# Portals

## Built for VR but perfect for non-VR Desktop and Mobile projects as well

Last update: November 21, 2024 - Version 1.2.0

If you're looking at the pdf bundled with the asset, the documentation might have already been updated. You can find the most recent documentation here:

https://docs.google.com/document/d/1H0ZYh-Rs5vwENm5eayC8ovxJjB5G0xh8EKm3325AQhM/edit?usp=sharing

Here's a YouTube channel with instruction videos. However please do check out the below documentation. It goes into great detail on all aspects of the portals.

### Demo APK files to sideload on your Quest

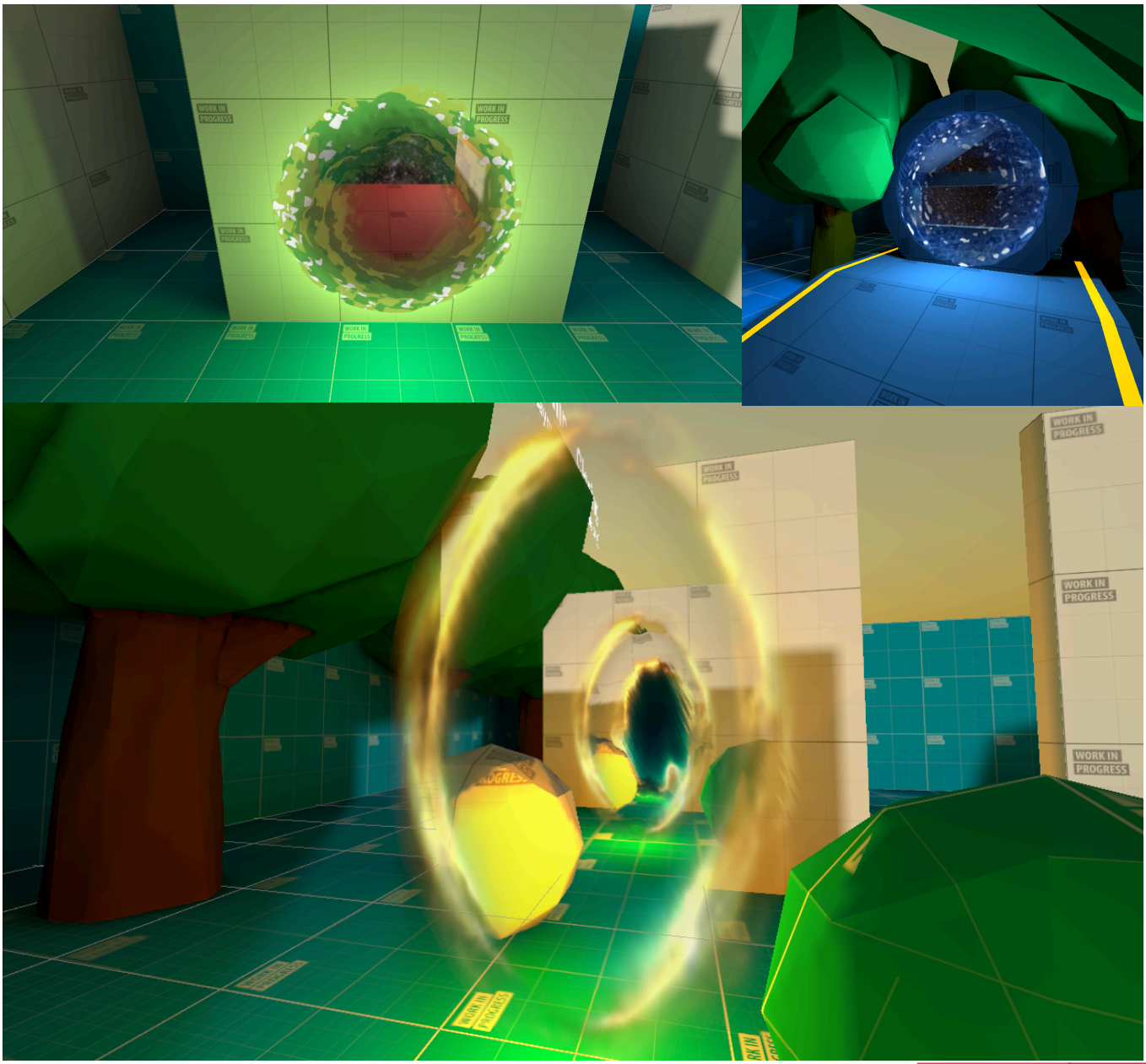
Hexabody Integration (Use trigger and B to shoot portals)
https://drive.google.com/file/d/1KroLiqGjJHO_9qxloZLlrnliGsOaNnfX/view?usp=sharing

Hurricane integration  (Use trigger and B to shoot portals)
https://drive.google.com/file/d/1wkrgx0Fa7rb8Pt2z9hIII_WG8bwTMF05/view?usp=sharing

## Warning!

Rendering portals is taxing on mobile hardware. Don't expect 2 portals seeing into each other 3 recursions deep at full screen resolution to hit framerate on an Oculus Quest 1. We're essentially rendering your scene multiple times over depending on how many portals and how deep you want the "reflections" to go.

That being said, this is most likely the fastest solution to do real-time portals on mobile VR hardware in existence using renderTextures.



# Known issues

~~Pimax 8kx is reported to have issues with double vision inside the portal. Currently investigating but please don't buy for the moment if you're targeting this hardware.~~

Pimax headsets are having clipping issues near the edges, however there is a fix in the code that can be enabled by uncommenting some lines.  (not 'on' by default because it needs SteamVR as a dependency)

HTC Vive has a glitch in your peripheral vision where you can see something flickering while in between 2 portals.

Forward rendering is the way to go. Deferred is a bit hit and miss with the latest Unity 2022 versions

AR Portals are now possible. Not all Portals in the generic demo scene have been made AR compatible, check out the dedicated AR demo scene for a good example.

# Compatibility

Are you working with the **URP rendering pipeline?** Then continue reading.
Are you using the standard rendering pipeline!? Request a refund.. This is **currently** not the package for you.

"Portals for VR" is created trying to be a great way to render real time recursive reflections. Everything is made to look good and to be as performant as I know how to make it.

Have a look at the below table.. Find your Unity / URP combination, then check which modes are available. **If your unity version is not included but higher than the lowest version number listed here, chances are good things will work.** It just means that combination was not verified working. This table is not complete so feel free to provide testing data by emailing. Fragilem17@gmail.com

| # Unity<br># URP | Non VR<br>(PC and mobile games) | VR<br>(Quest, Pico, ...) | Remarks |
|---|---|---|---|
| 6000.0.27<br>URP 17.0.3 | OK<br><br>Known issues: When both DirectX and Rendergraph are enabled and portals are being rendered in the scene view errors will flood the console. Either turn off rendergraph (enable compatibility mode) or (better option) switch to Vulkan/OpenGL for Desktop. | OK<br><br>Known issues: Vulkan switches the second recursion (portal in portal) enable the "flip" checkbox to flip it back. Should you see something glitchy with one eye on each side of the portal, this is the same issue and thus fixed by enabling the "flip" box | Fast and stable! |

| # Unity<br># URP | Non VR<br>(PC and mobile games) | PC VR<br>Single Pass Instanced | Mobile VR<br>Multiview | Remarks |
|---|---|---|---|---|
| 2022.03.37<br>URP 14.0.11 | OK | OK | OK | All Good |
| 2022.03.27<br>URP 14.0.11 | OK* | OK* | OK* | Needs a manual bugfix in URP |
| Unity 2022.03.27 and URP 14.0.11 has an issue that needs a manual bugfix in URP code: described here: https://forum.unity.com/threads/xrpass-getviewport-exceptions-in-editor.1577916/ | | | | |
| 2022.01.05f1<br>URP 13.1.8 | OK | OK | OK | All Good |
| 2022.01.00f1<br>URP 13.1.8 | OK | OK | OK | All Good |
| 2021.03.28f1<br>URP | OK | OK | OK | All Good |

| | | | | |
|---|---|---|---|---|
| 2021.03.18f1 URP | OK | OK | OK | All Good |
| 2021.03.02f1 URP | OK | OK | OK | All Good |
| 2021.03.00f1 URP 12.1.6 | OK | OK | OK | All Good |
| 2021.02.06f1 URP 12.1.2 | OK | OK | OK | All Good |
| 2020.03.36f1 URP 10.9.0 | OK | OK* | OK* | requires a skybox material to work in VR |
| 2020.03.24f1 URP 10.9.0 | OK | OK* | OK* | requires a skybox material to work in VR |
| 2020.03.19f1 URP 10.6.0 | OK | OK* | OK* | requires a skybox material to work in VR |
| 2020.03.10f1 URP 10.5.1 | OK | OK* | OK* | requires a skybox material to work in VR |
| 2020.03.02f1 URP 10.4.0 | OK | OK* | OK* | requires a skybox material to work in VR |

***requires a skybox material to work.** (Projection Matrices return identity Matrix when no Skybox is set.)

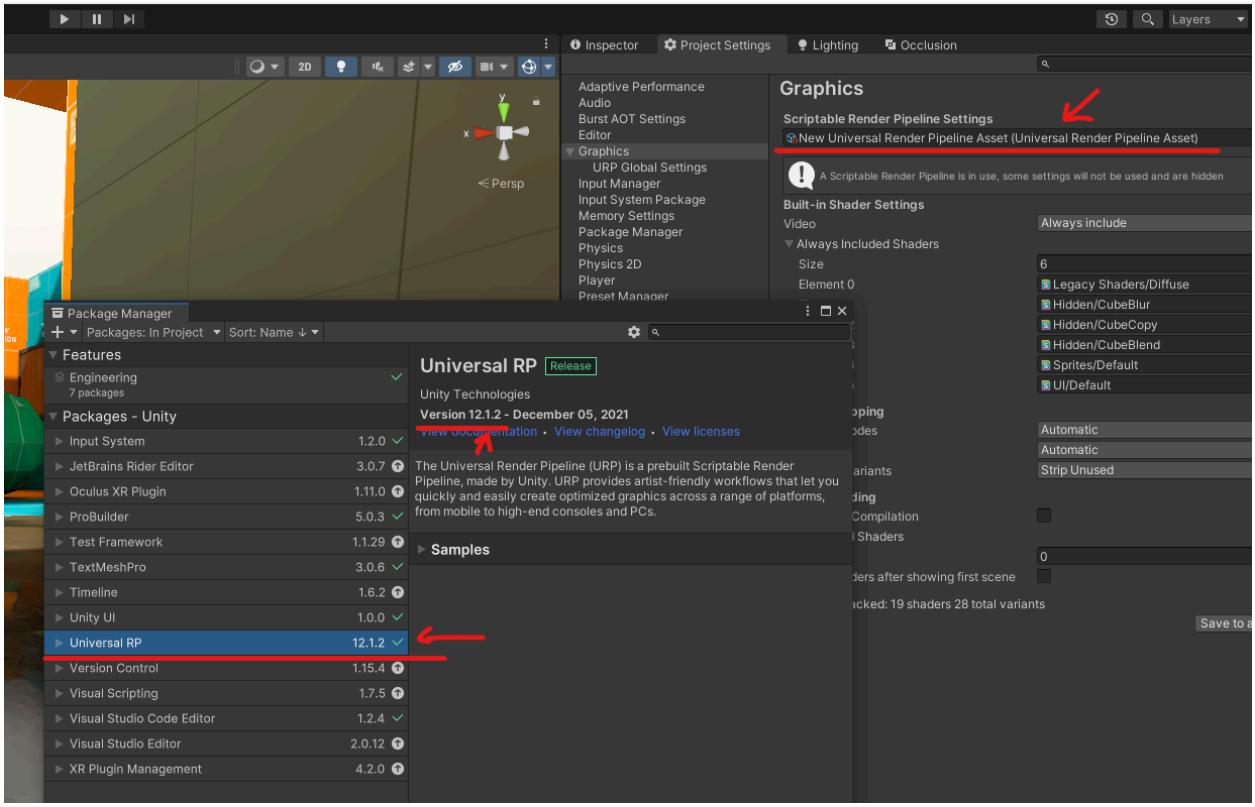
PS: make sure you switch the stereo rendering mode for desktop to your required setting even though you might be compiling for Android your development machine is using the setting for desktop during development.

# Using it.

First, make sure you're using the URP rendering pipeline.
The asset was originally made using:

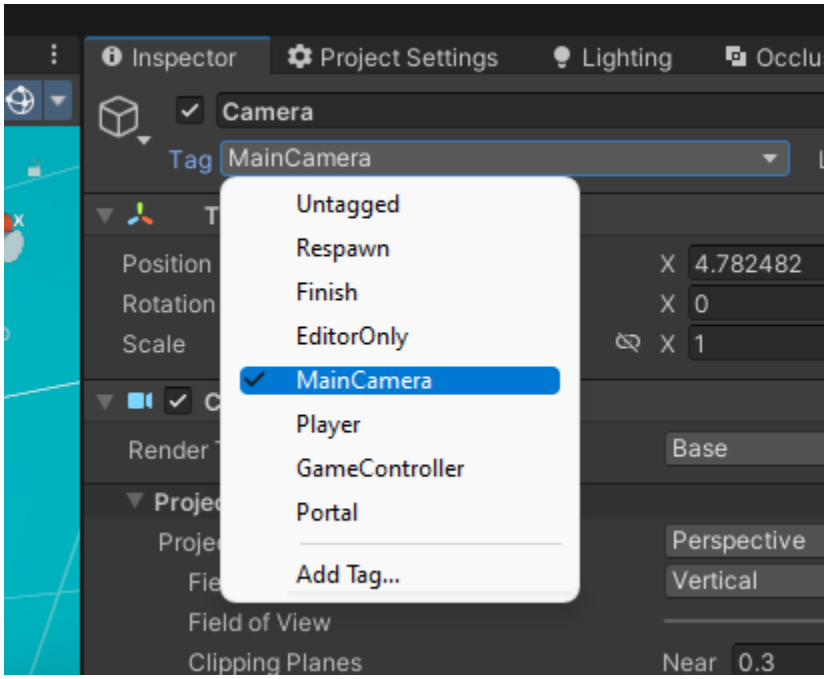
Universal RP 12.1.2
Unity 2021.2.6f1
Using: OpenGLES3

But newer versions will of course work. Check the table above for details.



## Tag your camera

Portals will only be rendered for the scene view in edit mode and Cameras tagged as "**MainCamera**" or "**SpectatorCamera**". So make sure your main camera has the tag "**MainCamera**".

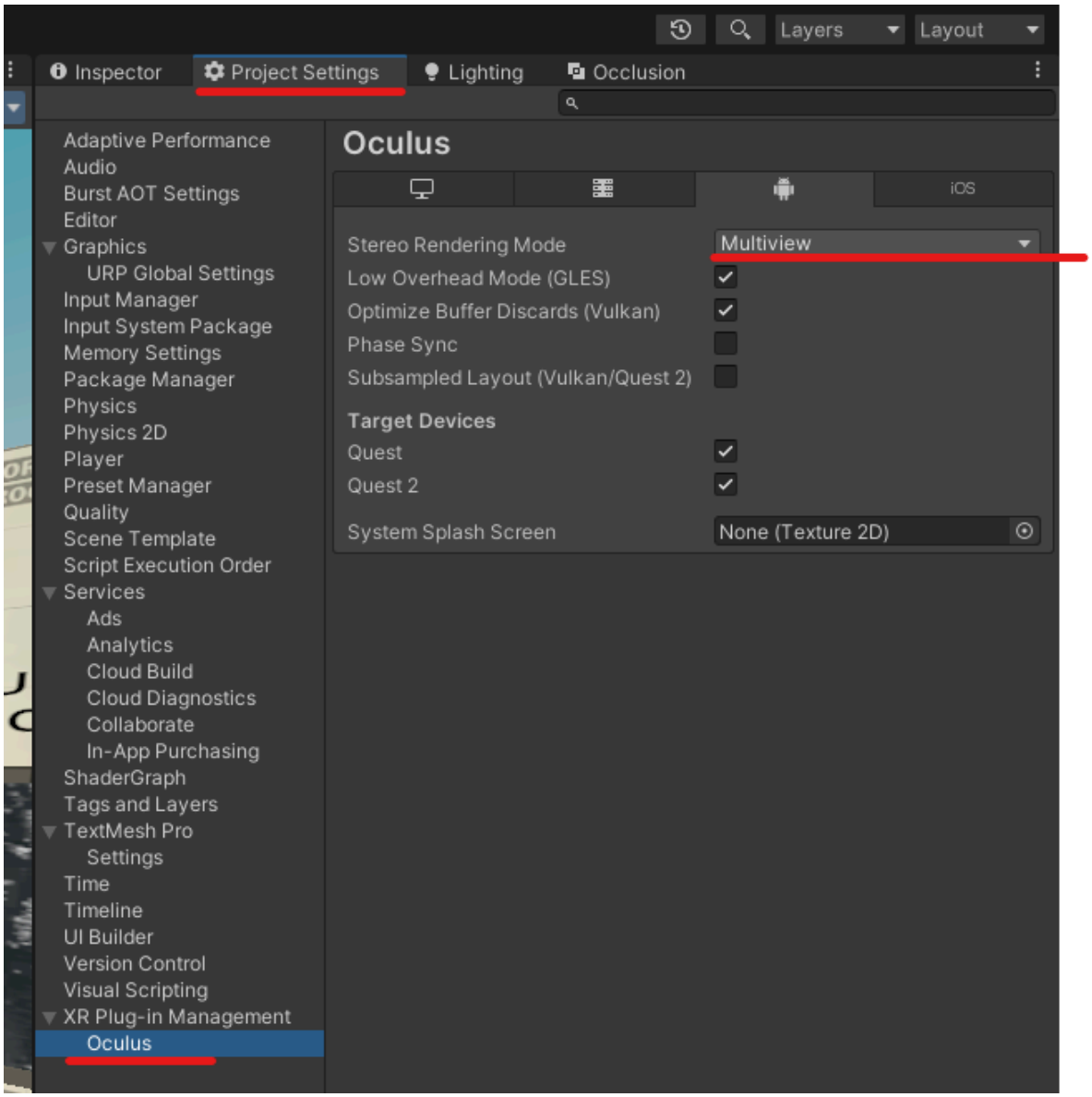



## Spectator Camera

If you tag a camera as "**SpectatorCamera**" and set it to target "no" eyes then on a desktop build that camera will be used to render the view on the desktop monitor. The MainCamera will still be rendered in the VR HMD. If you make it so the Spectator Camera smoothly follows your head and has a wide FOV then people following along on the desktop monitor don't get sick with the fast head movements.  Only when the camera has the tag "**SpectatorCamera**" will the portals be rendered.

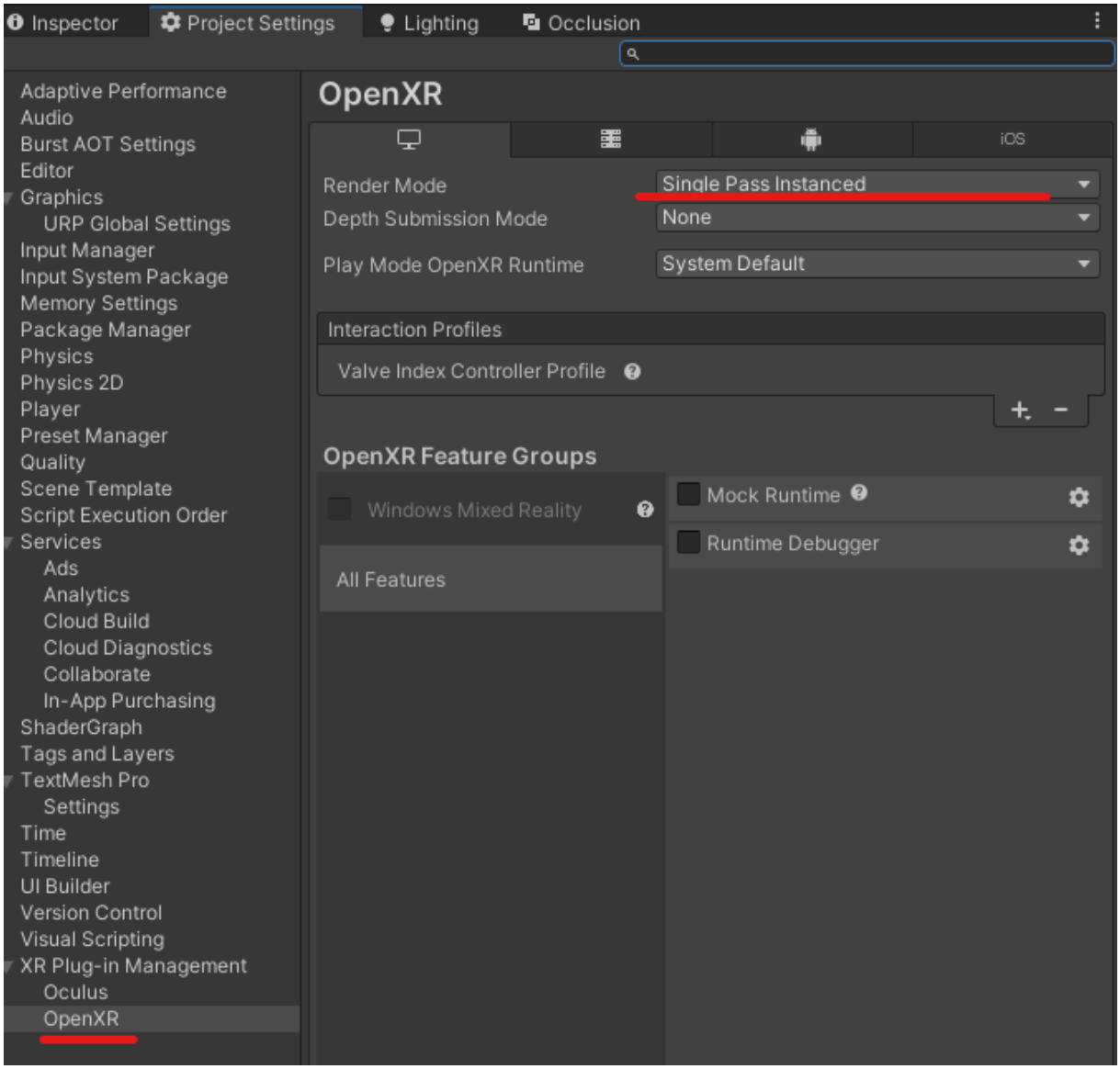
## For Quest or Native Mobile VR (meta):

If you're using the Oculus integration, make sure you're rendering in **Multiview** mode! This was previously named **singlepass** and is significantly faster than Multipass. **Multi Pass is currently not supported!** NOTE: Even though you're building for Android, your development PC/Mac is a desktop.. So **switch over to desktop, and make sure you've set the rendermode to singlepass instanced there as well.**



## For Oculus Link / Valve Index / Vive / any steam VR OpenXR based headset

If you're using OpenXR then, make sure you're rendering in **Single Pass Instanced** mode. This is significantly faster than Multi Pass. **Multi Pass is currently not supported!**

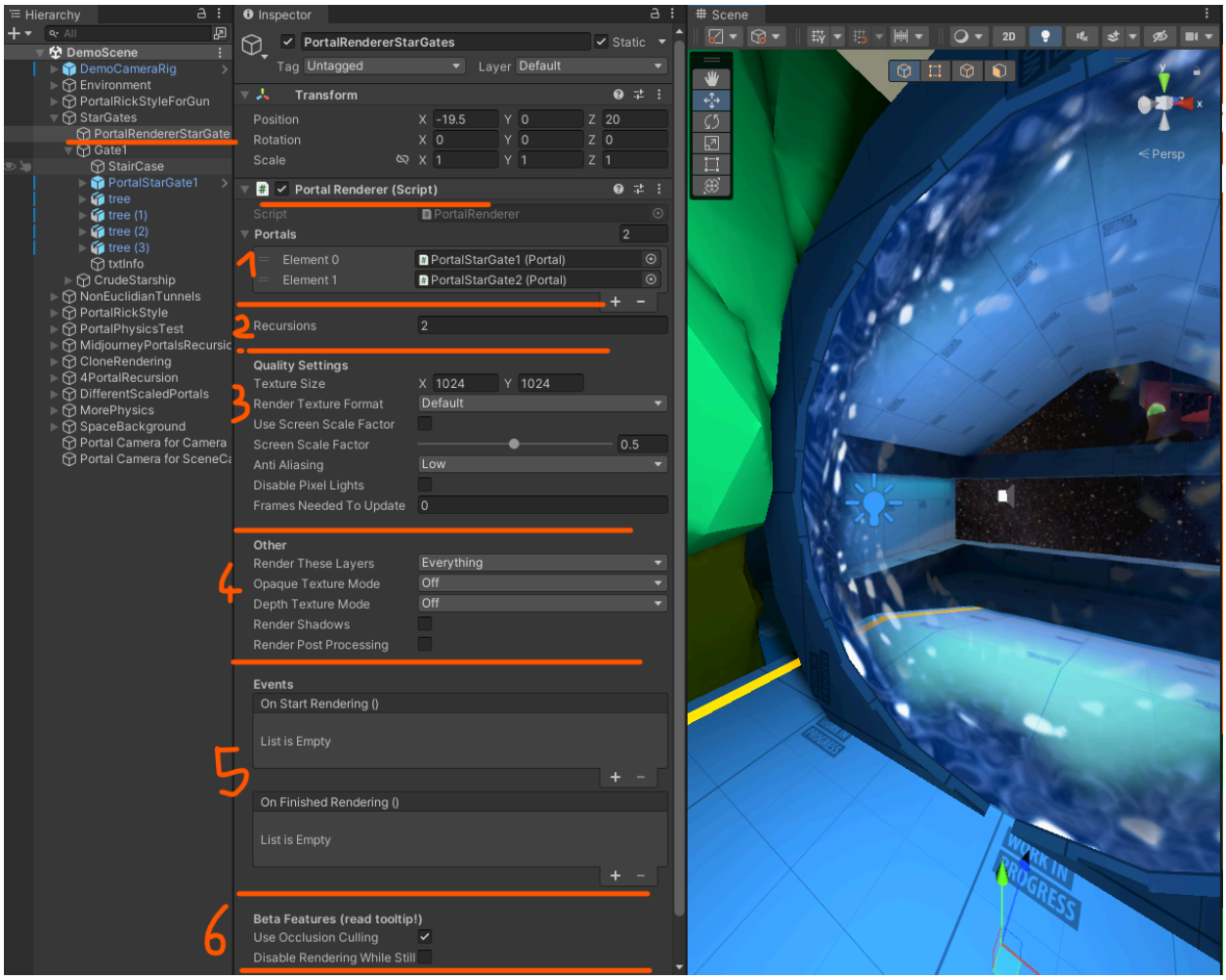


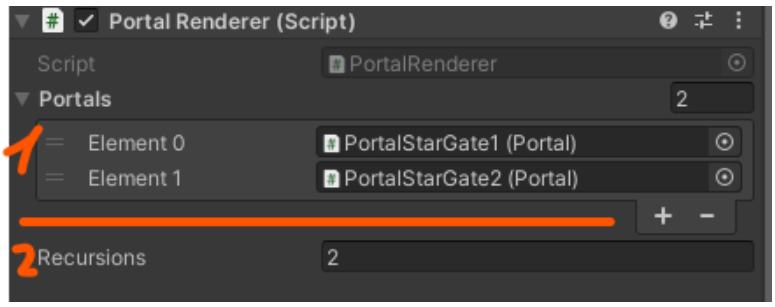

(Even though we're still stuck rendering the reflection as a pass per eye, i'm keeping an "eye" out for changes to URP to allow a rendertexture to be rendered as a double wide texture, I made a bug report explicitly showing that this is not working in URP while it used to in the deprecated old rendering pipeline )

# Open the Demo Scene

## PortalRenderer

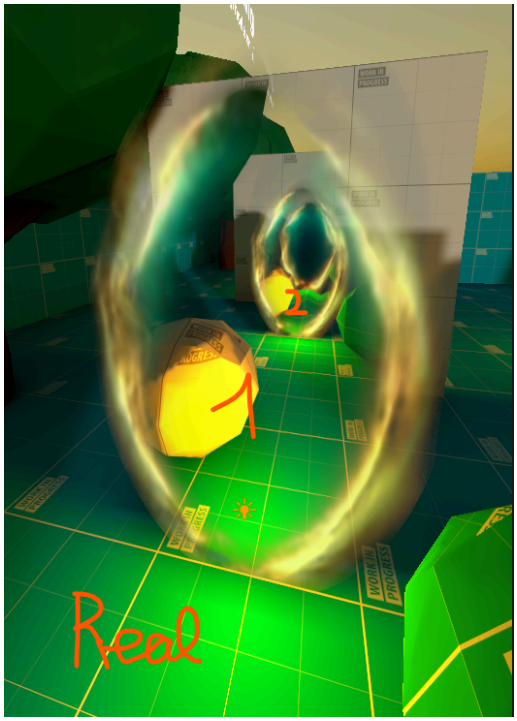
Have a look at ”StarGates” or “MidjourneyPortalsRecusion”, Select the Gameobject **PortalRendererStarGates**. It contains the **PortalRenderer**. Here you define which surfaces are to be rendered. Usually you’ll only assign your 2 portals, but you can put as many here as you like. They will all be able to “reflect” each other with the settings defined in the renderer. (all the same resolution) You can have multiple PortalRenderers with their own settings, but **Portals** will only be able to “reflect” each other when they’re in the same renderer.



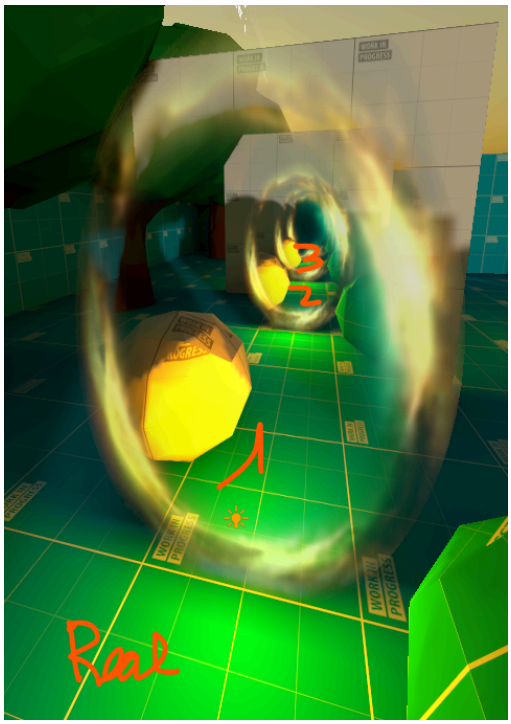



**1** Here we define which Portals are to be rendered.

**2** "recursions" define how many reflections of our own portal we can see in the other portal.
This defaults to 2. If a portal can't "see" the other portal it won't render it even though the recursion depth is higher than 1. **For Portals to correctly render when you're "inside" them in VR you need to have this at a minimum of 2 because the left and the right eye both need a reflection at that time. "PortalSurfaces"** (keep reading) have a "Max Rendering Distance" that might stop you from seeing the deeper recursions because they're too far away. If they are, they won't be rendered either, saving you some precious GPU cycles..

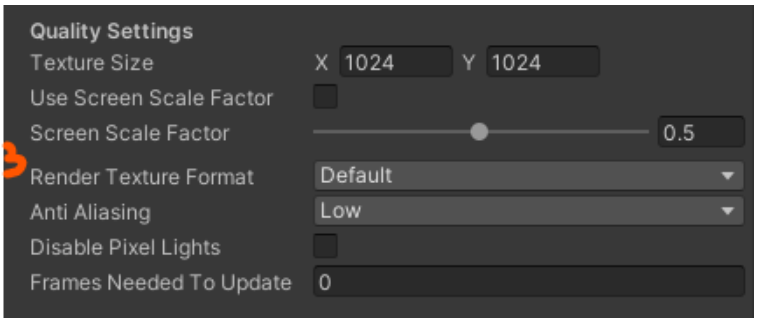



A recursion of **2**




A recursion of **3**

### 3 Quality Settings:




**"Texture Size"** defines the resolution at which the portal texture will be rendered. Square texture sizes seem to be a bit faster on Quest. I usually go with 1024x1024

**"Use Screen Scale Factor"** when enabled the texture size is calculated as a factor of the screensize. 0.5 is a good default value. On Quest 2 the display size is 3840x1832 a Factor of 0.5 would result in a texture resolution of 1920x916. I do prefer a fixed resolution if I know the target platform.

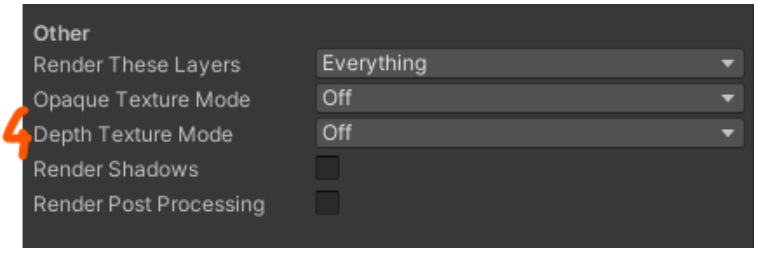
**"Render Texture Format"** Choose **Default** for 8 bits per color channel textures or Default HDR for 16 bits. **Default** is faster but might give some banding in the portal image.

**"Anti Aliasing"** It's not free but best to use at least a low setting.

**"Disable Pixel Lights"** If you can get away with real time pixel lights (you're probably not doing mobile VR), You can turn them off in the portal reflections.

**"Frames needed to Update"** Leave this at 0, in VR even a 1 frame drop to save performance looks terrible. But it might be useful for mobile games outside of VR.

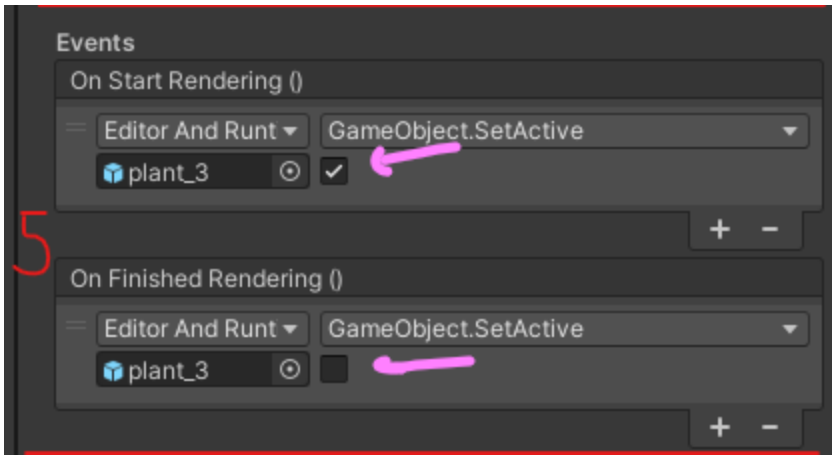
### 4 Other:




**"Render These Layers"** limit the things to render by changing the layer mask of the Portal Camera.

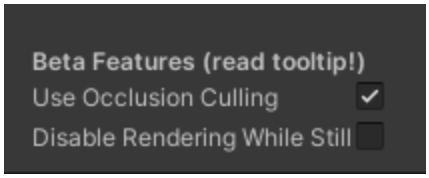
The rest of these settings speak for themselves and reflect the settings any other camera would have. If you're doing mobile VR you'll want all of these things to be the default values. (Off)

## 5 Events:




These 2 events allow you to change the scene just before the reflection gets rendered and then change it back. Use it for example to scale your head down in the VR camera and scale it up for the reflection camera. Can be used as an alternative for Culling masks.

## 6 Beta Features:

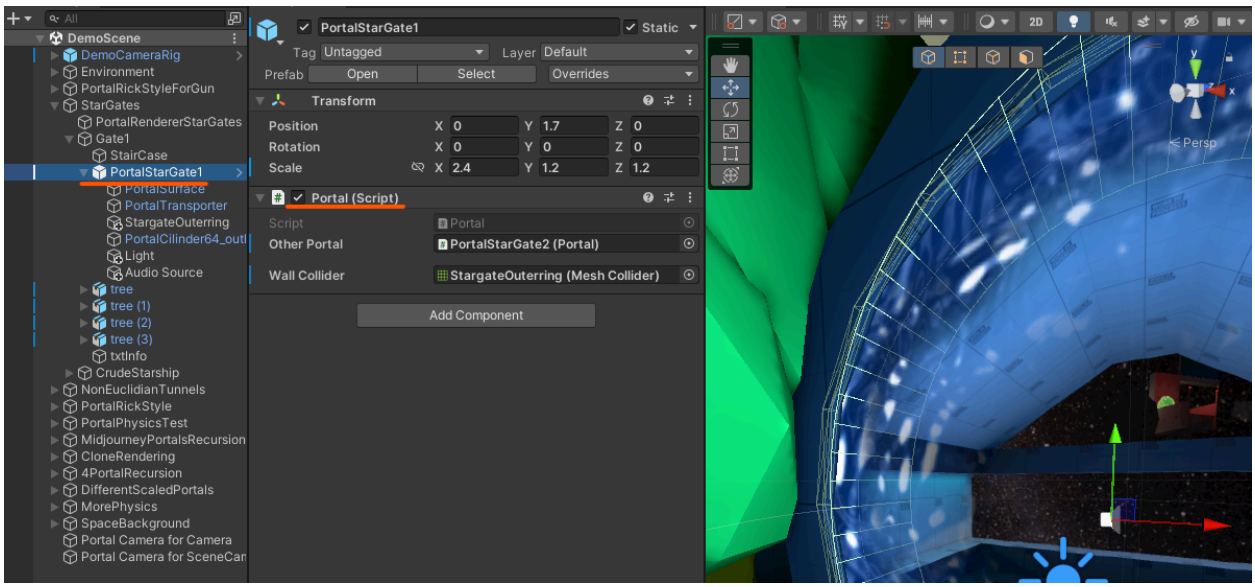



**"Use Occlusion Culling"** whether or not the camera that renders the portal is using Occlusion culling. This only helps if you've actually baked your occlusions. Read up on that! (Out of beta since 0.7)

**"Disable Rendering While Still Updating Materials"** When checked, the portal will stop rendering but the materials will still update their position and blending settings.

## Portal

Our **PortalRenderer** needs something to render. In comes the **Portal** Script.

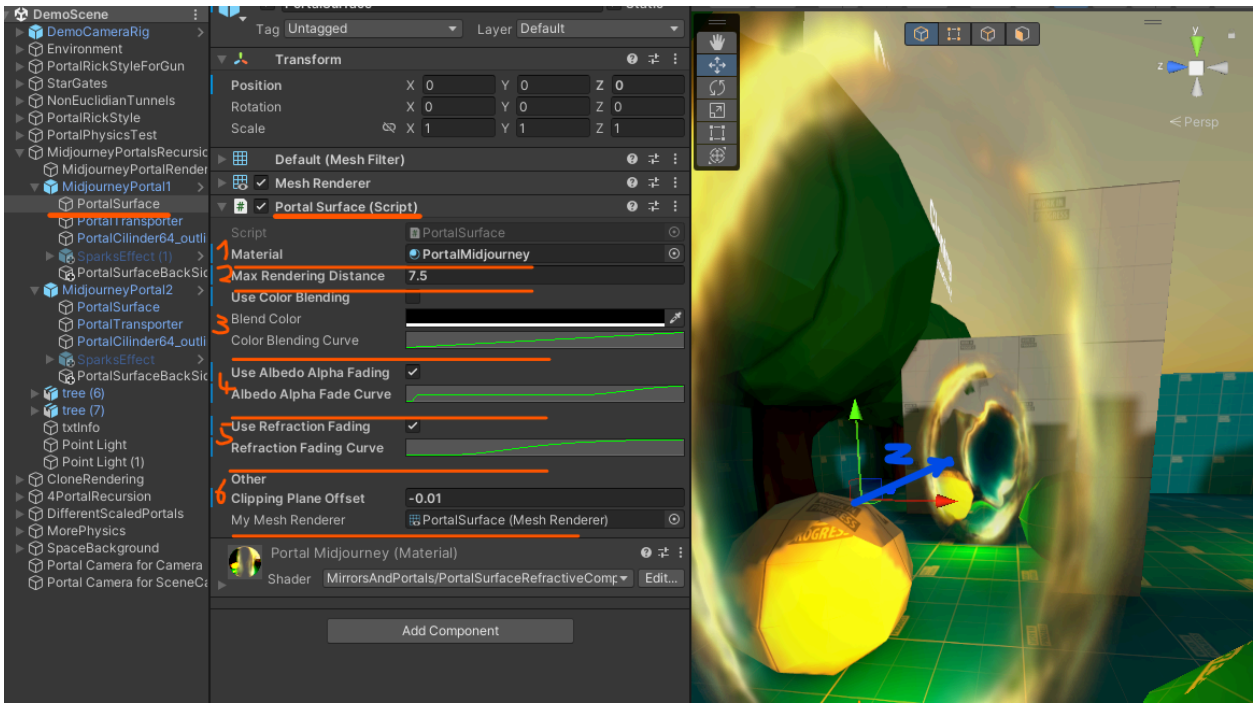



**“Other Portal”** A Portal always points to another Portal, just drag a reference in the scene to the other Portal in this slot.

**“Wall Collider”** If a portal is against a wall with a collider you can’t just walk through that wall. Putting the collider in this slot allows your “Portalable Object” to walk right through.

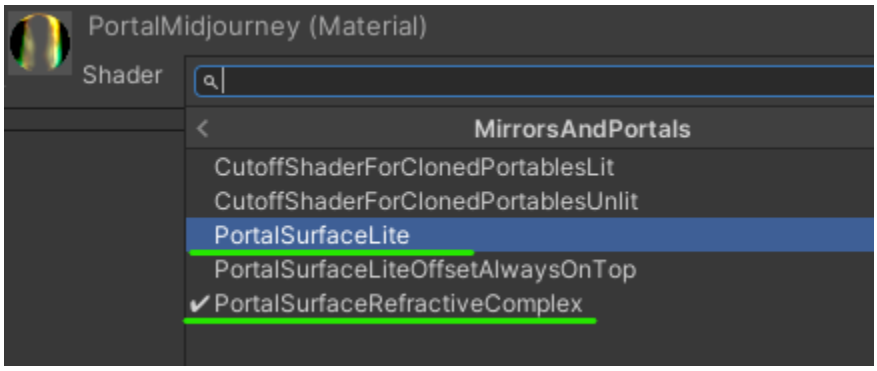
## PortalSurface

Each **Portal** can have 1 **PortalSurface** (either as a sibling or a child of the Portal GameObject)




**1** “Material” A surface needs a Material. Start by making a material and dragging it into the slot. Both Portals can use the same material instance of different ones, does not matter.

There are 2 PortalSurface shaders. a real simple unlit shader for simple portals and another unlit advanced shader that allows you to do refractions transparency and other nice effects.

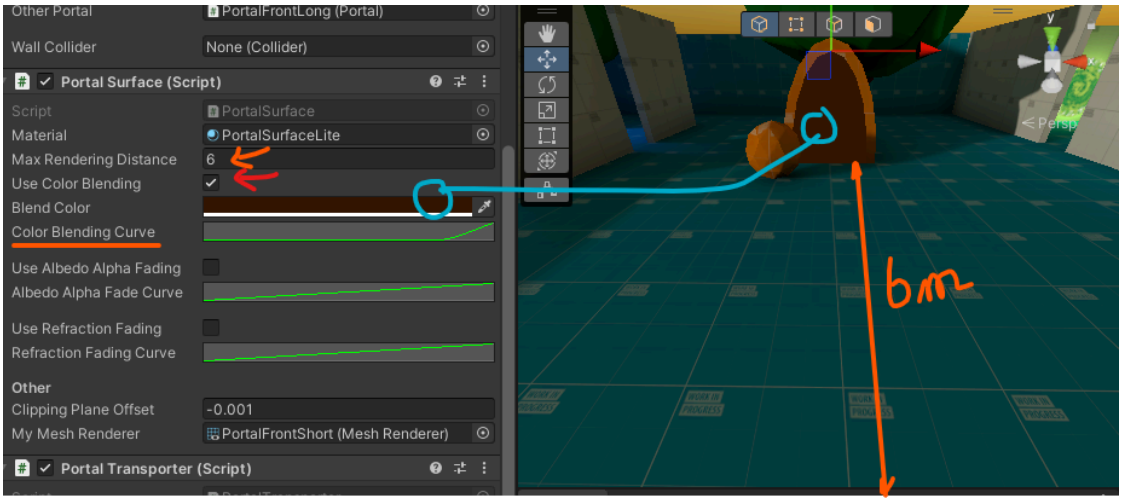


**2 "Max Rendering Distance"** an important one! The portal stops rendering the "reflection" when you're further away from this value. This includes recursions!


So if 2 portals are **3 meters apart** looking at each other and the **Max Distance is set to 4**. You are standing in between the portals then you'll see the reflection of 1 portal but the other will be too far away to also reflect your back. (Distance 1.5 + 3 > maxDistance 4).
As you walk closer to P2 the reflection of your back will start appearing through P2 in P1 once you get within **1 meter** of p2. (Distance **1** + 3 == maxDistance 4)

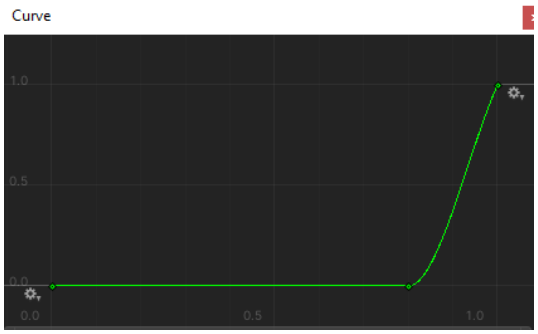
**3 "Use Color Blending"**

**Supported by both the simple and the complex shaders.**
When checked the portal will fade the "reflection" to a solid color over distance until it's at the Max Rendering Distance.




How much color is blended in over distance can be controlled with the "Color Blending Curve"

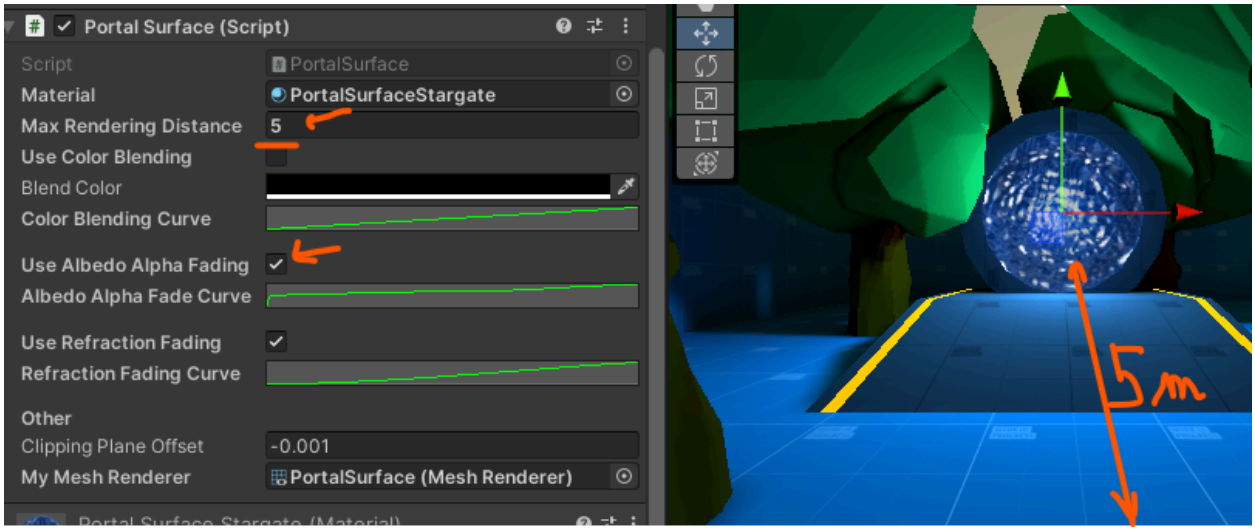
Zero on the left means zero color will be blended in at distance 0% up until 80% where it goes smoothly to 1, meaning at 0.8f * MaxDistance the color will start to blend in.



## 4 "Use Albedo Alpha Blending"

**Supported by both the simple and the complex shaders.**

When checked the portal will multiply the "albedo" texture's alpha over the reflection in function of distance to the portal. This allows the "portal opening" effect as you get closer.



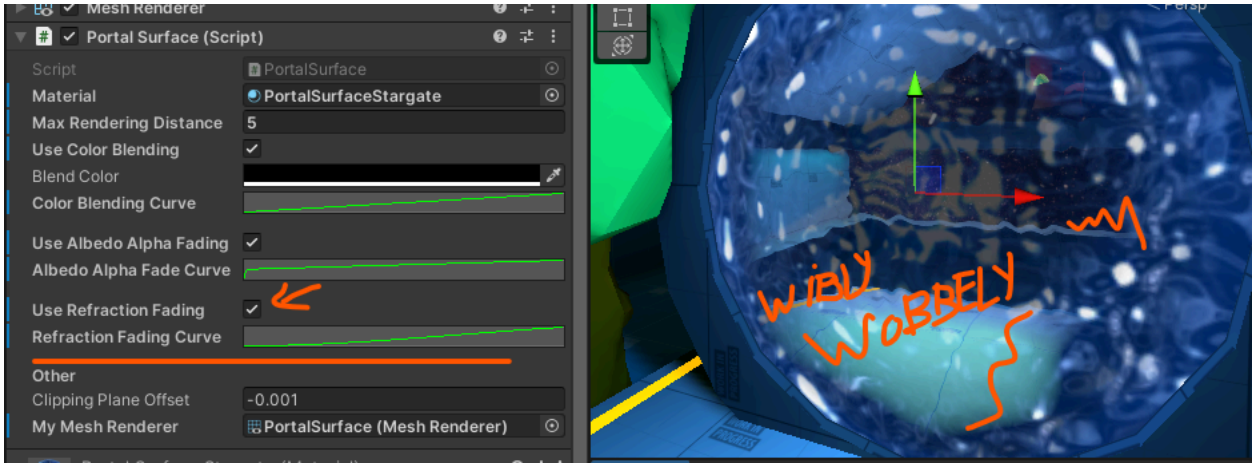

In the screenshot you'll see the stargate texture is fully opaque. In the curve you can see the alpha is multiplied with 1.5 (right side as we're more than 5 meters away)


As we get closer the alpha will get lower until it drops quickly to 0. (if we're up close with our nose against the texture) You'll only see the reflection at that point.

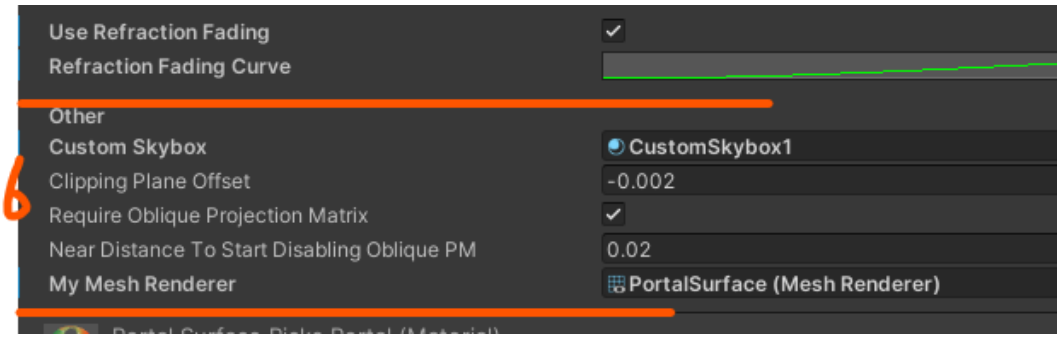
## 5 “Use Refraction Fading”

**Supported by the complex shader.**

When checked the portal will use the provided normal map to calculate refractions in the “reflection” The curve allows you to control how much refraction is happening over distance.




In the screenshot you’ll see the reflection being all wibbly wobbly, as we get closer the ripples will get less and less depending on how you set your curve. You want it to be 0 when you’re up close.




**6** When a "**Custom Skybox"** is defined, looking through the portal will render that skybox in the background, it's up to you to switch out the main camera's skybox with the custom one upon transporting (use the events on portalTransporter (See the demo)

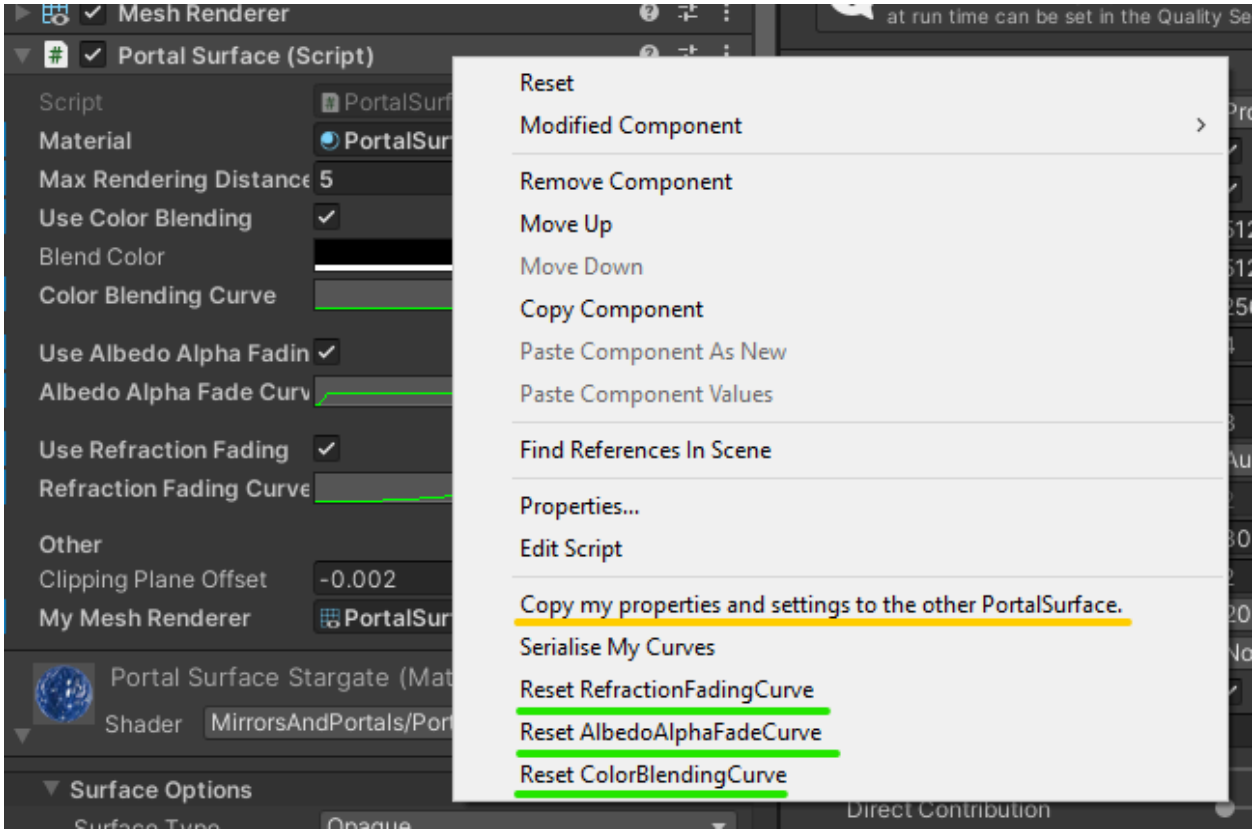
The **"Clipping Plane Offset"** allows you to move the reflection plane forward or backward from the actual Surface plane, a value if -0.001f usually gets rid of some small artifacts.

**"Require Oblique Projection Matrix"** an Oblique Projection Matrix is where the nearClipping is no longer right-angled to the forward of the Camera but instead follows the right angle towards the forward of the portalSurface (and thus cutting of all geometry on the back of the portal. When turned **off**, the Camera that renders the portal will have a normal Projection Matrix, some effects depend on the Matrix to be normal like the SSAO in URP.

The **"Near Distance to Start Disabling Oblique PM"** is the distance towards the portalSurface of the camera at which we no longer calculate the PM oblique. The Oblique PM suffers from low z-depth accuracy. So when the nearplane becomes small we want to turn off the oblique calculation. This should generally be smaller than the wall thickness (or you would start seeing the other side renderer over it)

**"My Mesh Renderer"** If your model does not have its pivotpoint set correctly you can create an empty GameObject with the PortalSurface script attached to it. Rotate and position that gameobject correctly with its blue arrow pointing away from the surface. Then drag the actual model in the "My Mesh Renderer" property. I do not recommend doing this as it messes up selecting your material instance.

In case you completely mess up the curves and want to get back to something sensible you can right click on the PortalSurface component.

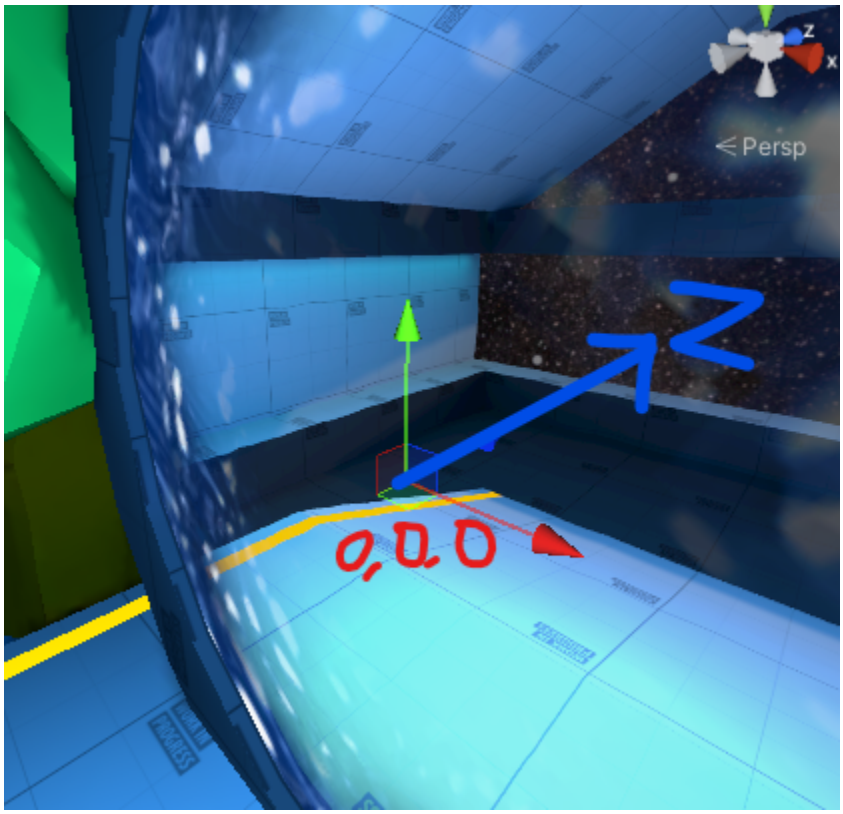


# Creating your own portal geometry

## Forward direction

You can use any shape planar model. (a square, a circle, a heart, egg shaped) As long as it's a planar surface and the pivot point and normal are facing the correct direction.

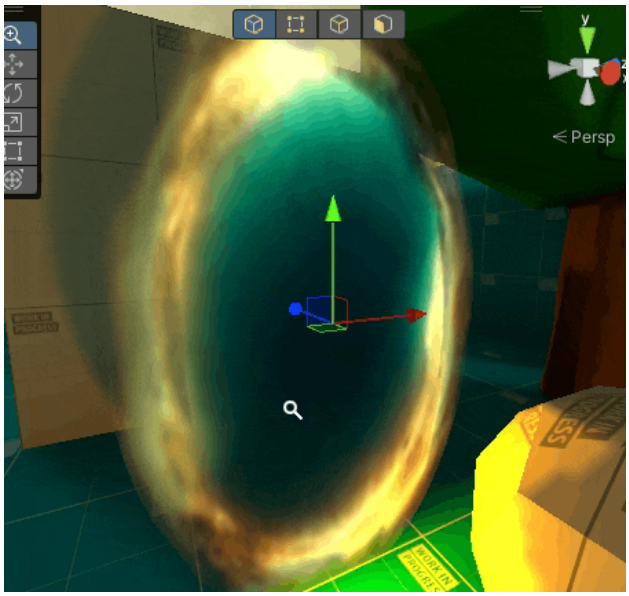
The "reflection" will be calculated looking back from the blue arrow of the model. So make sure to be looking at your local coordinates and that the blue arrow is looking away from the visible side of the plane. This is the default for the Unity 3D Quad.

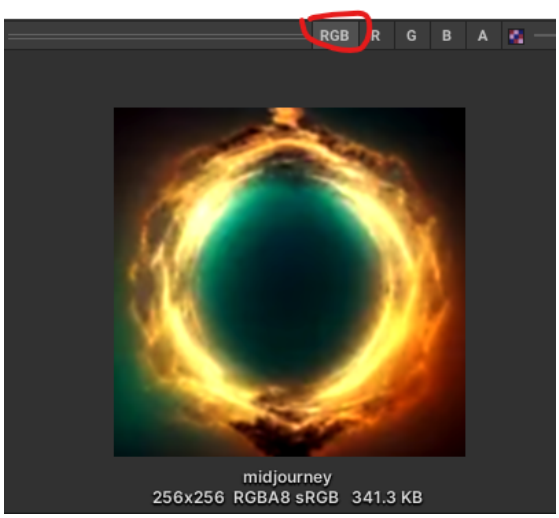


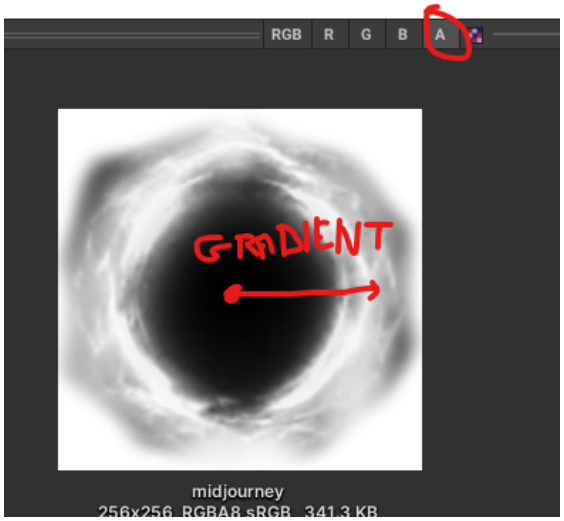
# The Portal Surface Shaders

## Both PortalSurface Shaders are pretty self-explanatory however:

This effect where the portal opens up requires an explanation on how to prepare your texture.

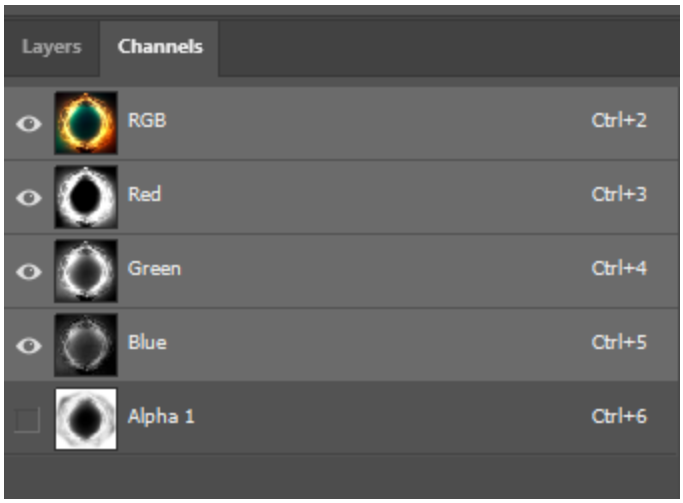



You barely notice in the screenshot but there's a gradient from almost black to whiter towards the edges.

When "**Use Albedo Alpha Fading**" is turned on in your **Portal Surface** the alpha channel of your albedo texture will control how transparent it is. The easiest way I know of to create an alpha mask is by using Photoshop and adding an alpha mask there.

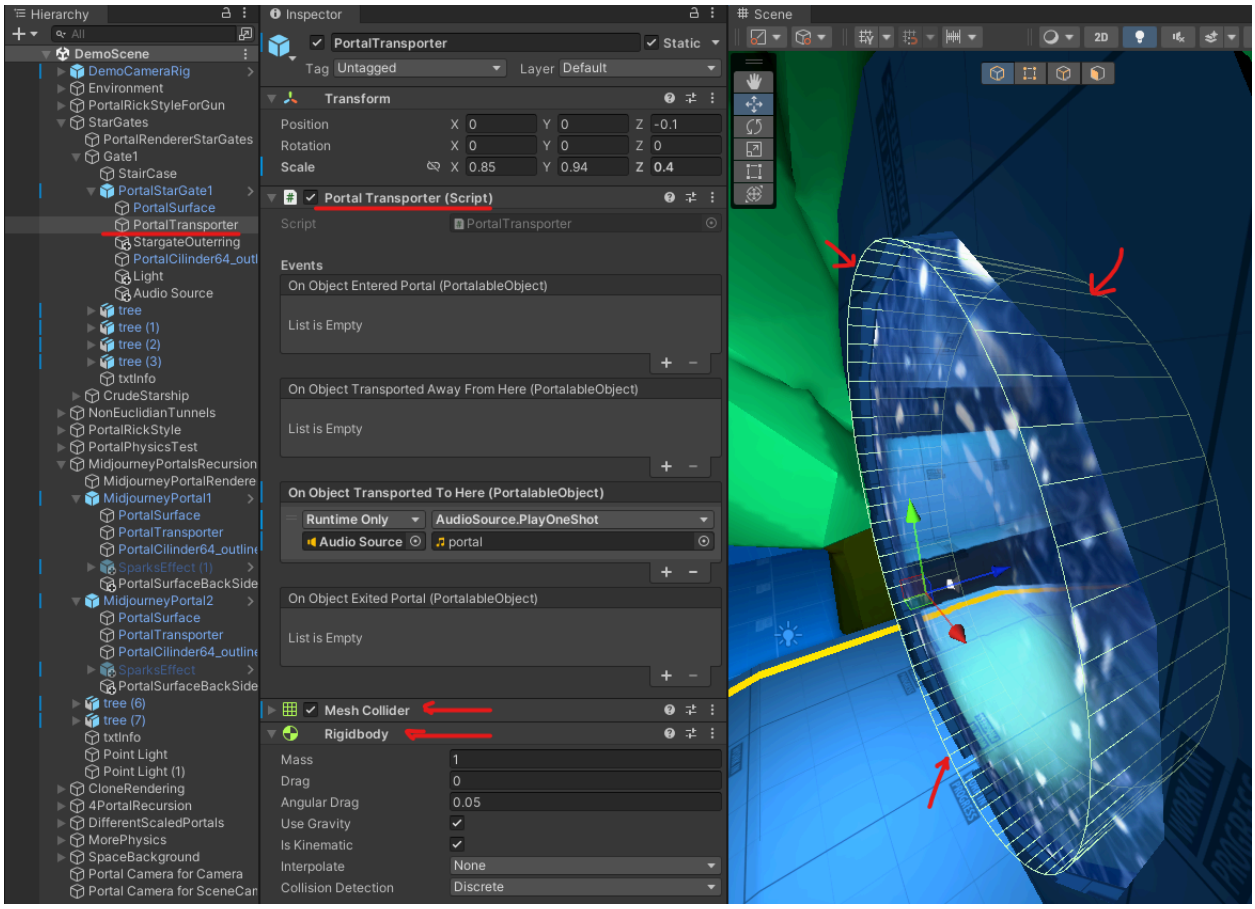



(https://www.instructables.com/How-to-use-Photoshop-to-Create-Textures-With-Alpha/)

The rest of the shader is pretty self-explanatory. Don't forget to mark your normals as normal maps.

# Portaling Through a Portal

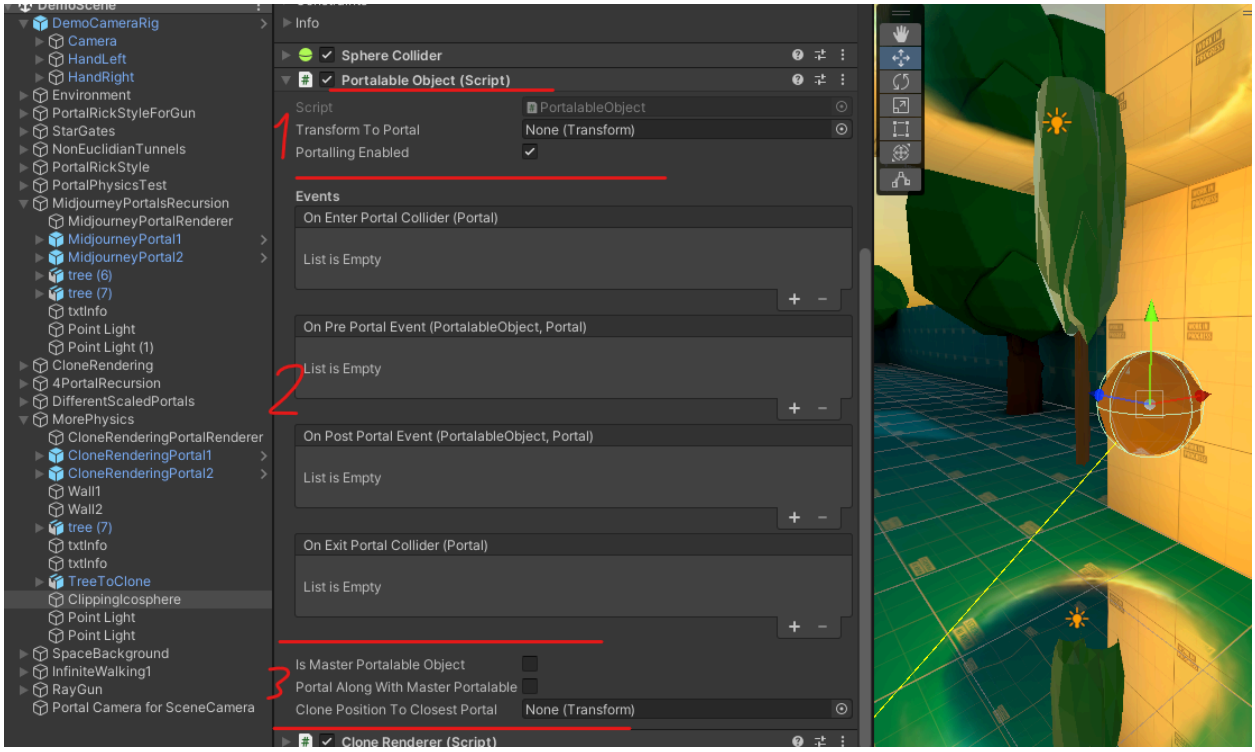
## PortalTransporter




For an object to be able to transport through a portal the portal needs a PortalTransporter along with a Collider and a Rigidbody. The collider needs to be able to capture the object before it touches the potential wall the portal is attached to behind it. (It needs to stick out a bit). It also needs to extend a bit behind the portal. (Things will only **Clone** themselves while touching the collider, keep reading)

## PortalableObject

Objects that want to be able to “Portal” (transport) through a portal need a “**PortalableObject**” component along with a Collider. You **playerController** would also need to have a “**PortalableObject**” component.




**1** **“Transform to Portal”** You can leave this empty if you want to target the transform from this object. More complex objects like your playerController might need a different “root” element to move when you pass through.

Important to realize is that the object will transport once it’s **pivot point** is on the other side of the Normal of the **PortalSurface**.

In the case of a playerController the **PortalableObject** needs to be on the camera’s pivot point but in most cases you don’t want just your camera to transport but the whole playerController. That's where you can enter the transform of the controller in the “**Transform to Portal**” slot.

Have a look at the DemoCameraRig for it to make sense.

So when Camera passes through the normal of the Portal's Surface, DemoCameraRig will be transported taking the camera with it as it's parented to it.

**"Portalling Enabled"** used to disable the portalling of an object (safer than than disabling the whole component as cloning will continue to work)

**2 "Events"**

OnEnterPortalCollider: When the portalableObject enters the collider.
OnPrePortalEvent: Just before the object is warping, the transform is still at the first portal
OnPastPortalEvent: Just after warping, the transform has been repositioned
OnExitPortalCollider: When the object leaves the portal collider (does not mean it has been portalled)

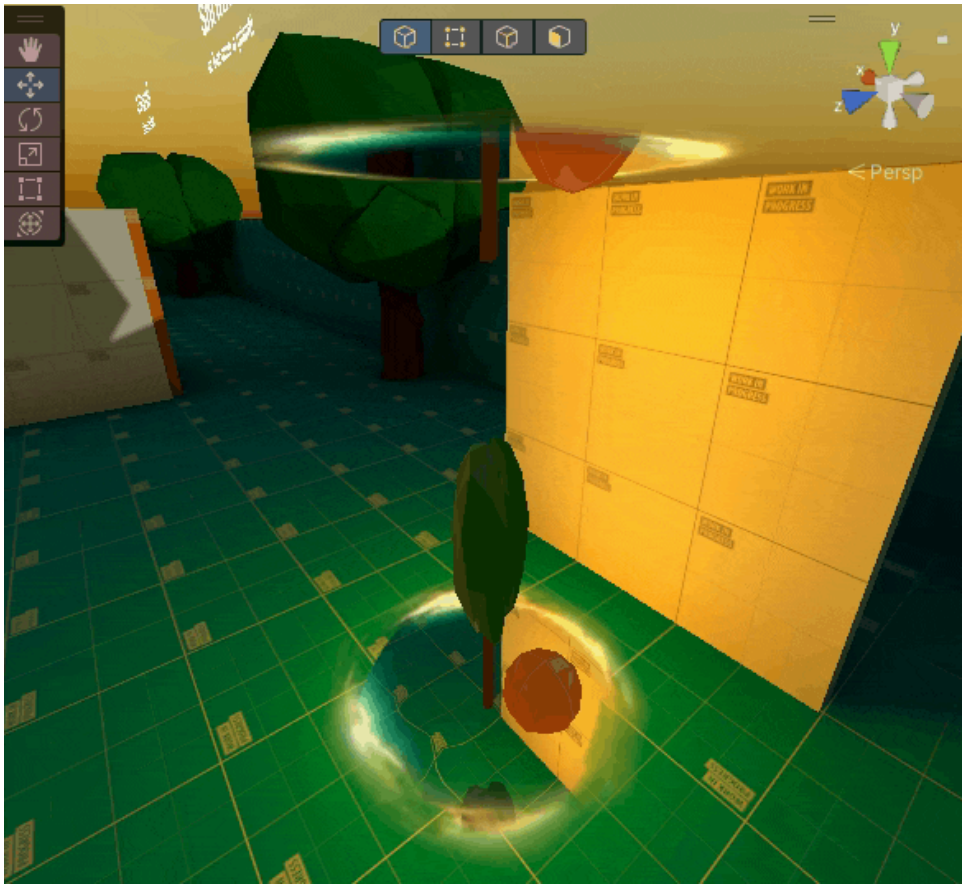
**3 "Is Master Portalable Object"**

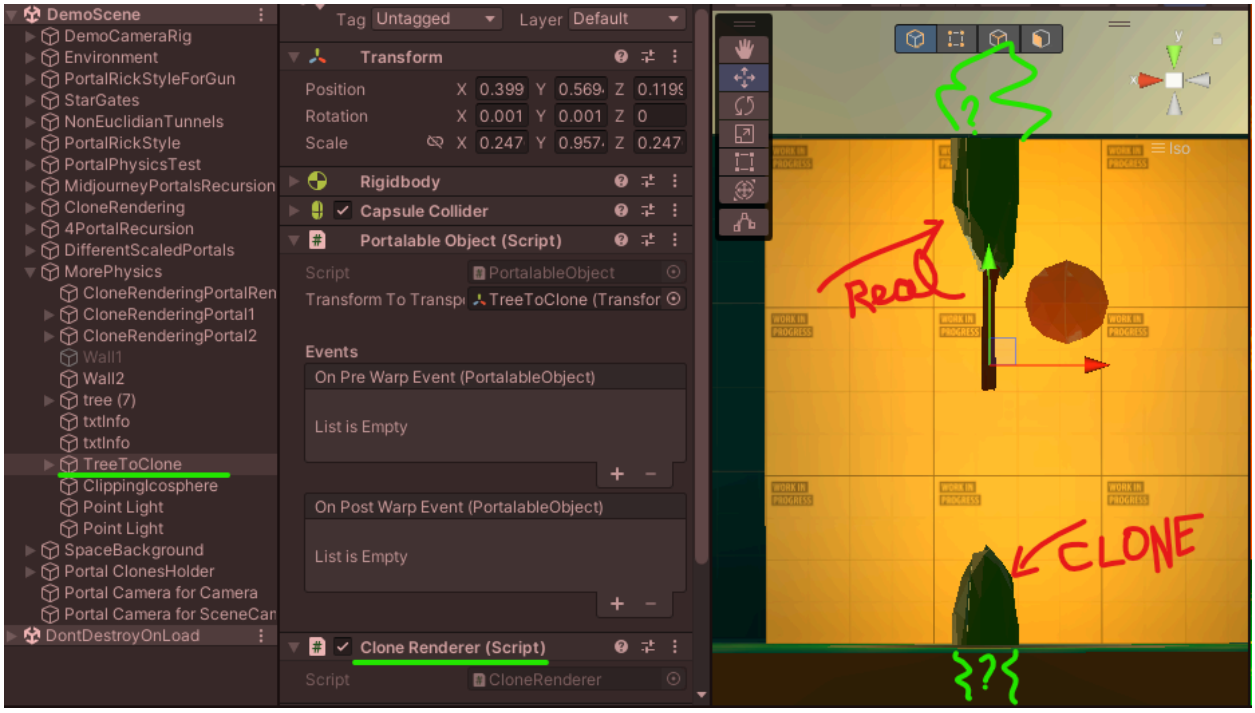
Set this to true if this is your character controller. All items that have "**PortalAlongWithMasterPortalableObject**" enabled will transport along when the master portals.

**"ClonePositionToClosestPortal"** If a transform is present in this slot, that transform will always be at the nearest Portal's OtherPortal in relation to your current position. Comes in handy for third person characterControllers (look at the CinemachineExampleScene for an example) or here: https://youtu.be/1-q7OfoB-II

## CloneRenderer

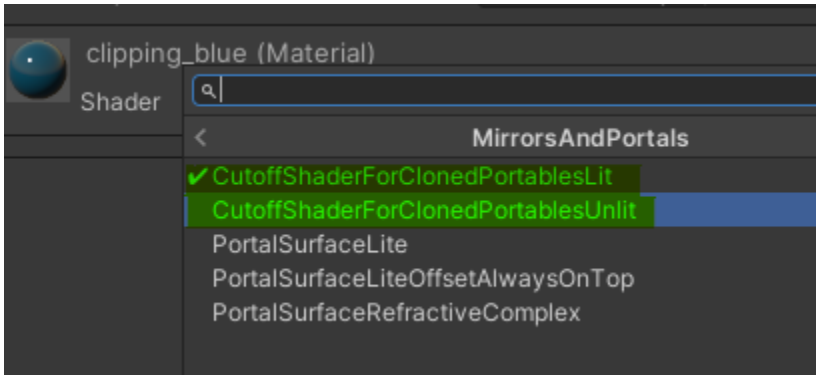
The CloneRenderer is the last piece of the puzzle. Have a look at the animation below (if you're looking at the PDF, you're not missing much) The tree and the ball exist twice in the scene, once as the real object and once as a clone. (This effect only runs at playTime)



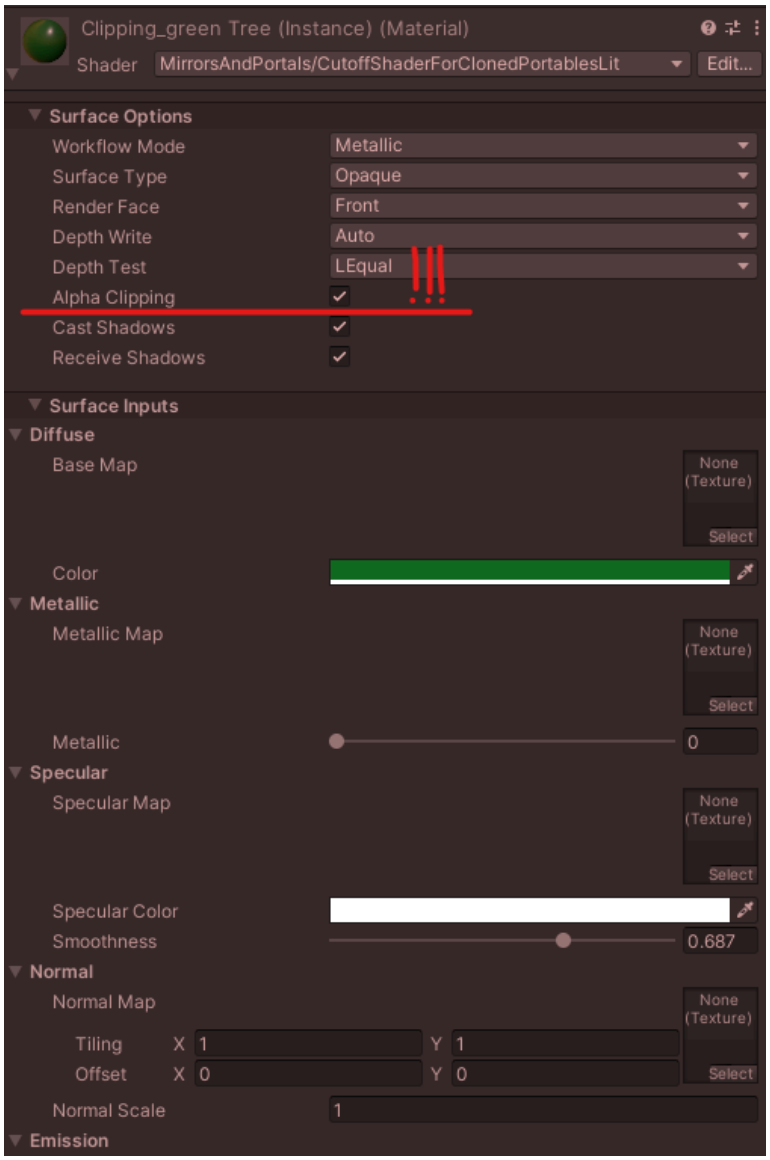



The **CloneRenderer** will copy all child objects and materials to render them at the other side **as long as they're in the PortalTransporters Collider**.

Notice how the top of the top tree is missing and the bottom of the cloned tree! The Materials are being clipped. For this to work you need to use one of these shaders.



**Make sure you check the Alpha Clipping checkbox in the Surface Options of your material.**



# Mobile URP and Performance

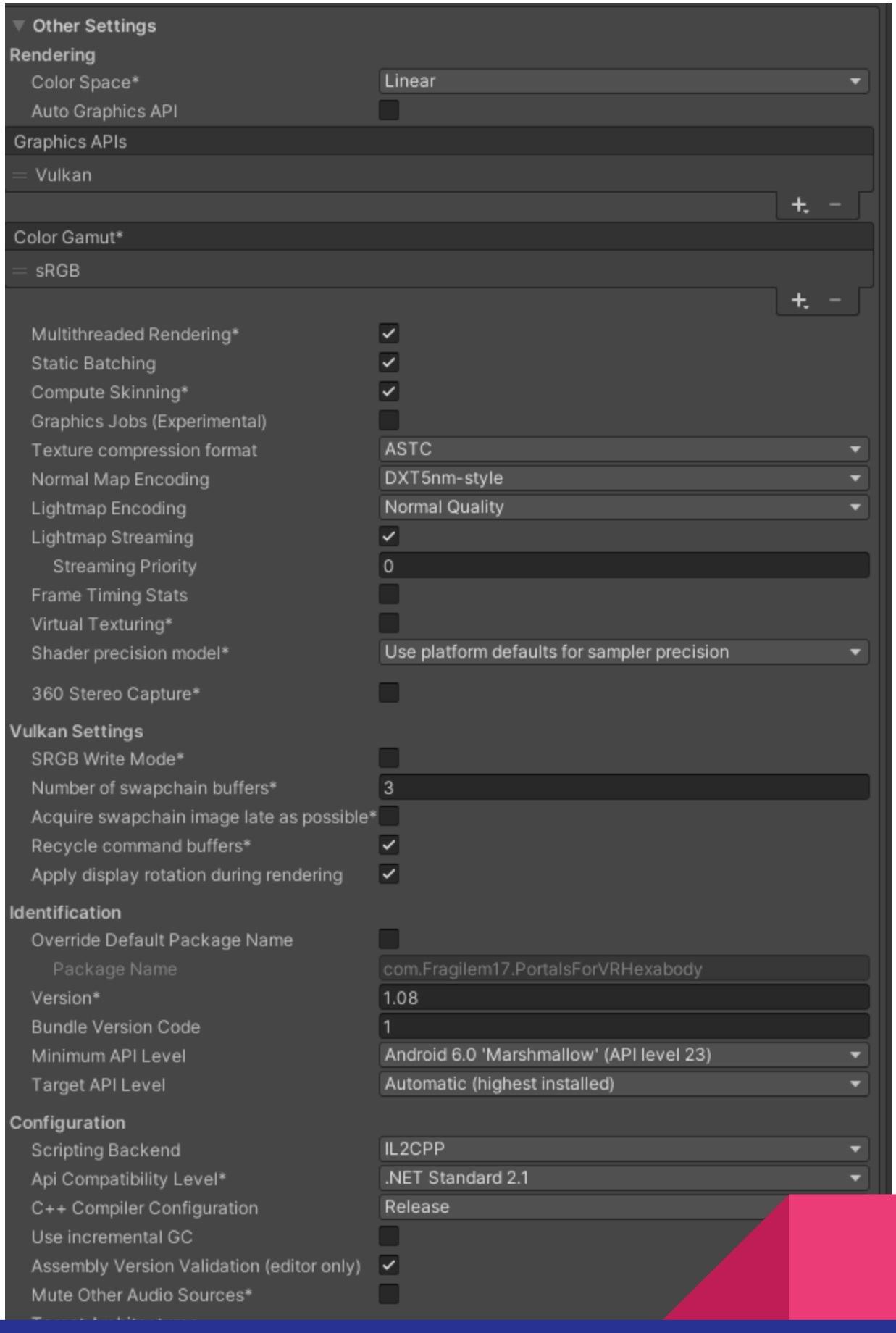
Performance for URP and Quest especially is not the same all across versions.
New features get introduced and there are a lot of options to choose from. Sometimes regressions may cause some versions to perform worse than others. I found 2021.2.6 to be good, it shows considerably less CPU overhead then later versions. **However! I've not done much objective performance measuring myself.** It might also really depend on your scene and in what areas it is "heavy".

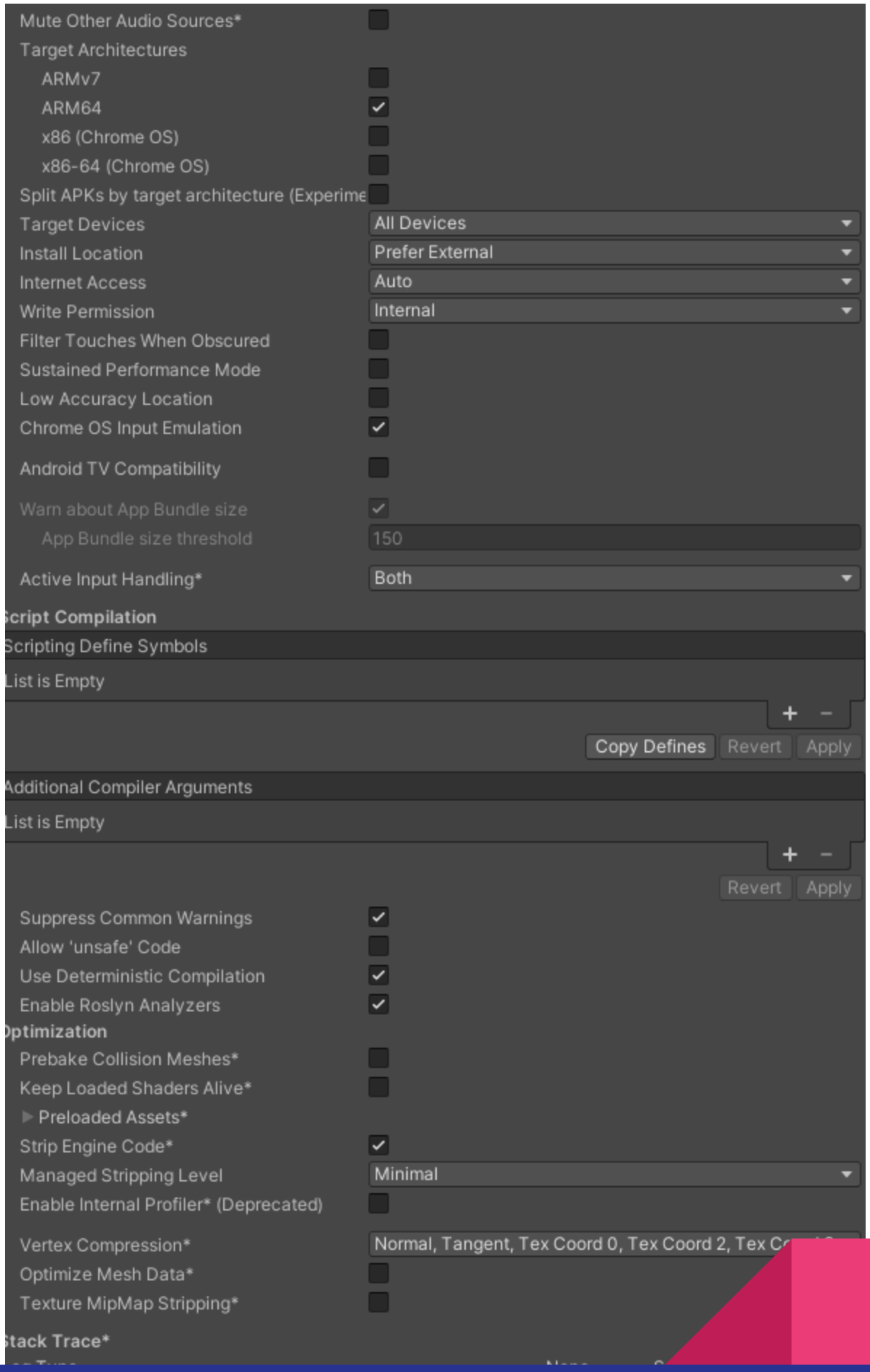
Keep an eye on this issue tracker regarding performance issues across versions.

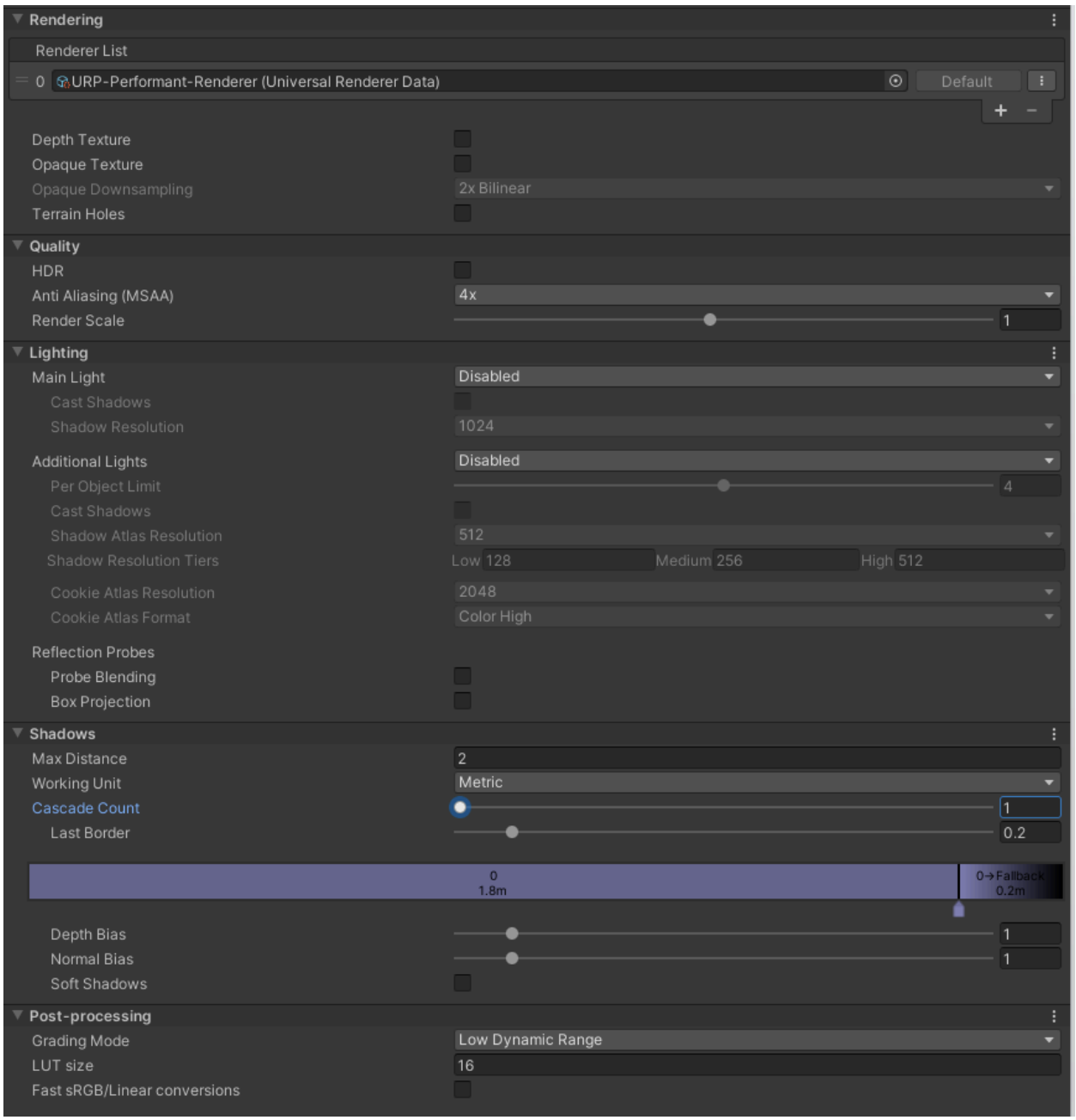
https://issuetracker.unity3d.com/issues/urp-xr-performance-degradation-when-comparing-android-quest-2-builds-across-2020-dot-3-and-2023-dot-x

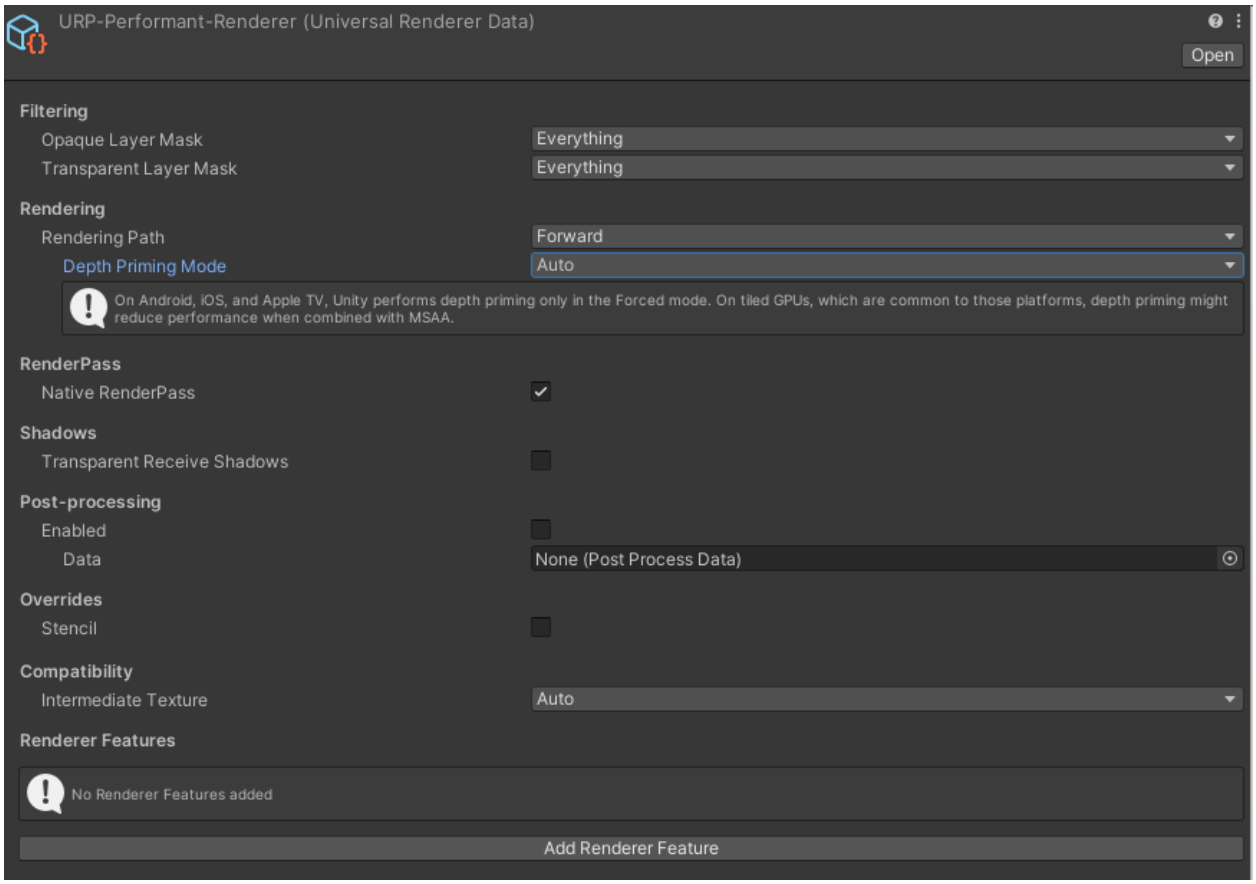
All that being said, below are screenshots of my 2021.2.6 version with URP/android settings focussed purely on framerate. I've been able to enable PostProcessing, Probe blending and Box Projected reflection probes on Quest 2, but better to start low and focus on making things look good by baking your lights, baking your occlusion culling, making sure your gameplay is final and only then start working on eye candy. Framerate is king!

**If you feel something can be changed to better performance, mail me!**


Other Settings
Rendering
Color Space*
Linear
Auto Graphics API
Graphics APIs
Vulkan
Color Gamut*
sRGB
Multithreaded Rendering*
Static Batching
Compute Skinning*
Graphics Jobs (Experimental)
Texture compression format
ASTC
Normal Map Encoding
DXT5nm-style
Lightmap Encoding
Normal Quality
Lightmap Streaming
Streaming Priority
0
Frame Timing Stats
Virtual Texturing*
Shader precision model*
Use platform defaults for sampler precision
360 Stereo Capture*
Vulkan Settings
SRGB Write Mode*
Number of swapchain buffers*
3
Acquire swapchain image late as possible*
Recycle command buffers*
Apply display rotation during rendering
Identification
Override Default Package Name
Package Name
com.Fragilem17.PortalsForVRHexabody
Version*
1.08
Bundle Version Code
1
Minimum API Level
Android 6.0 'Marshmallow' (API level 23)
Target API Level
Automatic (highest installed)
Configuration
Scripting Backend
IL2CPP
Api Compatibility Level*
.NET Standard 2.1
C++ Compiler Configuration
Release
Use incremental GC
Assembly Version Validation (editor only)
Mute Other Audio Sources*

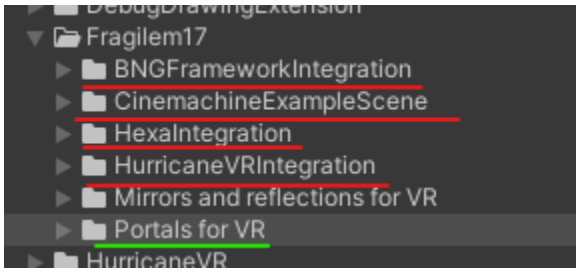

Mute Other Audio Sources*
Target Architectures
ARMv7
ARM64
x86 (Chrome OS)
x86-64 (Chrome OS)
Split APKs by target architecture (Experime
Target Devices
All Devices
Install Location
Prefer External
Internet Access
Auto
Write Permission
Internal
Filter Touches When Obscured
Sustained Performance Mode
Low Accuracy Location
Chrome OS Input Emulation
Android TV Compatibility
Warn about App Bundle size
App Bundle size threshold
150
Active Input Handling*
Both
Script Compilation
Scripting Define Symbols
List is Empty
Copy Defines
Revert
Apply
Additional Compiler Arguments
List is Empty
Revert
Apply
Suppress Common Warnings
Allow 'unsafe' Code
Use Deterministic Compilation
Enable Roslyn Analyzers
Optimization
Prebake Collision Meshes*
Keep Loaded Shaders Alive*
Preloaded Assets*
Strip Engine Code*
Managed Stripping Level
Minimal
Enable Internal Profiler* (Deprecated)
Vertex Compression*
Normal, Tangent, Tex Coord 0, Tex Coord 2, Tex
Optimize Mesh Data*
Texture MipMap Stripping*
Stack Trace*


Rendering
Renderer List
0 URP-Performant-Renderer (Universal Renderer Data)
Default
Depth Texture
Opaque Texture
Opaque Downsampling
2x Bilinear
Terrain Holes
Quality
HDR
Anti Aliasing (MSAA)
4x
Render Scale
1
Lighting
Main Light
Disabled
Cast Shadows
Shadow Resolution
1024
Additional Lights
Disabled
Per Object Limit
4
Cast Shadows
Shadow Atlas Resolution
512
Shadow Resolution Tiers
Low 128
Medium 256
High 512
Cookie Atlas Resolution
2048
Cookie Atlas Format
Color High
Reflection Probes
Probe Blending
Box Projection
Shadows
Max Distance
2
Working Unit
Metric
Cascade Count
1
Last Border
0.2
0
1.8m
0→Fallback
0.2m
Depth Bias
1
Normal Bias
1
Soft Shadows
Post-processing
Grading Mode
Low Dynamic Range
LUT size
16
Fast sRGB/Linear conversions


URP-Performant-Renderer (Universal Renderer Data)
Open
Filtering
Opaque Layer Mask
Everything
Transparent Layer Mask
Everything
Rendering
Rendering Path
Forward
Depth Priming Mode
Auto
On Android, iOS, and Apple TV, Unity performs depth priming only in the Forced mode. On tiled GPUs, which are common to those platforms, depth priming might reduce performance when combined with MSAA.
RenderPass
Native RenderPass
Shadows
Transparent Receive Shadows
Post-processing
Enabled
Data
None (Post Process Data)
Overrides
Stencil
Compatibility
Intermediate Texture
Auto
Renderer Features
No Renderer Features added
Add Renderer Feature

# BNG VRIF & Hurricane

Both VRIF and Hurricane have an example scene contained in a zip. **Unzip** the files in a folder **above** the “Portals for VR” folder. (Otherwise because of the assembly definition file the BNG or Hurricane files won’t be found)




For the Hurricane Integration to portal smoothly you need **version 2.91 of Hurricane** and up.

Basic Hexabody integration is implemented and compatible with **version 1.44a** of Hexabody

**Hurricanes integration currently does not support scaling the player by going through differently sized portals.**

The example scenes contain elements only available when you purchase Hurricane or BNG. These assets contain materials that are not set to URP, you can convert them to URP using Unity’s built in converter. Some materials should use the CutoffShaderForClonedPortables Shaders if you want the clipping to work. Don’t forget to check the Alpha Clipping checkbox. Should your object disappear, check the alpha on the color of the material.

# Thanks!

If you have any questions, don't hesitate to send me a mail at

Fragilem17@gmail.com

I hope you create beautiful things with this and don't forget. Framerate is life! Kill your darlings and if you can't hit framerate it's better to not use it.

I've spent an **enormous** amount of personal time creating this so thanks for your support in buying and not pirating this asset! It is very much appreciated.

Tom