E949
K-025
November 12, 2002
(revised December 14, 2004)

Experiment 949
Technical Note No. 25
Summary of the 2002 dataset and Pass0 processing

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Abstract

This technote describes some features of the 2002 data set and the processing of that data through Pass0.

The 2002 run (which was run during US FY02) continued from January 27, 2002 – June 9, 2002, with a one month interruption for an attempted repair of Separator #1, February 7, 2002 – March 7, 2002 and a 10 day break for a NASA run April 6–17, 2002. The Pass0 processing took place at BNL from July 5, 2002 through August 28, 2002. Much of this time was spent getting bnlku9 tuned up to handle the large SCSI volume (many crashes). The average number of tapes processed per week during 'relatively smooth' running was 40.

Our current best estimate for the Pass1 processing is to include runs 47592–50218 (tapes 30217–30398). See Section 4 for more details.

E949 Run	start	end	1^{st} run	last	1^{st} tape	last	LBp#	LBp#	$\|\vec{p}\|$	#tps
Cosmic-1	3/3/01	3/24/01	40823	41040	—	—	1p1	1p37		0
2001 g–2	3/24/01	4/21/01	41041	41766	—	—	1p38	2p53	710	0
Cosmic-2	6/28/01	8/31/01	42237	42909	30001	30015	2p53	4p18		15
2001 (RHIC)	8/31/01	11/8/01	42910	46097	30015	30100	4p18	8p50	710	123
2001 Total	2/15/01	11/8/01	40000	46097	30000	30100	1p1	8p50	710	135
Cosmic-3	1/14/02	1/29/02	46116	46314	30200	30203	8p51	ELOG		4
2002 #1	1/29/02	2/7/02	46315	46882	30203	30209	ELOG	—	710	13
Cosmic-4	2/7/02	3/7/02	46883	47405	30209	30215	ELOG	—		14
2002 #2	3/7/02	4/6/02	47406	48734	30215	30276	ELOG	—	710	182
Cosmic-5	4/6/02	4/19/02	48735	48828	30276	30279	ELOG	—		6
2002 #3	4/19/02	6/9/02	48830	50218	30280	30398	ELOG	—	710	351
Cosmic-6	6/10/02	6/11/02	50219	50234	30398	30399	ELOG	—		4
2002 Total	1/29/02	6/9/02	46116	50234	30200	30399	8p51	ELOG	710	575

Table 1: Summary of E949 runs.

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These numbers and conclusions were reached from analysis of the 2002 Pass0 job and from analysis of the 2002 monitor triggers, scaler records, run_log, and from searching through the logbooks and ELOG ...

1 2002 Run

1.1 Detector/Trigger/DAQ Chronology

The E949 experiment was proposed to the BNL High Energy and Nuclear Physics Program Advisory Committee (PAC) on October 10, 1998. The experiment was endorsed by the PAC and approved by the Associate Directory for High Energy and Nuclear Physics. A further proposal, under the Rosen Protocol, was submitted to DOE and was approved in August of 1999 to run for 60 weeks at 65 Tp on target. The DOE funding plan included 10 weeks of running in FY01, followed by 25 weeks each in FY02–03.

The upgrade of the E787 detector and LESB3 beam line consisted of several parts. The proposed beam line upgrades included: for the primary beam — new targets, new instrumentation, improvements to shielding of cooling water, and a beam dump downstream of the C-target; for the secondary beam — new standoffs for Separator #1, new instrumentation, spare Q01–02 quadrupoles, and a spare D01 dipole (see also `http://www.phy.bnl.gov/e949/detector/beam/lesb3`). The proposed detector upgrades included: a new Barrel Veto Liner (BVL), new scintillator for the RS (Layers 2–5), new T-counters, a monitor system for the RS/BV/BVL, new beam detectors (B4 and Active Degrader), a new upstream photon veto (UPV) and downstream photon veto (DPV), new Collar counters and new electronics for the UTC and RSSC. The electronics upgrades included: new RSTDC system, 4^{th} cable segment, new DAQ computer and peripherals, spare boards, new CCD's, new Trigger Board (OTB), new meantimer modules and various new electronics to support new detector channels (see also `http://www.phy.bnl.gov/e949`). DOE capital funding was half of that requested, so D01 and the beam dump were canceled and Q01-02 has been indefinitely postponed.

1.1.1 E949 Construction Highlights

A rough outline of the important milestones in the upgrade of the E787 detector to become the E949 detector follows:

- E787 detector was opened on August 26, 1999
- RS (Ll8–19) — BVL Installation completed in May 2000
- RS (L2–5) installation completed September 2000
- Last repaired RSSC installed November 2000
- Detector closed November 2000
- T-counters installed December 2000
- UTC electronics installed xxx
- Layout of RSMON fibers completed January 2001
- Reinstallation of BV,RS light-pipe and PMT with fibers completed February 2001
- March 2001 Detector ready for beam

- dsCO installed June 2001
- RSTDC installation completed June 2001
- RSSC electronics installed November 2001
- UPV installed January 2002
- usCO installed July 2002

A general overview of the time of when we think the AGS finished the upgrades to LESB3 for the E949 experiment follows (these times are mostly just our own estimates):

- construction of new strongback for Sep#1 10/00; installation of new standoffs 12/00??
- remove CW474, replace CW475, replace C-SEC, replace 90° monitor; check cables, camera, etc; visual inspection of Q01–2(boroscope), visual inspection of D01, survey of CP3/target, move CP3, install old target (T-112) 12/00–03/01
- The E949 experimental safety review was conducted on 02/28/01.
- Experimental Safety Walkthrough 03/20/01
- analog C-target temp to E949 05/15/01
- reroute Q01–2 water 06/01
- The new target (T-121), which is only 0.15" high, was installed on 08/22/01.
- complete old spares for Q01–2 09/01???
- Separator HV to file 09/01, to Dibbuk

More information on the LESB3 beamline and the C-line, as well as the upgrades for E949 can be found at `http://www.phy.bnl.gov/e949/detector/beam/lesb3`. Hopefully a technical note on the LESB3 performance will be forthcoming.

1.1.2 Spring 2001 Test Run (Parasitic to g–2)

E949 was funded by DOE DHEP to run for 10 weeks in FY01, and g–2 was funded to run for 15 weeks; however, since g–2 chose to run before RHIC started up, the running cost escalated and the E949 run was terminated. Instead we got only a few weeks of tune up with 1/10 pulses taken from g–2. g–2 ran from Feb 1, 2001 — April 24, 2001. E949 ran from March 23–30 and April 8–21, 2001. The Siemens Motor Generator set was being refurbished for the upcoming RHIC run, so this test beam was run with the Westinghouse MG. The SEB pulse-on-demand had a flattop of ∼0.5 sec on a cycle of ∼ 10×6 sec.

- New T-counters, new L2–5 and L18–19, new BVL, new UTC electronics, repaired/new RSSC's, new rsmon system, new RS TDC's, new DPV. Old beam package, old RSSC electronics, old Collars.
- 03/03/01 (1p2) turn on RS HV (work ongoing on UTC, beam)
- 03/14/01 (1p16–7) Cable rstdc's

- 03/16/01 (1p20) Install fiber target
- 03/20/01 (1p29) Experimental Safety Walk-through; Q09–10 installed
- 03/22/01 move detector into position
- 03/21/01 (1p32) UTC HV on
- 03/23/01 (1p37, 41041) **beam on**
- 03/29/01 (1p66) RSSC's on
- 04/01/01 (1p80, 41275) beam off for SNS 4/1–8/01
- 04/08/01 (1p99, 41401) beam back on
- 04/14–8/01 RS time trim
- 04/21/01 (2p53, 41766) **beam off** (due to lack of money)
- 04/26/01 (2p61) shutdown detector

1.1.3 Summer Shutdown/Cosmics

After the test run in the spring of 2001, the new downstream Collar was installed, as was most of the new beam package (with the exception of the UPV).

We installed several new safety systems and procedures as 'suggested' by the AGS Safety Committee.

Significant efforts over the summer included commissioning of RS TDC's, the RSMON system, the Osaka Trigger Board and the new Meantimers, plus the installation of the new beam detectors and electronics

- 04/26/01 (2p60) replace 7 bad RSSC cards
- 06/07/01 (2p61) turn on detector (dsEC, CO, MC, TT on floor)
- 06/08/01 (2p62) FERAPED studies
- 06/19–21/01 (2p65–6) install EC, MC, TT, and new CO
- 06/28/01 turn on detector intermittently
- 07/06/01 turn on detector full time (mostly)
- 07/10/01 Install B4, Active Degrader, $4\frac{3}{8}$" BeO and $\frac{3}{16}$" Lucite
- 07/11/01 add flammable gas solenoid for UTC, etc
- 07/16/01 Completed installation of 512 RG188 target CCD input cables
- 07/25/01 RHIC physics.
- 07/25/01 Completed installation of 143 RG188 end cap CCD input pig tails
- 07/25/01 (3p3) RSSC threshold data

- 07/27/01 (3p8) BWPC gas leak repaired
- 07/30/01 (3p16) Q09–10 installed, BWPC HV on, detector into position, beam signals into splitters
- 07/31/01 Completed installation of 80 RG188 beam package CCD pig tails
- 07/31/01 (3p20) D3 magnet review — OK
- 08/02/01 (3p28) D3 on
- 08/03/01 (3p31) **Siemens failure** (create fake_AGS clock)
- 08/09/01 (3p50) put N_2 into UTC buffer layers
- 08/10/01 (3p52) remove 32 nsec from DPV cables
- 08/24/01 (4p3) AGS has 3 Tp; p/Au switching tests down to 20 minutes
- 08/30/01 (4p14) new breakers
- 08/31/01 (4p17) 4 Tp on C-target
- 08/31/01 (4p18) **Beam in cave**

1.1.4 Fall 2001 Run Highlights

The Fall 2001 run was the first time the AGS tried to run an HEP program alongside of RHIC operations. It was a very rocky start. The AGS ultimately realized that they were limited to 40 Tp, due to a lack of manpower to program one of the Booster RF cavities to operate in a 2^{nd} harmonic for SEB, but not for RHIC. A further complication was the decision to run a couple of MEP experiments while E949 was tuning up. Tom Kirk's decision to give E931 (D-line experiment) half of the proton beam became a limiting factor after a few weeks of startup.

- 08/31/01 (4p18) **First beam**
- 09/11/01 (4p84) AGS off for 24 hours due to terrorist attack on NYC and DC
- 09/13–4/01 (4p94) RS trim data
- 09/18/01 (5p36, 43694) reduce C_{SEC} counts by x10
- 09/19/01 (5p42, 43732) **AGS momentum lowered from 24 to 21.5 GeV/c**, 4.6 sec cycle, 15 Tp
- 09/20/01 (5p51, 43796) **spill increased to 1.5 sec**
- 09/18–20/01 Trim RS cables
- 09/20/01 (5p57–8, 43825–47) RS trim data
- 09/21/01 (5p61) power in cave for new RSSC electronics
- 09/23–9/01 work through startup list
- 09/30/01 (6p22, 44345) **First smx running**

- 10/01/01 (6p36, 44451) add x10 amp to B0, increase HV to 2100
- 10/01/01 (6p36, 44458) exchange 24 T•2's from PB-1A and RS-TDC
- 10/02/01 (6p40, 44472) FTDC trim in Sect 1–2, 5P13,5M13
- 10/3–5/01 (6p43–55, 44498–587) RS trim
- 10/03/01 (6p46, 44508) DeToX and csihvmon automated
- 10/04/01 (6p47, 44528–31) RS trim data
- 10/04/01 (6p50, 44541) x10 amp for B0 into CCD
- 10/04/01 (6p51, 44544) put x10 amps on RV, UPV, AD
- 10/04/01 (6p53, 44560) increase spill gate by 150 msec (leading edge)
- 10/05/01 (6p53, 44561–70) RS trim data
- 10/06/01 (6p58, 44623–7) RS trim data
- 10/08/01 (6p74, 44715) FTDC trim 13–21, final RS trim
- 10/10/01 (6p82, 44776) AGS RF maintenance all day, access to check 90Dmon, T•2 efficiency plot
- 10/11/01 C_{SEC} and D_{SEC} calibrated, 35 Tp
- 10/25/01 (7p65, 45439) replace RS 11PT PMT with HPK tube
- 11/01/01 (8p3, 45698–705) online PV study
- 11/01/01 (8p7, 45727) Sep#1^+ down from +300 kV to +250 kV
- 11/05/01 (8p29, 45875–87) rsmon intensity study
- 11/05/01 (8p30, 45889) km22 intensity study
- 11/05/01 (8p31, 45903–25) Burst Guard discriminator study
- 11/05/01 (8p32, 45920) **fix for T•2 inefficiency (new discriminator cables)**
- 11/05/01 (8p31–2, 45906–25) RS discriminator in Burst Guard test
- 11/06/01 (8p33, 45938) all AGS beam to E949 until 18:00
- 11/06/01 (8p41, 46007–12) SCF study
- 11/07/01 (8p46, 46069) intensity scan (C_k 8.0→0.3)
- 11/08/01 (8p48, 46090) **SEB off**
- 11/08/01 (8p48, 46091) D3/CsI off
- 11/08/01 (8p49, 46097) shutdown detector

- Post 2001 run work
  - 11/11/01 (8p50) tests for new RSSC electronics
  - 11/13/01 (8p50) tests of RSTDC problems
  - 12/05/01 (8p50) gas problem in RSSC found (iso-butylene, not isobutane)
  - 12/05/01 (8p50) DPV, Cer removed.
  - 12/10/01 (8p50) Sep#1$^+$ cable cut to reduce sparking
  - 01/09/02 (8p50) survey of beamline and beam instrumentation
  - 01/14/02 (8p51) Cer+UPV installed.
  - 01/14/02 (8p51) attempt to upgrade bnlku9 to IRIX6.5 abandoned

1.2 2002 Run Highlights

The 2002 run started on February 1, 2002 and ran until June 9, 2002; with a 2 week break for a NASA run April 6–19 and one month of downtime for repairs to Separator #1 from Feb 7 – March 7. A summary of highlights from the run follows (some of the highlights can be found in Sections 1.4–1.5).

- new RSSC electronics installed, UPV installed
- 01/15/02 (8p51) move detector into position
- 01/16/02 (8p52) turn on detector
- 01/18/02 End of paper logbook (8p55) — all data in ELOG
- 01/29/02 (18:00, 46315) **First beam**
- 01/29–03/09?? work through startup list
- 01/31/02 Sep#1 trouble started
- 02/03/02 10:33 46573 first smx run
- 02/07/02 46817–27 RS/PV delay curves
- 02/07/02 46868–47027 rsmon delay curves
- 02/07/02 16:12 46882 shutdown for repair of Sep#1
- 02/20/02 Sep#1 removed for repairs
- 03/04/02 16:44 47347 add 39 nsec to E2CCD ECP58
- 03/07/02 (18:00, 47406) **First beam after Separator #1 repair**
- 03/08/02 03:11 47431 BM HV adjust, C_k efficiency data
- 03/09/02 00:25 47592 **Start smx**
- 03/12/02 16:19 47723 add 15 nsec to UPV, RV TDC

- 03/13/02 09:21 47769 target temp limit; I-Hung asks to raise limit
- 03/14/02 11:30 47830 **AGS increases spill length** 2.2 sec/5.4 sec (up from 1.6 sec/4.5 sec)
- 03/14/02 17:15 47840 new predet file loaded (predet.020314) for 2.2 sec spill
- 03/14/02 17:48 47841–1 1γ study
- 03/16/02 14:46 47946 Trimmed Range Stack FTDCs
- 03/17/02 19:57 48016 new predet file loaded (predet.020317), add 100 msec to end of spill
- 03/17/02 22:17 48019 study of Live Time and rejection vs Rate
- 03/19/02 16:46 48072 AGS will work on Booster RF/intensity. Woody to work on smoothing spill. Ionnis tried an AGS ramp at 20 GeV with 3.0s/5.6s.
- 03/20/02 01:20 48086 DAQ back (dead since 11:00 3/19)
- 03/20/02 13:18 48123 all events killed by L1.1, TDDAC fixes
- 03/22/02 18:49 48241–7 summary of Woody's 'ripple' studies
- 03/23/02 13:09 48280 C_{SEC} scan 10% eff drop since 9/01 (255/Tp then, 230/Tp now) 15% drop since C_{SEC} installed in early 2001.
- 03/23/02 15:49 48284 intensity scan (K07–8) LT 100% $\rightarrow$ 74% linearly as C_k 0 $\rightarrow$ 12.5M
- 03/23/02 18:27 48289 KBL 2.6M $\rightarrow$ 2.8M KB 3.5M $\rightarrow$ 3.9M
- 03/25/02 11:40 Woody starts giving beam to D-line
- 03/26/02 17:02 48404 AGS tuning for intensity
- 03/27/02 07:13-18:25 No beam.
- 03/27/02 07:09 Sep#1^- takes a nose-dive (we will be restricted to 150 kV)
- 03/29/02 14:58 48524–51 RSSC's tripping, Isobutane changed earlier
- 03/31/02 14:00 48587 AGS off for vacuum repairs until 4/1::21:30 (32 hours)
- 04/01/02 11:07 48606 Dibbuk replaced
- 04/01/02 18:22 48614 more cooling for EC PMT's
- 04/02/02 09:18 48626 ECkmu2 calibration data
- 04/03/02 16:22 48656 AGS off for rain storm
- 04/05/02 09:28 48691 start intensity study for Shaomin
- 04/05/02 14:03 48708 end of smx rate study
- 04/05/02 18:42 48720 Burst-Guard(48716–20)/Update(48713–5) study

- 04/05/02 19:16 48722 J10 bump off (Woody's study)
- 04/06/02 01:57 48730 UTC pulse height study
- 04/06/02 08:05 48734 **AGS off for NASA run**
  - 04/06/02 11:46 48742 work on fake-AGS-clock
  - 04/06/02 17:30 48743 modify/restore one UTC cathode post-amp
  - 04/08/02 19:30 48756 Two UTC postamps modified to short capacitors
  - 04/12/02 20:01 48781 work on UTC continues
  - 04/15/02 21:22 48783 UTC cathode electronics installed to layer 4
  - 04/16/02 11:56 48794 chiller problems, several crates trip (hot day)
  - 04/16/02 19:59 48794 isobutane replaced at 15:00 while beam is still off (use old bottle as spare) RSSC trips, then turn off HV
  - 04/17/02 11:10 48802 chiller problems again
  - 04/17/02 17:34 48805 problems restarting DAQ after chiller fixed
  - 04/18/02 12:09 48819 6 UTC foil electronics modified again
- 04/18/02 22:00 48830 **AGS on, end of NASA run**
- 04/19/02 12:07 48880 work on UTC continues while struggle with rstdc readout goes on
- 04/19/02 14:15 48884 mod of foil 1 UTC electronics (mod #2)
- 04/19/02 14:41 48885 AGS off for RF problem until 17:30
- 04/18/02 13:42 – 4/19/02 17:20 AGS cycle time increased to 6.0 sec (from 5.4 sec)
- 04/19/02 17:57 48889 mod of foil 2-4 UTC electronics (mod #2)
- 04/19/02 19:04 48891 AGS off for severe weather
- 04/19/02 22:00 48905 more mods of UTC foil electronics (mod #2)
- 04/20/02 12:00 48923 problem noted with COM#5 ADC
- 04/20/02 12:14 48923 spill uniformity is better (±25%)
- 04/20/02 18:00 48935 UTC electronics work completed (foil 1,2,3 and 4 and the first 8 strips in foil 5).
- 04/20/02 21:36 48941 **(re)start smx**
- 04/21/02 16:25 48959 13:00 find that ethane is low
- 04/23/02 18:47 49003 spill length increased from 2.0 to 2.2 sec (problem since Saturday 4/20) LT increase from 73% to 76%
- 04/24/02 09:23 49024 AGS techs install pump in cave for D3 water leak

- 04/25/02 15:56 49056 Kevin Brown tunes VHF
- 04/26/02 11:36 49074 AC repair ongoing
- 04/27/02 13:17 49103 spike in pnn triggers near beginning of spill
- 04/29/02 17:37 49150 AGS adjusts VHF frequency to remove 93 MHz structure
- 05/01/02 20:03 49196 AGS beam back at 19:45 (off since 3:38) after BTA problems and maintenance, off for 16 hours
- 05/02/02 11:40 49212 Kevin Brown works on spill structure
- 05/02/02 17:46 49217 KOPIO tests will give poor spill for 10 minutes
- 05/04/02 02:58 49256 kaon loss from MCR targeting?
- 05/04/02 04:27 49259 rejection vs rate
- 05/05/02 17:20 49300 C_{SEC} efficiency measure
- 05/07/02 09:19 49335 target temp increased, I-Hung lowers beam retune LESB3
- 05/07/02 16:00? I-Hung, Kevin study losses in C-line (no big ones)
- 05/07/02 15:02 49356 lower K/π (3.2$\rightarrow$2.8) get 7% more C_k
- 05/08/02 13:02 49379 new video camera for C-target
- 05/08/02 18:46 49388 30% modulation at 93 MHz
- 05/08/02 21:37 49388 AGS reduces 93 MHz to 16%
- 05/09/02 14:19 49410 Sep#1 in hard vacuum at +230 kV
- 05/09/02 15:28 49410 with Sep#1 +150 kV -100 kV we lose 30% of C_k and 5% of K/π — AGS tests Sep power supply
- 05/09/02 20:07 49413 AGS off until 18:30 for Sep#1 debugging
- 05/10/02 11:15 49428 MF#7 not communicating, cycle power, reboot ku37
- 05/14/02 15:38 49548 I-Hung studies target temp
- 05/15/02 22:55 49603 retune BS1 for +150 -100 kV
- 05/16/02 09:00 49614 increase BS1 to get K/π from 2.0 $\rightarrow$ 2.6
- 05/16/02 13:25 49620 check 4-jaw, tune Q01, K/π up to 2.8
- 05/18/02 00:52 49666 observe 93MHz structure
- 05/20/02 09:41 49750 AGS fixes beam bunching
- 05/21/02 08:52 49772 AGS will do F3 kicker work today (no beam today)

- 05/23/02 11:28 49847 clogged D3 filter replaced
- 05/24/02 13:26 49874 UTC study
- 05/25/02 04:54 49892 reduce deadtime from 30% to 25% with CCDPED
- 05/25/02 05:18 49893 e931 electrical problems, plus our C_{SEC}?
- 05/29/02 07:11 49984 RSSC calibration data
- 05/30/02 15:47 50025 spill length work
- 05/31/02 10:01 50042 I-Hung studies C-line tune
- 06/01/02 02:41 50047 summary of weather problems
- 06/02/02 13:16 50055 AGS test of BAF profile monitor
- 06/02/02 13:33 50055 C-target air sampling
- 06/04/02 02:39 50092 Sep#1 vacuum window failure at 23:00 6/3
- 06/05/02 02:00 50101 Sep#1 window replaced, momentum jaws removed
- 06/05/02 20:01 50113 no beam for 16 hours for BTA power supply
- 06/05/02 22:07 50115 AGS above 70 Tp
- 06/07/02 00:07 50141 no beam for 4 hours due to storm
- 06/07/02 18:54 50157 km21,ECkmu2 calibration data
- 06/09/02 (24:00, 50218) **beam off**
- 06/10/02 00:25 50218 RSSC calibration data
- 06/10/02 01:36 50221 start cosmic running
- 06/11/02 50234 shutdown detector

1.2.1 AGS

During the E949 runs in 2001–02 the Siemens MG was unavailable, necessitating the use of the Westinghouse MG set. To achieve a reasonable duty factor it was necessary to reduce the AGS momentum (September 19, LB5p42, 43732 AGS momentum lowered from 24 GeV to 21.5 GeV). The spill was then increased to the maximum possible value (for 21.5 GeV) of 2.2 sec on March 14, 2002 (47830). This allowed us to get to a cycle of 2.2s/5.4s (20% worse DF as compared to the beginning of the 1998 run when E787 had 2.2s/4.5s).

The AGS claimed a peak intensity of 76.4 Tp and an integrated flux of extracted protons in 2002 of 6.6×10^{19}. Operating parameters: run without Siemens (Westinghouse) with a spill length of 1.6 sec going up to 2.2 sec at a proton momentum of 21.5 GeV/c.

The major sources of AGS downtime (including separator conditioning) were:

- 2/07–3/07 (672 hours) AGS off for Sep#1 repair

- 3/11 (9 hours) separator conditioning, power dip 7:00–16:00
- 3/14 (5 hours) AGS RF problems
- 3/19 (14 hours) separator conditioning, plus RF maintenance (BLIP vacuum too)
- 3/27 (12 hours) separator conditioning, 7:00–19:00
- 3/28 (5 hours) F5 flow switch 8:00–13:00
- 3/30 (7 hours) power dip 8:00-15:00
- 3/31–4/01 (32 hours) AGS vacuum failure 12:30–21:00
- 4/06 (304 hours) 8:00–4/19::00:00 13 day shutdown for NASA (4/19 30 Tp, 4/20 55 Tp)
- 4/24 (9 hours) PASS problems, separator conditioning 2:00–4:00, 7:00–14:00
- 4/25 (3 hours) AGS MMPS 9:00–12:00
- 4/26 (3 hours) Extraction PS 16:00–18:00
- 4/28 (4 hours) chipmunk, LINAC (1:00–3:00, 18:00–20:00)
- 5/01 (17 hours) BTA magnet failure, conditioning, maintenance, etc 3:00–20:00
- 5/03 (2 hours) high losses 7:00–9:30
- 5/05 (1 hour) change C3 magnet polarity
- 5/08 (5 hours) conditioning 7:00–12:15
- 5/09 (3 hours) separator problem, inspection 16:00–18:00
- 5/10 (4 hours) LINAC trip 2:00–6:00
- 5/15 (11 hours) separator conditioning, F5 problem 7:00–18:00
- 5/17 (3 hours) off for C3 separator repairs, LINAC 0:00–1:00, 3:00–5:00
- 5/20 (3 hours) LINAC, Sep#1 21:00–24:00
- 5/21 (12 hours) LESB3 vacuum failure, maintenance 6:30–18:30
- 5/23 (3 hours) LESB2 interlock 12:00–14:00
- 5/24 (7 hours) LINAC trip, C-line vacuum pump, CP464, etc 8:00–10:00, 13:00–18:00
- 5/25 (4 hours) LESB2 separator, AGS MM 16:00–18:00, 22:00–24:00
- 5/28 (4 hours) CQ6–7, BMMPS 1:00–4:00, 12:00–13:00
- 5/29 (9 hours) maintenance 7:00–16:00
- 5/31–6/02 (42 hours) power dip, bnlku9 disaster,... 21:00–15:00

- 6/03–5 (27 hours) LTB PS, Sep#1 vacuum repair 23:00–2:00
- 6/05 (16 hours) BTA magnet problem 4:00–20:00
- 6/06 (4 hours) bad weather 20:00–24:00

The separators were a perennial problem this year, as can be seen in Table 2.

date	run	$\#1^+$ (kV)	$\#1^-$ (kV)	$\#2^+$ (kV)	$\#2^-$ (kV)	comments
3/22/01	41000	+290	-290	+260	-260	OK so far
4/10/01	41460	+275	-275	+220	-220	
8/31/01	42918	+300	-300	+260	-260	OK so far
11/1/01	45727	+250	-300	+260	-260	too many sparks on Sep$\#1^+$
11/8/01	46097					repair work (11/8/01-1/15?/02)
1/30/02	44048	+280	-300	+260	-260	Sep$\#1^+$ can't keep 300
1/31/02	46440					Sep$\#1^-$ problem, PS/tank OK
2/2/02	46504					Sep$\#1^-$ feedthru replaced
2/5/02	46645	+105	-105	+260	-260	Sep#1 struggling
2/6/02	46700	+140	-140	+260	-260	getting better
2/8/02	47000					Sep#1 $<$ 100 kV in vacuum - remove Sep#1
3/7/02	47406	+260	-260	+260	-260	Broken standoff on Sep$\#1^-$ replaced
3/27/02	48427	+300	-150	+260	-260	raise Sep$\#1^+$ to compensate Sep$\#1^-$
3/28/02	48444	+300	-150	+100	-300	raise Sep$\#2^-$ to compensate Sep$\#2^+$
3/30/02	48559	+230	-150	+100	-300	lower Sep$\#1^+$
4/1/02	48600	+300	-150	+260	-260	replaced Sep$\#2^+$ HV cable
4/1/02	48618	+200	-150	+260	-260	Sep$\#1^+$ deteriorated
4/5/02	48706	+225	-150	+260	-260	limp to NASA run
4/5/02	48720	+175	-150	+260	-260	crawling...
4/10/02	48800					Sep$\#1^-$ feedthru replaced (4/6–19 NASA run)
4/16/02	48800					Sep$\#1^-$ stuck at 150 kV
4/19/02	48936	+250	-100	+260	-260	Sep$\#1^-$ still has problems
4/23/02	49001					vacuum valves close
5/4/02	49250	+230	-100	+260	-260	Sep$\#1^+$ deteriorated, run in vacuum
5/9/02	49412	+200	-100	+260	-260	Sep$\#1^+$ deteriorated
5/9/02	49412	+150	-100	+260	-260	Sep$\#1^+$ deteriorated
5/9/02	49413	+150	-100	+260	-260	AGS off for Sep$\#1^+$ debugging
5/21/02	49767	+150	-100	+260	-260	AGS off for Sep$\#1^+$ debugging
6/4/02	50092	+150	-100	+260	-260	vacuum window failure at 23:00 6/3
6/5/02	50101	+140	-100	+260	-260	Sep#1 window replaced, K11–2 removed

Table 2: Summary Separator performance.

We started recording the Separator HV in our spill-by-spill scaler files on disk on September 19, 2001 (43745.00000).

After the 2002 run the AGS decided to remove the LESB2#2 separator to use as a new Separator #1 for LESB3. This new separator should be ready for the 2003 run, but will force us to run with a 4" gap instead of the current 5" gap. Phil Pile has calculated an 11% loss in kaon flux as a result. The separator guys think that the separator reliability will be significantly improved with the 4" gap (and the old standoff design). Reducing the HV by 20% will account for a big part of the reliability improvements... They also plan to remove LESB3#1 and to refurbish it as a spare LESB3#1. They should also build a test stand that will allow separator operations outside of the hot LESB3 cave.

The Siemens Rotor and Stator have been repaired by GE and should be installed by mid-September (rotor delivery was in August 2002), and so should be available for any running in FY03. This will allow us to get back to duty factors like we had in 1998 or as we proposed to run at (instead of being limited to 40% at an AGS momentum of 21 GeV).

1.2.2 Post-2002 Detector Work

After the 2002 run, upgrades were made to the upstream CO, the T-counters? and the beam system?

- Beam instrumentation removed, us EC removed
- 07/11–29/02 study of T-counter fibers in Sectors 6,7,11
- 07/19/02 New us CO installed to EC
- 07/22/02 EC fiber optics re-connected
- 07/24/02 Repair of 35 EC bases
- 07/25/02 EC re-coupled to iron
- 08/4?/02 EC re-cabled

1.3 Detector Summary

1.3.1 Improvements from new UTC electronics

New pre-amps were installed to reduce a positive overshoot on the UTC analog pulses that caused the ADC to cease functioning for some period of time and to improve the Z resolution by collecting more charge. This also had the effect of widening the UTC pulses into the ADC. This also had the effect of introducing an AC coupling that caused a severe rate dependent base-line shift (see Section 1.3.4). At lower rates (up to the '98 rate), the resolution was improved.

1.3.2 New T-counters

New T-counters with fiber readout were installed in E949. These counters were measured to have a light yield of $\geq$13 p.e./MIP (the value measured using the same technique as E787 is 6 p.e./MeV) as compared to the $\sim$3 p.e./MeV as measured with the old E787 T-counters. An independent measure of p.e. yield by Tetsuro can be found in /users/usr0/niyershov/Tcounters/npe_1995-2002.ps. Detailed documentation on the E949 T-counters in Technote K-013 and on the T-counter web-page `http://www.phy.bnl.gov/e949/detector/tracking/rs/t-counter`.

According to E787 TN-365, the T-counter inefficiency was 4% due to gaps between counters with an additional 4% loss due to photostatistics for $K_{\pi 2}$ pions and 8% for $K_{\mu 2}$ muons.

An early study of E949 kbeam data in the fall of 2001 by Milind Diwan measured a T-counter efficiency of 95% (see LB8p20–22 with data from runs 45639–775, and LB7p18 and LB6p82). This study also uncovered serious problems with the upstream end of #6 (6MT) and the downstream end of #11 (11PT). These two problems have been attributed to broken fibers (near the glue joint to the scintillator). A 'temporary' fix (at run 45920 on November 5, 2001) was to disconnect the input to these two discriminator channels and invert the output, to make the discriminators always ON. This fixed the large T•2 inefficiencies in sectors 6 and 11. This fix also disabled the TDC channels for 6MT and 11PT, unfortunately. After this fix it was understood that the major remaining source of inefficiency was sector crossings between the T and 2 layers. A new MT2A board has been built that will allow for these sector crossings if we wish (see `http://e949/detector/electronics/trigger/Logic_note.ps`).

A second study by Nikolai Yershov (see /users/usr0/niyershov/Tcounters/teff.ps) confirmed Milind's measurement of T-counter efficiency with 93.2% in the fall of 2001 (runs 44561–80, ignoring sectors 6 and 11), but then followed up with an efficiency measurement of only 88.3% for the spring of 2002 (runs 48991–49930). This efficiency drop has not yet been understood, but clearly needs to be!

1.3.3 RS Scintillator

A general description of the RS can be found at `http://www.phy.bnl.gov/e949/detector/tracking/rs/`. New scintillator was installed in layers 2–5 and 18–19. This new scintillator has significantly longer attenuation length and 2–3 times more light output. Layers L18–9 were installed along with the BVL; a technote describing the performance of the new and old L18–9 is available (see `http://www.phy.bnl.gov/e949/tn/k007.ps`).

Milind and Tetsuro studied the light output and attenuation length for each counter for E787 and E949 (data points for 1995, 1996, 1997, three for 1998, 2001 and 2002) using km22 triggers. Plots of the average values for each layer are shown here in Figure 1. Detailed values for each counter are also available at the

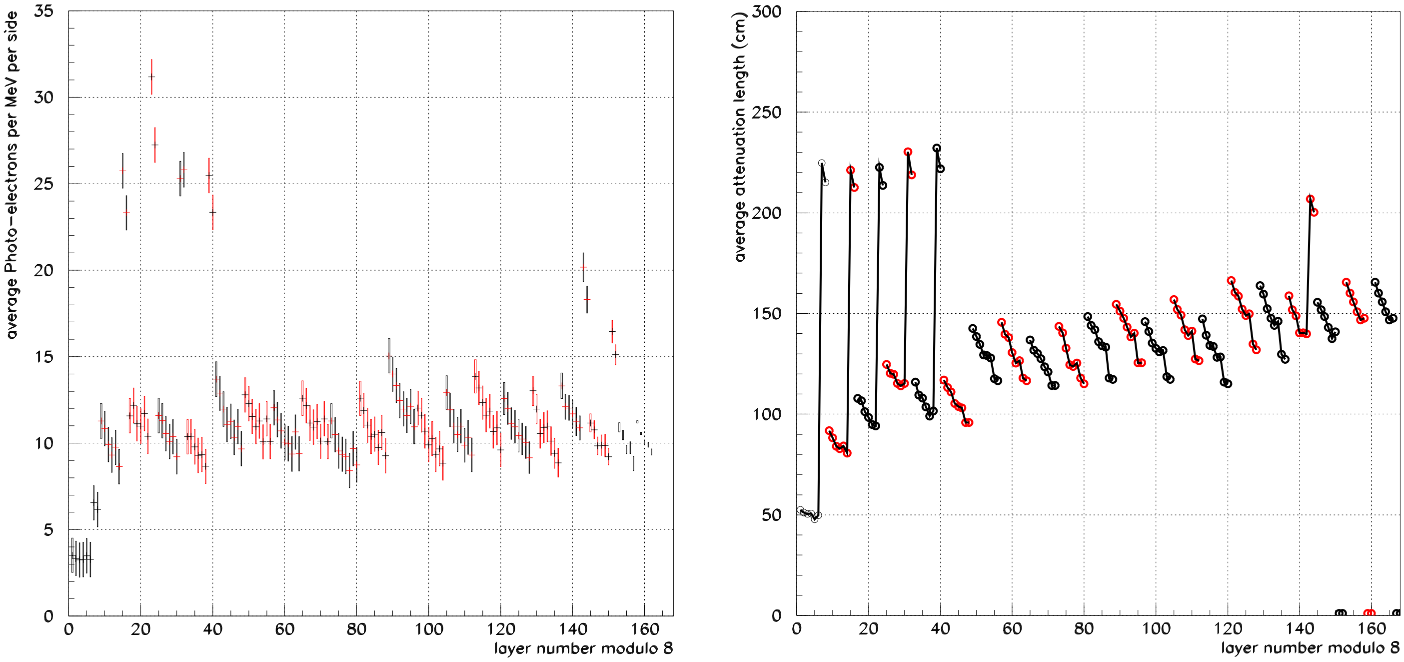

Figure 1: The Range Stack performance by year from 1995–2002 for each layer. a) the number of photo-electrons for each layer (8 points for each layer) b) the attenuation length.

RS web-site `http://www.phy.bnl.gov/e949/detector/tracking/rs/`.

1.3.4 UTC Rate Problems

The data collected before the NASA run had a baseline shift in the UTC ADC's that caused a noticeable loss in efficiency of finding z-hits in the inner foils at high rate. This problem was mitigated by changes to the post-amp electronics for the ADC signals for cathode foils 1-4 between 04/06–19/02 (48743–48905). In addition, zero suppression of UTC cathode ADC channels in ADC2 was turned off at run 48822 on 04/18/02, to allow for large baseline shifts. New pattern recognition software to use the cathode TDC's as well as ADC's was developed by Shaomin to reduce the magnitude of the problem before the NASA run, but the data from before the NASA run has qualitatively different performance in the UTC z-reconstruction.

When the electronics were changed in April, the ADC gate timing was delayed by 100 nsec to capture more charge.

1.3.5 RSTDC Overview and Performance

RS TDC is a system that is based on multi-hit LeCroy 3377 modules. Large time window (several μs) allowed this system to record prompt hit and hit from electron. Small output volume supposed to decrease dead time of the detector. A very detailed cabling map, trigger electronics, readout scheme are described at: `http://www.phy.bnl.gov/e949/detector/tracking/rs/rstdc/`

Rate problem, threshold change, discriminator mode

It was noticed in the beginning of October, 2001 that many RS TDC's had lack of efficiency. It was clearly effect of high intensity, because on cosmic triggers RS TDC efficiency was high. At the same time multiplicity plots showed the significant percentage of 8 hits events (maximum recording capacity of RS TDC electronics assuming both pulse edges are written) and recorded time distributions seemed to show the lack of early times. Keep in mind that RS TDC counts "backward" - the first hit in the common block is the first hit that came out of RS TDC system and it is actually the last hit that arrived to RS TDC from the detector. This brought us to the conclusion that RS TDC's could be overflowed, i.e. the number of incoming hits exceeded their 8-hit capacity, so that each next hit caused to loosing first hits. Lost of the prompt time hit causes an inefficiency.

To fight this the TDC discriminators were switched to allow us to record 16 times but for the price of dropping trailing edges, i.e. loosing pulse width information. It happened originally staring from run 44602. At the same time TDC gate was shortened and brought to more reasonable values of $[-2, 10]\,\mu sec$. This reduced the scale the problem but it still remained.

A study by Sasha Kushnirenko indicated that RS discriminators were firing on single photoelectrons. For new RS layers (2-5) high voltage on the PMT's was low enough, so that 15 mV threshold was above one photoelectron. For old layers high voltage was quite high and discriminators were firing on single photoelectrons. Based on this study the RS discriminator thresholds were raised from 15 mV to 25 mV. We raised thresholds from 15 mV to 25 mV on discriminators that read out layers 3-10 and 11-18. For the remaining layers (T,2,19,20,21) we kept the threshold of 15 mV. That was done on March 18, 2002, during run 48023 (except for a few sectors accidentally missed that were corrected on April 15 and 19, runs 48781 and 48887 correspondingly).

There had been some hope to be able to put the RS discriminators to Burst Guard mode and to extract some electron energy information for the RS TDC pulse width. Due to the high occupation of the RS TDC's this effort was abandoned.

RS bulk trim

The goal of this procedure is to make all signal to reach trigger boards simultaneously (we required all signals to be within 3 ns window). It is done by adjusting cable length of each individual channel. A very detailed procedure is given at:
`http://www.phy.bnl.gov/e949/detector/electronics/trigger/rs_trim/procedure`

Bulk RS trim was done in the end of September 2001
`http://www.phy.bnl.gov/e949/detector/electronics/trigger/rs_trim/Sep2001` and verified on January 5, 2002; February 5, 2002; March 15, 2002.
`http://www.phy.bnl.gov/e949/detector/electronics/trigger/rs_trim/Jan2002`

Calibrations

Two types of calibrations were done for RS TDC's:

1. Finding time walk correction function coefficients
2. Finding time offsets

Time walk correction

Time walk correction was done based on cosmic triggers in September 2001 by Sasha Kushnirenko `http://www.fnal.gov/projects/ckm/documentation/e949/010903/`. This was an unfinished study and next iteration was required. The time walk correction is a function of discriminator thresholds. Since these thresholds were changed other correction coefficients were obtained by Dima Vavilov (see `http://sitka.triumf.ca/~vavilov/twalk/index.html`). Current cfm settings are so that the former set of coefficient is applied to runs 40774-47849, the latter – to runs 47849-60000. This can be changed in the future.

Time offsets

The method of getting time offsets are also described at URLs above.

The basic equation used at finding time offset constants is that the signal originating from a particle crossing an RS counter at $z = 0$ comes at the same time as the Detector Strobe signal (DS).

Thus, the feature of this calibration is that it implicitly takes time of flight into account for the particle type used for calibration (mostly muons for calibrations above). I.e. one does not need to apply additional time of flight correction while, for example, averaging times from different counters to get track time for muon. Perhaps, better track time resolution for pion can be obtained if correction on the difference between muon and pion times of flight is applied.

As concerns timing DS is basically OR of 24 layer 2 mean times. Thus, the calibration relies on good layer 2 trimming (which is likely the case). Otherwise, if layer 2 meantime signals can come at different times, one offset should be used for a particular RS counter if DS originates from layer 2 in one sector and another one if DS originates in another sector. Perhaps, taking this effect into account gives a possibility for further timing accuracy improvement.

Currently cfm contains 3 sets of time offset constants. As demonstrated in the study at `http://www.phy.bnl.gov/e949/software/meetings/020617/rs/dv_talk.html` (see, e.g. "More TRK TIME-DS distributions (pic)") this is not enough and needs further work. Look for updates on this issue in `http://sitka.triumf.ca/~vavilov`.

1.3.6 Improvements from new RSSC electronics

New electronics for the RSSC's were installed between the 2001 and 2002 runs. These consisted of the addition of an amplifier and dual level discriminator (low level for timing, higher level for yes/no decision). This improvement was observed to reduce the tails in the RSSC z resolution.

For more information on the RSSC's see Technote K-023 and `http://www.phy.bnl.gov/e949/detector/tracking/rs/rssc`.

1.3.7 Summary of new Photon Vetos

New photon veto detectors were installed; most important was the Barrel Veto Liner (BVL), adding 2.4 χ_0. Other systems are primarily of importance for pnn2, including: Downstream Photon Veto (DPV), Upstream Photon Veto (UPV), Active Degrader (AD), and new thicker Collar counters (CO).

For more information on the BVL see `http://www.phy.bnl.gov/e949/detector/photon_veto/bvl`. For more information on the Collar counters see `http://www.phy.bnl.gov/e949/detector/photon_veto/co`. For more information on the DPV see `http://www.phy.bnl.gov/e949/detector/photon_veto/dspv`. For more information on the upstream photon vetos see `http://www.phy.bnl.gov/e949/detector/beam/bm`.

1.3.8 Summary of new Beam Instrumentation

New instrumentation and detectors: B0, Cerenkov and IC electronics; and new detectors , including: the B4, Active Degrader (AD), Upstream Photon Veto (UPV) and Ring Veto (RV). All systems have a CCD (CCDD) for each channel (except IC which has a TD for each channel). All systems also have a TDC (TDC3) for each channel. The Cerenkov counters have only an ADC on the multiplicity sum (also goes to TDC and TD), the AD only has 3 ADC's multiplexed by 4 and one multiplexed by 12; all other systems have an ADC for each channel. The channel count is as follows: B0 — 1, C_k — 14, C_π — 14, RV — 2, UPV — 2, AD — 12, B4 — 32, IC — 6.

Performance: compared with the old B4 (which had 16 segments), the new B4 (with 32 segments) has almost the same timing resolution and a better determination of $X--Y$ location of K entering target (from 10 mm to 4 mm), but the number of photoelectrons per MeV is lower by a factor of 2; compared to Lead Glass counter, AD is worse in K/π suppression; though the beam intensity for E949 is much higher than that for E787, Cerenkov counters have the same timing resolution with the help of CCD. A detailed report of the all the beam systems' performance will be given in an analysis technical note later.

1.3.9 HV Monitoring (DeToX)

The files and ntuples produced by DeToX [1, 2] are used to produce a glitch log. As described in [2], HV readings are taken every ∼30 seconds.

Each run is classified as

class	short description	comments
PERF	perfect	no HV problems
IsOK	OK	HV problems minor or due to glitches
BAD	bad	Major HV problems
ODD		Missing information in readback
UNKN	Unknown	no information in HV database

where 'major HV problems' = many channels off or out-of-tolerance or varying.

The recommendation would be that PERF, IsOK and UNKN runs should be processed, BAD and ODD runs should only be processed if more careful inspection of the database is done for individual elements. The glitch log contains a list of runs classified as BAD and a short description of why a run is bad.

class	description
HV offRead	HV is off according to readback
HV offSet	HV is off according to demand or set value
HV outtol	HV is out-of-tolerance by at least 10 volts
HV unstabl	The RMS for a channel is greater than 1.5 volts

Up to 4 individual BAD channels per run will be listed. If there are more than 4 bad channels, then the subsystems with BAD channels will be listed. If there are more than three subsystems with BAD channels, then 'Many' subsystems are reported.

Additional notes:

1. There are occasional readback glitches. At least two sequential readbacks satisfying the BAD criteria are required to classify a run as bad.
2. When ALL subsystems have HV off in readback, give the number of times/run that the HV was off and the total number of checks of the readback.

An example of the glitch log is included below:

```
42413       RS   DeToX  06/06/02 HV offRead
42439       ALL  DeToX  06/06/02 HV offRead  HV outtol
42491       TT   DeToX  06/06/02 HV offRead  HV outtol
42506       BM   DeToX  06/06/02 HV outtol
42509       ALL  DeToX  06/06/02 HV offRead  HV outtol
42529       Many DeToX  06/06/02 HV offRead  HV unstabl
42556       BV   DeToX  06/06/02 HV offRead  HV outtol
42557:42559 BV   DeToX  06/06/02 BV P 37 1   HV outtol Vset/dV/Vrms= -2331 897 64.1
42560       TT   DeToX  06/06/02 TT D 03     HV unstabl Vset/dV/Vrms= -1148 27  9.4,
                                 TT F 10     HV outtol Vset/dV/Vrms=  -978 43 13.9
42561:42562 TT   DeToX  06/06/02 TT F 10     HV outtol Vset/dV/Vrms=  -978 39  7.1,
                                 TT D 03     HV outtol Vset/dV/Vrms=  -1148 27  9.0
```

The first column is the run or range of runs, the second column has the two letter acronyms for BAD subsystems, the third and fourth column give the origin and time of the entry and the fifth column gives a brief description. For example, for runs in the range 42557:42559, inclusive, BV P 37 1 had HV out-of-tolerance, the set point `Vset` was -2331 volts, the largest deviation `dV` from that set point was 897 volts and the RMS `Vrms` was 64.1 volts.

`http://www.phy.bnl.gov/~djaffe/E949/HVmonitor/detox.glitch.log` contains the glitch log.

csihv: High voltage monitoring

The high voltage for the End Cap and Downstream Veto are monitored in a similar fashion with a few significant differences. HV readings are taken approximately every 30 minutes so the correspondence between run number and voltage reading may not be as simple as for DeToX. This uncertainty is reflected in the glitch log: `http://www.phy.bnl.gov/~djaffe/E949/HVmonitor/csihv.glitch.log`.

1.3.10 RS/BV/BVL Monitoring (rsled)

For more detailed information on the rsmon system please see technotes K-006 and K-014 and the web-page `http://www.phy.bnl.gov/e949/detector/monitor/rsmon`.

The rsmon system was designed to monitor the performance of the RS, BV, and BVL systems. One goal of this system was to determine very quickly if any of the phototubes or electronics failed during the course of acquiring data. Although the QOD program has been quite useful for this purpose, often many hours might elapse between the failure of a single channel, and our ability to determine what, if anything, had failed. A second goal was to help us determine individual channel gain-changes that might affect the energy calibration and resolution in the range stack.

To accomplish the first goal, an on-line monitoring program was written by Mhukin (see ~bnlonl/rsmon/). This calculated the efficiency of each phototube, and measured its relative gain. A typical rsmon pulse yielded ∼500 photoelectrons. Therefore, after just a few dozen pulses significant changes in calibration could be found. Warning messages were generated so that the people on shift could determine what, if anything, was wrong. Averages for each phototube for each run were saved on disk as another aid to the shift takers. An extension of this program, tdmon, written by Jaffe, in which only one of every four sectors was pulsed (see Section 1.3.11).

During the commissioning of the RSMON and TDMON diagnostics, we found that almost all phototubes demonstrated a significant time dependence. RSMON pulses during cosmic-ray running, or during any beam-off period, showed different average gains than when beam was on. These effects were typically in the 5-10% range, and often more. Further analysis has shown that the RS phototubes have gain changes as a function of beam intensity, time-in-spill, and beam history.

Fig. 2 shows a plot of the relative gain of the 24 upstream RS phototubes in layer 6. The abscissa is

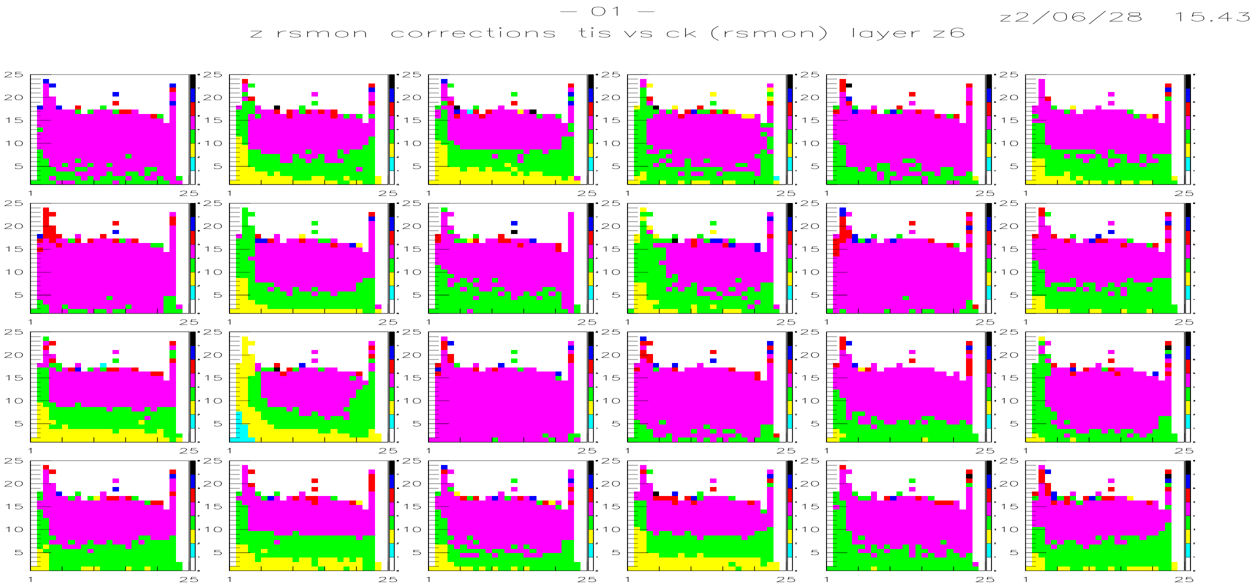

Figure 2: PMT gain variations (for 24 upstream L6 PMT's) as measured by RSMON triggers as a function of time in spill and rate.

time-in-spill in 0.1 second bins; the ordinate is a measure of the instantaneous Ck rate. The dominant magenta color is the region in which the gain average is stable to ±2%; the green regions have average gains 2–7% lower; and the yellow regions have an average gain drop by 7–15%. Fig. 3 plots the average rsmon gains for the 24 upstream RS phototubes in layer 2 over ∼150 runs. Only data in the normal high-intensity and stable part of the spill was included in forming these averages. Most tubes demonstrate a gradual fall-off in the gains, and many have a significant change after a couple of periods when the beam was off for an extended period.

It will take significant effort to determine if we can correct the gains of the phototubes based upon the rsmon averages in order to improve the energy resolution of the experiment. Analysis of this is on-going.

- 07/12/01 (2p75, 42055) add code to drop TD's for rsmon triggers

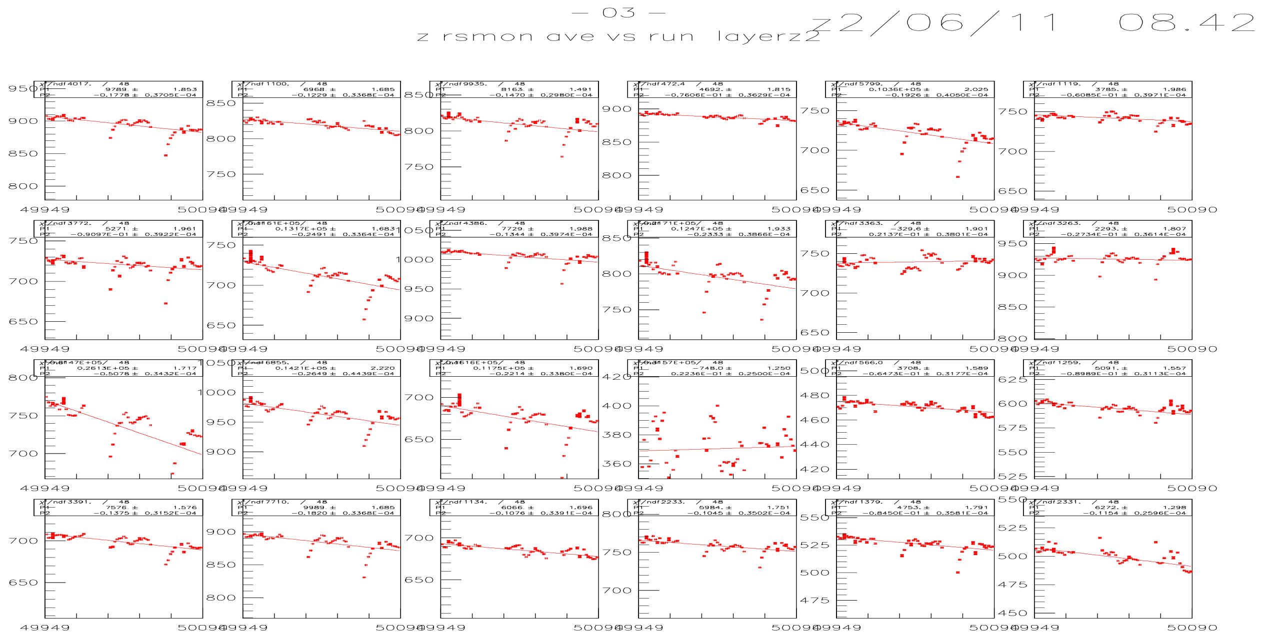

Figure 3: RSMON averages per run for the 24 upstream Layer 2 PMT's.

- 08/10/01 (3p53) clean contacts on 12 RS PMT's (see also 8/3/01, 3p100)
- 08/23/01 (3p100) clean contacts on 7 RS PMT's
- 11/05/01 (8p29, 45875–87) rsmon intensity study
- 02/12/02 14:29 47020 rsmon delay curve
- 02/22/02 15:22 47153 I-Hung's rate monitor commissioned
- 03/01/02 13:42 47304 load new predet with 200 msec pre-flash of rsmon
- 03/01/02 22:38 47310 rsmon pre-flash setup and turned on
- 03/01/02 47311 New dwf for rsmon trigger delay
- 03/09/02 13:08 47557 4 Ck rate monitors into ADC1 (100 msec, 47 msec, 22 msec, 10 msec)
- 03/11/02 16:51 47671 new trigger for rsmon pre-flash study prior to disabling pre-flash
- 04/19/02 15:04 48886 modify I-Hung's integrating circuit#3 from 22 msec to 1.1 msec

Early on we discovered that the deadtime for the readout of rsmon events was quite large (∼4 msec, compared to typical times closer to 1 msec). This forced us to take only 3–4 rsmon triggers per spill. We also learned relatively early on that the RS PMT gains changed a lot during the course of a spill. Since we have so few rsmon triggers in a spill, we realized that we would have to use the rate in the detector to correct the PMT gains within a spill rather than the rsmon triggers themselves. So the rsmon triggers were used to create a rate and time-in-spill dependent correction to the RS PMT gains (this is the direction that we are heading in anyway). Then the question arises as to how best to measure our detector rates within a spill; the scalers are insufficient as they only provide a sum over the spill. One suggestion by Peter Cooper was to maintain an event-by-event rate calculated from the a weighted average of the number of rstdc hits in each event (this may be implemented during the running of Pass1). A second technique was devised by I-Hung, who set up four different circuits for integrating the Ck signal (with time constants of ....). A third technique was setup by Renee, which was to put the Ck signal into the multi-channel scaler (read into the MCSC bank); this Ck signal gives us the Ck counts between L0 triggers (or at a rate of ~2 kHz. See details of when the multi-scaler (MCSC) was collecting CK rate data in Section 1.5.1.

1.3.11 TD Monitoring (tdmon.online)

During the interspill period when there is a TDMON trigger, the LED's are flashed for 1/4 of the range stack corresponding to 1 of the 4 RS counters multiplexed into the TD's. The tdmon.online program [3] processes this information and issues alarms and warnings to the shift crew. It also produces statistics and warnings for all observed TDMON triggers and logs the information to a file. Only the RS TD's are currently monitored.

These files are used to build a glitch_log for ADC's, TDC's and TD's for the RS for TDMON triggers. Here is how a run/counter/TD is classified as 'BAD' using TDMON triggers:

- Require at least 10 expected hits per counter/TD
- 'BAD' counter has miss fractions > 0.10, 0.10, 0.10 (layers 2-19) or 0.10, 0.10, 0.20 (layer 1) for ADC, TDC, TD, respectively.
- If a TD has a miss fraction >0.100 it is 'BAD'.

Up to 5 counters per subsystem and 5 TD modules will be listed if they are classified as bad, if there are more than 5 bad counters or bad modules, then only 'Many bad ADC TDC TD' is listed for the run.

Only the miss fraction is currently used to classify a counter or module as 'BAD', the run-to-run consistency of time (for TD's and TDC's) or pulse area (for TD's and ADC's) is not used. The miss fraction is simply the number of unobserved hits divided by the number of expected hits. If a hit is expected, but not present, it is 'unobserved'.

The glitch log is `http://www.phy.bnl.gov/~djaffe/E949/TDmonitor/tdmon.glitch.log.standard`.

1.4 Trigger Summary

For a complete summary of the changes to and performance of the E949 trigger see Technotes K-018 and K-xxx from Nomachi/Komatsubara/Yoshioka.

The addition of the BVL caused significant changes in the trigger, particularly for muon identification. It should be remembered that the trigger bits 20, 21, 20_CT, 21_CT are from the BVL counters in the corresponding RS sector.

The prototype Osaka Trigger Board (OTB) was installed on March 8, 2001, replacing the Princeton Trigger Board #5 (PTB#5 contained CEX,3γ, and prompt). By November 11 (run 45731) all triggers were generated by the OTB. The production board was installed on July 13, 2001.

A summary of changes in programming for the Osaka Trigger board (OTB) can be seen in Table 3.

[1] change $\overline{(19_{CT}+20_{CT}+21_{CT})}$ to $\overline{(19_{CT})}$.

[2] add $\overline{\mathrm{BVL}}$.

[3] remove $\overline{20+21}$.

OTB output	9/13/01	10/7 44668	10/30 45627	11/1 45731	1/29/02 46314	3/6 47375	4/22 48976	4/24 49034	4/29 49152
A01	CEX	**CEX**	**CEX**	**CEX**	**CEX**	**CEX**	**CEX**	**CEX**	**CEX**
A02	prompt	**prompt**	**prompt**	**prompt**[1,2]	**prompt**	**prompt**[4]	**prompt**	**prompt**	**prompt**
A03	km21	**km21**	**km21**	**km21**	**km21**	**km21**	**km21**	**km21**	**km21**
A04	km22	**km22n**	**km22**	**km22**	**km22**	**km22**[5]	**km22**	**km22**	**km22**
A05	kp21	**kp21**	**kp21**[1]	**kp21**	**kp21**	**kp21**	**kp21**	**kp21**	**kp21**
A06	kp22	**kp22**	**kp22**[1]	**kp22**	**kp22**	**kp22**	**kp22**	**kp22**	**kp22**
A07	kp23	**km21n**	**kp23**[1]	**kp23**	**kp23**	**kp23**	**kp23**	**kp23**	**kp23**
A08	1γ	**kp22n**	**1γ**[1]	**1γ**	**1γ**	**1γ**	**1γ**[6]	**1γ**[8]	**1γ**
B01	pnnl0	pnn2	—	**pnn1**[1]	**pnn1**	**pnn1**	**pnn1**[7]	**pnn1**	**pnn1**
B02	pnnl0o	1γ	**pnnl0o**	**pnnl0o**[1]	**pnnl0o**	**pnnl0o**	**pnnl0o**	**pnnl0o**	**pnnl0o**
B03	pnn2	CEX	—	**pnn2**	**pnn2**[3]	**pnn2**	**pnn2**	**pnn2**	**pnn2**[9]
B04	piscat	prompt	—	**piscat**	**piscat**[3]	**piscat**	**piscat**	**piscat**	**piscat**
B05	MB	piscat	**MB**	**MB**	**MB**	**MB**	**MB**	**MB**	**MB**
B06	MB2	MB2	—	—	—	—	—	—	—
B07	km21n	—	—	—	—	—	—	—	—
B08	kp22n	—	—	—	—	—	—	—	—
B09	—	—	pnn1	—	—	—	—	—	—
B10	—	—	pnn2	—	—	—	—	—	—
notes	all PTB	—	—	no PTB	—	—	—	—	—

Table 3: Changes in programming of OTB. All triggers in **boldface** are generated by the OTB; those in normal type are generated by the PTB.

A chronology of trigger modifications follows:

- 03/08/01 (1p12) Install Osaka trigger board (remove PU CEX board)
- 05/01/01 (2p61) fix L1.2 inputs
- 07/13/01 (2p76) shorten L19 cables
- 07/14/01 Install final version of OTB
- 08/17/01 (3p84) MT2A mode test for L19_veto
- 09/09/01 (4p72) mode of MT2A changed to require IC1–6 (all ICx set high)
- 09/13/01 (4p99) lower B4 thresholds
- 09/17/01 (5p27, 43628) add T$\bullet$2$\geq$2 to ext_con(7)

[4] remove all CT requirements.
[5] change $(20_{CT} + 21_{CT})$ to (19_{CT}).
[6] new 1γ trigger.
[7] add L0_zfrf.
[8] add $\overline{(20_{CT} + 21_{CT})}$.
[9] add $\overline{C_{\pi}}$.

- 09/21/01 (5p64, 43896) remove 10 nsec from RS FERA gate (.dwf.010921)
- 09/28/01 (6p9, 44235–8) L1.1 now working
- 09/30/01 (6p23, 44353) create B0 trigger
- 09/30/01 (6p23, 44360) add Hex_MT,BV_MT,BVL_MT trigger bits
- 10/04/01 delay CCDD stop by 200 nsec (.dwf.011004)
- 10/05/01 (6p56, 44590–7) Meantimer trimming
- 10/07/01 (6p69, 44668) OTB providing triggers: prompt, CEX, kp21, kp22, km21, km22, kp21n(1γ), km21n(kp23)
- 10/08/01 (6p71, 44688–9) test of L19_veto in MT2A
- 10/08/01 (6p71, 44689) discover HEX_MT5 in ext_con(24) turns off PTB prescale
- 10/08/01 (6p72, 44701) Meantimer trim
- 10/10/01 (6p83, 44791) Trigger Transmitter Ntgt>20→L0_ZFRF
- 10/11/01 (6p87, 44814–28) study piscat gate_faults (see 7p43, 10/21 and 7p48)
- 10/14/01 (7p7, 44963) apply L1.1 to 1γ (.andor.011014)
- 10/14/01 (7p10, 44980) add CEX to smx
- 10/21/01 (7p46, 45292) add L1.1 to prompt (.andor.11100111)
- 10/22/01 (7p50, 45323) remove piscat trigger (see 7p51)
- 10/25/01 (7p66, 45439) fix piscat problem (deadtime signal in kludge)
- 10/28/01 (7p82, 45545) re-enable piscats
- 10/30/01 (7p92, 45626) OTB for all by Oct 24: updated main, kumc (new trigger t pnn1,2; no more km21n, kp22n
- 10/30/01 (7p93, 45630) restore piscat to PTB
- 10/30/01 (7p94, 45635) apply L1.1 to prompt (smx_v12n) (.andor.11100111)
- 11/02/01 (8p8, 45731) pnn1,2 from OTB
- 11/02/01 (8p12, 45759) all triggers from OTB
- 11/02/01 (8p13, 45762) test L0_zfrf on pnn1 (runs 45762, 45848)
- 11/04/01 (8p28, 45855) MT thresh 30→50 mV
- 11/05/01 (8p33, 45935) MT threshold 50→100 mV
- 11/06/01 (8p35, 45955) MT threshold 100→30 mV

- 11/06/01 (8p39, 45987) add 20 cables to trim MT
- November–January **preparations for 2002 run**, finish MT trim
- 01/29/02 46330 enable both L1.1 and L1.2 for pnn1, pnn2, prompt, kp22, kp23 and 1γ (.andor.33300333)
- 03/01/02 47310 remove 15 nsec from rsmon trig (.dwf.020301)
- 03/12/02 47718–35 Study of BV/BVL/HEX online PV thresholds
- 03/14/02 13:50 47837 lower 1γ cluster thresholds
- 03/14/02 17:51 47841 tightened Delco by 0.5 nsec (0.9 nsec→1.3 nsec) kp22 L0 rejection 450→550; expect pnn1 L0 rejection 500→600.
- 03/17/02 47984–48007 Study of BV/BVL/HEX online PV thresholds
- 03/17/02 17:29 48003 switch to MT for PV (30 mV threshold) (swap ext_con 4,6 with 12–3, and HEX with ext_con 18–23), replace gamma clustering with BVL instead of BV
- 03/17/02 48004 switch back to analog sum for PV (swap ext_con 4,6 with 12–3, and HEX with ext_con 18–23)
- 03/17/02 48007 switch back to MT PV (swap ext_con 4,6 with 12–3, and HEX with ext_con 18–23)
- 03/17/02 48007–49170 Online PV thresholds BV_MT=30mV, BVL_MT=30mV, HEX_MT=30mV. Widths = 10 nsec.
- 03/17/02 17:55 48010 tighten Delco by 0.5 nsec (1.32 nsec→1.76 nsec)
- 03/17/02 22:39 48021 target threshold 100 mV→150 mV
- 03/18/02 01:23 48023 set RS discriminator threshold (L3–18) 25 mV during 48023.
- 03/18/02 09:43 48042 L0rr rejection 17.98 ± 0.52, acc = 0.89 ± 0.01 (runs 47931–5)
- 03/18/02 11:21 48048 TT width 25 nsec→10 nsec, delay TT by 6 nsec
- 03/18/02 13:24 48060 removed T•2=3 and T•2>3; installed BV-HI, BV-NG ext_con(10-1)
- 03/19/02 18:54 48077 L1.2 return code fixed
- 03/20/02 00:56 48086 **smx_v13**
- 03/20/02 17:38 48134 change HEX_analog to HEX_MT bits to L1.2
- 03/20/02 17:38 48134 polarity of HEX_MT bits to L1.2 corrected
- 03/23/02 16:05 48284–6 smx_l19, L19_veto of T•2
- 03/23/02 18:17 48289 target threshold 150→100 mV
- 03/23/02 20:22 48293 target threshold 100→150 mV

- 03/25/02 12:49 48370 lower target discriminator back to 100 mV from 150 mV
- 03/25/02 17:19 48376 try to replace TT amp crate, fix by power cycle instead — lost beam for ~1 hour (15:51-17)
- 03/26/02 18:09 48406 work on OTB prescaling (Nomachi, Yoshioka)
- 03/27/02 22:47 48436 load ps=16 into OTB for kp2, km2, pnn1L0o, MB, piscat — many SYNC errors (smx_v13.otb_ps16)
- 03/28/02 14:24 48474 more OTB prescaling studies
- 03/29/02 10:18 48515–23 OTB prescaling studies
- 03/29/02 12:37 48522 new OTB option
- 03/29/02 14:44 48525 new OTB diagnostics
- 03/30/02 12:06 48559 trigger programming instructions
- 04/02/02 01:47 48620 **smx_v14**
- 04/02/02 13:56 48632 bad +24 V (0.3 V RMS) on L5N5 target amp — bad pedestals
- 04/02/02 15:56 48637 move old trig files (no OTB ps=16) to /nopsOTB/
- 04/05/02 18:42 48720 Burst-Guard(48716–20)/Update(48713–5) study
- 04/15/02 15:51 48781 found RS discriminator in R7#3 and R4#3 to be 15 mV instead of 25 mV — reset
- 04/19/02 48883 add 100 nsec UTC delay (.dwf.020419)
- 04/19/02 16:54 48887 raise threshold in sector 5 to 25 mV
- 04/21/02 05:55 48950 clean up $TRIG_DATA
- 04/22/02 14:31 48976 new OTB program 1)add L0_zfrf to pnn1, new 1γ with only L16–7 stops.
- 04/22/02 16:48 48985 new trigger=smx_v14-1g.ps2, 1γ L=16–7, ps=2
- 04/24/02 11:53 49024 new IC HV
- 04/24/02 15:56 49032 new 1g trigger added $\overline{20_{CT}} \cdot \overline{21_{CT}}$
- 04/24/02 17:46 49036 new trigger file smx_v14-1g with 1g ps=1
- 04/25/02 10:39 49050 **smx_v15** = smx_v14-1g
- 04/25/02 14:44 49056 trim IC times
- 04/25/02 15:07 49056 trim Delco's — all at 2.4 nsec now
- 04/29/02 09:43 49144 remove 0.5 nsec from IC into Delco, now looser Delco=2.06 nsec
- 04/29/02 19:26 49151 new pnn2 trigger pnn2_new = pnn2.and.(pnn2_ps16 + $\overline{C_\pi}$)

- 04/30/02 22:10 49171 raise HEX_MT threshold from 30 mV to 50 mV (Online PV thresholds BV_MT=30mV, BVL_MT=30mV, HEX_MT=50mV)
- 05/04/02 20:37 49278 narrow IC#1 from 30 nsec to 10 nsec
- 05/08/02 12:31 49379 replace rs discriminators (7P10, 4M10)
- 05/09/02 12:30 49407 narrow IC#2-5 from 30 nsec to 10 nsec (see 49278)
- 05/14/02 17:37 49555 HEX=2 off 49545–54
- 05/20/02 11:09 49751 increase IC CFD width 10 nsec→30 nsec
- 05/27/02 21:45 49958 BV-HI (ext_con(10)) threshold changed from 135 mV to 50 mV
- 05/29/02 12:34 50002 create smx_v15-km22.ps1000h: with x2 more km22
- 05/29/02 20:49 50012 take smx with smx_v15-km22.ps1000h: km22 prescaling factor 8192→4096
- 05/30/02 13:35 50024 **smx_v16** = smx_v15-km22.ps1000h

1.4.1 Online Photon Veto

The online photon veto underwent a number of changes, most notably the installation of meantimed vetos for the BV, BVL and HEX. The meantimed signals were setup into extra bits of the Trigger Transmitter with a 30 mV threshold at run 44630. By run 47718 the BV_MT and BVL_MT were in regular use as the online photon veto bits; by run 47984 the HEX_MT was in regular use for the online PV. A final trim of the BV_MT cable, with +3 nsec was made at run 48015. A list of the changes in the online PV conditions for 2001 is provided in Table 4. A list of the changes in the online PV conditions for 2002 is provided in Table 5.

2001								
Date	Runs	Online PV bits (4,6)			other bits (12–13,19–23,25)		
		BV(4) (mV)	BVL(6) (mV)	HEX (mV)	BV(12) (mV)	BVL(13) (mV)	HEX' (mV)
9/30/01	44630–45697	A150	A200	A500	30	30	30
11/1/01	45698–45699	A150	A200	A500	30	30	30
	45700–45700	A150	A300	A500	30	30	30
	45701–45701	A150	A400	A500	30	30	30
	45702–45702	30	A300	A500	A150	30	30
	45703–45703	30	30	A500	A150	A300	30
	45704–45704	A150	30	A500	30	A300	30
	45705–45705	A150	A300	A500	30	30	30
11/4/01	45792–45793	30	30	A500	A150	A300	30
	45794–45794	A150	A300	A500	30	30	30
	45795–45795	30	30	A500	A150	A300	30
	45796–45844	A150	A300	A500	30	30	30
	45845–45845	30	30	A500	A150	A300	30
	45846–45855	A150	A300	A500	30	30	30
11/5/01	45855–45862	A150	A300	A500	50	50	30
	45863–45864	50	50	A500	A150	A300	30
	45865–45934	A150	A300	A500	50	50	30
11/6/01	45934–45936	A150	A300	A500	100	100	30
	45937–45942	100	100	A500	A150	A300	30
	45943–46055	A150	A300	A500	30	30	30
11/7/01	45955–46038	A150	A300	A500	30	30	30
	46039–46046	30	30	A500	A150	A300	30
	46047–46049	A150	A300	A500	30	30	30
	46050–46071	30	30	A500	A150	A300	30

Table 4: Changes in the E949 online Photon Veto conditions during the 2001 run. The prefix 'A' indicates the analog sum, instead of the meantimers. (The E787 online PV had threshold of BV analog sum = 150mV and HEX analog sum = 500mV).

2002							
Date	Runs	Online PV bits (4,6)			other bits (12–3,18–23)		
		BV(4) (mV)	BVL(6) (mV)	HEX (mV)	BV(12) (mV)	BVL(13) (mV)	HEX' (mV)
	46072–46826	A150	A300	A500	30	30	30
	46827–46831	A150	A300	30	30	30	A500
	46832–46836	A150	A300	50	50	50	A500
	46837–46837	A150	A300	75	75	75	A500
	46838–46838	A150	A300	100	100	100	A500
	46839–46839	A150	A300	25	125	125	A500
	46840–46840	A150	A300	25	25	25	A500
	46841–46853	A150	A300	50	50	50	A500
	46854–47717	A150	A300	A500	50	50	50
3/12/02	47718–47719	50	50	A500	A150	A300	50
	47720–47720	40	50	A500	A150	A300	50
	47721–47722	30	50	A500	A150	A300	50
	47723–47723	20	50	A500	A150	A300	50
	47724–47732	20	50	50	A150	A300	A500
	47733–47735	50	50	50	A150	A300	A500
	47736–47794	A150	A300	A500	50	50	50
	47795–47795	A150	A300	50	50	50	A500
	47796–47796	A150	A300	A500	50	50	50
	47797–47797	A150	A300	50	50	50	A500
	47798–47794	A150	A300	A500	50	50	50
3/17/02	47984–47989	A150	A300	50	50	50	A500
	47990–47991	A150	A300	40	50	50	A500
	47992–47999	A150	A300	30	50	50	A500
	48000–48002	A150	A300	20	50	50	A500
	48003–48006	30	50	20	A150	A300	A500
	48007–49170	30	30	30	A150	A300	A500
4/30/02	49171–50234	30	30	50	A150	A300	A500

Table 5: Changes in the E949 online Photon Veto conditions during the 2002 run. The prefix 'A' indicates the analog sum, instead of the meantimers (The E787 online PV had threshold of BV analog sum = 150mV and HEX analog sum = 500mV).

1.4.2 Bulk RS Time Trim

The range stack timing was trimmed in a two stage effort. The first round of trims started in the Spring of 2001, while running parasticially with g–2. A second round of trims was made after the beam returned in the fall. The largets effect was to remove ∼4 nsec of cables from the counters with new scintillator (L2–5,18–9). In these counters, which have 2–3 times more light, the PMT HV was lowered ∼300 V, necessitating shorter cables.

1.4.3 RS Discriminator Thresholds

A study by Sasha Kushnirenko indicated that the RS discriminators (and rstdc's) were firing on single photoelectrons. A plot showing a threshold curve (rate vs discriminator threshold) can be seen in Figure 4. Based on this study the RS discriminator thresholds were raised from 15 mV to 25 mV on March 18, 2002

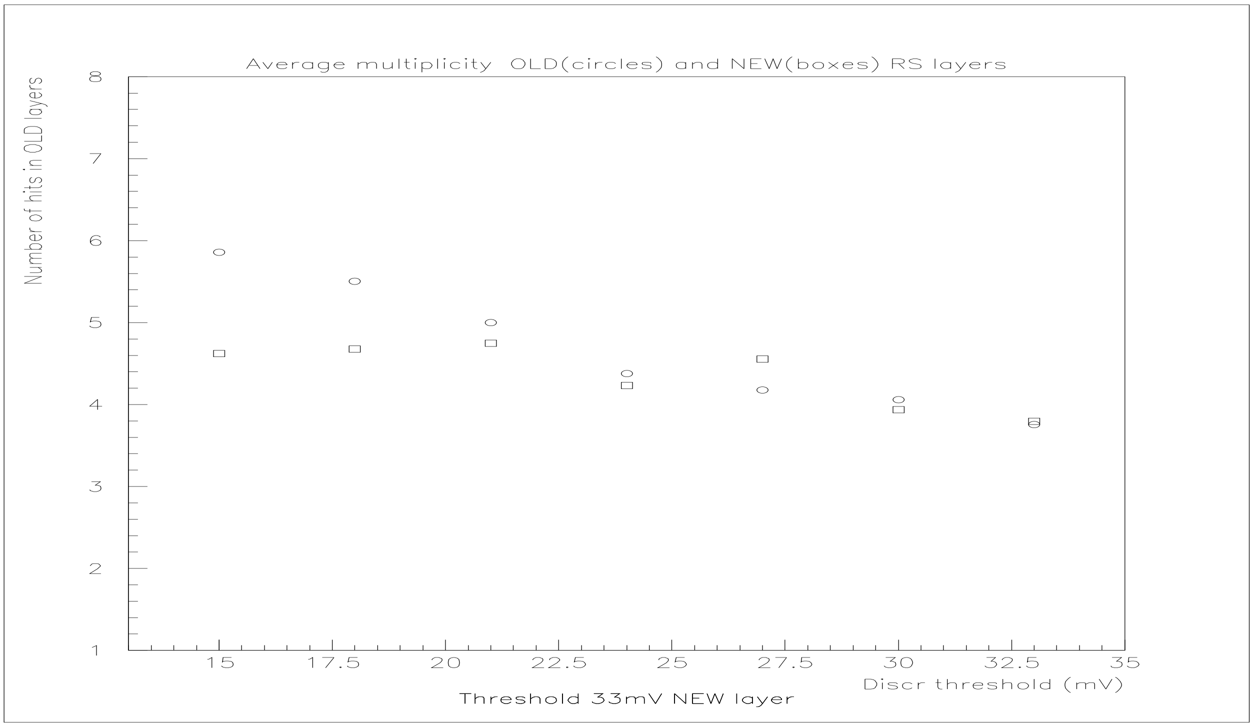

Figure 4: Threshold curve for rstdc's. RSTDC hit multiplicity as a function of RS discriminator threshold.

(except for a few errors that were corrected on April 15 and April 19). This was done to avoid overflowing the rstdc, which can only hold 16 leading edge times or 8 leading+trailing edge times.

1.4.4 Stopping Counter Finder (SCF)

There had been some concern early on about the performance of the stopping counter finder (SCF). Part of the concern arose due to the fact that the SCF fails to return 'one and only one T•2 sector' for both cosmics and rsmon (which is what most of our early data consisted of). It was later observed that the fraction of events with a good SCF is very high for normal triggers (km21, kp22,...)

During the 2001 fall run, some concern was raised whether the online Stopping Counter Finder (SCF) was or was not working as advertised. One simple idea was to check for the consistency of the stopping counter found online by the SCF and that found offline from the 'RD_TRK' routine. About 1587 events were studied with pnn1l0o trigger from the run 45918 and it was found that about 2.5% events (40 in total) stopped in layer above 19. Note that in the online hardware, L20–21 is still connected to the SCF, so SCF does not know that L20–21 was replaced by BVL and therefore tracks can still be found online in layer 20 and 21. From the 1587 events studied, with pnn1l0o trigger, the online and offline mismatch in the stopping counter was found to be about 11% (181 events in total). A major contribution to this 11% came from those 40 events which stopped above layer 19 (online) and the rest of the 141 events had random stopping counter distribution.

However, for the KM21 data, the mismatch between the online and the offline stopping counter was found to be about 77% (1688/2188). About 97% (1632/1688) contribution to this mismatch came from events which were recorded to be stopped above layer 19 in the online hardware.

The final conclusion of this study was that, the SCF was working as advertized and the mismatch between the online and offline stopping counter was understood to come mainly from events which were found to be stopped above layer 19 by the online hardware. Few suggestions were made to solve this problem for long tracks in range stack : 1) Make 'RD_TRK' a little bit more complicated and try tracking through the BVL, 2) Do not apply the STLAY cut to the KM2 events, 3) Remove the cables from L20–21 to the Range Cards. Also it was suggested that we should run with the most up-to-date version of the Xilinx code 'stc15.asc' which cause events with no T•2 to be cut at L1.1 and picks up the highest T•2 sector if there are more than one.

1.4.5 RS Discriminators in Burst Guard Mode

There was some suggestion in the E787 Technical Note TN-349, that if we put the RS discriminators in the Burst Guard mode and enable the trailing edges in the TDCs, then the RS TDC pulse width can be used to get energy information for pulse above $\sim$ 3 MeV and therefore the TDC width can be used to measure the electron energy. However, there was a concern that the idea of putting the RS discriminators in Burst Guard mode might weigh against the trigger efficiency. So it was suggested that one should measure F_s with RS discriminators in the Burst Guard mode. F_s, called the 'fudge factor' takes into account the acceptance loss factors like the fraction of kaons that stop in the target and various detector inefficiencies which cannot be calculated using monitor data and monte carlo. This factor is found by normalizing the measured $K_{\mu 2}$ branching ratio to the accepted value of this branching ratio.

Runs 45906 to 45920 were collected with RS discriminators in the Burst Guard mode and with trailing edges enabled and Runs 45759, 45776, 45785, 45859, 45762, 45903 (which were used in this study) were collected RS discriminators in Update mode and with trailing edges enabled in the RS TDC's, during the fall of 2001 run. The normal mode of operation is with RS discriminators in Update mode and with trailing edges disabled in the RS TDC's. The following F_s were measured with different configurations:

1. With RS discriminators in Update mode and with disabled trailing edges in the RS TDC's (the normal mode of operation):

   $$F_s = 0.7534 \pm 0.0024$$

2. With RS discriminators in Update mode and with enabled trailing edges in the RS TDC's:

   $$F_s = 0.764 \pm 0.0059$$

3. With RS discriminators in Burst Guard mode and with enabled trailing edges in the RS TDC's :

   $$F_s = 0.5462 \pm 0.0106$$

4. With RS discriminators in Burst Guard mode (L3–18) and with enabled trailing edges in the RS TDC's :

   F_s =??

The errors on these measurements are purely statistical. Note that in this study, I used T•2 (non-gap) efficiency as well as various acceptance factors based on monte carlo from the 1995-1997 PNN1 analysis. It was observed that with RS discriminators in the Burst Guard mode, there was a 28% failure in the RD_TRK reconstruction routine which returns a value 0 for the variable 'rrs', while with RS discriminators in Update mode with both enabled and disabled trailing edges for the RS TDC's, the observed failure in the RD_TRK reconstruction (rrs.eq.0.) was found to be less than 5% for events which just pass the KM21 trigger. Most of the events in 28% category with RS discriminators in Burst Guard mode were found to have I-counter hit about 10 ns earlier than the C_k hit. With the trigger counters in the Burst Guard mode in the range stack, this was understood with random events triggering for KM21 events. Attempt was also made to put only the discriminators for layers 3 to 18 in the Burst Guard mode and the trigger counters in the Update mode. The failure in the RD_TRK reconstruction (rrs.eq.0) was found to be about 7% in this configuration. (This loss in efficiencies in the RD_TRK reconstruction was understood to come from losing the prompt in the RS counters with higher rate which was also observed in several different studies. The Burst Guard study for L3–18 was done at higher rate.) The large apparent drop in F_s is likely to be due to changing the T-counters into BG mode. It would appear that the proper way to run is with BG mode on L3–18; however, this study was terminated due to the high rate in the RS TDC's. The high occupation of the RS TDC's, which combined with the need for enabling trailing edges, would lead to a substantial loss of prompt hits, forced the abandonment of this effort.

1.4.6 Trigger Performance

At the end of every run we wrote a file with the total scaler values for that run. Some plots showing E949 trigger performance based on these end-of-run scalers (see section 2) can be seen in Fig 5-8.

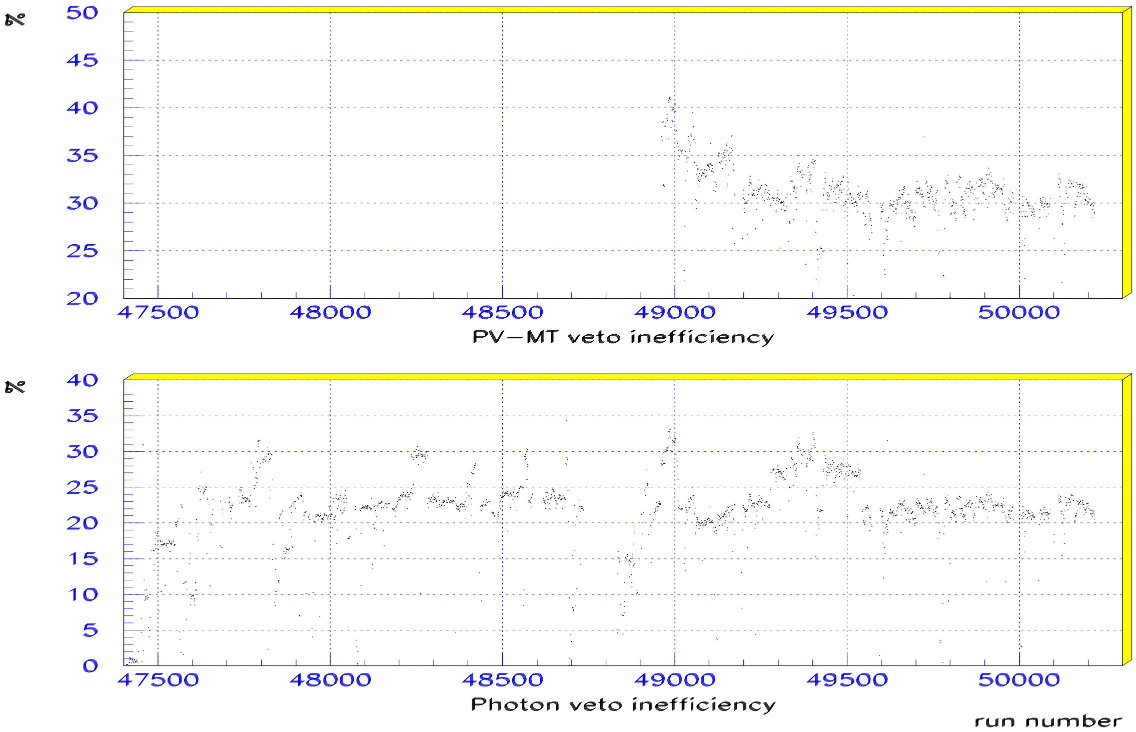

Figure 5: E949 trigger performance 1. Accidental losses due to the online photon veto using a) the meantimed signals for BV,BVL and HEX and b) using the old analog sum signals for BV, BVL and HEX. Note that according to the scalers, the meantimed PV signal appears to have a larger loss than the analog sum. Some early studies by Takeshi during the run indicated that the meantimed signal did have higher acceptance (as expected). We did discover that the signal created by Yoshioka in the meantimers to mimic the HEX signal in the Trigger Transmitter was quite a bit wider than expected. It may be that the PV-MT estimate of acceptance loss is too high due to an artificially wide HEX-MT signal. However, the offline study had difficulties due to variations in beam intensity, as well as in selecting a clean km2 signal in the E949 km21 triggers.

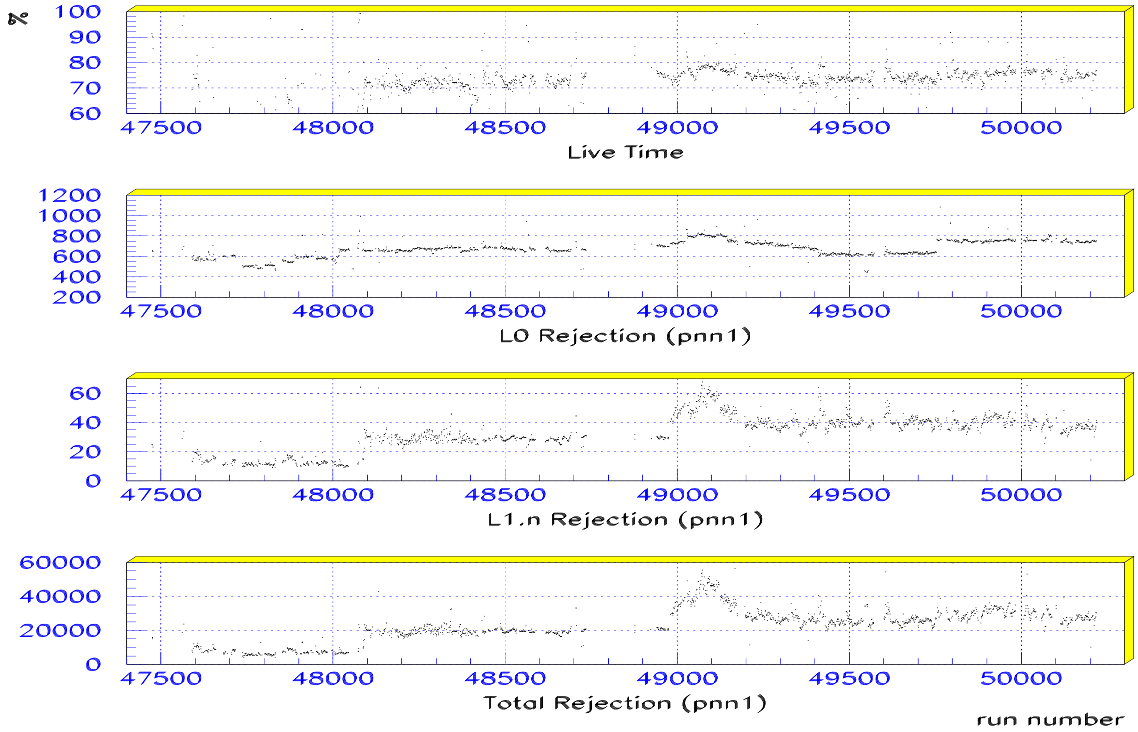

Figure 6: E949 trigger performance 2. The increase in pnn1 L0_rejection at run 48976 is due to the addition of the L0_zfrf cut. The decrease in pnn1 and pnn2 L0 rejection from runs 49278–49407 to 49751 is due to the reduced IC CFD width (30 nsec→10 nsec). The increase in L1.n rejection for both pnn1 and pnn2 at run 48077 is due to the fixed L1.2 return code. The apparent increase in pnn1 L1.n rejection and total rejection from runs 48980 to 49180 is not understood (and may not be real). It is unlikely due to a problem in the pnn1l0 scaler (or else we would have seen a problem in the L0 rejection). It could be an artifact of some problem in the L1.n_fail_1 scaler? Although there is also a 10% decrease in Fitpi4 rejection at these runs (see K-029), so perhaps we are really rejecting more events online at this time??!?

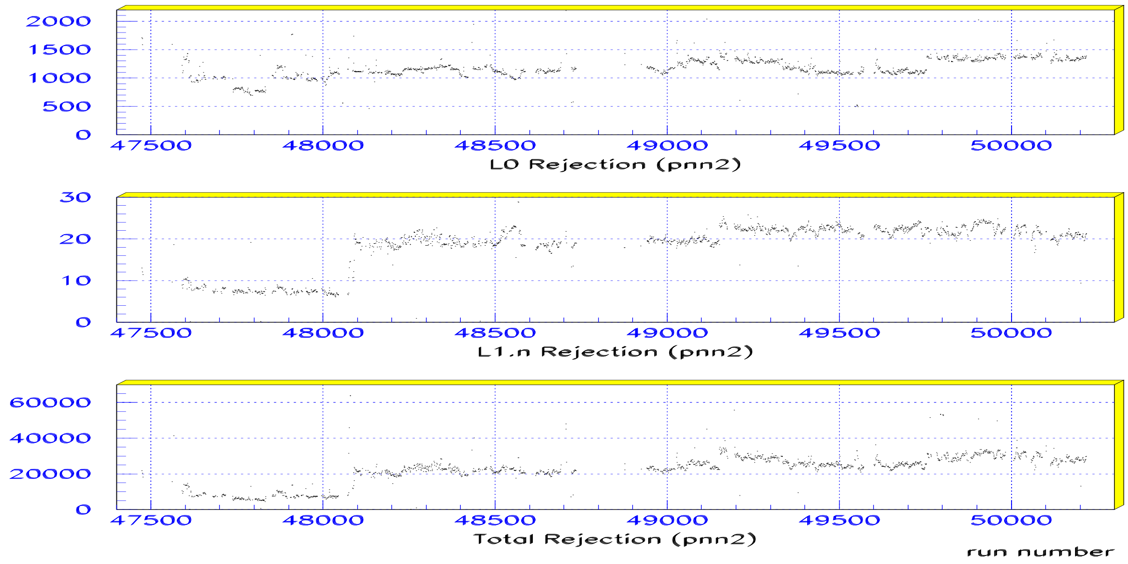

Figure 7: E949 trigger performance 3. The increase in pnn2 L0 rejection at run 497xx is due to xxx. The increase in pnn2 L1.n rejection at run 48077 is due to the fixed L1.2 return code. The decreased pnn1 and pnn2 L0 rejection from run 47737 to run 47841 is due to a change in B4 timing that was later corrected in the Delco timing (Delco 0.9 nsec→1.3 nsec). The increased pnn1 and pnn2 L0 rejection at run 48010 was due to a tightening of Delco (1.3 nsec→1.8 nsec). The increase in pnn1 and pnn2 L0 rejection from runs 49056 to 49144 was due to a tightening of Delco (2 nsec→2.4 nsec).

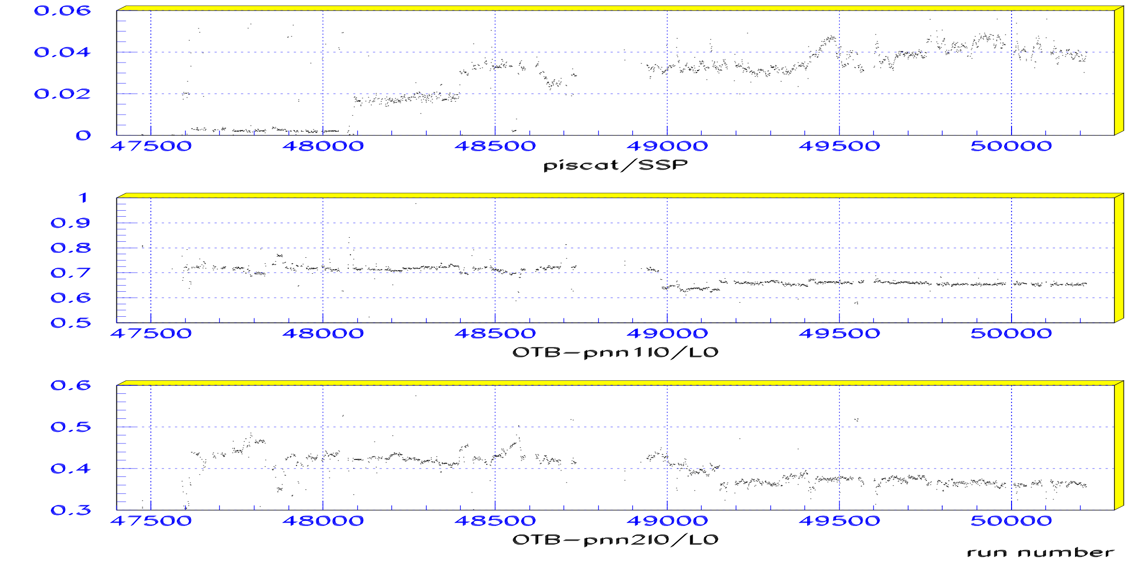

Figure 8: E949 trigger performance 4. The drop in pnn1l0 triggers at run 48976 is due to the addition of the L0_zfrf cut. The drop in pnn2l0 triggers at run 49151 is due to the addition of the C_π veto. The drop in pnn2l0 triggers at run 47841 is due to a tightening of Delco. The jump in piscat triggers at run 48077 may be due to the application of L1.2 to pnn triggers and the jump at 484xx?

1.4.7 Trigger Definitions

A list of the trigger definitions as of the end of the 2002 run is provided in Table 6.

trigger	Definition
	A-type: DS=T•2, BS=KB
MB	$\mathrm{KB} \cdot \mathrm{IC} \cdot \mathrm{DC} \cdot \mathrm{T}\bullet 2$
kp21	$\mathrm{KB} \cdot \mathrm{T}\bullet 2 \cdot (6_{CT} + 7_{CT}) \cdot \overline{19_{CT}}$
kp22	$\mathbf{kp21} \cdot \mathrm{IC} \cdot \mathrm{DC} \cdot \mathrm{L1.n}$
kp23	$\mathbf{kp22} \cdot (\mathrm{BV} + \mathrm{BVL}) \cdot \mathrm{L0rr1(3)}$
pnnl0o	$\mathbf{kp21} \cdot \mathrm{IC} \cdot \mathrm{DC} \cdot \overline{\mathrm{BV} + \mathrm{BVL} + \mathrm{EC}}$
pnnl0	$\mathbf{pnnl0o} \cdot \mathrm{HEX} \cdot (\mathrm{L0rr1(1)} + \mathrm{L0rr1(2)}) \cdot \overline{\mathrm{L0_{zfrf}}}$[10]
pnn1	$\mathbf{pnnl0} \cdot \mathrm{L1.n}$
pnn2	$\mathbf{MB} \cdot 3_{CT} \cdot \cdot 6_{CT} \cdot \overline{(13_{CT} \cdot \cdot 18_{CT})} \cdot \overline{19} \cdot \overline{\mathrm{BV} + \mathrm{BVL} + \mathrm{EC}} \cdot \mathrm{HEX} \cdot \mathrm{L0rr2(1)} \cdot \mathrm{L1.n} \cdot (ps16 + \overline{C_\pi})$
prompt	$\mathrm{KB} \cdot \mathrm{C}_\pi \cdot \mathrm{T}\bullet 2 \cdot \overline{\mathrm{BV} + \mathrm{BVL} + \mathrm{EC}} \cdot \mathrm{HEX} \cdot \mathrm{L0rr1(4)} \cdot \mathrm{C}_\pi \cdot \mathrm{L1.n}$
km21	$\mathrm{KB} \cdot \mathrm{T}\bullet 2 \cdot (6_{CT} + 7_{CT}) \cdot (17_{CT} + 18_{CT} + 19_{CT})$
km22	$\mathrm{KB} \cdot \mathrm{T}\bullet 2 \cdot (6_{CT} + 7_{CT}) \cdot \mathrm{DC} \cdot 19_{\mathrm{CT}} \cdot \mathrm{BVL}$
CEX	$\mathrm{KB} \cdot \overline{\mathrm{DC}} \cdot 2(\mathrm{T}\bullet 2) \cdot (6_{CT} + 7_{CT}) \cdot \overline{(\mathrm{EC} + \pi\mathrm{B})}$
1γ	$\mathbf{kp22} \cdot (8_{CT} \cdot \cdots 16_{CT}) \cdot \overline{20_{CT}} \cdot \overline{21_{CT}} \cdot \overline{\mathrm{EC}} \cdot \mathrm{BV} \cdot \mathrm{BVL}$
	D-type: DS=T•2, BS=πB
piscat	$\pi\mathrm{B} \cdot \overline{\mathrm{DC}} \cdot \mathrm{IC} \cdot \mathrm{T}\bullet 2 \cdot (6_{CT} + 7_{CT}) \cdot \overline{(\mathrm{BV} + \mathrm{BVL} + \mathrm{EC})} \cdot \mathrm{HEX}$
	B-type:
B0	B0
kbeam	$\mathrm{KB} \equiv C_k \cdot B4 \cdot TT \cdot spill$
ECkmu2	$\mathrm{KB} \cdot (\mathrm{ECP+ECM+COM+COP+MC+DPV}) \cdot \overline{(\mathrm{T} \bullet 2 + \mathrm{BV} + \mathrm{BVL} + \mathrm{RS} + \mathrm{prompt_{BM}})}$
Xe	Xe Ref PMT#7
pibeam	πB
cosmic	$\mathrm{T}\bullet 2 \cdot \mathrm{IC} \cdot \overline{\mathrm{BG}}$
pulser	Prescaler
EOS	EOS from predet
YAlO	EC
random	BV_sum
rsmon	Prescaler·BG
tdmon	predet or pulser
rs_ref	(rsmon Ref PMT OR) · (predet gate)
pulser•$\overline{\mathrm{BG}}$	Prescaler·$\overline{\mathrm{BG}}$

Table 6: E949 trigger definitions as of June 10, 2002.

[10] $\mathrm{L0\_zfrf} = 13_{CT} \cdot 14_{CT} \cdot \overline{15_{CT}} \cdot ext\_con(14)$

At run 44666, the kp21, kp22, kp22n, km21, km21n, km22, CEX and prompt triggers were generated from the OTB (piscat, MB, pnn2, pnnl0 and pnnl0o continued from PTB). At run 45627 the $\overline{20_{CT}+21_{CT}}$ trigger requirement was removed from kp21, kp22, kp23, and 1γ. Also the 1γ and kp23 triggers were generated from OTB and the MB was moved from PTB to OTB. At run 45731, all triggers were moved to OTB, the $\overline{BVL}$ was added to prompt and the $\overline{20_{CT}+21_{CT}}$ requirement was removed from prompt, pnnl0 and pnnl0o. At run 45762 L0_zfrf was added to pnn1. At run 46314, the $\overline{20+21}$ requirement was removed from pnn2 and piscat. At run 47375, the $(6_{CT}+7_{CT})$ and $\overline{19_{CT}}$ requirements were removed from prompt (to expand the range of layers for $\pi \to \mu$ calibrations), also the km22 requirement of $(20_{CT}+21_{CT})$ was changed to 19_{CT}. At run 48006, the online photon veto was changed from analog_sum to meantimers (HEX,BV,BVL). At run 48077 L1.2 was fixed. At run 48134, L1.2 was provided with HEX_MT bits instead of HEX_analog bits. At run 48976, the L0_zfrf requirement was added to pnnl0 and the 1γ trigger was changed to require stops in $(16_{CT}+17_{CT})$. At run 49034, the 1γ trigger was changed to add the requirement of $\overline{20_{CT}} \cdot \overline{21_{CT}}$. At run 49152, the requirement of $\overline{C_\pi}$ was added to the pnn2 trigger. From October xxx–28 (run xxx–45635) we ran with a L1.1 requirement on pnn1, pnn2, prompt, 1γ and kp23. At run 45636 on 10/30/01 we added L1.1 to kp22. At run 46387 on January 30, 2002 we added L1.2 to all 6 triggers.

1.4.8 Standard Mix Files

A listing of trigger files is provided in Table 7. The total number of runs in DAQLOG for 2002 with trig=smx and cfg=all is 1915, from 46573–50218.

$TRIG_DATA/	dates	runs to tape	# run	KBL	changes
smx_v12*	2/3–3/19	46573–48083	366	4%	various monitor prescales
smx_v13	3/20–4/2	48086–48620	407	9%	first stable trigger file
smx_l19	3/21–3	48186–48286	3	0%	x8 km21, x20 km22, no L19 veto
smx_v13_nopnn2	3/23	48270	1	0%	no pnn2
smx_v13.otb_ps*	3/27–30	48441–555	75	3%	various OTB ps
smx_v13.otb_ps16	3/27–4/2	48436–620	40	3%	≡smx_v14
smx_v14	4/2–25	48621–49048	163	11%	x16 prescale in OTB (7 trigs)
smx_v14-1g.ps2	4/22–24	48985–49035	44	3%	1γ ps=2
smx_v14-1g	4/24–25	49036–48	13	1%	≡smx_v15
smx_v15	4/25–5/30	49051–50023	830	54%	1γ ps=1
smx_v15-km22.ps1000h	5/29–30	50012–23	12	1%	≡smx_v16
smx_v16	5/30–6/10	50024–50218	146	11%	km22 ps=8192→4096
unknown_trig	—	—	0	0%	—
Total	2/3–6/10	46573–50218	1915	100%	—

Table 7: 2002 trigger files (all, standard_mix data).

1.4.9 Prescale Factors

A table of prescale factors (trigger board + prescaler board) can be found in /e787d/e949/tn/k025/prescales. These prescales are derived from a trigger board (OTB/PTB) prescale file:
/e787u/kettell/prescale/2002/otb_ps.txt (based on
`http://www.phy.bnl.gov/e949/detector/electronics/trigger/ps_history.txt`) and the Prescaler Board (PS) prescales as found in the trigger files in $TRIG_DATA/.

The PS board prescales were checked by the scaler data where possible. The ratio of actual/expected PS prescales are found in /e787d/e949/tn/k025/prescale_ratio. Most of these look pretty good. A few are clearly off by a factor of $\times 0.5$ or $\times 4$, although it is not clear where the error is (quite possibly someone made a new $TRIG_DATA file and typed in the wrong number and later corrected it.) We expect that deadtime in the scalers may cause the 'actual' prescale to come out to be too low, so I expect that many of the prescale_ratio entries between 0.9–1.0 are actually 1.0.

1.4.10 Lost Trigger files

A number of trigger files, from early in 2001, were apparently overwritten later and the original files were not saved. Several of these lost files were recreated in /e787u/kettell/prescale/2002/trig/ with a '.fix' appended to the end of the file name.

1.5 DAQ Summary

We added a 4^{th} cable segment to handle the new rstdc's (CAMAC based LRS3377 0.5 nsec TDC's, 16/8 hits, ...) We added new ADC/TDC/CCD channels for new beam detectors and DPV and rsmon Ref PMT's.

Logfiles for CAMAC loads can be found in /e787d/bnlonl/online_logfiles/camac, the PPC logfiles can be found in /e787d/bnlonl/online_logfiles/ppclog and the DAQ/DUI logfiles can be found in
/e787d/bnlonl/online_logfiles/daq.current.log.

The runlog file was corrupted at several times during the E949 run, as a result several days are missing (all data before 06/13/01 is lost, including all of the run with g–2; during the shutdown from 11/5/01–01/10/02; Jan 31 runs 46464–87; 05/28/02–06/03/02 runs 49960–50071).

A summary of the DAQ highlights follows:

- 03/28/01 Install 720 gigabyte 10 disk tower, towA, on bnlku9
- 05/01/01 (2p61) fix L1.2 inputs, enable 4^{th} cable segment in CSC
- 07/23/01 (2p98) attempt to fix pause/continue with 2^{nd} copy of clear (see also 8/7/01, 3p45)
- 08/20/01 (3p91) auto-pause/continue (see 9/5/01, 4p35)
- 09/07/01 (43189) add 24 T•2's to rstdc
- 10/02/01 (6p40) fix DUI error logging
- 10/04/01 (6p51, 44544) fix B0 output stream (see 6p53, 44557)
- 10/04/01 (6p51, 44547) rebuild DAQ etc with more FIFO's
- 10/05/01 (6p57, 44602) rstdc 32→12 μsec, drop trailing edges

- 10/09/01 (6p79, 44745) increase EB buffers from 10→20
- 10/11/01 (6p84, 44794) increase Event Builders from 2→4
- 10/11/01 (6p88, 44831) start cycling to 2 tapes
- 10/18/01 (7p31, 45143) **all_v2_432.cfg**: new beam TDC time window
- 10/25/01 (7p64, 45439) discovery of RS TDC problem again
- 10/27/01 (7p72, 45490) **all_v3.cfg**: (check RS TDC event)
- 10/29/01 (7p87, 45590) install BS+DS into TDC1:5:15–16, TDC2:19:94–5
- 10/29/01 (7p87, 45594) BS into TDC3
- 10/31/01 (7p100, 45672) add attenuation on CCD strobes
- 11/02/01 (8p11, 45757) rstdc range 10 μsec → 6 μsec
- 11/02/01 (8p12, 45758) rstdc trailing edges enabled
- 11/04/01 (8p26, 45838) discovery of tape cycling problem
- 11/05/01 (8p32, 45927) drop RS TDC trailing edges
- 11/06/01 (8p39, 45992) tape cycling works
- 11/06/01 **End of 2001 run, rstdc readout work...**
- 01/21/02 46213 Start writing to tape
- 01/28/02 46299 PS7132 32 channel scaler added to readout
- 01/29/02 46323 L1.2 running, but not cutting
- 01/31/02 46315 **all_v3.cfg**: All crates being read out
- 02/03/02 46580–47228 TDC3 readout time goes to 1.3 msec from 700 μsec
- 02/04/02 46634 km21 and km22 moved at AO board input
- 02/04/02 46650 PPC code checks each event for RSTDC mismatch (but doesn't stop automatically)
- 02/06/02 46772 L1.1 and L1.2 cutting events
- 02/08/02 Install 2 gigabytes of memory in bnlku9 reaching 2.56 gigabytes
- 02/12/02 47031 **all_v4.cfg**: New TD masks, new TRIG program to get RSTDC time (also readout is faster), new TDC3 program (faster)
- 02/14/02 47054 Might not have gone to tape due to dp0 write failure (tape 30209)
- 02/20/02 47115 Tapes 30209 and 30210 have screwed up labels (also part of 30211)
- 02/25/02 47209 Pause/continue problem fixed for RSTDC

- 02/26/02 46580–47228 FCW was unplugged in TDC3, now fixed. (DT 1.6 msec $\rightarrow$ 0.9 msec, bad since 2/21::18:24)
- 03/01/02 13:15 47300 screwup of stops in TDC3
- 03/01/02 20:54 47308 **all_v5.cfg** (TDC3 is 50 μsec faster; TRIG has a retry loop reading status code from secondaries
- 03/05/02 12:52 47360 13:00–18:00 breaker problems fixed, FERAPED now OK
- 03/06/02 17:34 47381 PPC02: initDC2 at Start/Continue instead of clearDC2
- 03/07/02 15:07 47400 event_in_spill counter added to EVCL
- 03/07/02 19:03 47412 TDC1 only leading edges readout
- 03/09/02 13:26 47558 CCD stops inverted on CCDA, CCDD
- 03/10/02 13:47 47617 PPC02 will stop run on RSTDC data error
- 03/11/02 12:15 47688 wait for RSTDC increased, more diagnostics (fixed rstdc corruption problems)
- 03/16/02 20:26 47959 **all_v6.cfg**: reduced TD gate [-1.5:6.5] μsec $\rightarrow$ [-1.5:2.5] μsec. Event size reduced from 120kB/event to 93kB/event.
- 03/17/02 17:20 48007 reduced the CCDA prompt readout window [150,165] $\rightarrow$ [158,163]
- 03/18–9/02 48055–86 Major DAQ problems (due to glitch in rstdc trig clear) lost 21 hrs.
- 03/20/02 15:32 48128 comments about CSC
- 03/22/02 09:44 48226 fixed the tape label script for pibeam stats
- 03/22/02 10:14 48227 **all_v7.cfg**: shorten TD gate [-1.5:2.5] μsec $\rightarrow$ [-0.5:2.0] μsec
- 03/22/02 11:47 48230–3 could not run FERAPED after replacing RS FERA
- 03/25/02 17:24 48376 fix tape labels for pibeam,b0,1g,MB
- 03/27/02 04:39 48419 fix problems with TDC2 from power dip
- 03/27/02 13:39 48424 ADC2#10 replaced
- 03/28/02 Install 1773 gigabyte 10 disk tower, towB, on bnlku7
- 03/29/02 12:44 48522 no data due to screwup after CCDPED
- 03/29/02 14:48 48526 new Fast Clear to TDC3 (same as RS TDC)
- 03/30/02 18:24 48572 TDC problem fixed
- 04/02/02 09:24 48627 modified *_v7 to all use TDC3_all_448_setup.dat
- 04/03/02 01:31 48646 DAQ running, but no data to tape
- 04/05/02 20:23 48724 no ADC2 sparsification cs1-2_noCCD_noADCSPv7.cfg

- 04/07/02 23:17 48753 fix semaphore for VME interrupts — no cleanup after pedestal runs
- 04/07/02 23:50 48753 faster FBPED
- 04/08/02 09:38 48756 work on new TDDAC
- 04/11/02 02:12 48773 added OPTION in TRIG SSP program to limit # events
- 04/11/02 09:35 48775 EVTn timing discussion
- 04/11/02 10:14 48775 check FB ADC gates
- 04/11/02 16:41 48775 recompile DAQ (multiple files from multiple CS, fake_int, default event_limit = 500k
- 04/11/02 18:48 48776 CCD maintenance is done (04/06/02 23:41 48747 CCD maintenance)
- 04/15/02 13:13 48781 moved strobes in TD's
- 04/16/02 15:04 48794 new TDDAC between spills
- 04/17/02 17:21 48804 changed TDCB A01#5
- 04/18/02 10:48 48819 bug in retry loop at SSP INIT fixed
- 04/18/02 16:17 48822 new $FBPED_DATA/fbped_control.nml - no sparsification for instrumented channels; all UTC cathode ADC channels will be readout on every event
- 04/19/02 04:11 48853 struggle with rstdc readout problems
- 04/19/02 12:06 48880 delay UTC cathode ADC gate by 150 nsec
- 04/19/02 14:02 48884 CCD stop/clear swapped 4/11–19 48778:48883
- 04/20/02 01:45 48909 diagnosis of bad VME memory for rstdc readout problem
- 04/20/02 21:01 48940 new VME memory fixes rstdc readout
- 04/23/02 13:39 49002 crate readout times ADC2=842$\pm$15 CCDA=808$\pm$95 TD=831$\pm$76, ADC2=37%
- 04/23/02 17:31 49005 mod to loss log (shift summary)
- 04/24/02 10:11 49024 extend rstdc range to [-2:10] μsec
- 04/24/02 10:31 49024 change all cfg files to set max words = 4000h (fix TDDAC forcing a reload of SSP's)
- 04/24/02 11:46 49024 change TDDAC, no limit at 64 events
- 04/24/02 12:15 49025 new pedestal routines
- 04/24/02 14:26 49030 new ethernet connection from ku9 to ku7
- 04/25/02 12:15 49053 RSTDC [-2,10] μsec, add 4 μsec deadtime (6 μsec$\rightarrow$10 μsec after clear) to all L0 events

- 04/25/02 14:27 49056 improve deadtime for TDC's (1.5%)
- 04/25/02 14:48 49056 modify CCDPED to remove ccd_punp errors
- 04/28/02 01:53 49115 move DAQ from bnlku37 to bnlkx15
- 04/30/02 08:55 49161 /data4 fills up
- 05/03/02 22:04 49251 replace SSP TD03, forget TDDAC
- 05/04/02 01:16 49255 TD03 saga
- 05/04/02 12:10 49268 PPC01 problems
- 05/05/02 11:56 49296 cycle power on CCDA+D (did not fix ped problems)
- 05/05/02 15:52 49299 TDDAC improvement
- 05/06/02 11:09 49320 blown fuse in FERA L17C2, ku7 crash — lost 1.5 hours
- 05/06/02 15:23 49332 rstdc mpi cable problem
- 05/06/02 14:50 49326 rstdc cable swap 49324–6
- 05/06/02 15:39 49332 update tape_label script (1g, pib wrong)
- 05/06/02 20:49 49341 change tape drive configuration
- 05/07/02 11:34 49353 work on mx0 (not in use) causes glitch on mx2
- 05/07/02 20:09 49361 change tape configuration, kill jobs on ku9, missing some spills before these changes
- 05/08/02 06:43 49374 /data0 full
- 05/08/02 08:38 49377 swap rstdc cables slots 18+6 in L17C3
- 05/08/02 14:30 49381 lots of DAQ problems during Sep conditioning
- 05/09/02 00:32 49389 no pnn data to tape?
- 05/09/02 07:47 49404 replace CCDC SSP
- 05/09/02 14:25 49410 lost pnn data in run 49389
- 05/09/02 16:47 49411 unstable peds in CCDD — cycle power
- 05/11/02 15:35 49459 change tape default 0,1,3
- 05/12/02 13:43 49483 DS in CCDD attenuated by $\times 2$
- 05/14/02 05:03 49527 PPC03 problems, cycle power on master crate
- 05/14/02 08:19 49533 tape 30242 already used?
- 05/14/02 10:48 49538 PPC04 problems

- 05/14/02 13:51 49545 replace crate controller in Cr19 (rstdc)
- 05/14/02 16:06 49553 new terminator on CS4
- 05/14/02 18:00 49557 CS3 problem, reseat CS at PPC03
- 05/14/02 16:06 49560 new tape labels, 30241–2 recorded twice
- 05/17/02 00:57 49634 lots of DAQ problems
- 05/21/02 16:16 49773 CCDA trigger board repaired
- 05/22/02 14:01 49818 new PPC code for 'resetstatus'
- 05/22/02 15:56 49824 PPC 'resetstatus' fix caused problems, removed
- 05/23/02 20:46 49856 CCDPED problem in CCDA (after power cycle?)
- 05/24/02 18:31 49881 replace ancillary logic board (bad hybrid) on CS3
- 05/24/02 20:01 49883 discover crontab problem (ku7 and ku9)
- 05/24/02 23:51 49887 fix crontab problem
- 05/25/02 13:34 49901 problem with tape drive configuration
- 05/29/02 11:05 49988 recompile DAQ with 'tatem' and B-field fix in DAQLOG
- 05/29/02 12:30 49989 manually change run number to 50000 (no runs 49990–50000)
- 05/29/02 14:03 50002 run 50000 bug found
- 05/30/02 13:30 50023 run_log problems due to ku9 crash
- 05/31/02 15:06 50045 Joe DePace coming to look at ku9
- 06/01/02 01:31 50047 tell MCR we cannot take beam until SGI comes tomorrow
- 06/01/02 18:41 50042 ku9 problems, tell AGS to shut down
- 06/02/02 12:54 50055 ku9 disks fixed at 05:00 today, AGS tries to restart (beam by 12:30)
- 06/02/02 14:57 50058 beam back, running smx
- 06/03/02 06:00 50074 need to reload FERA map, struggle with UTC ADC problems
- 06/03/02 07:12 50077 rstdc#19 replaced
- 06/03/02 12:07 50080 UTC ADC cable problems?
- 06/07/02 16:03 50149 update cs1-4_noCCD_v7.cfg, cs1_noCCD_v7.cfg
- 06/07/02 17:54 50152 10 hours lost to SCSI problems on towa
- 06/08/02 22:01 50187 RSTDC 13P11 problem

$SSP_DATA/	dates	runs on tape	# run	KBL	changes
all_v3	2/3–7	46573–849	23	0%	
all_v5	3/9–16	47560–958	250	2%	trig=31e, tdc3=v9, td=01_3, tdc1 option
all_v6	3/16–22	47959–48226	204	4%	move td prompt window, td=01_3_v2
all_v7	3/22–6/10	48227–50218	1436	93%	", td=01_3_v3
all_noADCSP_v7	4/5	48725	1	0%	adc2_option=0x02002020
tddac_all	5/10	49424	1	0%	mistake (bad_run)
unknown_nml	—	—	0	0%	—
Total	2/3–6/10	46573–50218	1915	100%	—

Table 8: 2002 cfg files (all, standard_mix data).

- 06/09/02 12:23 50204 TD08, FERA problems - cycle power on TD08
- 06/24/02 Irix 6.5.14 upgrade bnlku9 to install towB from bnlku7

A listing of SSP configuration files (.cfg) is provided in Table 8.

We will cut data with tddac_all.cfg or unknown_nml, but all other SSP configuration files will be kept. (Renee points out that all_noADCSP_v7.cfg data will look the same as all_v7.cfg after processing by Kofia.

1.5.1 MCSC Memory Overflow

Data corruption, may not be usable? So perhaps we need to worry about runs 47033:47617, 47727:47955, 48129:48178, 48430:48468, 48632:48637.

By my count, if we toss all of these runs we will lose between KBL=6–8$\times10^{10}$ or about 4% of our total KBL for 2002. Renee plans to write code to identify if any memory overwrites actually occur in any given run or any given event, so we do not need to put these in any bad_run lists now.

- 02/13/02 47042 MCSC readout installed (but not enabled?)
- 03/06/02 47378 Playing with L0 signal into MCSC (data not valid)
- 03/07/02 22:10 47420 SSP start into MCSC control#1
- 03/09/02 47590 MCSC readout disabled (when was it enabled?)
- 03/12/02 47728-47957 re-enable MCSC
- 03/16/02 19:46 47958–48127 disable MCSC
- 03/20/02 15:19 48128 re-enable MCSC
- 03/20/02 15:54 48128 comments about MCSC
- 03/21/02 12:15 48180–48430 disable MCSC again
- 03/27/02 12:58 48424 work on MCSC, still not working
- 03/27/02 18:11 48430 Renee fixed problem in PPC code for the MCSC readout
- 03/27/02 18:27 48431–69 re-enable MCSC readout

- 03/28/02 13:31 48470–631 disable MCSC again
- 04/02/02 14:12 48632 reenable MCSC readout
- 04/02/02 16:22 48638 'final' MCSC fix
- 04/11/02 02:13 48773 replace MCSC with E949 module
- 04/25/02 16:38 49049 modify MCSC start to be L0+BOS

1.5.2 rstdc Data Quality

There are two categories of rstdc problems: Annoyance/data collection inefficiency and bad data. According to David's survey of tdmon data, there are no occurrences of bad data after run 46644, which is before the proposed start of Pass1 data.

- 09/07/01 17:00 add 24 T•2's to RS TDC
- 09/23/01 19:00 44017 LB5p80 fix T•2#24 into RSTDC
- 10/05/01 16:25 44602 LB6p57 Change RSTDC 32 μsec $\rightarrow$ 12 μsec, drop trailing edges
- 10/05/01 21:30 44614 LB6p58 found BS unplugged in RSTDC (44581–44614)
- 10/09/01 01:00 44728 LB6p75 bad RS TDC data, DYC wrong readout sequence
- 10/23/01 01:10 45348 LB7p52 load CAMAC had errors, RS TDC fucked up
- 10/25/01 10:25 45439 LB7p64 discovery of RS TDC problem again
- 10/26/01 18:30 45469 LB7p70 Renee George study RS TDC event bits
- 10/26/01 22:30 45483 LB7p71 study of all_v3 (check RS TDC event #)
- 10/30/01 01:00 45609-16 LB7p90 RS TDC disaster, from Renee's unpacking
- 11/02/01 17:00 45757 LB8p11 change RS TDC stop from 10 μsec to 6 μsec
- 11/02/01 17:00 45758 LB8p12 change RS TDC to keep trailing edge (12$\rightarrow$8 μsec)
- 11/05/01 17:15 45927 LB8p32 drop RS TDC trailing edges
- 02/13/02 16:16 47033 all_v4, new TRIG(measure RS TDC readout time, reduce time by 100 μsec) and TDC3(remove wait loop) code, new TD masks
- 03/10/02 13:47 47617 PPC02 will stop run on RSTDC data error
- 03/11/02 12:15 47688 wait for RSTDC increased, more diagnostics (fixed data corruption problem)
- 03/20/02 15:32 48128 comments about CSC (this was actually a gate generator problem that caused corrupted rstdc data over the last couple of days)
- 03/29/02 14:48 48526 new Fast Clear to TDC3 (same as RS TDC)
- 04/16/02 08:12 48790 RS TDC serial # mismatch

- 04/18/02 05:05 48814 RS TDC serial # mismatches in #33.
- 04/19/02 04:11 48853 struggle with rstdc readout problems
- 04/20/02 01:45 48909 diagnosis of bad VME memory for rstdc readout problem
- 04/20/02 21:01 48940 new VME memory fixes rstdc readout
- 04/24/02 10:11 49024 extend rstdc range to [-2:10] μsec
- 04/24/02 13:22 49030 rstdc range back to [-2:6] μsec
- 04/25/02 12:15 49053 RSTDC [-2,10] μsec, add 4 μsec deadtime (6 μsec$\rightarrow$10 μsec after clear) to all L0 events
- 05/06/02 14:50 49326 rstdc cable swap 49324-6
- 05/06/02 15:23 49332 rstdc mpi cable problem
- 05/08/02 08:38 49377 swap rstdc cables slots 18+6 in L17C3 (49377–9)
- 05/14/02 13:51 49545 replace crate controller in Cr19 (rstdc)
- 06/03/02 07:12 50077 rstdc#19 replaced

1.5.3 Pedestal Problems — new circuit breakers

When the pedestals are taken during running there is a check to determine if the individual channels pass a given set of standards. One way a FERA channel can fail is when the sigma of the pedestal value is greater than 2.0. This value was chosen, somewhat arbitrarily, to make nearly all of the channels to pass when everything is working properly. If too many individual channels fail then the new pedestal file will not be loaded. Coinciding exactly after electrical work on the breakers was done, 01/24/02 09:38 run:46238, a great many of the FERA-pedestals' sigmas exceeded 2.0 and the new FERAPED file was not able to be loaded. Although the sigma of many channels jumped to larger values, many well above 2.0, the pedestal values were not effected. After the breakers were fixed, 03/05/02 12:52 47360 13:00–18:00, the FERAPED sigmas went back to the original values.

- 08/30/01 (4p14) new breakers
- 03/05/02 12:52 47360 13:00–18:00 breaker problems fixed, FERAPED now OK

1.5.4 Voltage Monitor System

A new voltage monitoring system was installed (to help improve our operating efficiency). More detailed documentation can be found at `http://www.phy.bnl.gov/e949/detector/monitor/voltage`.

A summary of highlights and modifications to the system includes:

- 01/18/02 46158 MIDAS run number synchronized to main DAQ
- 02/23/02 23:25 47175 update of hardware for Midas voltage monitoring
- 03/21/02 05:00 48162 MIDAS gate generator re-timed for 2.2 sec spill

- 03/22/02 06:13 48220 Midas gate generator adjusted A,B 2.2,2.2 msec
- 03/31/02 15:58 48589 Voltage Monitor alarms activated
- 04/27/02 12:47 49101 -5V on TD07 bad
- 05/05/02 23:14 49308 ALANA issues
- 05/09/02 05:56 49397 MIDAS not running for 5.5 hours, restart
- 05/15/02 13:52 49593 test writing MIDAS voltages into DAQ
- 05/21/02 16:51 49776 test writing MIDAS data to DAQ
- 05/23/02 12:41 49848 remove/insert PU summer to fix ripple on -6V of R6N5

1.6 Special Runs

The calibration run information comes only from DAQLOG (only runs written to tape). The other special run information was culled separately from DAQLOG (only to tape) and from runlog (to tape or disk).

1.6.1 Regular Calibration Runs

The regularly scheduled special runs, as specified on the whiteboard and in `http://www.phy.bnl.gov/e949/run/0204_requestedruns.txt` included RSSC calibrations (pulser), RS gain calibrations (km22), EC calibrations (ECkmu2) and TT/UTC calibrations (km21).

RSSC: Data is collected with TRIG=pulser NML=tdc3_fe55.cfg, request was for 10M events every 2 weeks. Data was collected on: March 19 (48070–1), March 31 (48589–95), April 18 (48818–9), May 15 (49572–90), May 29 (49984–8), June 10 (50219–20)

RS gain: Data is collected with TRIG=km22_mix, request was for 50k events once per week. Data was collected on: January 30 (46345–8, 46400–6), Feb 2 (46505–7), Feb 3 (46578–96), Feb 4 (46609–12), Feb 5 (46689–92), Feb 6 (46815–23), March 8 (47467–70, 47501–10), March 20 (48101, 5–7, 48125–8), March 22 (48233), March 23 (48258–61), March 26 (48405,7,10), March 30 (48564), April 2 (48633,5–8), April 4 (48675), April 5 (48709), April 19 (48847–50,6–7), April 20 (48930), May 1 (49187), May 4 (49280,2–3), May 29 (50005)

EC: Data is collected with TRIG=eckmu2, NML=cs1_noCCD.cfg; request was for 400k events once per month. Data was collected on: February 6 (46787–9,94–5,46800,7–12), March 6 (47429–30,6–9), March 14 (47847–50), March 29 (48528,33,5–40), April 2 (48627–9), April 19 (48854–5,48902–5,25–9), May 15 (49596–600) June 7 (50152–6). We also collected eckmu2 data with cosmics and a modified trigger to try to accumulate data for understanding the light yield of the new downstream collar counter.

TT/UTC: Data is collected with TRIG=km21_mix, NML=cs1.cfg; request was for 100k events once per month. Data was collected on January 29 (46315–20,31–3), January 30 (46370–2,46407–13), February 2 (46509–10,8,24–64), February 3 (46574–5,80–5,8–9,93–4,602,13–20,28–9,36–55), February 5 (46664–80,711,23–5), February 6 (46730–48,61–2,97–8,801,3,5), March 6 (47375), March 7 (47411–6,23–8,31–4), March 8 (47480-99,511–2,4–8,23–9,43–4,8,57), March 12 (47736,98–801), March 15 (47884–5), March 17 (47987,91–3,48001), March 20 (48117), March 22 (48242–4,7), April 5 (48674,6–7,92–701,8–20,4), April 18 (48830–40,44–6,51–3,58–61,70–5,80–2,906–11), April 20 (48936–40), (49281), May 15 (49594), June 7 (50150–1)

1.6.2 Other Special Runs

From DAQLOG (written to tape) we have lots of cosmics, 791 runs. B0: 17 runs, 47421–2, 47435, 47844–6, 48050, 48060, 48889–91, 48931–5. piscat: 68 runs. minbias: 31 runs. kbeam: 29 runs. pibeam: 10 runs. kp2: 228 kp21 and kp22 runs. 1γ: 8 runs. special pnn/pnnl0 runs: 60. prompt: 7 runs. rsmon/tdmon: 31 runs. l19_test: 4 runs.

Checking the runlog (which includes runs not written to tape) we have: 2766 cosmic runs, 97 rsmon/tdmon runs, 42 b0 runs, 178 piscat runs, 199 minbias runs, 140 pulser runs, 643 km21 runs, 112 km22 runs, 73 eckmu2 runs, 229 kp22 runs, 181 kp21 runs, 272 kbeam runs, 53 pibeam runs, 8 1γ runs, 117 special pnn runs, 10 prompt runs, 2 cex runs, and 4 L19 trigger test runs.

1.7 DAQLOG

DAQLOG records information for data written to tape. (Therefore we have no record from the run in the Spring of 2001.)

There are several known instances of corrupted data in the DAQLOG, mainly due to improper manual entry of tape labels from the dp0 window. The known corrupted tape labels are shown in Table 9.

Other known problems are:

- No KBL recorded from run 43596 on September 16, 2001 through run 45592 on October 29, 2001.
- KBL screwed up from 45593–47983 plus some later runs too.
- Cycling to two tapes incorrectly from 44831–45991.
- Cycling to two tapes correctly from 45992–47635.
- Cycling to 3 tapes from 47636–50229.
- Runs 47232,48909 have no SSP namelist

After the run 2002 run a new version of DAQLOG was introduced to get around some of the limitations of the old DAQLOG. These limitations included: 1) the difficulty of correcting corrupted data, 2) the difficulty of adding new information (for example the information stored in bnlonl/online_logfiles/runlog), and 3) the user interface was not very flexible.

The DAQLOG information from the 2001-2002 runs has been converted to the new database and the corrupted tape labels listed in Table 9 have been fixed there. Access to the new version of the DAQLOG is via the web at http://bnlku28.phy.bnl.gov/daqlog/daqlog.php.

1.8 Loss Log

'Macro' Efficiency of Data-taking in the 2002 Run

The macro efficiency of data-taking for the last 7 weeks of the 2002 run based mainly on our shift summaries is summarized. The fraction of time beam was delivered down our beamline was 81%. When beam was being delivered, the fraction of time we took data was 87.4%. The sources of inefficiency were: DAQ (0.079), tape change/pedestal (0.031) and problems with our beamline (0.015). Excluding the disastrous last week of the run, the numbers become the following. Beam delivered: 0.858. Data taking efficiency: 0.890. Inefficiency: DAQ (0.061), tape change/pedestal (0.033), beamline (0.015). Some ideas for improvement are listed.

Corrupt label	Run number	Correct label
302084363.2.1	46715,6	30207.2.1
302084363.2.2	46715,6	30207.2.2
302094365.2.1	46760,1	30208.2.1
302094365.2.2	46760,1	30208.2.2
302648040.3.1	48583,4,5	30264.3.1
302648040.3.2	48583,4,5	30264.3.2
302648040.3.3	48583,4,5	30264.3.3
Multistre30262.3.1	48554,5	30262.3.1
Multistre30262.3.2	48554,5	30262.3.2
Multistre30262.3.3	48554,5	30262.3.3
.2.1	46394	30204.2.1
.2.2	46394	30204.2.2
.2.1	47494	30215.2.1
.2.2	47494	30215.2.2
.2.1	44871	30052.2.1
.2.2	44871	30052.2.1
.2.1	45043	30058.2.1
.2.2	45043	30058.2.2
300546372.2.1	44904	30053.2.1
300546372.2.2	44904	30053.2.2
302014410.1.1	46230	30200.1.1
33056.2.1	44997,8,9	30056.2.1
33056.2.2	44997,8,9	30056.2.2
32010.2.1	47066,7,8	30210.2.1
32010.2.2	47066,7,8	30210.2.2
30241.3.n	49520-49532	30341.3.n
30242.3.n	49533-49558	30342.3.n

Table 9: Known corrupted tape labels in DAQLOG.

Thanks to the efforts of shift-takers during this past run (and some better software tools), we now have fairly detailed information in the shift summaries of the main sources of our data-taking inefficiency.

This summary starts at 0:00 on April 21, which was approximately when we started taking smx data again after being down for the NASA radiobiology run and after replacing the VME memory board for the RSTDC and changing the UTC cathode electronics. My intention was to see how well we did in the 'steady state' after most of the hardware and software modifications/improvements. The primary source of information is the shift summaries, where the shift takers were asked to categorize and comment on the periods where we had beam but were not taking data. Where the information was unclear, the ELOG was used. In some cases, the shift summaries were screwed up, due either to cron job problems or bnlku9 being down; in such cases the source was George's notes. The criterion in the shift summary for 'beam on' is $K_B > 50000$ per spill; in particular, this meant that if one of the separators was down, the time would still be counted as 'beam on'. 'Taking data' means the DAQ system was in the so-called 'active' state; this happens after clicking on the 'write' button in the request for a begin run comment (the data could be going to trashcan).

1.8.1 Results and discussion

The results are shown in Table 10 for the fraction of time beam was on and in Table 11 for the fraction of time we took data. 'LESB3' includes downtime due to D3 trips.

Week	Hours	'Beam on'	Comment
4/21-4/26	132	0.869	
4/26-5/03	168	0.816	
5/03-5/10	168	0.894	
5/10-5/17	168	0.884	
5/17-5/24	168	0.836	
5/24-5/31	168	0.854	
5/31-6/09	228	0.605	46 hrs ku9 problem (also weather) 24 hrs separator vacuum problem 20 hrs AGS booster/magnet problems
Average		0.810	
Ex. last week		0.858	

Table 10: Fraction of time beam was delivered to the kaon stopping target in the last 7 weeks of the 2002 run. The average is a weighted average, weighted by the number of hours in the 'week'.

While we have not yet reached the levels of efficiency of the LEP experiments (overall efficiency $\sim 95\%$, DAQ efficiency $> 99\%$)[1] our overall macro efficiency in the steady state of the 2002 run was respectable (87% overall and 92% DAQ), reaching as high as 94% overall (97% DAQ) in one of the weeks. Can we improve further?

Obviously we were hurt by the repeated ku9 crashes and SCSI bus problems of the last week. Some ideas here include upgrading the SGI coverage of ku9, mirroring or RAID'ing the DAQ-critical disks, and buying a ku9 spare (pretty cheap now on e-Bay!). Our temperature sensor system seems to be vulnerable to power dips; we will be looking into possible remedies this summer. Intermittent SSP cable segment problems plagued us at the $\sim 1-2\%$ level. It is not clear what can be done further. More retry loops can

[1] These are the numbers claimed for ALEPH in `http://alephwww.cern.ch/ALPUB/pub/pub01/4/online.pdf`

Week	Eff.	DAQ	Tape/ped	LESB3	Comment
4/21-4/26	0.900	0.039	0.028	0.021	0.58% computer crash
					0.58% lengthen RSTDC gate
					0.51% TDDAC trouble
					2.23% misc DAQ
4/26-5/03	0.891	0.060	0.031	0.017	1.95% HV MF4
					0.43% power dip recovery
					0.43% PPC3 boot problem
					0.43% shift crew error
					0.30% /data4 full
					0.24% TD readout
					2.22% other DAQ
5/03-5/10	0.863	0.104	0.024	0.012	1.83% SERR in CCD-C
					1.67% FB power supply
					1.55% SSP hybrid
					1.00% tape drive
					0.72% TDCB ch. 149
					0.61% misc SSP trouble
					0.28% /data0 full
					2.74% other DAQ
5/10-5/17	0.880	0.070	0.044	0.004	1.06% misc SSP trouble
					1.01% CAMAC crate ctrlr
					0.79% CS4 problems
					0.56% tape drive
					3.58% other DAQ
5/17-5/24	0.869	0.055	0.047	0.031	1.13% SERR in CCD-C
					0.71% SFI blk rd problem
					0.71% computer crash (ku7,37)
					0.59% summer oscillation
					0.36% SSP hybrid
					2.00% other DAQ
5/24-5/31	0.941	0.032	0.022	0.004	1.05% computer crash (ku9)
					0.64% tape drive
					0.35% CCD adjustment
					1.16% other DAQ
5/31-6/09	0.806	0.155	0.024	0.015	5.19% tower A SCSI prob
					2.29% FERA map problem
					2.72% temp sense trips
					1.39% replace UTC ADC, RSTDC
					0.66% MIDAS stuck
					0.48% tape drive
					2.77% other DAQ
Average	0.874	0.079	0.031	0.015	
4/21–5/31	0.890	0.061	0.033	0.015	

Table 11: Fraction of time we were taking data when beam was being delivered down our beamline. The category 'beamline' consists mainly of separator and D3 trips.

be put into the SSP code, perhaps. We are looking into an active SSP cable segment connector that would allow the segment to be terminated at an arbitrary SSP, ultimately via software control; this should make it possible to automate the process of finding bad hybrids, and also to avoid powering off/on the SSP's on the segment in order to find the offending SSP. Downtime due to tape drive problems can be decreased by making it easier for the shift crew to change the tape configuration.

2 Scalers

The scaler configuration was changed for E949 to take advantage of the new PS7734 scaler (225 MHz) on September 12 (LB4p93, 43424). Three new scaler channels added on 9/14/01 (43513). Several broken scaler circuits were fixed on September 15 (43535). Scaler #1 was incorrectly, not-cleared after each spill from run 44747–45315. PPC#1 code was fixed before run 45316 (10/22/01, LB7p49).

An important parameter for understanding detector rates is the spill length. We have two measures of the length of time that we have beam in the cave, 10kHz_beam_100 and 10kHz_beam. These are coincidences of a 10kHz clock with KB where KB opens a gate for 100 μsec or 1 msec, respectively.

A more important method to measure the spill length is to look at the number of accidental coincidences compared to the singles rate of a counter, where the counter is put in coincidence with itself with a suitable delay. From the following expression we can then derive an effective spill length, T_{eff}.

$$\frac{coinc}{T_{eff}} = \frac{signal^2}{T_{eff}^2} \times \tau_r \implies T_{eff} = \frac{signal^2 \times \tau_r}{coinc} \tag{1}$$

where τ_r is the resolving time of the coincidence circuit and $signal(coinc)$ is the number of counts from the input(output) to the coincidence circuit. We have three circuits for measuring T_{eff}: one using B4 (B4u2) and two using the 90° telescope (one with a long coincidence gate, 90°_{long}). The 90°_{long} circuit has a resolving time of 200 nsec and one signal is delayed by the AGS revolution period of 2.8 μsec. The delays of the 90°_{short} and B4 are 300ns. The resolving time of the T_{eff} coincidence for the 90° telescope (90Dmon) was measured on 10/2/01 LB6p42 (44486)

Some plots showing the spill length are available in Figure 9. Figure 9a shows the spill length as measured by 10kHz_beam_100; we can see that a small fraction of the 2002 run had a spill length of 1.6 sec (up to run 47829). Figure 9b shows the effective spill length T_{eff} and Figure 9c shows the ratio of two of the measures of T_{eff}: B4 and 90°.

Some detector rates as measured by the end-of-run scalers can be seen in Figure 10. Here we see the C_k, KB and KBL rates. We also have plots (Fig. 11) showing the online stopping fraction (C_k/KB) and the fraction of pions in the beam (C_k/C_π) and the AGS proton targeting efficiency (C_k/C_{SEC}). Some additional plots showing detector performance can be found in Fig. 12-13.

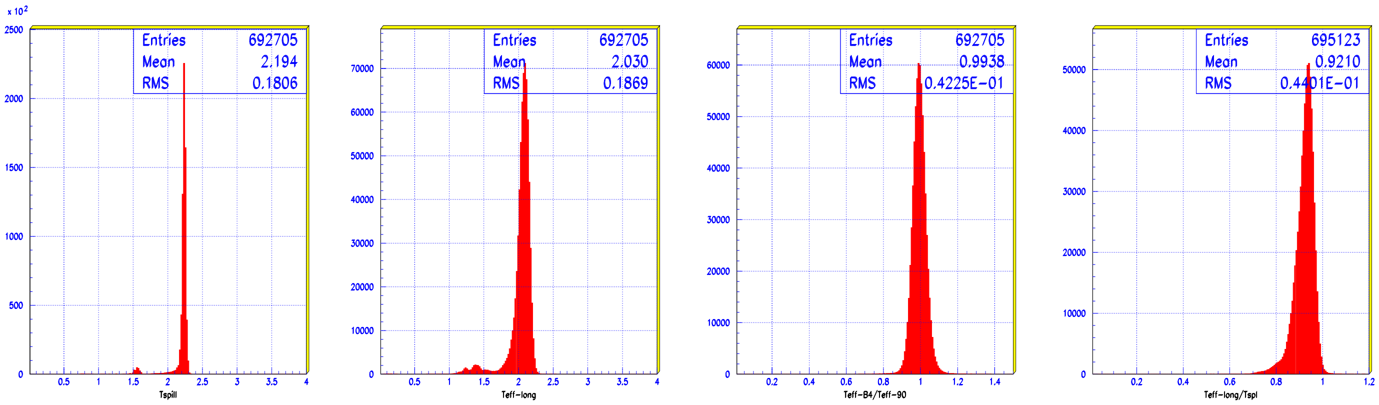

Figure 9: The spill length in 2002, as measured by the spill-by-spill scalers. a) the length of time beam is in the cave, 10kHz_beam_100; b) the effective spill length (T_{eff}) as measured by 90°_{long}; c) the ratio of T_{eff} from B4 and 90° and d) the effective spill ratio T_{eff}/T_{spill}.

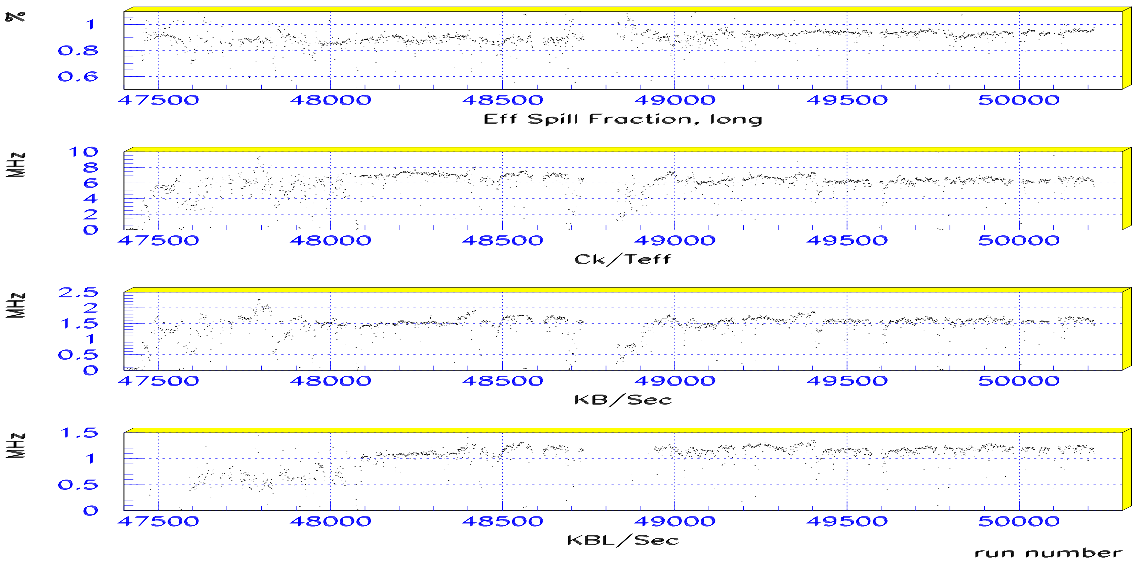

Figure 10: E949 rates. The AGS went off for the NASA run at run 48734; the AGS came back on at run 48830, with a ramp up to smx running at run 48941.

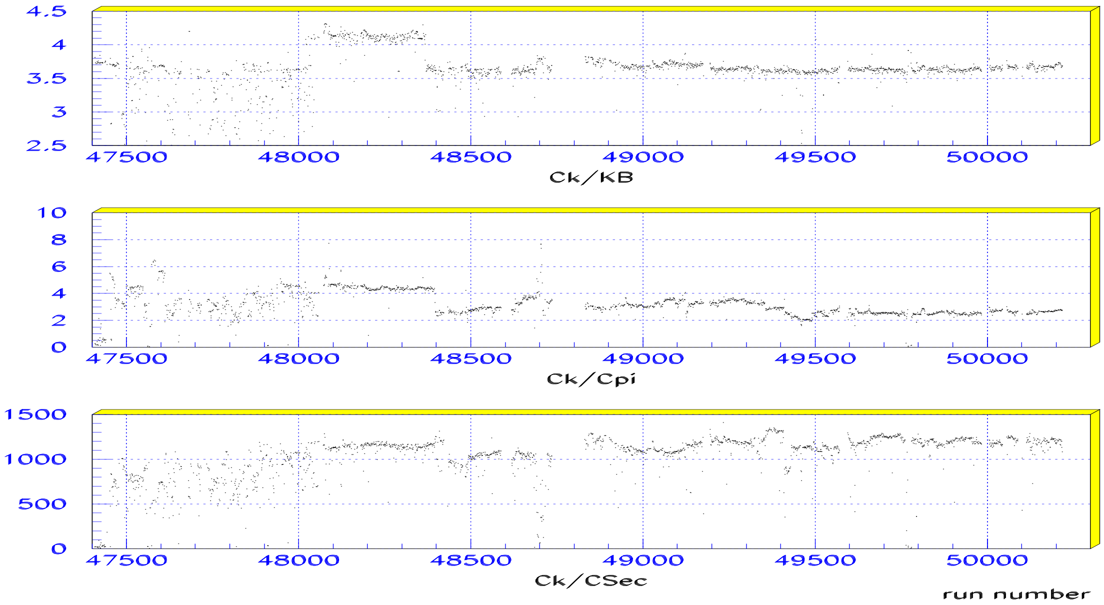

Figure 11: E949 beam conditions. The increase in C_k/C_π and C_k/C_{SEC} at run 47406 is due to the separator standoff repair. The drop in K/π and C_k/C_{SEC} at run 48427 is due to the deterioration of the negative plate of Separator #1. The increase in C_k/KB from runs 48021 to 48370 is due to an increase in the target threshold from 100 mV to 150 mV.

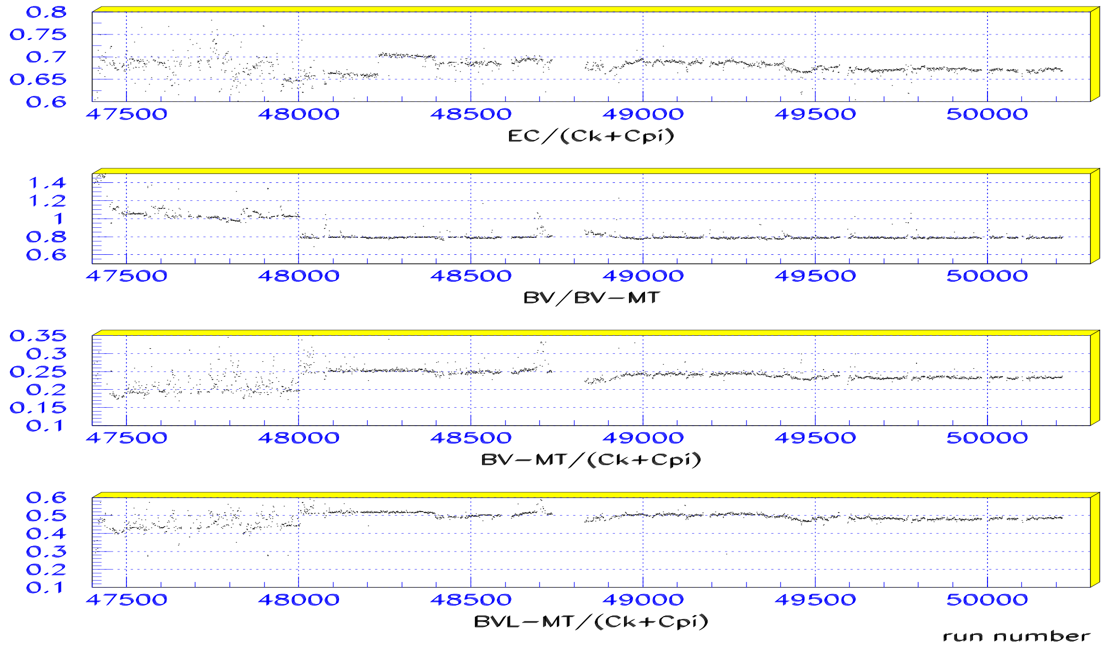

Figure 12: E949 detector rates. The increase in EC at run 48232 was due to the restoration of the input cable to discriminator #6. The drop in BV/BV-MT at run 48006 is presumably due to an increase int eh BV-MT threshold?

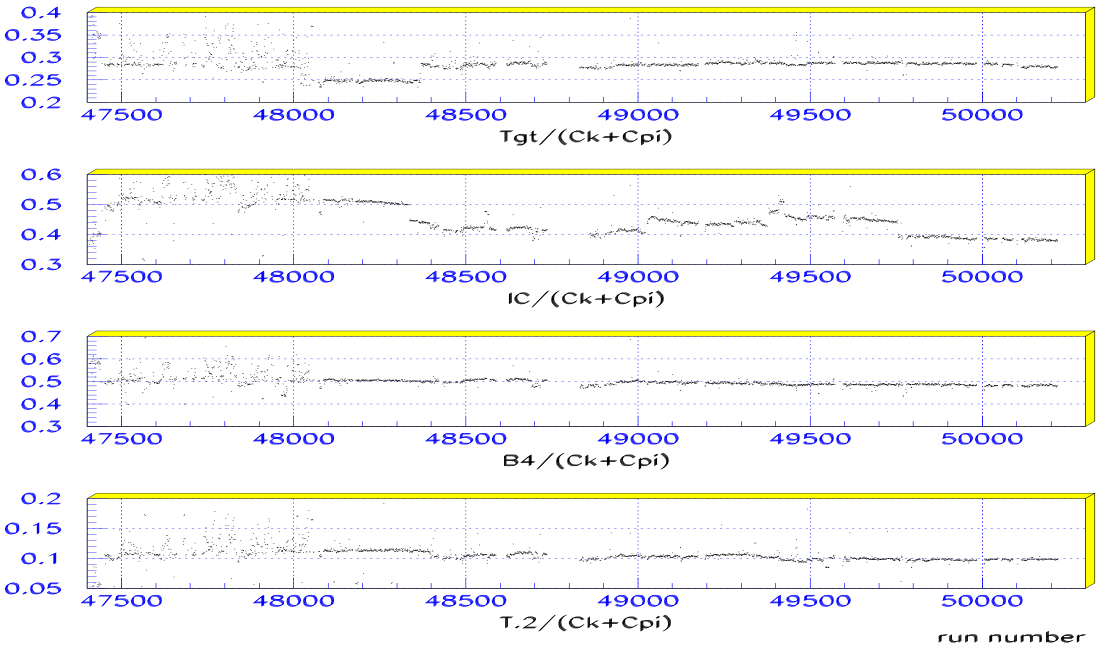

Figure 13: E949 detector rates. (The drop in target rate from runs 48021 to 48370 is due to an increase in the target threshold from 100 mV to 150 mV. The drop in IC rate at run 483xx has not been understood; the increase in IC rate at run 49024 is due to new IC HV's. The increase in IC rate from runs 49407 to 49751 is due to a decrease in IC CFD width from 30 nsec to 10 nsec.

2.1 End-of-run scalers

We had 399 files with incorrect scaler data. The data from the previous run was duplicated into these files. These files were are renamed as 'junk_$run', instead of 'scalers_run_$run'. These files spanned run numbers 42385 to 50199. It is not known what went wrong with the DAQ to write out scalers for a prior run, but in most or all cases it occurred for a run that died almost immediately.

The total KBL as measured by the end-of-run scalers from run 46293 to run 50218 is 1.783×10^{12} (1.633×10^{12} smx).

2.2 Spill-by-spill scalers

The individual scaler records for each spill have been saved in the monitors-to-disk data in the undef stream. In 2001–02 we have no undefined data, so all that is saved is the end-of-spill records, which contain scalers and some scanning ADC data. The total KBL for 2002 is 1.818×10^{12} of which 1.766×10^{12} is presumed to be smx (L1.n rejection > 2).

We have also saved the scaler data, along with the beamline magnets and the separator HV and the target temperature into files in /e787d/bnlonl/online_logfiles/scalers. There are periods of time with missing data when the script was not working.

Some examples of the spill-by-spill scaler data can be found in Figure 9 and in Figure 14. A summary

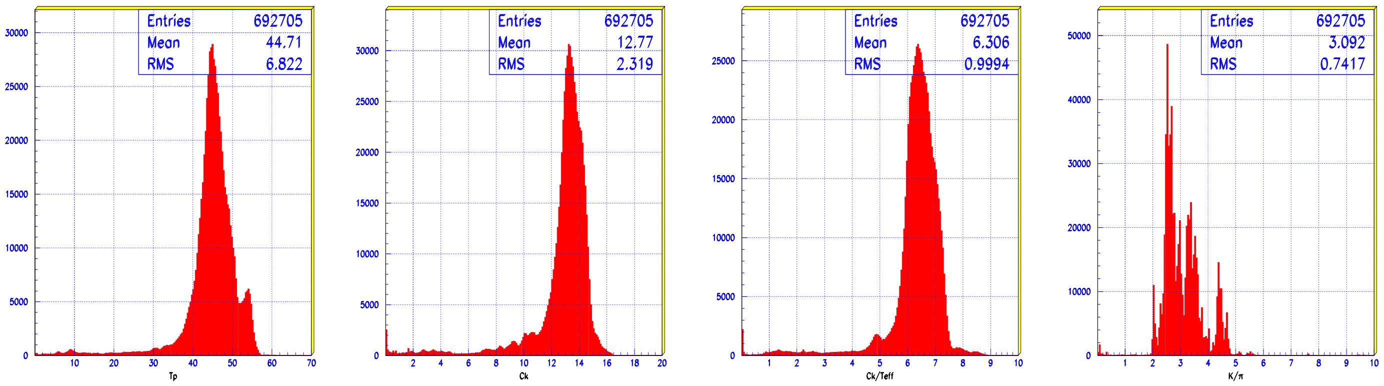

Figure 14: Some plots showing the running conditions in 2002, as measured by the spill-by-spill scalers. a) the number of protons per spill on the C-target ($C_{SEC}/250$), b) the number of kaons per spill (C_k), c) the kaon rate (C_k/T_{eff}), and d) the K/π ratio.

of comparative operating conditions for E787 and E949 based on the undef scaler records can be seen in Table 12.

2.3 Run_log

The run_log is filled by a cronjob that runs at regular intervals on bnlku9. This interval had been every 10 minutes up until October 8, 2001 (LB6p72, 44705); at this time the interval was reduced to every 5 minutes. The cronjob started a job on bnlku7 to read a scaler in the serial CAMAC system in the crate downstairs. This data is saved in a disk file. Another job is started on bnlku9 that attaches to the dd-system and reads the scalers from the disk file. A combined output is written, one line per 5(10) minutes into the file bnlonl/cron_jobs/run_log/run_log. At the end of each week the file is saved as run_log.$date. These files were analyzed to provide our official log of KBL during the run. The total KBL was 1.8944×10^{12}. A summary of the weekly KBL totals (measured on Fridays at 12:00) is provided in Table 13.

year	1995	1996	1997	1997	1995–7	1998	1998	1995–8	2001	2002
spill	'1.4'	1.6s	1.6s	1.6s	'1.5'	2.2s	2.8s	'2.0'	'1.6'	'2.2'
DF(%)	41	44	44	44	43	49	55	'48'	36	41
$\|\vec{p}\|$	790	730	710	670	'745'	710	710	'730'	710	710
Run	21529	29650	33719	34924	21529	35800	39901	21529	42910	46116
hours	2555	1797	916		5268	2490		7758	600	1600
Start	1/1	3/2	4/1	5/13	1/1	6/10	10/7	1/1	9/1	1/29
End	6/14	6/28	5/11	6/3	6/3	10/7	12/31	12/31	11/8	6/9
'ϵ_{C_SEC}'	0.80	0.92	0.77	0.72	0.83	0.67	0.58	0.76	0.14	0.14
Tp/sec	11.3	9.0	12.2	11.2	10.6	11.3	11.2	11.0	11.5	20.4
Tp/spill	16.3	14.0	20.3	18.7	16.1	24.9	34.7	19.4	15.5	44.7
C_K/spill		5.3	6.2	4.4	5.8	7.9	11.4	6.8	2.9	12.8
C_K/sec	4.3	3.4	3.7	2.6	3.8	3.6	3.9	3.8	2.1	5.8
C_K/T_{Eff}	5.1	4.0	4.5	3.4	4.5	4.3	4.5	4.5	2.9	6.3
KB/sec	0.81	0.78	0.92	0.72	0.81	0.97	1.06	0.87	0.6	1.57
KB_L (MHz)	0.61	0.58	0.75	0.61	0.61	0.78	0.86	0.67	0.4	1.15
KB_L/sp(M)	0.88	0.91	1.24	1.02	0.93	1.70	2.46	1.26	0.6	2.55
C_K/Csec	265	225	220	180	240	265	315	255	760	1145
K/π	3.8	4.2	4.3	3.7	4.0	4.0	3.5	3.9	4.3	3.1
KB/C_K	0.188	0.231	0.245	0.274	0.215	0.269	0.269	0.230	0.275	0.270
LT	0.76	0.76	0.82	0.86	0.77	0.81	0.81	0.78	0.77	0.74
DT/KB	0.24	0.25	0.17	0.15	0.24	0.16	0.15	0.21	0.30	0.15
T_{Eff}/T	0.85	0.85	0.82	0.78	0.84	0.84	0.88	0.85	0.71	0.92
KB_L/hr (10^9)	0.95	0.99	1.22	1.00	0.98	1.42	1.75	1.21	—	—
$KB_L(10^{12})$	1.55	1.01	0.38	0.26	3.36	1.22	1.64	6.21	0.06	1.90

Table 12: E787 and E949 Operating Conditions

2.4 Midas run_log

At the end of each spill a process on bnlku33 read a scaler in the Midas crate downstairs (same signals as in the run_log in the Serial CAMAC crate downstairs. Every day, starting on January 22, 2002, a new file was created that has one entry for every spill in the area /data2/bnlonl/midas_spill/midas_spill. (Filenames correspond to month-day-year, where months run from 0–11.) This data is written independent of the state of DAQ. We can construct a summary of KBL for each run from these files (midas_kbl). The total KBL is 1.781×10^{12} (1.629×10^{12} smx).

2.5 Summary of Sensitivity and Trigger Rejection/Acceptance

The official record of KBL for the 2001–02 runs (compared with E787 runs in 1995–98) can be seen in Figure 15.

A summary of our various measures of KBL before Pass1 can be seen in Table 14. A run by run summary of KBL from various sources is available in /e787u/kettell/doc/2002/kbl_new.log.

Week	date	protons (10^6 Tp)	KBL ($\times 10^{11}$)
1	3/08/02	0.008	0.000
2	3/15/02	5.666	0.383
3	3/22/02	6.547	0.761
4	3/29/02	7.089	1.452
5	4/05/02	6.125	1.492
	4/12/02	0.996	0.176
	4/19/02	0.199	0.000
6	4/26/02	6.408	1.600
7	5/03/02	6.130	1.839
8	5/10/02	4.450	1.894
9	5/17/02	4.290	1.875
10	5/24/02	3.906	1.852
11	5/31/02	3.859	1.808
12	6/09/02	3.976	1.468
total		59.608	16.598

Table 13: Weekly Summary of KBL.

3 Monitors

In 2002 the disk based monitors were bru'd to DLT (as in 1998). The data was separated into separate streams in the Pass0 job that ran on bnlku9 during July and August of 2002. The bru process allowed us to keep the file structure and run-by-run information.

The first monitor triggers written to disk were cosmics starting at run 46228 on 1/22/02. The first monitors with beam started at run 46316 on 1/29/02.

A total of 74 DLT tapes were created during 2001 (mon01.0001–0074) and 213 tapes tapes were created during 2002 (mon02.0001–0213).

The prescale factors on writing of all monitors to disk was 1, except for pnn1or2 and smx each of which were 100.

No TD banks were shrunk during the writing of monitors to disk (although the TD banks were dropped from the rsmon triggers during event readout by DAQ).

3.1 Backup

The monitor backup procedure was essentially unchanged form the one introduced for the 1998 run. The procedure is entirely automated,[2] including the recovery and clean-up from a variety of problems. In fact, the principal design criterion was to minimize the amount of human intervention required, both in its normal operation and in recovery from problems, in order that the shift crew would be able to easily manage the required tasks as a part of their regular duties.

The main drivers (c-shell scripts) are located in /e787d/bnlonl/monitors/backup_new/run and are called backup_monitors and backup_monitors_bckgnd . But in fact, the normal mode of initiating and

[2]Well, not quite: human beings are still required to load/unload DLT's from drives and to issue the 'Start' command via a mouse-click in an xmessage window that pops up on the DAQ console…

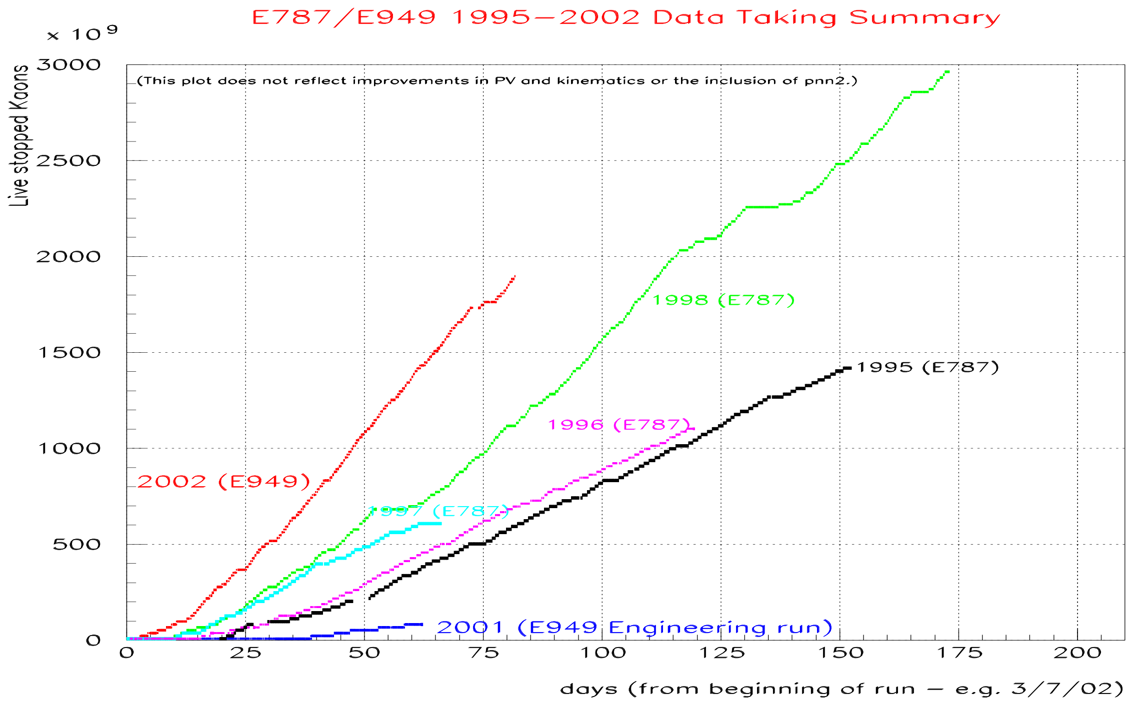

Figure 15: Official E949 KBL

launching the scripts is via a cron job called monitors.check located in /e787d/bnlonl/monitors/backup_new/cron_jobs , which also does any necessary recovery and cleanup tasks, should the backup script have crashed for any reason during the most recent backup job. In addition, monitors.check launches/restarts the disk space management script called manage_disks.csh.[3]

The standard operating procedure for the script is to be running continuously on the machine where the monitor disks are located, which was bnlku7 for the 2002 run. If it stops for any reason — computer crash, script crash, etc. — it will be restarted within an hour by the cron job monitors.check. The cron job was initially set to check on the status of backup_monitors every 6 hours, but this interval was reduced following an incident in which one of the disks filled up because manage_disks.csh was not restarted soon enough following a computer crash.

Every 6 hours backup_monitors_bckgnd 'wakes up' and checks how much un-backed up data exists in the monitor data directories. If the amount exceeds the capacity of a DLT (about 38 GB), a new backup job is initiated. When this happens, an xmessage window pops up on the DAQ console alerting the shift crew that a backup job needs to be run, requesting that a DLT with the appropriate label be loaded into a drive, and presenting a list of choices for which tape drive to be used. The job resumes upon confirmation via a mouse-click in the xmessage window from the operator that the correct tape has been loaded into the correct drive. This is all that is required from the operator until another xmessage pops up to tell him that the job is finished, and thus the tape should be unloaded from the drive.

If the job does *not* complete successfully, which means that anomalies were encountered in either the backup or readback phase, another xmessage window is produced to relay this information, with a suggested course of action for the operator to take; occasionally, this course of action is to seek 'expert intervention'.

Any particular backup job writes *all* species of monitor triggers within a specified run range, which is determined by the data size, i.e. all runs starting with the oldest, whose combined size is less than the DLT

[3]In the same directory as backup_monitors.

	2001		2002		2001–02	
Source	all	smx	all	smx	all	smx
end-of-run scalers	8.540×10^{10}	6.323×10^{10}	1.788×10^{12}	1.753×10^{12}	1.962×10^{12}	1.776×10^{12}
spill-by-spill scalers	6.558×10^{10}	—	1.840×10^{12}	1.790×10^{12}	1.904×10^{12}	—
midas_run_log	—	—	1.793×10^{12}	1.741×10^{12}	—	—
DAQLOG	1.797×10^{11}	8.902×10^{10}	3.430×10^{12}	3.426×10^{12}	3.707×10^{12}	3.384×10^{12}
run_log	8.991×10^{10}	—	1.894×10^{12}	—	1.984×10^{12}	—
Pass2—km21	—	6.192×10^{10}	—	1.799×10^{12}	—	1.861×10^{12}
Pass2—kp21	—	6.365×10^{10}	—	1.735×10^{12}	—	1.799×10^{12}
Pass2—piscat	—	5.759×10^{10}	—	1.792×10^{12}	—	1.850×10^{12}

Table 14: Summary KBL.

capacity.[4] Each species is written to a separate bru archive, with a header label indicating the tape label, the run range, the species, and the size of that archive. This information is also summarized in numerous log files, and on paper labels that get printed at the end of each job, to be inserted into the DLT case, and to be pasted into either the paper or electronic log book, as the case may be.

Files that have been backed up successfully are moved to the 'to_be_deleted' areas of the monitor disks, where they are then fair game for the disk management script. This script also runs continuously and ensures that the monitor disks do not fill up, thereby causing a loss of data. The free space on the disks is checked every 15 minutes, and if it is below the pre-set threshold of 5 GB, the oldest files in the to_be_deleted areas are deleted until the free space is once again above threshold.

A couple of high/low-lights of the monitor backup in 2002:

- 03/10/02 12:29 47615 All monitors written to towb on bnlku7
- 03/16/02 14:01 47946 monitor data was lost in 47894–942 for the triggers km22, 1γ, rs_ref, rsmon, tdmon. (Cause described above.)

3.1.1 2001

A summary of the monitor tape data from the 2001 run is shown in Table 15. The pnn1or2 prescale was increased from 1 to 10 at run 44429 (LB6p33, 10/1/01) and to 100 at run 44778 (LB6p79, 10/9/01). The writing of monitors-to-disk smx_flg was added at run xxx12(10/10/01). Writing of B0 was added at run 44343 (9/30/01). Writing of Xe and pulser was enabled at 45399 (10/24/01). The km21n and kp22n triggers were recorded from runs 44759–45677 as kp23 and 1γ respectively. We had undef events in the following runs: 41468 = 8172, 43005 = 7517, 43006 = 31469, 43008 = 20101, 43025 = 25537, 43076 = 69946, 43077 = 54769, 43078 = 54287, 43079 = 54327, 43080 = 52289, 43082 = 9775, 43084 = 23638, 43086 = 10177. All of these were pibeam triggers (with the possible exception of 41468, for which we lost the runlog file and do not know what the trigger was).

All the logfiles from the 2001 PASS0 can be found in : /e949d/e787/monitors/backup_new/mcopy/log_e949/ From the 74 input tapes (mon01.0001–74), we had the following output monitor streams and number of tapes:

- km21_kp22: 13(12) output tapes

[4]Because of the limitations of the bru backup facility, files larger than 2 GB cannot be written without truncation. These files are moved to a special "too_big" areas on the monitor disks for later consideration. In practice, these large files are *never* from standard mix pnn data taking, but rather from special-purpose runs for calibrations, etc.

- km21n_kp22n: 4 output tapes
- kbeam_kp21_pnnl0: 12 output tapes
- piscat_pnn1or2: 5 output tapes
- rsmon_tdmon_rsref: 13 output tapes
- prompt_ECkmu2_pnn1l0o: 6 output tapes
- minbias_b0_pibeam: 6 output tapes
- km22: 3 output tapes

The data from the Pass2 analysis of the 2001 monitors can be found in /data3/e949/pass2/. The analysis of the streamed output tapes started with the start of smx, on tape mon01.0027.

A summary of the 2001 Pass0 output tapes can be found in Tables 16-17

	2001 monitor backup						Pass2/0 output	
type	runs	ps	events	# files	Gby	banks	KB_L	events
km21	42911–46089	1	11,730178	1231	537.1	all	6.192×10^{10}	1,917,230
cosmic	42205–46097	1	6,972,037	1808	336.6	all		
kbeam	43447–46089	1	5,799,710	786	209.2	all	6.558×10^{10}	6,190,813
rsmon	42205–46097	1	4,031,343	2421	252.9	-TD/CCD		
minbias	43085–46089	1	3,788,525	682	130.1	all		
kp21	43024–46089	1	2,885,380	622	126.8	all	6.365×10^{10}	111,2903
kp22	43218–46089	1	2,886,700	979	187.1	all		
km22	44358–46089	1	2,170,205	496	104.6	-CCD		
piscat	43227–46089	1	1,865,441	542	117.9	all	5.759×10^{10}	589,252
prompt	44766–46089	1	1,803,869	482	140.8	all		
tdmon	42386–46097	1	1,704,438	2358	171.6	-CCD		
km21n	44759–45677	1	1,416,439	320	97.7	all		
pnnl0	43598–46089	1	1,112,544	610	66.7	-CCD	6.224×10^{10}	348,112
pnnl0o	43639–46089	1	1,036,795	578	52.4	-CCD		
ECkmu2	43201–46089	1	940,907	452	10.4	-TD/CCD		
std_mix	42463–46097	10^2	898,250	2775	37.2	all		
pibeam	43005–46089	1	883,918	503	41.8	all		
kp22n	44770–45675	1	580,023	323	38.1	all		
rs_ref	42386–46097	1	527,517	2044	11.5	-TD/CCD		
pnn1or2	41227–46089	10^{0-2}	369,130	546	23.3	all	6.287×10^{10}	299,293
b0	44343–46089	1	221,663	551	13.3	all		
Xe	41227–46097	1	122,163	378	7.2	all		
kp23	45630–46089	1	32,019	135	2.9	all		
cex	44755–46089	1	32,158	411	3.2	all		
1γ	45630–46089	1	10,440	134	1.1	all		
pulser	45980–46018	1	17,334,071	10	6.4	TDC3/FERA		
undef	41325–46097	1	422,004	2905	5.1	all		
Total	41227–46097	—	71,577,887	29664	2785.4	—		

Table 15: Summary of 2001 monitor tapes.

#	km21_kp22	kbeam_kp21_pnnl0	rsmon_tdmon_rsref
.01	42911–43000	43024–43599	42375–42545
.02	43001–43061	43598–43766	42548–42577
.03	43091–43144	43685–44178	42578–42718
.04	43145–43262	44181–44420	42665–42875
.05	43295–43741	44425–44503	42829–43350
.06	43771–43853	44467–44853	43352–44074
.07	43866–44080	44881–45267	43959–44580
.08	44190–44329	45252–45424	44581–44855
.09	44330–44511	45388–45706	44857–45152
.10	44467–44720	45707–45873	?
.11		45844–46015	45268–45550
.12	45475–45532	46022–46096	45533–45812
.13	45648–45841		44330–44369

Table 16: 2001 Pass0 output tapes #1. km21_kp22 tape number 11 was relabeled as km21n_kp22n.01. Tapes with a '?' correspond to actual physical output tapes that appear to have no entry in /e949d/e787/monitors/backup_new/mcopy/log_e949/*.read.

#	km21n_kp22n	piscat_pnn1or2	prompt_ECkmu2_pnnl0o	minbias_b0_pibeam	km22
.01	44733–45104	41227–44613	43201–44983	43005–43350	44760–45324
.02	45105–45293	44581–45213	44984–45213	43351–44501	45325–45775
.03	45294–45473	45214–45762	?	44522–44732	45830–46089
.04	45745–45645	45768–46026	45268–45446	?	
.05		46027–46096	45447–45614	45268–45919	
.06			?	?	

Table 17: 2001 Pass0 output tapes #2.

3.1.2 2002

A summary of the monitor tape data from the 2002 run is shown in Table 18. (KBL comes from Pass2 logfiles from monitor processing. The km21, piscat and pnn1or2 values come from processing at TRIUMF and the kp21 values from processing at BNL. Piscats and km21's were processed with a prescale of 10 at staging, kp21's were prescaled by 2 and pnn1or2 were not prescaled. A bad_run cut, requiring that all runs show up as smx in DAQLOG was also applied to each of these jobs? It is not clear where the extra 30k pnn1or2 events came from.)

	2002 monitor backup						Pass2/0 output		
type	runs	ps	events	# files	Gby	banks	files	KB_L (10^{12})	events
1γ	46340–50218	1	12,870,249	1604	1118.7	all			
km21	46316–50218	1	10,135,698	1894	721.4	all	1648	1.799	564,694×10
rsmon	46228–50231	1	6,626,490	3056	717.7	-TD/CCD	1657		2,123,870
piscat	46340–50218	1	6,500,697	1701	578.2	all	1641	1.792	605,111×10
eckmu2	46340–50234	1	5,150,933	1674	154.6	-TD/CCD			
cosmic	46228–50231	1	5,329,740	1416	276.3	all			
kp21	46340–50218	1	4,294,937	1741	294.6	all	1626	1.747	1,966,132×2
km22	46340–50218	1	3,883,127	1689	270.1	-CCD	1632	1.768	3,077,494
kbeam	46340–50218	1	3,318,356	1667	324.3	all			
kp22	46340–50218	1	2,710,581	1717	262.3	all			
cex	46340–50218	1	2,645,766	1636	293.0	all			
std_mix	46228–50234	10^2	2,428,554	3119	246.3	all			
minbias	46334–50218	1	1,771,721	1656	201.3	all	1532	1.604	1,358,160
prompt	46340–50218	1	1,454,890	1631	189.1	all			
pnn1or2	46329–50218	10^2	1,407,622	1635	187.1	all	1621	1.780	1,438,586
pibeam	46326–50218	1	1,340,482	1649	168.5	all			
b0	46340–50218	1	1,346,456	1648	159.4	all			
tdmon	46228–50231	1	1,333,483	3037	310.4	-CCD			
pnnl0	46321–50218	1	1,222,278	1644	132.1	-CCD			
Xe	46228–50218	1	1,211,949	2193	135.5	all			
rs_ref	46228–50231	1	941,509	2741	77.3	-TD/CCD	2679		683,559
pnnl0o	46340–50218	1	911,854	1629	122.3	-CCD	1405	1.437	762,590
kp23	46340–50218	1	252,491	1605	86.9	all			
pulser	48026–49988	1	26,193,345	29	23.0	tdc3/fera			
undef	46098–50234	1	2426	2941	72.2	all			
Total	46098–50234	—	105,285,654	47372	7244.9	—			

Table 18: Summary of 2002 monitor tapes.

We had undef events in the following runs: 49530 = 78, 49582 = 221, 49868 = 576, 49882 = 27, 50073 = 125, 50126 = 1399. All of these were pulser triggers (pulser.500hz.BGbar, pulser.25hz.BGbar, pulser.1hz).

The KB_L counting from the Online Pass2 (autorun) for the pnn1or2 monitors was 1.66×10^{12} and only 1.18×10^{12} from the kp21 monitors. The autorun process did not always keep up with the data collection, so these are underestimates of the actual KB_L.

(The following good runs were found in the smx data, but not on the monitor tapes: xxx.) A list will be generated after Pass1.

3.2 "Inline" Pass2 (Autorun)

The autorun system was set up primarily to generate high-level "physics" output on recently acquired data, in order to check/verify those aspects of data quality and integrity that may not be readily apparent from the (mostly) raw quantities available in QOD. This was done by generating pass2 ntuples, using the latest available code and calibrations, from monitor data residing on disk.

The procedure is referred to as "inline" (rather than "online") because of the time delay between when the data were originally written and when the pass2 jobs were run. The jobs were run only on monitor data that had already been backed up, in order to avoid the possibility of disruptions due to data being moved from one subdirectory to another during the backup process. Thus, although the results were not available immediately following the data taking, they were available following a brief and (more or less) predictable interval after data taking.

The autorun scripts along with all of the output reside in or below the /e949dsk/towb09/e949/autorun directory. The main script is autorun.csh, which ran continuously on bnlku7, "waking up" every 6 hours to check whether enough data were available to launch any new jobs. A cron job called autorun.check was used to re-start autorun.csh in the event of bnlku7 crashes, which were in fact quite frequent for much of the 2002 run.

The main function of autorun.csh was to read "standing requests" from a list of jobs, and then to set up and execute these jobs if enough (unanalyzed) data existed on disk. Below is a sample of the job list stored in autorun_master.list:

```
#    Jobname         Trigger    Nevents   First_run  Last_run  SMX       Notify
 pass2_1gamma        1gamma       15000     50217     50217     Y       koma@post.kek.jp      559
   pass2_km21          km21       15000     50215     50217     Y       joseph@triumf.ca      543
   pass2_kp22          kp22       15000     50192     50213     Y       joseph@triumf.ca      245
 pass2_piscat        piscat       15000     50216     50217     Y       joseph@triumf.ca      521
pass2_pnn1or2       pnn1or2       15000     50194     50217     Y       joseph@triumf.ca      204
  pass2_kbeam         kbeam       15000     50198     50215     Y       joseph@triumf.ca      355
  pass2_pnnl0         pnnl0       15000     50161     50189     Y       joseph@triumf.ca      142
   pass2_kp21          kp21       15000     50194     50214     Y       joseph@triumf.ca      247
   pass2_km22          km22       15000     50215     50217     Y       joseph@triumf.ca      264
```

If enough data had accumulated since Last_run (according to the statistics files updated by the DAQ scripts) a new job would be launched and a notification sent to the user listed under "Notify". Each job was also labeled by a sequential job number (last column) that was incremented by 1 each time a new job of that type was launched. The column labeled "SMX" was used to limit processing to runs with standard mix data taking.

An internal job queuing algorithm assured that no more than a specified number of jobs would be running at any one time, so as not to place to high a processing load on bnlku7.

In addition to autorun_master.list, a second list called autorun_special.list was used to process "special requests". This could be used to look at datasets with specific run boundaries, or to re-run selected data with a lower prescale value (most jobs prescaled the events by 3…). The jobs in the special request list were processed before the jobs in the standard list.

In addition to making pass2 ntuples for general use, the autorun system was advertised to the collaboration as a useful tool for the general public to use to automatically run their own various (private) calibration jobs: all that was required was a "self-contained"[5] job script and specifications of the trigger and number of events to use for each job.

3.3 Pass0 (2002)

The Pass0 scripts were rewritten by Brett, with the goal being to produce individual streams for each monitor type onto their own set of tapes. This was accomplished by staging all of the data on up to 50 tapes to disk (up to 2 Tbytes on towers A & B). Then the data was written out to tape stream by stream; simultaneously copies were made for other institutions.

- 06/07/02 Configure bnlku9 for Pass0 code development
- 06/24/02 Irix 6.5.14 upgrade bnlku9 to install towB from bnlku7
- 06/26/02 3 DLT stackers and 4 singles used on bnlku9 to begin Pass0
- 07/05/02 Start Pass0
- 07/08/02 Secure bnlku9 SCSI cables with cable ties
- 07/25/02 Repair five corrupt bnlku9 file systems
- 07/25/02 Stable Pass0 bnlku9 running for streaming from/to 7 DLT drives
- 08/28/02 Pass0 processing finished

Tape mon02.0015 was unreadable after a few archives and so has some lost data. This lost data was cosmics, rsmon, etc from the period before we started getting beam. The b0 archive from tape mon02.0145 was unreadable.

3.3.1 Pass0 Software

Pass0 processing was done with a Perl program implemented as a set of Perl modules, some custom written and some adapted from freely available code from cpan.org. The code exists and was run from '/e787d/bnlonl/moni-stream'. The main program is 'moni-streamer.pl' and the Perl modules are in a 'Moni/' subdirectory. There are also a number of support scripts useful, but not required, in this area. Instructions for the monitor streamer scripts can be found using a Netscape browser on bnlku9 at 'file:/e787d/bnlonl/moni-stream/doc/index.html'.

The main goal of Pass0 was to read in the monitor backup tapes which contain a heterogeneous mix of monitor archive files and write out tapes which contain a homogeneous mix of monitor archive files. Additionally, in some instances, duplicate output tapes were made.

The processes took place as a series of sessions. Each session consisted of three phases. First, a collection of tapes had their archive files copied to buffer disks and arranged into directories representing output tapes (located at '/e787d/bnlonl/moni-stream/moni-streamer/SPECIES/NNN/' (NNN is the 3 digit output tape number). Second, any output directories with enough data to fill a tape were written

[5]Meaning: no operator-supplied input required.

out. Finally, all archive files which were successfully written out were deleted to make room for the next session.

To verify data integrity, BRU was used to produce a listing ('.readback' file) of the contents of the archive both at the time of reading the original input tape and after writing the output tape. This listing includes file names, sizes, dates, etc. This listing was compared against the one created when the original tape was written.

For book keeping purposes all the verification listings were collected on an output tape by tape bases in order to produce full '.readback' file analogous to the one from the original backup tapes. Also produced were '.label' files analogous to the ones created in previous Pass0 runs and '.label.extended' which have an additional column giving the input tape label from which each archive file came. The label files are located in sub-directory 'labels/'. Finally, the output directories themselves serve as a redundant record of what went on to each tape. These files are in '/e787d/bnlonl/monitors/backup_new/log/moni-streamer'.

A MySQL database was built to hold information useful in locating a tape holding particular data, or knowing what data is on a particular tape. This database is accessible via the phpMyAdmin web interface at `http://minos.phy.bnl.gov/phpmyadmin`. To access this database, use the user name 'e949' and the usual corresponding password. Select the 'pass0' database from the entry in the top left hand corder. You will see two tables: 'archive_files' and 'monitor_files'. The former has per-archive information such as what input and output tape number the files belongs. The latter has information at the per-run level including things like run number, size in KB and to what archive it belongs (which is the form of an ID which indexes into the former table). Choose one of the tables and then click '[Select]' to try some searches. The archives on the streamed output tapes are not necessarily in sequential order. To find output tapes with the runs you need, click '[Select]' on 'archive_files'. Then type the trigger you are using in the 'species_name' field, in the 'Display order' field select 'first_run' and click the 'Go' button. Scroll through the table pages by clicking the '> ' and '<' buttons. When the runs needed are found in the 'first_run' and 'last_run' columns look in the 'output_tape_number' column to determine the streamed output tape(s) needed.

3.3.2 Pass0 Output Data Summary

There were 212 input tapes read and 419 output tapes, (217 of which were unique), written. This corresponds to 7086 GB read, (not including a 15-20% BRU overhead). In addition, 1 input tape, 'mon02.0015' had an unrepairable read I/O error and could only be partially read. This tape includes runs 46895–47031 and includes the following triggers: undef, std_mix, Xe, rs_ref, tdmon, rsmon, cosmic. Archives undef and std_mix were recovered and streamed out at the end of pass0 running. Tape mon02.0145, runs 49604-49611, also had an read I/O error on the last archive (b0).

BNL received all monitor species but 1gamma, filling 183 tapes. KEK received 1gamma, cosmic, km21, km22, kp21, kp22, and piscat filling 118 tapes. TRIUMF received cex, cosmic, kbeam km21, km22, kp21, kp22, kp23, piscat, pnn1or2, and prompt, also filling 118 tapes. In order to save money, TRIUMF and KEK received only the first 9 rsmon and first 2 tdmon tapes.

Table 19 gives a summary of the data copied, broken down by monitor species.

4 Preliminary bad_run and glitch_log Information

A first guess at a starting run for 2002 is run 47592 (tape 30217) from March 9, 2002 at 00:25. A preliminary list of tapes to run through Pass1 is: 30217.2.1-2 – 30276.3.1-2 and 30280.3.1-2 and 30282.3.1-2 – 30398.3.1-2. The range of runs is likely to be 47592–48734, 48876–7, 48941–50218.

Two types of bad_run files will be used for Pass1 (and possibly Pass2–3) processing. One will eliminate all non-smx runs and the other will eliminate runs that have fundamental flaws in data quality or in having

Species	#files or runs	Data Size (GB)	First run	Last run	#tapes in	#tapes out
1gamma	1604	1118.7	46340	50218	185	34
km21	1894	721.4	46316	50218	196	22
rsmon	2956	698.2	46228	50231	212	21
piscat	1701	578.2	46340	50218	190	17
ECkmu2	1674	154.6	46340	50234	187	5
cosmic	1327	264.0	46228	50231	96	9
kp21	1741	294.6	46340	50218	191	9
km22	1689	270.1	46340	50218	190	8
kbeam	1667	324.3	46340	50218	191	10
kp22	1717	262.3	46340	50218	188	8
cex	1636	293.0	46340	50218	184	9
std_mix	3119	246.3	46228	50234	213	7
minbias	1656	201.3	46334	50218	191	6
pnn1or2	1635	187.1	46329	50218	187	6
prompt	1631	189.1	46340	50218	187	6
b0	1642	158.5	46340	50218	184	5
pibeam	1649	168.5	46326	50218	188	5
tdmon	2959	307.4	46228	50231	212	9
pnnl0	1644	132.1	46321	50218	191	4
Xe	2176	134.9	46228	50218	205	4
rs_ref	2679	76.9	46228	50231	212	3
pnnl0o	1629	122.3	46340	50218	184	4
kp23	1605	86.9	46340	50218	185	3
pulser	29	23.0	48026	49988	7	1
undef	2941	72.2	46098	50234	213	2

Table 19: Statistics on pass0 copying. GB = 1024^3 Bytes

significant parts of the detector not working.

The final construction of the bad_run files will take place after all Pass0 data has been run through Pass2 and problems can be uncovered. Based on the calibration work that has taken place so far and various other investigations we are able to start with a preliminary bad_run list now. Also some of the runs in the glitch_log may be added to the bad_run list as we understand the data better.

- Power Dips:
  - 03/16/02 22:23 47961
  - 03/26/02 22:59 48412
  - 03/30/02 07:43 48554
  - 04/30/02 15:28 49167
  - 05/03/02 18:23 49243
  - 05/30/02 00:23 50014
- D3 trips:
  - 03/20/02 19:27 48139 one of many D3 trips due to rainwater
  - 03/27/02 09:18 48423
  - 04/07/02 17:49 48751 load noB_10mV.2002_01 HV for CsI with D3 off
  - 04/18/02 18:23 48831 D3 on at 17:00, EC B=10kG HV loaded at 22:00
  - 05/18/02 03:15 49668 D3 trip, ped CsI HV problems
  - 05/23/02 03:20 49835
  - 05/23/02 05:40 49838
  - 05/23/02 06:19 49841
  - 05/23/02 11:16 49847
- non-smx runs:
  - The list of non-smx bad_run's is in $PASS1_TAPES/bad_run.non_smx.02002.02
- too small runs:
  - We decided to cut runs with only ~1 spill of data. We loose very little KBL by this cut, but get rid of many runs that show up in pnn1or2 data, but not km21 data or vice-versa..... The list of runs with less than 500 events is in $PASS1_TAPES/bad_run.too_small.02002.01

4.1 glitch_log

Specific problems that have been identified so far, that have as of yet not been conclusively assigned to the bad_run files can be found in the glitch_log at http://www.phy.bnl.gov/e949/run/glitch_log.

- RSTDC data corruption
- MCSC memory overwrites
- 47963:47981 TT found during analysis all target CCD's missing

- 48412:48419 TDC2 ELOG 3/27 TDC2 problems after power dip
- 48417 TT frank 8/21/02 TT timing shifts by 2 nsec (power cycle)
- 48488:48816 TD Jaffe 8/13/02 RS 10P5-8 TD#110 bad
- 47662:48186 TD Jaffe 8/13/02 RS 10P21-24 TD#142 bad
- 48523:48551 RSSC 3/29/02 problems in RSSC and BWPC due to isobutane (HV effectively off from 48531-48546)
- 47018:47663 BM ELOG 2/12 12:54 the stops were swapped for slot#5 and slot#6 (also refer to ELOG 3/11 14:24)
- 48074:48412 TD jaffe 8/13/02 RS 10P5-8 TD#110 bad `http://www.phy.bnl.gov/~djaffe/E949/TDmonitor`

During the period of runs under consideration for the 2002 Pass1 (47592–50218), there were some important changes in operating conditions, including:

- tighten Delco (47841, 48010, 49056, -49144)
- use analog sum for online PV (BV, BVL, HEX) (47592–48002, 48004–6)
- raise HEX_MT threshold (49171)
- use high target threshold into KB (48021–48288, 48293–48369)
- raise RS discriminator thresholds at 48023, 48781, 48887
- decrease target width into KB (48048)
- no functioning L1.2 (47592–48076)
- incorrect or not fully correct L1.2 afterburner (47592–48134)
- narrow IC CFD widths (49278,49407–49751)
- rstdc susceptible to data corruption (47592–47688)
- TD gate reduced (to 2.5 μsec 47959), (to 2.0 μsec 48227)
- CCDA prompt readout window reduced (48007)
- no ADC2 sparsification (UTC pedestal drift) (48822)
- UTC electronics modified to reduce rate dependent baseline shift (48743–48905)
- extend rstdc range from 6 μsec to 10 μsec (49024)

4.2 bad_run

The bad_run list can be found at $PASS1_TAPES/bad_run.glitch_02:

- 41000:47591 — early data
- 48123 — all events killed by L1.1
- 48412:48419 — tdc2 bad after power dip
- 48522 — no data due to CCDPED screwup
- 48570 — tdc,adc bad after power dip
- 48644 — causes efix2,tof jobs to crash?
- 48646 — DAQ running but no data to tape
- 49174 — crashes jobs with 'signal 11'
- 49211 — no CsI HV
- 49251 — forget TDDAC
- 49389 — pnn data lost
- 49424 — NML = tddac_all.cfg

We are also cutting non-smx runs (see /e787u/kettell/doc/2002/bad_run.non_smx.02002.03), runs without a full namelist ('all_*.cfg') and runs with only ∼1 spill (see /e787u/kettell/doc/2002/bad_run.too_small.02002.02) All of the bad_run files can be found in $PASS1_TAPES (~e949/pass1/02/tapes), and the concatenated file is bad_run.02002.

A summary of the losses from the bad_run cuts can be found in Table 20 (these values of KBL come from /e787u/kettell/doc/2002/kbl_new.log).

cut	eor KBL (10^{12})	midas KBL (10^{12})	spill KBL (10^{12})
$47591 < run < 50219$	1.7767(1.00)	1.7851(1.00)	1.8290(1.00)
smx	1.7507(0.99)	1.7395(0.97)	1.7877(0.98)
$nevent > 500$	1.7496(0.98)	1.6592(0.93)	1.7764(0.97)
glitch	1.7357(0.98)	1.6509(0.92)	1.7656(0.97)

Table 20: Loss of KBL from the bad_run cuts. 'eor' is the KBL from the end-of-run scalers; 'spill' is the KBL from the scalers in the 'undef' stream; 'midas' is the KBL from the Midas scalers read every spill. The cut on 'smx' is not possible to relax. The cut on $nevent > 500$ is actually a cut if both the ELOG and the DAQLOG report less than 500 events. This cut was not carefully tuned, but cuts less than 1% of our KBL and gets rid of a lot of runs that do not show up in some of our monitor streams. The midas KBL count is the least reliable, since sometimes the run number passed to Midas was not properly incremented, so I do not believe the loss from the cut on nevents.gt.500 from the Midas KBL.

We are not currently planning to cut the data in runs 47963:47981 with the missing target CCD's. This may ultimately need to be cut, particularly in the pnn2 analysis, but since this information is 'redundant' with the ADC/TDC information, it is possible that we can keep this data for pnn1.

We are also not currently planning to cut the data in the run range of 48523:48551 when the RSSC's had problems due an isobutane problem. The HV was effectively off from 48531:48546. We have never seen evidence of higher backgrounds in the sectors with dead RSSC's, so this will give us more opportunity to see if the RSSC's do provide any background rejection.

References

[1] 'DeToX' is a acronym contrived from Demon Tolerance eXamination.

[2] D.E.Jaffe, 'DeToX: LeCroy HV monitor program', E949 Technote K-028, 4 September 2002.

[3] D.E.Jaffe, 'TDmon: TD monitoring program', E949 TN K-027, 4 September 2002.