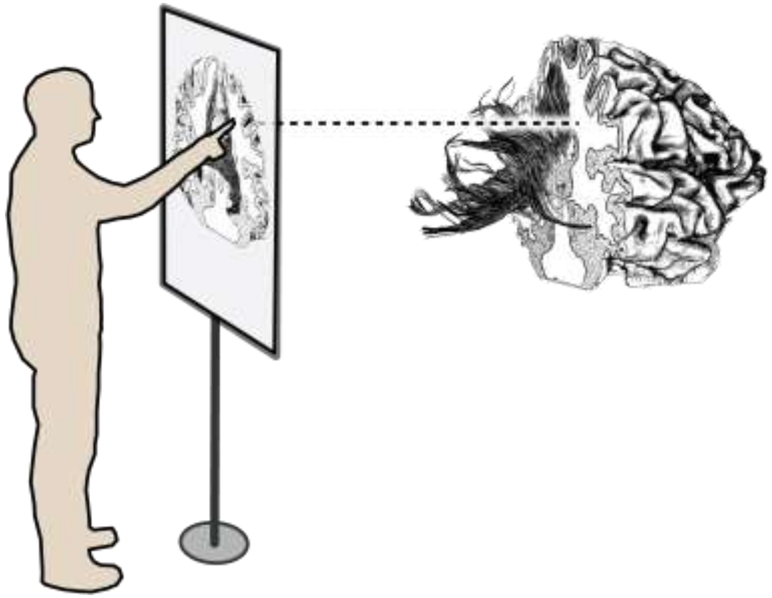


Tools & Techniques for Direct (Volume) Interaction

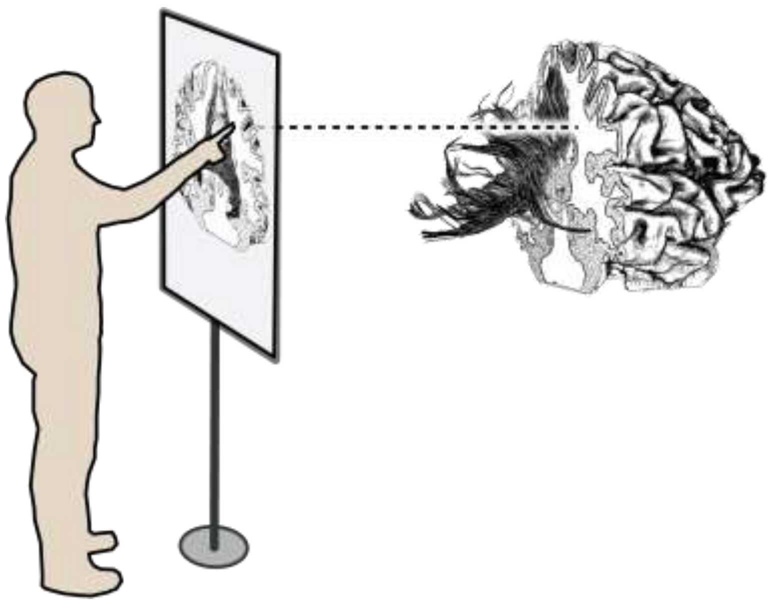
3. Interaction with Non-Standard Input and Output Devices

Traditional vs. Non-Traditional Environments

images: Logitech, LG, A. Wiebel, Univ. Groningen, Microsoft, D. Keefe, Google

Outline

- general considerations
  - output type: stereoscopic vs. monoscopic
  - input type: direct vs. indirect
  - tactile interaction feedback type: none, somesthetic, haptic
  - benefits and challenges
  - various combinations
- some specific interaction techniques
  - dataset navigation & selection
  - parameter specification
  - technique combinations



Interaction with Non-Standard Input and Output Devices

Part 1: General Considerations

Monoscopic vs. Stereoscopic Display

less immersion

$\rightarrow$ good stereo perception only w/ interaction

high visual immersion

$\rightarrow$ stereo perception w/o interaction

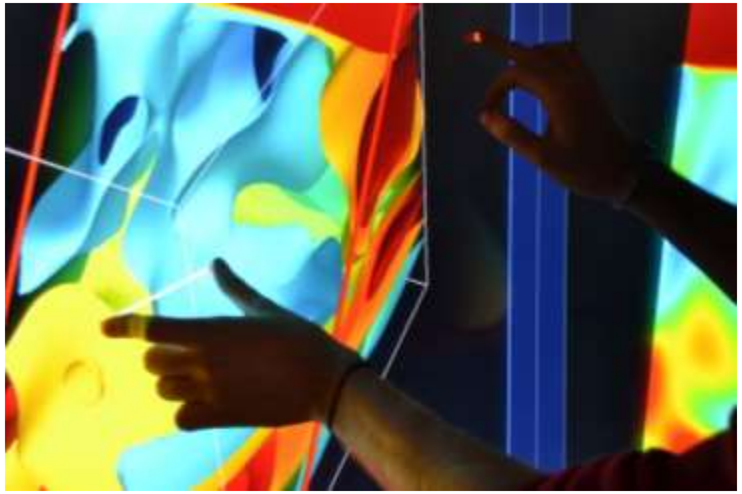
$\rightarrow$ ppl. can understand 3D data well

images: Univ. Groningen, LG, A. Wiebel

Indirect vs. Direct Input

input location ≠ data location

→ always mental mapping necessary



input location = data location

→ no mental mapping necessary

→ ppl. feel more in control

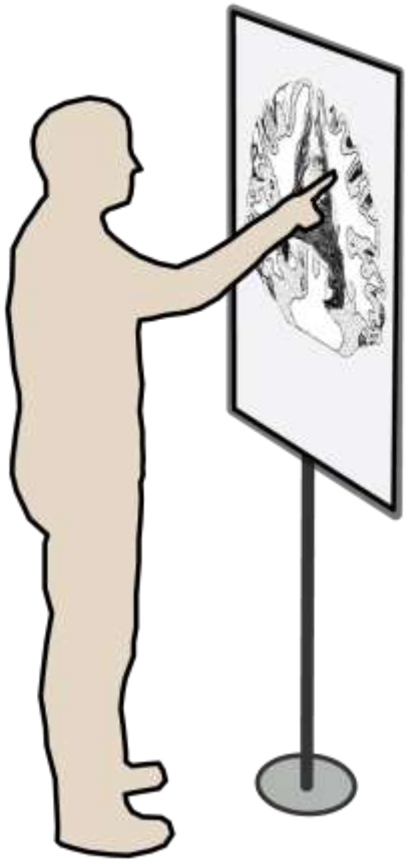
→ immersion from interaction

e.g., pen, touch, 3D tracking

images: Logitech, [Klein et al., 2012]

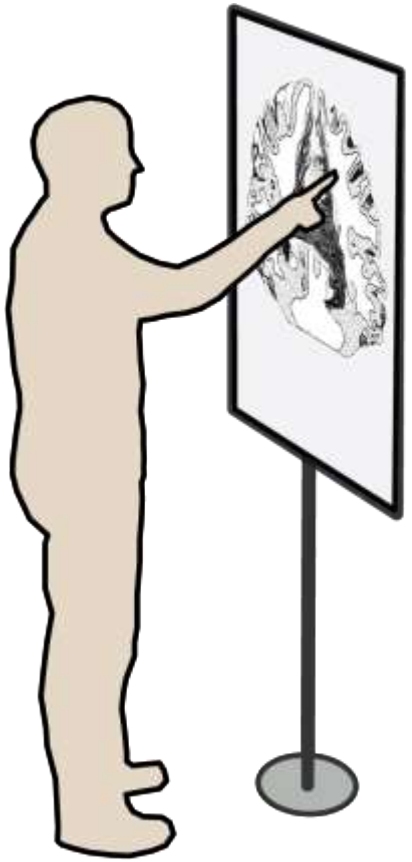
Direct Input for 3D Data? Input vs. Data Domain

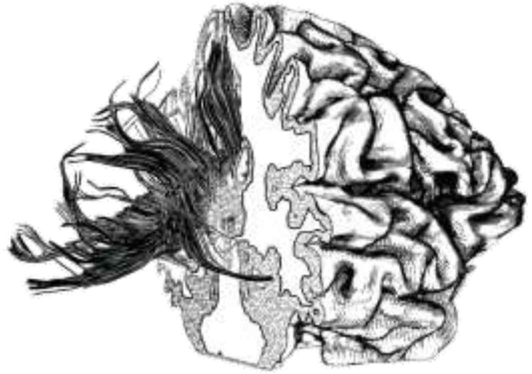
- input space: 2 DOF (1 finger)



Direct Input for 3D Data? Input vs. Data Domain

- input space: 2 DOF (1 finger)
- target space:
  - 3 DOF for position
  - 3 DOF for orientation
  - 1–3 DOF for scale
  - n DOF for additional parameters





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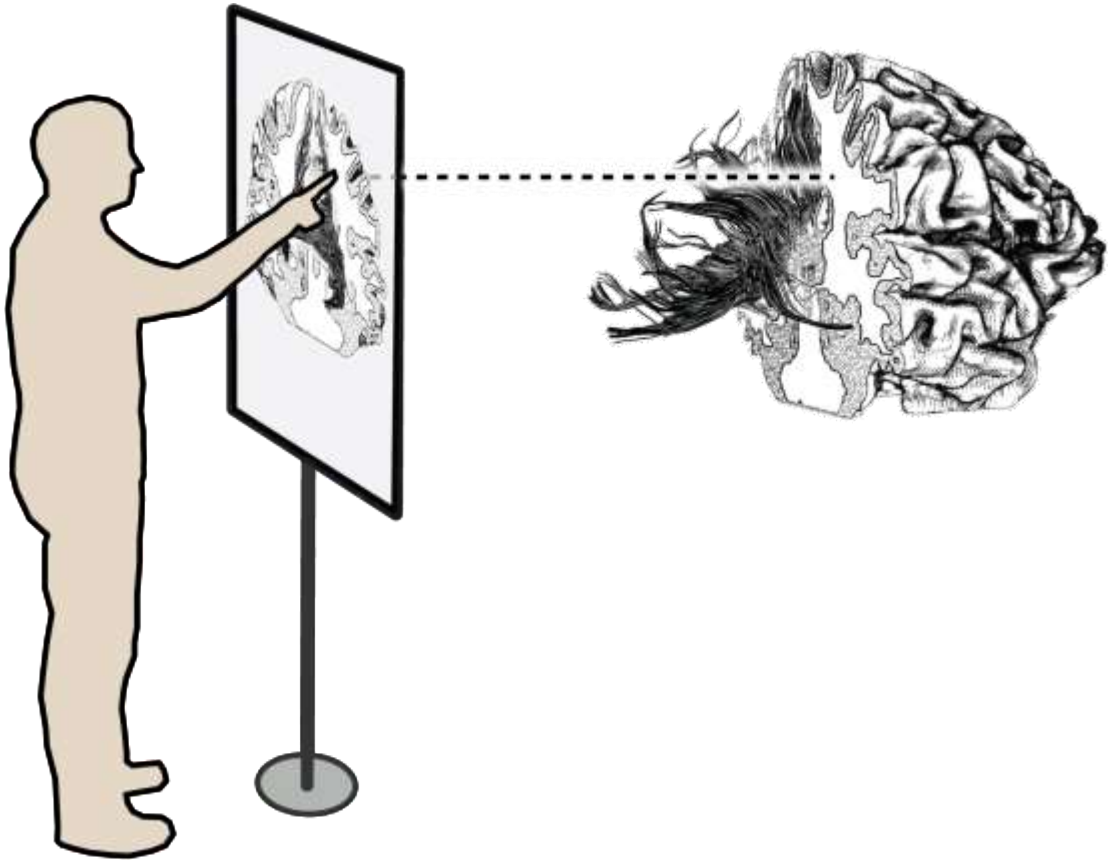

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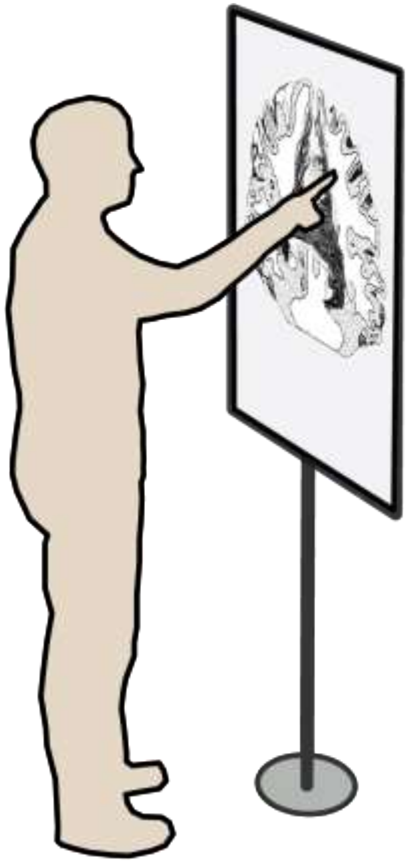

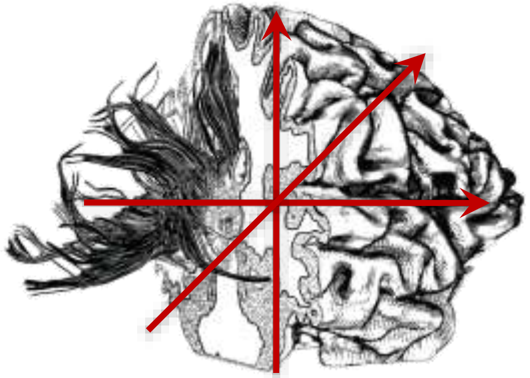

Direct Input for 3D Data? Input vs. Data Domain

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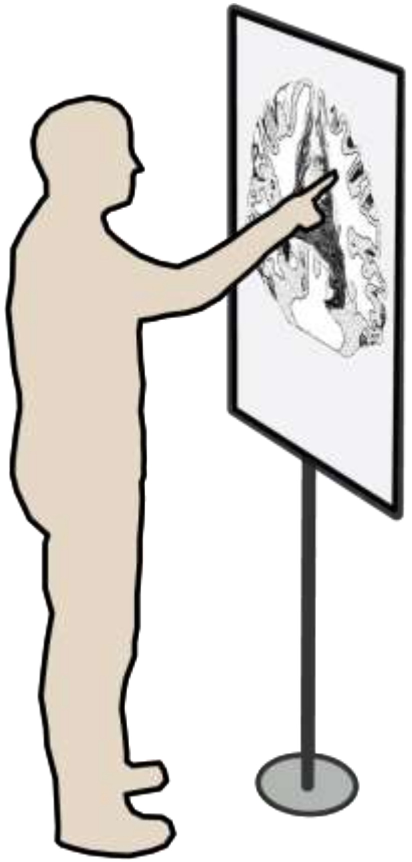
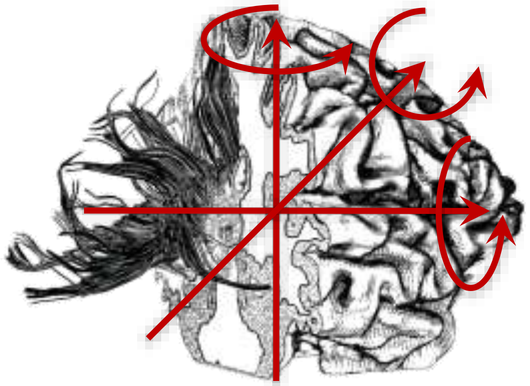
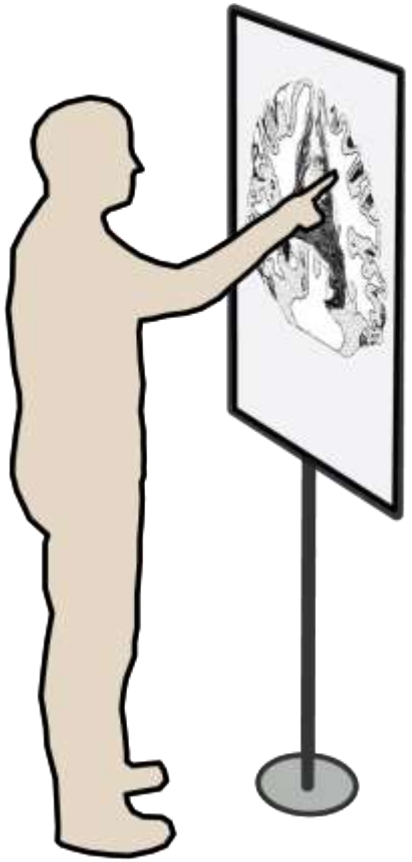
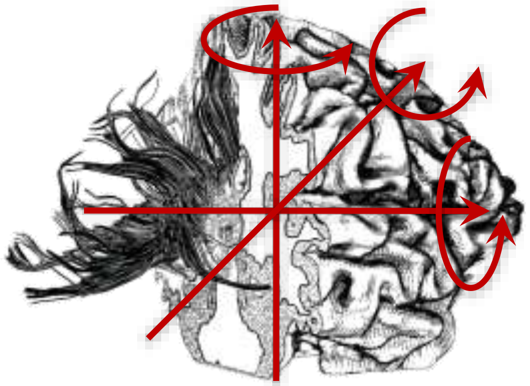




Direct Input for 3D Data? Input vs. Data Domain

- input space: 2 DOF (1 finger)
- target space:
  - 3 DOF for position
  - 3 DOF for orientation
  - 1–3 DOF for scale
  - n DOF for additional parameters
- all per object/element





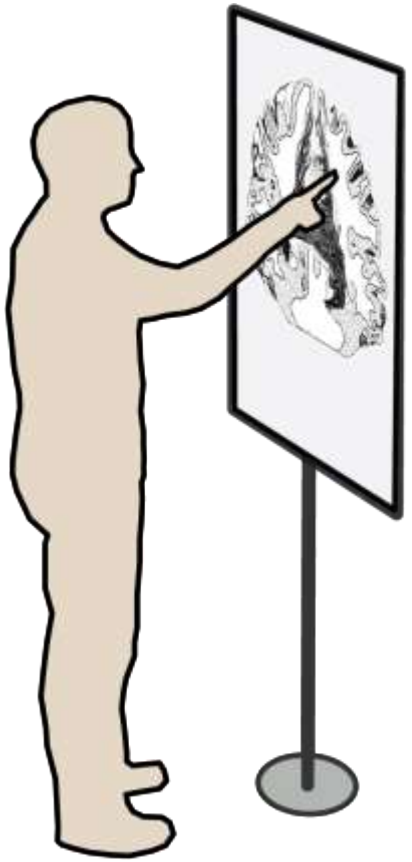
Direct Input for 3D Data? Input vs. Data Domain

- input space: 2 DOF (1 finger)
- target space:
  - 3 DOF for position
  - 3 DOF for orientation
  - 1–3 DOF for scale
  - n DOF for additional parameters

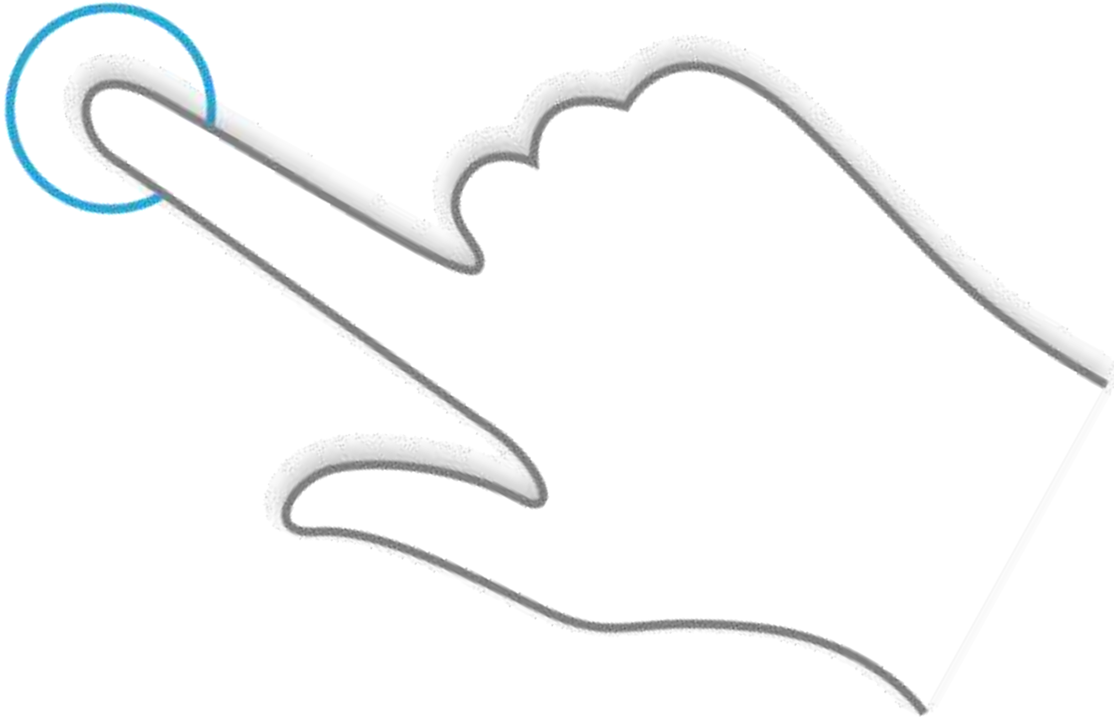
- all per object/element

- typically control of only 4 DOF simultaneously (4–5 max.)*

** some scientific evidence for this limit*

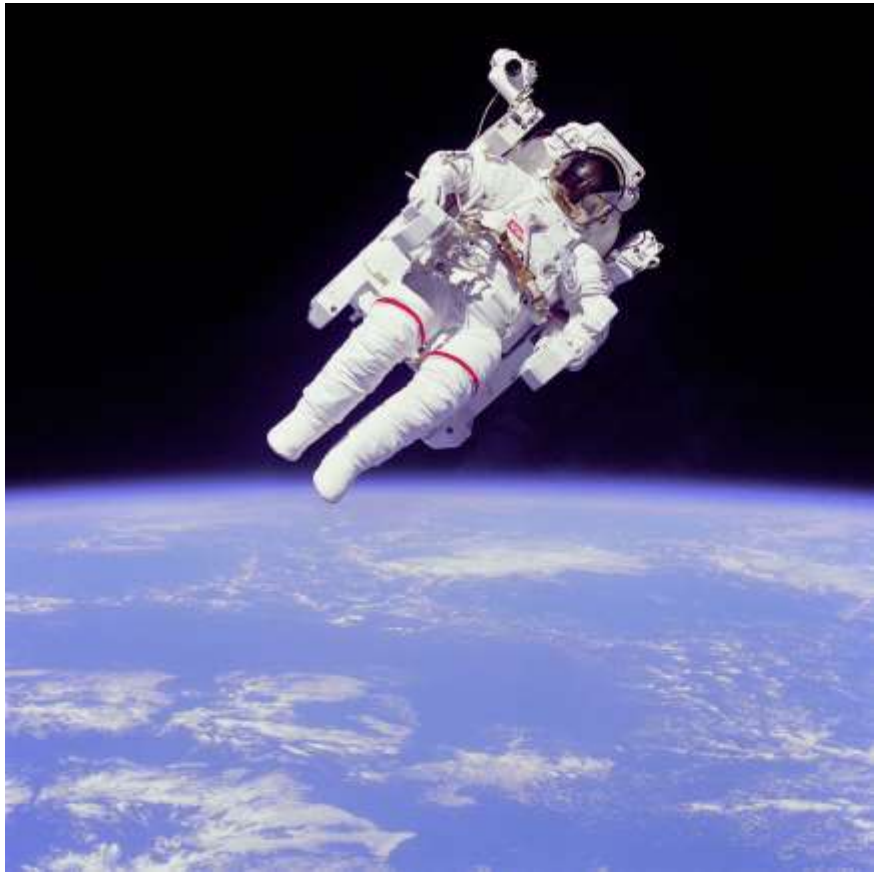


Tactile Feedback



images: Wikipedia user GRPH3B18, SCI Institute, NASA, [Coffey et al. 2011/2012], [Klein et al., 2012], 3D Systems

Tactile Feedback



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Tactile Feedback

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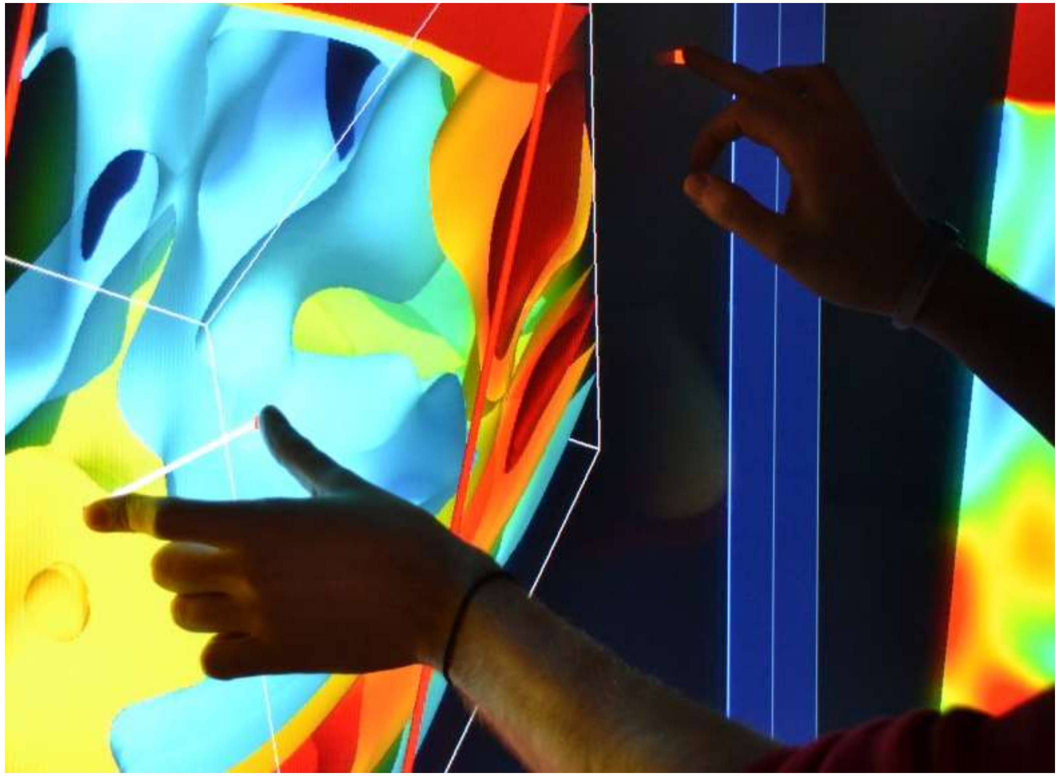
Tactile Feedback



images: Wikipedia user GRPH3B18, SCI Institute, NASA, [Coffey et al. 2011/2012], [Klein et al., 2012], 3D Systems

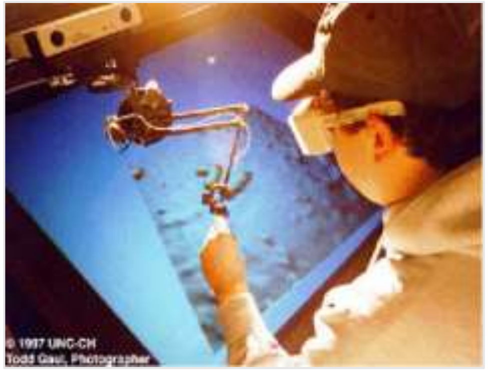
Taxonomy of Input/Output Environments

input type: / tactile feedback:	none	somesthetic	haptic
indirect			
direct	(except hover)	 	(for 3D content)

monoscopic displays

images: Logitech, LG, Microsoft, D. Keefe, Google

Taxonomy of Input/Output Environments

input type: / tactile feedback:	none		somesthetic	haptic
indirect				
direct				

stereoscopic displays

images: Univ. Groningen, Purdue Univ., Coffey et al. 2012, D. Keefe, Google, Schmalstieg et al. 1998, UNC Charlotte

Direct Input plus Stereo? → Complex HW

[Taylor, II, et al. 1993]

Direct Input plus Stereo? → Special Control

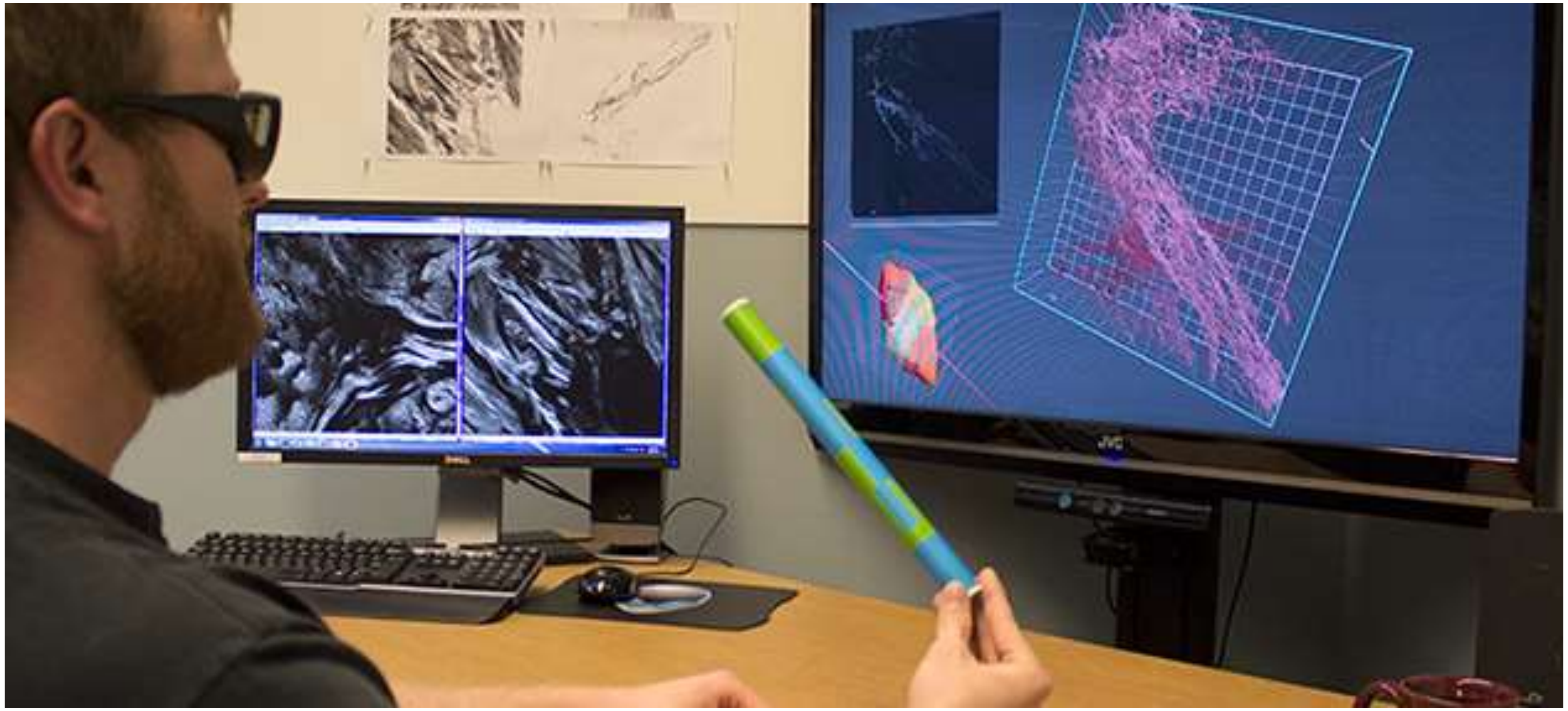
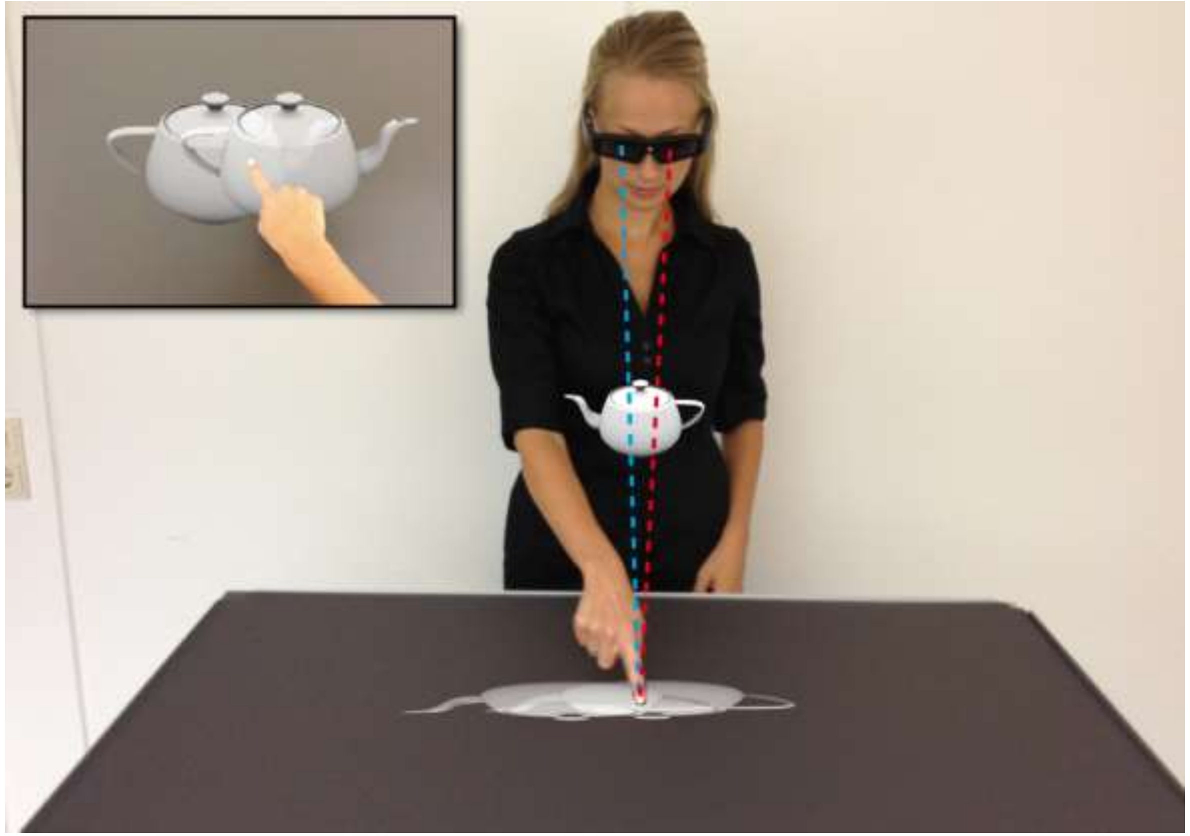
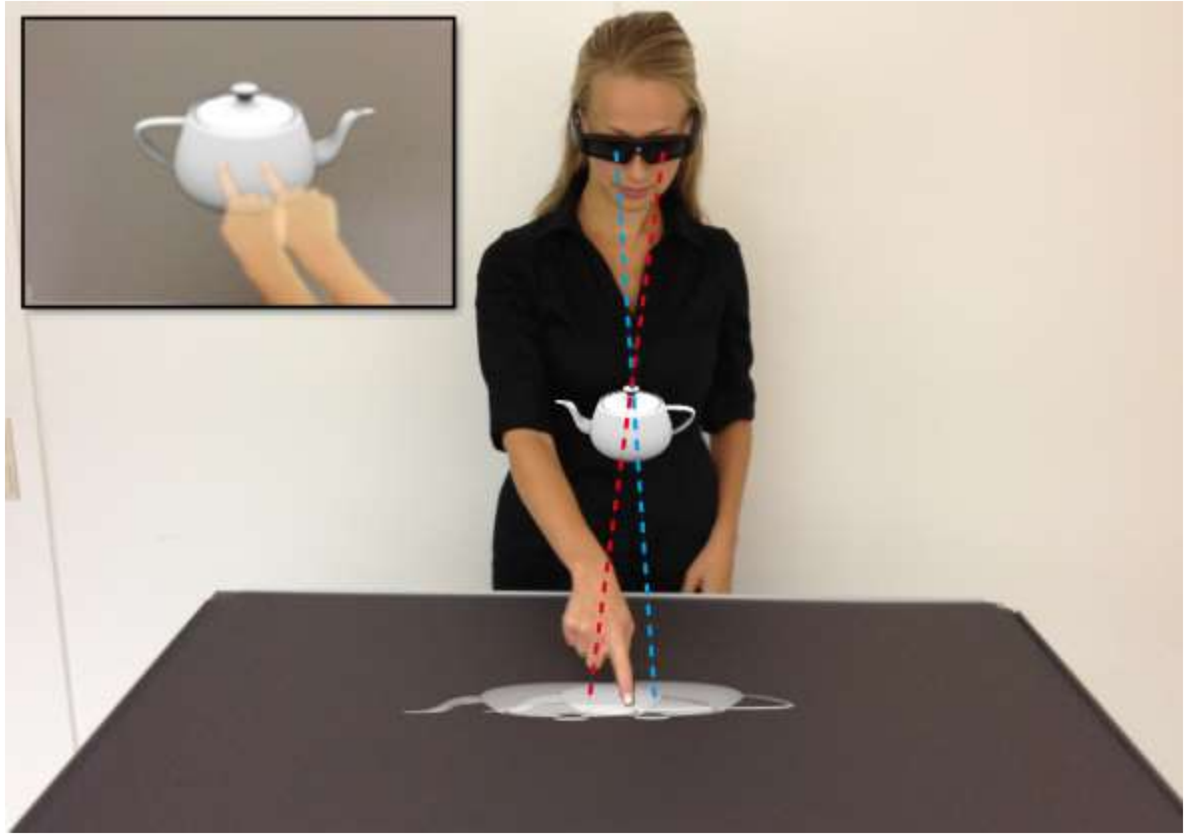


image Daniel F. Keefe

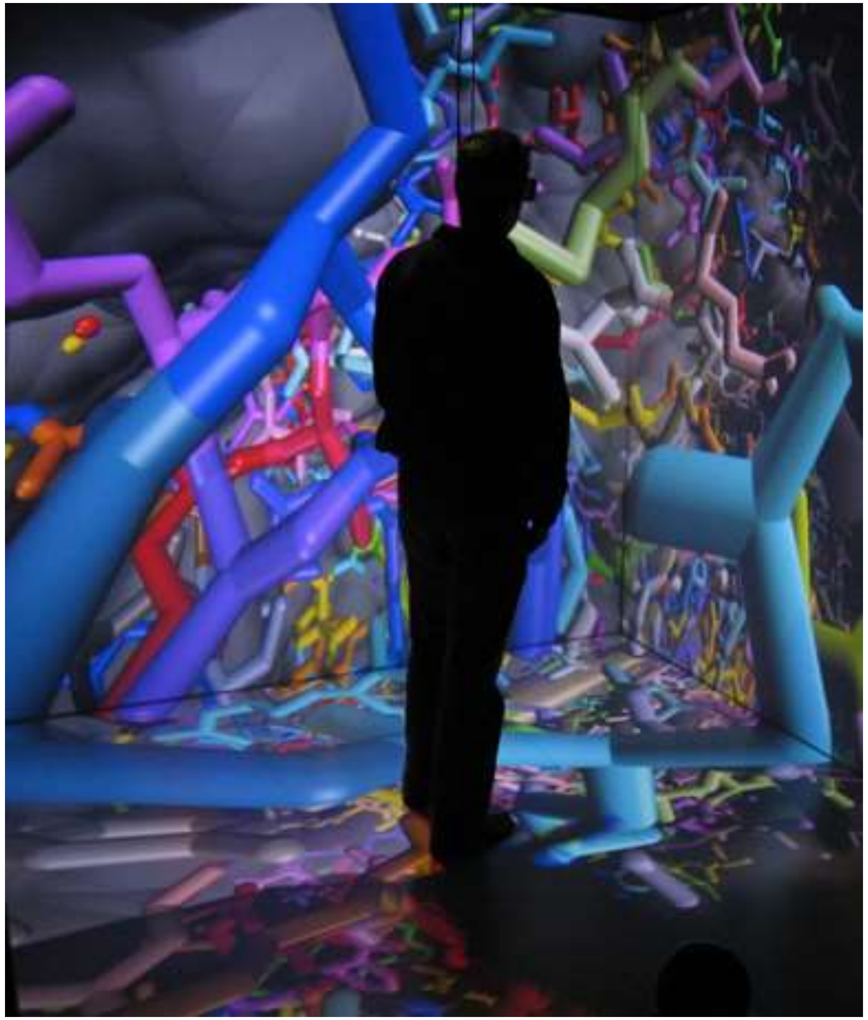
Direct Touch plus Stereo? → Fundamental Issues





[Bruder et al. 2013]

Compromise: Stereo View + Indirect Input



images: Univ. Groningen, Purdue Univ.

Compromise: Stereo View + Indirect Input

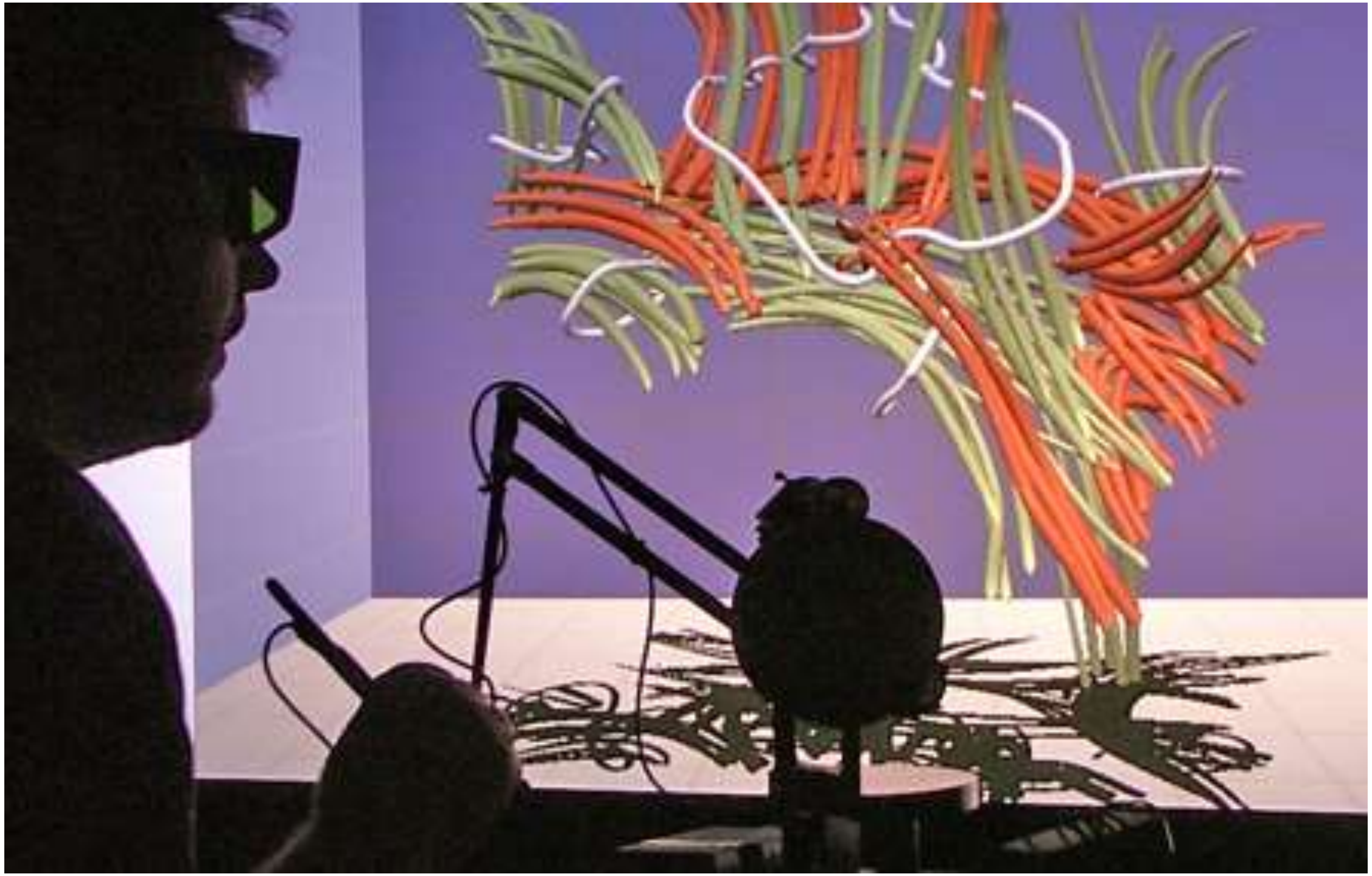
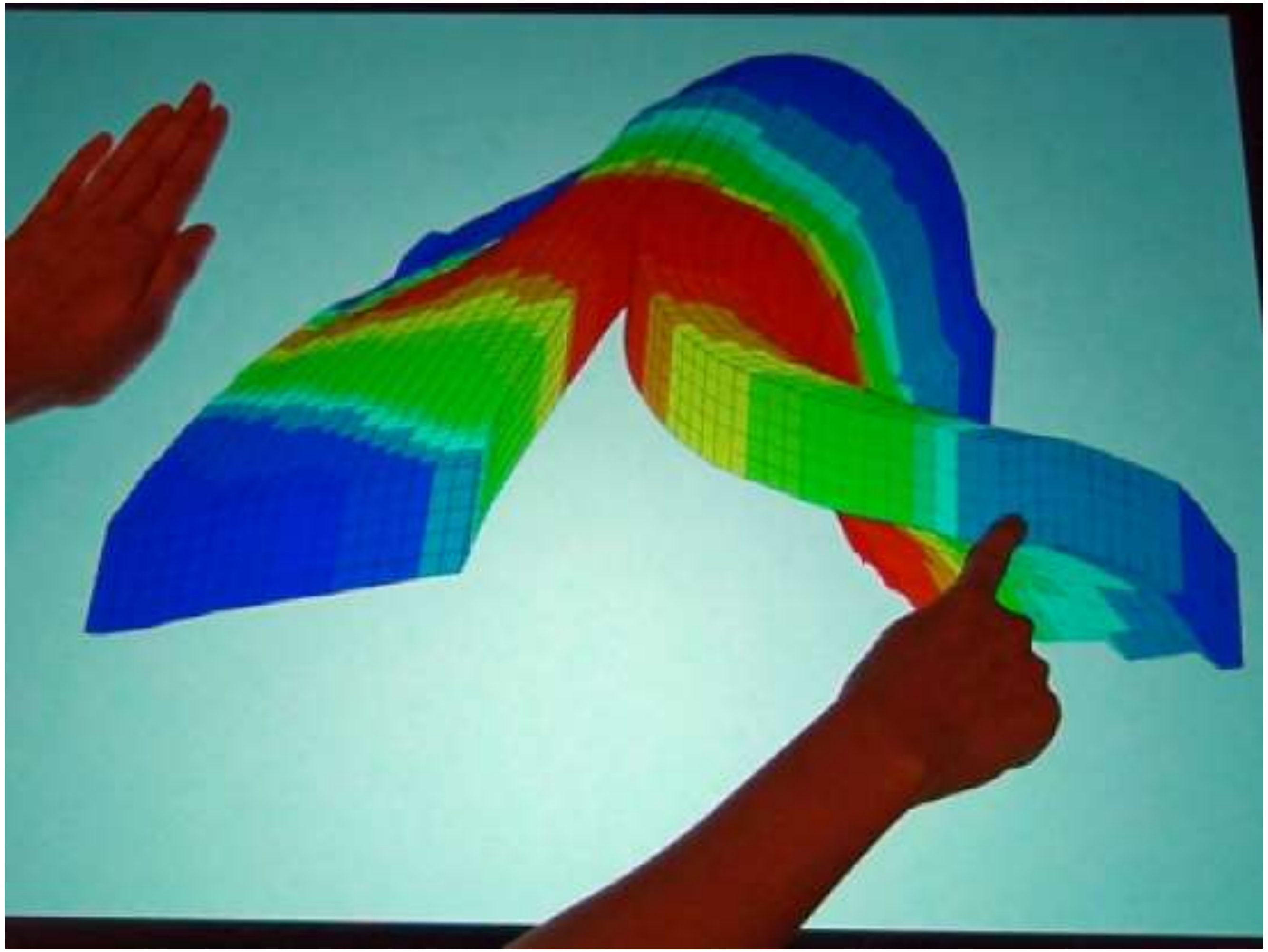


image: Daniel F. Keefe

Compromise: Mono View + Direct Input

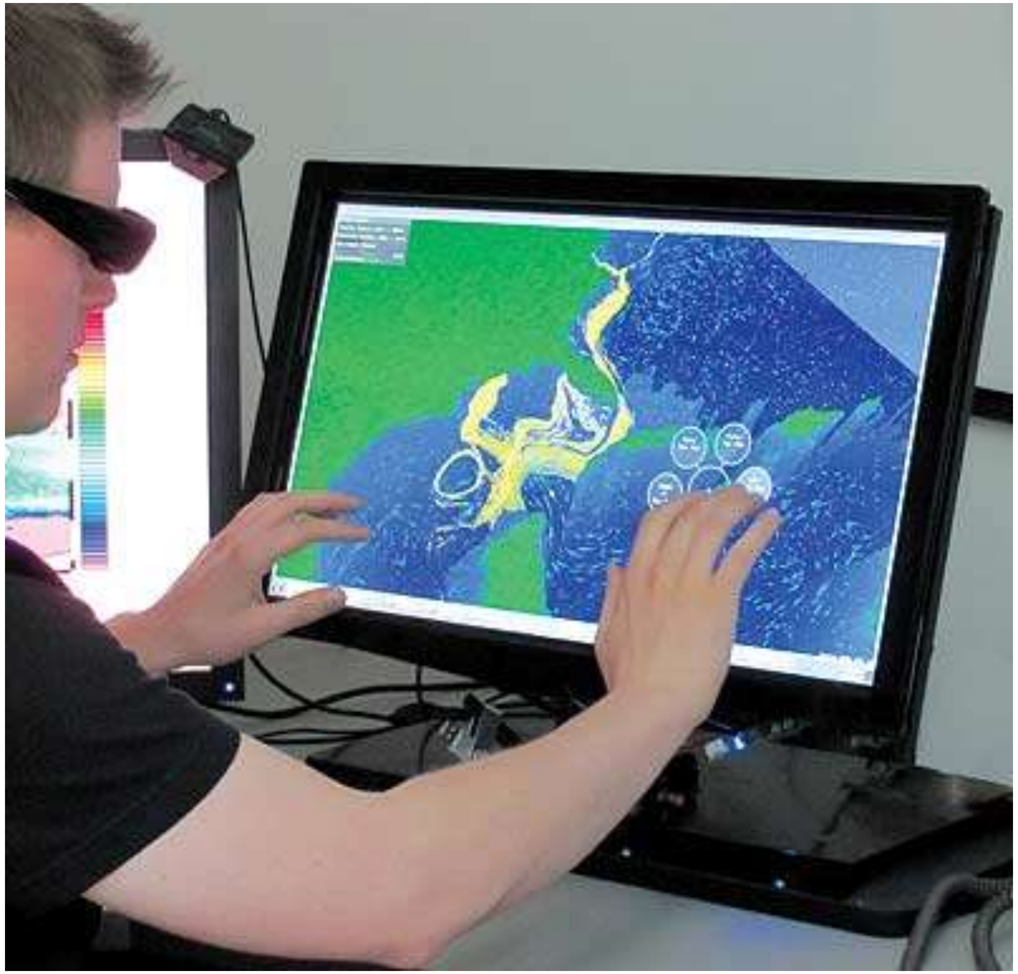


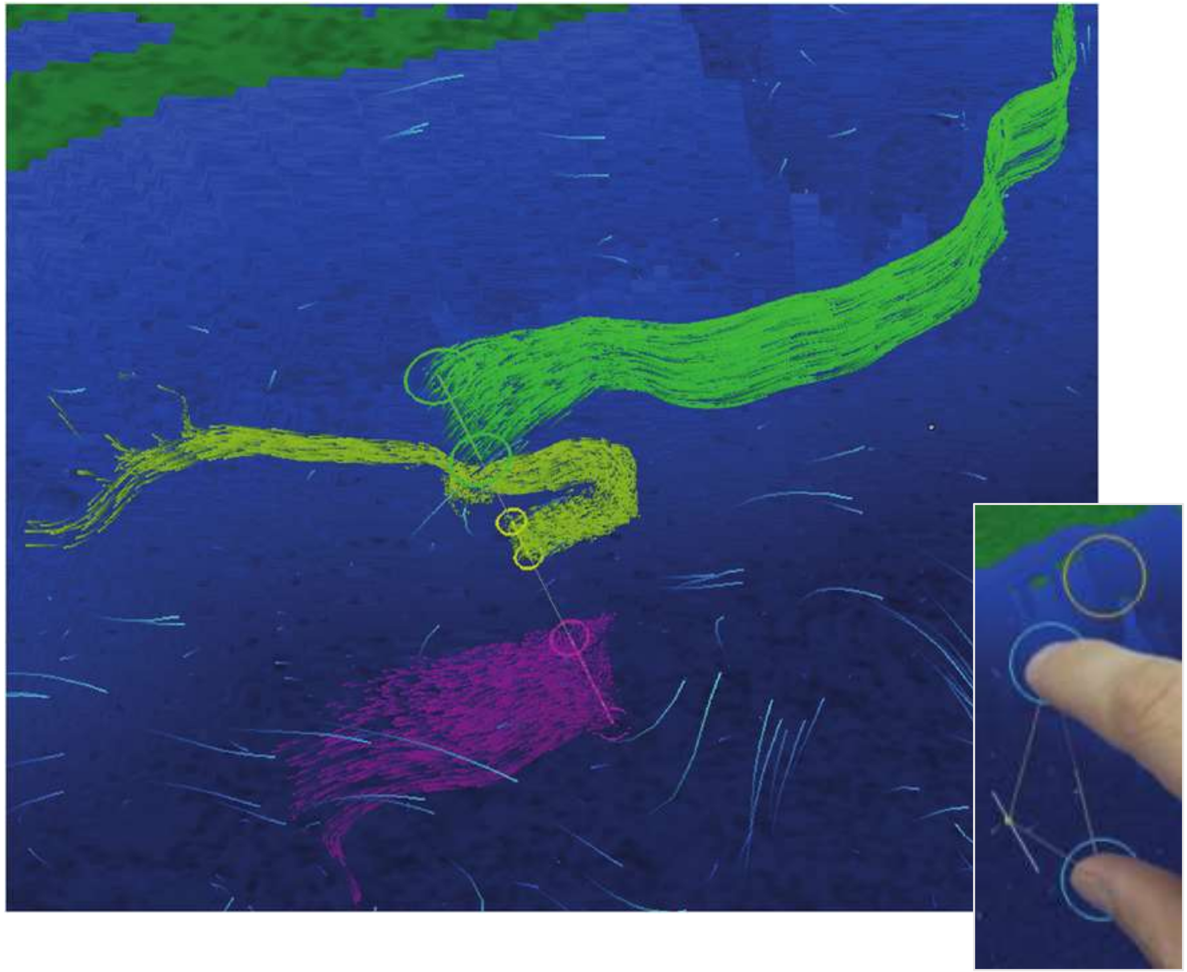
[Sultanum et al. 2010/2011]

Compromise: Mono View + Direct Input

[Lundström et al., 2011]

Direct Input + Stereo View – Shallow 3D



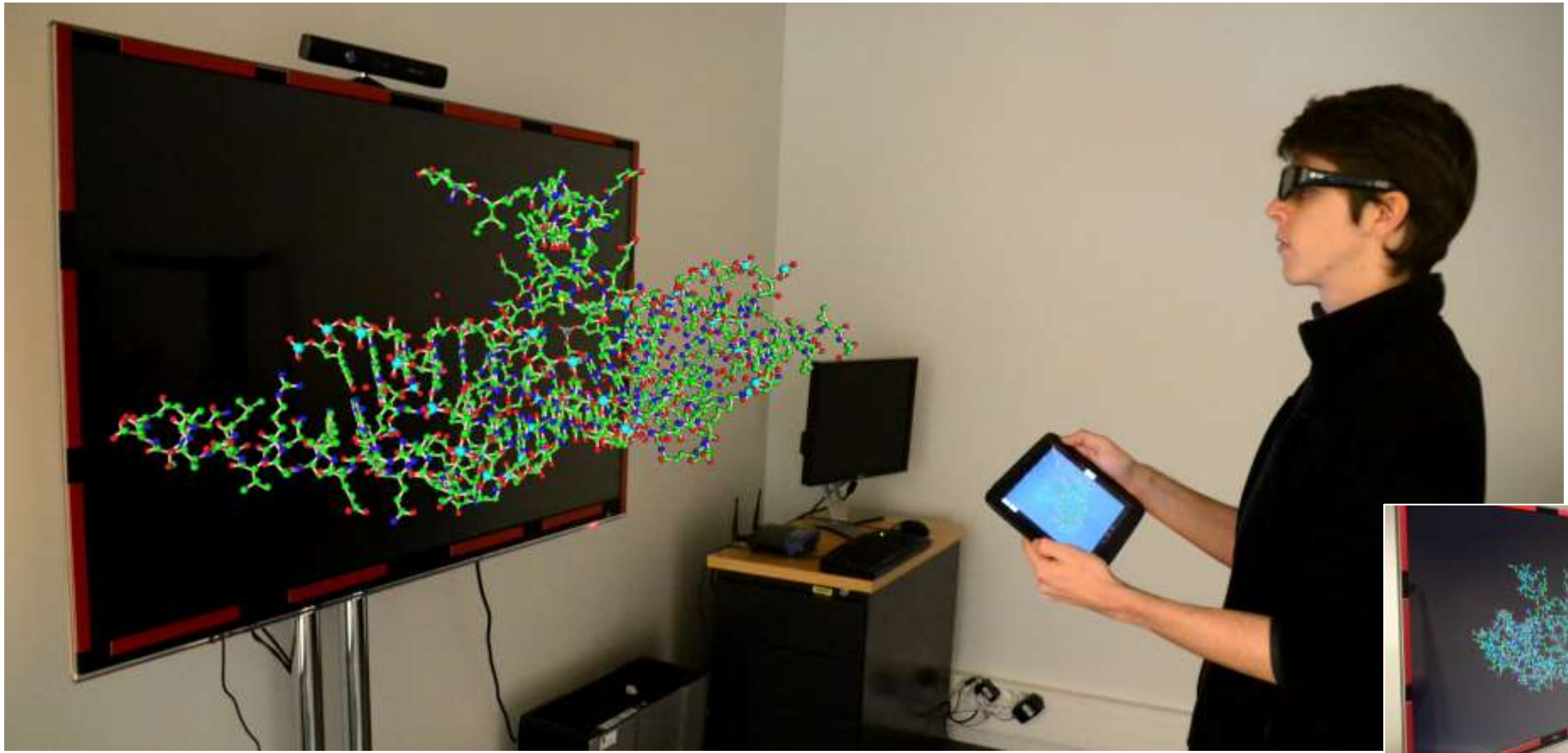


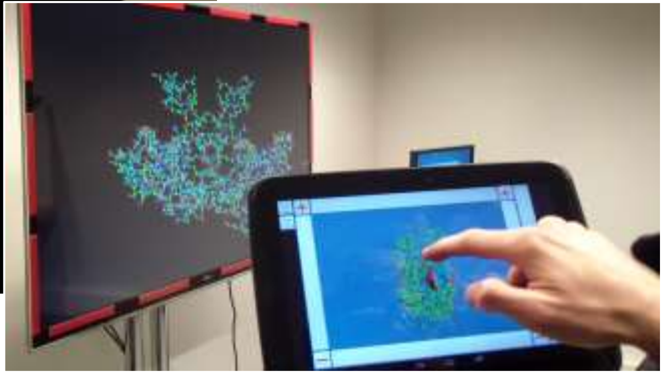
[Butkiewicz & Ware, 2011]

Direct Input + Stereo View – Separate Views

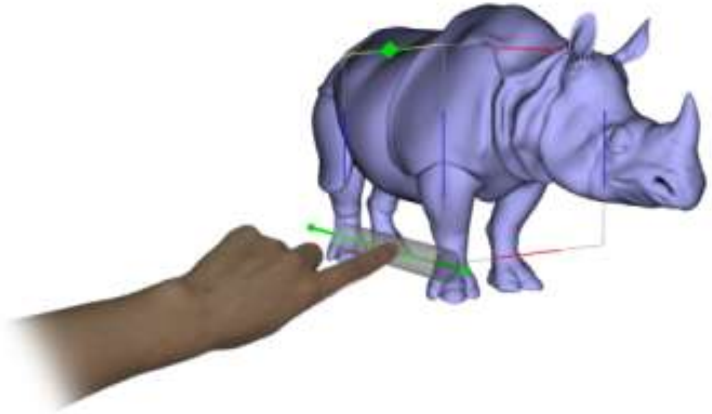
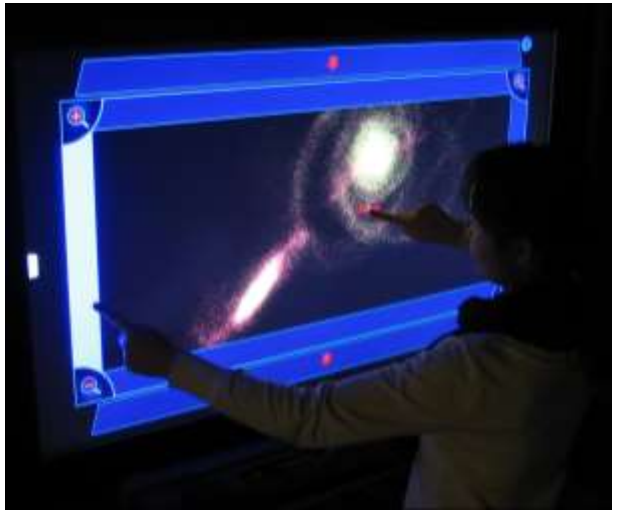
[Coffey et al. 2011/2012]

Direct Input + Stereo View – Mobile Touch





[López et al. 2016; presented later this week on Tuesday at 16:30]

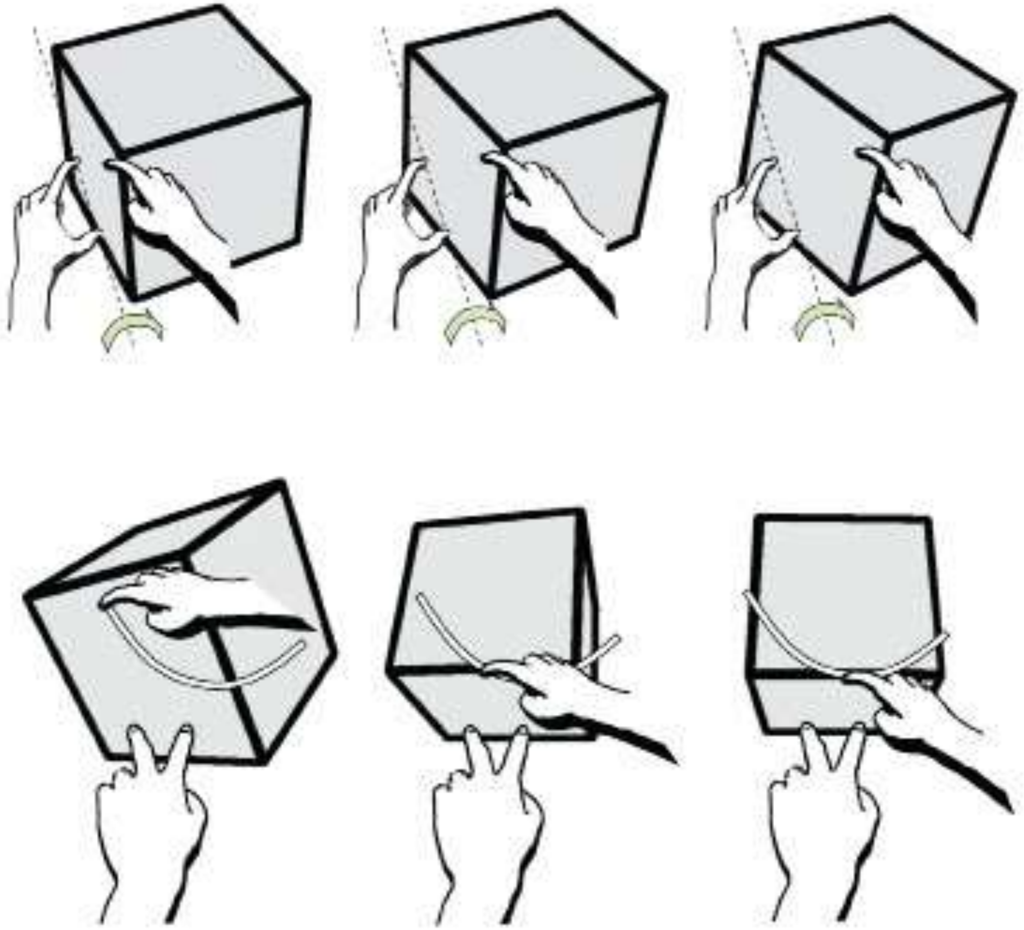

Interaction with Non-Standard Input and Output Devices

Part 2: Fundamental Interaction Techniques for Direct(-Touch) Input: Navigation

Navigation using Touch Input: 3D RST

image by Wikipedia user GRPH3B18

→

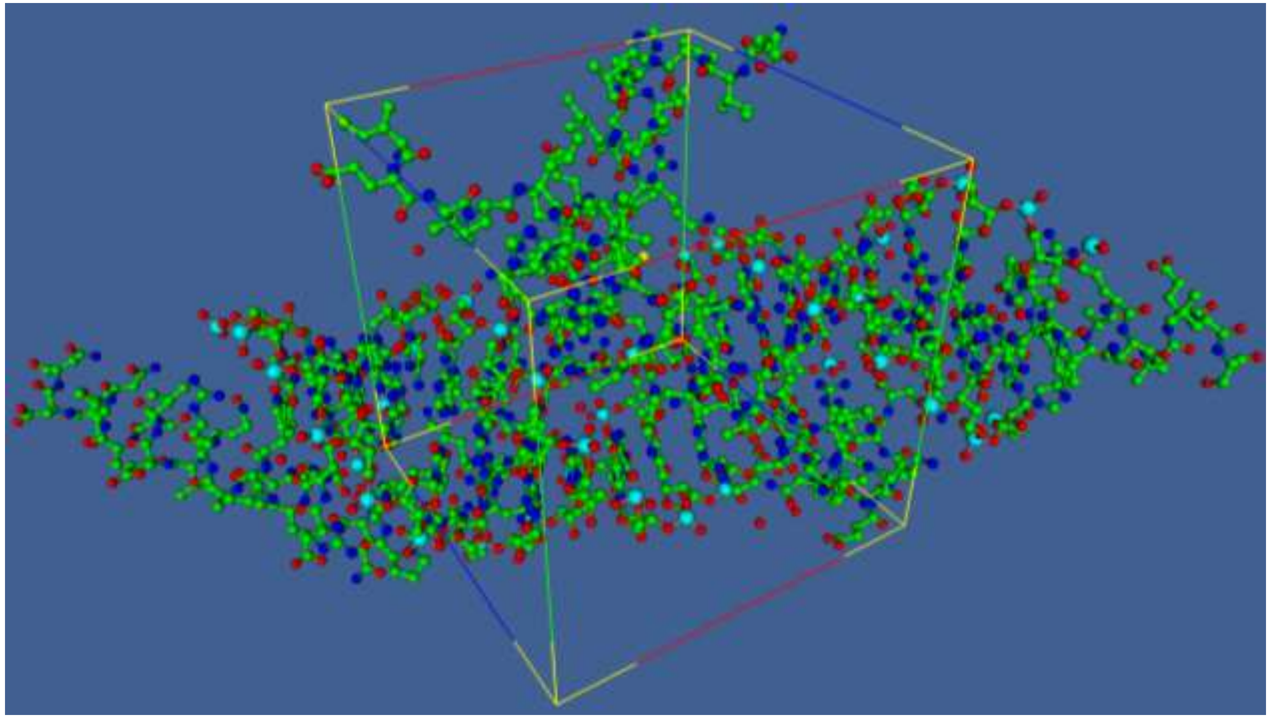


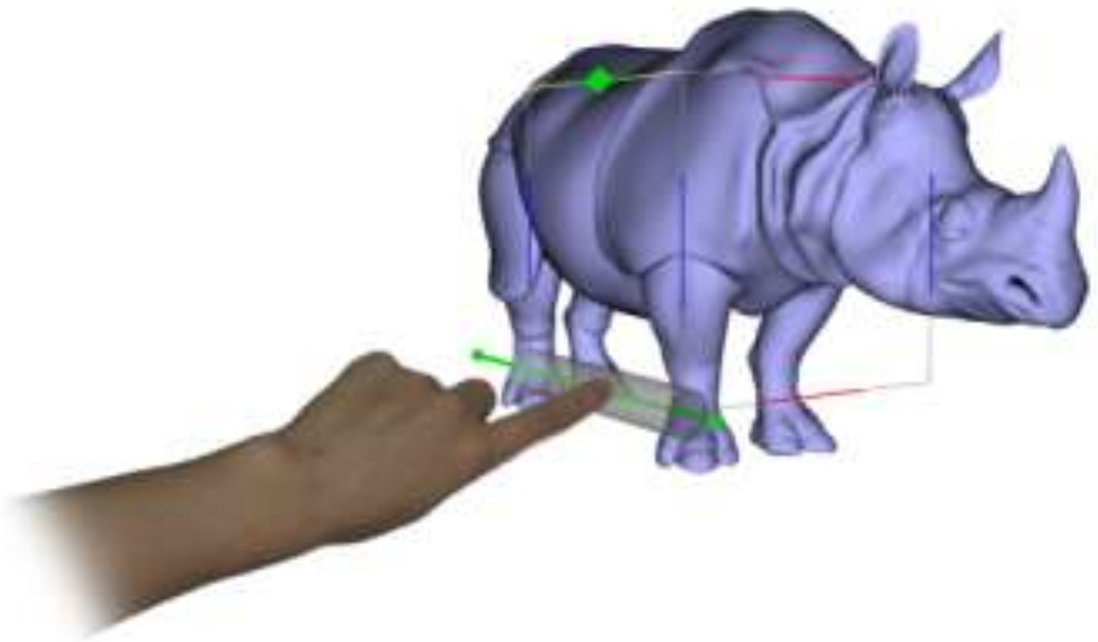
[Reisman et al., 2009]

Navigation using Touch Input: 3D RST

[Reisman et al., 2009]

Navigation using Touch Input: tBox



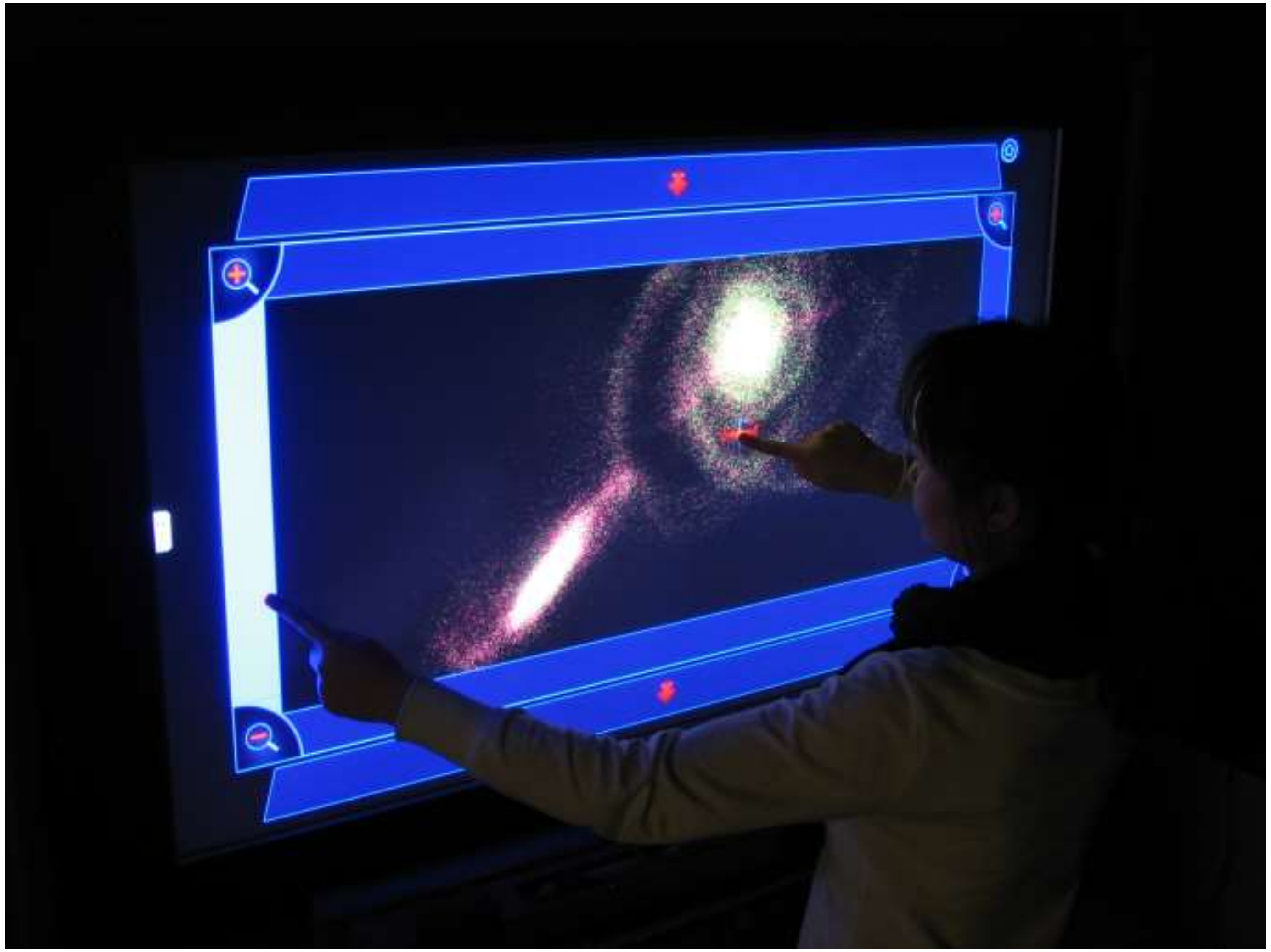


[Cohé et al., 2011]

Navigation using Touch Input: tBox

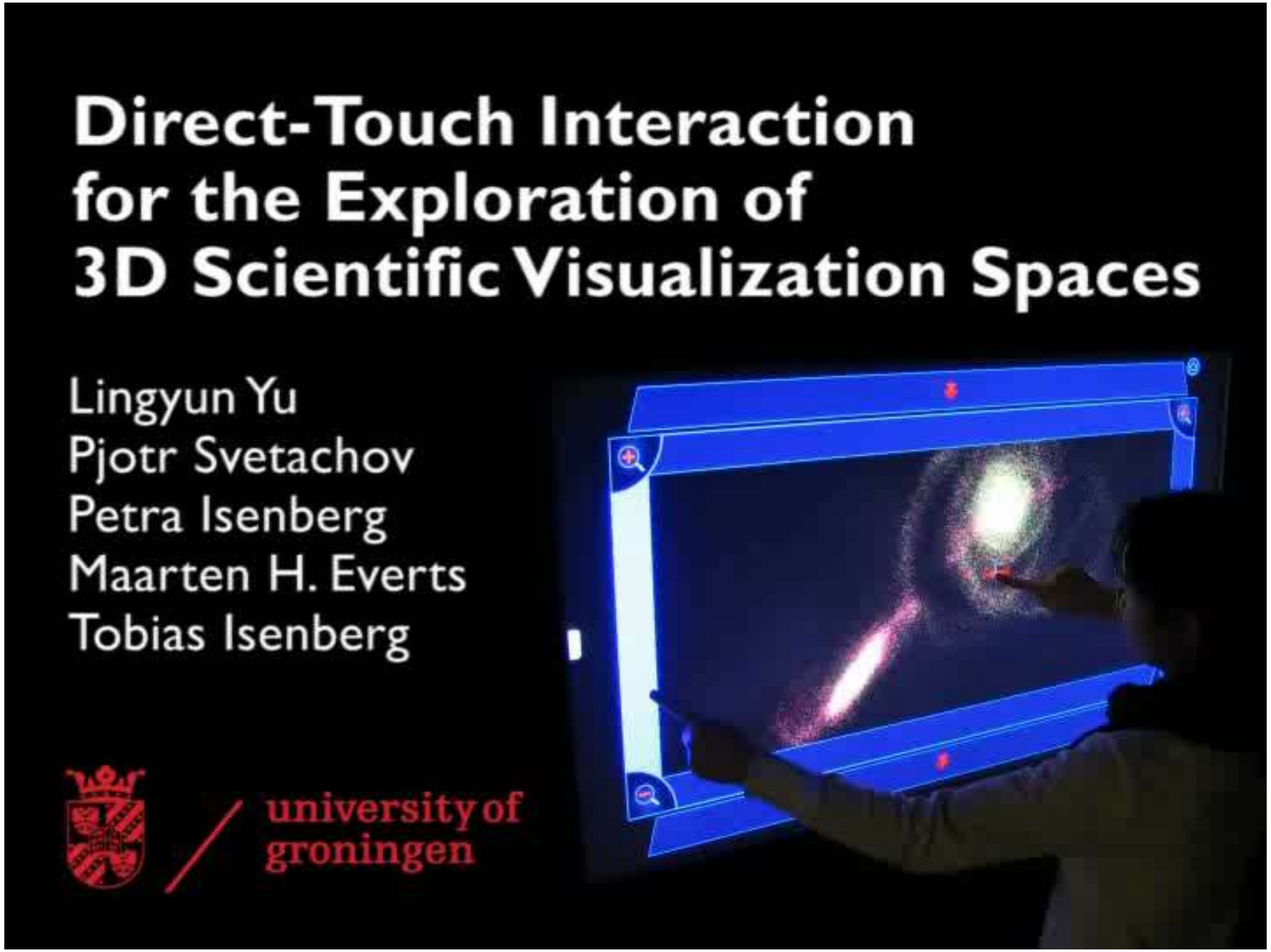
[Cohé et al., 2011]

Navigation using Touch Input: FI3D



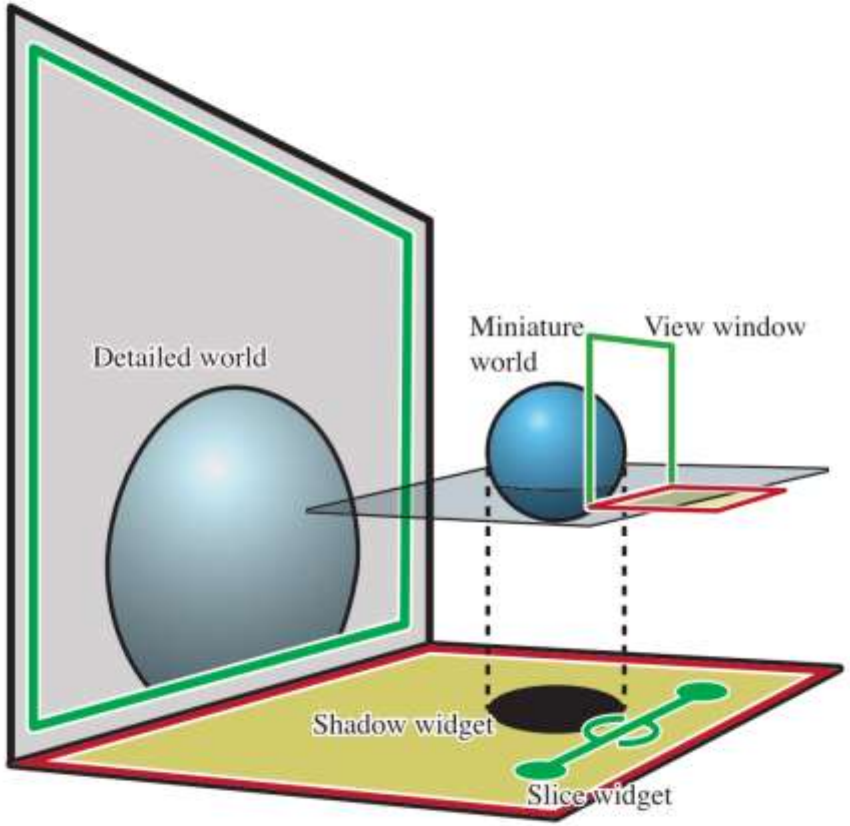
[Yu et al. 2010]

Navigation using Touch Input: FI3D



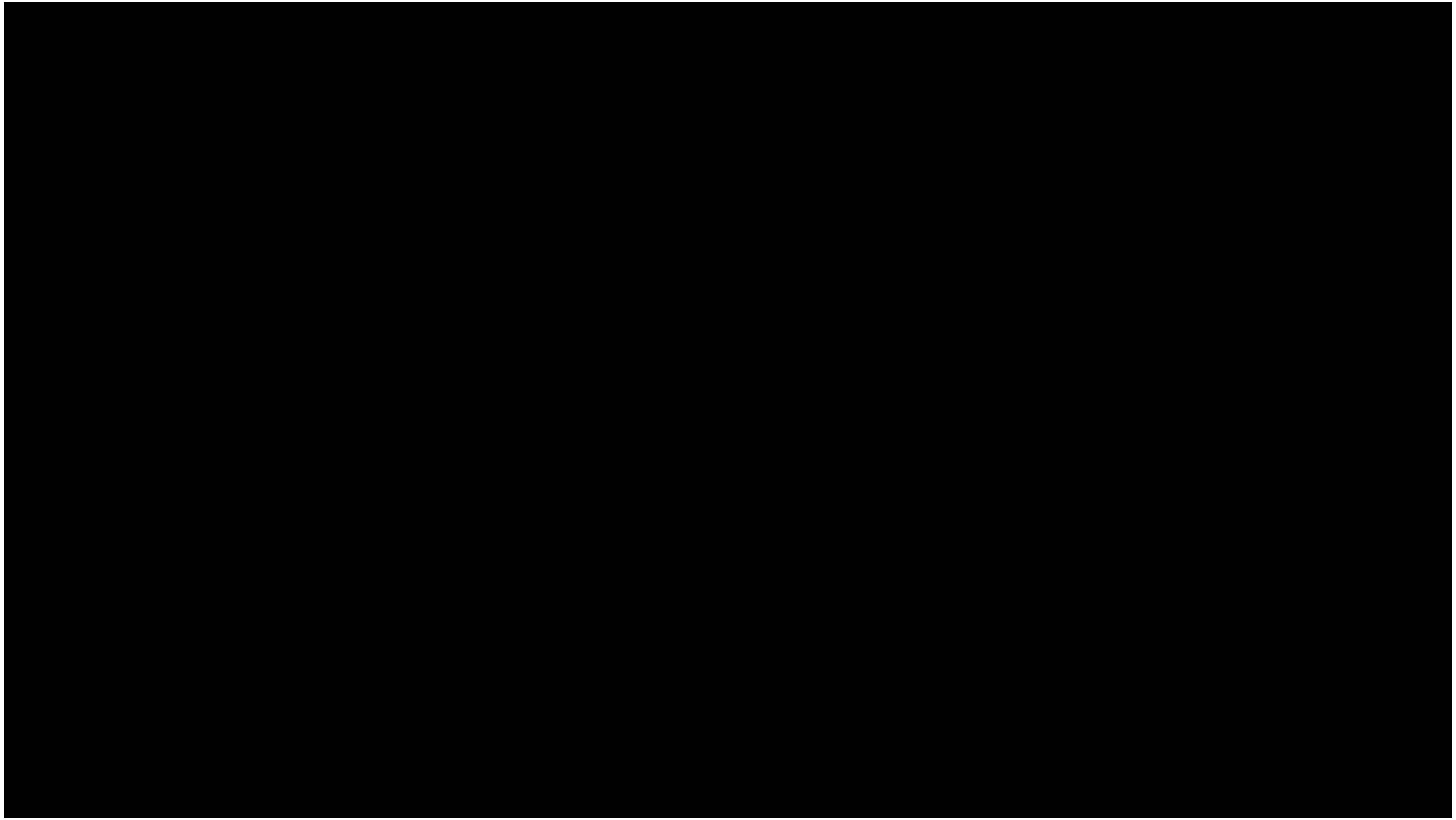
[Yu et al. 2010]

Navigation using Touch Input: Slice WIM



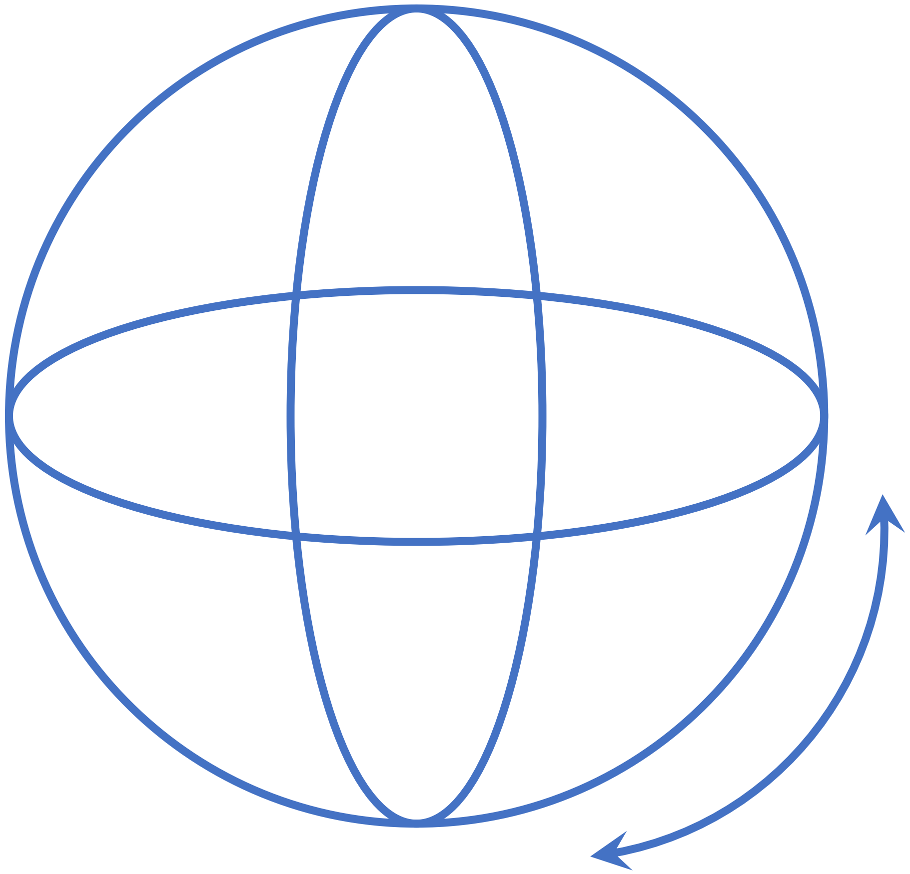
Coffey [et al. 2011/2012]

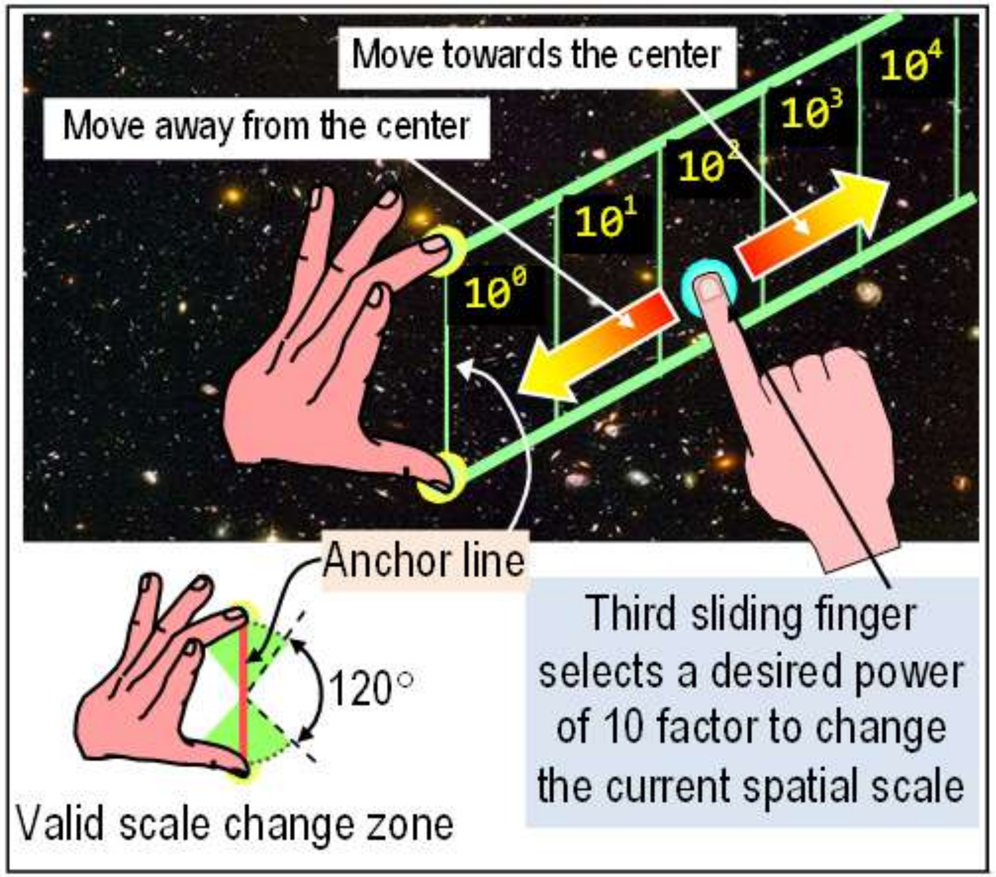
Navigation using Touch Input: Slice WIM



[Coffey et al. 2011/2012]

Navigation using Touch Input: Powers of 10



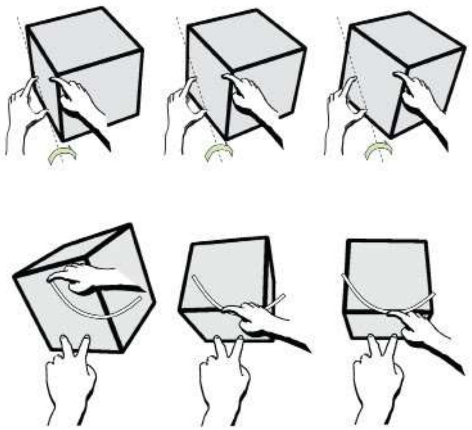


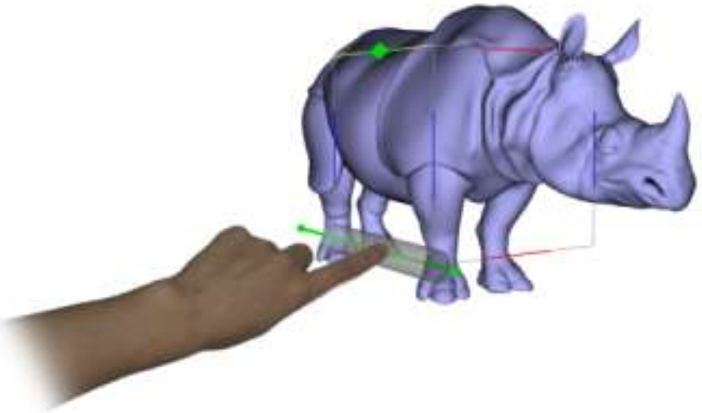
[Fu et al. 2010]

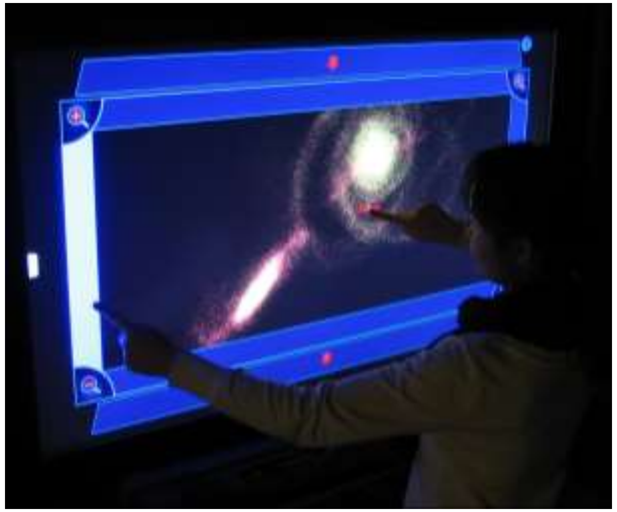
Navigation using Touch Input: Powers of 10

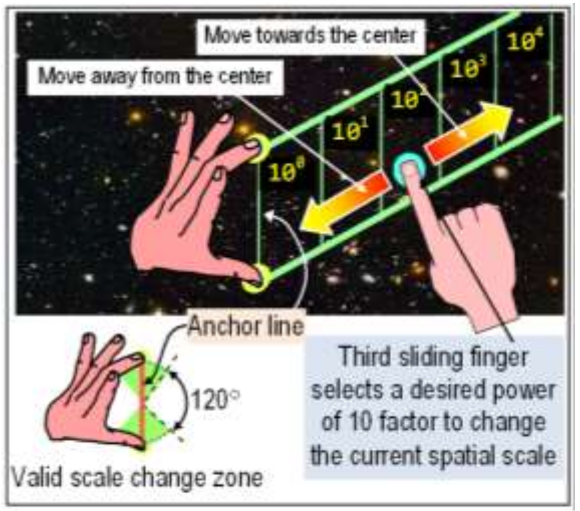
[Fu et al. 2010]

Which navigation to use? – It depends …

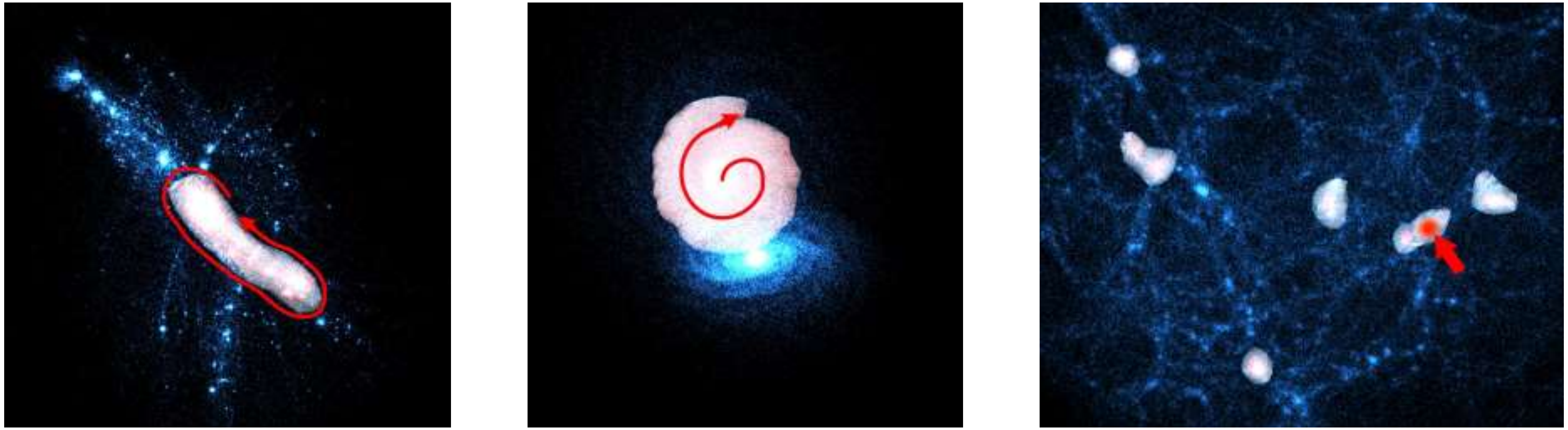








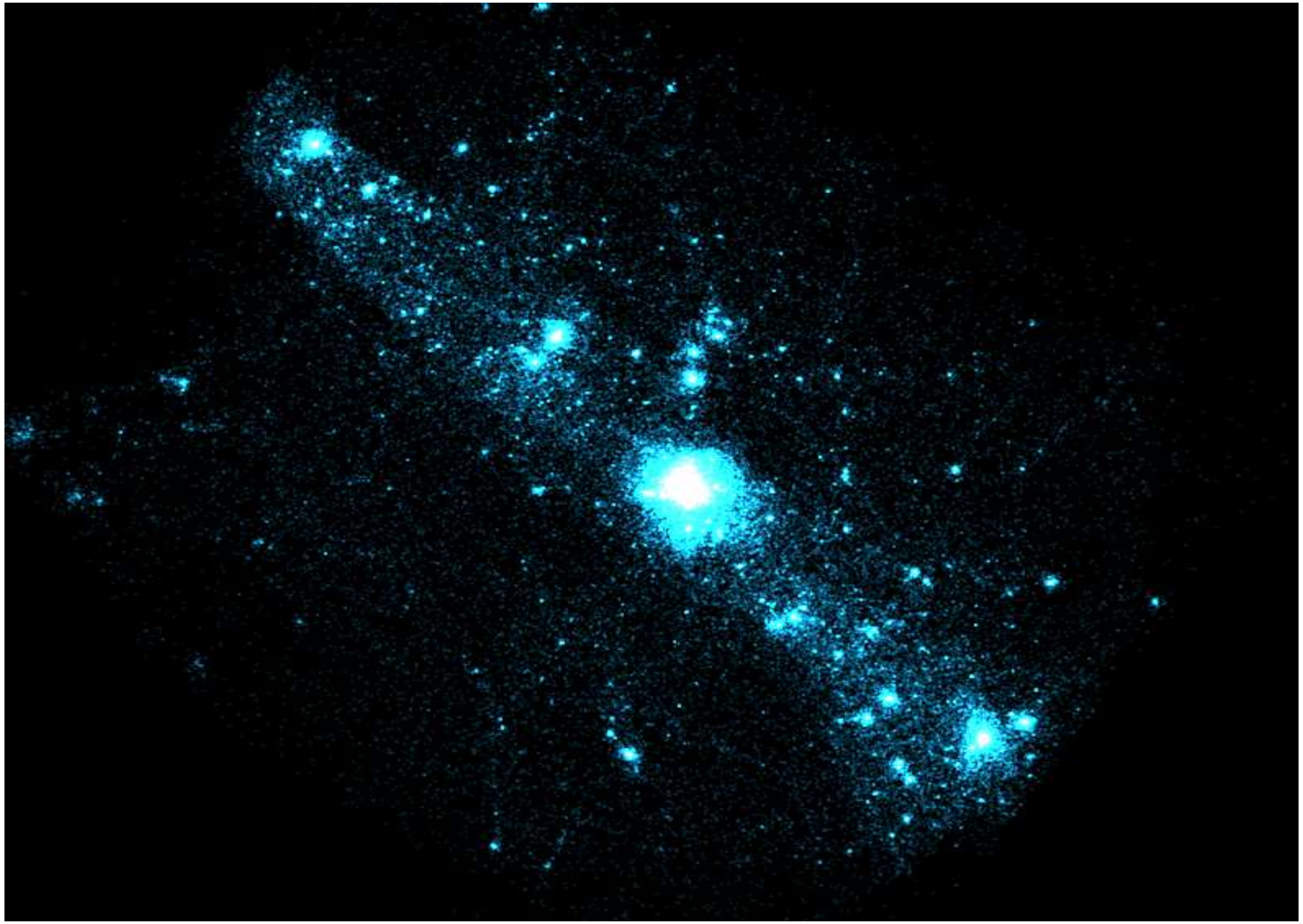
[Reisman et al., 2009], [Cohé et al., 2011], [Yu et al. 2010], [Coffey et al. 2011/2012], [Fu et al. 2010]



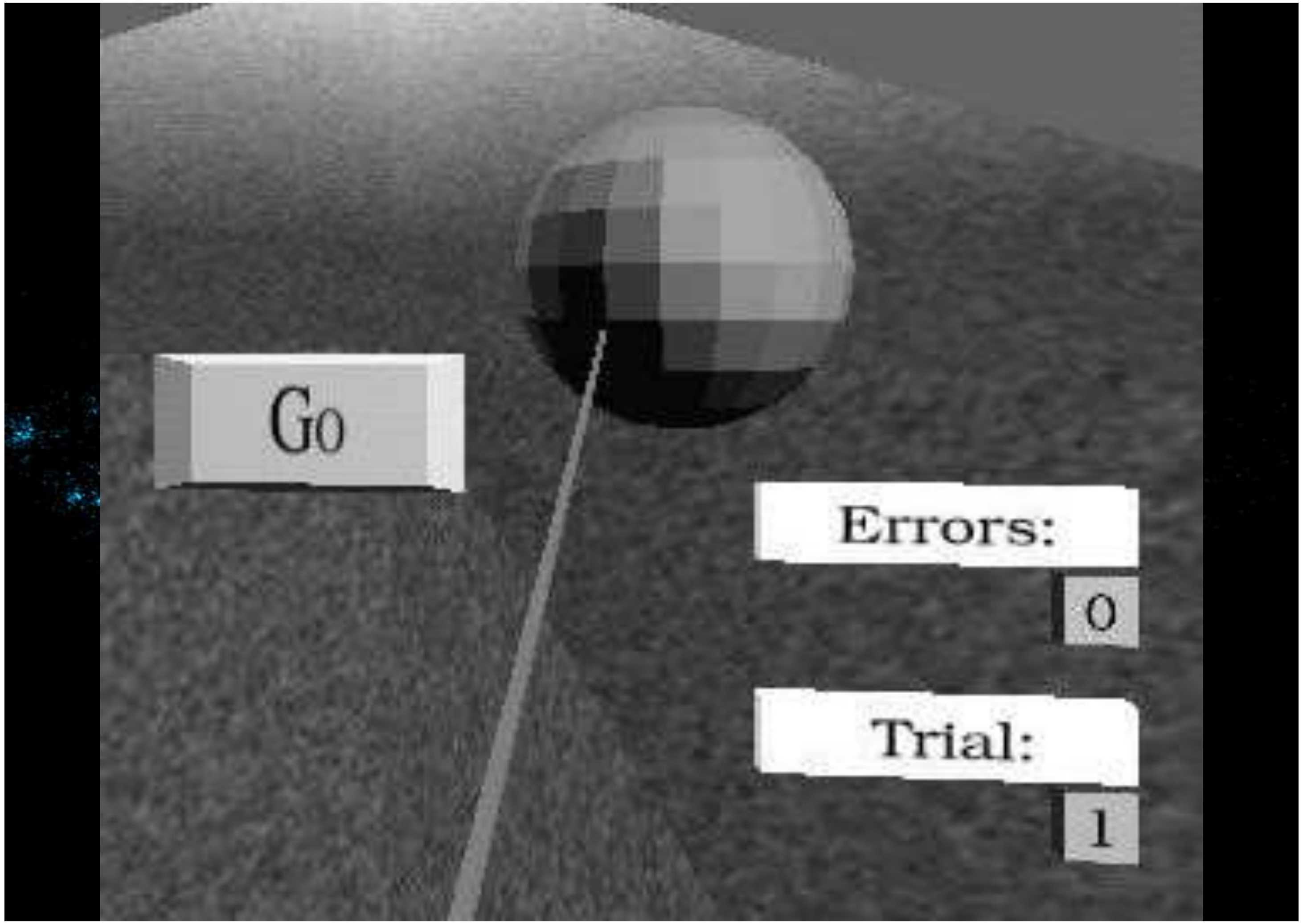
Interaction with Non-Standard Input and Output Devices

Part 3: Fundamental Interaction Techniques for Direct(-Touch) Input: Selection

Selection using Direct Input

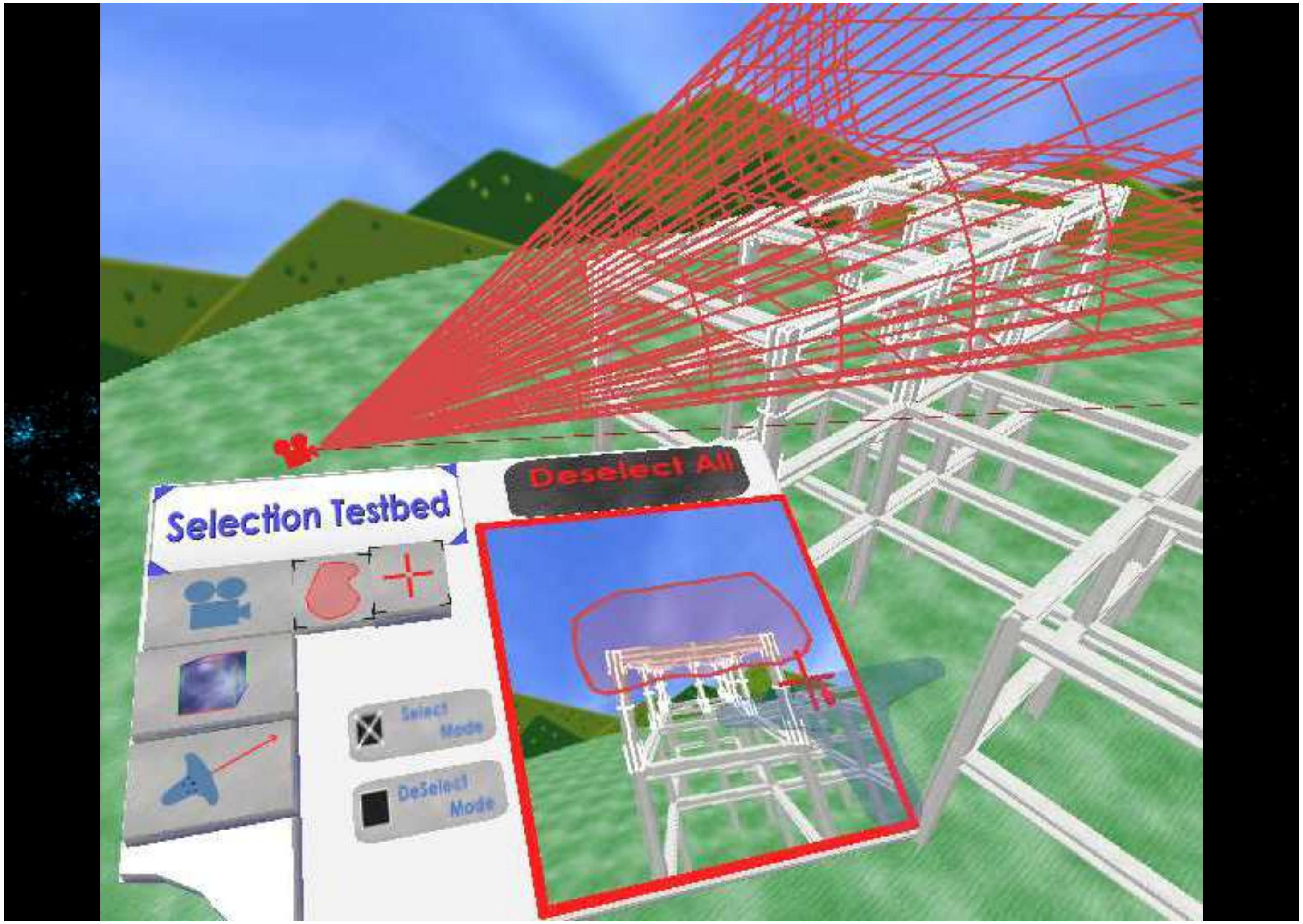


Selection using Direct Input



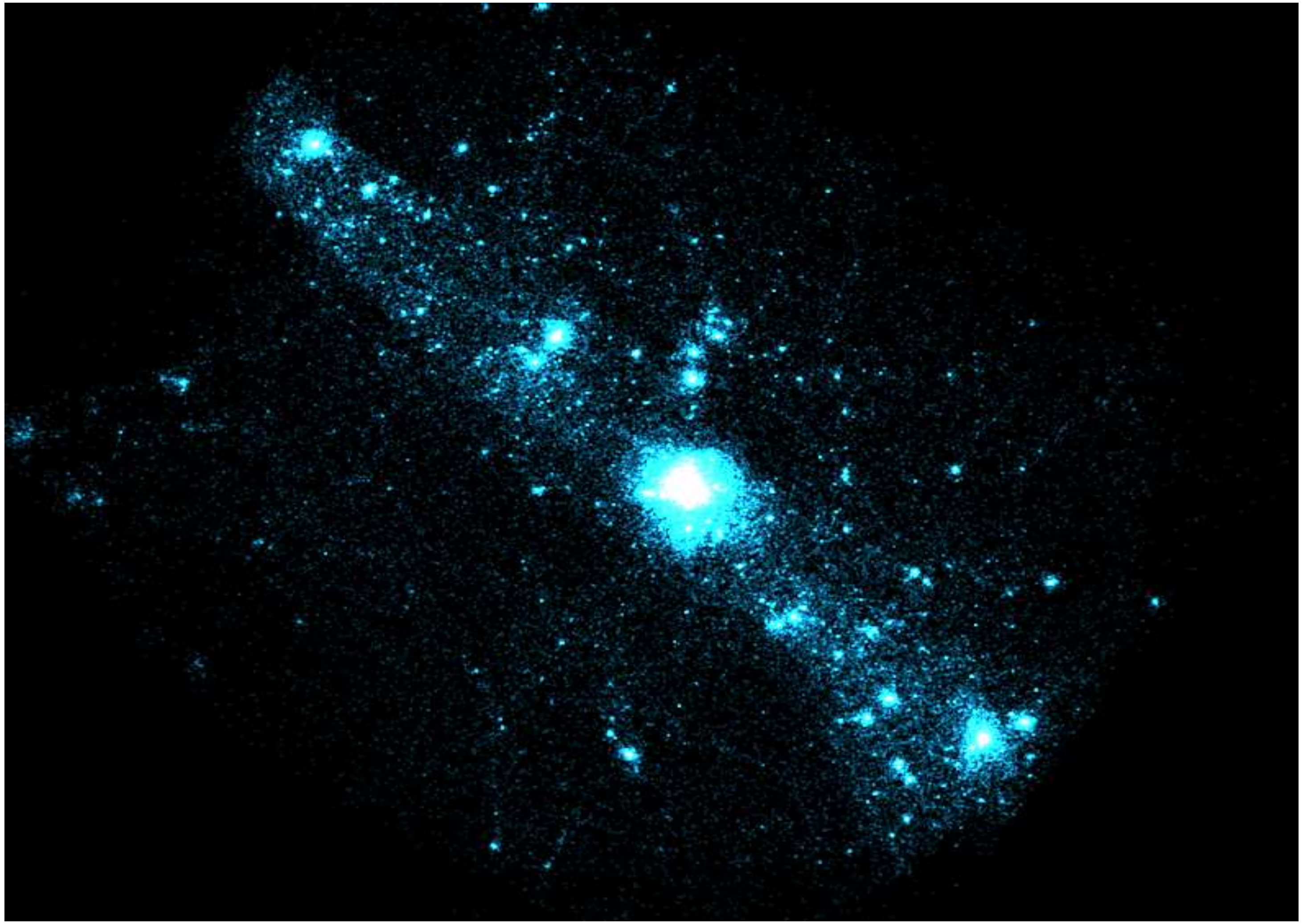
[Wingrave & Bowman, 2005]

Selection using Direct Input



[Lucas & Bowman, 2005]

Selection using Direct Input



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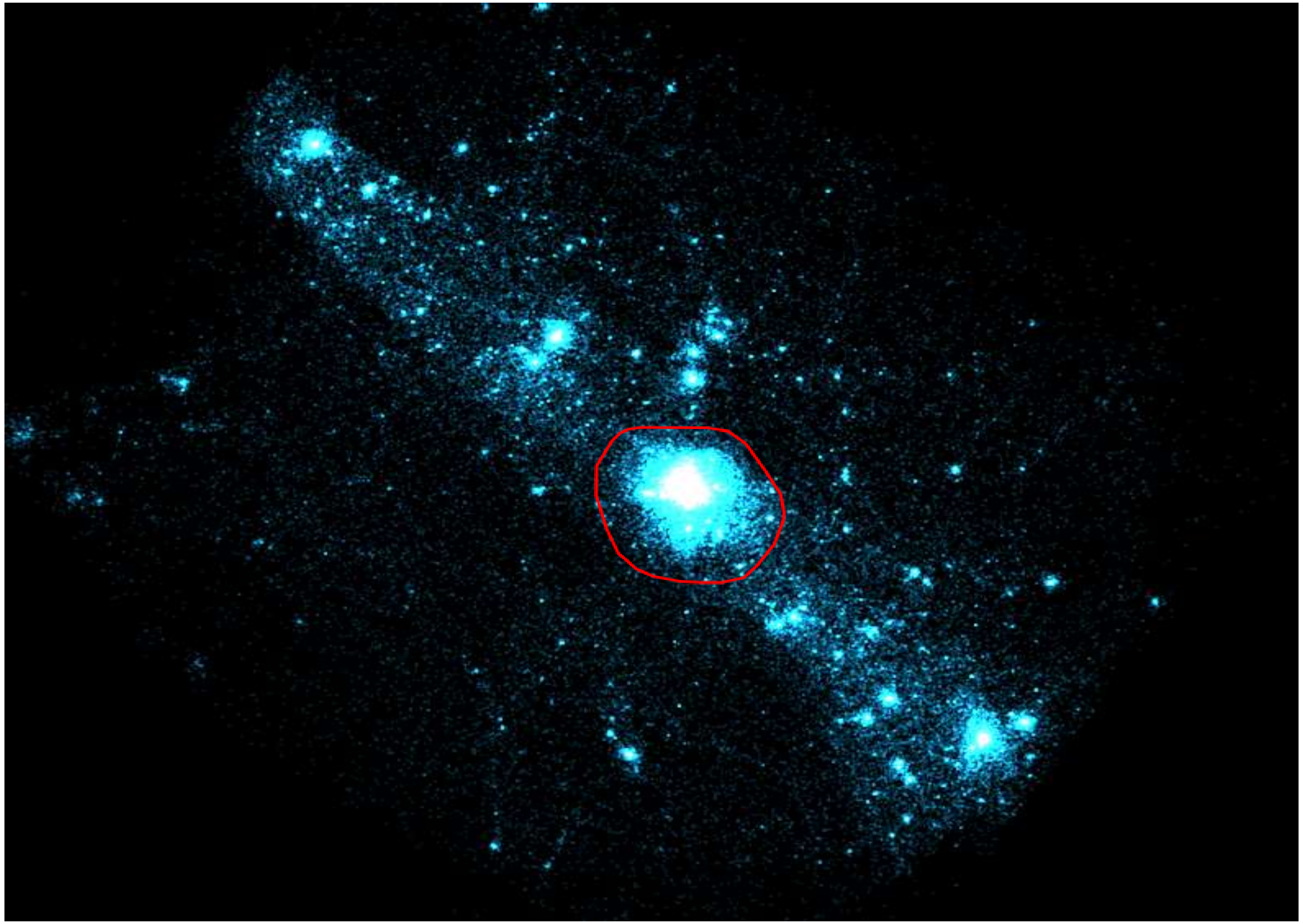
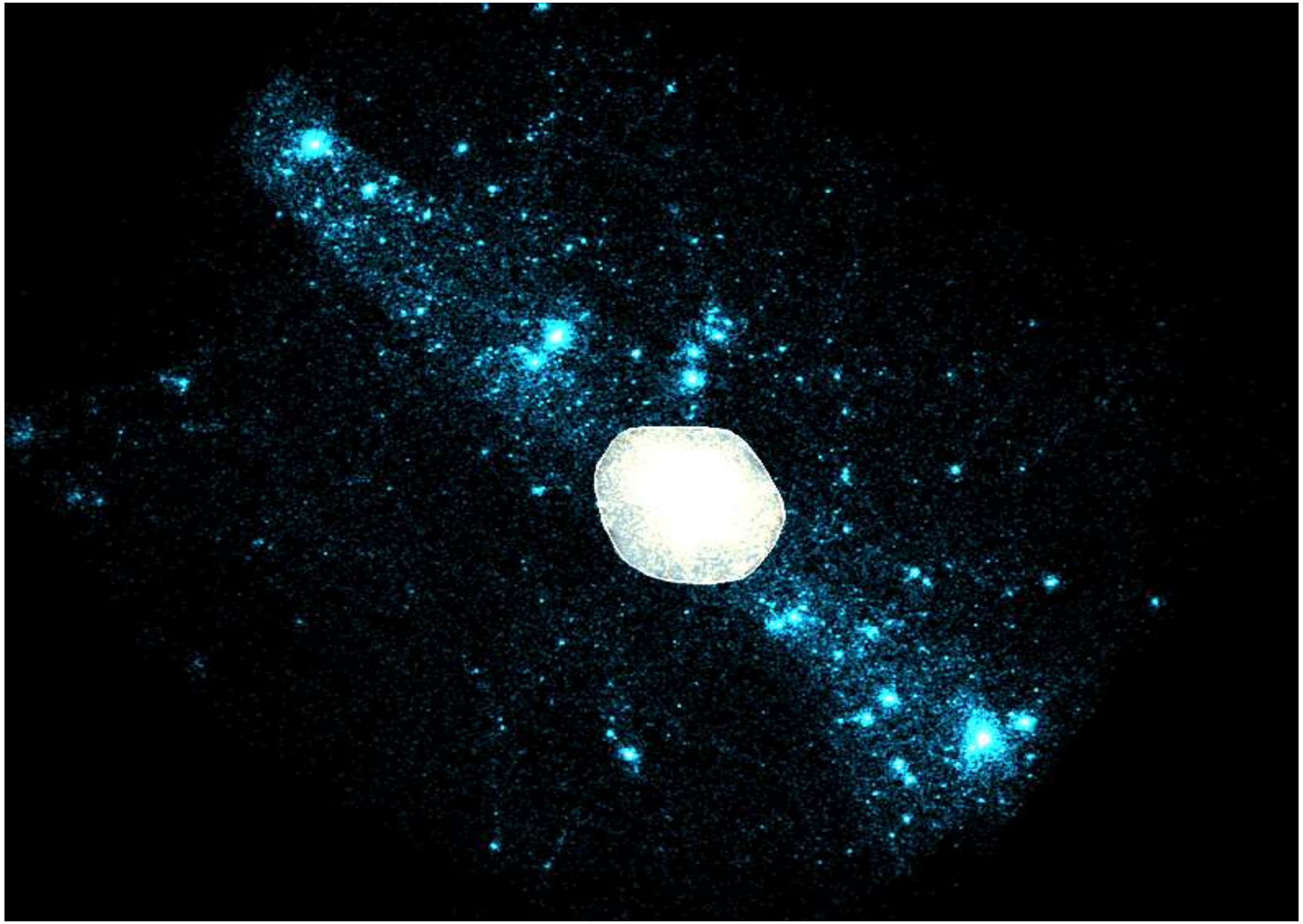
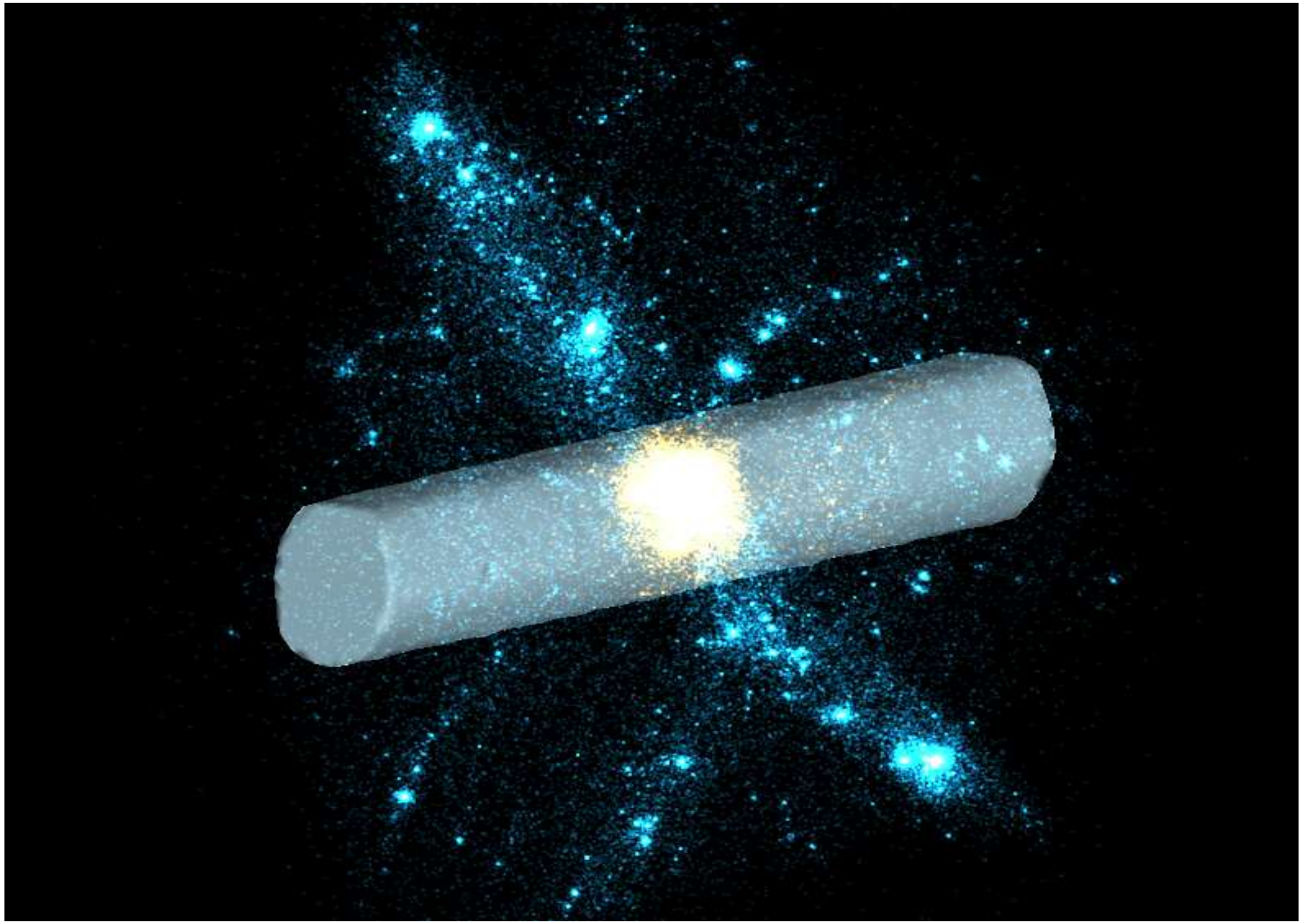


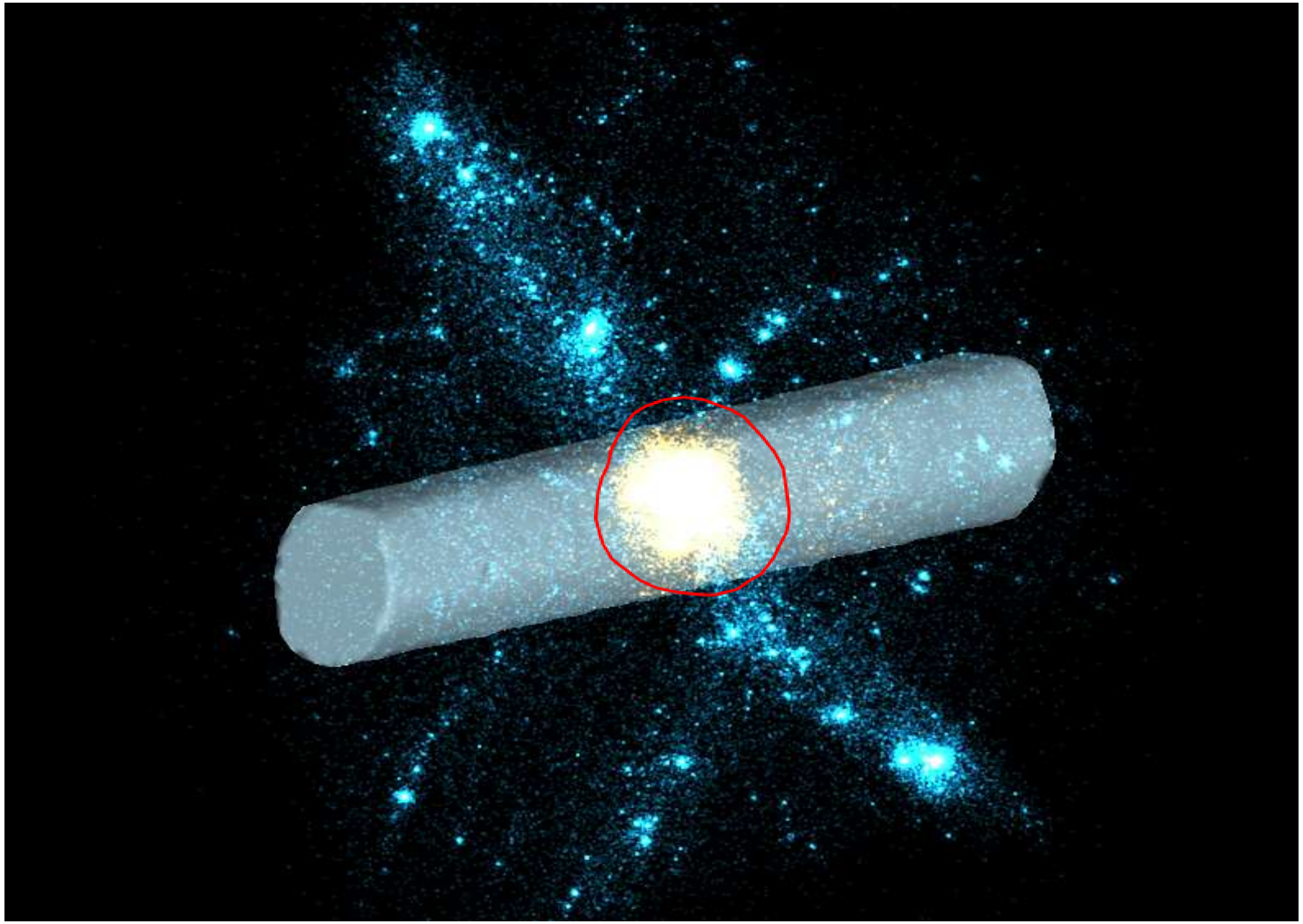
Selection using Direct Input



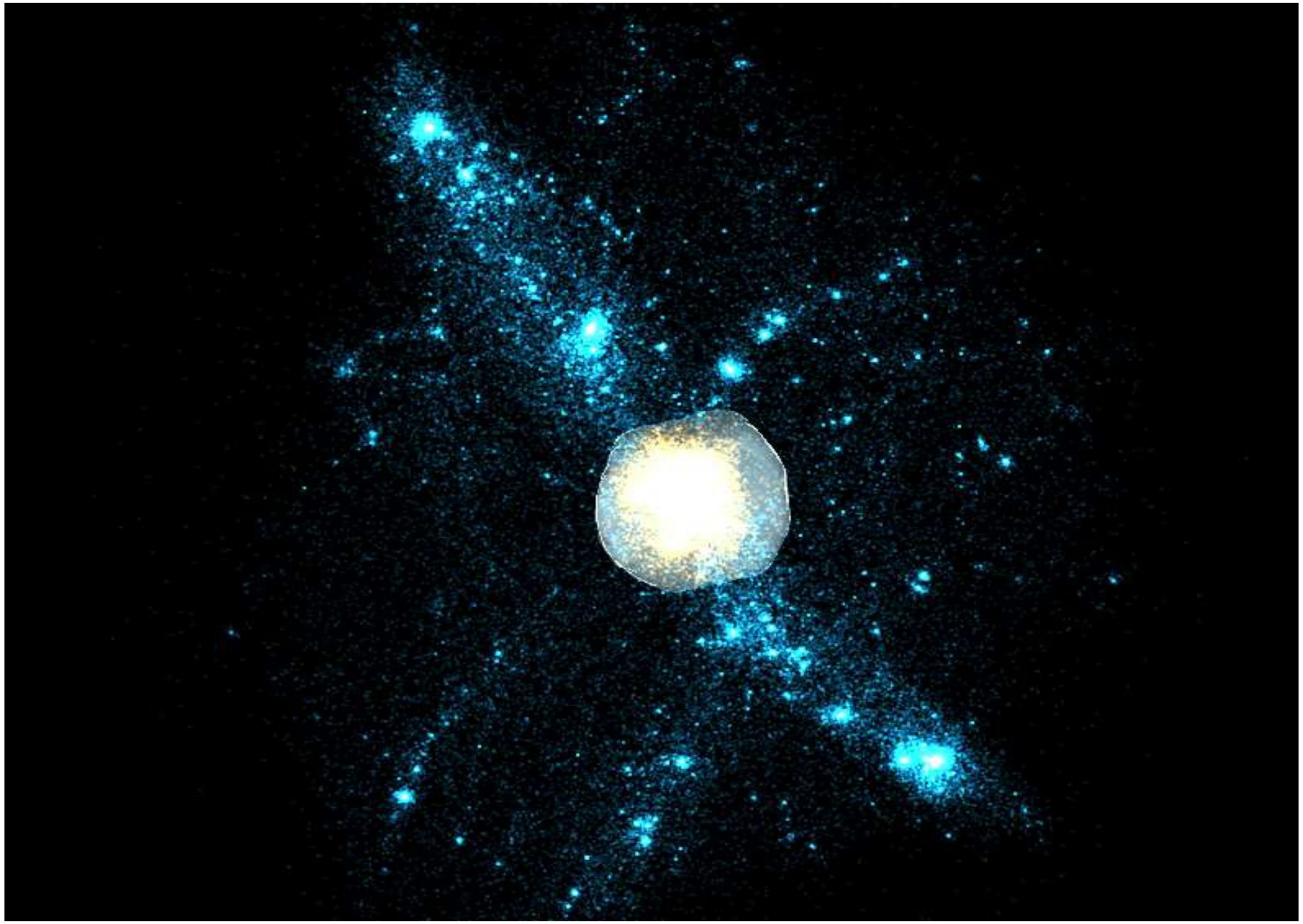
Selection using Direct Input



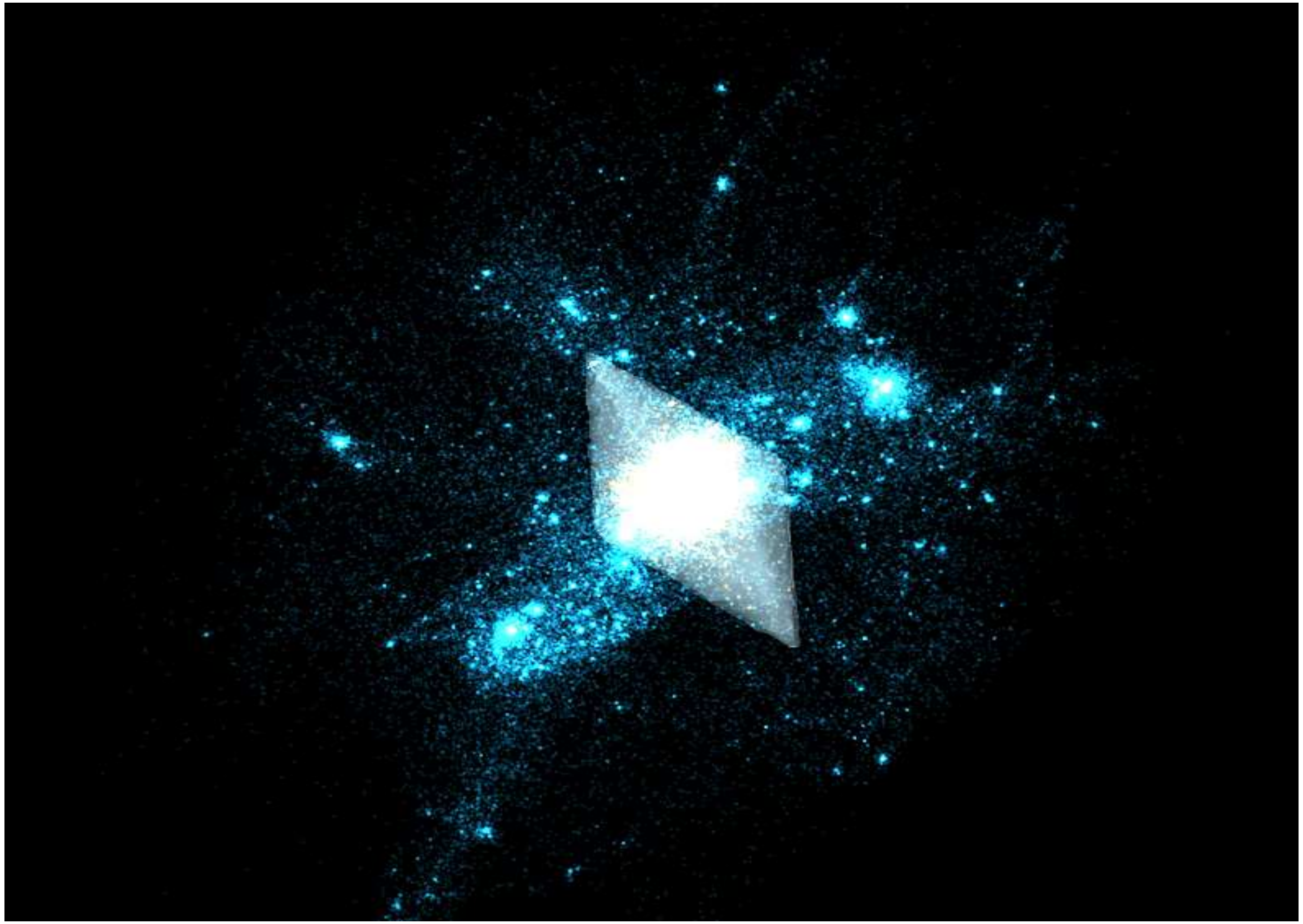
Selection using Direct Input



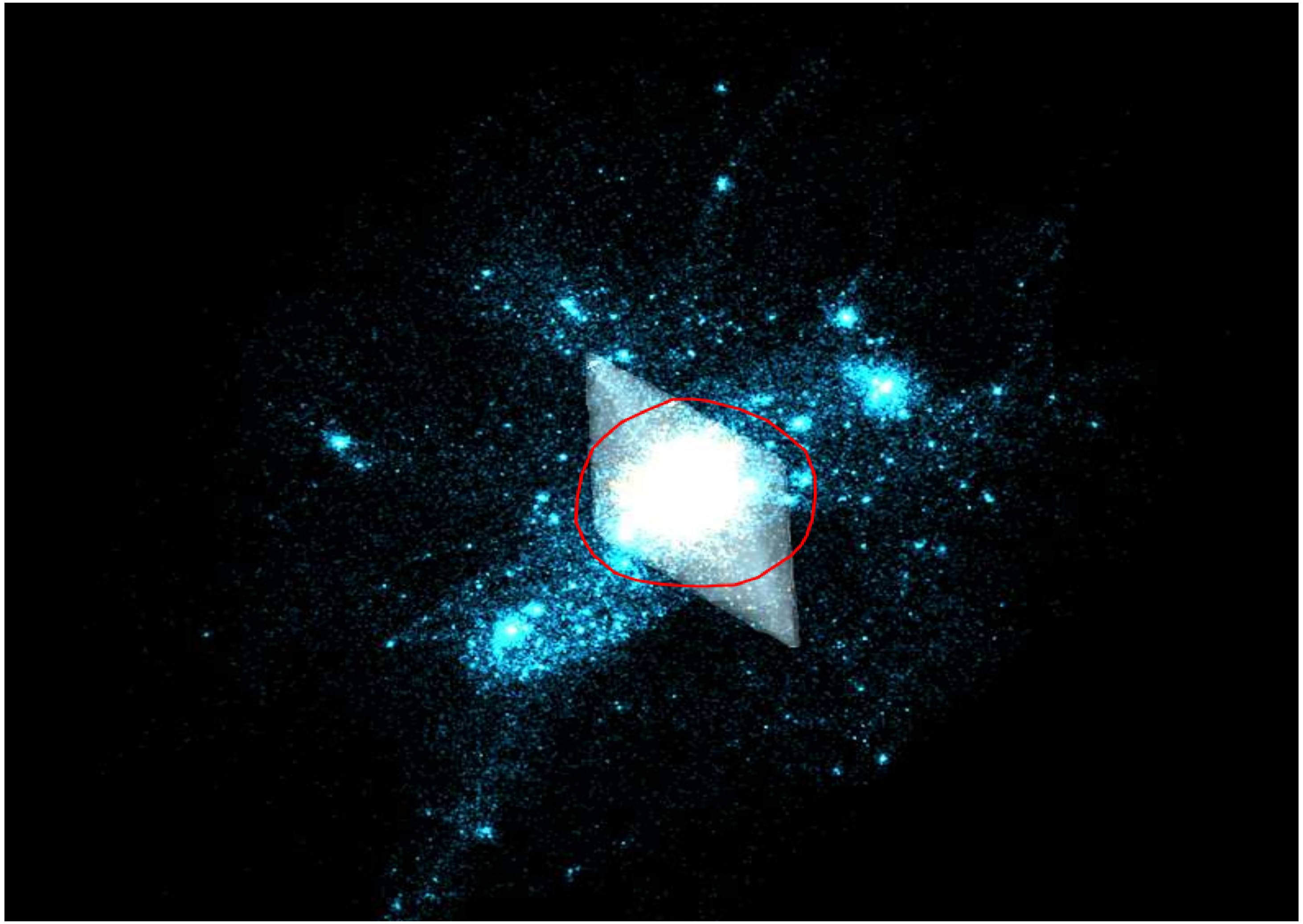
Selection using Direct Input



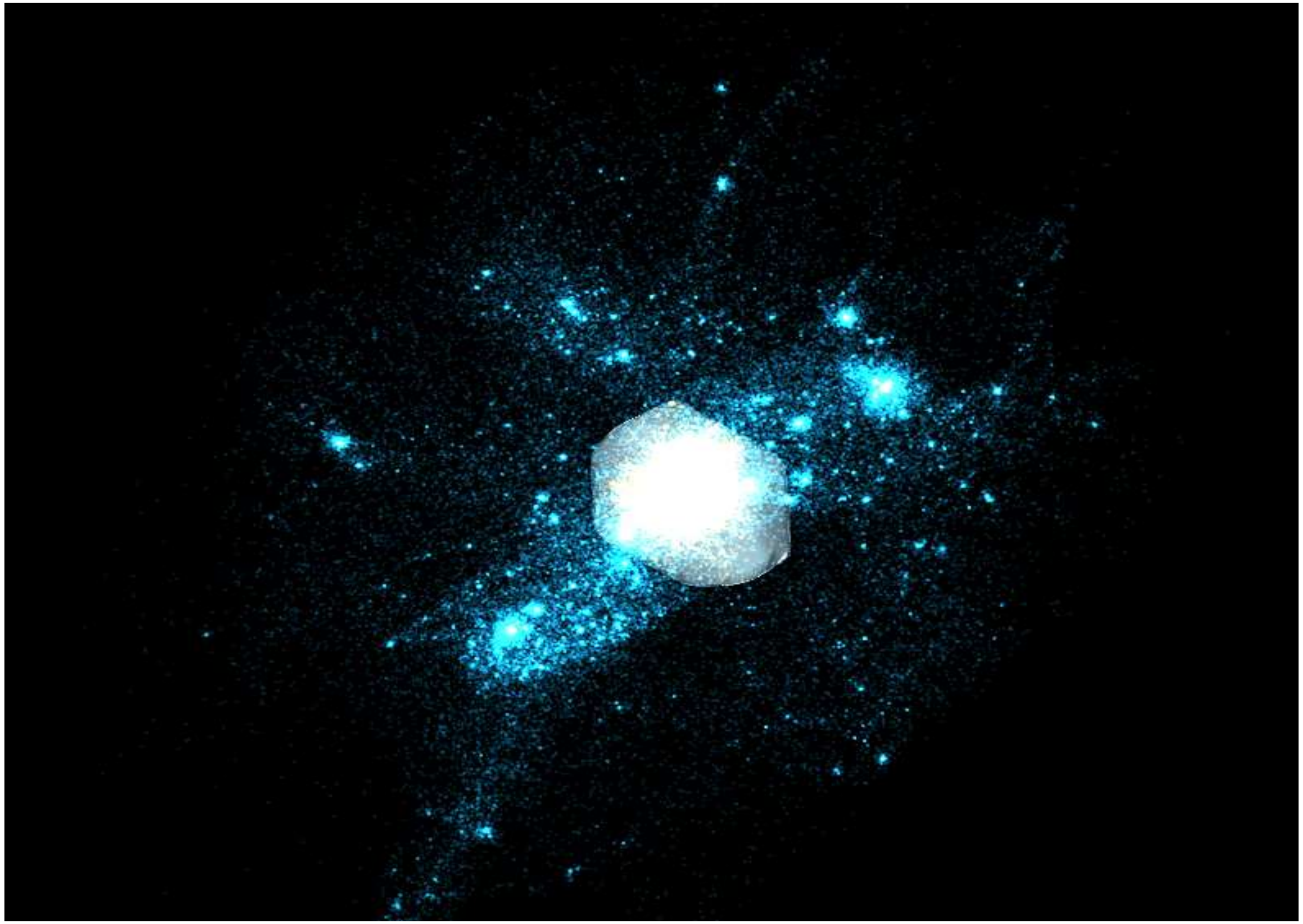
Selection using Direct Input



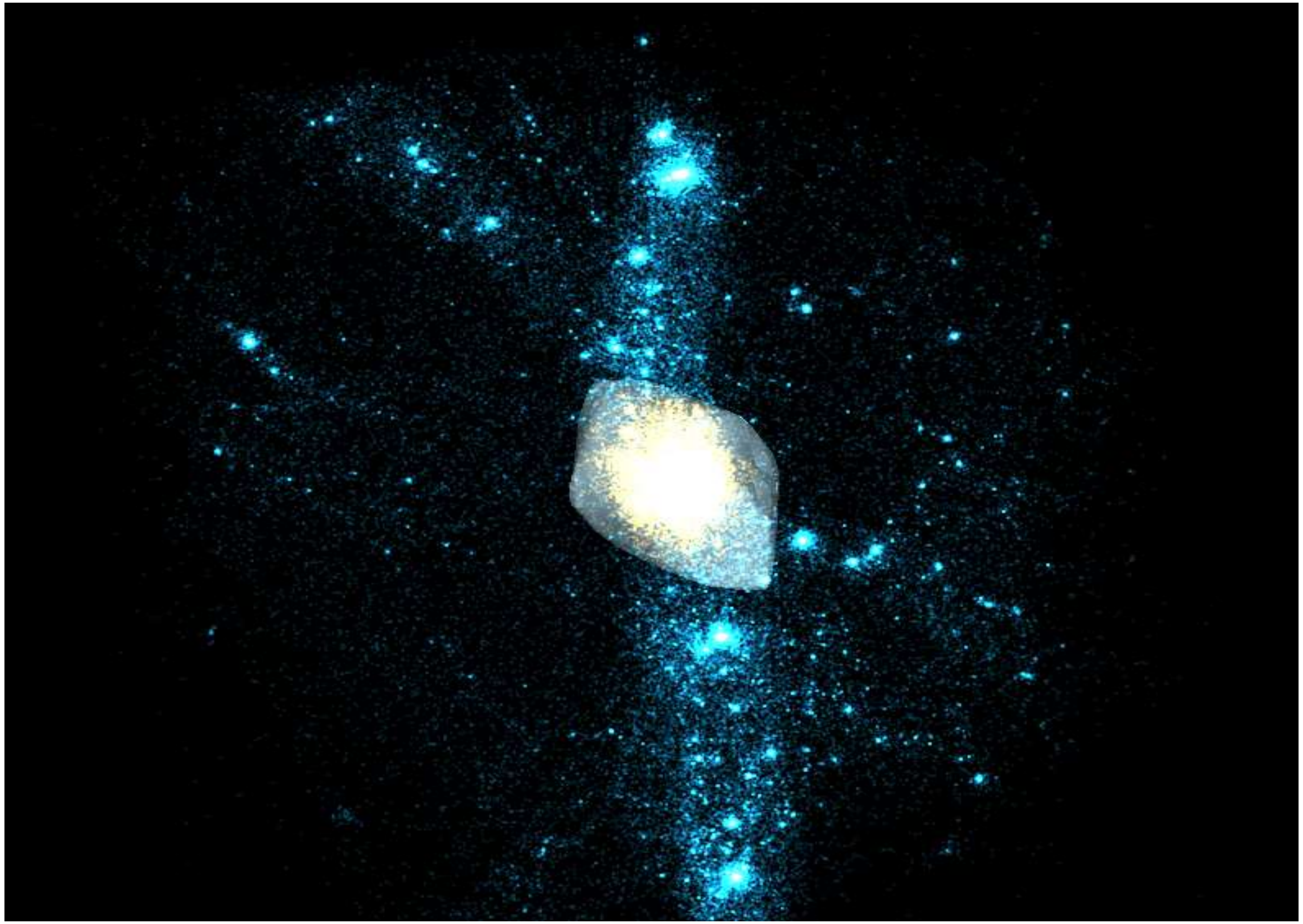
Selection using Direct Input



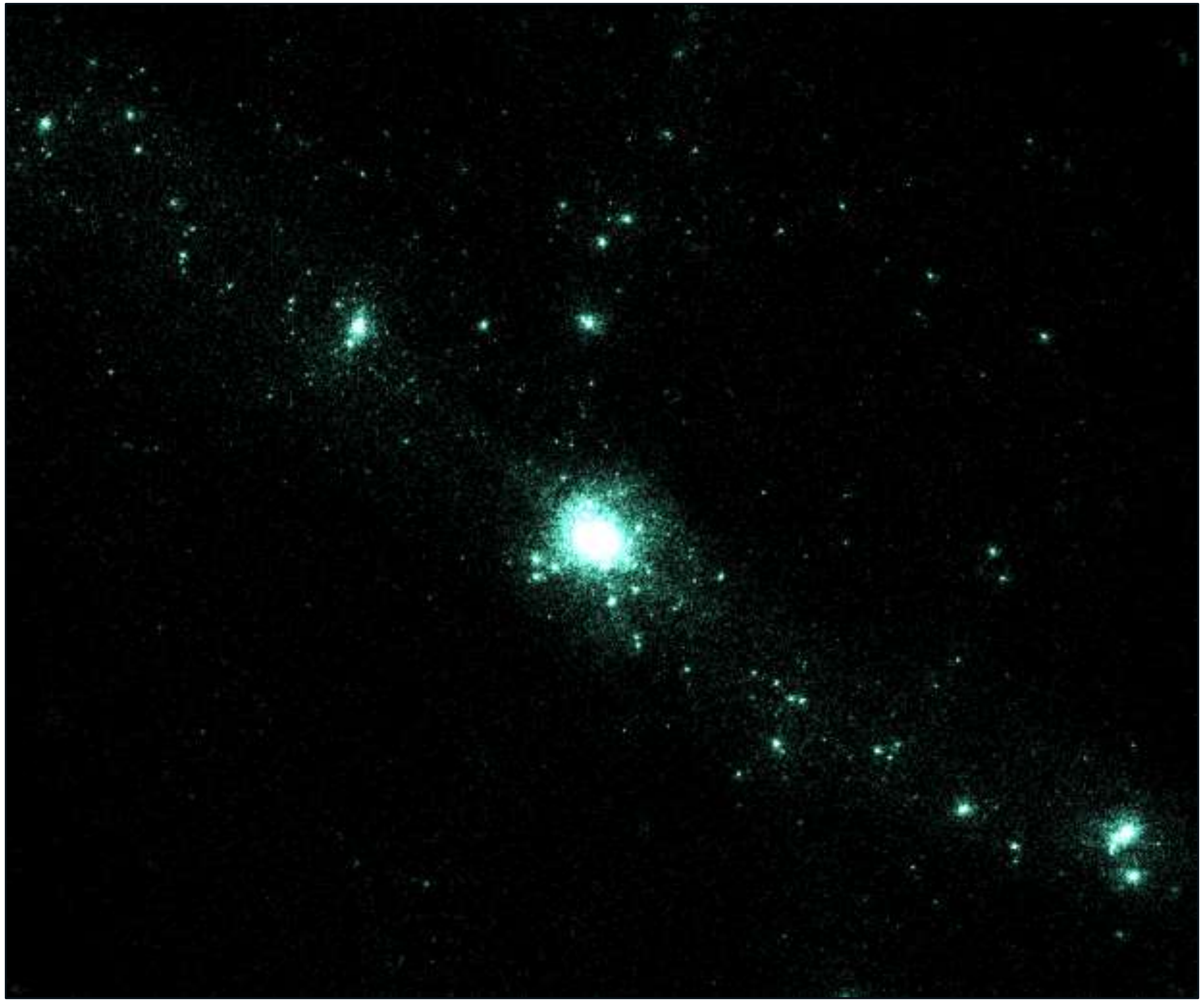
Selection using Direct Input



Selection using Direct Input

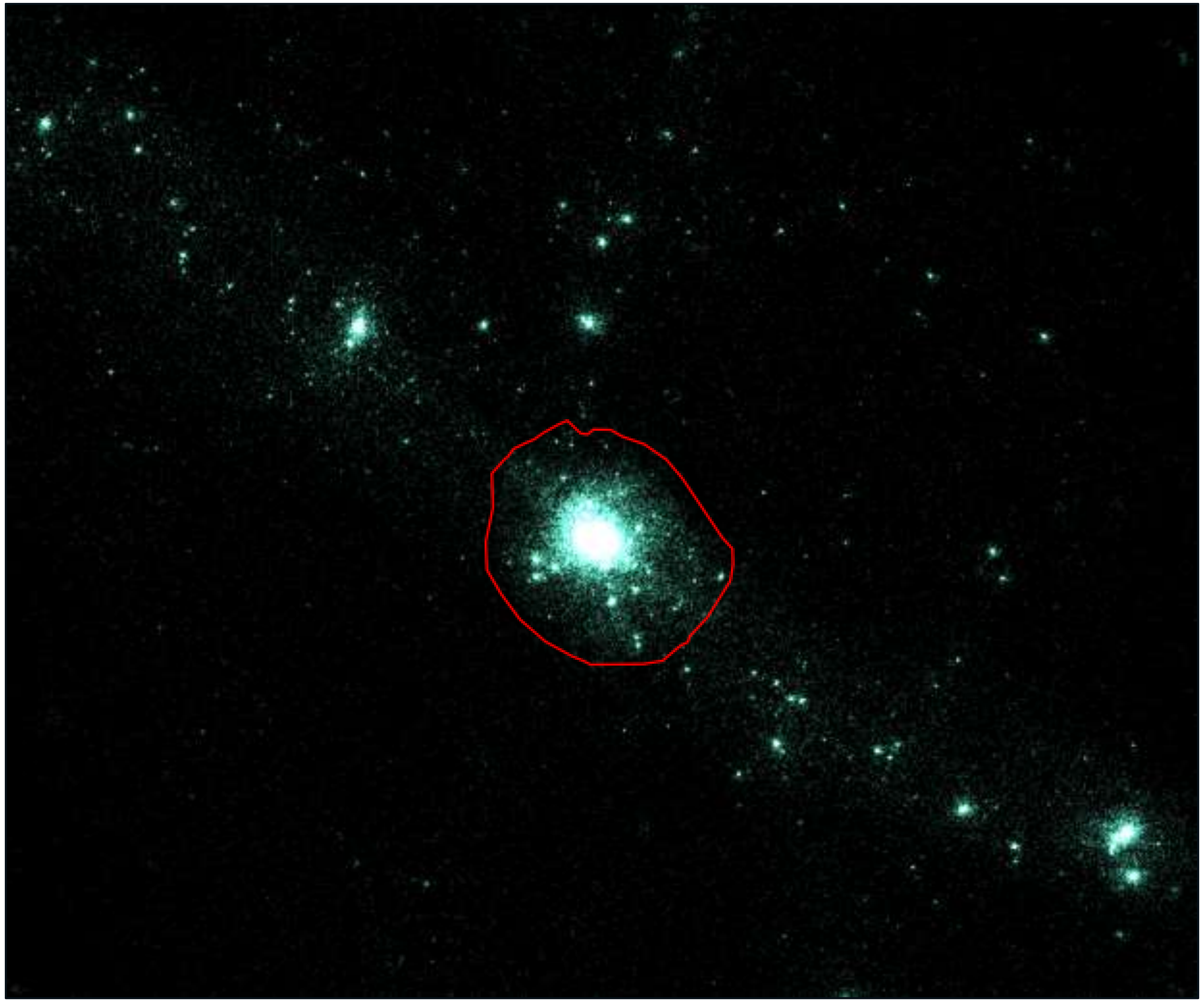


Envisioned Spatial Selection in 3D Space



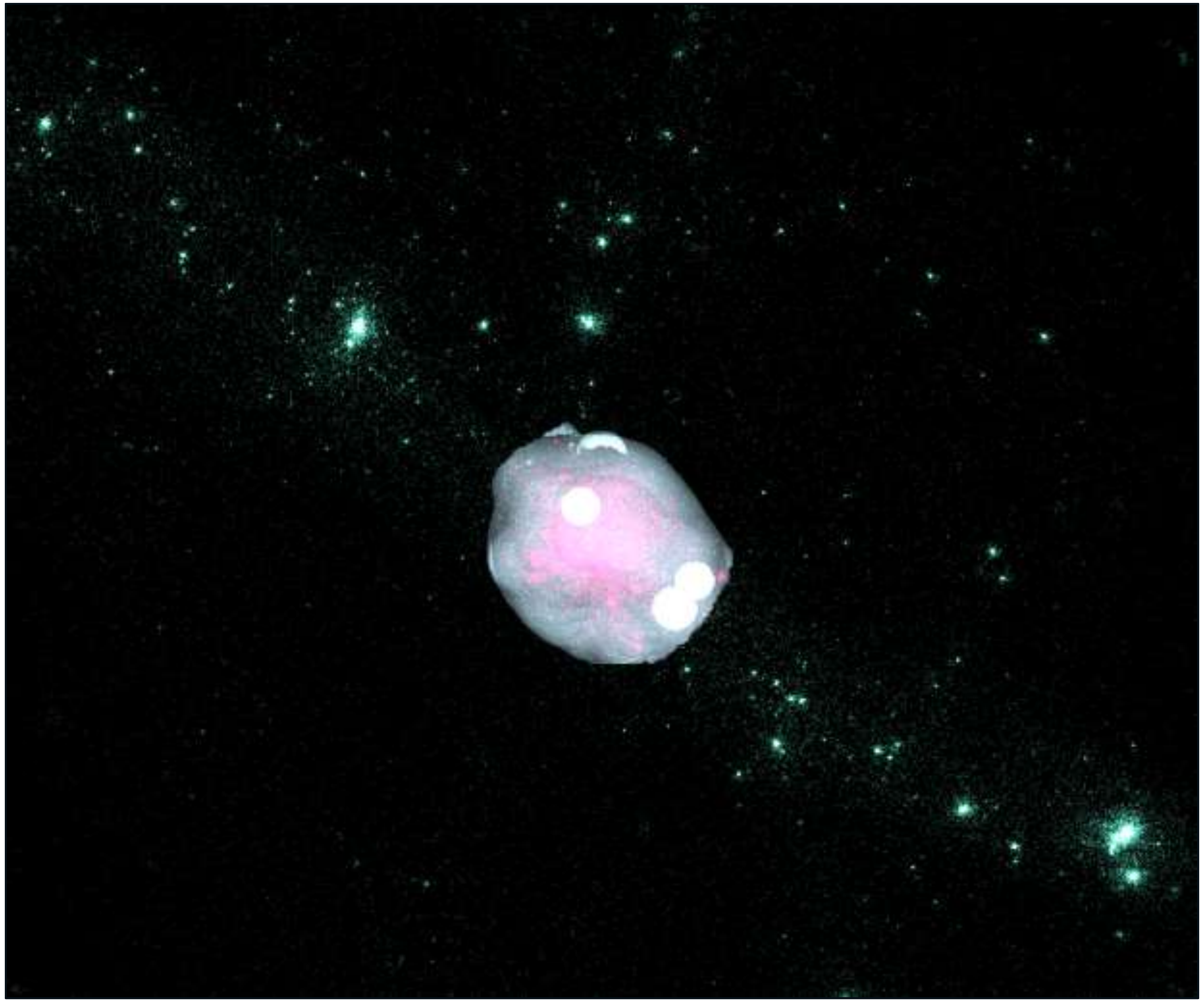
[Yu et al. 2012]

Envisioned Spatial Selection in 3D Space



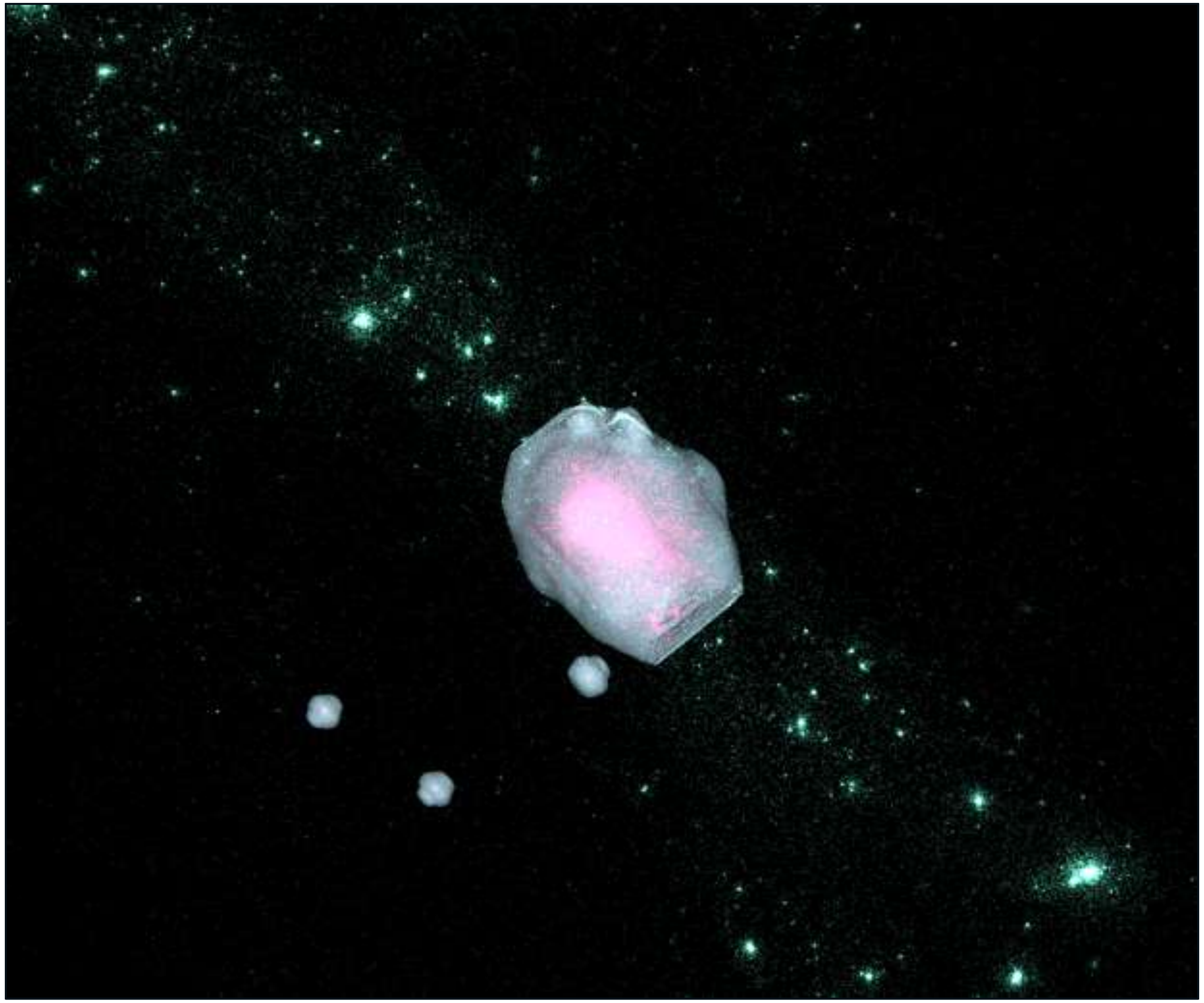
[Yu et al. 2012]

Envisioned Spatial Selection in 3D Space



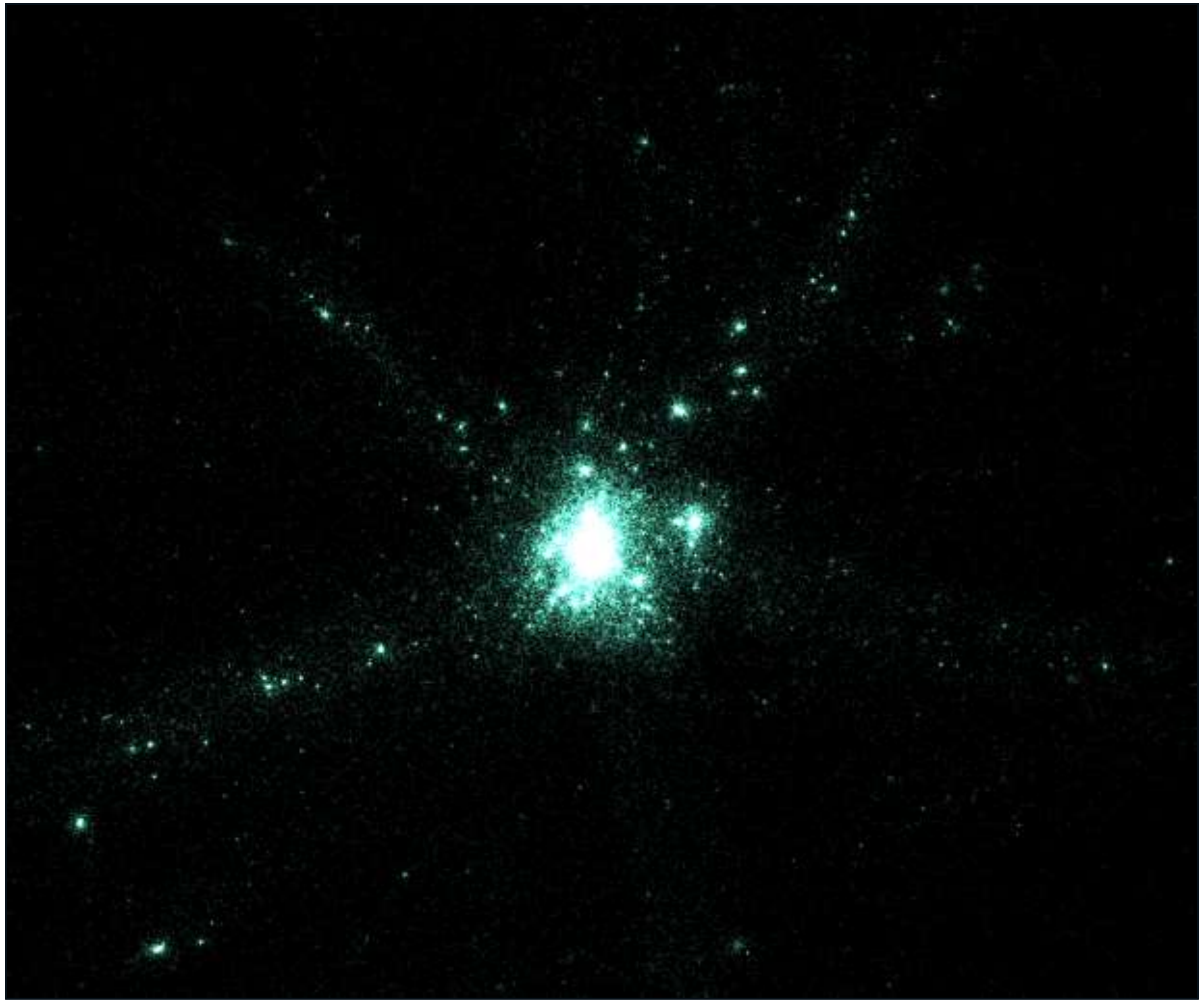
[Yu et al. 2012]

Envisioned Spatial Selection in 3D Space



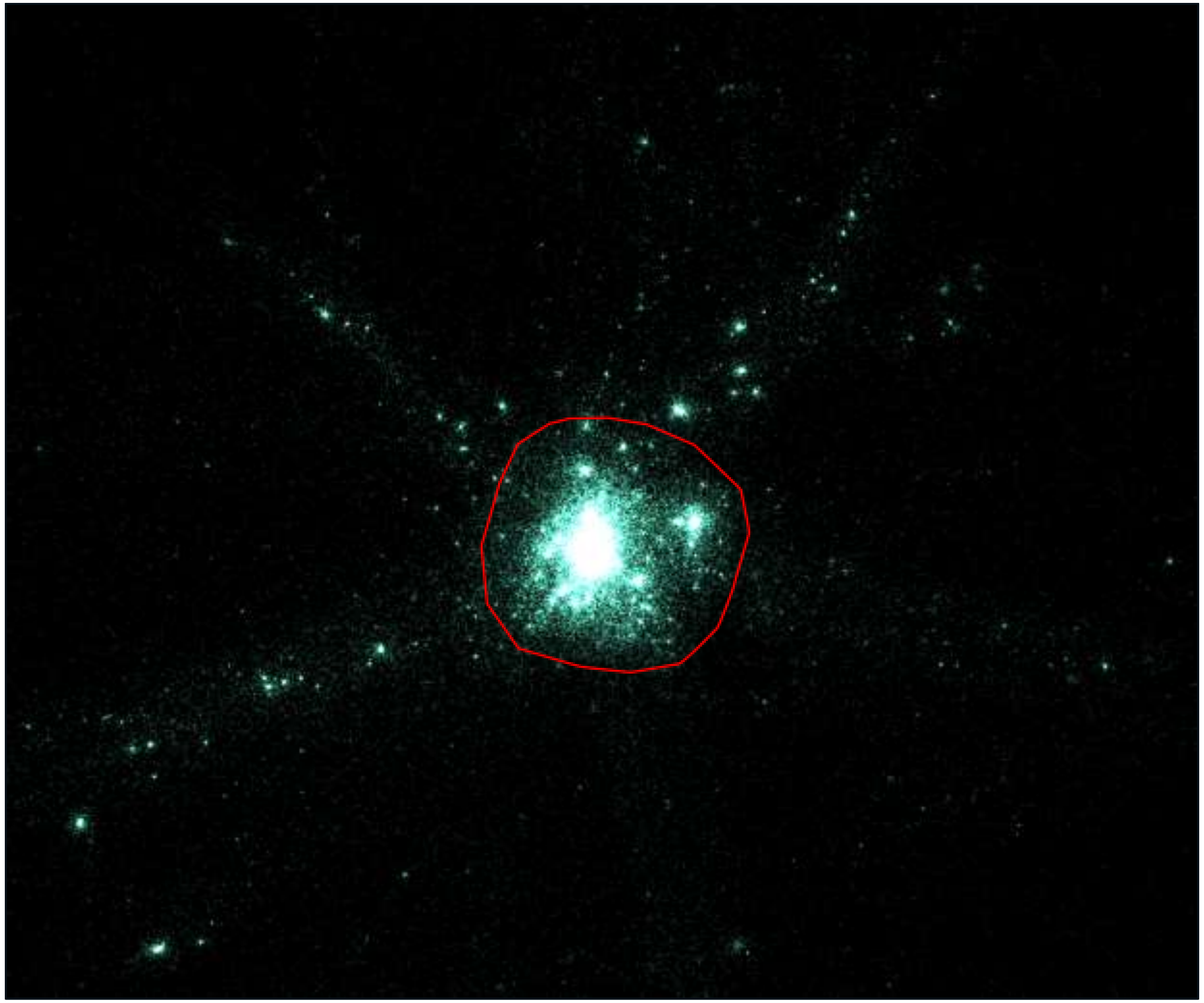
[Yu et al. 2012]

Envisioned Spatial Selection in 3D Space



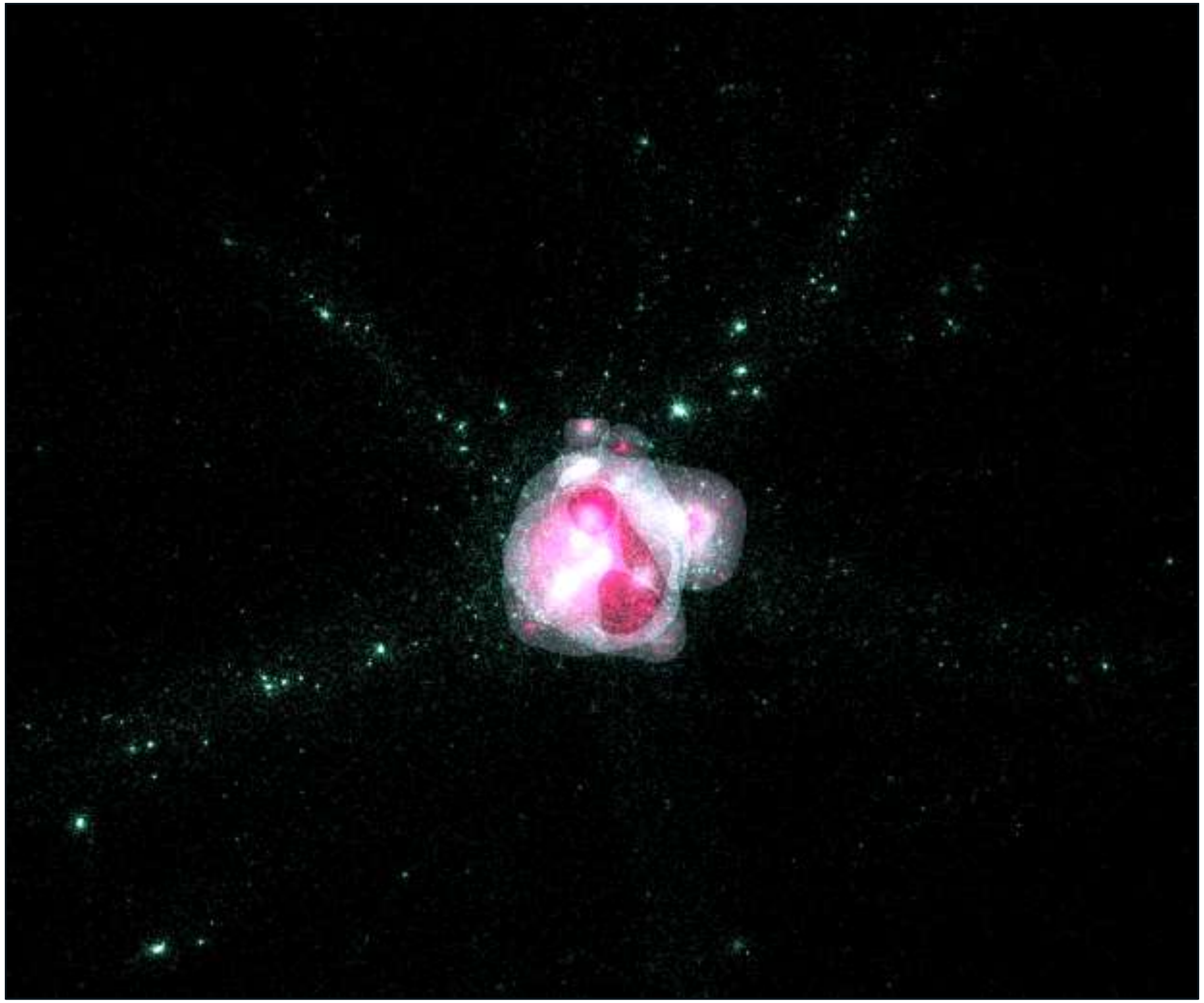
[Yu et al. 2012]

Envisioned Spatial Selection in 3D Space



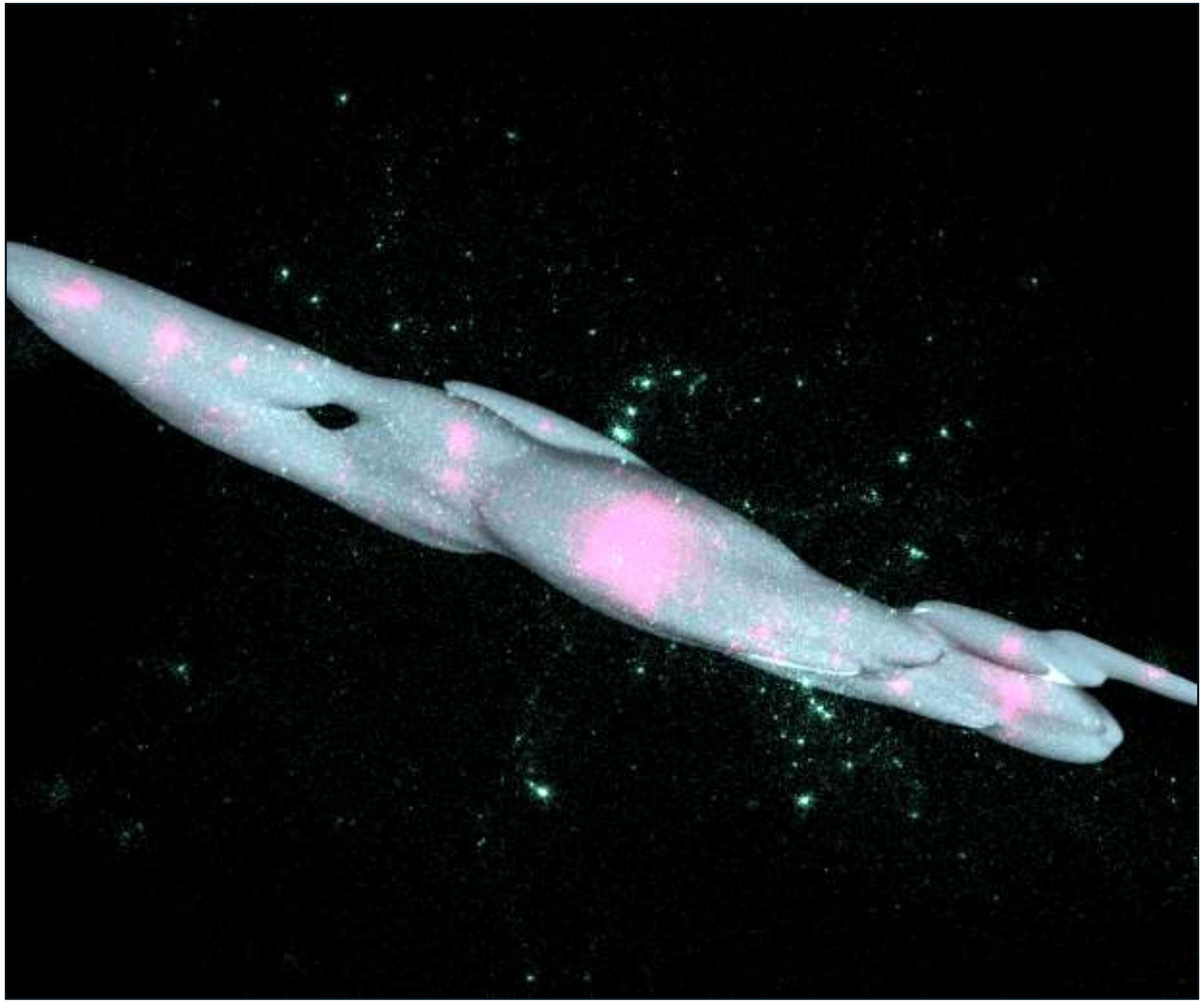
[Yu et al. 2012]

Envisioned Spatial Selection in 3D Space



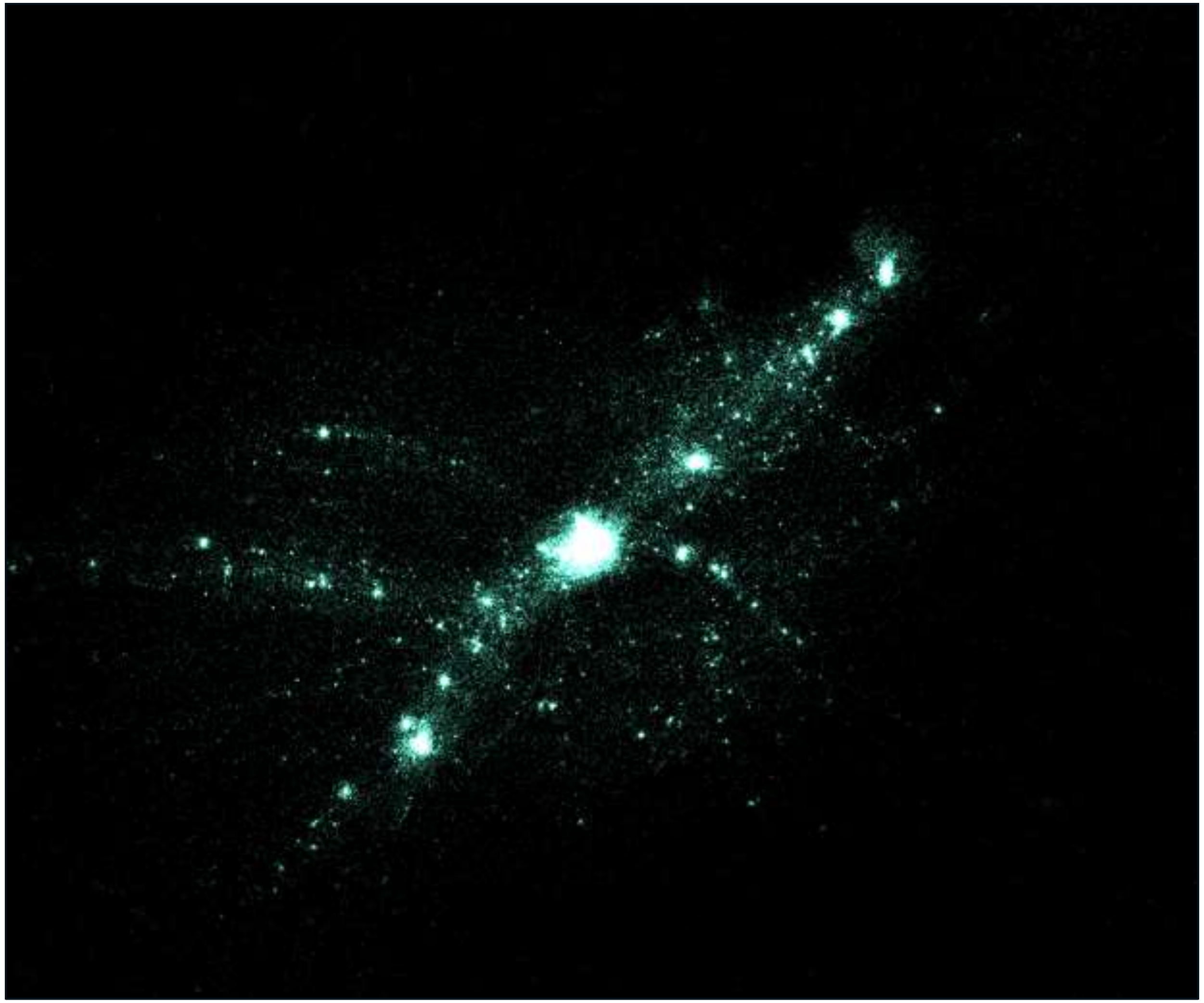
[Yu et al. 2012]

Envisioned Spatial Selection in 3D Space



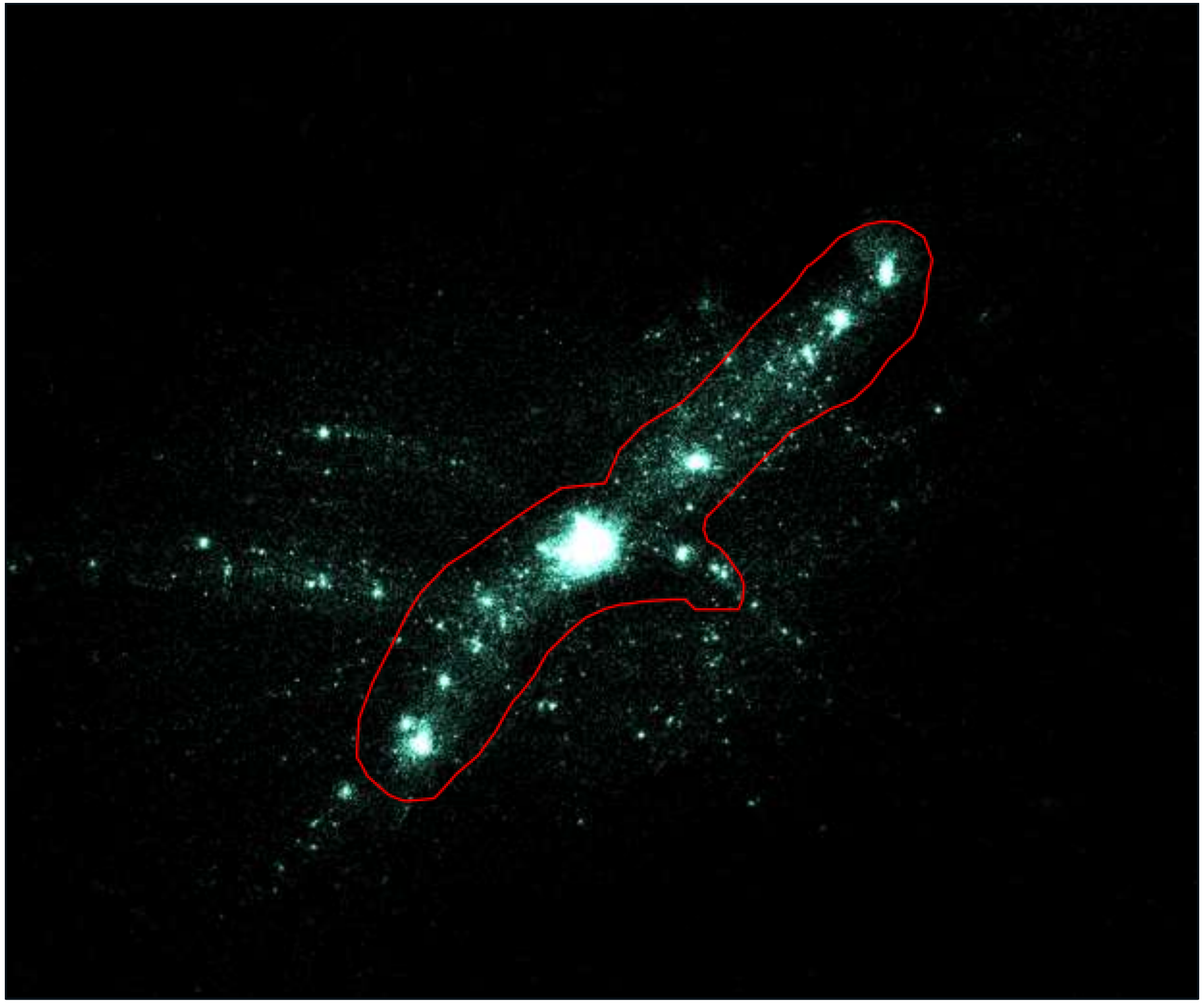
[Yu et al. 2012]

Envisioned Spatial Selection in 3D Space



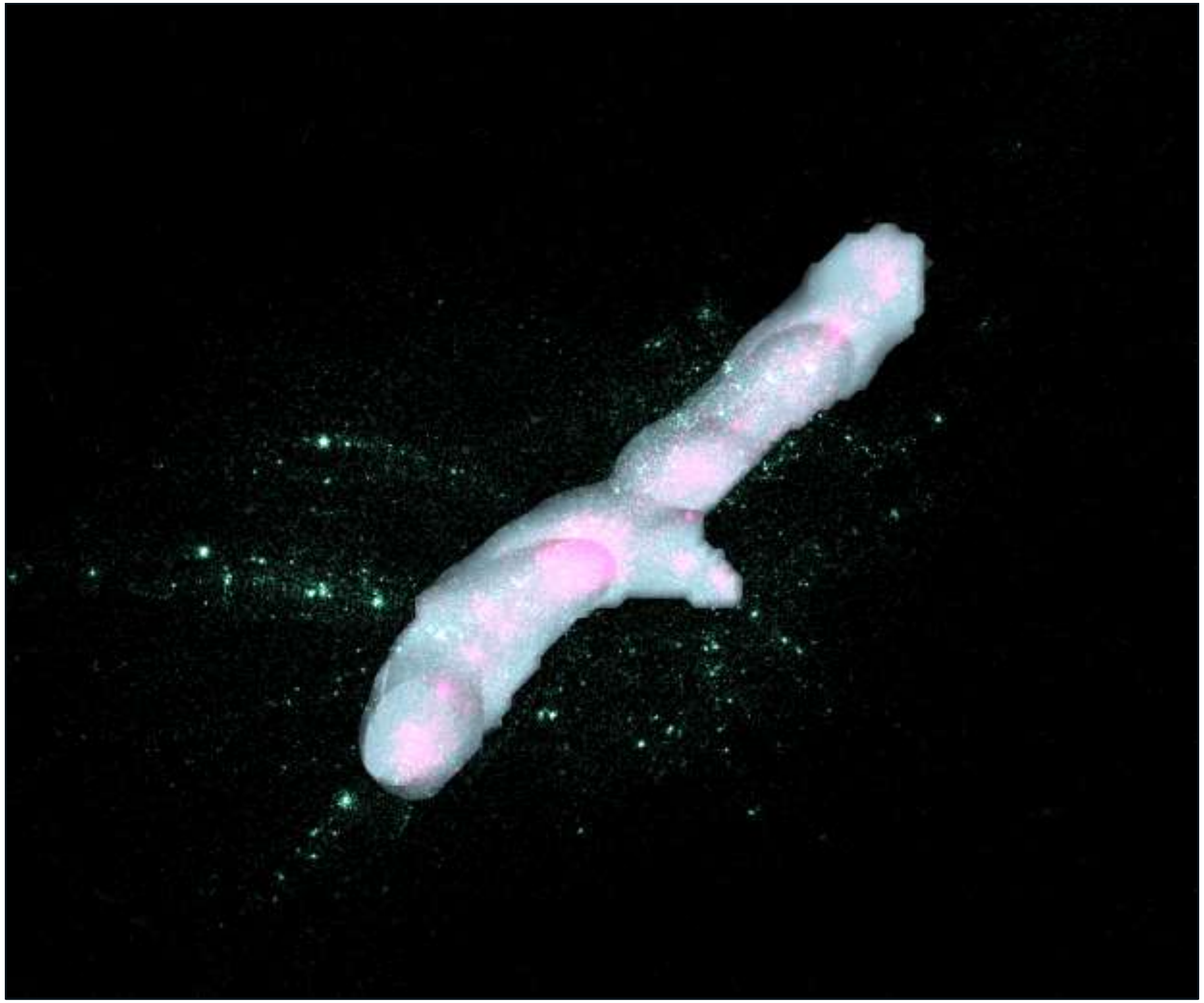
[Yu et al. 2012]

Envisioned Spatial Selection in 3D Space



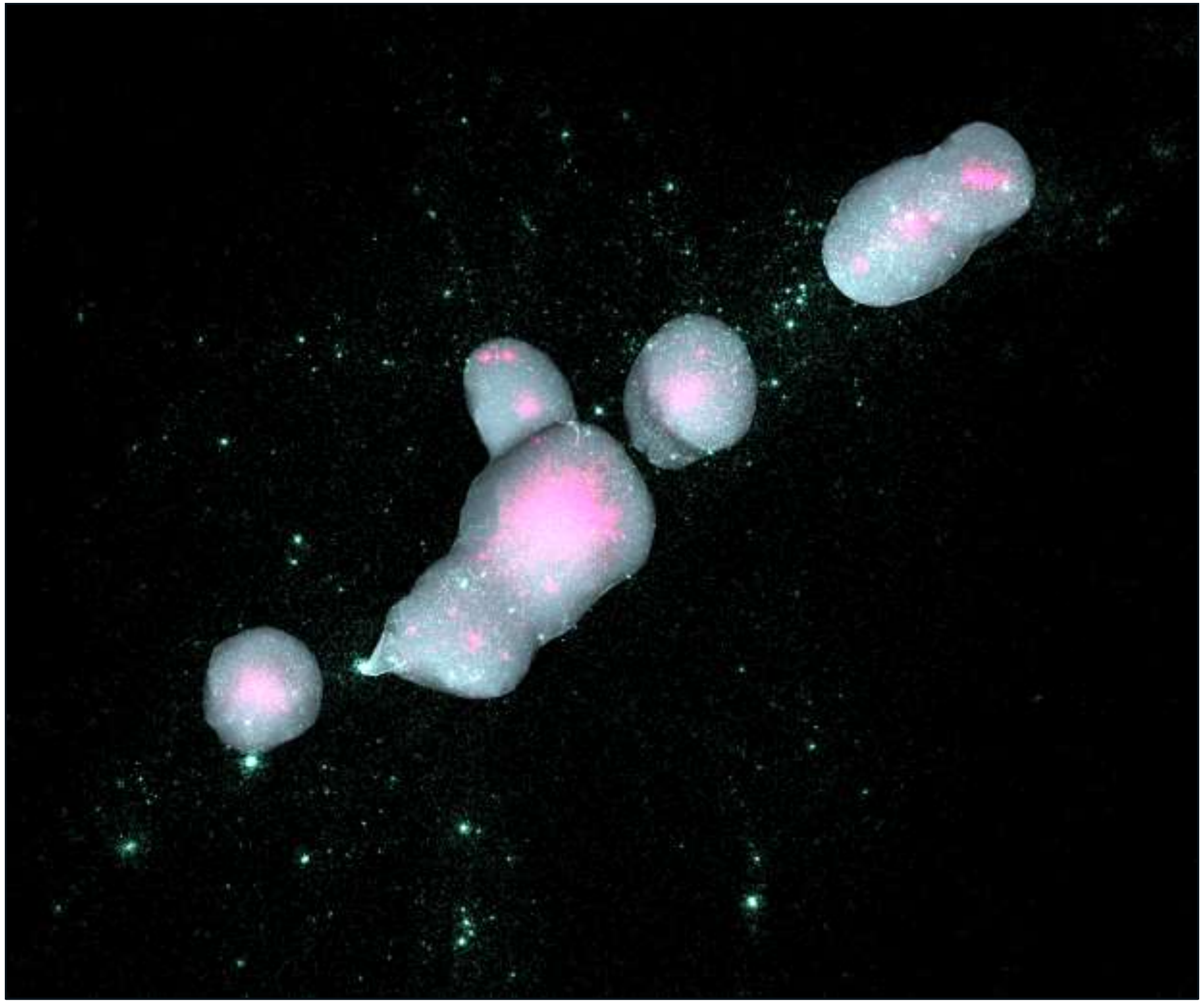
[Yu et al. 2012]

Envisioned Spatial Selection in 3D Space



[Yu et al. 2012]

Envisioned Spatial Selection in 3D Space



[Yu et al. 2012]

Structure-Aware Selection of Data: CloudLasso

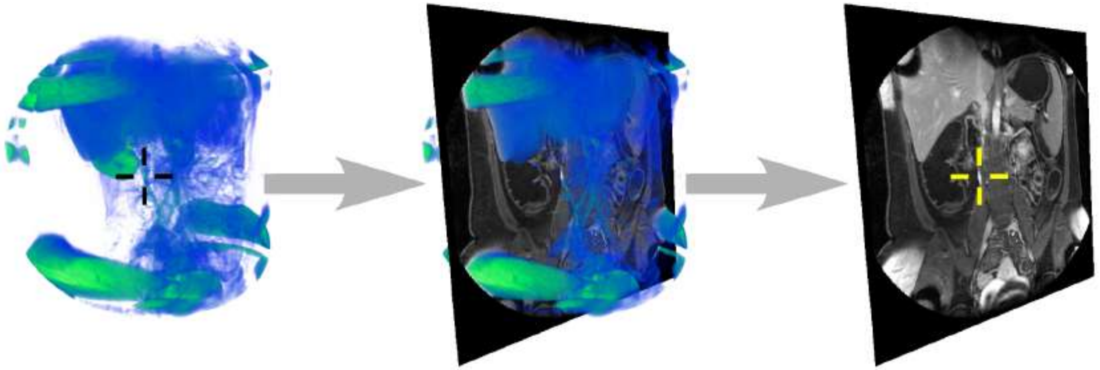
[Yu et al. 2012]

Structure-Aware Selection of Data: CAST

[Yu et al. 2016: presented later this week on Thursday at 8:30]

Other Interaction Techniques for Direct Input

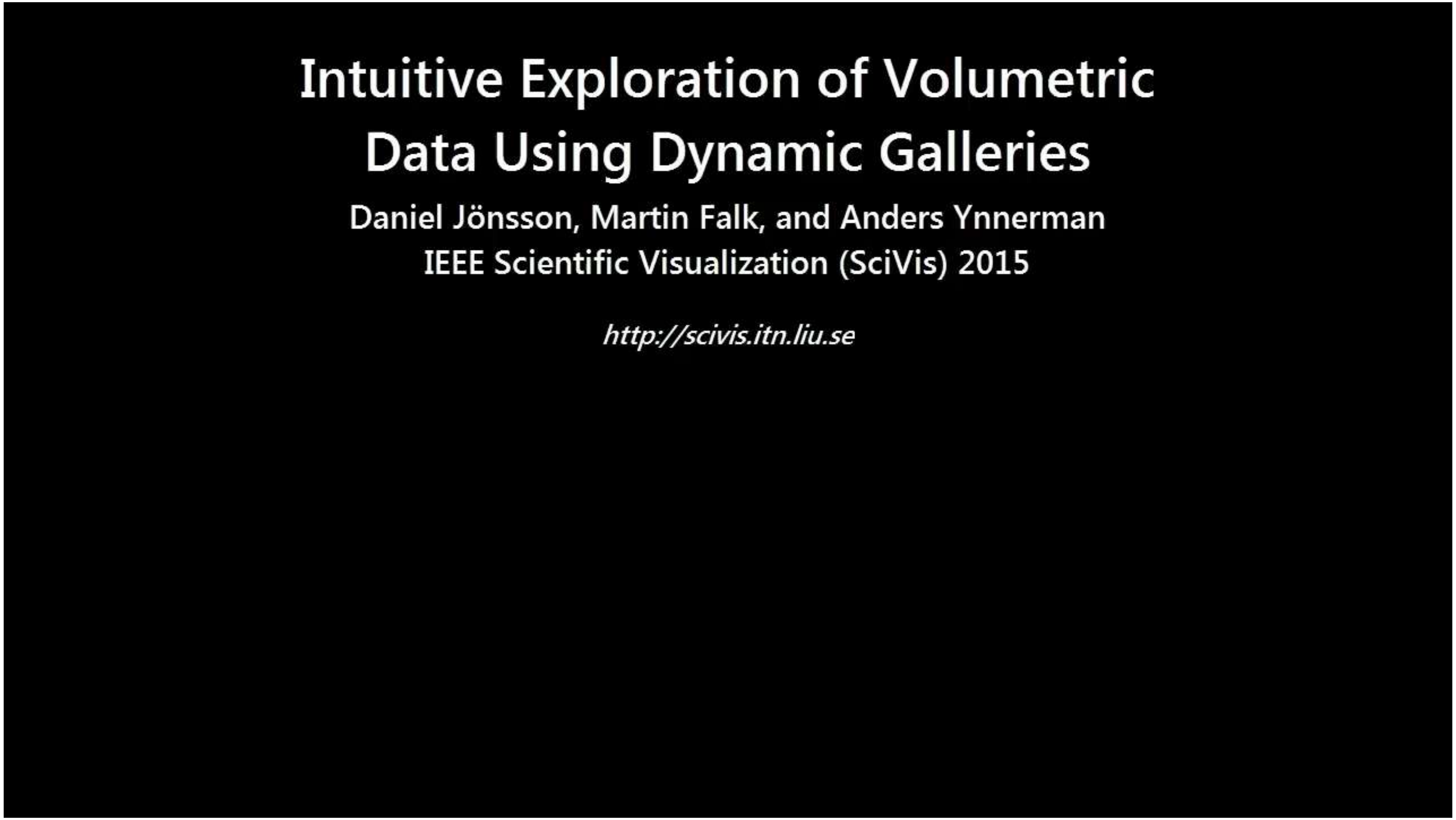
- two generic types discussed
- many others exist: special tasks, special hardware
- challenges & advantages: precision, speed, effectiveness



[Wiebel et al. 2012]

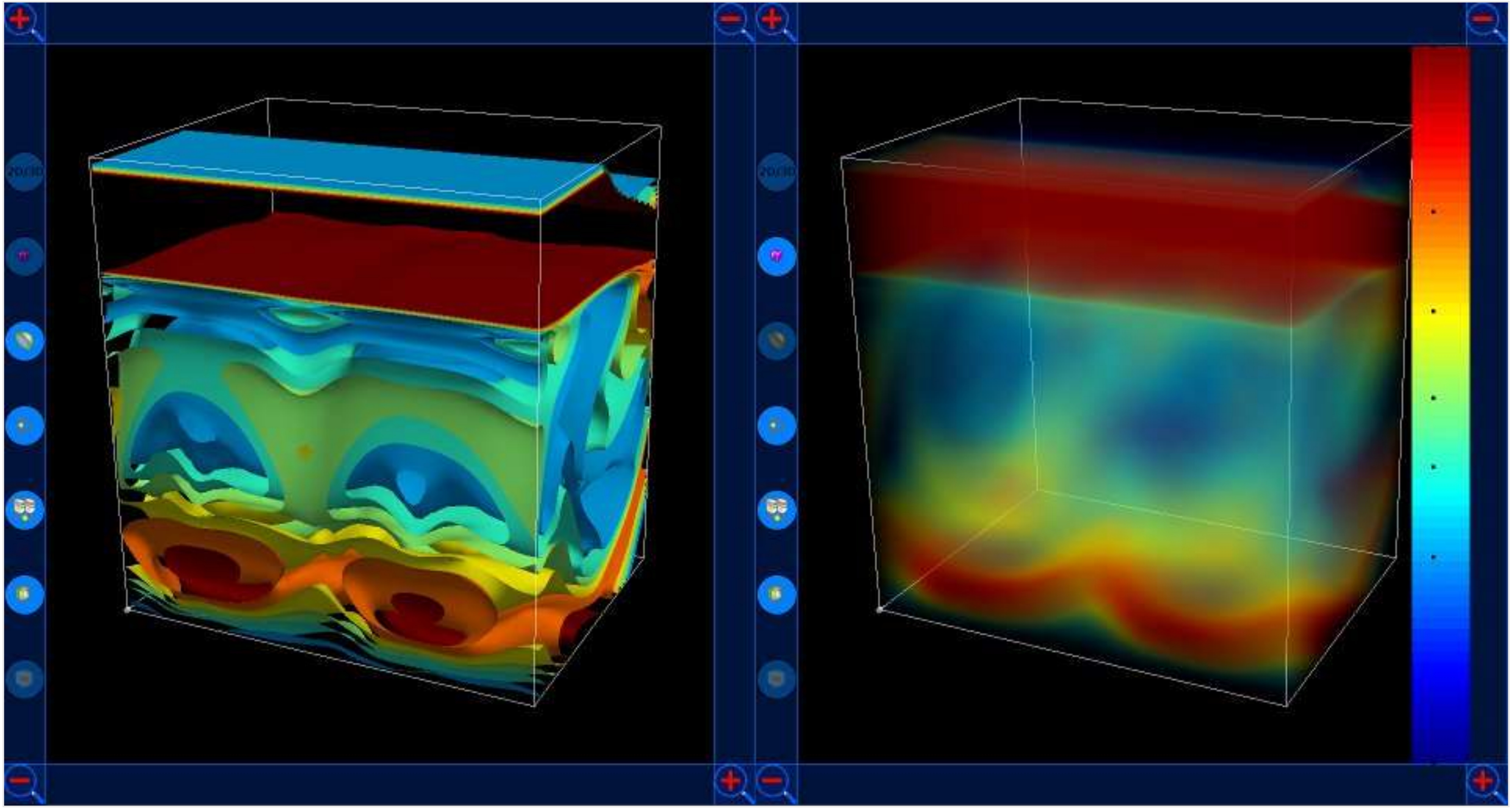
image: Daniel F. Keefe

Parameter Specification



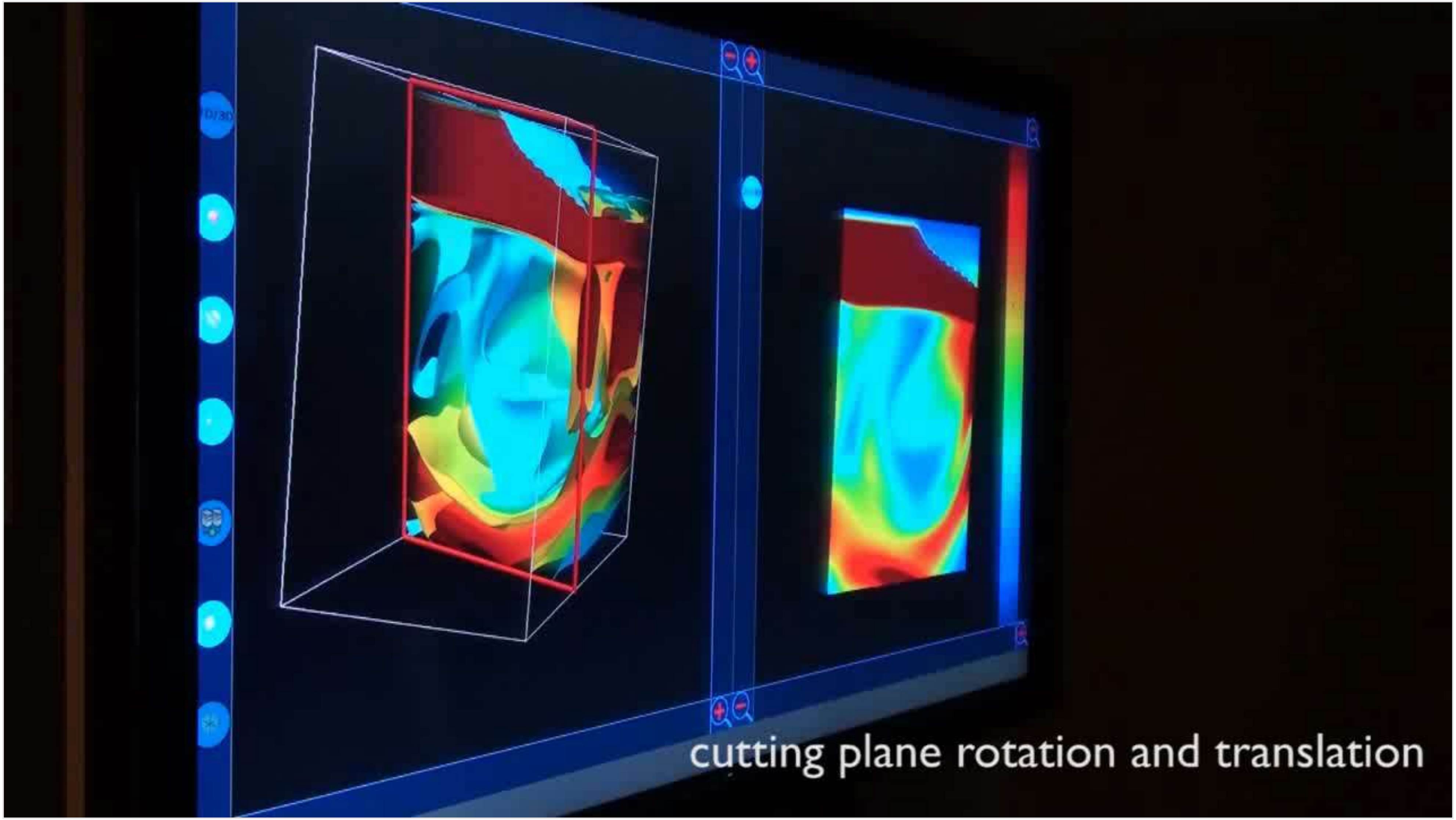
[Jönsson et al. 2016: presented later this week on Thursday at 8:30]

Combinations in Data Exploration Tools



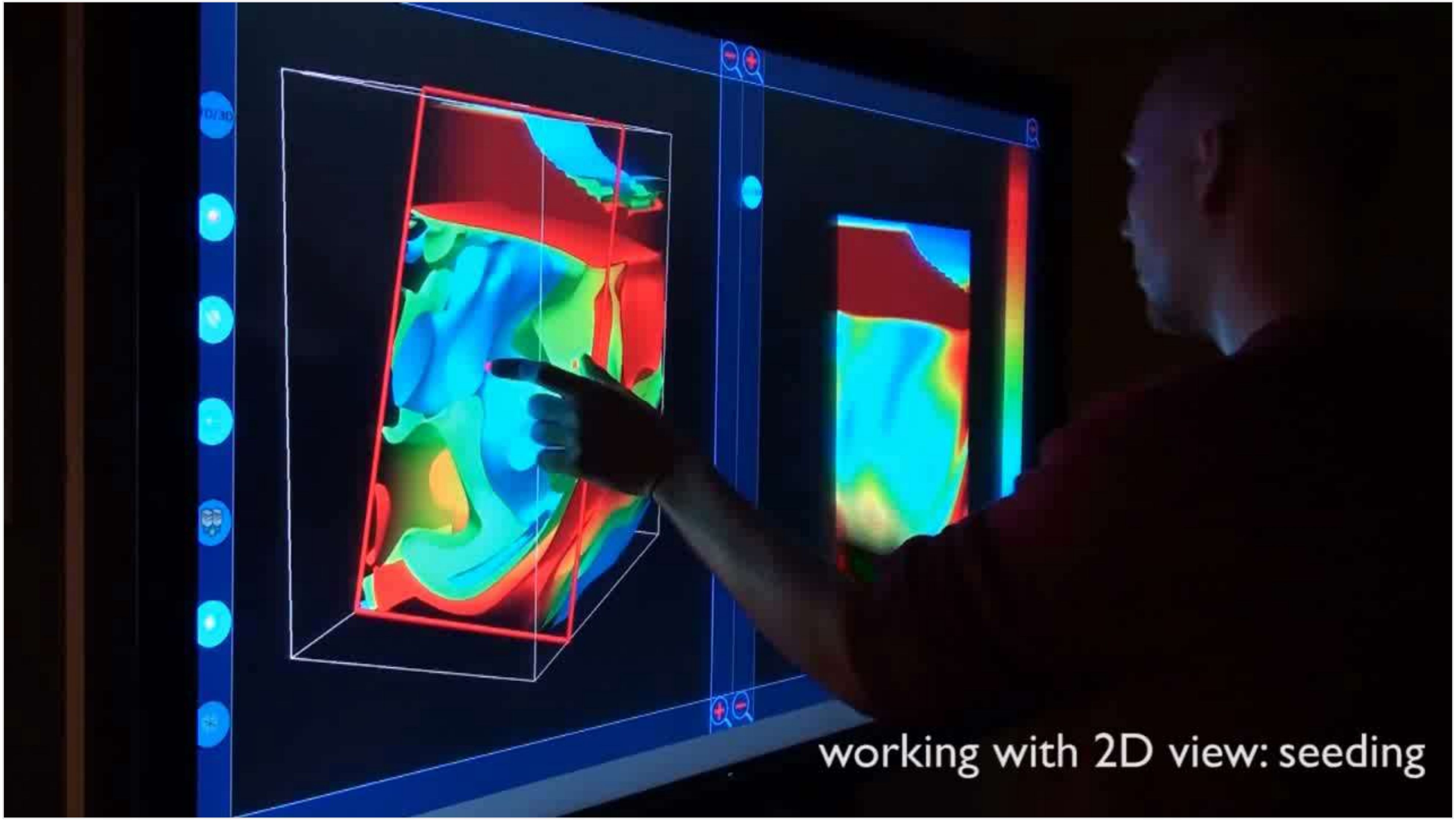
[Klein et al. 2012]

Combinations in Data Exploration Tools



[Klein et al. 2012]

Combinations in Data Exploration Tools



[Klein et al. 2012]

Combinations in Data Exploration Tools

[Sultanum et al. 2011]

Talks to go to this week

Tuesday, Oct. 27: 16:15—17:55

- López et al.: Towards an Understanding of Mobile Touch Navigation in a Stereoscopic Viewing Environment for 3D Data Exploration

Thursday, Oct. 29: 08:30—10:10

- Schroeder & Keefe: Visualization-by-Sketching: An Artist’s Interface for Creating Multivariate Time-Varying Data
- Yu et al.: CAST: Effective and Efficient User Interaction for Context-Aware Selection in 3D Particle Clouds
- Jönsson et al.: Intuitive Exploration of Volumetric Data Using Dynamic Galleries

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