ATLAS-Geant4 Collaboration

on

G4 Physics Comparison Projects

Geant4 Review

20th June 2001 @CERN

Katsuya Amako

(CERN/KEK)

Introduction

- **Geant4 Physics Validation**
  - This is a major milestone in ATLAS Simulation.
  - The goal of the validation is to convince ourselves that we trust Geant4 at least as much as GEANT3, such that we can use Geant4 for our data production.
  - The time scale of this activity was originally set by the end of 2001.
    - ← *However, it is certain that we need more time to reach the goal.*
- **Two activities for G4 physics validation in ATLAS**
  1. Collaboration projects with the Geant4 team.
  2. ATLAS' own internal activity.

Collaboration projects with the Geant4 team

- **Call for 'Expression of Intent' on collaboration to study G4 physics by the G4 team**
  - ← *24th February, 2000.*
- **ATLAS' EoI**
  - Date of submission
    - ← *28th March, 2000.*
  - Detectors to be studied**:**
    - EM barrel calorimeter (EMB)
    - Hadronic endcap with forward calorimeter (HEC/FCAL)
    - Hadronic barrel calorimeter (TileCal)
      - ← *Limited only to the calorimeter type after discussion with the G4 team..*
  - Type of physics to be studied and data to be used
    - All physics processes related to these three detectors.
    - Test beam data available for three detectors.

Kickoff of Atlas-G4 collaboration

- **Date of kickoff**
  - ← *28th June, 2000*
- **Three project teams established**
  - EMB
    G4: M. Maire, G. Cosmo, K. Amako (contact person)
    Atlas: LAL-Orsay, Grenoble, BNL, Nevis
  - HEC/FCal
    G4: L. Urban, V. Grichine, F. Jones (contact person)
    Atlas: Univ. of Montreal
  - TileCal
    G4: G.Folger, H.Fesefeldt, H.Krashige (contact person)
    Atlas: IHEP, Barcelona
- **Some agreements**
  - Results of studies will be published.
  - Code developed during the collaboration will be used by the Geant4 team in a standard test procedure to release new G4 codes.

ATLAS' Own Internal Studies

Issues of the ATLAS-Geant4 collaboration

- ATLAS needs to work on G4 physics validation not only on calorimeters but also on inner tracker, muon spectrometer, etc.
- For these studies ATLAS also needs a close contact with the G4 team.
- How to satisfy this need?

  [Pragmatic solution]

  ➔ *To organize a regular joint meeting of ATLAS and Geant4.*

  ➔ *There we discuss not only the calorimeter related studies but also the inner trackers and muon spectrometers.*

Joint ATLAS-Geant4 regular meeting

- Monthly meeting participated by
  - *simulation people from **all ATLAS subsystem detectors**,*
  - *Geant4 team members especially from the physics category*
- So far we had 10 meetings including a 2-day workshop.
- More than 100 presentations on physics validation given so far.

  ➔ *Quite a substantial effort by both ATLAS and G4 team.*
- These meetings provide
  - *an ideal place for close communication between ATLAS and G4,*
  - *seamless connection of all Geant4 related activities in ATLAS.*

Strategy of Validation

Strategy of studies

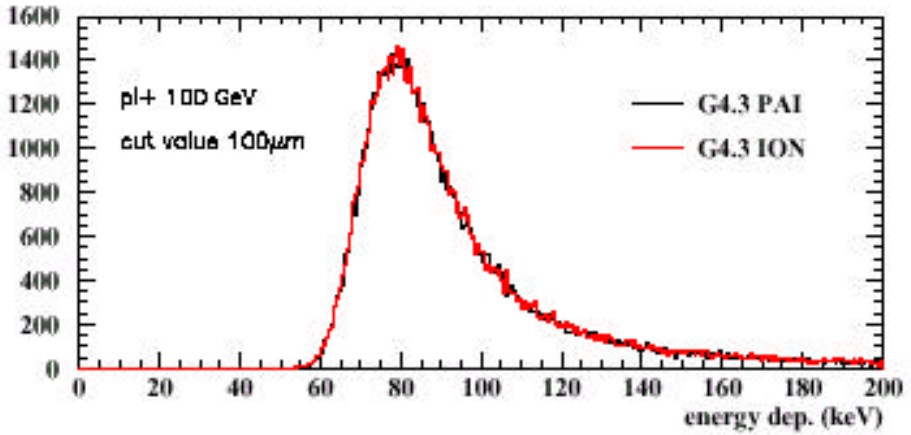
- Systematic studies, i.e. simple interaction to complicated one
  - muon ➔ electron/gamma ➔ hadrons
- Use simple but realistic geometry
  - ← test beam geometry is simple comparing to the ATALS full geometry and this makes comparison relatively easier.
- Four subsystem detector groups (IT, LiqAr, Tile, Muon) work in parallel and equally on
  - comparing Geant4 with test beam data,
  - comparing Geant4 with GEANT3 using the same geometry.

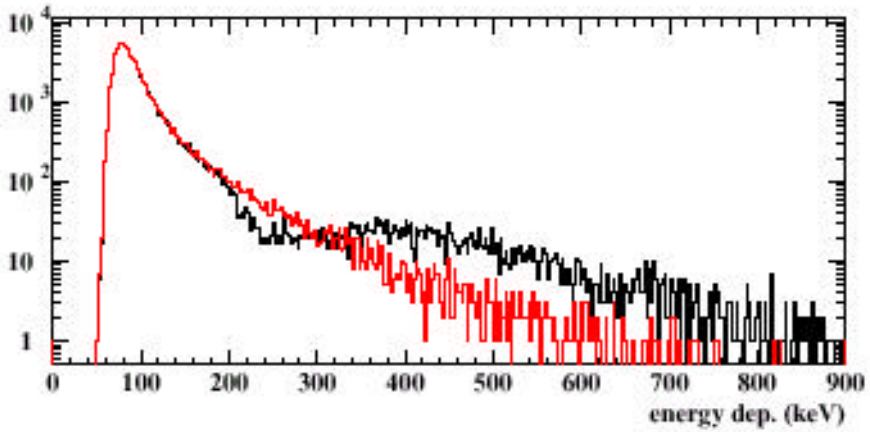
Presentations in this review

- In the following slides, I highlight some results by the IT and Muon groups.
- Results from the other detectors will be presented by
  - Liq. Ar ➔ J. Collot
  - TileCal ➔ A. Solodkov

Silicon Tracker

- **Energy deposition in thin silicon layers**
  - Studies to compare the energy loss models in silicon detectors (t=280μ)
    - G4 standard ionisation model vs. PAI model
  - Gross features (peak, mean, width) are equivalent;
  - PAI model has the funny shape in the Landau tail
    - ← Study continued by V. Grichine.

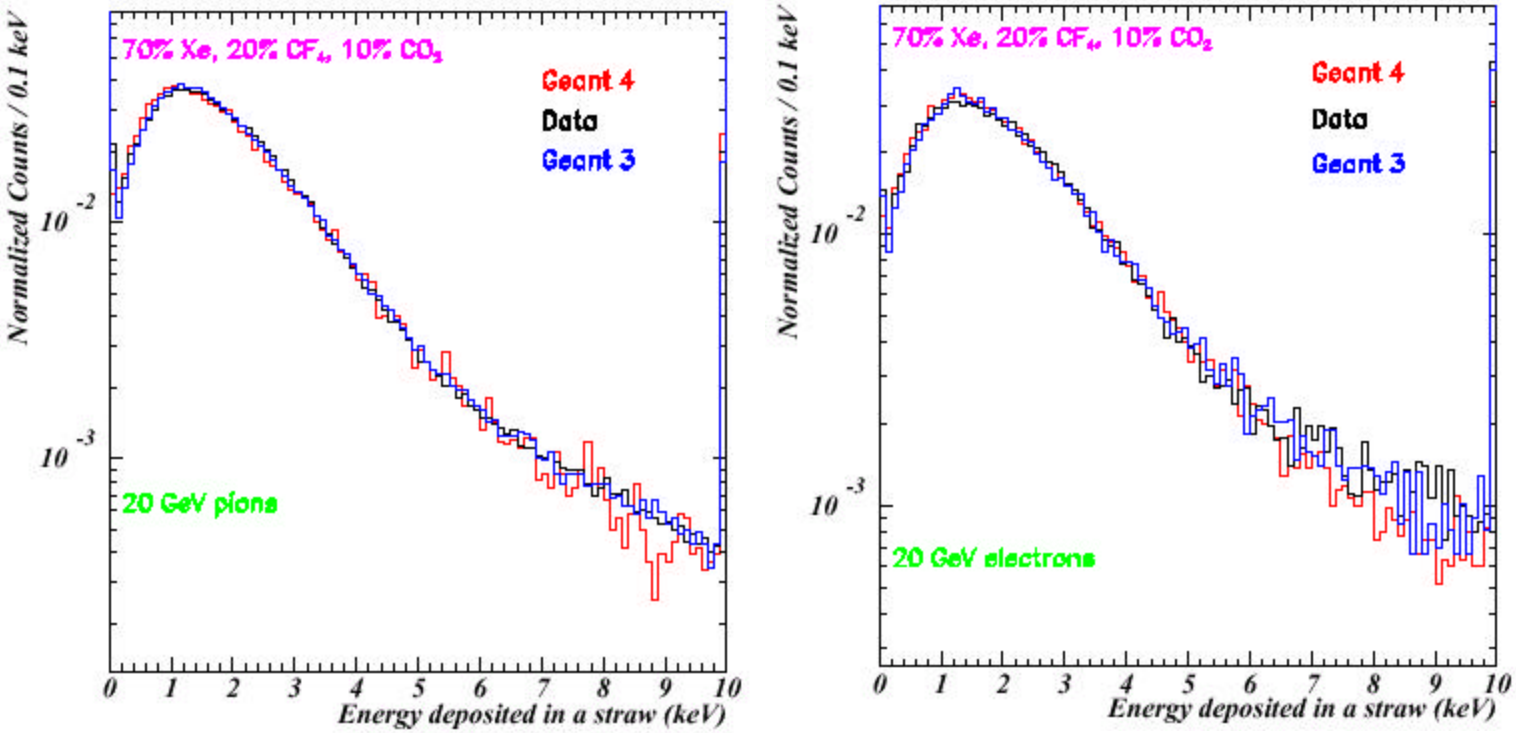




Transition Radiation Tracker

Ionization in TRT straws

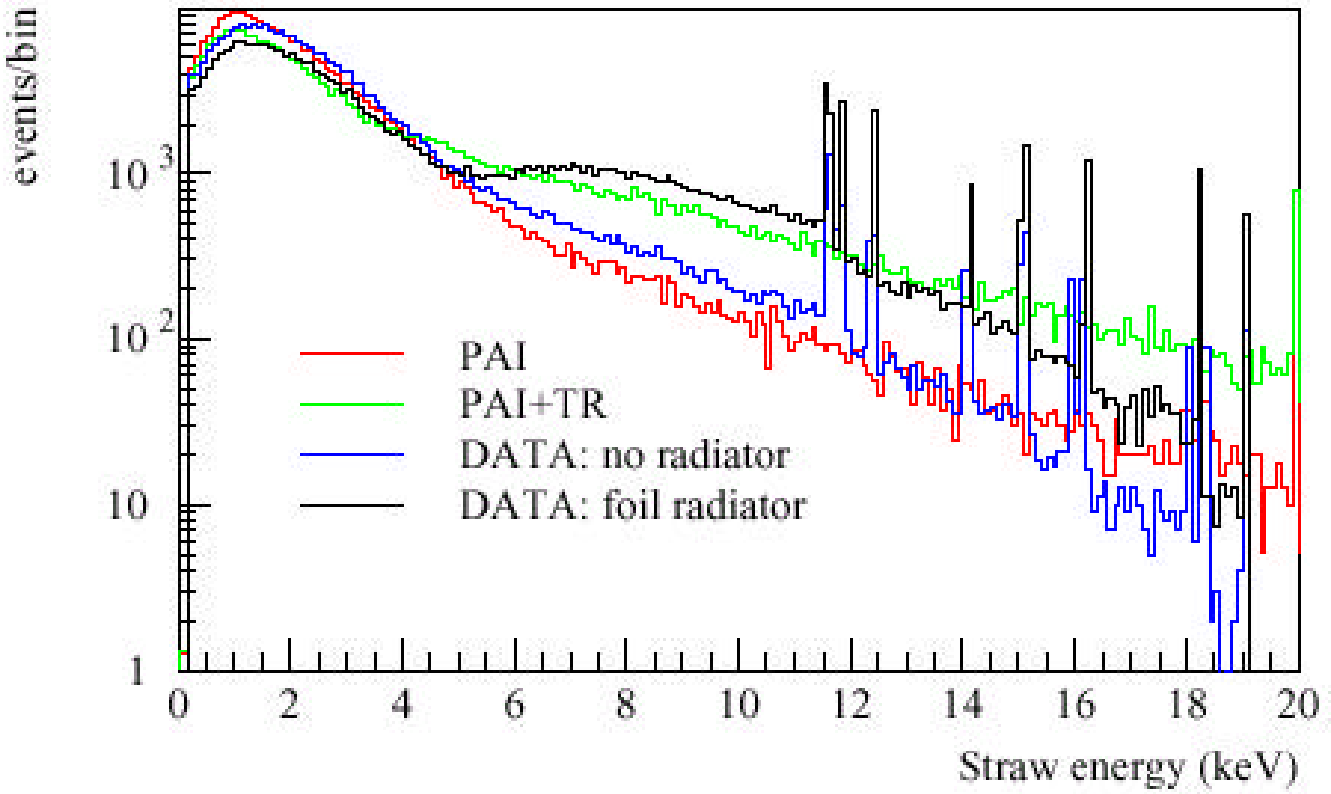
- Studies of the energy loss models in the TRT straws
  - PAI model in standard G4 PhysicsList vs. Parametrised model
- The cluster energy distribution is important in the study. Two models have identical cluster energy distribution, but # of clusters has a long tail for standard G4 process
  - ➔ treatment of d-rays from straw walls and central wire.
- However, this difference is not important in energy distribution in straw. After including detector effects (energy smearing), spectra for total deposited energy agree:



Transition Radiation Tracker

Transition radiation in TRT straws

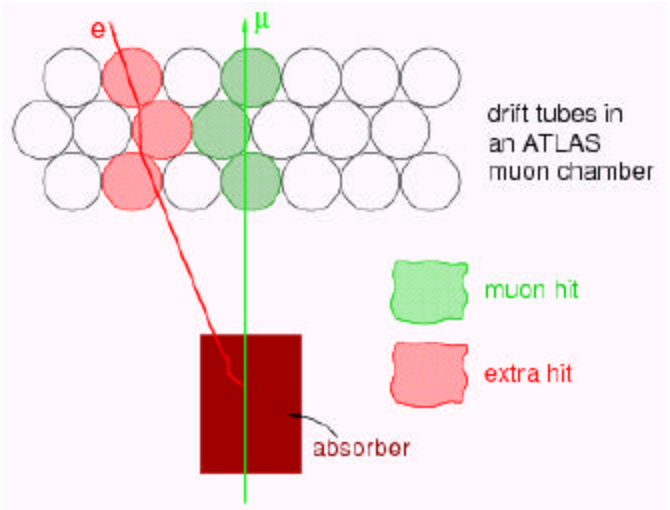
- Studies of energy deposition in TRT straws
  - Parametrised model is used.
- Agreement to data is not too good yet.
  - More work is needed to understand the differences and the inputs used in the model.:

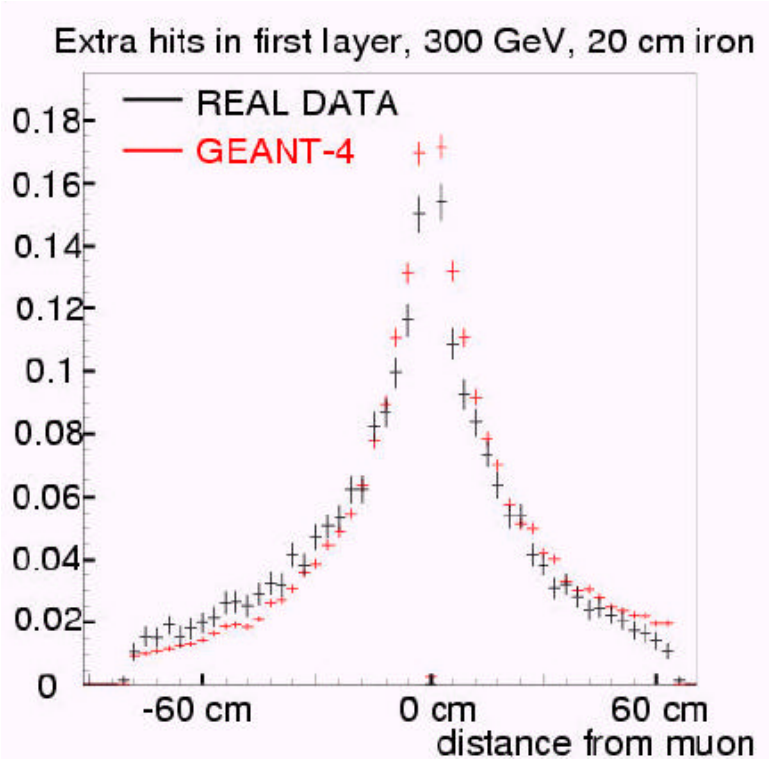


Muon Spectrometer

Shower production by muons

- Studies the production of extra particles from muon-induced electromagnetic showers in absorbers placed in front of the muon chambers and compares to test beam data:
- Gross features are fairly reproduced (at the 10% level) for light absorber material (Al), less so for heavier material (Fe):





Remarks

- What I have shown is really a small portion of what we have done so far by the IT/Muon groups.
  - ← They have already accumulated a quite amount of comparison data. I simply couldn't show them because there is not enough time.
  - ← You can find slides of most presentations given in regular ATLAS-Geant4 meetings and minutes under the following web page:

    http://atlas.web.cern.ch/Atlas/GROUPS/SOFTWARE/OO/domains/simulation/G4PhysicsStudies/index.html
- In parallel to the work of G4 physics validation, ATLAS already spent a quite huge amount of efforts to make use of G4 for serious simulation. These include
  - developing and optimizing subsystem geometry codes,
  - developing the ATLAS G4 simulation framework,
  - ……
    - ← *ATLAS as the whole already made a serious commitment to G4.*

Conclusions

- Monthly joint meetings by ATLAS and the G4 team provides an ideal place for close communication.
- Two activities in ATLAS, i.e.
  - official collaboration projects with the Geant4 team
  - ATLAS' own internal activities

  are discussed equally in the meeting. This makes all Geant4 related works in ATLAS coherent, and practically the distinction between above two activities is "zero".
- Study of electomagnetic processes
  - Large progress in understanding them since the beginning of the project.
  - However, there are still a lot of issues remain to be solved.
- Study of hadronic processes
  - Now we started to focus on this subject.
  - We expect it is much harder than the electromagnetic case.

    ➔ *We need more time to reach the original goal.*