# Study (preliminary) of GCR heavy-ion population throughout CAL

- **Goal:** estimate time needed for GLAST Calorimeter to calibrate on orbit using CR heavy-ions
- **Method:** run MC simulation with CrHeavyIonPrimary source
- **Good hits:** heavy ion hits in CAL layers prior to interaction
- **Study:** Carbon ions (most abundant, processed relatively quickly)
- **Software:** GR v7r3p10 with customized userAlg, G4Generator, Event, and FluxSvc packages
- **Run:** at SLAC LSF; 70 batch jobs (~95,000 events each)
- **Statistics:** Out of 6,650,000 CR particles ~ 1,900,000 are Carbon ions
  ~ 190,000 Carbon ions entered CAL sensitive volume (CsI)

# Brief details

- **Tracking:** I traced the original heavy-ion's path through the CAL, using Geant4 "userAction" functions (TrackingAction, EventAction, and SteppingAction).

  Tracking was done until primary heavy-ion gets involved in a nuclear interaction, defined by one of the following G4ProcessTypes:

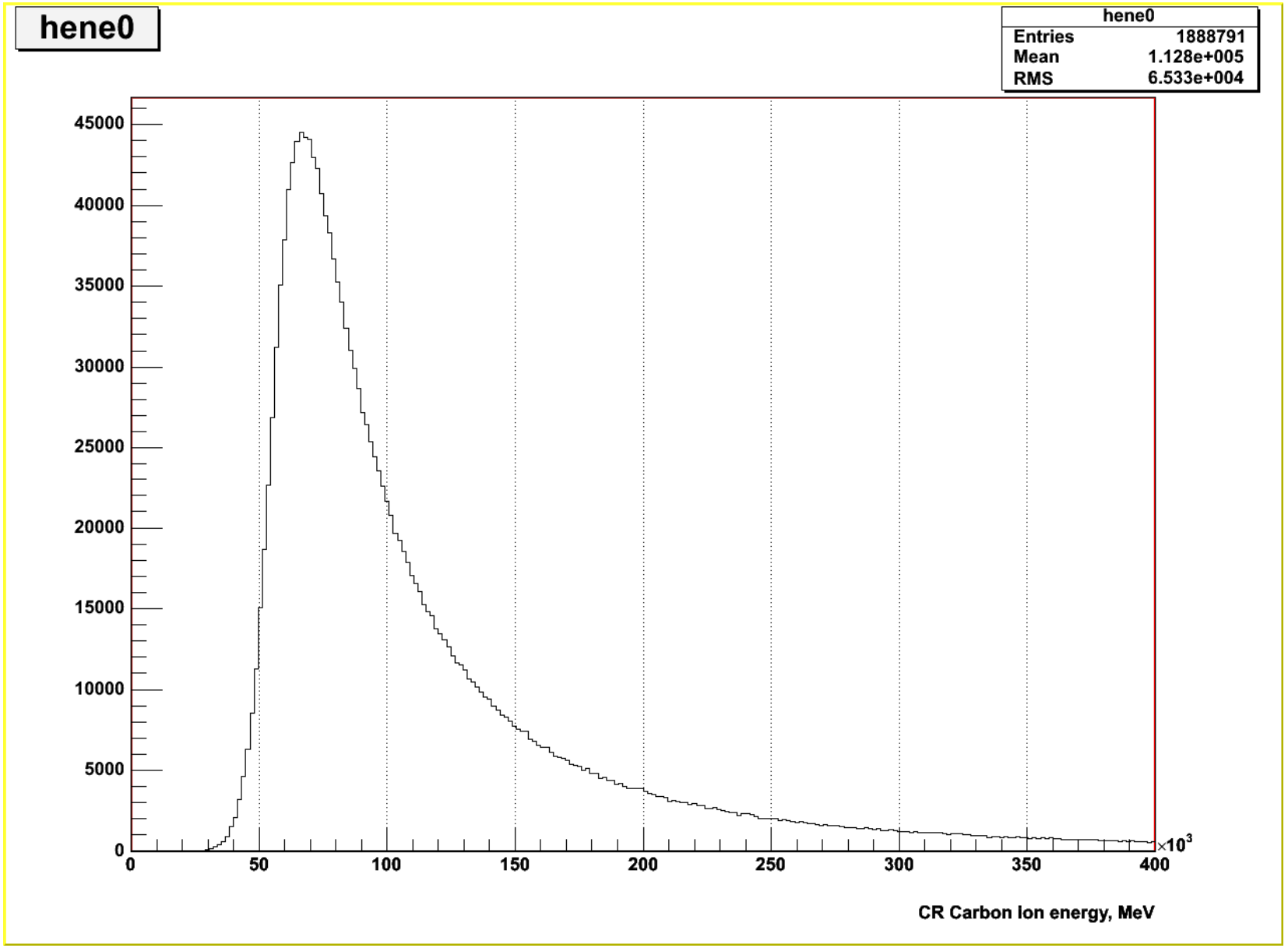
  ***IonInelastic***, *Hadronic, Photolepton_hadron, Decay;*

  or its propagation was ceased by Geant4

- **Output:** heavy-ion's energy loss in CsI, its pathlength in CsI, IDs of crystals that were hit, type of event (nuclear or non-nuclear), event number, original particle's type, energy, and time, as well as McIntegratingHit totalEnergy for crystals hit by heavy-ion.

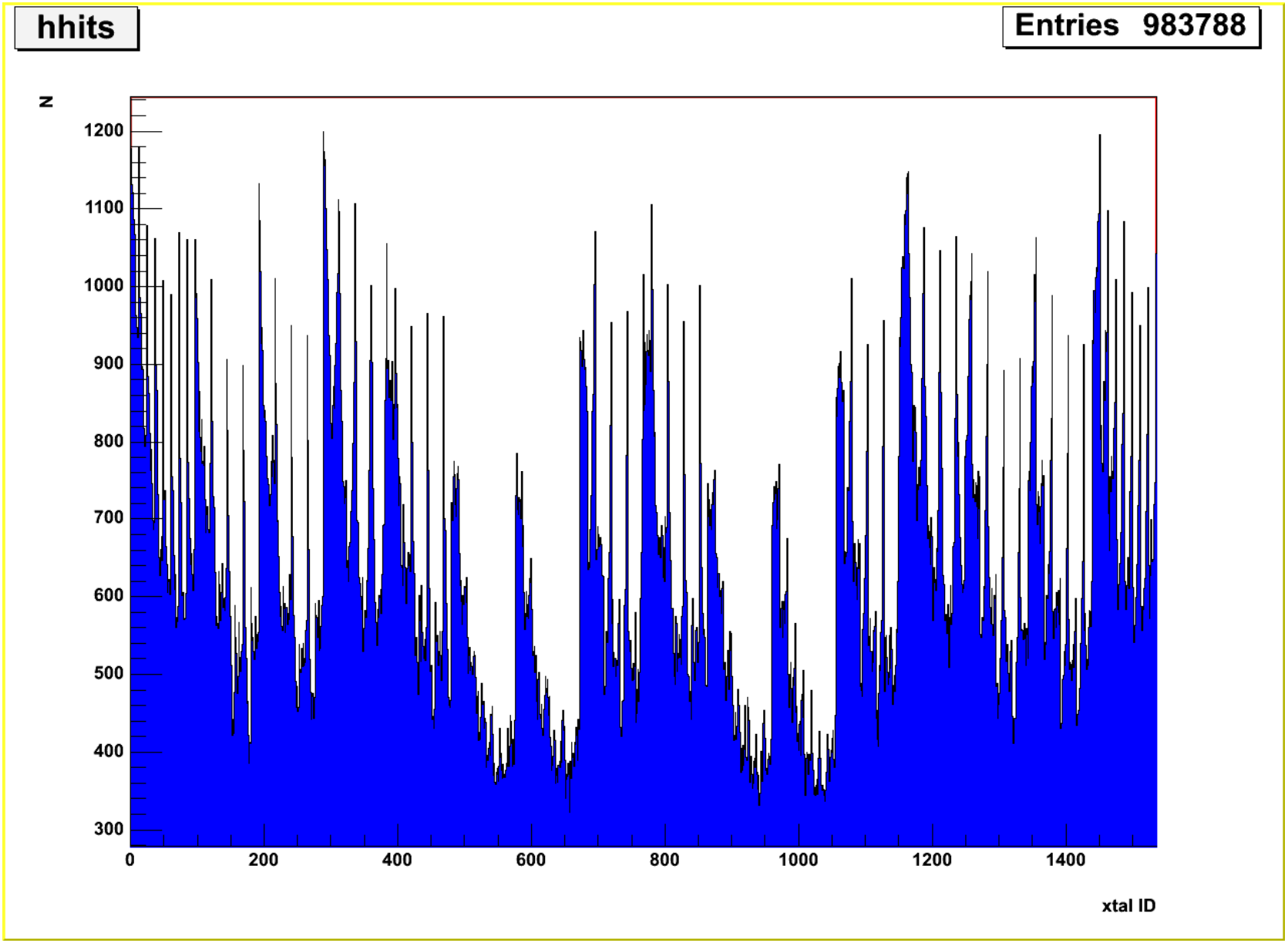
  Energy loss per step is calculated as a difference in total energy of the particle between the beginning and the end of the step

# Spectrum of incident CR Carbon ions



# Carbon hits distribution throughout CAL

GLAST Calorimeter consists of 16 towers assembled in 4x4 array; each tower has 8 layers of 12 CsI crystals
CAL has a total of 1536 CsI crystals



- To collect an average of 640 (a minimum of 320) Carbon hits/crystal it would require exposure time

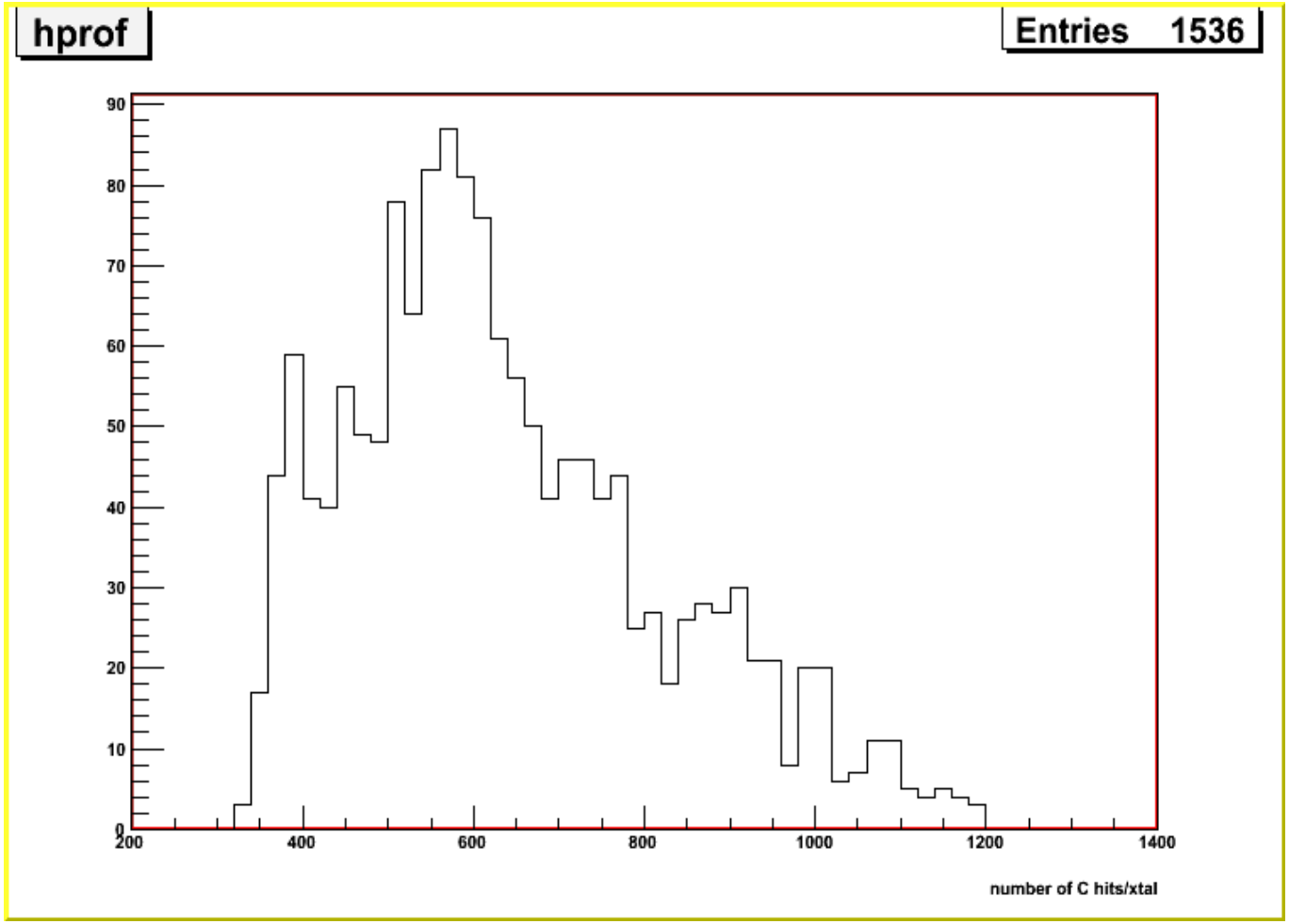
  $\Delta t \approx 42900 \text{ sec} \approx 12 hrs$

- To collect minimum 1000 hits/crystal it would take

  $\Delta t \approx 36 hrs$

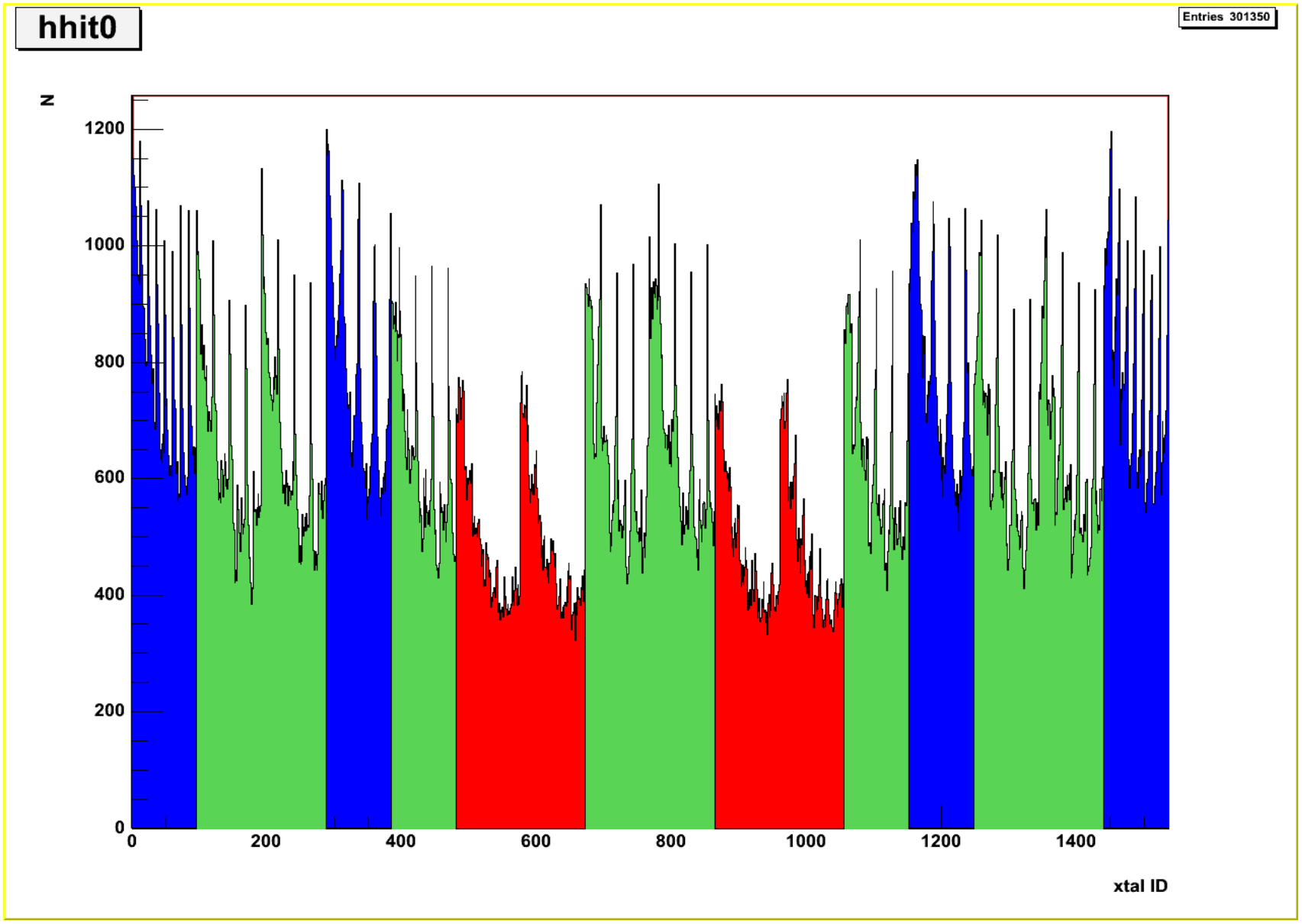
- There is a factor of ~ 4 difference between the most populated and the least populated crystals

Histogram of number of hits per crystal



Differrent regions of CAL painted with different colors:

- Red – four central towers, Blue – four corner towers, Light green – eight other towers
- As expected from geometrical pathlength considerations the inner towers are least populated, conversely the corner towers are most populated



- Approximately 60% of Carbon ions entering the CAL suffer nuclear interactions
- Four central towers have ~ 20% of useful hits, four corner towers have ~ 30% of useful hits, remaining 50% fall on eight other towers