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Beam spectroscopy and monitoring at particle accelerators

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Beam monitoring is vital for current particle accelerators. High currents and/or energy of the beams transported means that they have a high potential for damage from several mechanisms: radiation dose, single event upsets, electronic or even physical damage. Examples of the various aspects that this might take on are the subject of this contribution. Throughout this presentation, a few of these aspects are demonstrated by detailed examples of the equipment and techniques that are presently used, with a bias towards the Large Hadron Collider for examples.

Interlocks based upon beam monitoring play an important role in limiting the possibility of serious damage to equipment. The role of particle type and spectra are important factors in determining safety levels when monitoring measurements are typically of particle flux or rate of energy deposited.

Beam monitoring also has a role in both determining that the beam is transported correctly and cleanly and in feedback so that corrections can be made to optimize beam transport. Monitoring here takes several forms; measuring beam position/timing, flux of losses, as well as more advanced techniques aimed at determining the energies and particle types of losses. Maximising the "luminosity", the "deliverable" of the accelerator, is another important function that monitoring plays.

Another essential aspect in understanding this complex environment at modern accelerators is detailed and well-qualified simulations. The simulation is essential for both the design of the accelerators as well as for understanding the bigger picture given the necessarily incomplete measurements from diagnostic measurements. An outline of how state of the art codes can be used is given, along with an example of how the simulation is qualified and subsequently leads to understanding the underlying mechanism for losses. In particular, it is often the simulation that gives true clarity as to the energy and particle spectra.

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