LHC Protection — Plans

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Introduction

- Protection of colliders became a very important topic these past few years
- A beam, in particular in the LHC, is very powerful and has to be under control from his creation to the end of the experiment.

So we must :

- Protect equipment from damage and quenches
- Avoid beam dump when it is not necessary
- Have a precise diagnostic in case of failure in order to understand it and to improve protections

In this presentation, we present some data to show how powerful is the beam and explanations about the beam dump system and the quench protection will be given.

Why is it needed ?

A beam loss can damage the accelerator : it can be expensive to repair and time is lost (Remember the accident in 2008...)
It can be useful to compare the energy magnitude order with something known.

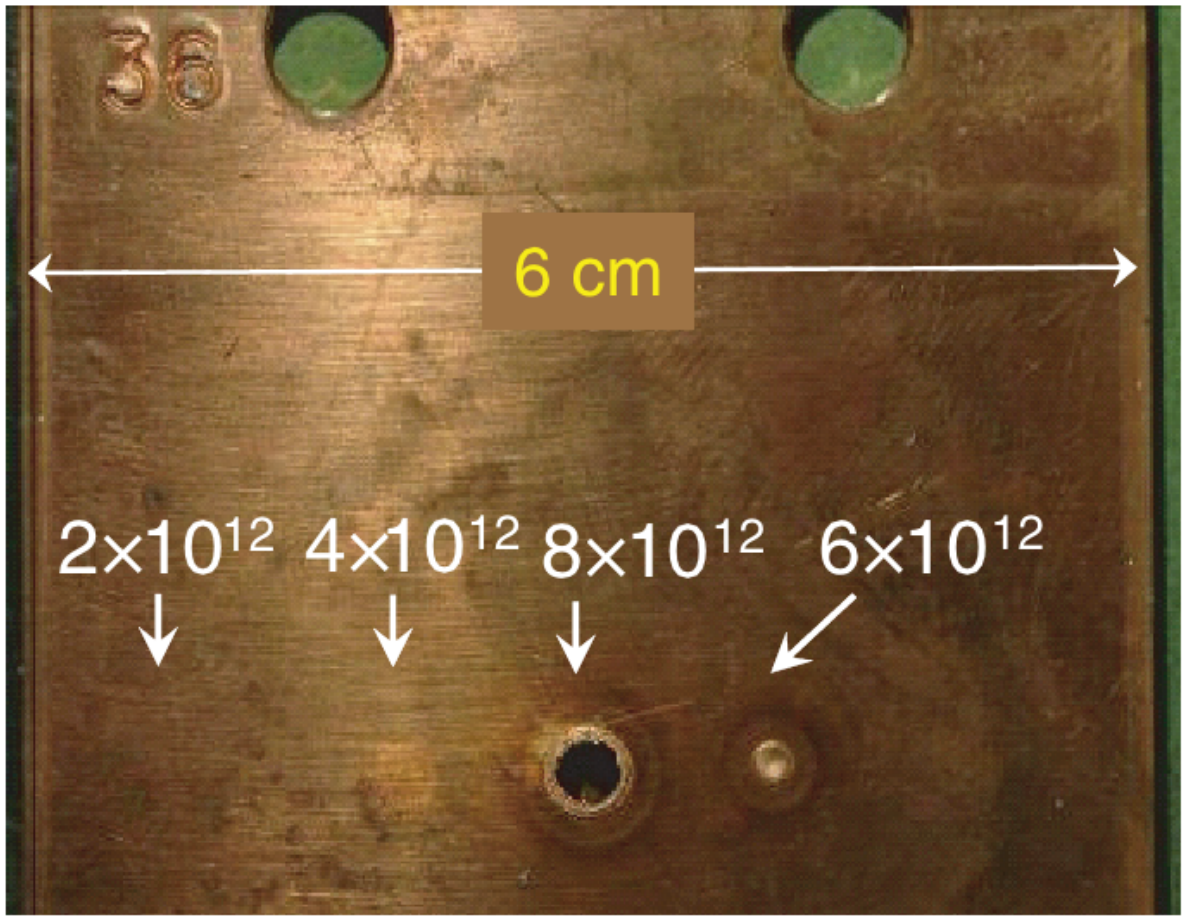
Some comparisons

- Energy per proton: $\sim$ 10 μJ
- Total beam energy: $\leq$ 362 **MJ** per beam
- Equivalent to 100kg of TNT

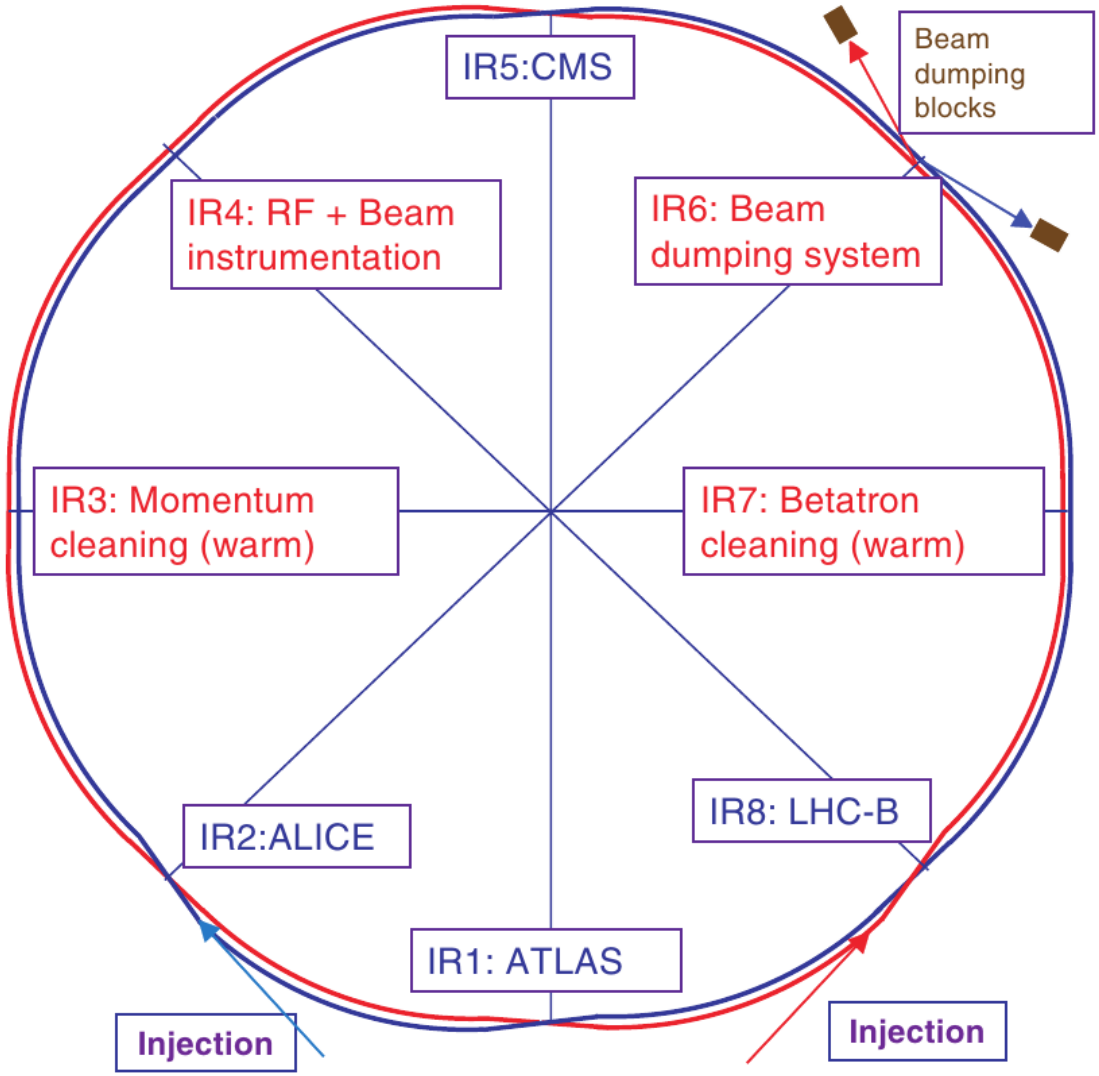
- Magnetic energy: $\leq$ 10 **GJ**
- Enough to melt nearly **15 tons of copper** $\Longrightarrow$ DANGEROUS

Damage test with a 450GeV beam

Experiment : A beam of protons with E=450GeV impact on a copper plate

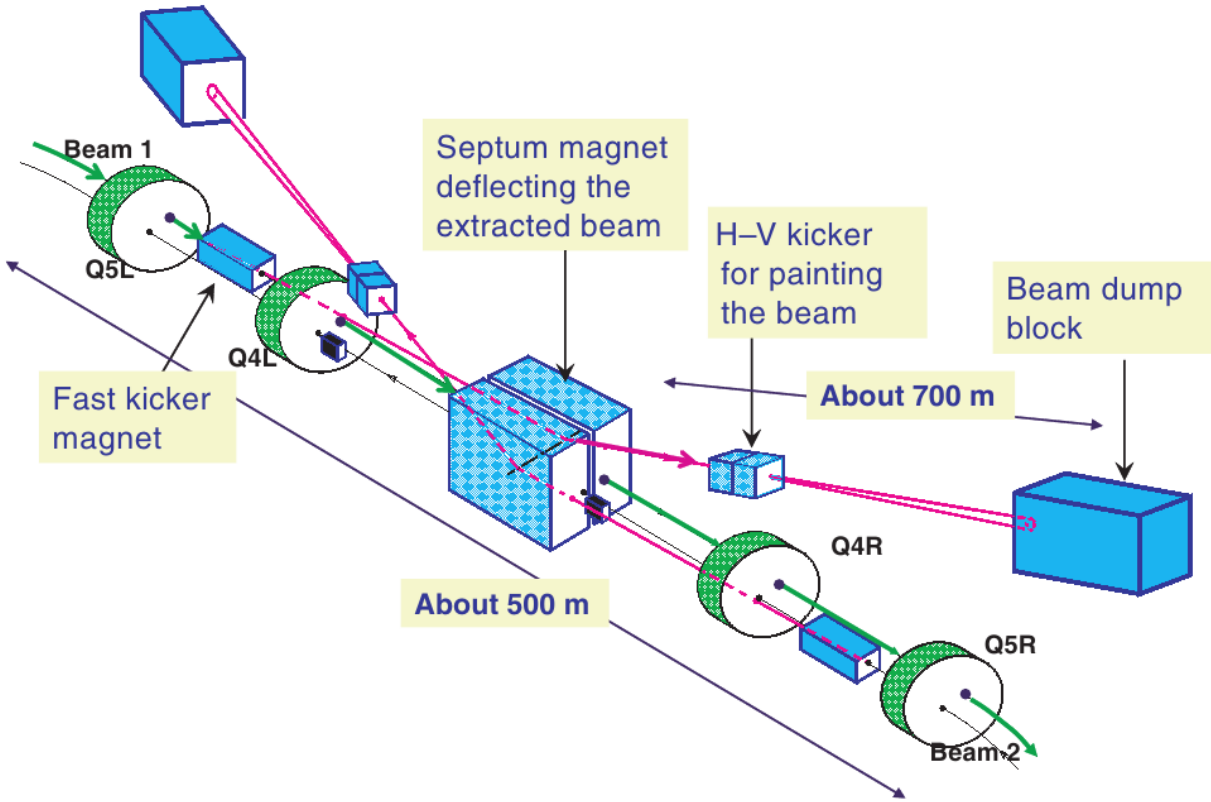


Imagine the damages with an energy of 7TeV...

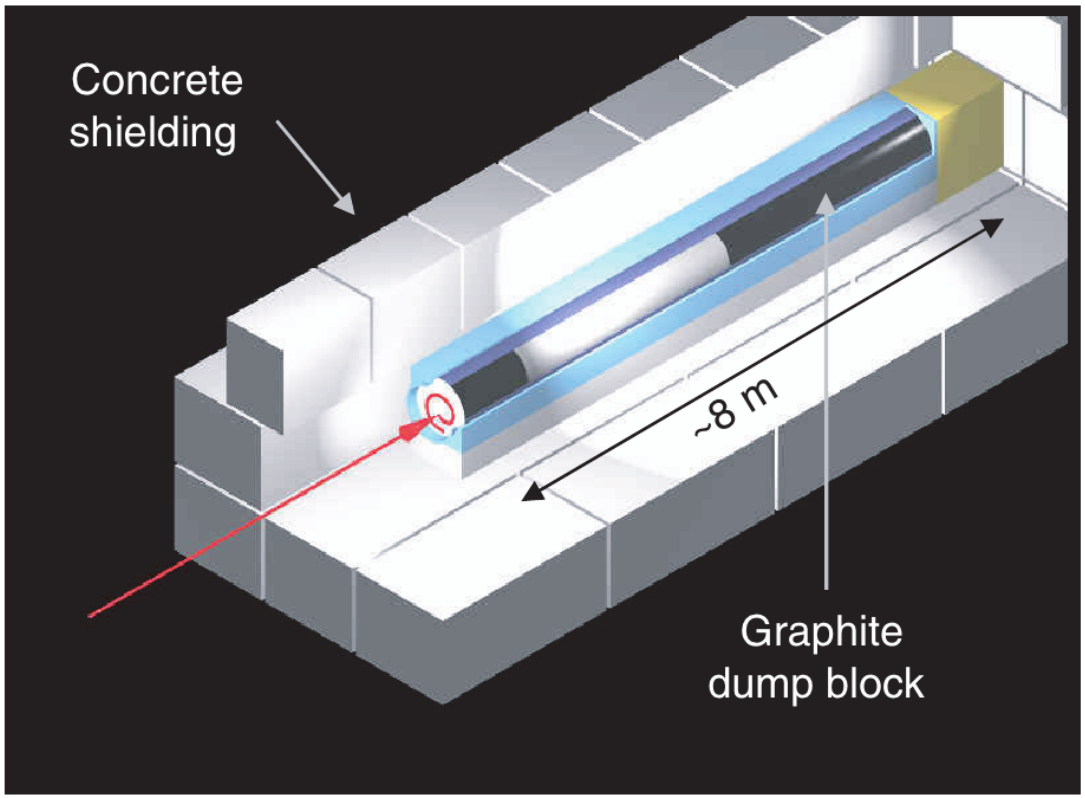

IR5:CMS
Beam dumping blocks
IR4: RF + Beam instrumentation
IR6: Beam dumping system
IR3: Momentum cleaning (warm)
IR7: Betatron cleaning (warm)
IR2:ALICE
IR8: LHC-B
IR1: ATLAS
Injection
Injection

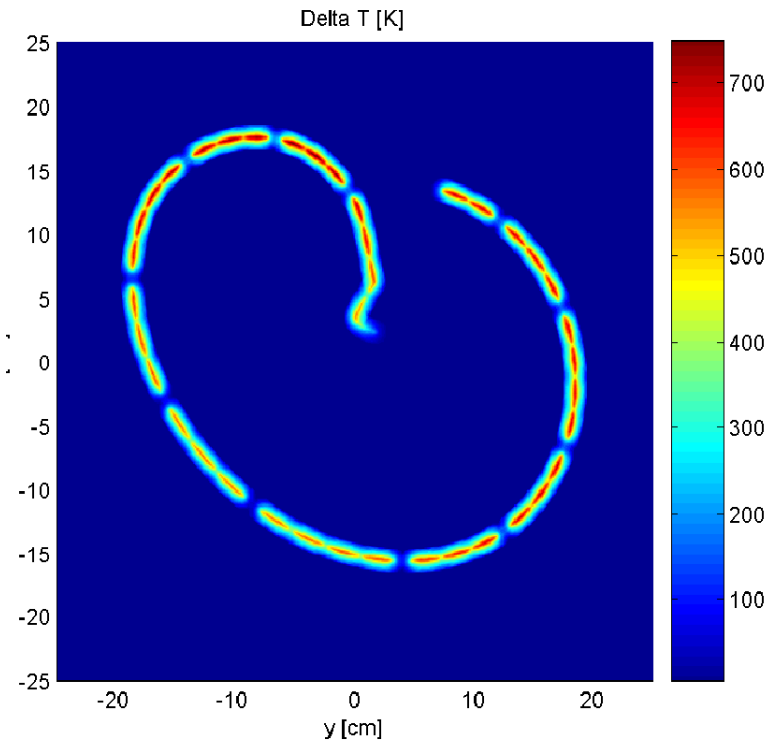
Beam Dump System

- Idea: Quickly & safely remove beam in case of irregularities or at end of run
- 3 μs abort gap
- 15 fast kicker magnets, then septum magnets, deflect beam
- Beam transmitted through 700 m long tunnel (dump line)
- Graphite blocks absorb beam



This is What it Should Look like





Quench Protection

- 1232 dipole magnets, up to 8.3 T
- 7.6 MJ per magnet, 10 GJ total
- Quenching = (spontaneous) transition to normal conducting phase
- Concentrated dissipation of field energy (1000 K) = explosion
- **Need protection against quenches!**
  - Prevention
  - Switch off power, controlled heating of magnet coils (10 K)
  - Resistor circuit to dissipate energy from other magnets $\sim$ 1 s

And the Reality?

Always use protection!

Presentation based on R Schmidt et al., Protection of the cern large hadron collider. *New Journal of Physics*, 8(11):290, 2006.