AIDA: Concerted Calorimeter Development, CERN Bulletin

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AIDA: CONCERTED CALORIMETER DEVELOPMENT

AIDA – the EU-funded project bringing together more than 80 institutes worldwide – aims at developing new detector solutions for future accelerators. Among the highlights reported at AIDA’s recent annual meeting in Frascati was the completion of an impressive calorimeter test beam programme, conducted by the CALICE collaboration over the past two years at CERN’s PS and SPS beam lines.

The CALICE tungsten calorimeter prototype under test at CERN. This cubic-metre hadron calorimeter prototype has almost 500,000 individually read-out electronics channels – more than all the calorimeters of ATLAS and CMS put together.

Calorimeter development in AIDA is mainly motivated by experiments at possible future electron-positron colliders, namely ILC or CLIC. The physics requirements of such future machines demand extremely high-performance calorimetry. This is best achieved using a finely segmented system that reconstructs events using the so-called particle-flow approach, which allows precise jet energy reconstruction. This technique thrives with an optimal combination of tracking and calorimeter information and has already been successfully applied in the CMS detector. Reconstructing each particle individually requires very fine cell granularity in three dimensions and has spurred the development of novel detection technologies, such as silicon photo-multipliers (SiPMs) mounted on small scintillator tiles or strips, gaseous detectors (micro-mesh or resistive plate chambers) with two-dimensional readout segmentation, and large-area silicon pad arrays.

The AIDA project addresses two main topics: how to tackle the integration challenge that comes with the enormous channel density, and the validation of hadronic shower and detector simulations based on the Geant4 tools with test beam data. It supports, for example, the development of a family of highly integrated mixed-circuit ASICs*, with front-ends adapted to the technologies above but with common back-ends and interfaces. These "systems on chip" include signal processing, self-triggering, digitisation and read-out sequencing. Thanks to power cycling, they can be integrated into the detector without extra cooling. AIDA also offers a versatile absorber structure made of tungsten. This very dense material is favoured for ultra-compact electromagnetic calorimeter designs and is currently being considered for a hadronic calorimeter at CLIC.

With this building-block approach, various combinations of gaseous or scintillator-SiPM-based read-out technologies have been tested in steel and tungsten absorber structures over a wide range of beam energies, from 2 to 350 GeV. Some of the very detailed results have already been presented at conferences, and were eagerly absorbed by the Geant4 model builders to test and refine their predictions to match the needs of
almost any high-energy experiment. The test-beam campaigns - which included a successful test of the power cycling - also provided important technical feedback and demonstrated how the new technologies perform when larger structures are implemented (see photo).

*ASIC: Application Specific Integrated Circuits.*

by Felix Sefkow