Facility Highlight

New G-Line Laboratory for Cornell Faculty Members

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CHESS is constructing a major addition that will provide a leap forward in X-ray research capabilities in applied science. The CHESS wiggler beam lines are heavily over-subscribed by about a factor of three and sometimes the Cornell faculty members have to go off-site in order to find enough synchrotron radiation beam time. The new beamlines are to address this problem.

The new G-line (next letter in sequence after our F-line) will be supported and operated by Cornell University faculty members and will be available for their use for 80% of the time with the remaining 20% to be available for general CHESS users. The beamline equipment is being funded by a separate $2.5M NSF proposal to five Cornell faculty members: Joel Brock, Professor of Applied and Engineering Physics and the lead researcher on the G-Line, together with Physics Professors Sol Gruner and (the late) Barbara Cooper, Chemistry and Chemical Biology Professor Hector Abruna, and Chris Ober, Professor of Materials Science and Engineering. Cornell University has provided the new $3.0M, 3,000 sq. ft building (see layout view of facility in Figure 1) that will house the equipment for the beamline and its three associated X-ray stations.

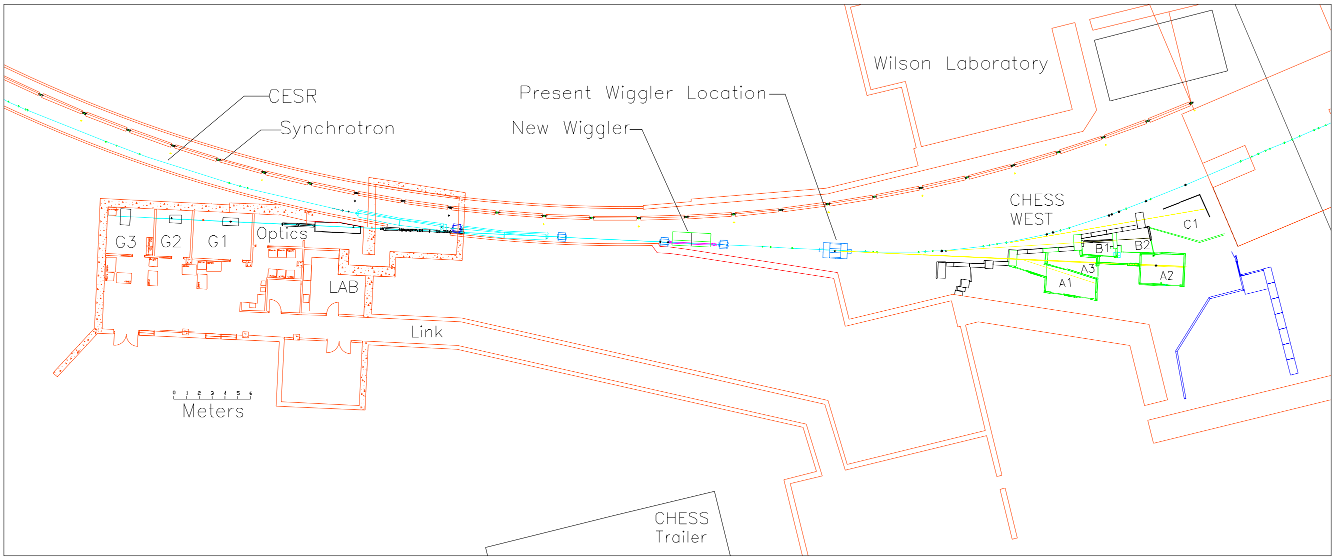

Figure 1: G-line building and its connection to CHESS West. Since both electrons and counter rotating positrons pass through the same wiggler, two X-ray beams are produced. The forward directed beam from electrons feeds A-line. The "back-fire" beam from the positrons feeds the three stations of G-line. As a consequence of a new wiggler being installed 12 meters further into the tunnel, the A-line optics will also have changes in their focal length ratios. A link tunnel from Wilson Laboratory to G-line provides the connection between the two facilities.

Of the three experimental stations on G-Line, G-1 will be used for study in such areas as the time-resolved response of large molecules to electric fields, high-pressure stimuli and mechanical deformation. The systems to be studied range from liquid crystals used in computer displays to synthetic silk and other biopolymers. The G-3 station will be used for the study of the growth of semiconductor films (Figure 2) and will heavily involve faculty and students from the Cornell Center for Materials Research (which will also provide administrative help in scheduling the beamlines). This station will be patterned after the facilities that Randy Headrick and collaborators have developed and built up at the CHESS A-2 station. The third station, G-2, will be for general purposes.

G-line will bring substantial benefits for both Cornell University and general CHESS users by increasing the availability and kinds of stations available at CHESS. Participating Cornell users benefit from the availability of larger blocks of beam time and the flexibility of determining the configuration of the station; this comes at the cost of having to support the extra beamlines. General CHESS users benefit from the extra availability of beam time, flowing both from the 20% of G-line allocated to the general user pool and from the reduction of Cornell usage on the existing beamlines, and from additional beamline capabilities. It's a win-win situation all around.

Figure 2: Hutch G-3 under construction. Exhaust stacks are being connected between the two ladders to the 4 gas cabinets that house containers that will feed reactive gasses into the real-time growth chamber (not yet installed). The front lead and steel hutch doors are not yet in place.

What makes synchrotron radiation facility really unique is that it's in the heart of the Cornell campus. It's really the only such facility in the U.S. actually embedded in the central campus of a university. As a result, we intend to emphasize the educational aspects of the facility for undergraduate and graduate research. We also expect to run a summer school, a Research Experiences for Undergraduates (REU) program and provide K-12 outreach.

The construction project involved uncovering the CESR tunnel and building a partially underground building next to it. During the summer 1999 shutdown, the ring was uncovered and a building constructed. During the construction phase, Don Bilderback and Dave Rice of the Laboratory for Nuclear Studies provided day-to-day oversight. The new building and CESR tunnel have now been re-covered with dirt and the ring is running next to the G-line space. Design work for the beamline equipment inside is proceeding, with installation of the beamline equipment expected during the spring of 2001 with commissioning taking place in the summer. Technically, the G-line project involves building a new 50-pole wiggler (see article on wiggler specifications and construction methods, page 22 by Ken Finkelstein) and associated vacuum chamber, front-end, optics boxes and hutches. The proposed wiggler will have more poles (2x), and in conjunction with a new quadrupole to be added to CESR, will produce more flux (see Figure 4) in a smaller emission angle (2x), and from a smaller horizontal source size (2x smaller).

Figure 3: G-line building from the exposed south-facing exterior. The rest of the building is underground. Wilson Laboratory is to the right and the Kite Hill parking lot 50' above the G-line floor level. The storage ring is in a bored tunnel (not shown) 50' under the Kite Hill parking lot. **Photo by:** *Charles Harrington, Cornell University Photography.*

CESR, will produce more flux (see Figure 4) in a smaller emission angle (2x), and from a smaller horizontal source size (2x smaller). When outfitted with wide-bandpass multilayer optics, this will make this beamline line one of the highest-flux lines available, a very useful feature, especially for time-resolved X-ray diffraction measurements. When CESR runs at 500 ma (2x above the present 250 ma currents), a brilliance gain of about $2^4 = 16$ will be obtained over the existing A-line. The beamline is expected to deliver (optimal design values) 10^{15} X-rays/sec in a 1.1 mm x 0.28 mm FWHM with a divergence of approximately 2.1 mr (H) x 0.4 mr (V) with a 1% energy bandpass at 15 keV. Both multilayers and silicon crystals will be available for creating the double-focused beams into three experimental stations called G-1, G-2 and G-3. The beam will be split two ways with G-1 receiving half of the beam and G-2 and G-3 hutches sharing the other half of the beam. G-2 and G-3 will share beam via a transmission diamond monochromator.

The research and development program for G-line is developing under the guidance of a Cornell faculty group (Joel Brock, H. Abruna, D. Bilderback, S. Gruner, C. Ober and R. Thorne). In addition, most of the CHESS technical staff are involved in the G-line development and expect to do experiments at G-line. Many other Cornell and off-campus collaborators were also involved in the proposal and also expect to perform work at G-line. G-line will have two permanent staff members: Alan Pauling, formerly a CHESS Operator, has taken over design duties for G-line and will serve as the technical staff member for the facility and Dr. Detlef Smilgies, formerly of the ESRF staff, has now joined the G-line team to head up the day-to-day scientific operations of the new laboratory. In addition to the permanent staff, Dr. Oana Malis has a post-doctoral appointment with the G-line group. Other graduate students involved in G-line at this time are: Aaron Fleet, Gregory Maskel, and Raphael Kapfer.

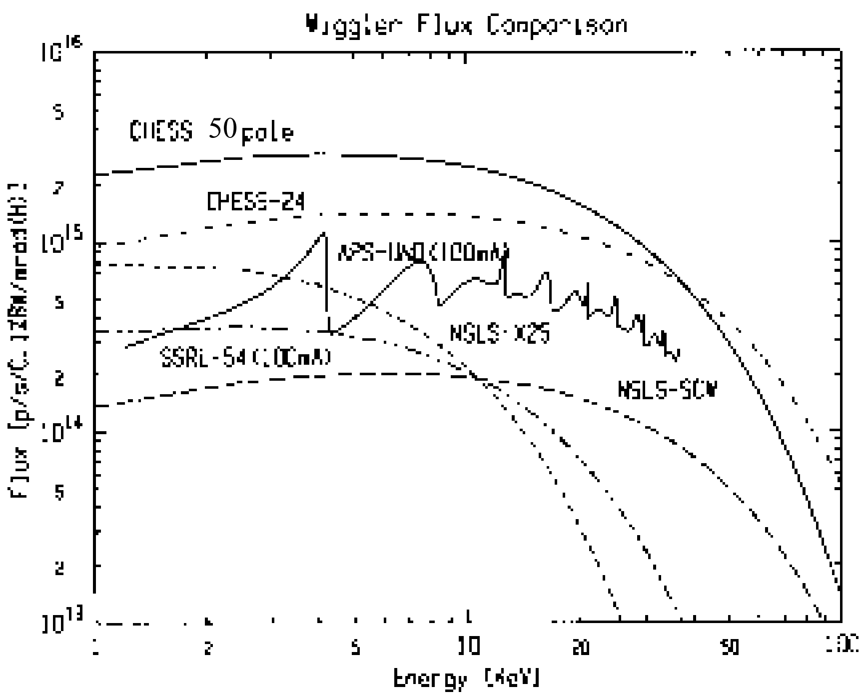

Figure 4: Spectral curve of wiggler vs. photon energy at 500 ma, 5.3 GeV operation of CHESS and comparison to other machines. All curves are for 500 mA operation except as noted for 100 mA operation of APS and SSRL. In addition, the total flux of APS undulator A is shown for closed gap operation with the flux integrated over the entire opening cone and not per horizontal milliradian.

Figure 5: View down the 140' long link tunnel from G-line to Wilson laboratory. This link provides all-weather underground access to G-line for staff and users. **Photo by:** *Charles Harrington, Cornell University Photography.*

In summary, G-line will provide new high-intensity X-ray capabilities and more capacity in synchrotron radiation research for Cornell faculty research groups as well as the CHESS general user community. Sometime in the near future it will be possible to stroll down the connecting link tunnel, figure 5, and walk into the latest synchrotron radiation facility on campus - a laboratory brimming with the excitement and enthusiasm of professors working with students!