BABAR/PEP-II Origins: The Collider

Presentation by Jonathan Dorfan

at the

BaBar 25th Anniversary

December 11, 2018 at SLAC

This talk is dedicated to the memory of colleagues whose contributions to PEP-II were invaluable.

Burt Richter

Bob Bell

Bill Davies White

Mike Zisman

Hobey DeStaebler

John Rees

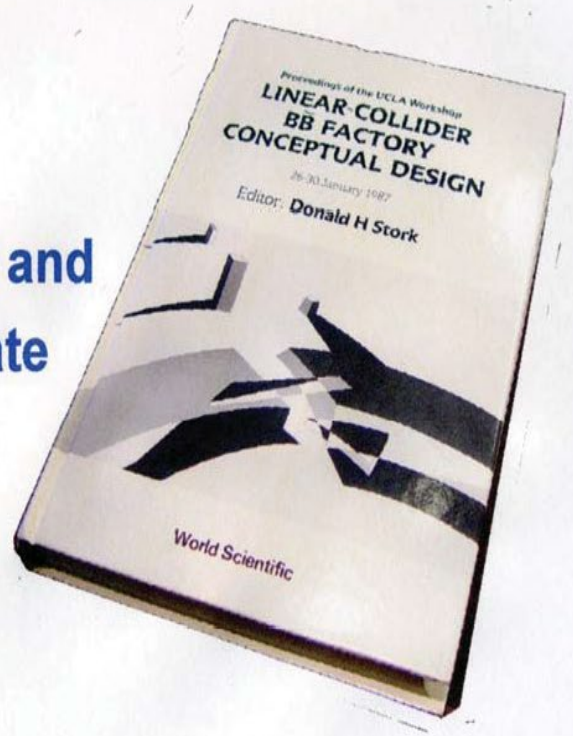
HiLum PEP

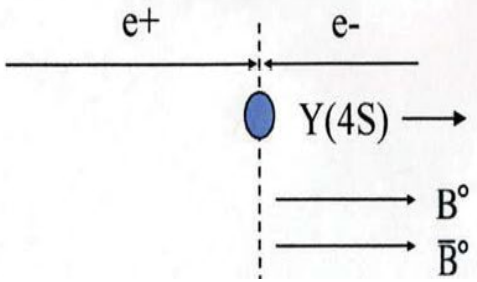
- In the mid 1980s the TPC collaboration at PEP, led by its co-spokesman Elliott Bloom, were pushing SLAC to upgrade PEP in pursuit of high statistics studies of B mesons and τ leptons. The proposal was called *HiLum PEP*
- *HiLum PEP* was not adopted by SLAC
- Burt coined the phrase "Boutique Physics", which was not meant as a compliment
- It took about 8 years to turn Burt into a supporter of "Beauty/CP Physics", but once on board, he was a powerful advocate

	HiLum PEP
circumference(m)	2200
#rings	1
#IR'S	1
n	3
β^*_y	4
$\Delta\nu$	0.07 (@12.5)
Wigglers	no
L_{peak} ($\times 10^{32}$ cm^{-2}sec^{-1})	
@12.5 GeV/beam	1.4
@5.4 GeV Υ(4S)	NA
<L> (pb^{-1}/day)	
@12.5 GeV/beam	4.0
@5.4 GeV Υ(4S)	NA
P_{beam} (MW)	
@12.5 GeV	0.3
@5.4 GeV Υ(4S)	NA
I_{bunch} (ma)	
@12.5 GeV	8.3
@5.4 GeV Υ(4S)	NA
I_{beam} (ma)	
@ 12.5 GeV	24.9
@5.4 GeV Υ(4S)	NA
$B\bar{B}$ pairs/200 days ($\times 10^6$)	
@ 12.5 GeV	0.04
@5.4 GeV Υ(4S)	NA

Things Come Together January 1987

- Discussions with Ikaros Bigi and Tony Sanda
- "Crazy Asymmetric Idea" just what was needed for CP studies
- Could be done by modifying PEP
  - Two rings: give high luminosity
  - Y(4S): gives high cross section and $B^{o}\bar{B}^{o}$ in coherent state
  - Asymmetry: separated vertices give time evolution





Slide Courtesy of Pier Oddone

This led to at least 21 *e+e- B* Factory concepts and proposals (19 $\Upsilon(4S)$ + 2 $Z0$) and several hadronic machine approaches (HERA-B, …

$\Upsilon(4S)$ Storage Rings		$\Upsilon(4S)$ Linac-Ring Collider	$\Upsilon(4S)$ Recirculating Linear Collider	Z Factory
Symmetric	Asymmetric			
PSI (2)	APIARY	Grosse-Wiesmann	Amaldi/Coignet	SLC
Novosibirsk	CITAR	JLAB	ARES	LEP
KEK accumulator	PEP-II		UCLA	
CESR Plus	PETRA		TBA	
	ISR Tunnel			
	KEK accumulator			
	KEK-B			
	CESR-B			

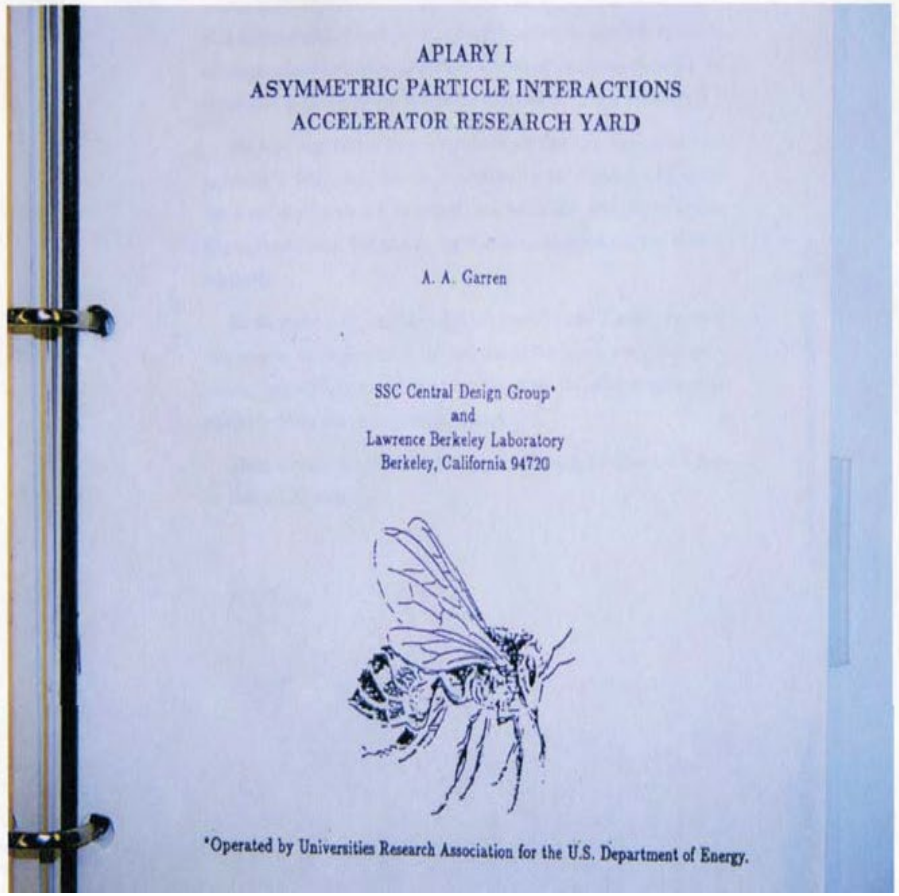
Table Courtesy David Hitlin

Two colliders, PEP-II and KEKB, were ultimately built. Pier Oddone's concept of using an asymmetric *e+e-* collider to boost the distance between the two decay vertices was, in the end, the most successful approach.

Next thrust: Apiaries.....

- **APIARY 1: June 1988**

AL Garren

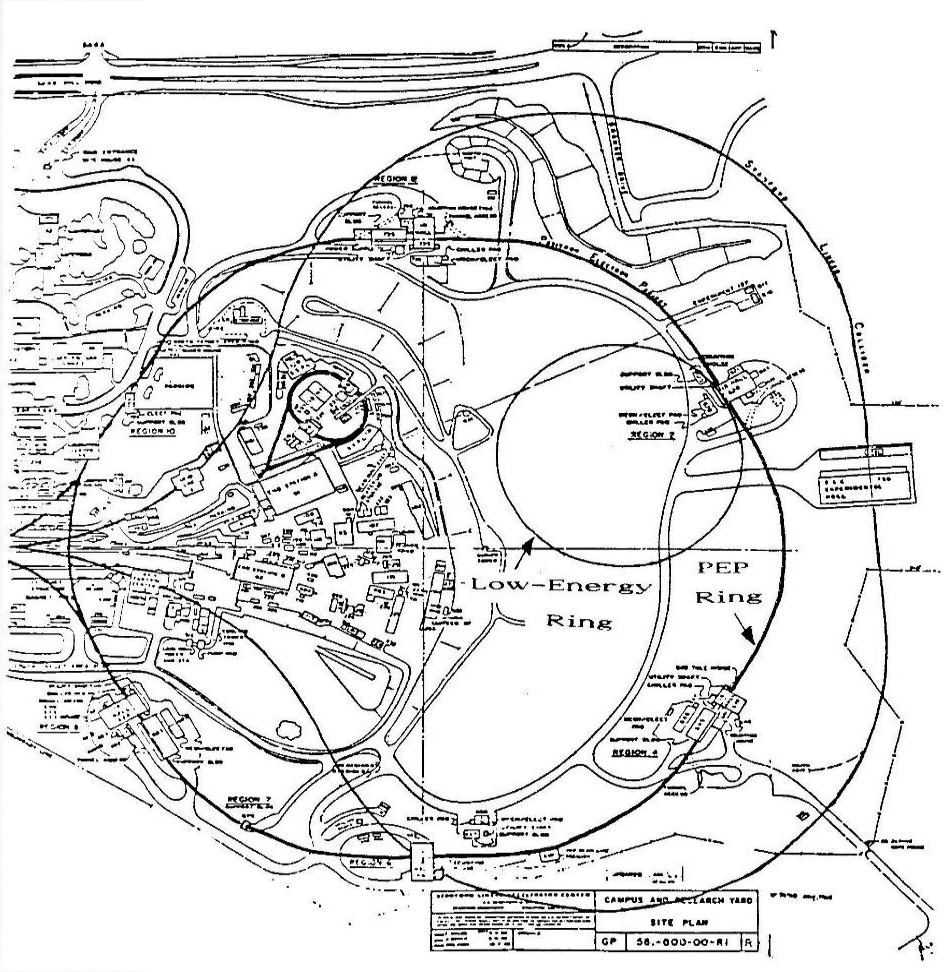


APIARY I
ASYMMETRIC PARTICLE INTERACTIONS
ACCELERATOR RESEARCH YARD

A. A. Garren

SSC Central Design Group*
and
Lawrence Berkeley Laboratory
Berkeley, California 94720

*Operated by Universities Research Association for the U.S. Department of Energy.



Slide Courtesy of Pier Oddone

Workshop in Chateau de Blois, Blois, France: Summer 1989
CP violation and beauty factories and related issues in physics

B-Factories: A Personal Overview

PIER ODDONE

Lawrence Berkeley Laboratory
University of California at Berkeley
Berkeley, California 94720

INTRODUCTION

At the conclusion of this Workshop, three of the participants, Karl Berkelman, Claudio Pellegrini, and I, were asked to give brief, personal overviews of the development of *B*-factories. In the following pages I summarize the reasons for the choice of an assymetric *B*-factory based on storage rings, a facility that I believe will be necessary for the full exploration of CP violation in *B*-meson decays.

Workshop in Chateau de Blois, Blois, France: Summer 1989
CP violation and beauty factories and related issues in physics

Review of Caltech Workshop and Some Parametric Questions for a High-Luminosity Asymmetric *B*-Factory Collider[a]

FRANK C. PORTER[b]

Charles C. Lauritsen Laboratory of High Energy Physics
California Institute of Technology
Pasadena, California 91125

CONCLUSION

The possibility of constructing an $\mathscr{L}_{pk} = 10^{34}$ cm^{-2}s^{-1} asymmetric storage-ring *B*-factory no longer seems so remote as it appeared a year ago. There remain many challenges, but with the mounting enthusiasm in both the accelerator and particle physics communities, and the lure of an outstanding physics program, I am confident that solutions will be found.

How I Got Involved

- In 1989, MarkII completed its running at SLC
- George Trilling encouraged me to join the SDC collaboration – but the lure of $\not{C}P$ was stronger
- There was a need to form an engineering/R&D effort in support of the asymmetric B Factory accelerator studies ongoing in California
- Fortunately, Burt did not take away the MarkII operating budget from me: rather he let me invest it in an engineering-based effort working initially with LBL and Caltech, and soon thereafter adding LLNL, on what ultimately became the PEP-II machine
- In 1990-1993 we made R&D demonstration projects a very strong adjunct to the development of the Conceptual Design

There was a substantial need to "Educate" and "Convince" the SLAC Leadership and the SLAC Community: Colloquium March 1990

B FACTORY

SLAC COLLOQUIUM

MARCH 19, 1990

JONATHAN DORFAN.

Physics Requirements

1. Integrated luminosity of $\geq 30\ fb^{-1}$ / year
   This corresponds to

$$\begin{cases} \mathscr{L}_{peak} = 3\times10^{33}\ cm^{-2}\ sec^{-1} \\ 2\times10^{7}\ \text{seconds} \\ \varepsilon \simeq 50\% \end{cases}$$

2. Two storage rings colliding asymetrically at $\Upsilon(4s)$ with $E_{hi} \geq 8$ GeV
3. Beampipe radius $\leq 3\ cm$
4. Detector well instrumented for
   $-0.95 \leq \cos\theta_{cm} \leq 0.9$
   This corresponds to restricting the machine components to $\theta_{lab} \leq 300$ mrad in forward direction

The Three-Lab collaboration was formally established in 1991 with an Advisory Group Reporting to the 3 Lab Directors.

SLAC MEMORANDUM

May 29, 1992

TO: Distribution

FROM: Jonathan Dorfan

TOPIC: B Factroy Advisory Group

The B Factory Advisory Group continues to be a very valuable forum for guiding the machine and detector development for PEP-II. The group met recently and agreed to maintain its bi-monthly meetings, which are held every other friday in the Yellow room at SLAC at 2:30pm. Two members have left the group – Andrew Hutton and John Rees. We welcome as a new member David MacFarlane from Mc Gill. His first meeting was last week – the speaker-phone arrangement seems satisfactory. The present membership is attached.

Distribution:

Burton Richter, Director SLAC

Charles Shank, Director LBL

John Nuckolls, Director LLNL

B Factory Advisory Group

Members of the B Factory Advisory Group in May 1992:

Bloom, Dorfan, Chattophadyay, Barletta, Bell, Hitlin, Leith, Oddone, Porter, MacFarlane, Witherell and Zisman

Progress Towards a Conceptual Design

- Conceptual design history
  - — design started in earnest in December 1989
    - o coordinated by A. Hutton at SLAC and MZ at LBL
  - — goal was to produce a conceptual design for asymmetric B factory in PEP tunnel
    - o $\mathscr{L} = 3 \times 10^{33}$ cm^{-2} s^{-1}
    - o 9 GeV x 3.1 GeV
  - — goal was reached after 1-year design study
    - o held (self-inflicted) internal reviews on key design aspects
      - – lattice, IR, vacuum system, RF and feedback
      - – international experts validated our key design concepts
    - o message here is that we have tried to be complete and careful in our design work

      ...or maybe we're masochists
    - o continue to rely on reviews of R&D activities
      - – suggests the second explanation is correct
  - — CDR completed in February 1991
    - o DOE review of project in March 1991
      - – the last "Temple" review
    - o review report was very favorable

      "The B Factory team has presented a credible design, and it is the judgment of this Committee that there is a high probability of attaining the physics goals."

Chairs were: Willeke, Eichler, Grobner, Boussard

- THE REVIEW PANEL DEEMED THE PROJECT:
  - ☐ TECHNICALLY FEASIBLE AS DESIGNED
  - ☐ ENDORSED THE COST ESTIMATE AND CALLED FOR MODEST (3%) INCREASE IN CONTINGENCY
  - ☐ ENDORSED THE SCHEDULE
  - ☐ WAS COMPLIMENTARY REGARDING QUALITY OF ENGINEERING SOLUTIONS
  - ☐ ENDORSED THE PROPOSED MANAGEMENT PLAN
  - ☐ ENDORSED THE TECHNICAL STRENGTH WHICH THE THREE-LAB APPROACH BRINGS TO THIS CHALLENGING PROJECT

Slides taken from Mike Zisman's talk to Witherell Subpanel

1990-1994:
Garnering Community and Government Support and Approval

APRIL 90, SCIULLI SUBPANEL REPORT:

" The Subpanel strongly endorses the physics aims of a B Factory and recommends a vigorous research and development effort leading to a proposal to build such a facility"

HEPAP MEETING JUNE 4,5 1991:

Letter of transmittal, July 3,1991, to Dr. James Decker:

" The major item of discussion at this HEPAP meeting revolved around the question of e+e- B Factories and their ability to resolve the question of CP violation. ....

.....The Panel is convinced that understanding the origin of CP violation is one of the central goals of particle physics. Moreover it is our opinion that this important question can be addressed in much more breadth by the e+e- machines than by hadron colliders.....Thus we reaffirm strongly the importance of the physics goals of B factories.

In summary,.....The one major new development, a much greater confidence in the technical feasibility of the B Factories, leads us to urge the funding agencies to try to find a way to begin construction of such a facility in the near future...."

1992 Witherell HEPAP Subpanel

- Witherell Subpanel met at SLAC on February 21-22, 1992 having just been at SSC
- The afternoon before the Subpanel arrived, I became aware of discussions amongst some of the Subpanel members:
  - SSC was short about $120M a year of operating funds: closing down SLAC was the most expedient way to solve the problem
- I found Burt and warned him that unless he could put up a credible, <u>near-term</u> scientific scenario – namely to offer up a sizeable chunk of the Lab. to allow the B Factory to go ahead ASAP - SLAC was extremely vulnerable to closure

Summary

Witherell Subpanel of HEPAP

February 22, 1992

Burton Richter
Director
Stanford Linear Accelerator Center

We have presented to you today:

- ❑ A vision of the long term.
- ❑ A program for 1993–1997 within a constrained budget (constant purchasing power model).
  - Opportunities for HEP experiments with SLC as appropriate, new fixed-target opportunities, support for users working elsewhere.
  - An accelerator improvement project to turn PEP into a B-Factory for CP studies.
  - An aggressive program of linear collider R&D, including linac experiments and technology development coordinated with the rest of the world.

Long-term Vision

Main elements of HEP program in 2005:

- ❑ The U.S. high energy physics program includes a significant electron component as well as the SSC.
- ❑ The NLC is under construction and soon to turn on. SLAC is heavily involved in machine construction and detector development wherever the facility is located.
- ❑ PEP II has produced 100-200 fb^{-1} and CP violation is becoming much better understood.

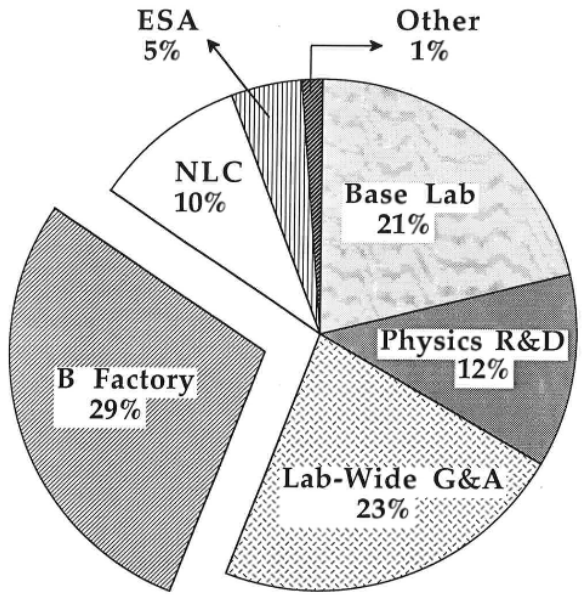
B-Factory Program

- It is a very important missing element in the standard model.
- It is a difficult machine.
- $\mathcal{L} \geq 3 \times 10^{33}$ is required to do CP.
- e^+e^- is needed to do the full problem.

Can be done within constraint of constant purchasing power SLAC budget. Requires refocusing of the laboratory and sharing people between operations and maintenance and B project.

We have been working on this in the U.S. for many years. There is a large U.S. (and foreign) user interest. We should do it.

SLAC BUDGET
FY199X



We would like **you** to endorse:

- The vision for the 2000's.
- The physics research program of 1993-1997.
- The NLC R&D program.
- The B-Factory as an accelerator improvement project to start as soon as possible.

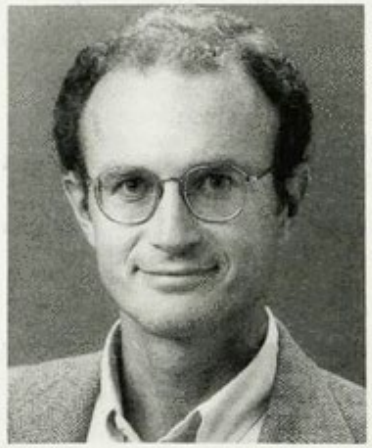
A DOE PANEL THINKS THE UNTHINKABLE: BUDGET SQUEEZE COULD ELIMINATE SLAC

The good times may have stopped rolling for high-energy physics. Not only is the Superconducting Super Collider in grave trouble politically and financially, but the US high-energy community itself is brandishing signs that there may be one or two labs too many for these hard times.

Since its first meeting in 1967, the High Energy Physics Advisory Panel has always recommended building larger new facilities for particle physics and has seldom proposed shutting any. But in an era when the Department of Energy's physics budgets are almost certain to be flat or worse for the next few years, the agency's leaders and some particle physicists have decided that they just cannot afford everything on HEPAP's wish list. This was exactly what Energy Secretary James D. Watkins said bluntly last fall to the HEPAP task force led by Charles H. Townes of the University of California at Berkeley. In the course of his statements to the Townes group, Watkins posed an unnerving question: If DOE funding for the high-energy physics program for fiscal 1993 had to be chopped savagely, by as much as 10% before inflation, what should happen? The answer from the task force was unexpectedly brutal: Should push come to shove, the SSC continues to be the highest priority and should be completed in 1999, no matter what the cost or pain to the rest of the community. Second to the SSC, the Townes group recommended upgrading Fermilab's Tevatron.

In 1990, a HEPAP subpanel headed by Frank Sciulli of Columbia University "strongly" endorsed building an electron-positron "B factory" with asymmetric rings, for which SLAC and Cornell have issued competing plans. The Sciulli subpanel ranked the project third on its priority list after the SSC and the Tevatron main-injector upgrade (PHYSICS TODAY, December 1990, page 20). One year later, confronted by DOE demands to fit the high-energy physics program to a sharply pared-down research budget, the Townes subpanel reluctantly concluded that neither the $204 million Tevatron upgrade nor the $184 million B factory at SLAC should proceed (PHYSICS TODAY, December 1991, page 53). In addition, the Townes subpanel found that the worst-case scenario would most likely reduce the 1993 operating budgets for Fermilab by 9%, Brookhaven by 13%, and SLAC, Argonne, Brookhaven and Lawrence Berkeley by some 12% if the SSC is to go forward with flat funding. Under this budget model, even university research would suffer reductions of about 6%.

Accompanying a copy of the Townes report to DOE officials last November was a letter from HEPAP Chairman Stanley Wojcicki, of Stanford University, addressed to William Happer, the department's director of energy research. Wojcicki's letter appeared uncommonly bitter: "It is no exaggeration to say that the recently concluded HEPAP meeting . . . was by far the most depressing one in my memory. Being asked to respond to such drastic budgetary cuts gave us all a feeling that we were being asked to advise DOE on how to implement the demise of high-energy physics research in the US. The budget reduction will undoubtedly cause severe and long-lasting damage to the compelling and balanced program of research investigations in particle physics under way now. Moreover, this new apparent policy seems to us to be especially unwise because the nation is simultaneously investing heavily in . . . the SSC. We are very concerned that reductions in the breadth and personnel of the high-energy physics base program at this time will inevitably undermine our ability to exploit [the SSC] when it turns on in eight years. . . . It makes very little scientific or economic sense to maim the existing high-energy physics program and even less sense to do so at a time when everything should be done to ensure the smooth transition of the present activities to the SSC era. . . . We are distressed because, if the contemplated scenario does indeed occur, then many exciting physics opportunities will have to be postponed, significantly reduced or, most often, simply thrown away."



Witherell: Advising in hard times.

Among the "grave consequences" likely to follow the proposed Draconian actions, Wojcicki foresaw "no way to 'balance the budget' without turning off, phasing out or seriously curtailing" high-energy physics conducted at US universities. "We are concerned that we may not be able to live up to the current expectations for our future participation in international collaborations," he asserted. Equally painful, Wojcicki lamented, would be the effect on "perhaps hundreds of people [who] will have to be laid off at the national labs [and on] graduate students, postdocs and assistant professors [who] will be forced out of the field. Senior faculty will have to decide whether they can responsibly encourage young people to join the field. Young people will find it hard to commit to a field which has difficulty

Physics Today:July 1992

ly estimated annual budget of the SSC Laboratory"—or about $307 million in fiscal 1991 dollars. But when the subpanel looked at the number of experimentalists entering the field, it was modestly optimistic. It projected increases of about 2% per year, from 1993 through 1997, stimulated by the "much expanded opportunities offered by the SSC."

Indeed, the subpanel claimed the second or third scenarios, showing small budget increases, would be just scarcely enough to maintain the vitality and diversity of the field. Using the second scenario, which the subpanel considered the most likely to happen, the Witherell group argued for funding the Fermilab upgrade for operation early in fiscal 1997 and for constructing the B factory in the existing PEP tunnel at SLAC for completion in 1996. Building a B factory would mean cutting back SLAC's experimental program, including research on Z particles. While DOE has not indicated whether SLAC will be allowed to go ahead, the subpanel found that if DOE obtained an additional $20 million for high-

physics would be done, and the field would be poorly positioned for the next decade."

If worst comes to worst, the future of the field is grim. In the lowest-budget scenario, concludes the Witherell report, accelerator operations at two laboratories, SLAC and Brookhaven, would stop over a period of two years, the number of particle physicists would shrink, and gains in understanding the fundamental laws of nature would slow considerably.

The subpanel rejected a proposal by the University of California at Los Angeles to build a 1-GeV e^+e^- accelerator producing phi mesons, mainly because such a machine is already being built in Italy. It also turned down proposals by Los Alamos, Lawrence Livermore and Oak Ridge to establish new high-energy physics groups, all to be supported by DOE. The reason the subpanel gave for scotching these plans was the current financial pressures on the program. "We recognize the scientific and technical talents available at these laboratories," it said with faint praise.

"This blueprint for the future of

consequences because I know my lab will be next on the hit list."

Melvin Schwartz, associate director at Brookhaven, was dejected. "What the Witherell subpanel is telling us is that there will be few if any discoveries from 1995 to the end of the century," said Schwartz. "I hope they're wrong with their prediction. If they're right, it will be a sad time for particle physics."

Energy Department officials have said that if the SSC budget is approved by Congress for fiscal 1993, fully half of the budget for high-energy physics will be devoted to research at the lab in Texas. To be sure, the SSC's funding projections have raised some hackles. Even particle physicists are complaining that the two large detector experiments at the SSC would have annual budgets greater than most of the national laboratories'. Richter has observed that a burgeoning cadre of younger high-energy physicists are "turned off" by the impersonal style and bureaucratic operation of large-scale experiments involving several hundred researchers and that they

Witherell Subpanel Recommendation

In the middle and upper budget scenarios, the subpanel recommended "construction of an asymmetric B-factory in the existing PEP tunnel at SLAC.. . ," commenting that 'The origin of CP violation is one of the most fundamental questions in high energy physics today.'

Stanford-Cornell Shootout

- 1994 Bush outgoing budget proposal included $36M for a DOE B Factory. The Clinton 1994 budget proposal similarly included $36M for DOE to commence construction at SLAC
- Senate Finance Chair Daniel Moynihan (D,NY) had the SLAC designation removed from the Senate Bill and convinced OMB Director Panetta to compel an impartial review of the two competing proposals: PEP-II and CESR-B
- In May 93, DOE and NSF convened a 12-person, one month review under the Chairmanship of Stanley Kowalski of MIT Bates Lab. The review did not rank the projects and concluded that either project was capable of achieving the desired luminosity

Stanford-Cornell Shootout

- President Clinton announced in SF on October 4, 1993: “Today, Energy Secretary Hazel O'Leary and my science advisor, Jack Gibbons, have given me their recommendations for the B-factory. After much study and serious comparisons of all proposals, the recommendation is that the B-factory go to the Stanford Linear Accelerator Center (SLAC)."
- "I have selected Stanford because the Department of Energy has a much higher margin of confidence in the ability of the Stanford proposal to meet the project’s extremely high performance requirements, as well as to meet its proposed cost and schedule,“ said Secretary O’Leary
- Cornell University President Frank Rhodes reacted sharply to the decision and called upon the Department of Energy to release the review panel's report. Rhodes said in a press release that Cornell was "hard pressed to understand how in these difficult fiscal times the federal government can justify awarding the project to a facility where it will cost $100 million more to accomplish the same scientific objectives than it would if built here at Cornell."

Stanford-Cornell Shootout

- Pier Oddone: "I am delighted that Secretary O'Leary has decided to put the B-factory in the Bay Area. I want to thank her, the President, the Department of Energy, the National Science Foundation, and the many colleagues who worked together during the review of the two proposals to provide a technically sound basis for this decision. …. I would also like to salute our colleagues at Cornell University. They have a great laboratory and have given us some very tough competition. We hope that they will join us in building and using this exciting new accelerator."
- I am purported to have said: "The government has done the wise thing. SLAC is the premier electron lab in the world; a continued investment in this lab makes real sense. ……. I'll celebrate when we have the check in hand. President Clinton's announcement is a tremendous step, but we must be patient. When we get approval from the Senate and the House, then I'll drink my champagne. But for now, it's on ice."

SLAC's Response

The Interaction Point

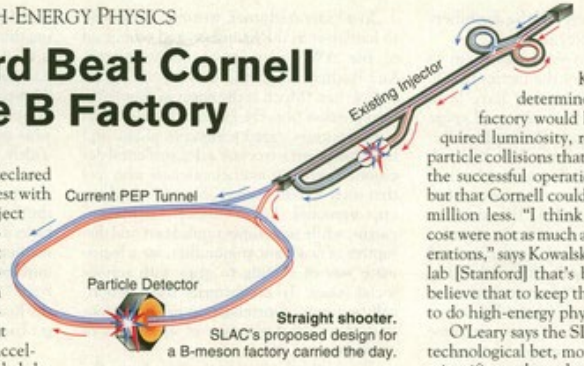
Events and Happenings in the SLAC Community
October 1993, Vol. 4, No. 10

SLAC WINS *B*-FACTORY COMPETITION

Science, Vol. 262, 15 October 1993

HIGH-ENERGY PHYSICS

How Stanford Beat Cornell And Won the B Factory



Straight shooter. SLAC's proposed design for a B-meson factory carried the day.

Last week President Clinton declared Stanford the winner in a 4-year contest with Cornell to build a physics megaproject known as a B factory. The competition was hot and heavy: Physicists at both institutions had banked the futures of their labs on this $200 million project to explore fundamental questions about the origins of matter. But the choice of the Stanford Linear Accelerator Laboratory (SLAC) hasn't ended the debate. Instead, Cornell officials and others in the physics community are sputtering about the reasons the Administration gave for rejecting their bid, and others are suggesting that economics and politics played a central role in the decision.

The argument centers in part on the report of an independent scientific review of the two proposals, which concluded this summer that both were technically feasible but Cornell's would cost about half as much as SLAC's. Department of Energy (DOE) Secretary Hazel O'Leary, who made the decision, disputed Cornell's cost advantage and, in a written statement issued with Clinton's announcement, said DOE had more confidence in SLAC's design. O'Leary acknowledged, however, that one additional factor weighing in SLAC's favor is that the B factory is critical to the lab's future—a point made clear in an April 1992 memo from the lab's director, Burton Richter, to his staff, warning that "substantial layoffs" would result from even a 2-year delay in construction. And the economic impact of the choice was underscored by the fact that Clinton announced it during a trip to San Francisco that emphasized his desire to rejuvenate the region's sagging economy.

Given the size of the project, it's no surprise if politics played a role in the outcome. Indeed, political forces have been brought to bear on behalf of both camps during the long history of this project. The idea of this type of accelerator—called a B factory because it is supposed to generate large numbers of particles known as B mesons—arose in the mid-1980s as a way for physicists to solve a scientific puzzle about the balance between matter and antimatter in the universe. In theory, all particles of matter have their nemesis—perfect equals but opposites called antiparticles. When these counterparts chance to meet they annihilate one another. Physicists believe that B particles and anti-B particles will show a sort of skew in their perfect opposition—a fundamental asymmetry known in the jargon as "charge-parity violation"—and it is this property that may have allowed the primordial Big Bang to produce more matter than antimatter.

Scientists at both Cornell and Stanford proposed converting existing accelerators into B factories, and set to work to find the money. Cornell appealed to the National Science Foundation, its present source of funding, and Stanford turned to DOE, which owns SLAC. Although the science was exciting, both agencies decided that there wasn't room in their budgets for a new accelerator, and in January 1992 officials jointly agreed to postpone indefinitely a decision on building a B factory.

Neither lab was willing to let the matter drop, however, and by the fall of 1992 SLAC had persuaded the Bush Administration to put $36 million for construction into DOE's 1994 budget request, which was sent to Congress in January 1993. William Happer, then director of DOE's Office of Energy Research and now a professor of physics at Princeton University, says that the California congressional delegation had lobbied hard for its inclusion. After Bush left office, the delegation took the matter up with the Clinton Administration, and convinced the Office of Management and Budget (OMB) to make a similar request. Buried on page 1223 of the appendix to Clinton's budget, submitted to Congress in April, is a request for $36 million for a B factory at SLAC.

At that point, Cornell's elected representatives got into the act. Finance committee chairman Senator Daniel Moynihan (D–NY)—a key figure in securing passage of Clinton's economic program—persuaded OMB Director Leon Panetta that an impartial review of both proposals was needed. In May, Happer and William Harris, associate NSF director for mathematics and physical sciences, named a 12-member panel headed by MIT physicist Stanley Kowalski, and told it to conduct a 1-month technical review but not to rank either proposal. The panel's report was submitted in August (*Science*, 27 August, p. 1111). Kowalski says his panel determined that either lab's B factory would have achieved the required luminosity, referring to the rate of particle collisions that is the crucial factor in the successful operation of the accelerator, but that Cornell could have done it for $100 million less. "I think technical things and cost were not as much a driver as other considerations," says Kowalski. "They [DOE] have a lab [Stanford] that's been important. They believe that to keep the lab viable they have to do high-energy physics projects," he says.

O'Leary says the SLAC design was a safer technological bet, more likely to achieve its scientific goals under budget and on time. She also noted that Stanford, which will collaborate with Lawrence Livermore and Lawrence Berkeley labs, could draw upon a larger pool of engineers. But O'Leary took issue with the panel's financial conclusions: "[T]he department questions cost estimates in the Cornell proposal…the Cornell budget is considerably understated…the remaining cost difference between these proposals does not become a driving factor for the department's decision."

Cornell's disappointed lab director, Karl Berkelman, says O'Leary's statement "is based on a biased reading" of the Kowalski panel. He points to a statement in the report that, "Although the CESR-B [Cornell's design] represents an innovative approach, it will reach the desired physics goals and is cost-effective, well engineered, and buildable." The report contains similar praise of SLAC's design but refers to it as "conservative" rather than innovative.

Richter says his lab won the competition on its merits. He insists that a careful reading of the 100-page report favors his lab by pointing out a greater number of technical risks associated with Cornell. "I have always been confident that any objective and fair peer-review process would come up with the SLAC/LBL/Livermore project," he says.

Now that they have won the competition for the B factory, Richter and his SLAC colleagues face another formidable challenger in a different race. Across the Pacific, Japan's Ministry of Education has requested money to begin building a similar B factory at Japan's KEK lab. Approval of the U.S. project should spur the Japanese effort, says physicist Aki Maki of the Japan Society for the Promotion of Science. Japan's facility is intended to come on line by 1998, the same year as SLAC's accelerator. "We don't want to be too far behind the U.S. project," Maki says. "If we are not too far behind we will have a chance to find charge-parity violation before the United States."

–Faye Flam

FYI
SCIENCE POLICY NEWS FROM AIP
Bulletin

Department of Energy's Reasoning on B-Factory Selection

Publication date: 14 October 1993 Number: 137

As reported in FYI #136, the Department of Energy has decided to construct the B-factory at the Stanford Linear Accelerator Center. This decision implements an April 1992 recommendation of the High Energy Physics Advisory Panel to construct a B-factory, and follows a joint DOE and National Science Foundation study of competing SLAC and Cornell University proposals.

Competition for this facility was keen, but judging from the six page statement by Secretary Hazel O'Leary entitled, "Selection of the Preferred Site for the B-Factory," the decision was not as close as some expected it might be. Last April, Office of Management and Budget Director Leon Panetta requested that DOE and NSF perform a technical review of the two proposals. The committee, chaired by Stanley Kowalski of MIT, evaluated, but did not rank, the two proposals. That ranking, and the final decision, was left to O'Leary.

In her October 4 statement, O'Leary cited three "risk factors" bearing on her selection: schedule risk, performance risk, and cost risk. In each of the three areas, O'Leary's statement clearly favored the SLAC proposal. This proposal, which involves a collaboration with Lawrence Berkeley Laboratory and Lawrence Livermore National Laboratory, was favored in the area of schedule risk, O'Leary said, because, "The SLAC proposal represents an extremely powerful combination of scientific and engineering talent which resides among three Department of Energy laboratories." O'Leary expressed concern about Cornell's ability to complete the project on time, her report stating, "...the Cornell proposal does not have an adequate safety margin for remaining on its planned schedule."

O'Leary's assessment of the comparative performance risk of the two proposals followed along this same track. After describing the "very stringent" performance requirements for the B-factory, she said that "the smaller tunnel at Cornell forces a technically riskier design," which "will generate an unprecedented level of synchrotron radiation," as well as requiring a never-attempted collision scheme.

DOE's analysis of cost risk also favored SLAC. Although Cornell's proposed budget was considerably smaller, DOE warned of schedule slippage on the order of six months to a year, "with an associated cost risk of $10 million to $20 million." O'Leary said that Cornell's cost contingency for unexpected problems was too low.

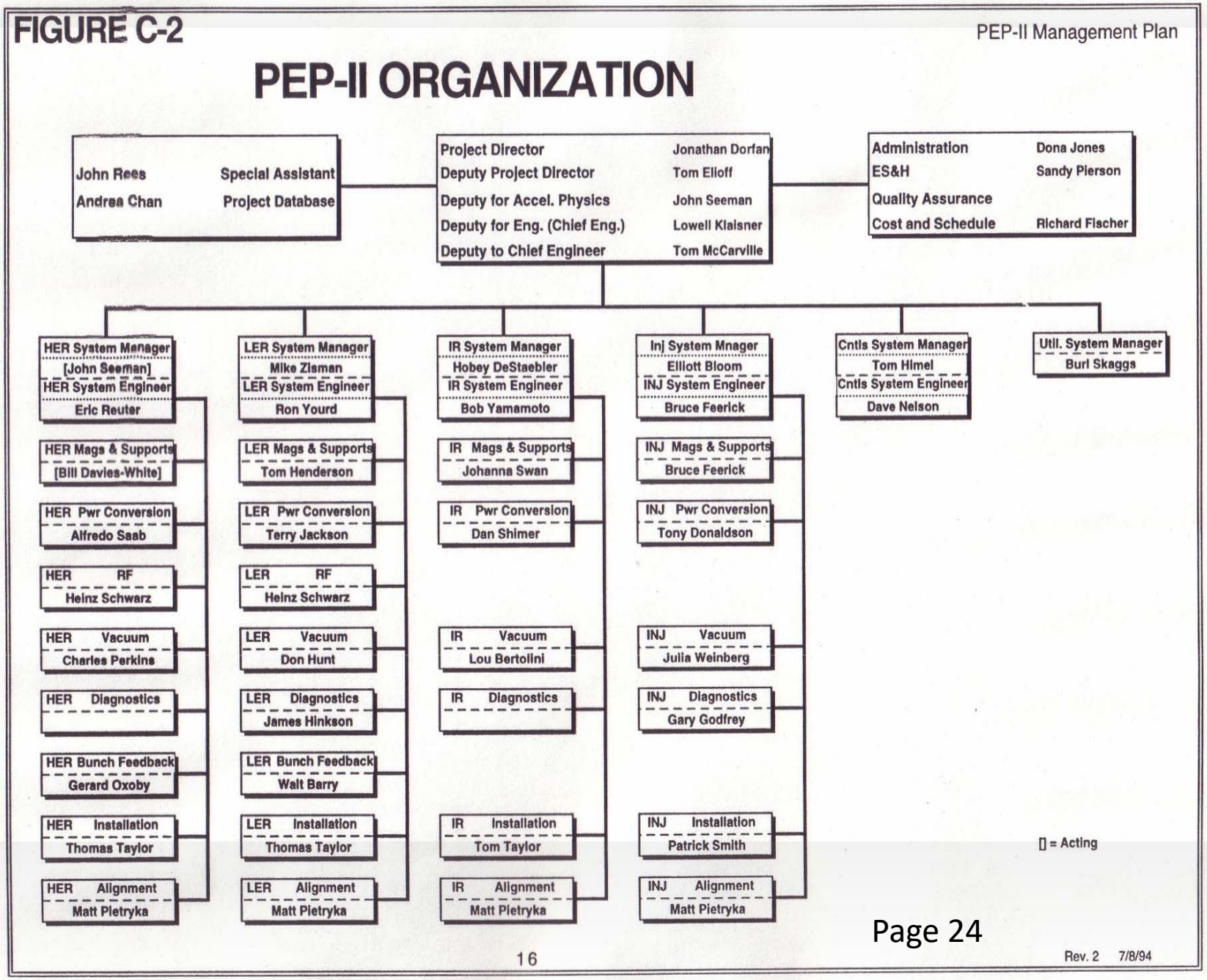
Other the heading of "Other Factors," DOE found that SLAC "is well prepared to handle the approximately 300 physicists expected to utilize the B-factory." Finally, the statement noted, "The unique work force which resides at SLAC has been established over a period of 30 years and represents a national repository of expertise that cannot be easily replicated. However, in a fashion unlike that of Cornell's Laboratory of Nuclear Studies, the fate of SLAC and its personnel will be strongly impacted by this decision."

Construction of the $170 million B-factory (plus an additional $60 million for a new particle detector) will begin this fall, with its completion scheduled by late 1998.

AIP | American Institute of Physics

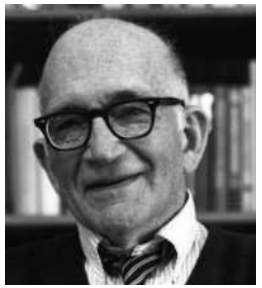
October 14, 1993

* **Three lab team: : SLAC, LBL, LLNL**



1994







STANFORD LINEAR
ACCELERATOR CENTER
OPERATED BY STANFORD UNIVERSITY FOR THE
DEPARTMENT OF ENERGY


SLAC/LBL/LLNL
SLAC-Based B Factory:
PEP-II and BABAR

BERKELEY LAB

Lawrence Livermore
National Laboratory

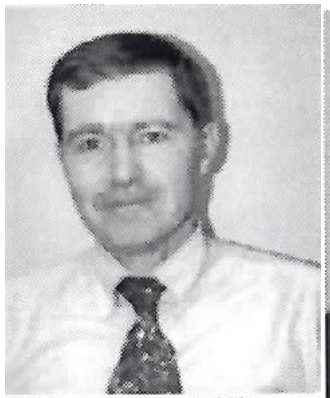
The Sponsor : DOE

John O'Fallen: The believer

Danny Lehman: Uber "Auditor"

On-Site Oversight Office

Reilly, Kevin



Franzwa, Bill

Treacy, David

The Funders : Congress

PEP-II Central Management

Special Assistant

Safety

Data Management

Administration

Whatever Needed To Be Done

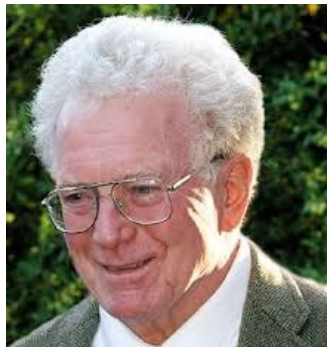
PEP-II Construction “System Managers”

High Energy Ring

Low Energy Ring

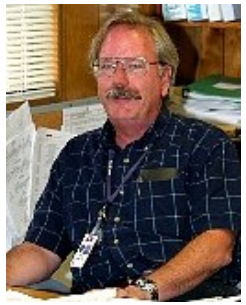
Injection

Controls



Backgrounds,
Interaction Region

RF



Utilities

Installation

LER Magnets and Aluminum Vacuum System (LBNL,SLAC)

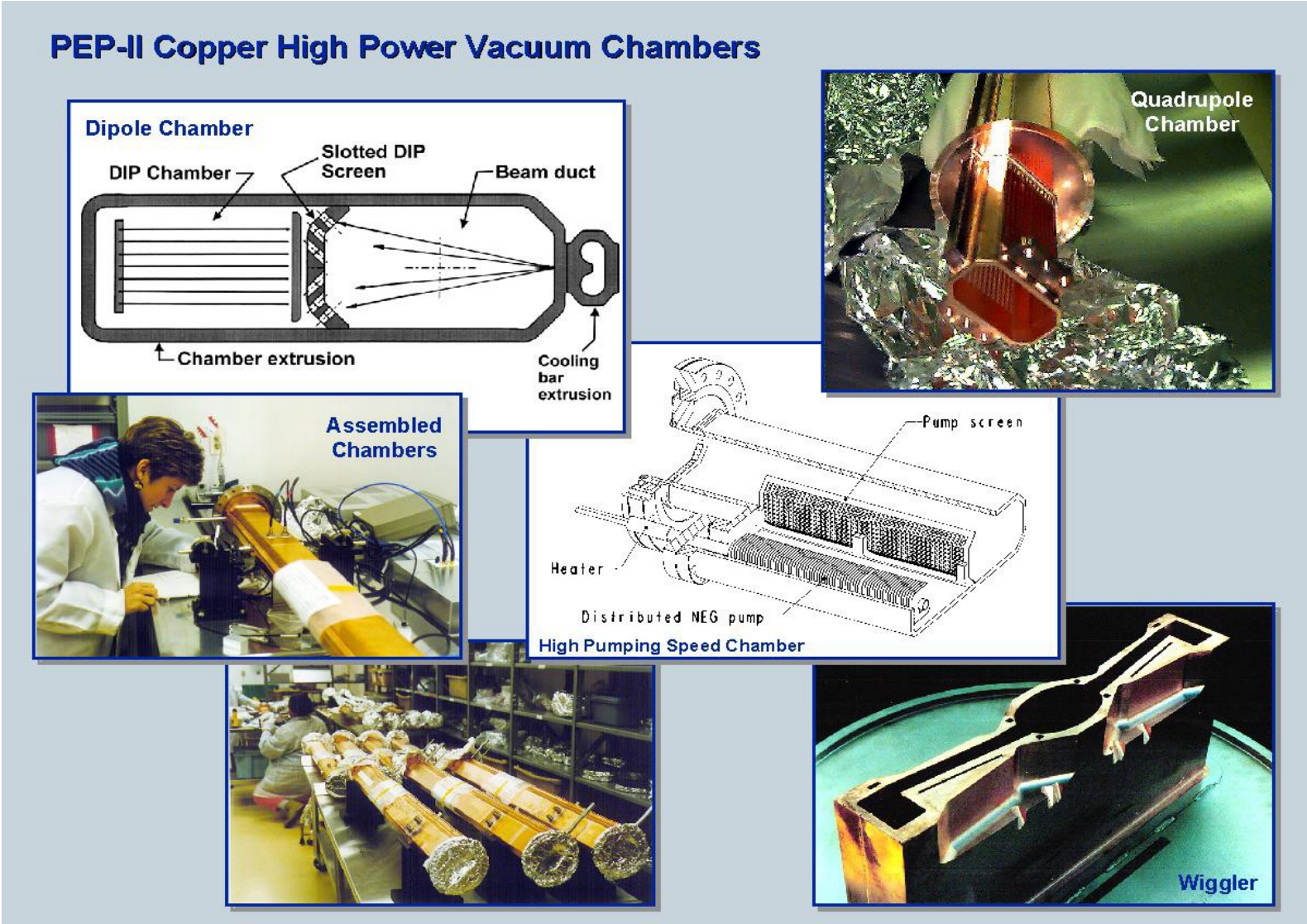
Magnets made by our Chinese IHEP collaborators

Antechambers Reduce Electron-Cloud-Instability

High power photon stops

LER SR power = 2 MW.

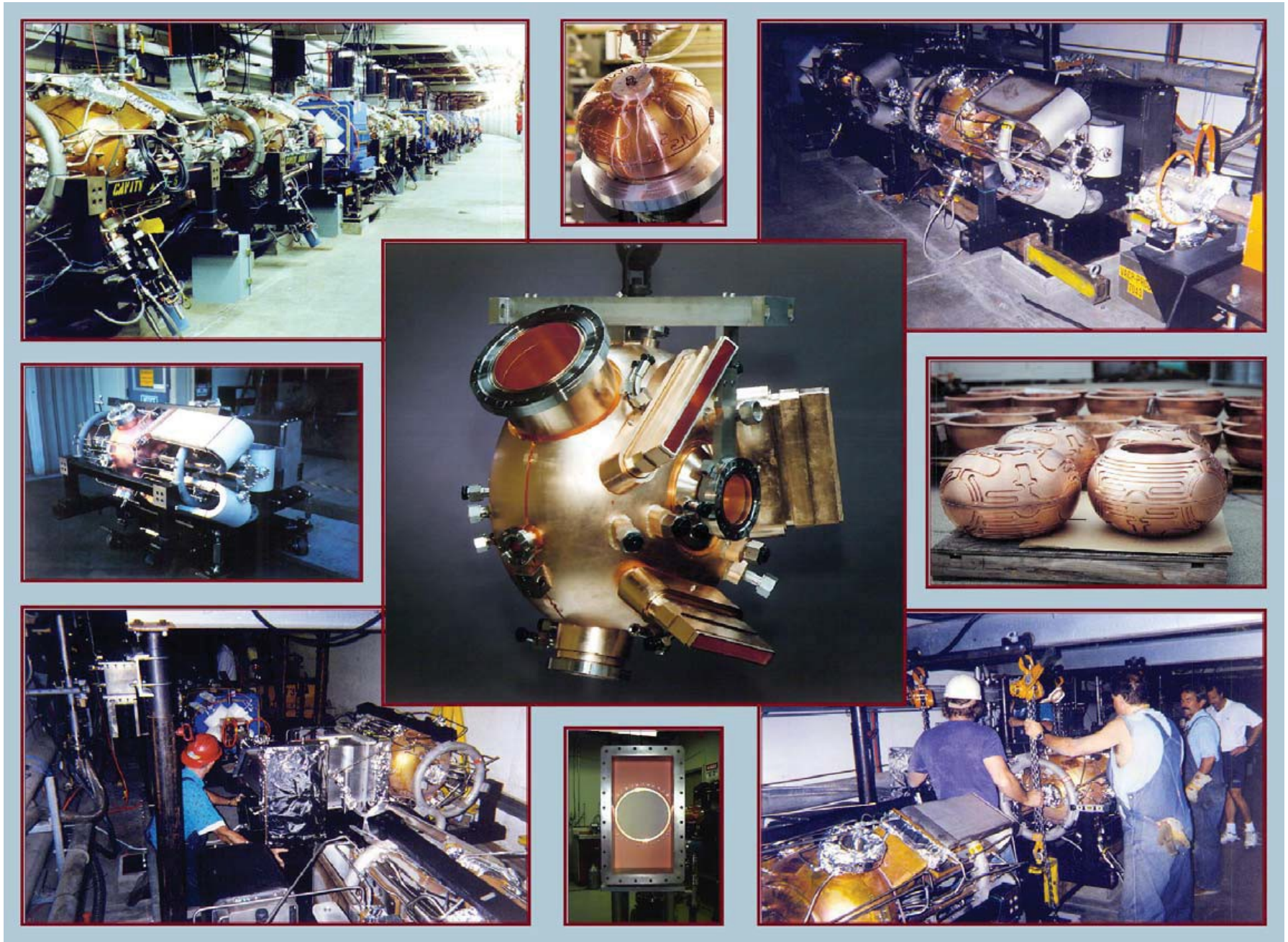
PEP-II Copper Vacuum System (SLAC)



Cu chambers absorbing 100 W/cm of synchrotron radiation

Total SR power = 5 MW in the HER

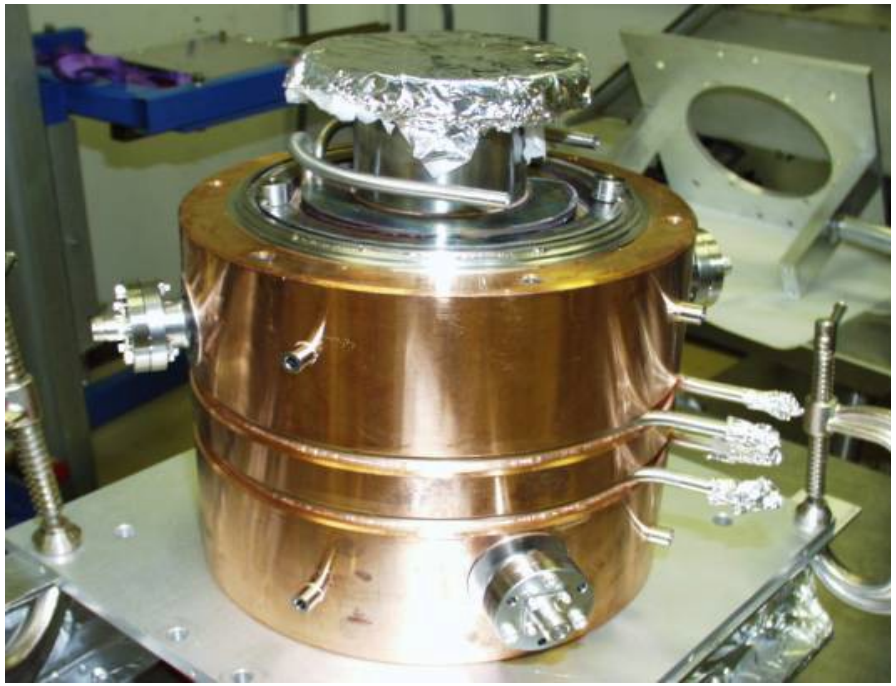
PEP-II RF Cavaties (LBNL,LLNL)



Bunch-by-Bunch feedback kickers
(LBNL/SLAC)

Transverse

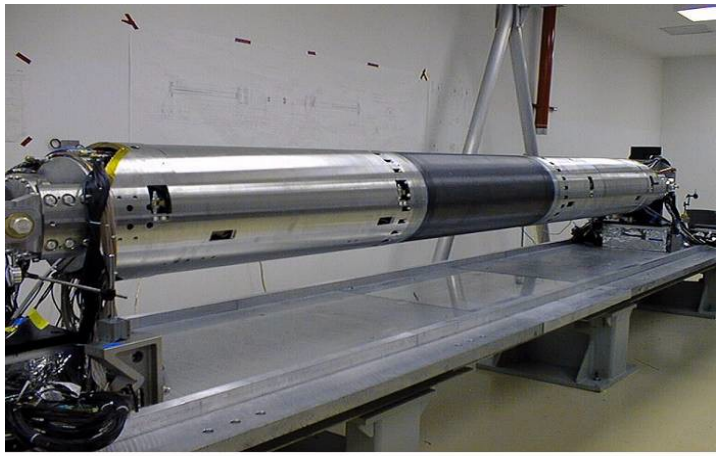
Longitudinal



Interaction Region Magnets, Vacuum in Support Tube (SLAC)

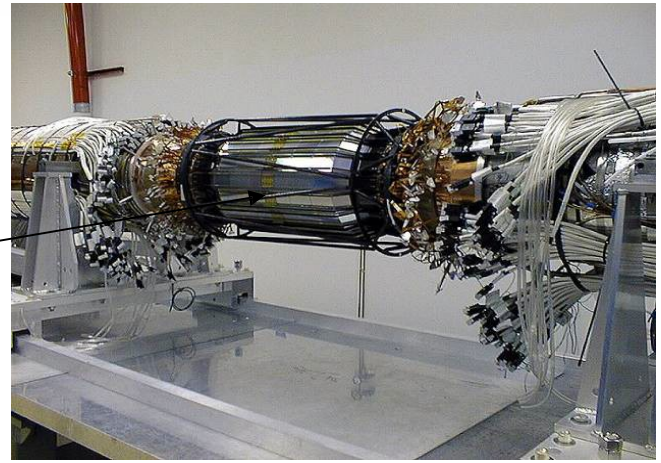
MS_108 05/27/98

Be chamber

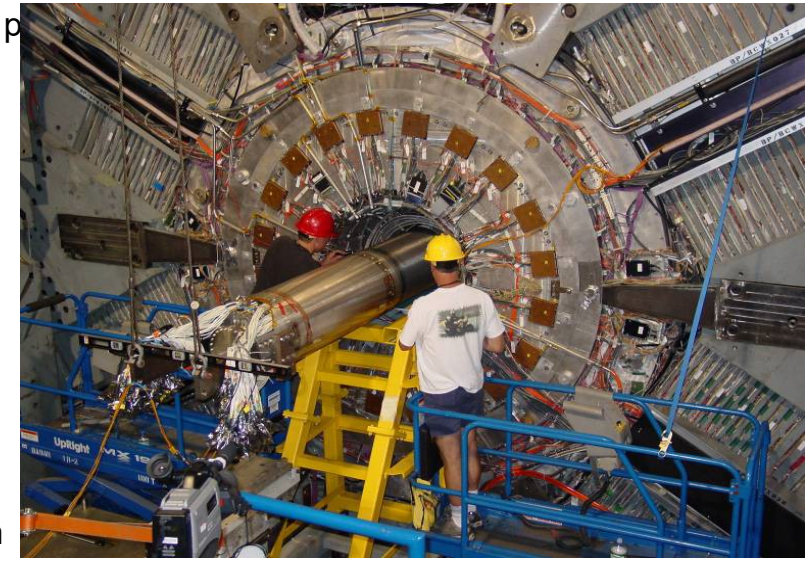


MS_140 Support Tube ready for Installation 06/08/98

Silicon
Vertex
Tracker
SVT

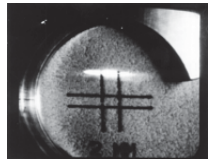
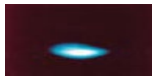


p

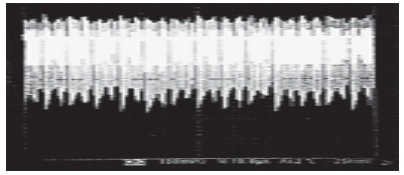


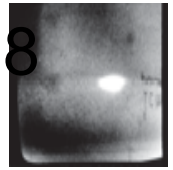
m

Strategy of *Staged Completion and testing* of the major subcomponents with real beam

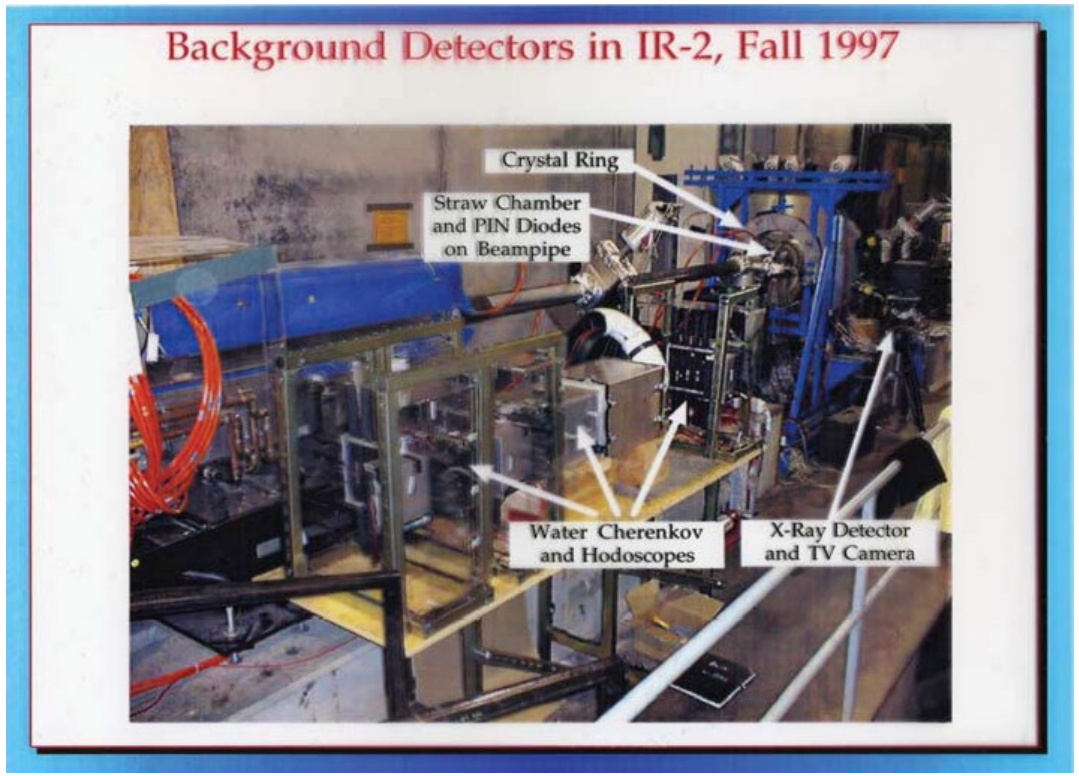
e^- (e^+) at end of New Injection Lines: Oct ’95 (97)  

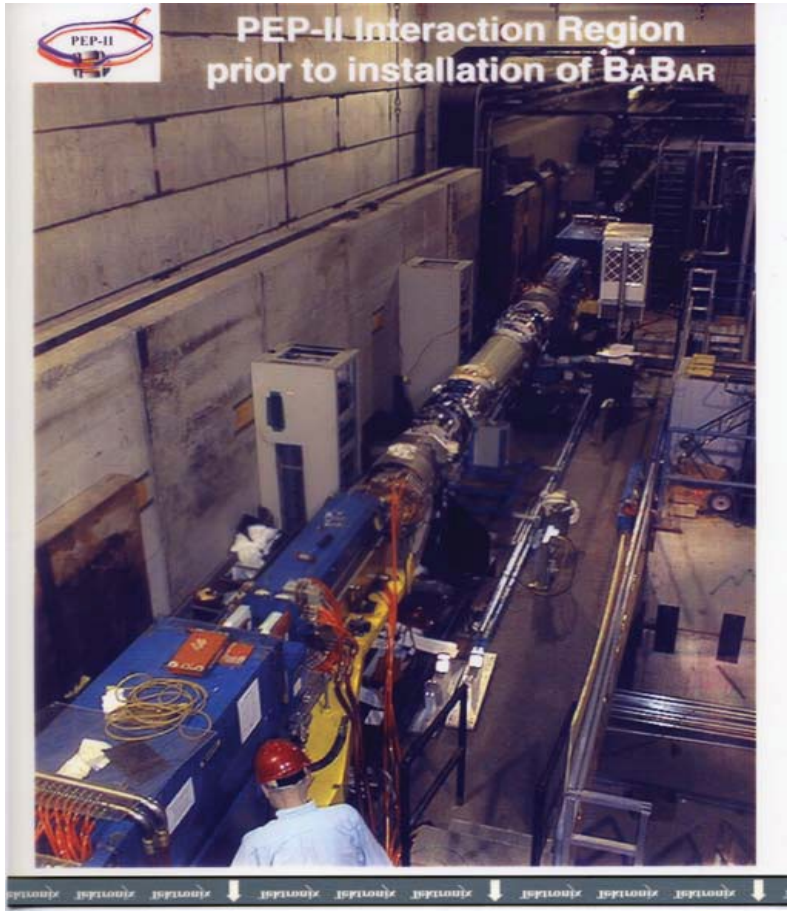
e- beam through 1/3 of HER : May ‘97 

Stored e- beam in High Energy Ring: June ‘97 

e+ beam to Low Energy Ring Arc 7 Temp. Dump: Jan 98 

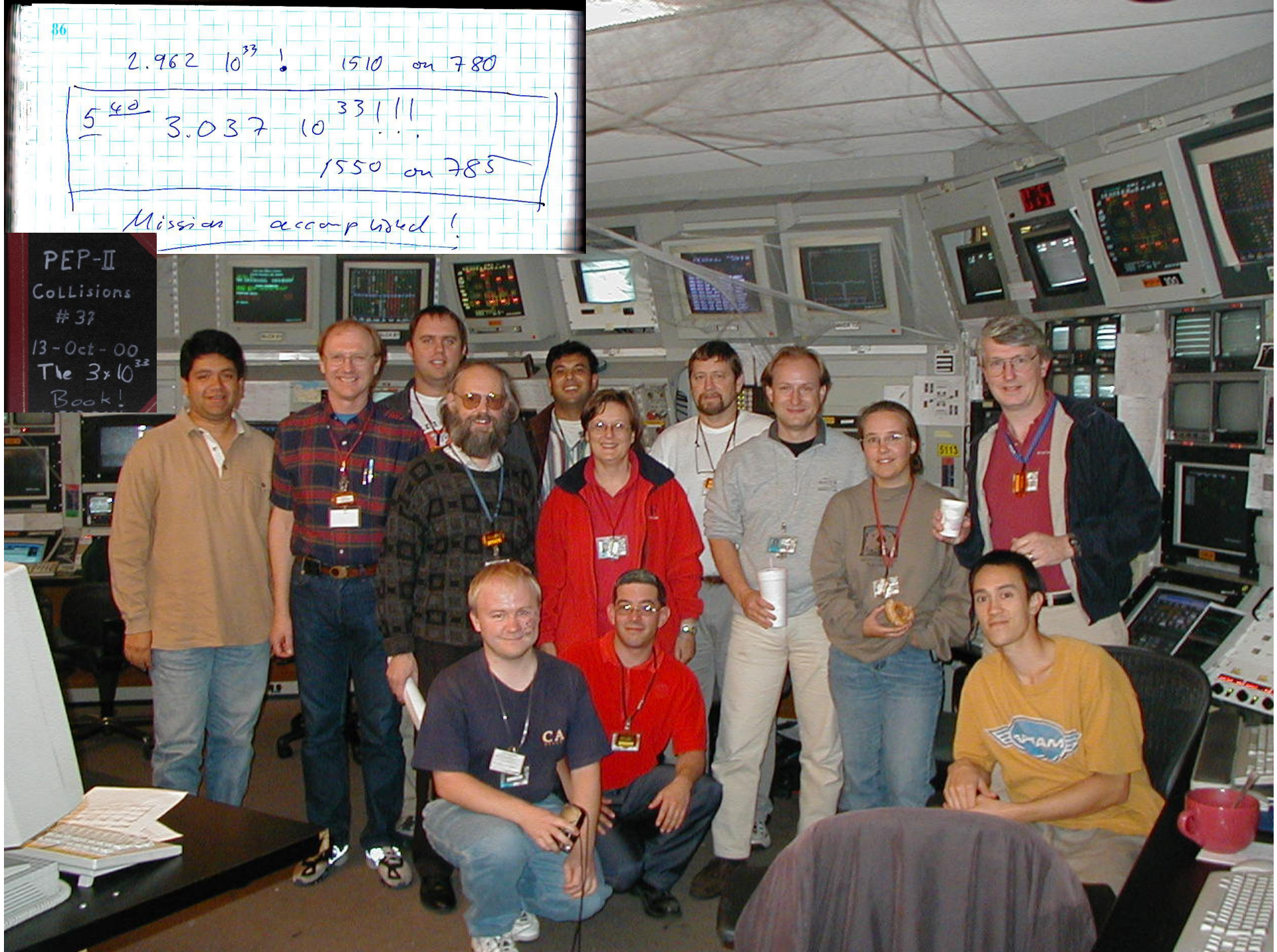
Measure/Characterize the backgrounds before Babar moved on line





Background Detectors and Groups

Detector	Purpose	Groups
Solid State X-Ray Spectrometer	Synchrotron radiation spectrum	Colorado State U. + LBL
Silicon Diode Stacks	SR, lost-particle rate near beam pipe	Stanford U.
Straw Chamber (from Crystal Ball)	Lost-particles in tracking chamber	SLAC, Tennesee, Ecole Polytechnique
Scanning Crystal Ring	MeV photons from lost-particle showers	LAPP (Annecy) + Saclay (France)
Water Cherenkov + Scintillator Hodoscope	BaBar DIRC backgrounds	U. Cincinnati + LBL
Mini Time Projection Chamber	High-granularity tracking chamber near beam pipe	Orsay (France) +LBL + U. Cincinnati
Silicon Strip Detector (BaBar prototype)	SR, lost particles next to beam pipe	UCSD+UCSC+UCSB + LBL + INFN + ...
Calorimeter Module (BaBar prototype)	Energetic photons, tracks (>100 MeV)	SLAC

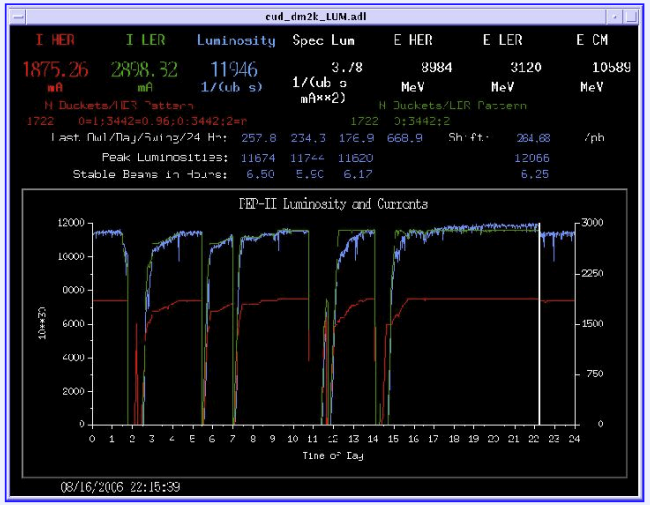

86
2.962 10^33 ! 1510 on 780
5^40 3.037 10^33 !!!
1550 on 785
Mission accomplished !
PEP-II
Collisions
37
13-Oct-00
The 3x10^33
Book!

$1.2 \times 10^{34}/cm^2/s$!!

PEP e-Logbook 16. August 2006

2006-08-16 22:17 Yocky, Decker, Boyes, Milanovich **Luminosity crosses the 12 barrier: 12.066E33**

Tweakmasters: Boyes, Yocky, Decker.
Witnesses: Milanovich, Otts, Sanzone, Sullivan, Fisher, Krauter, Gierman.
Pizza courtesy of Sullivan's coupon.
Currents: 2900 on 1875.

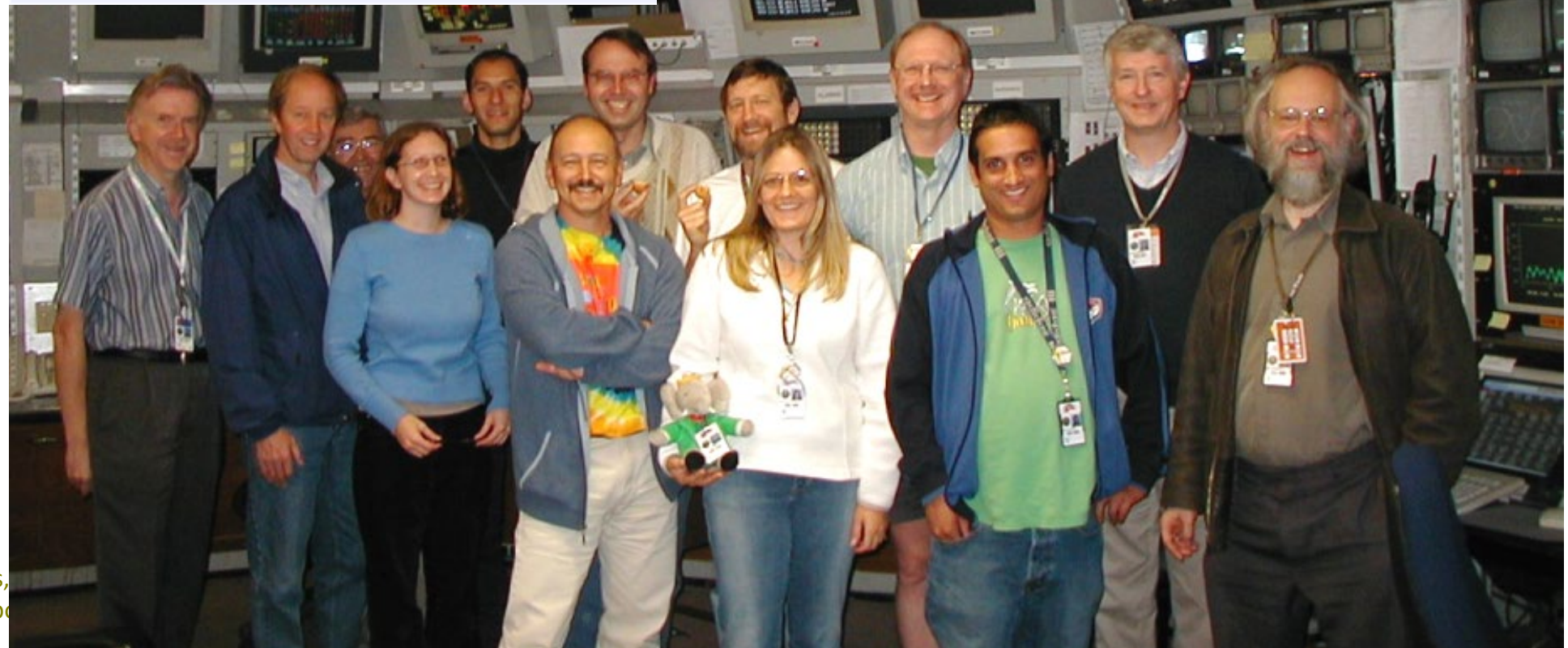


1875 mA/HER

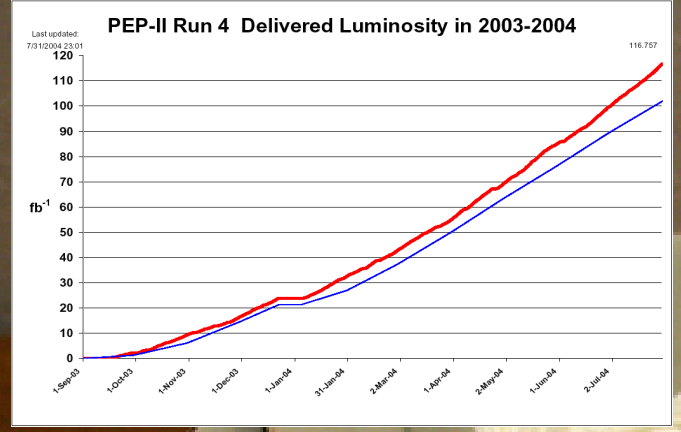
2900 mA/LER

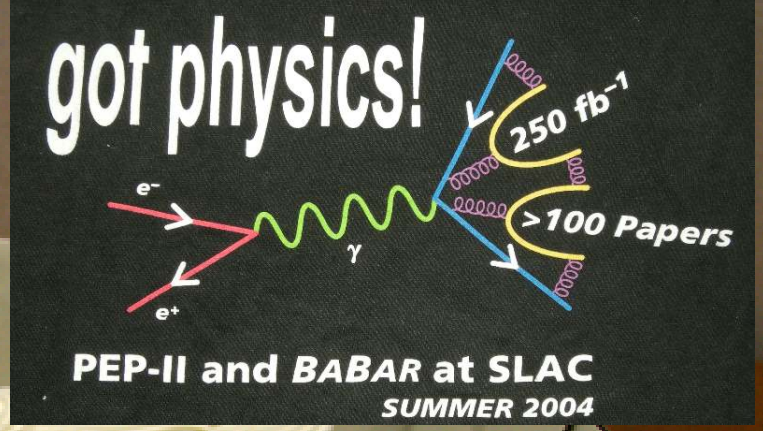
1722 bunches

≈154/fb



U. Wienands,
B-Fact. Sympo





Mega - Congratulations!

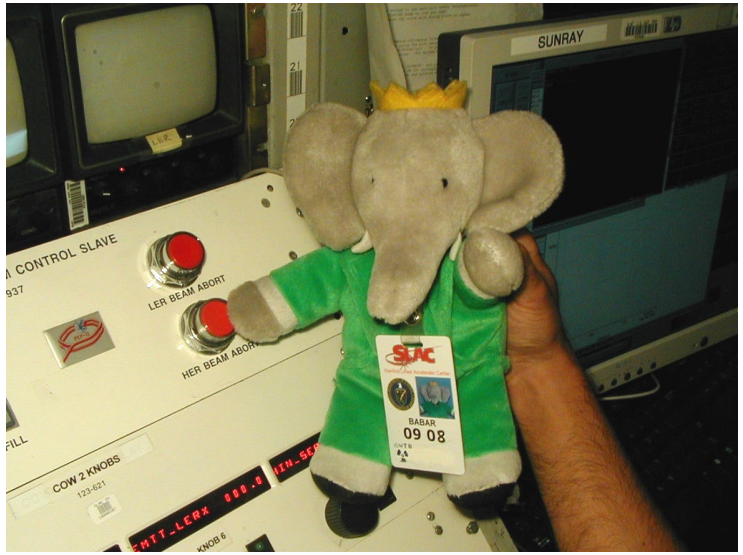
100 fb-1 for Run 4

And they said it couldn't be done?

PEP-II Team April 2008

*

PEP-II Turned Off April 7 2008



PEP-II Final Parameters

Parameter	Units	Design	Overall best
I+	mA	2140	3213
I-	mA	750	2069
Number bunches		1658	1732
β_y^*	mm	15-20	9-10
Bunch length	mm	15	10-12
ξ_y	tune shift	0.03	0.05-0.065
Luminosity	$x10^{33}$	3	12
Int lumi / day	pb^{-1}	130	911

4 times design

7 times design

PEP-II Records

Last update:
April 8, 2008

Peak Luminosity

12.069×10^{33} $cm^{-2}sec^{-1}$ **August 16, 2006**

1722 bunches 2900 mA LER 1875 mA HER

Integration records of delivered luminosity

Best shift (8 hrs, 0:00, 08:00, 16:00)	339.0 pb^{-1}	Aug 16, 2006
Best 3 shifts in a row	910.7 pb^{-1}	Jul 2-3, 2006
Best day	858.4 pb^{-1}	Aug 19, 2007
Best 7 days (0:00 to 24:00)	5.411 fb^{-1}	Aug 14-Aug 20, 2007
Best week (Sun 0:00 to Sat 24:00)	5.137 fb^{-1}	Aug 12-Aug 18, 2007
Peak HER current	2069 mA	Feb 29, 2008
Peak LER current	3213 mA	Apr 7, 2008
Best 30 days	19.776 fb^{-1}	Aug 5 – Sep 3, 2007
Best month	19.732 fb^{-1}	August 2007

Total delivered 557 fb^{-1}

PEP-II turned off April 7, 2008