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APS/Users Monthly Operations Meeting

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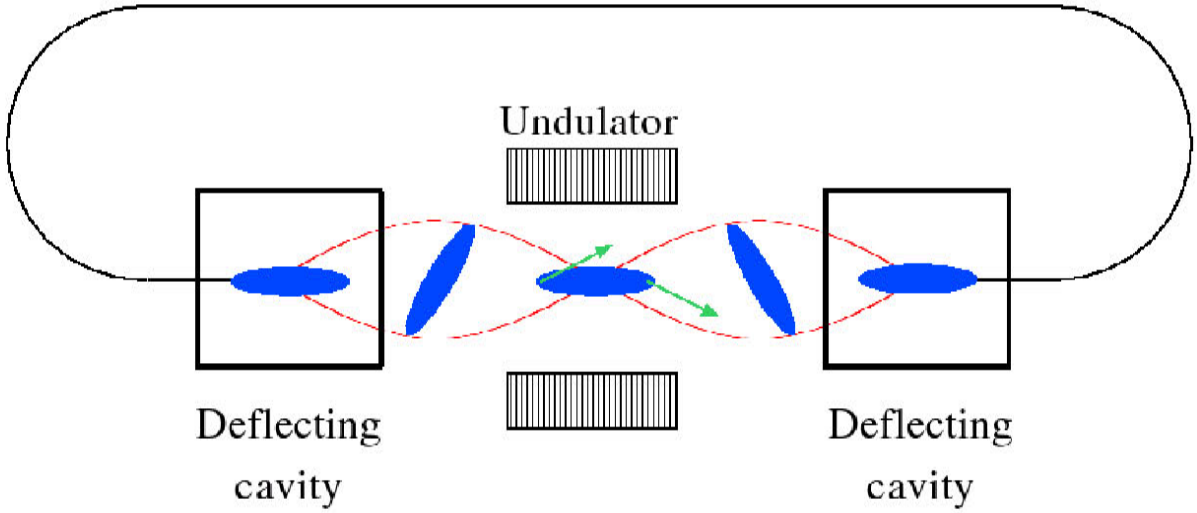
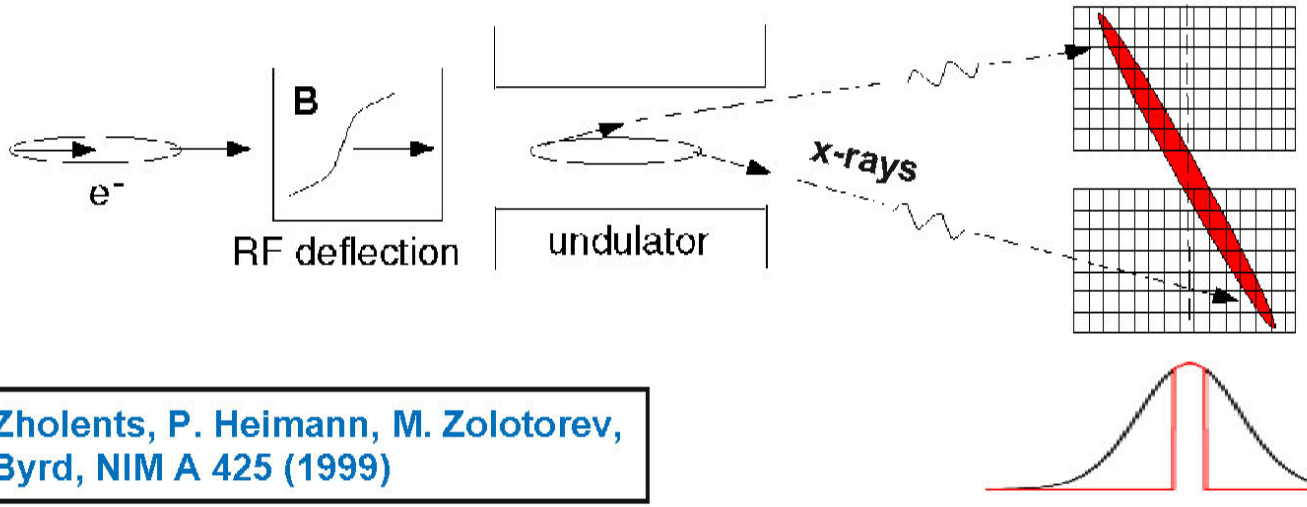
APS Internal Assessment of the Short Pulse (SPX) Project

December 17, 2008

Short-pulse generation with rf deflection†





Slits can be used to clip out a short pulse.

Can also use asymmetric cut crystal to compress the pulse.

† A. Zholents, P. Heimann, M. Zolotorev, J. Byrd, NIM A 425 (1999)

Some definitions

- SPX – Short Pulse X-rays: The capability to longitudinally compress an X-ray pulse by manipulation of the electrons and X-rays. The goal is on the order of several picoseconds rms.
- AIP – Accelerator Improvement Project: Money provided by DOE to build hardware that improves the facility.
- FTSPX – An implementation of the SPX project that was meant to be developed quickly as an interim solution until the full fledged system is built.

SPX Assessment - Summary

- The APS recently suspended activity on a project that had become known as the Fast Track SPX (FTSPX) project. A program to develop a picosecond scale x-ray source was initiated in 2006 as part of the APS Upgrade program in order to provide a tool for picosecond science for the time-resolved user community. The FTSPX was an R&D program with an aggressive timeline to provide a “fast and cheap” interim picosecond source with limited capability in order to start building the user community. (A white paper had already been submitted to DOE for project funds to develop a more expensive full-performance system.) A primary consideration in setting the aggressive timeline for SPX was a desire to perform the first user experiments before LCLS turn-on in 2008. APS Management and the project team alike recognized that there were technical risks, but it was considered that the risks were worth taking because of the potential pay-off from delivering the source quickly.

SPX Assessment - Summary

- As R&D progressed, it became increasingly clear that the project would be significantly more expensive and take much longer than originally anticipated. Following a re-baseline of the project schedule and budget in October 2007, APS Management called a meeting with SPX project leadership at which it was decided to terminate FTSPX. Concurrently, this assessment of what occurred was requested by APS management. It is noted that, although the FTSPX project has been terminated, benefit has come from the R&D effort. The APS has developed the capability for strongly coupled cavity RF, thermal, and mechanical design & modeling. Development programs have also been initiated on digital low-level RF control and precision timing distribution. All these will reap benefit in future developments for the APS upgrade and in the case of the precision timing distribution, there could be significant benefit to the APS users well in advance of the APS upgrade.

SPX Assessment - Timeline

- In late summer, 2004 an APS strategic planning meeting was held at Lake Geneva. At this meeting the workshop, "Time Domain Science Using X-ray Techniques" introduced a conceptual approach (attributed to Alexander Zholents of LBL) of generating short X-ray pulses at the APS. The scheme anticipated using superconducting rf cavities to provide a “CW capability”
- A white paper was written and sent to DOE in April of 2005 making the scientific case for the development of this capability and projecting a cost of $15-$20M for both the accelerator and beamline upgrades, and a time line that ranged from 18 to 36 months after funding.
- A one day workshop on the development and use of this capability was scheduled for May 6, 2005, appended to the APS users meeting.
  - Just prior to this meeting an APS user wrote a lengthy e-mail to APS management urging rapid deployment of the capability by taking what was claimed to be an inexpensive and quick approach using normal conducting rf.

SPX Assessment - Timeline

- With this push from the community, APS management called a special meeting to decide which approach to take. (August 12, 2005). The merits, technical challenges, costs and schedules of both approaches were presented. The outcome of this meeting is not documented, but the decisions made are evidently reflected in the funding granted to two project proposals, one which was submitted for SRF R&D and one for normal conducting rf R&D. The SRF received full requested funding, and the normal received about half of the requested funds. Thus we proceeded into FY2006 still concentrating on the SRF option.
- In June, 2006 while preparing for the APS Upgrade Summary Workshop in August of 2006, APS management began to press the beamlines for a location to locate the SRF cavities. (at least two consecutive straight sections are needed)

SPX Assessment - Timeline

- There was resistance to giving up adjacent beamline space. During these discussions, the possibility was introduced of implementing a pulsed source in a single sector, taking advantage of an existing preliminary design for normal conducting crab cavities from SLAC, and utilizing an unused RF klystron and modulator from the APS linac. The proposal was well received by XSD and the user representatives.
- On July 31, 2006 the above proposal was brought to the weekly Upgrade Meeting, namely to implement the project in a single straight section using normal conducting rf cavities. ***This was coupled to the previously made statements that this could be done quickly*** (the meeting notes indicate that a completion in 2007 was suggested). We presented our answer at the APS Upgrade Summary Workshop on August 11, in which we announced the decision that we would pursue the normal conducting implementation, it would be a one sector implementation in sector 7. It would not preclude future upgrades to multi-sector or CW implementations.

SPX Assessment - Timeline

- The project became known as the “fast track” implementation. Portions of the above text are included to show what the interviewees conveyed… namely that through the project phase “inexpensive” was assumed and schedule became everything.
- The ASD technical staff fully understood this to be an R&D oriented project. The worldwide experience with normal conducting s-band cavities is extensive but they had never been installed in a circular (i.e, many passes of the beam) machine with all of the associated issues of high average power, and parasitic mode rejection. Thus these were the first technical issues addressed. It turned out to be more difficult than anticipated.
- Early indications of these challenges were manifest in the determination that the space needed for rf hardware could not be accommodated in the existing buildings, and an external building would be needed.

SPX Assessment - Timeline

- At this point (May 2007) the decision was made to go ahead with the construction of the building. It was understood that the building was on the critical path and would need to be started to meet the schedule. This formally was the start of the project; i.e., AIP funds were spent.
- Subsequent R&D results, and technical reviews ultimately led to the full realization that the cost to address the technical challenges would be well over the initial estimate (by about a factor of three) and that it would require a longer time to complete, thus negating the fast track argument. The fast track project was terminated in late November, 2007.

SPX Assessment

- The project suffered from ‘budget creep.’ The project was initially budgeted on the basis that the RF klystron would come from linac avoiding the need to purchase a new klystron spares (at least in the first phase). Similarly, it was assumed that the SPX system would be installed in the experiment hall. Several months into the project, it was decided that a new klystron should indeed be purchased and it was concluded that the system would be better housed in a new separate building. Both decisions were made on the basis of good technical judgment and with the agreement of APS Management. However, they increased the first-phase project cost by over $1M from the initial budget. Furthermore, the re-baselinings that came from these and other changes were communicated informally and via email, namely they were not formally documented so that the budget history could be easily tracked and reconstructed. Project Reports showed “Cost to Date”. Management did not ask for EAC and contingency analysis.

SPX – Lessons Learned, Corrective Action

- 1.) Decision making lacked documentation. The ALD office is taking action to correct this. Decisions are being documented both in Operations Directorate meetings, in the Renewal/Upgrade meetings and in Division Directors meetings.
- 2.) Rigorously define R&D programs as opposed to construction projects, and be very intentional when transitioning from the former to the latter. It is noted that at the UofC review of the APS in April of 2007, the review committee stressed the R&D nature of this project.
- 3.) Project proposals often don't capture all costs, and certainly don't allow for the requestors to include contingency. It is not always clear from the proposals what the cost and schedule risks are. For many small projects this may not be necessary, but for larger R&D oriented projects, this should be required input.
  - Projects requiring significant R&D should be noted as such, and receive higher levels of scrutiny, regardless of their overall estimated cost. However, it was noted by many that APS Management must strike a balance between encouraging and supporting R&D activities with technical risk (knowing they could fail) and ensuring that funds are effectively utilized.
  - Criteria based on overall cost, risk or impact should be utilized in determining the project reporting level based on a graded approach. APS management together should define these criteria.

SPX – Lessons Learned, Corrective Action

- 4.) APS Management has not required that APS project status reports include an “estimate to complete” or “estimate at complete”. Also not included in reports are schedule evaluations. Reports tend to simply note what had been done to date. A form will be provided for project status reports, and utilized in projects as determined by the criteria developed in point 3.

- Positives:
  - Much benefit came from the R&D work that will benefit the APS in the future.
  - The potential for SPX capability is still very much alive, and is being treated as all other ideas in the APS Renewal strategy. R&D continues to be done on the accelerator technology.

  Link to Report:

  http://www.aps.anl.gov/About/Committees/Documents/aps_1265708.pdf