MPS upgrade status

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Overview and run 2020 summary

Component	details	status
Delayed aborts	Fully redundant system, 6ms delay, most of run 2020	✓
Delayed quench switches	When RHIC abort system is delayed, quench switches are too	✓
BLM	Considerably tighter limits at all machine modes	✓
BPM MPS	Selection of 40 BPM per ring continuous logging, high sampling Flexible setup Limits change automatically Included in PM analysis Include more BPMs Incorporate into modeswitch	✓ ✓ ✓ ✓ ✓ X in progress
PS	All 18 alcoves equipped with CPSBPS Service building supplies	✓, in progress X
RF	Enabled to pull permit, no changes to 2019	✓
Abort analysis	Abort database Abort by abort analysis 10 kHz, inclusion in PMViewer	✓ In progress ✓, in progress

Overview of MPS components

Plenty of progress!! Thanks to LOTS of help from Matthieu, Rob, Jon, Phil and Tustin

Power supplies

Alcoves

- The new and fast system trips when the corrector supply is NOT ON
- It is AT LEAST 20 ms faster than the old system (typically more)
- All alcoves are equipped with the new CPS BPS board
- The system was active in run 2020 but only operated masked
- Still diagnosing occasional communication issues
- Expected to be fully operational in 2021

Service buildings

- CPS BPS system will be expanded to service buildings
- Design will be based on alcove system
  - Needs modifications
  - monitor analogue voltage and current error of each supply
  - Compare to window
- 4 boards per service building would be required
- Test one prototype in run 21 in one service building (1006b?)

BPM MPS

Brief overview

- Total of the 36 H + 4 V BPMs per ring
- Each has 4 individual trip limits:
  - Coherence
  - Minimum position
  - Maximum position
  - Difference
- Up to 16 different events to change trip limits are supported
- Shared with the 10 Hz feedback system
- The MPS BPMs have their own (fast) link
- Controlled by dedicated ADOs, one V301 board
- 1 kHz continuous logging of position, coherence and difference
- 10 kHz sampling rate, included in PM analysis

Summary of all permit trips during run 19 and 20

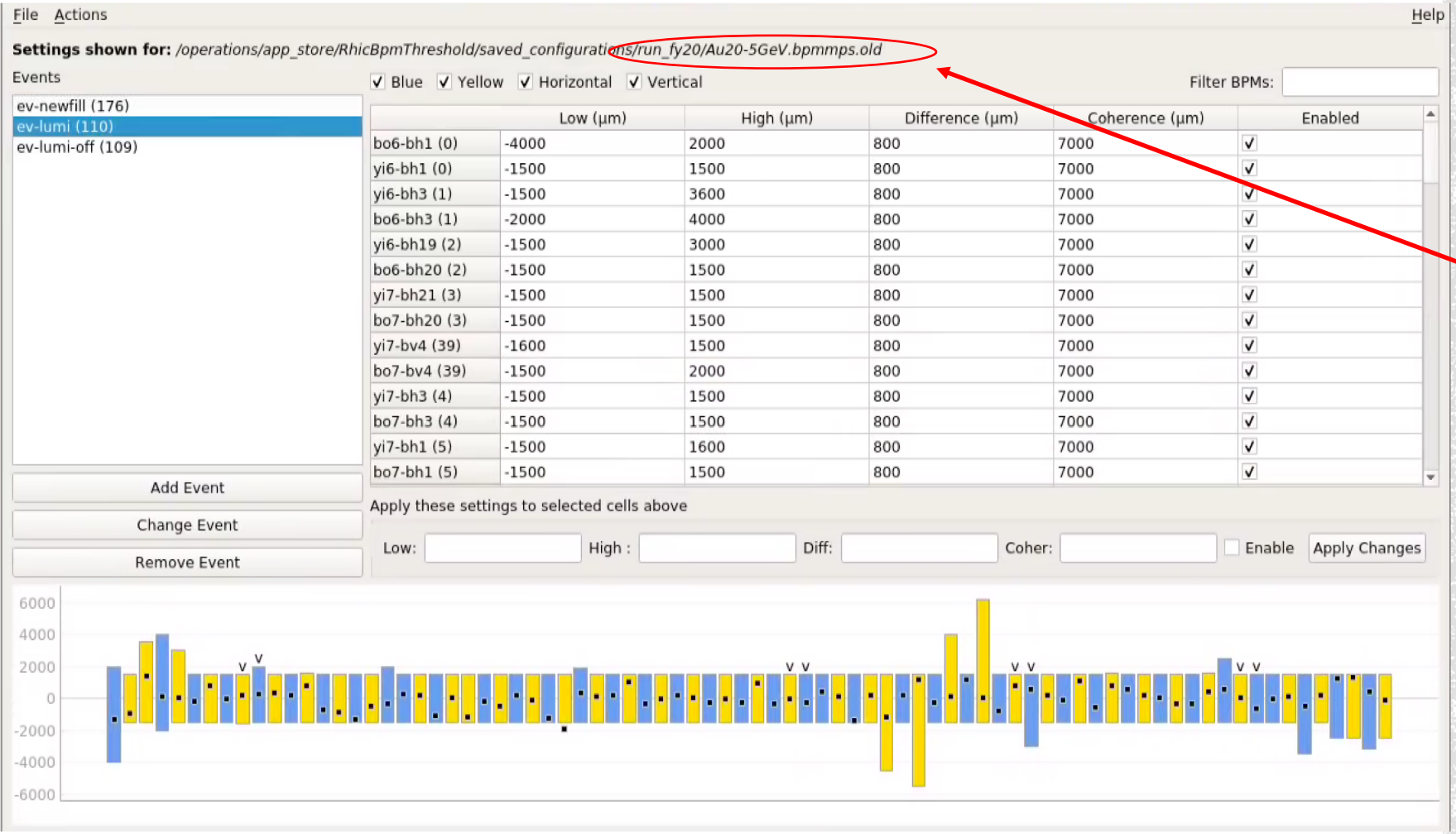
	Run 19 total	physics	Run 20_1 total	phyiscs	Run 20_2 total	physics	Total
All	847	238	492	229	336	146	1675
Delayed	15	15	29	28	71	69	115
BPM MPS	27	11			27	23	54
Abort Kicker	13	3	21	12	51	10	85
PS main	37	2	18		33	1	88
PS	2	1	9	3	3	2	14
BLM	369	187	300	191	122	91	791
Quench	17	8	16	12	6	3	39
RF	218	22	95	9	64	7	377
Vacuum	4		3		7	3	14
STAR	5		1		6	3	12
LEReC	129	2	25	1	5		159
CeC			3	1	8	2	11

RHIC BPM MPS trips

- Fast BPM input was active but masked for most of the run
- Enabled and unmasked:
  - Aug 18 – Sept 1
  - fill #28453 to #28785 (span of 332 fills)
  - not engaged during CeC fills (due to ramping)
  - 27 permit pulls/aborts during those 14 days:

Testing	injection	Bad reading	noise	Setup	BTF or bump	Wrong attribution	Protective dumps
2	6	4	2	3	5	1	4
voluntary	Event timing	Ignore count?	Low intensity	Procedure?	After ev-lumi-off	Postmortem analysis	Quench, coherence or 10Hz FB

RhicBpmThreshold application

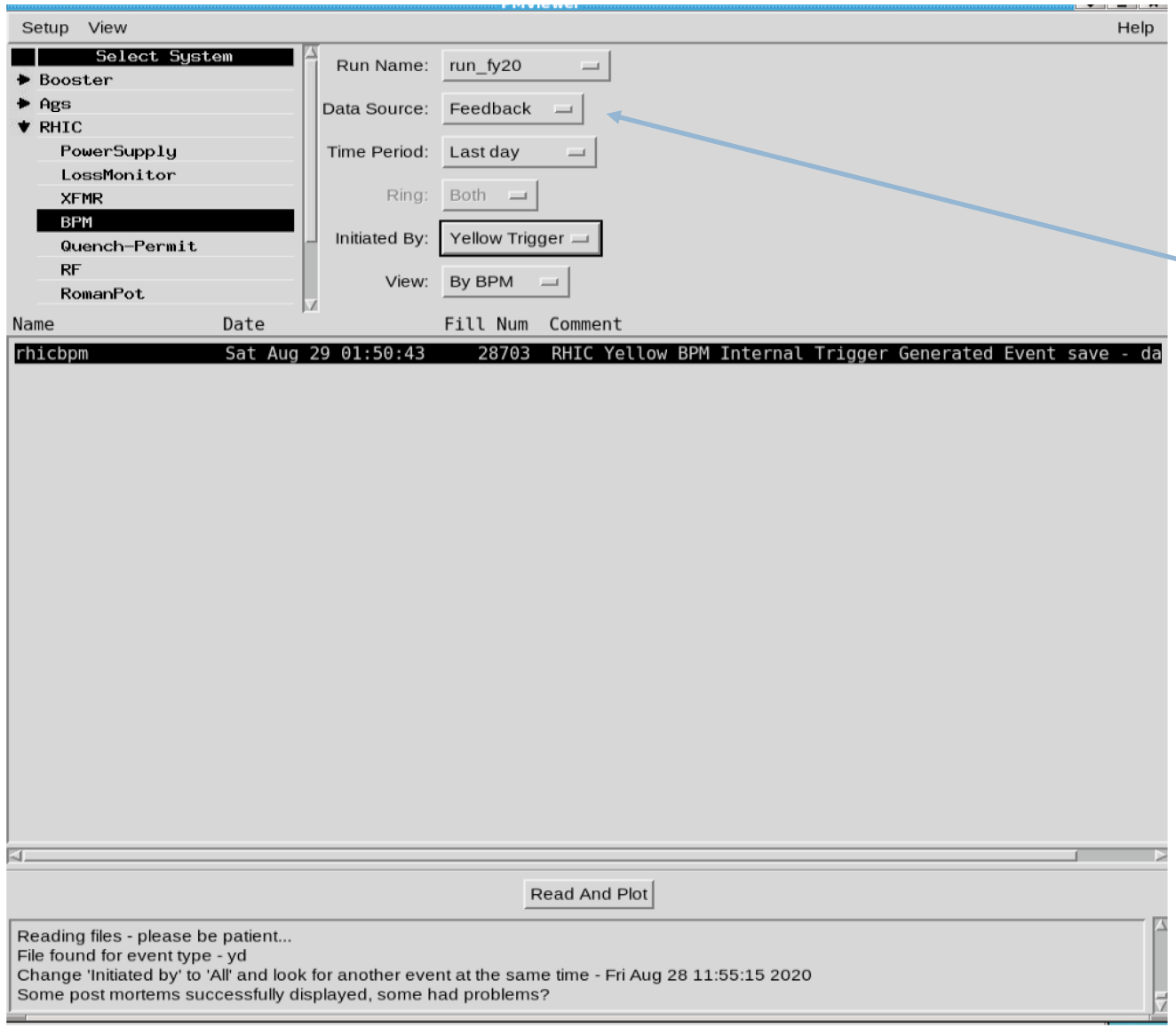


- Similar to RhicLossThreshold
- Contains a set of tables for blue and yellow BPMs
- File shown here is:
- Au20-5GeV.bpmmps.old
- Which file is used can be found (and set) in SSOP -> **Expert only** activity to change that file!
- Handles up to 16 events with varying sets of limits.
- Shown here are the limits for event2 = ev-lumi
- The number and order of events will vary from file to file
- Units are micron
- Permit input needs to be enabled in BisConfig

	Input Channel	Permit dropped	Loss Monitor	Prefire	PS Faults	QLI (B Y)	Ramping (B Y)	Ion (B Y)	Blue Energy (GeV/n)	Yellow Energy (GeV/n)	Blue Intensity (1E9 Ions)	Yellow Intensity (1E9 Ions)	
	Loss Monitor 1	10a-ps3.A	y9-lm4	No	No	No No	No No	Au Au	4.59257	4.59257	85.3504	127.216	?
ter	Yellow Abort Kicker	10a-ps3.B		No	No	No No	Yes Yes	Au Au	1.79546	1.79554	0.0	0.0	?
	BPM Yellow	2a-bcm1		No	No	No No	Yes Yes	Au Au	21.69895	21.69868	0.000237848	14.0663	?
	RF Blue	4a-bsyn		No	No	No No	No No	Au Au	4.59257	4.59257	0.00140211	0.0	?
	BPM Yellow	2a-bcm1		No	No	No No	No No	Au Au	4.59257	4.59257	42.9104	42.9973	?
	RF Yellow	4a-bsyn		No	No	No No	No No	Au Au	4.59257	4.59257	0.00130612	0.0	?
	Loss Monitor 1	7w-ps2.A	g6-lm8	No	No	No No	No No	Au Au	4.59257	4.59257	0.00190796	0.0	?
	Loss Monitor 1	5e-ps2.A	g5-lm7.2	No	No	No No	No No	Au Au	4.59257	4.59257	0.0041707	0.0	?
	Loss Monitor 1	5e-ps2.A	g5-lm7.2	No	No	No No	No No	Au Au	4.59257	4.59257	0.00262689	0.0	?
	BPM Blue	2a-bcm1		No	No	No No	No No	Au Au	4.59257	4.59257	11.3203	32.996	?
ter	Yellow Abort Kicker	10a-ps3.B		No	No	No No	No No	Au Au	4.59257	4.59257	0.00128504	0.0	?
	BPM Yellow	2a-bcm1		No	No	No No	No No	Au Au	4.59257	4.59257	0.00154908	0.0654334	Coherence tri
	Loss Monitor 1	5e-ps2.A	g5-lm9.2	No	No	No No	No No	Au Au	4.59257	4.59257	139.579	126.644	Trip of g5-lm9 tripped the BP
	BPM Yellow	2a-bcm1		No	No	No No	No No	Au Au	4.59257	4.59257	0.00184707	18.1022	Coherence tri
	BPM Blue	2a-bcm1		No	No	No No	No No	Au Au	4.59257	4.59257	14.8538	18.5945	Fourth on mar the reflection

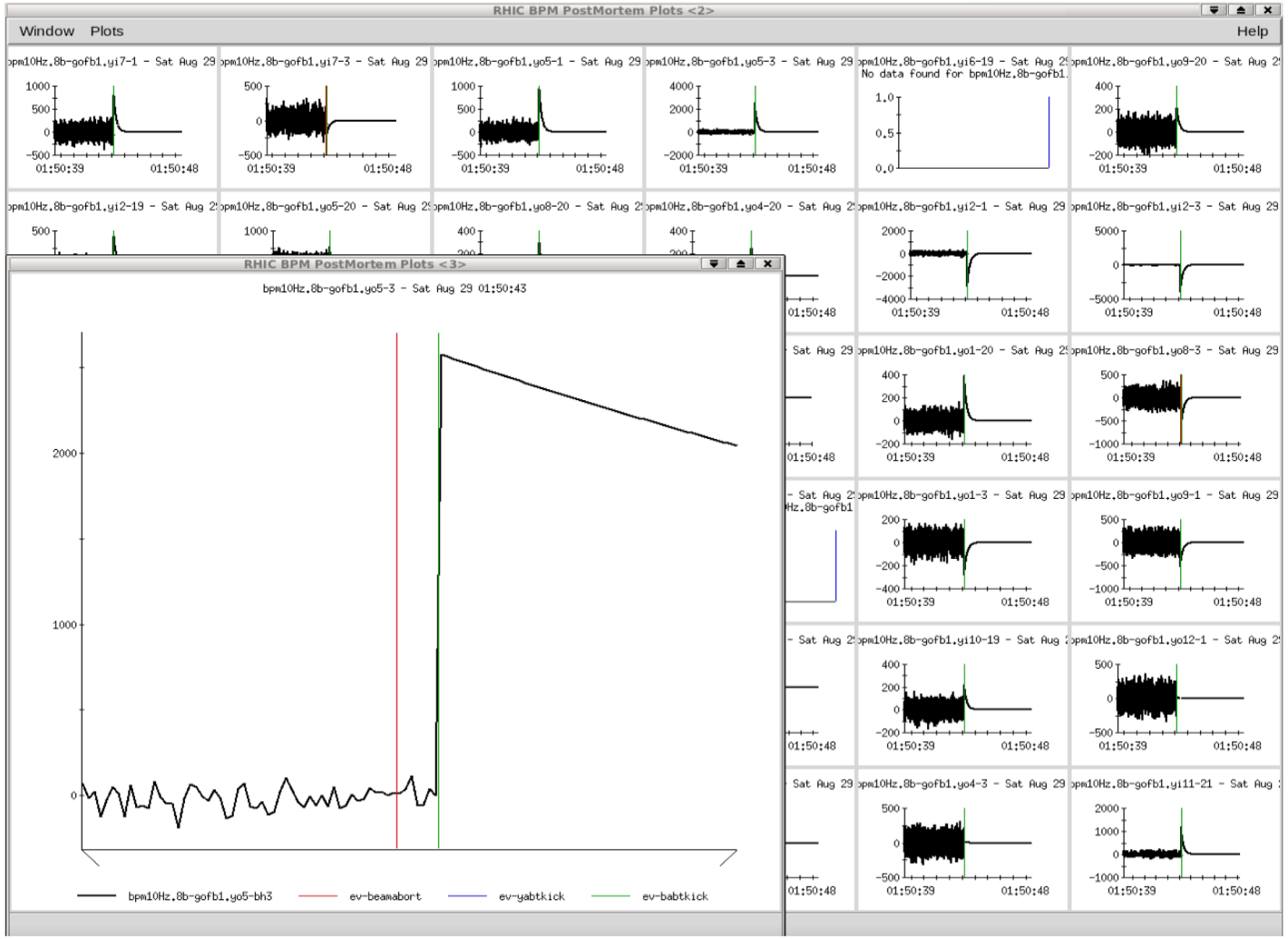
Abort database

- Appends semi-automatic
- 2019 and 2020 data included



PostMortem analysis

- Two Data sources:
  - PostMortem
  - Feedback
- Post Mortem
  - Shows about 100 ms of 10kHz data from the MPS BPMs
  - Time axis is wall clock time
  - Allows you to add abort and abtkick events
- Feedback
  - Same 100 ms of 10kHz data
  - Same subset of BPMs
  - Time axis is seconds from ev-abort



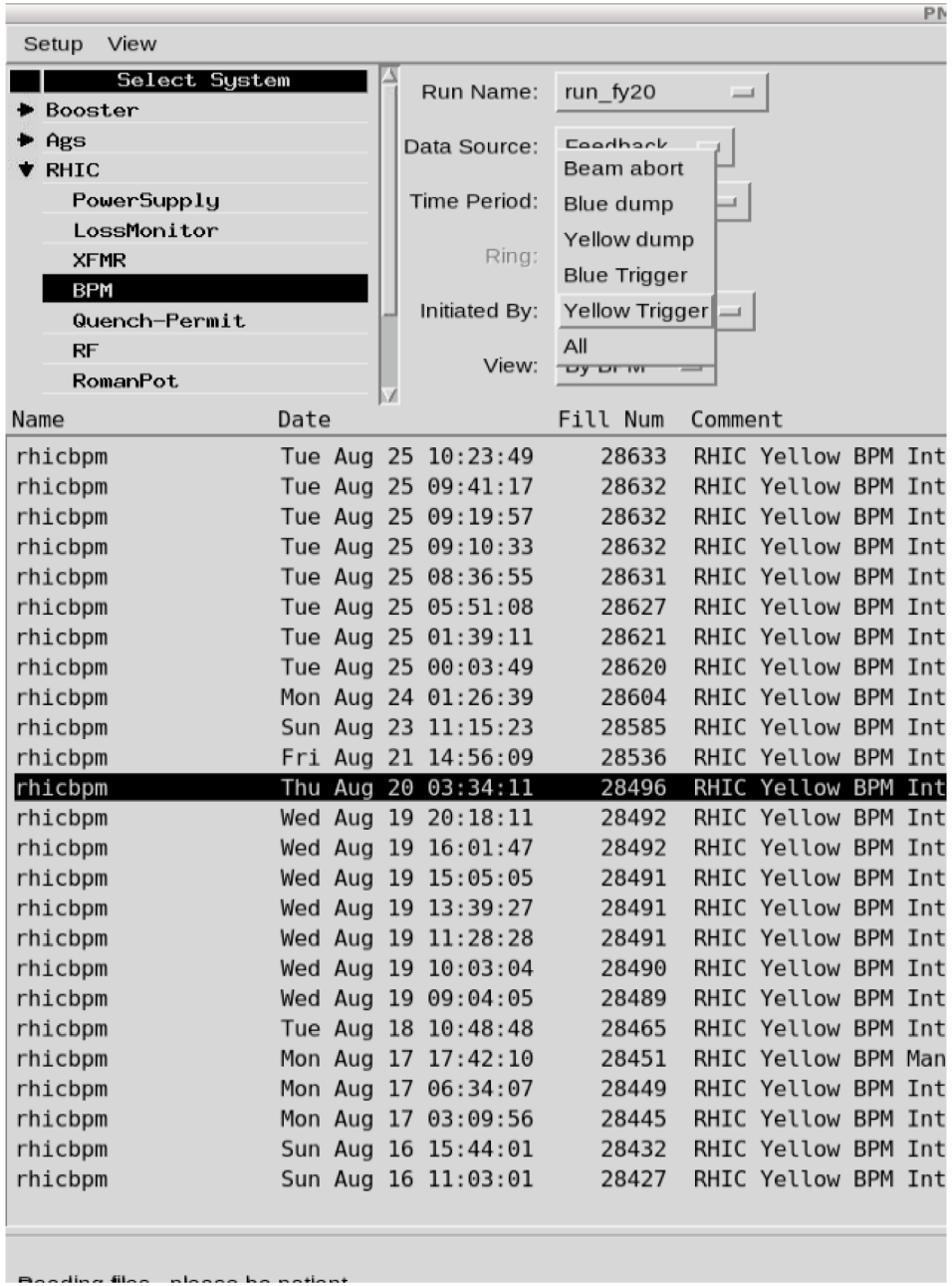
Data source PostMortem

Summary panel

Expanded graph

Markers can be added from “Plots” menu in the top

ev-abort and ev-abtkick are different by 6ms = delayed abort



Data source FeedBack

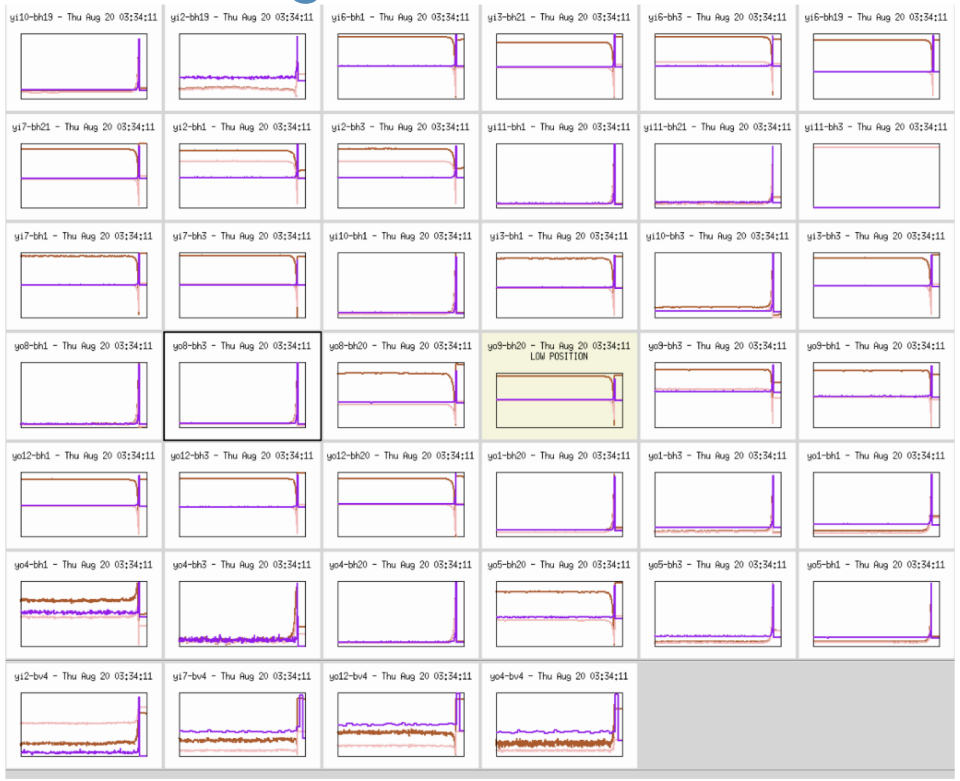
Allows you to select "Initiated By"

List of files will be different depending on what you select

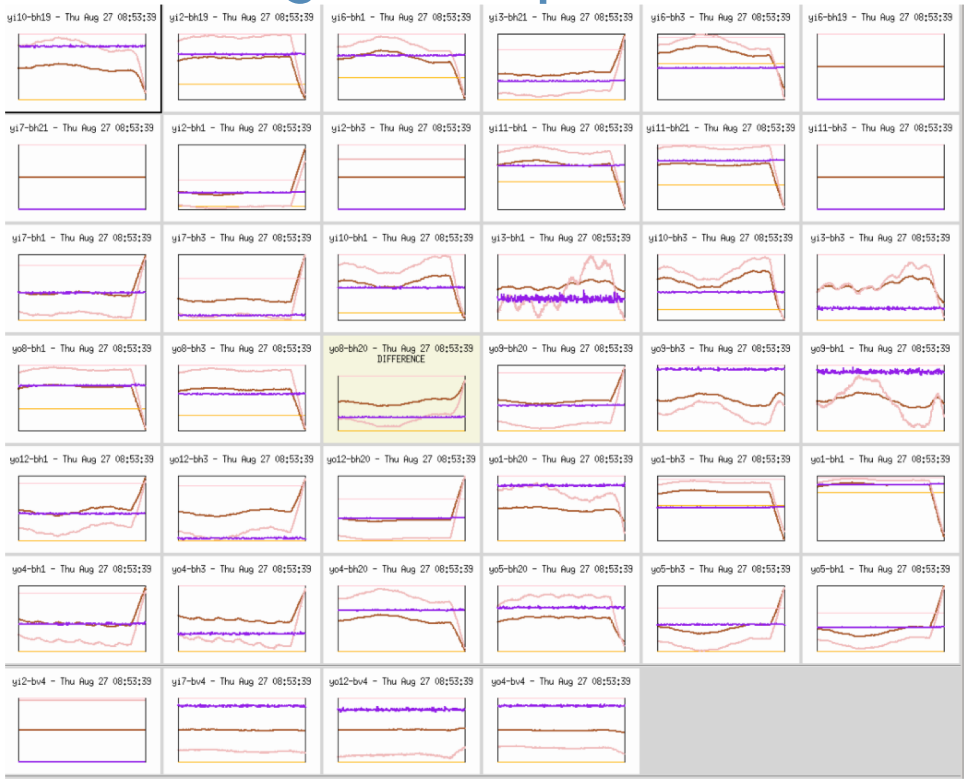
Shown here is Yellow Trigger

Post Mortem Data analysis (every 8th turn, 10 kHz)

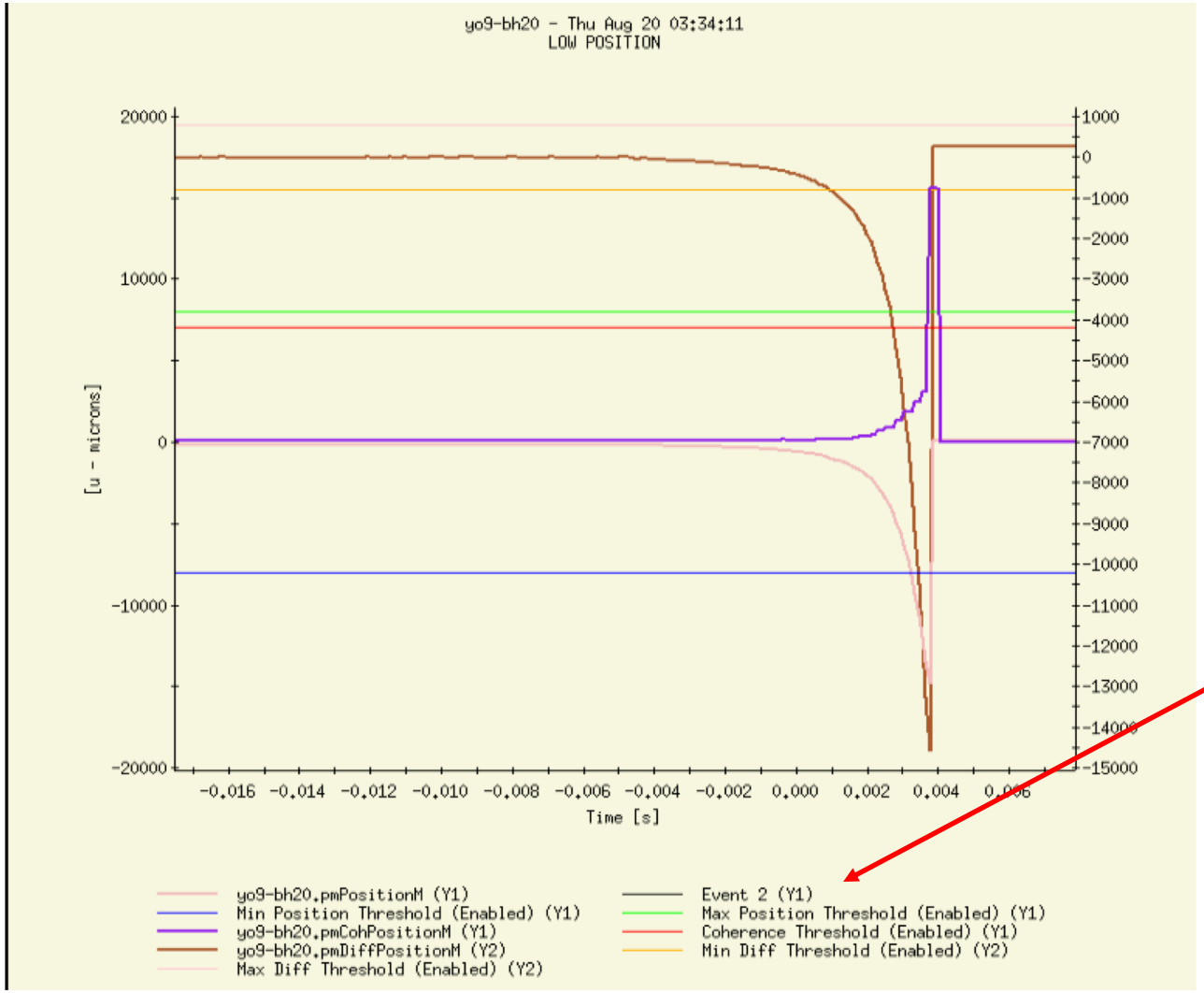
Abort during 10HzFB failure 08/20



Abort during CeC ramp 08/27

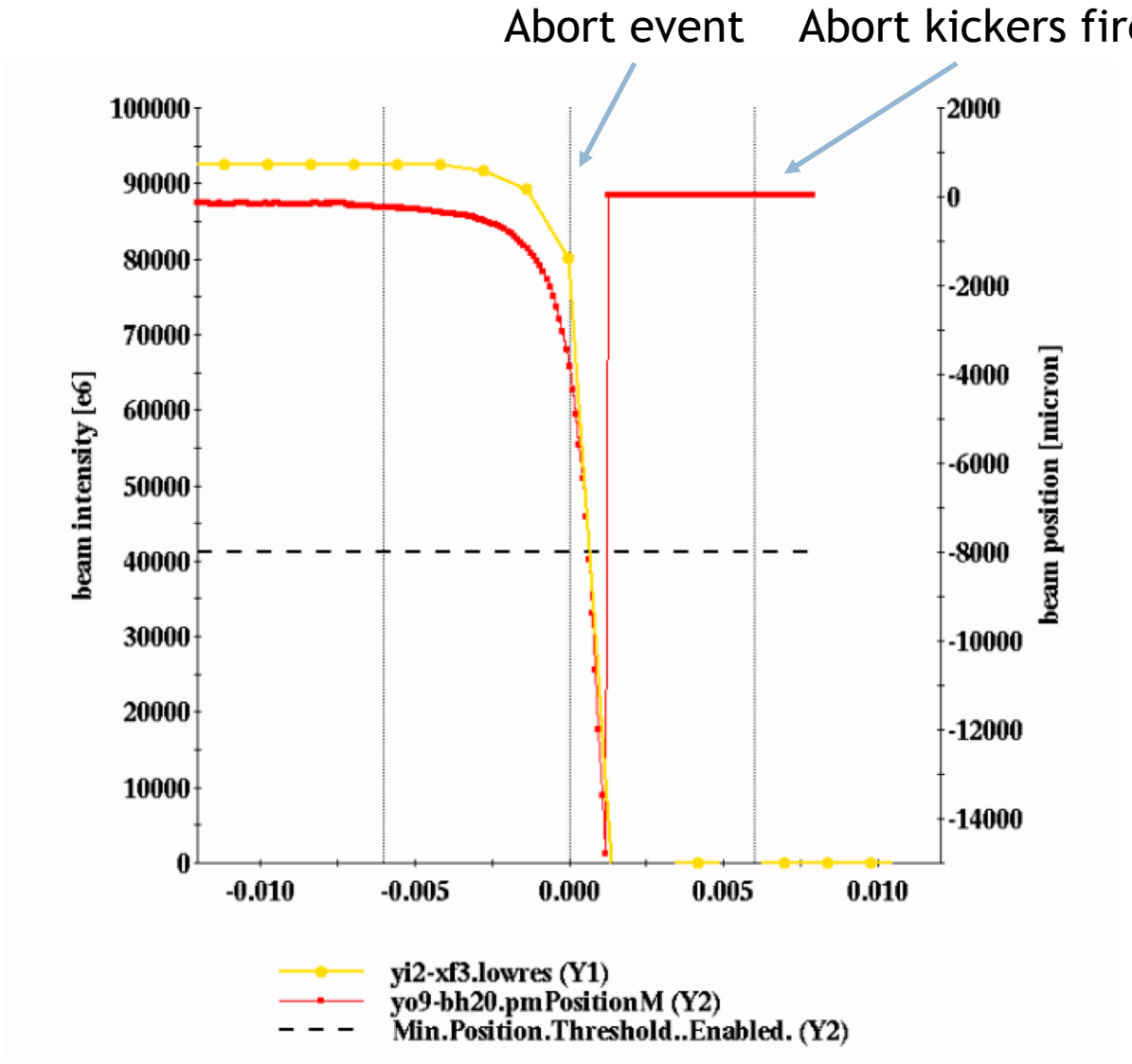


Summary page, failed input highlighted, data plot can be expanded (next slide)



Expanded Graph

- All three categories of data shown:
  - absolute position
  - difference
  - Coherence
- Event 2 is the 2nd event in the list (see RhicBpmThreshold)
  - This might change to event name later
- All limits (from that event) are added
- t=0 is ev-abort



PM analysis of 10Hz FB failure 08/20

Beam intensity 720 Hz data

Beam position: 10 kHz (every 8th turn)

Individually set limit (here -8 mm)

Very fast amplitude increase:

6ms from 0 to -14 mm

4.59 GeV (very low rigidity beam)

Driven by 10Hz FB supplies

Abort event is triggered at t=0 s

Abort kickers are fired at t = 0.006 s

NO BEAM left when abort kickers fired

=> Need to monitor 10Hz supplies

SUMMARY

- BPM MPS ready for use during a physics run
  - Individual trip limits
  - Flexible with changing beam modes
  - should add more vertical BPMs to the system
  - Needs careful procedures to avoid trips after mode switches
- New tools developed to analyse individual aborts and gather statistics
- All alcove PS included in CPS BPS
  - Needs to be operated without masking in run 2021
  - Needs to be upgraded to include service building PS (35-40 per building)
    - One proto type to be tested in run 2021
- we are preparing a tech note to summarize our experience
  - We shall be able to conclude if we are ready for sPHENIX after checking the available data