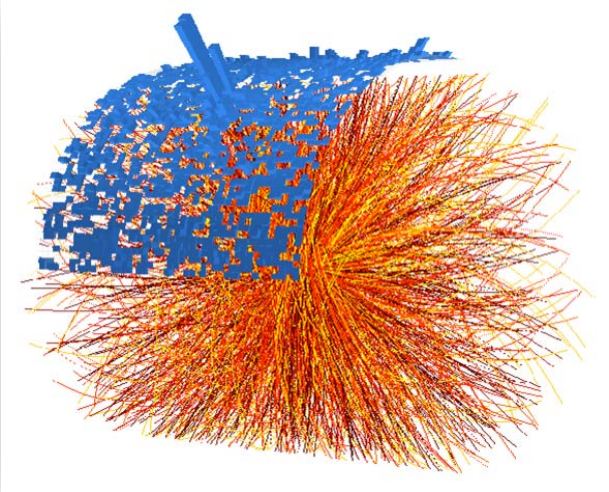
Nuclear Science Division Newsletter

In this issue: **March 2012**

ALICE EMCal is commissioned

The EMCal, a major sub-system of the ALICE experiment at the CERN Large Hadron Collider, was completed during the 2011-12 Winter LHC Shutdown, with the installation of its final two "one-third super-modules". The EMCal Project was a joint effort by US, French and Italian institutions, with 70% of the funding provided by the US Department of Energy. US institutions provided the project management and engineering leadership, and have led the commissioning and first physics analyses from the EMCal.

The EMCal provides ALICE with unique capabilities to measure jet quenching, one of the most important experimental tools for the study of the Quark-Gluon Plasma (QGP). Jets are among the most dramatic phenomena that occur in high-energy collisions, corresponding to very energetic quarks or gluons that have been scattered away from the beam direction by the interaction. A jet that is produced inside the Quark-Gluon Plasma will interact with the surrounding material and be modified by that process. Careful measurements of jets and their modification in the QGP give scientists powerful tools to understand the nature of the QGP, much like tomographic probes are used in medicine to image internal organs of a patient in detail.



One of the first "jet events" recorded by the EMCal during the LHC Pb+Pb run in November 2011. The orange-red lines show the multitude of particles tracked by the ALICE detector, while the blue boxes show the energy registered in the EMCal cells. The prominent cluster of very energetic cells in the EMCal is a clear visual signature of a jet.

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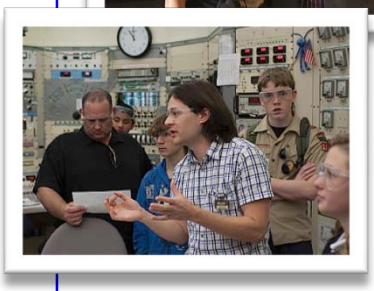
Girl Scouts and Boy Scouts Get Nuclear



The second annual Nuclear Science Day for Girl Scouts and Boy Scouts was held on March 3, 2012. The response from the community was enthusiastic and overwhelming. Although over 900 youths registered for the event, only 180 of them could be accommodated and invited to spend a fun-filled day at Berkeley Lab. Some of the participants came from over 100 miles away!

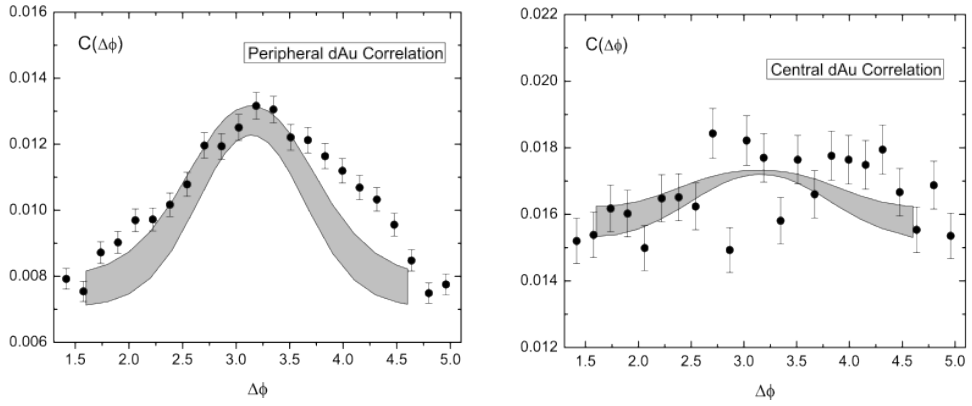
"Professor (Heino Nitsche) Radiation" kicked off the program at Berkeley Lab's main auditorium with a short, entertaining lecture on the ABC (alpha, beta, gamma radiation) of Nuclear Science. Following the lecture, youths participated in the activities at different stations. The youths had the opportunity to gain hands-on experience with radiation monitors, investigate the nature of cosmic rays with a portable cosmic-ray detector, and build a small electroscope to detect static charges and ionization. They also learned the exciting careers of a few nuclear scientists: an Air Force test pilot who became a doctoral student in neutrino physics, and nuclear scientists whose research interests have evolved to studying energy efficiency in buildings and in clinical medical research. One of the highlights was the tour of the 88" Cyclotron. The participants had a chance to tour the ion sources and advanced detector systems.

Many thanks are due to the over 40 lab employees and affiliates who help out with the event, and to our co-sponsor, Berkeley Lab's Center for Science and Engineering Education (CSEE).

The secrets of low-x pertubative QCD

QCD factorization enables us to separate short distance perturbative physics from long distance non-perturbative effects. Perturbative QCD calculations rely on the universality of the parton distributions among different processes. Recently, **Feng Yuan**, Fabio Dominguez, Bo-Wen Xiao and and Anna Stasto (in Phys. Rev. Lett. 106, 022301 (2011) & e-Print: arXiv:1109.1817) established an effective factorization in hard processes in nuclei scattered by a dilute probe. This factorization identifies key observables to probe the so-called unintegrated gluon distributions, key objects in the saturation framework, solving a long-standing issue in small-x physics. Dijet-correlations in deep inelastic scattering in electron-nucleus collisions directly measure the Weizacker-Williams gluon distribution function, while photon-jet correlations in proton-nucleus (pA) collisions probes the dipole gluon distribution. The dijet (di-hadron) correlations in pA collisions can probe both gluon distributions. Data from deuteron-gold (dAu) collisions at RHIC, and future pA collisions at LHC, and the planned electron-ion collider (EIC) experiments, will provide great opportunities to study these two-particle collisions in more detail.

Already, STAR and PHENIX have studied two-hadron correlations in the forward direction of dAu collisions at RHIC [2], where the strong de-correlation of the away-side hadron has been considered strong evidence for saturation physics. Numeric calculations based on our factorization formalism describe the experimental data in the saturation formalism, including the broadened angular distribution and suppressed away-side hadron peak. The figures below compares calculations with STAR results on two-hadron correlation as function of the azimuthal angle ΔΦ in peripheral (left) and central (right) collisions, respectively.



The disappearing of the away-side peak in central collisions indicates that the saturation scale is comparable to the hard jet transverse momentum -- a clear signal of the onset of the saturation. The kinematics points to a saturation scale of 2 GeV at Bjorken x~6x10-4 in the center of the gold nucleus with jet transverse momentum kt~3GeV. Future data from RHIC and LHC and the planed EIC will provide more information and help to map out the complete phase structure of the cold nuclei at small-x.

NSD Fragments

NSD Senior Scientist and theory program head **Volker Koch** was named a 2011 Fellow of the American Physical Society, *"for his contributions to the understanding of fluctuations and penetrating probes in high-energy nuclear collisions."* Congratulations to Volker.

NSD senior scientist **Jørgen Randrup** has been named one of about 150 'outstanding referees' by Physical Review and Physical Review Letters.

Hao Qiu has joined the Relativistic Nuclear Collisions Group as a postdoc. He will work on the STAR Heavy Flavor Tracker and on heavy-flavor analysis with STAR.

NSD senior scientist (and Deputy Division Director) **Spencer Klein** was one of four "Extreme Science" speakers at LBNLs "Science at the Theater" presentation in Berkeley Repertory Theater on February 27. The video is available on YouTube at: http://www.youtube.com/watch?v=zuyaPaFbT3A

Newsletter Notes

Please send any comments, including story suggestions to Spencer Klein at: srklein@lbl.gov

Previous issues of the newsletter are available at: https://commons.lbl.gov/display/nsd/NSD+Newsletter