RHIC SYSTEMS

Power Supplies, Superconducting Magnets, Quench Protection, etc.

<u>3 Topics</u>

Improvements before Run 9

Problems (Reliability) During Run 9

Improvements & Maintenance after Run 9

7/16/09

Improvements made Before Run 9

- All qd's
  - Removed and new fan trays installed
  - Cleaned as best as possible.
  - Increased UPS spares inventory/self tests UPS's
  - Vicor ps issue addressed
  - Learned how to install files on qd, some knowledge transferred and procedures written.
- Bipolar Suncraft 150's & 300's
  - Cooling added, power supplies cleaned
  - FET Monitoring
  - New connectors (fet drive and converter enable)
  - Much more (work done by Algen)
- Snake & Rotator QPA's
  - New energy extraction resistor installed
- All QPA's
  - Removed for new fan switch board and replaced faulty relay that cause false OVC's. Finished fan job replacement.

Improvements before Run 9

- Shunt bus repairs
  - Completed
- Snake magnet tree fans
  - All replaced summer 2008
- Correctors
  - 60 amp ps installed but leads not tested
- 6kA quench switch
  - Corrected problem that went on for 2 runs and added instrumentation in case it returned
- Ran buildings on a short at 10 amps
  - Helped find some problems before run started

Improvements before Run 9

- DX Heater ps's
  - All found to be missing locking hardware on dc bus. Hardware was installed.
- Completed one instrumentation setup
  - Used for testing in 7W, can be used in bldgs for IRs
- QLI analysis
  - Taught others how to do QLI analysis
  - Now 4 on rotating list, need more, they are still learning
  - Automatic analysis (beam induced) improved but needs more work.
- Corrector Check out program for Start Up

Improvements during Run 9

- Hired 3 more techs, trying to hire 2 more engineers
- 6000A quench switch failures for runs 7, 8 fixed
  - Chip going into current limit mode
  - Instrumentation added just in case
- More software improvements
  - V ripple check program
  - QD UPS's alarmed at MCR now.
- New Current reg card prototyped and tested in y4-dh0
  - Eliminates relays, 2 daughter boards, problems with small lands breaking.
  - Will not have people to test new cards before next run but we are trying to get most boards stuffed on outside
- The weather was very cool

Down Time in Hours Run 9-Run 8-Run7

Main p.s.'s	79	20	52
Quench Detectors	51	4	4
IR p.s.'s - Dynapowers	26	30	63
IR p.s.'s – SCE 300's	18	8	30
IR p.s.'s – SCE 150's	17	10.8	45
Snakes & Rotators	16	1	NU
QPA's (fan warnings)	11	1	8
Current Regulator Cards	9	5	7
Communication Failure QPA's	8	1	14
Sextupole p.s.'s (q10 tree cleaning)	6	6	5
Correctors (3 of 4 swapped on maintenance days)	6	4	7
6000A Quench Switches	0	12	16
Gamma-T's	0	6	0
Housekeeping ps	0	3	0

Down Time in Hours Run 9 - 500GeV - 200GeV

Main p.s.'s	60	19
Quench Detectors	31	20
IR p.s.'s - Dynapowers	21	5
IR p.s.'s – SCE 300's	13	5
IR p.s.'s – SCE 150's	6	11
Snakes & Rotators	7	8
QPA's (fan warnings)	3	1
Current Regulator Cards	6	4
Communication Failure QPA's	7	1
Sextupole p.s.'s (q10 tree cleaning)	3	3
Correctors (3 of 4 swapped on maintenance days)	3	3
6000A Quench Switches	0	0
Gamma-T's	0	0
Housekeeping ps	0	0

RHIC PS Performance Numbers (see next slide for run 9)

Average RHIC PS Failure Hours/Week (Peter Ingrassia)

fy01-fy02	fy03	fy04	fy05	fy06	fy07	fy08
18.28	4.36	3.29	2.4	4	8.89	3.78

MTBF of RHIC due to any PS Failure

	HERA e+p 1996 (comparison only)	RHIC Run 4	RHIC Run 5	RHIC Run 6	RHIC Run 7	RHIC Run 8
MTBF_M (hours)	22.3	20.48	30.79	28.23	14.74	30.28
Number of Problems	238	148	138	109	182	96

What would be the %AV of RHIC be if only RHIC ps Failures?

	HERA e+p 1996 (comparison only)	RHIC Run 4	RHIC Run 5	RHIC Run 6	RHIC Run 7	RHIC Run 8
AV%	96.6	91.97	97.09	95.03	90.87	92.18
Number of Problems	238	148	138	109	182	96

MTBF of an individual PS Failure

	HERA e+p 1996 (comparison only)	RHIC Run 4	RHIC Run 5	RHIC Run 6	RHIC Run 7	RHIC Run 8
MTBF (hours)	29310	19106	27989	26339	14161	29098
Number of P.S.'s	1166	909	909	933	961	961

Average Failure Hours per week (* does not include qd or qpa)

Run 6	Run 7	Run 8	Run 9
4	8.89	3.78	7.1*

MTBF of RHIC due any ps failure (* for 51 hours of qd downtime)

	Run 6	Run 7	Run 8	Run 9
MTBF (hours)	28.23	14.74	30.28	15*
# problems	109	182	96	215

% Availability (* for 51 hours of qd downtime)

	Run 6	Run 7	Run 8	Run 9
% Av	95.03	90.07	92.18	91.08*
# problems	109	182	96	215

MTBF of RHIC due to an individual ps failure (* for 51 hours of qd downtime)

	Run 6	Run 7	Run 8	Run 9
MTBF (hours)	26339	14161	29098	14415*
# problems	933	961	961	961

Leading Problems (other than mains)

- Quench Detectors
  - 2b-qd2 adc card, found 4 open traces. 16 boards over-etched.
  - 7c-qd1 adc card poor solder joints
  - Fan fail board insufficient solder on pins
  - Relay board waiting on findings
  - All qd’s removed for fan tray replacement. Related to problems.
- Dynapowers (Replaced 4 run 9, 1 run 8, 6 run 7)
  - 3 had contactors burn up – DCCT cable and Contactor rating
  - 1 was very noisy. Found shunt loose
  - Time consuming to replace: chassis slides, weight (Now CAS does them)
  - Time consuming to diagnose correctly (Auto Analysis pgm helps)

Leading Problems (continued)

SCE 150’s/300’s

- Replaced 7 -150’s (6 -Run 8,13-Run 7)
- Replaced 7 – 300’s (2–Run 8 , 9-Run 7)
- 150A problems: Connections, cards not seated properly, voltage drop outs
- 300A problems: Conv. Brd. transformer with broken wire, connections, crimps not done properly.
- Monitoring LEM’s during run 9
- 3-300’s installed with Conv. Brds. enabled
- We have run bipolar 300’s on a real load, with a real ramp in 7W. We would like to do this while floating the ps.

Other Problems

Other problems

- Air conditioning (caused OverTemps, 3 hours)
- K-lock connectors (4 hours this run)
- Beam induced quenches (21 this run for 15 hours)
- Human error (14 hours)
- Beam permit bypass chassis 2b (6 hours)
- Yo9-snk7-1 ground, did not cause downtime
  - Magnet will be removed summer 2009

Work Planned before Run 10

- Valve box work
  - **This is the primary job and almost everyone is on it**
  - We must disconnect all cables and re-connect correctly or PS start up will go from 10 days to 20 (?) days
  - Fix icing problem on 12x50's which can cause cracked feedthroughs, ground current problems.
  - Replace cracked high current lead feedthroughs. Could create ODH problem if they cracked more.
  - 3 groups involved. Must stick to schedule. Inspections at 3 different stages of re-connect.
  - Trying to come up with a low voltage test to confirm leads and V-taps re-connected correctly
  - Temperature controller boxes must be built. Two by us. Rest by outside vendor
  - Link Box?

Some Major Work Planned before Run 10 (if there is time)

- Dynapowers (If there is time)
  - Work on replacing Dynapower q3 contactors and dcct cable
  - Replace other Dynapower dcct cables
  - Relays for dhx ps transformer shields?
  - Replace fans?
  - Remove other noisy ps’s.
  - Make new 3 channel iso amp board
  - Solder DCOC pots on V reg cards
- Continue teaching others in group QLI analysis
- Complete Air Conditioning
- Install the rest of the alcove UPS’s (they we need to connect to)

Some Major Work Planned before Run 10 (if there is time)

- Bipolar 300's (If there is time this work will be done to spares only)
  - Specification written and going out week of 7/13 for some new 150's & all new 300's
  - Investigate LSII bipolar p.s.
  - Enable both converters
  - New LEM connectors
  - New connectors for lower fet control board
  - Current limit converter boards
  - Eliminate SCE current limit circuit
  - Critical harnesses and molex connectors replaced
  - There is a new trouble shooting procedure that will stop techs from missing problems.

Some Major Work Planned before Run 10 (if there is time)

- Clean or replace yo5-q10 feed through
- Finish work left over from our maintenance day list

Quench Detector/ Warm Up Heater Update

- Will have 3 spare main buckets, 2 spare aux buckets.
- We might make new adc cards to replace over etched ones. Need to discuss.
- Transferring qd test system from 902A to 911-A
- Dan Oldham will work by us if there is a qd problem that needs the test set up.
- Dan is training one of our techs on repairing QD cards then he will learn software end. This process began around 12/08. It will take time. He won’t be doing this during valve box re-work.
- During summer 08 transferred a lot of knowledge on how to load file into qd fec, how to install a new fec, how to load dsp, some troubleshooting lessons. Wing and Dan Oldham very helpful.
- During Run 9 we were doing datastores and tuning. Still learning. Wing very helpful.
- Warm up heater work went well, learned a lot, found problems. Would like gas flow and warm up heater ac currents logged in LogView.

Some work we won’t get to

- Tq upgrade to >100A
- Voltage monitoring
- Replacing Corrector fans
- Many pc boards need to be made to replace boards made by hand.
- Link Boxes?
- Kepco’s to replace 150’s
- Kepco’s to replace trim ps’s in the ATR line
- K-lock connector test?
- Fix fan warning problem in qpa’s
- Install Vmonitor gauges
- Should examine new snake energy extraction R
- Need someone to understand how new plc works for the warm up heater system.
- Tefzel insulation problem with the sextupole magnet feed throughs
- See other 2009 & 2008 shutdown list

List of Controls PGMs that did help (**DONE**)

- qdVerify program.
- qd UPS alarms on the alarm screen. Before we just got e-mails.
- Quench Recovery Program checks TempQPBypas page before running.
- Vripple check program for all supplies.
- Corrector checkout program works but multiple tapes must be run to checkout more than one alcove at once. Would be nice to just run one tape.
- Warning to tell us if the primary dcct and redundant dcct difference has changed.
- LEM Monitoring for 300’s.
- Automatic QLI analysis program, needs more work but helps a lot.

List of Controls PGMs that could help (to do before run 10)

Start Up Programs

- Need to modify corrector program so it also checks the GTs and the sextupoles. Before 4 techs 4 days. Now 1 tech 1-2 days. Could save 0.5 days if GT's and Sext's included.
- Make a program that looks at all of the voltage taps after we do a datastore to check a new ramp out. Could save 1 person 6 hours. Automatic tuning?
- Need a program for startup that checks the polarity of the IR supplies and watches VT moves. Could save 12 hours.
- Need a program that does polarity checks on the snakes and rotators. It should also check the gas cooled leads don't take off. Could save some time but ramping time takes most of it.
- Need a program that looks at shutoff data at injection and high current. Could save about 12 hours. Inj & Store 2x, 3 hrs each.
- Look at 6kA quench switches during a shutoff. Make sure the SCR's all turn off before the contactor opens. Could save 1-2 hours.

List of Controls PGMs that could help (to do before run 10)

- Need something to watch the TempQPBypass page when the links are up. If one building changes then we need a warning to the alarm screen.
- Alarm for when the MAIN ps digital current does not equal the analog current.
- Fix sextupole quench recovery so all 6 alcoves can run at once.
- Fix tq quench recovery so all 6 buildings can run at once.
- Make Al’s change to qd’s so they don’t print so much diagnostic information.
- Make a decision on Al’s SF changes to real ramp rates.
- New quench recovery for blue and yellow needs to be fixed because it does not recover tq’s correctly.

List of Controls PGMs that could help (to do before run 10)

- Need something to look at the SCR’s in the 6kA quench switches. If the difference between any is >300A then alarm.
- Ice ball manager alarm for when pet page goes red.

List of Controls PGMs that could help (to do before run 10)

- Mods to QLI analysis program
  - Look at tq trip or anything that comes up in snapshot before a qli. This is done for a beam abort now but this must also look at anything in snapshot besides a trip.
  - Oscillation program needs to be worked on. Does not always get it right.
  - Add other supplies to be checked to the auto analysis program
  - Add abort kicker pre-fire to this program.
  - If there is no beam in the machine the program should know it.
  - Check difference between analog and digital current of mains

720Hz chassis reset/slip problem – 4 possible solutions

- Use AGS cold snake 720Hz board
  - Testing started and so far it looks fine
  - It has been running on 4b-qd3 since June 17th
  - Proven design
  - Separates the mains from the qd's
- New Regulator might eliminate the problem
  - Alarm existing 720Hz chassis (not real solution but will reduce downtime)
  - Build a spare 720Hz chassis (not real solution but will reduce downtime)
- Make qd more robust
- Switch to controls internal clock when 720Hz signal goes away

AGS Cold Snake

- AGS cold snake quenched due to power dip on 7/13/09
- Will do electrical tests to make sure magnet is ok. Should be fine.
  - Hi-pot
  - Continuity of heater coil
  - Check Solenoid ps
- Need FEC on a UPS

Spares

- Need to build helical spare qpa for AGS Cold Snake.
- Have lists of spares we need to order and we have started. This is for all of the IR supplies and the tunnel supplies.
- New 2kW ps (spare) for ATR line.

Technicians and Engineers

- Original group had 12 techs
- We had been down to 8 techs for a few runs.
- We have 12 techs now and one student.
- We will lose the student and possibly one tech to another group so we will be down to 11 techs.
- We hired one engineer at the beginning of Run 8 and we might hire 2 more engineers. Needed since we don’t have George and Wing.

ATR

- 20 degree bend supply replacement work?
- Fix broken temperature sensor on WD1 bottom. Sometime this whole A string goes down but I think WD1 bottom is the bad one.
- Xarc90 and yarc90 microswitch on pump room disconnects kirklock
- Add voltage monitor to X and Y arc disconnects in the pump room or a panel next to it so switch can be thrown.
- Install new capacitors in the xarc90 and yarc90 filter banks, last trip on 6/4/09
- Check all of the SCR’s in the 451. fuses had to be replaced.
- Reversing switch maintenance or removal

RHIC ps Start up

- Controls programs would speed things up
- We usually work 10 days straight 12-16 hours per day. Might be nice to work 10 hour days or get more people and split work up.
- Would like a day at the end of our start up where we ramp ps’s for 12 hours and sit at store for 12 hours before we hand over the ps’s.

END

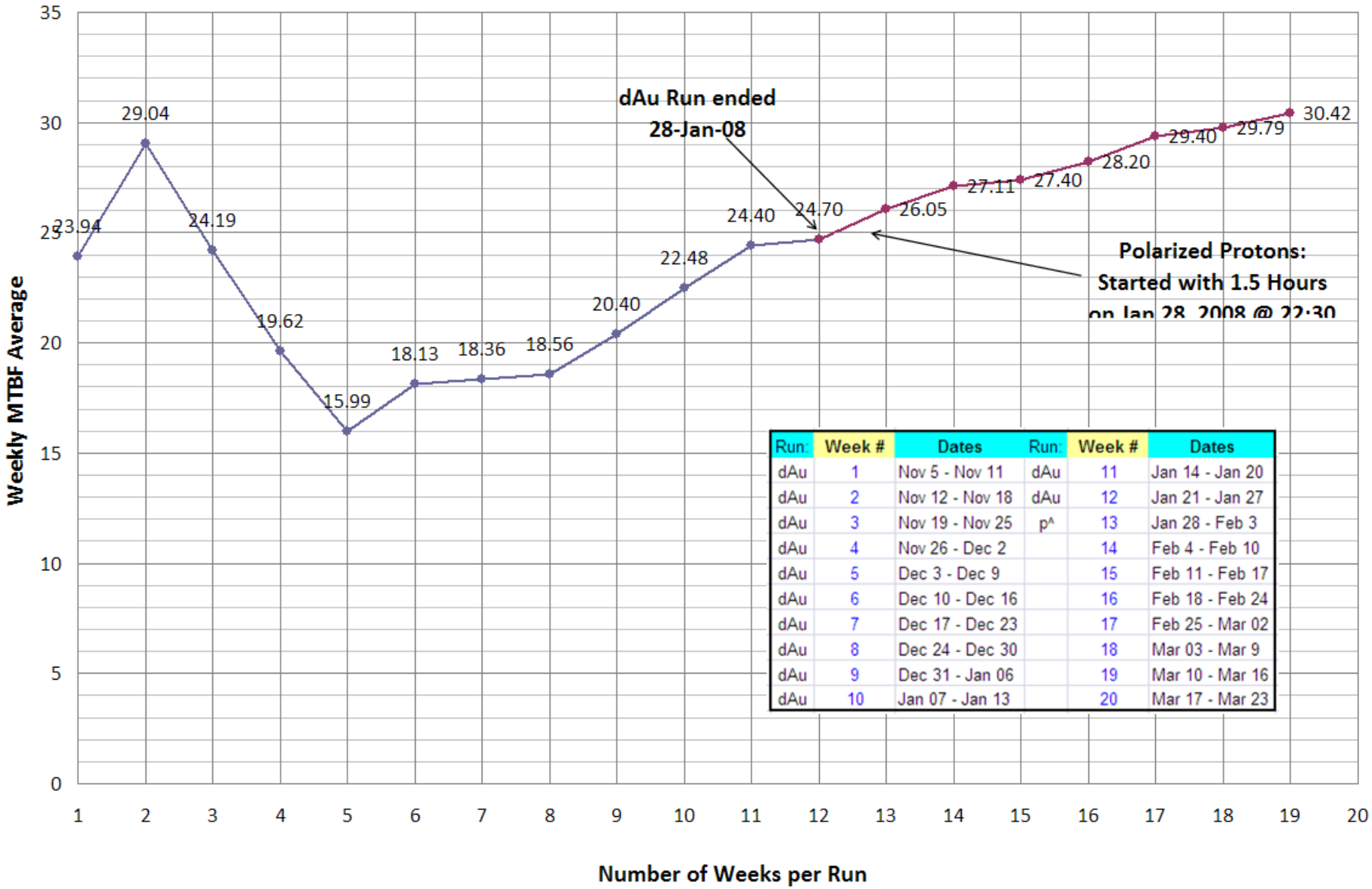
More slides follow if needed

RHIC Physics Yearly Run - QLI Fault Counters

Main QLI Faults	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9
Beam Induced		46	69	54	37	18	47	27	21
Controls 6B Yellow Permit Fail	No Data	25	9	24	0	0	0	0	0
Controls Related		20	15	20	13	5	4	6	2
Cryo Related		6	9	2	4	2	8	0	5
Human Error		34	15	17	12	4	5	4	17
Power Supply RHIC Faults		100	44	24	51	29	59	22	49
Magnetic Coupling						New Field added starting Run 9			4
Main PS (Total) Faults		68	38	46	6	14	41	24	40
Other / Misc		27	27	24	29	9	17	16	8
Power Failure		10	8	3	7	9	3	1	8
Power Supply Induced Quench	Available	6	1	4	0	0	0	1	7
QPA System Faults		40	6	9	6	5	20	8	3
Quench Detector Faults		13	29	13	20	2	3	3	11
Quench Detector / Controls CFE			New Field added starting with Run 6			10	3	0	0
Temperature Related						New Field added starting Run 9			5
Totals:		395	270	240	185	107	210	112	180
Snake / Spin Quench Faults	**Run 1**	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Run 6**	**Run 7**	**Run 8**	**Run 9**
Beam Induced		20	17	5	2	3	0	3	3
Controls Related	No Data		New Field added starting with Run 6			9	0	0	0
Cryo Related		2	0	1	3	3	0	0	0
Human Error		2	0	2	1	2	0	0	8
Other		2	6	0	5	0	0	0	0
Power Failure		0	0	2	2	9	0	0	1
Power Supply Faults		10	2	4	0	1	0	2	0
QPA Faults		0	0	0	0	0	0	0	7
Quench Detector Faults	Available	0	0	1	0	2	0	0	0
Quench Detector / Controls CFE			New Field added starting with Run 6			1	0	0	0
Totals:		36	25	15	13	30	0	5	19
AGS Cold Snake Quench Faults	**RUN #**				**Run 5**	**Run 6**	**Run 7**	**Run 8**	**Run 9**
Beam Induced					0	0	0	0	0
Controls Related		First Cryogenic Magnet Installed into the			0	0	0	0	0
Cryo Related		AGS Accelerator Ring!			0	0	0	0	0
Human Error		Commissioning Run March 30, 2005 (Run 5)			9	3	0	0	0
Other					0	0	0	0	0
Power Failure					0	1	0	0	0
Power Supply Faults					13	9	0	0	0
QPA Faults					0	1	0	0	2
Quench Detector Faults					0	0	0	0	0
Quench Detector / Controls CFE					0	2	0	0	1
Quench Heaters					0	1	0	0	0
Totals:		0	0	0	22	17	0	0	3

Not up to date, this is after ~16-17 weeks of running

RHIC Run 8 CEPS Weekly Average MTBF



Run:	Week #	Dates	Run:	Week #	Dates
dAu	1	Nov 5 - Nov 11	dAu	11	Jan 14 - Jan 20
dAu	2	Nov 12 - Nov 18	dAu	12	Jan 21 - Jan 27
dAu	3	Nov 19 - Nov 25	p^	13	Jan 28 - Feb 3
dAu	4	Nov 26 - Dec 2		14	Feb 4 - Feb 10
dAu	5	Dec 3 - Dec 9		15	Feb 11 - Feb 17
dAu	6	Dec 10 - Dec 16		16	Feb 18 - Feb 24
dAu	7	Dec 17 - Dec 23		17	Feb 25 - Mar 02
dAu	8	Dec 24 - Dec 30		18	Mar 03 - Mar 9
dAu	9	Dec 31 - Jan 06		19	Mar 10 - Mar 16
dAu	10	Jan 07 - Jan 13		20	Mar 17 - Mar 23

Details on Algen work for 150s 300s Phase 1

- **Work to do 300A & 150A. Phase 1 Started Summer 2007**
- Front grills cut out.
  - 4 cut outs for each 300's.
- Voltage Regulator Card 20K resistor tacked in across R236 and label applied to Voltage Regulator card.
- Converter Overhead adjusted to:
  - 1.8V (0.9V on test point) for 300's only
- 12VDC fan installed on top of each converter board
  - Two fans total for each 300's
- 208VAC fan installed behind each FET heatsink inside p.s.
  - Two fans total for each 300.
- For the 300 the four rear top outside DC fans shall be replaced with 208VAC fans.
- 12VDC external hkps fan will be replaced with a new 12VDC fan the 300's.
- Install new 208VAC fans on the front
  - Four for the 300's on the front
- Install 208VAC relay, MOV and in line fuse for front, rear and inside 208VAC fans. Use one of the old 12VDC fan line to control the 208VAC relay. The 208VAC relay and additional TB will be installed on the rear of the ps with covers.
- Make covers for new 208VAC relay, new TB and old TB. We need covers for all AC TB's. Nomex should be used.
- Measure DCCT head voltage. This can be done from backplane
  - The DCCT voltage for the 300's shall be +/-12VDC BNL to supply replacement if necessary.
  - Also check the ripple with a scope.
- Check front panel Circuit Breaker rating
  - The CB in the 300A shall be rated for 20A
- Replace resistor (R538) in soft start circuit with bigger resistor.
- Install new LEM's in bipolar 300A only.
- Install FET monitoring. New pc board made by algen. Four missing wires have to be added.
- Install nomex around dc bus
- Do off trip fix.
  - If this was one of the **13 300 amp** p.s.'s that we have identified as a problem then replace the backplane as well as removing all connections and using Deoxit. (All connections means everywhere, including backplane connectors and housekeeping connections, make sure the molex spring tension connectors are tight) Vendor to assemble backplane. The backplane will have a wire added to it from E3-E4-J3A3-J3C3.
  - If this was one of the p.s.'s we have not identified as giving us a problem then we will do the same things as #17-1 but we won't replace the backplane.
  - See list at end of serial numbers that have given us problems and need backplane replaced.
- Clean all connectors on backplanes not identified as problematic with Deoxit.
- Replace all 30A FET fuses with 40A FET fuses.
- Disconnect all connectors inside ps and spray Deoxit on ALL connections. Use Deoxit D5S-6 first and then G5S-6, follow instructions.
- Check soldering of FET source resistor
- Install Heatsinks on Converter board chips IC501, IC502, IC503, IC504, IC505 and IC512.
- Verify source resistor on FET's = 5mohms, we must talk about how we want to do this. Measure to with 1% because they are 1% resistors.
- Replace 48 FET drive connector with a box style molex connector. There is a high force box style molex connector and a box style that is not high force. We should pick the high force one I think.
- Replace any rusted hardware that is found on busbars. Replace corroded bus bars.
- Add 48 diodes 1N4743 across gate to source resistor of all lower FETS.
- Measure Vgs and rds of old style and new style spare FETS. Record Vgs and rd on front of FET.

Details on Algen work for 150s 300s Phase 1

- **Phase II**
- See file “150A Overall Phase 2.doc”
- Replace Converter Drive Connector pins with a Molex box style pins. We must order these parts.
- Replace Converter board drive connector backshell to accept new box style molex pins. We must order these parts.
- Add RC soft ground network to ground from converter board common to chassis ground. We must order these parts.
- RC network for converter enable.
- Tell algen to only replace backplane on ps’s that have given us problems unless a supply comes in tagged to replace the backplane. They can go back to original s/n list. Done.
- Tell them how to completely disable ac phase fault.
- Make sure Algen checks for 110VAC fans on front of 150’s and some 300’s have 20A CB already.
- I will make a 300A s/n list for algen of supplies that have CB installed already. The bipolar 300A supplies that have the 20A circuit breakers installed by BNL already are s/n’s: 12, 1, 9, 18, 2, 6, 10, 4
- Tell them some of the power supplies have the correct soft start resistors. They will have to be careful not to remove these. I will try to come up with a s/n list of these.
- Algen should put a sticker on the supply that says “150A 2/7/08 Phase 2 Mods”
- Measure bus voltages – see procedure
- Re-connect FET fault wires now that it is only a warning.
- Check soldering of all FET legs and resistor to bus.
- Inspect re-work.

Main ps plans from summer 2008

- Analyze setpoint card that was removed for problems
- Finish new main ps regulator
  - Finish new voltage signal conditioning card
  - Improve voltage isolation board temperature characteristics
- Finish 720Hz warning circuit
- Finish High Performance diagnostics system
- Investigate REG DCCT errors
- Replace DCCT fans once every 3 years

Power Supply and other Systems Performance for Run 8
Run to Run Comparison

Main QLI Faults	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8
Beam Induced	46	69	54	37	18	47	27
Quench Detector Faults	13	29	13	20	2	3	3
Quench Detector / Controls CFE	New Field added starting with Run 6				10	3	0
IR Supply Faults	100	44	24	51	29	59	22
QPA Faults	40	6	9	6	5	20	8
Main PS (Total) Faults	68	38	46	6	14	41	24
Controls 6B Yellow Permit Fail	25	9	24	0	0	0	0
Controls Related	20	15	20	13	5	4	6
Operations Error	34	15	17	12	4	5	4
Cryo Related	6	9	2	4	2	8	0
Power Failure	10	8	3	7	9	3	1
Other	27	27	24	29	9	17	16
Power Supply Induced Quench	6	1	4	0	0	0	1
Totals:	395	270	240	185	107	210	112

Power Supply and other Systems Performance for Run 8
Run to Run Comparison

Snake / Spin Quench Faults	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8
Beam Induced	20	17	5	2	3	0	3
Controls Related	New Field added starting with Run 6				9	0	0
Quench Detector Faults	0	0	1	0	2	0	0
Quench Detector / Controls CFE	New Field added starting with Run 6				1	0	0
Power Supply Faults	10	2	4	0	1	0	2
QPA Faults	0	0	0	0	0	0	0
Operations Error	2	0	2	1	2	0	0
Cryo Related	2	0	1	3	3	0	0
Power Failure	0	0	2	2	9	0	0
Other	2	6	0	5	0	0	0
Totals:	36	25	15	13	30	0	5

MTBF DETAILS IF NEEDED

What is the average time RHIC can run before experiencing any PS Failure?

$$\text{MTBF_M RHIC} = \frac{\text{MT}}{\text{NOF}}$$

	RHIC Run 4	RHIC Run 5
MTBF_M (hours)	20.48	29.82
Number of Problems	148	130

The bigger the MTBF_M number is, the better we are doing.

How does this MTBF_M compare with other labs machines?

	RHIC Run 4	RHIC Run 5	HERA e+p 1996	Doris 1996	Entire DESY
MTBF_M (hours)	20.48	29.82	22.3	61	9.2
Number of Problems	148	130	238	87	574

If you ignore all other failures in the machine, except for ps failures, what <u>would be</u> the %Availability of the RHIC machine.?

$$AV\% = \left(\frac{[MT - (NOF \times TOR)]}{MT} \right) \times 100$$

	RHIC Run 4	RHIC Run 5
AV%	91.97	96.9
Number of Problems	148	130

How does this %AV compare with other labs?

	RHIC Run 4	RHIC Run 5	HERA e+p 1996	Petra 1996	Entire DESY
AV%	91.97	96.9	96.6	98.7	91.9
Number of Problems	148	130	238	87	574

What is the average time an individual P.S. can run before experiencing a Failure?

$$\text{MTBF_Power Supply Systems} = \left(\frac{(\text{MT x NOPS})}{\text{NOF}} \right)$$

	RHIC Run 4	RHIC Run 5
MTBF(hours)	19106.33	27823.85
Number of PS's	933	933

How does this MTBF_PS SYSTEMS compare with other labs?

	RHIC Run 4	RHIC Run 5	HERA e+p 1996	Doris 1996	Petra 1996
MTBF(hours)	19106.33	27823.85	29310	8968	13988
Number of PS's	933	933	1166	93	269

Work that was planned for mains summer shutdown 07 – see next 2 slides. The things that were done in summer 07 are in red. The one in blue was done during run 8

RMMPS's – problems – plans

(summer shutdown 07 work that was planned)

- BD Voltage Loop Hardware Gain Problem
  - Caused 18.8 hours of down time.
  - Making new voltage signal conditioner pc boards.
  - Add new test points.
- YQ 24 volt dropout to Remote PLC, fixed in run 8
  - Caused 10.5 hours of down time.
  - Still must be solved. Replaced PS but had 1 event after this.
- YD DCCT fan
  - Caused 5.7 hours of down time.
  - Replace DCCT fans once every 4 years, starting this summer.
- 720 Hz chassis phase slip
  - Caused 1 hour of down time.
  - Install a warning circuit so chassis can be conveniently reset.

RMMPS's – problems – plans- cont'd

(summer shutdown 07 work that was planned)

- Other preventative maintenance this shutdown
  - OCC Vertical bus bar rework, done summer 07
- Additional Improvements for better performance
  - Improve the voltage isolation board Temperature characteristics
    - Additional test points (Run 9)
- High Performance Diagnostics System
  - 16 bit simultaneous sample & hold
  - 100kHz acquisition rate
- Quench ground current monitoring code, done summer 07