DATA COMPARISON IN ATLAS INNER DETECTOR

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16/10/00

Talk Summary:

1. **dE/dx and PAI Model**
2. **Transition Radiation (TR) Model**

Definitions:

Pixels: The pixels are a grid of small rectangular silicon detectors instead of the traditional strips. Pixels measure space points (i.e. X, Y, & Z).

TRT: The Transition Radiation Tracker is a straw (drift) tube system that occupies the outer part of the ATLAS tracking system.

The TRT identifies energetic e^- (Lorentz $\gamma > 1000$) by detecting the Transition Radiation (TR) X-Rays they generate in radiator material surrounding the straws.

I could not get slides about the ATLAS muon system.

Introduction

PAI and dE/dx:

To test the GEANT4 PAI model, Dario Barberis developed a simulation of the TRT test beam setup which contains 12 straws and is used for testing different radiator materials. Dario worked this simulation until the PAI model results looked reasonable.

Ketevi Assamagan is now making an OO design for a full GEANT4 digitization routine based on our TRT GEANT3 digitization routine. Ketevi is transferring the algorithms that model response of the straws and electronics to the new routine.

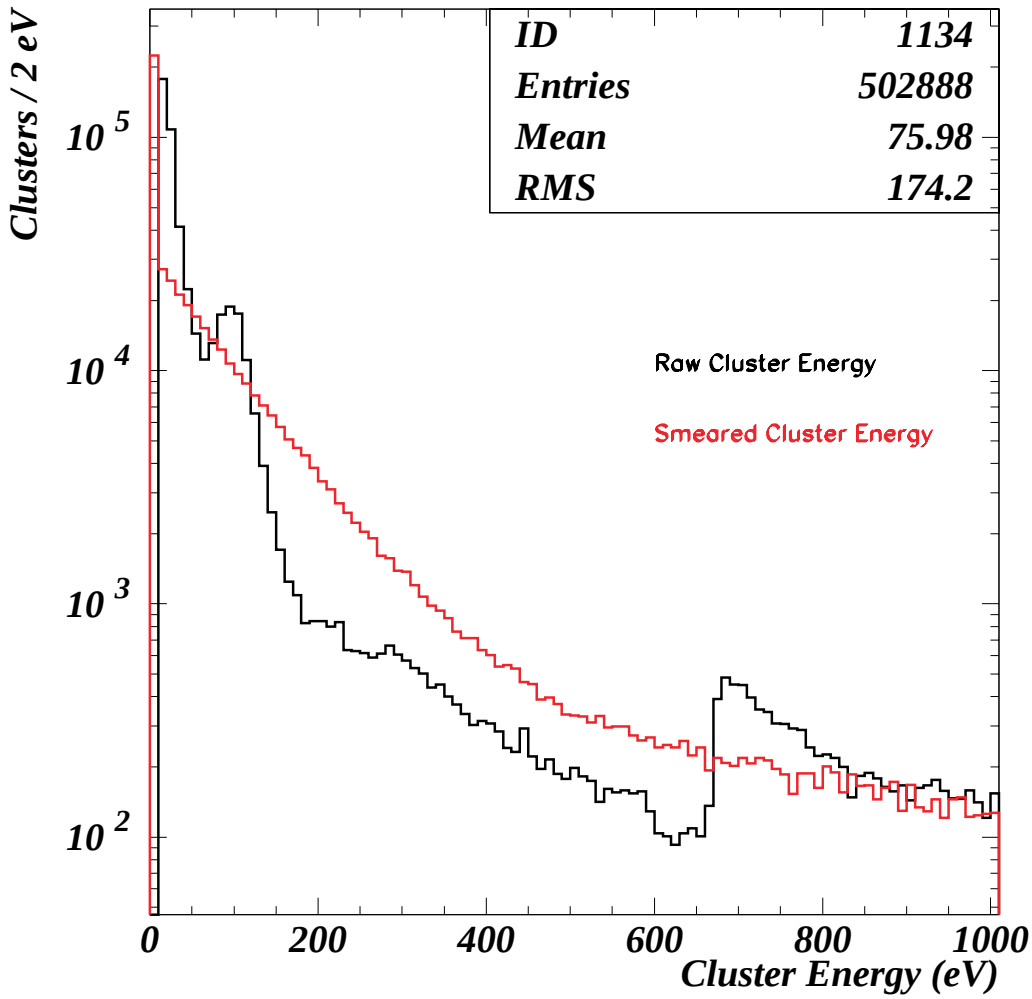
Markus Klute (with Dario's guidance) has been looking at dE/dx with in GEANT4 using a simulation of the pixel testbeam.

Transition Radiation (TR):

Vaso Mitsou has recently begun to study the GEANT4 transition radiation (TR) model using the same simulation used by Dario and Ketevi. She is using the regular radiator model which is the best match to the ATLAS radiator geometry.

Energy Smearing

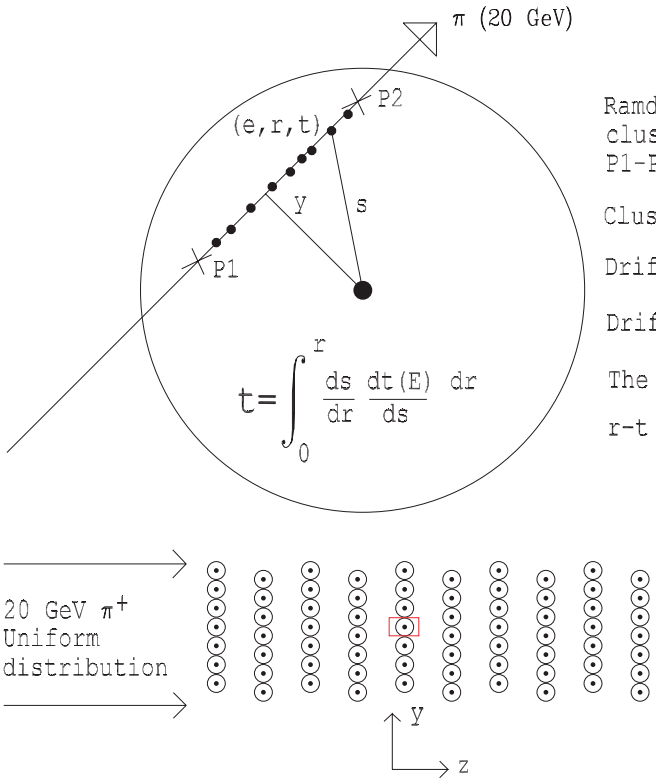
By writing the cluster energies to an external file and reading them back in the digitization routine Ketevi was able to generate a smeared ionization cluster energy distribution using the GEANT4 PAI model:



Ketevi Assamagan

Adding Drift Time

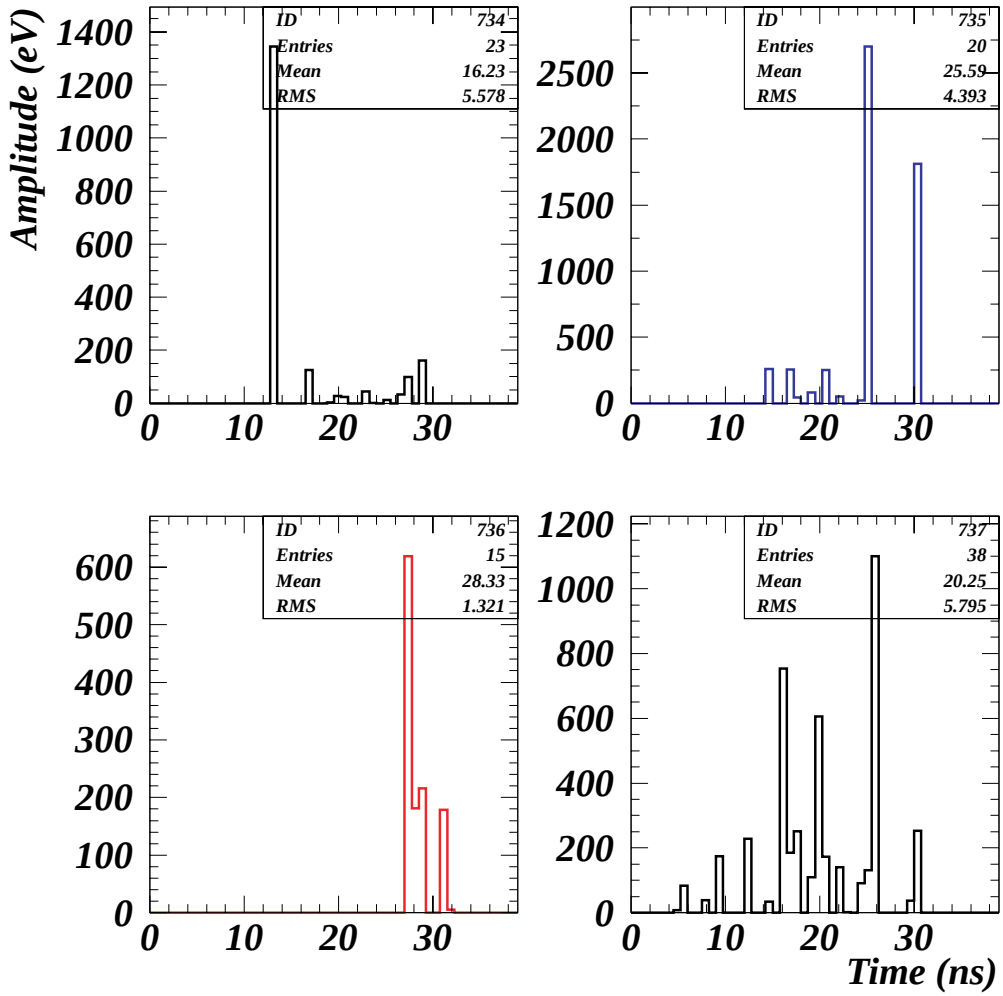
Ketevi then calculated the drift-time from randomly selected locations along the step to the wire. This calculation is done for each individual cluster in each straw of the TRT:



Ketevi Assamagan

Energy Vs. Time

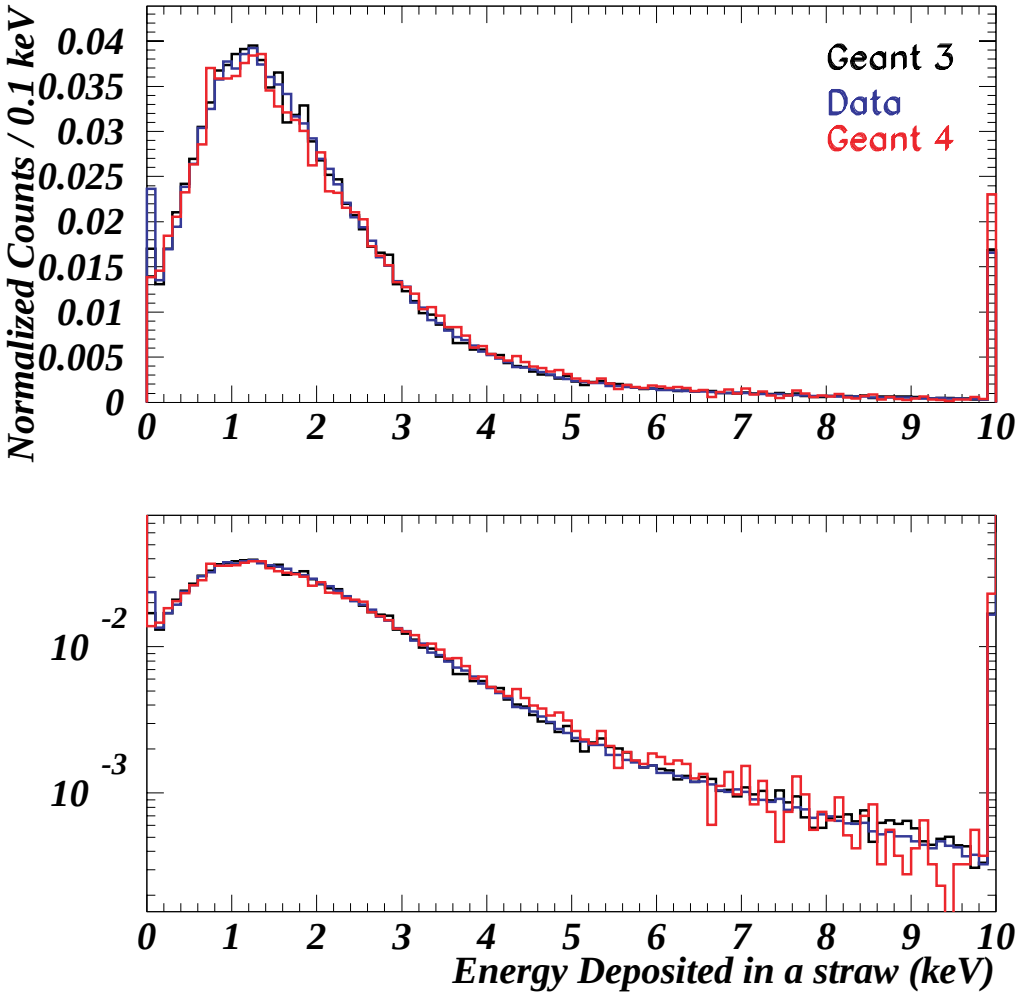
For every straw a distribution of the arrival time of the charge (energy) of each cluster at the wire is calculated. Each plot is for a single straw and event:



Ketevi Assamagan

PAI Comparison to Data

Except for the large energy deposition tail (last bin in plot), the results look good when compared to data and to our GEANT3 simulation. Note: the GEANT3 curve is a private calculation within our digitization routine and not the GEANT3 PAI routine.



Ketevi Assamagan

Pixel Work

This work was done by Makus Klute of Bonn who compared the ATLAS GEANT3 and GEANT4 simulations (no testbeam data comparison).

Pixel Off-line meeting Markus Klute

Status of dE/dx studies

- Programs used

  G4 Pixel Test-Beam Simulation:

  geometry from Laurent Vacavant

  Geant4 version 4.2.0

  G3 Pixel Test-Beam Simulation:

  code from Alexandre Rozanov

- Studied the energie deposited in the Pixel Sensor.

  thickness= 280 μm

  dE/dx = $\sum E_{loss}$ per hit

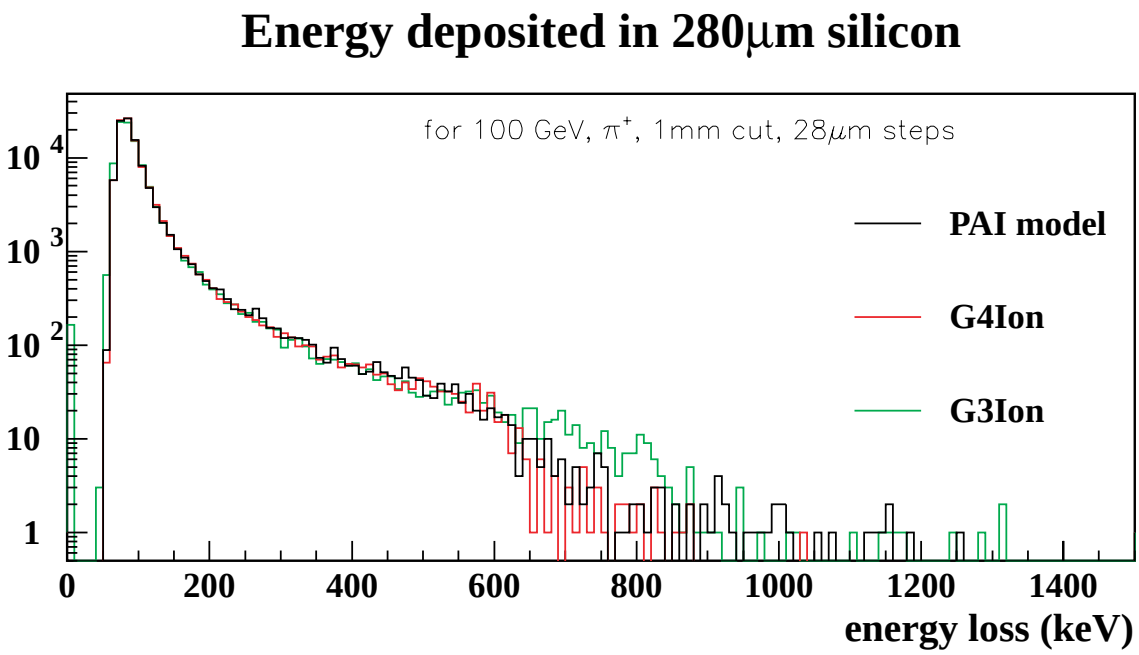
  no electronic or geometrical effects

  are considered

University Bonn 30.September 2000

Pixels

To quote Markus: "This looks good how did I get there?"



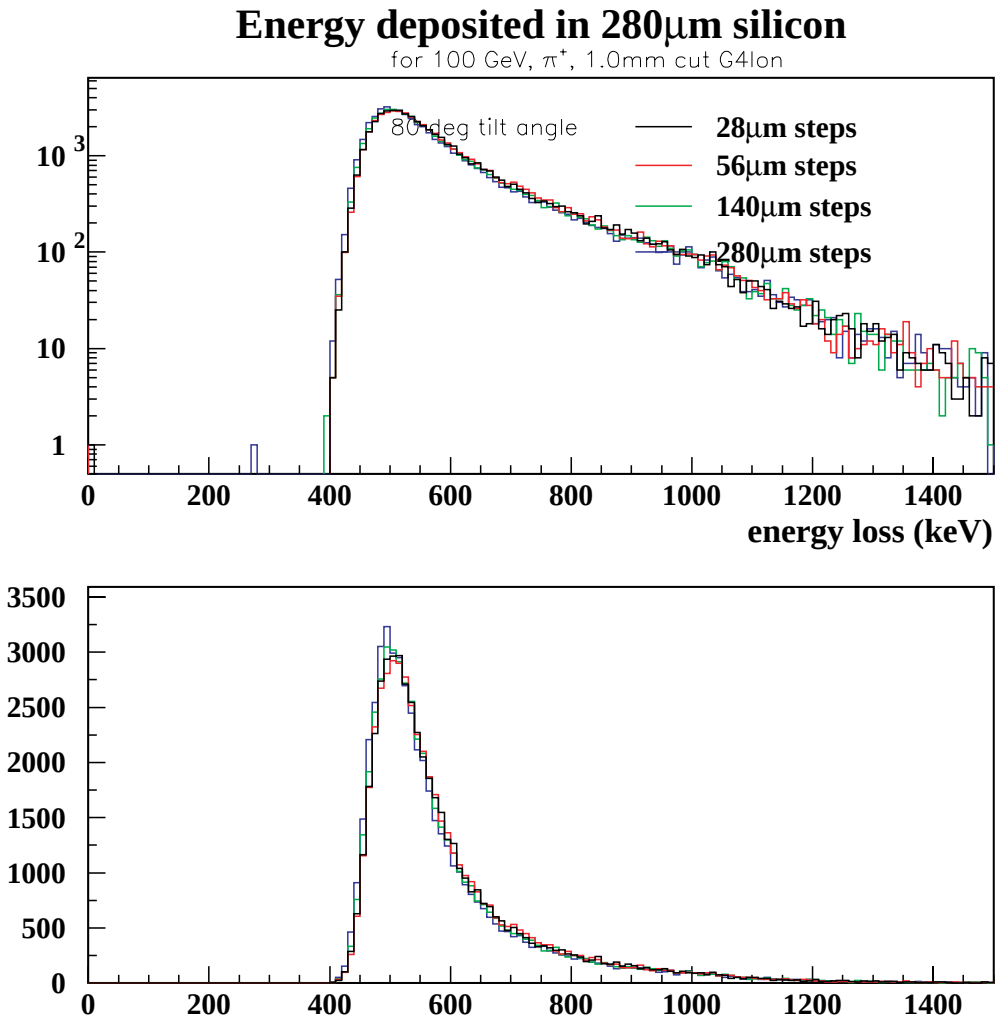
Answer:

1. **Range Cut: A range cut of 1.0 to 1.5 mm seems to agree best with the default GEANT3 cuts.**
2. **Step Length: He found that he needed at least 5 steps in the thickness of the pixel silicon wafer.**

Markus Klute

Tilt Angle

Markus even got reasonable results if he tilted the Pixel wafer to large angles to increase the path length in the wafer. Here is a plot using the standard G4Ionisation model with the wafer tilted to 80° from normal (1/cos(80°) is ~6):



Markus Klute

Pixel Conclusions

CONCLUSION and OUTLOOK

The agreement between G3, G4, G4 (PAI) is good after choosing the right parameter. Which are:

- 1.5 mm cut range
- at least 5 steps in the sensitive volume

The next steps are to redo the study in more quantitative way and compare the results with the real world.

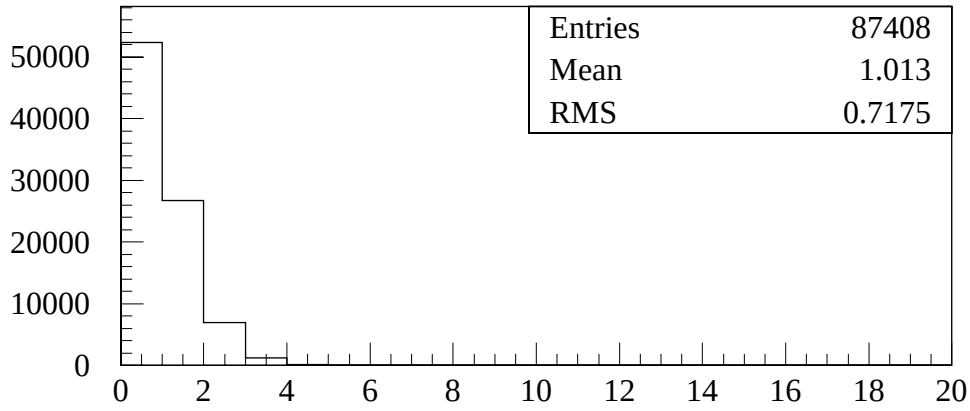
TR Work

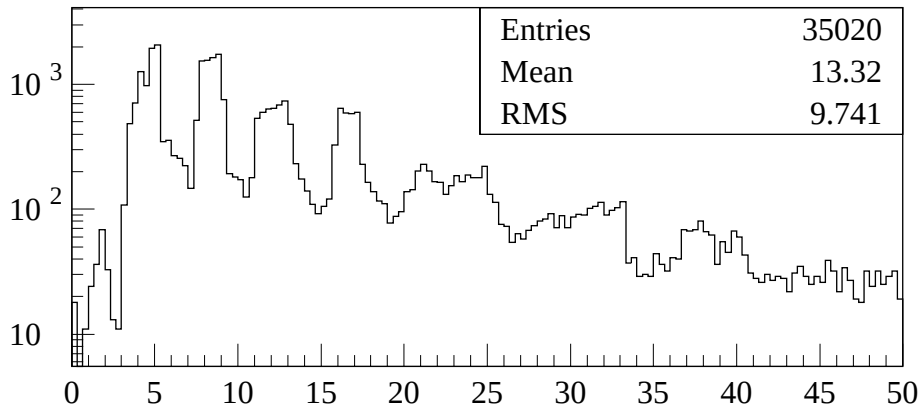
Introduction

- Geant 4.2.0 includes parameterization models for the production of Transition Radiation
  - The base class determines the trigger and implements the production from one interface
  - Various models treat the interference from multiple interfaces
- Available data from ATLAS TRT beam-tests
  - Three radiator types: regular, fibre, and tilted fibre
  - 5, 10, 20 GeV electrons
  - 5, 10, 20 GeV pions
  - 300 GeV muons

X-Ray Spectrum

When Vaso uses a stack of 37 foils (matches TRT testbeam setup) with Vladimir's most recent code she gets a reasonable looking TR photon spectrum:

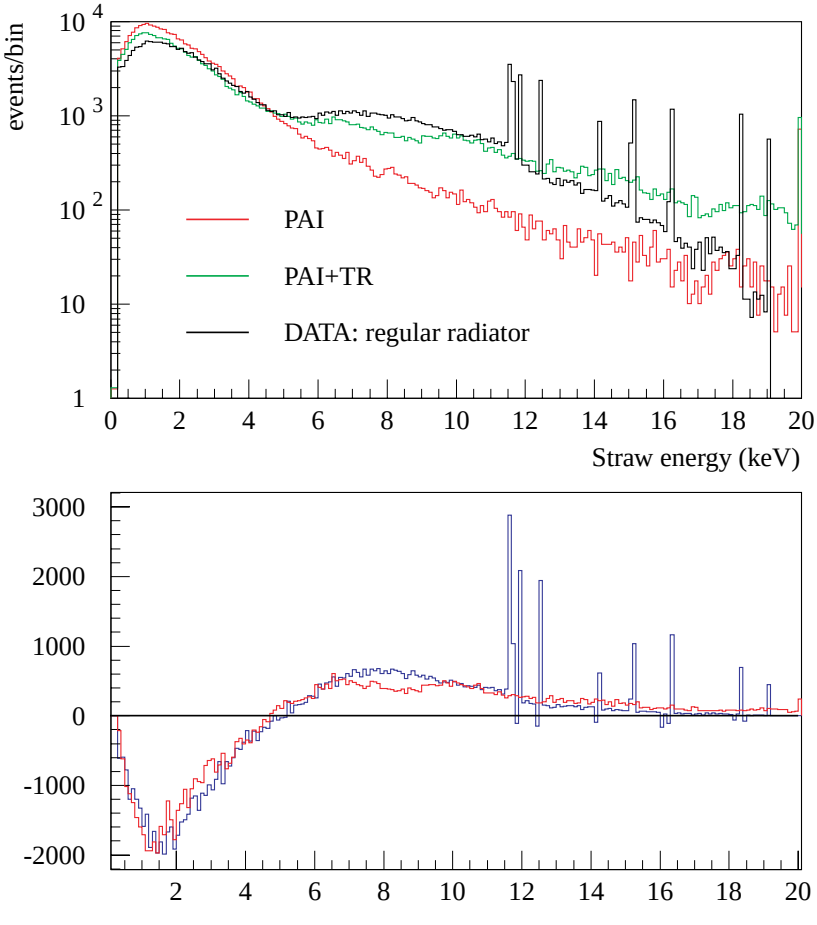




Vaso Mitsou

Testbeam Comparison

By subtracting the energy spectrum measured in testbeam runs with no radiator it is possible to extract the TR spectrum from the data:



Ignore the spikes they are caused by a testbeam read-out problem.

Except around 6-8 keV, the agreement is reasonable.

Vaso Mitsou

TR Conclusions

Conclusions – Future

- Good description of the emitted photons
- $\longrightarrow$ to be compared with Geant3
- Dependence on foil/gap thickness to be studied
- Study TR production with pions

FINAL COMMENTS

- **A number of problems have been identified and then fixed GEANT4 team. The GEANT4 team has added additional functionality to the code several times at our request.**
- **We are happy with the PAI model especially after the fix of the most recent problem.**
- **Ketevi wanted me to ask the GEANT4 team about two things that we discussed at our last meeting:**

  Investigating a parameterization model for the PAI with the TRT gas mixture.

  Adding user information (i.e. PAI cluster energies) to G4Step.
- **We still see a problem in the TR model with photon spectrum but we don't know if it is a bug in GEANT4. We will contact the GEANT4 team if we need assistance.**
- **We thank the GEANT4 team for their responsiveness to our needs. I would like to thank John Apostolakis and especially Vladimir Grishin for the considerable amount help that they have provided to us on both PAI and TR work.**