Construction and Use of a Micro Resolution Phantom for Small Bore MRI

Samuel Barnes[1], Naomi Santa Maria[1], and Russell Jacobs[1]
[1]*Biology, Caltech, Pasadena, CA, United States*

TARGET AUDIENCE – All users of small bore MRI systems that are interested in QA of new or existing sequences.

PURPOSE – Despite the wide availability of resolution phantoms with a feature size 1 mm for large bore MRI systems there is a lack of commercially available resolution phantoms with a feature size of approximately 100 um for small bore systems. Presumably this is due to the difficulty of machining plastic to these dimensions. This works describes the design, manufacture, and use of such a small resolution phantom for use in small bore systems using modern laser drilling to achieve these feature sizes.

METHODS – The design of the phantom was modeled after the high contrast resolution insert of the American College of Radiology (ACR) accreditation phantom (Figure 1). Holes diameters were selected to be 90, 100, 110, 180, 200, 220, 450, 500, 550 um to span the resolutions commonly used in small bore MRI systems. The 90 to 220 um holes were drilled through a 0.5 mm sheet using a UV laser while the 450 to 550 um holes were drilled through a 1.0 mm sheet with a micro CNC. All manufacturing was done by Potomac Photonics (Lanham, MD). To prevent bubbles forming in the very small holes 1 g of sodium dodecyl sulfate was added to 50 ml of water to reduce the surface tension.

RESULTS – The phantom was manufactured to specification and high quality holes were achieved. The use of sodium dodecyl sulfate as a wetting agent eliminated bubble formation and water easily filled all the drilled holes.

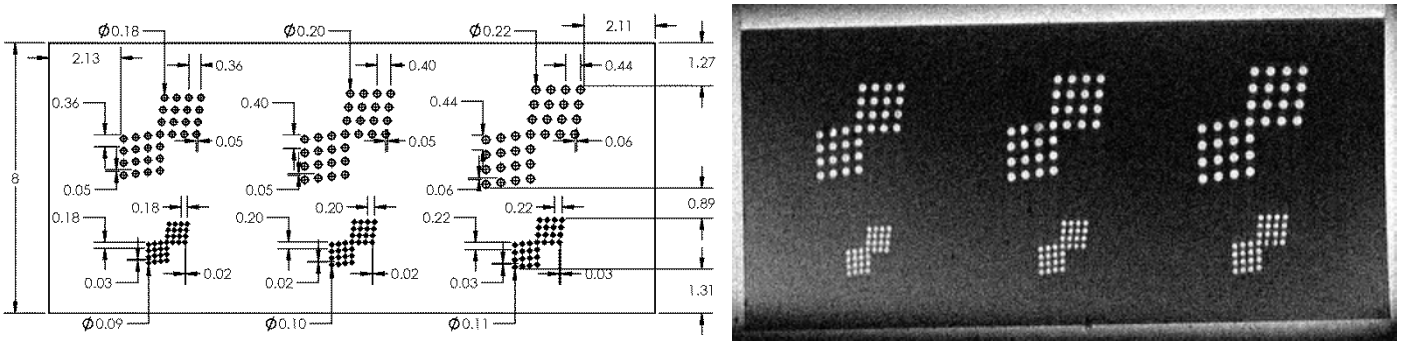

Figure 1. CAD drawing (left) and MRI (right) of the 90-220um hole patterns, all dimensions are in mm. The MRI has an in plane resolution of 50 um.

DISCUSSION – The limiting factor in drilling small holes is the aspect ratio, the ratio of hole diameter to hole depth. Laser drilling can achieve hole sizes down to 1 um but only in extremely thin materials. Drilling holes much deeper than the diameter is difficult to achieve. For 100 um holes the maximum depth we could achieve was 500 um. This thickness proved adequate when a high resolution pilot image was used to center the imaging slice on the resolution phantom.

CONCLUSION – Modern laser drilling systems allow for the manufacture of small resolution phantoms that are well suited for use in small bore MRI systems. Custom designs can be quickly generated using CAD software and the manufacturing contracted to any number of companies that poses this equipment for a reasonable price. These high quality phantoms allow reliable and realistic quality assurance of new and existing sequences.