FLUKA studies: channeled ions on LHC TCSGs @ IP7

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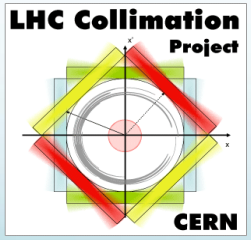

ColUSM#32

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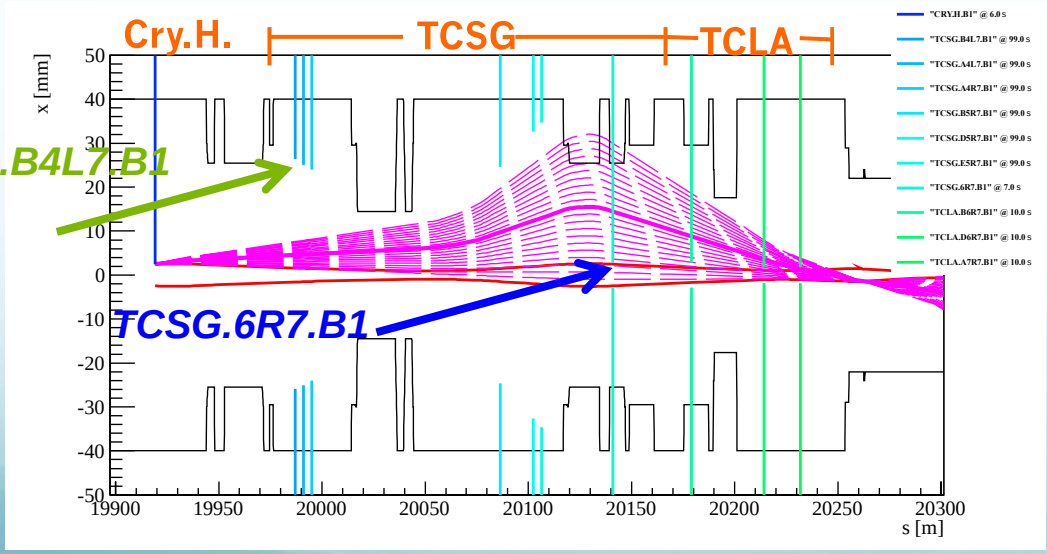
Motivation

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



Color code in the plots

Beam pipe

trajectory of kicked particle at the crystal (from 0 to 100 μrad with steps of 5 μrad)

6 σ beam envelope

Collimator chain aperture

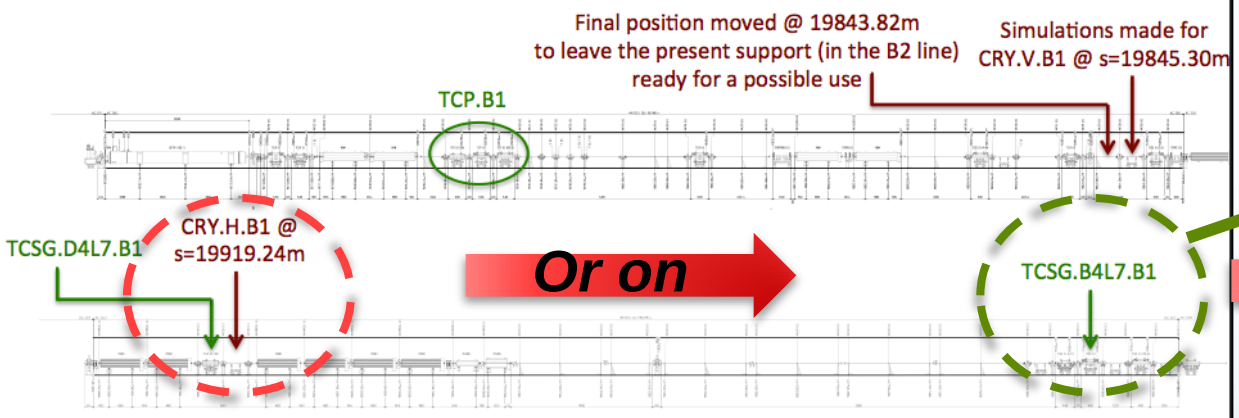
LHC IR7 post LS1

LHC Layout

Main steps to achieve optimum layouts with nominal IR7 optics and minimum impact on standard collimation:

- ✓ Suitable candidates identified with semi-analytical analysis of channeled beam trajectories
- ✓ Conceived set of setting for the whole collimation system (~50 collimators each beam) to achieve MD goals
- ✓ Complete tracking simulations to predict loss maps

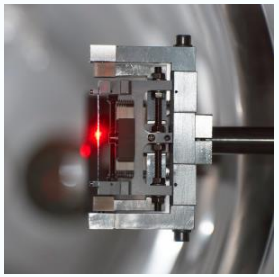
Proposed two positions for installation of H&V crystals on beam1:



04/11/13 UA9 Collaboration Meeting 6

Presented by D. Mirarchi at the UA9 Collaboration Meeting (5-7 November 2013)

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.

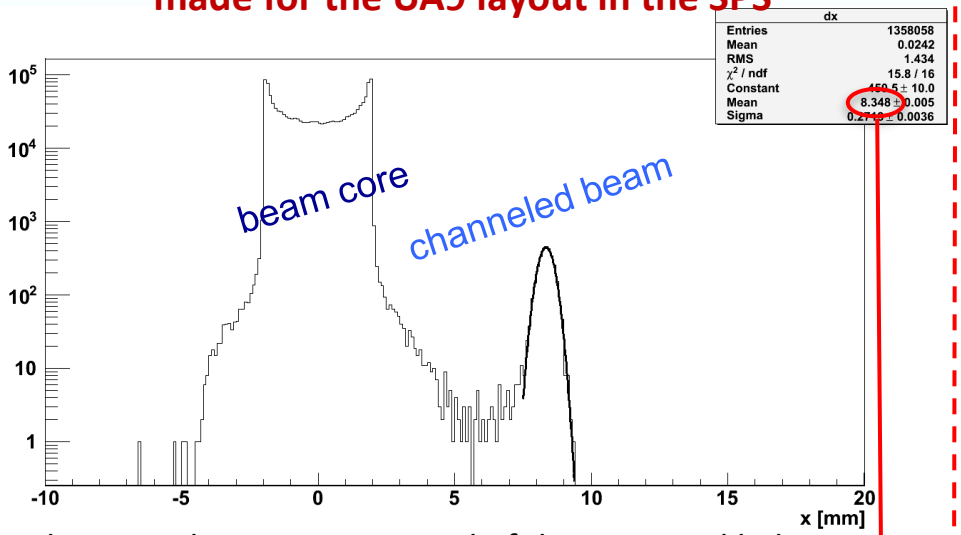
Or on **TCSG.6R7.B1**

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



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

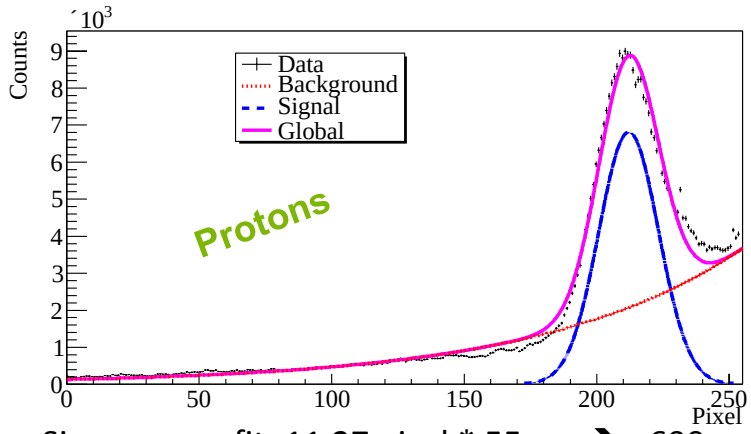
Many impacting halo distribution tested:
from an average b of <2µm up to 100µm

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

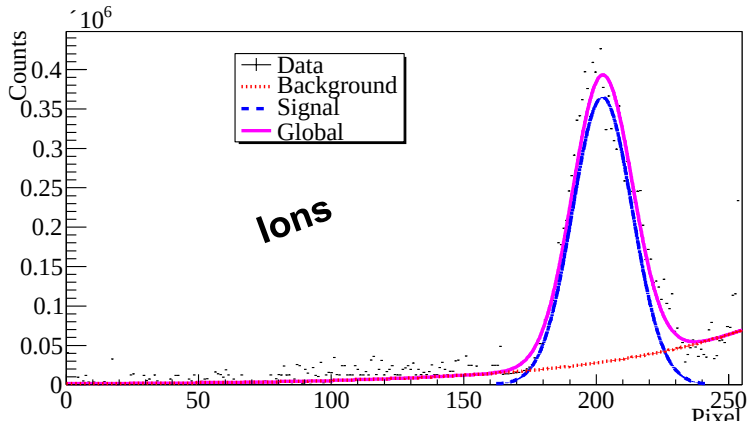
$$\Delta x = \Delta\theta\sqrt{\beta_{Cr}\beta_{Abs}}\,\sin\left(\Delta\varphi_{Cr-Abs}\right)$$

Dimension in the orthogonal plane:
"natural" beam size at the Abs. (i.e. only optics)

Experimental data:
Profile of the extracted halo on the Medipix

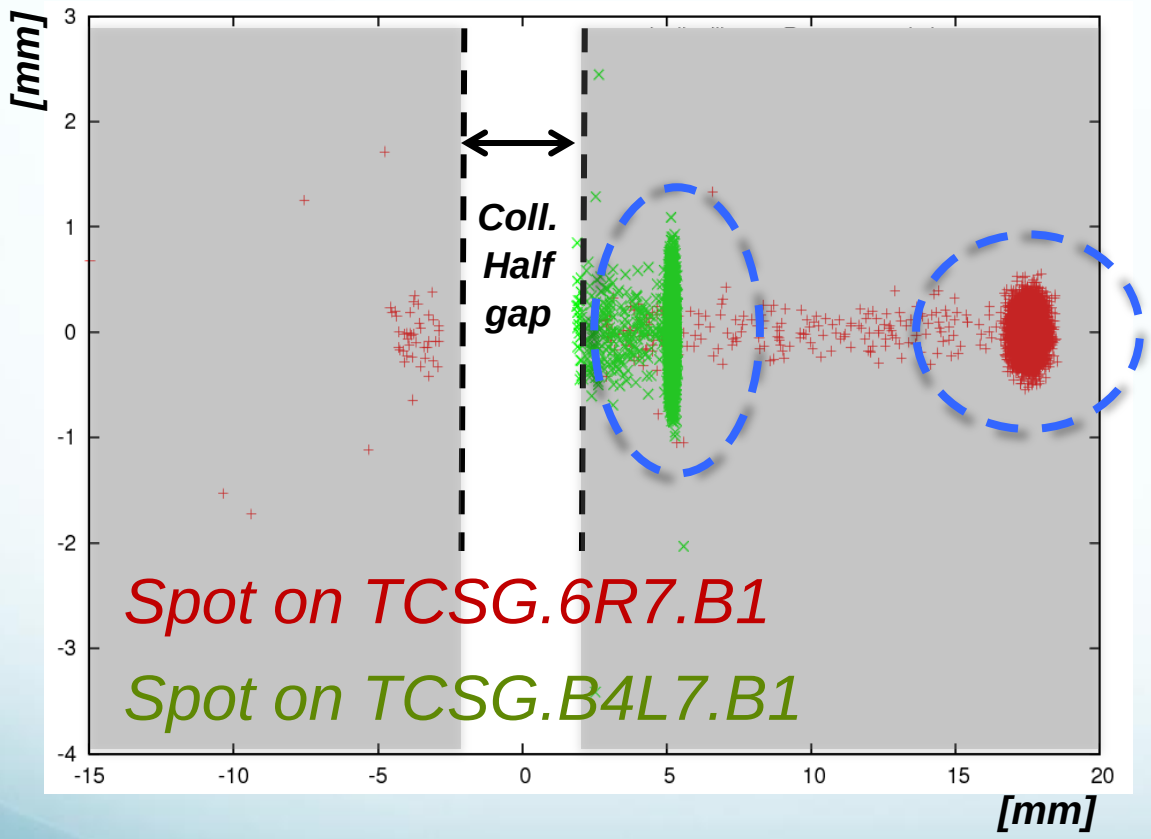


Sigma gauss fit~11.27 pixel * 55µm ➔ ~600µm



Sigma gauss fit~11.30 pixel * 55µm ➔ ~600µm

Fluka Input data (SixTrack)



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

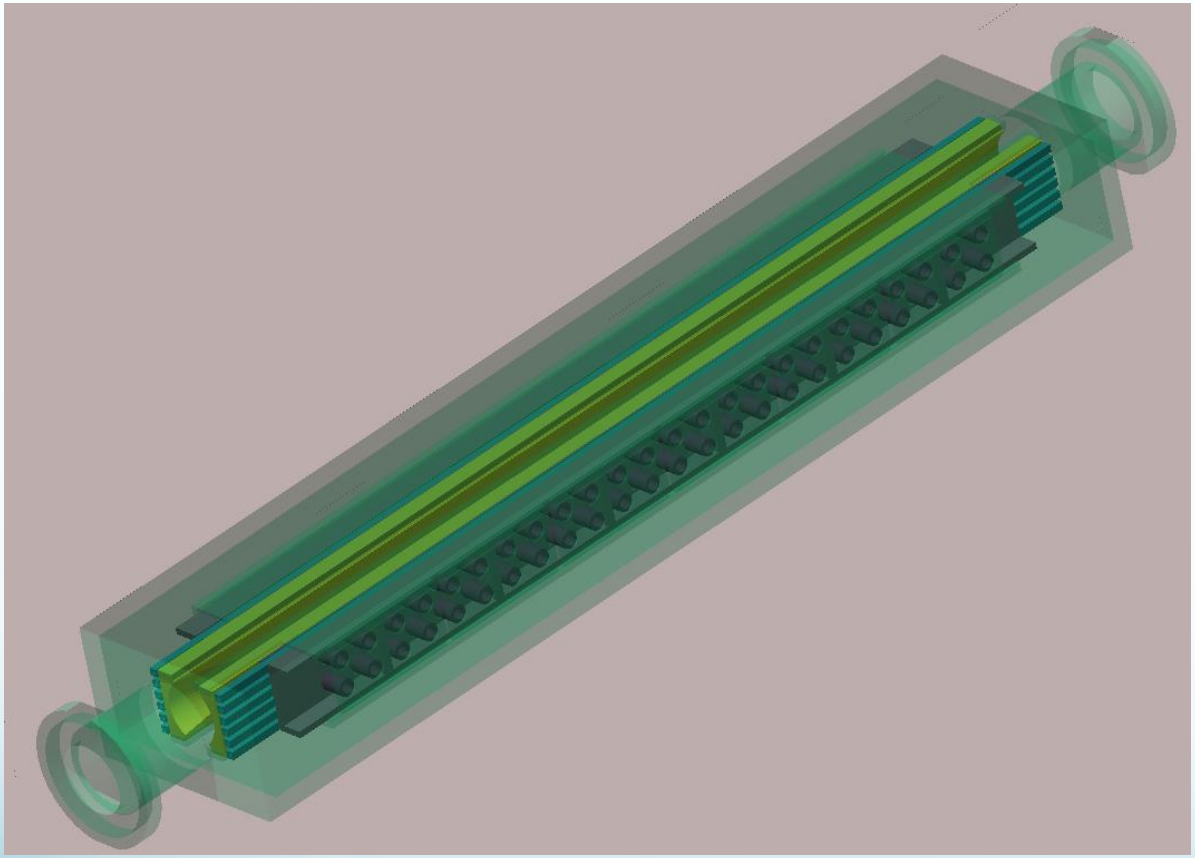
Fluka simulations (1/2)

Performed:

- By using $^{208}Pb^{82}$ @ energy/nucleon 2759 [GeV]
- By impacting ions beams on CFC surface
- By normalizing the results using as data:
  - Cleaning efficiency of 1 → 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: 1.8×10^8 ions each 600 bunches (note that after LS2 a factor 2 more should be considered)

(Courtesy J. Jowett & M. Schaumann)

Fluka simulations (2/2)



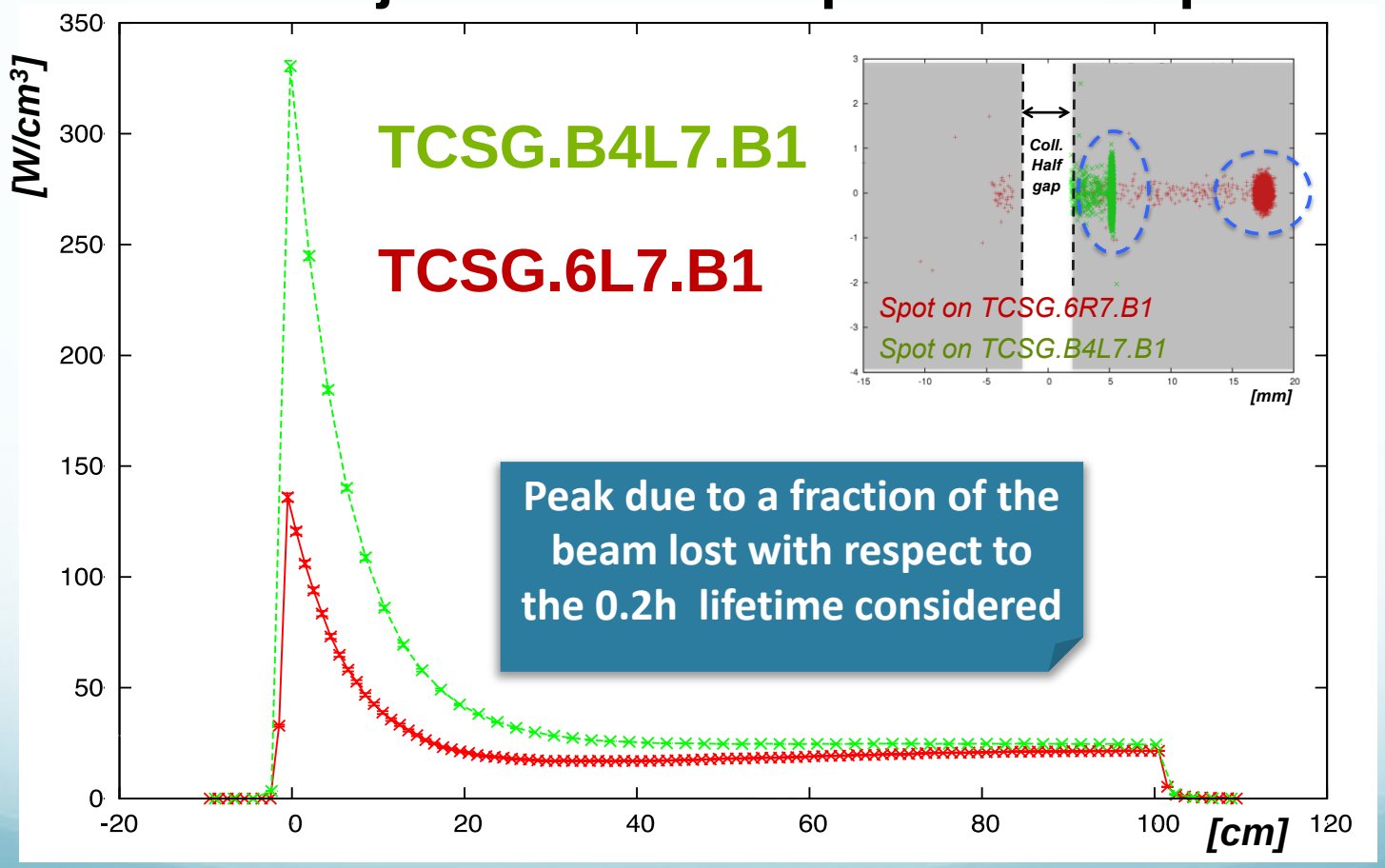
- By using a detailed TCSG fluka geometry developed by the fluka team.
- Remember that the TCSG has CFC jaws!
- Scoring using binning size properly set, with reference to the spot sizes under study:

TCSG.B4L7.B1
(0.005x0.01x2.2 cm)

TCSG.6R7.B1
(0.01x0.008x1 cm)

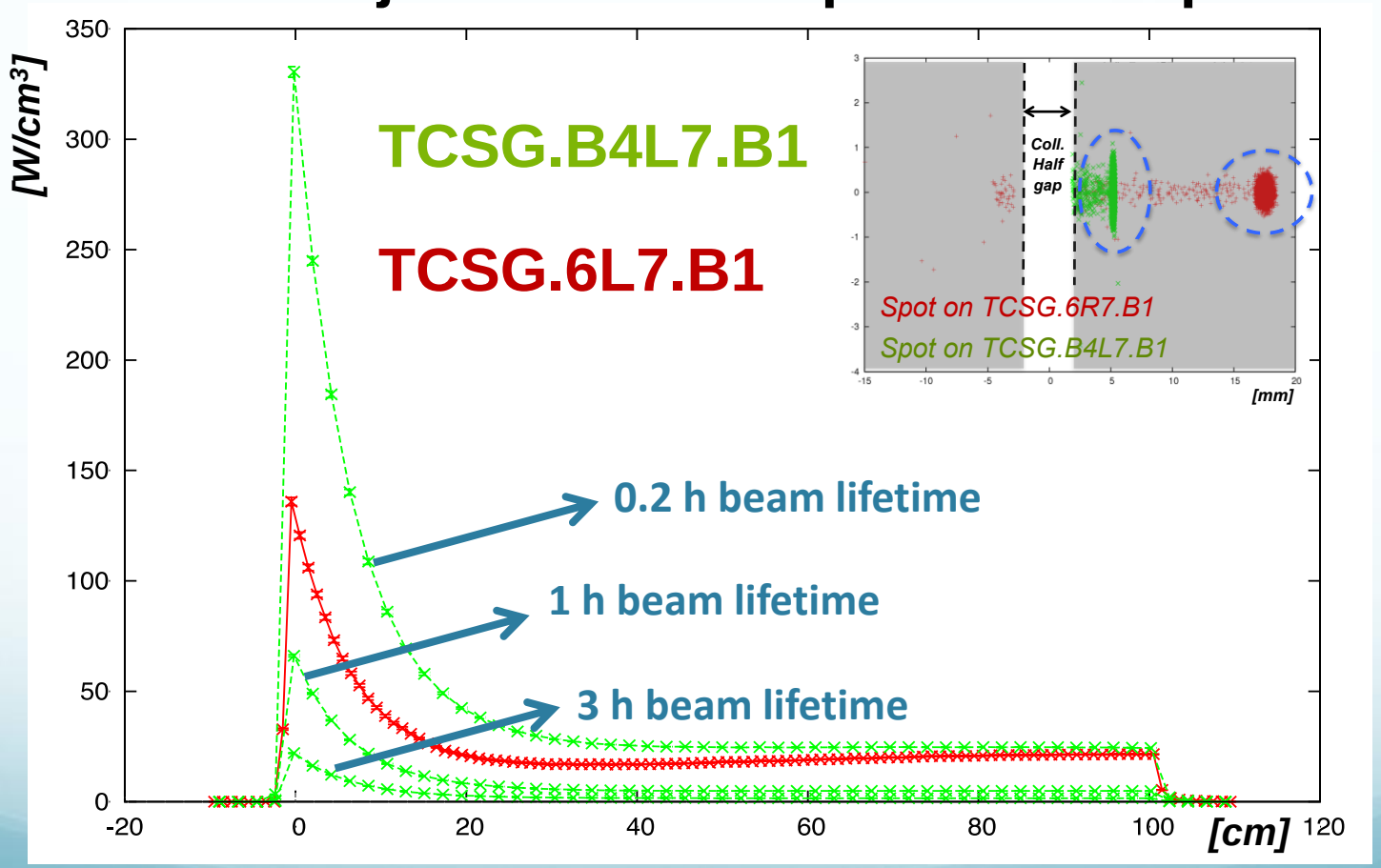
Fluka Results (1/3)

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



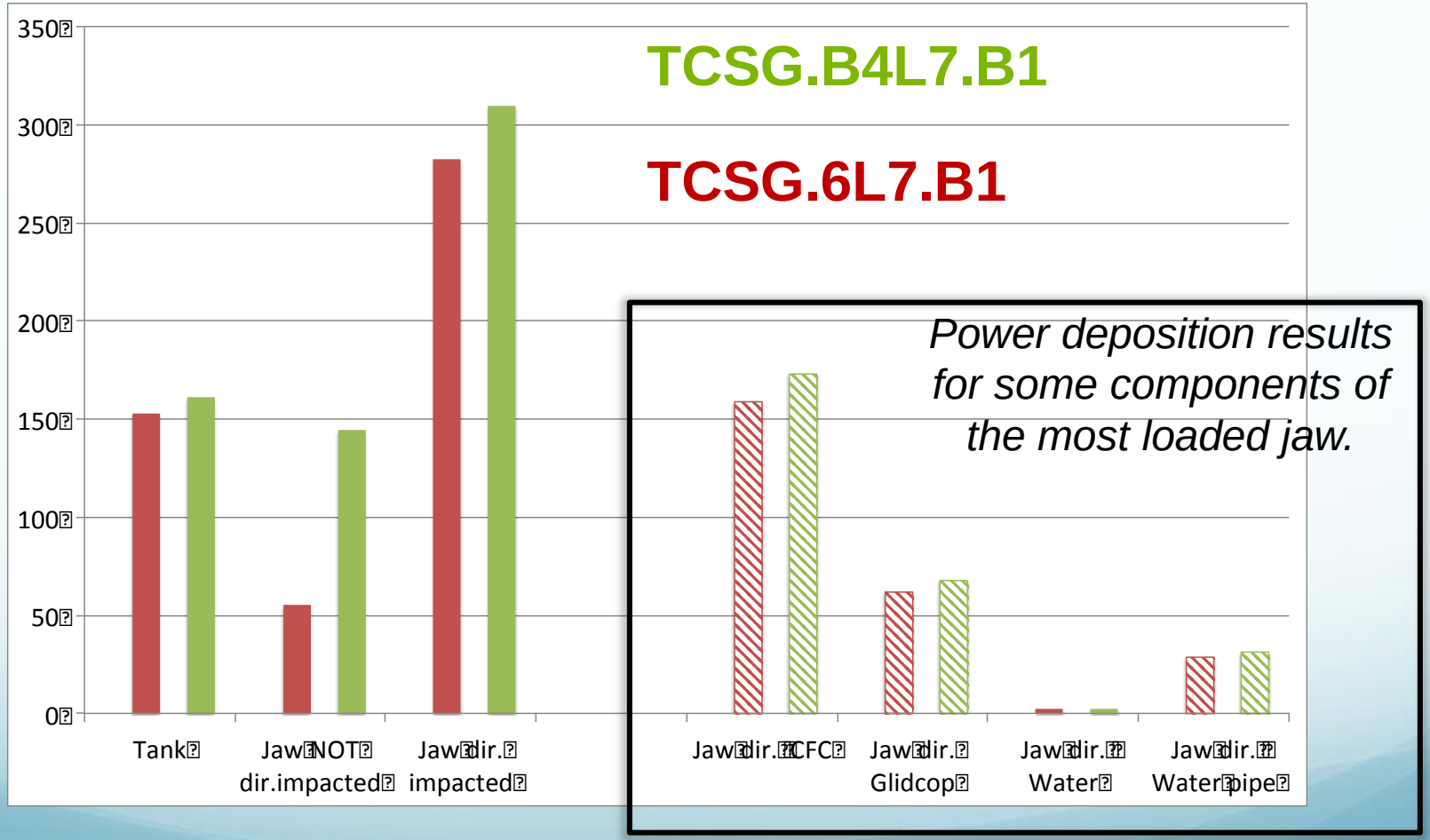
Fluka Results (2/3)

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



Fluka Results (3/3)

TCSG Power load distribution (ref.0.2h lifetime)



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.