

Review of available piezo-based nano-positioners for operation at milli-Kelvin temperature range.*



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Abstract

There are several ongoing and proposed experiments that required application of linear (and rotational) positioners that must be able to operate in mK temperature range and capable to deliver several millimeters stroke with nanometers resolutions. Nano-positioners, based on the piezoelectric ceramics with "stick-and-slip" mode of operation, deployed in many experiments. Major challenge in application of piezo-based nano-positioners for experiments inside Dilation Refrigerators is significant heat generation by piezo-stack. Overview of different piezo-based nanopositioners produced by several vendors will be presented. Experience for applications of several type nano-positioners for FNAL's projects will be presented.





There are several vendors capable to produce piezo-based nano-positioners that operate at milli-Kelvin range. Appling "stickslip" principal, companies able to use small piezo-stack and produced stages with stroke up to 20mm. Linear stages, when

workload moved horizontally, demonstrated quite good performances. At the same time operation of the positioners in vertical direction (to lift workload more that 100-200 grams) is not reliable (at least we were not able to demonstrated it at FNAL). Power dissipation of "stick-slip" nanopositioners, when operated at mK range and moving workload with speed ~1micron/sec, could be estimated in the range of 40uW (when operated at Vpp~40V) - 120uW (for Vpp~120V). (For reference typical power dissipation of DR for 20mK is ~30uW and for 100mK is ~1mW). Piezo-actuator (JPE Piezo-knob - inertia & stick and slip) exhibited very large power dissipation (~40mW when lift workload with speed 1um/sec)

Onnes Technology company developed positioner arQtika based on "piezo-walker" scheme for cryogenics applications. They measured power dissipation from their unit at 20mK around 50uW while moving workload at 1 micron/sec. As response of big demand from Quantum Technology community, big size and small "start-up" companies are investing significant resources into development of low power dissipation piezo-based nano-positioner capable operate at milli-Kelvin

range.