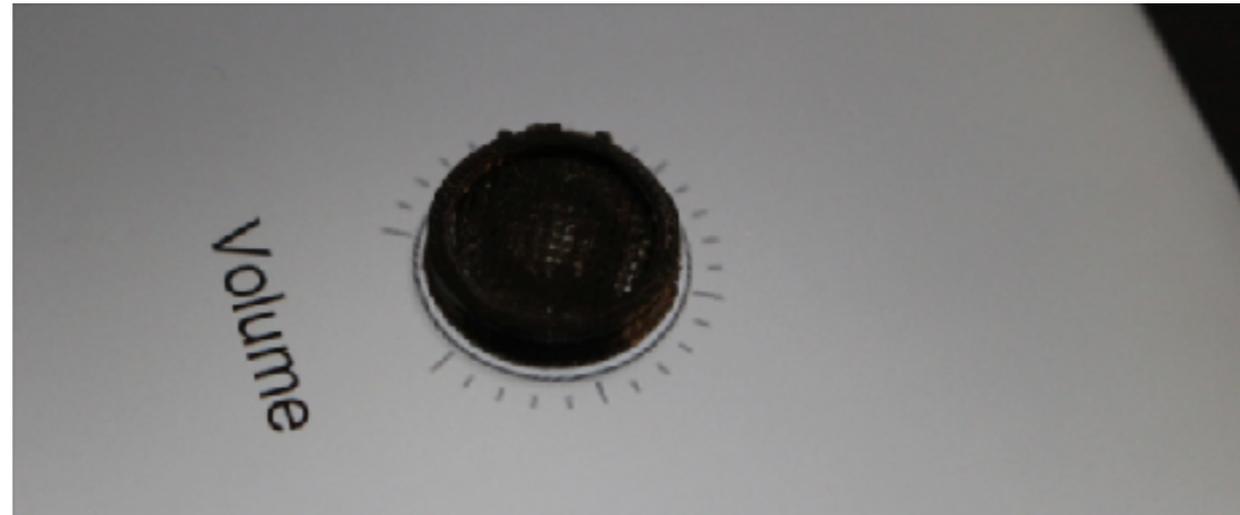


# Emergeables



## Deformable Displays for Continuous Eyes-Free Mobile Interaction

Simon Robinson

**Céline Coutrix**

**Jennifer Pearson**

Juan Rosso

Matheus Fernandes Torquato

Laurence Nigay

Matt Jones



# Mobile UIs lack tangibility



# Mobile UIs lack tangibility



# Mobile UIs lack tangibility



# Mobile UIs lack tangibility



# Mobile UIs lack tangibility



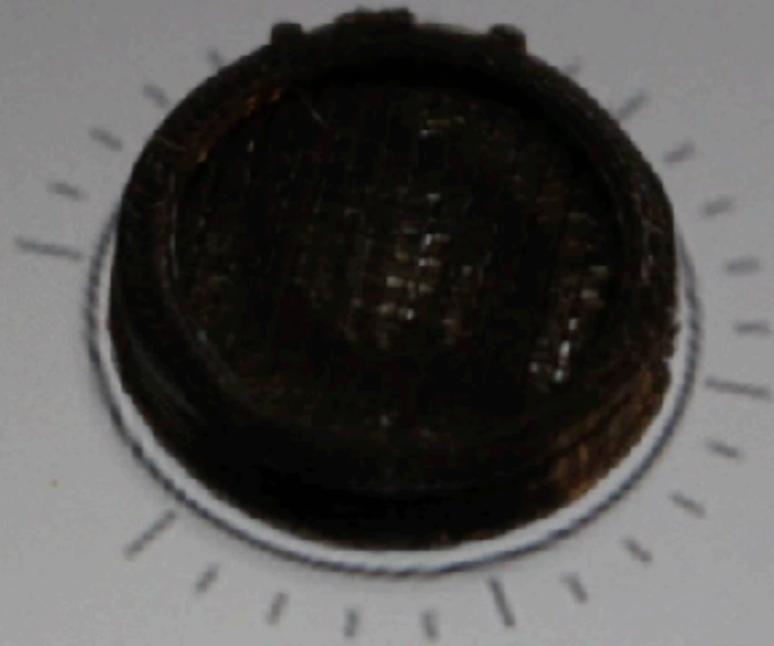
Low preference

Low performance

Low safety

# Emergeables

Volume



# Emergeables



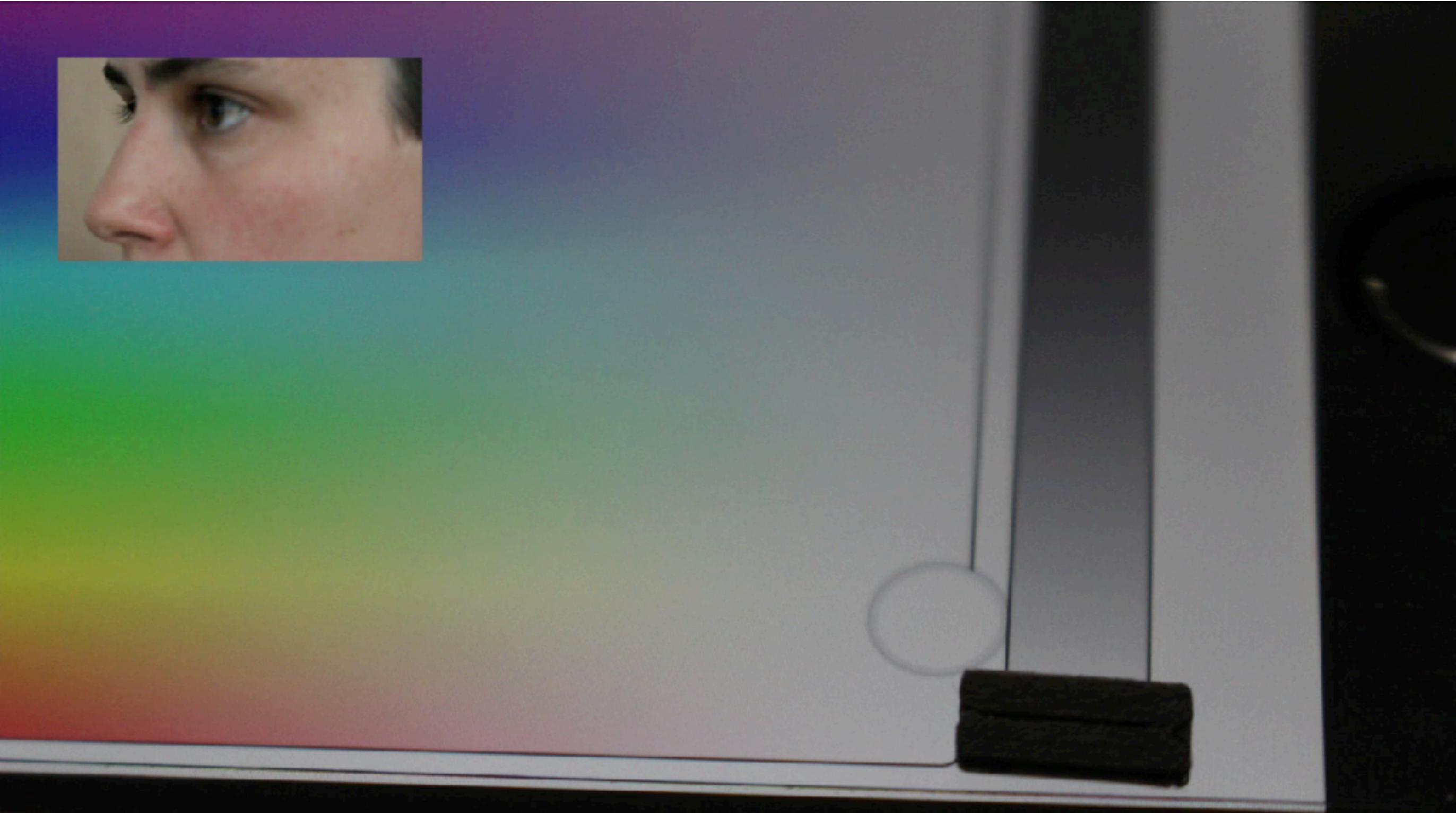
# Emergeables



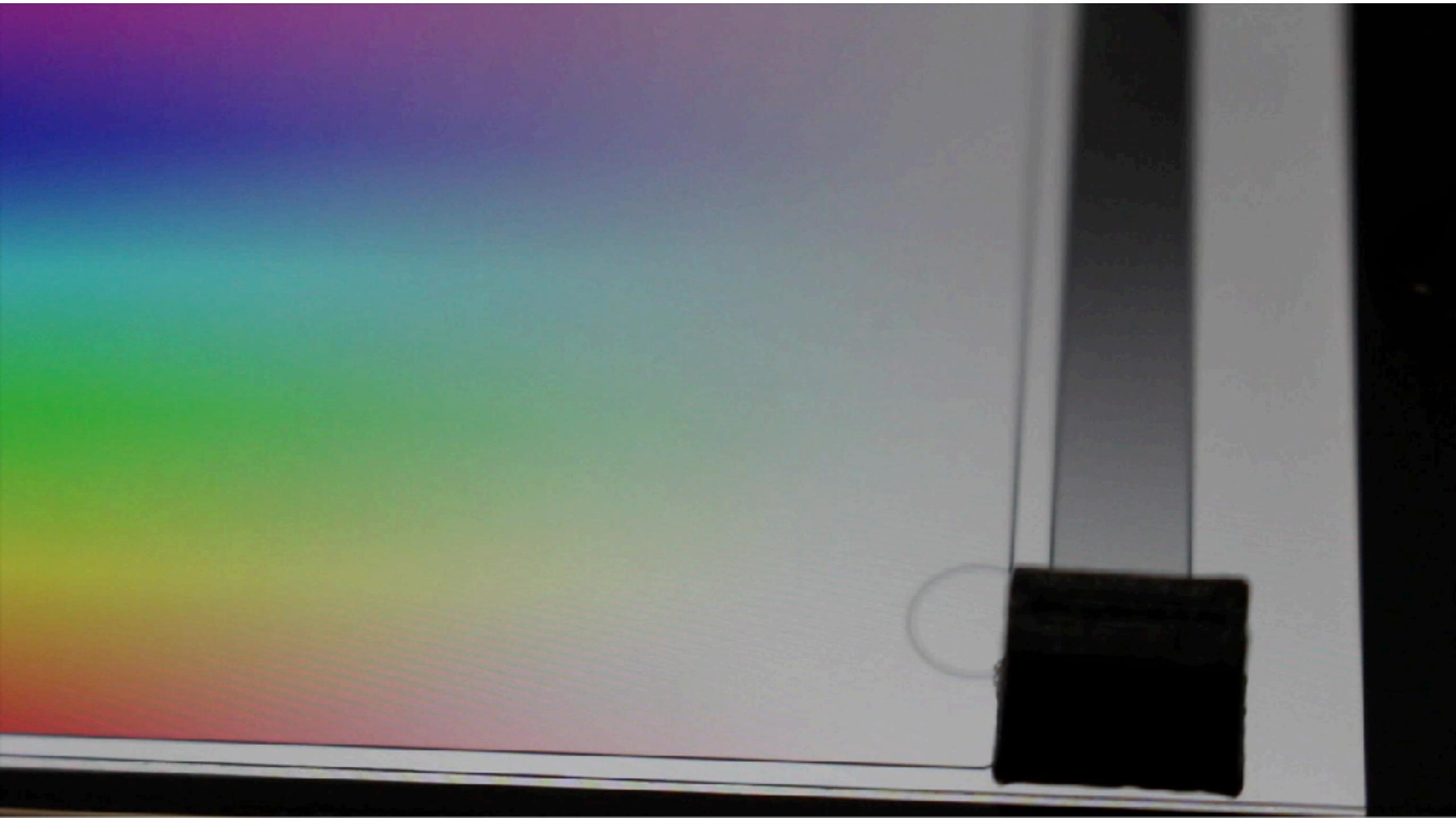
# Emergeables



# Emergeables



# Emergeables



# Emergeables



# Emergables

**During half-time  
and advertisements**

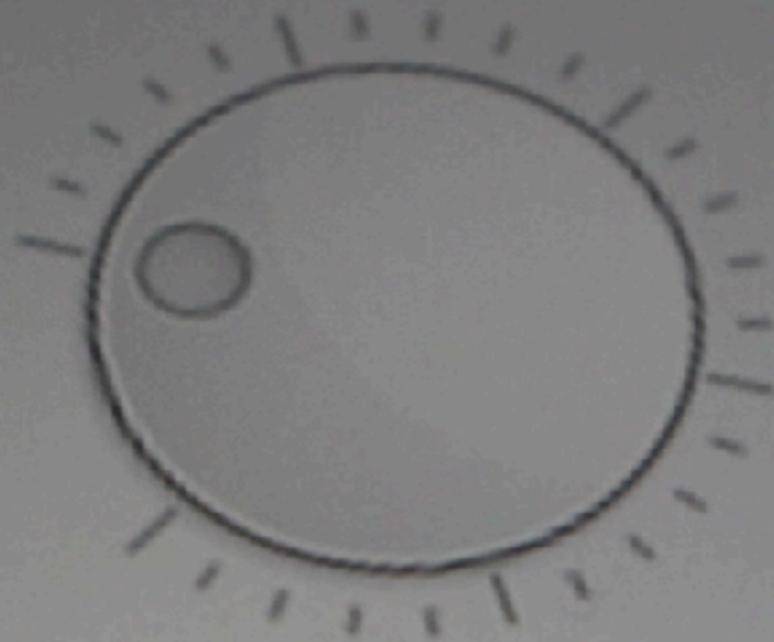
# Emergeables



she washes the dishes

# Emergeables

Volume



# Emergables



# Emergeables

Volume



# Benefits of Emergeables vs. new interaction



Karrer *et al.*, 2011



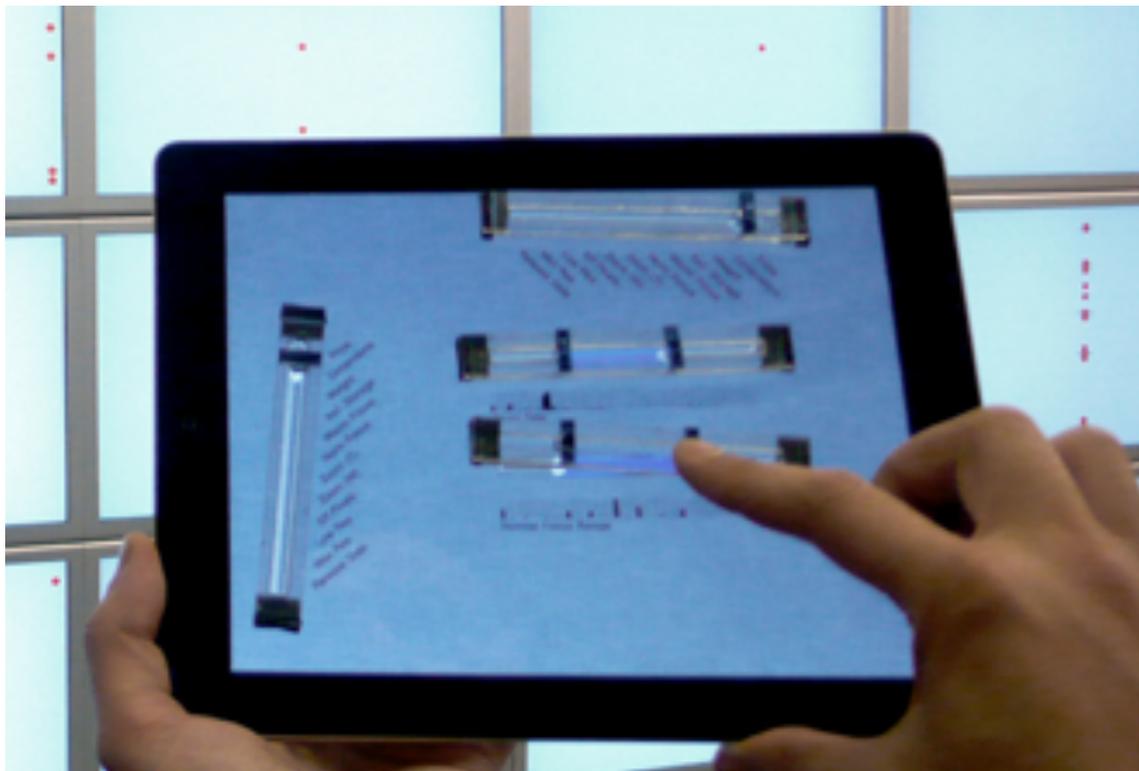
Serrano *et al.*, 2014



Ramakers *et al.*, 2014

≠ known tangible control

# Benefits of Emergeables vs. additional controls



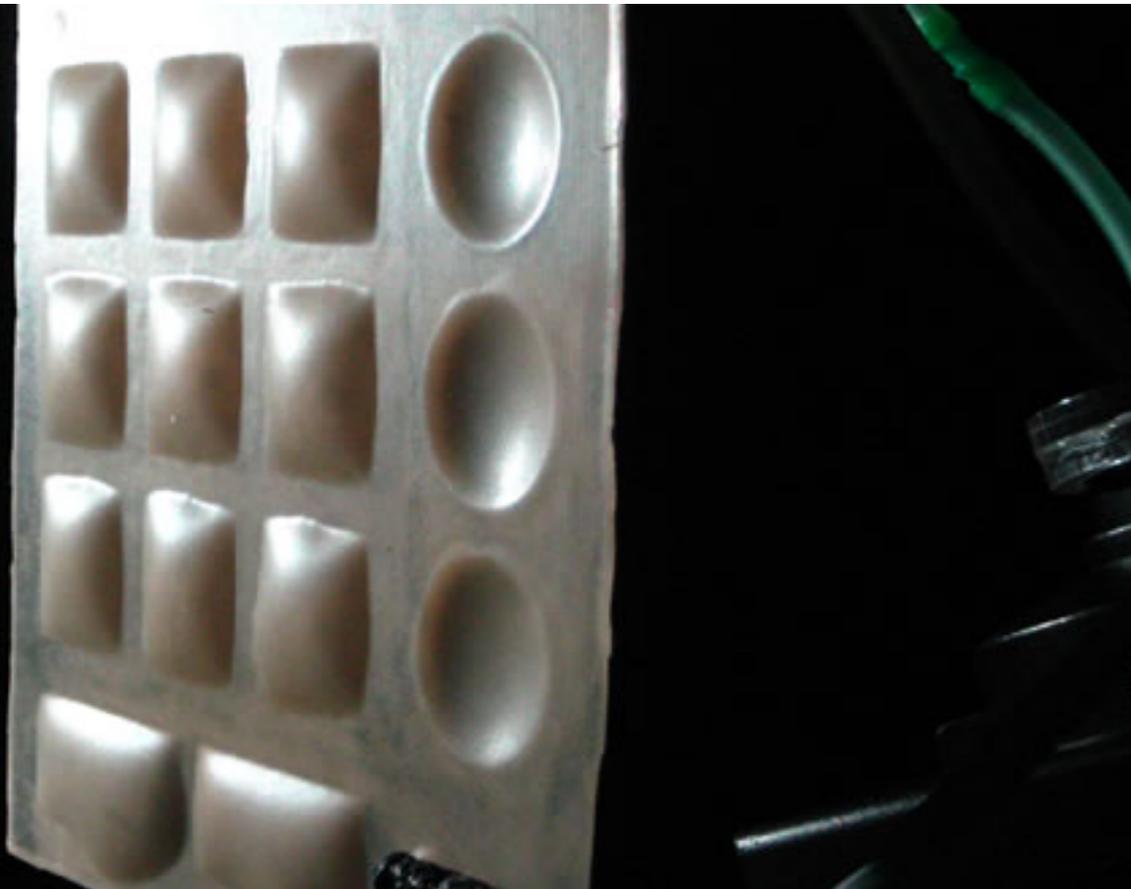
Jansen *et al.* 2012



Florian Born, 2013

≠ no additional articulatory task

# Benefits of Emmergeables vs. discrete control



Harrison and Hudson, 2009



<http://tactustechology.com>

≠ continuous control

# Benefits of Emergeables for eyes-free mobile tasks

- + known tangible controls

- + no additional articulatory task

- + continuous control

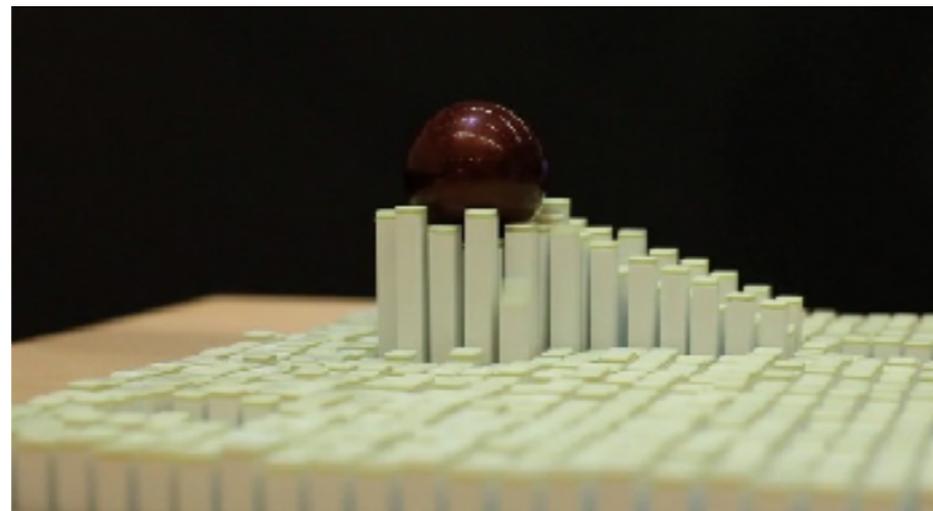
# Difficulty: technology



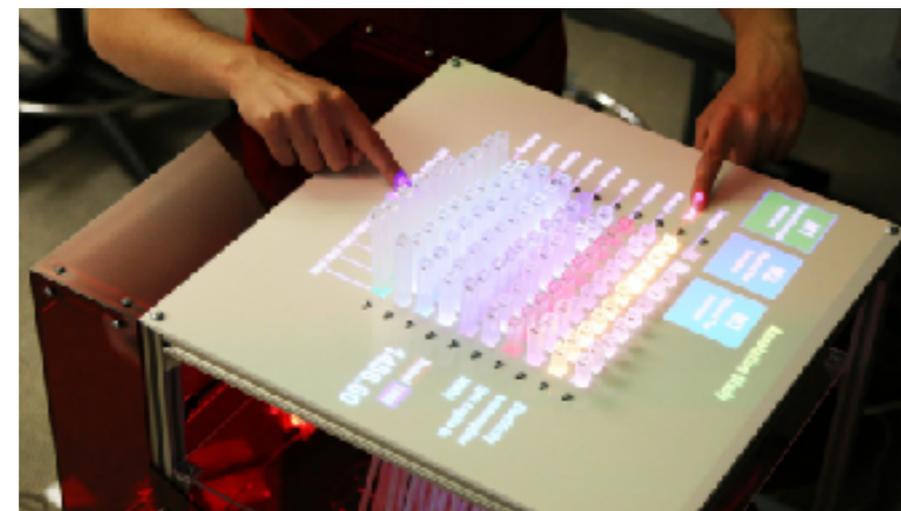
# Technology: current approach



Poupyrev *et al.*, 2004



Follmer *et al.*, 2013

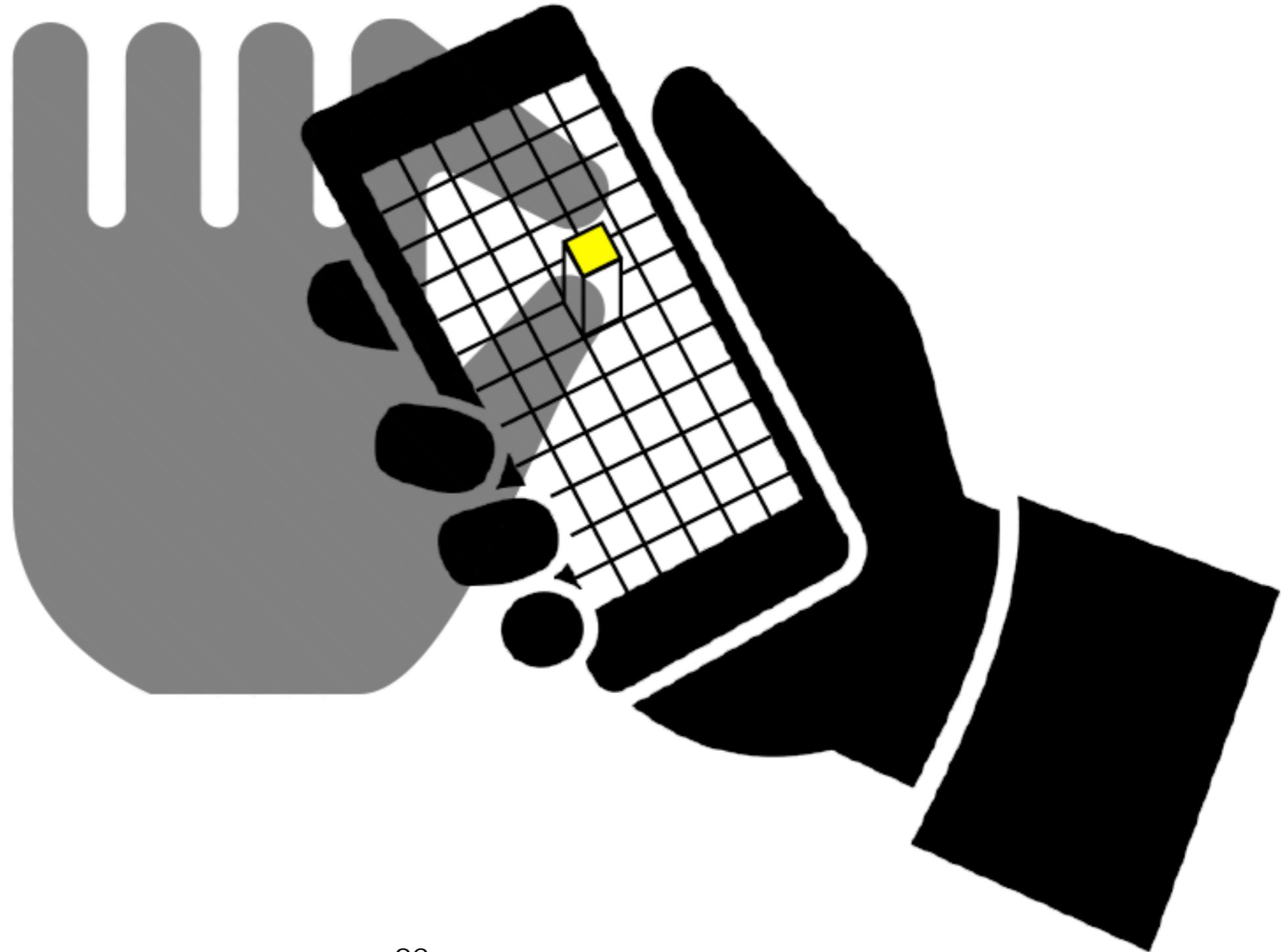


Taher *et al.*, 2015

# Our approach



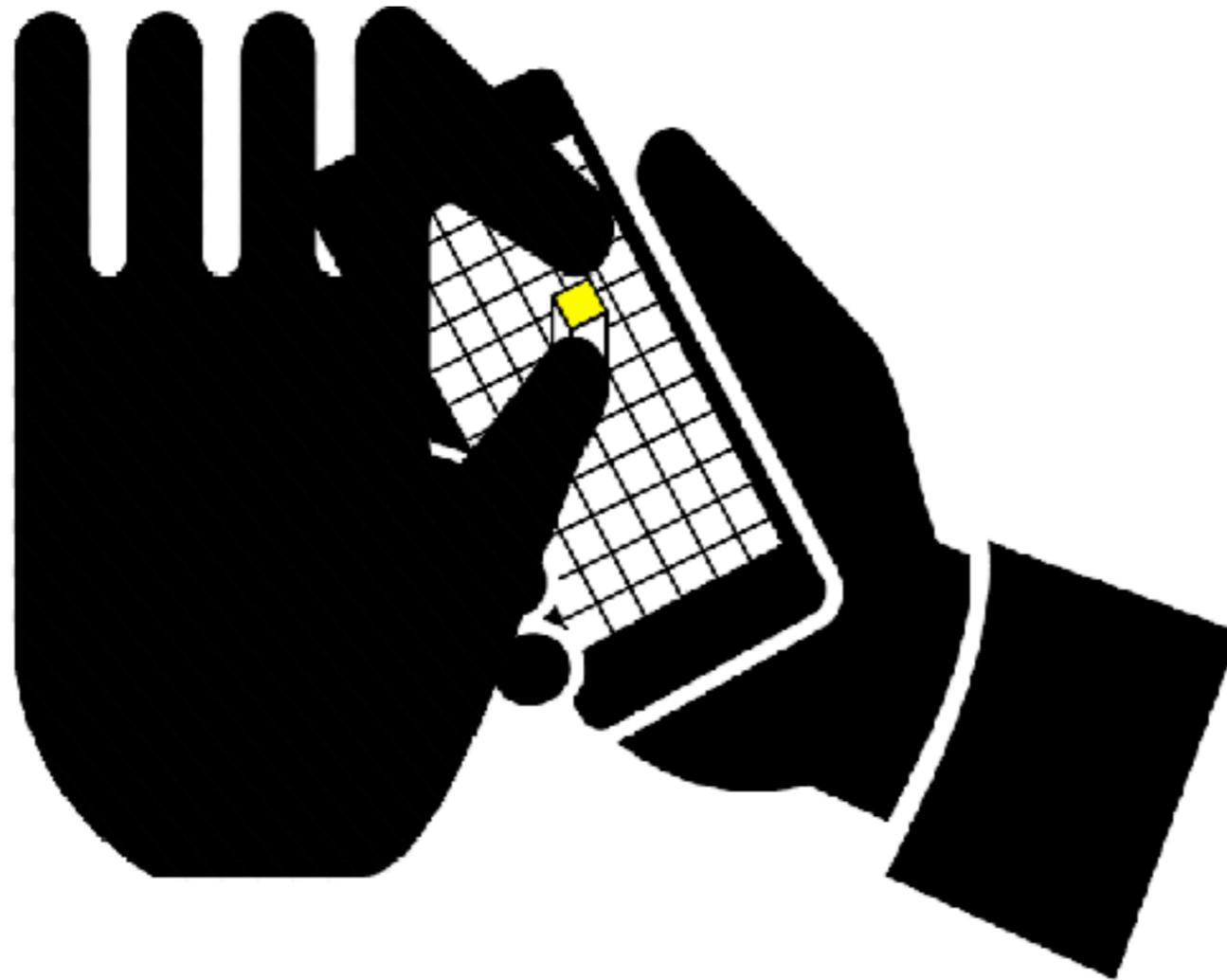
# Manipulation



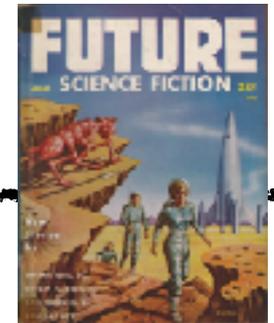
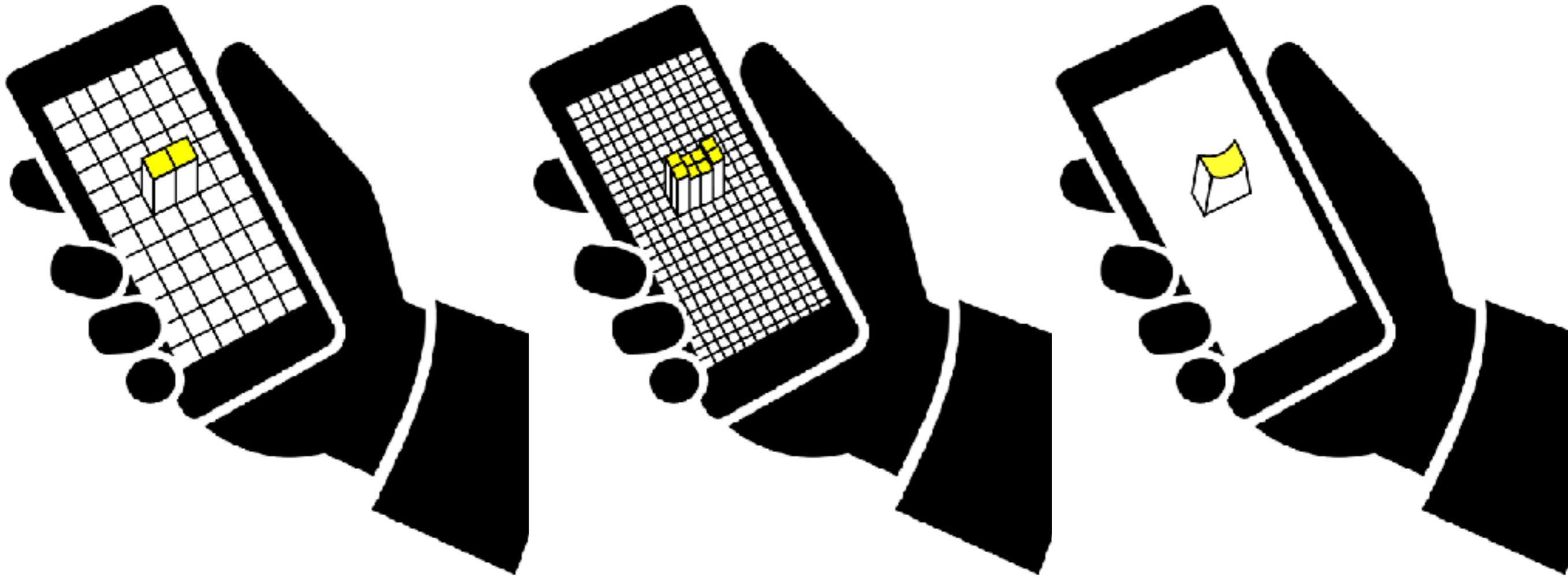
# Manipulation: Translation



# Manipulation: Rotation



# Resolution



Is it worth the effort?

How far are we today?



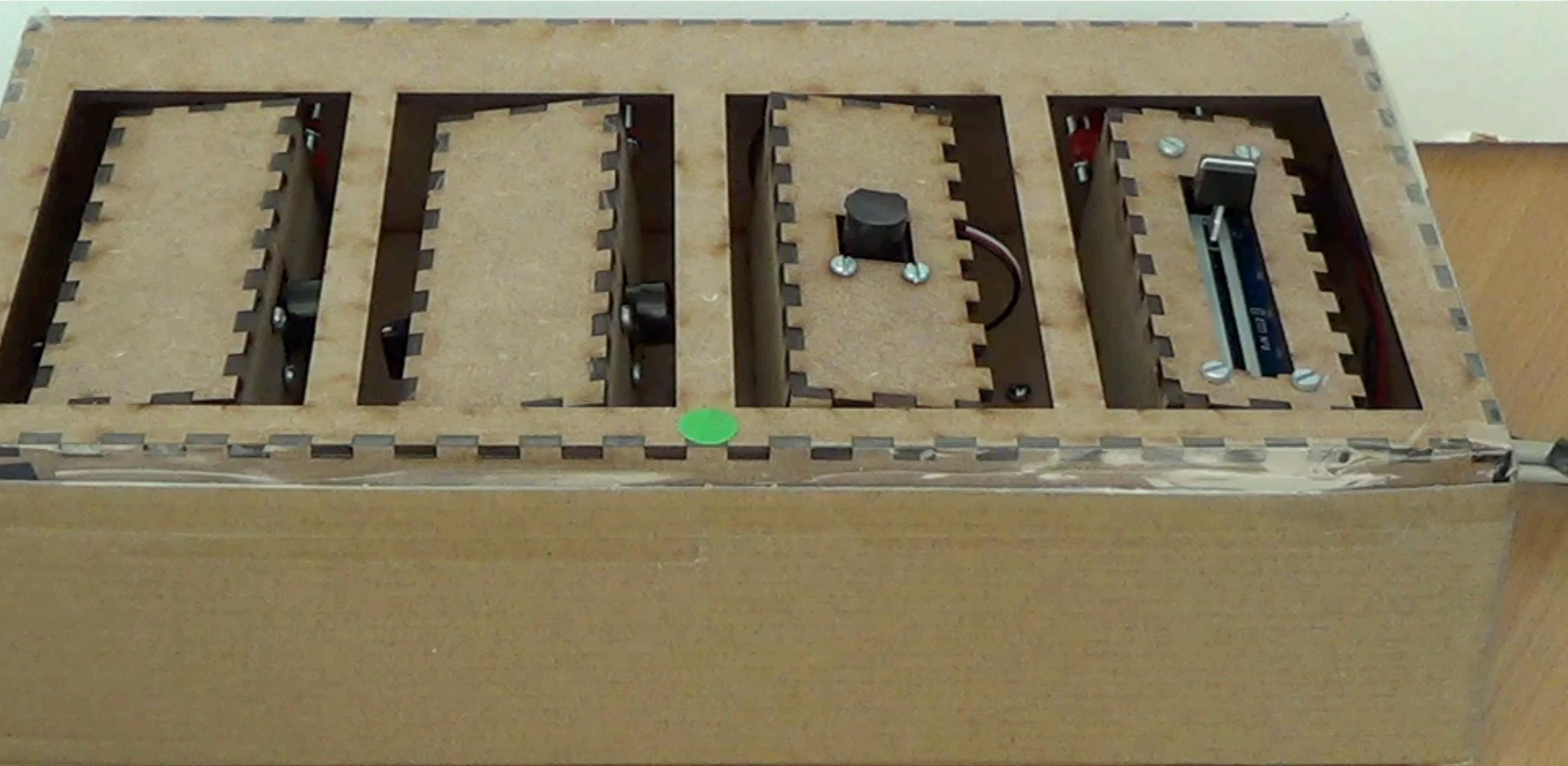
# Prototype simulating high-resolution: tailored for experiment





High-resolution:  
Simulation prototype

# High-resolution: Simulation prototype



# Is it worth the effort?



Is it worth the effort?

How far are we today?

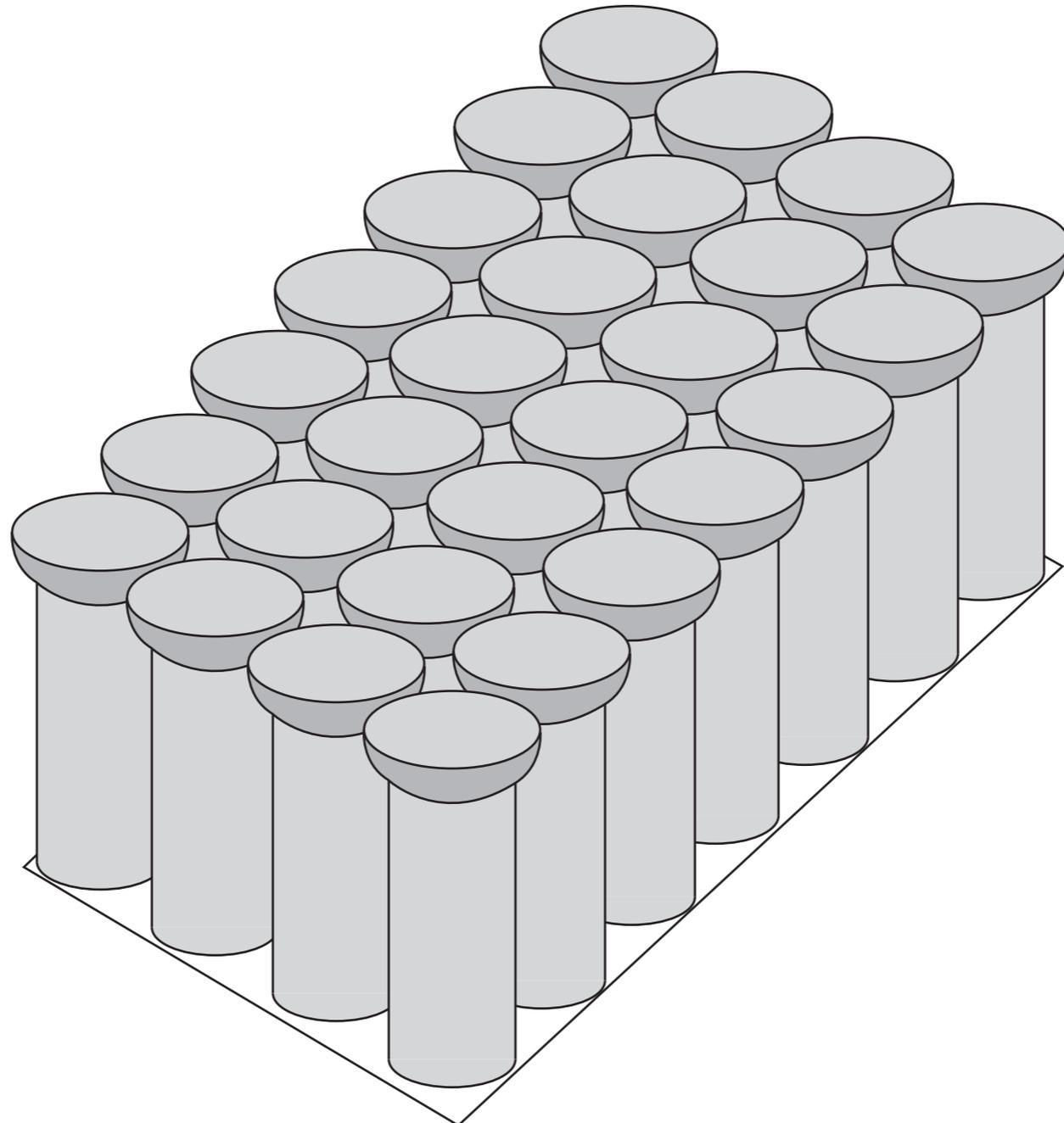


# How far are we today?

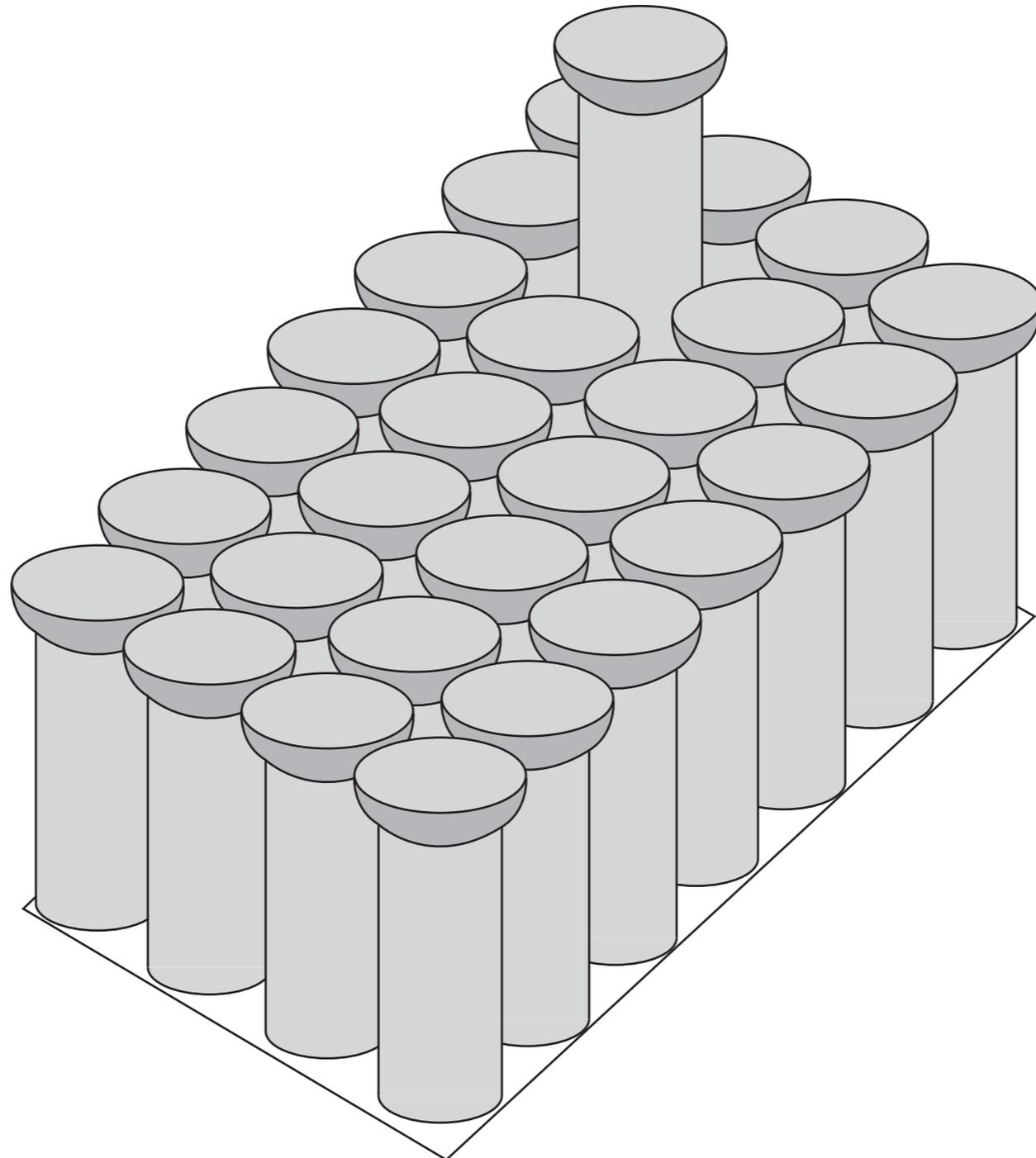


# Low-resolution prototype

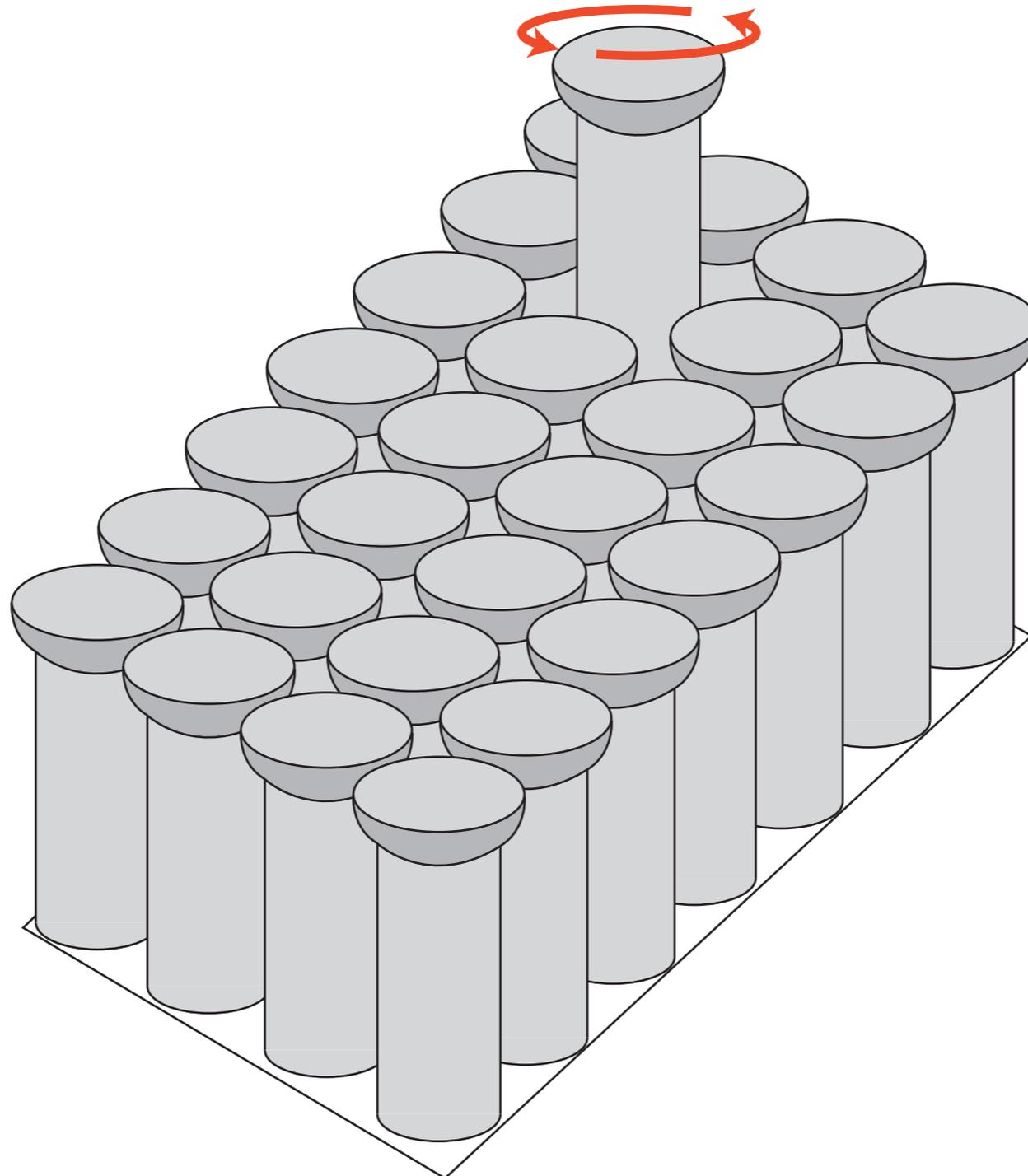
# Design



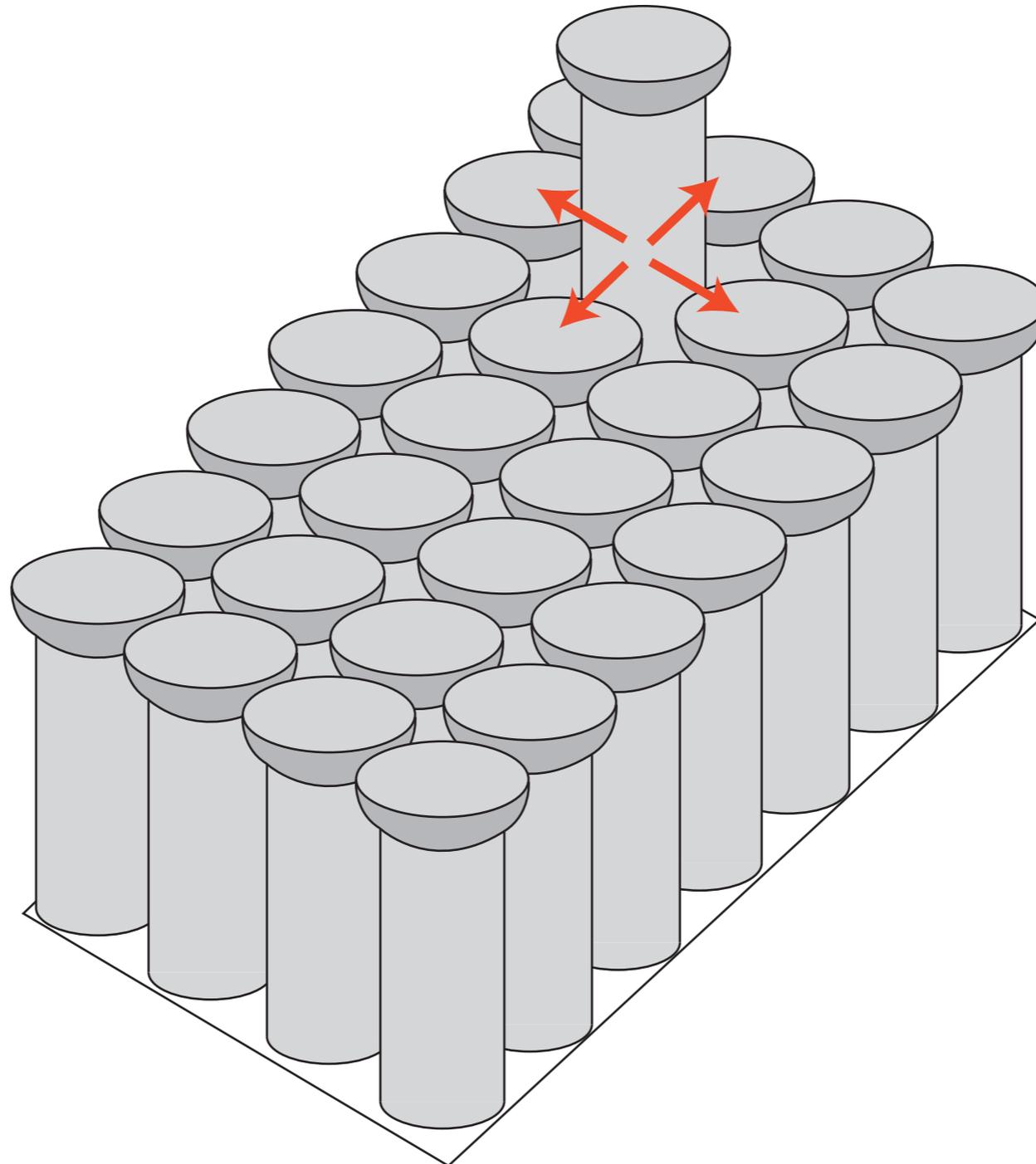
# Design



# Design



# Design



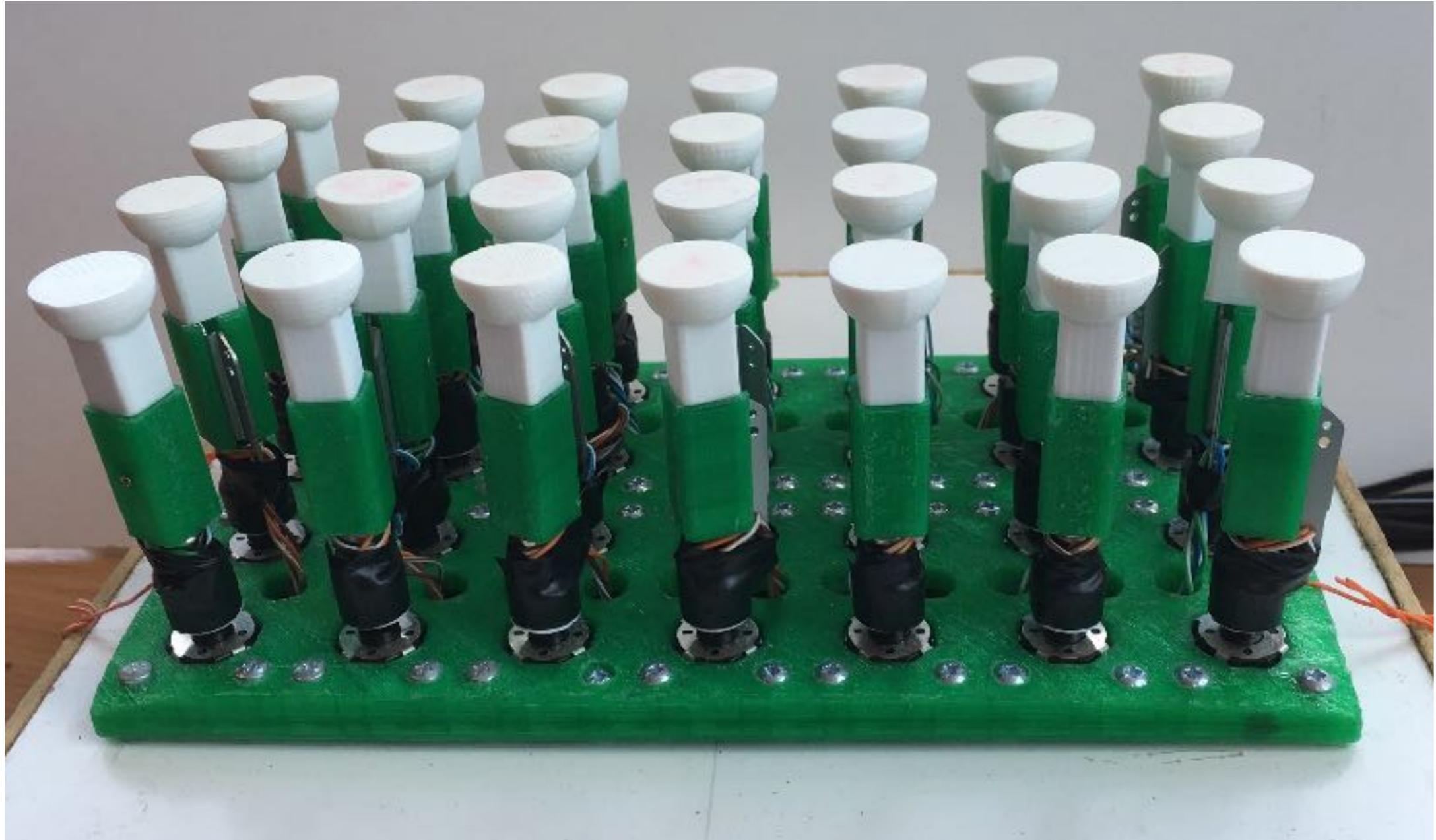
# Components



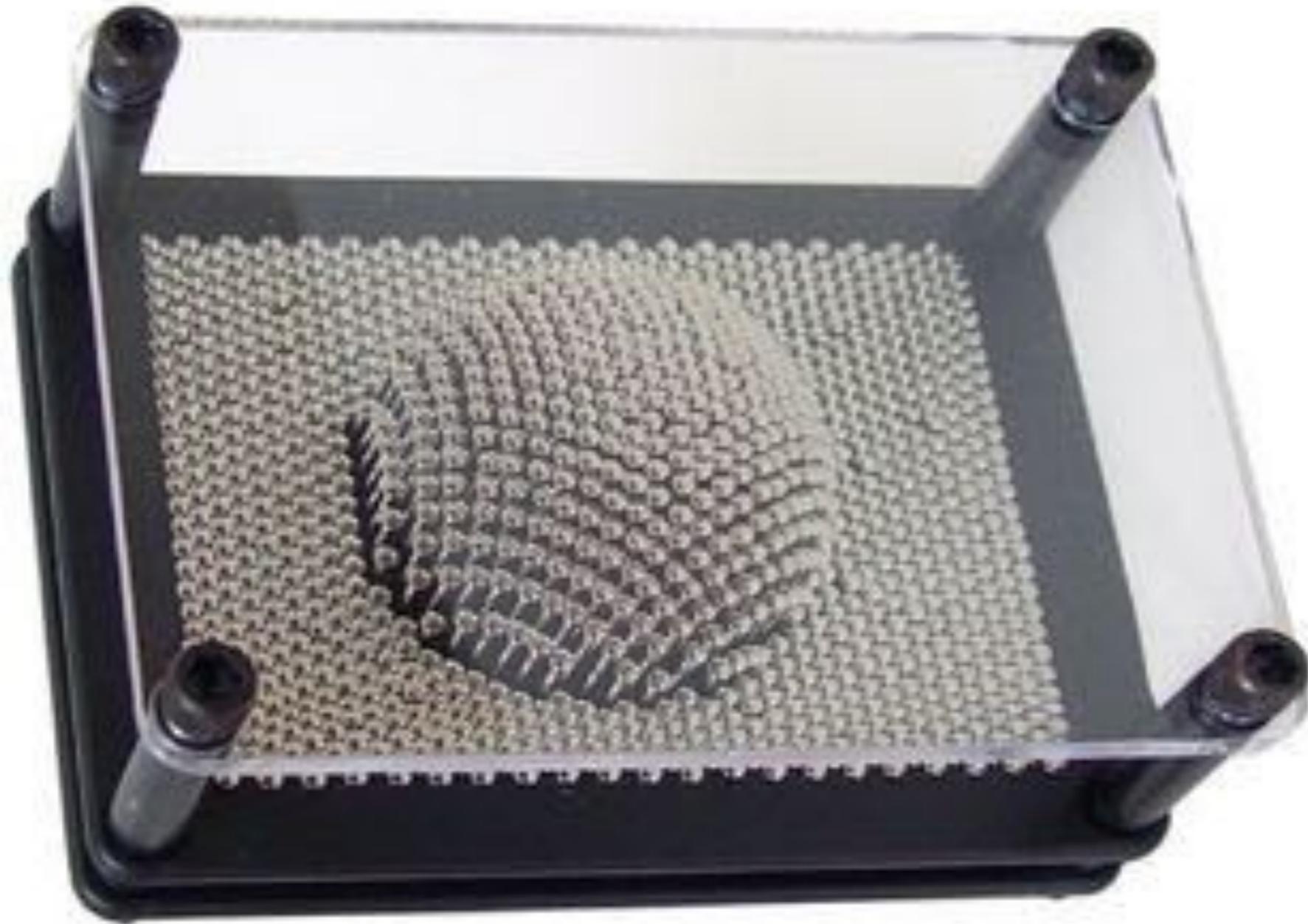
# Components



# Prototype



# Prototype



# Controls



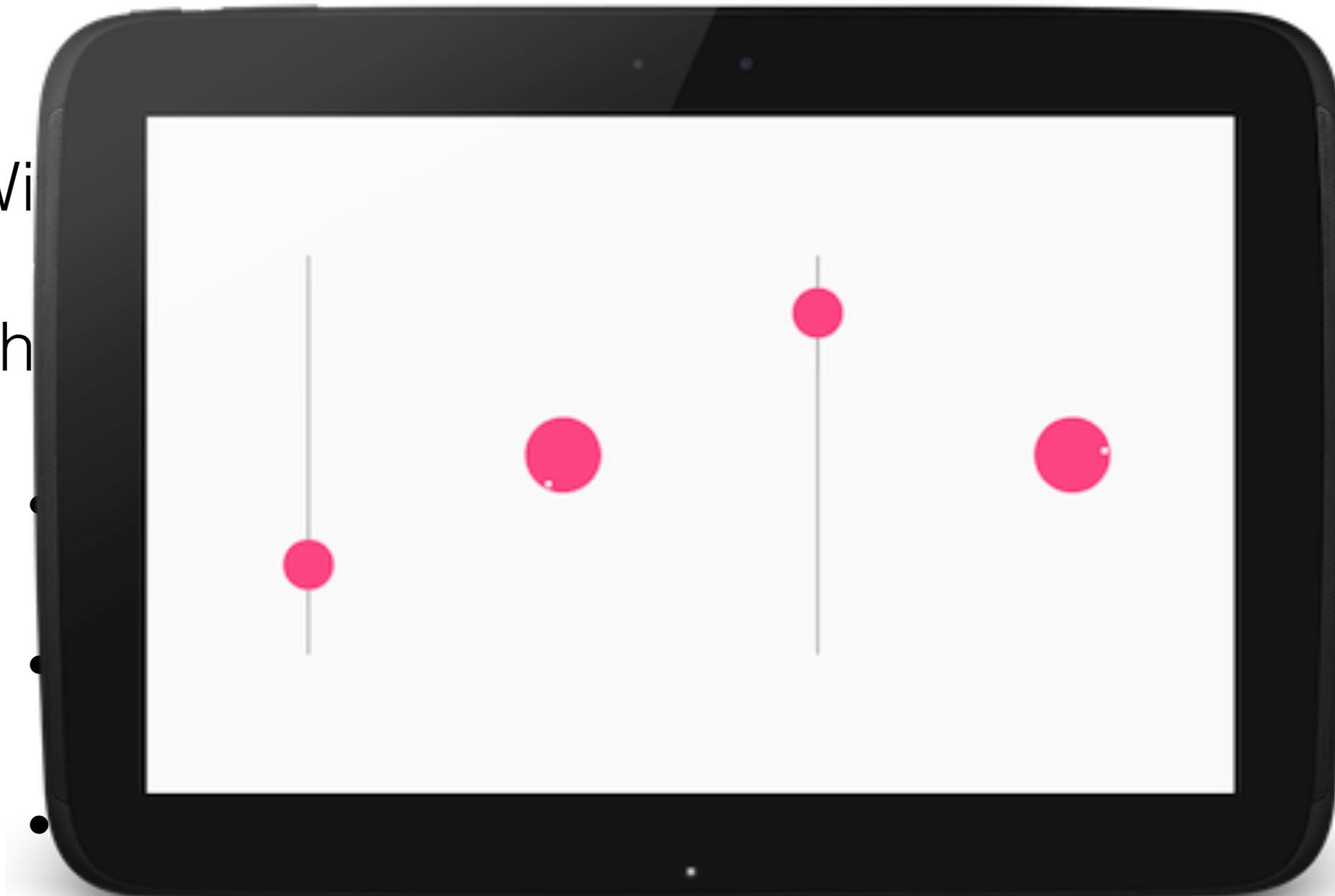
# Experiment

# Experiment

- Within-subjects design
- Three interfaces:
  - High-resolution prototype
  - Low-resolution prototype
  - Graphical comparison interface

# Experiment

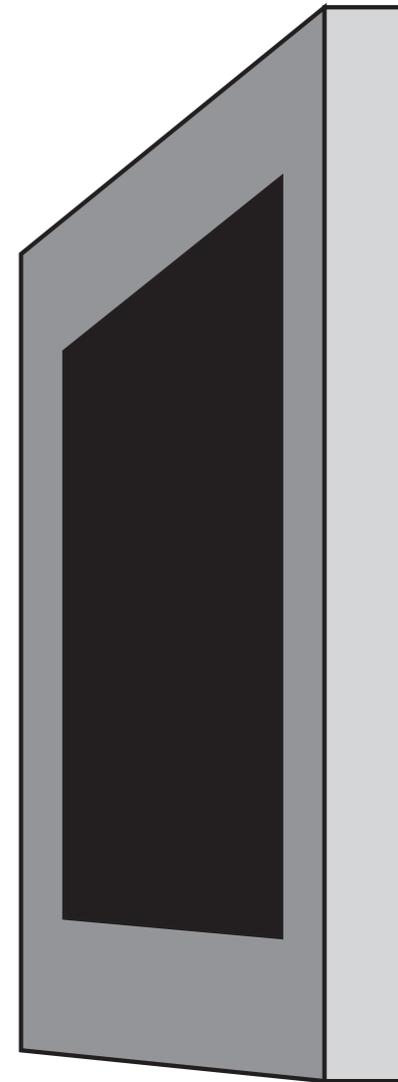
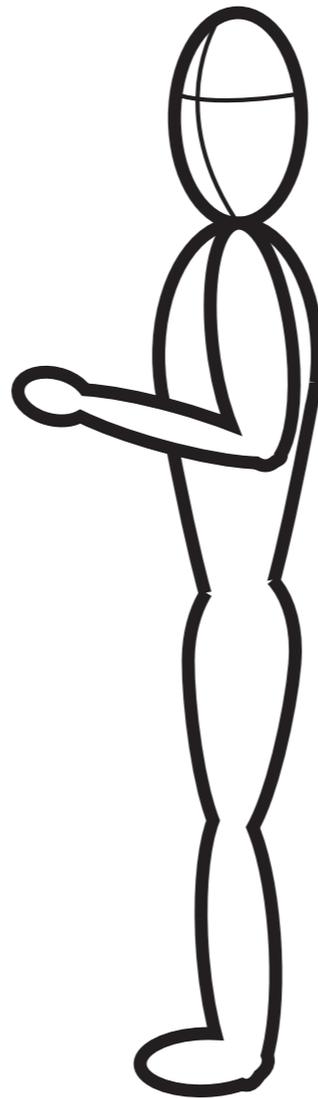
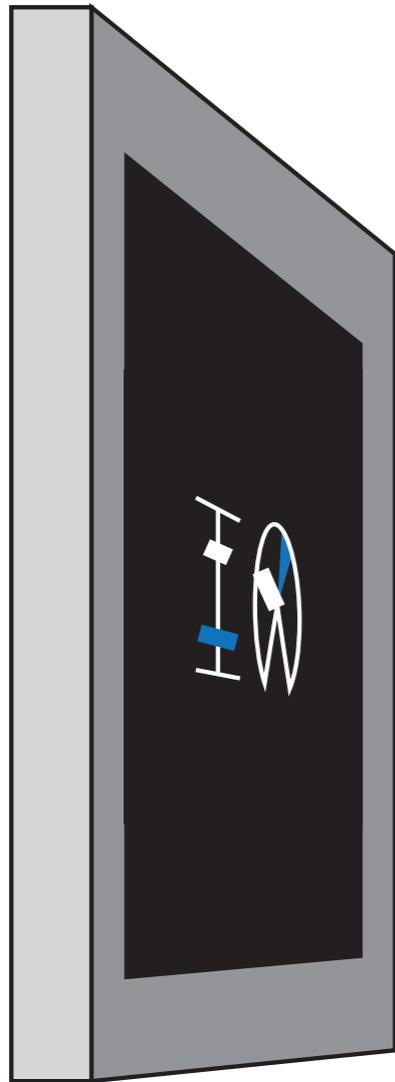
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# Experiment

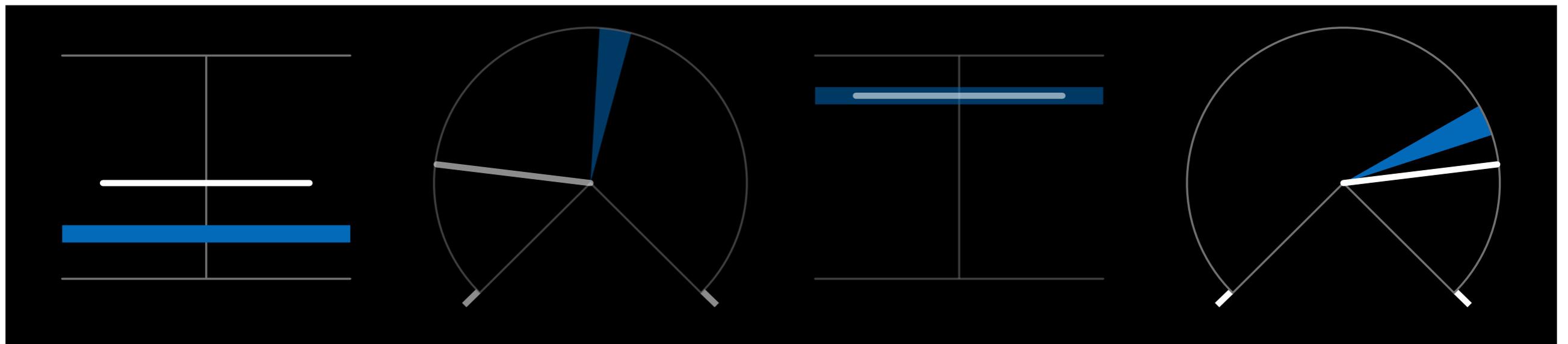
- Three independent variables
  - Resolution: GUI, low-resolution, high-resolution
  - Complexity: 1 or 2 widgets (controlled simultaneously)
  - Widget: dial or slider

# Setting



# Pursuit Tasks

- Solid white line: user's controller
- Blue shaded areas: target region



# Pursuit Tasks



# Experimental Design

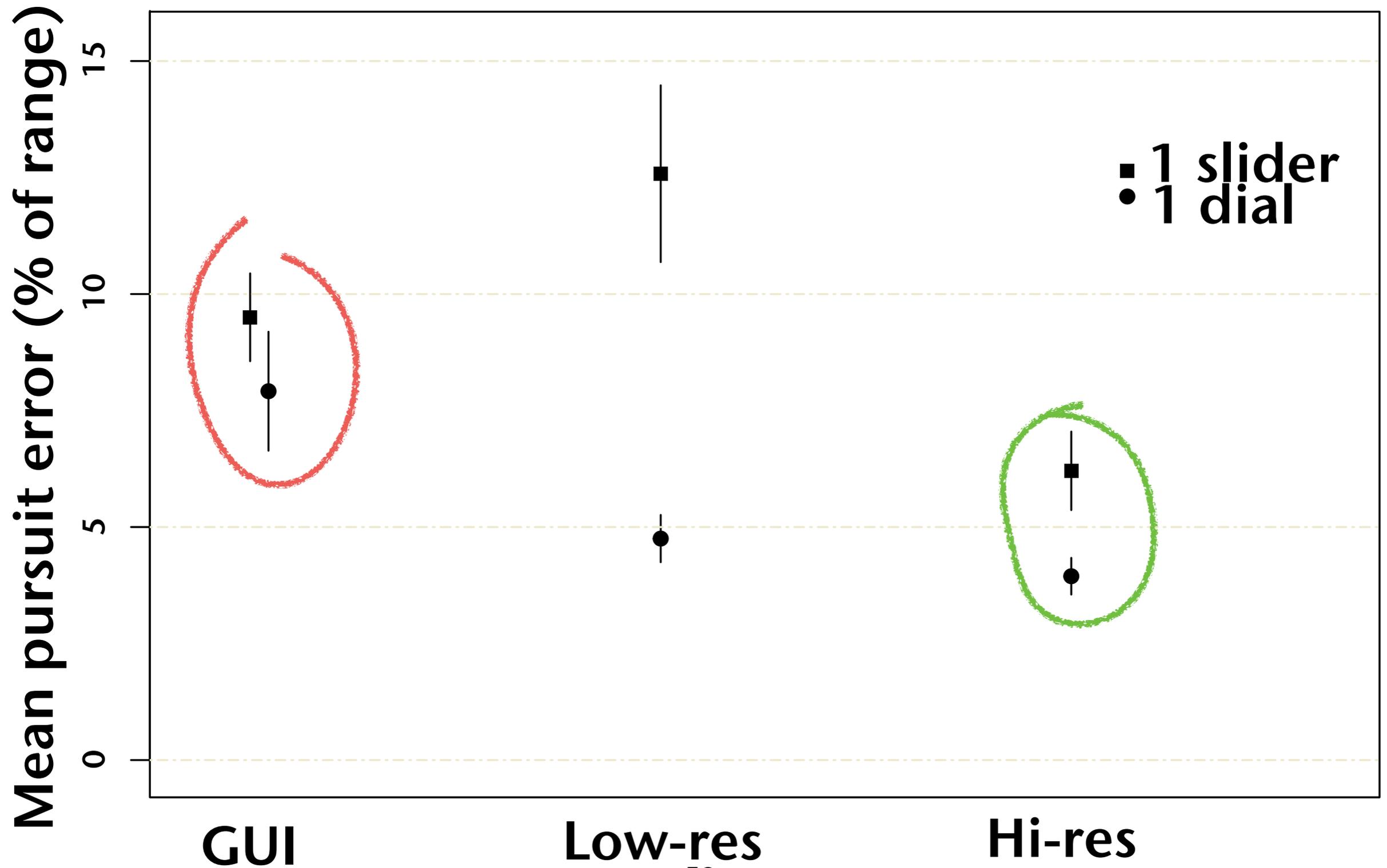
- 18 participants; 50 minute sessions
- Format:
  - Concept design video
  - Training
  - Tasks
  - Structured interview

# Measures

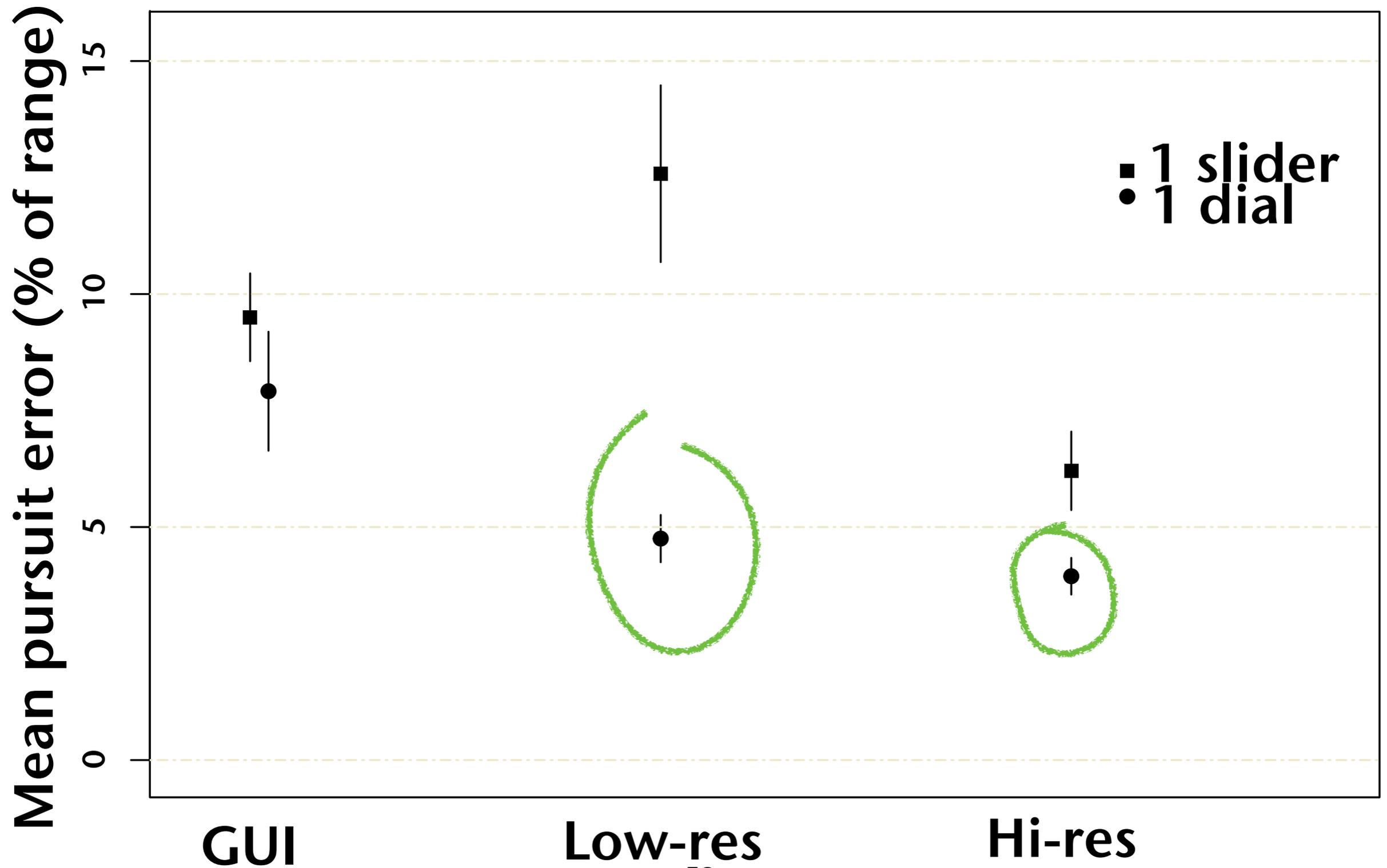
- Pursuit accuracy
- Visual attention required
- Perceived usability
  - Ease of use (1 – 10)
  - Rank interfaces in order of perceived visual attention required

# Results

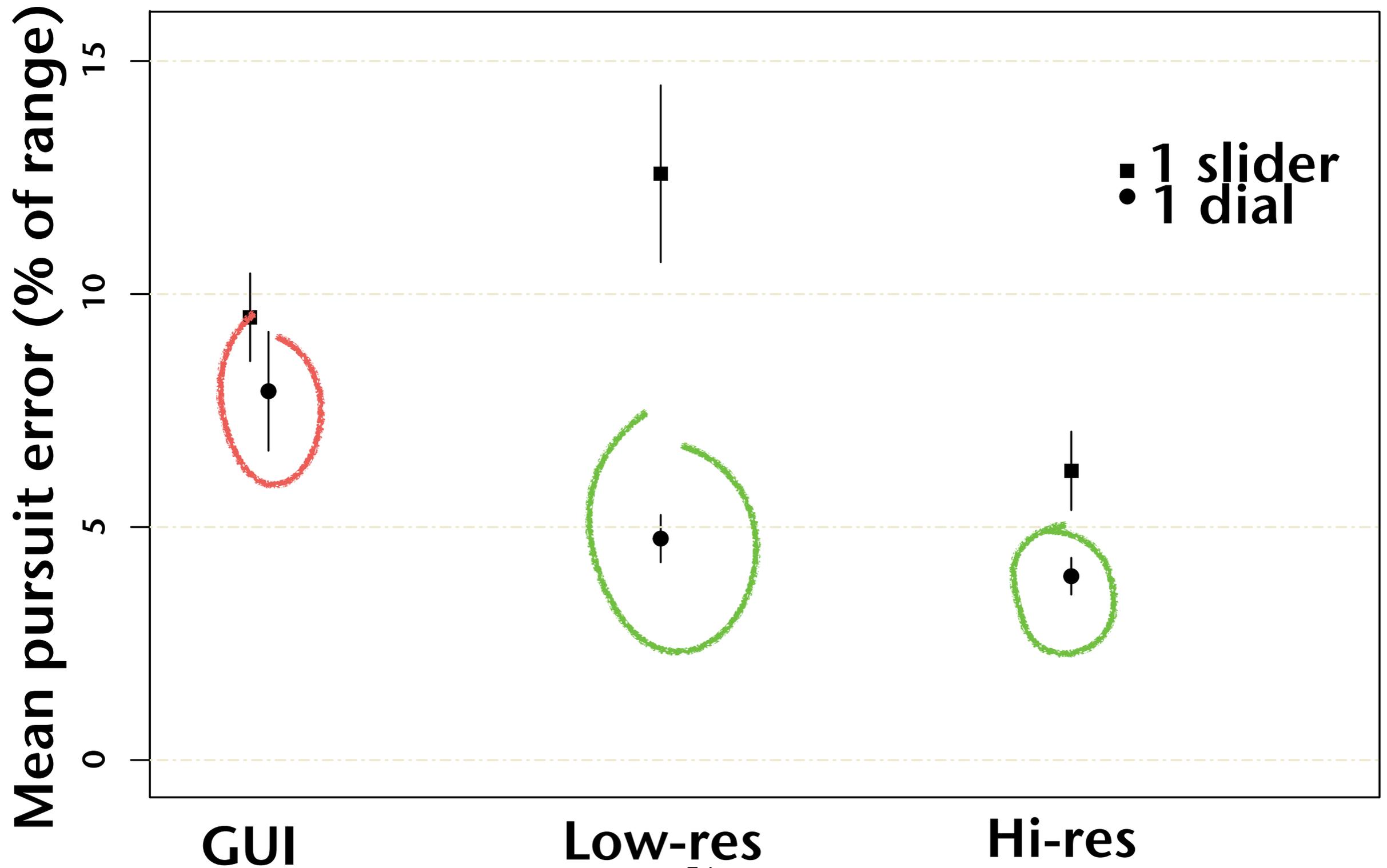
# Pursuit error



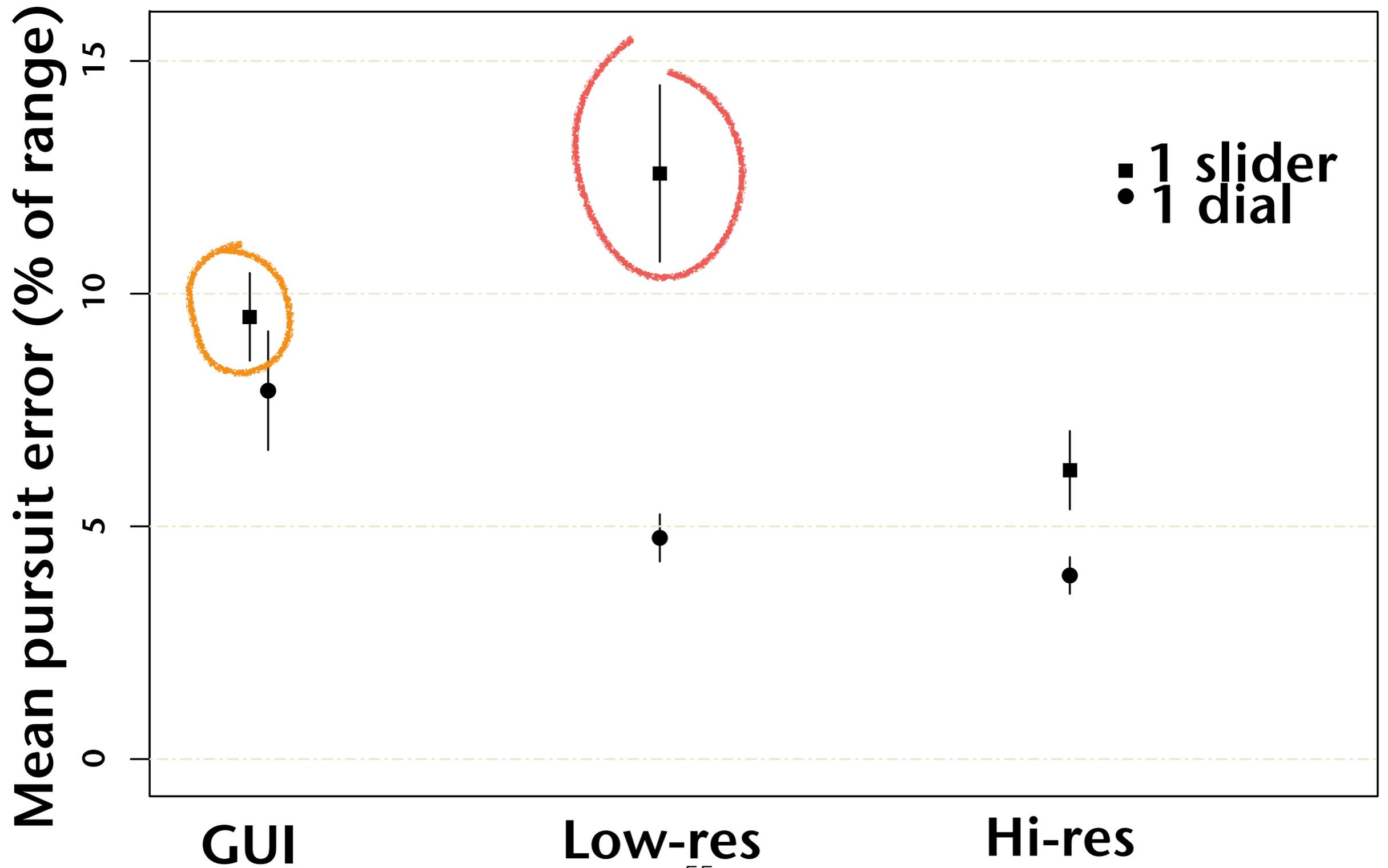
# Pursuit error



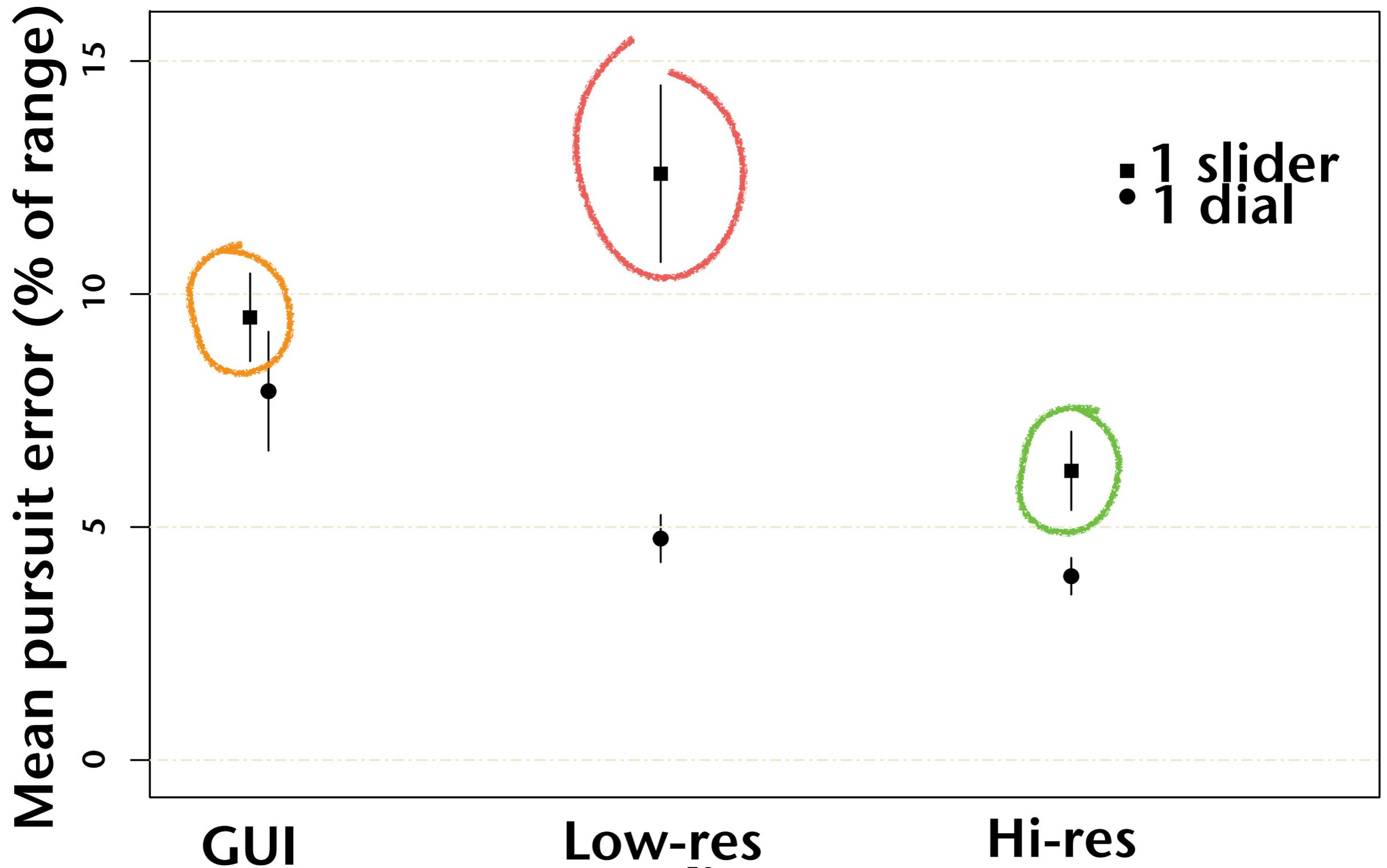
# Pursuit error



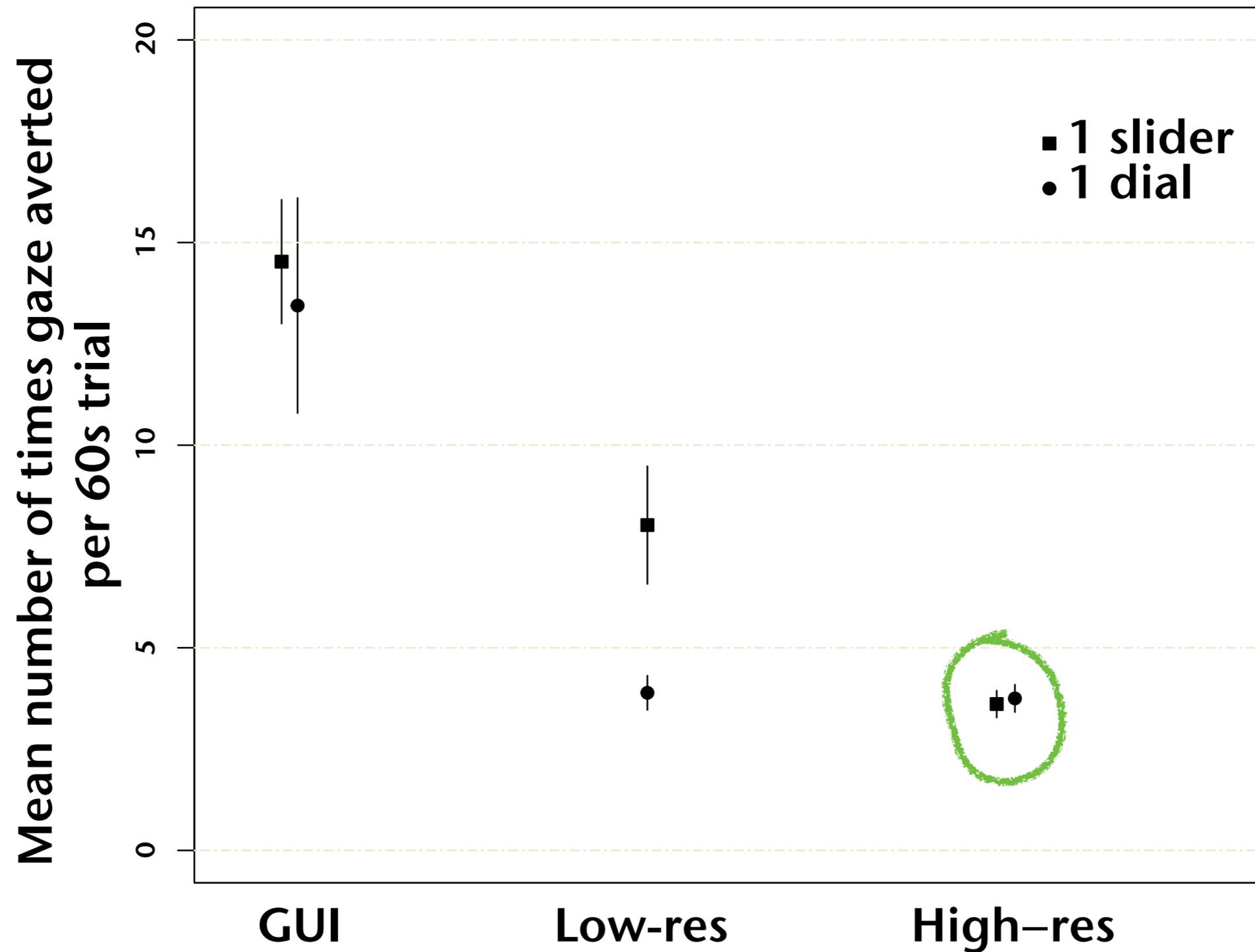
# Pursuit error



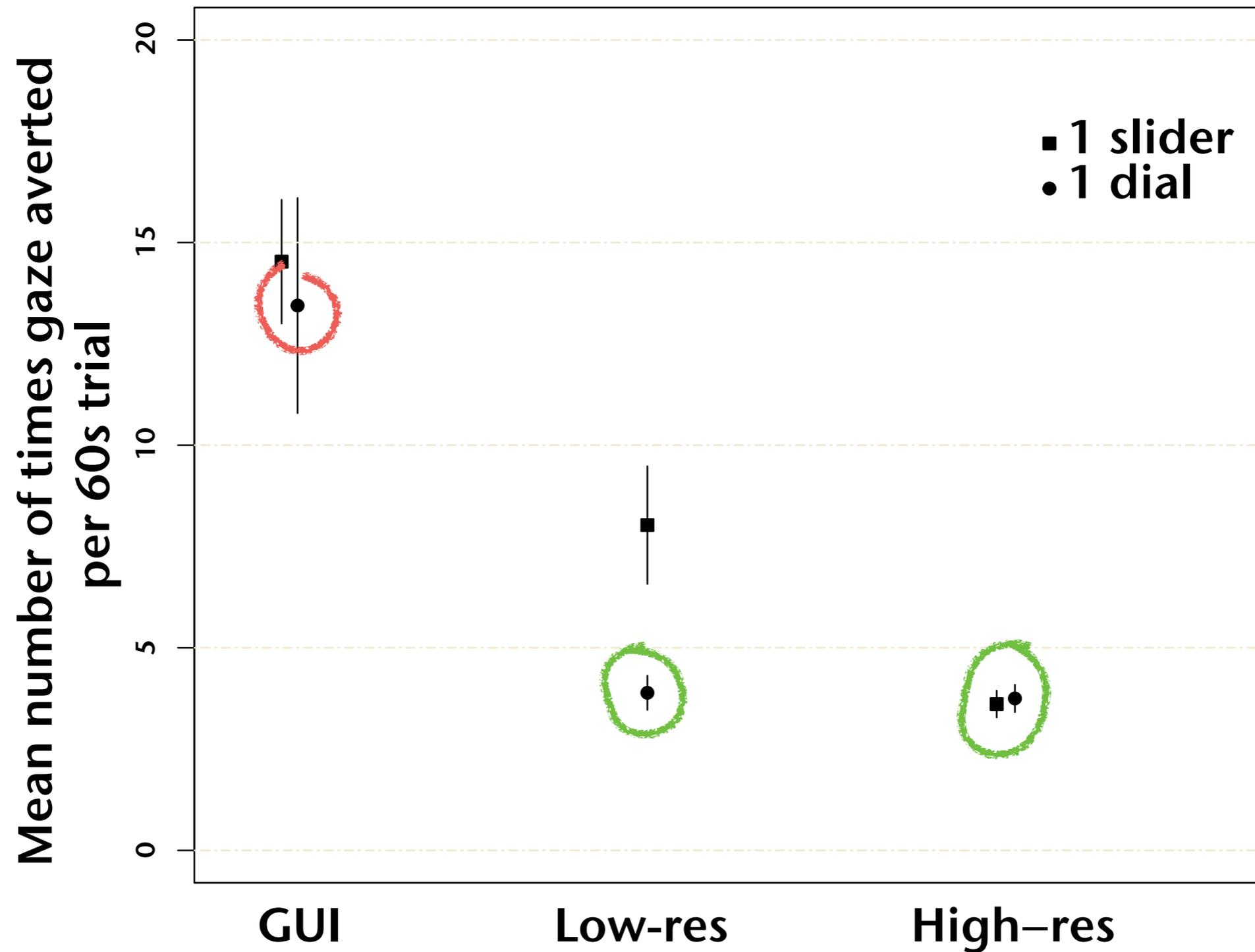
# Pursuit error



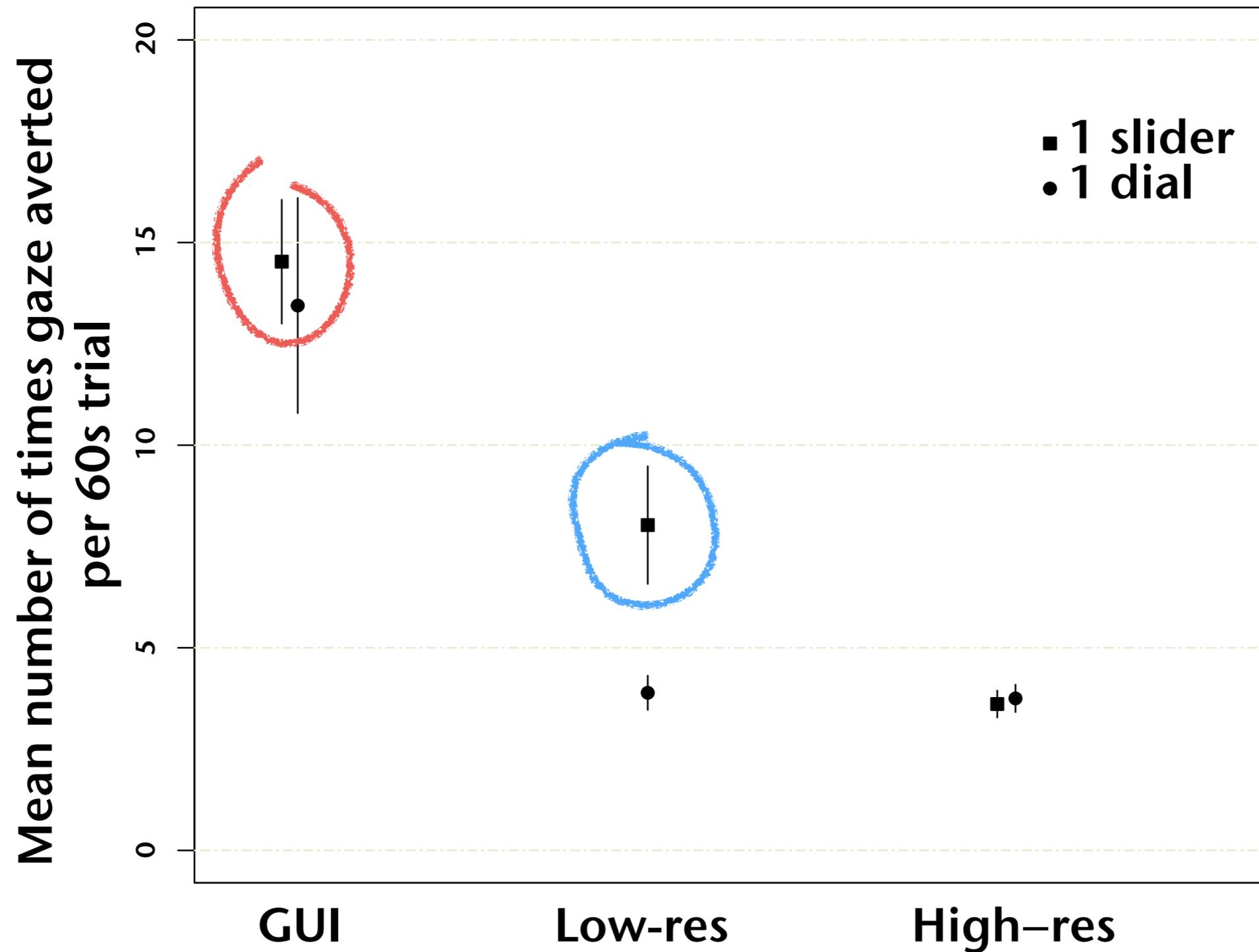
# Visual Attention



# Visual Attention



# Visual Attention



# Users' preferences

- Hi-res most preferred (8.8 / 10)
- Low-res promising (4.8 / 10)
- GUI least preferred (3.4 / 10)

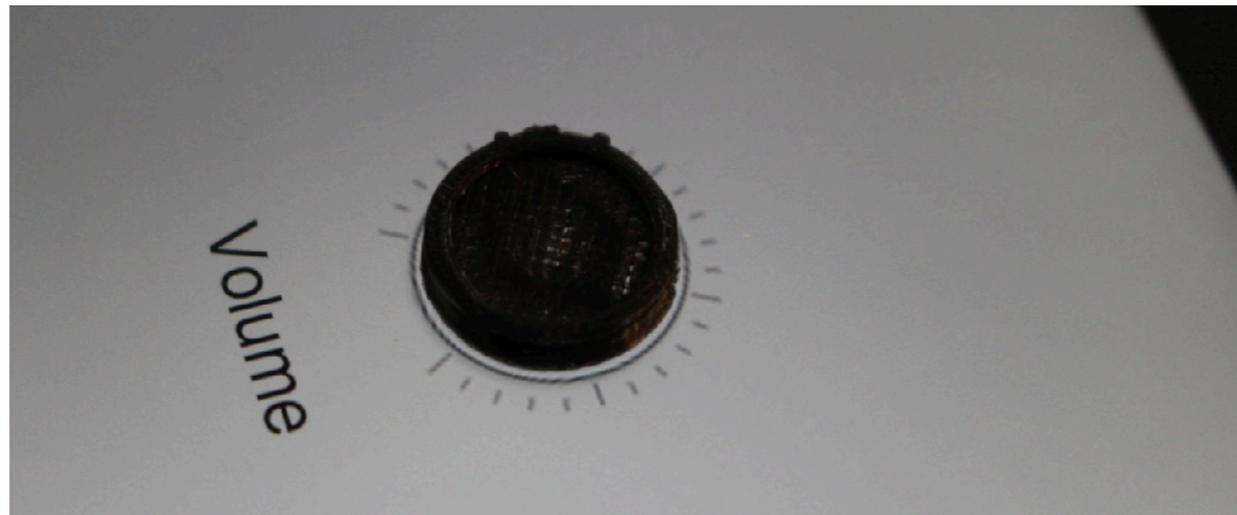
# Summary

- Accuracy
  - Dial
  - Slider
- Visual Attention
- Perceived Usability

# Conclusions

- We have presented emergable surfaces for eyes-free control of continuous widgets
- Future Work:
  - How to do higher resolution emergeable dials?
  - How to improve interaction with emergeable sliders?

# Thank you



## Emergeables: Deformable Displays for Continuous Eyes-Free Mobile Interaction

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EPSRC

