Living in a Material World Introduction

Research and development of the materials discussed in today's teleconference have required a variety of techniques including neutron diffraction techniques employed by the ISIS neutron source at the Rutherford Appleton Laboratory in Harwell.

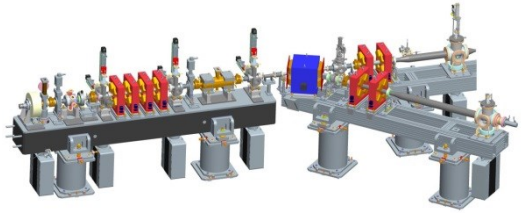
The stories of these two materials are fascinating and we hope that you will tell them again at your centres.

There are a number of facilities that are involved in the development of new materials that are both part of or in partnership with STFC campuses. All are fascinating and all have their own stories to tell. You can find out more about these using the following links:

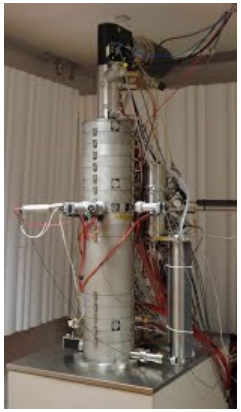
1. Diamond Light Source, Harwell

2. Central Laser Facility, Harwell

3. Versatile Electron Linear Accelerator, Daresbury Laboratory

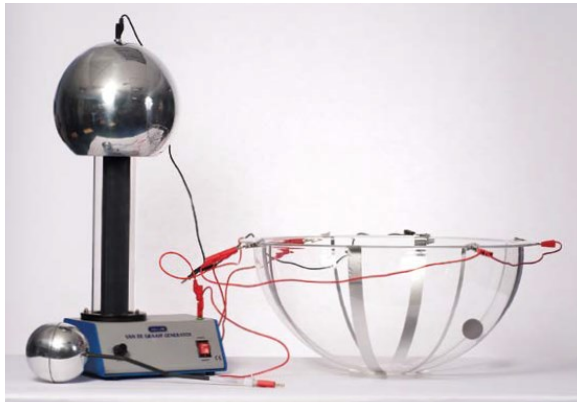


4. SuperSTEM (Scanning Transmission Electron Microscope), Daresbury Laboratory



5. Hartree Super Computer, Daresbury Laboratory

Linking Living in a Material World to EYU



The particle accelerator in a salad bowl is an ideal starting point to introducing these two stories, as you can use this to explain how the ISIS neutron source facility works.

Take the ping pong ball and attach two small pieces of blue tac either side to suggest that what you have is a proton with two electrons (this is your negative ion source). Explain to your audience that this ion source is going to be fed into 3 different accelerators.

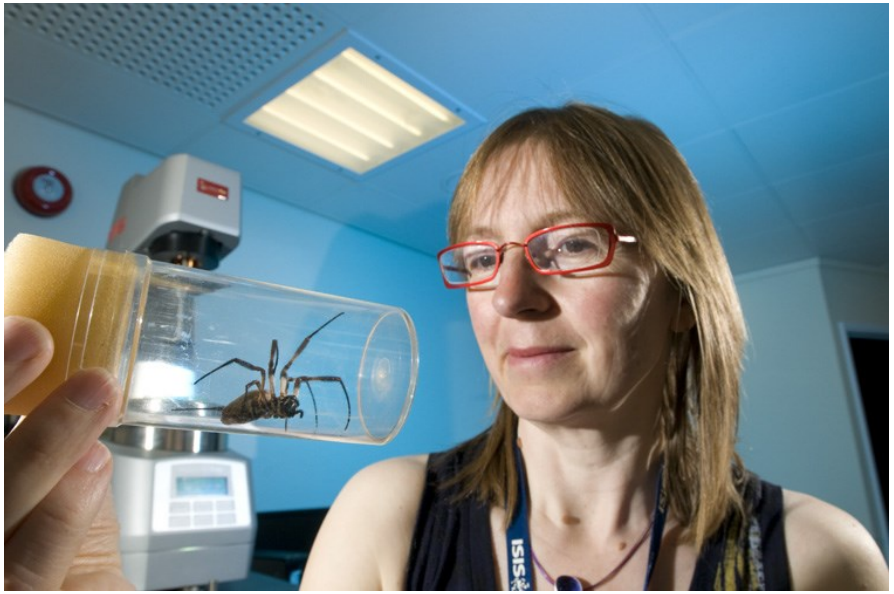
1. The first accelerator will focus the ions a little like an optical lens.
2. The second accelerator (a linear accelerator or linac) (you could drop the ball through a transparent piece of tubing here) then accelerates the ions up to 35% of the speed of light.
3. The ions are then transported to the third and final accelerator – the circular synchrotron (our salad bowl) but not before being stripped of their electrons by passing them through a thin foil (so make sure that you remove bluetac at this point).
4. The synchrotron is made up of ten sections each consisting of a magnet to bend the proton beam around in a 163m circle, you could explain that rather than using magnets, we have used the curvature of the bowl and gravity to keep the ball bending in a circle.
5. Electric fields supply the accelerating forces on the proton just as the electric field here are accelerating the ping pong ball, except that in our model the charges on the ping pong ball changes every time it contacts a strip – this does not happen in ISIS.
6. Use the EYU handbook to explain how the salad bowl accelerator works.
7. The magnetic field grows ever stronger as the speed increases to keep the proton bunches moving in their circular path. After 12, 000 revolutions the protons will reach 84% of the speed of light (they would travel six times around the Earth in one second). The beam then hits the primary target where each proton produces about 20 neutrons.

Linking Living in a Material World to EYU (cont'd)

Neutron instruments are used like powerful microscopes to study the atoms in materials. Scientists can work out where atoms are and measure the forces between them, and these techniques were employed by both Steve and Ann when researching and developing the materials that you will hear about on the telecon. These stories are therefore a perfect way to illustrate to your audiences what this technology can help achieve and inspire them about what UK science and technology is currently achieving

To make your workshops interactive consider making use of hydrogen fuel cell cars and kits, and demonstrations involving the combustion of hydrogen to get people thinking about hydrogen as a potential energy source. Get the children to work in groups measuring the tensile strengths of materials to compare this to spider silk.

The applications of naturally occurring silk proteins (Spider Silk) – Dr Ann Terry



http://www.isis.stfc.ac.uk/news-and-events/news/2013/spider-silk-scaled-up-could-stop-a-boeing-747-ann-terry-on-bbc-oxford13692.html

http://www.thenakedscientists.com/HTML/content/interviews/interview/1000888/

http://news.bbc.co.uk/1/hi/sci/tech/7709435.stm

Nanostructures for hydrogen storage (future fuels) – Professor Stephen Bennington

http://cellaenergy.com/

http://www.telegraph.co.uk/finance/businessclub/10082671/Fuelling-the-dream-of-clean-cars.html

http://www.automotiveworld.com/analysis/cella-energy-advances-hydrogen-range-extender-trials/

How ISIS works

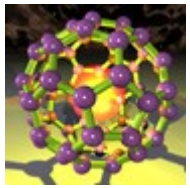
Link

ISIS is made up of many components. At the heart of ISIS is an 800 MeV proton accelerator producing intense pulses of protons 50 times a second. The accelerator consists of an injector and a synchrotron.

How ISIS works - in depth

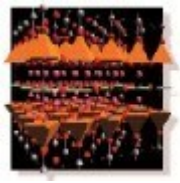
ISIS Instruments by technique

Neutrons sometimes behave as waves, just like light. If the neutrons are going at the right speed, their wavelength is ideal for looking at atomic structure. The following links will allow you to find out more about the various ISIS instruments, how they use neutrons or muons and how they work.



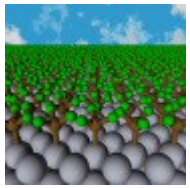
Muon spectroscopy

Muons provide a complementary probe to neutrons, particularly in the areas of magnetism, superconductivity and charge transport.
Argus, Emu, Hifi, MuSR



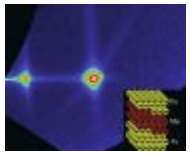
Neutron diffraction

Neutron diffraction experiments determine the atomic and/or magnetic structure of a material. This technique can be applied to study crystalline solids, gasses, liquids or amorphous materials.
Gem, EnginX, Hrpd, Nimrod, Osiris, Pearl,Polaris, Rotax , Sandals, SXD, Wish , Ines



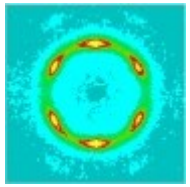
Neutron spectroscopy

Neutron spectroscopy measures the atomic and magnetic motions of atoms.
Iris, MAPS, MARI, Merlin, Tosca, Vesuvio, Let,Osiris



Reflectometry

Neutron reflectometry is a technique for measuring the structure of thin films. It has applications from materials science through to soft matter and bioscience.
Crisp, Inter, Offspec, Polref, Surf



Small angle scattering

Small angle neutron scattering is a neutron technique able to probe structures at length scales from around 1 nanometre to more than 100 nanometres. It has a wide range of applications from studies of polymers and biological molecules to nanoparticles to microemulsions and liposomes used for cosmetics and drug delivery.
Loq, Sans2d, Nimrod, Sandals

Science & Technology Facilities Council

Other Fascinating ISIS Stories

Optimising machining strategies for Boeing

Breaking the Barriers to a solar Future

Building safer ships with Lloyd's Register

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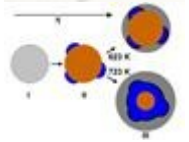
Testing new welding techniques for the nuclear industry with AREVA



What do you do when the oil runs out? You make it!

Helping make hydrogen cars a reality

The Linde Group launches revolutionary carbon nanotube ink with help from ISIS

Letting the train take the strain

Solar flares, muons and micro-electronics – what's the connection?

Intriguing ISIS Videos

Hydrogen Storage - Backstage Science

1 year ago

23,531 views

A team from the University of Bath use the neutrons at ISIS to make a breakthrough. Special thanks to Valeska Ting and Tim Mays.

Making Muons - Backstage Science

3 years ago

12,856 views

Strange, exotic particles which are made at the huge ISIS particle accelerator in Oxfordshire.

Muon Man - Backstage Science Q & A

3 years ago

4,628 views

Philip King from the Muon Group at ISIS tells us a little more about himself and his work.

Neutrons and Nanoscience - Backstage Science

2 years ago

11,282 views

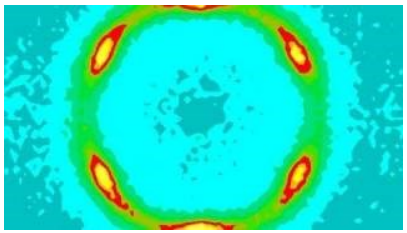
Beams of neutrons can be used to make important discoveries in the world of nanoscience. Here we explore three instruments.

Engin-X - Backstage Science

3 years ago

7,355 views

Engin-X is an instrument at the ISIS neutron source, in Oxfordshire.



How to make Neutrons - Backstage Science

3 years ago 17,537 views

One of the world's leading neutron sources is the ISIS facility, in Oxfordshire, UK. We take a look around its cavernous buildings.