



Technical brief

FiftyOne Physical AI Workbench

A unified environment for real-world and synthetic workflows with Voxel51 and NVIDIA.

Executive summary

Modern physical AI systems, such as autonomous vehicles, humanoid or industrial robots, require millions of hours of testing in virtual worlds before encountering the real world. These systems depend on diverse and well-calibrated datasets from a variety of sources: cameras, LiDAR, radar, GPS, and other sensors. Yet real-world data is often incomplete, inconsistent, or costly to collect.

The [FiftyOne Physical AI Workbench](#) bridges the gap between real-world sensor data and synthetic simulation—providing turnkey access to NVIDIA neural reconstruction and generative AI models. Developed by Voxel51 and NVIDIA, the workbench combines FiftyOne multimodal data engine with NVIDIA Omniverse and NVIDIA Cosmos libraries and models to transform raw sensor captures into rich, reconstructable scenes that precisely reflect the physical world.

Unlock greater realism and scalability with Physical AI workflows, libraries, and models.

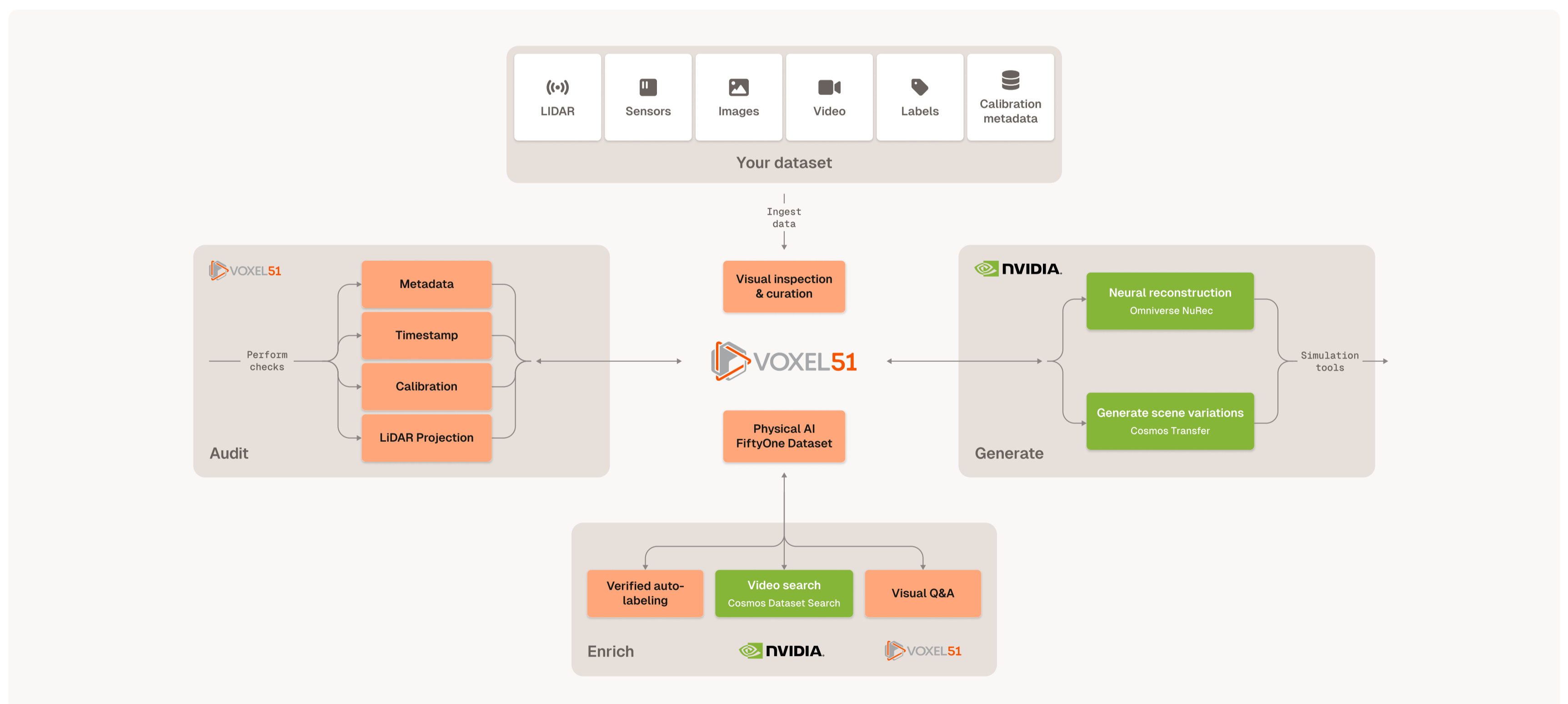
KEY TECHNOLOGIES

- > FiftyOne
- > NVIDIA Omniverse NuRec
- > NVIDIA Cosmos Transfer
- > NVIDIA Cosmos Dataset Search

BENEFITS

- > **Faster development**
Reduces dataset preparation and validation time from weeks to hours.
- > **Robust production models**
Enables simulation of rare and hard-to-capture conditions.
- > **Data governance**
Ability to visualize and track every single transformation.

Architecture overview



The FiftyOne Physical AI Workbench unifies Voxel51 and NVIDIA tools into a connected data flywheel that spans the entire perception data lifecycle: ingest → explore → audit → enrich → reconstruct → simulate, orchestrated from within FiftyOne.

At the center of the architecture is FiftyOne, the control hub for ingesting, visualizing, and curating multimodal datasets. Through FiftyOne, engineers can launch operators that directly integrate with NVIDIA Omniverse NuRec and Cosmos, enabling fluid transitions between real sensor captures and physically accurate virtual scenes.



- **Audit:**
FiftyOne inspects and visualizes dataset quality, calibration, and metadata.
- **Reconstruct:**
Omniverse NuRec converts real-world sensor captures into 3D environments, preserving geometry, lighting, and camera alignment. Cosmos Transfer creates scene variations.
- **Enrich:**
Voxel51 adds contextual structure to the datasets. NVIDIA Cosmos Dataset Search supports fast, high-recall semantic searches over video data.

- **Simulate:**
Omniverse applies physics-based rendering for realistic reflections, shadows, and environmental effects.

All components communicate through lightweight APIs and GPU-enabled microservices. The system can be deployed locally, in the cloud, or across enterprise infrastructure, giving teams a consistent and secure environment to audit, reconstruct, and enrich perception data without switching tools.

Core components

Enable physics-accurate reconstructions and realistic simulations with Voxel51 and NVIDIA technologies.

FiftyOne

The data engine to curate, explore, audit, and enrich multimodal datasets. Connects directly to NVIDIA libraries and models through custom operators for reconstruction and simulation workflows.

NVIDIA Cosmos Dataset Search

A GPU-accelerated vector search workflow that quickly embeds and searches video datasets. It enables efficient search, retrieval, and understanding of real-world visual data.

NVIDIA Omniverse NuRec

A set of technologies for neural reconstruction and rendering that enables developers to use their existing fleet data to reconstruct high-fidelity digital twins, simulate new events, and render sensor data from novel points of view.

NVIDIA Cosmos

A set of world foundation models that generate world states and amplify data variations. Cosmos Transfer is a style transfer model that takes your reconstructed scene and applies realistic variations such as changing weather, lighting, or time of day while preserving scene structure and sensor geometry.



Talk to the experts

Enough data wrangling. Request a demo.
voxel51.com/sales