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Magnet design for electron-beam additive manufacturing

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Electron-beam additive manufacturing, or electron-beam melting (EBM) is a type of additive manufacturing, or 3D printing for metal parts. The raw material (metal powder or wire) is placed under a vacuum and fused together from heating by an electron beam. This technique is distinct from selective laser sintering as the raw material fuses having completely melted.
For industries such as healthcare and aerospace, this creates new opportunities for both prototyping and low volume production of titanium parts. The time cost, and challenges of machining or investment casting are eliminated, which makes titanium parts readily available for functional testing or installation on the aircraft. Additionally, the additive process opens the door to new design configurations and weight-reduction alternatives.
In EBM, to precisely control the focused electron-beam on a spot within hundreds of microns in diameter over a large build plane requires different types of magnets that are similar as those used in accelerators to some extents. While special design requirements must be meet for EBM which includes but not limited to focus strength, deflection strength, field homogeneity, multi-pole harmonics, stray field, total power losses, eddy current compensation and etc.
This paper compared different design options for focusing magnet used in EBM and selected two of the best options for beam optics simulation and tests. Simulation results and some experimental data will be presented in this paper.

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