UK news from CRN

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Chips with everything

It looks just like a memory stick but that is where the similarity ends. Inside, the tiny black box is far more sophisticated, contains considerably more technology and is offering a revolution in space dosimetry. The tiny device is just one of many applications for a pixel detector technology developed at CERN.

© Michael Campbell/Medipix/CERN

Back in the 1980s integrated circuit technology was in its infancy. CERN's Erik Heijne suggested that it could be adapted to create a new kind of radiation detector. His vision was to pack all the electronics required to process the signals from a radiation sensor into a 1mm square of silicon. By building up an array of these tiny circuits on the top surface of a single electronics chip, and connecting each circuit to its own equally tiny sensor element on a matching sensor chip using a flip chip process, you would have a new type of 'hybrid' pixel detector.

Erik had set a considerable challenge; at the time, the electronics required for a standard multi-channel radiation sensor would have occupied the size of a bookshelf.

That challenge was picked up by a team of physicists and engineers including Michael Campbell, a then recent recruit to CERN and an alumnus of Strathclyde University. "Pixel detectors didn't exist," he says, "so we not only had to prove that they could be built, but also that they would work for particle physics".

Twenty years after the publication of Erik's paper, the first data were collected by the LHC's pixel detector systems.

During the development of the detectors in the early 90s, it became apparent to Michael and his colleagues that their new technology had applications outside high energy physics. They had tested the sensors using radioactive sources, and sometimes experimented by putting objects between the sensor and the source to produce an X-ray image.

The results were a bit rough and ready, but they had established that you could potentially detect individual X-rays, pixel by pixel, and measure their energy. They had the idea that by adding camera logic to each of the pixels (where each

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pixel is able to detect incoming particles over a pre-defined time frame) you could create an image from the number of pixel 'hits'. The idea was followed up by the team at CERN in collaboration with groups in Germany, Italy and Scotland, and the Medipix1 chip was born.

Whilst the technology showed potential for detecting low energy X-rays commonly used in mammography and therefore minimising radiation dose to the patient, more work was needed; the pixel size of 170μm was considered too large, and the number of pixels on the chip (64 x 64) too low.

Technology develops at a furious pace, and in 1999 a new collaboration was formed with the goals of reducing the pixel size to ~50μm and creating a 256 x 256 array. The collaboration also set itself the challenge of creating colour images by adapting the pixel sensors to detect the energy of the X-rays, not just their presence.

The Medipix2 chip - which counts particles which deposit energy in a pixel within a pre-defined energy window - was unveiled in 2002. Following some refinements to the chip in the following years, the chip, the technology was picked up by an international group working on gas detectors (the EUDet Collaboration) in 2005. The developments that they required (making each sensor record the precise arrival time of the particle) led to the creation of the Timepix chip.

Michael and his colleagues are currently testing the Medipix3 chip. Taking the technology a step further, this chip is addressing the issue of how to identify and calculate the energy from single X-ray particles when the charge is spread unevenly over several neighbouring pixels.

"We think that spectroscopic X-ray imaging based on this technology could complement PET", explains Michael. "It's a cheaper technology and could be made available in more hospitals. There are still a number of big challenges to scaling up the technology but if you think something is possible, you should definitely try!"

And what about the other applications? Space dosimetry is just one of many; thanks to the efforts of teams at the Institute of Experimental and Applied Physics (IEAP) in Prague and the University of Houston, five devices the size of a memory stick are currently monitoring the exposure of astronauts on the International Space Station to ionising radiation. Simpler, smaller and lighter than existing monitoring technology, the devices have attracted interest from NASA and ESA.

The IEAP group has also used the chips to film parasites invading the eggs of leaf miners and metamorphosing into wasps. Other teams are studying the growth of graphene flakes on a surface, developing new high resolution gas detectors or producing lightweight, sensitive imaging systems that can be used to monitor radiation when decommissioning nuclear installations.

An instrument using five Timepix chips devised by a team from Canterbury in Kent will shortly be launched into space on the TechdemoSat satellite to study cosmic radiation and help predict the occurrence of solar flares (proton storms) which disrupt artificial satellites..

What makes the experiment unusual is that the team comprises students from the Simon Langton Grammar School, and all the data from the instrument will be made available to other schools via the LHC's computing GRID. The students' interest in Timepix arose from a visit to the Medipix lab back in 2006.

This opportunity to inspire school students to develop their own experiments based on medipix chips is now available to schools throughout the CERN member states via the CERN@school programme.

The potential of the Medipix/Timepix technology seems limitless. "With each generation of chip, we're putting more brains inside the pixels" says Michael. "Medipix makes friends in other research fields– it's taking particle physics detector technology into new places."

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Reaching out to Africa

Fundamental Physics Prize winner Tejinder (Jim) Virdee (Imperial and CMS) is supporting a project which will bring physics and particle physics to more secondary school students in the continent of his birth.

Improving the quality of physics teaching in sub-Saharan Africa might seem a strange aspiration when some countries may be facing far more fundamental development challenges. But that's the point – a good understanding of physics is a pre-requisite for studying many of the subjects at university that are essential for these countries to realise their goals through the expertise and enterprise of their own countrymen and women.

Jim, who was born in Kenya, took part in a science festival organised by the BBC in Uganda earlier this year. As a result of the visit, he enabled four teachers from Uganda and Kenya to take part in CERN's well-established summer programme for international teachers. The aim is that these four teachers will now transfer their knowledge and enthusiasm to other science teachers, as well as their students.

Jim Virdee © CERN

Jim is working with the Institute of Physics to support on-going projects in nine sub-Saharan countries. The IOP's programmes not only address teacher professional development, but also provide the participants with experimental equipment to enable them to teach physics in a more exciting way. By making the subject more dynamic, the hope is that more students will study physics at university and then be equipped with the knowledge and skills to exploit and develop ideas that will take their countries forward.

You can learn more about Jim's project through an excellent documentary first broadcast on the BBC World Service.

Who says that the discovery of a Higgs boson doesn't change lives?

CERN is not the only big science project inspiring people in Africa – nine African countries (as well as Australia) will be hosting antennae for SKA, the world's largest radio telescope.

An artist's impression of SKA © SKA Organisation/Swinburne Astronomy

Winning words

Entries have now opened for the Award for Physics Journalism sponsored by the Institute of Physics and STFC. The prize is for a work of journalism aimed at a general audience which has been published or broadcast between 1 January 2013 and 13 December 2013.

The aim of the competition is to increase the amount of great physics coverage in the media and hopefully lead to an increase in the number of stories that can inspire the next generation of physicists.

Entry is open to journalists, students of a recognised journalism course, students of a recognised qualification in physics, or holders of a recognised qualification in physics, whose

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work is published or broadcast and is accessible to the general public.

Your submission should cover physics research and related areas of technology, and/or the work and related lifestyles of physicists, engineers or other people working in physics. Articles on the application of physics in industry, or on interdisciplinary research including physics and other scientific disciplines, are particularly encouraged.

The prize itself is superb; return flights from the UK to US, a tour of Fermilab and registration fees for the American Association for the Advancement of Science meeting in Chicago in February 2014. Please make sure that you check the terms and conditions carefully.

Entries close on 13 December 2013 so there is plenty of time to get writing and recording.

Thankfully, that's not a plea from a member of the team working on the Inner Tracker at ATLAS. It's an opportunity for early career researchers with the X-factor to get involved in what one previous winner has described as "one of the best and most efficient pieces of public engagement I've done".

This year one of the 'I'm a Scientist' zones is Particle Physics and we're looking for young scientists to take part.

You'll join four other scientists online where you'll take questions from secondary school students through madly intense real time chats and thought provoking questions that come at a steadier pace. You can inspire hundreds of students about the wonders of particle physics, without leaving your desk. And if you survive the students voting you out of the competition, you could walk away with £500 to spend on a science communication project of your choice.

Ceri Brenner, a laser scientist with STFC scooped the prize in 2011, "It really helped me understand how to communicate my research to a wider audience. School students force you to use language anyone can understand."

If you fancy taking part, the next round of '*I'm a Scientist, Get me out of here 2013'* takes place from **11-22 November** but you'll need to register to take part by 30 September.

Check out the I'm a scientist website for more information.

Physics on the small screen

Don't forget to tune in to BBC2 at 9pm on 25 September to see the latest episode of Science Britannica, a celebration of Britain's pivotal role in creating modern science

Brian Cox (Manchester) will be exploring 'Method and Madness' using CERN as a case study (hopefully for the method rather than the madness).

You can watch the first episode on the BBC iPlayer and find out more about the series via the BBC website

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Diary dates

CERN public open days – 28 and 29 September
Public Engagement Symposium – 25 November
CERN Council – 9 – 13 December

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