Contribution ID: **34** Type: **not specified**

Mass reduction by additive manufacturing

Friday 10 June 2022 09:20 (25 minutes)

Optimization of component geometry and minimization of metallic mass is crucial for building a well performing particle tracking detector. Although advances in composite technologies have allowed us to construct strong and lightweight assemblies from non-metallic, low atomic-number materials, metallic materials still have some key advantages over composites. Properties like non-permeability, isotropicity and compressive strength are some of the key factors why metals have not yet been replaced by composites in certain mechanical applications.

In the case of the CMS Tracker, the key areas where these constraints support the use of metallic components are fluid manifolds, tubing and fittings; wheel and wheel support assemblies, screws, nuts and bolts; detector coupling mechanisms and support pieces too complex, work-intensive and time-costly to justify replacement with composites. In these cases, it is crucial that the material usage is optimized to reduce excess metallic material.

A very promising technology for material optimization is the so called Selective-Laser-Melting -technology, SLM for short. In this process a mirror/lens guided laser is used to fuse together metal particles in a protective gas volume to create strong metallic components additively. With this technology it is possible to construct geometry that is impossible or impractical to create with traditional subtractive manufacturing methods alone. Moreover, when combined with traditional subtractive manufacturing the SLM technology can deliver parts that outperform traditional parts in accuracy, complexity, strength and mass, all at the same time.

The aim of this talk is to provide an in-depth look into the process of optimizing the mass and design of few key Inner Tracker components like manifolds, coupling pieces and supports to fully utilize the potential of the SLM manufacturing with by-hand, generatively or subtractively -optimized designs. Additionally, the talk aims to show the effectiveness of the SLM technology in the CMS Inner Tracker applications by comparing the resulting mass and performance of the components to those manufacturable by subtractive means with FEA studies.

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