LNL **TANDEM-ALPI NEWSLETTER** N^0 16, March 1999
Laboratori Nazionali di Legnaro, Via Romea 4, I-35020 Legnaro, Italy

Next important dates

June 24, 1999	**Deadline for new proposals**
July 19-20, 1999	**PAC meeting**

The Tandem-ALPI accelerator

During the first three months of 1998 the XTU-ALPI complex suffered from the already reported faults of the XTU laddertron. As described in the 1997 annual report, a wrong manufacturing of the laddertron bushes together with anomalous moisture content were the basic motivations for these faults. Nevertheless, also in this unlucky period the XTU was able to deliver beam for more than 500 hours to seven different experiments corresponding to 30% of the total Beam on Target (BoT) achievable in normal conditions. At the beginning of April a laddertron assembled with old links (more than 10000 hours of work in previous laddertrons) and new bushes was mounted on the XTU, waiting for a completely new laddertron. The old links with the new bushes gave a very good result allowing the terminal to reach 15 MV after a long period of use at lower potentials (13-14 MV). This laddertron ran during the rest of 1998 without any further electrostatic problems, with the XTU tandem working in normal conditions with a total BoT of 4018 hours, which corresponds to 70% of the possible total BoT over the reduced period (9 months), with peaks of 85% in July and October. Starting from February 1998 the ALPI booster delivered beams (^{28}Si, ^{32}S, ^{37}Cl, ^{48}Ti, ^{58,62}Ni and ^{64}Ge) for 12 different experimental runs with a maximum energy of 390 MeV.
The list of experiments performed in the period September 10, 1998-March 7, 1999 is given in Table 1.
On March 8, 1999 the accelerators stopped for a scheduled shut down, mainly devoted to the removing of the hybrid laddertron and the fixing of the electrostatic triplet on the terminal, in order to increase the XTU transmission for masses ≤ 100. The general maintenance is now going on and in the next months (April-June 1999) a systematic work will be also done to accelerate a ^{90}Zr beam with ALPI at $E_{lab} \simeq 370$ MeV and with currents of few pnA. A first test of the transmission of such a heavy beam through the XTU will be done before the starting of the new run period (April 16). Meanwhile, the energy upgrade of ALPI is carried on with the substitution of lead on copper Quarter Wave Resonators (QWR) with sputtered niobium on copper QWR and with the installation of the low-beta section which will be accomplished before the end of 1999.

Tests of the ALPI low beta cryostat

In 1998 the first low beta accelerating cryostat was installed and cooled. The 80 MHz, bulk niobium resonators for the ALPI low beta line, built since 1994 and successfully tested in a laboratory cryostat, could be commissioned and operated with the beam. Even if they belong to the cathegory of the low frequency, large size resonators, they have some unique features that allow them to reach very high performance at a moderate cost. The stabilization against mechanical resonances, affecting all low beta cavities and usually cured by means of powerful fast tuners, was solved by means of a new device, developed at LNL and called "dissipator", acting as a mechanical damper; the stability against helium pressure changes, affecting resonators made of thin metal sheets, was solved by a software control program, called "soft tuner", acting on the mechanical tuner in a feedback loop. The elimination of the need of fast tuners and a careful choice of the construction and mounting procedures allowed us to double the resonator performance and reduce by 50% the low beta line dimensions and cost (three cryostats instead of six). The on line resonators had an average accelerating field of 7.1 MV/m (to be compared with the design requirements of 3 MV/m) at the nominal power of 7 W; the maximum peak electric field reached by all cavities in cw operation was above 50 MV/m and the maximum peak magnetic field was about 1100 G. The total energy gain produced by the cryostat, at the design cryogenic power of 28 W in the cavities, was above 5 MeV/q, more than twice the initial requirements. These rather good results are in a substantial agreement with the performance obtained off line, confirmed also by the other low beta resonators ready for installation. The resonators have been locked for days, with our original rf equipment planned for 3 MV/m, up to the field of 6 MV/m and both the dissipator and the pressure compensation system worked reliably even in severe conditions. The resonators and the components for the two remaining low beta cryostats are ready to be assembled and installed in ALPI. The completion of the low beta line will not only increase the ALPI beams final energy but will also allow for acceleration of ions with heavy masses. The LNL Tandem could be used as an injector of heavy beams using the gas stripper, as planned in the ALPI project, with the double advantage of making a new kind of experiments possible and to practice the transport of heavy beams in the view of the completion of the new PIAVE positive ion injector.

Developments of Calcium beams

Calcium is usually difficult to accelerate as a negative ion and the Ca beam intensity in tandem accelerators is normally rather low. After some runs dedicated to the search of optimum source parameters, very promising results have been recently obtained at the LNL negative ion sources test bench using a metallic calcium target and ammonia gas. We used routinely this technique in the past for Mg beams in the Tandem injector, with good results. In a 20 days run we have obtained an intense calcium beam for 18 days with one target only; for 16 days the current was around 400 nA or more, and above 600 nA for 8 days. It took a relatively short time (about 6 hours) to reach the beam current of 150 nA which is usually considered satisfactory for a Tandem run; the change of the exhausted target required less than 3 hours to obtain again a good current. This technique will be now used at the Tandem injector to produce Ca beams.

Table 1 – Experiments performed at the Tandem-ALPI accelerator in the period September 10, 1998 - March 7, 1999.

98.02 *Spectroscopy of 2^{nd}-well proton emitters in the mass $A \approx 60$ region*
D. Rudolph (Lund)

98.03 *Search for proton-neutron pairing in nuclei with mass number $A \approx 70$*
F. Dönau (Rossendorf)

98.07 *SIRAD/TOLRAD: Proton and ion induced damage on silicon detectors, electronic devices and systems*
D. Bisello (Padova)

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

98.10 *Search for excited states in ^{103}Sn*
C. Fahlander (Lund), L. O. Norlin (Stockolm)

98.12 *Neutron pair transfer channels in ^{62}Ni + ^{206}Pb*
L.Corradi (LNL)

98.14 *Search for γ-decay of the giant dipole resonance in superdeformed nuclei*
A. Bracco (Milano)

98.15 *High spin studies of nuclei around doubly magic ^{40}Ca*
J. Nyberg (Uppsala)

98.25 *Study of fission dynamics in multinucleon transfer induced fission of ^{28}Si + ^{232}Th*
R.K.Choudhury (Bombay), E.Fioretto (LNL)

98.29 *Investigation of T=0 coupling in the N=Z nuclei ^{62}Ga, ^{66}As and ^{68}Se - a survey of the deformation dependence*
S. Skoda, J. Eberth (Köln)

98.31 *Search for γ-ray transitions in hyperdeformed 4N-nuclei with A=36-44*
B. Gebauer (Berlin)

98.33 *High spin states in neutron deficient $f_{7/2}$ nuclei*
S.M. Lenzi (Padova)

98.36 *Investigation of pairing correlations and collectivity in the N=Z nucleus ^{80}Zr*
P.H. Regan (Surrey), R. Wadsworth (York)

98.38 *Detector tests for the PRISMA spectrometer*
A.M. Stefanini (LNL)

98.45 *Superdeformation, shell structure and neutron-proton correlations at $A \approx 90$, $N \approx Z$*
B. Cederwall (Stockolm), O. Skeppstedt (Göteborg)

98.49 *Energy calibration of the CsI(Tl) detectors for the Garfield apparatus*
P. F. Mastinu (Trieste)

99.03 *γ-decay of the GDR in excited rotating ^{140}Ce nuclei as a probe of thermal shape fluctuations*
F.Camera (Milano)
99.06 *Search for proton and α radioactivity of ^{117}La*
F.Soramel (Udine)
99/08 *Study of the fission process in the system ^{32}S + ^{100}Mo at E_{lab}=240 MeV. Cross section and neutron multiplicity measurements*
G.La Rana (Napoli)
99.15 *SIRAD/TOLRAD : proton and ion induced damage on silicon detectors, electronic devices and systems*
D.Bisello (Padova)
99.18 *High spin states in ^{32}S*
D.R.Napoli (LNL)
99.22 *Surface columnar defects as a tool to shut down anisotropy in high temperature superconductors*
E.Mezzetti (Torino)
99.34 *Detector tests for the PRISMA spectrometer*
G.Montagnoli (Padova)
99.37 *GARFIELD : test and calibration of the anular detector*
S.Cavallaro (LNS)

The Legnaro Laboratories as Large Scale Facility of the European Community

The Legnaro Laboratory is recognized by the European Community as Large Scale Facility under the TMR/LSF/RA (i.e. Training and Mobility of Researchers, Large Scale Facilities, Researchers Access) program. Therefore, groups from the European Union and associated states are eligible for financial support, through that program, for carrying out experiments at Legnaro. Users of the Tandem-ALPI accelerator should have a research proposal approved by the Legnaro PAC, in order to get access to funding within the TMR/LSF program. The deadline for the *Call of proposals* related to the TMR program is **June 24,1999**, i.e. the same as for the next PAC meeting. Proposals will be evaluated and selected on the basis of scientific merit by a Users Selection Panel. For more informations about the TMR/LSF/RA program contact *Luisa Pegoraro* or *Giusy Vitaliani*, e-mail : *lsf_secr@lnl.infn.it*, or visit the LNL web page *www.lnl.infn.it*

The Euroball array at Legnaro

After its installation in the second half of 1996 and beginning of 1997, the Euroball γ-ray spectrometer has been operational with the beams of the Tandem-ALPI complex at Legnaro from April 15, 1997 to November 15, 1998, when it has been moved to Strasbourg. In this period, 40 experiments have been performed with it. Of these, 14

were using the array in its standard configuration, 25 with ancillary detectors and one was an off-beam experiment using a fission source of ^{252}Cf. The most used ancillary detectors were: the neutron wall coupled to the charge-particle detectors ISIS (8 experiments), ISIS (6 exps.), Plunger (3 exps.) and gas detector for heavy ions (3 exps.). As concerns the physics done at Euroball, 14 experiments were devoted to the study of various aspects of superdeformation (linking transitions, spectroscopy in the second well,...), 12 to the study of $N = Z$ nuclei from the Ca to the Sn region, and 6 to the spectroscopy of neutron-rich nuclei produced in deep-inelastic reactions or fission. Other themes that have been attacked include hyperdeformation at high spins, spectroscopy in the unpaired regime, GDR studies and search for octupole-phonon states.
The number of proposals discussed by the Legnaro PAC regarding Euroball were 101 with 47 of them approved. For various reasons (problems with the accelerators, safety regulations, mounting of the neutron-wall at Euroball) one of them was moved to GASP, one was actually not performed and five have been moved to the Strasbourg phase of Euroball. During its Legnaro phase Euroball has used $\approx 70\%$ of the beam time available with the Tandem-ALPI beams.

The GASP γ-array

After the move of Euroball to Strasbourg, the GASP spectrometer is now again in operation at Legnaro and available to the users. GASP consists of 40 Compton suppressed, large volume germanium n-type detectors and a 4π calorimeter composed of 80 BGO crystals. The detector houses a reaction chamber of 34 cm diameter where a charged particle detector array (named ISIS) composed of 40 ΔE-E Si-telescopes can be installed (its efficiency for protons is $\approx 70\%$). Evaporation residues produced in the centre of GASP can be injected into the recoil mass spectrometer CAMEL for mass selection. The coupled operation of GASP, CAMEL and ISIS gives a powerful instrument for identification and study of weak reaction channels. The absolute photopeak efficiency od GASP at 1332 keV is about 3% but reaches $\approx 6\%$ if the BGO inner ball is removed and the 40 Ge detectors are positioned at ≈ 20 cm from the target. This second configuration is being used when the detection efficiency, and not the resolving power, is the relevant figure in the experiment.
The electronics and data acquisition System of GASP are being improved and updated in order to keep the array in good operation, but for the first semester 1999 no mayor modifications to the systems will be introduced. A neutron detector to be installed in the forward part is also under construction in order to allow the study of very proton-rich nuclei.
In January 1999 the first in-beam experiment (Proposal 99.18 "High Spin States in ^{32}S" Spokesperson D.R.Napoli), after the EUROBALL departure, has been successfully performed. The average energy resolution was 2.25 keV with the ^{60}Co source. The experimental activity with GASP will continue from April 18, 1999 in the so-called "Configuration 1" with the BGO ball and ISIS. Four experiments will use also the CAMEL spectrometer. The reduced number of available Ge detectors (12 are in Strasburg at Euroball) could imply a reduction of gamma-ray efficiency. Following the

guidelines established in the 1998 October user's meeting the expected configuration for the second semester could be the C2 with the BGO ball removed, if a sufficient number of proposals will require it. Therefore, in order to optimise the use of the array during the second semester of 1999, users are kindly invited to manifest their intention by writing to:
CRA@lnl.infn.it before the end of May 1999,
and by attending a one day GASP user's meeting which will be held in LNL on June 1^{st}, 1999.
For any further information please use the available WEB page :
http://axpd30.pd.infn.it/GASP
or mail to
CRA@lnl.infn.it for access to GASP

For specific information on parts of the array please contact:
Bazzacco@pd.infn.it for electronics
DePoli@lnl.infn.it for DAQ
Spolaore@lnl.infn.it for the CAMEL spectrometer
DeAngelis@lnl.infn.it for ISIS

The LNL offers also a beam-time support person (Trinitario Martinez) that could be reached at the address:
Trinitario@lnl.infn.it
To receive updated information you can also subscribe to the general GASP mailing list just sending a e-mail to:
majordomo@pd.infn.it
with the following message:
subscribe gasp_mail your@mail.address

The PRISMA spectrometer

PRISMA is the project of a magnetic spectrometer for heavy ions which will especially exploit the possibilities offered by the new positive ion injector PIAVE of the ALPI linac, presently under construction. The most interesting features of PRISMA are its large solid angle (up to 80 msr) and momentum acceptance ($\pm$ 10%), good mass resolution (1/300) via TOF measurement and capability of rotation around the target position. There will be many interesting possibilities offered by PRISMA both in the field of reaction dynamics, and in studies of nuclear structure, particularly for neutron-rich nuclei, when PRISMA will be used (as it is planned) in a coupled operation with a large array of γ-detectors. The optical design consists essentially of a quadrupole singlet (ϕ=30 cm, length = 50 cm) at around 50 cm from the target, and of a dipole (gap 20 cm, usable width 100 cm, radius of curvature 120 cm, deflection angle 60^0) at $\approx$60 cm from each other. The bidding procedures for the acquisition of the two magnets have been nearly completed, so that it is planned that the contract may be signed within May 1999. It is planned to have the magnets at LNL within the first half of 2000.
An advanced prototype of the entrance detector, based on a pair of micro-channel plates, has been constructed and will be tested soon with the XTU Tandem beams,

after positive results obtained with an α-source. It exploits an electrostatic field for the acceleration of secondary electrons from a thin Carbon foil onto the MCP assembly; a parallel magnetic field is applied in order to preserve and optimize the information on the position which is read out by a two-dimentional anode. A good timing signal will be obtained as well. The focal plane detector will consist of different parts: 1) a set of multi-wire PPAC's for time and X, Y signals, followed by 2) an array of split-anode ionization chambers with Y sensitivity and a proportional wire at the entrance, to give the X (Bρ) information. The distance between the MWPPAC and the ionization chambers will be around 60 cm, so to measure the direction of the analyzed ions with sufficient accuracy ($\pm$ 0.08 mrad in the dispersion plane). Prototypes of MWPPAC and ionization chambers have been tested with a ^{252}Cf source and with the beams from the XTU Tandem. Subsequently, the final design of the focal plane detector has been completed, and its construction is starting. R&D activities are in progress as far as the acquisition system and some parts of the electronics are concerned; prototypes of low-cost preamplifiers and amplifiers for the ionization chambers have been successfully tested, with results which are in some cases superior to those of commercially available modules.
Depending most critically on the delivery times of the magnets, the present schedule is to be able to complete the assembly of the spectrometer and to start the tests with the beam within the second half of 2000. This would allow us to be ready for the first experiments with the PIAVE-ALPI facility in 2001.

The HECTOR array

The HECTOR array is a result of a collaborative project between the INFN of Milano, the Niels Bohr Institute of Copenhagen and the Niewodniczanski Institute of Nuclear Physics of Krakow. It consists of array of BaF_2 detectors specifically designed to measure the high-energy γ-rays emitted by the decay of the Giant Dipole Resonance in hot rotating nuclei. The complete Hector setup is at present fully operative. The beam line of the Tandem + Alpi accelerators in the new hall III which hosts the HECTOR setup has been completed and successfully tested in mid-February. At that test the reaction ^{11}B + D = ^{12}C was used to calibrate the detectors and the reaction ^{16}O (80 MeV) + ^{124}Sn to measure the γ decay of the GDR in ^{140}Ce. In both cases data have been acquired with the HECTOR new acquisition system and written on tape. The data are presently being analyzed.

The GARFIED set-up

The Garfield apparatus is under calibration in the III Experimental Hall of the Tandem-Linac building. A first calibration has been done on some samples of the drift chambers CSI(Tl) crystals with different beams at different energies (from proton to Ni): this was necessary because of the known non linearity of the light output response of scintillators to heavy ions. An analytical formula has been deduced, which will permit to calibrate all the 200 Garfield CSI crystals just using few normalization points. Test and calibration of the gas section are also necessary, both from the field cage (drift field performances) point of view and from the microstrip detectors. As for the field cage a particular care had to be devoted to the part in front of the CsI detecors: in fact the guard rings have to be performed using gold strips evaporated on very thin (1.5 micron) mylar windows, in order to minimize energy loss of heavy particles in the cage; a resistive chain between the gold strips has been mounted gluing small SMD resistors on the mylar and/or sputtering a longitudinal Germanium strip (see LNL Annual Report 1998). Besides the original project, an anular detector will also be used in the Garfield apparatus to cover the small angle region (3-12 degrees): it consists of three stages (axial ionization chambers, 300 micron silicon detectors, 6cm thick CsI(Tl) crystals). All the crystals have been calibrated using different light beams (from protons to Carbon) and a final calibration of the gas-silicon part will be performed soon.

New PAC members of LNL

On December 1998, the INFN board has appointed the following new members of the LNL PAC committee :

Chairman : A.Covello (Univ. Napoli)

Members : P.Bortignon (Univ. Milano), F.Catara (Univ. Catania), C.Fahlander (Lund Univ.), K.E.Rehm (Argonne Nat. Lab.), N.Rowley (IRES, Strasbourg), D.Schwalm (MPI, Heidelberg)

The PAC meeting of February 4-5, 1999

The new PAC met on February 4-5, 1999 and examined a total of 37 proposals, which were submitted by November 1998 for the beam-time period January 18 - July 31, 1999. Two experiments (99.08,99.18), chosen by the LNL director among those proposed, were scheduled and performed before the PAC, just after accelerators started operation on January 18, 1999. 17 days had to be recovered from the previous semester, while additional 7 days were lost during January for accelerator repairing operations.
A list follows of the days allocated by the PAC :

Total number of requested days : 223
Total time available : 107
Time reserved to the Director of LNL: 10 days
Time to be assigned : 97 days
Time assigned : 99 days

Table 2– Proposals accepted by the PAC for the period January-July 1999.

99/03	*γ-decay of the GDR in excited rotating ^{140}Ce nuclei as a probe of thermal shape fluctuations* F. Camera (Milano)
99/04	*Lifetimes of triaxial SDF bands in ^{164}Lu established in a very early Euroball experiment* G. B. Hagemann (NBI)
99/05	*Measurement of spin distributions in the ^{58}Ni + ^{60}Ni systems using the GASP array* S. Courtin (Strasbourg)
99/06	*Search for proton and α radioactivity of ^{117}La* F. Soramel (Udine)
99/09	*Heavy element production via binary reactions in ^{58}Ni + ^{208}Pb* L. Corradi (LNL)
99/11	*Enhanced E3 strengths in ^{211}Po and multi-phonon excitation of the ^{208}Pb core* P. G. Bizzeti (Firenze)
99/15	*SIRAD/TOLRAD: proton and ion induced damage on silicon detectors, electronic devices and systems* D. Bisello (Padova)
99/17	*Electromagnetic transition rates within magnetic dipole bands in $^{104,105}In$ and ^{101}Ag* A. Jungclaus (Gottingen)
99/20	*What is the effect of the strong octupole vibration of ^{96}Zr on near-barrier fusion?* A. M. Stefanini (LNL)
99/21	*Test of the EUCLIDES Si-ball* E. Farnea (LNL)
99/22	*Surface columnar defects as a tool to shut down anisotropy in high temperature superconductors* E. Mezzetti (Torino)
99/23	*DSAM lifetime measurements in the $Z = N$ nuclei ^{46}V and ^{44}Ti* F. Brandolini (Padova)
99/25	*In beam tests of a highly segmented geramnium detector* D. Bazzacco (Padova)
99/26	*Cold fusion of the symmetric system ^{90}Zr + ^{90}Zr. High spin spectroscopy of ^{180}Hg* C. Rossi Alvarez (Padova)
99/30	*Towards the proton drip line in the deformed A=130 mass region: Spectroscopy of the lightest Pr and Pm nuclei* C. M. Petrache (Padova)

99/31 *Search for rotation induced octupole correlations in the neutron-deficient* ^{111}Xe *and* ^{111}I *nuclei*
G. de Angelis (LNL)

99/33 *Lifetimes of high spin states in* ^{107}Sn *with the ISIS+Plunger set-up*
A. Dewald (Köln)

99/34 *Detector test for the PRISMA spectrometer*
G. Montagnoli (Padova)

99/36-99/37 *GARFIELD: Test and calibration of the drift chambers - Test and calibration of the anular detector*
F. Gramegna (LNL), S. Cavallaro (LNS)

The Next PAC Meeting

The date for the next PAC meeting is July 19-20, 1999.
The deadline for the presentation of experimental proposals is June 24, 1999.

Forms for presentation of proposals will be mailed in the beginning of May 1999 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).

List of contact persons

Users should directly contact the proper person for specific questions/problems related to the activities with the Tandem-ALPI accelerator.

Coordinator of the Tandem-ALPI accelerator :
Lorenzo Corradi
e-mail : *corradi@lnl.infn.it*

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Antonio Dainelli
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Responsible of the GASP γ-array :
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Secretaries for access to LNL as a Large Scale Facility under the TMR/LSF/RA (i.e. Training and Mobility of Researchers, Large Scale Facilities, Researchers Access) program.
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