XXX-opticks, XXX $\in$ {EIC, LAr, WbLS}

Kick off meeting for extending eic-optics

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Topics

- Brief overview
- Scope of the group
- The LDRD-C parts

Overview of software parts

Opticks related

NVIDIA OptiX	GPU accelerated ray tracing on RTX hardware
Opticks	Integration of **Geant4** and **OptiX** by Simon Blyth
eic-opticks	A fork++ of **opticks** by BNL NPPS (Gabor, et al) originally for EIC detector R&D.
xxx-opticks	Unofficial label for further extension of **eic-opticks** by this group.

Targeted software

edep-sim	a Geant4 application and library used most by **DUNE ND**.
LArG4	an *art* module integrating Geant4 into LArSoft for **DUNE FD**.
ratpac2	software framework with Geant4 module used by **WbLS** and others.

Possible implications of our work

Wire-Cell Toolkit	SOTA TPC drift/response sim, signal processing and reconstruction.
phlex	DUNE's framework to replace *art*, similar to WCT design.
tred	EDG's DUNE ND pixel or FD wire/strip GPU-accelerated drift/response sim

None of these have G4, let alone optical. Yet....

Makeup of this group

LDRD-C BNL (Gabor+Xuyang+bv), assure **eic-opticks** works for LAr and esp. DUNE using a reference application target (**edep-sim**).

- LDRD-A proposal (Chao++), includes an eic-opticks component.

LArSoft Rice (Aaron+Ilker), integration of **opticks** to **LArG4**.

- Maybe move to eic-opticks through this group?

WbLS BNL (Yousen+Guang), integration of **eic-opticks** to **ratpac2** for water-based liquid scintilator R&D.

edep-sim Stony Brook (Clark), original author.

I now focus on some LDRD-C issues.

BNL LDRD-C project

Coordinates

- Short run: Feb 15 - Sep 30 2026.
- Xuyang (45%), Gabor (10%), Brett (3%).

Expected results, paraphrased from proposal

- Implement eic-opticks in framework-independent production-ready application.
- Validate its optical physics models as relevant to LAr / DUNE.
- Produce benchmarks and guidance for CPU/GPU hardware specs.
- Expertise and planning for integration into future DUNE software framework.

Some technical work items

Implementing into edep-sim

- Can use GDML from DUNE FD GeGeDe group.
- Reproduces existing “optical maps” from LArG4.

Wavelength shifting

Two paths to support WLS:

- Efficiently bring photons back to the CPU for standard G4 WLS, restart results on GPU.
- Implement WLS physics processes directly on the GPU, ultimately the best approach.

Geometry and shapes

- Support what shapes are required for DUNE FD and ND geometry descriptions.
- Leverage existing work (PNNL) on using GeGeDe for DUNE FD geometry description.

Bonus:

- Async CPU/GPU processing to maximize GPU utilization.

Why edep-sim as the LDRD vehicle?

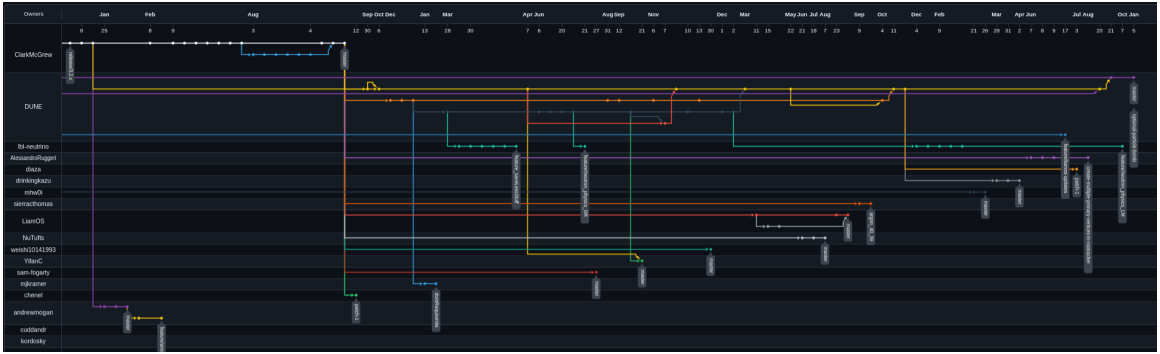
Some self-imposed constraints

- Want a low-dependency, high-quality, existing package to accelerate our development.
- Integration of (base) opticks into LArG4 already handled by Aaron+Ilker.
  - Here, we want to amplify that effort, not compete with it.
  - Enable / assist adoption of eic-optics fork.
- Phlex, Wire-Cell Toolkit and tred currently lack any G4 interface.
  - Developing this interface is a **large effort**.
  - Perhaps edep-sim ends up being the integration target?
- ratpac2 is used by BNL WbLS R&D which has large optical sim needs
  - BNL hinted the LDRD-C funding should focus on DUNE/LAr but more the merrier.

Best candidate: edep-sim

- Already used by DUNE and fits satisfies the above constraints.
- Candidate for providing basis for G4 in phlex and/or WCT.
- In-house expertise (Xuyang) and the original author lives down the road from BNL.

Which edep-sim?



- Original repo: last commit Aug 2022, last release 3.20 Sep 2021.
- DUNE fork is the most recent, parent of many sub-forks, some being merged back.
  - No releases, last tag 3.0.1 Feb 2021.
  - Most other forks have small number of commits and no merging.

Survey of changes in DUNE fork

- About 30 commits merged across multiple branches and forks.
- Last 1.5 years of original repo development was merged in Aug 2025.
- New: CLI options, shapes, physics, saving of truth, particle bomb.

My (non-expert) opinion:

- Changes seem modest and reasonable.
- We should fork DUNE's fork with intention to PR back.

Rough work plan for LDRD-C

- Learn eic-opticks (next talk by Gabor).
- Define how we will interacts with eic-opticks and edep-sim repos (PRs? pushes? fork?).
  - Need to understand DUNE's many existing forks of edep-sim.
- Set up developer environments (likely Spack based).
- Demonstrate initial build and run of edep-sim + eic-opticks.
- Provide wavelength shifting process.
- Provide support for needed geometry shapes.
- Reproduce optical maps.
- Perform benchmarking.
- Document in 2 papers: compute + physics performance.

Vision for LDRD + LArG4 + WbLS parts

I see us as a working group with many common interests.

- I must focus on fulfilling the LDRD project.
- But, otherwise let's freely mix our ideas and effort to all benefit.
- I won't manage how LArG4 and WbLS parts go, I leave that to you experts.

Future meetings

Let's meet weekly or bi-weekly to share progress, ideas, ask questions.
Tuesday morning is not so good. Can we figure out a time now, quickly?

One schedule caveat

I will take extended vacation March 9 - April 3!

$\mathcal{FIN}$