Safe Beam Flag and BLMs thresholds for LHC ion beam operation

3.5 TeV collisions		Early ions (nom)	Nom ions	Protons (nom)
Energy/nucleon	GeV	1380	1380	3500
No ions/p per bunch		7E7	7e7	1.15E11
No of bunches		62	592	2808
Stored energy per beam	MJ	0.2	1.91	181

0.1% and 1% of nominal proton beam

@ 7 TeV	p collision	^{208}Pb collision
Ionisation energy loss dE/Edx	0.0088 %/m	0.73%/m
MS RMS angle	4.72 μrad/√m	4.72 μrad/√m
Nucl. inter. length	38.1 cm	2.2 cm

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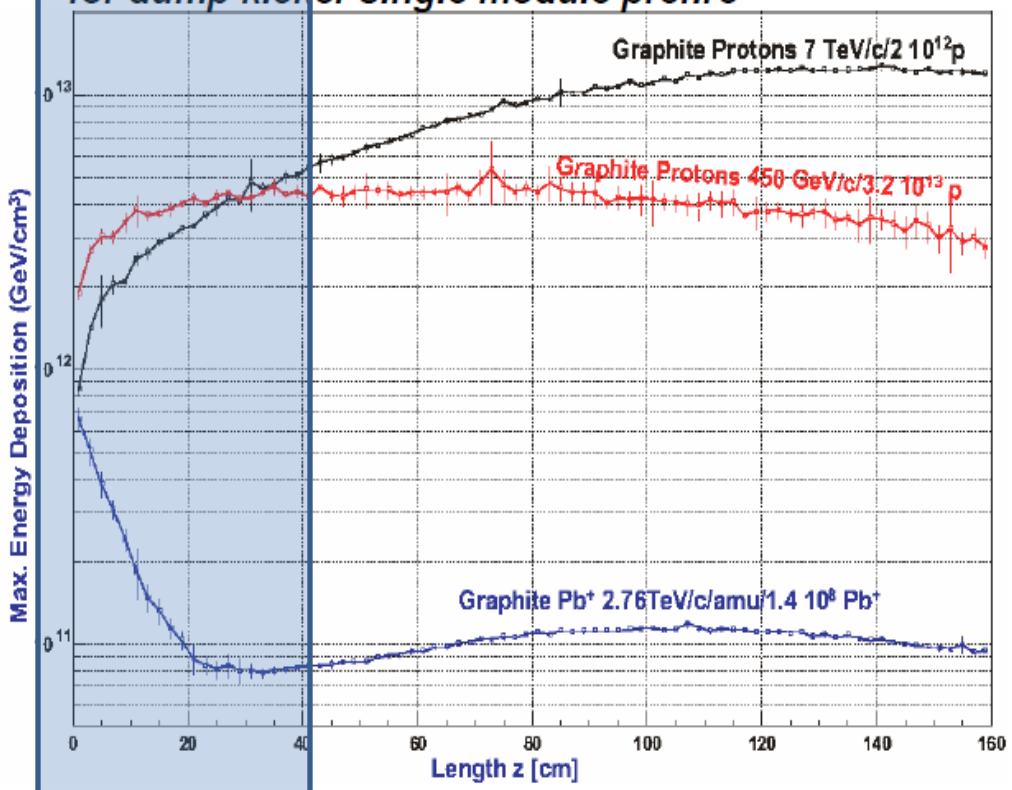
Robustness of collimator against mishaps

FLUKA calculations from Vasilis Vlachoudis for dump kicker single module prefire

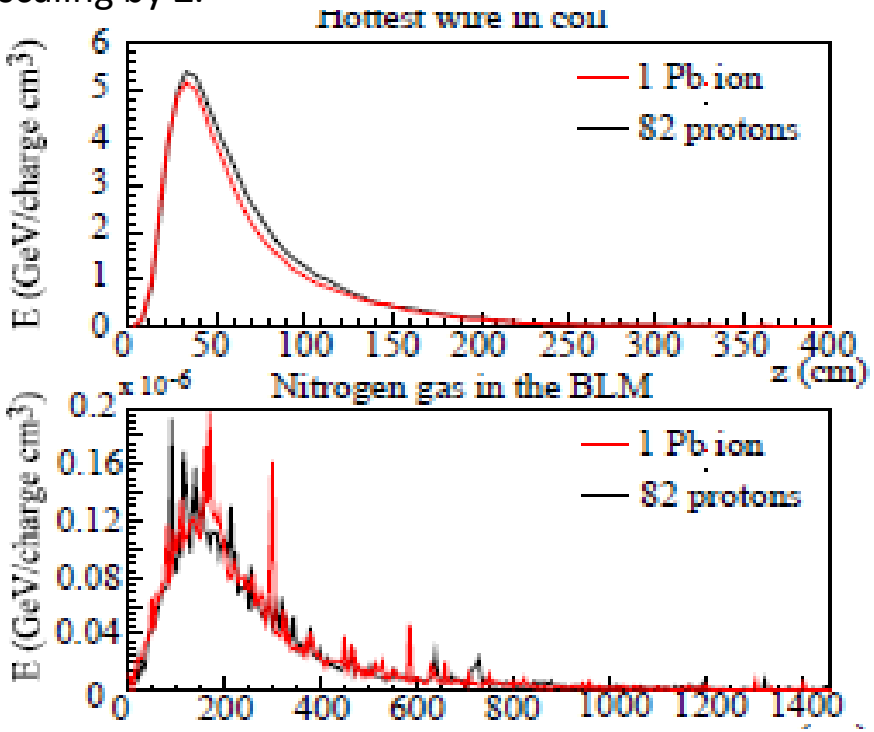


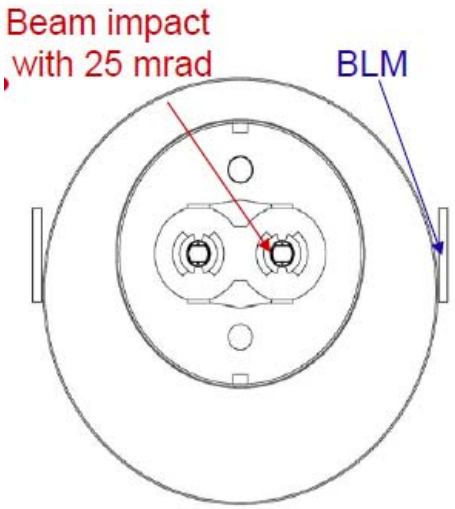
The higher Ionisation loss makes the energy deposition at the impact side almost equal to proton case, despite of 100 times less beam power

H Braun, 2005
LHC Design Report

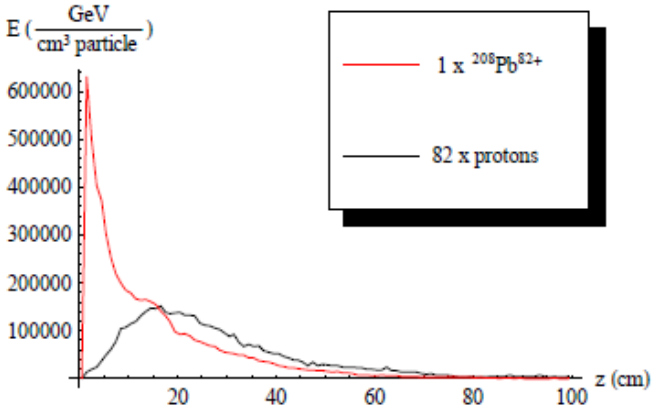
Ratio b/w heat deposited in the MB coils and energy deposition in the BLMs is the same as for protons, scaling by Z.

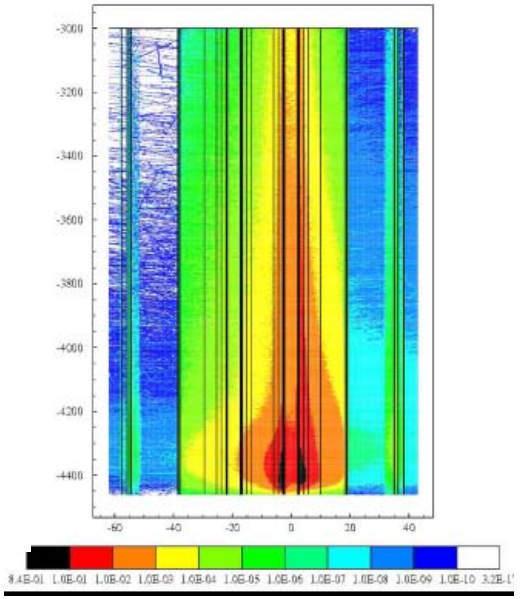
R Bruce, LHC Project Note 402





Differences on microscopic scale: innermost 0.1mm of the beam screen





Safe Beam Flag derived from beam intensity and machine energy from [EDMS 1080848]

$$\left(\frac{E[GeV]}{450[GeV]}\right)^{1.7} \times I \leq threshold$$

Nominal threshold set to 1X 10^{12} proton charges in 2009-2010:
(relaxed = 4x nominal but <1X 10^{12})

Energy [GeV]	p nominal threshold	p relaxed threshold
450	1.00 x 10^{12}	1.00 x 10^{12}
1000	2.65 x 10^{11}	1.00 x 10^{12}
2000	8.15 x 10^{10}	3.26x 10^{11}
3500	3.14 x 10^{10}	1.26x 10^{11}
5000	1.71 x 10^{10}	6.86x 10^{10}
7000	9.60 x 10^{9}	3.87x 10^{10}

Why 10^{12}? Simply rescale for ions by stored beam energy ratio?

Protons:
1x10^{12} at 450 GeV

Early Ions:
7x10^{7}x208x62=9x10^{11}
up to 1.38TeV