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**SESSION 6: GM & GM-Type Pulse Tube  
Cryocoolers**

**Paper No. 6-4 Wednesday Morning 9:45 AM**

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***Development of High Cooling Capacity  
3 K Two-Stage Pulse Tube Cryocooler***

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The quantum computing and dilution refrigerator (DR) market is growing very rapidly, and development of high cooling capacity, ultra-low vibration, fast cool-down, high energy efficiency and reliable cryocoolers for this market is of great importance. This application has the potential to become another major industrial market for cryocoolers in the near future. Higher cooling capacities are normally required at 3 K or below, rather than 4.2 K, for most dilution refrigerators. Commercial 4 K cryocoolers (either Pulse Tube or G-M) are normally designed for optimum performance at 4.2 K. In addition to higher cooling capacities at 3 K, lower no-load temperatures are also required for this application. A high cooling capacity 3 K two-stage pulse tube cryocooler has been developed at Cryomech, which can provide more than 1.0 W at 3.0 K on the 2nd stage with 33 W at 35 K on the 1st stage simultaneously operating on either 60 or 50 Hz power. The no-load base temperature is lower than 2.30 K. The input powers are 13.0 kW (60 Hz) and 12.0 kW (50 Hz) at steady state. The cooling performance and experimental results will be presented in this paper.