BLM thresholds for Collimators

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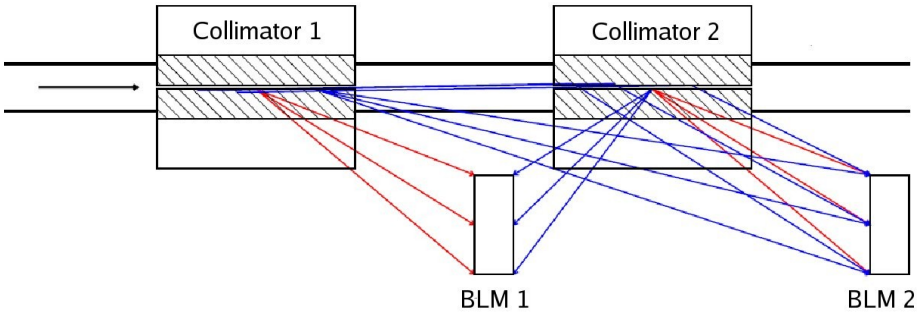
based on simulations of Andres Gomez Alonso
CERN, December 17th 2008

Procedure of BLM threshold settings on collimators

- Values of maximum allowed lost protons from Ralph
- Correction for fast failures scenarios from Andres
- Correction for low signal when a higher order halo particles deposit their energy (first approach)



drawing from Till

- Generation of signals in the BLMs from Till

Input from Collimation WG

Device	Location	Energy	T > 10s	1s < T < 10s	T < 1s
			$dN_{>10}/dt$ [p/s]	dN_{1-10}/dt [p/s]	$N_{<1}$ [p]
TCP	IR3	450 GeV	1.20E+12	6.00E+12	6.00E+12
TCP	IR3	7 TeV	8.00E+10	4.00E+11	4.00E+11
TCP	IR7	450 GeV	1.20E+12	6.00E+12	6.00E+12
TCP	IR7	7 TeV	8.00E+10	4.00E+11	4.00E+11
TCSG	IR3	450 GeV	1.20E+11	6.00E+11	6.00E+11
TCSG	IR3	7 TeV	8.00E+09	4.00E+10	4.00E+10
TCSG	IR7	450 GeV	1.20E+11	6.00E+11	6.00E+11
TCSG	IR7	7 TeV	8.00E+09	4.00E+10	4.00E+10
TCLA	IR3	450 GeV	6.00E+08	3.00E+09	3.00E+09
TCLA	IR3, IR7	7 TeV	4.00E+07	2.00E+08	2.00E+08
TCLA	IR7	450 GeV	6.00E+08	3.00E+09	3.00E+09
TCLA	IR3, IR7	7 TeV	4.00E+07	2.00E+08	2.00E+08
TCTH, TCTVA, TCTVB	IR1, IR2, IR5, IR8	450 GeV	6.00E+08	3.00E+09	3.00E+009
TCTH, TCTVA, TCTVB	IR1, IR2, IR5, IR8	7 TeV	4.00E+07	2.00E+08	2.00E+008
TCL, TCLP	IR1, IR5	450 GeV	6.00E+09	3.00E+10	3.00E+010
TCL, TCLP	IR1, IR5	7 TeV	4.00E+08	2.00E+09	2.00E+009
TCLIA, TCLIB, TCSG	IR2, IR6, IR8	450 GeV	1.20E+11	6.00E+11	6.00E+011
TCLIA, TCLIB, TCSG	IR2, IR6, IR8	7 TeV	8.00E+09	4.00E+10	4.00E+010

Remark:

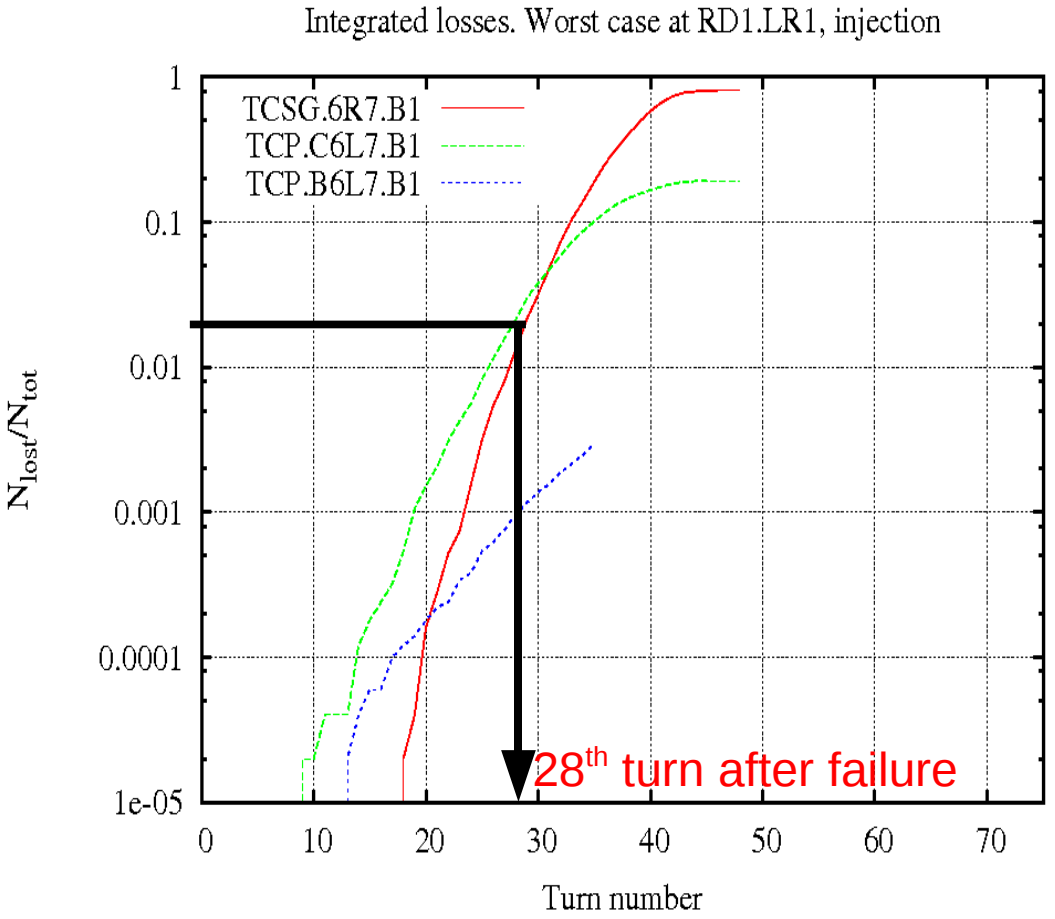
- The numbers does not contain any safety factor for Collimator jaws for 7 TeV (some for 450 GeV)

Algorithm:

- For $t < 1$ s : $N_{prot} = 1\,[s] \cdot dN_{1\text{-}10}/dt$
- For $1\text{ s} < t < 10$ s: $N_{prot} = t \cdot dN_{1\text{-}10}/dt$
- For $t > 10$ s : $N_{prot} = 10\,[s] \cdot dN_{1\text{-}10}/dt + (t\text{-}10[s]) \cdot dN_{>10}/dt$
- Scaling with beam energy is linear

Fast failures

- Some failures lead to very fast loss rate increase
- The worst case scenario is quench of D1 (Andres)
- Threshold for TCP in IR7 at injection is $6 \cdot 10^{12}$ protons ie. $0.02 \cdot N_{tot}$



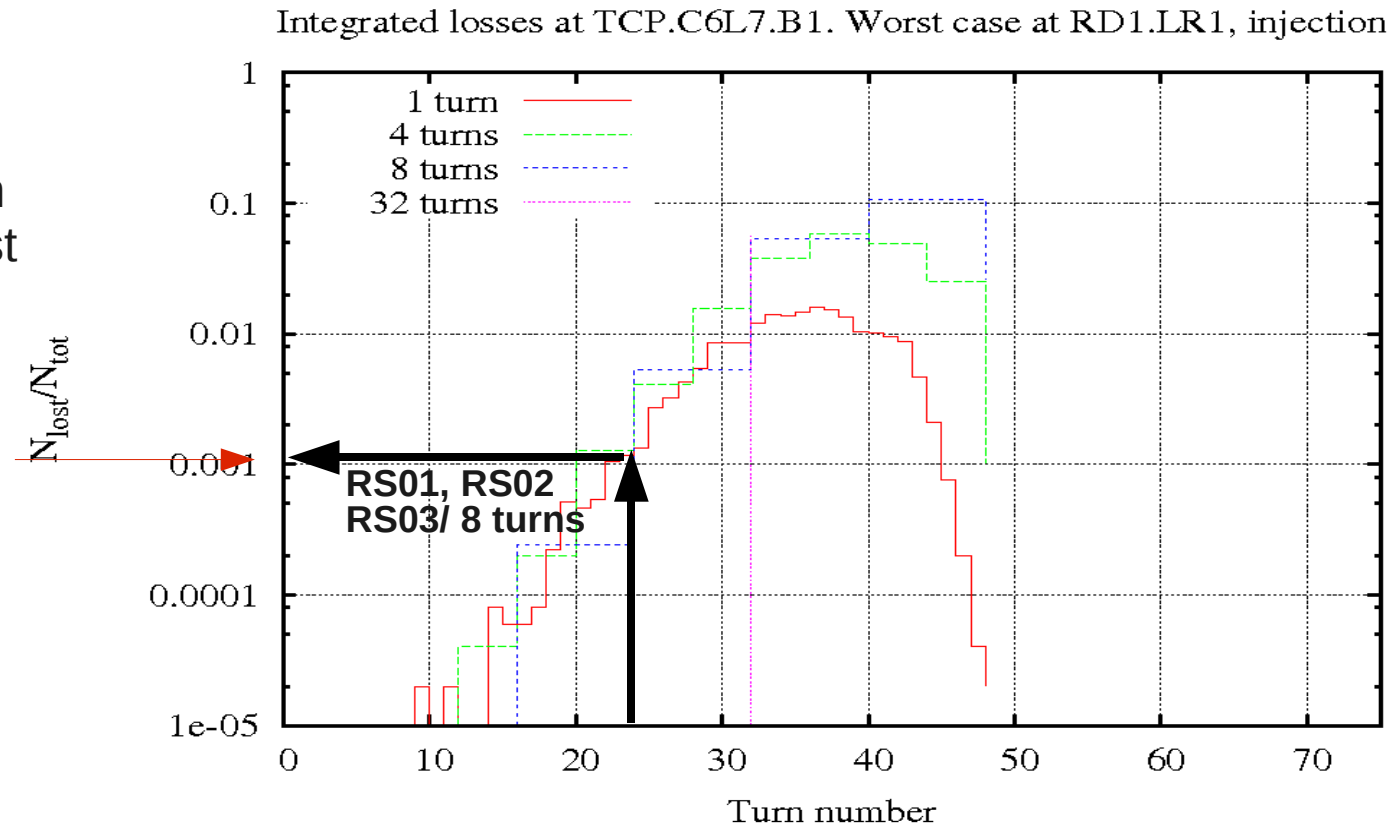
Knowing that 4 turns are needed to dump the beam (RS01 and RS02) therefore the threshold should correspond to loss during 24th turn.

Fast failures - correction

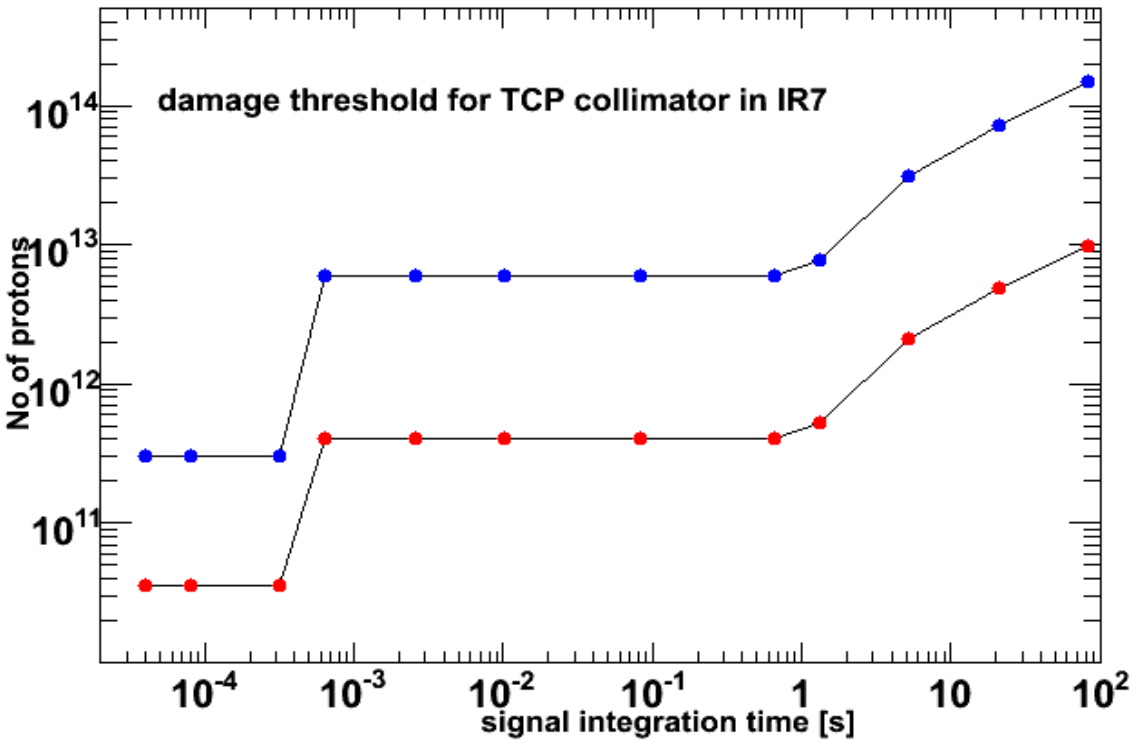
- The question is: what will be the number of lost protons 4 turns back:

New maximum numbers of lost protons:

$3 \cdot 10^{11}$



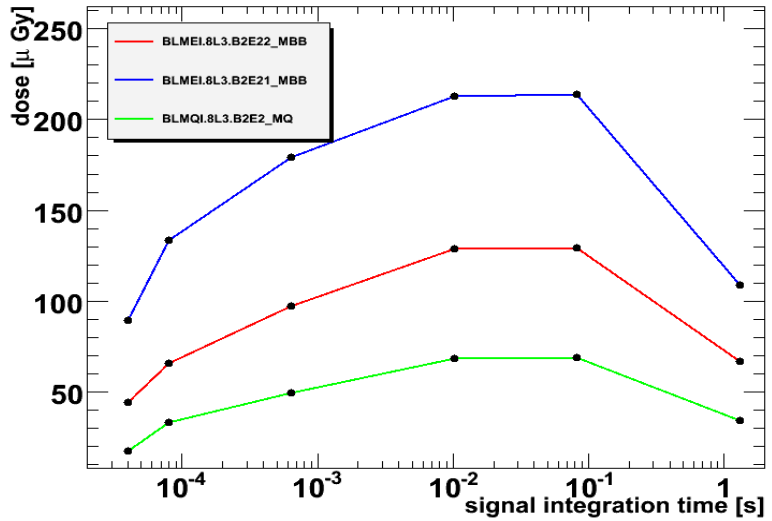
Threshold expressed in number of protons

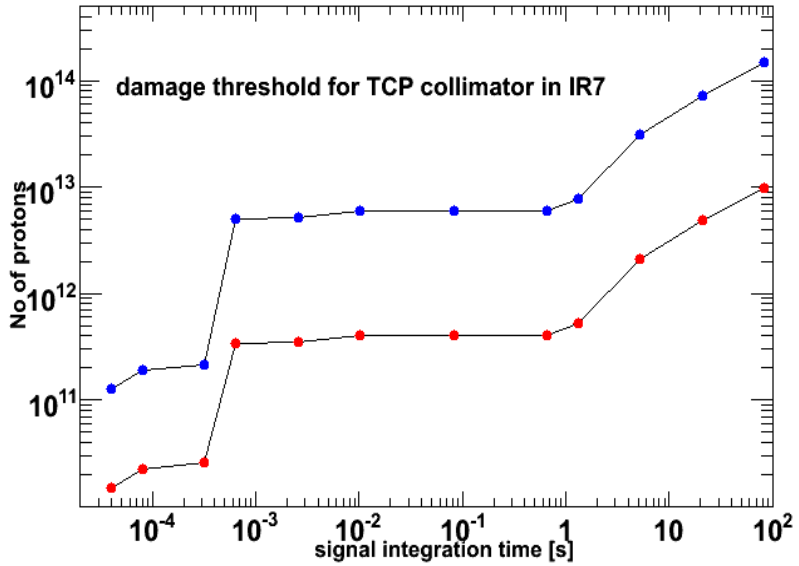


injection

collision

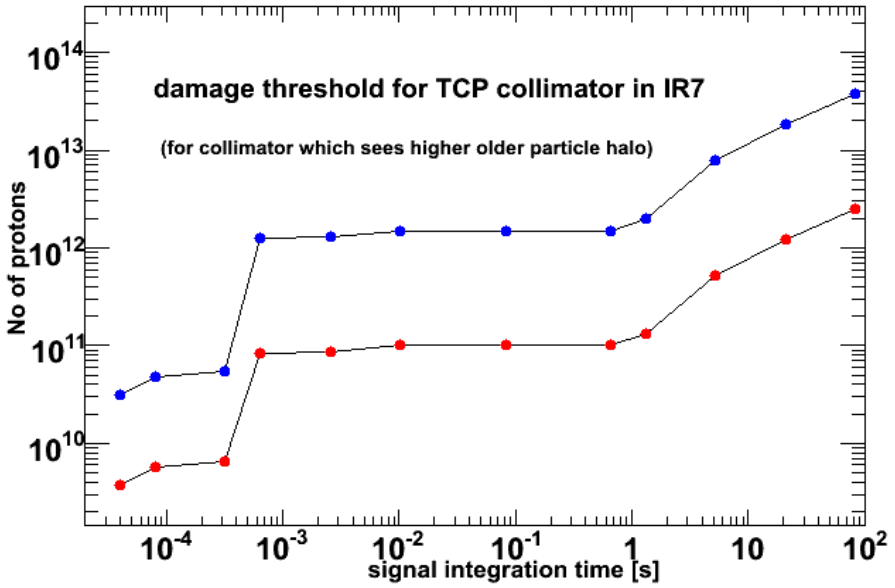
Time for signal collection in electronics

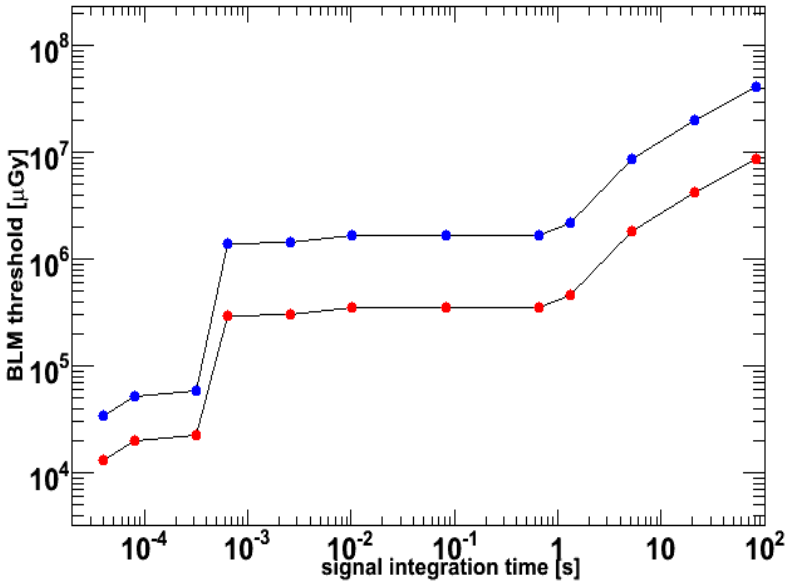




- Results from LHC losses (single shots on magnets and collimator)
- Drawing is for IC, but the effects comes from cables so should be the same for SEM
- Correction for all running sums up to 10 ms (maybe 2.56 ms – to be checked)
- This correction is about factor 2 for short running sums.

Correction for higher order halo





In case of first TCP there is no factor 5 due to higher-order halo particles but there is almost factor 10 due to jaw angle!

Some numbers:

- For transient loss at injection energy the threshold is about 70 times higher then quench-protecting threshold on the MB
- For RS01 it is 864 Gy/s

Conclusions

- The algorithm to determine initial setting of LHC collimator thresholds is established
- It includes the correction for losses with very high increase rate (like D1 magnet failure)
- Additional corrections due to long signal integration time in the electronics are made (factor 2-3)
- Initial correction for higher-order halo estimated – more study required
- What about additional correction for peak energy for fast losses (factor 5)