who wears me?

bioimpedance as a passive biometric

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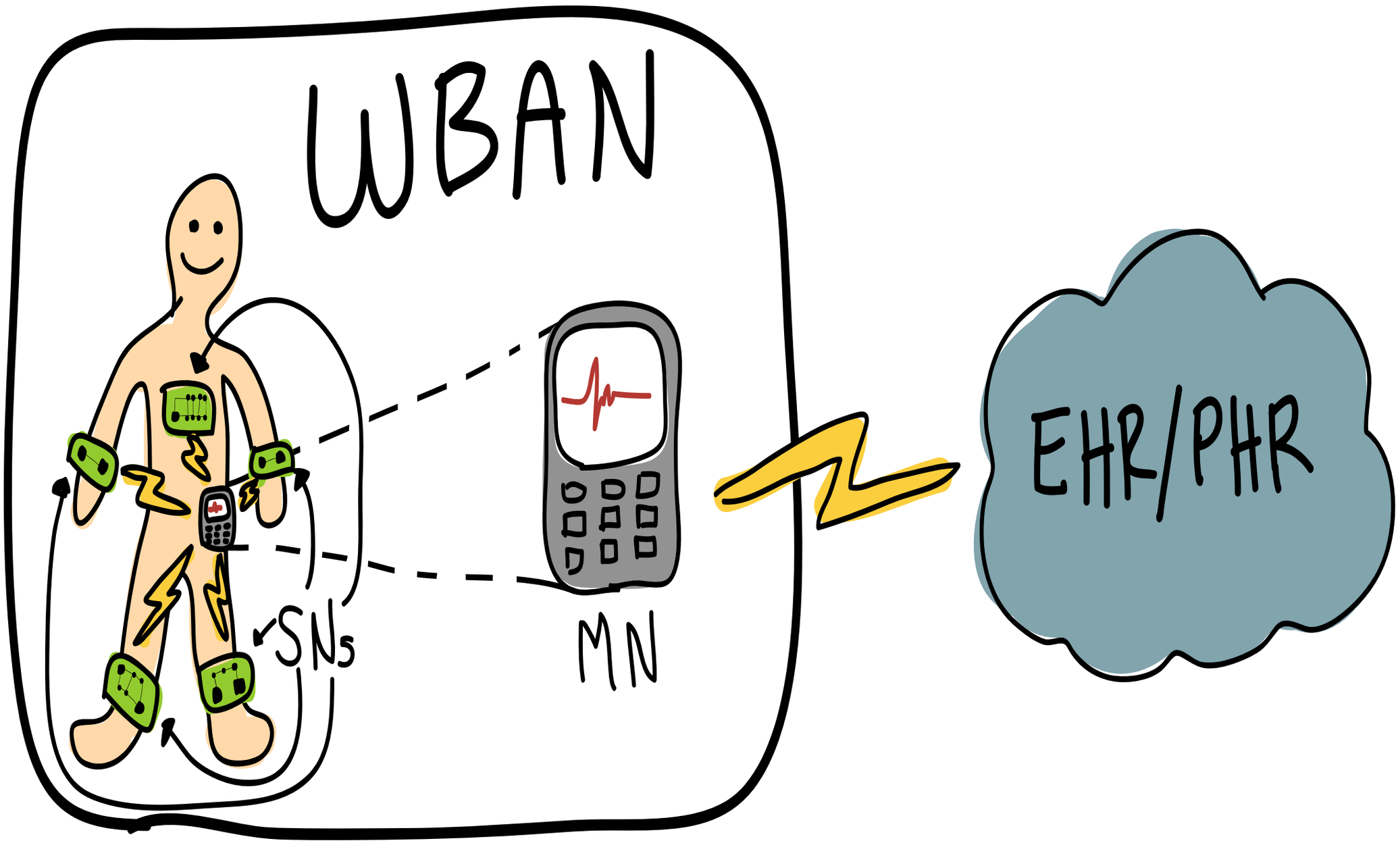
w/ jacob.sorber, ronald.peterson, joseph.skinner, ryan.halter, david.kotz

wearable sensing systems



the problem

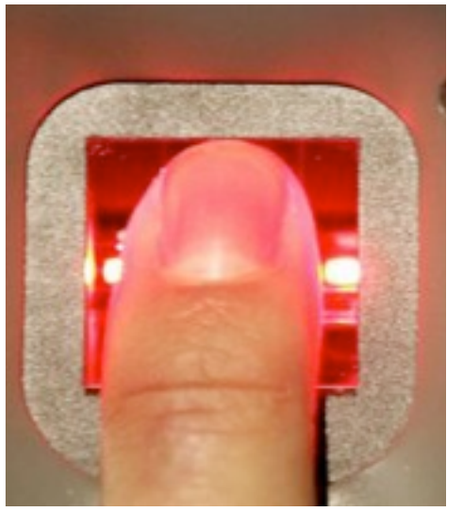
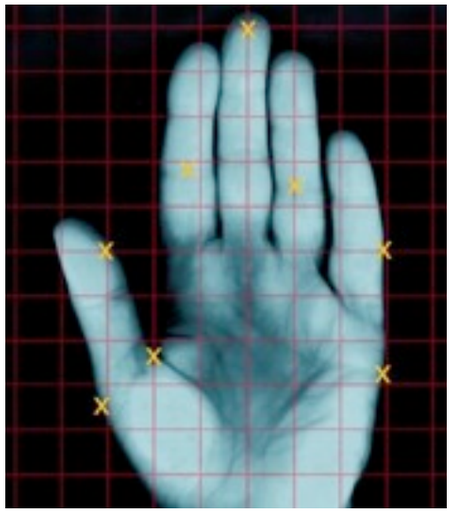

bodybugg

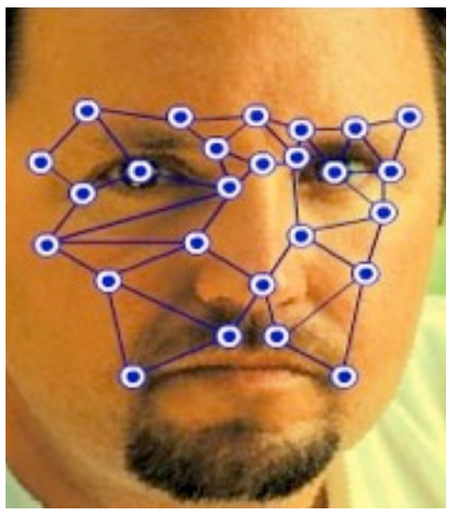

AT&T 3G
17:10
Cancel
Add Alarm
Save
Repeat
Never
Sound
Marimba
Snooze
ON
Label
WakeMate Alarm
15 07
16 08
17 09
18 10
19 11

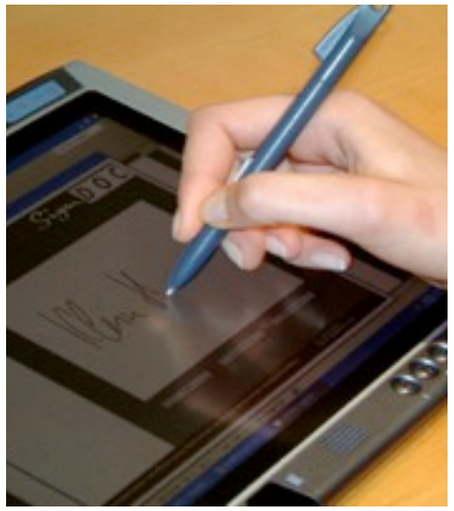

NONIN

> ...activate on deployment, in a plug-n-play manner, with minimal (ideally none) initialization procedures.
>
> — Venkatasubramanian et al.

biometrics



physiological

behavioral

passive biometrics

passive biometrics

- **universal**
  - do most people have it?

passive biometrics

- **universal**
  - do most people have it?
- **unique**
  - is it unique for most people?

passive biometrics

- **universal**
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- **permanence**
  - is it stable over time?

passive biometrics

- **universal**
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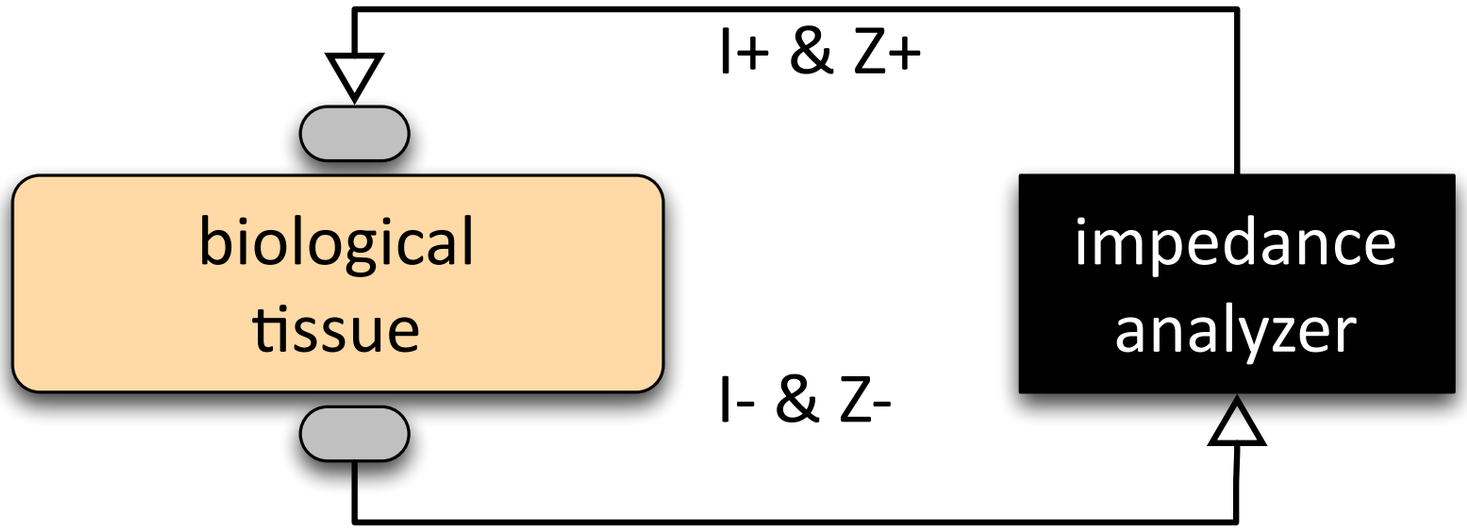
  - is it stable over time?
- **unobtrusively measurable**
  - can it be easily measured?

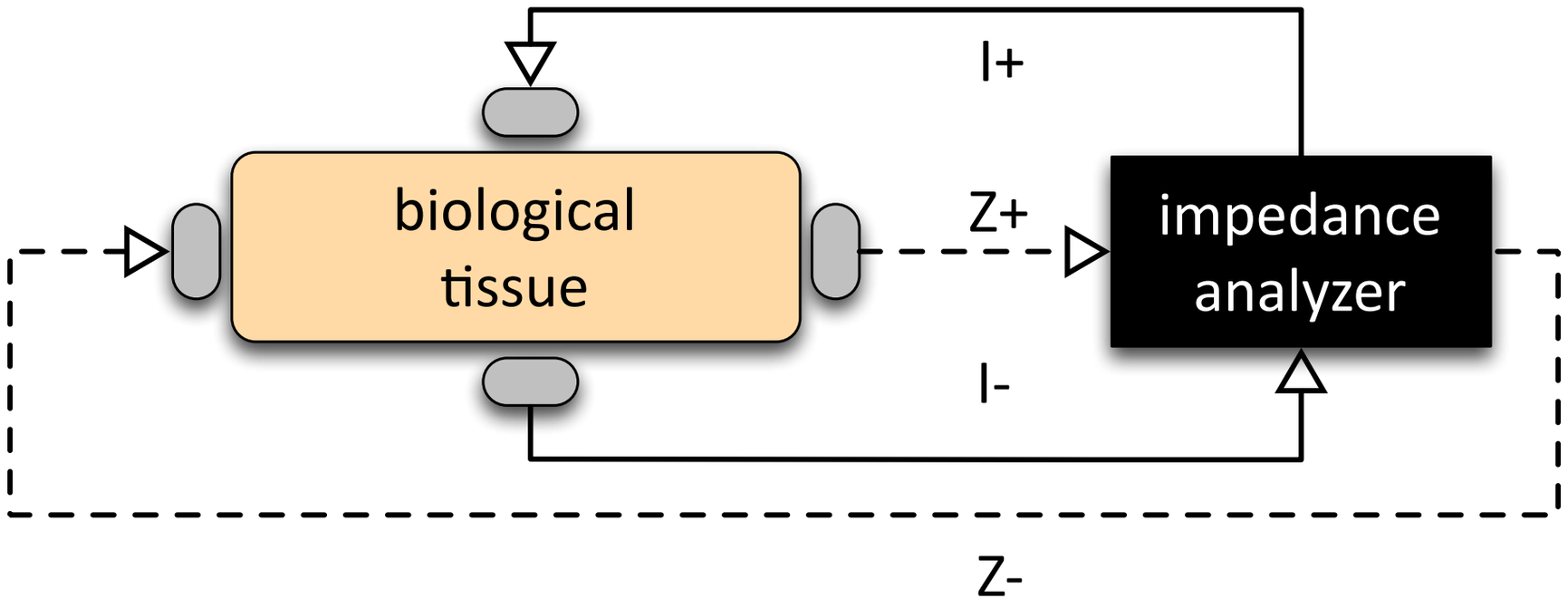
passive biometrics

- **universal**
  - do most people have it?
- **unique**
  - is it unique for most people?
- **permanence**
  - is it stable over time?
- **unobtrusively measurable**
  - can it be easily measured?
- **difficult to circumvent**
  - how difficult it is to fool?

bioimpedance

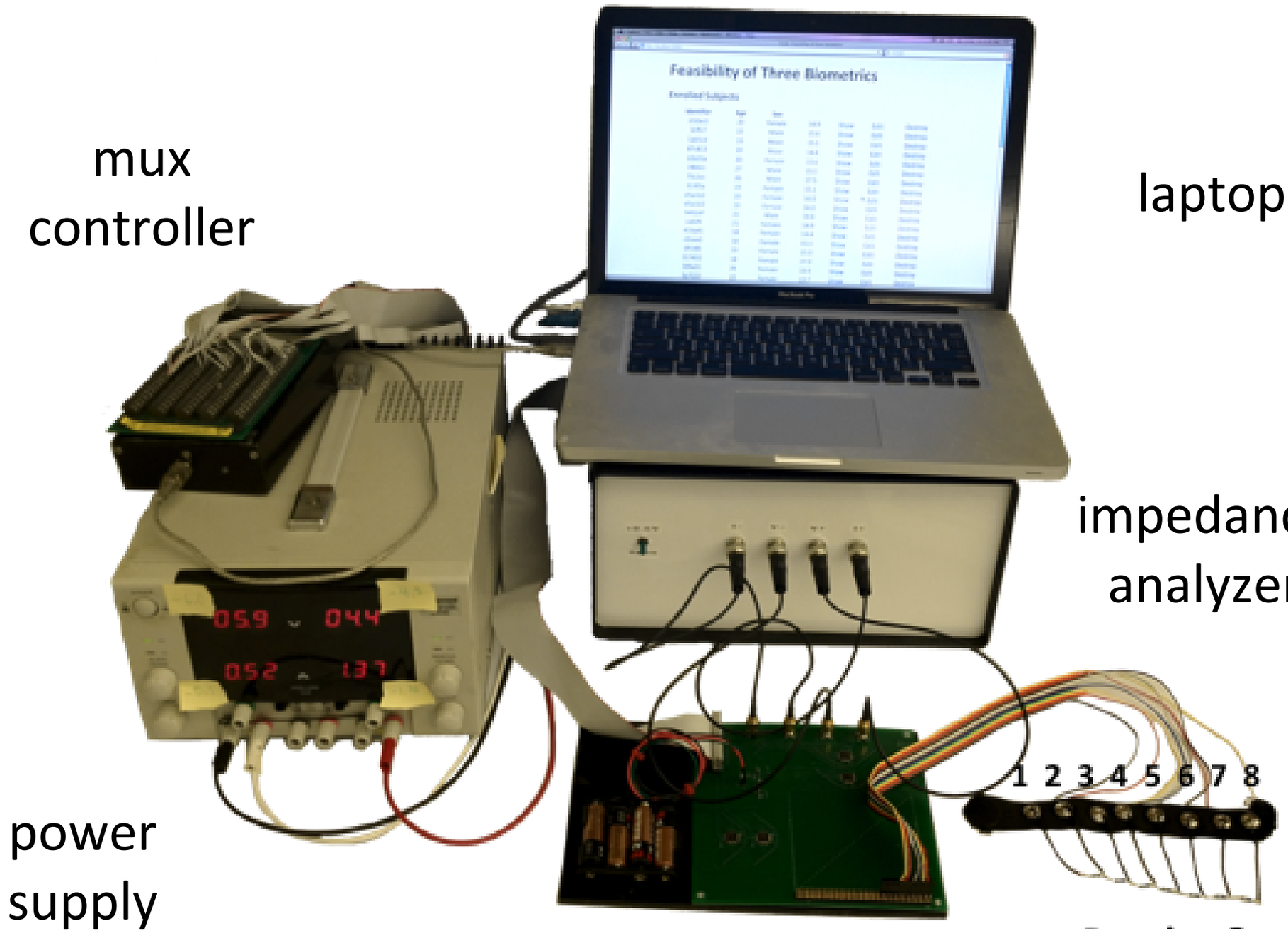


bi-polar



tetra-polar

an unwearable device



mux controller

laptop

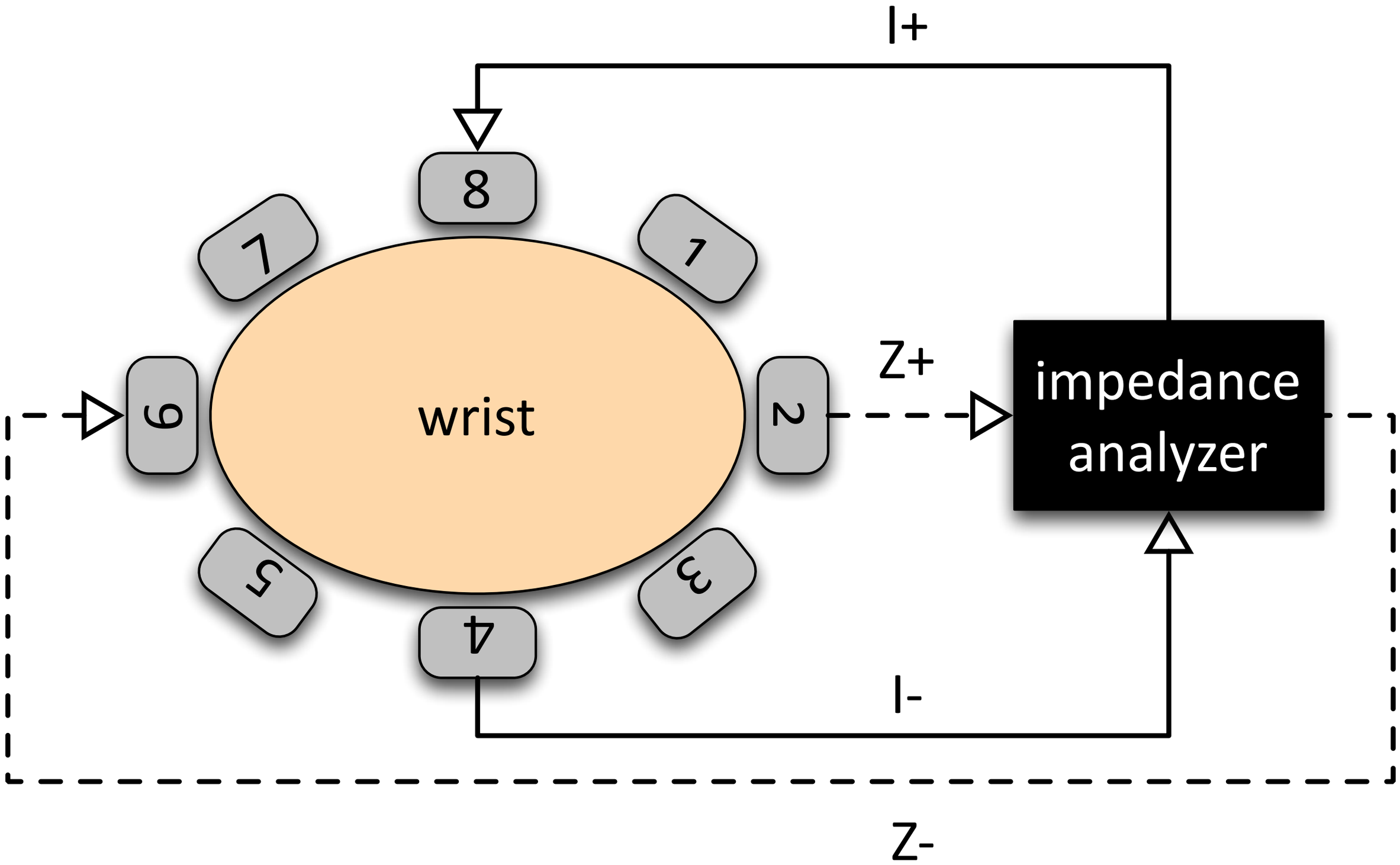
impedance analyzer

power supply

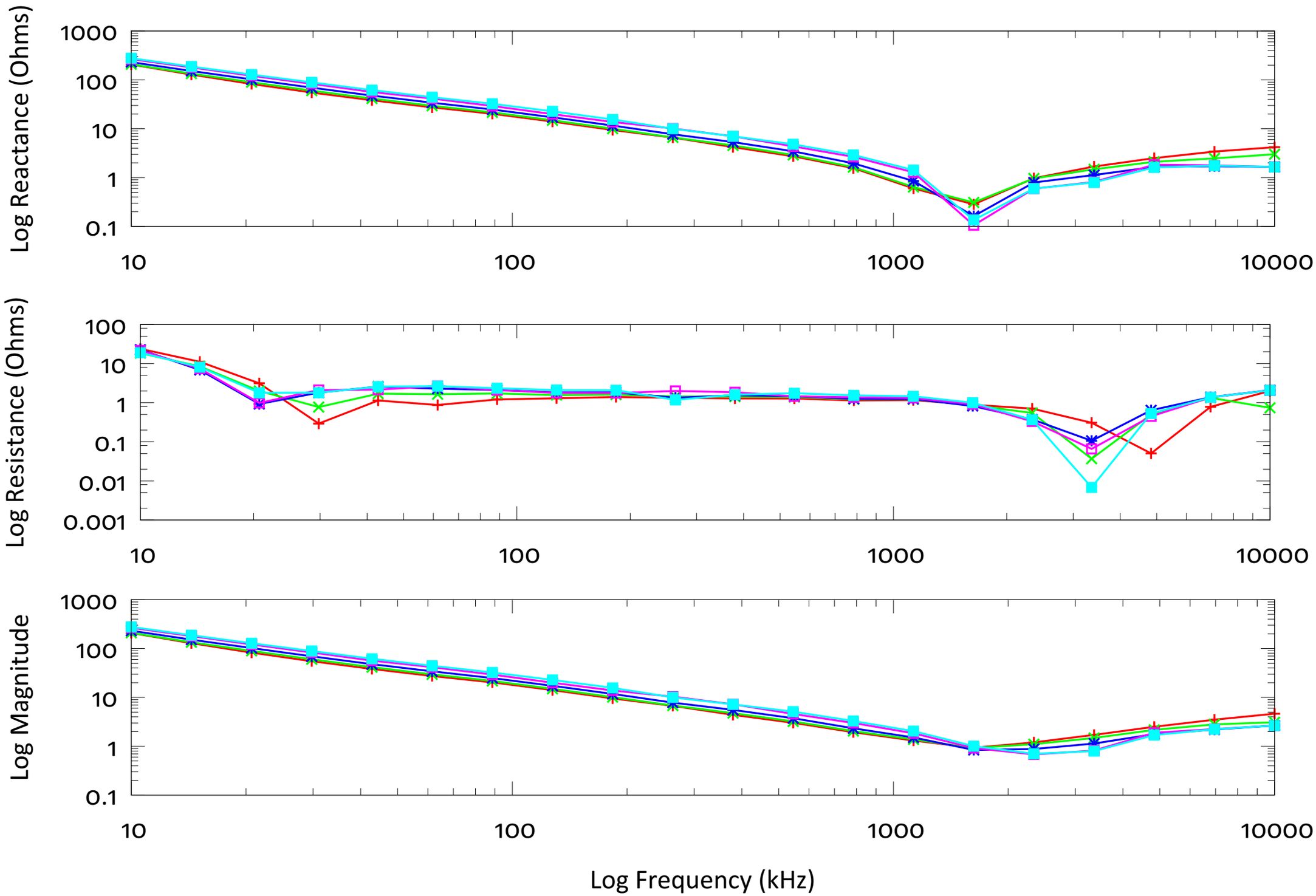
mux

bracelet

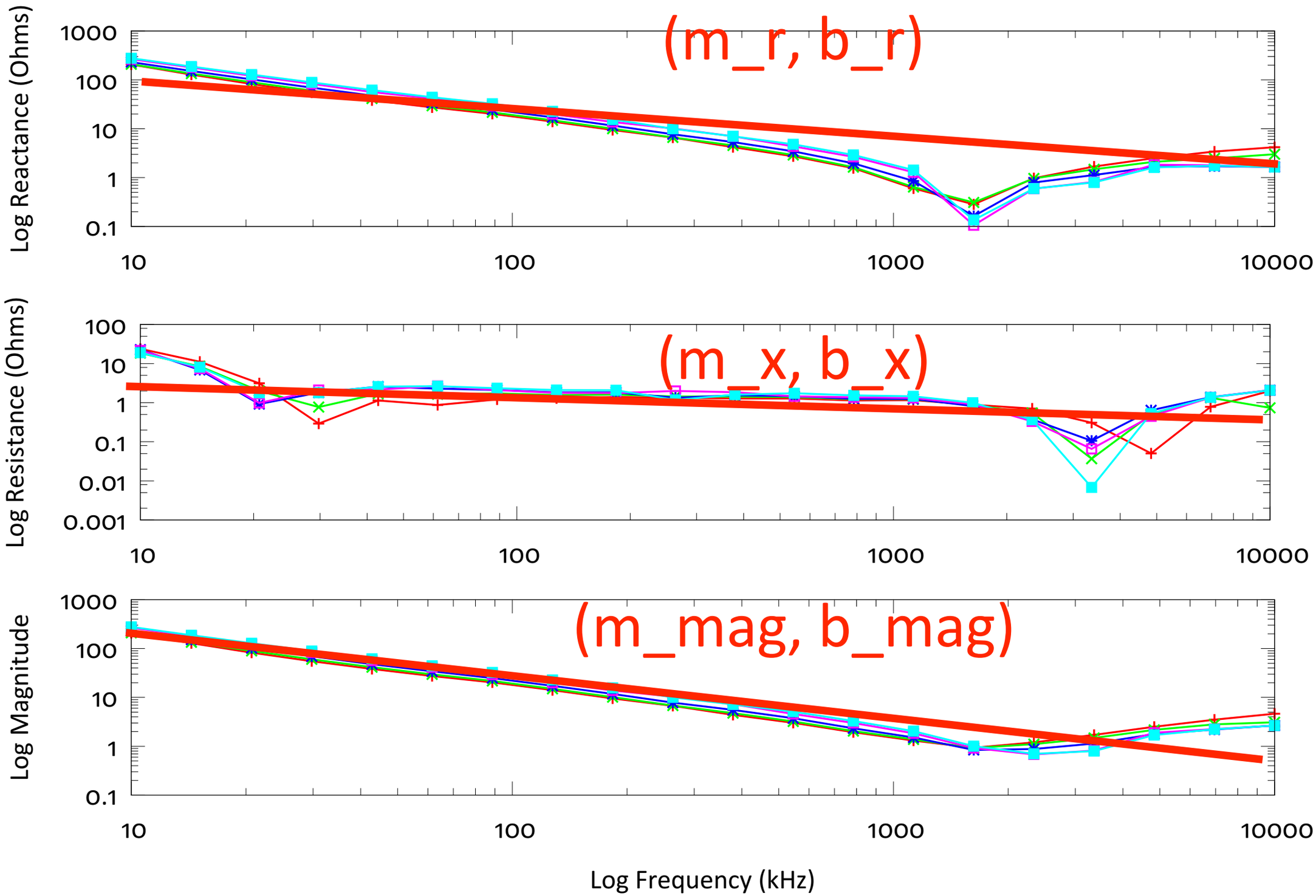
measuring bioimpedance



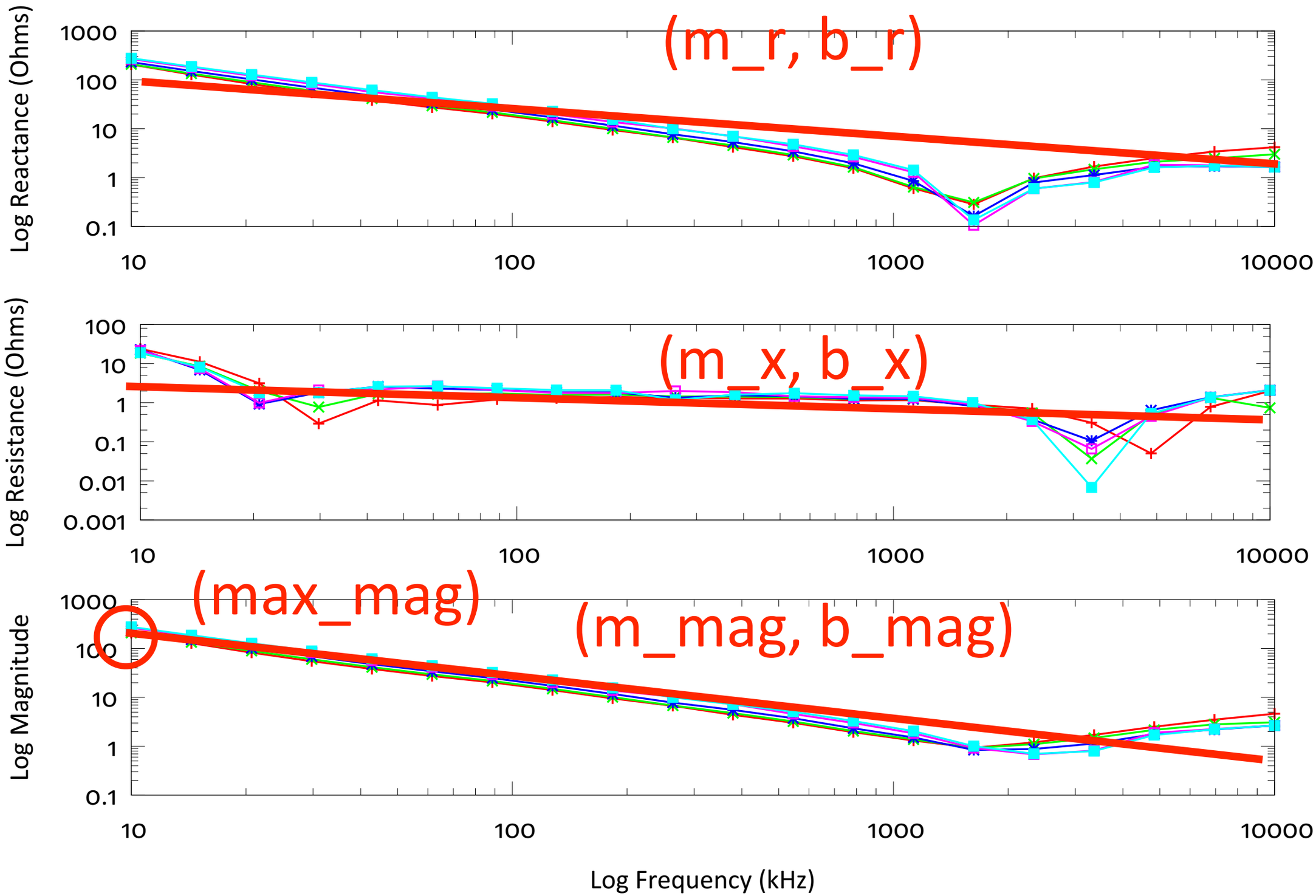
feature extraction



feature extraction



feature extraction



enrollment & recognition

enrollment

- collect a set of **training feature vectors** for some **cohort** of subjects

- use these training feature vectors to **learn a multi-class classifier**, where each class corresponds to a particular subject

- we empirically determined a **naive bayes** classifier worked best

recognition

- given a **test feature vector** collected from a subject

- use the classifier to **predict** which subject the test feature vector was collected from

- we ran a **leave-one-bioimpedance-out cross-validation** to determine the accuracy of our learned classifier

parameters, dataset, metrics

parameters

- cohort size: 2, 3, 4, 5, 46
- bi-polar patterns: 1515, 2626, 3737, 4848
- tetra-polar patterns: 1526, 1537, 1548, 2637, 2648, 2651, 3748, 3751, 3762, 4851, 4862, and 4873

dataset

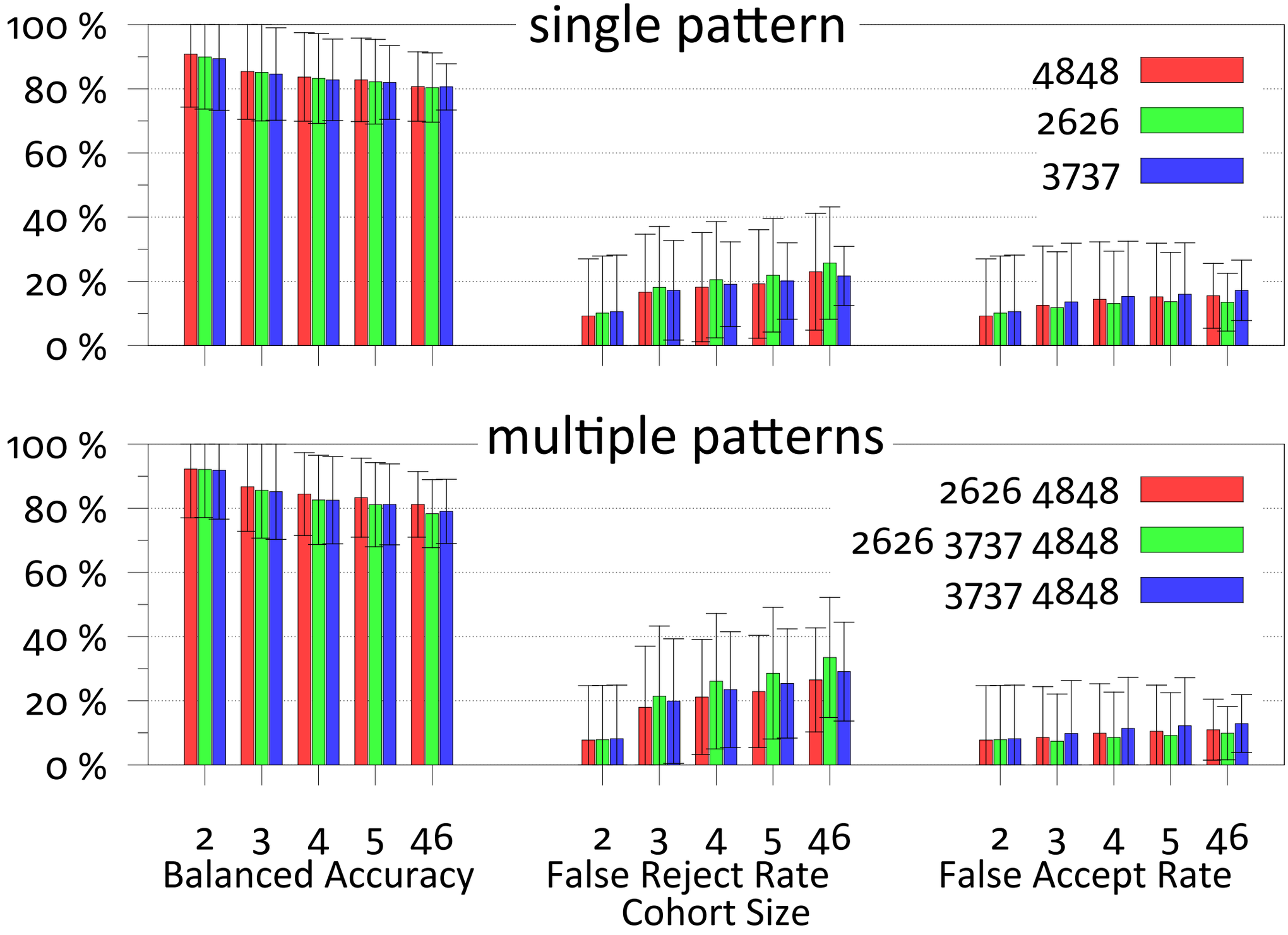
- 46 subjects (22 ♂, 24 ♀)
- 21 years old (σ = 3 years, ≥ 18)
- 5 measurements for each pattern
- 3680 total measurements

metrics

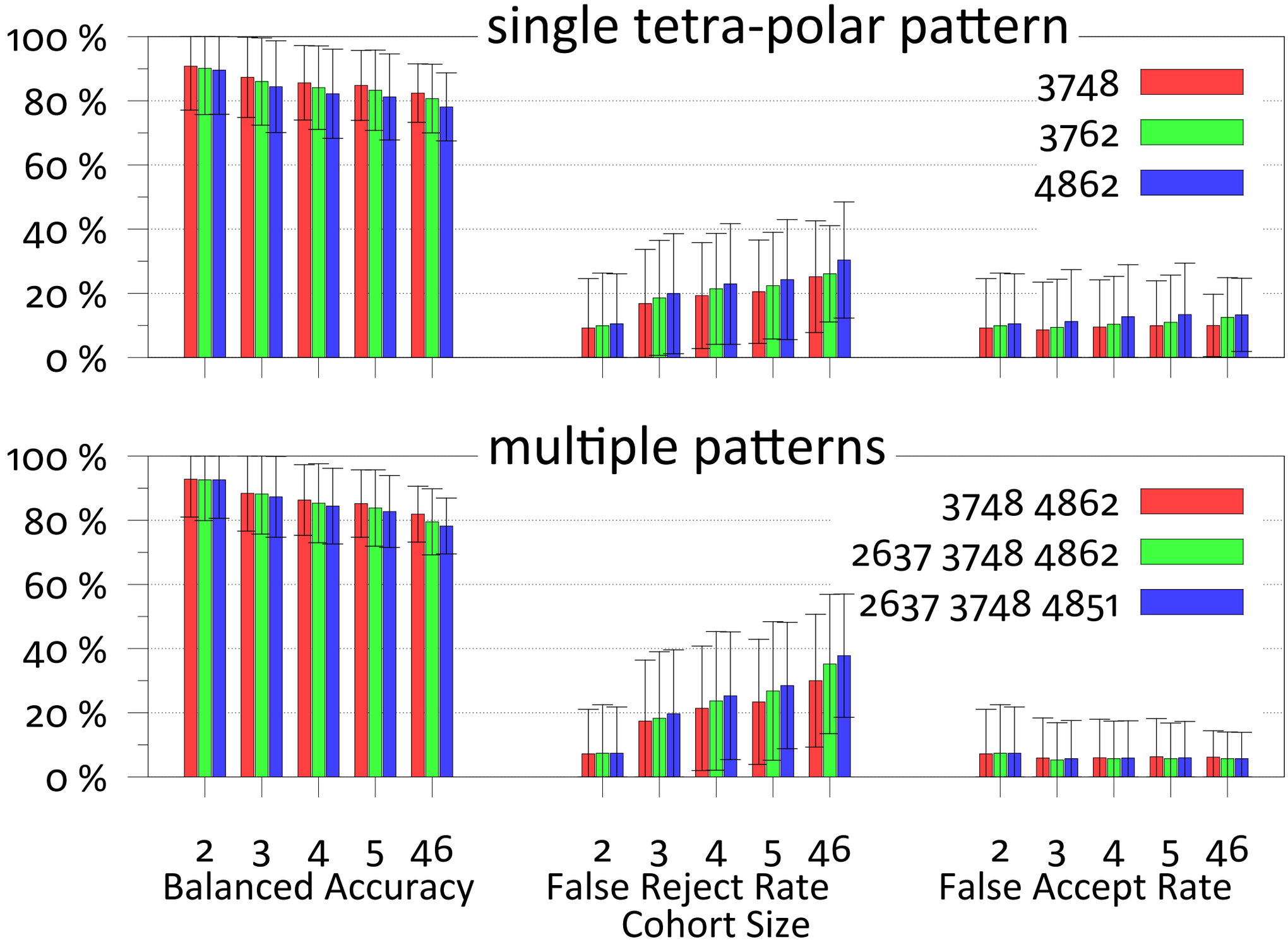
- balanced accuracy
  - (TA + TR) / (TA + TR + FA + FR)
- false accept rate
  - FA / (FA + TR)
- false reject rate
  - FR / (FR + TA)

prediction	ground truth: genuine	ground truth: impostor
accept	true accept (TA)	false accept (FA)
reject	false reject (FR)	true reject (TR)

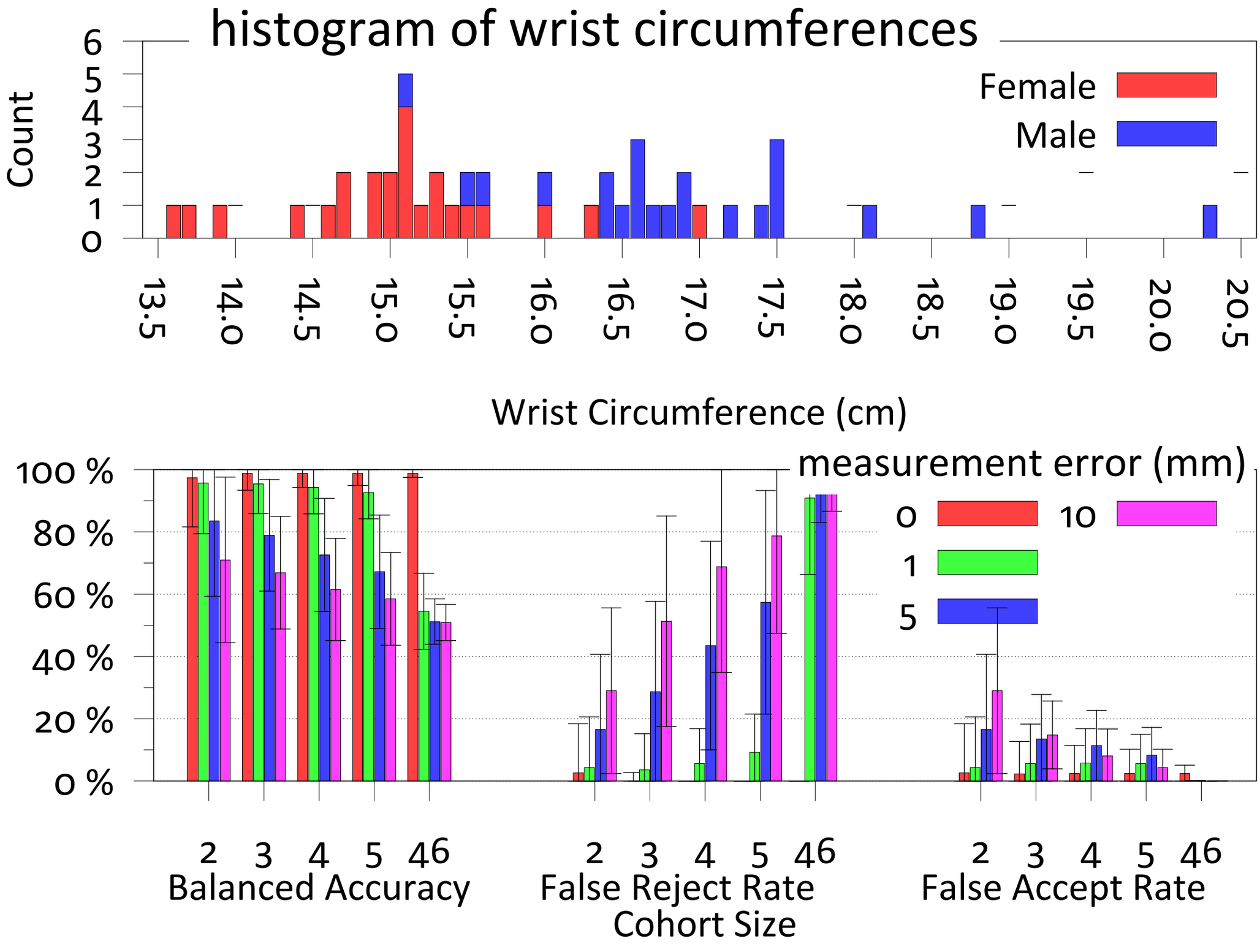
bi-polar experiments



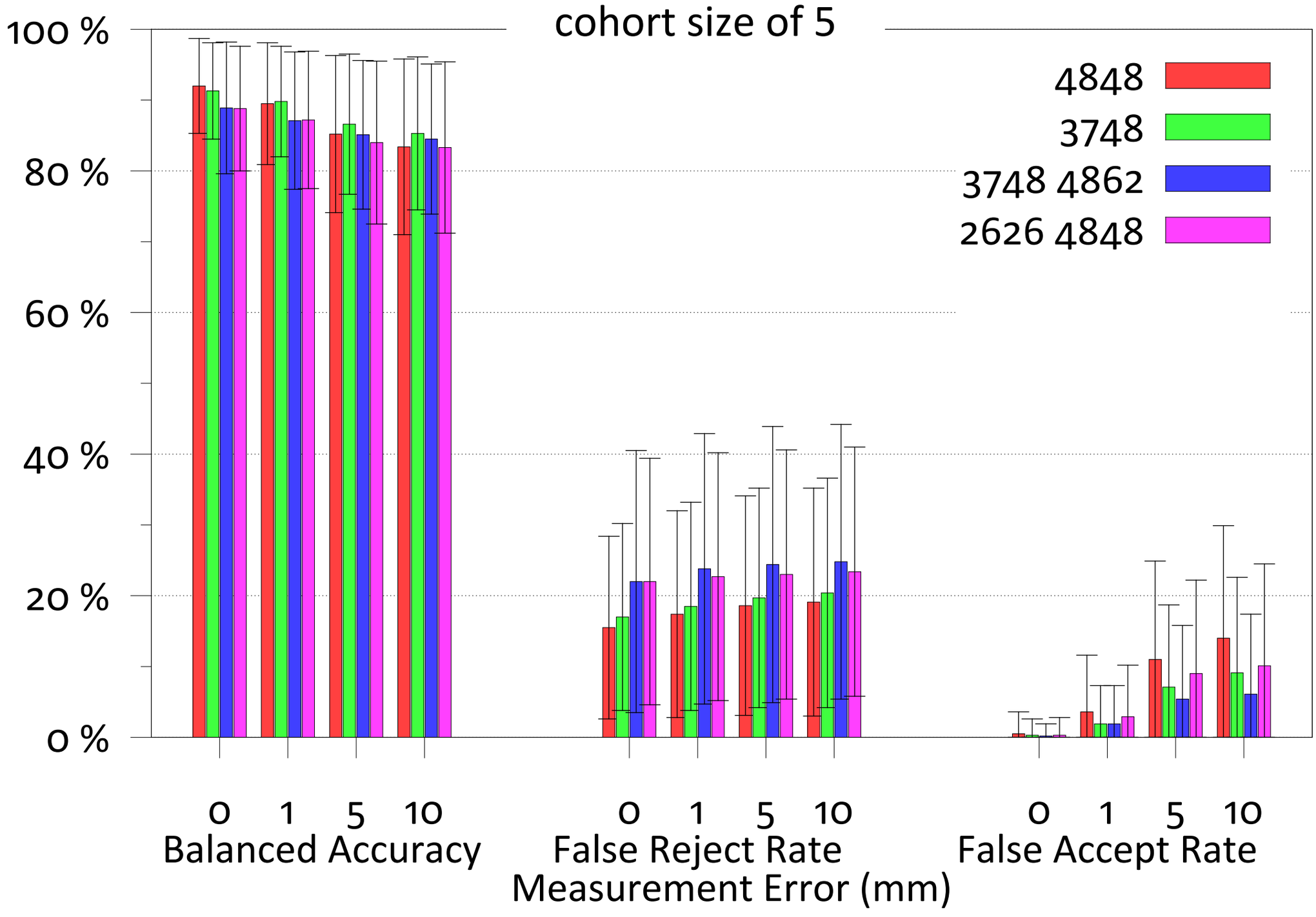
tetra-polar experiments



circumference experiment

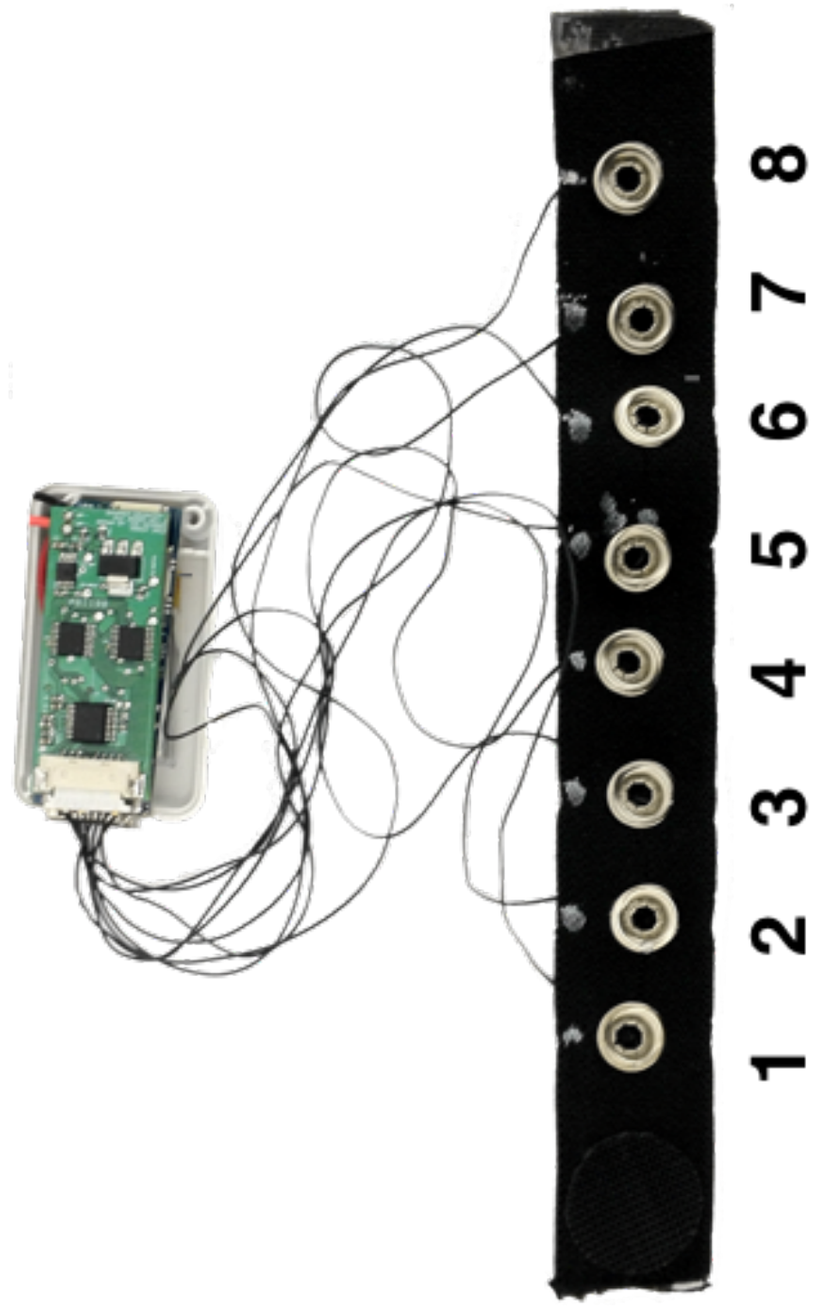


combined experiment



summary

- we collected wrist circumference and bioimpedance from 46 subjects
- we were able to predict a subject with ~85% accuracy using a single bi-polar electrode pattern
- boosted to ~90% when combined with wrist circumference as a feature
- we are currently developing a wearable prototype to collect longitudinal data



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