



UNIVERSITY OF  
OXFORD

DEPARTMENT OF  
**COMPUTER  
SCIENCE**

# Broken Hearted: How to Attack ECG Biometrics

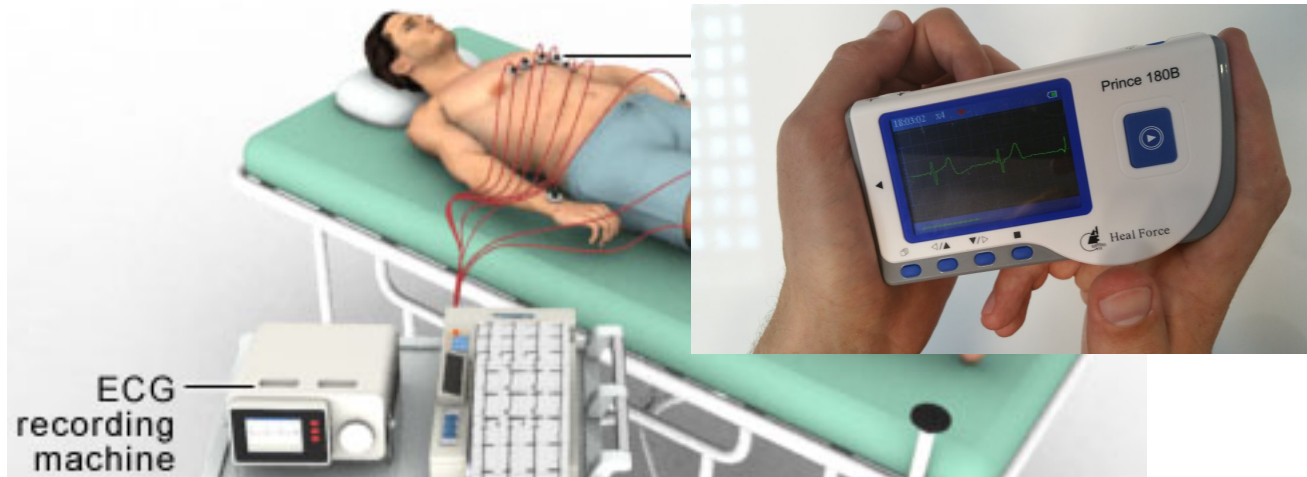
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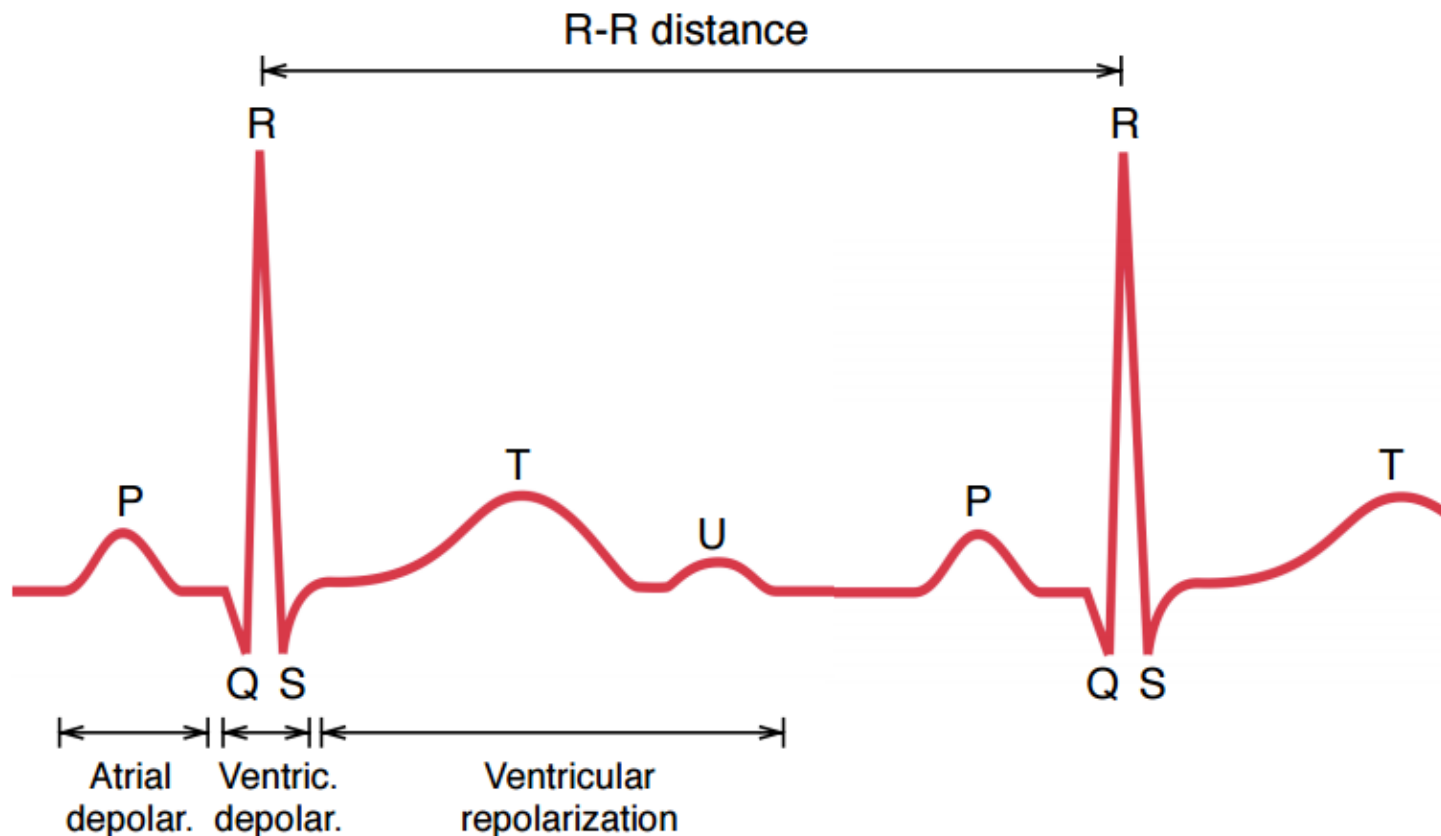
# Background - ECG

- Recording of the heart's electrical activity
- Electric potential differences measured on a person's skin
- Most common use: Medical diagnosis



# Background – ECG Biometrics

- Generic waveform common to healthy individuals
- Individual differences in amplitude, duration and distance
- Significant body of academic work



# Background – Nymi Band



# Background – Nymi Band (2)



- Communication with all Bluetooth/NFC devices (NEAs)
- Trialled for contactless payments and online banking



# Threat Model

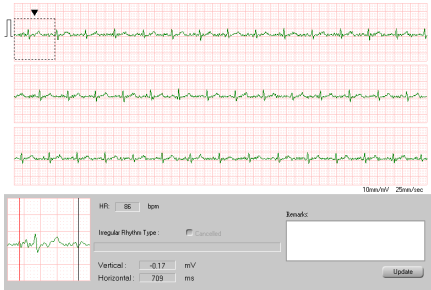
- To break the Nymi Band, the attacker needs to
  - Obtain access to the band itself
  - ~~□ Obtain access to the NCA (e.g., user's smartphone)~~

□ Circumvent ECG-based authentication

Focus of this work

# A Presentation Attack Against ECG

- Goal: Impersonation of the legitimate user
- ECG is available through a number of sources



Printed ECG Signal

E-health

Fitness Devices

- Different measurement locations and device properties!
- Cross-Device attacks

# Collecting Data for the Attack

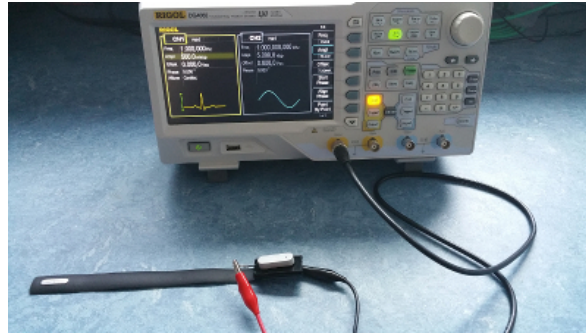
- 41 Participants
- 3 different devices
- 5 measurement modes





# Signal Injection Methods

- Hardware arbitrary waveform generator



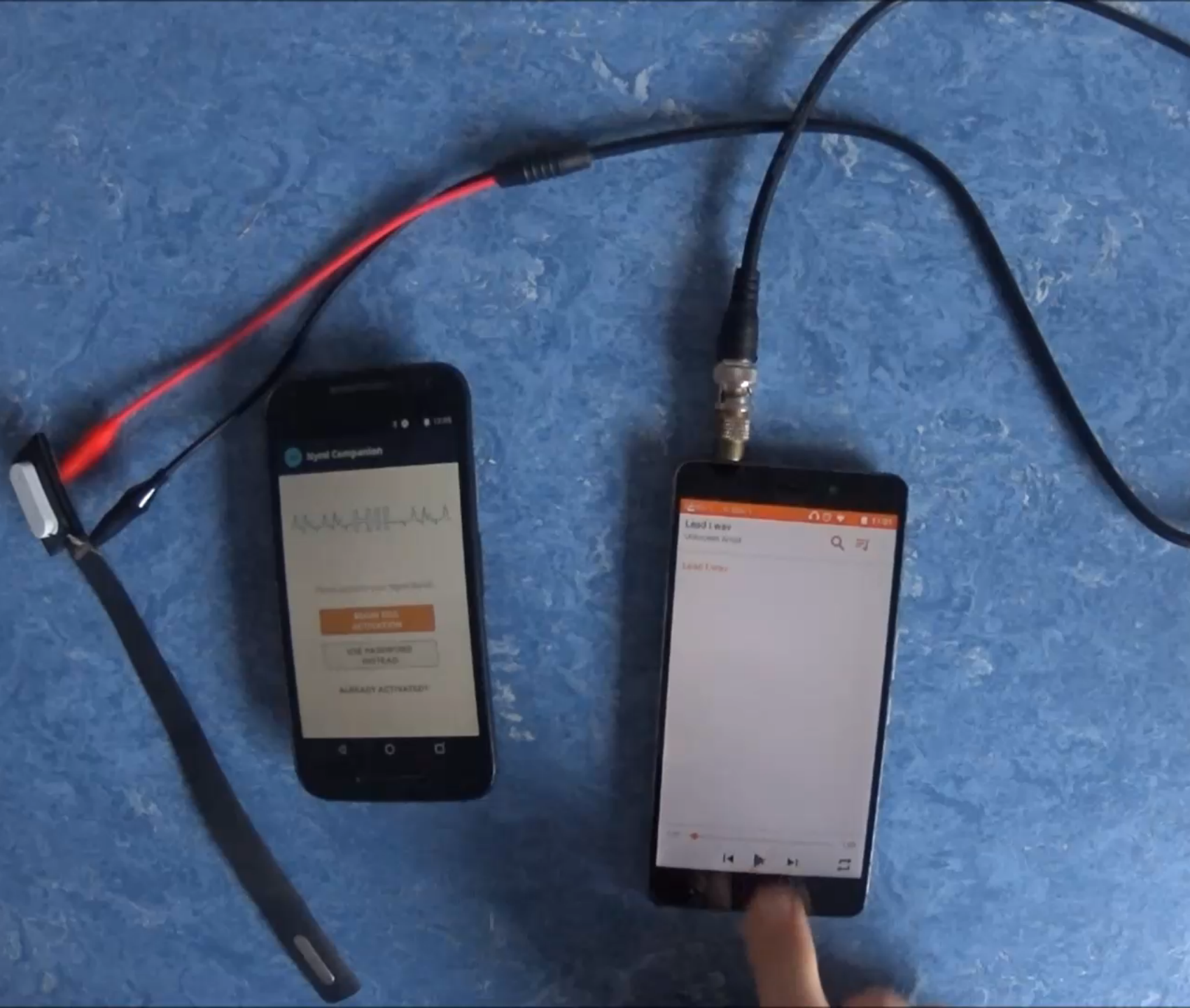
- Laptop soundcard with SW-based waveform generator



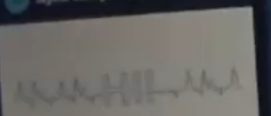
- Playback of .wav-encoded ECG signal

*“There is currently no known means of falsifying an ECG waveform and presenting it to a biometric recognition system. ”*





Mynd Companion



Personalized your app's data.

SHOW BCG ACTIVATION

USE PAGERING INSTEAD

ALREADY ACTIVATED?

Lead 1 wav

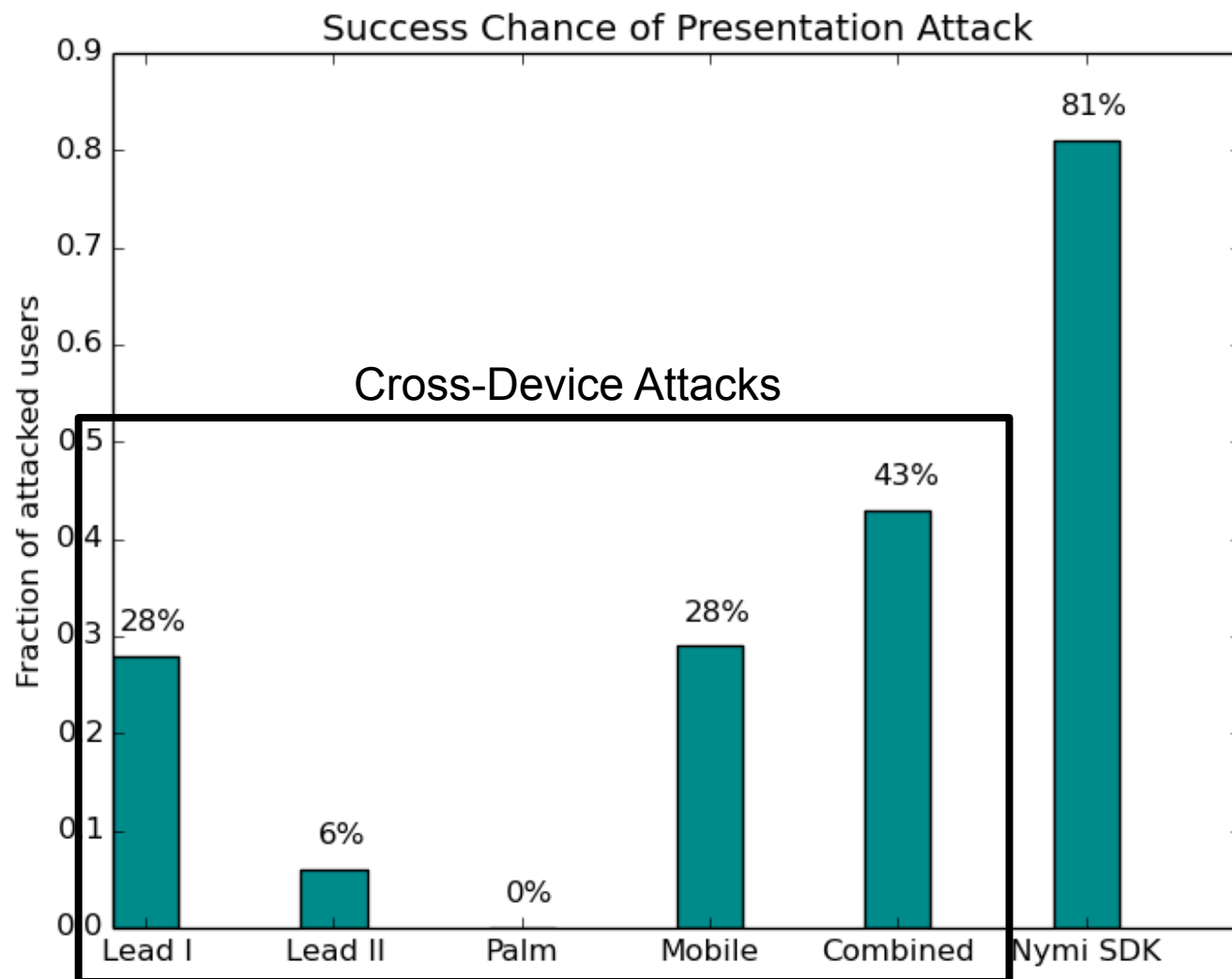
Ultrasound Apps

Label Entry

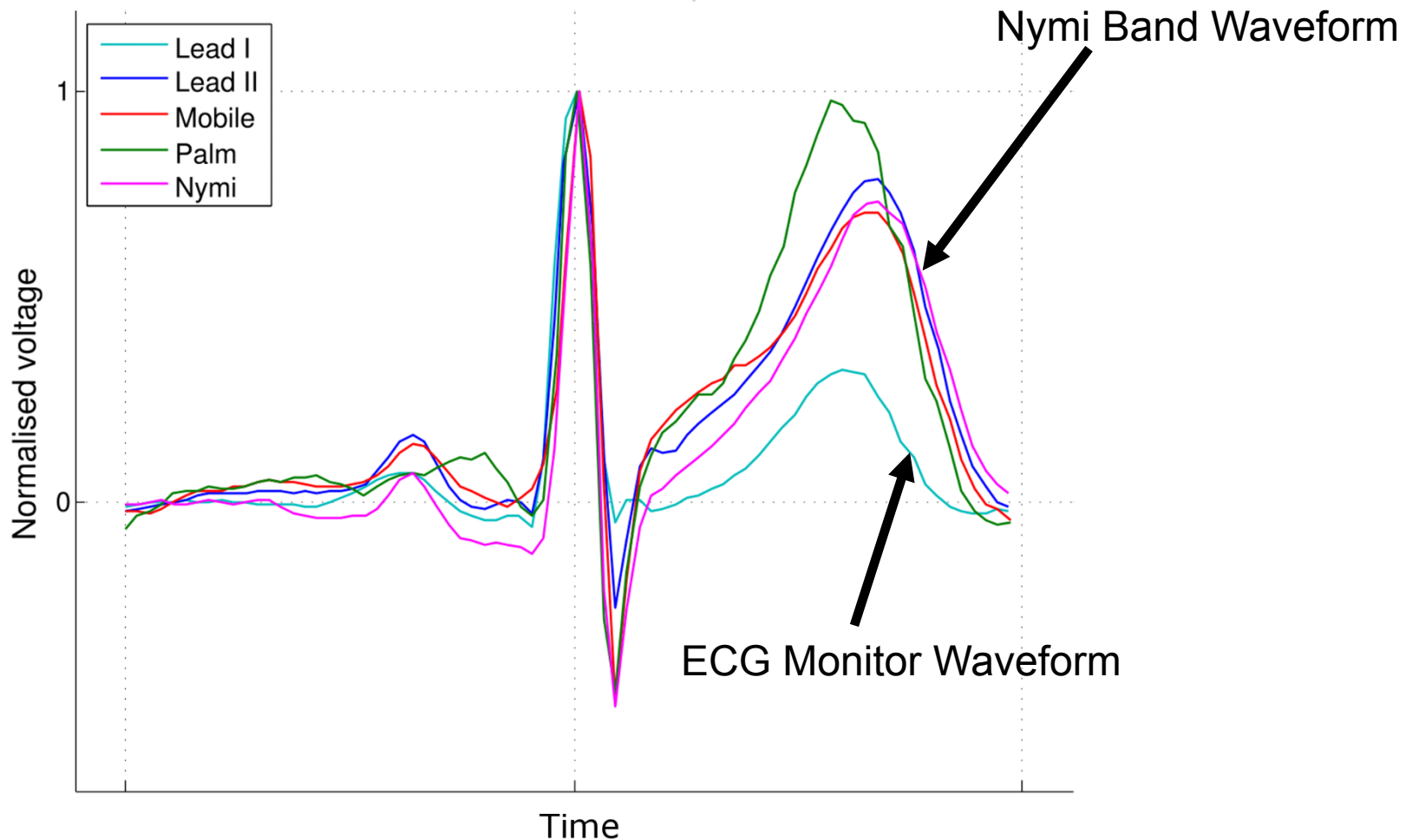


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# Initial Results

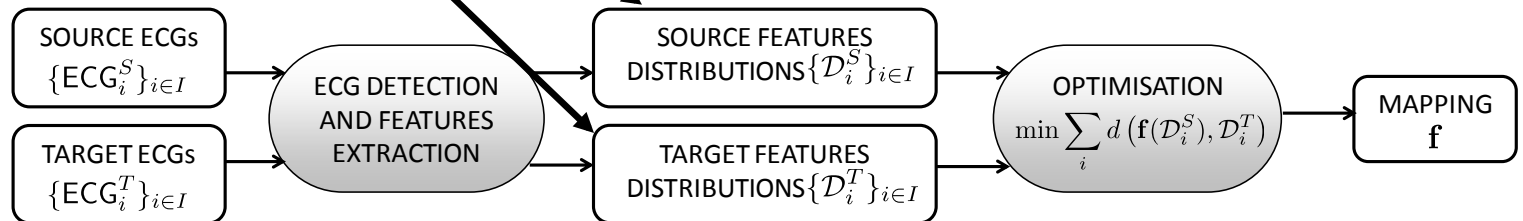
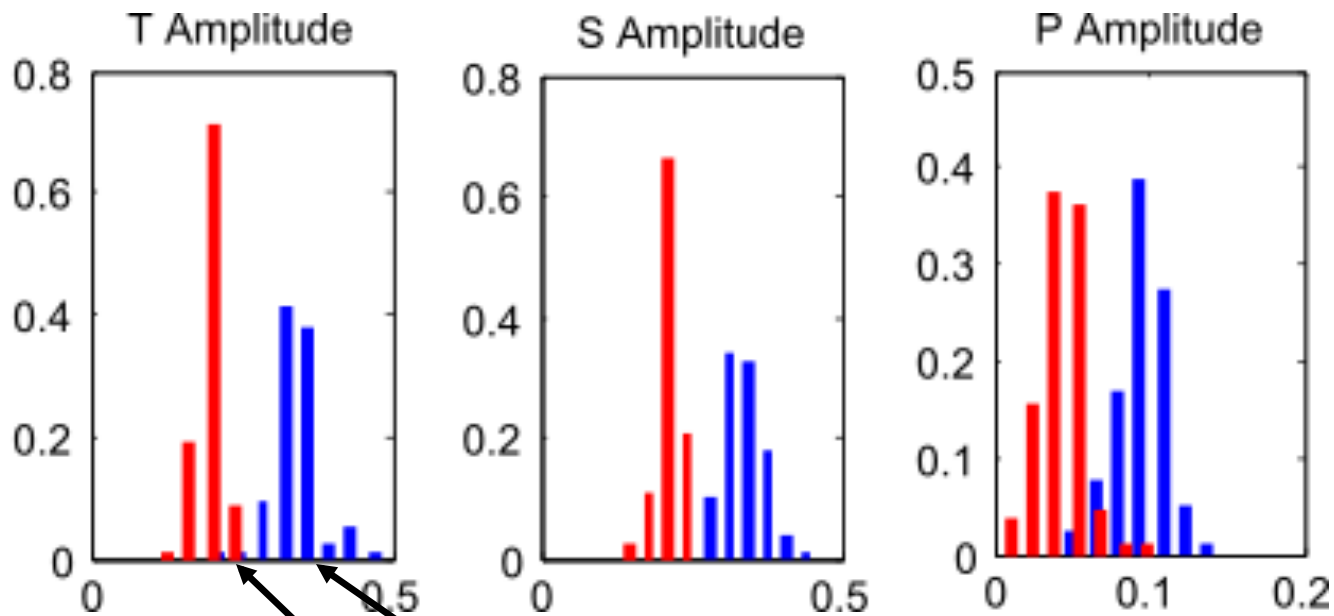


# The Challenge of Cross-Device Attacks

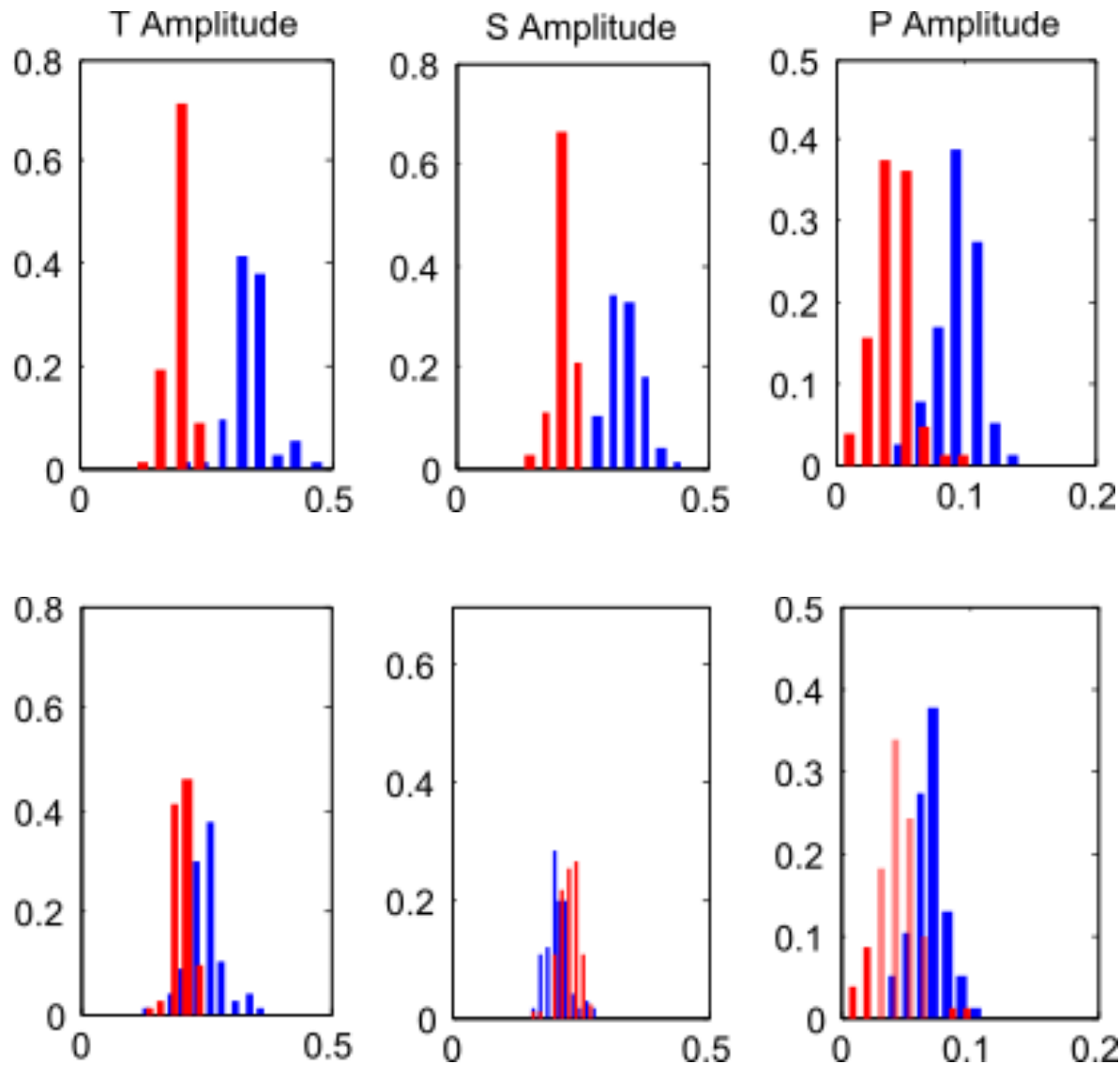


- Different waveform morphology between devices!

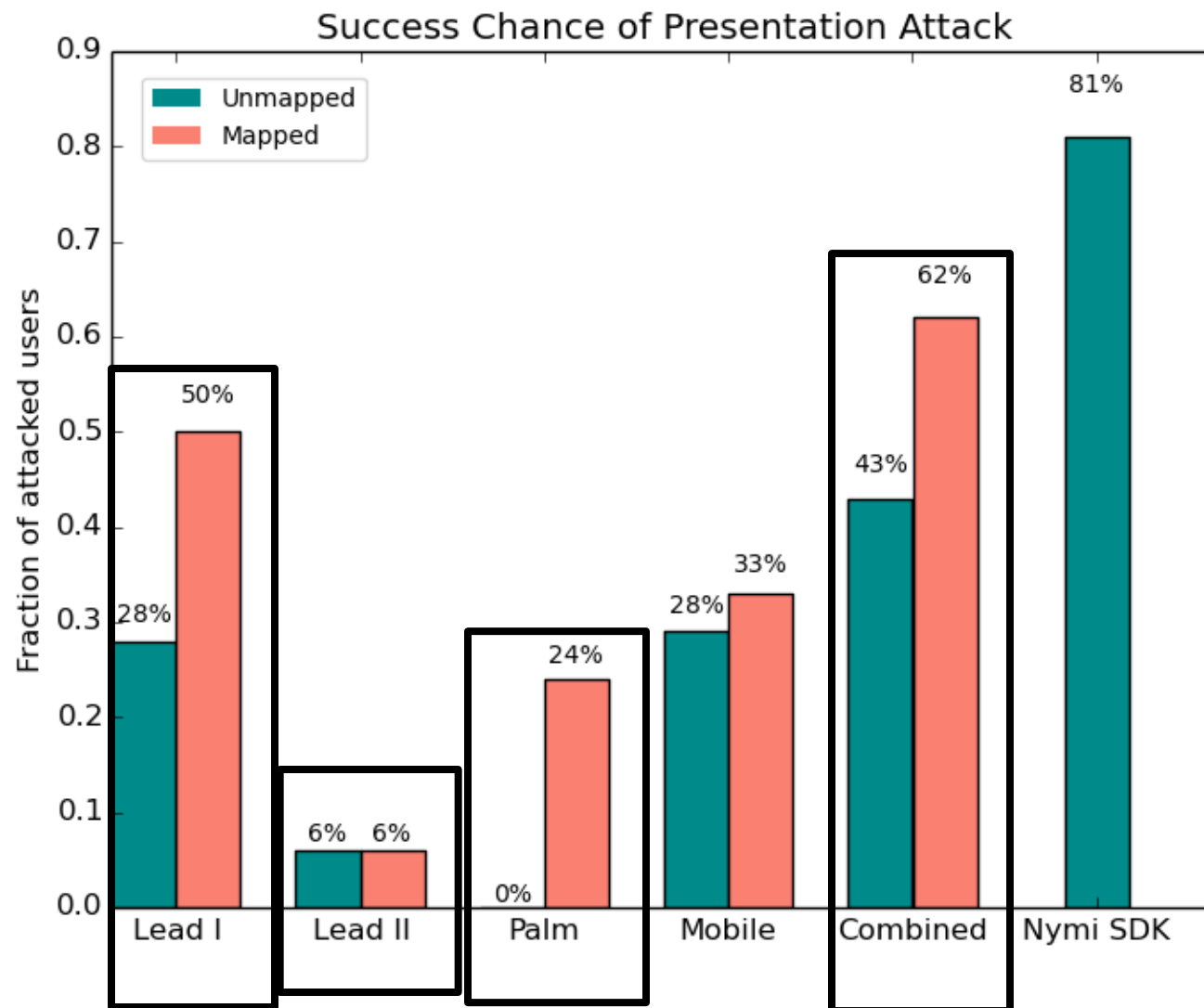
# Training a Cross-Device Mapping



# Training a Cross-Device Mapping - Results



# Final Results





# Conclusion

- Successful presentation attack against ECG biometric
- Wide variety of data sources suitable for attacks
- Remarkably low technological barriers
- Future Work
  - Further improve cross-device mapping
  - Can very old data be used for the attack?

# Conclusion – Questions?

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- Wide variety of data sources suitable for attacks
- Remarkably low technological barriers
- Future Work
  - Further improve cross-device mapping
  - Can very old data be used for the attack?

Thank you for your attention. Questions?

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