LNL **TANDEM-ALPI NEWSLETTER** N^0 12, January 1997
Laboratori Nazionali di Legnaro, Via Romea 4, I-35020 Legnaro, Italy

Calendar

May 13, 1997	Users meeting
May 31, 1997	**Deadline for proposals** (for the period Sept. 97-Febr. 98)
July 2-4, 1997	PAC meeting

The Tandem-ALPI accelerator

In 1996 the XTU-Tandem accelerator has been working (beam on target) for 5440 hours delivering 21 different beam species ranging from ^{11}B to ^{197}Au. Besides calcium, two further interesting beams, magnesium and zirconium were successfully produced and accelerated. The total amount of time devoted for conditioning and beam preparation was 820 hours, whereas maintenance and scheduled shut-downs took 2058 hours. Unscheduled shut-downs occurred for only 60 hours.
The superconducting linac ALPI, that in the first semester suffered from many failures of the cryogenic system, ran with sufficient reliability in the last part of the year. A total number of 702 hours of beam on target was delivered by the linac in 1996.
The major failure in the Tandem accelerator occurred to the ion pumps located in the terminal, preventing therefore the use of gas stripping in the last three months of the year. In the coming semester no major maintenance operation are foreseen for the Tandem accelerator.

The list of experiments completed in the second semester 1996 is given in Table 1.

Table 1 – Experiments performed at the Tandem-ALPI accelerator in the period July-December 1996.

96.A03 Search for pre-equilibrium effects in GDR excitation.
G. Viesti (Padova)
96.T32 Spectroscopy of the highly neutron deficient ^{141}Dy.
M. N. Rao (Sao Paulo), D. R. Napoli (LNL)
96.T33 g–factor of a shears–band head in ^{193}Pb
H. Hübel (Bonn)
96.T34 Superdeformation built on an N=6 hyper–intruder orbital in ^{85}Y.
A. G. Smith (Manchester)
96.T36 Stability of the $N = 72$ shell closure at highly–deformed shapes.
C. M. Petrache (Padova)
96.T38 Gamma–ray spectroscopy of the yrast line of ^{84}Mo.
D. Bucurescu (Bucarest)

96.T39 Multinucleon transfer reactions in $^{40}Ca +^{124} Sn$ studied via γ–particle coincidences.
L. Corradi (LNL)

96.T41 A three–octupole phonon state in ^{148}Gd.
P. G. Bizzeti (Firenze)

96.T46 The structure of collective intruder bands in ^{114}Sn.
A. Dewald (Köln)

96.T52 High spin and band crossing phenomena in the ^{76,77}Sr isotopes.
G. de Angelis (LNL)

96.T53 Search for magnetic rotation in ^{107}Sn.
G. de Angelis (LNL)

96.T55 Commissioning of the beam transport lines serving to third experimental hall.
G. Fortuna (LNL)

96.T56 Latent track formation induced by high energy ions in HTSC materials and their interaction with flux lines.
E. Mezzetti (Torino)

96.A01 Search for the $\nu g^2_{9/2}$ structure in ^{70}Ni isotope. Angular momentum transfer in ^{208}Pb+ ^{76}Ge deep-inelastic collisions.
R. Broda (Kracow)

96.A04 Population of isovector GDR in the intermediate system formed in heavy-ion deep inelastic collisions.
M. Sandoli (Napoli)

96.A09 $8\pi LP$ Spectrometer test experiments.
G. Prete (LNL)

96.A10 Two–phonon γ vibrational states in ^{166}Er.
C. Fahlander (LNL)

96.A12 Search for p–radioactivity in rare earth nuclei.
F. Soramel (Udine)

Euroball at Legnaro: a status report.

1. Mechanics.

The installation of the mechanical platform and of the detector holding frame has been completed in September 1996. The original project needed some slight modifications in order to properly fit the 71 anticompton shields of EUROBALL to the frame. Furthermore, some additional support structures were added to hold the channels carrying the cables from the detectors to the electronic racks.
In an array like EUROBALL with its different type of detectors (15 Cluster, 26 Clover, 30 Tapered), a proper collimation of the anticompton shields is rather complicated. Several modifications to the existing heavy metal pieces from EUROGAM and PEX set-ups were necessary to take care of scattering from the collimators of the cluster shields into the Clover shields which sit closer to the target.
The manipulator which has to be used for a safe installation of the heavy Cluster detectors has to be modified because with the present design it is not possible to access the detectors of the lower part of the ball.

A standard EUROBALL reaction chamber, which has been designed and machined in Danemark is ready to be installed into the beam line.

2. BGO shields

After completion of the holding structure, the installation of the BGO anticompton shields could begin. As first, the 15 shields of the Cluster detectors sitting in the backward sector of the array were mounted, cabled and partly tested.
The installation of the central Clover section started as soon as the detectors arrived at LNL after the end of operation of EUROGAM2. By now 25 shields are installed and cabled and the section will be completed when the 26^{th} shield, being ordered by the UK, will be delivered.
The 30 BGO shields of the forward section have also been installed and cabled. However, some of them will be soon dismounted in order to fix a problem with the precise closure of the holding frame, likely due to a misfit of the lead collimators used for these shields.

3. Ge Detectors.

To date, 110 of the 116 encapsulated germanium crystals which have been ordered for the 15 Cluster detectors have been delivered and tested. Of them 102 work well while 7 (1 DK, 4 I, 2 S) have some problems and one from the UK is used for testing the VXI electronics. In order to have a sufficient number of spares, one extra capsule has been ordered by Danemark and two will be soon ordered by Italy. The delivery of these capsules is expected by March-May 1997.
All cryostats, manufactured by CINEL, Padova, have been delivered and successfully assembled. To date, 11 Clusters detectors are already mounted in the frame and 2 more are ready for test or in the cooling phase. In order to check the quality of the grounding system and of the power supplies, 9 of the installed detectors have been tested in the Christmas period. Using NIM electronics we found no appreciable deterioration of the energy resolution with respect to the value obtained in the laboratory. However, we had 2 FET failures and 2 preamplifiers turned out to be very unstable. This means that as soon as further Clusters will be available the defective ones will be dismounted and repaired.
By the end of the year 1996 19 Clover and 7 EUROGAM phase one Ge detectors were mounted and cabled and await to be tested. The final mounting of the forward section will proceed as soon as the mechanical problem with the closure of the ball will be fixed.

4. Electronics.

The high voltage system for Ge and BGO detectors is based on CAEN SY527 for the Cluster detectors while it uses LeCroy 1440 power supplies from EUROGAM for the Clover and the Tapered detectors. During the PEX experiments there has been a suspicion that powering more than one Cluster (7 channels)with the same HV card on the SY527 (which has 12 HV channels) could cause a deterioration of the resolution. However, in the test performed at LNL and mentioned above we found no problem at all. The low voltage power supply system which uses both new modules, developed at Padova, and existing modules from EUROGAM, is operational.
The VXI electronics for Ge and BGO detectors is powered by 9 crates located into 3 racks equipped with a cooling system which can remove 10 kW per rack. There has been lot of concern from part of the collaboration about this cooling system as it uses some innovative features in order to avoid problems with condensation of water. However, tests performed at the beginning of November, first without electronics cards

(i.e. generating 6.5 kW with a heater) and then in the realistic situation have shown that the system works in a very satisfactory way.
Concerning the VXI electronics, EUROBALL will use newly developed cards for the Cluster Ge and BGO while for the Clover and the Tapered detectors the EUROGAM electronics will be used. In order to exploit fully the big detection efficiency of the set-up the trigger and readout system of EUROBALL will be operated in a parallel mode. This feature is built into the new VXI electronics for the Cluster detectors while the Clover cards from EUROGAM must be modified in order to support it. In order to save some money, for the 30 detectors of the forward section this modification will not be done also in view of their smaller overall efficiency. At the VXI crate level the parallel mode is implemented through a standard Struck STR8080 readout engine which however needs to be fitted with an additional card, known as P3 card manufactured by the UK.
To date (January 10, 1997) the situation of the VXI electronics is as follows:

Cluster: 5 Ge cards delivered out of 15; 7 BGO cards out of 15.
Clover: 14 cards out of 26.
Tapered: 5 cards (both Ge and BGO) out of 6.
Resource Manager: 4 out of 9.
Readout Controllers: 6 out of 9.
Trigger card: not yet ready.

The main concern is with the new Ge Cluster cards as, among the various parts of the project, they have the largest and unrecoverable delay.
The whole electronics is powered by 3 UPS systems in order to avoid problems with power failures which are relatively frequent at LNL. A signal multiplexer, similar to that used at GASP, for convenient inspection of the Ge signals during HV ramping is being manufactured in Danemark.

5. Autofill system.

The liquid nitrogen autofill system has been developed following the experience made with GASP. The system, controlled by a HP3852A microprocessor with the graphic interface running on a Macintosh, has been successfully tested at the beginning of November and is now operational routinely. In this system the temperature of the Ge detectors is checked continuously and a refill starts automatically for all detectors in case one of them gets warming up. Some ancillary detectors planned for EUROBALL will use the space of the 30 individual Ge detectors in the forward part of the array, which have then to be dismounted. The dismounted detectors will be kept in the LN_2 filling system by storing them in a stand close to the EUROBALL frame which is being built now.

6. Data Acquisition.

The data acquisition system has been tested in July. All the basic elements (hardware and software) are now in operation and ready to work. The job is still in progress to provide a smooth integration of those elements.
In December 1996 a full test of the system has been made using the available Cluster cards. Data from radioactive sources has been written to magnetic tape. A full commissioning of the DAQ is awaiting the delivery of the missing electronics.
The parts already tested are:
Event collectors (dt32 and FERA);
GUI;
Neo++;

Processor farm control;
Event builder protocol;
Tape server;
Histogramm server;
Histogramm viewer.
In progress are the following parts:
A grafic user interface (GUI) for the back end set up (processor farm, servers);
Neo++ with the last revision of the tape format;
Tuning of the Neo++;
Spy farm.

<u>The magnetic spectrograph PRISMA</u>

A collaboration has been initiated, aiming at a detailed project for a magnetic spectrograph with very large solid angle and broad momentum acceptance. The spectrograph, named PRISMA, will exploit the heavy ion beams from the Tandem -ALPI accelerators for experiments on reaction dynamics and on nuclear structure. Interesting possibilities will be offered for the study of neutron-rich nuclei, in connection with other devices.
The main performance of PRISMA should be as follows:

Solid angle	$\simeq$80-100 msr
Energy acceptance	$\pm$20%
Resolving power	p/Δp $\simeq$3000
Mass resolution	1/300 (via TOF)
Energy resolution	1/1000 (via TOF)
(Z resolution)	$\leq$1/70
Mass energy product	ME/q^2=70 MeV amu
Kinematical correction	via software
Aberrations correction	via software
Count rate capability	at least $\leq$10^5 sec^{-1}

The proposing groups have got funds from INFN for R&D on the various parts of the project during 1997, and in particular for studies on the detectors. The subsequent construction, installation and commissioning phases will require 2-3 years, with the final aim of performing the first test experiments in 2000. By that time, the beams produced by the new ALPI injector (ECR source) will be available. The projected performance of PRISMA will actually exploit the possibilities offered by those very heavy beams (A$\geq$100, E/A = 6-10 MeV).
People interested in getting more detailed information on the project and/or in the future use of the spectrograph should contact

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<u>The PAC meeting</u>

In the meeting held on December 4-6, 1996 the PAC has examined the experimental proposals presented for the period January-July 1997. The proposals presented were 58 requesting for 271 days of beam-time: 45 of them were Euroball proposals with a beam time request of 219 days.
The proposals approved (for a total of 135 days) for both the Tandem and Linac accelerators are listed in Table 2. Some other experiments (18 days of beam time), not

requesting EUROBALL, have been approved *conditionally* in case a delay will occur in the starting of the EUROBALL array.

Table 2– Proposals accepted by the PAC for the period January-July 1997.

97.03 A study of the N=72 shell gap and $i_{13/2}$ intruder orbital occupation in the superdeformed mass A=130 region.
A.T. Semple (Liverpool)

97.07 Fission decay of exotic shapes in actinide nuclei.
P.A. Butler (Liverpool)

97.08 Measurements of g-factors in neutron-rich fission fragments.
A. G. Smith

97.09 RDTF g-factor measurement in the dipole yrast superdeformed band in ^{192}Hg.
A. Jungclaus (Göttingen)

97.10 Lifetime measurements and collectivity in ^{114}Te: from discrete rotational bands to the chaotic regime.
A. Bracco (Milano)

97.11 Detector tests for the PRISMA spectrometer.
A.M. Stefanini (Legnaro)

97.14 Decay out and other aspects of superdeformation in ^{143}Eu.
A. Atac (Uppsala)

97.15 Investigation of prolate-oblate shape mixing in the N=Z+1 nucleus ^{73}Kr: a precise measurement of transition probabilities.
J. Eberth, S. Skoda (Köln)

97.16 The level scheme of superdeformed ^{196}Pb: search for linking transitions.
H. Hubel (Bonn)
F. Azaiez (IPN Orsay)

97.17 A study of superdeformation and search for superdeformed-normaldeformed linking transitions in ^{154}Er.
B. Cederwall (Stockolm)

97.19 Investigation of the deformed oblate minimum in ^{74}Kr.
P.H. Regan (Surrey)

97.24 Pre-scission emission in the decay of ^{209}Bi nuclei: exploring the role of the shell effects in fission.
G. Prete (Legnaro)

97.27 Gamma-spectroscopy in neutron-rich *sdf* nuclei produced in deep-inelastic heavy-ion reactions.
R. Broda, B. Fornal (Cracow)

97.30 Decay-out of the yrast superdeformed band in ^{144}Gd.
S. Lunardi (Padova)

97.31 SIRAD: a dedicated beam line at the LNL tandem accelerator for radiation-damage and single-event phenomena studies on silicon detectors and electronic devices.
D. Bisello (Padova)

97.32 Staggering effects in N=85 isotones: the ^{150}Tb case.
J.P. Vivien (Strasbourg)

97.37 Collectivity of low-lying SD states and members of the ΔI=1 bands in ^{196}Pb.
I. Wiedenhover (Koln)

97.39 Search for hyperdeformation in nuclei around ^{152}Dy with the ^{37}Cl+^{120}Sn reaction.
G. Viesti (Padova)

97.40 High spin and band crossing phenomena in the ^{64}Ge nucleus.
G. de Angelis (Legnaro)

97.42 Study of K-forbidden transitions in ^{178}Hf by coulomb excitation.
Ch. Schlegel (Darmstadt)

97.45 GARFIELD: simultaneous detection and identification of light charged particles and heavy fragments.
F. Gramegna (Legnaro)

97.46 Ultra-cold fusion by symmetric reactions as a gateway to hyperdeformation.
B. Herskind (NBI)

97.47 Tilted rotation in a triaxial SD well and ND residual interaction.
G. Hagemann (NBI)

97.48 The investigation of SD states and their population in nuclei around ^{82}Sr.
P.J. Dagnall (Manchester)
J. F. Chemin (Bordeaux)

97.49 Spectroscopy in the unpaired regime of ^{161,162}Er.
J. Simpson (Daresbury)

97.50 γ–ray studies of the fission of ^{238}U induced by ^{12}C: spectroscopy and fission dynamics.
J. Durell (Manchester)
C. Theisen (Saclay)

97.52 High spin states in ^{48}Cr.
S. M. Lenzi (Padova)

97.54 Test of a new detector and setup for recoil-decay tagging with the system GASP+RMS.
P. Spolaore (Legnaro)

97.55 Investigation of the backbending region of heavy Dy isotopes via incomplete fusion.
T. Härtlein (Heidelberg)

97.57 Study of the superdeformed octupole vibrational structures in ^{190}Hg.
A. Korichi (CSNSM Orsay)

The Next Users and PAC Meetings

The next meeting of the Tandem-ALPI users will take place on May 13 at LNL, at 10 am. During the meeting complete information will be provided on the beam time available with the Tandem and Linac accelerators in the period September 1997-February 1998.

Deadline for the presentation of experimental proposals is May 31, 1997.

The next PAC meeting will take place on July 2-4, 1997.

Forms for presentation of proposals will be mailed in the middle of April 1997 to those receiving the present newsletter. If you wish to receive the "call for proposals" but you are not in our mailing list, please contact the coordinator of the Tandem-ALPI accelerator (see address below).

News from physics

Magnetic rotation in nuclei $\approx {}^{100}Sn$

Regular sequences of ΔI=1 M1 transitions with weak E2 crossover transitions have been discovered and subsequently intensively studied in the Pb nuclei. Summarizing the various experimental results one can say that regular rotational-like sequences are observed in nuclei with very low deformation, which differs from the familiar concept that regular rotational bands appear as a consequence of a substantial deformation of the nucleus.

The interpretation of these bands has been given in terms of a novel type of excitation, called *magnetic* rotation. In contrast to normal rotation of the deformed electrical charge distribution, it is the magnetic dipole that rotates about the angular momentum vector. In the Pb region, the angular momentum increase along the band is generated by the simultaneous reorientation of the spins of the proton-particles ($h_{9/2}$ *or* $i_{13/2}$) and of the neutron-holes ($i_{13/2}$). These angular momentum vectors are essentially perpendicular near the bandhead and align with the total angular momentum of the nucleus by increasing rotational frequency ("shears mechanism"). The Tilted Axis Cranking (TAC) model provides the theoretical framework for the description of such magnetic rotation.

The appearance of similar bands has been predicted for the A=100 mass region where particle hole excitations in the $\nu h_{11/2}$ $\pi g_{9/2}$ orbits are possible. High spin states of the light tin isotopes have been studied at GASP, after producing them through the ^{50}Cr+^{58}Ni reaction at 190 MeV of beam energy. The target consisted of a self supporting foil with a thickness of 0.4 mg/cm^2. In order to get charge identification a Si-ball composed of 40 E-ΔE Si-telescopes with a thickness of 130 μm and 1000 μm respectively has been used. Setting gates on the alpha and proton multiplicity, the various reaction products have been selected and by using triple and higher fold coincidences, the high spin states of the final nuclei have been studied. Regular sequences of ΔI=1 transitions of M1 character have been observed in ^{105}In, ^{105}Sn and ^{101}Ag.

Specially interesting is the ^{105}Sn case where calculations have been performed within the TAC model in order to describe the observed band. The most likely configuration of this $\Delta I = 1$ band consists of $\pi(g_{9/2}^{-1} g_{7/2})$ coupled to two neutrons in the $h_{11/2}$ orbit and one neutron in one of the orbits originating from the mixed $d_{5/2}$ and $g_{7/2}$ multiplets.

Any correspondence related to the use of the Tandem or ALPI linac has to be addressed to the coordinator of the Tandem-ALPI accelerator

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