Portal Problems

Development hurdles in Rendering, Design, & Physics

Dave Kircher & Tejeev Kohli

VALVE

Agenda

What is a Portal?

Rendering

- Texture vs Stencil Tradeoffs
- Rendering is 1:1
- Rendering using stencils
- Duplicate Models
- Clip Planes
- Banana Juice
- Recursion
- Third Person Gotchas
- Pixel Queries

Design

- Prototyping in 2D
- Training Basics
- Helpers
- Fun Physics > Accurate physics
- Gels
- Cutting Features
- Combining Elements

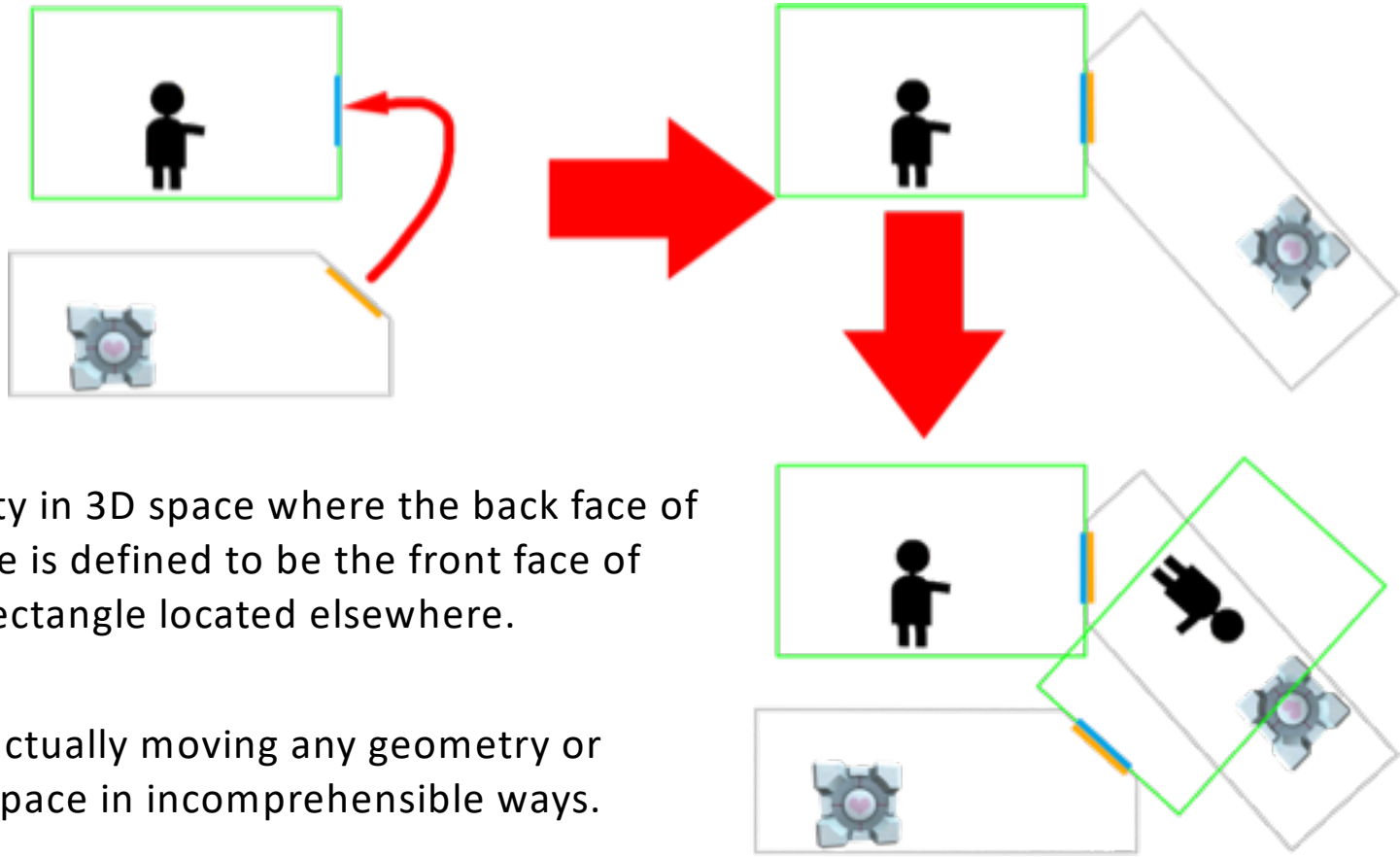
Physics

- Triggers and Vectors and Planes, Oh My
- Carving Holes
- Collision Lists
- Shadow Clones

Miscellaneous

- Camera interpolation
- Discontinuous interpolation
- Moving portals
- Frustums
- Non-rotating player bounding box
- Unstuck
- Binary gravity

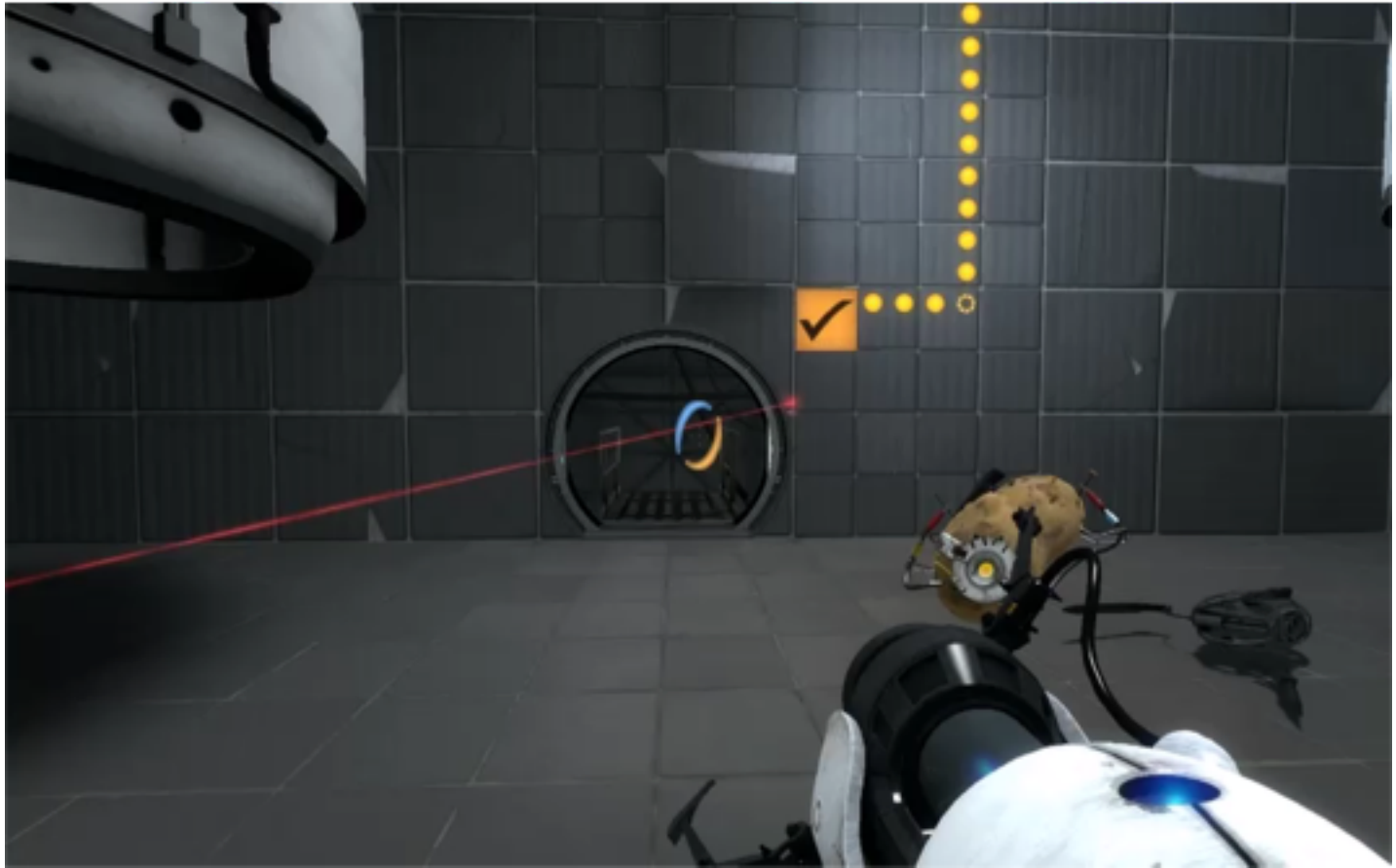
What is a Portal?



A discontinuity in 3D space where the back face of a 2D rectangle is defined to be the front face of another 2D rectangle located elsewhere.

But without actually moving any geometry or overlapping space in incomprehensible ways.

What is a Portal?



Agenda

What is a Portal?

Rendering

- Texture vs Stencil Tradeoffs
- Rendering is 1:1
- Rendering using stencils
- Duplicate Models
- Clip Planes
- Banana Juice
- Recursion
- Third Person Gotchas
- Pixel Queries

Design

- Prototyping in 2D
- Training Basics
- Helpers
- Fun Physics > Accurate physics
- Gels
- Cutting Features
- Combining Elements

Physics

- Triggers and Vectors and Planes, Oh My
- Carving Holes
- Collision Lists
- Shadow Clones

Miscellaneous

- Camera interpolation
- Discontinuous interpolation
- Moving portals
- Frustums
- Non-rotating player bounding box
- Unstuck
- Binary gravity

Rendering: Texture vs Stencil Tradeoffs

Texture:

- Separate textures per portal view. Recursion gets big fast.
- Use Painter's Algorithm. Deepest portals first
- Can't effectively use antialiasing. Small visual artifacts.
- Simplest to implement when constrained to a depth of 1

Stencil:

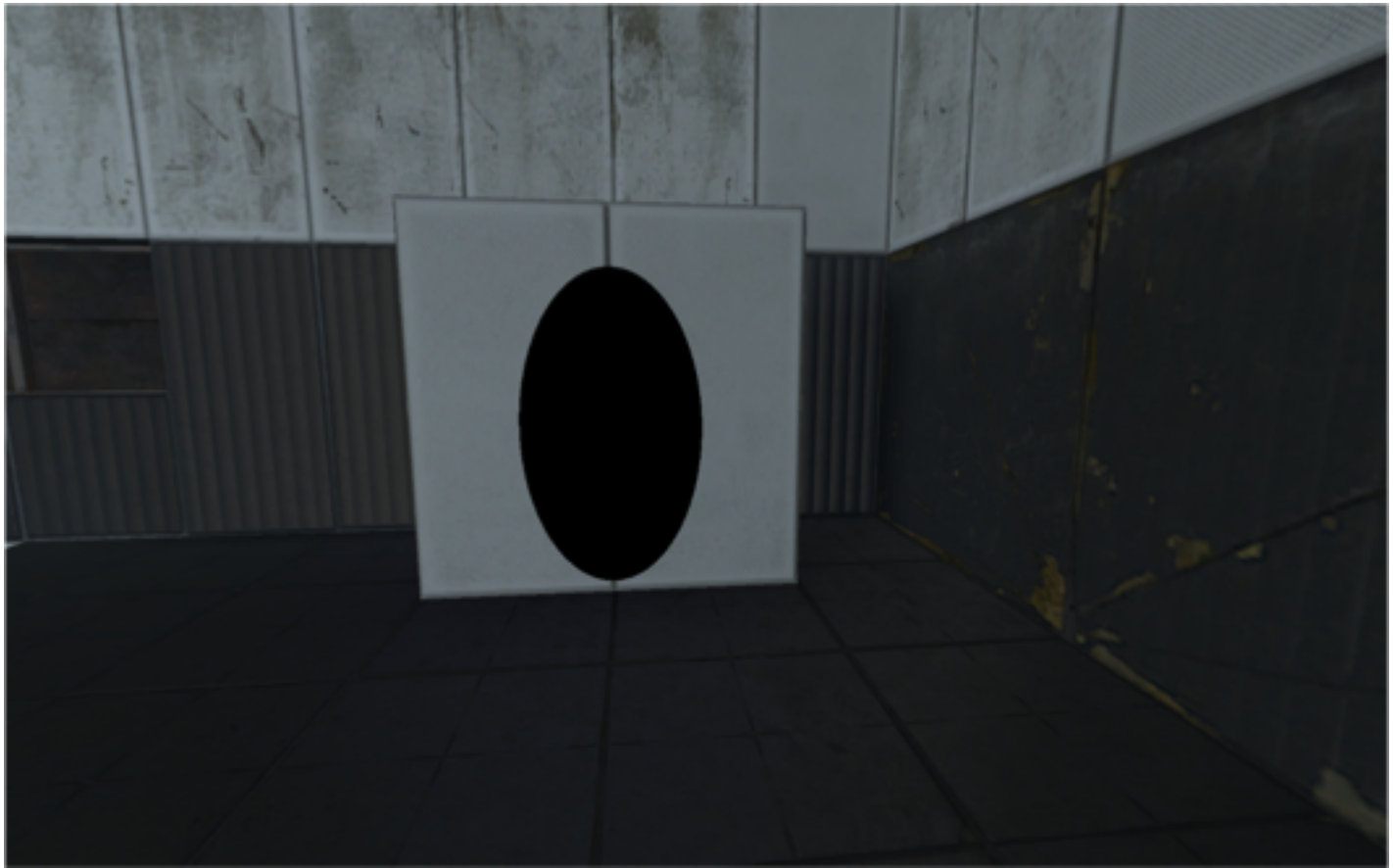
- Renders entire frame in the back buffer. No texture memory needed.
- Start from the main view and recurse as necessary.
- Homogenous visual quality
- Need to recurse after opaques, but before transparencies.

Rendering example layout

Rendering is 1:1

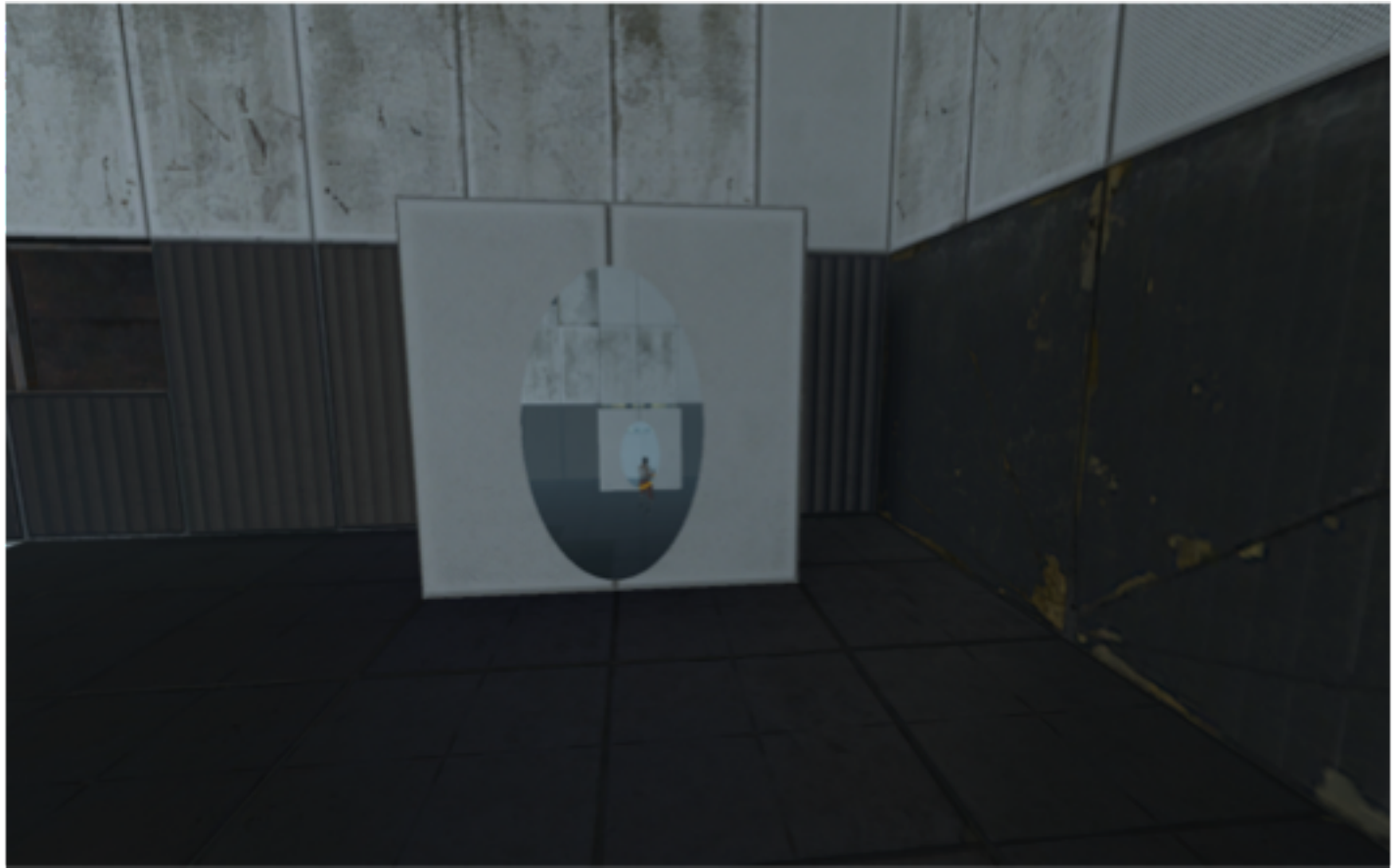
Rendering using stencils

Rendering using stencils

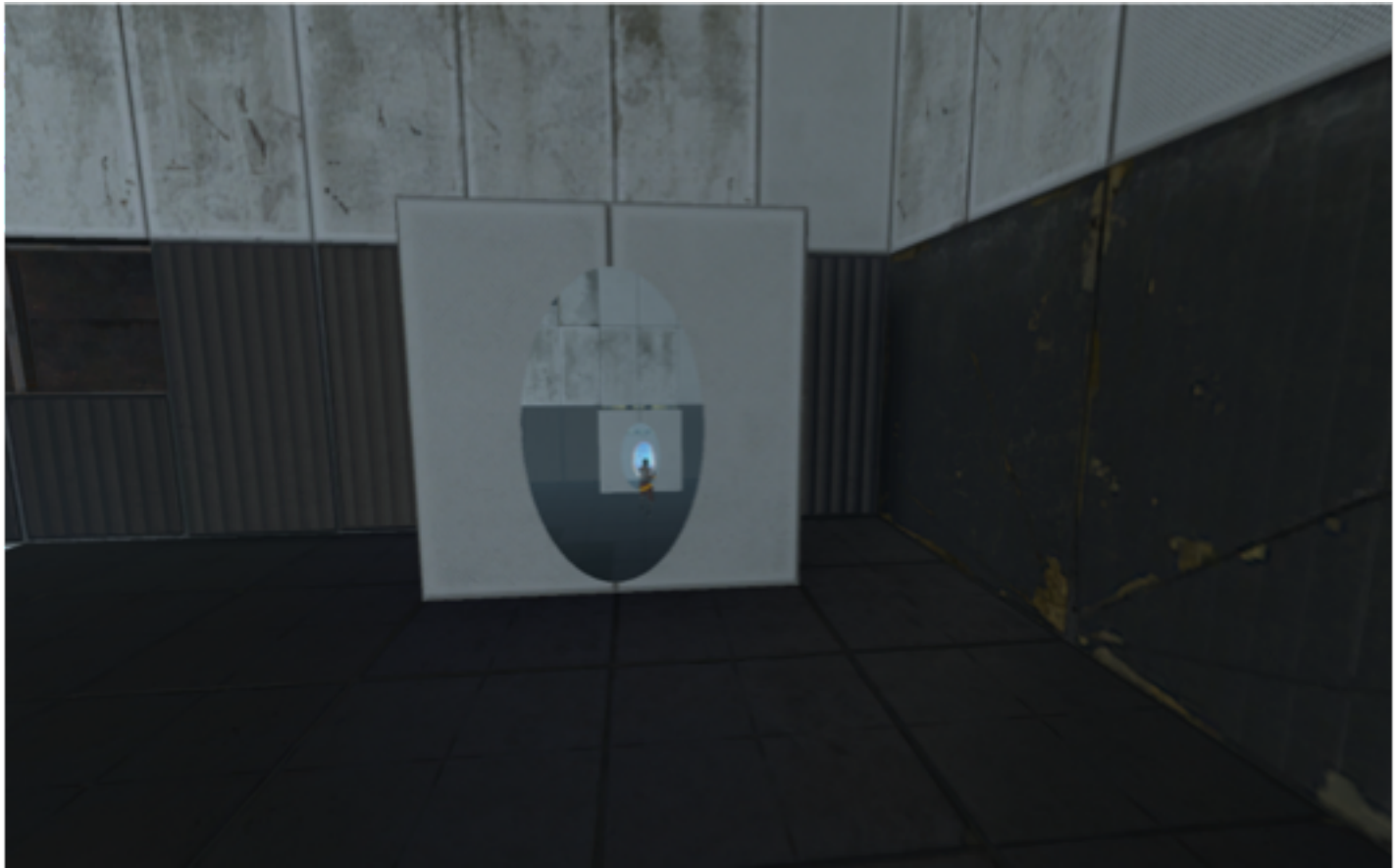


Rendering using stencils

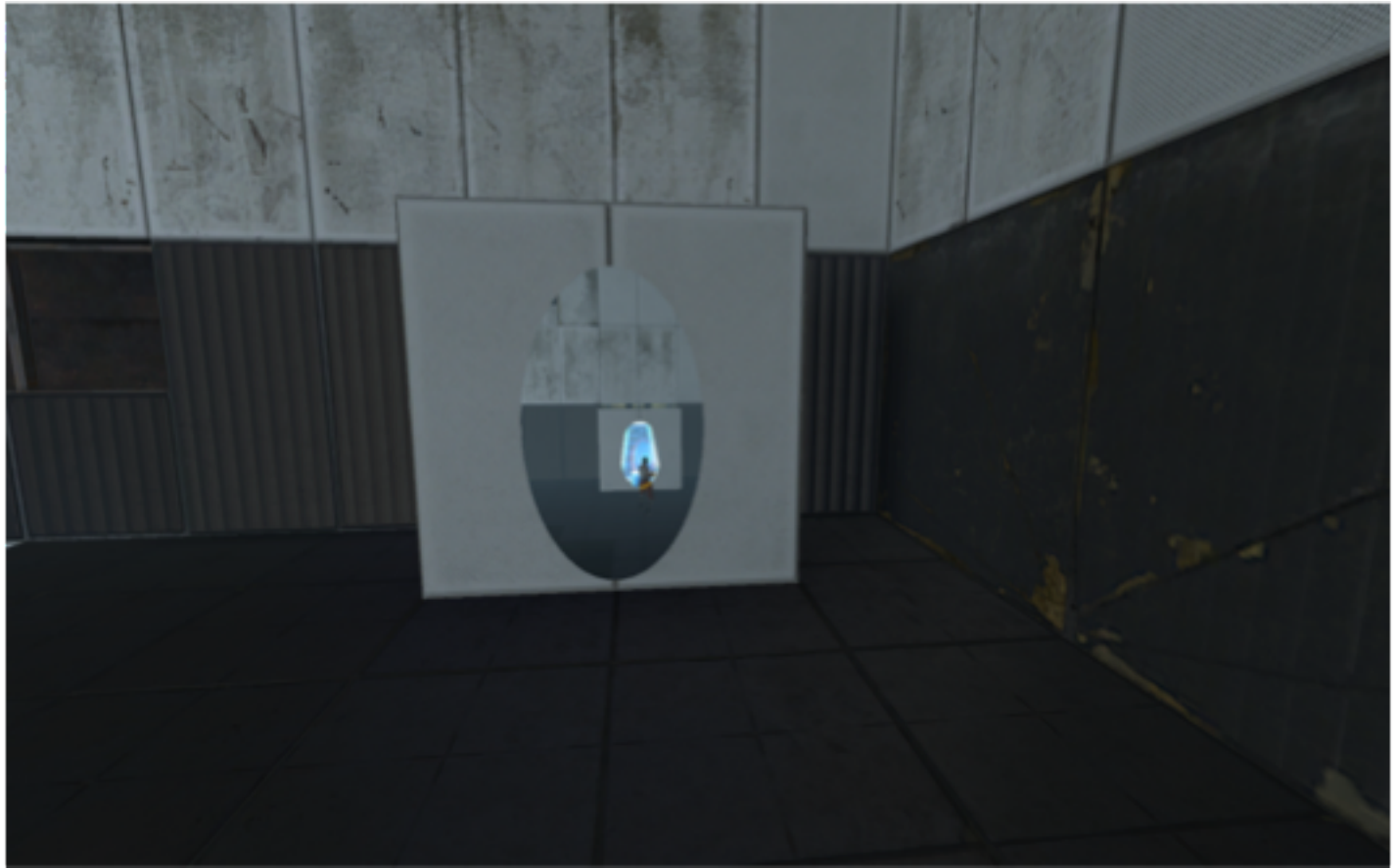
Rendering using stencils



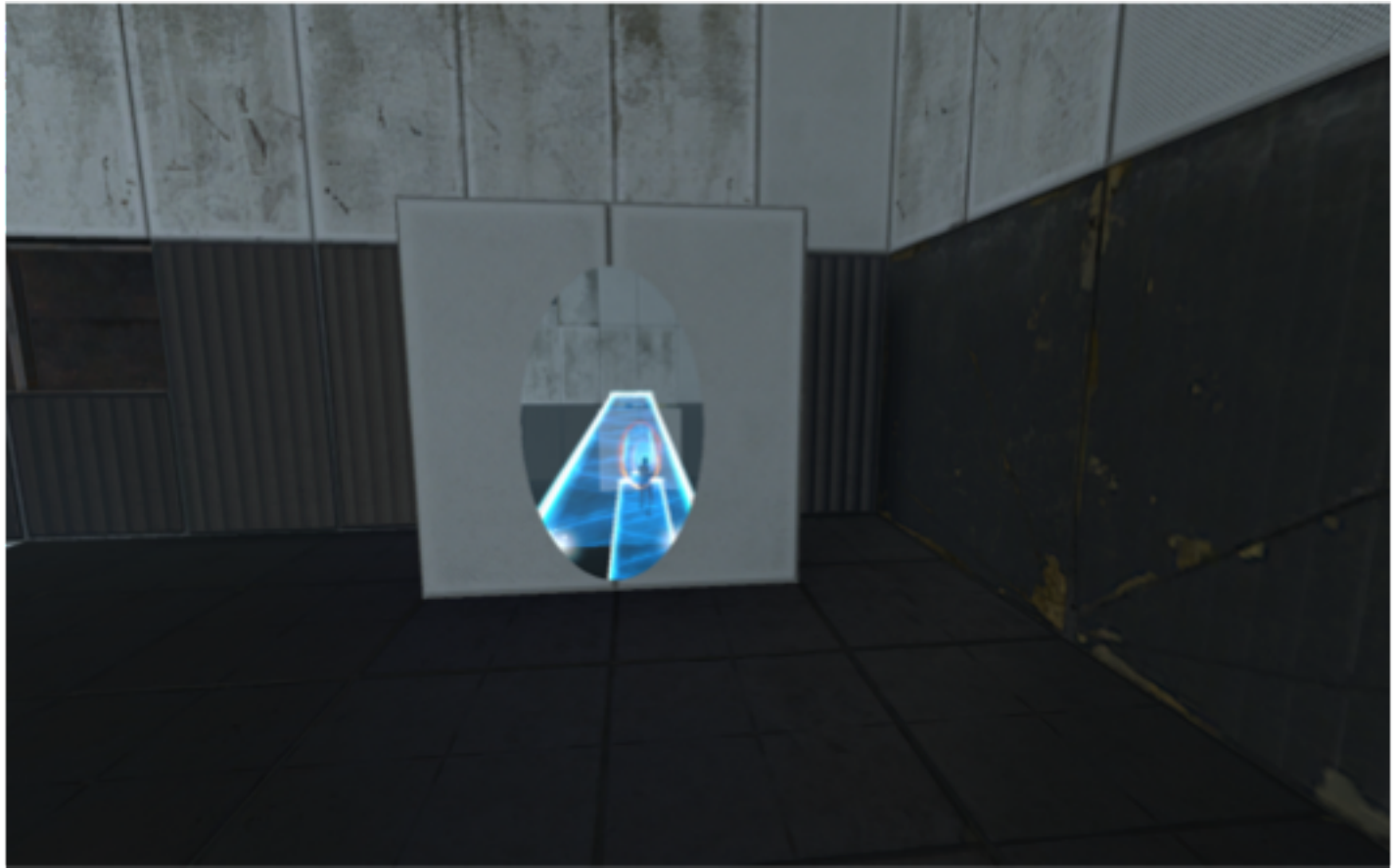
Rendering using stencils



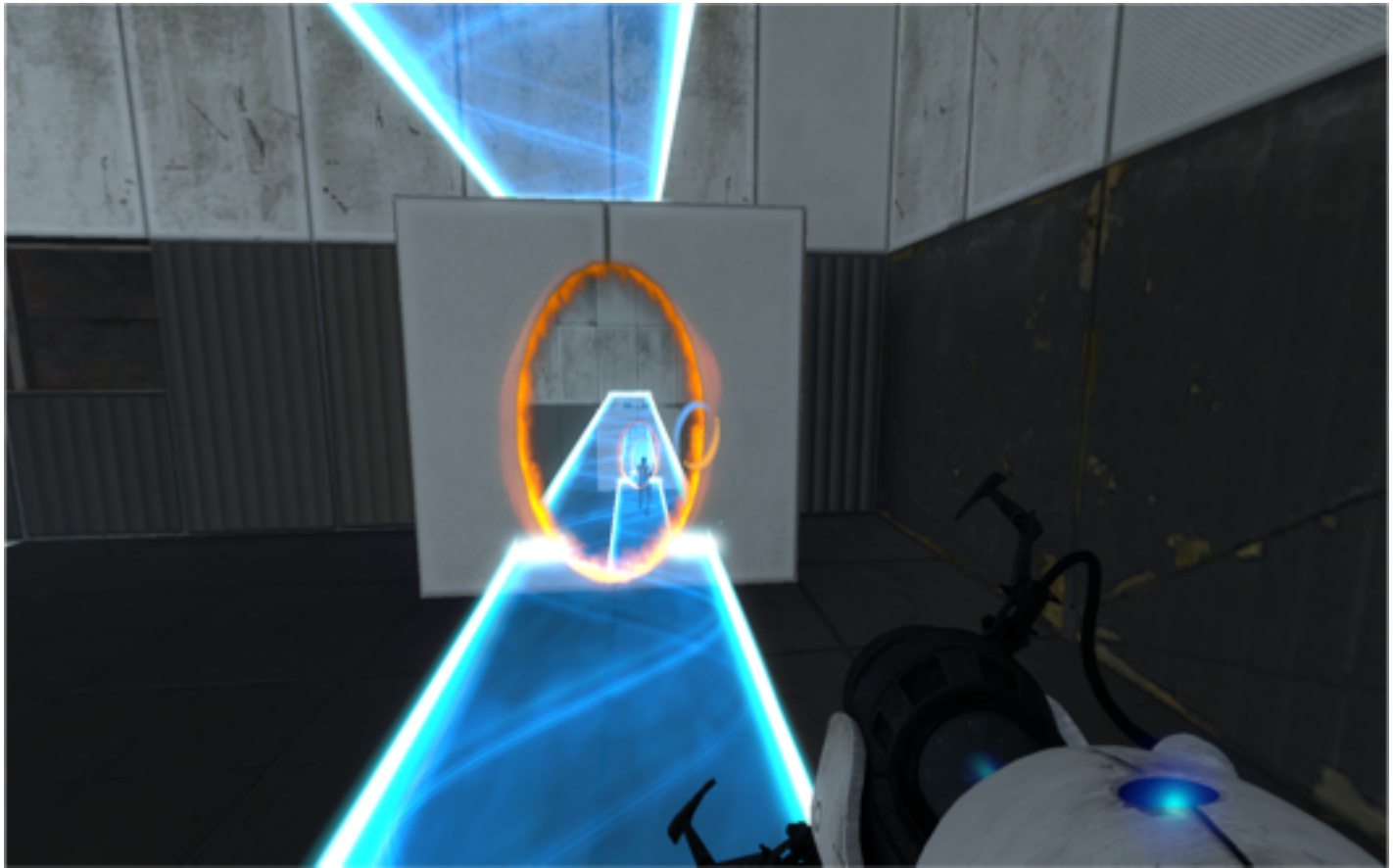
Rendering using stencils



Rendering using stencils



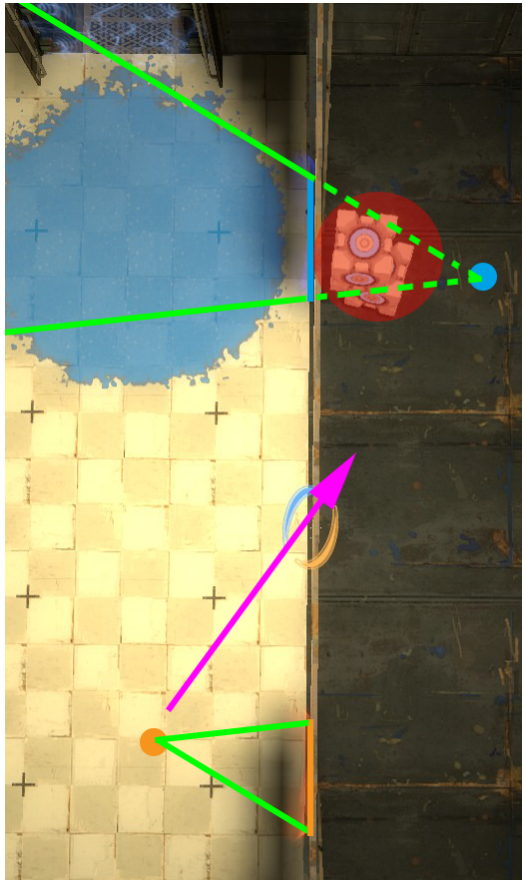
Rendering using stencils



Rendering: Duplicate Models

Rendering: Clip Planes

Rendering: Banana Juice



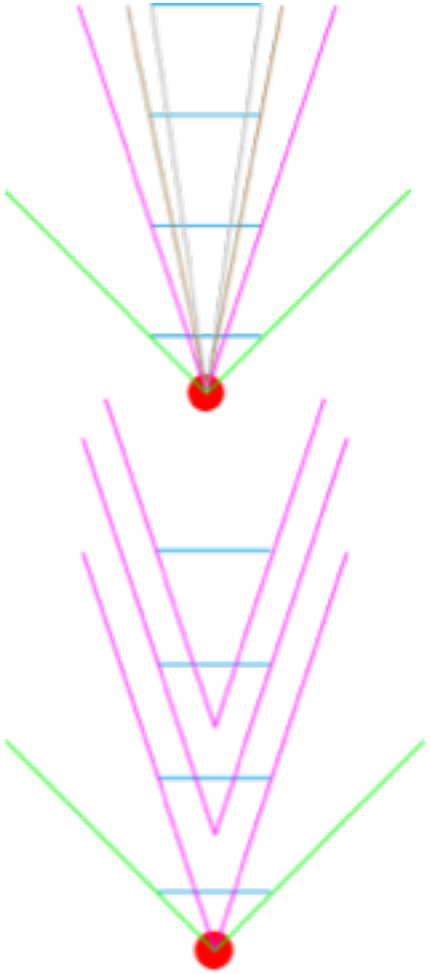
Shorthand for a complicated problem while trying to make it obvious that explanation was required.

When rendering a portal view. Objects between the virtual camera and the exit portal can occlude the view.

Rendering: Banana Juice

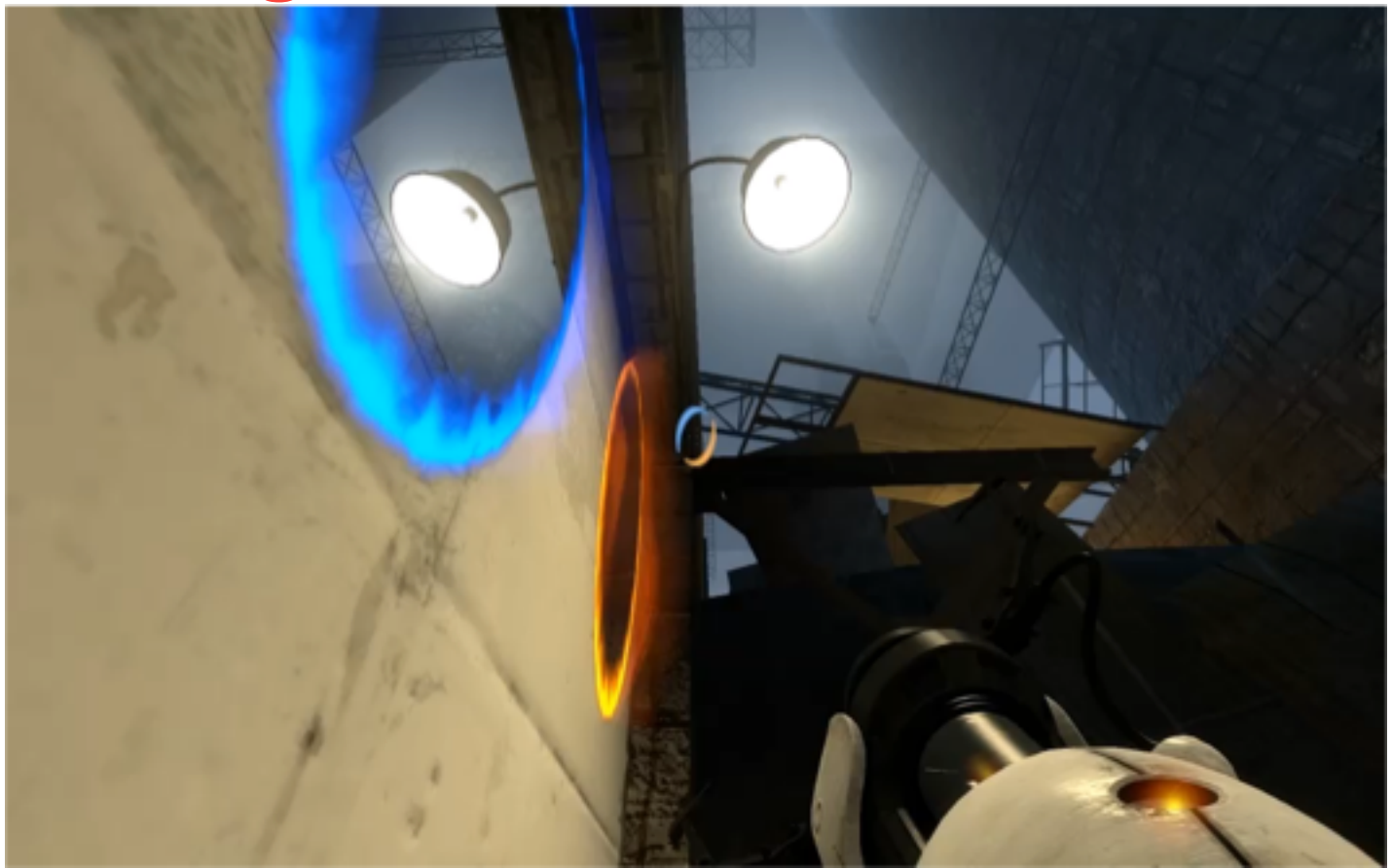
Rendering: Recursion

Rendering: Recursion



Rendering: Third Person Gotchas

Rendering: Pixel Queries



Agenda

What is a Portal?

Rendering

- Texture vs Stencil Tradeoffs
- Rendering is 1:1
- Rendering using stencils
- Duplicate Models
- Clip Planes
- Banana Juice
- Recursion
- Third Person Gotchas
- Pixel Queries

Design

- Prototyping in 2D
- Training Basics
- Helpers
- Fun Physics > Accurate physics
- Gels
- Cutting Features
- Combining Elements

Physics

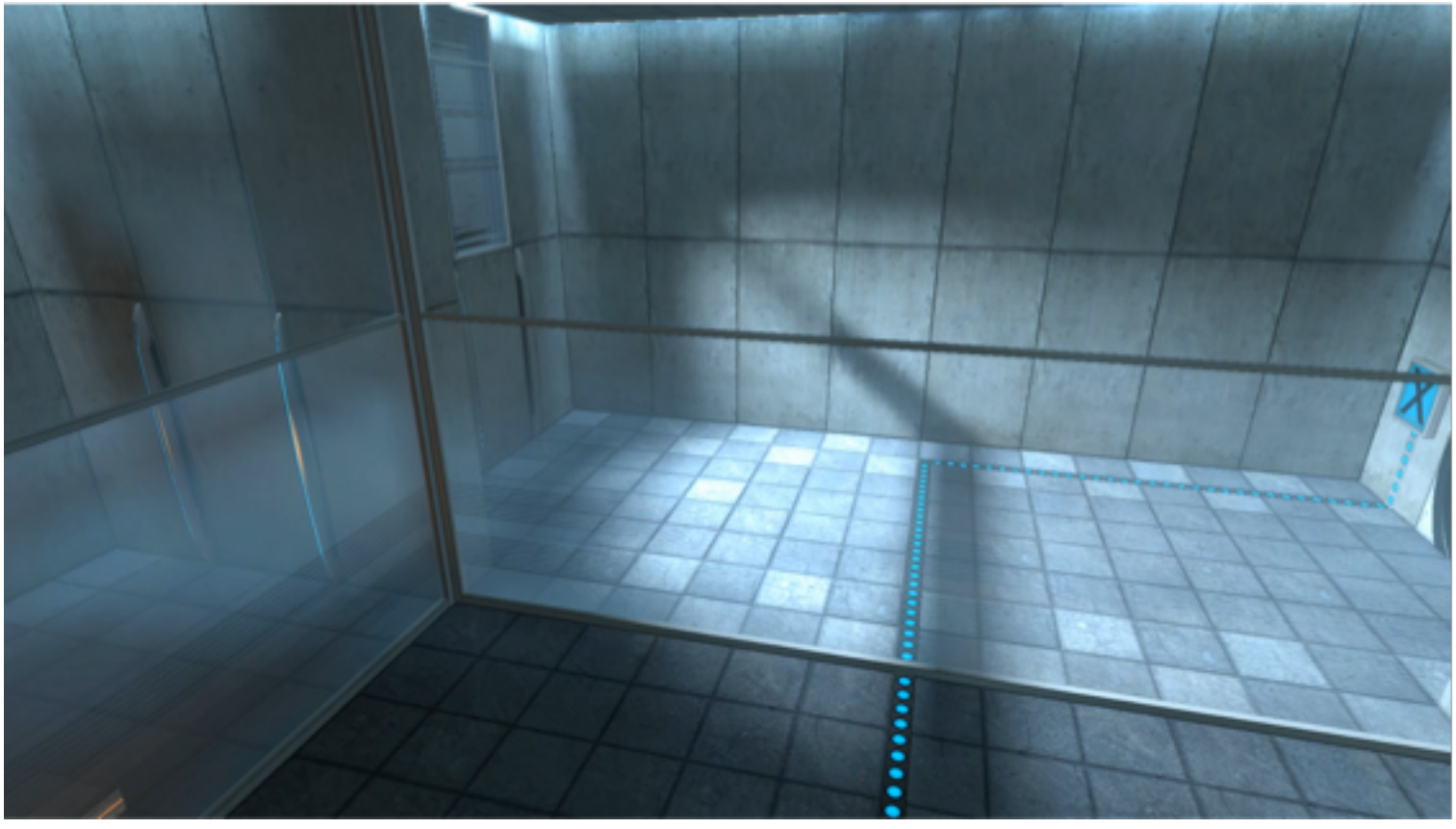
- Triggers and Vectors and Planes, Oh My
- Carving Holes
- Collision Lists
- Shadow Clones

Miscellaneous

- Camera interpolation
- Discontinuous interpolation
- Moving portals
- Frustums
- Non-rotating player bounding box
- Unstuck
- Binary gravity

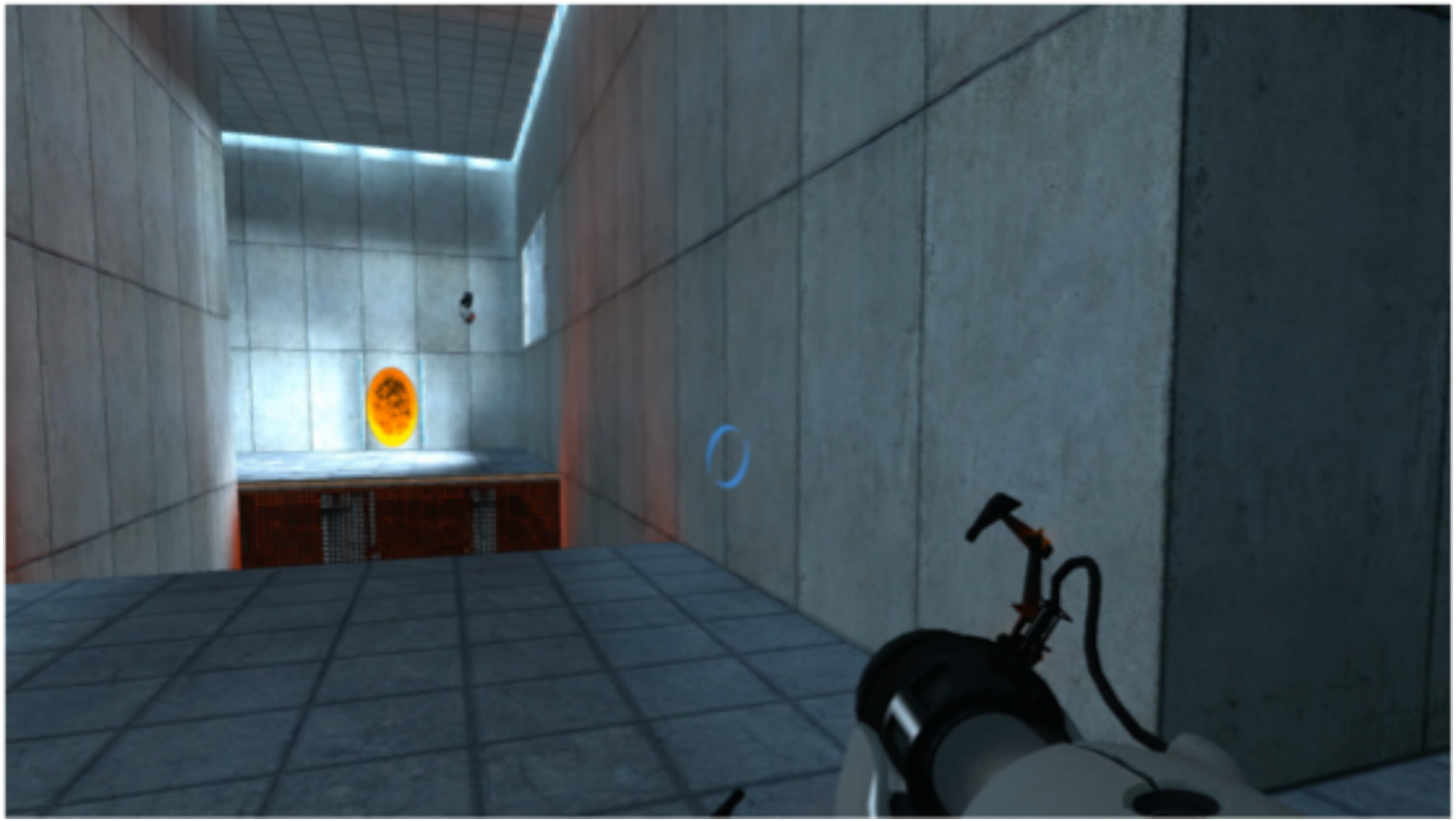
Design: Prototyping in 2D

Design: Training Basics

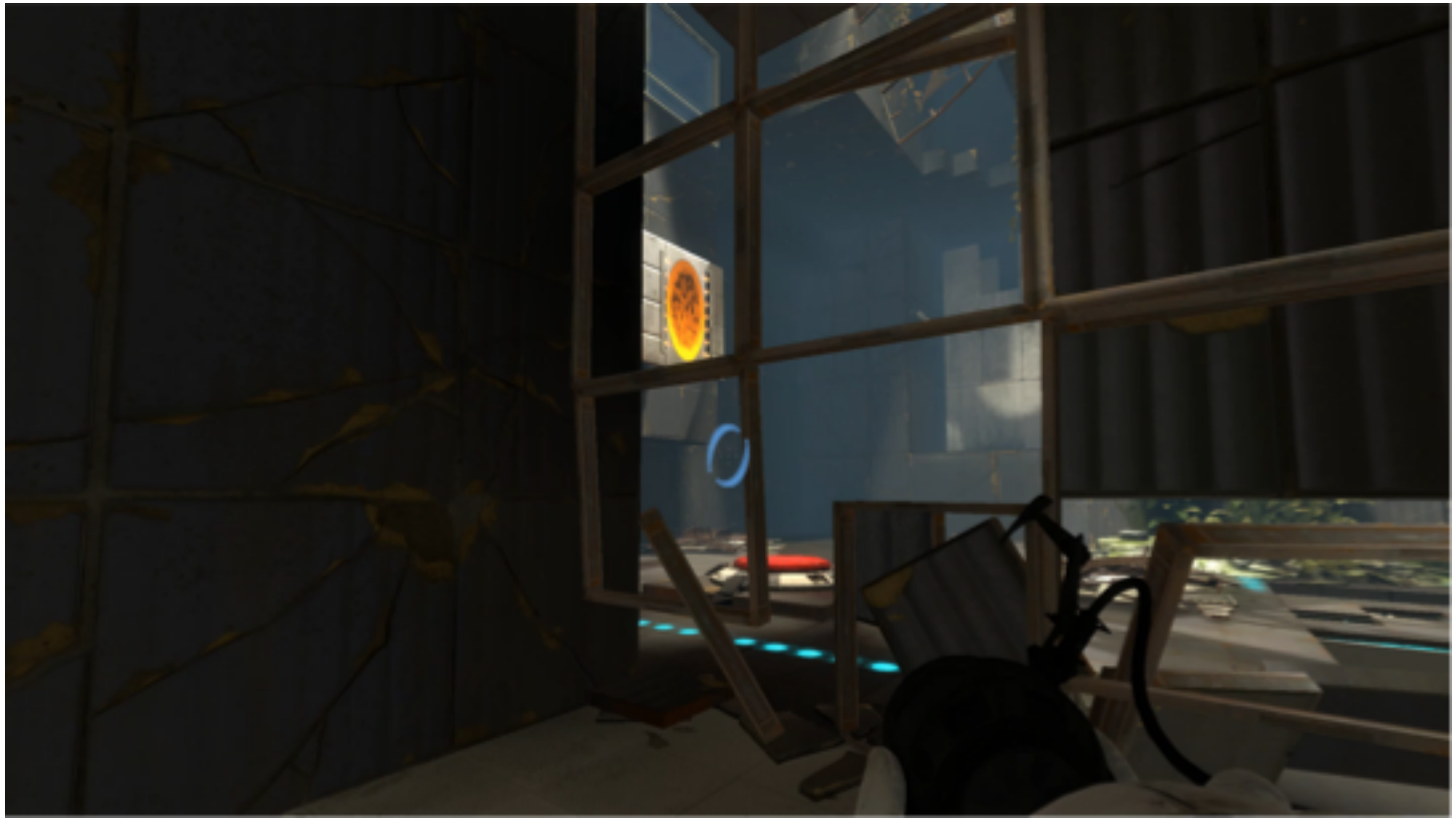


Design: Training Basics

Design: Training Basics



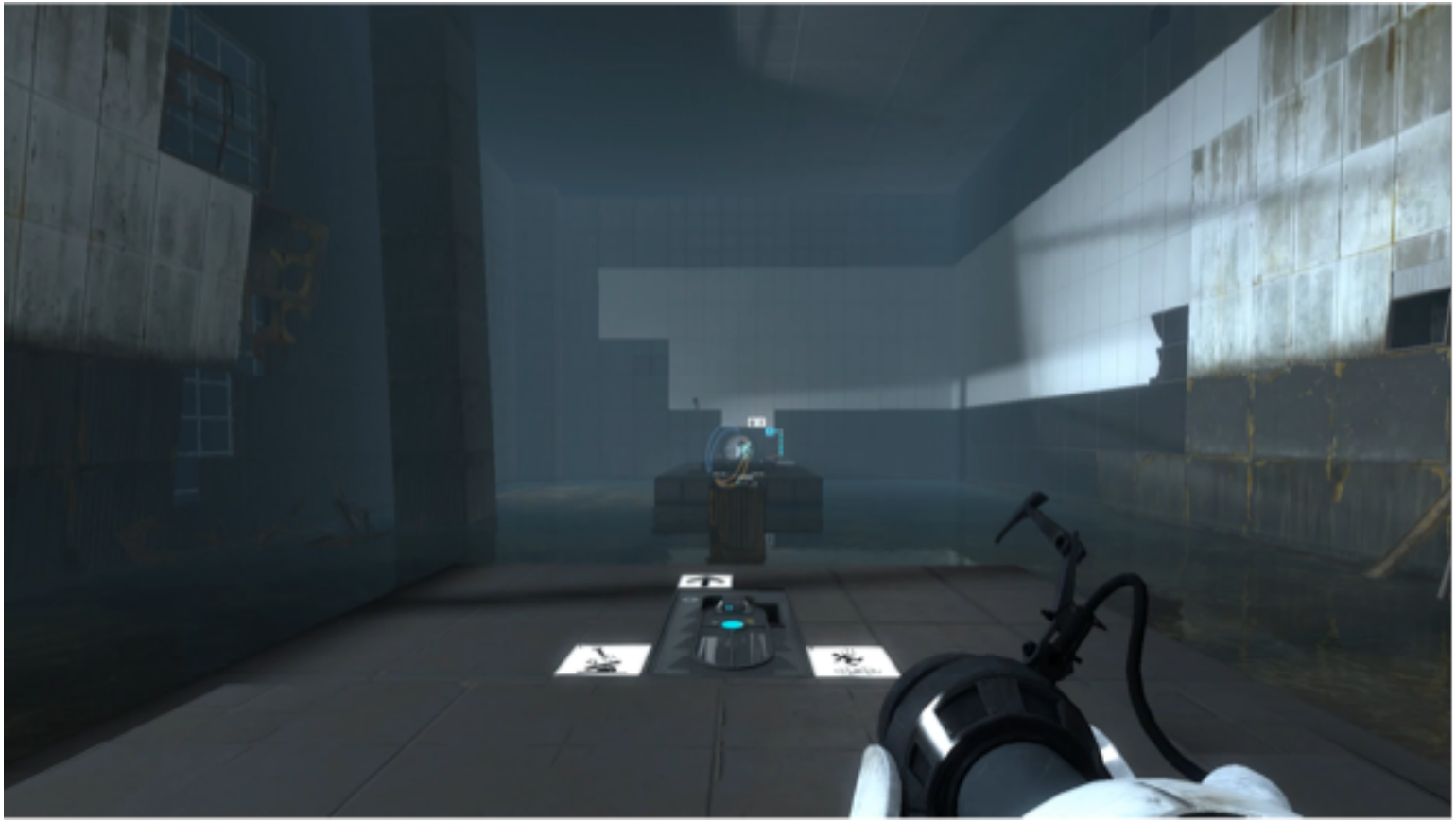
Design: Training Basics



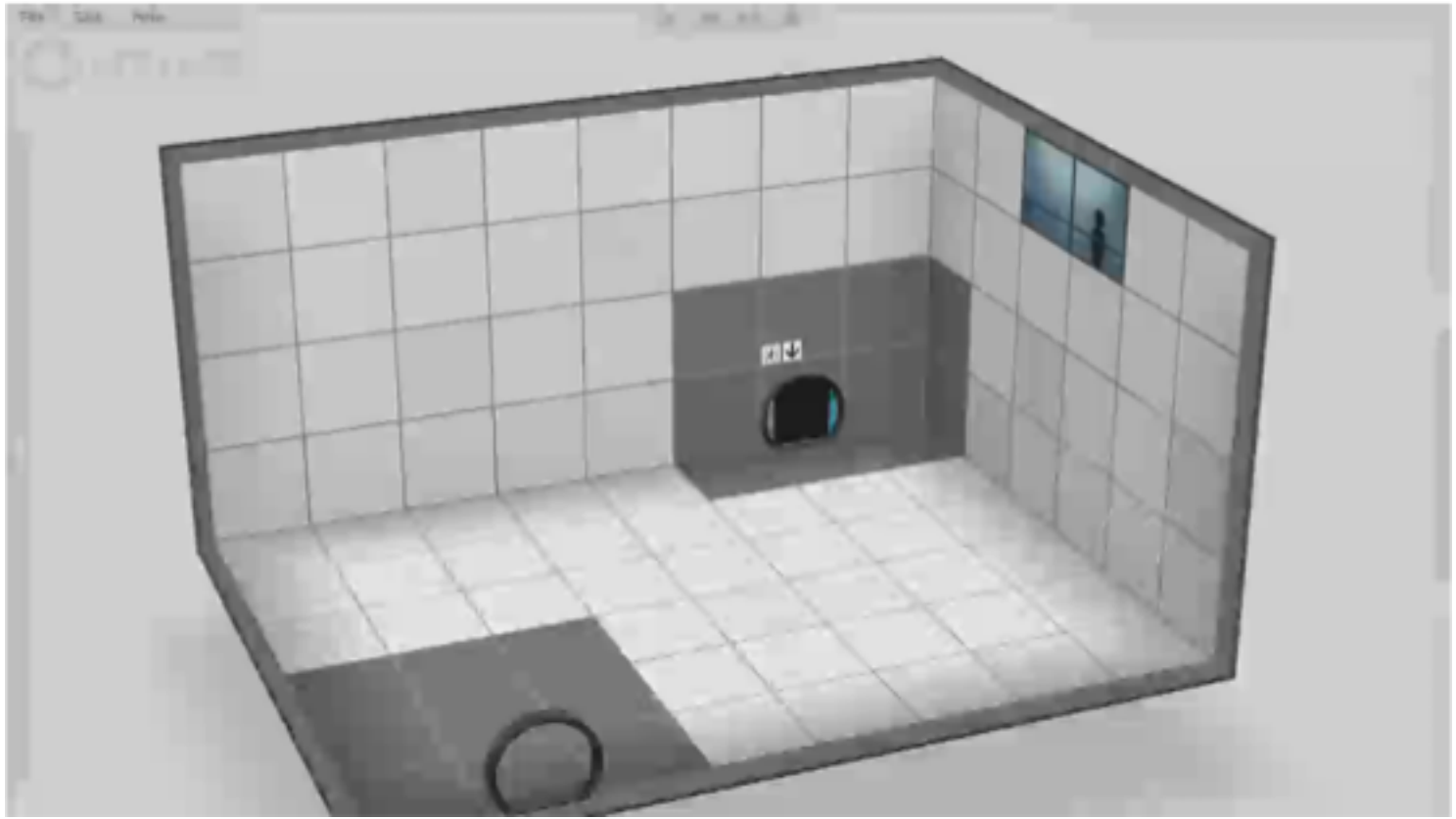
Design: Portal Funnels

Design: Portal Funnels

Design: Aerial Faith Plates

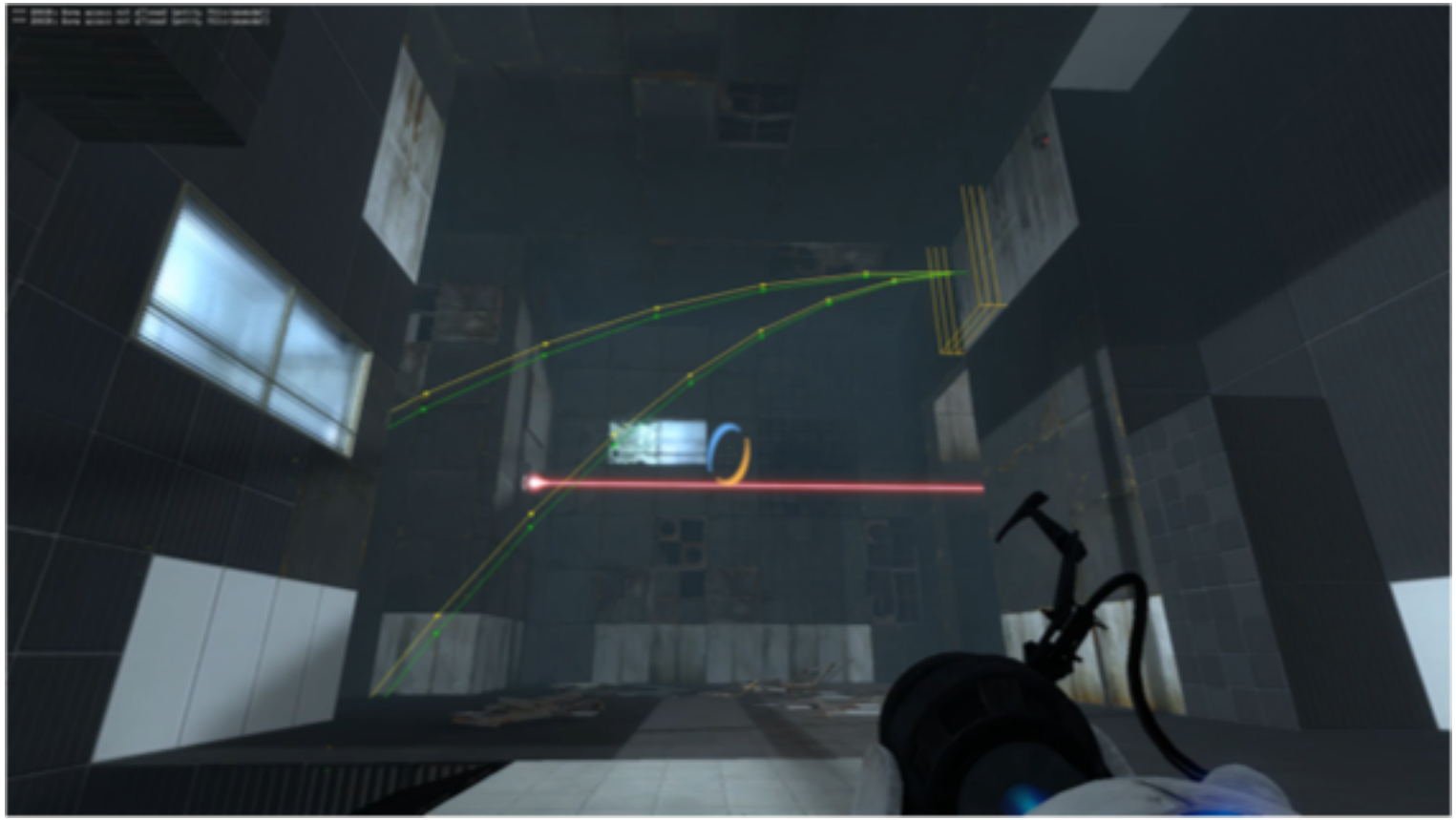


Design: Aerial Faith Plates



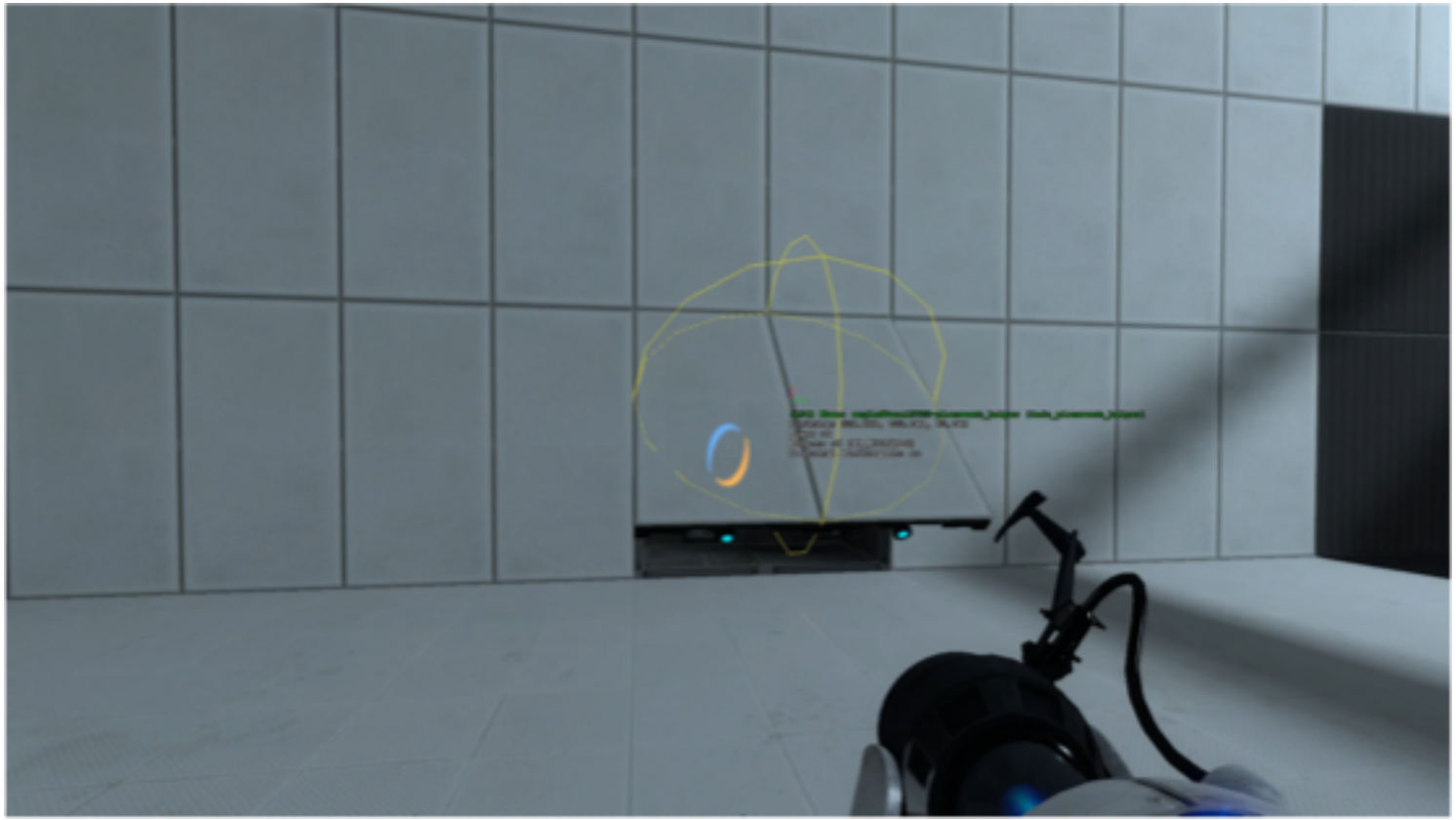
Design: Trigger Catapult

Design: Trigger Catapult



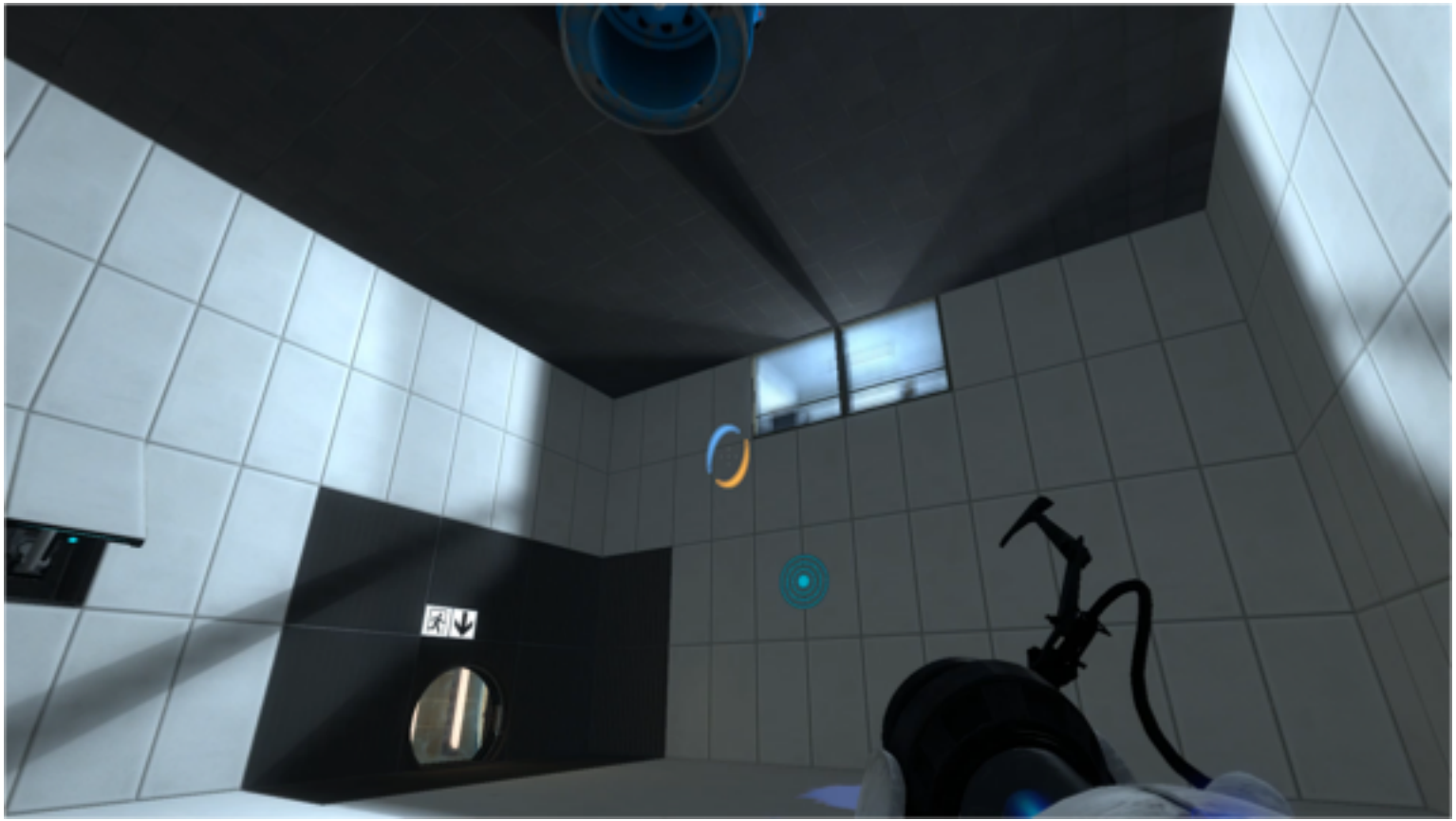
Design: Portal Highlight

Design: Portal Placement Helper



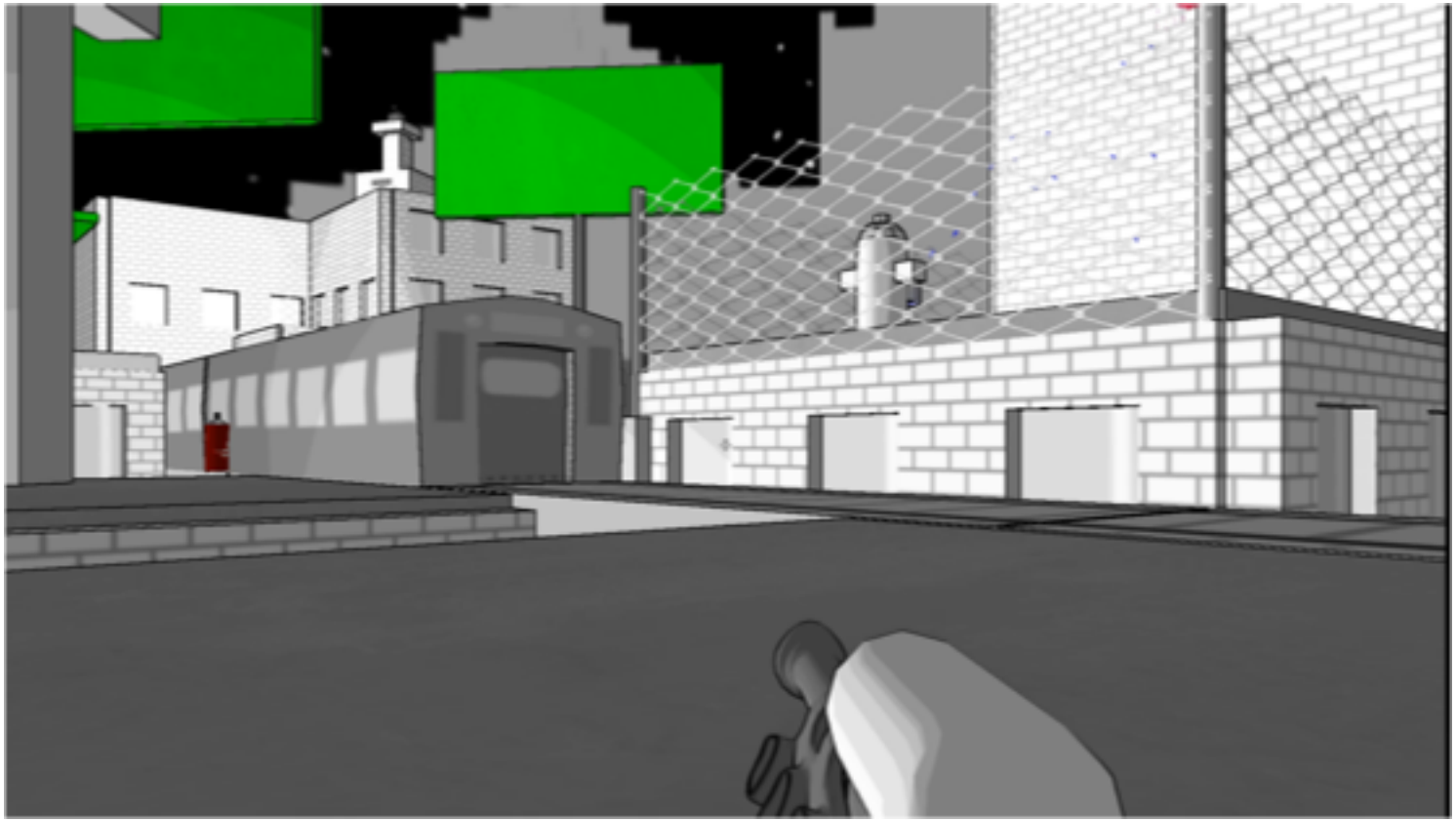
Design: Fun > Accurate Physics

Design: Fun > Accurate Physics



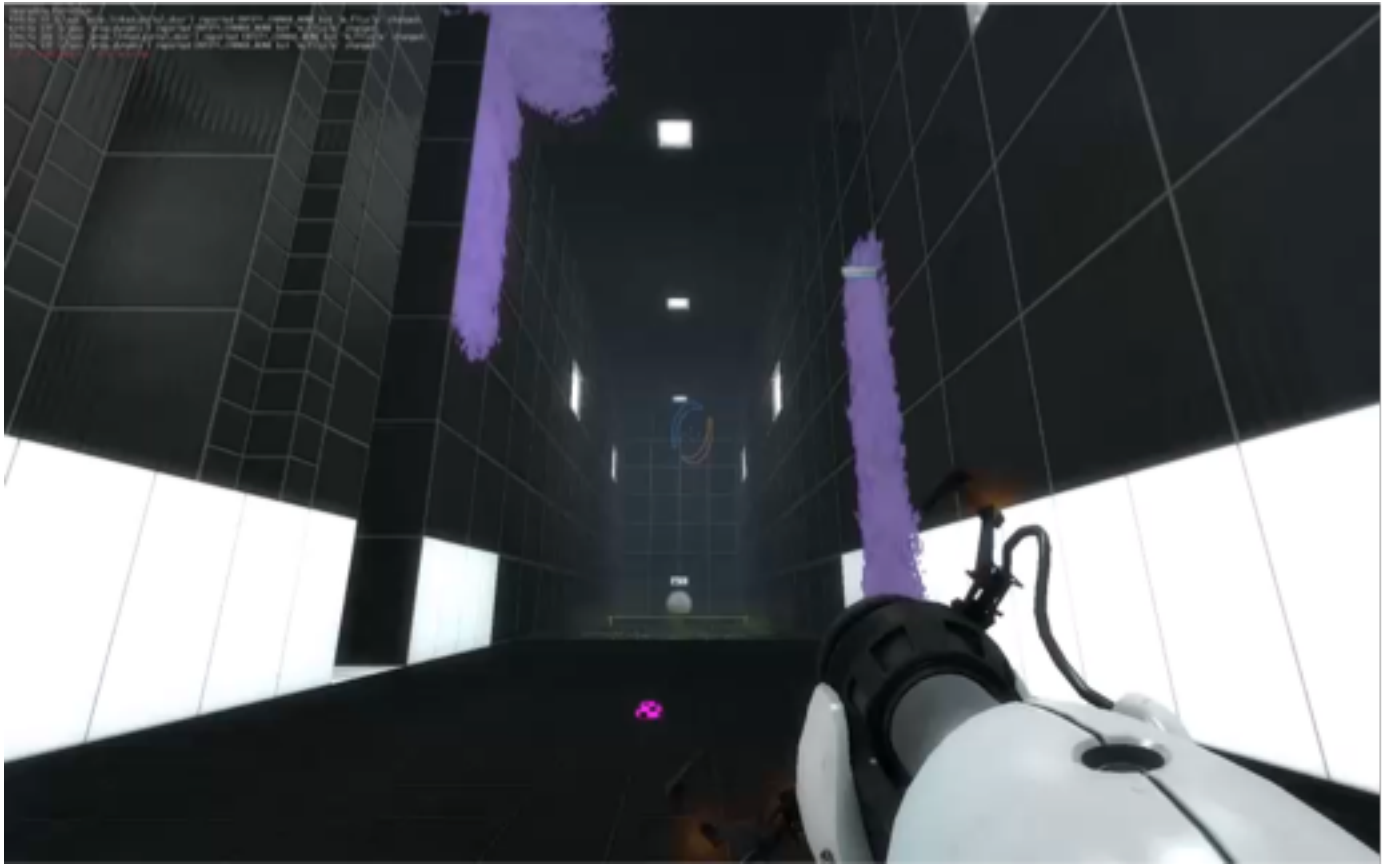
Design: Gels

Design: Gels



Design: Portal Gel

Design: Cutting Sticky Gel



Design: Cutting Sticky Gel

Design: Cutting Portal Through Portal

Design: Cutting Double Flings

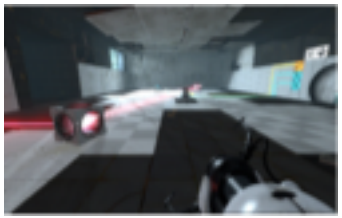
Design: Energy Ball -> Laser

Design: Energy Ball -> Laser

Design: Combining elements

Introduction

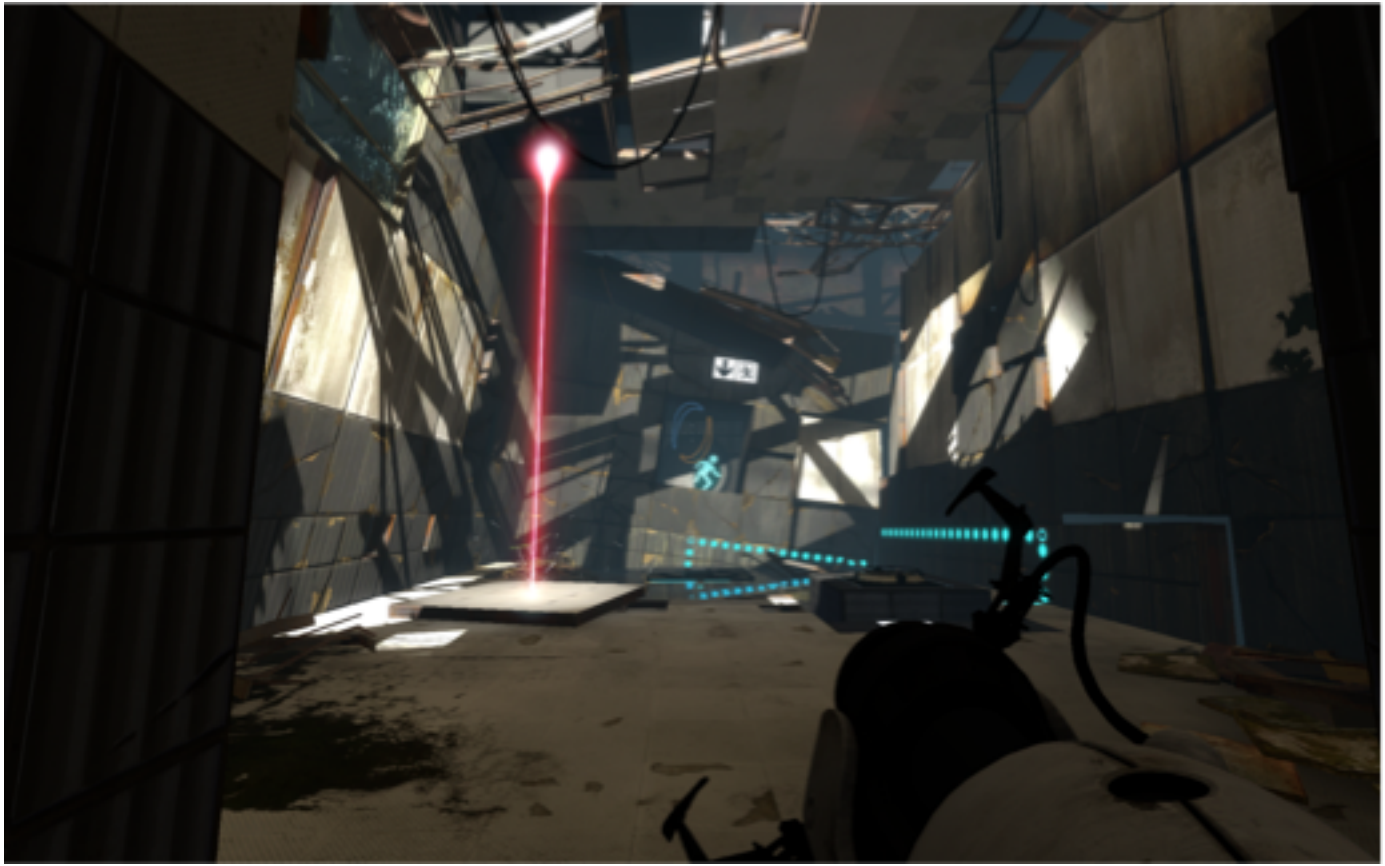
Saturation



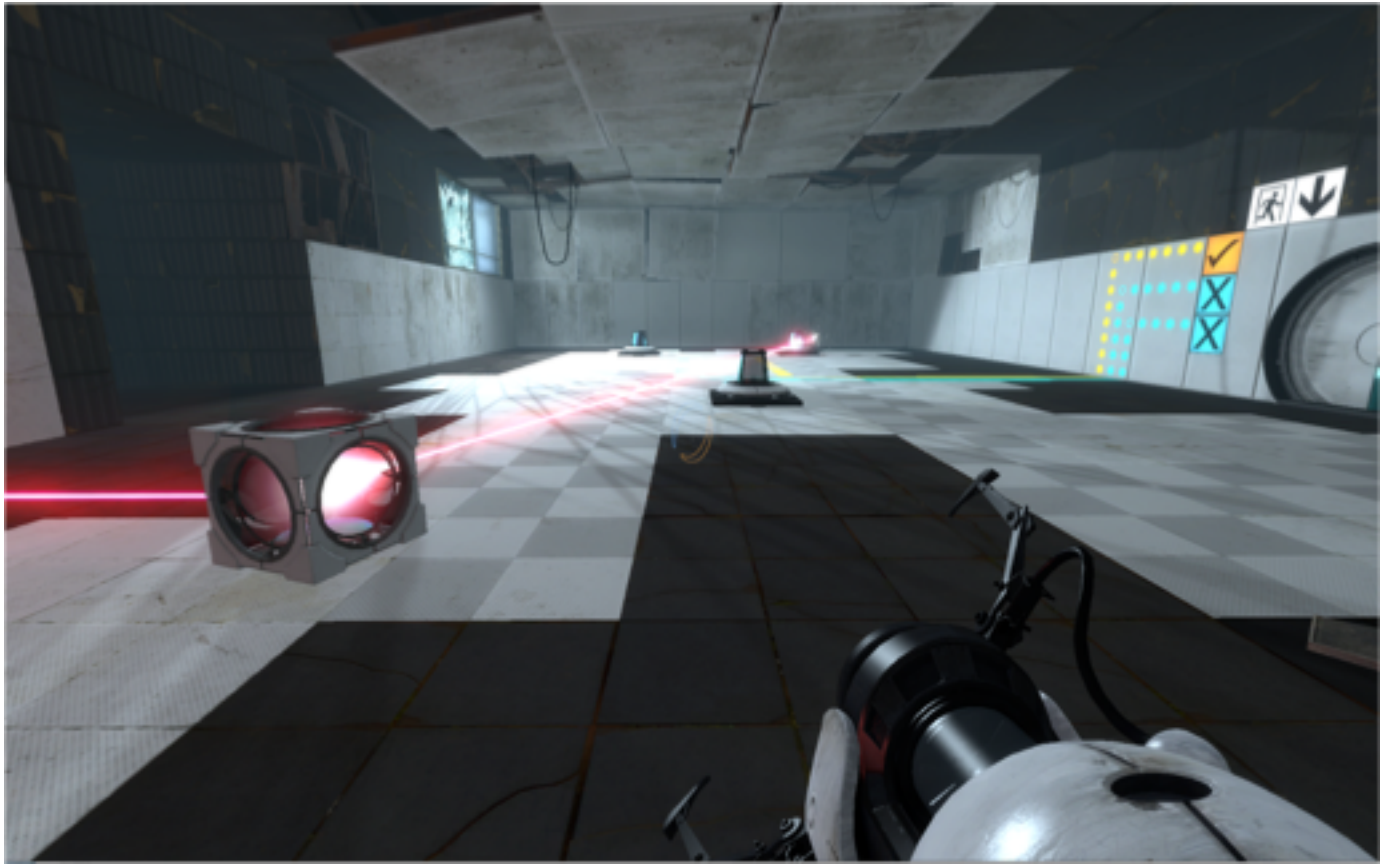
Graduation

Combination

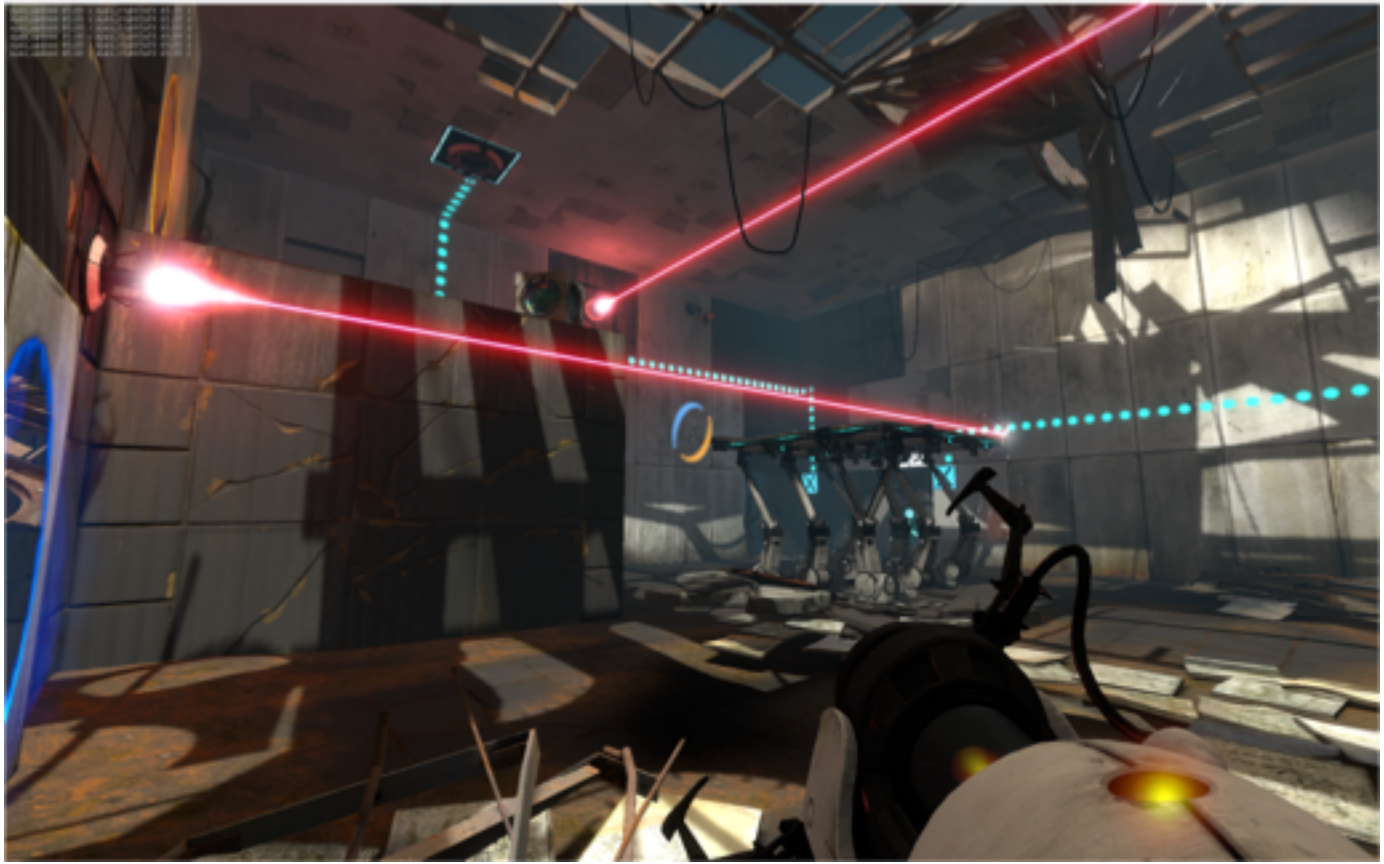
Design: Laser Introduction



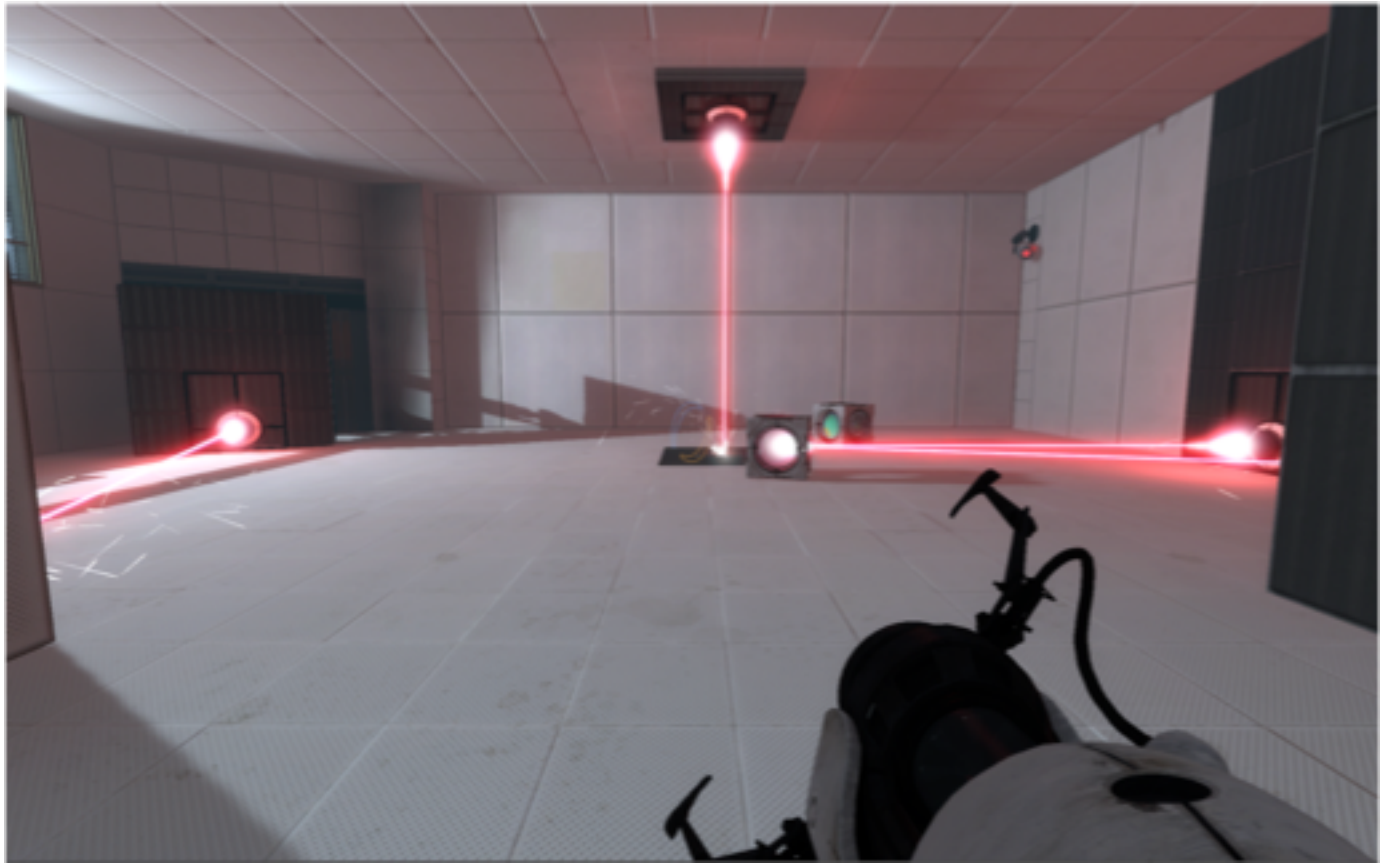
Design: Laser Saturation



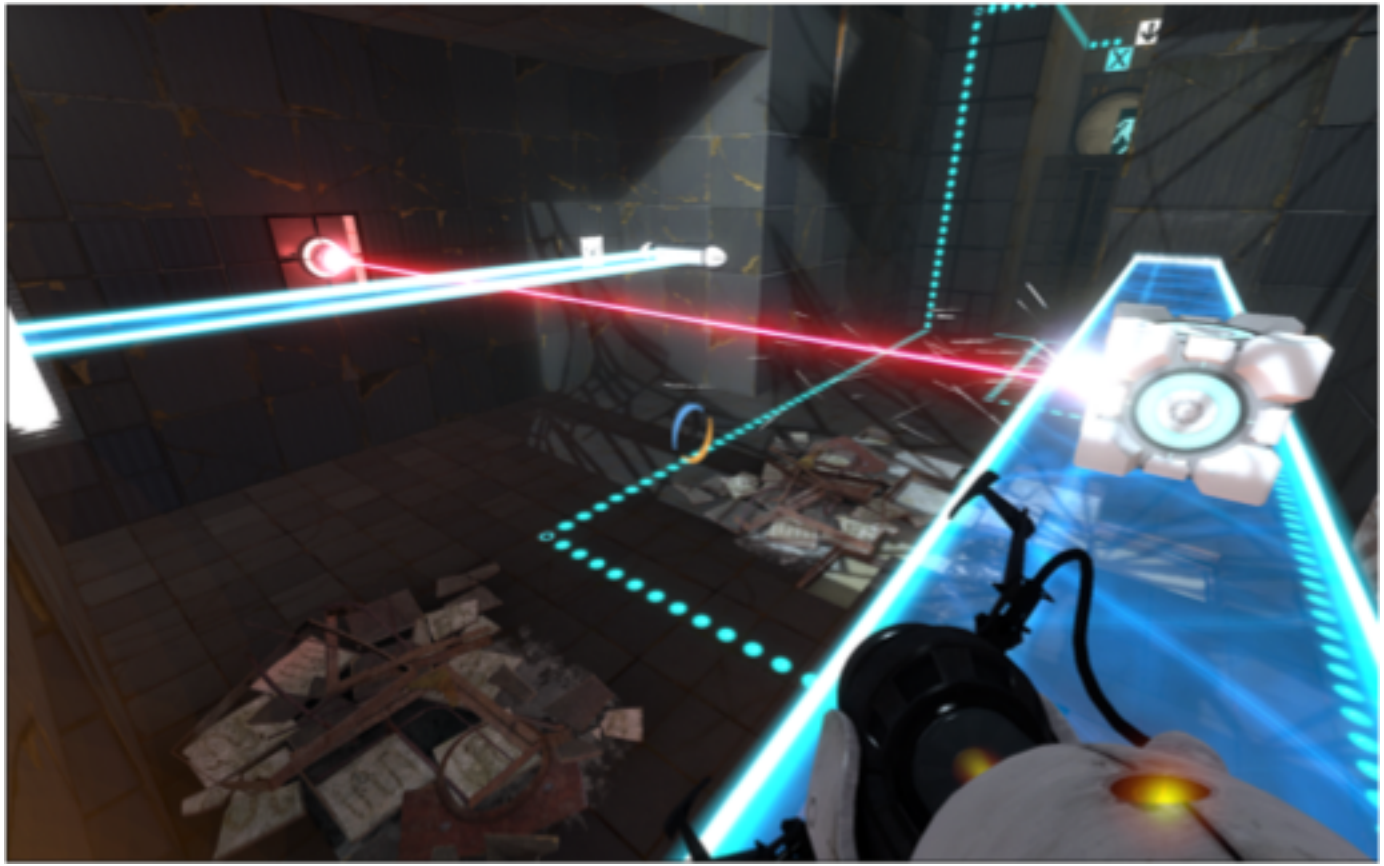
Design: Laser Saturation



Design: Laser Graduation



Design: Laser Combination



Design: Laser Combination

Agenda

What is a Portal?

Rendering

- Texture vs Stencil Tradeoffs
- Rendering is 1:1
- Rendering using stencils
- Duplicate Models
- Clip Planes
- Banana Juice
- Recursion
- Third Person Gotchas
- Pixel Queries

Design

- Prototyping in 2D
- Training Basics
- Helpers
- Fun Physics > Accurate physics
- Gels
- Cutting Features
- Combining Elements

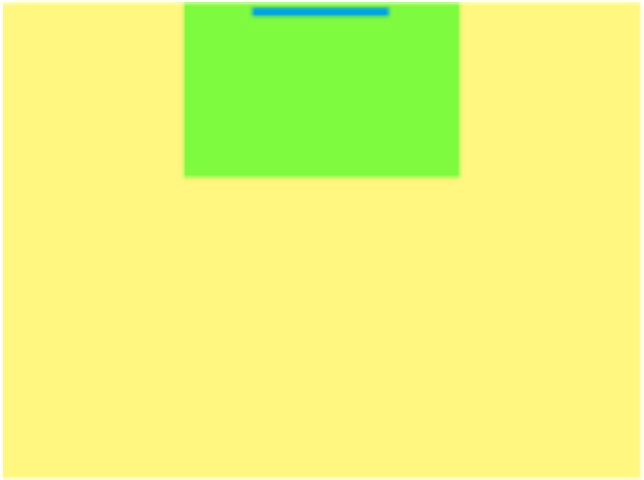
Physics

- Triggers and Vectors and Planes, Oh My
- Carving Holes
- Collision Lists
- Shadow Clones

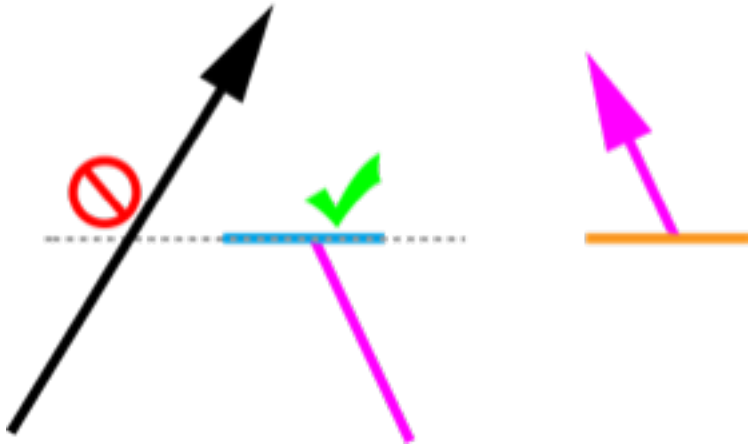
Miscellaneous

- Camera interpolation
- Discontinuous interpolation
- Moving portals
- Frustums
- Non-rotating player bounding box
- Unstuck
- Binary gravity

Physics: Volumes, Vectors, & Planes



Touch volumes for physics objects

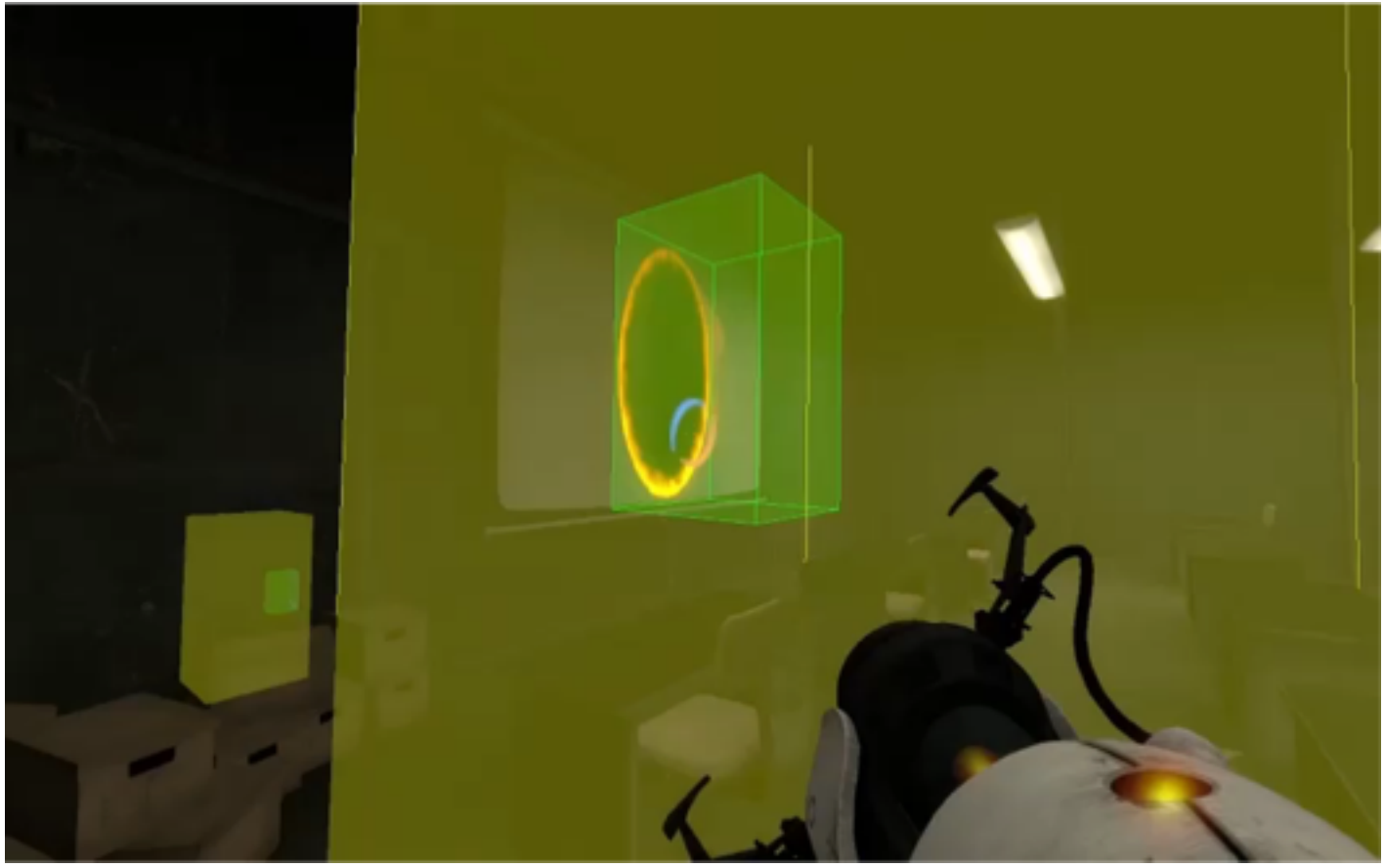


Planes and quads for rays

Uses ray test when object origin crosses the portal plane

Physics: Carving Holes

Physics: Collision Lists



Physics: Shadow Clones

Agenda

What is a Portal?

Rendering

- Texture vs Stencil Tradeoffs
- Rendering is 1:1
- Rendering using stencils
- Duplicate Models
- Clip Planes
- Banana Juice
- Recursion
- Third Person Gotchas
- Pixel Queries

Design

- Prototyping in 2D
- Training Basics
- Helpers
- Fun Physics > Accurate physics
- Gels
- Cutting Features
- Combining Elements

Physics

- Triggers and Vectors and Planes, Oh My
- Carving Holes
- Collision Lists
- Shadow Clones

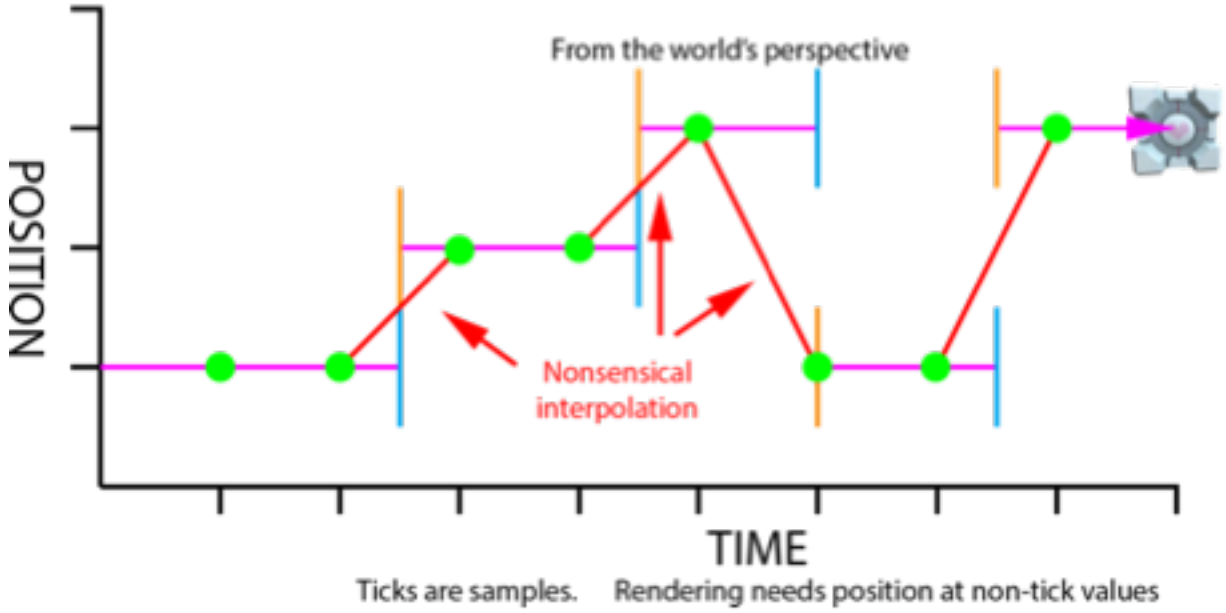
Miscellaneous

- Camera interpolation
- Discontinuous interpolation
- Moving portals
- Frustums
- Non-rotating player bounding box
- Unstuck
- Binary gravity

Camera Interpolation

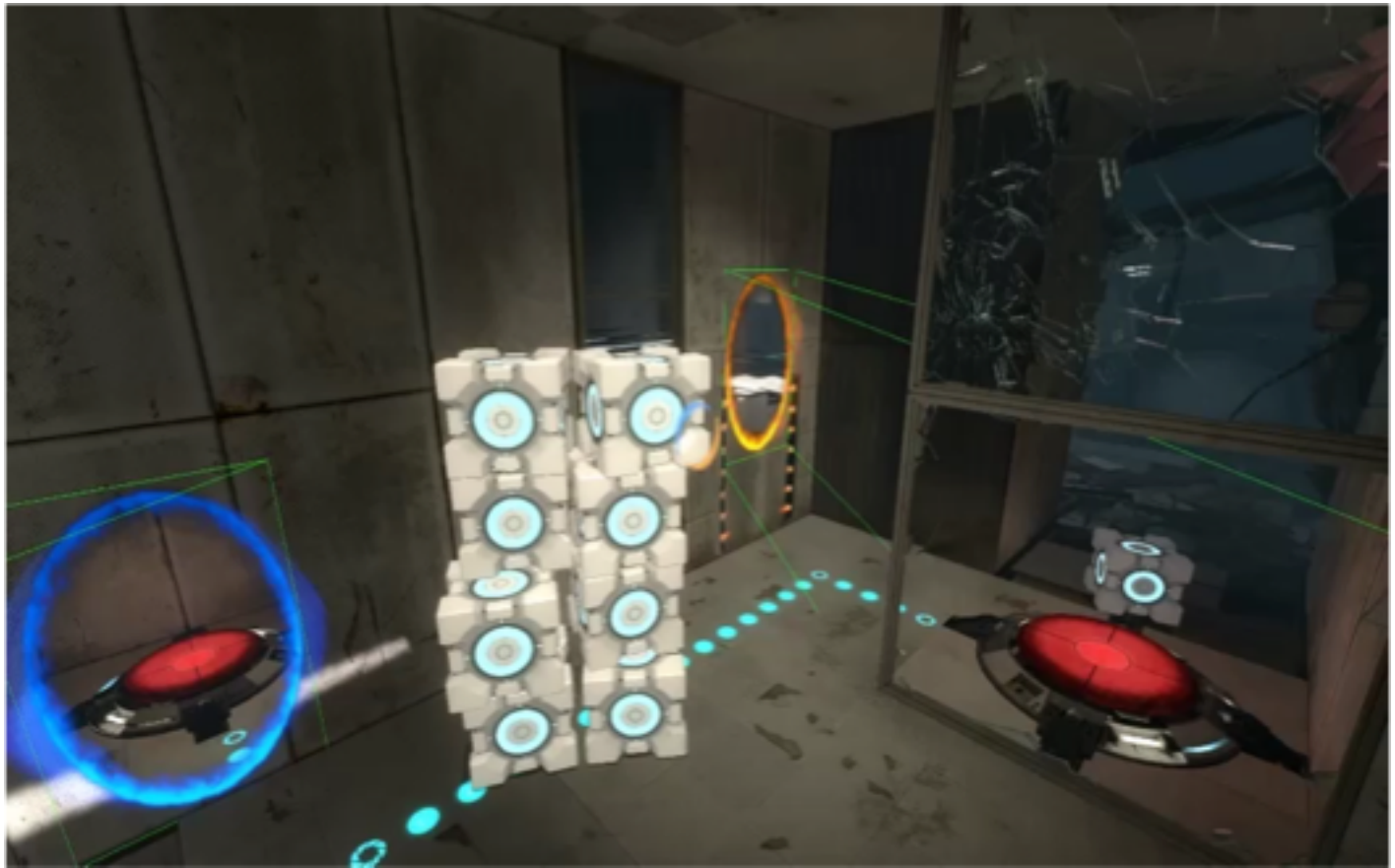
More Camera Interpolation

Discontinuous Interpolation

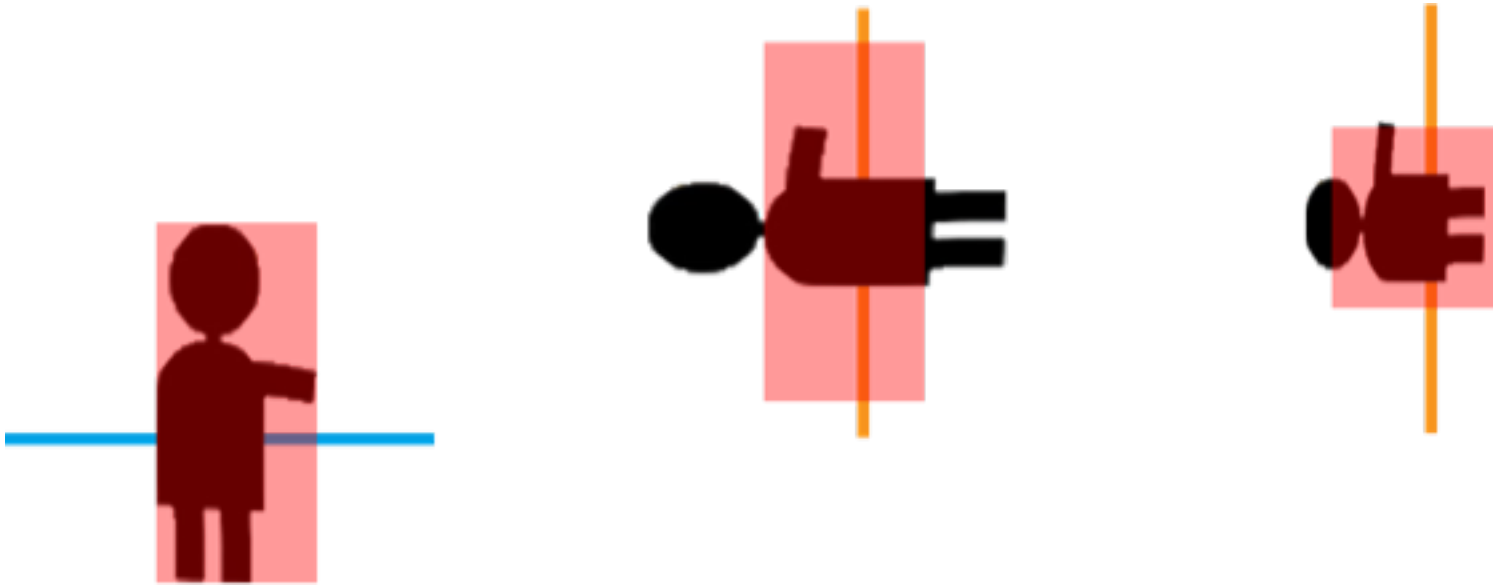


Moving Portals

Reduce Rendering Frustum

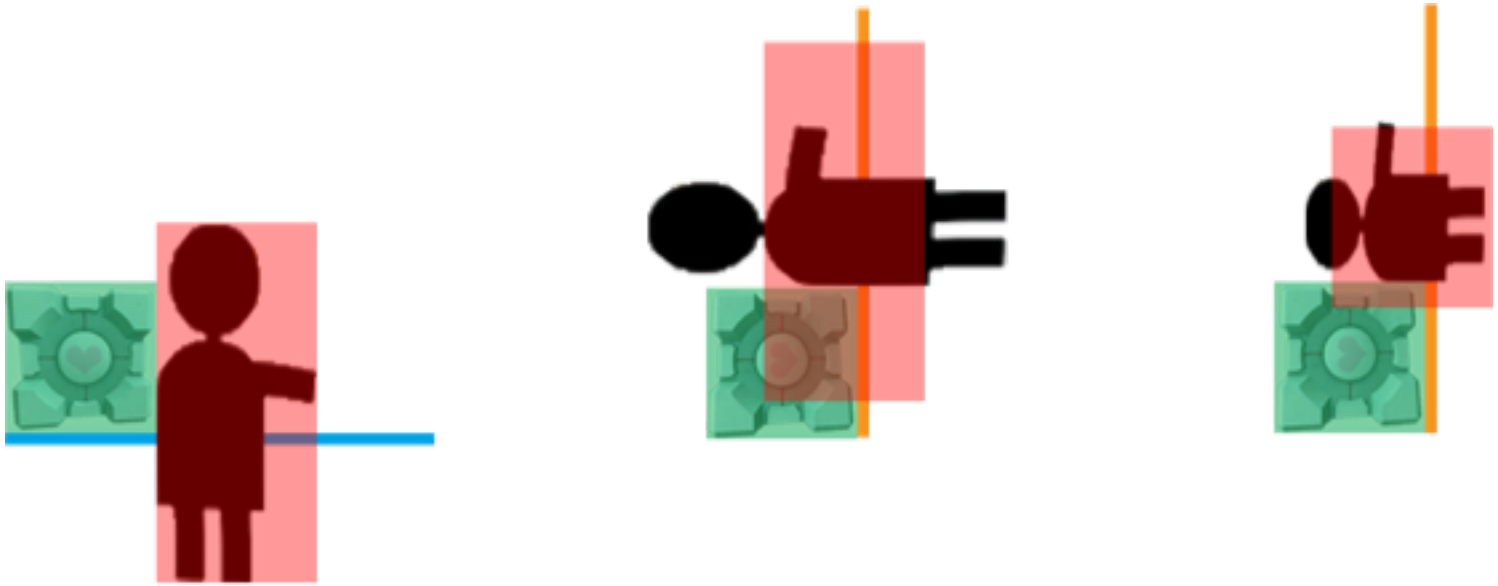


Non-rotating Bounding Box



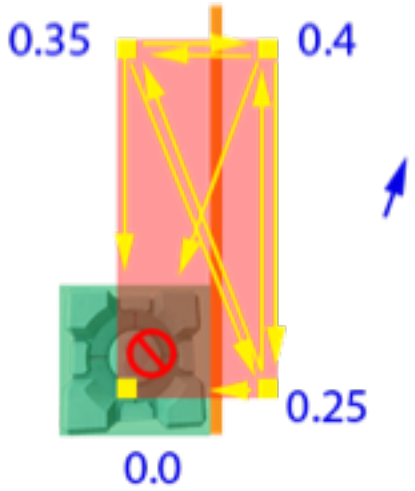
Axis Aligned Bounding Box doesn’t look the same after some rotations. So we force the player to duck for a nearly cubical shape.

Unstuck



Sometimes the player bounding box teleports into another bounding box and the movement system needs a little help.

Unstuck



Since we can’t usually just go back to the last known good position. We sweep a bunch of smaller boxes from extent to extent inside the player box to figure out which way is the most unobstructed..

Binary Gravity

Questions?


dave@valvesoftware.com


@DirkSwizzler


tejeev@valvesoftware.com

www.valvesoftware.com/jobs

Because I’m sure someone will ask…