Contribution ID: **39** Type: **not specified**

The Camera Alignment System for the Mu3e Experiment

The Mu3e experiment under construction at the Paul Scherrer Institute, Switzerland, aims to search for the lepton flavour violating decay of a muon into one electron and two positrons with an ultimate sensitivity of one in 10^{16} muon decays. The Mu3e detector consists of High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) for an accurate track and vertex reconstruction complemented with scintillating tiles and fibres for precise timing measurements. The individual subdetector systems are placed in the 1m diameter bore of a 1T superconducting magnet.

In order to achieve the high sensitivity goal, special attention must be paid to the exact alignment of the detector elements. Misalignment may occur not only due to the construction or integration of the different detector parts but may also be caused by environmental influences during the operation of the experiment. To reduce the effects of misalignment and to achieve the best possible momentum resolution, a track-based alignment program is used. With the help of this tool, however, certain deformations of the detector that produce the same track quality, the so-called weak modes, cannot be resolved.

To compensate for this, an optical system based on 18 camera modules is also being developed. In combination with high contrast optical fiducials, the cameras determine their positions among each other and to the different detector elements. At the moment several combinations of camera settings and different fiducials are being tested in order to achieve a sufficient precision to fulfil the experimental objectives.

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