# BaBar Collaboration

Robert J. Wilson

LBNE Symposium

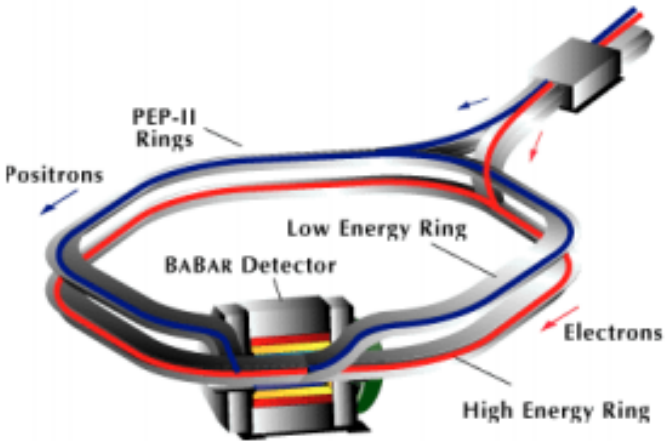
Fermilab, Oct. 3rd 2012

# Caveats

- The collaboration formed nearly 20 years ago!
- I left the collaboration in 2006…after a mere 13 years
  - to pursue neutrino CPV/PDK/SNB
- The following is garnered from
  - Documents on the public BaBar web site
  - Documents and notes from when I was collaboration council (Vice-) Chair 1994-1998
  - Recollections…possibly faulty
- David MacFarlane – a founding collaboration member from Canada, now SLAC Director of Particle Physics and Astrophysics

# PEP-II Asymmetric B Factory

First collisions: 1998
Final collisions: April 2008
Collide 9.0 GeV electrons with
3.1 GeV positrons for Y(4S)



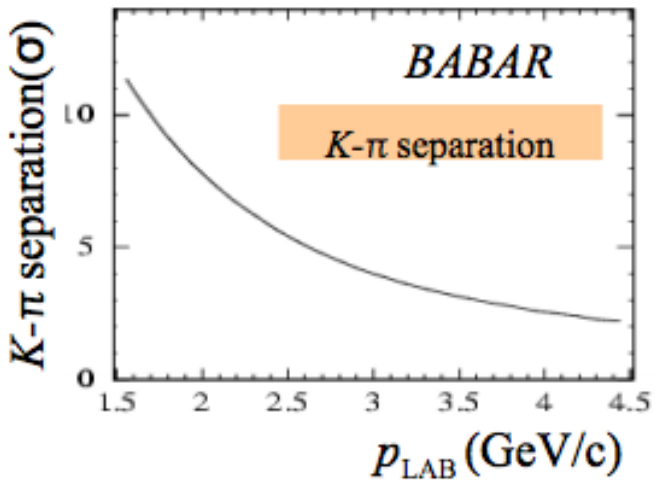

CM Energy = 10.58 GeV
Design luminosity $3.0 \times 10^{33}$ $cm^{-2}$ $s^{-1}$
Record luminosity $12.07 \times 10^{33}$ $cm^{-2}$ $s^{-1}$

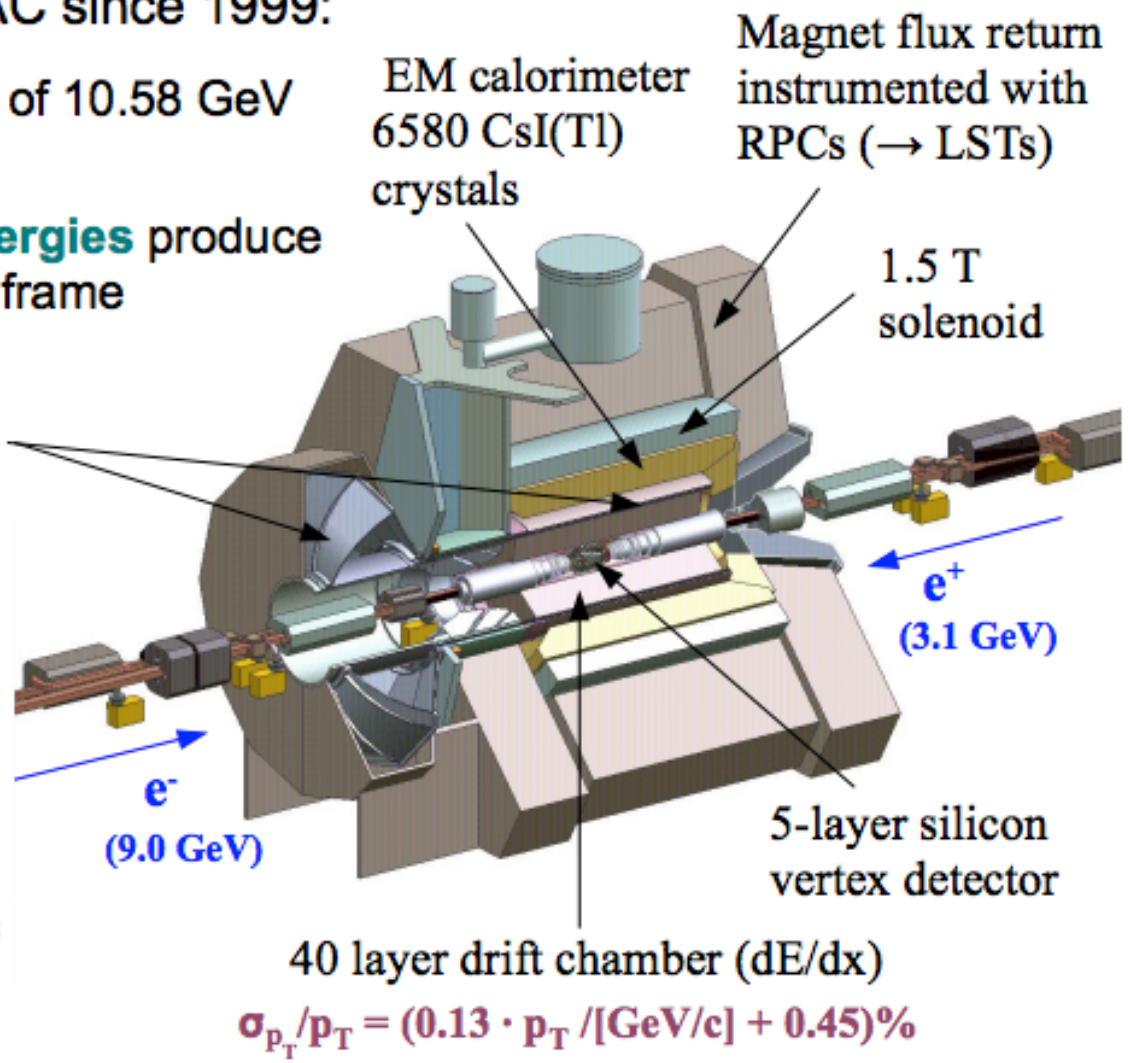
| | |
|---|---|
| Number of bunches: | 1720 |
| Beam current: | (HER) 1.875 A<br>(LER) 2.9 A |

# The *BABAR* detector

B factory operations at SLAC since 1999:

- Centre of mass energy of 10.58 GeV for $\Upsilon(4S) \rightarrow B\bar{B}$
- **Asymmetric beam energies** produce boost of $\beta\gamma=0.56$ in lab frame

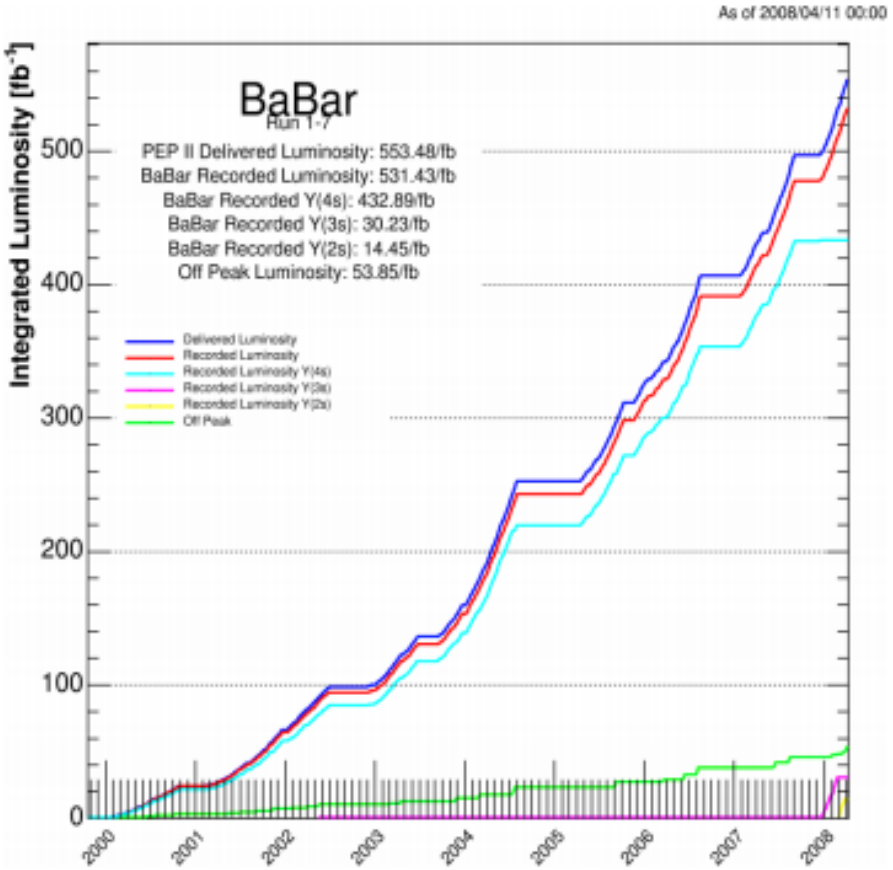


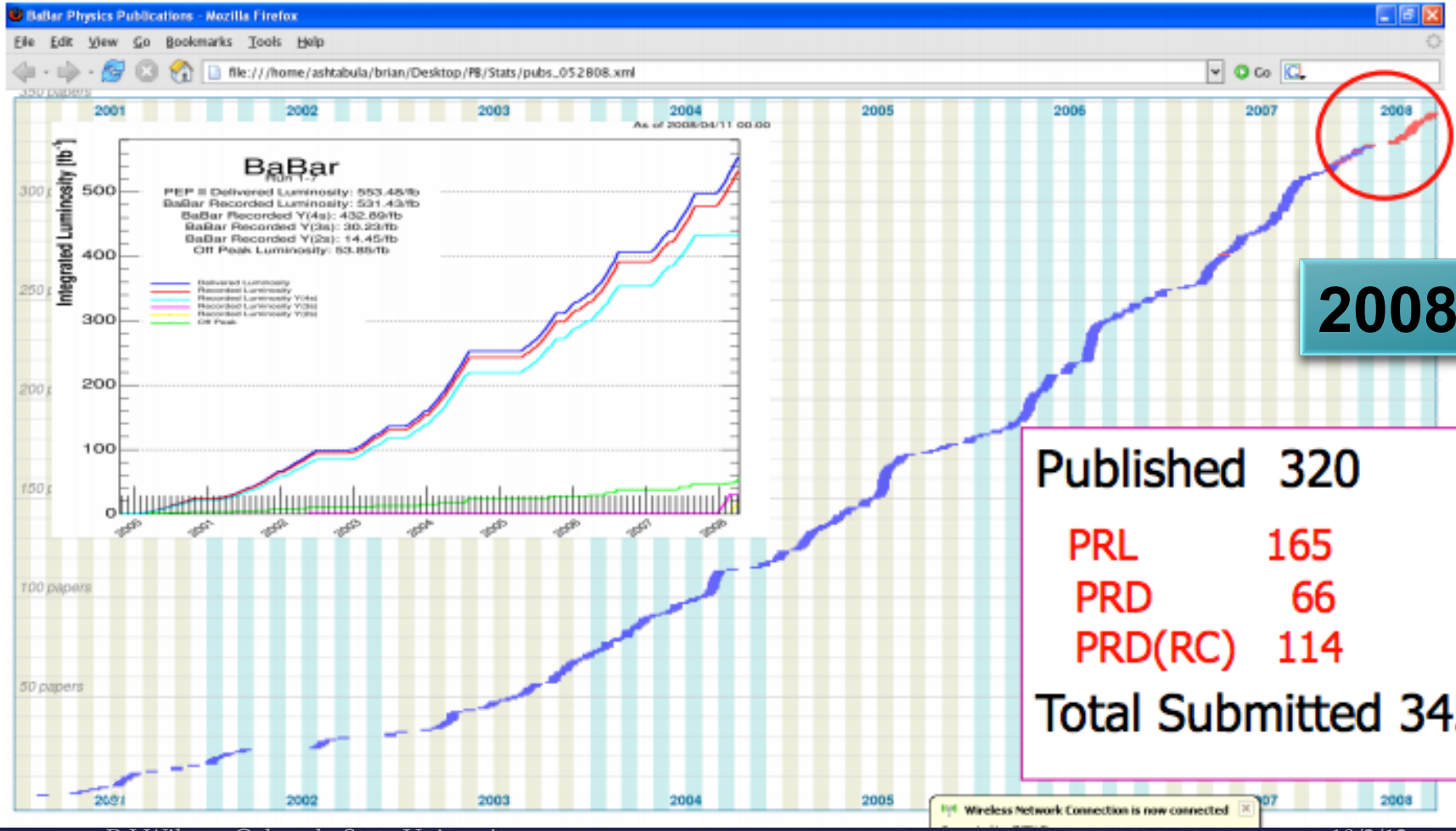

$\sigma_{p_T}/p_T = (0.13 \cdot p_T\,/[\mathrm{GeV/c}] + 0.45)\%$

# BABAR/PEP-II Operations

- Final BABAR Υ(4S) "onpeak" data sample corresponding to an integrated luminosity of 430 $fb^{-1}$ ~$0.5x10^9$ BB pairs
  - substantial samples of continuum tau and charm
  - also ~45$fb^{-1}$ of Υ "narrow resonance" data (surprise!)...
-

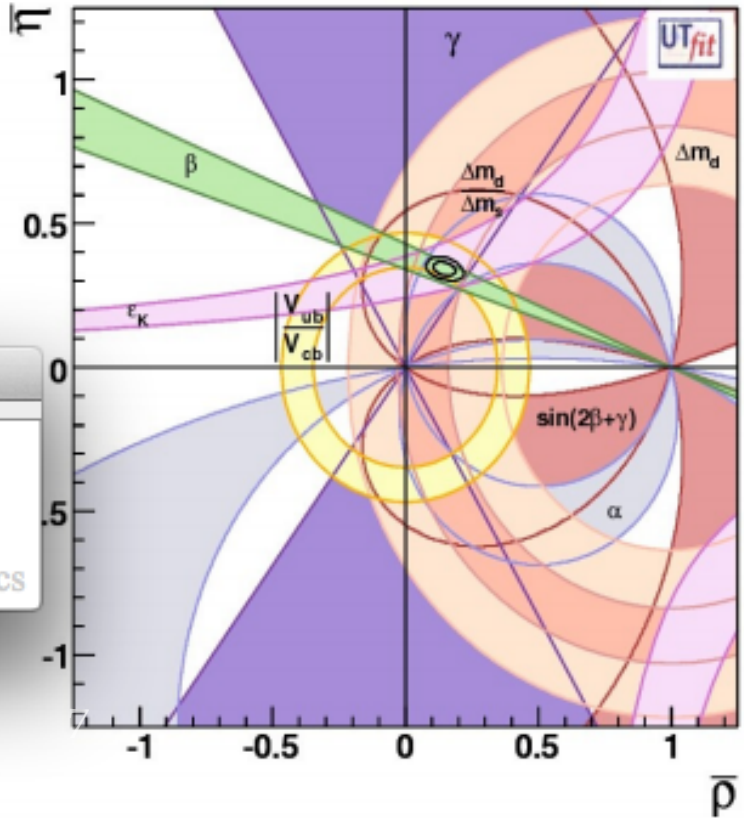


# Publication statistics

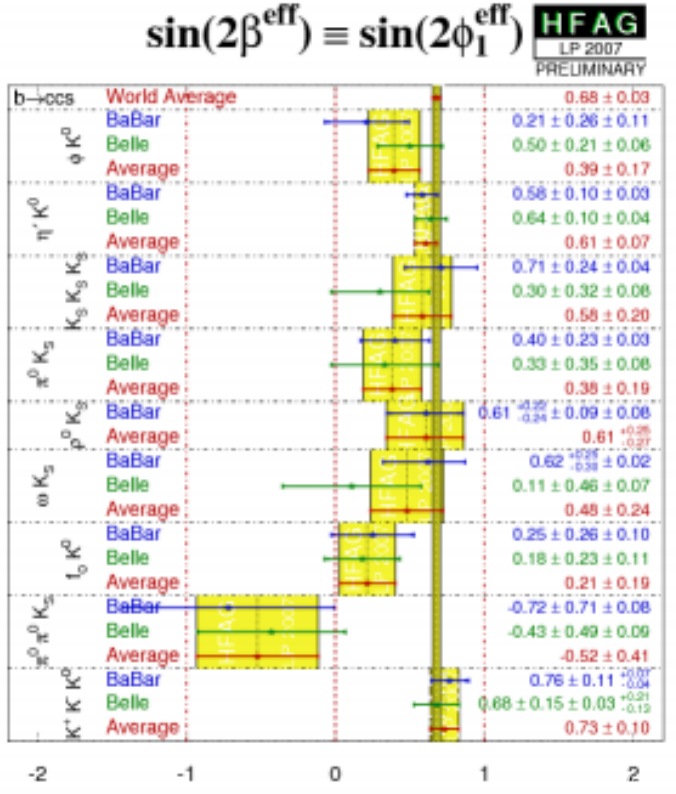


# Trees vs penguins

- Determination of sin2β from b→ccs modes consistent with overall CKM fit (both including and excluding kaon constraints):




- Determination of sin2β from penguin-dominated modes not as clearly consistent with SM expectation:



# BaBar Collaboration

- Collaboration formed 1993
  - Pier Oddone Interim Council chair
- TDR Report – 1995
  - 77/488 Institutions/people (incl. engrs.)
  - 10 Countries
  - 42/248 non-US
  - 35/240 US
  - 63 SLAC; 28 LBNL

BaBar Collaboration, July 2000

# BaBar Collaboration Governance Rules

## Collaboration Council

**Chairman** - L. Piemontese
**Vice-Chairman** - R. Wilson

**Institution Representatives**

IRs: >2 PhDs;
1 vote/10 PhDs

CC:
(Vice-)Chair are elected
Policy: Membership, publication, speakers, Nomination Comm.
May vote to remove the Executive Board

## Project Management

**Spokesman** - D. Hitlin
~~**Deputy Spokesman**~~ - R. Aleksan
**Technical Coordinator** - V. Luth
**Project Engineer** - R. Bell

Spokesperson:
3 years, renewable
-> 2 years non-renewable
"responsible for all scientific, technical, organizational and financial affairs."

## Executive Board

**Canada** - D. MacFarlane
**France** - G. Wormser
**Germany** - K. Schubert
**Italy** - M. Giorgi
**UK** - J. Fry
**US** - K. McDonald
**US** - A. Seiden
**US** - M. Witherell
**SLAC/US** - [V. Luth]
**LBL/US** - M. Pripstein
***Spokesman*** - *D. Hitlin*
***Deputy Spokesman*** - *R. Aleksan*
***Technical Coordinator*** - *V . Luth*
***PEP-II*** - *J. Dorfan*

EB: Advise Spokesperson;
"will reflect national composition;
*ex oficio* members are non-voting

## Technical Board

Advise Spokesperson tech & financial

**Technical Coordinator** (Chairman) - V. Luth
**Project Engineer** - R. Bell
**Chief Electronic Engineer** - G. Haller
**Chief Software Engineer** - D. Quarrie
**Integration Physicist** - H. Lynch
**PEP-II Representative** - J. Dorfan
**Safety Officer** - F. O'Neill
***Spokesman*** - *D. Hitlin*
***Deputy Spokesman*** - *R. Aleksan*
**System Managers:**
**PEP-II/BABAR Interface** - H. DeStaebler
**Vertex Detector** - F. Forti/N. Roe
**Drift Chamber** - D. MacFarlane
**DIRC PID** - G. London/B. Ratcliff
**Aerogel PID** -
**CsI Calorimeter** - R. Schindler
**IFR** - C. Sciacca
**Magnet** - R. Bell/[T. O'Conner]
**Electronics** - A. Lankford
**Computing** - N. Geddes/F. Porter

# MOUs/MOAs

- "General Conditions for Collaborative Experiments Performed at SLAC" – 1996, 11 pp.
- Memoranda of Understanding – Funding agencies
- Memoranda of Agreement – Institutions
- "Mutual Agreement Concerning Participation in the Collaboration Common Fund for the BaBar Detector" – 1997, 7 pp.
- Some detector items funded through Common Fund
  - Magnet & supporting hardware
  - Some utilities
  - Online computng hardware and some software development

## 4.3 Finance Review Committee

a. Initial Decision

For experiments involving large capital investments and international collaborators, a Finance Review Committee (FRC) may be established.

b. Membership

The FRC will be chaired by a representative of SLAC as host, normally the SLAC Research Director. Its membership will consist of one representative of each Funding Agency. The Spokesperson of the Collaboration will normally attend the meetings of the FRC.

c. Terms of Reference

The task of the FRC will be to monitor the financial aspects of the experiments as detailed in the Memorandum of Understanding (MoU). If DOE funds are involved, SLAC will be responsible for financial oversight and monitoring of the Collaboration, and the Collaboration must conform to SLAC's financial management practices and procedures.

## 4.4 Financial Rules

a. SLAC as host will be responsible for the oversight and monitoring of the financial aspects of the Collaboration. The Collaboration must conform to the management practices and procedures established by SLAC and approved by the DOE. Financial management of the Common Fund monies must conform to Stanford University's practices and procedures.

b. For large experimental programs, the DOE will periodically conduct a formal review of financial estimates and management plans.

c. The financial responsibilities of each Funding Agency will be defined in the MoU.

d. The financial responsibilities of individual collaborators will be summarized in the MoA.

e. It is recognized by SLAC that Collaborating Institutions will be required to conform to the financial practices and procedures of their funding agencies.

# Multilateral Agreement Concerning Participation in the Collaboration Common Fund for the BABAR Detector

## Introduction

- The participants in the BABAR Collaboration have accepted that the Stanford Linear Accelerator Center (SLAC) will be responsible for the financial oversight and monitoring of the Collaboration and the Collaboration will conform to SLAC's financial management practices and procedures.
- The present agreement between the parties signing below covers the setting-up and the monitoring of the funding for the common items of equipment, supplies, and service, hereinafter referred to as the *BABAR Common Fund*.
- On the signing of the *Memorandum of Understanding (MoU)* for the BABAR experiment, the present agreement will become an Appendix to that agreement.
- The *General Conditions for Collaborative Experiments Performed at SLAC* are incorporated by reference, and become a part of this agreement.

| Subsystem | Institutions | |
|---|---|---|
| Vertex Detector | Italy: | Milano, Pavia, Pisa, Torino, Trieste |
| | US: | UC Santa Barbara, UC Santa Cruz, LBL, Stanford |
| Main Tracking Chamber | Canada: | UBC, Carleton, CRPP, McGill, Montreal, TRIUMF, Victoria, York |
| | US: | Colorado, Colorado State, MIT, SLAC |
| DIRC PID | France: | Ecole Polytechnique, Orsay, Paris 6/7, Saclay |
| | US: | UC Santa Barbara, Cincinnati, Colorado State, LBL, Rutgers, SLAC |
| Aerogel PID | France: | LAPP Annecy |
| | Italy: | Ferrara, Milano, Padova, Roma |
| | Russia: | BINP |
| | US: | UCLA, Caltech, Maryland |
| CsI Calorimeter | China: | Beijing, BGRI, SIC |
| | Germany: | Dresden |
| | Russia: | BINP |
| | UK: | Bristol, Brunel, Edinburgh, Lancaster, Liverpool, Manchester, ICSTM, QMW, RHBNC, RAL |
| | US: | UCIIRPA, UC Irvine, Caltech, Iowa, LLNL, UMass Amherst, Mississippi, Mt. Holyoke, Notre Dame, SLAC |
| Instrumented Flux Return | China: | Beijing |
| | Italy: | Bari, Frascati, Genova, Napoli |
| | US: | LLNL, Vanderbilt, Wisconsin |

**Table 15-1.** *Institutions interested in construction of BABAR detector systems.*

| Subsystem | Institutions | |
|---|---|---|
| Magnet | China: | Beijing |
| | Italy: | Genova |
| | Russia: | Dubna, BINP |
| | UK: | RAL |
| | US: | LLNL, ORNL/Y12, SLAC |
| Electronics | Canada: | Montreal |
| | France: | Ecole Polytechnique, Orsay, Paris 6/7 |
| | Germany: | Dresden |
| | Italy: | Genova, Napoli, Milano, Pavia, Pisa, Torino |
| | Taiwan: | Academia Sinica |
| | UK: | Bristol, Edinburgh, Lancaster, ICSTM, QMW, RHBNC, RAL |
| | US: | UCIIRPA, UC Irvine, UC Santa Cruz, Caltech, Colorado, Iowa, Iowa State, LBL, Penn, SLAC |
| Computing | Canada: | McGill |
| | France: | LAPP, Orsay, Saclay |
| | Germany: | Dresden |
| | Italy: | Padova |
| | UK: | Manchester, RAL |
| | US: | Caltech, UC Davis, UC Irvine, UC Santa Cruz, LBL, LLNL, Mississippi, Pennsylvania, SLAC, Prairie View |

**Table 15-2.** *Institutions interested in construction of BABAR detector systems (continued).*

# Construction Interest

Because of the international nature of the collaboration, local conventions for cost accounting are being used. This means:

- The engineering and labor are recorded for each task in terms of the time required.
- All materials, fabrication and procurement costs are recorded on the basis of local rates.
- For work performed at US or Canadian institutions, local rates for engineering and labor are applied; the assigned rates are not burdened with operating overhead charges.
- For activities that are supported by non-US/non-Canadian institutions, expenses for engineering and labor are not recorded, they are included in operating budgets of those institutions.
- For items funded from US sources, contingency is added to the base cost to cover additional costs, above and beyond the base, that are necessary to ensure the completion of the task.
- For items funded from non-US sources, no contingency is added, since the base cost includes a certain allowance for uncertainties in the cost projections. Significant cost overruns can be dealt with by additional grants.
- In all cases support from operating or infrastructure funds are recognized and not included in the estimate. Also, work performed physicists is not charged to the project.

| | US Cost in US Accounting (1995 k$) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Description | Funding Agency | EDI&A (mm) | EDI&A ($) | Labor (mm) | Labor ($) | M&S | Base Cost | Contin gency | Total |
| 1.1 | Vertex | US DoE | 112 | 821 | 114 | 527 | 733 | 2,081 | 25% | 2,599 |
| 1.2 | Drift Chamber | US DoE | 3 | 24 | 16 | 103 | 255 | 382 | 22% | 467 |
| 1.3.1 | DIRC | US DoE | 122 | 1,049 | 183 | 897 | 1,862 | 3,808 | 26% | 4,799 |
| 1.3.2 | Aerogel | US DoE | 1 | 7 | 12 | 63 | 198 | 268 | 25% | 334 |
| 1.4 | Calorimeter | US DoE | 136 | 1,219 | 436 | 1,507 | 11,257 | 13,983 | 16% | 16,258 |
| 1.5 | IFR | US DoE | 7 | 58 | 63 | 219 | 196 | 473 | 16% | 551 |
| 1.7 | Electronics | | | | | | | | | |
| 1.7.1 | Vertex | US DoE | 59 | 506 | 0 | 0 | 132 | 638 | 27% | 813 |
| 1.7.2 | Drift Chamber | US DoE | 84 | 296 | 2 | 6 | 493 | 795 | 32% | 1,051 |
| 1.7.3 | DIRC | US DoE | 79 | 529 | 9 | 56 | 341 | 926 | 20% | 1,111 |
| 1.7.4 | Calorimeter | | | | | | | | | |
| 1.7.5 | IFR | | | | | | | | | |
| 1.7.6 | Aerogel | US DoE | 6 | 37 | 0 | 2 | 8 | 47 | 32% | 62 |
| 1.7.7 | Trigger Level I | US DoE | 44 | 409 | 0 | | 154 | 563 | 28% | 718 |
| 1.7.8 | Trigger Level II/DAQ | US DoE | 60 | 523 | 0 | | 187 | 710 | 32% | 938 |
| 1.7.9 | Controls | US DoE | 5 | 44 | 0 | | 47 | 91 | 37% | 125 |
| 1.7.D | System Engineering | US DoE | 71 | 533 | 0 | | | 533 | 42% | 757 |
| 1.8 | Computing | US DoE | 156 | 1,289 | 137 | 446 | 243 | 1,978 | 31% | 2,600 |
| 1.9 | Management/Integration | | | | | | | | | |
| 1.9.1 | Tech. Coordination | US DoE | 504 | 3,097 | 126 | 529 | 1,027 | 4,653 | 12% | 5,227 |
| 1.9.2 | QA/ES&H Oversight | US DoE | 84 | 696 | | | 10 | 706 | 8% | 764 |
| SUM | | | 1,533 | 11,137 | 1,098 | 4,355 | 17,143 | 32,635 | 20% | 39,174 |

US Institutions

**Table 16-1.** *Estimated Detector Cost in FY1995 US dollars, for items supported by US Institutions. Not included in these tables are items that might be financed through the Common Fund. These include the magnet and some of the infrastructure, some of the expenses for computing equipment, the electronics common to all systems, and expenses for detector installation and project coordination.*

All costs are stated in 1995 US$. The estimates cover the design, engineering, procurement and fabrication, the assembly, tests and installation. The duration of the project is assumed to be 42 months, beginning in April 1995 and ending in September 1998.

| | Non-US Cost in Local Accounting (1995 k$) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Description | Funding Agency | EDI&A (mm) | EDI&A ($) | Labor (mm) | Labor ($) | M&S | Base Cost | Contin gency | Total |
| 1.1 | Vertex | INFN Italy | 60 | | 162 | | 2,864 | 2,864 | 0% | 2,864 |
| 1.2 | Drift Chamber | NSERC Canada | 95 | 316 | 149 | 602 | 888 | 1,806 | 0% | 1,806 |
| 1.3.1 | DIRC | France | 111 | | 106 | | 2,641 | 2,641 | 0% | 2,641 |
| 1.3.2a | Aerogel | France | 12 | | 12 | | 173 | 173 | 0% | 173 |
| 1.3.2b | | INFN Italy | 0 | | 4 | | 146 | 146 | 0% | 146 |
| 1.4a | Calorimeter | BMFT Germany | 0 | | 89 | 286 | 2,768 | 3,054 | 0% | 3,054 |
| 1.4b | | PPARC U.K. | 72 | | 151 | | 2,268 | 2,268 | 0% | 2,268 |
| 1.5 | IFR | INFN Italy | 8 | | 21 | | 1,060 | 1,060 | 0% | 1,060 |
| 1.7 | Electronics | | | | | | | | | |
| 1.7.1 | Vertex | INFN Italy | 0 | | 0 | | 120 | 120 | 0% | 120 |
| 1.7.2 | Drift Chamber | NSERC Canada | 55 | 364 | 0 | | 1,945 | 2,309 | 0% | 2,309 |
| 1.7.3 | DIRC | France | 84 | | | | 1,734 | 1,734 | 0% | 1,734 |
| 1.7.4 | Calorimeter | PPARC UK | 185 | | 18 | | 1700 | 1,700 | 0% | 1,700 |
| 1.7.5 | IFR | INFN Italy | 19 | | 29 | | 409 | 409 | 0% | 409 |
| 1.7.6a | Aerogel | INFN Italy | 6 | | 0 | | 126 | 126 | 0% | 126 |
| 1.7.6b | | France | 2 | | 0 | | 33 | 33 | 0% | 33 |
| 1.7.7 | Trigger Level I | PPARC U.K. | 23 | | 0 | | 78 | 78 | 0% | 78 |
| 1.8 | Computing | France | 53 | | 0 | | 0 | 0 | 0% | 0 |
| SUM | | | 785 | 680 | 741 | 888 | 18,953 | 20,521 | 0% | 20,521 |

**Table 16-2.** *Estimated Detector Cost in FY1995 US dollars, for items supported by non-US Institutions. Not included in these tables are items that might be financed through the Common Fund.*

Non-US Institutions

accounted. Table 16-2 refers to items that are to be funded by non-US institutions. Not included in either table are items that could potentially be financed through a Common Fund. While there is consensus that such a fund should be established, the size of the fund.

the obligations of various national funding agencies to this fund, and the list of items that should be supported from this fund remain to be negotiated.

The total cost of materials and services (in Europe referred to as investment costs) to be financed from the US and non-US resources, including the Common Fund, amounts to 45 million US$.

## BABAR Common Items

| WBS | Description | Common Fund in Thousands of Dollars |
|---|---|---|
| 1.6 | Magnet | |
| 1.6.0 | Magnet Engineering | 385 |
| 1.6.1 | Solenoid | 1,625 * |
| 1.6.3 | Cryogenics | 1,455 |
| 1.6.4 | Cryogenics Monitoring | 152 |
| 1.6.6 | Flux Return | 3,440 |
| 1.6.7 | Installation | 263 |
| 1.7 | Electronics | |
| 1.7.B | Common Systems | 124 |
| 1.7.C | Infrastructure | 202 |
| 1.8 | Computing | 1,344 |
| 1.9 | Management/Coordination | |
| 1.9.5 | Detector Assembly | 3,397 |
| | Contingency | 413 |
| | Reserve | 500 |
| **Total** | | **13,300** |

* "In-kind" contribution (not cash).

## ex II: BABAR Common Fund Contribution

Total Estimated Cost of Common Items in 1995 US Dollars: $13,300,000

| Collaborator | Contribution% | 1995 USD |
|---|---|---|
| Canada NSERC | 0.6% | 85,000 |
| France CEA | 5.0% | 660,000 |
| France IN2P3 | 5.0% | 660,000 |
| Germany BMBF | 5.8% | 775,000 |
| Italy INFN | 12.2% | 1,625,000 * |
| UK PPARC | 7.4% | 990,000 |
| US DOE | 62.3% | 8,285,000† |
| To be distributed | 1.7% | 220,000 |
| **Total** | **100.0%** | **13,300,000** |

* "In-kind" contribution.

† DOE portion is maintained in a separate account; there is no commingling of US and foreign funds.

- BaBar Collaboration ~50:50 US/non-US
  - Many senior non-US collaborators had worked in the US as younger researchers, post docs, students
  - Early input to Governance document was very important to "buy-in"
- Functioned well for 20 years
  - ~6 years design/construction
  - + 10 years operation
  - + > 4 years post-data analysis

# Summary