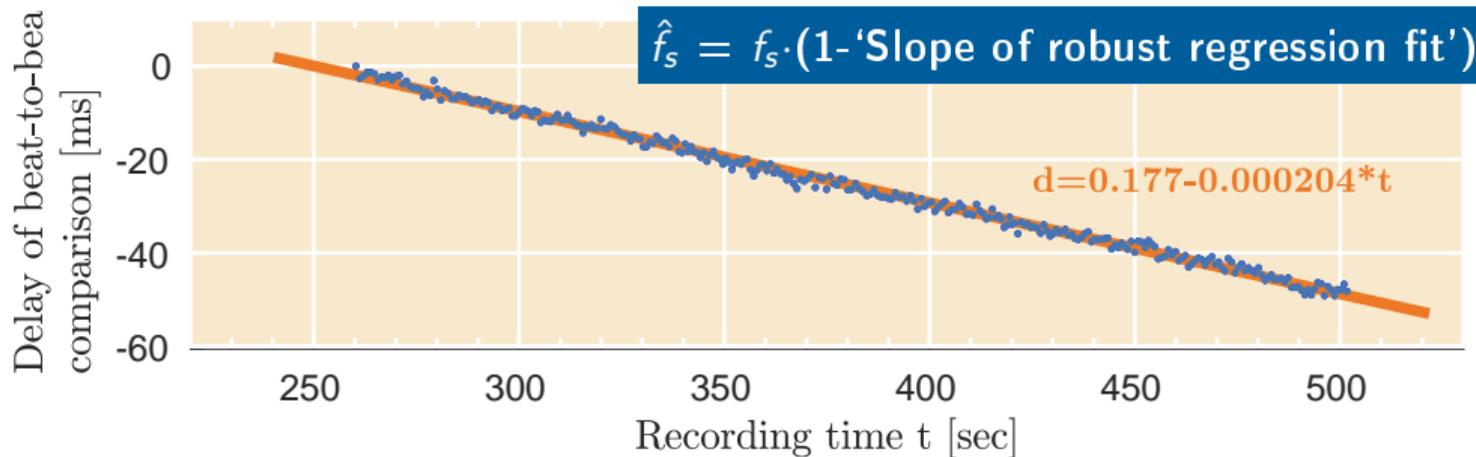Manufacturer's specifications and actual sampling frequency (Hexoskin assumed to be have precise f_s). Two Faros' devices in use, $\hat{f}_s$ splitted according to device ID.

Recording Device	f_s	Mean $\hat{f}_s$	min	max
SomnoTOUCH NIBP	512	511.97	511.97	511.97
NeXus-10 MKII	8000	7999.67	7999.67	7999.68
eMotion Faros 360°, ID1	1000	1000.29	1000.19	1000.36
eMotion Faros 360°, ID2	1000	1000.18	1000.15	1000.21
Polar RS800 Multi	1000	999.91	999.87	999.95

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Is a linear adjustment sufficient?
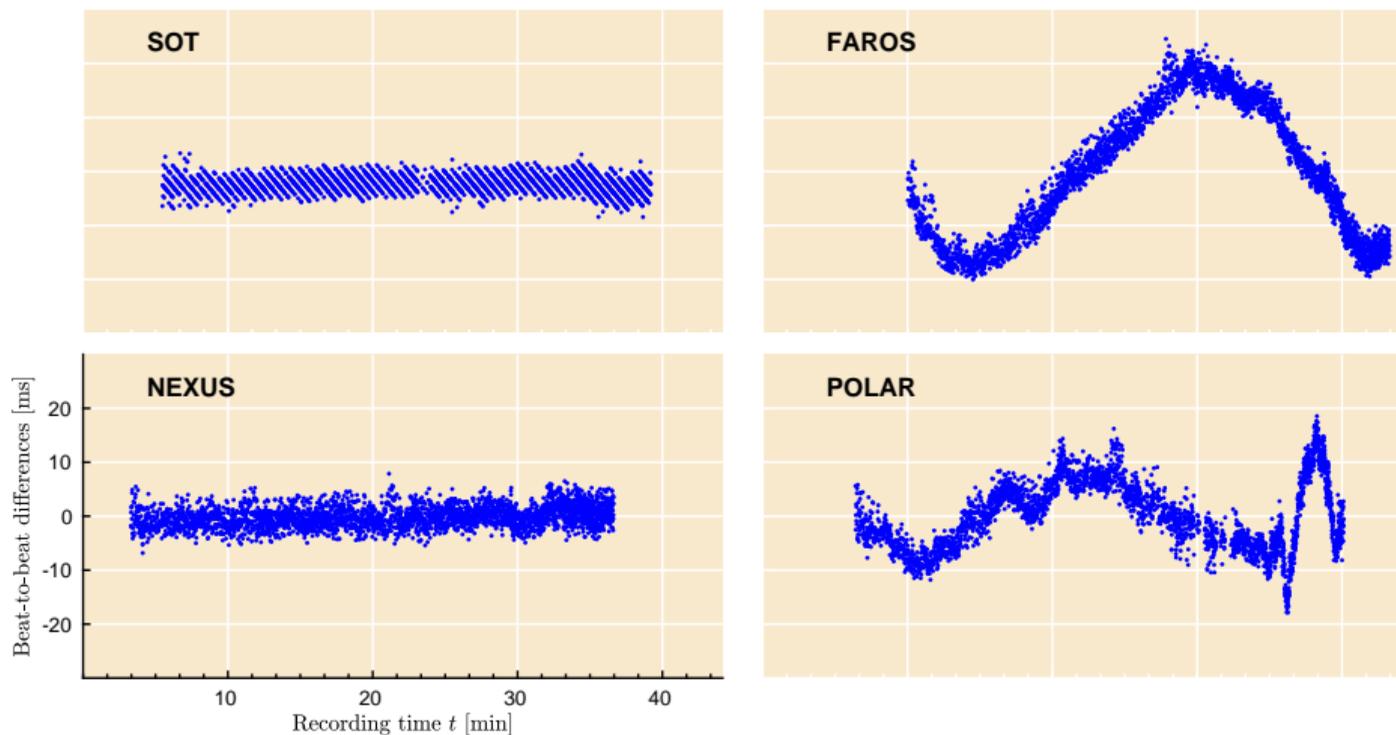
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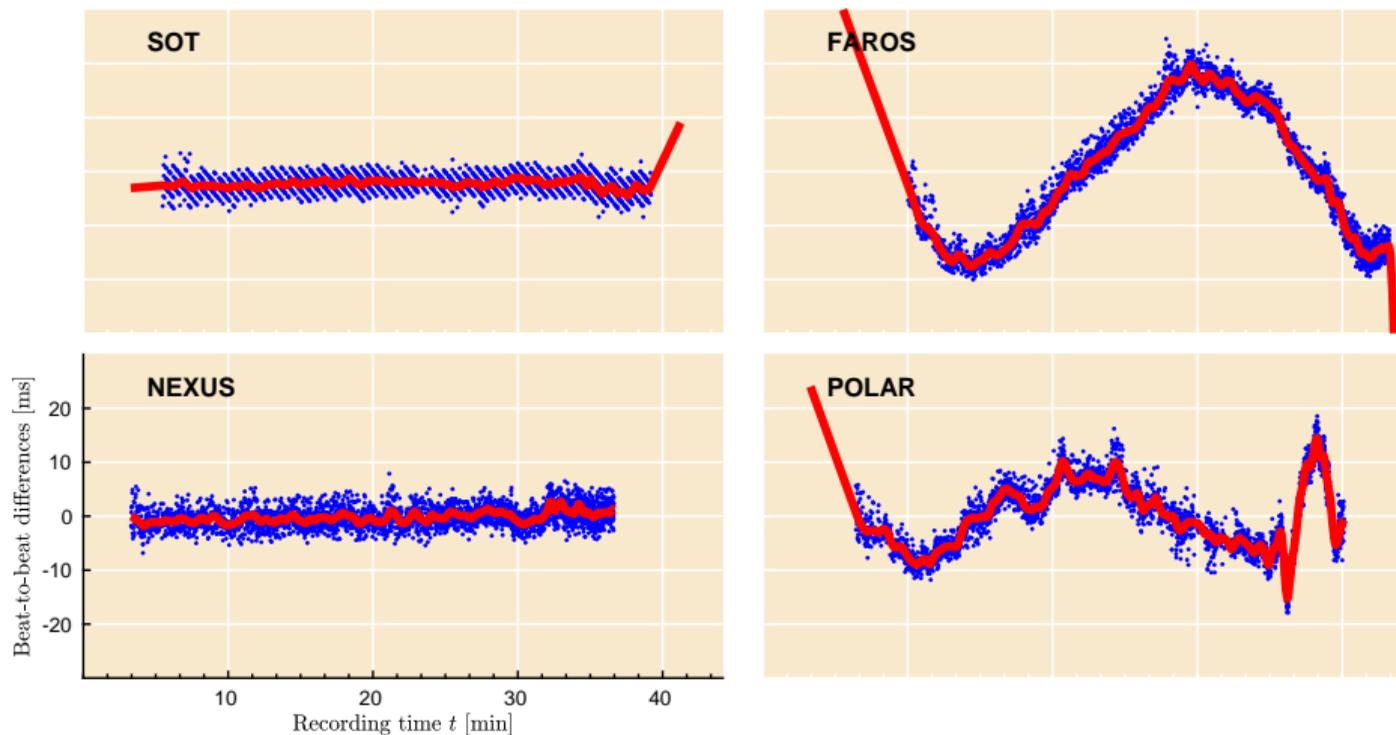
Benefits from multi-sensor data

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- Quality assurance
- Increased confidence
- Backup signals
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- ▶ Comparison of signal quality
- ▶ Extraction of realistic noise
- ▶ Verification/accuracy of sampling frequency

Summary – Workflow

Correction of time shifts
by RR interval sequence alignment
(300 Intervals from resting state)

Frequency correction
Slope of aligned beat differences transformed
into adjustment factor

Expert annotation
Accurate annotation of beats for the
reference device

Non-linear resampling
Robust quadratic regression to fit
   beat misplacements for the entire period
Relocation of beats an linear interpolation
   of interbeat segments
Resampling

Happy to discuss at Poster 52

4th Floor Foyer: 12:00–14:00