

Cryo-Collimator Layouts for IR3

John Jowett

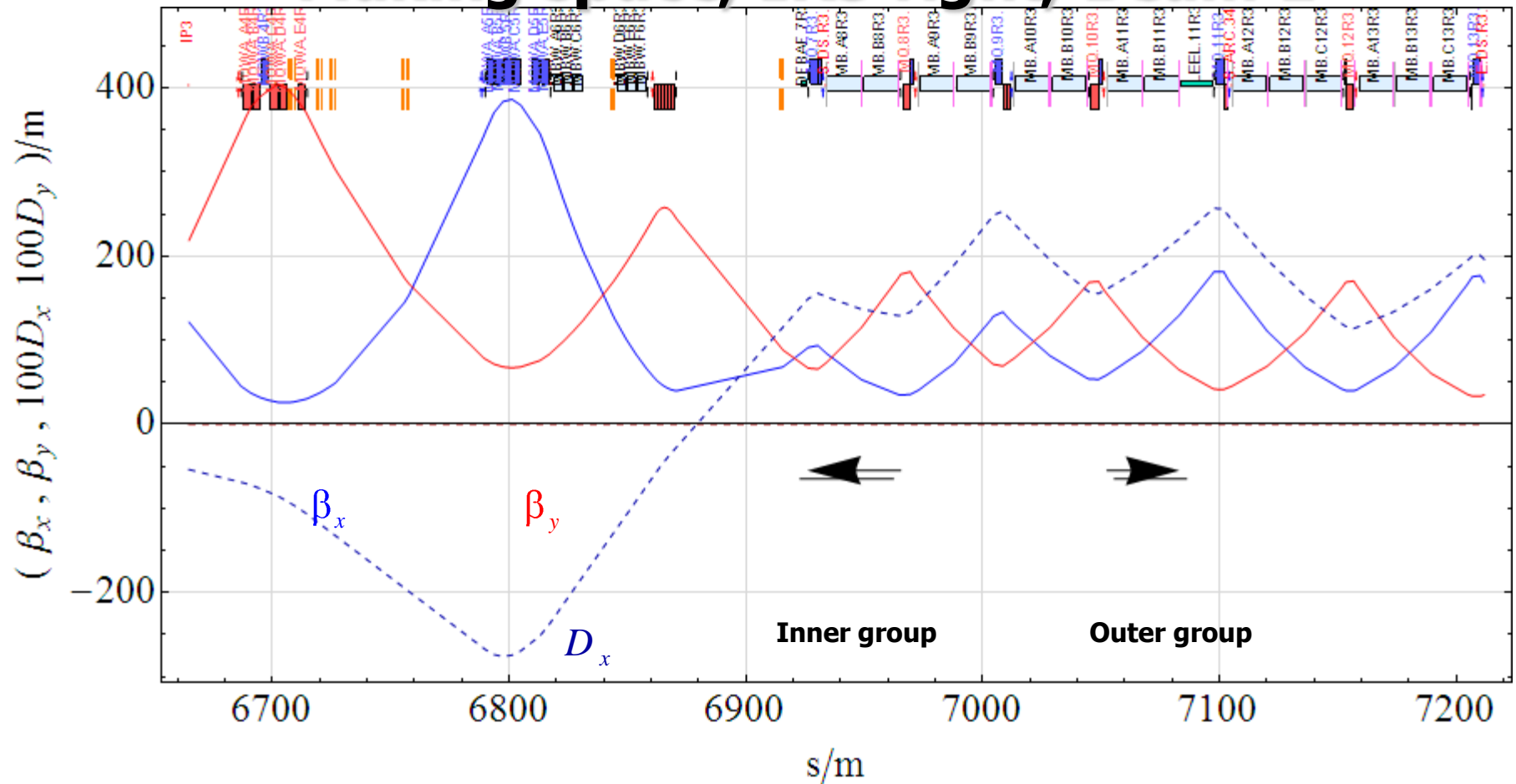
Plan of talk

- Previously gave baseline layout and new optics for IR7
 - See my slides in Phase II Collimation review (April 2009)
- Layouts now needed for IR3
 - Baseline, analogous to one done for IR7
 - Alternative, proposed by J P Tock

Baseline layout

- Minimises geometrical perturbations
- Should not be difficult to recover similar optics

Making space, IR3 right, Beam 1

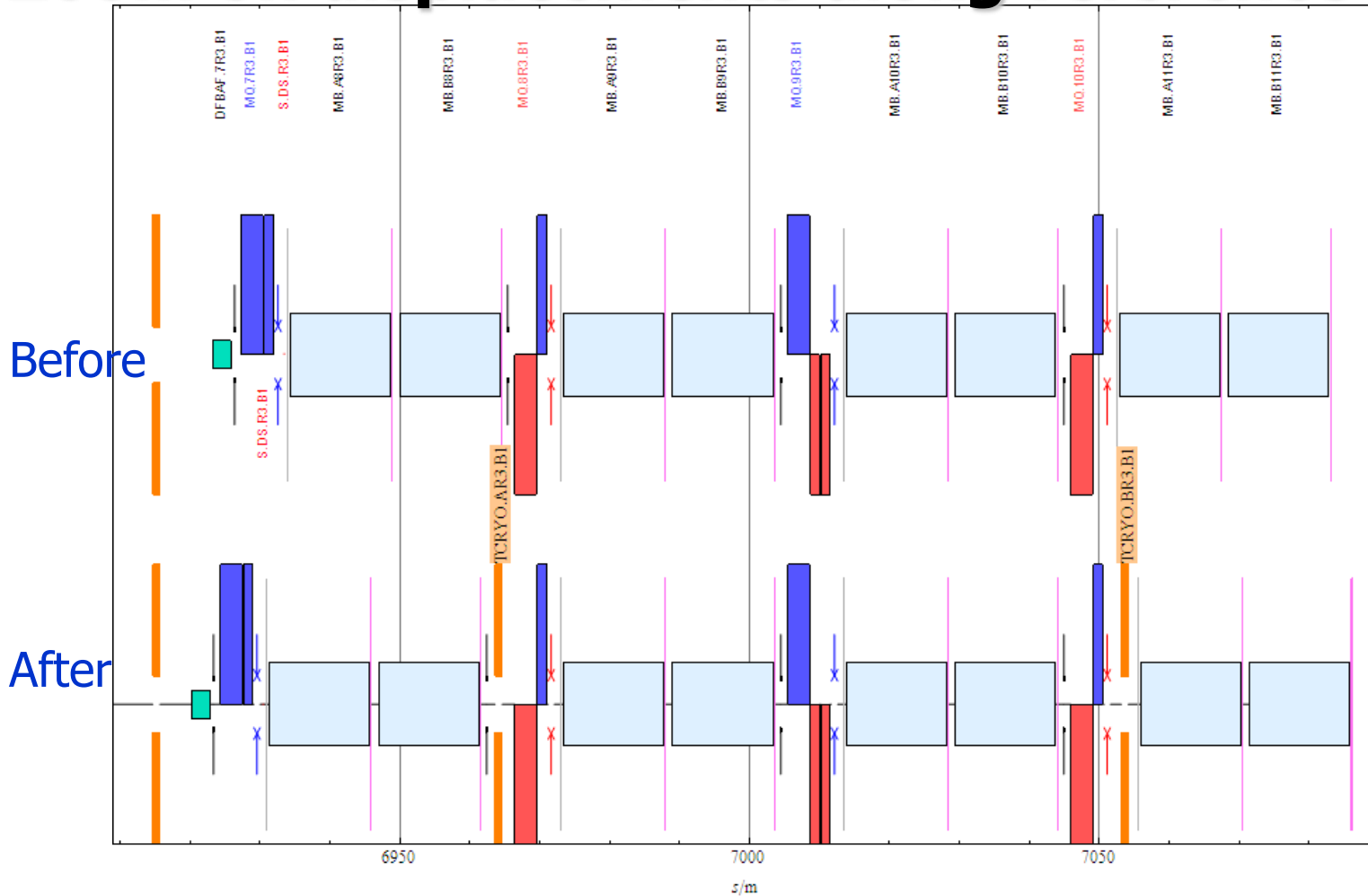


Move outer group of elements 3 m away from IP into missing dipole space.

Move inner group of elements 3 m towards IP to (roughly) compensate change in geometry.

Similarly on right of IP3.

Zoom on displacements along reference orbit

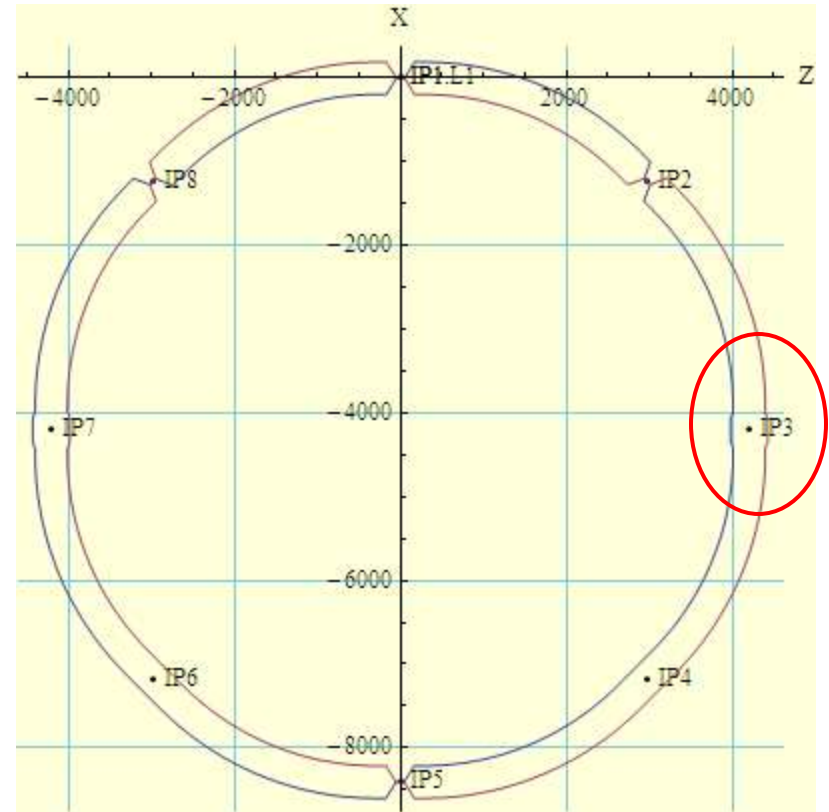


This vacates enough space in the right places to install the cryogenic collimators.

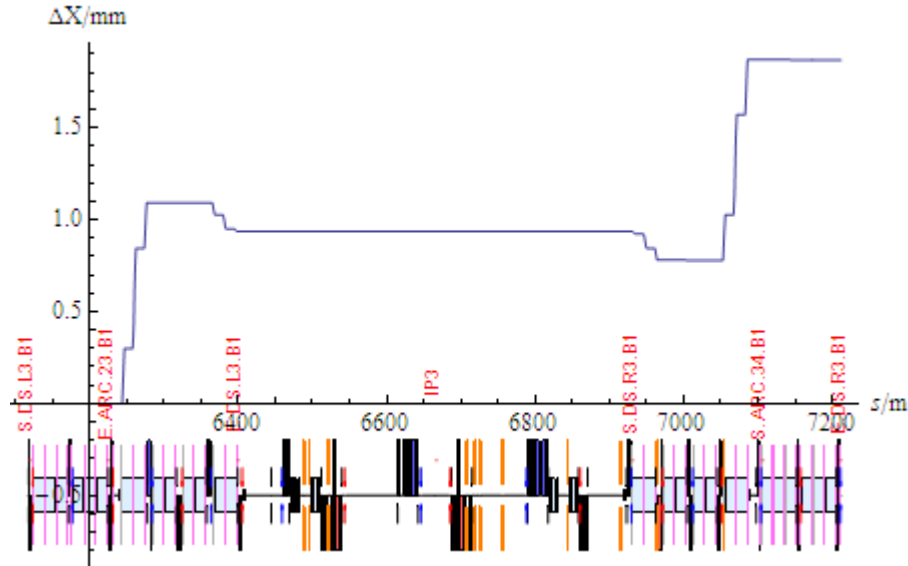
N.B. this is in Courant-Snyder coordinate s , so we do not see the change in geometry of the LHC.

Global Cartesian Coordinate System

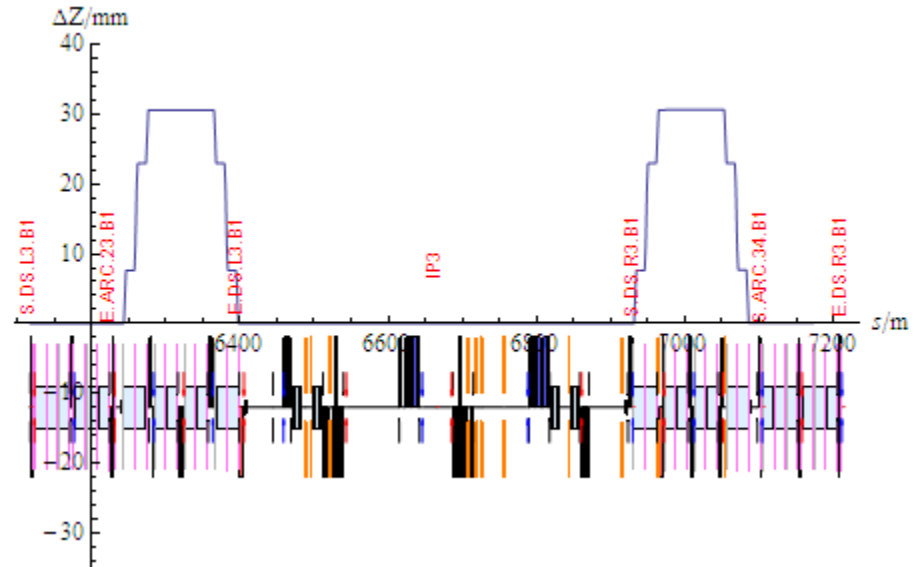
- Global coordinates, in the straight part of the betatron collimation insertion section around IR7:
 - X is longitudinal
 - Y is vertical
 - Z is radialw.r.t. Courant-Snyder coordinates.
- Use (Z, X) as coordinates in the machine plane



Displacements of reference orbit, Beam 1



Longitudinal displacement mainly reflects change in length of reference orbit – can be fixed.



Radial displacement of reference orbit between shifted sections by 30 mm.
N.B. Not the displacement of elements!

Displacements of moved elements, Beam 1, left of IP7

In the global cartesian frame, the displacements of the outer and inner groups of elements include a component from the angle ("curvature") of the initial reference orbit.

MAD - and the LHC Layout Database - use the "beads on a necklace" method of laying out the machine so everything downstream of IR7 moves and the ring does not close ... this is not real of course but has to be corrected in our description.

Outer group

	$\Delta Z/ m$	$\Delta X/ m$
MCO.11L3.B1	- 0.1224	2.998
MCD.11L3.B1	- 0.1224	2.998
MB.B11L3.B1	- 0.1224	2.998
MCS.B11L3.B1	- 0.1224	2.998
MB.A11L3.B1	- 0.1224	2.998
MCS.A11L3.B1	- 0.1224	2.998

Inner group

	$\Delta Z/ m$	$\Delta X/ m$
MCO.8L3.B1	0.00001910	- 3.001
MCD.8L3.B1	0.00001910	- 3.001
MB.B8L3.B1	0.00001910	- 3.001
MCS.B8L3.B1	0.00001910	- 3.001
MB.A8L3.B1	0.00001910	- 3.001
MCS.A8L3.B1	0.00001910	- 3.001
E.DS.L3.B1	0.00001910	- 3.001
BPM.7L3.B1	0.00001910	- 3.001
MQ.7L3.B1	0.00001910	- 3.001
MQTLI.7L3.B1	0.00001910	- 3.001
MCBCV.7L3.B1	0.00001910	- 3.001
DFBAE.7L3.B1	0.00001910	- 3.001

	$\Delta Z/ m$	$\Delta X/ m$
IP1	0	0
IP2	0	0
IP3	0.00001910	-0.0009361
IP4	0	-0.001872
IP5	0	-0.001872
IP6	0	-0.001872
IP7	0	-0.001872
IP8	0	-0.001872
IP1.L1	0	-0.001872

Corrected layout

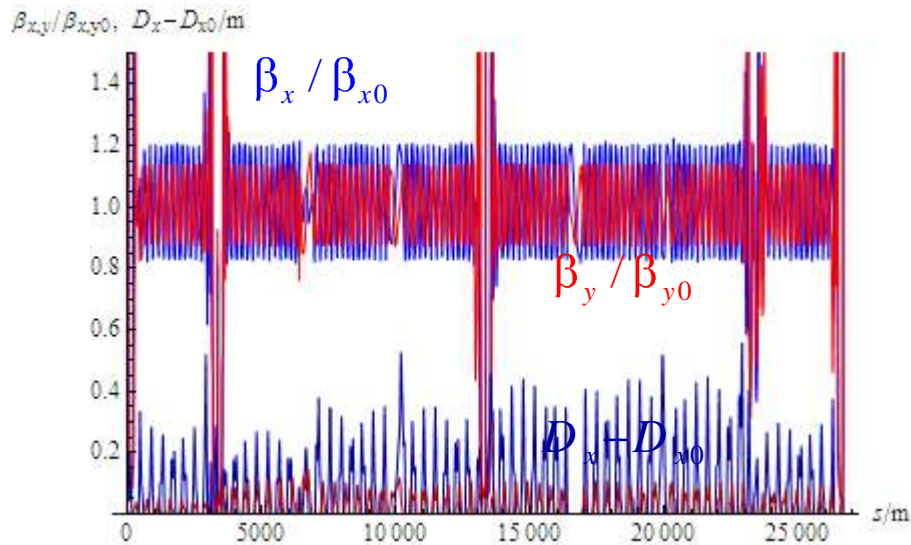
Small negative displacements of all elements downstream of IR7 along the reference orbit restores them to their original position in the global cartesian system and closes the ring.

New sequence descriptions created for both rings.

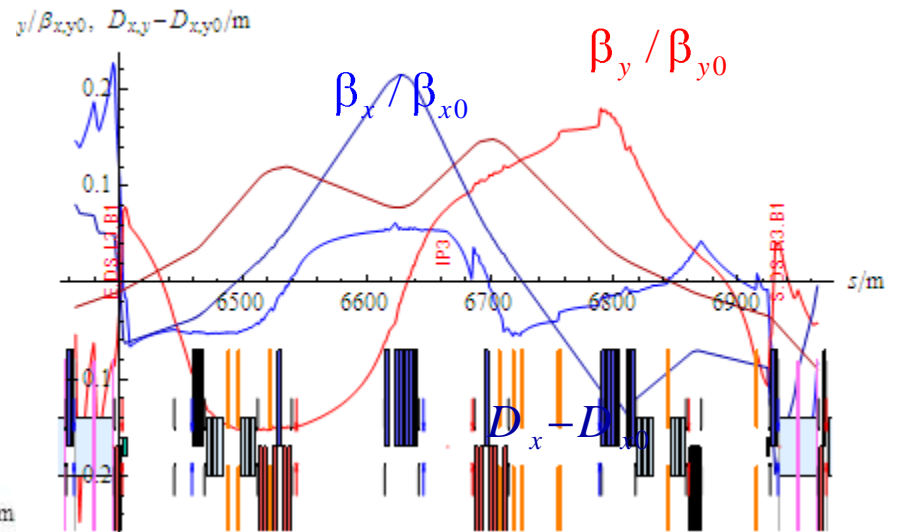
	$\Delta Z/ m$	$\Delta X/ m$
IP1	0	0
IP2	0	0
IP3	0.00001910	0
IP4	0	$- 4.202 \times 10^{-10}$
IP5	0	$- 4.202 \times 10^{-10}$
IP6	0	$- 4.183 \times 10^{-10}$
IP7	0	$- 4.183 \times 10^{-10}$
IP8	0	$- 4.183 \times 10^{-10}$
IP1.L1	0	$- 4.184 \times 10^{-10}$

LHC circumference is changed by -1.872 mm.

Optical perturbations



β -beating in whole Ring 1

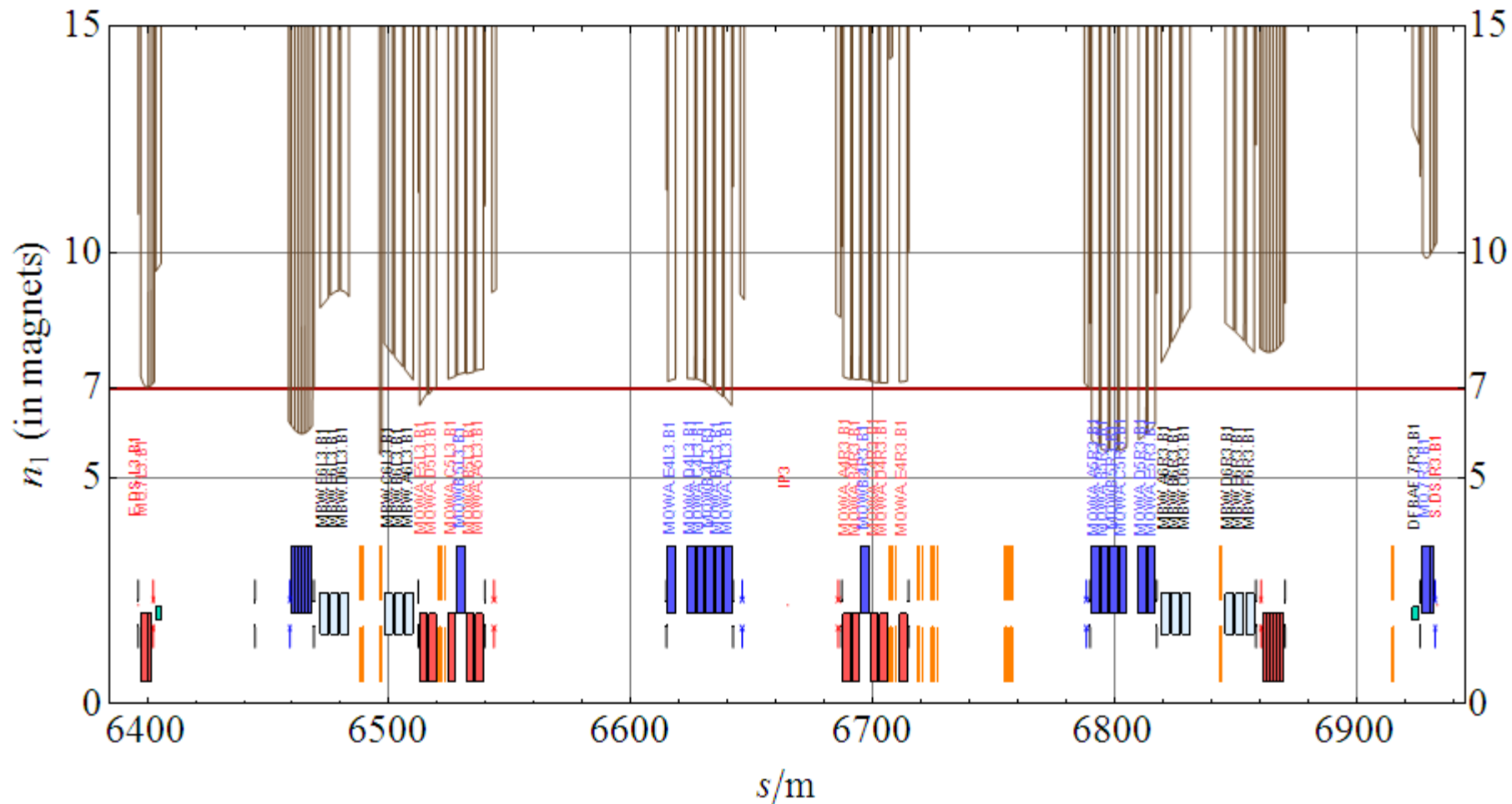


β -beating in IR3, Ring 1

Change in layout perturbs the optical functions, giving about 20% β -beating which must be corrected.

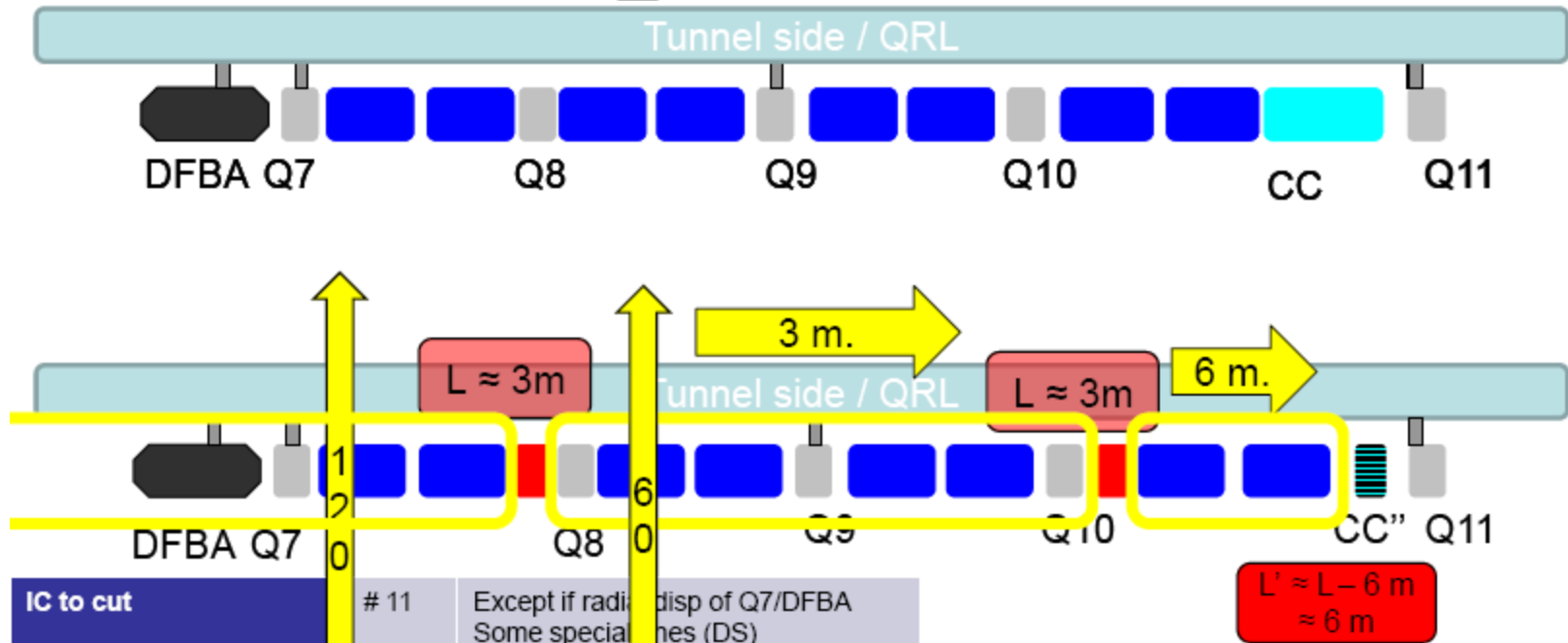
Rematch IR3 for each ring without using the common quadrupoles that affect both – done for IR7, not yet for IR3.

n1-aperture of nominal IR3, Beam 1 at injection



Alternative layout, avoid moving DFB

DSR_: "Alternative 1"



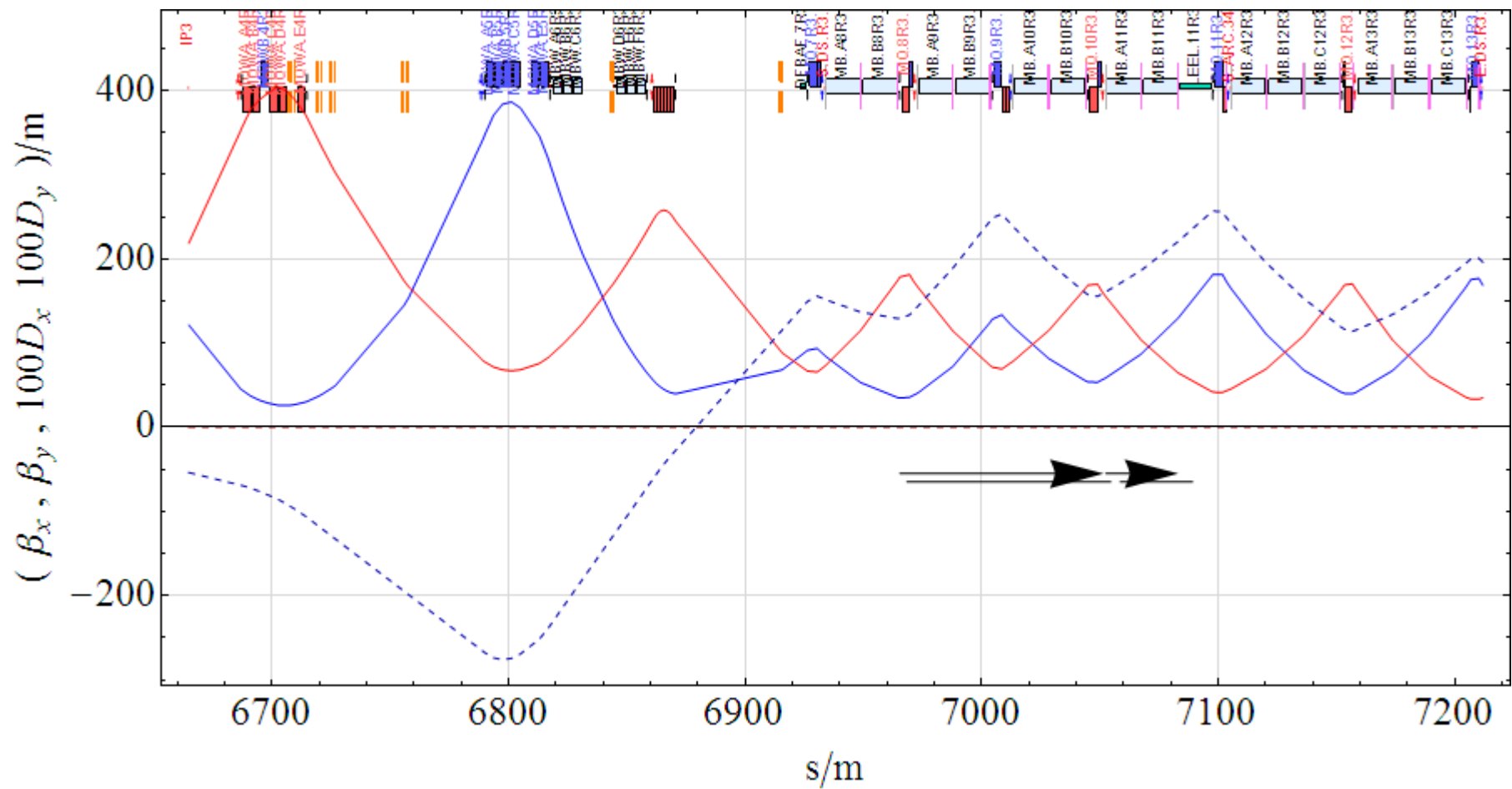
IC to cut	# 11	Except if radial disp of Q7/DFBA Some special cases (DS)
Jumpers to cut	# 1	
Cryostats to move	# 9	9 Longitudinally & Radially Except if radial disp of Q7/DFBA
DFBA to move	# 0	No (Limited) impact on warm region
CTW Modules	# 4	Cold To Warm : 2 per collimator
New cryostats	# 3	1 CC' of ≈ 6 m length + 2 CColl
Jumper longi motion	# 1	Q9
Modif line N	# 1 (2)	

Difficult due to lateral space limitations

15th of March 2010

Collimation WG

4/12
JPh Tock TE/MS-CI

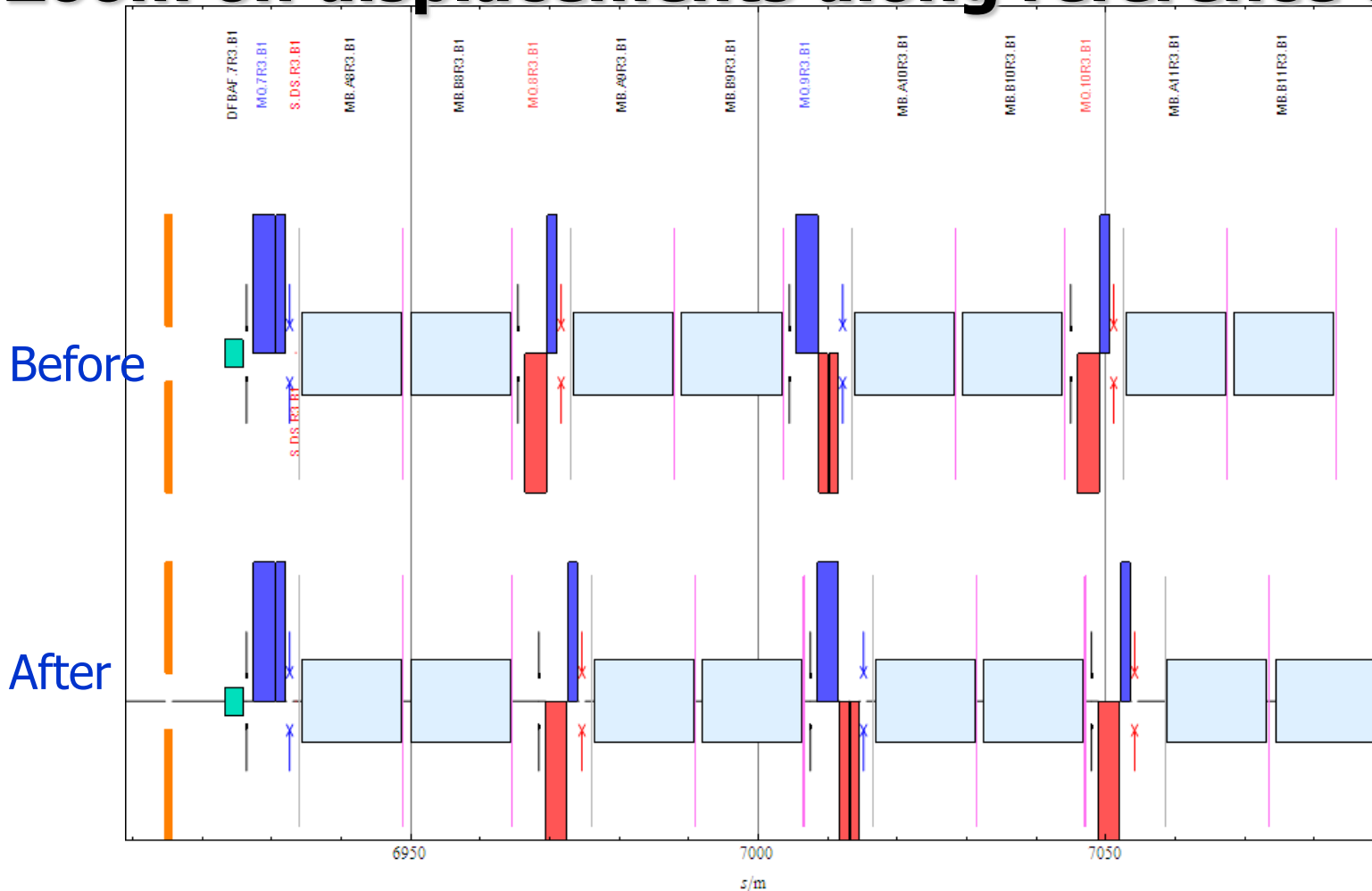


Move outer group of elements 6 m away from IP into missing dipole space.

Move inner group of elements 3 m away from IP, leaving another space/

Similarly on right of IP3.

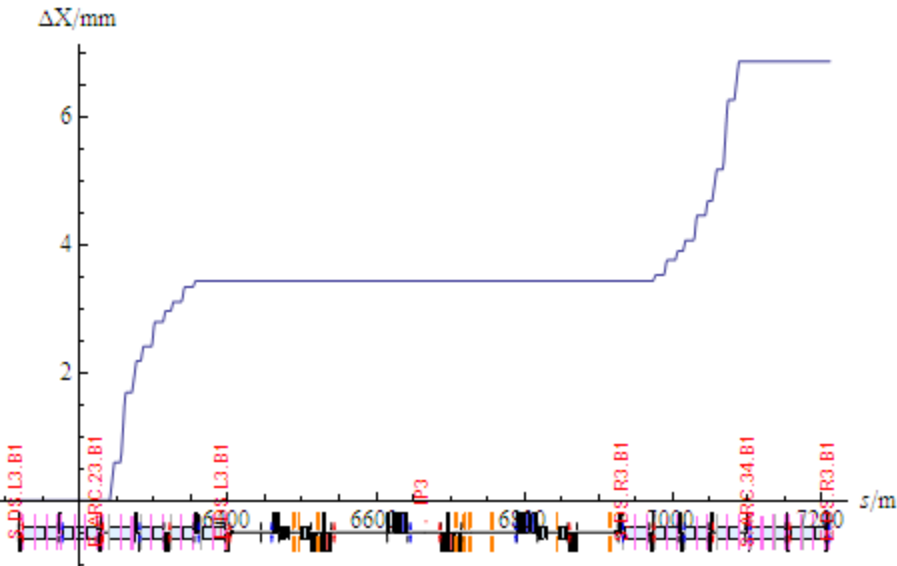
Zoom on displacements along reference orbit



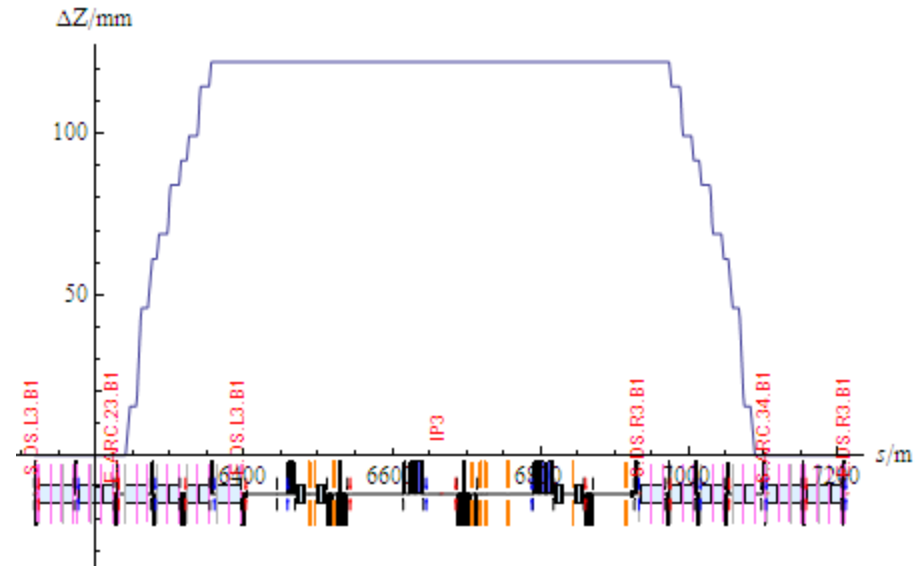
This vacates enough space in the right places to install the cryogenic collimators.

N.B. this is in Courant-Snyder coordinate s , so we do not see the change in geometry of the LHC.

Displacements of reference orbit, Beam 1



Longitudinal displacement mainly reflects change in length of reference orbit – can be fixed.



Radial displacement of reference orbit between along straight section by 120 mm.
N.B. Not the displacement of elements!

Displacements of moved elements, Beam 1, left of IP7

In the global cartesian frame, the displacements of the outer and inner groups of elements include a component from the angle ("curvature") of the initial reference orbit.

MAD - and the LHC Layout Database - use the "beads on a necklace" method of laying out the machine so everything downstream of IR3 moves and the ring does not close ... this is not real of course but has to be corrected in our description.

Outer group

	$\Delta Z/m$	$\Delta X/m$
MCO.11L3.B1	-0.2447	5.995
MCD.11L3.B1	-0.2447	5.995
MB.B11L3.B1	-0.2447	5.995
MCS.B11L3.B1	-0.2447	5.995
MB.A11L3.B1	-0.2447	5.995
MCS.A11L3.B1	-0.2447	5.995

Inner group

MQTLI.10L3.B1	-0.1529	2.996
MCBCH.10L3.B1	-0.1529	2.996
MCO.10L3.B1	-0.1529	2.996
MCD.10L3.B1	-0.1529	2.996
MB.B10L3.B1	-0.1529	2.996
MCS.B10L3.B1	-0.1529	2.996
MB.A10L3.B1	-0.1529	2.996
MCS.A10L3.B1	-0.1529	2.996
BPM.9L3.B1	-0.1529	2.996
MQ.9L3.B1	-0.1529	2.996
MQTLI.B9L3.B1	-0.1529	2.996
MQTLI.A9L3.B1	-0.1529	2.996
MCBCV.9L3.B1	-0.1529	2.996
MCO.9L3.B1	-0.1529	2.996

	$\Delta Z/m$	$\Delta X/m$
IP1	0	0
IP2	0	0
IP3	-0.1223	-0.003433
IP4	0	-0.006865
IP5	0	-0.006865
IP6	0	-0.006865
IP7	0	-0.006865
IP8	0	-0.006865
IP1.L1	0	-0.006865

Corrected layout

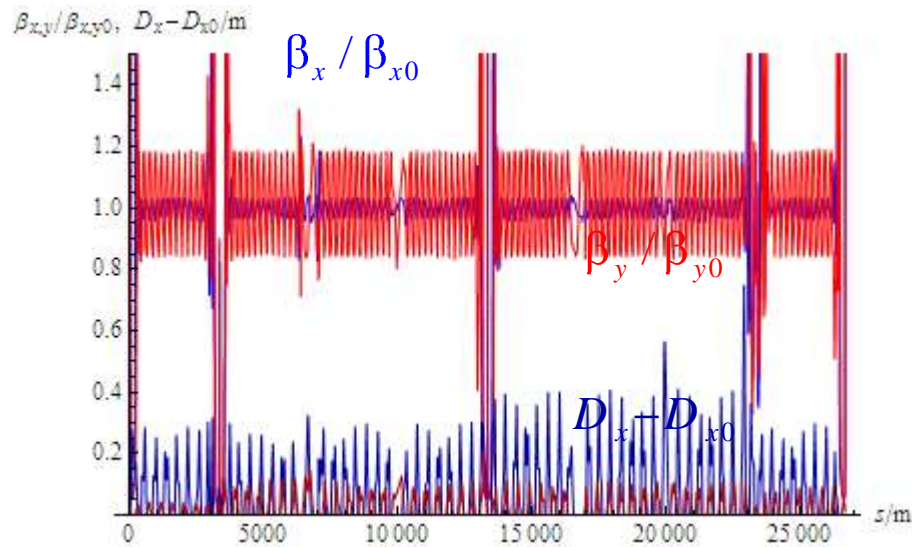
Small negative displacements of all elements downstream of IR3 along the reference orbit restores them to their original position in the global cartesian system and closes the ring.

New sequence descriptions created for both rings.

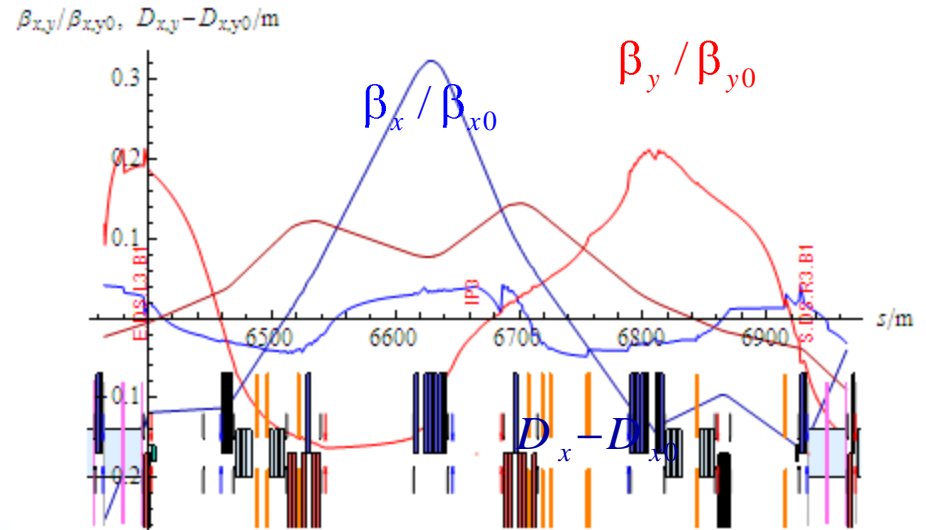
	$\Delta Z/m$	$\Delta X/m$
IP1	0	0
IP2	0	0
IP3	-0.1223	0
IP4	0	-4.352×10^{-9}
IP5	0	-4.351×10^{-9}
IP6	0	-4.349×10^{-9}
IP7	0	-4.349×10^{-9}
IP8	0	-4.349×10^{-9}
IP1.L1	0	-4.349×10^{-9}

LHC circumference is changed by -6.865 mm.

Optical perturbations



β -beating in whole Ring 1



β -beating in IR3, Ring 1

Change in layout perturbs the optical functions, giving about 20% β -beating which must be corrected.

Rematch IR3 for each ring without using the common quadrupoles that affect both – looks feasible but not done yet.

Conclusions

- Baseline layout for cryo-collimators in IR3 is similar to IR7, minimising geometrical perturbation, as expected
 - Should be possible to match optics
- Alternative proposed by J P Tock
 - displaces the central straight section by 122.3mm towards the centre of the ring.
 - Larger displacements up to 153 mm of some other elements
 - If this is acceptable, optics should still be checked.