UTILIZING ADDITIVE MANUFACTURING TO CREATE PROTOTYPE AND FUNCTIONAL BEAMLINE INSTRUMENTATION AND SUPPORT COMPONENTS

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ABSTRACT

The world of beamline science is often fast-paced and dynamic. One of the major challenges in this environment is to be able to design, manufacture and then implement new items for use on the beamlines in a fast and accurate manner. Many times, this involves iterating the design to address unknown or new variables which were not present at the beginning of the project planning task. Through the use of additive manufacturing, I have been able to support the user programs of various (APS) Advanced Photon Source beamlines* across multiple scientific disciplines. I will provide a few detailed examples of Items that were created for specific beamline applications and discuss what benefits they provided to the pertinent project. I will also talk about why choosing consumer-level printer options to produce the parts has been the direction I went and the pros and cons of this decision. Primarily, this choice allowed for quicker turnaround times and the ability to make more frequent changes in an efficient manner. Currently, we are utilizing only the fused deposition modeling (FDM) type printers but I am exploring the addition of UV-activated resin printing, exotic materials that can be utilized using the current toolset, and the possibility of commercial metal printing systems. This technology has been a game-changer for the implementation of new support items and instrumentation over the last couple of years for the different disciplines I am supporting. I will discuss how the roadmap ahead and what the evolving technologies could potentially allow us to do.

MOTIVATION

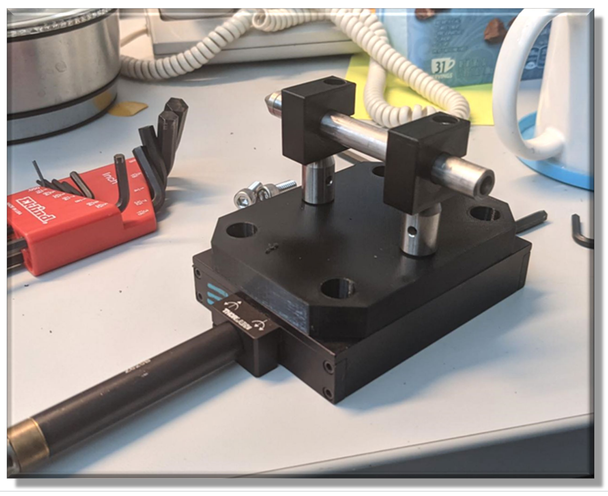
- In the fast paced world we operate in supporting the experiments in a efficient way is a must.
- Cost saving can also be beneficial. This allows the funds to be directed other aspects of the project.

METHODS

- Fused Deposition Modeling (FDM)
  - Fused deposition modeling is an additive manufacturing technology commonly used for modeling, prototyping, and production applications. It is one of the techniques used for 3D printing.
- Printers used were Consumer Grade printers costing between $350 and $750 USD.

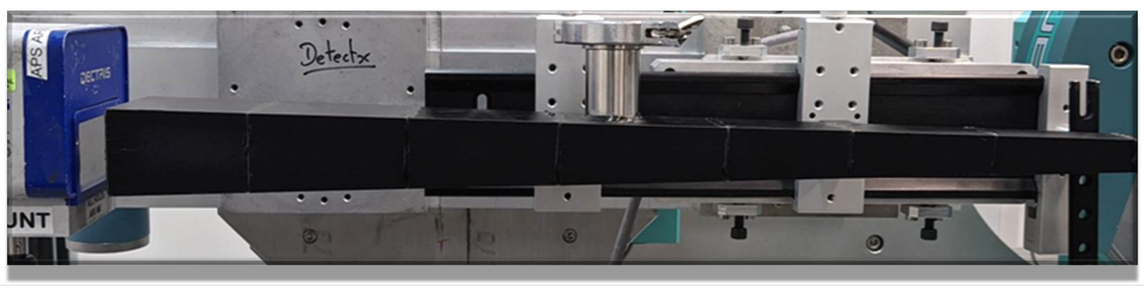
COLLIMATOR MOUNT 11-ID-D (TRR)

- There was a need to Quickly and Accurately install a Collimator into the hutch. It was needed the next week. Item was designed and printed within two days including the interface plate to the stage.
  - Cost was under ten Dollars
  - 100% infilled parts
  - Components were Tapped



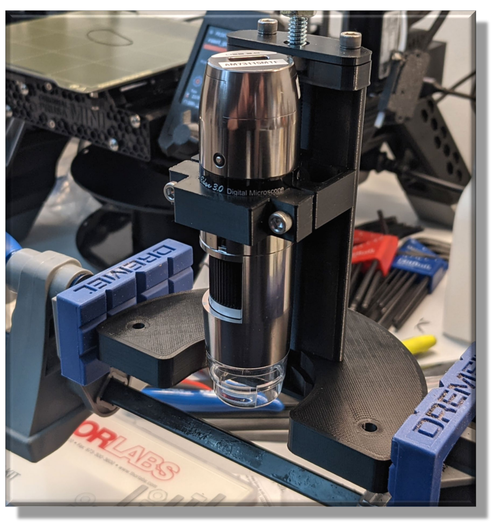
FLIGHT PATH TO DETECTOR 6-ID-B (MM)

- Item was quoted in Stainless at nearly Twelve hundred Dollars and 8 weeks minimum lead time. Broke component down into small sections to print.
  - Print time was under 24 hours
  - Cost was fifteen dollars
  - Assembly done with Epoxy
  - Ends capped in Kapton
  - Holds rough vacuum



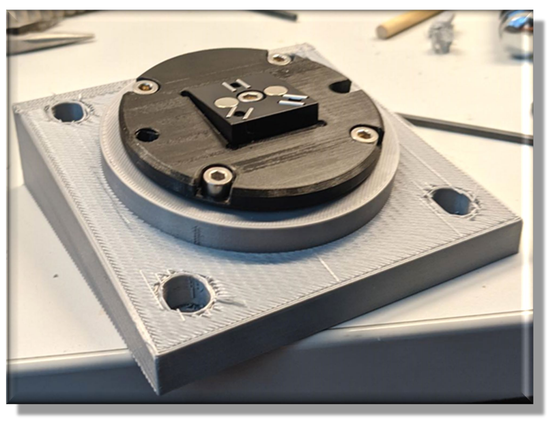
MICROSCOPE ADJUSTABLE MOUNT 6-ID-B (MM)

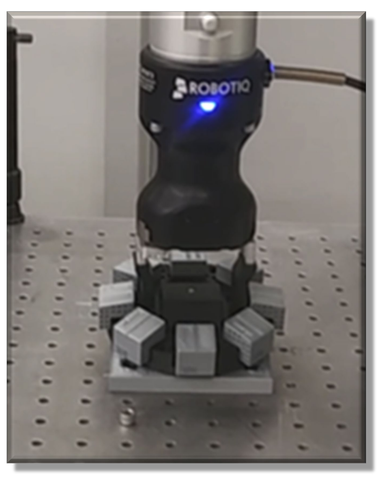
- There is a need to mount a microscope on the Diffractometer using existing holes on the device. Gives the ability to adjust to accommodate 4 magnification levels.
  - Cost was under ten Dollars
  - 100% infilled parts
  - Components were Tapped
  - 8 hours total print time
  - 2 day Design to parts in hand
  - Allows for hands on test for V2



AUTOMATED CHANGE OVER SAMPLE WHEEL (DYS)

- This sample holding wheel allows for the automated change outs of the sample wheels. With the future intention of sending the users the sample blocks to be loaded and sent to us for processing.





CONCLUSIONS

- The results on the given examples and other which have been implemented have been very positive. In many case's the want to move to a metal post prototype version, has been found to not be needed.
- The Rough vacuum uses have been interesting as many have been concerned that vacuum would not hold.
- There is still the limitation of the parts being a polymer but new additive manufacturing processes are opening op other options.

NEXT STEPS

- Looking into adding resin printers
- Looking at the use of metal additive manufacturing type printers for future use and possibly addition to our toolset. By implementing this we could turn the time needed for instrumentation manufacturing to days instead of weeks.

REFERENCES

- Dynamics & Structure (DYS)
  - https://tinyurl.com/ysj6rwxn
- Magnetic Materials (MM)
  - https://tinyurl.com/68fsba8p
- Time-Resolved Research (TRR)
  - https://tinyurl.com/vw62x5pv
- X-Ray Science Division
  - https://tinyurl.com/566cfv7n

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