BERKELEY LAB

ACCELERATOR TECHNOLOGY & APPLIED PHYSICS DIVISION ATAP

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Accelerator Technology &
Applied Physics Division

Overview of the Multi-Office Accelerator Team (MOAT) collaboration activities

June 30, 2026 meeting
of the EIC-Beam AI WG
and the Accelerator sub-WG
of the AI4EIC WG of the EICUG

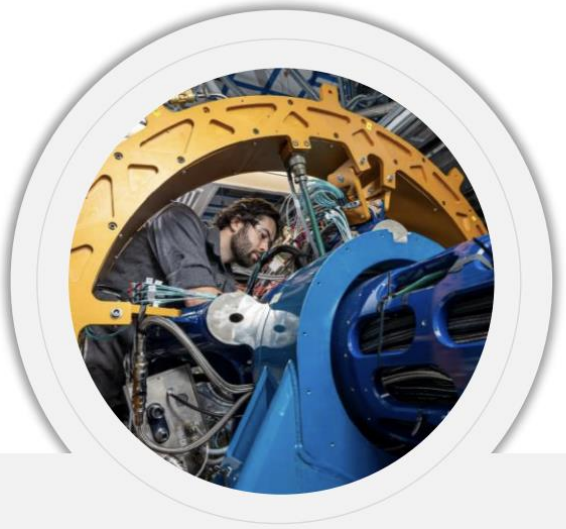
U.S. DEPARTMENT of ENERGY | Office of Science

Genesis Mission

Genesis Mission: A National Mission to Accelerate Science Through AI

Energy

Discovery Science



National Security

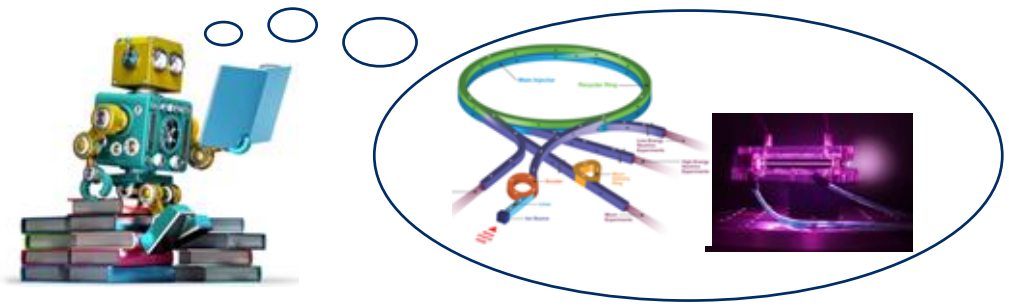
https://genesis.energy.gov

AI is Ideally Suited to Transform Accelerators and Applications

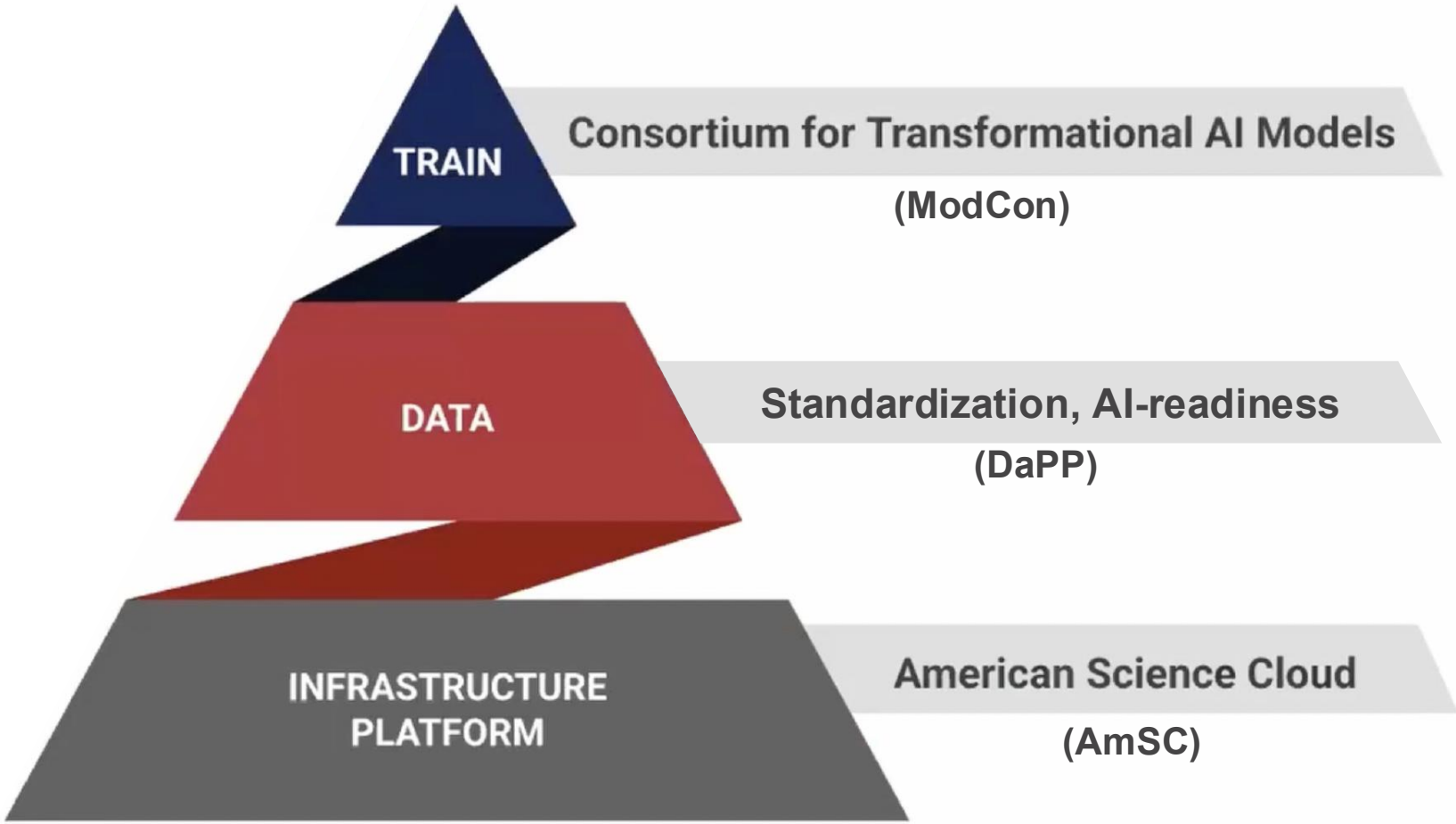
- **Long-term vision: AI becomes indispensable partner in accelerators**
  - Full lifecycle, from design to operation to R&D and workforce development
- **Many benefits expected to come from AI assistance and control, e.g.:**
  - Novel designs with integrated optimization
    - Including end-to-end, detailed physics, cost, safety, etc
  - Faster designs (spans years for largest accelerators, which are among the most complex machines)
  - Higher efficiency and performance
  - Unprecedented on-demand beam customization and beam quality
  - Higher precision (control, pointing, etc)
  - Automated failure prediction and prevention
  - AI-assisted to fully autonomous operation

➔ **Better colliders, light sources & accelerators for many applications, e.g.:**

  - DOE accelerator-based science
  - Nuclear waste transmutation
  - Advanced reactor and fusion concepts
  - EUV lithography
  - Advanced manufacturing
  - Ultracompact accelerators for medical and industrial use



Genesis simplified structure*

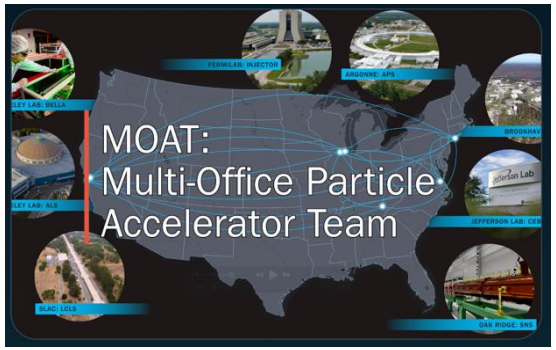


*From "Introduction to the American Science Cloud (AmSC) : Part One" – 11/13/2025 https://vimeo.com/1137699305

Initial accelerator projects embedded at all levels of Genesis

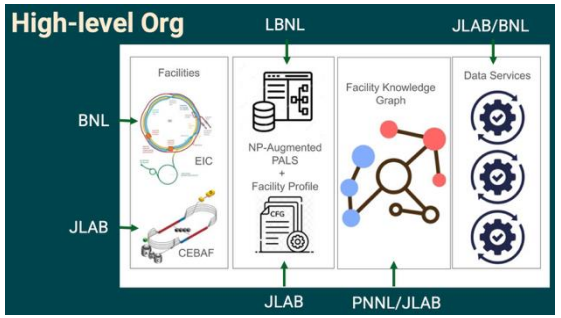
Multi-Office Accelerator Team (MOAT-seed)

- LBNL, ANL, BNL, FNAL, JLAB, ORNL, SLAC (BES+HENP)
- Deployment of shared accelerator agentic AI software across facilities (8 to date)
- Deployment of digital twin prototypes across facilities (3 to date)



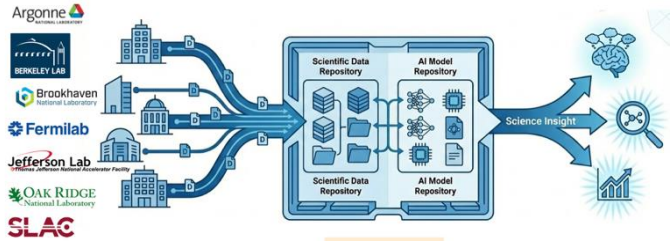
Nuclear Physics AI-Ready Accelerator Data (NARAD)

- JLAB, BNL, LBNL, PNNL; (HE)NP-focused, but coordinating with all US accelerators
- Augments the Particle Accelerator Language Standard (PALS) with facility-specific profiles and a shared ontology; Delivers cross-facility knowledge graph tools that supports subgraph extraction for diagnostics/optimization tasks



AmSC Scientific User Facility IP

- LBNL, ANL, BNL, FNAL, JLAB, ORNL, SLAC
- Establish Genesis as a shared platform to host and distribute AI models and scientific data for (mostly) accelerator-based BES, HEP, and NP Scientific User Facilities (SUFs), along with their industry and research partners

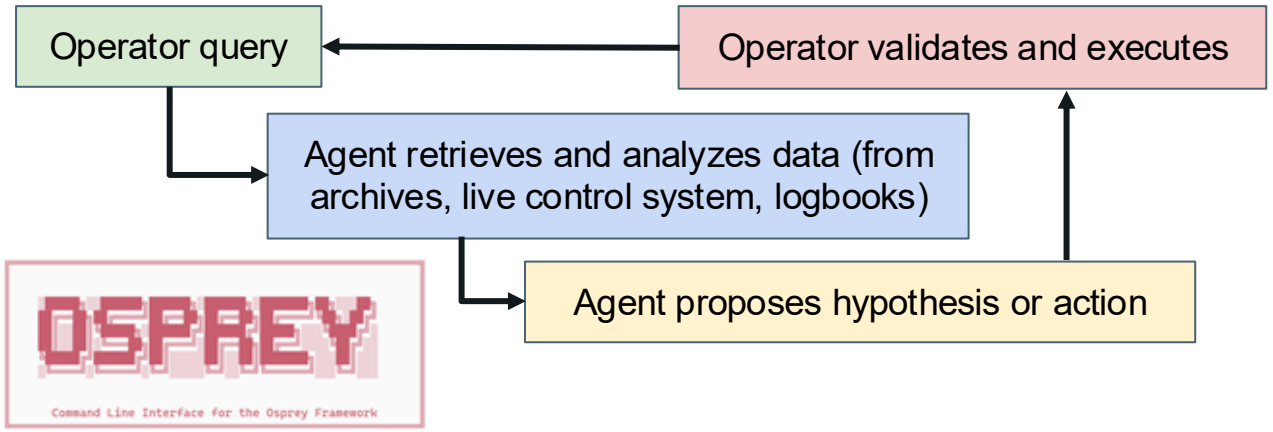


March Demo(s): MOAT in coordination with AmSC SUF

Deployment of agentic platform at 8 sites (MOAT), digital twins at 3 sites (MOAT+AmSC SUF IP)

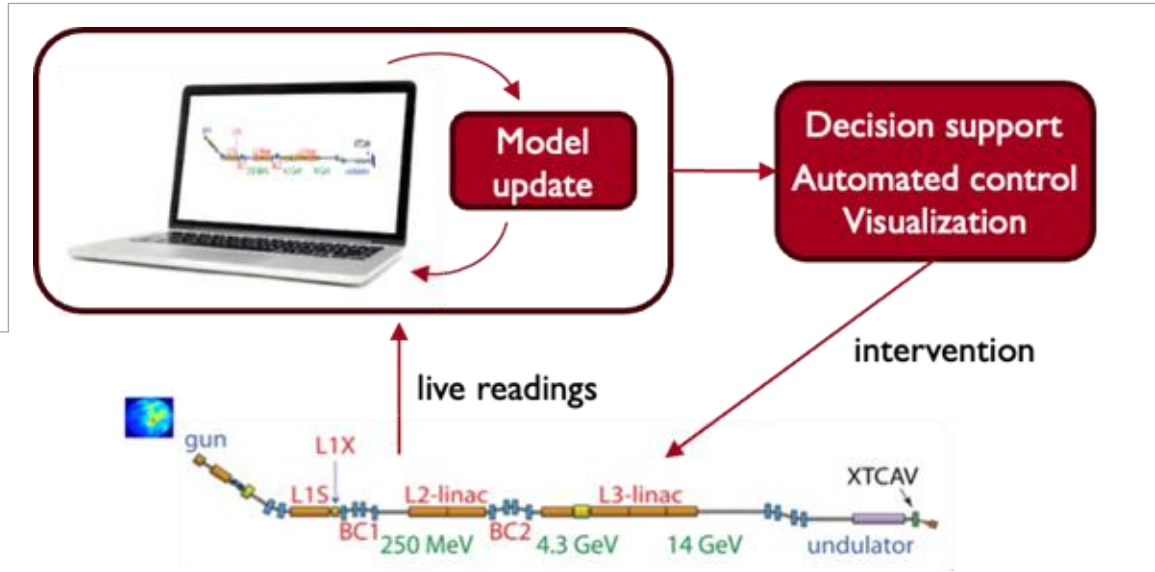
Deployed agentic platform Osprey at multiple facilities

Supports accelerator operations @ LBNL (ALS, BELLA), FNAL (Accelerator Complex, FAST), ORNL (SNS), ANL, (APS), SLAC (LCLS), JLab (CEBAF, UITF), BNL (RHIC/EIC)



Uses MOAT's Osprey framework (initially developed at LBNL/ALS) ⇒ outperform ad-hoc workflows based on fragmented institutional knowledge that operators currently rely on*

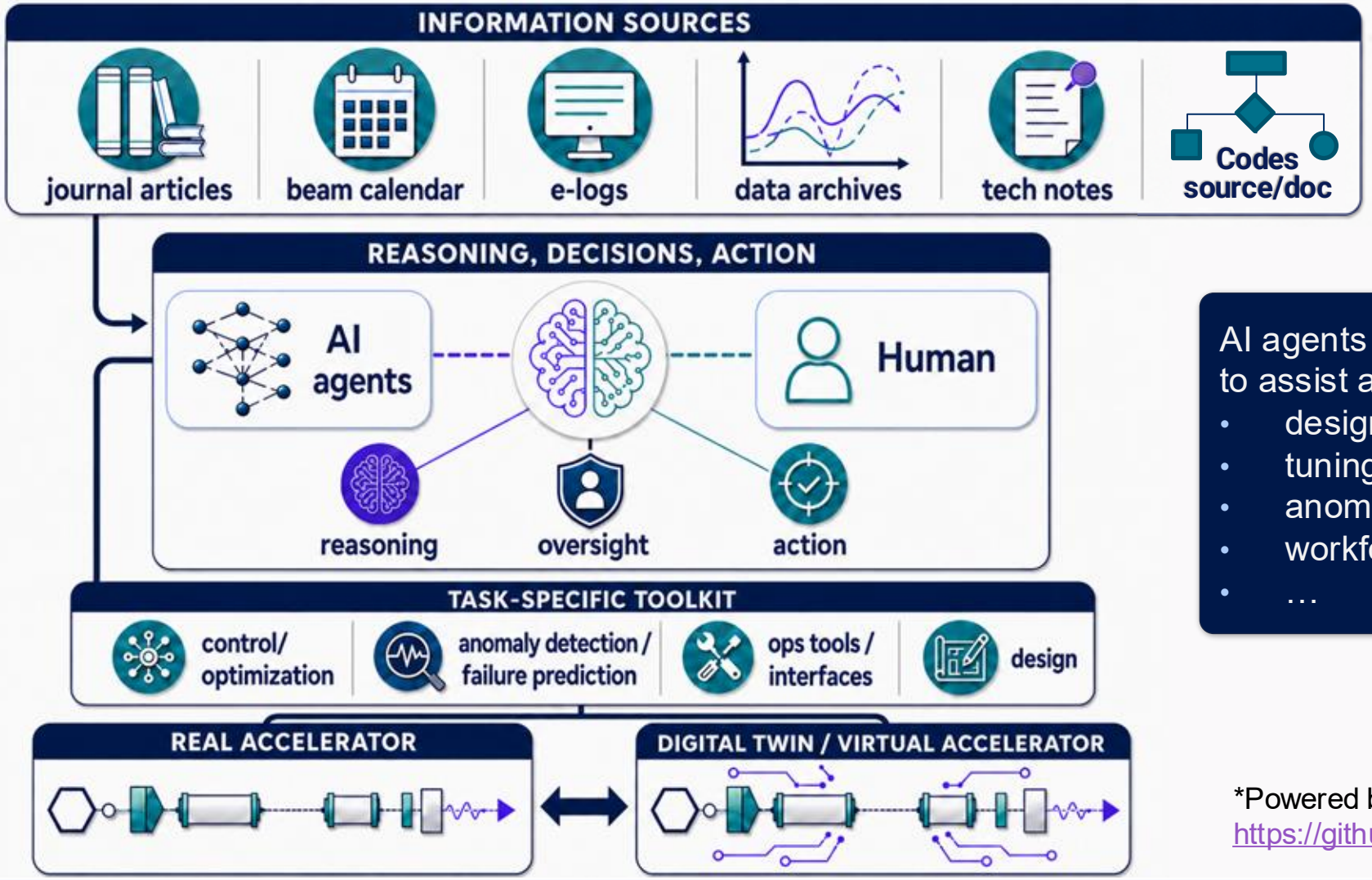
*"*the preparation effort is reduced from what would typically take several hours of manual scripting and debugging to only a few minutes from a single natural language prompt—**a speedup of 2 orders of magnitude**."* T. Hellert, *PRR* **8**, L012017 (2026).



Digital twin demos at subset of facilities (collab. AmSC SUF IP)

- HPC integration (e.g., IRI, Perlmutter@NERSC)
- Deploying at LBNL (BELLA), FNAL (FAST), SLAC (LCLS)
- Ongoing: ML model retraining (coord. w/ ModCon BASE SIM)
- Ongoing: Linking digital twin to Osprey agents

MOAT plans to expand scope of AI framework around Agentic AI



AI agents use information sources and tools to assist accelerator activities:

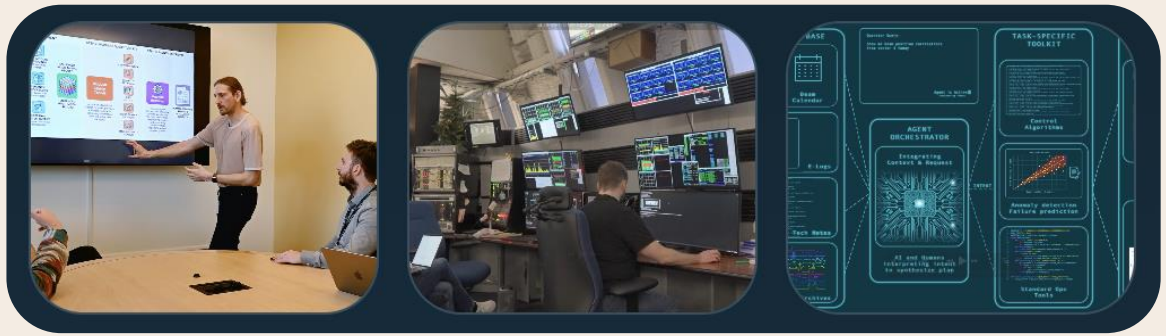
- design
- tuning
- anomaly detection & prevention
- workforce development
- …

*Powered by the LBNL-led Osprey agentic framework
https://github.com/als-apg/osprey

MOAT is expanding into a cross-projects, cross-facility collaboration
extending to additional labs, universities and industry

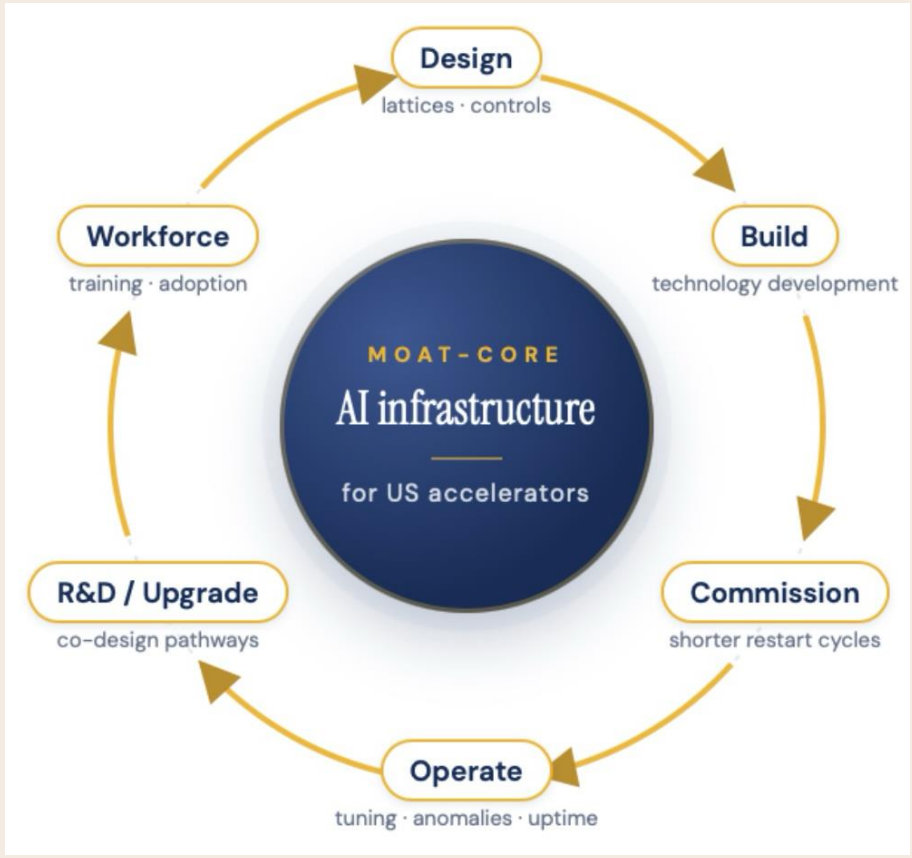
The MOAT Collaboration

Collaboration focus: shared infrastructure & coordination of AI-enabled accelerator work



MOAT connects institutions, workflows, tools, technical knowledge so progress can be reused across facilities

More info: https://moat-ai.github.io
moat@lbl.gov



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Thank You!

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