Trigger and Data Acquisition

Charles Young (SLAC)

U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

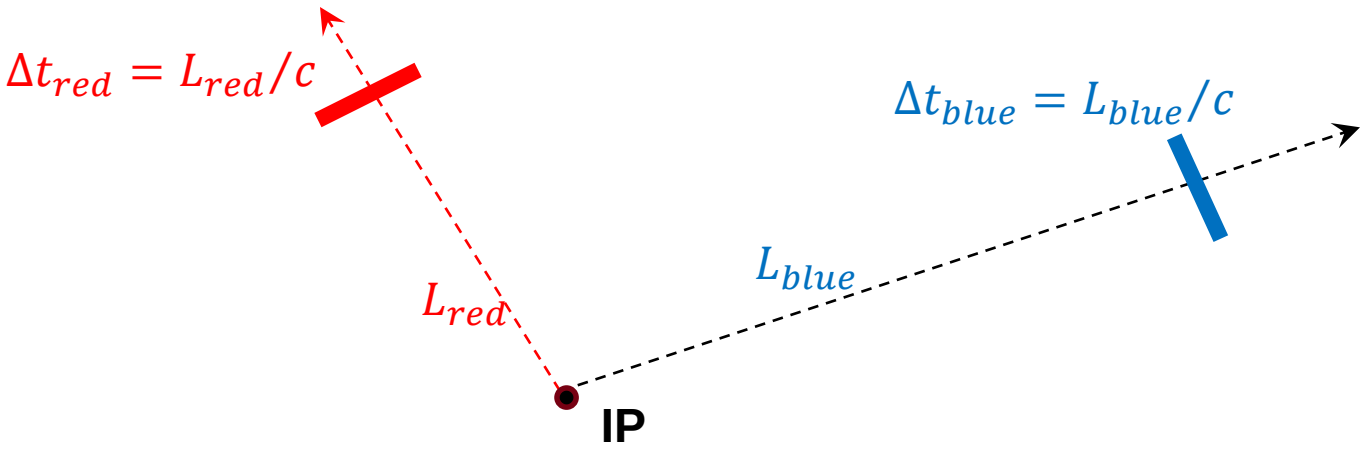
Trigger and Readout

- 3x3 array of modules to define trigger
  - Large enough to accommodate most inclined LLP track (for trigger purposes)
  - Limit on cosmic ray angle probably acceptable
  - Localized concept scalable to any MATHUSLA size and/or shape
- Readout event upon trigger
- What is an event?

What Is An Event?

Typical collider and fixed target experiments:

- ”Event” = collection of all in-time hits
- “In time” depends on distance from interaction point
  - $\Delta t = t_{hit} - t_{IP} \approx L/c$ depends only on position of sensor
  - t_{IP} given by beam signal



Event In MATHUSLA

LLP decay point plays the role of IP, but …

- Position of “IP” is not fixed – anywhere in decay volume
- Time of “IP” is not fixed – LLP time of flight
- Δt therefore not a constant
- Concept of “in time” does not exist (until reconstruction)

What is an event?

Event in MATHUSLA

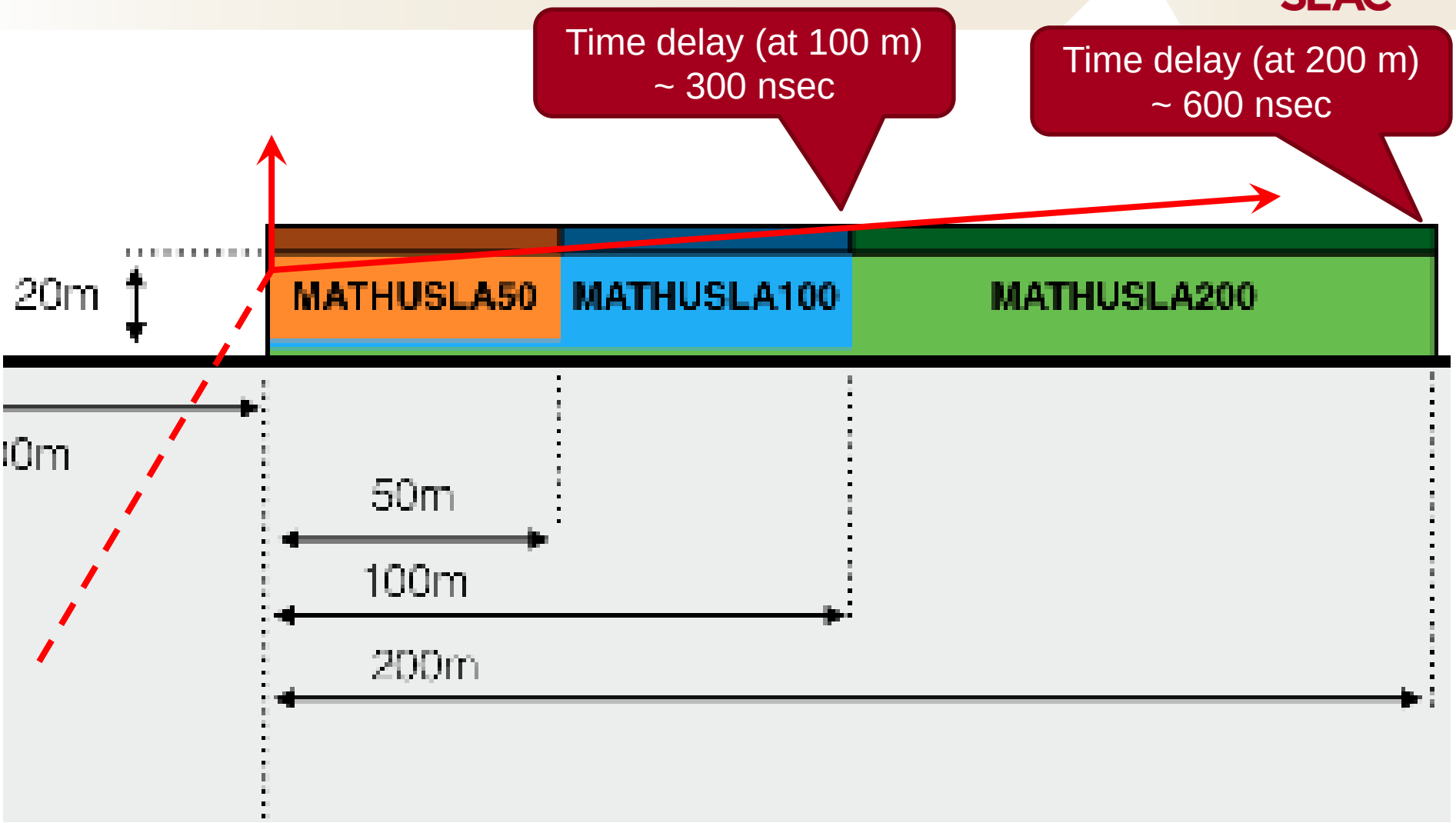
All hits within sufficiently large window relative to trigger

- Must allow for all possible topologies
- Up to O(500 nsec) depending on MATHUSLA layout and event topology

Cosmic ray rate ~2 MHz in MATHUSLA100

- Almost always within one (or more) readout windows, i.e. everything read out
- Likely to have overlapping time windows, i.e. possibility of duplicated readout

Time Window


Time delay (at 100 m)
~ 300 nsec
Time delay (at 200 m)
~ 600 nsec
20m
MATHUSLA50
MATHUSLA100
MATHUSLA200
50m
100m
200m

MATHUSLA Event

Proposal:

- Data streamed to storage continuously without selection (but with zero suppression)
- Separately for each module
- Trigger information written to storage
- Matched together in software to form events

Benefits

- Module fully tested through data acquisition before installation: logical next step in modular approach
- Highly scalable
  - Need to demonstrate for one module
    - 2 MHz / 100 = 20 KHz
    - # hits ~ # layers (tracker plus floor) + noise hits
    - Headroom for additional channels for detector upgrade
  - No choke point when more modules added
- Adaptable time window for event definition
  - Window size depends on MATHUSLA footprint, e.g. square vs rectangular, applied offline
  - No impact on trigger and DAQ

Summary

- Stream all data to disk without selection or trigger
- Every module independently
- Trigger defined using 3x3 tower of modules
- Trigger information, such time time, written out
- Events formed offline using time window.