



ADVANCED TONEMAPPER

Version 1.0 | Unreal Engine 5.6
by **TOXIC STOCK**a

ACES · Filmic · UDK · Source · AgX · Khronos · Reinhard · LinearClamp ·
sRGB Max Chroma

TOXIC STOCK toxic.stock@toxicdev.ru

// TABLE OF CONTENTS

01	Accessing the Plugin	3
02	Interface Overview	3
03	Tonemapping Operators	5
04	Tonemapper Parameters	6
05	Auto-Exposure Controls	8
06	Color Grading & LUT Pipeline	9
07	Local Exposure	10
08	Post-Process Effects	11
09	Console Variables (CVars)	12
10	Workflow & Usage	13
11	Technical Information	15
12	Support & Resources	16

// 01 ACCESSING THE PLUGIN

Advanced Tonemapper integrates into Unreal Engine as a dockable editor panel. It replaces the built-in tonemapper entirely, taking over the ReplacingTonemapper post-process pass while preserving all standard UE post-process effects.

> Opening the Panel

- ▶ **Menu** Window → Advanced Tonemapper
- ▶ **Tools category** Also registered under the Tools workspace category
- ▶ **Tab** Opens as a dockable NomadTab – drag, dock, or float

> Installation

1. Copy the AdvancedTonemapper folder into your project's Plugins/ directory.
2. Enable via Edit → Plugins → Rendering → Advanced Tonemapper.
3. Restart the editor. The plugin loads automatically at engine startup.

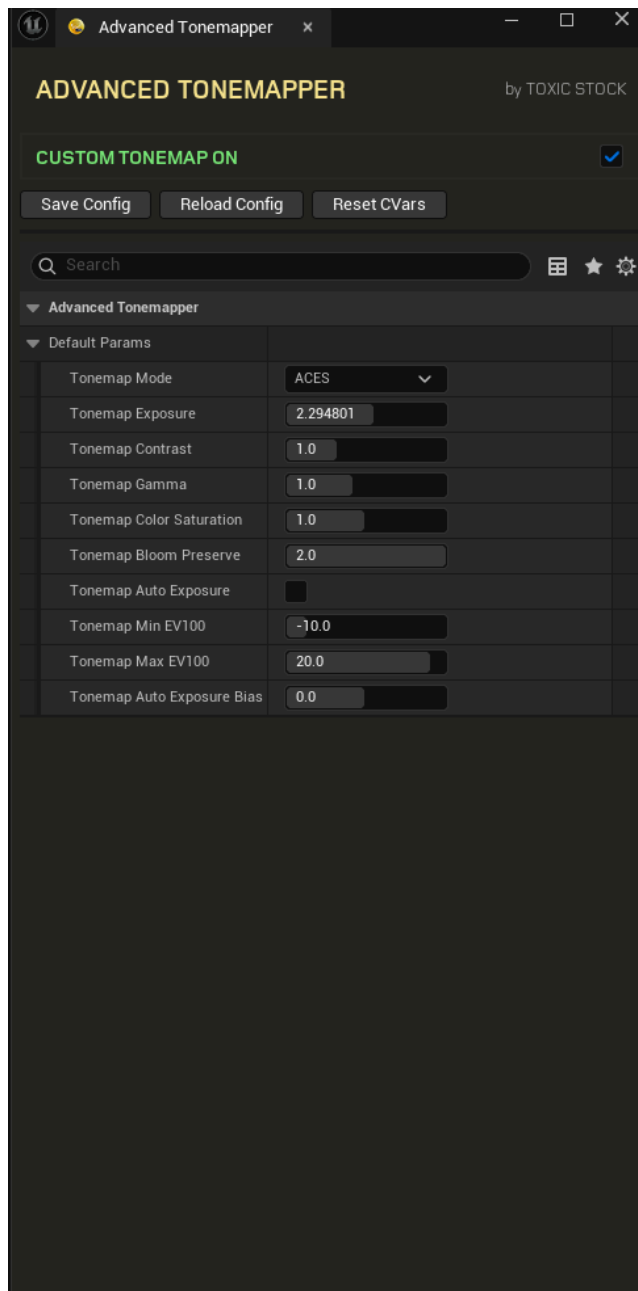
The plugin does NOT apply to Scene Captures, Reflection Captures, or Planar Reflections – only to primary game and editor viewports.

// 02 INTERFACE OVERVIEW

The panel is divided into four areas: Header, Status Bar, Action Buttons, and the Settings Details panel.

> Header

Displays "ADVANCED TONEMAPPER" in gold with "by TOXIC STOCK" right-aligned. Plugin version and build info appear below.



> Status Bar

- ▶ **CUSTOM TONEMAP ON** Green indicator – plugin active, overriding the engine tonemapper
- ▶ **CUSTOM TONEMAP OFF** Red indicator – plugin disabled, engine default rendering

- ▶ **Master Toggle Checkbox** Immediately enables/disables the override; saved to config

> Action Buttons

- ▶ **Save Config** Persists all current settings to the .ini config file
- ▶ **Reload Config** Reloads settings from disk, discarding unsaved changes
- ▶ **Reset CVars** Forces all CVars back to sentinel values, reapplying settings from the Details panel

> Settings Details Panel

A searchable UE Details View bound to UAdvancedTonemapperSettings. Properties are filtered by active TonemapMode – only relevant parameters appear:

Mode Filter	Visible Parameters
All modes	TonemapMode, TonemapExposure, TonemapContrast, TonemapGamma, TonemapColorSaturation, TonemapBloomPreserve
Filmic (1), UDK (2), Source (3), Reinhard (7)	TonemapShadowLift
AgX (4) only	TonemapAgXSlope, TonemapAgXOffset, TonemapAgXPower, TonemapAgXSaturation
Khronos (5) only	TonemapKhronosStartCompression, TonemapKhronosDesaturation, TonemapKhronosShadowOffset
Auto-Exposure enabled	TonemapMinEV100, TonemapMaxEV100, TonemapAutoExposureBias
Always hidden	bEnableTonemapping (controlled by Status Bar toggle)

Every proper at ty change auto-saves config and resets all CVars to sentinel – new setting takes effect on the very next rendered frame.

// 03 TONEMAPPING OPERATORS

Nine operators available via the TonemapMode property. Each maps linear HDR luminance to [0, 1] using a different transfer curve.

ID	Name	Characteristic	Best For
0	ACES	Full AP1 pipeline. RRT+ODT. Film S-curve, highlight desaturation. Respects Blue Correction + Expand Gamut.	Cinematic / PBR

ID	Name	Characteristic	Best For
1	Filmic	Hable / Uncharted 2. ExposureBias=2.0, white-scale normalised. AP1 pipeline. Punchy toe and shoulder.	AAA action, high contrast
2	UDK	Hejl/Burgess-Dawson from UE3/UDK era. Warm, aggressive compression.	Retro UE3 look
3	Source	Exponential $1-e^{-x}$. Flat highlights, minimal roll-off.	Valve / Source Engine
4	AgX	Inset matrix → log clamp → CDL grading → sRGB EOTF. No hue shift in highlights.	Photo-real, PBR review
5	Khronos Neutral	Shadow toe, luminance-threshold highlight compression, desaturation roll-off.	PBR reference / neutral
6	LinearClamp	saturate(x) only. No curve.	Debug / minimalist
7	Reinhard	Per-channel $x/(1+x)$. Smooth gentle roll-off.	Stylised / illustrative
8	sRGB Max Chroma	Max-channel Reinhard with hue/chroma ratio preservation.	Vibrant / saturated

ACES (0) and Filmic (1) route through Unreal's AP1 colour pipeline and respect Blue Correction / Expand Gamut on your Post-Process Volume. All other operators apply their curve directly in linear sRGB.

// 04 TONEMAPPER PARAMETERS

Core parameters in FAdvancedTonemapperParams, accessible via the Settings panel and saved to config.

> Universal Parameters

Parameter	Type	Description
TonemapMode	enum 0-8	Active tonemapping operator. See section 03.
TonemapExposure	float	Linear exposure multiplier applied before the tonemapping curve.
TonemapContrast	float	S-curve contrast pivoted at 0.18 grey. 1.0 = neutral.
TonemapGamma	float	Power function applied post-contrast. 1.0 = neutral.
TonemapColorSaturation	float	Global colour saturation. 1.0 = neutral, 0.0 = greyscale.

Parameter	Type	Description
TonemapBloomPreserve	float [0-2]	Scales the bloom contribution into the final composited colour. 1.0 = normal bloom.

> Shadow Lift (modes 1, 2, 3, 7 only)

Parameter	Type	Description
TonemapShadowLift	float	sqrt-based lift applied to shadow tones. Not exposed for ACES, AgX, Khronos, LinearClamp, or sRGB Max Chroma.

> AgX Parameters (mode 4 only)

Parameter	Type	Description
TonemapAgXSlope	float	CDL slope in AgX log space.
TonemapAgXOffset	float	CDL offset in AgX log space.
TonemapAgXPower	float	CDL power in AgX log space.
TonemapAgXSaturation	float	Post-CDL saturation before the EOTF.

> Khronos Neutral Parameters (mode 5 only)

Parameter	Type	Description
TonemapKhronosStartCompression	float [0.001-0.99]	Luminance threshold where highlight compression begins.
TonemapKhronosDesaturation	float	Desaturation amount in compressed highlight regions.
TonemapKhronosShadowOffset	float	Additive offset in shadow tones.

// 05 AUTO-EXPOSURE CONTROLS

The plugin includes a complete self-contained auto-exposure implementation. When `bTonemapAutoExposure` is enabled, it overrides the engine's auto-exposure CVars with its own controlled values, then restores the originals when disabled.

> Parameters

Parameter	Type	Description
bTonemapAutoExposure	bool	Master switch. Enables the plugin's auto-exposure override.

Parameter	Type	Description
TonemapMinEV100	float	Minimum scene exposure value (EV100). Clamps the lower adaptation bound.
TonemapMaxEV100	float	Maximum scene exposure value (EV100). Clamps the upper adaptation bound.
TonemapAutoExposureBias	float	Additive EV100 bias applied on top of the adapted exposure.

> Engine CVars Managed by the Plugin

When auto-exposure is active, the plugin takes control of these engine variables and restores original values on disable:

```
r.DefaultFeature.AutoExposure
r.EyeAdaptationQuality
r.AutoExposure.LowPercent      -> 10
r.AutoExposure.HighPercent     -> 90
r.AutoExposure.SpeedUp         -> 3
r.AutoExposure.SpeedDown       -> 1
r.AutoExposure.MinEV100 / MaxEV100
r.AutoExposure.MinBrightness / MaxBrightness
r.AutoExposure.Bias
r.ExposureOffset
```

> Supported Auto-Exposure Methods

The plugin's internal eye adaptation system supports all three standard UE methods:

- ▶ **Histogram (AEM_Histogram)** Full-frame luminance histogram. Requires SM5+.
- ▶ **Basic (AEM_Basic)** Simpler luminance average. Works on mobile HDR.
- ▶ **Manual (AEM_Manual)** Physical camera settings (aperture, shutter, ISO).

The plugin implements its own full FEyeAdaptationParameters pipeline including: exposure compensation curves, bilateral grid support, lens attenuation, exponential adaptation speed, and luminance weighting modes.

// 06 COLOR GRADING & LUT PIPELINE

Advanced Tonemapper implements a complete CombineLUTs pass – the same pipeline used by Unreal's built-in tonemapper. All standard Post-Process Volume colour grading settings are fully respected and baked into the 3D LUT before the tonemap pass executes.

> What the LUT Pipeline Handles

- ▶ **LUT Blending** Up to 4 external LUT textures blended by weight (from Post-Process Volume ContributingLUTs). A built-in neutral LUT occupies slot 0.
 - ▶ **White Balance** WhiteTemp and WhiteTint from Post-Process Volume. Supports both Chromatic Adaptation (colour temperature) and White Balance modes.
 - ▶ **Colour Grading** Full per-tonal-range grading: global + Shadows / Midtones / Highlights for Saturation, Contrast, Gamma, Gain, Offset.
 - ▶ **Color Scale & Overlay** SceneColorTint (ColorScale0) and OverlayColor from the view.
 - ▶ **Color Remap** `r.Color.Min / r.Color.Mid / r.Color.Max` polynomial remapping.
 - ▶ **Output Device** Target display device (SDR sRGB, HDR 1000/2000nit ACES, HDR ScRGB, Linear EXR, etc.) fully honoured.
 - ▶ **Working Color Space** Respects `GDefaultWorkingColorSpaceUniformBuffer` for AP1/AP0 matrix transforms.
- > **LUT Format & Size**
- ▶ **Format** 2D unwrapped LUT (not volume texture). Size = `LUTSize×LUTSize×LUTSize` unwrapped to `(LUTSize2) × LUTSize`.
 - ▶ **r.LUT.Size** Controls LUT resolution (default 32). Set via `r.LUT.Size` CVar.
 - ▶ **Pixel format** `PF_A2B10G10R10` (default), `PF_FloatRGBA` for HDR/float outputs.
 - ▶ **Compute or Raster** Dispatched as CS on SM5+; falls back to PS on lower feature levels.

> **LUT Caching**

The LUT is rebuilt only when any input changes (`FCachedLUTSettings` tracks all parameters). If nothing changes frame-to-frame, the cached GPU texture is reused, avoiding redundant compute work. Override with `r.LUT.UpdateEveryFrame 1` to force rebuild every frame.

Because the LUT bakes all colour grading before the tonemap curve is applied, all Post-Process Volume settings – including LUT textures dragged into the array – work exactly as they do with the stock UE tonemapper.

// 07 LOCAL EXPOSURE

The plugin includes a full reimplement of UE's Local Exposure system, supporting both the Bilateral Grid and Exposure Fusion methods. Local Exposure is enabled automatically when the corresponding Post-Process Volume settings are non-default.

> **Bilateral Grid**

Builds a 3D luminance grid over the scene at reduced resolution, then applies per-pixel contrast scaling in the tonemap pass.

- ▶ **LocalExposureHighlightContrastScale** Scales contrast compression in bright regions.
- ▶ **LocalExposureShadowContrastScale** Scales contrast expansion in dark regions.
- ▶ **LocalExposureDetailStrength** Controls how aggressively local detail is enhanced.
- ▶ **LocalExposureBlurredLuminanceBlend** Blends blurred vs. bilateral grid luminance estimate.
- ▶ **LocalExposureBlurredLuminanceKernelSizePercent** Gaussian kernel size for the blurred luminance pass.

> Exposure Fusion

A multi-scale Laplacian pyramid blend of differently exposed versions of the frame – produces HDR-like dynamic range without tone mapping the exposure map explicitly.

- ▶ **LocalExposureMethod = Fusion** Activates the fusion path instead of the bilateral grid.
- ▶ **r.LocalExposure.ExposureFusion.NumLevels** Pyramid depth (default 16, clamped to log2 of min dimension).
- ▶ **r.LocalExposure.ExposureFusion.TargetLuminance** Target luminance for the fusion setup pass (default 0.5).

> Resolution Scaling

Local exposure is computed at reduced resolution to save cost. The `r.PostProcessing.QuarterResolutionDownsample` CVar controls this:

- ▶ **0 (default)** Half resolution
- ▶ **1** Quarter resolution
- ▶ **2** Eighth resolution

HighlightContrastCurve and ShadowContrastCurve float curves are supported for scene-luminance-dependent contrast scaling.

// 08 POST-PROCESS EFFECTS

All standard Unreal Engine post-process effects that normally pass through the tonemapper are fully supported. The plugin reads them from `FPostProcessSettings` via the view and applies them in the custom tonemap compute shader.

> Bloom

- ▶ **Standard bloom** CombinedBloom input texture composited with the scene using BloomUVViewport parameters.
- ▶ **FFT Convolution Bloom** Fully supported. `BloomFFTKernel.ConstantsBuffer` is read and passed to the tonemap shader via `SceneColorApplyParameters` buffer.

- ▶ **Bloom Dirt Mask** BloomDirtMask texture with BloomDirtMaskTint and BloomDirtMaskIntensity – applied in the tonemap pass.
- ▶ **TonemapBloomPreserve** Plugin-specific parameter to scale bloom contribution independently of the bloom intensity setting.

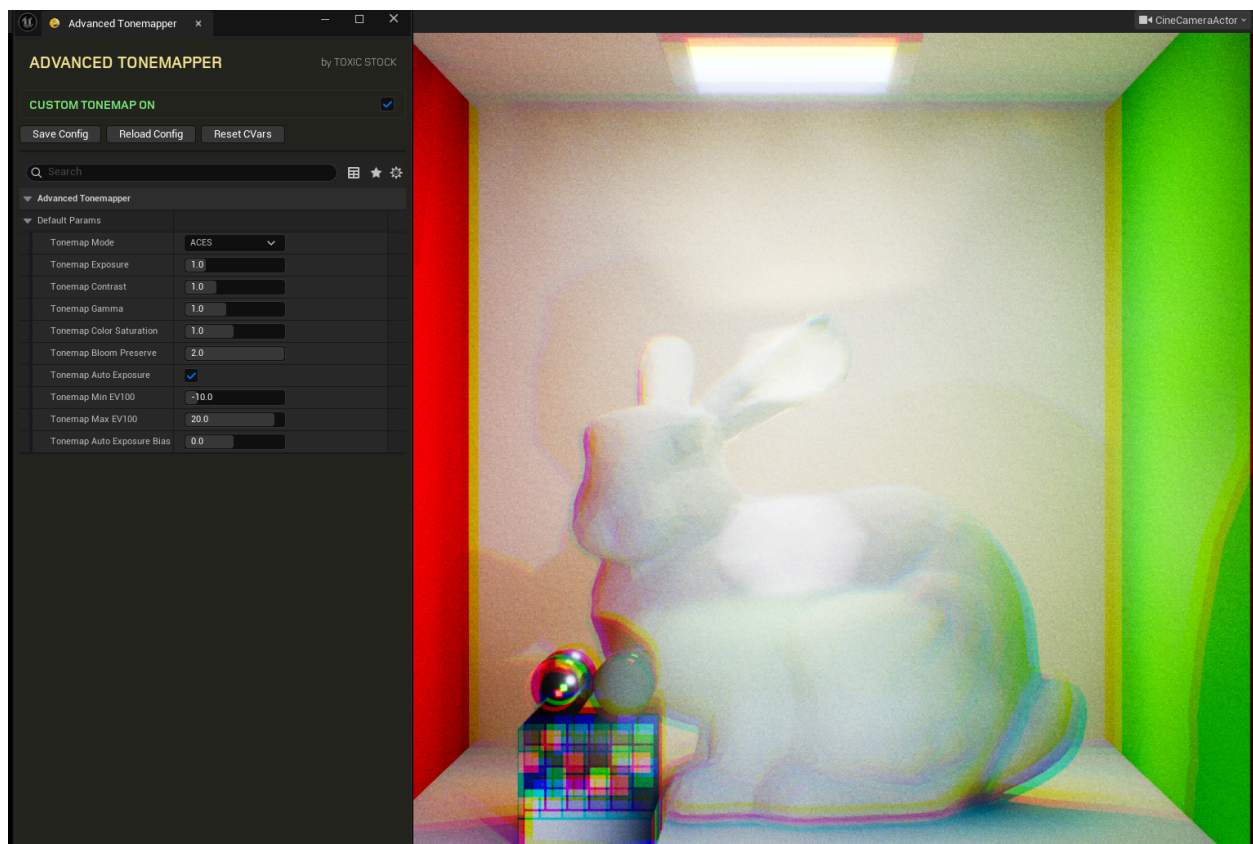
> Film Grain

- ▶ **FilmGrainTexture** Custom grain texture with per-tonal-range intensity (Shadows/Midtones/Highlights).
- ▶ **Compute reduction** Grain texture is pre-reduced in a mip chain and constants packed into a structured buffer for efficient GPU lookup.
- ▶ **Temporal randomisation** Grain offset randomised per frame using Halton sequences.
- ▶ **r.FilmGrain.SequenceLength** Controls the randomisation cycle length (default 97 frames).
- ▶ **r.FilmGrain.CacheTextureConstants** Enables caching of grain constants between frames when the texture hasn't changed.

> Chromatic Aberration

- ▶ **SceneFringeIntensity** Controls RGB channel separation radius.
- ▶ **ChromaticAberrationStartOffset** Normalised screen-space radius where aberration begins.

The plugin computes per-channel scale factors based on primary wavelengths (R: 611.3nm, G: 549.1nm, B: 464.3nm) for physically-motivated fringing.



> Other Effects

- ▶ **Vignette** VignetteIntensity from Post-Process Volume. Passed via TonemapperParams.x.
- ▶ **Sharpen** Controlled by r.Tonemapper.Sharpen CVar or PostProcessSettings.Sharpen. Passed via TonemapperParams.y.
- ▶ **Lens Principal Point** LensPrincipalPointOffsetScale for lens distortion correction.
- ▶ **Dithering** BackbufferQuantizationDithering computed from render target bit depth (1/255 for 8-bit, 1/1023 for 10-bit).
- ▶ **Scene Colour Tint** ColorScale0 (SceneColorTint) applied globally.
- ▶ **Film Tone Curve** FilmSlope, FilmToe, FilmShoulder, FilmBlackClip, FilmWhiteClip passed to both the LUT bake and the tonemap shader.

r.PostProcessing.PropagateAlpha is respected. When alpha propagation is enabled the output format switches to PF_FloatRGBA to preserve the alpha channel.

// 09 CONSOLE VARIABLES (CVARS)

Plugin CVars allow real-time override from the console. All are ECVF_RenderThreadSafe. Sentinel values mean "use the value from config/Settings panel".

> Plugin CVars

CVar	Sentinel	Description
r.AdvancedTonemapper.TonemapEnable	-1 (int)	Override master enable. 0 = force off, 1 = force on.
r.AdvancedTonemapper.TonemapMode	-1 (int)	Override tonemapping mode (0-8).
r.AdvancedTonemapper.TonemapExposure	-1.0 (float)	Override linear exposure multiplier.
r.AdvancedTonemapper.TonemapShadowLift	-1.0 (float)	Override shadow lift (active modes only).
r.AdvancedTonemapper.TonemapAutoExposure	-1 (int)	Override auto-exposure enable.
r.AdvancedTonemapper.TonemapMinEV100	-10000 (float)	Override minimum EV100.

CVar	Sentinel	Description
r.AdvancedTonemapper.TonemapMaxEV100	-10000 (float)	Override maximum EV100.
r.AdvancedTonemapper.TonemapAutoExposureBias	-10000 (float)	Override auto-exposure bias.

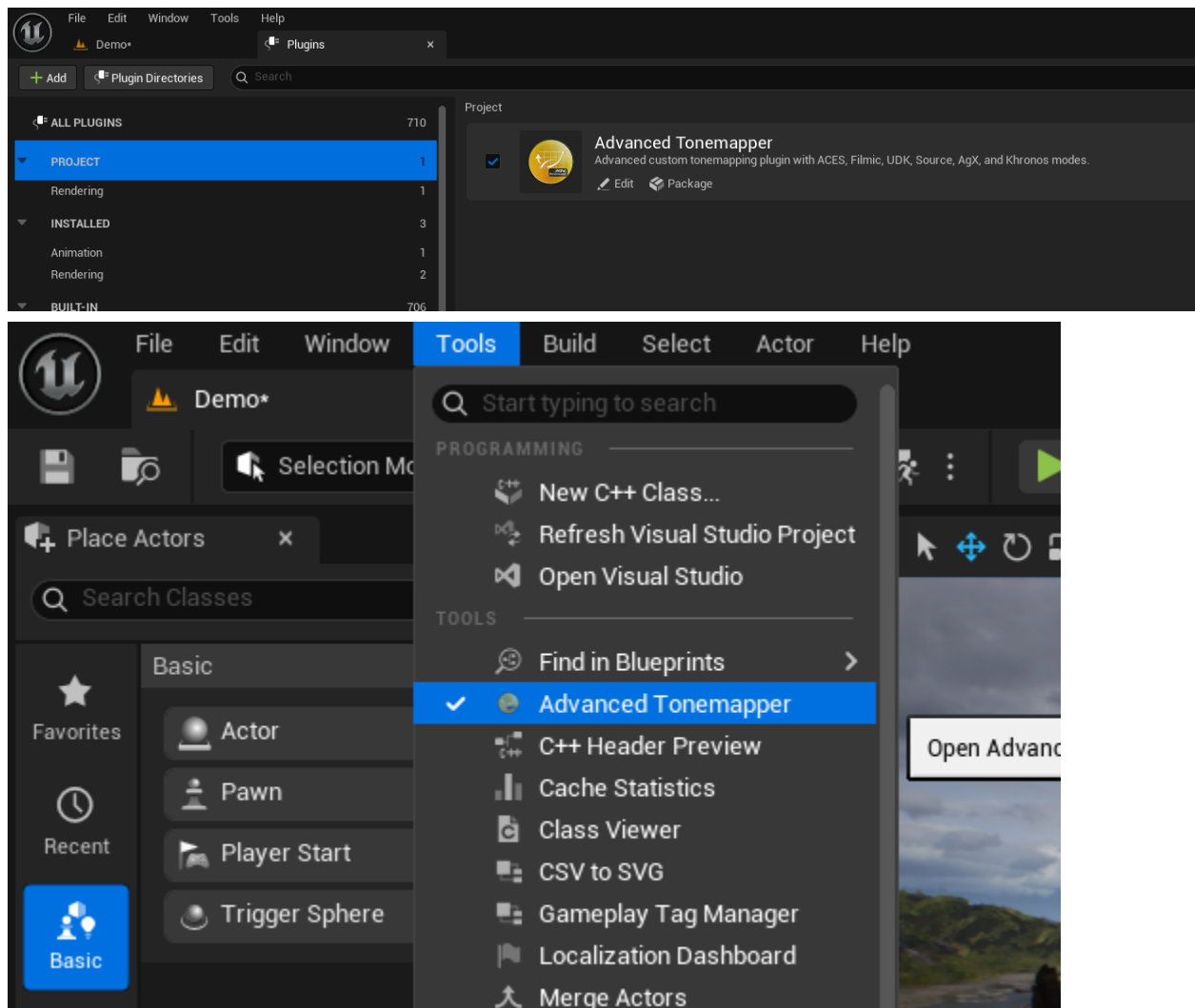
> Engine CVars Relevant to the Plugin

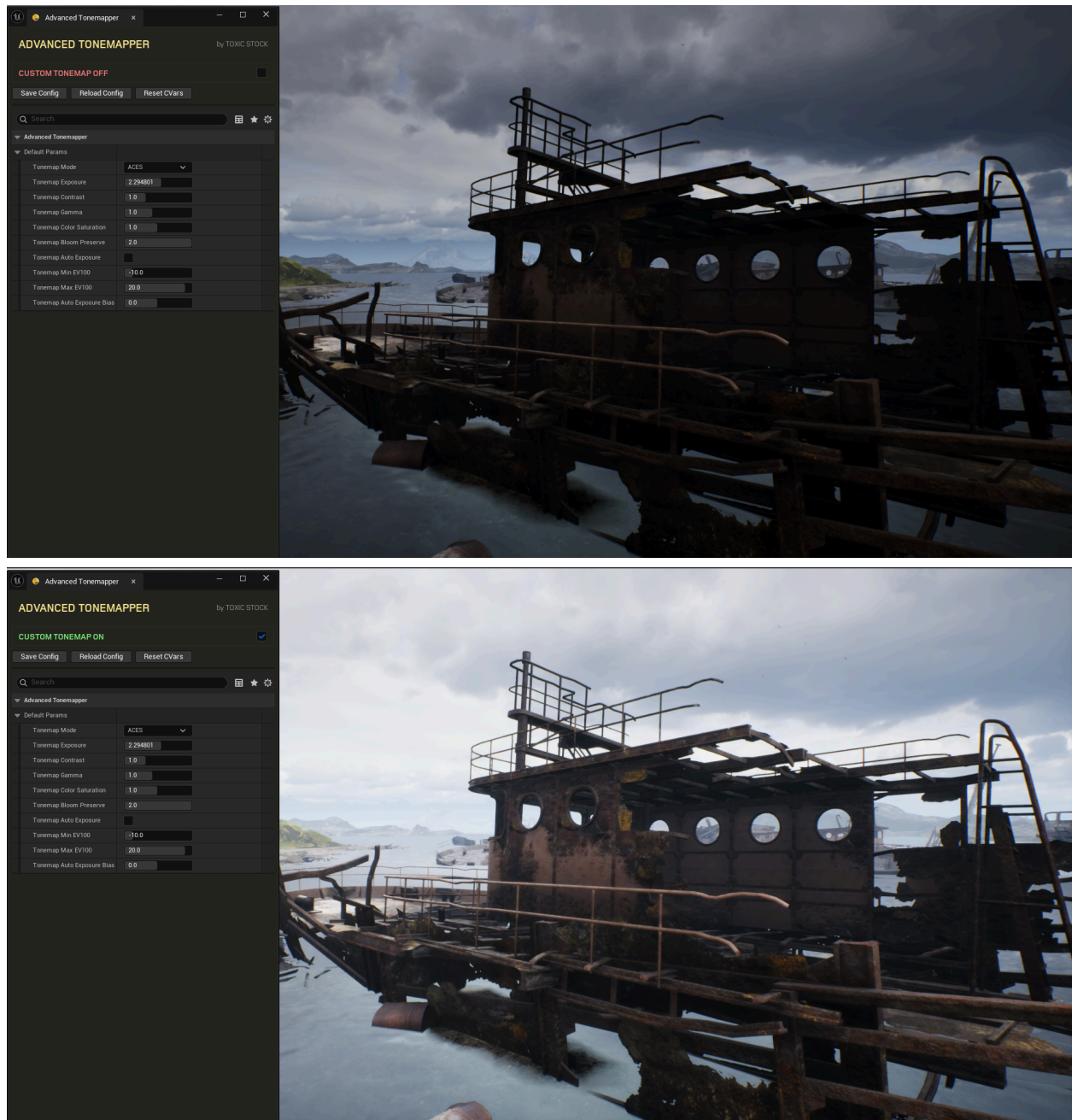
CVar	Notes
r.LUT.Size	LUT resolution (default 32). Higher = more accurate colour grading at GPU cost.
r.LUT.UpdateEveryFrame	Set to 1 to force LUT rebuild every frame (useful when debugging CVar-driven colour changes).
r.Color.Min / .Mid / .Max	Output value remapping polynomial. Affects LUT bake.
r.Color.Grading	Set to 0 to bypass all Post-Process Volume colour grading.
r.Tonemapper.Sharpen	Global sharpening override. Takes priority over PostProcessSettings.Sharpen when ≥ 0 .
r.PostProcessing.QuarterResolutionDownsample	Local exposure input resolution (0=half, 1=quarter, 2=eighth).
r.LocalExposure.ExposureFusion.NumLevels	Pyramid levels for Exposure Fusion (default 16).
r.BackbufferQuantizationDitheringOverride	Override dither bitdepth (0 = auto from render target format).

// 10 WORKFLOW & USAGE

> Basic Setup

4. Open the plugin panel: Window → Advanced Tonemapper.
5. Check CUSTOM TONEMAP ON in the Status Bar.
6. Choose a TonemapMode from the Details panel.
7. Adjust TonemapExposure if the scene appears under- or over-exposed.
8. Tweak TonemapContrast, TonemapGamma, and TonemapColorSaturation to taste.
9. Click Save Config to persist settings.





> Working with Post-Process Volumes

Because the plugin bakes a full CombineLUTs pass, all standard UE colour grading tools work exactly as expected:

- ▶ **Colour Grading** All shadow/midtone/highlight controls in the Post-Process Volume are respected.
- ▶ **LUT Textures** Drag textures into the ContributingLUTs array with weights — up to 4 external LUTs blended.
- ▶ **White Balance** WhiteTemp and WhiteTint affect the LUT bake.
- ▶ **Film Tone Curve** FilmSlope, FilmToe, FilmShoulder, FilmBlackClip, FilmWhiteClip are passed through.
- ▶ **Bloom & Dirt Mask** All bloom settings including FFT convolution and dirt masks are composited in the tonemap pass.

> Choosing a Tonemap Mode

Goal	Recommended Mode
Match UE default look	ACES (0)
Punchy AAA style with strong S-curve	Filmic (1)
Warm, retro UE3 aesthetic	UDK (2)
Flat, low-roll-off (stylised / Source engine feel)	Source (3)
Accurate, hue-preserving photo-real render	AgX (4)
Neutral PBR reference, no creative colour shift	Khronos Neutral (5)
Debug or passthrough (check linear values)	LinearClamp (6)
Gentle, soft roll-off for stylised / illustrative art	Reinhard (7)
Vibrant, saturated output with hue preservation	sRGB Max Chroma (8)

> Local Exposure

For cinematic shots with high dynamic range, enable Local Exposure in the Post-Process Volume:

10. Set `LocalExposureMethod` to `Bilateral` (detail-preserving) or `Fusion` (HDR-like multi-exposure blend).
11. Adjust `HighlightContrastScale` (< 1.0 compresses bright areas) and `ShadowContrastScale` (> 1.0 opens up shadows).
12. Use `r.PostProcessing.QuarterResolutionDownsample` 1 or 2 if performance is a concern.

> Auto-Exposure

If you need controlled scene-wide exposure adaptation independent of the engine's standard settings:

13. Enable `bTonemapAutoExposure` in the Settings panel.
14. Set `TonemapMinEV100` and `TonemapMaxEV100` to define the adaptation range.
15. Adjust `TonemapAutoExposureBias` for creative compensation.

The plugin automatically sets `r.AutoExposure.LowPercent = 10` and `HighPercent = 90` for metered adaptation, `SpeedUp = 3` / `SpeedDown = 1` for snappy adaptation response.

> Disable / Re-enable at Runtime

Toggle via the Status Bar checkbox, `r.AdvancedTonemapper.TonemapEnable`, or by unchecking `bEnableTonemapping`. The plugin returns full control to the engine's default tonemapper immediately.

// 11 TECHNICAL INFORMATION

> Architecture Overview

The plugin hooks into the engine via `FSceneViewExtensionBase` and registers a callback on `EPostProcessingPass::ReplacingTonemapper`. On each applicable view, it executes a two-pass pipeline:

- ▶ **Pass 1: CombineLUTs** Bakes all colour grading, white balance, LUT blending, and the Advanced Tonemapper curve into a 2D unwrapped LUT texture ($\text{LUTSize}^2 \times \text{LUTSize}$).
- ▶ **Pass 2: Tonemap** Dispatches a compute shader (8×8 tile groups) that reads scene colour, applies eye adaptation, local exposure, bloom, film grain, chromatic aberration, vignette, sharpen, dithering, and samples the CombineLUT – outputting the final tonemapped frame.

> Shader Files

File	Entry Points	Purpose
AdvancedTonemapperCombineLUTs.usf	MainPS, MainCS	LUT bake pass. Implements all colour grading and tonemapping curve in LUT space.
AdvancedTonemapperTonemap.usf	MainCS	Main tonemap compute pass. Applies LUT, eye adaptation, bloom, film grain, aberration, vignette.
AdvancedTonemapperCommon.ush	–	Shared tonemapping operator implementations (ACES, Filmic, AgX, Khronos, etc.).

> Shader Permutations

The tonemap pass compiles shader permutations for:

- ▶ **FTonemapperGammaOnlyDim** Bypass path when tonemapper or post-processing is disabled.
- ▶ **FTonemapperLocalExposureDim (0/1/2)** No local exposure / Bilateral / Fusion paths.
- ▶ **FTonemapperSharpenDim** Sharpening pass enabled/disabled.
- ▶ **FTonemapperFilmGrainDim** Film grain active/inactive.
- ▶ **FTonemapperColorFringeDim** Chromatic aberration active/inactive.
- ▶ **FTonemapperOutputDeviceSRGB** sRGB gamma curve in shader vs. separate pass.
- ▶ **FTonemapperAlphaChannelDim** Alpha channel propagation enabled/disabled.

> Platform Support

Platform	Support	Notes
Win64	Full	SM5/SM6 compute path. All features available.
Mac	Full	Metal compute. Film grain requires SM5 equivalent.
Linux	Full	Vulkan/OpenGL. USE_VOLUME_LUT disabled (always 2D unwrapped LUT).
Mobile (ES3.1)	Partial	Pixel shader fallback. Film grain and FFT bloom unavailable.

Volume texture LUT (USE_VOLUME_LUT) is always disabled. The plugin uses 2D unwrapped LUTs exclusively for maximum cross-platform compatibility.

// 12 SUPPORT & RESOURCES

> Contact

- ▶ **Email** `toxic.stock@toxicdev.ru`
- ▶ **Plugin Version** 1.0 | Unreal Engine 5.6.0-5.7.0
- ▶ **Module type** Runtime (PostConfigInit load phase) + Editor

> Config File

Settings are saved automatically to your project's Saved/Config/[Platform]/Game.ini under the [/Script/AdvancedTonemapper.AdvancedTonemapperSettings] section. You can version-control this file or share it between team members.

> Known Limitations

- ▶ **Scene Captures** Not applied. Use a separate post-process material for capture-specific grading.
- ▶ **Mobile LUT path** Volume texture disabled. Output quality equivalent on all platforms.
- ▶ **ACES ReachTable / GamutTable / GammaTable** Currently not wired (SRV = nullptr). ACES operates in standard pipeline mode.

For questions, bug reports, or feature requests contact `toxic.stock@toxicdev.ru` with subject line [Advanced Tonemapper].