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Laser Powder Bed Fusion: an innovative production method for creating components and devices for Nuclear Physics

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When we speak about Additive Manufacturing (AM), we think of a rather new manufacturing approach that allows to create objects layer-by-layer and without limits of shape. AM covers a wide range of techniques, that differ from each other by the class of material used for the process, the appearance of the raw material (powder, wire, sheet, etc.) and the way it is added and joined to the previous layer. Laser Powder Bed Fusion (LPBF) is probably the most important Metal Additive Manufacturing method, in which the energy source is a focused and powerful laser beam, whereas the feedstock material is a metallic powder. The process may look simple, but a deep knowledge of the thermodynamical and solidification behavior of each metal and the role that each process parameter plays in the final quality of the part must be held to properly manage this kind of process. Nonetheless, a great technical experience must be gained by the users.
The work here exposed intends to evaluate the applicability of LPBF for Nuclear Physics purposes. In particular, the studies made for the realization of ion sources and accelerators components are presented, starting from the process parameters tuning and material characterization initial stages, to the development of the final design and components production and test. LPBF of pure copper and copper alloys was investigated with the aim of producing the acceleration grids for nuclear fusion devices, while refractory metals were successfully processed for creating topologically optimized parts of a plasma ion source for Isotope-Separation-On-Line (ISOL) facilities. Also, the production via AM of pure copper and pure niobium superconducting radiofrequency cavities is examined.

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