

BUQ Project Meeting 2026-06-17 13:57(GMT-7:00)

Key Outcomes

Four research proposals were presented covering AI/ML acceleration for rare-event physics experiments, spanning liquid xenon TPCs, quantum sensors, heavy-ion hydrodynamics, and autonomous detector control. No funding decisions have been made; announcement expected around July 22 or PI contact starting July 1. [1](#)

Decisions Made

- Phase 2 proposals require an **industry partner** and must be submitted around **December** [2](#)
- Simon's talk deferred to next meeting due to absence
- All presenters to **upload slides to Indico** [3](#)

Proposals Presented

1. Petabyte Solution – Liquid Xenon TPC (Aobo/Liang Yang, UCSD)

- Problem: XLZD detector will produce ~10–20× more data than current ~1 TB/day; zero background events seen after month-long simulations [4](#) [5](#)
- Approach: **multilevel splitting** on Geant4 + **Resume surrogate model** to achieve ~100× simulation speedup; **quantized CNN on FPGA** for real-time reconstruction to reduce raw waveform storage [6](#)
- Risk: XLZD not currently DOE-supported; funding chances assessed as low [7](#)

2. Denoising Quantum Sensor – Axion/TES/QEC (Aobo, Brian, Yuri)

- Targets: Abracadabra, DM Radio (axion dark matter) and Cupid TES sensors; ~1 TB/day data volume [8](#) [9](#)
- Approach: **AI agent "Sidereus"** — multi-agent LLM framework autonomously proposes, trains, and refines denoising models; deploy winning algorithms to **FPGA for online**

denoising 9 10

- Industry partner **Edencode** (~\$100K allocated) supplies quantum error correction datasets 11
- Phase 2 path: connect agent to live axion detector or TES test stand at LBL 12

3. FLASH – Fourier Neural Operator for Heavy-Ion Hydro (Chun, BNL + Ford AI)

- Goal: **several orders-of-magnitude speedup** of relativistic hydrodynamics simulation using **Fourier Neural Operators (FNO)**; enables jet-medium and small-system phenomenology requiring millions of runs 13 14
- Transfer learning: apply relativistic hydro insights to non-relativistic fluid dynamics for **Ford car design** simulations 14 15
- Ford currently non-funded partner; full engagement targeted for Phase 2 16

4. Generative Model for High-Multiplicity QCD Events (Chun + Rice/CMS)

- Problem: rare high-multiplicity pp events require heavy CPU for Pythia generation; non-trivial long-range correlations not reproduced by standard generators 17 18
- Approach: **conditional particle transformers** to learn multi-particle correlations; target **1,000× generation speedup** 19
- Industry partner and Phase 2 scope not yet defined 19 20

5. Casually Grounded World Models for Cupid (Brian, Chris Grant/BU lead)

- Build a **world model** from Corey slow-control + pulse data (100+ parameters, MongoDB + Postgres) 21
- Planning layer simulates effect of control interventions; recommendation layer flags non-obvious anomalies 22 23
- Phase 1: train on existing Corey data; model expected to transfer to Cupid with minimal modification 3

Open Questions

- Whether DOE offices will prioritize XLZD-focused work given lack of current program support 7

- Quantitative speedup benchmark for Resume applied to liquid argon optical modeling not yet established [24](#) [25](#)
- Industry partner strategy for the high-multiplicity QCD generative model proposal unresolved [20](#)

Action Items

- **All presenters:** Upload slides to Indico
- **All PIs:** Begin identifying industry partners given December Phase 2 deadline [2](#)
- **Ann-Kathrin:** Define benchmarking methodology for Resume on liquid argon veto vs. existing high-fidelity simulations [25](#)
- **Chun:** Define Phase 2 scope and potential industry partner for QCD generative model proposal

Next Meeting

Simon's deferred talk + remaining proposal presentations scheduled for next meeting.