Daniel Scully

Working in a particle physics experimental collaboration

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Particle Physics is one of the most exciting branches of modern physics, which investigates the particles and forces that are the fundamental “building blocks” of the Universe we live in.

But long before startling discoveries can be made, experiments need to be conceived, researched, designed and built: a process that takes years to complete

This poster shows some of the work in which I was involved during my 8 weeks with the Warwick Particle Physics group.

The Experiment

One of the experiments worked on in the Particle Physics group at Warwick is the T2K (Tokai to Kamioka) experiment in Japan.

The experiment will look at the behaviour of a type of elementary particle called the “neutrino”.

What are Neutrinos?

- A class of elementary particles
- They interact very weakly – they pass straight through almost everything
- Millions from the Sun pass through your body every second
- The are three different types of neutrino
- As they travel, they change between the three different types – it is this process that particle physicist are interested in measuring

The T2K experiment will make neutrinos in a particle accelerator at Tokai, and then fire them 300km through the earth to the other side of Japan, to a large neutrino detector at Kamioka.

The T2K experiment

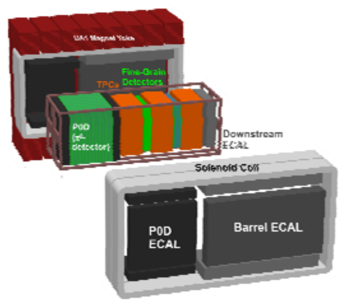
The neutrinos are made at the J-PARC accelerator in Tokai…
pass through the ND280 detector…
and on to the Super-KAMIOKANDE detector in Kamioka

Before travelling to the detector at Kamioka, the neutrinos will pass through a smaller detector close to the accelerator where they were made.

By measuring the neutrinos near to where they were made in the “near detector”, and at the large detector in Kamioka, the experiment can determine how many neutrinos have changed into a different type of neutrino during the journey.

It is this “near detector”, which Particle Physicists in the UK are working on.

It is called the ND280 detector (Near Detector at 280m)



An exploded diagram of the ND280 detector

Particle Identification

When the neutrinos pass through the ND280, some of them will interact with (hit) atoms in the detector, and the collision will make new particles.

By identifying these new particles, we can determine what type of neutrino interacted with the atom. Two of the particles that might be made are “photons” and “muons”.

When in the detector, these particles will also interact, and we can take measurements of when, where and how much this happens.

Different particles behave differently, and so the measurements of their interactions are also different.

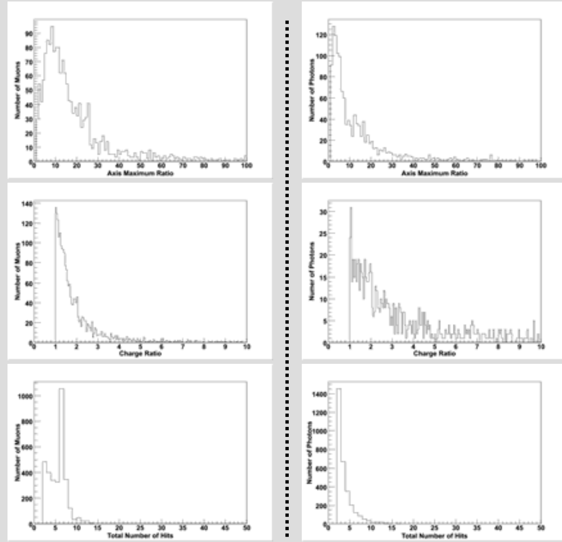
I was involved in finding which combinations of these measurements best showed the differences between muons and photons.

Some of them are shown in the histograms to the right.

Can you spot the differences?

Spot the difference

Muons | Photons



Optical Fibre Scanner

When the particles produced by neutrinos interact in the ND280 detector, they create a lot of light. Knowing the amount of light that a particle has created, allows us to calculate how much energy that particle has.

The amount of light is measured by light detectors called “photo-sensors”. But it must be carried along optical fibres to get to these photo-sensors.

However, because some of the light is absorbed while travelling down the fibre, we must first measure how much light is lost.

To do this, Warwick Particle Physics group have created an “Optical Fibre Scanner”.

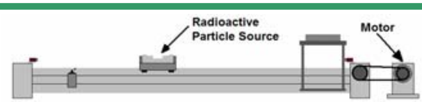


Diagram of the optical fibre scanner showing the motor and particle source
The optical fibre is suspended above.

I had to create a computer program to control this optical fibre scanner. The program was required to:

1. Instruct a motor to accurately position a source of particles at a chosen distance along the fibre.
2. Measure the light reaching the photo-sensor at the end of the fibre
3. Repeat the process along the whole length of the fibre.

THE UNIVERSITY OF WARWICK

Work was funded by the Nuffield Foundation

T2K members in the Warwick Particle Physics group

Dr Gary Barker, Dr Steve Boyd, Dr John Back, Dr Ben Morgan, Antony Carver, Martin Haigh

For more information

http://www2.warwick.ac.uk/fac/physics/research/epp www.t2kuk.org