

Mandelbrot Metal 3.0

Reviewer's Guide • Infinity Engine, Free + Pro, and the $10^{25}\times$ release boundary

Mandelbrot Metal 3 is a GPU-first Mandelbrot and Julia explorer for iPhone and iPad. Its central technical change is the Infinity Engine: one CPU-built double-double reference orbit feeds Metal quad-single perturbation and recovery so the expensive per-pixel deep-Mandelbrot work remains massively parallel.

The precise claim Version 3.0 raises the validated Mandelbrot zoom ceiling from $10^{16}\times$ to $10^{25}\times$. It does not claim arbitrary precision, unlimited zoom, instant full renders, or equal detail at every coordinate.

What is new in Version 3.0

- Infinity Engine for Metal-first deep Mandelbrot rendering through $10^{25}\times$.
- CPU double-double reference-orbit construction with Metal Float/quad-single perturbation, rebasing, and recovery.
- Retained-frame pan, pinch, and double-tap feedback while the exact target viewport renders.
- Full-frame completion percentage and timing through presentation of the entire requested fractal.
- Free + Pro access with the same renderer and built-in palettes at every entitlement level.
- Permanent Legacy Pro migration for verified Version 2 owners.
- Version 2 bookmark compatibility, Export All repair, and compensated deep-center persistence.
- A 16-language interface across iPhone and iPad.

How the Infinity Engine works

1. Reference construction

For a Mandelbrot reference parameter c_0 , the CPU evaluates $Z_0 = 0$ and $Z_{n+1} = Z_n^2 + c_0$ in double-double arithmetic. Each real and imaginary component is decomposed into four Float limbs and uploaded once for the target frame.

2. Per-pixel perturbation

Each Metal thread evaluates a nearby pixel $c = c_0 + \delta c$ by evolving $\delta z_{n+1} = 2Z_n \delta z_n + (\delta z_n)^2 + \delta c$. Well-conditioned pixels use the fast tier; ambiguous or unstable deltas restart through the complete quad-single path.

3. Recovery and presentation

Rebasing and direct recovery keep difficult pixels from silently becoming visible artifacts. Final work is scheduled in bounded GPU stripes, assembled into a private full-frame texture, and presented only after the requested drawable is complete. The established deep renderer remains a correctness fallback for failed or unusable work.

4. Interaction

The last complete frame moves immediately with pan, pinch, and double-tap gestures. Expansion-aware center state preserves deep movement until the committed exact view replaces the interaction transform. Navigation stops cleanly at $10^{25}\times$.

Suggested review path

1. Begin with Mandelbrot and Julia at shallow scale; compare palette, contrast, iterations, and Back/Forward history.
2. Load a high-iteration Mandelbrot bookmark and wait for the complete target frame.
3. Open bookmarks above $10^{16}\times$ and near $10^{25}\times$. Confirm Infinity in the HUD, stable final positioning, and an enforced ceiling.
4. Pan, pinch, and double-tap around recognizable structures; the old image should move immediately and the final view should not snap back.
5. Compare several of the 156 built-in palettes, including Ultra-Wide ramps, with Smooth and Exact LUT behavior.
6. Test the sixth-bookmark Free boundary and the Pro entry points for custom palettes, 3D Look, and 4K–8K output.
7. Import a Version 2 bookmark pack, use Export All, and reopen the exported pack on another device or clean install.

Measured performance

The published build 548 benchmark used separate v3.0 and v2.2.3 bundles on an iPhone 17 Pro Max running iOS 26.6.1. The drawable was 1320×2868. Timing began immediately before bookmark application and ended only after reference preparation, recurrence, color/lighting, final blit, and presentation submission completed. Each ten-scene corpus ran in forward and reverse order.

Scene / aggregate	v2.2.3	v3.0	Speedup
Ten-scene aggregate	203.890 s	42.419 s	4.81×
Earth Elephants	12.245 s	3.714 s	3.30×
Deep Deep Triplets	115.075 s	24.992 s	4.60×
Valley of Bulbs	57.711 s	10.827 s	5.33×

These are release-specific, full-frame device measurements—not universal promises. Results vary with coordinates, iterations, drawable size, lighting, SSAA, device, OS, and thermal state.

Free and Pro

Capability	Free	Pro
Renderer and $10^{25}\times$ ceiling	Complete	Complete
Built-in palettes	All 156	All 156
Bookmarks	Up to five	Unlimited

Custom/photo palettes	—	Included
3D Look	—	Included
PNG output	Canvas	Canvas + 4K/6K/8K/custom

Reference U.S. prices are \$2.99 monthly, \$19.99 annually, or \$39.99 for lifetime access. Live App Store storefront pricing is authoritative. Verified pre-v3 owners receive permanent access to Legacy Pro.

Claims reviewers may use

- GPU-first deep Mandelbrot rendering on Apple Metal, validated through 10²⁵×
- CPU double-double reference orbit with Metal quad-single perturbation and recovery.
- Adaptive finite precision and retained-frame deep interaction.
- The same rendering engine and all built-in palettes in Free and Pro.
- 156 built-in palettes, including 55 Ultra-Wide 768-step sets.
- Full-frame physical-device benchmark: 4.81× aggregate speedup across the published ten-scene corpus.

Claims to avoid

- Arbitrary precision, unlimited precision, unlimited zoom, infinite digits, or support beyond 10²⁵× in Version 3.0.
- Metal-only architecture: the CPU constructs and validates the shared reference orbit.
- Guaranteed 60 FPS, instant full-resolution deep renders, no heat, or identical timing across devices.
- Bit-identical rendering across devices, OS versions, app builds, renderer paths, or color pipelines.
- CPU-tiled deep rendering as the normal Version 3 Infinity path.

Quick facts

- Platforms: iPhone and iPad; iOS/iPadOS 26.0 or later.
- Fractals: Mandelbrot and Julia.
- Core technology: Swift, SwiftUI, Metal compute, double-double reference math, quad-single GPU arithmetic, StoreKit 2.
- Languages: Arabic, Brazilian Portuguese, Dutch, English, French, German, Hebrew, Italian, Japanese, Korean, Polish, Russian, Simplified Chinese, Spanish, Swedish, and Ukrainian.
- Developer: Michael Stebel / Mandelbrot Metal.
- Website: mandelbrot-metal.com.