RAL
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RUTHERFORD APPLETON LABORATORY
SCIENCE AND ENGINEERING RESEARCH COUNCIL

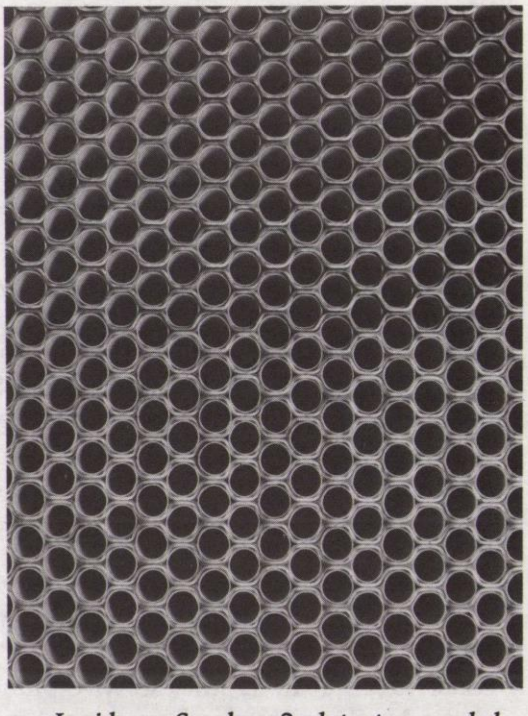
The Soudan 2 detector

What will Soudan 2 do?

The Soudan 2 experiment is designed to detect the possible decay of ordinary protons and neutrons in the atomic nucleus. The rate of decays is expected to be very low, maybe only one decay per year in 1000 tons of material ($6x10^{32}$ protons and neutrons).

What and where is Soudan 2?

It will consist of about 230 modules similar to the ones you see being built at RAL. Modules are constructed here and at Argonne National Laboratory in the USA before being sent to the Soudan mine in Minnesota USA where they are stacked together to form the complete detector. The experiment has to be done deep underground (710 metres beneath the surface) to shield the very sensitive detector from cosmic rays which could produce interactions that might be confused with proton decays.



Inside a Soudan 2 detector module

How does it work?

Each module is made up of a sandwich of corrugated steel sheets, plastic tubes and insulating plastic sheets contained in a gas tight steel skin. A mixture of Argon and Carbon Dioxide gas is circulated through the module. The source of protons and neutrons is the material of the detector itself. If a decay occurs, charged particles will be emitted with enough energy to pass through many steel sheets and plastic tubes before eventually coming to rest. When the particle crosses a plastic tube it knocks up to 100 electrons out of the atoms of gas in the tube. These electrons drift along the plastic tube under the influence of a -10 kilovolt electric field applied to the tube centre until they reach the tube mouth.

Stretched from top to bottom of the module, facing a column of tubes, is a long thin wire kept at an electrical potential of + 2 kilovolts. The electrons that have drifted out of one of the tubes in this column are accelerated towards the wire. The signal produced by their arrival is detected by the sensitive electronics attached to the wire. The arrival of the electrons on the wire is also detected on a strip of copper perpendicular to the wire, facing a row of tubes. By matching this signal with the signal on the wire the tube which was crossed by the track can be determined and from the time the electrons took to drift along the tube the crossing position can be found. The size of the signal measures the amount of ionisation deposited. The wires and copper strips are mounted on a flat board, called a "wire plane", which is carefully aligned and attached to the face of the steel sheets.

The signals on all the wires and strips are continuously examined by control computers. If an interesting, pre-programmed combination of signals is found the complete detector is read out and the data saved. A short while later the data are processed on a more powerful computer and the tubes crossed by particles are reconstructed. Stringing together the tubes produces tracks similar to those simulated in the display at the exhibit. From the characteristics of the tracks the nature of the initial decay or interaction can be determineed and genuine proton decays separated from background interactions.

What is the current status of Soudan 2?

63 modules have been built to date in the UK. The module stack is constructed at RAL and the wire planes at the Nuclear Physics Department in Oxford. The two are married here for testing, before being shipped to the Soudan mine. Each module costs £9000 to the UK and £7000 in materials supplied from the USA. It takes 7 people two weeks to construct and test a module. 120 modules are currently producing data in the Soudan mine.

Stacking a Soudan 2 module at RAL

For more information on this project, please contact Peter Litchfield, Soudan 2 group, tel (0235) 446265 or Esther Peacock, RAL Press & Public Relations section, tel (0235) 445777.