BEAM INCIDENT: TT40 TRANSFER LINE AT THE SPS

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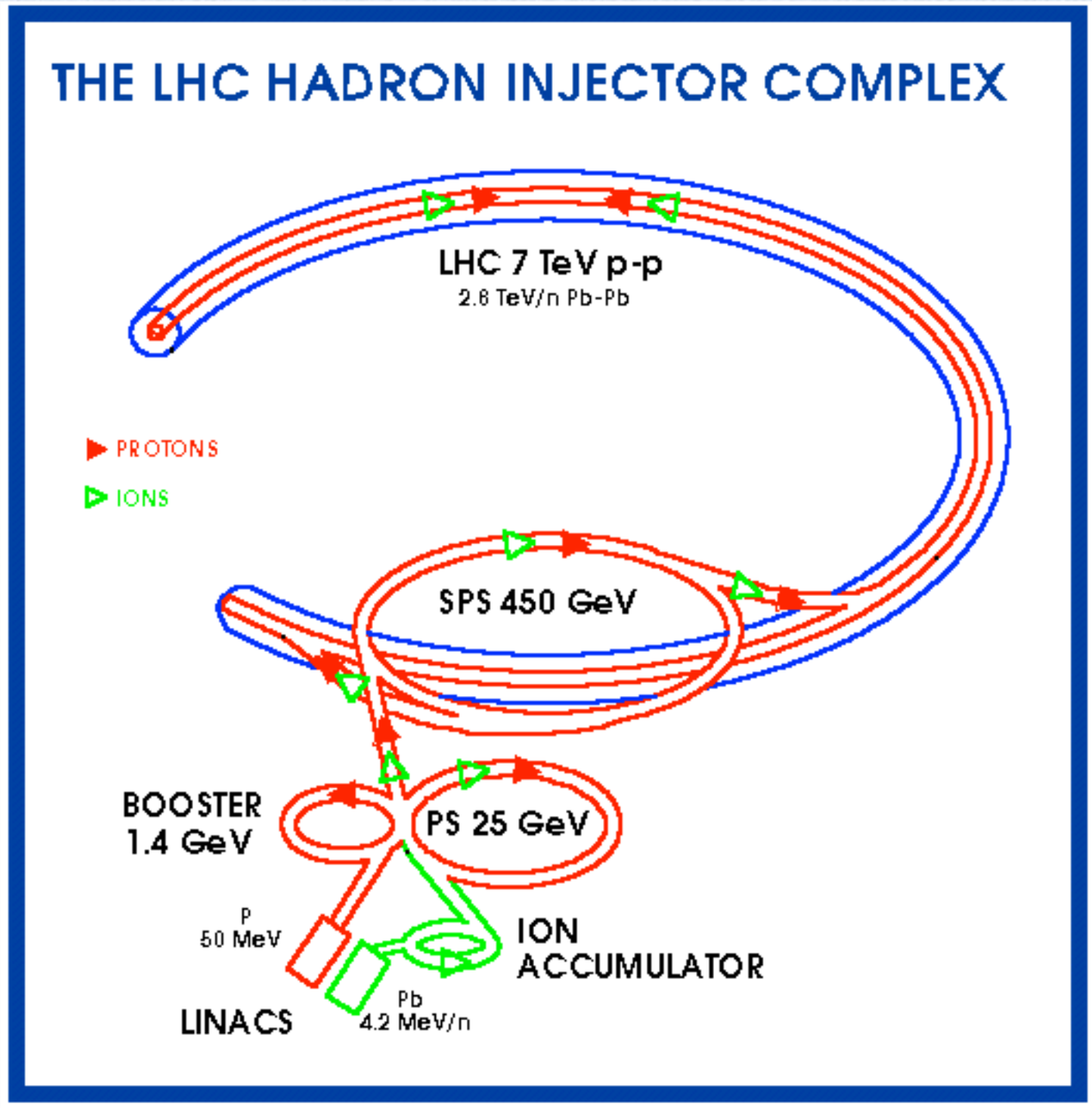
LHC INJECTION CHAIN

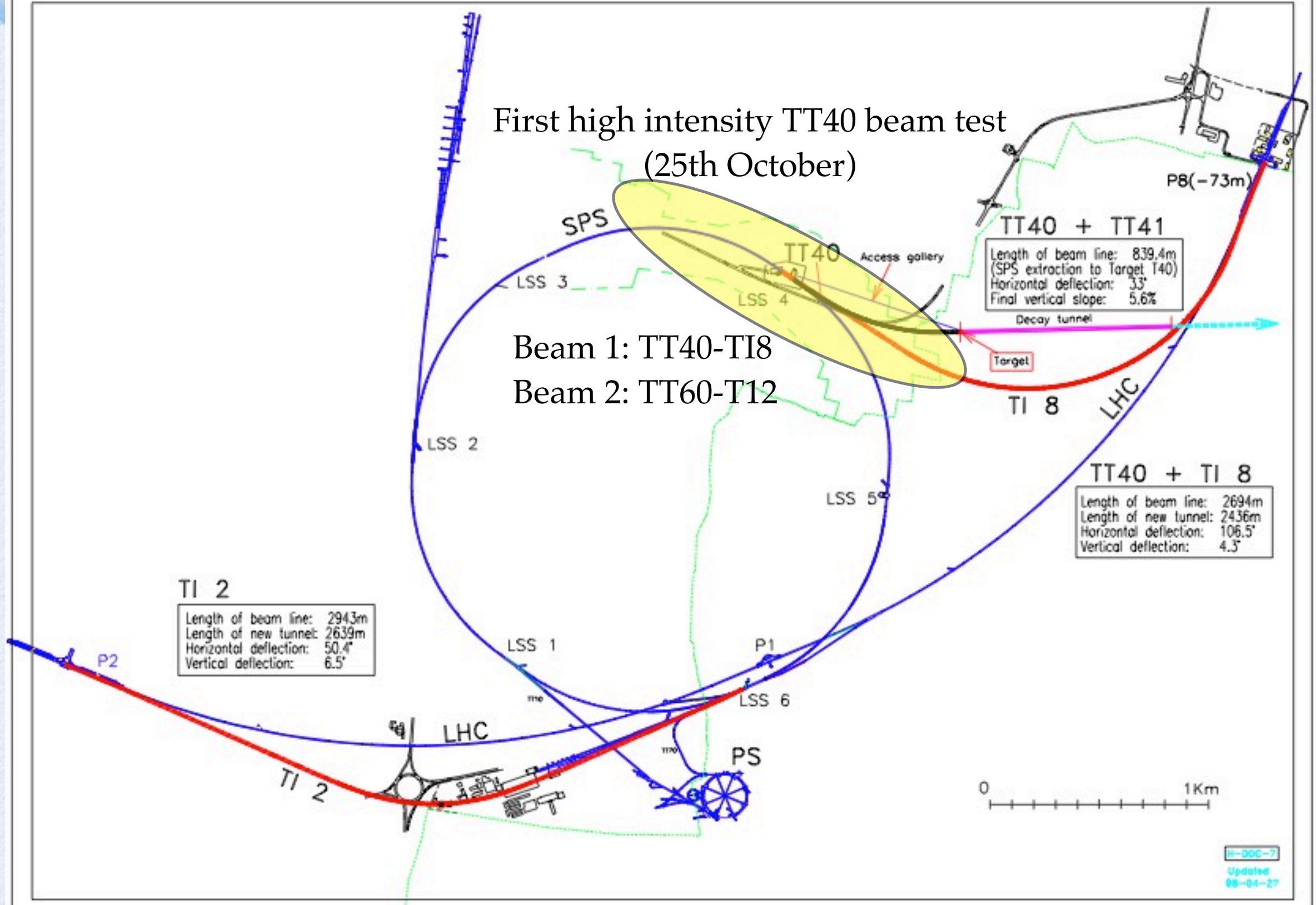
- Last part of the injection chain to the LHC is the SPS
- 6.9km
- 43.478 kHz
- 23 usec



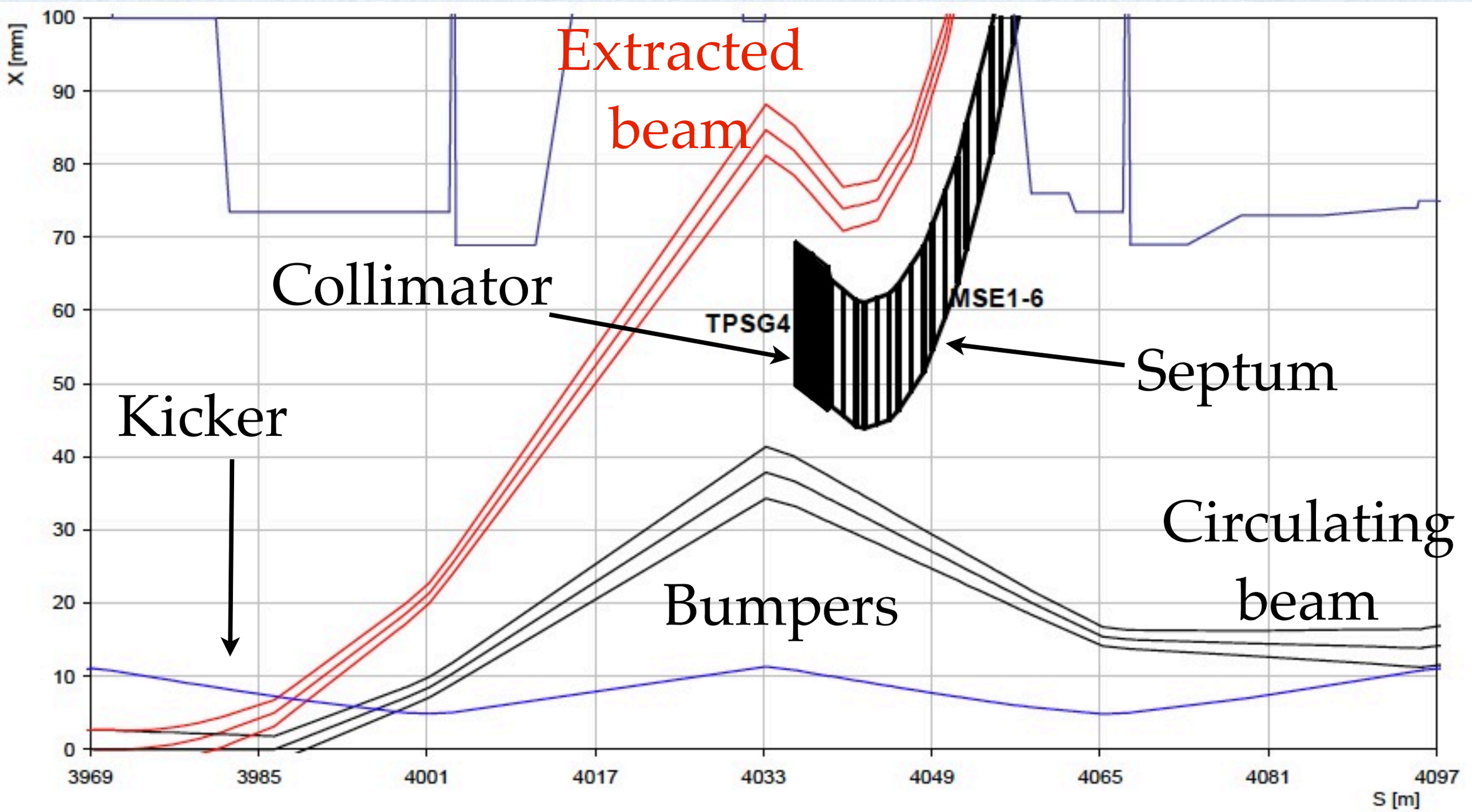
SPS AS INJECTOR

First high intensity TT40 beam test
(25th October)

Beam 1: TT40-TI8
Beam 2: TT60-T12

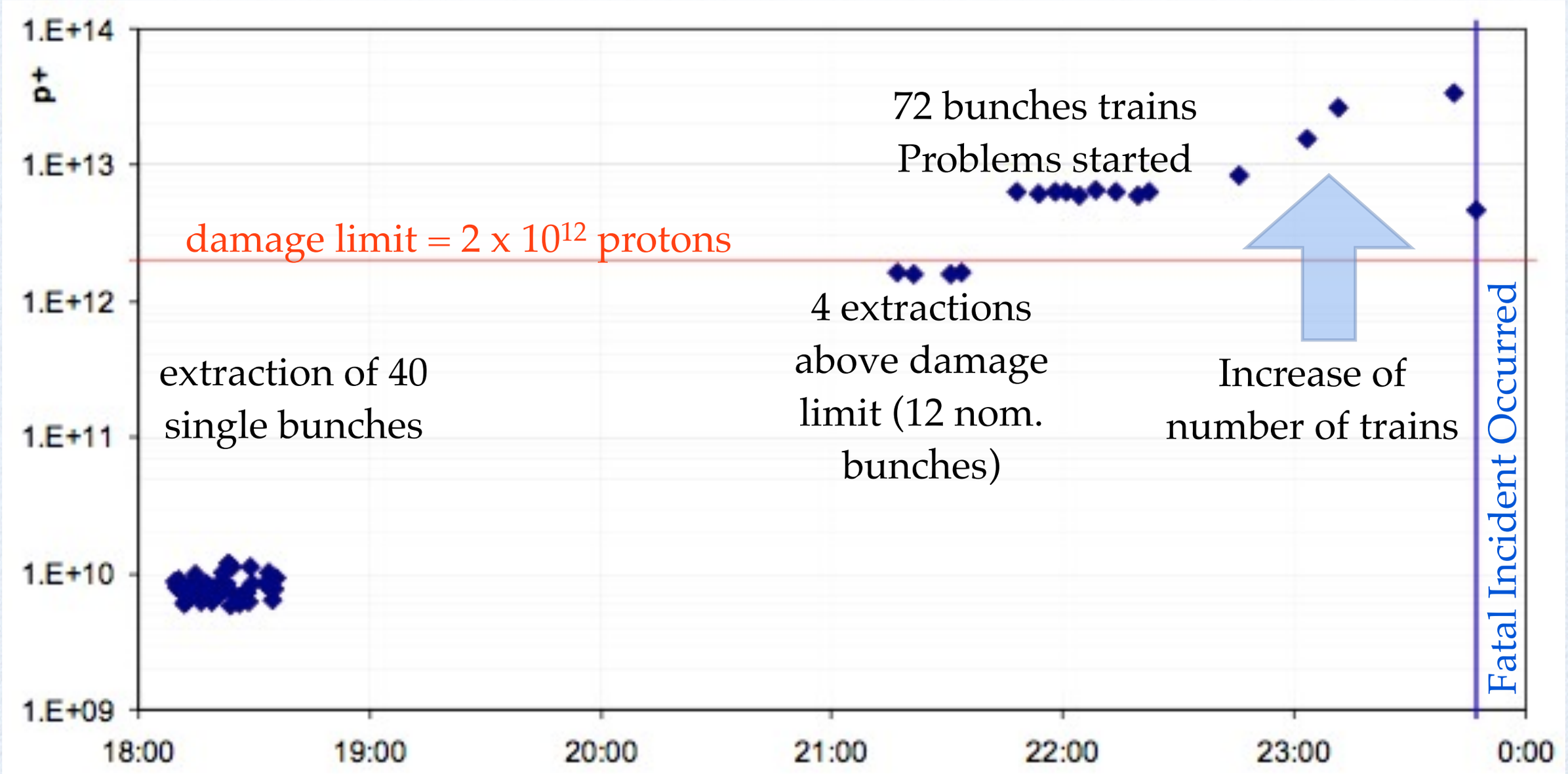


BEAM ENVELOPE IN LSS4 TO TT40



DESCRIPTION OF THE TEST

- Beam incident during extraction test at the SPS
- First time of high intensity extraction



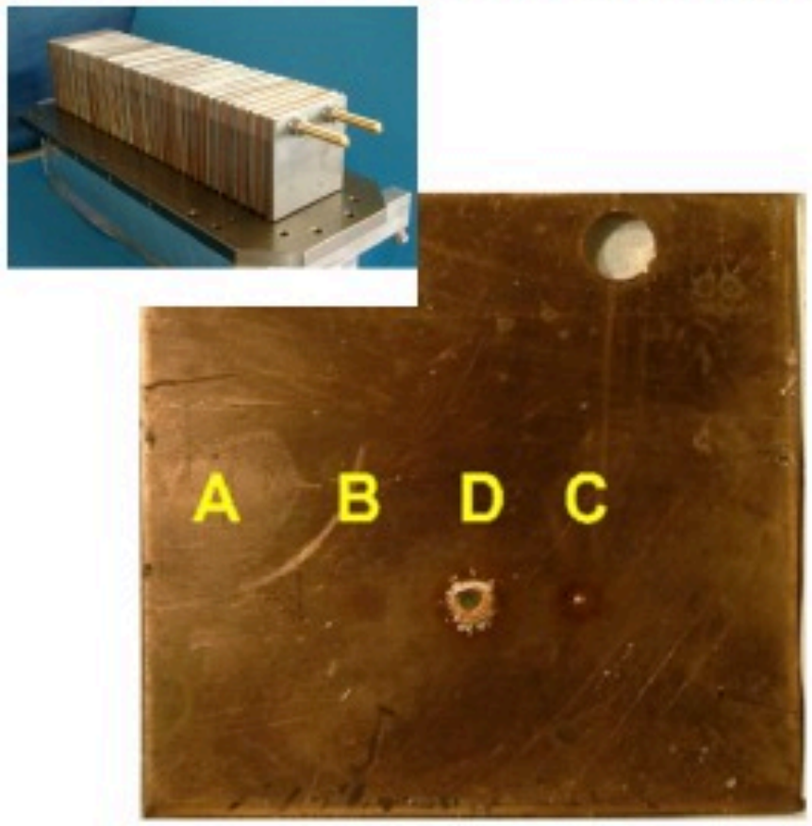
DAMAGE LIMIT

Ad "Setup Intensity"

The setup intensity must be reasonably high to be able to test under representative beam conditions.

The setup intensity should be below damage limit (quench limit).

The knowledge of the accelerator equipment damage limit is of importance. Test result at 450 GeV with LHC beam:



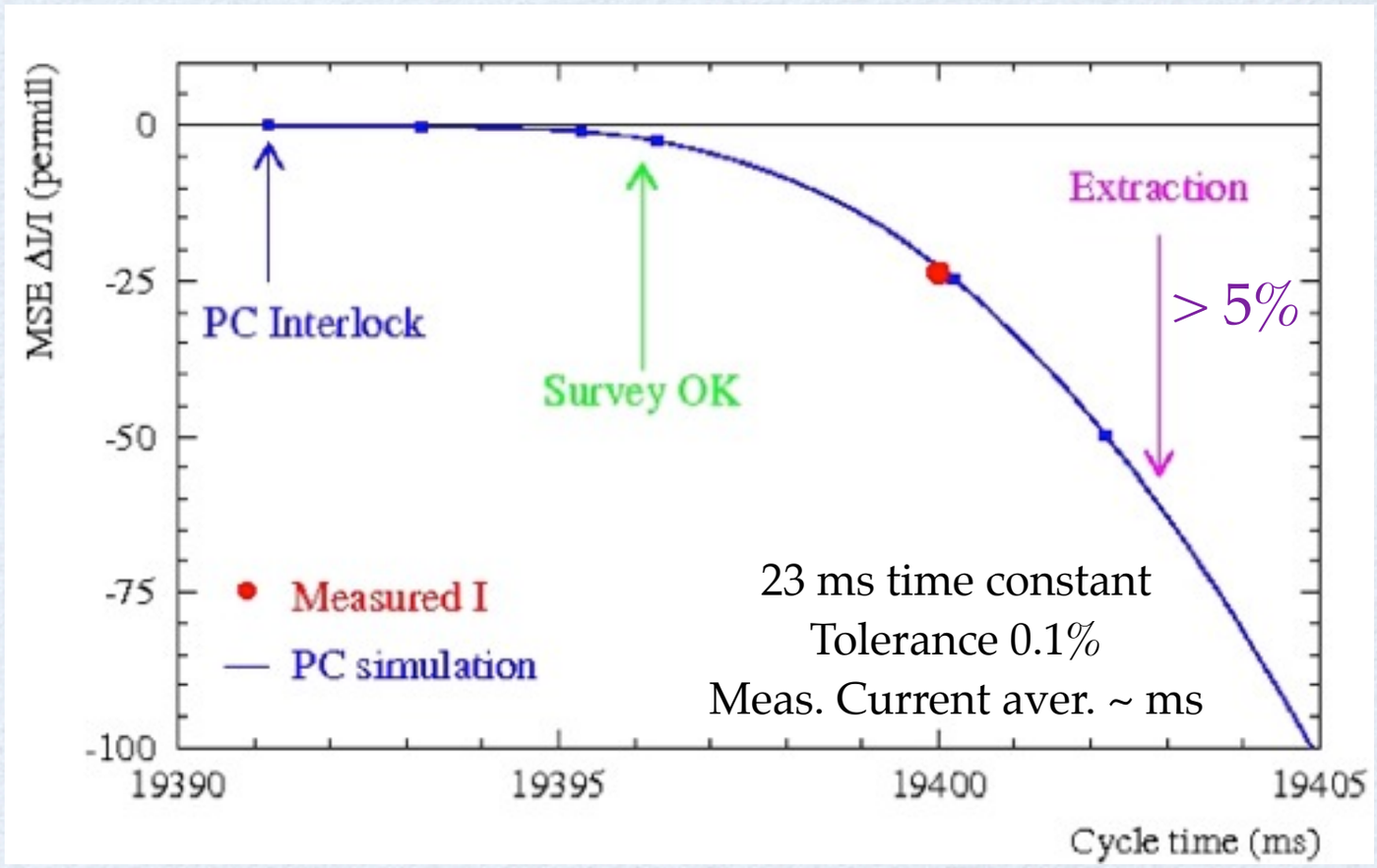
Intensity	# protons	Comments
A	1.2e12	No effect
B	2.4e12	Decolouration
C	4.8e12	Melting
D	7.2e12	Fragment ejection

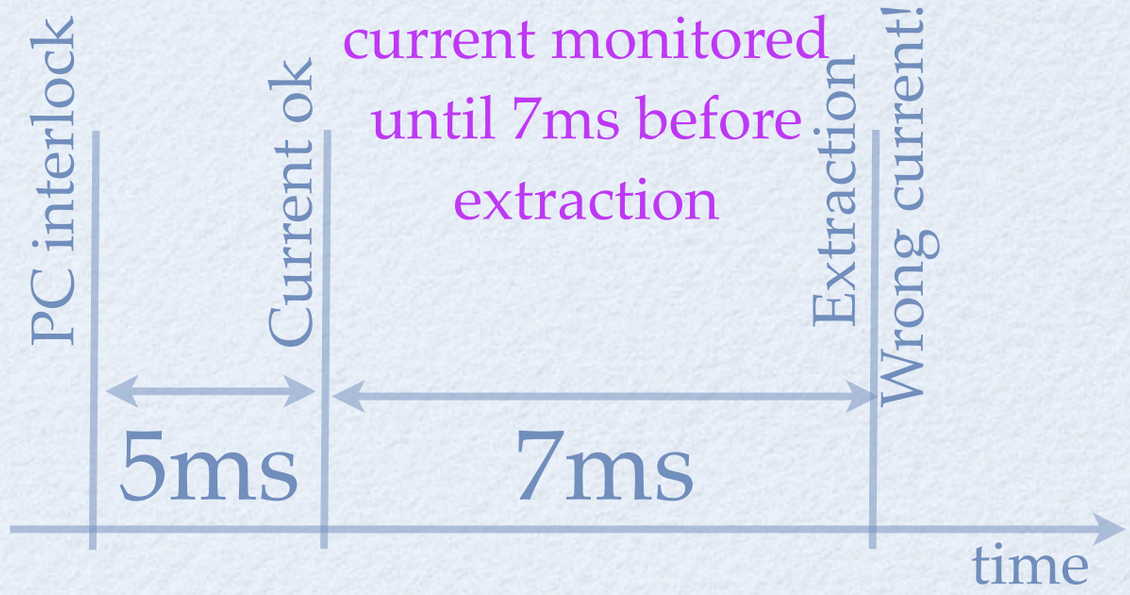
Definition of LHC Setup Beam Flag

$$\left(\frac{E[GeV]}{450[GeV]}\right)^{1.7} \times I[p] \leq 1 \times 10^{12}$$

WHAT HAPPENED?

- Some temperature probes on the septum where triggering the beam interlock due to induce e.m. noise from the high intensity beam.
- It was decided to mask these signals in the PLC (controller of the septum). It was (mistakable) though that we would be protected by the interlock the surveillance of the septum current.
- At the next extraction the PLC generated an interlock that switch off the septum, but as the current is going down slowly the surveillance did not pick-up this change and extraction was not inhibit.
- By the time the beam pass through the septum, the current was 5% of the nominal value, not sufficient to extract the beam and hit the quad after the septum.





RESULT

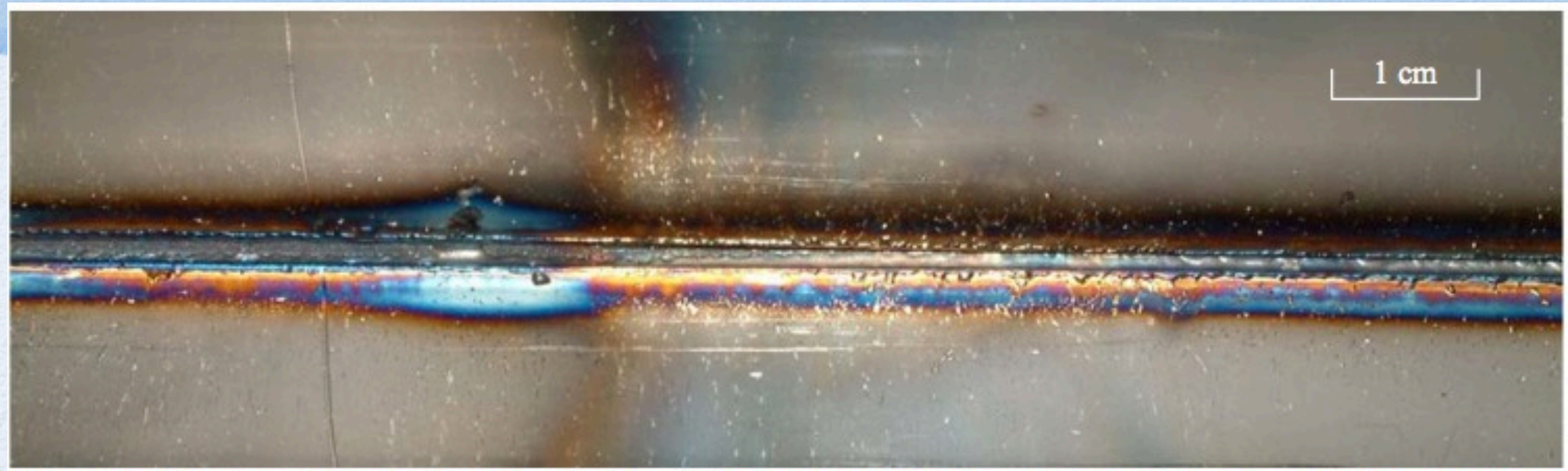


Figure 4. Damage observed on the inside of the vacuum chamber, on the beam impact side. A groove approximately 110 cm long due to removed material was clearly visible, starting at about 30 cm from the entrance.

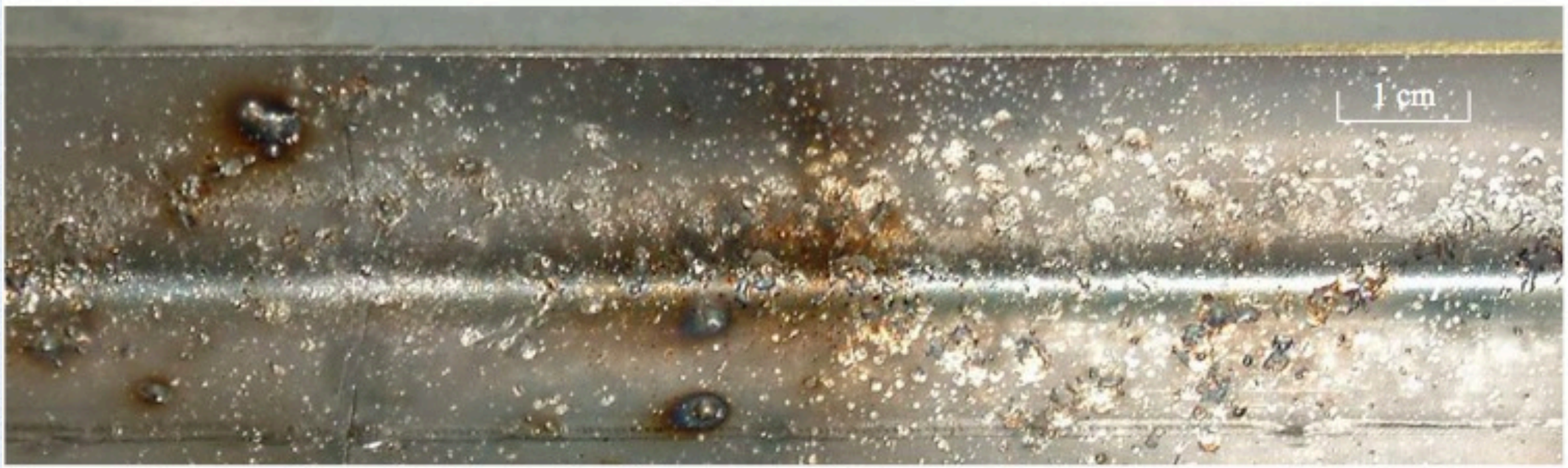


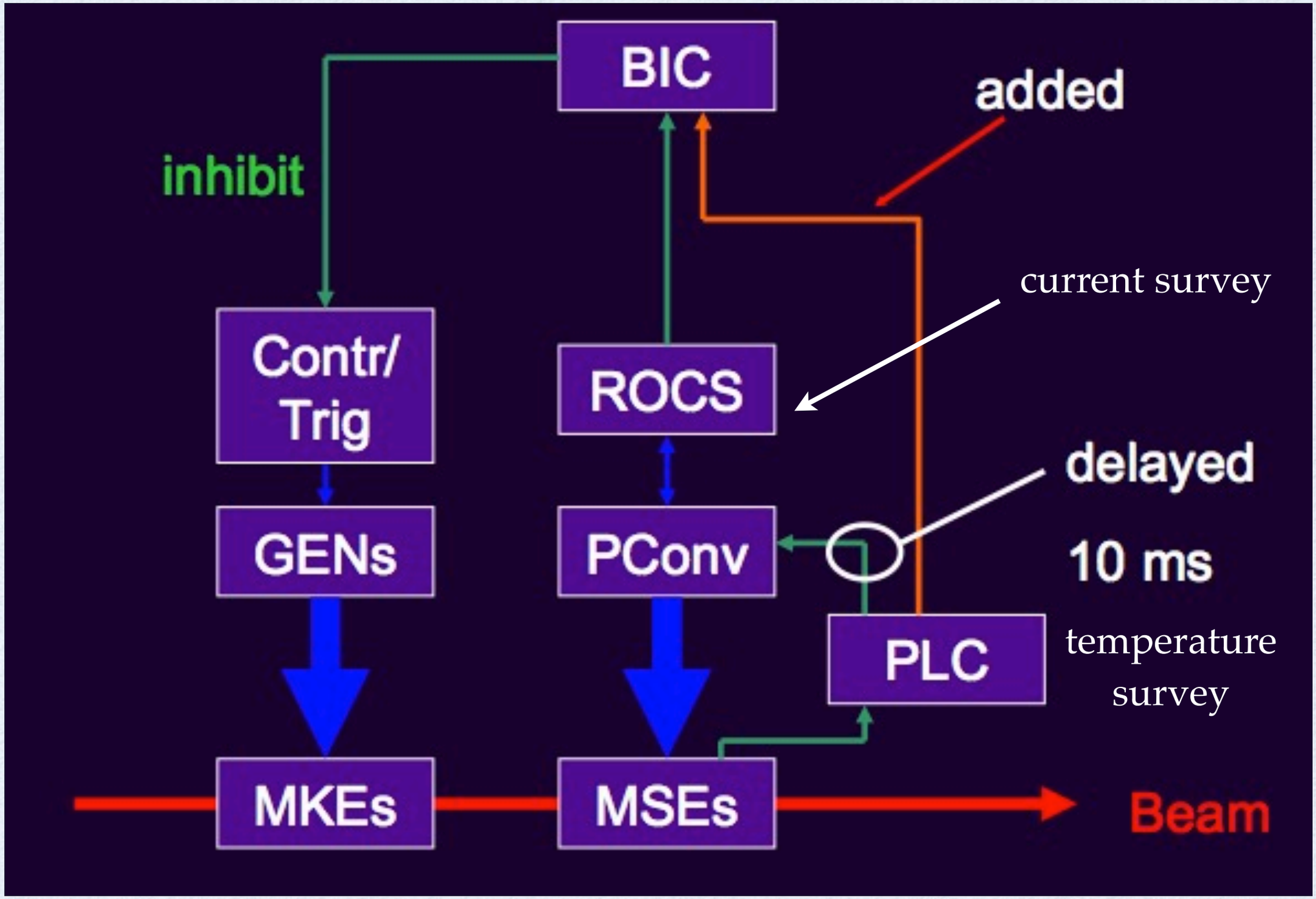
Figure 5. Damage observed on the inside of the vacuum chamber, on the side opposite to the beam impact. Molten material has been projected across the chamber and has condensed in droplets on the other wall.

SOLUTION

There was a whole on the active protection of the system.

Modifications of the interlock system took place

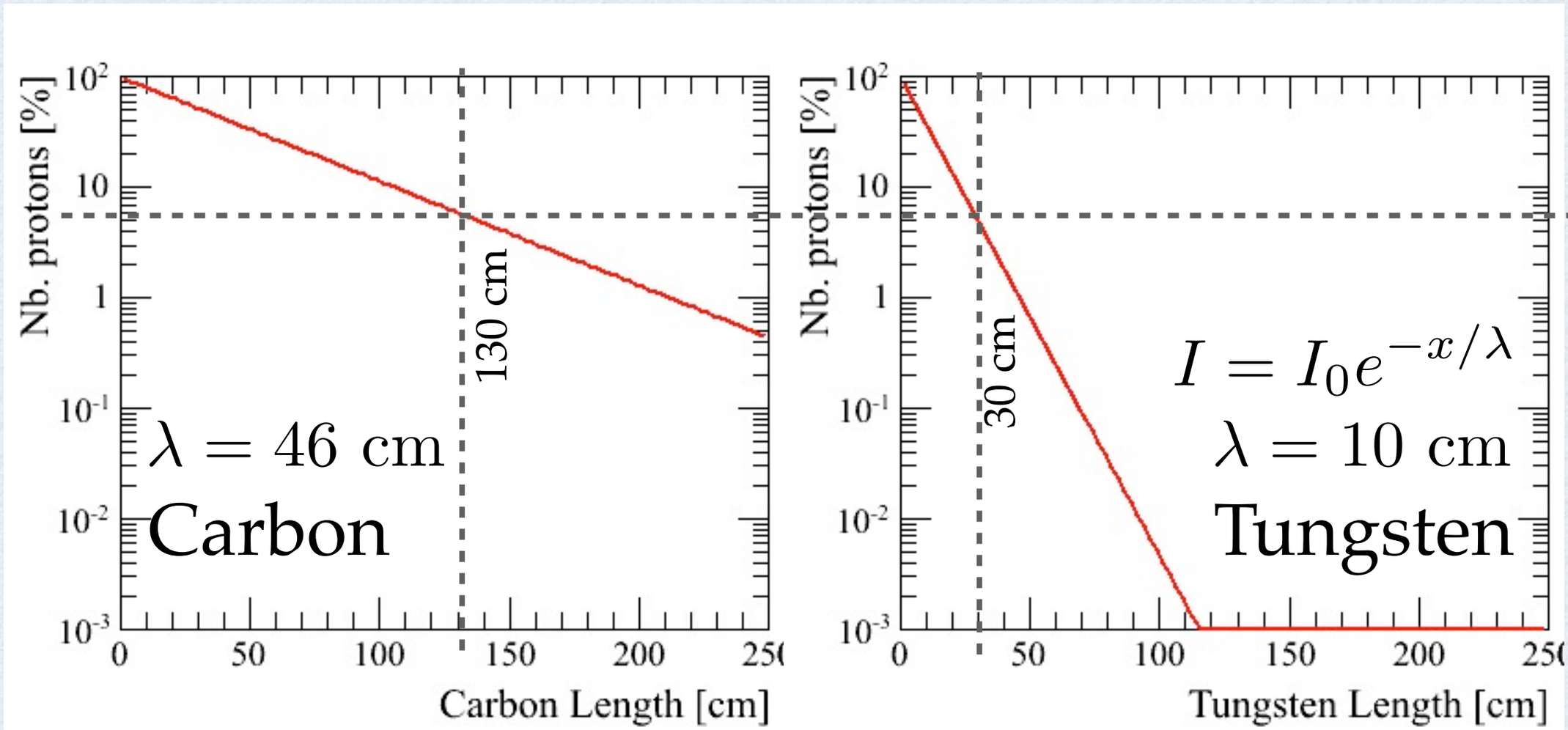
System Commissioning should ensure proper triggering of the extraction inhibit for each interlock input



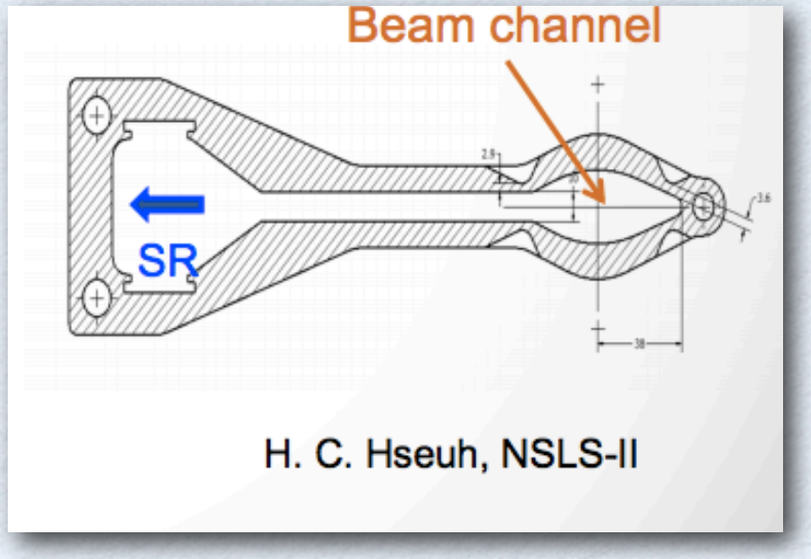
OTHER IDEAS

Adding passive protection after septum

- Max. SPS extraction at 25 ns
  - 288 bunches @ 1.15e11 p ~ 2.4 MJ
- Assuming damage limit: 2e12 p -> 6% of leakage

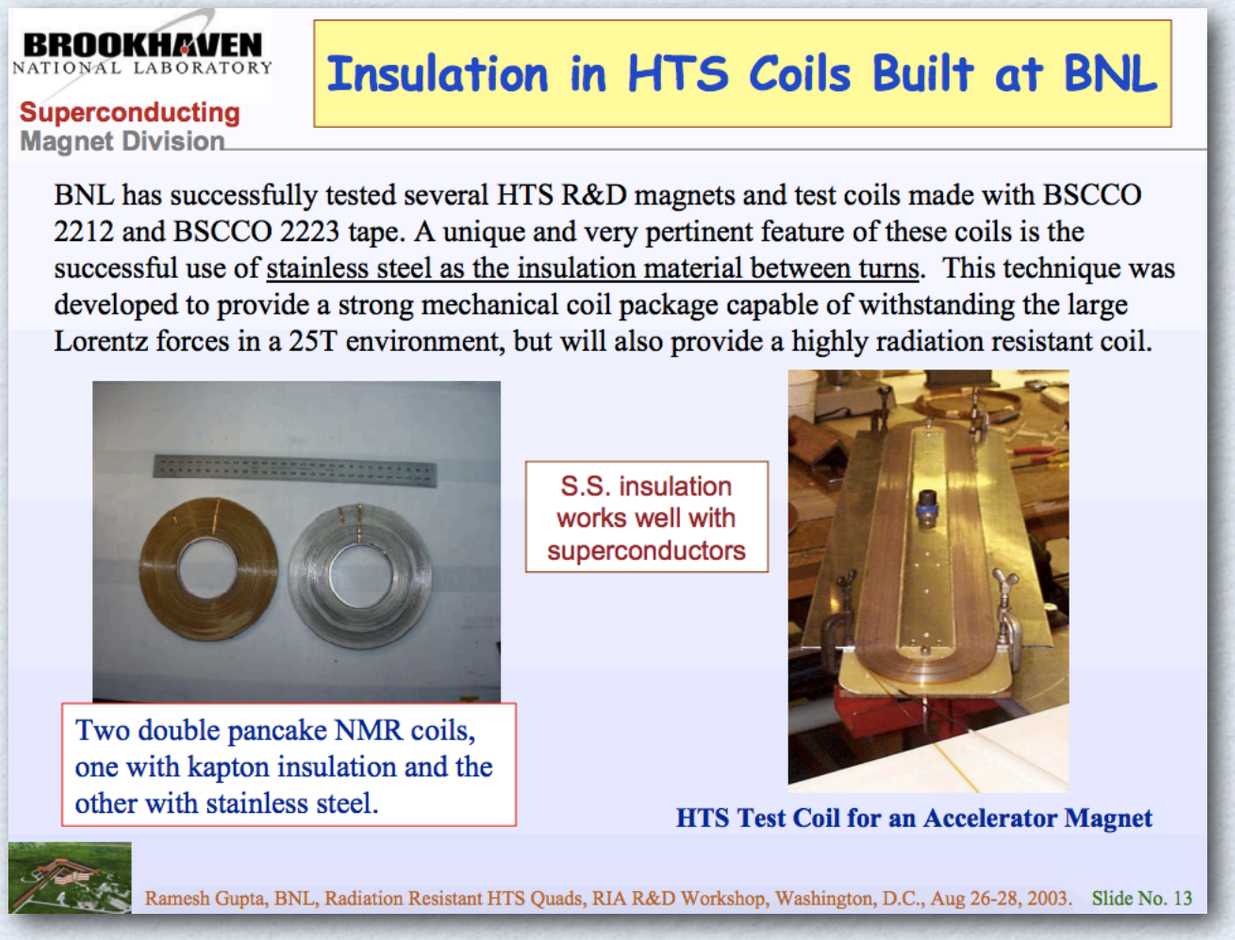


OTHER IDEAS



- Modify the shape of the absorber to match specific needs.
- As example, Antechambers currently used to stop Synchrotron Radiation (nuSTORM).

- Improve robustness of the system: use more resistant magnets so that they survive after this type of incident.



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- http://accelconf.web.cern.ch/accelconf/p05/papers/rppe018.pdf