NE697: Introduction to Geant4

C++ Geant4 Intro

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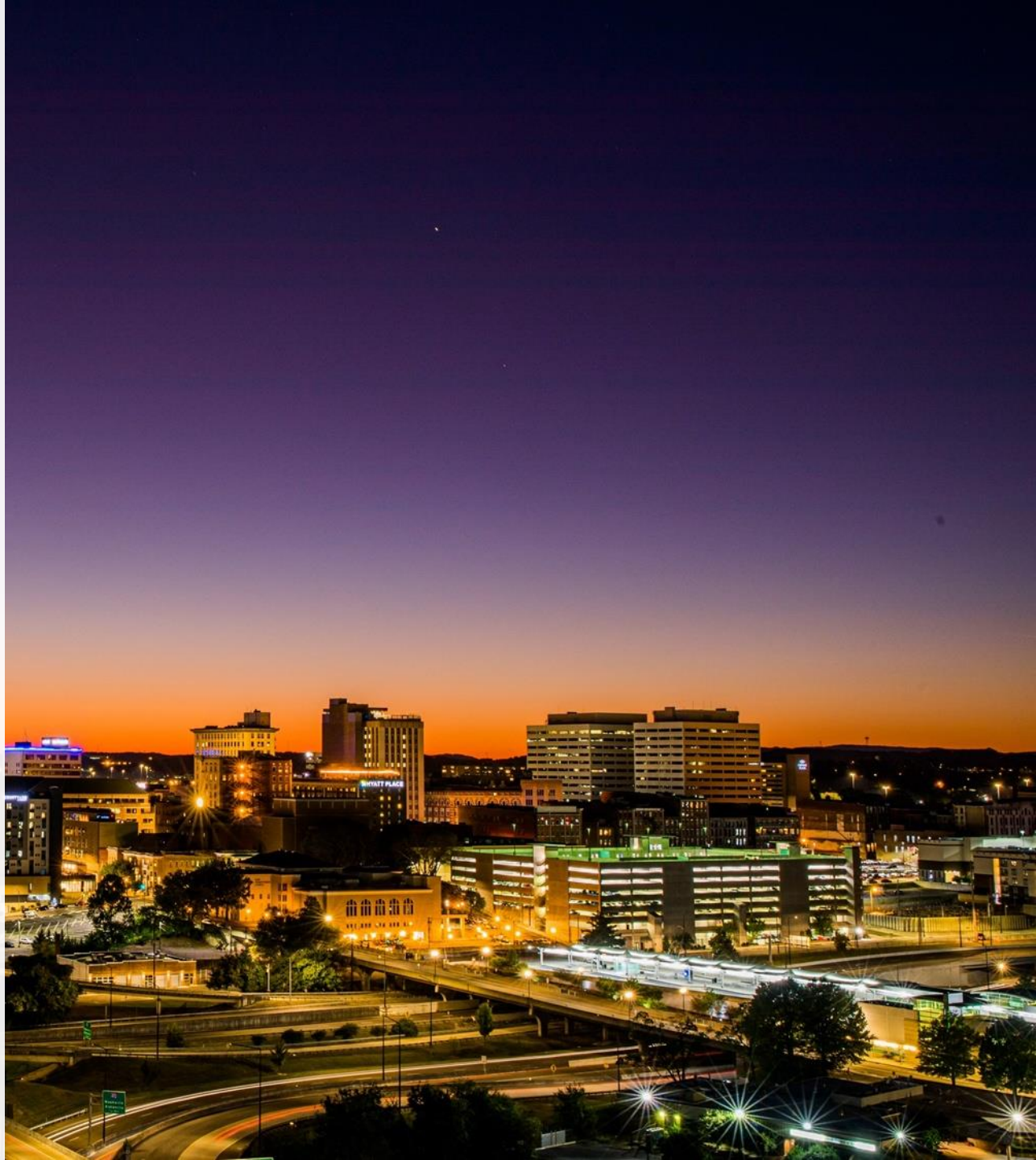

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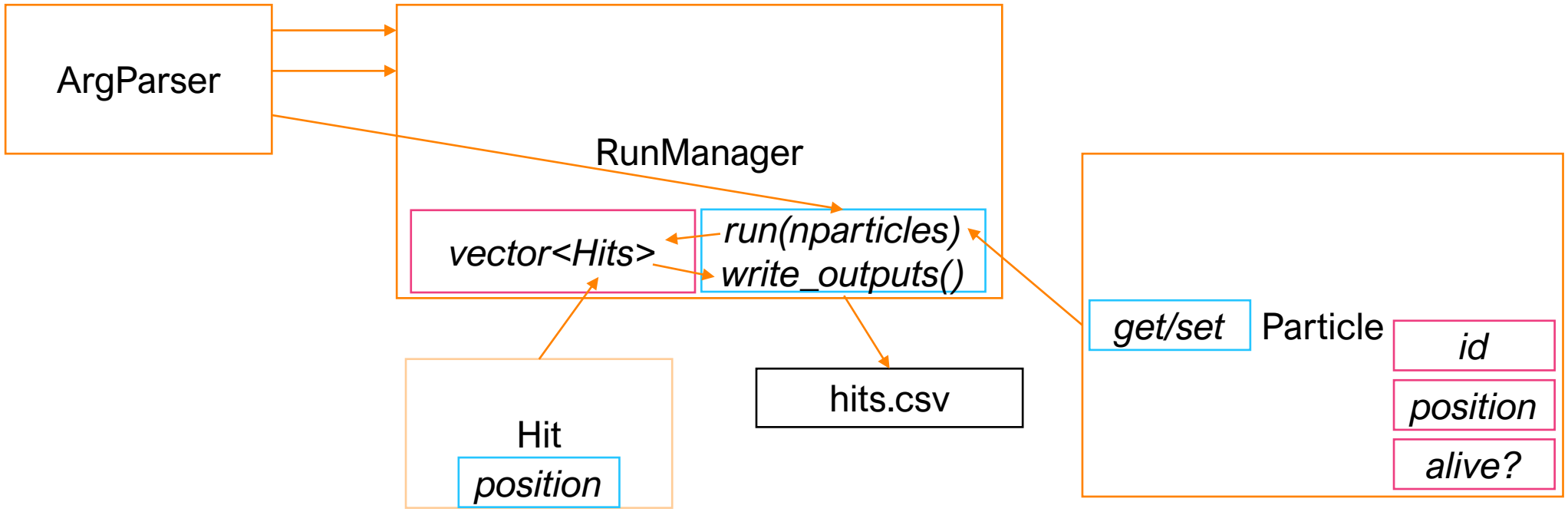
Today's Agenda

- Administrative items?
- Assignment 3 solution
- Do we need more C++ practice?
- exampleB1 detailed breakdown

Assignment 3



C++ to Revisit

- Is there anything you want me to cover again?
- More demos or just more practice?
  - Maybe more assignments, then we spend some chunk of class time working and discussing? So kind of like a lab class…
- Debugging demo session – common errors/issues that people encountered?

Assignment 4

- Expand MC1D
  - New interaction: “scattering”, skip 1 unit
  - 5 command-line args instead of 3
    - Scatter probability (skip one unit)
    - Start position on the track
  - Isotropic source – particles can go either direction (50/50)
  - Update .csv to contain type of interaction (“a”, “s”)

- …or something else? A different program? A few smaller programs?

Geant4 Resources

- Application Developer's Guide
  - https://geant4-userdoc.web.cern.ch/UsersGuides/ForApplicationDeveloper/html/index.html
  - **Read this!!!**
- Doxygen documentation (source code browsing)
  - https://geant4.kek.jp/Reference/
- Examples
  - https://geant4-userdoc.web.cern.ch/Doxygen/examples_doc/html/index.html

Geant4 Example B1

- [DEMO]
  - Code and slides side-by-side breakdown

Geant4: RunManager

- G4RunManager (G4MTRunManager)
- Initialize() (/run/initialize)
- Remember run() from our MC1D assignment?
  - BeamOn() (/run/beamOn)
- SetUserAction() is deprecated
- SetUserInitialization() -> ActionInitialization

Public Member Functions

	G4RunManager ()
virtual	~G4RunManager ()
virtual void	BeamOn (G4int n_event, const char *macroFile=0, G4int n_select=-1)
virtual void	Initialize ()
virtual void	DefineWorldVolume (G4VPhysicalVolume *worldVol, G4bool topologyIsChanged=true)
virtual void	AbortRun (G4bool softAbort=false)
virtual void	AbortEvent ()
virtual void	InitializeGeometry ()
virtual void	InitializePhysics ()
virtual G4bool	ConfirmBeamOnCondition ()
virtual void	RunInitialization ()
virtual void	DoEventLoop (G4int n_event, const char *macroFile=0, G4int n_select=-1)
virtual void	RunTermination ()
virtual void	InitializeEventLoop (G4int n_event, const char *macroFile=0, G4int n_select=-1)
virtual void	ProcessOneEvent (G4int i_event)
virtual void	TerminateOneEvent ()
virtual void	TerminateEventLoop ()
virtual G4Event *	GenerateEvent (G4int i_event)
virtual void	AnalyzeEvent (G4Event *anEvent)
void	DumpRegion (const G4String &rname) const
void	DumpRegion (G4Region *region=0) const
virtual void	rndmSaveThisRun ()
virtual void	rndmSaveThisEvent ()
virtual void	RestoreRandomNumberStatus (const G4String &fileN)
void	SetUserInitialization (G4VUserDetectorConstruction *userInit)
void	SetUserInitialization (G4VUserPhysicsList *userInit)
void	SetUserAction (G4UserRunAction *userAction)
void	SetUserAction (G4VUserPrimaryGeneratorAction *userAction)
void	SetUserAction (G4UserEventAction *userAction)
void	SetUserAction (G4UserStackingAction *userAction)
void	SetUserAction (G4UserTrackingAction *userAction)
void	SetUserAction (G4UserSteppingAction *userAction)
const G4VUserDetectorConstruction *	GetUserDetectorConstruction () const
const G4VUserPhysicsList *	GetUserPhysicsList () const
const G4UserRunAction *	GetUserRunAction () const
const G4VUserPrimaryGeneratorAction *	GetUserPrimaryGeneratorAction () const
const G4UserEventAction *	GetUserEventAction () const
const G4UserStackingAction *	GetUserStackingAction () const
const G4UserTrackingAction *	GetUserTrackingAction () const
const G4UserSteppingAction *	GetUserSteppingAction () const
void	SetNumberOfAdditionalWaitingStacks (G4int iAdd)
const G4String &	GetVersionString () const
void	SetPrimaryTransformer (G4PrimaryTransformer *pt)
void	StoreRandomNumberStatusToG4Event (G4int vl)
G4int	GetFlagRandomNumberStatusToG4Event () const
void	SetRandomNumberStore (G4bool flag)
G4bool	GetRandomNumberStore () const
void	SetRandomNumberStoreDir (const G4String &dir)
const G4String &	GetRandomNumberStoreDir () const
const G4String &	GetRandomNumberStatusForThisRun () const
const G4String &	GetRandomNumberStatusForThisEvent () const
void	GeometryHasBeenModified ()
void	PhysicsHasBeenModified ()
void	CutOffHasBeenModified ()
void	ReOptimizeMotherOf (G4VPhysicalVolume *)
void	ReOptimize (G4LogicalVolume *)
void	SetVerboseLevel (G4int vl)
G4int	GetVerboseLevel () const
void	SetGeometryToBeOptimized (G4bool vl)
G4bool	GetGeometryToBeOptimized ()
void	SetNumberOfEventsToBeStored (G4int val)
const G4Run *	GetCurrentRun () const
const G4Event *	GetCurrentEvent () const
const G4Event *	GetPreviousEvent (G4int i) const
void	SetRunIDCounter (G4int i)
G4int	GetNumberOfParallelWorld () const
void	SetNumberOfEventsToBeProcessed (G4int val)
void	SetDCtable (G4DCtable *DCtbl)
void	ConstructScoringWorlds ()

Geant4: ActionInitialization

Public Member Functions

	G4VUserActionInitialization ()
virtual	**~G4VUserActionInitialization ()**
virtual void	**Build () const =0**
virtual void	**BuildForMaster () const**
virtual G4VSteppingVerbose *	**InitializeSteppingVerbose () const**

- Used for “registering” user-defined action classes with Geant4
  - Register: give Geant4 a pointer to an instance of the object
    - Using inheritance; Geant4 keeps a **G4VUserActionInitialization***
- Build() is called by each thread
- BuildForMaster() is called by the master thread (often just RunAction)

Geant4: RunAction

- Used for Run management
- Functions called at the start and stop of a Run
- Allows us to provide a custom Run object (inherits from G4Run)
- Note “const G4Run*”: cannot change Run objects in these functions!
  - Reminder, same as G4Run const*
- We’ll revisit the Run objects later

Public Member Functions

	G4UserRunAction ()
virtual	**~G4UserRunAction** ()
virtual **G4Run** *	**GenerateRun** ()
virtual void	**BeginOfRunAction** (const **G4Run** *aRun)
virtual void	**EndOfRunAction** (const **G4Run** *aRun)
virtual void	**SetMaster** (**G4bool** val=true)
G4bool	**IsMaster** () const

Protected Attributes

G4bool	**isMaster**

Geant4: EventAction

- Used for Event management
- Functions called at the start and stop of an Event
- Often used for printing periodic updates (event number)
- EndOfEventAction() historically used for getting Event hit information (now done in Run::RecordEvent())

Public Member Functions

	G4UserEventAction ()
virtual	**~G4UserEventAction** ()
virtual void	**SetEventManager** (**G4EventManager** *value)
virtual void	**BeginOfEventAction** (const **G4Event** *anEvent)
virtual void	**EndOfEventAction** (const **G4Event** *anEvent)

Geant4: PrimaryGeneratorAction

- Sets the primary particle properties for the G4Event
  - Which, how many, position, direction, energy, etc
- GeneratePrimaries() is usually a pass-through to a particle gun's GeneratePrimaryVertex()
- G4GeneralParticleSource (GPS) built-in option

Public Member Functions

	G4VUserPrimaryGeneratorAction ()
virtual	**~G4VUserPrimaryGeneratorAction** ()
virtual void	**GeneratePrimaries** (**G4Event** *anEvent)=0

Geant4: DetectorConstruction

Public Member Functions

	G4VUserDetectorConstruction ()
virtual	~G4VUserDetectorConstruction ()
virtual G4VPhysicalVolume *	Construct ()=0
virtual void	ConstructSDandField ()
virtual void	CloneSD ()
virtual void	CloneF ()
void	RegisterParallelWorld (G4VUserParallelWorld *)
G4int	ConstructParallelGeometries ()
void	ConstructParallelSD ()
G4int	GetNumberOfParallelWorld () const
G4VUserParallelWorld *	GetParallelWorld (G4int i) const

- Interface for providing geometry to Geant4
- Also handles SensitiveDetectors (more on this later)
- Parallel geometries (I've never used these)
- Construct() returns your top level simulation physical volume ("world")

Geant4: Physics Lists

- We can define what physics we want, how we want
- We usually want to use the physics we all know* and love
- Most people 1) copy from a similar example and then modify or 2) use a built-in
- Completely dependent on details of the use case

Public Member Functions

	G4VUserPhysicsList ()
virtual	~G4VUserPhysicsList ()
	G4VUserPhysicsList (const G4VUserPhysicsList &)
G4VUserPhysicsList &	operator= (const G4VUserPhysicsList &)
virtual void	ConstructParticle ()=0
void	Construct ()
virtual void	ConstructProcess ()=0
void	UseCoupledTransportation (G4bool vl=true)
virtual void	SetCuts ()
void	SetDefaultCutValue (G4double newCutValue)
G4double	GetDefaultCutValue () const
void	BuildPhysicsTable ()
void	PreparePhysicsTable (G4ParticleDefinition *)
void	BuildPhysicsTable (G4ParticleDefinition *)
G4bool	StorePhysicsTable (const G4String &directory=".")
G4bool	IsPhysicsTableRetrieved () const
G4bool	IsStoredInAscii () const
const G4String &	GetPhysicsTableDirectory () const
void	SetPhysicsTableRetrieved (const G4String &directory="")
void	SetStoredInAscii ()
void	ResetPhysicsTableRetrieved ()
void	ResetStoredInAscii ()
void	DumpList () const
void	DumpCutValuesTable (G4int flag=1)
void	DumpCutValuesTableIfRequested ()
void	SetVerboseLevel (G4int value)
G4int	GetVerboseLevel () const
void	SetCutsWithDefault ()
void	SetCutValue (G4double aCut, const G4String &pname)
G4double	GetCutValue (const G4String &pname) const
void	SetCutValue (G4double aCut, const G4String &pname, const G4String &rname)
void	SetParticleCuts (G4double cut, G4ParticleDefinition *particle, G4Region *region=0)
void	SetParticleCuts (G4double cut, const G4String &particleName, G4Region *region=0)
void	SetCutsForRegion (G4double aCut, const G4String &rname)
void	ResetCuts ()
void	SetApplyCuts (G4bool value, const G4String &name)
G4bool	GetApplyCuts (const G4String &name) const
void	RemoveProcessManager ()
void	AddProcessManager (G4ParticleDefinition *newParticle, G4ProcessManager *newManager=0)
void	CheckParticleList ()
void	DisableCheckParticleList ()
G4int	GetInstanceID () const
virtual void	InitializeWorker ()
virtual void	TerminateWorker ()

Assignment 4

- Questions, discussion, time to get started?