TASCA 10

last update: Nov. 02, 2010

9th Workshop on
Recoil Separator for Superheavy Element Chemistry
November 18, 2010, GSI, Darmstadt, Germany

Program & Abstracts

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10:10	***Coffee Break***		
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17:00	***End of TASCA10 workshop***		
19:00	***Dinner for TASCA and IRiS Workshop participants (optional, details will follow)***		

The length of all presentations will be 15 minutes + 5 minutes discussion time, except * (→ 25 min. + 5 min. discussion time)

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Superheavy Element Research at the Berkeley Gas-Filled Separator

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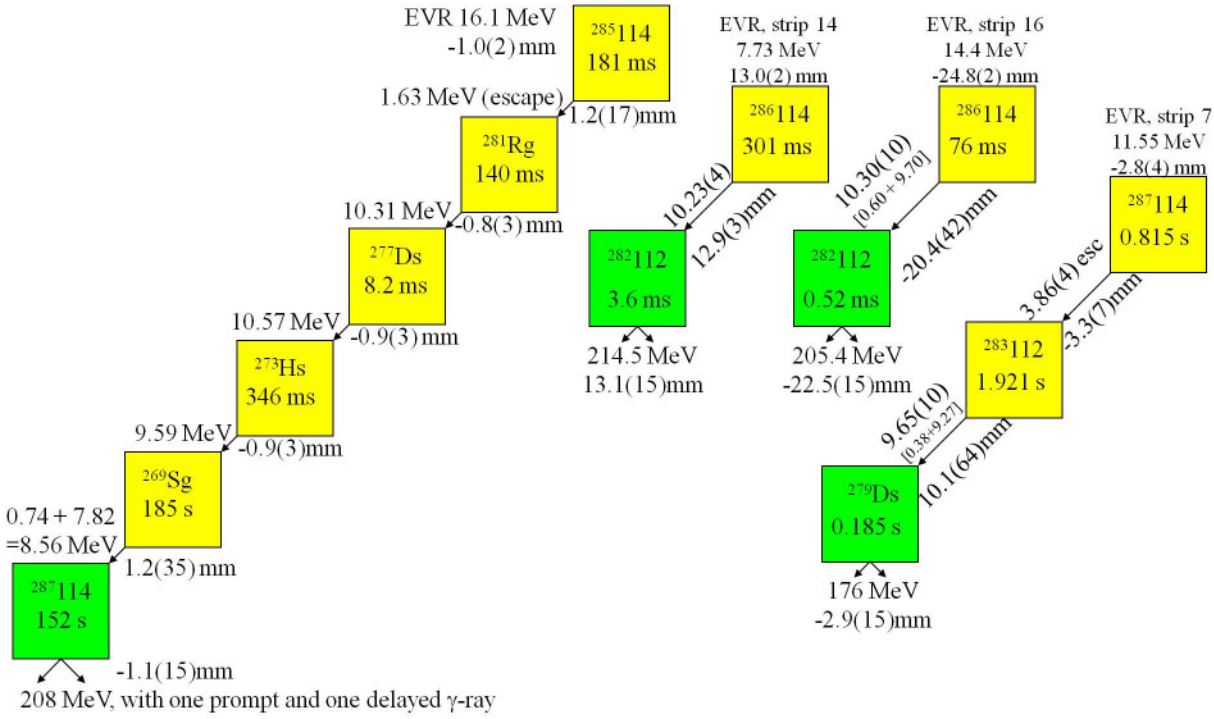
The study of transactinide elements (Z≥104) is a topic of great interest in current nuclear chemistry research. Recently, relatively long-lived nuclides with Z≥112 have been produced and confirmed in ^{48}Ca+Actinide reactions, opening up a new avenue for superheavy element research. Studies have been undertaken at the Lawrence Berkeley National Laboratory using the Berkeley Gas-filled Separator (BGS) to test heavy element formation models. Lately, these studies have been extended to ^{48}Ca beams with actinide targets and nuclear structure studies. These experiments have led to the first confirmation of element 114 in the ^{242}Pu(^{48}Ca,3-4n) reaction and the production of *Z*=100-106 isotopes around the *N*~152 shell for nuclear structure studies. More recently, the western slope of the island formed by nuclides produced via ^{48}Ca+An reactions has been extended with the discovery of 6 new isotopes using the ^{242}Pu(^{48}Ca,5n)^{285}114 reaction. Current develop-ments nuclear structure and superheavy element studies, as well as future plans and improvements at the BGS will be discussed.



Financial Support was provided by the Office of High Energy and Nuclear Physics, Nuclear Physics Division, and by the Office of Basic Energy Sciences, Division of Chemical Sciences, Geosciences and Biosciences of the U.S. Department of Energy, under Contract No. DE-AC02-05CH11231

First main beam experiment of TASISpec

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In Spring 2010 the TASISpec [1] (TAsca in Small Image mode Spectroscopy) setup was for the first time used in its full configuration with all five composite Ge detectors in place. The setup which comprises double and single sided Silicon Strip detectors as well as the composite Ge detectors is utilising the unique small image mode of the TASCA Separator. The produced SHE can be focused into an area of less than 3 cm in diameter providing the opportunity of obtaining a highly efficient detection of gamma-rays and X-rays in coincidence with implanted SHE and their subsequent decays.

The TASISpec experiment utilised the ^{207}Pb(^{48}Ca,2n)^{253}No reaction to produce the ^{253}No isotope of interest. The aim of the experiment is to disentangle the K-isomer decay scheme of the isotope and the longstanding purpose of these studies is to approach the structure of the SHE. If the K-isomers are fully understood, these will provide information about the single-particle shell structure of SHE which in turn will relate to shells responsible for magic numbers at or around the anticipated 'island of stability' [2].

Numerous question marks remain from previous studies of the decay scheme [3] due to the complicated underlying structure and the limited statistics especially regarding $\gamma - \gamma$ coincidences.

[1] L-L Andersson et al., Nucl. Instr. and Meth. A 622, 164 (2010).
[2] R-D Herzberg et al. Nature 442(7105), 896 (2006).
[3] F.P. Hessberger et al., Eur. Phys. J. A 22, 417 (2004).

Superheavy Element Research at RITU

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Superheavy elements are stabilized against prompt fission due to the quantal "shell effects". These shell effects give rise to additional binding, resulting in the well-known magic numbers at closed shells. It is predicted that an "island" of spherical superheavy nuclei should exist in the region of Z=114-126 and N=184, final magic numbers depending on which nuclear model is used. Superheavy elements are difficult to produce in large quantities for detailed spectroscopic studies. In Jyväskylä the JUROGAMII(SAGE) + RITU + GREAT combination is extensively used for spectroscopic studies in the trans-fermium region. By probing the single-particle states and other properties in these lower-Z nuclei, important input for the theoretical calculations (on superheavy elements) can be offered.

Average charges of heavy recoil ions in various gases and their mixtures

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The knowledge on the charge state distribution of heavy ions moving in the gas-filled region is the important issue of the physics related with the heavy ions beams. Renewed interest on charge states of heavy ions has been motivated due to the production of heavy and superheavy elements at the gas-filled separators. Several experimental works on a determination of the average charges of heavy ions have been performed at gas-filled separators in order to predict more precisely the average charges of heavy and superheavy ions which produced in fusion-evaporation reactions. As results of these experimental works a several semi-empirical expressions have been proposed for the prediction of the average charges of the heavy and superheavy ions.

Average charges of the heavy ions never been measured in the gas mixtures at the gas-filled separators. Therefore, we aimed to investigate the average charges of heavy ions in the mixture of helium and hydrogen gases in the case of ^{252}No and ^{254}No ions at the gas-filled separator TASCA. In this contribution, we will present the results obtained from these investigations.

Targets for SHE experiments with intense beams

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For the production of neutron-rich isotopes of SHE up to Z=117 hot fusion reactions of actinide target nuclei such as ^{238}U, $^{242/244}$Pu, ^{248}Cm, and ^{249}Bk with light ion beams like ^{18}O, ^{22}Ne, ^{26}Mg or ^{48}Ca are applied. For the synthesis of the so far unknown element with Z=120 fusion reactions employing the irradiation of ^{248}Cm or ^{249}Cf targets with ^{54}Cr- or ^{50}Ti-beams, respectively, are currently discussed. The choice of an appropriate backing material is a crucial point in many heavy-ion reaction studies. Very often, a low Z-material like C (Z=6), Al (Z=13) or Ti (Z=22) is used to prevent the production of nuclides whose decay interferes with the unambiguous identification of single SHE atoms, such as α-particle emitters or nuclides with a spontaneous fission decay branch.

In order to decrease the thermal and mechanical stress on the target during irradiations with high beam intensities (up to 2 $\mu A_{particle}$) a rotating target wheel can be applied. The wheel is usually mounted in a special box together with the target wheel drive and a fibre optics for rotation speed control. Thus, the rotating target is confined in a nearly closed container in order to protect the beam line and the separator against contamination in the case that a radioactive target gets destroyed.

Since isotopes like ^{244}Pu, ^{248}Cm and ^{249}Bk are available only in limited amounts, the target preparation technique requires high deposition yields. Easy and complete recovery and subsequent chemical purification of the actinide target material is another pre-requisite. Molecular plating (MP) is well suited for the preparation of actinide targets on metallic and non-metallic backing materials with deposition yields approaching 100 %. Deposition is performed from isobutanolic solution applying a current density of 1-2 mA/cm^2. Under these conditions target thicknesses of 500-1000 μg/cm^2 are possible. Deposition yield can be determined by α–particle spectroscopy and neutron activation analysis. Radiographic imaging is used to check the homogeneity of the deposited actinide layer. As shown in recent experiments Pu- and Cm-(Oxide) layers deposited on a Ti-backing are well suited as targets for SHE-production [1,2]. However, in long-term irradiations with ^{48}Ca-beams of 500-800 $nA_{particle}$ and accumulated total projectile doses exceeding 10^{18} particles they become partly damaged and the actinide compound needs to be reprocessed and chemically purified for future use as target material. Investigations concerning radiation induced damage due to a chemical interaction between the Ac-Oxide and the Ti-substrate are currently going on. With regard to this, the use of alternative backing materials like Be, SiN or DLC (diamond-like carbon), respectively, needs to be investigated with high priority.

Alternative target production techniques like Polymer Assisted Desorption (PAD) [3] and deposition onto super-hydrophobic surfaces [4] are currently explored but have not yet been tested with actinide target materials and high intensity ion beams

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References

[1] Ch.E. Düllmann et al., Phys. Rev. Lett. 104, 252701 (2010)
[2] S. Hofmann, private communication
[3] M.A. Garcia et al., Nucl. Instrum. Meth. Phys. Res. A613 (2009) 396-400
[4] D. Renisch, Diploma Thesis; Johannes Gutenberg-Universität Mainz (2010)

Digital signal processing and the studies of short-lived charged-particle emitters

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Digital data acquisition systems developed at the University of Tennessee Knoxville (UTK) and ORNL for the spectroscopy of exotic nuclei was proved in numerous challenging experiments on nuclei far from stability [1-10]. While the digital electronics can be used as an excellent general purpose data acquisition system, in most of these applications the ability to measure detector signals generated in very short time intervals (pile-ups) was critical for the success of the experiment. It is natural to expand the application of such system onto the super-heavy element research, where it can be used with minor adaptations. Such initiative was undertaken by the ORNL and UTK researchers. I will discuss the benefits of of using this system at the experiments aiming in super-heavy nuclei.

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References

[1] R. Grzywacz *et al.,* NIM. B **204**, 649 (2003)
[2] W. Królas *et al.,* Phys. Rev. C **65,** 031303 (2002)
[3] M. Pfützner *et al.,* NIM A 493 (2002) 155
[4] M. Karny *et al.* Phys. Rev. Lett. **90**, 012502 (2003)
[5] S.N. Liddick *et al.,* Phys. Rev. Let., **97**, 082501 (2006)
[6] R. Grzywacz *et al.,*NIM B **261**, 1103 (2007)
[7] C. Mazzocchi *et al.,* Phys. Rev. Let. **98**, 212501 (2007)
[8] M. Karny *et al.,* Phys. Let. B **664**, 52 (2008)
[9] J.A. Winger *et al.,* Phys. Rev. Lett**. 102**, 142502 (2009)
[10] I.G. Darby *et al.,* Phys. Rev. Lett. **105**, 162502 (2010)

Towards online coupling of TRIGA-SPEC to the research reactor TRIGA Mainz

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At the TRIGA research reactor in Mainz the TRIGA-SPEC setup is under construction [1]. The aim is to perform Penning trap mass spectrometry and collinear laser spectroscopy on short-lived neutron-rich nuclides in order to determine nuclear ground-state properties like masses and charge-radii. The nuclides are produced by neutron-induced fission of an actinide target located in a target chamber close to the reactor core. A key issue is the extraction of these nuclides from the target chamber through the 3 m thick concrete biological shield of the reactor, and ultimately the preparation of a mass-selected, cooled and bunched low energy ion sample for high precision experiments on nuclides with minimal half-lives in the order of 1 s. A relatively simple and rather inexpensive way to extract the fission products is a gas jet loaded with aerosols, where transport efficiencies up to 70 % and a transport time of 400 ms were achieved at TRIGA-SPEC using helium gas and carbon aerosols [2]. The carrier gas can be removed with the help of a skimmer and the remaining serious challenge is to separate the fission products from the aerosols and ionize them. For this purpose we are developing an ECR-type ion source on a high voltage platform [3]. Due to the small plasma volume and relatively low plasma density (~10^{11} cm^{-3}) very low ionization efficiencies are expected. The current status of TRIGA-SPEC will be given, some new achievements and ideas will be presented, and the issue of the online-coupling will be discussed.

[1] J. Ketelaer et al., Nucl. Instr. Meth. A 594, 162 (2008)
[2] M. Eibach et al., Nucl. Instrum. Methods A 613, 226-231 (2010)
[3] Ch. Smorra et al., J. Phys. B: At. Mol. Opt. Phys. 42, 154028 (2009)

Prospects for Ion Mobility Spectrometry at the heaviest elements

M. Laatiaoui
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In the past, Ion Mobility Spectrometry (IMS) devices have proven to be powerful tools for state-selective mobility investigations at a variety of elements. Hence, IMS increasingly gains importance when dealing with the heaviest elements, where relativistic effects strongly affect their valence electron configurations. In this talk I'll introduce the technique of ion mobility spectrometry based on recent studies in the lanthanide region. I'll explain the benefits of such a method in physics and chemistry and discuss prospects for its application also in the region of superheavy elements.

Nuclear structure of SHE: current developments

R.-D. Herzberg
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A growing number of experiments is currently opening up the transfermium region of nuclei for detailed spectroscopic investigations [1]. In the deformed nuclei in the nobelium region this allows an identification and mapping of single particle orbitals closest to the top end of the nuclear chart.

Initial in-beam measurements in the region focussed on γ-ray spectroscopy of even-even nuclei (e.g. ^{252,254}No, ^{250}Fm), studying the ground-state yrast bands and allowing extraction of parameters such as the moments of inertia, and proving the deformed nature of these nuclei. More recently, attention has switched to odd-mass nuclei such as ^{253}No, ^{251}Md and ^{255}Lr, the latter being the heaviest nucleus so far studied in-beam. Rotational bands have been observed in all these nuclei. Non-yrast and K-isomeric states have recently been observed in ^{252,254}No and ^{250}Fm through the use of both in-beam and focal plane decay spectroscopy. The studies employed a calorimetric technique, whereby the summed energy from a cascade of conversion electrons is detected in a DSSSD detector and used as a "tag" for γ-rays detected in the various germanium detectors. These experiments have yielded data which can be used to determine the excitation energies and configurations of two-quasiparticle states in the region, and compared to the predictions of various theories. These comparisons show that reasonable agreement is obtained with Woods-Saxon approaches but discrepancies are observed with the predictions of HFB calculations with SLy4 or Gogny interactions. Such observations highlight the need for such detailed spectroscopic data in order to improve the interactions used in these modern approaches.

An overview of the most recent results and the experimental techniques used will be presented and new experimental developments such as the SAGE spectrometer coming online in Jyväskylä and the new TASISpec setup at GSI will be discussed.

[1] R-D Herzberg & P.T. Greenlees, Prog Part Nucl. Phys. 61 (2008), 674.

X-ray Fingerprinting of Element 115 Decay Chains

D. Rudolph, G. Carlsson, C. Fahlander, U. Forsberg, J. Gellanki, P. Golubev, R. Hoischen, I. Ragnarsson, S. Åberg
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Ch.E. Düllmann, J. Even, K. Eberhardt, A. Gonschiov, D. Hild, J.V. Kratz, I. Pysmenetska, P. Thörle-Pospiech, N. Wiehl
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F.P. Heßberger, M. Schädel, A. Yakushev, D. Ackermann, M. Block, J. Gerl, E. Jäger, J. Khuyagbaatar, B. Kindler, I. Kojouharov, J. Krier, N. Kurz, B. Lommel, E.K. Merchan, J. Runke, H. Schaffner, B. Schausten
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During the past decade, a number of correlated α-decay chains, which all terminate by spontaneous fission, have been observed in several independent experiments using ^{48}Ca-induced fusion-evaporation reactions on actinide targets. Their natural interpretation implies the production of neutron-rich isotopes with proton numbers Z=113-118. However, neither their mass nor their atomic number have been measured directly. It is suggested to search for K- and L-X-rays characteristic for Z. These X-rays are expected to be emitted in the course of rather long α-decay chains starting from odd-A element 115 isotopes produced via the reaction ^{243}Am(^{48}Ca,2-4n)$^{287\text{-}289}$115. The gas-filled separator TASCA in its unique small-image mode is to be used in combination with the highly-efficient TASISPEC α/γ/CE/X-ray coincidence set-up.

Extraction chromatographic studies of Rf using crown ether based resins

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Chemical Sciences Division, Lawrence Livermore National Laboratory, Livermore, USA

Due to the short half-lives of the transactinide elements, fast and efficient separations are necessary so that the chemical properties of these can be studied and compared to those of their lighter homologs. Separations based on extraction chromatography resins show promise in achieving the short separation times, high yields and high separation factors that are necessary for transactinide studies. It has been previously shown that liquid-liquid extraction systems based on dicyclohexano-18-crown-6 and dibenzo-18-crown-6 are suitable for chemical studies of Rf. The extraction mechanism employed for the separation is based on the hydronium complex of the crown ether, this allows for intra-Group IV separations, however physical pre-separation of recoil products is necessary as the crown ethers complex formed is not inter-Group specific. The adsorption of Zr and Hf, the lighter homologs of element 104, on various crown ether based resins has been investigated from a hydrochloric acid matrix to evaluate the suitability of these systems for the study of Rf.

SHE Researches at RIKEN

Hiromitsu Haba
RIKEN Nishina Center, Wako, Saitama, Japan

Present status and perspectives of superheavy element (SHE) researches at RIKEN are reviewed. A gas-jet transport system has been coupled to the gas-filled recoil ion separator GARIS at the RIKEN Linear Accelerator. The commissioning of the system have been conducted using ^{206}Fr, ^{245}Fm, ^{255}No, and ^{261a,b}Rf produced in the ^{169}Tm(^{40}Ar,3*n*), ^{208}Pb(^{40}Ar,3*n*), ^{238}U(^{22}Ne,5*n*), and ^{248}Cm(^{18}O,5*n*) reactions, respectively [1–4]. Recently, we have investigated the production and decay properties of ^{265}Sg in detail for future chemical studies of Sg using the ^{248}Cm(^{22}Ne,5*n*) reaction. Alpha-particles of ^{265}Sg separated with GARIS and extracted to a chemistry laboratory were measured with a rotating wheel system for α-spectrometry under low background conditions. Based on time-correlated 24 α-α(-α) and 18 α-SF events, two isomeric states in ^{265}Sg, ^{265a}Sg (E_α = 8.84 MeV, $T_{1/2}$ = 6.7 s) and ^{265b}Sg (E_α = 8.69 MeV, $T_{1/2}$ = 15 s), were unambiguously identified. The observed decay patterns of ^{265a,b}Sg in the chain ^{265a,b}Sg → ^{261a,b}Rf → (^{257}No →) confirmed the literature data [5] fairly well. The cross sections for the ^{248}Cm(^{22}Ne,5*n*)^{265}Sg reactions at 118 MeV were determined to be 200 pb for ^{265a}Sg and 170 pb for ^{265b}Sg. On the other hand, a conventional gas-jet coupled target system was installed on a beam line of the RIKEN AVF Cyclotron to extend the detailed aqueous chemistry of Rf and Db at JAEA [6] to heavier SHEs [7]. A new chemistry laboratory was constructed at the upper floor of the AVF cyclotron. The gas-jet transport of reaction products to the chemistry laboratory was examined with ^{255}No, ^{261a}Rf, and ^{265b}Sg produced in the ^{248}Cm(^{12}C,5*n*), ^{248}Cm(^{18}O,5*n*), and ^{248}Cm(^{22}Ne,5*n*) reactions, respectively. An automated rapid α-particle detection system for aqueous chemistry is under development coupled to JAEA-ARCA and micro-chemical devices for ion exchange and solvent extraction. In the workshop, a chemistry program at RIKEN will be also presented.

References

[1] H. Haba *et al.*, J. Nucl. Radiochem. Sci. **8**, 55 (2007).
[2] H. Haba *et al.*, J. Nucl. Radiochem. Sci. **9**, 27 (2008).
[3] H. Haba *et al.*, Chem. Lett. **38**, 426 (2009).
[4] H. Haba, Seventh Workshop on the Chemistry of the Heaviest Elements, 13 Oct., 2009, Mainz, Germany.
[5] Düllmann and Türler, Phys. Rev. C, **77** 064320 (2008).
[6] Y. Nagame *et al.*, Radiochim. Acta **93**, 519 (2005).
[7] H. Haba *et al.*, Eur. Phys. J. D **45**, 81 (2007).

Berkeley Gas-filled Separator Focal Plane and Beyond

K. E. Gregorich[1], J.M. Gates[1], P. A. Ellison[1,2], O.R. Gothe[1,2], J. P. McLaughlin[1,2], N. E. Esker[1,2], and H. Nitsche[1,2]

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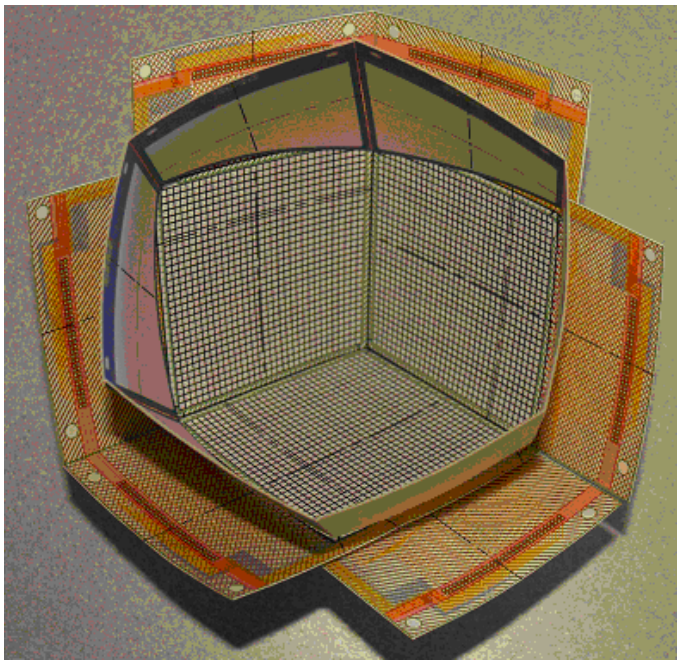
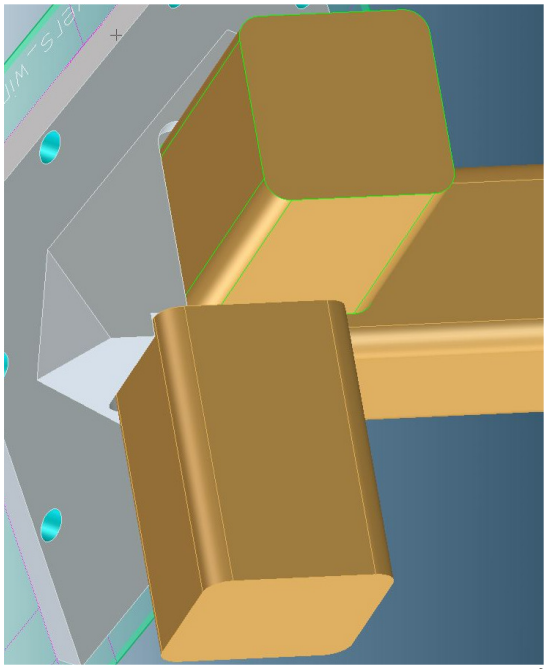
A new focal plane detector array is being built for use at the Berkeley Gas-filled Separator (BGS). Three Double Sides Silicon Strip Detectors (DSSSDs) arranged as the corner of a cube will comprise the focal plane. Directly behind these will be a second set of DSSSDs allowing detection of light, low-ionizing "punchthru" particles. Upstream of the cube corner will be a set of specially-shaped Single Sided Silicon Strip detectors (SSSSDs) arranged as a hexagonal tunnel. The hexagonal tunnel will allow efficient reconstruction of α-particle energies and detection of conversion electrons. A 2 mm-thick aluminum pyramidal vacuum window will be situated directly behind the focal plane and "punchthru" detectors. Three Ge clover γ-ray detectors will be posi-tioned directly outside of the pyramidal vacuum window for highly efficient detection of γ-rays and X-rays. Efficiency gains over present detector arrays will be discussed.

A RF gas catcher is being planned for the BGS focal plane area. The RF gas catcher will deliver heavy ion products to a RF quadrupole trap for bunching and rough mass selection. A mass separator with M/ΔM ~ 500 is planned after the RF quadrupole trap to deliver heavy ion products with unit mass resolution to a shielded detector station on a 5-ms timescale.

The same detector station described above will be used after the mass separator.



Paper model of the Si array
(hexagonal tunnel, focal plane, punchthru).



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Arrangement of Ge clovers outside
the pyramidal vacuum window.

SHE Chemistry Experiments at TASCA

Alexander Yakushev
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One of the main goals of TASCA is the pre-separation of neutron-rich isotopes of super-heavy elements (SHE) produced in the asymmetric reactions with actinide targets for chemistry experiments. Already during the commissioning phase, several chemistry experiments at TASCA have been performed. The adsorption behaviour of E114 pre-separated with TASCA in the small image mode on the gold surface have bee studied last year using two COMPACT detectors. Studies of a new class of SHE volatile compounds, metal carbonyls were started at TASCA very recently. The advantages of TASCA for chemistry experiments will be discussed.

Gas phase chemistry with element 114 behind the DGFRS

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for a
PSI-University Bern-FLNR-FZD-ITE collaboration

Chemical and physical separation was combined in a transactinide chemistry experiment performed in 2008 at FLNR Dubna, where the thermochromatographic separation device COLD was installed behind the Dubna Gas-Filled Recoil Separator (DGFRS). Rotating targets of $^{244}PuO_2$ were irradiated during 35 days. The energy of the beam in the middle of the target was 243±3 MeV. The presentation will cover a description of experimental details of this experiment and of preparatory experiments. In the course of our experiment one decay chain was observed that can be attributed unambiguously to the decay of $^{285}112$ and its daughter ^{281}Ds, which are the descendants of $^{289}114$. This decay chain was observed at a deposition temperature of -93 °C, hence at the deposition maximum expected for $^{289}114$ from our previous observations. Additionally, two distinct coincident fission (SF) events have been observed at -8°C and -16°C, respectively. Assuming that this SF is related to $^{284}112$, the observed deposition of $^{284}112$ is in agreement with our former results for element 112, the other way around also supporting this assignment. However, no unambiguous identification of $^{284}112$ is possible through the sole detection of an unspecific SF-decay. This experiment represents the first superheavy element chemistry experiment (Z>110) using physical preseparation. Having experiences from similar experiments with and without preseparation, we will try to discuss advantages and disadvantages of both experimental approaches.