FLUKA Analysis of the Large-Kick Event in 2008

N. Shetty, A. Lechner,
(on behalf of the FLUKA team)

C. Bracco

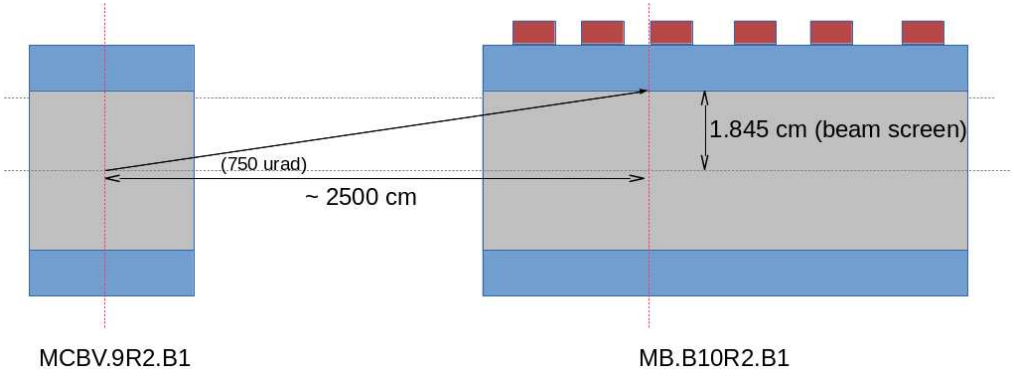
and with contributions from
J. Wenninger, M. Sapinski, B. Auchmann

Quench Test Analysis Working Group Meeting
March 28, 2014

Introduction

ist of beam-induced quenches in the years 2008-2013. Quenches 10, 15, 16, and 17 are analy

No	Date	Energy [TeV]	Loss Duration	Quenched Magnet	Magnet Temperature	Remark
1	2008.08.09	0.45	~ ns	MB	1.9 K	beam setup
2	2008.09.07	0.45	~ ns	MB	1.9 K	beam setup
3	2009.11.20	0.45	~ ns	MB	1.9 K	beam setup
4	2009.12.04	0.45	~ ns	MB	1.9 K	beam setup
5	2010.04.18	0.45	~ ns	MB+	1.9 K	wrong quad curren
6	2010.10.06	0.45	1 s	MQ	1.9 K	quench test
7	2010.10.06	0.45	1 s	MQ	1.9 K	quench test
8	2010.10.06	0.45	1 s	MB	1.9 K	quench test
9	2010.10.17	3.5	6 s	MQ	1.9 K	quench test, Sec. VI
10	2010.11.01	3.5	10 – 40 ms	MBRB	4.5 K	quench test, Sec. V
11	2011.04.18	0.45	~ ns	MB+	1.9 K	kicker flashover
12	2011.07.04	0.45	~ ns	MB	1.9 K	test
13	2011.07.28	0.45	~ ns	MQXB+	1.9 K	injection oscillatio
14	2012.04.15	0.45	~ ns	MB+	1.9 K	kicker flashover
15	2013.02.15	0.45/6	~ ns	MQM	4.5 K	quench test, Sec. IV
16	2013.02.15	4.0	5 – 10 ms	MQ	1.9 K	quench test, Sec. V
17	2013.02.16	4.0	20 s	MQ	1.9 K	quench test, Sec. VI



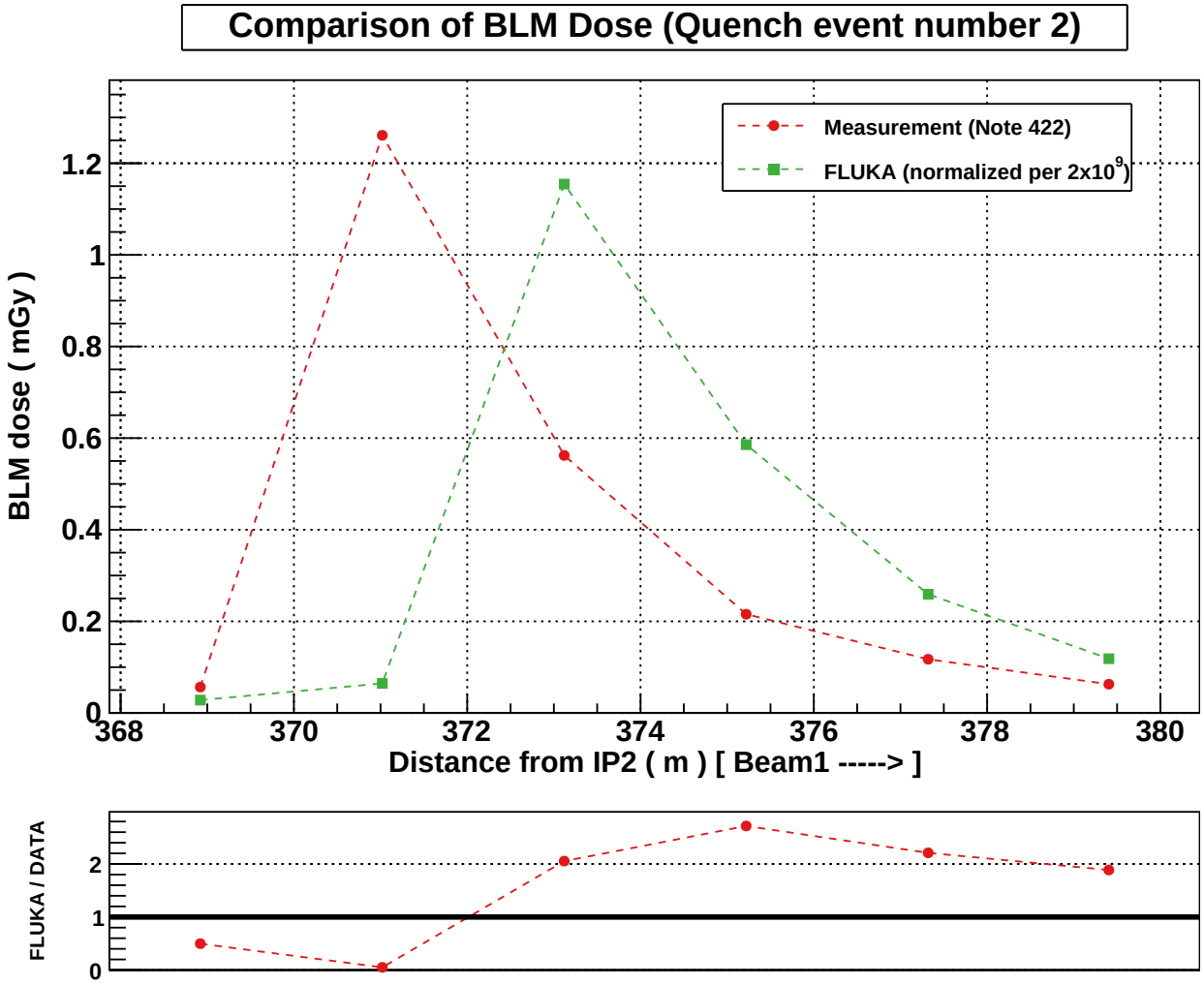
Quench event number 2 (not a quench test)

Documented in LHC Project Note 422. A bunch of 2×10^9 protons quenched a MB in a large vertical kick (750μrad) event

No quadrupole magnets between the kicker and the dipole -> simple beam trajectory

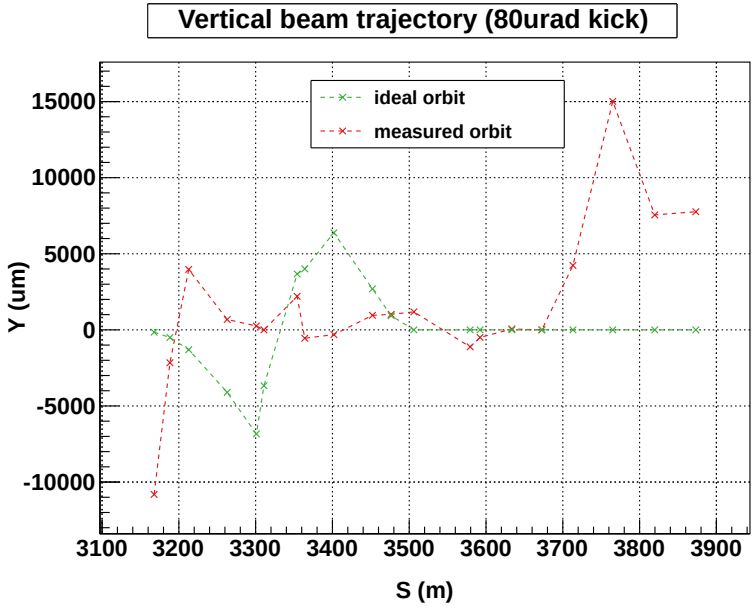
Beam emittance = 2 μm (assumed)

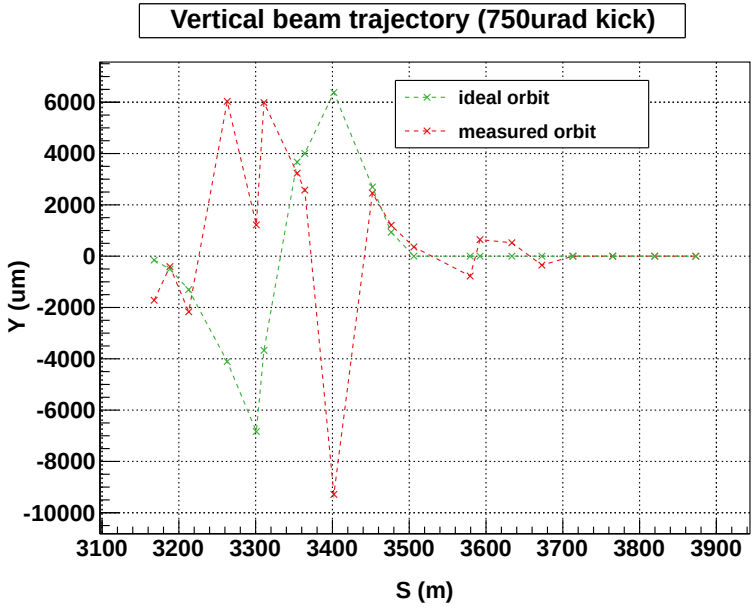
BLM dose comparison (ideal orbit + kick of 750 μrad)



Simulated BLM profile is shifted by one BLM

Orbit oscillations and MADX simulation



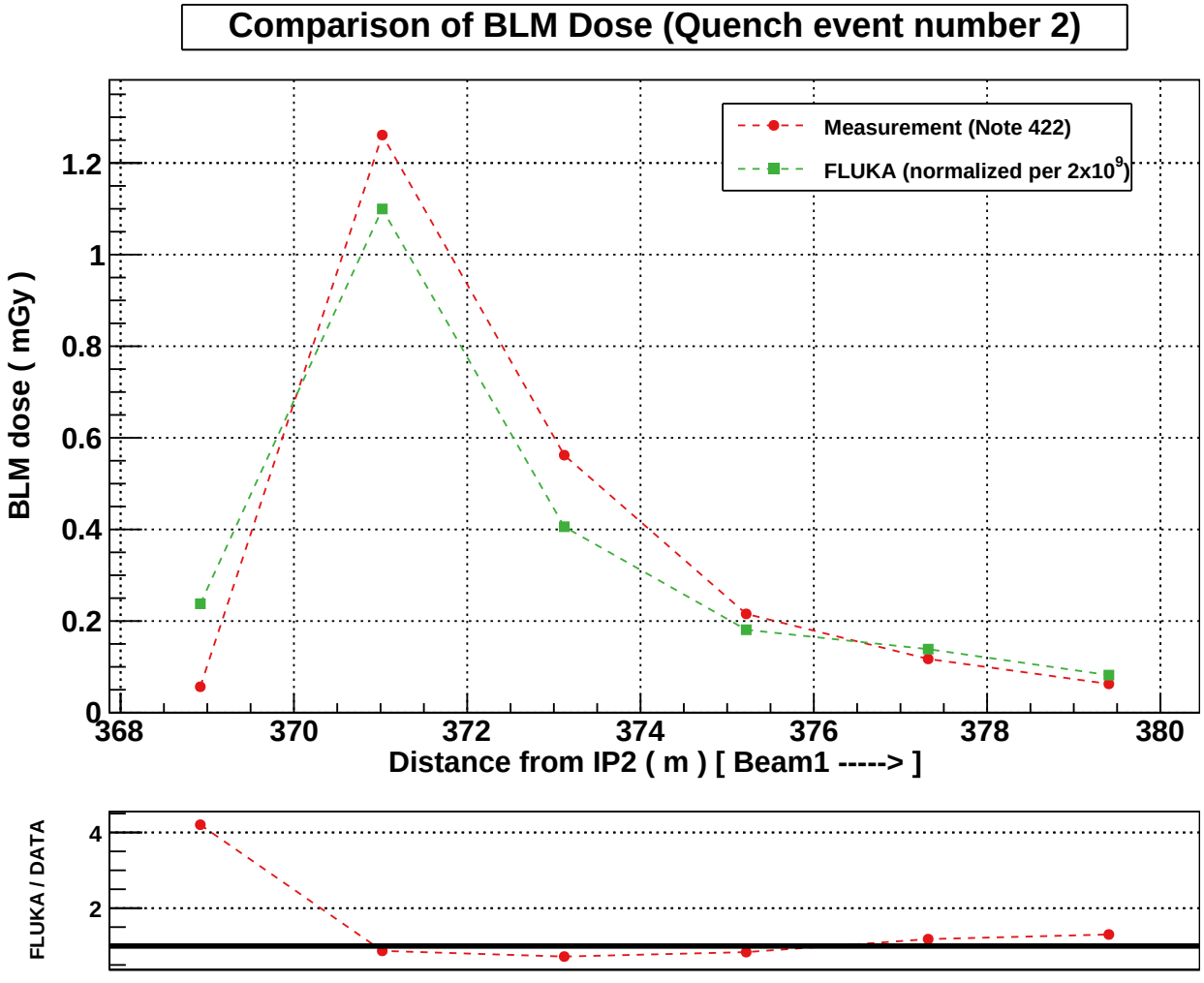


Measured data shows large orbit oscillations. In preceding injection, beam kicked by 80 μrad reached IP3. (BPM data courtesy of Jorg)

After matching using MADX, "real" vertical offset and kick were estimated at the center of the kicker. (See Chiara's presentation)

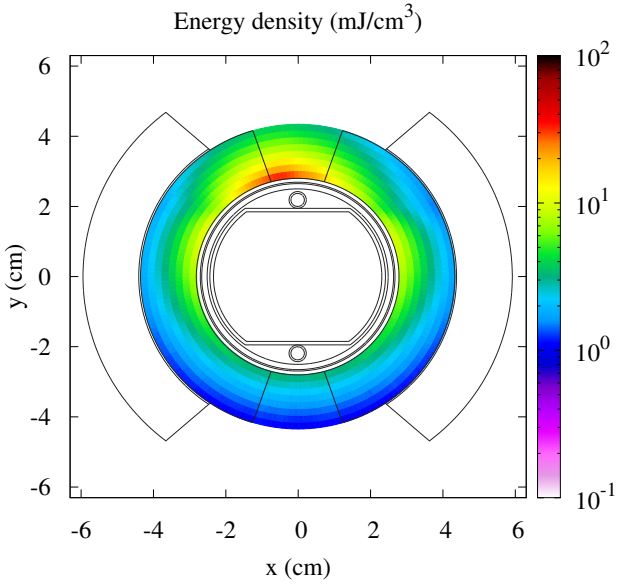
X = 1.4 mm, X$'$ = 70 μrad
Y = 3 mm, Y$'$ = 710 μrad

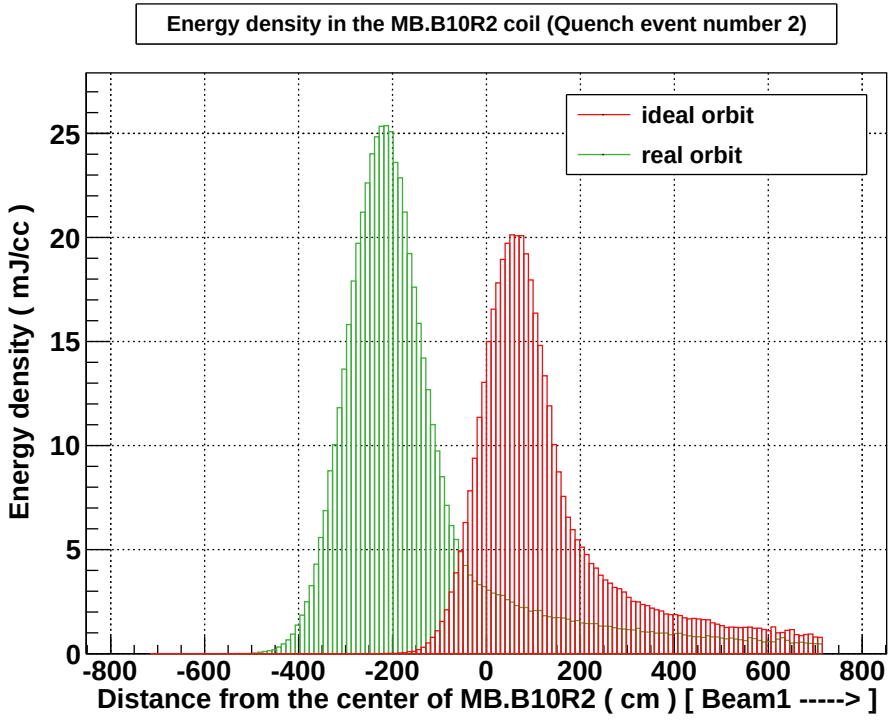
BLM dose comparison (real orbit + kick of 710 μrad)



Good agreement between simulated and measured BLM profile

Energy density in MB.B10R2





Max. energy density in the collar, not in the coil

Depends on horizontal deflection

In the coil, max. energy density is $\sim$ **25 mJ/cm^3**

Calculated quench limit is $\sim$ 38 mJ/cm^3 (See Bernhard's presentation)

Conclusions

Large-kick event (quench event number 2) analysed in detail

Very sensitive to initial conditions (X, X′, Y, Y′)

Tracking simulations required to match large oscillations

Simulated and measured dose of downstream BLMs agree within a factor 20%, though the simulated impact is slightly upstream

Max. energy density in the coil $\sim$25 mJ/cm^3, within a factor of 2 when compared to the quench limit