Migrating the MC to C++

Robert Hatcher

Fermilab, Computing Division

Factorize

- Event Generation & Tracking.
  - NEUGEN (or equivalent)
  - Flux
  - Geometry
  - GEANT3 or G4?
- Active Detector Simulation

Active Detector Simulation

Purpose: Generate “fake data” digitizations that reasonably approximate the detector response.

- Other packages (e.g. GEANT, NEUGEN) perform initial physics generation, particle propagation
- Start with *hit* information: one hit per particle per active volume
  - Volume Identifier (StripEndId)
  - Location information (begin & end of segment within strip)
  - Time-of-Flight
  - Particle energy loss, identity (PDG) and momentum.
  - Connection to initial particle list
- Currently this information is in `REROOT_FLSHit`; redesign new “hit” class. Unless new information needs to be stored this means a simple translation of the same data:
  - reformat
  - coordinate transformation

Scint+Fiber

- Scintillation γ generation from energy deposition
  - spread along track segment
  - Birk's law saturation
  - wavelength dependence
- Scintillation γ transport to WLS fiber
  - scintillator clarity, optical properties (n, λ)
  - $\mathrm{TiO_2}$ reflectivity
  - strip end effects
  - coupling via glue, depth in channel
  - timing effects due to varied (non-direct) path
- WLS γ absorption & re-emission
  - capture $\epsilon(\lambda, r)$
  - re-emission $f_e(\lambda)$
  - probability of total internal reflection $f_r(r)$
  - emission time (characteristic τ)

Scint+Fiber (2)

- Transport in WLS / Clear fiber
  - attenuation $f_a(\lambda)$
  - timing delay
  - mirror (near detector), connectors efficiencies
- MUX box
  - translate to correct spot on PMT

PMT

- Photocathode
  - QE & Collection efficiency of fiber spot
  - optical cross-talk
- PMT dynode chain
  - charge gain distribution shape (statistical)
  - gain variation vs. spot position (systematic)
  - saturation (whole tube effects)
  - electronic cross-talk

Electronics

- Electronic summation (near detector)
  - PMT pixel to channel is not 1:1
- Front End electronics
  - Near Detector
    - bucket splitting (> 2 buckets depending on shaping curve)
    - thresholds
    - range changing, quantization
    - non-linearity
  - Far Detector
    - charge shaping & integration
    - dead time
    - chip-wide time stamp
- DAQ trigger processor effects

Proposed Objects

- hits
- photons (scintillation & green, including λ)
- photo-electrons
- pulses (electrical)
- digits

Proposed Stages

Each stage uses well defined input collection and generates well defined output collection (ala UNIX filter)

hit $(\Delta E, t)$	
$\downarrow$	generation, transport
scint γ's	
$\downarrow$	absorption, re-emission
WLS γ's	
$\downarrow$	transport, photo-cathode
photo-electrons	
$\downarrow$	PMT
electrical pulses	
$\downarrow$	elec summation, FEE
digitizations	
$\downarrow$	DAQ (including trigger processor farm)
raw crate readout block	

Miscellany

- Some of the enumerated effects don't change averages but do change shapes of distributions tails (in charge or time) or lead to correlations.
- Each stage must allow navigation back to input collection that may be $N : M$:
  - for example a *digit* may be composed from multiple pulses, but a pulse may be split across multiple digits
  - Nick's `Navigation` package is a good candidate for supporting this functionality
  - hits must (and currently do) indicate specific particle (or at least primary particle out of event generation)

November 01 Workshop

George will do everything

November 01 Workshop, 2

- General agreement that we could take adiabatic approach: factorized tracking vs. active simulation
- To Do:
  - Define digitization interfaces, including objects:
    - hits (Robert)
    - photons, pe’s, pulses (Andre, Mark)
  - Codify steps necessary (Robert)
  - MC Record info: equiv. to `STDHEP` (Hugh), `NeuKin+NeuVtx` (Robert)
  - Possibility of avoiding `reroot` step: ADAMO to new MC Record format?
  - Investigate coding directly to G4 (embedding in offline framework) vs. standalone (like GMINOS currently). What drives toward standalone? Conflict w/ G4 interactive use? Configuration and control?