# The Impact of Pressure Regulation of Cryogenic Fluids and EPICS EPID Feedback on the Monochromatic Beam Position Stability of the 7ID Beamline at the Advanced Photon Source.

Time-Resolved Research Group

X-ray Operations and Research


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## Introduction

**The first crystal mount of the double crystal Si (111) cryogenically cooled monochromator of the 7ID beamline at the Advanced Photon Source (APS) is slightly sensitive to pressure variations in the cryogenic lines[1]. Pressure variations during a liquid nitrogen cryocooler fill every 4 hours move the beam slightly by tens of microns. Pressure variations due to the cryocooler closed loop pressure control with a heater element (~0.3 PSI) move the beam by 5 microns every 15 seconds. We have recently stabilized the coolant pressure with a simple pressure regulator that is in use at many beamlines of the APS. This poster shows the improvements in beam position stability made using this simple yet effective pressure regulation circuit. We also recently added beam position feedback to the second crystal Bragg angle of the monochromator. The EPICS EPID feedback implementation [2] resulted in an additional improvement of the beam position stability to 0.5 micron RMS.**

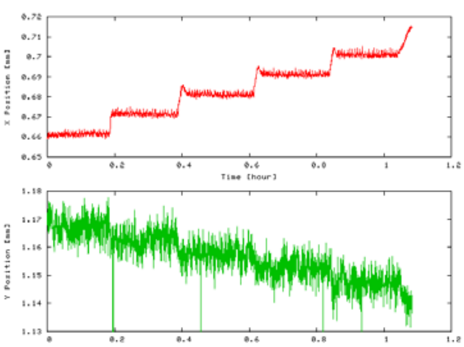
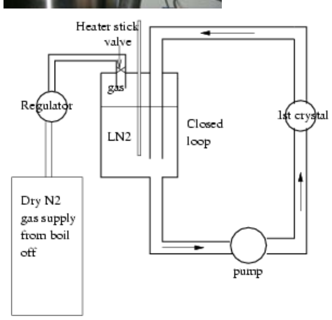



*Fig. 1. Horizontal (top) and vertical (bottom) beam position versus time following four one PSI steps in the buffer pressure. Here, dx/dP=10 $\mu$m/PSI, and dy/dP=5 $\mu$m/PSI.*

*Fig. 2A. New Omega pressure Regulator mounted on LN2 Dewar.*

*Fig. 2B (below) The new cryocooler regulation circuit.*




## Experimental method

•Dry N2 gas pressurizing the cryocooler HP buffer, and regulated by Omega PRG101-60, 0-60 PSI range (~0.01 PSI RMS) and **more recently** Omega PRG101-25 (2-25 PSI regulator). (See Fig. 2A and 2B. ) N.B. 1 PSI= 6900 Pa.

•We use an Omega PX271A-030GI (4-20 mA 0-30 PSIG) to measure directly the closed loop pressure.

•Implementation of EPICS EPID record [2] for the second crystal piezo, improving position stability while scanning energy.

•The cryocooler was moved on top of the 7ID-A hutch to reduce the risk of oxygen deficiency inside the hutch. It also stabilizes the beam, and reduces the noise (see Fig. 3).

•X-ray beam position monitor 20 m from mono, based on back fluorescence of Ti foil and quadrant detection [3,4].

•Beam typically at 10.5 keV, white beam apertured to 0.5 mm by 0.5 mm

*Fig. 3.* The new platform on top of 7ID-A for the cryocooler. New hoses were also purchased.

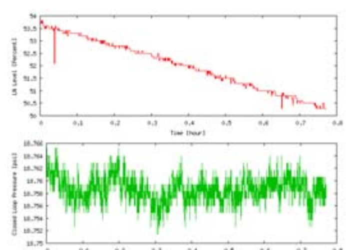


*Fig. 4. Bottom panel: the measured pressure versus time of the cryocooler closed loop with the 2-25 PSI regulator. RMS fluctuations are 0.002 PSI, or 0.01 % of average.*

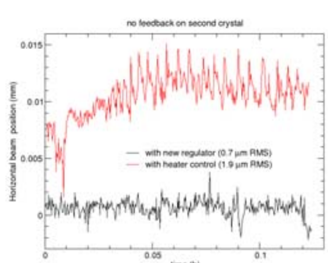



*Fig. 5. Horizontal beam position versus time with heater circuit on (Red) and with Omega regulator on and heater off (black). The 15 second variations disappear and the RMS fluctuations are reduced by a factor 3!*

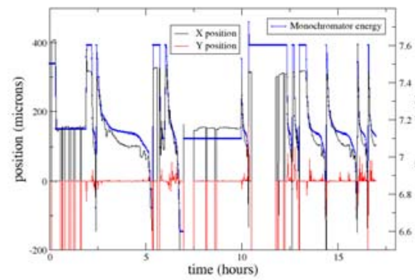



*Fig. 6. Horizontal and vertical beam position during an energy scan. The monochromator energy is also displayed on the RHS. Vertical feedback works very well for these experiments at the Fe edge. Significant horizontal beam motion remains (about 600 $\mu$m) .*

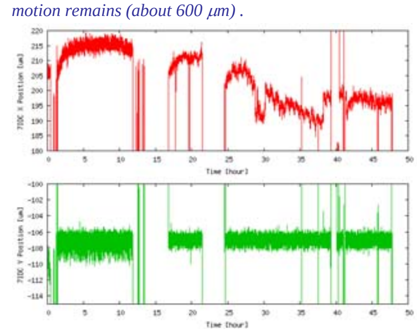


*Fig. 7. Horizontal (top) and vertical (bottom) beam position with feedback on. After t=15 hours, the regulator was also turned on, reducing the vertical RMS fluctuations to 0.5 $\mu$m. During fixed energy operation, the horizontal beam motion is on the order of +/- 10 $\mu$m in a day.*

## Discussion

With an inexpensive pressure regulation circuit, it is possible to stabilize an undulator beamline x-ray beam to 0.5 microns, 20 m from the monochromator (or 25 nrad), which compares well to the source pointing stability. Feedback and pressure regulation work best together. EPID feedback is essential for scanning the 7ID Si (111) monochromator. Adding horizontal steering capability and feedback would improve the performance of the monochromator.


## Acknowledgements:

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**References:**


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