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Large Model-Driven Tango Control & Data Interaction Analysis Tool

Intelligent Slow Control & Distributed Data Platform

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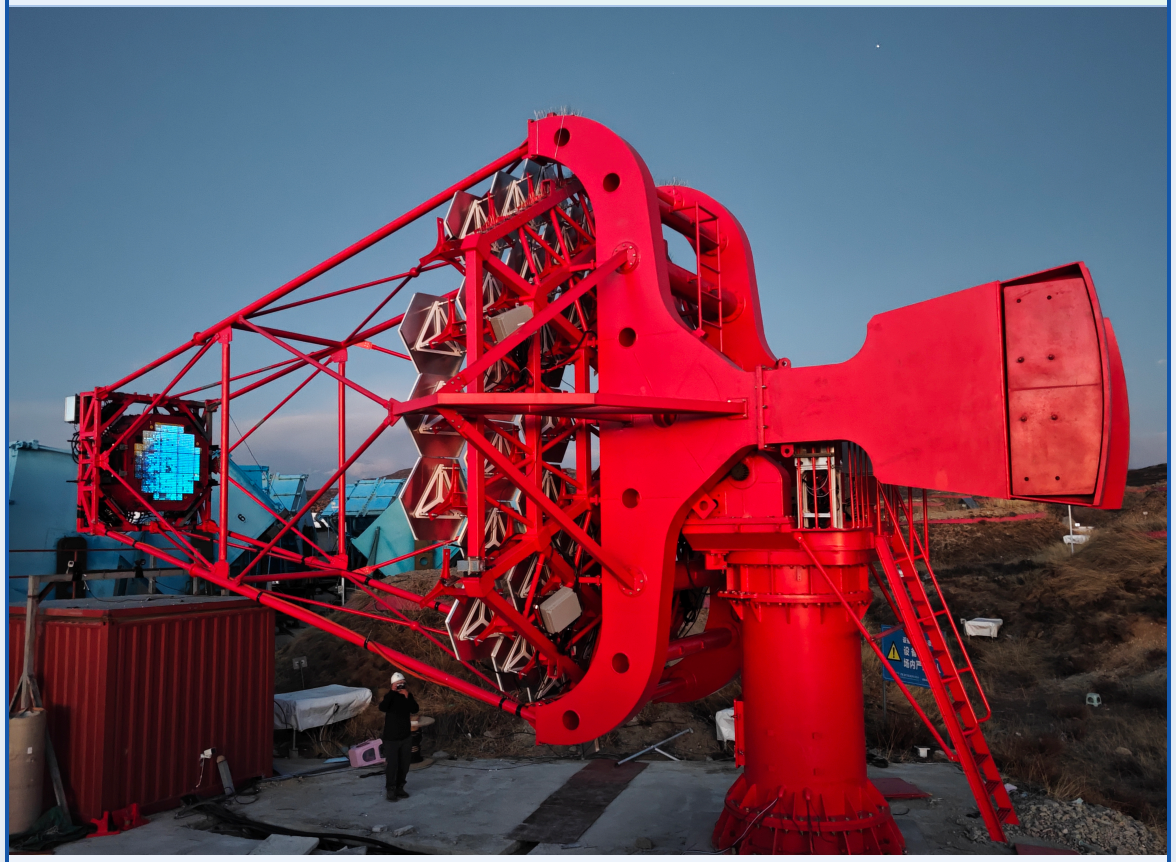
Wangxi 望曆号 · LACT 1st Unit



6 m Cherenkov telescope · prototype node (2025)

LACT Experiment & Science Goals

LACT — 32×6 m IACT array at LHAASO, Daocheng–Haizi Mountain (**4,410 m**), targeting the **PeV cosmic-ray origin** puzzle.

2025 · 1st unit (Wangxi)	2026 · 8 units	2028 · full 32

- **100+ devices** per unit, **19+ categories** (FEE, SiPM, thermal, turntable, DAQ, ...)
- Tango slow control scales **1 → 32** telescopes in one unified namespace
- **Wangxi** (1st unit): 101-channel FEE DAQ, turntable, thermal, cameras, nightly scheduling — validated 2025

Challenge: Massive telemetry & DAQ streams, complex O&M workflows — scripts alone cannot meet **real-time scale, auditability, and safety**. High-volume device data must never feed WebSocket directly.

Our Approach (3 Pillars)

- **Distributed storage plane** — PyTango → ZeroMQ → Flink → Iceberg / Cassandra → Spark
- **DIAT** — storage-backed acquire, visualize, analyze & interact
- **LLM Agent Platform** — NL intent → auditable MCP tools on the control plane + read-only monitoring

Design principle: dual-plane isolation — *control writes* vs *data reads*

SYSTEM OVERVIEW

Dual-Plane Architecture · DIAT · LLM Agent Platform

Control Plane vs Data Plane — Unified, Scalable, Auditable

Operator / DIAT UI → LLM Agent Platform (MCP) → FastAPI REST / WS → Tango REST Gateway → Storage Plane ZMQ·Flink·Lake

Distributed Storage

Ingest PyTango→ZeroMQ	Stream Flink QC
Store Iceberg+Cassandra	Analyze Spark replay

Read path: WebSocket from storage. Control path: Tango REST/MCP only — isolated from ingest bus.

DIAT

Acquire — 10 Hz WS from Iceberg/Cassandra
Visualize — Vue 3 + Three.js digital twin, DAQ maps
Analyze — Spark / Flink on history
Interact — Tango REST/MCP for control

Query ≠ control | Storage-backed

LLM Agent Platform

Tool Pool · Orchestration · Skill & audit. Sub-agents: Planning, DAQ, Thermal, Pointing, Schedule, Diagnostics.

Closed loop: Intent → Plan → Bind → Control → Monitor → Close

Phase I MVP | Phase II Scale | Phase III Federate

Deployed on Wangxi: control & data planes validated — platform ready for 8-unit science operations (2026) and full 32-unit array (2028).

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