A particle detector to

SSERC has been given a new piece of apparatus to lend to schools. We think you and your students are going to like it. It is a particle detector (Figure 1), capable of detecting alpha, beta and gamma radiation and other types such as muons.

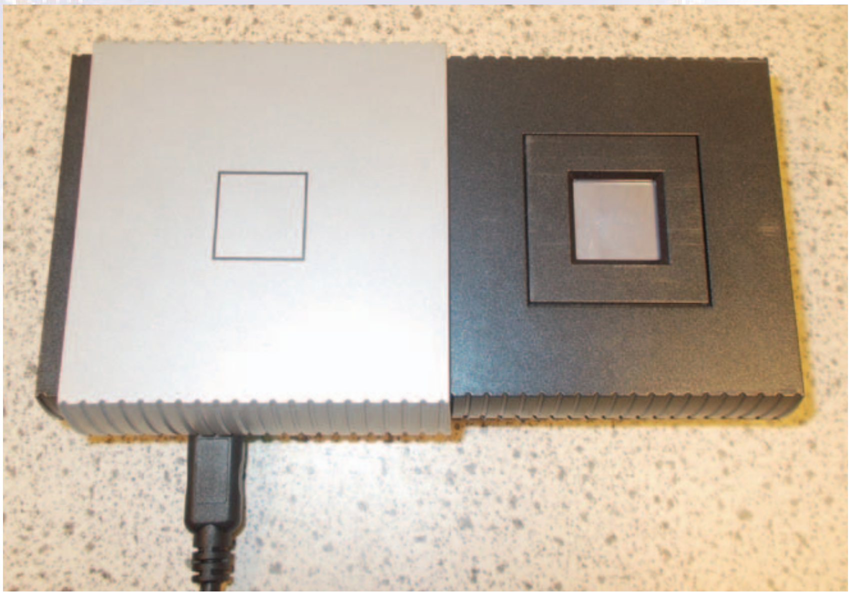

Figure 1 *- Particle detector,*

The detector is a Jablotron MX-10. It connects to a laptop (supplied to borrowers) that runs Pixelman software. What makes this system special is that the detecting chip, originally designed for medical imaging, is an array of 256 x 256 detector elements. It is effectively a digital camera for radiation detection. When a particle interacts with the detector, charge is deposited in the sensor. This charge diffuses. The device can measure how long each detector element remains above a particular energy threshold. The upshot is that different types of radiation show up as different pixel patterns. In a way, this is similar to the different types of track you see in a cloud chamber. Not only can you see the spatial distribution of the radiation, you can identify the type. Figures 2 and 3 illustrate this. Here we have updated Becquerel's Experiment. Becquerel used photographic film as his detector and a copper Maltese Cross as a mask. We have gone digital with respect to detection and our mask is the key for our radioactivity store. The radiation is emitted from a 3.7 kBq americium source. The experiment needed to run for only 10 seconds to obtain the results shown.

Americium is usually used in schools as an alpha radiation source. We're not surprised, then, to see an area of shadow corresponding to the position of the key. Alpha particles are absorbed by a sheet or two of paper, let alone a steel key a millimetre or more thick. Look closely at Figure 3. The large red dots are where alpha particles were detected. Americium also emits gamma rays. These show up as much smaller dots. You will see some amongst the alphas, but there are also a number that can be seen where they key lay. The gamma radiation has been able to penetrate the metal.

The software can be set to show individual counts for alpha, beta, gamma and "other" forms of radiation. In practice, we found that it had trouble distinguishing high energy gammas and lower energy betas, though other analysis software is available.

We have also used the detector with standard lab experiments - absorption of radiation, half value thickness, inverse square law, electrostatic deposition of radon daughter products on a charged balloon and potassium

Figure 2 *- Updated Becquerel's Experiment.*

borrow

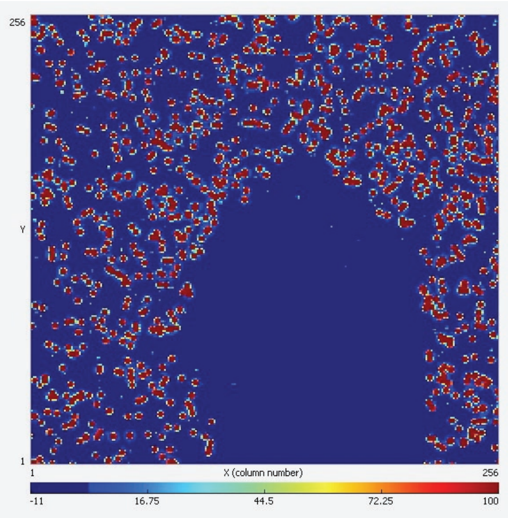

Figure 3 *- Screenshot from Pixelman software, using the set up shown in Figure 2.*

chloride investigations. It is worth saying a little more about the last two. The detector gave us more information on the nature of the radiation emitted by the daughters of radon, giving us clues to their identities. We also took the sensor back to its medical roots, modelling a medical tracer by filling a straw half full of sodium chloride, half with potassium chloride and laying it over the element. The potassium chloride part was considerably more active, as could be seen on the Pixelman image. We were also able to show the deflection of beta radiation much more quickly and convincingly than we ever could with a GM tube.

Our detector and laptop came in a backpack, which encouraged us to take it out and about. Though it is not weatherproof, as long as the laptop is charged, the system is quite portable. We decided to recreate an experiment by Scots Nobel Prize-winning physicist CTR Wilson (he is the only one so far unless you count Peter Higgs). Wilson knew that a charged electroscope discharged over time and that this must be due to ionisation in the air. He made the startlingly creative suggestion that this ionisation might be due to radiation from space, what we would now call cosmic rays. To test this out, he examined electroscopes inside a railway tunnel near Peebles, reasoning that they would be shielded from this radiation and would not discharge like those outside. His electroscope in the tunnel did discharge so he abandoned his cosmic ray hypothesis, not knowing that background radiation from rocks and building material was present.

Our team included Laura Thomas, a freelance science communicator who has been involved with the detector initiative, and work experience student Calum Duff from St. Margaret's Academy in Livingston. (Figures 4 and 5). We had the advantage that the railway tunnel is now disused. CTR Wilson had to wait until night time.

Comparing readings inside and outside the tunnel, we found that radiation levels were statistically significantly higher within. Further analysis is needed, but this could be due to being enclosed by rock and by the build up of radon - the tunnel is long and not well-ventilated.

Figure 4 *- Monitoring radiation outside the railway tunnel.*

We have been given the detector by the Institute for Research in Schools who run the CERN@school project. We hope that you will want to borrow the kit, not just to carry out experiments that support the curriculum but also to encourage your students to carry out original research. Do get in touch.

Figure 5 *- Entering the tunnel.*