BABAR Overview and Future Plans

David B. MacFarlane
B Factory Operations Review
April 26, 2006
### The BABAR Collaboration

**11 Countries**  
**80 Institutions**  
**623 Physicists**

#### USA [38/311]
- California Institute of Technology  
- UC, Irvine  
- UC, Los Angeles  
- UC, Riverside  
- UC, San Diego  
- UC, Santa Barbara  
- UC, Santa Cruz  
- U of Cincinnati  
- U of Colorado  
- Colorado State  
- Harvard U  
- U of Iowa  
- Iowa State U  
- LLNL  
- U of Louisville  
- U of Maryland  
- U of Massachusetts, Amherst  
- MIT  
- U of Mississippi  
- Mount Holyoke College  
- SUNY, Albany  
- U of Notre Dame  
- Ohio State U  
- U of Oregon  
- U of Pennsylvania  
- Prairie View A&M U  
- Princeton U  
- SLAC  
- U of South Carolina

#### Germany [5/24]
- Ruhr U Bochum  
- U Dortmund  
- Technische U Dresden  
- U Heidelberg  
- U Rostock

#### Canada [4/24]
- U of British Columbia  
- McGill U  
- U de Montréal  
- U of Victoria

#### United Kingdom [11/75]
- U of Birmingham  
- U of Bristol  
- Brunel U  
- U of Edinburgh  
- U of Liverpool  
- Imperial College  
- Queen Mary, U of London  
- U of London, Royal Holloway  
- U of Manchester  
- Rutherford Appleton Laboratory  
- U of Warwick

#### The Netherlands [1/4]
- NIKHEF, Amsterdam

#### Norway [1/3]
- U of Bergen

#### Russia [1/13]
- Budker Institute, Novosibirsk

#### Spain [2/3]
- IFAE-Barcelona  
- IFIC-Valencia

#### Canada [1/5]
- Inst. of High Energy Physics, Beijing

#### France [5/53]
- LAPP, Annecy  
- LAL Orsay  
- LPNHE des Universités Paris VI et VII  
- Ecole Polytechnique, Laboratoire Leprince-Ringuet  
- CEA, DAPNIA, CE-Saclay

#### Italy [12/99]
- INFN, Bari  
- INFN, Ferrara  
- Lab. Nazionali di Frascati dell’ INFN  
- INFN, Genova & Univ  
- INFN, Milano & Univ  
- INFN, Napoli & Univ  
- INFN, Padova & Univ  
- INFN, Pisa & Univ & Scuola Normale Superiore  
- INFN, Perugia & Univ  
- INFN, Roma "La Sapienza"  
- INFN, Torino & Univ  
- INFN, Trieste & Univ

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- U of Manchester  
- Rutherford Appleton Laboratory  
- U of Warwick
Pillars of BABAR physics program

- Highly constrained and redundant set of precision tests of weak interactions in the Standard Model
  - Full program of flavor physics/CP violation measurements will provide a legacy of fundamental constraints on future New Physics discoveries

- Searches for physics beyond the Standard Model in a well understood & characterized environment
  - Sensitivity to New Physics at LHC mass scales through rare decays and CP violation
  - Discovery potential from large data sample across a whole range of beauty, charm, tau, two-photon, ISR physics

Challenging measurements at the edge of sensitivity benefit enormously from operation of both PEP-II & KEK B Factories
### BABAR & Belle physics results

#### Journal Papers

<table>
<thead>
<tr>
<th>Total [Today]</th>
<th>BABAR</th>
<th>Belle</th>
</tr>
</thead>
<tbody>
<tr>
<td>204</td>
<td>167</td>
<td></td>
</tr>
</tbody>
</table>

+28 papers since last P-5 visit

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*Graph showing the number of journal papers for BABAR and Belle from January 2001 to January 2006.*
BABAR Organization Chart

Collaboration Council

D.B. MacFarlane Spokesperson

Executive Board

Computing Steering Committee

+ Hassan Jawahery Spokesperson-elect

Physics Analysis Coordinator
R. Faccini
J. Olsen (Deputy)

Technical Coordinator
W. Wisniewski

Senior Management Team

Analysis Working Groups

System Managers

Physics Tools Groups

Operations Manager

Run Quality Manager

Run Coordinator(s)

Area Managers

Technical Board

Computing Coordinator
G. Dubois-Felsmann
Technical Coordinator

- **Selection**
  - Proposed by Spokesperson after consultations between SLAC and BABAR Management; confirmed by majority of Executive Board for indefinite term

- **Responsibilities**
  - Broadly responsible for all technical matters related to the BABAR detector
  - In charge of the detector operations and hardware development
    - Manages resources to ensure capability to take data well adapted to the physics requirements of the experiment and to the conditions of the PEP-II rings
    - Supervises detector repairs and upgrades, anticipates and identifies potential problems, and is responsible for identifying the best strategy for their solution
  - Chairs PEPII/BABAR Forum, and together with the Spokesperson is the designated point of contact between the experiment and PEP-II management
  - Chairs the Technical Board, which advises on medium- and long-term issues
Technical Board

- Technical Board includes subsystem managers, senior management team, representatives from computing.
- Senior technical team for the collaboration. Includes electrical, mechanical and software engineers as well as the safety team.

<table>
<thead>
<tr>
<th>Detector Type</th>
<th>Manager(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon Vertex Detector (SVT)</td>
<td>G. Calderini/D. Roberts</td>
</tr>
<tr>
<td>Drift Chamber (DCH)</td>
<td>M. Kelsey/S. Prell</td>
</tr>
<tr>
<td>Detector of Internally Reflected Cherenkov Light</td>
<td>J. Schwiening/G. Vasseur</td>
</tr>
<tr>
<td>Electromagnetic Calorimeter (EMC)</td>
<td>M. Kocian/S. Playfer</td>
</tr>
<tr>
<td>Instrumented Flux Return (IFR:RPC)</td>
<td>H. Band/E. Robutti</td>
</tr>
<tr>
<td>Instrumented Flux Return (IFR:LST)</td>
<td>R. Calabrese/A.J.S. Smith</td>
</tr>
<tr>
<td>Trigger (TRG)</td>
<td>D. Su/R. Bartoldus</td>
</tr>
<tr>
<td>Machine Detector Interface (MDI)</td>
<td>W. Kozanecki/M. Weaver</td>
</tr>
</tbody>
</table>
Technical Board

- **Operations manager**
  - Reports to Technical Coordinator
  - Coordinates BABAR activities in IR-2, working closely with system managers and with chief mechanical and electrical engineers.
  - Proposes Run Coordinators to Technical Board

- **Run Coordinators**
  - Organize day-to-day BABAR operations
  - Responsible for planning and filling BABAR shifts

- **Chief Engineers**
  - Work with Operations manager and Technical Coordinator to design and implement maintenance, repairs, and improvements

- **Safety Officer**
  - Maintains safe and efficient operations environment
  - Reports to Spokesperson and Technical Coordinator
Physics Analysis Coordinator

Selection
- Proposed by Spokesperson via a search committee; confirmed by majority of Executive Board for a one year term as Deputy, followed by a year as PAC

Responsibilities:
- Provides guidance on physics priorities, Monte Carlo production priorities, machine energy parameters, etc
- Together with the Computing Coordinator, is responsible for a physics and computing integrated plan of delivery of data, MC, skims, and other computing resources
- Via the Tools and Validation Manager, ensures availability of physics analysis tools to analysts
- Ensures efficient production of high-quality physics results that realize the full potential of the BABAR detector
- Gathers abstracts and proposes topics for conference talks; serves as the interface for non-BABAR speakers presenting BABAR results
- Organizes Physics Analysis parallel and plenary sessions at Collaboration Meetings
- Organizes Analysis Working Groups (AWGs) and Physics Tools Groups
- Appoints convener(s) of AWG’s in consultation with AWG members
Physics Analysis Organization

- Physics analysis coordinator & deputy
- Advised by analysis coordination team including an advisory group, the pub board and speakers’ bureau chairs
- Coordinates analysis working groups & tools groups (2 conveners each):
  - sin2beta/lifetimes & mixing; charmonium; charm; exclusive B decay to charm; charmless B decays (3 sub-groups); inclusive hadronic B Decays; B lifetimes and mixing using fully-reconstructed decays; leptonic b and c decays; radiative penguins; inclusive hadronic particle spectra; inclusive semi-leptonic; exclusive semi-leptonic; tau & QED
  - charged particles ID; neutrals reconstruction and ID; luminosity; trigger and filter
Organization of Tools Groups

**Aims:**

- Single point of contact for PAC and Computing Coordinator:
  - Improved coordination of validation efforts & tools groups
- Consolidation and rationalization of tools effort

![Diagram of Organization of Tools Groups]

- PAC
- Computing Coordinator
- AWGs
- Tools and Validation Manager
- DQG
- Offline
- Physics Software
- Reco
- Generators
- Charged Particles
- Neutral Particles
- PID
- Tagging
- Trackings
- EMC
- Trigger, Filter and Luminosity
Computing Coordinator

Selection:
- Proposed by Spokesperson via a search committee; confirmed by majority of Executive Board to serve for an indefinite term

Responsibilities:
- Manages all aspects of BABAR computing, including offline computing, online computing, operations, and tools.
- Interacts with coordinators of these areas to plan and implement short- and long-term goals, and to ensure the integrity of the code.
- Coordinates wide-area networking.
- In consultation with the Collaboration, decides on supported platforms and code packages.
- Devises schedules for the development of BABAR software necessary to meet the physics goals of the experiment.
- Plans necessary hardware acquisitions with the directors of each Tier A computing site.
Scope of Computing System

- The BABAR Computing System includes the following elements:
  - Online including data acquisition, control, and monitoring;
  - Offline hardware, including CPU, network, and storage;
  - Software environment in which the computing work is done, including code development/management, user concerns, and distributed computing issues, etc.; and
  - Collaboration code itself, for online, event reconstruction, simulation, analysis, etc.

- Computing resources are distributed worldwide
  - 5 Tier A centers including SLAC
  - About 40 facilities for Monte Carlo production
  - Backbone of computing professionals (22.5 FTE) distributed to various sites
Usage 1

- Fast calibration pass at SLAC
- Data sent via network to Padova/Bologna for reconstruction & skimming
- Data reconstructed and returned via network to SLAC
BABAR Tier A computing centers

SLAC

RAL

Karlsruhe

Padova/Bologna

Lyon

Maximum transfer rates:

- IN2P3: 3 Tb/day
- RAL: 2 Tb/day
- GRIDKA: 1 Tb/day
- CNAF: 1 Tb/day

Usage 2

- Data skims are uniquely assigned to Tier A Centers
- Disk space for corresponding Analysis Working Group located at same Tier A

Ongoing shared contributions from all agencies

Operating Common Fund: $2.7 million for CY06
Computing Budget: $2.9 million for CY06
R18 full reprocessing

Skims are being allocated uniquely to Tier A sites and SLAC

Relies on planning for adequate resources over time to provide stability:
- May need to adjust current allocations
- Need adequate planning horizon
Current Monte Carlo production

Goals:
3x data BB events
1x data continuum

SP8 Production by Site
Cumulative Events by Location

Total Events: 4809969000

4.8x10^9 events

Very well distributed system: as designed!
Computed Budget Evolution

- "Total needs" estimate
- "SLAC"

Dip in budget is caused by difference between anticipated and delivered luminosity in 2005.
Installed computing capacity

![Graphs showing annual disk and CPU requirements from 2003 to 2009 for Total and SLAC.](image)
## Computing professionals - 2006

### DOE 8

<table>
<thead>
<tr>
<th>Role</th>
<th>FTE</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-line Core / System Engineer</td>
<td>1.0</td>
<td>Matthias Wittgen</td>
</tr>
<tr>
<td>Tools Manager</td>
<td>1.0</td>
<td>Douglas Smith</td>
</tr>
<tr>
<td>On-line Core / System Engineer</td>
<td>1.0</td>
<td>Chris O'Grady</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>1.0</td>
<td>Charlotte Hee</td>
</tr>
<tr>
<td>DB Administrator</td>
<td>1.0</td>
<td>Wilko Kroeger/Tofigh Azemoon</td>
</tr>
<tr>
<td>Bookkeeping</td>
<td>0.75</td>
<td>Will Roethel</td>
</tr>
<tr>
<td>DataFlow</td>
<td>0.25</td>
<td>Matt Weaver</td>
</tr>
<tr>
<td>Geant4 Core</td>
<td>1.0</td>
<td>Dennis Wright</td>
</tr>
<tr>
<td>Offline Manager</td>
<td>1.0</td>
<td>David Lange</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>8.0</strong></td>
</tr>
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</table>

### Common Fund “8”

<table>
<thead>
<tr>
<th>Role</th>
<th>FTE</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVS Core Support</td>
<td>1.0</td>
<td>Terry Hung</td>
</tr>
<tr>
<td>On-line Database</td>
<td>1.0</td>
<td>Andrei Salnikov</td>
</tr>
<tr>
<td>Eventstore Core</td>
<td>0.5</td>
<td>Andrew Hanushevsky</td>
</tr>
<tr>
<td>Database Core</td>
<td>0.5</td>
<td>Jacek Becla</td>
</tr>
<tr>
<td>Database Core</td>
<td>1.0</td>
<td>Igor Gaponenko (possibly split)</td>
</tr>
<tr>
<td>EPICS Core</td>
<td>1.0</td>
<td>Sherry Chu</td>
</tr>
<tr>
<td>Reco Core</td>
<td>1.0</td>
<td>(preparing for new hire)</td>
</tr>
<tr>
<td>Release Manager</td>
<td>0.5</td>
<td>Doug Johnson</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>6.5</strong></td>
</tr>
</tbody>
</table>

**+ 7 FTE non-DOE8 professionals**
Computing professionals - 2006

Non-DOE 8

<table>
<thead>
<tr>
<th>Category</th>
<th>Weight</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure</td>
<td>1.0</td>
<td>Jean Yves Nief (France)</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>0.5</td>
<td>Zoulikha Georgette (France)</td>
</tr>
<tr>
<td>Reco-core</td>
<td>0.5</td>
<td>Unfilled (France)</td>
</tr>
<tr>
<td>Online Run Control</td>
<td>0.5</td>
<td>Boda Franek (UK)</td>
</tr>
<tr>
<td>Kanga Development</td>
<td>0.5</td>
<td>David Bailey (UK)</td>
</tr>
<tr>
<td>Grid Tools</td>
<td>0.5</td>
<td>Chris Brew (UK)</td>
</tr>
<tr>
<td>Bookkeeping</td>
<td>0.5</td>
<td>Tim Adeye (UK)</td>
</tr>
<tr>
<td>Framework Core Support</td>
<td>0.5</td>
<td>Asoka de Silva (Canada)</td>
</tr>
<tr>
<td>Reco Core</td>
<td>0.5</td>
<td>Matthias Steinke (Germany)</td>
</tr>
<tr>
<td>XRootd</td>
<td>0.8</td>
<td>Fabrizio Furano (Italy)</td>
</tr>
<tr>
<td>Database Core</td>
<td>0.5</td>
<td>Elisa Stevanato (Italy)</td>
</tr>
<tr>
<td>Grid Tools</td>
<td>0.7</td>
<td>Armando Fella (Italy)</td>
</tr>
<tr>
<td>Grid Tools</td>
<td>1.0</td>
<td>Daniele Andreotti (Italy)</td>
</tr>
<tr>
<td>Total</td>
<td>8.0</td>
<td></td>
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April 26, 2006
DAQ replacement and upgrade

Arguments for replacement:
- Online event build switch may not keep up comfortably with increased rates and event sizes through 2008
- Online farm (Event Build / OEP / Level 3) will be over six years old by 2008
  - Well beyond normal replacement lifetime for production systems
- Farm capacity may also not be sufficient

Presentation of situation and plan to IFC resulted in $400K budget for upgrade this summer
- Envisions new switch, new dual-dual Opteron farm

Will be coordinated by Steffen Luitz
Major actions in computing

- Finish up R18c skim, complete configuration of small R18d skim
- Release capability to read ROOT conditions for analysis, avoiding run-time use of Objy altogether
- Bring two major reconstruction-improvement projects to conclusion:
  - EMC calibration (deferred from R18 reconstruction)
  - TrkFixup - refinements to charged-track selection and fitting, performed on the mini (no XTC reprocessing)
- Define and schedule next skim cycles
  - Including the deployment of the above...
Complete Objectivity phase-out

- **Objectivity still used in non-event databases**
  - Configuration, Conditions: used in analysis
  - Ambient, Spatial, Temporal: used in online, reco
- **Initial plan outlined in BaBar Note 576**
  - Object storage in ROOT-serialized form
  - ROOT (read-only) and mySQL (read-write) implementations
- **Make available for analysis (~January ⇒ now)**
  - Provide the code in an analysis-35 release
  - Regular data distribution of Cfg/Cdb snapshots
- **Switch online to mySQL Cfg database**
- **Make it possible to run SP without Objectivity**
  - Should help management of SP sites, esp. SPGrid
- **Eliminate Objectivity altogether from releases by Run 6**
  - Will be challenging and possibly an area where limits on available technical manpower may be an issue
BABAR Detector

- **DIRC (PID)**
  - 144 quartz bars
  - 11000 PMs
- **1.5T solenoid**
- **EMC**
  - 6580 CsI(Tl) crystals
- **Drift Chamber**
  - 40 layers
- **Silicon Vertex Tracker**
  - 5 layers, double sided strips
- **Instrumented Flux Return**
  - Iron / Resistive Plate Chambers or Limited Streamer Tubes (muon / neutral hadrons)

Collaboration founded in 1993
Detector commissioned in 1999
Integrated data sample to date

96% efficiency over the entire history of BABAR

BABAR, Run 5
A day in the life of a B Factory

PEP-II-Babar Oct 1 - Oct 2

Sat Day shift
08:00h (100.00%) Stable Beams
07:59h (99.83%) DAQ on
234.60/pb PEP-II Luminosity
233.91/pb Recorded Luminosity

Sat Swing shift
07:15h (90.76%) Stable Beams
07:12h (99.35%) DAQ on
209.50/pb PEP-II Luminosity
208.90/pb Recorded Luminosity

Sun Owl shift
07:12h (90.03%) Stable Beams
07:07h (98.86%) DAQ on
209.14/pb PEP-II Luminosity
207.35/pb Recorded Luminosity

Summary
22:27h (93.50%) Stable Beams
22:19h (99.37%) DAQ on
653.24/pb PEP-II Luminosity
650.15/pb Recorded Luminosity

Red: PEP Luminosity
Blue: HER beam current
Green: LER beam current
Pink: Deadtime
Yellow: DAQ on - stable beams
Blk: DAQ off - stable beams

↓ DCH Pause
↓ SVT Abort
Trickle injection implementation

Trickle injection: charge added to bunch at ~10 Hz

Problem

Injected bunch and its neighbors disturbed for about 5ms

Solution

L1 inhibit for injected bunch and its nearby neighbors for 3.85ms

BABAR Trigger & DAQ very flexible & high performance
Data Taking

- Two Run Coordinators with a deputy
  - Responsible for smooth data-taking; work with Operations Manager and Technical Coordinator.

- All institutions provide shift takers from among their members
  - Have recently emphasized need for more intensive participation in shifts
  - Instituted policy for minimal number of shifts by graduate students and postdocs

- Shift crew:
  - At IR2: shift leader “pilot”, data quality monitor “navigator”
  - At MCC: liaison at the start of major running cycle only
Task Coverage

- Each institution is responsible to provide its share of service proportional to its membership count
- Philosophy of 'you build it, you maintain it' works reasonably well
  - Funding agencies have a strong preference for this
    - a legacy of the Memoranda of Agreement signed during detector construction
  - Software/computing service is more flexible.
- Effort for major upgrades come from the existing groups. These new efforts never have problems attracting eager post-docs and students from the more flexible US institutions.
  - It is more difficult to man systems that require only routine maintenance: streamlining the task helps here.
- New groups joining BaBar sign MOAs taking responsibility for specific tasks. New member burdens are 0.5 FTE in the first year.
Detector Routine Maintenance

- **Operations**
  - Mechanical (ops crew, engineers, Operations:SEM)
  - Electronics (ops crew, engineers)
  - Cryogenics (Operations:EFD)

- **Upgrades**
  - Ops crew + Experimental Facilities Department
  - Rely on infrastructure of lab
  - Safety oversight help during upgrades crosses division lines
## BABAR Training Matrix

<table>
<thead>
<tr>
<th>Category</th>
<th>Training Requirement</th>
<th>Recommended Supervisor</th>
<th>Documentation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Short-term visitor</td>
<td>None. Category (b) or higher recommended for BABAR users.</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>b. Office worker</td>
<td>EOESH, GERT, ES&amp;H 239</td>
<td>Member of BABAR Management team or SLAC Group Leader</td>
<td>Office JHAM, Office Building AHA</td>
</tr>
<tr>
<td>c. Shift-taker</td>
<td>(b) above plus Shift Training</td>
<td>Run Coordinator</td>
<td>(b) above plus Shifter JHAM, IR-2 AHA</td>
</tr>
<tr>
<td>d. System worker</td>
<td>(b) above plus BABAR Orientation, job specific training</td>
<td>System Manager</td>
<td>(b),(c) above plus System JHAM(s)</td>
</tr>
<tr>
<td>e. R&amp;D worker</td>
<td>(b) above plus job specific training</td>
<td>R&amp;D Manager</td>
<td>(b) above plus job specific JHAM, job site AHA</td>
</tr>
</tbody>
</table>

BABAR Work Category Definitions

**Short-term visitor**
Attends no more than one collaboration meeting per year or equivalent

**Office worker**
Only works in the ROB or one of the other office areas but not IR-2 or other laboratory space

**Shift-taker**
Stands shifts on BABAR in IR-2

**System worker**
Does maintenance work on a detector system in IR-2 or in a system laboratory space

**R&D worker**
Does development or testing work in a lab setting or temporary system space
Training Database

- **Modified SLAC Training Assessment database to record training status against BABAR requirements**
  - Very useful tool for Run Coordinators and System Managers to verify training and suitability of shift crews and system workers
  - Required training keyed against assigned category from training matrix
  - Includes record of JHAMs signed by individuals
  - Includes automated expiration and renewal requirements
Line of Authority for Safety on BABAR

**BABAR shift worker**

- Spokesperson: D.B. MacFarlane
- Technical Coordinator: W. Wisniewski
- Operations Manager: W. Innes
- Run Coordinators: J. McKenna, G. Bonneaud
- BABAR Shifter

**BABAR system worker**

- Spokesperson: D.B. MacFarlane
- Technical Coordinator: W. Wisniewski
- System Manager
- System Operations Manager
- System Worker
**Planning**

- **Short term:**
  - Daily operations meetings where all subsystems represented
  - Daily operations meeting PEPII & BABAR
  - Weekly BABAR management meetings
  - Weekly PEPII-BABAR coordination meetings

- **Middle term: technical board & exec board (~monthly)**

- **Long term: We have done internal self-assessments.**
  - Soon after data-taking began (report Apr 2000), we looked forward to detector upgrades that might be needed for operations at up to 10x design luminosity. Some upgrades identified (trigger, online computing) and acted on.
  - In 2002 we returned to consider physics justification for the program to ~1-2/ab, with some consideration of possible detector upgrades (other than IFR).
  - Computing model evaluations have occurred in parallel. External reviews (e.g. Butler review for CM2; IFC, EPAC for IFR) follow.
BABAR Detector

**DIRC (PID)**
144 quartz bars
11000 PMs

**1.5T solenoid**

**EMC**
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**Instrumented Flux Return**
Iron / Resistive Plate Chambers or Limited Streamer Tubes (muon / neutral hadrons)

**Silicon Vertex Tracker**
5 layers, double sided strips

**Collaboration founded in 1993**
Detector commissioned in 1999

**Upgrades**

**e\(^+\) (3.1 GeV)**

**e\(^-\) (9 GeV)**
DCH electronics upgrade

Motivation:
- Remove anticipated deadtime problem due to serialization and shipping of data from DCH to readout module

Upgrade in two steps:
- Phase 1 (summer 2004): L1 to ~4kHz
  - Reduce ADC payload (32 → 16 bytes) from front ends with no impact on dE/dx performance
- Phase 2 (Oct 2005): L1 to ~5kHz
  - Larger FPGA to allow feature extraction on DCH endplate
  - New boards installed in Oct down, ready to activate FPGA code
IFR upgrade with LSTs

Bottom & top sextants installed summer 2004
Remaining sextants delayed until fall 2006
LST installation summer 2004

Bottom sextant: Aug 15-Sep 4
Top sextant: Sep 16-29
Impact on physics performance

Installation & schedule requirements based on 2004 experience

Installation of 4 remaining sextants in 4-month down concurrent with PEP-II & LCLS work
Fall 2006 preparations & tooling

Remove one of the forward supports

Now this middle corner plate can be removed

Transfer the load to the temporary tooling, remove the west flexible support arm and the corner plate can now be removed.

Richard Boyce, Les Dittert, Jim Krebs

Ready for fabrication with helpful improvements from reviewers

LST modules and almost all tooling ready installation


**Funding**

- **International Finance Committee (IFC)**
  - Provides oversight of the experiment, funds
  - Members represent the funding agencies
  - Common Fund: contributions based on PhD headcount distribution
    - Detector: consumables, some general upgrade funds & operations salaries
    - Computing: Common Fund-8, hardware (also in-kind)

- **Laboratory Support**
  - BABAR support group & EFD
  - Physics research groups (Ratcliff, et al.)

- **Upgrades**
  - Agencies which fund the groups involved in upgrade (legacy) and DOE
    - DIRC electronics: France only
    - Trigger DCZ: DOE, PPARC
    - IFR Upgrades: DOE, INFN, IFC
Budget Process

- **SLAC operating support**
  - Developed between BABAR Management and Laboratory management in consultation with the stakeholders of the technical board and the computing organization. (FY budget)

- **International Finance Committee support**
  - Oversight and approval of the Operating Common Fund and Computing Budget takes place twice yearly. (CY budget)
Projected data sample growth

- Double from 2004 to 2006
- Double again from 2006 to 2008
- $L_{\text{peak}} = 9 \times 10^{33}$

Events:
- PEP-II: IR-2 vacuum, 2xrf stations, BPM work, feedback systems
- BABAR: LST installation
- 4-month down for LCLS, PEP-II & BABAR

Timeline:
- Jul-99 to Jul-08
Projected data sample growth

- Integrated Luminosity [fb\(^{-1}\)]
  - Jul-99
  - Jul-00
  - Jul-01
  - Jul-02
  - Jul-03
  - Jul-04
  - Jul-05
  - Jul-06
  - Jul-07
  - Jul-08

- Sep 05 plan
- Feb 06 estimate

- \( L_{\text{peak}} = 9 \times 10^{33} \)
How does this compare with KEKB?

Integrated Luminosity [fb⁻¹]

KEKB from Oide
KEKB no crab effect (my guess)
Sep 05 plan
Feb 06 (estimate)
Updated performance comparison

Revised from 2005 results; conclusions unchanged from 2004 study

<table>
<thead>
<tr>
<th>S</th>
<th>Mode</th>
<th>Belle stat err</th>
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Typically better errors for BABAR despite larger Belle dataset

Normalized performance ratio
## BABAR CKM physics goals

<table>
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<th>Physics</th>
<th>Impact</th>
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<th>FY2007 650 fb⁻¹</th>
<th>FY2008 1000 fb⁻¹</th>
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<tr>
<td>Precision measurement of $\sin 2\beta$</td>
<td>Fundamental constant of the SM, whose precision is only limited by statistics</td>
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<td>Improve error by factor of two to 2%</td>
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<tr>
<td>Precision measurement of $CP$ asymmetry in $b \rightarrow s\bar{q}q$ penguin modes</td>
<td>Primary approach to new physics in loop decays; $b \rightarrow s\bar{s}s$ presently discrepant with SM predictions at 2.4σ level when averaged over all available modes</td>
<td>Potentially reach the 4-5σ level for average of all $b \rightarrow s\bar{s}s$ modes</td>
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<td>Could reach the 4-5σ level for individual theoretically-clean modes</td>
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<td>Precision measurement of unitarity angle $\alpha$</td>
<td>Fundamental constraint on the UT</td>
<td></td>
<td>Discovery of $B^0 \rightarrow \rho^0 \rho^0$ if it has SM branching fraction</td>
<td>Isospin analysis in $B \rightarrow \rho\rho$ allows better than 10° measurement</td>
</tr>
<tr>
<td>Precision measurement of unitarity angle $\gamma$</td>
<td>Fundamental tree-level constraint on phases and amplitudes originating from any new physics beyond the SM</td>
<td>Pioneering measurements with 10-15° accuracy</td>
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<td>Determine to 5-10° precision</td>
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<tr>
<td>Precision measurement of $</td>
<td>V_{ub}</td>
<td>$ with inclusive &amp; exclusive semileptonic $B$ meson decays</td>
<td>Fundamental tree-level constraint on amplitudes and phases originating from any new physics beyond the SM</td>
<td>Inclusive decays reach 6.5% precision</td>
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# BABAR rare decay physics goals

<table>
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<th>FY2007 650 fb⁻¹</th>
<th>FY2008 1000 fb⁻¹</th>
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<tr>
<td>Discovery of ( B \rightarrow \tau \nu_\tau )</td>
<td>Provides a determination of (</td>
<td>V_{ub}</td>
<td>) and constrains Higgs sector in MSSM and NP in a parameter regime that is complementary to LHC</td>
<td>Limit</td>
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<tr>
<td>Precision determination of ( b \rightarrow s \gamma ) branching fraction, ( CP ) asymmetry, and photon energy spectrum</td>
<td>Loop diagram that provides unique insight into ( B ) meson structure and constrains Higgs sector in MSSM and NP in a parameter regime that is complementary to LHC</td>
<td>Ultimate precision on photon energy spectrum</td>
<td>Strong constraints from 5% error on BF; 1-2% error on ( CP ) asymmetry</td>
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</tr>
<tr>
<td>Precision determination of ( b \rightarrow s \ell^+ \ell^- ) branching fractions, ( CP ) and FB asymmetries</td>
<td>Contributions from Z-penguin and W-exchange loops that give additional constraints on MSSM and NP in a parameter regime that is complementary to LHC</td>
<td>Useful precision for constraints on NP</td>
<td>Strong constraint for NP from BF, ( CP ) and FB asymmetries</td>
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<tr>
<td>Discovery of ( B \rightarrow \rho \gamma )</td>
<td>Provides a unique determination of CKM matrix elements (</td>
<td>V_{ud}</td>
<td>/</td>
<td>V_{ts}</td>
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**New Belle result**
# BABAR Physics Goals

<table>
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<th>Physics</th>
<th>Impact</th>
<th>FY2006 450 fb(^{-1})</th>
<th>FY2007 650 fb(^{-1})</th>
<th>FY2008 1000 fb(^{-1})</th>
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<tbody>
<tr>
<td>Search for (D^0 - \bar{D}^0) mixing</td>
<td>Highly suppressed in the SM and therefore an ideal place to search for new physics in charm mixing diagram</td>
<td>Hint if 1% mixing amplitude</td>
<td></td>
<td>Discovery if 1% mixing amplitude</td>
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<tr>
<td>Search for lepton-flavor violation in (\tau \rightarrow \mu \gamma) or other tau decays</td>
<td>Expected to be significantly enhanced in many extensions of the SM accommodating neutrino mass, but extremely small in the SM itself</td>
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<td></td>
<td>Limits reach 2x10(^{-8}) sensitivity</td>
</tr>
<tr>
<td>New discovery in heavy hadron spectroscopy</td>
<td>Improved understanding of QCD in non-perturbative regime</td>
<td>Discoveries possible anytime</td>
<td>Discoveries possible anytime</td>
<td>Discoveries possible anytime</td>
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</tbody>
</table>
Summary: Physics reach of BABAR

- **Goal for 2005-2006: double current data set**
  - Delay in Run 5 can be overcome by summer 2006 with extended running period, with substantial reduction in errors on CP violation asymmetries in rare decay modes
  - Error on average of Penguin modes should reach 0.06

- **Goal for 2007-2008: double again to ~1 ab⁻¹**
  - Individual Penguin modes with errors in range 0.06-0.12
  - Suite of fundamental Standard Model measurements with substantially improved levels of precision

  - Sensitivity to New Physics through rare decays, CP violation, & large data sample with a significant discovery potential
  - Full program of flavor physics/CP violation measurements provide fundamental constraints on future New Physics discoveries

- **Program will continue to be exciting and competitive through at least 2008**
Backup Slides
<table>
<thead>
<tr>
<th>Categories</th>
<th>Description</th>
<th>CY2005</th>
<th>CY2006</th>
<th>Change (CY06 - CY05)</th>
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Approved CY06 OCF budget

Grounds-up analysis suggests 64K reduction for CY06
Approved CY06 OCF budget

Media upgrade for new silo hardware system

- Do not have new media prices yet, but assume unspent balance in CY05 production account will cover this one-time copy of data set

DAQ replacement and network switch upgrade proposal

- October operations at $10^{34}$ revealed that DAQ deadtime wall is at somewhat lower L1 rates than models indicated
- Suggests replacement of network switch in event builder
- Re-examination of DAQ system also led to recognition of risk due to aging hardware in L3 farm
  - Farm machines, servers, and disks will be over 6 years old by summer 2008 with significant risk of common failure modes
- Propose replacement in 2006 down period

### Upgrade

<table>
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<tr>
<th>Categories</th>
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April 26, 2006

**Approved CY06 OCF budget**

- Including carry forward from CY05, net new funding for CY06 is down by 100K from CY05
- CY07 should see perhaps 400K reduction due to elimination of most Obj licenses & no upgrade costs

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