2 TA02: TRANSNATIONAL ACCESS TO GSI

2.1 PUBLICITY CONCERNING THE OPPORTUNITIES FOR ACCESS TO TA02

The measures taken to publicise the opportunities for access are:

- A dedicated web site: www.**gsi**.de/user/**funding**/**ENSAR**.html
- an E-mail to the GSI Users' Group with a 'Call for Applications'

In this web site it is described:

- General information on GSI
- Research capabilities
- Access procedure
- Beam time scheduling
- Support offered to user
  - Technical and logistic support
  - Financial support within ENSAR
  - How to get access funding
  - Who can apply for access funding
  - Open calls for proposals and deadlines
- Application form
- User registration
- Instructions for reimbursement of travel costs and statement of travel costs

2.2 SELECTION PROCEDURE

2.2.1 Users Selection Panel

GSI is open to national and international user groups. To apply for access to the accelerator and experimental facilities, a written project proposal has to be submitted. The proposals are reviewed by an international Programme Advisory Committee, the GSI General Program Advisory Committee (G-PAC). If a user group in addition applies for EC support under one of the Integrated Infrastructure Initiatives of FP7, a separate funding application has to be submitted. This is reviewed by a specific User Selection Panel.

The G-PAC presently has 12 members (all external), with more than half of them coming from universities or research institutes outside Germany. There are specialized PACs for some research activities pursued at GSI (plasma physics PPAC, biophysics BIO-PAC, and material science MAT-PAC). Regular All-PAC meetings have been introduced to improve the communication between the PACs, where the future beam time contingents are discussed and decided. The ENSAR User Selection Panel presently has 3 external members, all being members of the G-PAC and experts in the field of nuclear structure physics and applications of nuclear beams in other fields.

The Selection Panel members for the reporting period are listed in Annex 1.

GSI, together with national and international partner institutions, is planning the construction of a new large accelerator and research complex – the Facility for Antiproton and Ion Research (FAIR). A superconducting double-synchrotron SIS100/300 with a circumference of about 1,100 meters and with magnetic rigidities of 100 and 300 Tm, respectively, is at the heart of the FAIR accelerator facility. Following an upgrade for high intensities, the existing GSI accelerators UNILAC and SIS18 will serve as injectors. Attached to the large double-synchrotron SIS100/300 is a complex system of storage-cooler rings and experiment stations including a superconducting nuclear fragment separator (Super FRS) and an antiproton production target. FAIR will supply radioactive ion beams and antiproton beams with unprecedented intensity and quality. Moreover, the facility is designed to provide particle energies 20-fold higher compared to those achieved so far at GSI (up to 35AGeV for U^{92+}). A further important feature of the FAIR accelerator facility is that, due to the intrinsic cycle times of the accelerator and storage-cooler rings, up to four research programs can be run in a truly parallel mode. This allows, in a very efficient and cost-effective way, a rich and multidisciplinary research program to be conducted covering a broad spectrum of research fields such as: QCD studies with cooled beams of antiprotons; QCD-Matter and QCD-Phase Diagram at highest baryon density; nuclear structure and nuclear astrophysics investigations with nuclei far off stability; precision studies on fundamental interactions and symmetries; high density plasma physics; atomic and material science studies; radio-biological investigations and other application oriented studies.

During the construction phase GSI has taken over the responsibility not only for parts of the FAIR accelerator and storage rings but also for the link of the existing facilities to the FAIR complex. These tasks require major human and financial resources. Consequently, the GSI executive committee decided in April 2012 that GSI has to focus employees, infrastructure and financial resources on the building of FAIR. This had several consequences: Despite the fact that the beam time offered to users in 2012 was slightly larger than in 2011 (197 instead of 174 days) there is still a substantial backlog of granted beam times (in the order of at least 100 days for each of the three main experimental accelerators at GSI). As a consequence of the conditions enforced by the GSI executive committee beam time offered to the users has to be reduced severely, and the GSI directorate decided middle of 2012 to give up the Program Advisory Committees (except for plasma physics). Their members have been formally released from their duties. Instead of regular PAC – Meetings the selection of further experimental proposals and scheduling of experiments will take place in close collaboration with the user groups, the head of the Wissenschaftlicher Beirat WBR of GSI (Karlheinz Kampert, Univ. Wuppertal), the former chairperson of the G-PAC (Paolo Giubellino, CERN) und the Board of FAIR Collaborations BFC (Chair Reinhold Schuch, Univ. Stockholm) and representatives of the four scientific pillars of FAIR. The process of scheduling the beam time 2014 is just taking place.

In summary, the focusing of GSI towards FAIR and the necessary accelerator upgrades for linking the existing facilities to the FAIR synchrotrons had the following consequences:

- No PAC meetings
- For the beam time period in 2012 no further experimental proposals have been scheduled apart the ones which have been positively evaluated by the PACs.
- There was no beam time scheduled in 2013.

Hence, in the current reporting period the selection panel did meet once via e-mail and had to consider only few experiments because all other relevant user projects have been granted already.

2.2.2 Selection Panel meetings

Last meeting: November 23, 2011
Proposal evaluation via E-mail circulation in June 2012

External members of selection panel (apart from the Research Director of GSI, Karlheinz Langanke, and the TNA manager) are:

Yorick Blumenfeld (IPN Orsay)
Norbert Pietralla (TU Darmstadt)
Matthias Weidemüller (University Heidelberg)

2.2.3 Selection criteria

The Users Selection Panel bases its selection on scientific merit, following the prescriptions of the contract. Only user projects positively evaluated by the G-PAC are considered. The panel evaluates time and amount of travels requested for setting up and executing the experiment and decides on the numbers of person-days and travels to be allocated to the proposal in question.

2.3 TRANSNATIONAL ACCESS ACTIVITY DURING THE REPORTING PERIOD

A total of 16 projects have been supported during the reporting period:

(1) **115decay/Rudolph:** X-ray fingerprinting of element 115 decay chains by Dirk Rudolph et al.
(2) **208Pb/Rudolph:** Quadrantic evolution of collectivity around ^{208}Pb (S429) by Dirk Rudolph et al.
(3) **30Ar/Martel:** Search for 30Ar by Ismael Martel et al.
(4) **b-neutron/Redond:** Measurement of beta-delayed neutrons around the third r-process peak by Galviz Redondo et al.
(5) **Commiss/Korten:** Scientific and technical commissioning proposal for the AGATA – PreSpec campaign by Wolfram Korten et al.
(6) **E039/Indelicato:** Precision x-ray spectroscopy in one- and two-electron heavy ions by Paul Indelicato et al.
(7) **E105/Nasser:** Start-up of part of the EXL physics program with ^{56}Ni (E105) by Nasser Kalantar-Nayestanaki et al.

(8) **Fiss/Benlliure:** Fission investigations in inverse kinematics by Jose Benlliure et al.
(9) **Ionizat/Rothard:** Ionization dynamics by Hermann Rothard et al.
(10) **n-skin/Kraszna:** Constraining the symmetry energy of the EOS by precise neutron-skin thickness measurements (S408) by Attila Krasznahorkay et al.
(11) **p-hole/Korten:** Proton hole states in ^{132}Sn and N=82 shell structure by Wolfram Korten et al.
(12) **Pyg-64Fe/Wieland:** The Pygmy dipole resonance in 64Fe and the properties of neutron skin (S430) by Oliver Wieland et al.
(13) **S426/Rain:** AGATA@ GSI: Relativistic Coulomb M1 excitation of neutron rich ^{85}Br by Georgi Rainovski et al.
(14) **StopCell/Dendoov:** Commissioning of the first-generation cryogenic stopping cell for the low-energy branch of the Super-FRS by Peter Dendooven et al.
(15) **Yrast_trap/Gadea:** Coulomb excitation of the band-terminating 12^+ yrast trap in ^{52}Fe by Andres Gadea et al.
(16) **AGATA/Scheidenb:** Special funds for the AGATA campaign at GSI

Four more projects have been selected for support but did not retrieve any money because there was no beam time scheduled in the reporting period:

(17) **TransFerm/Antal:** Nuclear structure study of Transfermium nuclei by Stanislav Antalic et al.
(18) **Isospin/Recchia:** Isospin symmetry breaking transitions rates and mirror energy differences in isobaric multiplets by Francesco Recchia et al.
(19) **Chrom/Pantelias:** Mechanistic insights on the aetiology of space radiation - induced chromosomal aberrations and risk for carcinogenesis using conventional and interphase cytogenetics by Gabriel Pantellias et al.
(20) **70Kr/Sahin:** Breaking isospin symmetry in the mass 70 region: Study of the T_z=1 nucleus ^{70}Kr by Eda Sahin et al.

2648 hours of beam time were delivered; 116(131) individual users (users in projects) visited the facility and spent 1373 person-days at GSI.

User project acronym	Users	Scientific field	Number of days spent at the infrastructure
115decay/Rudolph	10	Physics/Nuclear Physics	207
208Pb/Rudolph	10	Physics/Nuclear Physics	87
30Ar/Martel	9	Physics/Nuclear Physics	71
AGATA/Scheidenb	28	Physics/Nuclear Physics	203
b-neut/Redond	6	Physics/Nuclear Physics	67
Commiss/Korten	8	Physics/Nuclear Physics	69
E039/Indelicato	5	Physics/Atomic Physics	52
E105/Nasser	11	Physics/Nuclear Physics	262
Fiss/Benlliure	14	Physics/Nuclear Physics	130
Ionizat/Rothard	4	Physics/Atomic Physics	40
n-skin/Krazna	4	Physics/Nuclear Physics	31
p-hole/Korten	3	Physics/Nuclear Physics	16

Pyg-64Fe/Wieland	5	Physics/Nuclear Physics	32
S426/Rain	3	Physics/Nuclear Physics	17
StoppCell/Dendoov	2	Physics/Nuclear Physics	25
Yrast_trap/Gadea	9	Physics/Nuclear Physics	64

In Annex 2 (Database) the User Projects for which costs have been incurred in 2012 are tabulated. The users are listed in Annex 3.

2.4 SIGNIFICANT ACHIEVEMENTS OBTAINED BY THE USERS DURING THE REPORTING PERIOD

Beam was available during the reporting period (March 2012 to August 2013) only in 2012. Beam time delivered to the users was slightly more in 2012 than in 2011, i.e. 197 days of SIS and/or UNILAC operation. Nevertheless, not all demands of the experiments which got grants from the Transnational Access within ENSAR could be satisfied. Due to the large backlog of proposals and the future perspective of having only limited beam time available at GSI there was a huge demand in 2012: UNILAC beam was devoted – essentially for the whole period – to a production run for element Z=119. An impressive upper limit for the production cross section of 60 fb was reached. This experiment took place at the Recoil Separator for Transactinide Chemistry and Physics TASCA. At the end of the beam time period three additional weeks, which have not been foreseen in the original planning, were made available for the U261 experiment on X-Ray fingerprinting of element Z=115. Second, the AGATA beam time was limited to 28 days because of a very tight schedule at SIS with additional two major users, but the program will be continued in 2014.
A large number of remarkable scientific results are obtained. Some of these results are of particular importance for future nuclear physics studies later at FAIR or were even mentioned in the international press.

(1) **115decay/Rudolph**: In November 2012, three weeks of beam time for experiment U261 were scheduled. Despite the limited beam time thirty correlated alpha-decay chains were observed following the reaction $^{48}Ca+^{243}Am$. Decay schemes arising from high-resolution spectroscopic coincidence data, in conjunction with comprehensive Monte-Carlo simulations, open the door for direct nuclear structure insights of these heaviest man-made atomic nuclei. Previous assignments linking the majority of the decay chains to the decay of $^{287,288}115$ are confirmed. This includes first candidates for Z fingerprinting of the Meitnerium-decay by means of characteristic K-X ray detection. There is clearly potential for direct determination of the atomic number of the descendants of super-heavy elements.

(2) **208Pb/Rudolph**: In September 2012, the experiment S429 was the frontrunner experiment of the pan-European PRESPEC-AGATA campaign. Shortly after the experiment, a gamma-ray spectrum providing a Coulomb-excitation line of the radioactive isotope ^{206}Hg could be shown. Since ^{206}Hg is the isotope with the least Coulomb excitation cross-section of all isotopes investigated so far, the experiment as such can be declared very successful, while the detailed data analysis

by PhD students and PostDocs in Sweden, the United Kingdom and Germany is ongoing.

(3) **30 Ar/Martel:** Unknown exotic isotopes 30Ar, 29Cl have been observed beyond the proton drip line. Their decays in flight have been measured, which provided excitation spectra of the isotopes.

(4) **b-neutron/Redond:** During the participation at the GSI experiment S406 we were able to study for the first time the response of a prototype detector based on timing Resistive Plate Chambers (tRPCs) to relativistic neutrons ranging from energies between 200 and 1500 MeV. In addition, the characterization of the prototype to relativistic protons (in a similar energy range) was completed. These measurements will open a wide range of possibilities for this kind of detectors in fundamental nuclear physics studies.

(5) **Commiss/Korten:** The installation and commissioning of the AGATA array have been successfully accomplished. All detectors were verified in their performance and the analysis was tested. After commissioning the first part of the foreseen experimental program was started.

(6) **E039/Indelicato:** Experiment was performed successfully, analysis still ongoing.

(7) **E105/Nasser:** Experiment E105 which was supported in the framework of TNA at GSI was successfully performed in October 2012. In this experiment, we measured nuclear reactions with high statistical accuracies for the first time ever in a storage ring environment. The first goal of the proposal was to measure the elastic scattering of protons from the radioactive ^{56}Ni. The experiment was performed in inverse kinematics (scattering of a radioactive ^{56}Ni beam on a gaseous Hydrogen target), under such conditions it is crucial to detect the low energetic recoiling protons. To obtain precise energy and position resolution thin Double-Sided Silicon Strip Detectors (DSSD) were placed in the ultra-high vacuum of a scattering chamber inside the storage ring. A thick Si(Li) detector was placed behind the DSSD. The energy deposit of recoiling protons is obtained by summing the energy deposits in the thin Double-sided Silicon Strip Detector (DSSD) and the thick Si(Li) detector. The polar angle was obtained from the DSSD. The elastic band (i.e. the energy of the protons versus polar angle) of recoiling protons along with the band resulting after excitation of the first excited state in ^{56}Ni could be clearly determined. Also, the first minimum in the elastic scattering cross section is observed. After the calibration of the luminosity, experimental cross sections will be obtained for this reaction and the results will be published.

(8) **Fiss/Benlliure:** In this experiment the double humped fission yield distribution was observed in the fission of pre-actinides. The Neutron odd even effects were measured for the first time in the heavy peak in low energy fission. The fission cross sections and the widths of the mass and charge distributions of the fission fragments produced in proton induced fission of ^{208}Pb at 500 A MeV confirm the presence of pre-saddle dynamical effects in high-energy fission.

(9) **Ionizat/Rothard:** The fundamental process of electron nucleus bremsstrahlung (eNBS) with simultaneous detection of in-elastically scattered electron and emitted bremsstrahlung photon is at the high energy endpoint of the photon spectrum a process of intense theoretical interest due to its postulated deep relation with photoionization and pair production. Our experiment using inverse kinematics for U^{88+} beams in the ESR storage ring is the first ever to study this process by using

radiative electron capture into the projectile continuum RECC with simultaneous recording of the decelerated electron and the angular distribution of the bremsstrahlung photon emission.

(10) **n-skin/Kraszna:** The anti-analog of the Giant dipole resonance (AGDR) is the ($T=T_0-1, T_z=T_0-1$) component of the GDR which can be excited in (p,n) reactions. In this experiment the AGDR has been excited in the ^{124}Sn (p,n) reaction performed in inverse kinematics using ^{124}Sn beam with an energy of 600 MeV/A. The energy and angle of the neutrons were measured with a novel low-energy neutron time-of flight array (LENA). The excitation energy has been reconstructed from the energy of the decay to isobaric analogue state measured with large (3.5"x8") $LaBr_3$ detectors in coincidence with the ejected neutrons. The energy of the gamma-rays differs considerably from the energy of the GDR and turned out to be very sensitive to the neutron-skin thickness (ΔR_{pn}). Calculations performed with state of the art self-consistent random phase approximation (RPA), based on the framework of relativistic energy density functionals support also such strong ΔR_{pn} sensitivity of the energy of the AGDR. By comparing the theoretical results calculated as a function for ΔR_{pn} and the measured energy of the AGDR, the ΔR_{pn} value was deduced to be to be 0.18 ± 0.02 fm, which agrees nicely with the previous results. The energy of the AGDR measured previously for 208Pb was used also to determine the ΔR_{pn} for ^{208}Pb. In this way a very precise ΔR_{pn} = 0.16 ± 0.04 neutron skin thickness has been obtained for ^{208}Pb. The present method offers new possibilities for measuring the neutron-skin thicknesses also using rare isotope beams.

(11) **p-hole/Korten:** The settings of the radioactive beam necessary for the experiment were tested and optimized. The experimental setup and the analysis programs were verified, and the experiment will be continued in 2014.

(12) **Pyg-64Fe/Wieland:** The experimentalists have been able to measure high energy gamma rays with the AGATA detector up to and above 10 MeV using pulse shape analysis with highly segmented germanium detectors at GSI with exotic beams at 400AMeV and under relativistic coulomb excitation conditions.

(13) **S426/Rain**: In the PRESPEC-AGATA campaign in 2012 the feasibility of the experiment was proven by observing the Coulomb excitations of the gold target caused by the ^{85}Br beam.

(14) **StopCell/Dendoov:** On-line produced ions were extracted from the cryogenic stopping cell with extraction times of the order of a few tens of milliseconds. For the first time, direct mass measurements of short-lived projectile fragments were performed with a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS), among them the nuclide 213Rn with a half-life only 20ms.

(15) **Yrast_trap/Gadea:** The Coulomb excitation of the band-terminating 12^+ yrast trap in ^{52}Fe has been performed with the aim to unveil its collective structure. Other aspects that contribute to strengthen the experiment uniqueness and the importance of this experiment performed at the GSI FRS is the use of isomeric beams to perform nuclear structure studies by Coulomb excitation or knock-out reactions. This is an important goal of the FRS-AGATA-PRESPEC campaign. The 12^+ yrast trap in ^{52}Fe has been the first isomeric beam used for this purpose at GSI-FRS. It is a high spin isomer and it will provide valuable information on the experimental technique as well as on the reaction mechanism. Presently the FRS at GSI is the

only facility in Europe, most probably in the world, where the ^{52}Fe isomeric beam can be produced.

(16) **AGATA/Scheidenb:** During the reporting period the PRESPEC-AGATA experiment at the fragment separator at GSI was assembled, commissioned and a first series of experiments on the spectroscopy of exotic nuclei was performed. The Gamma – Spectrometer AGATA consisting out of 21 segmented Ge-crystals was installed in the FRS experimental hall. Apart from the mechanical and cryogenic work the main challenge of the installation was the complex data acquisition system and the electronics for the digital processing of the detector signals. For tracking and identification of the radioactive beams the standard FRS detectors were used. A newly developed segmented plastic scintillator capable to measure at particle rates $>10^6$ pps was mounted in the middle focus of the FRS. Behind the active secondary target the ΔE/E calorimeter LYCCA was positioned. It allows for mass identification by time-of-flight measurement. This set-up is the first implementation of the HISPEC experiment in its full functionality.
The commissioning and verification were done with stable and radioactive beams and could be finalized until September 2012. First experiments followed: Measurement of B(E2) values of Pb, Hg and Pt isotopes (an experiment which only can be done at GSI), Coulomb excitation of states on an isomer of ^{52}Fe, the investigation of the fine structure of the Pygmy resonance of ^{64}Fe and the determination of lifetimes of neutron-rich Zr and Mb isotopes after secondary fragmentation. Apart from their scientific relevance these experiments are important to advance experimental methods and get reliable estimates on the sensitivity reachable later at FAIR.

Data analysis is still ongoing, and at the moment only a limited number of peer-reviewed publications are available. However, several drafts are on the way of being submitted and will be listed in the next report.
The current list of peer-reviewed publications of these user projects is part of Annex 4.

2.5 USERS MEETINGS

No user meetings took place during the reporting period.