NPGrep/02/5

NUCLEAR PHYSICS SUPPORT ACTIVITIES

1st April 2002 – 31st March 2004

Nuclear Physics Group, CCLRC Daresbury Laboratory

This document summarises the programme of work carried out by the CCLRC Daresbury Nuclear Physics Group on behalf of the EPSRC. It is intended to satisfy the reporting requirement stipulated in the relevant Service Level Agreement between EPSRC and CCLRC.

1. INTRODUCTION

The Nuclear Physics Group at Daresbury Laboratory is part of the Surface and Nuclear Division of the Council for the Central Laboratory of the Research Councils (CCLRC) with access to the support staff, expertise and facilities available at both Daresbury and Rutherford Appleton Laboratories. The group's principal role is to provide scientific, technical and engineering expertise to support and co-ordinate the programme of research supported by EPSRC in the field of nuclear physics. This programme is carried out at a number of overseas accelerator facilities and requires the design, construction and installation of specialised equipment at those facilities. The group undertakes this design and development work for both existing programmes and new initiatives, including programmes of development aimed at the generation and exploitation of new opportunities in the overseas facilities. It continues to seek out new opportunities for the UK in terms of access to such facilities. Expertise is provided to co-ordinate these and other activities within EPSRC's overall nuclear physics programme.

2. OVERVIEW

This report covers all of the Nuclear Physics Group (NPG) activity relating to the UK nuclear physics experimental research programme in the period 2002/04. This activity has been funded through a dual support mechanism in which the funds arise from two sources:

(a) A core service level agreement (SLA)

(b) Responsive mode grants

The core SLA is intended to mimic the provision of a well-found laboratory implicit in the dual funding of universities. It therefore provides for the costs of the nuclear physicists in the group, allowing them to act as Principal Investigators on grant proposals, as well as for additional overhead charges such as accommodation costs. It also covers the general support services provided by the group that are not funded through grants as well as support for small scale ad-hoc activities. These latter categories encompass support for local computer hardware and software installations (particularly important for smaller university groups) and the feasibility studies or exploratory work necessary for any UK institution prior to the submission of a grant. It also covers the role played by the senior members of the group in representing the UK and its interests on several international working groups and committees, a list of which is given in Appendix 1.

The responsive mode grant funding is obtained in parallel with the university groups with the NPG acting as one of several institutions collaborating on a specific project. The two strands combine to fund the overall activities of the group. The majority of the group's output is related to responsive mode grants that are the subject of detailed peer review through specific, end-of-grant reports. The current document will not attempt to duplicate or pre-empt those reports but will rather provide an overview of the activities and principal achievements of the group in the four, broadly defined areas of technical support provided, namely, instrumentation and design, electronics support, software support and target fabrication. The final section of the report provides a year-end financial statement

Table 1 below summaries the major EPSRC responsive mode grants that were active during the current reporting period.

Table 1

Title	Known as	Grant Reference	Participating UK institutions
Exotic Nuclear States with Radioactive Beams	EXOGAM/VAMOS	(GR/M50706)	B,L,M,P,K,S,Y.
Digital Pulse Processing and Gamma Ray Tracking	TRACKING	(GR/M49489)	L,S.
Reactions of Exotic Proton-Rich Nuclei	TUDA	(GR/M76058)	E
Structures of Nuclei Far from Stability by Tagging Techniques	GREAT	(GR/M79998)	L,M,K,S,Y.
Structure and Reaction of Light Nuclei	CHARISSA/ECLAN	(GR/M97381)	Bi,S
Nucleon Transfer and Coulomb Excitation with Radioactive Beams	TIARA	(GR/N38541/01)	Bi,P,S
Isobaric Analogue States at High Spin	MIRRORS	(GR/R40081/01)	K
Study of Valance Space Limitations	HIGH SPIN	(GR/R57713/01)	L

Key: Bi = Birmingham; B = Brighton; E = Edinburgh; K = Keele; L = Liverpool; M = Manchester; P = Paisley; S = Surrey; Y = York

The most important achievements during the period of the current SLA were

- **EXOGAM**: The successful installation and commissioning of the new EXOGAM gamma-ray array at the GANIL radioactive beam facility in Caen, France.
- **GREAT/TDR:** The successful installation and commissioning of the GREAT spectrometer at the cyclotron laboratory in Jyväskylä, Finland and the accompanying development of the Total Data Readout technique for nuclear spectroscopy.

- **Gamma-Ray Tracking:** The development and successful demonstration of the feasibility of the γ-ray tracking method in Ge detectors.
- **TIARA:** The successful installation and commissioning of the TIARA combination of charged particle and γ-ray detectors, coupled to the VAMOS recoil spectrometer at GANIL.
- **ECRIS:** The successful commissioning and transfer of the ECRIS charge-breeding ion source to the ISOLDE facility at CERN.
- **MIDAS:** The further development and extension of the MIDAS data acquisition system.
- **RISING:** The successful design and installation of the RISING spectrometer at the GSI facility in Darmstadt, Germany.

All of the above attest to the role played by the NPG in paving the way for UK exploitation of the major accelerator facilities currently available or under construction in Europe.

3. INSTRUMENTATION AND DESIGN

The NPG works in collaboration with the project engineering division at Daresbury to provide mechanical engineering and design support to the experimental UK nuclear physics community. Through the use of advanced 3D modelling techniques and FEA software, mechanical engineers and designers have been able to design highly complex structures for supporting arrays of radiation detectors for both photon and charged particle detectors. They have designed and or provided input to many projects during the current period. In many instances, a UK design team coming from the NPG and the Universities of Liverpool and Manchester performs the design work. This team is co-ordinated by the NPG mechanical engineer and comprises skilled and experienced 3D CAD design engineers and physicists from the institutions involved. This team is world class and has designed almost all the large gamma-ray spectrometers currently in use in Europe. Technical effort from Daresbury has also been used to assemble many of these complex systems before shipment to the host overseas laboratory.

The period started with the successful installation of the EXOGAM mechanical support structure at the laboratory of GANIL, France. EXOGAM is a European collaboration to build a high efficiency and powerful gamma-ray spectrometer for nuclear structure studies using the exotic radioactive beams available at GANIL. This complex mechanical structure enables the array of γ-ray detectors to be operated in stand-alone mode or in coincidence with the VAMOS (VAriable MOde high acceptance Spectrometer) recoil spectrometer. During the period effort was used to design, procure, test and ship additional items including a beam line support mechanism, a pivot for the rotation of EXOGAM with the VAMOS spectrometer, a detector manipulator to enable safe installation of the detectors in the array and two table- top mounting structures, to enable the assembly and testing of the detectors. The first experiments with EXOGAM using the radioactive beams from the newly commissioned SPIRAL accelerator have now been successfully performed.

The VAMOS recoil spectrometer is also now fully operational. The NPG designed and constructed the ionisation chamber, the Q1/Q2 vacuum chamber and 0^0 – 45^0 target chamber for the operation of VAMOS and EXOGAM. In addition, the NPG designed, in collaboration with the University of Manchester, the focal plane detector boxes. VAMOS has been successfully commissioned in a series of in-beam tests, which involved a significant amount of physicist effort from the group to develop the ray-tracing algorithms and particle identification techniques. The first experiments with VAMOS have taken place in 2003/2004, with the spectrometer coupled to both EXOGAM and TIARA.

During the current period the NPG has completed the design, construction and installation of TIARA at GANIL. TIARA (Transfer and Inelastic All-angle Reaction Array) is a state-of-the-art detector system for studying direct reactions, in particular transfer reactions, of exotic nuclei. It consists of Si and Ge detector arrays, coupled to the high efficiency magnetic spectrometer VAMOS. The overall coordination of the TIARA project, the design of the array, support structure, electronics and data acquisition and the integration of TIARA with EXOGAM and VAMOS was accomplished by the NPG. TIARA was successfully assembled at Daresbury and installed at GANIL. Four in-beam tests and two experiments, coordinated by physicist effort from the group, have been successfully performed during 2003/2004. The analysis of the data from these experiments is being coordinated by a physicist in the group, using postdoctoral and student effort from within the TIARA collaboration.

The design and construction of the ECLAN (Experimental Chamber with Low Attenuation for Neutrons) reaction chamber was completed during the period. ECLAN, its motion control and vacuum systems, were assembled and commissioned successfully at Daresbury by the NPG. ECLAN has now been installed at GANIL in the LISE2000 area and is awaiting first experiments.

During the current period the NPG has contributed to a project at the INFN laboratory at Legnaro, Italy to couple an array of Clover Ge detectors called CLARA to the PRISMA magnetic spectrometer. Mechanical engineering effort, in collaboration with the University of Manchester, has been used for the design of the CLARA. This work involved FEA stress analysis of the support structure for the detectors. CLARA and PRISMA are now fully operational and an extensive experimental programme is now taking place. In addition, conceptual design work on new focal plane detectors for PRISMA has also been carried out.

The NPG has designed the RISING (Rare ISotope Investigations at Gsi) spectrometer. RISING is an array of EUROBALL Cluster Ge detectors that is used for spectroscopic studies of nuclei excited by the exotic relativistic beams from the GSI facility in Darmstadt, Germany. The NPG designed the array, performed a trial assembly at Daresbury and then installed the array at GSI. RISING is now fully operational and the first campaign of relativistic gamma-ray experiments has taken place. Towards the end of the period the NPG designed the next phase of the RISING project, which involved including the MINIBALL germanium detectors into the array. This phase is planned to operate towards the end of 2004.

The NPG are world-leading experts in array design and have developed a programme that can predict the performance of arrays of gamma-ray detectors. This JAVA based programme was used for the RISING project and often provides the platform for advice given to members of the UK community planning new gamma-ray experiments and arrays.

The NPG has the engineering responsibility for the GREAT (Gamma Recoil Electron Alpha Tagging) spectrometer. GREAT was successfully commissioned during 2002 and is currently being using in campaigns of experiments at the cyclotron facility of the University of Jyväskylä in Finland. The NPG worked closely with the designer at the University of Liverpool on the JUROGAM spectrometer. JUROGAM is an adaptation of the EUROGAM γ-ray array, originally designed at Daresbury, and is now in operation at Jyväskylä. The group also performed heat transfer calculations for the cooling system for the electronics.

The NPG collaborates in a European programme to develop an Electron Cyclotron Resonance Ion Source, ECRIS, for potential use in a radioactive ion beam accelerator. The source traps an injected, singly charged ion beam and, by stripping electrons from the ions in the source's hot plasma, enables the ion beam to be extracted in a highly charged state for acceleration to high energy. Such a "charge breeding" device makes the subsequent acceleration process far more efficient, reducing the cost and scale of the accelerator. A test facility was established at Daresbury and the new ion source and associated equipment has been successfully commissioned. Charge breeding of a stable noble gas ion beam was demonstrated with a singly charged beam of argon ions bred up to an 11^+ charge state. The ECRIS and much of the associated equipment acquired for the project has now been moved to the ISOLDE facility at CERN where it is has been reassembled on a dedicated beam line. The next stage of the programme is to demonstrate and characterise the charge breeding process with radioactive ion beams. The first experiments have just been completed and have achieved the first demonstration of charge breeding with radioactive species. These and future results are eagerly awaited by a number of radioactive beam facilities, including ISOLDE, GANIL and TRIUMF in Canada.

4. ELECTRONICS SUPPORT

The majority of the electronics effort was concentrated in two areas in this review period: the GREAT project's triggerless acquisition system called Total Data Readout (TDR) and Gamma Ray Tracking. Both projects constitute major, innovative developments in nuclear spectroscopy that represent new generations of data acquisition systems. The NPG electronics engineers also worked on a number of other projects during the period, including EXOGAM, TUDA, EUROBALL, TIARA, RISING and CLARA. In addition to project work, advice was given to members of the Nuclear Physics community about the feasibility of several new ideas and discussions were undertaken about potential new grants (for which outline designs, costs and manpower estimates were provided).

The TDR system for GREAT is based on the concept of an acquisition system with no triggers. Instead, each signal is digitised and given a timestamp, which is accurate to 10ns. Events are then reconstructed entirely in software. The system eliminates common dead time that can be a problem in conventional acquisition systems. The work of the NPG centred on the ADC cards that collect and timestamp the data from the detectors and the Metronome card which ensures that the timestamps are consistent throughout the system. As well as designing the ADC card and a prototype Metronome card, protocols for system error detection and recovery were worked out, even to the point of recovering from a power failure. 16 ADC cards were tested and delivered and 2 prototype Metronome cards were constructed and used prior to the delivery of the full specification production Metronome card from the University of Liverpool. VXI crate control and interface cards were designed, built and tested to allow the use of a commercial C-sized resource manager for physics applications in a larger, D-sized, VXI crate. All these items were completed on time and on budget. During the course of the project a need was identified to test the full electronics and data acquisition in the UK before delivery to Finland where the detectors were installed. To meet this need a pattern generator card was designed and built. These cards comprised 16 channels of pulsers with programmable pulse height and pulse separation, controlled on a per channel basis. Four such cards (64 channels) were used successfully to debug the GREAT TDR system at rates up to 10kHz/channel using pseudo-random data, resolving many problems prior to delivery.

Further GREAT project work centred on the 32 input Pattern Register cards which collect and timestamp logical data from the detectors. Five Pattern Register cards were tested and delivered along with the full specification Metronome cards from the University of Liverpool. The TDR system can now recover from a power failure of up to 2 hours, without losing track of elapsed time to an accuracy of 10ns. The Pattern Registers are configured to produce a timestamp of coincidence between a Ge detector timing signal and a Veto timing signal from its BGO suppression shield. The data is used to generate escape-suppressed spectra. All these items were completed on time and on budget.

The GRT (Gamma Ray Tracking and digital pulse processing project) work centred on designing, building and testing a VME based digital electronics card to instrument the two segmented Germanium detectors purchased by the project. Each GRT4 card has 4 channels of 80MHZ 14 bit Flash ADCs with digital processing on each channel. Twenty such cards were built by the NPG for the project. The cards were put together into a 64 channel system, which was used initially in the University of Liverpool for characterisation scans of the detectors. Afterwards the system was moved to the University of Cologne where a highly successful in-beam experiment was performed. The experiment demonstrated the effectiveness of the pulse shape analysis by correcting an energy peak that had been Doppler broadened. The efficacy of the Doppler correction depends strongly on knowing the energy and exact position where the gamma ray first interacted in the crystal. The same position information is key to the success of gamma ray track reconstruction towards which the GRT project was working. The pulse shape analysis work was undertaken in partnership with the University of Liverpool. The Moving Window Deconvolution algorithm, which extracts energy from the digitised data stream, has been implemented in the programmable logic part of the GRT4. The project was completed on time and to budget. The EPSRC IGR report was edited by NPG on behalf of all the partners and several papers were presented at the IEEE Nuclear Science Symposium.

The GRT project has shown that a gamma-ray tracking array is feasible, so the NPG group members have taken leading roles in technical discussions about electronics systems for the European gamma tracking project AGATA (Advanced Gamma-ray Tracking Array). A significant amount of preparatory work was done for the EPSRC grant proposal for AGATA, which involved detailed discussions of system design, specifications and costs. European collaborations have been established within the AGATA framework and the UK has taken responsibility for much of the front end digitising and the processing part of AGATA's electronics, both at the detailed design level and at the level of managing engineers in other European countries.

Electronics engineering support was provided for many, previously installed, systems running experiments during the reporting period including:

- The trigger systems in EXOGAM, EUROBALL and RISING.
- The Neutron wall in EUROBALL
- The CLARA, and RISING systems using equipment from the EUROBALL experiment
- The readout system of EXOGAM.

Problems were also solved by telephone, email and by on-site visits, e.g. to GANIL for EXOGAM.

The TUDA (Triumf UK Detector Array) system is the main user of the relatively new Silena 9418 VME peak sensing ADC card (32 channels, 12 bit resolution), which has also been purchased by most UK university Nuclear Physics groups. Support for setting up these ADCs with the commercial Fairbus control/readout system was provided. A FERA version of a 48-bit register was designed, built and tested by the NPG. Other groups used the VME bus for control and readout. For this a Silena ADC control card was designed, built and tested. One card was supplied to each UK university group who had bought the Silena 9418 ADCs including the TIARA and VAMOS experiments.

The Silena ADC Control (SAC) card firmware was developed to add a single-event mechanism to allow other manufacturers cards, not directly controlled by the SAC, to be included in experimental set-ups. This proved very successful, and has been produced for use in TIARA, and TUDA experiments, and installed in existing SAC cards throughout the UK Nuclear Physics community.

Grant request preparation work (outline system design, selection and discussion of appropriate technology for detectors and electronics, planning manpower and costing) was undertaken for several projects. These included: AGATA, SAGE (an enhancement for GREAT), CLARA, RISING, ACTAR (EC Framework 6) and two bids to CCLRC's internal funds for ASIC developments.

One of the CCLRC funding bids for ASIC development was successful and so, at the end of the reporting period, work was just starting on the detailed specifications for an ASIC preamplifier suitable for Germanium detectors. The aim is to develop an ASIC which can be applied in both the X-ray (XAFS on synchrotrons) and gamma-ray (nuclear physics) spectroscopy fields.

5. SOFTWARE SUPPORT

The NPG software team provides data acquisition and data analysis software solutions for all activities of the community. In many cases since all experimental facilities are outside the UK these are international collaborations and the team works closely with the hosts to ensure that the software systems are compatible with the environment and requirements of the host laboratory. It also works closely with university groups who provide data analysis software.

The MIDAS data acquisition software environment, developed by the NPG, is in use throughout the UK community as well as in many of our overseas host laboratories. It continues to be developed as needed to meet the evolving requirements of the community. The group is always looking to adopt new technologies where these lead to more cost effective solutions. At the same time the use of common solutions within the MIDAS framework leads to extremely efficient use of resources.

During this reporting period, there has been a continuing development and exploitation of a general purpose and modular data acquisition system that is fully integrated into the MIDAS environment. This permits to a large degree a common solution to be deployed across all of the development activities. Not only is this approach highly efficient from the development and maintenance aspect, it has the added advantage that the users of the system see a familiar user interface. This development is fundamental to, and used by, all the project activities that follow.

A data analysis package for both online and offline use has been developed that is fully integrated into the MIDAS environment. This is intended as a replacement in particular for online use for various packages used within the community for which maintenance is becoming a problem. It has been designed from the outset to be independent of both hardware and operating system (which is an overriding aim of the MIDAS software) in order that it can be as widely used as possible.

A support service by email and telephone is provided to the community. This is particularly of use for the smaller university groups that may have no local source of expert advice and assistance. Site visits were also undertaken when necessary.

A data acquisition system was developed for the Gamma Ray Tracking project based on the MIDAS infrastructure. Developments were needed to handle the fully digitised signal output generated by the electronics and also to cope with the very high data rates produced which had to be written to tape. The latest generation of tape storage devices had to be used because of the volume of data acquired during a typical experimental run. The system was taken to the University of Cologne during February 2003 for a very successful test using the accelerator there. Following this test run the system was enhanced to handle the total energy (digital) calculated by the processors on the GRT4 VME card designed and built at Daresbury; to include an energy (analogue) for comparison from a VME ADC card; and integrated into the automatic detector-scanning table at Liverpool University. The Gamma Ray Tracking development proved the potential of fully digital analysis of the output from the detectors and led to the direct observation of effects within the detectors that had previously only been the subject of speculation or theory. Copies of the GRT system have been supplied to a number of UK Universities.

A data acquisition system was produced for the GREAT spectrometer that was installed and commissioned at Jyväskylä, Finland during September 2002. This was subsequently enhanced to handle the second phase of hardware developed for the project and to operate using a disc storage RAID array for lower rate experiments. The radically new trigger-less electronics built for GREAT required a new approach to the readout and processing of the data. This enabled the detection of events at a much higher efficiency than had previously been possibly by conventional techniques.

The data acquisition system used by the MEGHA array at ANU in Canberra, Australia was updated to take full advantage of the developments in the MIDAS infrastructure. The software now provides significantly better checking of the data received from the electronics in real time and filters out all bad data. This both makes the task of offline analysis easier and more efficient and also warns the users of problems with the electronics, with an indication of the possible reason.

Development has continued on the data acquisition system for the EXOGAM array that is deployed at GANIL. Meetings and discussions were held with the French team working on this project to plan for the use of other detector systems such as VAMOS and TIARA with the EXOGAM array. The software to control the hardware module that provides the co-ordination of these various detector systems was tested during November 2002. At the same time the software to control the prototype of the electronics module that handles the data from the outer contacts of the Exogam detectors was tested. These both became operational during 2003.

A data acquisition system was developed which handles the model 9418 ADCs purchased from the company Silena. These are compact low cost general purpose ADCs that can be used for a wide range of activities. Several of the UK University groups have purchased the systems for testing of detectors in their home laboratories. A control module (Silena Acquisition Control – SAC) was developed by the group to control a group of 9418 ADCs and to allow coordinated use of other VME data sources such as CAEN TDCs. Given the compact nature of the hardware it is possible for the system to be taken for short experimental runs at overseas laboratories. Examples have been at IReS, Strasbourg using the Vivitron; Orsay, France and Jyväskylä, Finland.

A data acquisition system was built for the TIARA detector that is now installed at GANIL. This uses a combination of electronics including the Silena 9418 ADCs; CAEN 767 TDCs and GANIL VXI ADCS and couples with the EXOGAM and VAMOS detector systems. This was tested successfully together with the software system that merges the data from the three detector systems during June and July 2003. Scheduled experiments took place starting in September 2003 and these were the first experiments at GANIL using EXOGAM in combination with other detectors.

A data acquisition system was built for the TUDA detector array that is now installed at the TRIUMF facility in Vancouver, Canada. This is a 512 channel system using the Silena 9418 ADCs and CAEN 767 TDCs. The system was installed and commissioned with beam at TRIUMF during August 2003.

A data acquisition system was built for use with the EUROBALL cluster detectors to be used for the RISING experiments at GSI in Darmstadt, Germany. Developments were needed in order to combine the EUROBALL detectors with existing GSI detector systems and to link into the existing GSI environment. The first experimental campaign took place during September and October 2003 when a total of 4 different data acquisition systems (including the system for the EUROBALL cluster detectors) were successfully combined online in one of the most complex experimental configurations so far attempted by the Nuclear Physics community.

The time tagging module used to coordinate the RISING experiment was also used at INFN Legnaro, Italy for the CLARA/PRISMA experiment. This uses the EUROBALL clover detectors (CLARA) and essentially the same data acquisition system as used for RISING together with the PRISMA data acquisition system. First experiments took place during Dececember 2003 and January 2004.

6. TARGET LABORATORY

Thin film targets and foils are required for low-energy nuclear physics experiments. In order to meet current demands of UK physicists engaged in nuclear structure experiments around the world, a large variety of targets are required from elements throughout the periodic table. The target preparation laboratory (TPL) at Daresbury Laboratory provides this service to the UK community and is the only facility of its kind available in the UK.

The TPL has been in operation since the early days of the Nuclear Structure Facility at Daresbury and target preparation has been performed by a specialist technician. Prior to this reporting period this experienced target maker retired and in March 2002 the NPG employed a replacement. The current period has involved the training of the new technician in the highly specialised area and this has been extremely successful.

During the previous reporting period the target laboratory was completely refurbished and new equipment installed. The laboratory is now equipped with two sputtering units, an electron beam gun, and three coating rigs, all for target preparation. In addition, several items essential for efficient operation of such a facility, such as an accurate balance and vacuum storage system, are available.

The new technician has rapidly become familiar with this equipment and new fabrication techniques for different target species are under continual investigation.

The target preparation laboratory is now fully operational and there is a continual stream of requests from the UK community. The feedback the laboratory has received, using the laboratories feedback form, has been very positive and informative.

A full list of target produced in the period in included in Table 1.

Table 1

Requested	Institute	Used at:	Target requested
Martin Freer	Birmingham	Ganil	Au
Gavin Smith	Manchester	ILL	Ni foil 1.5 microns 50 x 50
Alex Murphy	Edinburgh	Triumpf	Au 100 μg/ cm^{-2}
Carl Wheldon	Surrey	GSI	^{180} Hf 3mg
Jonathan Billowes	Manchester	Jyväskylä	^{120}Sn 1mg
Jonathan Billowes	Manchester	Jyväskylä	^{122}Sn 0.7mg
John Simpson	Daresbury	Jyväskylä	^{106}Cd 500μg/ $cm\text{-}^2$
Bob Wadsworth	York	Strasbourg	^{96}Zr 500μg/ $cm\text{-}^2$
Bob Wadsworth	York	Strasbourg	^{96}Zr 1.5mg/ $cm\text{-}^2$ on 8mg Pb
Alison Bruce	Brighton	Yale	^{24}Mg 300μg/ $cm\text{-}^2$
Mike Taylor	Brighton	Yale	Ca nat 200μg/ $cm\text{-}^2$ backing Ni 1mg/cm and flashed on the front Ag
Mike Taylor	Brighton	Yale	^{39}K 700ug/cm2 Nat KBr on 500ug/cm2 Au
Andy Boston	Liverpool	Cologne	TiD
Wilton Catford	Surrey	Ganil	^{6}LiO 100μg/ $cm\text{-}^2$
Wilton Catford	Surrey	Ganil	^{6}LiO 200μg/ $cm\text{-}^2$
Bob Wadsworth	York	Jyväskylä	^{104}Pd 500μg/ $cm\text{-}^2$
Rodi Herzberg	Liverpool	Jyväskylä	^{208}Pb 500μg/ $cm\text{-}^2$
Thomas Davinson	Edinburgh	Jyväskylä	CD_2 100μg/ $cm\text{-}^2$
Thomas Davinson	Edinburgh	Jyväskylä	CD_2 200μg/ $cm\text{-}^2$
Thomas Davinson	Edinburgh	Jyväskylä	^{197}Au 100μg/ $cm\text{-}^2$
Thomas Davinson	Edinburgh	Jyväskylä	C 50μg/ $cm\text{-}^2$
Thomas Davinson	Edinburgh	Jyväskylä	C 100μg/ $cm\text{-}^2$
Thomas Davinson	Edinburgh	Jyväskylä	C 200μg/ $cm\text{-}^2$
David Joss	Daresbury	Jyväskylä	^{112}Sn 400μg/ $cm\text{-}^2$
Mike Bentley	Daresbury	Oakridge	^{12}C 250μg/ $cm\text{-}^2$
Mike Bentley	Daresbury	Oakridge	^{12}C 500μg/ $cm\text{-}^2$
Roy Lemmon	Daresbury	Ganil	C 10mg/cm2
Roy Lemmon	Daresbury	Ganil	$CH_2$1mg/cm2 (Polyethylene)
Roy Lemmon	Daresbury	Ganil	D 200ug/cm2 (Deuterium)
Roy Lemmon	Daresbury	Ganil	Au 100ug/cm2 10mg/cm2 C
Roy Lemmon	Daresbury	Ganil	C 1mg/cm2
Roy Lemmon	Daresbury	Ganil	Au 100ug/cm2 1mg/cm2 C
David Joss	Daresbury	Jyväskylä	^{106}Cd 400ug/cm2
Dave Cullen	Manchester	Jyväskylä	^{92}Mo 500ug/cm2
Dave Cullen	Manchester	Jyväskylä	^{92}Mo 300ug/cm2
Eddie Paul	Liverpool	Argonne	^{100}Mo 500ug/cm2
David Jenkins	York	Rex Isolde	Nat Ni 1mg/cm2
David Jenkins	York	Rex Isolde	Nat Si 1mg/cm2
Bob Wadsworth	York	Jyväskylä	^{105}Pd 500ug/cm2
David Jenkins	York	Rex Isolde	Nat Ti 1mg/cm2

Patrick Regan	Surrey	Yale	^{98}Mo 500ug/cm2
Patrick Regan	Surrey	Yale	^{100}Mo 500ug/cm2
Patrick Regan	Surrey	Yale	^{98}Mo 500ug/cm2 Au 10mg/cm2
Patrick Regan	Surrey	Yale	^{100}Mo 500ug/cm2 Au 10mg/cm2
John Smith	Manchester	Jurogam	^{58}Ni 1mg/cm2
John Smith	Manchester	Jurogam	^{58}Ni 750ug/cm2
John Smith	Manchester	Jurogam	^{58}Ni 500ug/cm2

APPENDIX 1:

The following summarises the activity of group members in respect of committee memberships and related duties:

D. Warner:

- EPSRC Peer Review College.
- NuPECC Long Range Plan; Nuclear Structure Working Group.
- EURISOL Steering Committee
- ISOLDE and Neutron Time-of-Flight Committee, CERN.
- IOP Divisional Committee.
- Steering Committee for Future Nuclear Physics Facilities.
- EPSRC/CCLRC Working Group on Future of Nuclear Physics.
- UK Heads of (Nuclear Physics) Groups
- GANIL Evaluation Panel
- Referee of SPIRAL2 facility proposal for IN2P3 Council
- Science and Technological Issues Committee for GSI facility
- Co-organiser of:
  - Mini-Colloquium on Applications of Radioactive Nuclear Beams, IOP Congress
  - Int. Conf on Nuclear Structure, Wyoming, USA
  - Workshop on Nuclear Theory, University of Surrey NuSTAR'05 - International conference on NUclear Structure Astrophysics and Reactions, University of Surrey.

J. Simpson:

- Project Leader EXOGAM Project
- UK EXOGAM Management Board
- Project manager AGATA. Chairperson of the AGATA Management Board
- Programme Allocation Panel, Vivitron Accelerator IRES Strasbourg France
- Programme Allocation Panel, Accelerator Laboratory, University of Jyväskylä, Finland
- UK GREAT Management Board
- Chairperson of the RISING design and infrastructure group
- RISING Steering Committee
- Chairperson of the IN2P3/EPSRC Loan Pool Committee
- Chairperson of the UK Gamma Ray Users group
- Co-organiser of the UK community Coseners House meeting in 2002
- EPSRC Peer Review College
- GSI Community council

R.Lemmon:

- Bureau des Utilisateurs du GANIL, UK representative
- R[3]B, GSI, high-resolution spectrometer working group

I.Lazarus:

- Gretina, Department of Energy, USA, review team
- Chairperson of the UK Gamma-ray Tracking project management committee
- Leader, AGATA pre-processing team
- AGATA Local level processing working group
- AGATA Digitizer team
- EXOGAM Electronics and data acquisition working group
- GREAT Electronics and data acquisition working group, secretary
- RISING Electronics and data acquisition working group
- EURISOL Electronics and data acquisition working group
- R[3]B, GSI, data acquisition working group

V.Pucknell:

- GREAT Electronics and data acquisition working group
- RISING Electronics and data acquisition working group
- AGATA Global level processing working group
- AGATA Run control and Graphical User Interface team
- AGATA Electronics and data acquisition integration team
- CLARA/PRISMA data acquisition system coordinator
- EXOGAM Electronics and data acquisition working group

S.Letts:

- GREAT Electronics and data acquisition working group
- EXOGAM Electronics and data acquisition working group

P.J.Coleman-Smith::

- GREAT Electronics and data acquisition working group
- RISING Electronics and data acquisition working group
- AGATA Global clock and trigger team
- EXOGAM Electronics and data acquisition working group

K.Fayz:

- UK mechanical design team leader
- EXOGAM design working group
- GREAT design working group
- AGATA mechanical design team leader