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AIDA

Advanced European Infrastructures for Detectors at Accelerators

Miscellaneous

Pixel party

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AROUND THE WORLD

Pixel party

Marcel Vos (IFIC Valencia, Spain), with help from Igor Rubinsky and Hanno Perrey (DESY, Germany), Carlos Marinas and Theresa Obermann (Bonn University, Germany), and David Cussans (Bristol University, UK) | 25 July 2013

Three detector R&D collaborations developing the next generation of pixel detectors tested their systems in a combined test beam. The goal is to build a beam telescope that will bring users not only precise information about where particles went, but also when they passed through the device under test – a much-needed novelty for many future detector tests. The work forms part of the EU-sponsored AIDA project.

These are the components of the combined beam test: the MIMOSA telescope, the ATLAS-FEI4 arm and the DEPFET device under test.

The philosophy of the AIDA project is to bring together institutes from all over Europe to solve common problems. Once the problem is solved, the solution is made available to the entire community. A good example is the 'beam telescope' that AIDA has made available to users from all over Europe. R&D groups that come to DESY, Germany or CERN, Switzerland to test their devices in a beam of particles find a whole range of commodities that make their life easier.

Primarily, of course, there is the hardware, the telescope itself. It must provide a precise reference position of incoming particles to characterise the spatial resolution of new detector prototypes. To this end particle physicists need a telescope with a resolution that exceeds that of the device under test. And the telescope material must not disrupt the trajectory of the particles. The latter is relatively easy for the high-energy beams at CERN. To do well at DESY, however, requires that the sensors must be made extremely thin. In the past, detector R&D groups had to devote considerable effort to find or build a telescope, and the results were not always very satisfactory.

The first telescope to serve a large user community was provided by the EUDET project, AIDA's predecessor in the previous round of EU subsidies (FP6) (further reading). For over five years, this telescope based on MIMOSA sensors has served a very large number of groups. Several copies have been made – a good indication of their success.

But AIDA provides much more. A flexible DAQ solution (EUDAQ) allows users to plug in their devices with a minimal effort. The Trigger Logic Unit (TLU) that forms the heart of this system has been reproduced in multiple copies. The analysis software (EuTelescope) has a large number of users.

The first goal of the sub-project responsible for the telescope was to provide continued support for the telescope user community, so the AIDA project makes sure the infrastructure remains operational and also supports the TimePix telescope developed by institutes involved in the Large Hadron Collider's LHCb.

The core of the AIDA telescope project is the upgrade and extension of the telescope. For many users who work on LHC applications a precise reference position is not enough. They also need to know the exact time of arrival of the particle. It's hard to find a single system that can provide both at the required precision. Devices with a fast response tend to be less precise in the spatial domain or they put too much material in the way of the particle's trajectory. To provide both we combine two technologies – MIMOSA sensors with their spatial resolution and thin sensors provide the position, while special detectors called FE14 from the LHC's ATLAS provide time information with the desired LHC structure.

In this respect the first beam test in 2012 with a combined MIMOSA-FEI4 telescope was something of a milestone. A collage of photographs of the components involved in the setup in the DESY beam line is shown in Figure 1. Charged particles from the accelerator – electrons in this case – first traverse three read-out planes of the MIMOSA sensors, then the device under test, the second triplet of MIMOSA planes and, finally, the ATLAS-FEI4 arm. The user group that acted as guinea pig in this experiment is the DEPFET collaboration. In a single metre the electrons thus traverse pixel detectors from three major detector R&D collaborations.

The point of the multi-technology telescope is to take advantage of the strong points of each technology. Combining the precise time information from the ATLAS-FEI4 and the excellent spatial resolution brings together the best of both worlds. The combined test beam is an important step towards the production of a versatile and user-friendly telescope that can follow the particle trajectory very precisely in space and provide precise information in the time domain. Now that the devices can successfully be read out together, work can continue to improve the infrastructure available to users towards the end of the AIDA project.

However, there is an additional advantage that the people who drew up the proposal three years ago hadn't realised. The ATLAS FEI4 chip has self-triggering capability. The chip can issue a trigger signal based on the response of the pixels. If we overlay the response of the FEI4 pixel matrix with a programmable mask and feed the resulting signal into the trigger logic we can trigger on a very small area. The definition of the triggered area is much more flexible than the traditional trigger based on scintillators; to change it, all we need to do is to upload a new mask to the device. This turns out to be a very useful feature if the prototypes under test cover a very small area.

The institutes involved in the AIDA project are developing the follow-up to the EUDET telescope used by many detector R&D groups that submit devices to test beams at DESY and CERN. The combined read-out of three different pixel detector technologies – MIMOSA, ATLAS-FEI4 and DEPFET – is an important milestone towards a more versatile system that can provide a precise reference position and time information.

Further reading: AIDA-NOTE-2012-005.pdf

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