

US HFCC: **AI**, Integrated Detector Concepts, & **Microelectronics**

L2 : Julia Gonski, Jim Hirschauer

L3 : Tim Andeen, Liza Brost, Jennet Dickinson, Loukas Gouskos

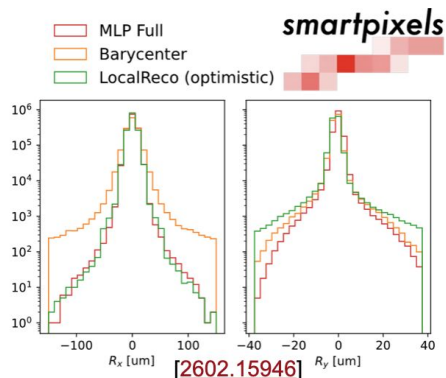


L2 AIM Update

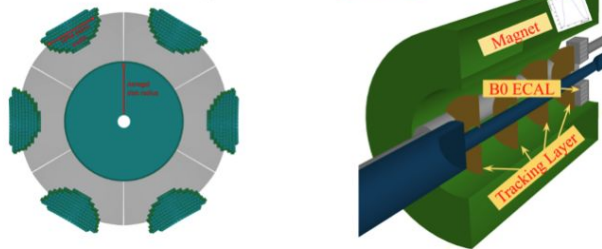
8 September 2026

Introduction to AIM

- **AIM = “AI, Integrated Detector Concepts, and Microelectronics”**
 - New L2 to make sure we capture critical emerging technologies for FCC and play leading role in overall detector design
- **Covers many areas of US leadership:**
 - “Smart” electronics (e.g. SmartPixel, eFPGA)
 - AI-assisted detector design (differentiable programming)
 - Agentic AI for colliders



AI-Assisted Design for EIC [2405.16279]



AI Agents Can Already Autonomously Perform Experimental High Energy Physics

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¹Department of Physics, Massachusetts Institute of Technology

²NSF AI Institute for Artificial Intelligence and Fundamental Interactions

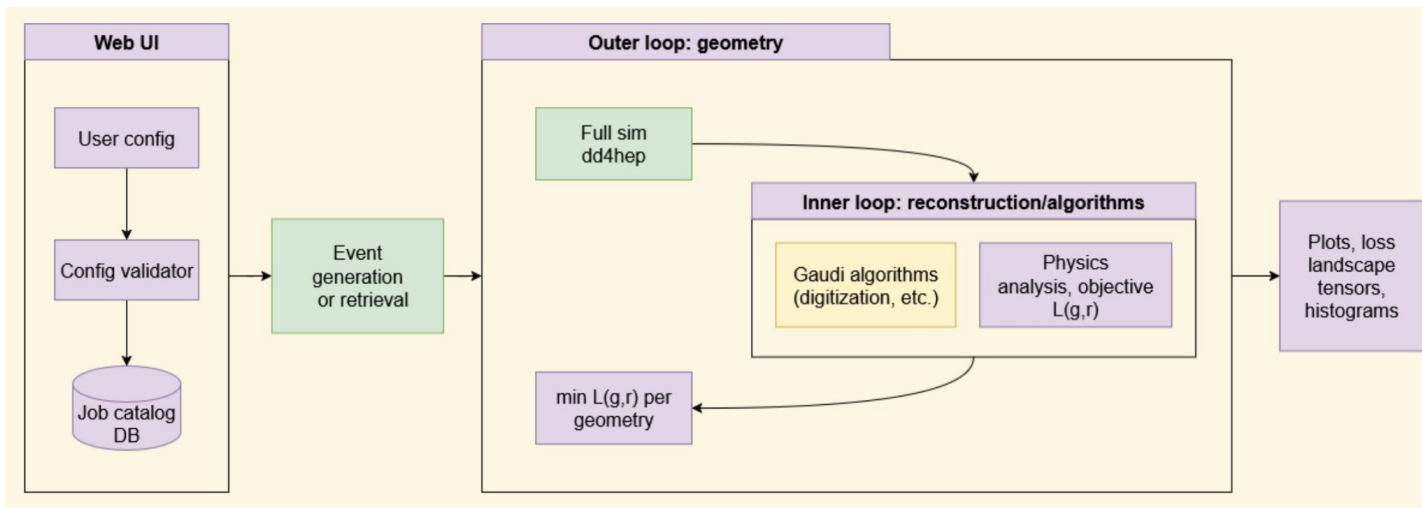
³CERN

June 23, 2026

2603.20179

FY26 Funded Activity: Bi-level Detector Optimization Framework

- Wonyong Chung (Princeton) “Vertically Integrated Bilevel geometry, Reconstruction, And TDAQ Optimizer (**VIBRATO**)”
- **Status:** Wonyong implemented framework and complete example of outer (reconstruction) + inner (geometry) loops for dual readout crystal [Mar 2026]
 - Code available and ready for users: https://github.com/wonyongc/bilevel_det_opt

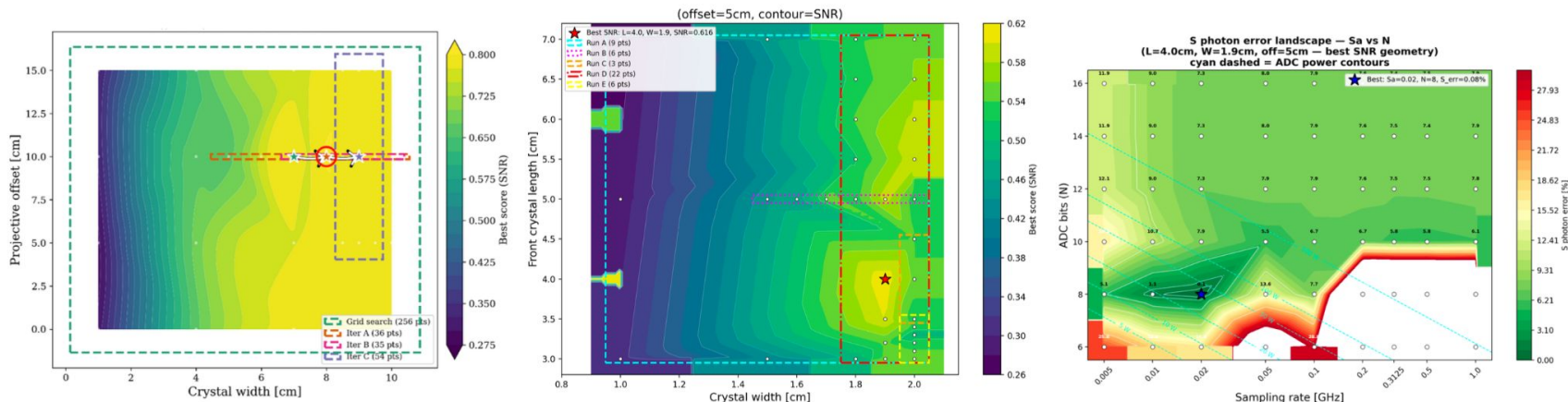


VIBRATO + Agentic Workflows

- Building on Wonyong's framework, SLAC has adapted scientific-focused AI agentic workflows to (a) improve efficiency / completeness of traversal of optimization space and (b) identify more optimal points
 - **First result** for the Stanford Physics & AI conference (PAI26) [[2604.21804](#)]
 - Extended result in preparation for JINST: incorporating e/p π^0 physics objectives

Next plans:

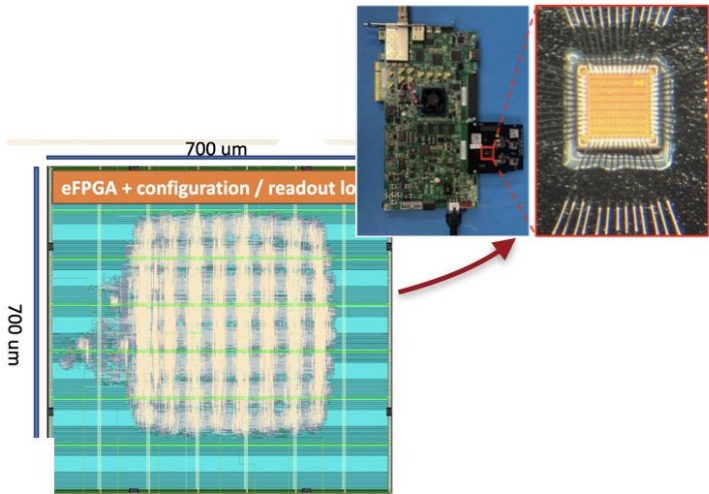
- Incorporating other detectors (HCAL, tracker, MDI)
- Full FCC-ee physics study, optimizing for ex. to sensitivity to trilinear higgs self coupling from ZH recoil



“Smart” Electronics

- **Embedded FPGA** for reconfigurable digital electronics in ASIC (R&D synergistically funded by SLAC LDRD)
- Co-design with fast (<50 ns) lightweight **ML-based feature extraction** for data rate management at FCCee
 - Drift chamber: at-source cluster counting with better performance than derivative-based methods
 - Crystal dual readout calorimeter: C/S waveform decomposition with better performance than template fitting (*2026 FCC Week Early Career Award winner!*)

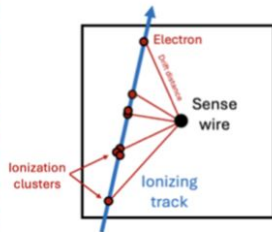
Embedded FPGA



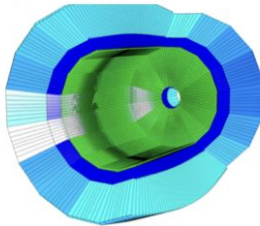
FCC Front-End Applications

[2511.10540]

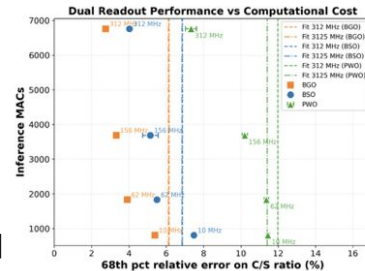
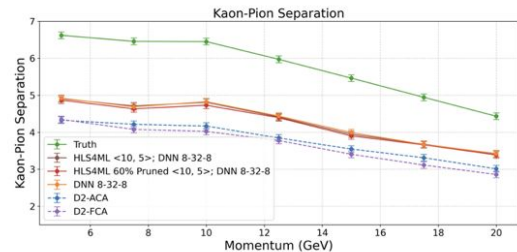
Drift Chamber



Crystal Dual Readout Calorimeter



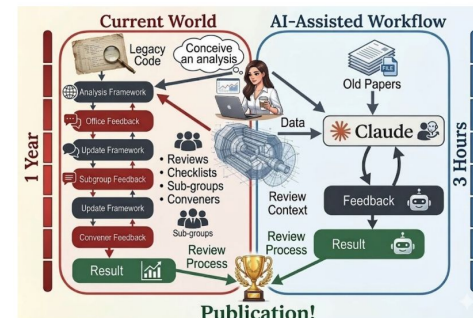
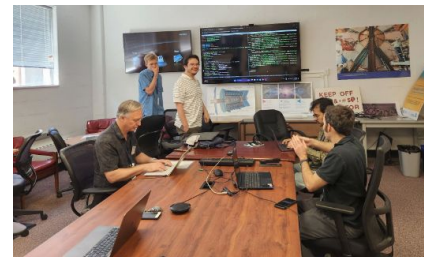
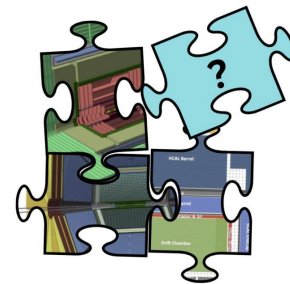
Dual-Readout Segmented Crystal ECAL



[2604.26090]

FY27 Goal: Detector Design/Optimization Challenge

- First proposed December 2024: US-led “challenge” to use efficient optimization tools to improve on/come up with new FCC detector designs
- Common goals for AIM, TDAQ, and PS&C:
 - Up-to-date and detailed subsystem simulations
 - Updated physics studies/projections
 - Full detector data rate estimates and studies
 - Full detector optimizations
- *Progress so far:*
 - Contributing to development of full sim for all subsystem/detector concepts
 - VIBRATO beta version available for community use
 - [FCC Hackathon](#) at BNL with work packages on using Key4HEP
- In parallel: “**Agents for FCC**” taking off...



FY27 Planned Activities

Task	Description
AI-based/ agentic detector optimization	Continue successful work towards increasingly complex/realistic optimization scenarios and integrating results into FCCee detector teams. Provide regular tutorials to community to ensure broad tool usage.
AI-enabled electronics	Continue exploring design space of DRO calorimeters for AI edge data compression, incorporating impact on physics (PFlow → jets → analysis)
Detector Optimization Challenge / “Agents for FCC PED” workshop	Inspire better community engagement in detector concepts. Play leading role in introduction and best practices of agentic AI for FCC.