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Thermal Simulations of a Proton CT Calorimeter Detector

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The development of a proton computed tomography (pCT) detector is motivated by proton therapy, which is a novel treatment against cancer, based on the cell-killing effect of proton radiation. The planning of this treatment requires the 3D Relative Stopping Power (RSP) map of the patient, which is converted from Hounsfield Units, measured by X-ray computed tomography (X-ray CT). This conversion increases the uncertainty of RSP values, which can be avoided, by direct imaging with protons, called pCT.

The Bergen pCT Collaboration was established to develop a prototype proton CT system, which overcomes the main limitation of nowaday systems, as data taking speed. This detector will be built of alternating sensitive and absorber layers. The sensitive layers are built of silicon pixel detectors and measure the deposited energy in their material. A Bragg-curve is fitted into these energy deposits, which gives an accurate enough measurement of incoming proton energy for pCT imaging.

This presentation demonstrates the thermal simulations of this detector. The main task of the cooling system is to transfer away the 1.4 kW heat generated by the silicon pixel detectors and ensure a homogeneous temperature distribution inside the sensitive area without components, which would impair the homogenous material budget of the same area, so only external components are allowed. This presentation shows the comparison of two cooling concepts, and the more accurate modelling one of theme, including the investigation of the effect of the contact resistances and inhomogenous loads.

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