

LHC Beam Operation Committee meeting

February 8th, 2011

CERN, Geneva, Switzerland

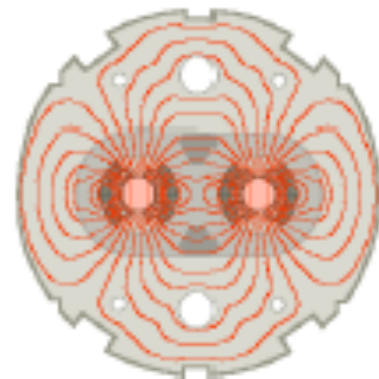
LHC Cycle for Physics Operation

S. Redaelli, M. Lamont, J. Wenninger

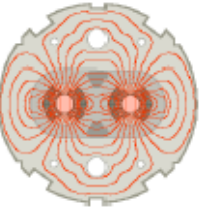
CERN - BE department - OP group

Acknowledgments: X. Buffat (EPFL), W. Herr,

M. Giovannozzi, G. Müller, R. Tomas.



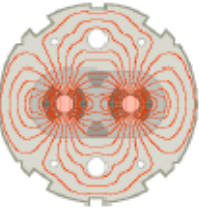
Outline



- Introduction**
- 2011 parameter table**
- Ramp and squeeze**
- Conclusions**

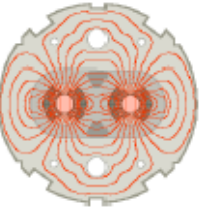


Introduction - Scope





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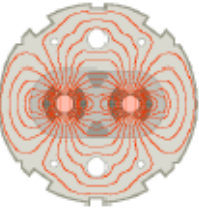


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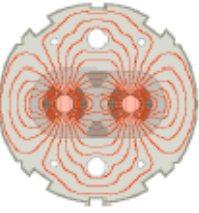
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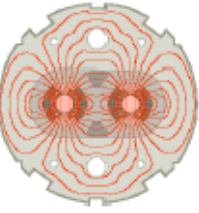
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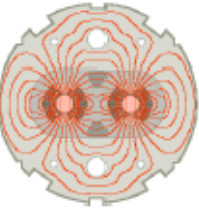
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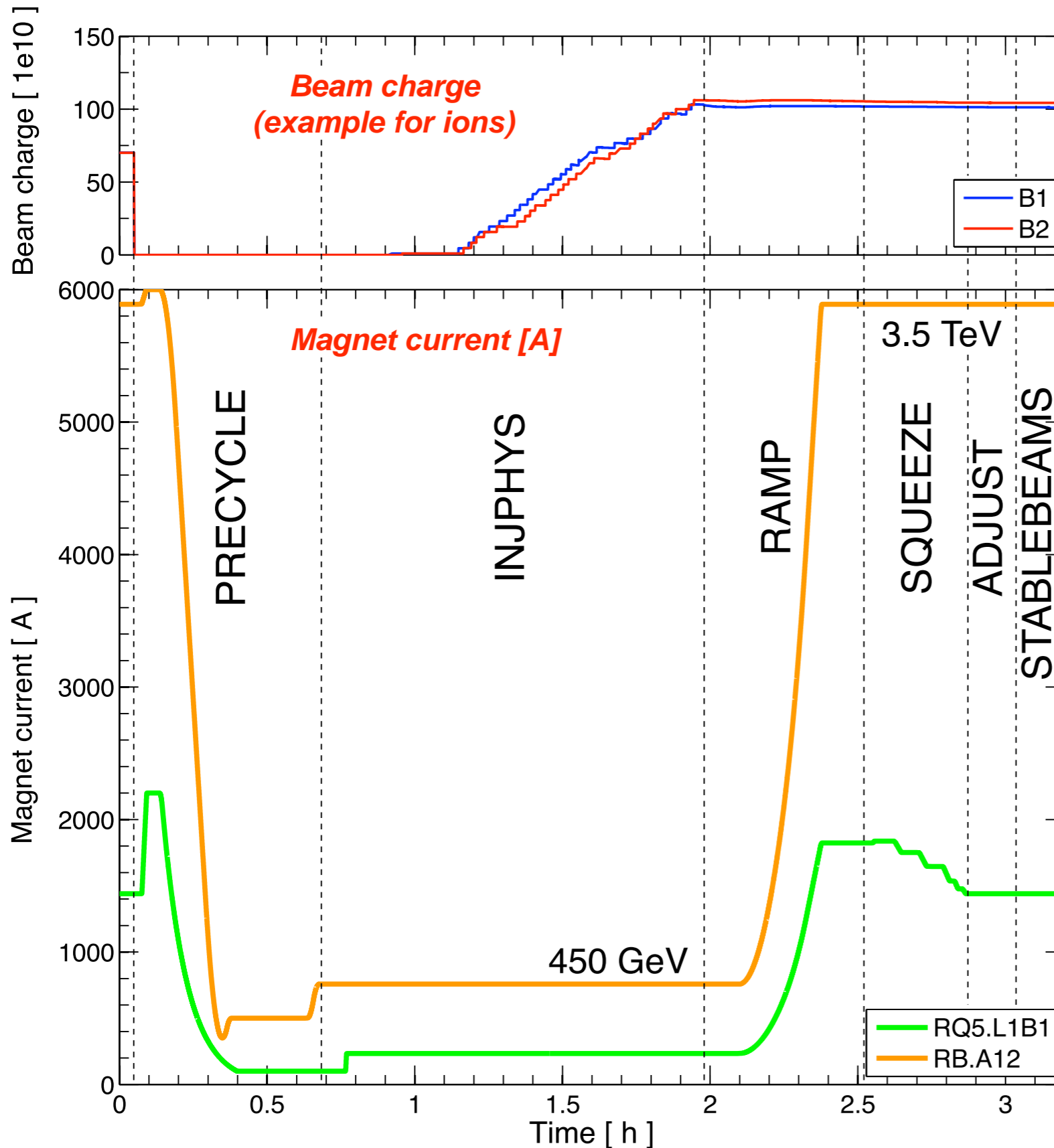
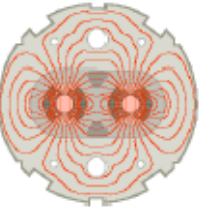
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- Reduce ramp and squeeze duration.
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Improve various operation aspects to reduce risk of errors.

- Minimize changes of references if possible (e.g. Xing at top energy);
- Reduce un-necessary source of errors (e.g. squeeze stop points).

Modes within the LHC cycle



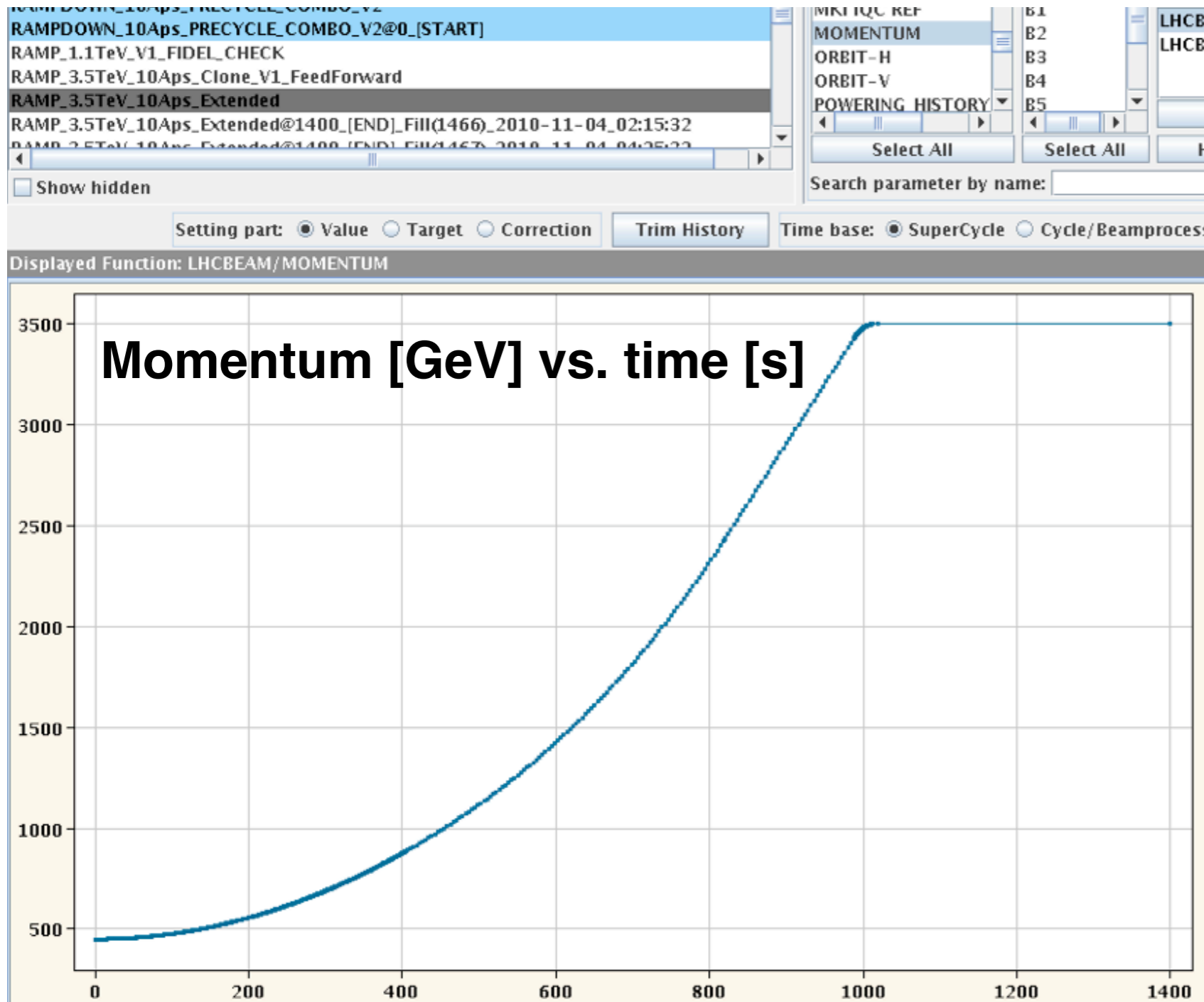
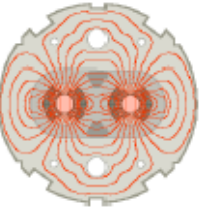
Time-functions for settings of

- (1) ramp,
- (2) squeeze,
- (3) collisions,
- (4) pre-cycle (without beam).

Discrete ("actual") settings for:

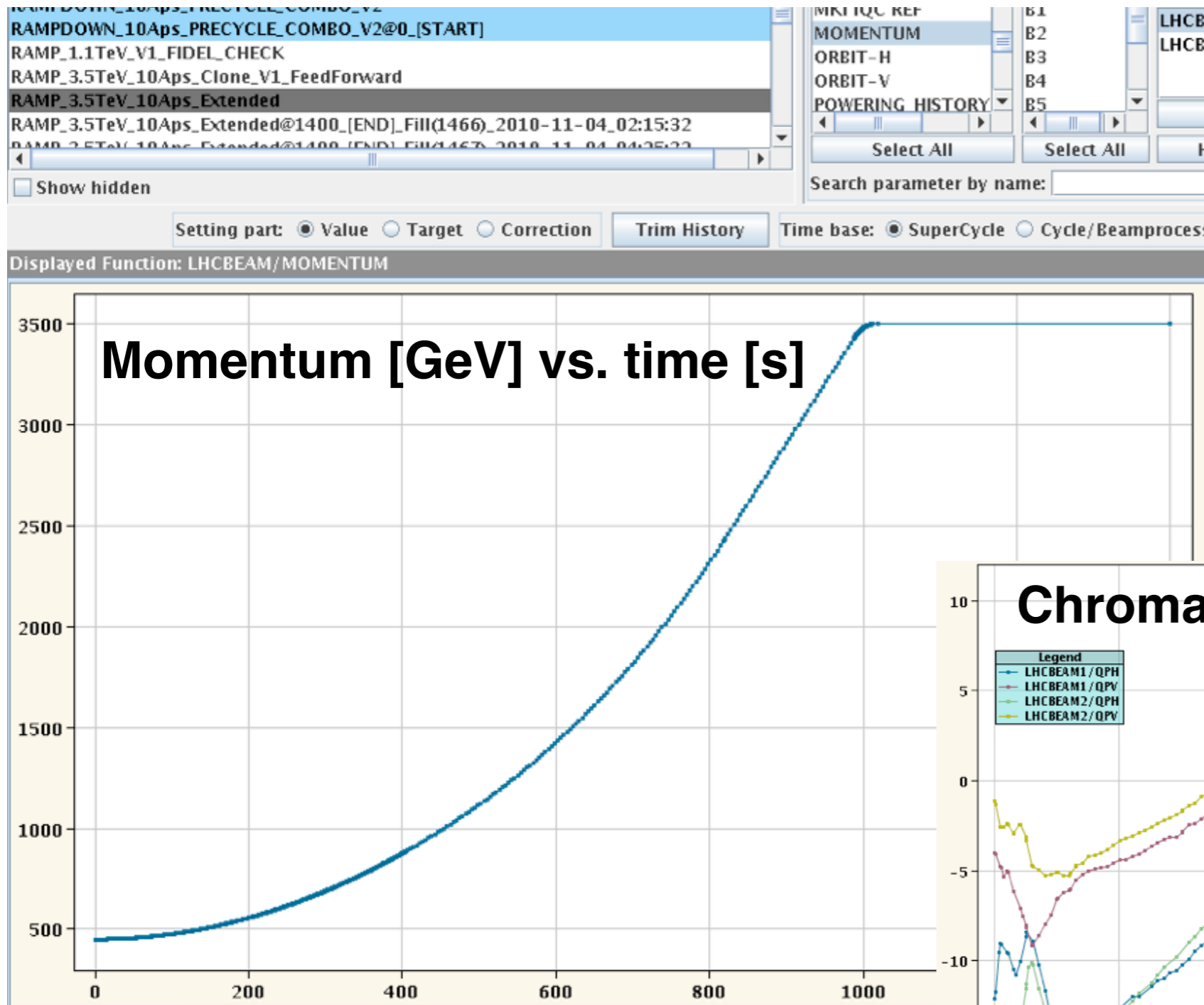
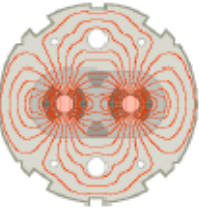
- (1) injection,
- (2) prepare ramp,
- (3) flat-top,
- (4) adjust (end of squeeze),
- (5) stable beams.

Ramp in 2010

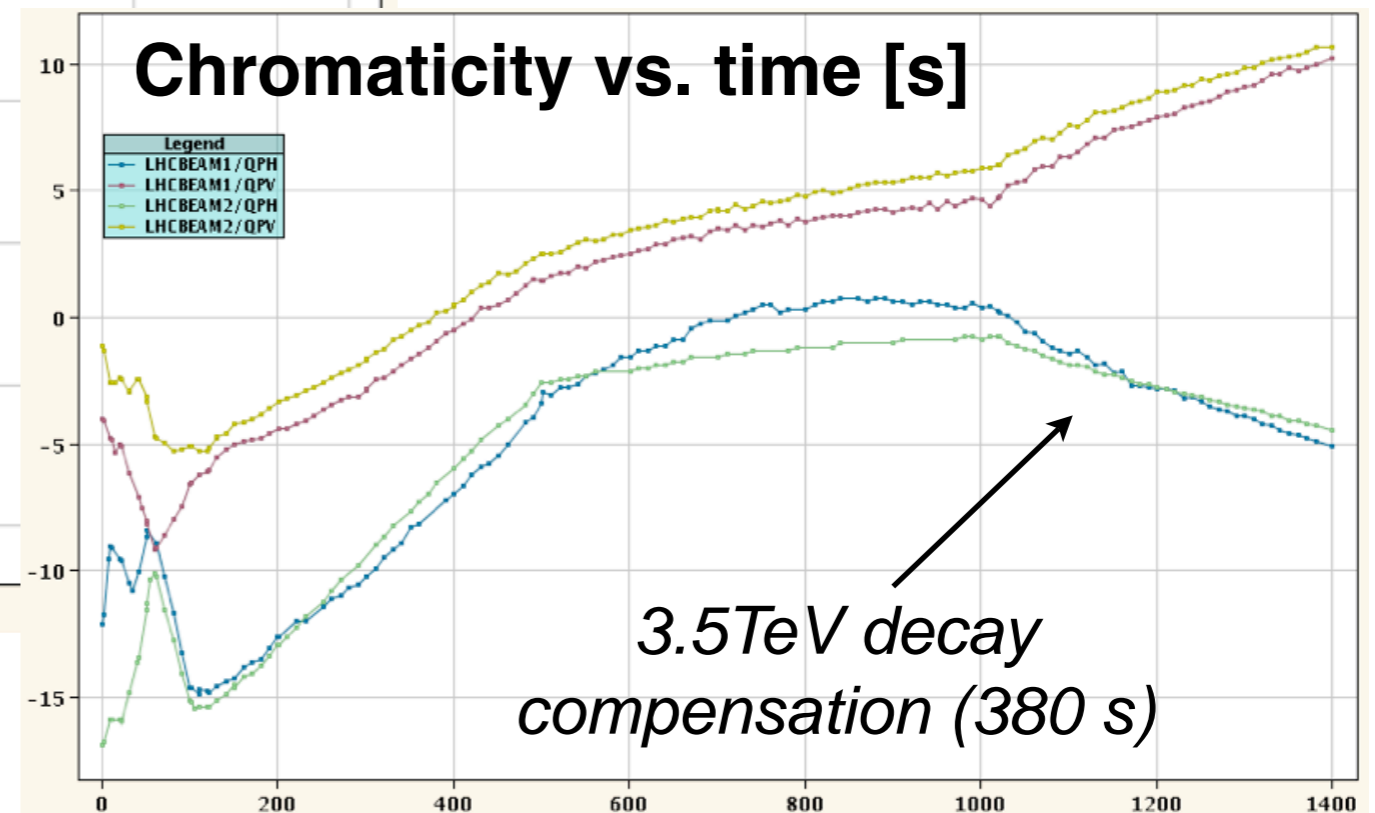


- Nominal ramp rate of 10 A/s
- Duration = 1400 s
- Optics and tune constant
- Separation and crossing kept constant in mm/mrad
- 3.5 TeV decay compensation

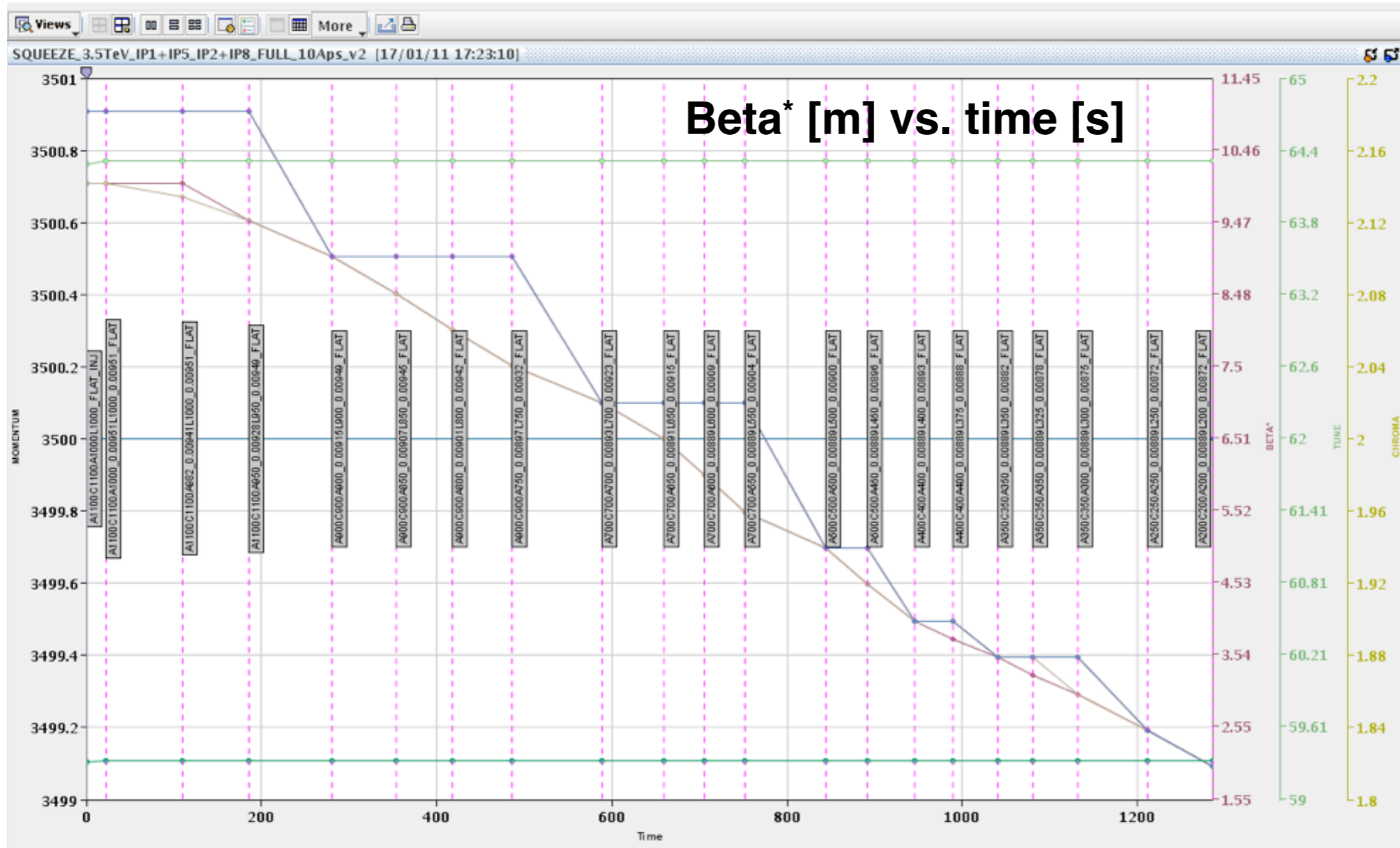
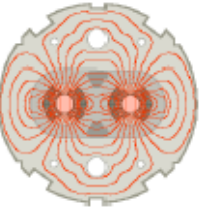
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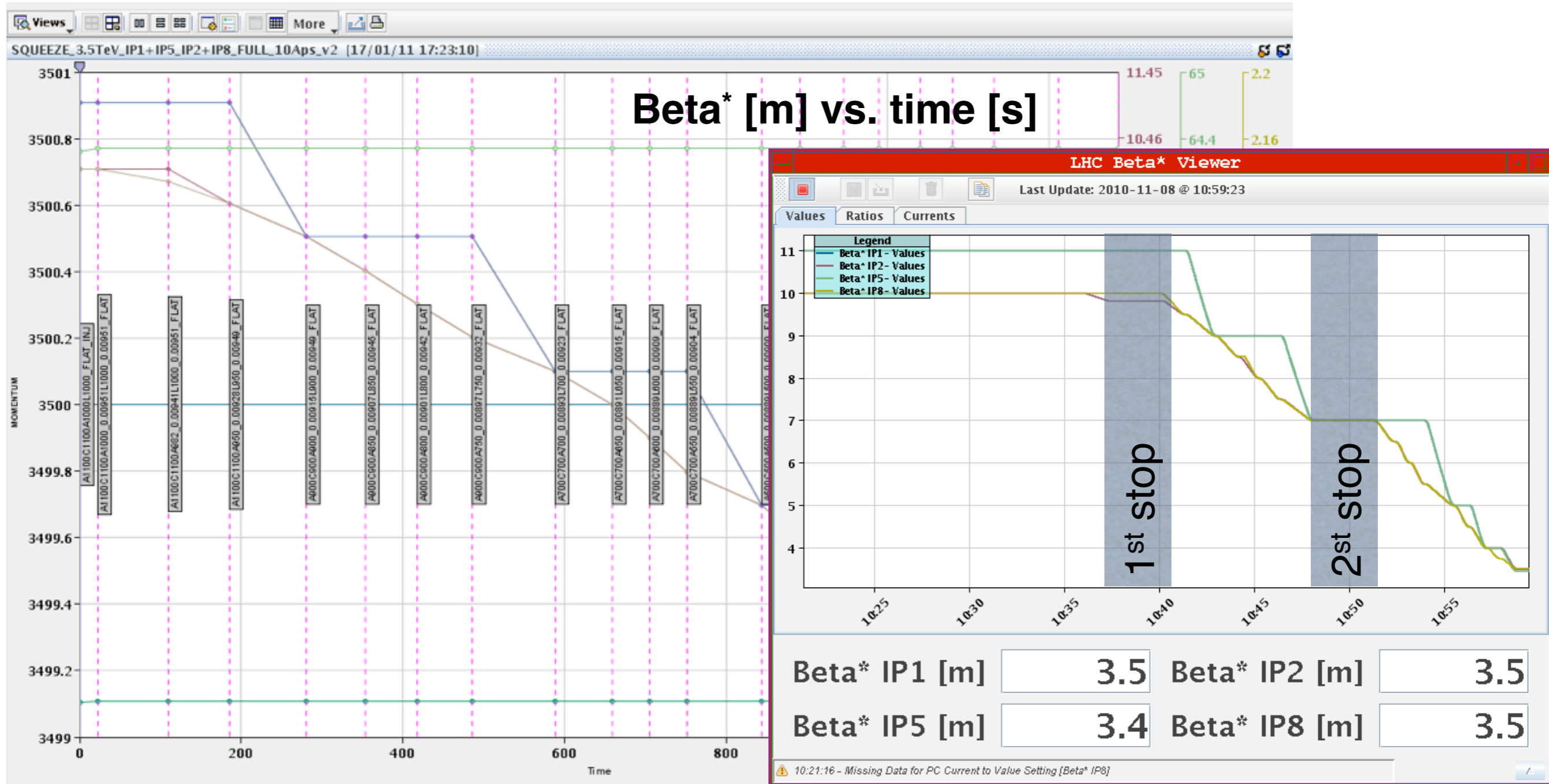
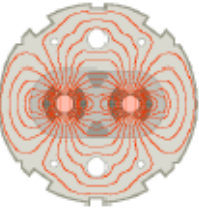


Squeeze in 2010

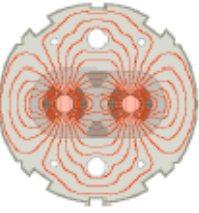


- Settings generated for **2 m** (1280s), then used the segment down to **3.5 m** (1041s);
- Tunes changed over first 23 s (0.28, 0.31) → (0.31, 0.32);
- Two stop points for FB references and collimator movements;
- Used ALL available matched points from ABP (**conservative**).

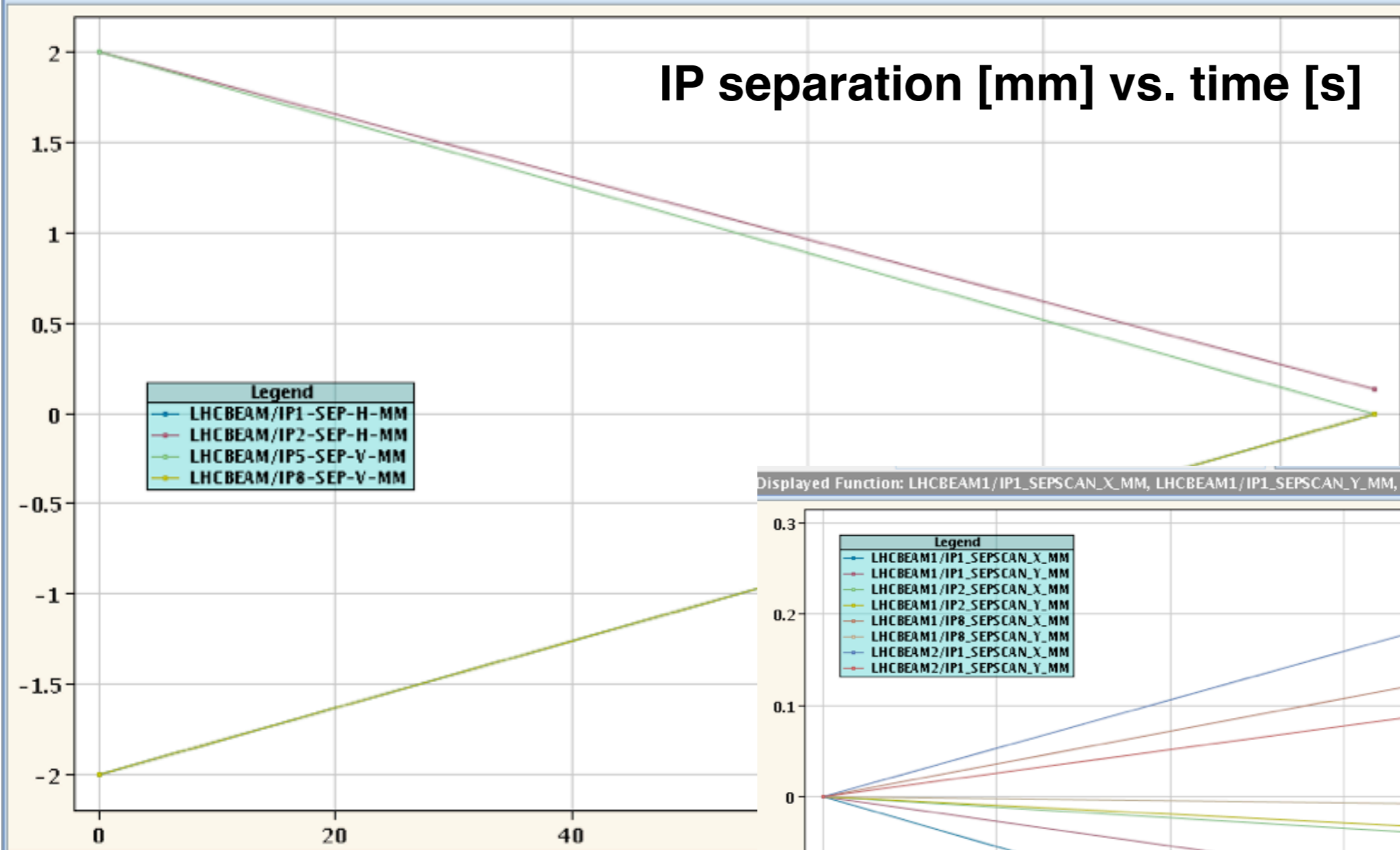
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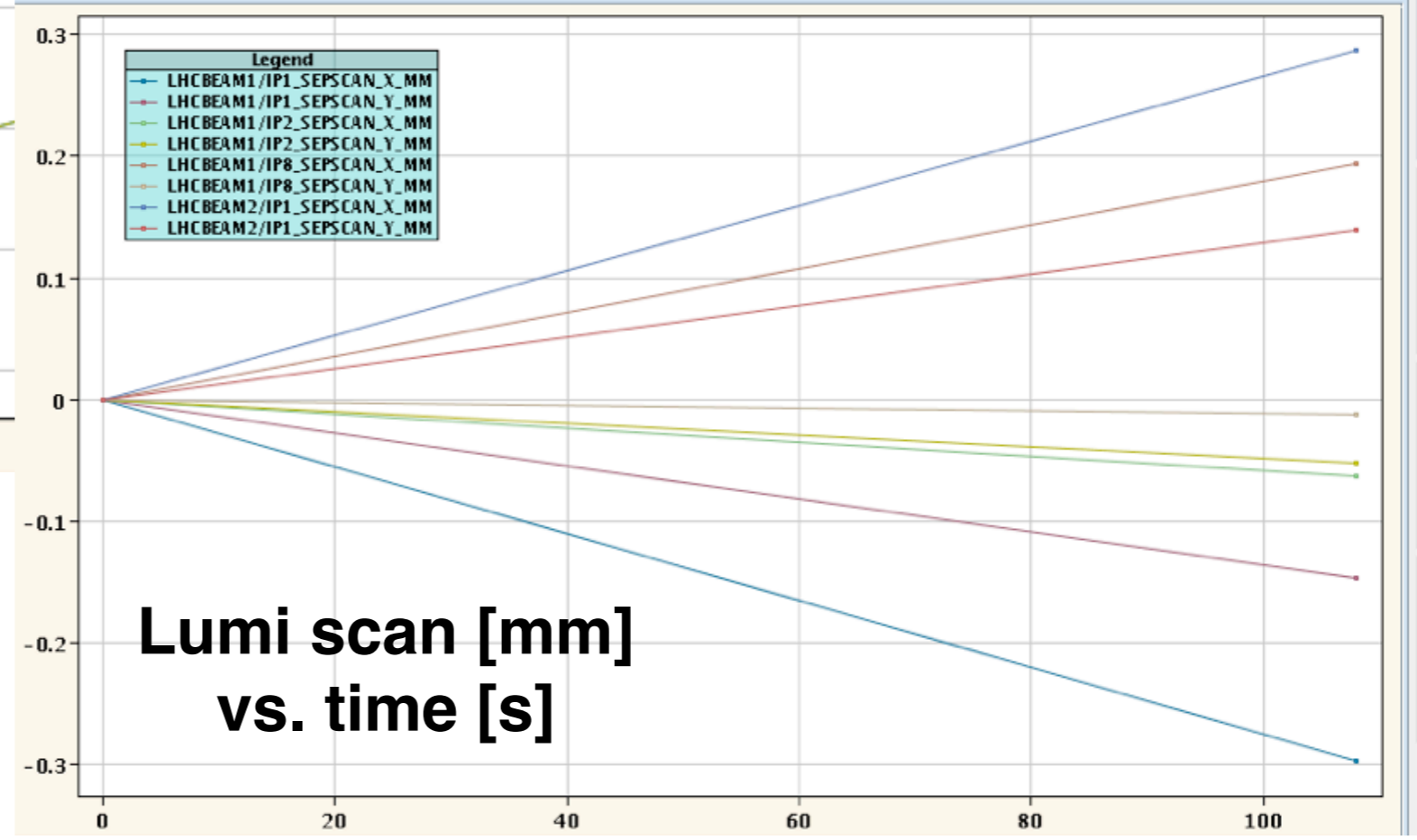
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Displayed Function: LHCBEAM/IP1-SEP-H-MM, LHCBEAM/IP2-SEP-H-MM, LHCBEAM/IP5-SEP-V-MM, LHCBEAM/IP8-SEP-V-MM

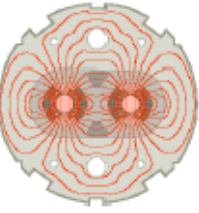


Displayed Function: LHCBEAM1/IP1_SEPSCAN_X_MM, LHCBEAM1/IP1_SEPSCAN_Y_MM, LHCBEAM1/IP2_SEPSCAN_X_MM, LHCBEAM1/IP2_SEPSCAN_Y_MM, LHCBEAM1/IP8_SEPSCAN_X_MM, LHCBEAM1/IP8_SEPSCAN_Y_MM, LHCBEAM2/IP1_SEPSCAN_X_MM, LHCBEAM2/IP1_SEPSCAN_Y_MM



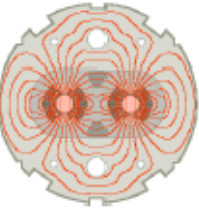
*Duration: 108 s (p) and 180 s (ions),
driven by orbit correctors in IPs
Lumi-scans feed-forwarded fill after
fill → good convergence!*

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2011 parameter table (protons)

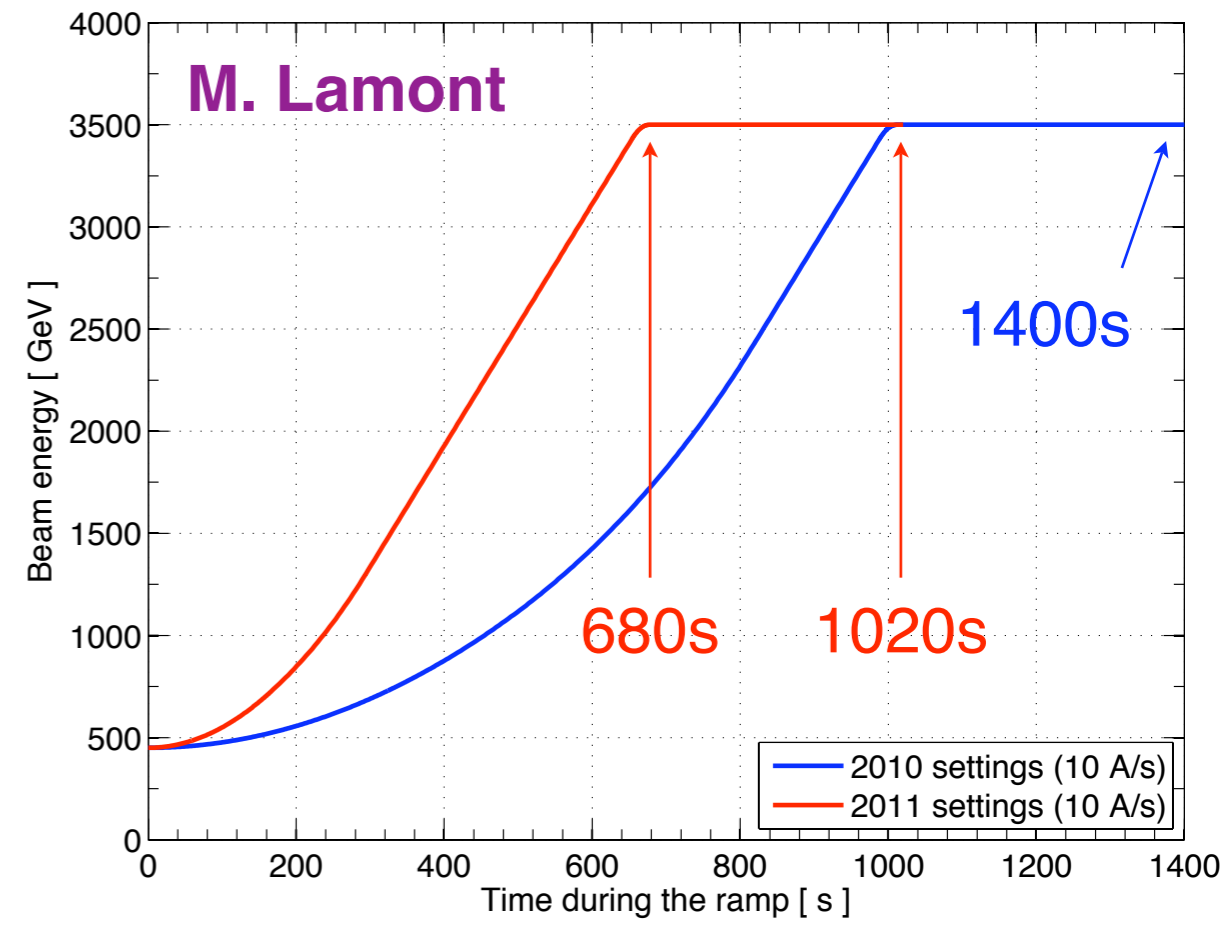
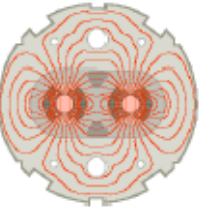


Parameter	Value at 450 GeV	Value at top energy
Energy [GeV]	450	3500
Beta* IP1/5 [m]	11.0	1.5
Beta* IP8 [m]	10.0	3.0
Beta* IP2 [m]	10.0	10.0 [#]
Parallel separation [mm]	2.0	0.72
Crossing angle IP1/5 [mrad]	0.14	0.12
<i>Crossing angle IP2 [mrad]</i>	± 0.14	± 0.08
<i>Crossing angle IP8 [mrad]</i>	0.14	0.25 [*]
Ramp duration [s]	1400 → 1020	
Squeeze duration [s]	1041 (3.5 m) → 474 (1.5 m)	
Collision BP duration [s]	108 → 60	

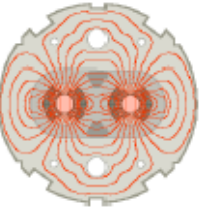
^{*} Depending on beam emittance and spectrometer configuration, see W. Herr at Chamonix2011.

[#] Beta* below 2 m prepared for ion run (T. Risselada, E. Laface + ABP).

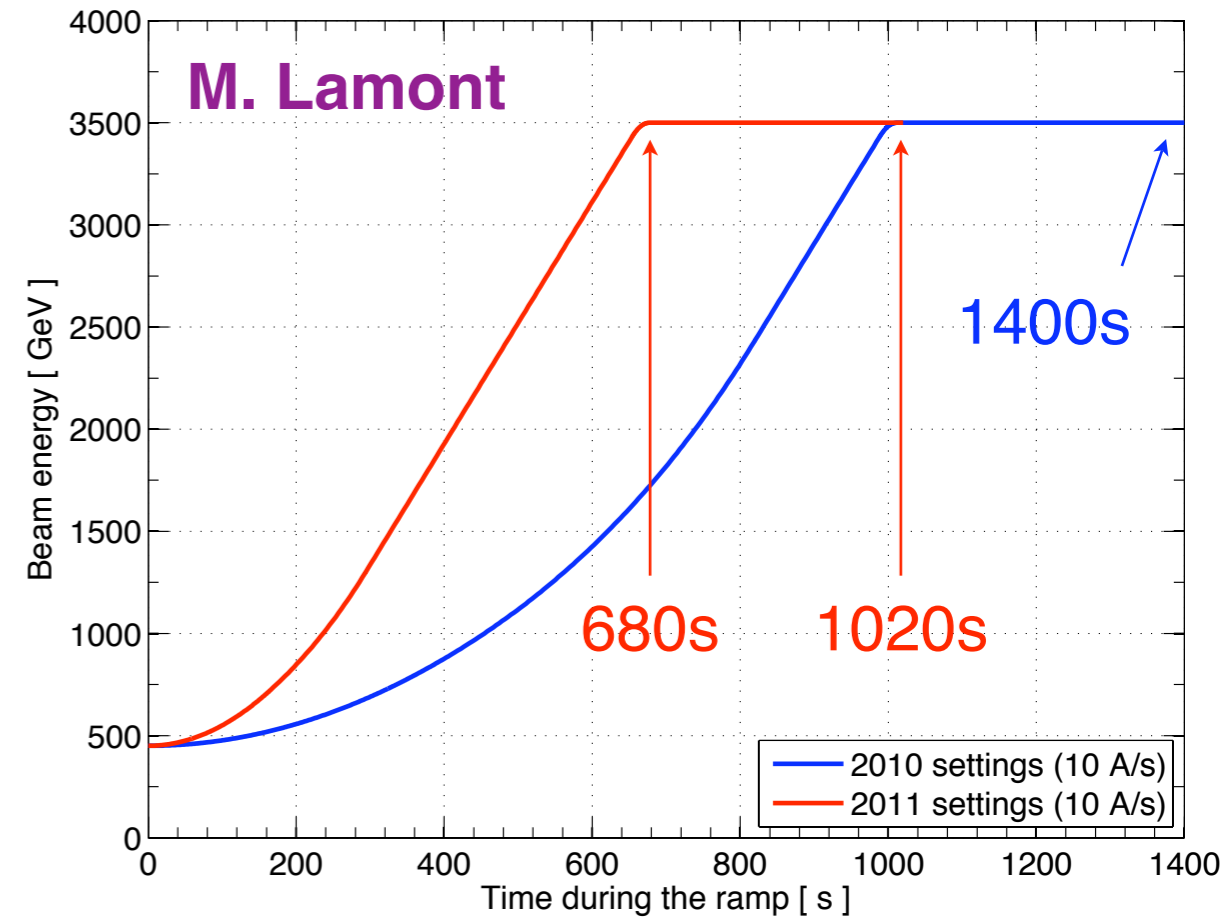
Ramp in 2011



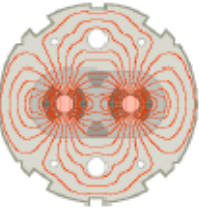
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Same optics as 2010 in all IPs



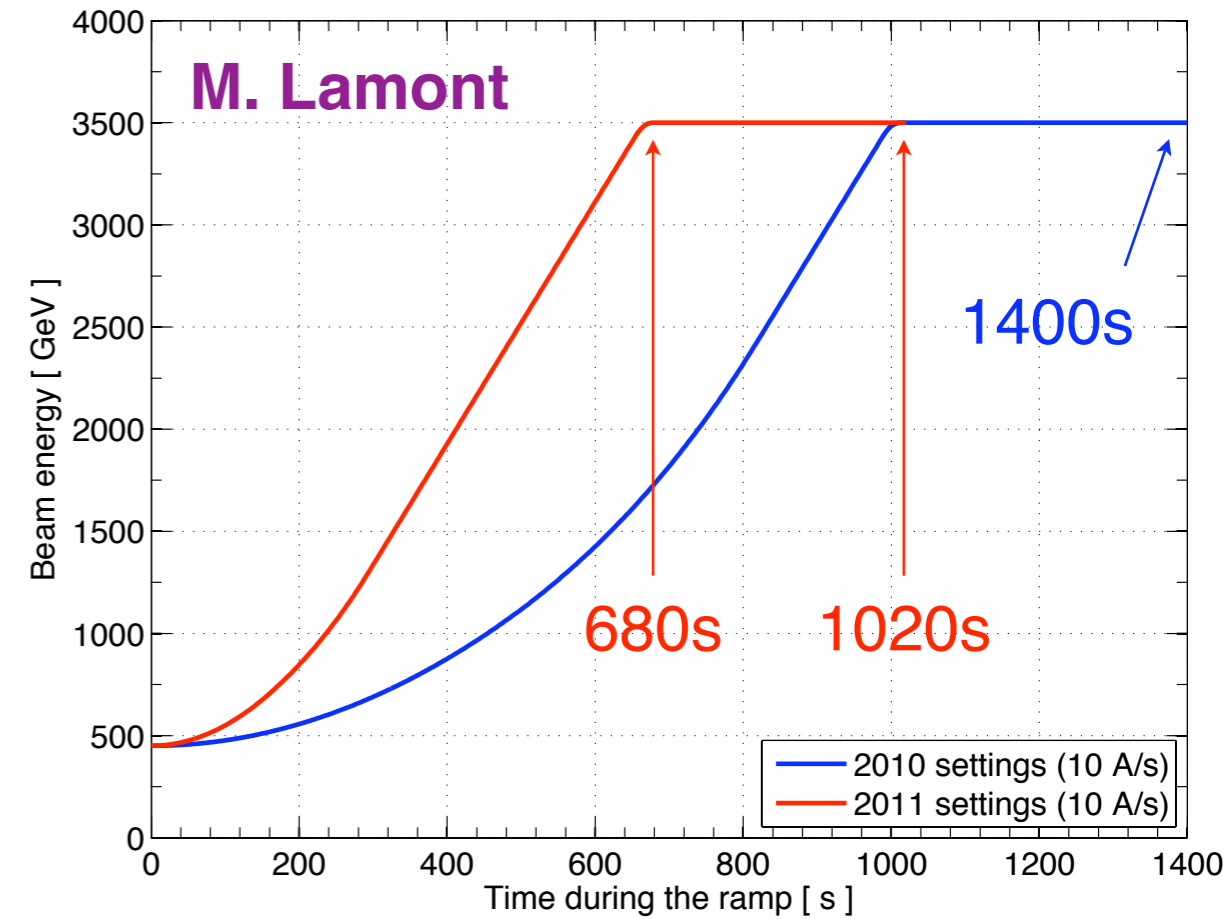
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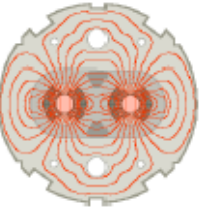


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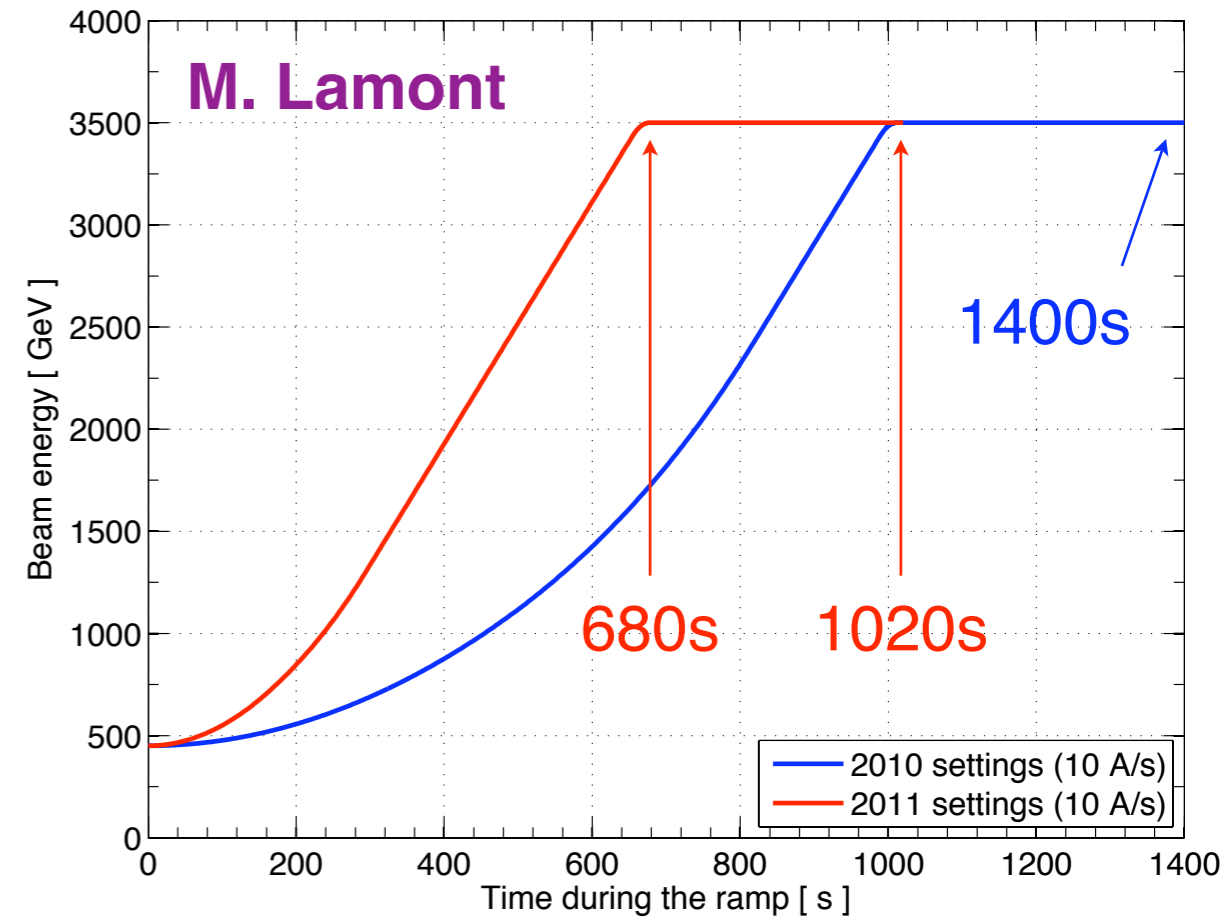
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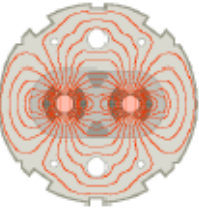
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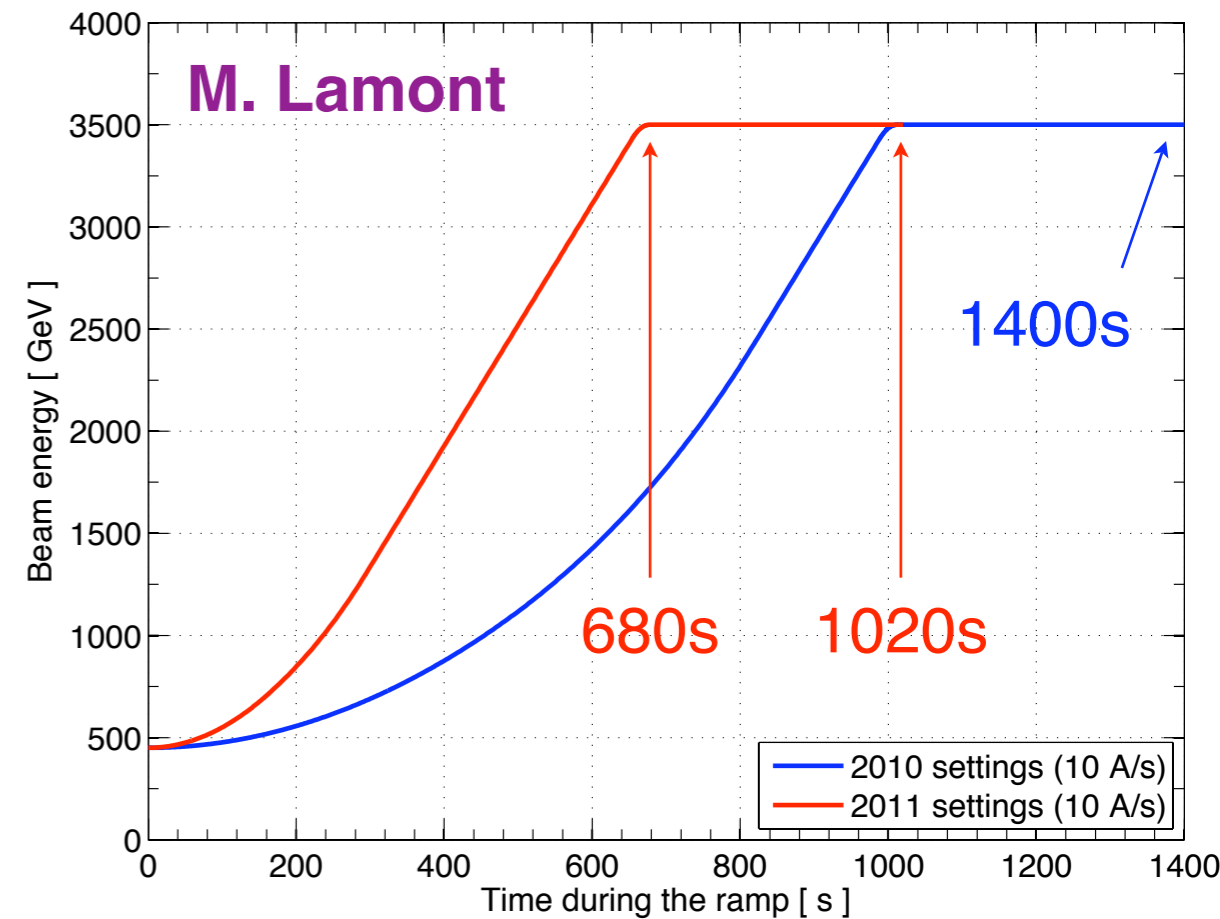
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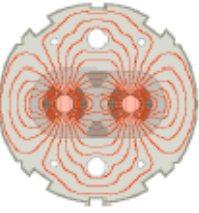
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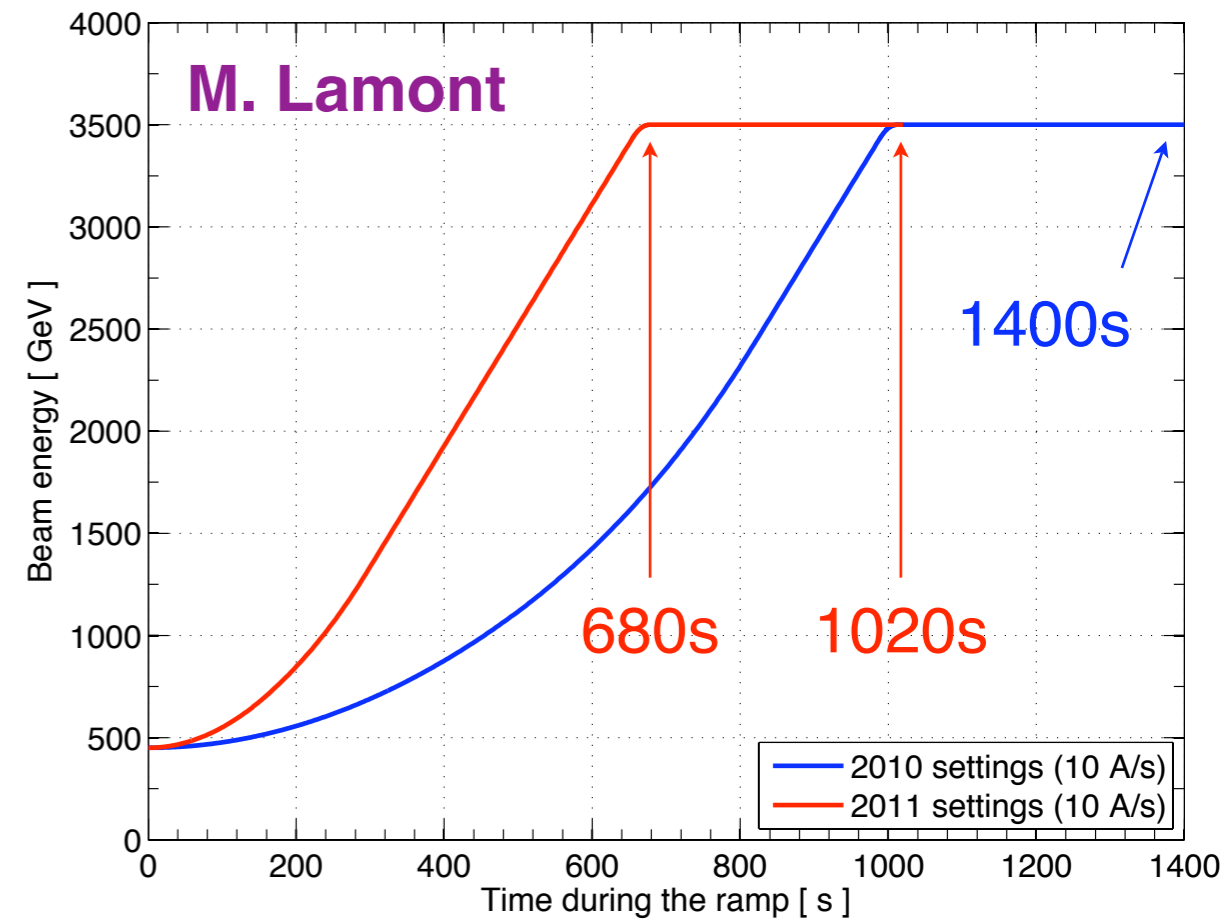
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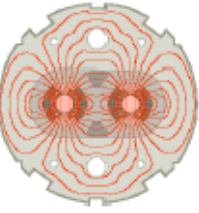
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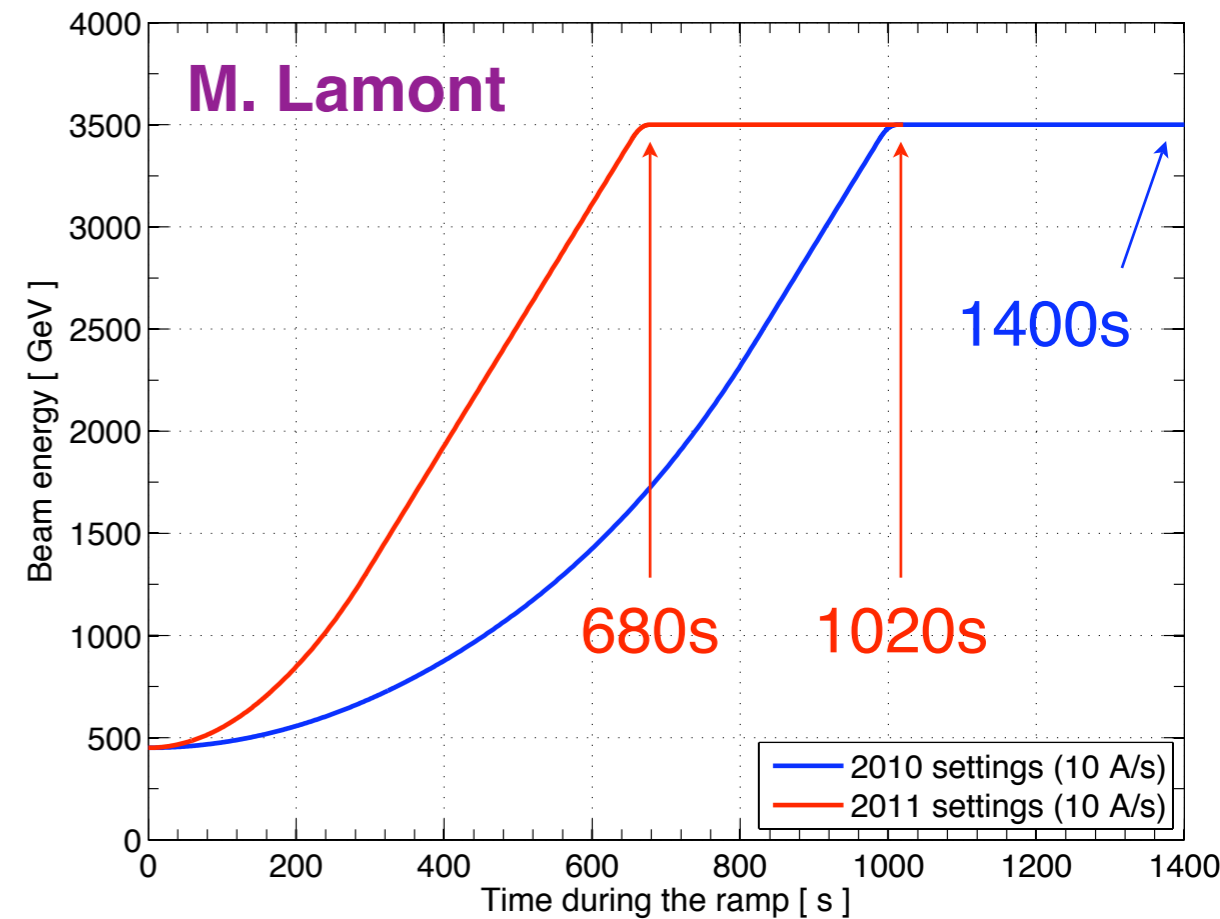
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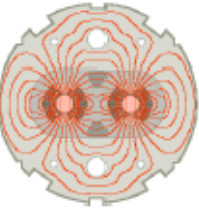
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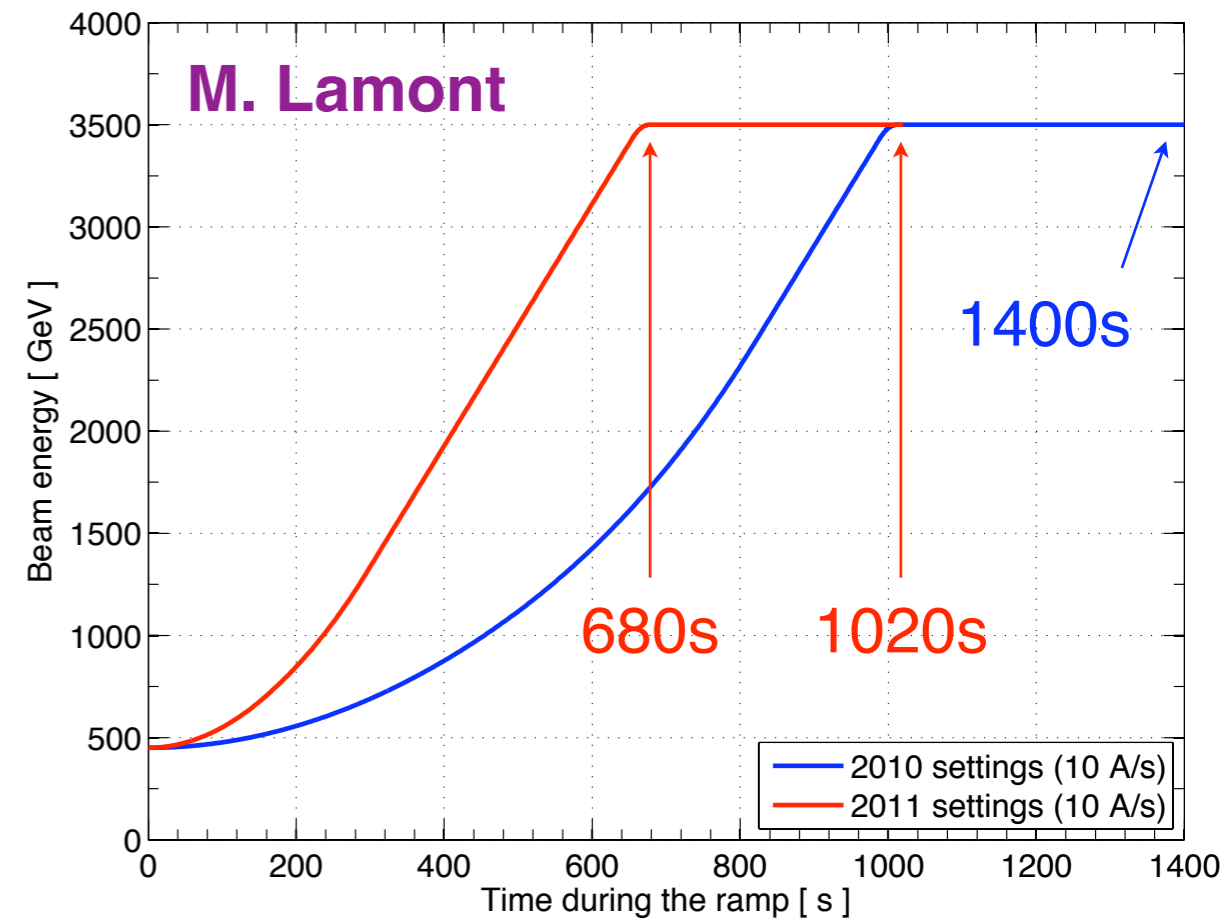
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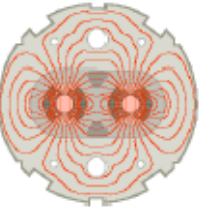
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☑ **Re-use beta corrections of 2010 from day 1.**



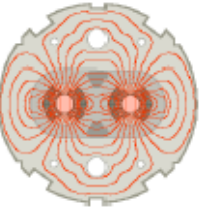


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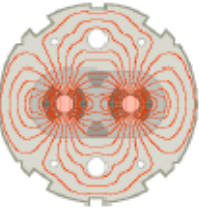


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- Remove primary source of errors in 2010.
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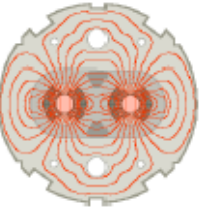
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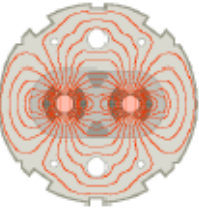
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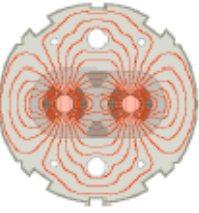
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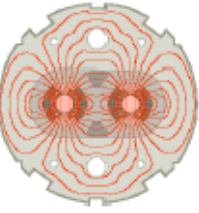
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☑ Commissioning strategy proposal:

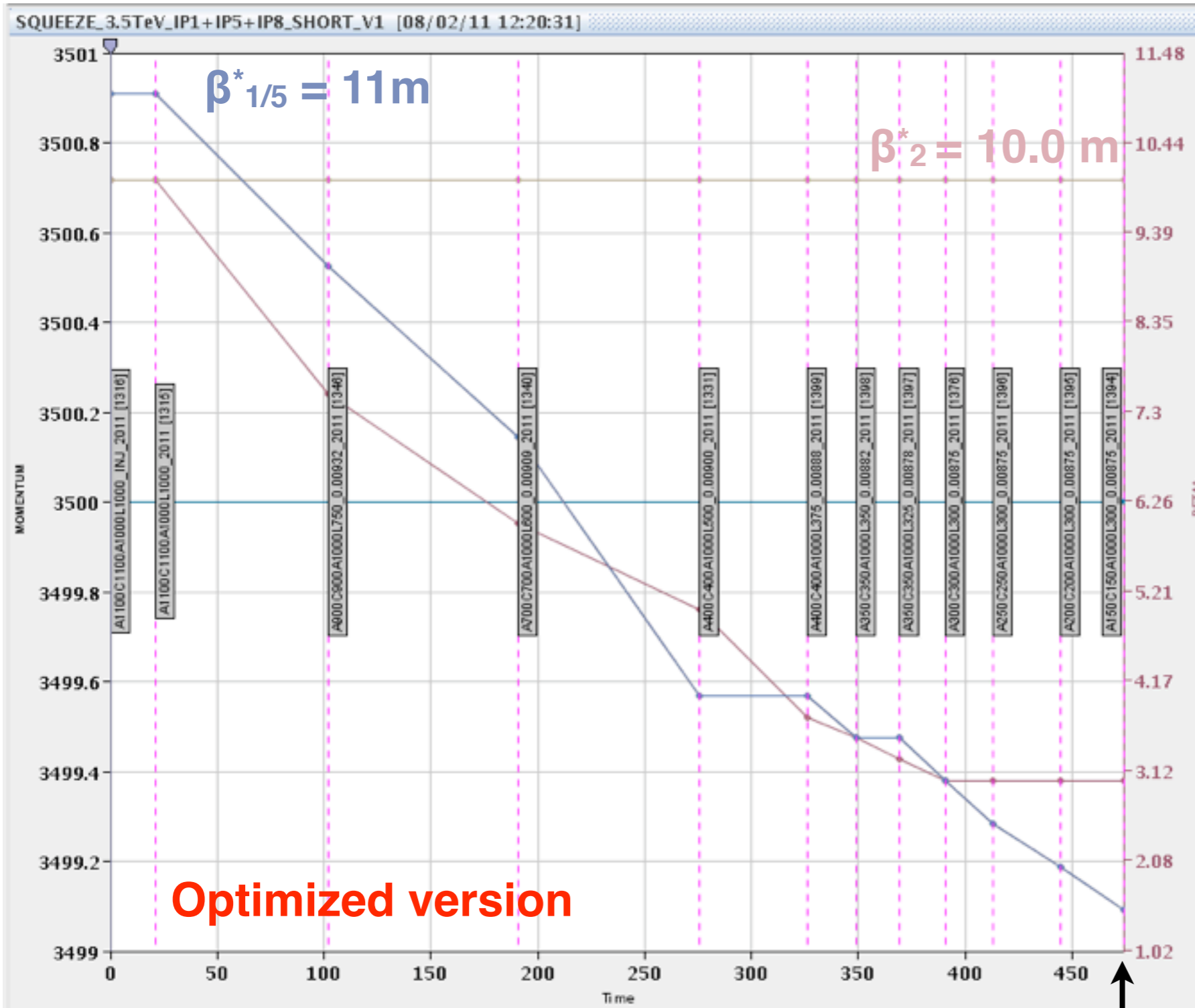
- (1) try a shorter beam process, with continuous beta measurements;
- (2) roll-back to previous settings with all matched points if needed.

Short squeeze in 2011



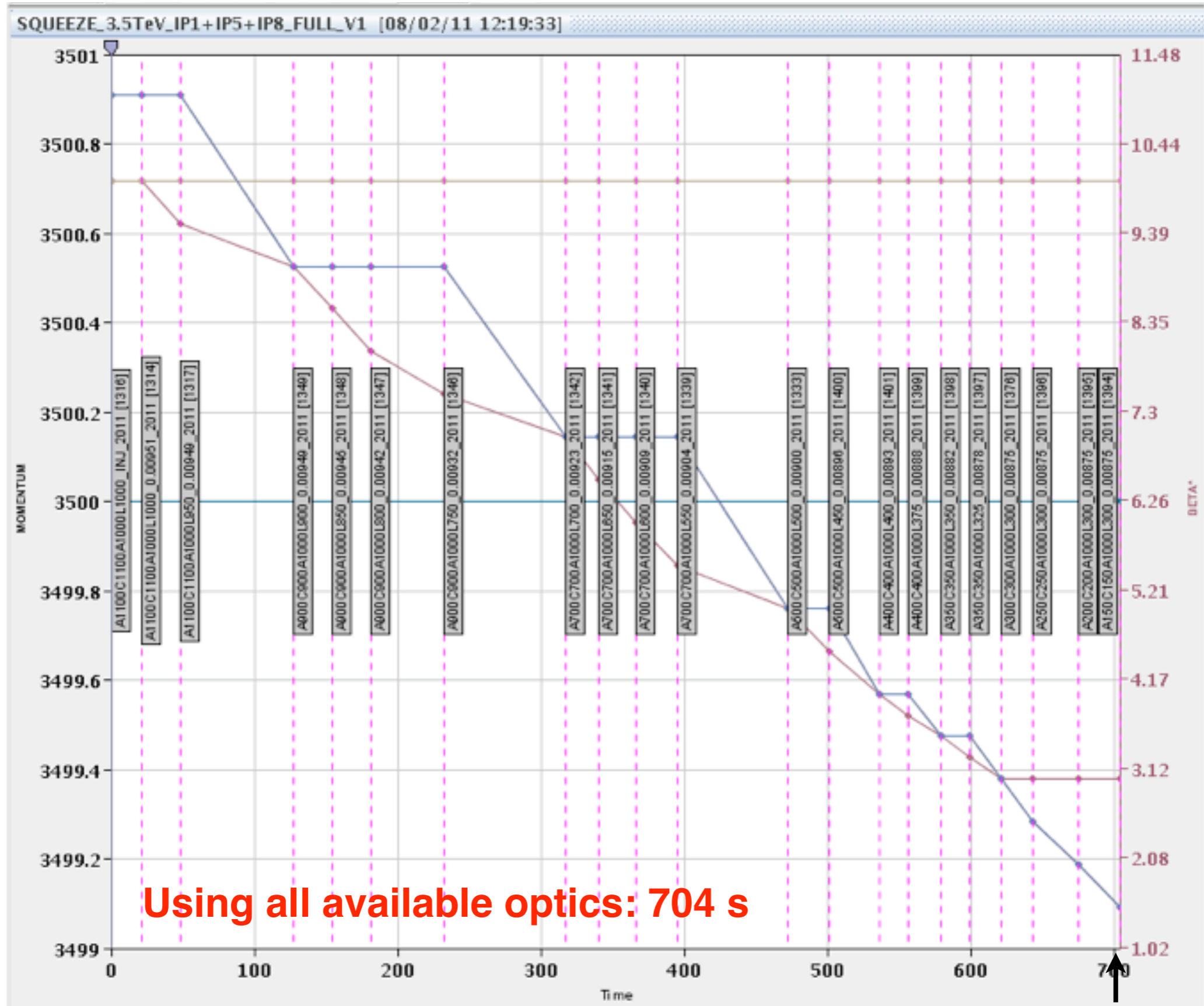
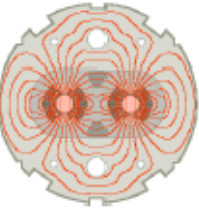
Simultaneous squeeze of IP1/5 and IP8.

Squeeze duration:	
2010 (2m)	1280 s
2011 (1.5m)	704 s
2011 (1.5m opt.)	474 s



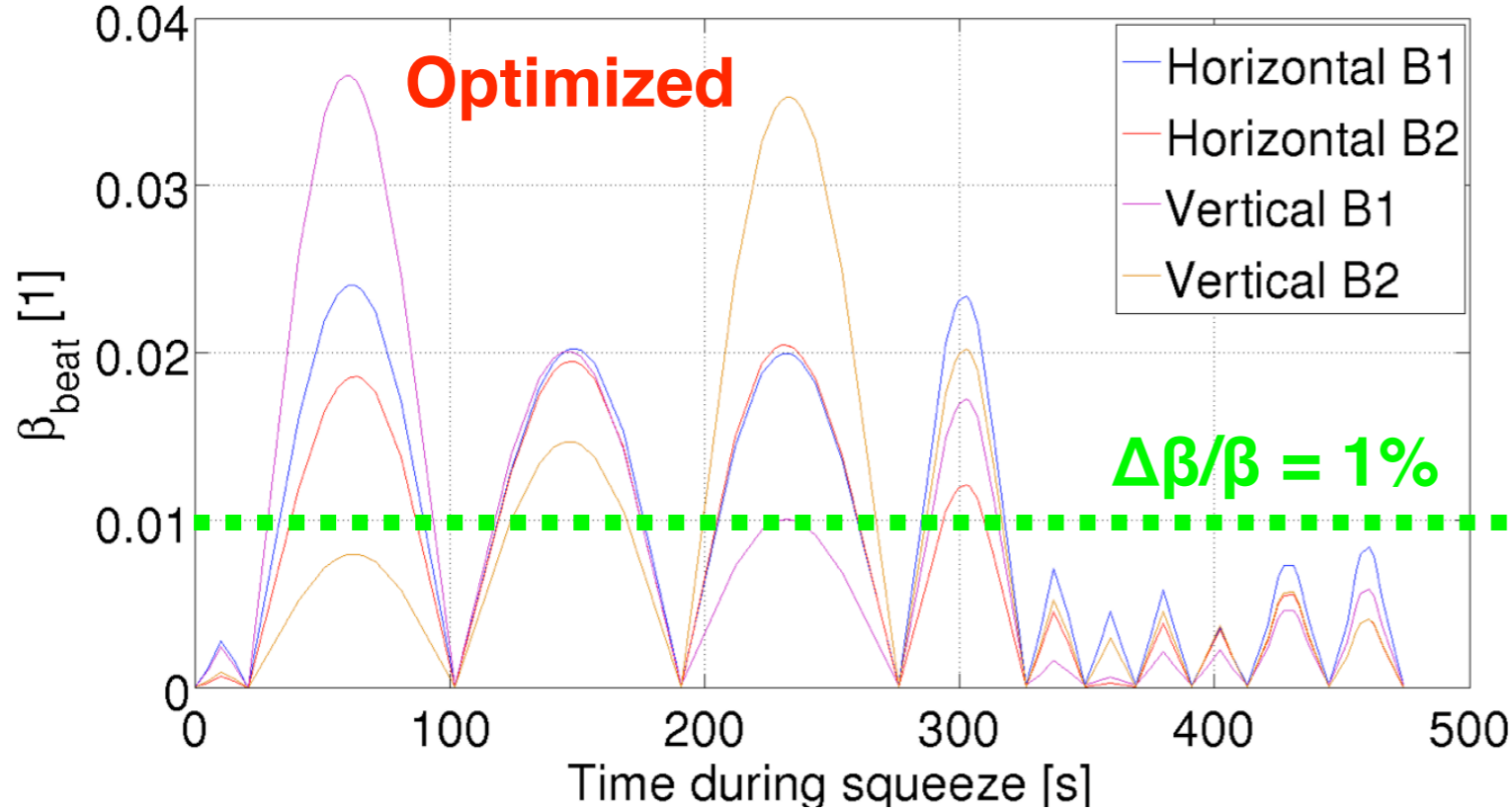
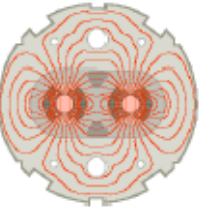
T = 474 s

Longer squeeze with all optics



T = 704 s

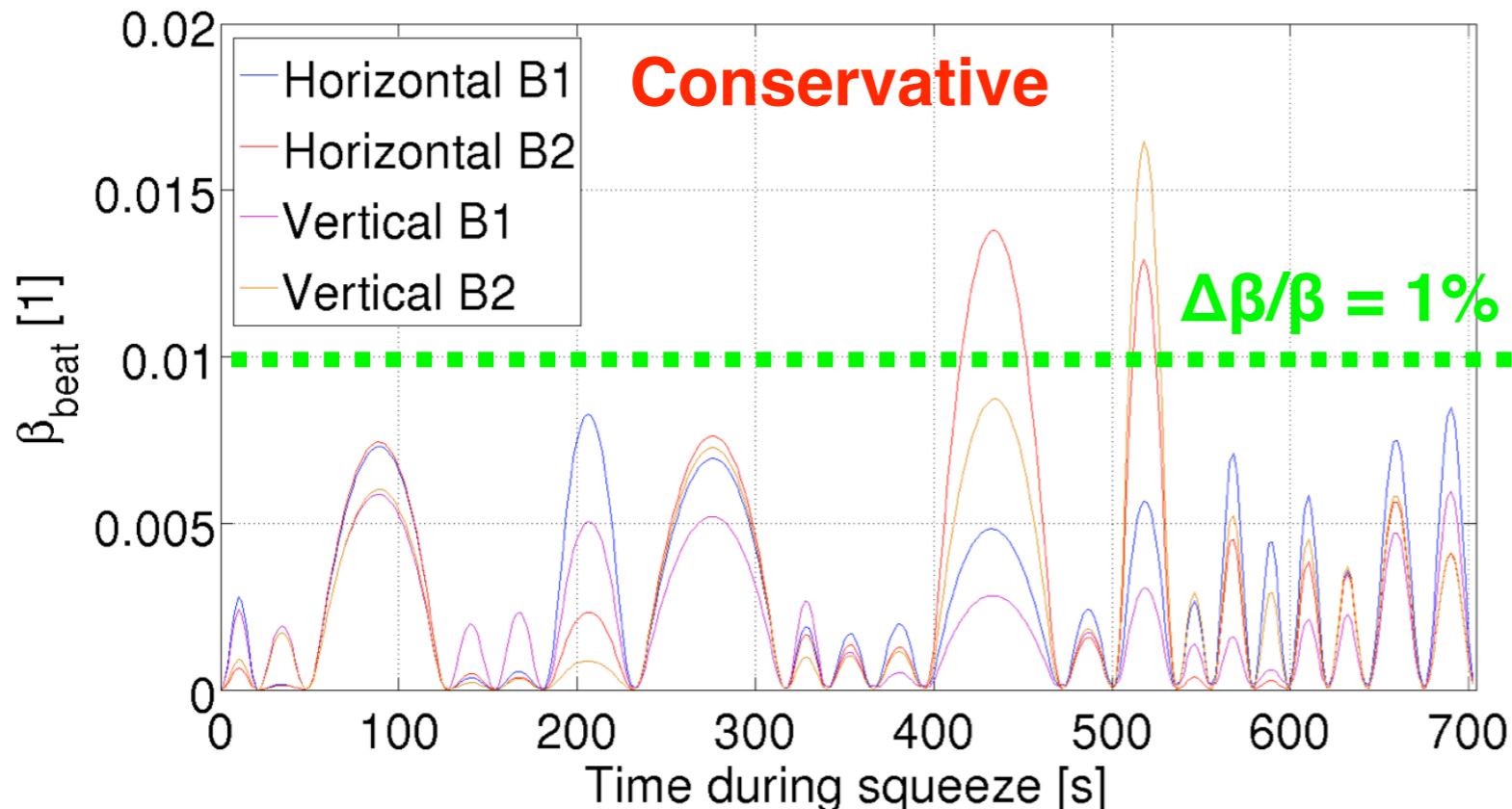
Errors during the squeeze



**Additional beta-beat error:
2-3% in the region of $\beta^* > 4\text{m}$.**

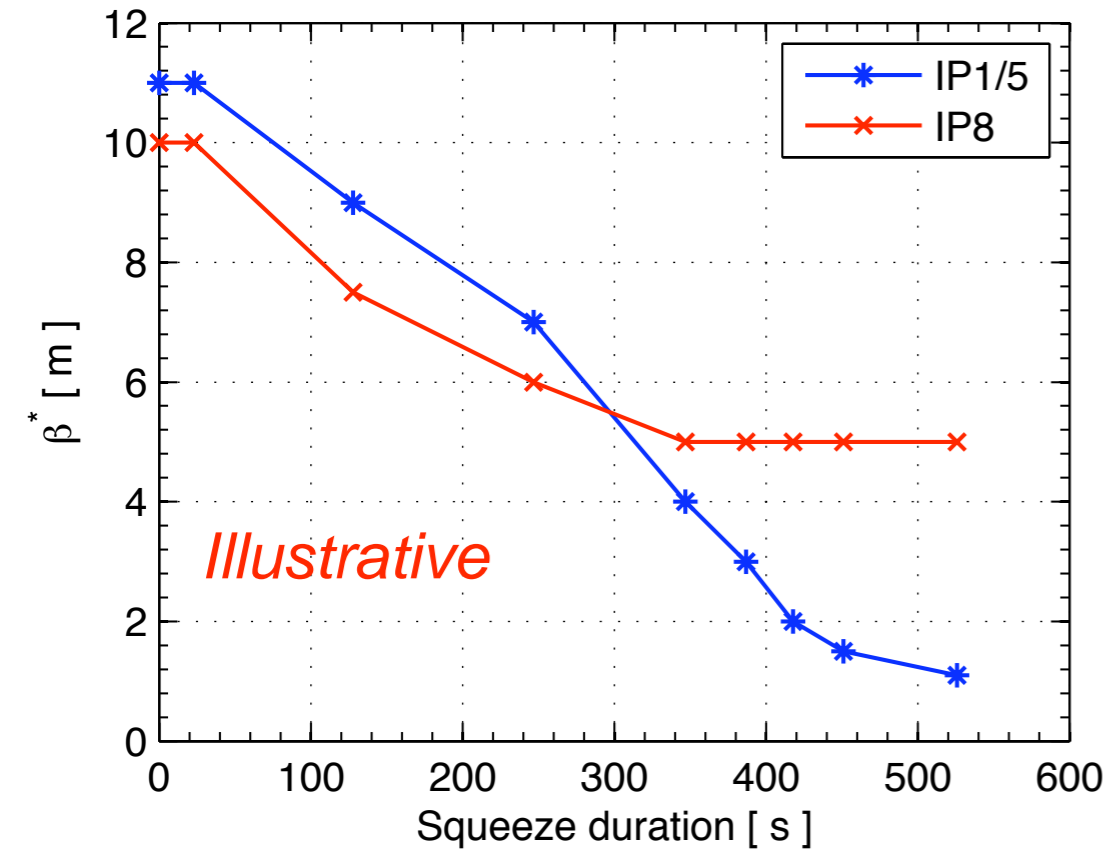
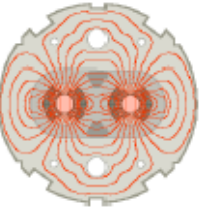
Not expected to be critical.

Within measurement errors.



*X. Buffat, EPFL.
More details in his
seminar this Friday.*

Squeeze in IP8: LHCb case

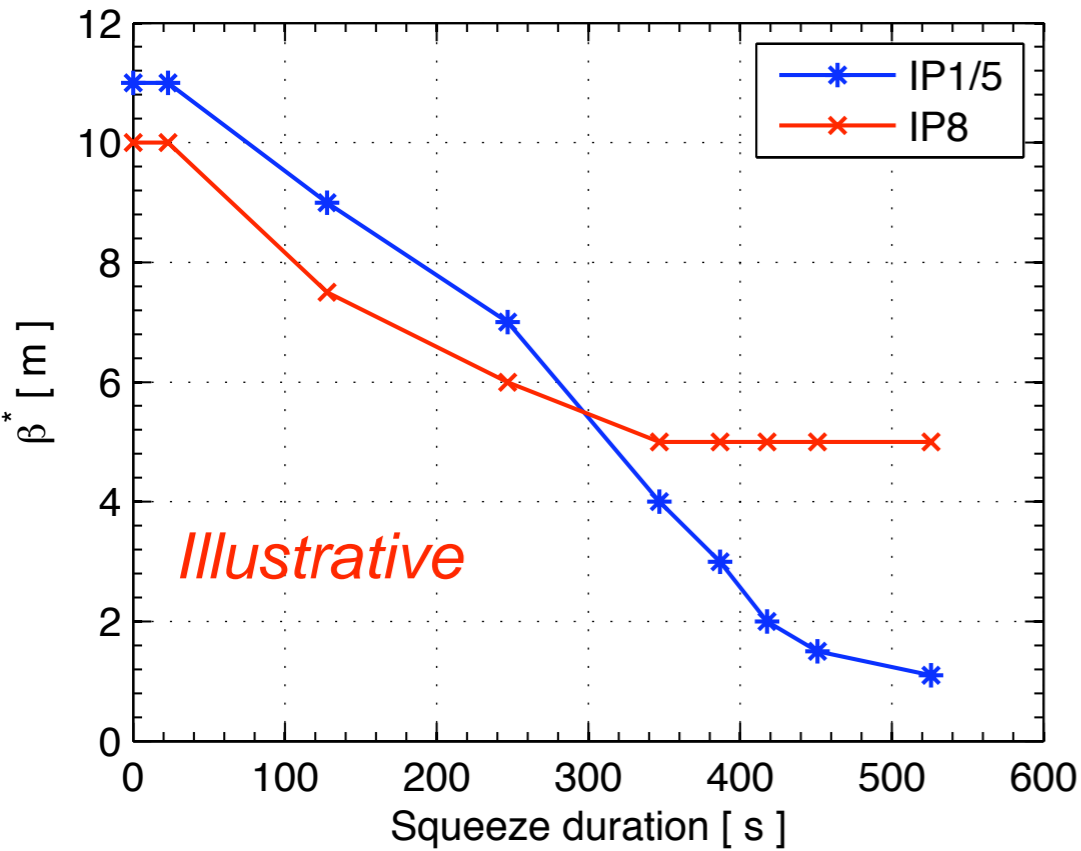
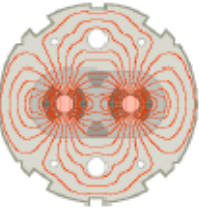


LHCb request: keep optimum lumi as we ramp-up number of bunches (they want larger β^* 's at higher I_{tot}).

Present baseline:

- Stop at 3 m. Keep this all the year.
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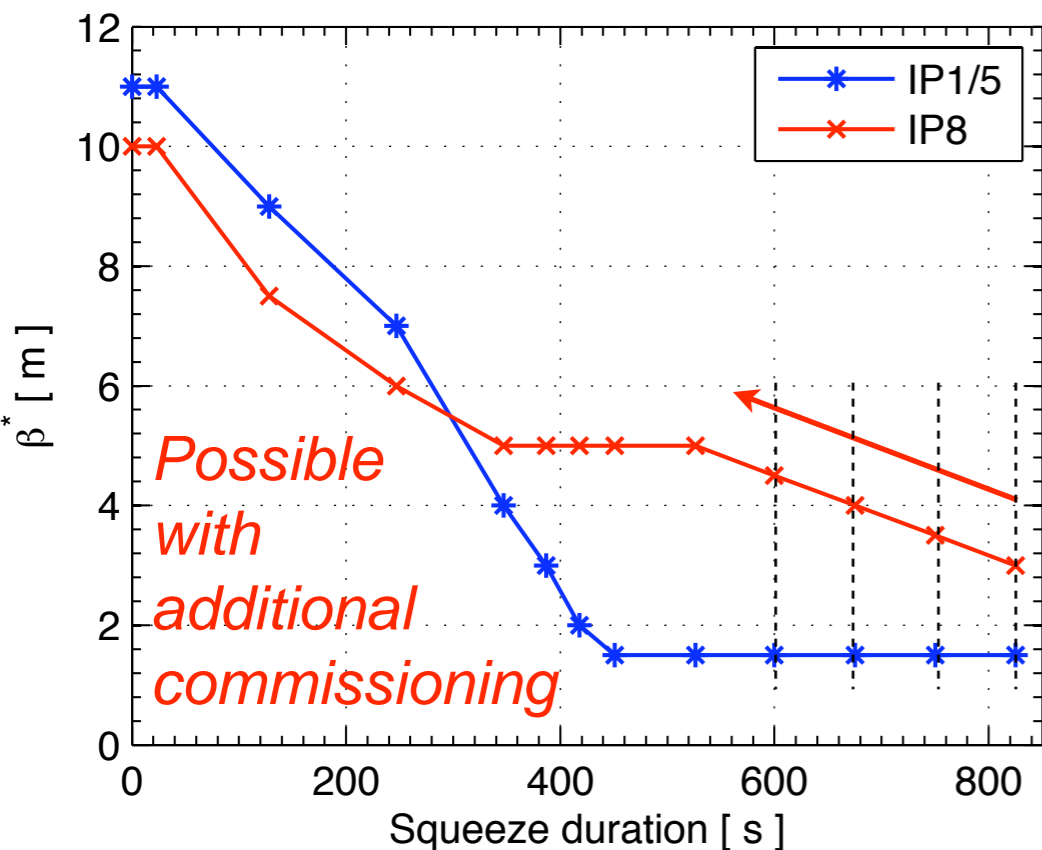
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Possible (fall-back if problems with levelling by offset):

- Longer functions: **Requires ~250s from 6m to 3m.**
- Commission all the way down;
- Stop "earlier" as the num. of bunches increases;
- No changes in IP1/5 and IP2.

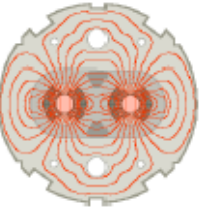
Additional commissioning time per β^* value:

- 1 safe pilot ramp&sq. to check new stop point;
- 1 fill with 1 nominal bunch for 4 TCT setup in IP8;
- 1-2 fills for validation (loss maps);

Realistically: 2-4 shifts with no physics!

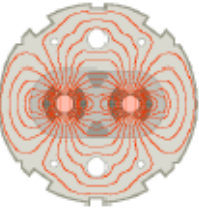


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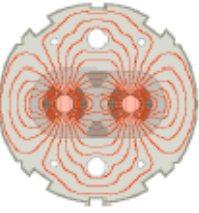


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- Squeeze below 1.5m addressed after aperture measurements;
- improve dynamic beta-beat between 1.5 m and 1.1 m.



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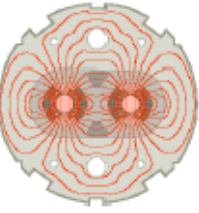
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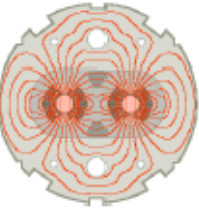
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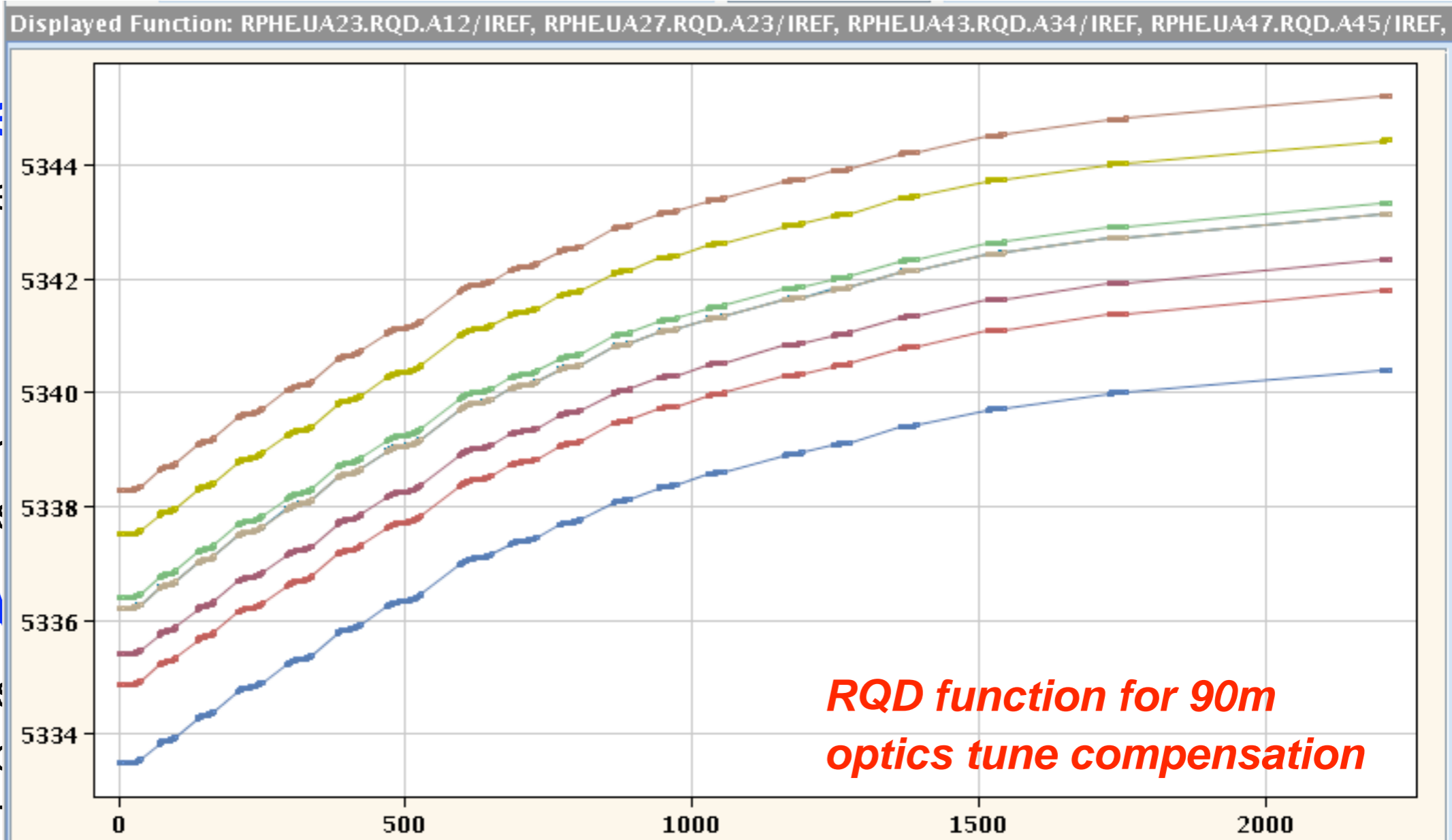
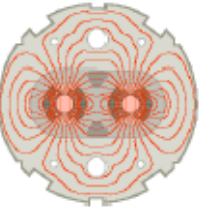
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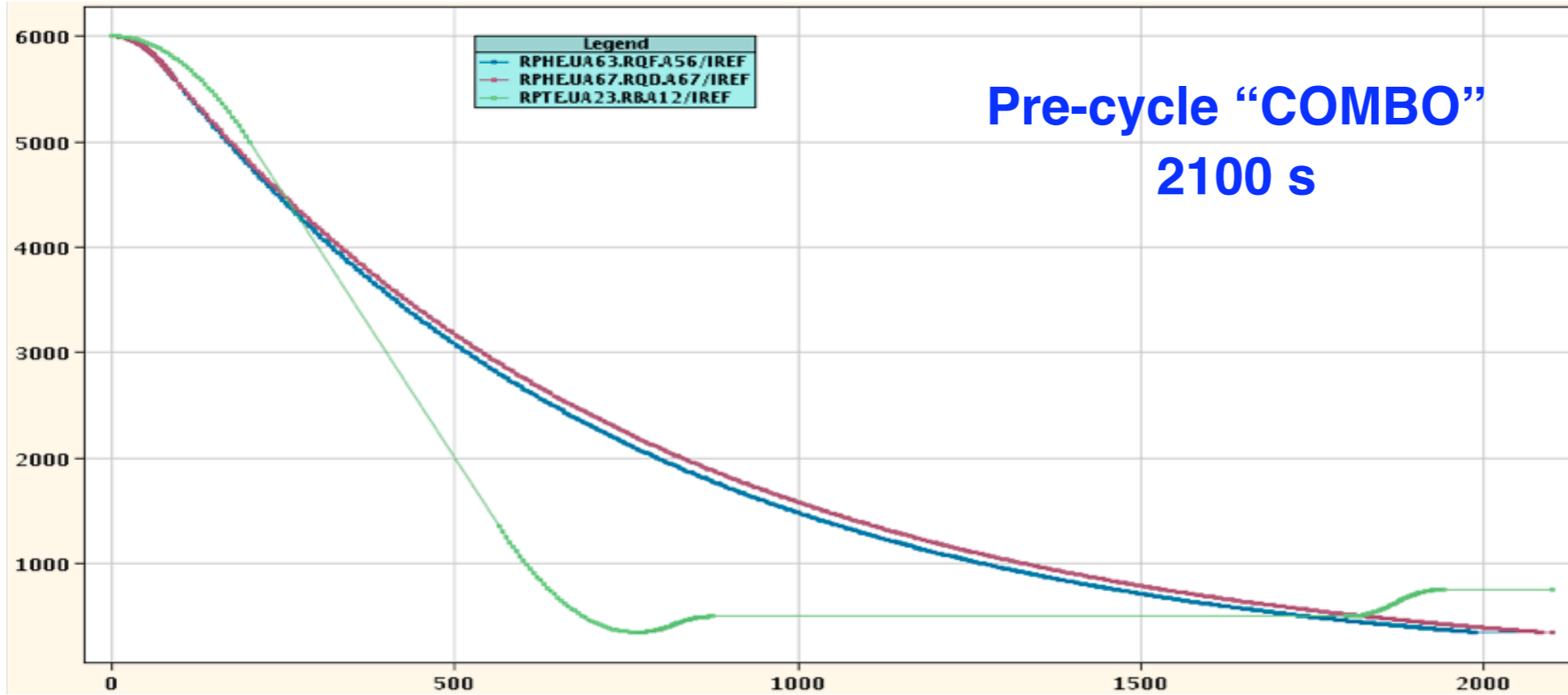
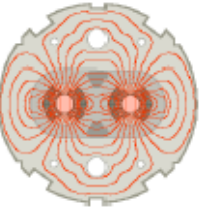
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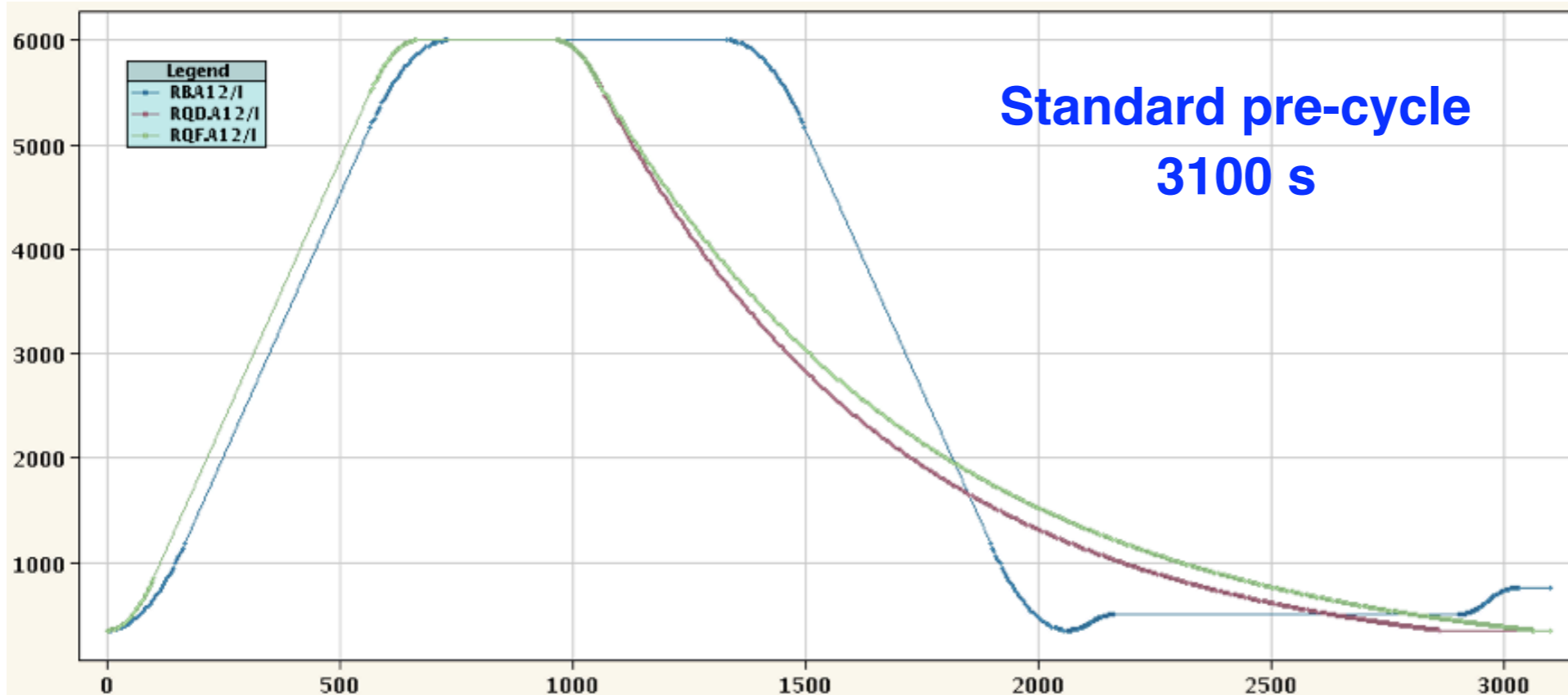
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Pre-cycle



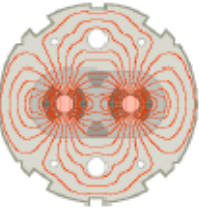
Two possible changes:
1) Reduce I_{\min} of MB's to 100 A to allow access with machine at injection.
(*W. Venturini, Cham2011*)

2) Updated I_{\max} with the parameters of the 2011 HWC.

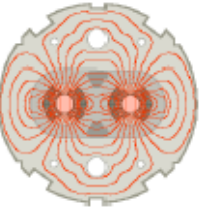




Conclusions

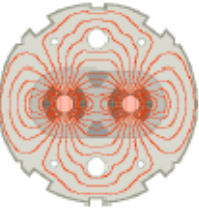


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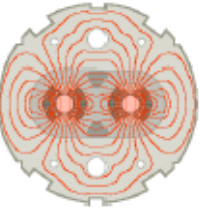
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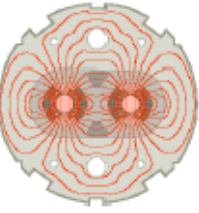
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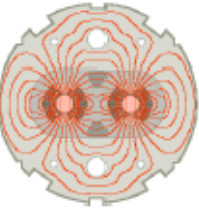
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- ☑ **Looking forward to start the beam commissioning!**