MC update to Geant4-v.11

Simulation meeting

Melba D'Astolfo, 28/04/2025

CYGNO'S

MONTE CARLO

GEANT4
A SIMULATION TOOLKIT

CADMesh

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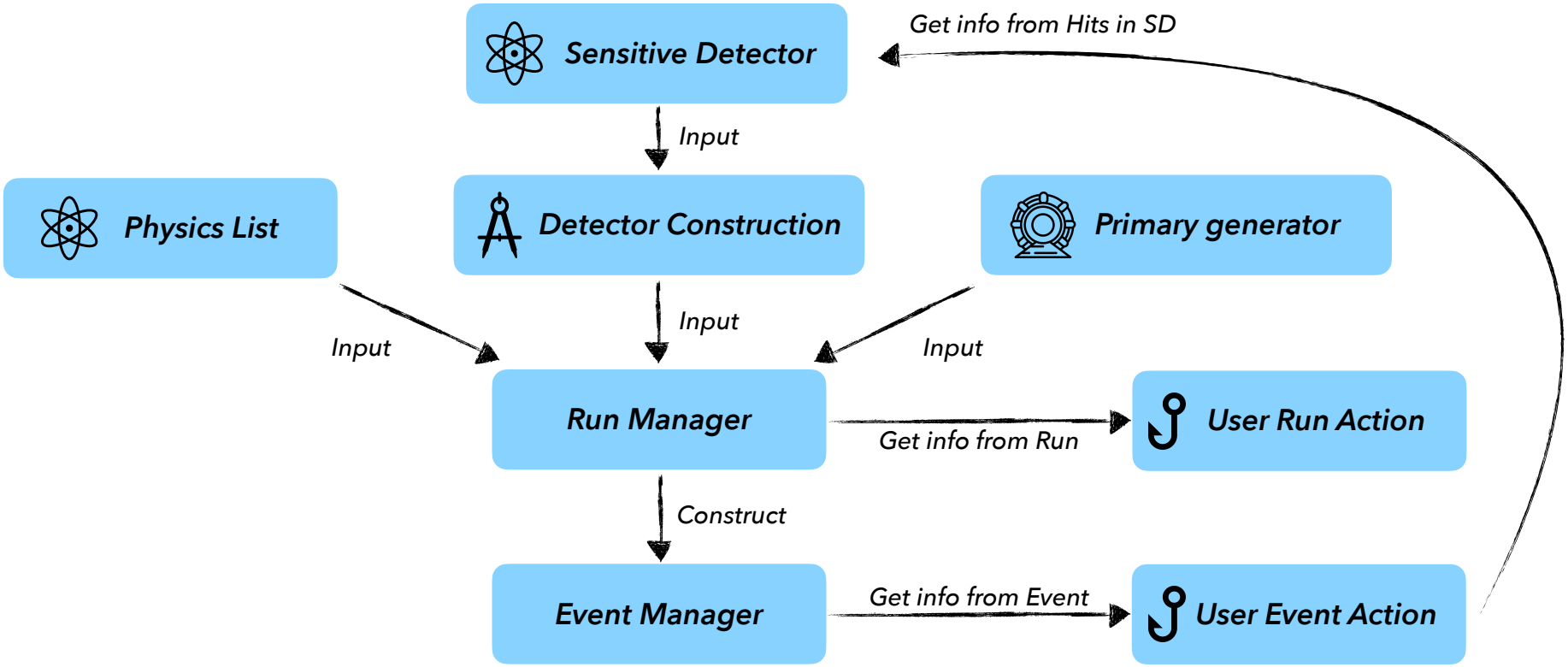
Sensitive Detector
Get info from Hits in SD
Input
Physics List
Detector Construction
Primary generator
Input
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Run Manager
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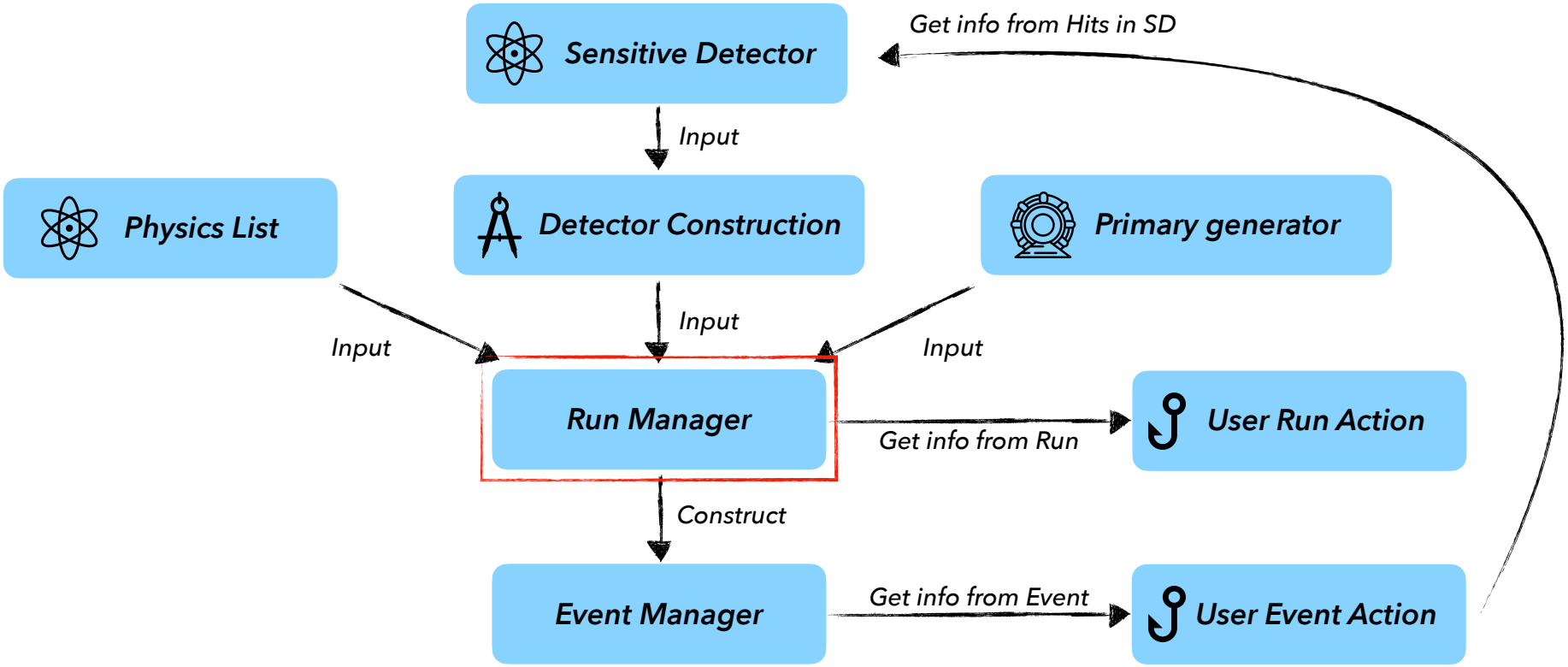
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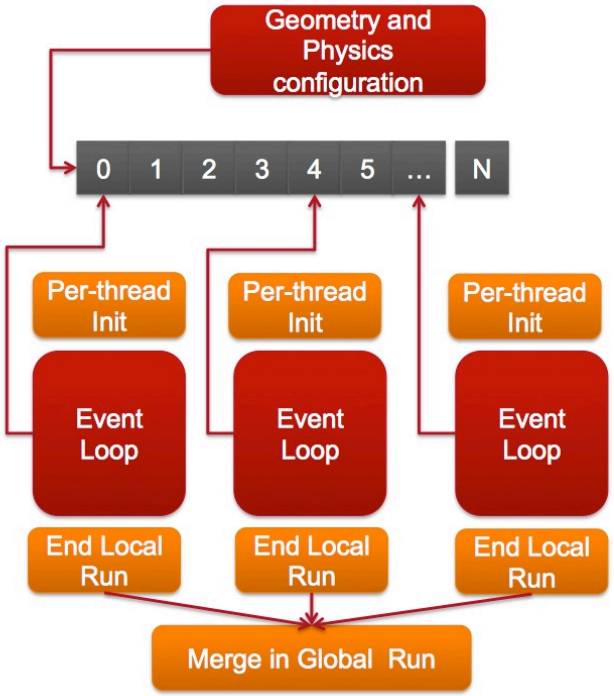
CYGNO.cc

```
// Run manager
G4MTRunManager* runManager = new G4MTRunManager;
runManager->SetNumberOfThreads(G4Threading::G4GetNumberOfCores());
```

+

CYGNOActionInitialization.cc

```
void CYGNOActionInitialization::BuildForMaster() const
{
  CYGNORunAction* run_action = new CYGNORunAction(event_action, fDetector);
  SetUserAction(run_action);
}
```

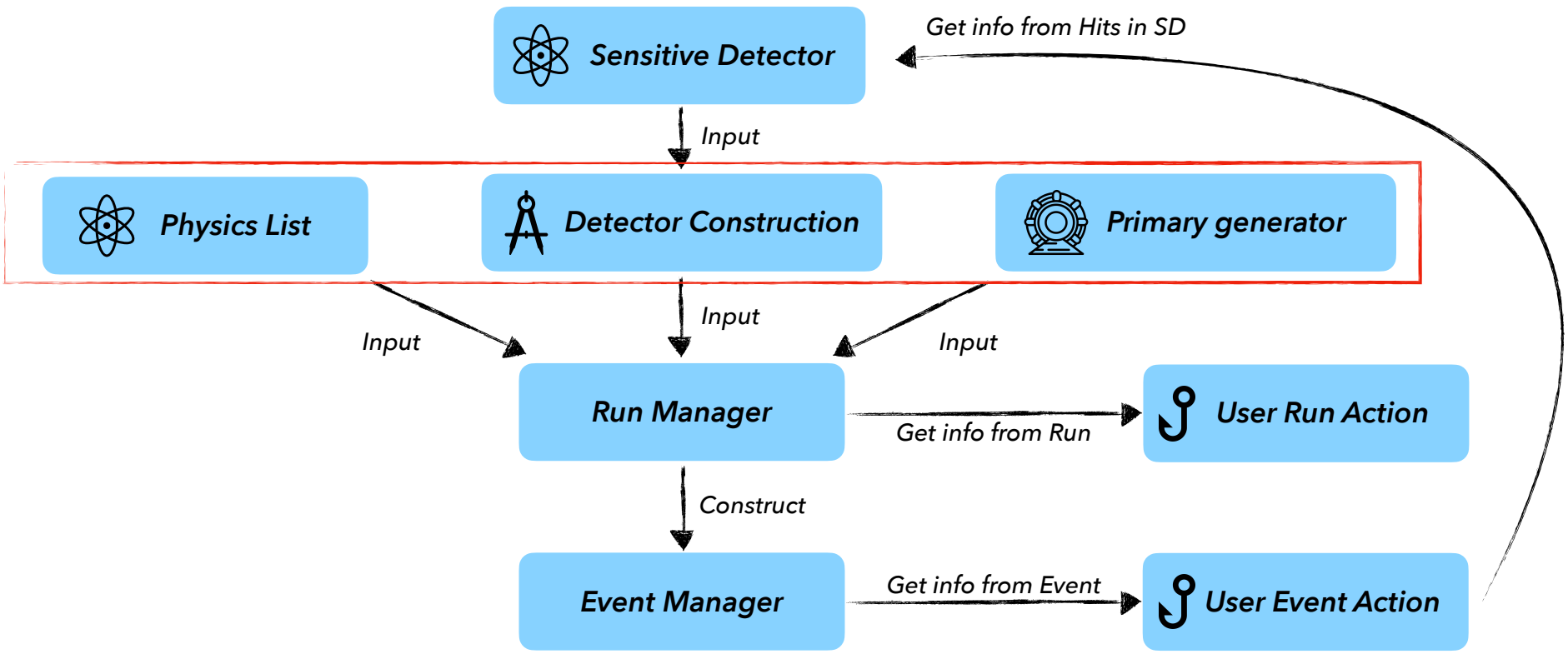


Per-event seeds pre-prepared in a "queue"

Threads compete for next event to be processes (new in ref-08)

Command line scoring and G4tools automatically merge results from threads

MUCH FASTER!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```
// Em options
G4EmProcessOptions emOptions;
emOptions.SetBuildCSDARange(true); //not really fundamental
emOptions.SetDEDXBinningForCSDARange(10*10); //not really fundamental
emOptions.SetFluo(true);
emOptions.SetAuger(true);
emOptions.SetPIXE(true);
```

BEFORE

```
// Em options
G4EmParameters* emParameters = G4EmParameters::Instance();
emParameters->SetFluo(true);
emParameters->SetPixe(true);
emParameters->SetAuger(true);
```

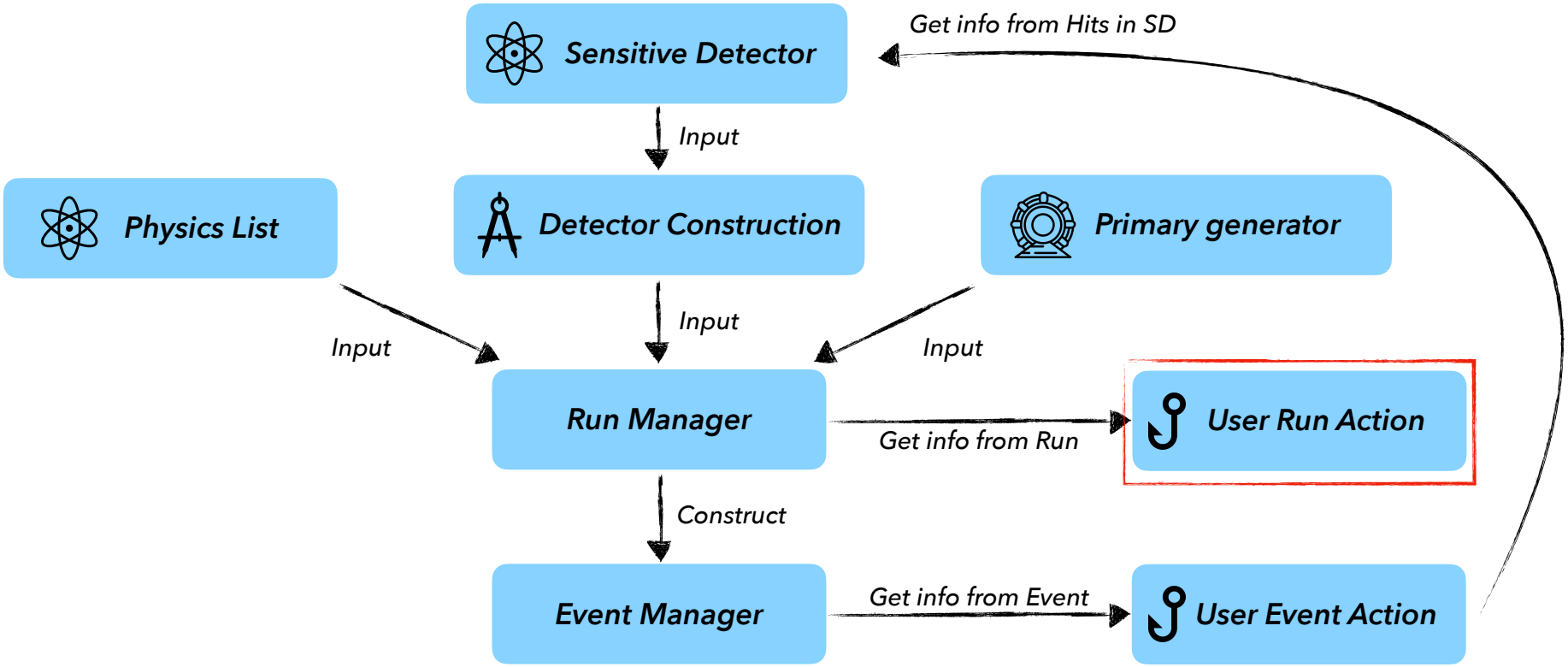
AFTER

CYGNODetectorConstruction.cc

```
void CYGNODetectorConstruction::ConstructSDandField()
{
  //
  // Sensitive detectors
  //
  auto cygnoSD
    = new CYGNOSensitiveDetector("cygnoSD");
  G4SDManager::GetSDMpointer()->AddNewDetector(cygnoSD);
  SetSensitiveDetector("CYGNO_log",cygnoSD);

}
```

```
void CYGNOPrimaryGeneratorAction::GeneratePrimaries(G4Event* anEvent)
{
  // Generate primary vertex
  particleGun->GeneratePrimaryVertex(anEvent);

  if (fFillNtuple) {
    energy_pri = 0.;

    // Access particle energy
    energy_pri = particleGun->GetParticleEnergy();

    // Access particle position
    G4ThreeVector particlePosition = particleGun->GetParticlePosition();

    //Fill ntuple #1
    G4AnalysisManager* man = G4AnalysisManager::Instance();
    man->FillNtupleDColumn(1,0,energy_pri);
    man->FillNtupleDColumn(1,1,particlePosition[0]);
    man->FillNtupleDColumn(1,2,particlePosition[1]);
    man->FillNtupleDColumn(1,3,particlePosition[2]);
    man->AddNtupleRow(1);
  }
}
```

STORE PRIMARY PARTICLES INFO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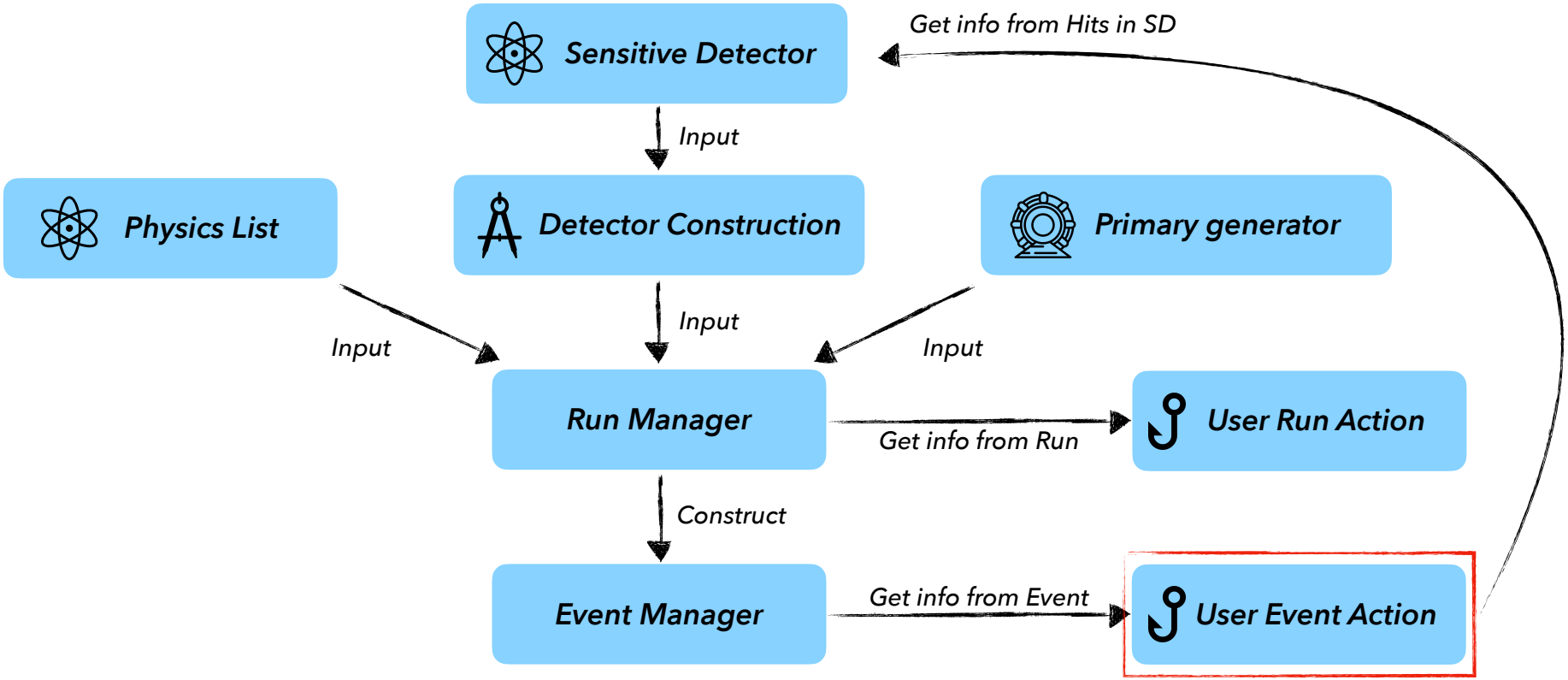
```
void CYGNORunAction::Book()
{
  // Get/create analysis manager
  G4AnalysisManager* man = G4AnalysisManager::Instance();
  man->SetDefaultFileType("root");

  man->SetNtupleMerging(true);

  man->SetFirstNtupleId(1);


  // ---- primary ntuple ------
  // id==1
  man->CreateNtuple("tree1", "Particle Source Info");
  man->CreateNtupleDColumn("Energy");
  man->CreateNtupleDColumn("xpos_vertex");
  man->CreateNtupleDColumn("ypos_vertex");
  man->CreateNtupleDColumn("zpos_vertex");
  man->FinishNtuple();

  // ---- secondary ntuple ------
  //id==2
  man->CreateNtuple("nTuple", "Hits Info");
  man->CreateNtupleIColumn("eventnumber");
  man->CreateNtupleIColumn("numhits");
  man->CreateNtupleDColumn("ekin_particle");
  man->CreateNtupleIColumn("particle_type");
  man->CreateNtupleDColumn("energyDep");
  man->CreateNtupleDColumn("energyDep_NR");
  man->CreateNtupleIColumn("pdgID_hits", fEventAction -> Get_pdgID_hits());
  man->CreateNtupleDColumn("tracklen_hits", fEventAction -> Get_tracklen_hits());
  man->CreateNtupleDColumn("px_particle", fEventAction -> Get_px_particle());
  man->CreateNtupleDColumn("py_particle", fEventAction -> Get_py_particle());
  man->CreateNtupleDColumn("pz_particle", fEventAction -> Get_pz_particle());
  man->CreateNtupleDColumn("energyDep_hits", fEventAction -> Get_energyDep_hits());
  man->CreateNtupleDColumn("energyDep_ion_hits", fEventAction -> Get_energyDep_ion_hits());
  man->CreateNtupleDColumn("x_hits", fEventAction -> Get_x_hits());
  man->CreateNtupleDColumn("y_hits", fEventAction -> Get_y_hits());
  man->CreateNtupleDColumn("z_hits", fEventAction -> Get_z_hits());
  man->FinishNtuple();

  // Open an output file
  man->OpenFile(FileName);

  return;
}
```

ADD A FUNCTION TO CREATE NTUPLES TO STORE DATA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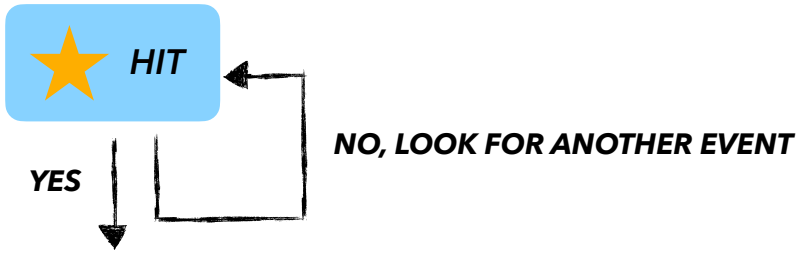


```
if (CYGNO_hits > 0) {

      man->FillNtupleIColumn(2,0,event_id);
      man->FillNtupleIColumn(2,1,CYGNO_hits);
      man->FillNtupleDColumn(2,2,(*CYGNOHC)[0]->GetKineticEne());
      man->FillNtupleIColumn(2,3,(*CYGNOHC)[0]->GetParticleID());
      G4cout << "firstParticleE =" << (*CYGNOHC)[0]->GetKineticEne() << "keV" << G4endl;

      for (G4int i=0; i<CYGNO_hits; i++) {

        hitEnergy         = (*CYGNOHC)[i]->GetEdep();
        hitEnergy_ion     = (*CYGNOHC)[i]->GetEdep_ion();
        totEnergy        += hitEnergy;

        v_pdgID_hits.push_back((*CYGNOHC)[i]->GetParticleID());
        v_tracklen_hits.push_back((*CYGNOHC)[i]->GetLength());
        v_px_particle.push_back((*CYGNOHC)[i]->GetMom().x());
        v_py_particle.push_back((*CYGNOHC)[i]->GetMom().y());
        v_pz_particle.push_back((*CYGNOHC)[i]->GetMom().z());
        v_energyDep_hits.push_back(hitEnergy);
        v_energyDep_ion_hits.push_back(hitEnergy_ion);
        v_x_hits.push_back((*CYGNOHC)[i]->GetPos().x());
        v_y_hits.push_back((*CYGNOHC)[i]->GetPos().y());
        v_z_hits.push_back((*CYGNOHC)[i]->GetPos().z());

        if ((int)(*CYGNOHC)[i]->GetParticleID()>1000000000){
          totEnergyNR += hitEnergy;
        }
      }
      man->FillNtupleDColumn(2,4,totEnergy);
      man->FillNtupleDColumn(2,5,totEnergyNR);
      man->AddNtupleRow(2);
    }
```

FILL NTUPLES WITH DATA

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```
char namestl[50];
sprintf(namestl,"%s/LIMEbody-ShortCone.stl",CYGNOGeomPath.c_str());
G4cout << namestl << G4endl;
ifstream infile(CYGNOGeomPath.c_str());
if (infile.good())
    mesh_LIMEDetectorBody = new CADMesh(namestl);
sprintf(namestl,"%s/LIMEinternalStructure.stl",CYGNOGeomPath.c_str());
G4cout << namestl << G4endl;
```

BEFORE

NO NEED TO INSTALL CADMESH ANYMORE!

```
char namestl[70];

    snprintf(namestl, sizeof(namestl), "%s/LIMEbody-ShortCone.stl", CYGNOGeomPath.c_str());
    G4cout << namestl << G4endl;
    ifstream infile(CYGNOGeomPath.c_str());
    if (infile.good())
      mesh_LIMEDetectorBody = CADMesh::TessellatedMesh::FromSTL(namestl);
```

AFTER