Contribution ID: **32** Type: **Poster**

Design and prototyping of large-scale flex circuits for the ATLAS ITk Pixel detector

Tuesday, 20 September 2022 16:40 (20 minutes)

The tight space constraints of the ATLAS ITk Pixel system motivate the design of large-scale flex circuits for carrying low-voltage power, high-voltage sensor bias, and command/data transmission. These circuits extend over long distances in the barrel or large areas in the endcap rings, and they pose unique design challenges. We report on the design and prototyping of large-scale flex circuits for the ATLAS ITk Pixel system, with a focus on technical issues encountered and lessons learned.

Summary (500 words)

The ATLAS ITk Pixel detector design places stringent requirements on the large-scale flex circuits used to carry low-voltage power, high-voltage bias, and command/data transmission. In the outer barrel, these circuits can be up to one meter long, while in the outer endcaps the ring flex circuits are up to 30 cm in radius. The pixel system uses serial powering chains so that the power lines in the flex circuit must carry a current of up to 8A, and the high voltage lines must satisfy a dielectric withstanding voltage specification of 850V. In some parts of the detector, smaller flex circuits must transmit commands and data to and from the front-end ICs at speeds of 1.28 Gb/s with signal losses less than 5 dB. These electrical specifications and the mechanical challenges of the large bus-tape structures have led to an iterative design and prototyping process. The bus tape stack-up thickness and via dimensions have been tuned due to feedback from the manufacturers and results from electrical testing. The latest iterations of the large-scale structures satisfy the electrical and mechanical specifications for the ITk pixel system.

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Session Classification: Tuesday posters session

Track Classification: Production, Testing and Reliability