Development of a Strategy for NNSA Investments
At Synchrotron Sources

DC-CAT: Dynamic Compression – Collaborative Access Team
HP-CAT Upgrade Plan
National Synchrotron Light Source II
And Others…

NNSA has been in making investments to establish and support essential scientific and technological capabilities aimed at addressing national security missions. The establishment of long-term partnerships with academic research institutions, as well as with other federal agencies, has been a key feature for maintaining the ongoing vitality of the NNSA scientific enterprise and for sustaining the development of leading-edge capabilities. The return to NNSA has been the delivery of breakthrough capabilities and scientific advances that have had significant impact on DOE's national security missions.

New investments have been proposed for the establishment of the Dynamic Compression Collaborative Access Team (DC-CAT) facility and the High-Pressure Collaborative Access Team (HP-CAT) Upgrade, both located at the Advanced Photon Source (APS) at Argonne National Laboratory (ANL), and the National Synchrotron Light Source at Brookhaven National Laboratory. Understanding the individual efforts and beginning to develop a coordination strategy for cooperative interactions are the subjects of this workshop. As a potential majority sponsor of these efforts, NNSA expects a cooperative relationship between these facilities.

Goals

1) Develop a User Facility Charter for DC-CAT. This has to be articulated consistently with the General User Program at the APS – APS sets the guidelines of its User Program and its Scientific Advisory Committee (SAC).
2) Review the Proposed HP-CAT Upgrade Plan
3) Define the relationship between DC-CAT and HP-CAT and identify strategic opportunities for cooperative efforts

Location

Meeting is at Carnegie at 5251 Broad Branch Road, NW, Washington DC 20015. The meeting will take place in the lecture hall of the Greenewalt Building.
The contact at Carnegie is Morgan Phillips (mphillips@ciw.edu)
The contact at NNSA is Robert Hanrahan (robert.hanrahan@nnsa.doe.gov)
And Terri Batuyong (terri.batuyong@nnsa.doe.gov)
Please copy both Morgan and Terri with your attendance confirmations.

DC-CAT Background

DC-CAT is a facility proposed by Washington State University and several partners for the Advanced Photon Source (APS) at Argonne National Laboratory to perform experiments investigating in situ characterization of materials undergoing rapid phase transformations such as under shock loading. . These experiments should enable quantitative progress to achieving greater understanding of dynamic materials behavior and that ultimately support the goal of moving from "observation to control" with *in-situ* measurements. Potential other lines of experiment should also support discovery physics and chemistry in extreme conditions and leverage the scientific knowledge derived from theory and experiment to the design and control of real materials.

Before NNSA makes any decision on the construction of DC-CAT the opportunity for refining the g experimental and diagnostic capabilities which should be prioritized for the facility. In the current proposal, two dynamic compression stations and a "non-single event" experiment station will be established at a new insertion device on a currently vacant sector. This would enable a broad range of dynamic experiments at several length and time scales. In a proposed Phase II, a much more ambitious construction project, major laboratory and office module modifications would take place to allow for the addition of ramp compression, more complicated laser-shock experiments, and possibly a 2-stage gas gun. The focus of this workshop will be on "Phase I."

DC-CAT may resolve long-standing fundamental scientific and diagnostic problems; the scope of possible experiments is limited by the intensities, time durations, and diagnostics. It can be argued that many of the proposed DC-CAT goals could be achieved utilizing other existing sectors of APS, other beamlines, or other existing resources,; but the example of HP-CAT suggests that rapid advances can be enabled by having a dedicated facility for the mission of dynamic compression- especially when utilized in tandem with other developing tools (e.g. LCLS MECI, the FEL SLAC source for high-resolution imaging, or other concepts in development). Furthermore, it will be a platform for developing a generation of scientific tools beyond DC-CAT. The challenge is to maximize the capability of DC-CAT to address the broader scientific challenges faced by the academic and national security laboratories.

HP-CAT Upgrade Background

Designed in 1998, HP-CAT has pioneered the establishment of a dedicated high-pressure facility in which multiple techniques have been developed and integrated at a single sector at a 3rd generation synchrotron source for the advancement of multidisciplinary HP research. Ten-year explorations and operations at HPCAT have revealed clear directions for the next generation of HP synchrotron research. In response to the aging infrastructure and steep competition from newly established HP beamline in Europe and Asia, there is a plan for an upgrade to HPCAT to advance existing HP-SR techniques beyond the current

cutting-edge and to enable new HP-SR science and technology that was previously unfeasible.

The requested upgrades would provide orders-of-magnitude enhancements of crucial parameters including x-ray source brilliance, source flexibility, beam stability, on-sample x-ray flux, micro-nano focusing size, sampling spatial resolution, temporal resolution, diffraction *d*-spacing and energy resolutions. Such improvements require a systematic upgrade of key components, including the undulator source, the x-ray optics train, the focusing systems, and detectors, using the newest technologies that have only become available very recently. The upgraded HPCAT will be a superior facility for enabling next-generation HP synchrotron techniques such as submicron HP diffraction, submicron HP imaging, Mbar single crystal diffraction, Mbar HP spectroscopy, High-resolution HP x-ray diffraction, time-resolved HP synchrotron instrumentation, and optimized medium energy resolution HP inelastic x-ray scattering. The unmatched brilliance, matching optics, and novel integrated techniques at HPCAT will provide superior tools for studying physical properties of materials under extreme conditions relevant to NNSA missions in the foreseeable future.

Other Facilities

The National Synchrotron Light Source has been used by NNSA lab personnel as a calibration source, for materials research and for technique development. With the decommissioning of NSLS and the construction of NSLS-II there is some understandable interest in both replacing existing capabilities and in the development of new capabilities relevant to (among others) NNSA on the new synchrotron. This and other NNSA light sources and beamlines, both existing and proposed (e.g. LANSCE, Z, NIF MaRiE) will also be the subject of some brief presentations and discussions.

Workshop Organization and Community Engagement

This workshop is by invitation only and will be organized to include an i) overview of the proposed DC-CAT capability and HP-CAT upgrade, ii) assessment based on scientific grand challenges in dynamic compression and high pressure science, iii) community input and evaluation and iv) discussion of workshop goals and expectations. The assigned discussion leaders and participants will engage in an atmosphere of promoting open and free exchange. A workshop chair or co-chairs and leadership team will be drawn from recognized scientific and programmatic leadership in the relevant research communities. The detailed organization of the workshop will be coordinated with the NNSA program officials.

Charge for this Workshop

The charge for the workshop is based on gathering needed information to accomplish the three goals stated above: Based on the three goals stated above, the charge for the workshop will include: 1) develop a User Facility Charter for DC-CAT; 2) review the

proposed HP-CAT upgrade Plan; 3) define the relationship between DC-CAT and HP-CAT and identify strategic opportunities for cooperative efforts.

To accomplish the first goal, the charge to this workshop is to consider DC-CAT in the context of existing and planned facilities, and by so doing determine how DC-CAT is best utilized as a user facility that both builds upon existing facilities and helps affect the design/scope of future facilities. This has to be articulated consistently with the General User Program at the APS – APS sets the guidelines of its User Program and its Scientific Advisory Committee (SAC). To answer this charge, we are asked to review the following mission related questions:

- What types of experiments are best suited for DC-CAT?
- Given the above, how does DC-CAT become a user facility for both academia and the complex?
- What are the gaps and diagnostic needs to future our fundamental understanding of a particular phenomenon?
- Does the current proposal for the facility capture the needs of the user base?
- Are equipment needs captured and have the appropriate experts (time-resolved diagnostic specialists, for example) been engaged?
- What operational constraints should be defined on types of materials (explosives, radiological materials, etc.)?
- What will be the operational model for the facility?
- How will institutional ownership and "CAT" partnerships be established and maintained?
- What are the principles and underlying objectives, which will be used to determine the relevance and priorities of proposed experiments?
- How will this set of experiments provide balance to the expectations of a general user facility and the interests of the national security laboratories?
- How are the experiments prioritized? What role will a governance board have in prioritization decisions?

For the second goal, evaluating the upgrade plan for HP-CAT, the following issues need to be discussed:

- Systems to be upgraded
- New capabilities and science challenges being targeted
- Budgetary allocations and proposed construction plan

Finally, for the third goal, defining the structure of a cooperative relationship between HP-CAT and DC-CAT, the following potential areas of cooperation should be addressed:

- Application of lessons learned from HP-CAT for DC-CAT design and construction
- Coordination on development of instrumentation (detectors, c-ray optics,)
- Cost-sharing opportunities (computer support, detectors,)

Workshop Expectations

The product of this workshop should be a white paper which outlines the process for identifying and prioritizing the experiments that provide maximum benefit from DC-CAT. In addition, the paper should include comments on the proposed HP-CAT upgrade plan, and opportunities for cooperative operational and scientific efforts between the facilities.