FLUKA studies: channeled ions on LHC TCSGs @ IP7

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Motivation

To investigate the worst cases of energy deposition on different TCSGs location in IP7, due to channeled ions from crystal foreseen to be installed in Beam1 line in the first preliminary tests after LS1:

- TCSG.B4L7.B1 (h) → in the middle of IR7
- TCSG.6R7.B1 (h) → at the end of IR7
Fluka studied only horizontal losses from the horizontal oriented crystal.

In case of using the TCSG.B4L7.B1 as absorber the downstream coll. @ nom 7TeV aperture to avoid secondary losses on DS area.

In case of using the TCSG.6R7.B1 the downstream TCLAs closed at 10 σ are sufficient to protect the DS area.
SixTrack benchmark w.r.t. data

Screen placed at the Medipix location to evaluate the particle distribution

**SixTrack simulation:**
made for the UA9 layout in the SPS

**Experimental data:**
Profile of the extracted halo on the Medipix

Theoretical position expected of the extracted halo:
8.4 mm and full spot width ~700μm

Many impacting halo distribution tested:
from an average b of <2μm up to 100μm

Spot of channeled beam on absorber determined by: crystal angular acceptance and optics

\[ \Delta x = \Delta \theta \sqrt{\beta_{Cr} \beta_{Abs}} \sin(\Delta \varphi_{Cr - Abs}) \]

Dimension in the orthogonal plane:
“natural” beam size at the Abs. (i.e. only optics)
Fluka Input data (SixTrack)

- Tracking studies with SixTrack performed for protons.
- only the spots were used as input for fluka studies.

Spot on TCSG.6R7.B1
Spot on TCSG.B4L7.B1
Fluka simulations (1/2)

Performed:

- By using $^{208}\text{Pb}^{82}$ @ energy/nucleon 2759 [GeV]
- By impacting ions beams on CFC surface
- By normalizing the results using as data:
  - Cleaning efficiency of 1 $\rightarrow$ we considered the worst case in which all the ions are channeled by the hor. Crystal during the whole lifetime.
  - Beam lifetime of 1 hours and 0.2 hours investigated.
  - Intensity after LS1: $1.8 \times 10^8$ ions each 600 bunches (note that after LS2 a factor 2 more should be considered)

*(Courtesy J. Jowett & M. Schaumann)*
Fluka simulations (2/2)

- By using a detailed TCSG fluka geometry developed by the fluka team.
- Remember that the TCSG has CFC jaws!
- Scoring using binning size properly set, with reference to the spot sizes under study:
  - TCSG.B4L7.B1
    (0.005x0.01x2.2 cm)
  - TCSG.6R7.B1
    (0.01x0.008x1 cm)
Fluka Results (1/3)

Peak power density longitudinal profile into the jaw that intercept the ions spot

![Graph showing peak power density longitudinal profile](image)

- **TCSG.B4L7.B1**
- **TCSG.6L7.B1**

Peak due to a fraction of the beam lost with respect to the 0.2h lifetime considered
Fluka Results (2/3)

Peak power density longitudinal profile into the jaw that intercept the ions spot

TCSG.B4L7.B1
TCSG.6L7.B1

0.2 h beam lifetime
1 h beam lifetime
3 h beam lifetime

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Fluka Results (3/3)

TCSG Power load distribution (ref.0.2h lifetime)

Power deposition results for some components of the most loaded jaw.
Conclusions

The energy deposition values for worst cases were presented for 2 different impact cases on TCSGs. The case of collimation in the horizontal plane has been taken as reference for both planes, during the first feasibility tests.

Results similar to the TCSG.B4L7.B1 case are expected for the vertical case in terms of beam spot size on TCSG.D4L7.B1.

Results show low energy deposition values, but in small volumes. Fluka maps have been provided to the MME team for needed detailed structural analysis.

Local degradation of the CFC material should be evaluated.

Note that in case of orbit errors the peak of energy deposition follows the location of the channeled spot, which is always inside of the TCSG under consideration.