DTI Technology Programme
Sensors for Industrial and Environmental Application Theme
Portable Gamma Ray Spectrometer (PORGAMRAYS)

Project Summary - *Status September 2005*

Project Partners:
CCLRC
Centronic Limited (CENTRONIC)
Corus Northern Engineering Services (CORUS)
John Caunt Scientific Limited (JCS)
National Physical Laboratory (NPL)
University of Liverpool (LIVERPOOL)
University of Manchester (MANCHESTER)

The Need
Detection, and high resolution measurement, of gamma rays provides a unique signature of radioactive isotopes. Such spectroscopic measurements both identify the species and can give quantitative information. Presently, the high-resolution detectors used are normally made from germanium which has an excellent spectral response. However, germanium has the disadvantage that it has to be cooled during operation, typically using liquid nitrogen. For measurements in the field, mechanical cooling systems are being developed but these can be expensive and need a power source - hence the need for a portable gamma ray spectrometer.

The Solution
Cadmium Zinc Telluride (CZT) has the potential to be an excellent gamma ray spectrometer with a performance close to that of germanium. It has the advantage of being operated at room temperature and the sensor element is small. Its disadvantage is that due to material problems charge does not move through the material easily (holes get trapped) with the result that incomplete information is recorded. This results in a poor spectral response especially for gamma ray energies above 100 keV.

Modern instrumentation using pulse shape analysis techniques are to be employed to track the incident photon interactions throughout the CZT sensor. The time profile of the charge collection on both electrodes will be measured. Using a pair of sensors this information will be used to produce an image of the radiation that has spectroscopic quality. In order to make an imaging system it is necessary to segment or pixellate the electrodes resulting in multiple outputs. To keep the electronics compact an ASIC (Application Specific Integrated Circuit) and associated low power signal processing electronics will be developed in order to produce a truly portable instrument.

Project Description
Pulse shape algorithms are to be determined to find the gamma ray interaction positions within the detector. With this information and the energy deposited at each point it is possible to improve the spectral response of CZT to be much closer to that of germanium. The group in Liverpool are also experts in Monte Carlo modelling, which will be needed to understand the detector operation as part of the development of the pulse shape analysis algorithms. Liverpool and Manchester have well-equipped laboratories and research staff to carry out this development work. The electronics including the ASIC will be developed by CCLRC at Daresbury and Rutherford Laboratories who have previous experience of developing ASICs for CZT and electronics for spectroscopic imaging systems.

Objectives
To produce a technical demonstrator of a hand-held, battery operated radiation detection system with both energy resolution (for identification) and imaging (for location).

The Benefits
The industrial consortium partners will be direct beneficiaries of the project. The commercial development of the sensor will follow, leading to both discrete instrumentation and embodiment into multi-sensor systems.

The National Physical Laboratory will derive benefit in developing standards for measurements involving radioactive waste and other aspects related to homeland security.

The expertise gained in the development of CZT detectors could have an impact on a number of research fields. In addition, the development of low power consumption installation capable of remote control would be transferable to other sensor systems.

Progress to date
The project start-up meeting was held on 11 August 2005. The academic partners are receiving financial support from EPSRC and postdoc contracts start 1st September. The first quarter is mainly devoted to defining the specification of the system. Samples of CZT have been acquired and measurements are being made to determine characteristics.

Exploitation/Spin offs
A wide range of applications have been identified for this unique sensor: Medical Physics, Decommissioning, Security, University Research & Instrument Companies.

The development of a low power consumption ASIC and the associated FPGA algorithms for position determination, charge trapping correction and imaging applications could result in spin-offs for other low-power remote sensor applications.

Further information
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