

NE697: Introduction to Geant4

Geant4: Adding Features

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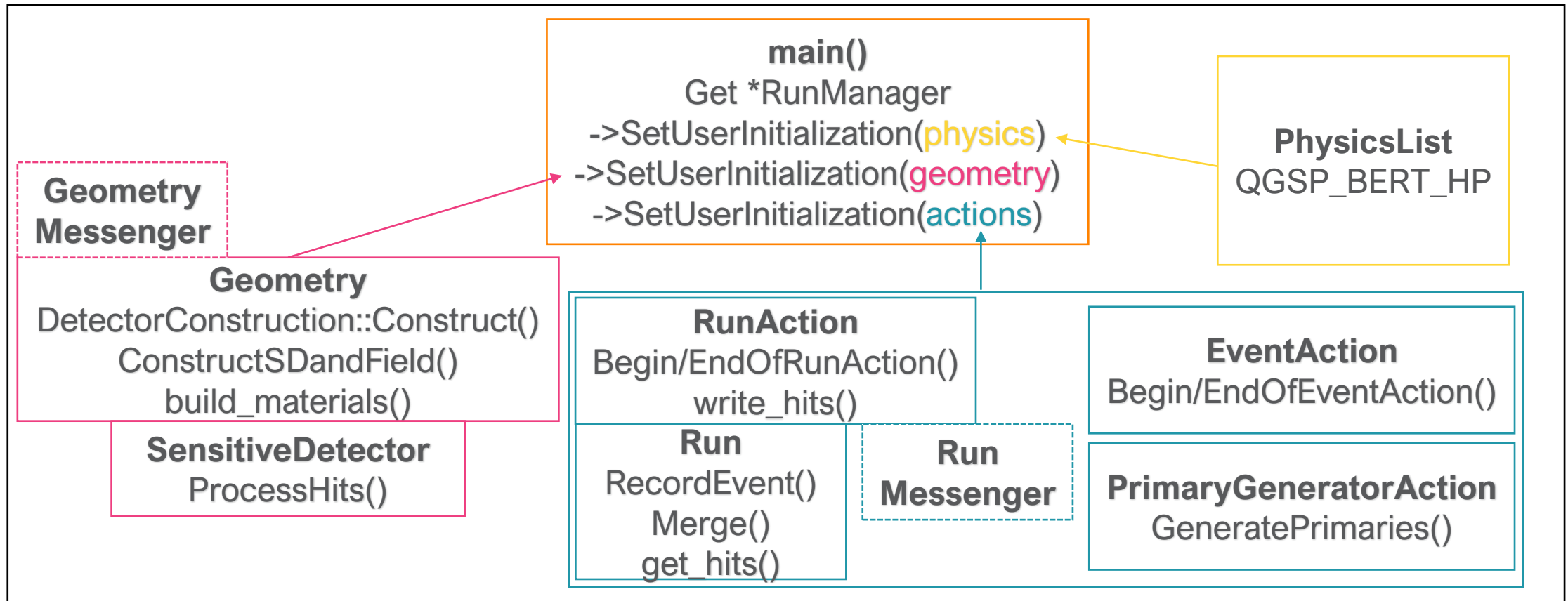
Today's Agenda

- Building our own Geant4 simulation
- Assignment 6 – Questions?
- Office hours TODAY, 8-9 PM ET
- Think about what you want to do for your final project (DUE TODAY)
 - Create a “detection scenario”: some sort of radiation bouncing around an environment
 - Ideally something relevant to your work (it's ok to simplify it a lot)
 - Record the hits and do something interesting with it
 - Imaging, different spectra, event reconstruction, dose calculation, etc
 - May use our current WIP as starting point

Final Project

- This class's final exam slot is Tuesday, Dec 7, 1:00-3:15 PM ET
- Final project will be due at this time
- Please prepare a 5-minute presentation outlining your work and showing some results
- So far, proposals sound reasonable

Geant4 Program Anatomy



Geant4: NE697 Version

- Minimum working example using best practices
- [DEMO]
 - Build system & directory structure - DONE
 - main() - DONE
 - DetectorConstruction - world created
 - Physics - DONE
 - PrimaryGeneratorAction – DONE
 - ActionInitialization - DONE
 - EventAction – DONE
 - RunAction – DONE

Geant4: NE697 Version

- Next steps...
- [DEMO]
 - Run object – DONE
 - Hit - DONE
 - HitTracker (SensitiveDetector) – need to connect in DetectorConstruction - DONE
 - File IO in RunAction → .csv (inefficient, but simple!) – write_hits() - DONE
- [DEMO]
 - Custom material definitions (build_materials())
 - Messengers (custom UI commands)

Geant4: Materials

- As we've seen, we can get many things from the G4NistManager
- <https://geant4-userdoc.web.cern.ch/UsersGuides/ForApplicationDeveloper/html/Appendix/materialNames.html>
- We can also build up G4Materials manually
 - G4Isotope(Z, A, molar mass)
 - G4Element(G4Isotopes, mass or number fractions)
 - G4Material(G4Elements, density, number fractions)
- /material/nist/printElement
- /material/nist/listMaterials

Geant4: Materials

- [DEMO]
 - Adding a new material (liquid oxygen)
 - Building it manually
 - Asking G4NistManager for a pre-built (preferred)
 - Asking G4NistManager for our “NE697_LIQUID_OXYGEN” material (there’s a global table)

Geant4: UI Commands

- We can define custom commands (e.g. /gun/particle)
- Grouped into *messenger* classes, attached to a target
 - RunMessenger, GeometryMessenger, MaterialMessenger, etc
 - Typically, each messenger gets its own directory (/run/, /geometry/, /material/)
- For each command, define the interface
 - Command path
 - Guidance (help string)
 - What does the command take as args? 1 double? 3 doubles with units?
 - Parameter name(s), omittable (will use the default if not provided)
 - Range (number) or list of valid options (string)
 - Default value
 - Units, if applicable
 - What state can this command be executed in? Usually: PreInit and Idle

Geant4: UI Commands

- Start with the command directory: G4Uldirectory
- Pre-baked commands:
 - G4UlcmdWithoutParameter
 - G4UlcmdWithAString
 - G4UlcmdWithABool
 - G4UlcmdWithAnInteger
 - G4UlcmdWithADouble, G4UlcmdWithADoubleAndUnit
 - G4UlcmdWith3Vector, G4UlcmdWith3VectorAndUnit
- We can define our own, of course!

Geant4: UI Messengers

- Pick a target (e.g. RunAction; be mindful of multithreading)
- Inherit from G4UImessenger and implement the following:
 - **Constructor**: define/instantiate commands and parameters
 - **Destructor**: clean up the memory (**we** have to do this!)
 - **SetNewValue**(G4Ulcommand*, G4String)
 - Check which command was issued, then do our thing
 - Geant4 will parse the G4String for us (GetNewDoubleValue, GetNew3VectorValue, GetNewBoolValue, etc)
 - **GetCurrentValue**(G4Ulcommand*)
 - Check which command was issued, and print the current value
 - Usually involves asking the *target* about its current state (file path? Saving data?)

Geant4: UI Commands

- What if we want to be able to change the file path and toggle saving data?
- [DEMO]
 - RunMessenger
 - Attached to RunAction, which controls the file IO
 - /ne697/run/path, /ne697/run/save_data
 - Takes a string path to a .csv file | Takes a boolean value (true/false)
 - GeometryMessenger
 - Attached to DetectorConstruction, which controls the geometry
 - /ne697/geometry/det_size
 - Takes a “3VectorAndUnit” (G4ThreeVector, with units specified)