Preliminary results of off-momentum aperture measurements

C. Alabau Pons, M. Giovannozzi, G. Müller,
S. Redaelli, F. Schmidt, R. Tomás

Thanks to the beta-beat group

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Off-momentum aperture measurements

- LHC aperture measurements performed for the off-momentum case (dp/p=-0.0015) for BEAM1 HORIZONTAL.

- Aperture measurements performed inducing orbit oscillations for different phases.

- Increased + and – amplitude until losses are observed in the BLM's.

- Systematic emittance measurements performed for each phase.

Beam 1 – Horizontal (Off-momentum)

computed from measured optics and emittances

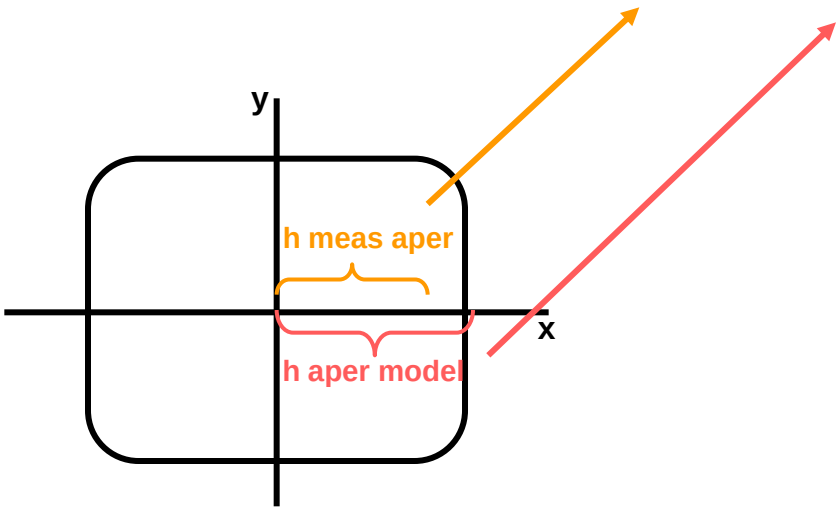
BPM measurements

meas orbit + 3 sig env

aperture – (tolerances+max profile)

meas aper – aper model

BEAM 1 – HOR	Meas Orbit (m)	3sig env (m)	h meas aper (m)	h aper model (m)	Diff (%)
MQ.16R2.B1	-0.011	0.004	0.015	0.021	-25.9
MQTLH.A6L3.B1	-0.013	0.005	0.017	0.021	-17.6
MQM.6R8.B1	-0.011	0.002	0.014	0.021	-35.8
MQ.22R2.B1	-0.014	0.003	0.017	0.020	-16.5
MQ.16L3.B1	-0.014	0.003	0.017	0.020	-15.7
MQ.18R2.B1	-0.014	0.004	0.017	0.021	-15.0
MQM.6R8.B1	-0.008	0.003	0.011	0.021	-49.1
MQY.4R6.B1	0.013	0.003	0.016	0.027	-41.8
MQY.6R4.B1	0.020	0.003	0.023	0.027	-17.8
MQ.28R2.B1	-0.014	0.004	0.017	0.021	-16.6
MQM.6R2.B1	-0.015	0.002	0.017	0.021	-20.2



Beam 1 – Horizontal (Off-momentum)

computed from measured optics and emittances

BPM measurements

meas orbit + 3 sig env

aperture – (tolerances+max profile)

meas aper – aper model

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MQM.6R8.B1	-0.011	0.002	0.014	0.021	-35.8	-0.001
MQ.22R2.B1	-0.014	0.003	0.017	0.020	-16.5	-0.003
MQ.16L3.B1	-0.014	0.003	0.017	0.020	-15.7	-0.003
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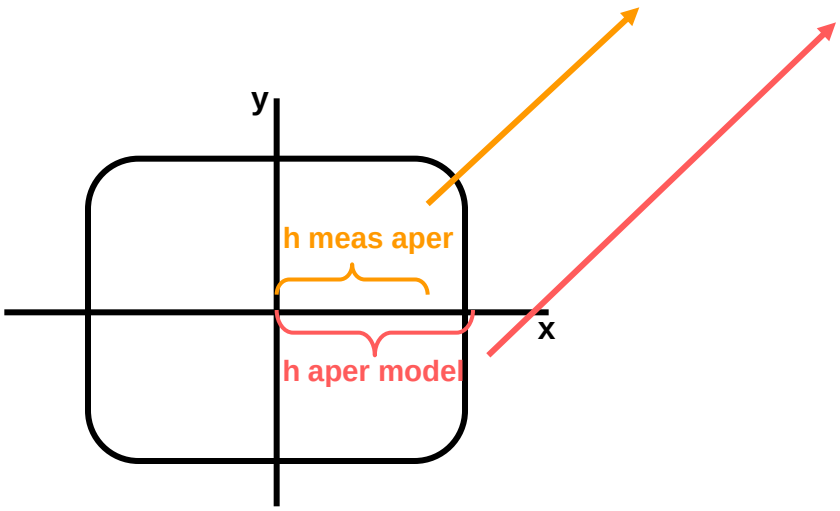

c.o. with dp/p=-0.0015
without free oscillation

Beam 1 – Horizontal (Off-momentum)

computed from measured optics and emittances

BPM measurements

meas orbit + 3 sig env

aperture – (tolerances+max profile)

meas aper – aper model

BEAM 1 – HOR	Meas Orbit (m)	3sig env (m)	h meas aper (m)	h aper model (m)	Diff (%)	h ref orbit (BPM)	n1 nominal	n1 model
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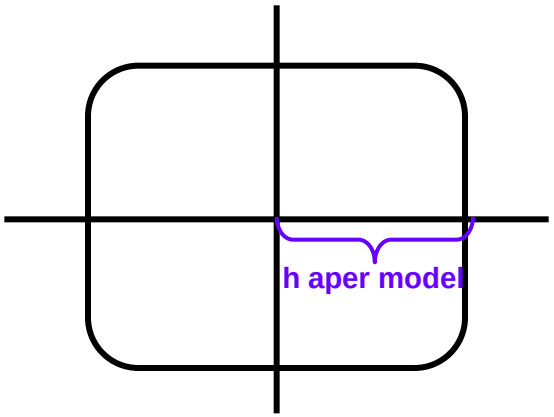
MQTLH.A6L3.B1	-0.013	0.005	0.017	0.021	-17.6	-0.004	7.3	7.1
MQM.6R8.B1	-0.011	0.002	0.014	0.021	-35.8	-0.001	8.0	9.5
MQ.22R2.B1	-0.014	0.003	0.017	0.020	-16.5	-0.003	8.5	9.5
MQ.16L3.B1	-0.014	0.003	0.017	0.020	-15.7	-0.003	8.3	8.9
MQ.18R2.B1	-0.014	0.004	0.017	0.021	-15.0	-0.003	8.5	9.4
MQM.6R8.B1	-0.008	0.003	0.011	0.021	-49.1	-0.001	8.0	9.5
MQY.4R6.B1	0.013	0.003	0.016	0.027	-41.8	0.000	8.1	9.53
MQY.6R4.B1	0.020	0.003	0.023	0.027	-17.8	0.000	8.9	10.4
MQ.28R2.B1	-0.014	0.004	0.017	0.021	-16.6	-0.003	8.5	8.7
MQM.6R2.B1	-0.015	0.002	0.017	0.021	-20.2	0.000	8.1	10.2

n1 nominal:
- model aperture
- nominal optics
- c.o.=4 mm

n1 model:
- model aperture
- meas optics
- meas c.o.



+ meas optics + meas c.o

Beam 1 – Horizontal (Off-momentum)

computed from measured optics and emittances

BPM measurements

meas orbit + 3 sig env

aperture – (tolerances+max profile)

meas aper – aper model

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MQTLH.A6L3.B1	-0.013	0.005	0.017	0.021	-17.6	-0.004	7.3	7.1	4.9
MQM.6R8.B1	-0.011	0.002	0.014	0.021	-35.8	-0.001	8.0	9.5	5.6
MQ.22R2.B1	-0.014	0.003	0.017	0.020	-16.5	-0.003	8.5	9.5	7.2
MQ.16L3.B1	-0.014	0.003	0.017	0.020	-15.7	-0.003	8.3	8.9	6.8
MQ.18R2.B1	-0.014	0.004	0.017	0.021	-15.0	-0.003	8.5	9.4	7.3
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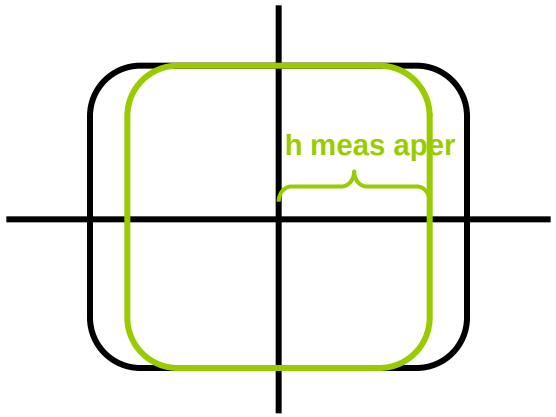

redefine rectellipse dimensions

n1 nominal:
- model aperture
- nominal optics
- c.o.=4 mm

n1 model:
- model aperture
- meas optics
- meas c.o.

n1 measured (method 1):
- meas aper (no tol)
- meas optics
- meas c.o.

Beam 1 – Horizontal (Off-momentum)

computed from measured optics and emittances

BPM measurements

meas orbit + 3 sig env

aperture – (tolerances+max profile)

meas aper – aper model

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Bottlenecks corresponding to secondary peak losses (main peak in another magnet for the same phase)

Losses found corresponding to the main peak for MQM.6R8.B1

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BPM measurements

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aperture – (tolerances+max profile)

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Bottlenecks corresponding to secondary peak losses (main peak in other magnet for the same phase)

Losses found corresponding to the main peak

Some cases to be checked by means of local bump scans

Conclusions

- LHC aperture measurements performed for both beams, for the on-momentum case.

- Some doubtful cases were checked by means of local bump scans → no important bottlenecks found.

- On-momentum aperture is above 9 (H) / 11 (V) nominal sigmas.

- Off-momentum aperture measurements performed for BEAM1-HOR.

- Off-momentum aperture is about 2 nominal sigmas smaller than the on-momentum one.

- Need to complete off-momentum measurements, and performe local bump scans in some doubtful cases.