

Multi-Touch surfaces

Simon Voelker <voelker@cs.rwth-aachen.de>



Multi-touch Workspaces



The DigitalDesk (Wellner, CHI '91)



Living with a Tabletop '04

Interactive tables and walls



Interactive wall



Interactive tabletop



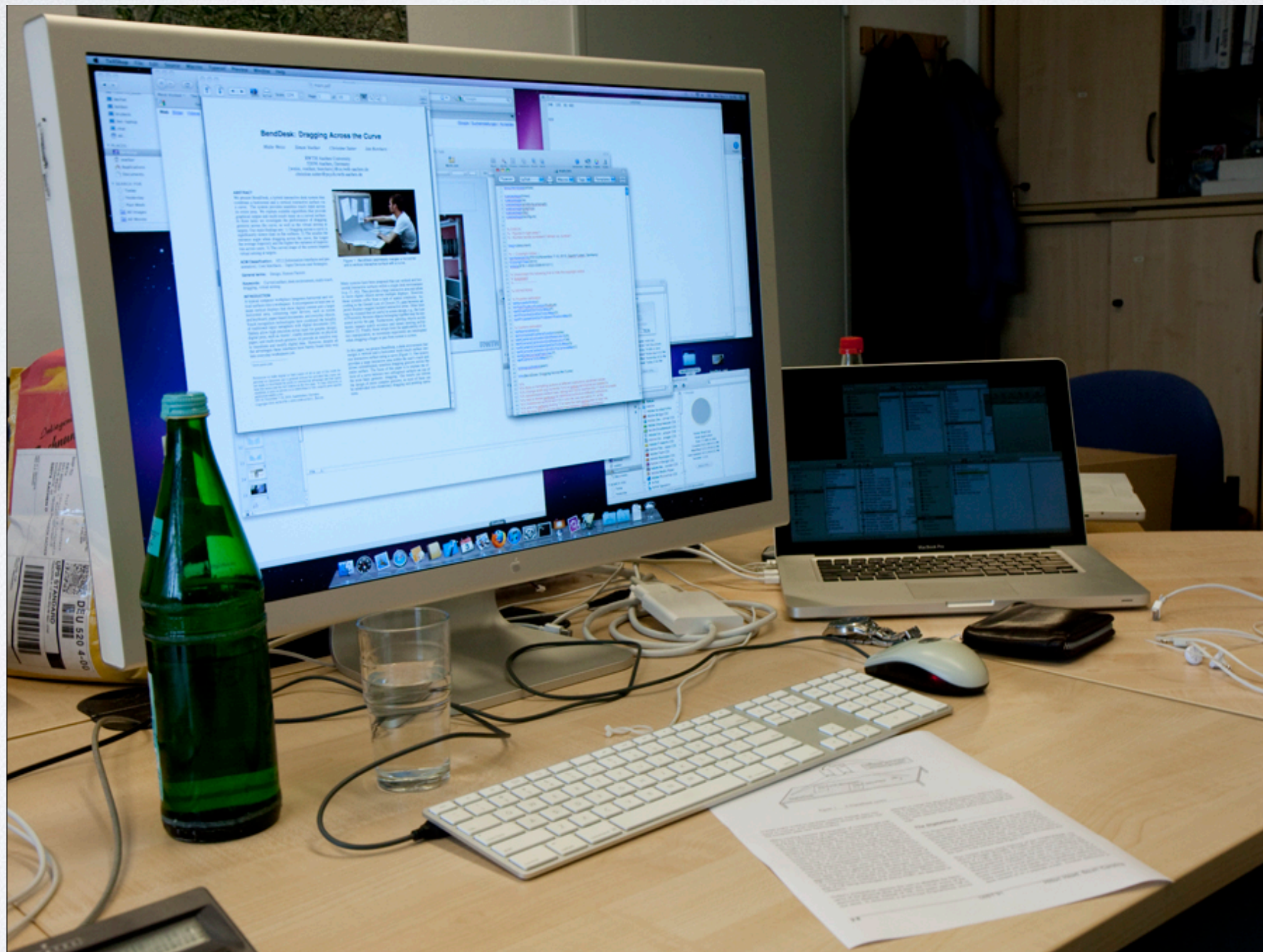
Microsoft Surface







Multi-touch Workspaces



Combining Horizontal and Vertical Surfaces



Curved Surfaces



Sun Starfire (Tognazzini, CHI '94)

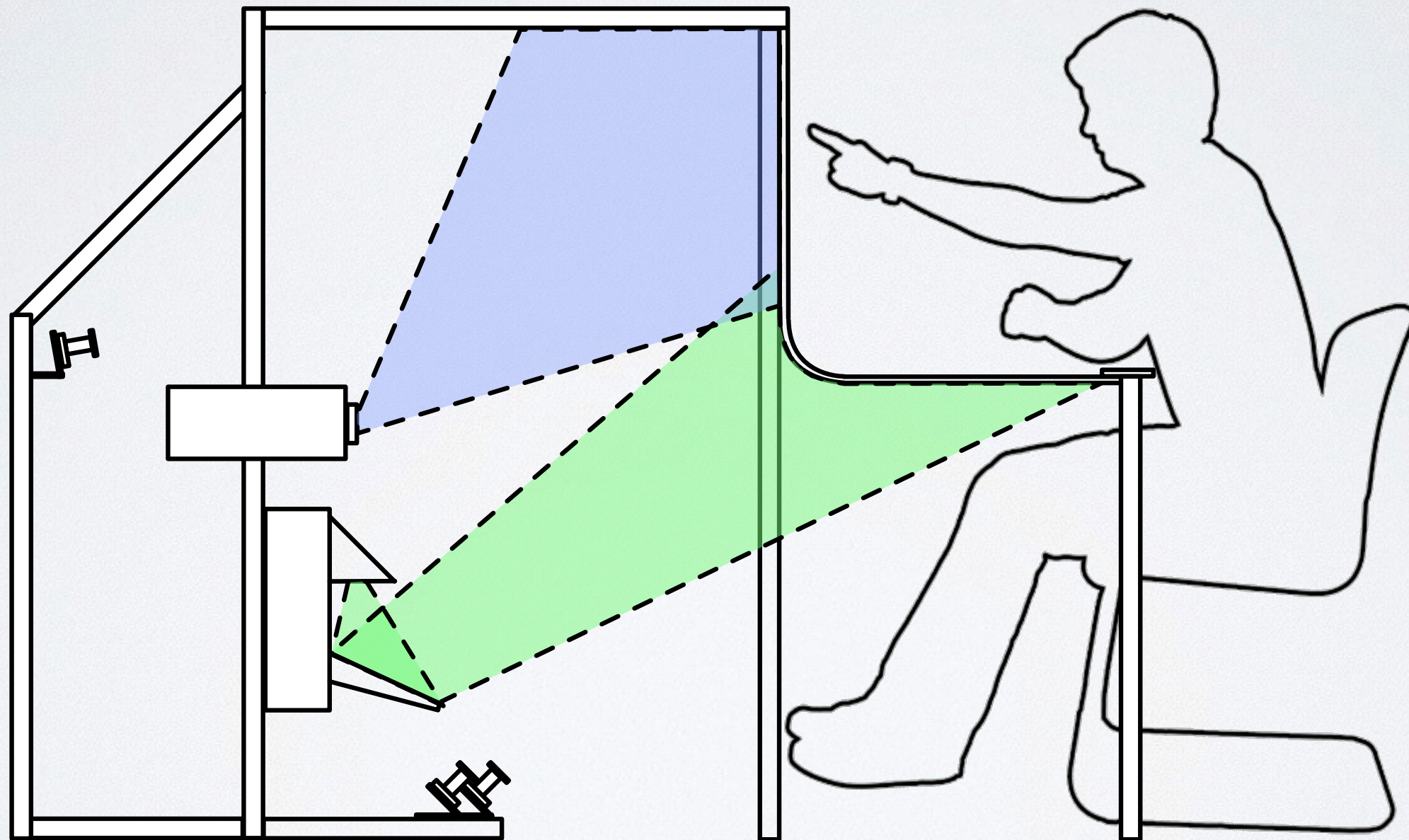


BendDesk (Weiss, ITS '10)

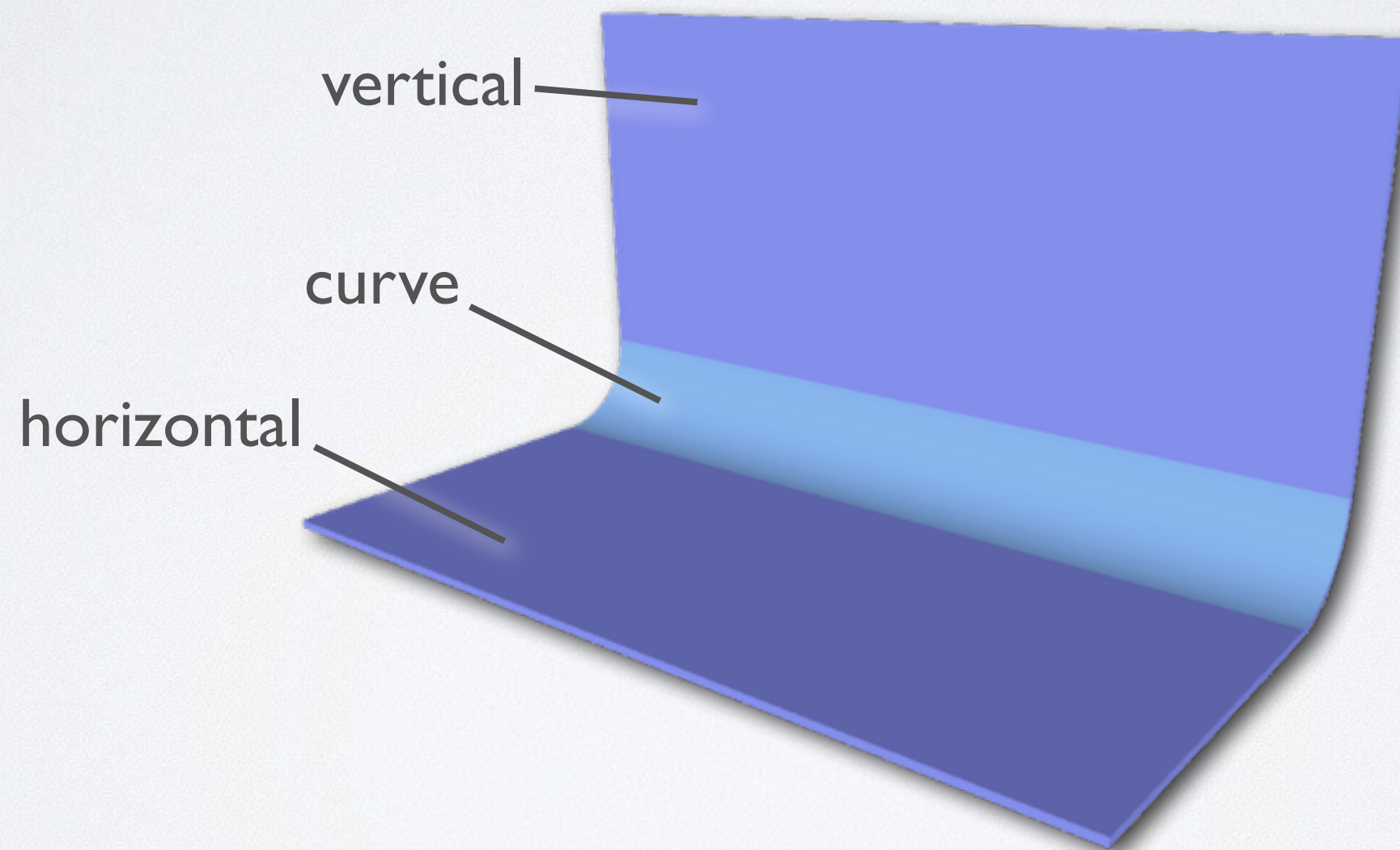


Curve (Wimmer, NordiCHI '10)

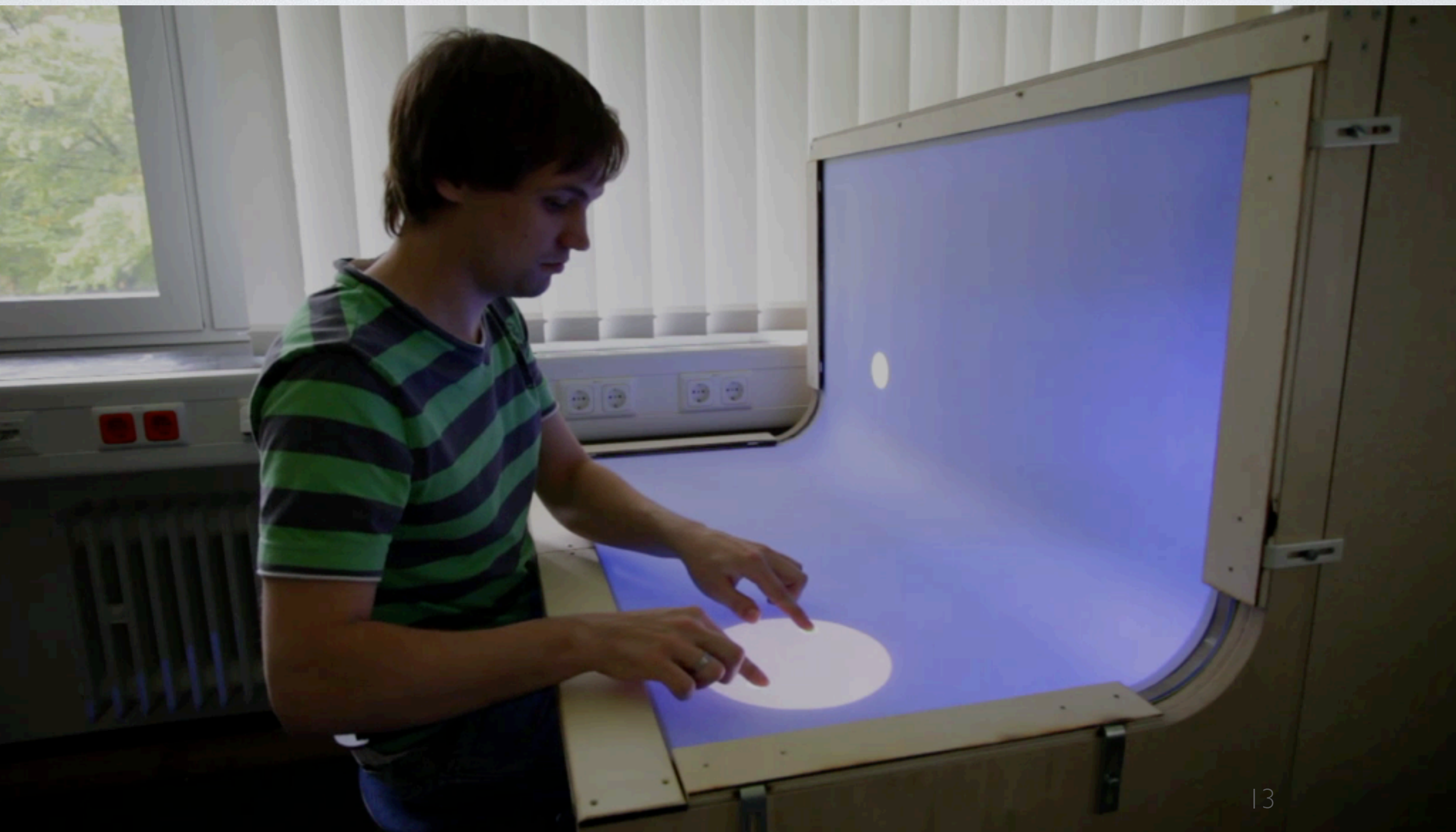
BendDesk System Overview



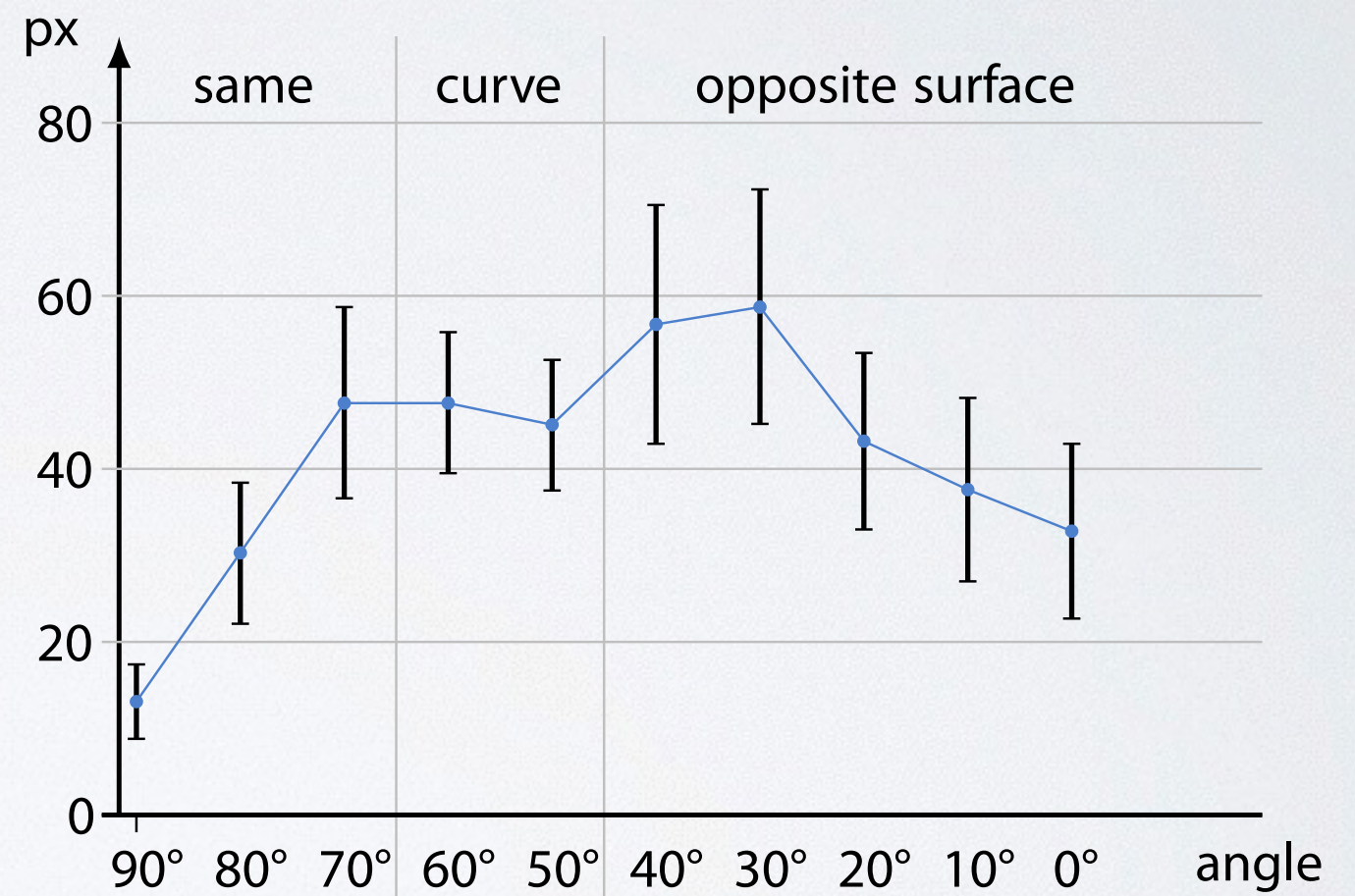
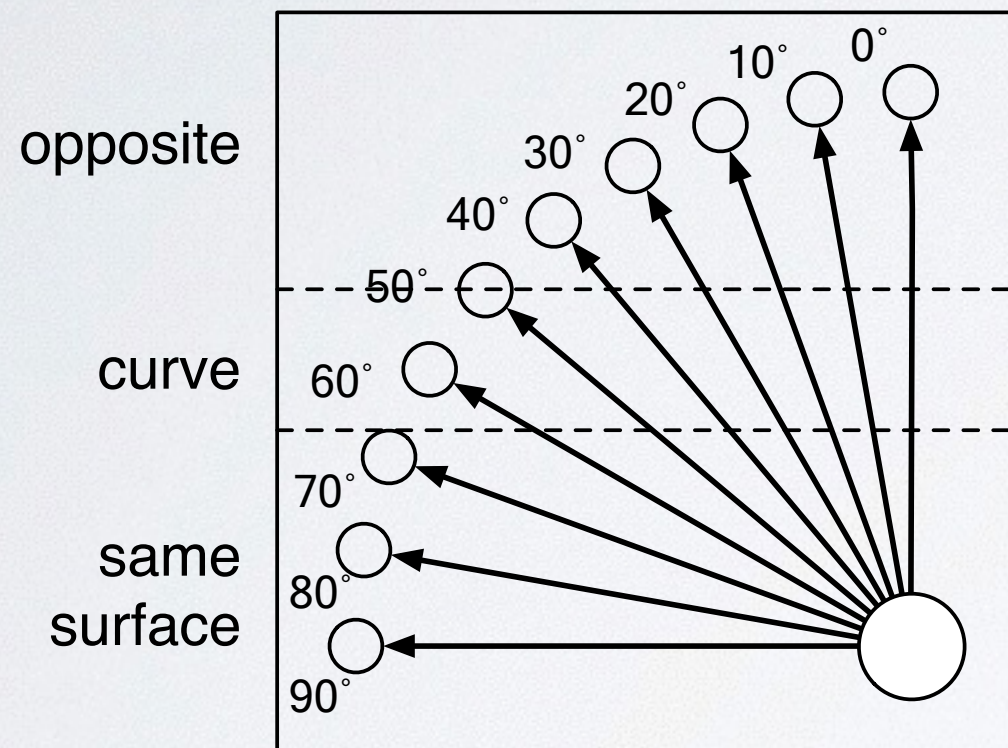
BendDesk System Overview



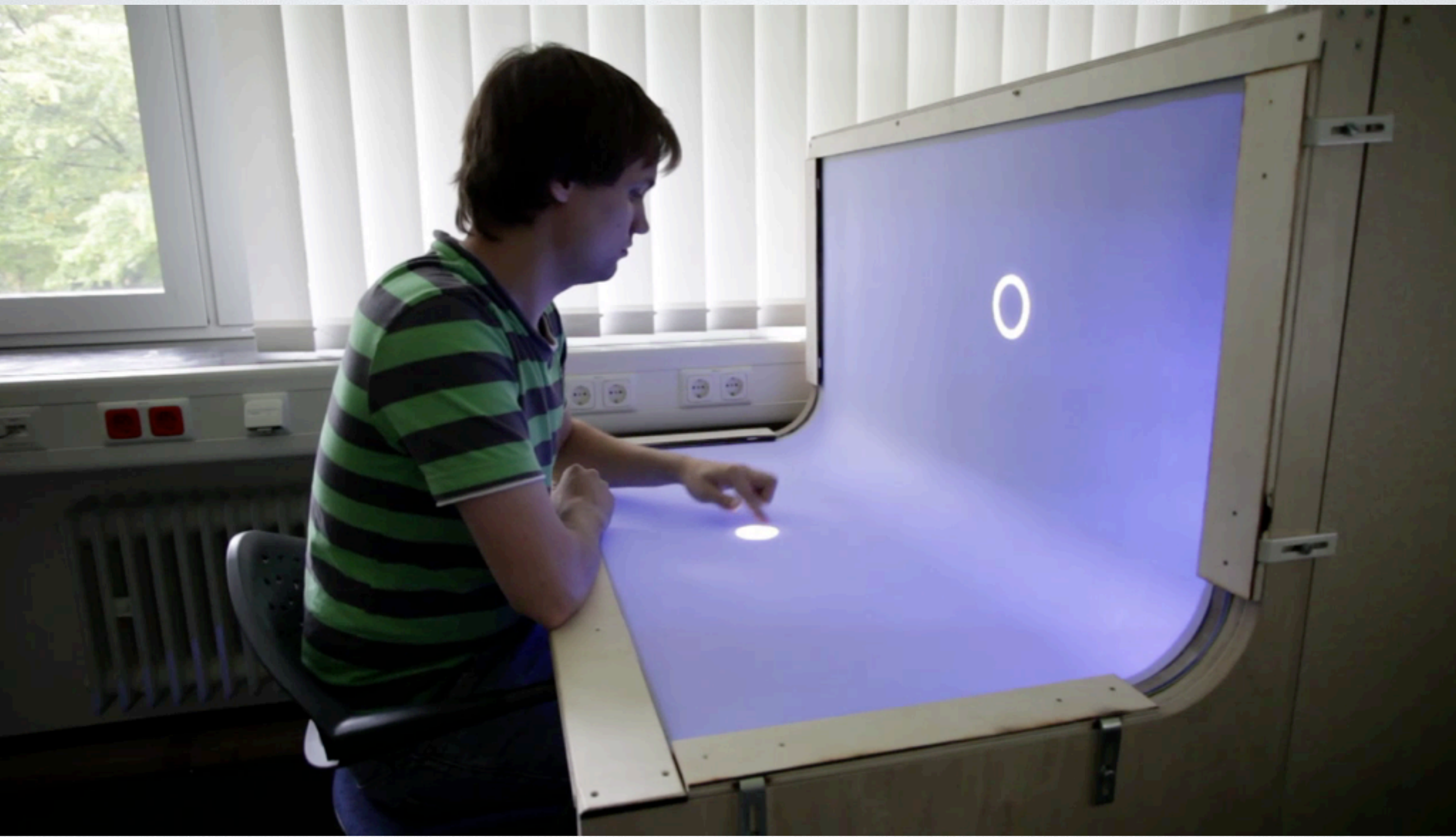
Perception



Perception

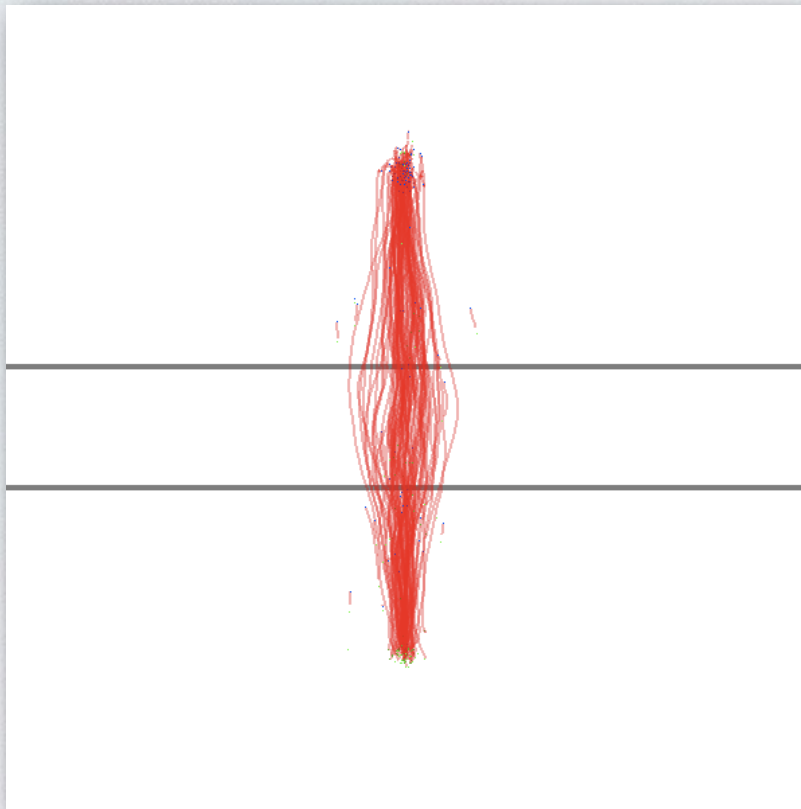


Interaction

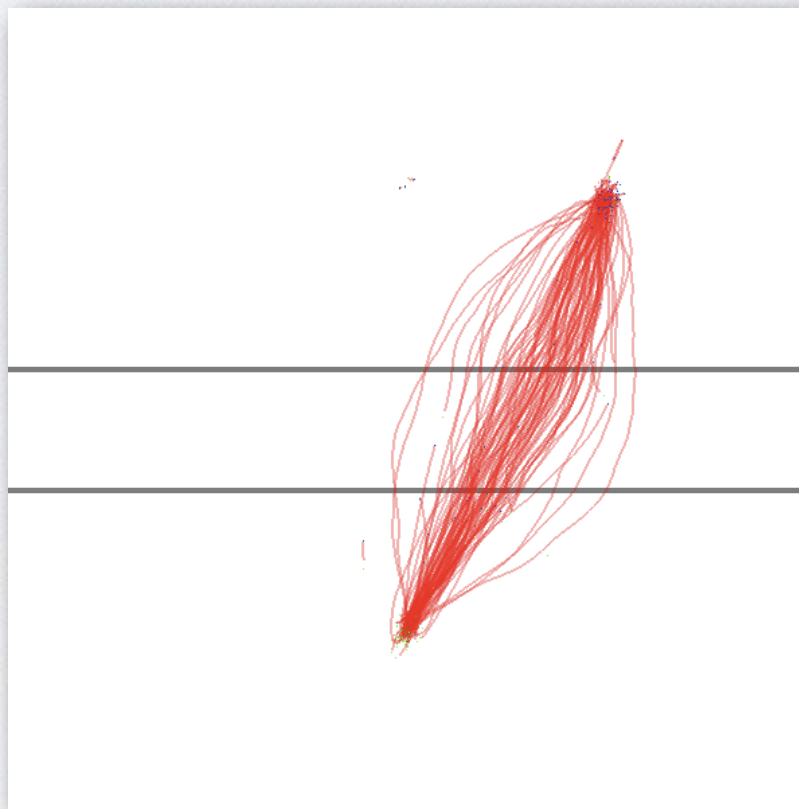


Interaction

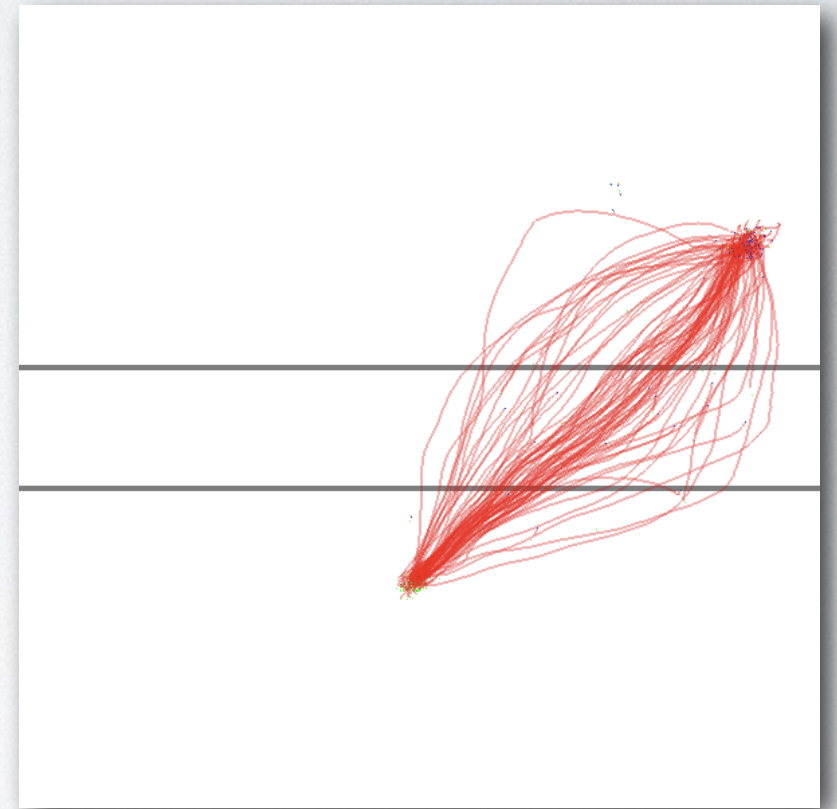
0°



25°

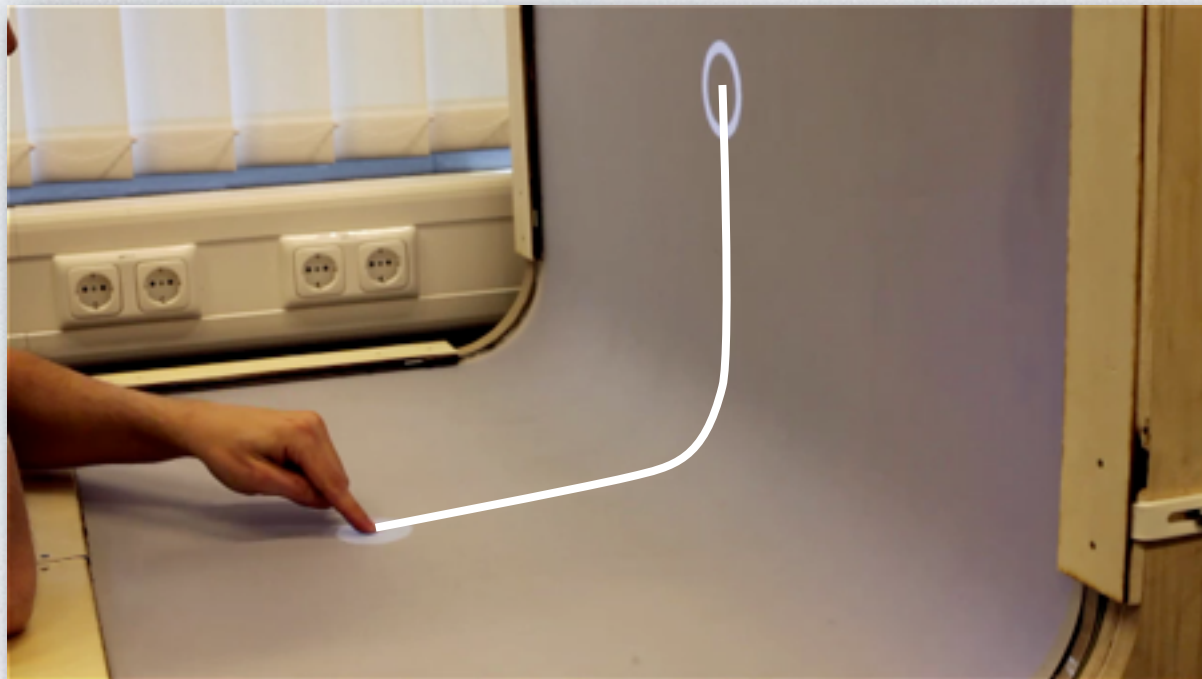


45°

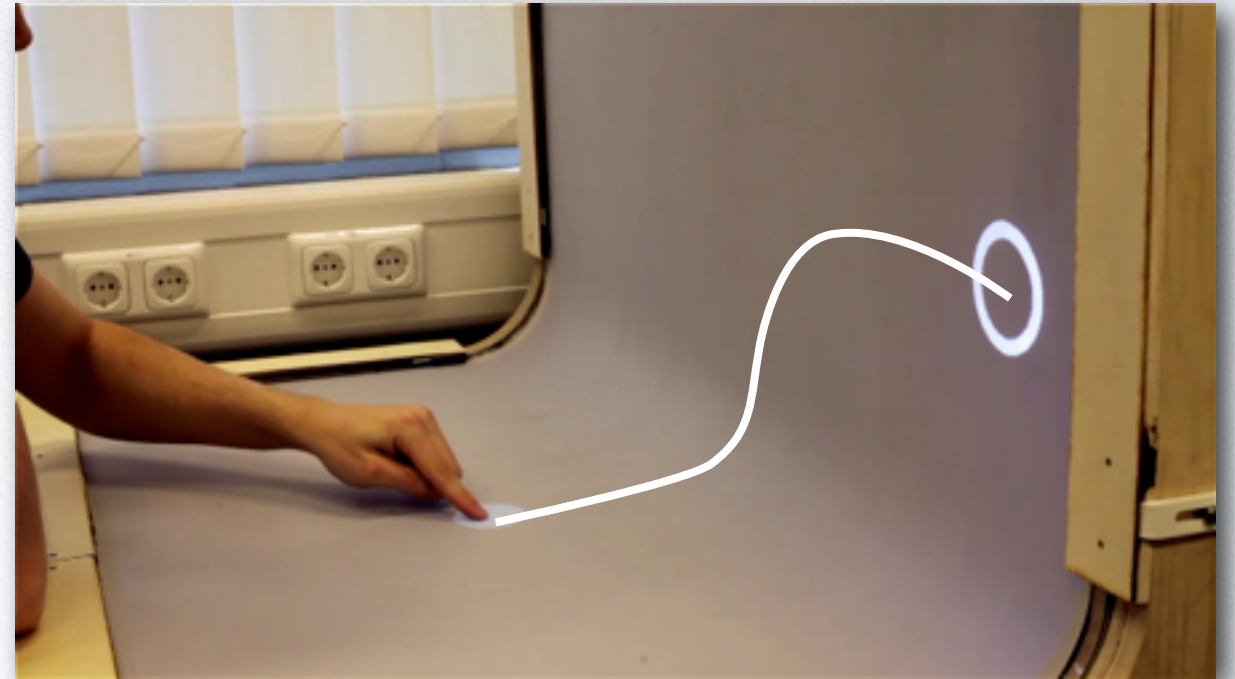


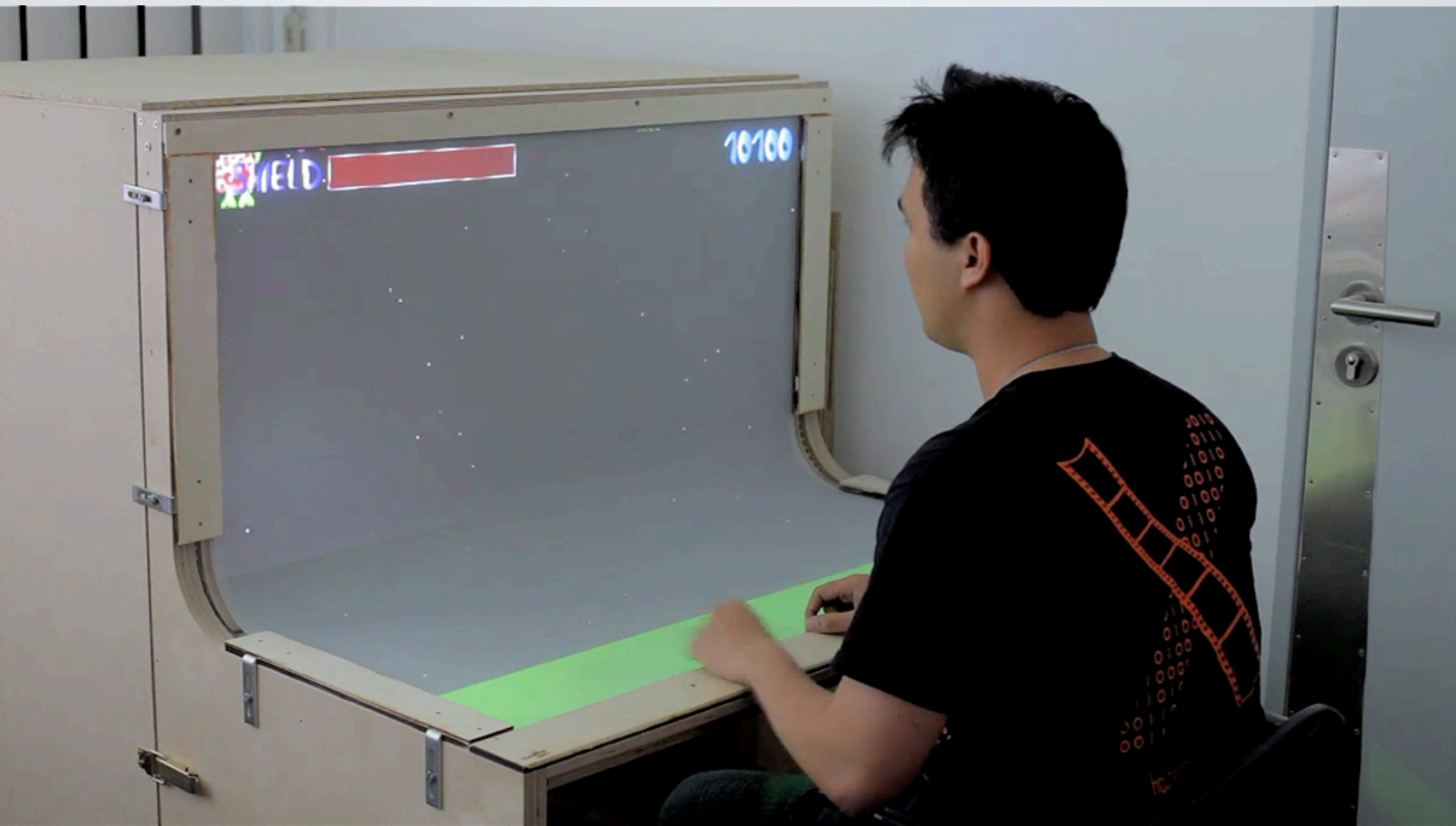
Interaction

0°



45°







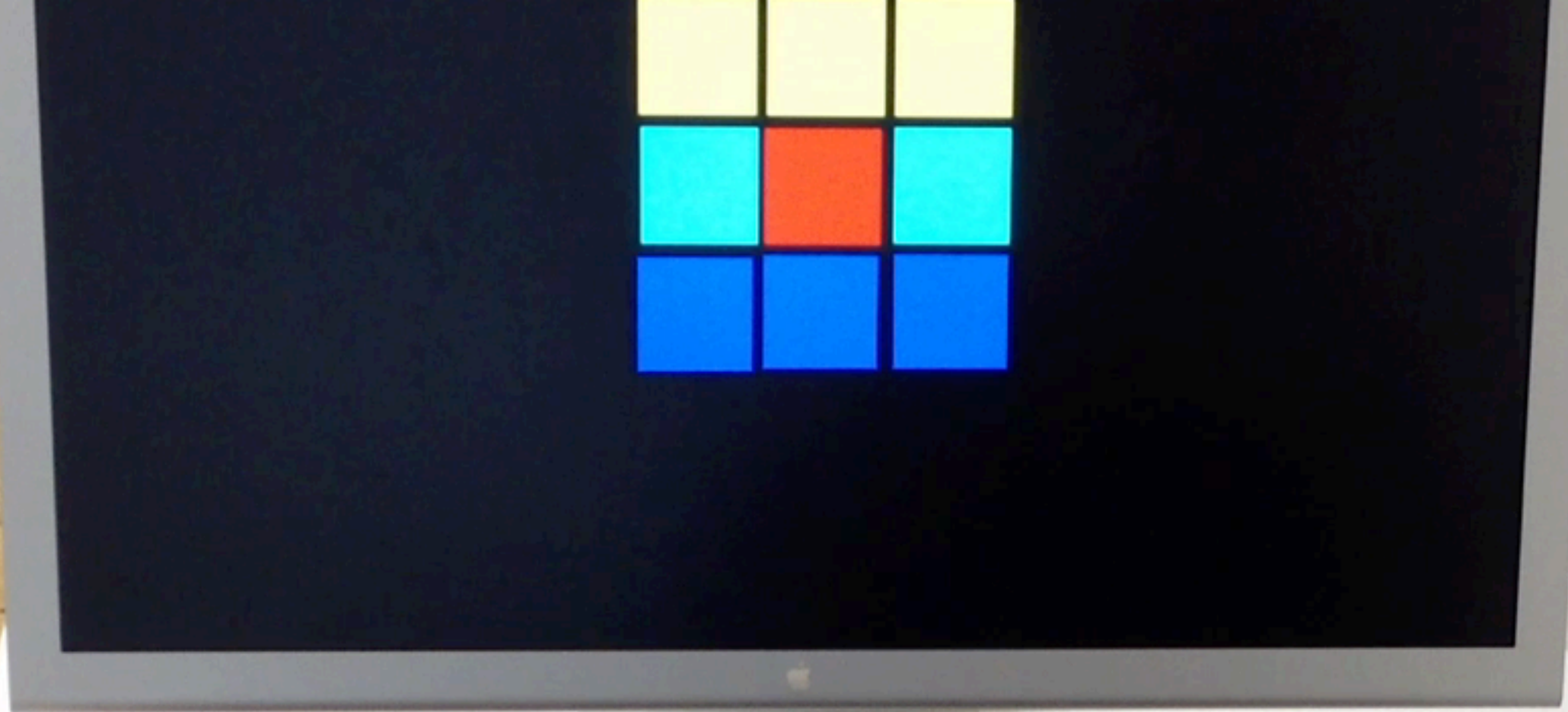


Finger: 4

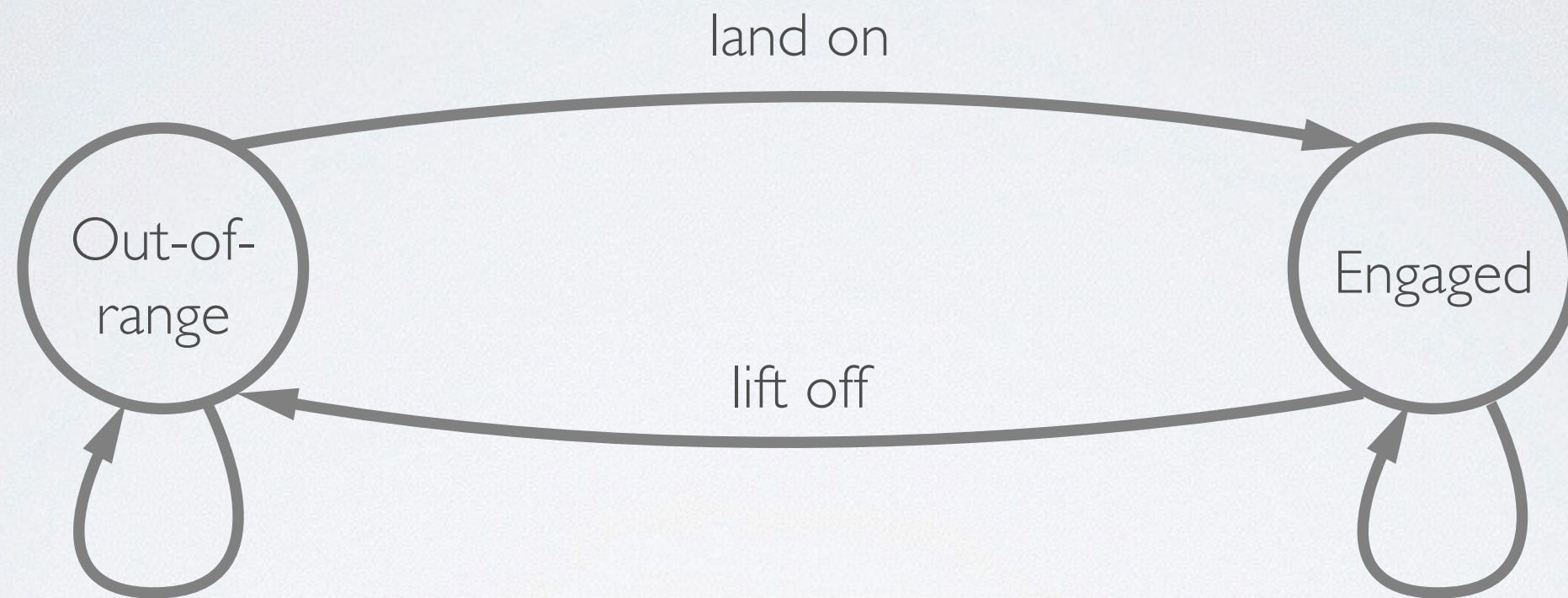
PressureMode

Visual
Output

Touch Input



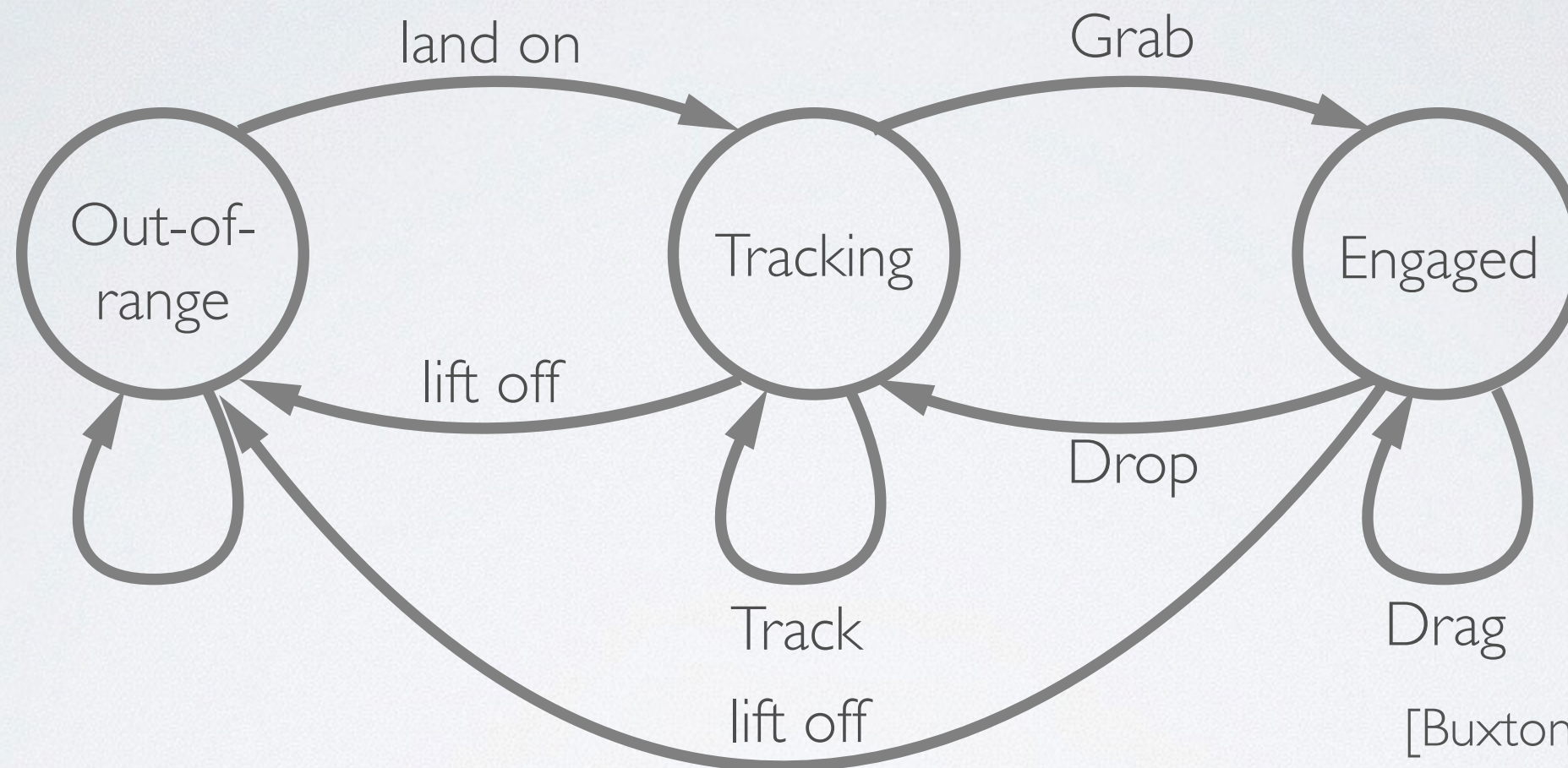
Two-State Touch Model



[Buxton, INTERACT '90]



Three-State Touch Model



[Buxton, INTERACT '90]

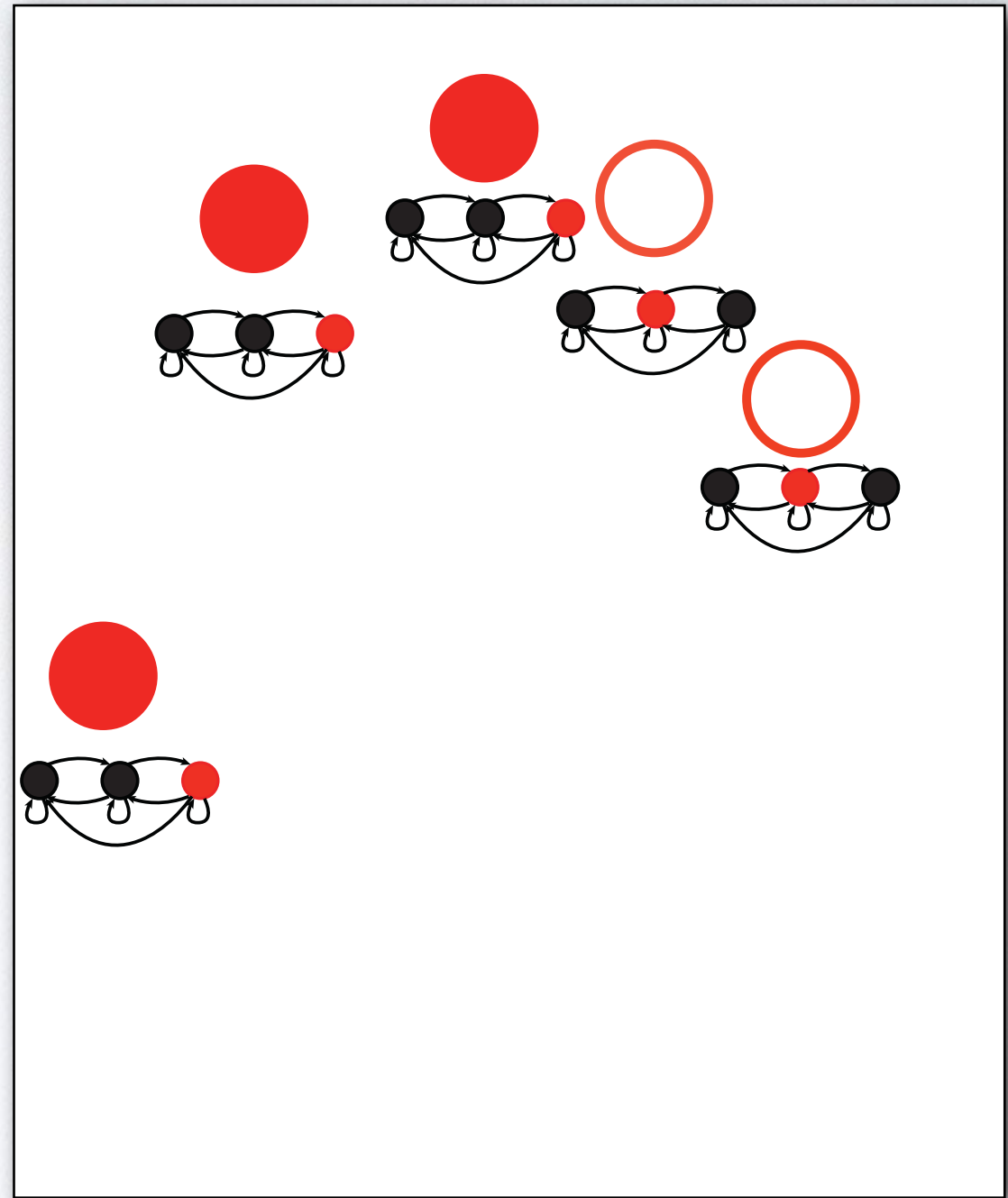


Multiple State Machines

Input



Output

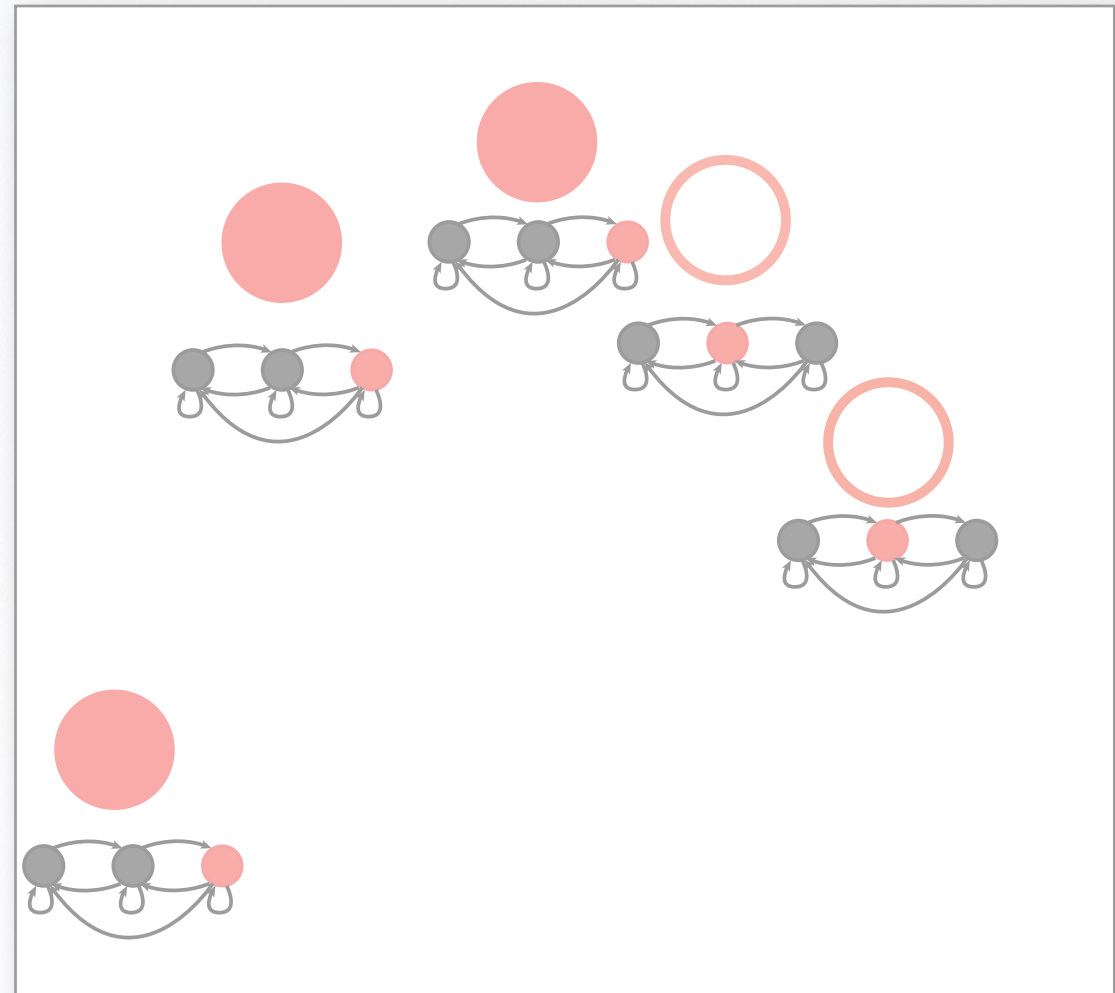


Multiple State Machines

Input



Output



In class:

What is the best state-switching method
for indirect multitouch system?

Properties of Each Individual Finger

[Wang and Ren, CHI '09]

- Position
- Motion
- Event Properties

| | | |
|-----|------|-------|
| Tap | Hold | Flick |
|-----|------|-------|

- Physical Properties

| |
|--------------------------|
| Pressure |
| Size of the Contact Area |
| Orientation |
| On/off the surface |



Properties of Each Individual Finger

[Wang and Ren, CHI '09]

- ~~Position~~
- ~~Motion~~
- Event Properties

| | | |
|-----|------|------------------|
| Tap | Hold | Flick |
|-----|------|------------------|

- Physical Properties

| |
|--------------------------|
| Pressure |
| Size of the Contact Area |
| Orientation |
| On/off the surface |



Evaluation

Hold



Pressure Switch



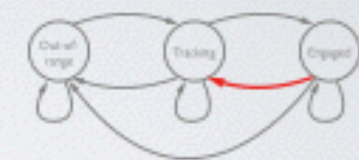
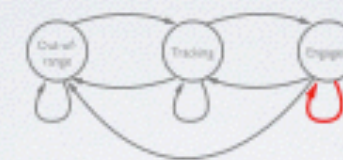
Lift-and-Tap

[Buxton SIGGRAPH '85]



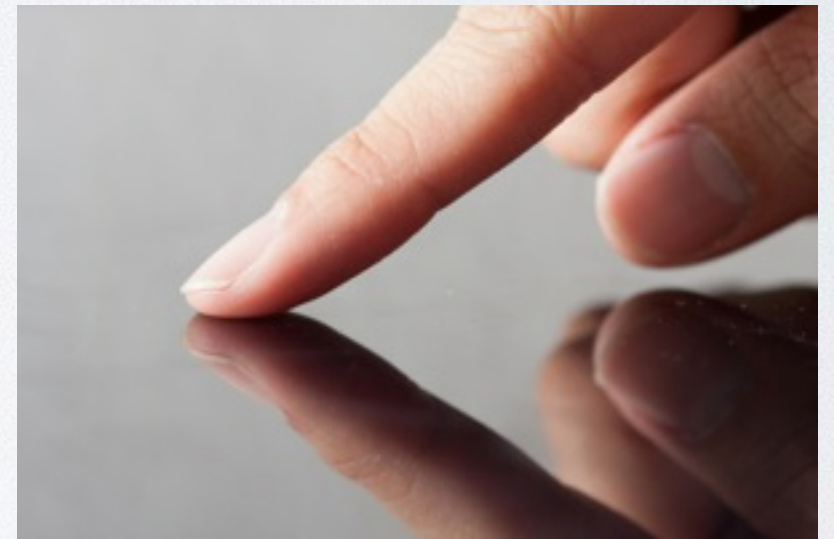
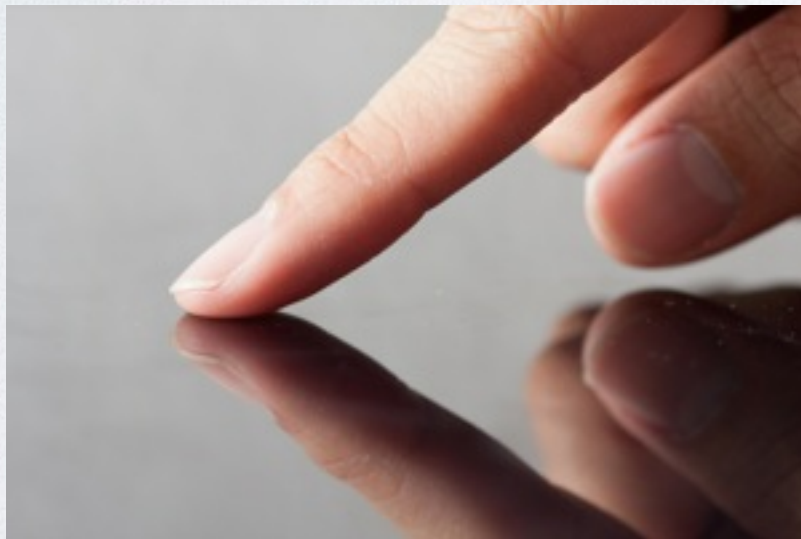
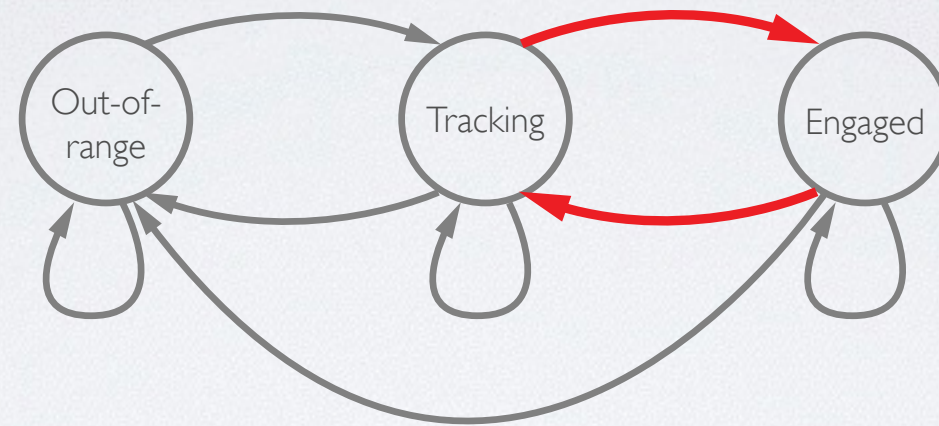
Pressure Quasimode

[Buxton SIGGRAPH '85]



Lift-and-Tap

[Buxton, SIGGRAPH '85]



What to do with it?



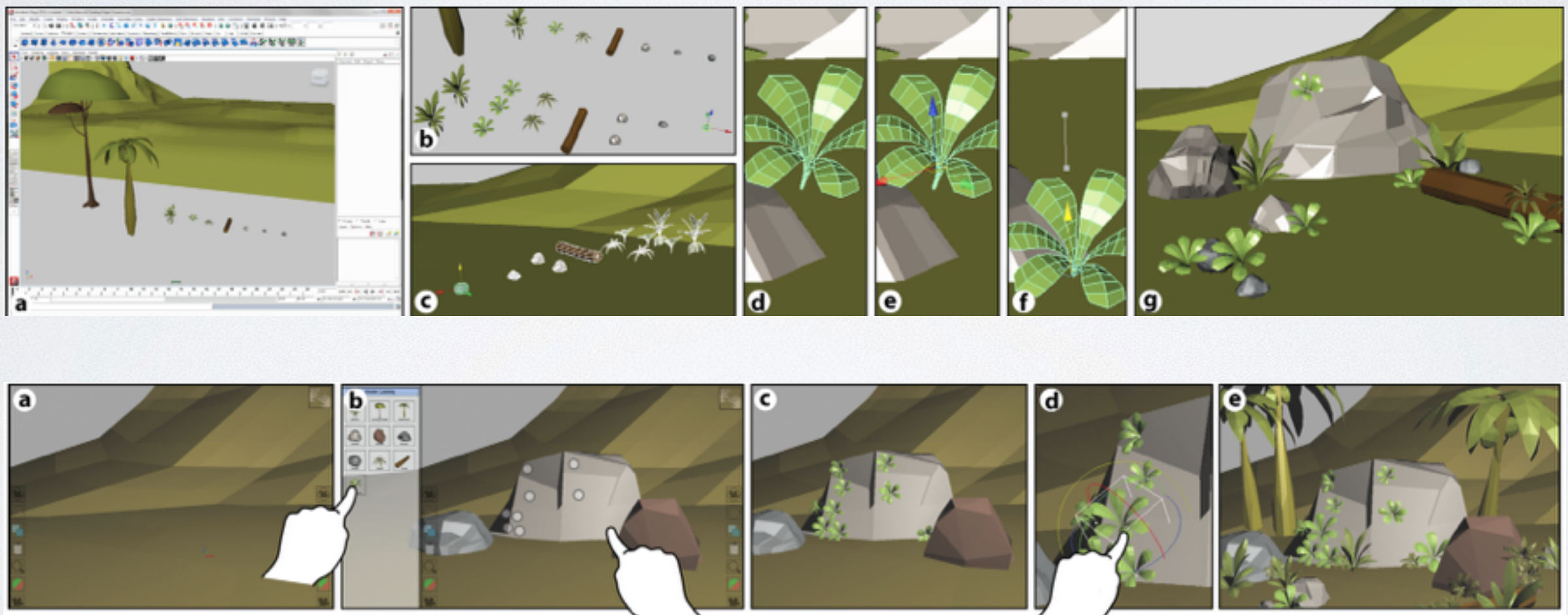
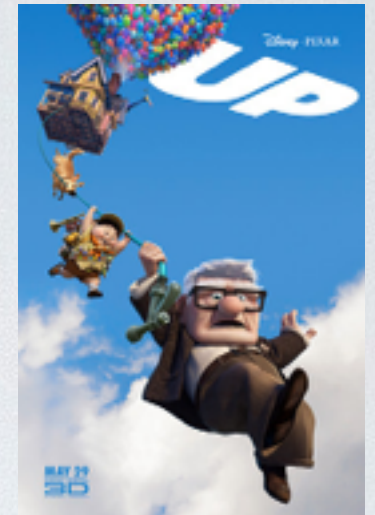
Museum Exhibitions



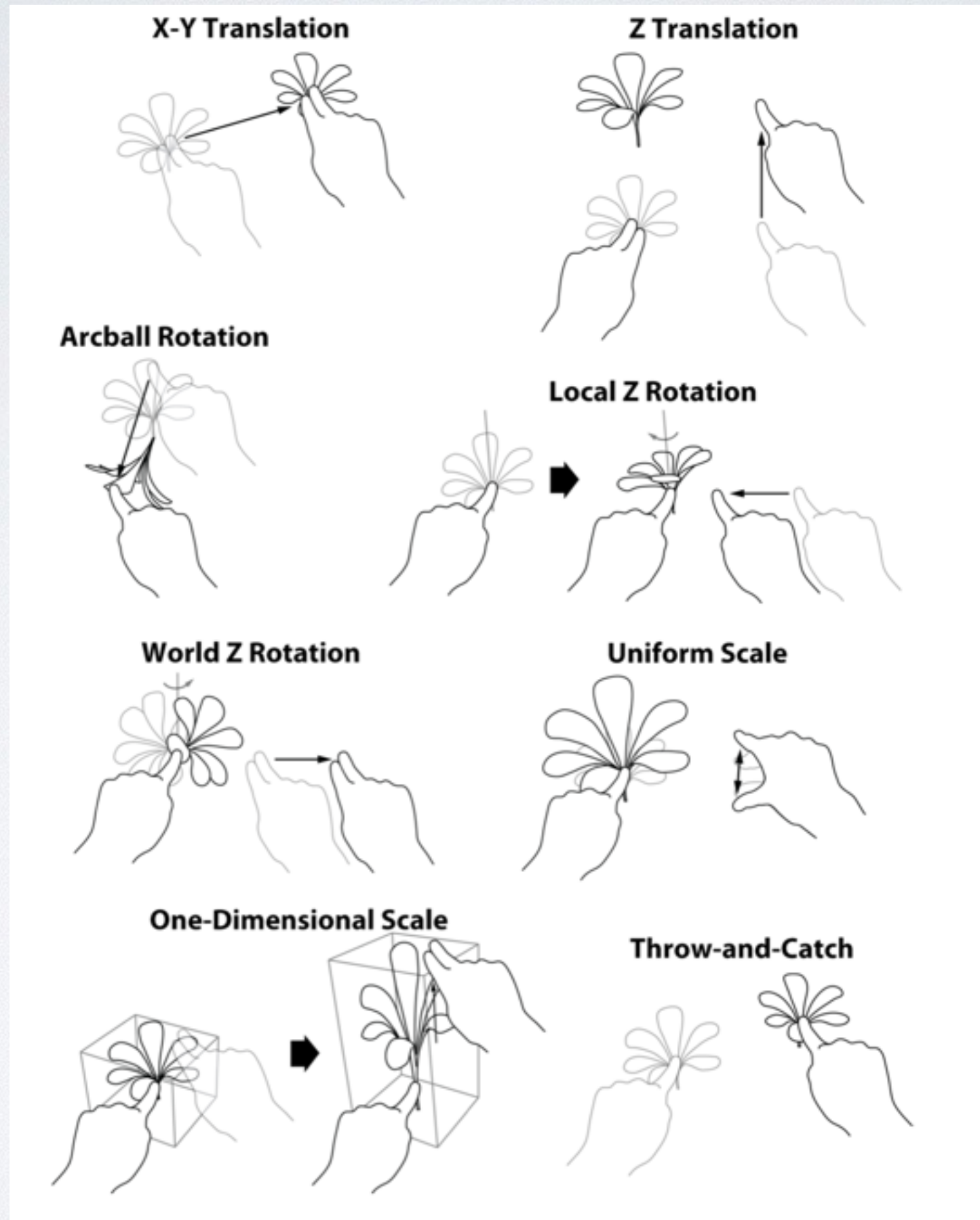
[Hinrichs and
Carpendale, CHI '11]

Single-user Applications

Eden: A Professional Multitouch Tool for Constructing Virtual Organic Environments



[Kin et al., CHI '11]



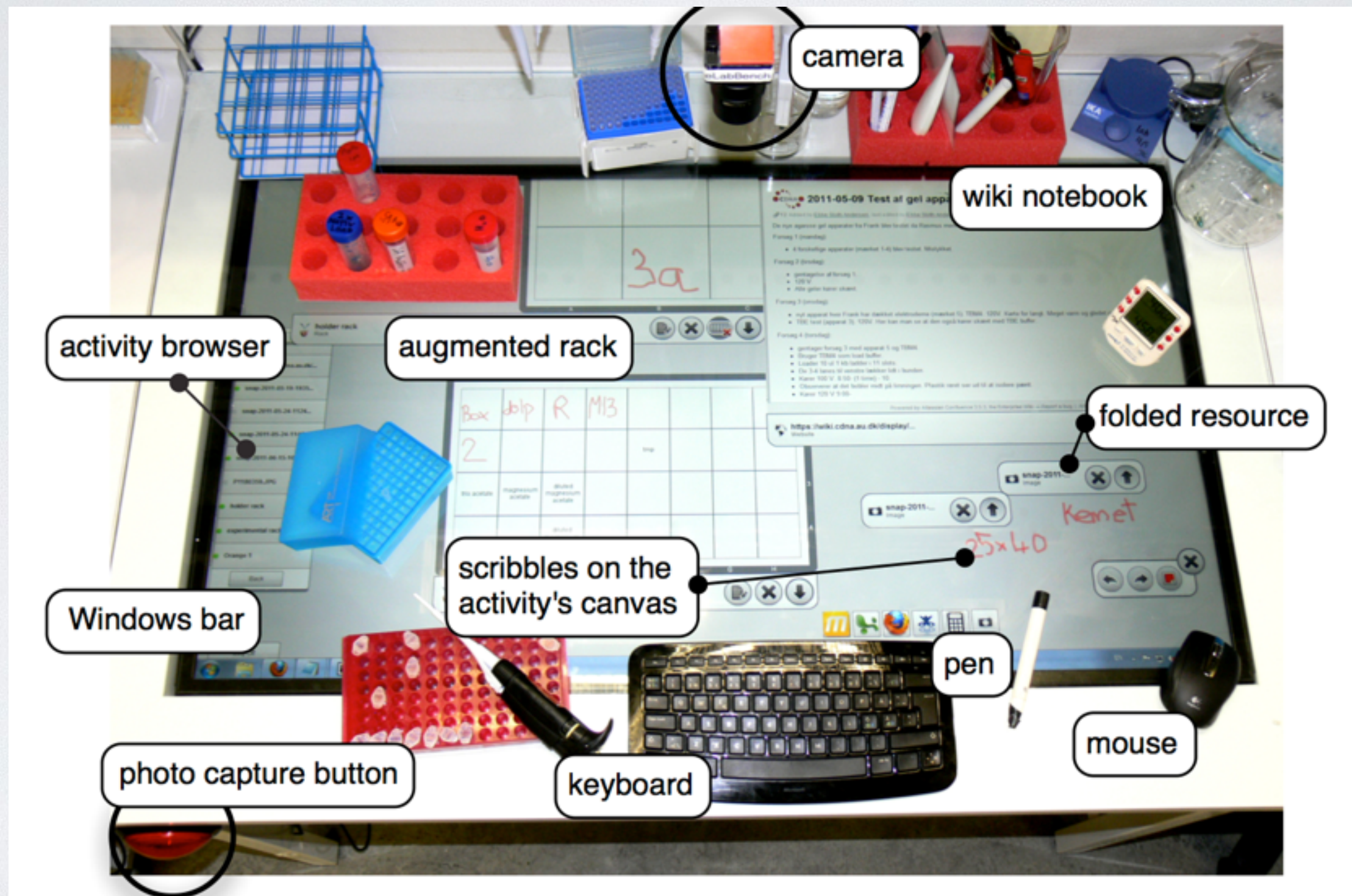


The eLabBench



[Tabard et al. ITS '11]

The eLabBench



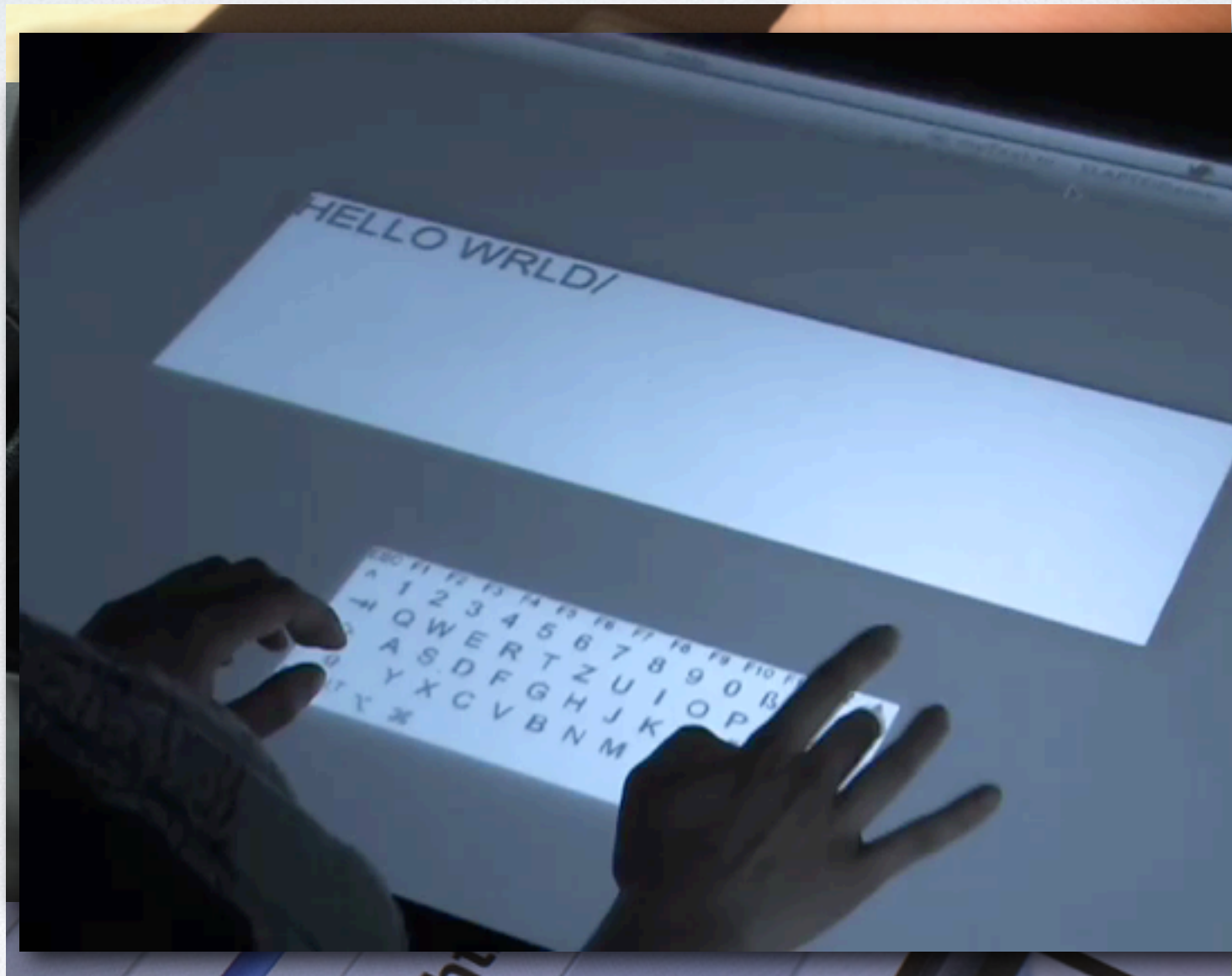
[Tabard et al. CHI '12]

Physical Object on the table?



[Tabard et al. ITS '11]

Limited Haptic Feedback

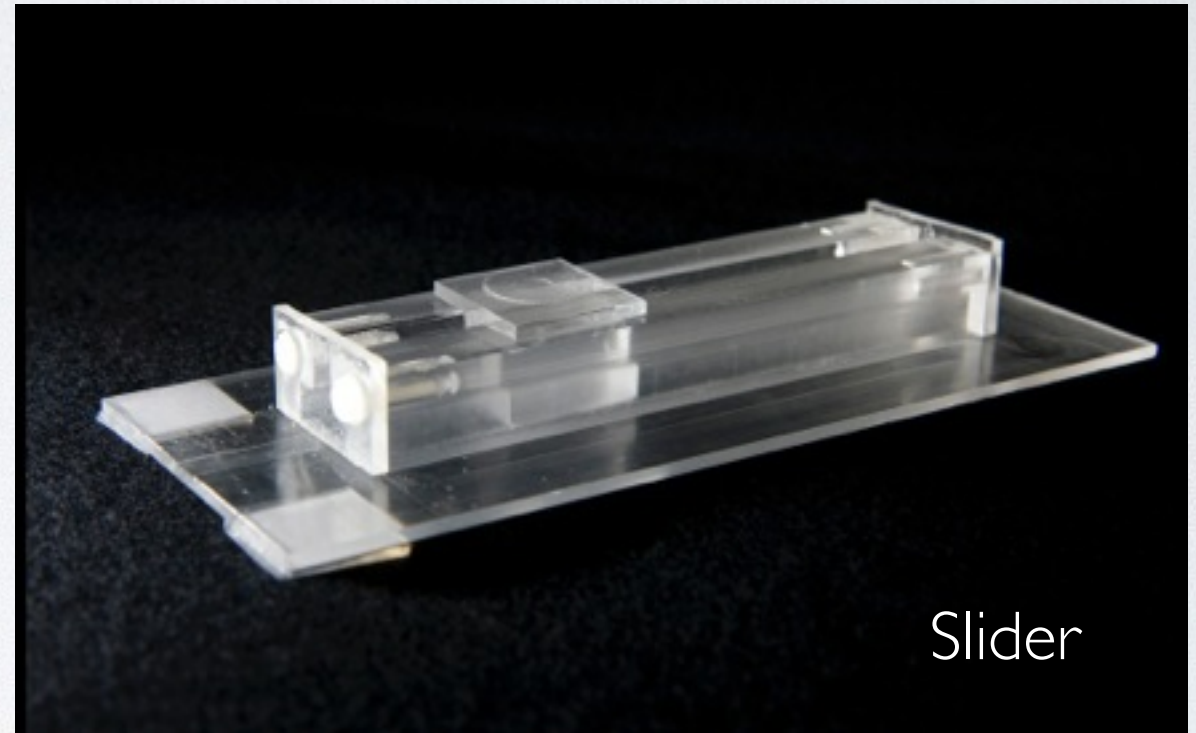


SLAP Widgets

[Weiss et al. CHI '09]



Keyboard



Slider

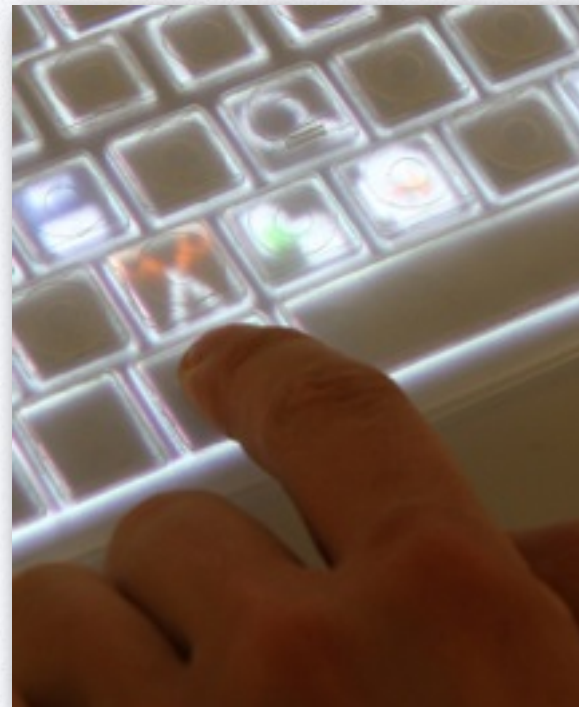
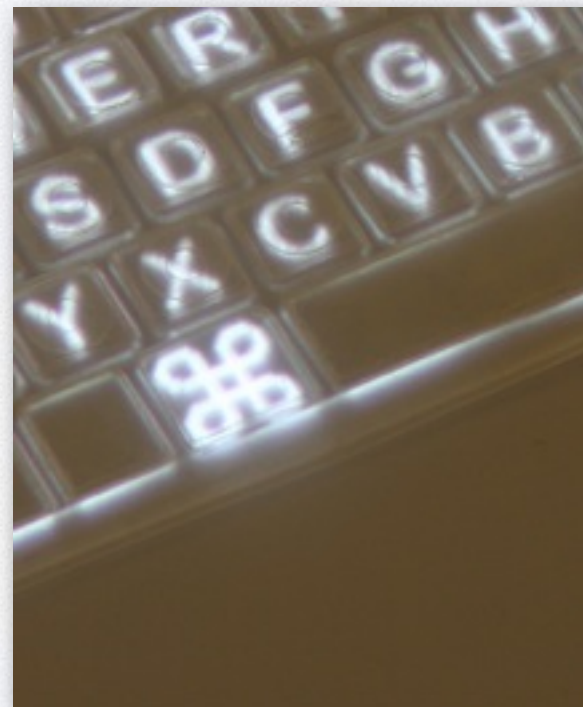
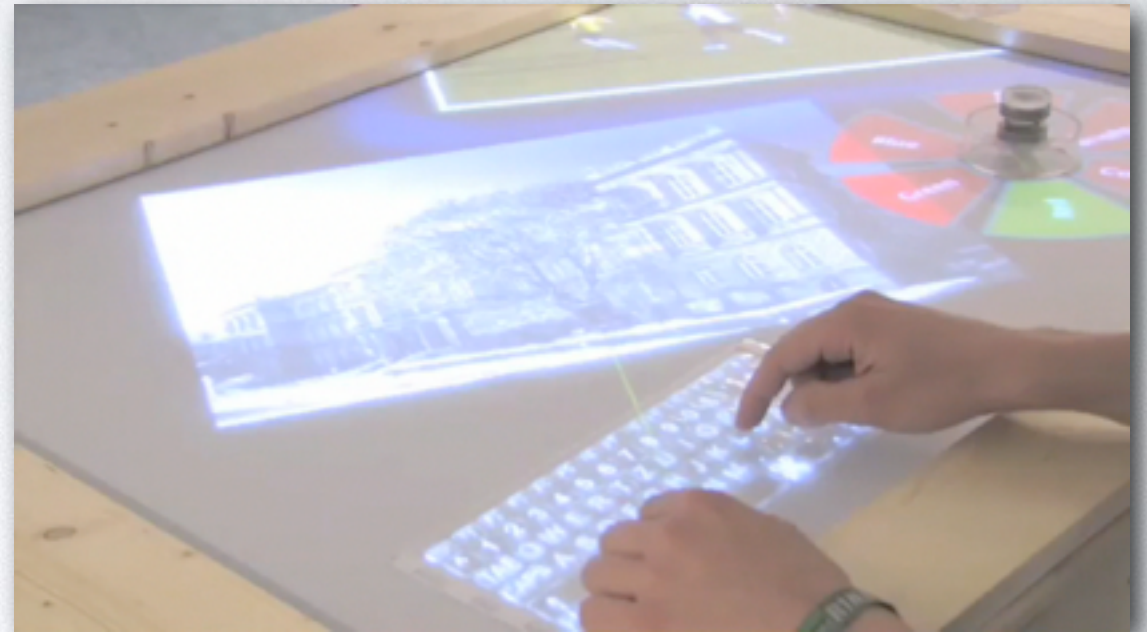


Keypads



Knob

SLAP Keyboard



SLAP Knob

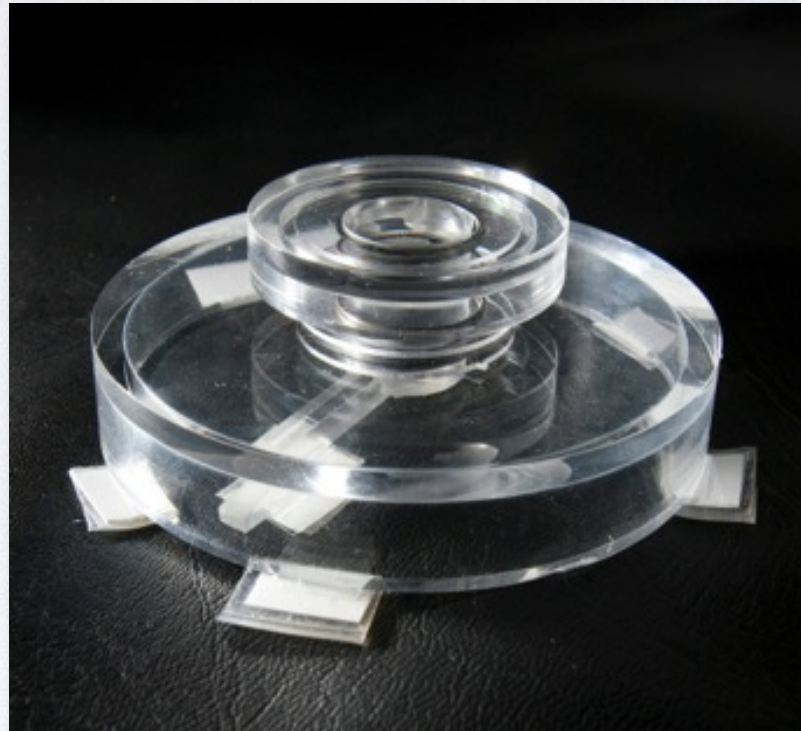


jog wheel mode



menu/value mode

SLAP Knob



value



jog wheel

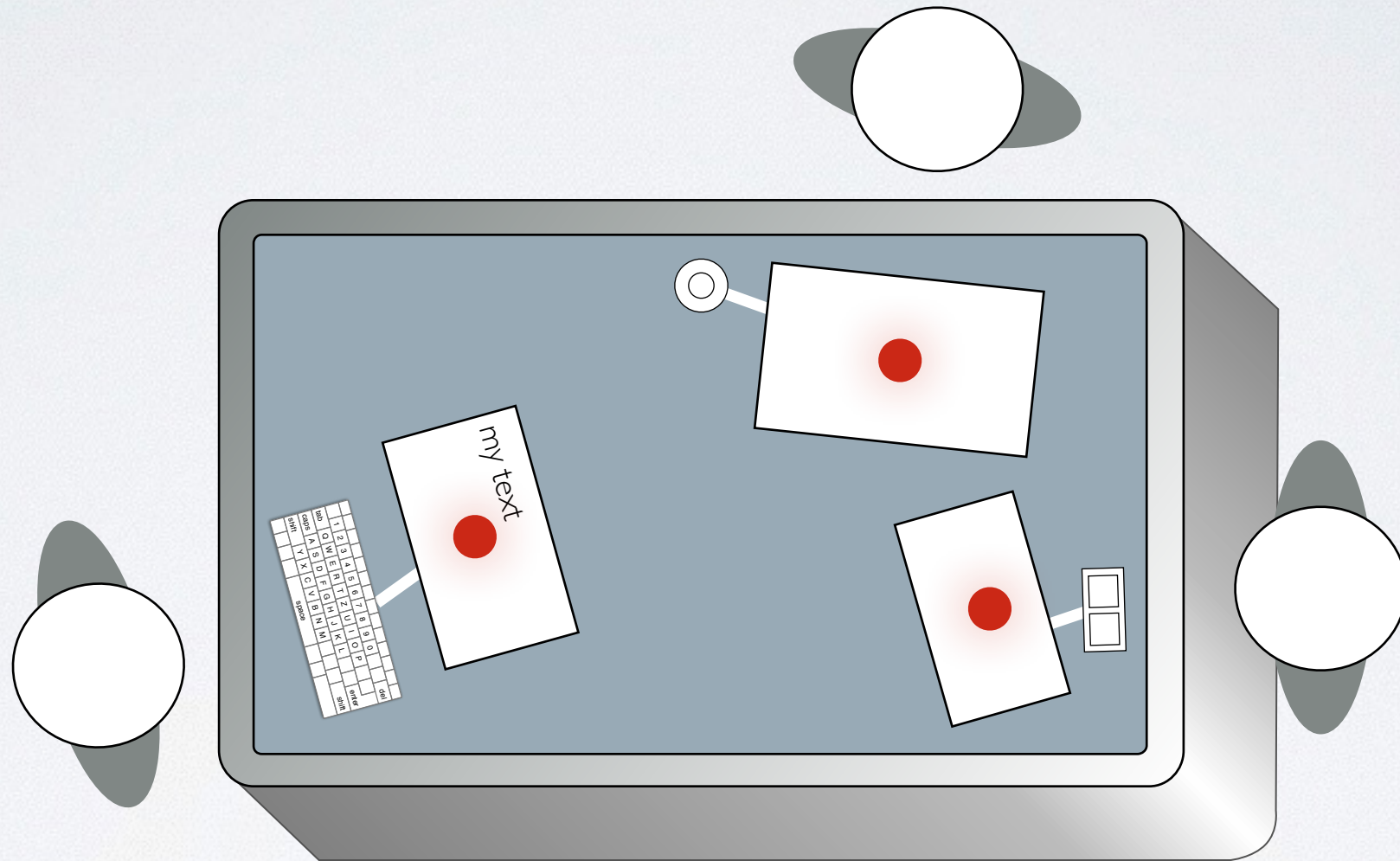


menu

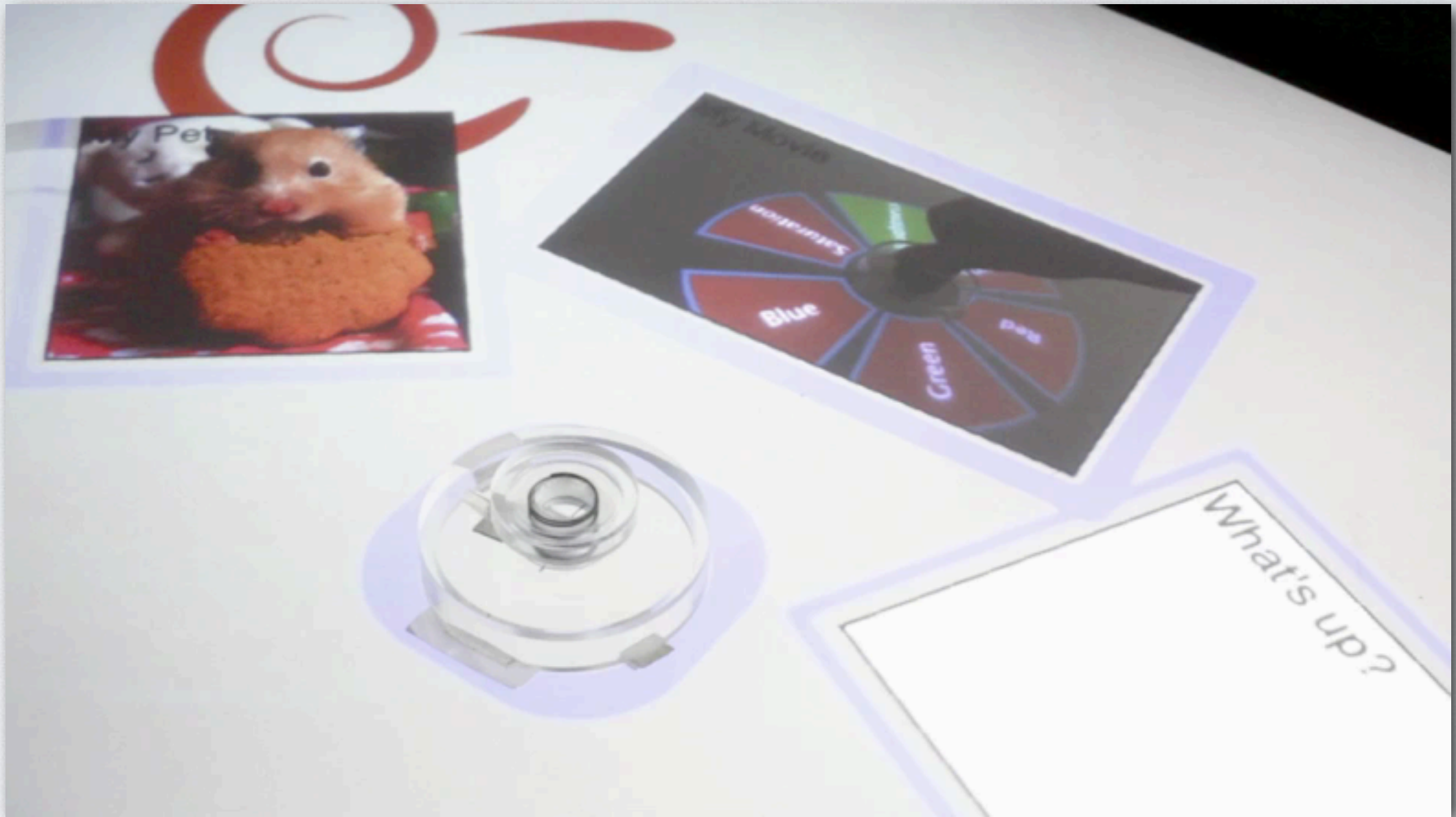


hue

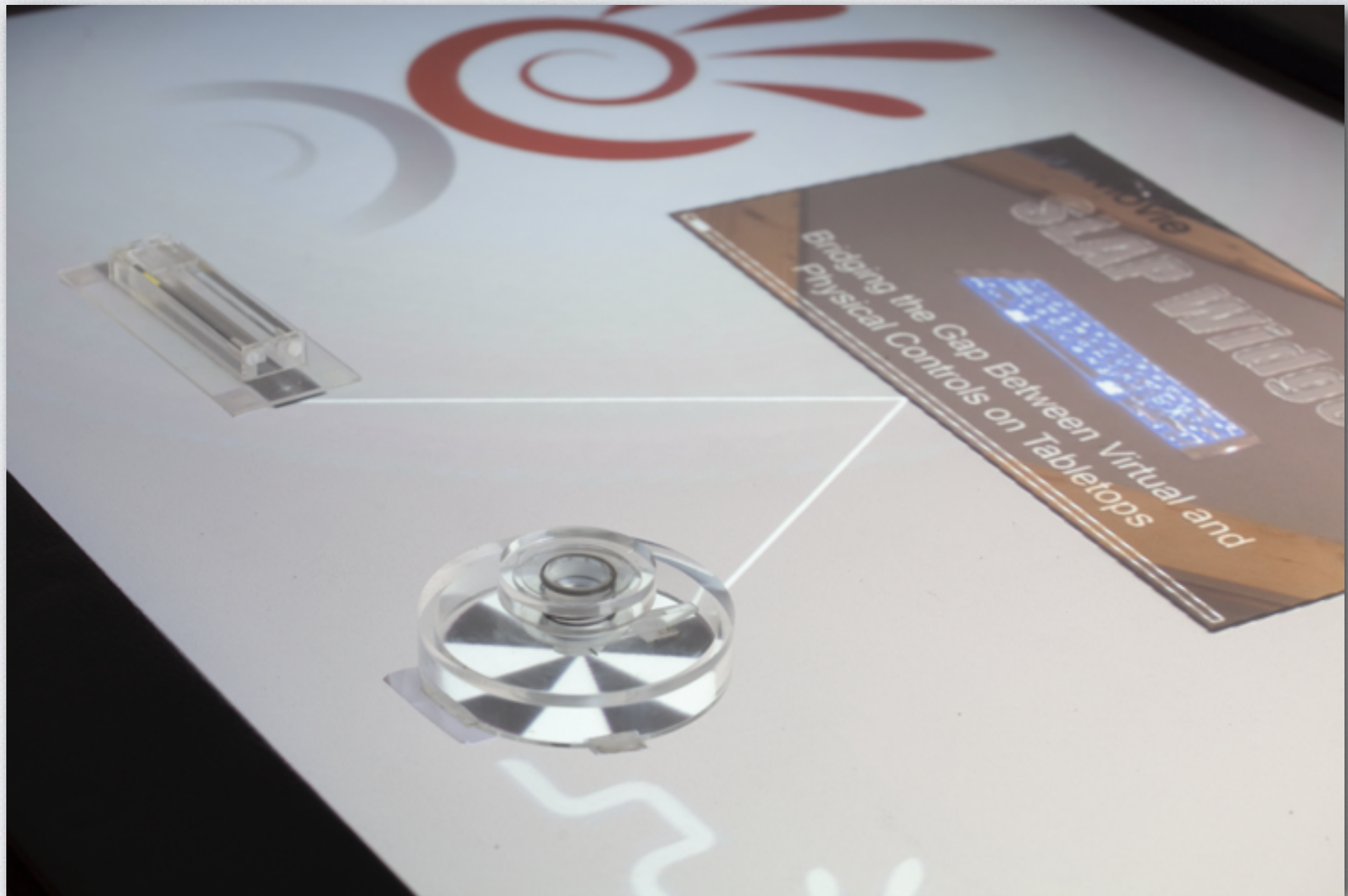
Multi-Focus Policy



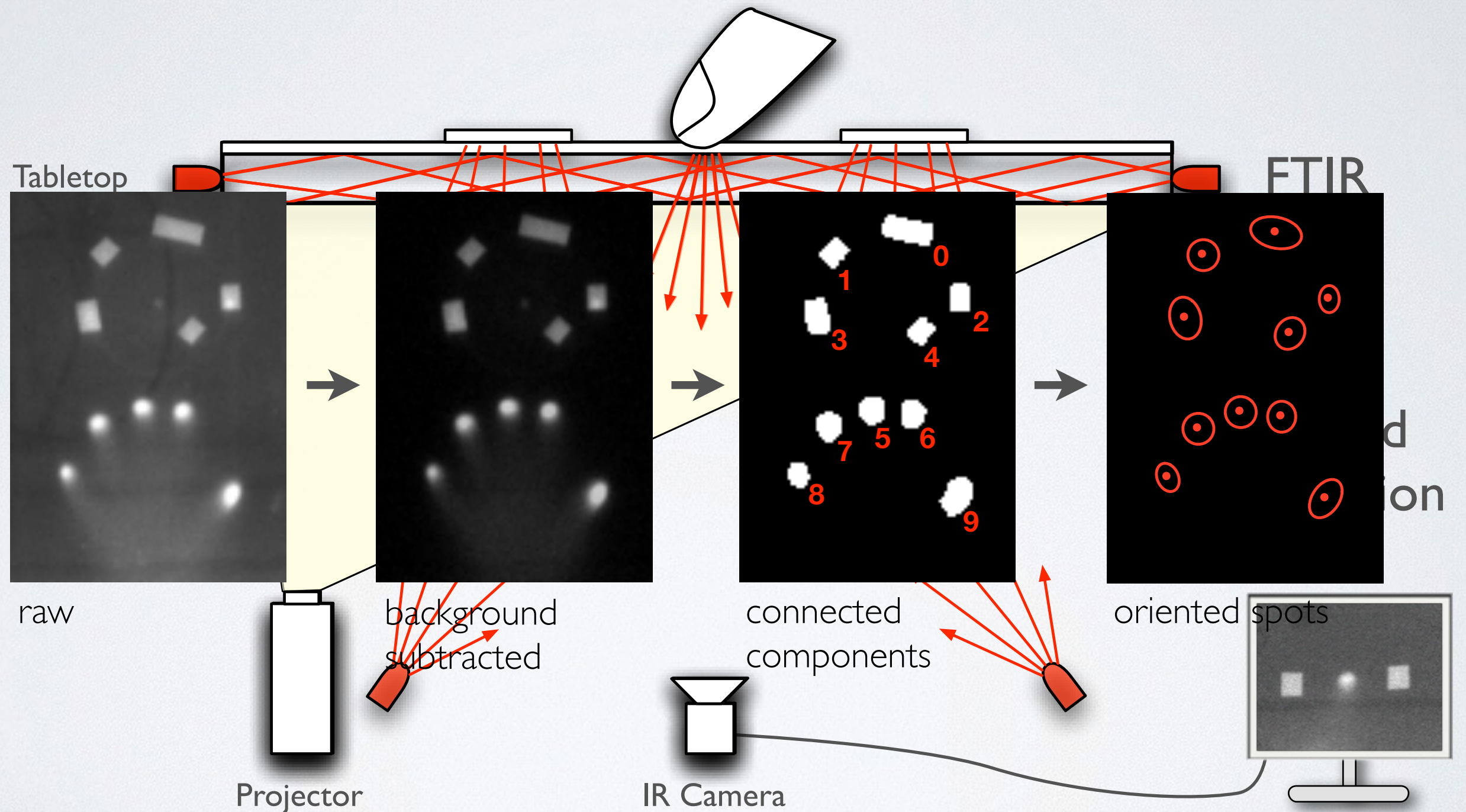
Pairing



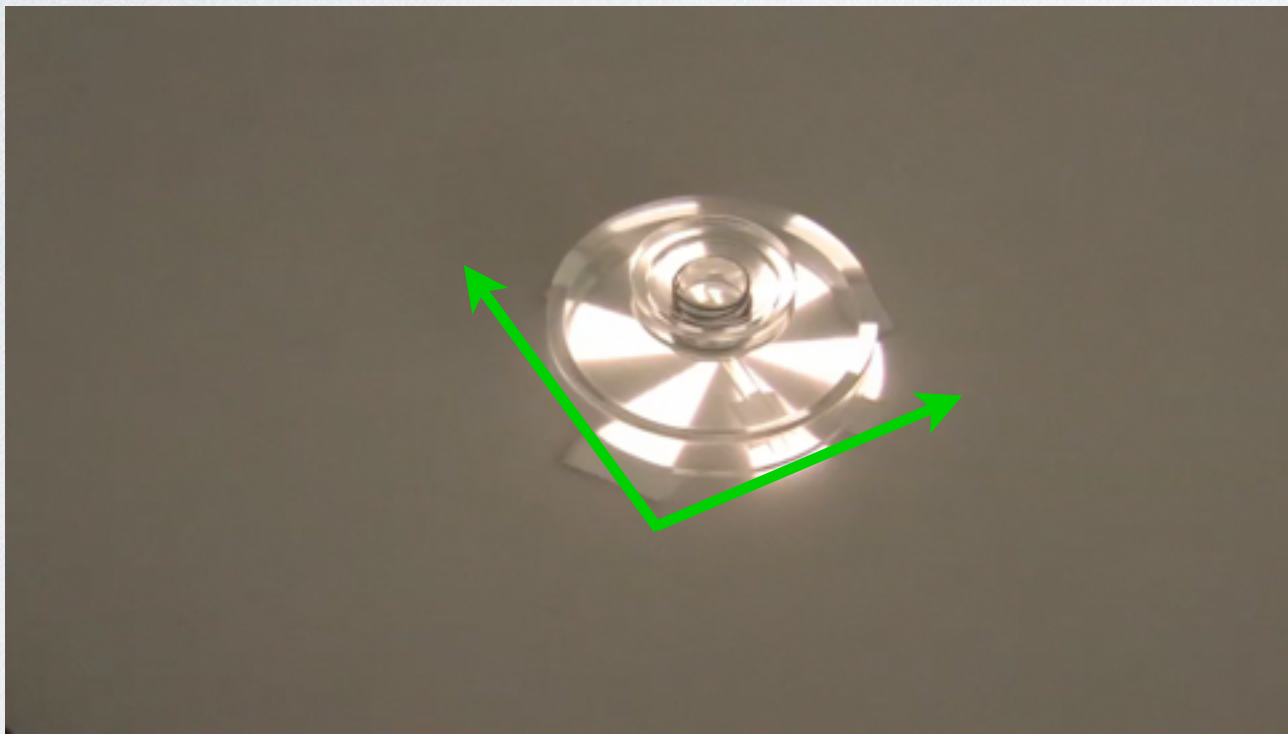
Pairing



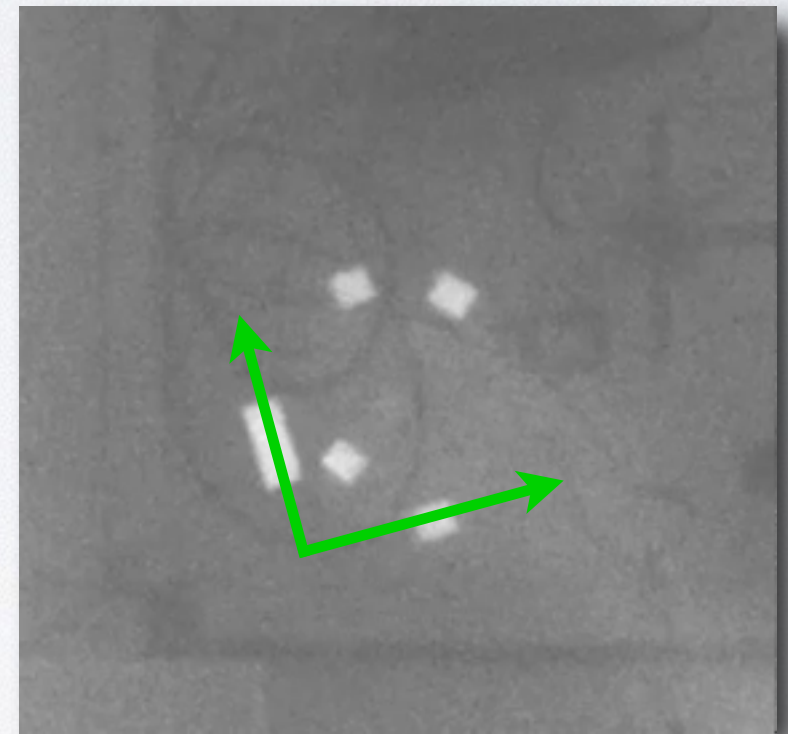
Multi-Touch Table



Widget Detection



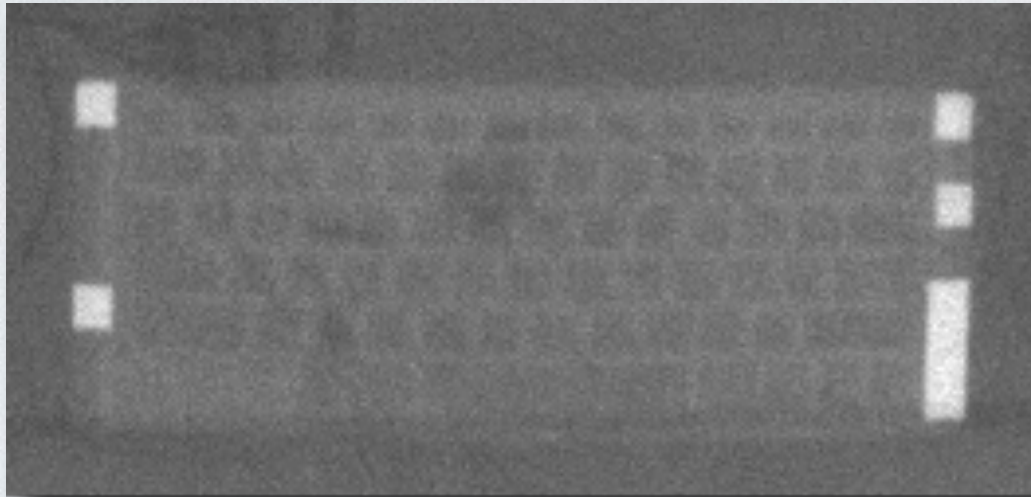
Tabletop view



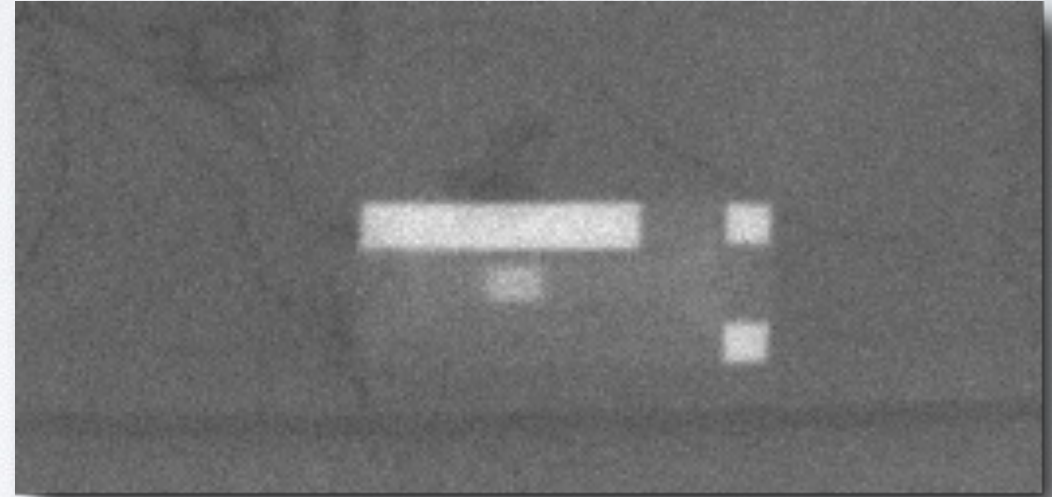
*IR camera view
(640x480, 120fps)*

Widget Detection

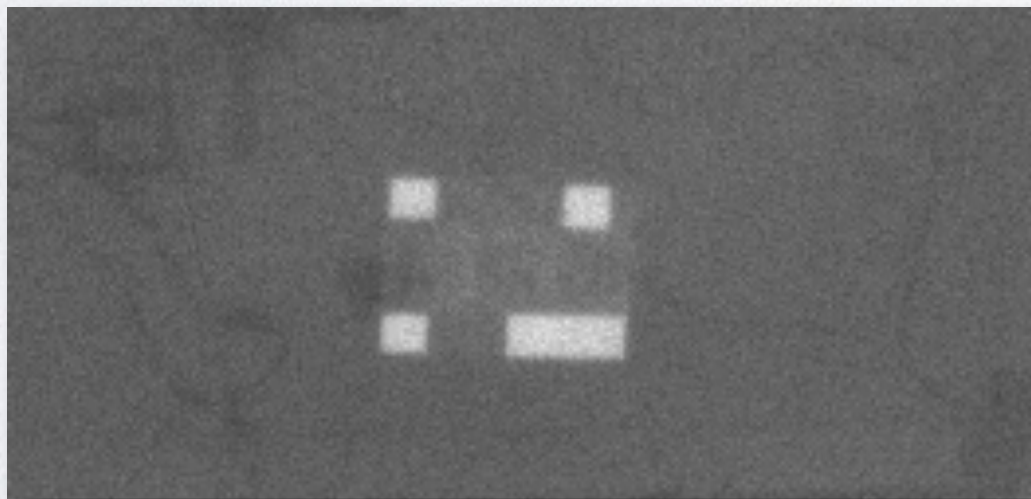
Keyboard



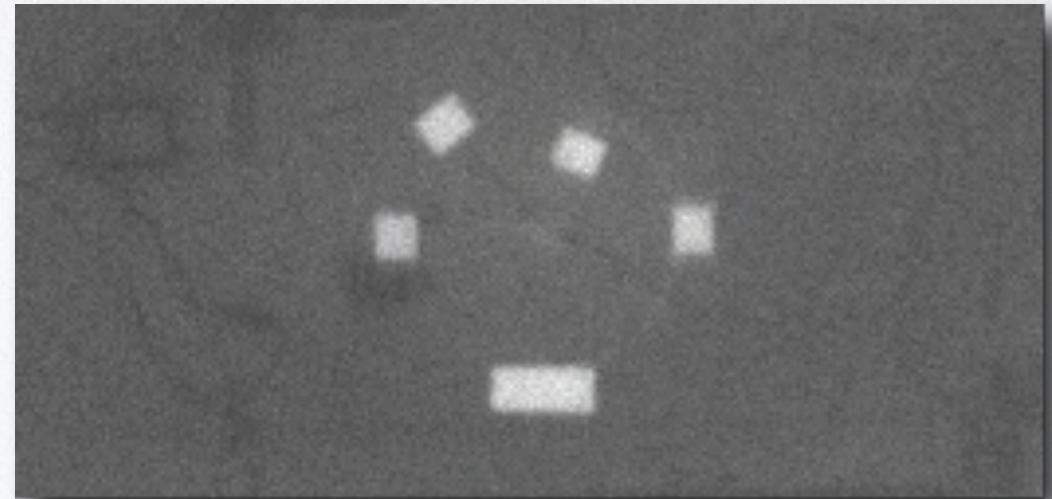
Slider



Keypad



Knob



Unidirectional Interaction

SLAP Widget

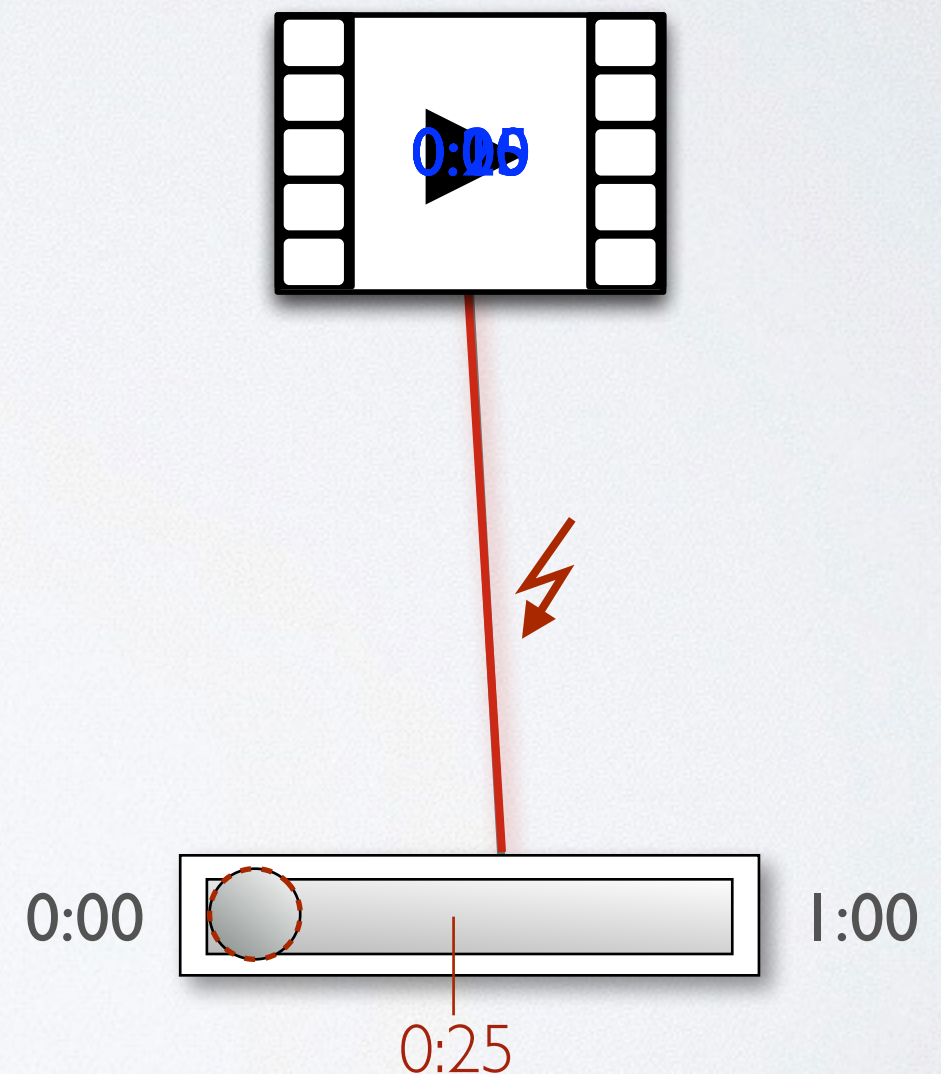


Physical

Digital

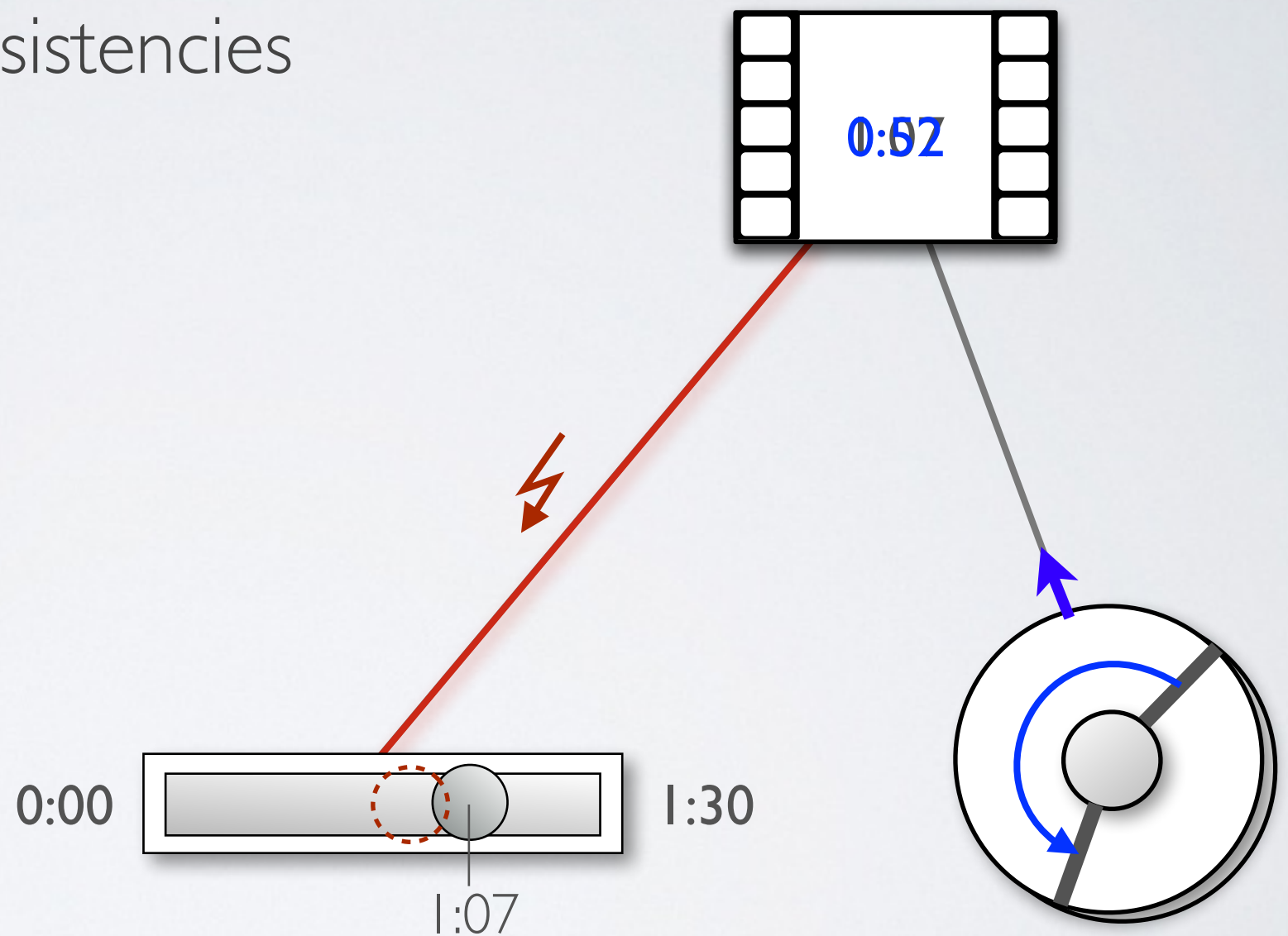
Unidirectional Interaction

- Software cannot change physical UI
- Physical-visual inconsistencies
 - Internal update



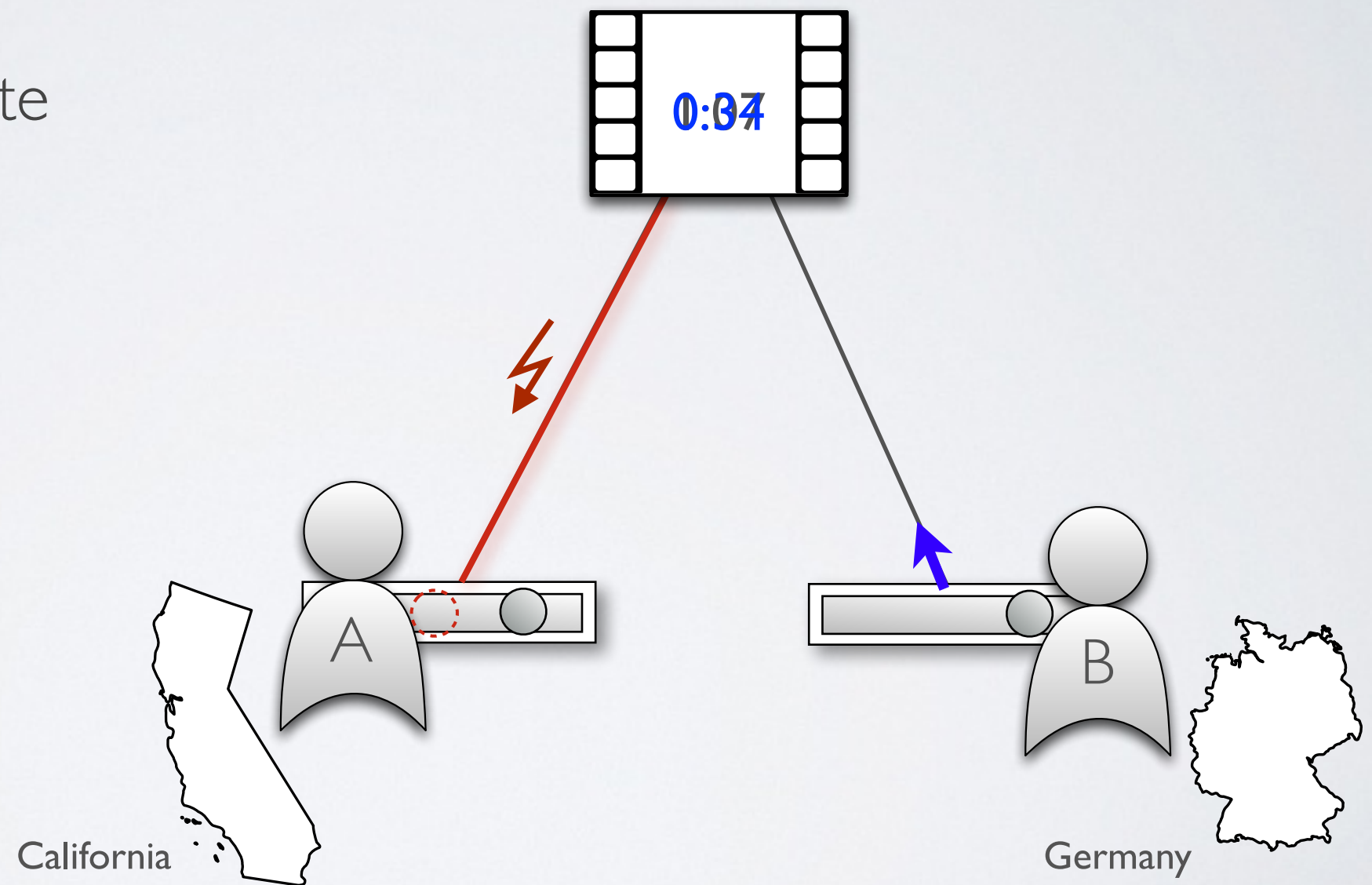
Unidirectional Interaction

- Software cannot change physical UI
- Physical-visual inconsistencies
 - Internal update
 - Inter-widget



Unidirectional Interaction

- Software cannot change physical UI
- Physical-visual inconsistencies
 - Internal update
 - Inter-widget
 - Remote

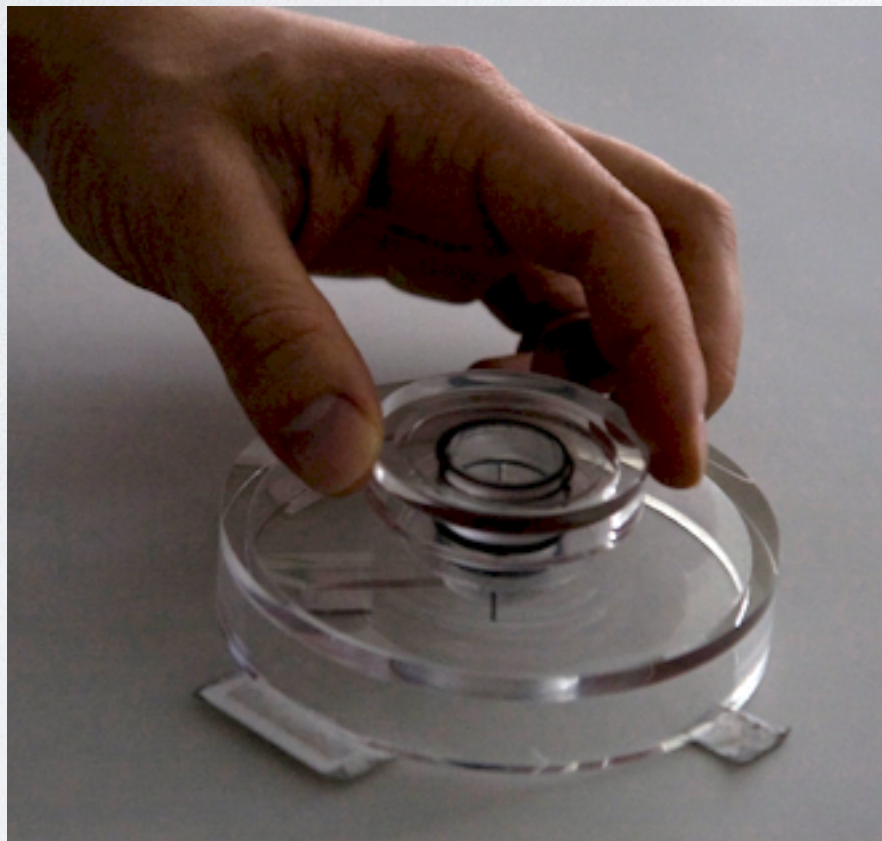


Unidirectional Interaction

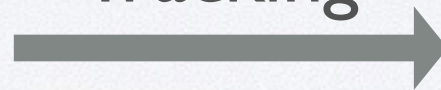
- Software cannot change physical UI
- Physical-visual inconsistencies
 - Internal update
 - Inter-widget
 - Remote
- SLAP Widgets require **exclusive access** to parameters
- No UI adaption, load/save, undo/redo, ...
- ▶ **Software** should be able to change **physical UI**

Bidirectional Interaction

SLAP Widget
Physical



Tracking



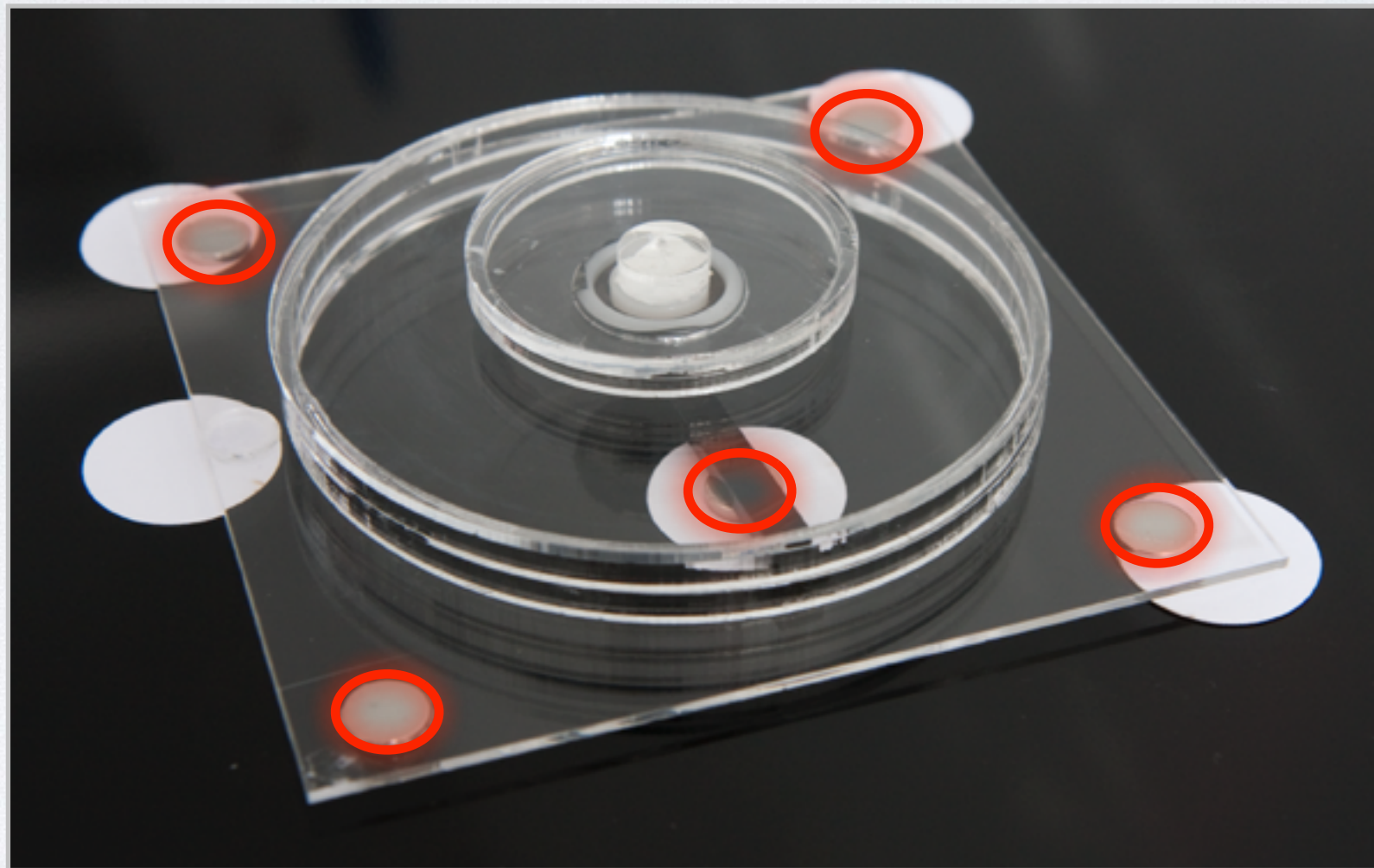
Actuation



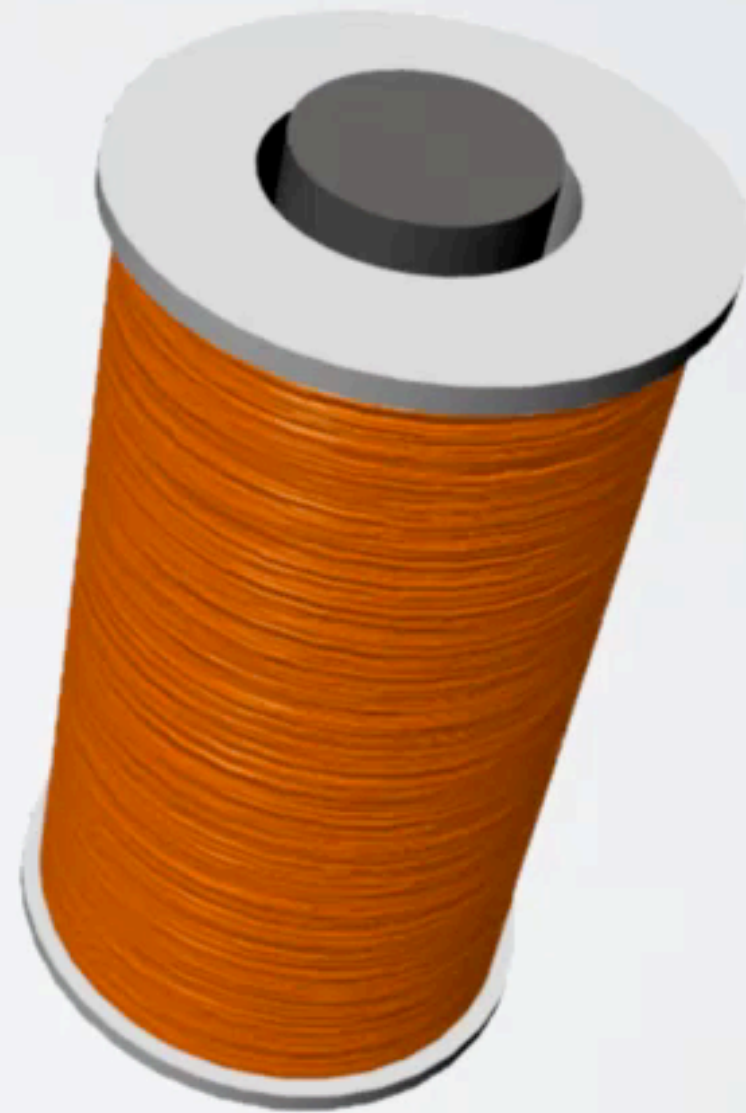
Digital



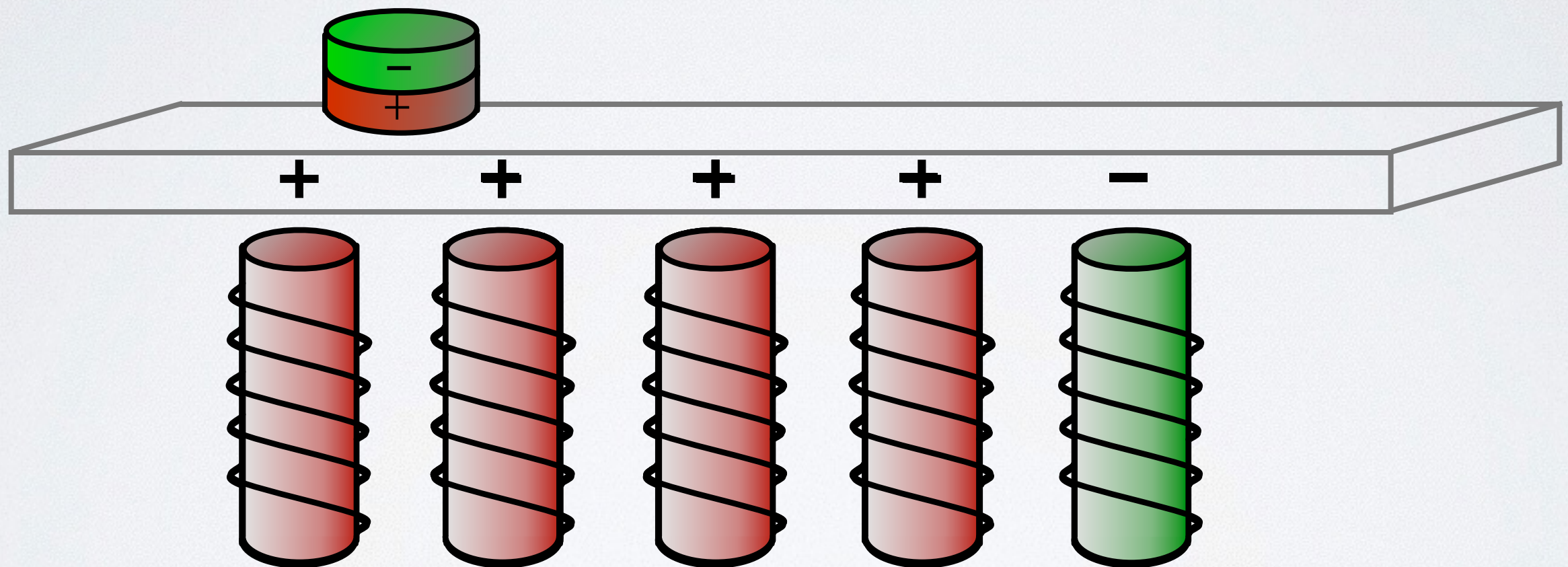
Magnetic Widgets



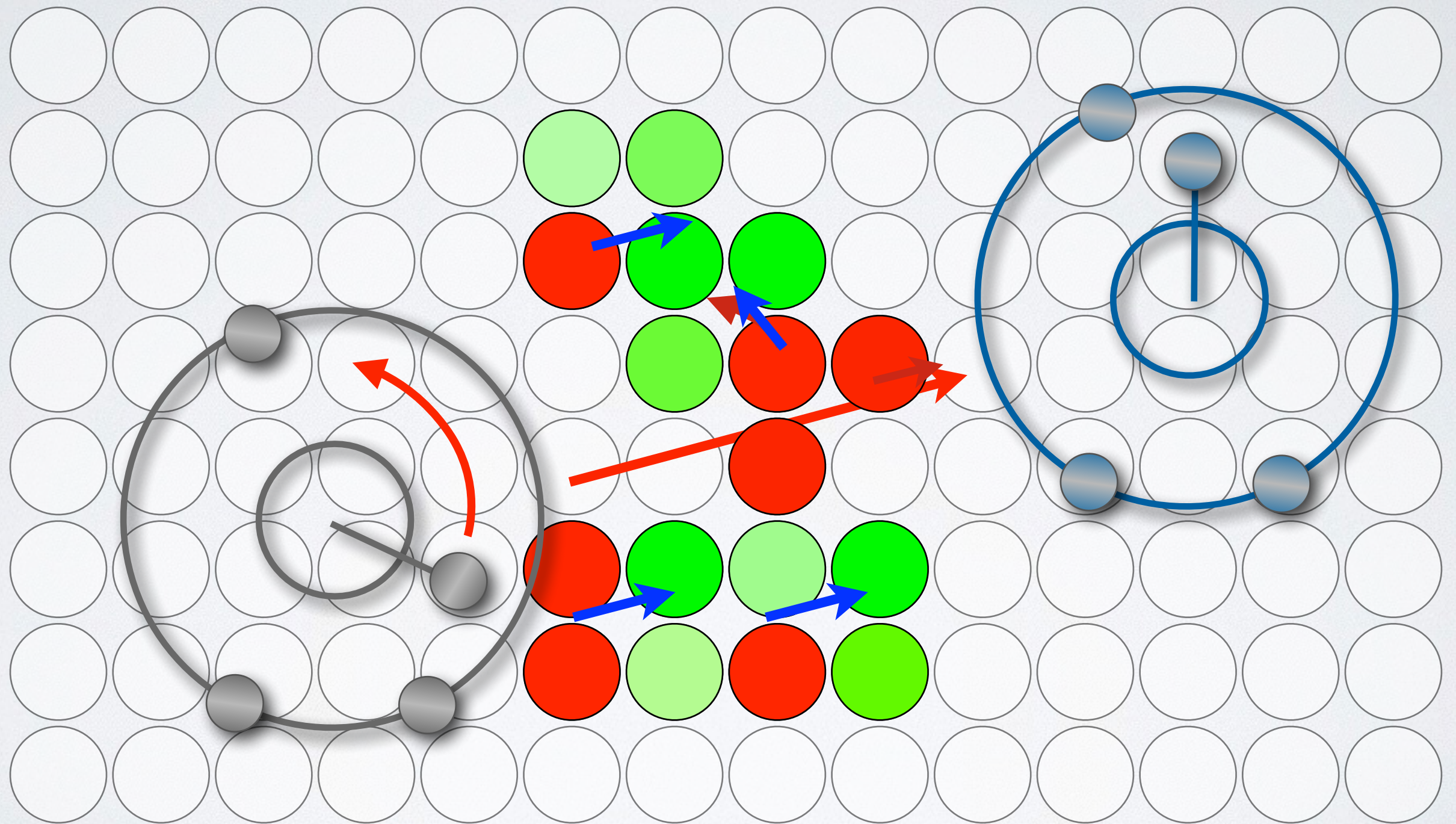
actuation



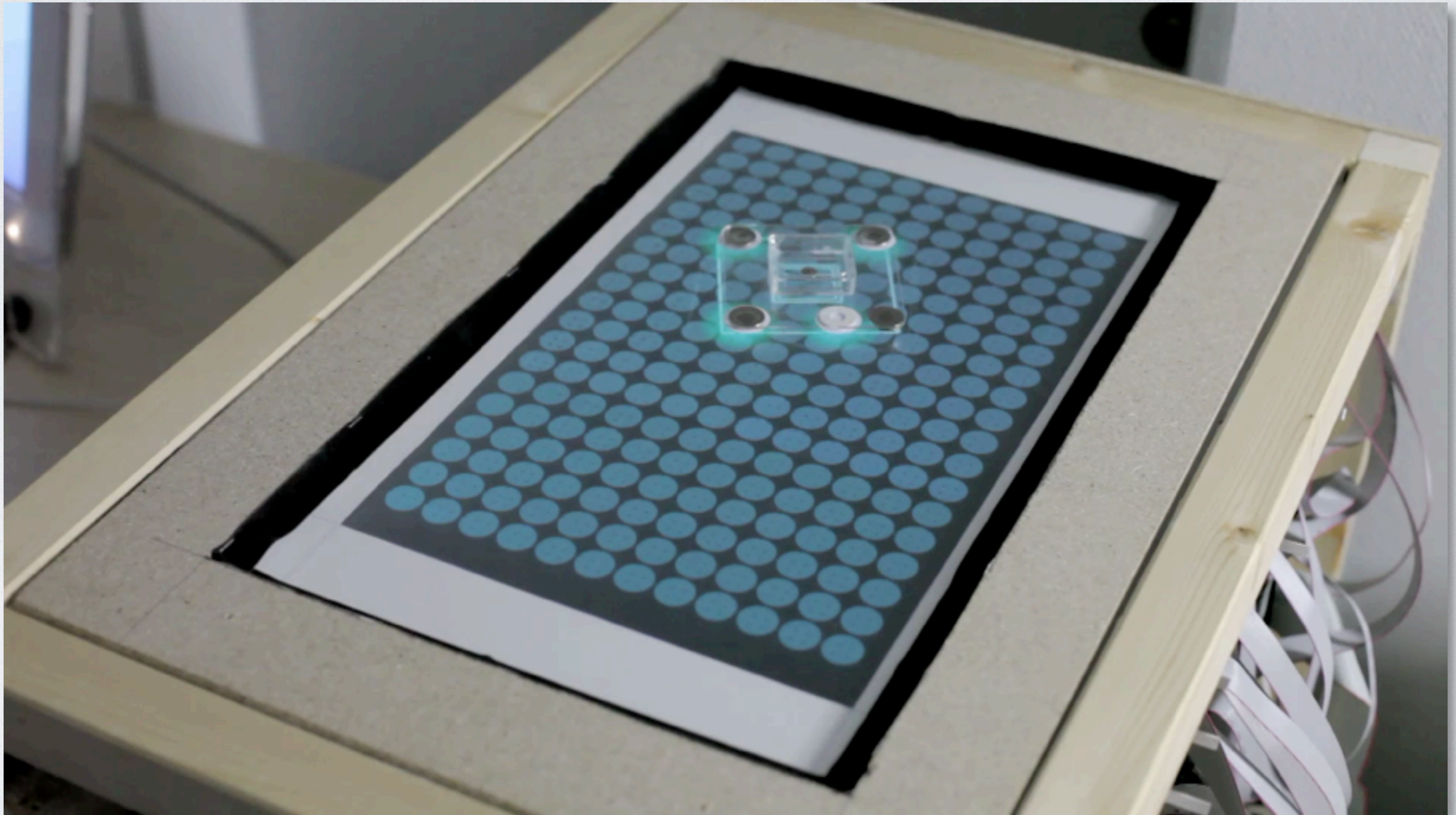
Actuation



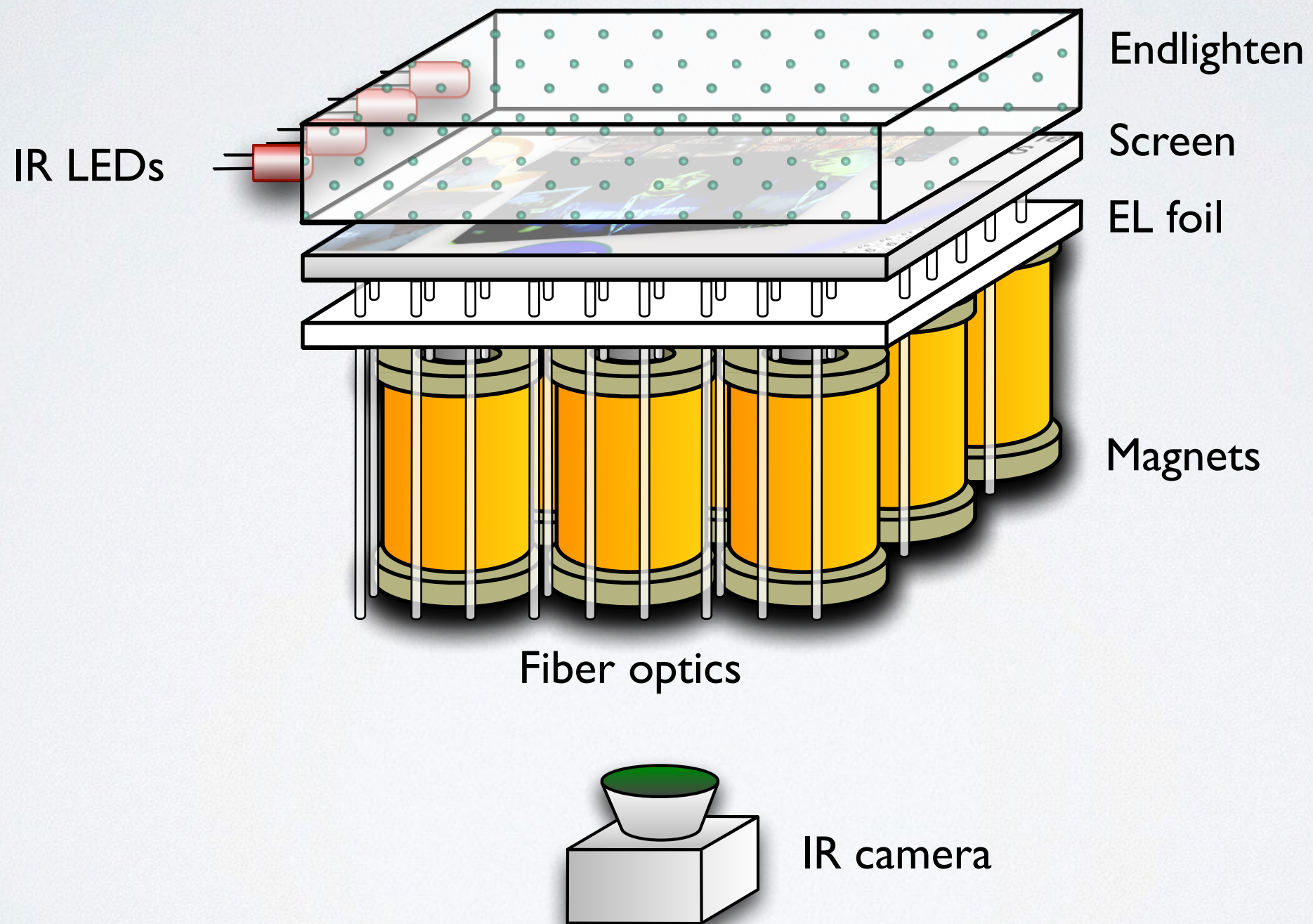
Actuation



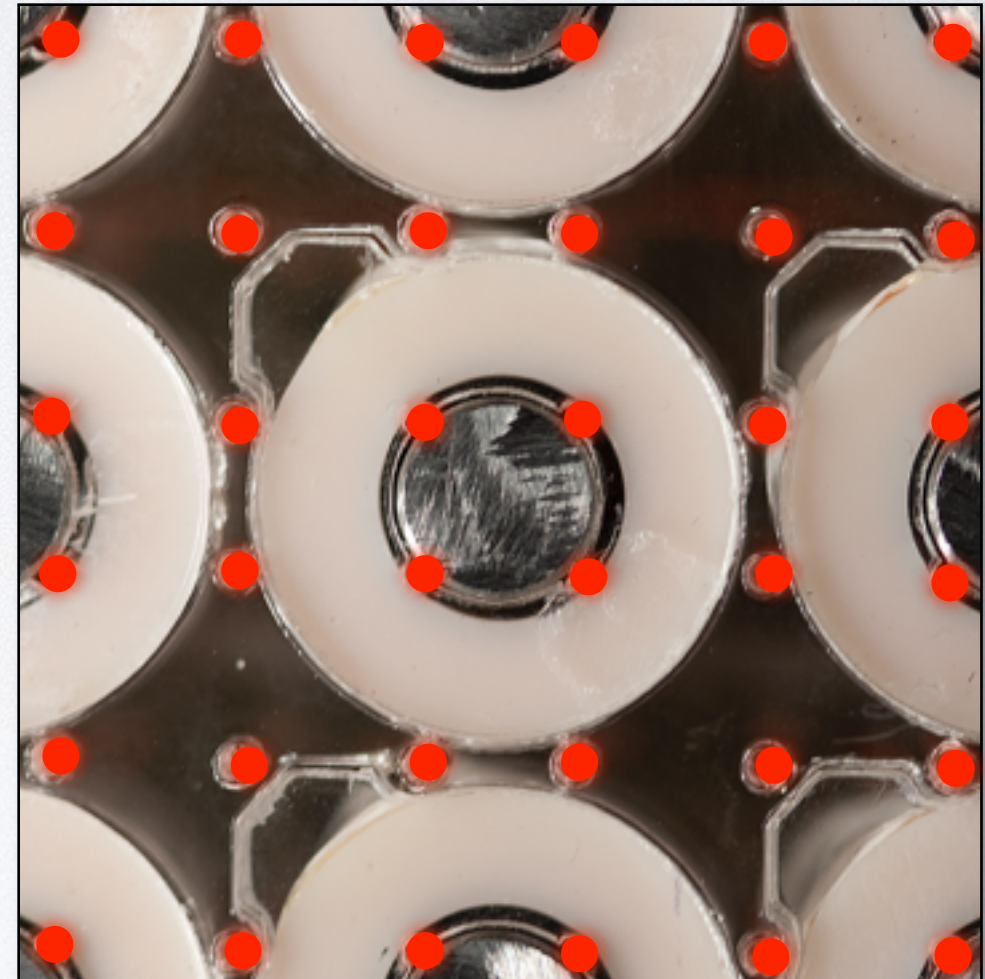
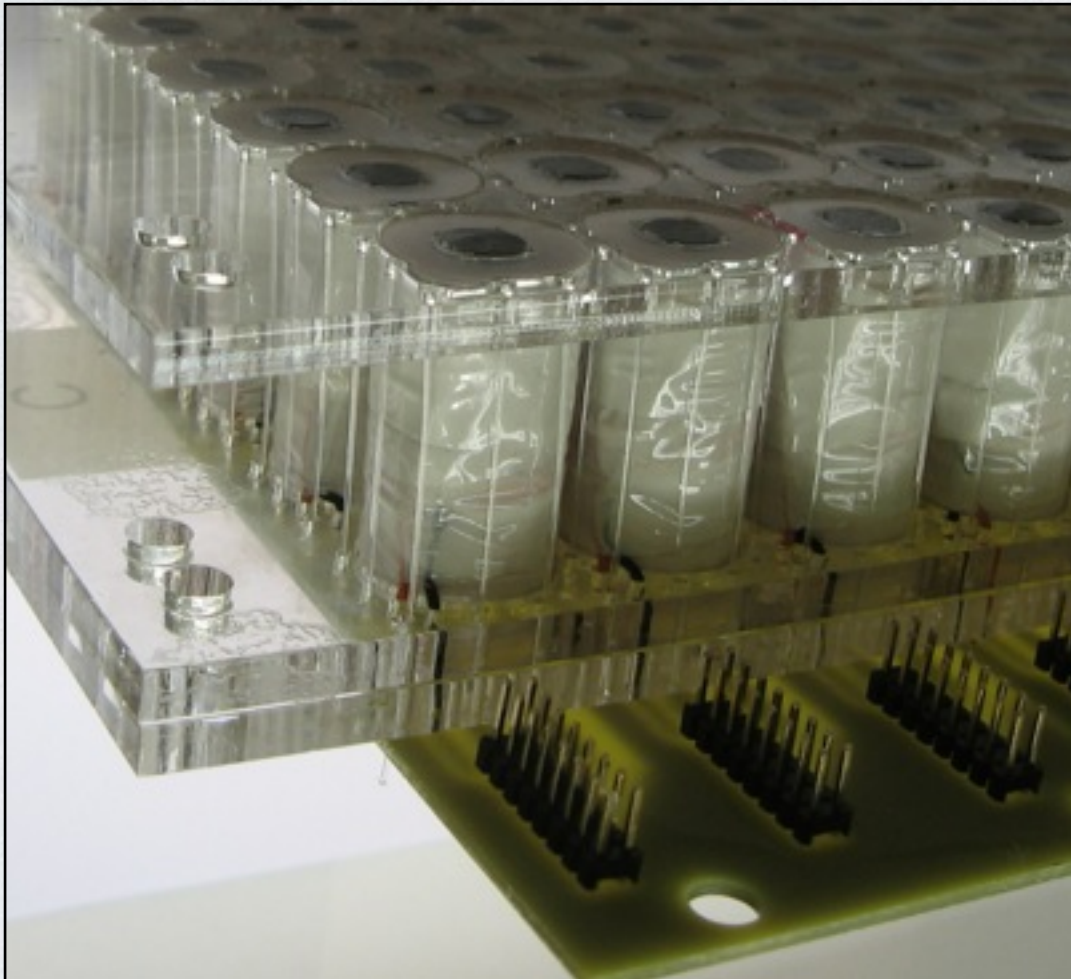
Actuation



Tracking



Tracking



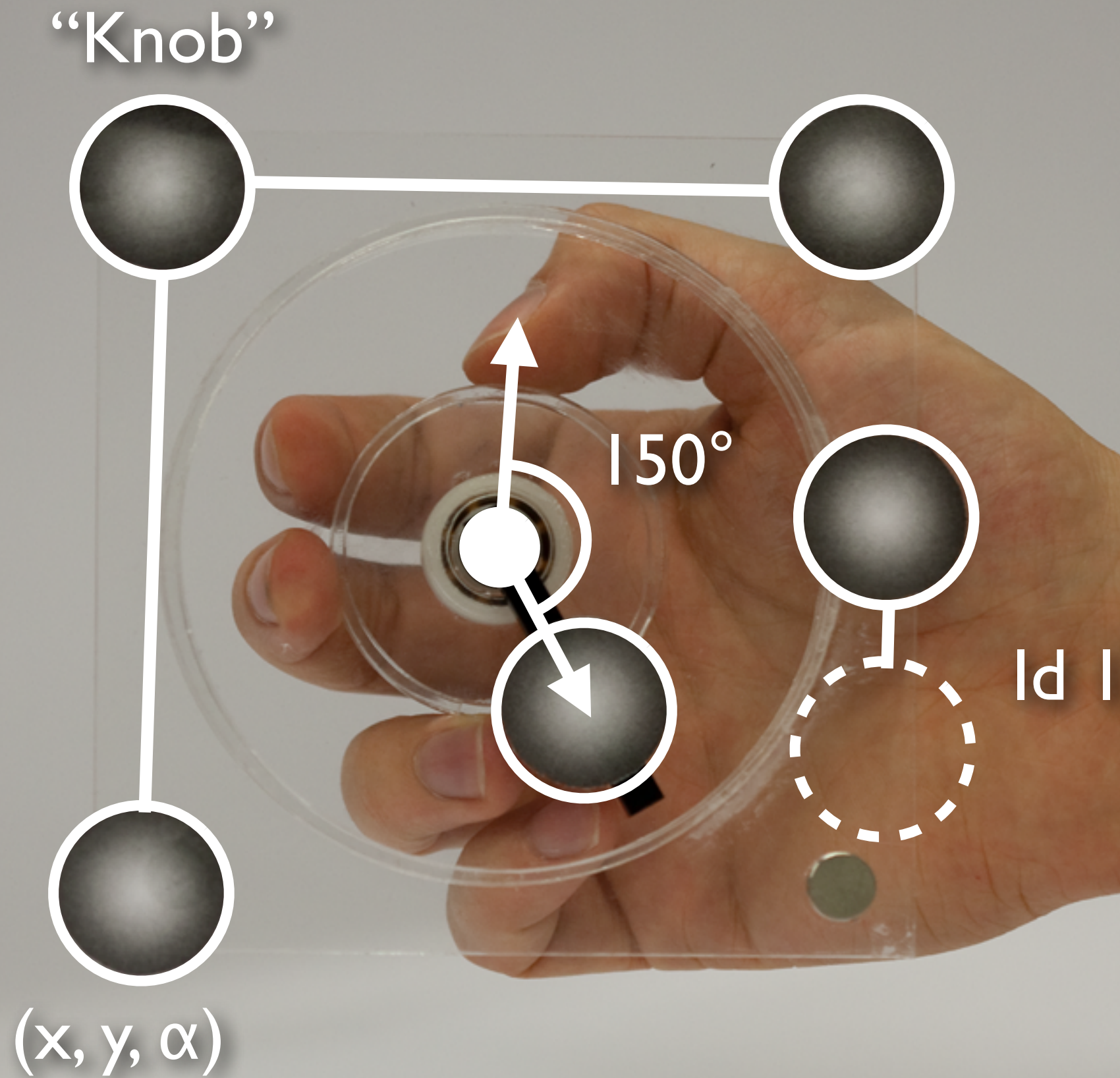
~ 5mm

Tracking

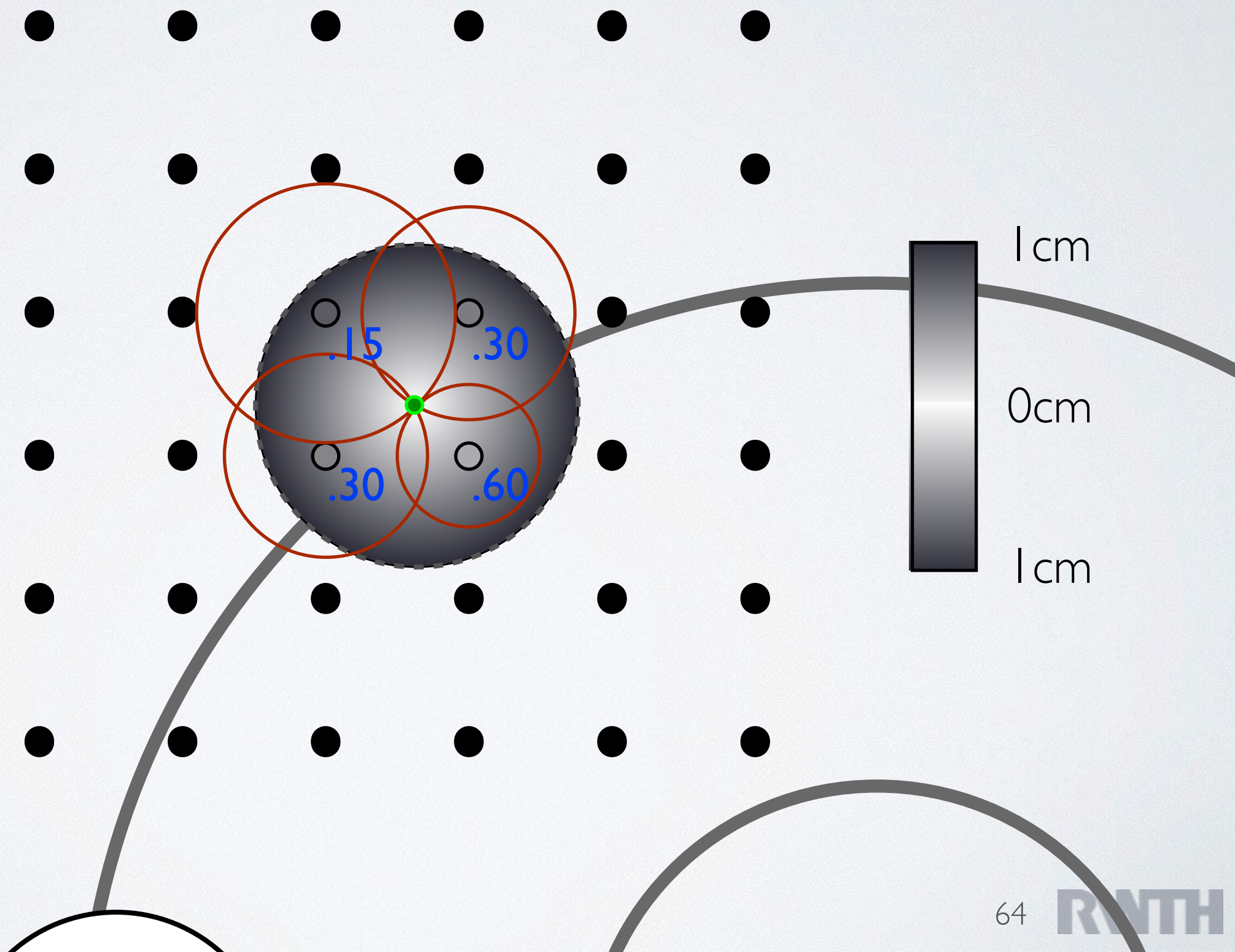


Array

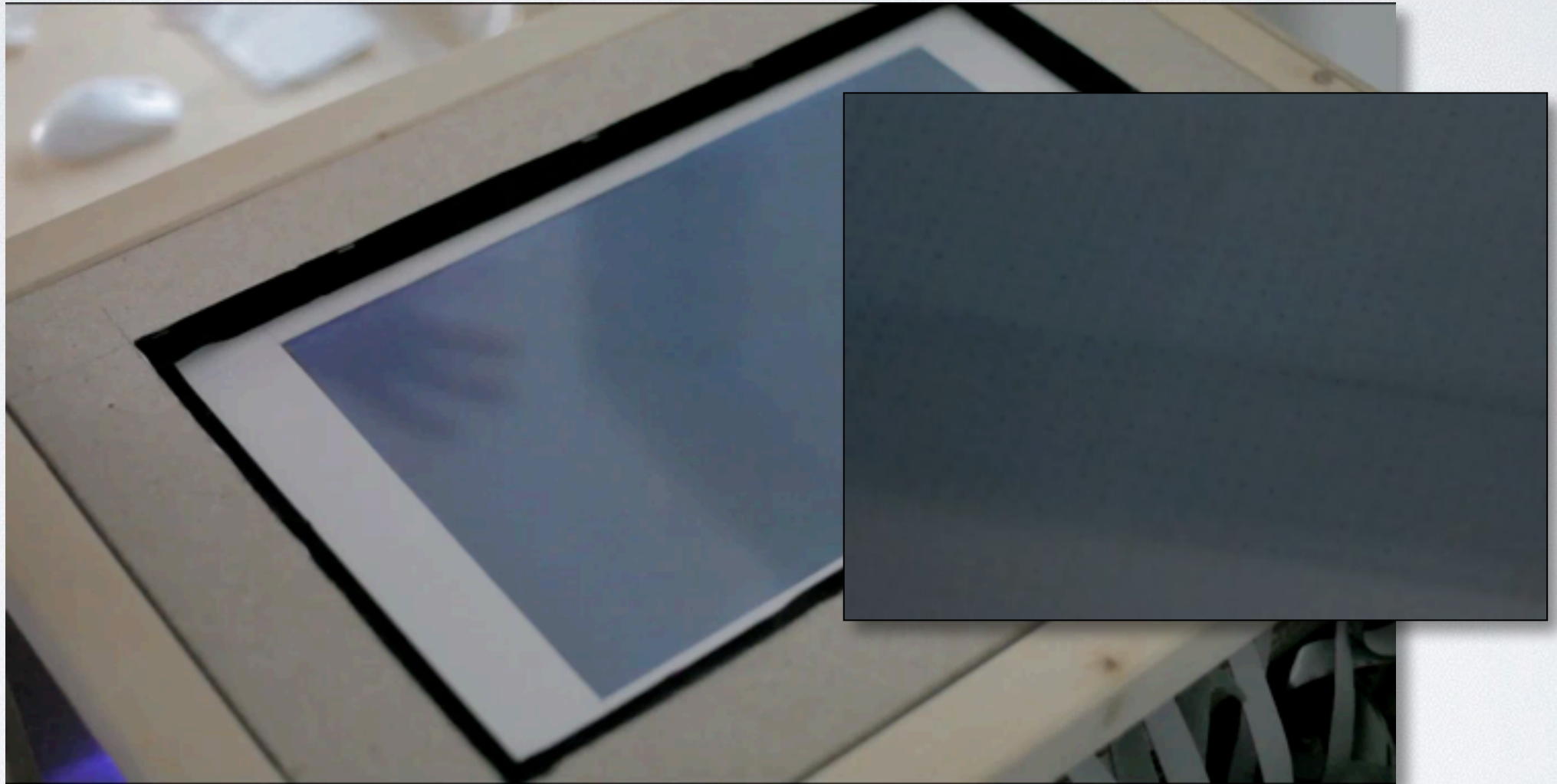
Cameras



Gradient Markers

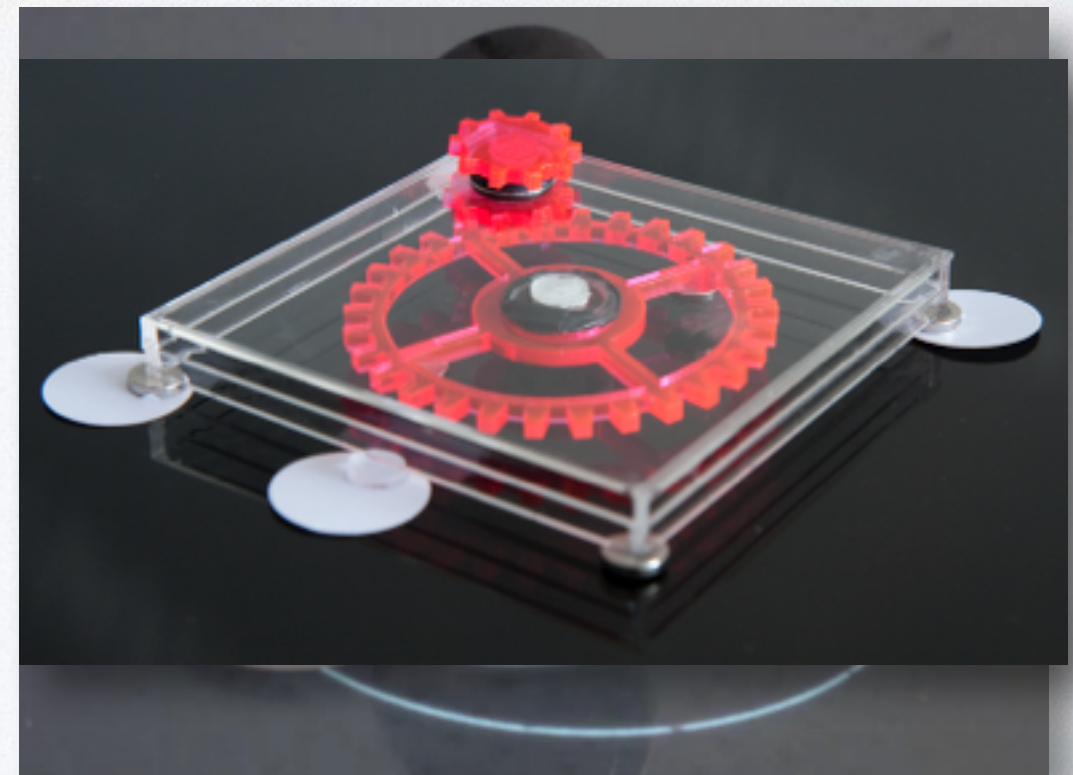
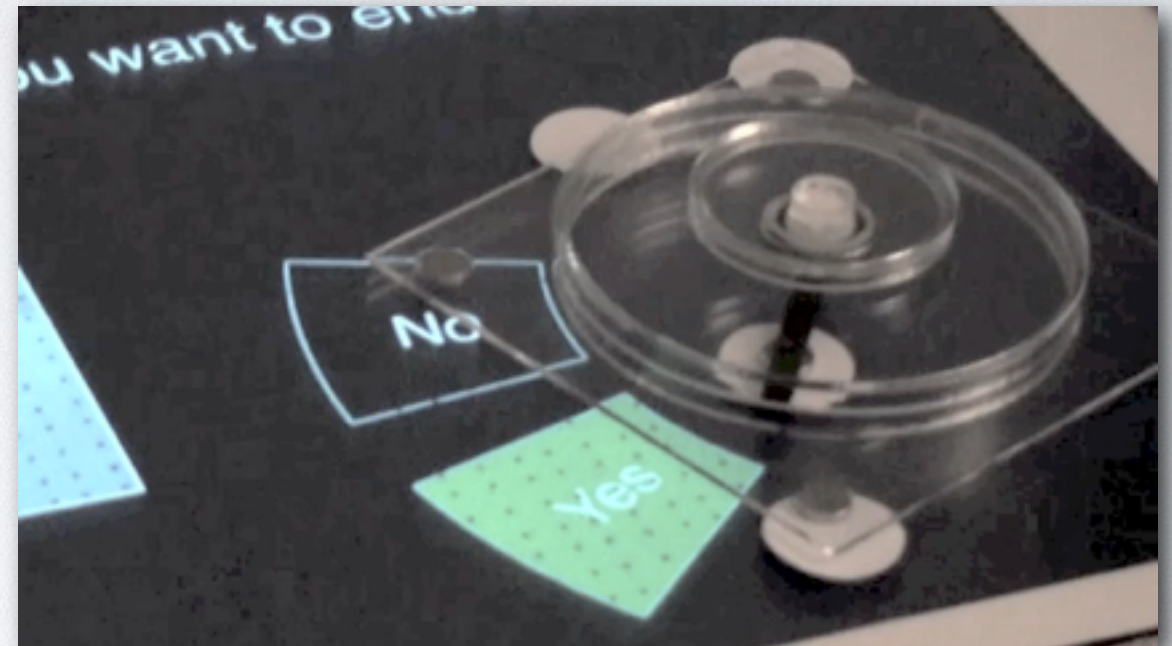


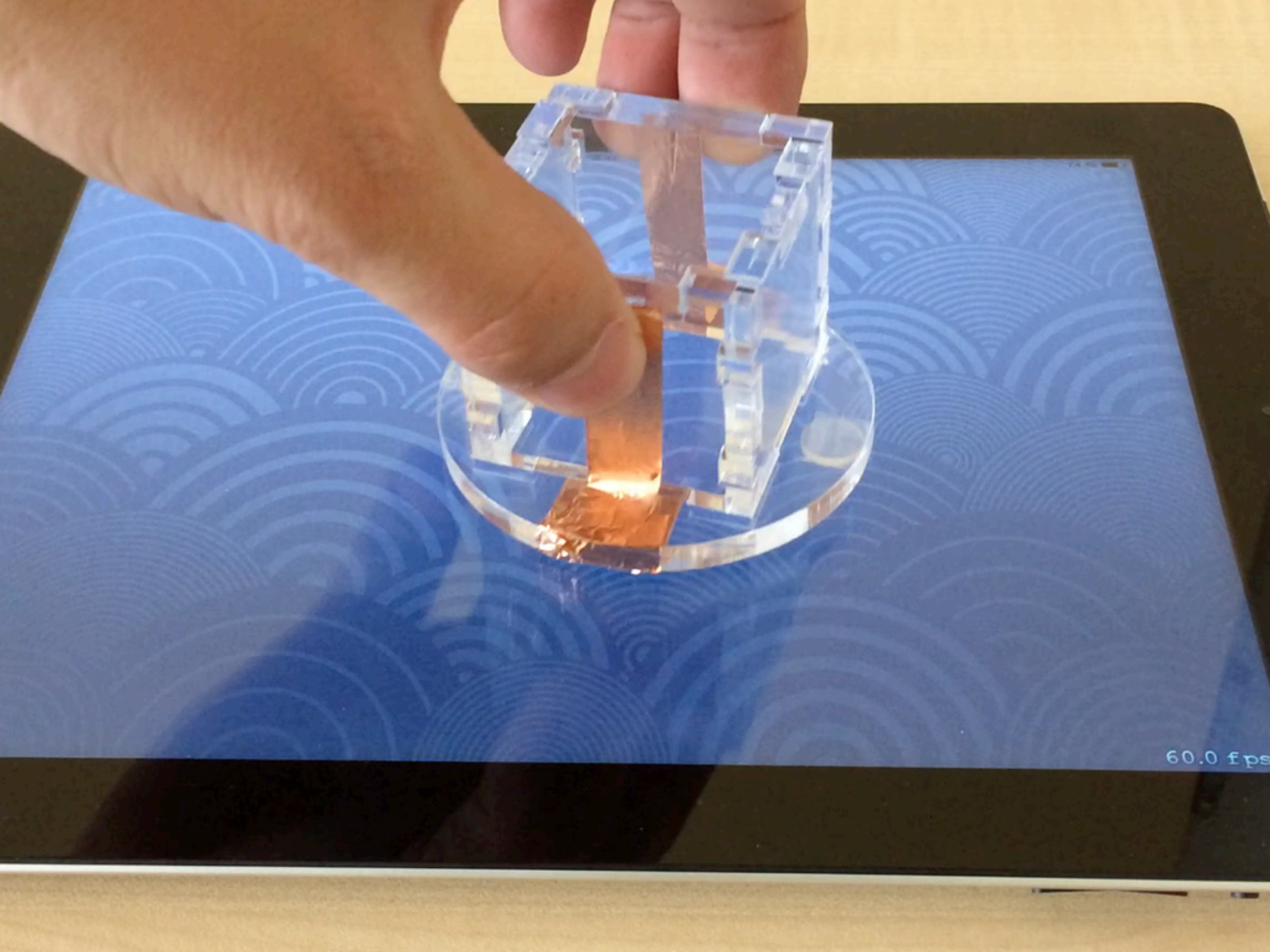
Tracking



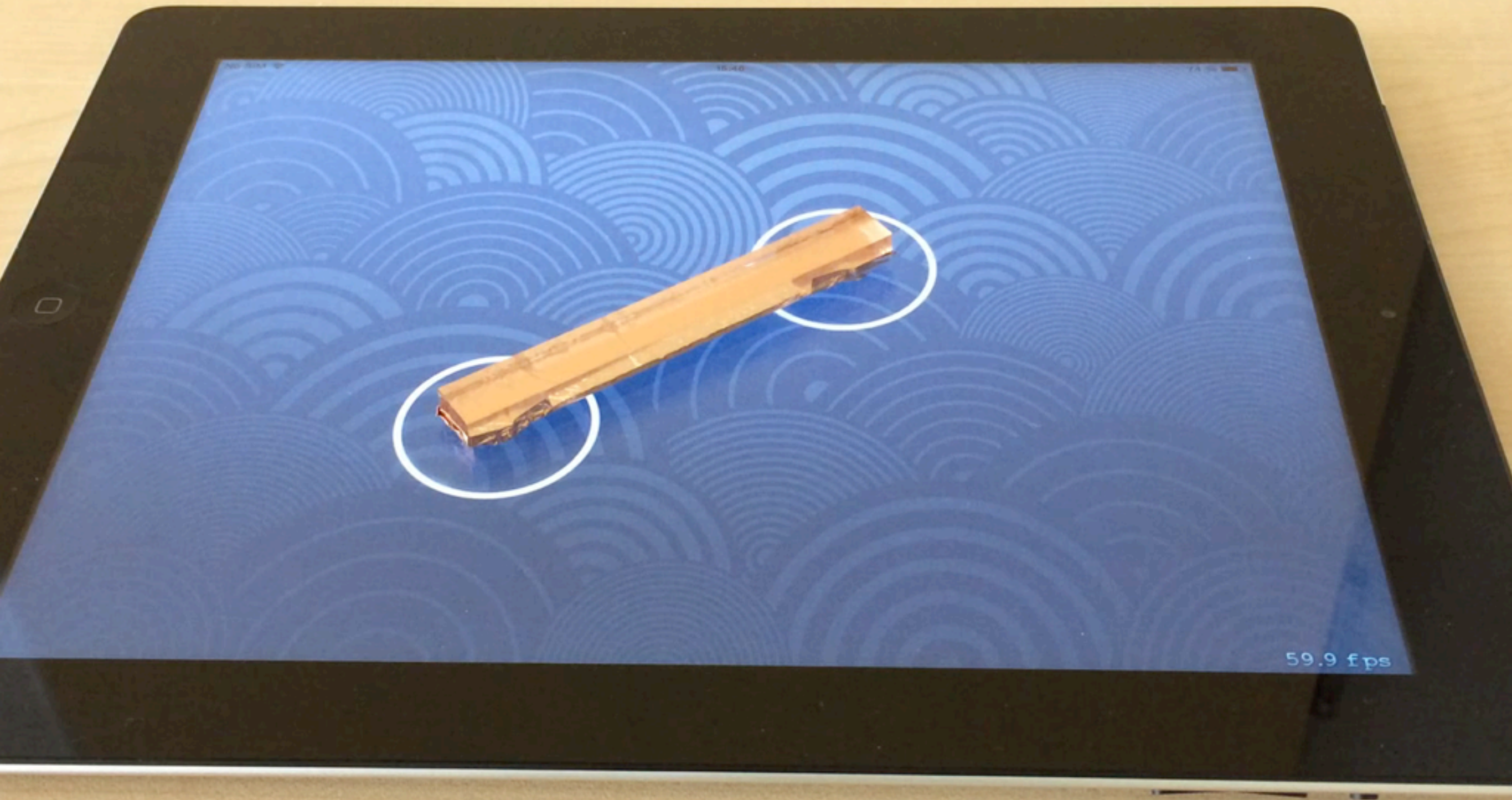
Applications

- Physical-visual consistency
 - Load/save, undo/redo
 - Remote tangible collaboration
- Height
- Power transfer





60.0 fps

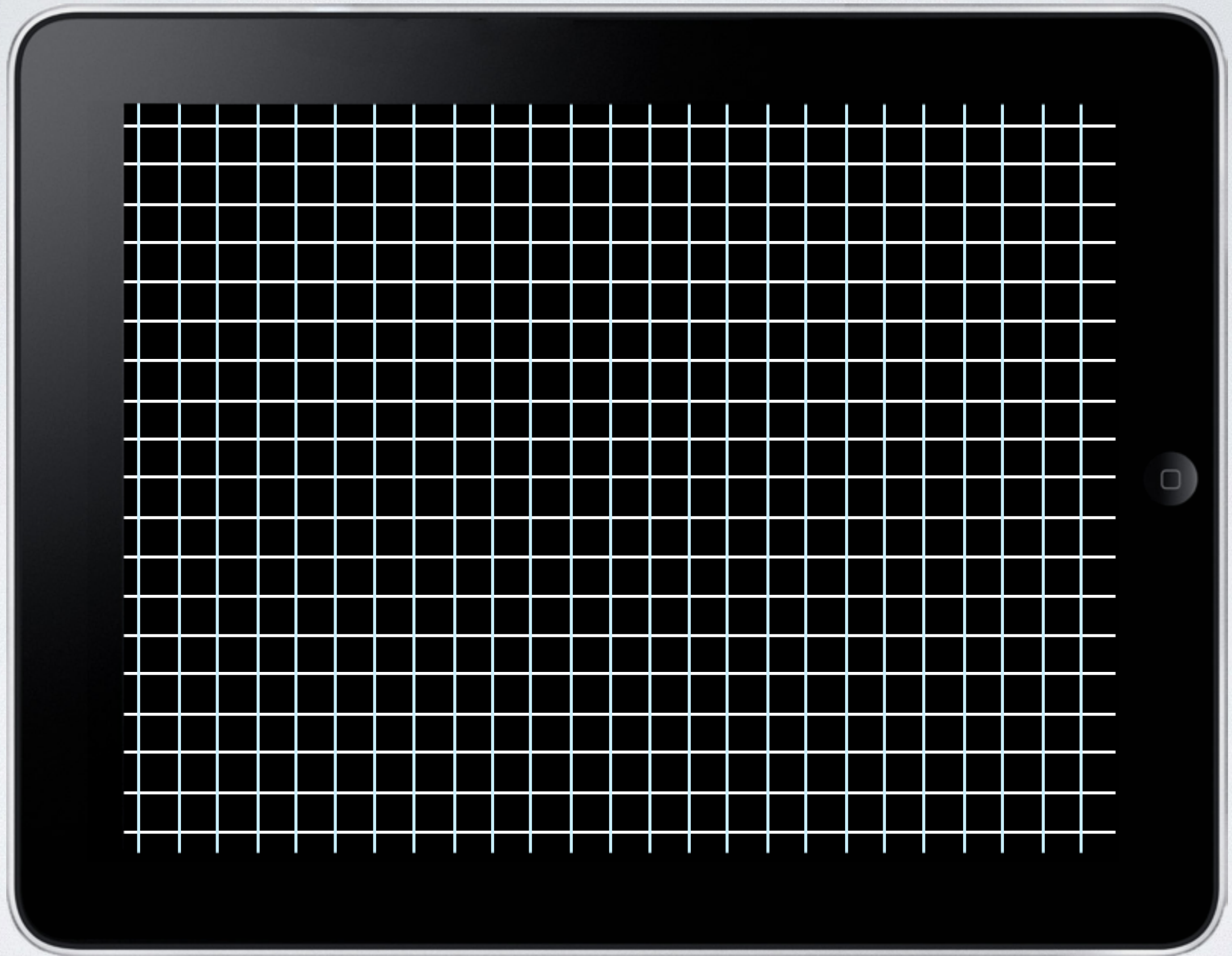


PUCs Bridge



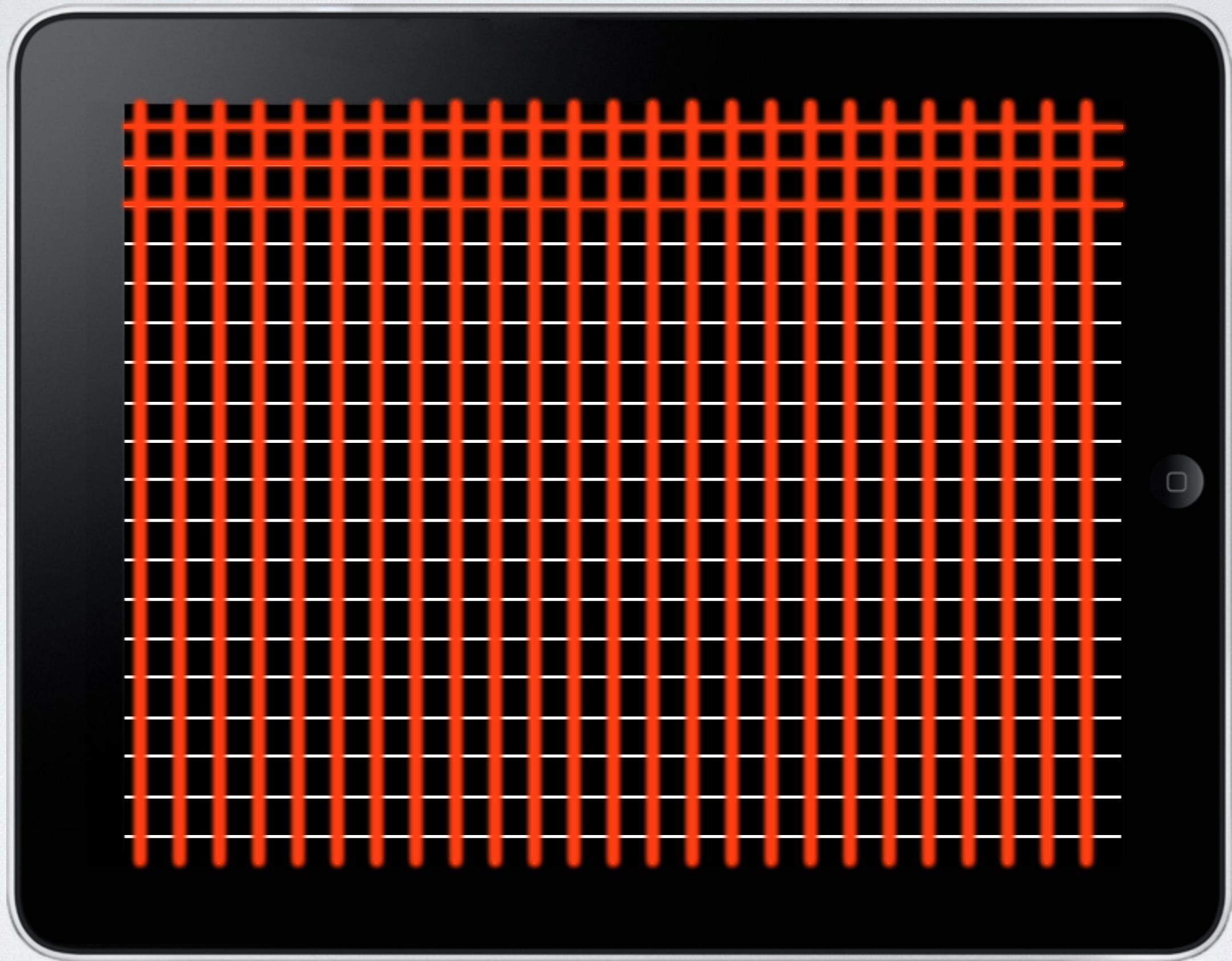
Receiving
Electrodes

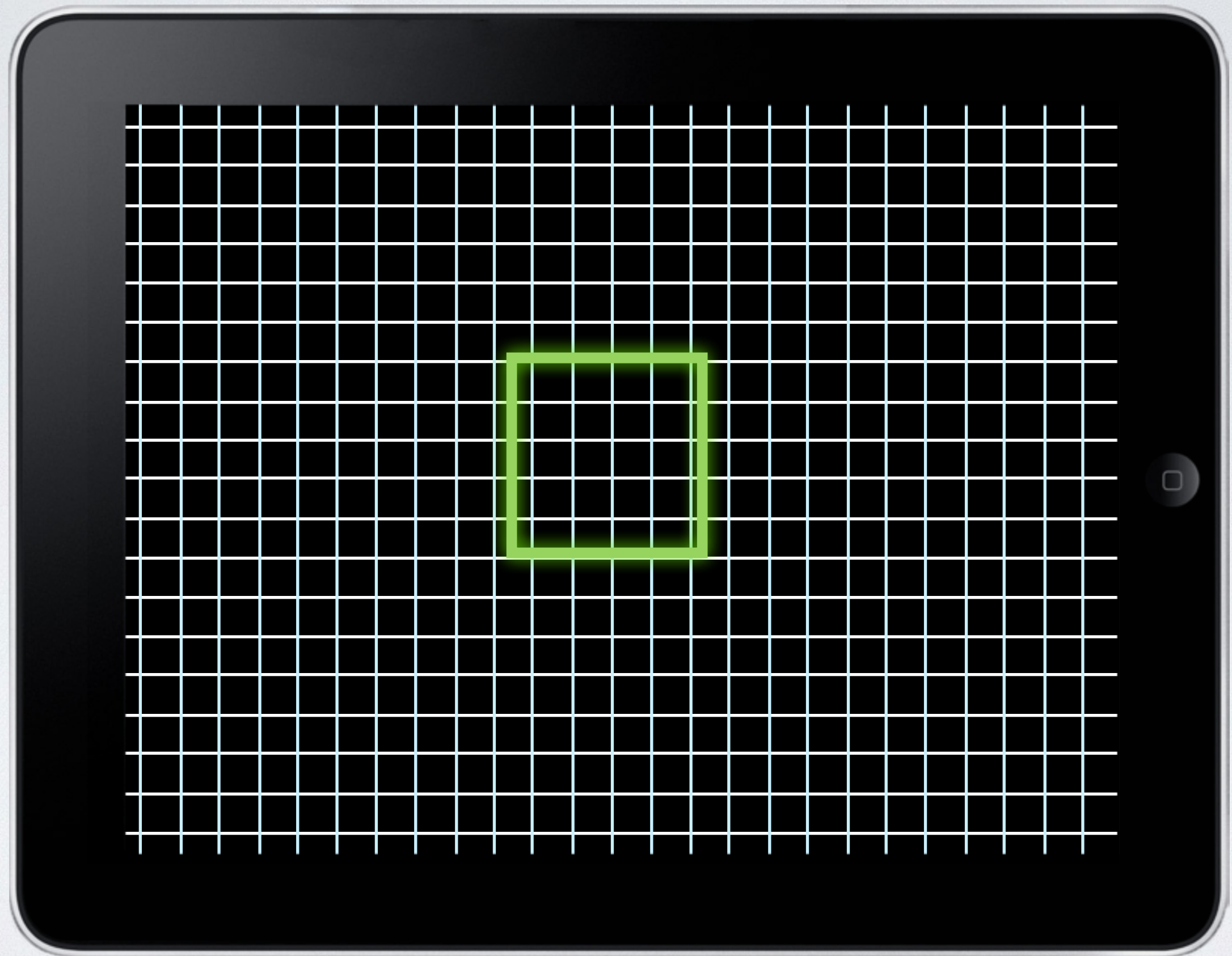
Transmitting
Electrodes



Receiving
Electrodes

Transmitting
Electrodes





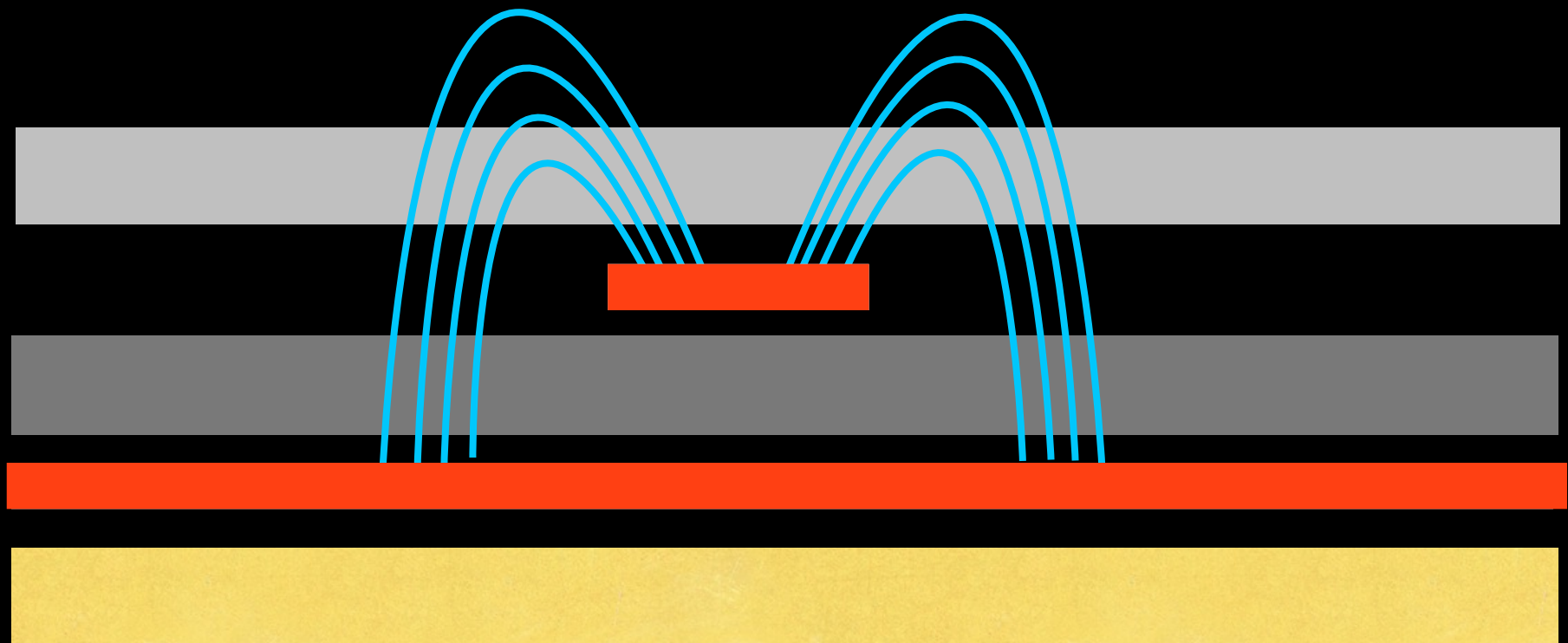
Glass Surface

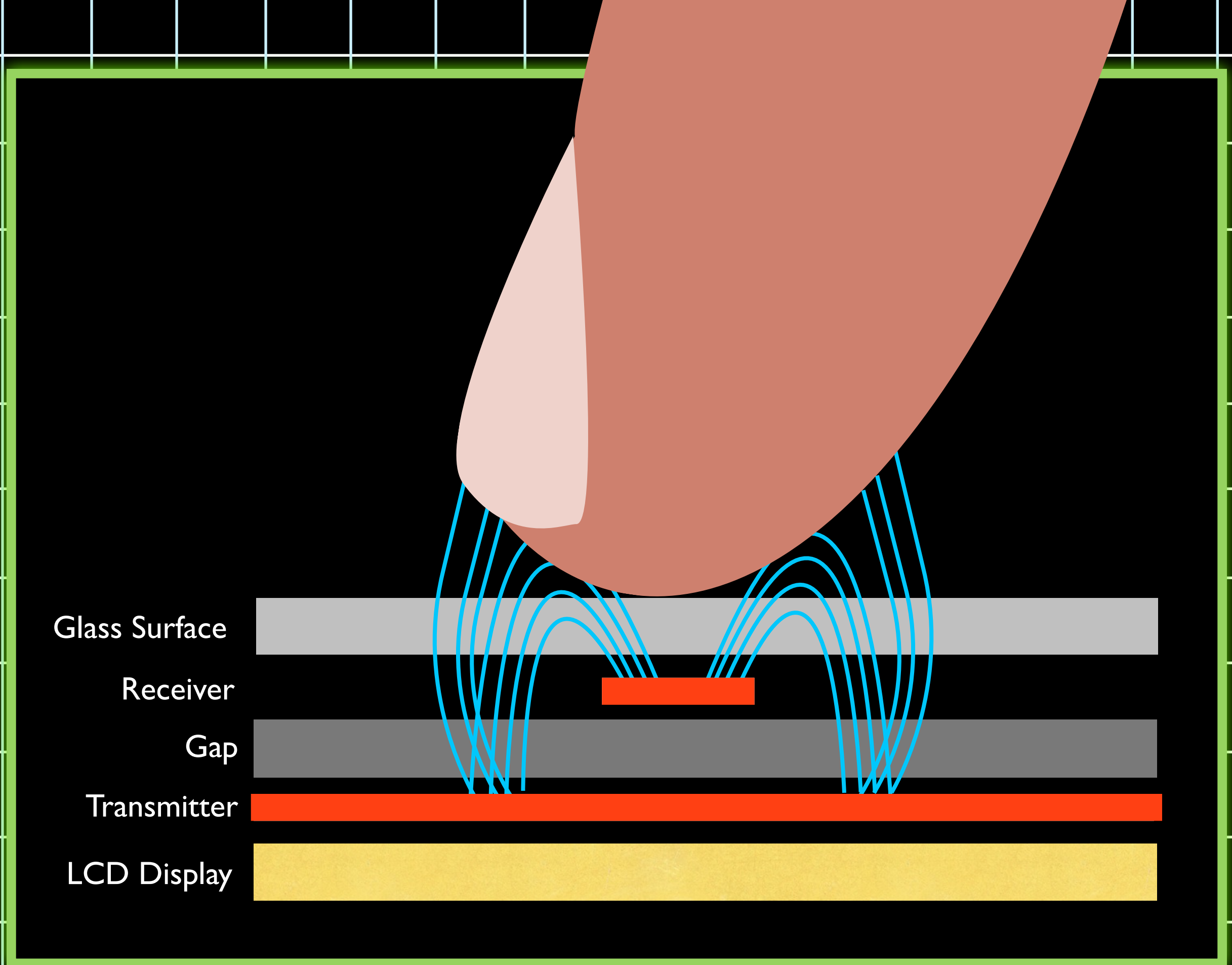
Receiver

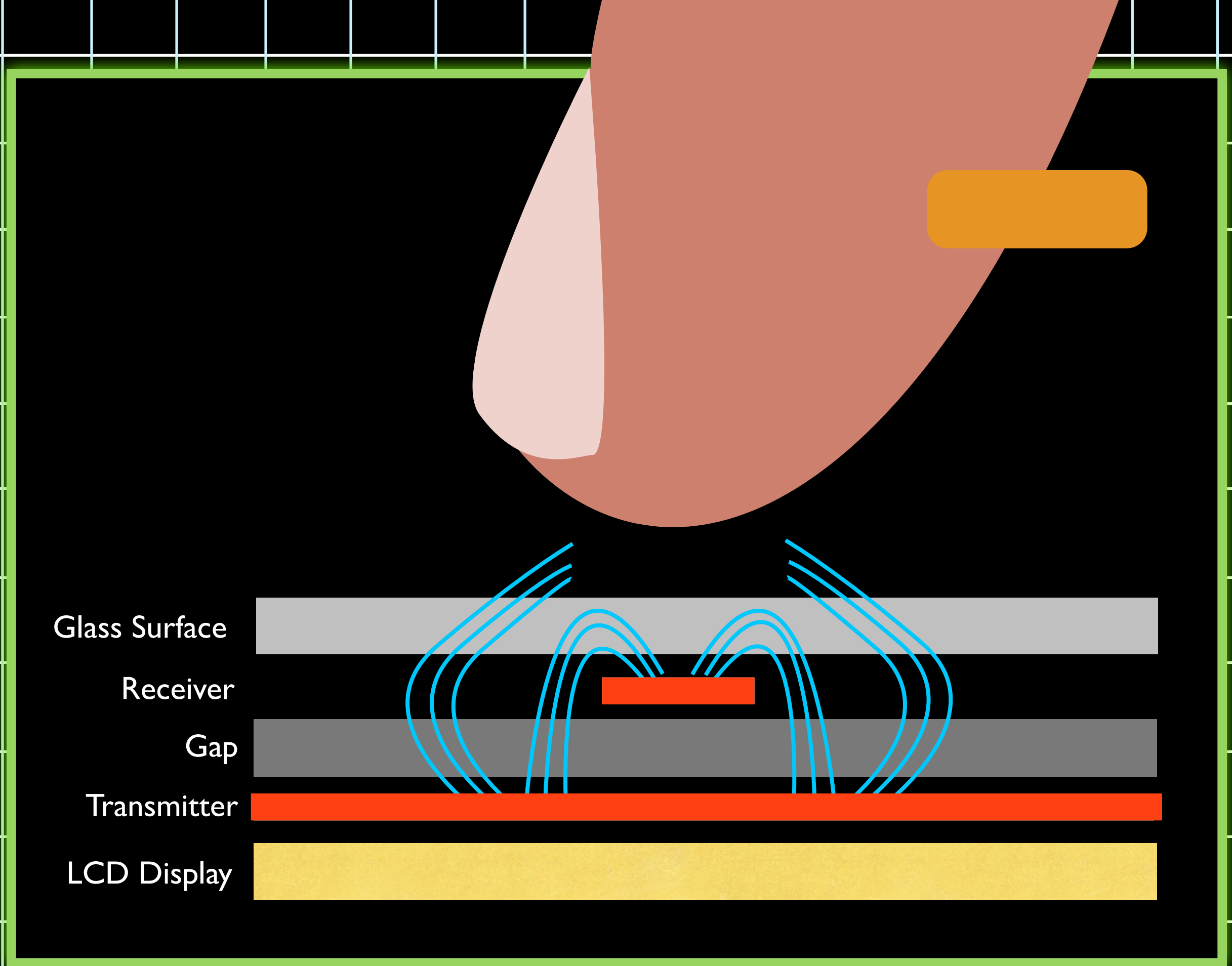
Gap

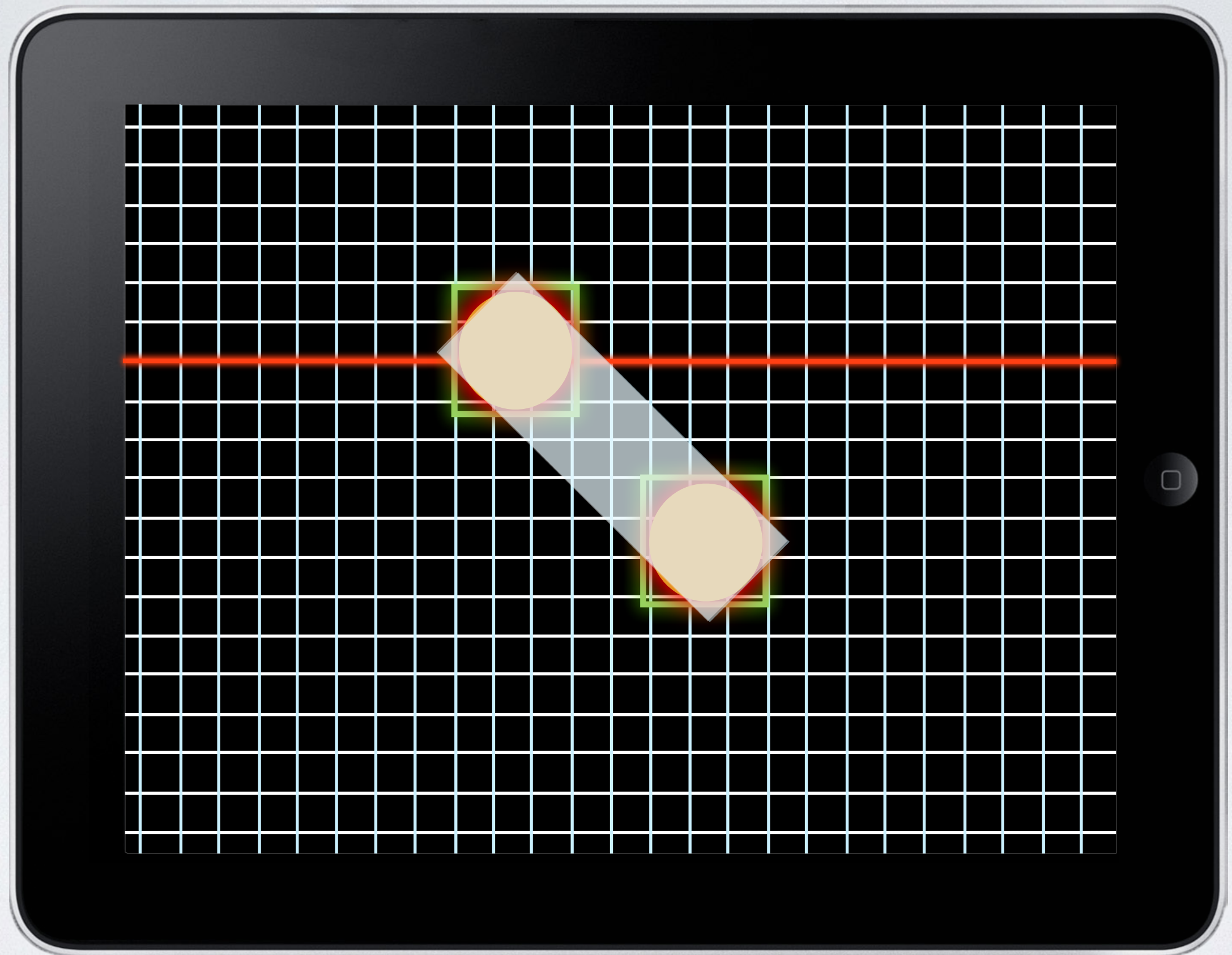
Transmitter

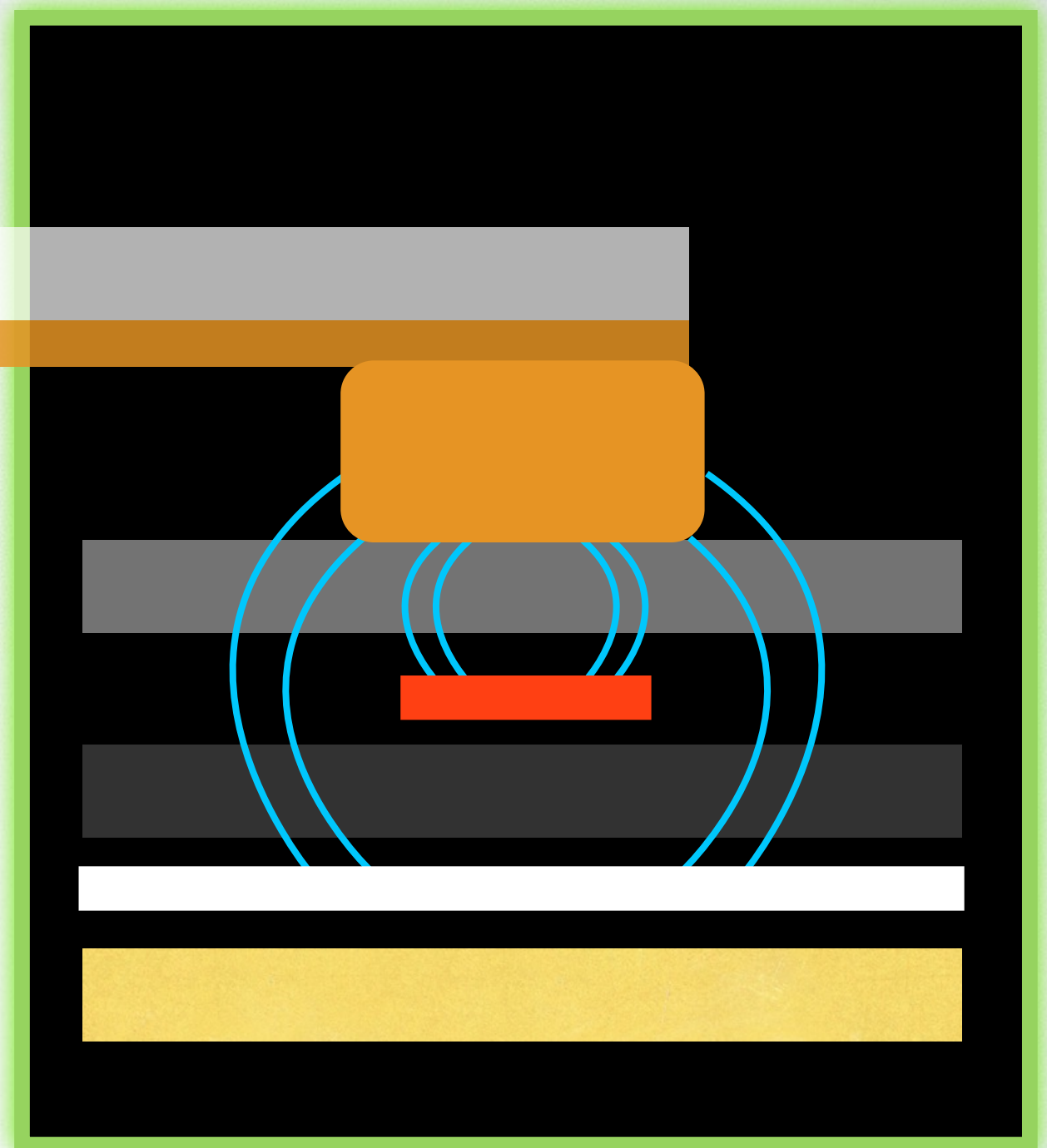
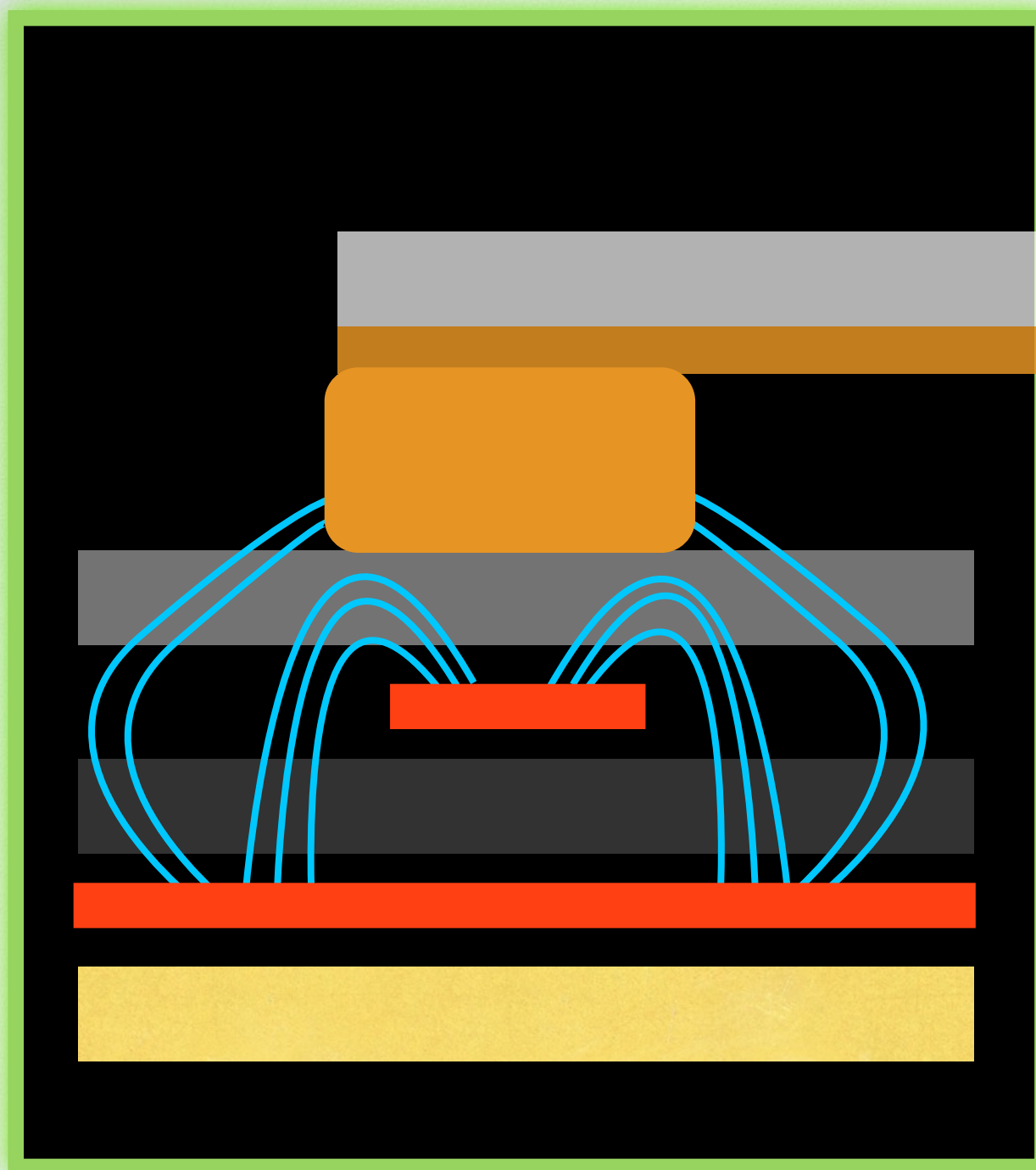
LCD Display

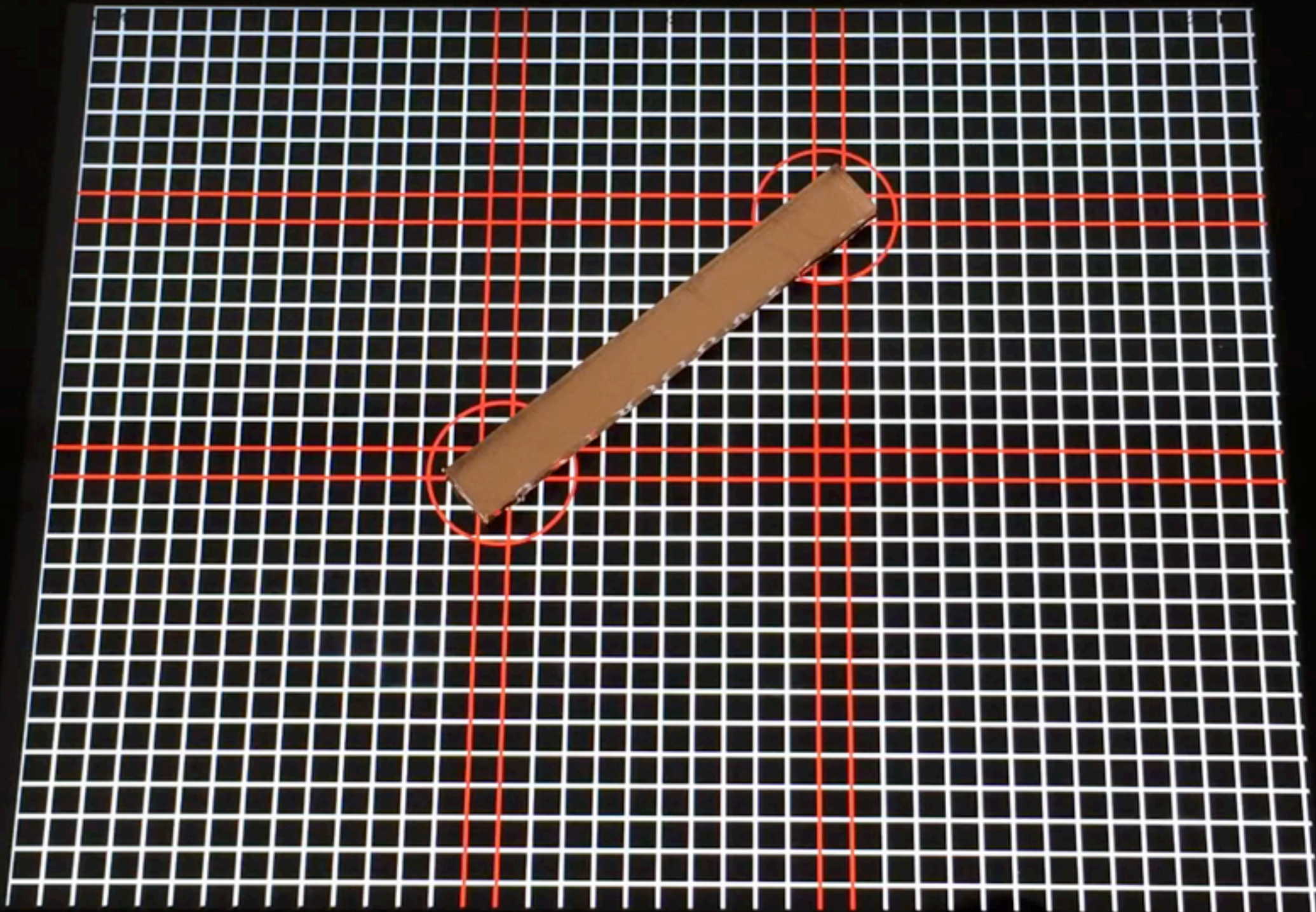


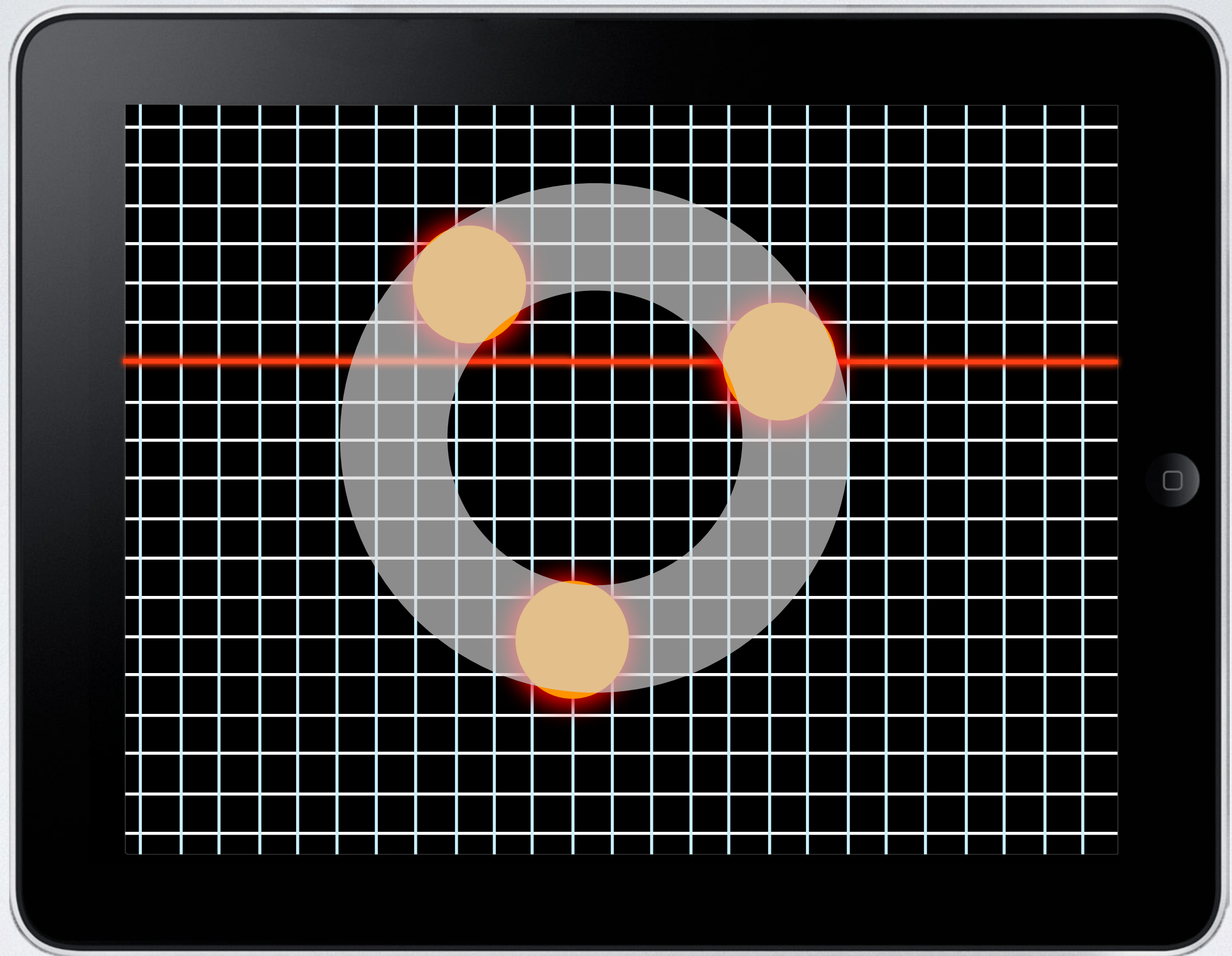












Multi-Touch Summary

- Form factor matters
- Rethink applications
- Tangible can help!

