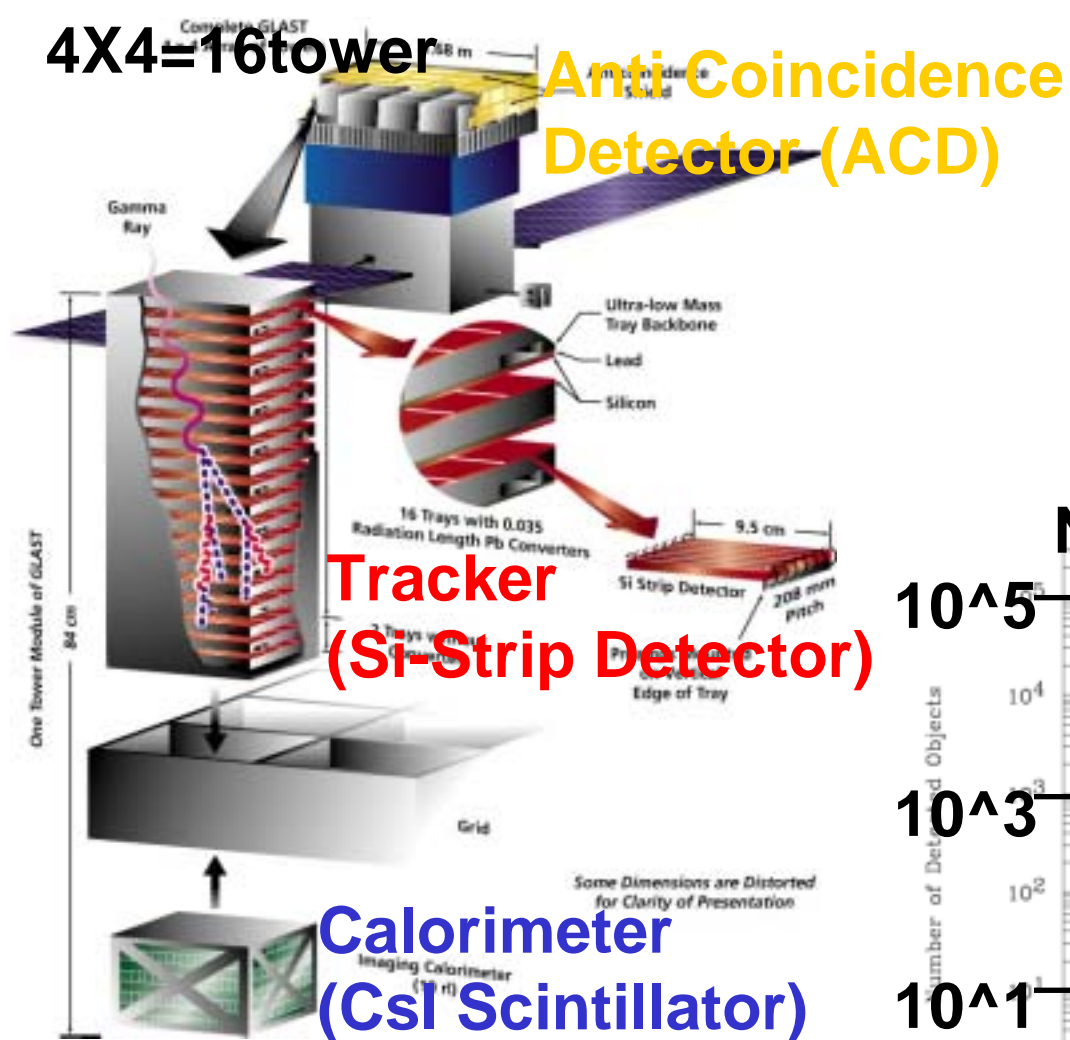# Study of Data from the GLAST Balloon Prototype Based on a Geant4 Simulator

February 22, 2002 @ Geant4 Work Shop

Tsunefumi Mizuno

- The GLAST Satellite (p. 2)
- The GLAST Balloon Flight (p. 3)
- Geant4 Simulation for the GLAST Balloon (pp. 4-5)
- Comparison between the simulation and real data (pp. 6-8)
- Summary (p. 9)

GLAST (Gamma-ray large Area Space Telescope)

20MeV-300GeV

4X4=16tower

Anti Coincidence Detector (ACD)

Tracker (Si-Strip Detector)

Calorimeter (CsI Scintillator)

- large field of view (~2sr)
- large effective area (~10000cm^2)
- high angular resolution 10' (>10GeV)

⇒ **High Sensitivity**

Number of Detected source

10^5

10^3

10^1

1960   1980   2000 year
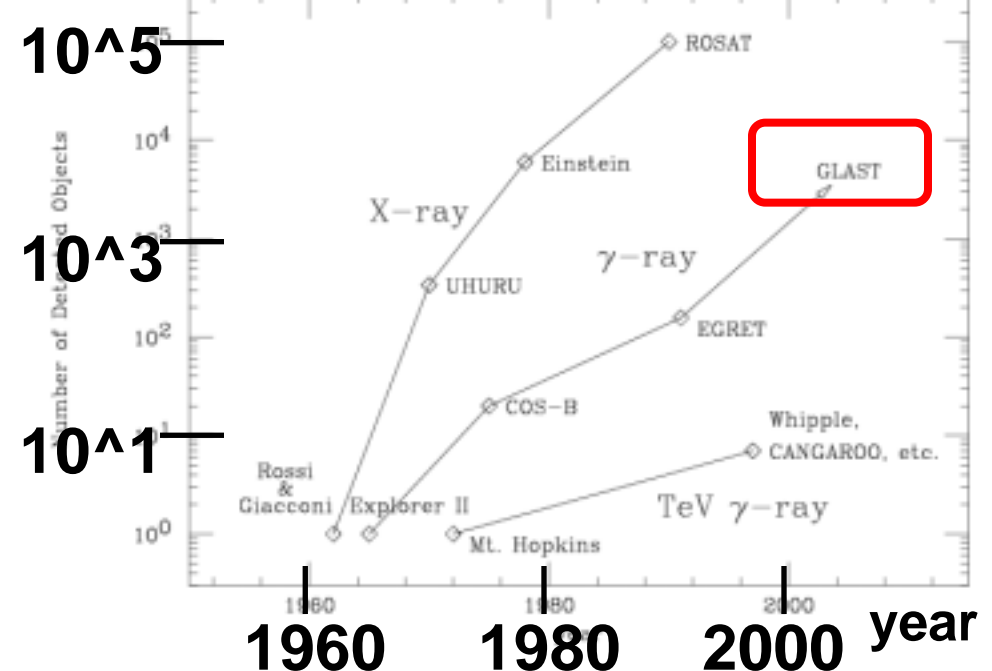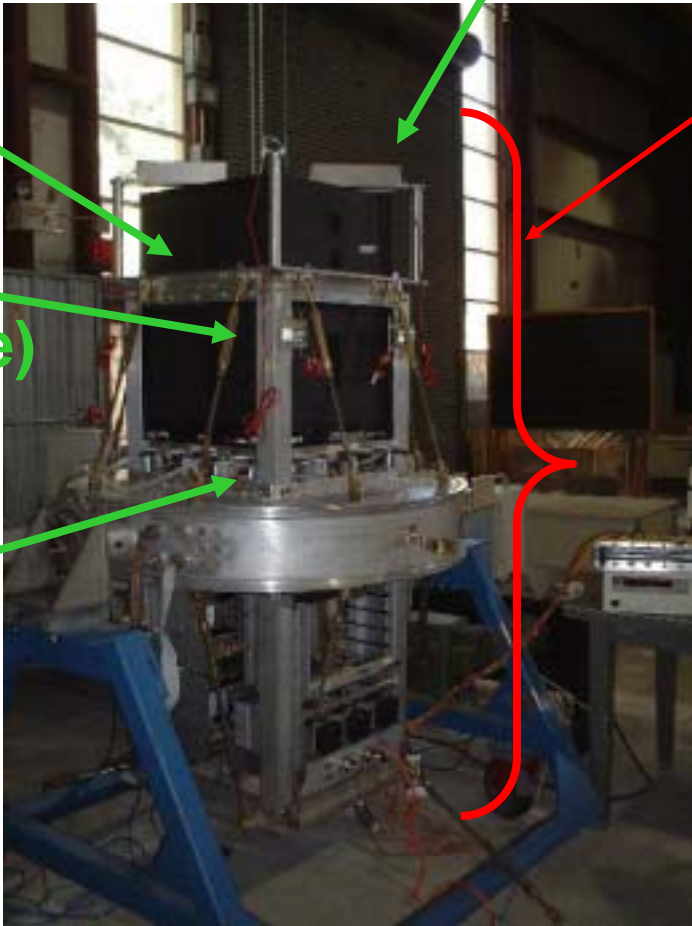
Balloon Flight for the GLAST

Balloon Flight Engineering Model (BFEM)

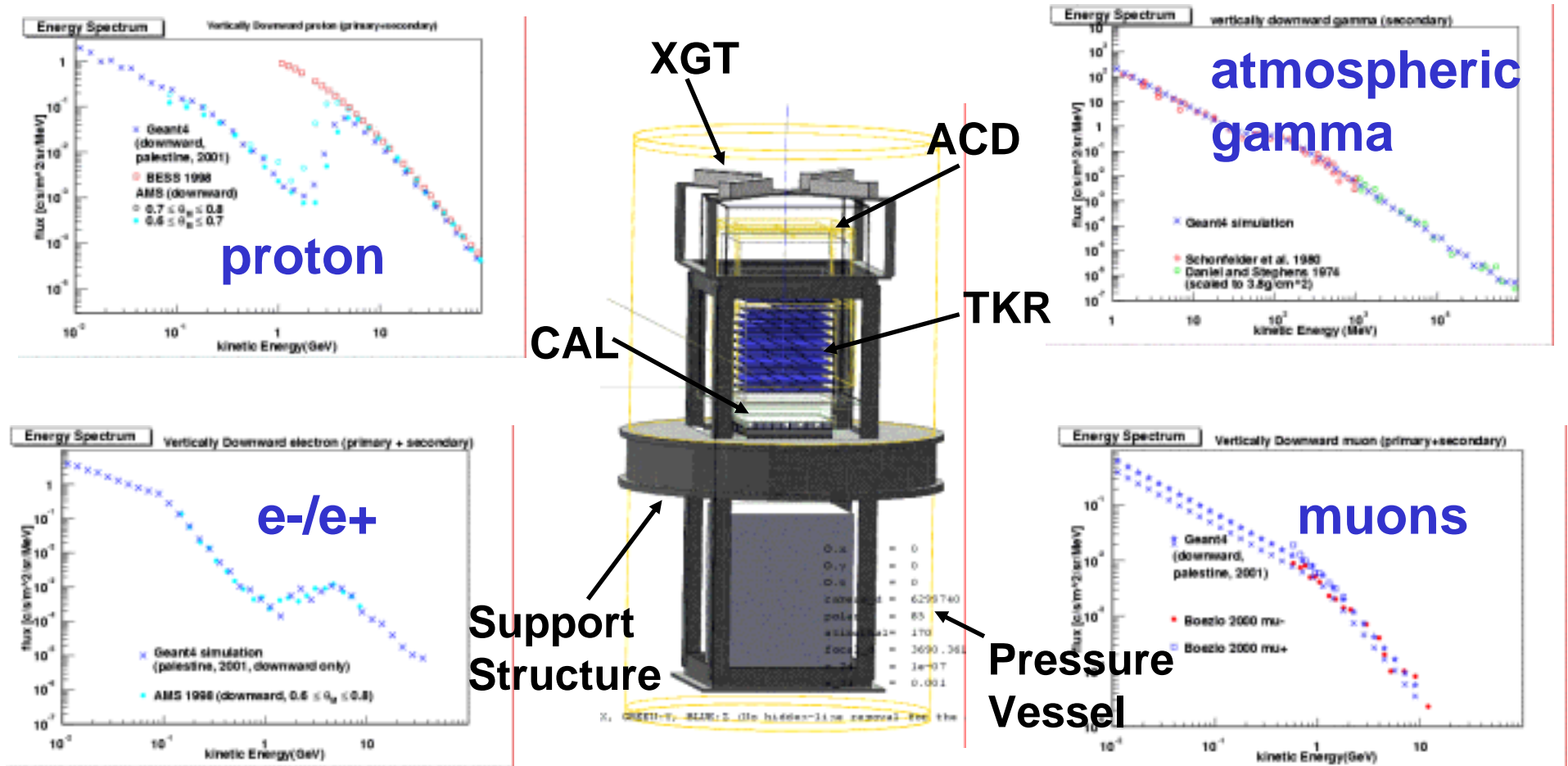eXternal Gamma-ray Target(XGT)

ACD

TKR (inside)

CAL

Objectives

a. Validate the LAT design at the single tower level
b. Show the ability to take data in a space-like environment
c. <u>Collect cosmic-ray events to be used for a background database for the GLAST satellite.</u>

We have developed a cosmic-ray generator and an instrument simulator based on Geant4 (2.0)
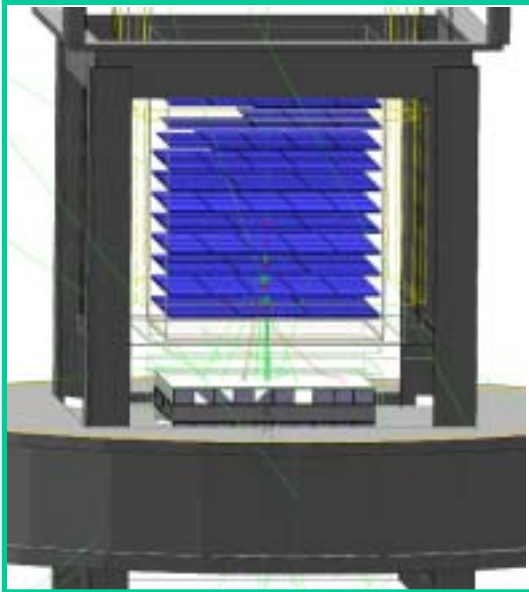
August 04, 2001 @Palestine, Texas
~100000events via telemetry

3

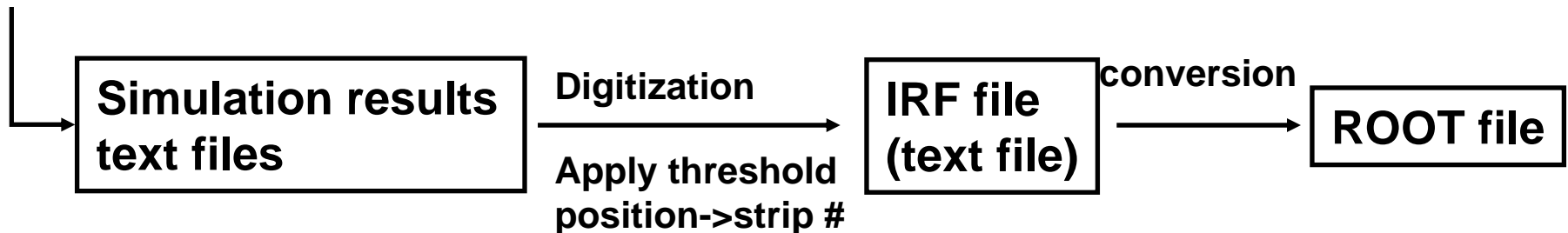# Geant4 Simulator for the GLAST Balloon Flight (1)

proton

atmospheric gamma

e-/e+

muons

XGT

ACD

TKR

CAL

Support Structure

Pressure Vessel

- model cosmic-ray spectra
- generate particles and shoot them
- do Geant4 Monte-Carlo simulation

4

Geant4 Simulator for the GLAST Balloon Flight (2)

- Physics process (example#4)
  - General process (decay)
  - Electromagnetic process
    (ionization, multiple scattering, photoelectric effect, compton scattering, pair creation, bremsstrahlung, annihilation)
  - Hadronic process
    elastic scattering, inelastic scattering
- Cutoff length
  - 0.4mm(e-), 0.1mm(others)

| Simulation results text files | Digitization
Apply threshold
position->strip # → | IRF file (text file) | conversion → | ROOT file |

We ran typically 1M events for each particle type, and ~1% of them cause trigger.

Angular distribution of charged particles

- Event selection
  - Hit in any of ACD tiles
  - Single track
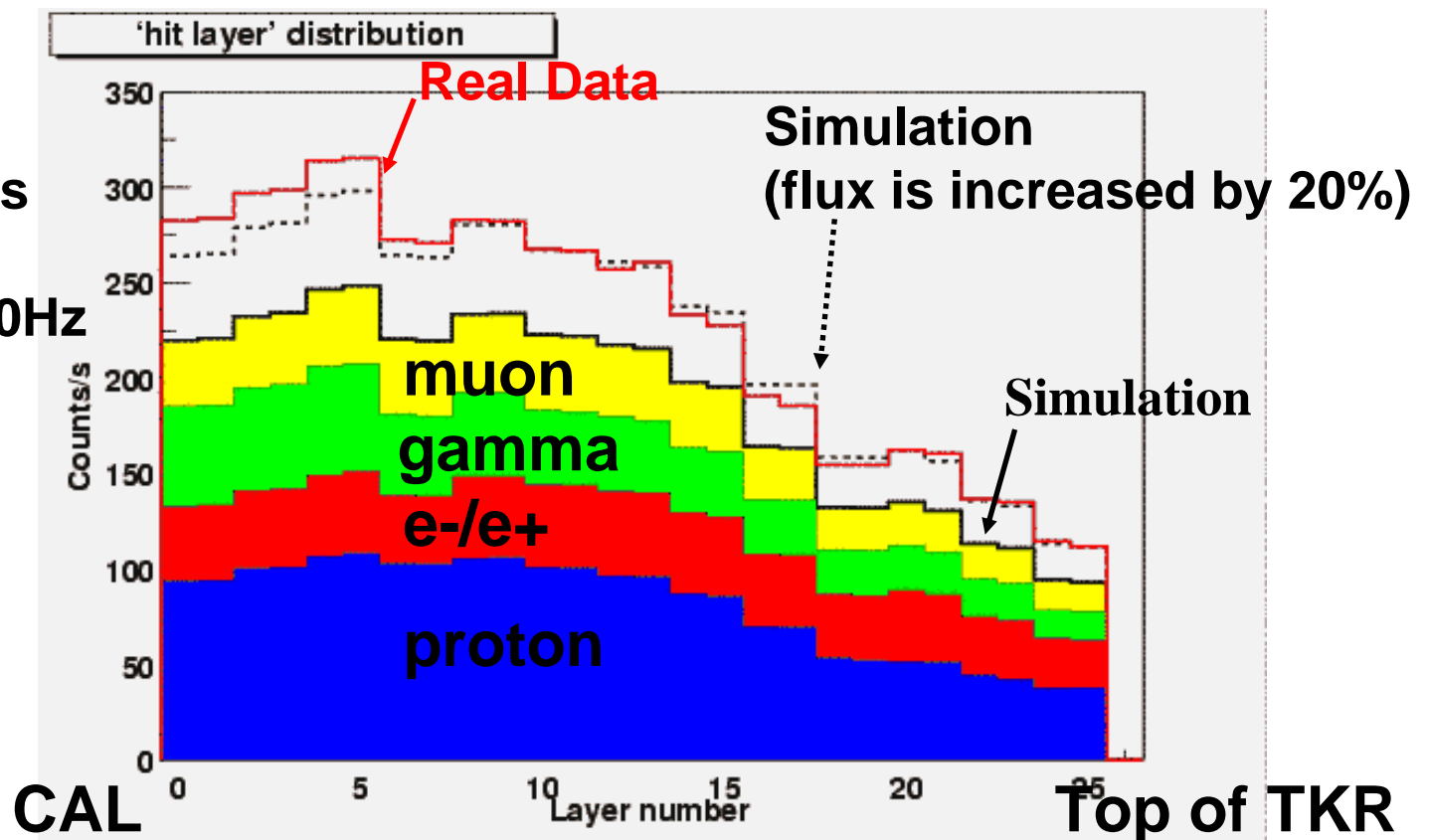- Compare the reconstructed direction between data and simulation
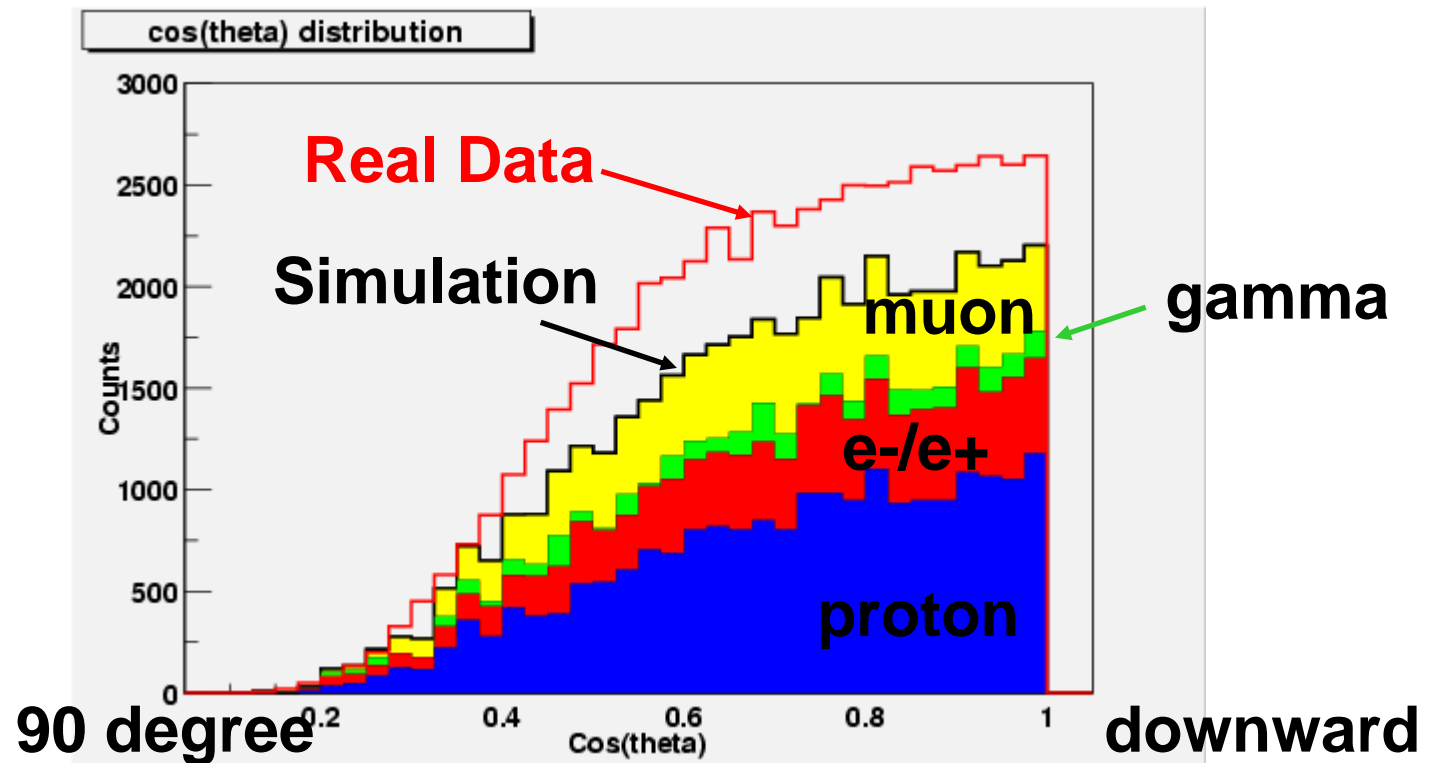
We modeled the angular distribution and flux(<=20%) of charged particles well.

Hits in each layer for "charged" events (deposit energy in ACD)

Trigger rate of "charged" events
- data: ~440Hz
- simulation: ~350Hz

'hit layer' distribution

Real Data

Simulation (flux is increased by 20%)

Simulation

muon
gamma
e-/e+
proton

Counts/s
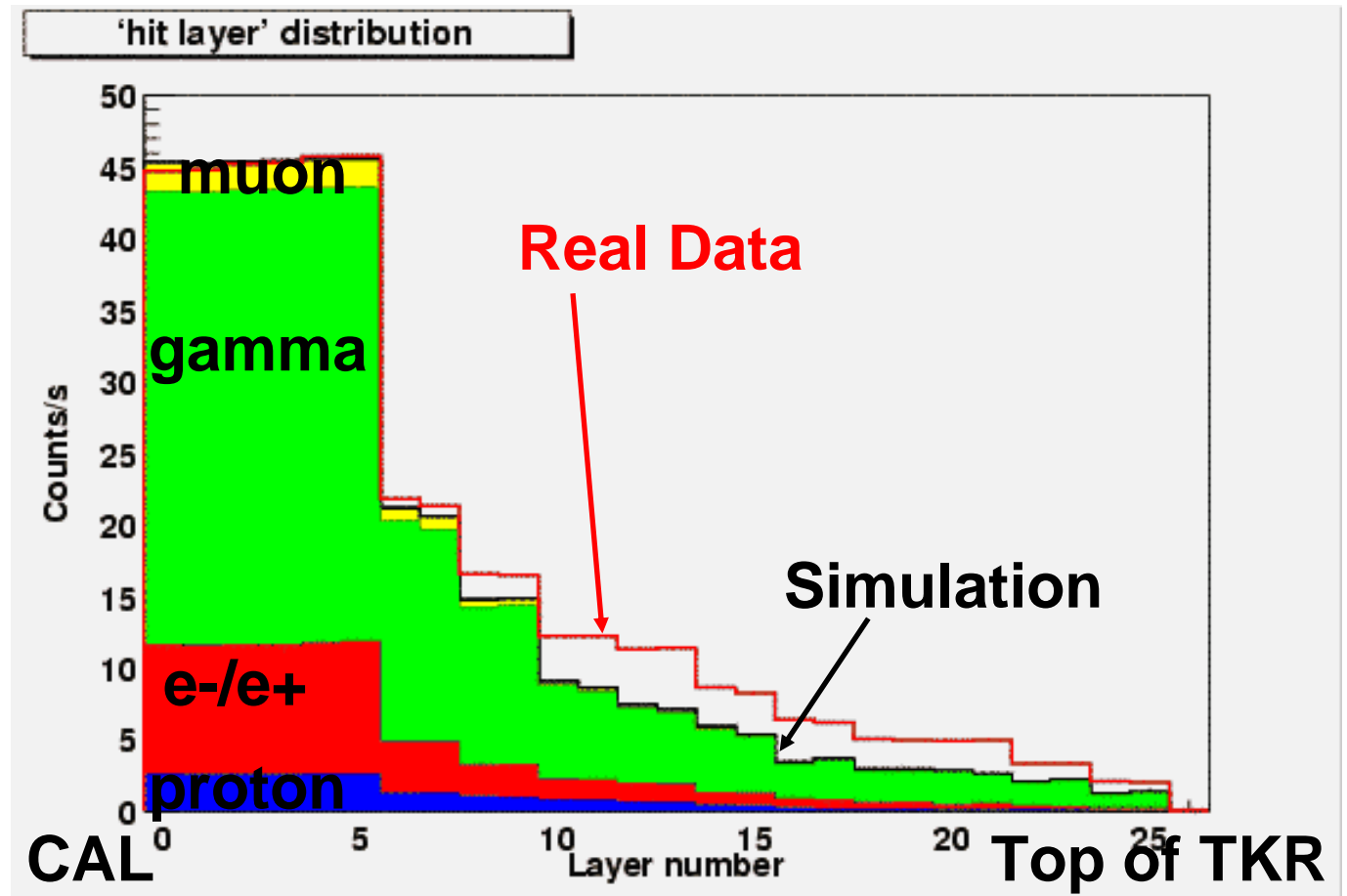
Layer number

CAL

Top of TKR

- **The G4 BFEM simulator and cosmic-ray generators well reproduced hits in TKR** (20% difference could be explained by He and the flux uncertainty.)
- small discrepancy is seen in layers near the CAL.

Hits in each layer for "neutral" particles

Trigger rate of "neutral" events
- data: ~55Hz
- simulation: ~50Hz

Discrepancy is seen in upper layers in the TKR (gamma-ray spectrum? angular distribution? Interaction?). **Further study is required.**

Summary

- We have performed the **GLAST Balloon Experiment** in August 4, 2001 at Palestine Texas.
- For this experiment, we have developed **cosmic-ray generators and an instrument simulator based on Geant4**.
- Trigger rate (charged/neutral events) and angular distribution (charged events) **are well reproduced by the Geant4 BFEM simulator**.
- Some discrepancies are seen in Hit Distribution in TKR (layers near the CAL in charged events and upper layers in neutral events). **We still need to continue the study**.
- CAL will be investigated in future.