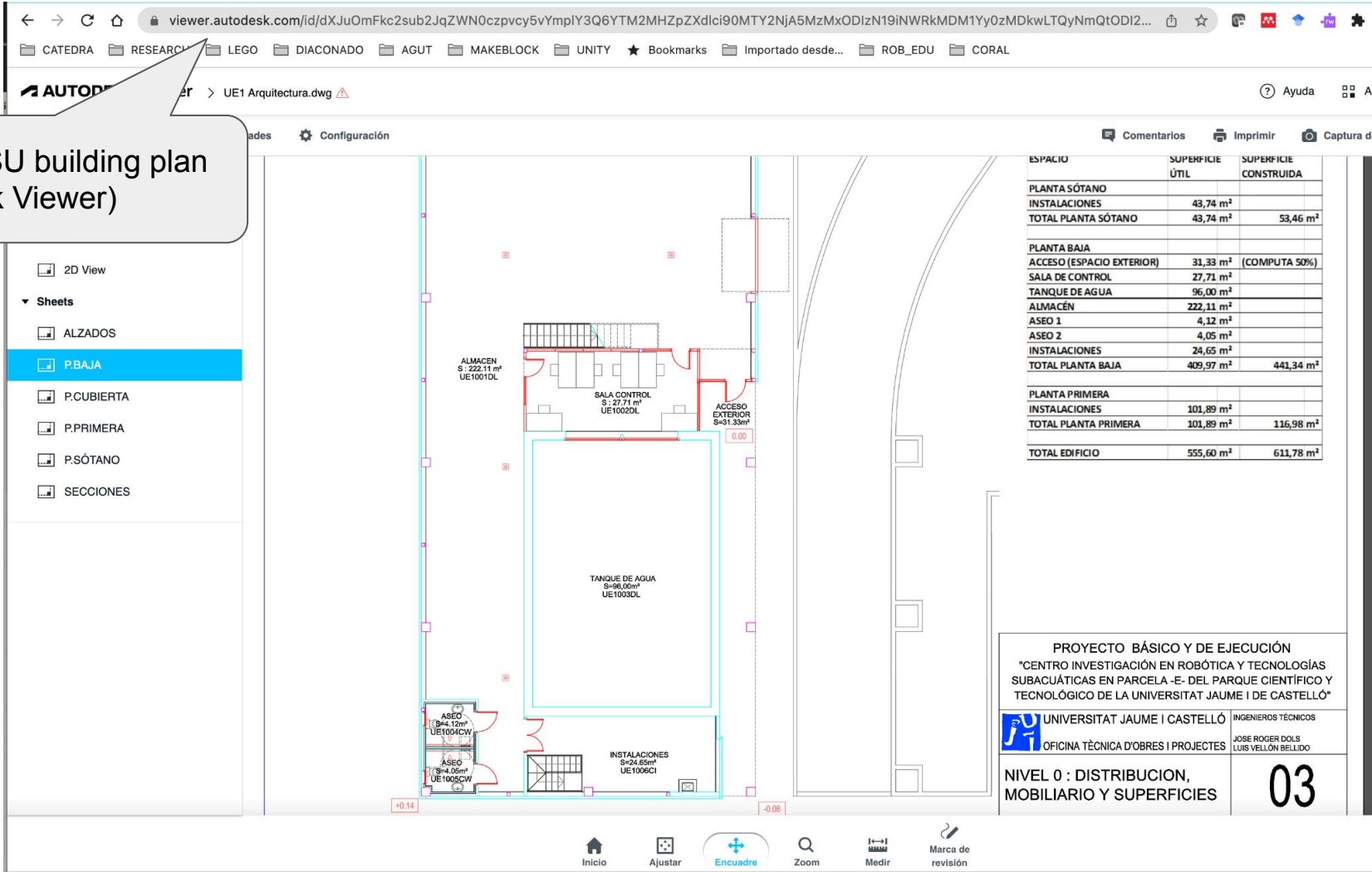
UNITY FOR ROBOTICS

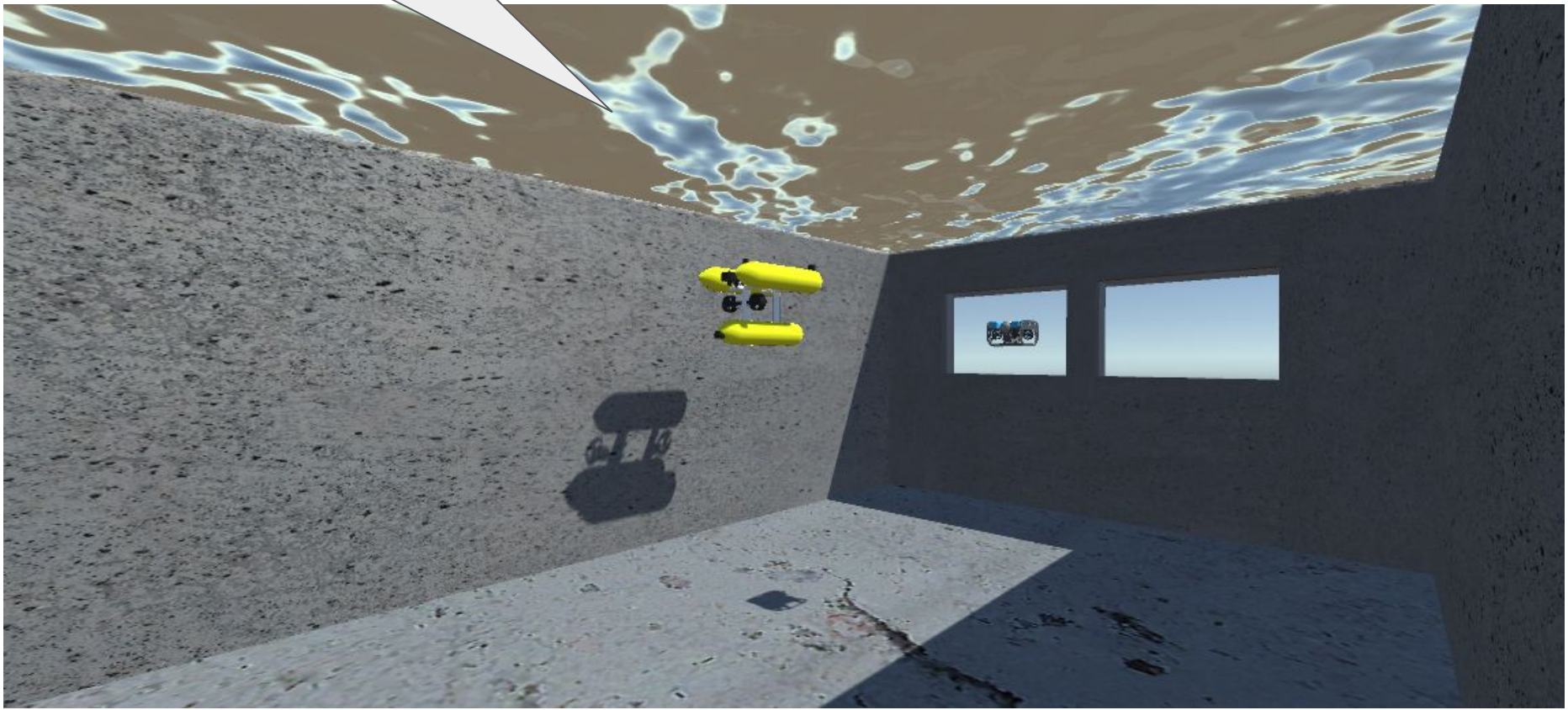
CHAPTER 6: Exercise Scenario CIRTESU

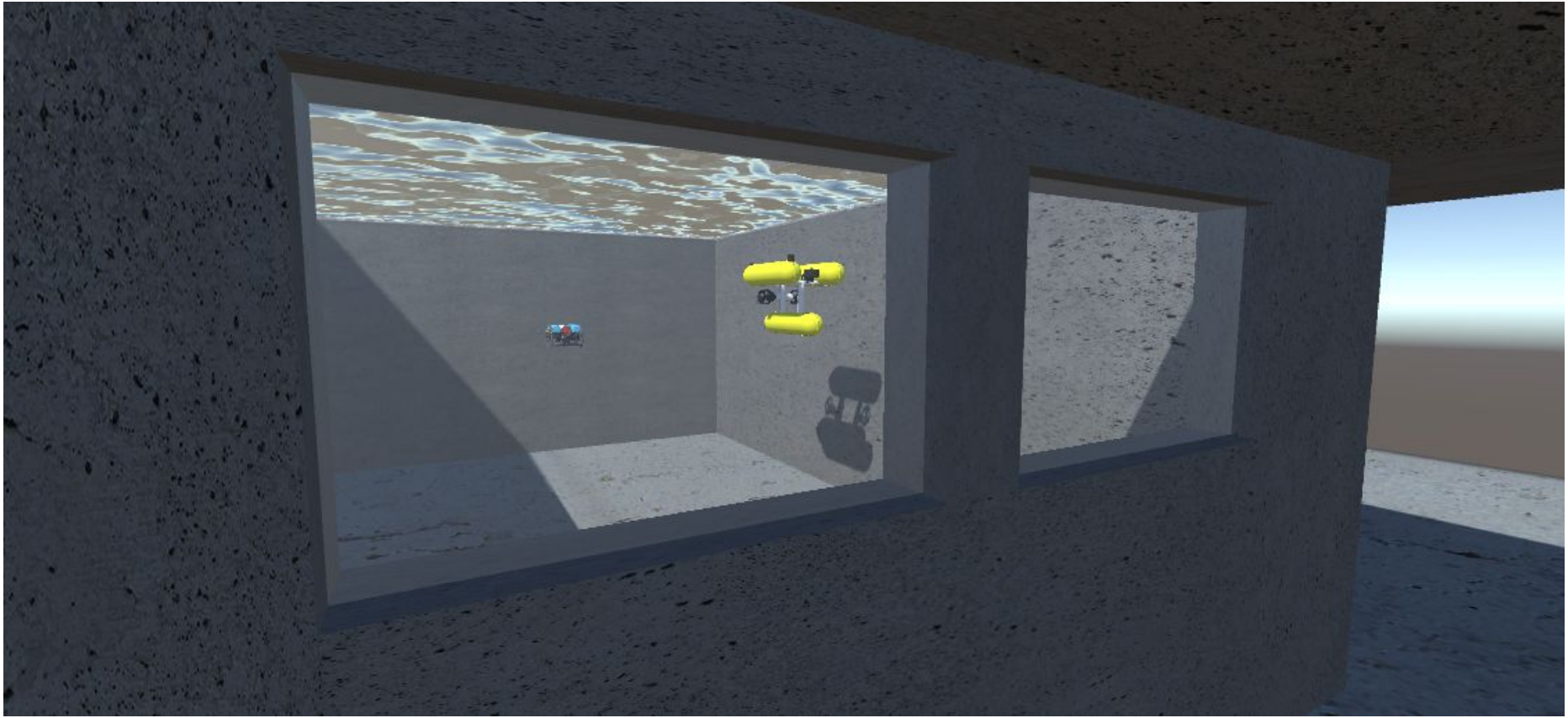
Raúl Marín Prades

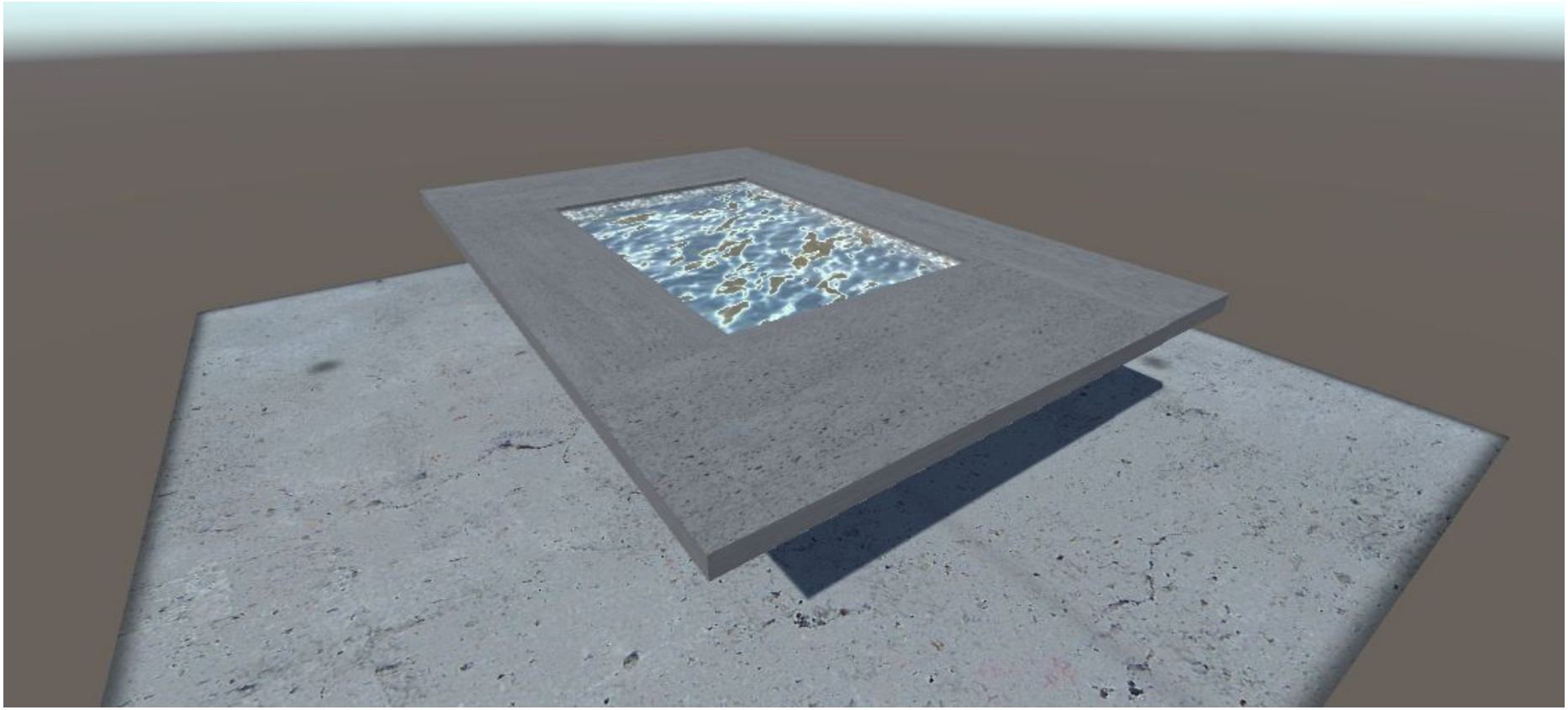
Open CIRTESU building plan
(e.g. Autodesk Viewer)



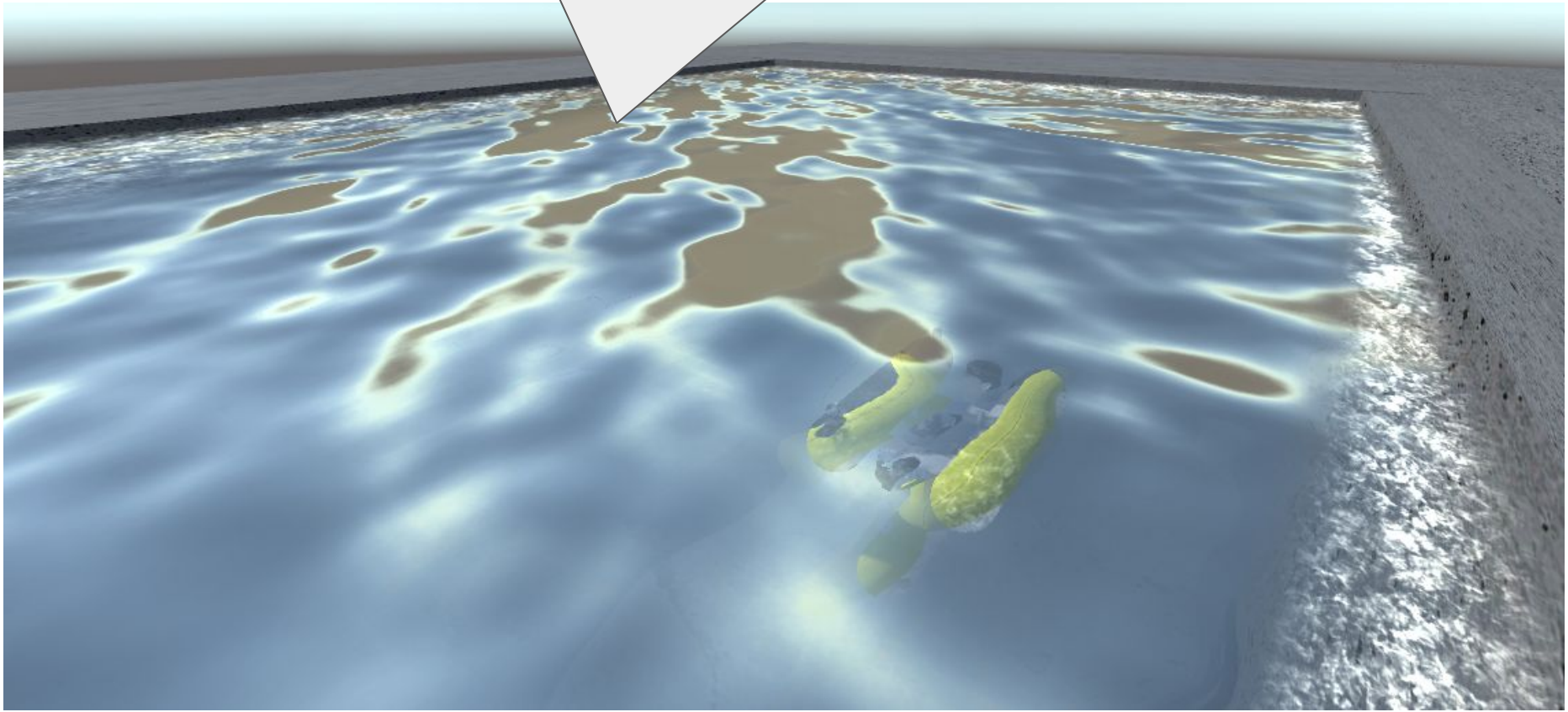
Create Unity Scene using Unity Blocks, OnShape, etc. Use Asset Store for concrete materials



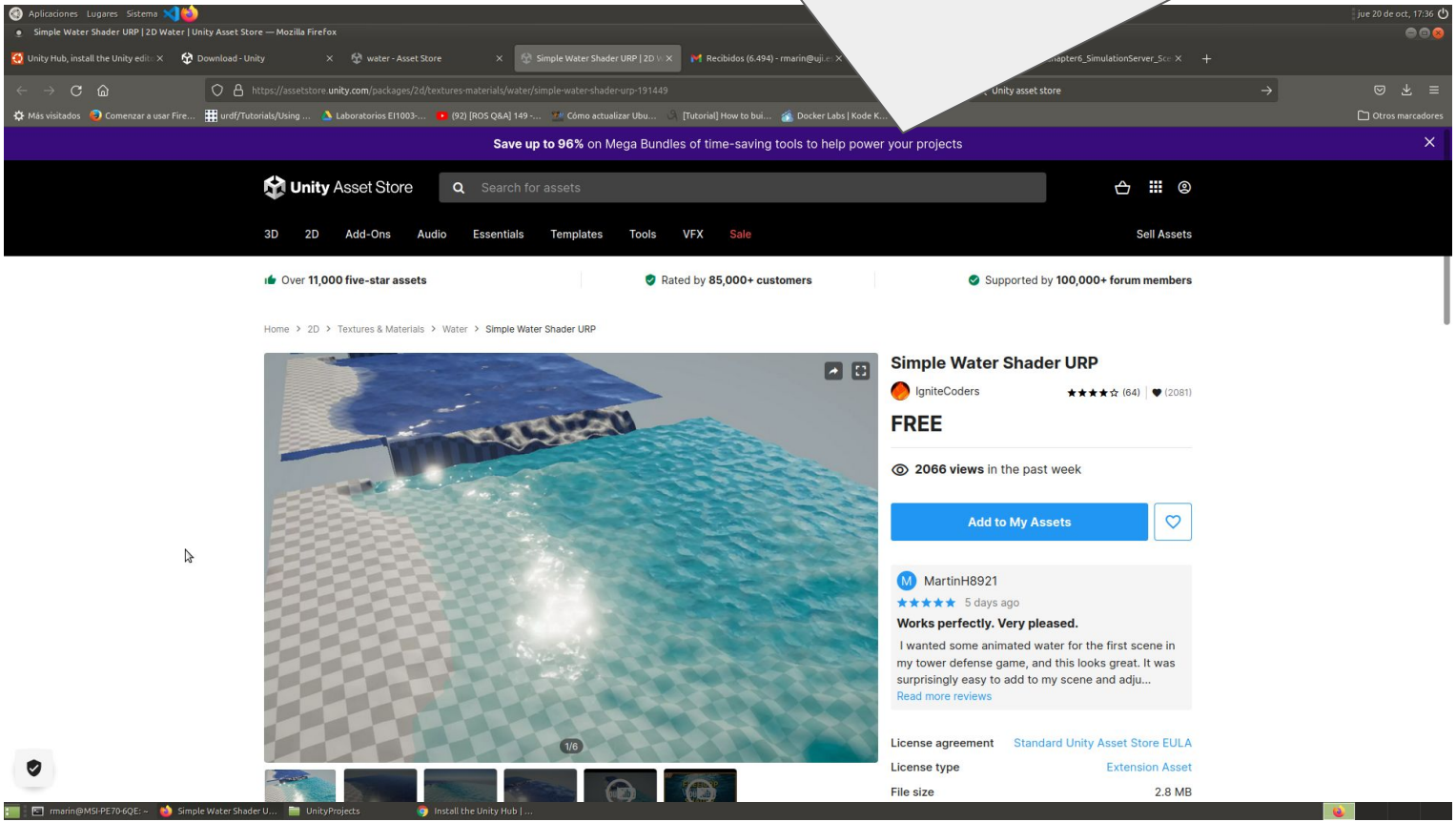


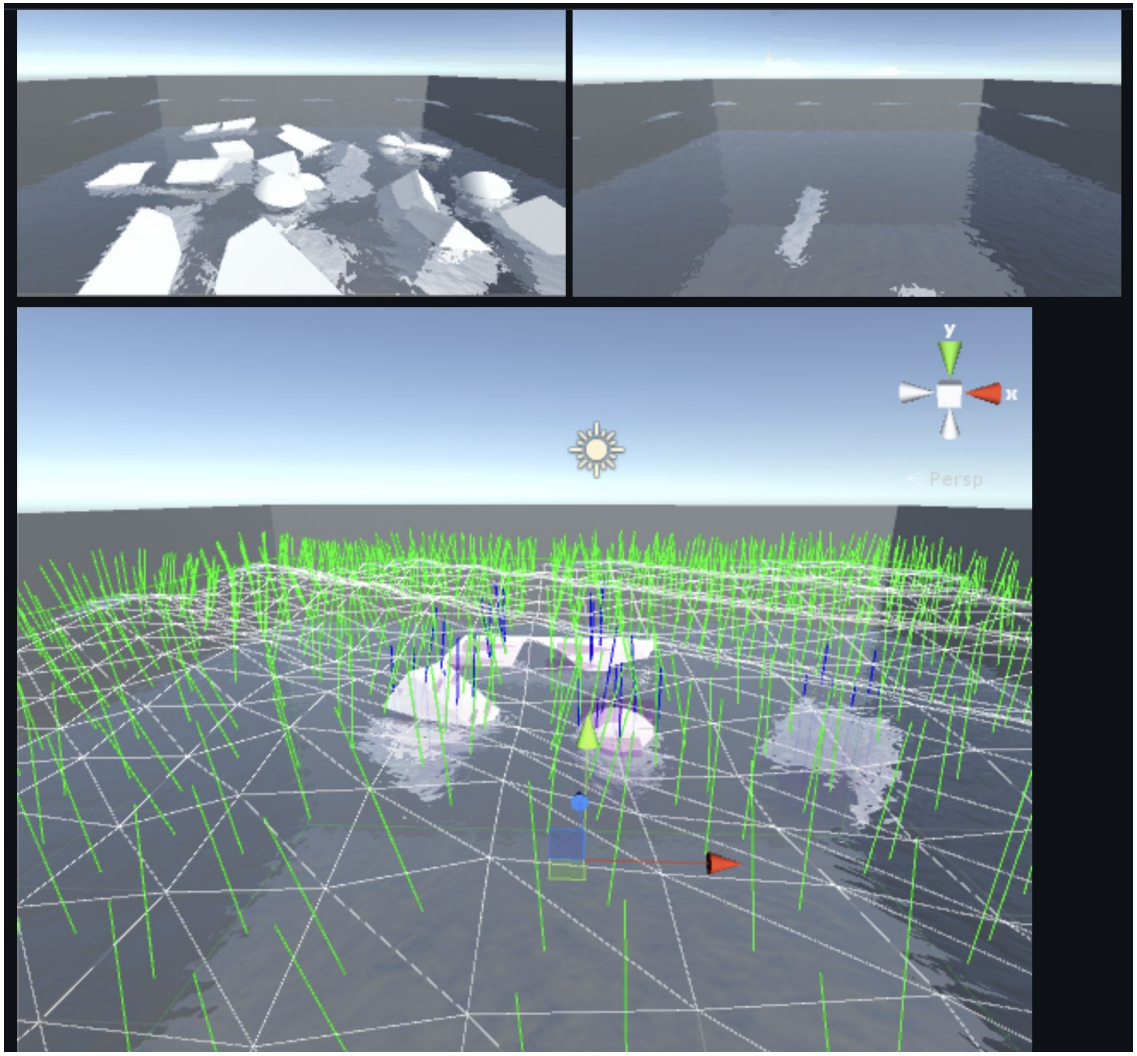


Study Water Plane Options (e.g. Aquas, Gaia, HDRP 2022)



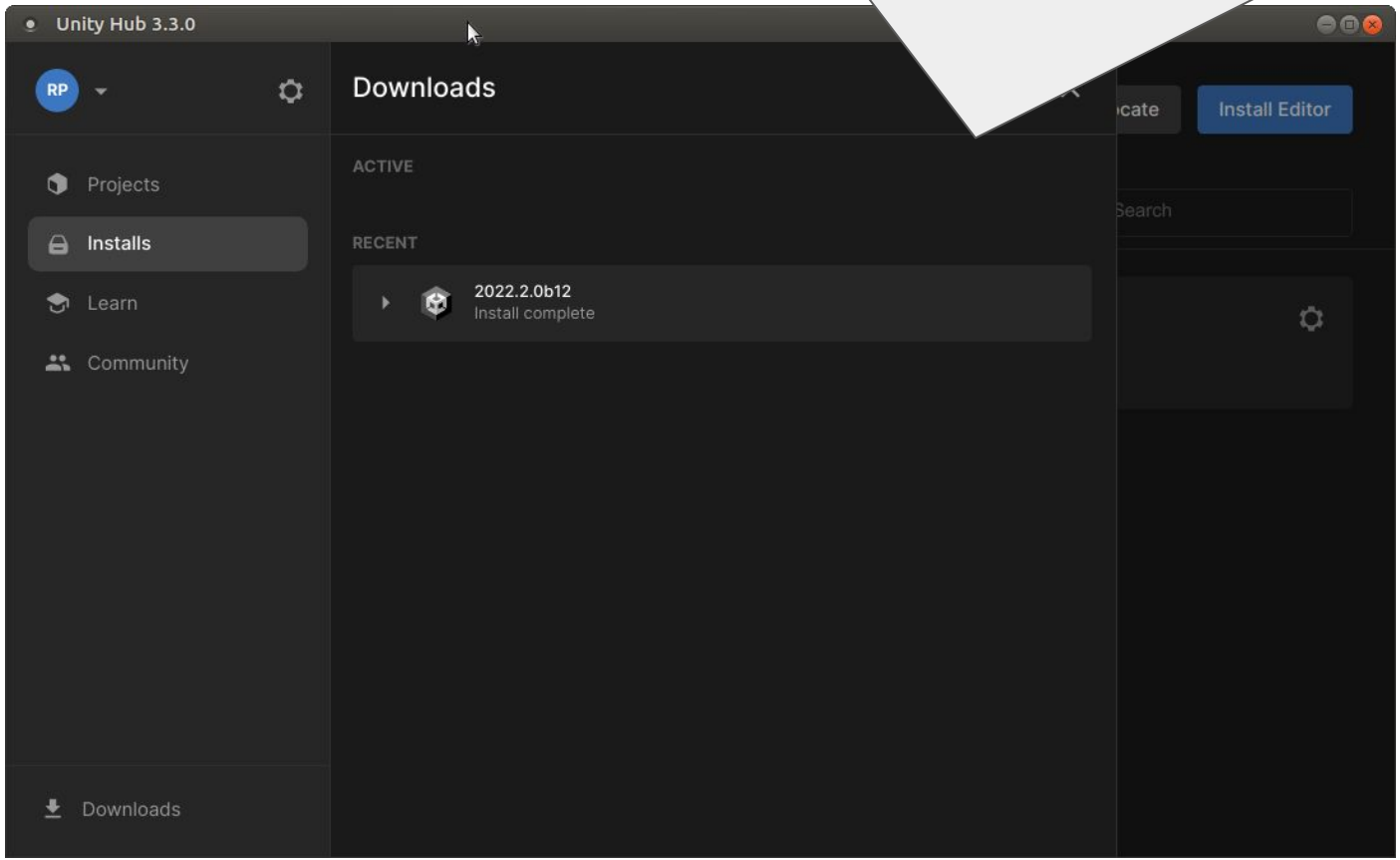
https://assetstore.unity.com/packages/2d/textures-materials/water/simple-water-shader-urp-191449



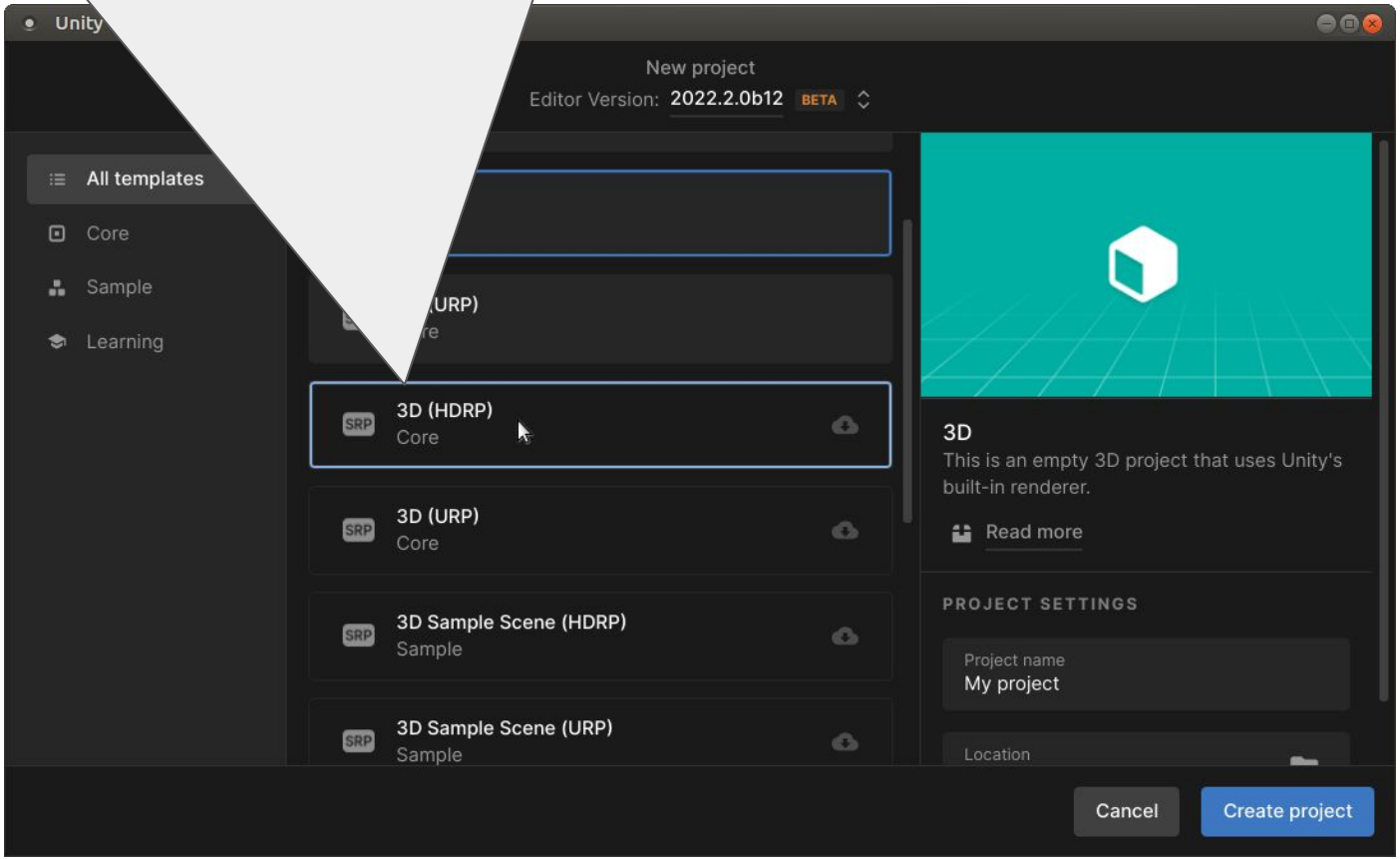


https://github.com/dbrizov/NaughtyWaterBuoyancy
Tutorial:
https://www.youtube.com/watch?v=KKXZ3860o7w

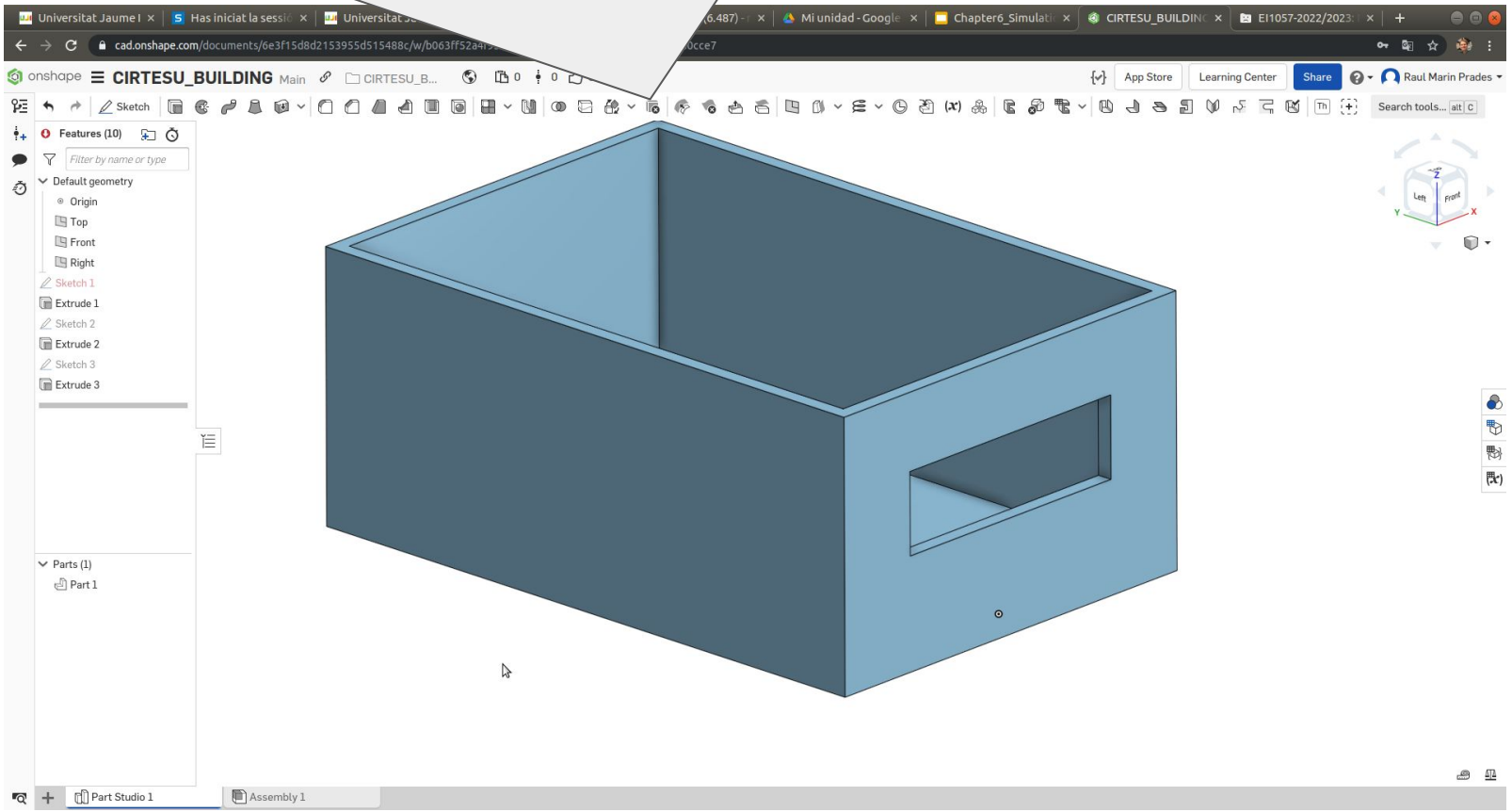
Run Unity Hub and Install Unity editor more recent than 2022.2.0b8



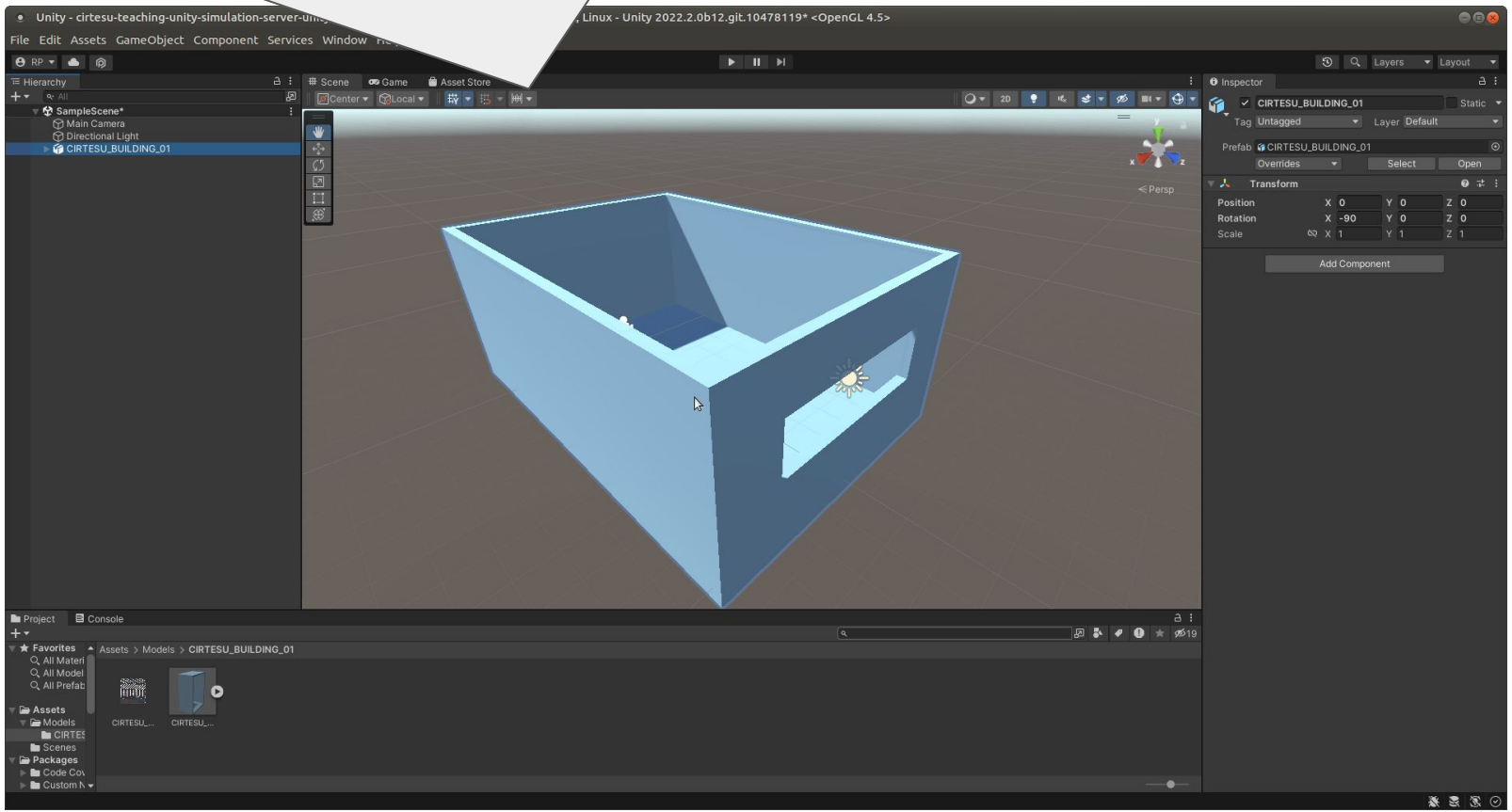
Creat new 3D HDRP Project (contains Water Plane)



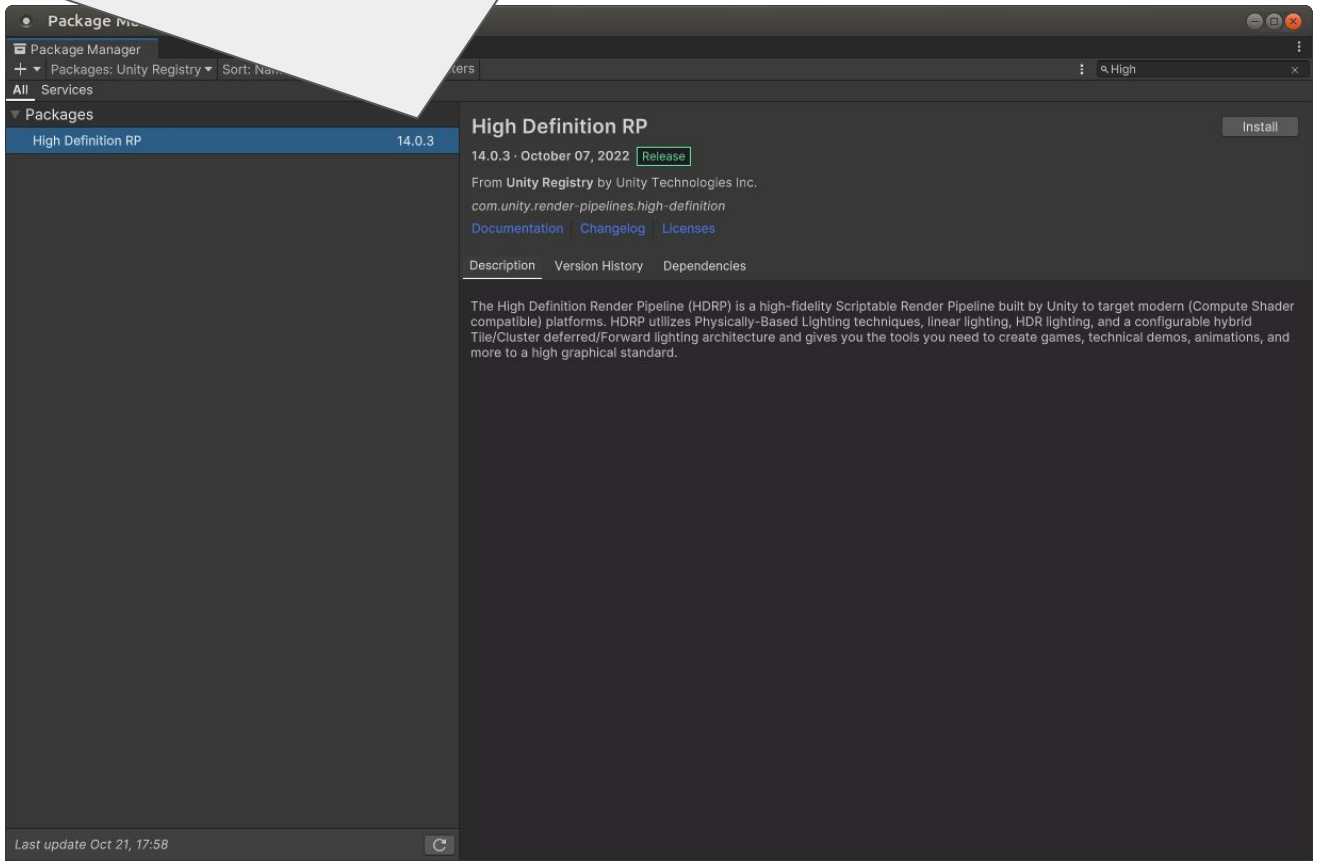
Desing with Unity or a 3D Designer tool (e.g. Onshape) the pool scene, and import it to the Unity Scene



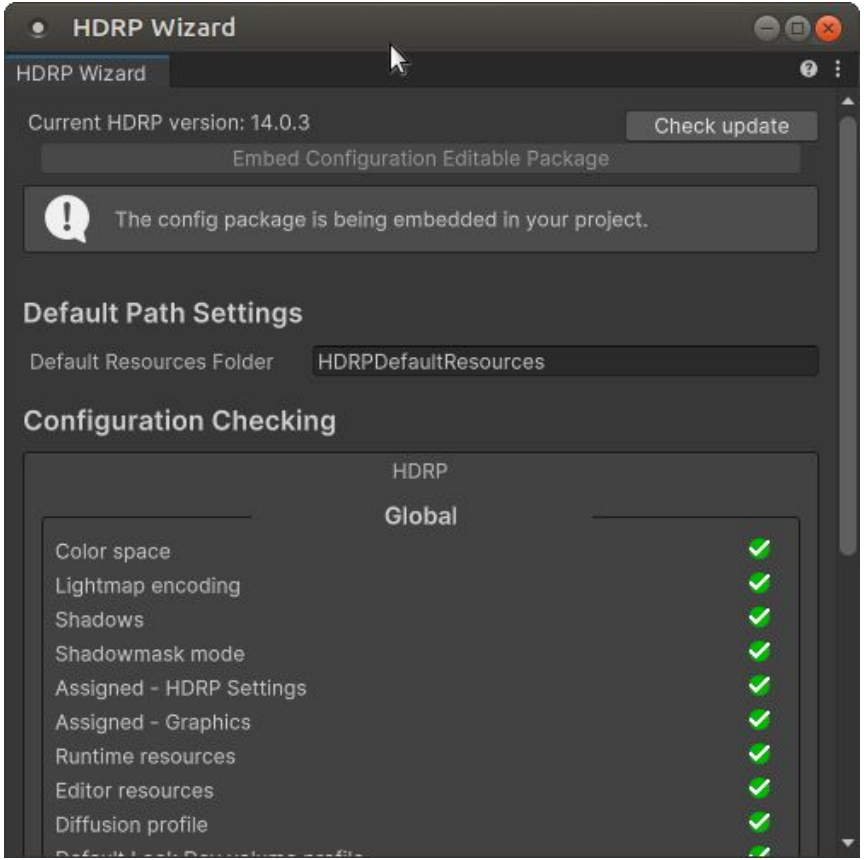
Import model (e.g. obj) to Unity by copying the file in the Assets folder and drag it to the hierarchy window

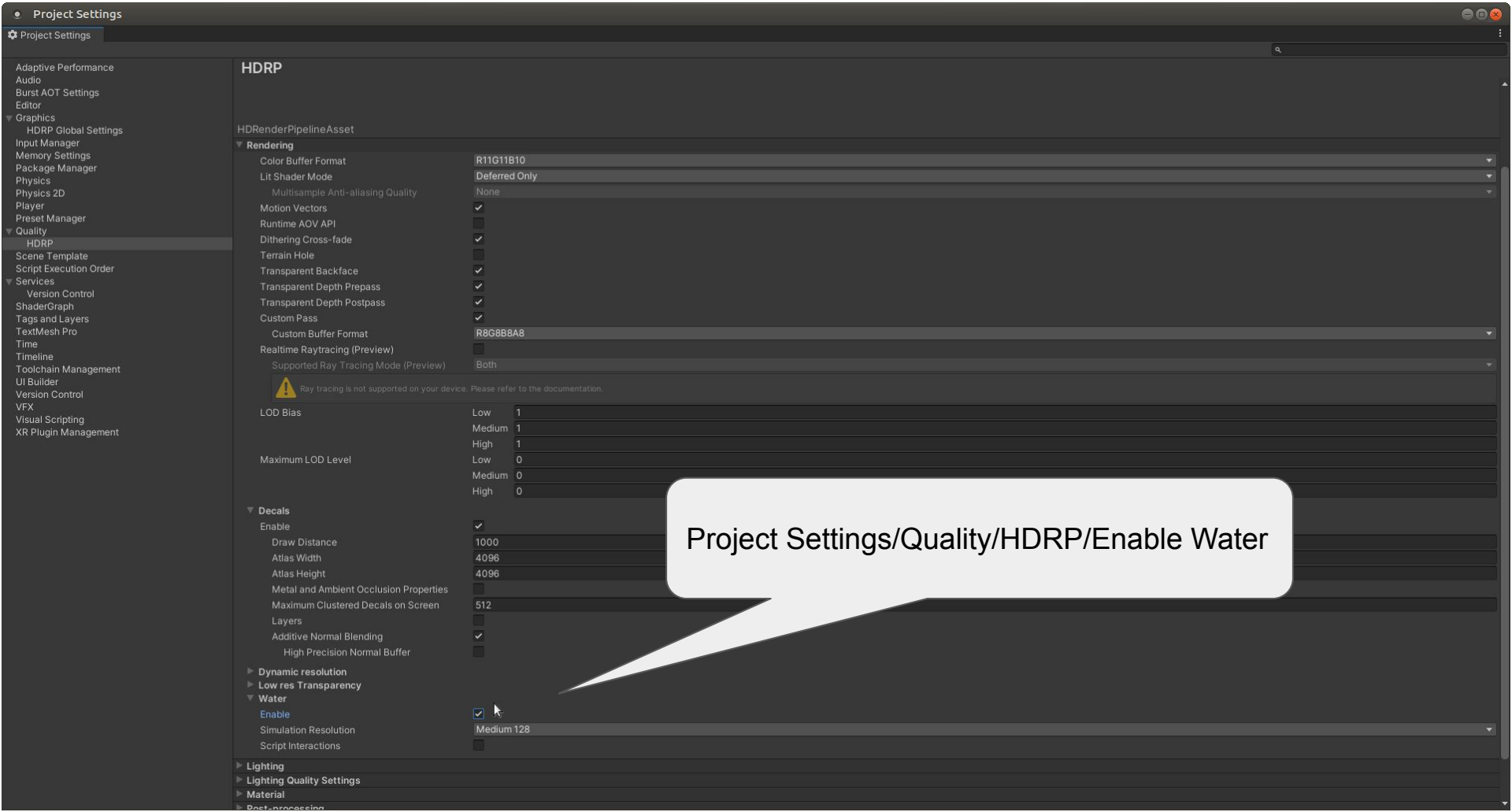


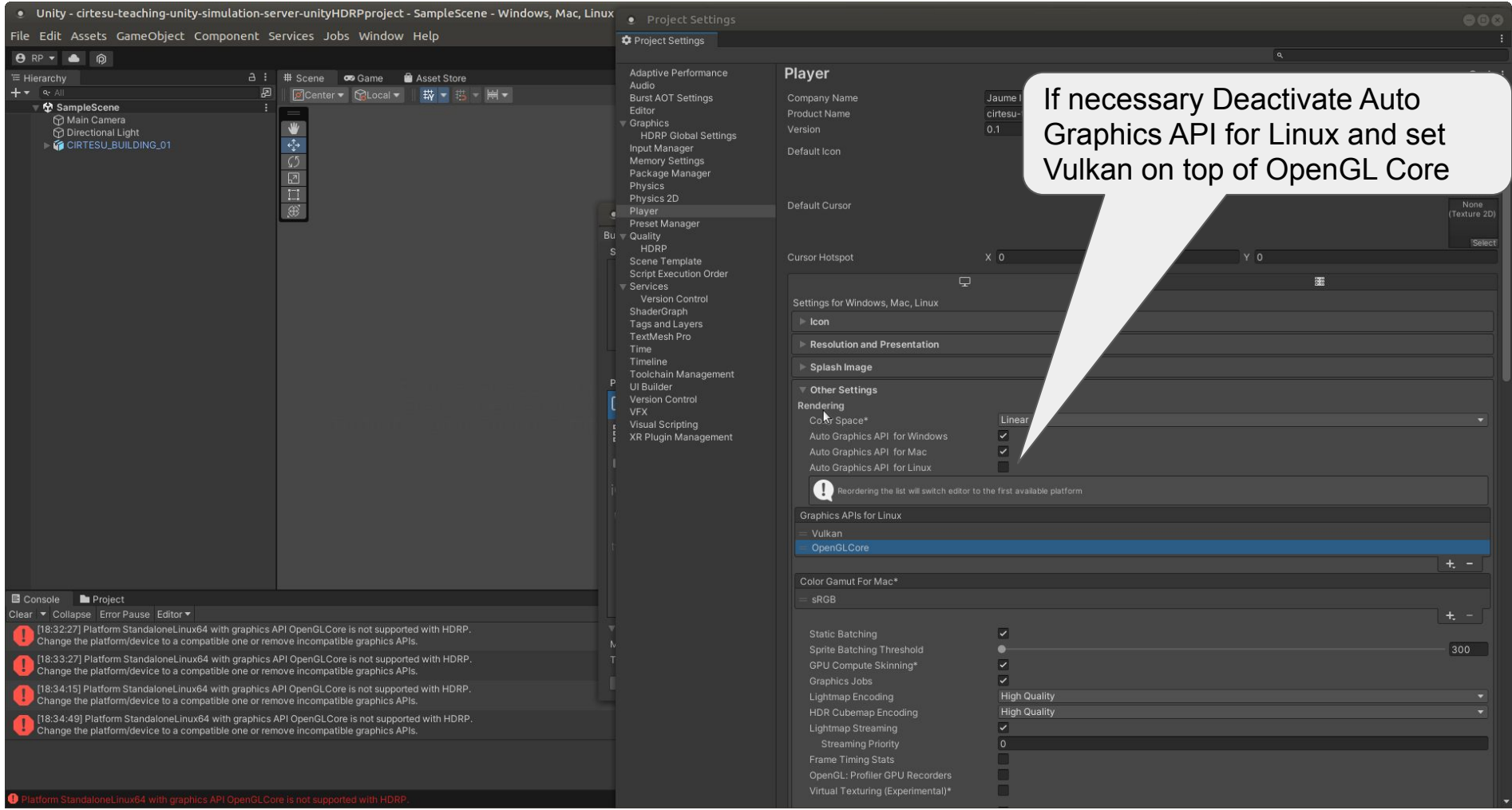
Make sure the High Definition Rendering Pipeline Asset is installed



Review the HDRP Wizard Status and Fix problems




Project Settings
Project Settings
Adaptive Performance
Audio
Burst AOT Settings
Editor
Graphics
HDRP Global Settings
Input Manager
Memory Settings
Package Manager
Physics
Physics 2D
Player
Preset Manager
Quality
HDRP
Scene Template
Script Execution Order
Services
Version Control
ShaderGraph
Tags and Layers
TextMesh Pro
Time
Timeline
Toolchain Management
UI Builder
Version Control
VFX
Visual Scripting
XR Plugin Management
HDRP
HDRenderPipelineAsset
Rendering
Color Buffer Format
R11G11B10
Lit Shader Mode
Deferred Only
Multisample Anti-aliasing Quality
None
Motion Vectors
Runtime AOV API
Dithering Cross-fade
Terrain Hole
Transparent Backface
Transparent Depth Prepass
Transparent Depth Postpass
Custom Pass
Custom Buffer Format
R8G8B8A8
Realtime Raytracing (Preview)
Supported Ray Tracing Mode (Preview)
Both
Ray tracing is not supported on your device. Please refer to the documentation.
LOD Bias
Low 1
Medium 1
High 1
Maximum LOD Level
Low 0
Medium 0
High 0
Decals
Enable
Draw Distance
1000
Atlas Width
4096
Atlas Height
4096
Metal and Ambient Occlusion Properties
Maximum Clustered Decals on Screen
512
Layers
Additive Normal Blending
High Precision Normal Buffer
Dynamic resolution
Low res Transparency
Water
Enable
Simulation Resolution
Medium 128
Script Interactions
Lighting
Lighting Quality Settings
Material
Post-processing
Project Settings/Quality/HDRP/Enable Water


Unity - cirtesu-teaching-unity-simulation-server-unityHDRPproject - SampleScene - Windows, Mac, Linux
File Edit Assets GameObject Component Services Jobs Window Help
Hierarchy
SampleScene
Main Camera
Directional Light
CIRTESU_BUILDING_01
Scene
Game
Asset Store
Console
Project
Clear Collapse Error Pause Editor
[18:32:27] Platform StandaloneLinux64 with graphics API OpenGLCore is not supported with HDRP.
Change the platform/device to a compatible one or remove incompatible graphics APIs.
[18:33:27] Platform StandaloneLinux64 with graphics API OpenGLCore is not supported with HDRP.
Change the platform/device to a compatible one or remove incompatible graphics APIs.
[18:34:15] Platform StandaloneLinux64 with graphics API OpenGLCore is not supported with HDRP.
Change the platform/device to a compatible one or remove incompatible graphics APIs.
[18:34:49] Platform StandaloneLinux64 with graphics API OpenGLCore is not supported with HDRP.
Change the platform/device to a compatible one or remove incompatible graphics APIs.
Platform StandaloneLinux64 with graphics API OpenGLCore is not supported with HDRP.
Project Settings
Adaptive Performance
Audio
Burst AOT Settings
Editor
Graphics
HDRP Global Settings
Input Manager
Memory Settings
Package Manager
Physics
Physics 2D
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Quality
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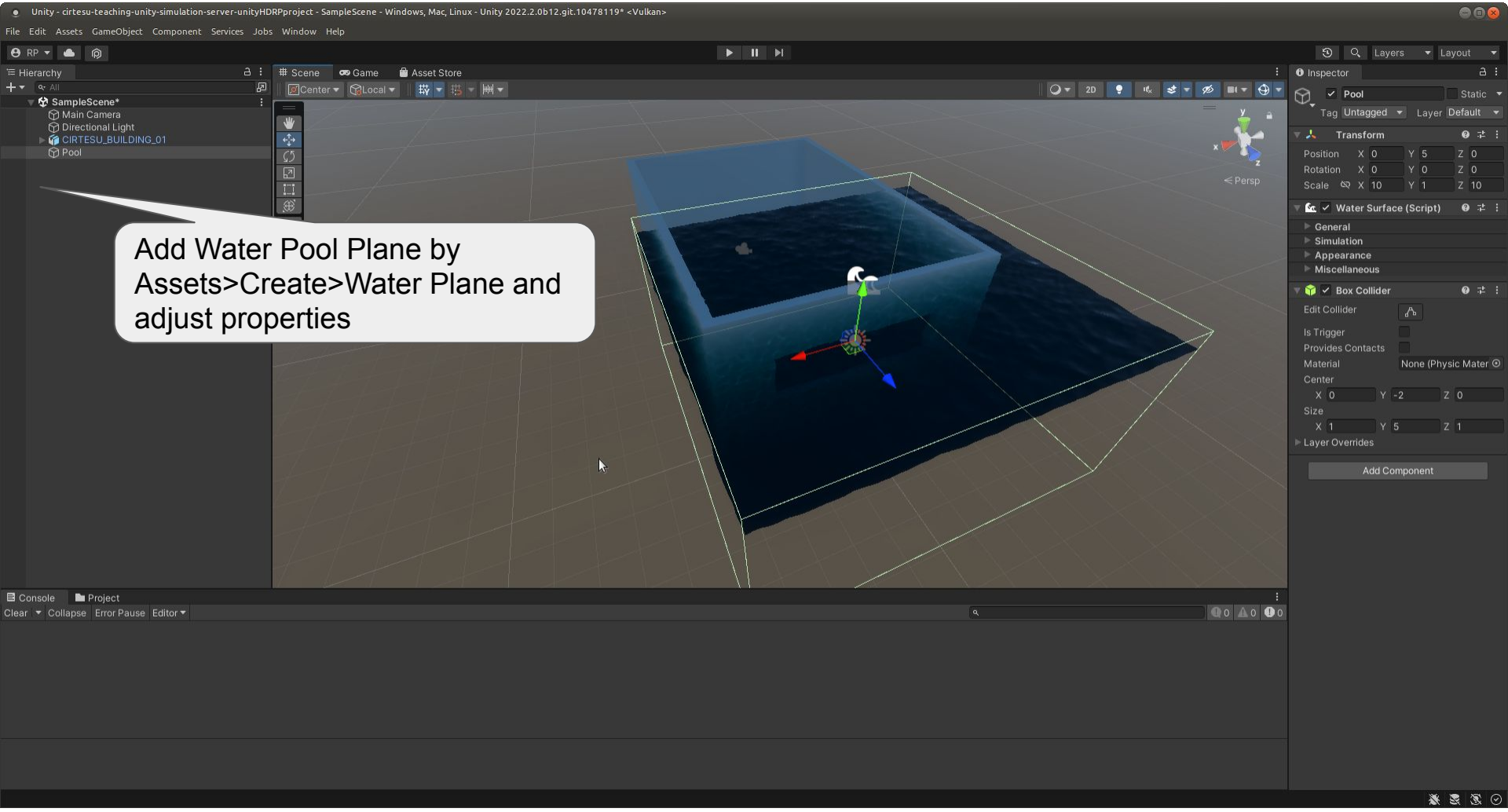
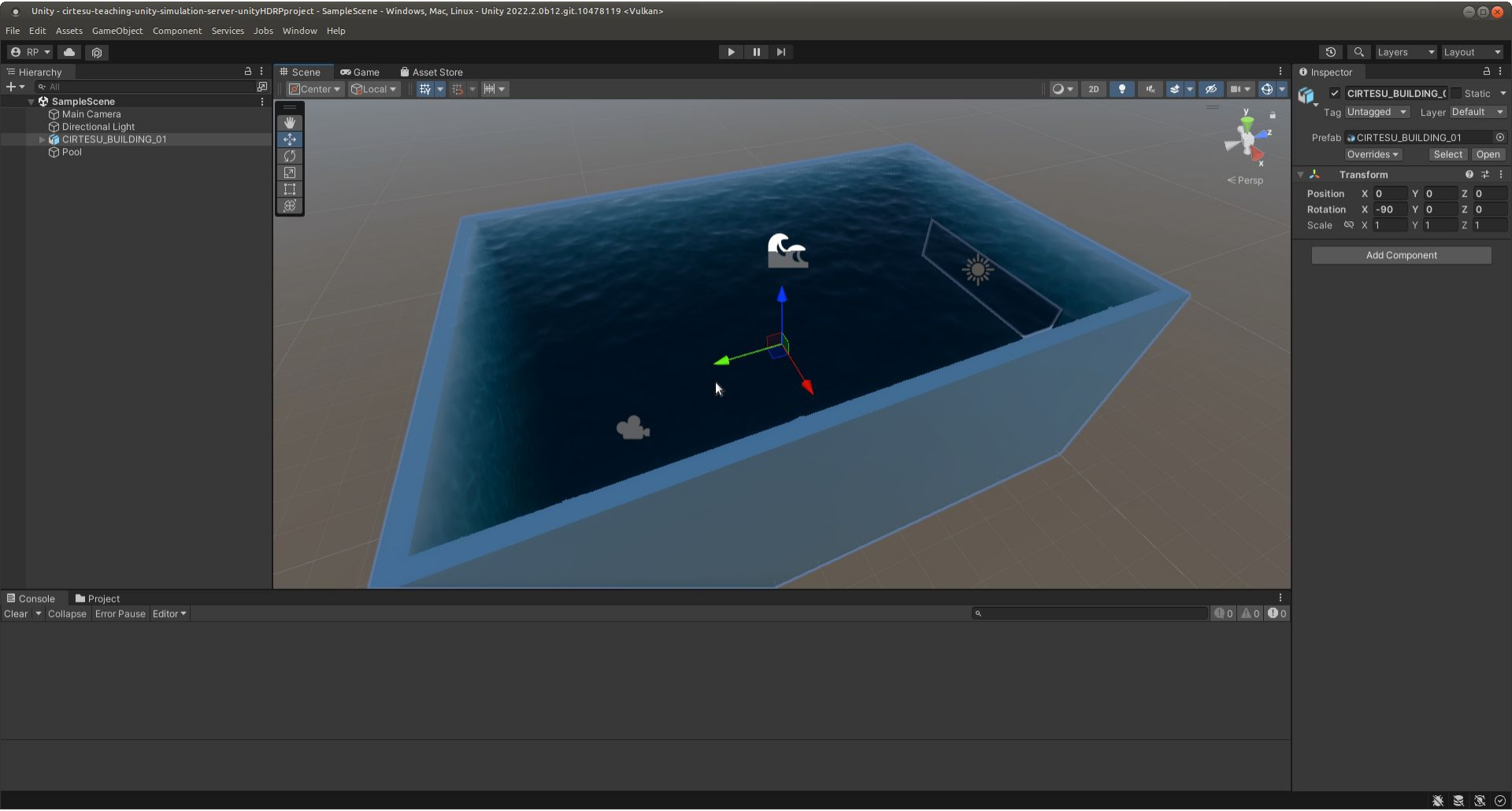
Toolchain Management
UI Builder
Version Control
VFX
Visual Scripting
XR Plugin Management
Player
Company Name
Product Name
Version
Default Icon
Default Cursor
Cursor Hotspot
Settings for Windows, Mac, Linux
Icon
Resolution and Presentation
Splash Image
Other Settings
Rendering
Color Space*
Auto Graphics API for Windows
Auto Graphics API for Mac
Auto Graphics API for Linux
Reordering the list will switch editor to the first available platform
Graphics APIs for Linux
Vulkan
OpenGLCore
Color Gamut For Mac*
sRGB
Static Batching
Sprite Batching Threshold
GPU Compute Skinning*
Graphics Jobs
Lightmap Encoding
HDR Cubemap Encoding
Lightmap Streaming
Streaming Priority
Frame Timing Stats
OpenGL: Profiler GPU Recorders
Virtual Texturing (Experimental)*
If necessary Deactivate Auto Graphics API for Linux and set Vulkan on top of OpenGL Core


Unity - cirtesu-teaching-unity-simulation-server-unityHDRPproject - SampleScene - Windows, Mac, Linux - Unity 2022.2.0b12.git.10478119* <Vulkan>
File Edit Assets GameObject Component Services Jobs Window Help
Hierarchy
SampleScene*
Main Camera
Directional Light
CIRTESU_BUILDING_01
Pool
Scene
Game
Asset Store
Persp
Add Water Pool Plane by Assets>Create>Water Plane and adjust properties
Inspector
Pool
Static
Tag Untagged
Layer Default
Transform
Position X 0 Y 5 Z 0
Rotation X 0 Y 0 Z 0
Scale X 10 Y 1 Z 10
Water Surface (Script)
General
Simulation
Appearance
Miscellaneous
Box Collider
Edit Collider
Is Trigger
Provides Contacts
Material None (Physic Mater
Center
X 0 Y -2 Z 0
Size
X 1 Y 5 Z 1
Layer Overrides
Add Component
Console
Project
Clear Collapse Error Pause Editor


Unity - cirtesu-teaching-unity-simulation-server-unityHDRPproject - SampleScene - Windows, Mac, Linux - Unity 2022.2.0b12.git.10478119 <Vulkan>
File Edit Assets GameObject Component Services Jobs Window Help
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Layout
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SampleScene
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Scene
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CIRTESU_BUILDING_(
Static
Tag Untagged
Layer Default
Prefab CIRTESU_BUILDING_01
Overrides
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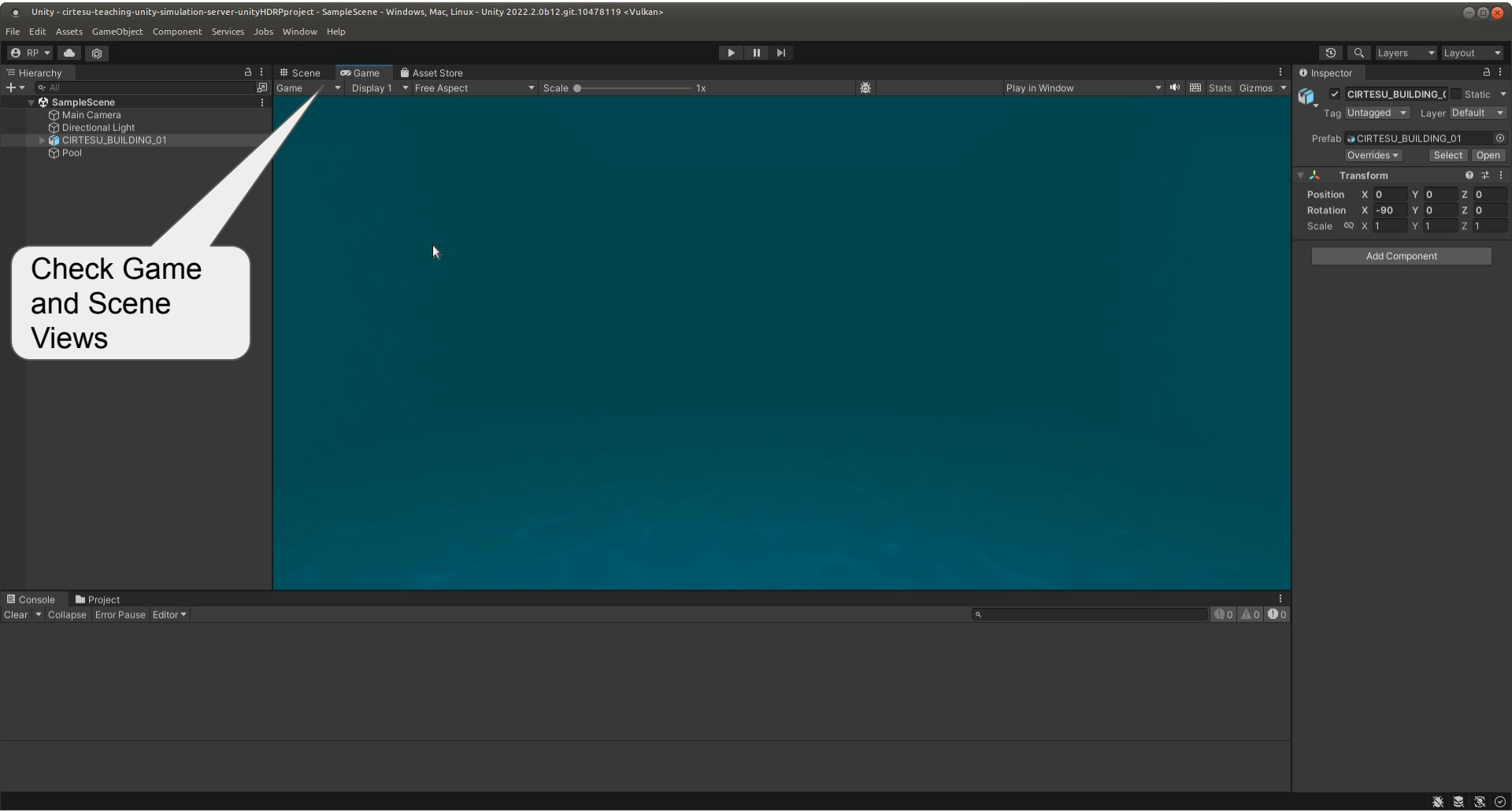
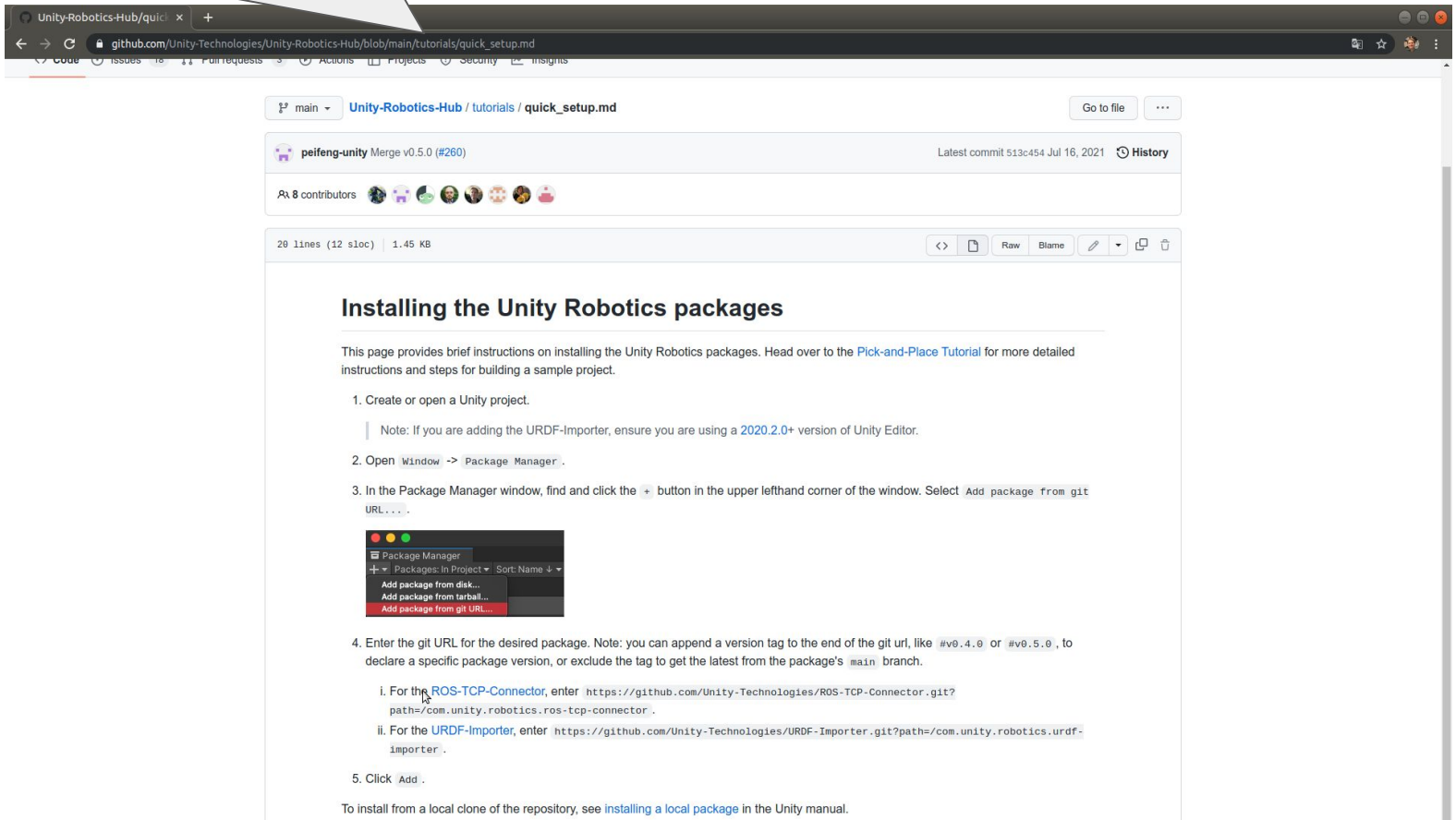
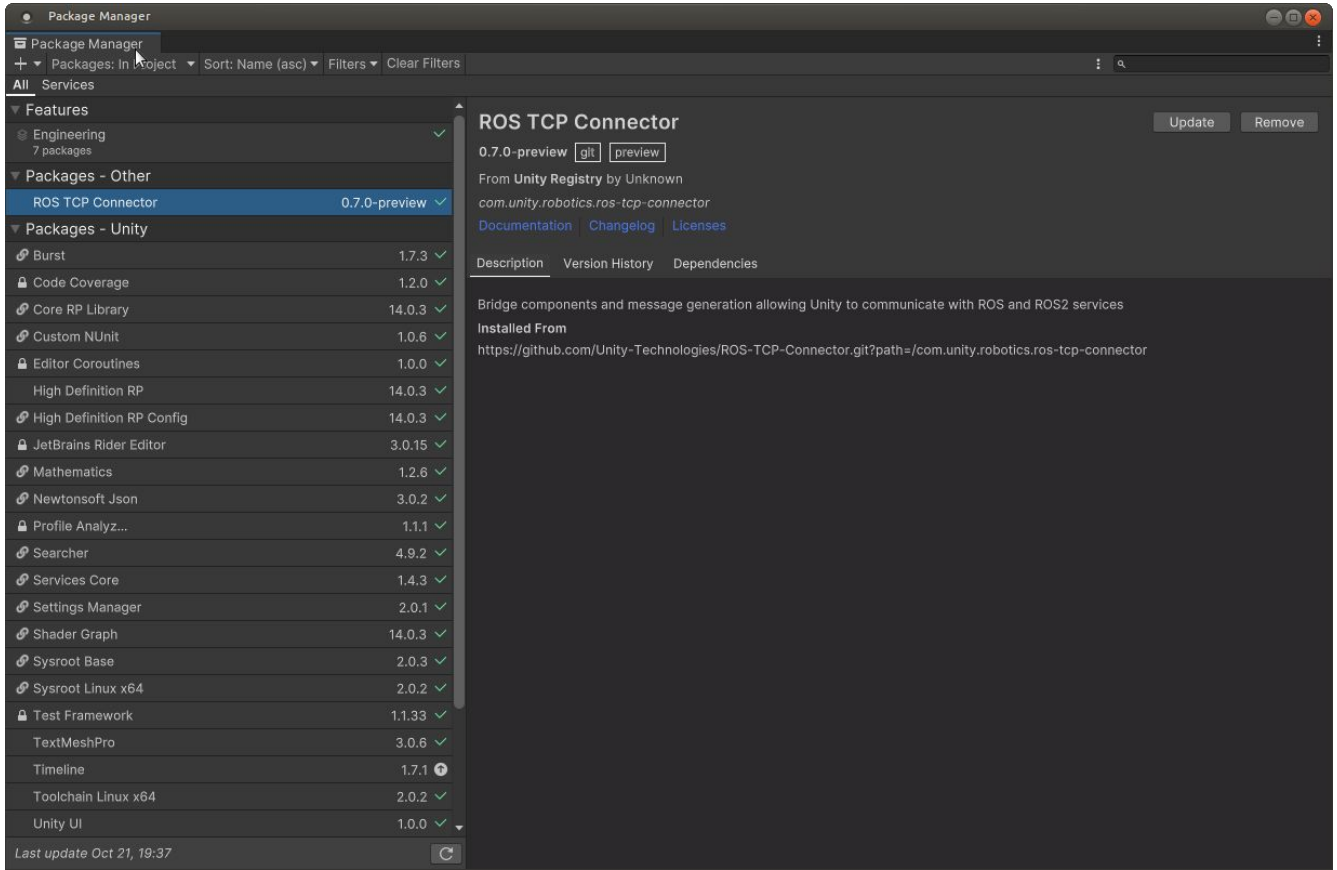
Rotation X -90 Y 0 Z 0
Scale X 1 Y 1 Z 1
Add Component
Console
Project
Clear
Collapse
Error Pause
Editor


Unity - cirtesu-teaching-unity-simulation-server-unityHDRPproject - SampleScene - Windows, Mac, Linux - Unity 2022.2.0b12.git.10478119 <Vulkan>
File Edit Assets GameObject Component Services Jobs Window Help
RP
Layers
Layout
Hierarchy
All
SampleScene
Main Camera
Directional Light
CIRTESU_BUILDING_01
Pool
Scene
Game
Asset Store
Game
Display 1
Free Aspect
Scale
1x
Play in Window
Stats
Gizmos
Inspector
CIRTESU_BUILDING_(
Static
Tag
Untagged
Layer
Default
Prefab
CIRTESU_BUILDING_01
Overrides
Select
Open
Transform
Position
X 0
Y 0
Z 0
Rotation
X -90
Y 0
Z 0
Scale
X 1
Y 1
Z 1
Add Component
Check Game and Scene Views
Console
Project
Clear
Collapse
Error Pause
Editor

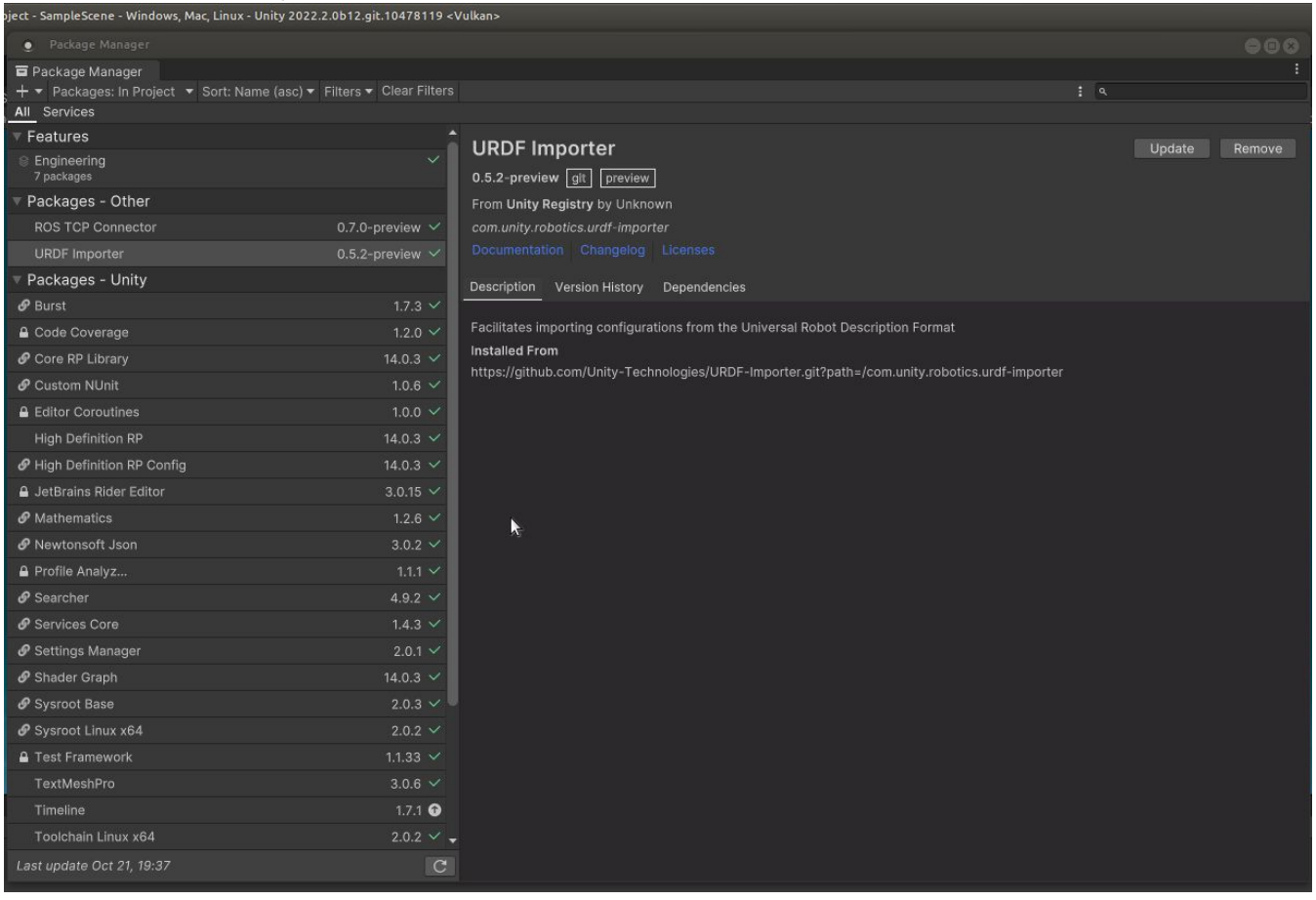
https://github.com/Unity-Technologies/Unity-Robotics-Hub/blob/main/tutorials/quick_setup.md



Install ROS TCP Connector
https://github.com/Unity-Technologies/ROS-TCP-Connector.git?path=/com.unity.robotics.ros-tcp-connector



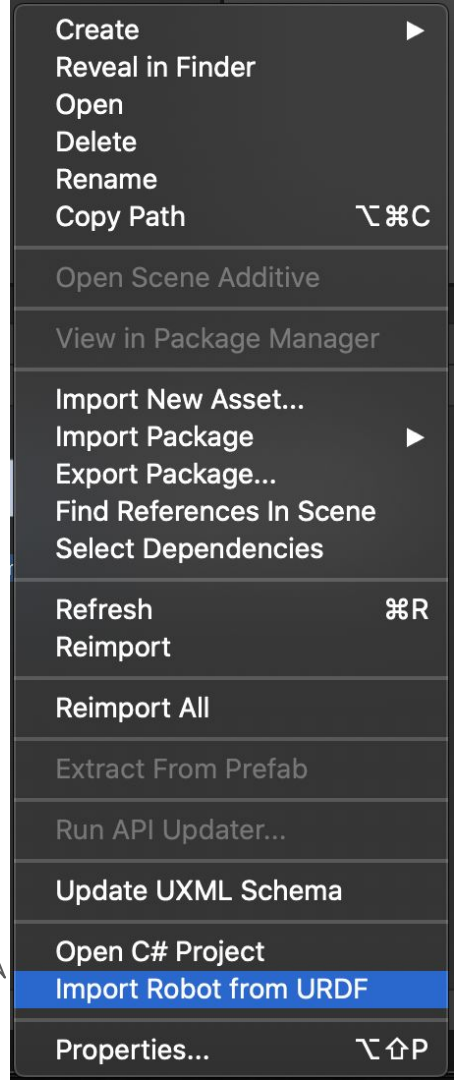
Install ROS URDF Importer



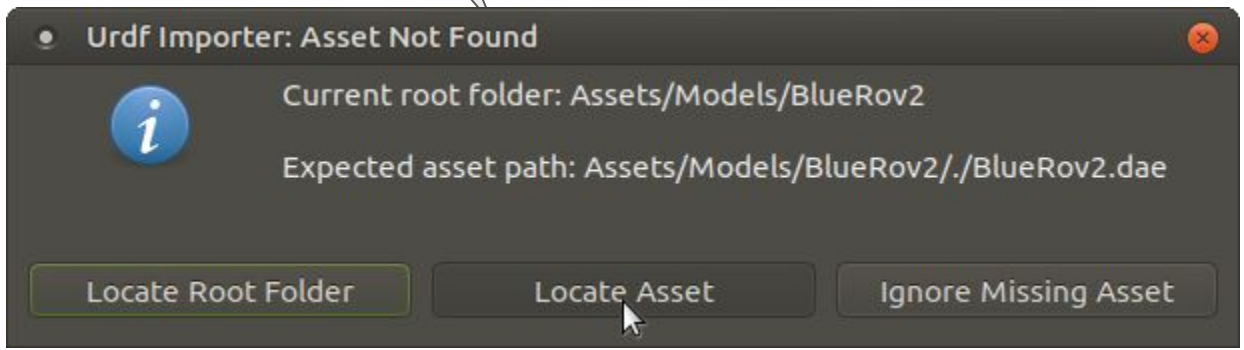
Download Bluerov URDF Xacro File from bluerov_ros_playground repository and use xacro tool to get the URDF file. Copy the .dae and urdf files in Assets/Models directory.

https://github.com/patrickelectric/bluerov_ros_playground/tree/master/model

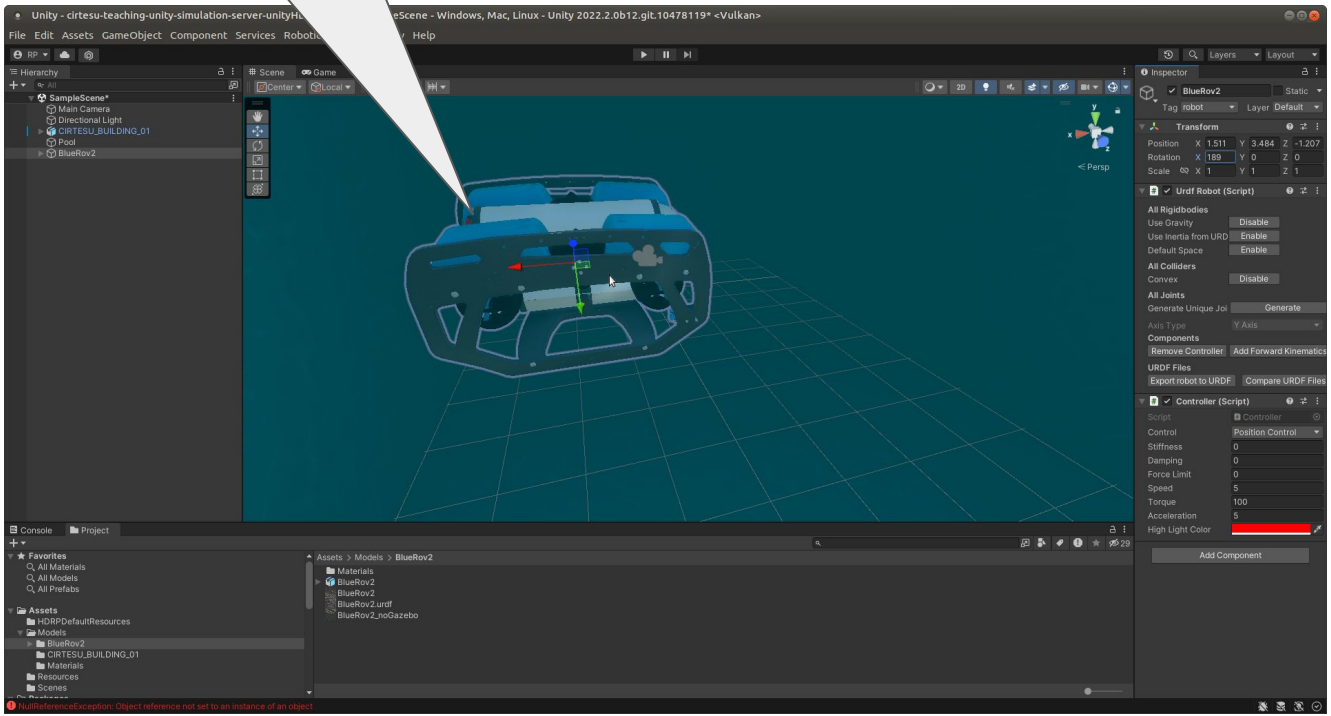
In Unity, Project Window, Right-click the URDF File and select Option… “Import Robot from URDF”

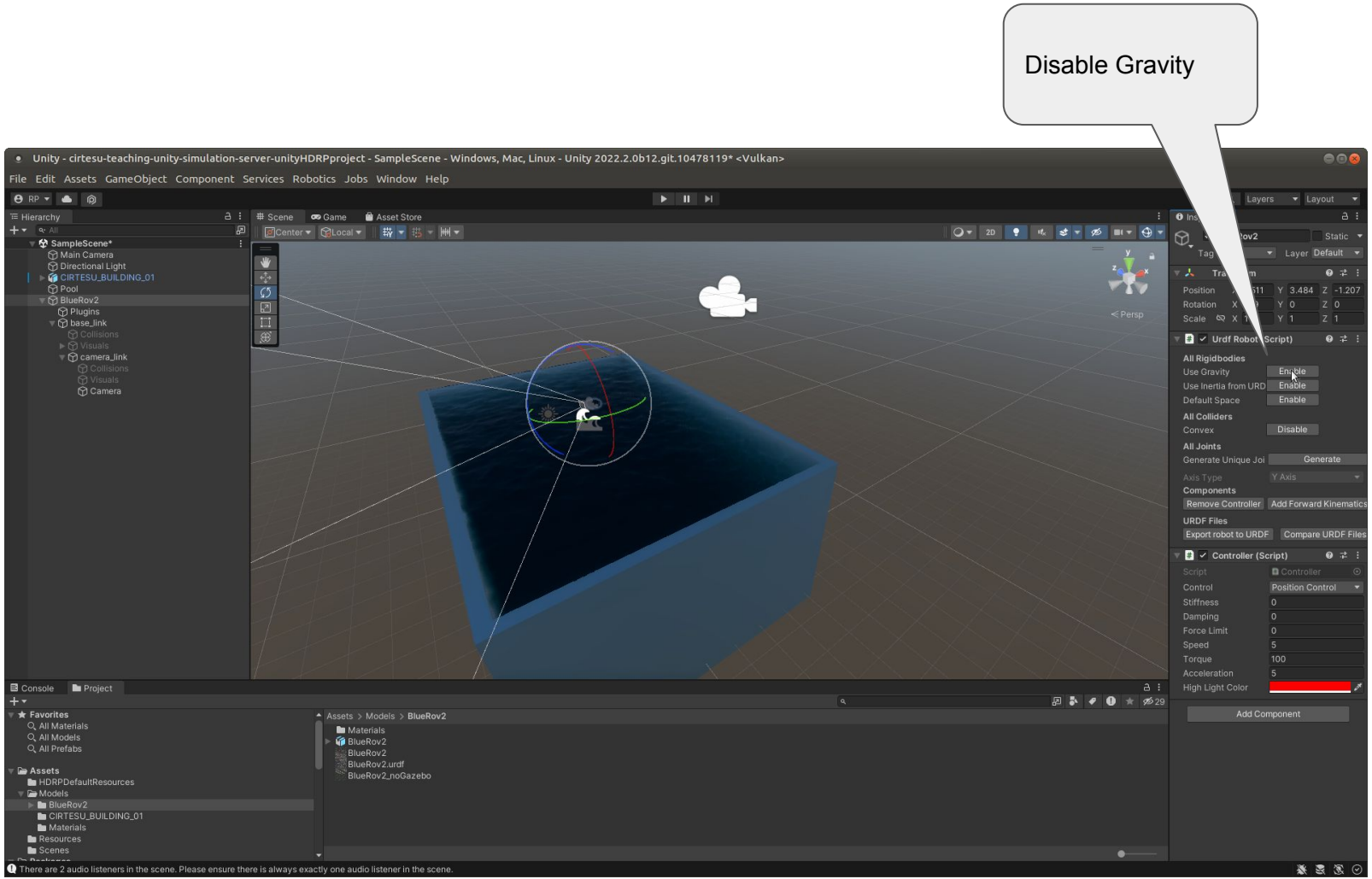


Indicate the BlueRov2.dae file location



Adjust GameObject Properties to make it show in the right direction




Disable Gravity
Unity - cirtesu-teaching-unity-simulation-server-unityHDRPproject - SampleScene - Windows, Mac, Linux - Unity 2022.2.0b12.git.10478119* <Vulkan>
File Edit Assets GameObject Component Services Robotics Jobs Window Help
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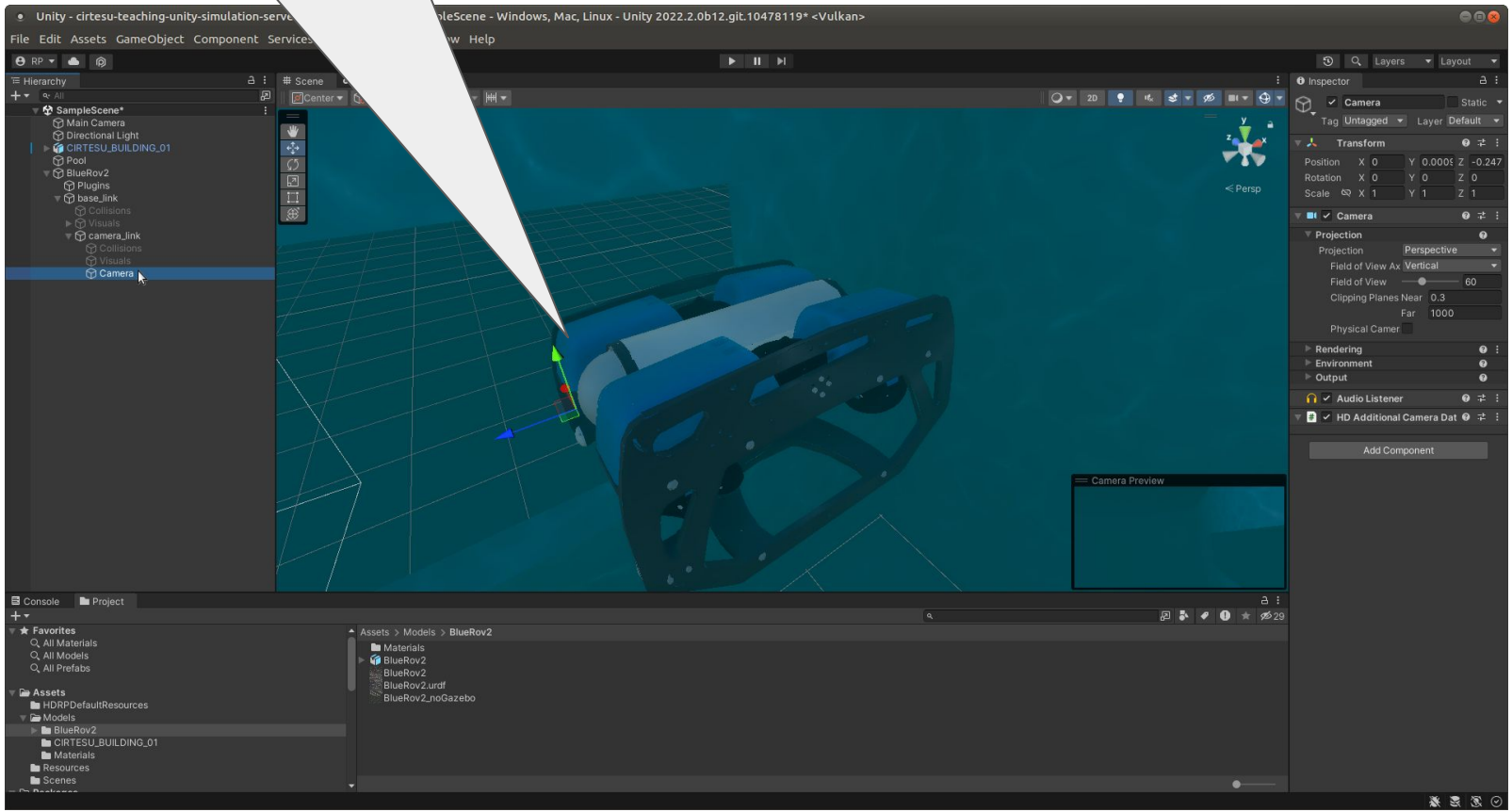
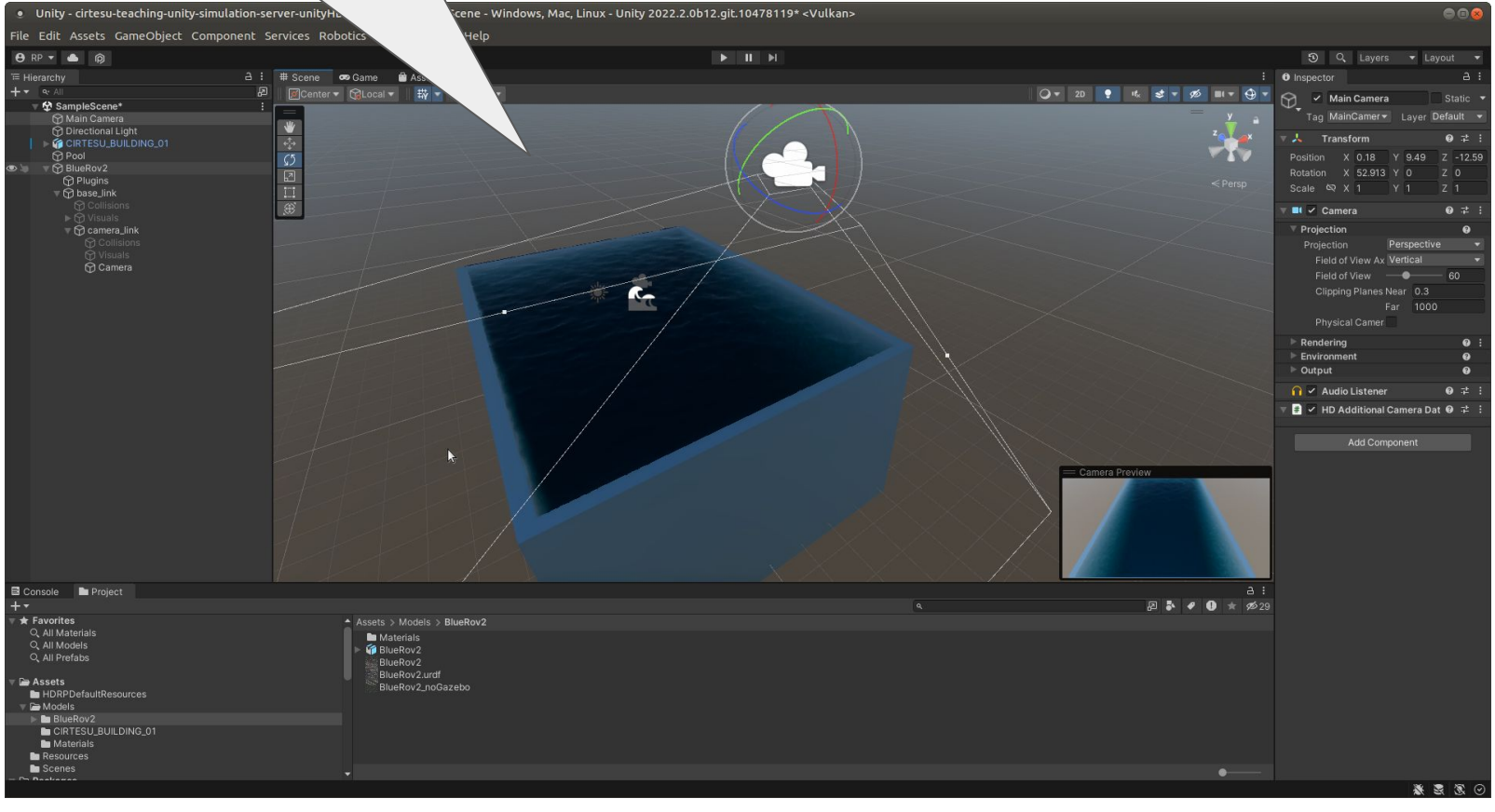
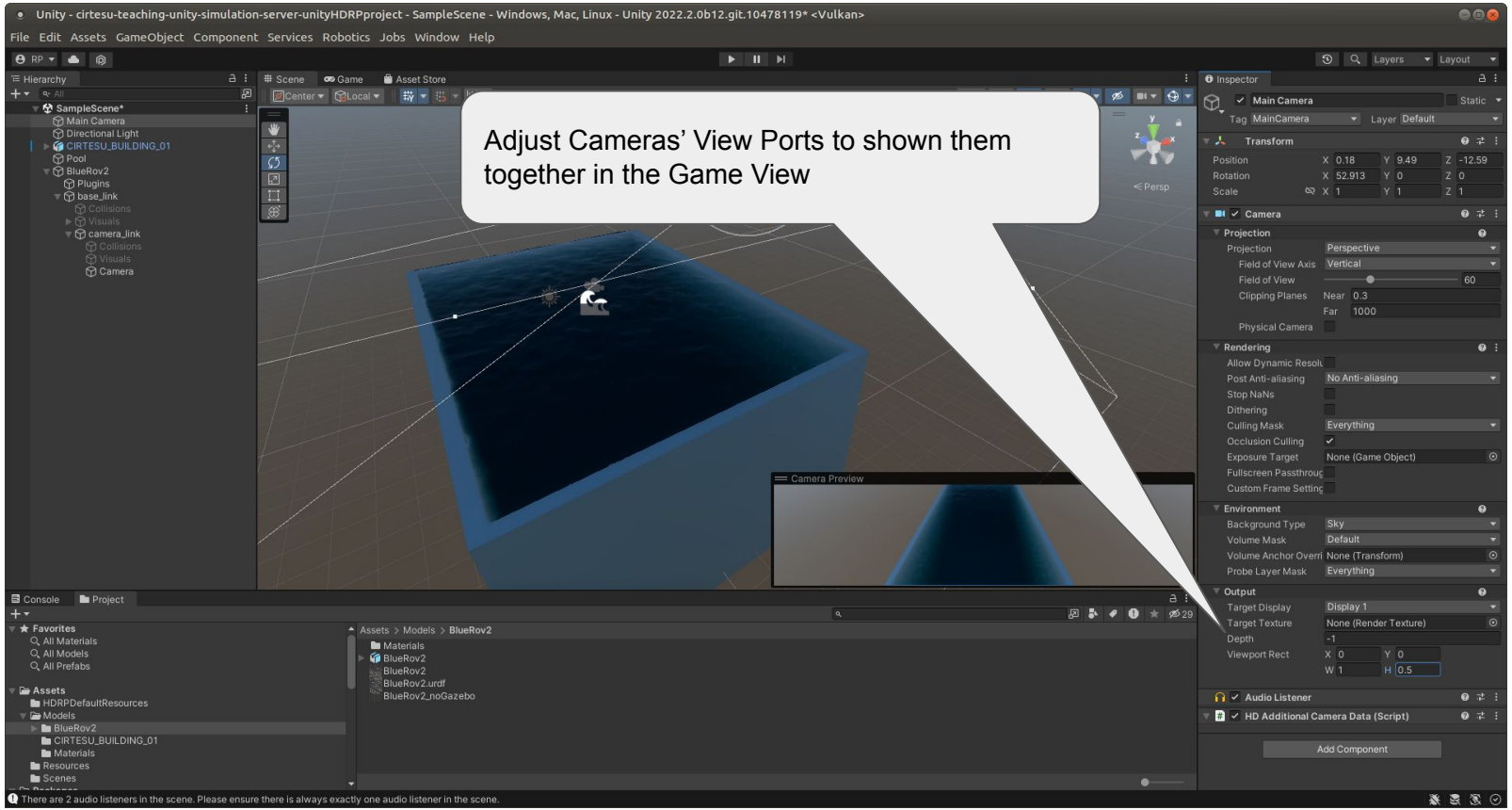
BlueRov2
Plugins
base_link
Collisions
Visuals
camera_link
Collisions
Visuals
Camera
Scene
Game
Asset Store
Persp
Urdf Robot (Script)
All Rigidbodies
Use Gravity
Use Inertia from URD
Default Space
All Colliders
Convex
All Joints
Generate Unique Joi
Axis Type
Components
Remove Controller
Add Forward Kinematics
URDF Files
Export robot to URDF
Compare URDF Files
Controller (Script)
Script
Control
Position Control
Stiffness
Damping
Force Limit
Speed
Torque
Acceleration
High Light Color
Add Component
Console
Project
Favorites
All Materials
All Models
All Prefabs
Assets
HDRPDefaultResources
Models
BlueRov2
CIRTESU_BUILDING_01
Materials
Resources
Scenes
Assets > Models > BlueRov2
Materials
BlueRov2
BlueRov2
BlueRov2.urdf
BlueRov2_noGazebo
There are 2 audio listeners in the scene. Please ensure there is always exactly one audio listener in the scene.

Add GameObject Camera to the Bluerov under camera_link



Adjust MainCamera Properties to look at the top of the Pool




Unity - cirtesu-teaching-unity-simulation-server-unityHDRPproject - SampleScene - Windows, Mac, Linux - Unity 2022.2.0b12.git.10478119* <Vulkan>
File Edit Assets GameObject Component Services Robotics Jobs Window Help
Hierarchy
SampleScene*
Main Camera
Directional Light
CIRTESU_BUILDING_01
Pool
BlueRov2
Plugins
base_link
Collisions
Visuals
camera_link
Collisions
Visuals
Camera
Scene
Game
Asset Store
Persp
Adjust Cameras' View Ports to shown them together in the Game View
Camera Preview
Inspector
Main Camera
Static
Tag MainCamera
Layer Default
Transform
Position X 0.18 Y 9.49 Z -12.59
Rotation X 52.913 Y 0 Z 0
Scale X 1 Y 1 Z 1
Camera
Projection
Projection Perspective
Field of View Axis Vertical
Field of View 60
Clipping Planes Near 0.3
Far 1000
Physical Camera
Rendering
Post Anti-aliasing No Anti-aliasing
Stop NaNs
Dithering
Culling Mask Everything
Occlusion Culling
Exposure Target None (Game Object)
Environment
Background Type Sky
Volume Mask Default
Probe Layer Mask Everything
Output
Target Display Display 1
Target Texture None (Render Texture)
Depth -1
Viewport Rect X 0 Y 0 W 1 H 0.5
Audio Listener
HD Additional Camera Data (Script)
Add Component
Console
Project
Favorites
All Materials
All Models
All Prefabs
Assets
HDRPDefaultResources
Models
BlueRov2
CIRTESU_BUILDING_01
Materials
Resources
Scenes
Assets > Models > BlueRov2
Materials
BlueRov2
BlueRov2
BlueRov2.urdf
BlueRov2_noGazebo
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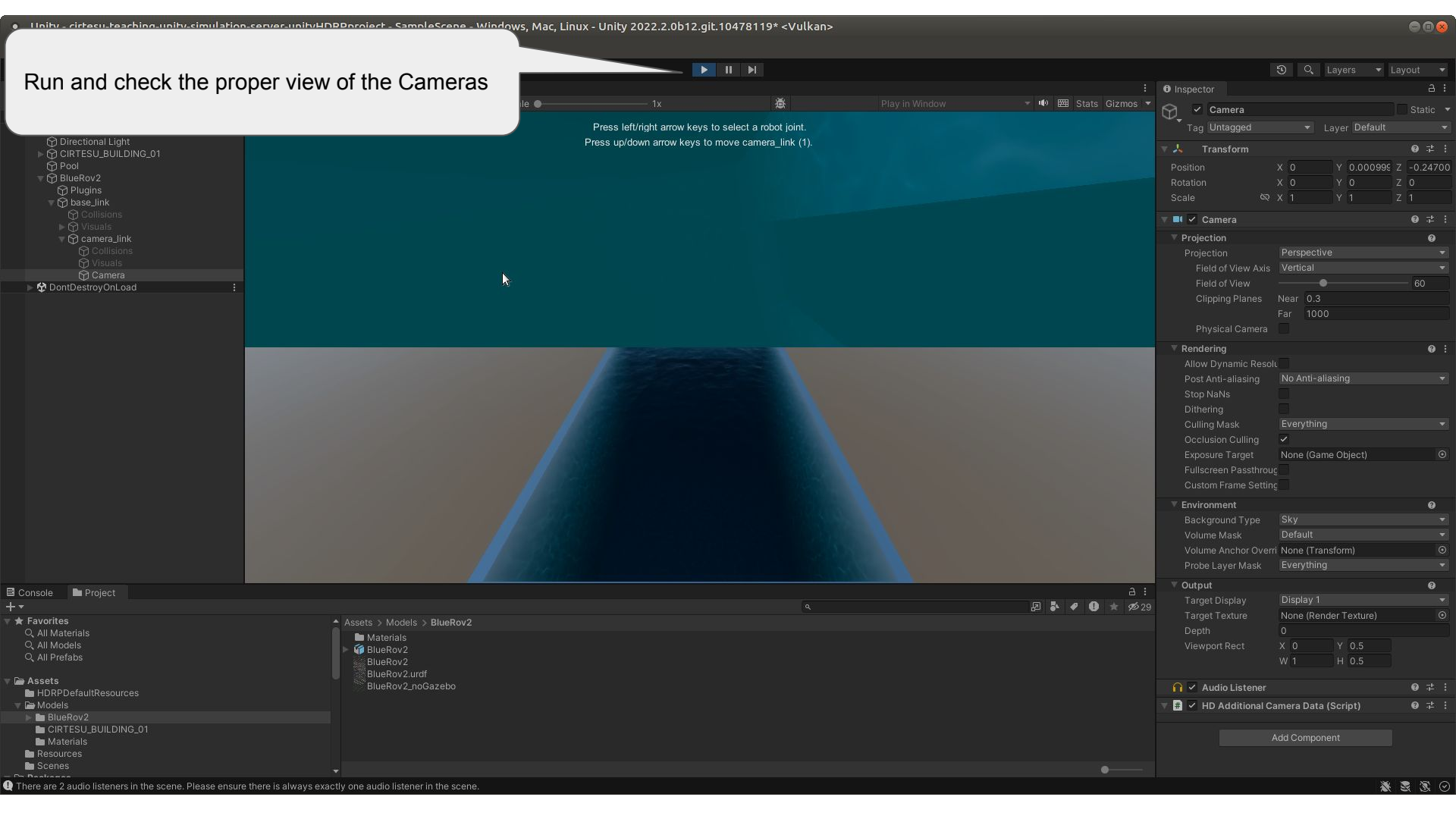
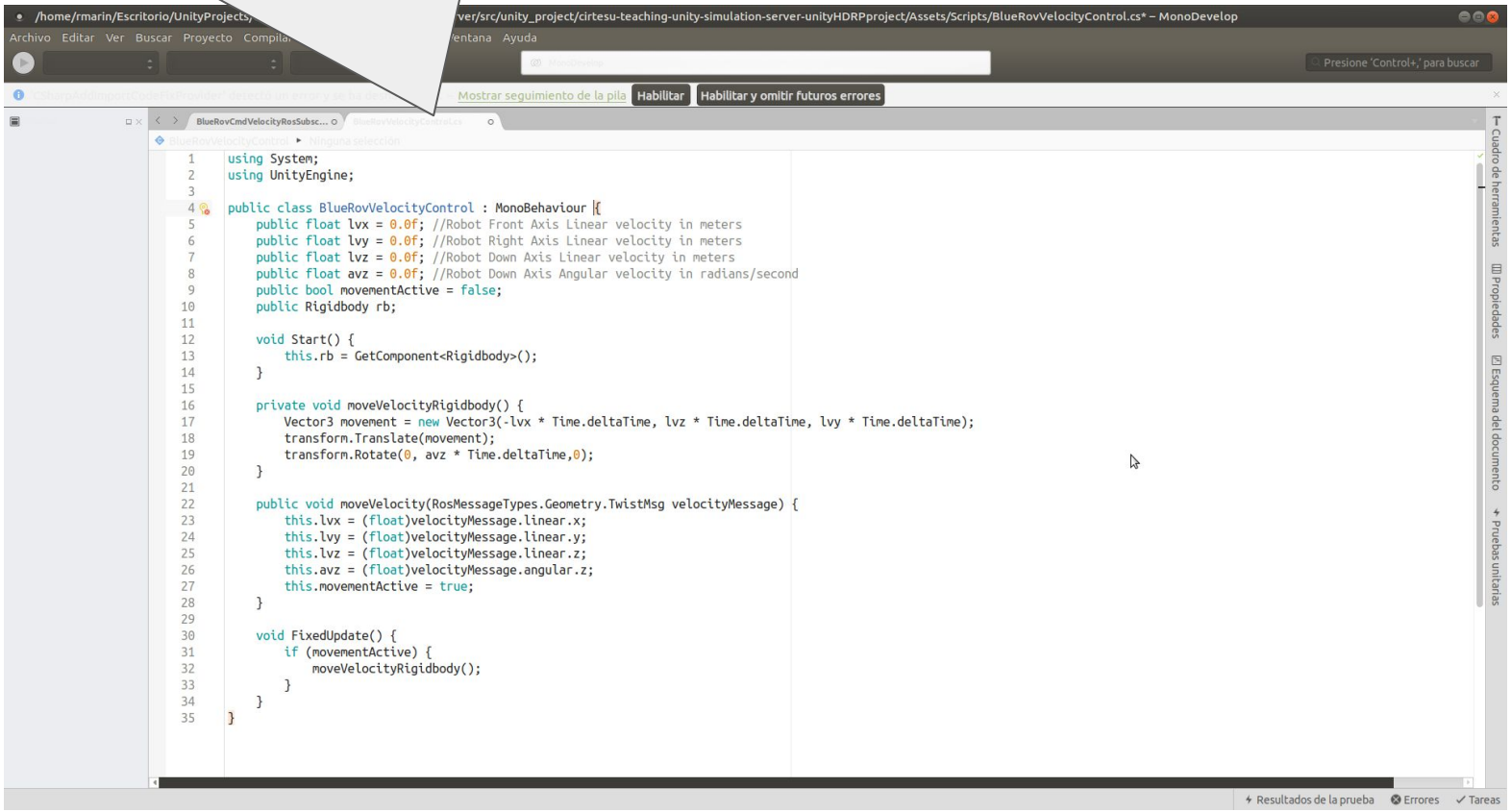
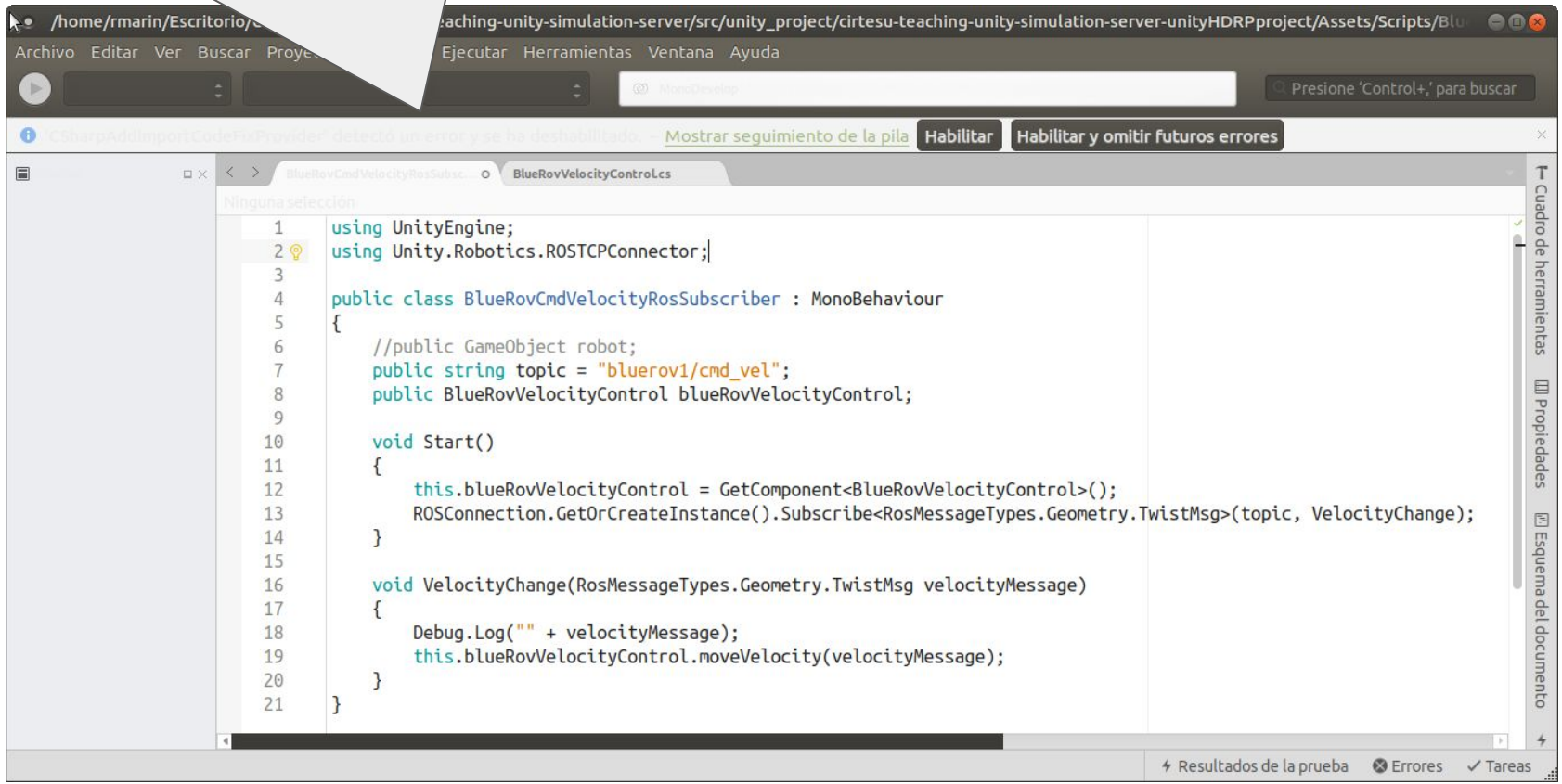

Run and check the proper view of the Cameras
Unity - cirtesu-teaching-unity-simulation-server-unityHDRPproject - SampleScene - Windows, Mac, Linux - Unity 2022.2.0b12.git.10478119* <Vulkan>
Press left/right arrow keys to select a robot joint.
Press up/down arrow keys to move camera_link (1).
Directional Light
CIRTESU_BUILDING_01
Pool
BlueRov2
Plugins
base_link
Collisions
Visuals
camera_link
Collisions
Visuals
Camera
DontDestroyOnLoad
Inspector
Camera
Static
Tag Untagged
Layer Default
Transform
Position
Rotation
Scale
Camera
Projection
Perspective
Field of View Axis
Vertical
Field of View
Clipping Planes
Near 0.3
Far 1000
Physical Camera
Rendering
Post Anti-aliasing
No Anti-aliasing
Stop NaNs
Dithering
Culling Mask
Everything
Occlusion Culling
Exposure Target
None (Game Object)
Environment
Background Type
Sky
Volume Mask
Default
Probe Layer Mask
Everything
Output
Target Display
Display 1
Target Texture
None (Render Texture)
Depth
Viewport Rect
Audio Listener
HD Additional Camera Data (Script)
Add Component
Console
Project
Favorites
All Materials
All Models
All Prefabs
Assets
HDRPDefaultResources
Models
BlueRov2
CIRTESU_BUILDING_01
Materials
Resources
Scenes
Assets > Models > BlueRov2
Materials
BlueRov2
BlueRov2
BlueRov2.urdf
BlueRov2_noGazebo
There are 2 audio listeners in the scene. Please ensure there is always exactly one audio listener in the scene.

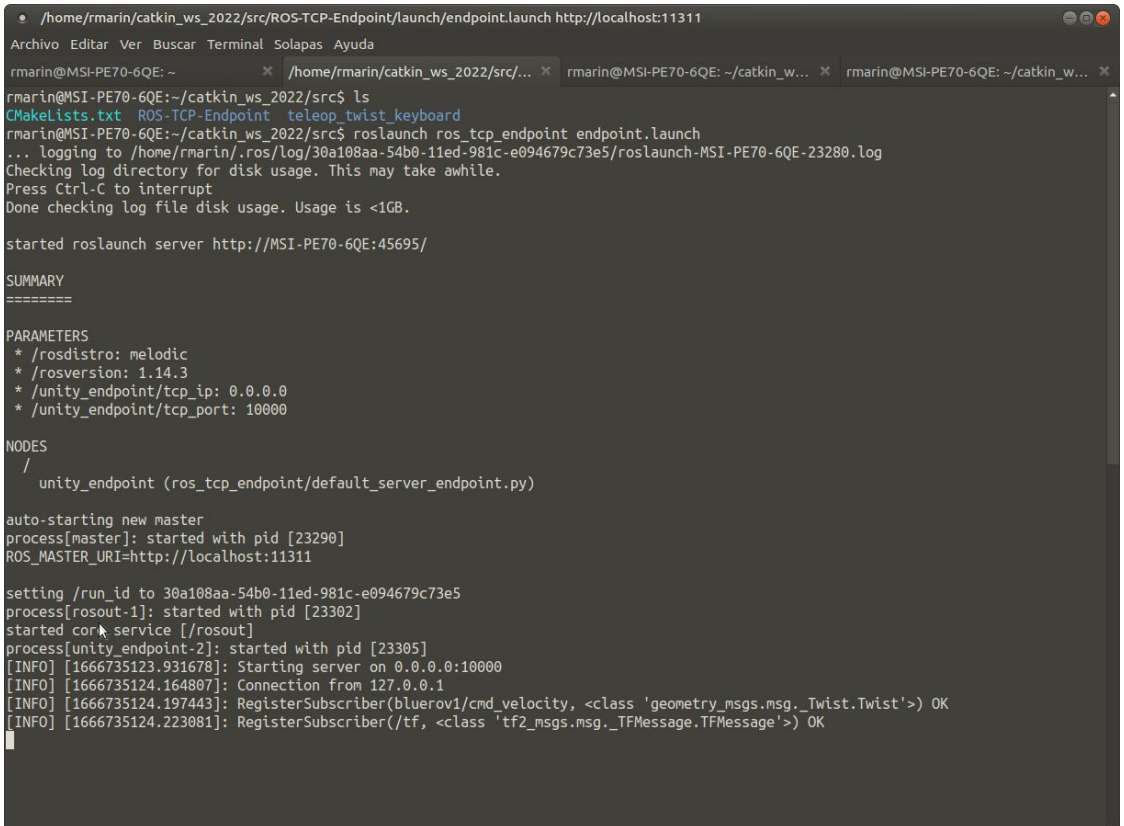
Script to move the Bluerov simulated robot. Test changing the properties while running and adjust it as required to your robot



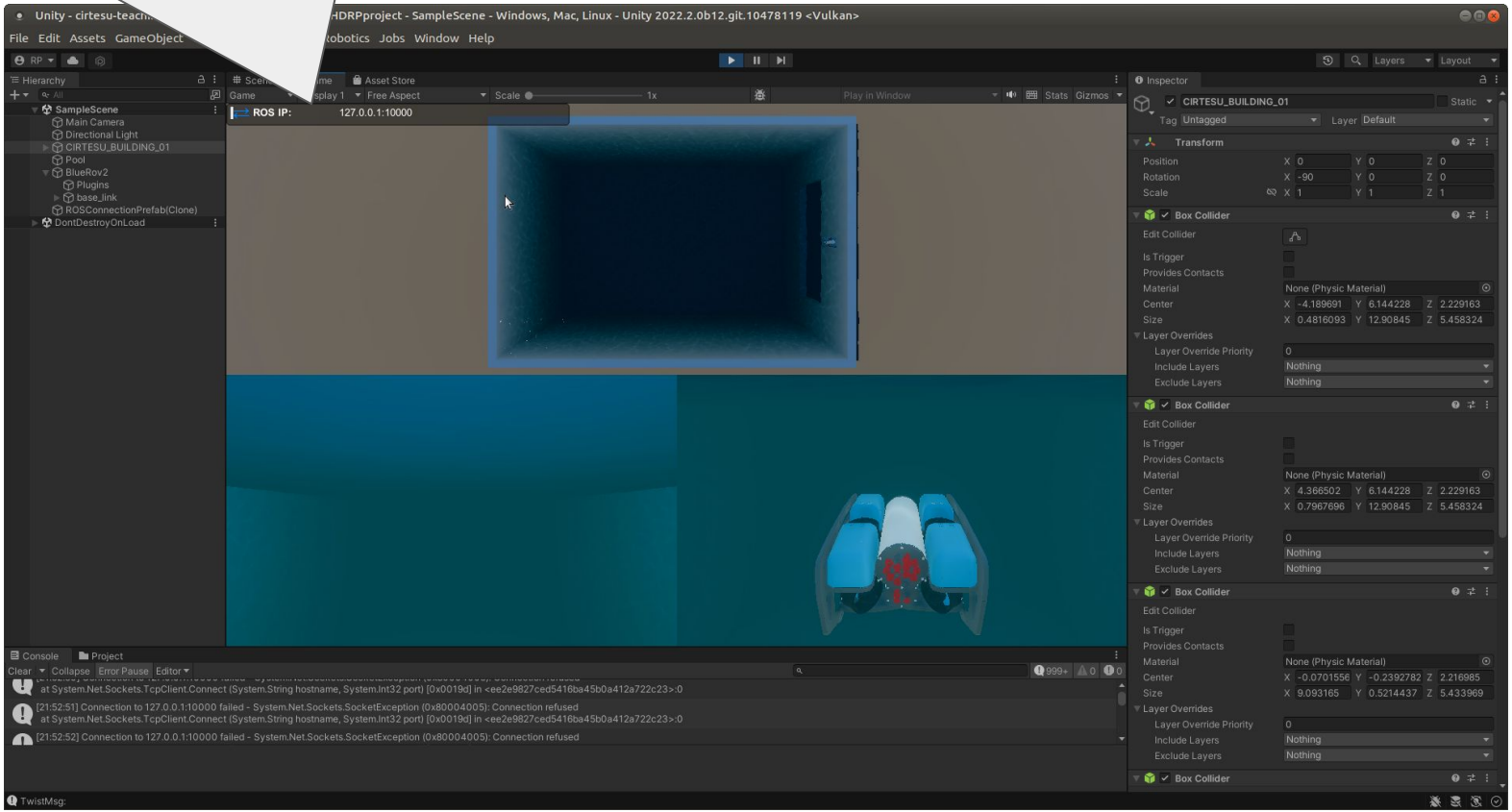
Script to subscribe to ROS Velocities. Add it to the Bluerov imported gameObject



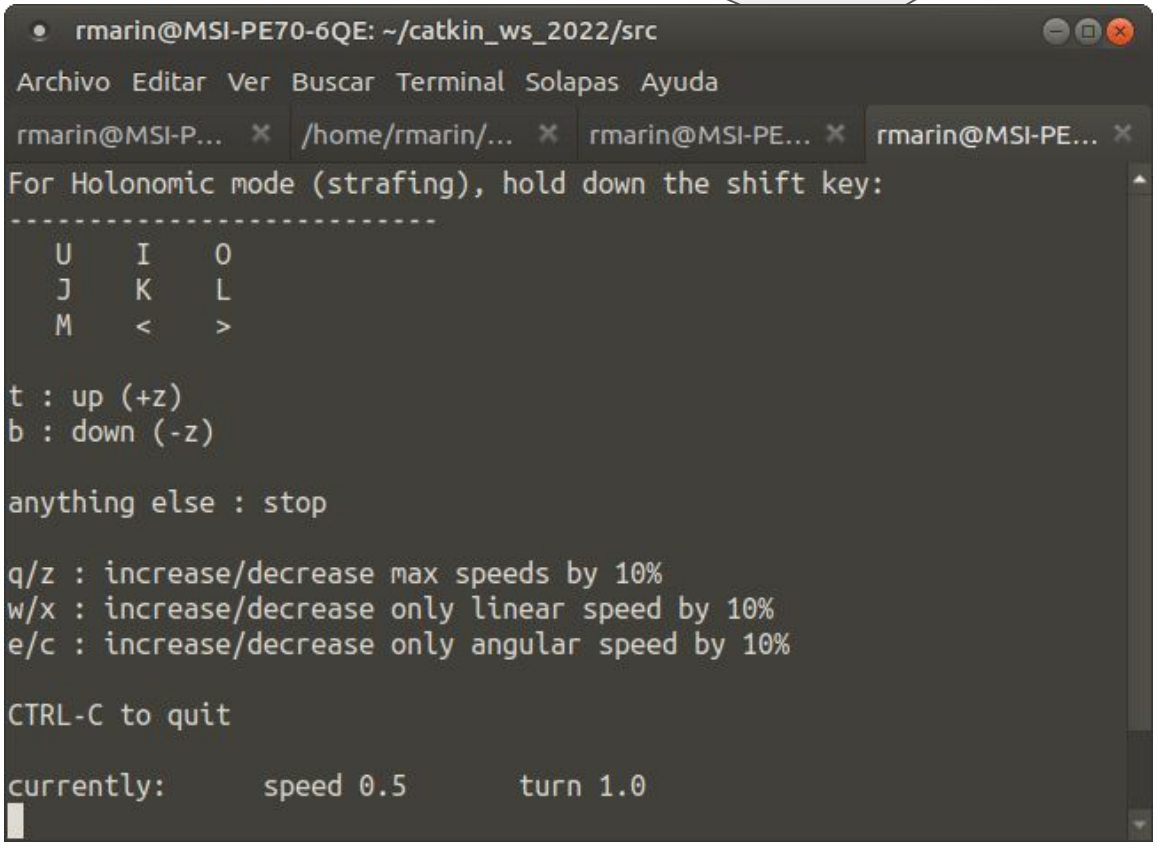
Install ROS TCP End point in your linux ROS workspace:
https://github.com/Unity-Technologies/ROS-TCP-Endpoint
Run it with $roslaunch ros_tcp_endpoint endpoint.launch



Connected to ros_tcp_endpoint



ROS1 Example of Teleop using keyboard
Install and run:
https://github.com/ros-teleop/teleop_twist_keyboard.git
ROS2:
https://github.com/ros2/teleop_twist_keyboard.git



Script to Capture the JPG from a Camera render

```
using System;
using UnityEngine;

public class CameraCapturer : MonoBehaviour
{
    public bool IsCaptureEnable = false;
    Camera _camera;
    public int resWidth;
    public int resHeight;
    public byte[] jpg;

    void Start() {
        this._camera = GetComponent<Camera>();
    }

    private void FixedUpdate() {
        if (this.IsCaptureEnable) {
            this.jpg = getJPGFromCurrentCamera();
            this.IsCaptureEnable = false;
        }
    }

    public byte[] getCapturedJpegImage() {
        this.IsCaptureEnable = true;
        while (this.IsCaptureEnable) { }
        if (this.jpg != null) {
            return this.jpg;
        }
        return null;
    }

    private byte[] getJPGFromCurrentCamera() {
        try {
            RenderTexture rt = new RenderTexture(resWidth, resHeight, 24);
            _camera.targetTexture = rt;
            Texture2D screenShot = new Texture2D(resWidth, resHeight, TextureFormat.RGB24, false);
            _camera.Render();
            RenderTexture.active = rt;
            screenShot.ReadPixels(new Rect(0, 0, resWidth, resHeight), 0, 0);
            _camera.targetTexture = null;
            RenderTexture.active = null;
            Destroy(rt);
            byte[] bytes = screenShot.EncodeToJPG();
            return bytes;
        }
        catch (Exception e) {
            return null;
        }
    }
}
```

Exercise

Add an script to the Bluerov Camera in order to Publish in a ROS Camera topic

Visualize the camera topic via RVIZ or ROS package

Teleoperate the simulated BlueRov from ROS, visualizing the camera and sending cmd_vel commands via keyboard

Useful links

Onshape tutorials

https://learn.onshape.com/catalog

Onshape-to-robot documentation

https://onshape-to-robot.readthedocs.io/en/latest/

Onshape-to-robot examples

https://github.com/rhoban/onshape-to-robot-examples/