F. EQUIPMENT DEVELOPMENT AT THE ATLAS FACILITY

This section describes the various technical developments linked with the experimental program associated with Heavy-Ion research within the Division.

During 1999 Gammasphere completed its second full year of operation at ATLAS, and much effort was devoted to the effective operation of the device. Nevertheless, a large number of other developments have taken place and these are described hereafter.

This section also contains a description of new developments associated with target making and computing.

f.1. Gammasphere Operations (M. P. Carpenter, C. J. Lister, R. V. F. Janssens, F. Kondev, T. Lauritsen, D. Seweryniak, and I. Wiedenhöver)

On March 15, 2000, Gammasphere will have completed its cycle at ATLAS marking two years and two months of experimental activity. In that time, 100 experiments were performed. Many of the nuclei studied in these investigations lie at or near the proton drip line as Fig. I-89 clearly illustrates. Approximately 60% of the Gammasphere experiments used the Argonne Fragment Mass Analyzer to provide mass identification of residues. Nearly all of the experiments performed utilized one or more of the 19 auxiliary detectors available for use in tandem with Gammasphere.

The operation of Gammasphere has proceeded smoothly while the device has been at ATLAS. For nearly all experiments, Gammasphere has run with its full compliments of Ge detectors (101 maximum). Table 1 summarizes the beam on target hours for Gammasphere while operating at Argonne. A total of 9864 hours of beam time was available for experimental research. This represents 72% of the total ATLAS beam time delivered to the experimental areas for the period January 15, 1998 to March 15, 2000. In addition, 1224 experimental hours were utilized for Gammasphere experiments with radioactive sources bringing the total time of Gammasphere operations at ATLAS to 11088 hours.

Table 1: Beam on target hours for ATLAS and Gammasphere for the period of Jan. 15, 1998 to March 15, 2000.

Year	ATLAS Hours	GS Hours	% of Beam time
FY1998[1]	4597	3011	65%
FY1999	6046	4719	78%
FY2000[2]	3096	2134	69%
Total	13739	9864	72%

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[1] ATLAS ran a total of 5749 hours in FY98, including the period GS was not available for experiments.

[2] For the period Oct. 1, 1999 to March 15, 2000.

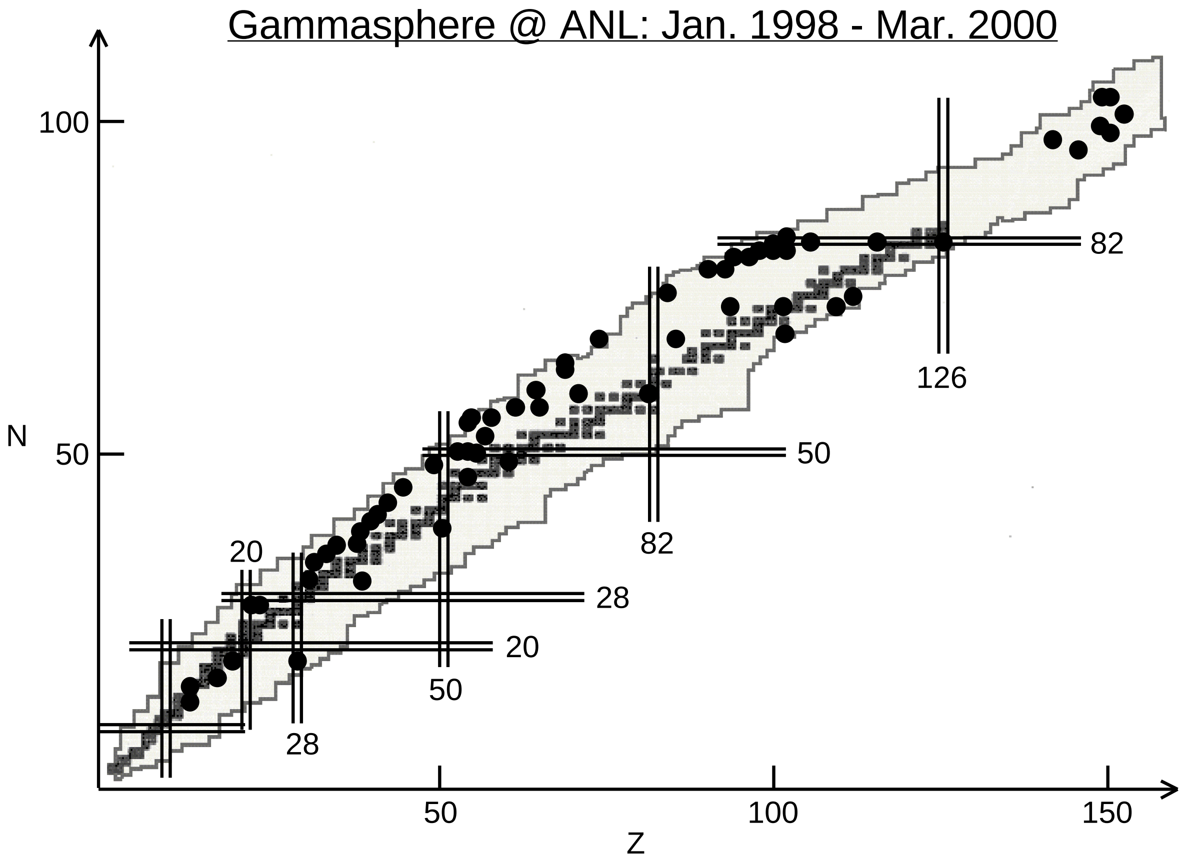

Fig. I-89. Known chart of the nuclides. Black squares represent stable nuclei. Black circles represent nuclei which have been measured with Gammasphere at ATLAS between January 1998 and March 2000.

f.2. Maintenance of Gammasphere's Germanium Detectors (I. Wiedenhöver, K. Abu-Saleem, R. V. F. Janssens, F. Kondev, C. J. Lister, and P. Wilt)

The Germanium detectors of Gammasphere continued to perform outstandingly in their second year of operation at ATLAS. In the standard configuration at the FMA, Gammasphere can hold 101 γ detectors with their respective escape-suppression systems. Most of the Gammasphere experiments ran with the maximal number of detectors possible.

One major reconfiguration of Gammasphere was undertaken for a series of experiments in the period of September-November 1999, when the newly built Neutron wall from Washington University was installed. For these experiments, 22 Germanium detectors had to be removed in order to make room for neutron-detectors. The Ge detectors in these most forward positions are usually exposed to an increased flux of high-energy neutrons, which slowly deteriorates the detector's performance during normal in-beam operation. Thus, the opportunity to repair the effects of neutron radiation on these 22 detectors was used. Most of the defects induced into the Germanium crystals by neutrons can be repaired by heating the crystal to temperatures around 105 C for 3-5 days. During this process, the vacuum around the crystal is maintained by a turbo-pump to avoid contamination of the crystal surfaces. After the annealing, 20 of the Germanium detectors could be restored to their original performance, while two detectors developed a more serious problem and had to be returned to the manufacturer. Twenty-two detectors were returned to the array, incorporating two spare systems.

Apart from this planned operation, six other detector systems developed problems during this year of intensive use and had to be taken out of the setup for repair. Also in these cases the detectors were replaced by spare systems so that the normal configuration could be restored after a short time, while the repair took place. Two of these detectors had developed vacuum leaks, which were repaired by welding in house. In another case, a leak proved to be mechanically unaccessible and the cryostat-vacuum housing of the detector had to be replaced by the manufacturer. The other problems were due to failing electronic components, which usually could be repaired in-house.

The overall performance of Gammasphere's Germanium detector systems remains excellent.

f.3. The Gamma-Ray Box Project (GARBO) (C. J. Lister, M. P. Carpenter, R. V. F. Janssens, D. G. Jenkins, F. G. Kondev, T. L. Khoo, T. Lauritsen, B. Phlips,* and R. Kroeger*)

The next generation of gamma-ray detectors, beyond Gammasphere and Euroball, will be designed to meet the needs of RIA-based physics projects. These include: high efficiency (both in discrete transitions and for calorimetry), excellent Doppler correction capability for swiftly-moving sources (up to 7% c for accelerated ISOL beams, or 50% for fragmentation beams), polarization sensitivity for all events, excellent timing characteristics (for “chance” coincidence suppression, and for electronically measuring the lifetime of states in the nano-second regime), and finally high countrate capability to allow operation in an environment where radiation from beam-decay is an issue. To achieve these goals the detectors will have to be more highly pixelated, have higher data collection capability, and be more hermetic for high-resolution calorimetry, ideally consisting of a pure germanium shell. Around the world, many groups are investigating technologies which may satisfy the needs of these arrays. The implications of these investigations go far beyond nuclear structure studies. New detector systems could have profound impact on medical imaging, space science and on environmental monitoring.

One promising technology involves the development of large-area planar germanium detectors. These counters can be made position sensitive through using orthogonal “strip” electrodes on their front and back faces. Depth information can be gained from the risetimes of pulses, thus allowing a full x,y,z location of the electromagnetic interaction, and tracking of photons in material. The parallel-plate electric field should make “tracking” of multiple interactions between a photon and the germanium, through Compton, pair, and photoelectric interactions, more straightforward than for more complicated geometries.

At present, many technical challenges have been surmounted, but many remain. The basic physics of tracking the interaction in a uniform, parallel-plate field seems to be on a sound footing. We have continued to work on this technology to see how far it can be developed. We have procured the worlds largest planar detector, from EG&G Ortec. It is a 90 mm × 90 mm × 20 mm crystal, with 16 × 5mm strips on each side. The prototype is mounted in a large cryostat to avoid thermal problems, and had 32 individually mounted preamplifiers to allow easier individual adjustments. The detector was delivered in March 2000 and is undergoing preliminary testing. The Li-implanted side with room temperature electronics meets specifications, with a resolution of 1.8 keV at 122 keV, but the B-implanted strips, with cold FET’s still experience noise problems and have resolutions between 3.0 and 4.0 keV.

We are also working on GEANT simulations of an array of such detectors. Using 24 streamlined modules, arranged in stacks of 3 in a single cryostat, we have been evaluating the performance of an array which we call the GAmma-Ray BOx, GARBO. The simulations are interesting and educational. However, until a true detector “module” has been built and evaluated it is difficult to develop a clear picture of what the working array would look like or how well it might perform. It would appear that a full 4-π coverage detector is very difficult, but a very powerful device could be built which covers 3-π with germanium and which would be ideal for radioactive beam physics.

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*Naval Research Laboratory

f.4. Refinement of Channel Plate Detectors: Second Generation Design (C. J. Lister, D. J. Henderson, and T. O. Pennington)

The use of Channel-Plate detectors at the FMA has continued. Considerable operational experience has been gained for a wide variety of ions, count rates and energies. Continuous small modifications of the design continues to make the system more reliable, and the detectors operational characteristics more clear-cut. New interlocked power supplies built by the Physics Division Electronics group have proved extremely useful and reliable. The detectors are very sensitive to the state of the FMA electric fields and to the vacuum in the beam line. More careful shielding of the detectors has reduced the noise level from these background sources, so "false" firing has been eliminated. A new vacuum system using cold-cathode gauges allows continuous pressure monitoring, and automatic shut-down of the channel-plate system is vacuum irregularities occur. Normal operation now has a two-foil arrangement, one in the focal plane for generating mass spectra and one about 25 cm behind the focal plane for generating a clean, efficient identification trigger.

It is clear that the experience gained from the current detectors has been very useful, but an entirely new detector is needed to remedy the remaining problems which are three-fold: insufficiently good mass resolution, modest time-resolution, and in-efficient "fringe" regions at the counter periphery. Indeed, our most recent measurements indicate the response is only highly efficient for the central 2-3 cms of the counter. We believe that most of the problems can be solved with a new foil-and-mirror system, which will shorten the electron trajectories and have larger mirror surfaces which extend well beyond the active area. A new design is in progress, and a new prototype should be ready for testing by summer 2000.

f.5. Current Modifications of the Focal Plane Ion Chamber Detector (T. Pennington, D. Henderson, and C. J. Lister)

The Focal Plane Ion Chamber Detector Window has been redesigned. It is now much easier to change the window because of breakage, leakage, or if a different window thickness is needed. There are three different sized windows: 5 cm × 5 cm, 5 cm × 10 cm (there are three window frames for each size), and 5 cm × 15 cm (this window frame and wire support frame has currently not been constructed). The wire support system has also been redesigned for a 0.9 μm thick Mylar window (125 $\mu g/cm^2$) and 33 Torr of pressure. Plans are being made to construct and to conduct tests to see if 0.5 μm thick Mylar window (70 $\mu g/cm^2$) is workable. Another modification to the ion chamber is the front electric field gradient wires have been removed from the window frame and have been permanently mounted inside the ion chamber. The final modification to the ion chamber that has been implemented is the ability to install a 5 cm × 5 cm silicon detector. This detector will allow the measurement of the total energy of the particles that have not completely lost their energy in the ion chamber. This preserves Z resolution capability of the ion chamber while allowing for thinner windows, which reduces energy straggling and allows for lower operating pressures.

f.6. Degrader Foils for Gas Catcher Cell (J. A. Caggiano, J. P. Greene, G. Savard, and B. J. Zabransky)

The gas catcher cell after the Area II spectrograph is designed to stop reaction products and then reaccelerate them through a small potential for transport to an ion trapping system, i.e. the Canadian Penning Trap. Since the cell is only 18 cm long and runs at a maximum of 180 Torr, the stopping power of the gas is limited. Furthermore, the combined system is required to stop even the most energetic light ions, such as ^{6}He. Thus, it is required to slow down the ions to an energy of 0.3-0.5 MeV/u. Decelerating the ions was attempted by increasing the pressure in the spectrograph (in gas filled mode) to slow the ions, but this method was unsuccessful.

A method was developed and implemented to degrade the ions prior to entering the gas cell but without increasing the pressure in the magnet. The method is based on a ladder of degrader foils that can be fine-tuned to stop almost any ion in the gas cell. The degrader foils had to be large enough to accommodate the ~ 4 cm diameter beam spot, and span a range of thicknesses from 0 to 100 mg/cm^2 continuously. A ladder of 5 foils that could rotate up to 60° was chosen to be the most flexible and easiest to implement.

The degrader ladder was designed to be rotated up to 60° and still allow a window (bigger than the beam spot) of 5 × 5 cm^2 for the reaction products to pass through. Thus, the foils had to be 5 cm by 10 cm to accommodate a ~ 4 cm diameter beam spot when rotated to 60°. Three sets of five aluminum foils were made to allow thicknesses of 0.1-100 mg/cm^2. Each set of 5 foils are designed to span one decade of thickness using the 60 degree rotation, i.e. 0.1-1 mg/cm^2, 1-10 mg/cm^2, and 10-100 mg/cm^2.

The degrader ladder is mounted on a small turntable. The small turntable is mounted on an arm attached to a linear drive mechanism. One motor is used to control the height of the ladder by moving the arm up and down, while the other is used to rotate the ladder. Speedometer cables transfer the power from the motors, mounted outside the focal plane detector housing, to the drives. The cable is coupled to the linear drive through a 90°, 3:1 reducing gear box. The threaded rod in the linear drive has a pitch of 10 threads/inch, and vertical motion is readout at the motor, with a pitch of 10 numbers/revolution. Thus the vertical motion is controlled and accurate to 0.003”, adequate for our purposes.

The ladder is rotated by rotating the turntable that is mounted on a 3:1 reducing gear box. The turntable is a timing-belt sprocket, and a timing belt is run to another sprocket mounted on a rotation encoder for reading the angle. The rotation encoder is 12-bit for one revolution, for a reading accurate to 0.09°. To control the motor at this level, the motor was coupled to the gear box through a 360:1 speed reducer, which gives control at the 0.03° level, well matched with the rotation encoder readout. Figure I-90 shows photographs of the ladder as installed in the spectrograph.

The ladder has been tested during experimental runs and works well.

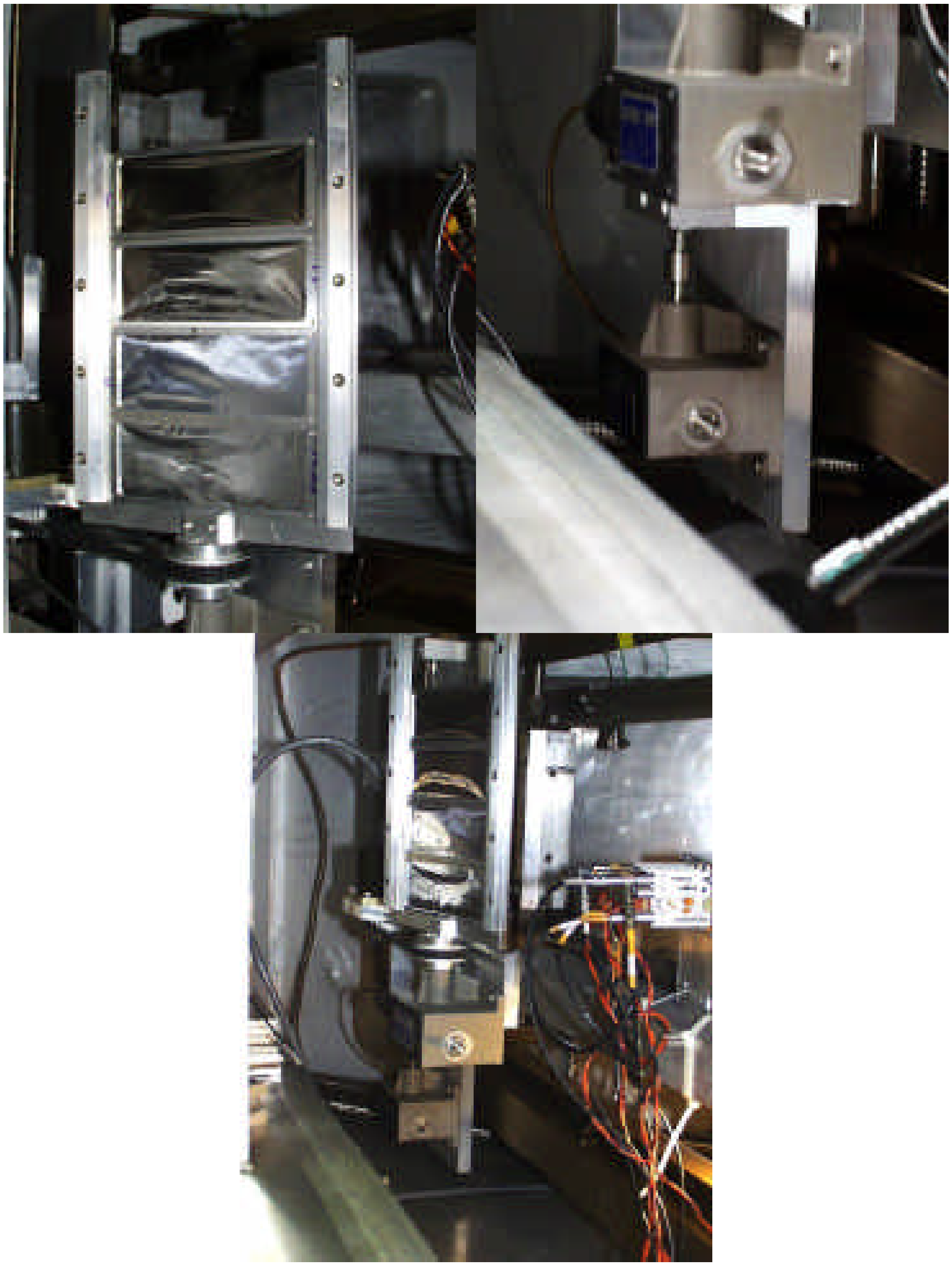

Fig. I-90. Pictures of the degrader ladder. *<u>Top left:</u>* *Just the ladder itself with 4 of the 5 foil positions filled.* *<u>Top right:</u>* *The two gear boxes that control the height and rotation of the ladder.* *<u>Bottom:</u>* *The whole ladder, as it is installed in the spectrograph.*

f.7. **Status of the Beam Monitoring Circuit** (P. Wilt, B. Harss, R. Pardo, and P. Ostroumov)

The Beam Monitoring project is being developed to allow operators and experimenters to determine the position of weak beams as they are accelerated through ATLAS. This is accomplished by placing a set of 64 scintillation fibers in the path of the beam; thirty-two of which are horizontal and the thirty-two others are vertical. As the beam passes through the fibers, they scintillate, producing a light that follows the fiber to an X-Y grid photomultiplier tube. With the information produced from the photomultiplier tube and some post acquisition calculations the intensity, location and size of the beam in the X and Y directions can be determined.

An additional requirement is to place the entire system into a CAMAC module. This includes amplification, trigger logic, acquisition (ADC′s), post acquisition calculations, a multichannel analyzer and oscilloscope display driver circuit.

A number of design criteria needed addressed. They were:

1. Design a Track and Hold circuit that could track 5 ns pulses to 2.5V.
2. Design an acquisition system that could convert >1M events per second.
3. Design a Ratio Conversion circuit that operates at the desired event rate.
4. Design the complete circuit into a one or two slot wide CAMAC module.
5. Construct the complete system at a reasonable cost.

Because of the design criteria and the speed at which this system would have to operate to accommodate all the acquisition, conversion and display functions, it was decided that prototypes of the individual circuits would be built and tested to determine the feasibility of this project. This approach would then also provide guidance for the final lay-out.

At present, the basic logic design has been completed. It is based on a fast microprocessor which uses a fast SRAM memory for the display, and EPRoM for the data transfer and various operations. The analog circuit has been designed and built as well. Considerable attention has been devoted to the design and signal compatibility of the PMT base.

The various sub-systems have undergone an extensive number of tests, some of which were performed with beam. A number of design changes are currently being implemented as a result of these tests.

f.8. **LEPPEX Development** (D. Hofman, B. B. Back, D. Henderson, and I. Dioszegi*)

The machining and assembly of the LEPPEX scattering chamber has been completed. The fabrication of the eight PPAC chambers has been completed at Stony Brook. The printed circuit boards for the wire planes have been fabricated. Vacuum tests of the scattering chamber have been completed successfully. Remaining items are: design, fabrication and installation of the target wheel mechanism, procurement of vacuum system, installation of old Apex gas handling system, assembly and testing of PPAC's.

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f.9. **BaF$_2$ GDR Measurement Collaboration** (D. Hofman, B. B. Back, M. Carpenter, P. Collon, A. Heinz, D. Henderson, M. Kelly, T. L. Khoo, F. Kondev, C. Lister, T. Pennington, R. Siemssen, V. Nanal,[*] I. Dioszegi,[†] A. Bracco, [†] F. Camera, [†] R. Varner, [‡] M. Thoennessen,[§] and U. Garg[¶])

A collaboration with participation from Argonne, Oak Ridge, Michigan State University, Texas A&M University, Stony Brook, Notre Dame University, and INFN Milano has been formed with the goal of studying Giant Dipole Resonance γ emission from well identified hot nuclei formed in heavy-ion fusion reactions. The experiments will be carried out at Argonne using the FMA augmented with the BGO Spin spectrometer to identify the spin range and the mass (M/q) of the nuclei under study. The high energy (GDR) gamma rays will be measured in a high efficiency array of BaF$_2$ detectors arranged on four packs of 30-37 BaF$_2$ crystals centered at ±90 and ±135 degrees w.r.t. the beam axis. The BaF$_2$ detectors will be provided by ANL, ORNL, MSU and TAMU.

An organizing workshop was held at ANL on January 22-23, 2000 in order to discuss the scientific opportunities and technical details of this program.

Proposals for a comprehensive study of hot GDR emission and other topics using this setup has been submitted to the ATLAS Program Advisory Committee for the Spring-summer 2000 period.

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f.10. **Nuclear Target Development** (J. P. Greene and G. E. Thomas)

The Physics Division operates a target development laboratory that produces targets and foils of various thicknesses and substrates, depending on the requirements, for experiments performed at the ATLAS and Dynamitron accelerators. The targets are prepared from both naturally occurring materials and stable isotopes that are supplied either in pure, elemental form or as stable compounds. Targets are made not only for the Physics Division but also for other divisions at the Laboratory and occasionally for other laboratories and universities.

In the past year, numerous targets were fabricated either as self-supporting foils, on various substrates or as "sandwich" targets. Targets produced included AgS, Al, Au, Be, Bi, ^{12,13}C, ^{40,48}Ca, Co, ^{52}Cr, Cu, CD$_2$, Fe, formvar, ^{72,76}Ge, Havar, ^{180}Hf, kapton, ^{24,26}Mg, ^{94,95}Mo, MoS$_2$, mylar, ^{58}Ni, ^{206,207,208}Pb, ^{208}PbO, PbS, ^{106}Pd, polyethylene, polypropylene, Pt, ^{102,104}Ru, Se, ^{30}SiO$_2$, Ta, ^{130}Te, Th, ^{46,50}Ti, Ti/V/Al, U, UC$_2$, ^{176}Yb and ^{90,91,92,96}Zr. Many of these target foils have been fabricated via mechanical rolling using our small rolling mill. Approximately 400 targets have been prepared for various experiments during this calendar year. With second full year of Gammasphere operation at ATLAS, support continues for both researchers in-house, as well as others outside the Division. Preparation of targets absorbers, reset foils, etc. has progressed steadily. A new rotating target wheel was developed based on designs previously employed at APEX so as to increase lifetimes and allow for higher beam currents on target. This Gammasphere target wheel is now in routine use for many experiments where high beam currents are necessary. Successful runs employing auxiliary detector systems other than the FMA have included μBall, CHICO and fission source studies, each employing specialized target holders. The Physics Division Target Laboratory fabricated approximately 260 targets for the research effort at Gammasphere this year.

As part of ATLAS support, the target lab routinely produces carbon stripper foils of 2 μg/cm^2 for use in the Tandem as well as other thickness for additional stripping throughout the accelerator. A total of 304 carbon stripper and gold foils of various types were prepared for ATLAS in 1999. In addition, there continues to be an increase in the preparation of various dilutions of isotopic source material into a form and shape suitable for introduction into PIIECR and SNICS sources to produce enriched beams at ATLAS. This includes reducing separated isotopes. Some examples include ^{40}Ca, ^{76}Ge, ^{54}Fe, FeS, ^{26}Mg, ^{58}Ni, ^{6}LiH and

$^{44}TiO_2$ which was the first accelerated beam of ^{44}Ti produced by ATLAS and delivered to the FMA for experiments of astrophysical significance. This material, used in the SNICS source at the Tandem, was obtained by bombarding a scandium disk target with protons at IPNS, producing a small quantity of ^{44}Ti, which was then chemically separated by CMT Division. The resulting oxide precipitate was mixed with natural TiO_2 and packed in a source cone for use in the Tandem. Future experiments are planned. The continuing procurement of stable and enriched material for ATLAS consumption and maintenance of isotope inventories for enriched beam production is being provided by the target laboratory staff.

The target development laboratory includes state-of-the-art equipment used for thin-film fabrication. The available techniques consist of multiple resistive heating, focused ion beam sputtering, glow-discharge plasma deposition, electron beam and electron bombardment evaporation, electrodeposition and mechanical rolling. The evaporators are maintained under high vacuum and each vessel contains a quartz-crystal film-thickness monitor with deposition rate indicators. Also included are movable shutters, quartz-lamp substrate heaters and thermocouple temperature sensors, allowing for complete process monitoring during target deposition.

Other auxiliary equipment used for target development includes electrodeposition equipment, a small rolling mill, an alpha particle counting chamber, inert atmosphere glove box, laminar flow clean bench, pellet press, a reduction furnace, and a variety of precision balances. A turbo-pumped target storage facility is in operation for maintaining, under high vacuum, those targets that readily oxidize in air. This system utilizes computer-controlled circuitry to prevent targets from exposure to atmosphere during power interruptions. A second storage system employing a bank of vacuum desiccators and connected to a mechanically pumped manifold is available for use by individual experimenters. Similar systems are in operation at ATLAS just inside the entrance to Target Area II. A new additional set-up, consisting of two large glass desiccators evacuated using a small turbo-pump system, is in operation for long-term material storage. This allows a separation of material storage from target storage, hence eliminating repeated exposure when transferring and retrieving targets.

A low-level radioactive source and target preparation laboratory exists at a separate location within the Division that is dedicated to the production of these sources and targets. Available preparation techniques include multiple resistive heating, employing a diffusion-pumped vacuum evaporator. A second, smaller evaporator system was constructed for close proximity evaporations of higher activity materials, to be used as targets as well as radioactive sources. The small size of this system allows for installation within a hood. Preparation of actinide targets by electrodeposition is continuing, most notably Cm and Pu for Coulomb excitation studies using Gammasphere at ATLAS. The Physics Division finds itself in the unique position of having the ability to obtain, process and handle actinide elements and, therefore, prepare the thin deposits used as targets for these experiments while Gammasphere presents the necessary experimental opportunity to accomplish this effort. Production also continues for natural and depleted uranium and natural thorium foils by mechanical rolling. A large effort went into the preparation of several geologic samples for an AMS run involving ^{236}U. Ore and mineral samples were received from many locations and needed processing into forms acceptable for the ECR source. A clean hood, work area and special tools were procured so as to avoid contamination of the samples. This work is still in progress.

Outside of target development, support is being provided for the production of thin films and foils for use in various new detector systems developed for experiments at ATLAS. Several variations of metallized plastic foils were prepared for use in the channel plate detector at the FMA. A variety of windows employed in CPT experiments at the SPS in Area II were produced. These included windows of Ti, Ni, Kapton and Havar. Also developed for the SPS II focal plane was an energy degrader system consisting of a ladder of various thickness, large area, aluminum foils, which were prepared by mechanical rolling. Support of the efforts involving fragmentation/high-pressure He gas stopper cell as a means to produce secondary exotic beams also being pursued at the SPS in Area II has required foils and gas cell window technologies previously developed for the production targets used in the ^{17}F experiments at ATLAS. This support is continuing. One area of considerable importance is the ability to manufacture and measure the thickness of large area foils of various kinds. In particular, for the preparation of formvar films for the channel plate detectors at the FMA. To accomplish this, we have constructed a new alpha particle counting system with a chamber large enough to accommodate these mounted foils.

Another area of increased research effort has been toward development of radioactive beams employing the ISOL technique involving neutron producing targets which induce fission in uranium or a uranium compound production target. One aspect of this development has been the design of a liquid uranium target for testing at the Dynamitron accelerator. Melts of uranium samples attempted via resistive heating using the Cooke evaporation in the Radioactive Target Laboratory have met with only little success. A higher temperature source is needed and will require the installation of the electron beam evaporator system obtained by ANL from Florida State University. In addition, the first direct measurements of the thermal conductivity of uranium carbide samples have been made using the method of heating by electron bombardment and measuring the surface temperature of thin UC_2 disks with an optical pyrometer. The uranium carbide sample disks are first prepared by the reduction of uranium oxide using carbon in a resistively heated source in the Radioactive Target Laboratory. Next, the samples are heated by a 10 kV electron beam provided by a mortar source in a vacuum evaporator in the target lab (R-154) and the temperature measured as a function of beam current using a two-color pyrometer. This work is still in progress.

f.11. Portable Data-Acquisition System (T. Pennington, D. Henderson, and P. Wilt)

A portable data-acquisition system for detector testing has been constructed. The system is composed of a 100 MHz Pentium PC (A 600 MHz Pentium III PC was purchased), a NIM bin, and a CAMAC crate with a GPIB Interface. The software that is being used is Labview 5.0. Currently, an EG&G ORTEC AD811 ADC is being used, but the system can be adapted for any CAMAC configuration (i.e. ADC, TDC, QDC, etc.).

A MCA program with real-time analysis was written, but this program is extremely slow. The count rate is approximately 6 Hz and the average dead time is approximately 100–120 microseconds. The lack of speed is mainly due to the large amount of overhead from the real time analysis and the speed of the PC being used.

Two low overhead programs were written that basically writes the ADC output to disk to increase speed of the data acquisition (which can be read by a spreadsheet program for data analysis and plotting). There is no real time analysis or real time spectra for these programs. The first program reads a single channel from the ADC. The count rate of the program is approximately 19 Hz. The second program reads two channels from the ADC. The count rate of this program is approximately 14.5 Hz. Both programs were tested on a 333-MHz Pentium II PC and the count rates of the programs increased by approximately 3 times.

The data-acquisition system is expandable to as many ADCs and ADC channels that can fit into the CAMAC Crate. All the low overhead programs are easily altered for the addition of more ADCs and ADC channels. Each ADC and ADC channel that is added will decrease the overall count rate of the system due to more program overhead and CAMAC read and writes. Also, any online analysis can be included in the system but at the cost of speed, i.e. average dead time, centroid, etc.

f.12. Physics Computing Facilities (K. Teh, D. R. Cyborski, and T. Lauritsen)

The Physics Division maintains several computer systems for data analysis, computation, and general computing. These systems are conveniently grouped into various clusters and are described briefly below.

The Division's Unix cluster consists of Suns Sparcstations and Linux PC workstations. Its primary function is data analysis and general computing. The VMS Analysis cluster consists of three Alphastations hosted by an Alphaserver. It is used primarily for sorting data obtained from ATLAS based experiments. In addition, the Division maintains a 4-processor SGI Origin 200 for numerically intensive computations.

The Vax cluster continues to provide general computing services, primarily mail, and serves as a disk storage to Windows PCs and Macintoshes. Last year, a dual processor Linux PC was installed as a possible replacement for the Vax cluster. It is now online and available.

The Division also operates four additional clusters. The Theory Group maintains a pair of IBM RS/6000 workstations that serve several X-window terminals. They also make use of the ANL IBM SP2 and the SGI Origin 2000, both massively parallel machines, for large numerical computations. The Medium Energy Group has two clusters: a Compaq Unix cluster and a VMS cluster which is used for data analysis and general computing. Finally, the ATLAS accelerator group maintains its own cluster of controlling the ATLAS accelerator.

f. 13. Data-Acquisition Systems (K. Teh, D. R. Cyborski, and T. Lauritsen)

The Division operates three MSU/Daphne data-acquisition systems. Each consists of an MSU VME front-end and a VMS Alphastation back-end running Daphne for online data monitoring.

Work continues on the SCARLET acquisition system which is intended to replace the MSU/Daphne system. This system is based on a custom CAMAC controller that is being built in-house. It is expected that it will be ready for use by the end of summer.