

Specification of the Beam Loss monitors

MPWG, June 2002

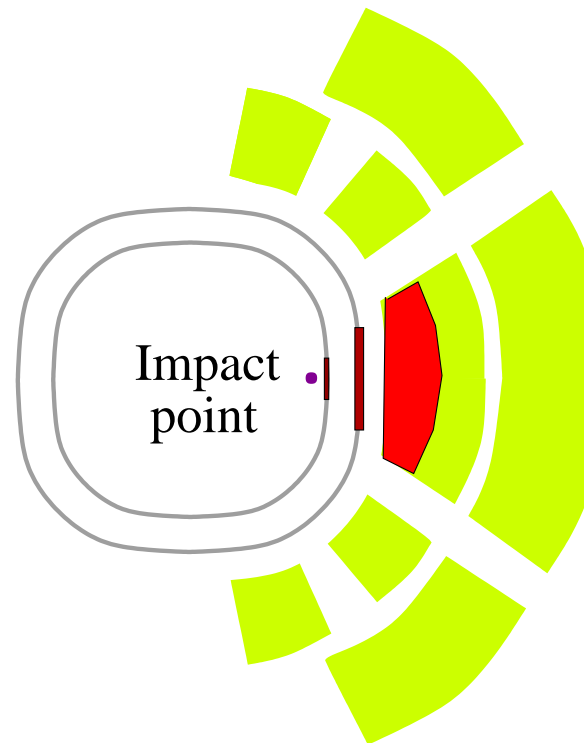
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Outline

- Beam losses , quench and damage levels
- What is measured
- What kind of monitors
- Decision logic for dump trigger

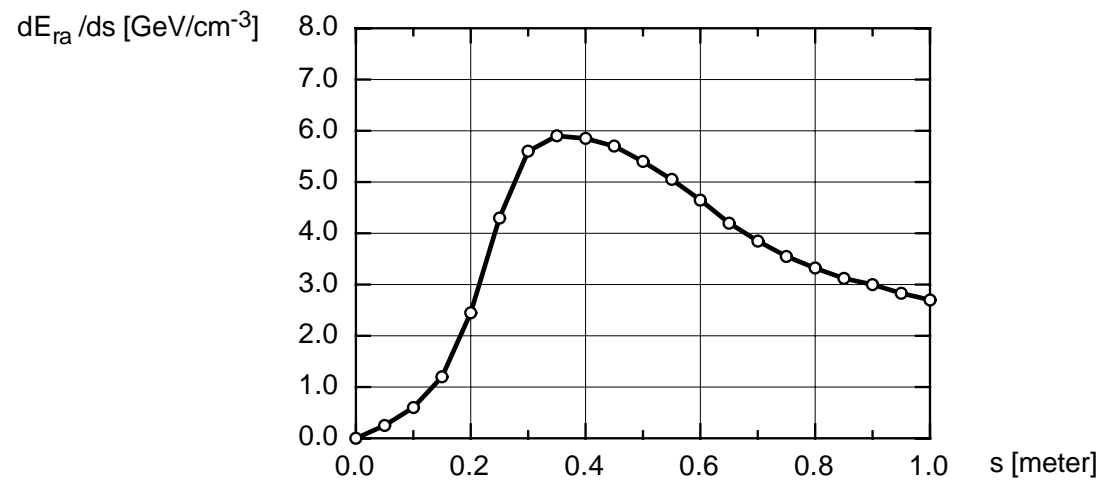
Beam and power deposition



1 proton at 450 GeV : $0.07\mu\text{Joule}$

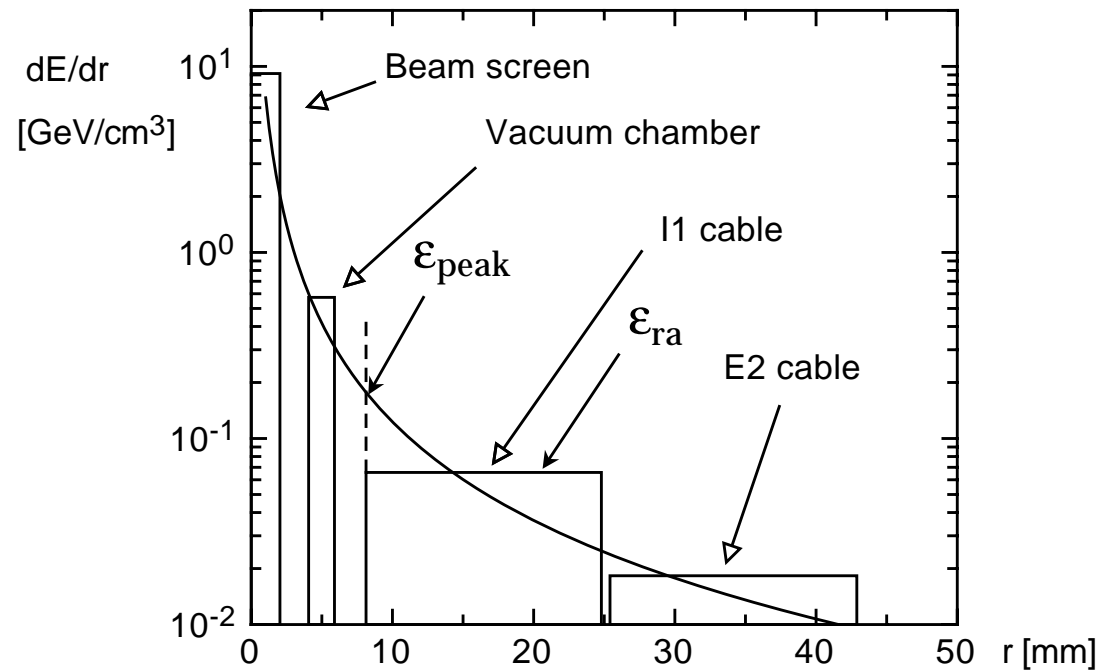
1 proton at 7 TeV : $1.1\mu\text{Joule}$

Beam and power deposition, longitudinal



Beam and power deposition, transverse

Injection, 450 GeV



Primary proton steady loss rates

	450 GeV		7 TeV	
	BLMA & BLMS [p/m/s]	BLMC [p/s]	BLMA & BLMS [p/m/s]	BLMC [p/s]
Pilot bunch & collimation	$2 \cdot 10^3$	$2 \cdot 10^7$	20	$2 \cdot 10^5$
Pilot bunch, no collimation	$2 \cdot 10^7$	$2 \cdot 10^7$	-	-
Nominal beam lifetime	10^7	10^{11}	$< 3 \cdot 10^5$	$< 3 \cdot 10^9$
Quench level	10^9	10^{13} (*)	$8 \cdot 10^6$	$8 \cdot 10^{10}$ (*)
Damage level	$5 \cdot 10^9$	$> 10^{13}$	$2 \cdot 10^8$	10^{12}

(*) Quench \times collimation efficiency

Nominal beam lifetime, 450 GeV: 1 hr, 7 TeV: 30 hr

Stored beam intensity : $3 \cdot 10^{14}$ protons

Hierarchy of beam lifetimes, loss levels and protection strategy in the regime of steady losses

	Loss level				Protection strategy
	450 GeV		7 TeV		
	t	level	t	level	
Damage level		5		25 (0.25)	
Quench level	< 1mn	1	1 hr	1 (0.01)	
Beam dump threshold for quench prevention	2mn	.3	2.5 hr	.4 ($4 \cdot 10^{-3}$)	Dump the beam
Warning	6 mn	.1	4 hr	.25 ($2.5 \cdot 10^{-3}$)	Stop interruptible actions
Nominal losses	1 hr	.01	30 hr	.03 ($.3 \cdot 10^{-3}$)	

Hierarchy of loss levels and protection strategy in the regime of transient losses

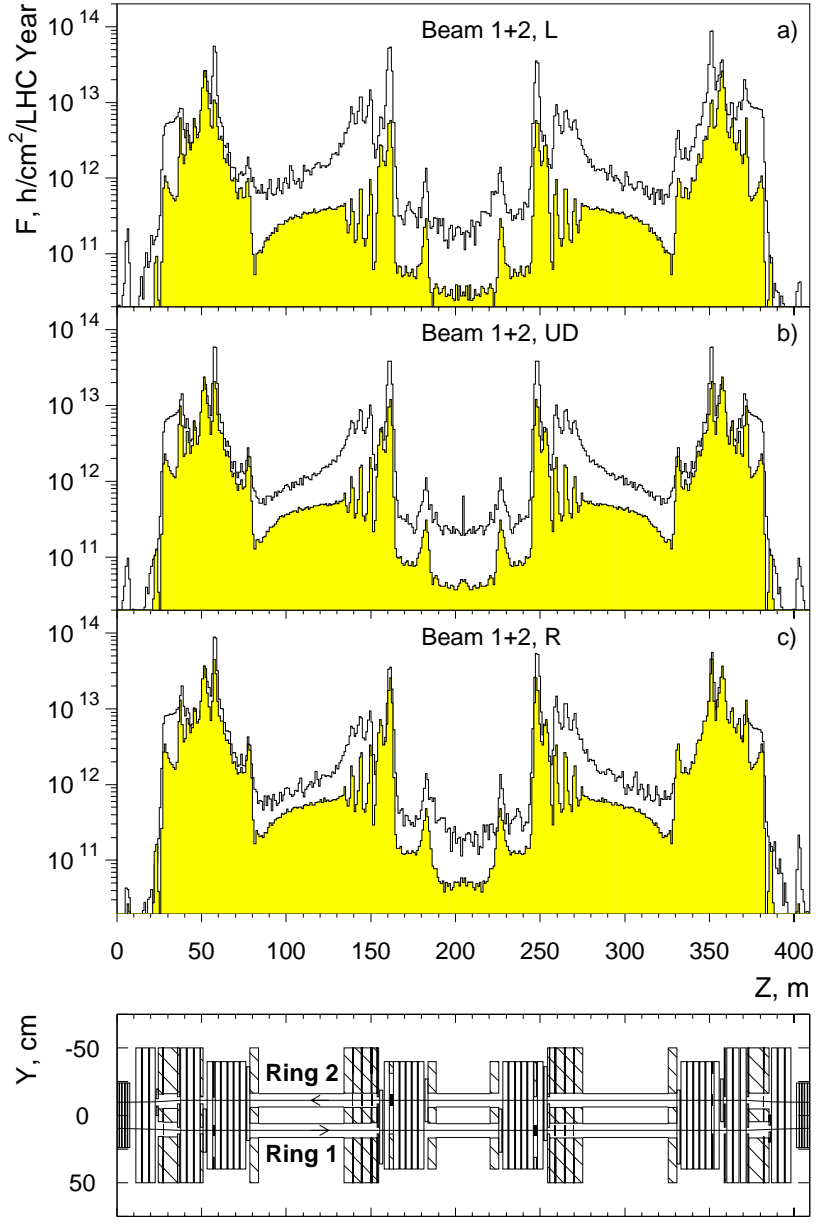
	Loss level		Protection strategy
	450 GeV	7 TeV	
Damage to components	320	1000 (3)	
Quench level	1	1 $3 \cdot 10^{-3}$	
Beam dump threshold for quench prevention	0.3	0.3 10^{-4}	Dump the beam
Warning	0.1	0.1 $3 \cdot 10^{-5}$	Stop interruptible actions

Quench level for transient losses lasting 1 ms:

$2 \cdot 10^9$ p/m at 450 GeV

$6 \cdot 10^6$ p/m at 7 TeV

Fluence in IR3 with 'thin' shielding



Intermediate conclusions

- **Operation with collimators in is mandatory**, except pilot
- Transient losses can a priori be very large
- BLM's must have a high dynamical range at collimators
- BLM's must be fast at collimators

<dump trigger decision time \Rightarrow 1 turn \equiv $89\mu\text{s}$

- In the arcs, time resolution \approx 2.5 ms adequate

\Rightarrow Several kinds of monitors

Functional families of BLM's

<i>Type</i>	<i>Area of use</i>	<i>Criticality</i>	<i>Time resolution</i>
BLMC	Collimation sections	yes	1 turn
BLMS	Critical aperture limits or critical positions	yes	1 turn
BLMA	All along the rings	no	msec
BLMB	Primary collimators	no	1 turn + bunch-by-bunch

Criticality:

Yes : fail/safe No : Small fraction not working acceptable

Machine protection and decisions

- | | |
|--|-------------------------------------|
| 1) Quench detection | → quench protection
→ dump |
| 2) Slow beam loss at BLM | → dump → quench prevention |
| 3) Too fast beam loss at BLM
→ quench not avoided | → dump → damage prevention
→ (1) |

Issues not discussed

- 993 BLM's
- Calibration
- Dynamic range and correlated time-scale