

CableAuth:

A Biometric Second Factor Authentication Scheme for Electric Vehicle Charging

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Inaugural Symposium on Vehicle Security and Privacy (VehicleSec 2023)

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Photo by Michael Fousert on Unsplash

Paying for a Charging Session

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Smartcard or mobile app

Photos from unsplash.com

Paying for a Charging Session



Smartcard or mobile app



Credit card or mobile payment

Photos from unsplash.com

Paying for a Charging Session



Smartcard or mobile app



Credit card or mobile payment



Certificate or unique identifier

Photos from unsplash.com

System Model - CableAuth

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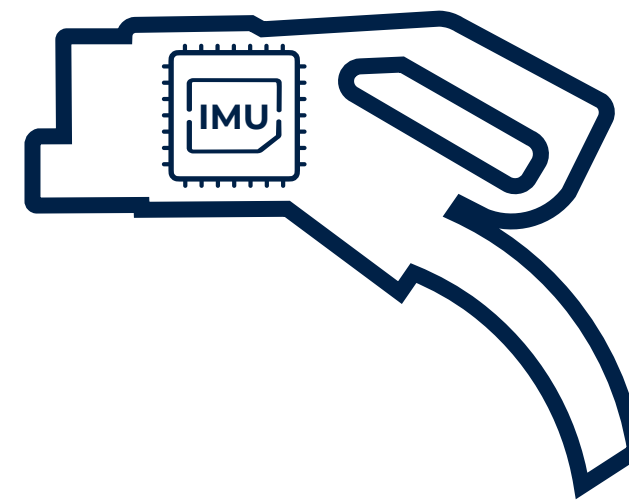


Unique movements

System Model - CableAuth



Unique movements

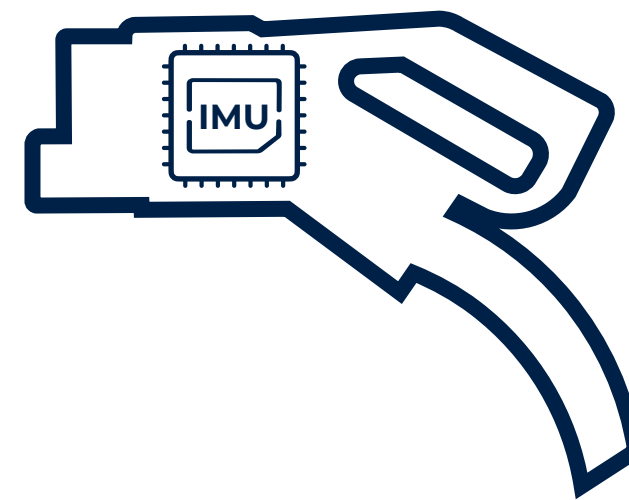


IMU sensor in the handle

System Model - CableAuth



Unique movements



IMU sensor in the handle

Optional



Smartwatch

Threat Model

Threat Model

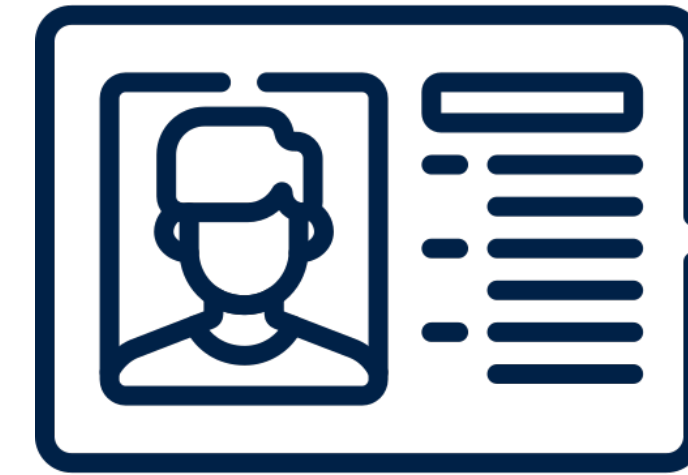


Vehicle theft

Threat Model



Vehicle theft

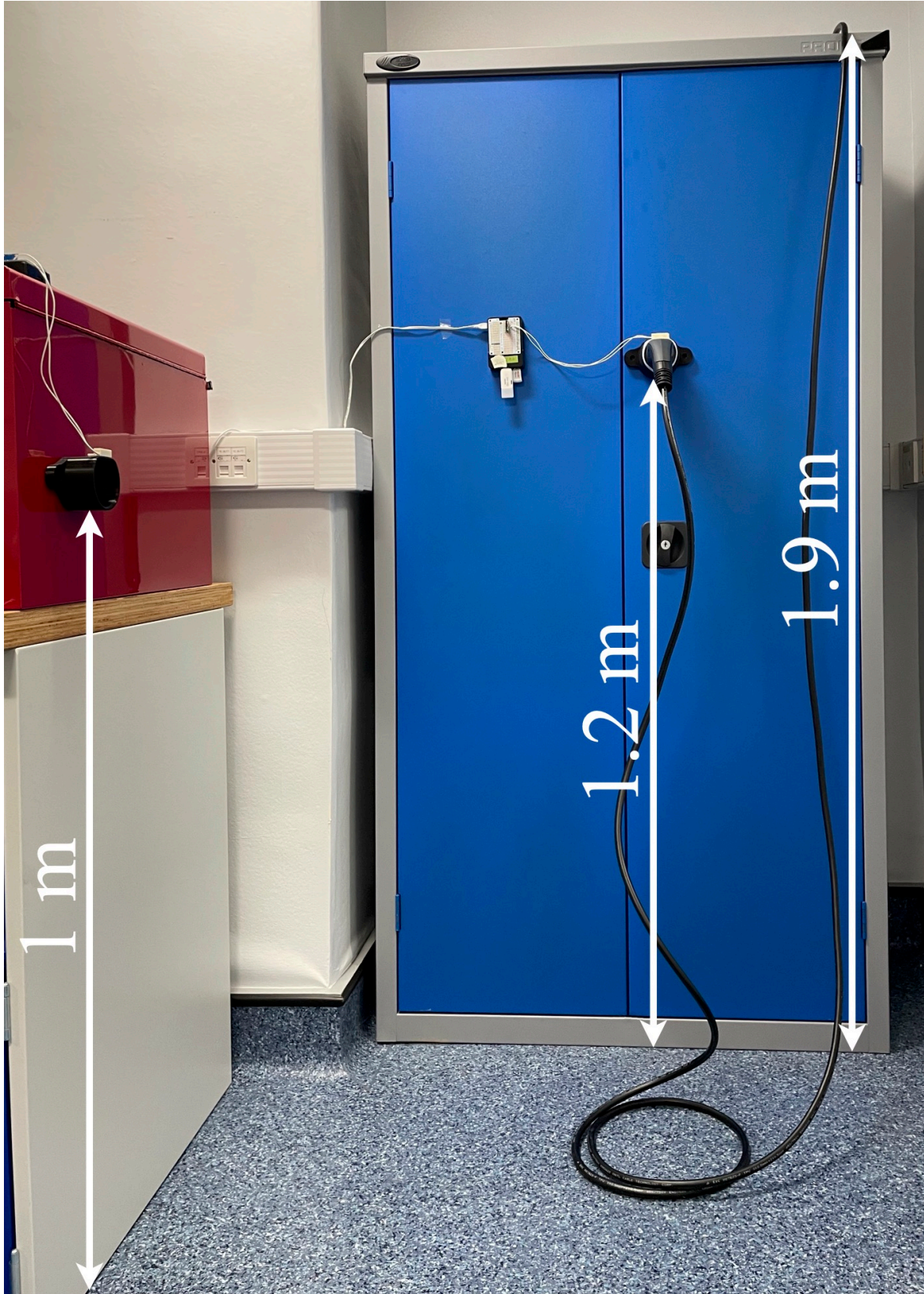


Credentials theft

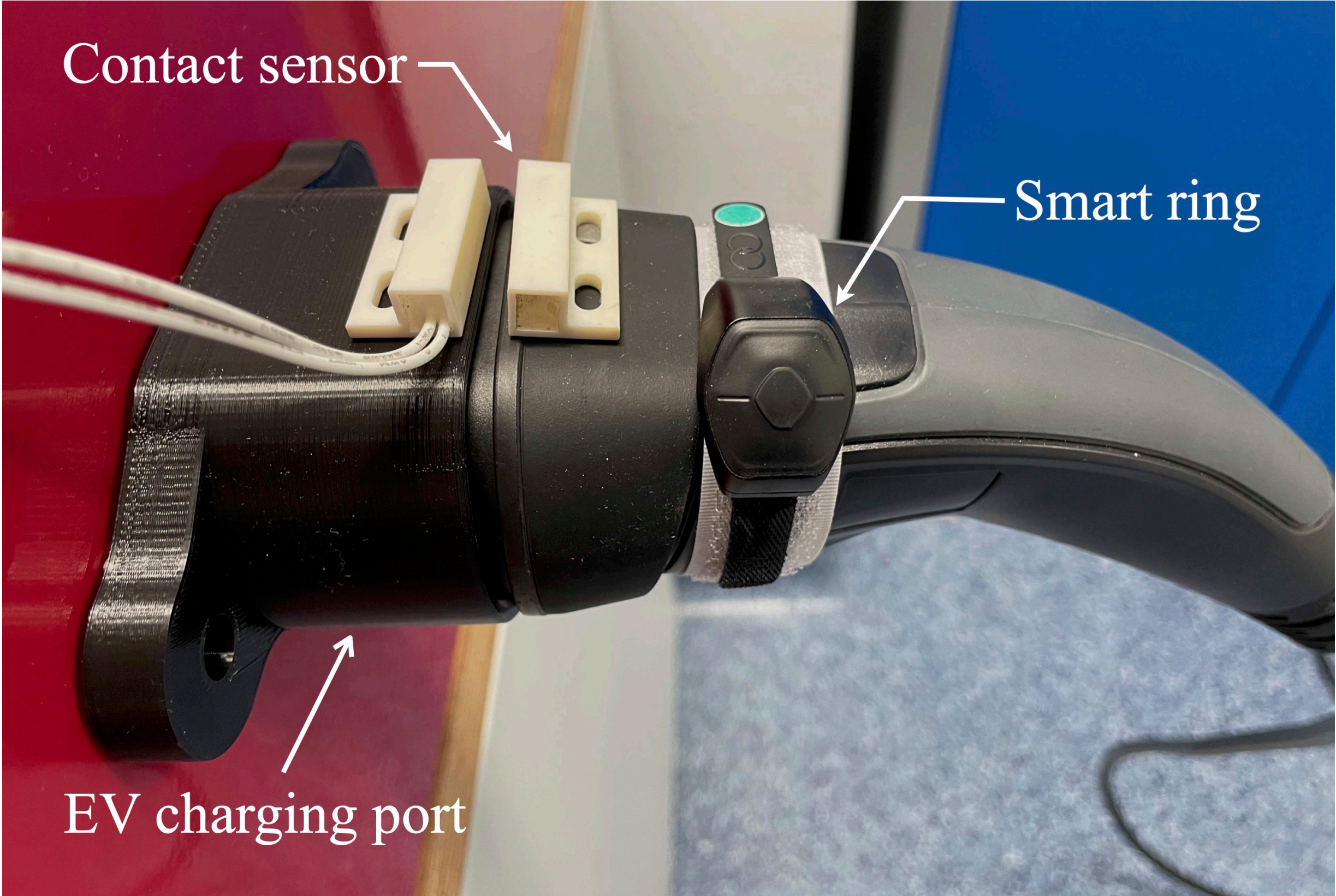
Experiment Setup



Real charging station



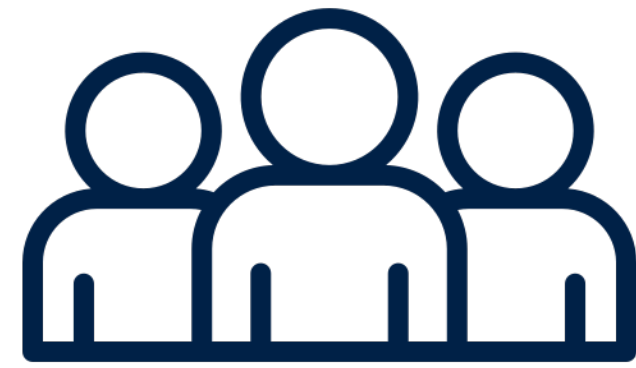
Charging station replica



Charging cable handle with smart ring attached

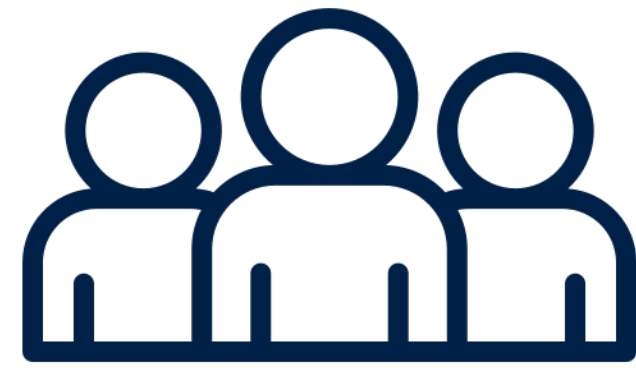
User Study - Data Collection

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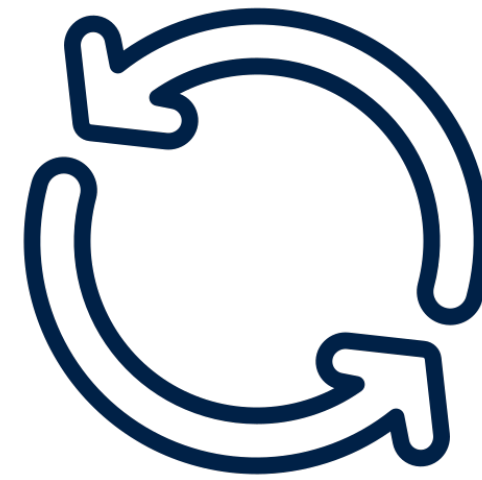


20 participants

User Study - Data Collection

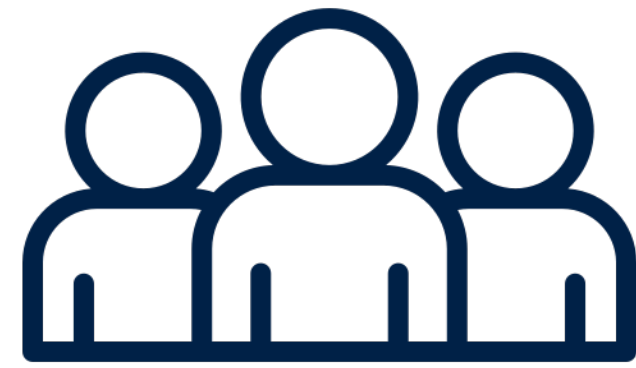


20 participants

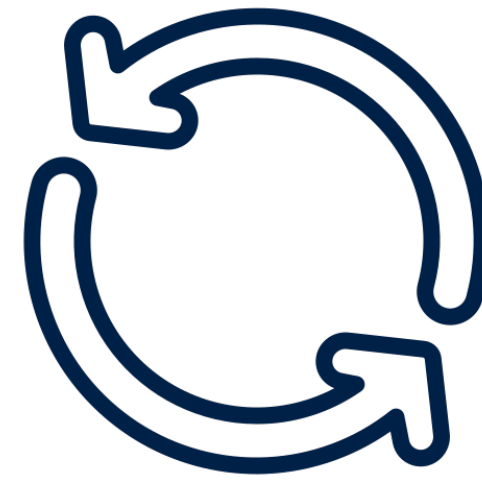


Three separate sessions

User Study - Data Collection



20 participants



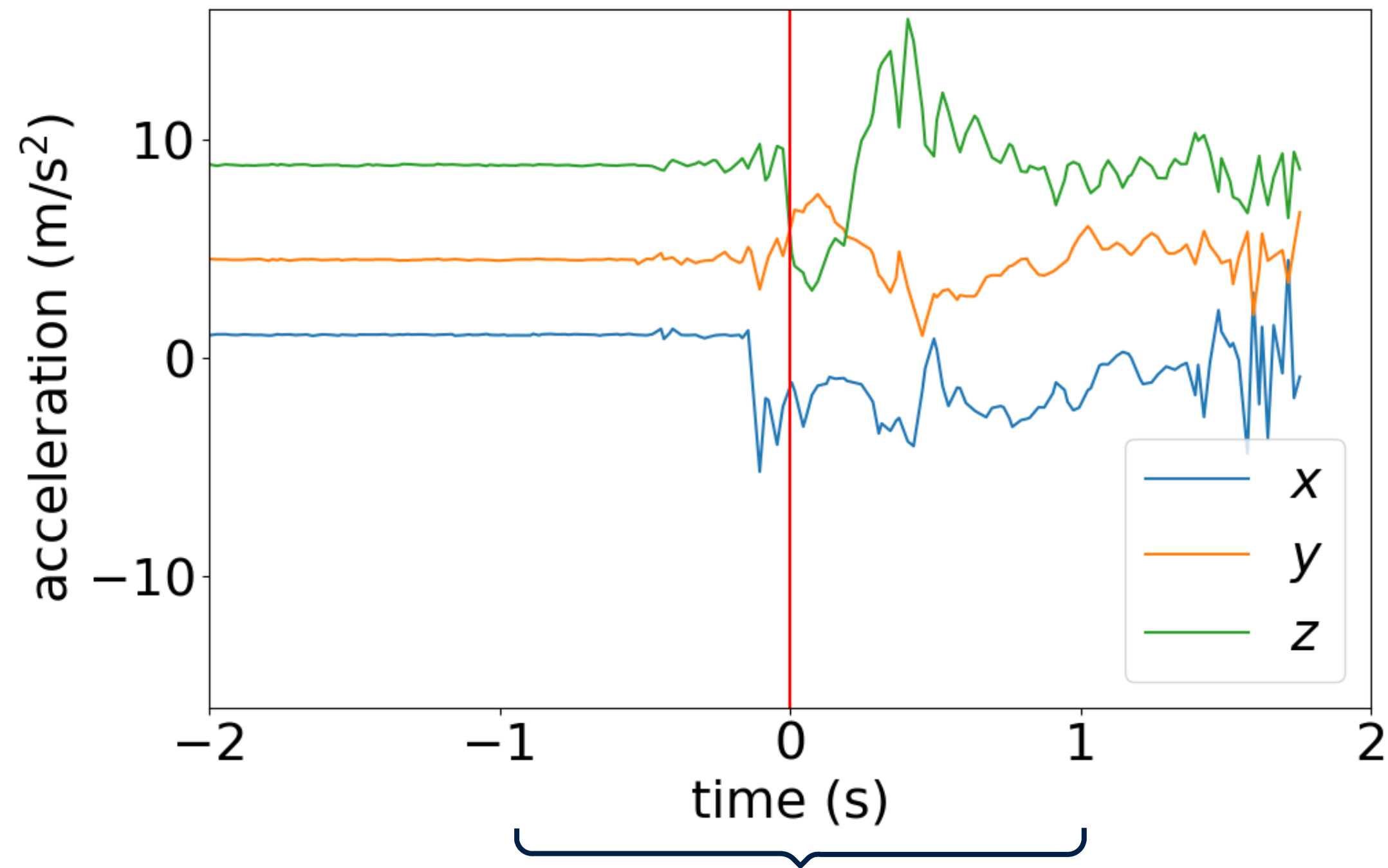
Three separate sessions



Total of 30 charging sessions per participant

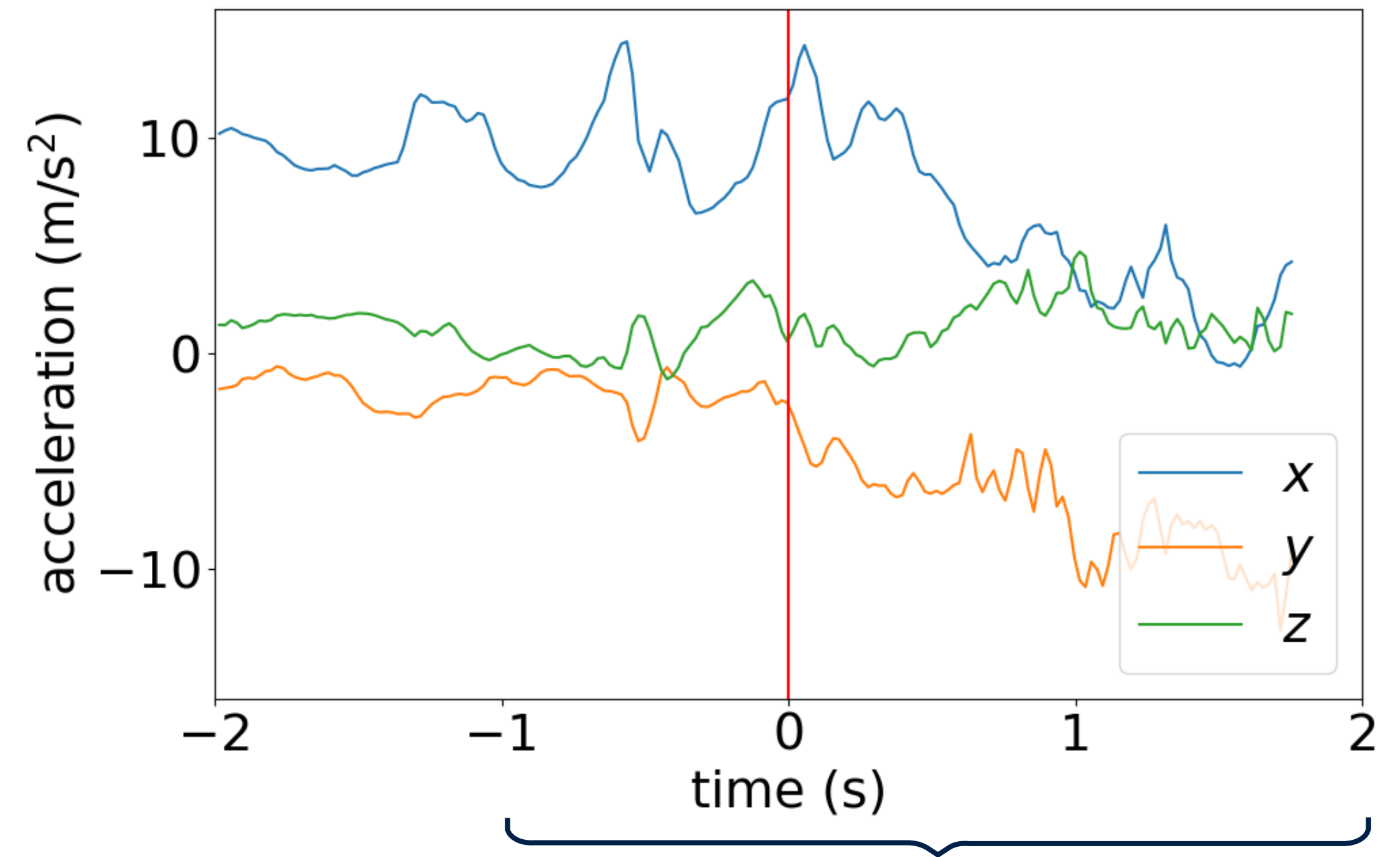
Data Processing - Unhook

Cable handle



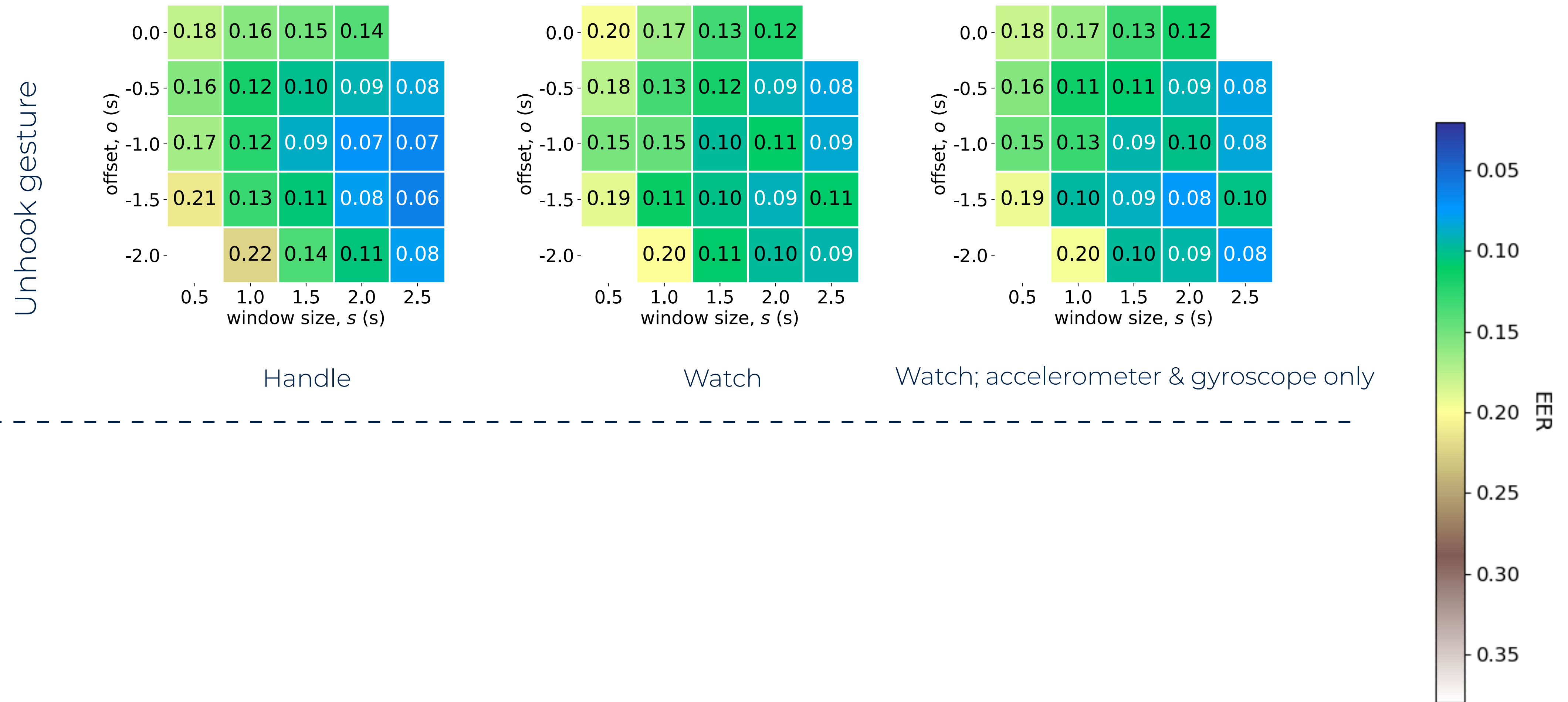
windows size = 2.0, offset = -1.0

Watch

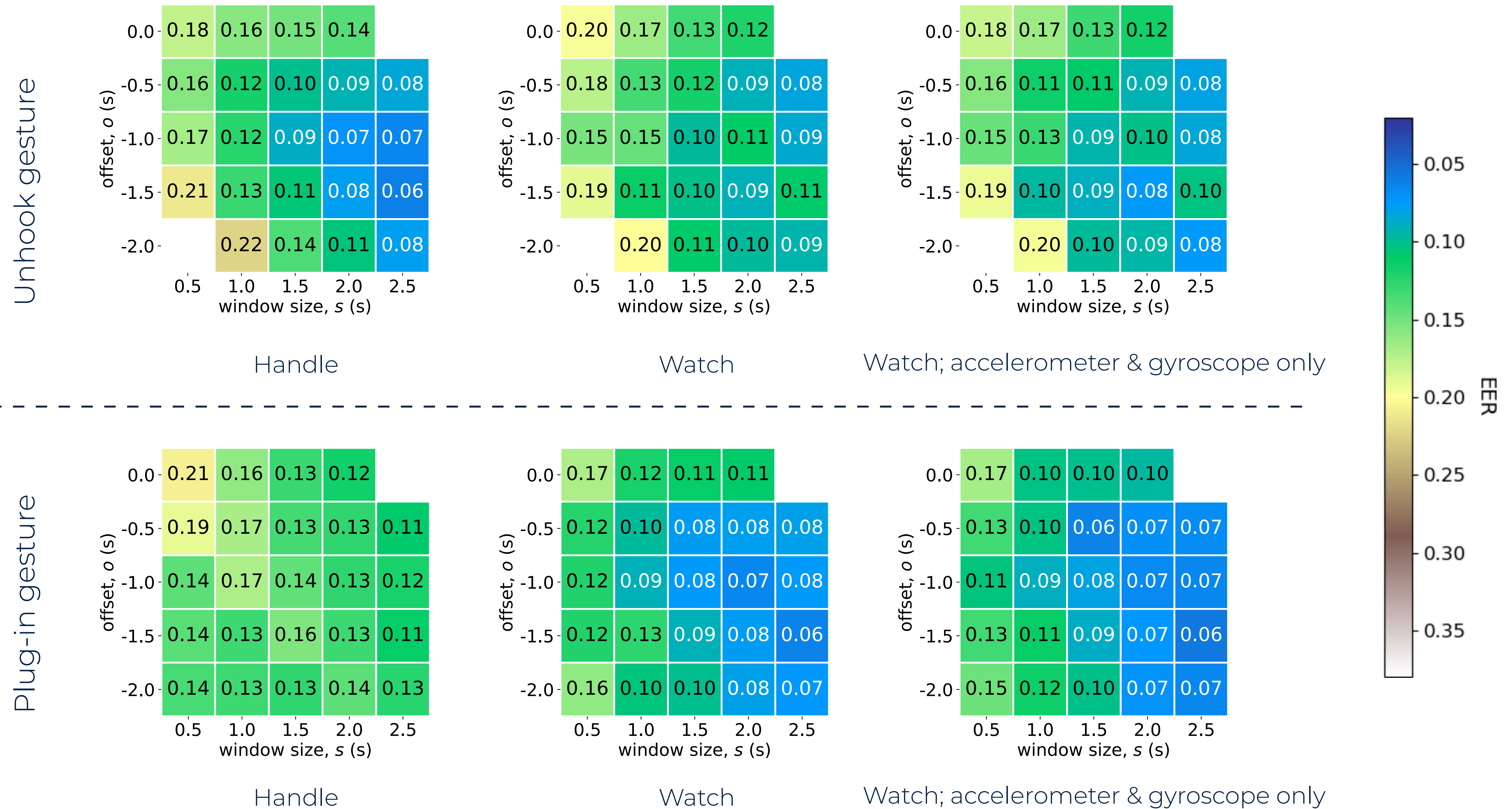


windows size = 3.0, offset = -2.0

Authentication Results



Authentication Results

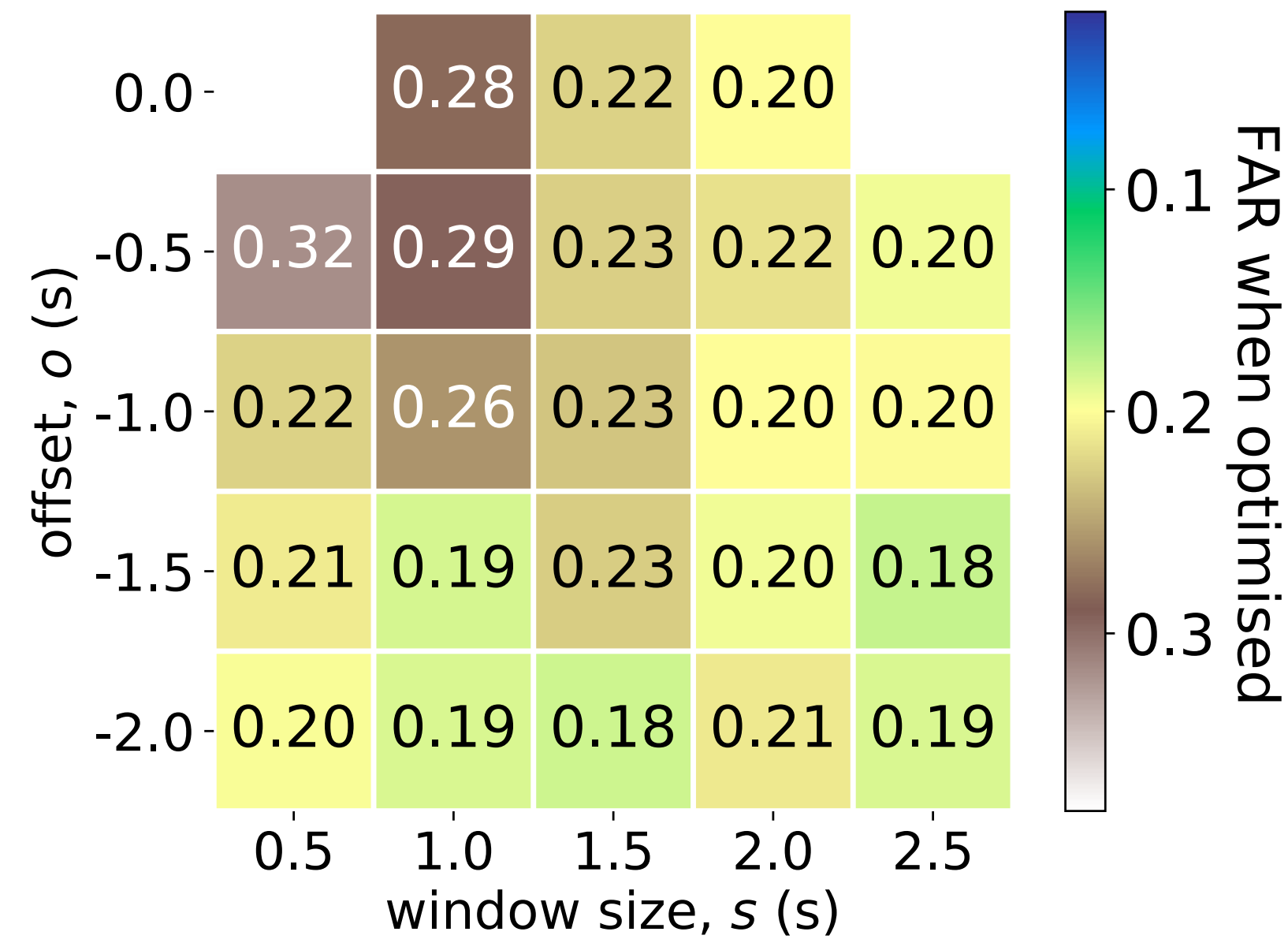


Combined-Gestures Results

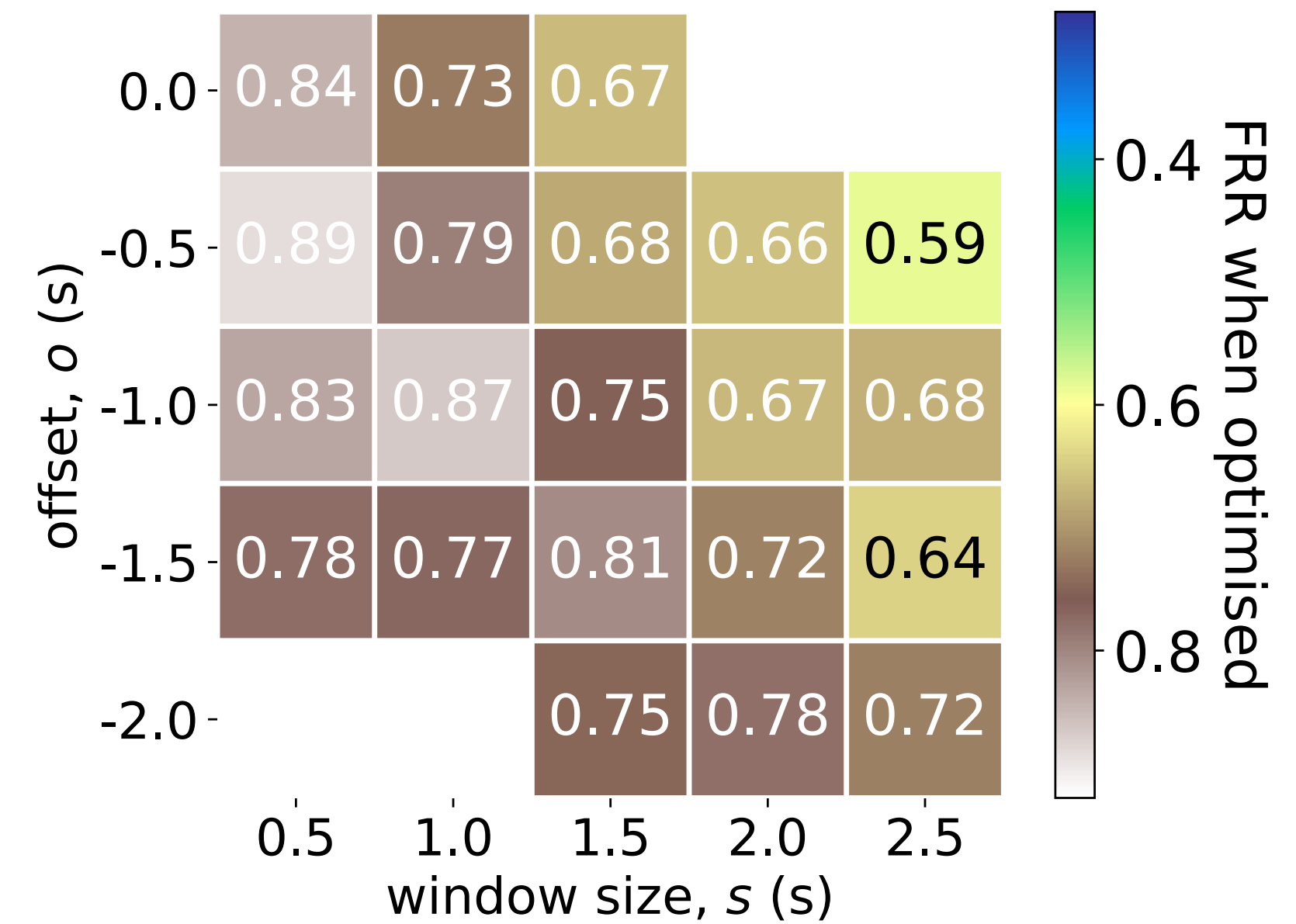
		Parameters for <i>plug-in</i> Gesture					
Device	Parameters for <i>unhook</i> Gesture	$\{s = 1.5, o = -1.0\}$	$\{s = 2.0, o = -1.0\}$	$\{s = 2.0, o = -1.5\}$	$\{s = 2.5, o = -1.5\}$	$\{s = 2.5, o = -0.5\}$	$\{s = 2.5, o = -1.0\}$
Handle	$\{s = 2.0, o = -1.0\}$	0.13	0.11	0.12	0.09	0.10	0.10
	$\{s = 2.0, o = -1.5\}$	0.13	0.11	0.12	0.09	0.10	0.11
	$\{s = 2.5, o = -1.0\}$	0.12	0.11	0.11	0.09	0.09	0.10
	$\{s = 2.5, o = -1.5\}$	0.12	0.11	0.12	0.09	0.09	0.10
Watch	$\{s = 2.0, o = -1.0\}$	0.13	0.12	0.13	0.12	0.11	0.12
	$\{s = 2.0, o = -1.5\}$	0.11	0.11	0.12	0.10	0.09	0.10
	$\{s = 2.5, o = -1.0\}$	0.11	0.10	0.11	0.11	0.11	0.11
	$\{s = 2.5, o = -1.5\}$	0.13	0.12	0.13	0.11	0.12	0.12

Average EERs for the combined-gesture model by *unhook* and *plug-in* window parameters

Second Factor Optimization



FAR optimized for low FRR (0.01%)



FRR optimized for low FAR (0.01%)

Conclusion



An IMU sensor in the charging cable handle is sufficient,



to extract unique user movements that can be used as a second factor.



Our authentication models achieved EERs of **0.06**.

Questions?

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 <https://seclab.cs.ox.ac.uk>

 <https://github.com/jacksturgess/cableauth>