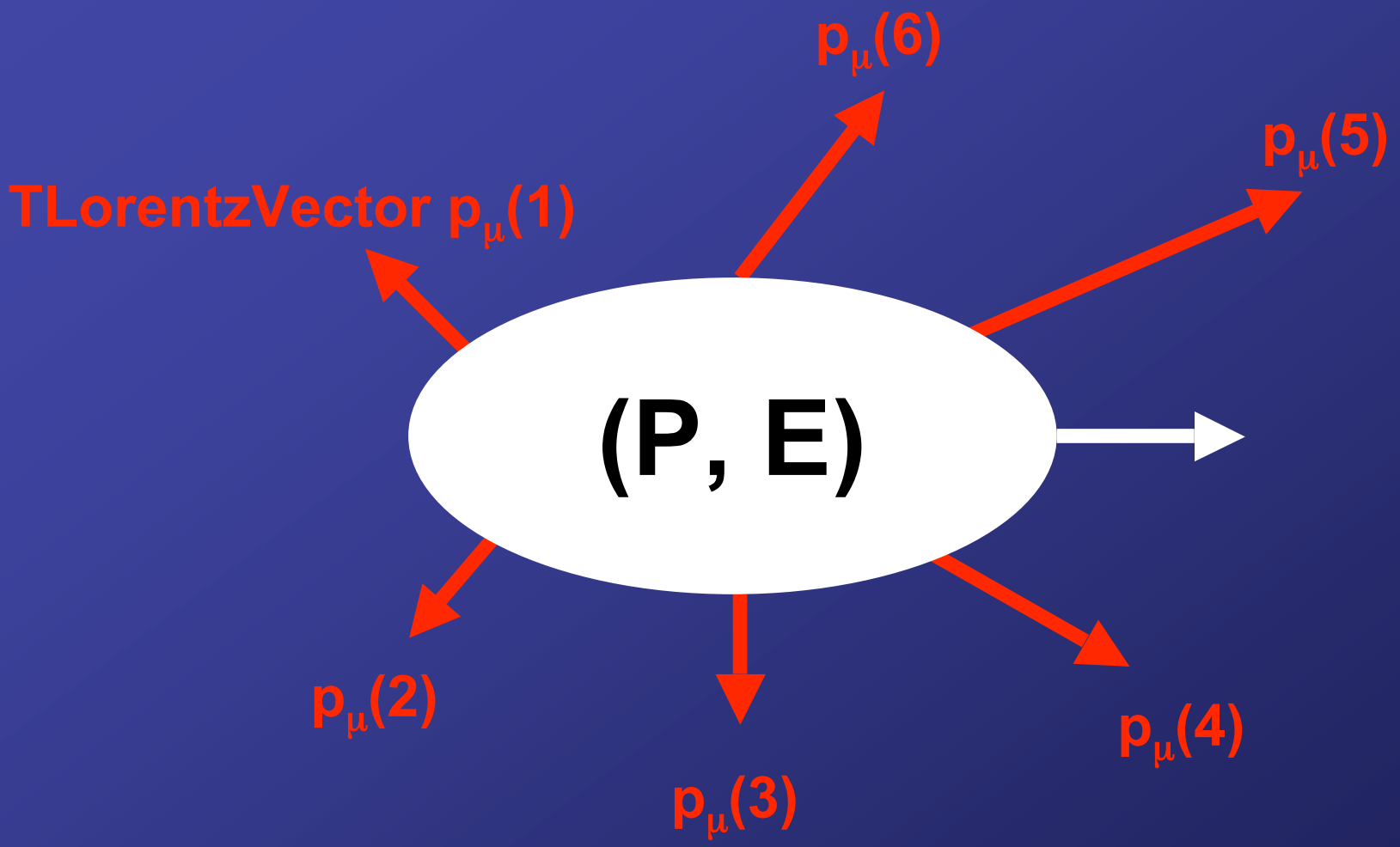
Kinematics and RNGs

class TGenPhaseSpace : public TObject ;

- N-body relativistic phase space event generator
- Produces kinematically allowed events according to phase space distribution
- Original code : GENBOD (F. James, CERNLIB)
- Fastest multi-purpose phase space generator available!!

TGenPhaseSpace



Produces randomly distributed particles with 4-momentum p_μ

TLorentzVector

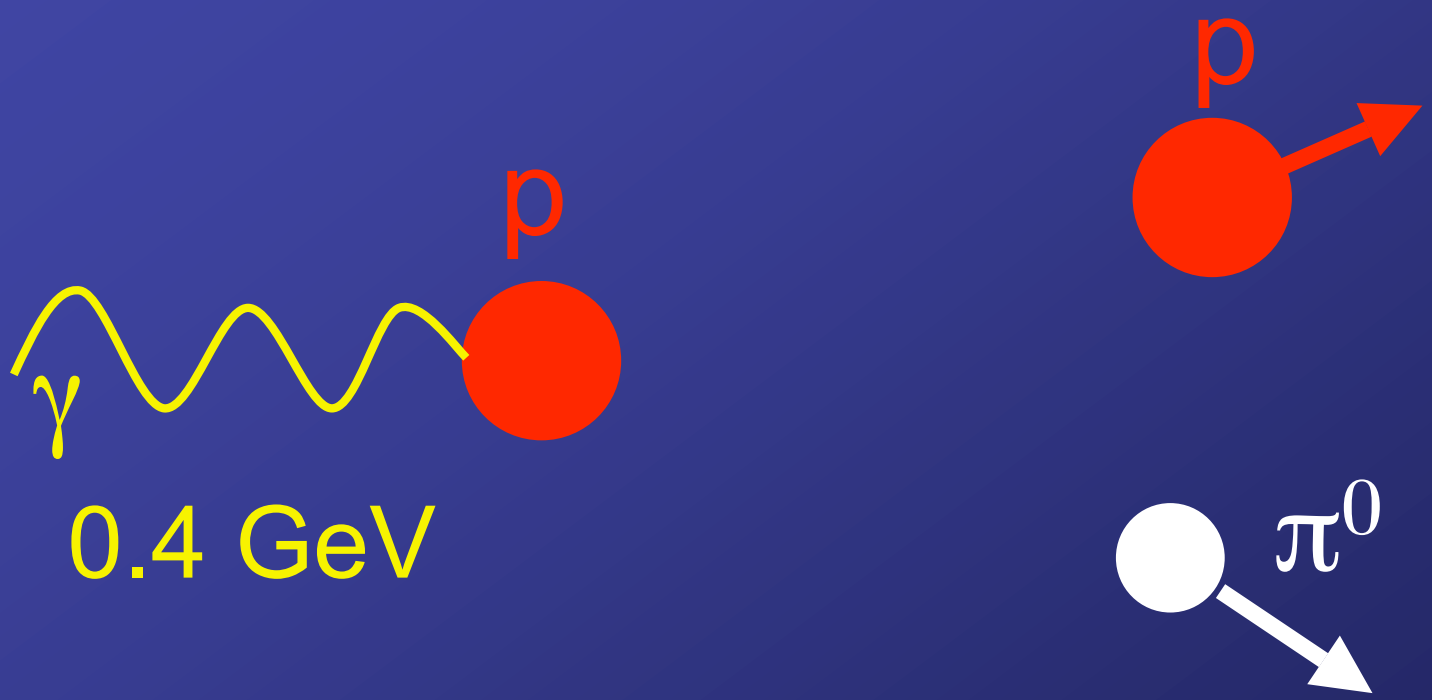
```
class TLorentzVector : public TObject ;
```

```
TLorentzVector fourMom(p_x, p_y, p_z, E)
TLorentzVector fourVec(x, y, z, t)
```

```
fourMom.M();                          /* Returns the mass */
fourMom.Beta();                       /* Returns β */
fourMom.Gamma();                      /* Returns γ */
fourMom.Theta();                      /* Return polar angle θ */
fourMom.Phi();                        /* Returns azimuthal angle φ */
fourMom.Boost(P_x,P_y,P_z);           /* Boost vector */

TLorentzVector totalMom = fourMom1+fourMom2;
                                      /* Add LorentzVectors! */
```

TGenPhaseSpace

An application



How to simulate this reaction using TGenPhaseSpace? What is for instance the angular distribution of pion?

TGenPhaseSpace
An application

Load the physics library to use TGenPhaseSpace/TLorentzVector

Define initial 4-momenta

Masses of final-state particles

Define Decay for TGenPhaseSpace

Book a histogram for results

Generate events!!

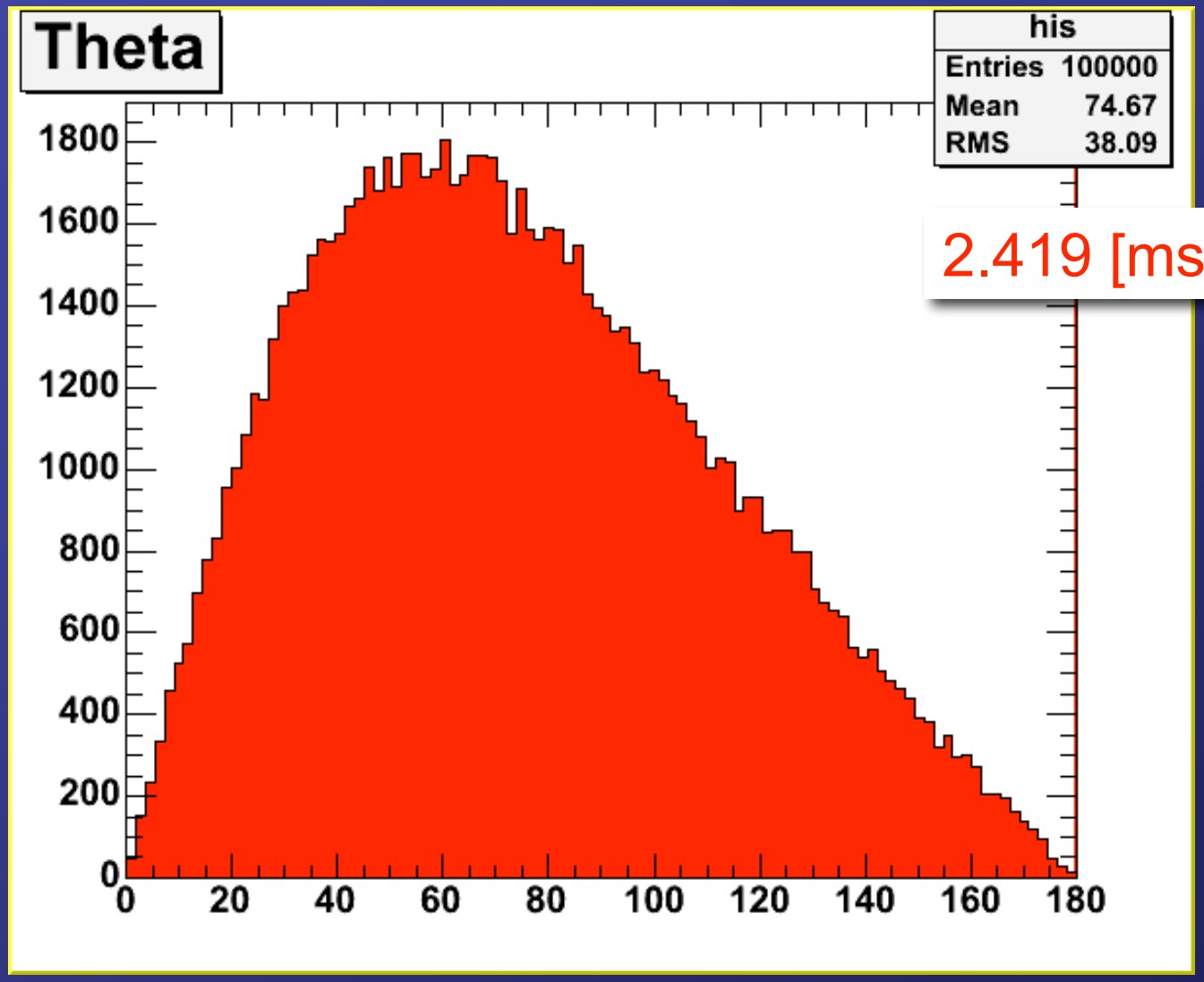
Extract 4-momenta of final-state particles

Update histogram

Draw histogram

```
{
   gSystem.Load("libPhysics");

   TLorentzVector target(0.0, 0.0, 0.0, 0.938);
   TLorentzVector beam(0.0, 0.0, .4, .4);
   TLorentzVector W = beam + target;

   Double_t masses[2] = { 0.938, 0.135} ;

   TGenPhaseSpace event;
   event.SetDecay(W, 2, masses);

   TH1D *h = new TH1D("his", "Theta", 100, 0, 180);

   for (Int_t n=0;n<100000;n++) {
      event.Generate();

      TLorentzVector *pProton  = event.GetDecay(0);
      TLorentzVector *pPi0     = event.GetDecay(1);

      h->Fill(pPi0->Theta()*57.3);
   }
   h->Draw();
}
```

TGenPhaseSpace
An application



2.419 [ms/event]

More advanced Generators and Simulation Packages

PLUTO++:

Fast Simulation Package for Hadronic Interactions, ROOT-based, no development

www-hades.gsi.de/computing/pluto/html/PlutoIndex.html

Geant3:

Detector Simulation Package Fortran-based, CERN, no development

Geant4:

Detector Simulation Package C++-based, in development

geant4.web.cern.ch/geant4/

Exercises for Lecture 7

Exercise 1)

Exercise 2)

Write a macro which generates kinematically allowed events for the reaction p+d->p+p+n with an incident proton energy of 200 MeV and a deuteron at rest. Make a histogram of the scattering angle of the neutron in the lab. frame and in the center-of-mass frame.