



Sorting through the Rubble: A Review of Destruction Techniques

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GAME DEVELOPERS CONFERENCE

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Overview

- Preparation
- In game destruction
 - Swap
 - Fracture
 - VFX Parameters
- Third party destruction
 - Sequencer

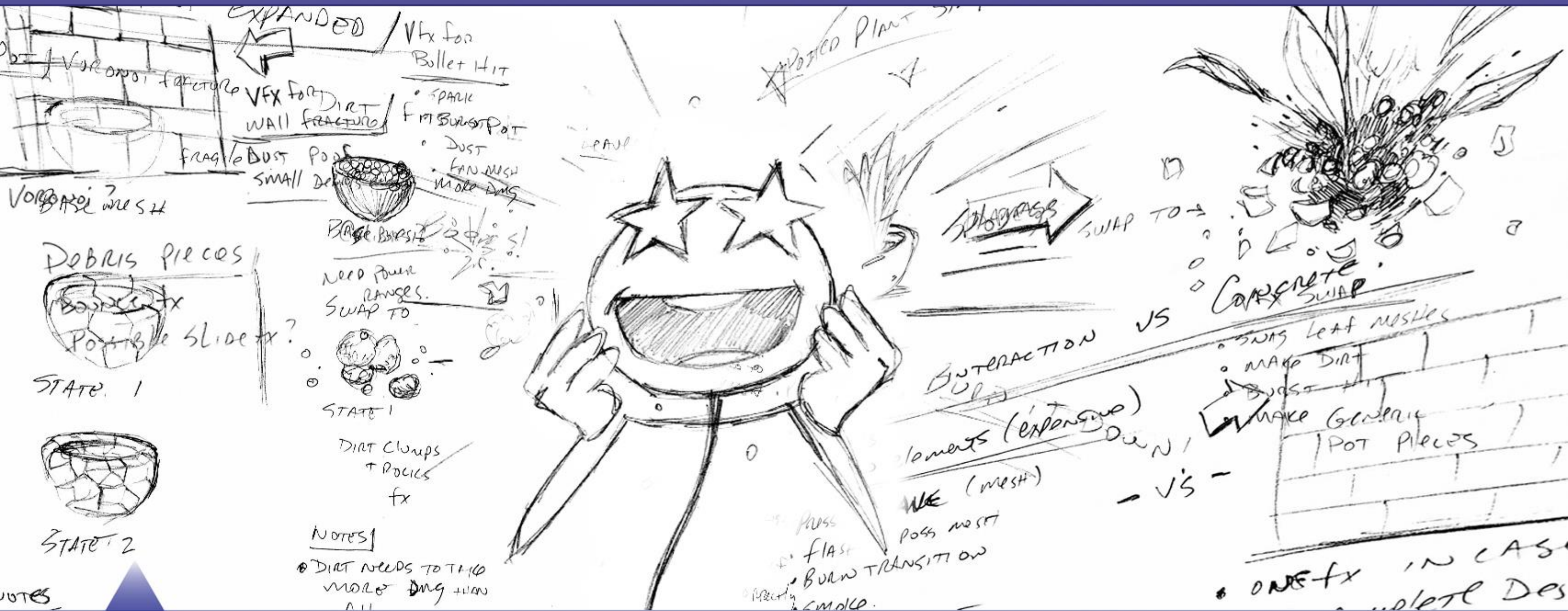


My Other Talk

- JC3 Free Reign talk (2016)
 - Destruction
 - RBD built destruction
 - Havok destruction
 - Forces
 - Chain reactions



Preparation



Preparation: Communication

- Project questions
 - Big dreams for destruction!
 - Help manage the big dream.
 - So how do you do that?



Preparation: Communication

- Design and Art questions
 - Scope: How many destruction objects are we looking at?
 - Design: Is there an overall design in place for destruction?
 - Simple or detailed?
 - How does destruction add to the game play loop?
 - Are there destruction set pieces?
 - AD: What is the visual language



Preparation: Communication

- Engineering questions!!
 - What does the engine do well?
 - Will engineers be creating a system?
 - How is damage being calculated?
 - Make sure damage makes sense!!!
 - How much budget do we have for destruction and physics?
 - Debris??



Preparation: Debris

- More engineering questions
- Debris Clean-up?
 - Live physics pieces can become expensive
 - Disappear?
 - Rest?
 - VFX to remove?
 - Game Logic specific removal
 - Or not?



Preparation: Research

- R&D
 - No destruction in place
 - Research Tools
 - Don't get stuck with a favorite
- New destruction tech
 - Be an active participant
 - Templates for solved problems

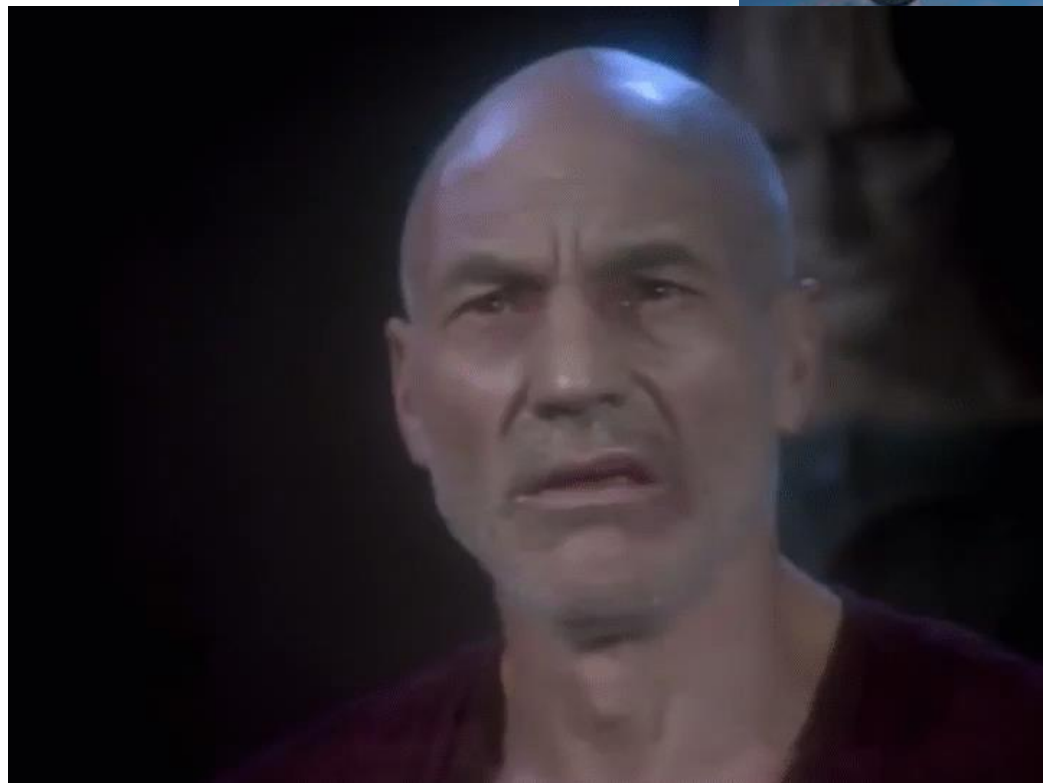


Preparation: Kick the tires

- If destruction system exists
 - Get some time to break the system
 - Make tests
- Be responsible by being irresponsible.
 - Create scenarios



Preparation: There are 4 tanks!



Preparation: Surface Types

- VFX questions
- Identify your surfaces
 - By type
 - Concrete
 - Wood
 - Glass
 - Metal
 - Special Cases



Preparation: Destro Method

- Identify how you might break each type
 - Examples
 - Props: (Swap)
 - Concrete (Voronoi fracture)
 - Wood (Voronoi fracture)
 - Glass (Radial Fracture)
 - Metal (Hide/Show/New Tech/electronics?)
 - Armor (Skel mesh constraint/Voronoi hybrid)
 - Vehicles (custom system)
 - Cinematic (off line third party for in game play or spectacle)



Preparation: VFX

- Identify your destruction VFX needs.
 - Please remember sound
 - General needs (per surface type)
 - Critical Break VFX
 - Fracture VFX
 - Slides VFX
 - Impacts
 - Trails
 - Special case VFX



Preparation: Specific objects

- Consider the potted plant...



Preparation: Version 1

- More than one way to break a potted plant
- Middle distance and 3rd person.
 - Here's Simple plan.
 - Hide the mesh
 - Play an effect.
- You can then use this plan to get a list together of needs and build your stuff.

POTTED PLANT Simple

Hide / Show



SWAP TO →



POTTED PLANT

- POT
- DIRT
- PLANT / STEMS
- ROOTS ?

VFX SWAP

- SWAP Leaf meshes
- MAKE DIRT
- BURST HIT
- MAKE Generic POT pieces

Preparation: Version 2

- Potted Plant part 2
 - FPS
 - Here's a less simple plan.
 - All elements have different damage
 - Pottery has more states
 - Leaves are using constraints
 - Still play an effect.
 - But its divided into the stages.
 - You can then use this plan to get a list together of needs and build your stuff.

POTTED PLANT EXPANDED

POT / Voronoi fracture



fragile

Base mesh



STATE 1



STATE 2

NOTES

SURFACE: CERAMIC
USE CONCRETE HITS

DIRT / FITS IN POT



MORE DMS

Base mesh

SWAP TO



STATE 1

DIRT CLUMPS
+ ROCKS
fx

NOTES

- DIRT NEEDS TO TAKE MORE DMS THAN ALL
- CLUMPS NEED TRANSITION fx

LEAVES



Base mesh
6 meshes
CONSTRAINED TO
DIRT MESH

NOTES

- DMS TO LEAVES
BREAK CONSTRAINT
- LEAVES MASS AND U LIST
- WOULD BE NICE IF THEY MOVED CORRECTLY

QUESTIONS

How to clean up?

Preparation: VFX

- VFX Scale
 - Size ranges per type?
 - In Game Data?
 - Can you reuse/scale those FX or will you be scaling dupes?
 - Example: Concrete?
 - Material Variants
 - Scale



Preparation: VFX

- Consider interactions
 - What interaction methods will happen with destruction?
 - Bullets (bullets/projectiles)
 - Physical (ramming/punch/etc)
 - Explosive ('instant' radial force)
 - DOT (burn)
 - Specialty methods
 - Try to not work in isolation



Preparation: Remember



- Sometimes things get lost:
 - Preparation Identifies holes (No pun)
 - Plan = systems
 - You'll need to budget time all this stuff.

Preparation: Wrap up

- Identify the Dream
- Design Questions
- Art Director Questions
- Engineering Questions
- Do your research
- Kick the tires
- VFX Considerations
- Get specific
- Systems are good



Create Overview

- Base Mesh Rules
- States
- Constraints
- Destruction Methods
 - “Destruction”
 - Fracturing
- Animated destruction
- Data driven destruction VFX (sprinkled)



Create: Base Mesh

- Base Mesh Rules
 - Watertight
 - Cheap-ish
 - Create all of the different states (if needed)
 - Create Pieces and parts for assembly (if needed)
 - Debris meshes/pieces
 - Inside surfaces (substance)



States

- The current condition of the object/actor
 - Initial state
 - Props might have only 2 states
 - More complex objects might have more
 - larger buildings
 - game loop dependent

POTTED PLANT Simple Hide / Show



SWAP TO →



POTTED PLANT

- POT
- DIRT
- PLANT / STEMS
- ROOTS ?

VFX SWAP

- SWAP LEAF MESHES
- MAKE DIRT
- BURST HIT
- MAKE Generic POT PIECES

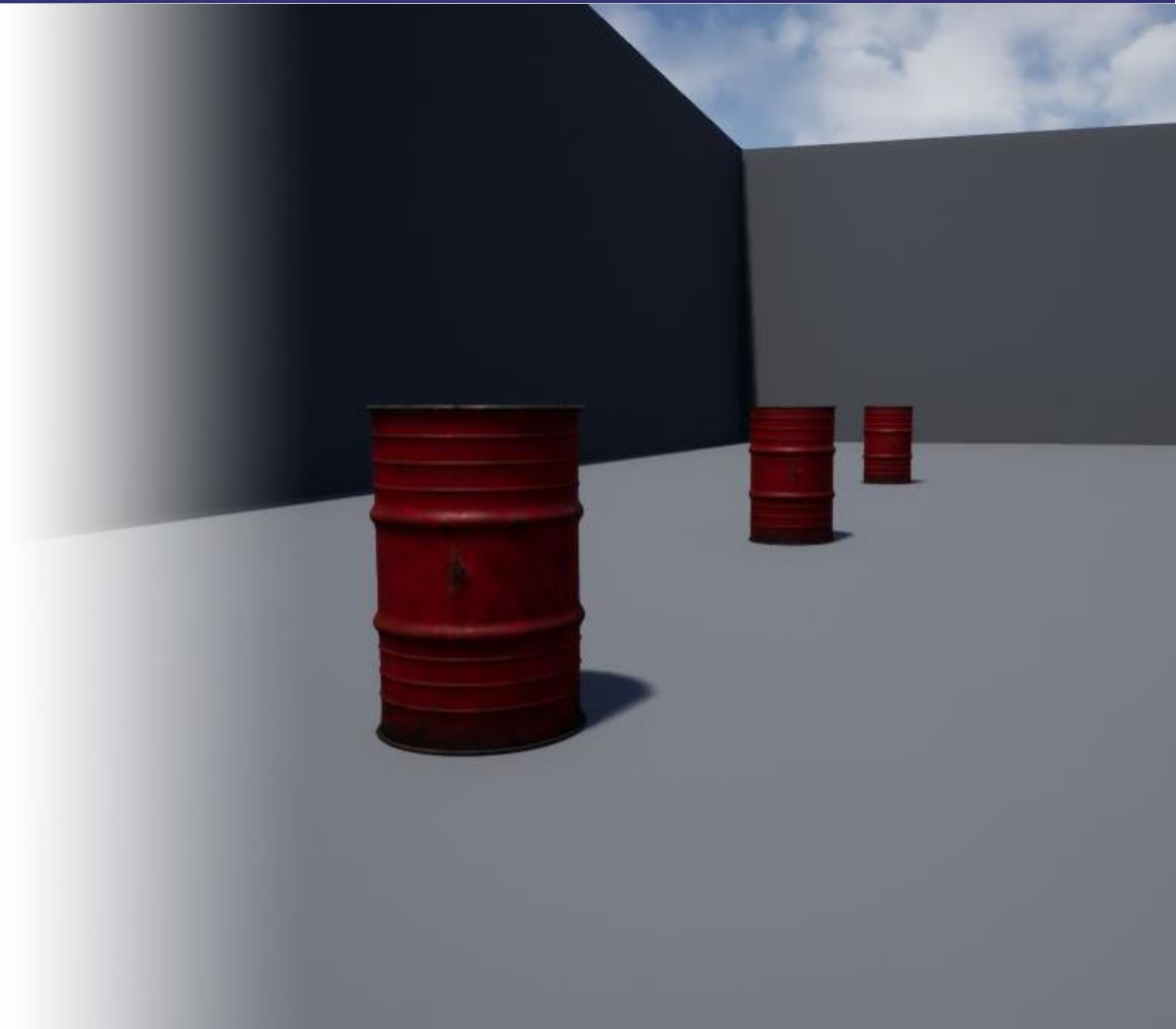
“Destruction”

- Stage Magic: Swap
- in game world destruction
- The destruction is the change to the effect
 - Can have multiple states (DOT)
 - Potentially damage
 - for game play loop



“Destruction”

- Generally fragile props
 - Takes damage and mesh hides/cleans up
 - Effect covers the ‘Hide’
 - The ‘Show’ is the effect

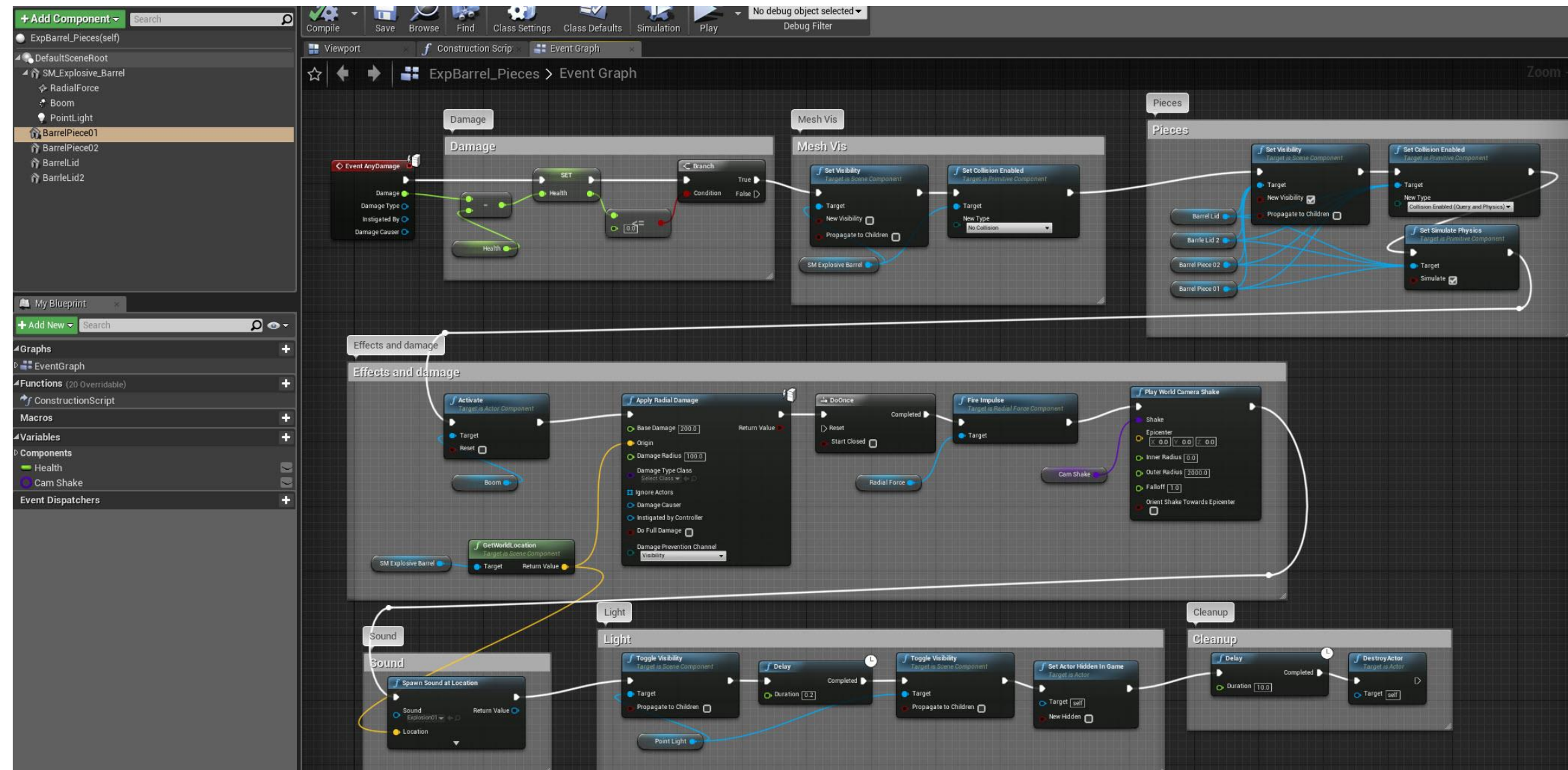


Barrel “Destruction”



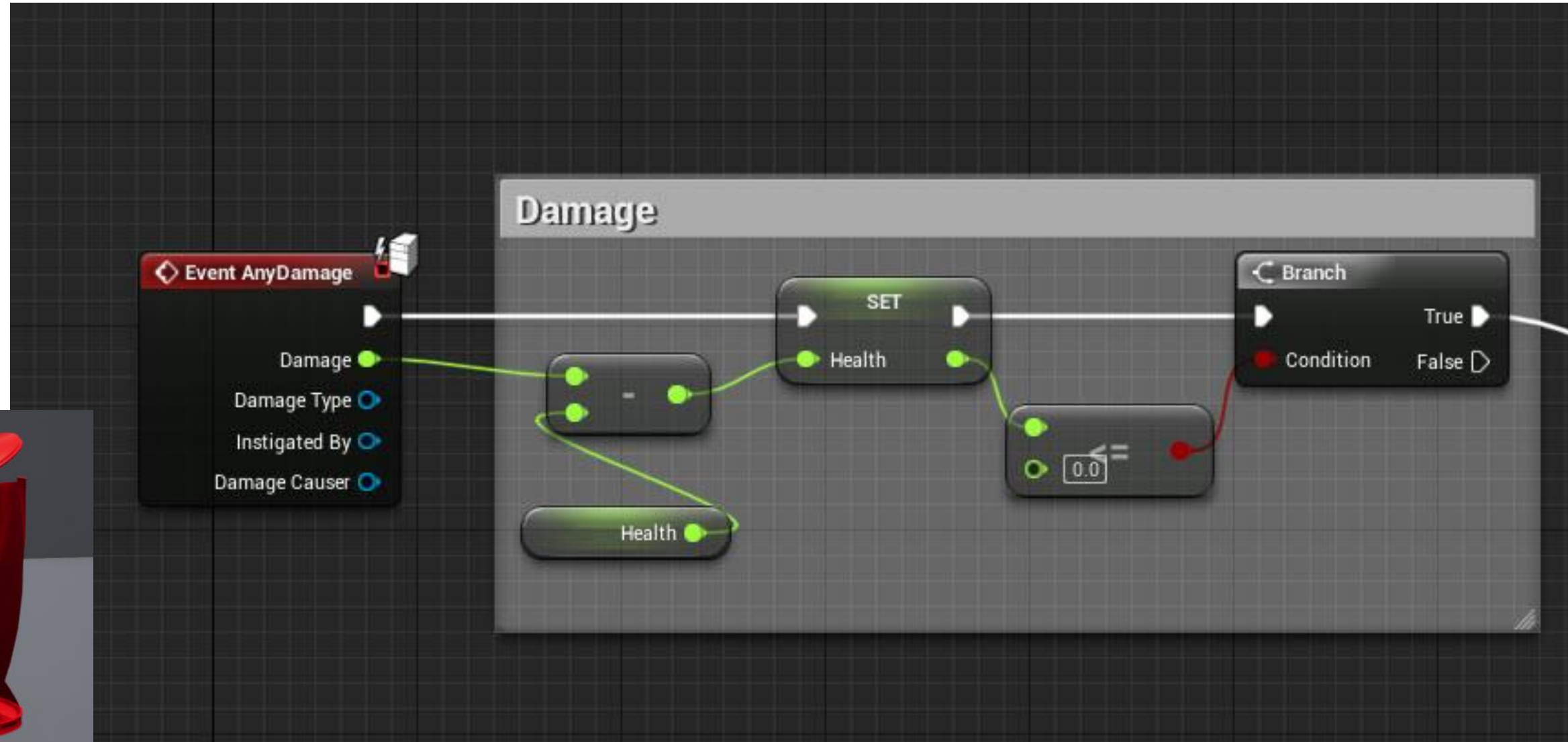
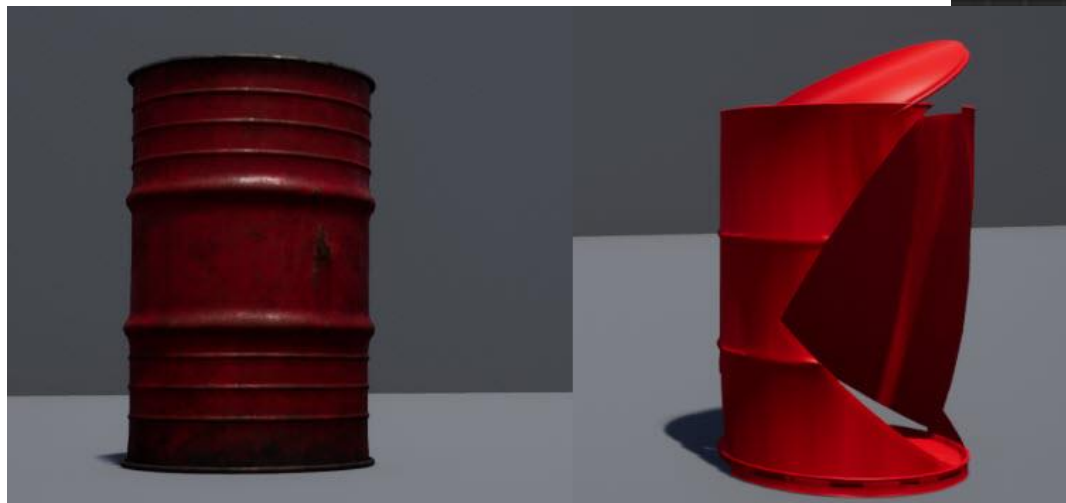
Barrel “Destruction”

- Blueprint
 - Clean barrel
 - Barrel Pieces
 - Light
 - Effect
 - Sound
 - Radial Force
 - Camera Shake



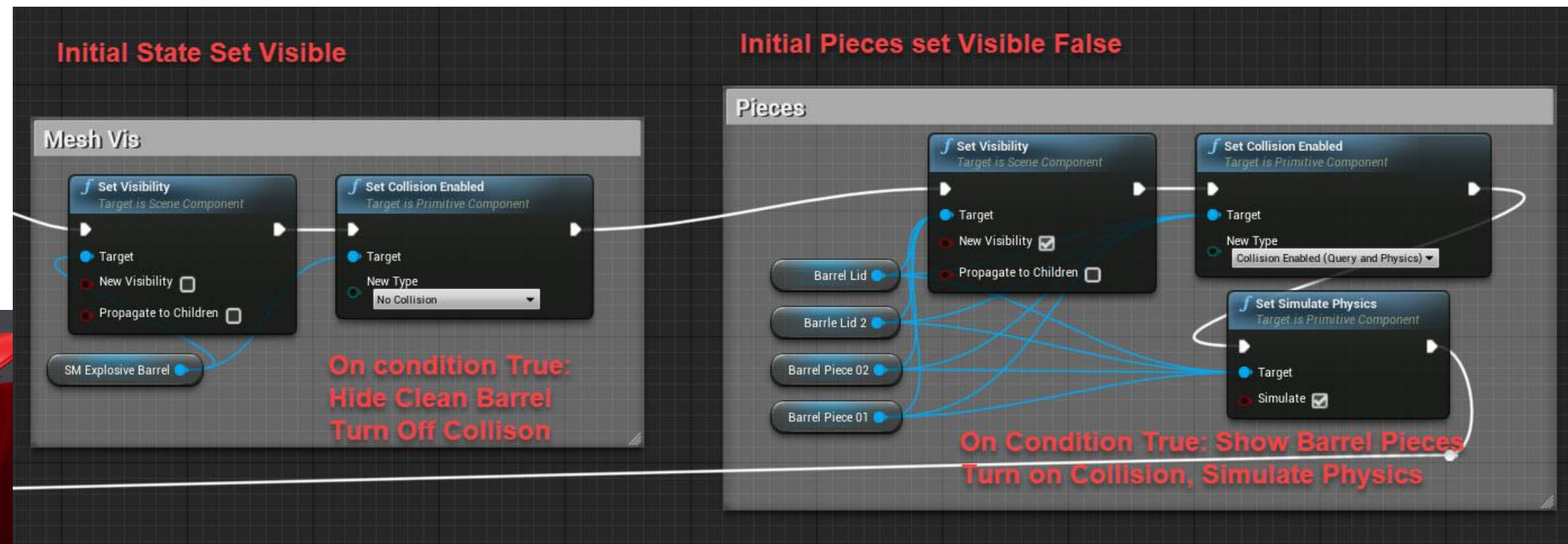
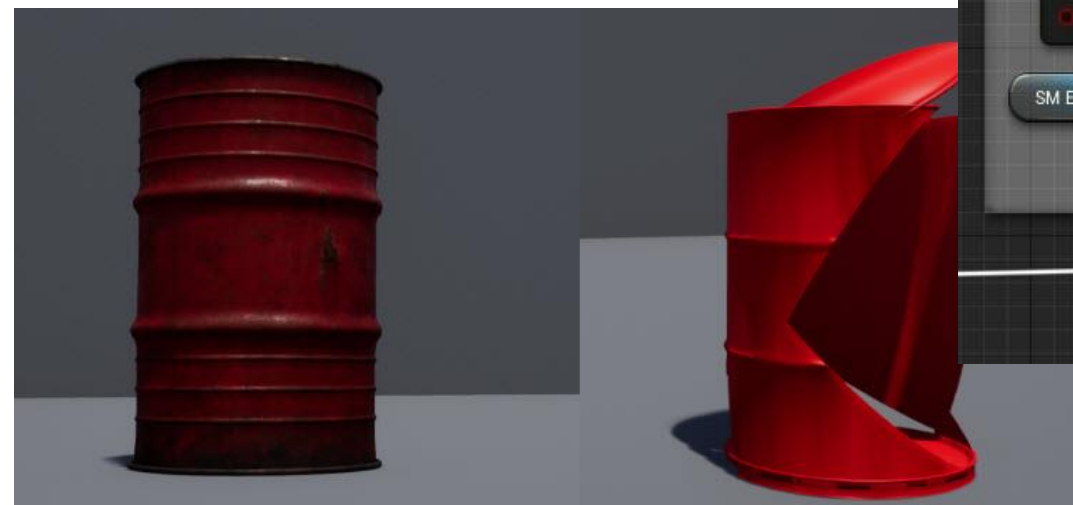
Barrel “Destruction”

- Event Damage
 - Set Health
 - ≤ 0
 - Cond true



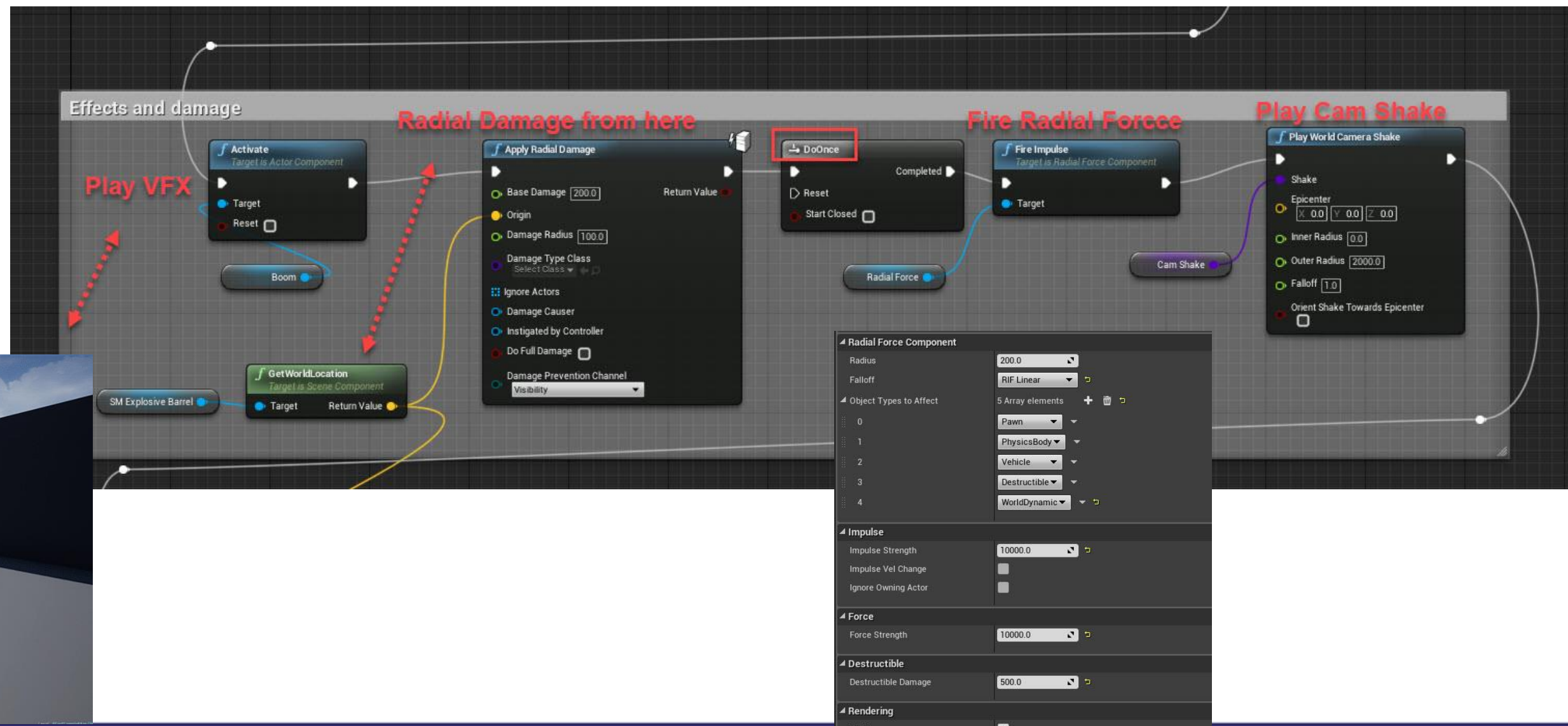
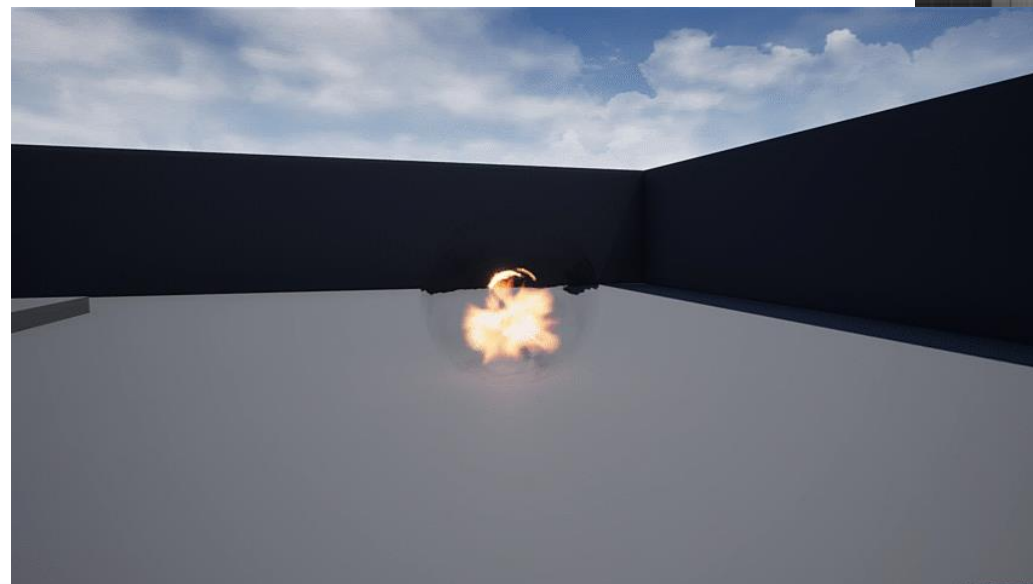
Barrel “Destruction”

- Visibility
 - Hide Clean
 - Show Pieces



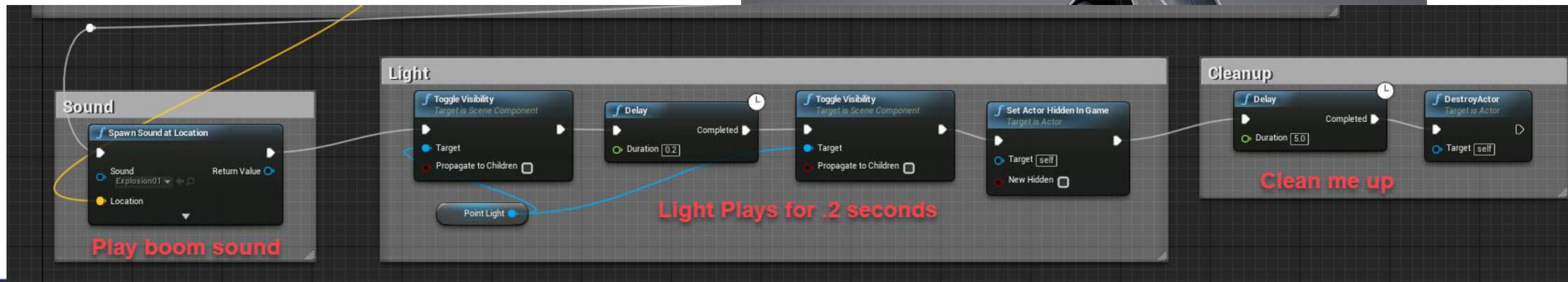
Barrel “Destruction”

- Damage/FX/Push/Camshake
 - Play FX
 - Damage
 - Once
 - Fire Impulse
 - Cam shake

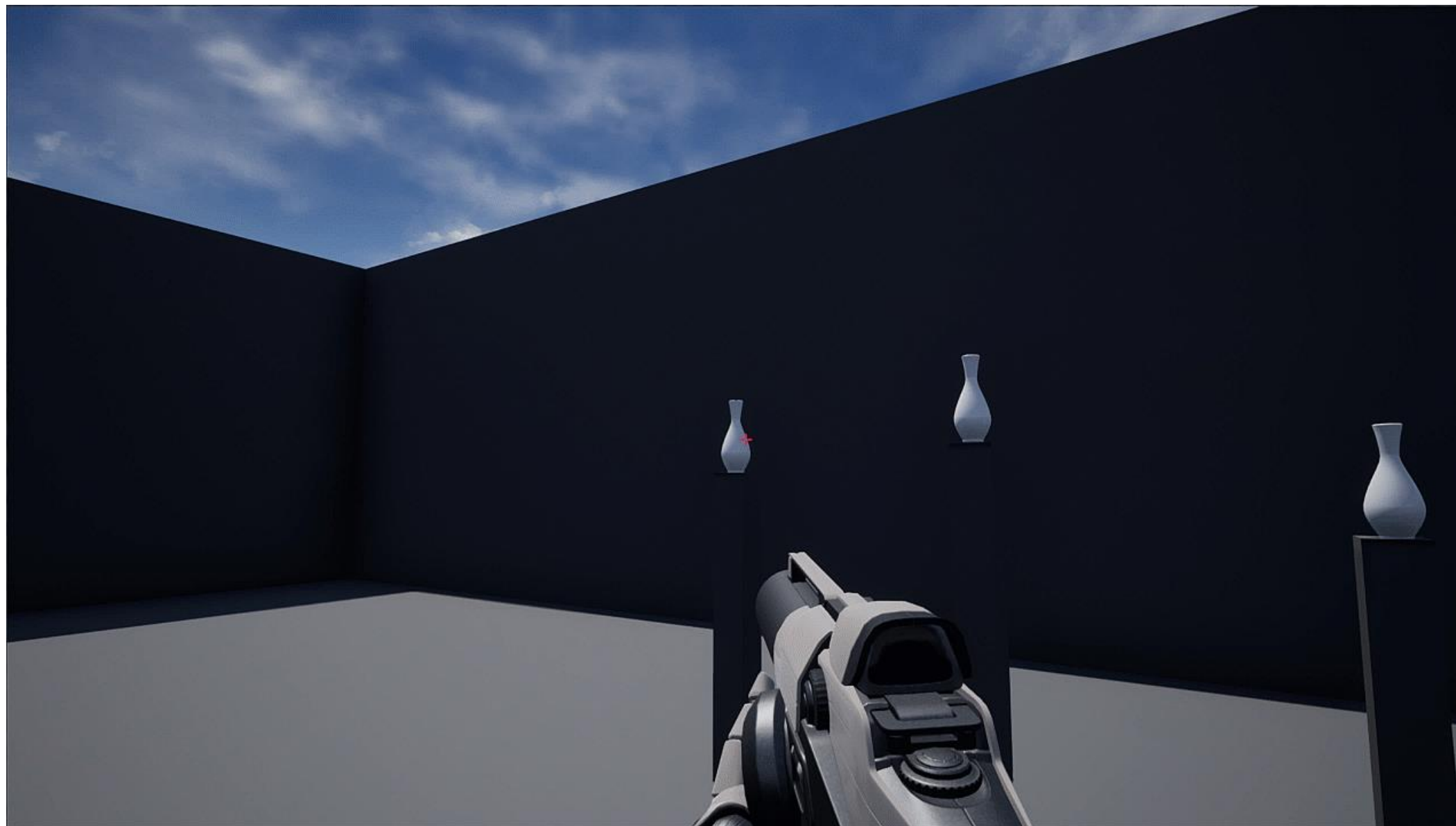


Barrel “Destruction”

- Light/Sound/Clean up
 - Play Sound
 - Light
 - Remove

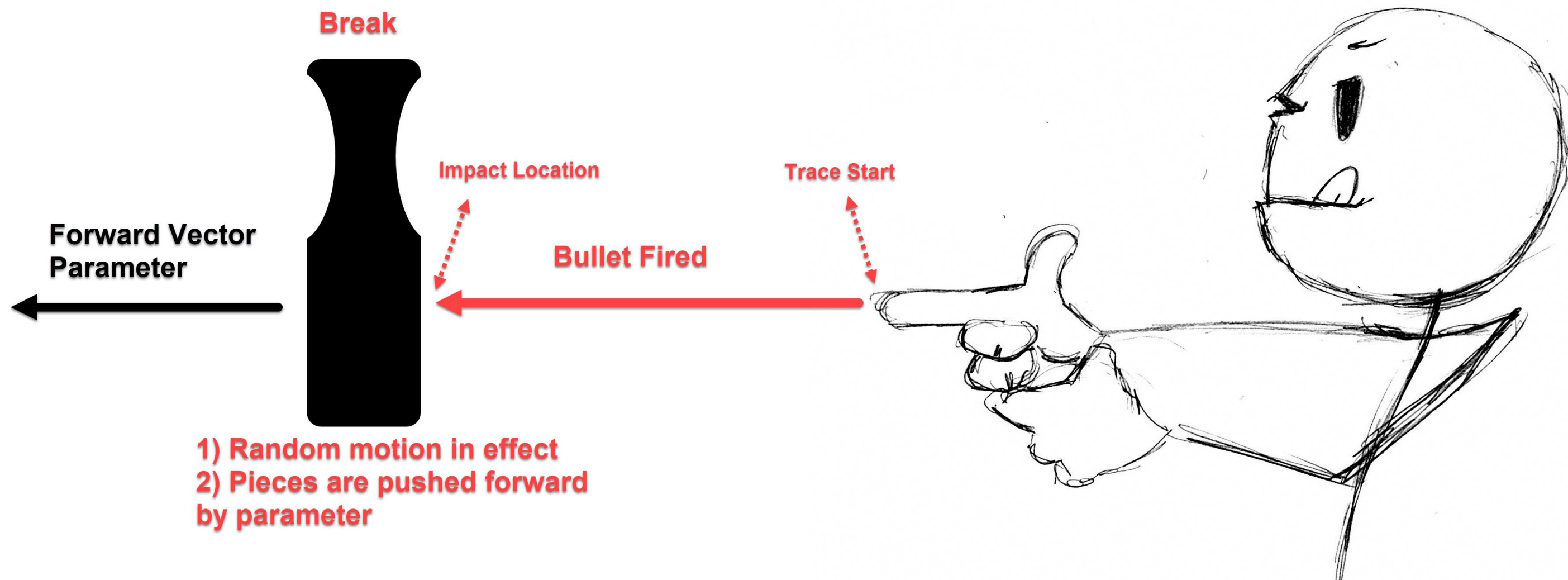


“Destruction” VFX Params



“Destruction” VFX Params

- Forward Vector Parameter



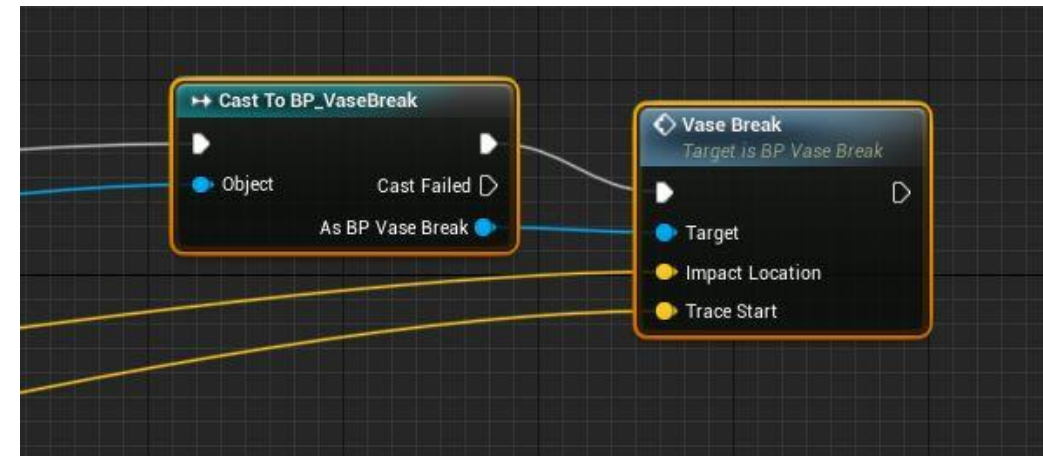
“Destruction” VFX Params

- Effect without parameters

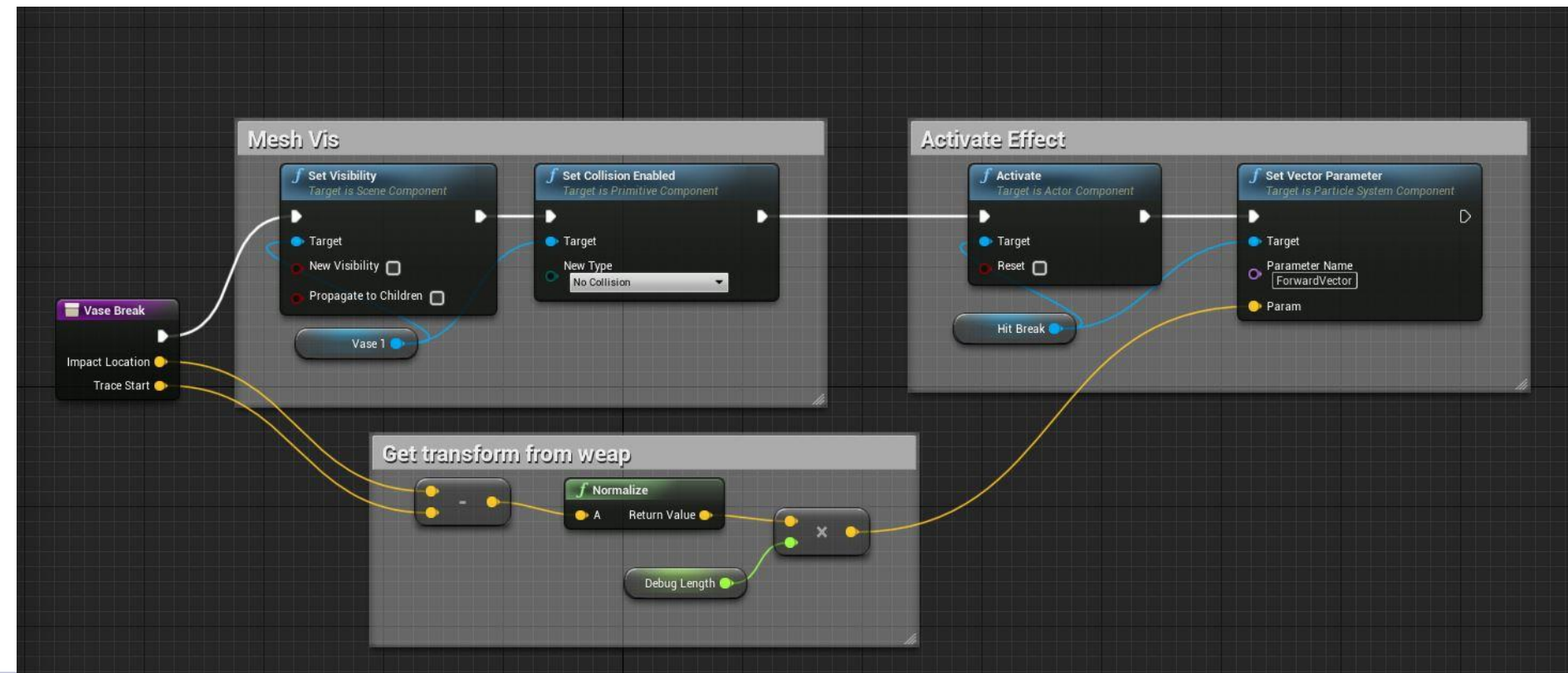


"Destruction" VFX Params

- In weapon BP
 - Line trace

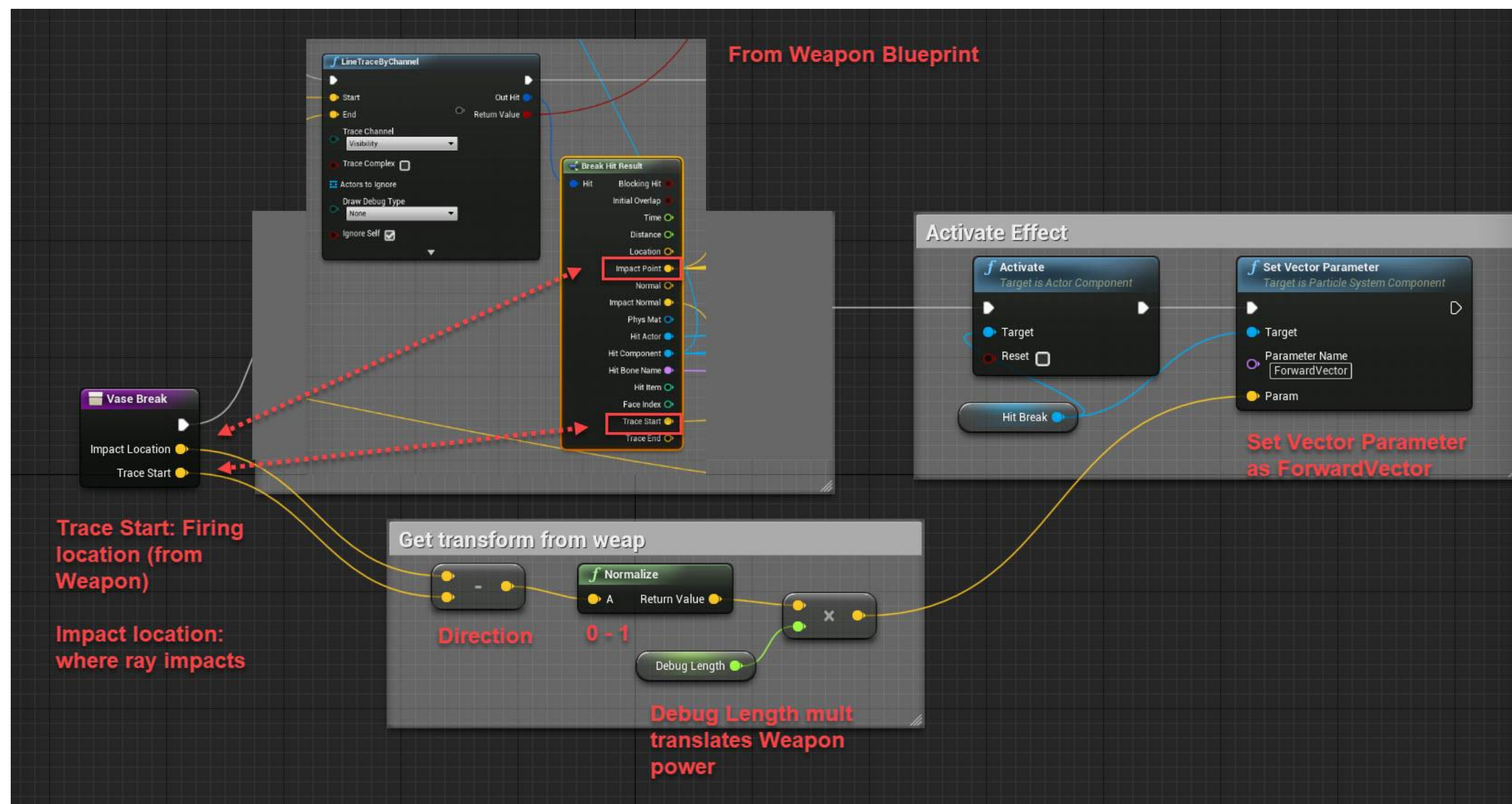


- Vase BP
 - Cast to...

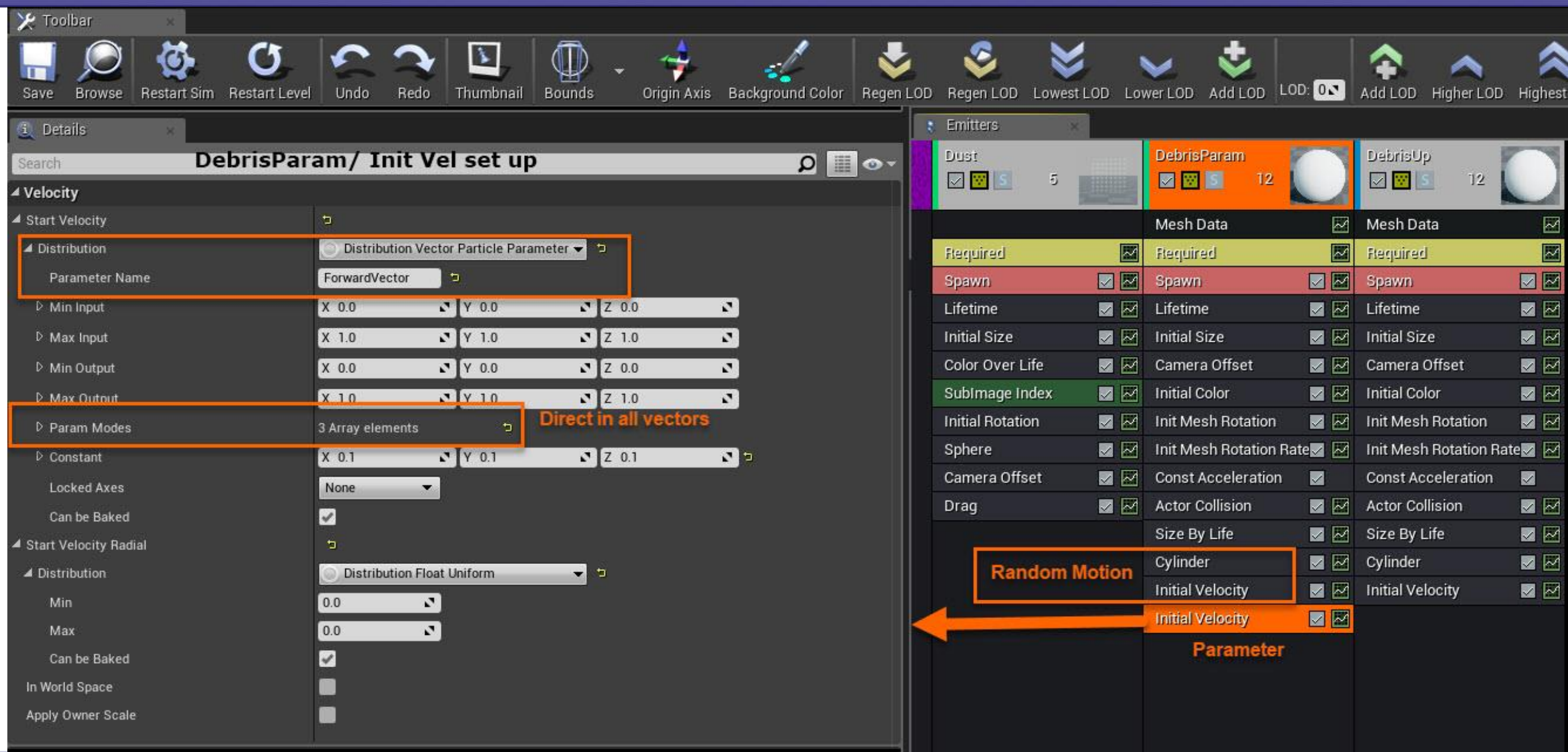


“Destruction” VFX Params

- What does any of that mean?



"Destruction" VFX Params



“Destruction” VFX Params

- Testing the parameter

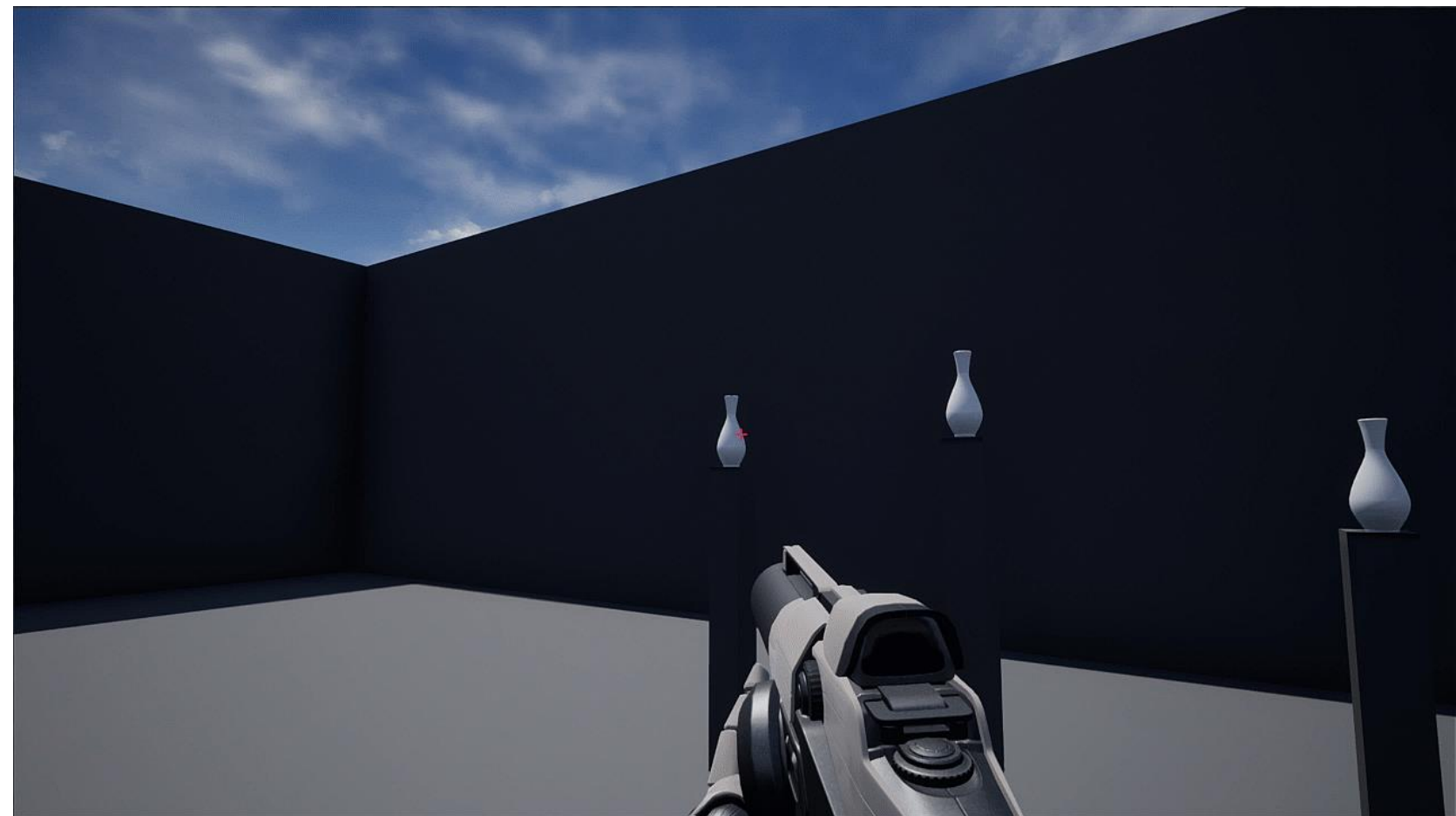


“Destruction” VFX Params

- No params



- Params

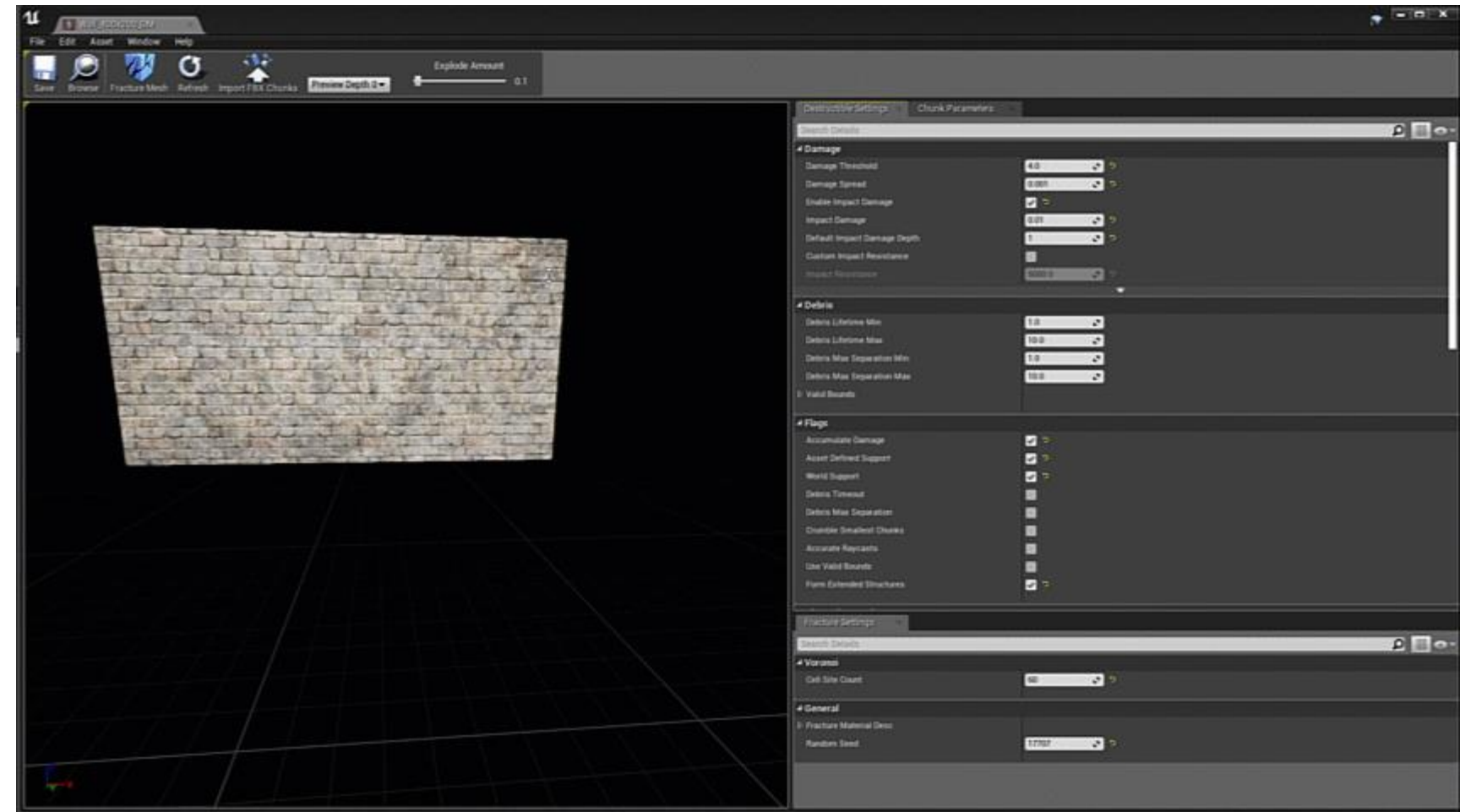


Fracture methods



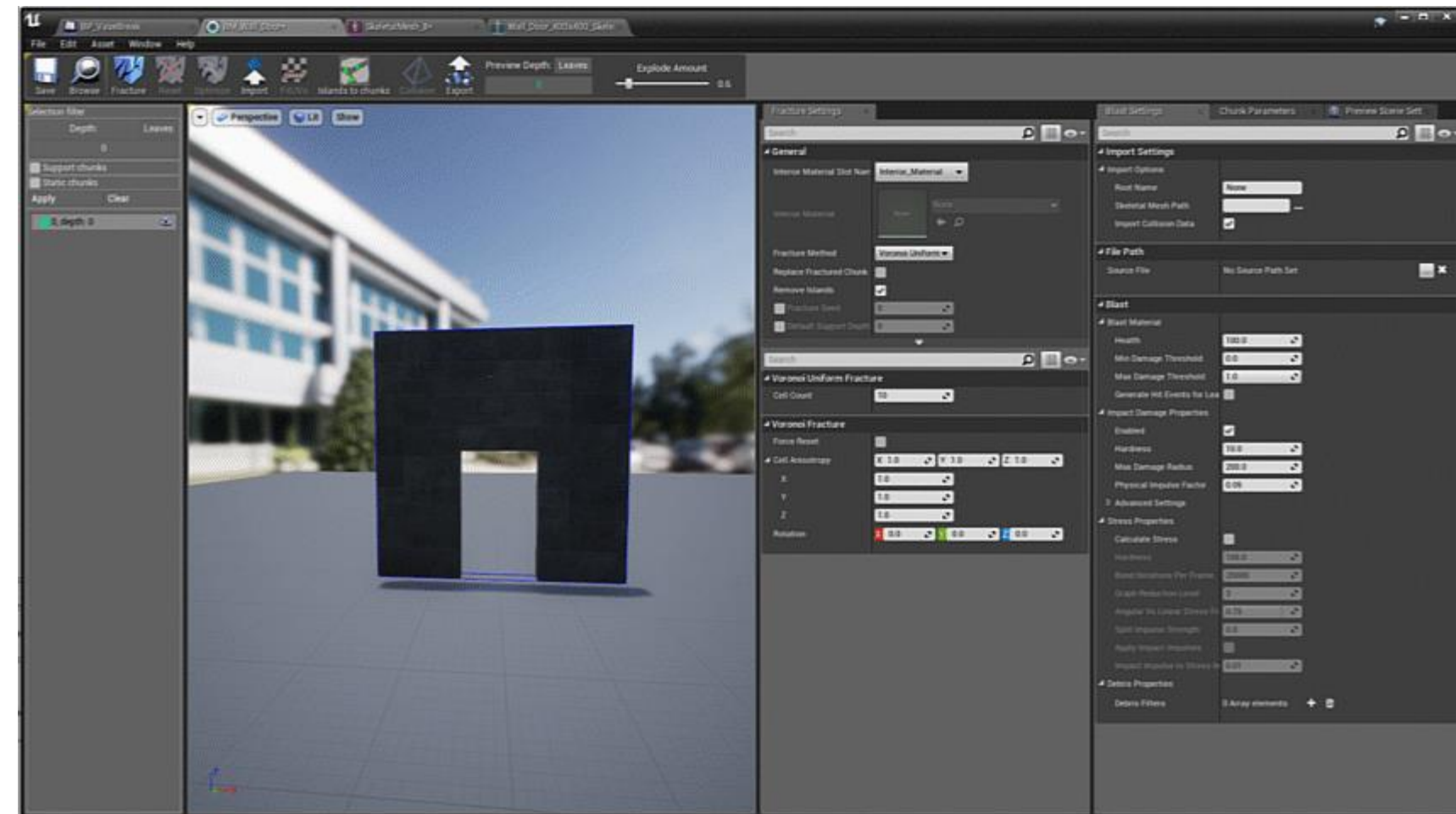
Fracture: PhysX

- PhysX
 - Unreal plug in
 - Single depth in game
 - Muti-depth in PhysX Lab
 - Determine damage
 - Fracture FX and Sound in game
 - <https://docs.unrealengine.com/en-us/Engine/Physics/Apex>
 - <https://developer.nvidia.com/apex-destruction-physxlab-tutorials>
 - <https://docs.unrealengine.com/en-us/Resources/ContentExamples/Destructables>



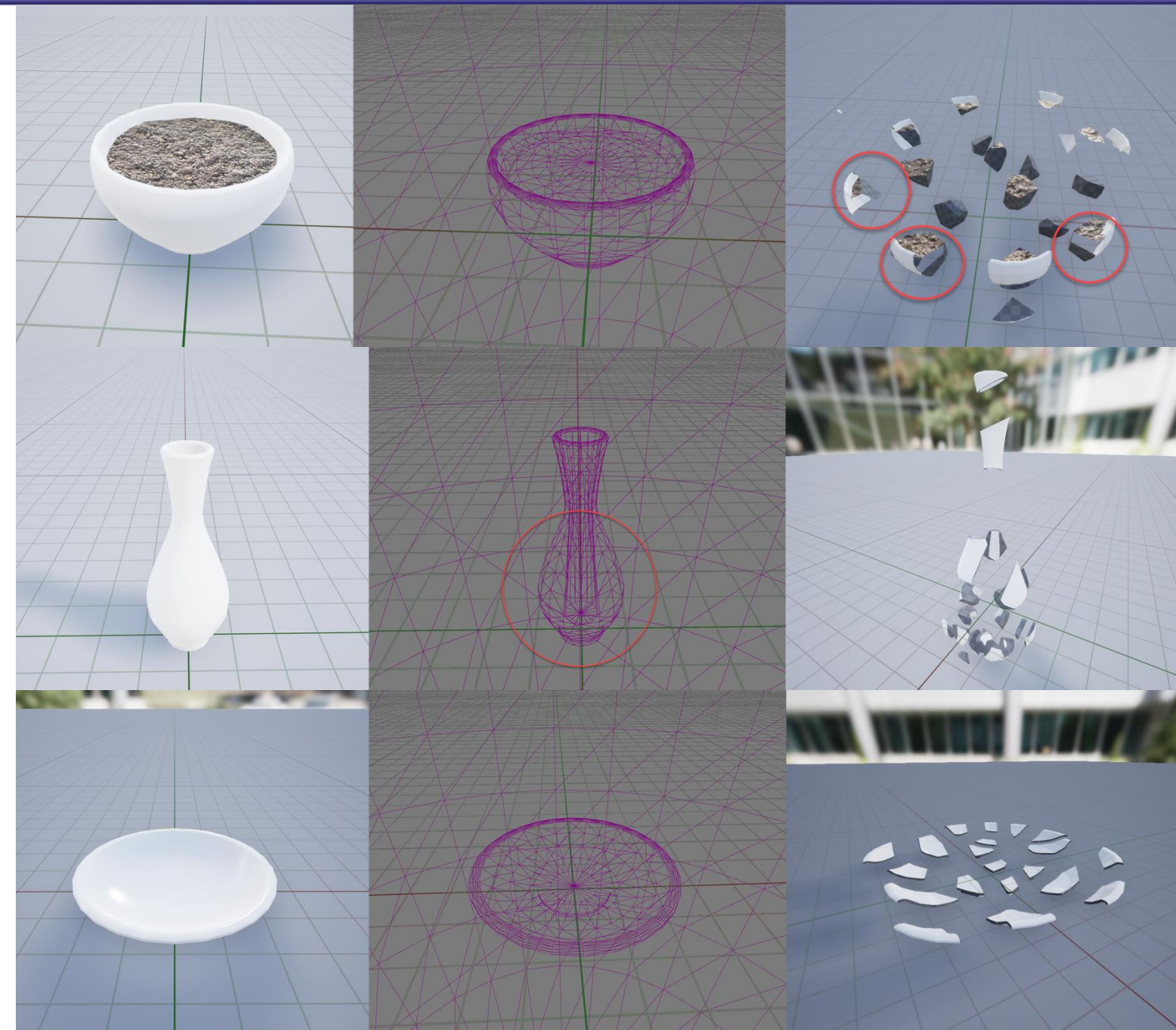
Fracture: Blast

- Blast
 - GitHub Repository 4.20
 - Multi-depth in game
 - Damage types
 - Impact and Stress
 - VFX are in Blueprint
 - <https://developer.nvidia.com/nvidia-gameworks-and-ue4>
 - https://docs.nvidia.com/gameworks/content/gameworkslibrary/blast/1.1/authoring_docs/Blast_Intro.html



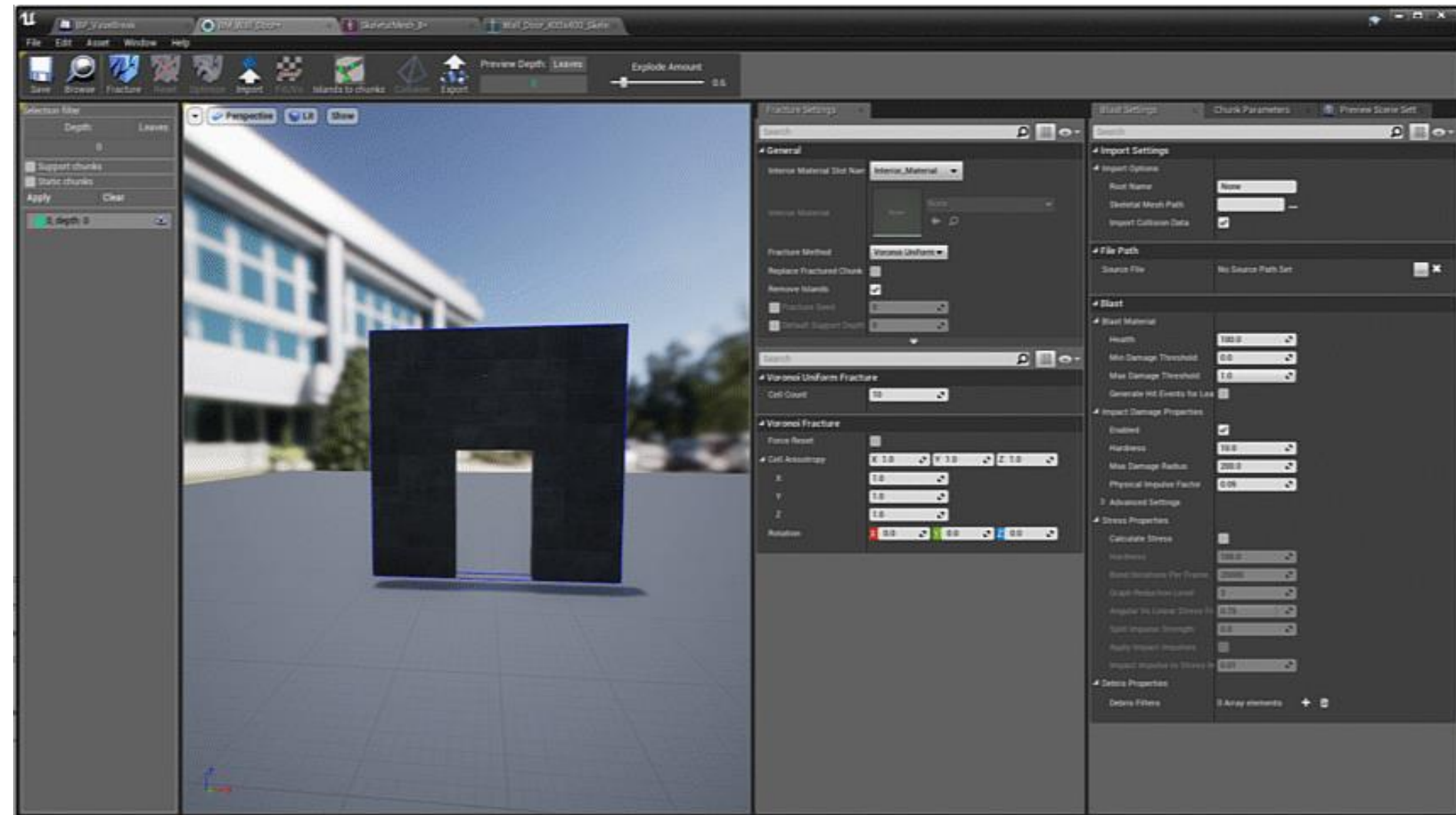
Fracture: Base Mesh

- Flower pot: Not Watertight = gaps
- Vase: probably ok. Inside simplified
- Plate: Yes this is good for pre fracture



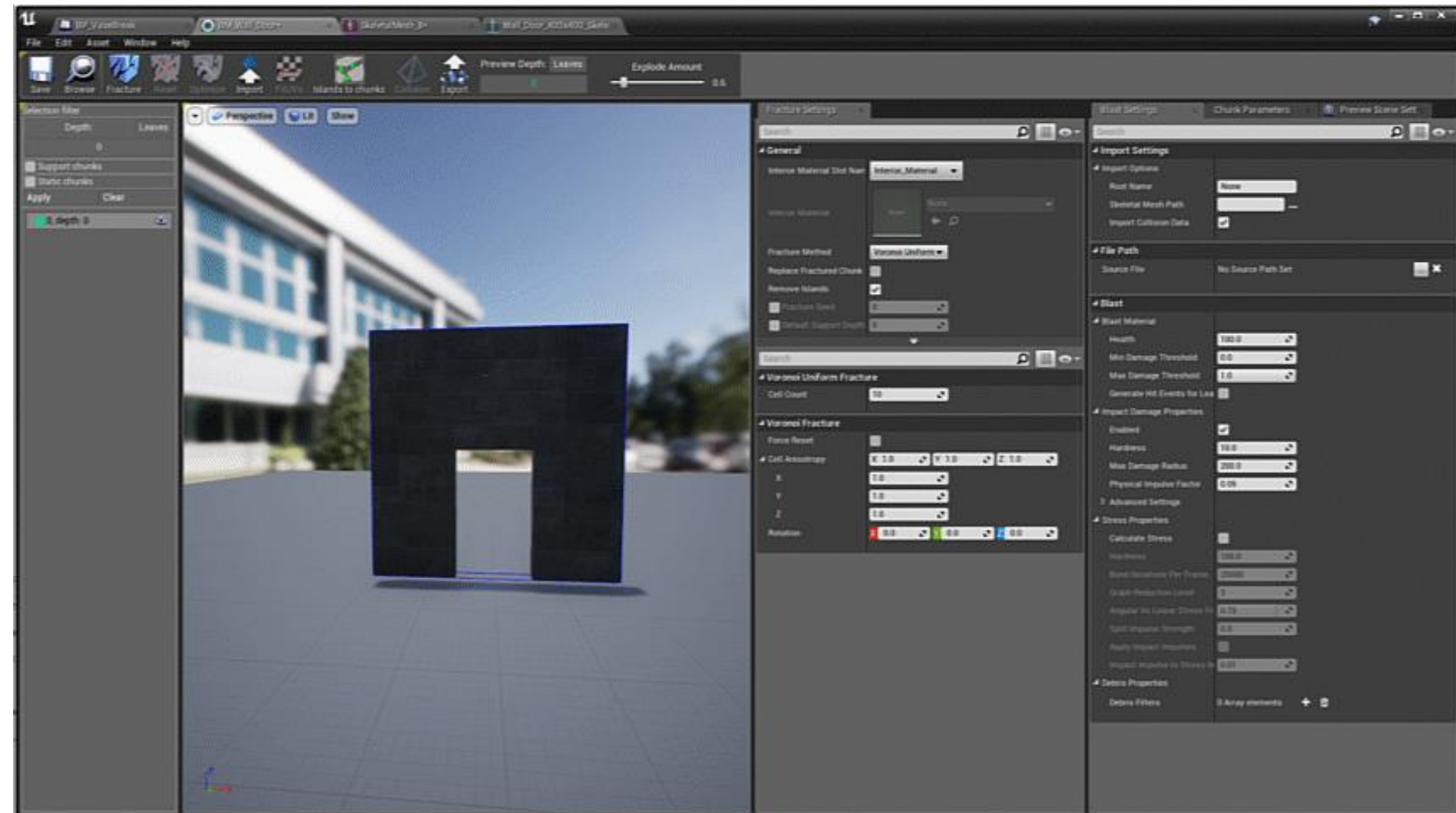
Fracture: Pipeline

- 2 ways for depth (physx/blast)
- Create depths by hand
 - More control
- Shoot for final depth
 - Debris Clean up
- And use the Optimize button
 - Creates Quick destruction
 - good for testing!!

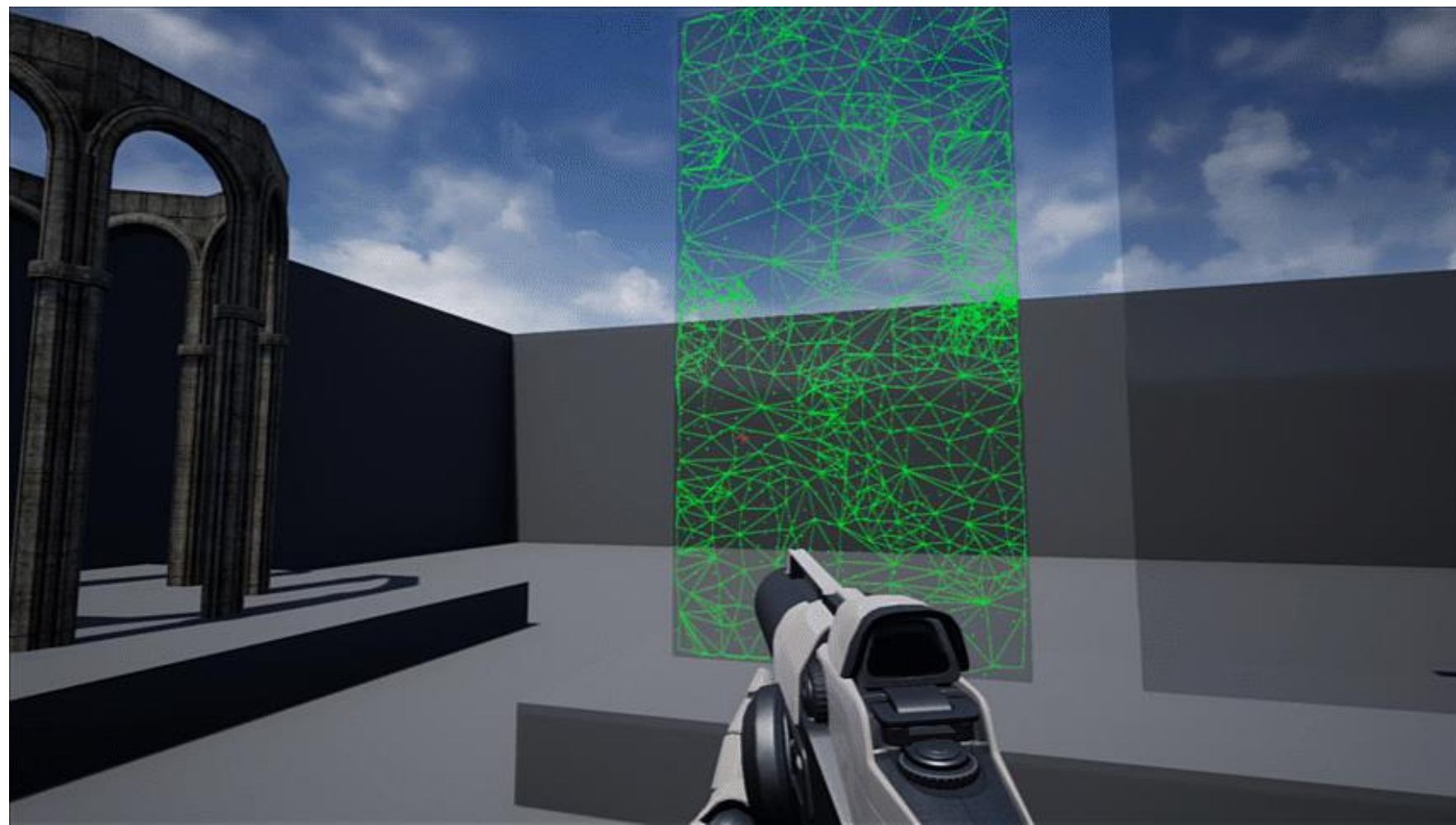
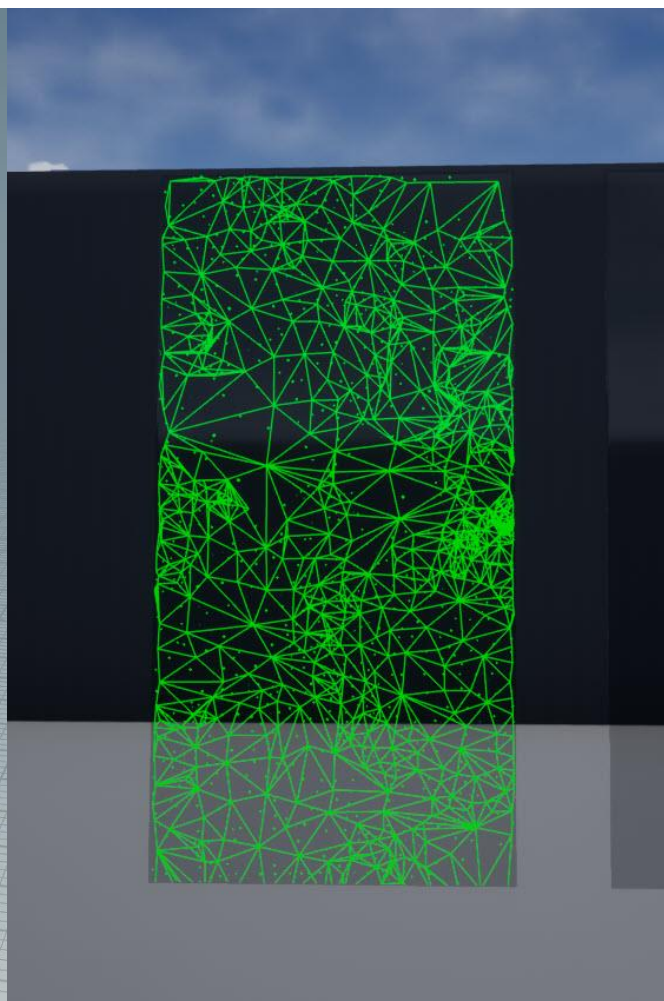
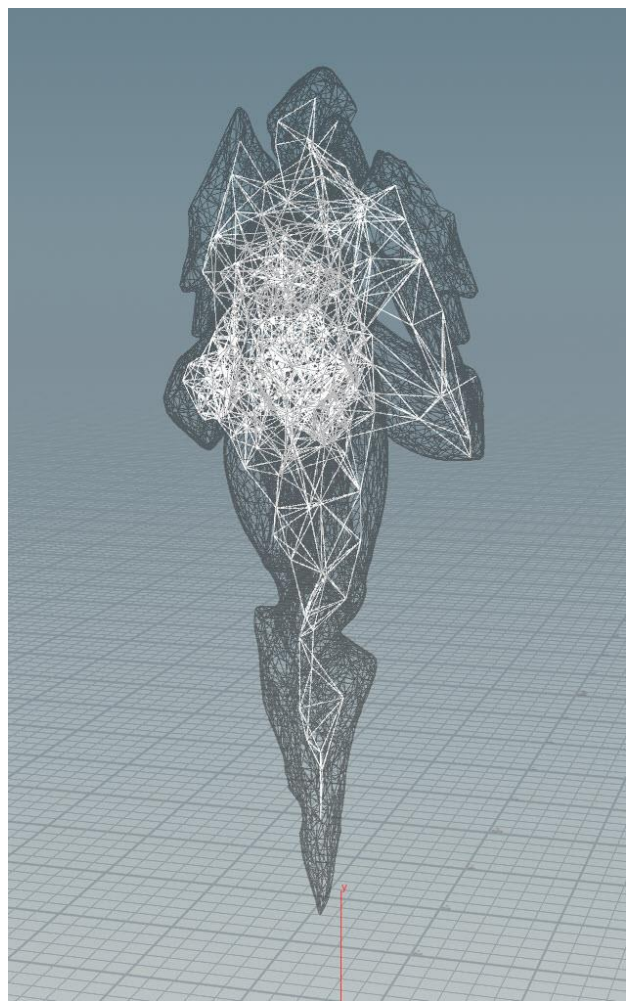


Fracture: Depths

- Hierarchy
 - Render
 - Physics



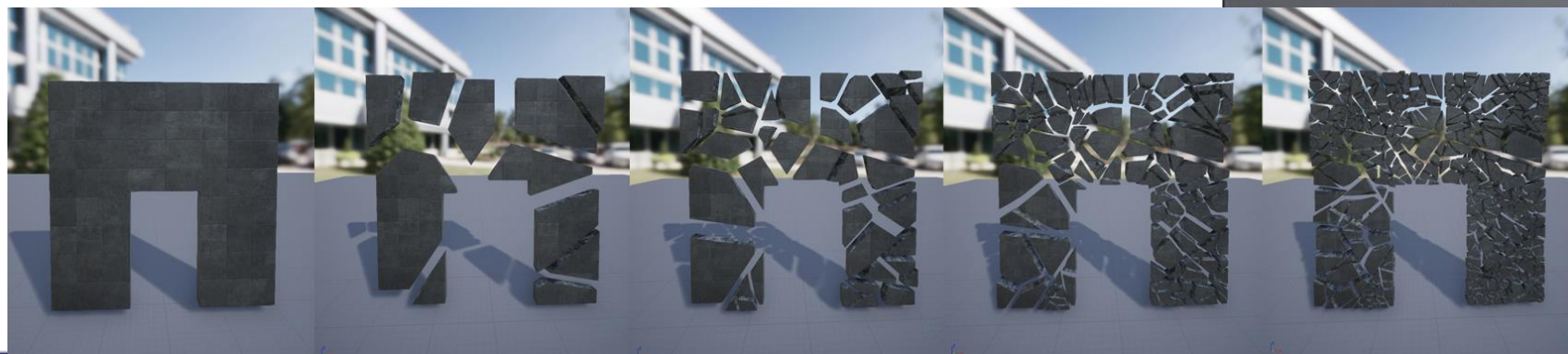
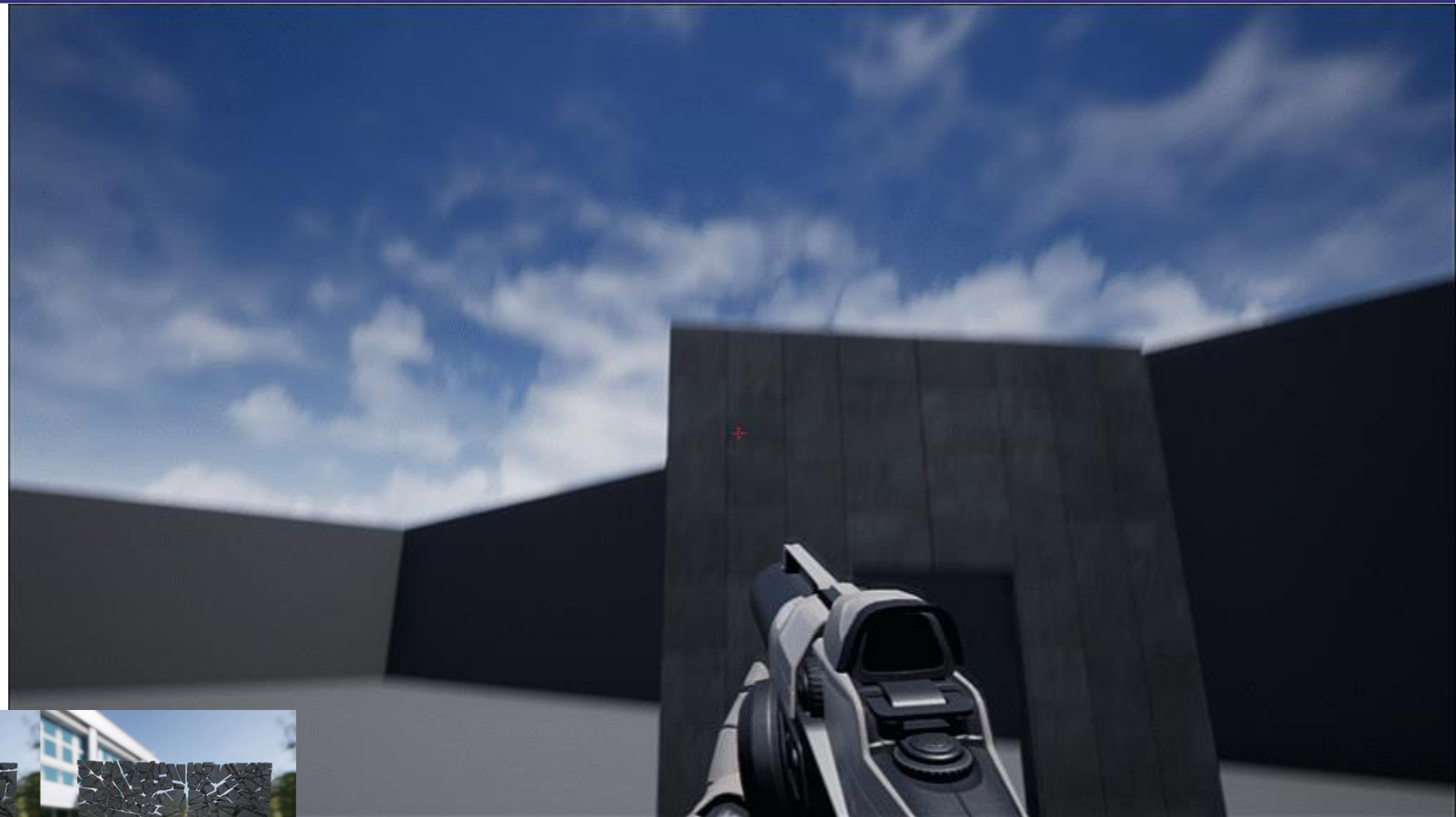
Fracture: Constraints



- Houdini
- Blast

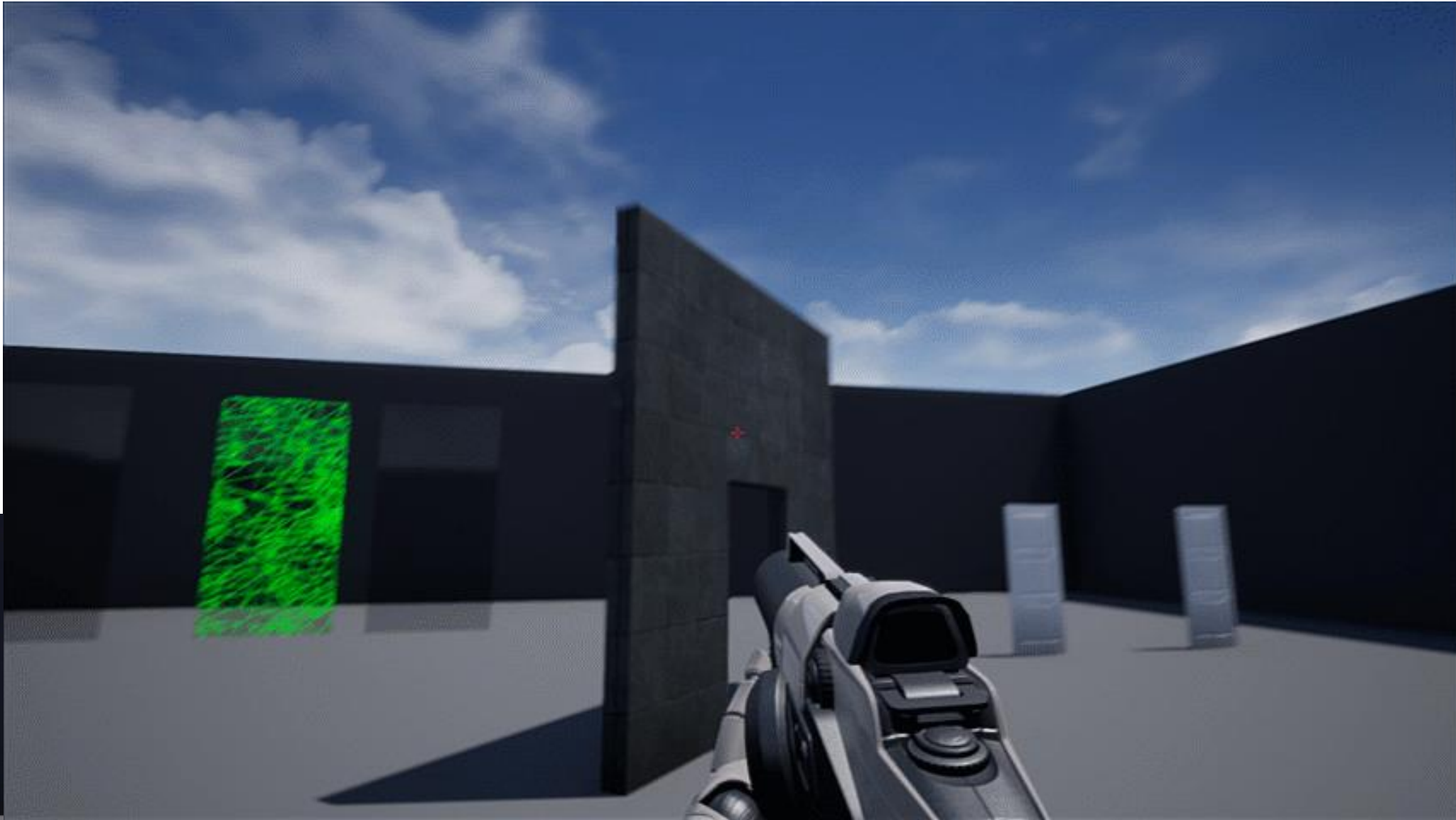
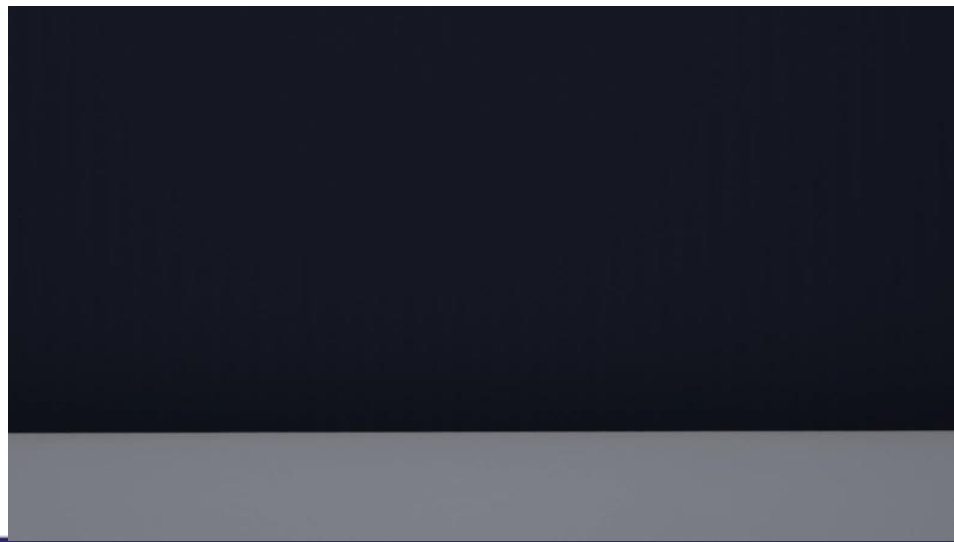
Fracture: Concrete settings

- Concrete Fracture
 - Default Voronoi
 - Using Health damage
 - Health 100
 - Hardness
 - 5 depths/states



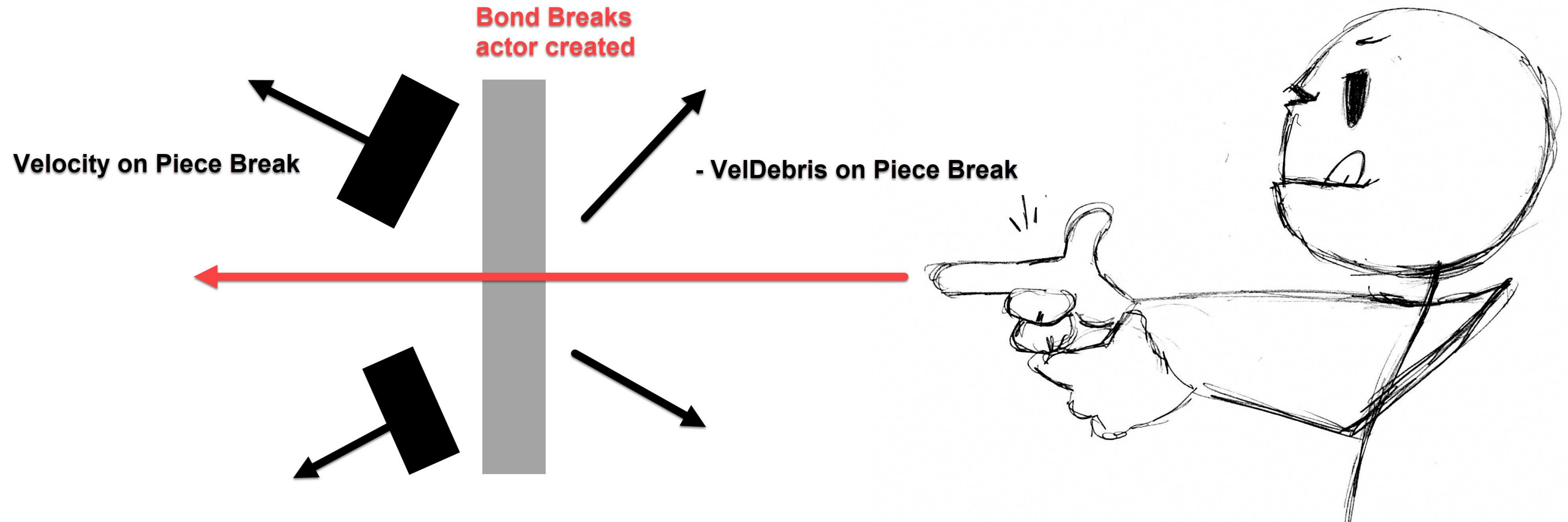
Fracture: VFX Params

- What do we want the parameter to do?
 - Couple things
 - Breaks
 - Parameters

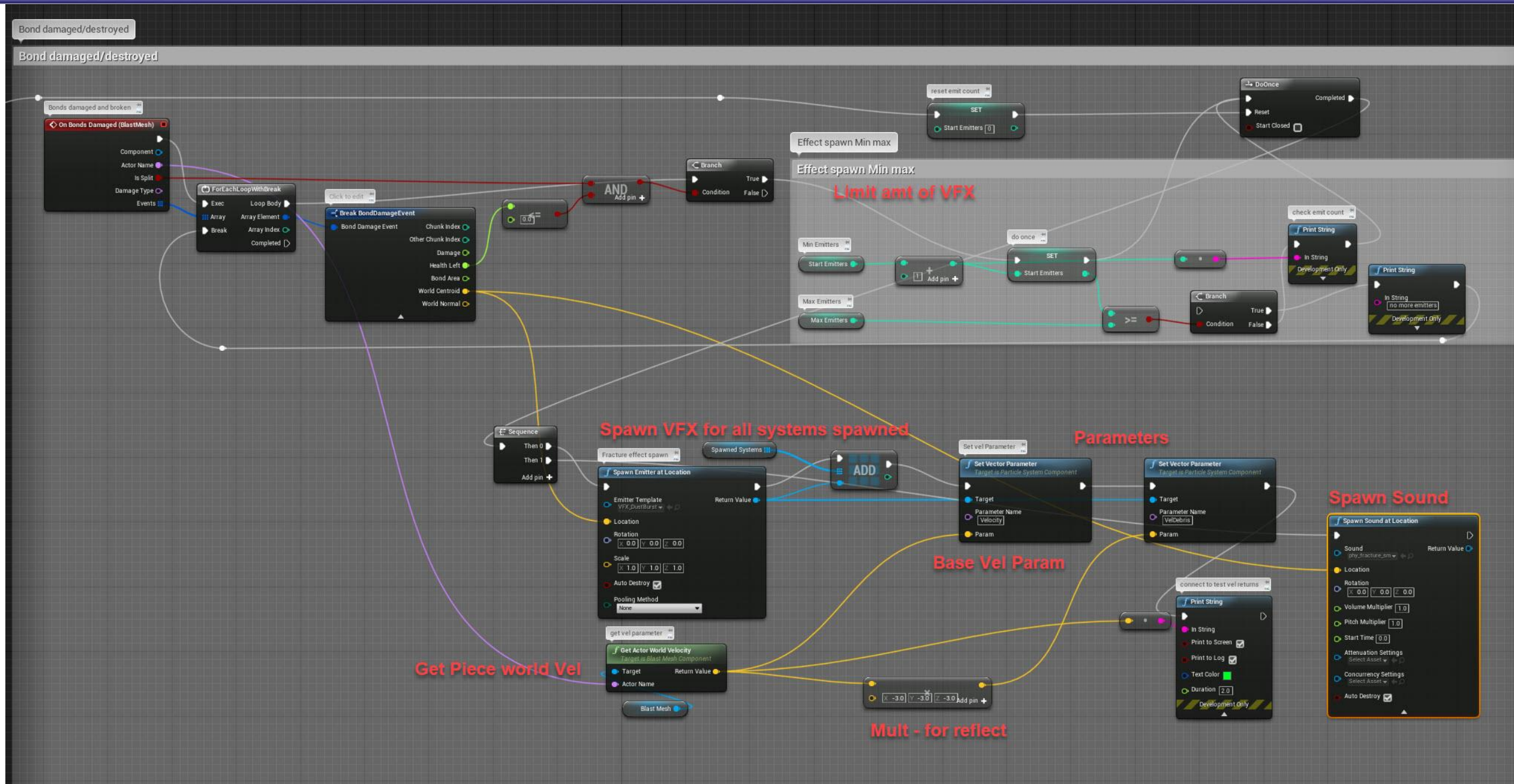


Fracture: VFX Params

- Fracture Params: Velocity and VelDebris

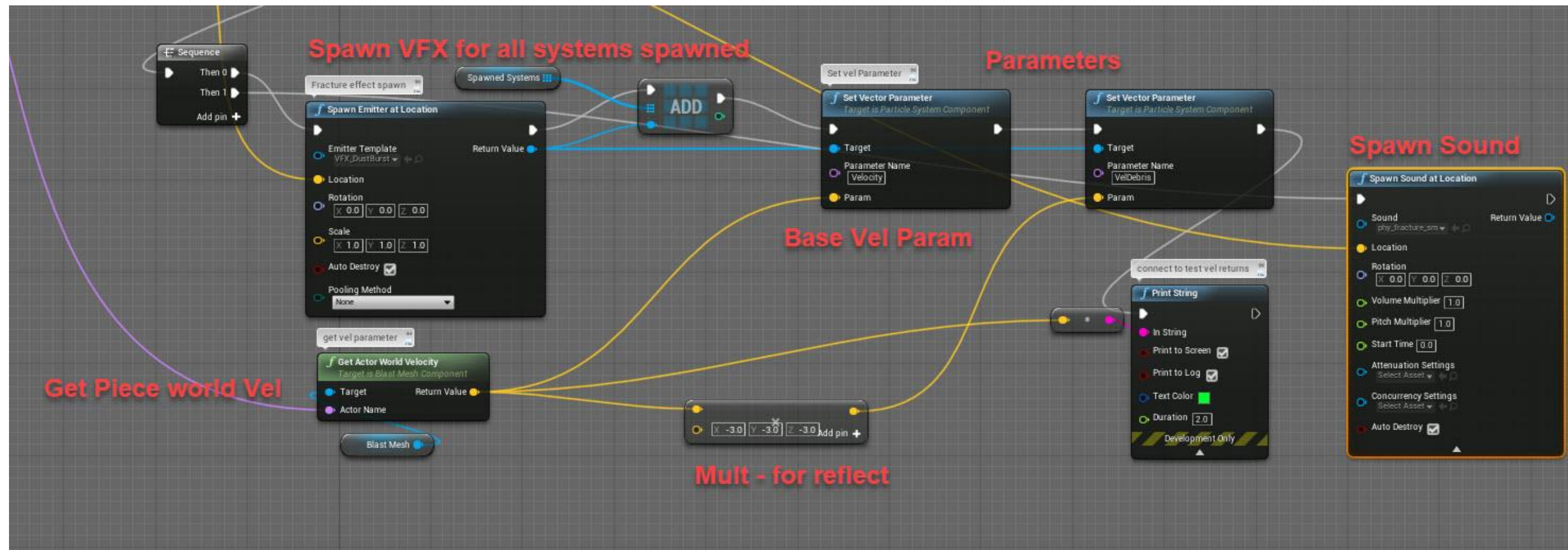


Fracture: VFX Params



Fracture: VFX Params

- Params for movement of dust and debris
- The dust is at a + while the debris is at - vel

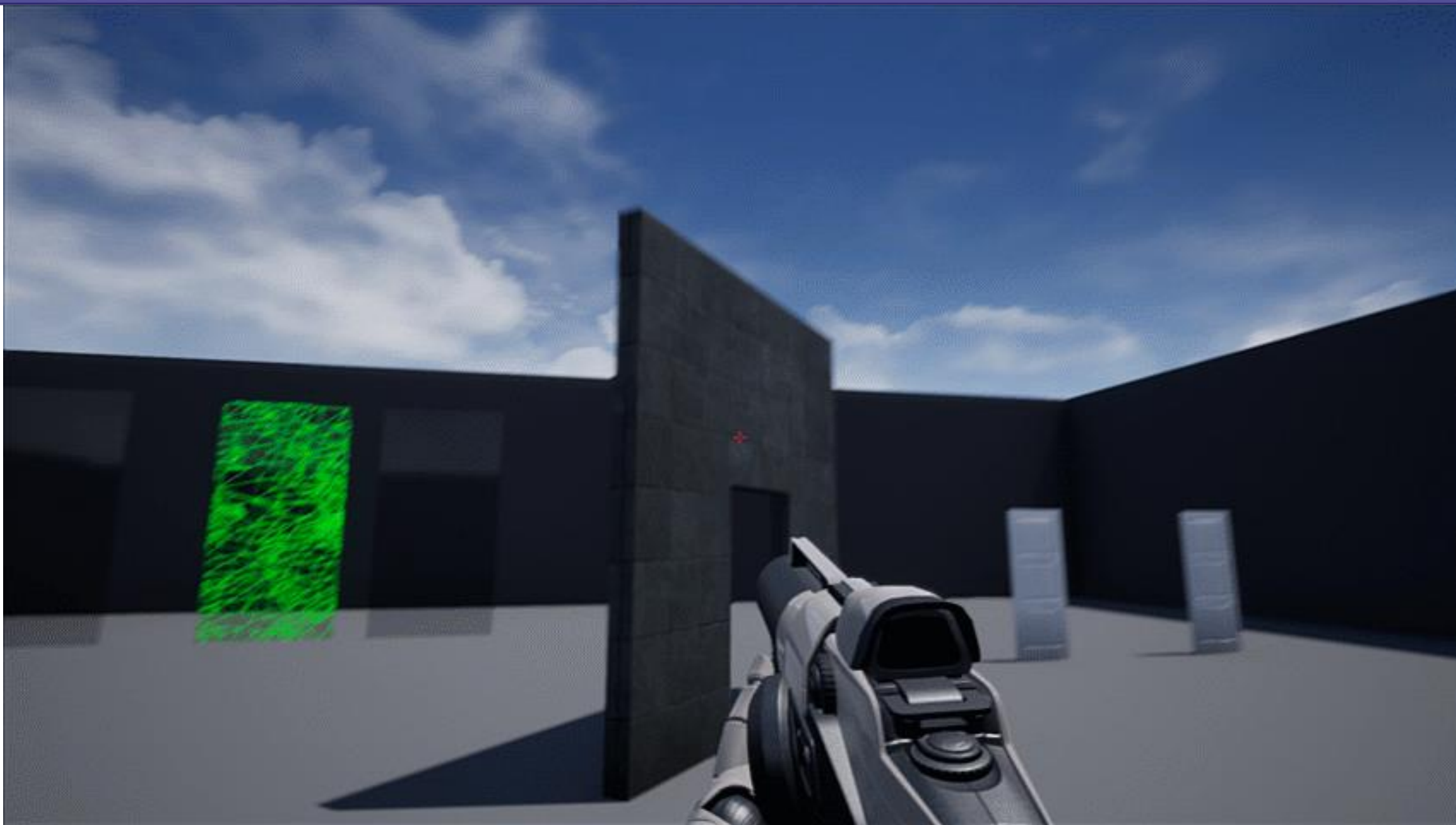


Fracture: VFX setup (Cascade)

- Initial Velocity Parameters
 - Bond breaks params push effects in directions

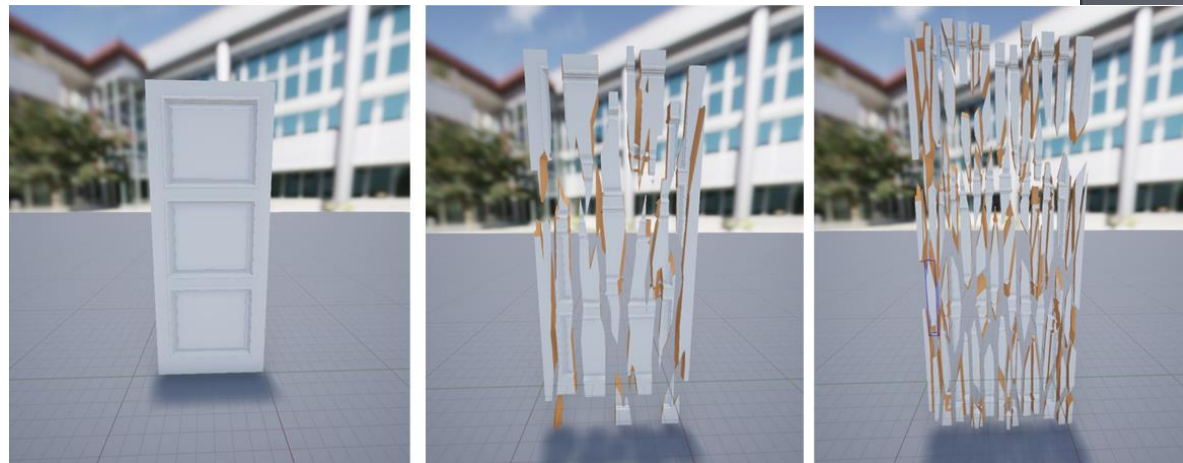


Fracture: VFX Params



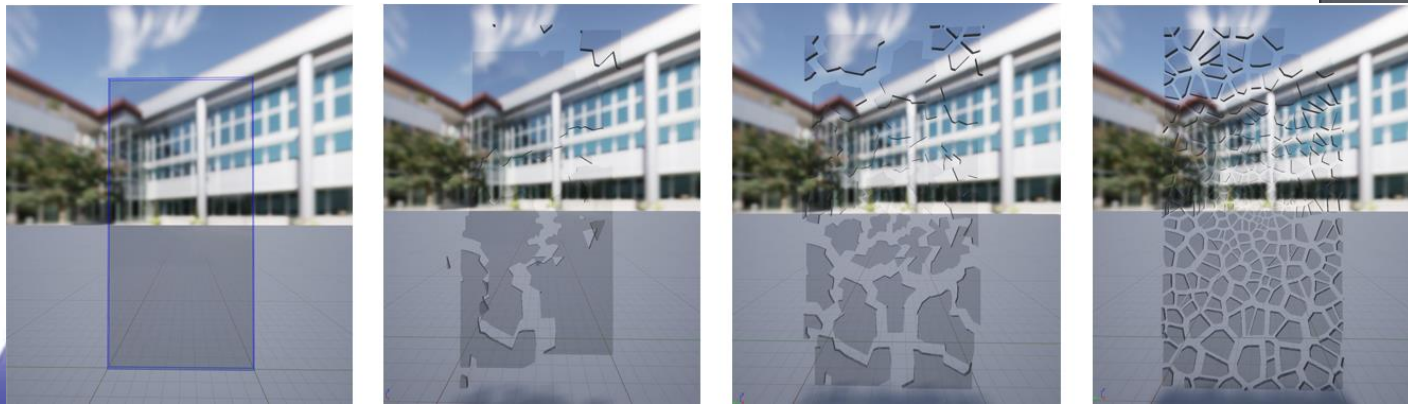
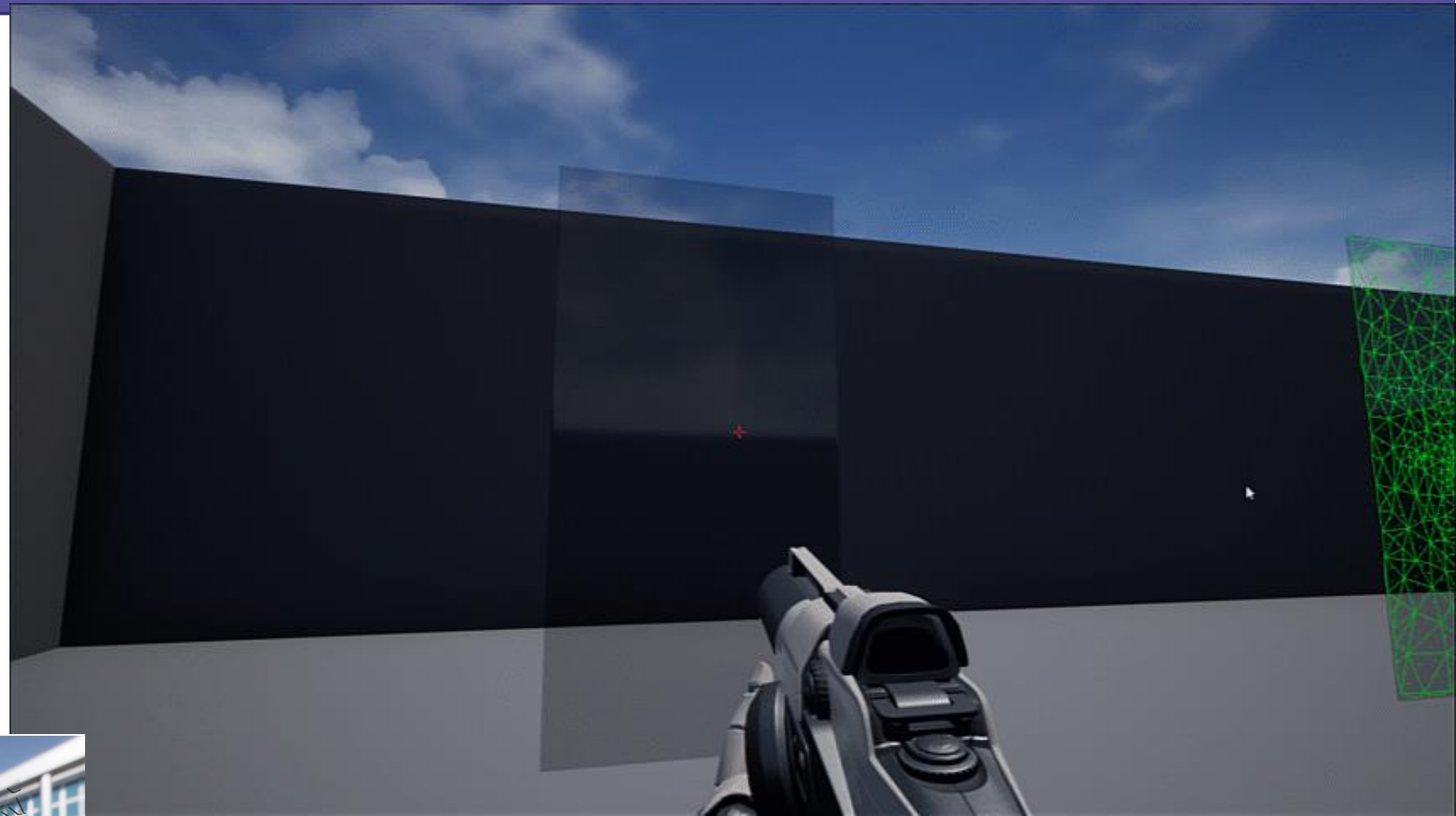
Fracture: Wood Settings

- Wood Settings
 - Voronoi Fracture controlled
 - Narrow settings in X and Y
 - for splintering
 - Still has impact damage
 - Solves in stress
 - 3 depths/states

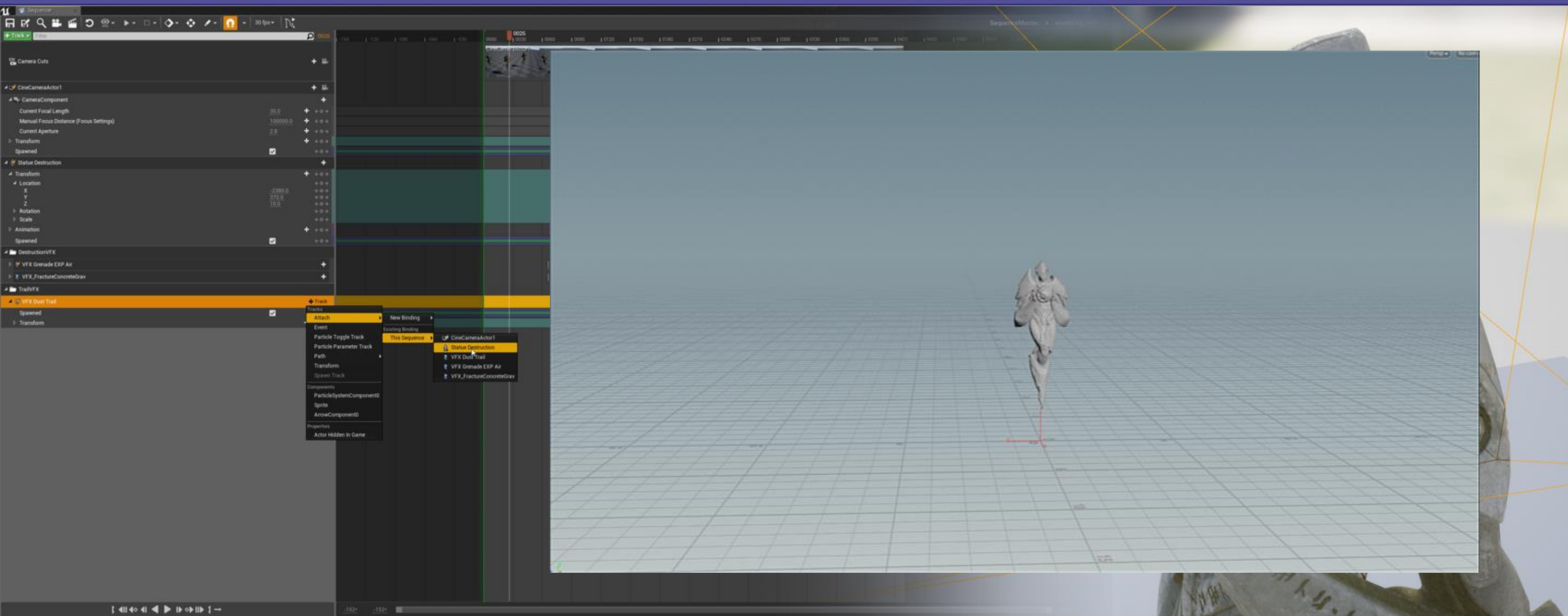


Fracture: Glass Settings

- Glass: Voronoi Radial
 - Noise up the radial less perfect
 - angle offset
 - variability
 - Health and stress solve
 - Very low hardness
 - 4 depths/states

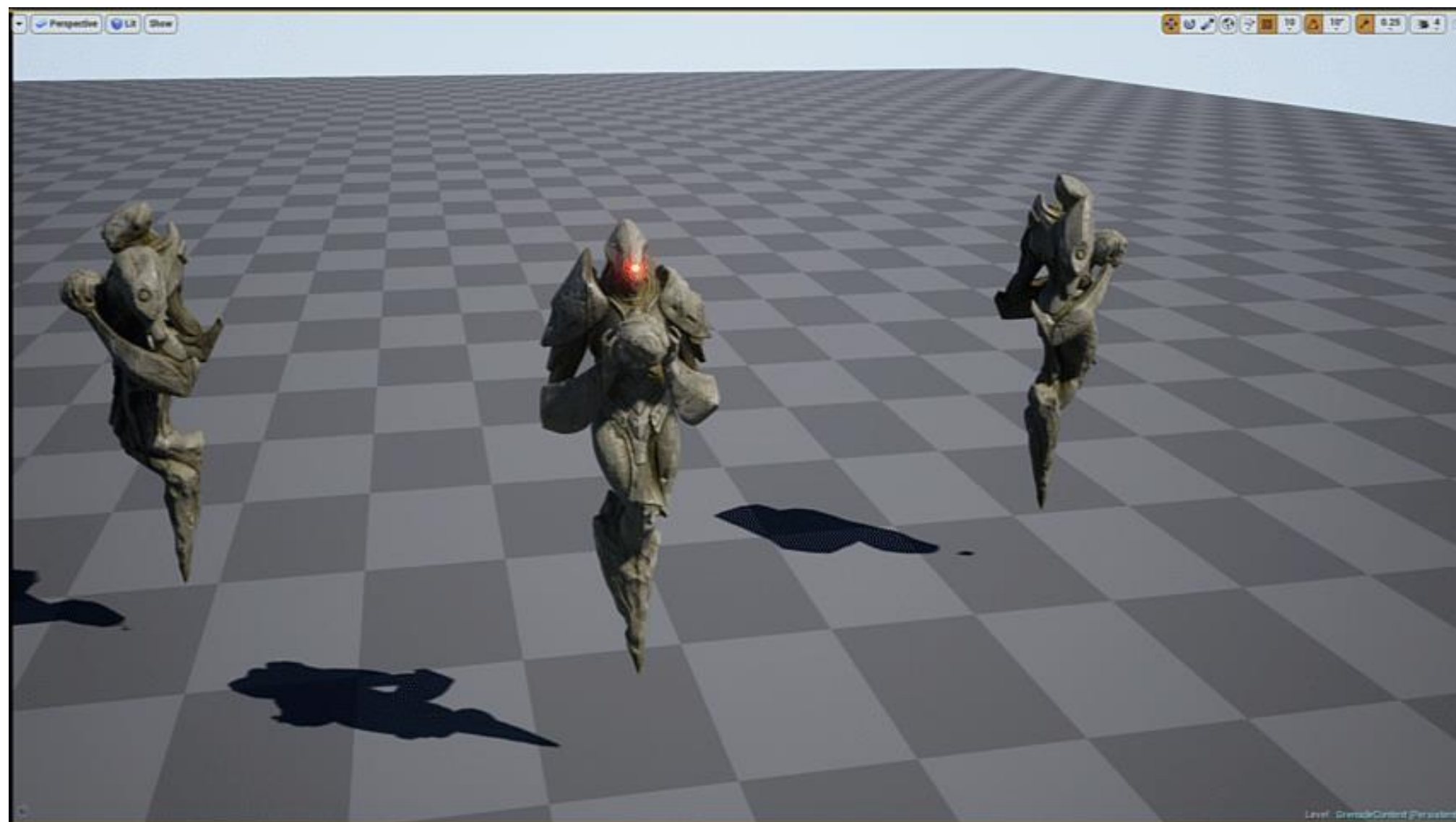


Sequence(r)(s)



Sequence(r)(s)

- Overview
 - Questions and Planning
 - Placing/Spawning
 - Triggering
 - Attachments
 - Sockets
 - Parameters
 - Gotchas
 - Tracks and Curves



Sequence(r)(s)

- Sequence Questions
 - Final output
 - Video or Real Time?
 - Aspect?
 - Resolution?
 - Run at real time?
 - Cameras locked or not?
- Get shots early if possible

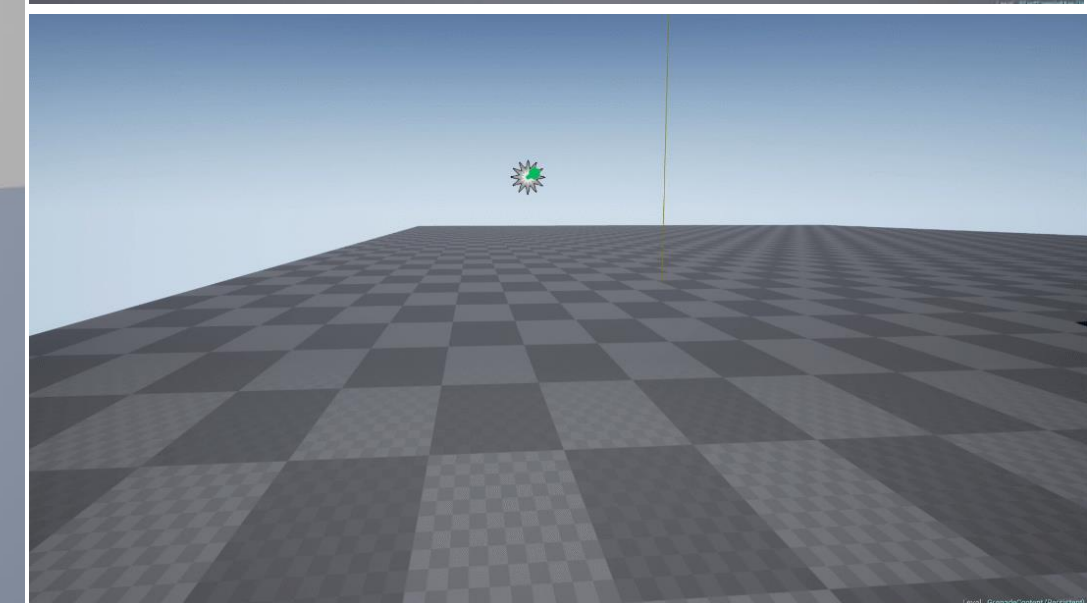
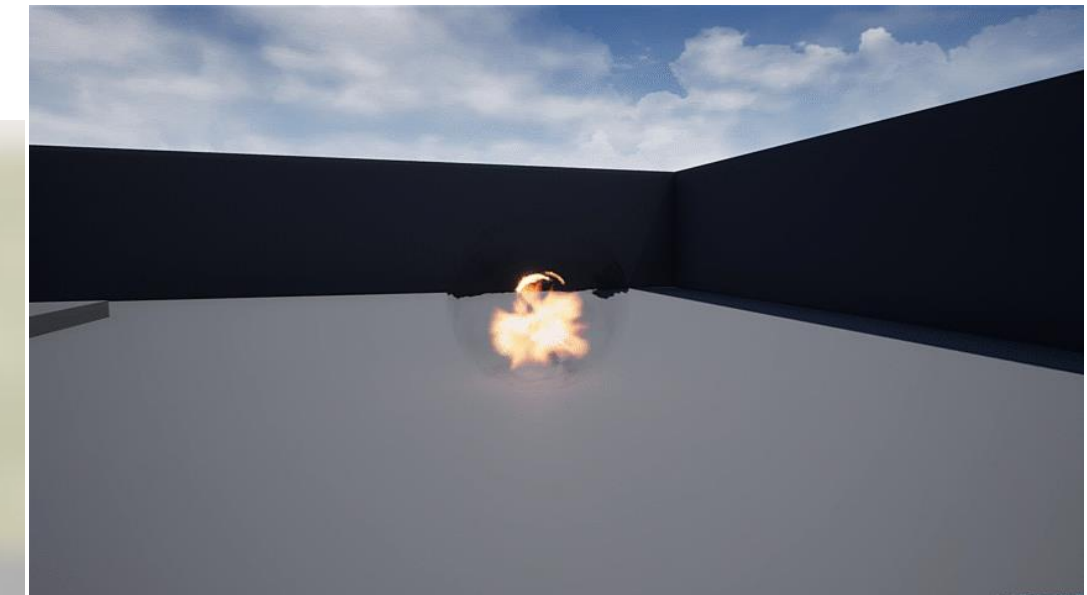


Sequence(r)(s): Planning

- Eye

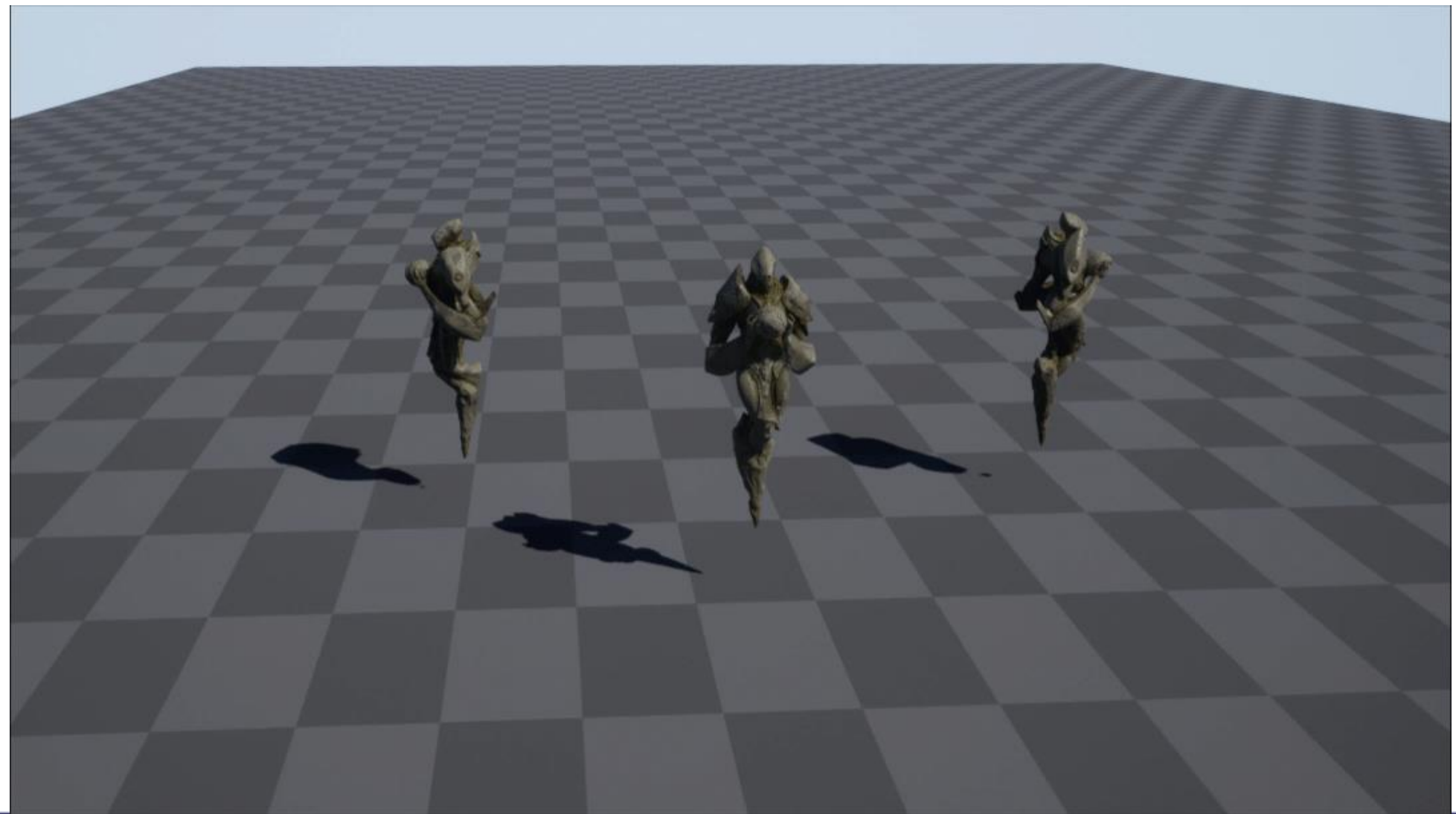
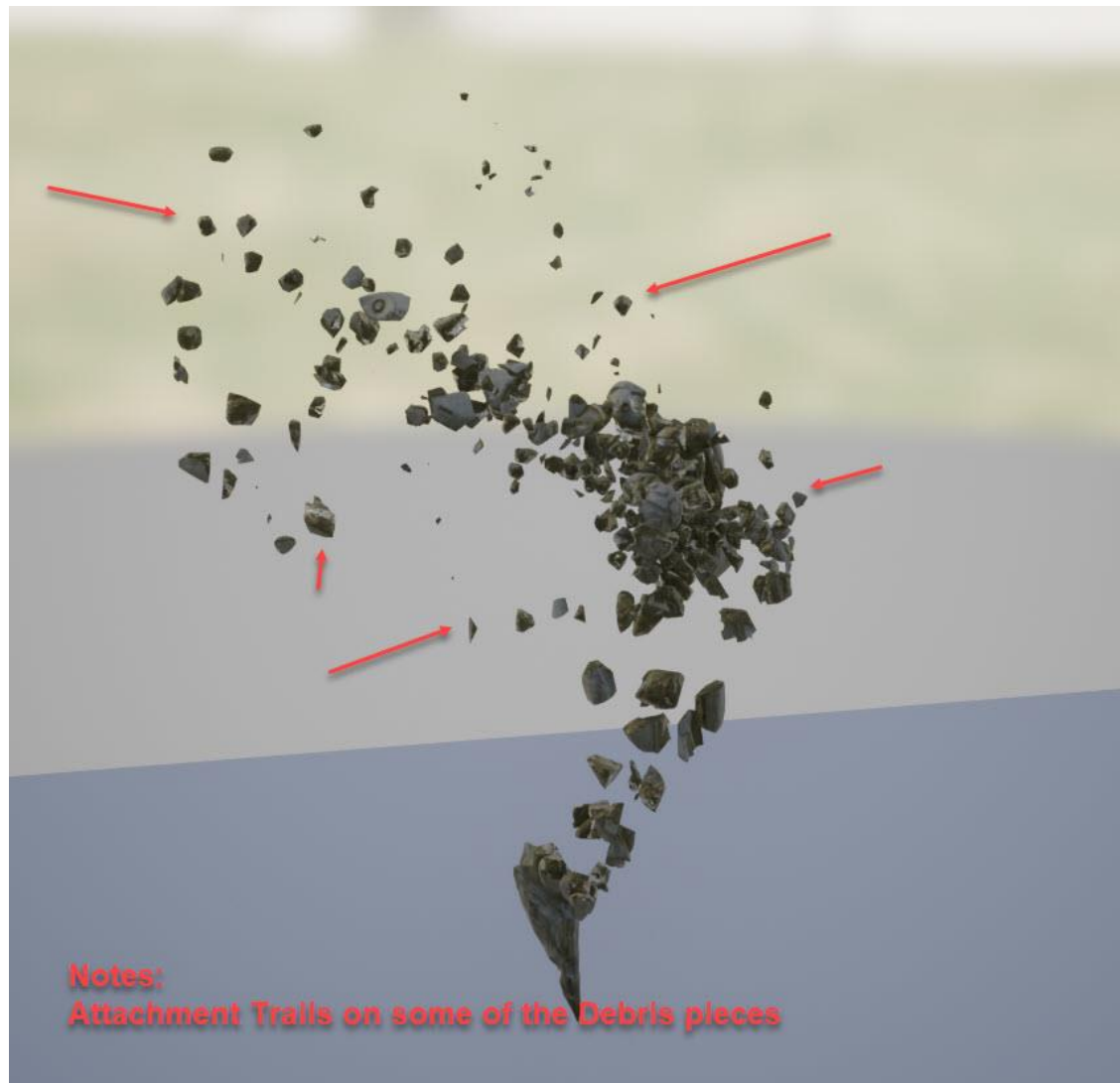


- Explosion/Fill



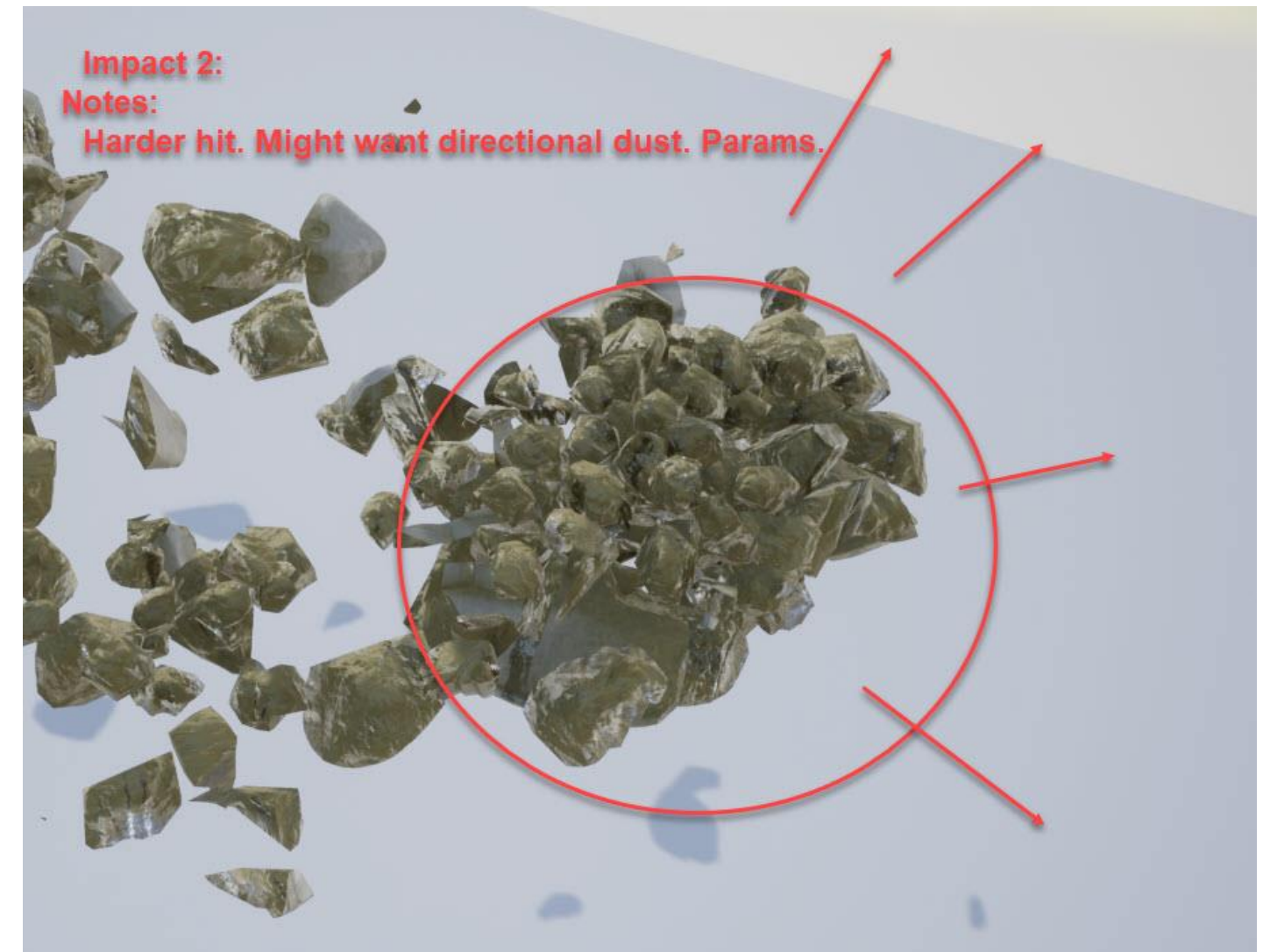
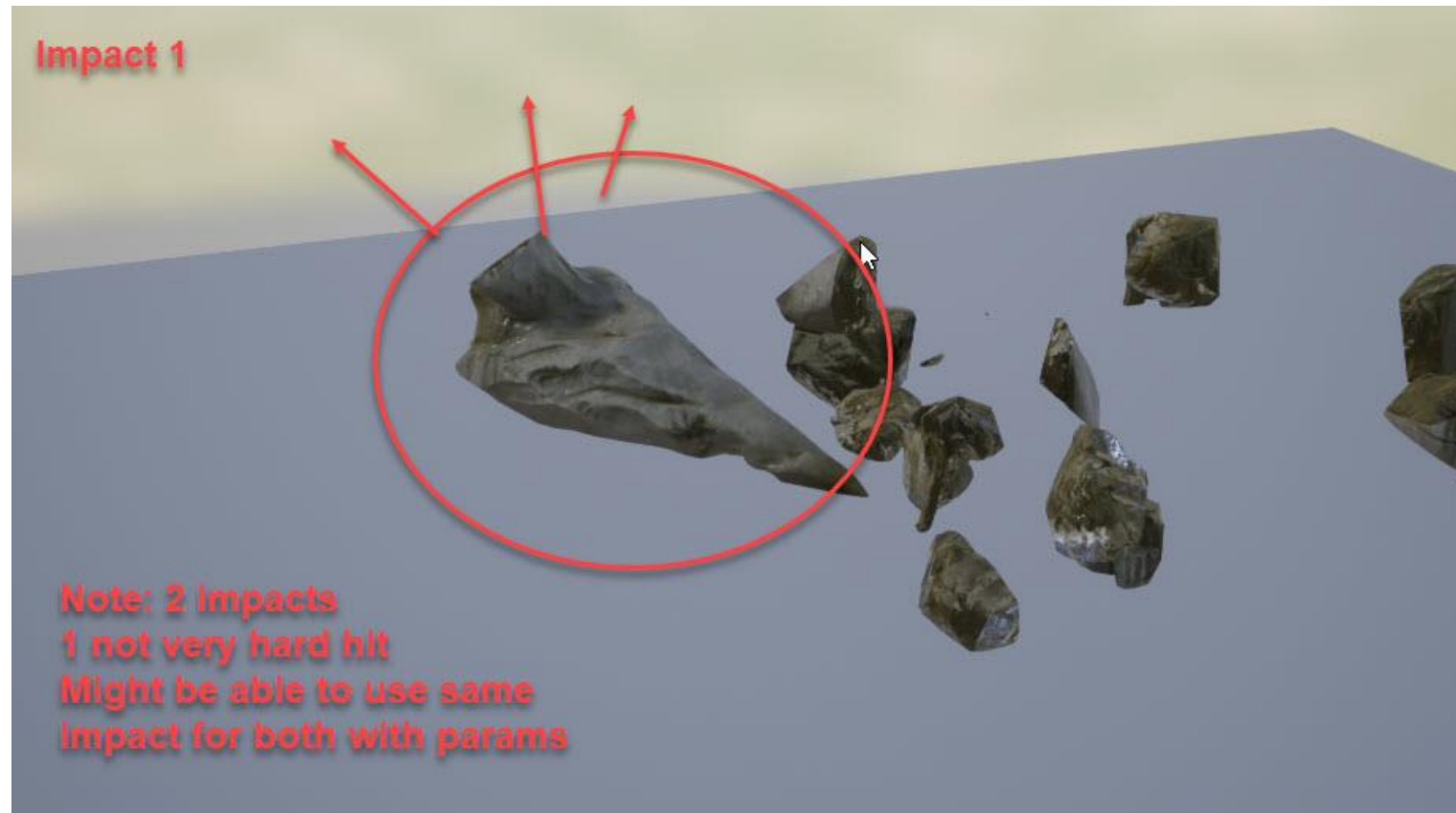
Sequence(r)(s): Planning

- Trail Attachments



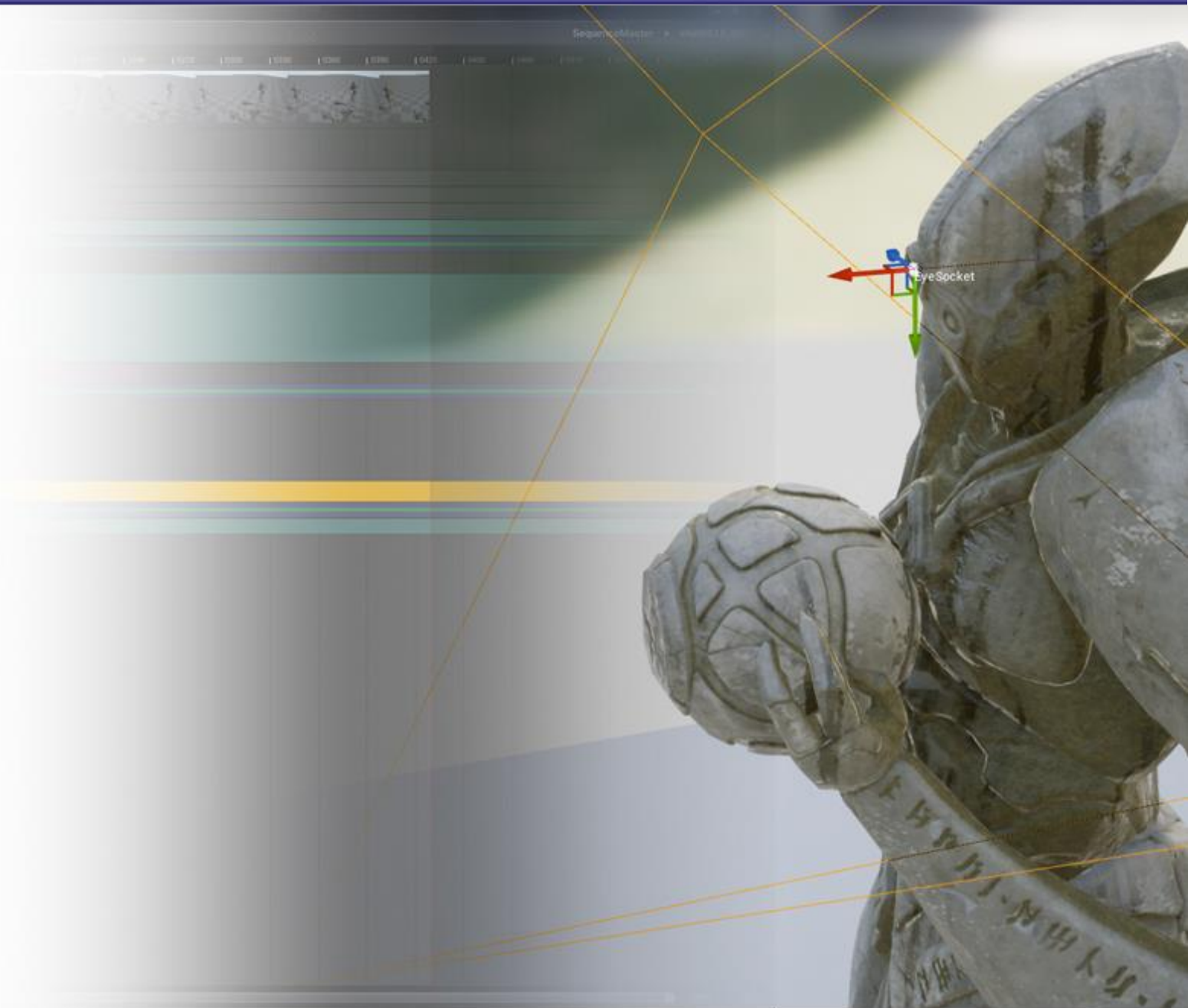
Sequence(r)(s): Planning

- Impacts



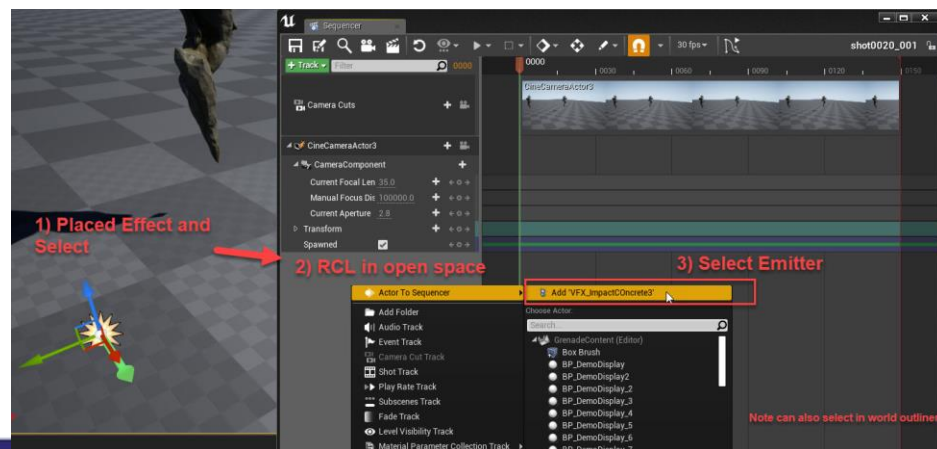
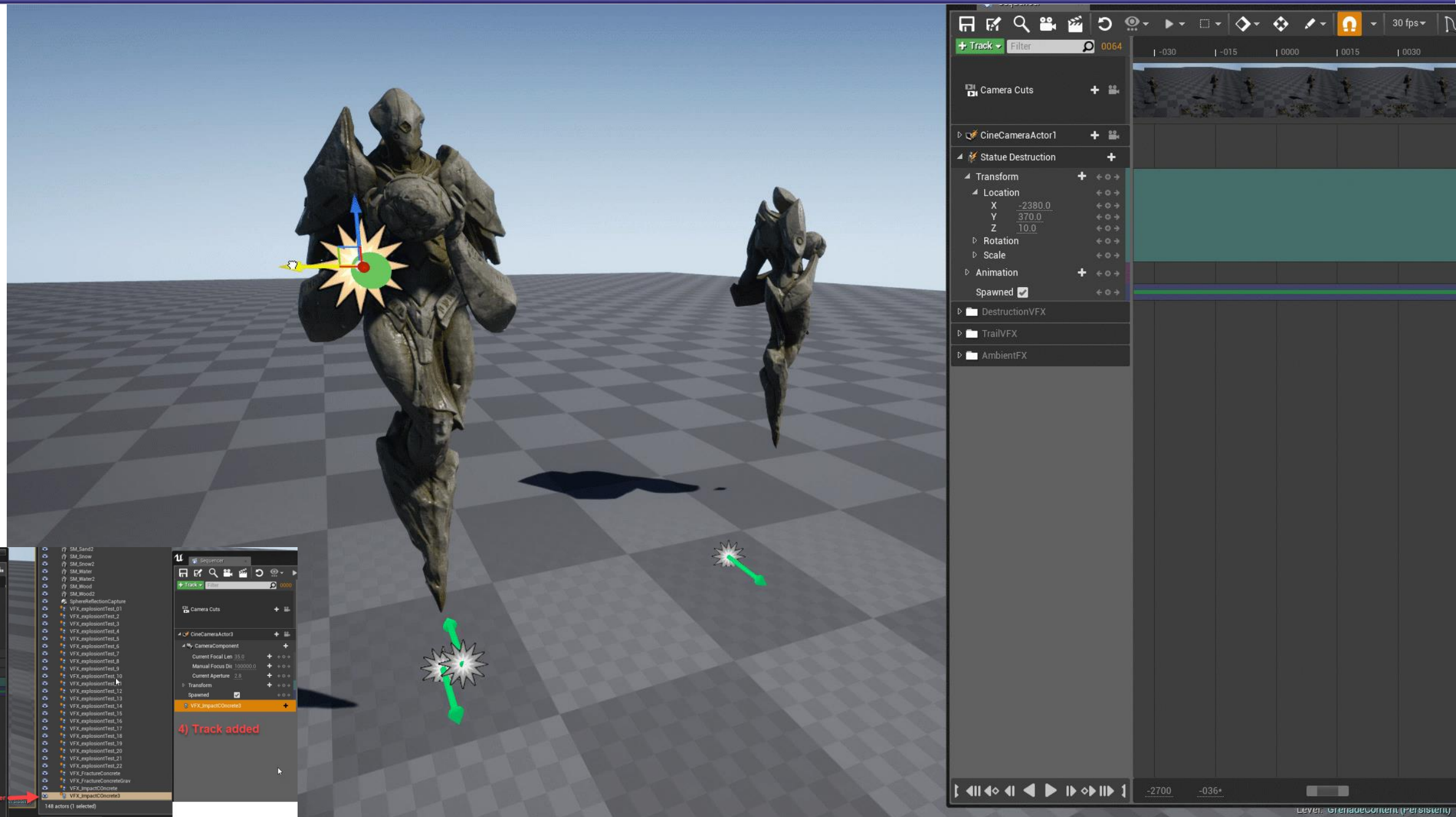
Sequence(r)(s): Add FX

- Placing vs spawning
 - Placing
 - Static world location effects
 - Spawning
 - for attachments
 - Only live in sequence
 - effects you want to unload



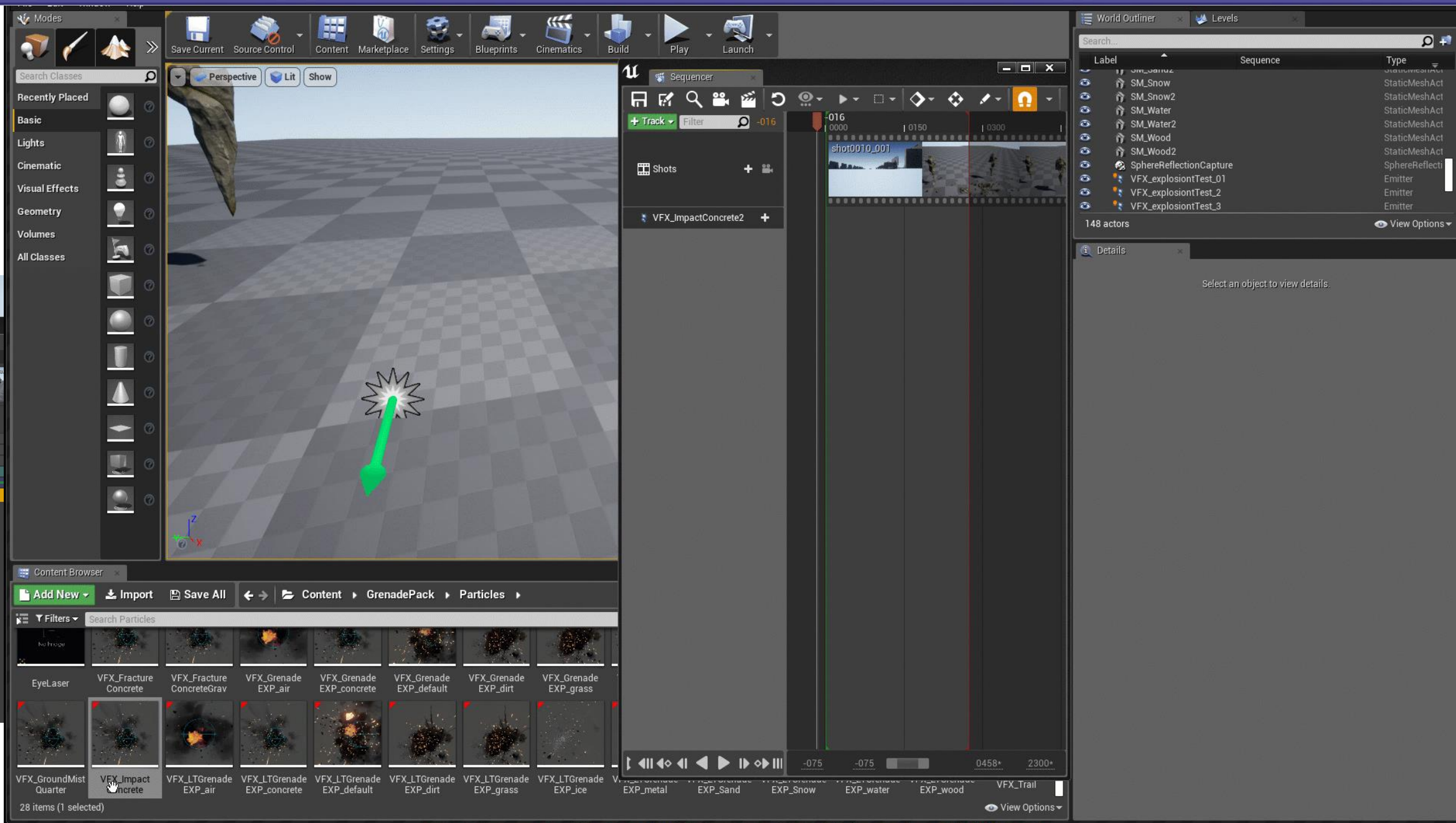
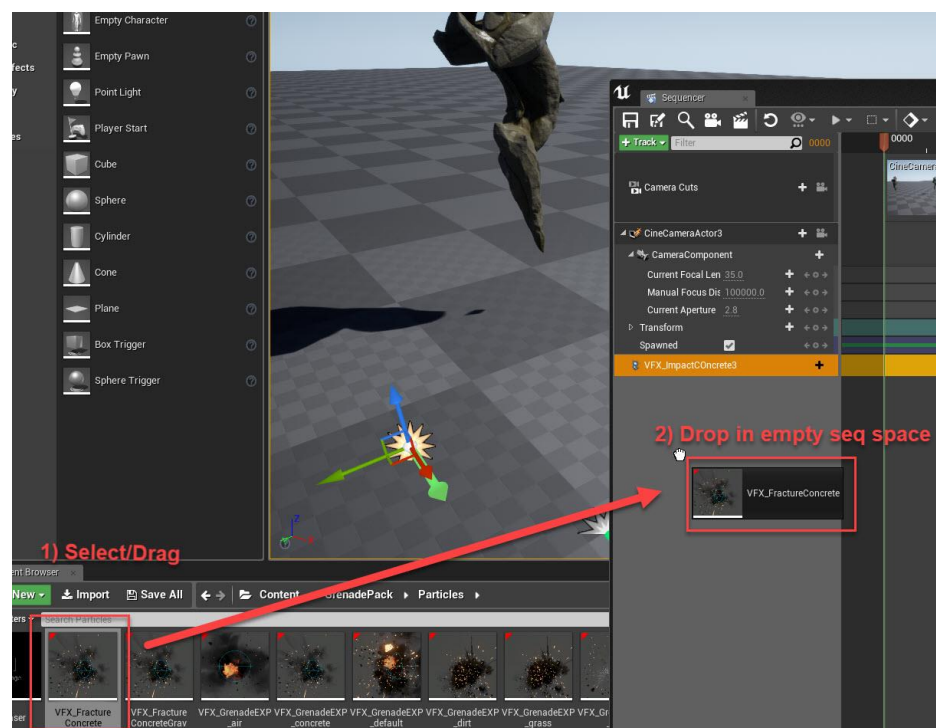
Sequence(r)(s): Add World FX

- Adding the Explosion and Fill Effects
- In world



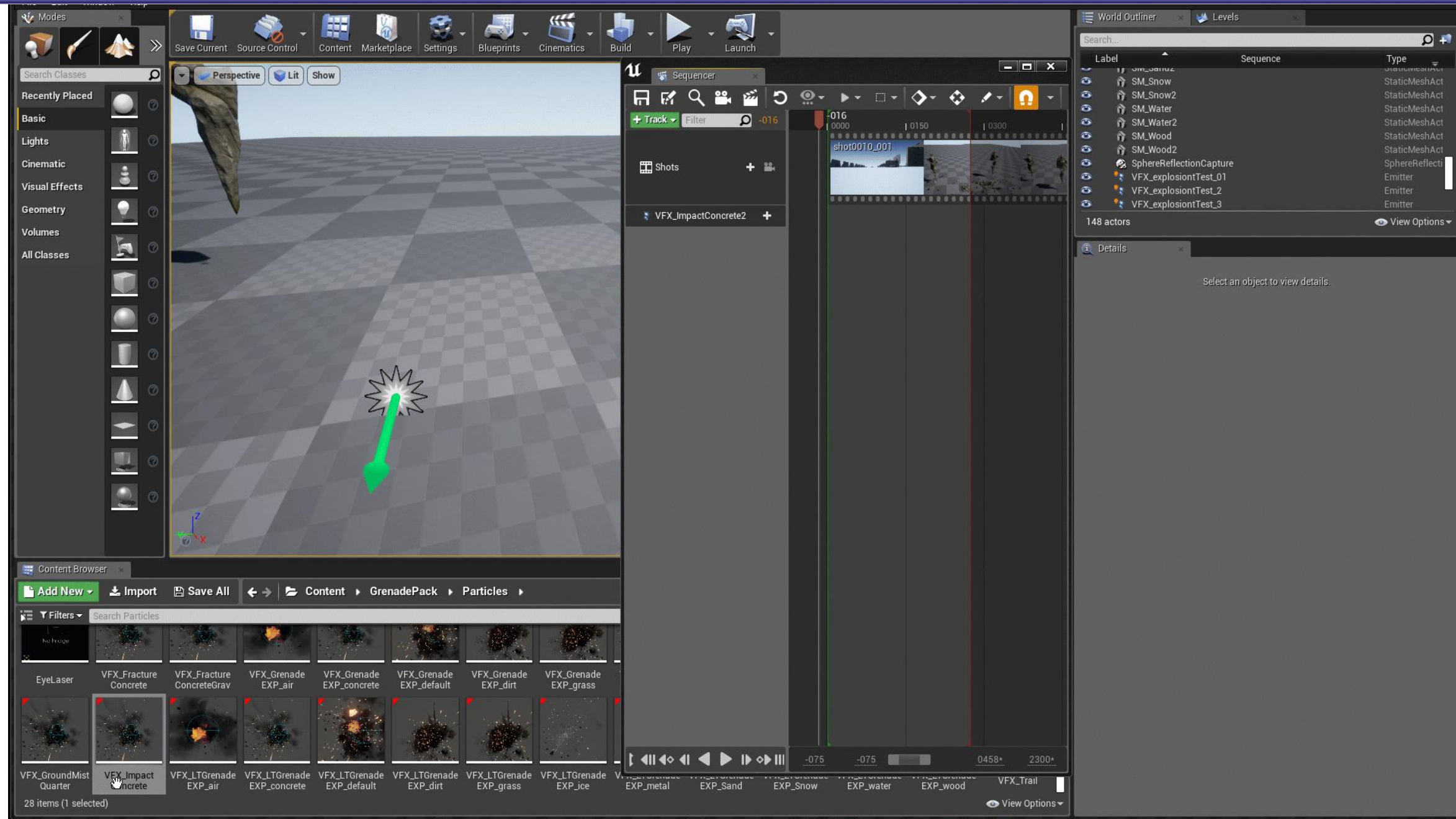
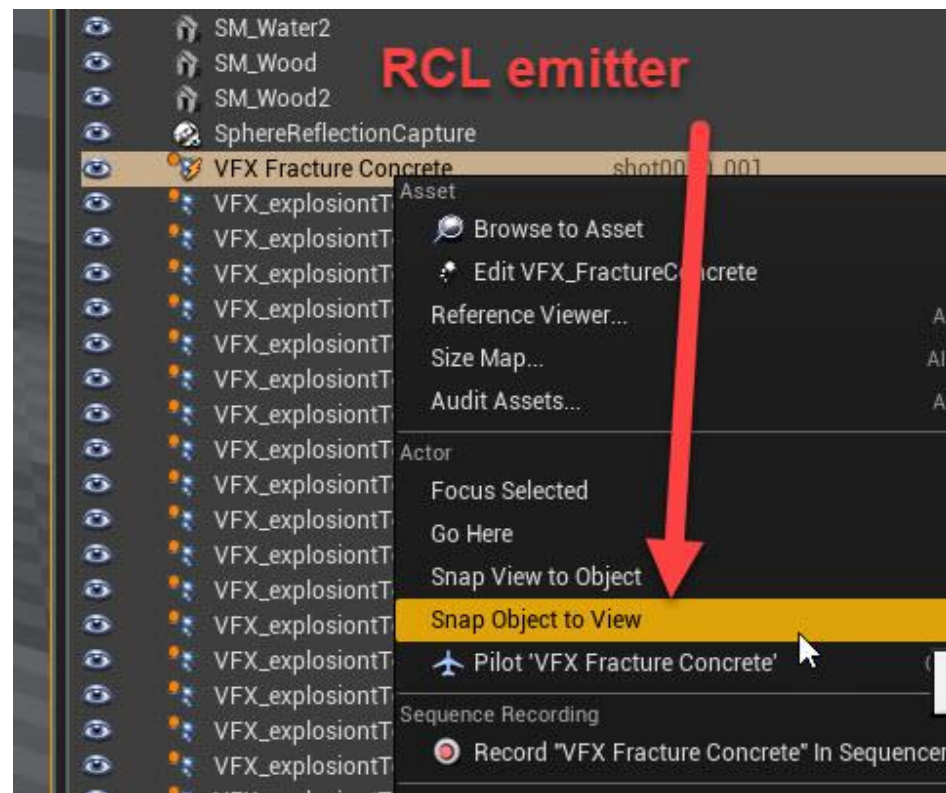
Sequence(r)(s): Add Spawned FX

- Spawn VFX Track
- Sometimes spawns in a weird place



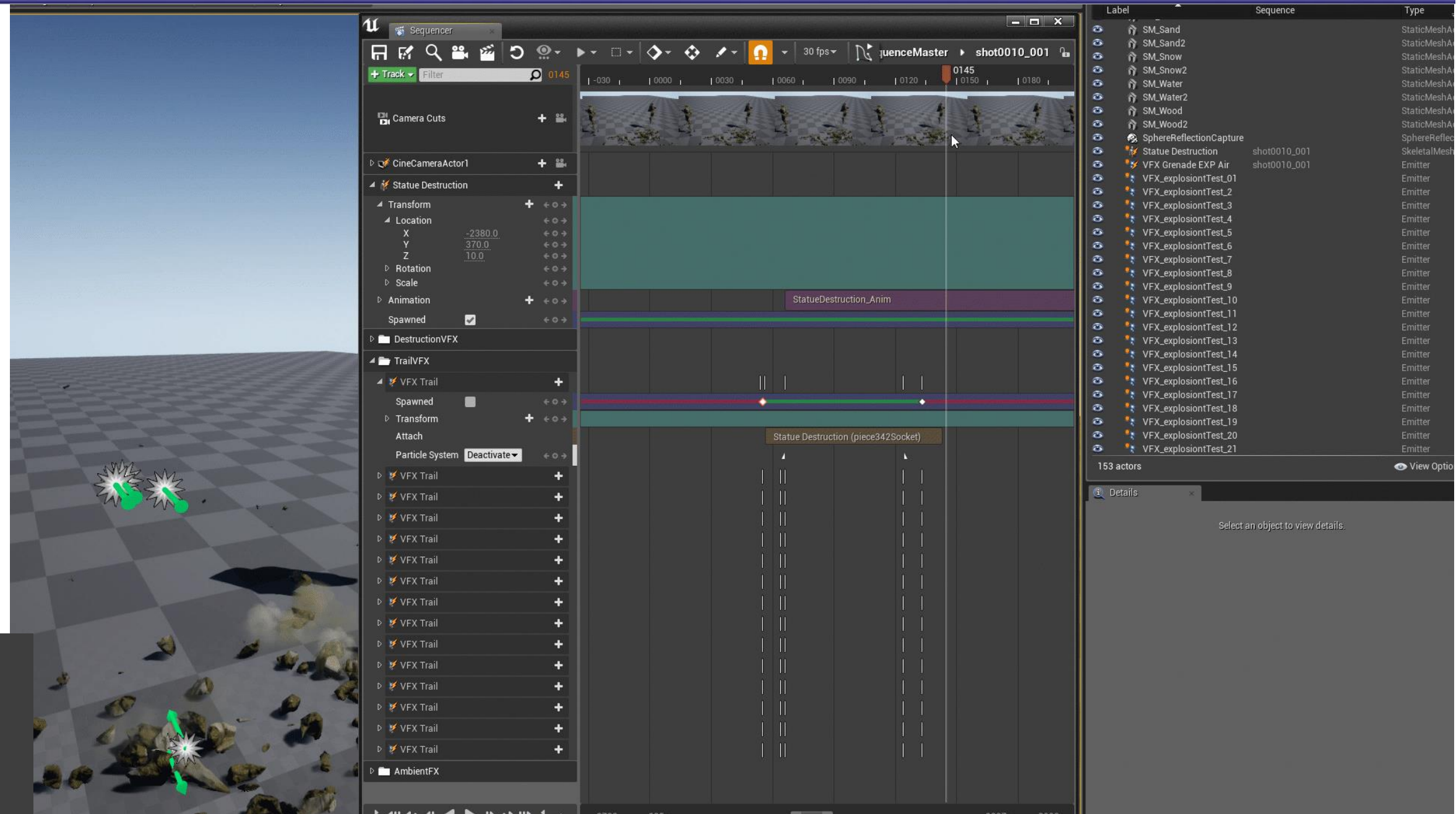
Sequence(r)(s): Add FX Gotcha

- Where is my Spawned FX?



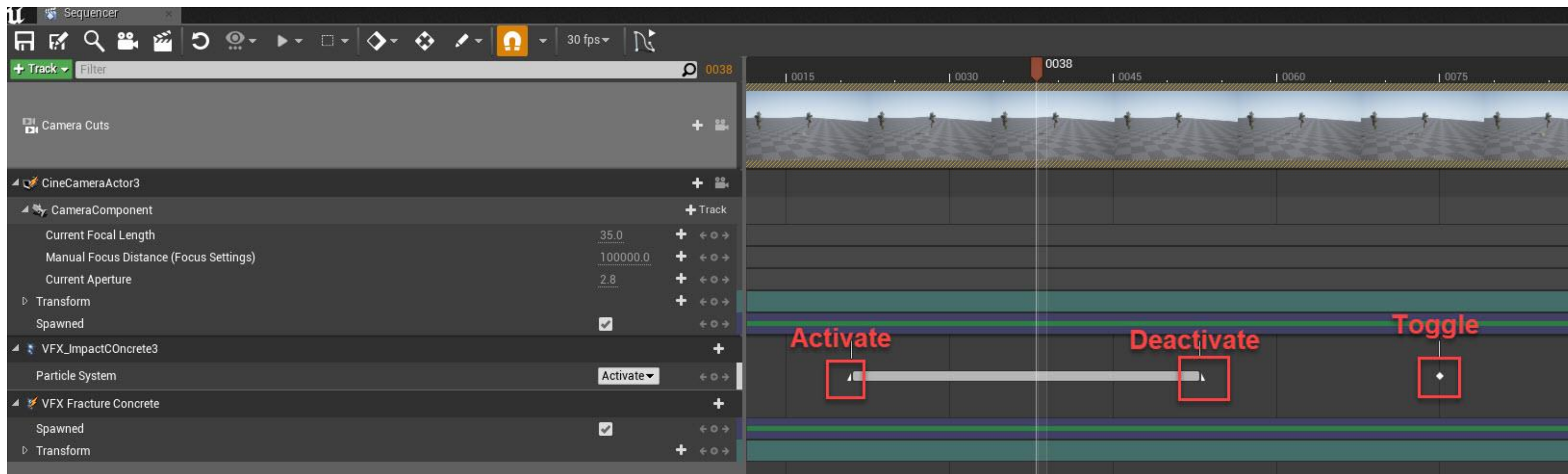
Sequence(r)(s): Add FX Gotchas

- Emitter types icons
 - Placed vs Spawned
- Spawned only in sequence
 - Only in outliner when active.
- Stay organized



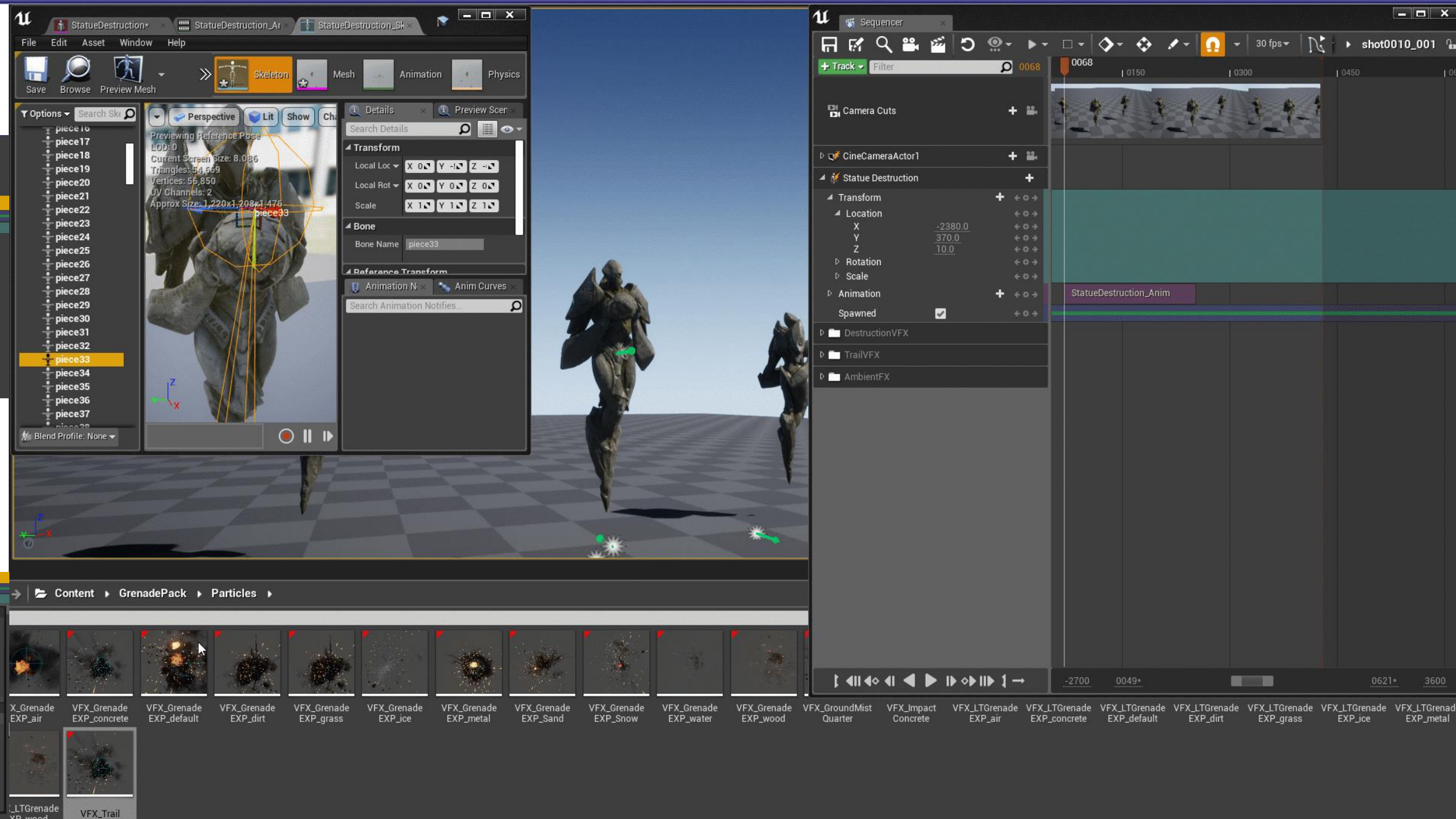
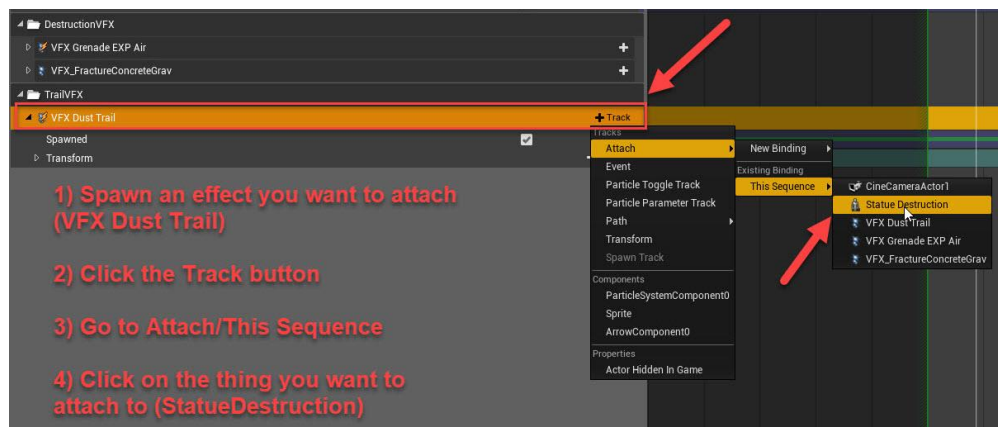
Sequence(r)(s): Toggle Track

- Three triggering keys

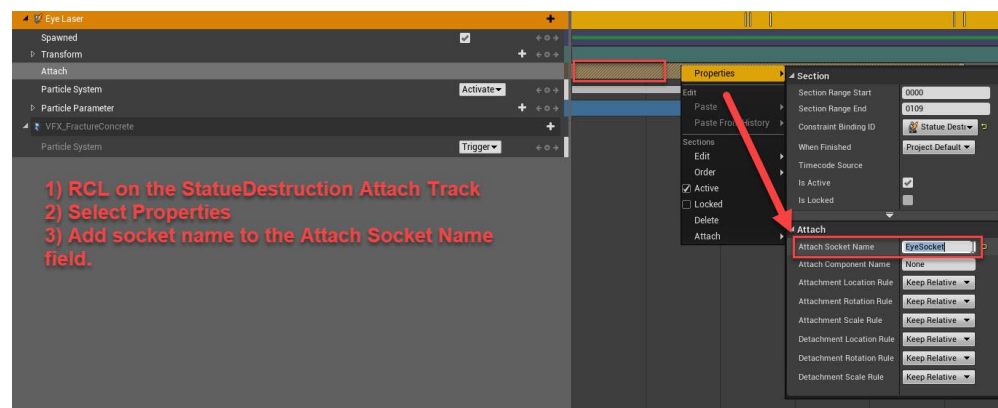


Sequence(r)(s): Attachment

- 1) Attachment track

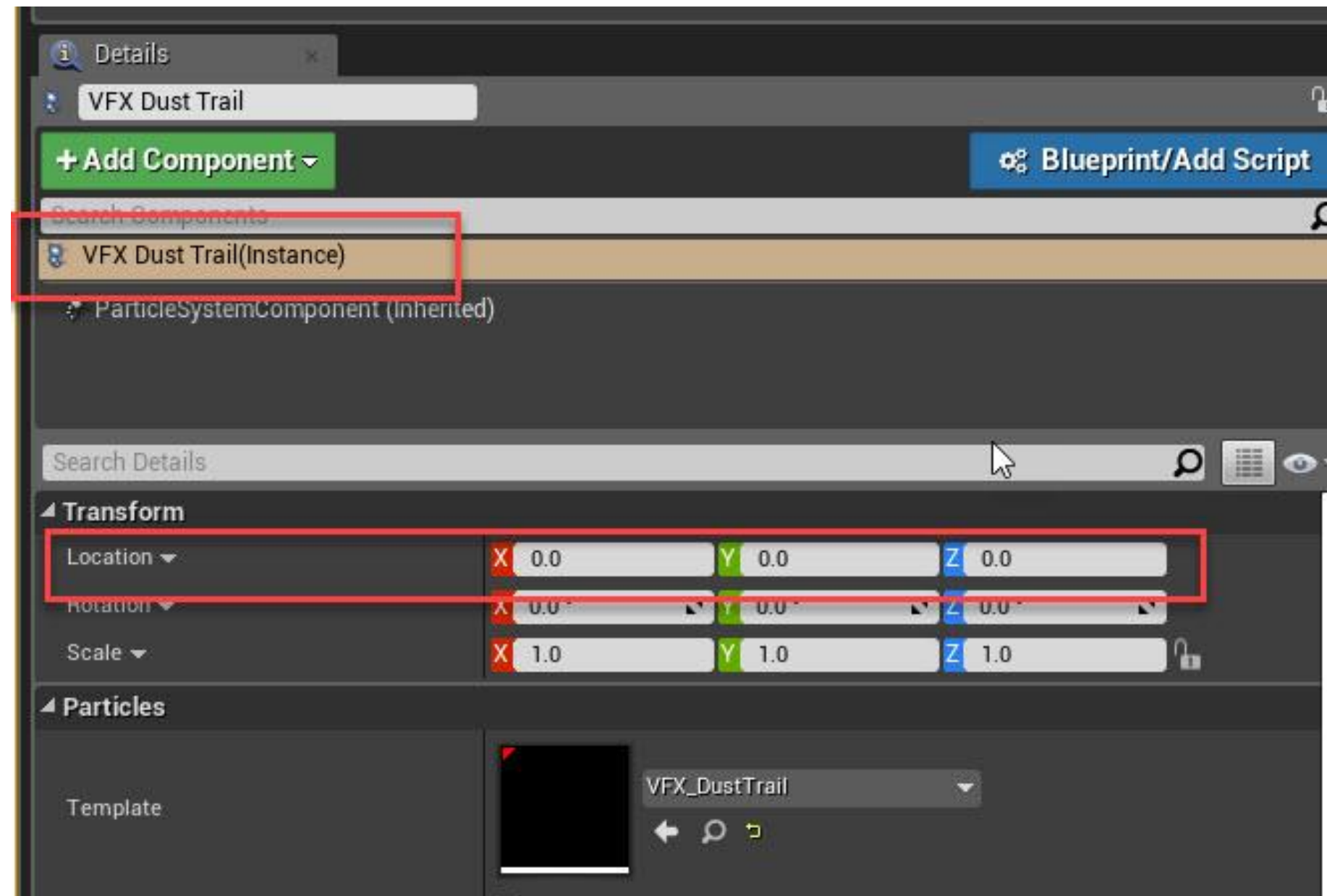


- 2) Socket Name



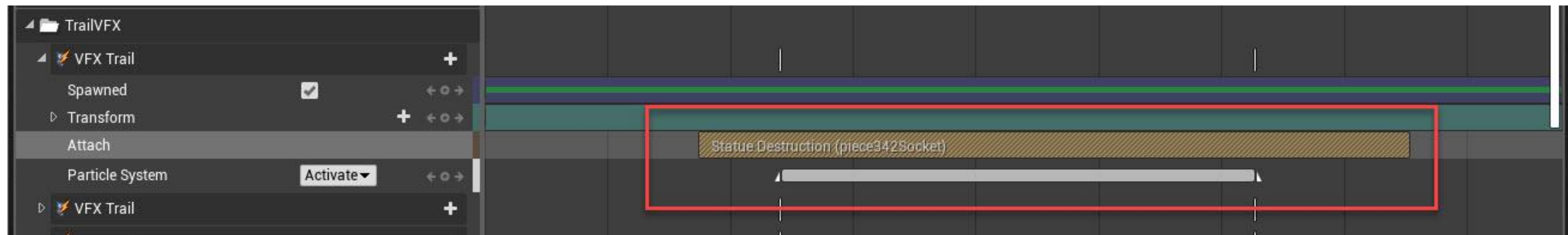
Sequence(r)(s): Attachment gotcha

- Attachment gotchas
 - Spawned emit will be somewhere
 - Make sure Location is set to
 - 0, 0, 0
 - Whatever is there will be an offset of the socket



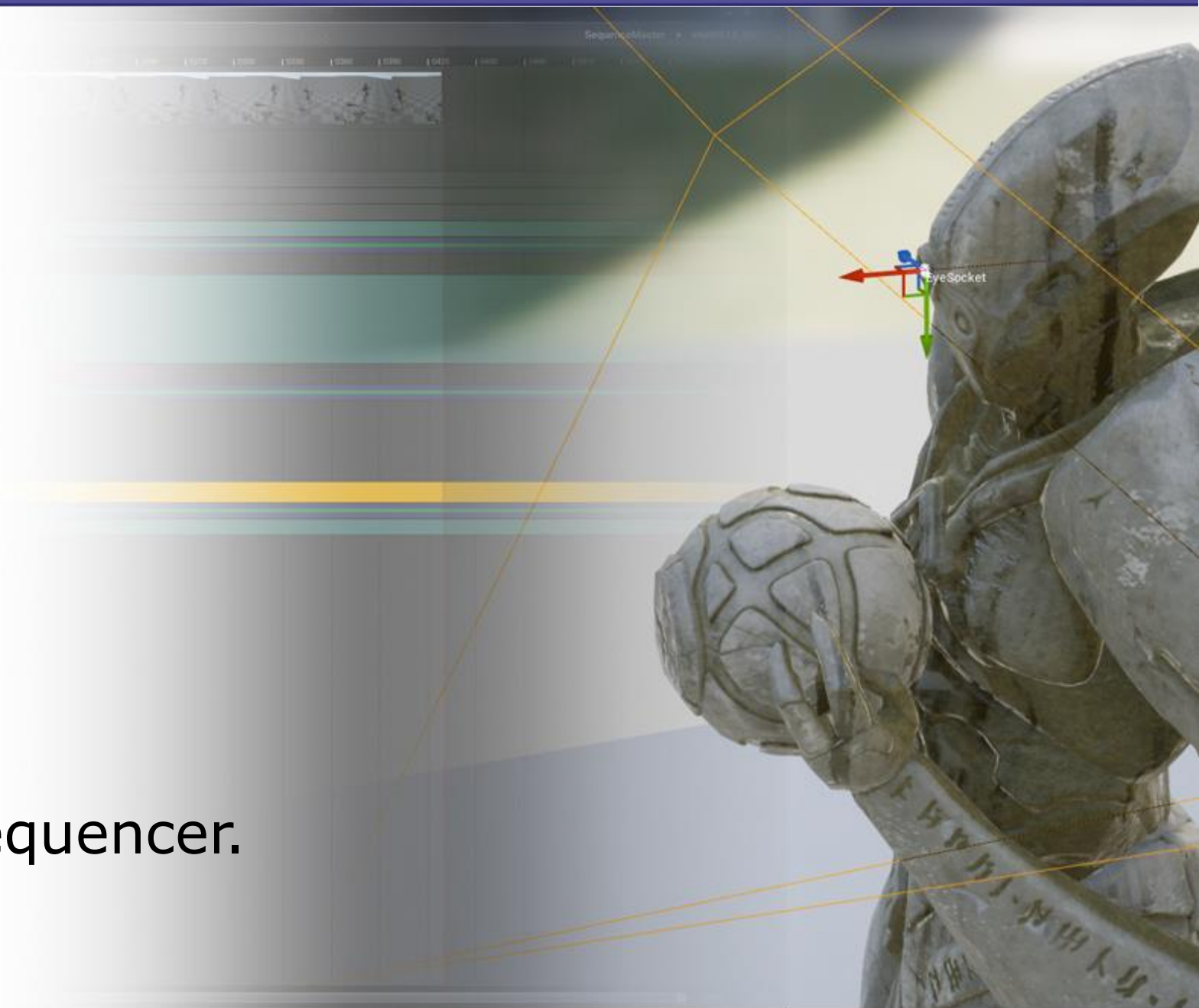
Sequence(r)(s): Attachment gotcha

- Attachment gotchas
 - Make sure the attach covers your whole emit
 - It will dethatch if its too short



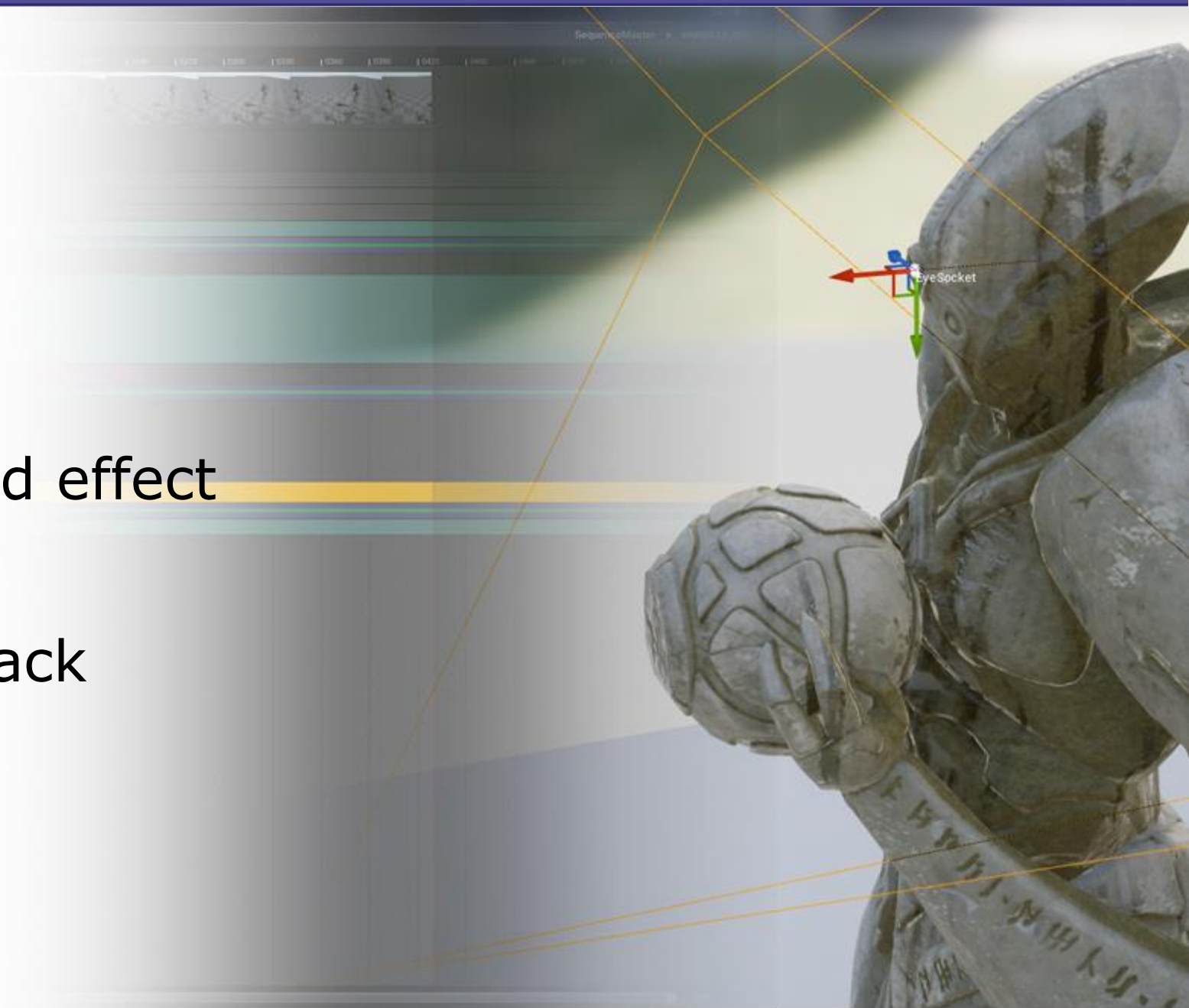
Sequence(r)(s): Parameters

- Before you set the effect
 - How do you want to change it?
 - Inits vs over life
 - Color changes?
 - Movement changes?
 - Scale?
 - Emit rates?
 - Locations?
 - Param in cascade you can use it in sequencer.



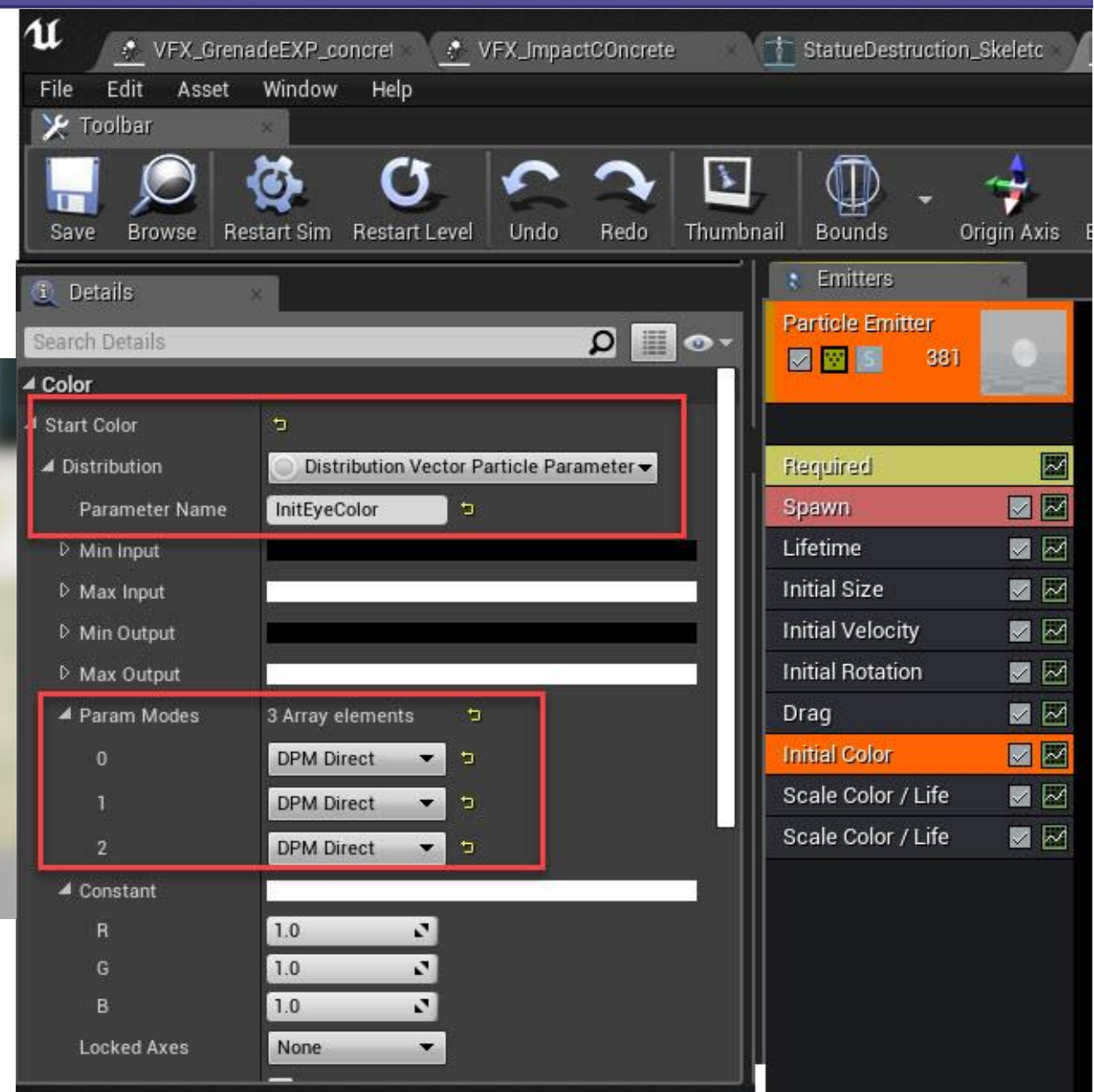
Sequence(r)(s): Parameters

- Parameters
 - Need to change the effect in time
 - controls in the sequence
 - Prep Effect in Cascade
 - Expose the parameters in the spawned effect
 - Add the effect to the sequence
 - add the parameters to the effect track
 - set your values in the track



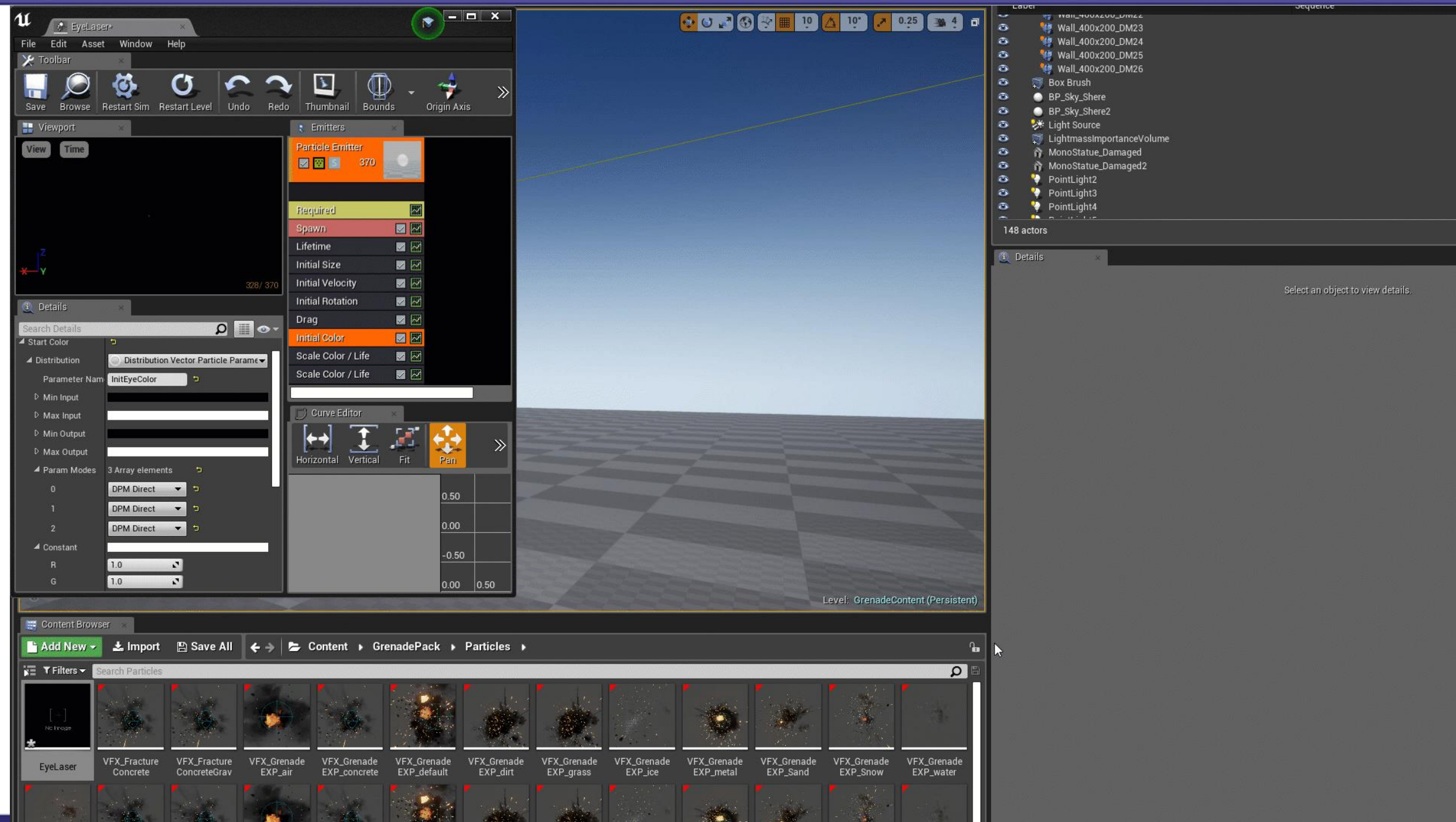
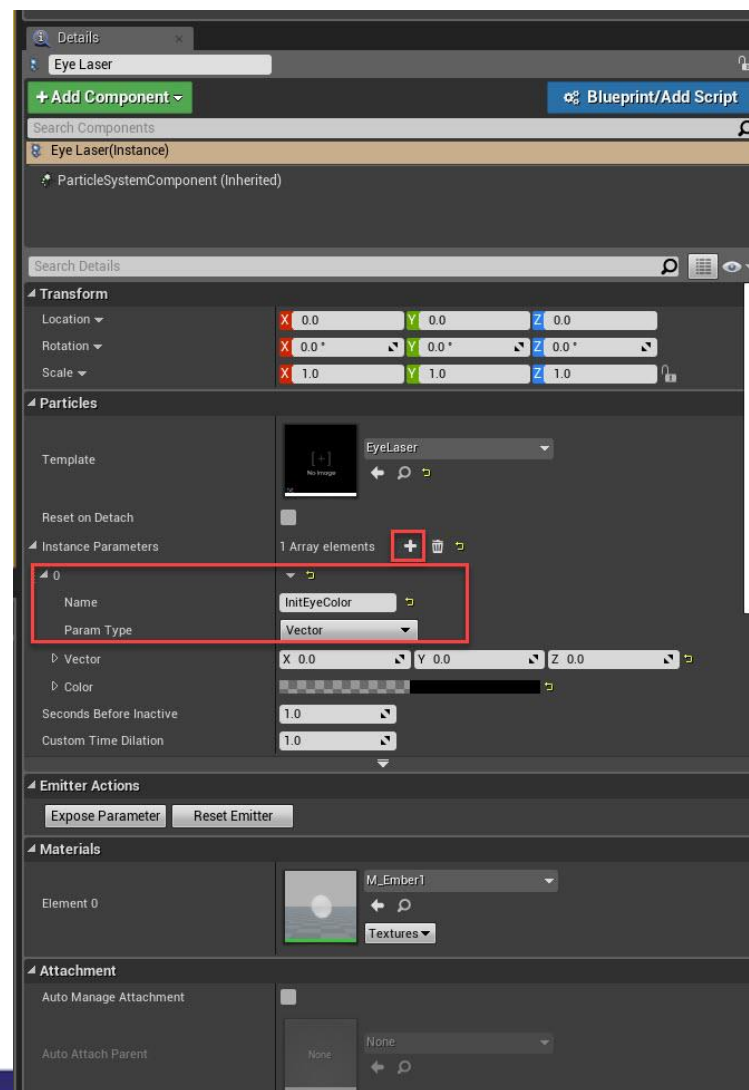
Sequence(r)(s): VFX Prep

- EyeLaser
 - Param Names
 - InitEyeColor
 - InitVel
 - AlphaOverLife



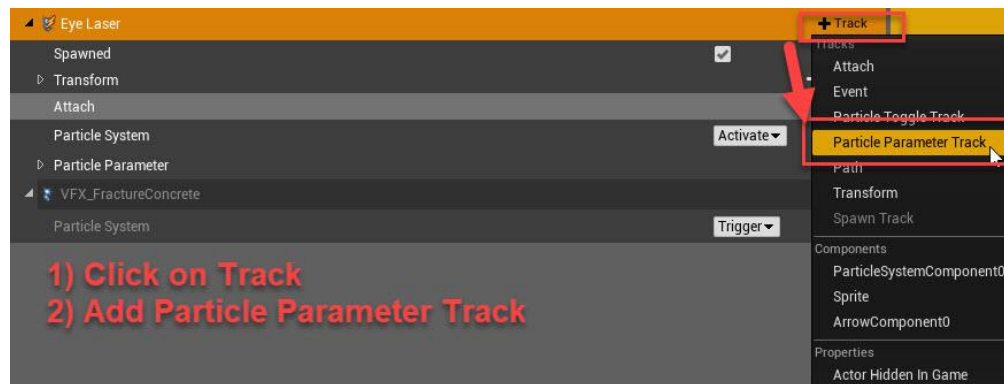
Sequence(r)(s): Expose Params

- Expose param button
- Or add manually

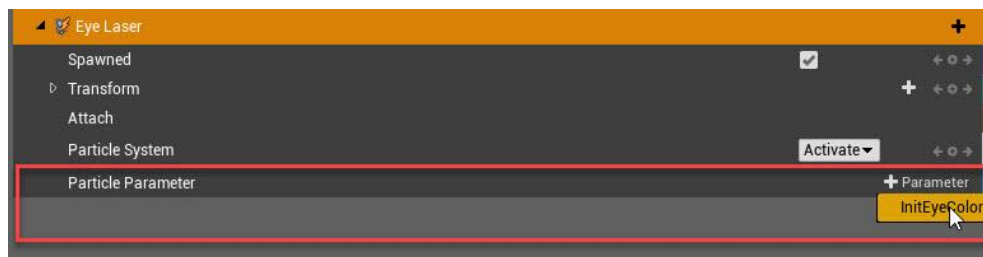


Sequence(r)(s): Add Param Track

- 1) Add parameter track

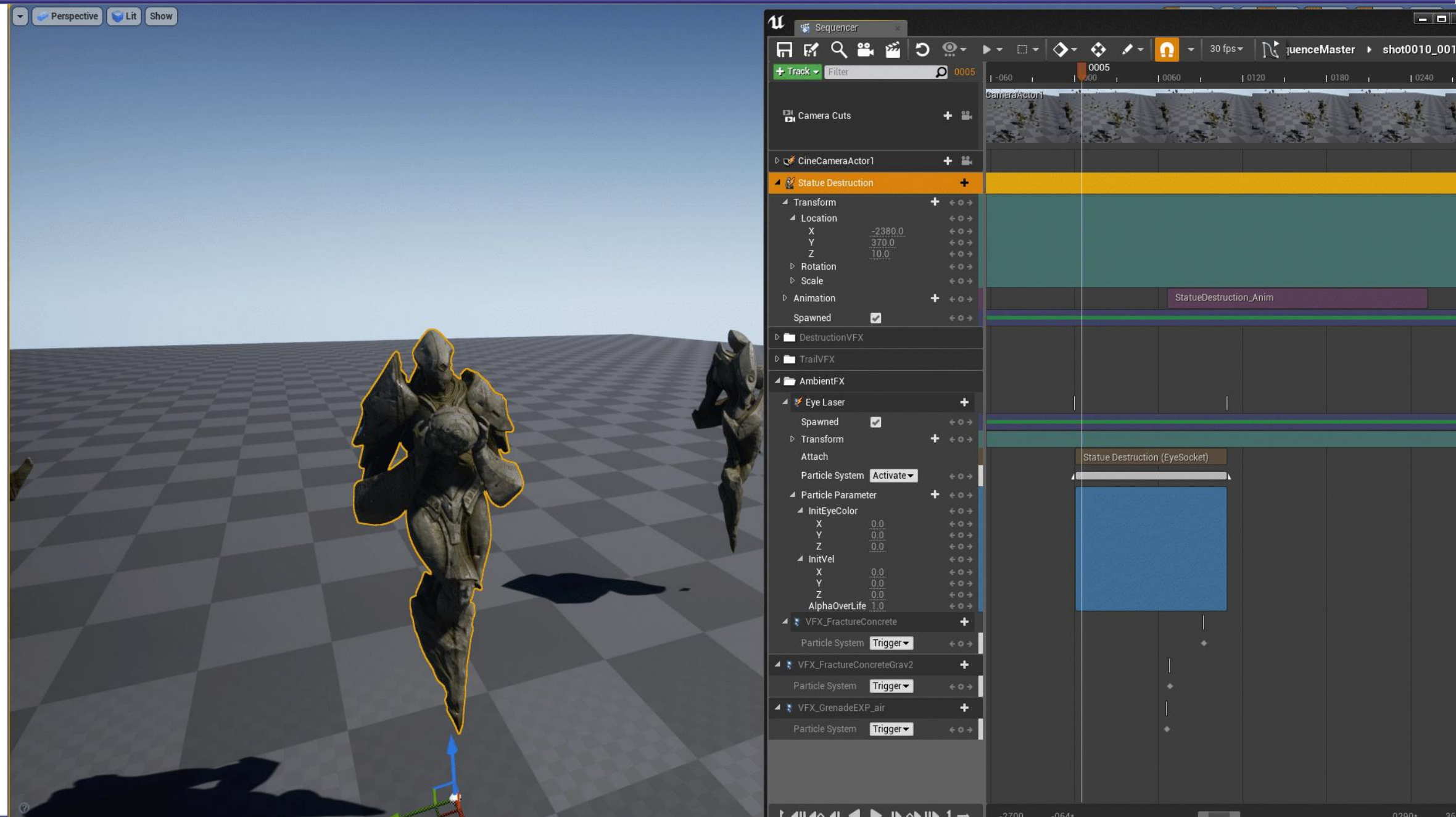


- 2) Add parameters



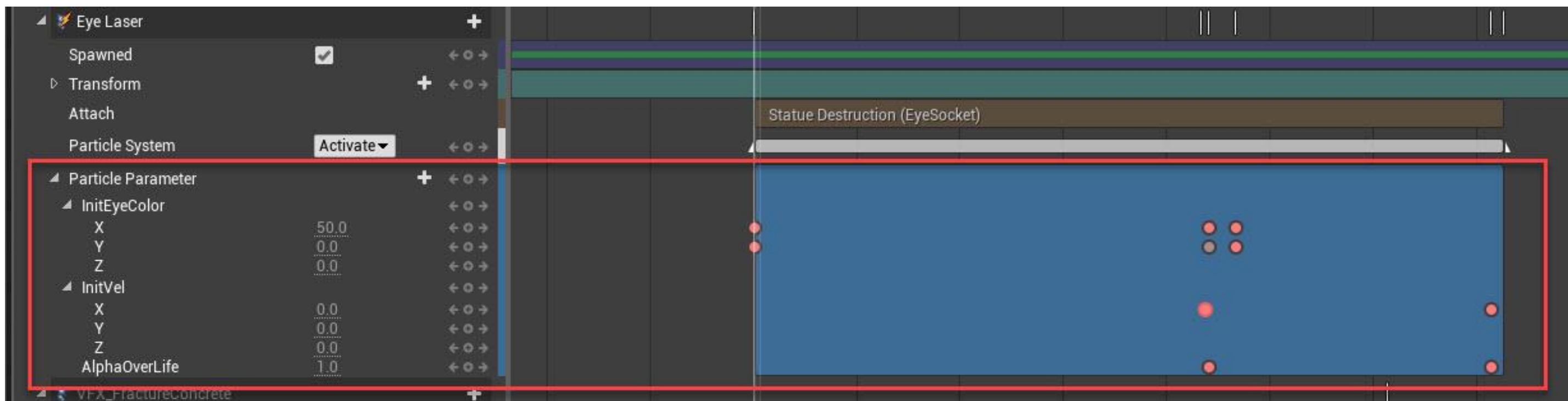
Sequence(r)(s): Add Param Curves

- Add Parameter Keys
 - Change Init Color
 - Change Init Velocity
 - Change Alpha Over Life



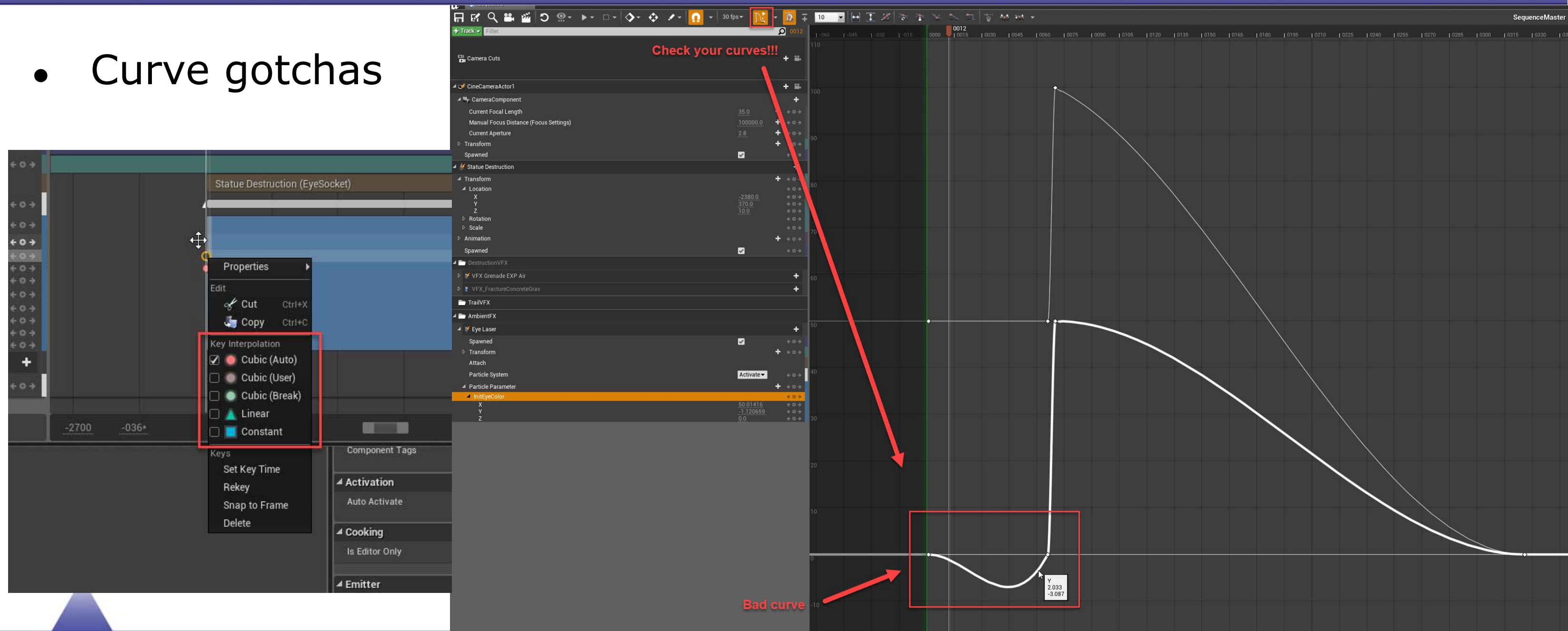
Sequence(r)(s): Param Curves

- Parameter Curves



Sequence(r)(s): Curve Gotchas

- Curve gotchas



Sequence(r)(s): Ground Impacts

Initial Size

Details

Search Details

Size

Start Size

Distribution

Distribution Vector Particle Parameter

Parameter Name

InitSize

Initial Velocity +

Details

Search Details

Velocity

Start Velocity

Distribution

Distribution Vector Particle Parameter

Parameter Name

InitVel

Size by Life

Details

Search Details

Size

Life Multiplier

Distribution

Distribution Vector Particle Parameter

Parameter Name

SizeByLife

Emitters	CONCRETEDustFing	CONCRETEDustOut	CONCRETEDebris
	33	53	104
Required	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Spawn	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Lifetime	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Initial Size	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Sphere	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
SubImage Index	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Dynamic	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Pivot Offset	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Const Acceleration	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Initial Color+	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Scale Color / Life	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Size By Life	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Initial Velocity+	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Sphere

Details

Search Details

Location

Start Radius

Distribution

Distribution Float Particle Parameter

Parameter Name

SphereRad

Impact Parameter Setups

All Direct

Initial Velocity (Debris)

Details

Search Details

Velocity

Start Velocity

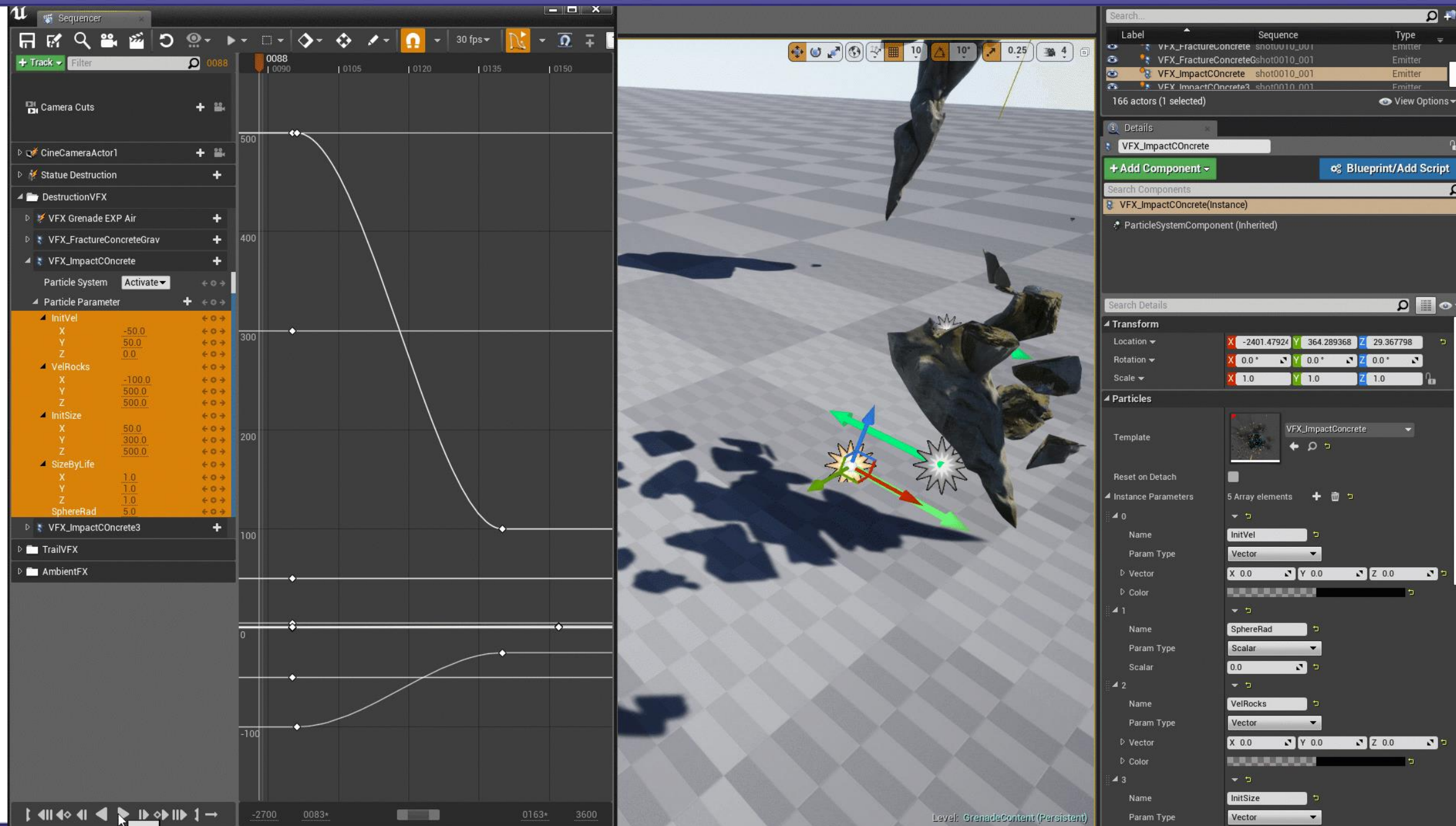
Distribution

Distribution Vector Particle Parameter

Parameter Name

VelRocks

Sequence(r)(s): Ground Impacts





Wrap it up!

- Sorting thru the Rubble
 - Preparation
 - In game destruction
 - Hide/show
 - Fracture
 - Animated destruction
 - Sequencer tips and tricks
 - Visual effects parameter uses



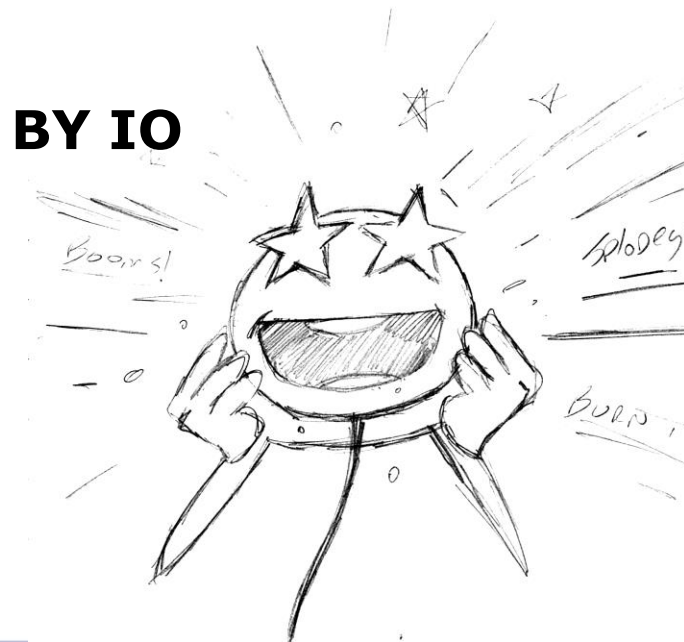
Thanks!

- Mark Teare
- Mike Lyndon at SideFX
- The Blast Team
- Epic Games
- The Unreal Marketplace
- Coffee
- Avalanche Studios
- DICE
- Guerrilla Games
- Machine Games
- Naughty Dog
- Volition



MOAR Destruction

- Wednesday, March 20 | 11:00am - 12:00pm
- **CAUSING CHAOS: THE FUTURE OF PHYSICS AND DESTRUCTION IN UNREAL ENGINE (PRESENTED BY EPIC GAMES)**
- **Sponsor Speakers:** Matthias Worch (Epic Games Special Projects), Jim Van Allen (Epic Games), Michael Lentine (Epic Games)
- **Location:** YBCA Theater
- Thursday, March 21 | 12:45pm - 1:45pm
- **CREATING A SCALABLE AND DESTRUCTIBLE WORLD IN 'HITMAN 2' (PRESENTED BY IO INTERACTIVE, IN ASSOCIATION WITH INTEL)**
- **Sponsor Speakers:** James Vango (IO Interactive), Leigh Davies (Intel)
- **Location:** Room 3009, West Hall



VFX Roundtables

- Wednesday, March 20 | 10:30am - 11:30am
- **VISUAL EFFECTS ROUNDTABLE DAY 1**
- **Speaker: Drew Skillman** (Google, Inc.)
- **Location:** Room 208, South Hall
- Thursday, March 21 | 2:00pm - 3:00pm
- **VISUAL EFFECTS ROUNDTABLE DAY 2: ARTISTIC LENS**
- **Speaker: Jason Keyser** (Riot Games)
- Friday, March 22 | 10:00am - 11:00am
- **VISUAL EFFECTS ROUNDTABLE DAY 3: TECHNICAL LENS**
- **Speaker: Drew Skillman** (Google, Inc.)



Questions?

