FLUKA studies of UFO-induced beam losses in the LHC

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Introduction

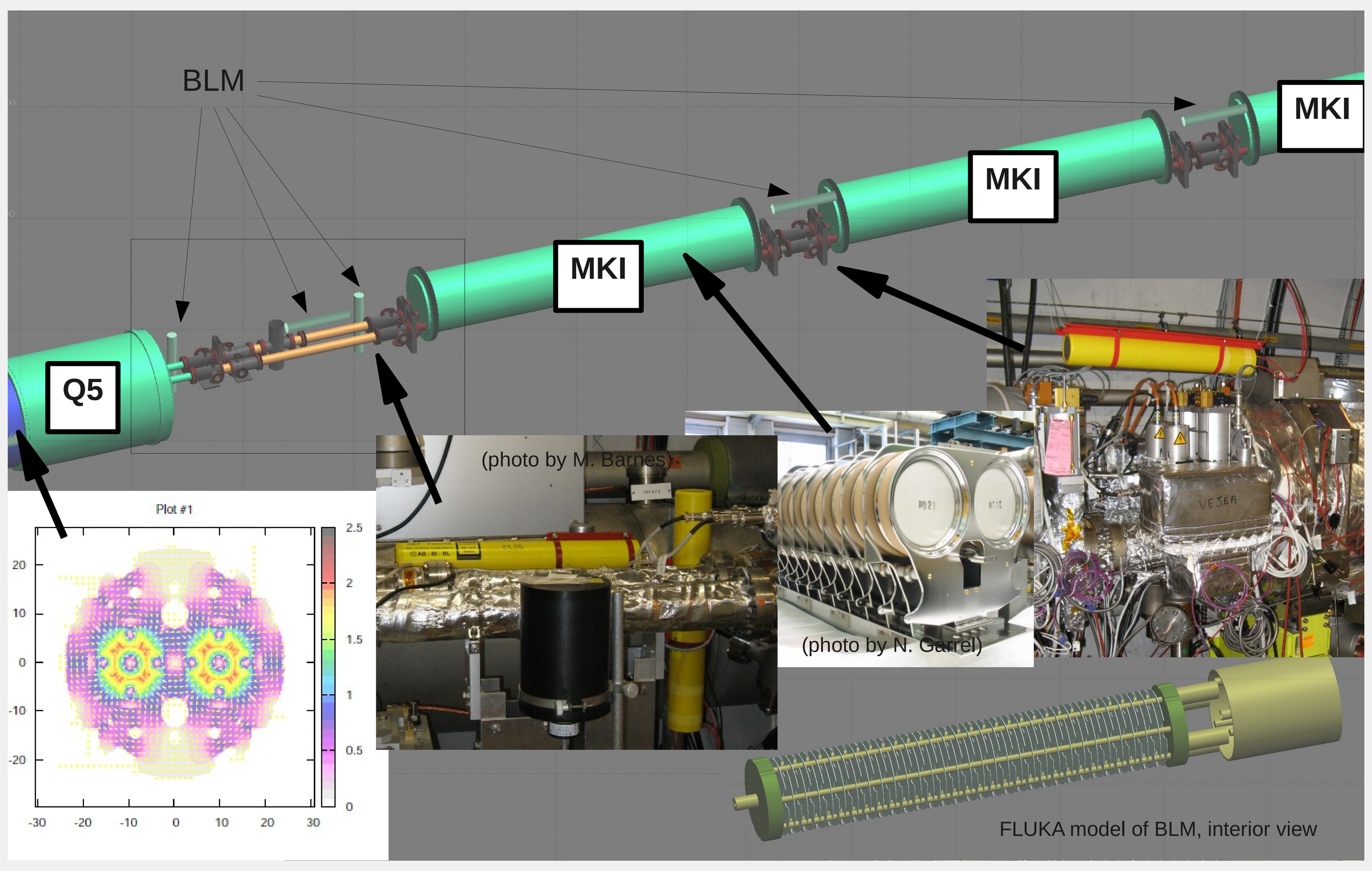
Beam losses due to proton interactions with micrometer-sized objects of yet unknown origin - commonly referred to as Unidentified Falling Objects (UFOs) - have caused notable perturbations in the past operation of the LHC [1]. A significant number of UFOs has been observed in the proximity of LHC injection kickers left of P2.

To gain a better understanding of UFO-induced losses at current and future LHC energies, corresponding shower propagation studies were performed by means of the FLUKA code [2, 3]. Simulation predictions of dose deposition in Beam Loss Monitors (BLM) were compared against measurements along the most impacted magnet string comprising MKI kickers and superconducting magnets (Q4 and D2). In addition, beam line elements (e.g. Q5) and loss monitors upstream of the assumed UFO location were included to study backscattering.

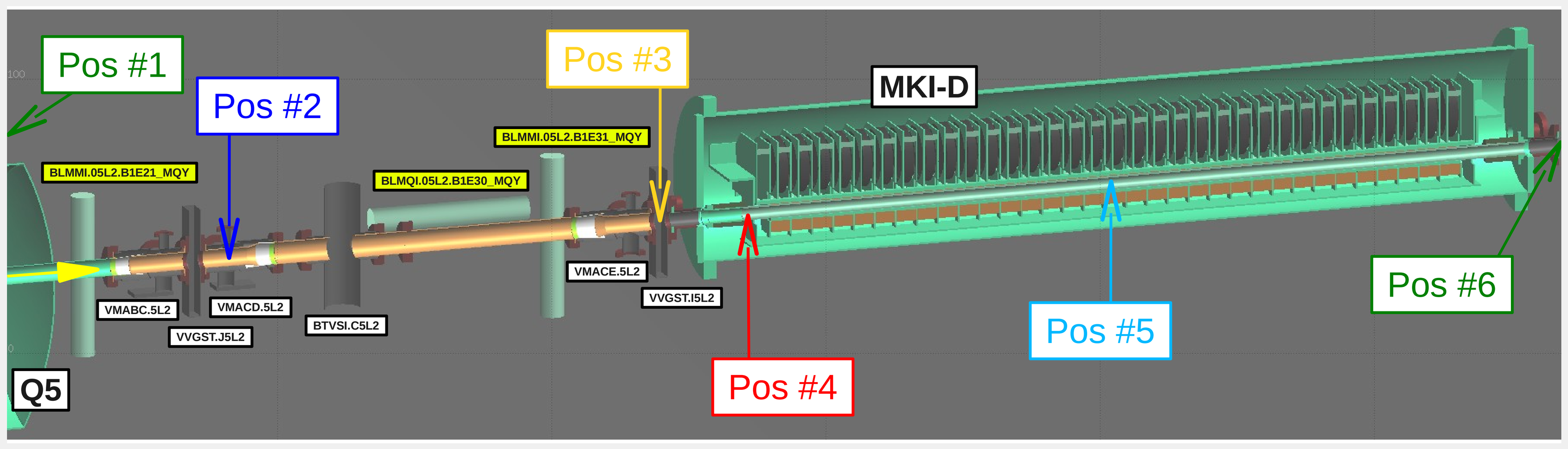
Here, obtained results are presented, attempting to narrow down the actual position of UFOs in the concerned region. In addition, simulation predictions of the peak energy density in magnet coils are given for proton-UFO interactions at 450 GeV, 3.5 TeV and 7 TeV.

The simulations complement ongoing analysis activities of UFO events at the LHC [1].

FLUKA geometry implementation



Impact of UFO location on BLM pattern for protons at 3.5 TeV

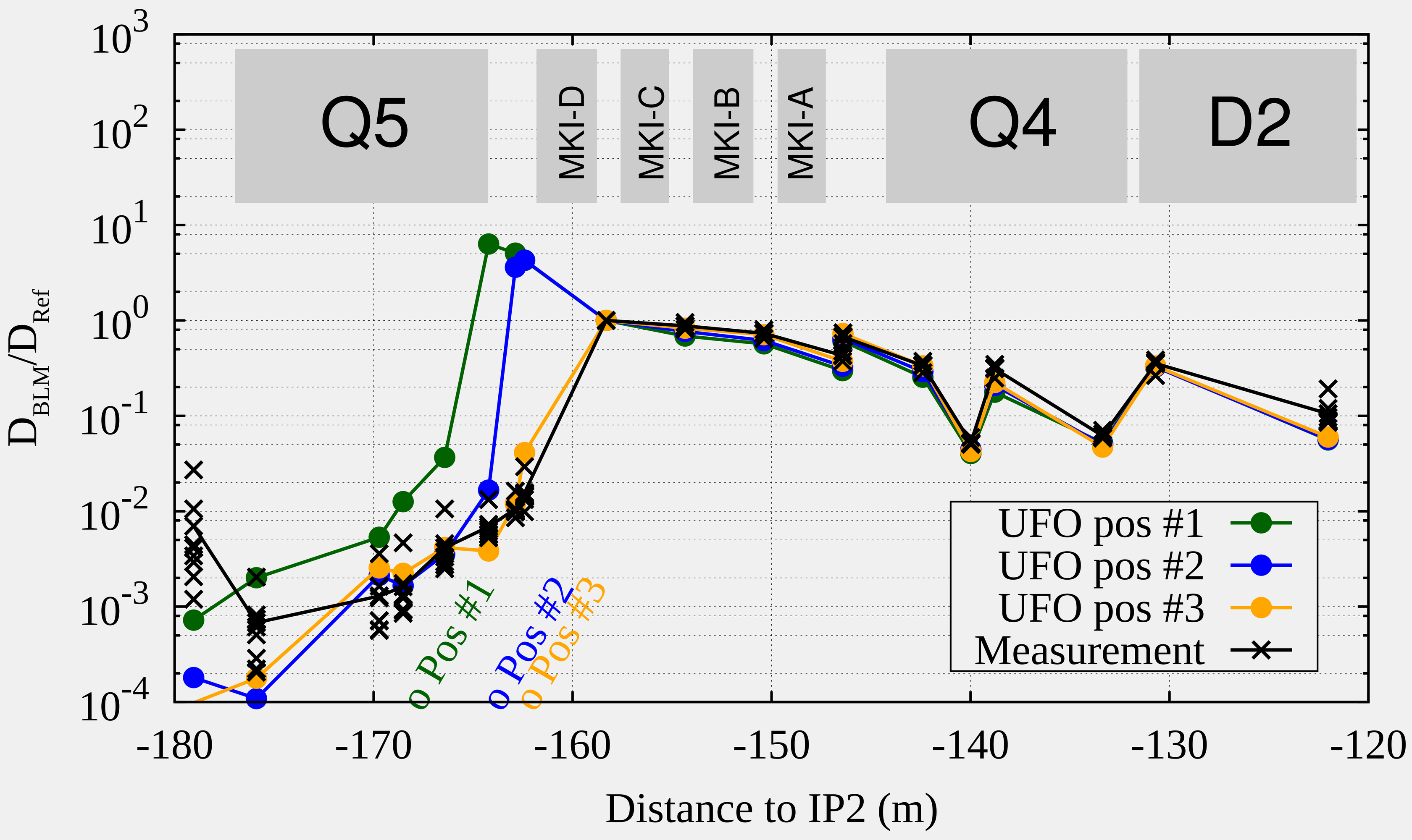


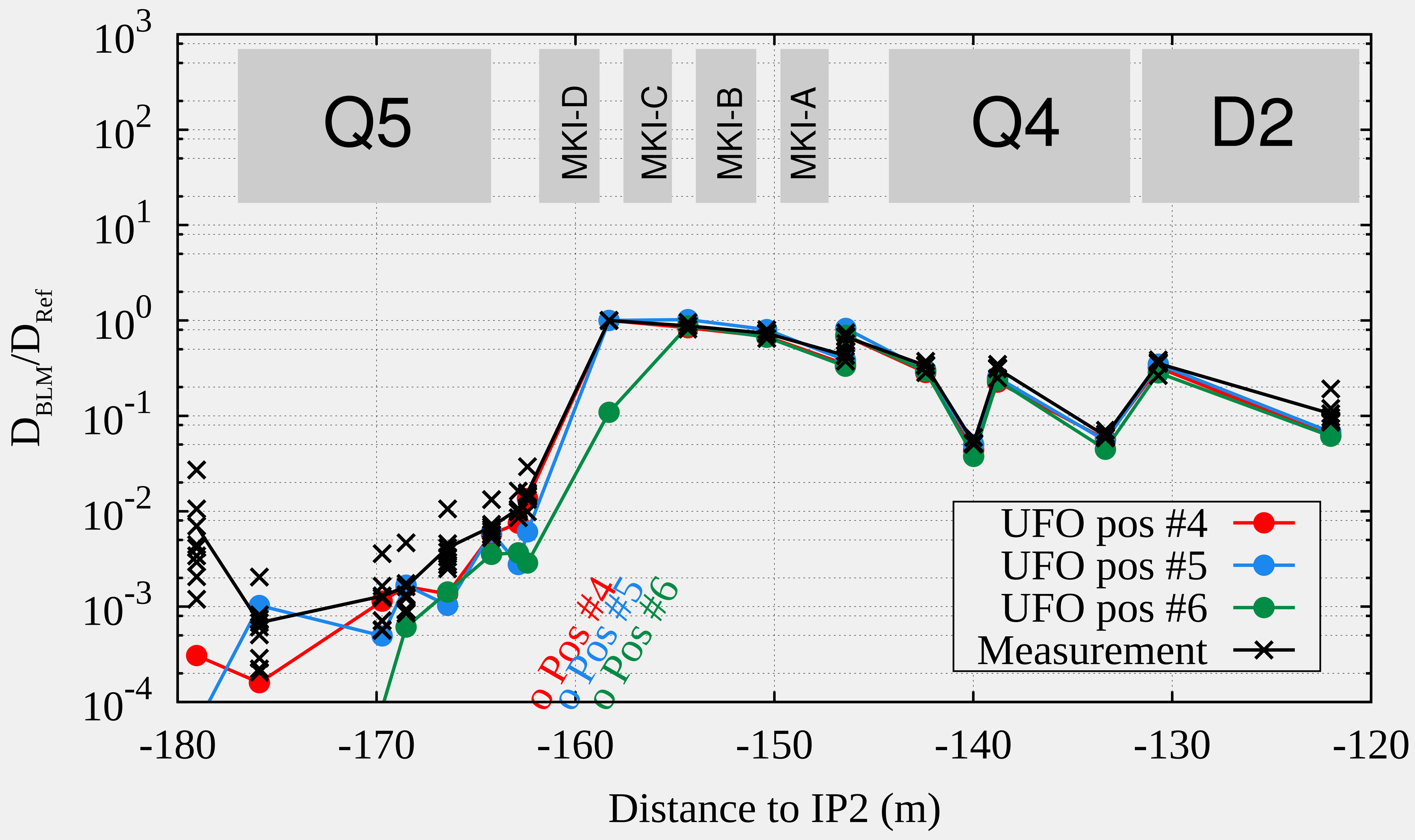
The figures present a comparison of calculated dose values against a set of representative UFO-induced BLM pattern measured in July/August 2011. Simulations were performed for a series of possible UFO locations, including positions inside the Q5, between the Q5 and the MKI-D, as well as inside and downstream the MKI-D.

The results show that UFOs are likely to originate from within the MKI-D (or the vacuum valve in front of the MKI-D), while potential UFO locations significantly upstream (e.g. inside the Q5) or downstream of the kicker could be excluded.

The simulation confirms that measured BLM dose values upstream of the MKI-D are caused by backscattered particles.

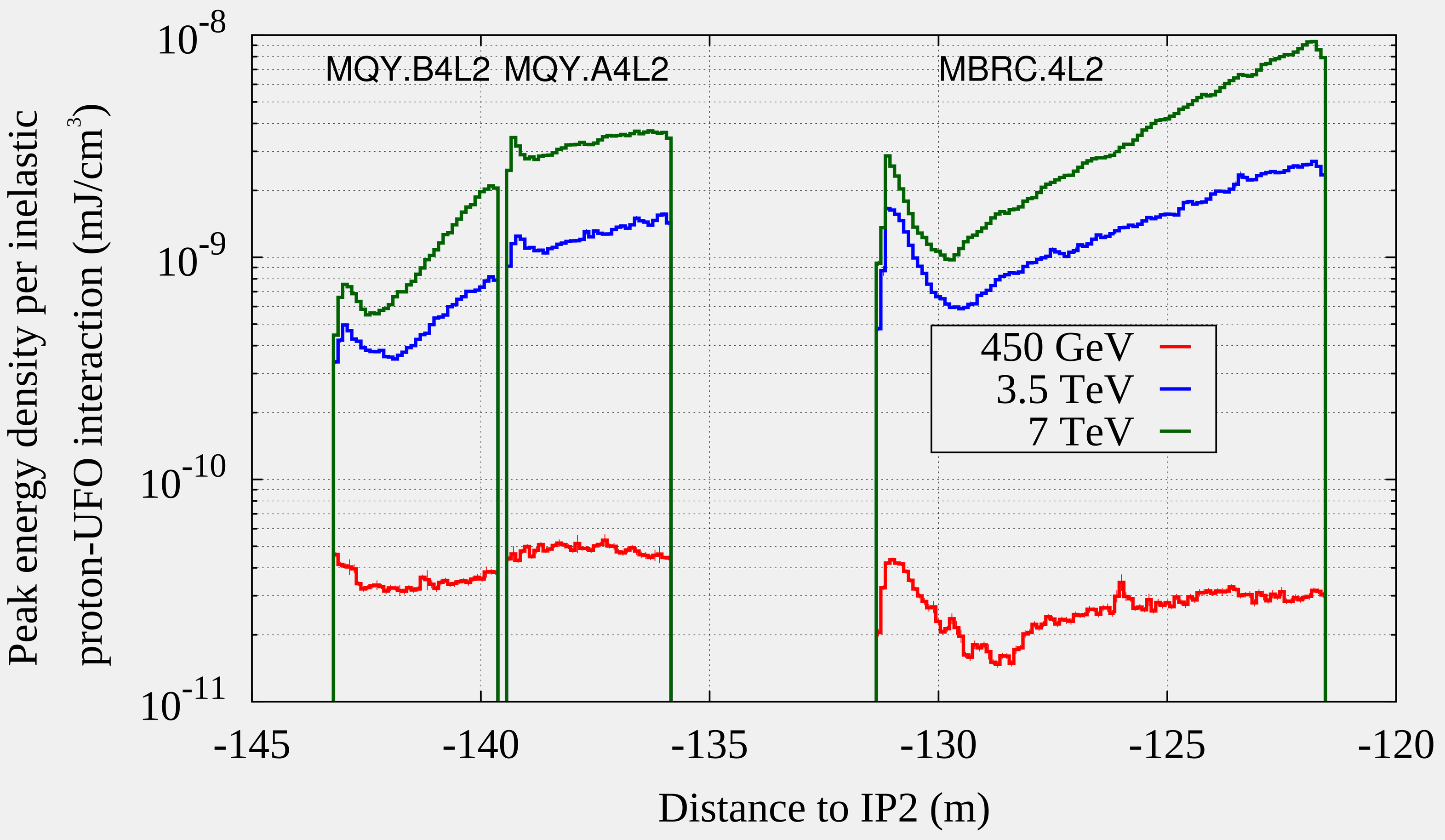
All measurement data by courtesy of the CERN-BLM team.





Comparison of UFO-induced losses at 450 GeV, 3.5 TeV and 7 TeV

Calculated peak energy density in Q4 and D2 magnet coils per inelastic proton–UFO interaction (assuming UFO to be located in MKI-D):



Considering a given number of inelastic proton–UFO interactions, the simulation predicts a peak energy density in the D2 which is more than 3 times higher at 7 TeV than at 3.5 TeV

Summary & Conclusions

FLUKA simulations of the BLM response in proximity of the LHC injection kickers (in IR2) were performed, aiming at a better understanding of losses caused by proton–UFO interactions.

The expected UFO location around the MKI-D kicker magnet has been quite well confirmed, while potential locations significantly upstream of the MKI-D could be excluded. Similarly, potential UFO locations in the MKI-D and -C interconnect are less likely.

Complementary studies of the peak energy density in coils of Q4 and D2 magnets suggest that values are more than 2–3 times higher at 7 TeV than at 3.5 TeV.

Acknowledgement

Valuable input by T. Baer and M. Barnes is gratefully acknowledged

References

[1] T Baer, M Barnes, B Goddard, E B Holzer, J M Jimenez, A Lechner, V Mertens, E Nebot Del Busto, A Nordt, J Uythoven, B Velghe, J Wenninger, and F Zimmermann, "UFOs in the LHC", 2nd International Particle Accelerator Conference - IPAC 2011.

[2] G Battistoni, F Cerutti, A Fassò, A Ferrari, S Muraro, J Ranft, S Roesler, and P R Sala, "The FLUKA code: description and benchmarking", In M Albrow and R Raja, editors, *Proceedings of the Hadronic Shower Simulation Workshop 2006*, volume 896, pages 31–49, 2007.

[3] A Fassò, A Ferrari, J Ranft, and P R Sala, "FLUKA: a multi-particle transport code", CERN-2005-10 and INFN/TC-05/11 and SLAC-R-773, 2005.

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