

Perfecting X-ray Capillary Optics to Make Smaller Diameter Microbeams

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The CHESS capillary optics group, (<http://capillary.chess.cornell.edu/>) continues to develop its capability to draw hollow glass tubing into precision elliptically-tapered single-bounce x-ray optics that make most of the microbeam experiments possible at CHESS beam lines. The applications range over protein crystallography for biology, the study of fish ear stones to learn about their life history (environmental science), to solving problems in art history of paintings underneath paintings for museum masterpieces, etc.

The common denominator for all these applications is our microbeam optics. We are continually trying to improve the quality of the optics by making more precisely-figured parts as we improved the hardware/software tools on our LabView operated, custom-built drawing tower consisting of an precision linear air bearing + small-bore electric furnace. The instrument allows us to soften the wall the borosilicate glass tubing of a few mm in diameter and stretch it to the proper shape (elliptical, parabolic, or linear) as determined in advance by an web-based mathematical design program.

The hope in the long run is to make higher quality capillaries with slope errors below 50 microradians - our present level of performance - and figure errors of less than 1 to 2 microns. This will help us to make smaller diameter microbeams. The puller mechanics are undergoing some performance testing at present as we continue to produce specialized parts for various x-ray experiments and optimize the shape for each application.

We will continue to do "detective work" to try to figure out where the current slope errors are generated by the current drawing process and try to beat them down to even smaller levels. Doing so will increase the performance of the resulting optics. The person selected to help us will join our 4 person group effort and be immersed in operating and improving our computerized instrumentation for glass drawing and its associated metrology. We want to investigate the correlation between pulling the capillaries under constant tension vs. constant pressure and of the effect of rotational speed on the capillary quality. We also either need a way to mathematically (or empirically) correct our conservation-of-mass drawing equation to achieve a better match between the design figure and what is actually produced, especially in the tip region of the capillary. Evaluation of the data with Matlab tools will help to interpret the data from puller and metrology equipment. We also like to do some statistical work from capillary data already on hand from prior drawing periods. Observation of the pull and its imperfections with fresh eyes would be helpful. The expected end result is a plot and/or summary of what was observed over multiple draws and to see if trends could be observed and recommendations made for future draws.