Application of Agentic AI to Vertically Integrated Bilevel Reconstruction and TDAQ Optimization (VIBRATO)

Wonyong Chung[1], Qibin Liu[2], Liangyu Wu[3], Julia Gonski[2]
[1]Princeton University, [2]SLAC, [3]Stanford University

Enabling simultaneous geometry-digi-reco optimization and analysis at long-awaited scale for the first time

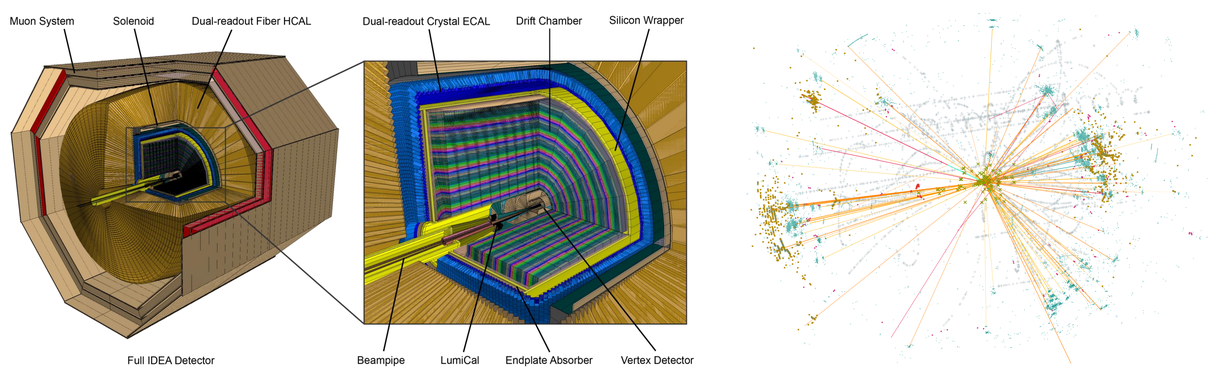
Poster also presented at Stanford Physics and AI (June 2026); talk by W. Chung on Thurs.

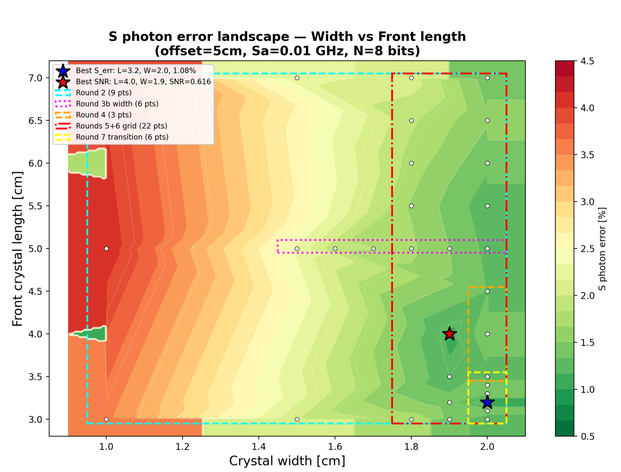
Overview

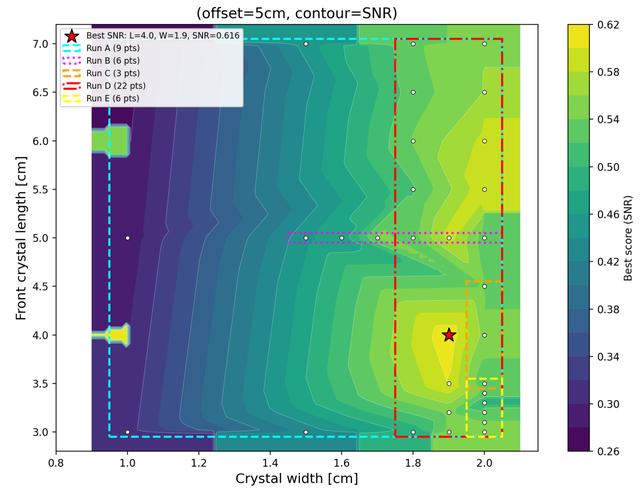
- No objective measure of comparison between different detectors exists (performance varies by physics task/regime)
- Full sim capabilities needed for sub-percent precision EW studies
- We built an iteration scaffold around a dual-readout segmented crystal ECAL (IDEA/SCEPCal), added digitization (ADC bit-depth and sampling rate), and drove compute statistics with a scientific-reasoning agentic-AI layer, SciFi (vs. grid-scan/Bayesian)
- Geometry parameters: transverse crystal granularity, longitudinal segmentation, projective offset
- 2 reco objectives at 1-45 GeV: single electron resolution (log-weighted center-of-gravity clustering: radius, mass threshold, weight), combinatorial pi0 to diphoton matching (mass window, angular separation, depth correction)
- Dual-readout capabilities not yet used (S only, no C photons)

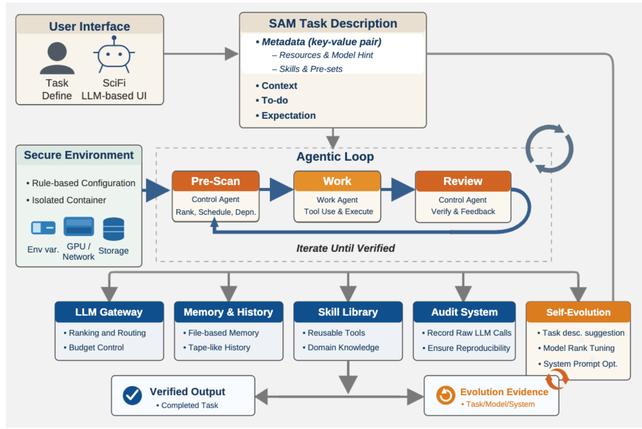
Findings

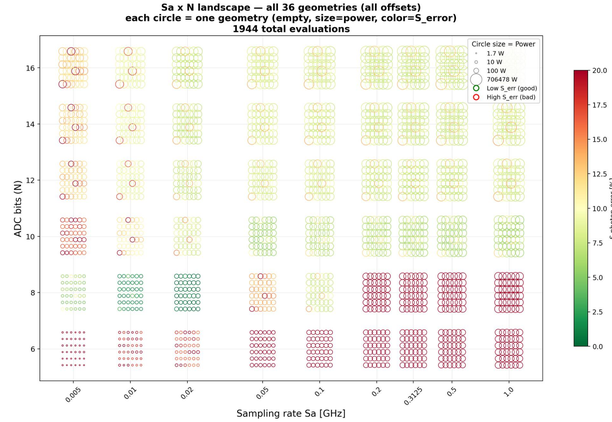
- We show definitively that geometry-digi-reco are coupled by task regime in ways not yet identified by first principles approaches
- However, human input or specialized context needed to establish global parameter space bounds
- Potential for huge savings in compute with agent-reasoning gradients vs. Bayesian/other methods, exact numbers WIP











Paper: [arxiv:2604.21804]

SciFi: A Safe, Lightweight, User-Friendly, and Fully Autonomous Agentic AI Workflow for Scientific Applications: [arxiv:2604.13180] [github:qibin2020/scifi]