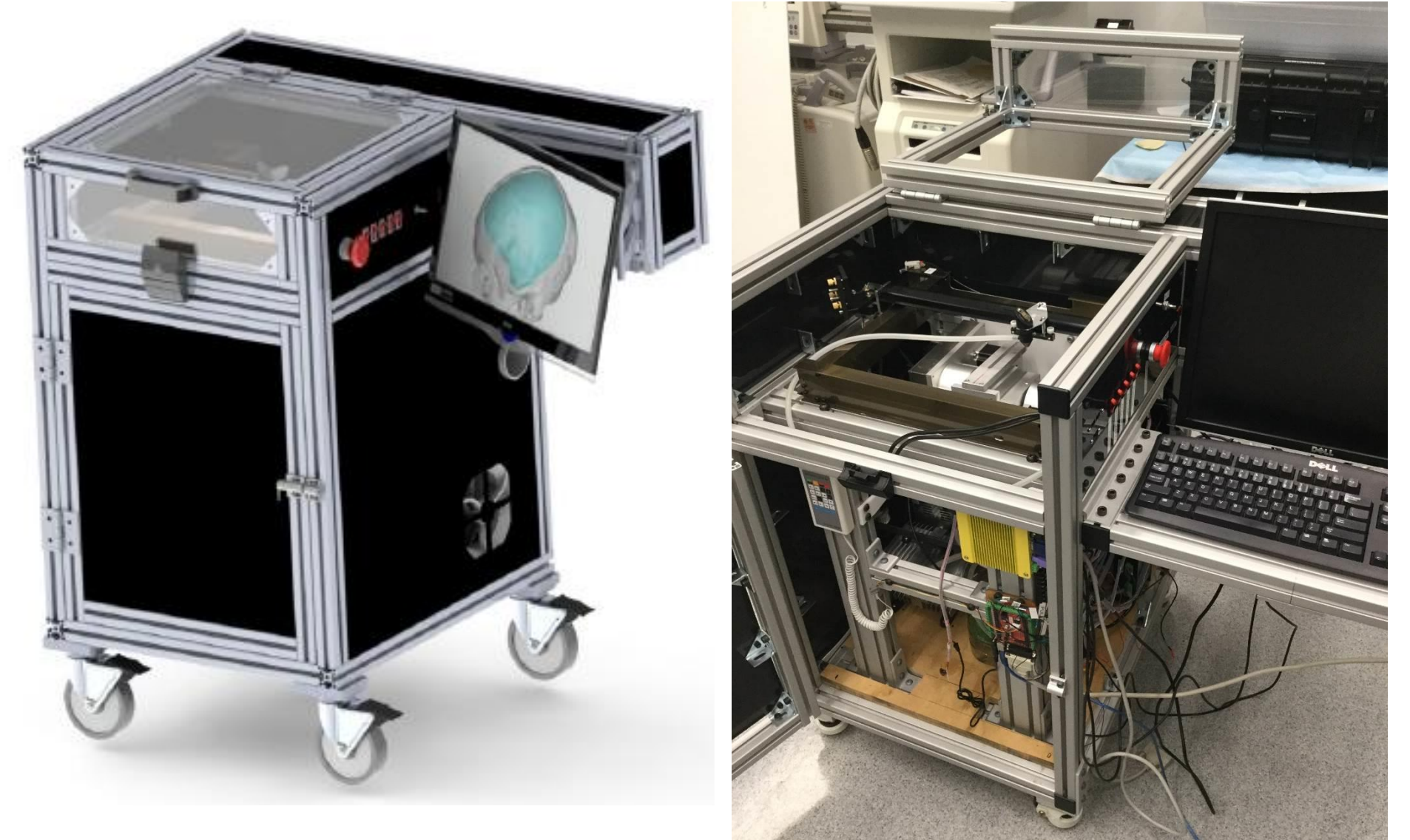


*Computer Integrated Surgery II, Spring 2016*

*Joshua Liu and Jerry Fang, under the auspices of Dr. Mehran Armand, Dr. Ryan Murphy, and Dr. Chad Gordon*

## Introduction

- Cranioplasty is a procedure to repair cranial defects using custom cranial implants (CCIs).
- The goal is to develop a portable 5 DOF laser cutting system that assists surgeons in resizing CCIs in single-stage cranioplasty.
- Currently, CCIs are resized manually. This system aims to automate the current procedure. Benefits include decreasing surgery time and labor cost, and improving accuracy of implant modifications.
- Area of research
  - Biomedical engineering
  - Surgical instrumentation

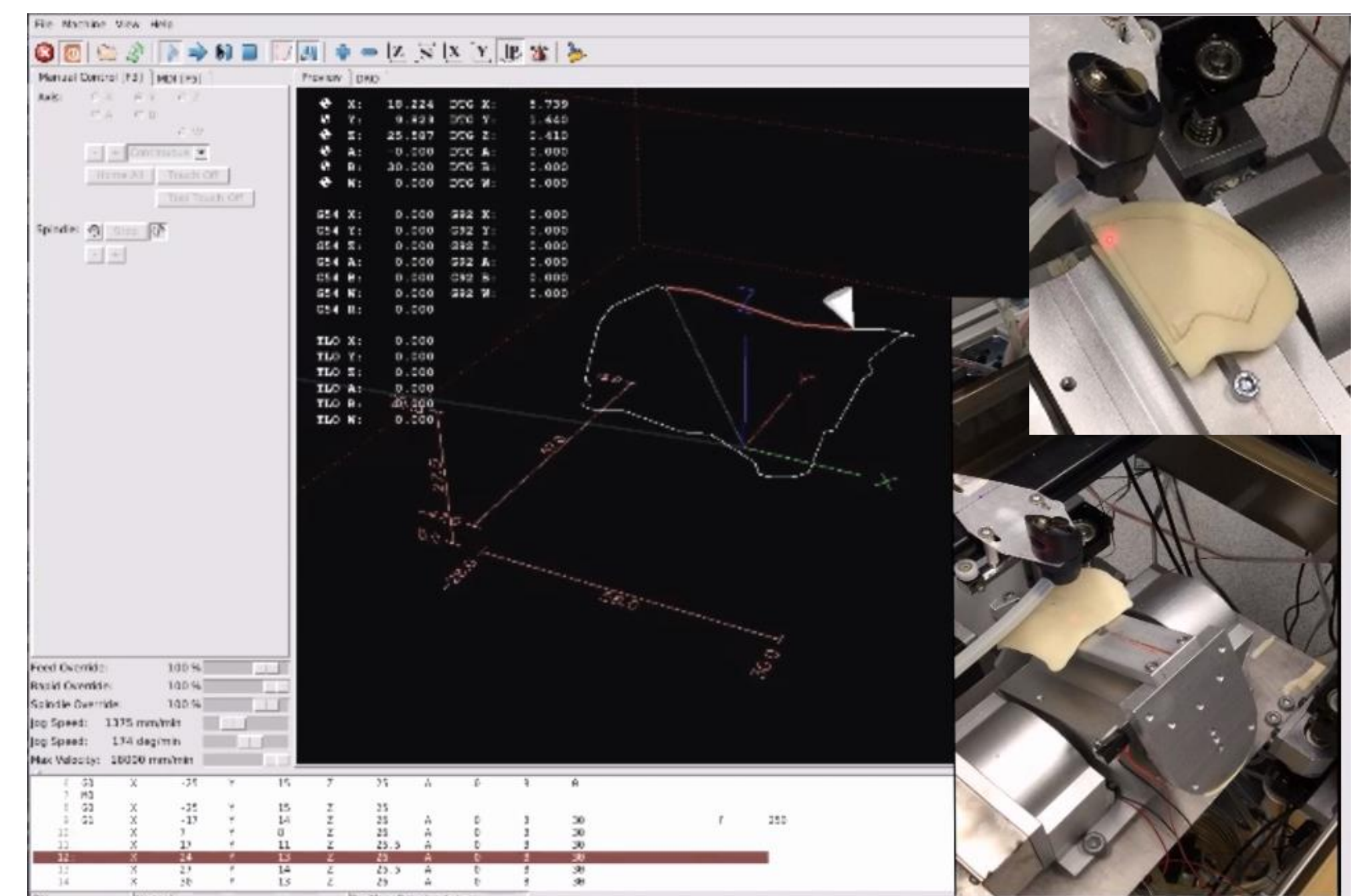


Laser cutting system: CAD model shown on left, real device shown on right

## The Problem

- CCIs are made in oversized profiles, and require numerous iterations of manual modification to become suitable for patients.
- This process can take up to 80 minutes depending on the size of the implant and the complexity of the modification.
- Modification is based on the surgeon's visual analysis, and therefore is prone to errors in precision and accuracy.

## Outcomes and Results



## The Solution

- CNC laser system consisted of 35W CO<sub>2</sub> laser, mirrors, and linear stage; constitutes 3 transitional axis
- Rotary table; constitutes 2 rotational axis

## Future Work

- Implant registration
- Cutting path to G-Code conversion algorithm
- FreeCAD cranioplasty module

## Lessons Learned

- We acquired experience in tool path generation, FreeCAD, LinuxCNC, hardware abstraction layer, system configuration, and software/hardware debugging.

## Credits

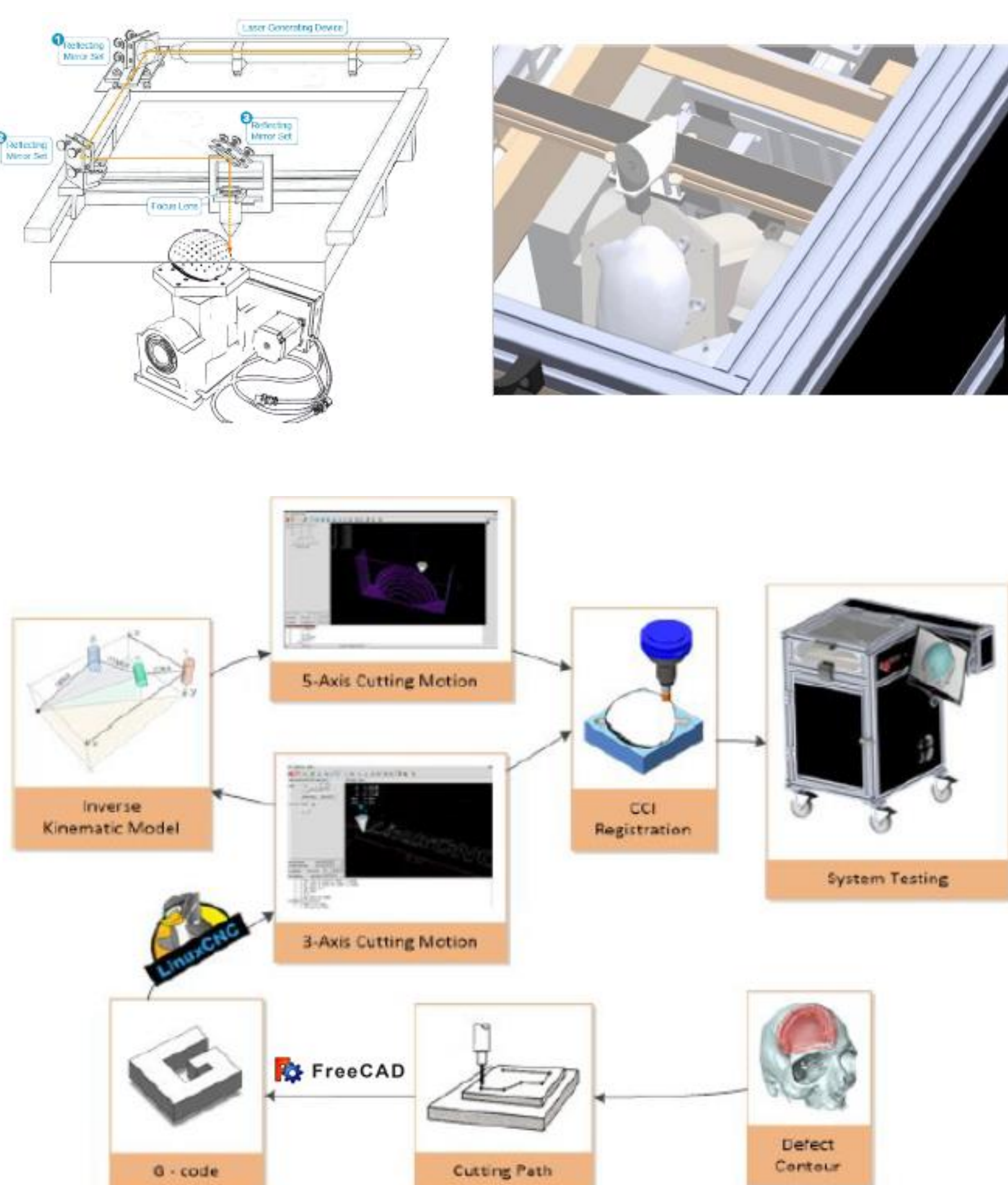
- Joshua focused on implementing algorithms for cutting motion and tool path generation, and developing GUI
- Jerry focused on assembling hardware, aligning laser components, path to G-Code conversion
- Both contributed to configuring and debugging the system

## Publications

- R. J. Murphy, K. C. Wolfe, P. C. Liacouras, G. T. Grant, C. R. Gordon, and M. Armand. Computer-assisted single-stage cranioplasty. 2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2015.
- Milutinovic, D., Glavonjic, M., Slavkovic, N., Dimic, Z., Zivanovic, S., Kokotovic, B., & Tanovic, L.. Reconfigurable robotic machining system controlled in a machine tool manner. The International Journal of Advanced Manufacturing Technology Int J Adv Manuf Technol, 53(9-12), 2010, pp. 1217-1229.

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- We would like to thank the LCSR Rotorium and Wyman Park for providing access to the machine shops



Software Design for the laser cutting system