Supernova ν Burst data stream and Simphony Optical GPU sim

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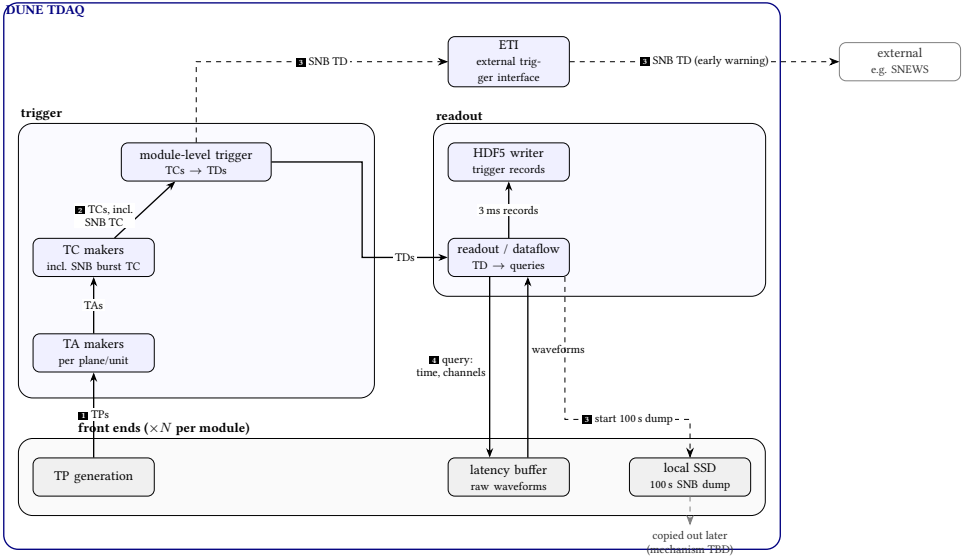
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Brief introduction to two unrelated topics

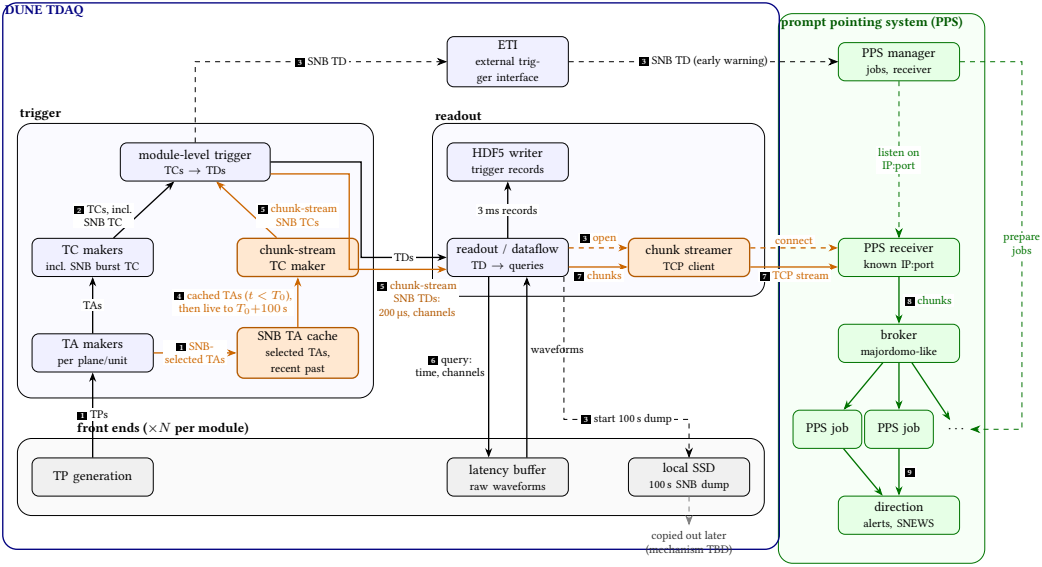
1. DUNE TDAQ for supernova ν burst (SNB) **trigger** and **prompt pointing data stream** idea
2. **Simphony** GPU-accelerated optical simulation and Phlex/edep-sim integration

DUNE TDAQ SNB trigger and prompt SNB pointing data stream.

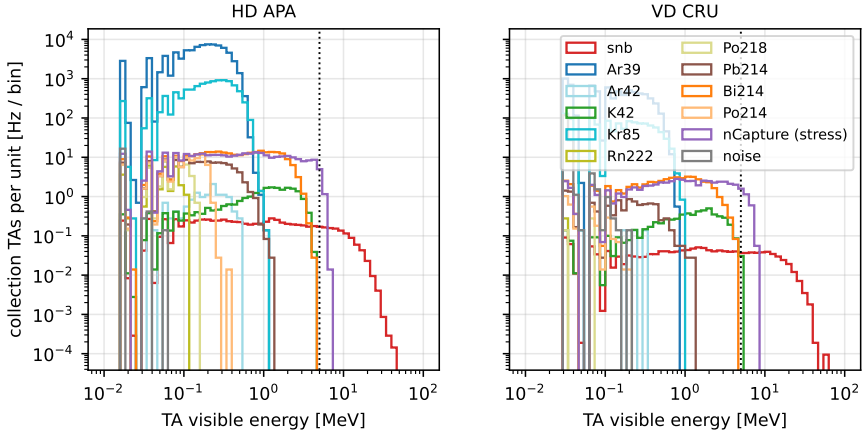
DUNE TDAQ with SNB trigger



DUNE SNB prompt pointing data stream



FDHD/FDVD: SNB and background TA energy



It is the ability to select higher energy ES, which carries the bulk of pointing information, at the TA-level that makes this idea feasible.

Prompt pointing data stream numbers

- 200 μs sing-APA/CRU readouts.
- Retains 7-8° true pointing resolution (not including reco).
- 10-20 MByte/sec data rate (tiny).
  - 1-10 seconds latency from SNB trigger to first chunk at GPU is feasible.
  - Reco goal is to output a pointing result in less than 3 minutes.
- Reco can include Wire-Cell SPNG.
  - SPNG processes 100 GPU-ms for a 200 μs readout.
  - SPNG can operate in streaming mode.

DUNE Prompt processing system

For day-to-day prompt signal processing (SPNG):

- Provide signals for fast feed back to detector operations.
- Avoid reading back data from tape, save DUNE $\approx$ \$1M/year

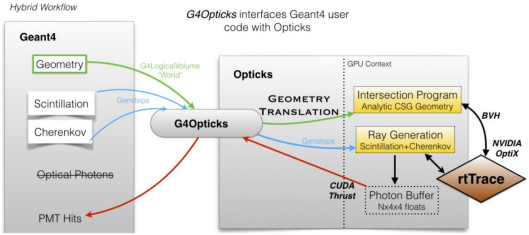
Can also be an SNB prompt pointing facility

- Receive SNB trigger, immediately kill SPNG, start pointing reco.
- Provide receiver from DUNE TDAQ SNB pointing stream.
- Dispatch SNB chunk stream to reco workers.

Simphony GPU-accelerated optical simulation and Phlex/edep-sim integration

Simphony (née opticks)

- Opticks, Simon Blythe (TaiwanU, Juno)
  - Integrates Geant4 with nvidia ray tracing library (OptiX) and RTX GPUs.
- Simphony, Gabor Galgoczi (BNL, NPPS)
  - Forked for EIC and more recently LArTPC
  - Adds wavelength shifting, more shapes, and many compute optimizations.
  - $1300x$ **faster** on modest RTX 4090 compared to single CPU Geant4.
    - ★ 2x hardware speed up each RTX generation.



edep(sim)phony LDRD-C project

- edep-sim, Clark McGrew (Stony Brook).
  - Chosen for being stand-alone Geant4 app+lib, and used by DUNE (ND group).
- edep-sim + simphony integration, Xuyang Ning (EDG).
  - Developed edep-sim plugin using Simphony.
  - Updates to edep-sim to use larsoft's variant of GDML.
  - Validate Geant4 is reproduced with LArTPC.
- edep-sim-phlex, me.
  - Integrate edep-sim into Phlex

LDRD-C project is complete and results live on in the Phlex ecosystem I'm building (xerosere).

- Includes edep-sim, Wire-Cell, DUNE raw data, geometry, kinematics and more being added.

What to do with Simphony?

- Remake optical lookup tables more quickly.
- Replace optical LUTs entirely by with Simphony as part of the full simulation.
- Produce huge data sets for training surrogate models.
  - Use surrogate as a “better LUT”.
  - Use differential surrogates for forward-model, gaining back-propagation speed ups.
- Use Simphony as the forward-model.
  - It’s speed may make up for lack of back-propagation in some practical cases.

$\mathcal{FIN}$