First Calibration of a New Scintillation Detector at CERF

S. Burmeister, R. Beaujean, E. Böhm, F. Petersen

Institut für Experimentelle und Angewandte Physik, Universität Kiel

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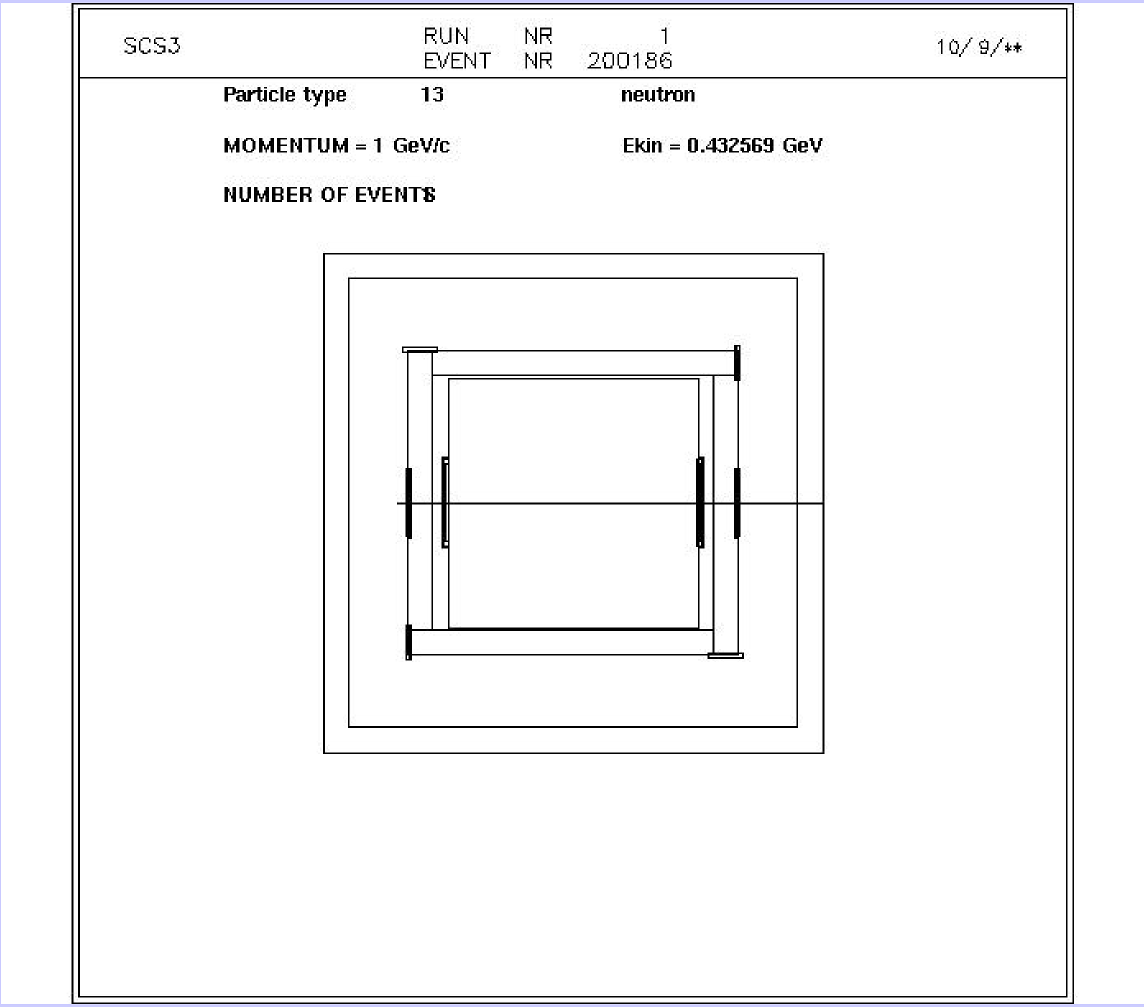
Development of a New Neutron Detector

- Why?
  - measurement of the dose contribution of the neutral component in a mixed field like onboard civil aircraft
  - the Si detector of DOSTEL is not tissue-equivalent, but a plastic scintillator nearly is
- How?
  - read out of an organic BC-430 scintillator with PIN-photodiodes
  - surrounding anticoincidence
- What happened?
  - efficiency tests of the anticoincidence
  - very first calibration with relativistic halo muons at CERF

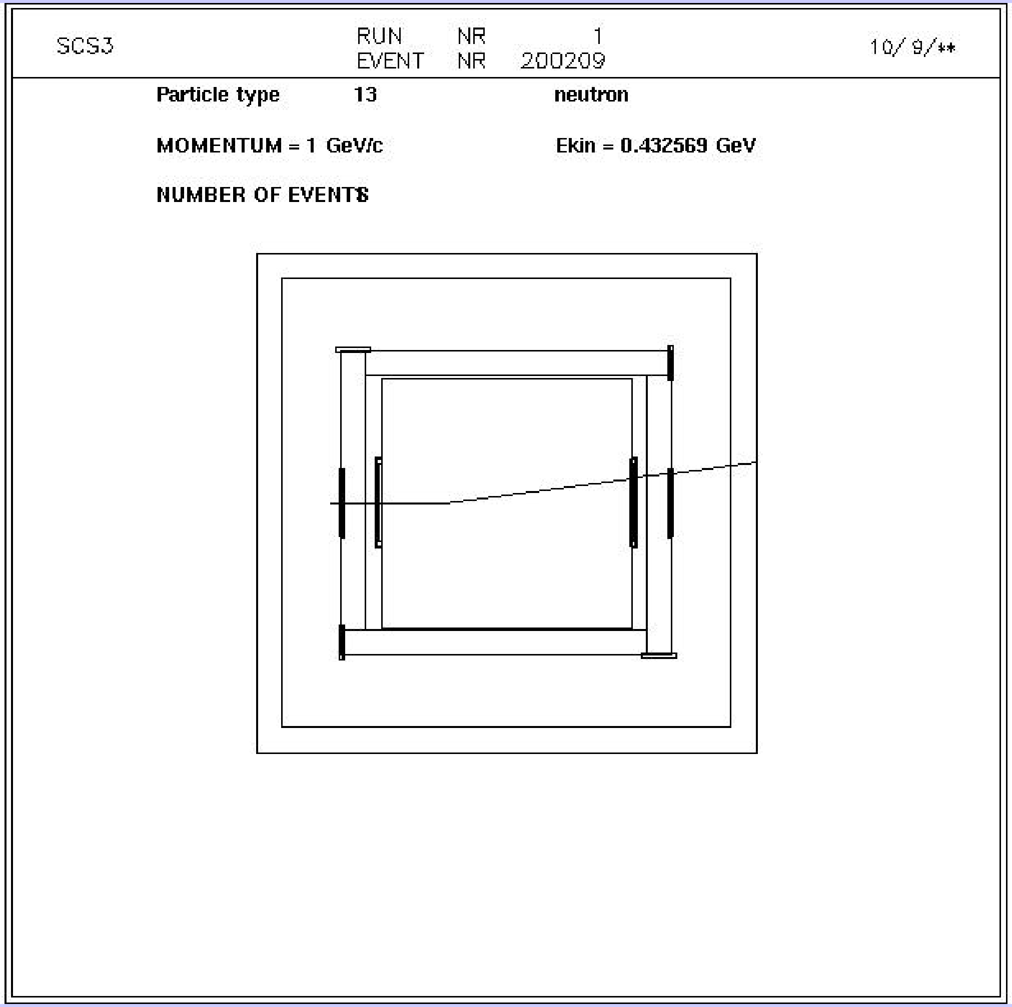
How does the neutron detection work?

- detection of recoil protons in an solid organic scintillator
- a 10x10x5 cm^3 BC-430 plastic scintillator is read out by two 2.8x2.8cm^2 silicon PIN photodiodes
- the scintillation material BC-430 was chosen because of its emission spectrum, it has its emission maximum at higher wavelength than most of other scintillation materials

GEANT3 Simulated Neutron Interactions



GEANT3 Simulated Neutron Interactions



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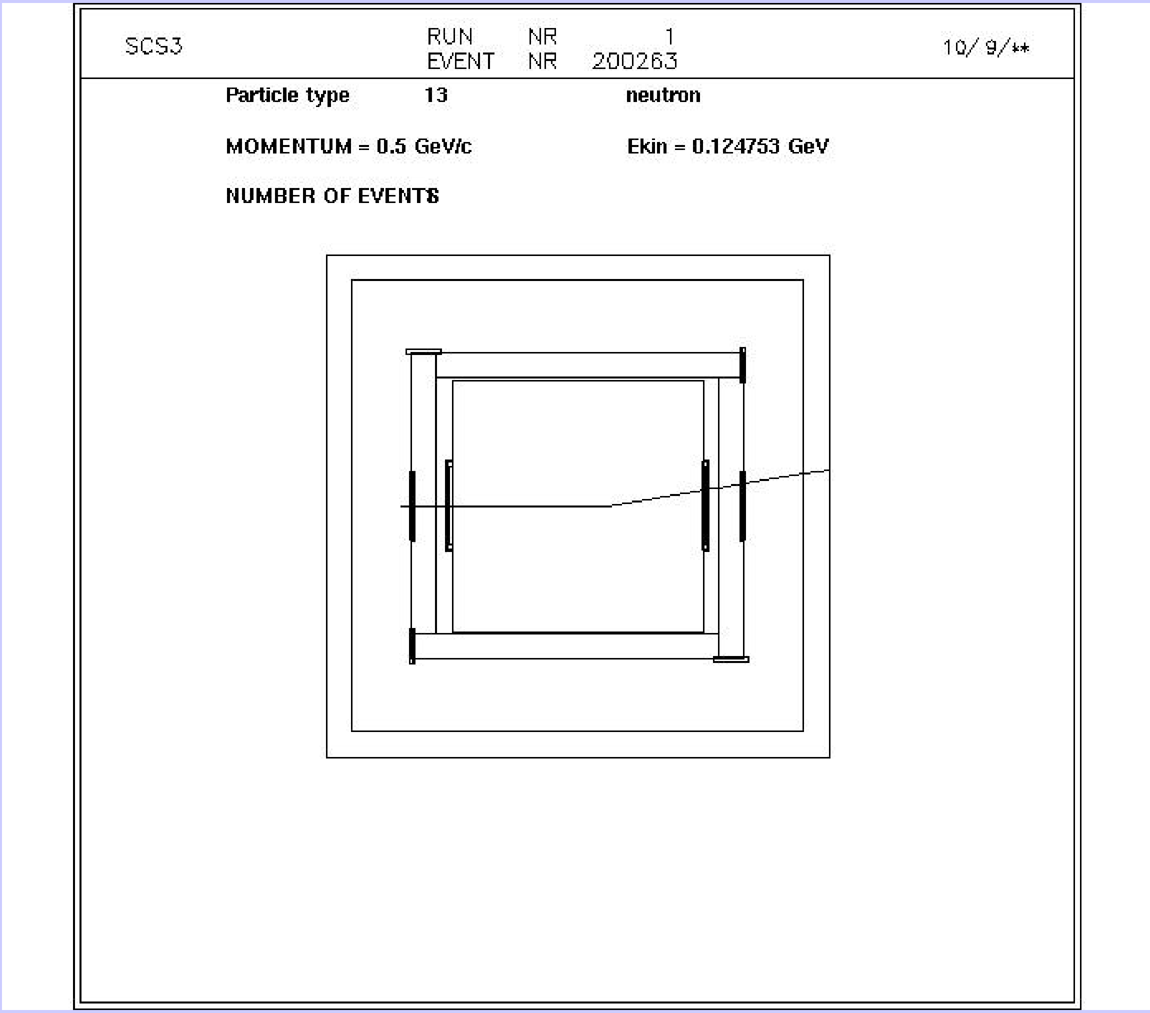

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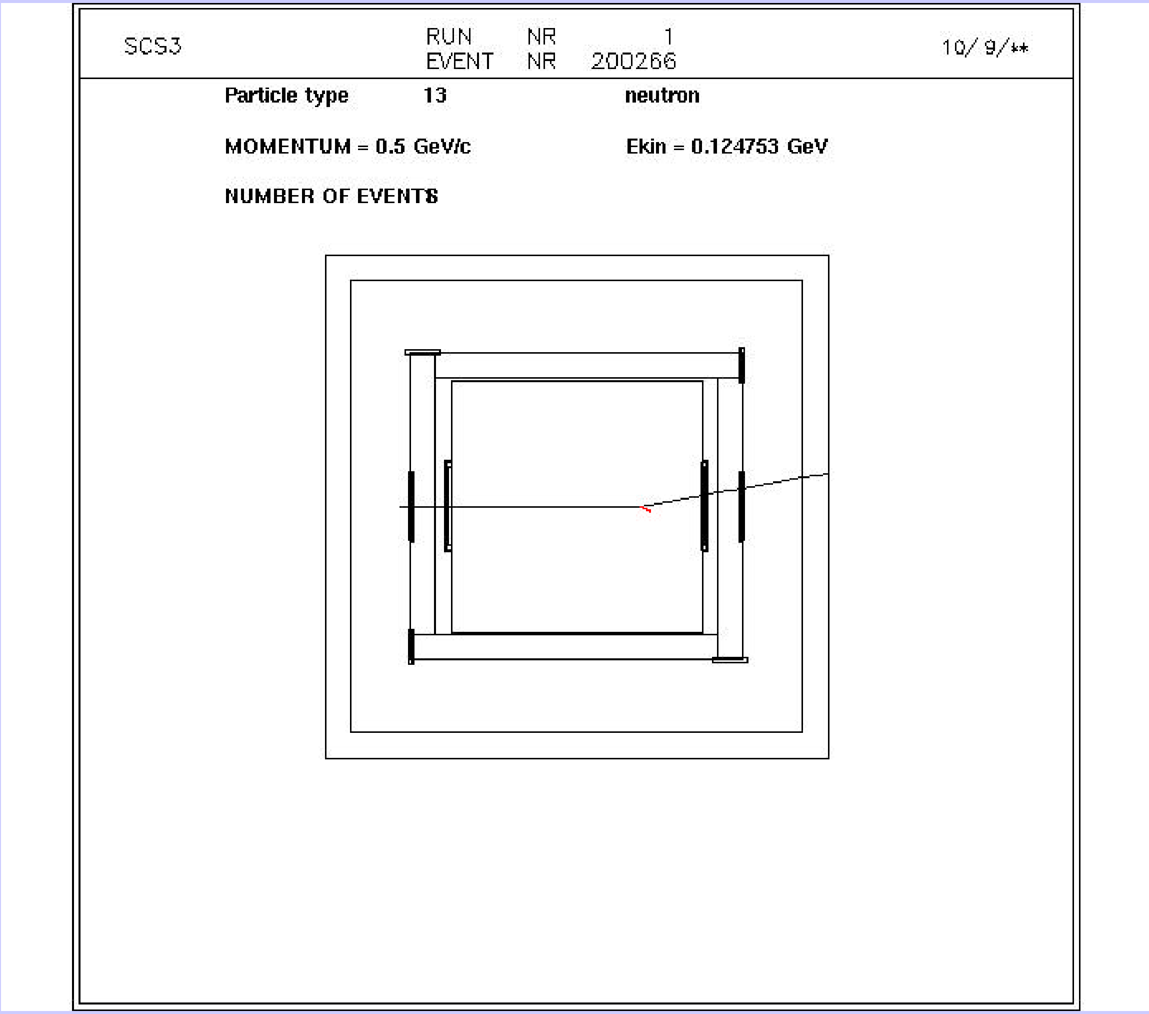

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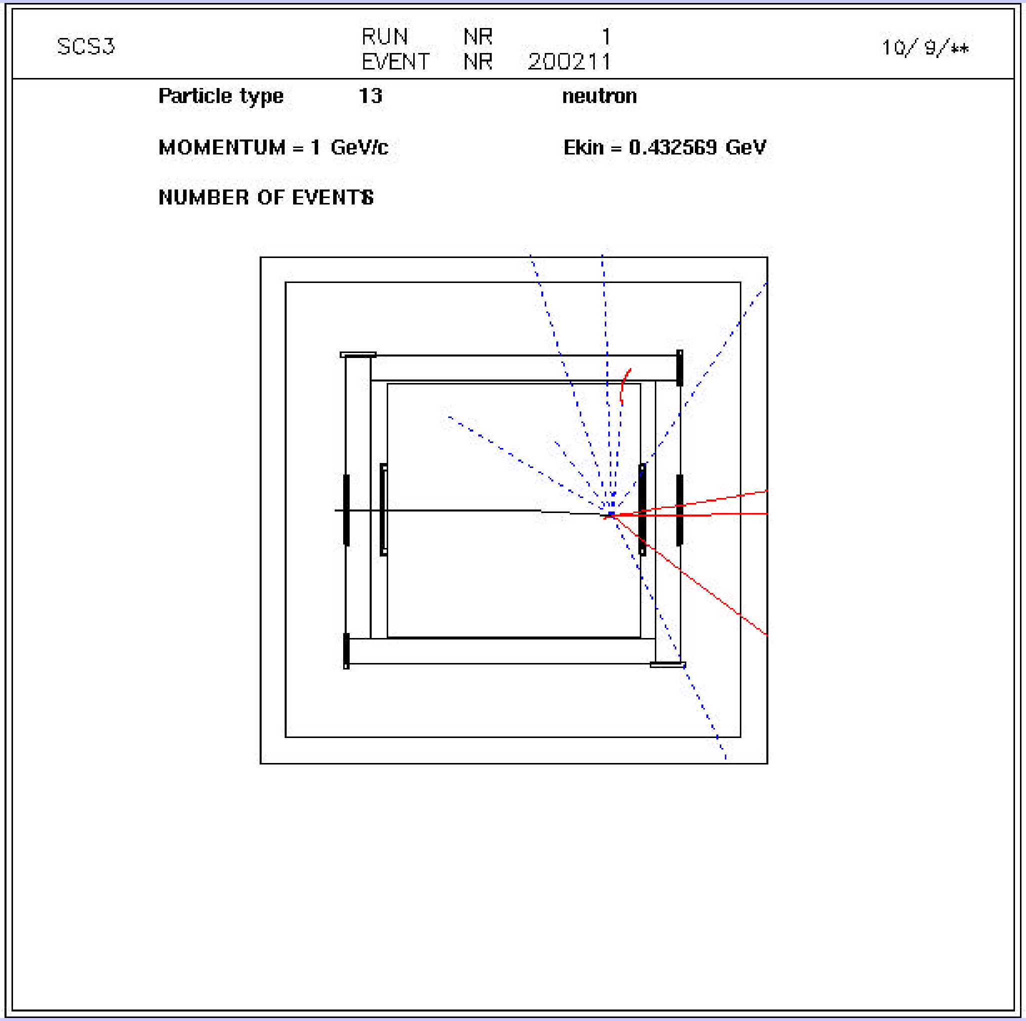

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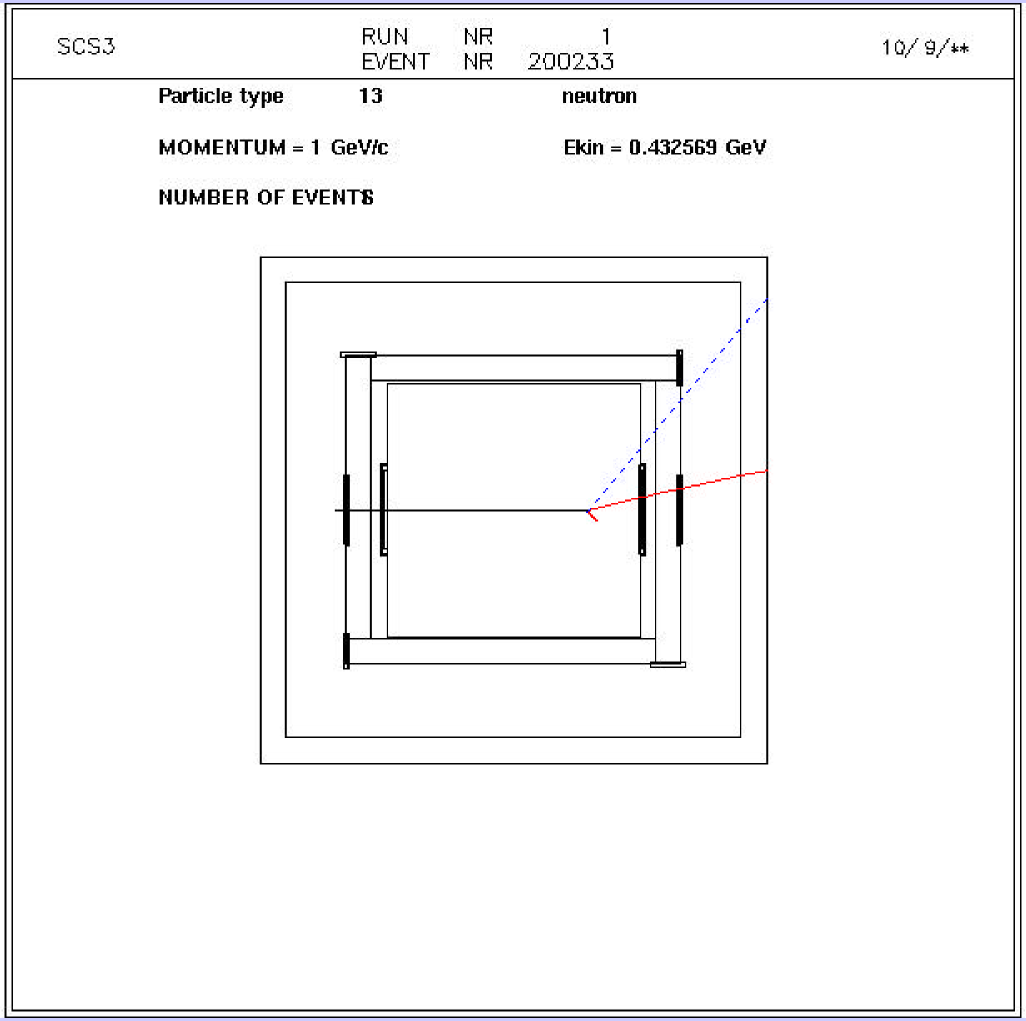

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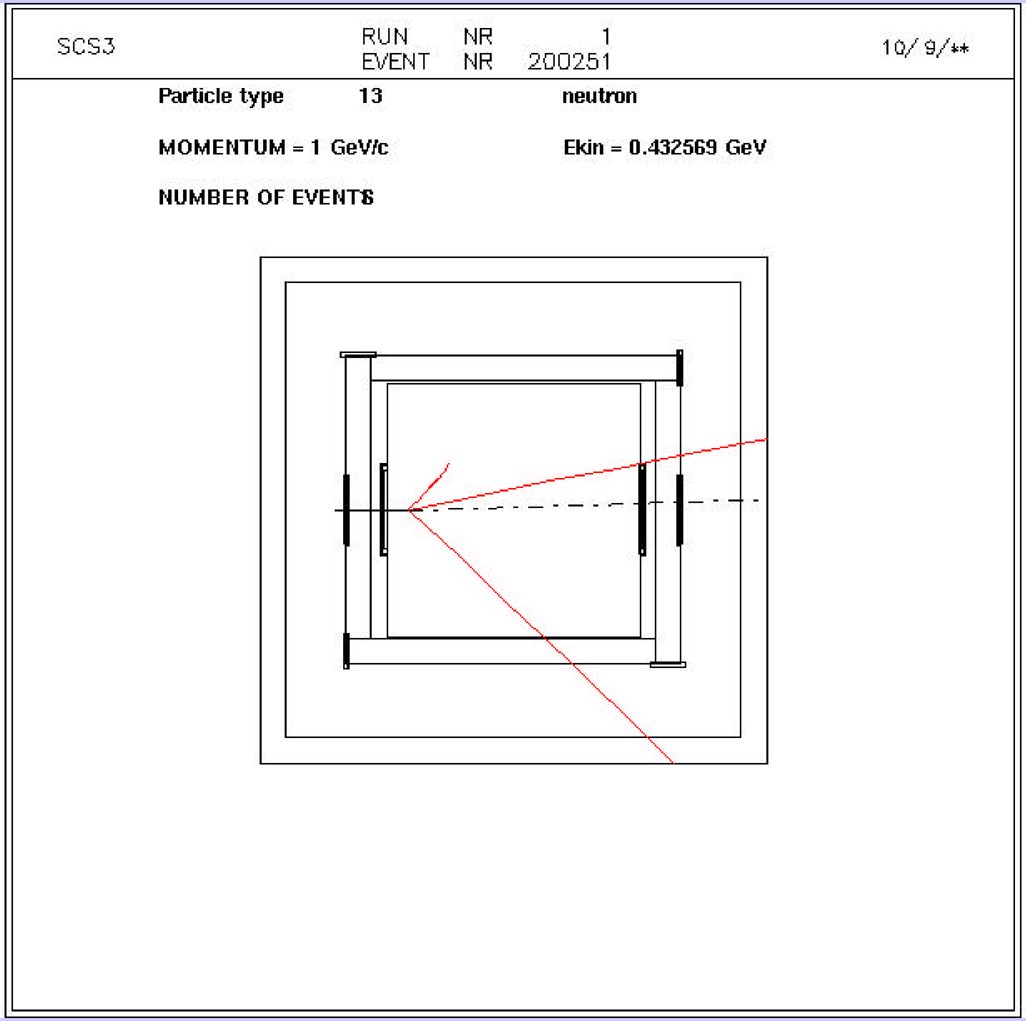
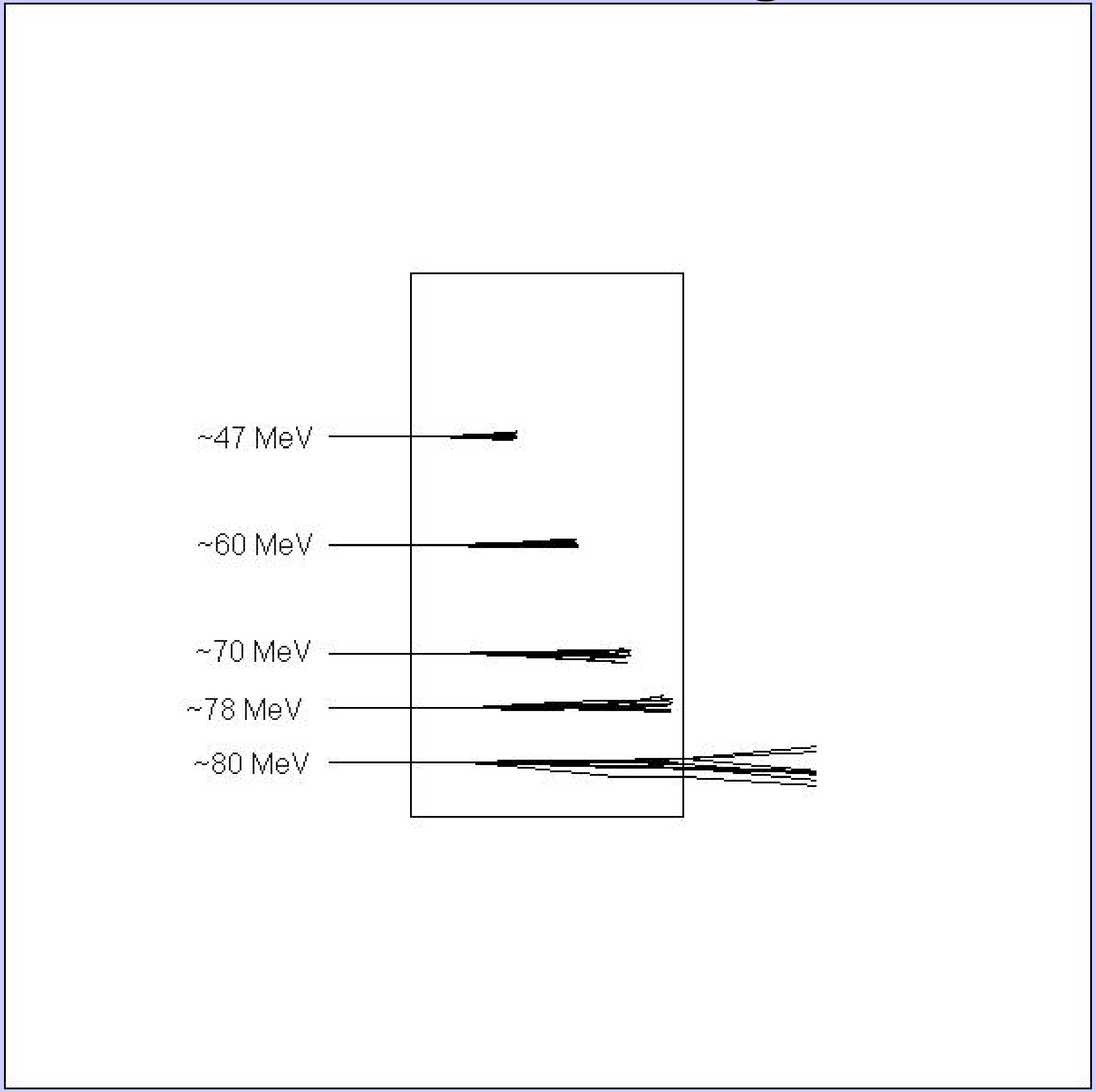
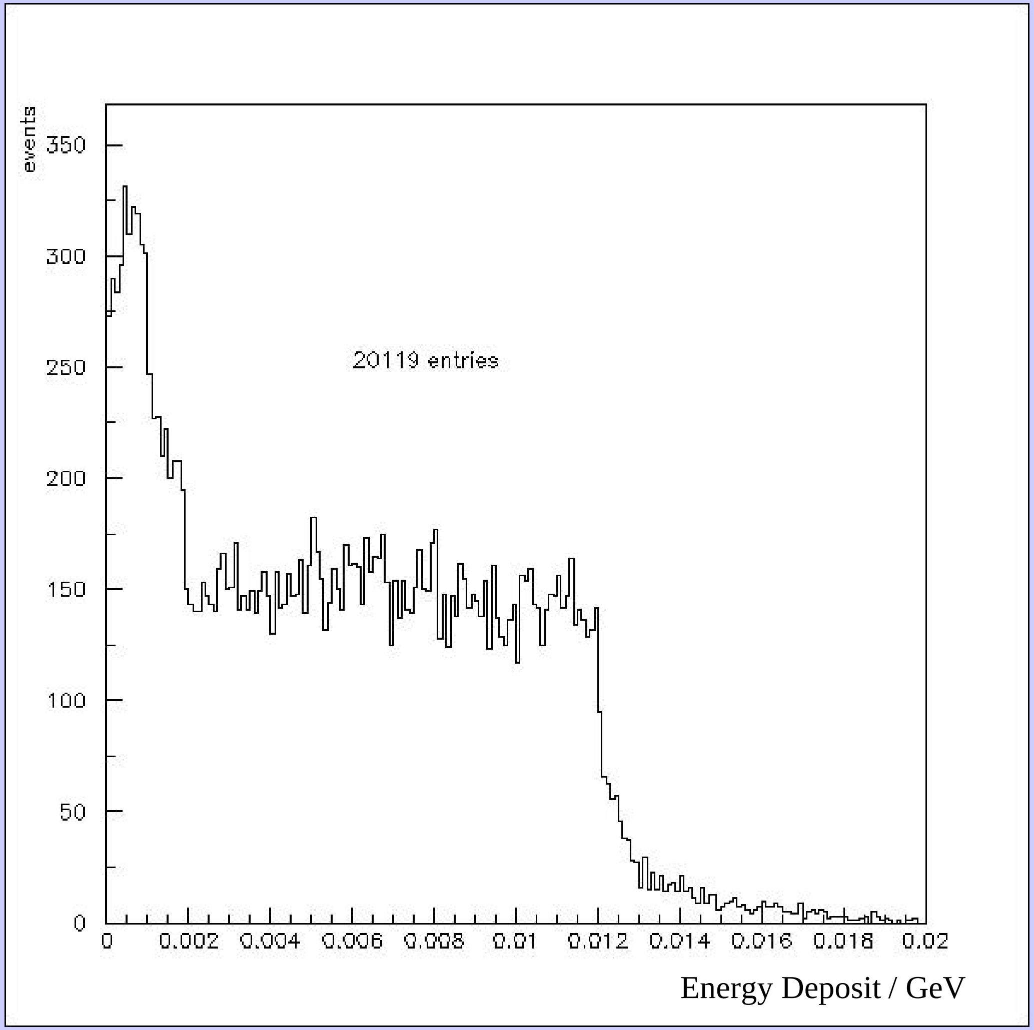


GEANT3 Simulated Proton Range in 5cm BC-430



GEANT3 Simulated Neutron Interactions
Neutron InducedEnergy Deposit in 5cm BC-430



Monte Carlo Simulation of 200,000 12MeV Neutrons penetrating 5cm BC-430.

How does the neutron detection work?

- detection of recoil protons in an solid organic scintillator ✓
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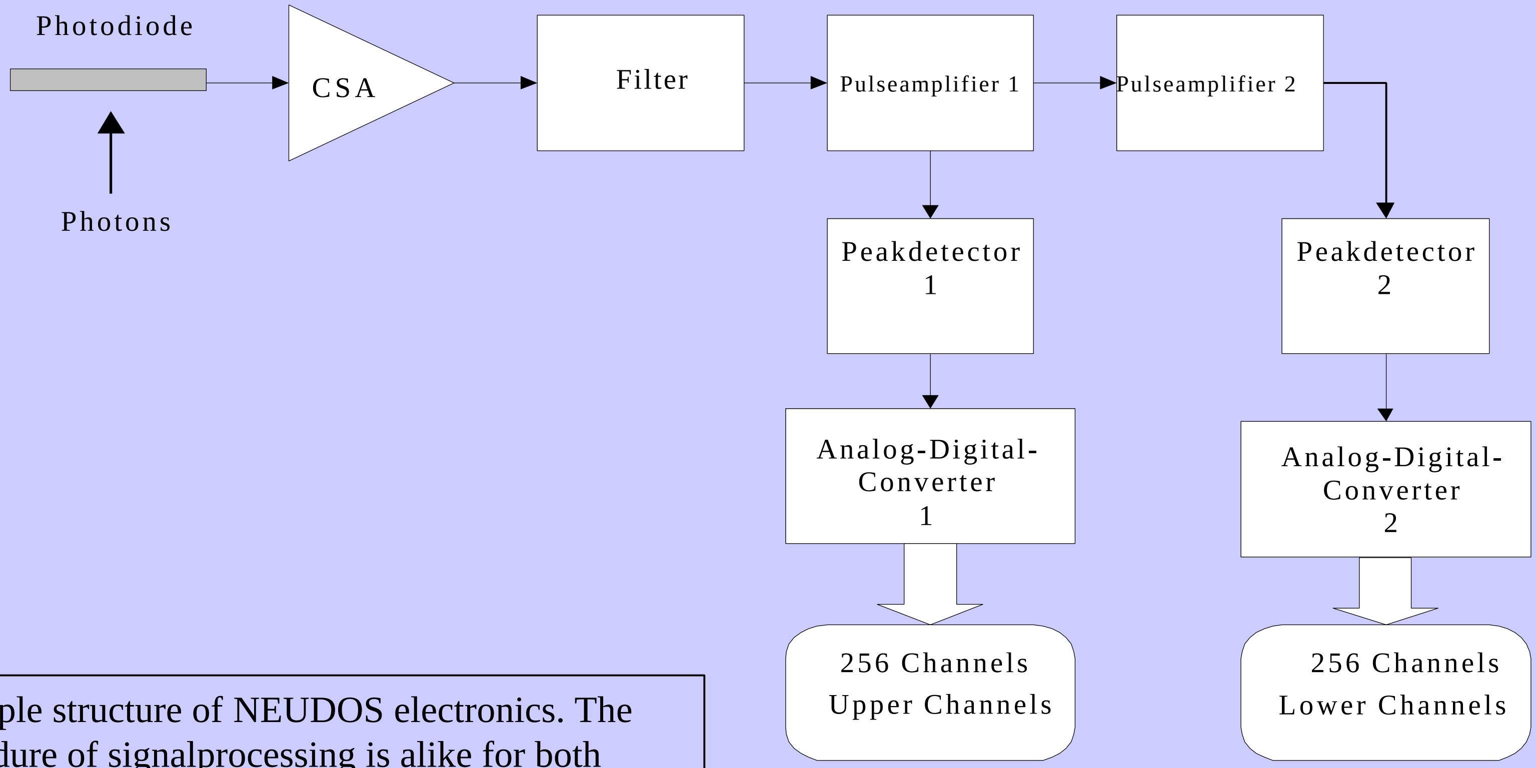
- the scintillation material BC-430 was chosen because of its emission spectrum, it has its emission maximum at higher wavelength than most of other scintillation materials

Block Diagram of the NEUDOS Electronics



Principle structure of NEUDOS electronics. The procedure of signalprocessing is alike for both photodiodes. Only coincident events are processed.

How does the neutron detection work?

- detection of recoil protons in an solid organic scintillator ✓
- a 10x10x5 cm^3 BC-430 plastic scintillator is read out by two 2.8x2.8cm^2 silicon PIN photodiodes ✓
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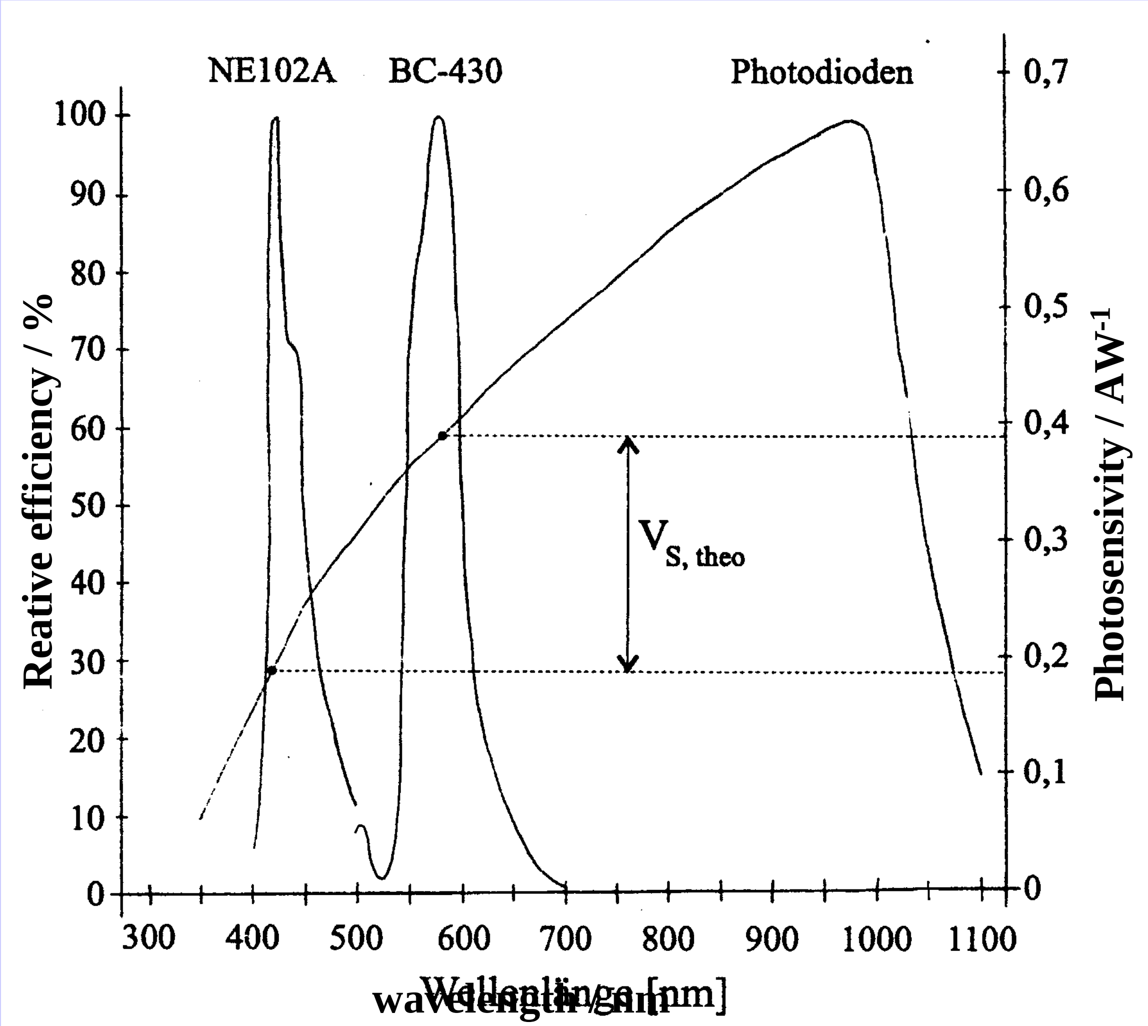
BC-430 Scintillator

- material: polivinyltoluen
  - density: 1.032 g/cm^3
  - refractive index: 1.58
  - ratio(H/C): 1.108
  - melting point: 70°C
  - raisetime: 3.2 ns
  - falltime: 16.8 ns
  - intensity maximum: 570 nm
- Plastics are nearly tissue-equivalent

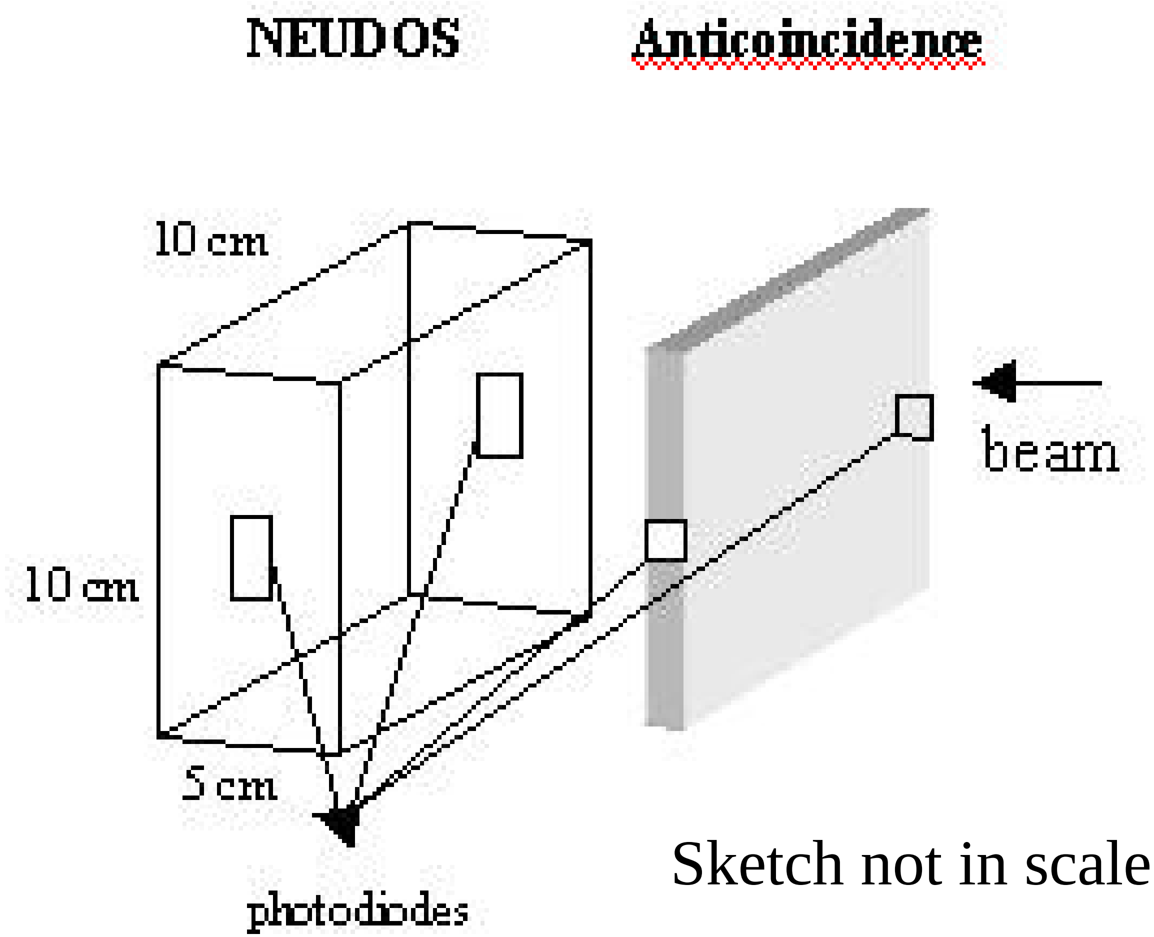
Emmissionspectra and Photosensitivity



How will the neutral component be seperated from charged particles?

- The main scintillator for neutron detection is surrounded by several scintillators as anticoincidence
- The anticoincidence consists also of organic BC-430 scintillators
- The signal of the surrounding scintillators is only used as anticoincidence trigger

First Tests of the Anticoincidence

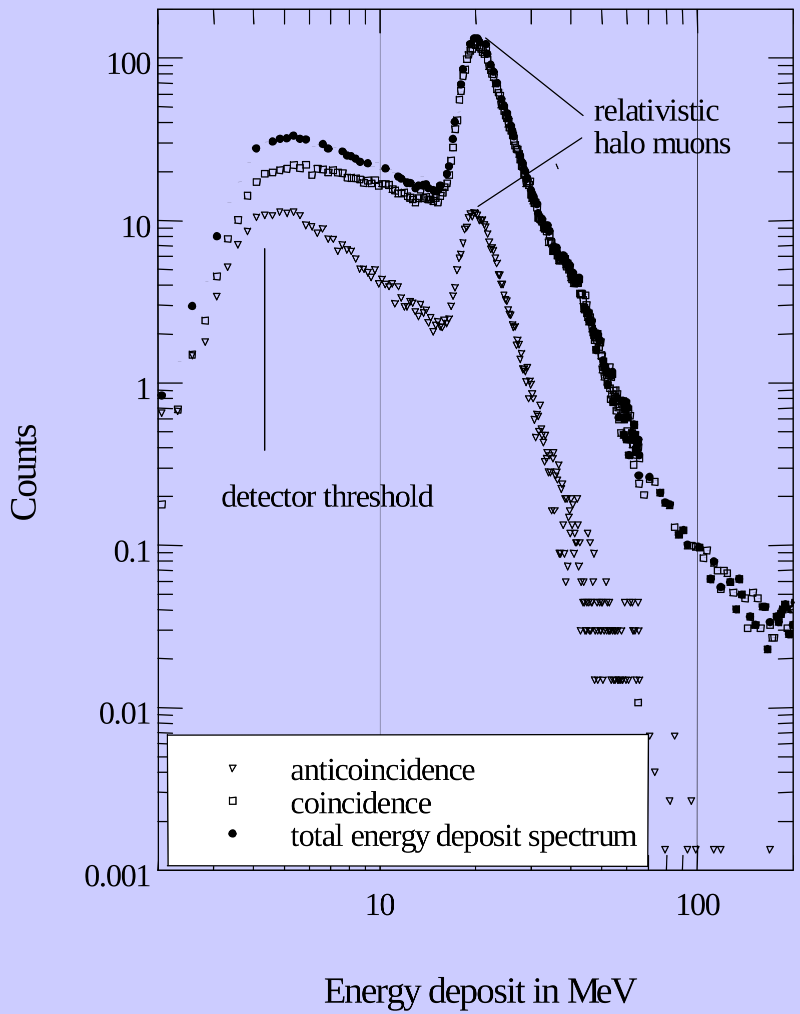


Sketch not in scale!

Response of the Anticoincidence

- The response of the anti-coincidence can be tested with relativistic muons
- as one can see by these spectra, the efficiency of one plate as anticoincidence was ‚only‘ about 92%

NEUDOS, PD2

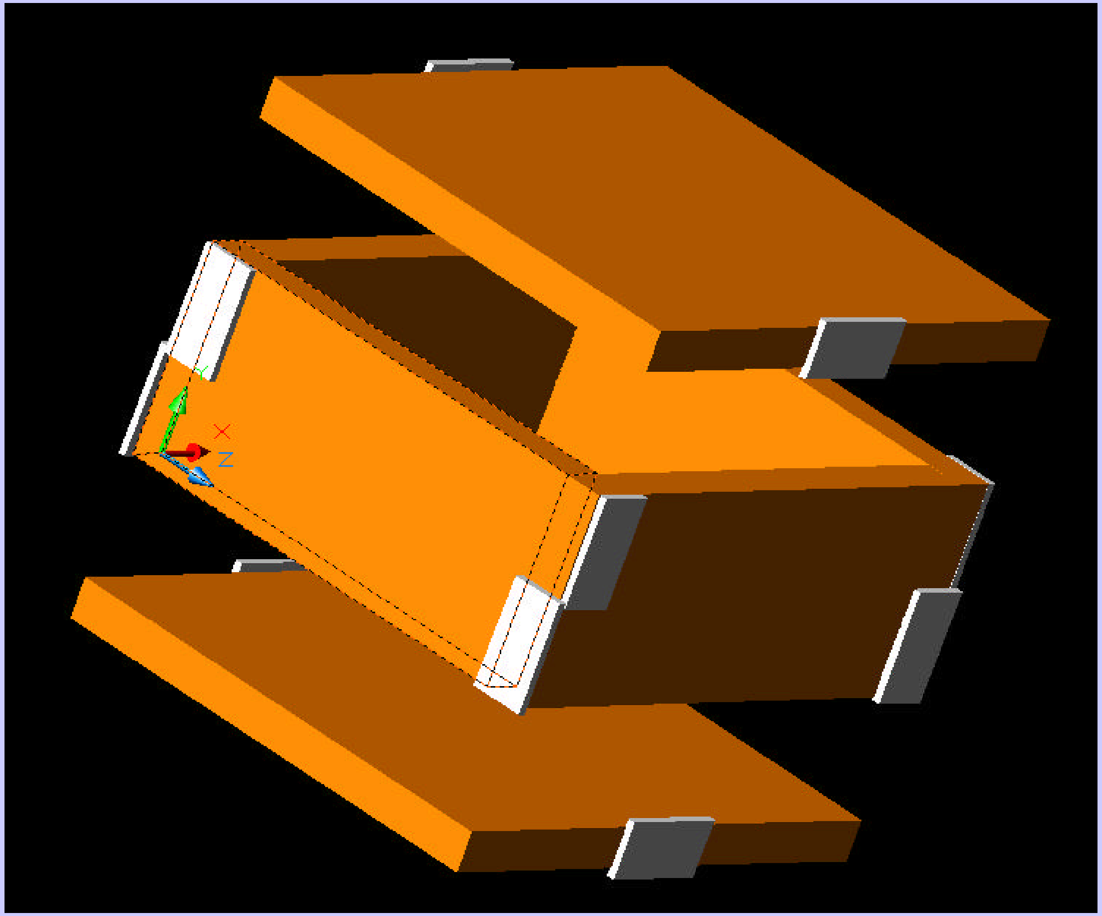


Response of the Anticoincidence

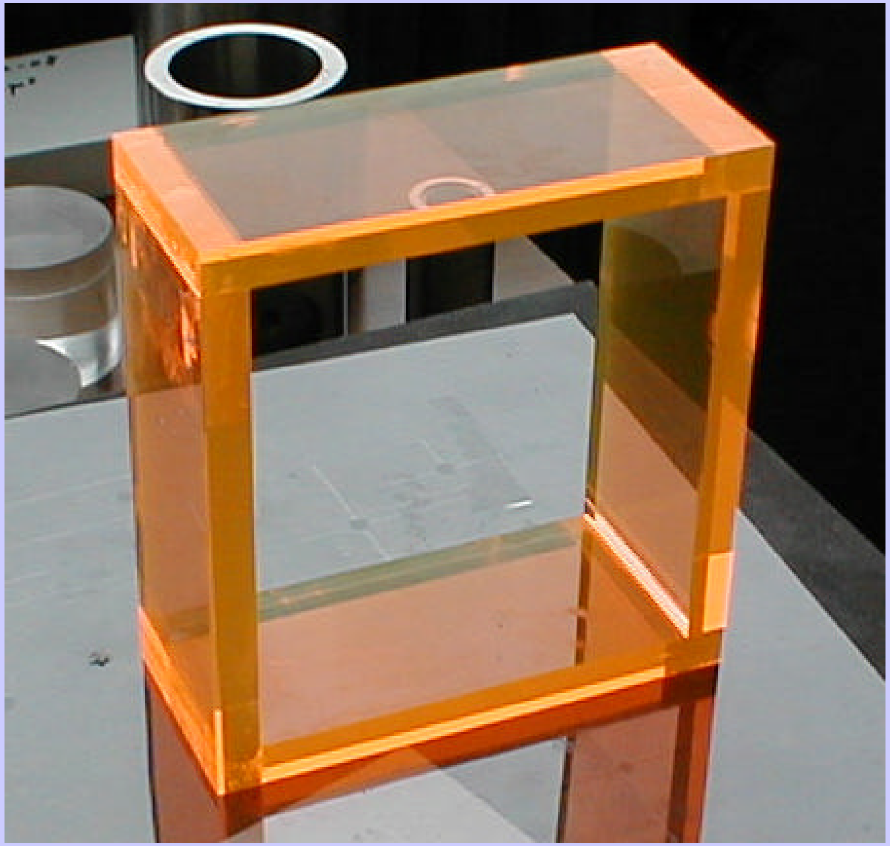
- minimum ionizing particles (e.g. relativistic muons) represent the worst case
- a minimum ionizing particle will mostly cross the whole detector system, that means it penetrates one anticoincidence scintillator on its entry and another on its exit. From this and the response of one plate follows the detection efficency: $1-0.08^2=99.4\%$

The Anticoincidence (The Next Step)

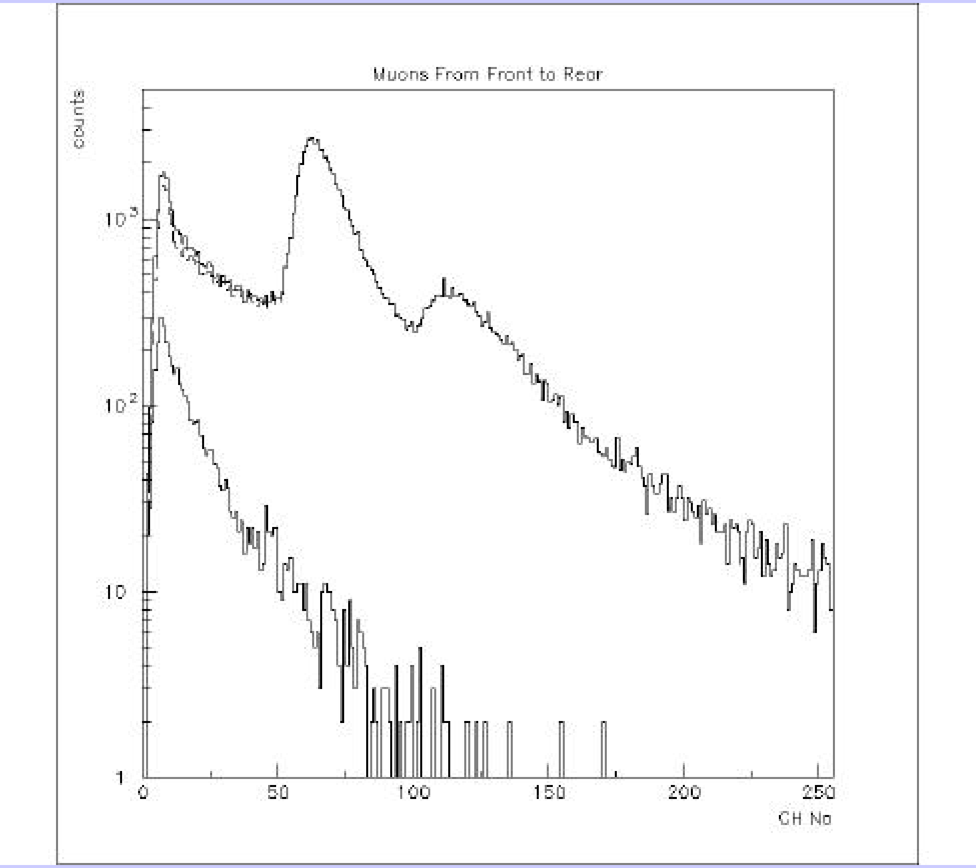
Anticoincidence structure for NEUDOS, with 20x10mm PIN diodes in ceramic carriers.



The Anticoincidence

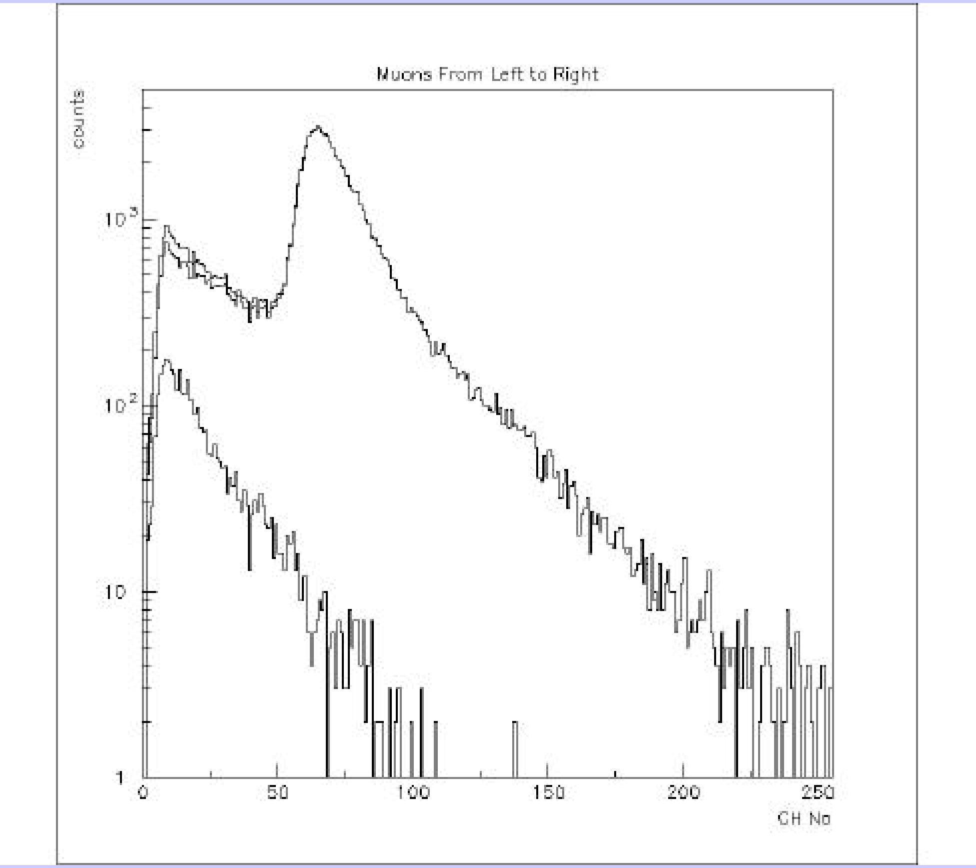


Muon Spectra



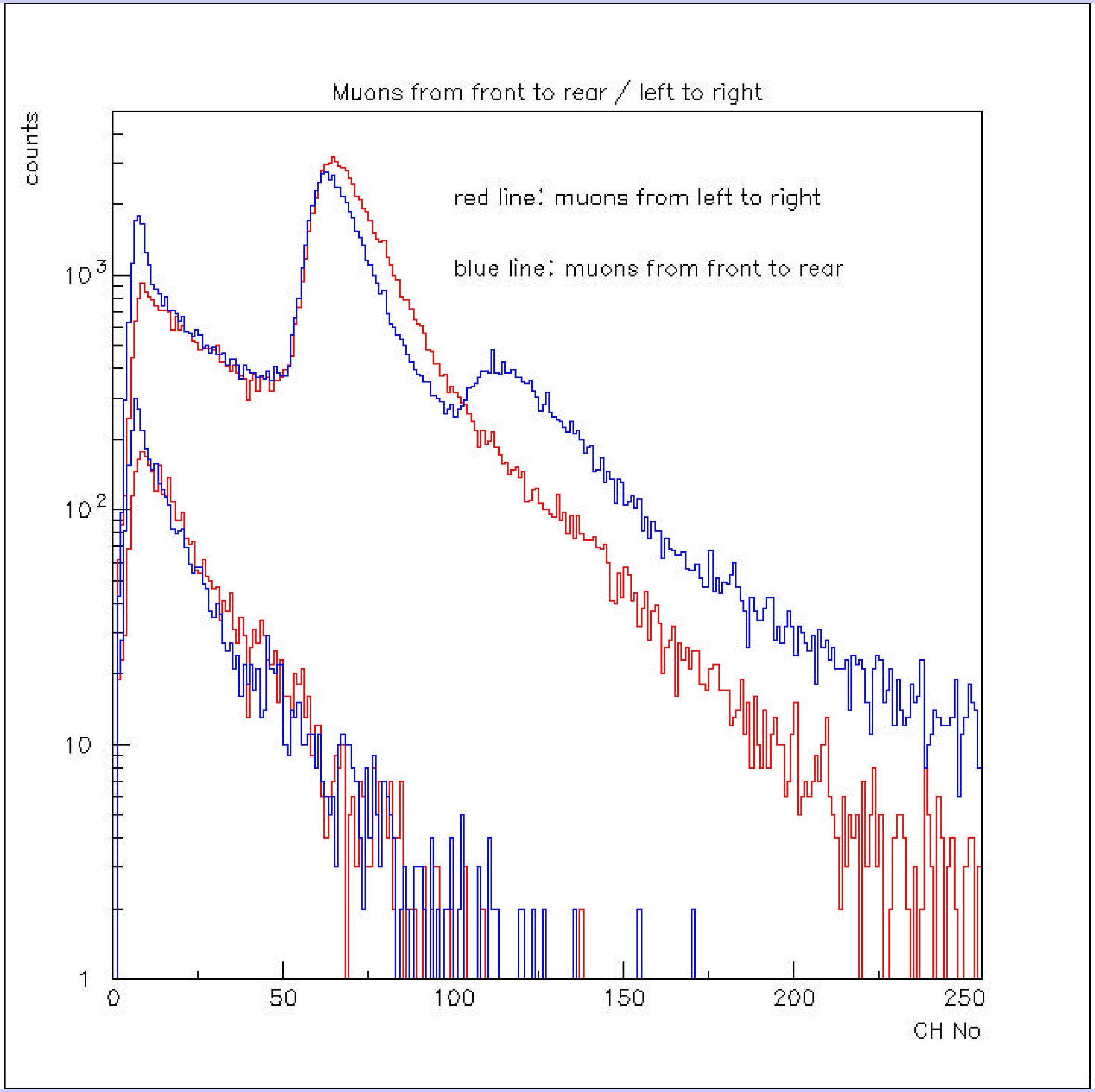
Muons crossed through front and rear anti-coincidence scintillator and through 10cm of the inner scintillator

Muon Spectra

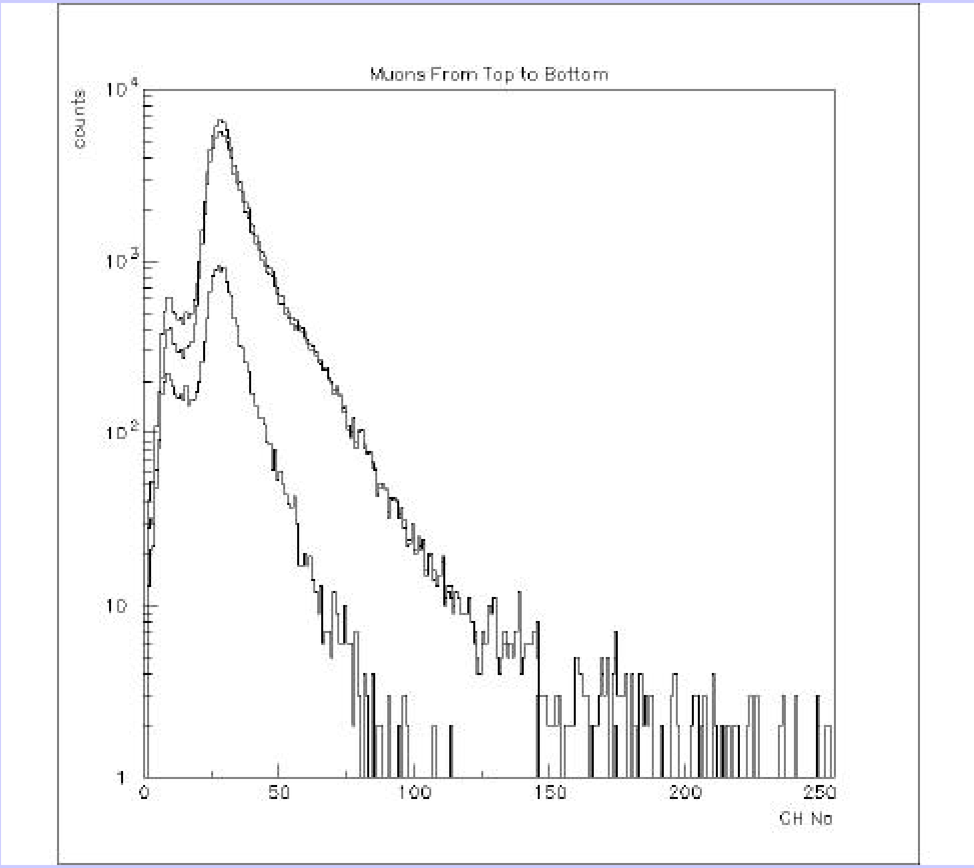


Muons crossed through left and right anti-coincidence scintillator and through 10cm of the inner scintillator

Muon Spectra

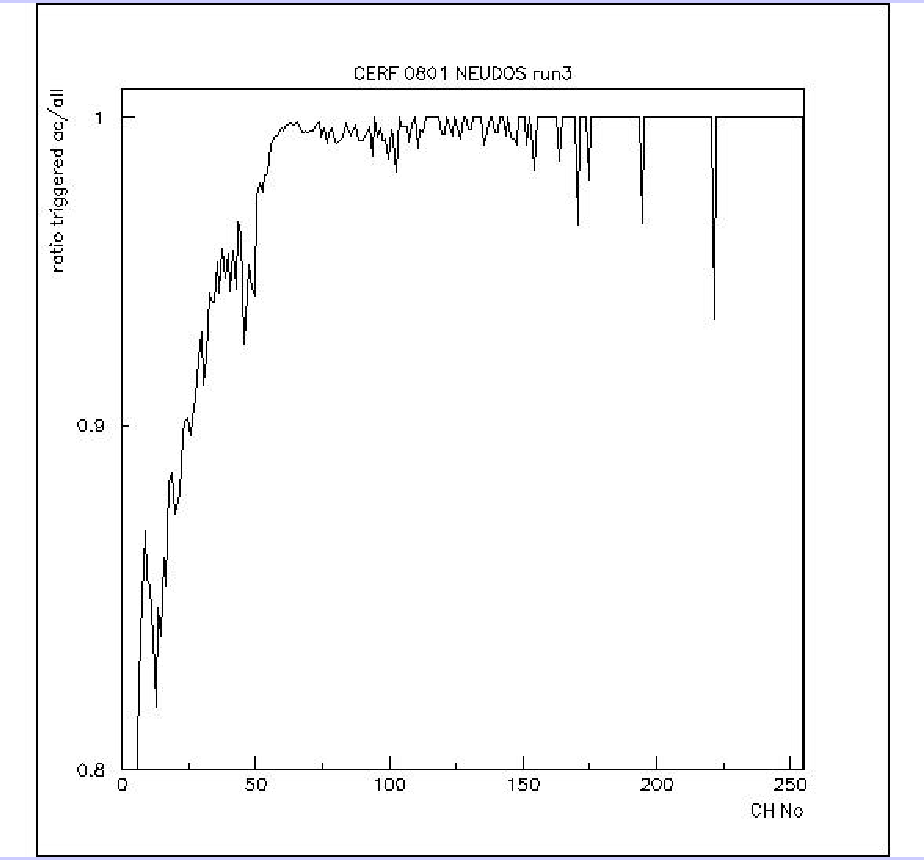


Muon Spectra



Muons crossed through top and bottom anti-coincidence scintillator and through 5cm of the inner scintillator

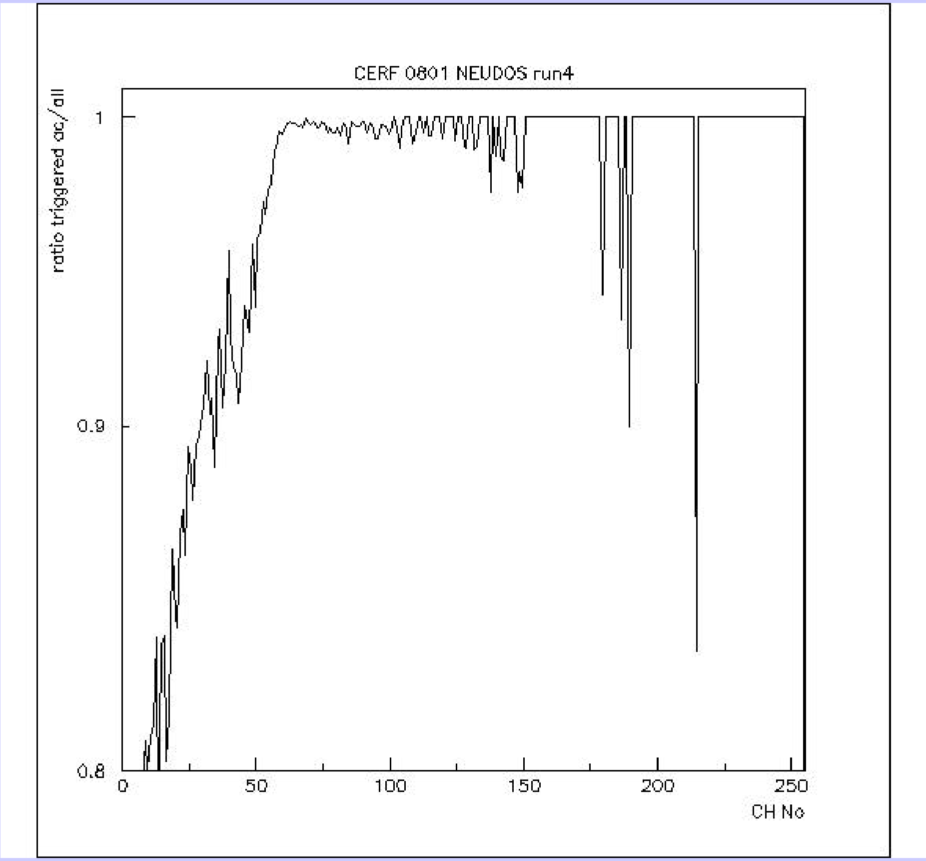
Efficency of the anticoincidence



Ratio between all events and those with triggered anticoincidence. Muons crossed the detectorsystem through front and rear anticoincidence scintillator.

In channel 62 where the scintillation muon peak can be seen, the ratio amounts to 0.998.

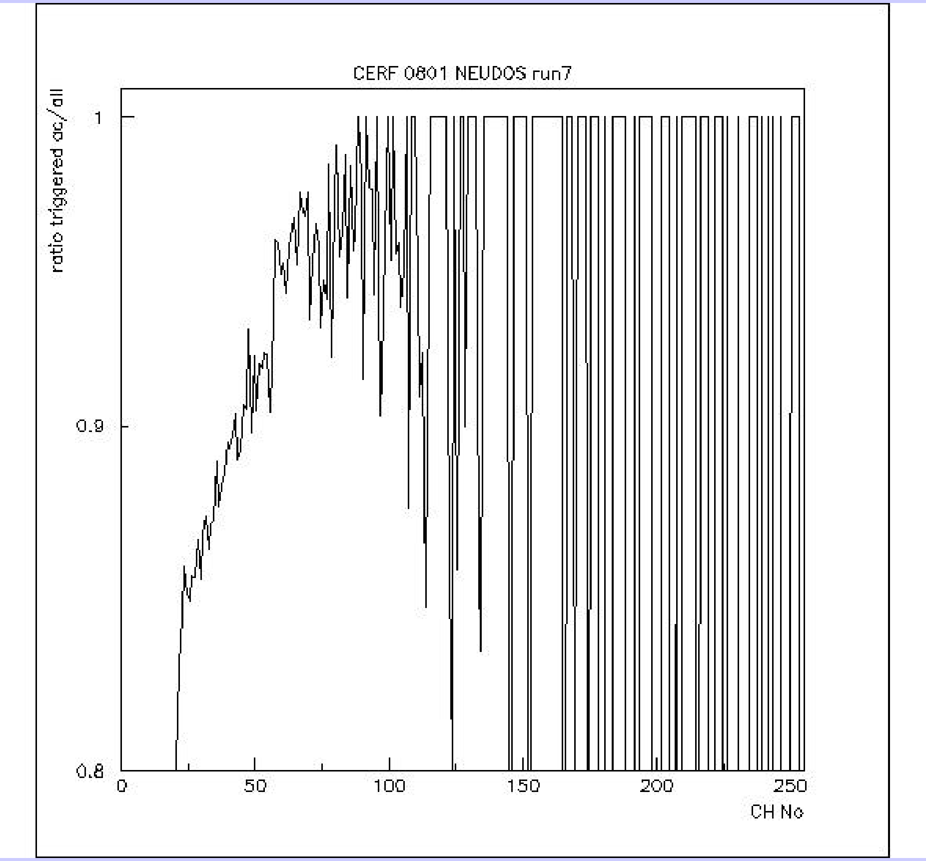
Efficency of the anticoincidence



Ratio between all events and those with triggered anticoincidence. Muons crossed the detectorsystem through left and right anticoincidence scintillator.

In channel 64 where the scintillation muonpeak can be seen, the ratio amounts 0.998.

Efficency of the anticoincidence



Ratio between all events and those with triggered anticoincidence. Muons crossed the detectorsystem through top and bottom anticoincidence scintillator.

In channel 28 where the scintillation muonpeak can be seen, the ratio amounts 0.858.