Tests of the Advanced Implantation Detector Array (AIDA) at RIBF

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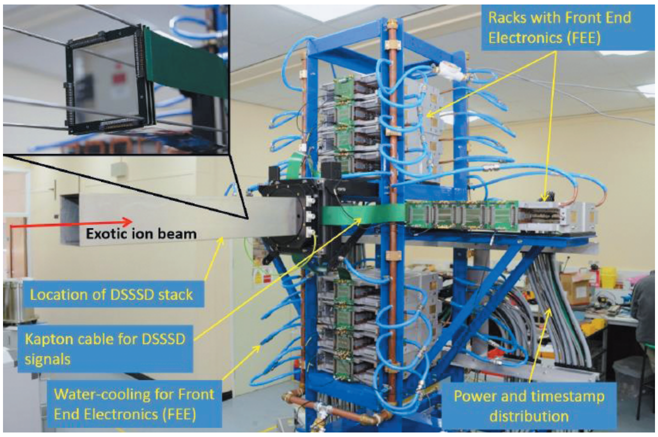

Fig. 1: A photograph of the fully constructed AIDA assembly.

The Advanced Implantation Detector Array (AIDA)[1)] represents the latest generation of silicon implantation detectors for use in decay spectroscopy measurements of exotic nuclei at fragmentation beam facilities.
Designed to improve upon current generation, AIDA features high detector pixilation and fast overload recovery (~1 μs), required at modern RI facilities with increasingly high secondary beam intensity and access to isotopes with very short half-lives.
Application specific integrated circuits (ASICs)[2)] were specifically designed to meet the above requirements. One ASIC can process 16 data channels, each with two dedicated preamplifiers: one, with selectable gain to cover the low and medium energy ranges of up to 1 GeV, and the other, a low-gain amplifier covering the full dynamic range of 20 GeV. Detector signals are carried via flexible Kapton PCBs to the front end electronics (FEE) cards, which support 64 channels of instrumentation. The FEE cards contain: multiple analogue-to-digital converters (ADCs) for use in signal processing; a field-programmable gate array (FPGA) for control, signal processing and data management; and additional supporting electronics.
As each FEE card runs a separate data acquisition system (DAQ), reading data from just 64 channels, dead-time is vastly reduced compared to current generation detectors dealing with high pixelation. Fig. 1 shows the full AIDA assembly.
To study the response of AIDA to implantation of heavy ions, in-beam tests have been conducted at the Radioactive Ion Beam Factory (RIBF) at RIKEN. The tests were conducted parasitically to experiments part of the SEASTAR campaign, placing AIDA at the F11 focal plane. In the most recent test configuration, AIDA comprised three MSL BB18-1000 type DSSSDs, each with a thickness of 1 mm and featuring 128 strips with a 0.625 mm pitch in both the x and y directions.
These tests have demonstrated both the capability of AIDA to detect position and energy of fast fragment beams and their decay products, as well as our ability to integrate multiple DAQs – AIDA, and the BigRIPS in-beam detectors for particle identification – into one data stream. DAQ integration is achieved through the timestamping of all data items in each data stream, which are then time-ordered in the analysis software. This forms one continuous stream of data containing information on the implant positions, decay positions and energies, and particle identification data from BigRIPS. A method has also been developed by which the BRIKEN/AIDA DAQs can be synchronised, which will be tested with the full-scale BRIKEN array once it has been assembled. In addition to this, an online monitor has been developed to check the status of the DAQ synchronisation and to provide some basic analysis in real-time.
Preliminary analysis of the data collected during these tests is underway, from which we hope to see some early results in the near future. Further steps must still be taken to better understand the efficiency of the analysis software in correlating implants and decays, and in characterising the background to reduce the likelihood of random correlations.
With promising progress being made on all fronts, AIDA is planned for use at RIBF throughout 2016-2017 with two main focuses: β-decay half-life and decay spectroscopy measurements with the EURICA γ-ray detector, and measurements of β-delayed neutron emission probabilities as part of the BRIKEN collaboration.

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References

1) C.J. Griffin, T. Davinson, A Estrade et al., POS(NIC XIII) 097 2014
2) D. Braga, P. J. Coleman-Smith, T. Davinson, I. H. Lazarus, R. Page, and S. Thomas in ANIMMA 2nd International Conference, IEEE, 2011.