White Paper 3

Baseline Instability, Ground-Zero Noise, and the Preconditions for Semantic Emergence

1. Experimental Motivation

The white paper experiment was designed to probe the lowest-contrast boundary at which a physics-anchored semantic system can distinguish *meaningful change* from *background stability*. Uniform white paper was selected as a deliberately adversarial substrate: visually simple, low texture, and typically assumed to be "featureless" by conventional inspection and AI systems.

The intent was not to detect defects, but to characterize the system's behavior at **ground zero**—the point at which physical variation is minimal and semantic interpretation should be withheld unless justified by persistent, admissible drift.

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2. Reference Configuration: Properly Prepared Baseline

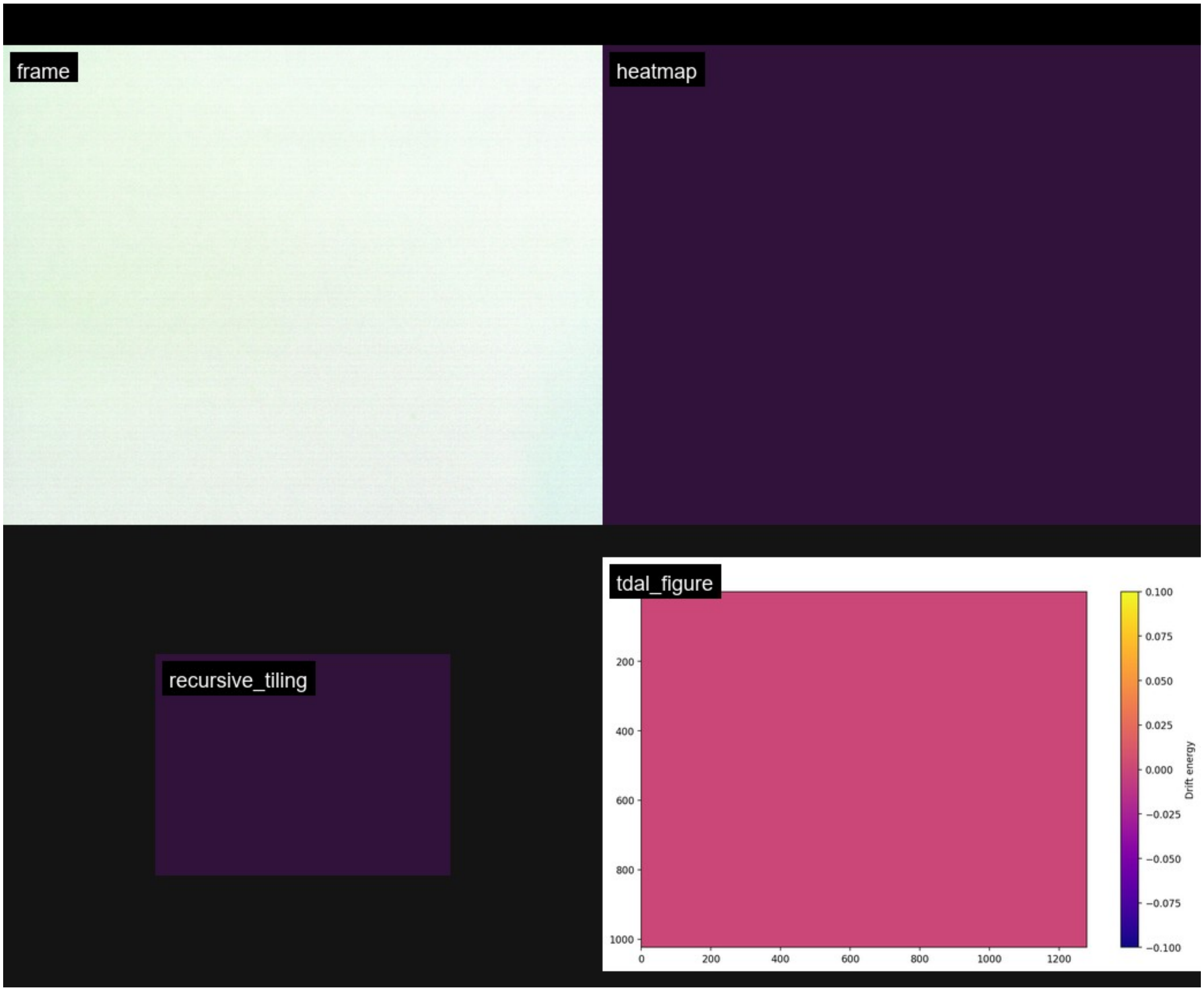
Scope and Interpretation Guidance

At first glance, the figures presented in this paper may appear visually unremarkable. Several frames depict surfaces that would typically be described as uniform or featureless, and in some cases differences between frames are difficult to detect without careful side-by-side comparison. This apparent simplicity is intentional.

The objective of this experiment is not to showcase visually obvious anomalies, but to examine the boundary at which **physical change becomes semantically eligible**. By selecting an adversarial substrate with minimal texture and contrast, the experiment forces a separation between *what is perceptible* and *what is physically admissible*. Readers are therefore encouraged to interpret the figures not as images to be visually "read," but as inputs to a structured drift evaluation process governed by persistence, coherence, and physical plausibility.

Importantly, the absence of visually salient features should not be interpreted as an absence of signal. Throughout this paper, intermediate representations reveal micro-variation, background instability, and low-amplitude drift that are invisible or ambiguous to human observers. The significance of these representations lies not in their visual appeal, but in whether detected variation survives admissibility filtering and propagates downstream.

Figure 1 should therefore be understood as a *baseline characterization*, not a null result. It establishes the conditions under which the system explicitly withholds semantic interpretation, despite the presence of measurable but non-admissible variation. Subsequent figures build upon this baseline to demonstrate how instability, preparation quality, and perceptual bias influence whether change is treated as meaningful or suppressed.



The first image set (Figure 1) shows a properly prepared reference sequence, presented as a four-panel composite:

- **Frame**: Visually uniform white paper under controlled illumination
- **Heatmap**: Low-amplitude, spatially diffuse drift consistent with sensor and illumination noise
- **Recursive tiling**: Fine-grained texture revealing micro-variation without directional structure
- **TDAL snapshot**: Near-zero drift energy across the field, with no admissible regions flagged

The TDAL panel visualizes the spatial distribution of admissible drift energy after physics-based filtering, indicating whether detected variation survives persistence and coherence constraints.

Despite the apparent “noise” visible in intermediate representations, the system correctly treated this configuration as *baseline-stable*. Drift was present but non-persistent, non-directional, and uniformly distributed. No semantic escalation occurred.

This result is important: it demonstrates that the system does **not** require visual texture or contrast to establish stability, nor does it hallucinate structure in visually sparse scenes.

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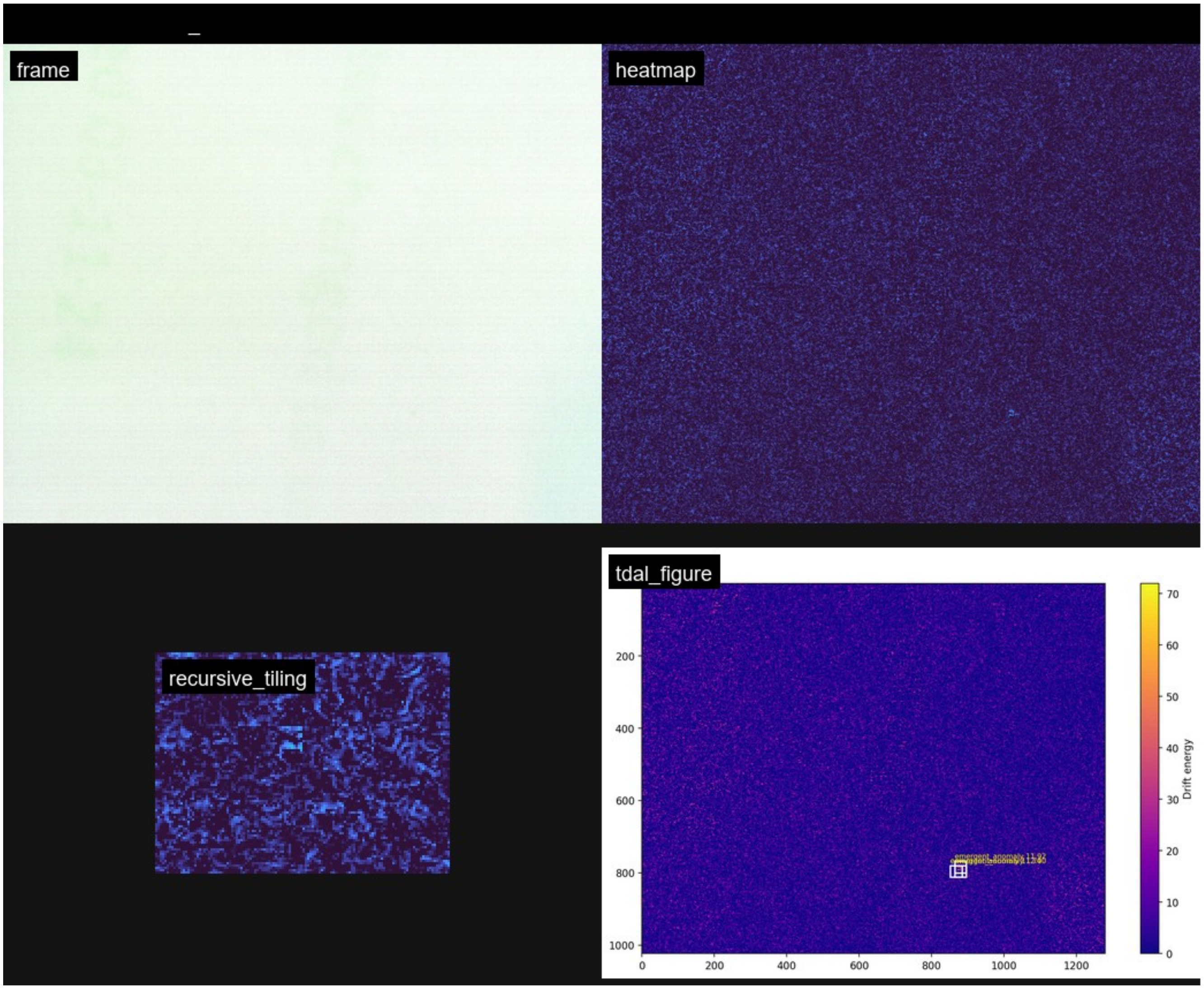
3. Improper Configuration: Physically Unstable Input That Produced Insight



The second image set (Figure 2) originated from a *poorly prepared* sequence. Although visually similar to the reference configuration, this set contained subtle but uncontrolled physical variations, including minor mechanical shifts, illumination inconsistency, and surface settling effects.

The resulting outputs differed markedly:

- The **heatmap** collapsed into a saturated, low-information field, indicating loss of contrast between null and perturbation states.
- **Recursive tiling** showed uniform suppression rather than structured micro-variation.

- The **TDAL snapshot** exhibited a flat response dominated by background instability rather than localized drift energy.

At first glance, this appeared to be a failed experiment. However, it produced a critical insight: **baseline instability can dominate the signal space to the extent that meaningful comparison becomes impossible**, even when the scene appears visually unchanged.

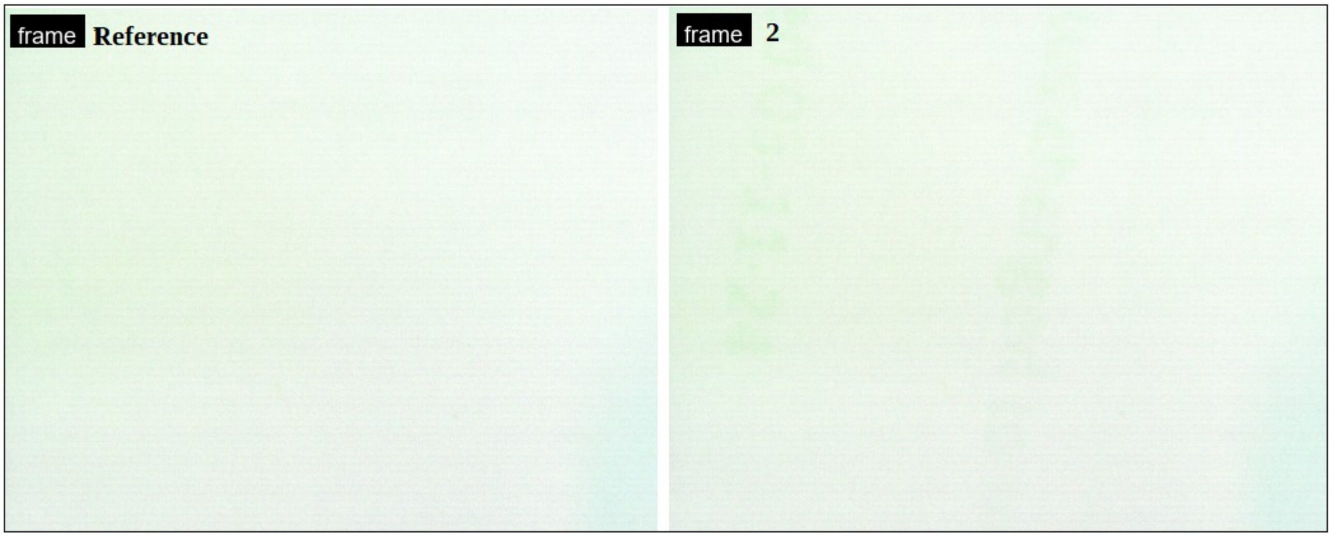


Figure 3 presents a side-by-side comparison between the reference frame and a subsequent frame (frame_0002) captured under nominally identical conditions. Upon close visual inspection, a human observer can perceive subtle differences between the two images, including faint tonal gradients and low-amplitude illumination variation. These differences are real and perceptible, particularly when the images are compared directly.

However, critically, these visually detectable differences do **not** propagate into the downstream four-panel analytical representations (heatmap, recursive tiling, and TDAL outputs) shown elsewhere in this study. Despite human perception registering a change, the physics-anchored pipeline does not treat the variation as admissible drift.

This outcome highlights an important distinction between *perceptual difference* and *physically meaningful change*. Human vision is highly sensitive to relative contrast and contextual comparison, often detecting differences that are transient, non-persistent, or physically unstructured. By contrast, the system evaluates whether a detected variation exhibits sufficient persistence, directional coherence, and physical plausibility to qualify as drift rather than background fluctuation.

In this case, the observed difference fails to satisfy those admissibility criteria. As a result, it is correctly suppressed and does not manifest as elevated drift energy, localized anomalies, or semantic escalation in subsequent representations.

This figure therefore demonstrates a key design principle of the system: **the presence of a visible difference is not sufficient to justify semantic interpretation**. Only variations that survive physical admissibility filtering—across time, structure, and coherence—are permitted to influence downstream analysis. The system's refusal to amplify a human-visible but physically weak difference underscores its resistance to false positives and perceptual bias.

5. Key Finding: Ground-Zero Noise Is Structurally Dominant

The contrast between Figures 1 and 2 reveals a central result of this study:

> At extremely low contrast, *baseline preparation matters more than the perturbation itself*.

In the unstable configuration, ground-zero noise overwhelmed the system's ability to resolve admissible drift. Rather than producing false positives or averaging the instability away, the pipeline effectively *refused to assign meaning*. This behavior is not a limitation—it is an intentional safeguard.

Conventional AI or reference-based inspection systems would typically:

- Treat both scenes as equivalent,
- Smooth over instability through averaging, or
- Produce spurious classifications driven by statistical artifacts.

By contrast, the physics-anchored pipeline surfaced the instability itself as the dominant signal and withheld semantic interpretation.

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5. Implications for Semantic Testing

These results establish several prerequisites for semantic emergence in physics-anchored systems:

1. **Baseline convergence must precede comparison**
   Semantic layering cannot be evaluated until physical invariance is established.
2. **Ground-zero noise must be characterized, not ignored**
   What appears visually negligible can be structurally decisive at low drift amplitudes.
3. **Failure modes are diagnostic**
   A flat or suppressed response under unstable conditions is evidence of correct system behavior, not insufficiency.
4. **Meaning is staged, not inferred**
   Semantic interpretation arises only after persistent, directional drift survives admissibility filtering.

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6. Why This Experiment Merits a Dedicated White Paper

Although simple in construction, the white paper experiment exposed a boundary condition rarely documented in inspection or AI literature: the transition from *physical admissibility* to *semantic eligibility*.

The most valuable outcome did not come from the clean reference case alone, but from the contrast with an improperly prepared baseline. Together, these results demonstrate that **semantic systems grounded in physics must first solve the problem of physical stability**—and must be allowed to reject interpretation when that stability is absent.

This finding directly informs subsequent experimental design and provides empirical justification for staged semantic pipelines, where meaning is earned rather than assumed.