FLUKA Simulations of the FAIR HEBT System: Optimization of the Safety Beam Plugs (Diffusors)

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The complex High Energy Beam Transport (HEBT) system of FAIR allows for parallel user operation with different beams. To ensure safe operation the installation of safety beam plugs ('diffusors') is foreseen. These are mobile blocks to be used in case of an emergency situation to intercept an unwanted beam and thereby reduce the radiation level in the neighbouring areas accessible by personnel during normal operation. This provides redundancy to interlock magnets. FLUKA studies have been performed for accidental scenarios with such diffusors (named 'Dnn'), individually for D20, D23, D22 and D14, assessing the resulting radiation level and optimizing the diffusor lengths and material.

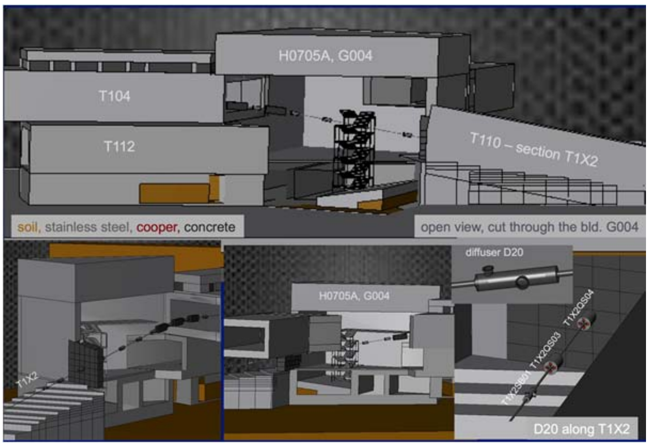

Figure 1: FLUKA geometry of bld. G004 with the diffusor D20 along the sloped beam line T1X2.

To obtain realistic radiation fields, precise modelling of the geometry of the HEBT system over extended regions was required. This includes the complex building G004 with the sloped beam line T1X2 from SIS100 along the tunnel T110 (extraction region) and the complete tunnels T104, T112 (Fig.1), and the tunnel T113 with the beam lines TAP1, TSN1, TAP2, TXL3, TPP1, TPP2 (Fig.2 left). The right part of Fig.2 indicates the two modelled regions with the two shaded areas (upper for Fig.1).

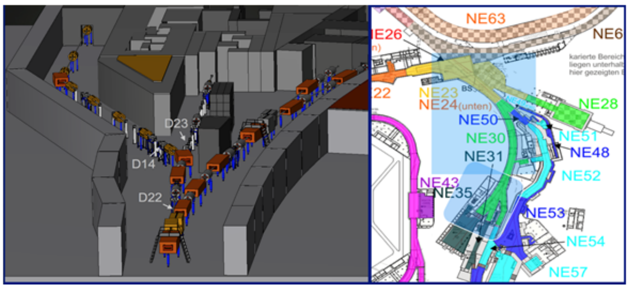

Figure 2: FLUKA geometry of the last section of the tunnel T113 with the diffusors D23, D22 and D14 (left).

The results of the effective dose distribution from a SIS100 proton beam with an intensity of 2.5×10^{13}p at E_k=29 GeV hitting the diffusors D20 and D23 (made of iron) are shown in Figs.3 and 4, resp. It is found that for an accidental scenario with D20 a diffusor length of 20 cm would be optimal. This would lead to effective doses <1μSv at the surface level of bld. G017 (areas NE25 and NE26), allowing for 10 shots per year, and <<1mSv in the areas of NE30 and NE50, allowing for open access to these areas. The length of the diffusors D23, D22 and D14 placed in the last section of the tunnel T113 was optimized to keep the access to the areas NE31, NE35 (antiproton target area and experimental caves) and NE53.

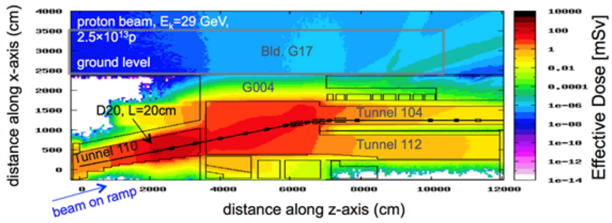

Figure 3: Effective dose for one beam pulse hitting the diffusor D20 placed along the sloped beam line T1X2.

For accidental scenarios with the diffusor D23 where a beam meant to be transported to the APPA cave accidentally was directed to the pbar target area, a minimum length of 40 cm iron would be required to keep the access to all neighbouring areas, while 20 cm would be sufficient for D22 and D14. The replacement of 40cm iron by 20cm tantalum would assure the same length for all diffusors. In the future, two more diffusors, D12 and D13 (intercepting the SIS18 beam) will have to be studied before concluding on the final specification of the material and dimensions of the diffusors and their chambers.

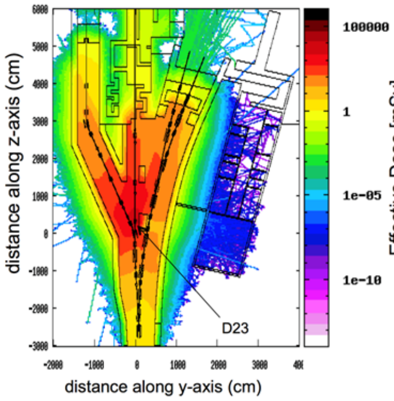

Figure 4: Effective dose for accidental scenario with D23.

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