



Enabling Next-Gen Effects through NVIDIA GameWorks New Features

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Overview

- GPU Rigid Bodies (GRB)
- FleX
- Flow
- WaveWorks



UE4-GRB Demo



GPU Rigid Bodies in PhysX 3.4

- A new feature introduced in PhysX 3.4
- Implemented in CUDA
- Supports Windows and Linux with NVIDIA Kepler (GTX 6 series) GPU or later
- Same API and semantics as CPU PhysX rigid bodies
- Supports most PhysX rigid body features except articulations



GPU Rigid Bodies in PhysX 3.4 cont.

- Hybrid CPU/GPU rigid body simulation
- Execute the following rigid body pipeline stages on GPU
 - Broad phase
 - Narrow phase
 - Solver
 - State management
 - Bounds computation
- Execute the following stages on the CPU
 - Island management
 - Shape filtering
 - CCD
 - Triggers
 - User callbacks

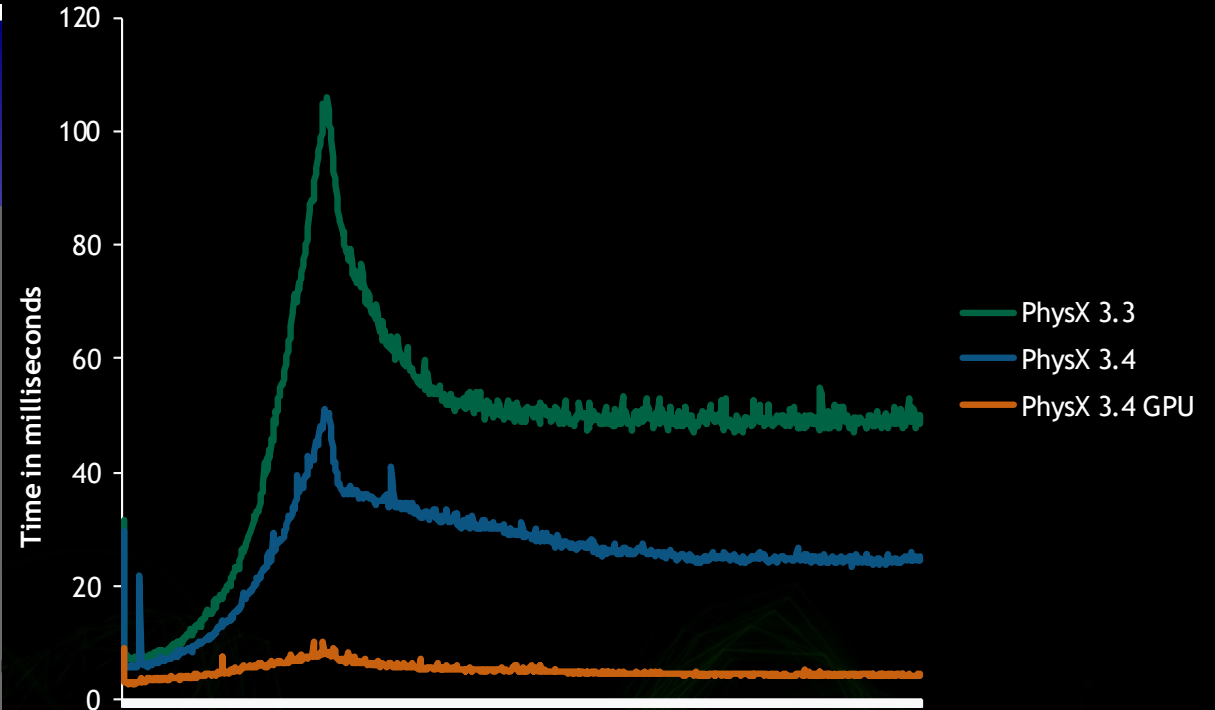
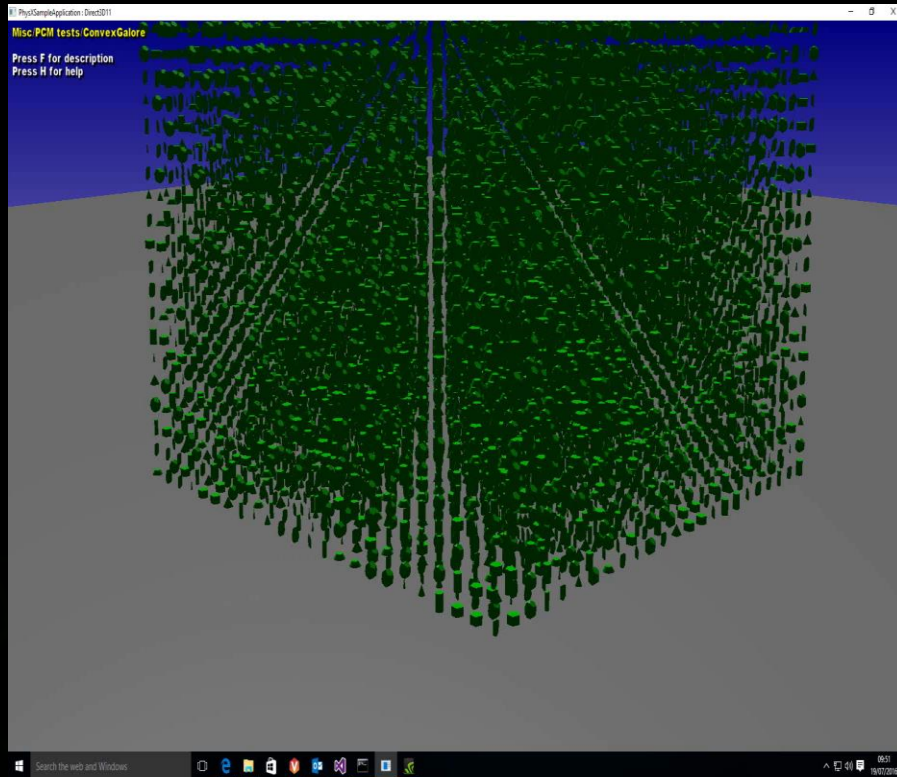


Performance Results

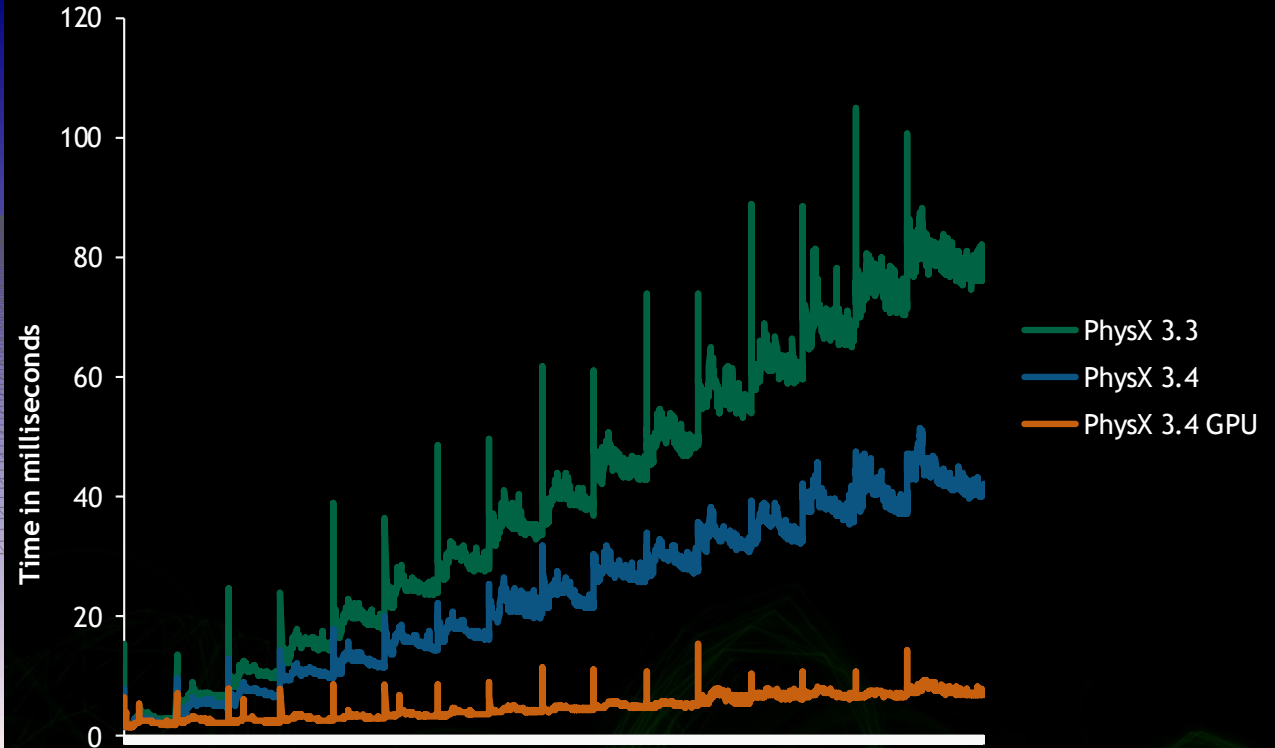
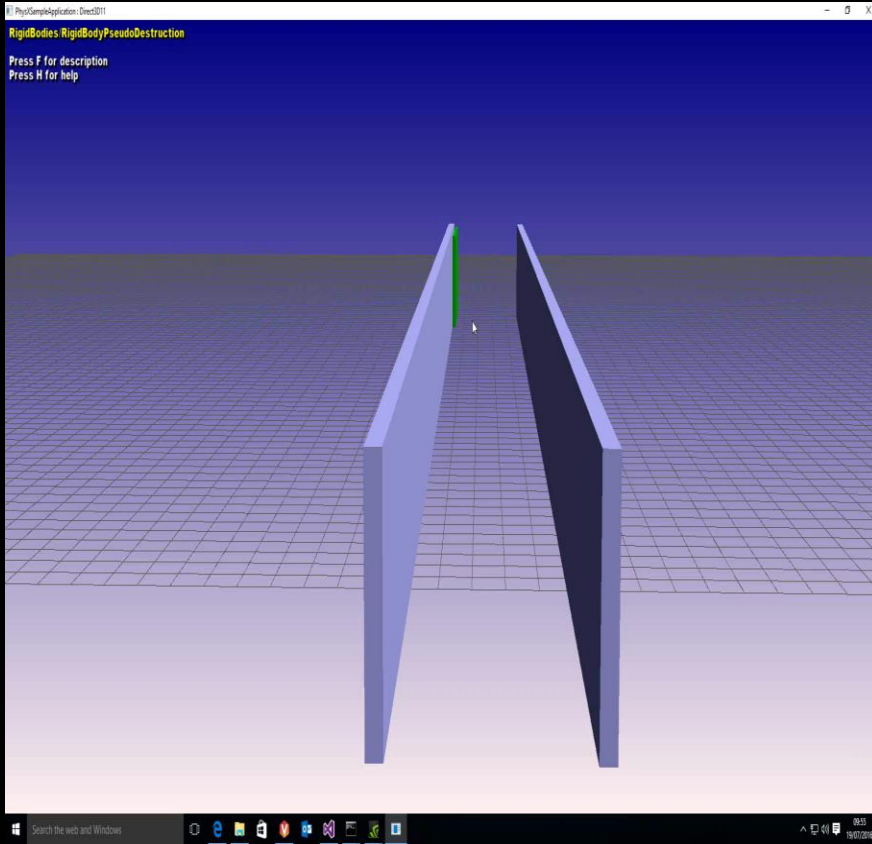
- Test Platform
 - Windows 10 64-bit
 - I7-5930k
 - 32GB RAM
 - GTX 1080



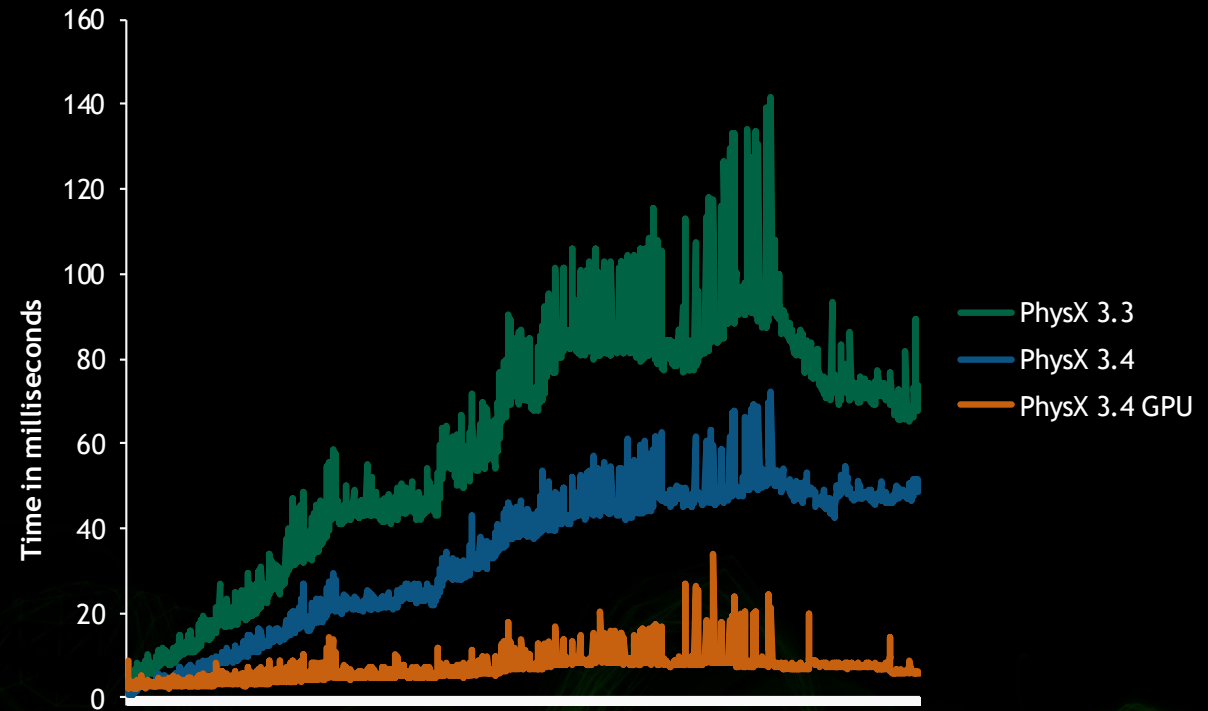
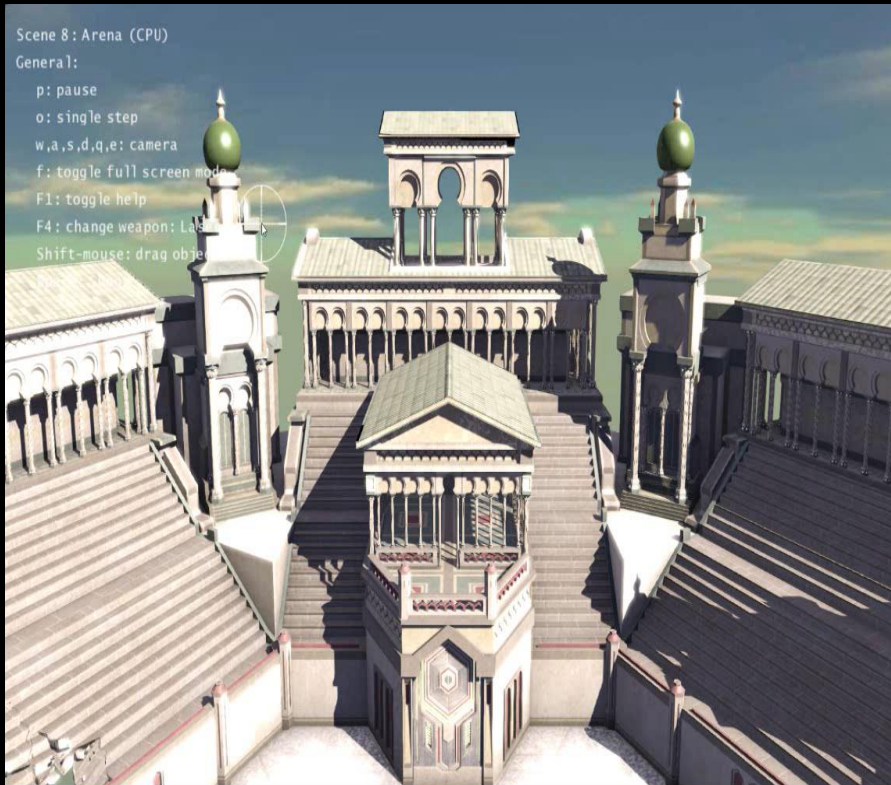
13,824 Convex Objects



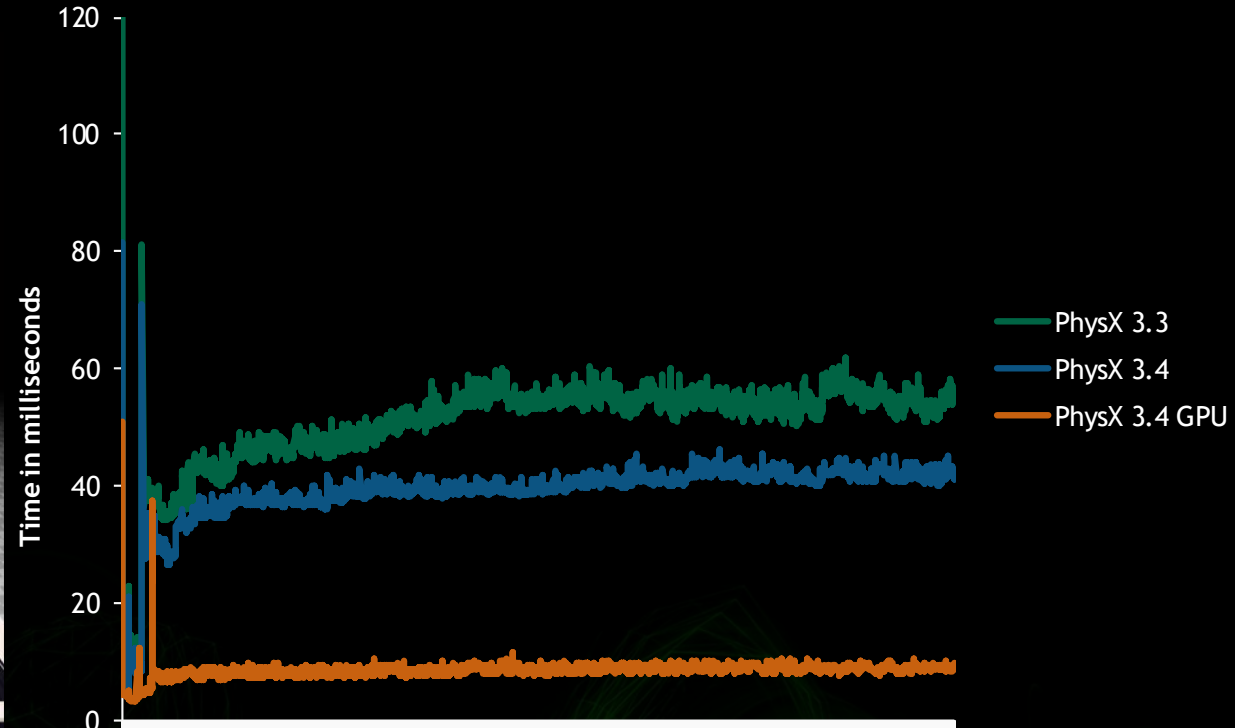
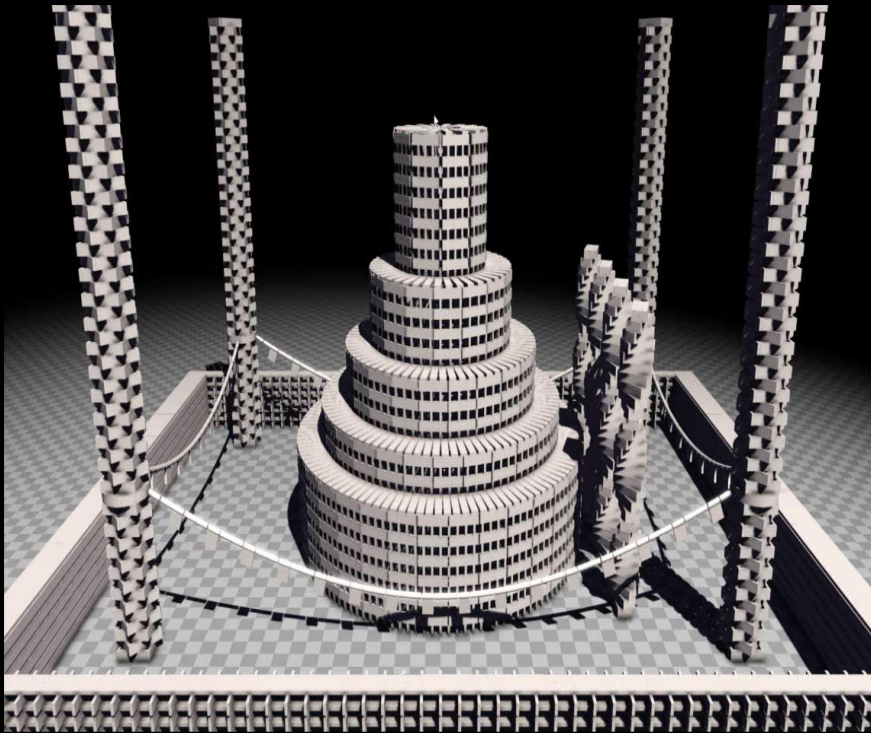
Hallway (16,000)



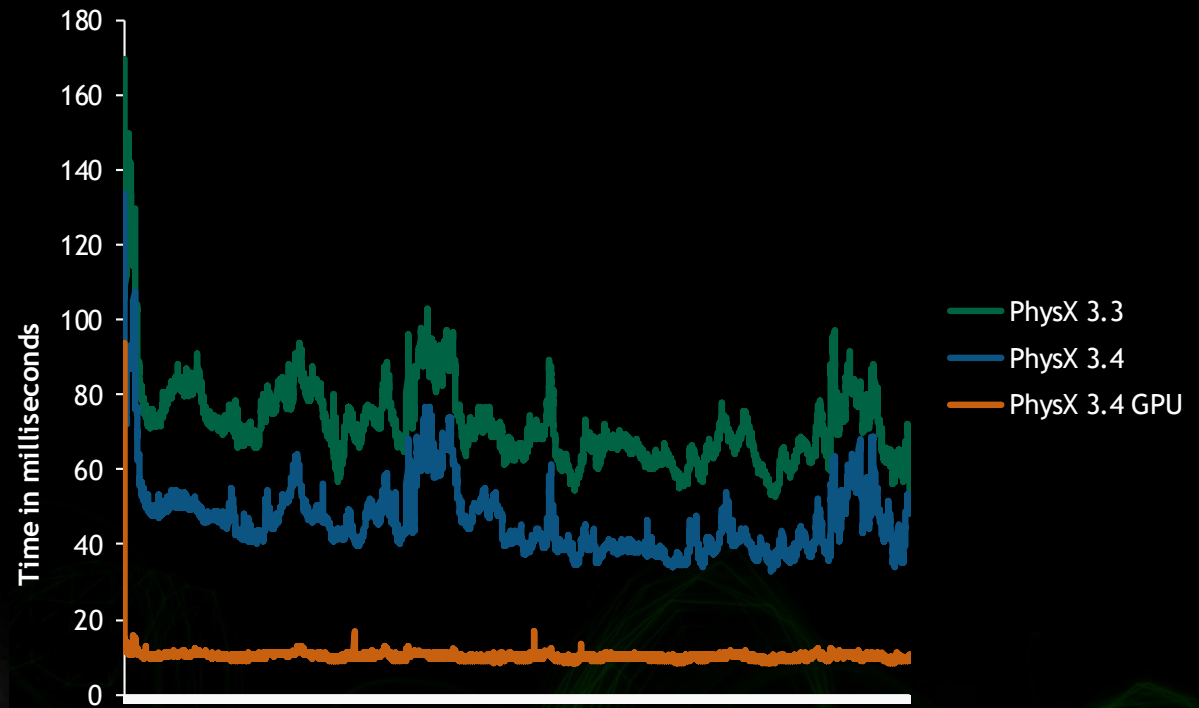
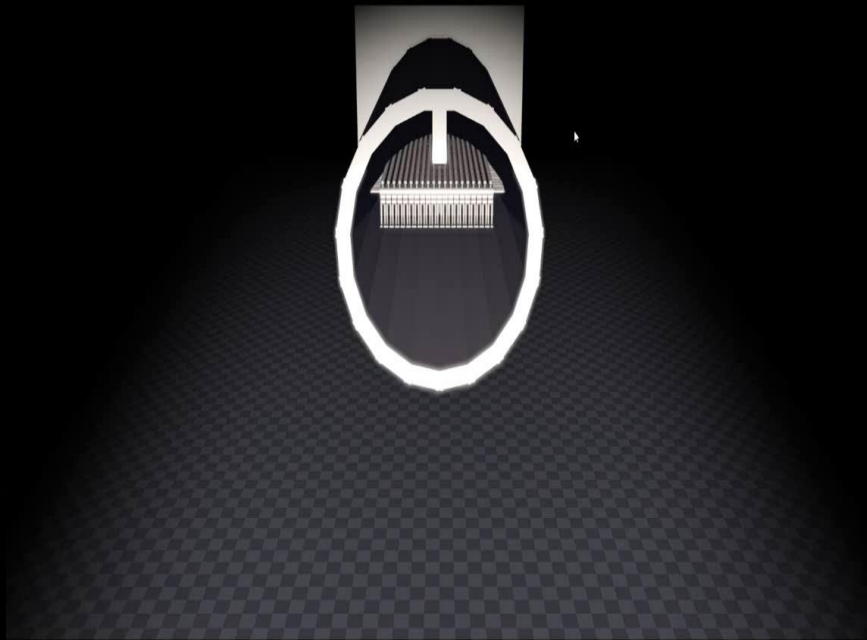
Arena Demo (15, 000)



Kapla Tower 20,000 convexes



700 Ragdolls



Overview

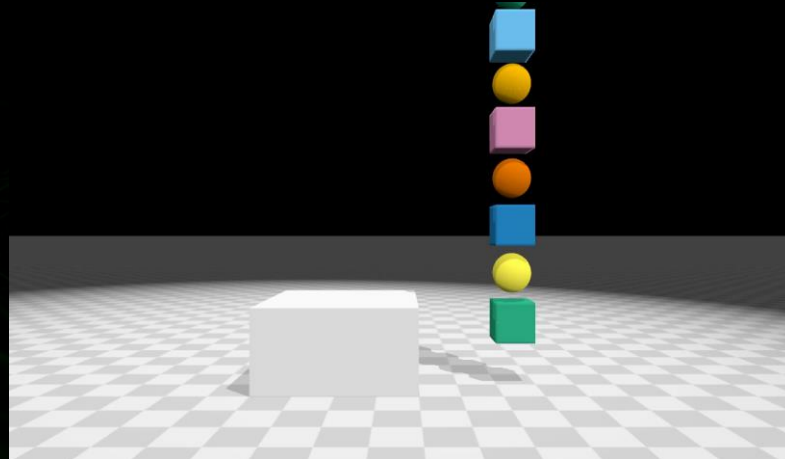
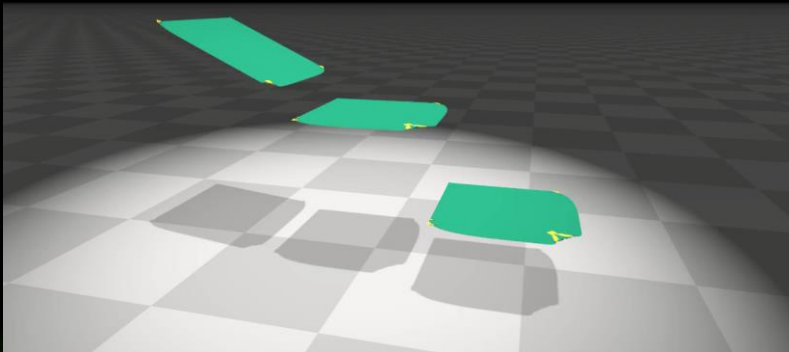
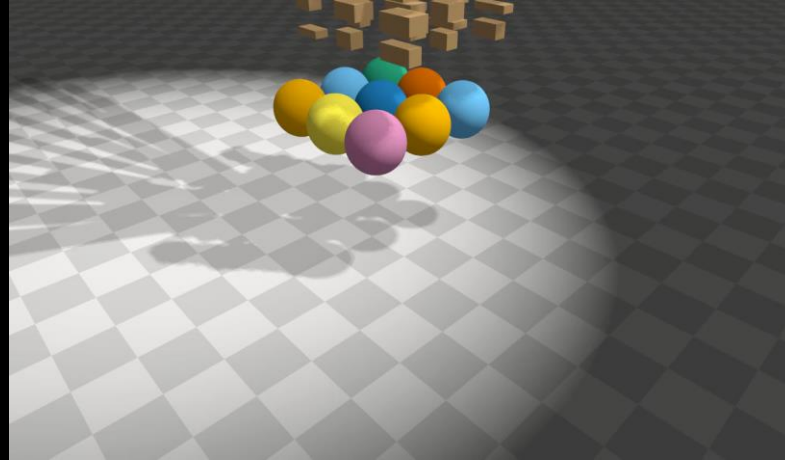
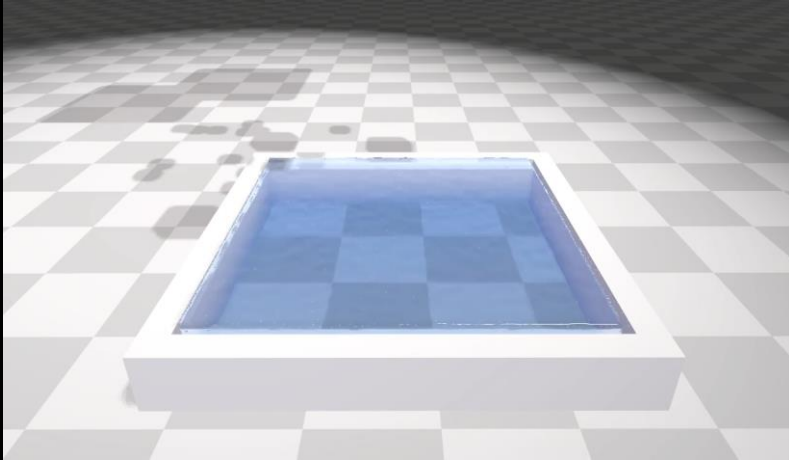
- GPU Rigid Bodies (GRB)
- **FleX**
- Flow
- WaveWorks



FleX In Funhouse

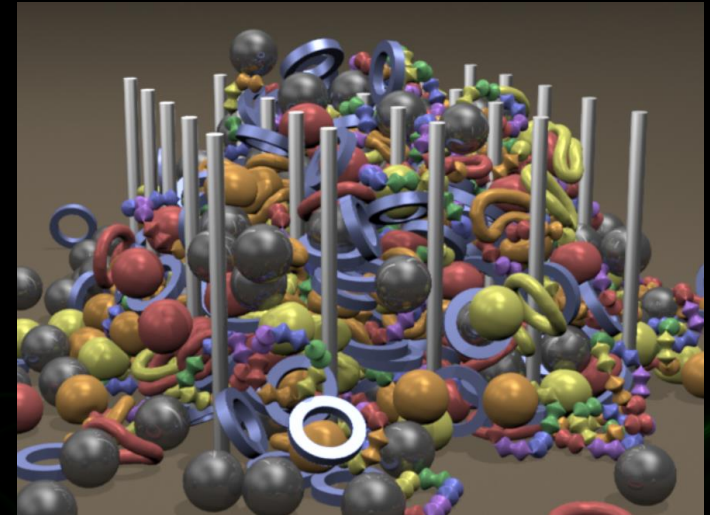
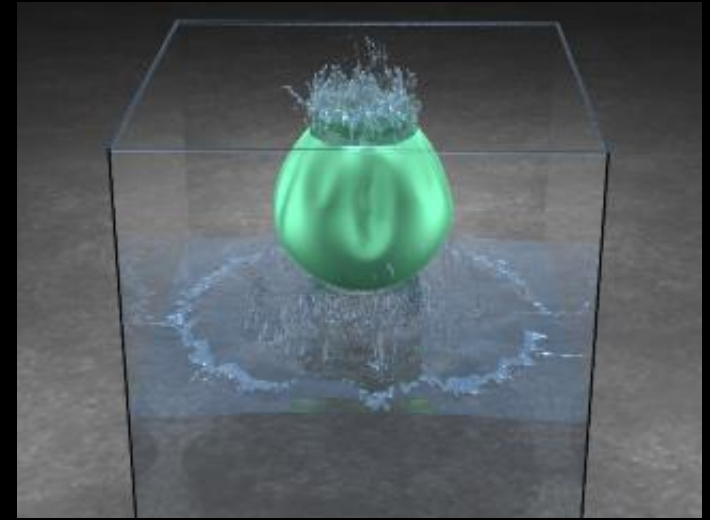


FleX



Motivation

- Too many solvers
- Creates redundant work
- Want one optimization target
- Want two-way interaction between all object types



Core Idea

Everything is a set of particles connected by
constraints

Advantages

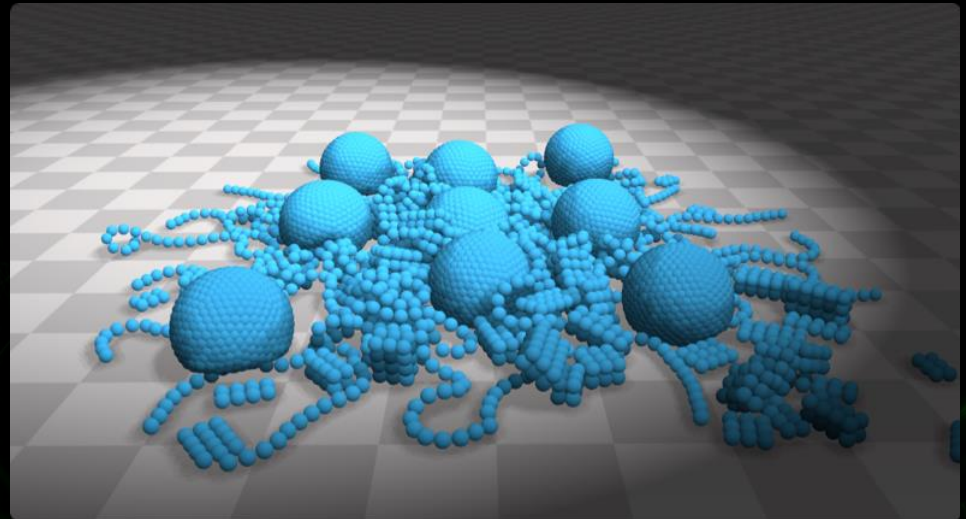
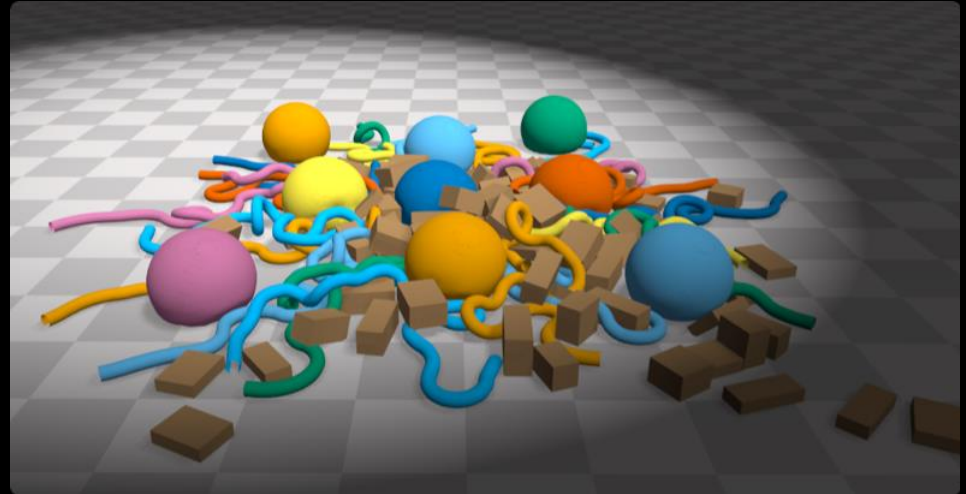
- Simplifies collision detection
- Stable two-way interaction of all object types:
 - Rigid Bodies
 - Deformables
 - Liquids
 - Cloth
- Fits well on the GPU



Particles

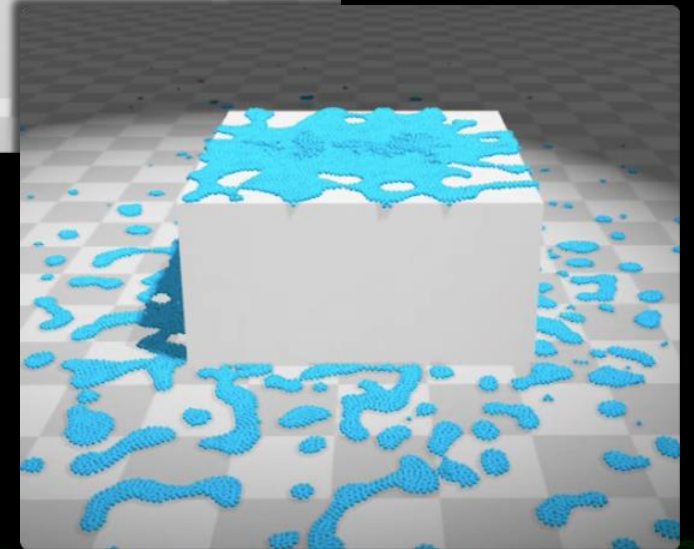
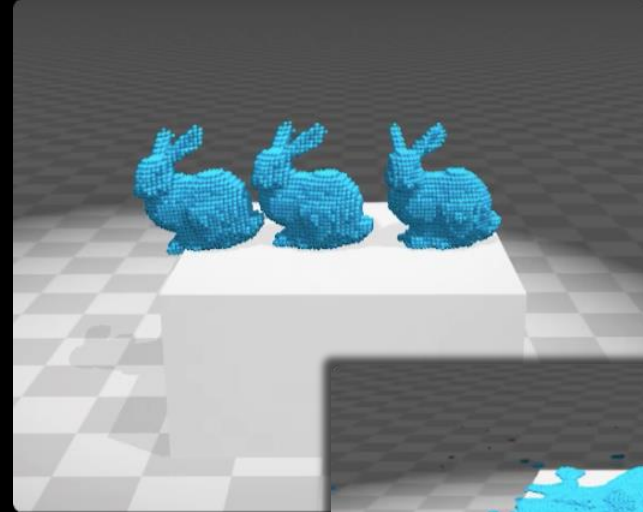
```
struct Particle
{
    float pos[3];
    float vel[3];
    float invMass;
    int phase;
};
```

- Phase-ID used to control collision filtering
- Single collision radius



Constraints

- Constraint types:
 - Distance (clothing)
 - Shape (rigids, soft bodies, plastics)
 - Density (fluids)
 - Volume (inflatables)
 - Contact (non-penetration, friction)
- Combine constraints to create wide variety of effects
 - Melting, phase-changes
 - Stiff cloth



FleX new features

- New buffer-centric API
- New collision shape API
- Add support for CUDA 8.0
- Add support for D3D 11/D3D12
- Local space simulation

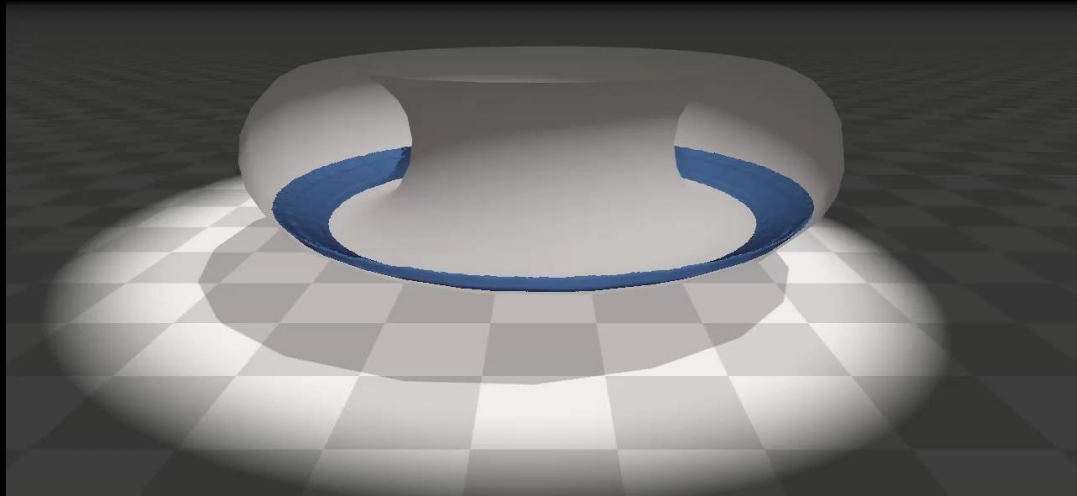


Local Space Simulation

Particles inside an attached parent frame are updated by inertial forces

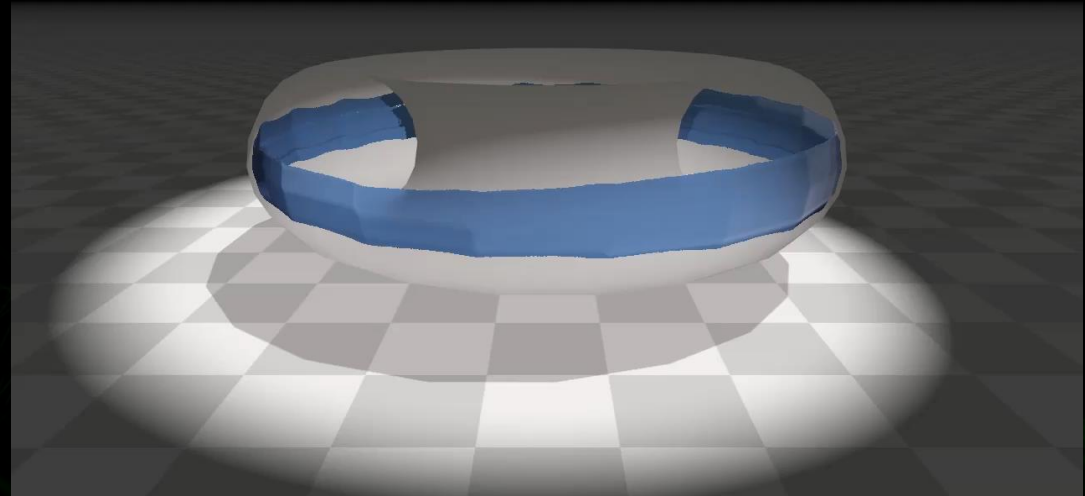
Without

www.fraps.com



With

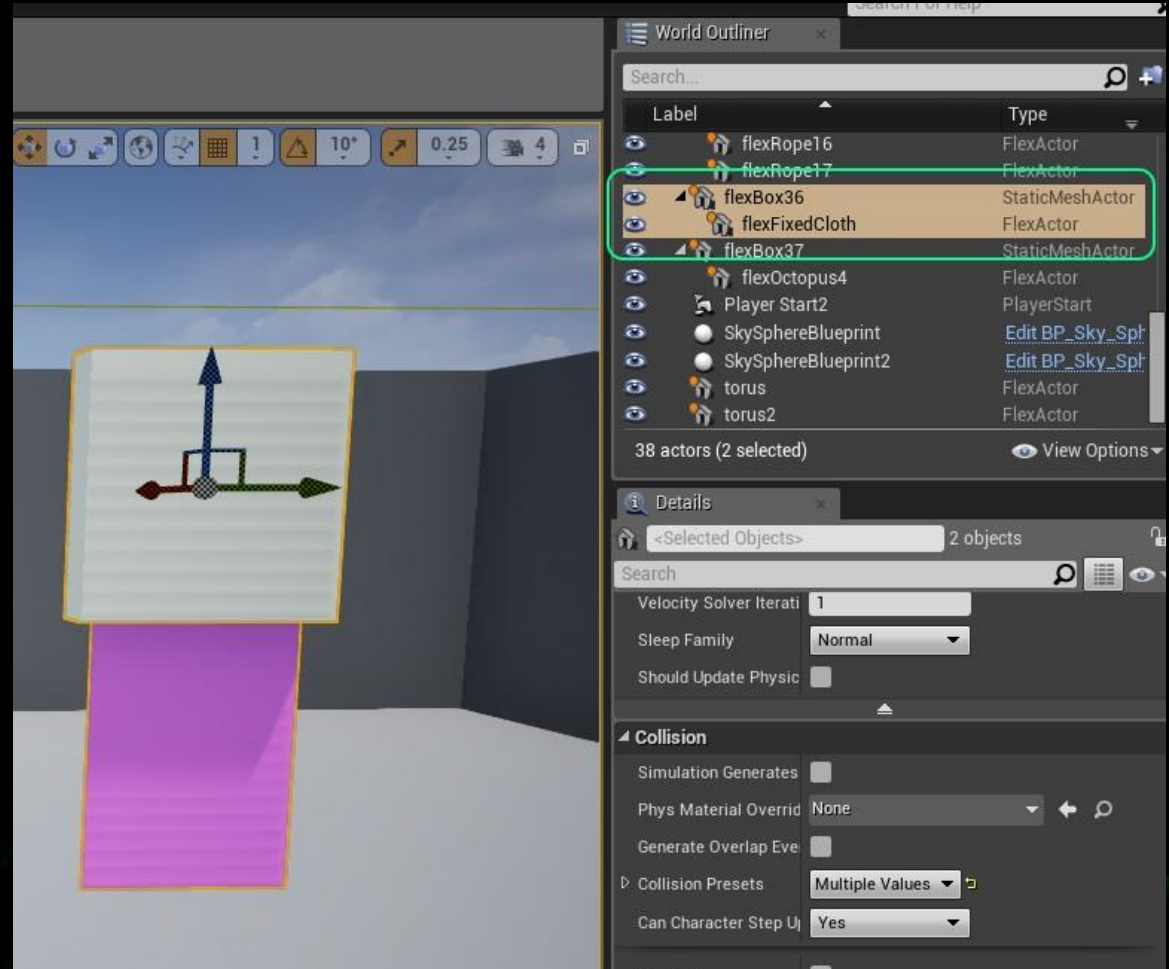
www.fraps.com



Enable Local Space Simulation in UE4

● Step 1

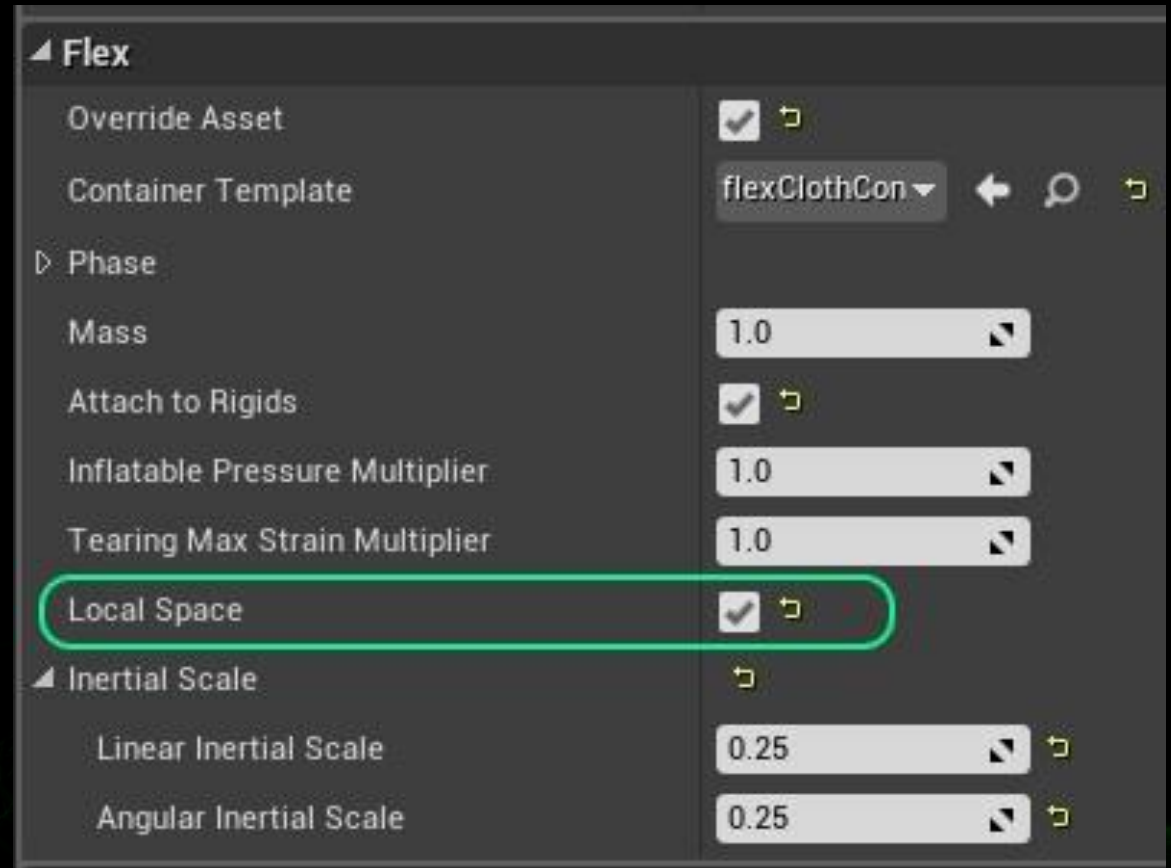
Make the Flex component a child of the object it should be parented to



Enable Local Space Simulation in UE4 cont.

- **Step 2**

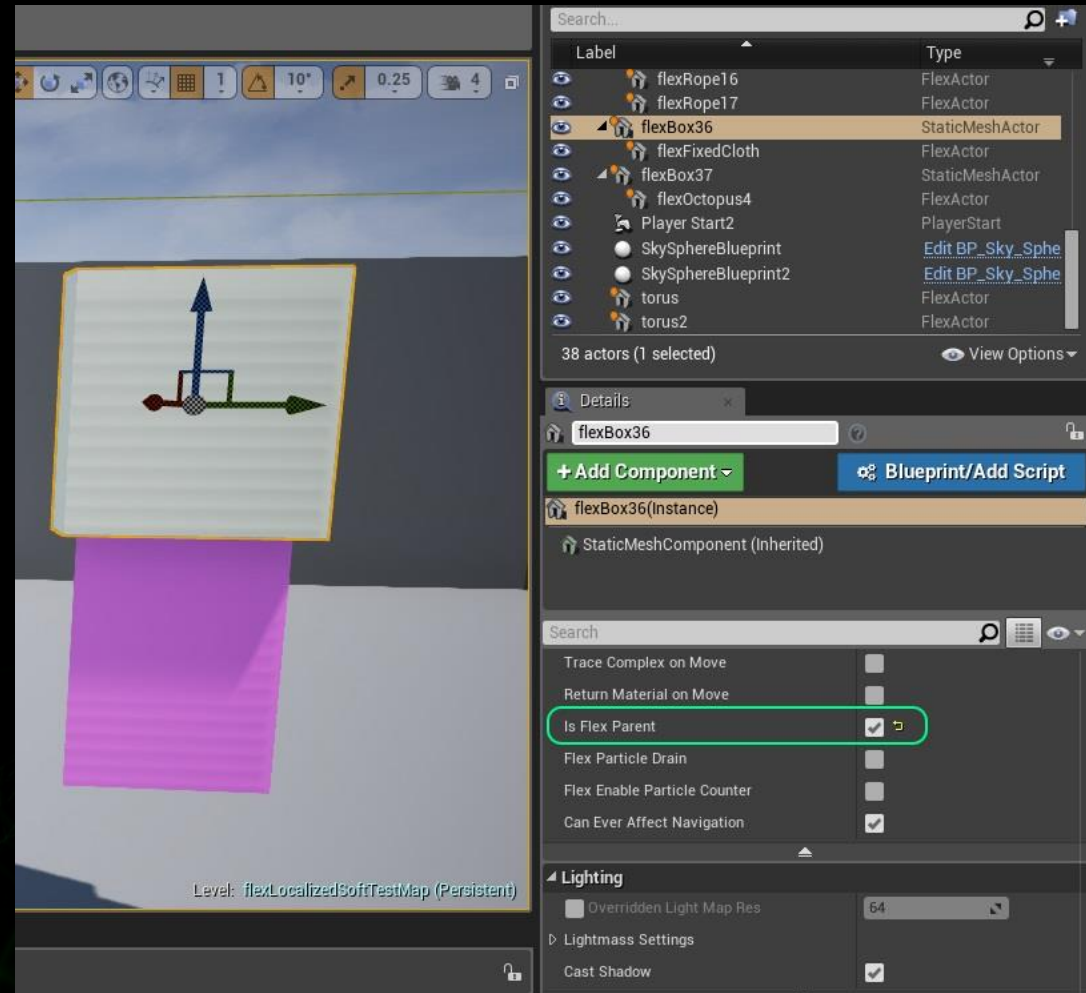
Enable the Local Space simulation option on the Flex component



Enable Local Space Simulation in UE4 cont.

● Step 3

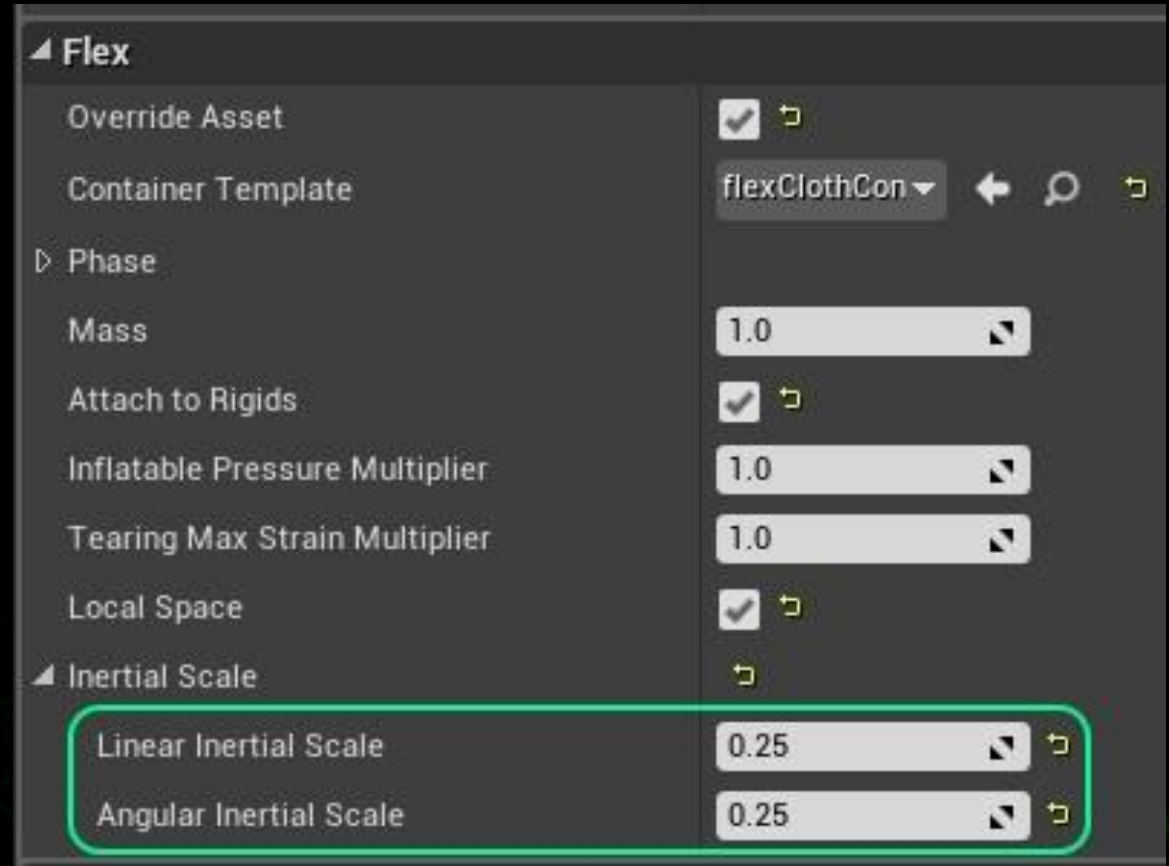
Enable Is Flex Parent on the parent object



Enable Local Space Simulation in UE4 cont.

- **Step 4**

Set the linear and rotational inertial strengths



Comparision

Global Space Simulation

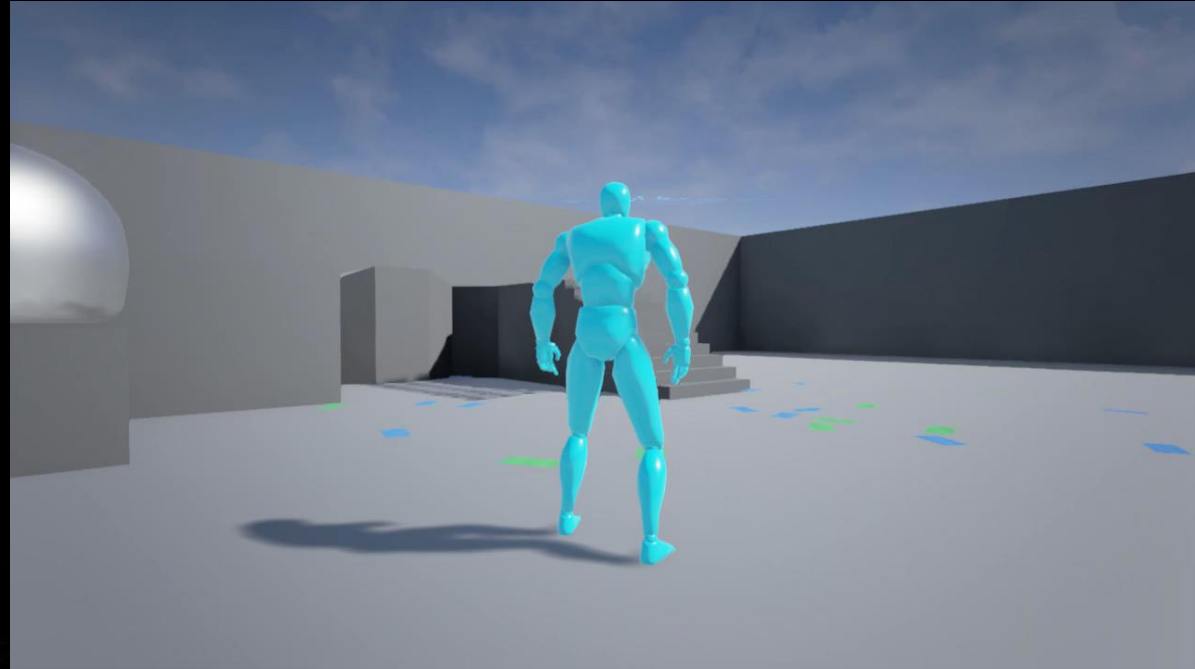


Local Space Simulation



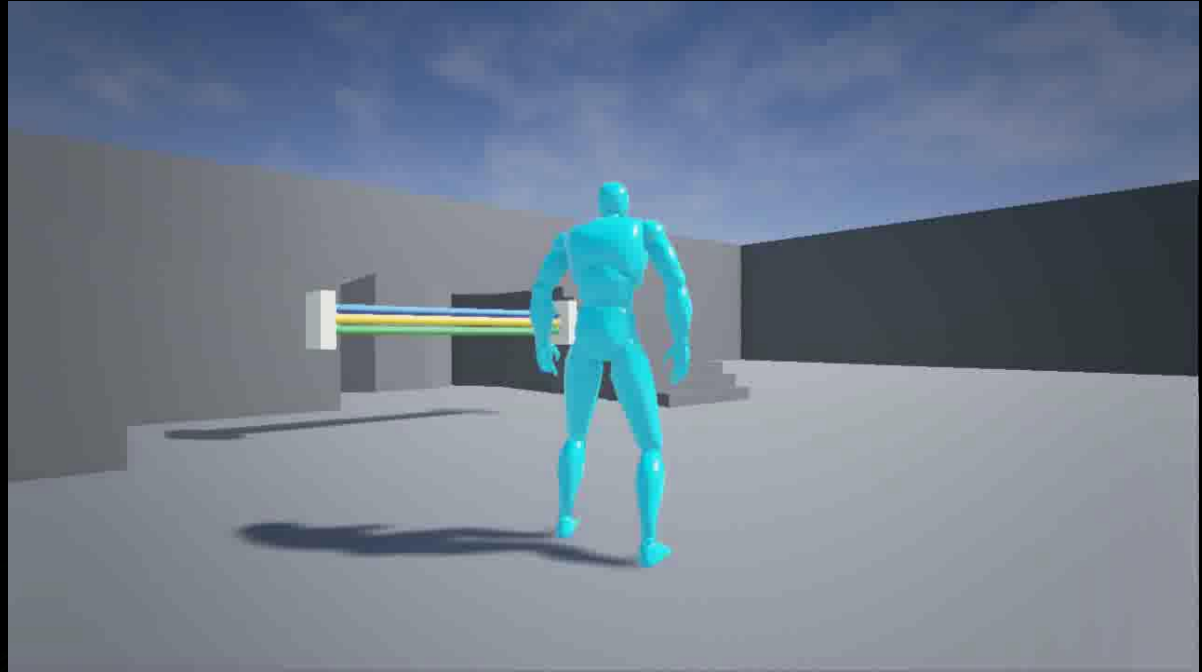
UE4-FleX Cloth

- Environmental cloth
- CCD Triangle Tests
- Auto-attachment to static or dynamic actors
- Inflatable constraints



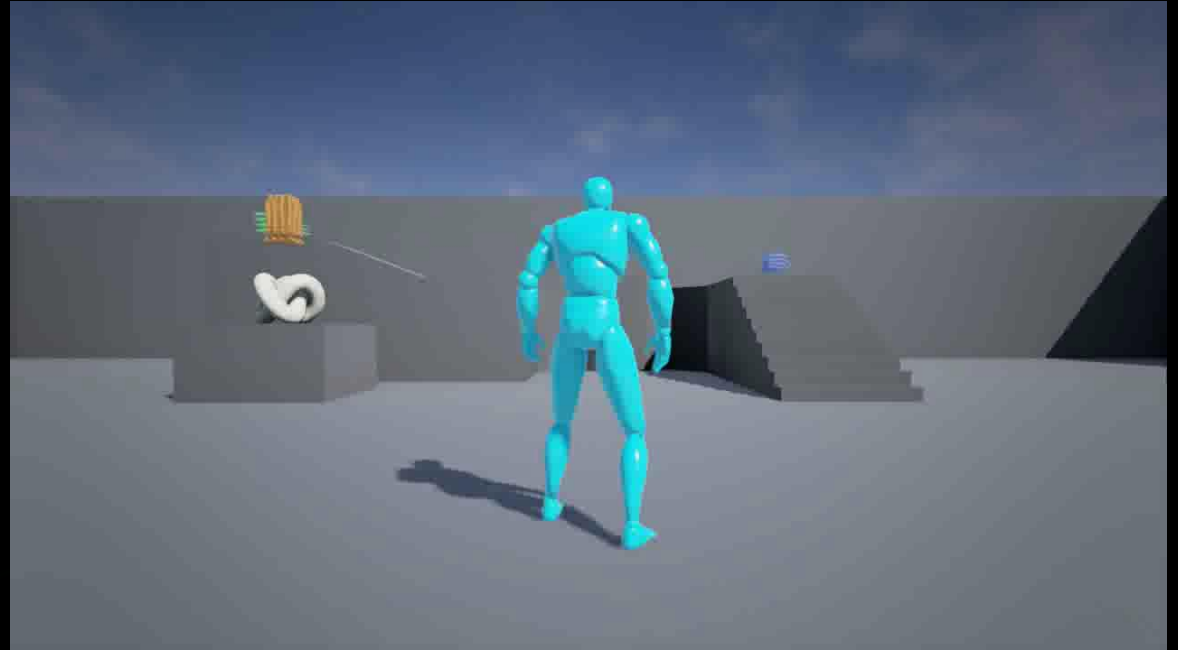
UE4-FleX Ropes

- Based on built-in UCableComponent
- Supports bending / self-collision / world collision



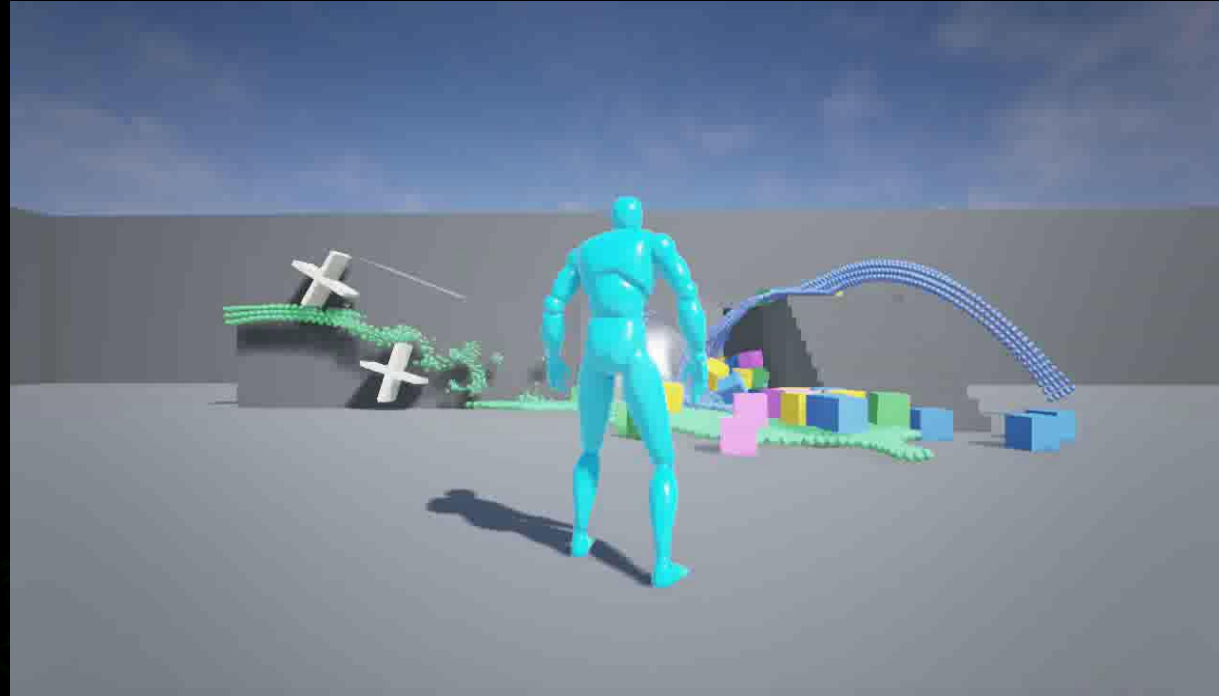
UE4-FleX Force Fields

- Integration with UE4
URadialForceComponent
- Scriptable with Blueprints
- Applied in CUDA through
FlexExtensions

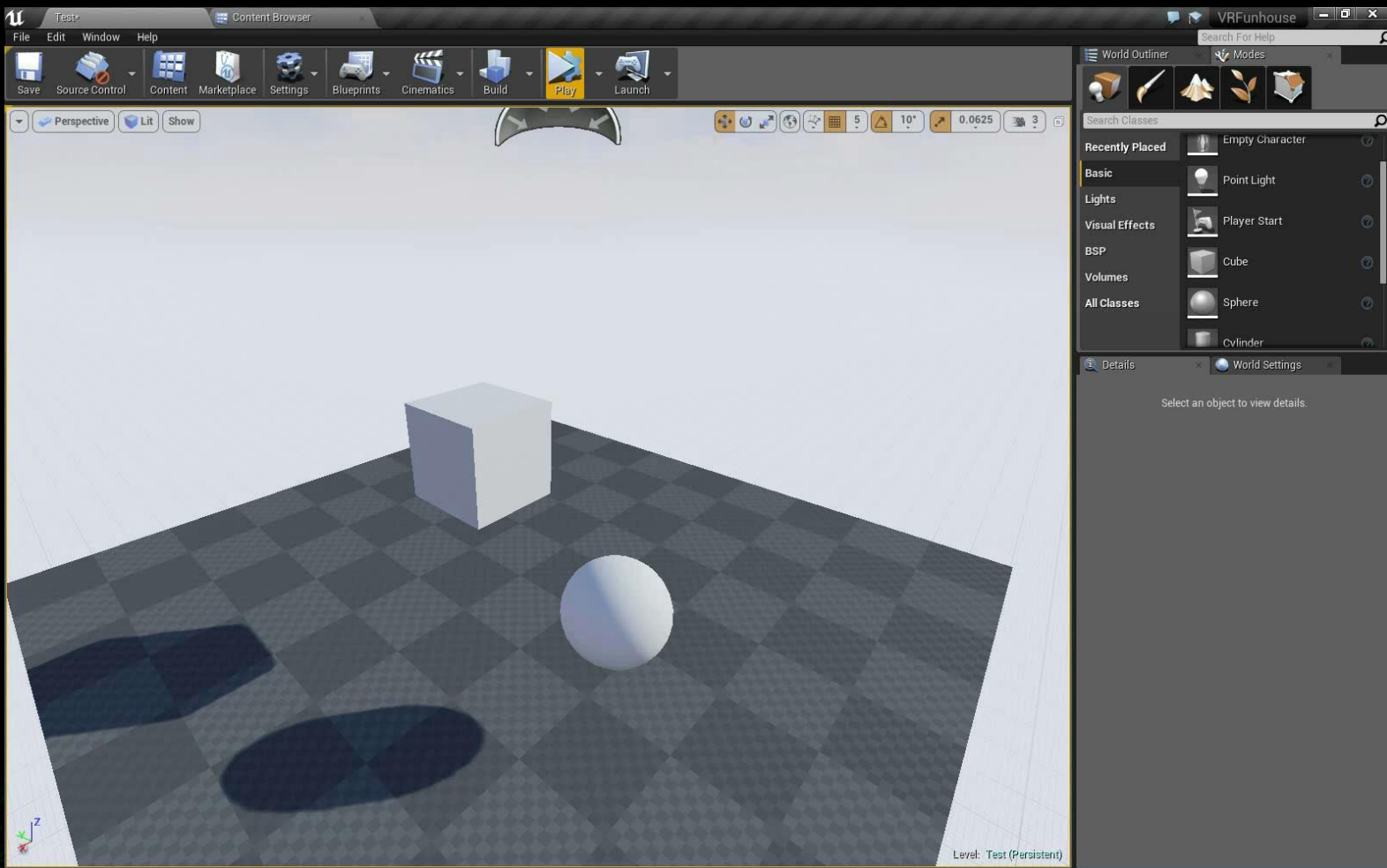


Interop between PhysX

- Two-way interaction between Flex \leftrightarrow PhysX
- Flex actors insert bounds into PhysX scene
- Overlap query per-Flex Actor
- Allows CCT to interact with Flex objects



Create a simple cloth demo with UE4-Flex



Overview

- GPU Rigid Bodies (GRB)
- FleX
- Flow
- WaveWorks



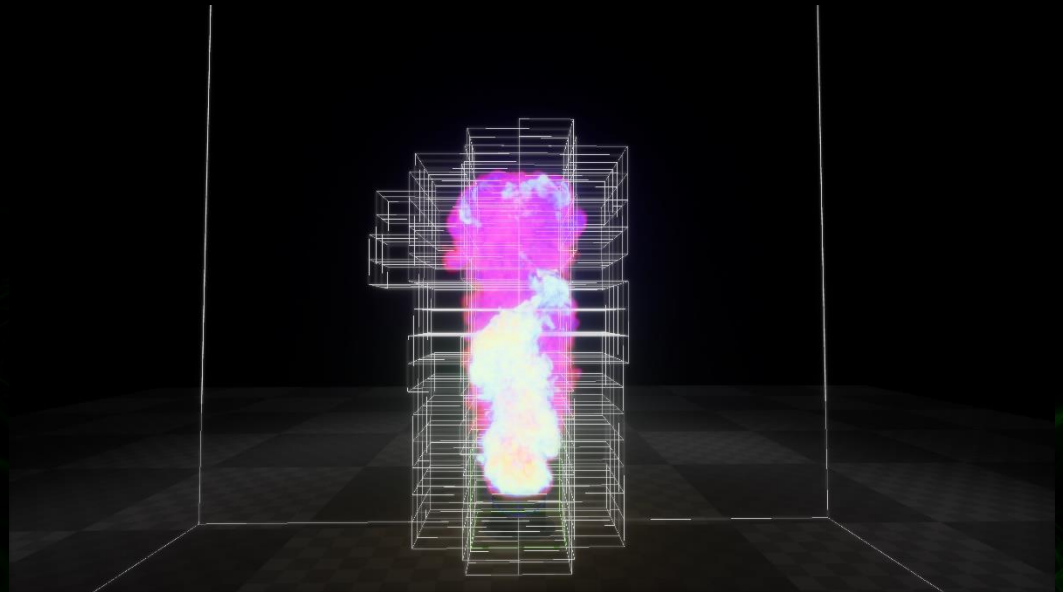
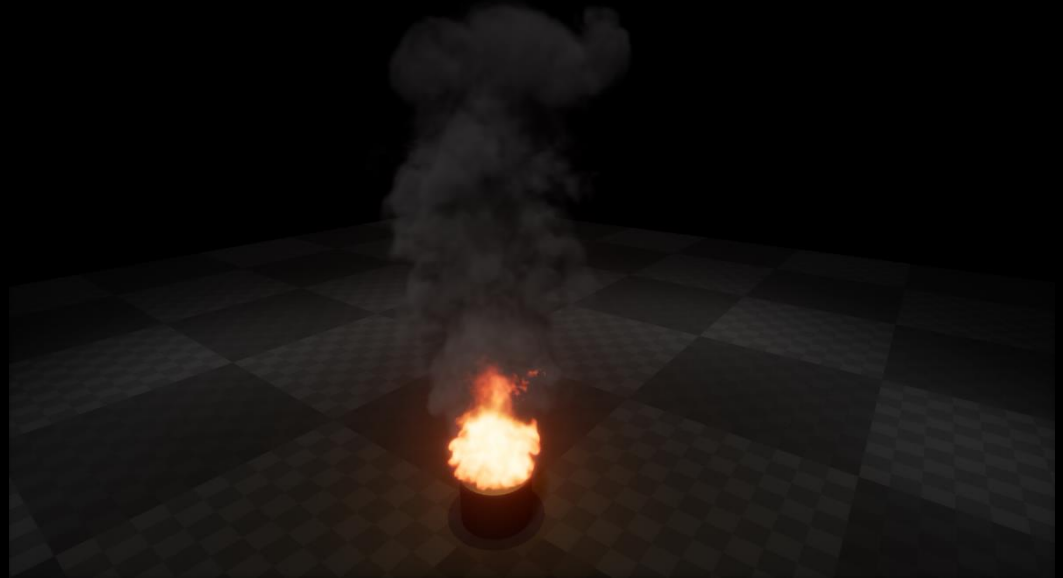
UE4-Flow Demo



FLOW

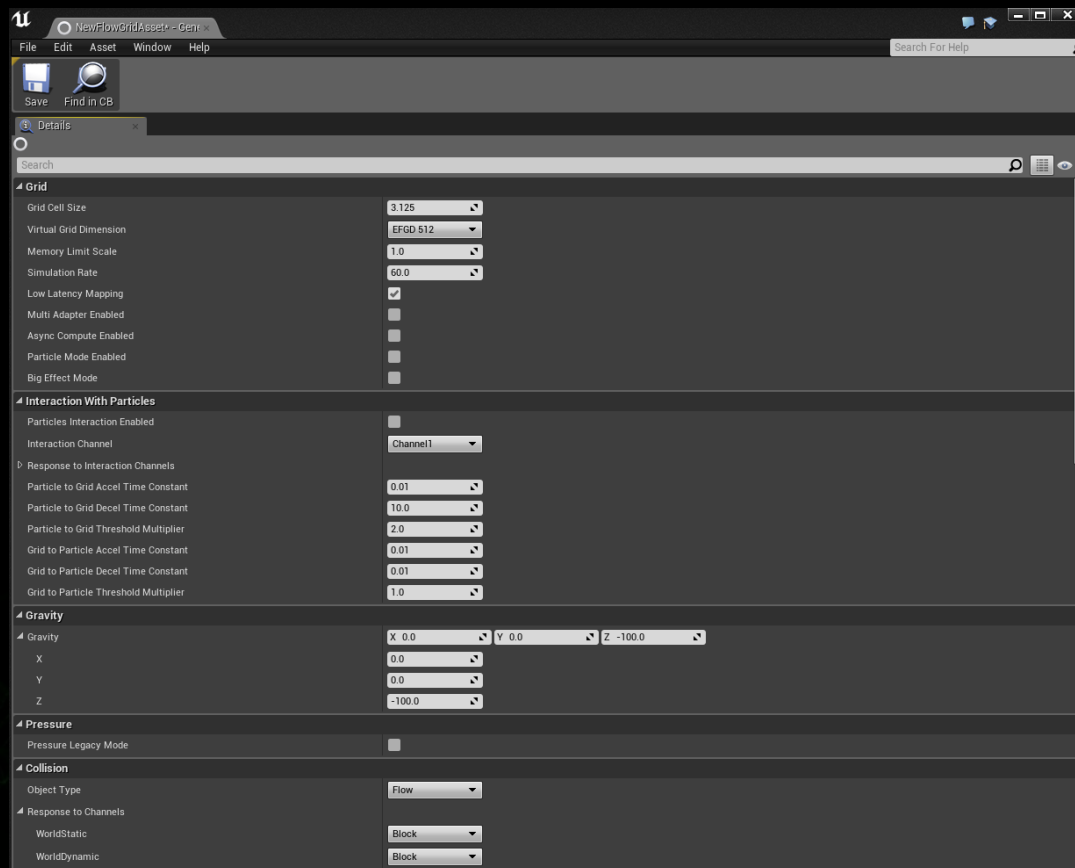
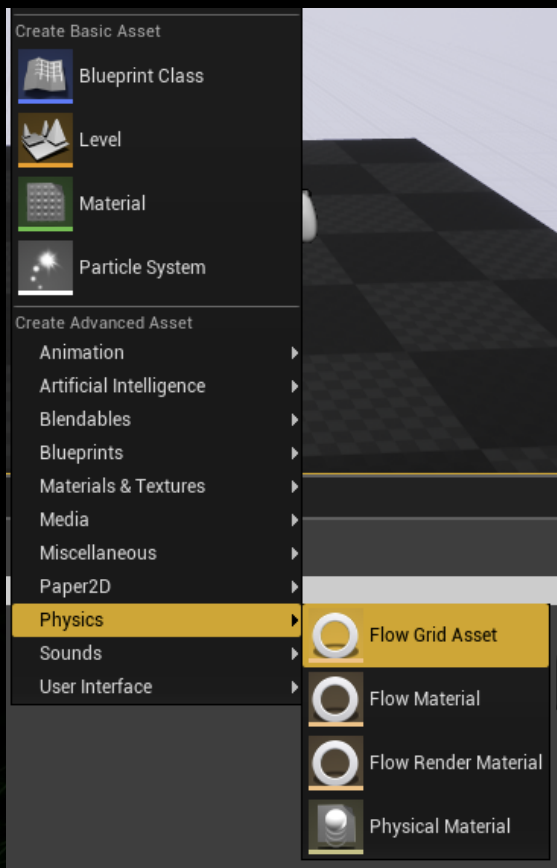
Features:

- Combustible fluid, fire and smoke
- Dynamic grid simulator
- D3D11 and D3D12 support
- Volume rendering



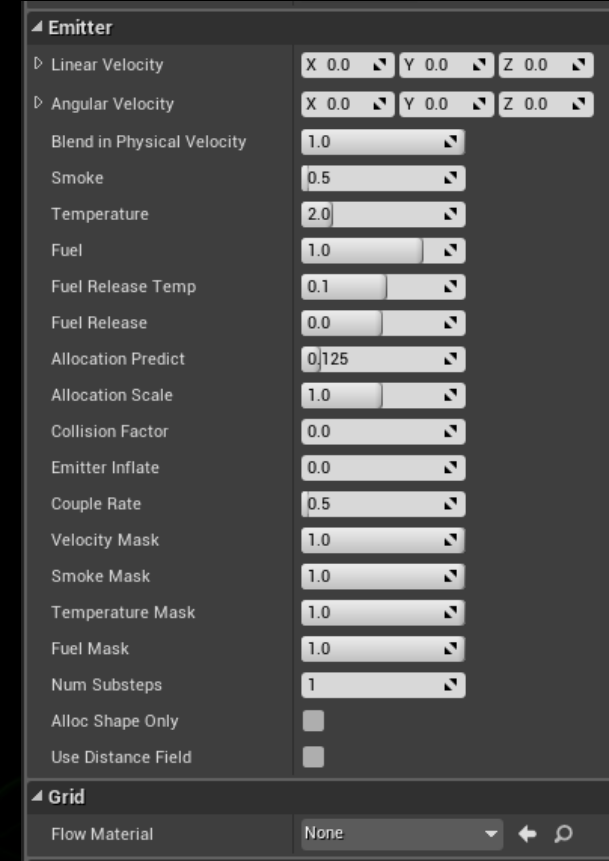
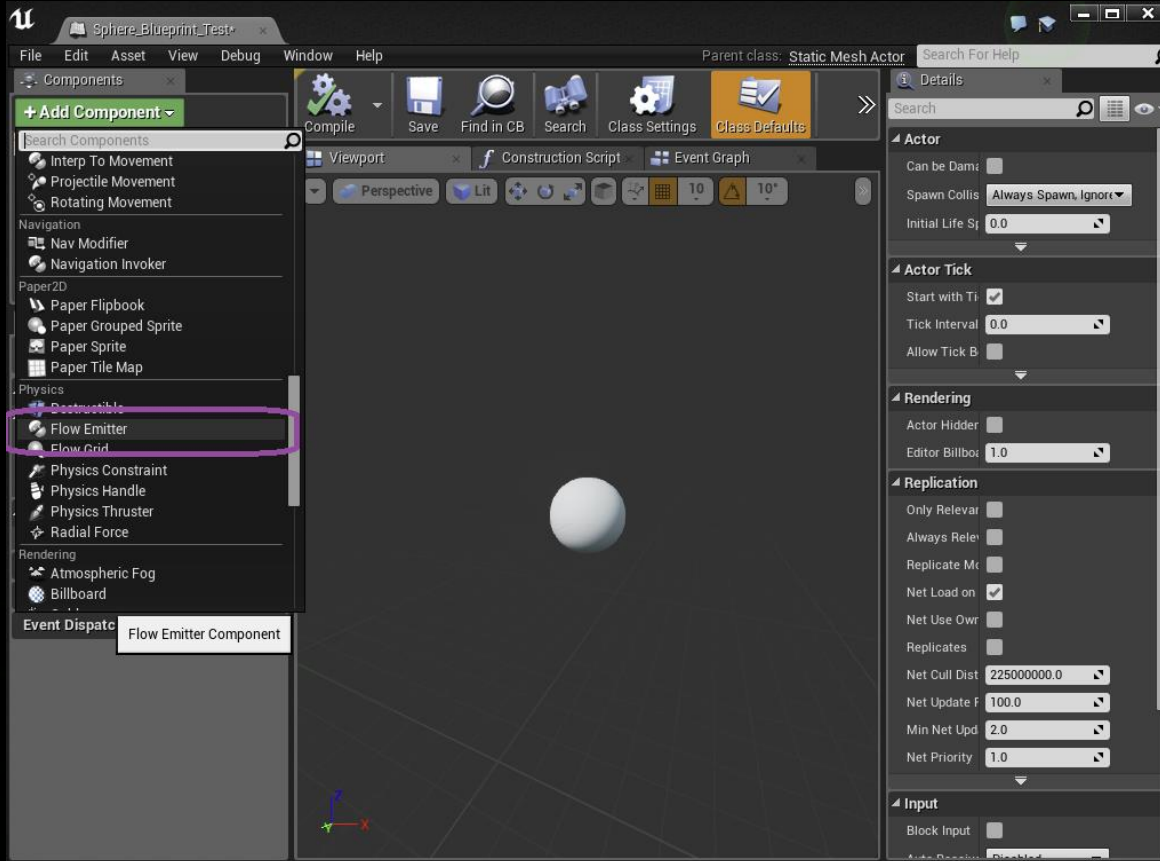
NVIDIA Flow In Unreal Engine 4

Create a grid



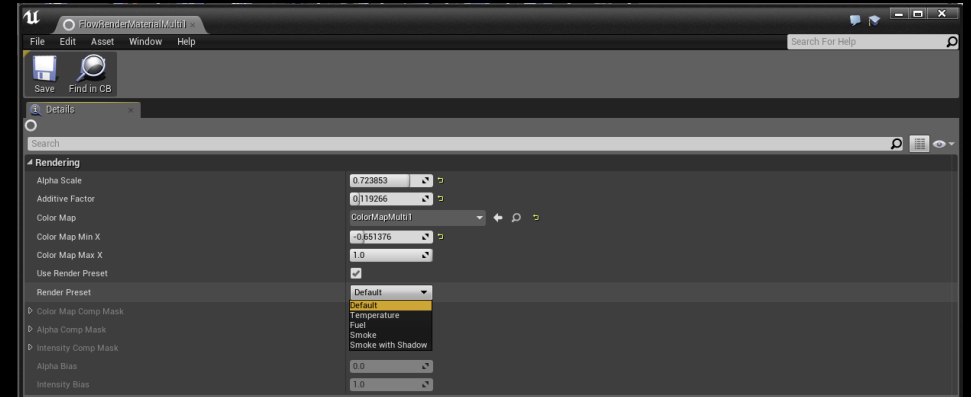
NVIDIA Flow In Unreal Engine 4 cont.

Create an emitter

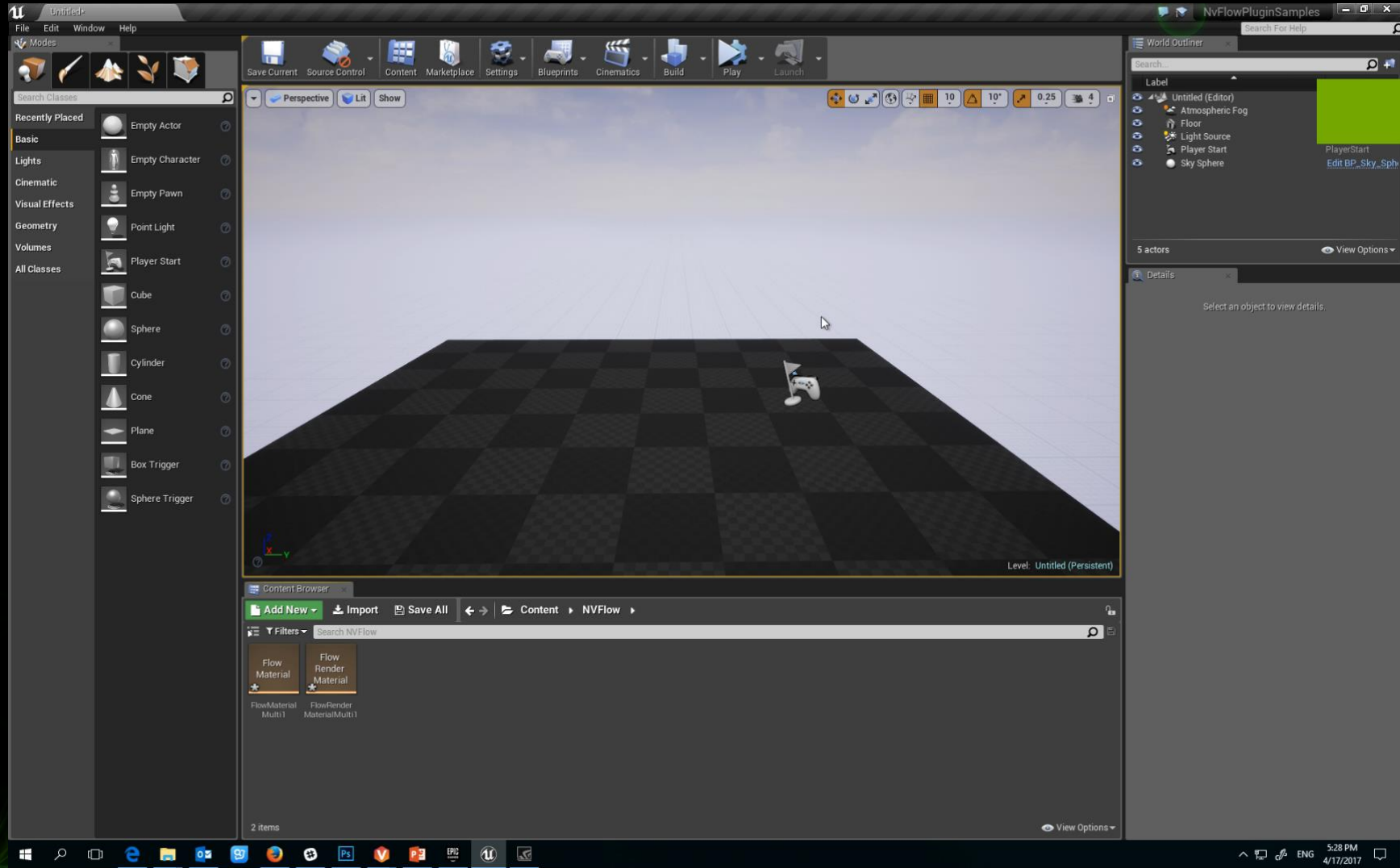


NVIDIA Flow In Unreal Engine 4 cont.

Setup Flow Material and Flow Render Material



Create a simple fire demo with UE4-Flow



Overview

- GPU Rigid Bodies (GRB)
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- Flow
- WaveWorks



Agenda

- UE4 WaveWorks Overview
- UE4 WaveWorks key features
- UE4 WaveWorks core components introduction
- How to use WaveWorks in UE4



UE4 WaveWorks Overview

- Enable developers to deliver a cinematic-quality ocean simulation for interactive applications
- Integrated to UE4 now
- Completed tools to create ocean and lake
- More features are coming ...





<https://www.youtube.com/watch?v=DhrNvZLPBGE>



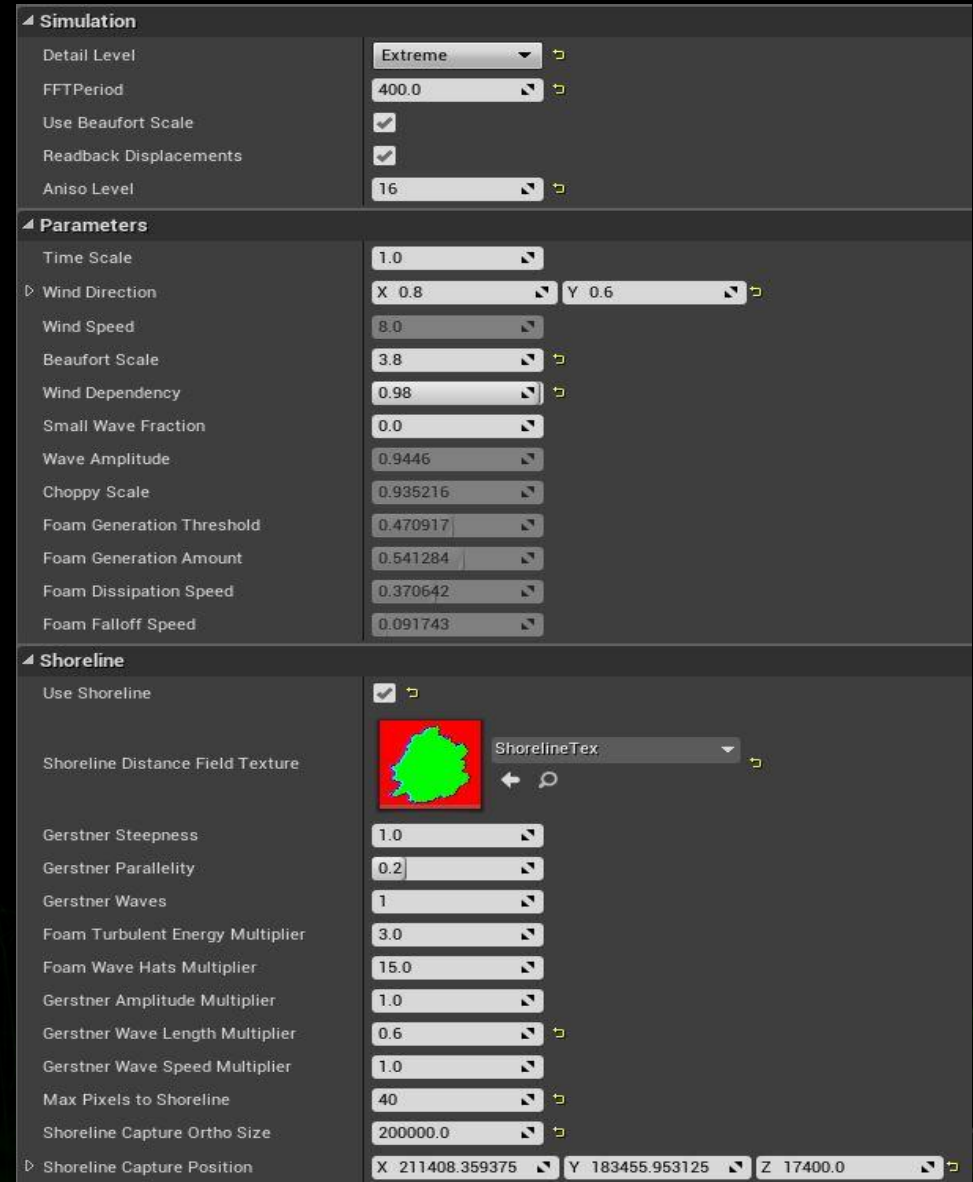
Key Features

- Completed ocean's simulation and rendering systems
 - Foam's simulation and rendering
- Shoreline effect
- Realtime physics feedback
- Tessellation
- Quad-tree tile-based LoDing
- Also can be used to create lake

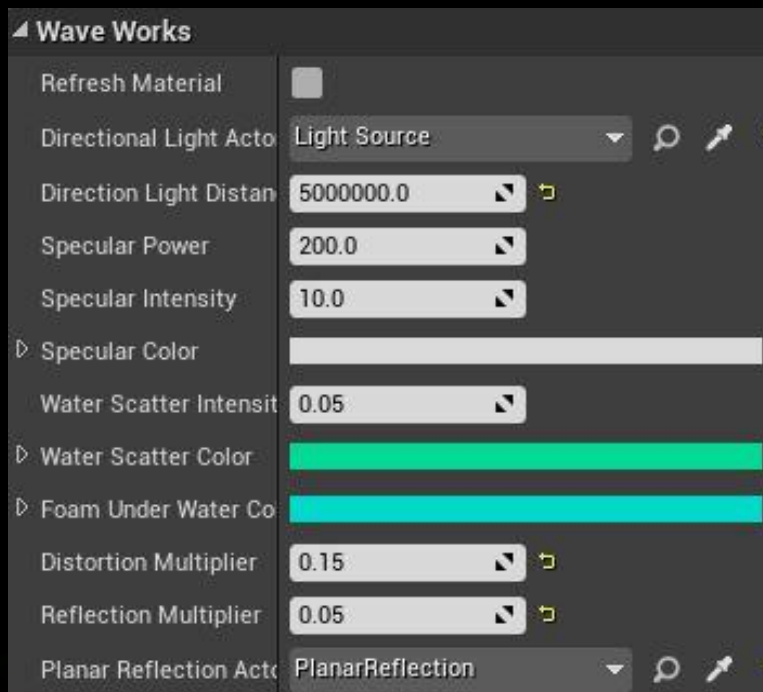


WaveWorks Asset

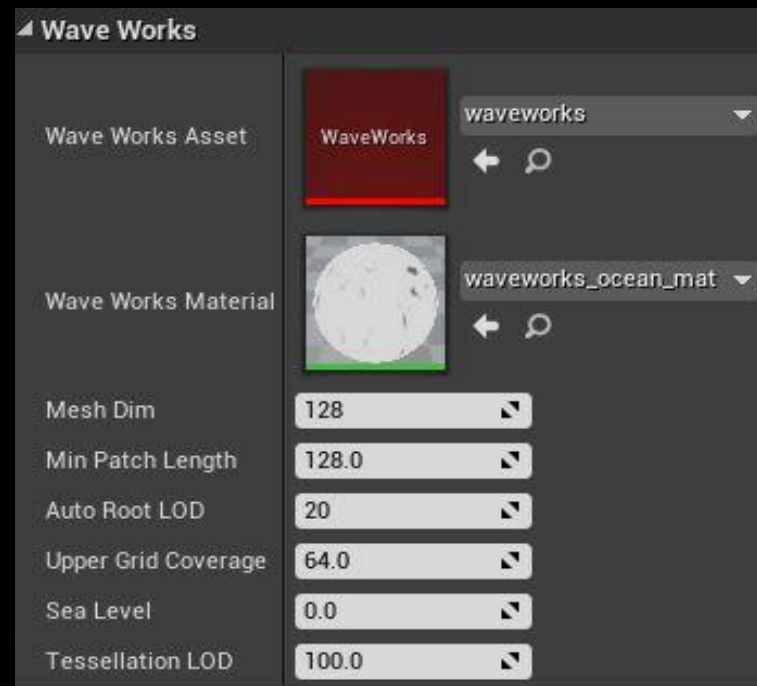
- Create WaveWorks Asset
- WaveWorks Asset details panel
 - WaveWorks simulation parameters
 - Shoreline parameters



WaveWorks Actor, Component



WaveWorks Actor

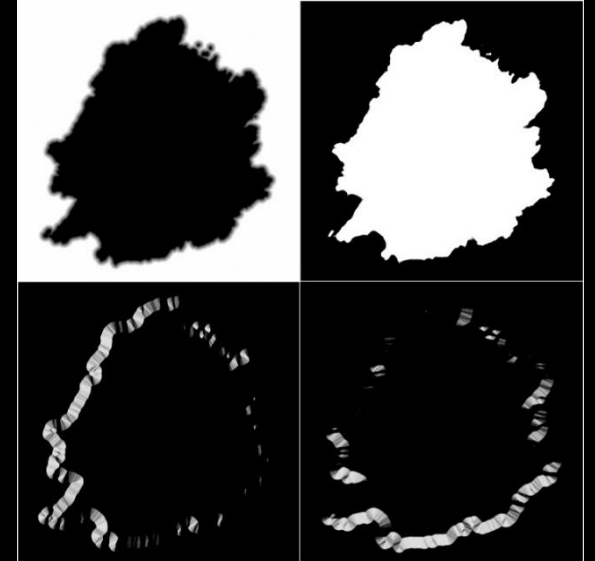
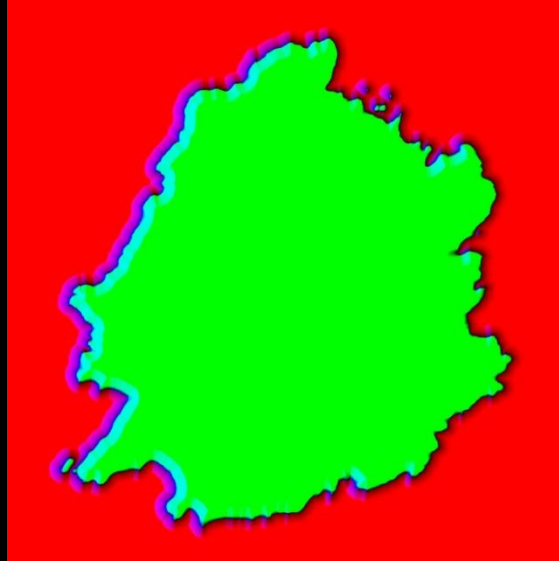


WaveWorks Component



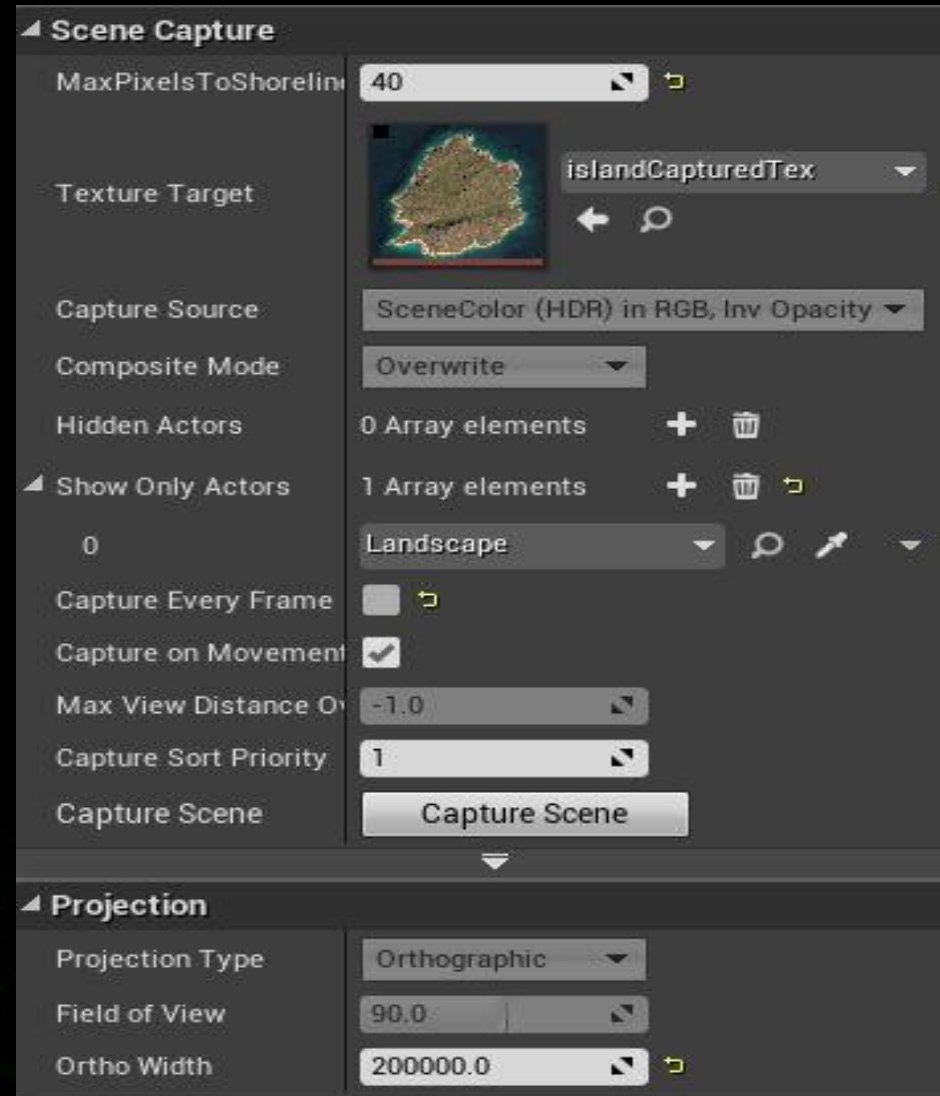
Shoreline

- Distance Field Texture
 - R: distance to shoreline
 - G: depth
 - B,A: gradient



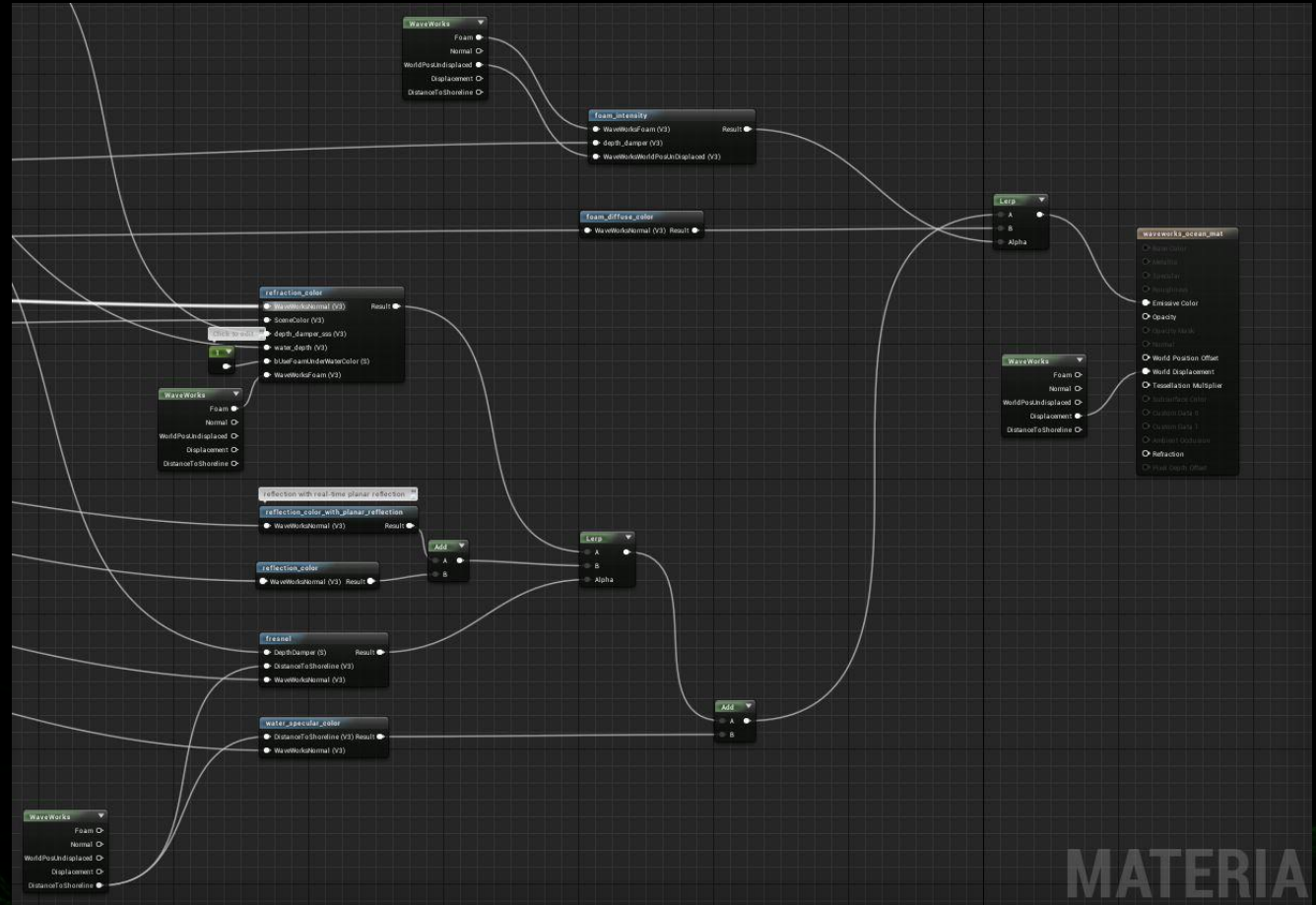
Shoreline

- Create Distance Field Texture
 - Set Capture Actor's Position
 - Fill the parameters
 - Click “Capture Scene” button



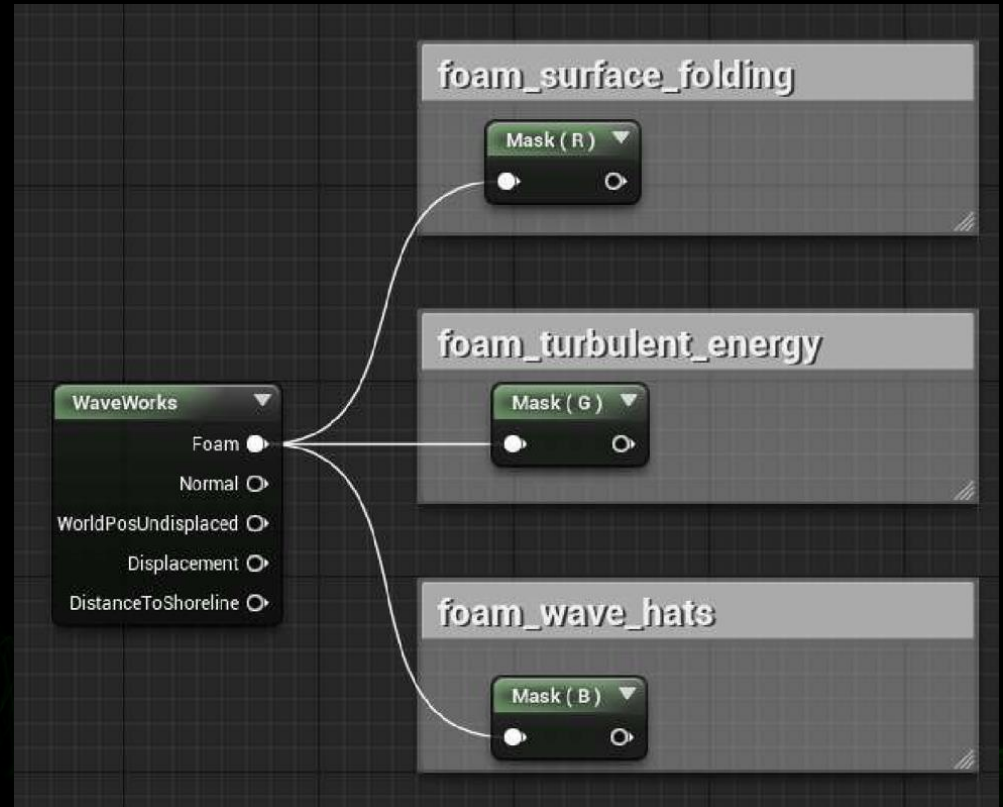
Rendering

- Ocean's Rendering
 - Reflection
 - Refraction
 - Specular
 - Foam



Rendering

- WaveWorks material node
 - Foam attributes
 - World normal
 - Un-displaced world position
 - Vertex's displacement
 - Distance to shoreline

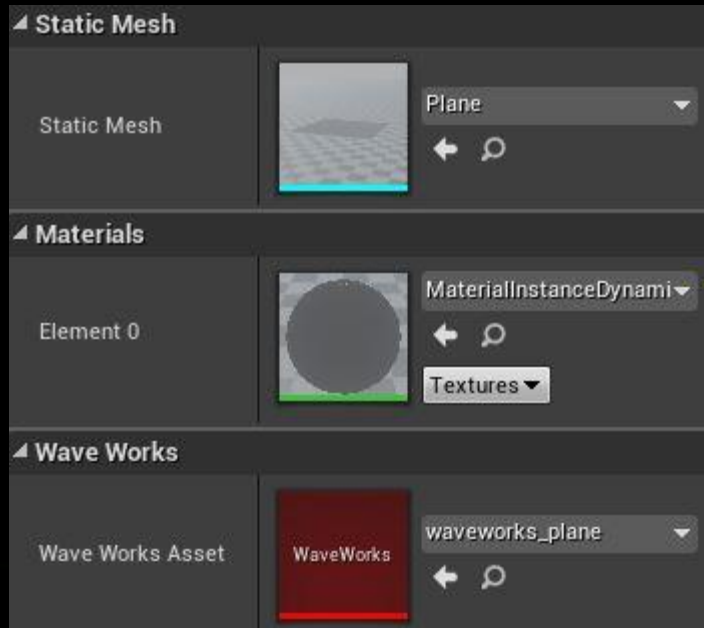


Physics Feedback

- Sample displacement
- Get intersection point between ray and ocean



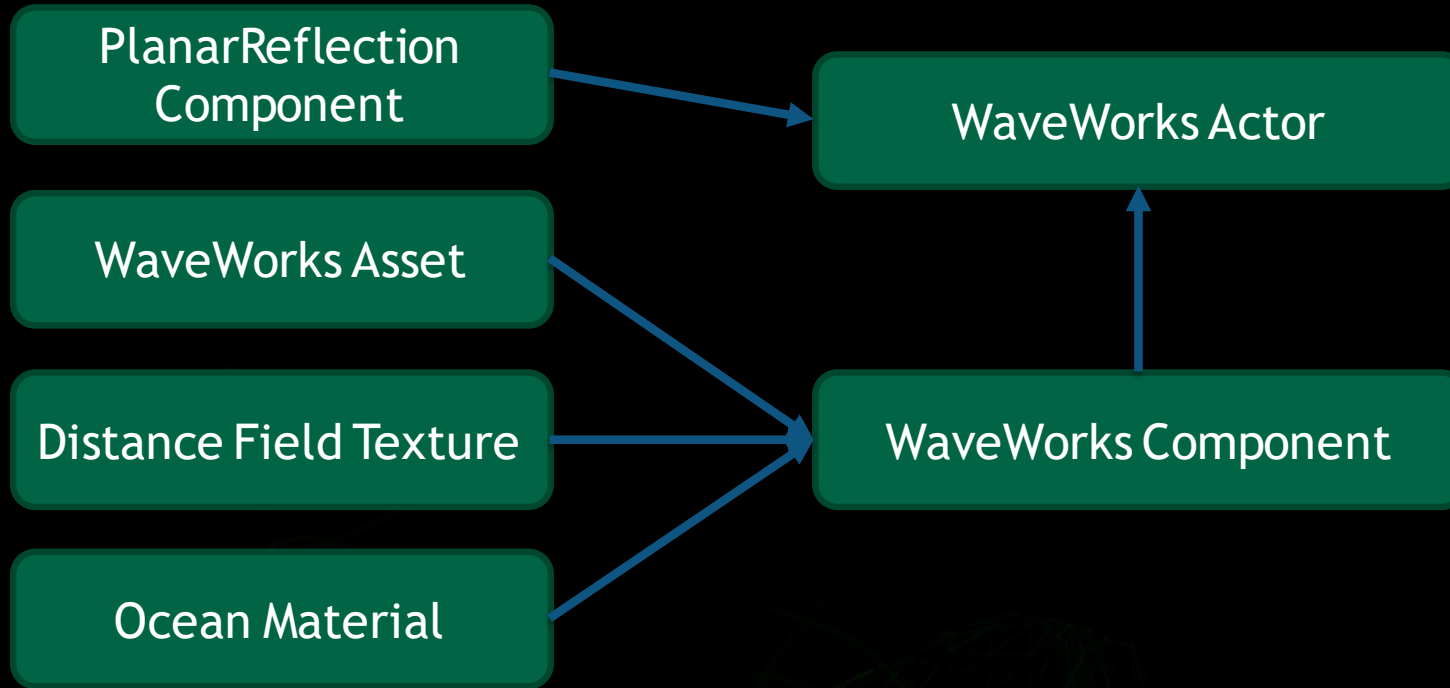
WaveWorksStaticMesh Component



WaveWorks StaticMeshComponent



Workflow in UE4



Join the GameWorks developer program

- If you don't have an account on developer.nvidia.com or are not a registered member of the NVIDIA GameWorks developer program then register here:

<http://developer.nvidia.com/registered-developer-programs>

- If you are logged in, accept the EULA and enter your GitHub username at the bottom of the form:


<https://developer.nvidia.com/gameworks-source-github>



<https://github.com/NvPhysX/UnrealEngine/tree/WaveWorks-4.16>

Branch: WaveWorks-4.16 ▾ New pull request Create new file Upload files Find file Clone or download ▾

This branch is 18 commits ahead, 89 commits behind EpicGames:release. [Pull request](#) [Compare](#)

 jackran111 update README.md Latest commit 9b4c758 an hour ago

Engine	fix bug : switch waveworks detail level to normal cause crash	an hour ago
Samples	Copying //UE4/Release-Staging-4.14 to //UE4/Dev-Main (Source: //UE4/R...	8 months ago
Templates	Updating config ini on some templates to include ResetVR input to res...	3 months ago
WaveworksTester	Add a floating sphere BP	9 days ago
.gitattributes	Engine source (4.0 branch up to CL 2027741)	3 years ago
.gitignore	Copying //UE4/Dev-Platform to Dev-Main (//UE4/Dev-Main)	5 months ago
GenerateProjectFiles.bat	Copying //UE4/Dev-Mobile to //UE4/Dev-Main (Source: //UE4/Dev-Mobile ...	7 months ago
GenerateProjectFiles.command	Updating copyright notices to 2017 (copying from //Tasks/UE4/Dev-Copy...	7 months ago
GenerateProjectFiles.sh	Updating copyright notices to 2017 (copying from //Tasks/UE4/Dev-Copy...	7 months ago
LICENSE.md	Always reference the latest EULA from GitHub rather than including a ...	3 months ago
README.md	update README.md	an hour ago
Setup.bat	Don't append the --prompt argument to GitDependencies.exe if it's alr...	2 years ago
Setup.command	Updating copyright notices to 2017 (copying from //Tasks/UE4/Dev-Copy...	7 months ago
Setup.sh	Updating copyright notices to 2017 (copying from //Tasks/UE4/Dev-Copy...	7 months ago
UE4Games.uprojectdirs	PR #877: Fix typo (Contributed by DaJoker29)	2 years ago

