Mechanical and Thermal Management for Silicon Tracker Systems

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Abstract:

A very large silicon tracking detector is planned for a possible future upgrade to the ATLAS detector at the Large Hadron Collider. Under current study is a cylindrical array of long, very thin stave structures; onto to which one places an array of silicon strip detectors. Hybrids and detectors may be mounted on both sides of this thin composite sandwich support structure. Technical issues under study are both cooling and structural in nature, a general problem in ultra-lightweight HEP detectors. Cooling tubes, for an evaporative coolant, are placed in the sandwich core for removing heat from the hybrids and electronic chips. From a structural point of view, the stave-like component must be self-supporting to limit sag to <75microns over a one meter length. Staves up to 2meters in length, with a mid-span support, are under consideration.

Results from FEA studies of thermal strains brought on by cooling the detector will be presented, along with gravitational sag effects. Sub-cooling the detector from room temperature to -25ºC by far produces the largest thermal strain effect. By employing very high modulus laminates in our sandwich concept, thermal distortion has been limited to a maximum of 10μm out-of-plane. Judicious choice of laminate properties and sandwich internal structure has limited gravity sag to a range of 50 to 60μm. Detailed design leading to the fabrication of a 1m prototype structure is underway.