

A detailed technical diagram of the Relativistic Heavy Ion Collider (RHIC) beam ring. The diagram shows two concentric arcs: an 'Outer Arc' and an 'Inner Arc'. A vertical dashed line represents the 'Crossing Point'. Other labels include 'Centerline of U235', 'Centerline of O10', and 'INJECTION PT.' at the bottom. The diagram is overlaid with a grid of numbers and lines, representing the complex structure of the particle accelerator.

Results of the Beam-Beam Long Range Experiment

# Effects of a DC wire on the RHIC Au beams

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# Outline

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LR interactions with proton beams (2006);

Experimental Setup;

Beam Parameters;

Experiment Results:

- Particle loss vs position and current (scans overview);

- Orbit and tune results;

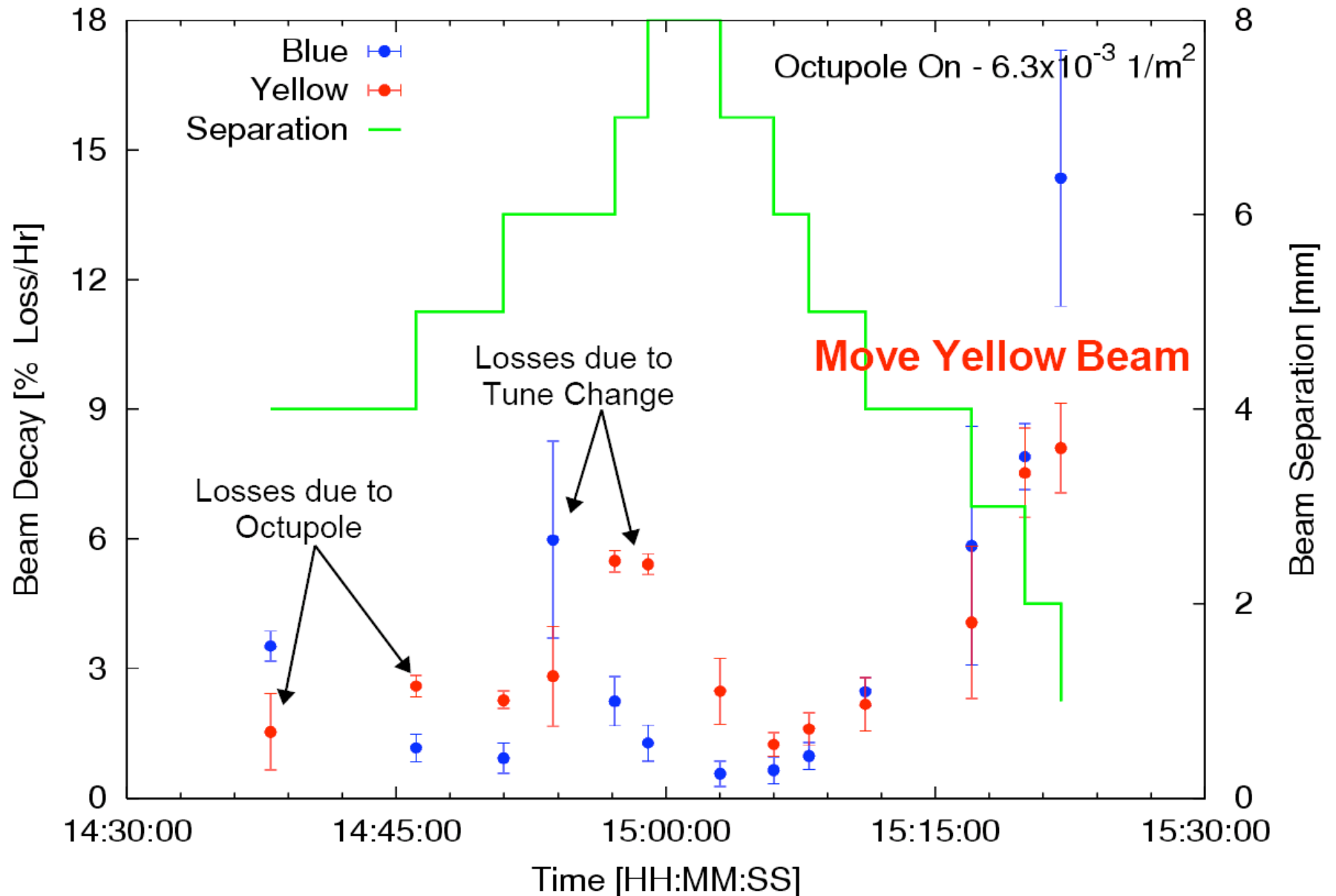
- Loss rate patterns and

- Chromaticity and current scans.

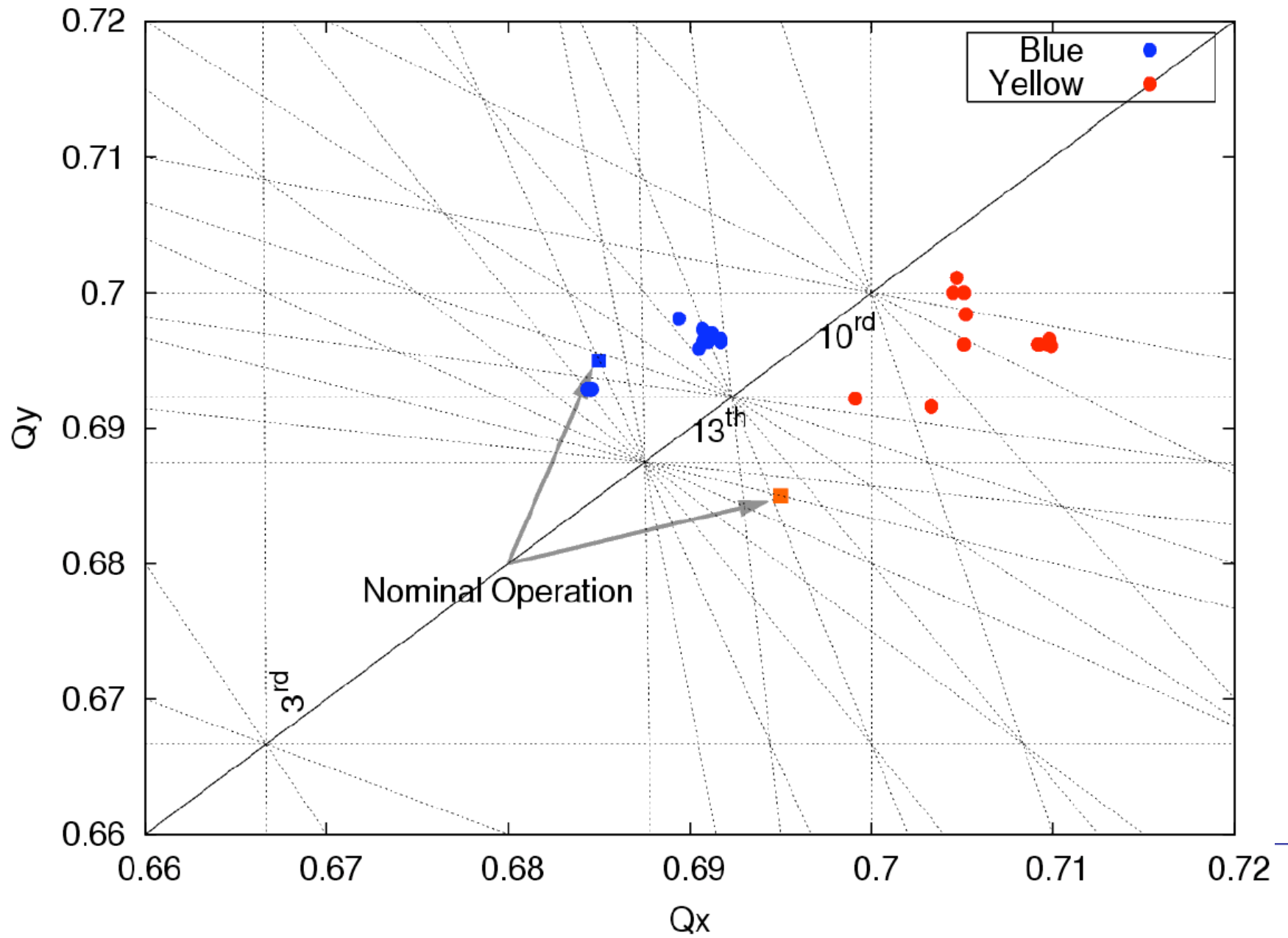
Summary

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# Long range with proton beam (2006)



# Tunes during scan

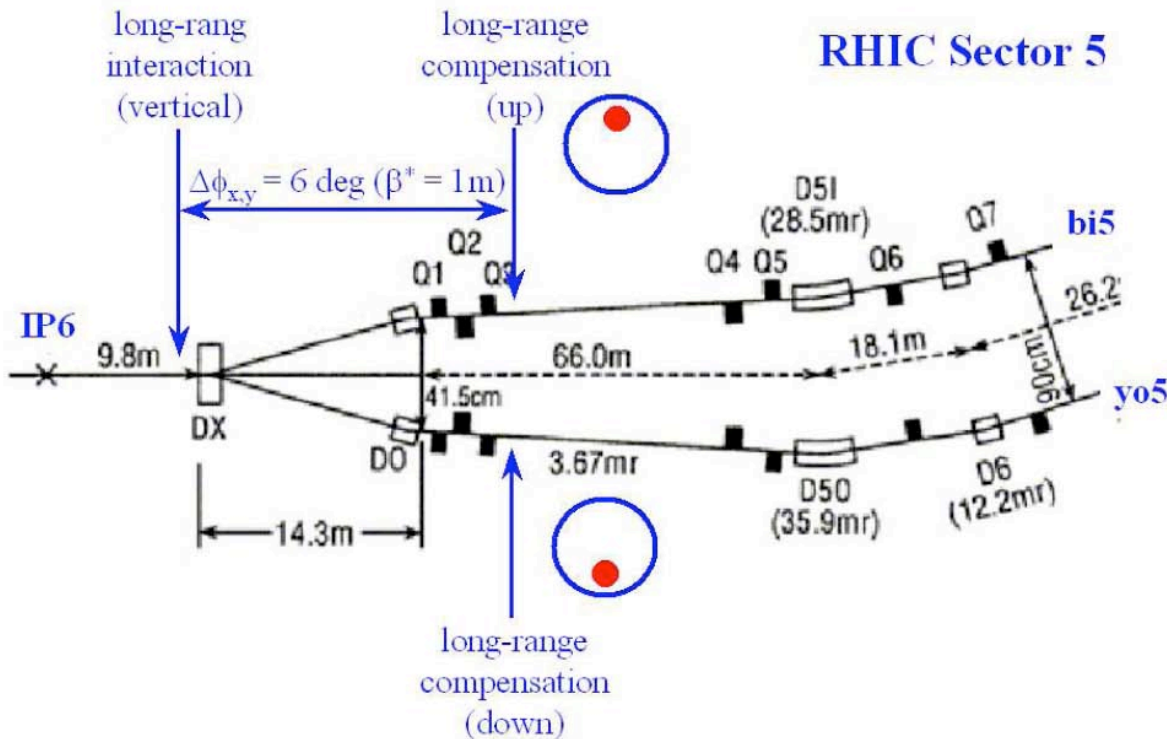
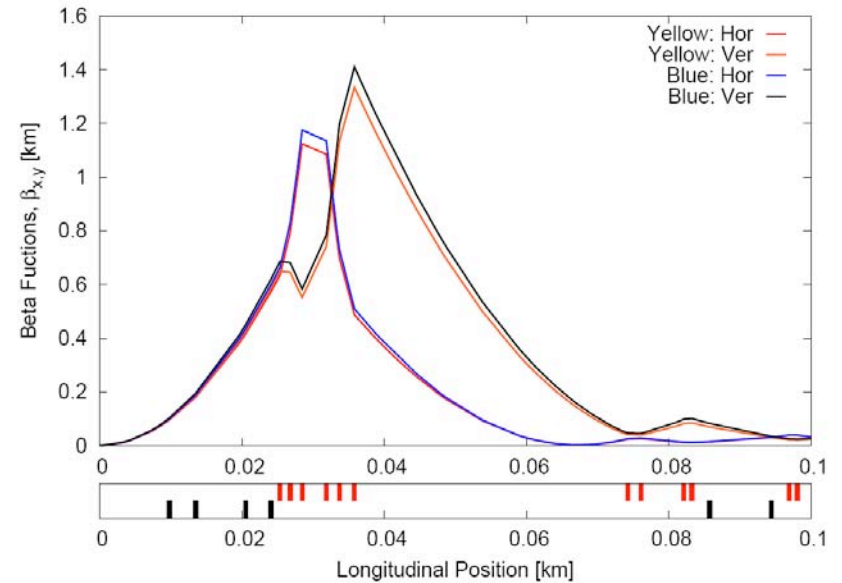


# Experimental Setup

We used  $\beta^* = 0.9 \pm 0.1$  m at the IPs and the initial beam sizes were measured with the ionization profile monitor (IPM):

$$\epsilon_{\text{blue}} = 20 \pm 2 \text{ mm mrad} \quad \text{and}$$

$$\epsilon_{\text{yellow}} = 30 \pm 3 \text{ mm mrad.}$$



The wires were installed in 2006 and the experiments carried out during the 2007 run.

# Parameters for the experiments

Experiment II: Apr 24, 2007 (2 Hrs)

Blue & Yellow **Nominal Tunes**

Wire Scan with 5 Amps & 50 Amps

Experiment III: May 09, 2007 (2 Hrs)

Blue & Yellow with **Tunes Swapped**

Wire Scan with 5 Amps & 50 Amps & Current Scan

Chromaticity Scan in Yellow

Experiment IV: End of June 20, 2007 (BNL + CERN Folk)

Wire scan with large beam, use end of store

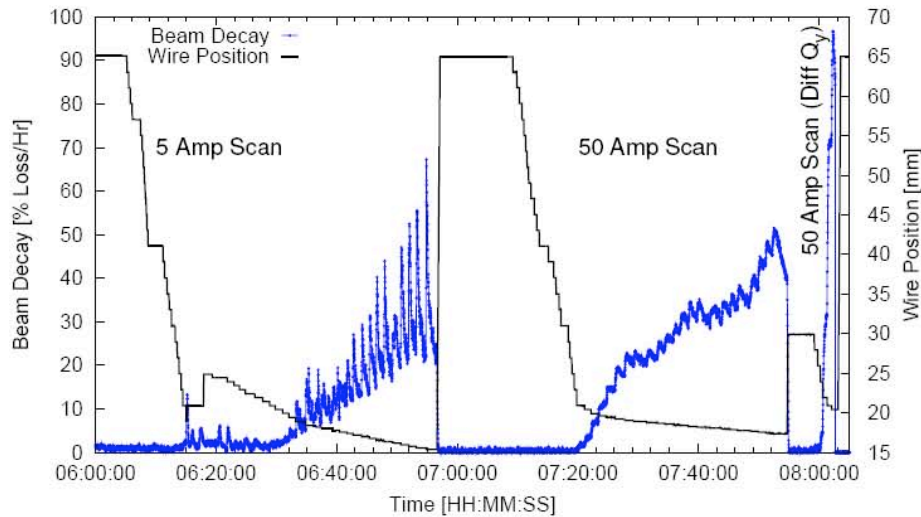
RHIC parameter for experiments with  
Au beam at 100 GeV

quantity	unit	Blue	Yellow
beam energy $E$	GeV/n	100	
rigidity ( $B\rho$ )	Tm	831.8	
number of bunches	...	23	
max. wire current $I_{max}$	A	50	
distance IP6 to wire center	m	40.92	
parameter $K$ (at 50 A)	nm	-30.1	
wire length $L$	m	2.5	
position range $d$	mm	0...65	-65...0
$\beta_x$ at wire location	m	1091	350
$\beta_y$ at wire location	m	378	1067
curr ripple $\Delta I/I$ (at 50 A)	$10^{-4}$	< 1.7	

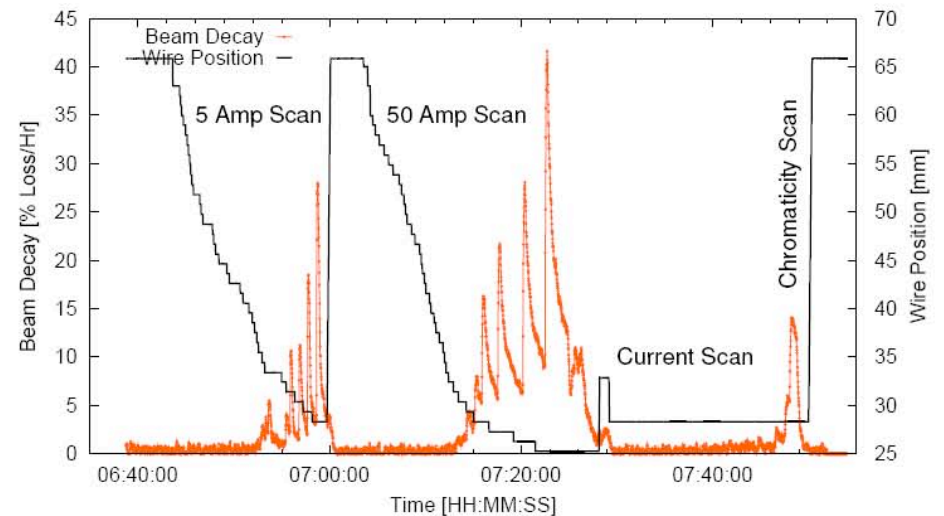
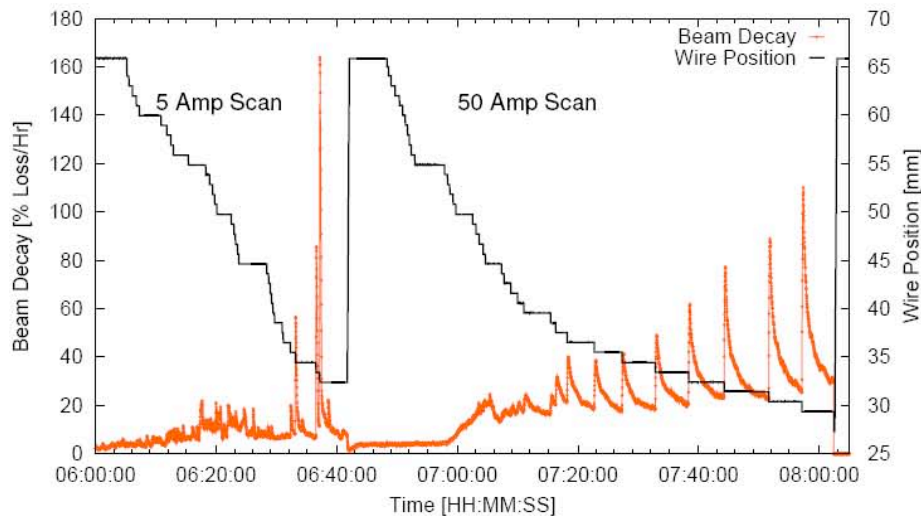
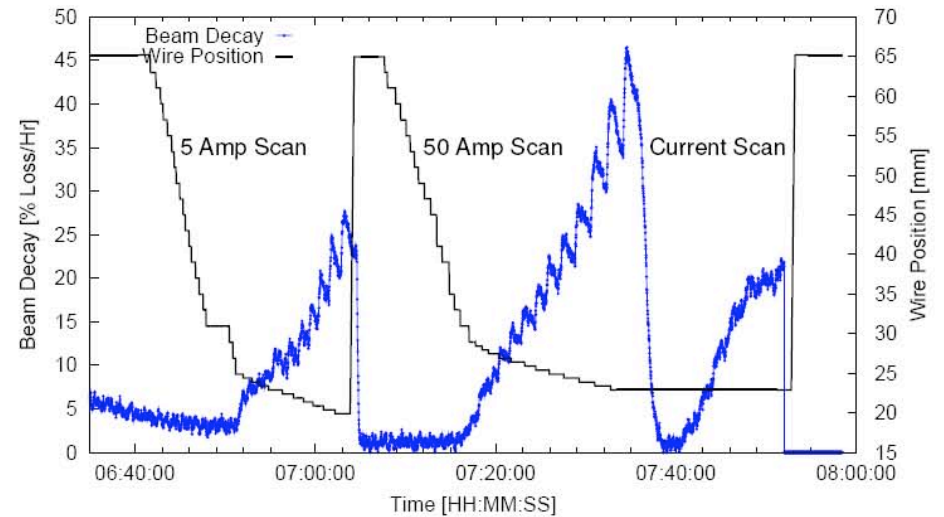


# Overview of the Scans

## Experiment I:

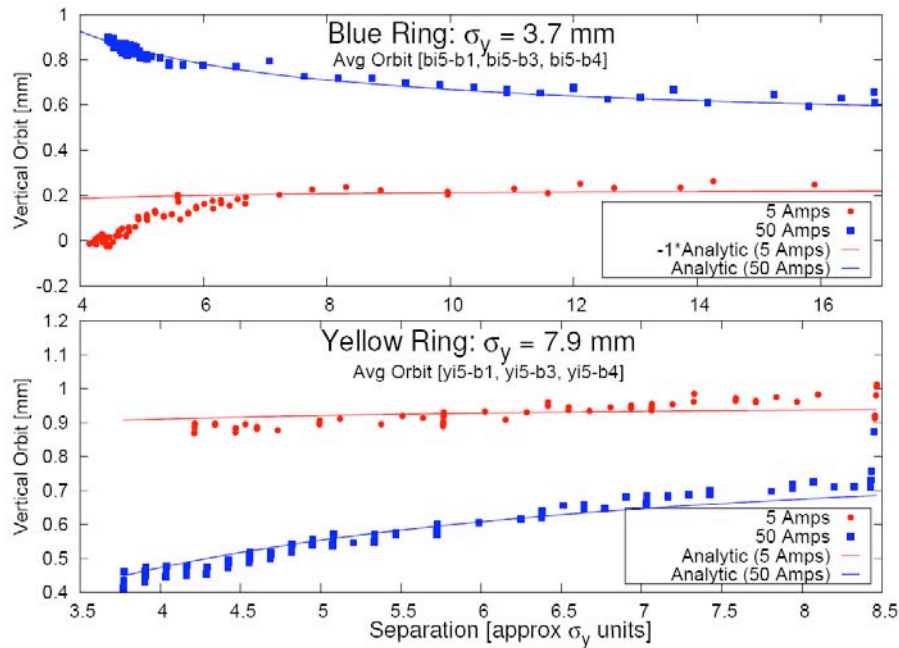


## Experiment II:



# Orbit: position scan

## Experiment I:

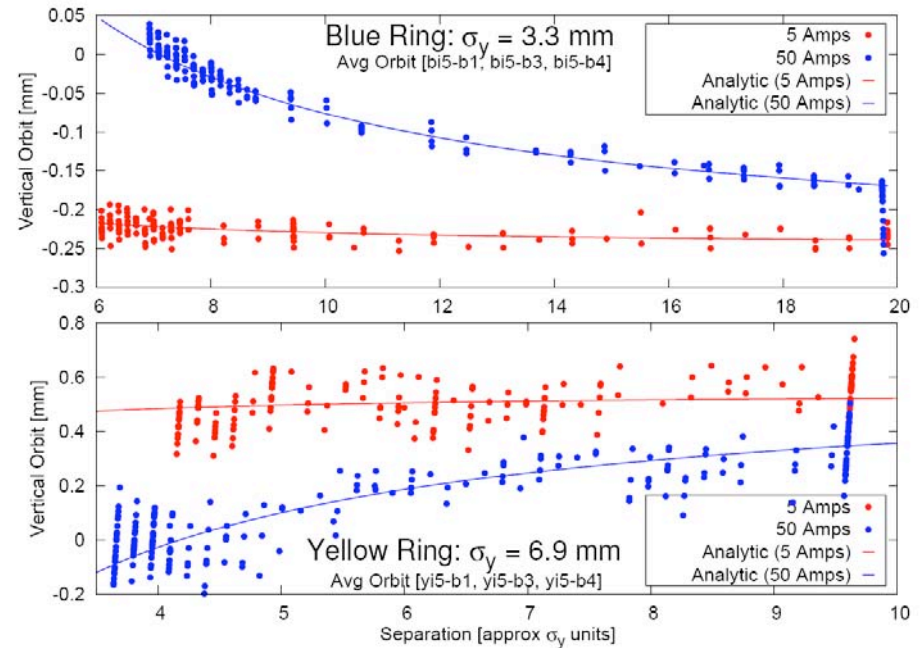


The full lines are the curves calculated using the following expression:

$$\Delta y = \frac{K\beta_y}{2d} \frac{\cos(\pi Q_y)}{|\sin(\pi Q_y)|}$$

The vertical orbit corresponds to the averaged position of three BPMs reading near the wire.

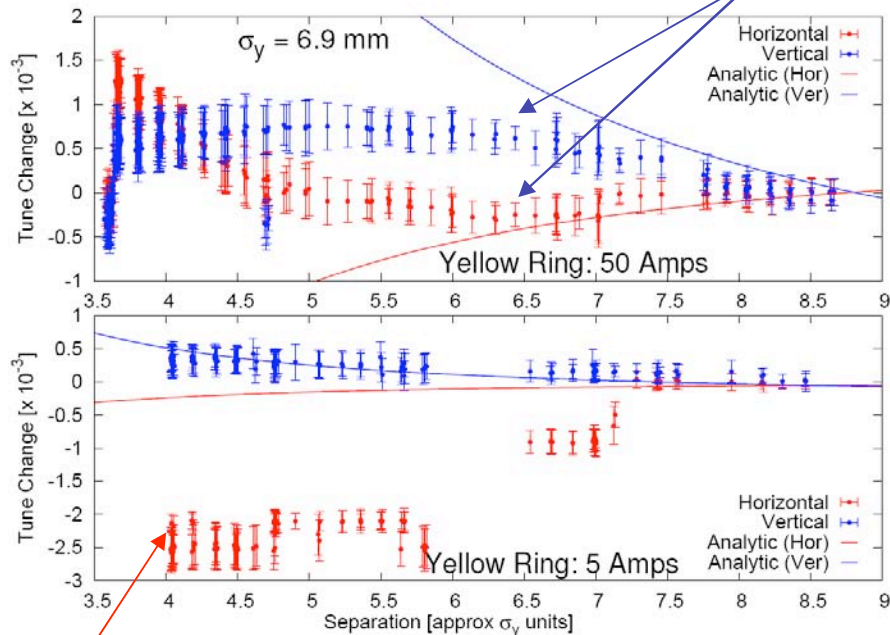
## Experiment II:





# Tune: position scan (Exp. II)

Yellow Beam: coupling

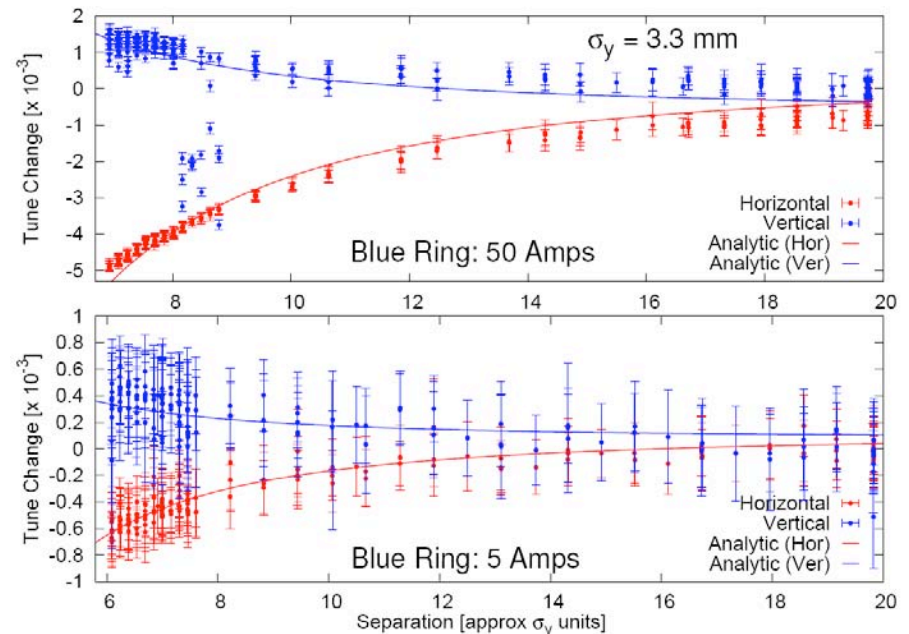


bad tune measurement

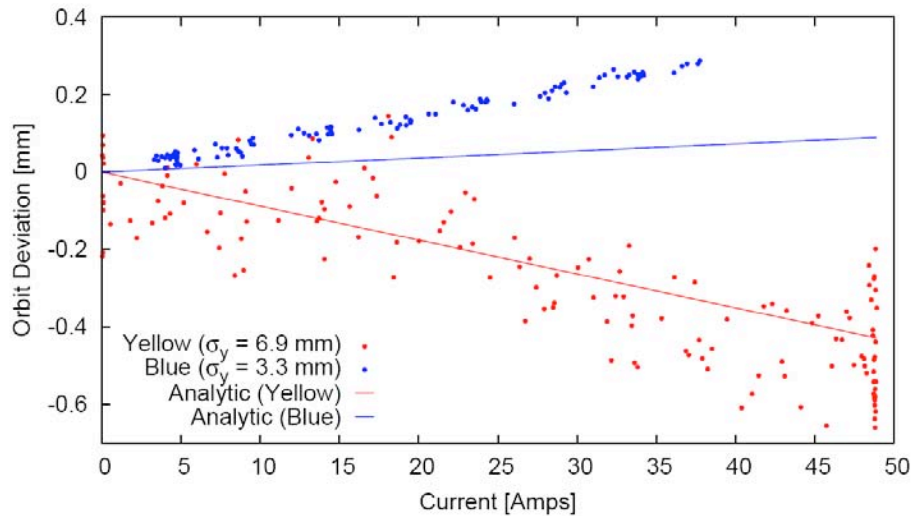
The full lines are the curves calculated using the following expression:

$$\Delta Q_{x,y} = \pm \frac{K \beta_{x,y}}{4\pi} \frac{1}{d_y^2}$$

Blue Beam:

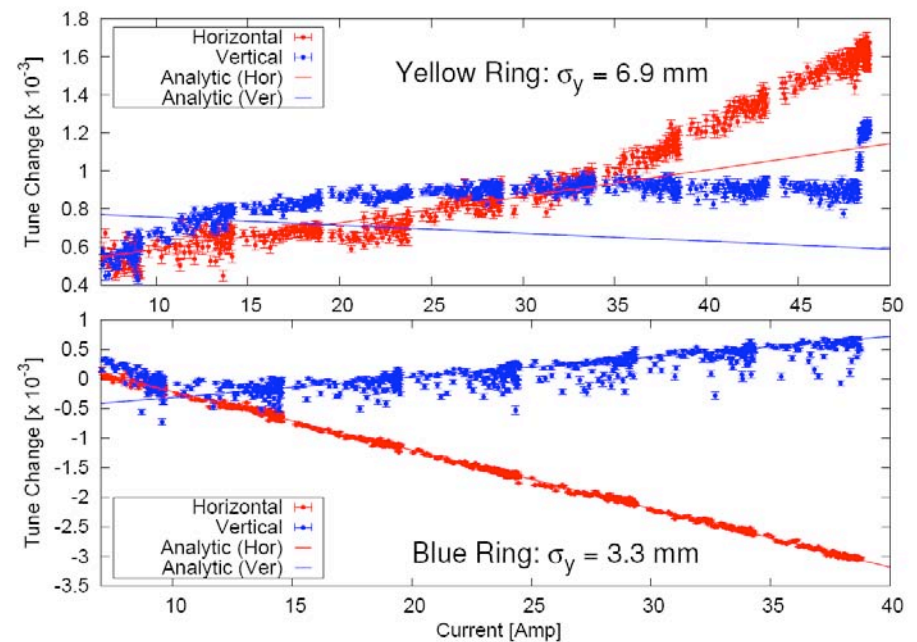


# Tune and Orbit: current scan

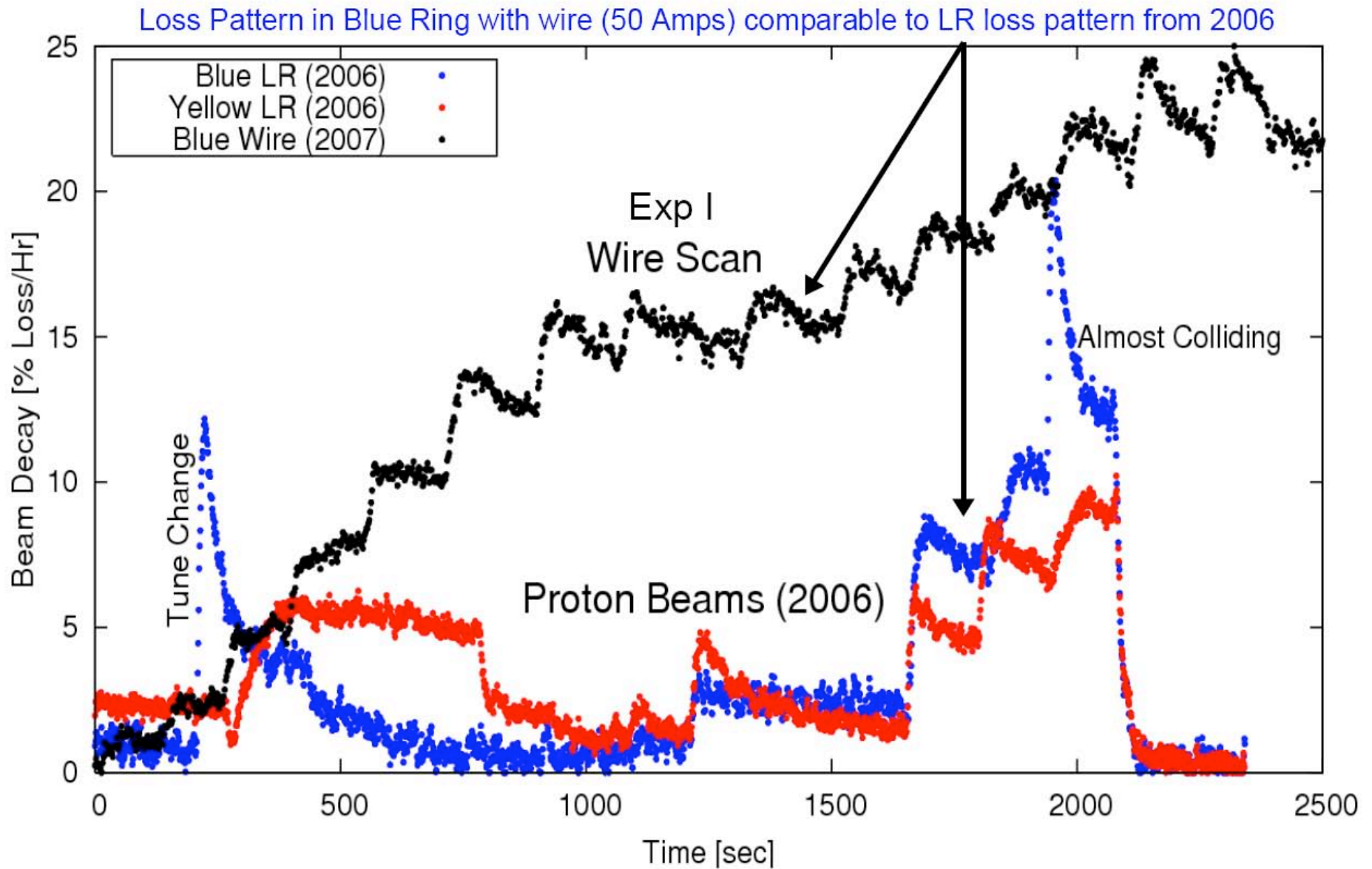


Blue and Yellow tunes as a function of the wire current. The Blue wire was at +23 mm and the Yellow wire at -29 mm.

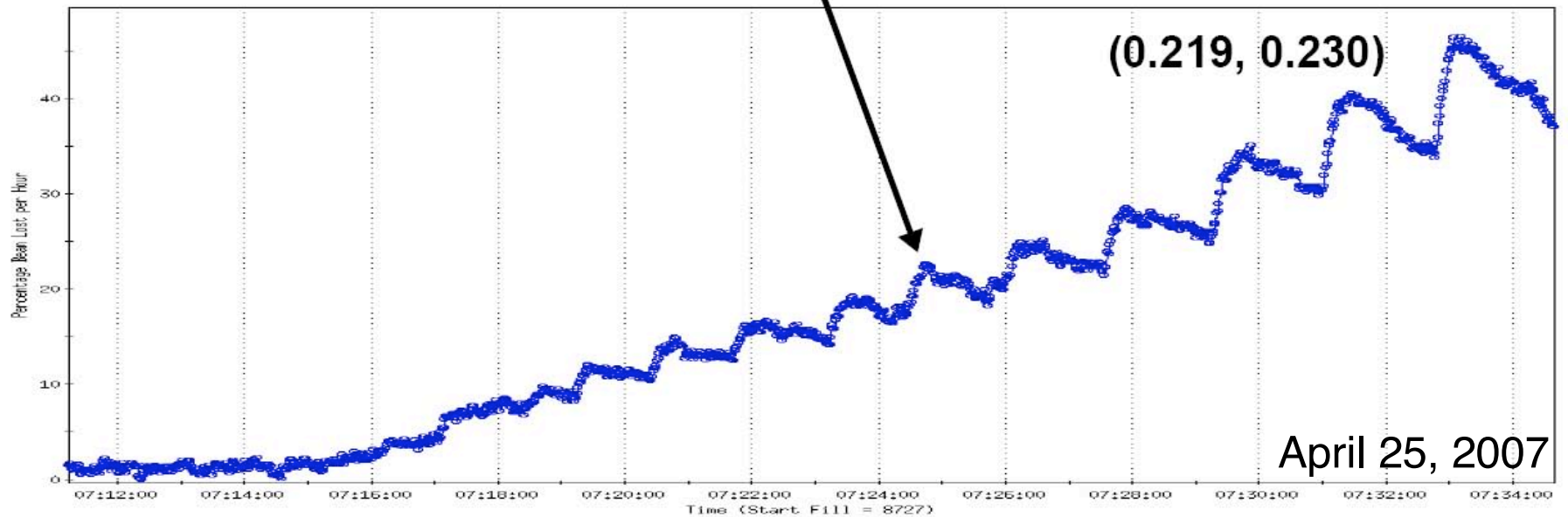
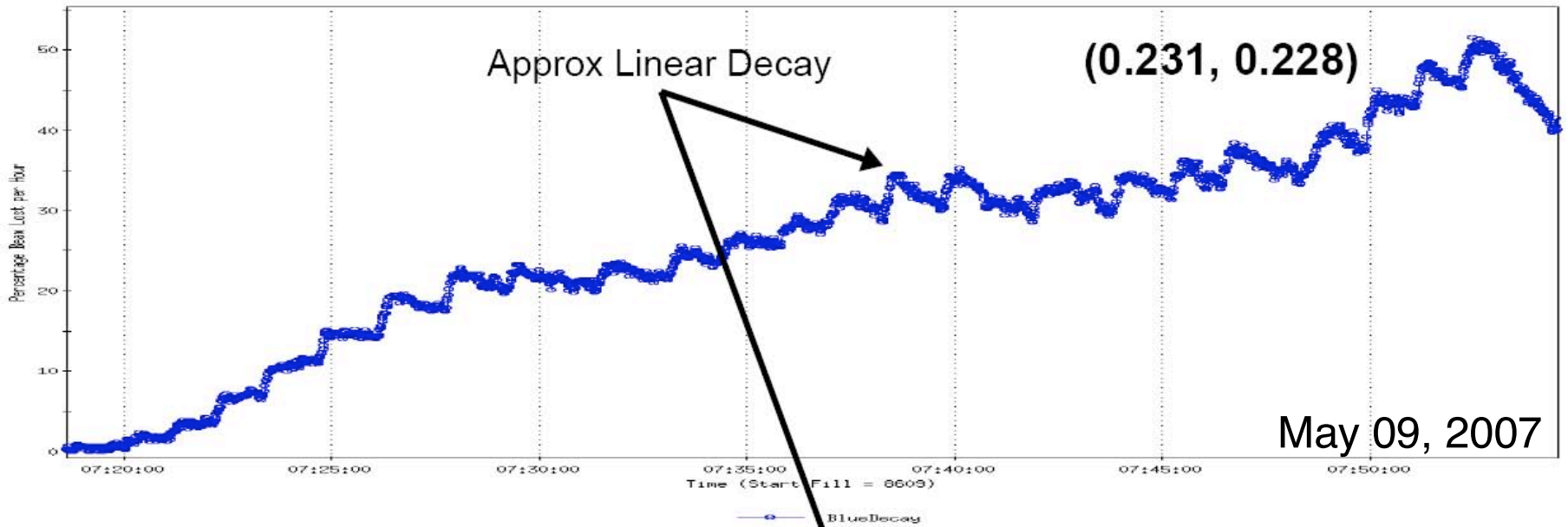
Blue and Yellow orbit at the wire locations as a function of the wire current. The Blue wire was at +23 mm and the Yellow wire at -29 mm.



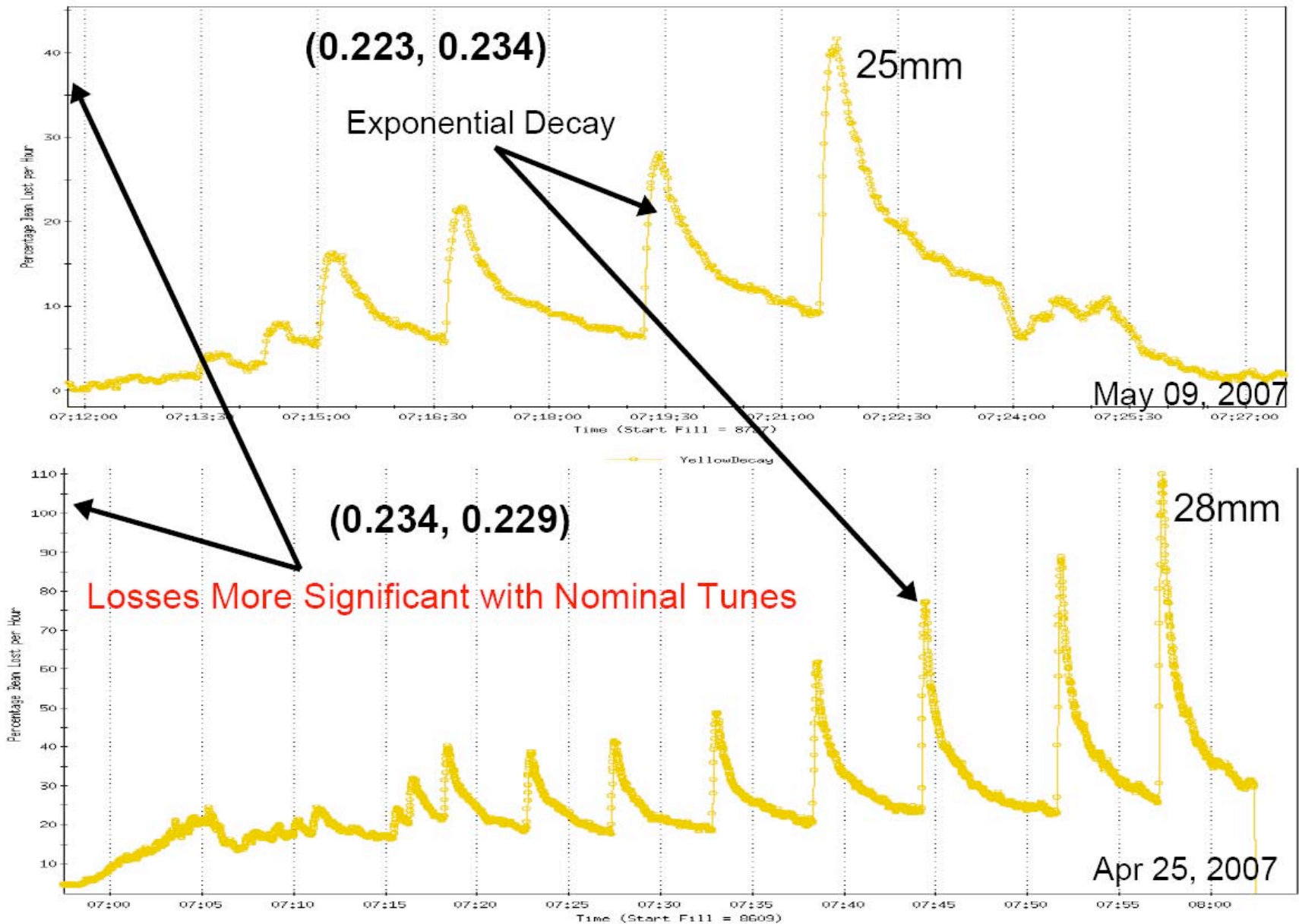
# Proton beam vs Wire scan



# Loss Pattern: Blue (50 Amps scan)



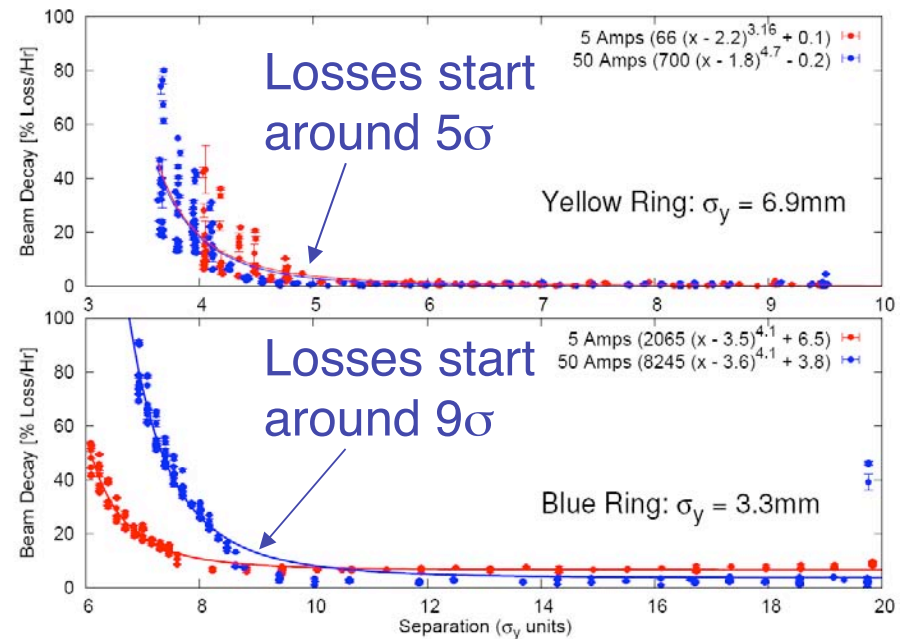
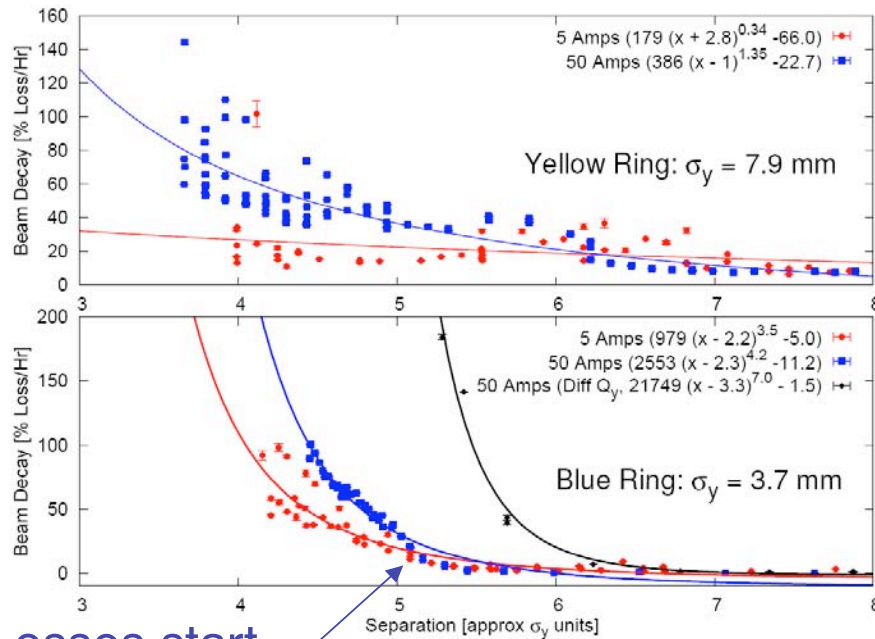
# Loss Pattern: Yellow (50 Amps scan)



# Beam Decay: position scan

Experiment I:

Experiment II:



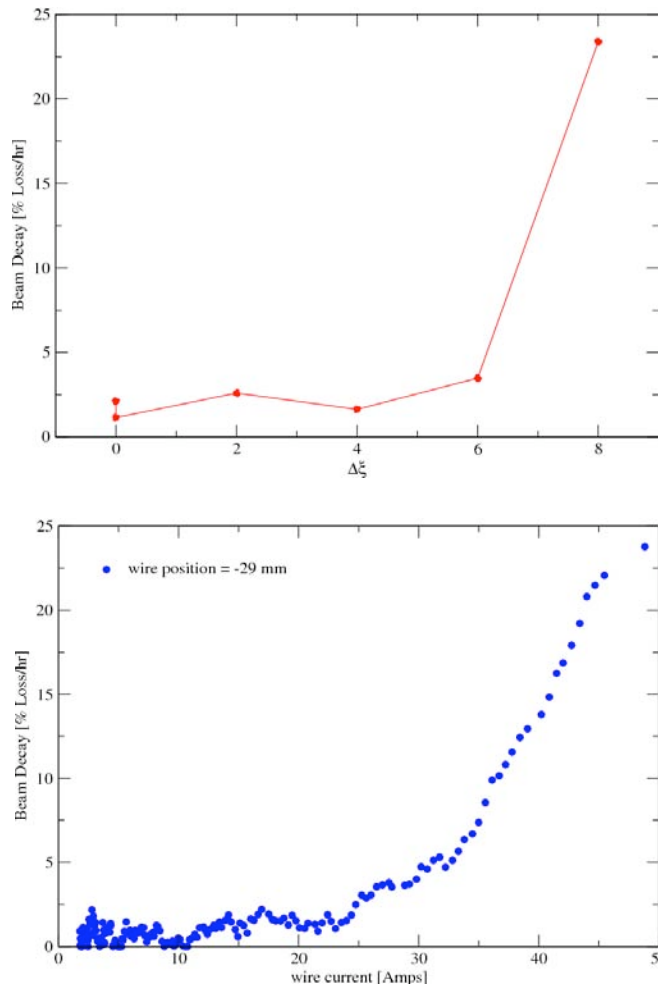
Losses start around  $5\sigma$

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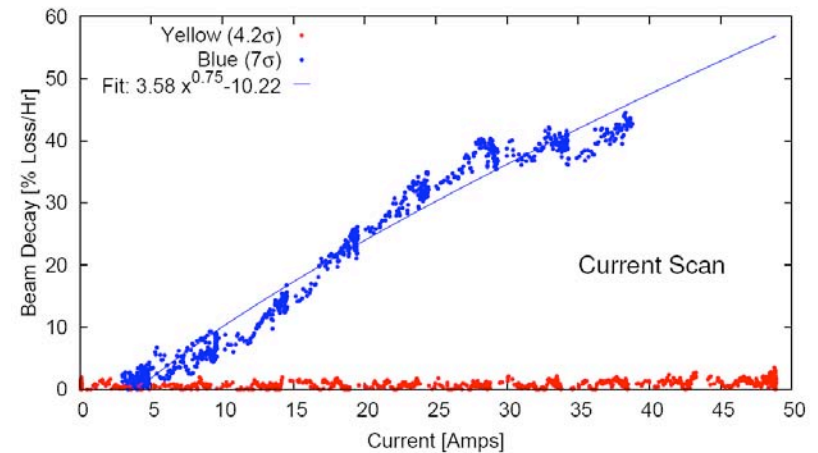
Losses start around  $9\sigma$

Beam loss rate as a function of vertical distance, in Yellow and Blue ring for experiments I (left) and II (right). The solid lines are power law fits to the respective data.

# Current and chromaticity scan



Blue and Yellow beam loss rates as a function of wire current. The Blue wire is fixed at +23 mm, the Yellow wire at -29 mm.



Yellow beam loss rates as a function chromaticity (top left). Yellow beam loss rate as a function of wire current at the maximum chromaticity setting (bottom left) - the wire current was turned off.

# Summary

The effect of a DC wire on the RHIC gold beam at 100 GeV/nucleon has been measured;

The measured orbits and tune changes are calculable in most cases;

The loss rate was measured as a function of wire current, wire position, tune and chromaticity.

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# Acknowledgements

BNL Operations

Engineering team for the wire

CERN people:

F. Zimmermann

J.P. Koutchouk

U. Dorda

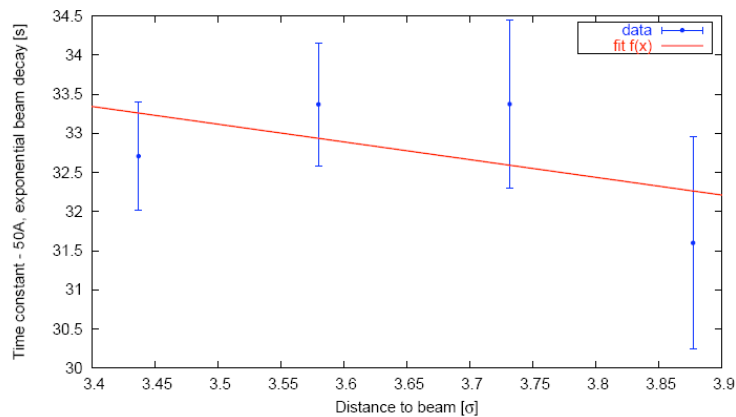
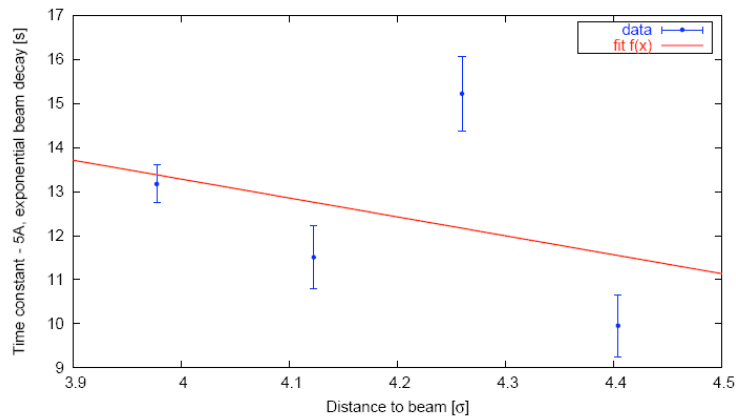
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# Decay Constants (Experiment II)

Fitted exponential decay constants after a distance step was made. All data are taken during experiment II.

Yellow Beam:



Blue Beam:

