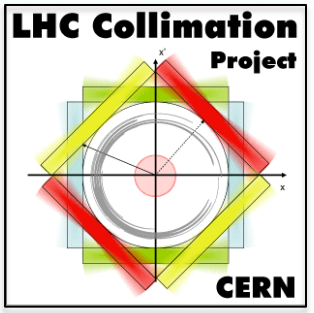
ColUSM #31
Friday, 1st November 2013



Collimator failure losses for various HL-LHC configurations

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Thanks to C. Bracco and B. Goddard

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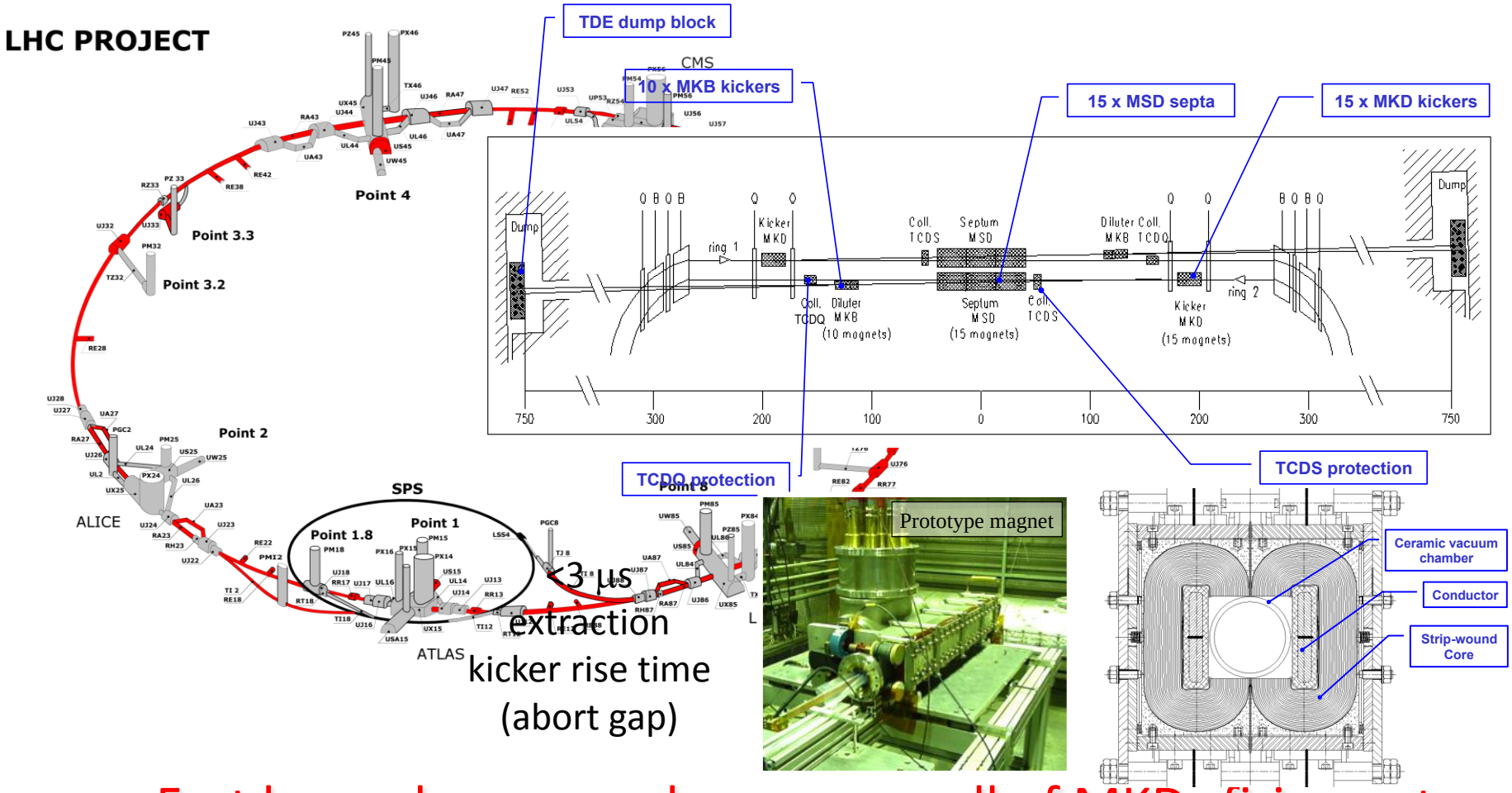
Outline

- Asynchronous dump: what is this?
- Tools used in the simulations
- Validation of the simulation set-up
- Risks by using the HiLumi optics with nominal and 2 σ retraction collimation setting:
  - *Beam1*
  - *Beam2 + including optics errors*
- Conclusions

Asynchronous dump: what is it?

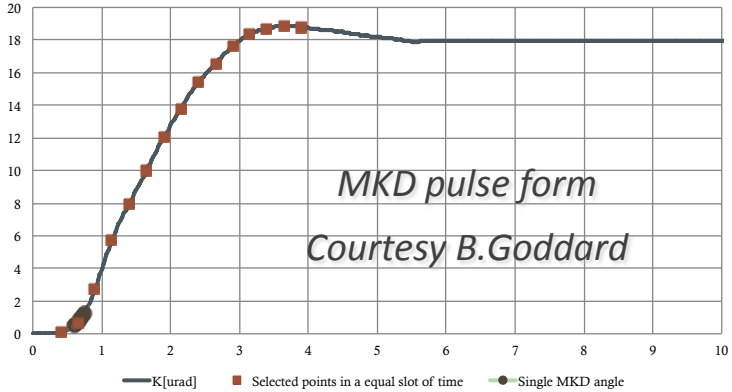


<3 μs extraction kicker rise time (abort gap)

Fast losses happens when one or all of MKDs firing not synchronously with the abort gap.

Tools used in the simulations

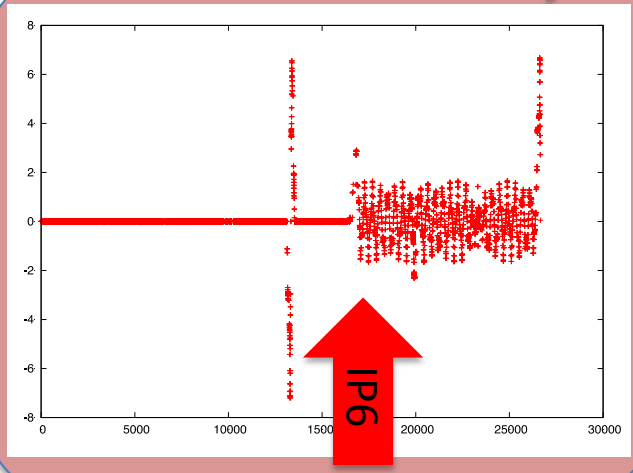
A **modified SixTrack collimation routine** to allow studies of asynchronous dump with the whole collimation system in place, including **set-up** and **optics errors**.



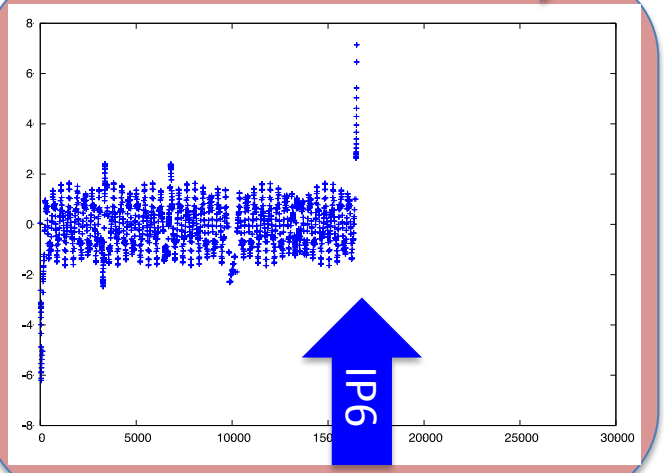
1st turn

The collimator are put in place with respect to the optic scenario under study

IP1 2nd turn IP8



IP1 3rd turn IP8



[See also: L.Lari et al. *Asynchronous beam dump treatment*, Sixtrack for collimation: new available features meeting, 7th June 2013, CERN]

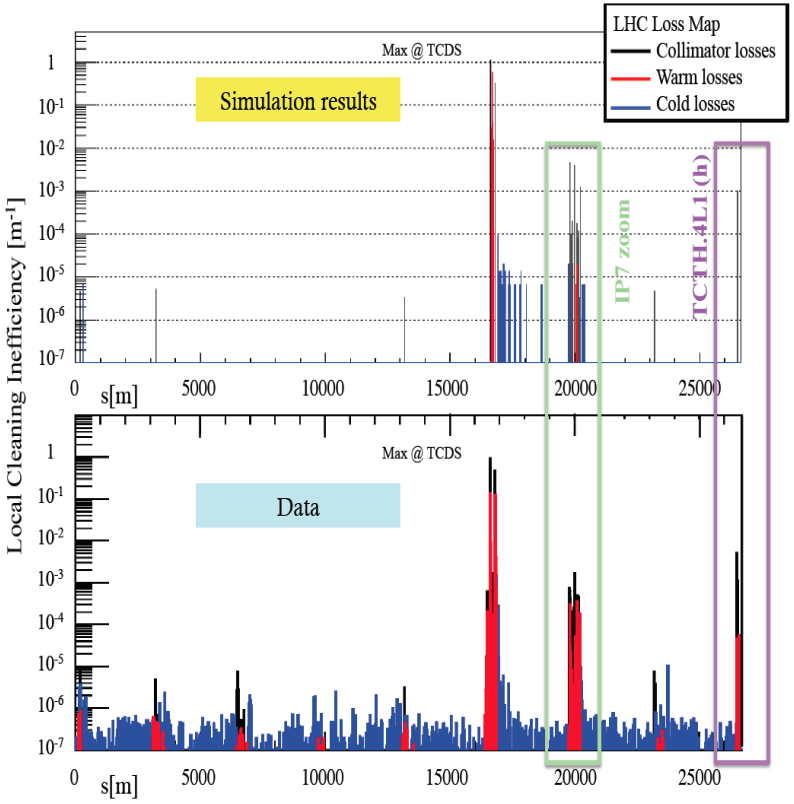
Validation of the simulation set-up

June 2012

4TeV nom. Optics + out 1.5 mm @IP6

+ 1 mm out 3 TCSG +1 TCLA @IP7

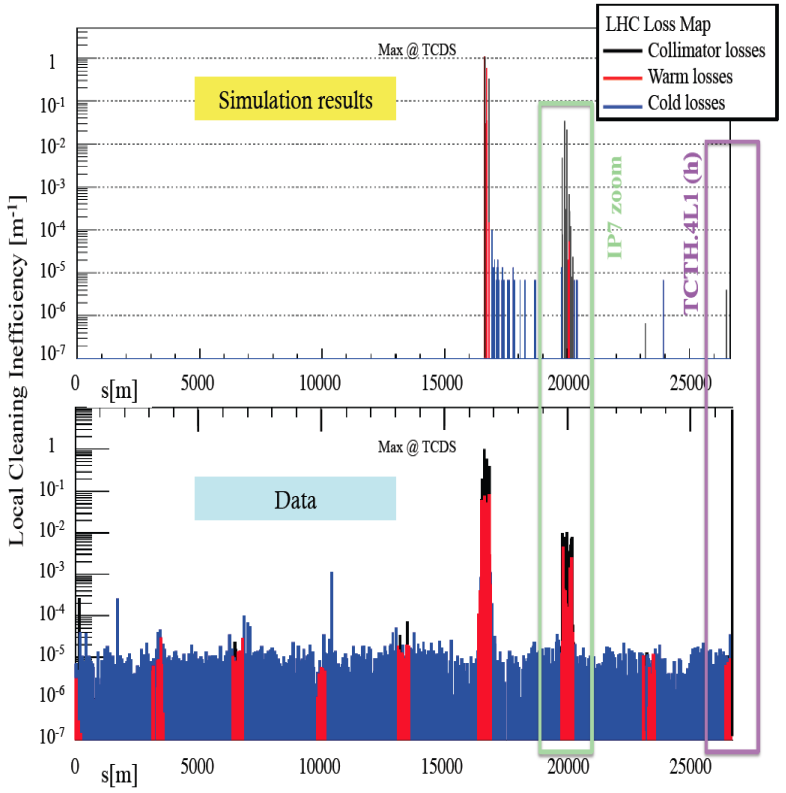
+1σ in the most exposed TCT @IP1



November 2012

4TeV nom. Optics + out 1.5 mm @IP6

+1σ in the most exposed TCT @IP1



[REF: L.Lari et al. *Simulations and Measurements of Beam Losses on LHC Collimators during Beam Abort Failures*, IPAC13, Shanghai, China]

Past studies

Beam1

+ out 1.5 mm @IP6

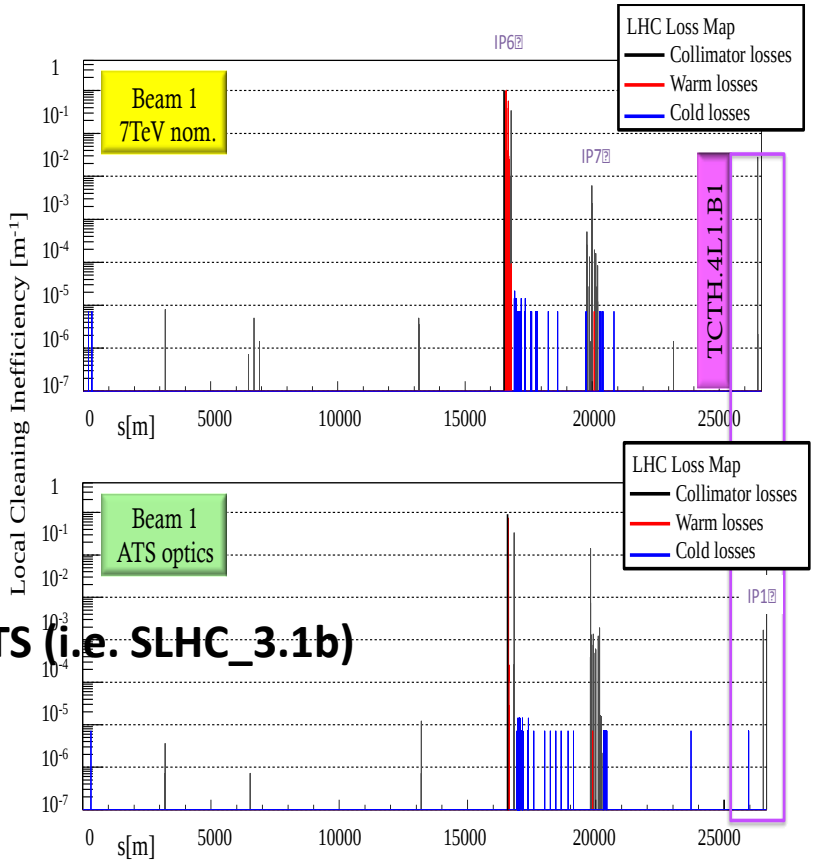
+ 1 mm out 3 TCSGs + 1 TCLA @IP7

+1σ in the most exposed TCT @IP1

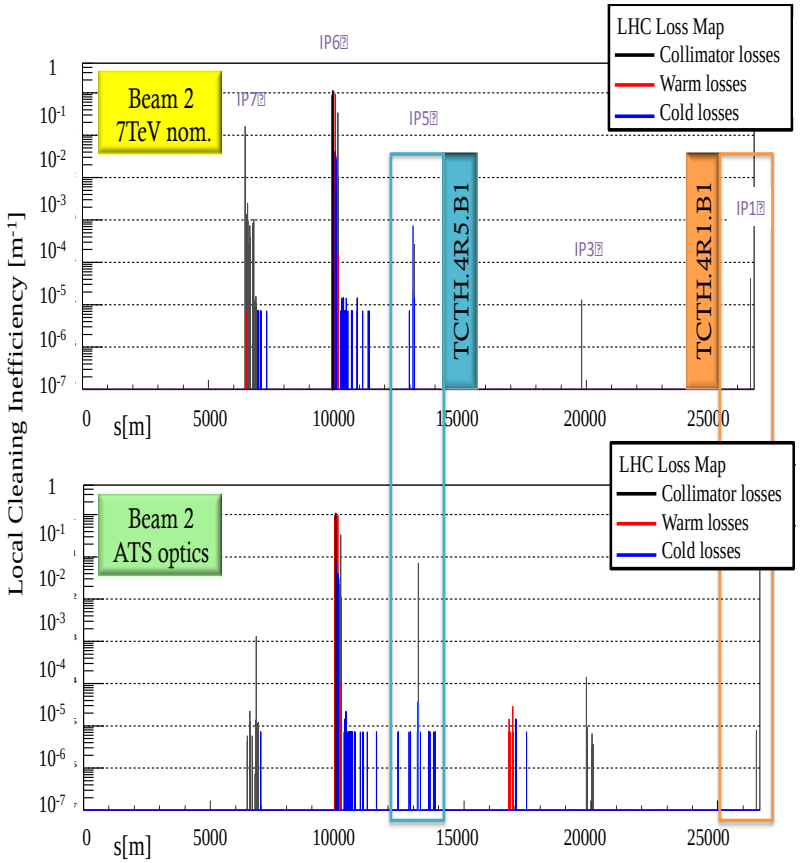
Beam2

+ out 1.5 mm @IP6

+1σ in the most exposed TCT @IP5



ATS (i.e. SLHC_3.1b)



[REF: L.Lari et al. *Studies of Thermal Loads on Collimators for HL-LHC Optics in case of Fast Losses*, IPAC13, Shanghai, China]

Phase advance

Calculated form the MKD.4O6 (the furthest away form TCDQs)

	7TeV nominal	ATS (i.e. SLHC_3.1b)	HLLHCV1
Beam1			
TCTH.4L1.B1	55.8	97.2 	208.8
TCTH.4L2.B1	257.3	182.8	265.7
TCTH.4L5.B1	47.3	145.6	244.6
TCTH.4L8.B1	335.7	166.5	213.1
Beam2			
TCTH.4R1.B2	198.1	303.2	139.6
TCTH.4R2.B2	170.4	184.7	230.9
TCTH.4R5.B2	175.8	220.4	103.5
TCTH.4R8.B2	18.7	225.2	215.2

[See also R.Bruce et al. *Collimation requirements for the IR1/5 layout and on-going WP5 studies*, 8th HL-LHC Extended Steering Committee meeting, 13/08/2013, CERN]

Collimation system aperture

For **Beam1** and **Beam2**

Updated ATS optics for Hi-Lumi
(i.e. HLLHCV1 optics)

Asynchronous dump accident scenarios studied:

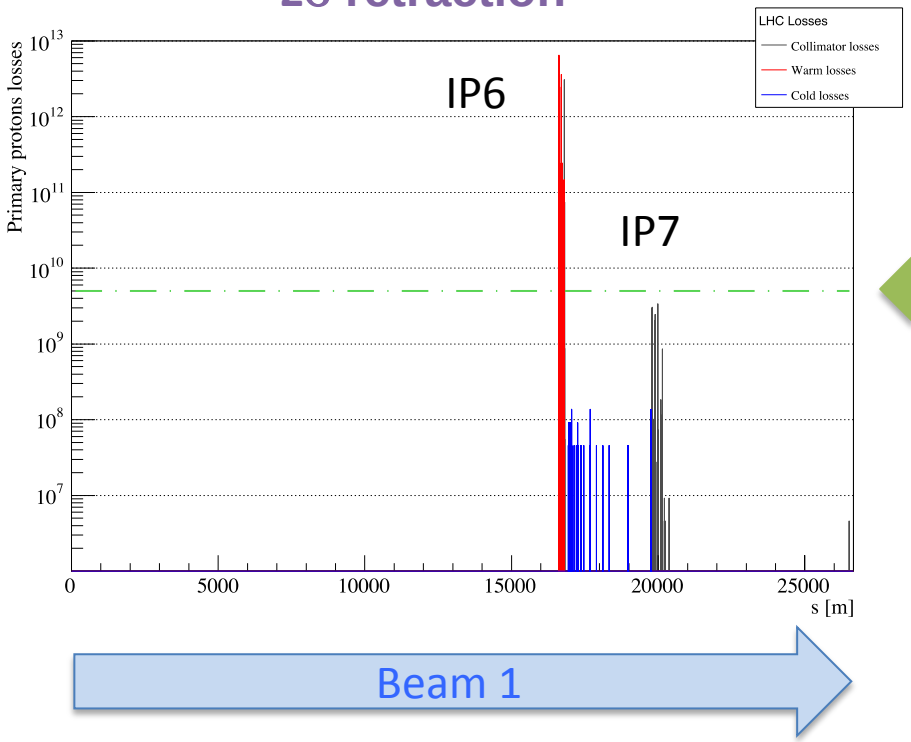
1. Perfect machine;
2. + Retraction of 1.2 mm @IP6;
3. + Retraction of 1mm of the of 11 most critical coll. (TCSGs) @ IP7 + TCTHs @IP1 and @IP5 in of 1 σ more;
4. Optics error (for the most critical Beam2) for 1. and 3. scenarios;
5. TCDQs misalignment (precision in alignment = 100urad → max offset of ~0.946 mm (2 preliminary cases studied);

	Nom. setting	2σ retraction
TCP.IP7	6	5.7
TCSG.IP7	7	7.7
TCLA.IP7	10	10.7
2*80cm W DS @IP7	10	10.7
TCP.IP3	15	15
TCSG.IP3	18	18
TCLA.IP3	20	20
TCT.IP1/IP5	8.3	10.5
TCT.IP2/IP8	30	30
TCL.IP1/IP5 (2 Cu +1 W)	15	15
TCLI/TDI.IP2	Tot opened	Tot opened
TCDQ.IP6	8	9
TCSG.IP6	7.5	8.5

Beam1

1. Perfect machine

2σ retraction

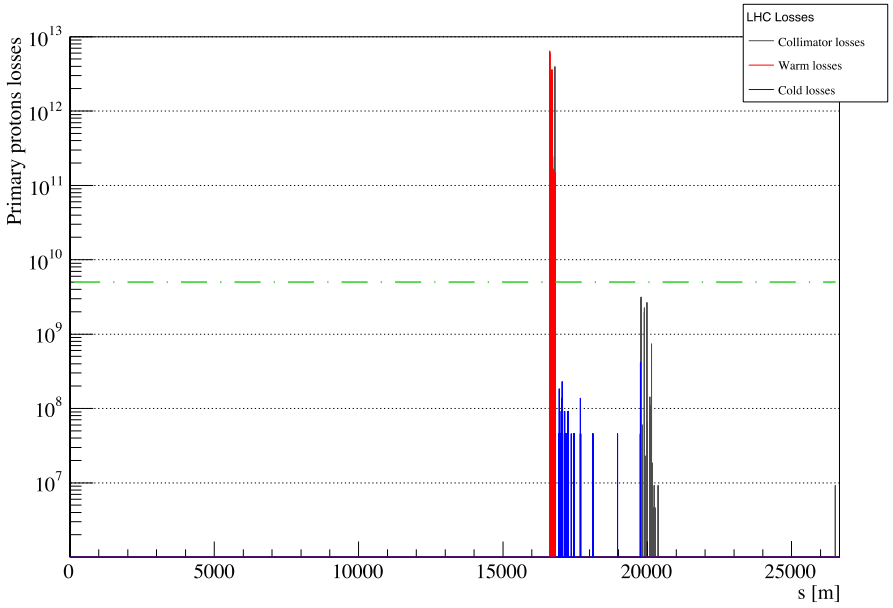


Beam 1

[REF: A. Bertarelli et al. *Updated robustness limits for collimator material*, LHC Machine Protection Workshop, Annecy, France]

Onset of plastic damage on Tungsten collimators : 5x10^9 p

Nom. setting

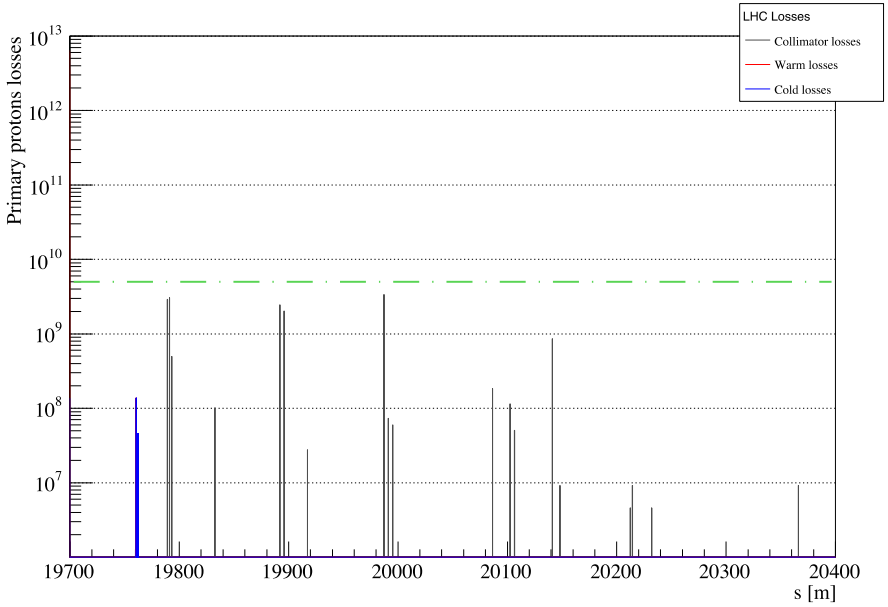


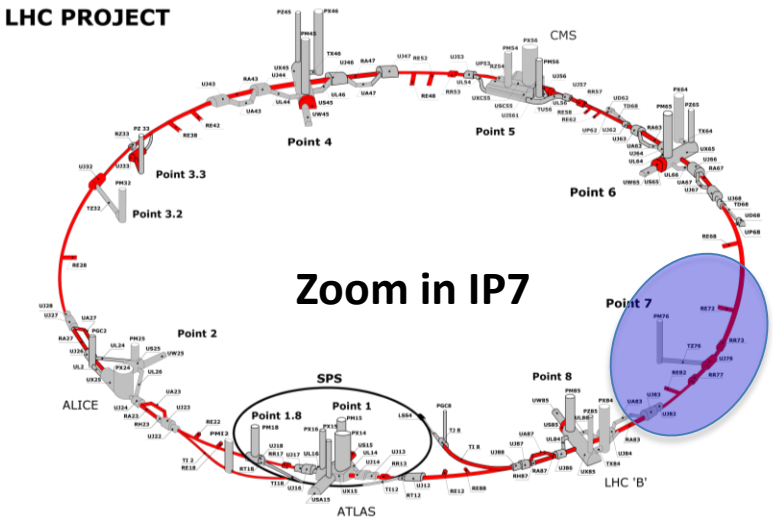
Results are normalized to 2.2x10^{11} p+ (25 ns)

Beam1

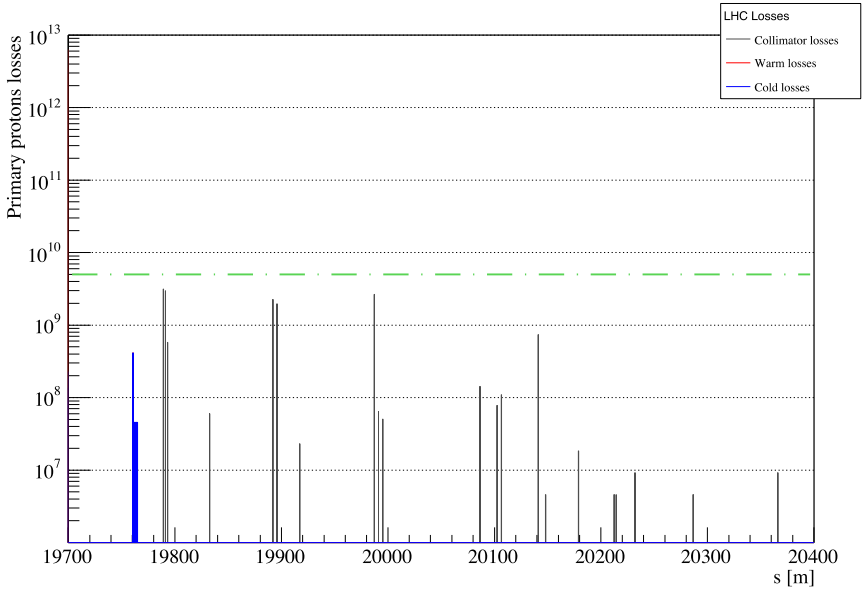
1. Perfect machine

2σ retraction





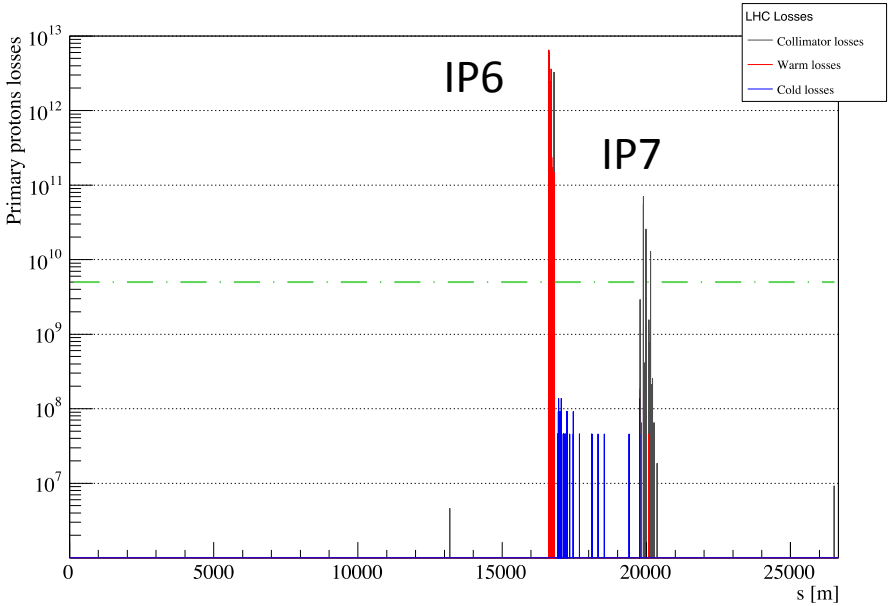
Nom. setting



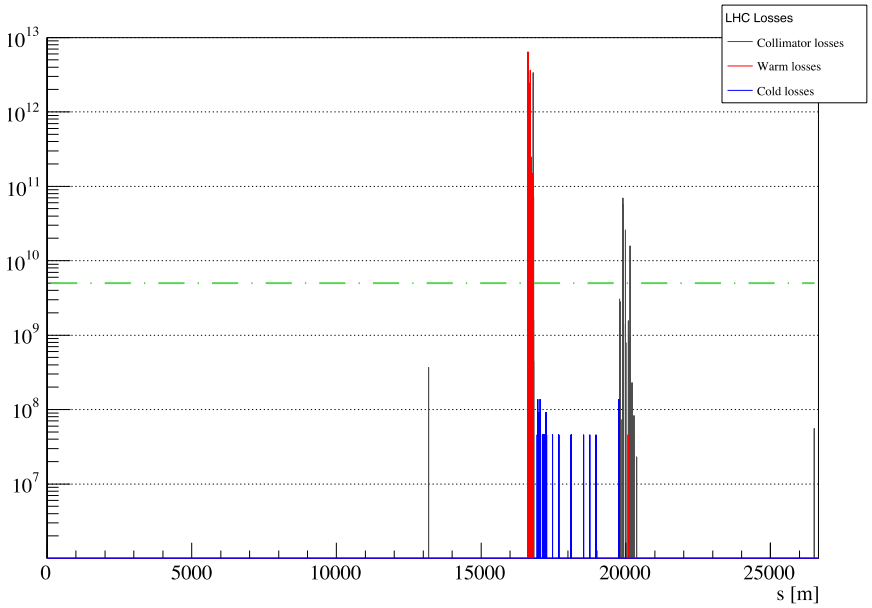
Beam1

2. + Retraction of 1.2 mm @IP6

2σ retraction



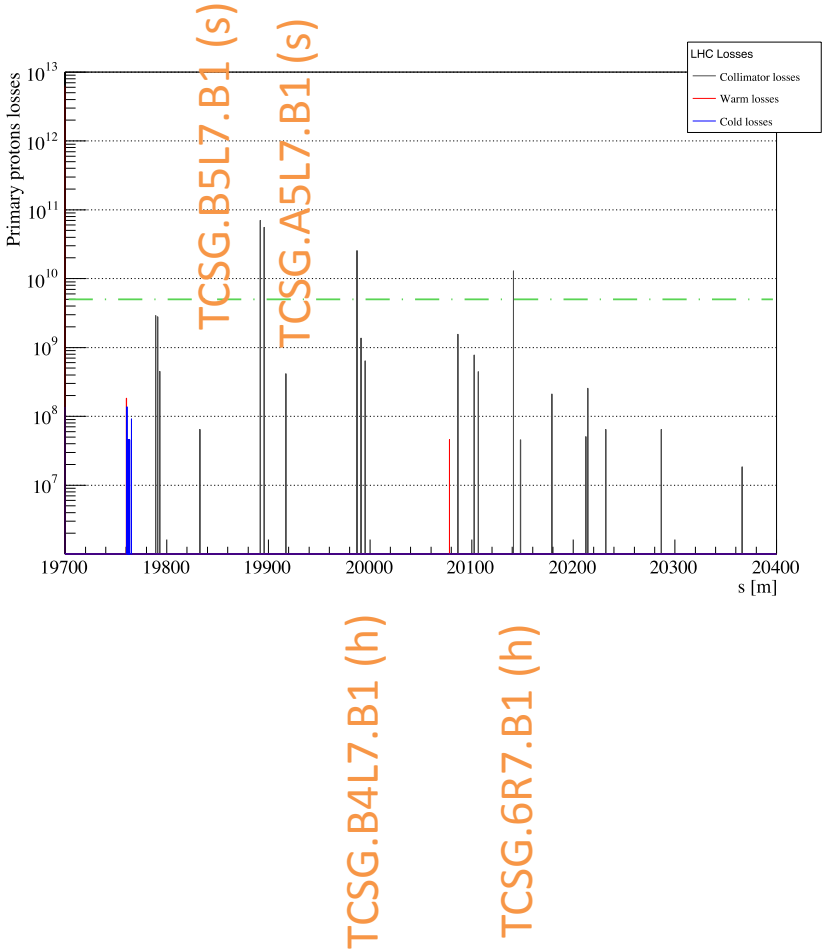
Nom. setting

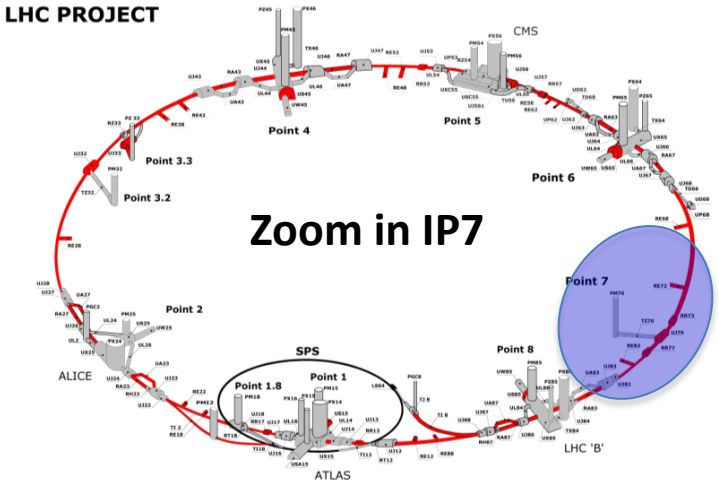


Beam1

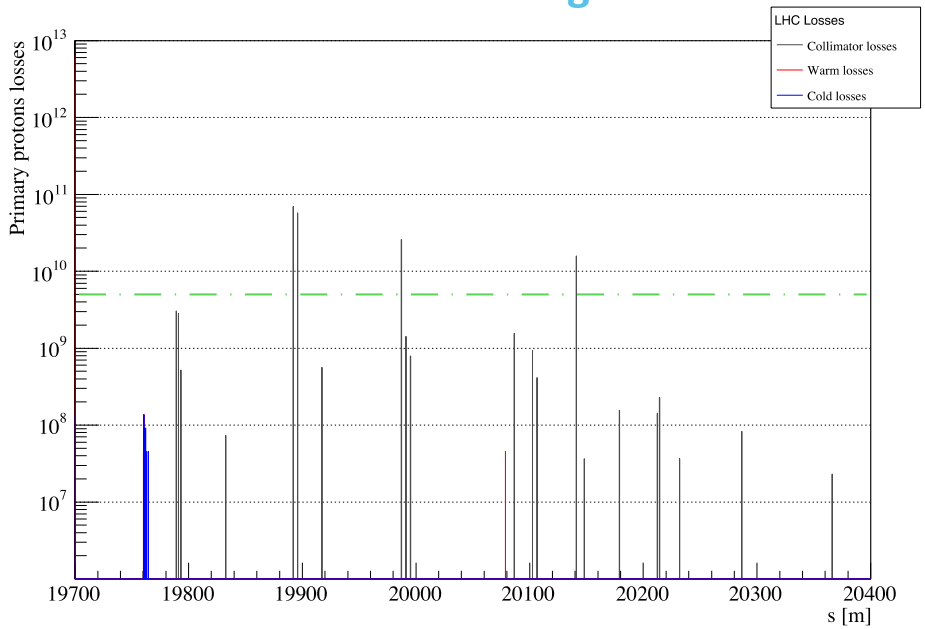
2. + Retraction of 1.2 mm @IP6

2σ retraction





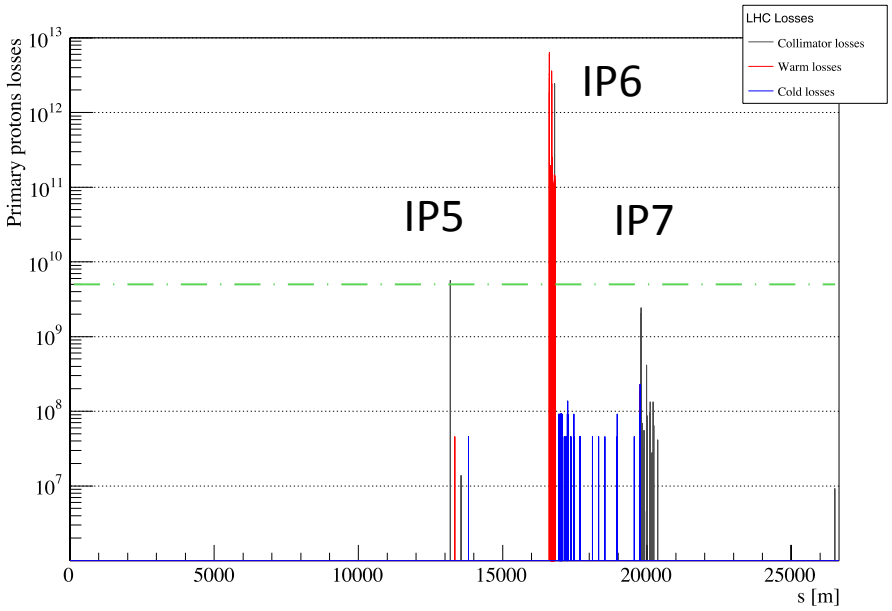
Nom. setting



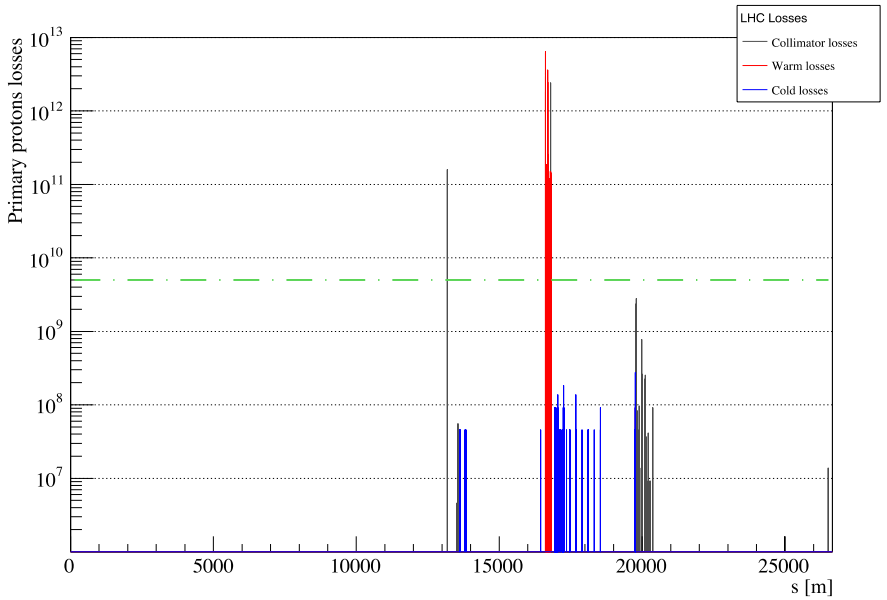
3. + Retraction of 1mm @IP7 + TCTHs @IP1 and @IP5 in of 1 σ.

Beam1

2σ retraction



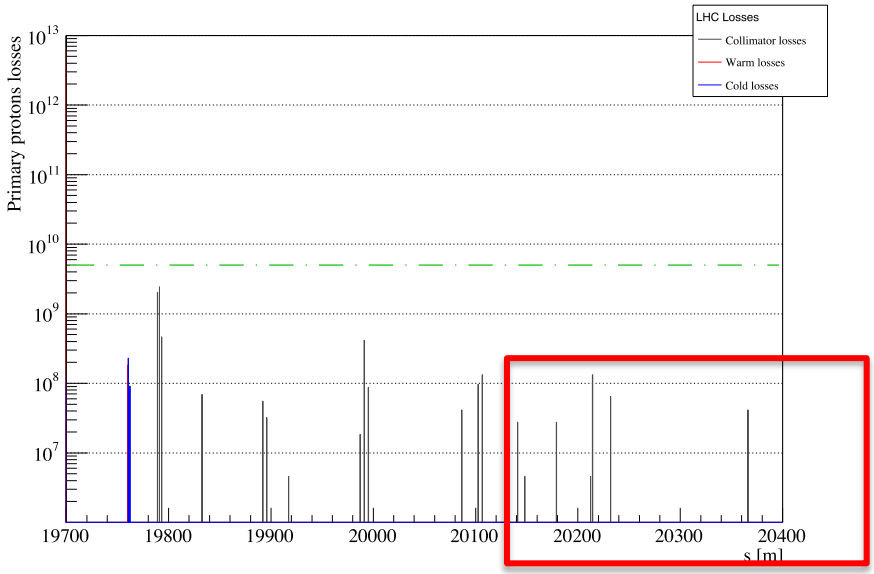
Nom. setting



3. + Retraction of 1mm @IP7 + TCTHs @IP1 and @IP5 in of 1 σ.

Beam1

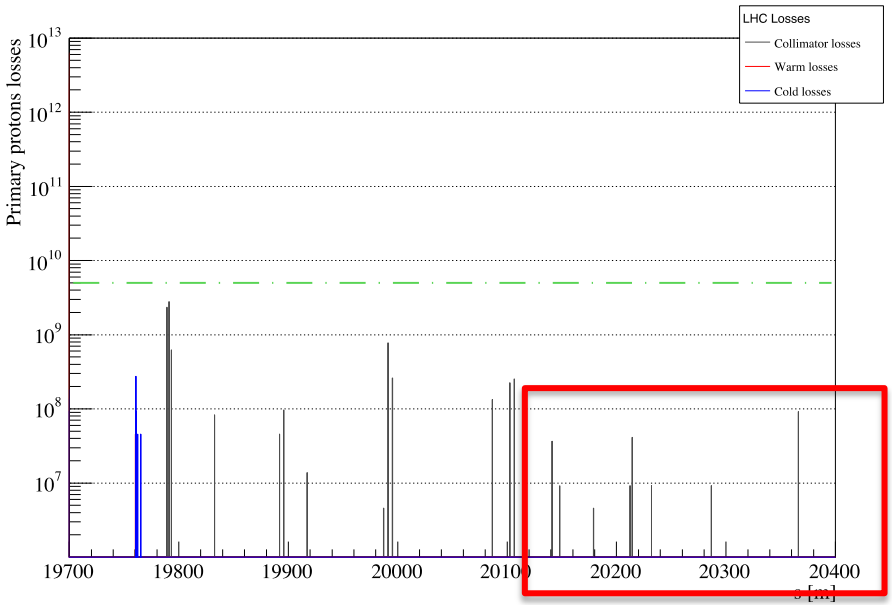
2σ retraction



TCLAs and DS coll.

Zoom in IP7

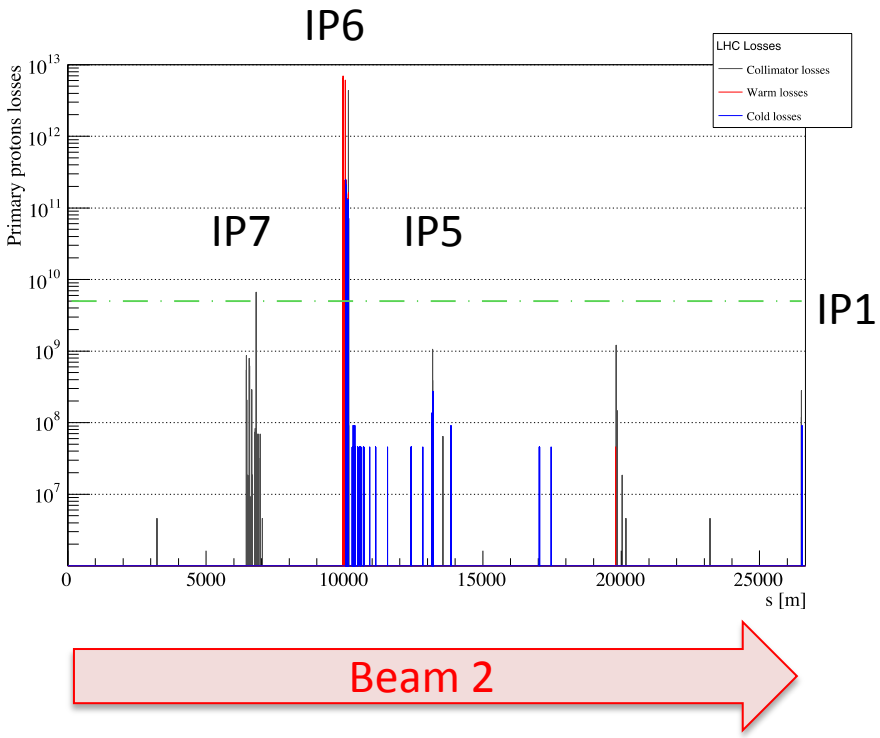
Nom. setting



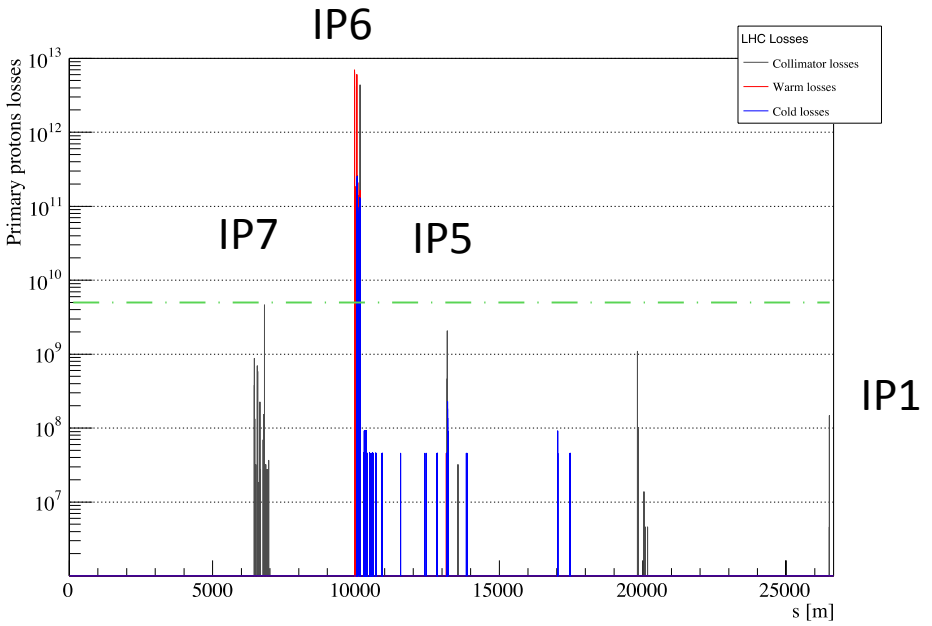
Beam2

1. Perfect machine

2σ retraction



Nom. setting

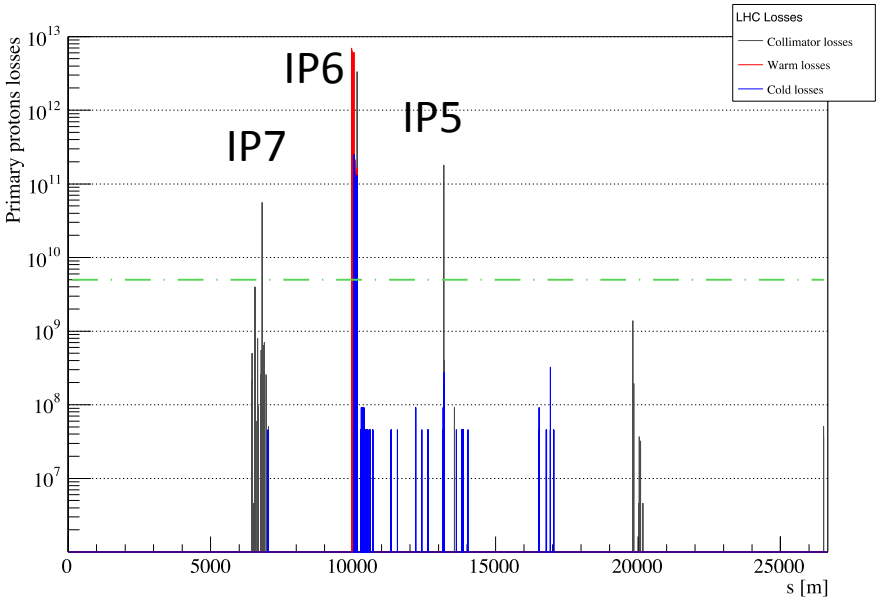


High Luminosity LHC

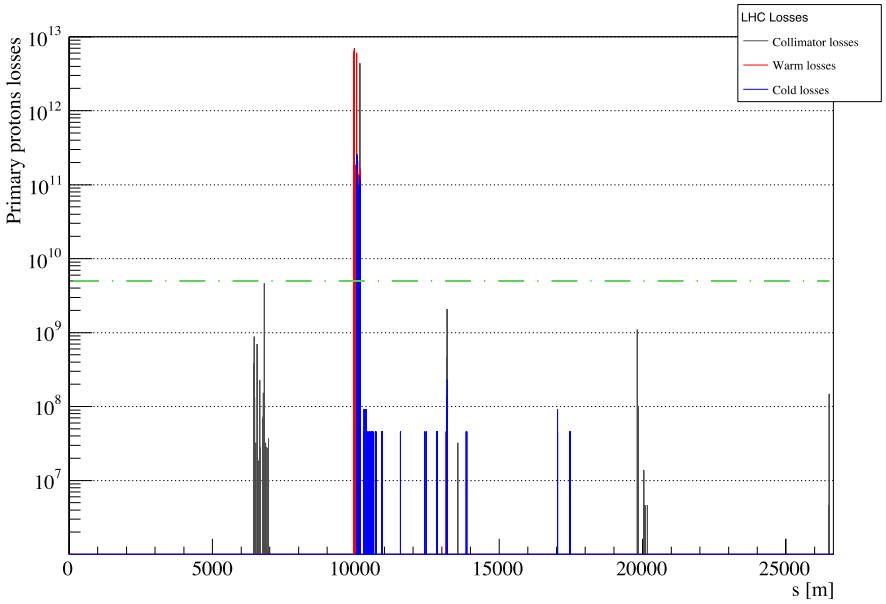
Beam2

Nom. setting

+ Retraction of 1.2 mm @IP6



Perfect Machine



High Luminosity LHC

Conclusions

- As shown, the TCTH@IP5 is the most exposed location for both beams – in particular **B2** - for the HLLHCV1 optics.
- 2 σ retraction collimation settings is found as better than the nominal one in terms of protection from an asynchronous dump accident, including setting and error scenarios.
- On going studies on optics errors and TCDQs misalignment will give us more complete picture of the failure scenarios.

3rd Joint HiLumi LHC-LARP Annual Meeting

11-15 November 2013
Daresbury Laboratory

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