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FLUKA simulations of the radiation environment at the CMS detector at the LHC

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FLUKA is used in the Beam Radiation Instrumentation and Luminosity project (BRIL) of CMS to simulate the radiation levels due to proton-proton collisions. Results are used by the whole CMS collaboration for various applications: Comparison with detector hit rates, pile-up studies, predictions of radiation damage based on various models (Dose, NIEL, DPA), shielding design, estimations of residual dose environment etc.

For specific needs, additional programs were developed, of which some will be shown.

A python based web plotting framework was developed to share FLUKA results of common interest with collaborators. Users can select plotting options on a website and create 2D flux and dose maps. Binary USRBIN result files are loaded by the web server and visualized using Matplotlib. The plotting code is specialized for the needs of CMS, but the concept can be generalized and could be of interest for other collaborations, where FLUKA results are shared.

The built-in FLUKA one-step method for simulating residual dose environment due to activation is heavily used. However, this method does not allow a geometry modification in between the prompt and the decay step (except for the removal of elements). During interventions in the central parts of CMS, the detector is brought into an open configuration. A two-step simulation framework was developed, where in a prompt step the creation of radioactive isotopes are simulated in a closed scenario. A manipulation of the geometry can then be performed using a graphical user interface, where the list of isotopes is modified according to the geometry modifications. The modifications include the moving of elements, the removal of elements, and the installation of additional elements like shielding. In a second simulation step of the modified geometry, the decay radiation is simulated to obtain the residual dose environment in the opening scenario. The concepts of this method could be of !
interest for any simulations of residual dose environments, where elements are moved, or where shielding is installed after irradiation.

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