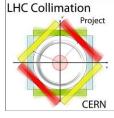
Scope of the Meeting: the Framework of the Collimation Project

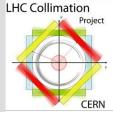
3 Primary Collimators in Betatron Cleaning (IR7)



R.W. Aβmann Meeting on Interface 11 T - Cold Collimation 5 Oct 2011, CERN



The Collimation Project Team & Close Collaborators



 Results on phase I collimation are outcome of lot of work performed over last 9 years by the following CERN colleagues:

O. Aberle, J.P. Bacher, V. Baglin, G. Bellodi, A. Bertarelli, R. Billen, V. Boccone,
A.P. Bouzoud, C. Bracco, H. Braun, R. Bruce, F. Burkart, M. Cauchi, J. Coupard, D.
Deboy, N. Hilleret, E.B. Holzer, D. Jacquet, J.B. Jeanneret, J.M. Jimenez,
M. Jonker, J. Jowett, Y. Kadi, K. Kershaw, G. Kruk, M. Lamont, L. Lari, J. Lendaro,
J. Lettry, R. Losito, M. Magistris, A. Masi, M. Mayer, E. Métral, C. Mitifiot, N.
Mounet, V. Parma, R. Perret, S. Perrolaz, V. Previtali, C. Rathjen, S. Redaelli,
G. Robert-Demolaize, C. Roderick, S. Roesler, A. Rossi, F. Ruggiero, M. Santana,
B. Salvachua, R. Schmidt, P. Sievers, M. Sobczak, J.P. Tock, K. Tsoulou, G.
Valentino, E. Veyrunes, H. Vincke, V. Vlachoudis, T. Weiler, J. Wenninger, D.
Wollmann, ...

Crucial work also performed by collaborators at:

EuCARD/ColMat partners (see GSI talk), TRIUMF (D. Kaltchev), IHEP (I. Baishev & team), SLAC (T. Markiewicz & team), FNAL (N. Mokhov & team), BNL (N. Simos, A. Drees & team), Kurchatov (A. Ryazanov & team).



The Last Phase 1 Collimator

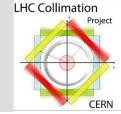
LHC Collimation

Project





Many PhD's & Fellows Related to Collimation



- This challenging topic attracts many excellent students and fellows!
- PHD's (some later fellows):
 C. Bracco, M. Brugger, M. Cauchi, A. Dallocchio, D. Deboy, L. Lari, V. Previtali, G. Robert-Demolaize, G. Valentino, ...
- Master students:
 F. Burkart, ...
- Fellows:

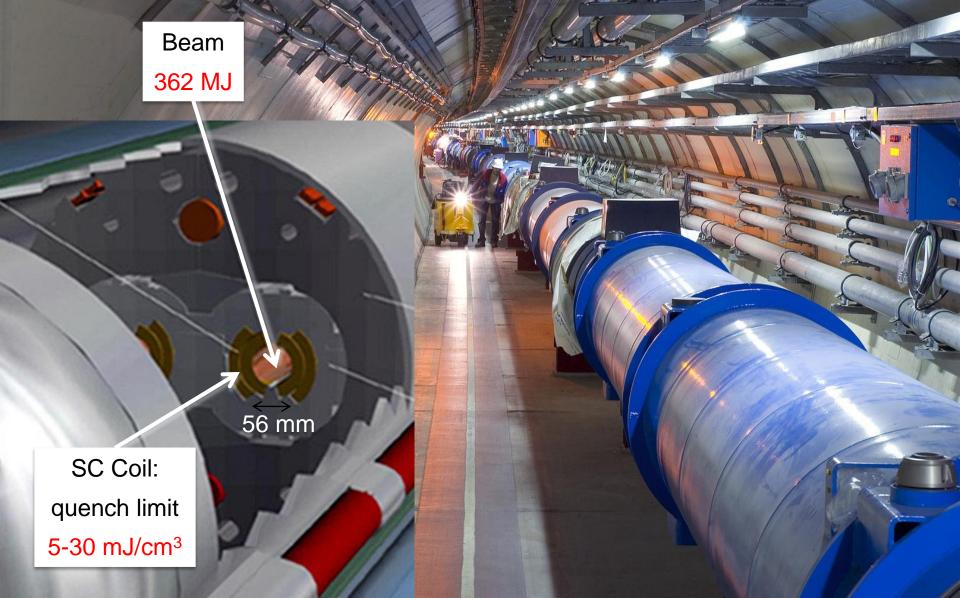
R. Bruce, S. Redaelli, B. Salvachua, T. Weiler, D. Wollmann, FLUKA fellows for collimation, ...



Quench Limit of LHC Super-Conducting Magnets

Nominal design at 7 TeV







Quench Limit of LHC Super-Conducting Magnets

Situation at 3.5 TeV (on September 26, 2010)



Not a single beam-induced quench at 3.5 TeV yet!

LHC beam is about 60,000,000 times above quench limit of superconducting magnets (per cm³)! Of course, diluted...

SC Coil: quench limit

15-100 mJ/cm³

56 mm

Beam

6.2 MJ



CERN-ATS-Note-2011-042 MD (LHC)

May 24,2011 Stefano.Redaelli@cern.ch

Collimator losses in the DS of IR7 and quench test at 3.5 TeV

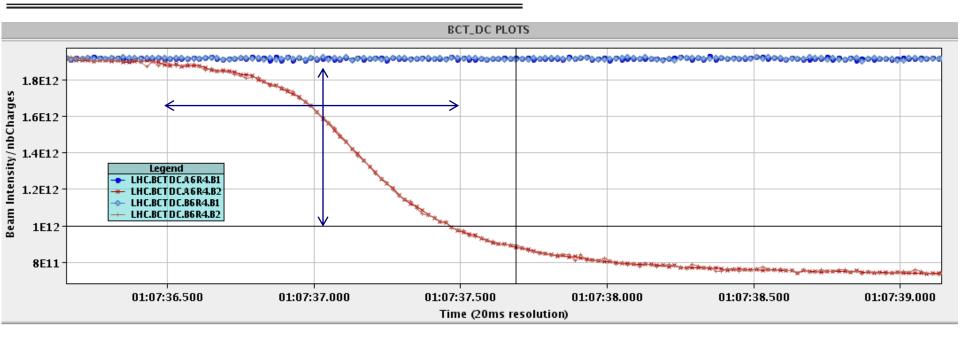
R.W. Assmann, R. Bruce, F. Burkart, M. Cauchi, D. Deboy, B. Dehning, E.B. Holzer, E. Nebot del Busto, A. Priebe, S. Redaelli, A. Rossi, R. Schmidt, M. Sapinski, G. Valentino, J. Wenninger, D. Wollmann, M. Zerlauth, CERN, Geneva, Switzerland

Keywords: Collimation, beam losses, quench, dispersion suppressor

LHC Collimation Project CERN

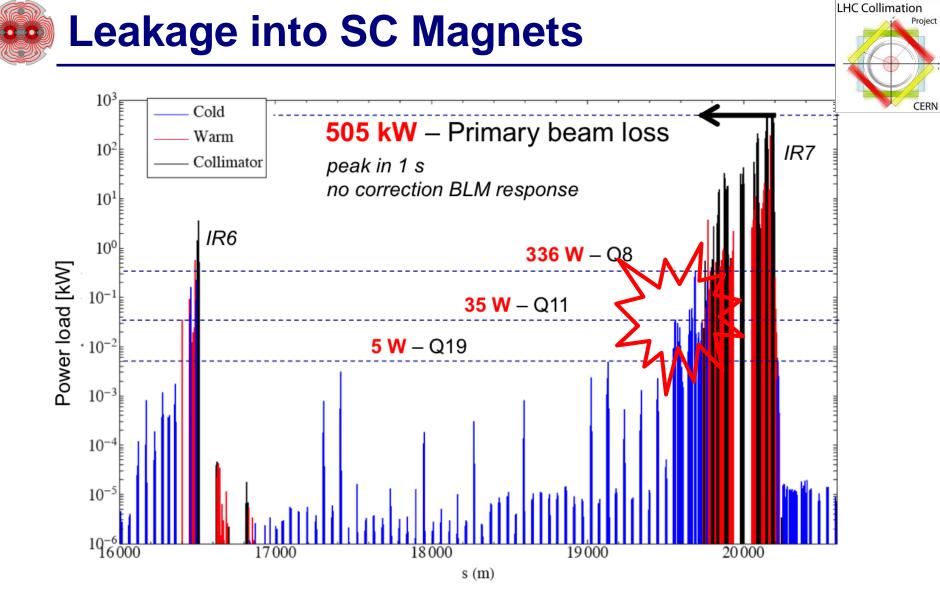
16 bunches, 3.5 TeV

Provoked beam loss: beam blow up on 1/3 resonance



Loss rate:

9e11 p/s @ 3.5 TeV → 505 kW



3.5 TeV operational collimator settings (not best possible)

No quench of any magnet!

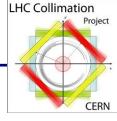


CERN-ATS-Note-2011-036 MD

2011-05-24

07-05-2011 23:11:00

Roderik.Bruce@cern.ch Adriana.Rossi@cern.ch Benoit.Salvant@cern.ch



Summary of MD on nominal collimator settings

R.W. Assmann, R. Bruce, F. Burkart, M. Cauchi, D. Deboy, L. Lari, E. Metral, N. Mounet, S. Redaelli, A. Rossi, B. Salvant, G. Valentino, D. Wollmann

Keywords: Collimator settings, collimator impedance

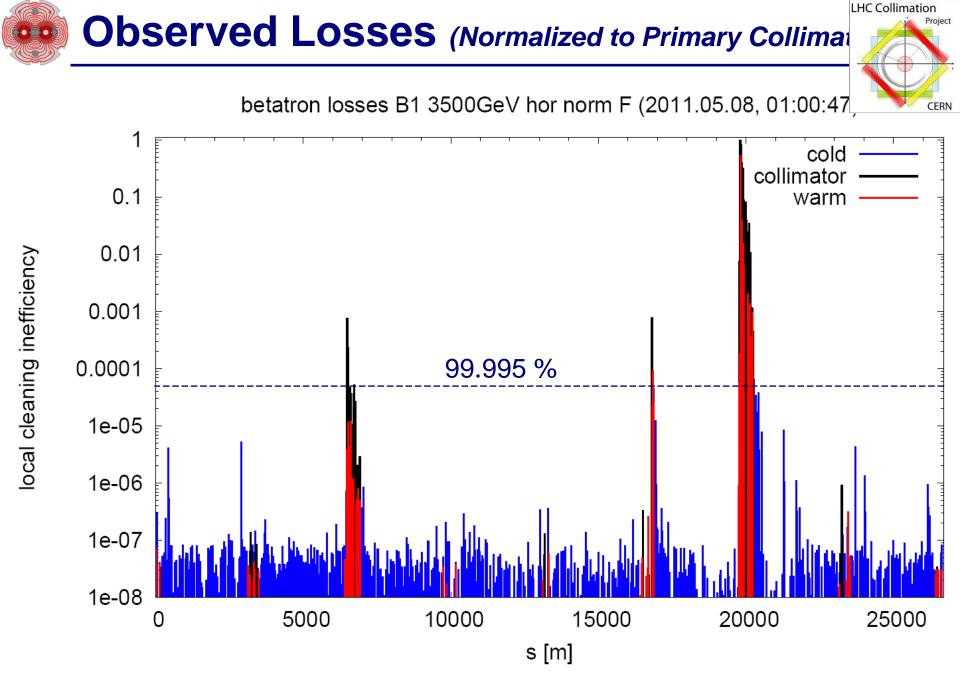
	TCP IR7	TCSG IR7	TCLA IR7	TCSG IR6	TCDQ IR6
2010 settings	5.7	8.5	17.7	9.3	10 10.6
Nominal	5.7	6.7	9.7	7.2	7.7
Tight B1	4.0	6.0	8.0	7.0	7.5
Tight B2	4.0	5.0	7.2	6.2	6.7

Settings	in nominal
beam sigma	at 3.5 TeV

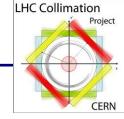
Settings in mm at 3.5 TeV for
tightest collimator settings
achieved (beam 1)

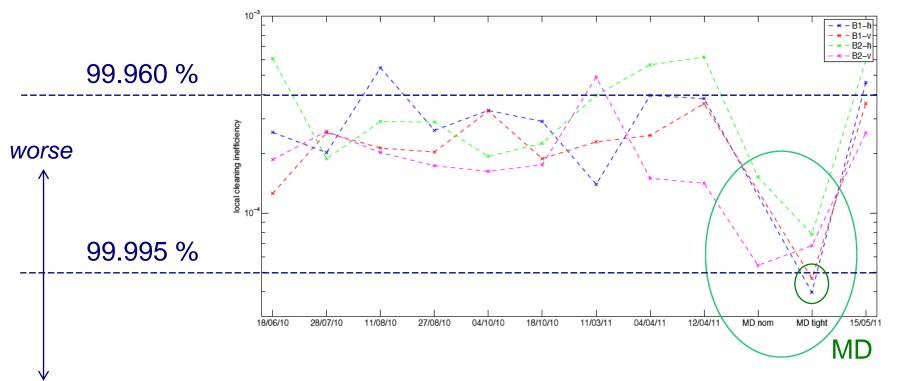
				c
HC	Collimators	Beam: B1	Set: HW Group:LHC COLLIMATORS	

10.25 TCTH.4L1.B1 -9.92 7.19 TCTH.4L5.B1 -13.02 3.07 TCSG.6R7.B1 -3.62 8.73 TCTVA.4L1.B1 -5.46 7.28 TCTVA.4L5.B1 -6.97 1.97 TCLA.AGR7.B1 -1.38 IP2 24.87 TCLSR5.B1 -25.15 2.72 TCLA.AGR7.B1 -3.44 4.69 TCTH.4L2.B1 -6.25 24.87 TCLSQ.A4R6.B1 -25.15 2.72 TCLA.AGR7.B1 -1.78 20.02 TDI.4L2 -20.07 6.16 TCDQ.A.44R6.B1 1.85 TCLA.AGR7.B1 -2.12 4.64 TCTVB.4L2 -6.88 5.58 TCSG.4R6.B1 -4.26 TCLA.AGR7.B1 -2.12 0.71 TCDD.4L2 -0.7 IP7 I.85 TCLA.AGR7.B1 -2.14 24.96 TCLIA.4R2 -2.55 1.45 TCP.DGL7.B1 -0.72 8.9 TCTH.4L8.B1 -2.04 24.86 TCLIB.6R2.B1 -2.498 1.03 TCP.CGL7.B1 -1.94 5.34 TCTIV.4L8.B1 -2.04 24.86 TCLIB.6R2.B1 -4.32 1.62 TCSGA.6L7.B1 -2.92 <	L(mm) MDC	C IP1 PR	S R(mm)	4.3	TCLA.7R3.B1	-4.43	2.2	TCSG.D5R7.B1 -2.78
8.73 TCTVA.4L1.B1 -5.46 7.28 TCTVA.4L5.B1 -6.97 1.97 TCLA.AGR7.B1 -1.38 IP2 24.87 TCL5R5.B1 -25.15 2.72 TCLA.AGR7.B1 -3.44 4.69 TCTH.4L2.B1 -6.25 IP6 4.26 TCLA.AGR7.B1 -1.76 20.02 TDI.4L2 -20.07 6.16 TCDQA.A4R6.B1 4.26 TCLA.AGR7.B1 -2.1 4.64 TCTVB.4L2 -6.88 5.58 TCSG.4R6.B1 -4.2 1.74 TCLA.AGR7.B1 -2.1 0.71 TCDD.4L2 -0.7 IP7 IP8 -2.04 1.45 TCP.DGL7.B1 -0.72 8.9 TCTH.4L8.B1 -2.04 24.86 TCLIB.GR2.B1 -24.98 1.03 TCP.DGL7.B1 -0.72 8.9 TCTH.4L8.B1 -2.04 24.86 TCLIB.GR2.B1 -4.32 1.62 TCSGA.6L7.B1 -1.94 TI2 1.24 4.12 TCP.6L3.B1 -4.32 1.62 TCSGA.6L7.B1 -2.32 1.42 TCDIV.20607 -2 2.74 TCSG.5L3.B1 -4.34 1.9 TCSGA.6L7.B	24.87	TCL5R1.B1	-25.13		IP5		2.44	TCSG.E5R7.B1 -2.54
IP2 24.87 TCL5R5.B1 -25.15 2.72 TCLABGR7.B1 -3.44 4.69 TCTH.4L2.B1 -6.25 IP6 4.26 TCLACGR7.B1 -1.79 20.02 TDI.4L2 -20.07 6.16 TCDQA.A4R6.B1 1.85 TCLADGR7.B1 -2.1 4.64 TCTVB.4L2 -6.88 5.58 TCSG.4R6.B1 -4.2 1.74 TCLAA.GR7.B1 -2.1 0.71 TCDD.4L2 -0.7 IP7 IP3 -2.1 IP8 -2.04 24.86 TCLIB.GR2.B1 -24.98 1.03 TCP.CGL7.B1 -0.72 8.9 TCTH.4L8.B1 -2.04 24.86 TCLIB.GR2.B1 -24.98 1.03 TCP.CGL7.B1 -2.01 5.34 TCTVB.4L8 -6.2 IP3 0.63 TCP.GGL7.B1 -1.94 TI2 -2.14 </th <th>10.25</th> <th>TCTH.4L1.B1</th> <th>-9.92</th> <th>7.19</th> <th>TCTH.4L5.B1</th> <th>-13.02</th> <th>3.07</th> <th>TCSG.6R7.B1 -3.62</th>	10.25	TCTH.4L1.B1	-9.92	7.19	TCTH.4L5.B1	-13.02	3.07	TCSG.6R7.B1 -3.62
4.69 TCTH.4L2.B1 -6.25 IP6 4.26 TCLA.C6R7.B1 -1.79 20.02 TDI.4L2 -20.07 6.16 TCDQA.A4R6.B1 1.85 TCLA.D6R7.B1 -2.1 4.64 TCTVB.4L2 -6.88 5.58 TCSG.4R6.B1 -4.2 1.74 TCLA.A6R7.B1 -2.1 0.71 TCDD.4L2 -0.7 IP7 IP8 -2.01 1.85 TCLA.A7R7.B1 -2.1 24.96 TCLIA.4R2 -2.5 1.45 TCP.D6L7.B1 -0.72 8.9 TCTH.4L8.B1 -2.04 24.86 TCLIB.6R2.B1 -24.98 1.03 TCP.C6L7.B1 -2.01 5.34 TCTVB.4L8 -6.2 IP3 0.63 TCP.B6L7.B1 -1.94 TI2 T12 1.2 1.2 TCP.6L3.B1 -4.32 1.62 TCSG.A6L7.B1 -2.32 1.42 TCDIV.20607 -2 2.74 TCSG.513.B1 -4.34 1.9 TCSG.B5L7.B1 -2.74 2.66 TCDIV.29012 -1.74 1.29 TCSG.4R3.B1 -3.62 2.24 TCSG.A5L7.B1 -2.51 3.76 TCDIH.29050	8.73	TCTVA.4L1.B1	-5.46	7.28	TCTVA.4L5.B1	-6.97	1.97	TCLA.A6R7.B1 -1.38
20.02 TDI.4L2 -20.07 6.16 TCDQA.A4R6.B1 1.85 TCLA.D6R7.B1 -2.1 4.64 TCTVB.4L2 -6.88 5.58 TCSG.4R6.B1 -4.2 1.74 TCLA.A7R7.B1 -2.1 0.71 TCDD.4L2 -0.7 IP7 IP8 -2.04 24.96 TCLIA.4R2 -25 1.45 TCP.D6L7.B1 -0.72 8.9 TCTH.4L8.B1 -2.04 24.86 TCLIB.6R2.B1 -24.98 1.03 TCP.C6L7.B1 -2.01 5.34 TCTVB.4L8 -6.2 IP3 0.63 TCP.66L7.B1 -1.94 TI2 TCDIV.20607 -2 2.74 TCSG.5L3.B1 -4.34 1.9 TCSG.A5L7.B1 -2.51 3.76 TCDIV.29012 -1.74 1.29 TCSG.4R3.B1 -3.52 1.24 TCSG.A5L7.B1 -2.51 3.76 TCDIH.29050 -3.28 2.74 TCSG.A5R3.B1 -3.55 1.6 TCSG.D4L7.B1 -1.48 2.4 TCDIH.29205 -2.06 3 TCSG.B5R3.B1 -4.14 3.17 TCSG.B4L7.B1 -1.18 3.37 TCDIV.29234 <th>-</th> <th>IP2</th> <th></th> <th>24.87</th> <th>TCL5R5.B1</th> <th>-25.15</th> <th>2.72</th> <th>TCLA.B6R7.B1 -3.44</th>	-	IP2		24.87	TCL5R5.B1	-25.15	2.72	TCLA.B6R7.B1 -3.44
4.64 TCTVB.4L2 -6.88 5.58 TCSG.4R6.B1 -4.2 1.74 TCLA.A7R7.B1 -2.1 0.71 TCDD.4L2 -0.7 IP7 IP8 -2.1 24.96 TCLIA.4R2 -25 1.45 TCP.D6L7.B1 -0.72 8.9 TCTH.4L8.B1 -2.04 24.86 TCLIB.6R2.B1 -24.98 1.03 TCP.C6L7.B1 -2.01 5.34 TCTVB.4L8 -6.2 IP3 0.63 TCP.B6L7.B1 -1.94 TI2 TCDIV.20607 -2 4.12 TCP.6L3.B1 -4.32 1.62 TCSG.A6L7.B1 -2.74 2.66 TCDIV.20607 -2 2.74 TCSG.5I 3.B1 -4.34 1.9 TCSG.A5L7.B1 -2.51 3.76 TCDIV.29012 -1.74 1.29 TCSG.4R3.B1 -3.62 2.24 TCSG.A5L7.B1 -2.51 3.76 TCDIV.29010 -3.28 2.74 TCSG.A5R3.B1 -3.55 1.6 TCSG.D4L7.B1 -1.48 2.4 TCDIV.29234 -2.20 3 TCSG.B5R3.B1 -4.14 3.17 TCSG.B4L7.B1 -1.18 3.37	4.69	TCTH.4L2.B1	-6.25		IP6		4.26	TCLA.C6R7.B1 -1.79
0.71 TCDD.4L2 -0.7 IP7 IP8 24.96 TCLIA.4R2 -25 1.45 TCP.06L7.B1 -0.72 8.9 TCTH.4L8.B1 -2.04 24.86 TCLIB.6R2.B1 -24.98 1.03 TCP.C6L7.B1 -2.01 5.34 TCTVB.4L8 -6.2 IP3 0.63 TCP.6L7.B1 -1.94 TI2 TCDIV.20607 -2 4.12 TCP.6L3.B1 -4.32 1.62 TCSG.A6L7.B1 -2.74 2.66 TCDIV.20607 -2 2.74 TCSG.5L3.B1 -4.34 1.9 TCSG.A5L7.B1 -2.51 3.76 TCDIH.29050 -3.28 2.74 TCSG.A5R3.B1 -3.55 1.6 TCSG.D4L7.B1 -1.48 2.4 TCDIH.29050 -2.06 3 TCSG.B5R3.B1 -4.14 3.17 TCSG.B4L7.B1 -1.18 3.37 TCDIV.29234 -2.22	20.02	TDI.4L2	-20.07	6.16	TCDQA.A4R6.B1		1.85	TCLA.D6R7.B1 -2.1
24.96 TCLIA.4R2 -25 1.45 TCP.D6L7.B1 -0.72 8.9 TCTH.4L8.B1 -2.04 24.86 TCLIB.6R2.B1 -24.98 1.03 TCP.C6L7.B1 -2.01 5.34 TCTVB.4L8 -6.2 IP3 4.12 TCP.6L3.B1 -4.32 1.62 TCSG.A6L7.B1 -2.74 1.42 TCDIV.20607 -2 2.74 TCSG.5L3.B1 -4.34 1.9 TCSG.A5L7.B1 -2.51 3.76 TCDIV.29012 -1.74 1.29 TCSG.4R3.B1 -3.62 2.24 TCSG.A5L7.B1 -2.51 3.76 TCDIH.29050 -3.28 2.74 TCSG.A5R3.B1 -3.55 1.6 TCSG.D4L7.B1 -1.48 2.4 TCDIH.29205 -2.06 3 TCSG.B5R3.B1 -4.14 3.17 TCSG.B4L7.B1 -1.18 3.37 TCDIV.29234 -2.22	4.64	TCTVB.4L2	-6.88	5.58	TCSG.4R6.B1	-4.2	1.74	TCLA.A7R7.B1 -2.1
24.86 TCLIB.GR2.B1 -24.98 1.03 TCP.CGL7.B1 -2.01 5.34 TCTVB.4L8 -6.2 IP3 0.63 TCP.BGL7.B1 -1.94 TI2 TI2 4.12 TCP.GL3.B1 -4.32 1.62 TCSG.AGL7.B1 -2.32 1.42 TCDIV.20607 -2 2.74 TCSG.SL3.B1 -4.34 1.9 TCSG.ASL7.B1 -2.74 2.66 TCDIV.29012 -1.74 1.29 TCSG.4R3.B1 -3.62 2.24 TCSG.ASL7.B1 -2.51 3.76 TCDIH.29050 -3.28 2.74 TCSG.ASR3.B1 -3.55 1.6 TCSG.D4L7.B1 -1.48 2.4 TCDIH.29050 -2.06 3 TCSG.BSR3.B1 -4.14 3.17 TCSG.B4L7.B1 -1.18 3.37 TCDIV.29234 -2.22	0.71	TCDD.4L2	-0.7	_		<u>4</u>		IP8
IP3 0.63 TCP.B6L7.B1 -1.94 TI2 4.12 TCP.6L3.B1 -4.32 1.62 TCSG.A6L7.B1 -2.32 1.42 TCDIV.20607 -2 2.74 TCSG.SL3.B1 -4.34 1.9 TCSG.A5L7.B1 -2.74 2.66 TCDIV.20607 -3.28 1.29 TCSG.4R3.B1 -3.62 2.24 TCSG.A5L7.B1 -2.51 3.76 TCDIH.29050 -3.28 2.74 TCSG.A5R3.B1 -3.55 1.6 TCSG.D4L7.B1 -1.48 2.4 TCDIH.29050 -2.06 3 TCSG.B5R3.B1 -4.14 3.17 TCSG.B4L7.B1 -1.18 3.37 TCDIV.29234 -2.22	24.96	TCLIA.4R2	-25	1.45	TCP.D6L7.B1	-0.72	8.9	TCTH.4L8.B1 -2.04
4.12 TCP.6L3.B1 -4.32 1.62 TCSG.A6L7.B1 -2.32 1.42 TCDIV.20607 -2 2.74 TCSG.5L3.B1 -4.34 1.9 TCSG.B5L7.B1 -2.74 2.66 TCDIV.29012 -1.74 1.29 TCSG.4R3.B1 -3.62 2.24 TCSG.A5L7.B1 -2.51 3.76 TCDIH.29050 -3.28 2.74 TCSG.A5R3.B1 -3.55 1.6 TCSG.D4L7.B1 -1.48 2.4 TCDIH.29255 -2.06 3 TCSG.B5R3.B1 -4.14 3.17 TCSG.B4L7.B1 -1.18 3.37 TCDIV.29234 -2.22	24.86	TCLIB.6R2.B1	-24.98	1.03	TCP.C6L7.B1	-2.01	5.34	TCTVB.4L8 -6.2
2.74 TCSG.5I.3.B1 -4.34 1.9 TCSG.B5L7.B1 -2.74 2.66 TCDIV.29012 -1.74 1.29 TCSG.4R3.B1 -3.62 2.24 TCSG.A5L7.B1 -2.51 3.76 TCDIH.29050 -3.28 2.74 TCSG.A5R3.B1 -3.55 1.6 TCSG.D4L7.B1 -1.48 2.4 TCDIH.29050 -2.06 3 TCSG.B5R3.B1 -4.14 3.17 TCSG.B4L7.B1 -1.18 3.37 TCDIV.29234 -2.22		IP3		0.63		-1.94		TI2
1.29 TCSG.4R3.B1 -3.62 2.24 TCSG.A5L7.B1 -2.51 3.76 TCDIH.29050 -3.28 2.74 TCSG.A5R3.B1 -3.55 1.6 TCSG.D4L7.B1 -1.48 2.4 TCDIH.29050 -2.06 3 TCSG.B5R3.B1 -4.14 3.17 TCSG.B4L7.B1 -1.18 3.37 TCDIV.29234 -2.22	4.12	TCP.6L3.B1	-4.32	1.62	TCSG.A6L7.B1	-2.32	1.42	TCDIV.20607 -2
2.74 TCSG.A5R3.B1 -3.55 1.6 TCSG.D4L7.B1 -1.48 2.4 TCDIH.29205 -2.06 3 TCSG.B5R3.B1 -4.14 3.17 TCSG.B4L7.B1 -1.18 3.37 TCDIV.29234 -2.22	2.74	TCSG.5L3.B1	-4.34	1.9	TCSG.B5L7.B1	-2.74	2.66	TCDIV.29012 -1.74
3 TCSG.B5R3.B1 -4.14 3.17 TCSG.B4L7.B1 -1.18 3.37 TCDIV.29234 -2.22	1.29	TCSG.4R3.B1	-3.62	2.24	TCSG.A5L7.B1	-2.51	3.76	TCDIH.29050 -3.28
	2.74	TCSG.A5R3.B1	-3.55	1.6	TCSG.D4L7.B1	-1.48	2.4	TCDIH.29205 -2.06
	3	TCSG.B5R3.B1	-4.14	3.17	TCSG.B4L7.B1	-1.18	3.37	TCDIV.29234 -2.22
6.64 TCLA.A5R3.B1 -7.64 2.99 TCSG.A4L7.B1 -1.26 2.96 TCDIH.29465 -2.32	6.64	TCLA.A5R3.B1	-7.64	2.99	TCSG.A4L7.B1	-1.26	2.96	TCDIH.29465 -2.32
6.22 TCLA.B5R3.B1 -7 2.96 TCSG.A4R7.B1 -1.32 9 TCDIV.29509 -2.9	6.22	TCLA.B5R3.B1	-7	2.96	TCSG.A4R7.B1	-1.32	9	TCDIV.29509 -2.9
6.17 TCLA.6R3.B1 -6.1 2.74 TCSG.B5R7.B1 -2.22	6.17	TCLA.6R3.B1	-6.1	2.74	TCSG.B5R7.B1	-2.22		



(In) Efficiency Reached (Coll → SC Magnet)





better

Figure 5: Beam 1 and Beam 2 maximum local cleaning inefficiency in the cold parts of the LHC at 3.5TeV over about one year operation. The results from this MD are contained in the second and third sets of points from the right, where a clear decrease can be observed.

LHC Collimation Status & Outlook

The LHC collimation problem has been solved for nominal beam:



LHC Collimation

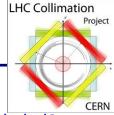
Project

CERN

- Better than design cleaning efficiency was shown.
- In addition gain from lower than specified beam losses.
- Some improvements are ongoing (e.g. minimize collimation setup time):
 - Faster collimation setup with direct feedback from beam loss monitors (2011/12 christmas stop).
 - □ IR2 collimator move (2011/12 christmas stop).
 - □ Replacement of IR1/2/5/8 tertiary collimators and IR6 collimators with BPM collimator design → faster setup, lower beta* (long shutdown 1).
 - □ Radiation measures: remote handling, easy handling, remote survey, ...
 - R&D on low impedance materials (collimation phase 2, for LS2)
 - □ R&D on new solutions: hollow e-beam lens, crystal coll., non-linear coll.
- On long-term (LS2, performance > nominal) expect to become limited by fundamental losses into LHC dispersion suppressors:
 - Protect dispersion suppressor collimators in IR1/2/3/5/7/8



Work Ahead for DS Collimation Concept



- Specify cases for collimation (p intensity, ion intensity, lifetimes, p-p luminosity, Pb-Pb luminosity, any other future use cases) for IR1/2/3/5/7/8 independently, including HL-LHC parameters!
- 2. Define candidate locations for DS collimators, candidate material and candidate jaw length (also 1-sided vs. 2-sided).
- 3. Define gaps for DS collimators.
- 4. Simulate collimation efficiency (SixTrack with Collimation) for defined cases. Vary parameters (material, length, gaps).
- 5. Possibly iterate location until losses for all cases are reliably intercepted (study 1 versus 2 collimators per DS).
- 6. Once OK for beam losses, define reference case (material, length, gaps, locations). Define power load. Try to have one collimator solution.
- 7. Calculate energy deposition (FLUKA) and heating for defined cases, including accident cases.
- 8. Calculate jaw temperature and cooling. Check response to accident cases (ANSYS). Define design reference case.
- 9. Check impedance and trapped modes (RF simulations).
- 10. Iterate if necessary.
- 11. Freeze design.



- Collimation project management & project meeting
- Collimation upgrades in DS's and IR's: Studies and specifications
- DS upgrade technical feasibility
- Phase 1 studies and improvements
 - □ includes BE studies crystal coll, coll with BPM's, hollow e-beam lens

LHC Collimation

Project

CERN

Collimator design and production

Upgrade Dispersion Suppressors

- Assumed solutions: 11T or IR3-type (magnet movements)
- Scope: IR1, IR2, IR3, IR5, IR7 for proton and ion losses
- DS upgrade specification:
 - □ Forum: Upgrade specification meeting
 - Mandate: Specify jaw material & length, collimator gaps & precision, collimator locations and power loads, performance improvement
 - Scope: loss simulations, tracking with protons and ions, energy deposition, radiation impact, optics studies, operational studies

LHC Collimation

Project

CERN

Runs until specification is provided

DS upgrade technical feasibility:

- □ Forum: Technical integration meeting (V. Parma & J.P. Tock)
- Mandate: Feasibility of installing cold collimators, housed in cryoassemblies, in the continuous cryostat during LHC LS2
- Collimator design for dispersion suppressors (warm/cold) → Coll Design Meeting



Conclusion

The LHC collimation system is very powerful but cannot protect the LHC cern dispersion-suppressors (long predicted, due to basic physical limits).

LHC Collimation

Project

- On the long term (for much beyond nominal performance, e.g. for HL-LHC) we will need to protect the dispersion suppressors against losses from collimation insertions and collisions.
- 11T magnets provide an elegant solution to the problem (preferred). Backup solution is the movement of magnets and use of missing dipole space (much less elegant).
- A lot of work is ahead to work out a detailed a solution and to prove that the 11T solution with collimator delivers the required performance:
 - Collimation efficiency and power loads for future requirements (nominal is not enough).
 - □ Behavior of cold surfaces under power load, cooling, ...
 - □ Technical feasibility of integration of a long collimator into an 11T assembly.
- Developments must be advanced in parallel to explore all possible issues early. Plan for success.
- We have all the tools and experience to advance this efficiently.

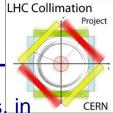


LHC Collimation Project

... Now more details from Adriana...



DS Upgrade Technical Feasibility



What ? Feasibility of installing really cold collimators, housed in cryo-assemblies, in the continuous cryostat during LHC LS2, as required by collimation (pt.1, 2, 3, 5 and 7)?

Goals

- □ Analyze potential schemes of cold collimators coupled to 11 T magnets;
- Identify potential show stoppers, either related to the implementation of the layout schemes or related to operational aspects of the associated technical systems (vacuum, cryogenics, machine protection, alignment, etc).
- □ Identify potential needs for R&D with its associated effort and timeline.
- How? Set-up a Working Group coordinated by MSC-CMI (V.Parma, J.Ph.Tock as alternate), meeting every 2-3 weeks with the following proposed participants by system:
 - □ Collimators:, EN-MME
 - □ Vacuum : V Baglin, TE-VSC
 - □ Cryogenics : R.Van Weelderen, TE-CRG
 - □ 11 T magnets: M Karppinen TE-MSC
 - □ Machine Layout & Integration: V.Parma (J.Ph.Tock), TE-MSC
 - □ HL LHC coordinator : L Rossi (TE-HDO)
 - □ Collimation project leader or representative
- Reporting? to the Collimation Management Meeting. Technical feedback and requests to the specification meeting.