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Micro Grids Fabricated for Miniature Ion Thruster

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Micro Grids Fabricated for Miniature Ion Thruster

Abstract

Part of the research at Boise State is a miniaturized plasma propulsion thruster. The purpose of the thruster is to provide the necessary location realignments for small satellites in space. The grid creates an electrostatic field, which extracts plasma ions from an Inductively Coupled Plasma (ICP) source. The ions are propelled toward a collector plate being a second identical grid, which in turn creates the desired thrust. The size and density of the openings in the grid are essential to optimizing the thrust produced. The grid geometry contributes to the ion departure angle (focusing) and the ion transparency. The Stainless Steel grids currently being made and tested are 26mm in diameter with an array of varying sized circular holes. Computer modeling of the thrust, which is to be created by the grids, is an integral part of the research to help establish the desired sizing and location of the holes within the grid. This presentation will primarily focus on the manufacturing process of the grids. Initially manufactured using a chemical etch process, the grids were not properly aligned and exhibited a rough surface finish. In this work, a more traditional machining process has been adapted with excellent results. A Computer Numerical Controlled (CNC) mill is programmed to drill and ream the grid and holes to the desired diameter. This gives a clean finish, which eliminates arcing. Data to illustrate the improved quality achieved will be presented in the form of images and functional thrust results.

Keywords

ion thruster, electric propulsion, plasma propulsion

Disciplines

Electro-Mechanical Systems

Micro Grids Fabricated for Miniature Ion Thruster

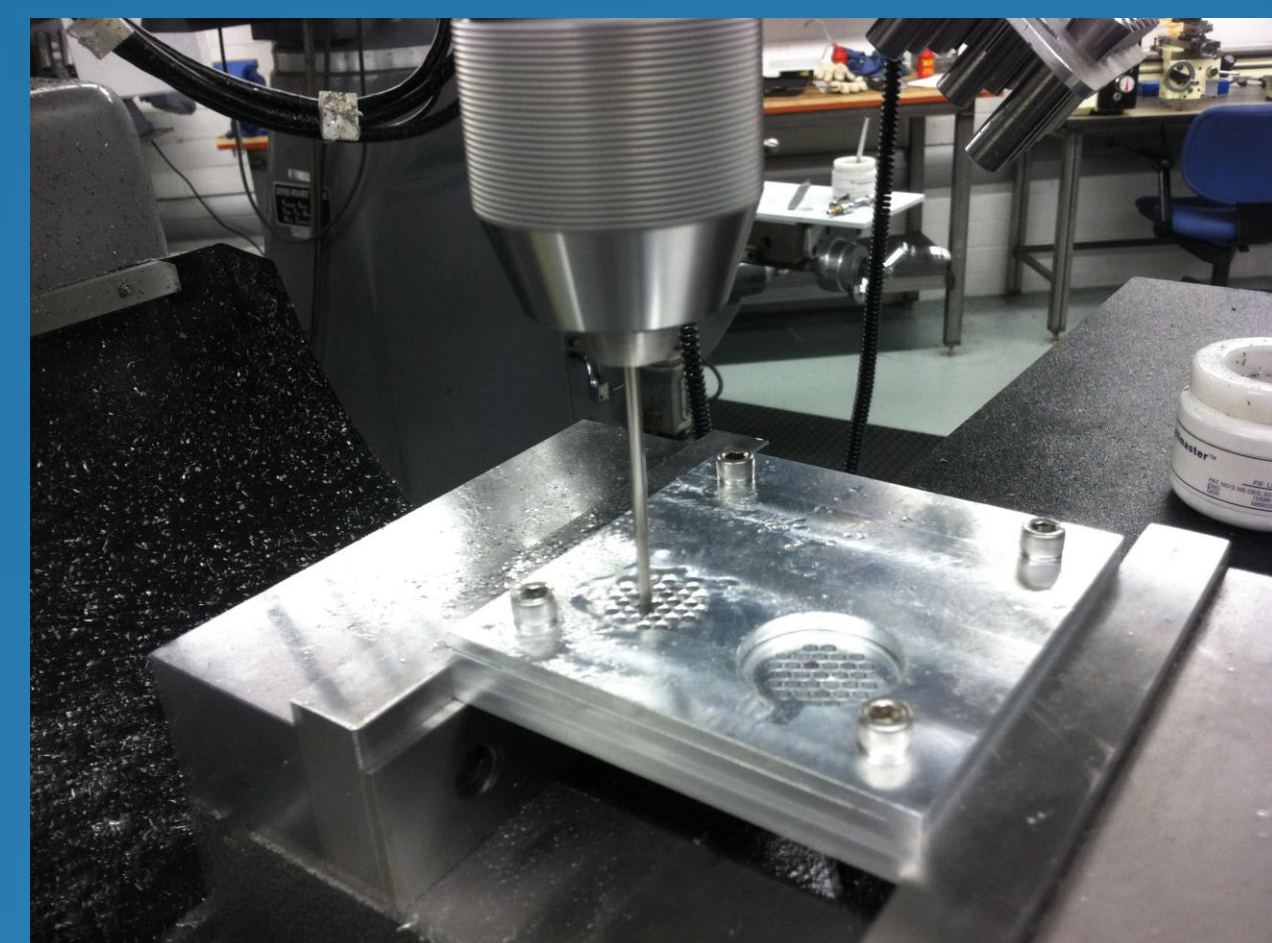
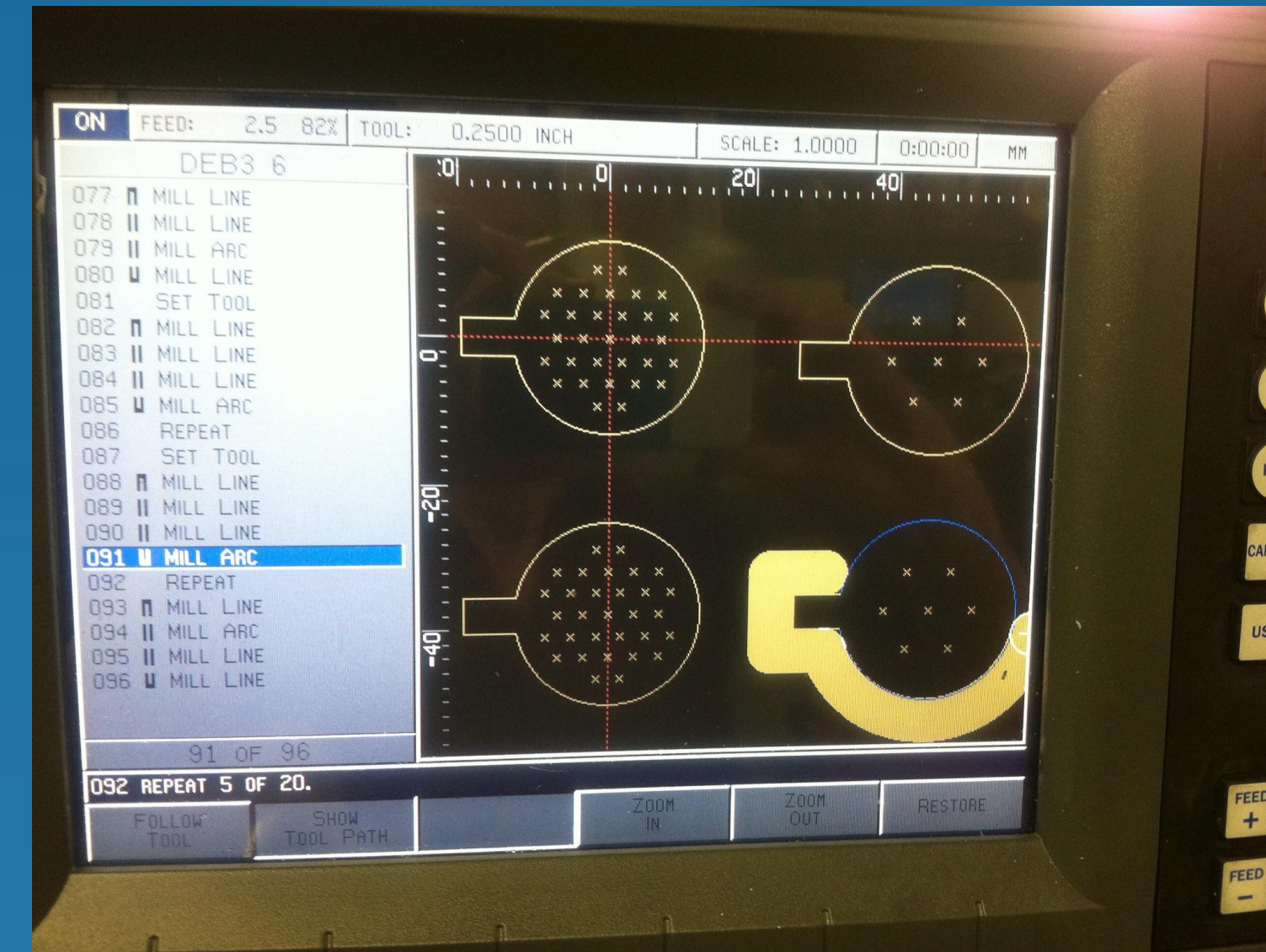
Presented by Deborah French¹ and Jesse Taff³

Introduction

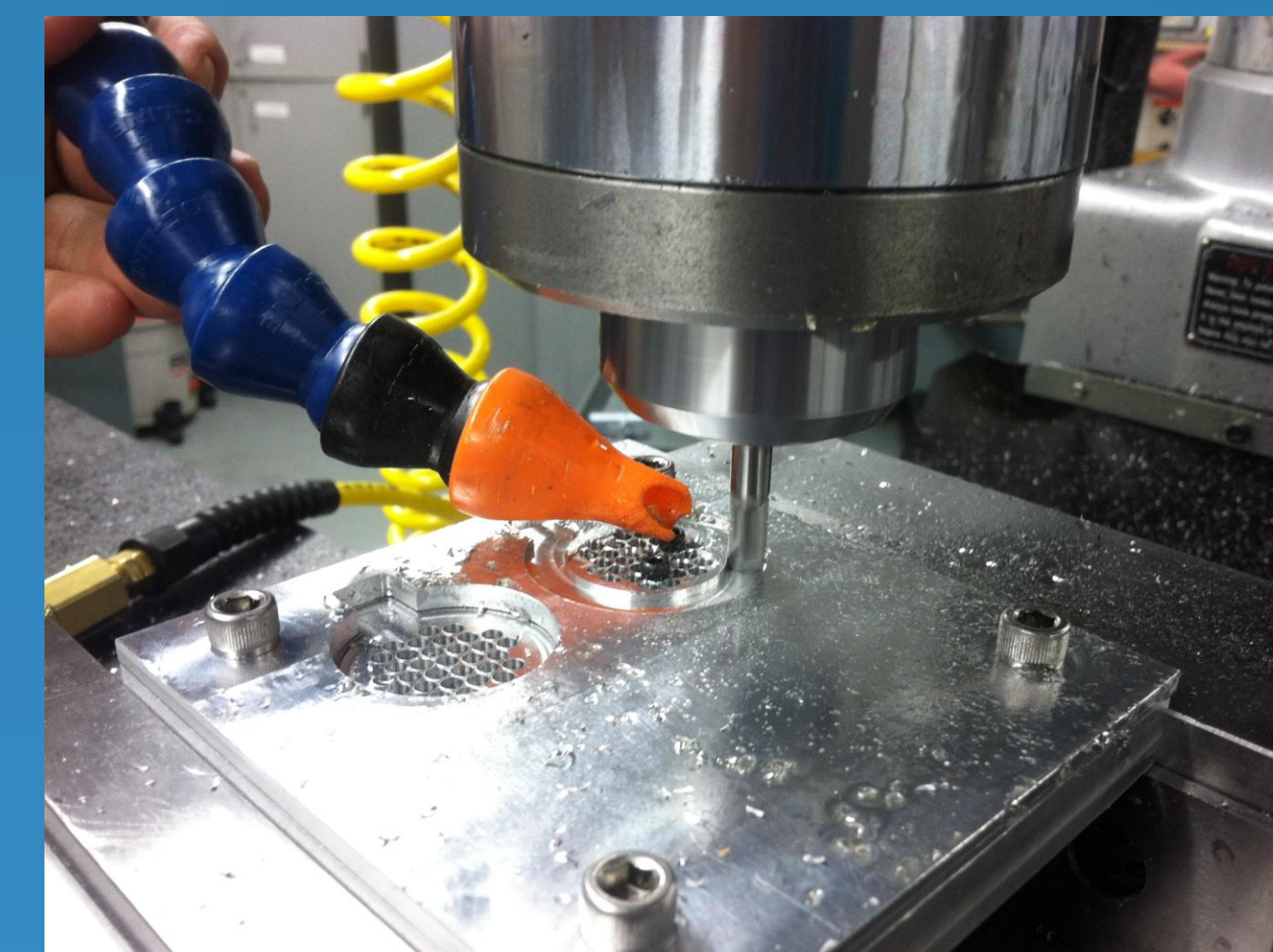
- Miniature Ion thrusters are being developed to align microsattellites in orbit
- The micro grid creates an electrostatic field which extracts plasma ions from an Inductively Coupled Plasma (ICP) source
- The assembly contains a stack of two identical grids with attachment tabs:
 - Screen grid for collecting ions
 - Accelerator grid for propelling ions

Mechanical Fabrication of Micro Grids

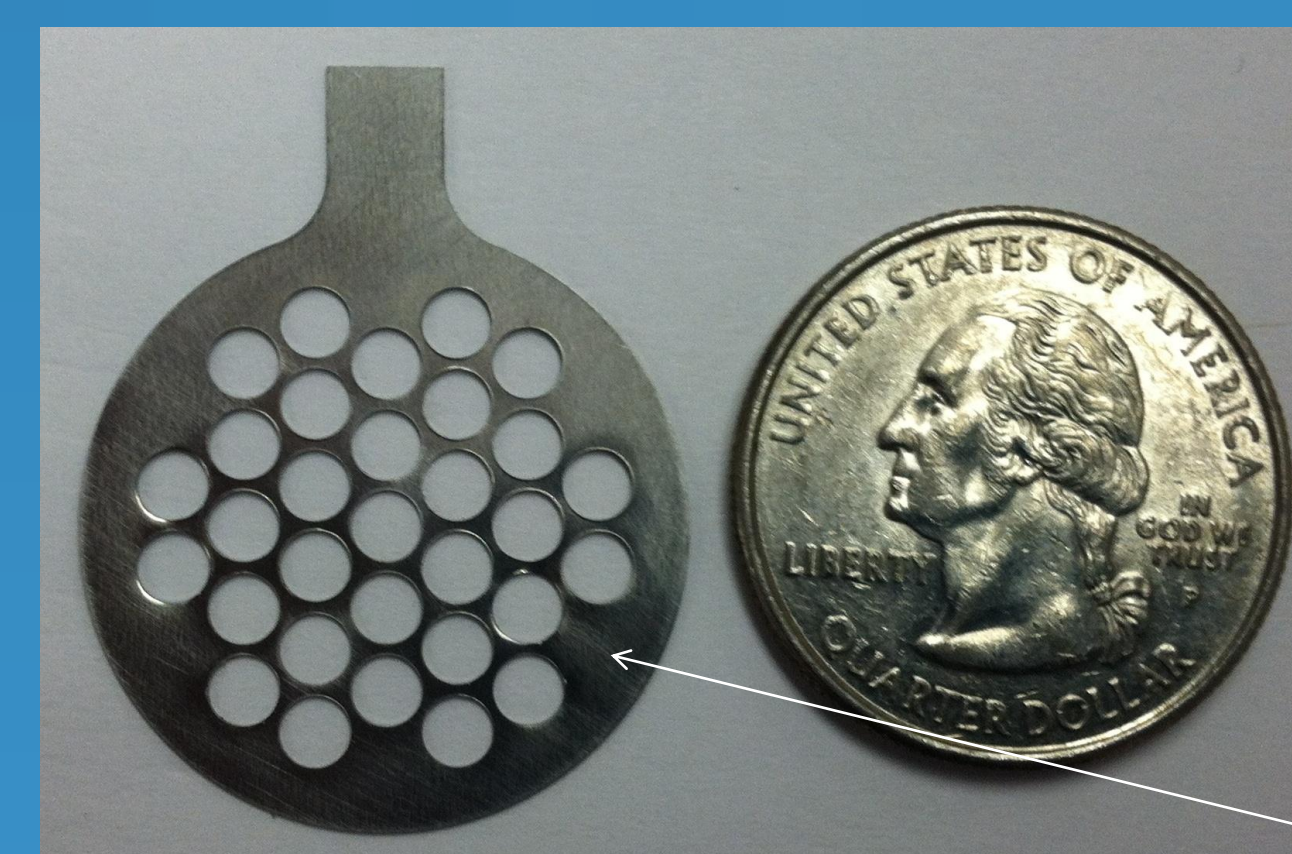
- SolidWorks drawing is created and transferred to the CNC milling machine



- Sacrificial top and base plates created to hold the stainless steel sheet in place while the grid is machined



- The grid is bolted to the sacrificial base plate while the perimeter is being machined



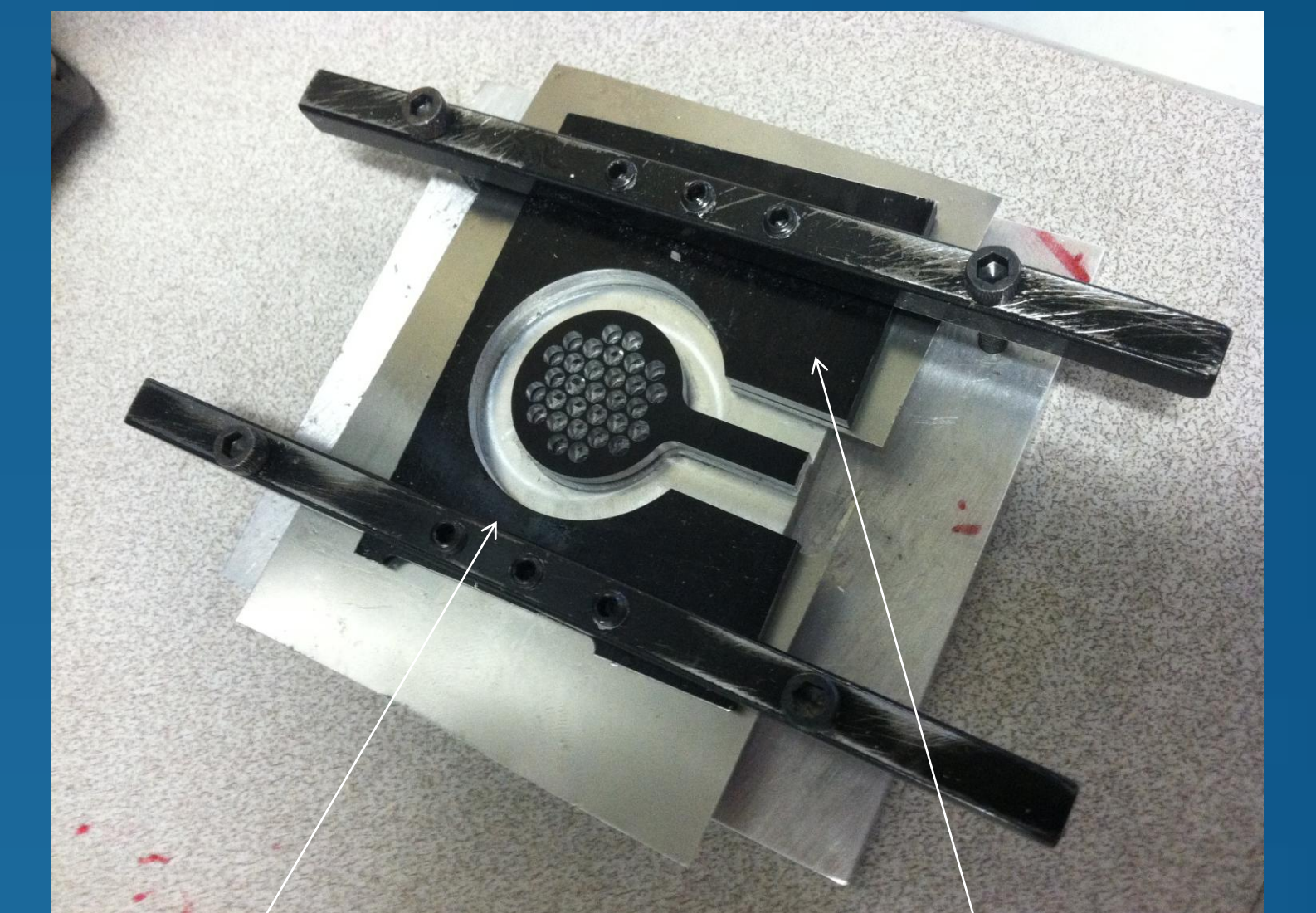
Shortcomings

- Stresses created in grid webbing
- Tabs too short

Stress in the grid webbing

Modifications

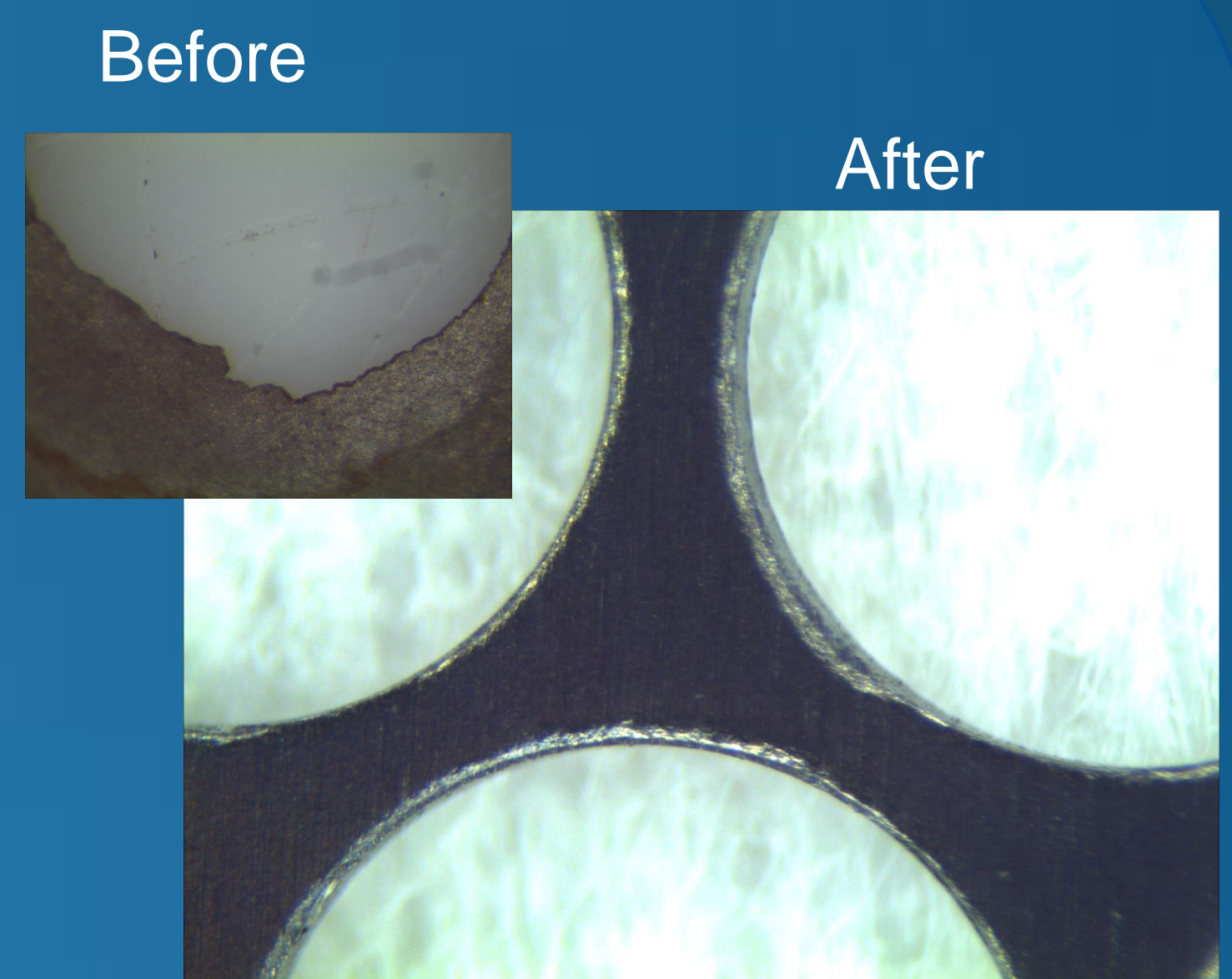
- New jig - no stresses in grid webbing
- Allowed for longer tabs
- Two sheets stainless steel milled together



Stainless steel sheets Lengthened tab

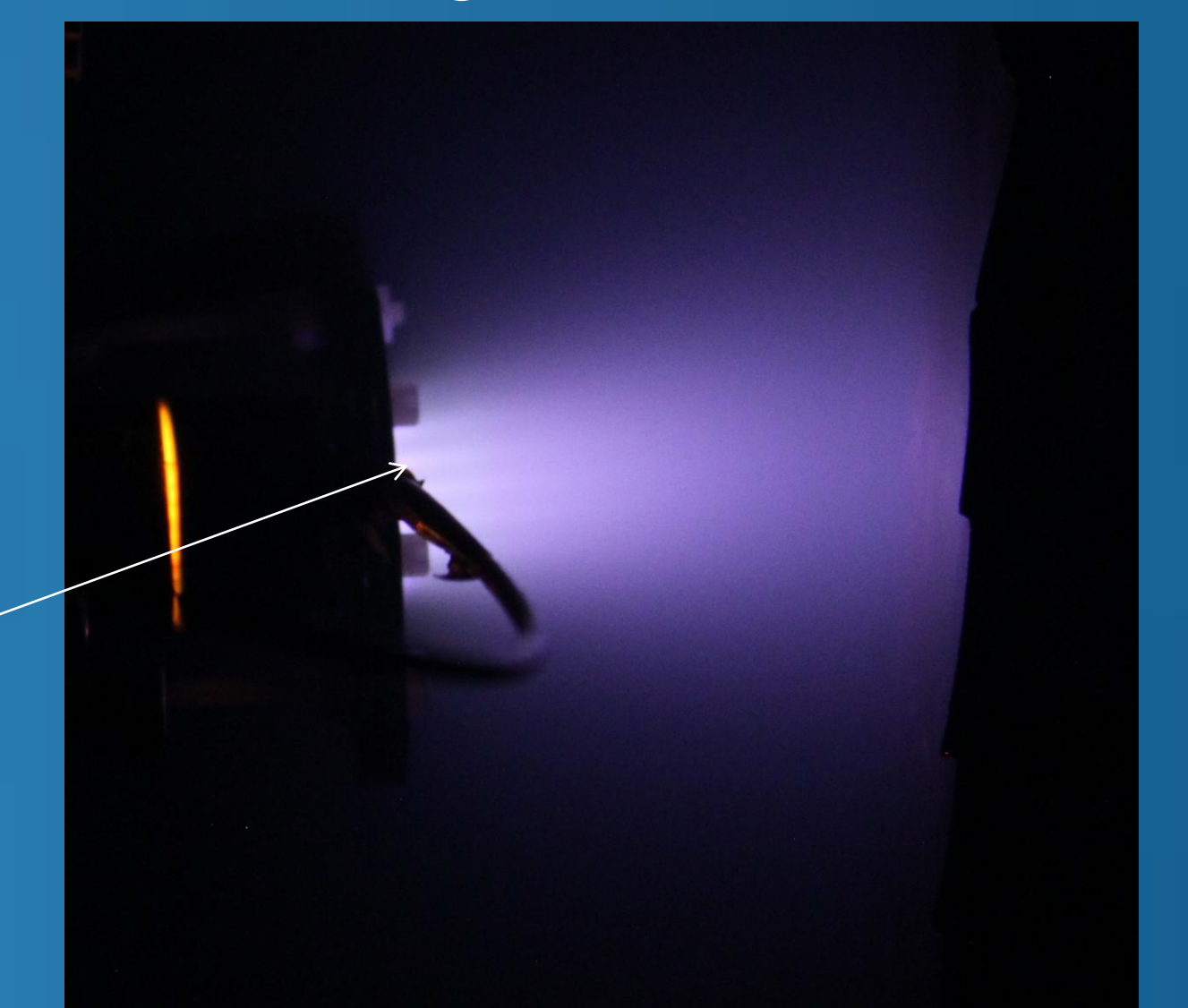
Results

- Finished grid hole fabricated through machining
- No stresses occurred on the grid webbing
- Clean round grid holes



Longer tab

- The grid with the longer tabs inserted in chamber for testing
- At pressures of 10^{-6} torr, no arcing occurred

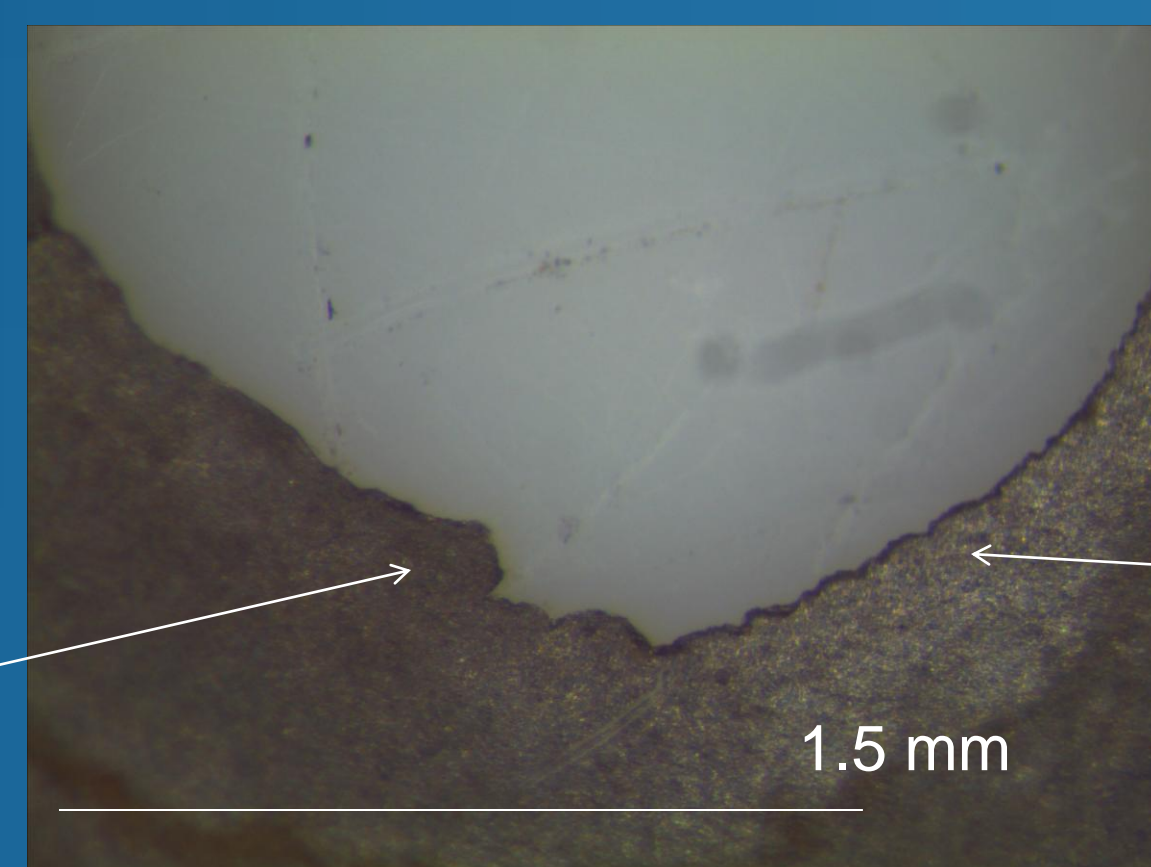


Streamlines from grid holes

Chemical Etch of Micro Grids

Problems Encountered

- Uneven removal of material
- Creation of burrs and non circular hole
- Burrs create arcing of ions

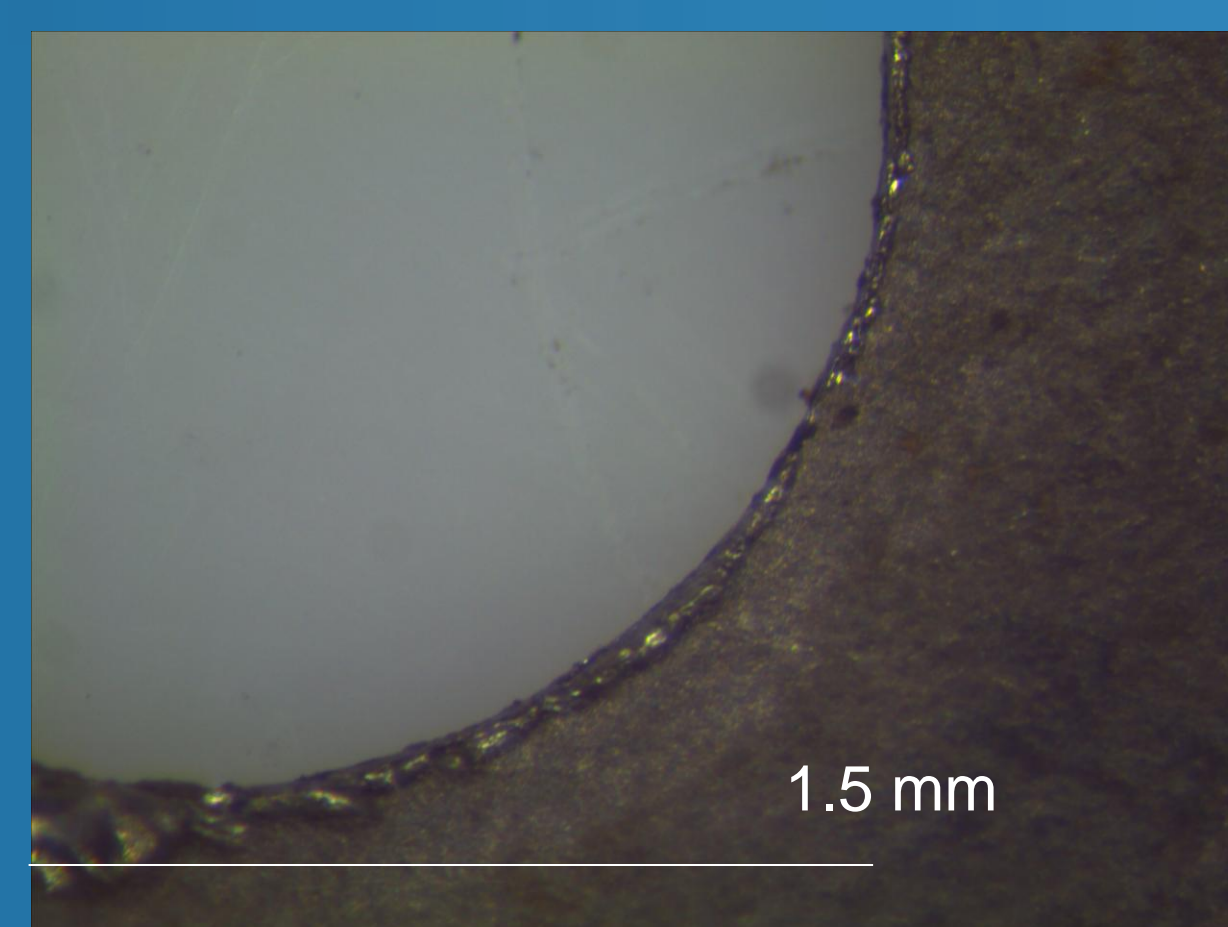


Burr

Uneven etch with non circular hole

1.5 mm

- Removal of burrs were done by hand filing
- Can not remove uneven etch



1.5 mm



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