First Optics Measurements - 2012
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Injection
Comparison 2011
Corrections
4TeV
Local Corr
Global corr
$\Delta\beta/\beta$ & D_x
0.7m
Summary

LHC Commissioning: First Optics Measurements - 2012

OMC: T. Bach, Y. Levinsen, E. Maclean*, T. Persson, P. Skowronski, R. Tomas, G. Vanbavinckhove.

26th March 2012

Outline

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1 Injection

- Comparison to 2011
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2 4TeV

- Local corrections
- Global correction.
- $\Delta\beta/\beta$ & D_x measurements.
- Measurements at 0.7m
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Injection.

15 March, Fill 2364.

- Local coupling correction applied.
  → **Local_coupl_corr_Injection_2012**
- Global corrections found for Beta-Beating and Dispersion.
  → **B1_global_betabeat_corr_injection_2012**
  → **B2_global_betabeat_corr_injection_2012**

Beam 1: 2012 vs 2011.

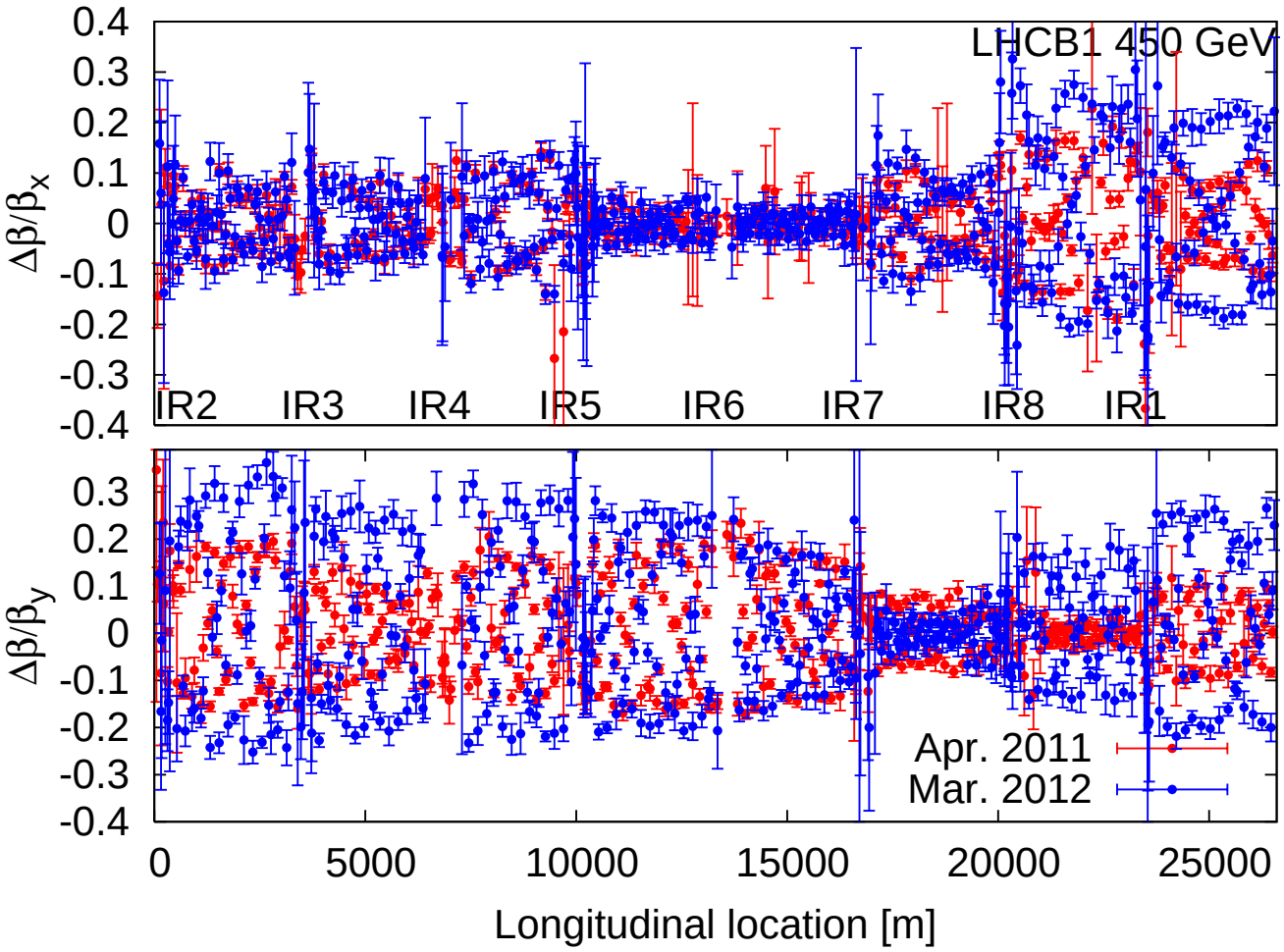

Figure: Comparison of the Beam 1 beta-beating at injection, as measured 15/3/12 and 4/4/11

Beam 2: 2012 vs 2011.

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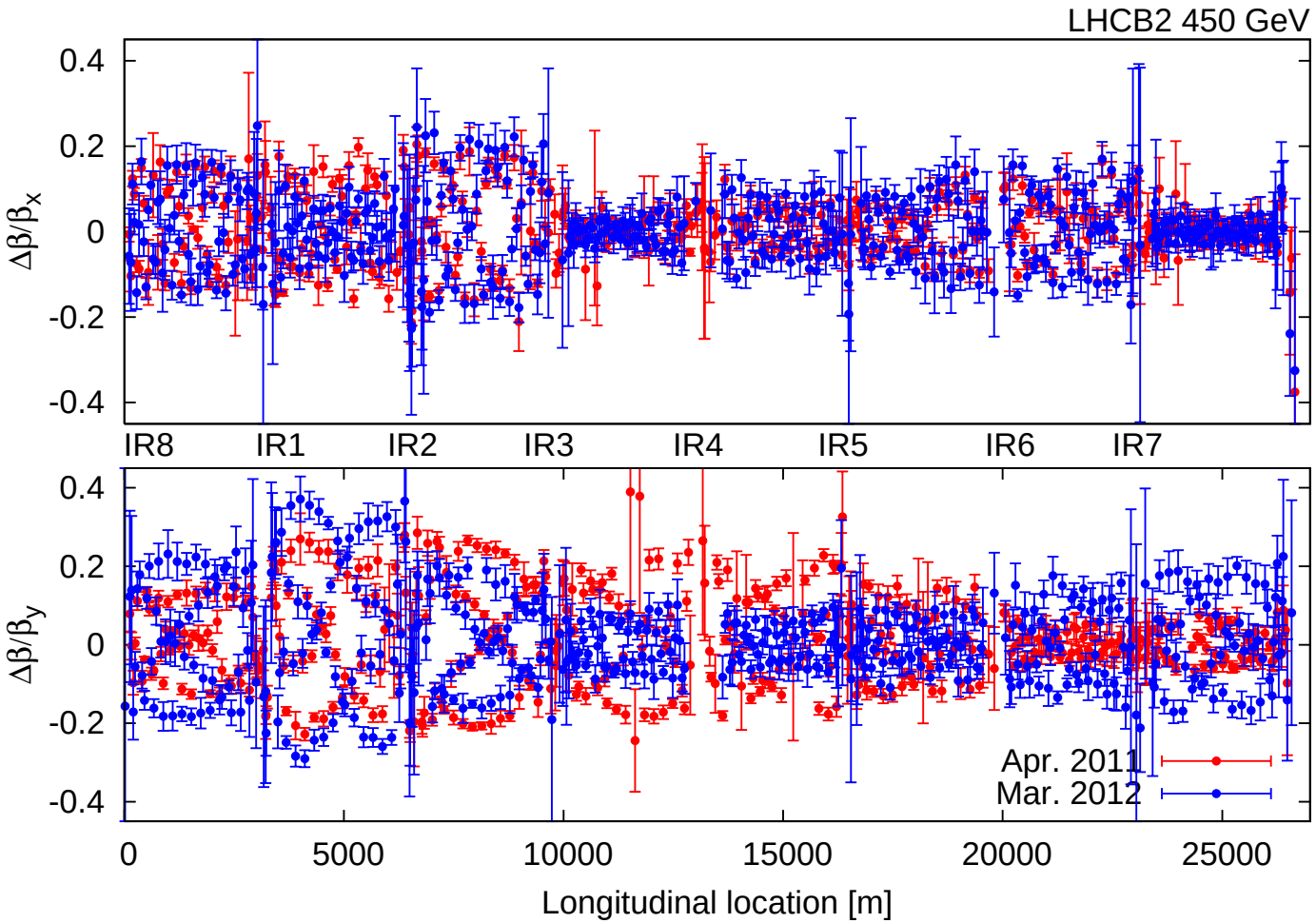


Figure: Comparison of the Beam 2 beta-beating at injection, as measured 15/3/12 and 4/4/11

Coupling correction.

Coupling was corrected locally,
2011 corrections were still valid:

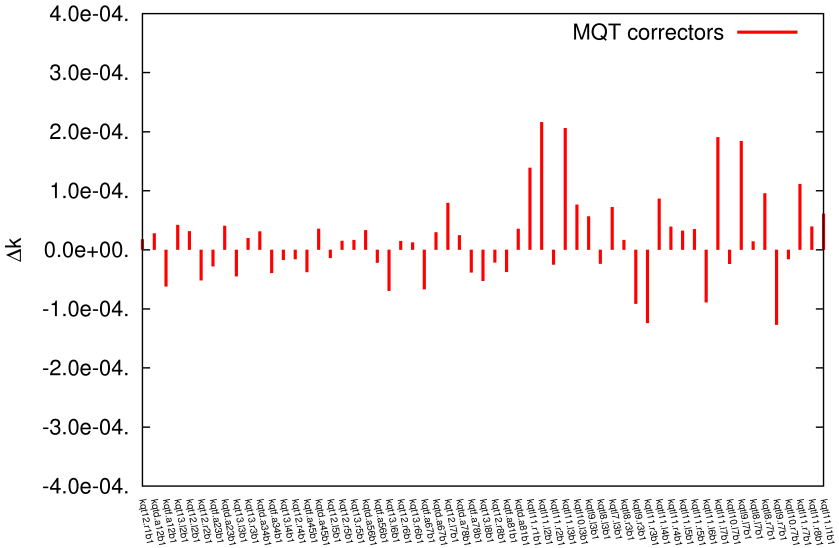
Element	Δk	Element	Δk
kqsx3.l1	0.0008	kqsx3.l5	0.0006
kqsx3.r1	0.0008	kqsx3.r5	0.0006
kqsx3.l2	-0.0009	kqsx3.l8	-0.0007
kqsx3.r2	-0.0009	kqsx3.r8	-0.0007

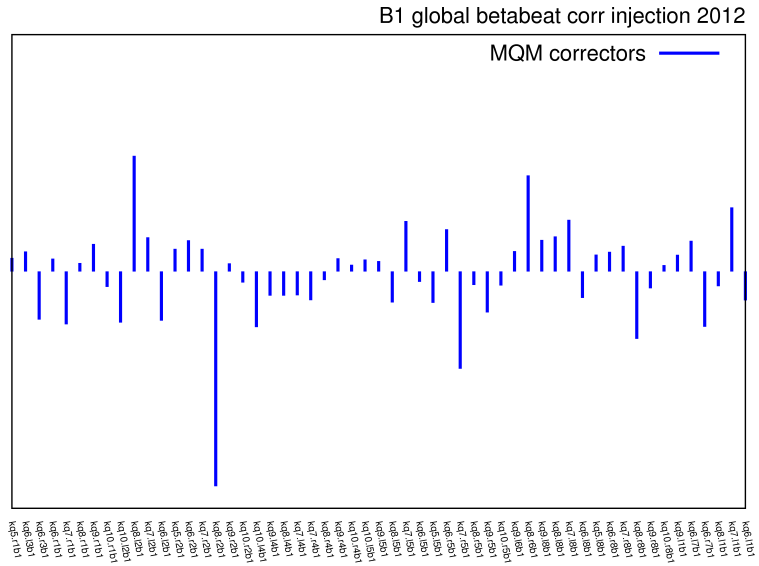
This reduced global B2 coupling knobs from -0.045 to 0.033 and 0.02 to 0.0.

Global correction.

Beta-beating and horizontal dispersion were corrected globally.

$\longrightarrow$ Independent corrections for B1 & B2 using MQM & MQT.





Global correction.

Beta-beating and horizontal dispersion were corrected globally.
$\longrightarrow$ Independent corrections for B1 & B2 using MQM & MQT.

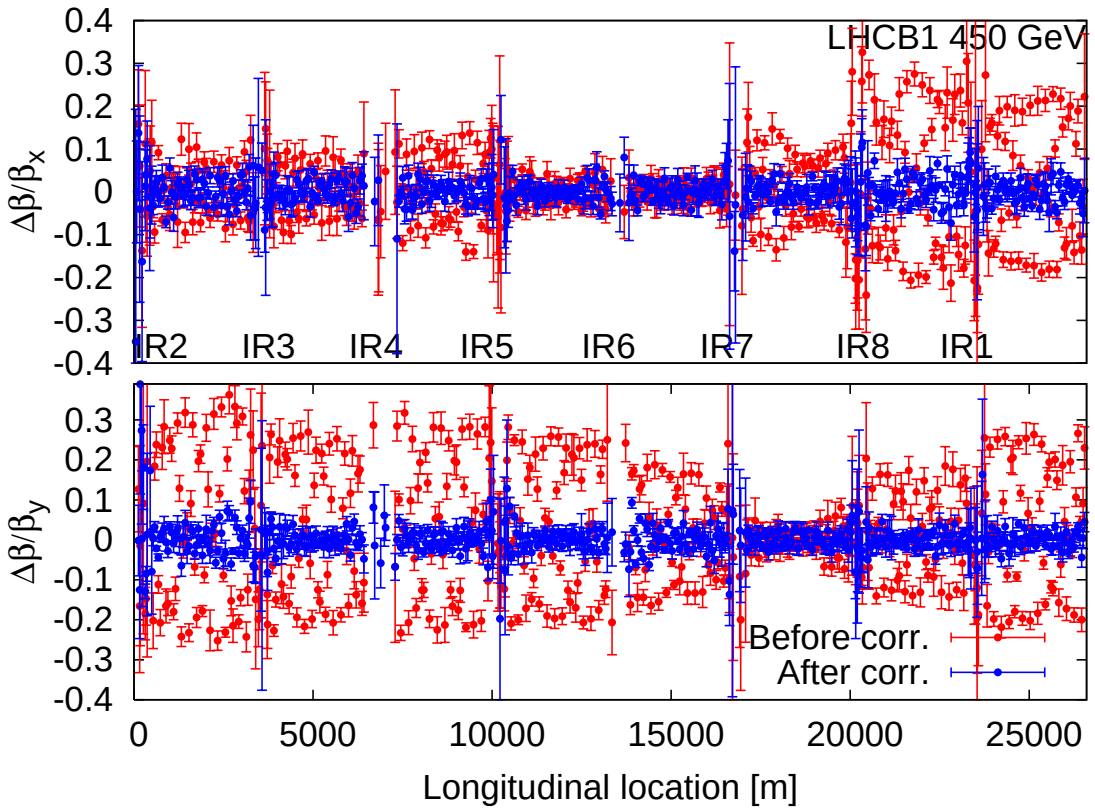


Figure: Beam 1 beta-beating before and after global correction.

Global correction.

Beta-beating and horizontal dispersion were corrected globally.
$\longrightarrow$ Independent corrections for B1 & B2 using MQM & MQT.

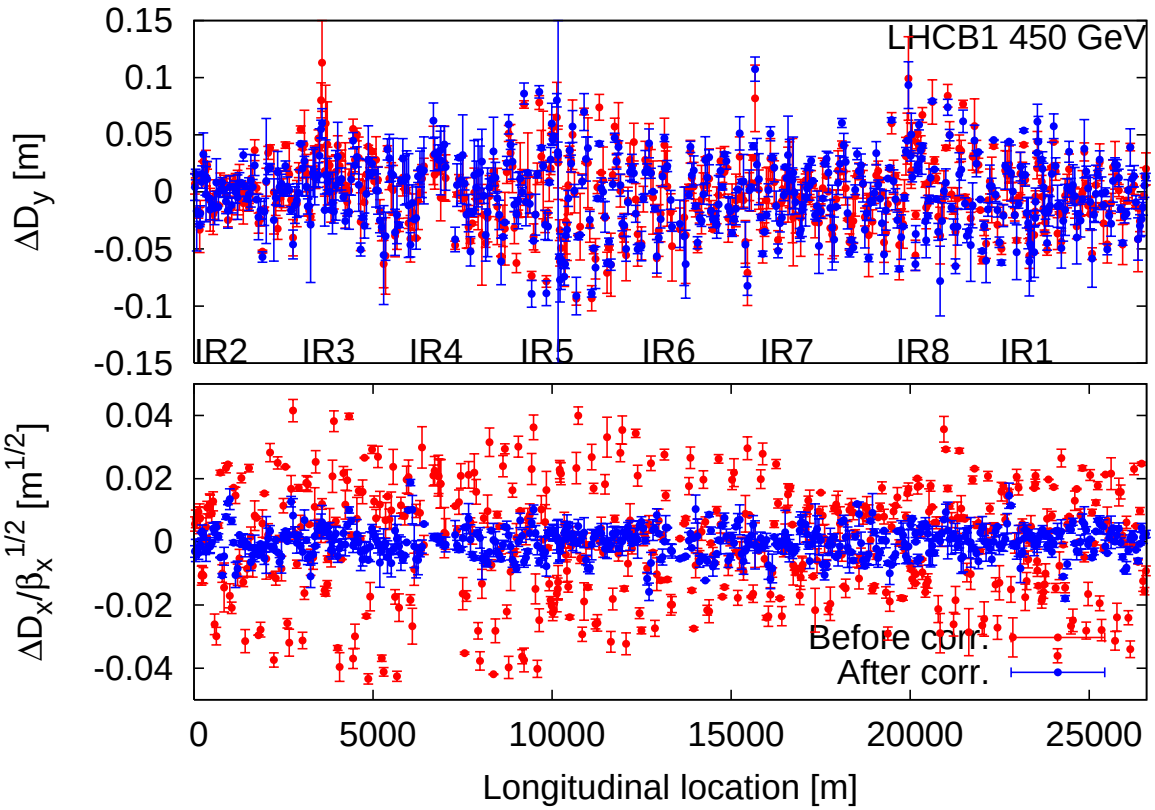


Figure: Beam 1 normalized dispersion before and after global correction.

Global correction.

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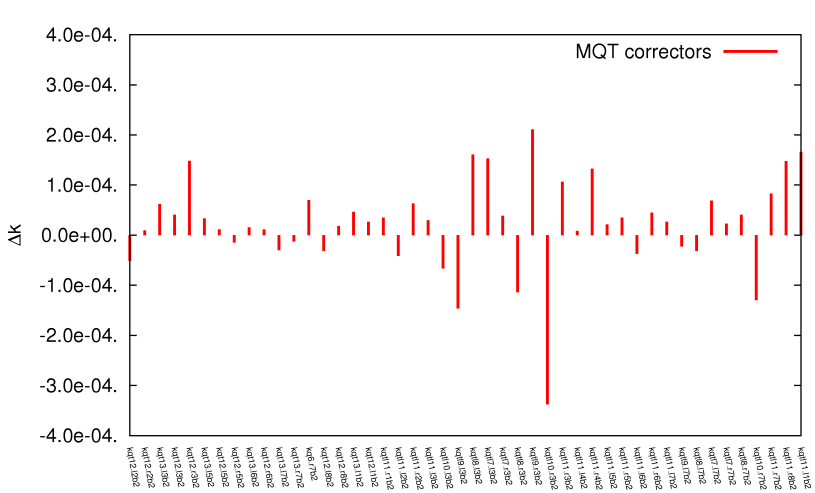
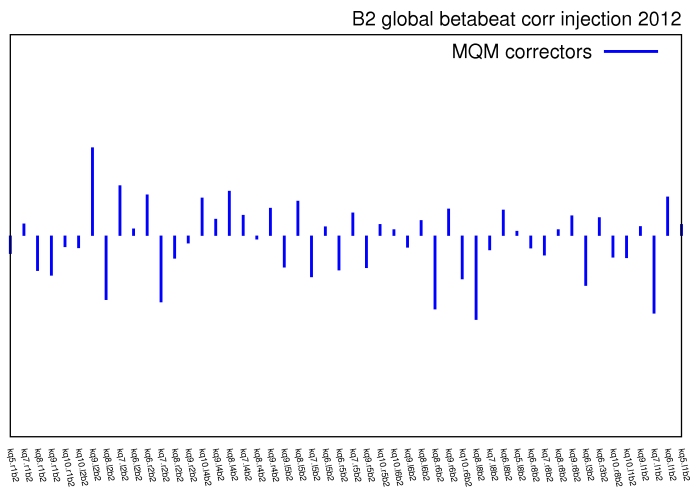
Beta-beating and horizontal dispersion were corrected globally.
$\longrightarrow$ Independent corrections for B1 & B2 using MQM & MQT.





Global correction.

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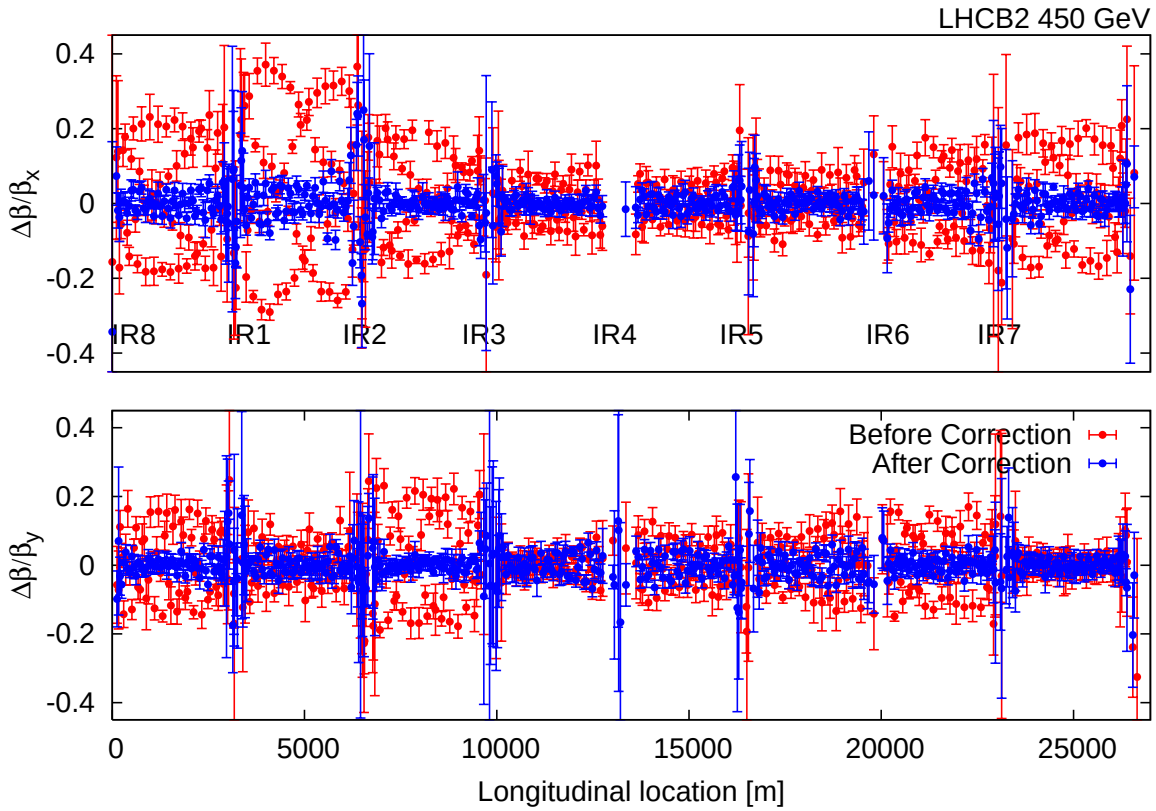

Figure: Beam 2 beta-beating before and after global correction.

Global correction.

Beta-beating and horizontal dispersion were corrected globally.
$\longrightarrow$ Independent corrections for B1 & B2 using MQM & MQT.

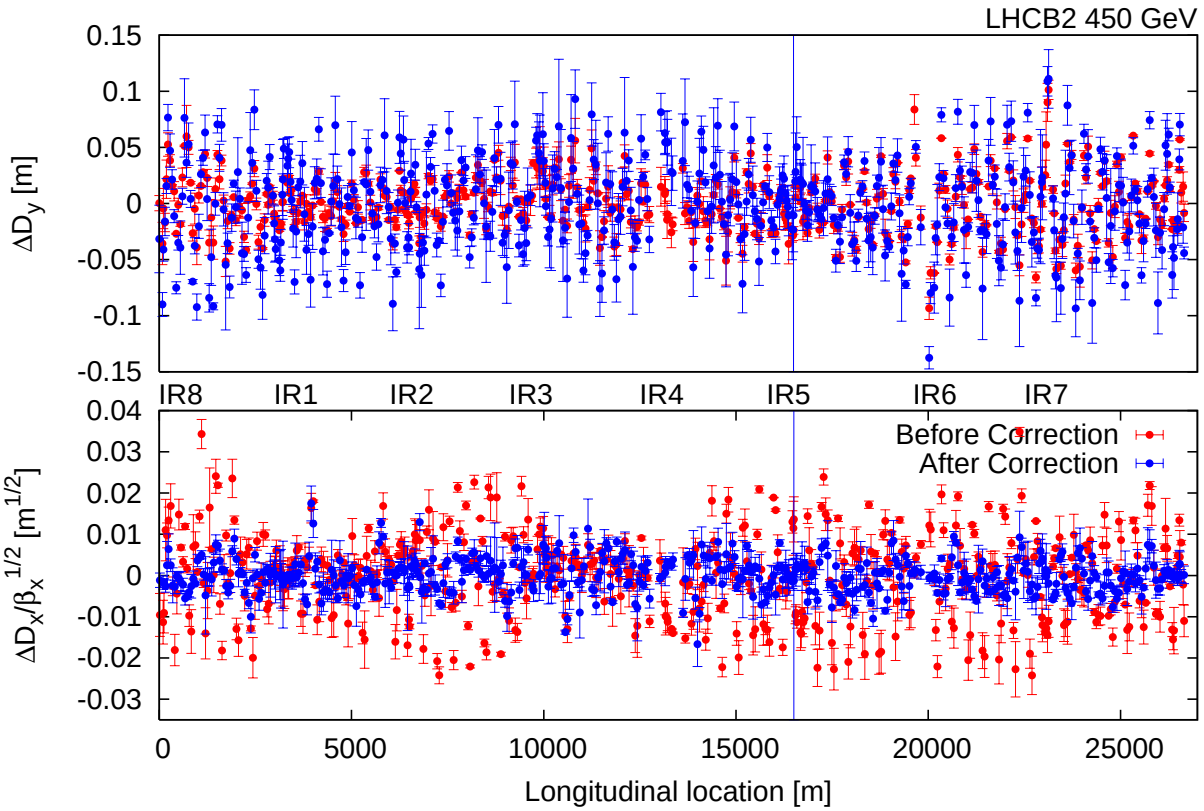

Figure: Beam 2 normalized dispersion before and after global correction.

Global correction

Independent corrections for B1 & B2 (MQM, MQT, MQTL)

Highest corrections: B1 $\longrightarrow$ kq8.r2b1 ~ 0.00036

B2 $\longrightarrow$ kqtl10.r3b2 ~ 0.00034

- Betabeating corrected from $\sim 30-40\%$ to $\sim 5-10\%$.
- Normalized H dispersion beat reduced $0.04m^{1/2} \longrightarrow 0.01m^{1/2}$

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4 TeV

18 March, Fill 2373.

- Measurements at 4TeV from Flattop to 0.6m.
- Local corrections calculated.

20 March, Fill 2385.

- Local corrections implemented. Measured from Flattop to 0.6m.
- Global corrections were calculated at 0.6m.
- Optics were remeasured with Global and Local corrections in.

22 March, Fill ?.

- On momentum optics measured at 0.7m with the Local and Global corrections implemented.

Betabeat through the squeeze.

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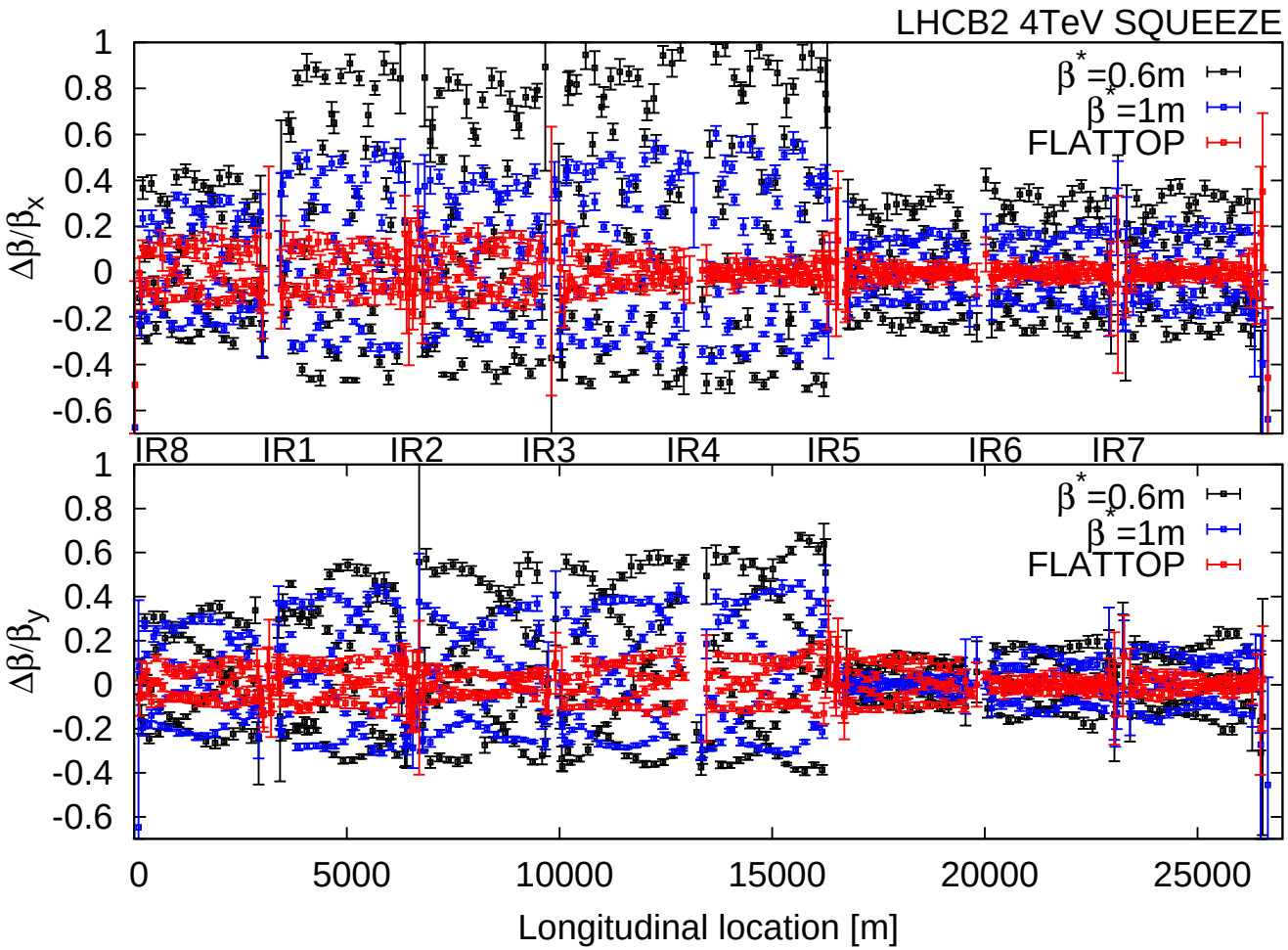
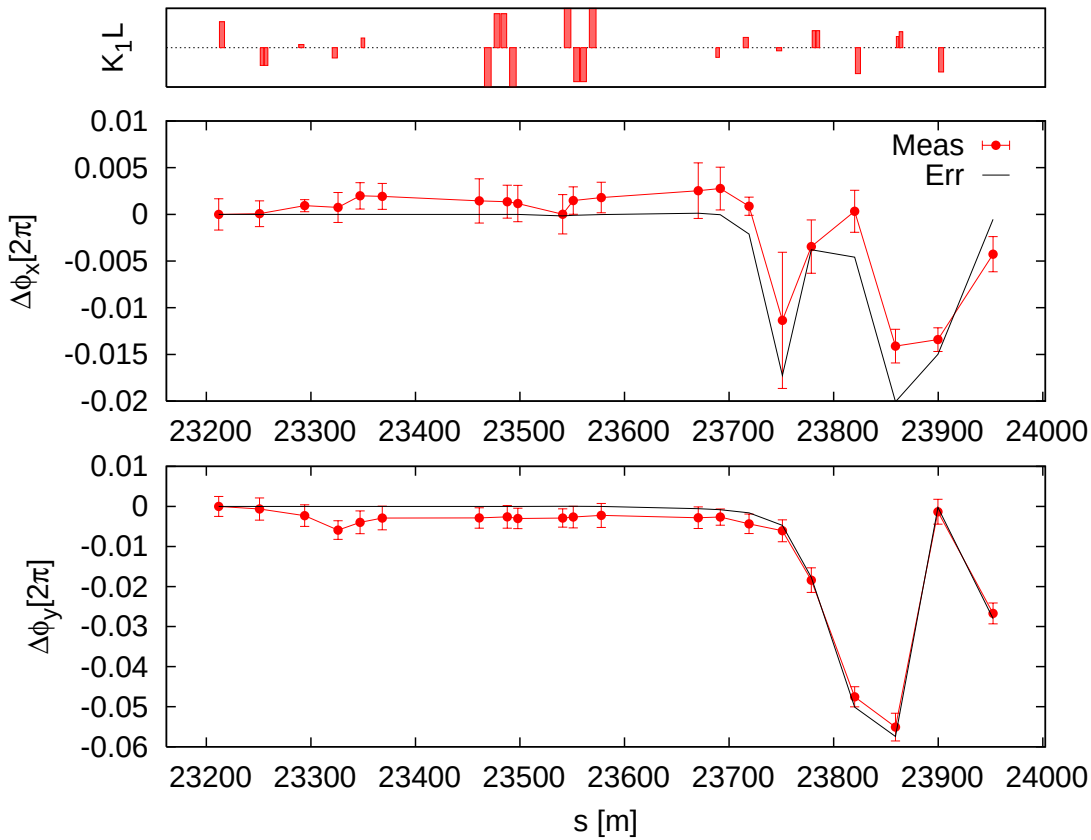


Figure: Uncorrected beam 2 beta-beating through the squeeze.

Local corrections.

Local corrections were performed for IP1,5,6,8.

betabeat_local_cor_squeeze_2012, constant trim from flattop to 0.6m



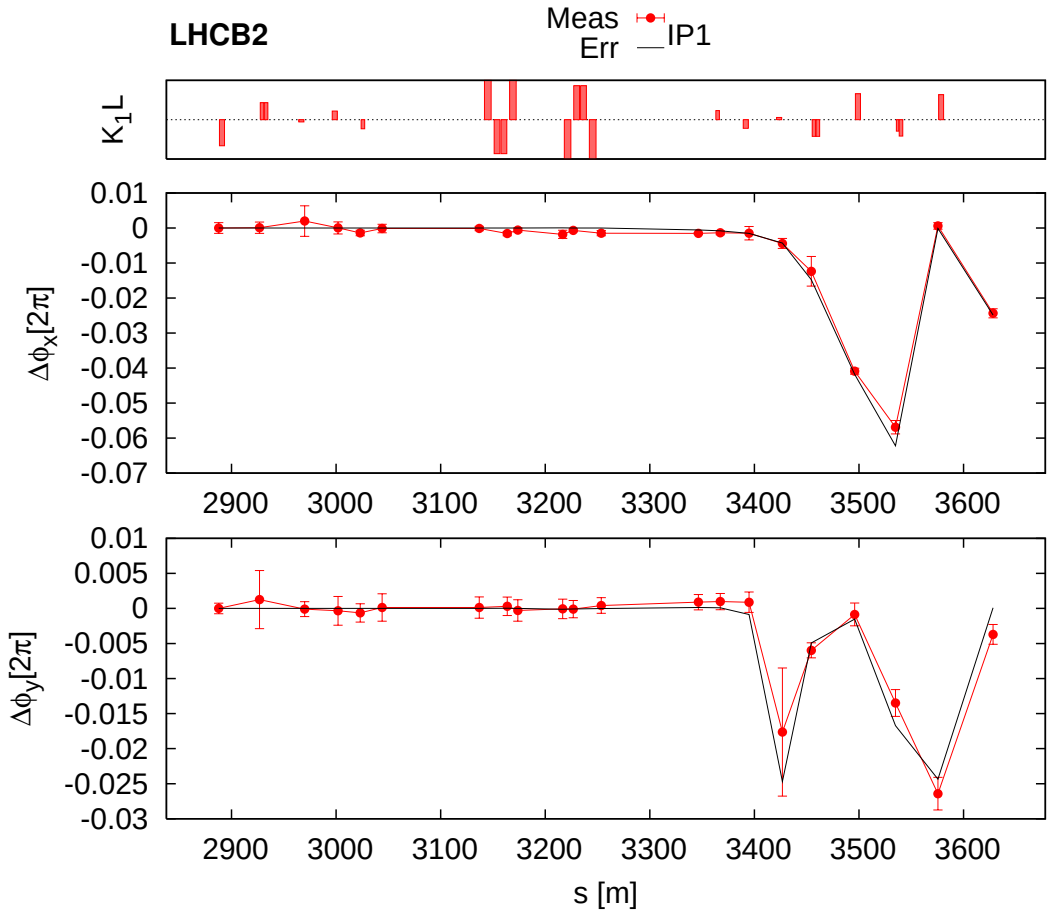
Element	Δk
ktqx2.r1	-1.4e-5
ktqx2.l1	1.0e-5
ktqx1.r1	1.0e-5
kq4.l1b2	-0.5e-5
kq9.l1b1	1.5e-5

Figure: Propagated phase for beam 1 IP1.

Local corrections.

Local corrections were performed for IP1,5,6,8.

betabeat_local_cor_squeeze_2012, constant trim from flattop to 0.6m



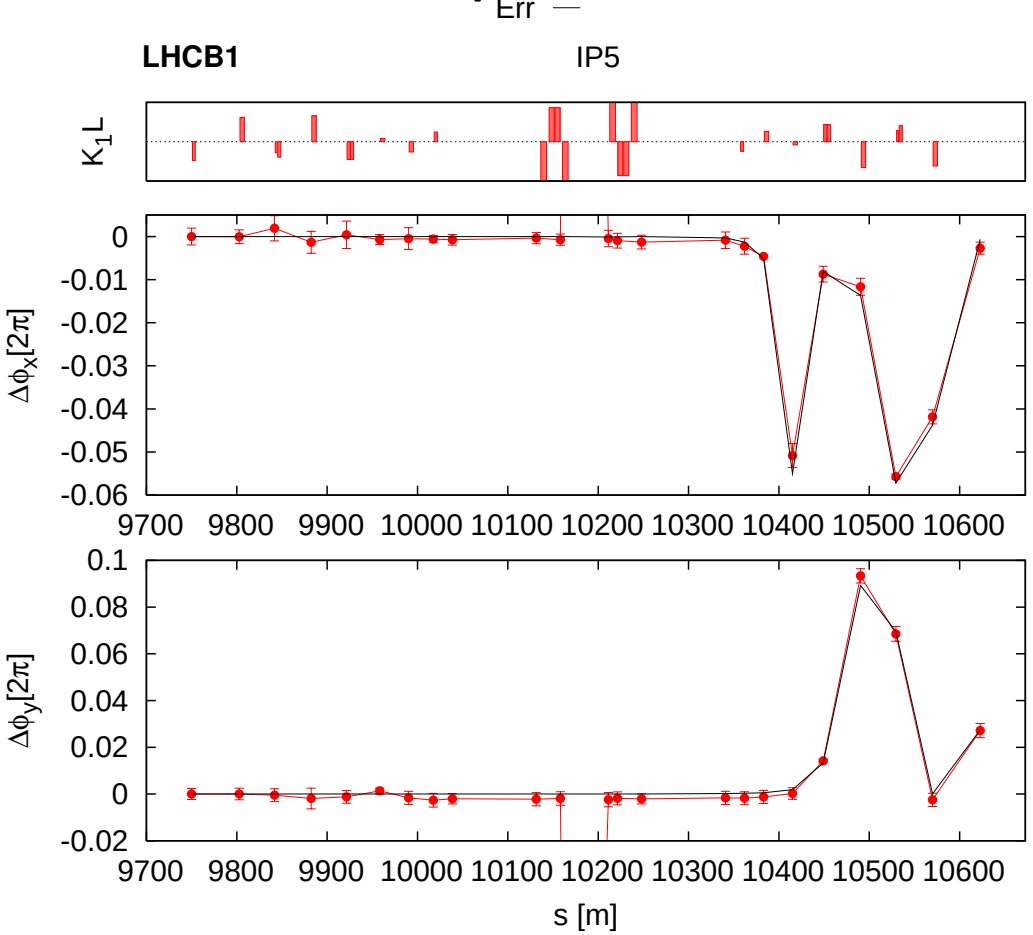
Element	Δk
ktqx2.r1	-1.4e-5
ktqx2.l1	1.0e-5
ktqx1.r1	1.0e-5
kq4.l1b2	-0.5e-5
kq9.l1b1	1.5e-5

Figure: Propagated phase for beam 2 IP1.

Local corrections.

Local corrections were performed for IP1,5,6,8.

betabeat_local_cor_squeeze_2012, constant trim from flattop to 0.6m



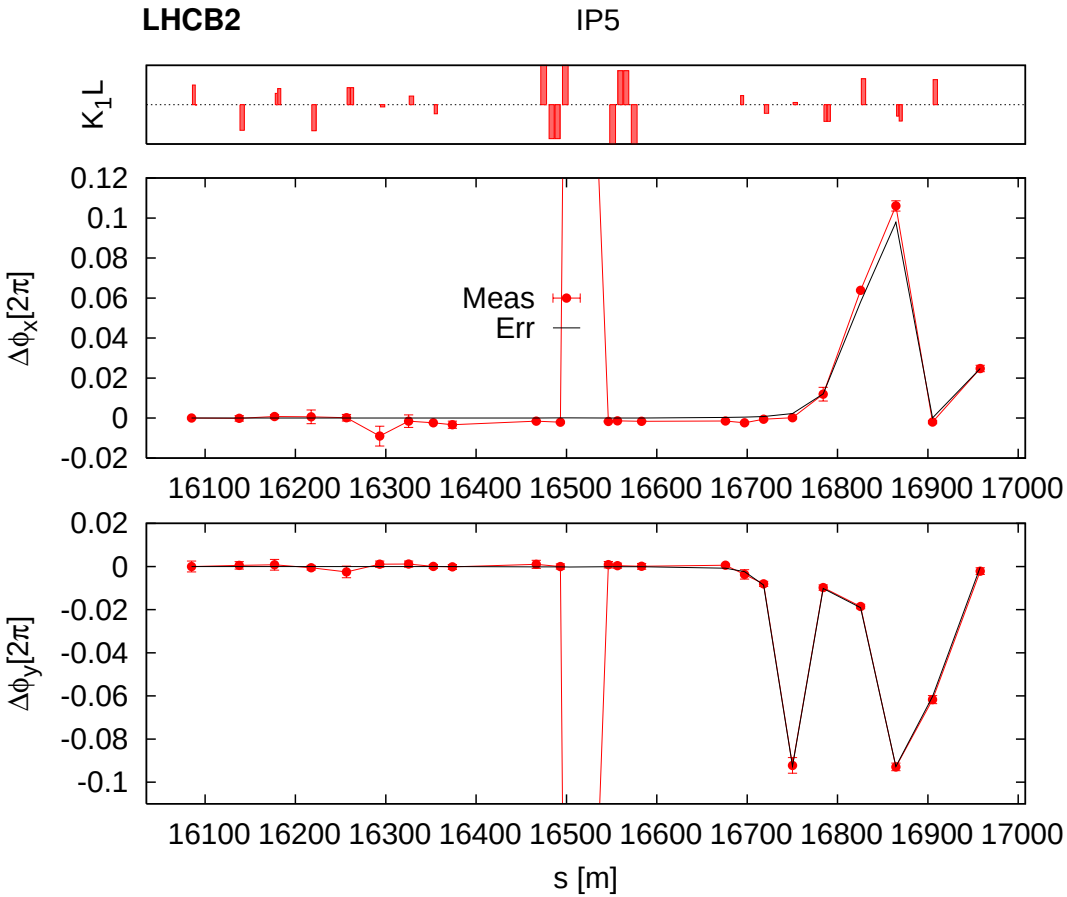
Element	Δk
ktqx2.r5	1.05e-5
ktqx2.l5	0.70e-5
kq4.l5b2	3.8e-5

Figure: Propagated phase for beam 1 IP5.

Local corrections.

Local corrections were performed for IP1,5,6,8.

betabeat_local_cor_squeeze_2012, constant trim from flattop to 0.6m



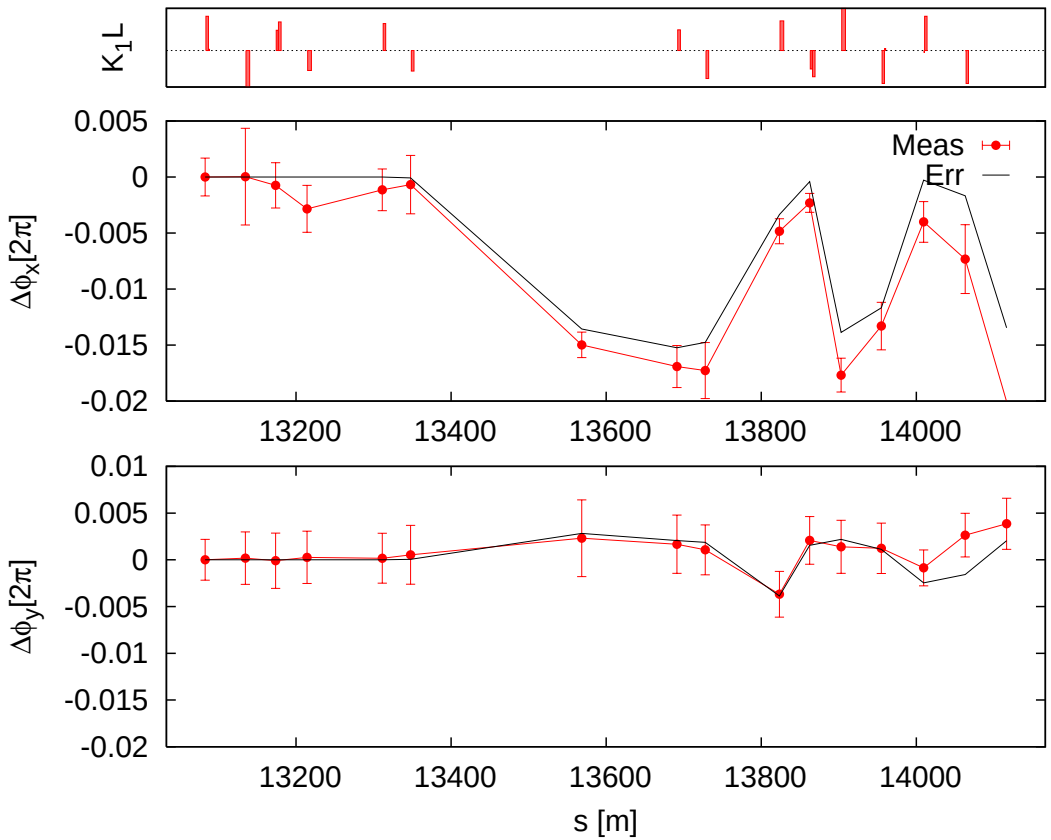
Element	Δk
ktqx2.r5	1.05e-5
ktqx2.l5	0.70e-5
kq4.l5b2	3.8e-5

Figure: Propagated phase for beam 2 IP5.

Local corrections.

Local corrections were performed for IP1,5,6,8.

betabeat_local_cor_squeeze_2012, constant trim from flattop to 0.6m



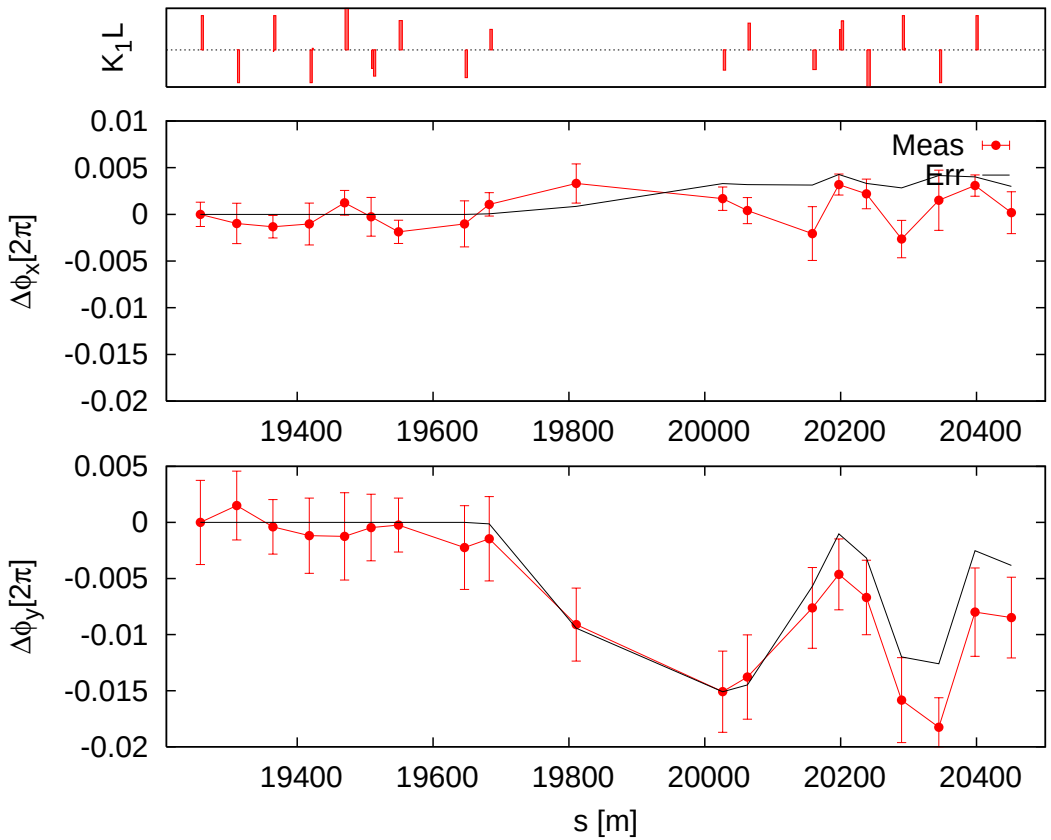
Element	Δk
kq5.l6B1	-3.9e-5
kq5.r6B1	9.0e-6
kq5.l6b2	4.8e-5
kq5.r6b2	1.0e-5

Figure: Propagated phase for beam 1 IP6.

Local corrections.

Local corrections were performed for IP1,5,6,8.

betabeat_local_cor_squeeze_2012, constant trim from flattop to 0.6m



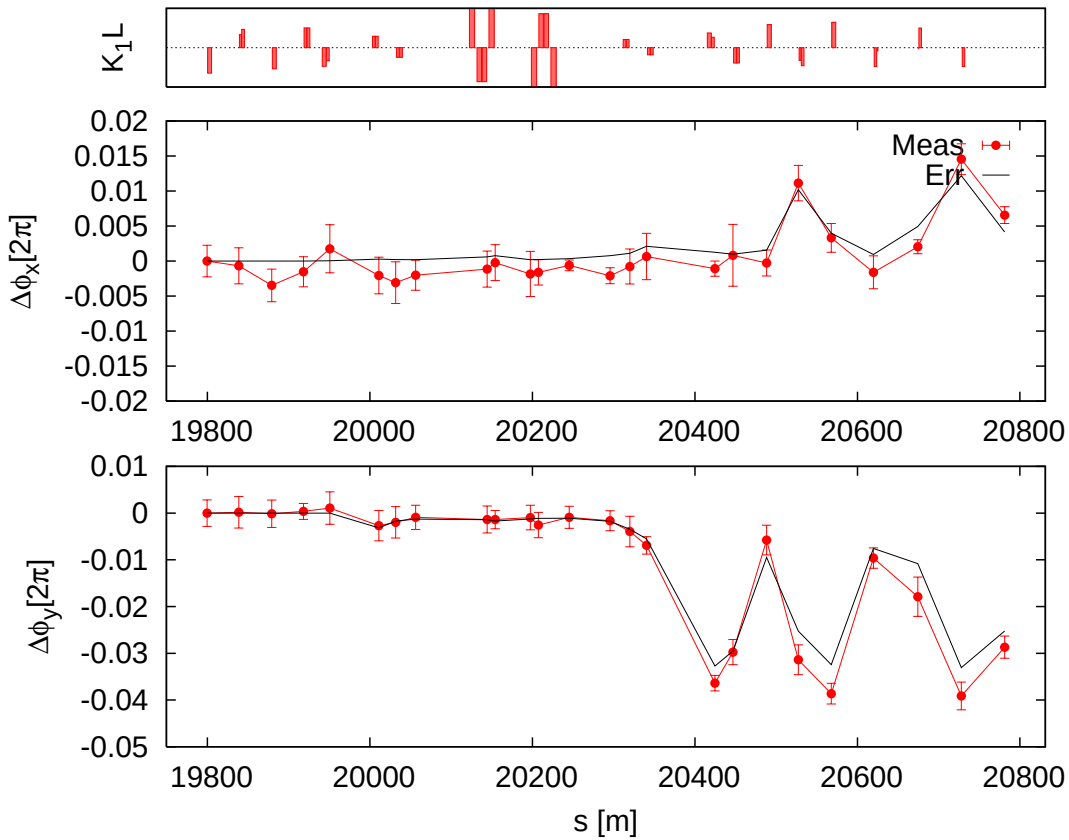
Element	Δk
kq5.l6B1	-3.9e-5
kq5.r6B1	9.0e-6
kq5.l6b2	4.8e-5
kq5.r6b2	1.0e-5

Figure: Propagated phase for beam 2 IP6.

Local corrections.

Local corrections were performed for IP1,5,6,8.

betabeat_local_cor_squeeze_2012, constant trim from flattop to 0.6m



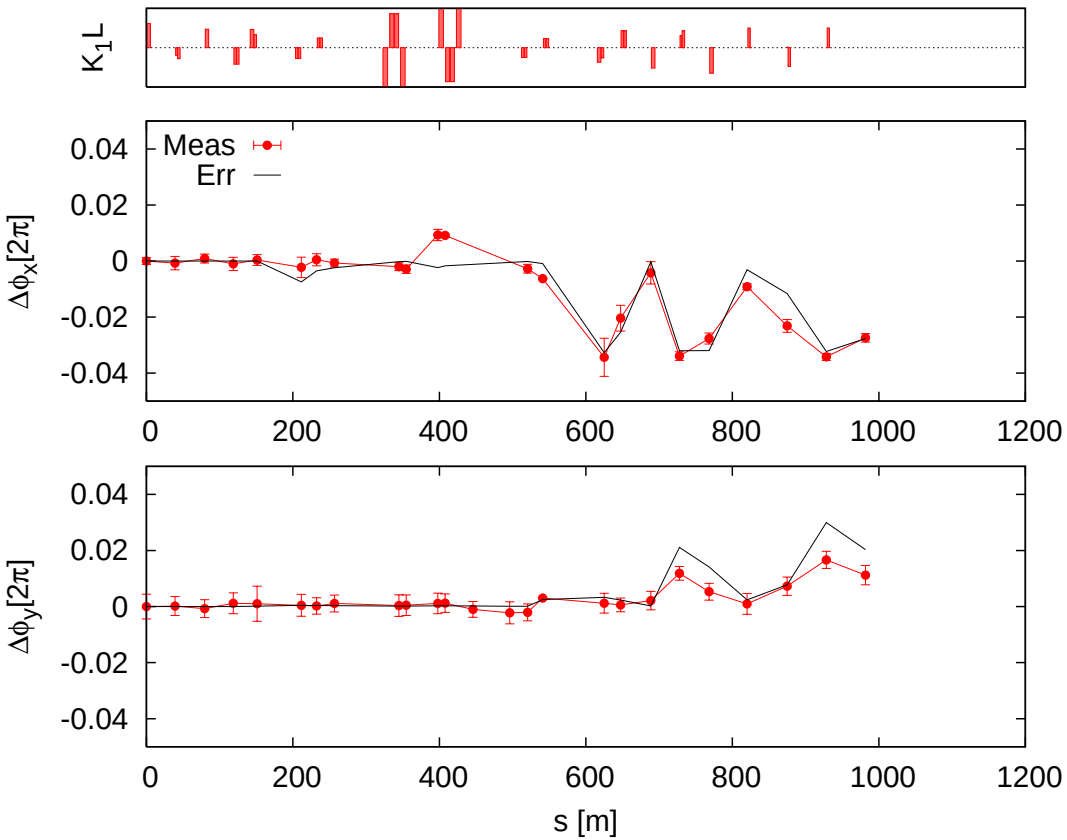
Element	Δk
kq4.r8B2	-1.0e-4
kq5.r8B2	-0.3e-4
kq6.l8B2	-3.0e-5
kq6.l8B1	0.2e-4
kq4.l8B1	0.4e-4
kq5.r8B1	0.8e-4

Figure: Propagated phase for beam 1 IP8.

Local corrections.

Local corrections were performed for IP1,5,6,8.

betabeat_local_cor_squeeze_2012, constant trim from flattop to 0.6m

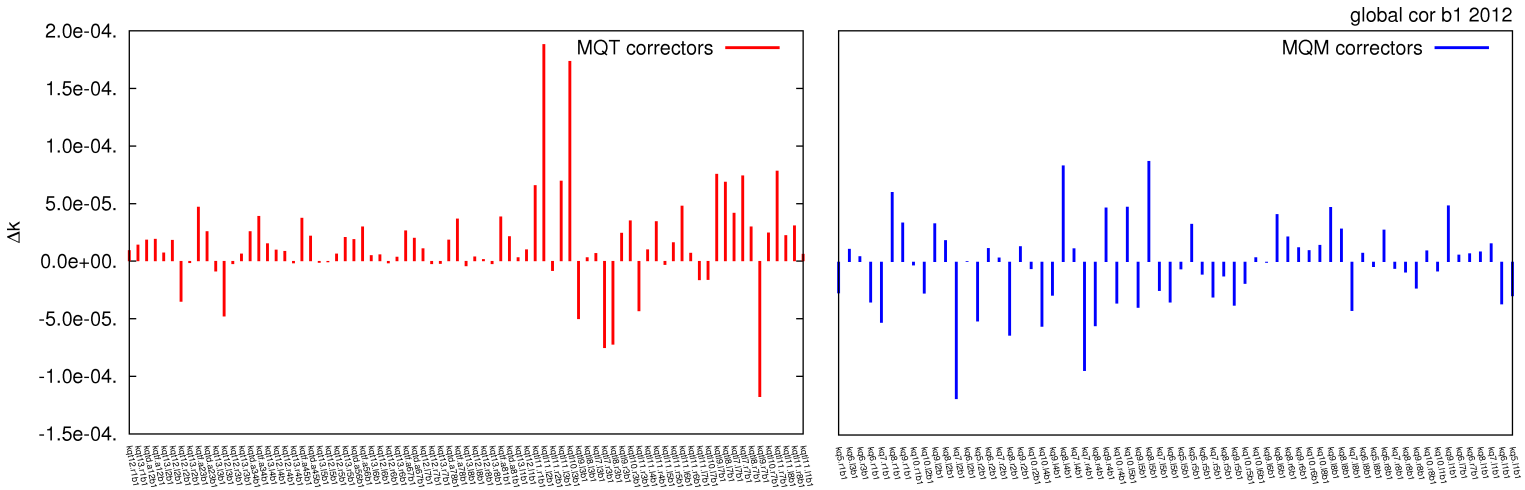


Element	Δk
kq4.r8B2	-1.0e-4
kq5.r8B2	-0.3e-4
kq6.l8B2	-3.0e-5
kq6.l8B1	0.2e-4
kq4.l8B1	0.4e-4
kq5.r8B1	0.8e-4

Figure: Propagated phase for beam 2 IP8.

Global corrections.

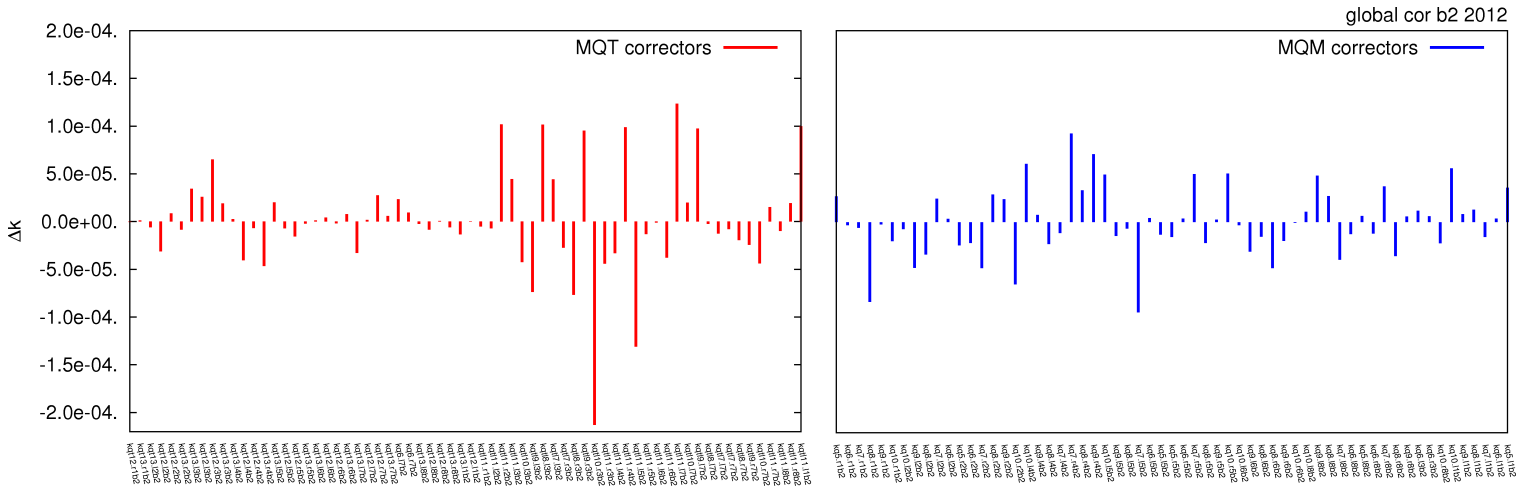
Global correction for $\Delta\beta/\beta$ & D_x found at 0.6m.
$\longrightarrow$ Independent corrections for B1 & B2 (MQM & MQT).



global_cor_b1_2012 Highest correctors: kqtl11.l2b1, kqtl11.l3b1, kqtl9.r7b1.
global_cor_b2_2012

Global corrections.

Global correction for $\Delta\beta/\beta$ & D_x found at 0.6m.
$\longrightarrow$ Independent corrections for B1 & B2 (MQM & MQT).



global_cor_b1_2012
global_cor_b2_2012 Highest correctors: kqtl10.r3b2, kqtl11.l5b2, kqtl11.l7b2

$\Delta\beta/\beta$ & D_x Measurements.

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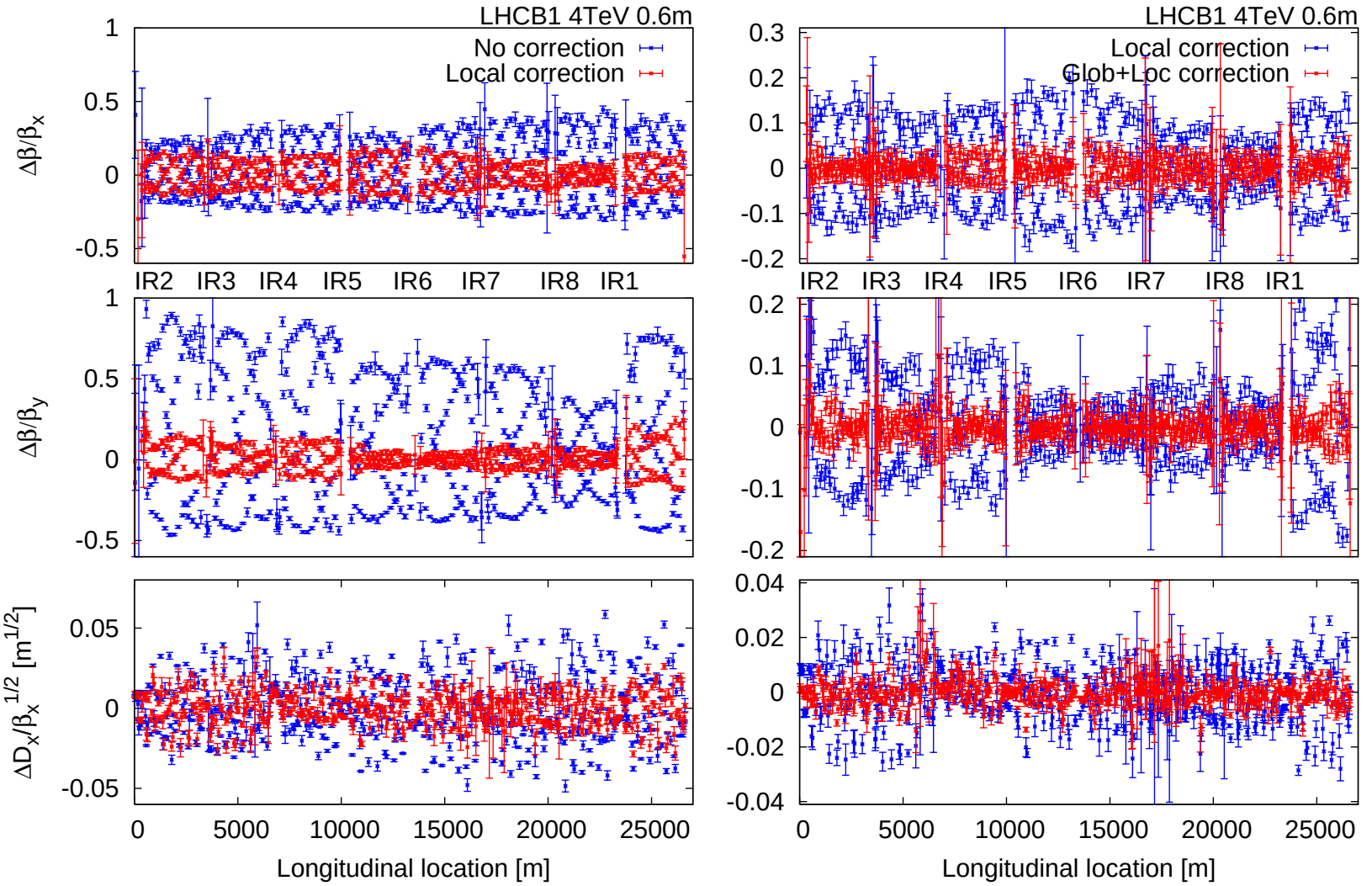

Figure: Beam1: Beta-beating and Normalized Dispersion before and after corrections were applied.

$\Delta\beta/\beta$ & D_x Measurements.

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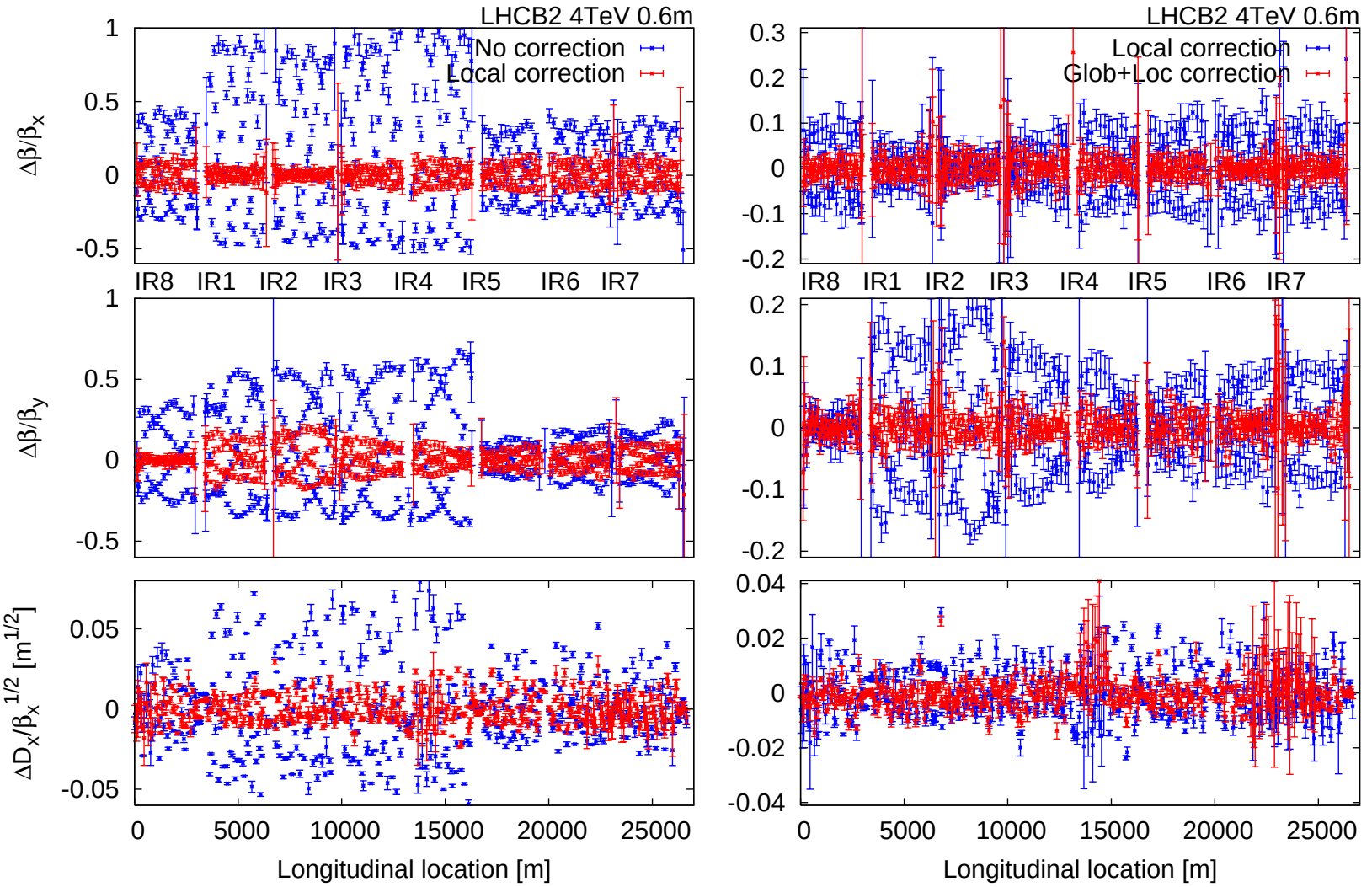

Figure: Beam2: Beta-beating and Normalized Dispersion before and after corrections were applied.

$\Delta\beta/\beta$ & D_x Measurements.

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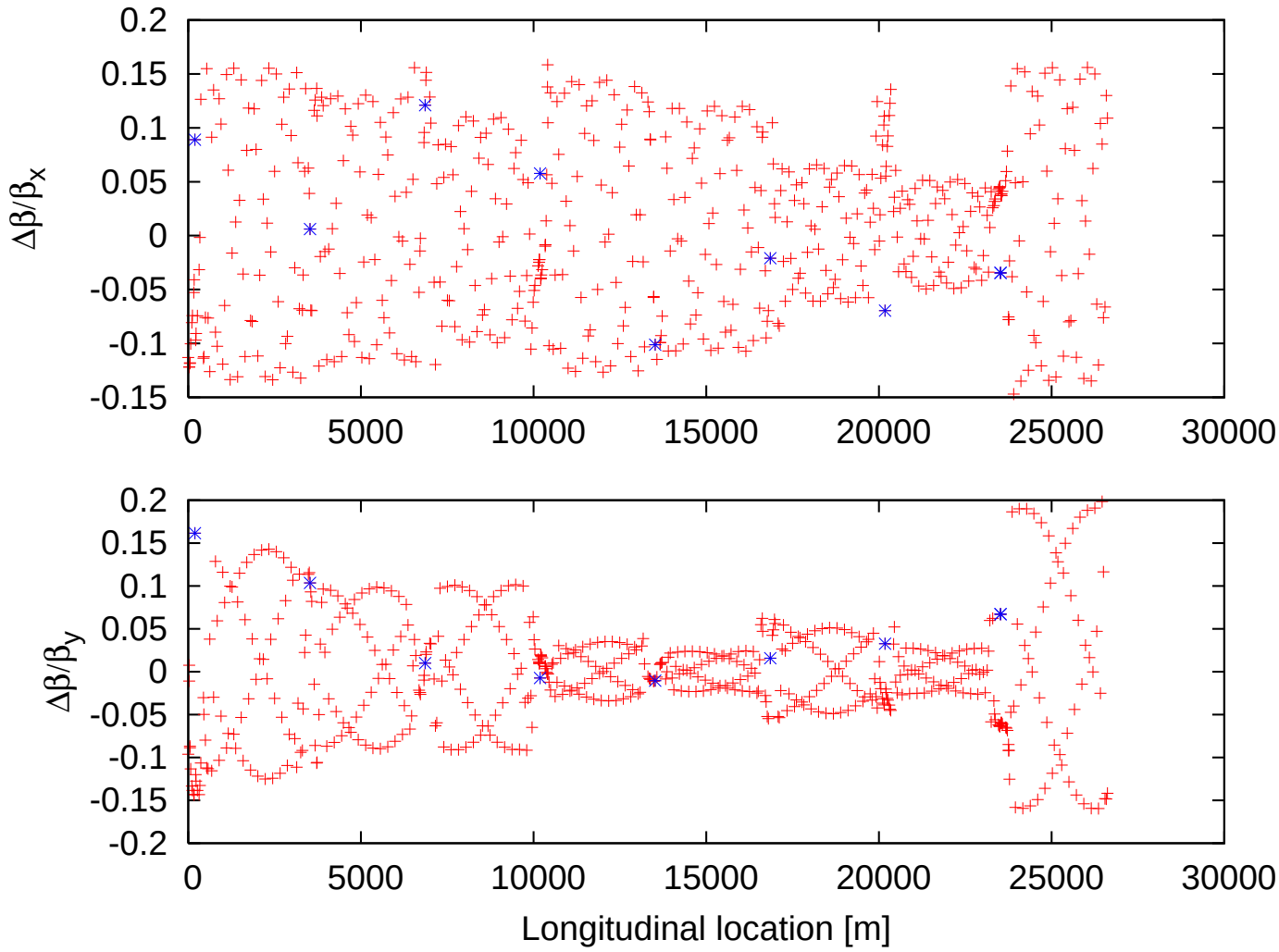

Figure: Beam1: Beta-beating generated in nominal model by global correction.

Measurements at 0.7m

Corrections were checked at $\beta^* = 0.7m$

·Local knob is constant from flattop.

·Global knob trimmed in linearly: $\beta^* = 0.7m \rightarrow 73\% trim$.

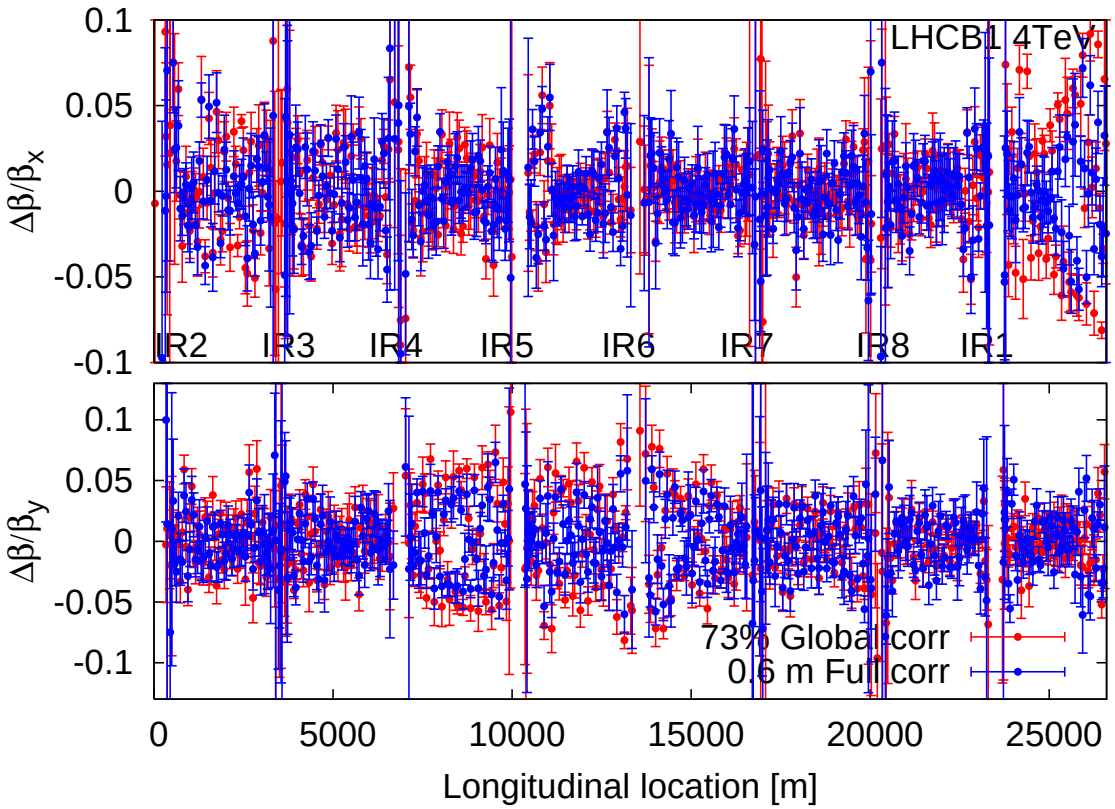

Figure: Beam1: 0.6m with 100% global knob trim vs 0.7m, 73% trim.

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Corrections were checked at $\beta^* = 0.7m$

·Local knob is constant from flattop.

·Global knob trimmed in linearly: $\beta^* = 0.7m \rightarrow 73\% trim$.

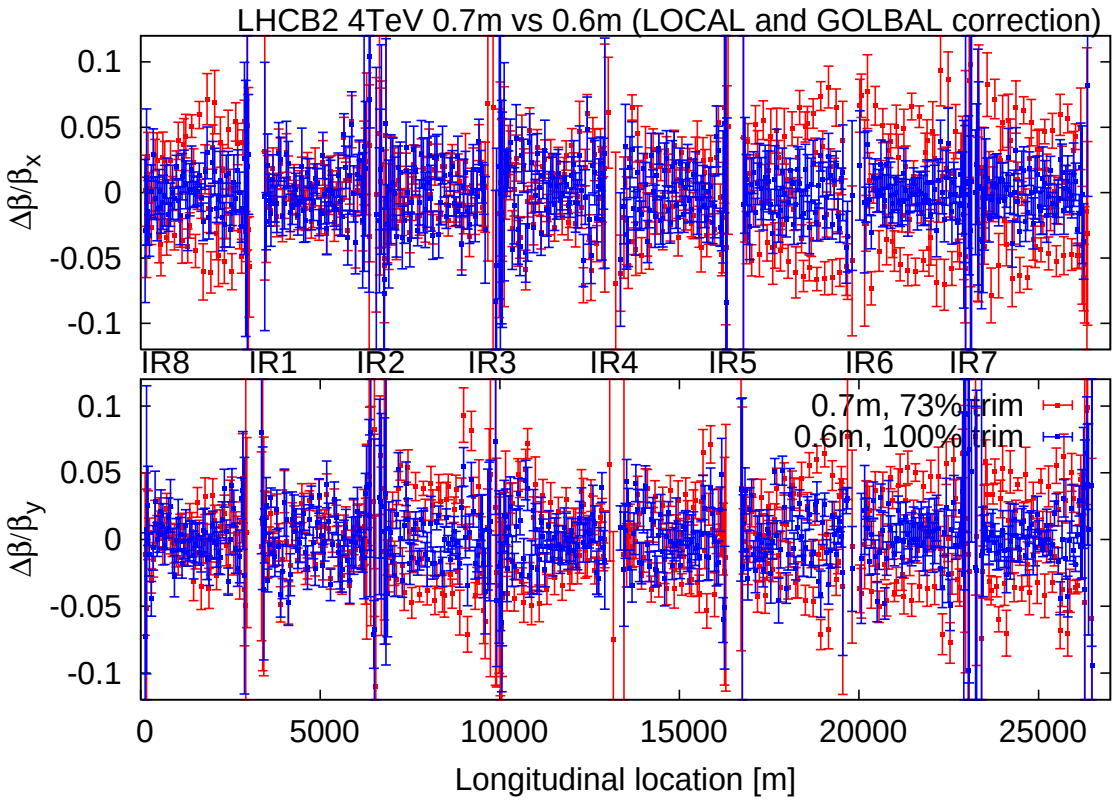

Figure: Beam1: 0.6m with 100% global knob trim vs 0.7m, 73% trim.

Summary 4 TeV.

Local correction:
$\rightarrow$ Reduced $\Delta\beta/\beta$ from $\geq 90\%$ to $\sim 20\%$ in both beams.

Global corrections:
Highest correctors $\leq$2.2e-4
$\rightarrow$ Further reduced $\Delta\beta/\beta$ from $\sim 20\%$ to $\sim 5\%$.

Local + global correction reduced normalized dispersion from $0.08m^{1/2}$(B1) & $0.05m^{1/2}$(B2) to $\sim 0.01m^{1/2}$ (both beams).

$\Delta\beta/\beta$ at 0.7m with local & 73% global remains $\sim 5\%$.