ICML 2026 AI for Science Workshop

How much of physical reality can language actually *see*?

LabProc & Tacit - Quantifying the Visual-Textual Prior Gap in Autonomous Laboratory Perception

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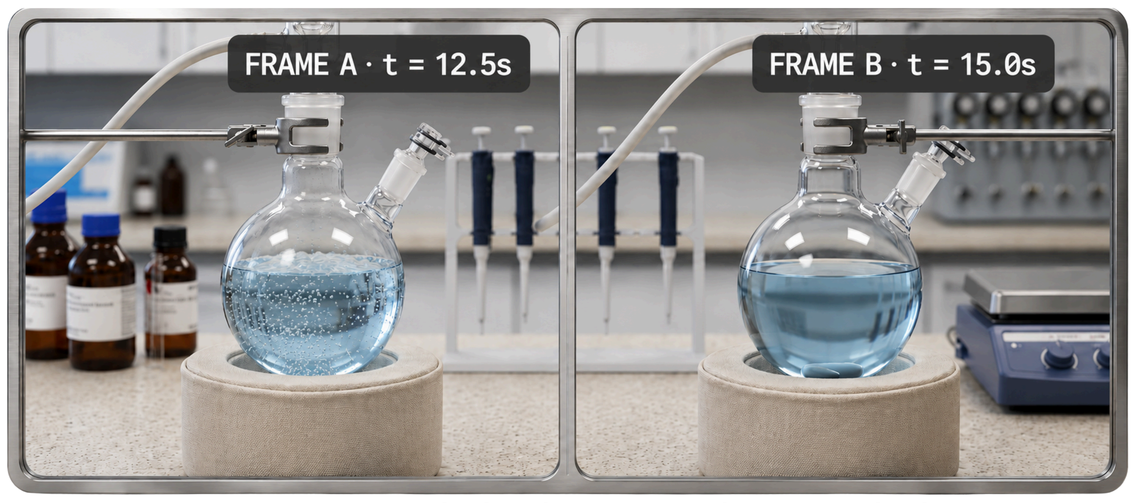
PROBLEM

Autonomous labs see through a frontier VLM i.e. sharp on apparatus and labels but blind to motion. Boiling reflux vs. settled reflux: same equipment, same label, only the fluid-state differs. Misread it, inject the next reagent early, lose a multi-day synthesis.



One is actively boiling. One has settled.
Can YOU tell from a single frame? Neither can a frontier VLM.

SETUP

LabProc

A six-task lab-video benchmark, ordered **text-amenable → motion-only.**

6 TASKS · TEXT→MOTION 241 CLIPS · 38 VIDEOS PUBLIC · CC BY 4.0

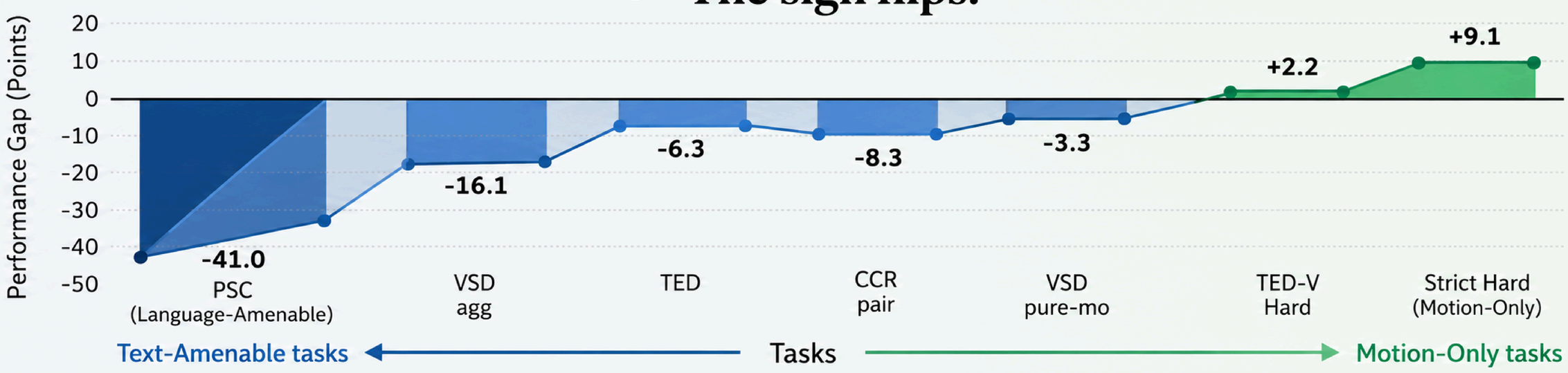
Tacit

A 305M-parameter video encoder, adapted on 160 h of lab footage — vision only, no language.

305M PARAMS 160 H VIDEO 28 MIN · $1.30 · 1×H100

THE CROSSOVER

The sign flips.



On the hardest motion-only task, a **1000× smaller model wins by 9.1 points** — **and the gap shrinks monotonically from language to motion before it reverses.**

WHY IT FLIPS?

−41 Language carries the signal — when pretraining can describe the state, the giant VLM wins.
PSC · single-frame state

+9.1 Motion carries the signal — when only motion distinguishes the state, the small specialist wins.
Strict Hard · motion-only

TAKEAWAY

SO WHAT?

Don't pick one. Route motion-only perception to a small specialist, language-amenable decisions to a VLM. **Hybrid beats either alone.**

~300 B Frontier VLM
≈ 1000× smaller

305 M Tacit — wins ✓

360× cheaper per perception call
$0.0035 vs $1.25

THE BIGGER PICTURE · TACIT WORLD

Language is lossy compression of physical reality.

Where a domain hinges on continuous physical state no caption captures, specialized perception should beat general-purpose VLMs. Labs are the first instance we've measured — the same gap likely lives in surgery, materials, manufacturing, drug discovery. *A hypothesis we invite you to test.*

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