The Implications of the FY06 Budget: the BTeV Cancellation

Ten years ago, several of us embarked on a scientific journey to build the best B physics experiment in the world. Over time, the effort grew to175 physicists from 28 universities and 3 national laboratories (Fermilab, IHEP/Protvino in Russia and Frascati Lab in Italy) in seven countries who contributed their ideas, time, and talents to the effort. On Monday February 7, 2005, we received the news that the BTeV project was cancelled, marking the premature and untimely end of that journey. This statement, which is the consensus of the collaboration and the project, is our comment on the impact of cancellation In writing this, one of the most difficult challenges for us is to avoid recriminations and to try to make a constructive contribution to the discussion of the budget process and the way in which projects are treated within it. We hope we have succeeded in that goal but we will make some statements that might make people uncomfortable. We hope we can stimulate a real discussion of the issues we raise.

The most significant effects on High Energy Physics of the FY06 Budget are the multiple impacts from the loss of BTeV. First, there is the loss of science that will follow from the termination of BTeV. We discuss the "scientific argument" that was cited for our cancellation and expose its flaws with the hope that we can prevent it from being used against other projects. Second, we believe that the process for advancing scientific projects in the DOE is broken We address this on three levels: a high level view based on the recent history of projects in the DOE Office of High Energy Physics, OHEP; a more BTeV-specific view based on the abrupt way in which we were terminated; and a view of the advisory and peer review process. It is imperative for US science that this process is fixed! Third, we discuss the effect of the cancellation of BTeV on Fermilab, US HEP, and our international partners. We want DOE to work to reassure Fermilab that it has a future and to show more sensitivity to the issues of international collaboration. Finally, we discuss the significance of the cancellation as part of a process in which HEP is being "outsourced" and discuss the implications of this for the physical sciences in the US.

Loss of Science

BTeV would have studied CP violation and rare decays of particles containing Bottom and Charm quarks. The goal was to look for new sources of CP violation that would explain why the amount of matter in our universe is so much larger than predicted by the Standard Model. The study of these new sources would have complemented the direct observation of them at the Large Hadron Collider (LHC) at CERN and helped determine the properties of new physics seen there. BTeV planned to use several relatively new technologies, applied in innovative ways, including a system of 23 million silicon pixels that are part of a massively parallel Level 1 trigger, followed by a massively parallel Level 2/3 trigger and a lead tungstate crystal calorimeter that allowed precision studies of final states containing photons, π^o's and η's. BTeV would have had the ability to record a wider range of different types of B decays, especially those of the B_s meson, than any other experiment and would have studied decays that contained photons, which are some

of the key ones for finding new physics. While some of BTeV's physics reach overlapped that of LHCb at the LHC, a significant part of it was unique, going beyond what could be done there. The existence of LHCb and this area of overlap were well known at the time of the inclusion of BTeV in the Office of Science Twenty Year Facility Plan. Our contention that BTeV would be the best B experiment ever built and would do physics beyond what any other experiment, including LHCb, could do was one of the most reviewed and best-supported claims in the history of US high energy physics. Furthermore, the new technologies had already been subjected to substantial development and testing and there was no question that they would have worked as evidenced by BTeV having passed many technical and cost reviews.
Dr. Orbach, Head of the DOE Office of Science, is quoted as saying BTeV was covering the same territory as LHCb. This is not accurate since BTeV had unique capabilities on many key states. With BTeV's cancellation, there is a large scientific territory that will not be covered. But, this also misses an important point. Results in physics and all science require confirmation. Competition and confirmation are central concepts of experimental research. Even where the two experiments do cover the same territory, the presence of each of them is still crucial to the successful accomplishment of a scientific program. Attacking the same problem with different techniques, and different sources of systematic uncertainty, helps eliminate errors. Friendly competition sharpens everyone's game and people also share ideas and approaches. We want to remind people of this because as long as there are active and imaginative scientists in Europe and Asia, they and we will always be trying to answer the most important scientific questions. If the appearance of a proposal anywhere else in the world makes US efforts in that area automatically redundant, because the territory will be "covered" in the minds of our scientific policy makers, and that results in further cancellations, how will be able to do any program in the US? The next neutrino project will face exactly this issue because of the J-PARC program. If we don't change this attitude, since we in the US have the most demanding approval process of any nation, and since we demand huge schedule floats while ceding to our competitors "just in time schedules" with no float, we will always start a little later than the competition and look like we are going to finish behind them and our projects will always be vulnerable to cancellation.

Broken Process for getting projects funded

The Process is broken: A high Level view

This cancellation demonstrates that the project approval process in HEP is broken. The first way to see this is to look at the situation at a very high level. The last major project (>$50M) to be approved to operate at a domestic accelerator lab in HEP was NUMI/MINOS, which was approved in 1999. Since then, only the small Run 2b upgrade, the remainder after 2/3 of that project was cancelled, has gone forward. During this period, several projects were initiated in the US. KAMI, a neutral kaon experiment, was rejected by the Fermilab PAC. The Run 2b upgrade, CKM, a charged kaon experiment, and BTeV were approved by Fermilab. The Fermilab Director, and P5 rejected the silicon

upgrades for Run 2b after their initial approval. P5 also recommended against doing CKM. P5 endorsed BTeV. BTeV was also included in the DOE Facilities 20 Year plan that Ray Orbach put together. In early 2004, BTeV was included in the President's FY05 budget. In February of 2004, BTeV received CD0 from Ray Orbach and later in the fall received a "conditional CD1 (pending resolution of a technical problem with an OECM review of a document)." In December of 2004, BTeV had a CD2/CD3a review that it passed with very high marks and was recommended for baselining and start of limited construction. The BTeV project used the DOE management structure, understood and complied with the 413.3 order, worked within the Integrated Project Team structure, and has been able to meet the requirements to be a DOE project with success. With the termination of BTeV and the completion of NUMI/MINOS, HEP effectively has no major accelerator-based construction projects at a domestic facility operated by OHEP. This has not happened in recent memory. **A process that demands so much of the proponents, in excess of 500 FTE-years in BTeV's case, and cannot advance one project in 5 or 6 years is broken!**

The process is broken: a view from the ground

The DOE has a very demanding process for approving projects that requires enormous scientific, technical, and managerial effort by the proponents. We invested this effort with the belief that our partners in the DOE would work with us throughout the budget process. We believed that, after some initial skepticism, OHEP had developed respect for our science and confidence in our technical and management capabilities. We repeat that in mid-December, we had a CD2/3a Lehman review that we passed with flying colors. It recommended baselining the project and beginning limited construction and we believed we were in good shape.

The first news we had that the project was cancelled was the announcement by Secretary Bodman on Feb 7. Our shock and disappointment was compounded by the fact that OHEP had never requested information from us about the possibility of dealing with funding profiles other than the one provided to us by Fermilab and that we fit into for the baseline review. Based on what we heard from Fermilab, the shortfall with respect to their expectations for FY06 was about $8M. If they had asked us whether BTeV could have absorbed this whole reduction, the project would have bravely and energetically executed a new round of value engineering and de-scoping to match the new situation, as we had done in the past when OHEP questioned our schedule. We had also obtained $9.5M of forward funding from our university groups and significant funding from the INFN in Italy. We do not know if the Office of Science was aware of the possibility of restructuring the project, which was certainly known to OHEP staff and Fermilab management. We are confident that we could have maintained the schedule with little slippage had we been given the opportunity. We feel we should have been asked to respond to a range of budget scenarios, which could have been done without us knowing the details of the budget. This could have been addressed at the Lehman review. By being cancelled in this fashion, we were given no opportunity to try to deal with the realities of the FY06 budget and out-year projections. Most projects that received cuts in

the DOE were given the opportunity to work within the system to make adjustments to the cost and schedule, not killed outright.

We believe that we could have lived within austere budgets in FY06 and FY07 and found a way to stay close to a schedule that has about 1 year of float. We also point out that we are competing with an experiment whose startup is also likely to be delayed. However, we could not have sustained shortfalls indefinitely. It occurs to us that DOE may already know that it is highly likely that there will be bad budgets for HEP for many years. If so, we appeal to them to make this known to any new projects that might start through the approval process. People should start down the path of project development and approval with some reasonable understanding of the probability of success. The cancellation of BTeV just as construction was to start resulted in a massive waste of effort and money in a time when both are in short supply. We estimate that the total sum of money invested in BTeV, not including salaries of University based personnel, was in excess of 25 M$.

The process is broken: The HEP review process

The last HEPAP Subpanel convened P5 to "prioritize" medium-cost projects with the hope that by doing this, the ones that survived would be funded. The thought was that P5 approval would provide assurance that all issues were examined. While BTeV had the unenviable privilege of two appearances before P5, and the second one, while reconfirming us, raised concerns about the schedule, we still have expired with the positive recommendation of every advisory committee and inclusion in the Office of Science 20 Year Facilities Plan. All projects that went into P5 got killed (at least in part) or cancelled, whether P5 was the agent or not. What then does the advisory process mean?

This is important because at this meeting HEPAP will discuss renewing P5 and setting up νSAG. If these panels deliberate and reach a positive conclusion, we want to believe that that projects that are approved will be funded, not that they be given the opportunity to do lots more work before they are killed.

Impact on Fermilab

At Fermilab, most, but not all, people see this decision as a disaster. BTeV was Fermilab's next program and was intended to be one of the two central elements of the particle physics program at U.S. accelerators at the end of this decade and into the early part of the next decade. The FY2005 budget was not very good and the staff is already worried. The FY06 budget language has brought a sense of fear to the scientific and technical staff. The decision to cancel BTeV eliminated Fermilab's only new project, a project that all four scientific and technical Divisions were working on. Without a new

project, many of Fermilab's best people, who thrive in an environment with technical challenges, will probably leave. Fermilab employees are left to question what the future holds for them. Without BTeV, the Tevatron will be turned off in 2009. Many jobs are connected to the Tevatron operations. Much of the Particle Physics Division was planning to work on the BTeV detector. There are rumors among lab employees that large layoffs are imminent. Operations after 2010 are also threatened by the language of the budget. Our field and future scientific discoveries are being "outsourced."

We keep hearing how important Fermilab is to the future of US HEP but the budget never seems to reflect this importance. According to the budget, SLAC is leaving the business of operating accelerators for HEP after 2008 when the B Factory will shut down. It is imperative to strengthen Fermilab and provide it with a future program that is reasonably certain to be supported and makes scientific sense. We do not think this can wait for very long.

Impact on foreign collaborators and implications for the US as host of international projects

The effect on our International Collaborators has of course also been devastating. The main issue here is that the US reputation in such endeavors, already not good, has suffered. Our four Italian groups had obtained INFN funding, about ~7.5M$ (equivalent). The future plans of our Italian colleagues have been destroyed, along with ours, and their careers negatively affected. We doubt that they will work in the U. S. again even though they have been working at Fermilab for the last 20 years. Our Russian and Chinese collaborators have also experienced similar effects. The Russian group has also been working at Fermilab for several decades and had obtained funding from Russia to support their participation in BTeV. They have expressed to us their disgust with our process and predict it will have serious negative effect in promoting any international collaborative effort in the U. S. Letters from the Principle Investigators of these groups have been sent to HEPAP giving their reaction. We have to find a way to show more respect for our international collaborators and to have more transparency in our process so that they can understand it and understand both the potential benefits and risks of participating. One foreign collaborator said in a letter to HEPAP "I have been a member of BTeV essentially since its inception and I'd just like to add my voice to the disillusioned international collaborators on the now cancelled project. A big part of the problem I had selling BTeV was a hesitance by my compatriots to get involved in the US because of funding uncertainties. I realize that there has to be accountability to US (and other) taxpayers and that any large, expensive project needs to be reviewed and placed in the context of the physics priorities of the nation. However, the system as it was applied to BTeV makes it basically impossible for any international collaborator to commit to a project. I have been involved in projects at DESY and CERN and in Japan and in these cases I could go to the funding agencies and say how much I wanted for doing science at a facility or project without having to convince them that it wasn't going to just disappear. Somehow the U.S. has to create a system or modify the present system so that a

commitment can be made to a project that is shielded by the annual political wrangling that goes on in Washington. Otherwise, I don't see how I, as a foreign collaborator, can consider to participate in US led projects in the future. And I can honestly say that I am very sad to have to write those words as I have enjoyed working on projects in the US and I think there are a number of exciting projects in the works.

"Outsourcing HEP": a bad strategy for our nation

Our final point concerns science education and the ability to attract young people to the physical sciences. This is intended to provide arguments for our DOE colleagues to use in defending HEP in the budget process to avoid future cancellations. High Energy Physics addresses questions that are very remote from everyday life. One might ask why we cannot let Europe and Japan do the costly projects and make the scientific discoveries. Another way to ask the question is, "Why can't the US (or any nation) be a leader in scientific applications, without sustaining the expense of investigating science's great mysteries by doing costly basic research?" While we can cite the intellectual value of the research and the obligation of a great nation to study the great questions of physics, we want to raise two more practical and more urgent issues.

First, basic sciences push to look at the most extreme conditions in the universe and try to achieve improvements of large factors like a 100 every few years. To do this, they are always aggressively pushing technology and demanding more of industry. By working with industry, often "Under the Radar,"[l] we can help propel new ideas and products. This quote is just one small, but significant example, taken from a book about Red Hat Linux:

"… Fermilab, the federally funded atom-smashing think tank overseen by the US Department of Energy, was a mecca of the world's top nuclear physicists. It had quietly added a new flavor of system software to its roster of those driving the lab's network of computers. … Such sites were known in the computer industry as "early adopters," technically savvy users that were often the first to install leading edge products before the market had fully accepted them."

This is one example of how HEP really helped a fledgling company, which has now become an operating system power, get started by our need to seize cutting-edge technology and put it to work.

If we outsource HEP and other basic research, it is likely that our best people will instead work with the best companies in Europe and Asia to help them get a head start on technological innovations, rather than work with US companies.

Second, much of our prosperity since the end of World War II has come from progress in the physical sciences. Innovations in many fields, especially medicine, are made possible by using techniques developed in physics. We have wonderful new opportunities for commercial development of nano-technology, quantum coherence and other recent

discoveries. Yet, it is very difficult to attract young people to study and pursue careers in the physical sciences because these are difficult disciplines and not as financially rewarding as other endeavors. This is becoming an even more serious problem in the post 9/11 world, since it is more difficult for foreign students, who have recently constituted a significant fraction of our enrollment in science programs, to gain access to the US. High Energy Physics has been a **"first attractor"**[ii] of young people to science, especially physics. It offers some of the "big ideas" and "big devices" that fascinate and excite young students. Once their attention is engaged, they study and explore and they often discover other areas of science or technology that they find more appealing. Science as a whole benefits, not just High Energy Physics. Many people on the Fermilab staff came to the US to be part of the program at the world's energy frontier machine, and stayed in the US. Europe and Japan recognize the drawing power of HEP and basic research. We cannot as a nation afford to lose our "first attractors" or to outsource them to Europe and Asia. To do so would put the physical sciences in the US at risk, and reduce our self-reliance in key areas of economic competitiveness, military strength, and security. We need to protect the "first attractors" we have, and develop new ones. The decline of our HEP program and the weakening of Fermilab and SLAC are not sound national strategies for science.

Concluding Remarks

The BTeV collaboration and project hope that the issues we have raised here today will help prevent others from suffering the abrupt cancellation of their initiatives. We have asked DOE to adopt a new view of international competition; we have asked for process improvement in the way projects are advanced; we know that Fermilab, the central HEP laboratory in the US has been damaged, and asked that it be repaired; we have decried our lack of dependability as an international partner and urged that it be fixed so that we can have the opportunity to host world-wide facilities in the future; and finally we have argued against the outsourcing of HEP to Europe and Asia.

Some members of BTeV believe that the termination of BTeV, the end of operations of the B Factory in 2008 and the Tevatron in 2009, and possibly the shut down of the Main Injector program soon after will mark the end of the US as a provider of facilities to carry out this kind of basic research. Some of us are more optimistic and will continue to pursue a better understanding of why we were cancelled and to work towards fixing the problems that we see with the hope of creating a brighter future for US HEP.

Recently, one of our younger colleagues sent an EMAIL to the BTeV collaboration with a quote from a former president, Theodore Roosevelt. We leave it with you as our valedictory.

"It is not the critic who counts, not the man who points out how the strong man stumbled, or where the doer of deeds could have done better. The credit belongs to the man who is actually in the arena; whose face is marred by dust and sweat and blood; who strives valiantly; who errs and comes short again and again; who knows the great enthusiasms,

the great devotions and spends himself in a worthy cause; who at the best, knows in the end the triumph of high achievement, and who, at worst, if he fails, at least fails while daring greatly; so that his place shall never be with those cold and timid souls who know neither victory or defeat."

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[i] From "Under the Radar," How Red Hat Changed the Software Business – and Took Microsoft by Surprise. Robert Young, CEO of Red Hat and Wendy Goldman Rohm. Fermilab's adoption of Red Hat Linux in 1998 appears in the "timeline" of the company's major events. This information was provided by Dr. G. P. Yeh of Fermilab.

[ii] This is similar to the concept of "Portals" often used at meetings on how to recruit new students to science.