

RHIC Tune/Coupling Measurement and Feedback

APEX Meeting, December 5, 2008
M. Minty

RECENT HISTORY

**ISSUES, STUDIES,
and IMPROVEMENTS**

RECENT HISTORY (2005-2008, BBQ = 3D + AFE):

PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS 9, 122801 (2006)

Simultaneous tune and coupling feedback in the Relativistic Heavy Ion Collider, and possible implications for the Large Hadron Collider commissioning

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(Received 9 October 2006; published 14 December 2006)

EXCITATION DETECTORS

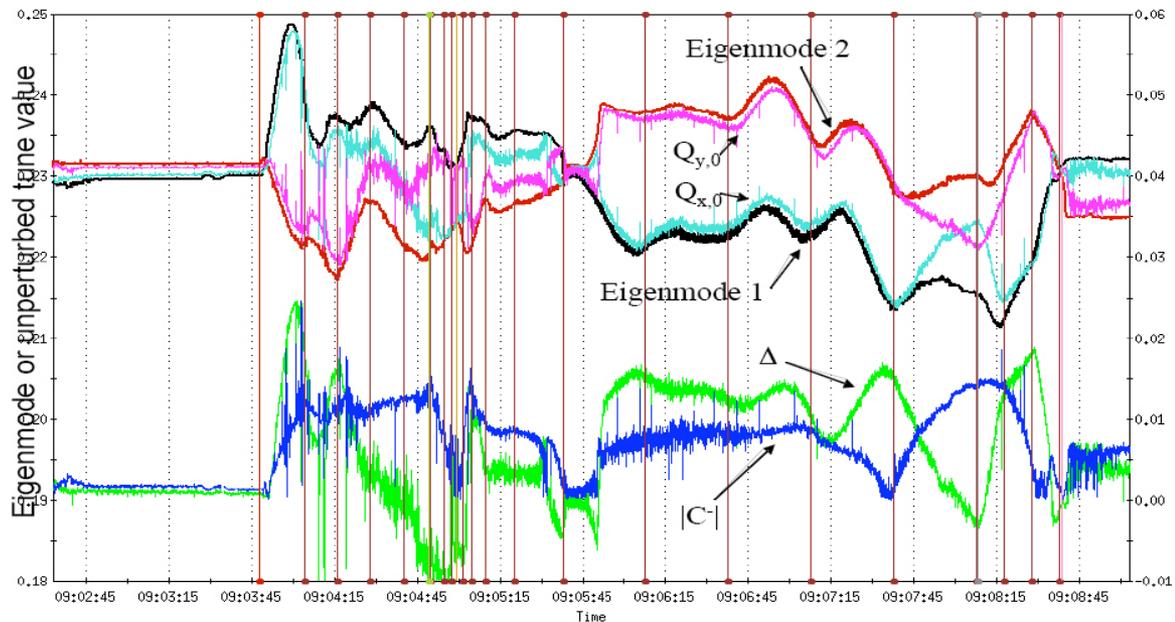
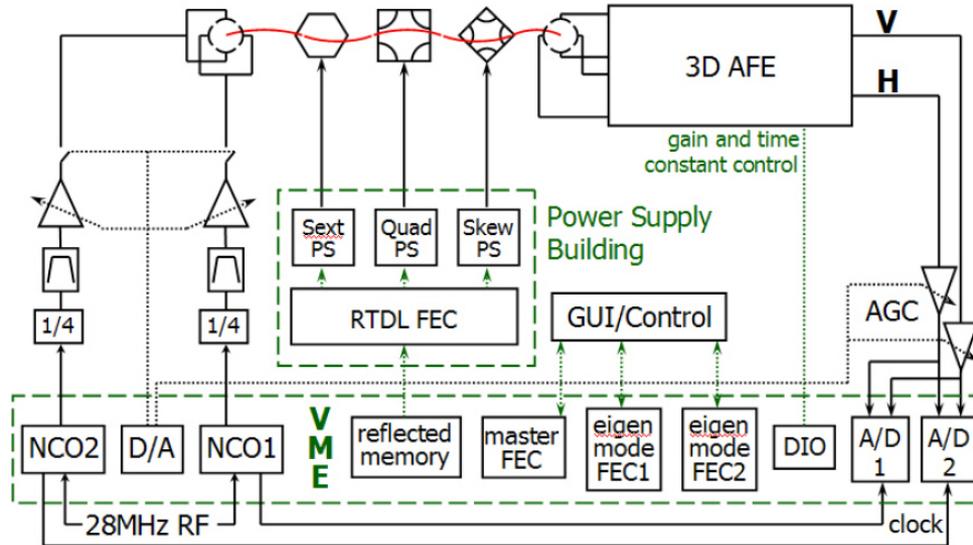
applied to 1 m stripline kicker
1 m stripline BPM

SIGNAL PROCESSING

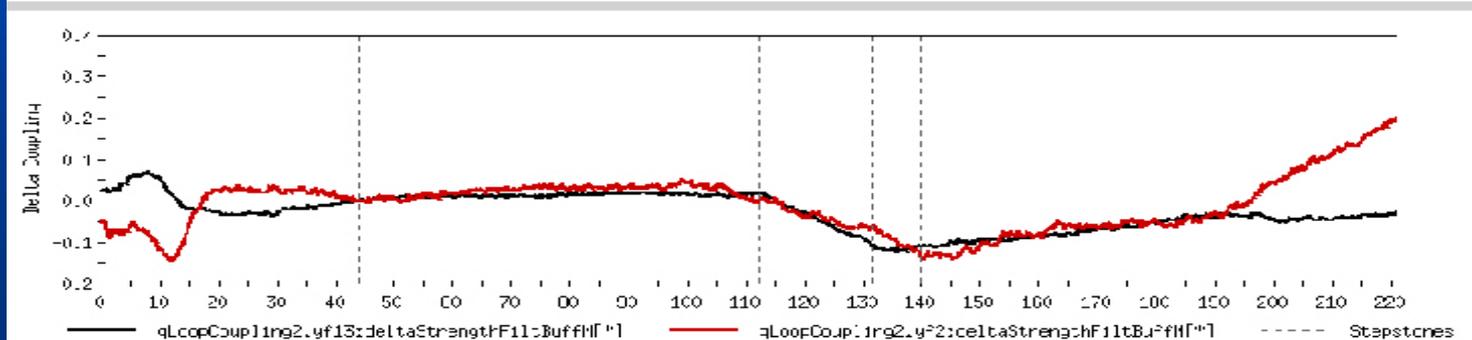
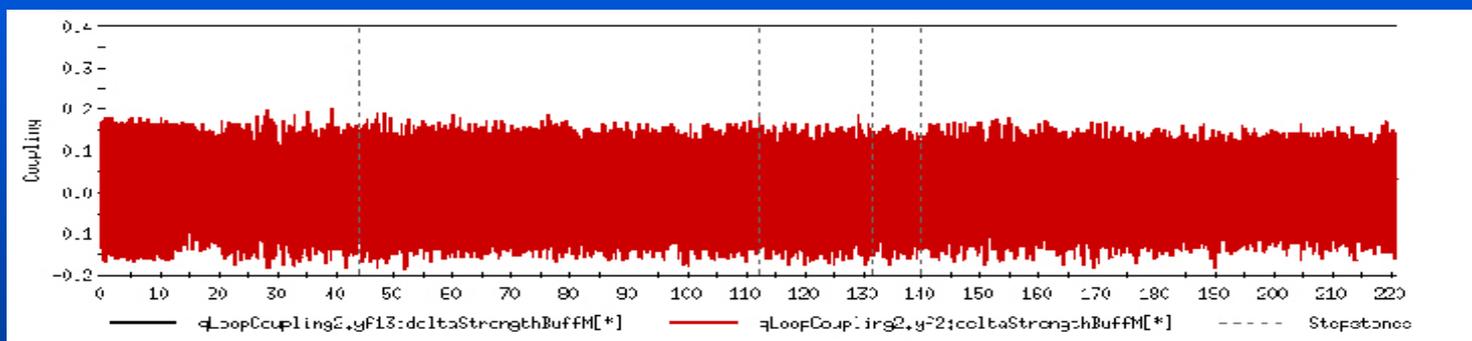
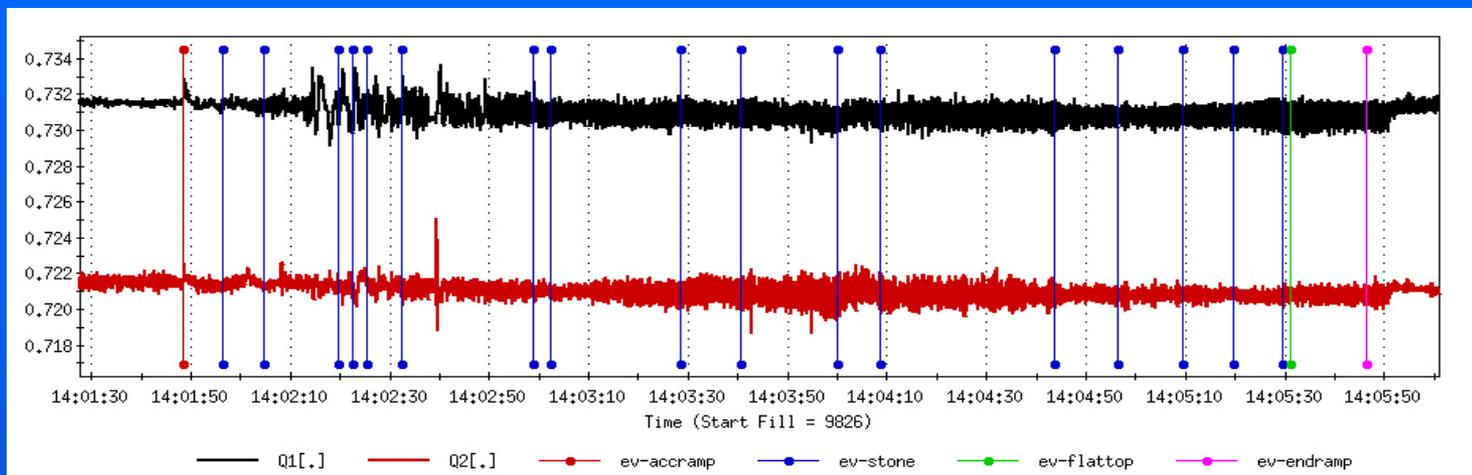
3D AFE + VME
I/Q demodulation with PLL
 $\rightarrow Q_{x,y}(t), Q_{1,2}(t), \Delta, \kappa$

ADVANTAGES

significantly increased sensitivity
large dynamic range (suppression of hf_{rev})
coupling measured and corrected



TUNE+COUPLING FEEDBACK: Yellow Ring, ramp 9826 (Feb 8, 2008)



ISSUES, STUDIES, IMPROVEMENTS

1) change of sign for coupling correction

- The coupling angles (in rad) in the past runs:

Run	Blue.F2	Blue.F1F3	Yellow.F2	Yellow.F1F3
pp06	3.57	2.00	1.69	6.5
Au07	5.34	0.53	0.93	-0.64
ibs07	2.27	3.94	4.64	3.04
D-Au08	5.3	0.56	4.64	3.04
pp08	0.42	5.14	4.67	6.24

from Y. Luo, RHIC weekly meeting (Nov 10, 2008)

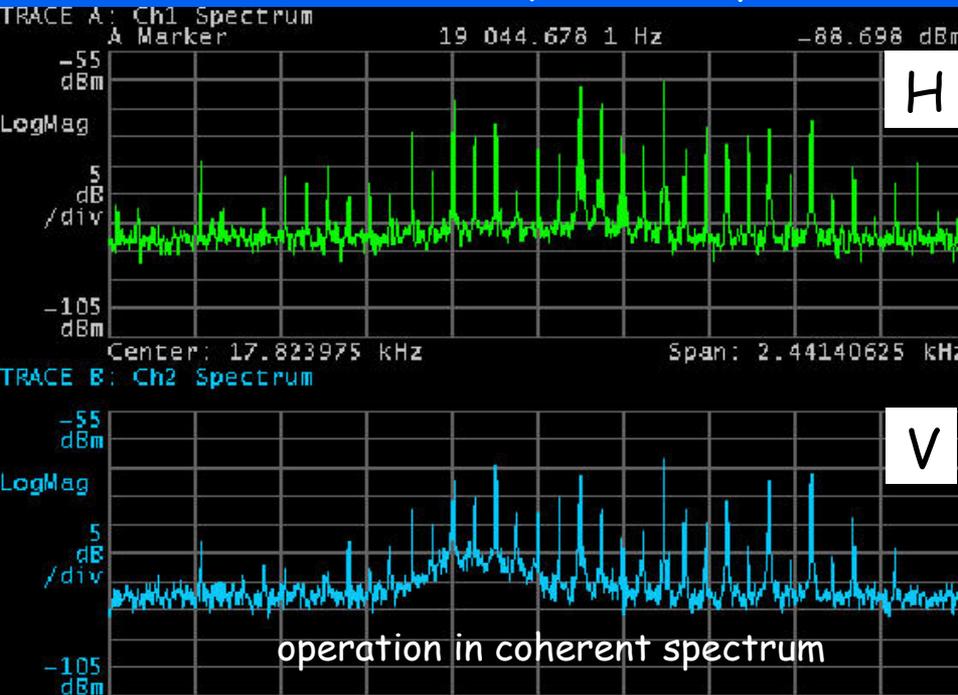
compare sign of coupling angles modulo π (in degrees):

pp06 vs pp08	0.5	0.1	9.3	14.9
Au07 vs dAu08	2.3	1.7	32.6	13.7
	<hr/>		<hr/>	
	Blue Ring		Yellow Ring	

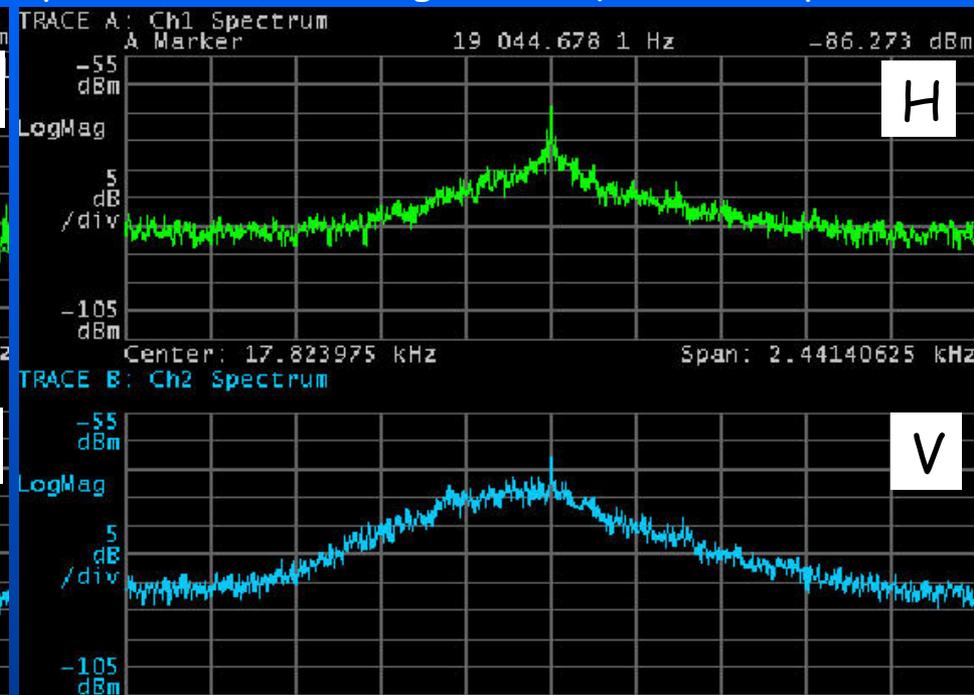
ISSUES, STUDIES, IMPROVEMENTS

2) 60/360 Hz interferences

BBQ (detect at low frequencies) spectrum



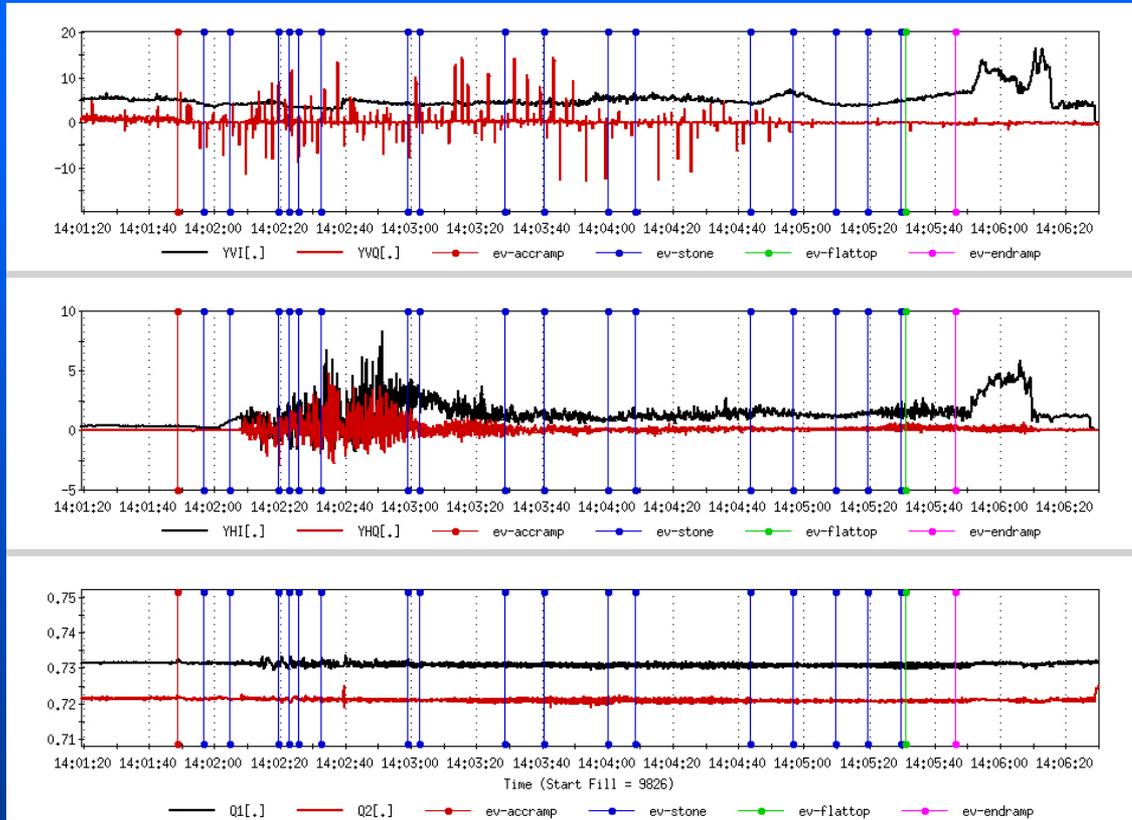
hybrid (detect at higher frequencies) spectrum



ACTIONS: review, repeat, and extend past studies of 60 Hz interferences
pursue hybrid tracker scheme (LF Schottky + 3D + AFE)

ISSUES, STUDIES, IMPROVEMENTS

3) signal-to-noise in measurements

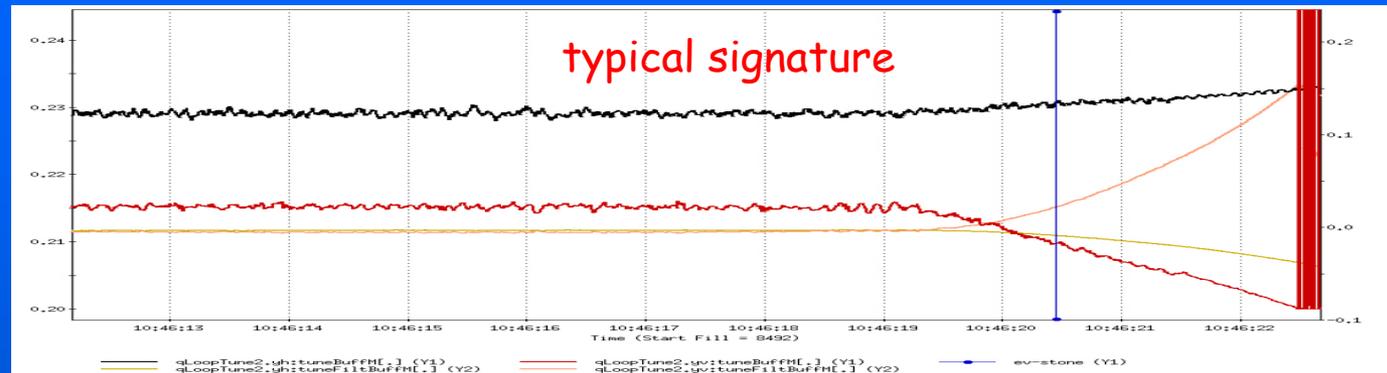


TUNE+COUPLING FEEDBACK:
Yellow Ring , ramp 9826
(Feb 8, 2008)

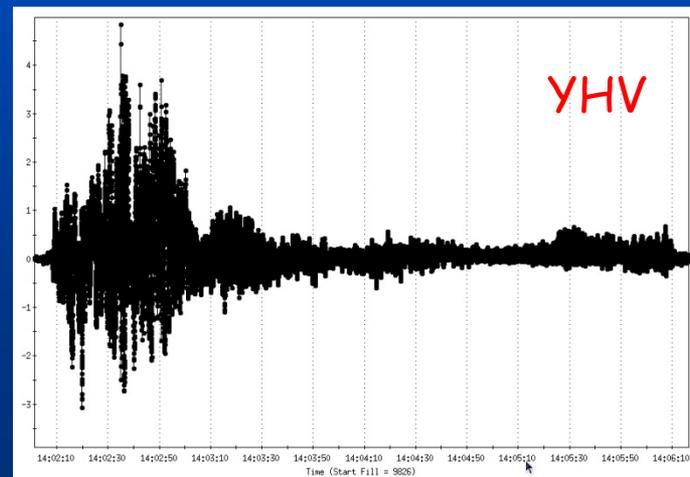
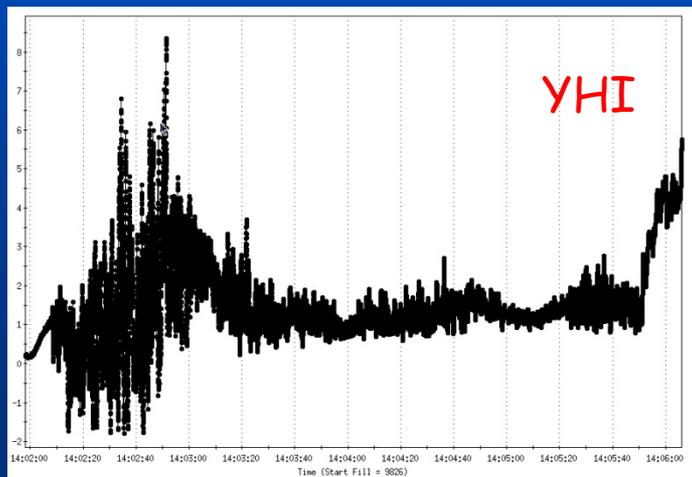
ACTIONS: review improvements suggested by P. Cameron (including AGC)
investigations with electrostatic shield on rectifier transformer (C. Schultheiss)
test new feedback on ring ground (C. Schultheiss)
need for phase compensation?
review PLL algorithm

ISSUES, STUDIES, IMPROVEMENTS

4) Loss of PLL lock



- ACTIONS:**
- review PLL algorithm
 - improve S/N
 - implement better tuning tools (spectrum analyzers)
 - improve diagnostics for "failed ramps" (correlation plots)
 - add bandpass filter before I/Q demodulation (C. Schultheiss)

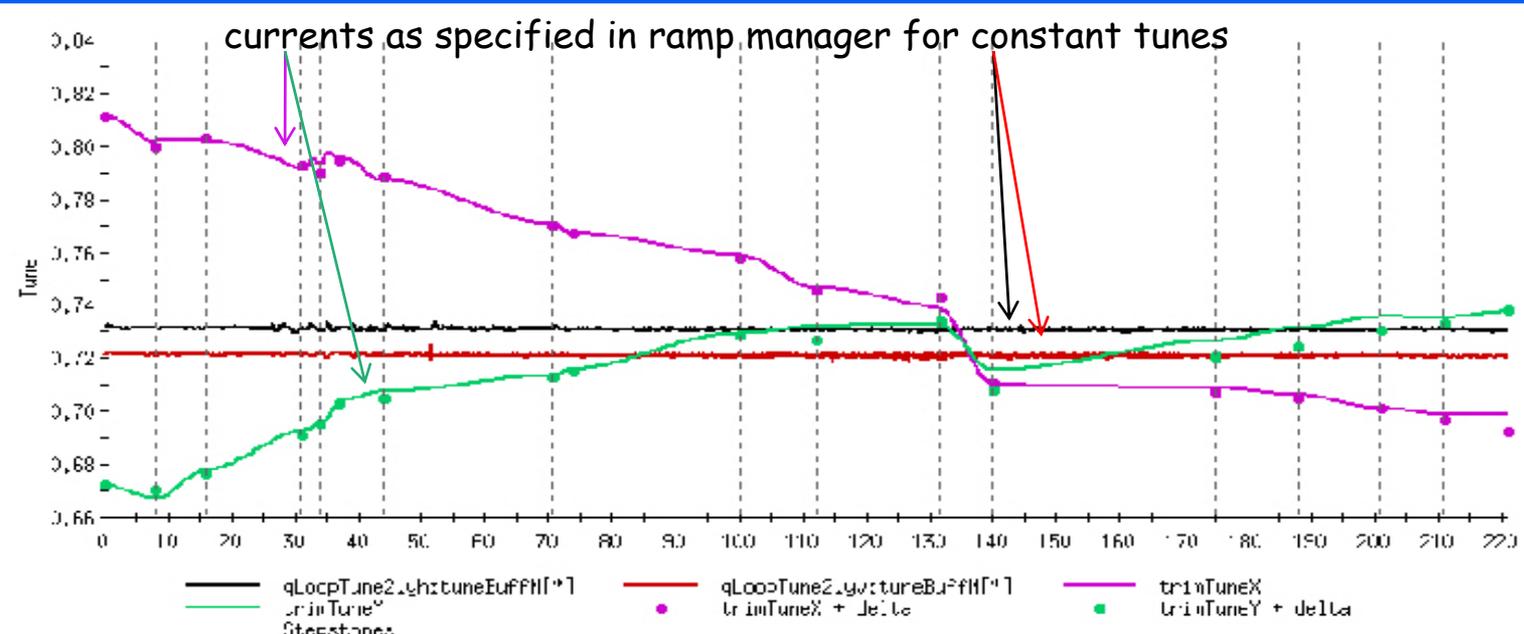


TUNE+COUPLING
FEEDBACK:
Yellow Ring ,
ramp 9826
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ISSUES, STUDIES, IMPROVEMENTS

5) Model inputs

TUNE+COUPLING FEEDBACK: Yellow Ring , ramp 9826 (Feb 8, 2008)



$dQ_x \sim 0.10$

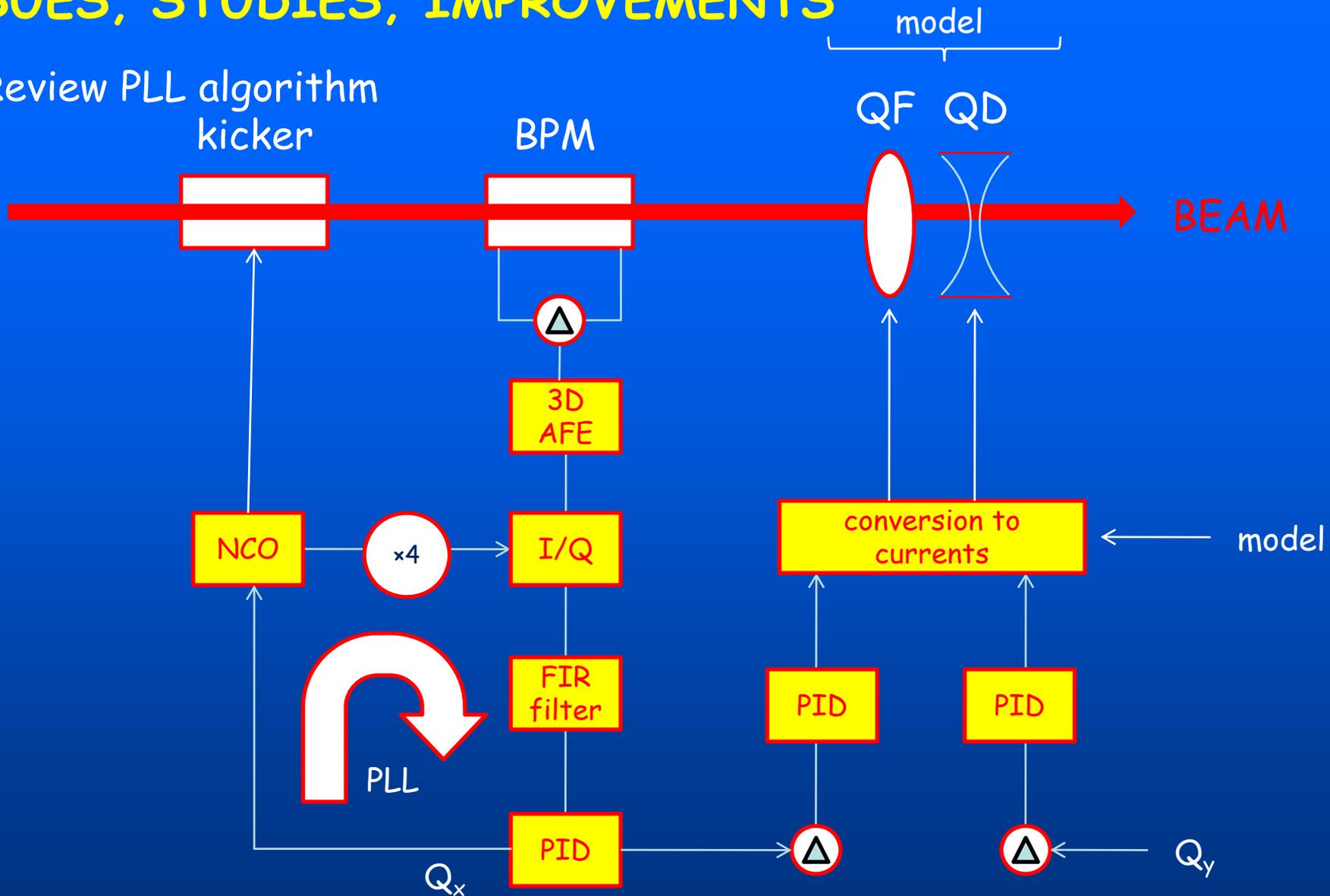
$dQ_y \sim 0.07$

also: programmed tune variation for \sim constant $f_{x,y}$ (in tune feedback)
tune variation not passed to PI-controller of PLL

remark: particularly an issue if beam optics change significantly
(i.e. change to $\beta^* = 7.5$ m at all IRs in 2009)

ISSUES, STUDIES, IMPROVEMENTS

6) Review PLL algorithm

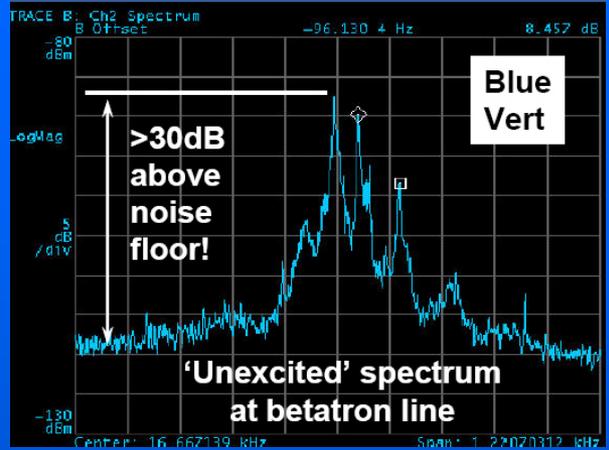


- ACTIONS:**
- develop algorithm for tuning PID parameters
 - standardize PID loop
 - possibly replace PID with adaptive filter (C. Schultheiss)
 - continue efforts towards chromaticity measurement and feedback

Backup slide: ISSUES, STUDIES, IMPROVEMENTS (for IONS)

BEAM-RELATED:

- 1) "anomalous BTF" with ions at injection (defer for now)
- 2) transition crossing (dynamic range) with ions (defer for now)
- 3) tune "scalloping" with ions (defer for now)



attributed to large kicker excitations
 high loop gain
 small chromaticity ("micro-instabilities")

