

RHIC IMPEDANCE MEASUREMENTS

RAMA CALAGA (PRESENTED BY S. WHITE)

APEX WORKSHOP, OCT 2010

Three Experiments injection energy:

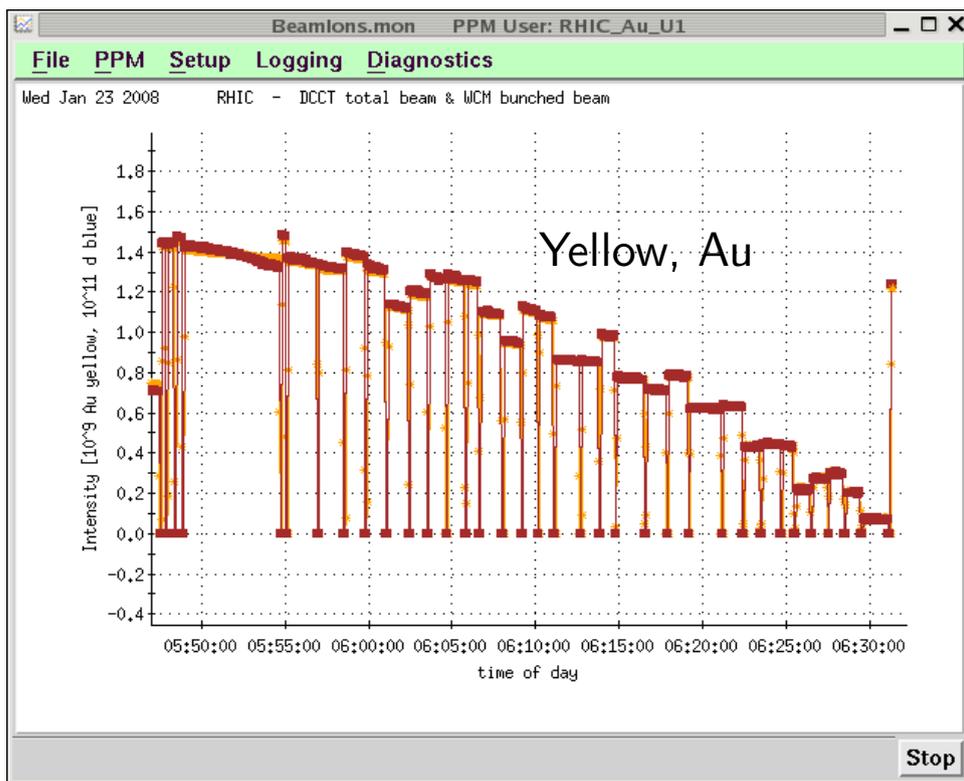
2008, Yellow: 1 Gold bunch ($1 \times 10^8 - 1.5 \times 10^9$ ions/bunch)

2008, Blue: 1 Proton bunch ($0.5 \times 10^{11} - 1.6 \times 10^{11}$ p/bunch)

2009, Yellow: 6 Proton bunch ($0.4 \times 10^{11} - 2.0 \times 10^{11}$ p/bunch)

~1-2 hrs each: Kick for each intensity, measure BPM data & emittance

THREE EXPERIMENTS

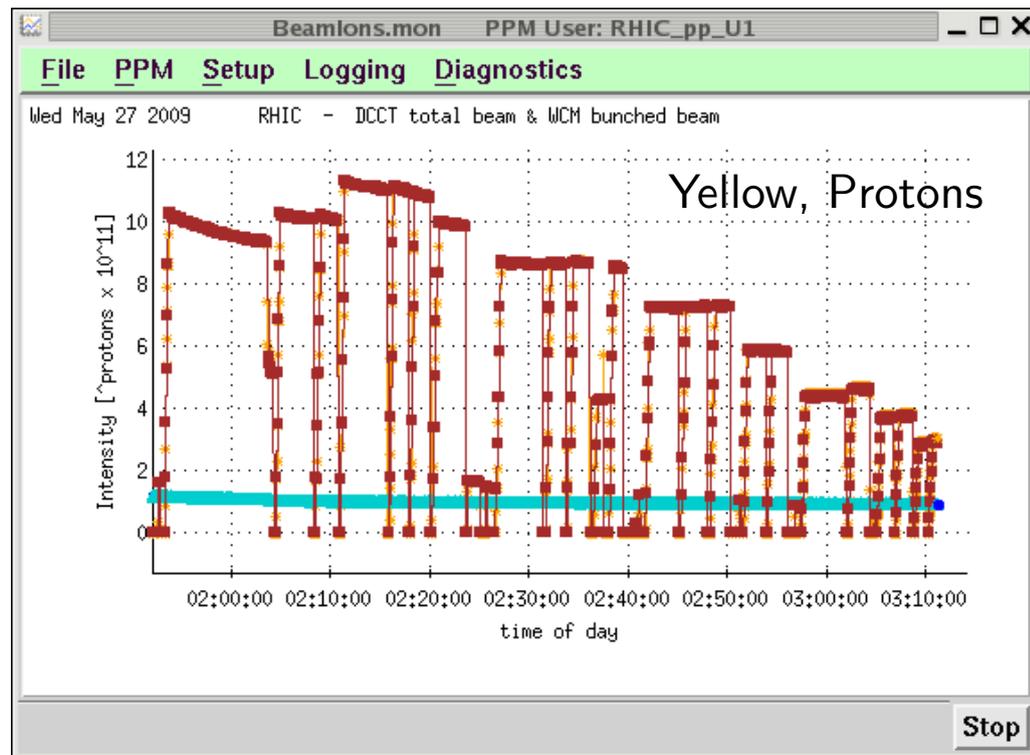


Approx 1 order of magnitude intensity scan

← Jan 2008, Au

& Mar 08, Blue Protons, Not Shown
(data acquired by: Bai, Satogata, OP)

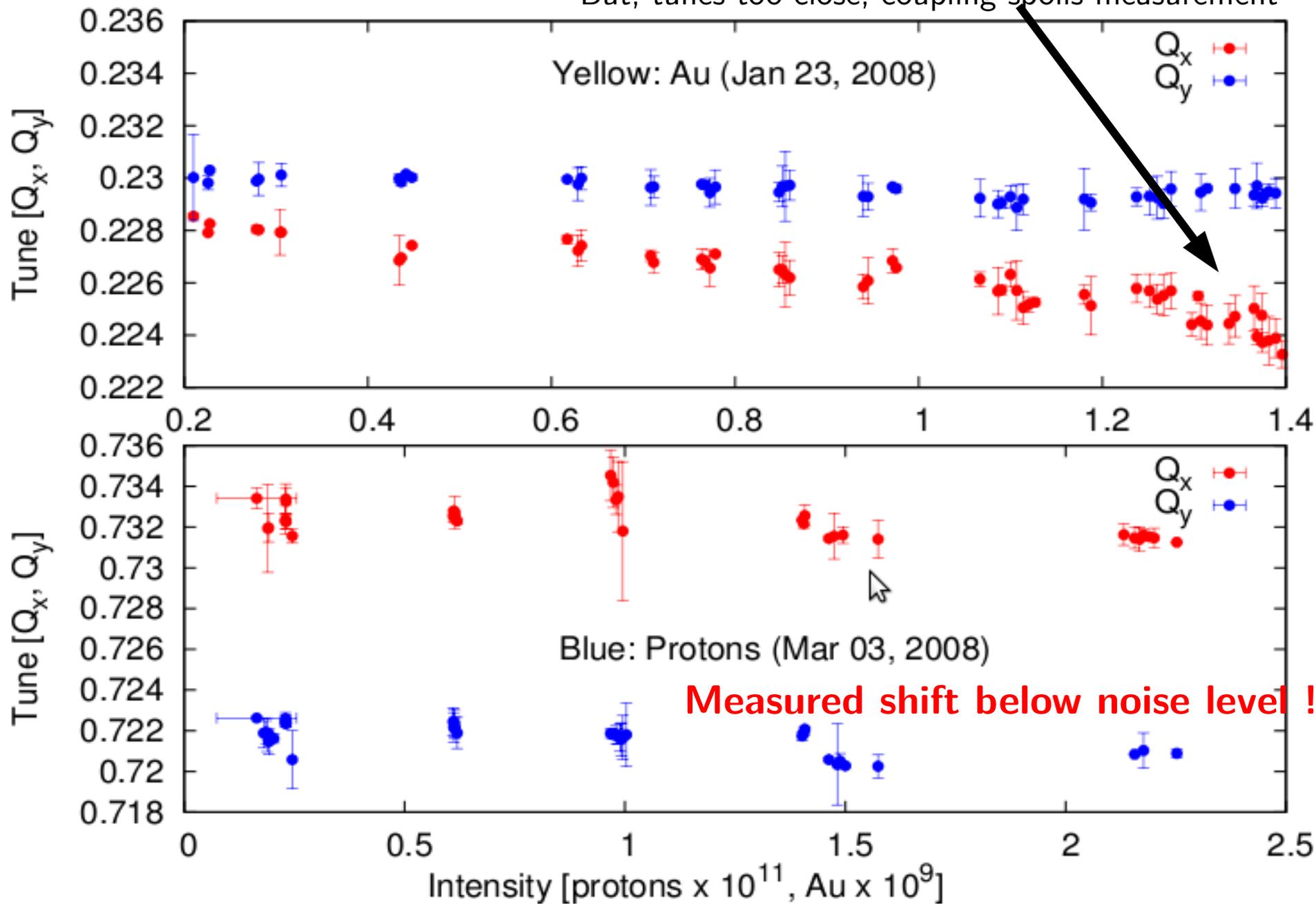
May 2009, Protons →



EXPS, 2008

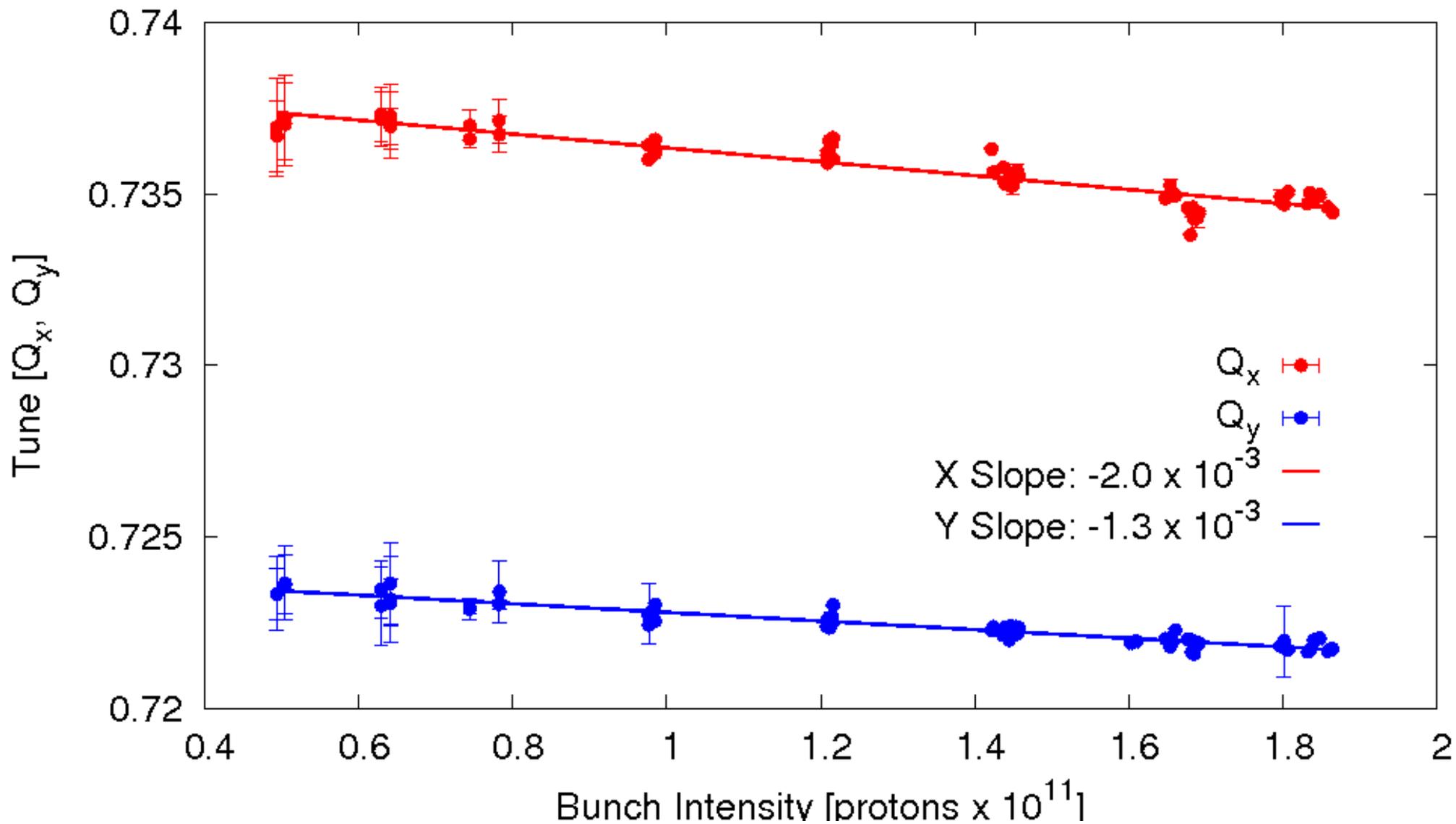
Some tune shift visible

But, tunes too close, coupling spoils measurement



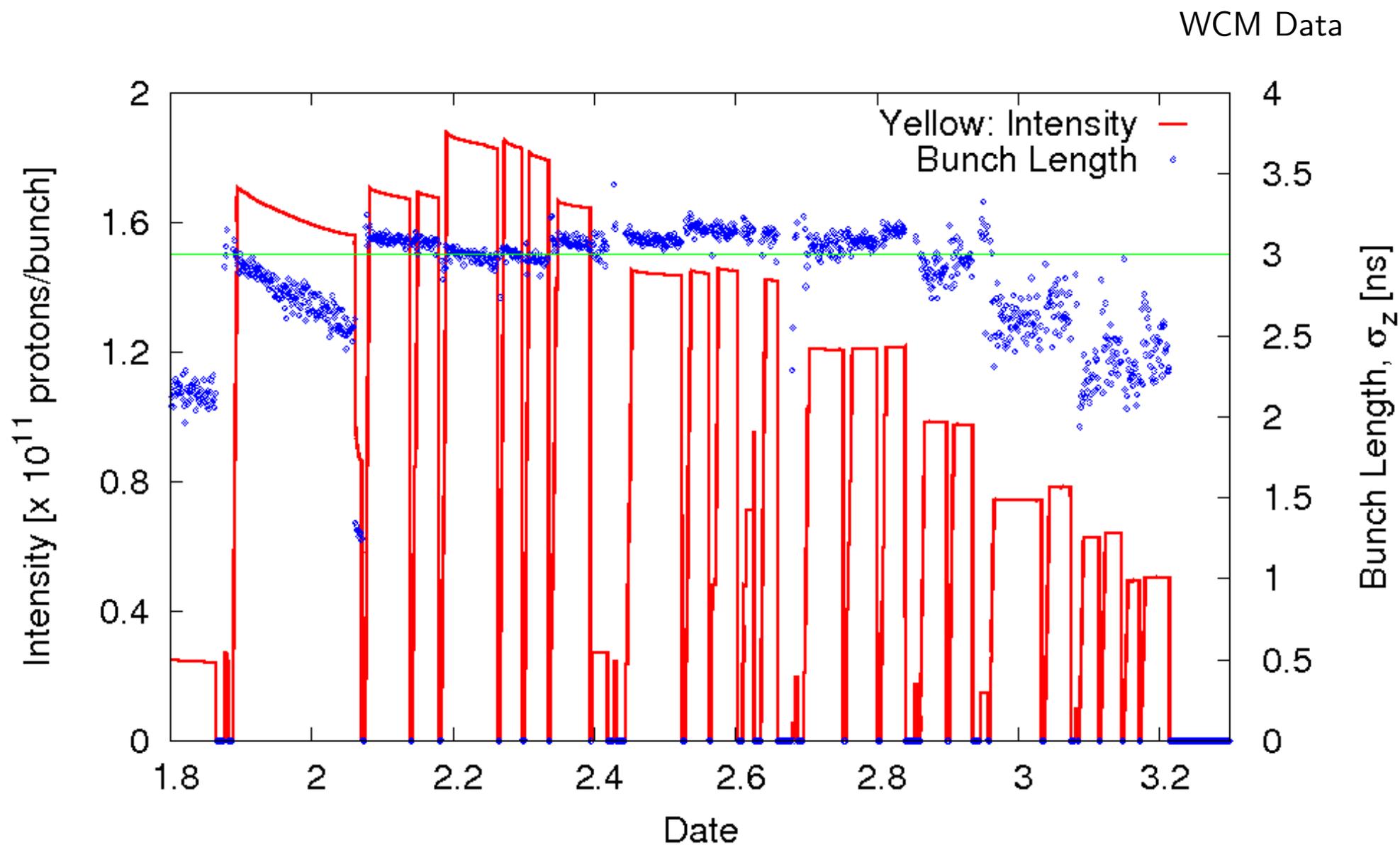
EXP, 2009

Tune shift is close to the limit of the measurement, but clearly visible



Some increase in transverse emittance observed

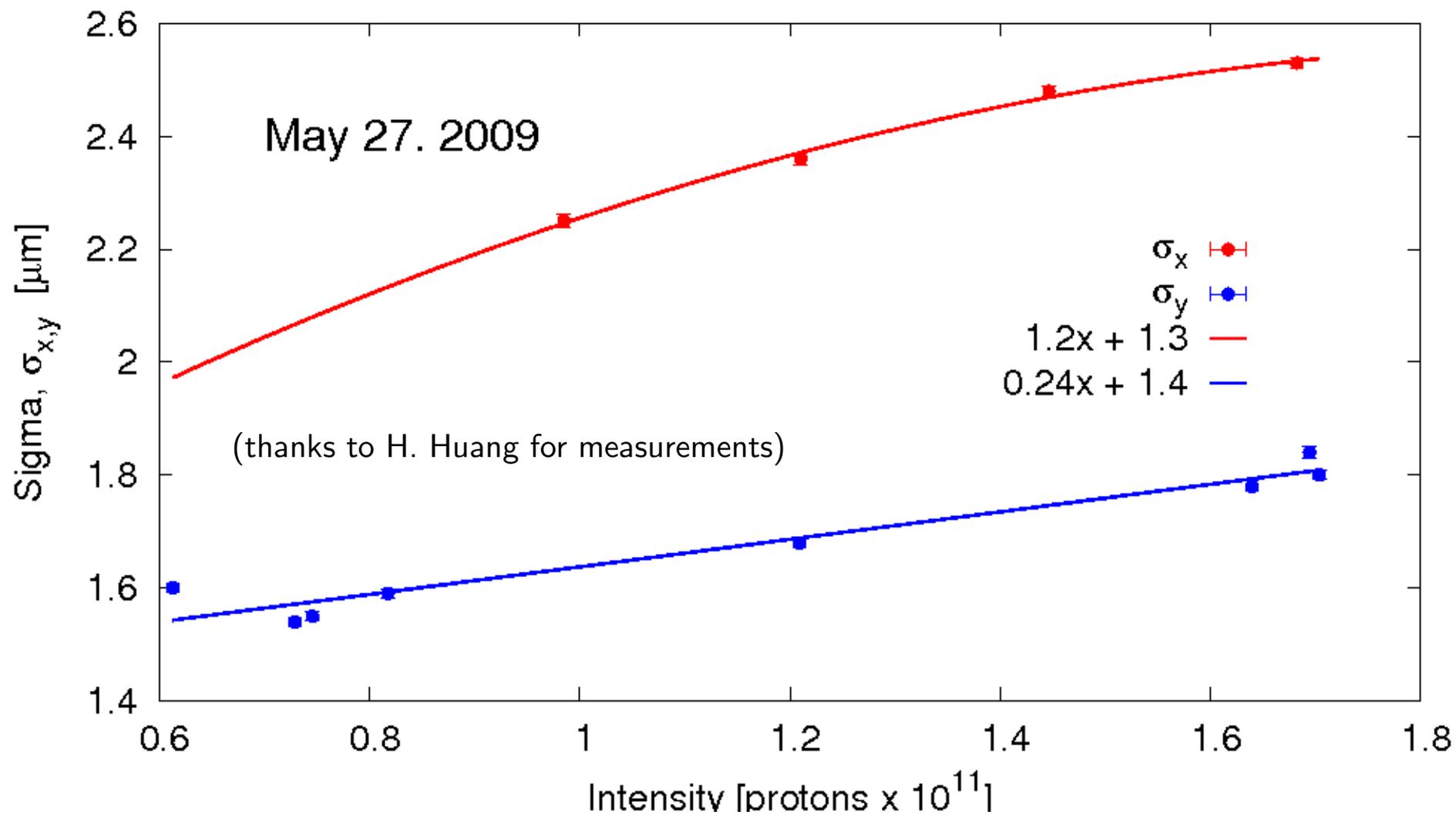
BUNCH LENGTHS



For comparison: SPS bunch length at injection ~ 0.6 ns (@26 GeV, 3MV)

EMITTANCE EVOLUTION

5-10% increase in transverse emittance



COMMENTS

Complex tune shift due to transverse impedance
(convoluted to bunch spectrum)

$$\Delta \omega_{\beta} = \frac{N e c}{f \sqrt{\pi} \omega_{\beta} (E/e) f_r \sigma_t} i (Z_T)_{eff}$$

To 1st order, tune shift approximated from a defocusing quad:

$$\Delta Q = \frac{1}{4\pi} \beta_k \Delta K$$

	Units	RHIC		SPS
		Gold	Protons	
Energy	GeV	10	28	26
$4\sigma_z$	[ns]	-	10-12	2.2
$\Delta Q_{x,y}$		-	2×10^{-3}	2×10^{-2}
Est. Imp	MΩ/m	-	20-23 !!	20

My estimate seems a bit high either due wrong bunch length assumptions (or tune shifts)

†Note: For SPS the tune shift is large in vertical plane (flat chamber)

COMMENTS

Three experiments (2 with protons, 1 with Gold)

- Measured tune shift in RHIC is small (at measurement limit), maybe BBQ can help
- Horizontal tune shift is higher by 35%

Last measurement yields $\sim 20 \text{ M}\Omega/\text{m}$, seems rather large (but not impossible)

Should re-measure in blue (and yellow) to reproduce (FY11 beam experiments ?)

Increase in transverse emittance, but no contribution to impedance related tune shift

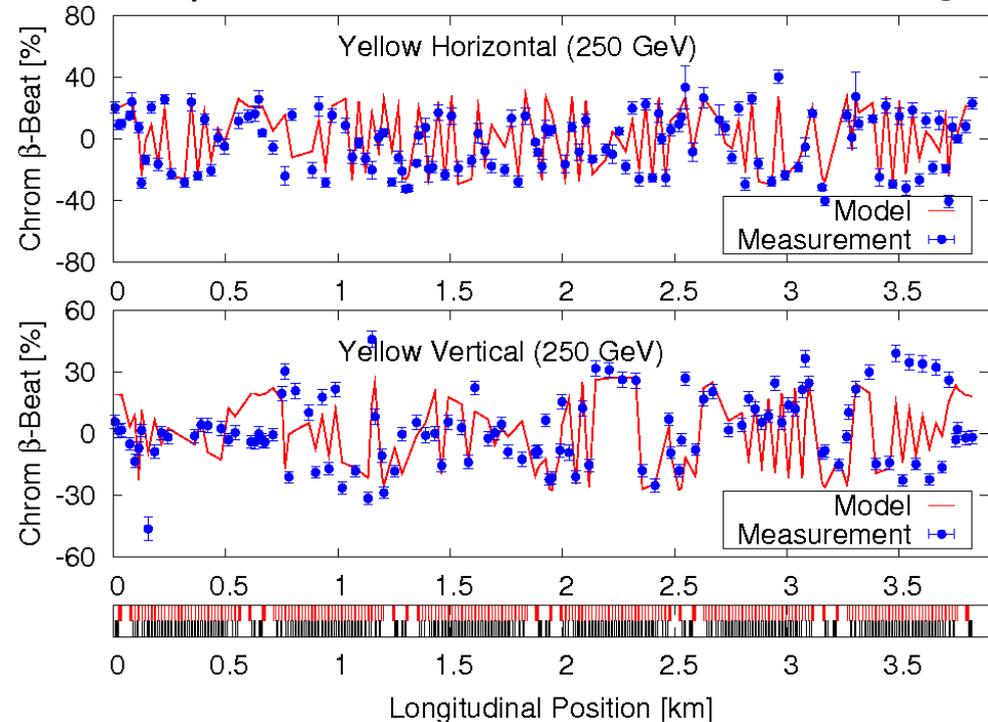
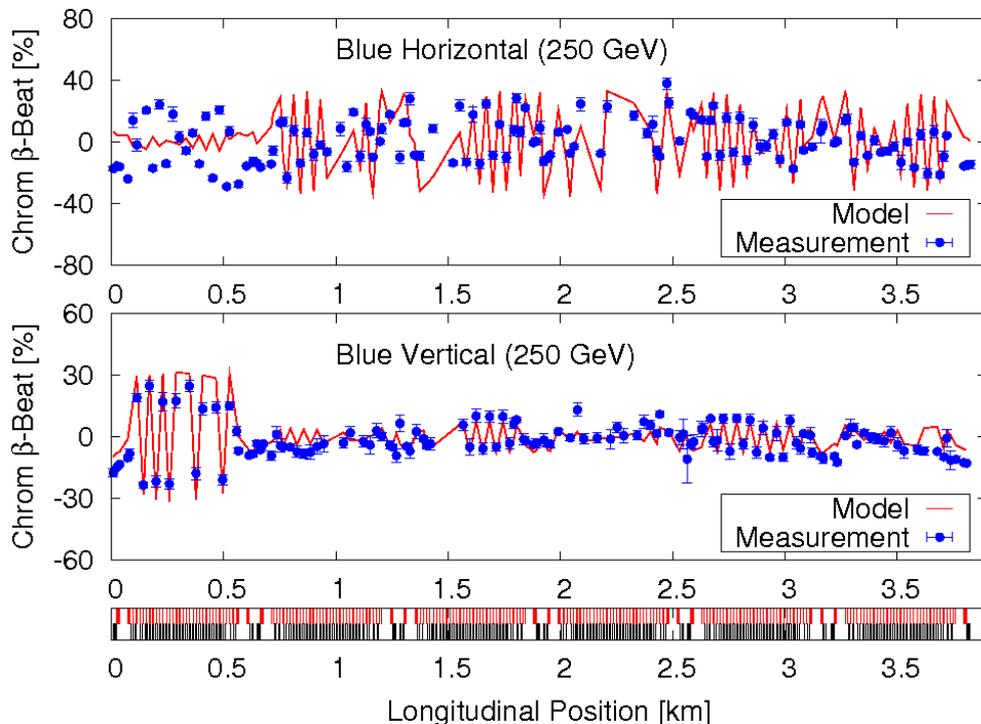
- Amplitude detuning, small contribution but could play a role

Possible **improvements** in localize impedance sources (Ph. Adv Vs. Intensity)

- Shorten the bunch length for enhanced tune shift (voltage ?)
- Measure impedance during lower energy run (lifetime, IBS etc..)
- Inject electrons into RHIC (Zimmermann) ?

FY11 PROPOSAL (CHROMATIC β -BEAT)

RHIC chromatic β -beat @250 GeV, IPAC10 Proceedings



Observation: Large chromatic β -beat for 0.7m optics (2009 measurements).

FY11 Proposal: For reduced β^* try phase advance scans between the two IPs to reduce the chromatic beta-beating in model and measure the chromatic β -beat (w/o deteriorating DA). Also, measure single beam lifetime and momentum aperture is compared to the nominal optics.