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## **SESSION 9: Cryocooler Drive & Control Electronics**

**Paper No. 9-4 Wednesday Afternoon 4:15 PM**

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### ***Compressor Stroke and Frequency Response Measurements Using Strain Gauges***

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LVDTs are commonly used displacement transducer devices integrated into cryocooler compressors in order to measure displacement stroke. They present the particular drawback of phase lag in the measurement signal. When flexure springs in an Oxford-style cryocooler fail, the off-axis forces on the moving motor shaft will increase and lead to a compressor failure that will halt the operation of the cryocooler. It is therefore important that a suitable method for detecting cryocooler stroke is in place during operation in order to detect early signs of off-axis movement and potential failure. The suitability of a novel method using strain gauges in a full Wheatstone bridge configuration, integrated onto a spring-moving magnet motor setup, is investigated in this study. Finite Element Analysis was conducted to explore regions of highest strain in the spring for a given displacement, which permitted appropriate strain gauge installation. The strain gauge bridge configuration was calibrated with an Omron laser displacement transducer and validated with the FEA model. A variety of tests were then conducted on the system to understand its harmonic characteristics. Finally, a series of dynamic and impact tests were conducted, where measurement during continuous operation and during impact collisions of increasing force were investigated. An analysis of the strain gauge bridge signal output and phasor characteristics of the integrated setup was completed. This measurement technique was successful in measuring in-situ compressor stroke as well as demonstrating a strong frequency response with the ability to detect small impacts on the compressor amid operation.