Contribution ID: **62** Type: **Oral**

Prototype flex hybrid and module designs for the ATLAS Inner Detector Upgrade utilising the ABCN-25 readout chip and Hamamatsu large area Silicon sensors.

Wednesday, 23 September 2009 11:00 (25 minutes)

We will present the development of prototype flex hybrids and modules for the short strip layers of the ATLAS inner detector upgrade. The hybrid utilises the ABCN-25 front end readout chip, which has been optimised for the short 2.5cm strip sensor topology. The design and production choices for a high yield, low cost reliable device will be discussed. Preliminary results from the first prototype hybrids and the first short strip module demonstrator, featuring a 10cm x 10cm Hamamatsu sensor with 4 x 1280 strips read out by 40 readout chips, will be presented.
We will also discuss the future plans for the development of a mass-producible, non-rigidised flex circuit that can be glued directly onto the silicon sensor for integration onto a stave structure.

Summary

For the SLHC upgrade of the ATLAS inner detector, over 10 000 short strip modules will have to be produced in a relatively short production time of 2 years. From the outset, it is important that yield and reliability issues are addressed to ensure that both electrical and mechanical operation are not compromised. Consideration should also be made for the physics requirements of minimising the material used in the module construction.
The design of the hybrid is implemented using multi-layer Cu-polyimide flex-circuit technology. A staged design approach has been adopted for the hybrid; firstly, a non-aggressive design was implemented to allow evaluation of the readout chip and sensor in an optimal electrical environment. The second design stage follows a more aggressive route of reducing hybrid mass by the removal of surface mounts, power planes, etc. It is also aimed to be more focused on a non-rigidised layout for mass production that is compatible with stave structures.
The flex hybrid architecture has been designed to be able to exploit the features of the new ABCN-25 readout chip without compromising performance. The circuit design rules have had to be chosen to take into account trace characteristic impedance, the number of drops on a loaded electrical bus, etc. Such considerations are necessary to ensure the reliable propagation of digital signals operating at 80Mb/s (though future designs may also operate at the higher speed of 160Mb/s). Compatibility has been maintained for either serial power distribution or DC-DC powering schemes.
Discussion of the design choices made, their features and characterization will be presented. We will also present the electrical characterization and performance of a fully populated single flex hybrid (comprised of 20 x ABCN-25 chips). Furthermore, results from the first full short strip module demonstrator utilizing 2 hybrid circuits coupled up to a 10cm x 10cm sensor produced by Hamamatsu will also be presented.
For the current ATLAS upgrade, the modules consist of two non-rigidised flex hybrids directly glued to a sensor, the design and studies necessary will be discussed. From initial studies, results on the affects of directly gluing onto the segmented sensor faces using Fuller Epolite 5313 epoxy will be shown. Depending upon the success of the program, first results with a non-rigidised hybrid/module will be shown.

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Session Classification: Parallel Session B3 - Packaging and Interconnects

Track Classification: Packaging and interconnects