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### **Imaging in particle therapy**

Medical Imaging can play a relevant role in particle therapy. The use of proton and ion beams to treat cancer, with the advantage of energy release mostly at the end of range in the very narrow Bragg peak, requires very high precision on the particle range.

Overshooting and undershooting, related to several possible effects, would respectively cause unwanted damage to healthy tissues besides the tumour and undertreatment of part of the tumour.

The measurement of particle range can be performed in a passive mode, by detecting the products of nuclear interaction-related effects of the therapeutic beam: prompt photons from nuclear de-excitation, charged particles and  $\beta^+$ -decaying nuclei from beam-tissue interactions. The selected detectors are photon cameras, particle trackers and PET, respectively.

Each of these approaches provides advantages and disadvantages, which are presented while reviewing recent developments in range measurement.

The ultimate goal, now getting closer, is online range monitoring, which would provide the capability to stop treatments before serious damage is caused.