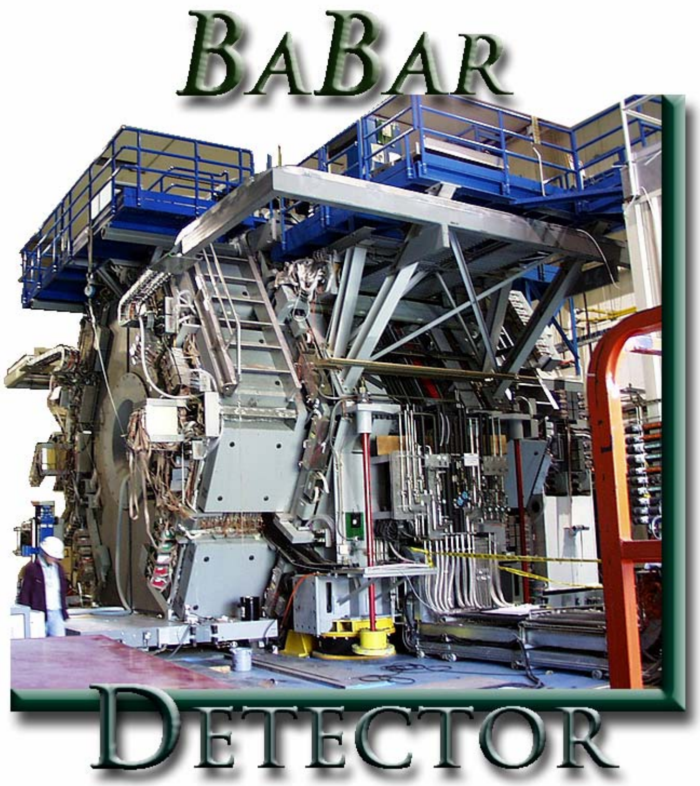
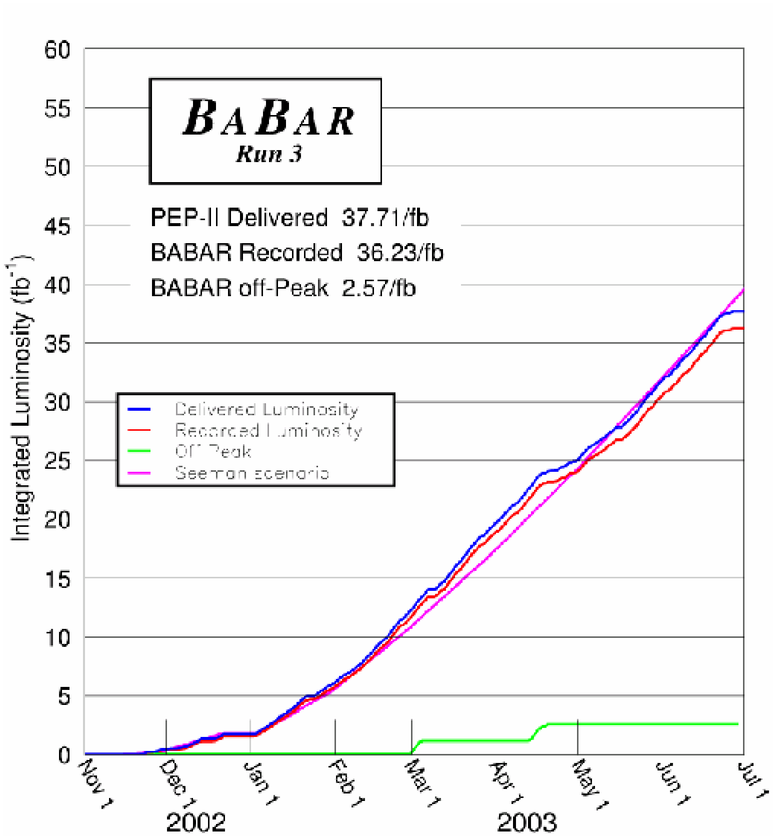
Detector Operations



- Run 3 End & Run 4 Progress
- System Status
  - MDI, SVT, DCH & DCH electronics upgrade, DIRC, EMC, IFR-RPC, Trig
- IFR Barrel Upgrade
  - LST detector progress & milestones
  - Electronics Review & QA Review
  - Engineering, Schedule, Installation Review
  - Installation Readiness Review & Safety
  - Summer 2005

Run 3

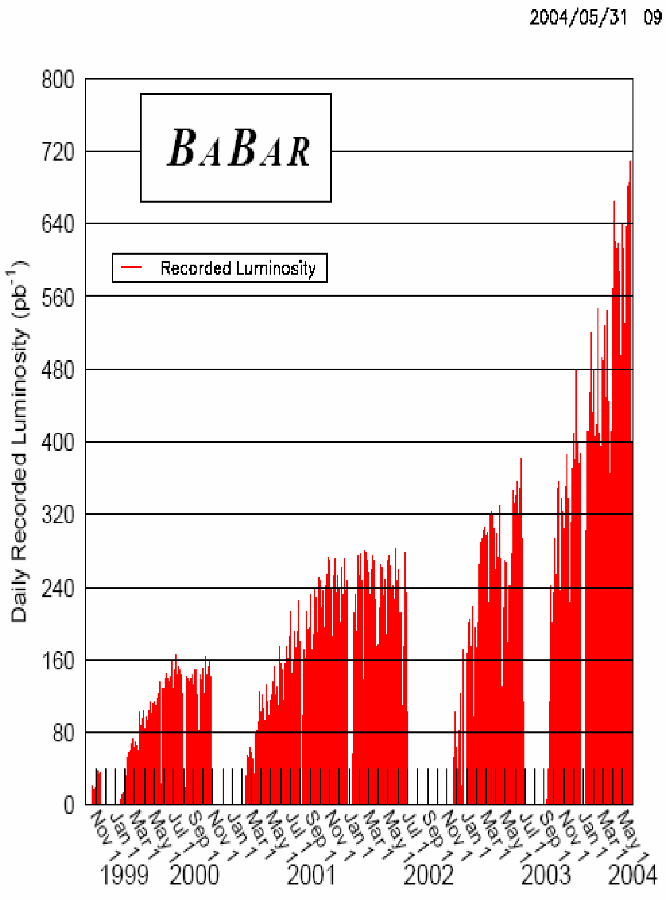


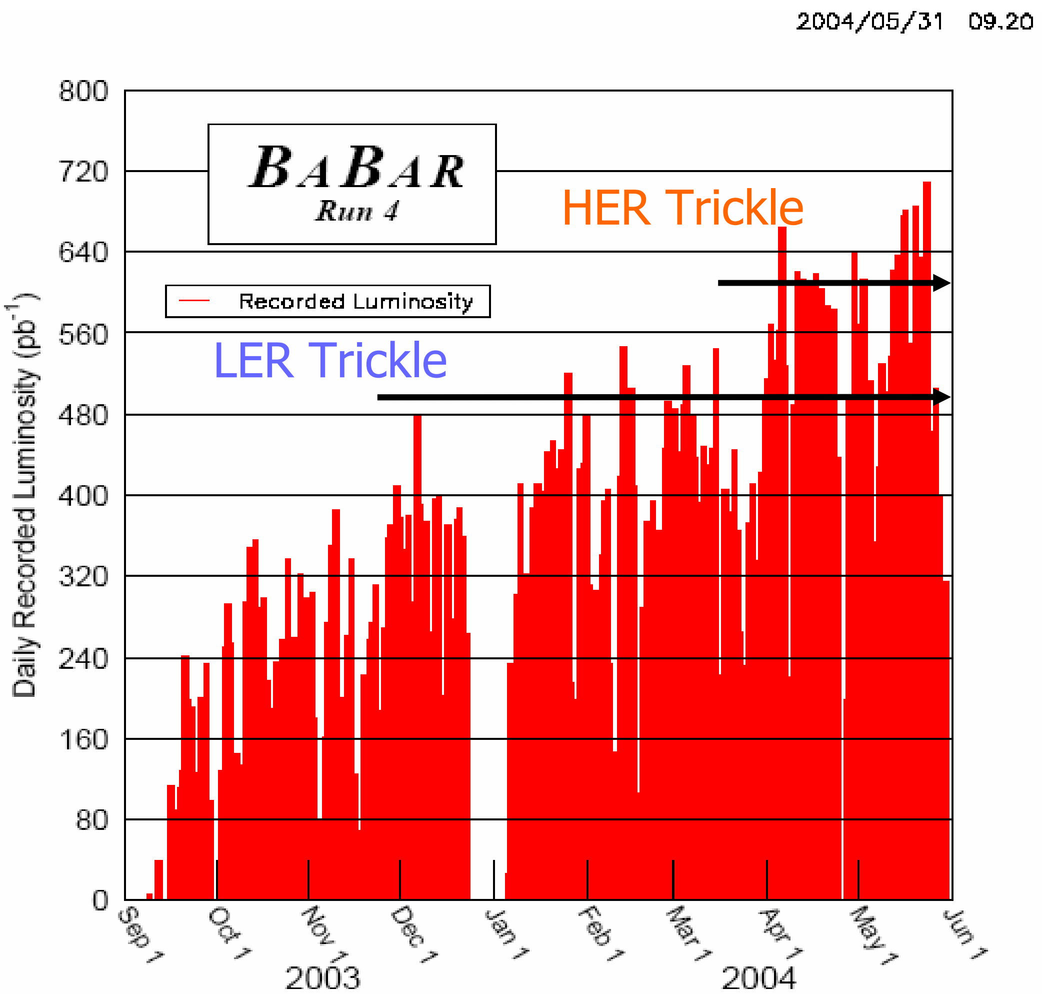
- End run with vacuum problems in LER in IR2
- First LER trickle injection tests
  - develop technique to deal with backgrounds and dead-time associated with injection
  - detector test mid-June: all look OK
  - need to assess impact on physics
  - need to adapt protection software

Summer '03 Shutdown

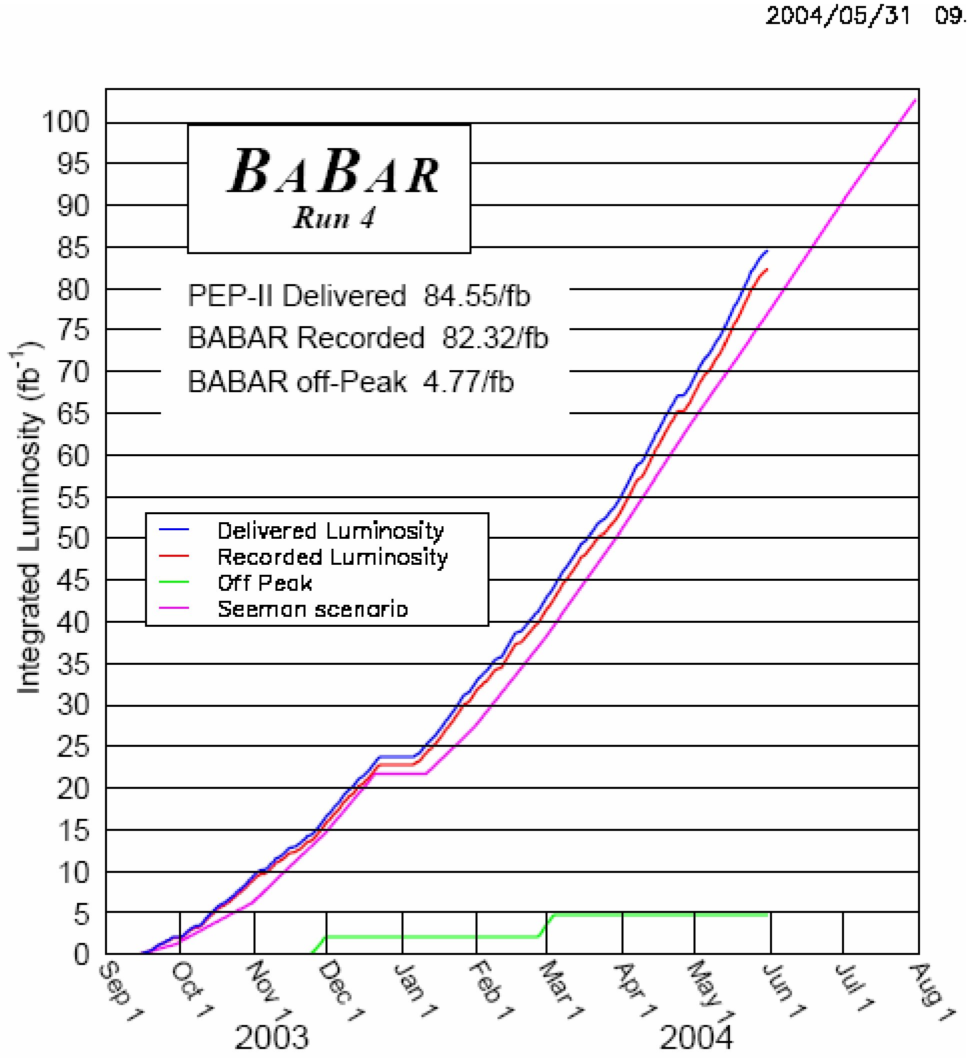
- period of consolidation for BaBar
  - general maintenance: door drives & interlocks; unfinished work from 2002 (door shims, stairs & handrails…); prep work for 2004 shutdown; cooling system work.
  - see subsystem reports

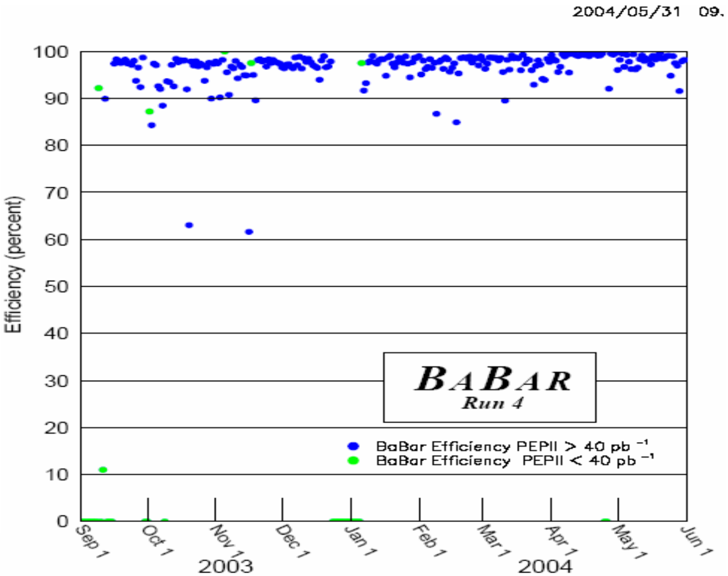
Run 4 Progress

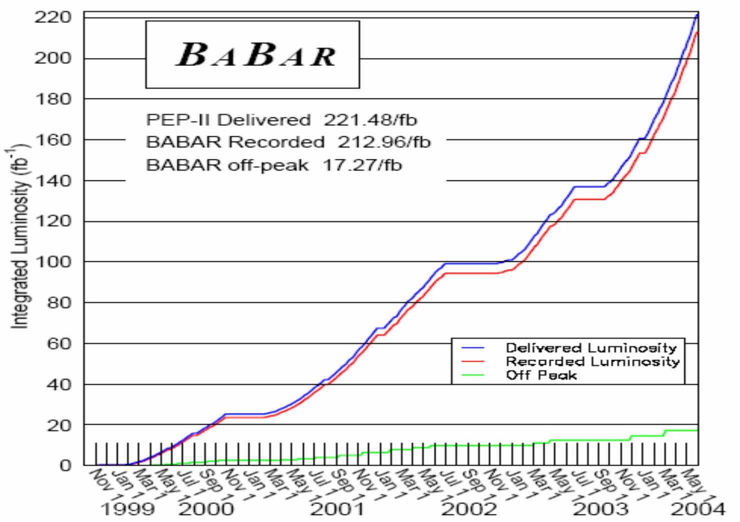




Run 4 Progress





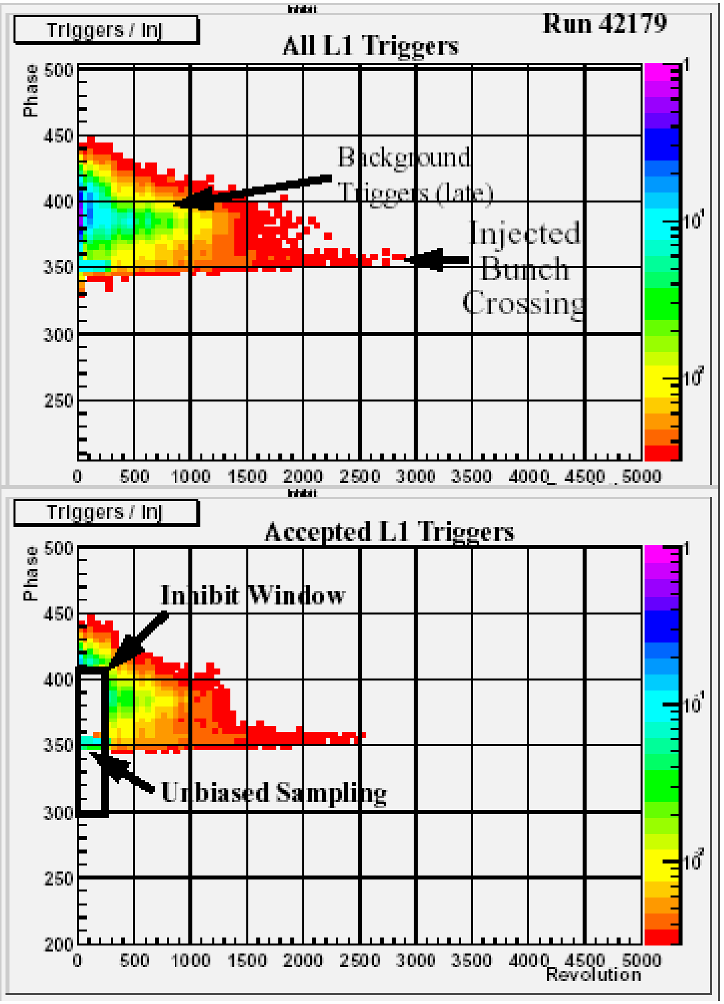


Run 4 Progress: Trickle Injection (I)

- Keeps LER/HER at constant current by continuously injecting positrons/electrons at 1-10Hz. PEP has learned to ameliorate the associated backgrounds. (Fear of flyers for HER trickle).
- The injected bunch causes backgrounds in BaBar. An L1 trigger inhibit window around injection is used to control dead-time.
- In LER trickle mode, top-off of HER was every 60-90 mins instead of 45mins. Machine stability better. Luminosity improvement clear immediately. For HER trickle, benefits initially hidden by problems.
- Injection time markers allow analyses to filter injection background contamination. The loss to this filtering is small compared to the gain in integrated luminosity.
- Important factor in almost doubling luminosity since last year.

Run 4 Progress: Trickle Injection (II)

Injection Readout Inhibit



Inhibit readout of injection-contaminated events in favor of recording unaffected events.

Sole purpose of inhibit is to control the deadtime.

Also need to systematicly sample inside the inhibit window to monitor detector exposure (and provide feedback to PEP).

LER

Run 4 Progress: Trickle Injection (III)

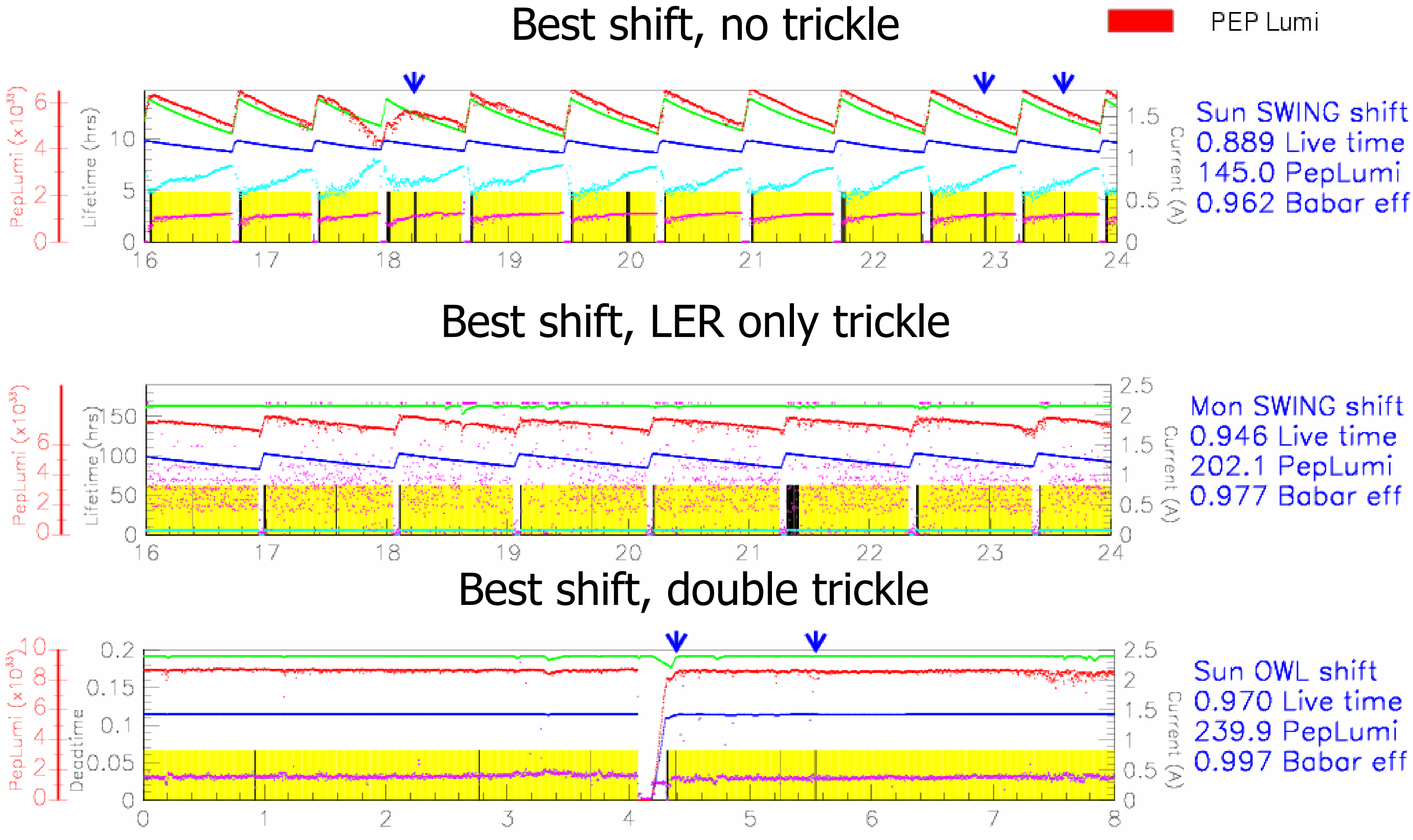
Production Trickle Injection Timeline

	LER	HER
Extended Test (accumulate 500 pb^{-1}) Sample range of conditions Estimate physics impact	Nov 13-17, 2003*	Mar 11-15, 2004
Evaluation Period No trickle while impact is assessed	Nov 17-28	
Production Started	Dec 2	Mar 15

Injection Filter Windows

	LER	HER
L1 Inhibit Window*	30 rev . 440/873 + 525 rev . 106/873 0.55 ms / injection	30 rev . 440/873 + 525 rev . 106/873 0.55 ms / injection
Reconstruction Filter** (encloses L1 Inhibit Window)	50 rev . + 1250 rev . 150/873 1.88 ms / injection	150 rev . + 2000 rev . 108/873 2.78 ms / injection
Average Injection Rate	5 Hz	1.5 Hz
Average Luminosity Loss	0.94%	0.42%

Run 4 Progress: Trickle Injection (IV)



Machine Detector Interface

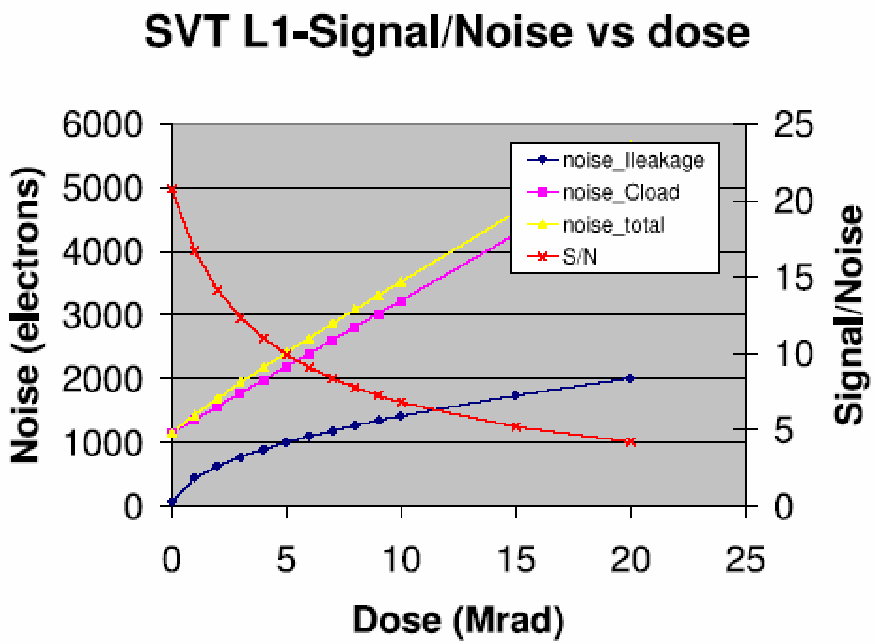
- Leads: W. Kozanecki, G. Wormser
- Backgrounds, present & future ***(kick-off: Background Worskhop, 22-24 Sep 03)***
  - Radiation-abort policies (an ongoing effort...)
    - detailed analysis of thresholds/procedures -> improved flexibility, reduced # aborts
  - Operational issues: some progress; can use MORE BaBar involvement in MCC
    - beam-beam backgrounds, injection (dose! inefficiencies!), radiation bursts
  - Long-term projections
    - medium-term vulnerabilities (SVT dose, DCH data flow) better understood
    - some subsystems may be marginal on the long run (>'06-'07)
  - Simulations: small group accreting and making progress
    - revive/update mothballed tools (beam-gas Turtle, GEANT IR description)
    - will benchmark on present machine + evaluate improv'mts (IR upgrade, collimation)
  - Need new background parameterizations (January, May)
  - Forward Shield Wall (summer '04)
- Accelerator Performance Improvements
  - machine tuning: trickle bkgds, detector occupancies → on-line in MCC
  - beam size measurements → understand optics, beam-beam ***(Workshop, Oct. 03)***
    - @ IP, using BaBar data ($\mu^+ \mu^-$, $e^+ e^-$) → on-line
    - bunch-by-bunch beam size in LER & HER commissioned ('gated camera')
    - new X-ray vertical size monitor for LER: engineering design, install summer
  - beam-beam simulations (→medium-term Luminosity optimization strategy)

SVT Routine Operations

- Summer 2003 activities
  - Cables removed for forward Q2 work, reconnected and tested OK.
    IV curves measured.
  - Water leak in PEPII cooling lines: FE cable disconnect/reconnect and test OK.
  - PS boards changed; chiller work; spare pump obtained; new monitoring boards.
  - Air Leak in layer 3 cooling lines larger than in Run 3. This is a negative pressure system. Cause for concern: decide to risk running till adequate time for repair. When FW chiller is replaced, returns to Run 3 values!
- Run 4
  - Miscellaneous chiller problems; temperatures adjusted
  - Crate replacement; minor power supply problems
  - DAQ link card firmware bug loses a few hours of data; temporary fix deployed; firmware fix summer 2004
  - BW diamond replaces BW:MID in 10 minute timer; thresholds for fast spikes raised; greater forgiveness in injection; extendable timer
  - SVTRAD 1.5 boards in production; installing this week.

SVT Radiation Damage

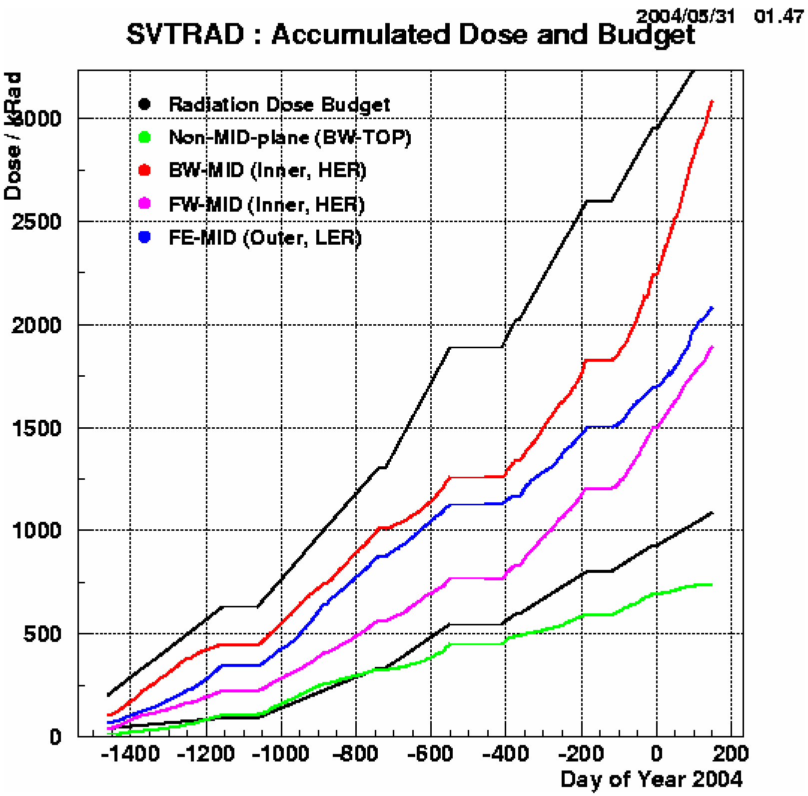
- Radiation Damage as the limiting factor to the lifetime of the SVT
  - Damage to the sensors:
    - Instantaneous: p-stop shorts; affect efficiency
    - Integrated: increase in leakage current→ shot noise; change in depletion voltage & type inversion→ electronics noise; damage to crystal structure→ decrease in charge collect efficiency
  - Damage to the electronics:
    - Increase in noise & decrease in gain → decrease S/N; Digital failures → inefficiency



Expected evolution in the noise level and signal/noise ratios as a function of the integrated dose

SVT Radiation Status

Sensors tested OK to 9 Mrad

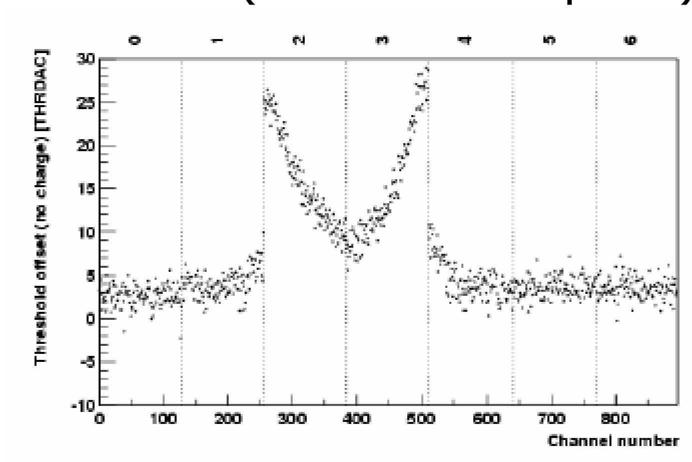


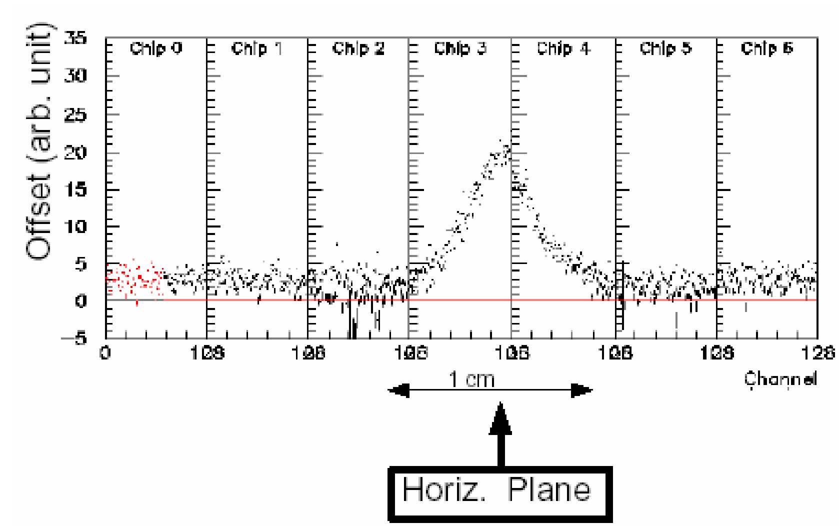
Present Backgrounds in SVT

- Instantaneous and integrated dose, trips
  - Double trickle has been very beneficial, due to more stable beams and much cleaner injection
    - On average, 2 SVTRAD aborts/day (was 3-4 before)
    - Dose rate < 3 krad/day in mid plane, < 0.4 krad/day outside
    - Dose < 2.5 Mrad in mid plane, < 0.8 Mrad outside
      - **Non-mid plane modules will reach ~1-1.5Mrad in 2009**
      - **Mid-plane modules under the design budget (5Mrad in 2005)**
- Occupancies
  - Jan04: 2x worse HER bkg compared to Feb02
  - Mar04: NEG regeneration
  - Now: HER bkg 25% lower than in Jan04 – halfway between Feb02 and Jan04. Price to be paid were 10 days with high LER bkg after NEG regeneration

SVT Readout Damage (I)

- Early irradiation tests on Atom chip suggest 5Mrads lifetime before signal/noise reduced from ~20 to ~10. No digital failures observed.
- After the 2002 shutdown noticed a change in pedestal in a few chips at ~1Mrad (first in L1 midplane)





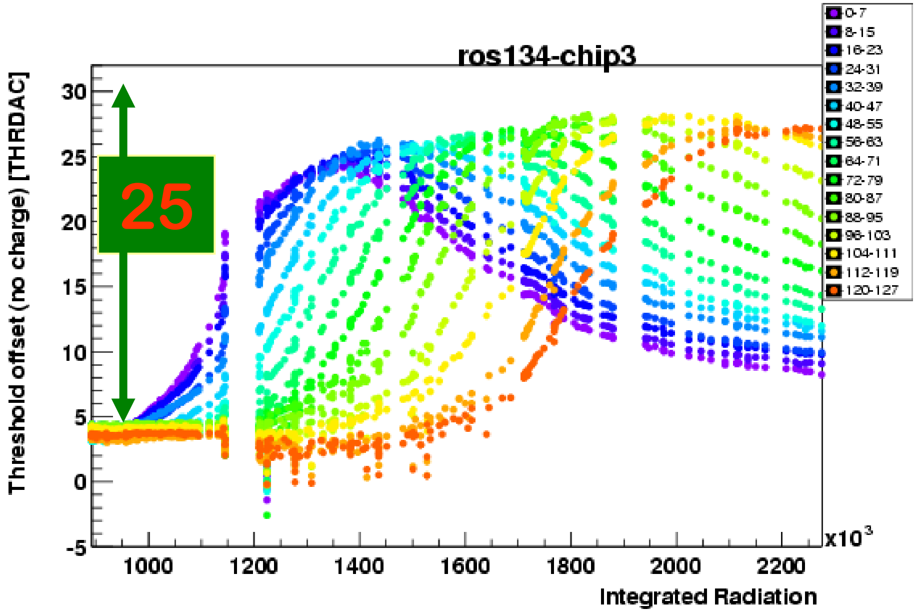
- Occupancies and efficiencies are affected
- Effect is highly non-uniform across the chip and evolves with time (dose)
- Thresholds can be changed only at chip level

SVT Readout Damage (II)

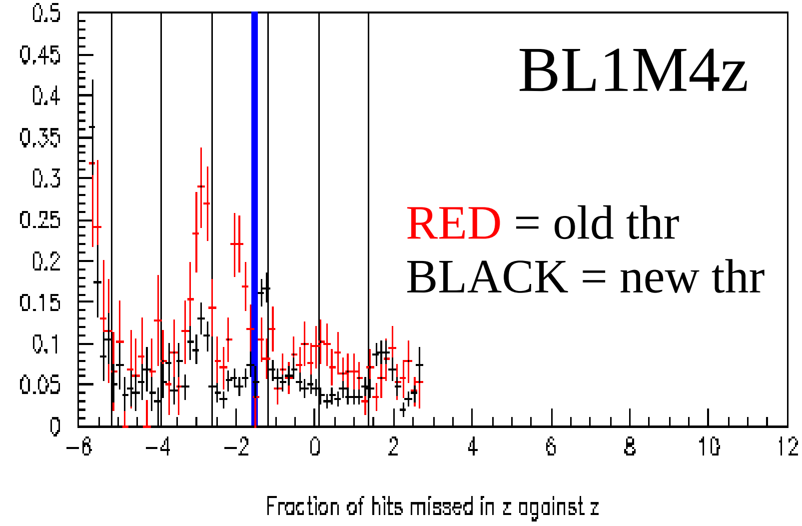
- A tool to evaluate the chip threshold setting which optimizes occupancy/efficiency has been written
  - based on the measured values channel gain, noise and pedestal (calibrations)
  - Validated against chip occupancy measured in cosmics and chip cluster efficiency measured in collisions.
- On Feb. 18th thresholds of 9 most affected chips (worst occ.=62%, worst cluster eff.=68%) have been changed accordingly
- All 9 chips are now back to cluster eff. > 90%
- In 7 chips occ.<6%, in 2 occ.<15% (electronic noise only)
- 4 new chips are starting to show the same behavior, but have the tools to ameliorate the problem.

SVT Readout Damage (III)

Pedestal shift vs dose (krad)



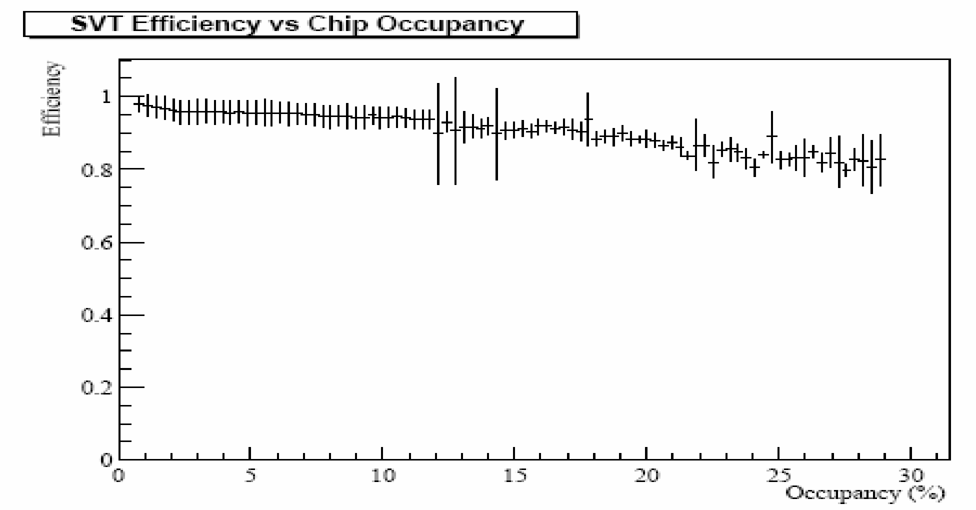
Inefficiency vs position after the threshold change



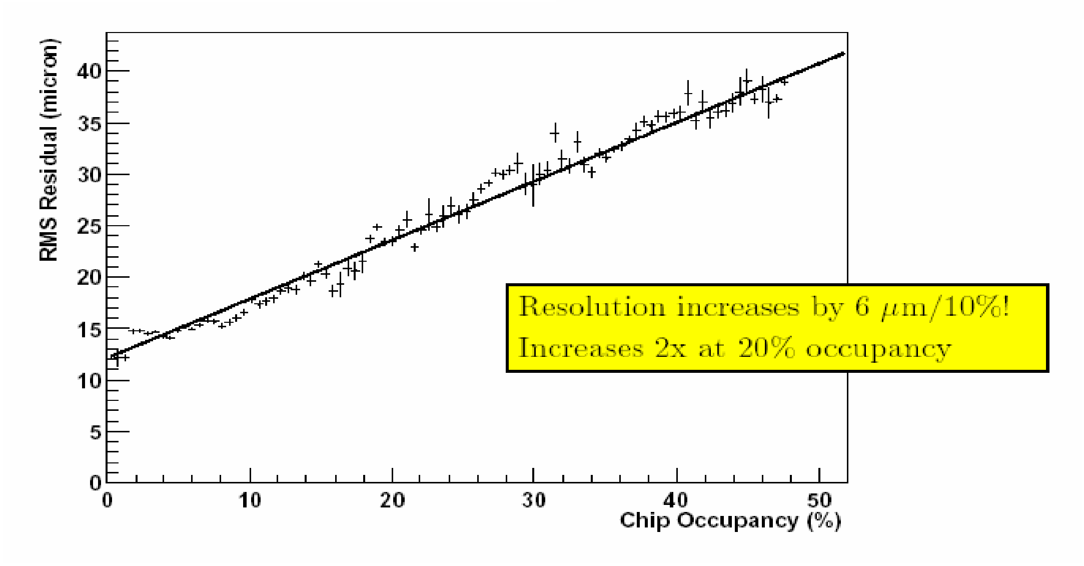
ATOM has been irradiated up to 9 Mrad at Trieste. Comparable magnitude pedestal shift seen, though doesn't drop, and gain drop is not as large. Neutron irradiation is also planned.

SVT Occupancy

- Hit Efficiency Effects



- Resolution



SVT Long Term Task Force Conclusions

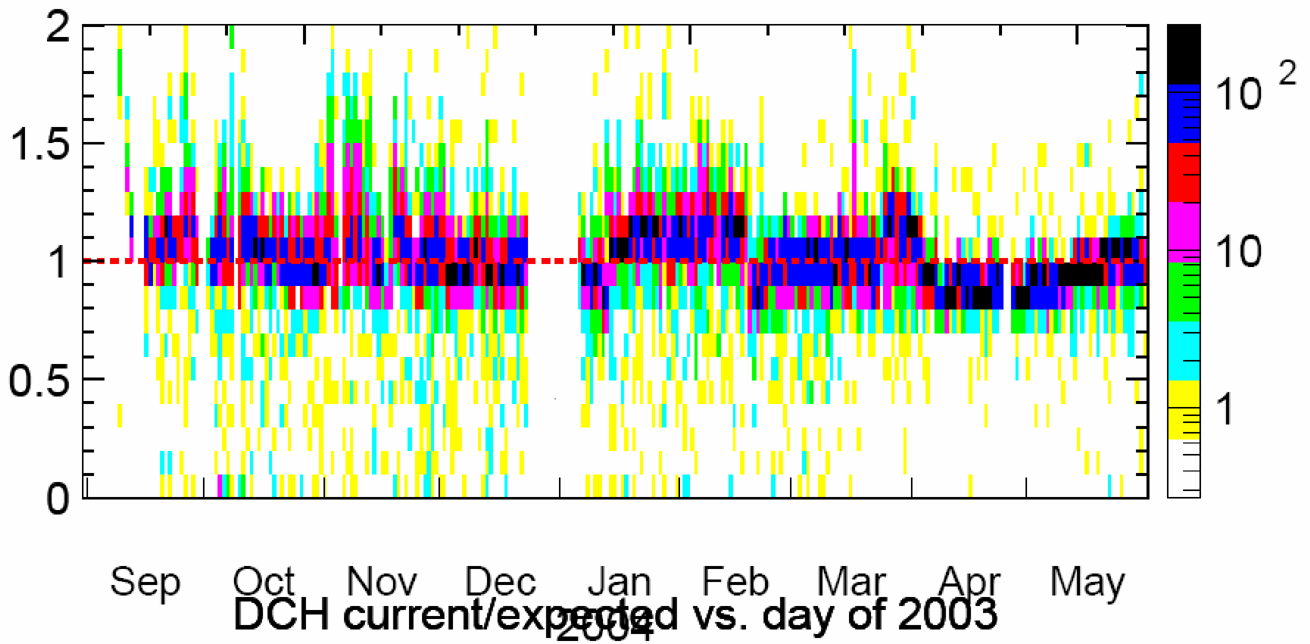
- Proceed with planning for module replacement in 2005
  - Modules in hand
- Proceed with engineering to allow for future SVT rotation
- Assess effect on physics of loss of horizontal strip due to extrapolated occupancy and radiation damage
- Decide on 2005 strategy from SVT perspective by July collaboration meeting
  - PIN diode replacement scheme requires removal of support tube from detector, but does not require disassembly of SVT
- Physics Analysis team to evaluate physics effects of not replacing mid-plane chips by September

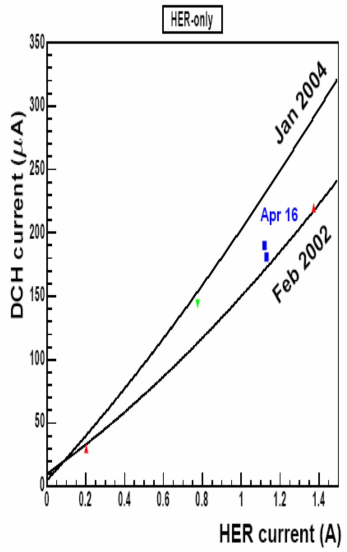
DCH

- Summer improvements:
  - explosion proof scales in gas shack for isobutane
  - improved EPICS and alarm handler
  - automatic reboot procedure for gas monitor IOC
  - backup cooling system flow settings adjusted
- Operations: mostly routine
  - replaced 2 FEAs
  - replaced 2 HADs
  - replaced bubbler
  - developed routine testing procedure for isobutane
  - HV mainframe problems
  - TDC resets: investigating if radiation caused resets

DCH Performance

Compare measured DCH background to that expected at the same LER current, HER current & Luminosity

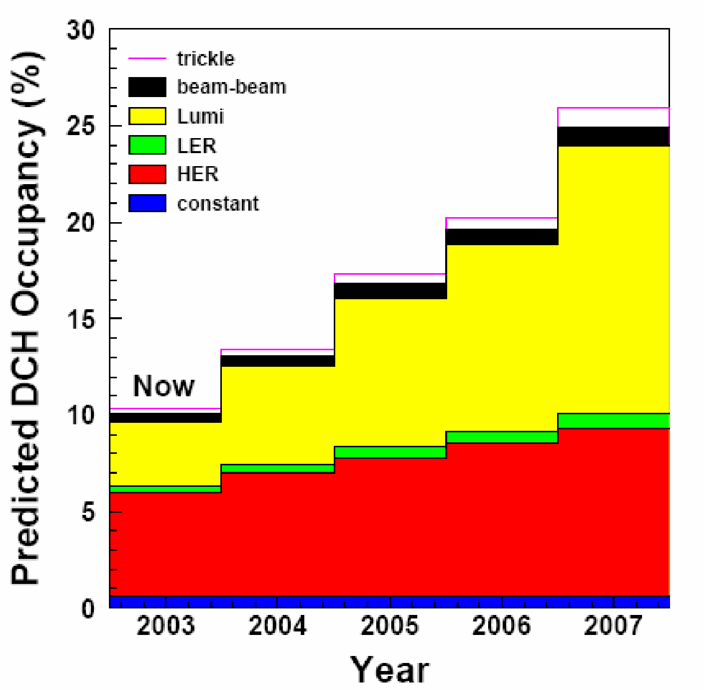


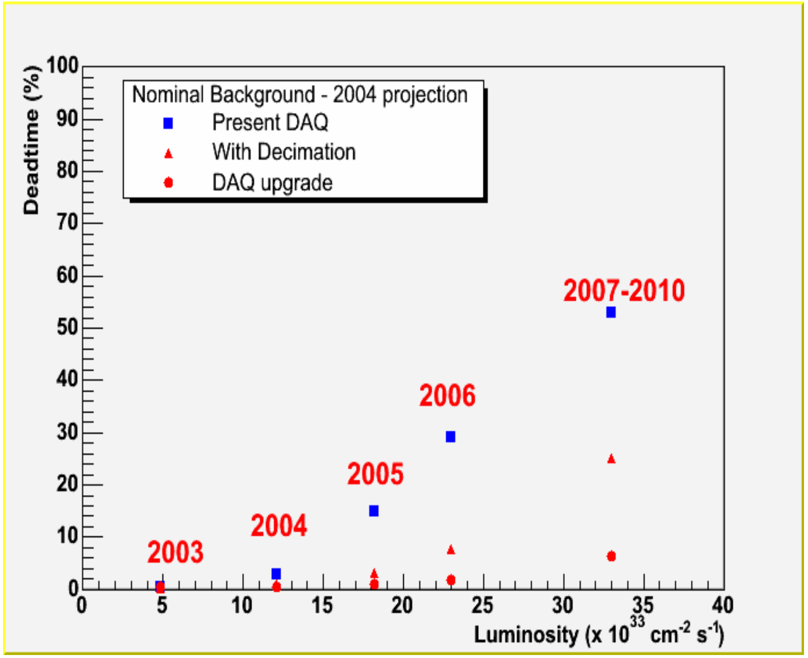


DCH Readout Dead-time (I)

- Drift chamber readout is incurring dead-time at times of high background.
- A task force is working on a remedy this problem.
- Several solutions have been investigated:
  - initial plan: replace one class of boards; later thought two classes might be needed
  - do feature extraction at the front end: one class of boards with new FPGAs.
  - need 1st stage fix this summer to deal with next year's expected dead-time: decimation

DCH Readout Dead-time (II)

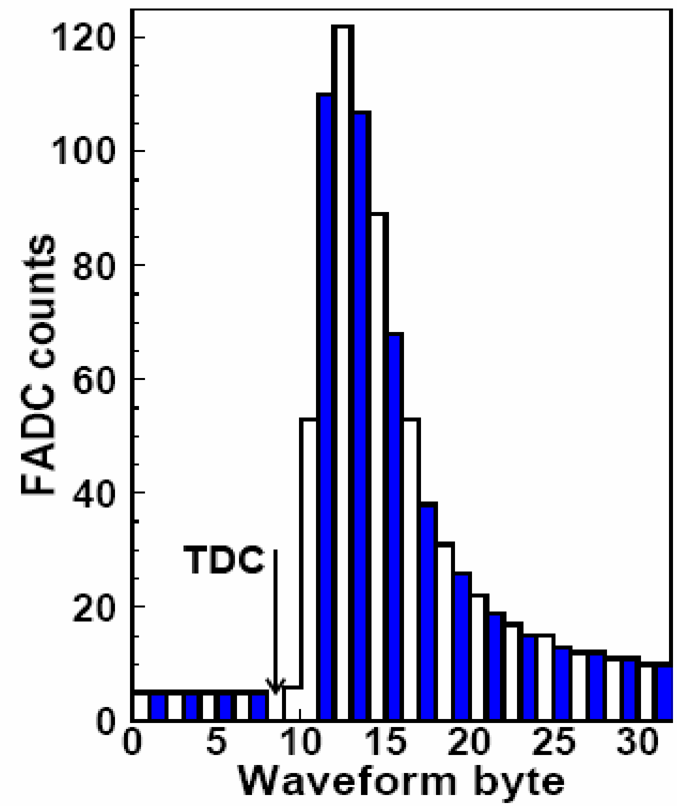




- FPGA on new board would be best implemented in 2005 shutdown.
- Situation may be helped by improving shielding
- Tightening trigger to lower Level 1 rate is another handle on the problem

DCH Readout Dead-time (III)

- Goal: Decrease data size out of front-end without building new front-end electronics
- Idea: Modification of FPGA firmware to ship only half of raw data (*every other byte*)
- Interpolate thrown-away data in ROM leaving feature extraction unchanged
- Gain (almost) factor of 2 in data reduction
- Installation of new firmware this summer



Physics effects of decimation appear to be benign.

DIRC

- Summer shutdown: no major activities:
  - Firmware reprogrammed on all DFBs to fix long-standing problems (dataflow and configurations errors, roms needed to be rebooted after FEE power-cycled)
  - FEE crates power cables replaced.
  - Epics changes (runnable flag updated, scalar thresholds increased,…).
  - Usual activities (fan tray cleaned, SOB water analyzed,…).
- Run IV Operations: DIRC running well
  - HV problems require crate change, replace couple of modules
  - several Xmas Tree PMTs unplugged.
  - ramp down during injection (to limit accumulated charge on the PMTs).
  - air flush system installed to keep He from PMTs
  - phi asymmetry problem in data readout
    - timing lost when ROMs rebooted during high beam backgrounds
    - workaround developed: sequencing of reboot and configure for ROM and TDC critical. (cause under investigation)

Trickle: Increase in singles rate in bottom sectors in phase with injection but has no effect on the PID performance of the DIRC.

EMC

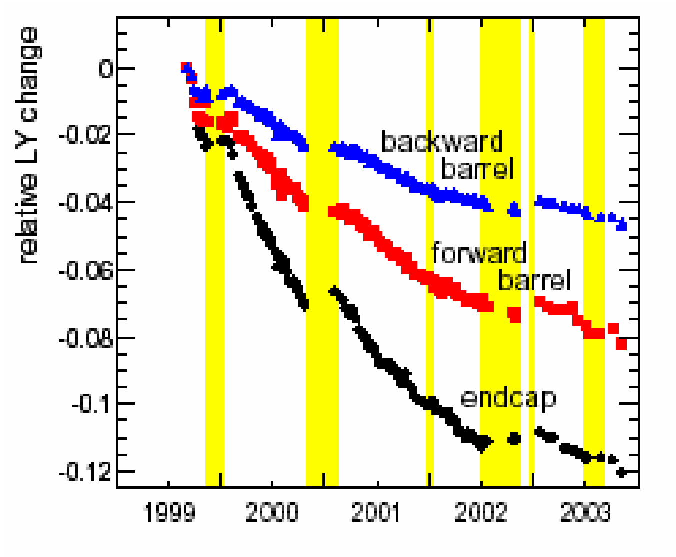
- New Neutron generator installed
- Source calibration takes ≤ 30′
- Go to calibration every ~month using naturally occurring down times

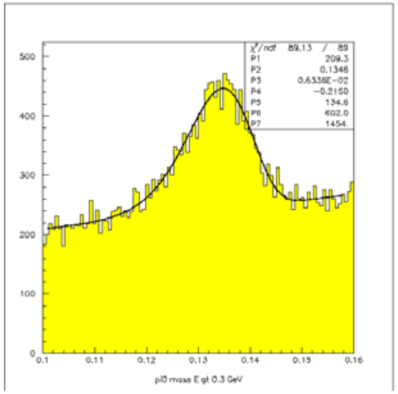
LV Power Supply fans system improved for ease of replacement

Light Pulser stability returns with replacement of air conditioner over holidays.

Routine upkeep of electronics

Light Yield





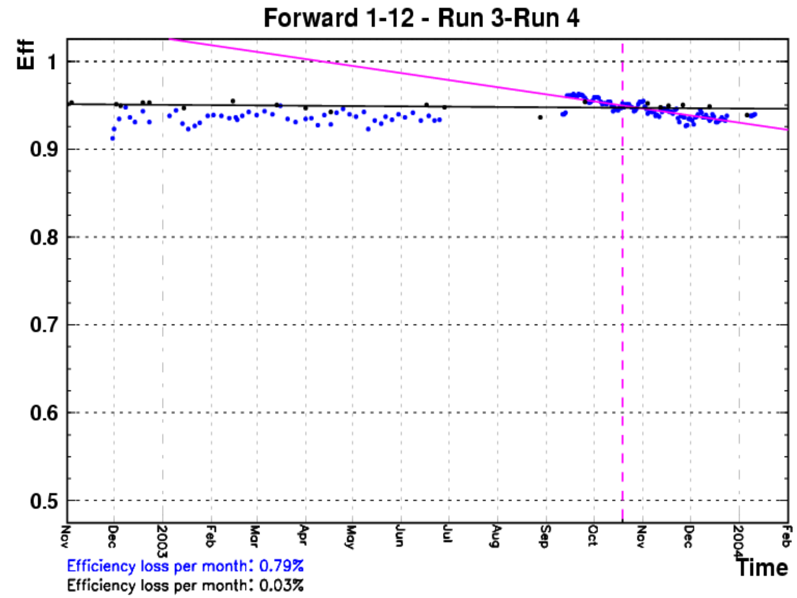
Trickle: π^0 mass and yield consistent with non-trickle runs

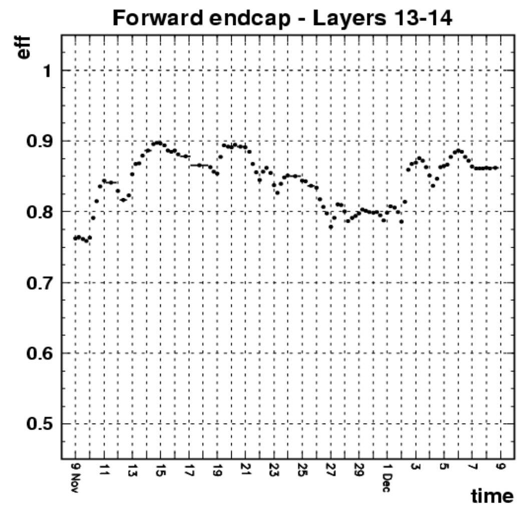
IFR (RPC)

- Gas
  - Finished installation of new distribution and bubbler boxes in barrel and Backward endcap
  - All gas channels monitored and in the database
  - Gas flow increased
    - 4-8 vol./day in Forward
    - ~ 3 vol./day in Barrel
    - 2-3 vol./day in Backward
  - Improved temperature control of mixing system gas lines
- High Voltage
  - Finer segmentation of HV groups
  - Raised Barrel HVs
- Monitoring
  - OPR efficiency measurements
- Background studies

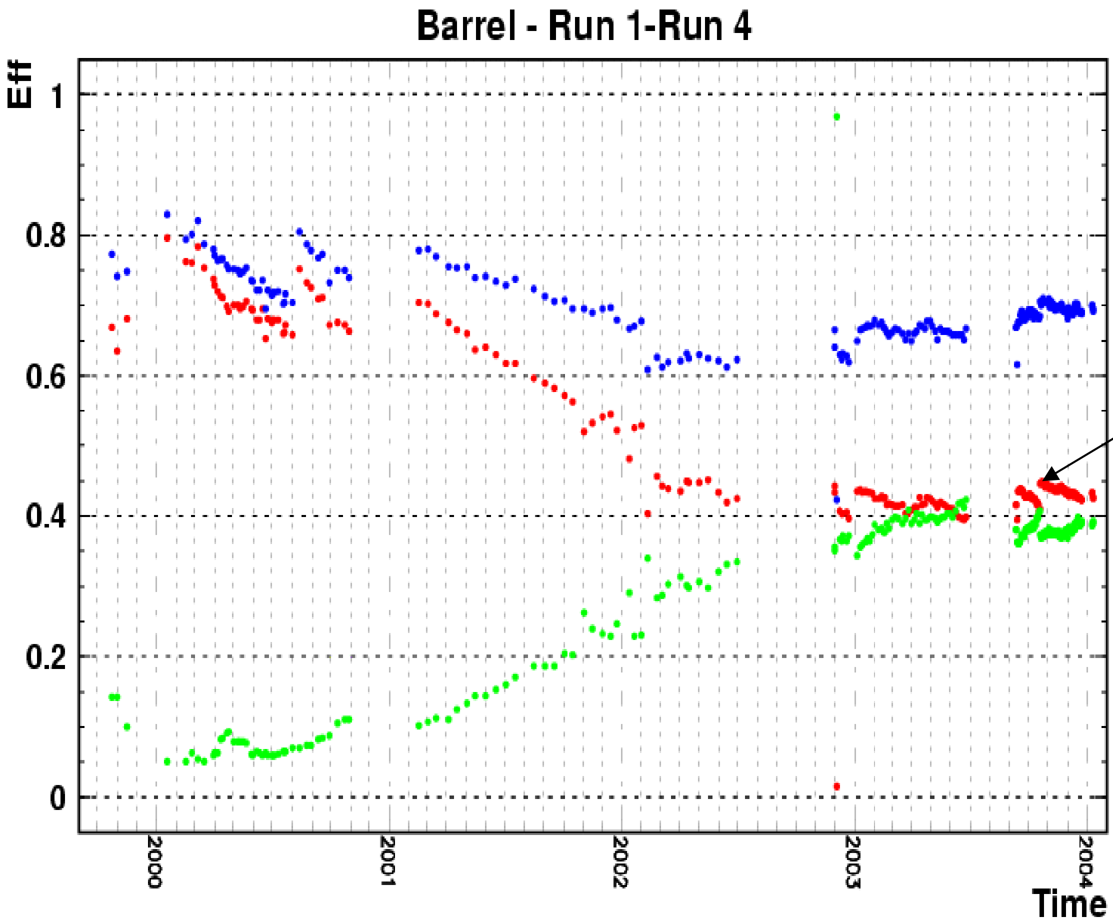
RPC Efficiency

- RPC Efficiencies measured with μ pairs.
- Forward
  - efficiency measured with cosmics flat
  - efficiency with data shows small decrease in Run 4
  - high backgrounds reduce endcap efficiency
  - Layer 14 (5/6) and 13 (1/6)
  - add shielding wall
  - water studies





RPC Efficiency



- Average efficiency
- Average efficiency of chambers with efficiency > 10 %
- Percentage of chambers with efficiency < 10 %

Efficiency gain due to the HV raise (~ +4%)

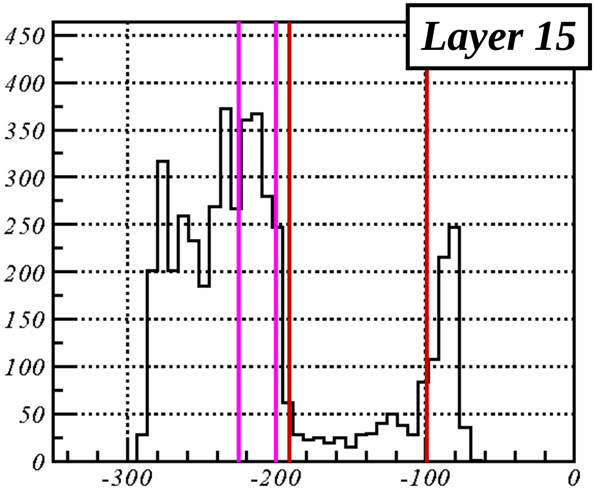
17% disconnected from HV

20% @ 7600 V (old nominal)

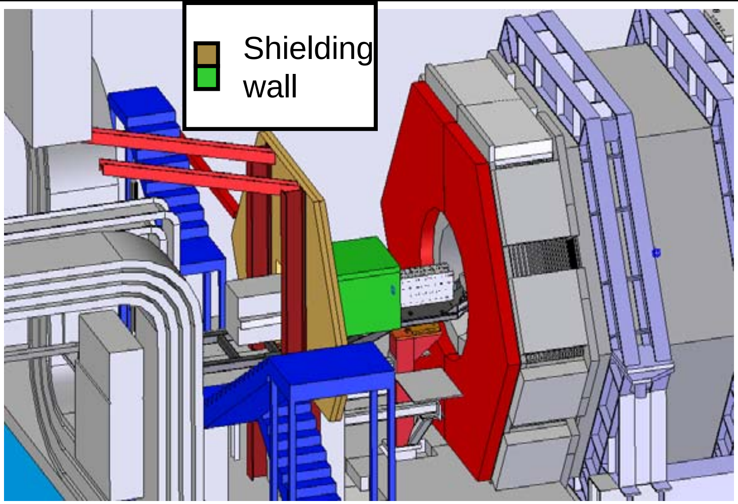
47% @ 8000 V

16% @ 8400 V (½ of Sextants 1 & 4)

RPC Shielding & Trickle Performance



Shadow of steel block on Layer 15



Complete installation Summer '04

- Trickle Experience

  Currents lower than 'normal operation'

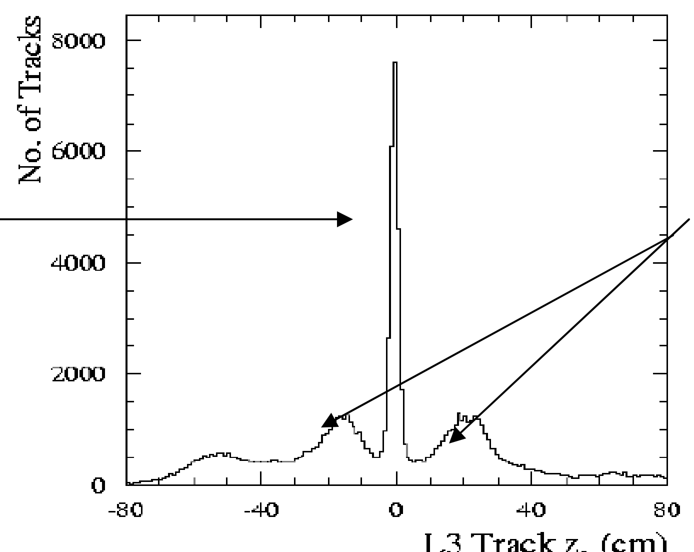
  No forward endcap HV trips. LV ok.

  Effects of trickle seen out to 30ms in phase 300-409

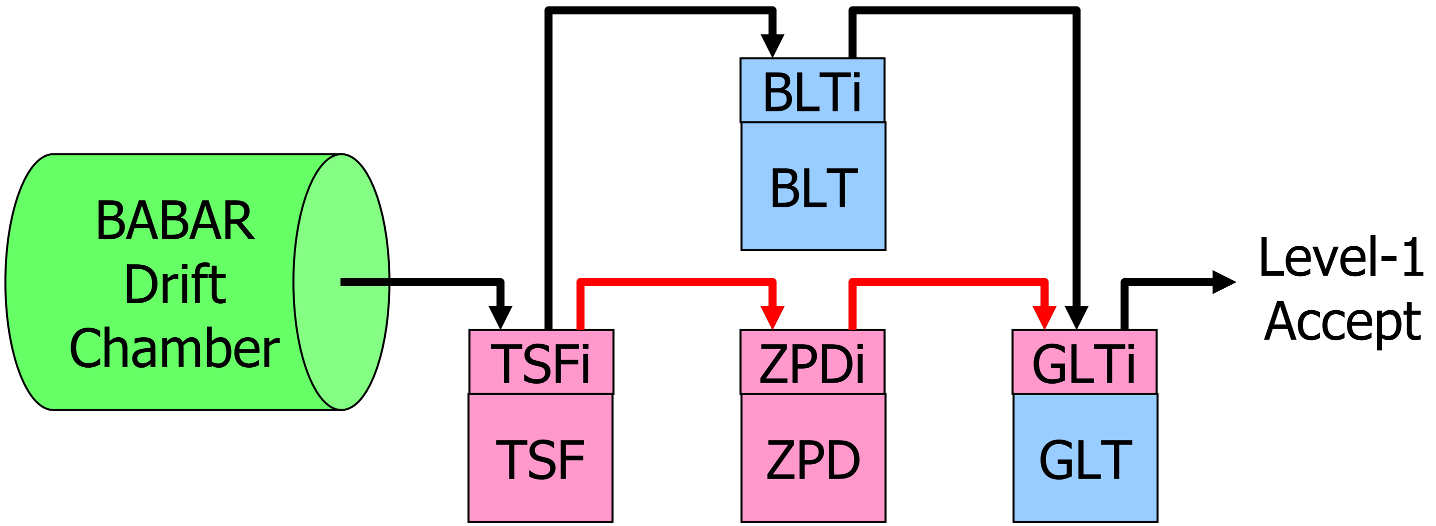
  Sensitivity in phase broader than other detectors

Trigger: Level 1 Upgrade

- Level 1 DCT (current) selects tracks with high Pt (PTD)
- New system (DCZ) will also allow to select on track Z_0
  - Will reduce L1 rate due to beam related background by cutting on the Z_0 of the track
  - Essential for running at luminosities > $\sim 10^{34}$



Trigger: L1 Upgrade



Need:

- 8 ZPD boards (to do the track fit in 3D)
- 24 New TSF boards to replace existing TSF (need to ship out axial & stereo layers to ZPD)
- Interface cards (24 TSFi, 8 ZPDi and 1 GLTi)
- Some modification to the GLT firmware

Trigger: L1 Upgrade

- TSF production: boards in production for arrival June
- ZPD production done Fall 2003. Boards test OK.
- Interface board production complete, testing in progress with no problems yet. GLTi production by the end of the month
- Partial DCZ system is running in IR2. Commissioning has proceeded well; system features understood.
- Triggering of BaBar with the new trigger in July

Trigger

- Level 1 Upgrades
  - EMT patch panel replacement was complete; this cured the hot tower problem at the EMT end. UPC firmware version correction fixes longstanding puzzle at that end. Another panel will be replace summer '04
- Level 3
  - Running smoothly; Bhabha pre-scales adjusted for lum.
  - Trickle injection: see ~no event level dead-time; record with time of most recent injection in every event for easier offline studies.

LST Milestones (I)

- ***Dec 15 '02 -- BaBar chooses LST for IFR Upgrade***
- ***June 12 '03 -- EPAC Review Approves LST Proposal***
- June 15 -- Cost/Schedule/WBS prepared
- ***June 22 -- INFN Gruppo Uno Evaluation***
- June 27 -- BaBar IFC Approves IFR Upgrade Project
- June 30 -- Choose Large-Cell Design
- ***July 17 -- Electronics Design Review***
- Aug 1 -- Place Orders for Tubes & Small parts
- ***Aug 26 -- Q/A Review***
- Aug 27 -- Install Test Module in BaBar
- ***Sept 3 -- Fire safety approval for tubes, strips, cables)***
- Oct 1 -- Decide to read out Phi via wire signals
- ***Oct 22 -- Mechanical, Schedule, & Budget Review***
- Nov 10 -- **Tube Production begins!**
- Nov 30 -- Orders placed for components: electronics, crates, HV system, signal cables, HV cables
- Dec 15 -- ϕ plane/Z-strip production begins at SLAC
- Dec 18 -- First shipment (24 tubes) to Princeton/OSU

LST Milestones (II)

- Jan 7 -- Q/C systems operational at OSU, Princeton
- Jan 9 -- First module assembled at Princeton
- ***Jan 12 -- Presentation to BaBar International Finance Committee***
- Jan 14 -- First module passes Q/C tests
- Jan 31 -- Prototype FEC tested on wire and strip signals
- Feb 15 -- First 2 modules shipped to SLAC, one installed in BaBar
- Feb 17 -- First container (168 tubes) shipped from Italy to Princeton
- Mar 2 -- Second container (168 tubes incl. layer 18) shipped
- Mar 3 -- Transition boards for 2 sextants delivered to P'ton &OSU.
- Mar 29 -- First container of 168 tubes arrives (finally!)
- Apr 12 -- Second container of 168 tubes arrives in Princeton
- ***Apr 5 -- Electronics Readiness Review,*** system test at SLAC
  - -- First HV Crates to SLAC
  - -- Installation tooling complete
  - -- IFR Test Stand reconstituted in CEH
  - -- Gas system assembled, under test at SLAC
- **May 4 -- 3rd shipment (192 Tubes) [all tubes needed for 2 sextants]**

May 6 -- Installation Readiness Review

May 15 -- Signal cables delivered

May 18 -- 4th shipment (168 Tubes) from PHT

June 1 -- 160 LST modules arrive at SLAC from Princeton and OSU

Arrival of LSTs at SLAC

Remaining 2004 Milestones

- June 15 -- HV Cables for 2 sextants to SLAC
- June 8 -- **Ship all modules for 2 sextants from OSU and P'ton**
- June 15 -- 5th, 6th shipments (168 tubes ea) shipped from PHT
  - **-- All HV supplies for 2 sextants to SLAC**
  - **-- All Modules for 2 sextants arrive at SLAC**
  - -- Q/C for all tubes for 2 sextants underway at SLAC
- *June 29 -- Safety Procedures Review*
- **June 30 -- All Electronics,crates, backplanes to SLAC**
- **July 8 -- 7th, 8th shipments (168 Tubes) from PHT [Final Shipment]**
- **July 15 -- Trigger boards to SLAC**

- Installation: hall crew 2 shifts/day, 6 days/week. Commissioning during owl shift and on Sundays. Non-IFR work will not interfere with installation

- Aug 3 -- RPC Removal begins
- Aug 15 -- Install First Layer (18 Bottom)
- Sept 4 -- Bottom Sextant Complete
- **Oct 6 -- Installation Complete**
- Oct 10 -- Close Detector
- **Oct 15 -- Detector buttoned up, Run 5 Begins**

LST Tube Production Status

	enteir production cumulative	%	8 cell 358cm cumulative	%	8 cell 318cm cumulative	%	7 cell 358cm cumulative	%
Due	1350	100	950	-	144	-	256	-
Assembled	1418	105.037	1003	105.5789	150	104.1667	265	103.5156
Conditioning OK	1282	94.96296	-	-	-	-	-	-
Plateau OK	1271	94.14815	-	-	-	-	-	-
Scan OK	1218	90.22222	-	-	-	-	-	-
L.T.T. OK	533	39.48148	-	-	-	-	-	-
Shipped	725	53.7037	336	35.36842	24	16.66667	0	0

	2004 Installation cumulative	%	8 cell 358cm cumulative	%	8 cell 318cm cumulative	%	7 cell 358cm cumulative	%
Due	450	100	316	-	48	-	86	-
Assembled	1418	315.1111	1003	317.4051	150	312.5	265	308.1395
Conditioning OK	1282	284.8889	-	-	-	-	-	-
Plateau OK	1271	282.4444	-	-	-	-	-	-
Scan OK	1218	270.6667	-	-	-	-	-	-
L.T.T. OK	533	118.4444	-	-	-	-	-	-
Shipped	725	161.1111	336	106.3291	24	50	0	0

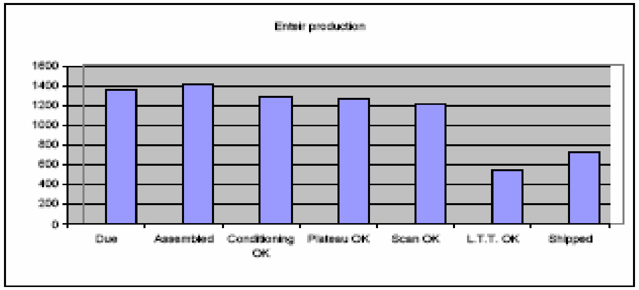
Present situation at PHT	
waiting for conditioning	0
under conditioning	132
waiting for scan test	42
waiting for L.T.T.	88
on L.T.T.	332
total in test phase	594

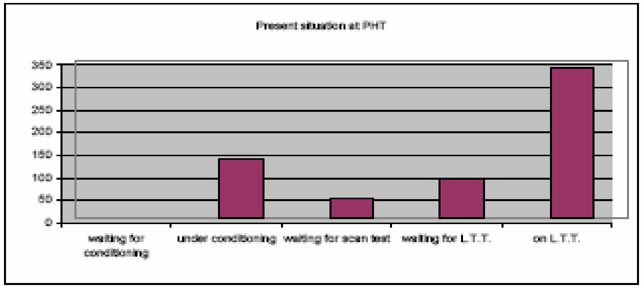
This week	
assembled	63
started conditioning	66
finished conditioning	66
measured plateau	66
scanned	57
started L.T.T.	24

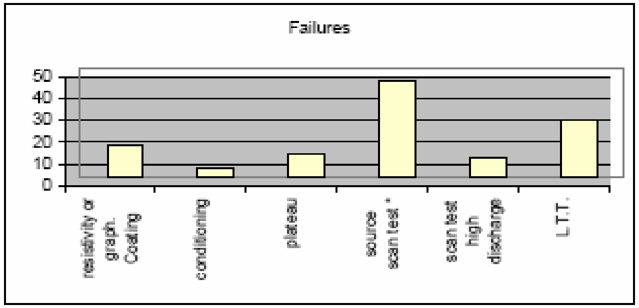
Failures	
resistivity or graph. Coating	15
conditioning	4
plateau	11
source scan test *	44
scan test high discharge	9
L.T.T.	26
total rejected	65

* tubes which failed the scan test are put on long term test and not rejected

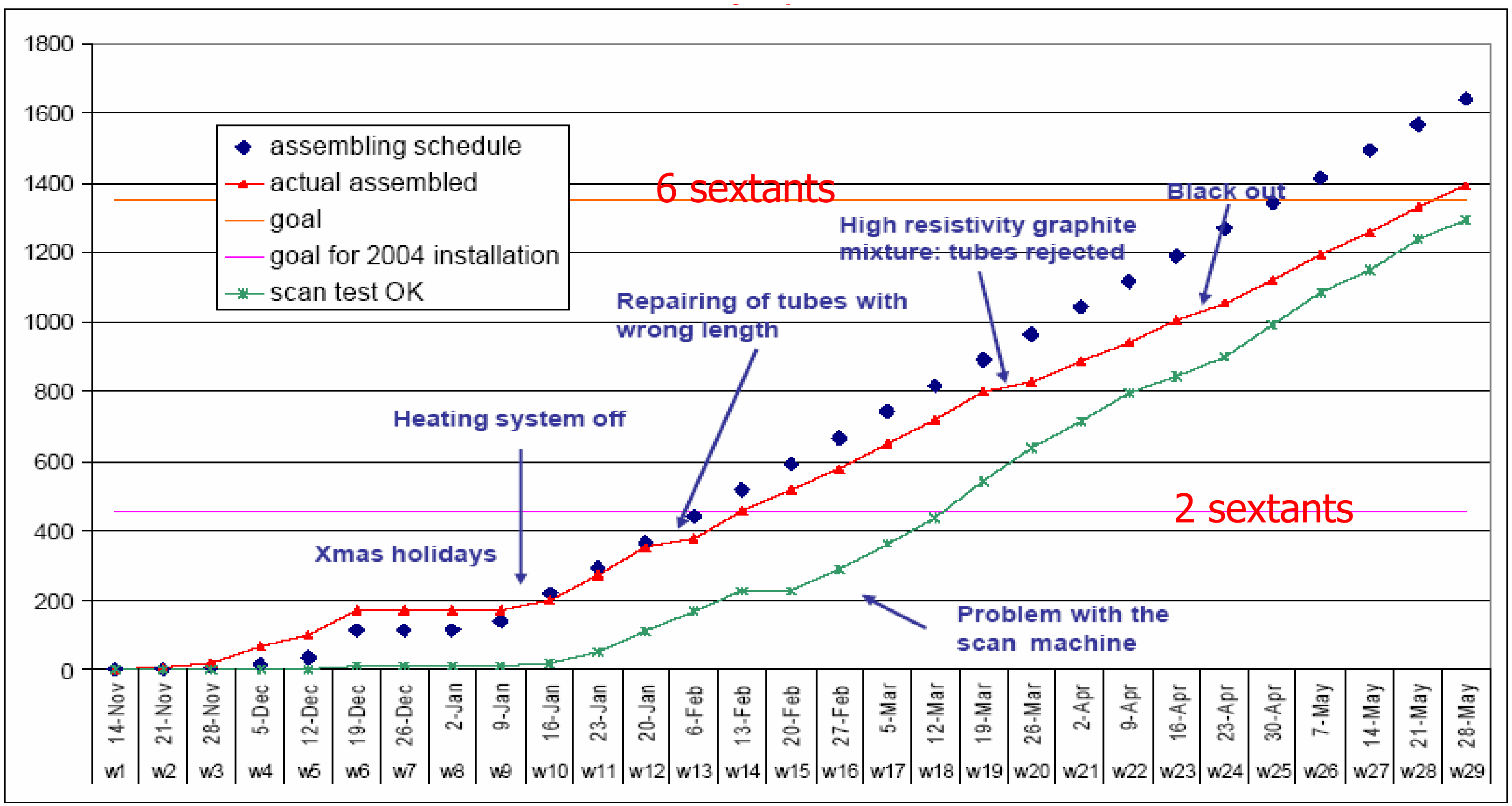
updated May. 30th 2004







LST Weekly Tube Production



LST Electronics Review

Review committee: D. Freytag, G. Haller, W. Innes, A. Lankford (chair),
M. Morii, J. Nash, D. Nelson, R. Rodriguez;
Consultants: M. Freytag, S. Luitz, C. O'Grady
Ex officio: W. Wisniewski

9:15 Introduction to the IFR/LST project

9:35 LST readout: summary of the requirements and features of the baseline design
(an overview of the whole project including cathode strips, cables, signal and utilities routing out of the IFR, the FE electronics)

10:55 Cost and schedule

11:15 Result of preliminary test on prototypes

11:45 The LST-FE crate
(covering the detailed description of the elements of the front end crate)

12:45 Lunch

14:00 The impact of the LST-FE electronics on the DAQ/slow control

14:20 HV power supply, control and monitoring

14:50 Test of the real system in IR2

15:10 Final questions and discussion betw. working group and committee

16:00 Committee closed session

17:00 Committee report to working group of conclusions

LST Electronics Review

Overview

A review of the electronics under design for the Limited Streamers Tubes (LST) of the BABAR Instrumented Flux Return (IFR) was held at SLAC on Thursday 17 July, 2003. The review committee and consultants consisted of the management of the BABAR Electronics System and experts from other detector front-end electronics systems and from other electronics subsystems interfacing with the LST electronics. The membership of the committee is listed above.

The review was comprehensive in that it covered all aspects of the LST electronics system, including the HV system and aspects of the detector controls, as well as the readout chain from its interface with the tubes through its interface with the data acquisition system. Detailed documentation was provided to the review committee in advance of the review. Presentations at the review included overviews of the IFR LST project and of the LST electronics system, reports on results from prototyping completed at the time of the review, description of the design of the system, plans for further work, and overview of cost and schedule. A verbal closeout at the end of the review provided committee recommendations to the group working on developing the system. The agenda is included in an appendix.

The review committee conclusions highlighted several design issues that needed further attention. Foremost among these issues concerned the location of the amplifiers, whether on the detector modules or in the front-end crate. A closely related issue was the need for further detailed understanding of the signal characteristics of LSTs of the geometry and gas gain planned for BABAR. Overall, the committee was very impressed by the work presented and the progress to date. The system design was found to be sound, to fit well within the design of the BABAR Electronics System, and to be feasible to realize considering the relatively short timescale available for development and production. The detailed recommendations of the review committee are summarized below.

LST Electronics Review

Recommendations

Documentation

- A number of important design documents were not available, including:
  - Design Requirements
    - Description of intrinsic signal properties
    - Including (list not inclusive):
      - Rate capability
      - Spatial resolution
      - Efficiency
        - Impacts threshold requirement
        - May impact choice of amplifier location
      - Timing
      - Failure rate
      - Signals for trigger
    - These influence required amplifier (and other) specifications
    - Will be needed to evaluate whether components and system mc requirements and are ready for production
    - Writing this document is not a task just for the engineering tear
  - System block diagram
    - Identifying relationship of components and interconnections
  - Grounding and shielding plan
    - Should be done now to guide planning for Test Tube implementation
  - Schedule
    - Will help keep project progressing as needed on aggressive timescale
- Completing these documents will be useful to design process, even in the presence of schedule pressures.

LST-FE crate and components

- Seriously consider deciding to use deeper (220mm) cards if space for crates permits
- Backplane
  - Reminder: Consider rearrangement of modules in crate to simplify backplane layout
    - For instance, some possibilities:
      - Incorporate CSC into custom backplane
      - Relocate modules within crate
      - Segment backplane
      - Use transition modules for output from LST-FE cards
  - Pay attention to design of 60MHz bussed ECL GCLK/60
    - Note: doesn't have to be ECL
    - ECL does not normally drive this many loads
    - Consider segmenting bus
- Reminder: define how many DAQ test stands needed
- CSC
  - Consider alternative configuration scheme via ODF instead of OI
    - E.g. implementation ala EMC
- Based on info presented, providing signals to ITB should be given very lo priority. Determining requirements for signals for IFT (and associated m should be given consideration now.
- LST-FE card
  - Schedule does not account for 2nd prototype iteration
    - May not be needed
    - If needed, aggressive schedule allows 2nd prototype with la delivery of production than planned, but still in time for Su 2004
    - If changes to 1st prototype and no 2nd prototype, then fabri articles (10-12 units) before full 1st lot
  - Positive feedback for plan to implement deadtimeless pipeline
- Positive feedback for crate monitoring conforming to ODC environment

Cable issues:

- Positive feedback for:
  - retainers on cable connectors
  - strain relief for cables
  - mounting of IADs on LST-FE with screws
- Produce cables as soon as possible, or well in advance of need

Grounding and Shielding:

- Concern for ability to maintain electrical isolation of modules from IFR iron following installation process, due to possible scratching/damage to thin insulating layer
- Documented grounding and shielding plan needed

Tests:

- Need to understand origin of negative pulses on adjacent phi strips
  - This level of understanding is relevant to performance issues such as extrapolating noise performance with respect to amplifier location
- Committee does not understand origin of wide signals on z-strips
  - (this comment may be out of date)
- Test environment for Test Tube should closely approximate real environment
  - Particularly regarding grounding and shielding
    - Consider making "metal" box without metal on edges and ends

High Voltage

- Positive feedback for use of CANbus interface for ODC
- Reminder: need to settle number of channels and number of cables
  - Requires trade studies
    - Include consideration of using existing Caen supplies with additional monitoring.
- Define required dynamic range for current monitoring.
- Reminder: pay attention to HV caps.
  - Care in choice
  - Be conservative
  - Keep as small as possible
- Consider likely presence of dirt entering racks.

Amplifier location

- Very important issue
- No tests with large tubes and new amplifier shaping reported.
- Location of amplifiers on modules should not be ruled out.
- Location on modules
  - offers robustness against noise pickup,
  - but requires demonstration of robustness against catastrophic failure during discharge or series of streamers along tube
- Location in FE crates
  - If this location is chosen, then must demonstrate sufficient noise immunity.
    - Challenging to establish enough confidence in noise immunity based on small scale tests in lab or IR.
- Establish an appropriate milestone for choice of amplifier location.
- May consider incorporating an optional amplifier into transition PCB (or similar location).

LST QA Review

- Past experience: QA critical to good performance of LSTs.
- Reviewers: Jaroslav Va'vra (chair); Giorgio Maggi; Darren Marsh
- Limitation: working to a tight schedule during late July & August: vacations, closed departments, etc. versus need to have the QA plan in place by September
- Are you satisfied that the LST team has a credible QA Plan?
- Process:
  - LST team completes QA plan and distributes it to reviewers Aug 6 (17 pages)
  - Reviewers examine plan for completeness, submit comments for changes, questions for clarification
  - LST team answers questions, amends plan ASAP
  - Reviewers determine if responses are satisfactory. Result: no need for additional round of review via teleconference, which could have included webpage presentations.
  - Comments from committee follow.

QA Q & A

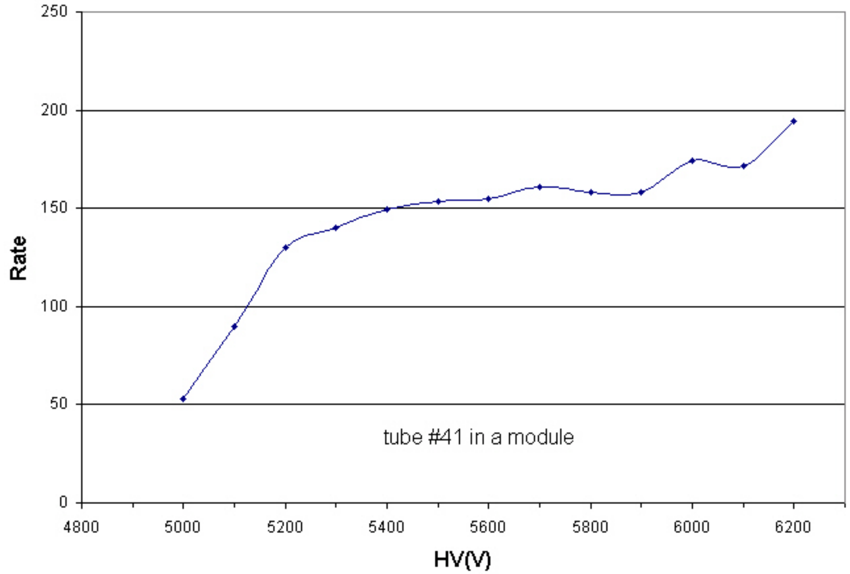
- The reviewers had ~30 questions requiring detailed responses. These were concerned with, among others:
  - Appoint a QA czar? Level of clean room required? Wire cleaning? Wire tension test? Extrusion straightness test? Material coupons for paint? Damage from probes for resistivity measure? Radioactive source test? Aging & amplifiers? Avoid changes from past experiments…
  - PVC extrusion company experience? Preproduction issues? Czar? Gloves? Why so many resistivity measurements? Gas tightness? Shipping box details? Transportation damage checks issue.
  - Post clean room requirements. Problem resolution? Stringing. PCB soldering check? Strip rejection? Spec values rather than 'small or zero'. Control of glues and epoxies. Decide to proceed ?

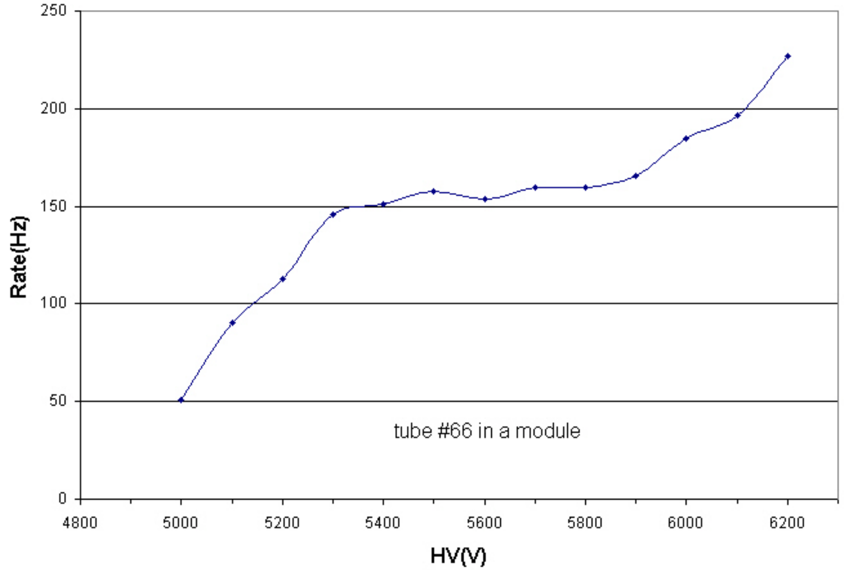
QA Reviewer Signoff

- Opinion of three reviewers that the QA plan plus the Q&A satisfied them that QA was adequate:
  - "…the answers provided show that the questions were taken seriously…These people are very experienced."
  - " I have reviewed the responses to our comments and questions and believe the LST Manufacturing Team has a good handle on the process controls needed to ensure requirements are met."
  - "As far as I am concerned, I am quite satisfied…I have learned that ….the company involved has great experience. That there is a person named to be in charge of production and QC…That the production rate will be low initially and there is a plan to QC the tubes produced and review the results early…'clean room practice' … is accepted."

Effect of QA Program

Plateaux from first module assembled at Princeton

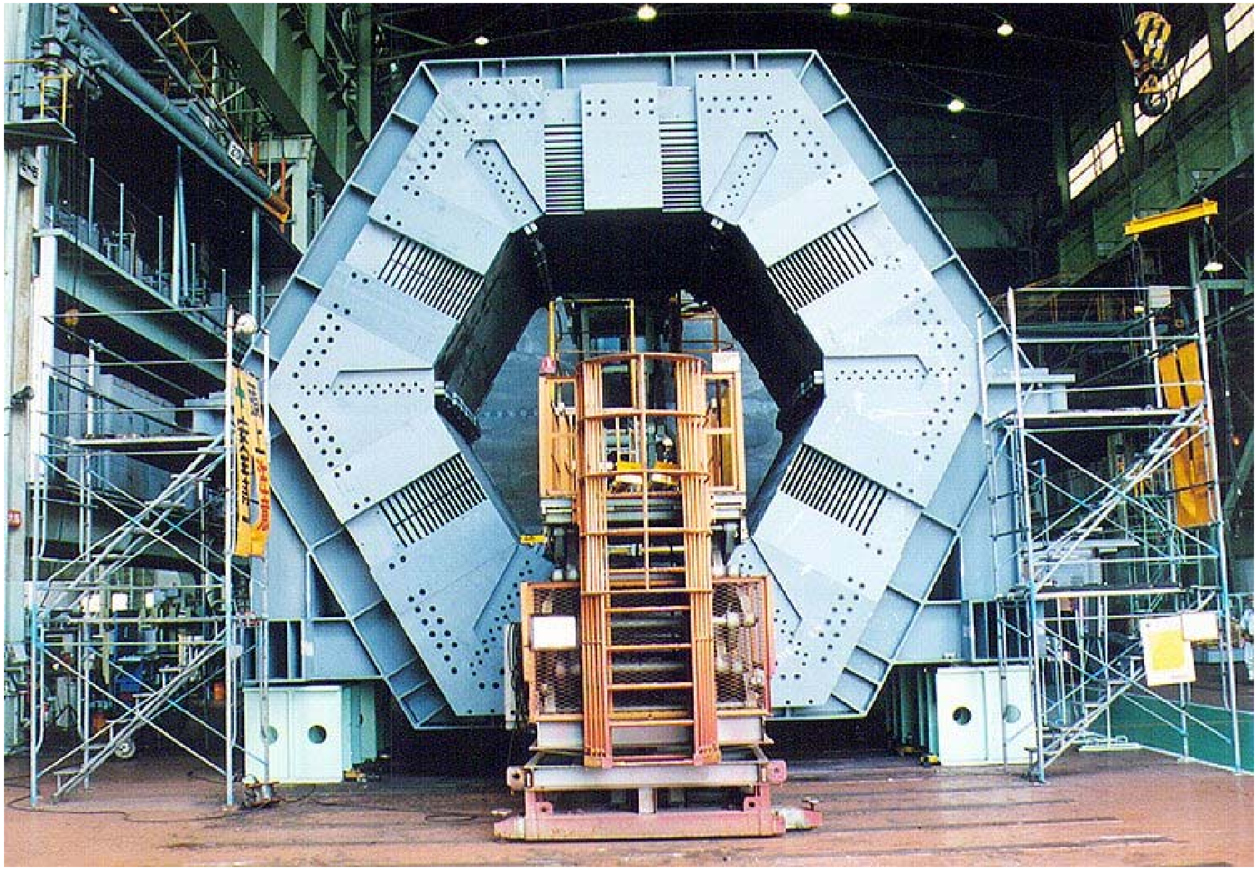




"The other thing is that I hope you and everyone else realizes that all the work for QA/QC is accomplishing a lot. My experience with SLD would have projected to 5-6 bad tubes out of the 16 tubes you are testing. About half of that number would have refused to take any HV at all. This is really impressive given the abuse the boxes received."

Bob Messner, SLD LST czar, in note to BaBar LST group

Vast disassembly…



LST Mechanical, Schedule & Budget Review

BaBar Barrel IFR Upgrade Mechanical, Schedule and Cost Review
Charge to the Committee
(W. Althouse, G. Bowden, G. Deis (chair), F. Raffaelli, J. Weisend)

The BaBar Instrumented Flux Return (IFR) system consists of the return yoke of the superconducting solenoid magnet along with instrumentation used to detect the passage of particles (μ's, π's and long-lived neutral kaons). The steel is arrayed in sextants consisting of 18 layers of steel with thickness increasing radially outward. Resistive Plate Chambers (RPCs) constitute the sensors located in the slots between the steel layers. The performance of the RPCs has been decaying since the start of the experiment. The performance in the barrel has now decreased sufficiently that the sensor elements must be replaced. The problems that have been found with the 'monolithic' RPCs have led BaBar to choose a better understood and more robust sensor technology, Limited Streamer Tubes (LSTs), to replace them. It is expected that this more modular technology will last reliably through the balance of the decade.

The barrel RPC system has 19 layers of sensor. The outermost of these layers can not be accessed. In order to more than compensate for the loss of the last layer of steel absorber, six of the gaps between the steel plates will be filled with brass.

Charge (cont'd)

Access to the RPCs is limited by the array of steel that covers the ends of the barrel and provides a connection path from the barrel to the endcap for the magnetic field. In order to remove the RPCs, these parts of the barrel structure which have been in place since the construction of the experiment will need to be removed. Engineering studies have been conducted to understand the stability of the barrel structure under the increased load from the brass while the structure is partially disassembled. Four of eight magnet vessel restraints will be disconnected during the first phase of the installation, when the top and bottom sextants will be upgraded. The four supports for the barrel calorimeter are attached to the steel corner blocks. Two of these blocks will be removed during the second phase of the upgrade, requiring a transfer of the calorimeter load. Please evaluate the adequacy of the engineering studies performed thus far. Are they moving in the right direction in cases where they are not yet complete? Can we put the detector together again?

Tooling and platforms will be needed for removal and restoration of the steel, for insertion of the brass absorber, and for the installation of the LSTs. Please comment on the status of the design of these items, as well as mechanical design of the LST modules. The sensor elements will require services: gas, readout cables, high voltage system. Is the plan for integration of these services on the BaBar detector adequate? Are safety considerations receiving sufficient attention?

Charge (cont'd)

The installation of the LSTs, brass and services is expected to be a complicated task. Installation plans have been developed. Manpower estimates have been made based on schedules which aim to minimize downtime, since BaBar is engaged in competition with another experiment. The schedule for summer 2004, when the first phase of installation will occur, is driven by the desire to match as closely as possible the normal two month machine shutdown. In 2005 the second phase of barrel upgrade will take place, as well as repairs to the Silicon Vertex Detector and upgrade of beam line elements also contained with it in the support tube. Due to the complexity of this multi-system upgrade, it is expected that it will take significantly longer. The 2005 schedule is less mature than that of 2004. Please comment on the installation plan. Does the manpower estimated appear adequate? Is there enough float in the 2004 schedule, or is it a very success oriented schedule? Is the time estimated to be needed in 2005 adequate?

Finally, please consider the cost estimates and WBS for this upgrade. Please comment on their maturity and adequacy.

Please provide your preliminary feedback via a closeout session on the afternoon of the second day of this review, with a written report to follow.

Project Review Agenda

- Introduction & Charge
- Mech/Elect Engineering & Design Manpower & Org Chart
- Overview of BaBar Steel Design
- Brass Absorber Design
- Earthquake Analysis
- Mechanical Engineering Analysis
- LST Schedule & Milestones
- LST Design
- Handling & Installation Fixture Status
- EMC Load Transfer Fixture
- Installation Platforms & Positioners
- S.C. Solenoid Issues
- LST Gas System
- Utility Routing, Cableways & Crate Locations
- LST Storage and Testing
- Hazard Analysis & Safety Oversight
- WBS & Cost Estimate
- Mechanical Installation Preparation
- 2004 Brass Absorber Installation
- LST Installation, Connection & Checkout
- IR-2 Installation Manpower & Org Chart
- 2004 IR-2 Installation Schedule
- 2005 IR-2 Installation Discussion

BaBar IFR Mechanical, Schedule Cost Review Outbriefing (1)

- **Excellent job on preparing and presenting review**
- **Overall, the Committee feels that the project is on track and there are no technical show-stoppers**
- **Risks for 2004 installation are resolved**
- **Some risks for 2005 installation remain, but there is adequate time to resolve them and to incorporate lessons from 2004**

BaBar IFR Mechanical, Schedule Cost Review Outbriefing (2)

- **Adequacy of engineering studies?**
  - — Overall, the engineering studies are at an appropriate state of development, and are moving in the right direction
- **Status of the design of tooling, platforms, and LSTs?**
  - — The design of the tooling and platforms appears to be in very good shape for this stage of the project. The mechanical design of the LSTs is mature and sound
- **Integration of gas, cables, HV systems?**
  - — Good drawings of proposed routings exist, but integration of those routings with other detector systems appears risky.
- **Safety considerations?**
  - — Safety attention so far has been good. More formal safety planning is required in the immediate future, to ensure that adequate resources and training will be available when the shutdown begins
  - — Small work areas, multiple shifts, aggressive schedule, increase risk of accident
    - » Continuous presence of safety officers on all three shifts is required
    - » Safety staffing must consider overload

BaBar IFR Mechanical, Schedule Cost Review Outbriefing (3)

- **Installation plan?**
  - — Installation planning is extremely well-done, detailed, complete
  - — Very success-oriented! No float! Risky!
  - — 2004 schedule of 2.5 months, is extremely optimistic
  - — Risks and choices (e.g., number of sextants vs. schedule duration, frequency/impact of tours) should be discussed with SLAC management, so that management is aware and can participate in tradeoffs
  - — Good effort in identifying risk-mitigation approaches. Continue looking for such opportunities
    - » Prototyping/mockups of equipment and procedures
      - = Consider mockup of full z and full x together

- **WBS and costs?**
  - — Very well-developed and detailed WBS and cost estimate
  - — Costs seem appropriate
  - — Top-level budget summary is not clear to us

BaBar IFR Mechanical, Schedule Cost Review Outbriefing (4)

- **Other Recommendations**

  — Project leaders should place more emphasis on technical and programmatic coordination across the entire (LST + installation) project

  » System managers should take full ownership of the project

  » One schedule, including all activities, is needed

  » Must be mindful of the need for coordination of LST systems with other detector systems

  » Integration of testing and QC into the project

  » Continue coordination with the rest of SLAC on downtime activities. Start assembling complete downtime task list soon

  — Review cable tray loading with relevant SLAC experts (P. Anthony)

BaBar IFR Mechanical, Schedule Cost Review Outbriefing (5)

- **Other Recommendations**

  — RPC removal technique appears risky, and would benefit from more consideration, with an eye toward more determinism

  — Design concept for the temporary EMC support is a good start. It is very important to work out the procedural details and then perform a stepwise mechanical analysis of each intermediate state to confirm that the load can be transferred in a deterministic and controlled manner without risking any of the detector hardware.

  — Encourage photo-documentation during both installations

  — Consider holding Production Readiness Review for LST manufacturing

LST Cost Estimate History

- Estimate at time of technology selection in Dec ’02, when 1 Euro = $1.01, with contingencies ~30% included:
  - ‘Detectors’ (LSTs and associated electronics, etc): $1.4M
  - ‘Hall Work’ (Engineering, tooling, installation): $2.9M

- Budget refined Jun ‘03:
  - ‘Detectors’ consideration of design and manufacture (module assembly labor, crates and shipping, quality assurance, installation, project management): $1.75M US + ~$.75M INFN (exchange dependent)(M&S contributions are equal; INFN ED&I, labor at comparable level)
  - ‘Hall Work’ consideration of likely older workforce: $3.55M

LST Cost Estimate History

- Budget refinement process for ‘detectors’
  - Between June and October, many engineering estimates are turned into firm quotes and contracts. The overall ‘detectors’ cost stands at $2.4M.
    - 1 Euro = $1.17. Effect on LST tubes Dec ’02 to Oct ‘03: ~$74K
- Budget Review (Oct 22)
  - An unclear response to reviewers questions causes a re-evaluation of costs. ‘Hall Work’ was burdened, but we found that salaries did not include benefits (~30%), also some items were not included in earlier sums.
- Current budget: $4.9M (DOE) + ~$.8M (INFN)(does not include salaries of techs and engineers) + $.2M IFC (brass, non-DOE) + $.6M IFC (detectors)

LST Installation Readiness Review

The Charge

Installation of the LSTs in the IFR Barrel is less than three months away.Please evaluate the readiness of the team to perform this installation considering:

1. design and production of the fixturing for steel removal and brass installation
2. production of the LST tubes and modules, their delivery, and status of their testing including plans for testing burn-in at SLAC
3. production of the phi and Z strips
4. construction of the gas system, hurdles to be passed before its use
5. production and testing of the high voltage system
6. design, performance and production of front end electronics
7. design and installation plan for the infrastructure related to system readout: cables, crates, racks, platforms
8. installation and testing of the installed LSTs (is test data accessible for comparison on installation?)
9. readiness of installation platforms and tooling; adequacy of pre-installation exercises
10. adequacy of safety planning (hazards analysis), oversight and monitoring
11. adequacy of manpower for the installation; identification and organization of that manpower
12. progress in understanding the detailed installation schedule: interplay of mechanical work with commissioning

Wednesday, May 5, 2004

PART I: PRODUCTION AND FABRICATION

Item	Person	Duration	Time
Committee Closed Session		30 min	08:30
Introduction	Bill Wisniewski	5 min	09:00
LST Production and Assembly	Stew Smith	20 min	09:05
Brass Absorber Production	Jim Krebs	5 min	09:25
LST Gas System	Robert Messner	10 min	09:30
Racks, Crates & Cableways	Peter Kim	20 min	09:40
Break		**15 min**	**10:00**

PART II: INSTALLATION

Item	Person	Duration	Time
LST High Voltage System		15 min	10:15
Z Strip Production	Rafe Schindler	15 min	10:30
LST Storage and Testing	Carsten Hast	15 min	10:45
LST Installation, Connection & Checkout	Bill Sands	30 min	11:00
IR-2 Installation Manpower & Org Chart	Jim Krebs	10 min	11:30
Hazard Analysis & Safety Oversight	Frank O'Neill	20 min	11:40
Lunch		**60 min**	**12:00**
Mechanical Installation Preparation	Jim Krebs	30 min	13:00
2004 IR-2 Installation Schedule	Jim Krebs	60 min	13:30
Review Committee Meeting		30 min	14:30
Breakout Session		60 min	15:00
Closeout Meeting		30 min	16:00

LST Installation Readiness Review

Report of the review committee

William Althouse, Gordon Bowden, John Weisend, (David Nelson), Walt Innes (Chair)

Executive Summary

The LST group is to be commended for the tremendous amount that they have accomplished since the last review. The project as a whole appears in excellent shape ar on track for the August installation. The quality of the design and production is very hig and we fully expect a successful installation. There are a small number of areas which could result in schedule slip, most of which the experimenters are well aware.

One is the funding of the non-SLAC U.S. institutional partners. In particular the Colora State funding is critical to the timely delivery of the HV cables.

Another is the lack of detailed schedules for the gas system and the rack and tray infrastructure.

The committee echoes the experimenters concern for safety versus the tight success oriented schedule. Safety must not be neglected in order to stay on schedule.

In case of schedule slip, we suggest this summer's work be completed even if it takes as much as two weeks longer than planned. The overhead of beginning and stopping an effort such as this admits no other logical choice.

The report contains six more pages of findings and comments addressing all the elements of the charge:

- LSTs appear to be a real improvement
- installation plan detailed, well-developed, success-oriented
- best to test procedures asap
- good job on identifying needed manpower

Summer 2004 Safety

From the installation readiness review report:

The project clearly understands the importance of safety and the relatively high risk associated with the extensive amount of work being done in a short period of time. F. O'Neill and S. Pierson have done a good job in developing a safety program for the project. The use of dedicated safety officers on each shift is a key component, and the requirement that each safety officer only cover 2 eight hour shifts a week is the right way to prevent burnout. The continuing use of job hazard analysis and safety reviews at the daily meeting will also help safety.

All people working in IR2 this summer will complete training in safety issues, including job hazard analysis and use of equipment

Summer 2005

- Baseline Plan: in a long shutdown (~5 months), install 4 diagonal sextants of LSTs; remove support tube for modifications of final focus permanent magnet configuration as well as replacement of damaged SVT ladders.
- Alternate Plan
  - Don't repair SVT (occupancy & rad damage): accept some loss of acceptance in the horizontal (SVT Long Term Task Force). This would allow a shorter shutdown in 2005 during which two/three of the four diagonal LST sextants are installed, with the balance in the following year.