IR Bumps, Model and Measurements

Nikolay Malitsky

S. Binello, A. Jain, Y.Luo, F.Pilat, V.Ptitsyn, S.Tepikian, R.Tomas, J. van Zeijts, J.Wei

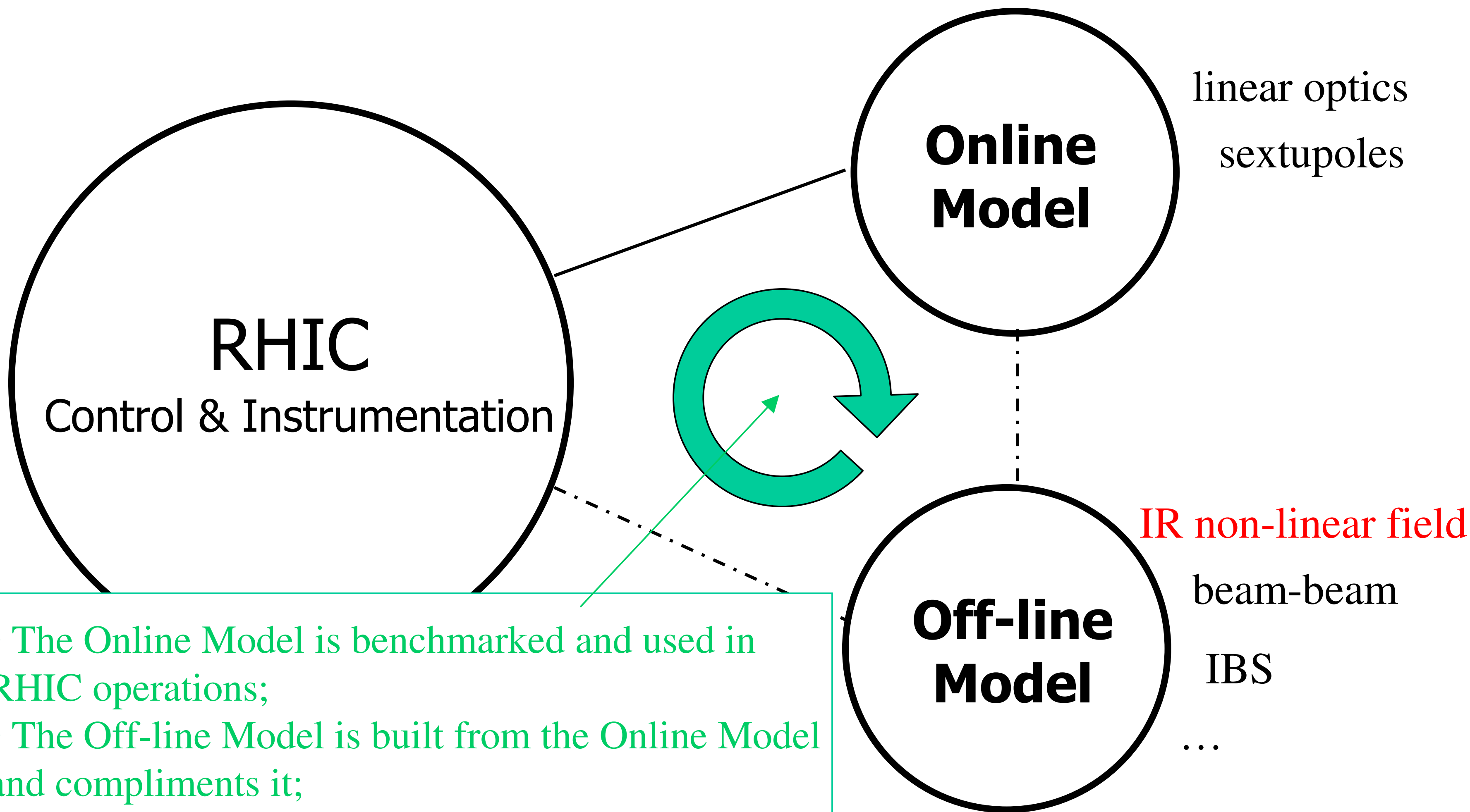
Outline

- Objectives and conceptual view of the off-line model
- IR Bump experiment
- IR Bump off-line model
- Summary from the RHIC Retreat 2004
- Comparison of old and new sets of IR dominant field errors
- Analysis of D0 sextupole harmonics
- Estimated effect of DX magnets
- Summary
- The next step

Objectives


SAFETY
SECURITY
and
HEALTH
ENVIRONMENT
continual improvement
Define
scope
of work
Identify
beam
experiment
RHIC
Excellence
Implement
controls &
perform
work
Assess,
communicate,
update model
Take
action for
improvement
EMS
ISM
ISSM
OSHMS

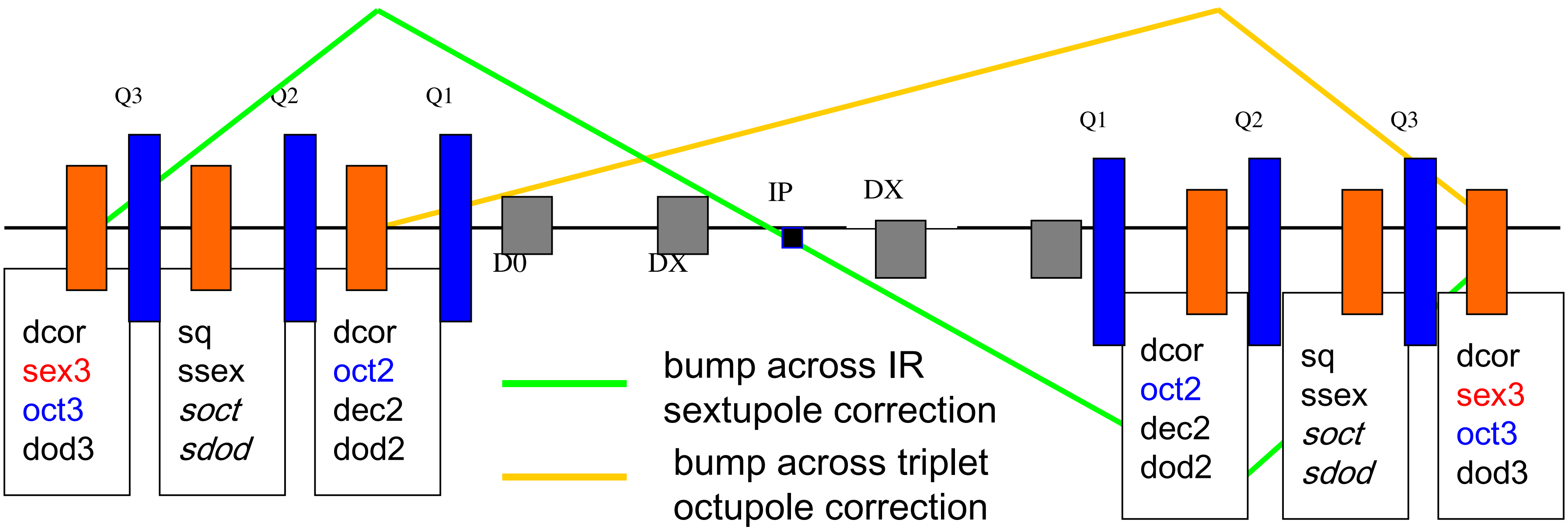
Conceptual View of the RHIC Control-Model interface



- The Online Model is benchmarked and used in RHIC operations;
- The Off-line Model is built from the Online Model and compliments it;
- The RHIC complex beam studies are based on off-line modeling;

IR Bump Experiment

P.Koutchouk, F.Pilat,V.Ptitsyn

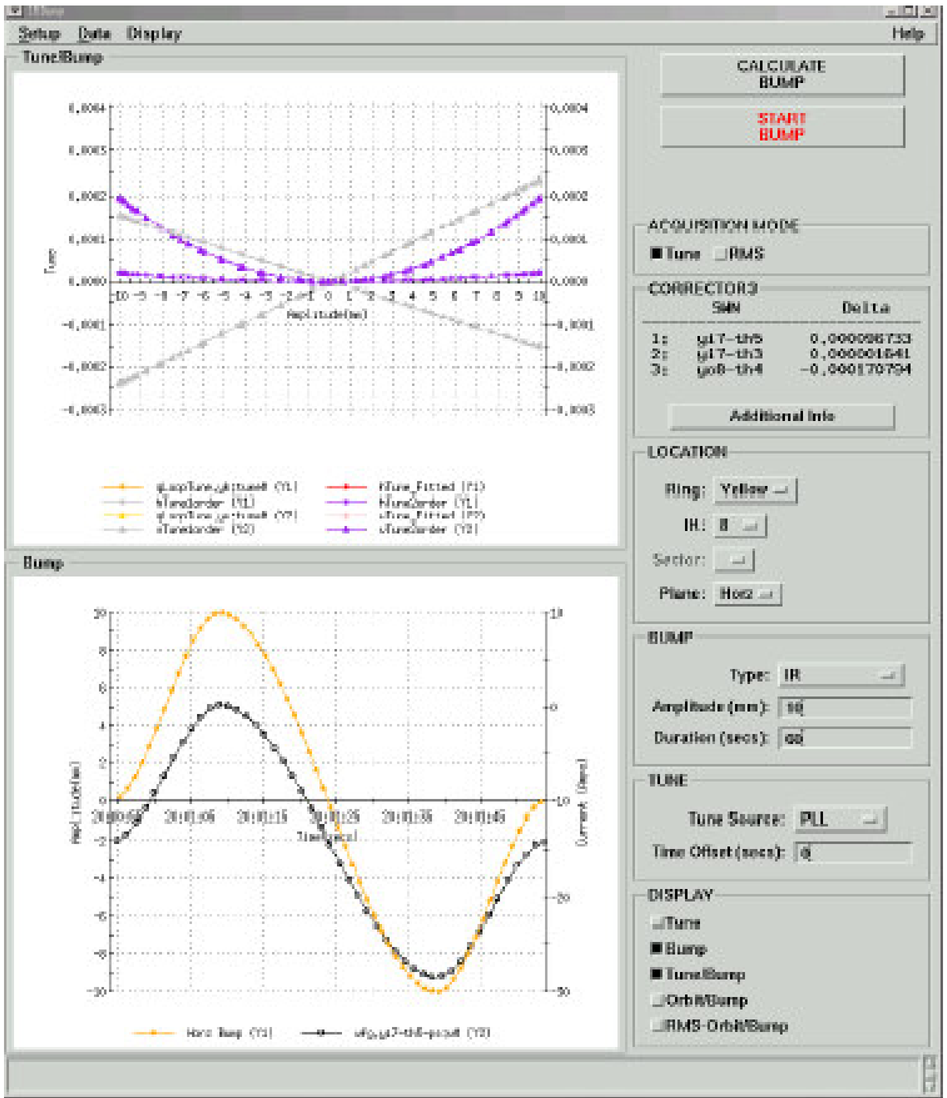


- Orbit bumps at triplets and across IR
- →rms orbit and tunes vs. bump amplitude
- PLL ~10^{-5} resolution

Motivation:
- Dynamic aperture
- Operations (closure of steering bumps)

IR Bump Correction Application

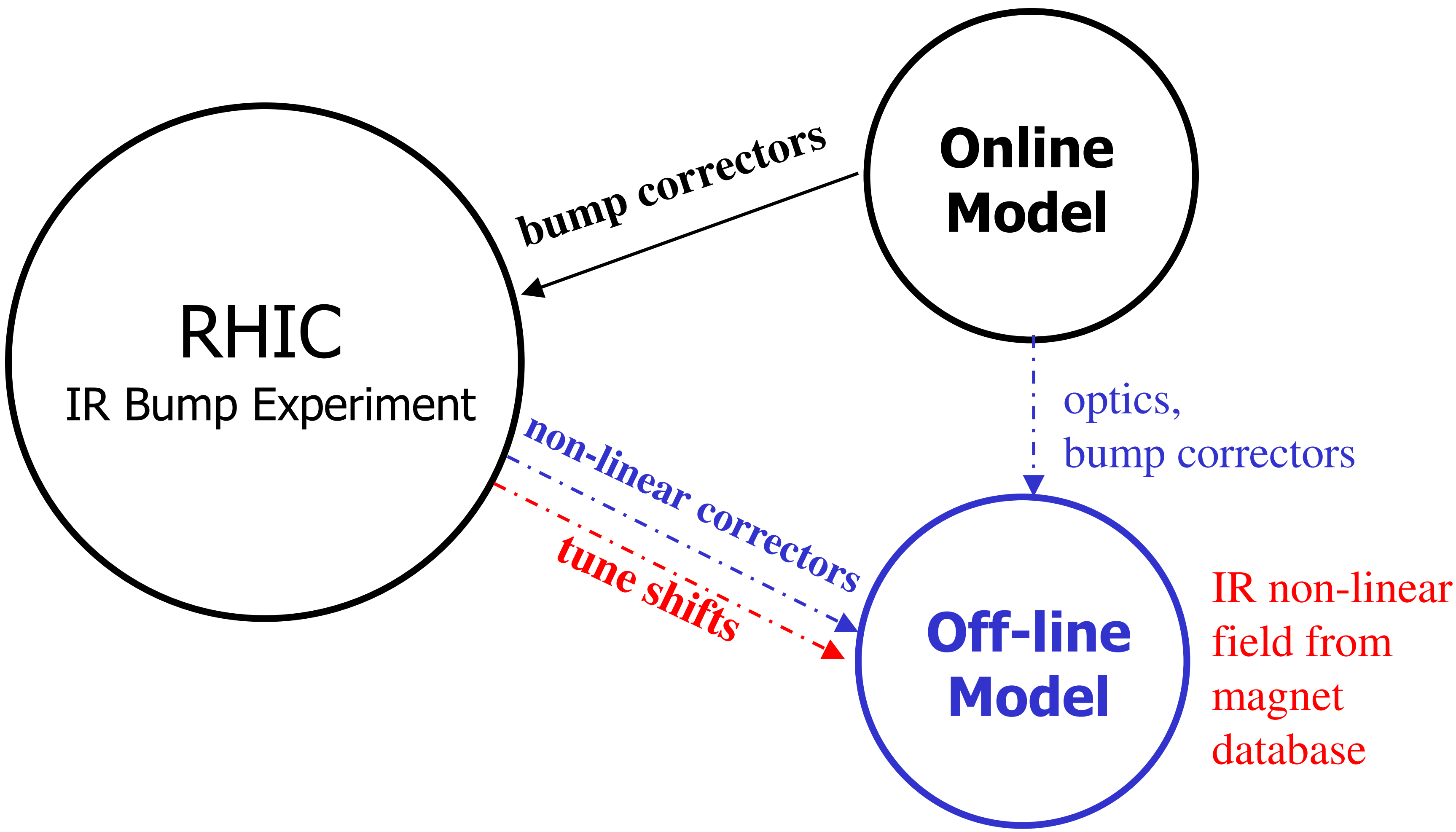
S. Binello, F. Pilat, V. Ptitsyn



IR bump application:

- **set-up** and **ramp-up** of IR and triplet bumps in specified time (1-2 minutes)
- Tune and power supply monitoring
- Plot orbit rms and tunes as a function of bump amplitude
- Polynomial fitting up to 5^{th} order of tunes versus amplitude → **coefficients**→nonlinear **corrector settings**

Off-line Model of the IR Bump Experiment

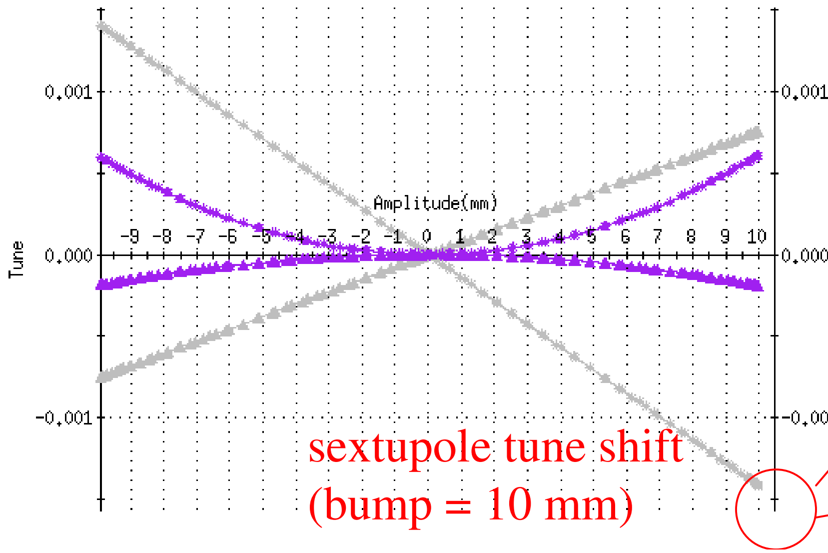


Beam Experiment vs Model-based phase shift budget

RHIC Retreat 2004, June 6-9

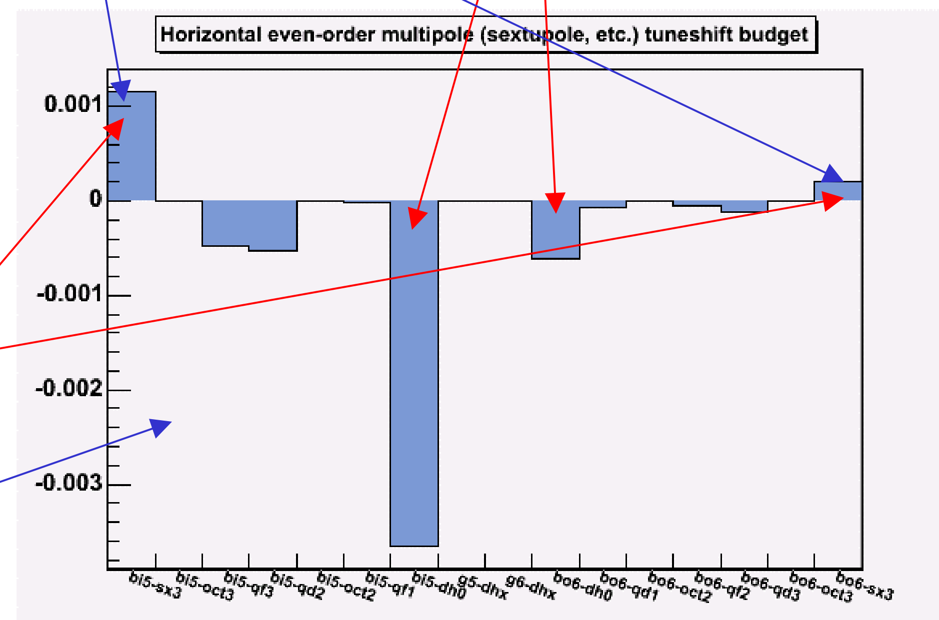
Operational sextupole correctors

dh0 from the magnet database



sextupole tune shift
(bump = 10 mm)

Beam Experiment measured tune shifts vs. bump amplitudes.



$$\Delta\nu_x \sim \beta_x\,(b_2\Delta_x + 1.5 b_3 \Delta_x^2 + \ldots$$

Model-based sextupole phase shift budget (bump amplitude = 10 mm)

Summary:

✓ The off-line IR Bump Model produces correct tune shifts for operational sextupole and octupole correctors

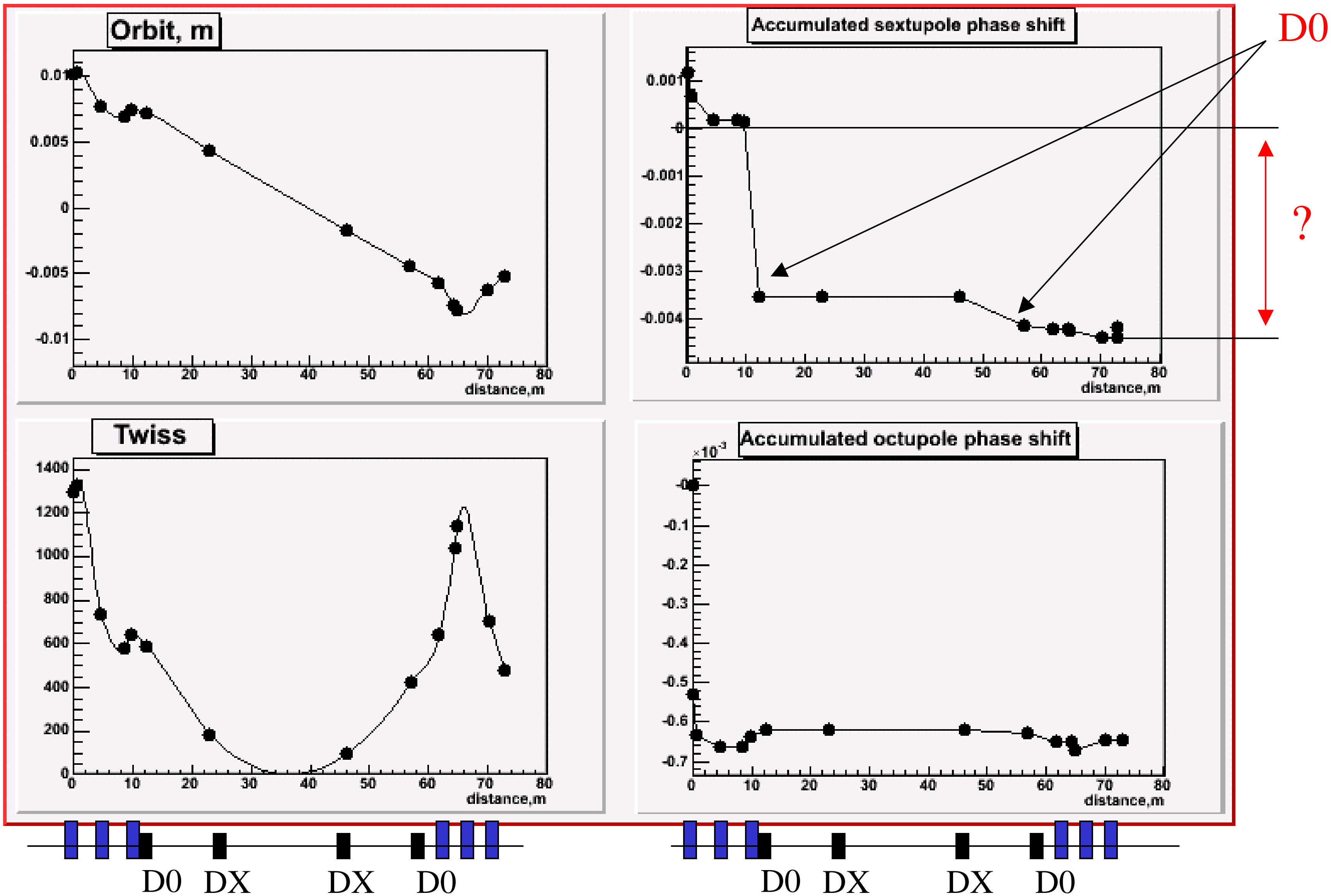
✓ The Model-based phase shift budget application helps to identify the *"bad"* magnets (*such as dh0*) inducing the wrong (*too strong*) tune shifts

To-do list:

- Consolidation of old and new sets of Model IR field errors
- Analysis of D0 magnets identified by the Model-based phase shift budget application

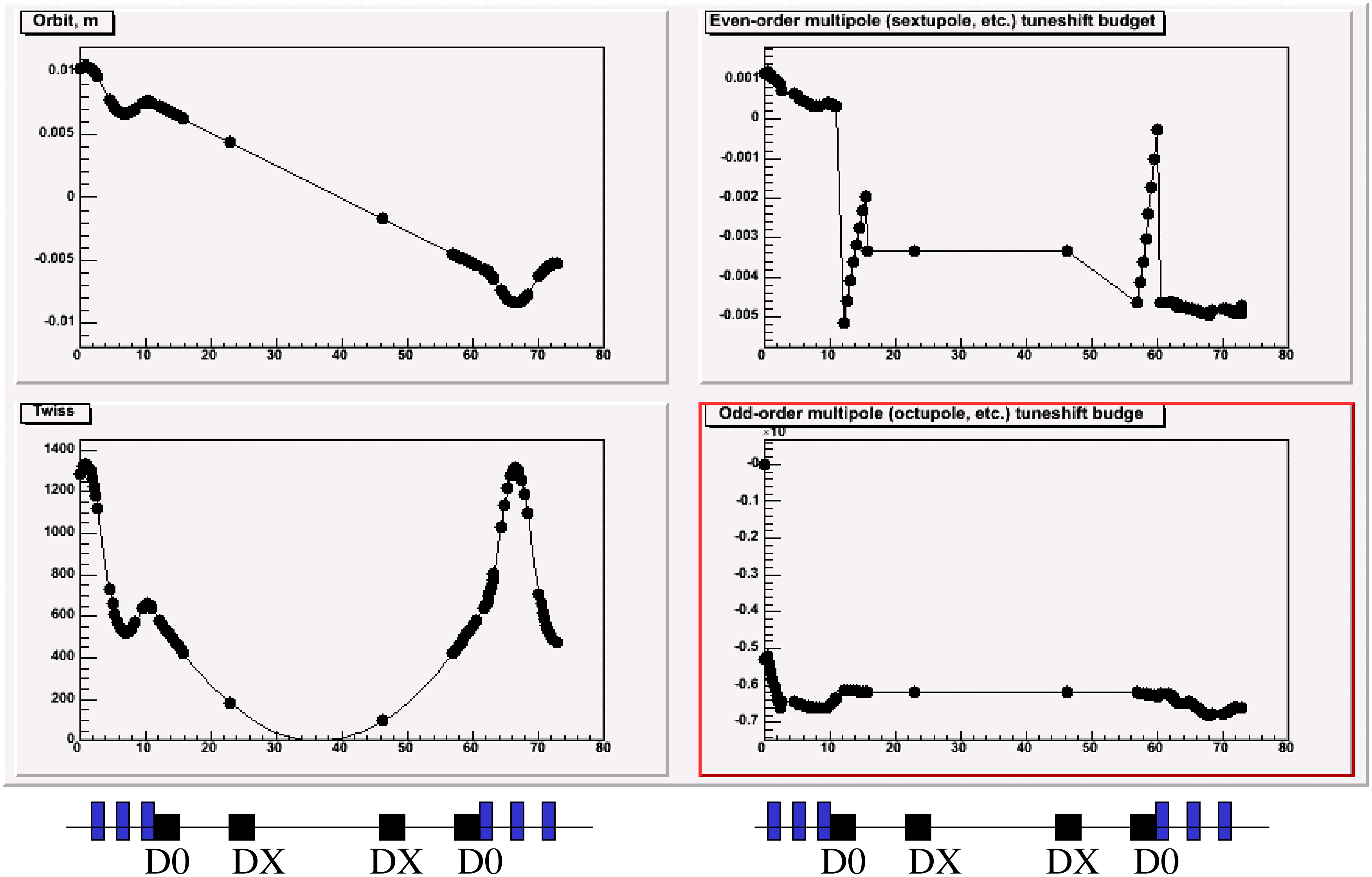
Blue IR horizontal phase shift budget

(based on the old version with integrated magnetic fields, W.Fisher)



Blue IR horizontal phase shift budget

(based on the new version with sliced magnetic fields, R.Tomas)



D0 sextupole (KL2) harmonics

A. Jain, S.Tepikian, J. Van Zeijts

	Blue IR6		Blue IR8		Yellow IR6		Yellow IR8	
Name	d0mm05	d0pp06	d0pm07	d0mp08	d0mp06	d0pm05	d0pp08	d0mm07
	DRZ106	DRZ117	DRZ114	DRZ122	DRZ110	DRZ105	DRZ123	DRZ121
body (cold)	+0.012	-0.0215				-0.014		
body (warm)	+0.010	-0.0095	-0.006	+0.005	+0.008	-0.013	-0.004	+0.008
lead (cold)	-0.0160	0.0170				0.0172		
lead (warm)	-0.0105	0.0120	0.0106	-0.0103	-0.0121	0.0112	0.0106	-0.0115
return (cold)	-0.0064	0.0086				0.0066		
return (warm)	-0.0015	0.0030	0.0022	-0.0017	-0.0025	0.0020	0.0019	-0.0017
Present Model (cold body, cold lead, cold return)								
integral	-0.0105	+0.004	(0.005)	(-0.006)	(-0.005)	0.011	(0.007)	(-0.004)
Composite model (cold body, warm lead, cold return)								
Integral	-0.005	-0.001	(0.000)	(-0.001)	(0.000)	+0.004	(0.002)	(+0.001)
Composite model (cold body, warm lead, warm return)								
Integral	0.0	-0.0065	(-0.005)	(0.004)	(0.005)	-0.001	(-0.003)	(+0.006)

1. unfinished

2. estimation

D0 phase shifts

	Blue IR6		Blue IR8		Yellow IR6		Yellow IR8	
Name	d0mm05	d0pp06	d0pm07	d0mp08	d0mp06	d0pm05	d0pp08	d0mm07
	DRZ106	DRZ117	DRZ114	DRZ122	DRZ110	DRZ105	DRZ123	DRZ121
Present model								
	-3.6e-3	-0.6e-3	**(-1.3e-3)**	**(-1.1e-3)**	**(-1.e-3)**	**-2.6e-3**	(-1.0e-3)	(-1.2e-3)
Composite model (cold body, warm lead, cold return)								
	-1.7e-3	**+0.2e-3**					**(-0.2e-3)**	**(+0.5e-3)**
Composite model (cold body, warm lead, warm return)								
	0	+0.9e-3					(+0.5e-3)	(+2.2e-3)
Experiment								
	-1.1e-3		**-2.0e-3**		**-3.9e-3**		**-0.5e-3**	

Estimated DX phase shifts

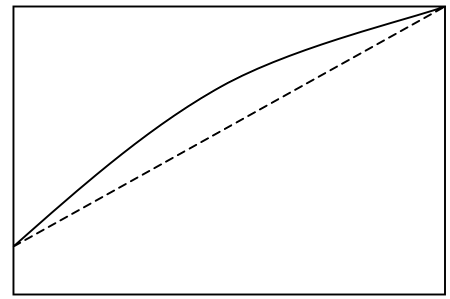
	IR8	
Name	g7-dx	g8-dx
	DRX110	DRX111
Body: b_n (kl_n)		
b2	-3 (-0.0025)	-0.3 (-0.00025)
b3	-0.13	-0.11
b4	-7.6 (-21.5)	-6.8 (-19.3)
Lead: b_n (kl_n)		
b2	7.8 (0.0018)	8.16 (0.0019)
b3	0.35	-0.32
b4	12 (9.2)	12 (9.2)
Return: b_n (kl_n)		
b2	1.58 (0.00036)	1.1 (0.00025)
b3	-0.23	0.25
b4	4 (3.1)	4 (3.1)

R_{ref} = 0.06 m

ρ = 242.5 m

L = 3.7 m

Δx 0.043 m



βx = 200 m

x_{bump} = 0.004 m

$\Delta\nu_{sext} = 2*kl_2*\beta x*x_{bump}/2!/(4\pi) \sim -3e-4$

$$\frac{1}{4\pi}\frac{4kl_4}{4!L}\int \beta_x(\Delta x(s)+x_{bump})^3 ds$$

$\Delta\nu_{sext} = 4*kl_4*\beta x*(3*\Delta x^2/3)*x_{bump}/4!/(4\pi) \sim -4e-4$

$\Delta\nu_{oct} = 4*kl_4*\beta x*(3*\Delta x/2)*x^2_{bump}/4!/(4\pi) \sim -0.6e-4$

Summary

- IR Bump sextupole tune shifts are induced only by D0 magnets;
- Discrepancy between the IR beam experiment and the off-line model results can be described by uncertainty in D0 measured fields.
- Future plan will be determined from analysis of Animesh' new estimated data and the impact of measured sextupole tune shifts on beam-beam studies and the performance of the online model.

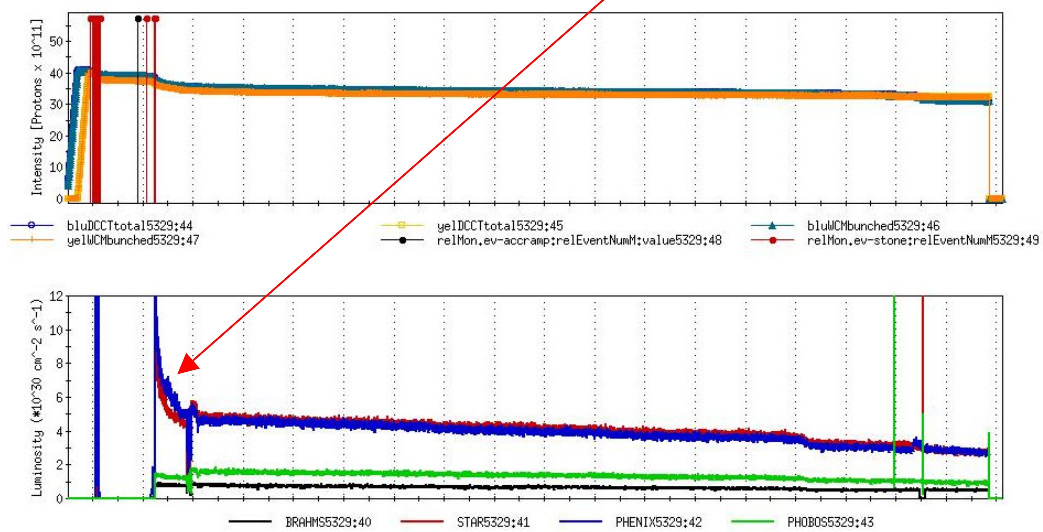
Plan and objectives of beam-beam studies

A. Fedotov, W. Fisher, N.Malitsky,C. Montag, R.Talman, R. Tomas

1. Build an efficient composite model using RHIC non-linear maps and strong-weak beam-beam approaches (C. Montag, R.Talman):

With the 5th order one-turn map one can track a single particle for 45 μs which is comparable with the RHIC revolution period of 12.5 μs !

It means we can deal with slow (20 min.) processes. We probably need QCDOC for a large bunch.



M. Bai. RHIC Retreat 2004

2. Propose beam experiments (TBD) motivated by the RHIC operational data (December).

3. Do model benchmarking experiment (Spring 2005)

4. Reuse the beam-beam model(s) in electron cooling beam studies.