

Diagnostics and Post-Mortem



- Initial Diagnostics
 - Permit link analysis
 - Loss analysis
- Quench diagnostics
 - Quench detection
 - Loss analysis
- Advanced diagnostics
 - Investigating beam induced losses

Initial diagnostics: permit link

- Nearly all beam failures involve the permit system.
 - BLM, PASS, vacuum, quench, PS, drives, RF
- Automatic diagnostic results posted in elog.
- Relevant pet data archived in RHIC/PostMortem branch
- BLM, other snapshot data preserved, viewed in PMViewer.
- It is the Operators responsibility to follow up on permit failures.
 - Subsystem failures are delegated to CAS, support groups.
 - Quench Link Interlocks (QLI) require additional investigation to determine cause.
 - If failure is beam-induced, further investigation is required.

Quench diagnostics

- Relevant pet data archived in RHIC/PostMortem branch.
- Power supply, BLM, other snapshot data preserved, viewed in PMViewer.
- Automatic results are posted in elog.
 - Some quench detector processing takes at least 5 minutes.
 - Analysis attempts determination of failure origins.
 - Sequence of failure (first link to drop).
 - Quench detector or power supply origin.
 - Relevant alarms
 - New this run: attempts to correlate beam losses with power supplies to separate cause/effect.
- Operators are responsible for QLI investigation.
 - If failure is beam-induced, further investigation is required.
 - In most cases, beam quenches should have been caught by permit system.
- ***All QLIs require action before returning to operation.***
 - “Try again” – NOT an option.

Advanced diagnostics

- For permits and quenches induced by beam losses, one must attempt to determine a root cause.
- Review logged instrumentation data for anomalies in tune, orbit, RF, etc.
- Case study follows.

Relatively
High
Impact
Catastrophes



A Case Study in Failure

V. Schoefer, G. Marr

Outline

- Example of the troubleshooting process and when tools are useful
- Not a detailed lesson in *how* to use specific applications. Can always get help from:
 - Experienced shift leaders
 - Operations
- Best to run the applications and explore a little:
 - BEFORE you're on shift.
 - IN the control room.
 - WITH permission from OC.
 - NEXT to someone who knows what is going on (in the app and at the moment).

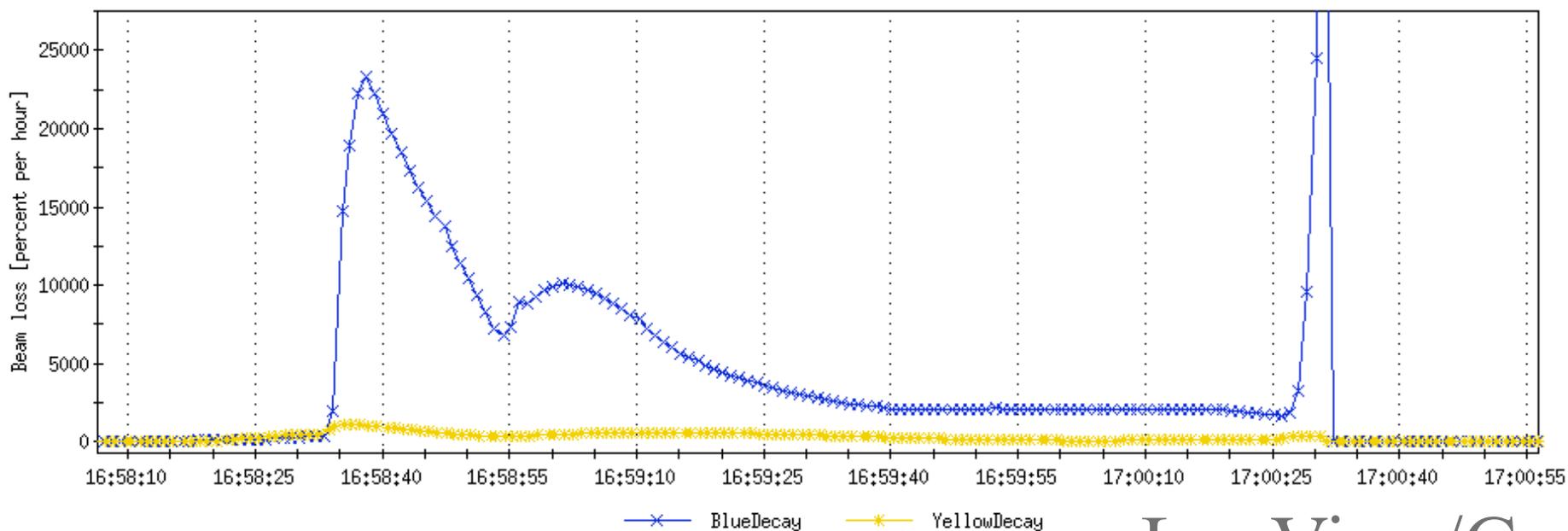
The Case of P^ Fill #09877

“But it’s just 6 little bunches!”



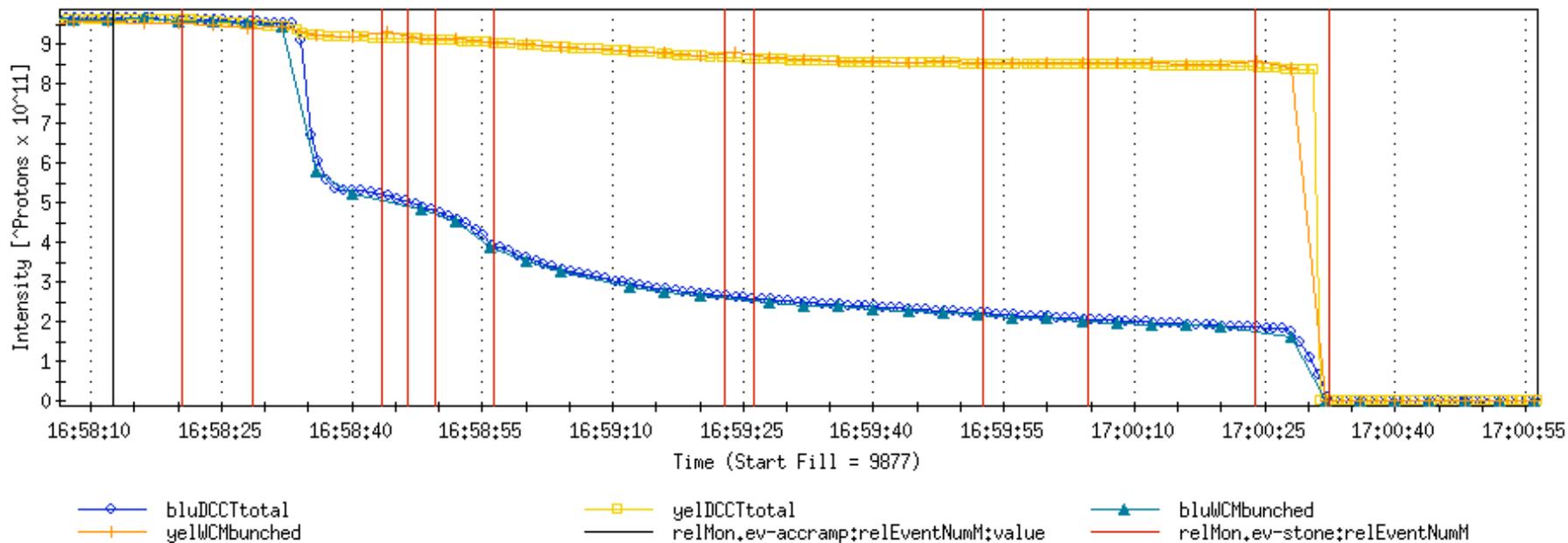
Window Markers Analysis

Beam Decay



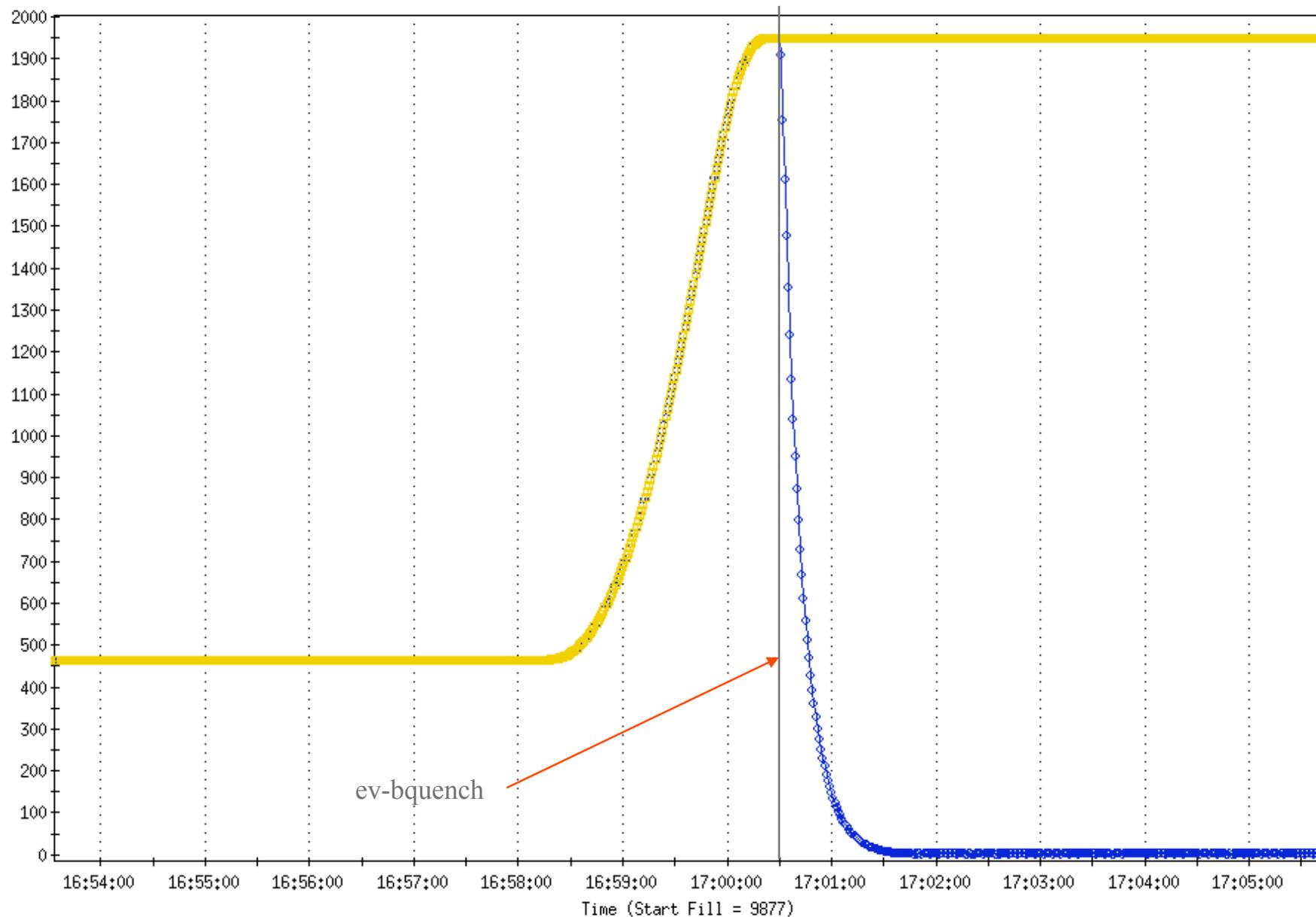
LogView/Gpm

RHIC - DCCT total beam & WCM bunched beam



NO DATA available for relMon.ev-lumi:relEventNumM

Blue & Yellow Main Magnet Currents



—◇— BlueDipoleCurrent —□— YellowDipoleCurrent

Always, always, always check for alarms!

Alarms can
separate

BEAM
PROBLEMS

From

EQUIPMENT
FAILURE

RHIC AD2000 - Tue Dec 16 11:03:30 2008

Setup Mask Logs Help

0 Critical Alarms Unfiltered View

lvl	Count	Name	Description	Time
728 Standard Alarms Unfiltered View Last Received @ Tue Dec 16 10:34:58 2008				
3	1	permit.Master:quenchedStatusM	Blue:Quench Link FAIL	
1	7	psCtrlM stateMismatch	Stby	
1	1	wfg.b-qtrim-ps:ioErrorM	Frame error,I/O difference	
1	1	PS:psCtrlM.bo7-sxd2-ps	Excursion attempt	
1	18	PS psCtrlM.b12-q7-ps	Error, With Faults, wfg(s) Not	
1	7	psCtrlM statusM	Quench	
Loss Monitor permit pull				

Ramp failures, especially quenches, can cause many more alarms.

It takes more than a glance to separate alarms CAUSED BY the quench from the alarms that may HAVE CAUSED it.

24 Acknowledged Alarms (0 Critical) Unfiltered View Last Received @ Sat Dec 13 16:33:02 2008

Selected alarms are being deselected so that new alarms will be visible (autoscrolling)

Quench Self-Diagnosis

Feb-14-2008 17:00 Quench Link Interlock in blue ring
First input dropped was 6b-ps1 (17:00:28 2893816)
First upstream carrier drop was 7b-ps1 (17:00:28 2893820) -Sequencer

← Notification

Feb-14-2008 17:00 Beam Abort, 7w-ps2.A dropped (Loss Monitor 1) -Sequencer

Feb-14-2008 17:03 Performing analysis for - QDS.1203026430
Thu Feb 14 17:00:30 2008
Blue Quench Link Interlock
First link to drop was the permit link - input permit.7a-ps3.
The permit link tripped at Thu Feb 14,2008 17:00:30.833725.
The blue link tripped at Thu Feb 14,2008 17:00:30.893816.
The permit link tripped 0.060091 secs before the blue link.

Analysis

Analyzing building 6 - due to problem in permit.6b-ps1.
Quench detector brought down the link.
Possible problems - Check if

1. A power supply in this building was oscillating
2. beam induced quench. Check qdRealquench pet page, delayed 5 minutes please wait 5 minutes for real magnet quenches to be displayed in elog.
3. quench detector problem, such as it being reset
4. Any snake magnets quench before this?
5. Check to see the abort kickers did not pre-fire or mis-fire

← Chicken/Egg

← Location

If none of these seem to be the cause, consult an expert.

Analyzing qdAlarms page.
qdprocess.6b-qd1 - Blue Quenched [B6QFQ3_VT Int 5] 02/14/2008 17:00:32 Tq:-24 [rhicMode: AUAU1]

Analyzing service building IR supplies for warning.

-Sequencer

Both
unlikely
in this case.
Why?

PMViewer

Let's try power supplies first.

The screenshot shows the PMViewer application window with the following settings:

- Run Name: run_fy08
- Data Source: PostMortem
- Time Period: All
- Ring: Both
- Sort By: Date
- Selected System: PS
- Selected FEC: 1006-B

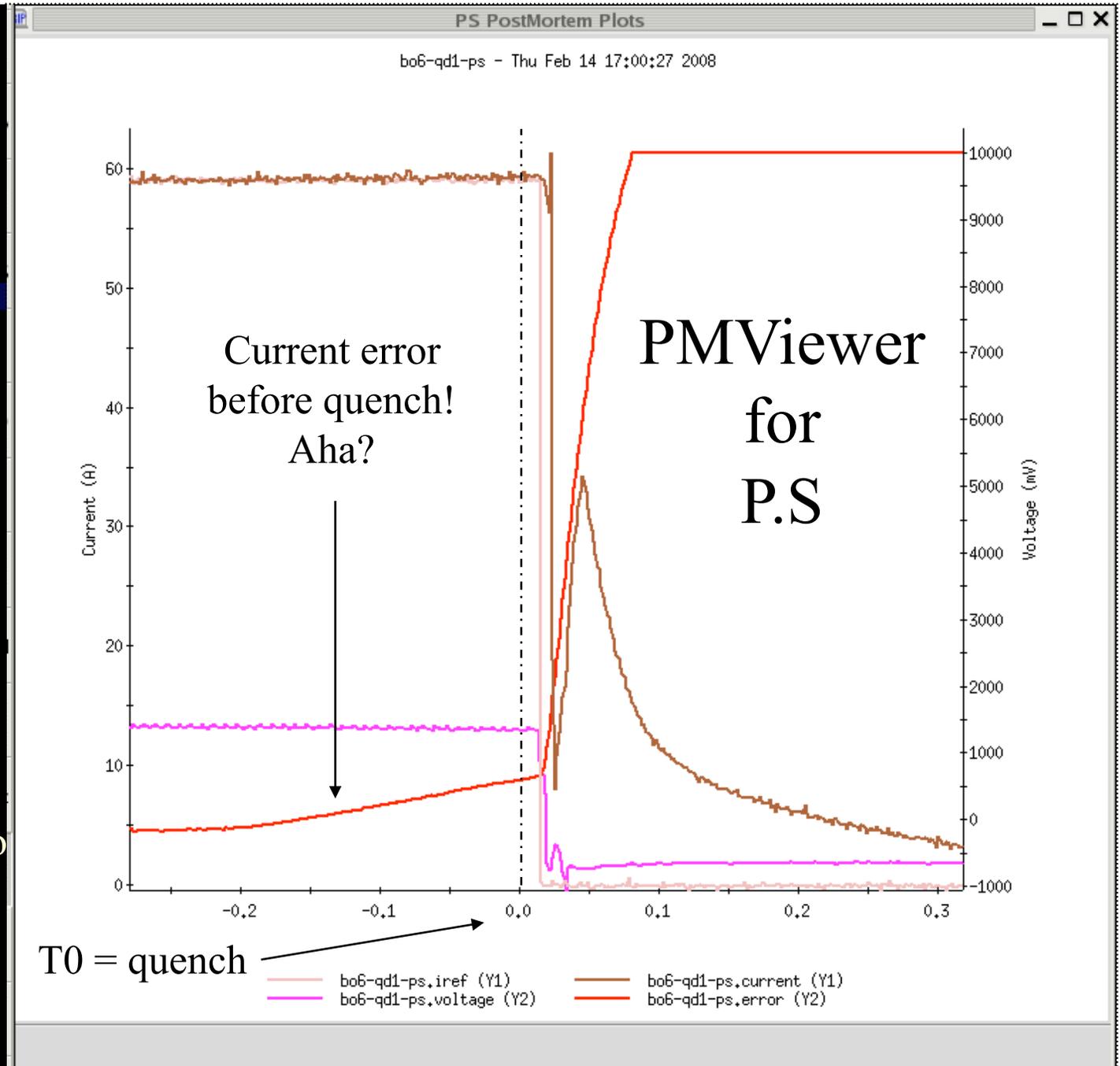
Name	Date	Fill Num	Comment
y	Sat Mar 1 14:56:11	9974	Yellow Quench ev.
b	Sat Mar 1 14:56:09	9974	Blue Quench ev.
y	Wed Feb 27 09:13:06	9961	Yellow Quench ev.
y	Sun Feb 24 10:32:32	9943	Yellow Quench ev.
b	Sat Feb 16 22:54:39	9888	Blue Quench ev.
b	Sat Feb 16 21:58:47	9888	Blue Quench ev.
b	Thu Feb 14 17:00:31	9877	Blue Quench ev.
y	Wed Feb 13 21:34:58	9862	Yellow Quench ev.
b	Tue Feb 12 11:34:56	9851	Blue Quench ev.
y	Mon Feb 11 04:20:42	9842	Yellow Quench ev.
b	Mon Feb 11 03:01:48	9842	Blue Quench ev.
b	Mon Feb 11 02:37:57	9842	Blue Quench ev.
b	Sun Feb 10 17:34:33	9838	Blue Quench ev.
b	Sat Feb 9 04:29:01	9829	Blue Quench ev.
b	Fri Feb 8 11:02:43	9823	Blue Quench ev.

Buttons at the bottom: Read And Plot, Read File, Delete Selected Files

*More chickens.
More eggs.*

Power supplies can respond to their magnets being quenched by beam.

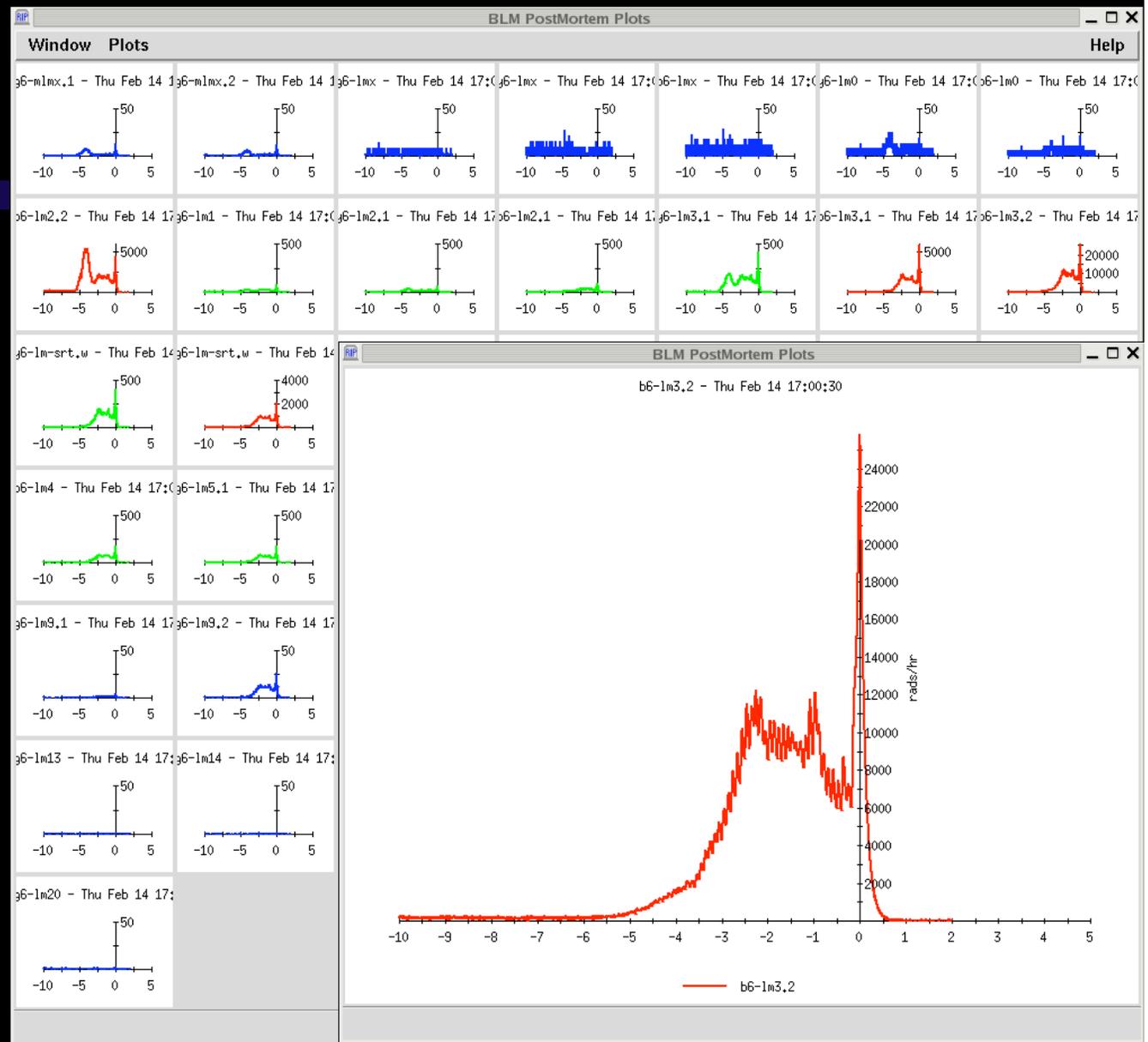
P.S QLIs
GENERALLY
Look like
-- oscillation
-- spikes (sp or rb)
-- sharp drops to zero



So let's check the losses:

Large losses near the magnets with the current error.

They get very high on the time scale of about 0.25s -- same as current error.

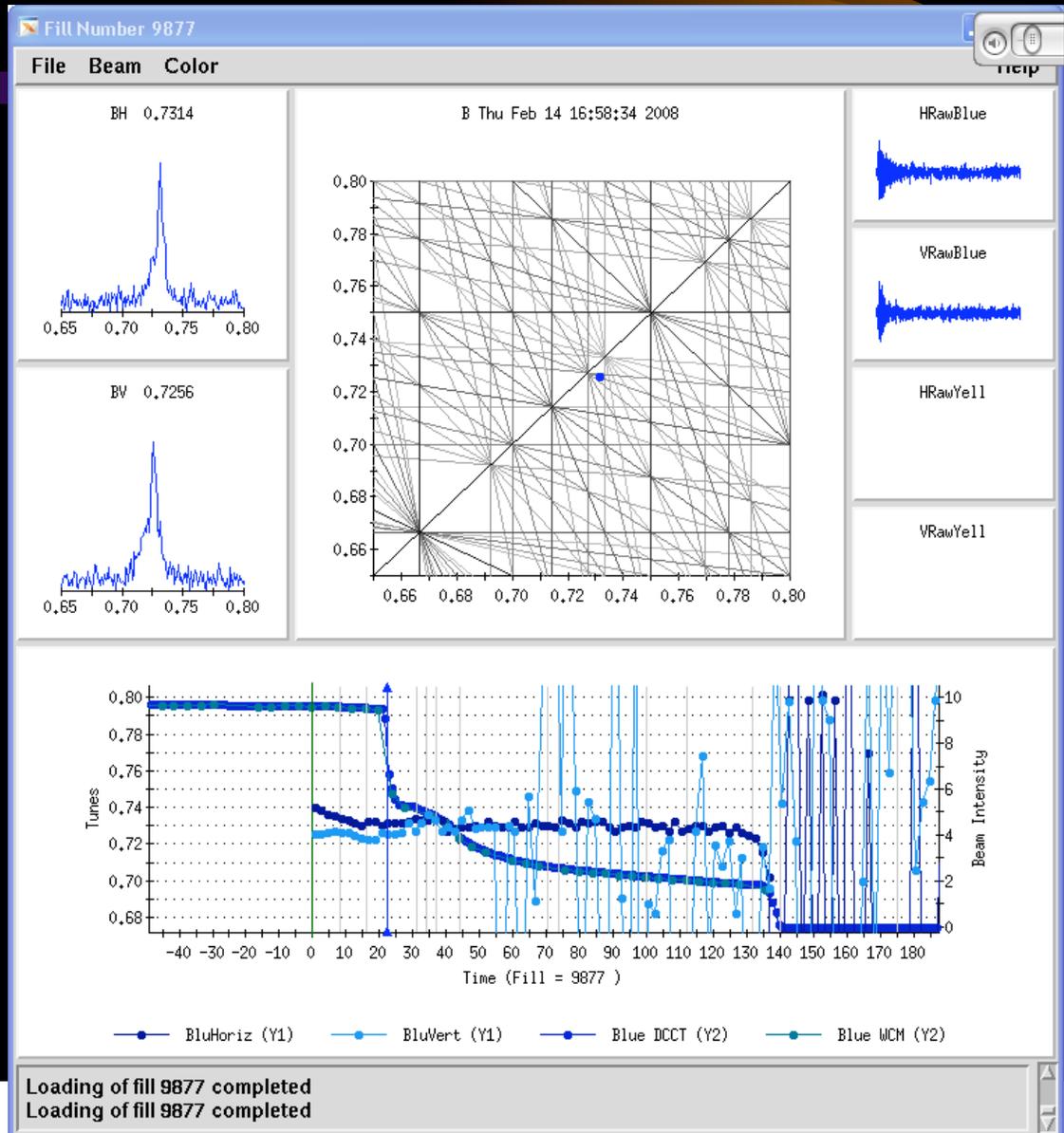


Now it's a beam problem (maybe)

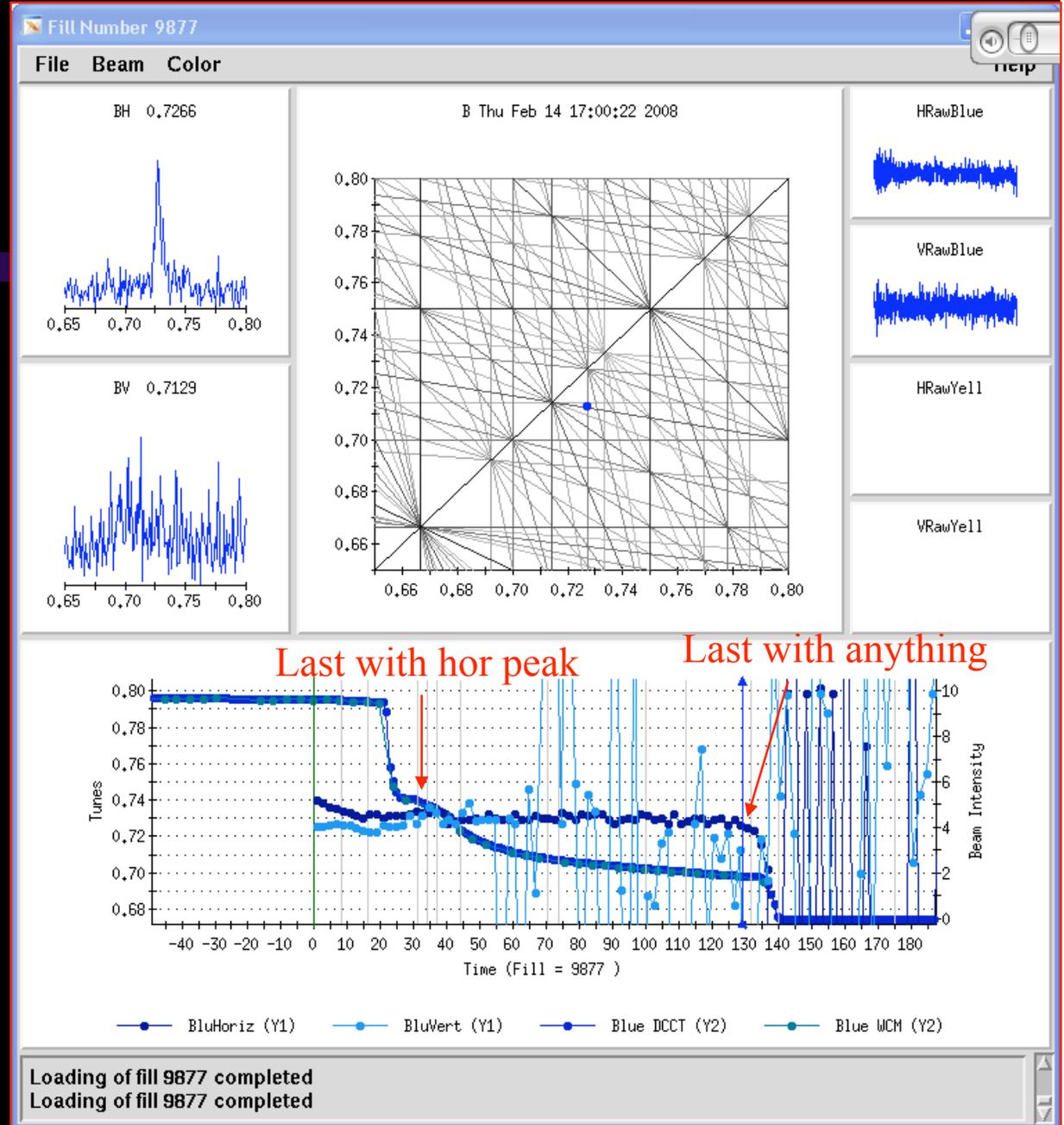
Loss at snapback.

Note 1: Think about
division of labor. Work
in parallel.

Note 2: Plotfill is awesome.



What's the problem?



pscompare (and cheating)

In this case, we had a good ramp to which to compare.

Blue sextupoles are identically zero.

Chromaticity problem and sextupole alarms are vindicated.

Call controls (RTDL failure)

No good ramp available?

-- does cur follow wfg?

-- are blue/yellow in the same ballpark?

-- previous runs

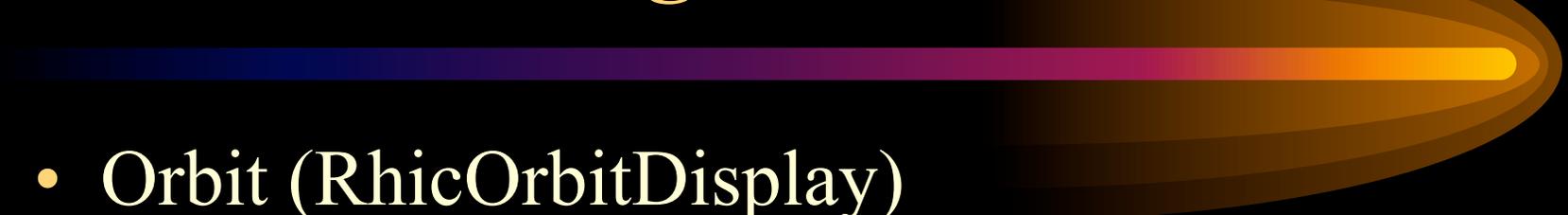
The screenshot shows the pscmpare software interface. The main window displays a graph titled "CombRamp_wfgs vs CombRamp_wfgs". The Y-axis is "Current (A)" ranging from 0 to 10. The X-axis is "Time since accramp (s)" ranging from -100 to 900. A green line represents the "bi5-sxd2-ps Target" current, which ramps up from 0 to about 8.5A between 0 and 200 seconds and then stays constant. A red line represents the "bi5-sxd2-ps Source" current, which remains at 0A. A vertical dashed red line indicates the "bi5-sxd2-ps Max Difference" at approximately 620 seconds.

Below the graph is a "Power Supply Difference Table (1Hz Samples)":

Power Supply	Difference (%)	Time (s)
bi5-sxd2-ps	10.3097	620
bi9-sxd2-ps	10.3058	621
bo11-sxd2-ps	10.2966	620
bo3-sxd2-ps	10.2898	621
bo7-sxd2-ps	10.2879	620
bi1-sxd2-ps	10.2865	620
bi5-sxd1-ps	7.73482	621
bi9-sxd1-ps	7.72782	620
bo7-sxd1-ps	7.72536	620
bi1-sxd1-ps	7.7242	621
bo3-sxd1-ps	7.7235	620
bo11-sxd1-ps	7.72065	620
bo11-sxf1-ps	3.3016	421
bo7-sxf1-ps	3.29758	422
bo3-sxf1-ps	3.29469	421
bi1-sxf1-ps	3.28772	831
bi5-sxf1-ps	3.28695	831
bi9-sxf1-ps	3.28515	831
bi5-xf9-ps	2.29716	147

The interface also includes a "Source Fill" and "Target Fill" list, "Source Capture" and "Target Capture" settings, and a "Run Name" field set to "run_fy08".

Things I did not check...



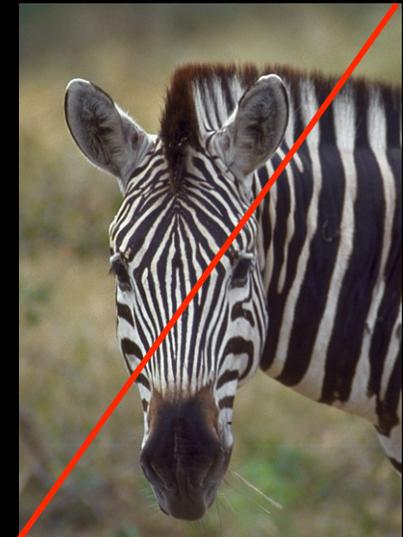
- Orbit (RhicOrbitDisplay)
- Global loss profile (RhicLossMonitor)

General Troubleshooting

- CHECK (CAREFULLY) FOR ALARMS! (especially permits)
- READ THE ELOGS.
- What is the time scale of loss (ms vs. seconds)?
- What is the spatial distribution of loss (local to arcs vs. distributed among apertures)?
- Every GPM looks good/bad at the right/wrong scale. Work in parallel (there are four of you, after all)
COLLABORATORS – NOT CUSTOMERS



When you see hoofprints, think horses, not zebras.
– (i.e The Big Four)



- The beam is the best diagnostic tool!



*Only one 'motherhood' comment
(no apple pie).....*



*TALK
TO
EACH
OTHER*