Optimization of the collapsing time of the separation bumps

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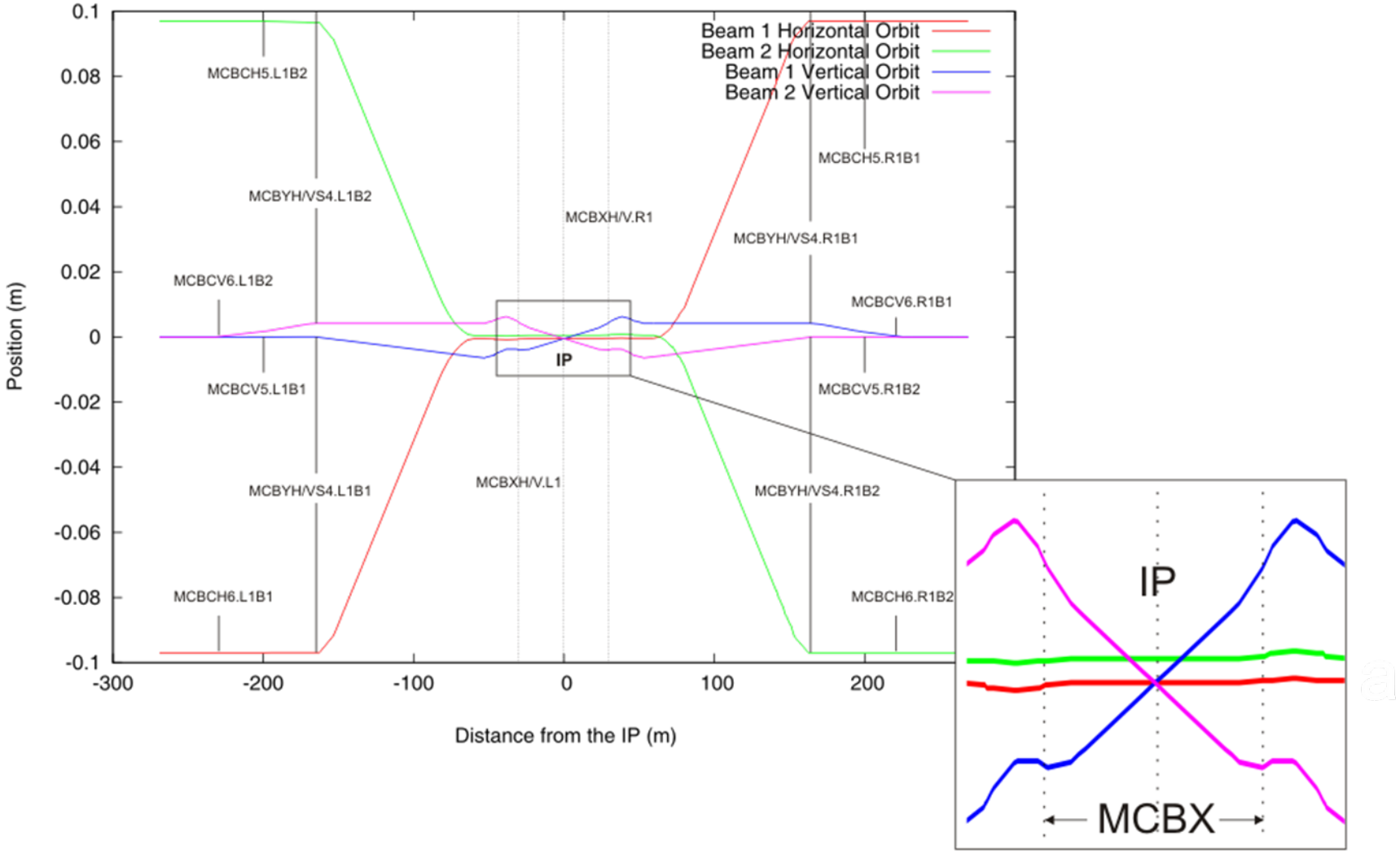
Motivations

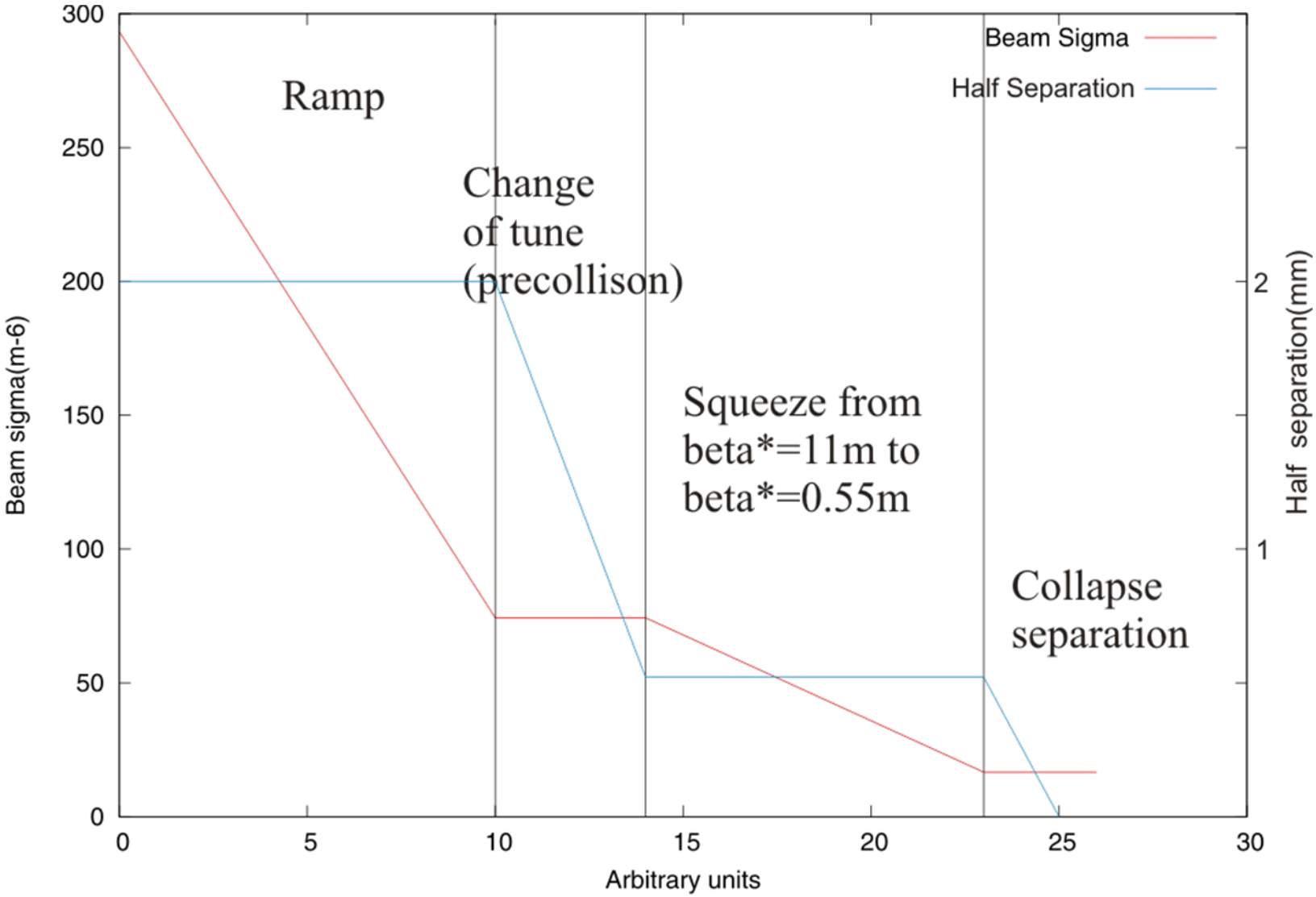
- It has been shown in simulations that due to beam-beam interaction an offset between the beams can result in an emittance growth.

$\Rightarrow$A solution to reduce this unwanted effect would be to decrease the time spent in the dangerous region (small offsets) by bringing the beams into collision as fast as possible.

The LHC crossing scheme



Evolution of the beam sigma



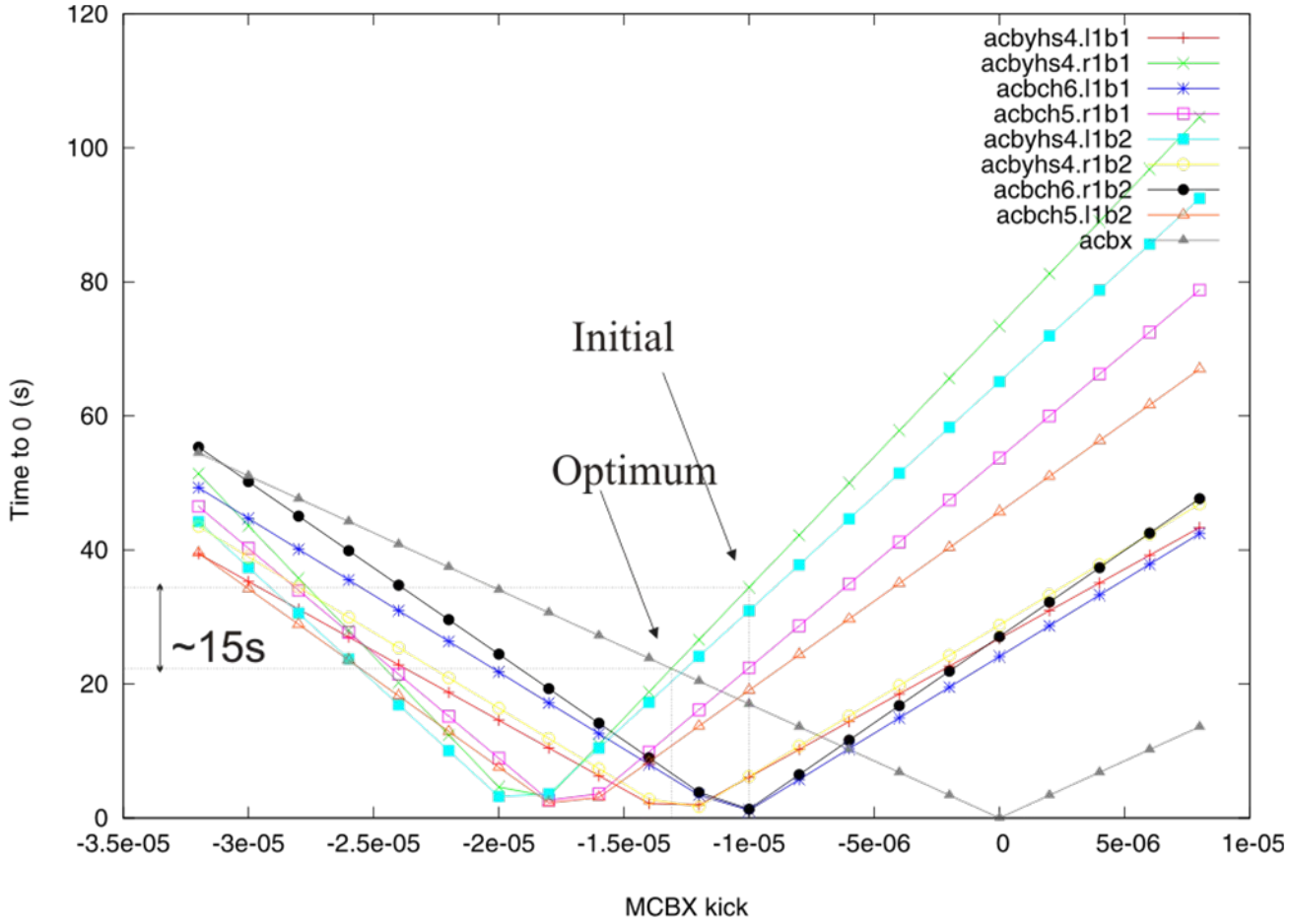
Magnets characteristics

PC NAME	LENGTH	I NOMINAL	B NOMINAL	OLD MAX DI DT	REAL MAX DI DT	Proposed NEW MAX DIDT	PC NAME	LENGTH	I NOMINAL	B NOMINAL	OLD MAX DI DT	REAL MAX DI DT	Proposed NEW MAX DIDT
IP1							**IP5**						
RPMBB.UJ16.RCBXH1.R1	0.45	550	3.35	5.00	23.77	15.00	RPMBB.UJ56.RCBXV1.R5	0.48	550	3.26	5.00	32.88	15.00
RPMBB.UJ14.RCBXH1.L1	0.45	550	3.35	5.00	25.28	15.00	RPMBB.USC55.RCBXV1.L5	0.48	550	3.26	5.00	37.03	15.00
RPLB.RR17.RCBCH5.R1B1	0.904	80	2.33	0.67	1.25	1.00	RPLB.RR57.RCBCV6.R5B1	0.904	80	2.33	0.67	2.07	2.00
RPLB.RR13.RCBCH6.L1B1	0.904	80	2.33	0.67	2.16	2.00	RPLB.RR53.RCBCV5.L5B1	0.904	80	2.33	0.67	2.56	2.00
RPLB.RR17.RCBYHS4.R1B1	0.899	72	2.50	0.67	1.60	1.50	RPLB.RR53.RCBYVS4.L5B1	0.899	72	2.50	0.67	1.76	1.50
RPLB.RR13.RCBYHS4.L1B1	0.899	72	2.50	0.67	1.65	1.50	RPLB.RR57.RCBYVS4.R5B1	0.899	72	2.50	0.67	1.67	1.50
RPLB.RR13.RCBCH5.L1B2	0.904	80	2.33	0.67	1.16	1.00	RPLB.RR57.RCBCV5.R5B2	0.904	80	2.33	0.67	2.46	2.00
RPLB.RR17.RCBCH6.R1B2	0.904	80	2.33	0.67	2.23	2.00	RPLB.RR53.RCBCV6.L5B2	0.904	80	2.33	0.67	2.27	2.00
RPLB.RR17.RCBYHS4.R1B2	0.899	72	2.50	0.67	1.60	1.50	RPLB.RR53.RCBYVS4.L5B2	0.899	72	2.50	0.67	1.75	1.50
RPLB.RR13.RCBYHS4.L1B2	0.899	72	2.50	0.67	1.66	1.50	RPLB.RR57.RCBYVS4.R5B2	0.899	72	2.50	0.67	1.67	1.50
IP2							**IP8**						
RPMBB.UA23.RCBXH1.L2	0.45	550	3.35	5.00	21.85	15.00	RPMBB.UA83.RCBXV1.L8	0.48	550	3.26	5.00	36.15	15.00
RPMBB.UA27.RCBXH1.R2	0.45	550	3.35	5.00	21.03	15.00	RPMBB.UA87.RCBXV1.R8	0.48	550	3.26	5.00	34.52	15.00
RPLB.UA27.RCBCHS5.R2B1	0.904	80	2.33	0.67	2.63	2.00	RPLB.UA83.RCBCV6.L8B1	0.904	80	2.33	0.67	2.17	2.00
RPLB.UA27.RCBYHS4.R2B1	0.899	72	2.50	0.67	1.49	1.00	RPLB.UA83.RCBYVS4.L8B1	0.899	72	2.50	0.67	1.41	1.00
RPLB.UA23.RCBYHS5.L2B1	0.899	72	2.50	0.67	1.07	1.00	RPLB.UA87.RCBYVS4.R8B1	0.899	72	2.50	0.67	1.29	1.00
RPLB.UA23.RCBYHS4.L2B1	0.899	72	2.50	0.67	1.26	1.00	RPLB.UA87.RCBYVS5.R8B1	0.899	72	2.50	0.67	1.22	1.00
RPLB.UA27.RCBCHS5.R2B2	0.904	80	2.33	0.67	2.56	2.00	RPLB.UA87.RCBCV6.R8B2	0.904	80	2.33	0.67	2.43	2.00
RPLB.UA23.RCBYHS4.L2B2	0.899	72	2.50	0.67	1.25	1.00	RPLB.UA83.RCBCVS5.L8B2	0.904	80	2.33	0.67	2.40	2.00
RPLB.UA23.RCBYHS5.L2B2	0.899	72	2.50	0.67	1.06	1.00	RPLB.UA83.RCBYVS4.L8B2	0.899	72	2.50	0.67	1.42	1.00
RPLB.UA27.RCBYHS4.R2B2	0.899	72	2.50	0.67	1.49	1.00	RPLB.UA87.RCBYVS4.R8B2	0.899	72	2.50	0.67	1.28	1.00

Strategy

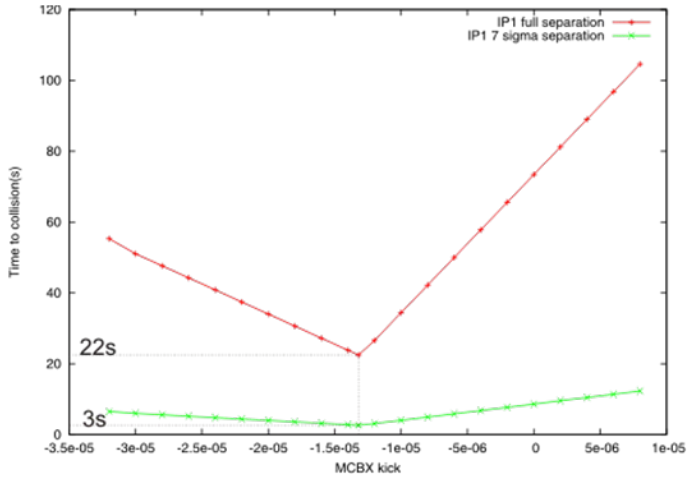
- Rematch the separation scheme for different MCBX kicks and try to find an optimum for the collapsing time.
- The maximum kick are implemented in the matching job.
- IP8 bump now closed at Q5.
- Look at the different dI/dt configurations.

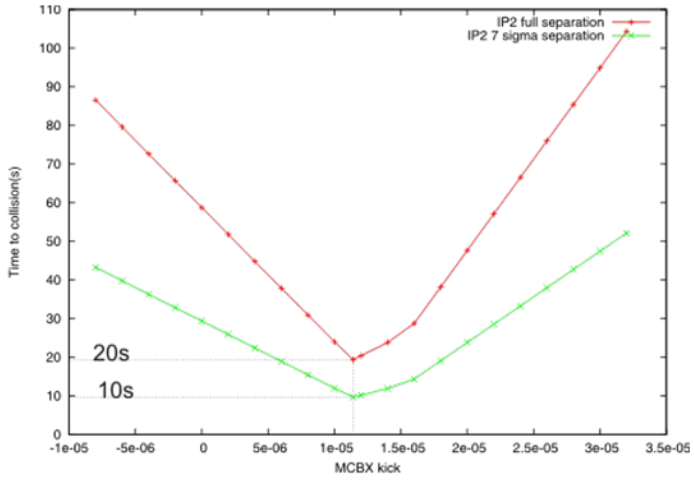
Optimization of the nominal collision scheme

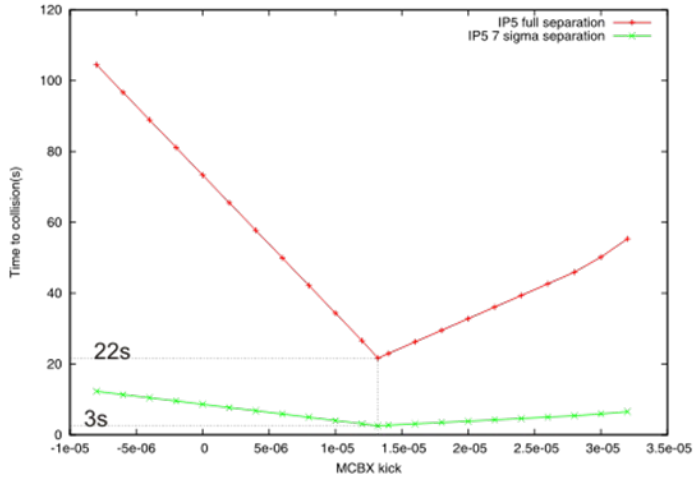


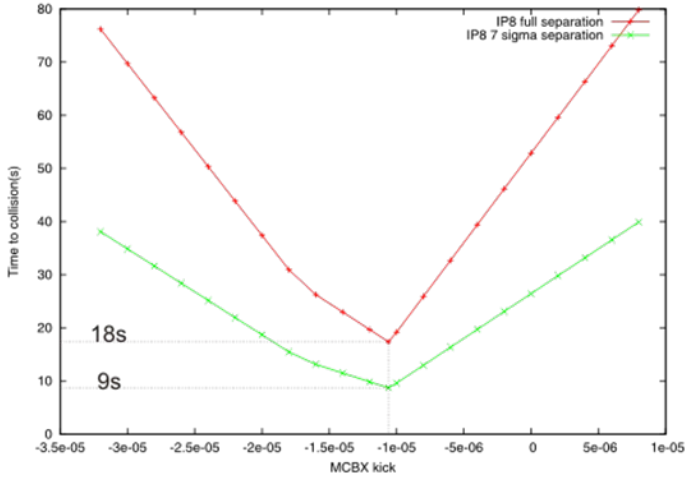
Example of IP1, beta*=0.55m, 1mm separation.

Optimization of the nominal collision scheme

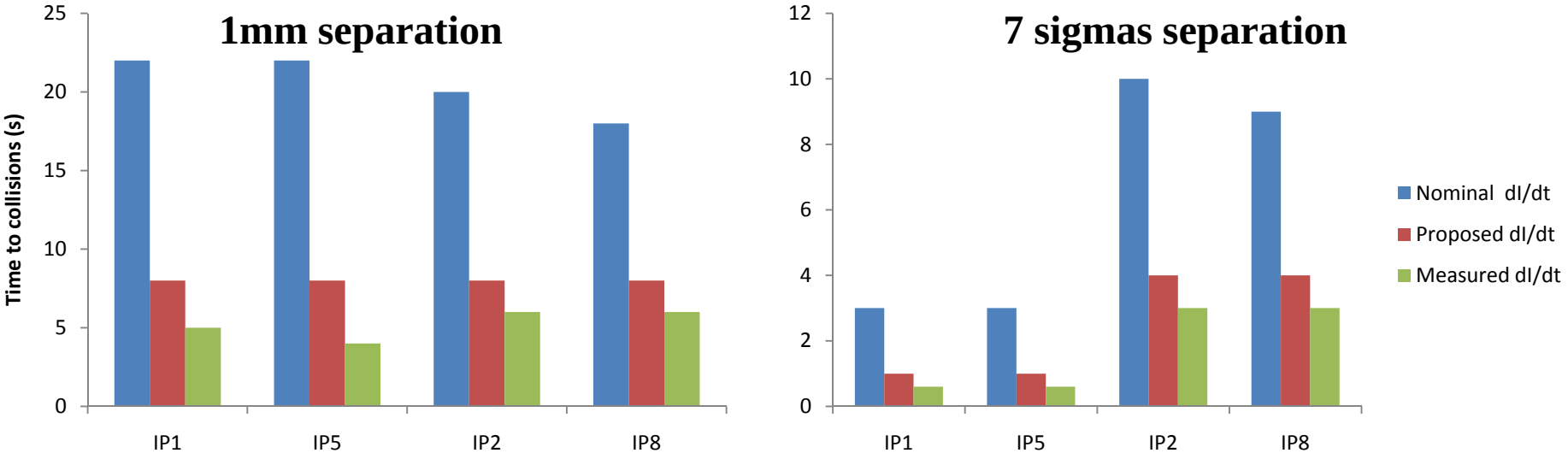








Effect of dI/dt configuration

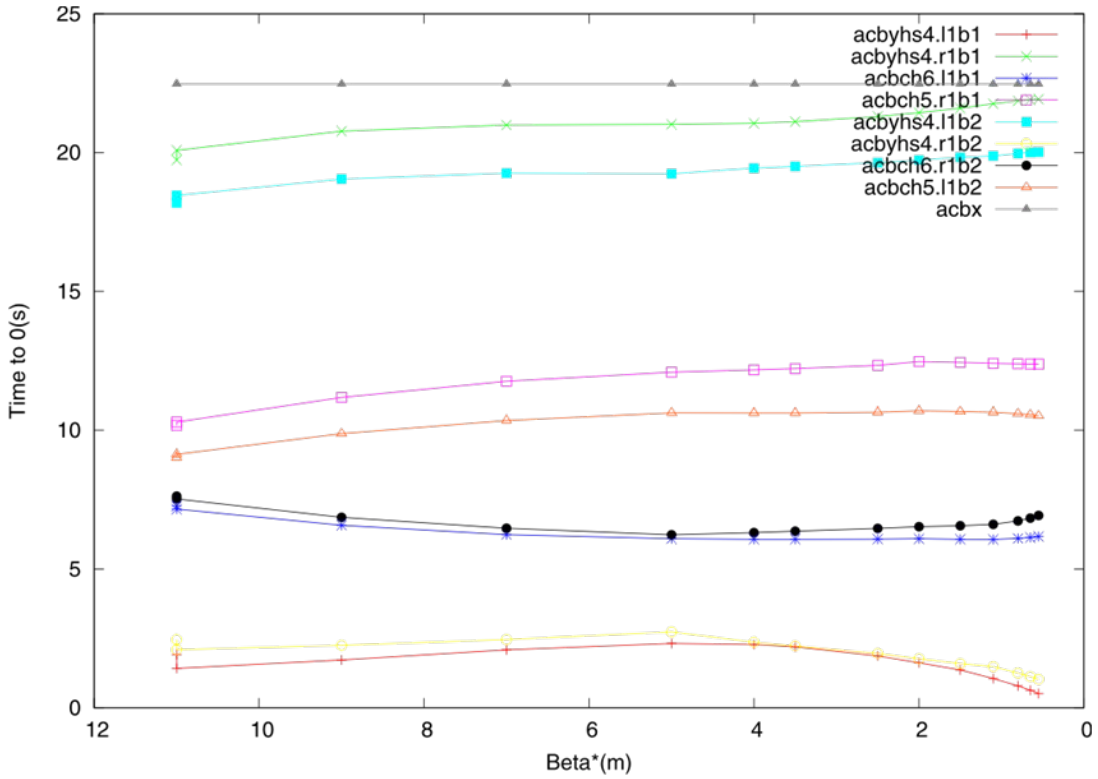


	IP1	IP5	IP2	IP8
	MCBX kick	MCBX kick	MCBX kick	MCBX kick
Nominal dI/dt	-1.32E-05	1.32E-05	1.14E-05	-1.06E-05
Proposed dI/dt	-1.42E-05	1.42E-05	1.36E-05	-1.25E-05
Measured dI/dt	-1.56E-05	1.60E-05	1.44E-05	-1.20E-05

⇒The proposed new dI/dt would result in a gain of a factor 2.

Effect of the beta*

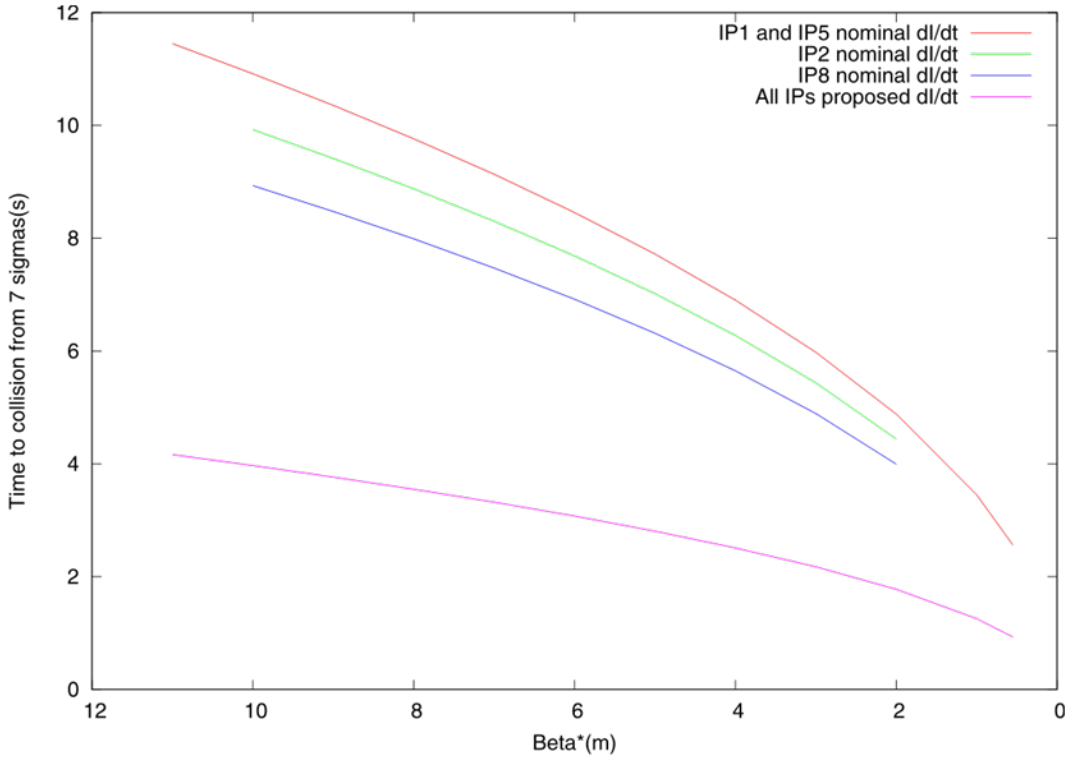
- The separation in mm and the MCBX kick are kept constant during the squeeze. The collapsing time of the full scheme is then constant.



Example of the Squeeze at IP1: The limitation is the MCBX during the whole squeeze.

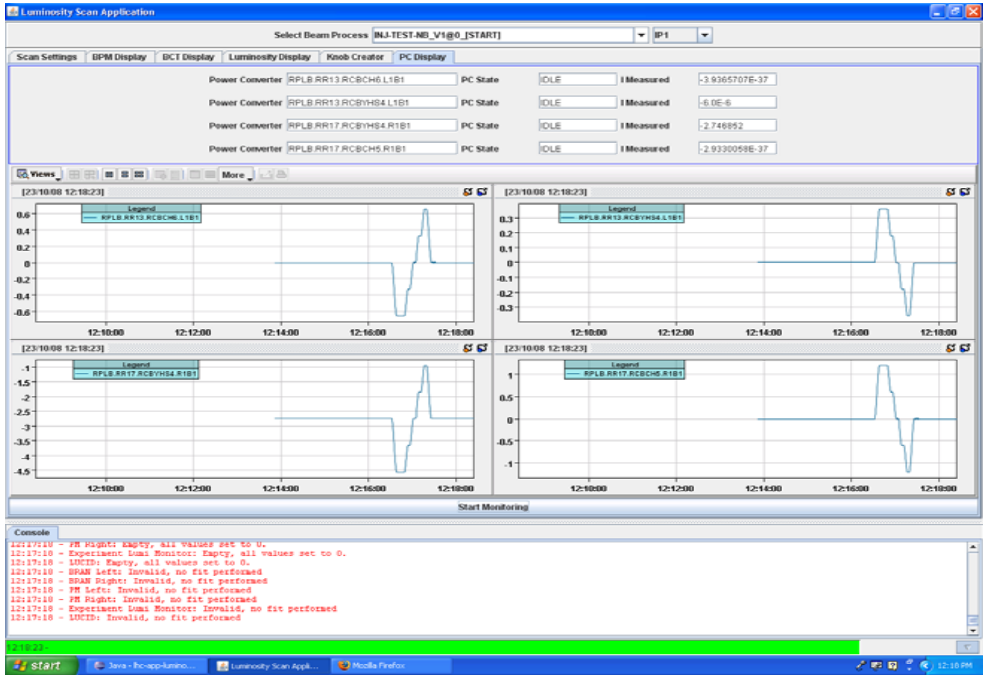
Effect of the beta*

- Evolution of the collapsing time from 7 sigmas during the squeeze for nominal and proposed dI/dt.



Special case of the Van Der Meer scans

- Principle: Sweep one beam through the other following a step function by trimming a knob generating a parallel orbit bump at the IP and acquire the luminosity at each step.



Screen shot of a dry run performed with the CCC application with nominal dI/dt.

Special case of the Van Der Meer scans

- We need to move each beam independently: we cannot use the MCBX, all the strength in the other magnets will be higher.

beta*(m)	t from 1 sigma to 0 (s) nom. dI/dt	t from 1 sigma to 0 (s) prop. dI/dt
11.00	10.12	4.52
2.00	4.01	1.79
0.55	2.18	0.97

With the actual configuration and beta*=11m it would take 10s to go from 0 to 1 sigma separation.

$\Rightarrow$Again by changing the configuration to the proposed new configuration we would gain a factor 2.

Conclusions

- Even after optimizing the separation scheme the actual configuration seems to insufficient:

$\Rightarrow$ 10s in the dangerous region for IP2 and IP8 while bringing the beams into collisions

$\Rightarrow$ Very slow IP orbit correction and Van der Meer scans.

$\Rightarrow$ It seems to be necessary to move to the new proposed configuration

- The optimized scheme is far from the current injection settings :

$\Rightarrow$ Need a complete rematch of the injection optics.

$\Rightarrow$ No solution was found for IP8 with the bump closed in Q5.

- This study will be followed by detailed beam-beam simulations