ELECTRONIC AND COMPUTER ENGINEERING
Sensors & Instrumentation Group

The SI Group develops detectors, instrumentation and data analysis methods. We apply our work to research in particle physics, space science, medical imaging, and remote instrumentation and control. Data processing techniques include Grid computing, genetic programming and data visualization.

A speciality of the group is the study and understanding of the effects of radiation on the performance of sensors, optical systems and electronics.

The group currently consists of 8 academic staff: Professor Hobson, Professor Khan, Dr Cole, Dr Kyberd, Dr Leslie, Dr Powell, Dr Smith, Dr Teodoresecu, several postdoctoral researchers and research students. The group is well funded by STFC, EPSRC and ESA.

Current Activities

Detector Development

Current work on detector development is focused on the development of fast radiation-tolerant photodetectors, scintillating fibre particle-trackers and novel dosimetric techniques.

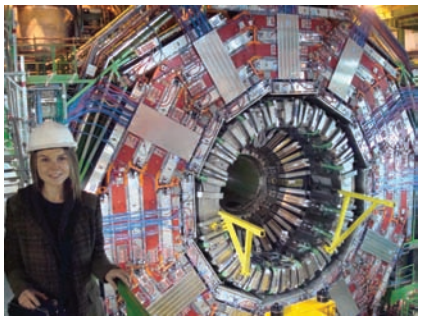

Figure 1. Dr Leslie standing above one half of the CMS detector just before it was closed for data taking.

The Compact Muon Solenoid (CMS) experiment has recently been installed at CERN's Large Hadron Collider. CMS is a very large and complicated detector system. The group made key contributions to the development of the Vacuum PhotoTriodes that are used in the electromagnetic calorimeter. The group is currently involved in long term testing of these detectors. A significant fraction of the devices are tested in the group's 4 Tesla magnetic field facility.

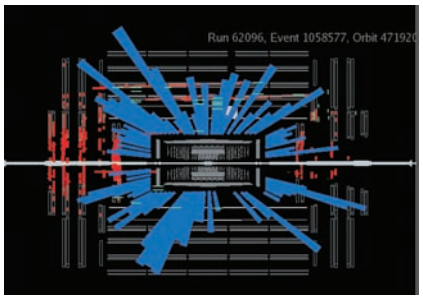

Figure 2. A computer display of energy deposited in the calorimeters of CMS during the startup of the LHC in September 2008

MICE is an experiment to test out techniques of producing high-intensity muon beams. In addition to beam-line modeling and contributions to operating the experiment we contributed to the fibre tracker system, particularly in the design of the optical system which is used in the quality assurance of the scintillating fibre planes and the assembly and commissioning of the complete muon tracking detector which is shown in Figure 3.

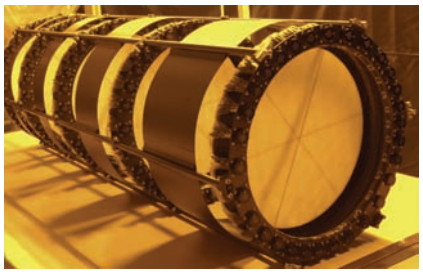

Figure 3. The MICE muon tracker after assembly. The yellow light prevents damage to the fluorescent chemical in the scintillating fibres.

The group has been actively involved with CCD detector testing and characterisation for the Chandrayaan-1 X-ray Spectrometer (C1XS) instrument, launched on the Indian Space Research Organisation Chandrayaan-1 lunar mission in late 2008 Figure 4.

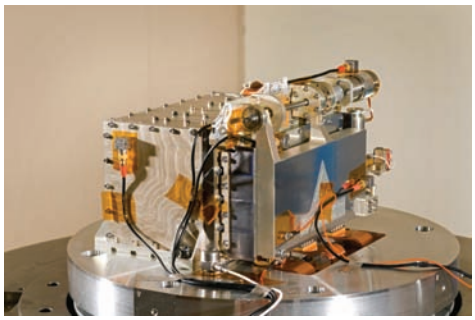

Figure 4. The Chandrayaan-1 X-ray Spectrometer. This will use the X-ray fluorescence technique (1.0-10 keV) to determine the elemental abundance of Mg, Al, Si, Ca, Fe, Ti distributed over the surface of the Moon

Along with selecting the most suitable devices for inclusion in the completed flight instrument, the group has also provided a detailed space radiation environment analysis for C1XS, investigating the possible effects of radiation damage on the operation of the C1XS swept-charge devices throughout the planned two year operational lifetime.

This work is being carried out in collaboration with the STFC Rutherford Appleton Laboratory with funding from the European Space Agency.

X-ray diffraction and X-ray spectroscopy

In collaboration with other research and industrial groups in Italy and the Netherlands, the group is involved with the development of instrumentation for a future Mars rover as part of the European Space Agency ExoMars programme. In particular, work has been carried out to develop an instrument that can perform combined X-ray diffraction and X-ray spectroscopy measurements. The effects of radiation on the performance of the system are to be evaluated in the coming year as part of the project.

Data analysis and modelling

The group works on data analysis and software development for the BaBar experiment at the Stanford Linear Accelerator Center (SLAC), the CMS experiment at CERN, and the Muon Ionisation Cooling Experiment (MICE) at the Rutherford Appleton Laboratory. Techniques from machine learning and statistical graphics are being applied to data analysis. For instance, Gene Expression Programming is being evaluated for use in particle physics data analysis.

The group performs Monte Carlo Modelling, Optical System and Semiconductor Device Modelling to guide the design and to optimize a wide variety of detector systems.

Large Scale Distributed Computing

The CMS experiment at CERN will produce data equivalent to 14 million compact disks every year.

For this reason Grid computing has become vital for many scientific communities. We provide significant computational resources to the London Tier-2 of GridPP; a UK wide project which is providing production-scale computational facilities for petabyte scale simulation and data analysis from particle physics experiments.

Interdisciplinary research using Grid computing techniques for the remote control and monitoring of sensor and renewable electrical power generation is being undertaken using software recently developed by us as part of the EU funded GRIDCC project. Digital holography is carried out by recording onto large charge coupled devices and carrying out large-scale 3D image reconstruction and analysis using both Grid and GPU computing platforms.

Research is also being undertaken into ways of encapsulating and interoperating environmental data using web technologies. This includes co-operation with researchers at CSIRO in Australia and the Environment Agency in the UK. As part of this we are investigating Google's "protocol buffer" technologies to optimise messaging of structured data.

Facilities

The group has a large laboratory for detector characterization, two optics laboratories containing a variety of lasers and a large-sample spectrophotometer. A Class 10000 clean room has recently been installed.

Characterization equipment includes high precision current-voltage, spectrum, and impedance analysers and GHz digital oscilloscopes. The group also operate a small superconducting 4T magnet, and two high-activity Cobalt 60 radiation cells. The optical laboratories contain CW and pulsed lasers covering the visible and near-IR spectrum, including one laboratory, inside the clean room, for time-correlated single-photon counting. The group has several vacuum chamber facilities for the testing and characterisation of electronic Imaging devices over a wide range of temperatures. A number of X-ray facilities, including a micro-focus X-ray source and Oxford Instruments X-ray tube equipment, are available for use in diffraction and spectroscopy measurements, while TEC and CryoTiger equipment allow for the testing of devices from room temperature down to –120C. The group has excellent computing facilities, including our London Tier2 Grid cluster and visualization facilities. Group members work and use facilities at international laboratories such as CERN, SLAC, ESA and RAL.

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