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## **SESSION 13: Cryocooler Analysis & Modeling Techniques**

**Paper No. 13-4 Thursday Afternoon 2:30 PM**

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### ***Square Wave Test for Characterization of Compressor Piston Blowby***

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Modern cryocooler linear compressors commonly use clearance seals as the primary sealing mechanism between the piston and cylinder. Such clearance seals are just very narrow non-contacting radial gaps on the order of 5 to 10 microns (0.0002"-0.0004") that limit the gas flow past the piston to a tolerable level. Such clearances are quite demanding to produce and are extremely difficult to measure accurately, even when the piece parts are available before final assembly. One means of testing the gaps is via a blowby test – conducted prior to compressor completion—where the flowrate of gas through the assembled clearance seal is measured as a function of differential pressure applied across the piston. For narrow clearance-seal type gaps, the gas flowrate is proportional to the cube of the gap radial distance, so the blowby test can be a sensitive measure of the initial clearance seal dimensions in a compressor. Because piston blowby is often an important factor in cryocooler efficiency, and increased blowby can be an important indicator of possible life limiting piston/cylinder wear, having an independent means of assessing blowby in an operational cooler is very desirable. Unfortunately, once a compressor is assembled and sealed into a working cooler, the direct measurement of piston blowby is no longer possible. However, indirect means of qualitatively assessing blowby are possible. One means is the square wave test described in this paper. This test involves driving the compressor pistons with a low-frequency square-wave voltage while simultaneously measuring the piston stroke response over time.