

Concept for an Online Beam Monitoring and Calibration Data Stream

J. Lewis

DUNE Italia Meeting

12 November 2025

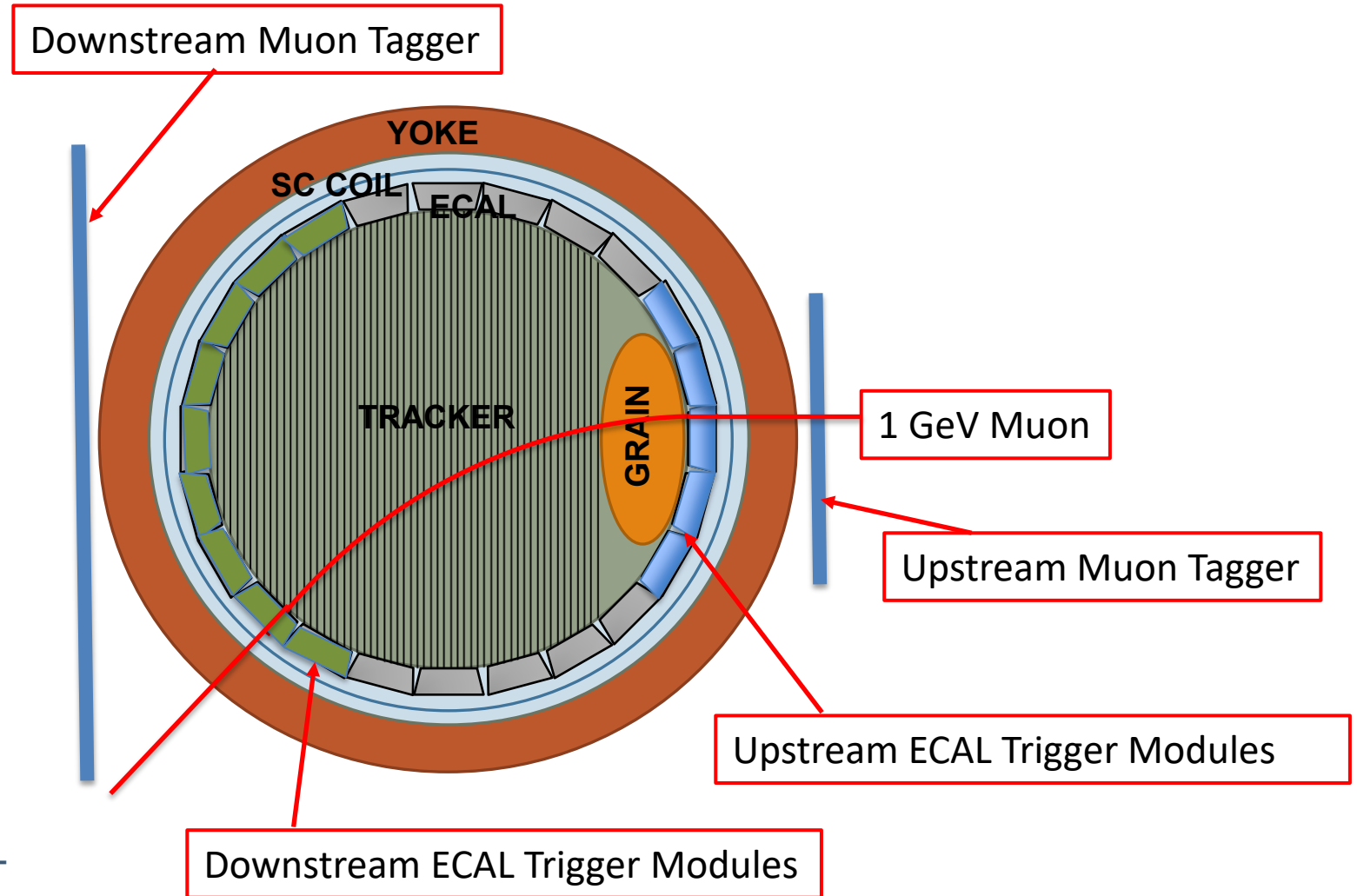


Problem

- No online monitor for neutrinos used in oscillation analysis
 - Beamline muon monitor limited to muons with $E > 5$ GeV
 - SAND TDR draft describes providing data at relevant energies with 1 week latency
 - Getting full offline production to run with fast turn-around is a lofty goal, but has not been achieved yet for large experiments
 - Reconstructing data in full detector for complete $10\mu\text{s}$ spill takes substantial computing resources
 - **Solution:** Enable region-of-interest reconstruction to get a large sample of low energy muons from neutrino interactions

Scheme

- Upstream ECAL
 - In-time hits in 3 out of 4 layers
 - ~10ns window
 - Ignore outer (upstream) layer
- Downstream ECAL
 - In-time hits in 4 out of 5 layers
 - ~10ns window
- Coincidence
 - Upstream left and right
 - Downstream left and right
 - Pick out 100ns window for event-builder

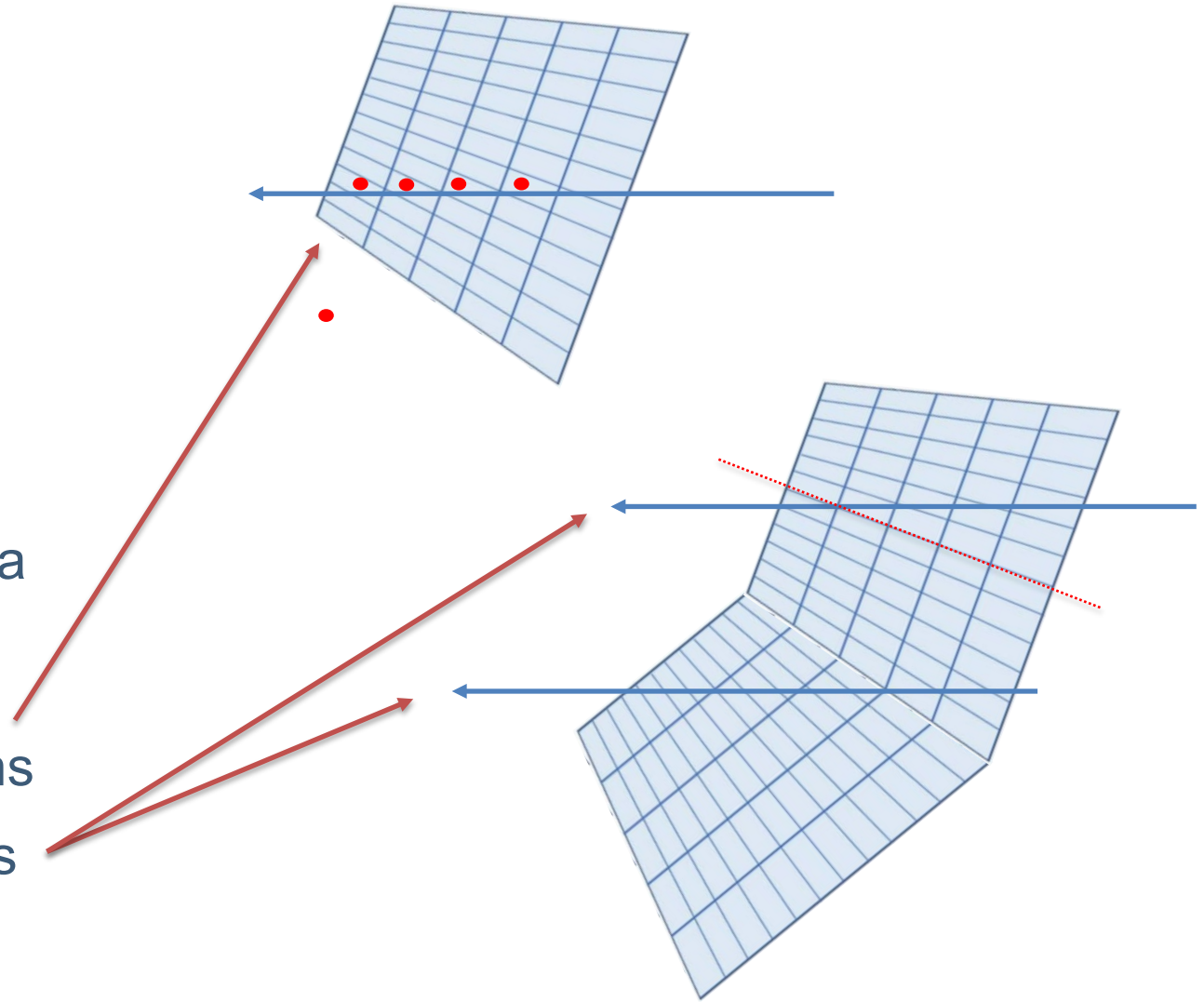


Reconstruction and Analysis

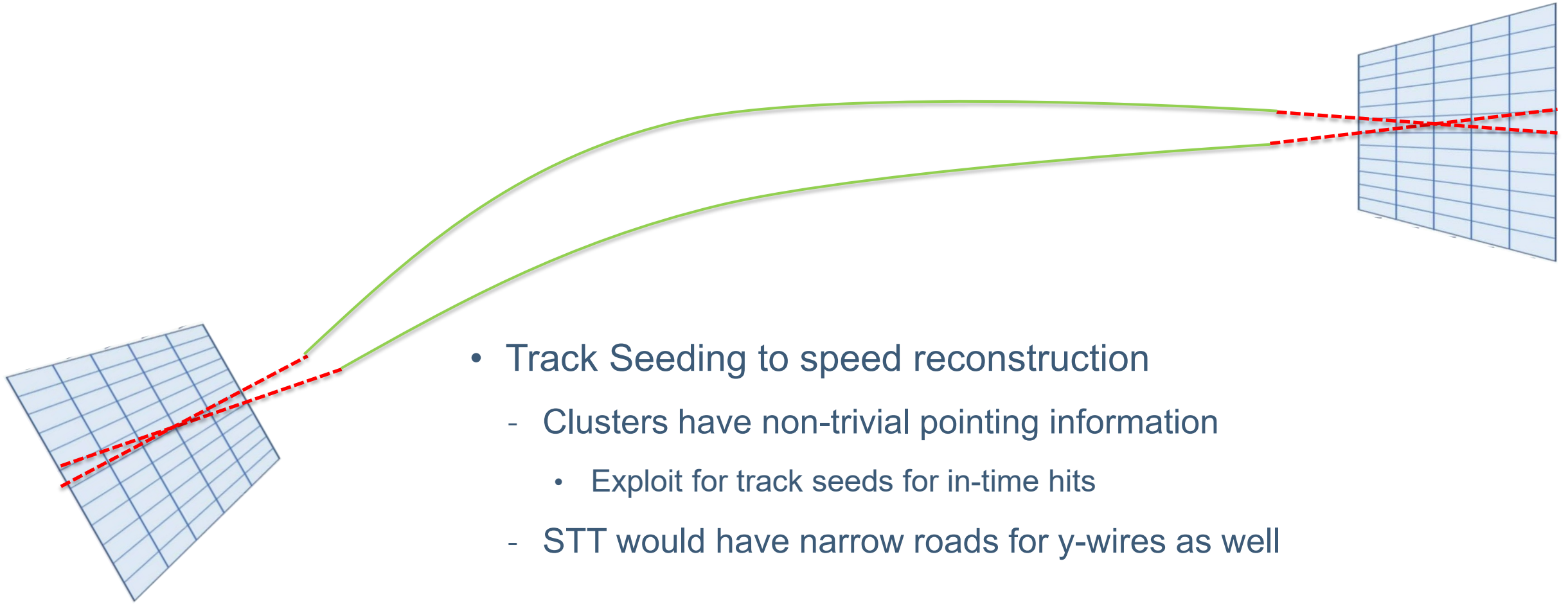
- Pick out 100ns window from event builder
 - Approximately 1% of data stream
- Reconstructed clusters in ECAL provide seed for tracking
 - Both space and time
 - Extremely fast region-of-interest tracking
- Reconstructed muons used for monitoring
- Data on or near muon-candidate tracks (in time or space) saved to compact data stream for calibrations
 - All detectors
- Samples
 - Rock muons
 - Hit in upstream and downstream tagger
 - Yoke muons
 - No hit in upstream tagger
 - Hit in outer ECAL layer
 - ECAL muons
 - No hit in upstream tagger or outer ECAL layer
 - Oops
 - Hit in upstream tagger
 - No hit in outer ECAL
 - Use to measure fakes and inefficiency

Gory Details

- Trigger Implementation
 - Add FPGA to QTDC
 - Logic with discriminated signals
- Trigger Logic
 - Are events clean enough to use a simple coincidence?
 - Not much more difficult to implement MIP cluster patterns
 - How to handle clusters that cross readout boundaries?
 - Board-to-board connections needed?



Gory Details



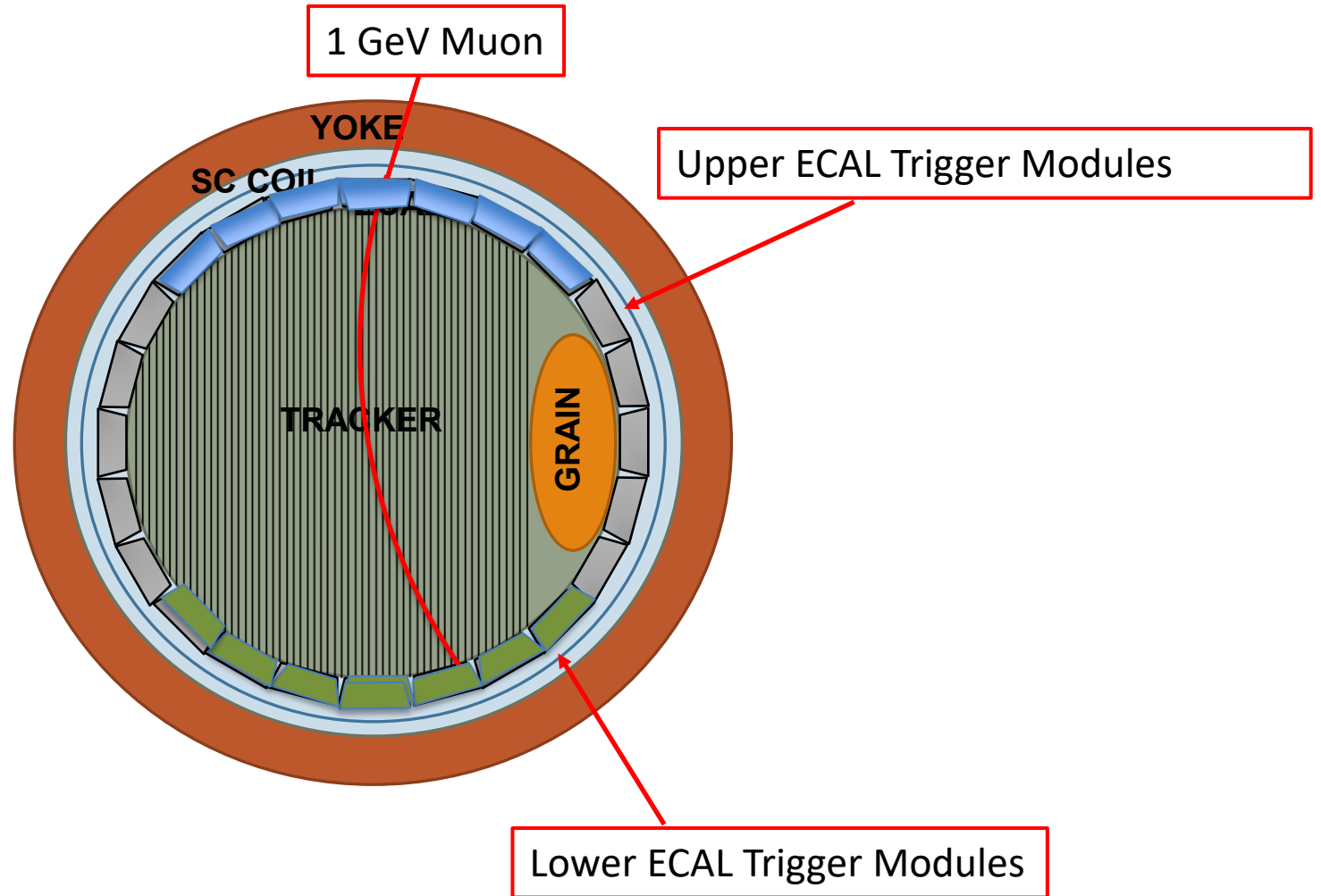
- Track Seeding to speed reconstruction
 - Clusters have non-trivial pointing information
 - Exploit for track seeds for in-time hits
 - STT would have narrow roads for y-wires as well

Calibration Sample

- Compact dataset of crossing muons
 - Calibrate tracker
 - Save in-time hits along roads
 - Calibrate GRAIN
 - Save all in-time data
 - Calibrate triggered part of ECAL
 - Investigate possibilities for other parts
 - Bootstrap to other regions with other samples
- Ready for early physics
 - SBND used dedicated crossing muon trigger sample to calibrate
 - Preliminary physics results 9 months after first physics data
 - 3 months after end of run

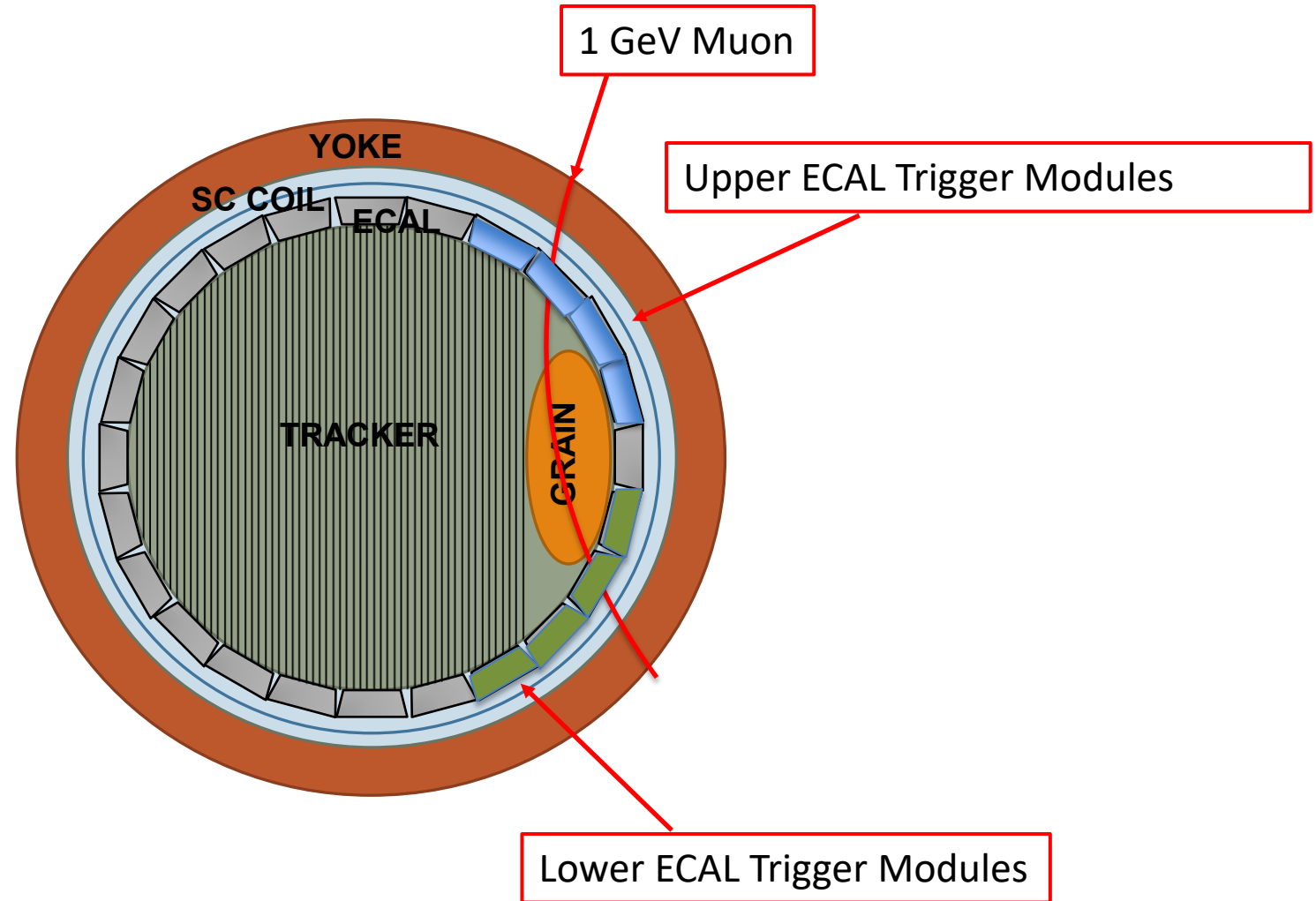
Possible Addition: Cosmics for ECAL

- Upper and Lower ECAL
 - In-time hits in 3 out of 4 layers if used in beam trigger
 - In-time hits in 4 out of 5 layers if not in beam trigger
 - ~10ns window
- Coincidence
 - Upper left and right
 - Lower left and right
 - Pick only valid combinations for muons $<30^\circ$ from zenith?
 - Pick out 100ns window for event-builder
- Output separate stream of barrel ECAL data only



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What's needed

- Simulation – Now
 - Develop ECAL seeded tracking
 - Determine required area for upstream and downstream muon taggers
 - Assume they are just outside the yoke
 - Calculate rates and spectra
 - Understand needs for connecting adjacent ECAL readout modules for triggering
- Implementation – Start thinking now, do later
 - Design/build muon tagger
 - Recycled detectors likely available
 - Extra Double Chooz modules to be sent to Fermilab soon
 - Add trigger logic to ECAL readout
 - Header to event data
 - Global trigger
 - Event Builder code

Discussion

- Concerns?
- How do we move forward?

