# CHESS Celebrates 25 Years of X-ray Beam at CESR

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At 9:47 am on April 27, 1979, I observed the first synchrotron light from CESR on the CHESS newly installed "A" line. I came in early in the morning looking to see if the newly started CESR machine could produce any observable x-rays. I lifted the x-ray beamstops remotely from the present CHESS operators desk area and saw a horizontal stripe of radiation light up the fluorescent screen as observed with a remote video camera. I can recall saying to myself "This must be the beam we are looking for"! Figure 1 shows the radiation stripe observed from the bending magnet. The size, according to the logbook, was 5.5" wide by about 1/8" high. The notebook also mentions "Maury Tigner says a few tenths of microamperes of electrons are in the ring" at an energy of around 4.7 GeV. CESR has just roared to life with x-rays [1] and their use has steadily increased over the last 25 years!

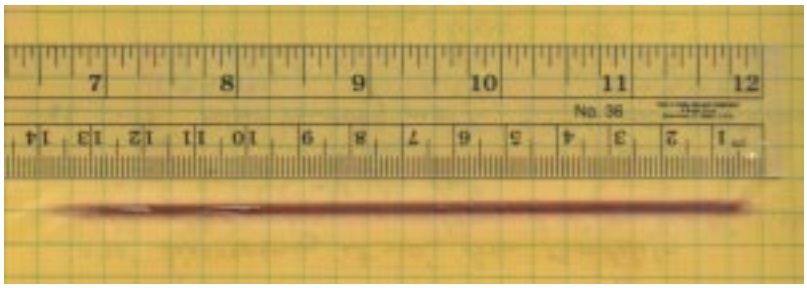

**Fig 1:** Kapton widows removed from a summer of exposure on Paul Hartman's split ion chamber for beam position sensing, show a permanent burn. These ion chambers are still in use today and are often called "Hartman monitors".

The beginnings of CHESS actually took place a few years earlier. Bob Batterman of Applied Physics and Neil Ashcroft of Physics had submitted a proposal (Figure 2) on September 30, 1977 for $1.3 million to build three bending magnet beamlines at CESR. The was the natural result of the work in the early 70's on the 12 GeV Cornell synchrotron that was carried out by John Wilkins, Val Kostroun, Denny Mills, and Bob Batterman. All of this activity was taking place with the encouragement of Boyce MacDaniels, the director of Wilson Laboratory at the time.

Lest you think that this was the beginning of synchrotron radiation usage at Cornell, we have to turn the clock backwards to the 1950s era when Hartman and Tomboulian [2] were confirming Schwinger's theory of synchrotron radiation on the 300 MeV synchrotron in the basement of Newman Laboratory in the UV region of the spectrum. [3]

Let me now give you a brief glimpse of life in this turn-on period with my remembrances and photos. I had initially come to Cornell in 1975 to work with Batterman in the Material Science Center X-ray Facility in the Department of Materials Science and Engineering as Research Manager. When Bob suggested working for the CHESS project in 1976, I jumped at the opportunity. Soon I was involved with Bob Batterman, Paul Hartman, Denny Mills, John Tischler, John Hart, Nari Mistry and many others to design the first

RESEARCH PROPOSAL SUBMITTED TO THE NATIONAL SCIENCE FOUNDATION

PROPOSAL TO ESTABLISH A HIGH ENERGY X-RAY SYNCHROTRON RADIATION LABORATORY ASSOCIATED WITH THE CORNELL 8 GeV STORAGE RING

September 30, 1977

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| Proposed Amount: | $1,374,450.00 |
| Proposed Effective Date: | June 1, 1978 |
| Proposed Duration: | 3 Years |
| Principal Investigator: | B. W. Batterman<br>Professor of Applied and Engineering Physics |
| | Phone: 607-256-5161 |
| Co-Principal Investigator: | N. W. Ashcroft<br>Professor of Physics |
| | Phone: 607-256-3520 |
| IRS Number: | 15-0532082 |
| Congressional District: | 27th |

Endorsements:

B. W. Batterman
Principal Investigator;
Director, Applied & Engr. Physics

N.W. Ashcroft
Co-Principal Investigator;
Professor, Dept. of Physics

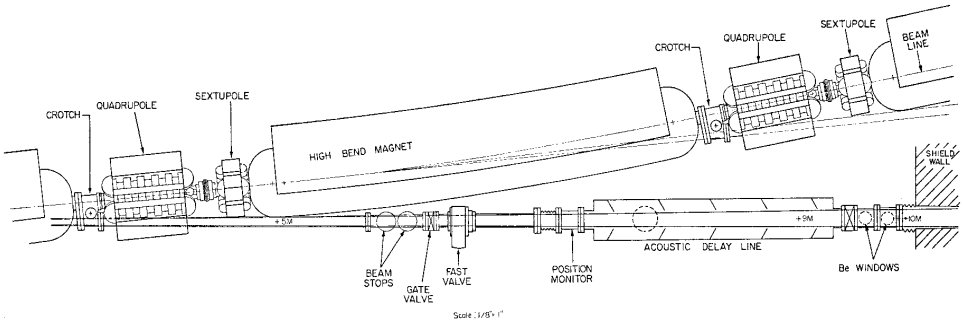
Fig 2: Title page of the original proposal to the NSF to build CHESS. The grant was funded at $1.3 million dollars.

hardware. As I recall, Denny did the numerical computer simulation work to arrive at a new crotch design since the SSRL crotch design would be overloaded with a higher energy CHESS type of beam. I took the thermal design and with Nari's help, turned it into mechanical drawings and had the crotches fabricated from copper and beryllium with particular help from John Hart and the LASSP physics machine shop. Virginia Bizzell was helping from the Applied Physics office to do rush purchasing of parts. There were only several of us to do the work, but it all got done so quickly as CESR was about to turn on and we didn't want to miss the opportunity. In fact, I believe that "Mac" MacDaniels and I together put in the last bolts on a crotch conflat flange that completed the CESR vacuum system.

Stewart Peck just showed me the log book from the month of April in 1979 and the entries read that "beam was across L0 (CLEO) on the 7th of April and the first miniscule amounts of current were stored on the April 13th. After that, things progressed quickly under the leadership of Maury Tigner who was leading the accelerator physics efforts to commission CESR. As a new guy to the accelerator field, I can recall simply being amazed at the way nearly 60 bunches of positrons were injected into the full circumference of CESR and then coalesced into 1 bunch by switching bunches one at a time into the shorter inner circumference of the synchrotron until they caught up to the lead bunch in the outer storage ring where they were reinjected to accumulate into one larger bunch. The process was like shooting ducks in a shooting galley where you knocked each one out in sequence, but all the ducks reappeared as one super-sized duck when it resurfaced! Wow – what wonderful beam gymnastics these guys could accomplish on the way to colliding electrons with positrons!

The first x-ray beamlines were installed in CESR and called "A", "B", and "C" lines. Figure 3 shows a schematic of a typical UHV CHESS beamline in this period. The x-rays were brought out of two beryllium windows to atmospheric pressure where we could begin to use the beams. In figure 3, a shielding wall is shown between the beamline and the user area, but for the first observed beams, there was no shielding wall, only the last ion chamber pointing out to many meters of open space, Figure 4.

**Fig 3:** Top part: CESR ring consisting of bend, quadrupole and sextupole magnets to guide the electron beam. Bottom part: x-ray beam stops, fast valve and acoustic delay lines plus two beryllium windows. Today's beamlines are similar, but we no long require the use of an acoustic delay line for equipment protection.




SCHEMATIC OF TYPICAL CHESS BEAM LINE

You may be interested to ask, "what did the first beamline look like". Figure 5 shows the answer! After the shielding wall was installed, a small hutch about the size of a telephone booth was constructed. As I recall, John Budai from the Steve Sass group was coming over to build up a diffractometer station that could look at twisted grain boundary reflections which were under study. Also in this period, Millard Baublitz (Physics and MS&E) came over to do the first high-pressure diamond anvil experiments on B-cave that would begin the long relationship of CHESS with Arthur Ruoff (MS&E) and Bill Bassett (Geology) at CHESS.

**Fig 4:** First CHESS A (left) and B (right) beamlines as photographed by C. Hadley Smith on 6/29/79. The A-line beamline ends in the Hartman split ion chamber for beam position measurement. The inner plates can be seen through the transparent Kapton window. Just upstream of it is the several meter long acoustic delay line with 7 sections. The seven sections were made of large stainless steel mixing bowls with slots cut in the orbit plane to let SR through but to slow any inrush of air should a window fail. On the right B-line beamline, the acoustic delay line is not yet attached as it was still coming off the production line. Signals were run back to the CHESS control room through the trenches from patch panels we scrounged up from the CESR group of C. O. Brown and Mike Ray.

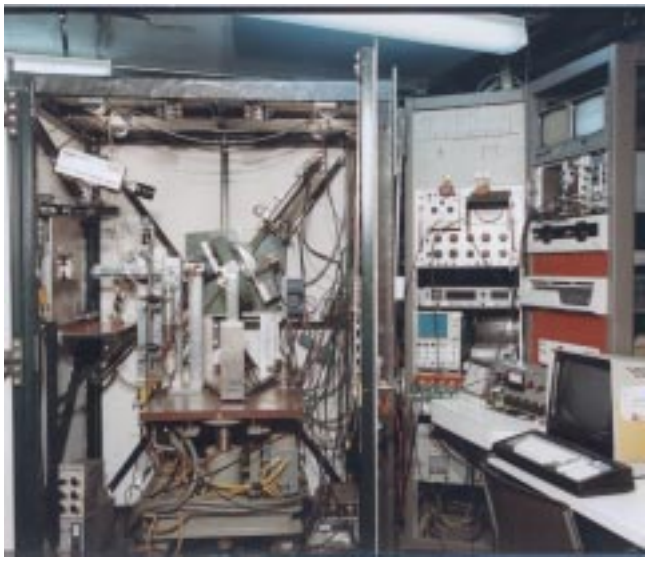
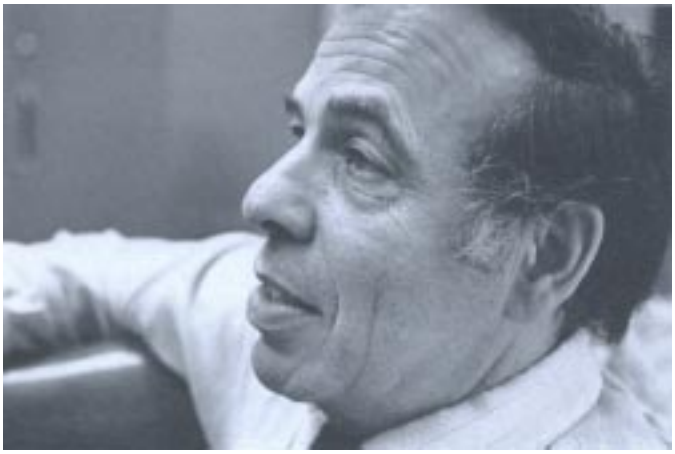


**Fig 5:** The original A1 hutch built by John Budai and the CHESS staff (2/18/81 C. H. Smith). An old Picker 4-cirle diffractometer was set up on a borrowed CESR table. Monochromatic x-rays at around 8 keV entered the hutch through a flange on the left and fell on a float glass mirror before being passed to the specimen at the center of the diffractometer. Outside the hutch on the right is an LSI-11 microcomputer and home made interface for stepping motors and counters that was built by Vic Pollock. The software was character driven. Note the pocket guide for the "Teco" editor. This is how we did things before the current SPEC program was available for instrument control.

Not long afterwards on A-line, an 8 pole wiggler magnet was loaned to us by the SSRL group of Herman Winick. With this step, the A-line intensities went up substantially. Keith Moffat and Marian Szebenyi and others from Biochemistry then came to put a precession camera in place of the A1 diffractometer and the results were so encouraging that the MacCHESS protein crystallography efforts were formed out of this experience.

For some reason, I don't have too many people pictures from this period. I would like to start to collect them and scan them in as electronic images. I show two of them from this period of Professor Batterman (Fig. 6) and myself (Fig 7), but if you have others, please draw them to my attention.



Boris Batterman, first CHESS director, taken from Cornell Engineering Quarterly, Vol. 20, Number 4, Spring 1986, page13.

I have one unforgettable quote, attributed to Jon Tischler (ORNL and APS now, but who was then a Batterman graduate student) at 9:50 pm on Saturday, June 27, 1981 and recorded by an unnamed CHESS operator. This was witnessed (and heard) by Gene Ice, Cullie Sparks and Andrea Holladay. The circumstance? A loud boom was heard in the CHESS West area about 9:30 pm while Jon had gone for food. Upon his return, the above individuals told him of this loud boom, and he asked in the most serious tone "Did it sound like a great big bunch of gas being let out?" Jon confessed that his first thought was that CLEO's superconducting solenoid had quenched. Thus we have Jon's apt description of that sound!

**Fig 7:** Don Bilderback, first operations manager and Staff Scientist sitting in the new CHESS library area.

I could say more, but perhaps that will be cause for another future article about CHESS in its real growth period of the mid 80's! But for this year, let's remember our humble beginnings of 25 years ago and how much we have learned from our science work in the intervening years both here at CHESS and by our numerous colleagues at other storage ring sources throughout the world. Synchrotron radiation research has really become a large scale endeavor and has "come of age"!

**References:**

[1] B.W. Batterman, "CHESS-The Cornell High Energy Synchrotron Source", NIM **172**, 21-23 (1980)
[2] Tomboulian and Hartman, Phys. Rev. 102, **1423** (1956)
[3] More details about the beginnings of SR can be found in his welcome address to the 2nd National Conference on Synchrotron Radiation Instrumentation held at Cornell in 1981 and published as P. L. Hartman, "Introductory Remarks", NIM **195**, 1-6 (1982)