

NE697: Introduction to Geant4

C++ Geant4 Examples

October 14th, 2021
Dr. Micah Folsom



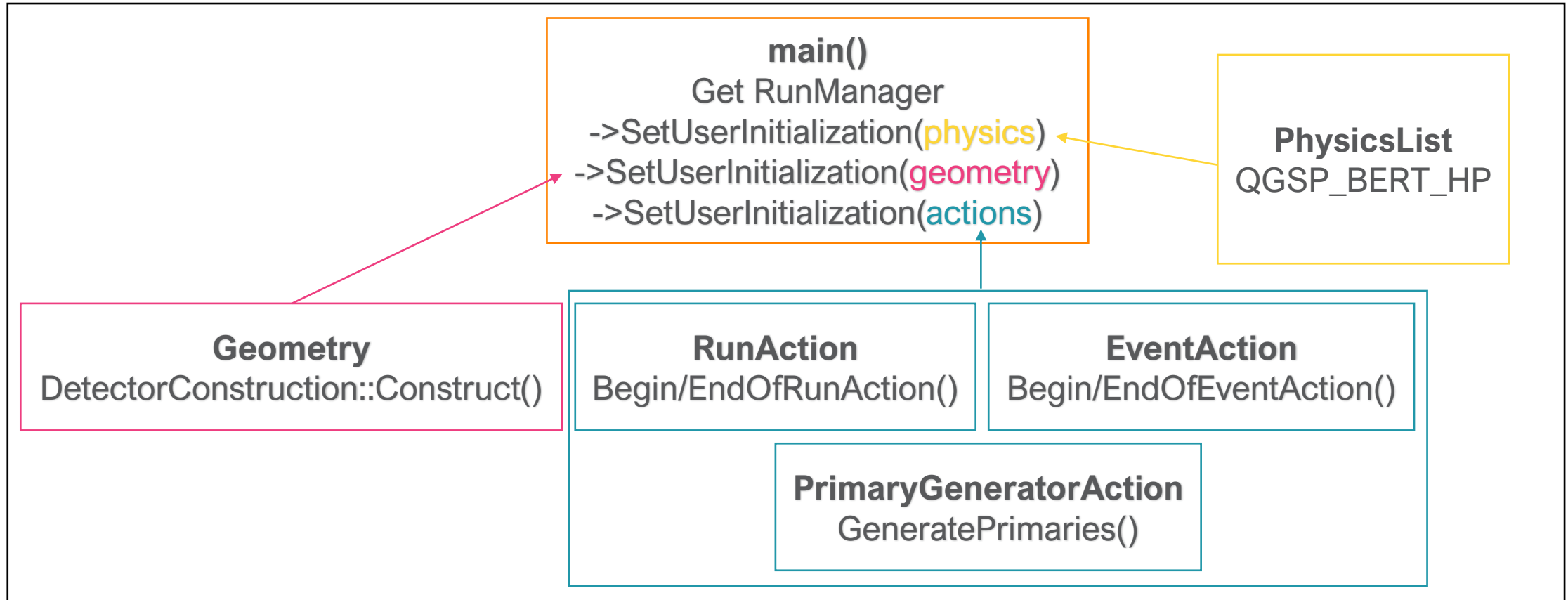
THE UNIVERSITY OF
TENNESSEE
KNOXVILLE



Today's Agenda

- Administrative items?
- Assignment 4
 - Comfortable writing and compiling C++?
- Does everyone have Geant4 running locally in some capacity?
 - Virtualbox demo?
- Geant4 examples

Geant4 Program Anatomy



Geant4 Geometry

- Capable of building very complicated geometries
 - Parameterized shapes, things with many identical elements (detector pixels)
- We're going to stick with the built-in primitives (Constructed Solid Geometry)
 - <https://geant4-userdoc.web.cern.ch/UsersGuides/ForApplicationDeveloper/html/Detector/Geometry/geomSolids.html>
- Volumes are nested like MCNP
 - Solid stainless-steel cylinder, then a “solid” air cylinder **inside** of it → air canister
 - Better than defining a hollow cylinder (think about the boundaries)

Geant4 Geometry

- Split into 3 components; build in this order
 - Shape (solid): G4Box, G4Sphere, G4Cons, etc
 - Logical (material): **G4LogicalVolume**, takes pointer to Shape
 - Physical placement (position, rotation, nesting, copying): **G4PVPlacement**, takes pointer to G4LogicalVolume
- Every geometric item must be somewhere inside the outermost volume (world, experimental hall)
 - Returned by DetectorConstruction::Construct()

Geant4 Action Classes

- These are the hooks to do things at specific points in the code
 - **RunAction:** Begin, EndOfRunAction()
 - Collect/merge all hit data from the run and write to disk/print to screen
 - **EventAction:** Begin, EndOfEventAction
 - Collect hits from the event history (generally 1 particle history)
 - **SteppingAction:** UserSteppingAction()
 - Generate hits when certain criteria are met (e.g. energy deposited > 0)
 - TrackingAction: Pre, PostUserTrackingAction()
 - StackingAction: ClassifyNewTrack()
 - **PrimaryGeneratorAction:** GeneratePrimaries()
 - Set the primary particle(s') properties (may be multiple, e.g. Cf-252)

Lab Time

- Geant4 examples
 - B1: dose calculations
 - Modify B1 to output periodic updates of the event number being processed
 - BeginOfEventAction() or EndOfEventAction()
 1. Get the G4RunManager, 2. Get the current Run object, 3. Get the total # of events
 - Create .mac files that run with 100,000 particles for these source configurations
 - Gamma, 511 keV
 - Neutron, 2 MeV
 - e-, 1 MeV
 - Change the size of the phantom objects, recompile and confirm they changed
 - Modify the geometry to use a G4Sphere instead of a G4Cons (use a similar size)

Lab Time

- Geant4 examples
 - B1: dose calculations
 - Add another component to the analysis: $eDep^3$

Lab Time

- Geant4 examples
 - B3b: PET scanner system
 - Uses a hook we haven't discussed: Stacking Action
 - Check out B3StackingAction
 - ClassifyNewTrack() triggered when a G4Track is created
 - Gives the opportunity to kill particles we don't care about (secondaries)
 - Run with 100,000 particles, and count the “Nb of good e+ annihilations”
 - Change the material to NaI instead of Lu2SiO5
 - Run again with 100,000 particles – how does it compare?
 - Check out B3bRun::RecordEvent
 - What is the energy threshold?
 - Change the source to N-13 with the /gun/particle command (see run2.mac for help) and run again with 100,000 particles