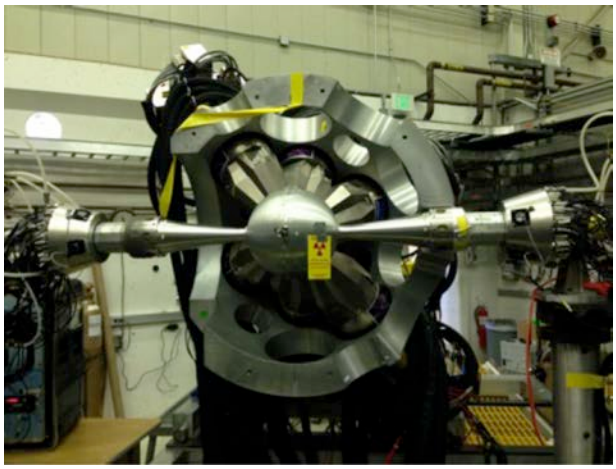
Nuclear Science Division Newsletter 2014/2

GRETINA has settled in at ANL

Following a successful scientific program at the NSCL/MSU, *GRETINA* is now at its new home, the ATLAS facility at Argonne National Laboratory.



The GRETINA and CHICO2 setup at ANL.

After a few months devoted to the installation and improvements in the operation and performance of the array, final debugging of the system operating with the *CHICO2 (*an upgrade of the Compact Heavy Ion COunter developed by Rochester/LLNL for improved position resolution) took place in February.

A series of commission runs were scheduled in March and April to further characterize the properties of *GRETINA* in terms of polarization and high–energy response, as well as a side-by-side comparison with Gammasphere in a high multiplicity environment.

The physics campaign started in May with an experiment led by C.Y. Wu from Livermore to study octupole collectivity in ^{144,146}Ba nuclei. The experiment takes advantage of the unique beams of Ba isotopes produced by *CARIBU* and the improved position resolution of *GRETINA* and *CHICO2*.

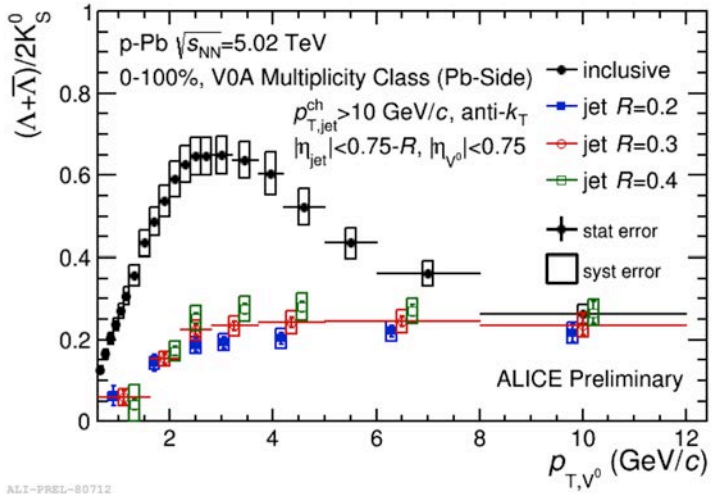
GRETINA (left) and Gammasphere (right) in the ATLAS hall.

Following the first call for proposals, the ATLAS Program Advisory Committee approved 13 *GRETINA* experiments. As in the experiment mentioned above, a major thrust of this program will be Coulomb Excitation studies of neutron rich nuclei produced by *CARIBU*. A second call is anticipated very soon.

New ALICE analysis resolves long-standing puzzle about particle formation

Over a decade ago, experiments at RHIC discovered a striking new phenomenon: The production rate of baryons (protons and Λ hyperons) relative to mesons (pions and kaons) is strongly enhanced in nuclear collisions, compared to similar measurements in proton-proton collisions. This baryon enhancement puzzle has generated much subsequent theoretical and experimental effort. One popular speculation is that the enhancement arises from the coalescence of energetic partons (quarks and gluons) in hard jets with low-energy partons in the thermalized Quark-Gluon Plasma. But a significant experimental test of this picture was not carried out, until now.

A new analysis by RNC members of the *ALICE* collaboration answers this question, using p+Pb data. The analysis isolates the "hard" (high-p_T) and "soft" (low-p_T) part of each event by dividing the event into two regions, one containing jet activity and the other containing the rest, called *underlying event*. The analysis measures the yields of *K* mesons and Λ hyperons separately in the two regions, and compares the ratio of the particle spectra.



The "baryon-to-meson ratio": The ratio of differential p_T spectra for Λ and K^0. Ratios within the jets (red, blue, green for various jet radii) do not show the features found in the "inclusive" ratio (black), so therefore the enhancement is a feature of the underlying event and is not associated with the jets. This new analysis was completed recently and first presented to the community at the Quark Matter 2014 Conference held in Darmstadt May 19-24.

The figure shows the main result of the analysis. The ratio in the jet region is consistent with the ratio within particle jets found in proton-proton collisions. Moreover, it does not depend on other features of the event, such as the total number of particles produced. This result shows that the peak in the baryon/meson ratio arises exclusively from the soft-particle production mechanisms, possibly including the collective radial expansion (radial flow). In addition, this measurement provides strong constraints on the Monte Carlo generators of hadron collisions at high energies. Similar analysis is ongoing for data obtained from nucleus-nucleus collisions at LHC.

Nuclear Science Day for Girl Scouts and Boy Scouts 2014

The LBNL Nuclear Science Division hosted the fourth annual Nuclear Science Day for Girl Scouts and Boy Scouts on Saturday, June 7, 2014. This year the Advanced Light Source (ALS) and the LBNL Workforce Development & Education Department co-sponsored of the event. About 180 scouts (drawn from over 400 applicants) and ~50 scout leaders spent the day participating in various nuclear science activities.

The event opened with two illuminating lectures: NSD scientist Dan Chivers from the Applied Nuclear Physics group gave "The ABC of Nuclear Science" explaining the various types of radiation (alpha, beta and gamma) and illustrated the ubiquity of natural radioactivity. Then NSD nuclear chemist Heino Nitsche enlightened the scouts on nuclear reactions and the discovery of super-heavy elements.

During the day's main activities, the scouts rotated between six stations conceived based on Boy Scouts of America's Nuclear Science merit badge requirements. The organizers of the event have submitted a similar set of requirements to Girl Scouts for inclusion into the organization's STEM program.

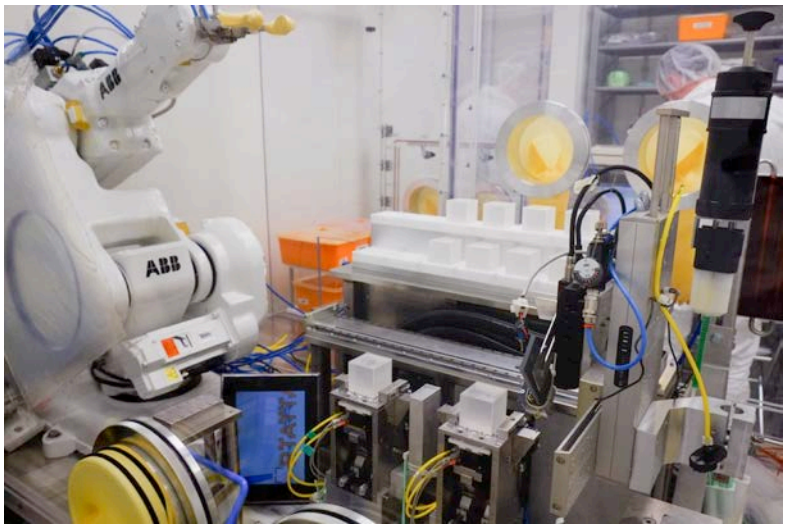
The participants had opportunities to construct atomic models, build a simple electroscope, use survey meters to look for hidden radioactivity, tour the ALS, and also discuss career options with guest scientists (and a political scientist who focused on nuclear policy). In addition to using Geiger counters in the survey activities, the scouts saw other types of radiation detector in action as well, including a cloud chamber, a cosmic-ray detector, and a cadmium-zinc-telluride (CZT) gamma-ray detector. At the end of the event, everyone could observe (and taste) Snickers bars cooled to liquid-nitrogen temperature.

NSD scientist Heino Nitsche (recipient of the 2014 Hevesy Medal Award, see page 5) is introducing a fully packed auditorium to the synthesis of superheavy elements by means of nuclear reactions. As part of his lecture, he showed a video clip in which nobelist Glen Seaborg (who was a co-discoverer of eleven new elements) explained how the actinide concept helps us understand the place of the transuranium elements in the periodic table.

The event was carried out with the help of over 50 volunteers from the NSD and elsewhere on campus; it received high praise from the accompanying scout leaders and it clearly had a stimulating effect on many of the participating scouts, many of whom asked questions revealing a keen science interest.

CUORE tower assembly completion

CUORE (Cryogenic Underground Observatory for Rare Events) is an international ton-scale bolometric detector that is currently under construction at the Instituto Nazionale di Fisica Nucleare Laboratori Nationali del Gran Sasso (INFN-LNGS) in Italy. The primary purpose of CUORE is to search for the neutrino-less double beta decay ($0\nu\beta\beta$) of ^{130}Te that, if observed, would establish that the neutrino is a Majorana particle (meaning that the neutrino and its anti-neutrino are identical) and, in addition, would provide information on the absolute mass scale of the neutrino. The issue of whether the neutrino is a Majorana or Dirac (the neutrino and anti-neutrino are different) particle is an open question in nuclear and particle physics and its resolution will provide a definite direction for Grand Unification Theories that describe physics beyond the Standard Model.



The picture shows the robot arm (upper left) that was used for gluing the NTD thermistors and the heaters into the TeO_2 crystal elements (some of which can been seen in the central part of the picture).

The *CUORE* detector consists of 988 elements of 5x5x5 cm natural tellurium-oxide (TeO_2) crystals that are mounted in 19 towers with a total mass of about 1 ton. Each crystal is instrumented with a Neutron Transmutation Doped (NTD) thermistor to measure the small temperature rise that would result from a $0\nu\beta\beta$ event. The NTD thermistors were produced at LBNL and NSD is the lead US institution on *CUORE*. The tower assembly procedure involved gluing the NTD thermistors and heaters (for stabilization) to the individual crystals, loading the crystals into the tower, and wire bonding the electrical connections. In order to prevent the introduction of radioactive contaminants, all of the tower assembly work was performed in a sealed glove box located in a clean room. The final wire bond on the last tower was performed on June 11, 2014 marking the completion of the *CUORE* tower assembly task – a significant milestone for bringing the *CUORE* experiment online. UC Berkeley postdocs Tom Banks and Tommy O'Donnell led the *CUORE* tower assembly task. NSD postdoc Ke Han and NSD research assistants Sam Meijer, David Miller, and Sachinthya Wagaarachchi made significant contributions to the tower assembly. NSD staff scientist Brian Fujikawa led the assembly database task. *CUORE* is expected to begin data taking in 2015.

NSD Fragments

NSD Scientist receives Hevesy Medal Award

NSD Faculty Senior Scientist, **Heino Nitsche**, has been awarded the 2014 *George Hevesy Medal* in recognition of his international contributions to heavy element chemistry and actinide environmental chemistry. Named after George de Hevesy (Chemistry Nobel Prize 1943), this is the premier international award of excellence in radioanalytical and nuclear chemistry and it was first given in 1968. Comprising an engraved bronze medal in a presentation case together with an ornamental scroll, it was presented at the opening session of the 17th Radiochemical Conference at Marianske Lazne in the Czech Republic on May 11.

The Berkeley School of Collective Dynamics in High Energy Collisions was held June 9-12 [tbs2014.lbl.gov]. Started in 2005 and taking place every two years, the school is organized by NSD scientists **Volker Koch** and **Nu Xu**; it is intended for experienced graduate students and young postdocs. This year's program concentrated on *pp* and *pA* collisions and was in honor of Wit Busza of MIT. It comprised four days of lectures by international experts: Wit Busza (MIT) , Jean-Paul Blaizot (Saclay), Zoltan Fodor (Wuppertal), Xiandong Ji (Maryland), Jiangyong Jia (SUNY), Krishna Kumar (Amherst), Jinfeng Liao (Indiana), Constantin Loizides (LBNL), Gunther Roland (MIT) , Ernst Sichtermann (LBNL), Raju Venugopalan (BNL), Fuqiang Wang (Purdue), as well as a number of contributed talks by students.

The Fifth Annual JET Collaboration Meeting & Summer School was held at UC Davis on 17-18 & 19-21 June, respectively [jetsummer14.ucdavis.edu]. The *JET Collaboration* is a DOE-funded Topical Collaboration led by NSD scientist **Xin-Nian Wang**. The meeting was chaired by JET co-PI Ramona Vogt (LLNL and UC Davis). There were 22 attendees of the collaboration part (including JET co-Pi's and their students) and the school had 29 registered students (four of whom gave talks); the lecturers were by Zhongbo Kang (LANL), Edmond Iancu (Saclay), Marco van Leeuwen (Utrecht), Ulrich Heinz (Ohio State), Jacopo Ghiglieri (McGill), Jiangyong Jia (SUNY), Pengfei Zhuang (Tsinghua), and Roy Lacey (SUNY).

Visiting Faculty Program: Professor **Brooke Haag** from Hartnell College in California has returned to spend the summer working with her mentor, NSD physicist **Grazyna Odyniec**, and Professor **Jorge Lopez** from the University of Texas at El Paso together with his undergraduate student, **Enrique Ramirez-Homs**, are spending their third summer in the Nuclear Theory Group hosted by senior physicist **Jørgen Randrup**.

Jennifer Shusterman, DOE NNSA Stewardship Science Graduate Fellow in the NSD, recently received an award at the 2014 DOE NNSA SSGF Annual Program Review for her poster entitled *Development of Solid Phase Extraction Materials for Actinide and Lanthanide Separations* describing her dissertation work. **Dragos Velicann,** graduate student at MIT, has arrived to spend three months working in the Theory Group with postdoc NSD **Mat Luzum** on fluid dynamics of nuclear collisions at ultrarelativistic energies.

NSD Picnic: The annual NSD picnic lunch took place on June 26 at Codornices Park in Berkeley.

It attracted all generations associated with the NSD….



Photos L-R: Daphne Trowbridge-Williams and her daughter Eleanor Rose (aka "Baby Cyclotronia"). Center: Lucille and Art Poskanzer. Right: Thorsten Kurth and his son Simon.

offered great food and good conversation……..


Photos L-R: Nuclear Science Division. Top right: Wick Haxton, James Symons. Bottom right: Jørgen Randrup, Grazyna Odyniec.



service awards were presented ….. …..and retiring colleagues were lauded.

Photos L-R: Jørgen Randrup, Lady Bonifacio. Center: Yuen-Dat Chan, James Symons. Right: Jørgen Randrup, James Symons.

This NSD Newsletter was edited by Jørgen Randrup (JRandrup@LBL.gov); issues are archived on the NSD home page: https://commons/lbl/gov/display/NSD