

TARGET FABRICATION FOR IMPACT EXPERIMENTS

Dynamic Compression Sector (DCS)

Washington State University

A DOE/NNSA SPONSORED USER CAPABILITY
At the Advanced Photon Source
Sector 35

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DCS Target Fabrication for Impact Experiments

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1.0 Introduction

This document details target preparation procedures necessary to utilize the Dynamic Compression Sector (DCS) impact facilities. It does not detail sample preparation, but it does address how to integrate a sample to the target assembly. Questions regarding sample preparation may be directed to your designated DCS Point of Contact (POC) If a DCS POC has not been assigned to you, please email [dc.admin@wsu.edu](mailto:dcadmin@wsu.edu).

The procedures in each section start with a list of materials needed for assembly. Most components are commercially available, while some must be fabricated. Section 8.0 Appendix B: Summary of Components for Target Assembly contains a summary of all the materials and equipment from all the sections including manufacturer and part number. Drawings for fabricated components can be found in Section 9.0 Appendix C: Custom Component Drawings.

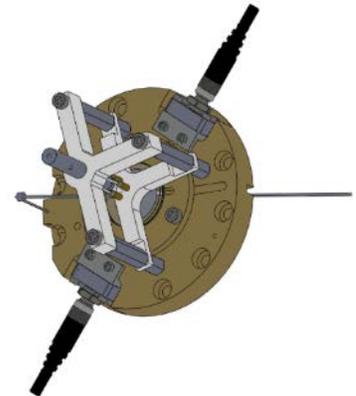


Figure 1. Assembled Target

2.0 Target Plates

2.1 Target Plate Design

Target assembly starts with the target base plate, Figure 2, which is common for all plate impact experiments. Detailed drawings of the target plate are provided in Appendix C, drawing numbers DCS-1000-1A and 1B.

All eight holes must be present along the plate's perimeter to ensure the target can be fixed securely to the target holder and prevent damage to the target holder during an experiment. The target plates are usually made from brass, but aluminum may be used if preferred. After fabrication, the plates should be sanded and lapped flat and parallel as described in Steps 2

- - Dowel pin holes for spacer ring
- - Dowel pin holes for target holder
- - 6-32 holes to attach spacer ring
- - 6-32 holes to attach interferometry
- - Hole for beam stop
- - Holes for TOBB optics
- - Holes for target mount
- - Slit for x-rays
- - Channel for TOBB

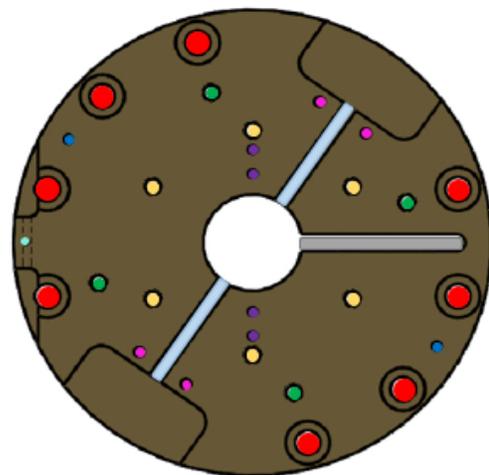


Figure 2. Target Plate. The central through hole is where the projectile will pass and the slot projecting from its right allows the direct x-ray beam to reach the sample in transmission geometry. The inner six 6-32 holes are for mounting the spacer ring. The inner two pairs of 0.063" through holes are optional for dowel pins to aid in precision positioning of the spacer ring. The outer four 6-32 holes are for attaching the interferometry probes. The 0.2" deep channel is to allow the TOBB optics and its beam path to be inset. The neighboring 2-56 threaded holes are to attach the TOBB optics. The 0.031" through hole on the far left is for a target mounted x-ray beam stop. The eight through holes on the plate perimeter are for attaching the plate to the target holder. At the same radius is a pair of 0.063" through holes for dowel pins to precisely guide the target plate onto the target holder.

through 4 in the following section on target plate preparation. As a final step, the thickness should be measured and recorded to a tolerance of 10 μm for use by DCS staff during experimental setup.

2.2 Target Plate Preparation and Characterization

Supplies Needed:

- Dowel Pin Shaft 1/16" (McMaster-Carr 90145A423)
- Beam stop (See 5.1 Target Mounted Beam Stop Assembly)
- 6-32 tap (McMaster-Carr 2522A667)
- 2-56 tap (McMaster-Carr 2522A663)
- 1/32" reamer (McMaster-Carr 8930A117)
- 1/16" reamer (McMaster-Carr 8803A141)
- 120-grit adhesive-backed silicon carbide sanding disc (McMaster-Carr 4678A172)
- Aerosol duster (Fisher Scientific 23-022-523)
- Cotton swabs, Puritan 868WCS (Fisher Scientific 19-120-472)
- Granite flat (Starrett G-81803)
- Drop gauge (Heidenhain 329352-01, with associated mounting and readout hardware)
- Lapmaster 15 lapping machine with lapping fluid
- Isopropanol
- Kimwipes (Fisher Scientific 06-666A)
- Optional: Ultrasonic cleaner (VWR 97043-988)

After an experiment, each brass target plate may be salvaged and refurbished for future shots. For refurbishment, refer to Part 1 in the Steps below. If the target plate is newly fabricated, then skip Part 1 and go directly to Part 2. The brass target plate must be made flat and parallel before it can be used in a new target assembly.

Steps:

Part 1

1. Remove all the TOBB brackets and fasteners and set aside (these can be refurbished later if desired).
2. Remove all plastic screws from the 6-32 threads.
3. Check all the threads and holes that are to be used on the plate.
4. Using a long 6-32 screw, make sure you can easily thread it through all ten of the 6-32 threaded holes.
5. Using a 2-56 screw, make sure that you can thread it into the four holes where the TOBB brackets are attached.
6. Take a dowel pin and make sure that it can slide through the two outer dowel pin holes.
7. Take a piece of rod used for beam-stops and make sure that it can slide in and out of the beam-stop hole. It should be a slightly snug fit.
8. Re-tap or ream any threads or holes that are blocked by debris using
 - 6-32 tap for 6-32 screw holes
 - 2-56 tap for 2-56 screw holes
 - 1/16" reamer for dowel pin holes
 - 1/32" reamer for the beam stop hole

Part 2

Sand the plate flat and parallel.

9. Use a 120-grit sanding disc fastened to a granite flat or steel lapping plate to sand both sides of the plate until the entire flat face regions appear sanded. Use random motions to reduce the chance of making the plate a wedge.
10. Use the compressed air to blow off any brass dust remaining on the plate.
11. Set the target plate on a granite flat in front of a Heidenhain drop gauge.
12. Place the drop gauge contact point on the plate and zero its encoder on the display unit.
13. Take measurements of 4 – 6 points on the outer region of the plate. Repeat for the inner region as well (near the central hole). Repeat for the other side of the target plate.
14. Repeat this section (steps 9 – 13) until the parallelism is within 25 μm .

Part 3

Use a lapping machine to achieve final parallelism.

15. On the lapping machine, lift the pump out of the slurry reservoir of the lapping fluid and use a mixing paddle to mix up the abrasive that has settled on the bottom of the reservoir. Return the pump into the reservoir.
16. Place the target plates in the retaining rings so they rest against the inside of the rings and on the side that the lapping plate moves toward. This prevents the plates from slamming into the ring when the machine is started. It is permitted to use all available rings at once (i.e. lap three targets at once if there are three rings).
17. Position each dripper over the outside of the three retaining rings and towards the center of the lapping plate.
18. Set the timer for 10 minutes.
19. Start the lapping machine.
20. Observe the flow rate of the slurry on each dripper and adjust the valves so each dripper has a slow steady drip of slurry (~one drop every couple of seconds).
21. After 10 minutes, flip the target plate over and repeat steps 16 – 20.
22. Repeat steps 16 – 21 so that each side has been lapped twice.
23. Clean the plate using isopropanol with Kimwipes and cotton swabs as necessary. It is not necessary to clean the plate when you flip it between lapping cycles. An ultrasonic cleaner is helpful for cleaning parts.

Part 4

24. Verify that the parallelism is within 10 μm across the entire surface of the plate. If not, repeat Part 3 until this parallelism is achieved. A parallel lapping jig is useful for getting good parallelism.
25. Re-check all the holes as described in Part 1.

Now the plate is ready for mounting the sample and additional components.

3.0 Trigger Method

X-ray cameras are triggered just before impact when the projectile breaks a laser beam located in front of the impact surface. This optical trigger is referred to as the Target-mounted Optical Beam Break (TOBB) and is shown schematically in Figure 3. The TOBB consists of a source fiber, focusing lens, collection lens, and collection fiber and is mounted directly to the target plate.

3.1 TOBB Assembly

The distance between the sample and trigger will vary depending on the projectile velocity. If the distance is too short, there may not be sufficient time to trigger the x-ray detector and diagnostic equipment. If the distance is too great, the timing uncertainty will increase due to uncertainty in the predicted projectile velocity (e.g. the equipment may trigger too early or too late). The required time from trigger to first camera gate is 1.2 (+0.8/-0.2) μ s. In other words, the time of flight of the projectile from the TOBB to impact with the sample should be no more than 2 μ s and no less than 1 μ s with a nominal time-of-flight of 1.2 μ s.

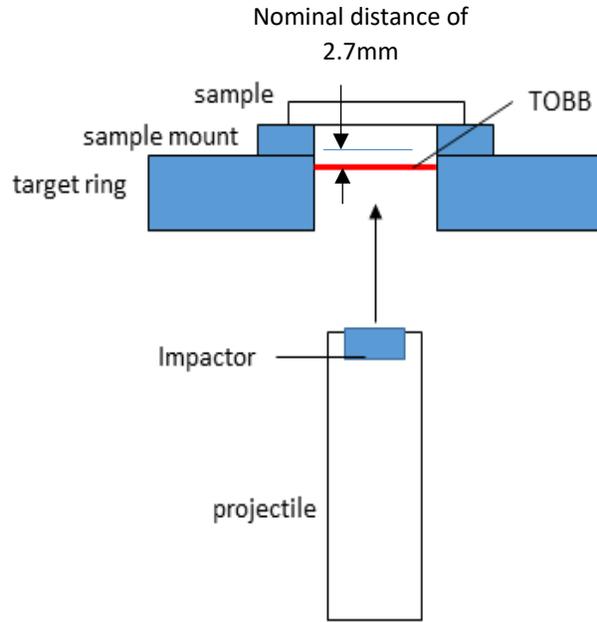


Figure 3. Target Mounted Optical Beam Break (TOBB) triggering setup

The distance from the TOBB laser beam to the back surface of the target plate (see Figure 3) is nominally 2.7 mm. This should be measured independently: see [Section 4.3: TOBB – Sample Distance Measurement](#).

However, the total distance from the TOBB laser to the impact surface of the sample can be varied with the use of a spacer ring for the sample (to *increase* the distance) and/or with the insertion of washers under the TOBB brackets (to raise the optics and therefore *decrease* the distance, see Figure 4). The following equation can be used to determine the Trigger to Impact distance (spacer ring thickness less washer thickness) needed to ensure successful triggering of the x-ray cameras during a particular experiment:

$$\frac{2.7 \text{ mm} + \text{spacer ring thickness} - \text{washer thickness}}{\text{projectile velocity}} + (1\text{st camera gate wrt impact time}) = 1.2 (+0.8/-0.2) \mu\text{s}.$$

Table 1 provides the suggested number of washers or the spacer ring thickness that should be used for a given projectile velocity range assuming that the user desires the first camera to trigger at impact. Note that we suggest discussing the TOBB timing setup with DCS staff if you plan on using velocities less than 0.70 mm/ μ s.

Table 1. TOBB Timing - for 1st camera gate at the time of impact

Velocity Range (mm/μs)	Trigger to Impact Distance (mm)	Number of Washers (Th=0.42mm)	Spacer Ring Thickness (mm)
0.35-0.6	0.6	5	0
0.5-1.0	1.02	4	0
0.7-1.4	1.44	3	0
1.0-1.8	1.86	2	0
1.2-2.2	2.28	1	0
1.5-2.5	2.7	0	0
2.0-3.5	3.7	0	1.0
2.5-4.5	4.7	0	2.0
3.0-5.5	5.7	0	3.0
3.5-6.0	6.7	0	4.0

Note that you may find it easier to mount your samples to a spacer ring even for low velocity experiments. In this case, additional washers can be inserted to compensate for the thickness of the ring.

Supplies Needed:

- (A) 2 SMA couplers cut to 0.5" (Thorlabs ADASMA-10)
- (B) 4 each 2-56, 3/16" screws (McMaster-Carr 92196A076)
- (C) Lens holder (see Appendix C, drawing DCS-1002-1 for detailed design)
- (D) 4 each -003 O-rings (McMaster-Carr 9452K11)
- (E) 8 each 2-56, 3/8" screws (McMaster-Carr 96006A234)
- (F) Lens bracket (see Appendix C, drawing DCS-1003-1 for detailed design)
- (G) #2 Flat washers as needed (McMaster-Carr 90945A705)
- (H) 2 each $\varnothing=7.40$ mm, f=4.6mm lenses (Thorlabs CAY046-100)
- 5-minute epoxy (All-Spec 14250-15093)
- 1.25" polystyrene dish (Fisher Scientific 08-732-112)
- Target Plate
- TOBB send fiber (Fiber Instrument Sales F104, custom fiber, see Appendix B for specifications)
- TOBB return fiber (assembled, steps below)
- Struers Accutom 100 Diamond Saw

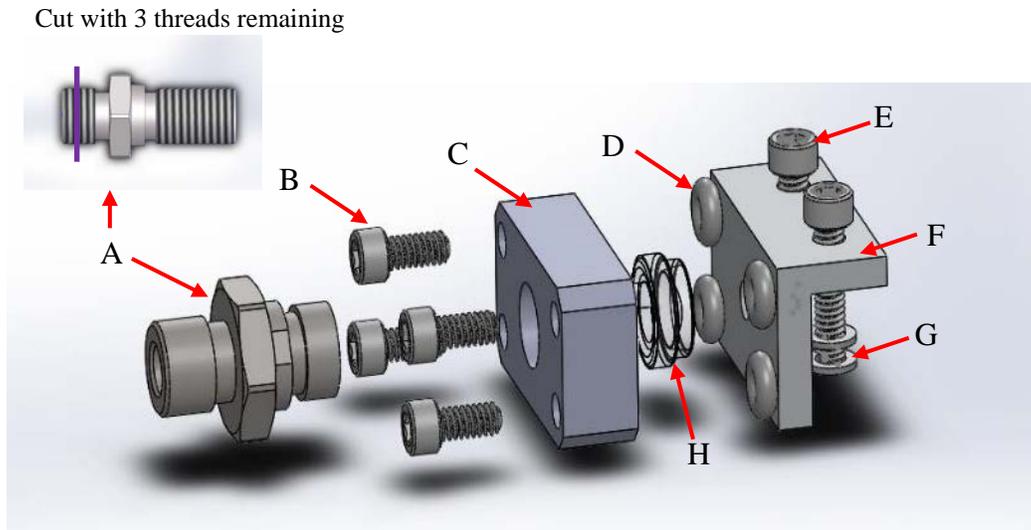


Figure 4. TOBB Lens Assembly: Attach completed TOBB lens blocks to the target plate using 4 each 2-56, 3/16" screws. If necessary and as shown in the figure, insert washers to raise the TOBB closer to the sample. Longer screws might be necessary if several washers are used. Shown is A - SMA coupler; B - 2-56, 3/16" screws; C - Lens holder; D - -003 O-rings; E - 2-56, 3/8" screws; F - Lens bracket; G - #2 flat washers (if needed); H - lens

3.2 Lens Assembly (refer to Figure 4)

1. Mix about 10 mL of 5-minute epoxy in the polystyrene dish. Apply a small amount of the epoxy in the pocket on the lens holder.
2. Place the lens in the pocket of the lens holder with the convex side up.
3. Cut the long end of the SMA coupler using a diamond saw so that only 3 threads remain. See Figure 4 inset (edges may need to be filed after cutting).
4. Repeat step 1 through 3 for the other holder as two lens holders are needed per target.

Note: Be sure not to get epoxy on the lens. Using minimal epoxy will help facilitate this.

5. Wait 20 minutes for the epoxy to cure then screw in the cut side of the SMA couplers to each lens holder.
6. Attach the lens bracket to the lens holder with four 2-56, 3/8" screws. Do so with both sets of lens holders, but for one, insert a set of four 2-56 O-rings (one per screw) sandwiched between the two pieces. The O-rings will be used for steering the beam during alignment. Ensure that the 2-56 screws are tight, so the lens units are secure.
7. Attach completed TOBB lens blocks to the target plate using 4 each 2-56, 3/16" screws. If necessary, insert washers under the lens block to raise the TOBB closer to the sample according to Table 1. Longer screws might be necessary if several washers are used.
8. Attach, via the SMA coupler, the TOBB send fiber to the lens block that has O-rings inserted.
9. Follow the steps for TOBB return fiber assembly below and then attach it to the remaining lens block.

3.3 TOBB Return Fiber Assembly

Supplies needed:

- Optical Fiber (Thorlabs FP400URT)
- 0.021mm fiber strippers (Micro-electronics MS1-21S-40-FS)
- 2 each 436 μm fiber connector tips (Fiber Optic Center 905-150-5004)
- 2 each 900 μm boot (Fiber Instrument Sales CONN10790025B)
- Masking tape or fiber holder (McMaster-Carr 76275A15)
- 5-minute epoxy (All Spec 14250-15093)
- 1.25" polystyrene weighing dish (Fisher Scientific 08-732-112)
- Cotton swabs, Puritan 868WCS (Fisher Scientific 19-120-472)
- Optional: Fiber connector heat oven (Fiber Instrument Sales F19772)
- Optional: Fiber patch cable SMA-SMA (Thorlabs M45L02)

Note: An alternative to building a TOBB return fiber, there is the option to purchase a premade patch fiber.

Steps:

1. Cut a length of fiber to approximately 72 inches.
2. Use fiber strippers with the 0.021 mm adapter (blue) to remove about 1/2 inch of the jacket off each end.
3. Gather two 436 μm fiber connectors and two 900 μm boots. Note: The metal strain reliefs and boots that ship with the fiber connectors should not be used.
4. Set up a system to hold fibers while the epoxy cures. There are various ways to hold the fibers. Two methods DCS uses are:
 - a. Taping them against a vertical surface. See Figure 5 for this setup.
 - b. Using a fiber holder apparatus such as a block of foam with an incision to hold the fibers in place. See Figure 6 for this setup.
5. Test fit the fibers into the connectors before applying epoxy.
6. Slide the boots up the fiber so they can be attached after epoxying the connectors on.
7. Mix 10 mL of 5-minute epoxy and apply to the stripped fiber end and part of the jacket.
8. Slide the connector onto the stripped fiber such that the fiber protrudes from the connector tip.
9. Apply a drop of 5-minute epoxy onto the tip. Be sure to keep epoxy from dripping down the sides (see Figure 5). If epoxy cures along the connector sides, the connector may not fit or screw into the bulkhead adapter in the hutch.
10. Wait for epoxy to cure for about 45 minutes such that the epoxy has hardened, then remove the tape from the fiber and slide the boot in place. To speed up curing times, a fiber connector heat oven may be used.
11. Proceed to polishing the fibers as described in [Section 7.0: Appendix A: Polishing Fibers](#).

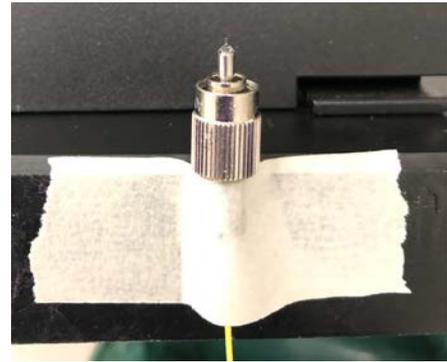


Figure 5. TOBB fiber taped with drop of epoxy on the tip



Figure 6. TOBB fiber holder apparatus with foam incisions

3.4 TOBB Optimization

Supplies Needed:

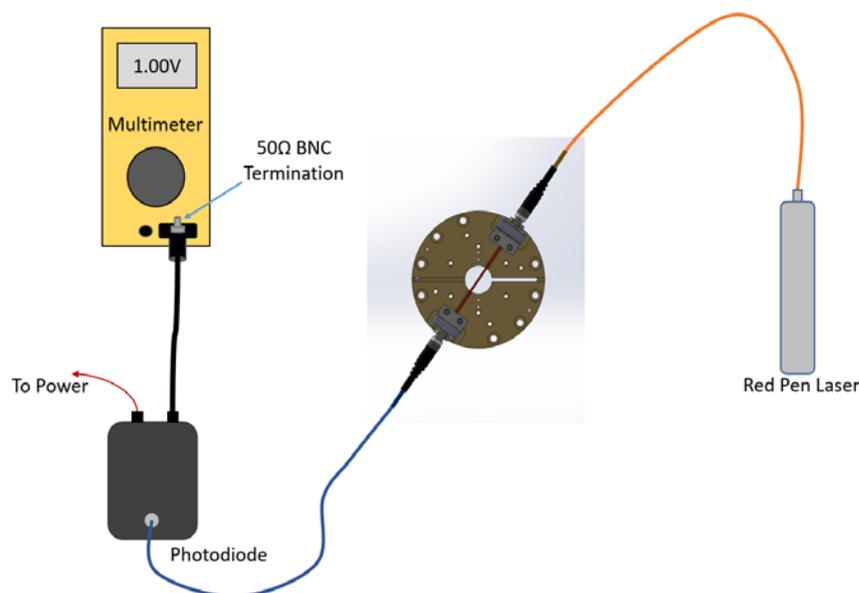
- Red Pen Laser (Wilcom F6230A VFL)
- Photodetector (Thorlabs PDA10A2)
- SMA fiber adapter cap (Thorlabs S120-SMA)
- Optional: 12V power supply to eliminate photodetector battery operation (Thorlabs LDS12B)
- Optional: PDA power supply cable to eliminate photodetector battery operation (Thorlabs PDA-C-72)
- Multimeter (McMaster-Carr 7093K761)
- BNC cable (Pasternack PE3067-12)
- BNC banana plug (Pasternack PE9008)
- 50Ω terminator (Pasternack PE6TR007)
- Target plate with TOBB assembly attached.

TOBB Optimization (refer to Figure 7)

1. Attach a fiber illuminator (red pen laser) to the send fiber's FC connector.
2. Attach the available end of the receive fiber to the photodetector and turn on the photodetector power supply. Turn on the multimeter to the DC voltage setting.
3. Check the TOBB signal. Maximize the signal by adjusting the pointing of the send fiber using the four socket-head screws that compress the O-rings [(B) in Figure 4]. 1-2 V is a typical signal level when aligned with a 50Ω terminator on the multimeter.
4. Check that the beam focus is near the center of the target plate by monitoring the beam diameter along the beam path with a slip of paper.

NOTE: Label TOBB fibers with the target plate number and remove them from the target plates before packing everything for shipment to the DCS.

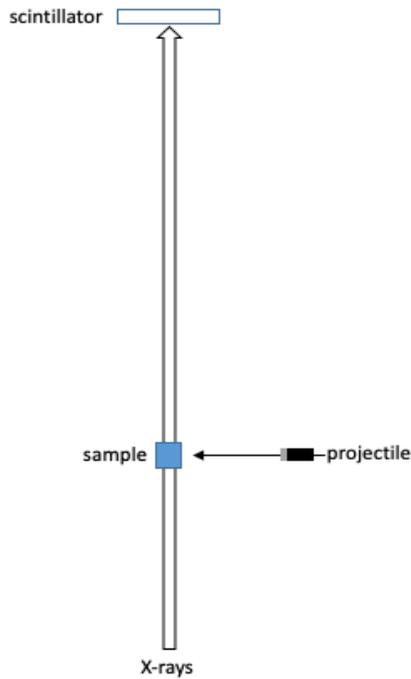
Figure 7. TOBB Optimization Diagram Setup



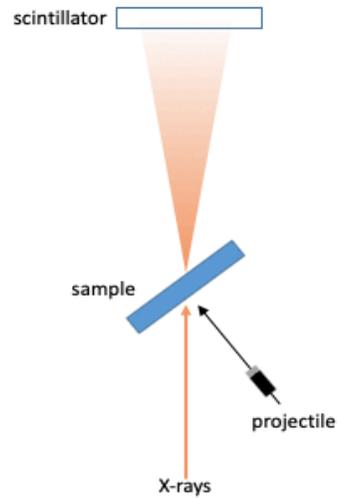
4.0 X-Ray Technique

Plate impact experiments at the DCS are typically conducted using X-ray Diffraction (XRD) or Phase Contrast Imaging (PCI). A typical experimental geometry for each technique is shown in Figure 8. PCI target designs can vary greatly depending on the scientific objectives, whereas XRD targets are standardized. Therefore, this document primarily focuses on XRD target assembly.

Figure 8. X-Ray Technique



Standard PCI Setup



Standard XRD Setup

4.1 XRD Sample Mounts

The spacer ring thickness is a straightforward parameter to change the trigger timing. Please refer to [Section 3.1: TOBB Assembly](#) describing the TOBB assembly for additional parameters to adjust. Appendix C, drawing number DCS-1001-1 details a spacer ring with a height of 3.8 mm. This is generally thick enough for the fastest velocities the DCS currently provides. After fabrication, the piece should be sanded and lapped. The sample is bonded in place over the central hole where the projectile passes. When positioning the sample, ensure that the sample does not cover both sets of dowel pin holes.

The following procedure details how to mount samples to the target plate for XRD experiments.

Supplies Needed:

- Brass target plate
- Spacer ring, (see Appendix C, drawing DCS-1001-1)
- Dowel pins, 1/16" diameter (McMaster-Carr 90145A423)
- Prepared sample
- 5-minute epoxy (All Spec 14250-15093)
- 1.25" polystyrene dish (Fisher Scientific 08-732-112)
- Cotton swabs Puritan 868WCS (Fisher Scientific 19-120-472)
- 4 each plastic 6-32, 1/4" socket head cap screws (McMaster-Carr 95868A294)

Steps:

1. Determine the appropriate TOBB to sample distance for your desired projectile velocity (See Formula on page 4 or Table 1 on page 5).
2. Prepare an appropriate thickness spacer ring, ensuring that the distance/time requirements are met. Follow Parts 2 through 4 from [Section 2.2: Target Plate Preparation and Characterization](#) on target plate preparation but with the spacer ring replacing the target plate.
3. Mix about 10 mL of 5-minute epoxy in a polystyrene dish or equivalent with the back end of a cotton swab or pick. Center the sample over the spacer ring center hole and bond it in place with the epoxy.
4. Once the epoxy has cured, attach the spacer ring to the target plate. Use plastic screws so that during a shot it separates intact from the target plate, reducing the risk of damaging the Lexan windows on the sides of the target chamber. Be sure that the x-ray slots on the spacer ring and target plate line up to avoid blocking incoming x-rays.

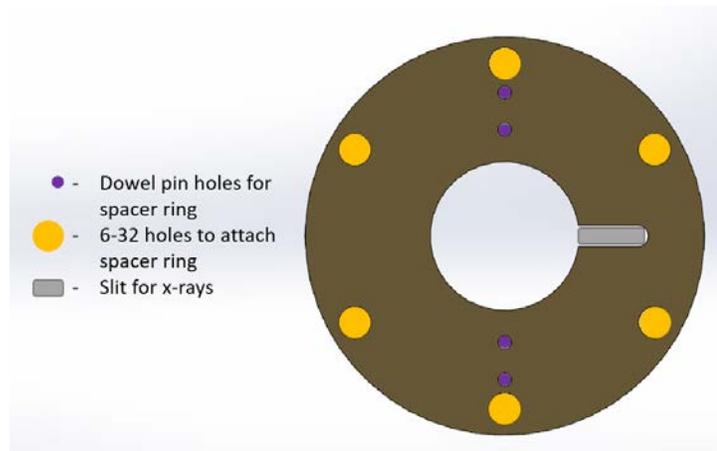


Figure 9. Spacer Ring: The slit on the right of the central hole allows the incident x-rays to reach the sample unimpeded in transmission mode. The six outer holes are to attach the spacer ring to the target plate and the dowel pin holes are used to precisely position the ring on the target plate.

4.2 PCI Sample Mounts

PCI sample mounts may be the same as those used for XRD but with x-rays incident normal to the gun barrel and projectile direction, a new sample mount design is usually preferred. The schematic below is an example configuration where the sample mount is U-shaped to allow the sample to sit above the target plate with enough clearance for the x-rays to pass through the sample unimpeded. The sample mount needs to be made of a soft material (aluminum or plastic) and the design requires DCS approval before fabrication.

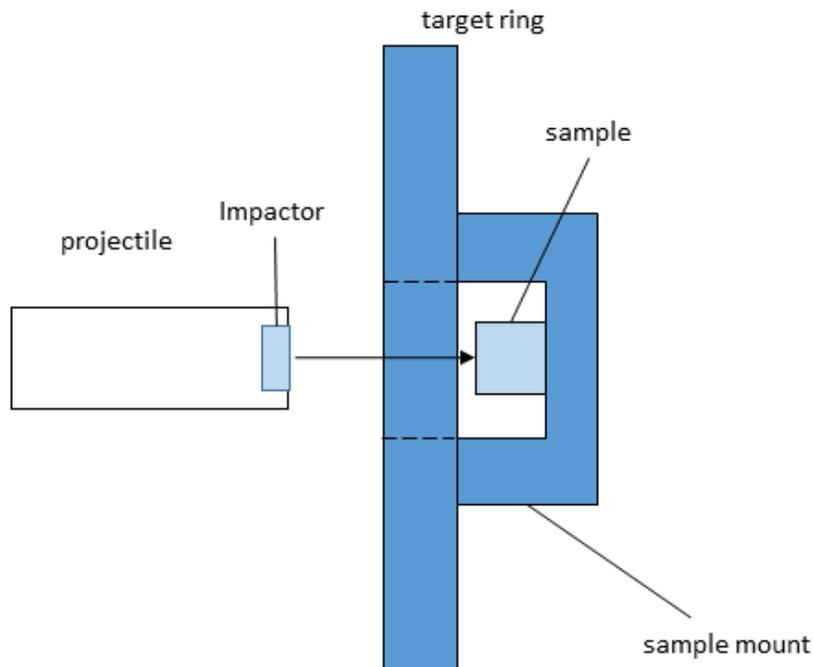


Figure 10. PCI Sample Mount: Take note that region of interest on the sample should reside above the back plane of the target plate to allow x-ray transmission

4.3 TOBB – Sample Distance Measurement

Supplies Needed:

- Red Pen Laser (Wilcom F6230A VFL)
- Photodiode (Thorlabs PDA10A2)
- Multimeter (McMaster-Carr 7093K761)
- BNC cable (Pasternack PE3067-12)
- BNC banana plug (Pasternack PE9008)
- 2 sets of 5x1” granite flats or equivalent (Starrett G-81691)
- Depth gauge (Mitutoyo 329-350-10)
- Completed target plate with TOBB assembly and sample attached.
- Depth gauge cylinder (see Appendix C, drawing DCS-1013-1)

Note: PDV/VISAR assemblies should not be attached for this step.

Before starting, ensure that the depth gauge has a half inch diameter cylinder attached to its shaft to act as a mock projectile. The cylinder must be fastened tightly to the depth gauge with its face perpendicular to the direction of travel. Instructions for attaching the cylinder to the shaft are provided after the measurement steps below.

1. With the target backside-down on a stand, place the granite parallels and depth gauge over it. Make sure one of each matching granite parallel is on each side.
2. Note the 100% transmission level on the multimeter and calculate what the 30% transmission level should be.
3. Hold the depth gauge firmly against the parallels and gently touch the depth gauge down on the sample impact surface. Zero the gauge.
4. Continue to hold the gauge firmly and back off the gauge until 30% transmission level is reached on the multimeter. At this location of 30% laser transmission, record the value listed on the depth gauge. This is the trigger to impact distance that must be provided to DCS staff for proper timing during an experiment.

Attaching cylinder to depth gauge shaft

Place cylinder polish-face down on a granite flat and fill the shaft hole with Epo-Tek 301 epoxy. Use granite parallels to support the depth gauge and lower the shaft into the cylinder shaft hole. Allow to cure for 24 hours.

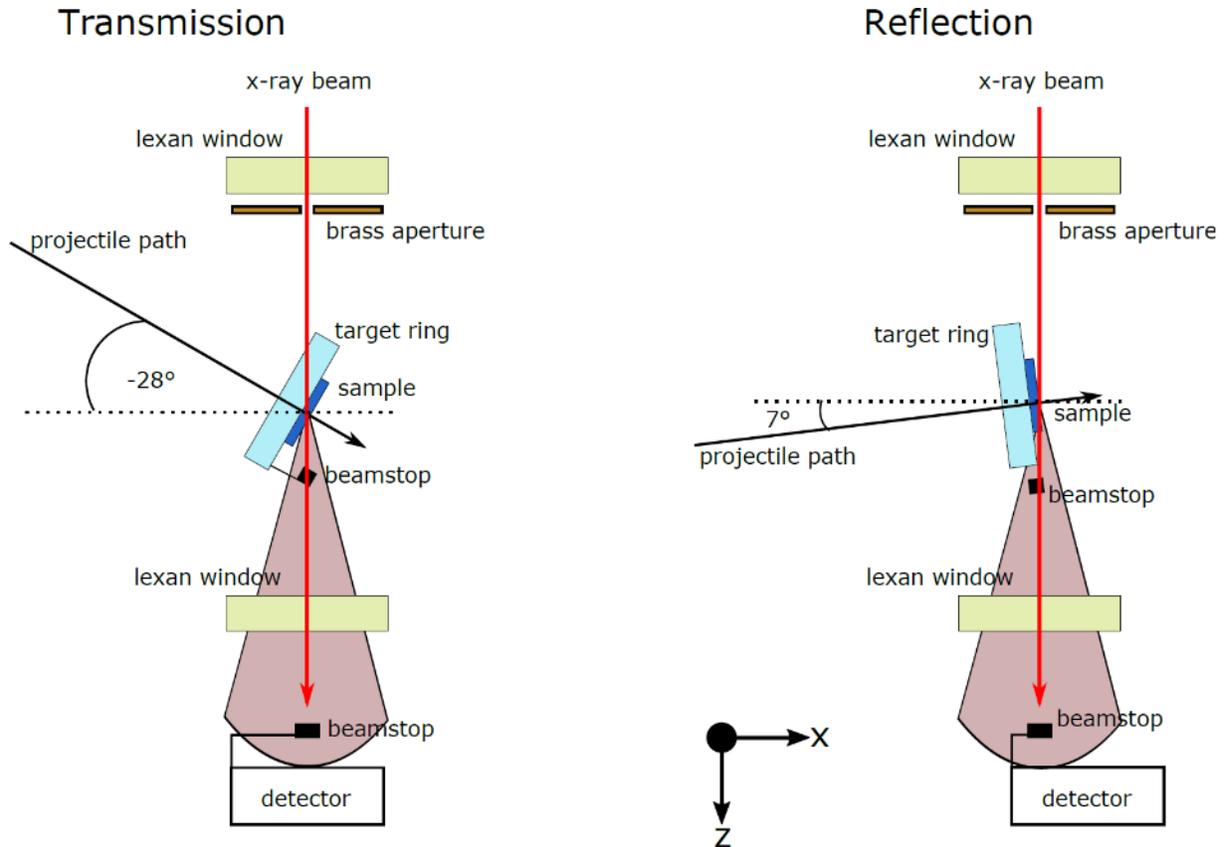


Figure 11. TOBB Distance

5.0 XRD Configuration

With x-ray diffraction, the user has the option to orient the sample either in transmission or reflection geometry (See Figure 12 below). Transmission experiments require a target mounted x-ray beam stop to prevent the main beam from impinging on the Lexan target chamber window. In reflection geometry, the target plate typically blocks the main beam and therefore the additional beam stop may not be needed. However, please review your final experimental geometry with your DCS POC before eliminating this beam stop from your target.

Figure 12. XRD Technique



5.1 Target Mounted Beam Stop Assembly

Supplies Needed:

- Dowel Pin Shaft 1/32" (McMaster-Carr 1263K11)
- Tungsten Carbide Rod 4mm diameter (McMaster-Carr 8791A95)
- Struers Diamond Saw (Accutom 100)
- 5-minute epoxy (All Spec 14250-15093)
- 1.25" polystyrene dish (Fisher Scientific 08-723-112)
- Cotton swabs, Puritan 868WCS (Fisher Scientific 19-120-472)

Steps:

1. Cut the Tungsten Carbide Rod into 2mm sections using the diamond saw.
2. Cut the dowel pin shaft into 1.5" length sections.
3. Mix about 10 mL of 5-minute epoxy and apply to a flat side of the Tungsten Carbide disk.
4. Center and press the tip of one end of the 1.5" dowel pin into the epoxy on the Tungsten Carbide.
5. Once the epoxy has cured, file the free end of the dowel pin to remove any burrs or deformation to the shaft.
6. Test that the beam stop inserts snugly into a target plate. If it does not, you may need to ream the target plate hole or re-file the dowel pin shaft. A snug fit is ideal during operation such that the stop position can easily be adjusted without the stop falling out of place.



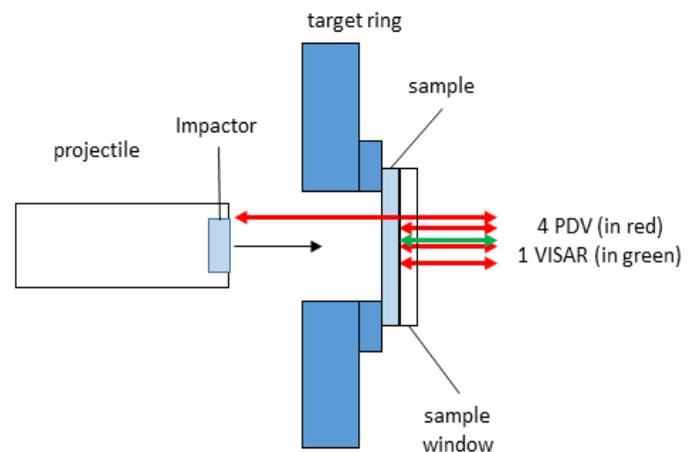
Figure 13. Target Mounted Beam Stop

6.0 Interferometry Techniques

All users have the option to incorporate dual VPF point VISAR and multi-point PDV diagnostics into their plate impact experiments. The interferometry techniques themselves will not be discussed in detail here, but the diagnostic preparation will depend on the interferometry techniques utilized. When the VISAR diagnostic is used, note that the standard DCS configuration is to use a “combo probe” as noted in [Section 6.3 PDV/VISAR Combo Probe Assembly](#) (i.e. both VISAR and PDV in the same probe). For the standard probe detailed in this document, the VISAR and PDV probe points are typically offset by 500-600 μm .

This section describes the assembly of the interferometry probes for a standard configuration provided by DCS. The user is welcome to modify the probe configuration, however, the design and materials to be used must be provided to the DCS POC, and approval granted prior to use of the components at the DCS. The standard configuration allows for 3 or 4 peripheral PDV probes with a central PDV/VISAR combo probe or a 4 or 5 PDV configuration without VISAR.

Figure 14. PDV with VISAR Standard Configuration



6.1 Target Plate Assembly for PDV Probes

Supplies Needed:

- 5-minute epoxy (All Spec 14250-15093)
- Red Pen Laser (Wilcom F6230A VFL)
- 1.25" polystyrene dish (Fisher Scientific 08-732-112)
- Cotton swabs, Puritan 868WCS (Fisher Scientific 19-120-472)
- 1 - 5 PDV probes (AC Photonics 1CL15P020LBC01)
- PDV probe holder (with 5 equally sized holes) (see Figure 15 and Appendix C, drawing DCS-1004-1)
- 3 plastic 6-32, 1/4" socket head cap screws (McMaster-Carr 95868A294)
- 3 of each standoff (McMaster-Carr 92745A340 or 92745A341)

Note: The example sample target in this section is using 6-32, 3/8" standoffs, and 6-32, 1/4" plastic screws.

Steps:

1. Record the length of the fiber leads for use in the post-shot timing measurements. They should be at least 1.5 m long to reach the fiber feed-through in the catch tank.
2. Mix about 10 mL of 5-minute epoxy in the polystyrene dish. Epoxy probes into the PDV-only probe holder as shown in Figure 16. Make sure probes are flush with the bottom of the assembly and do not pass too far beyond it as they may enter the scattering cone of the x-rays.
3. Using standoffs and plastic screws, attach the probe holder as pictured in Figure 17. The lengths of standoffs may differ depending on the target setup. Allow enough clearance for the x-ray scattering cone.

Note: DCS does not optimize the PDV probe pointing and return intensity. However, using the 3/8" standoff with about 1/8" distance to the sample surface has consistently provided adequate PDV return intensity.

4. Use the red pen laser to verify the PDV probe throughput. All outputs should have similar intensities.
5. Using a permanent marker, number each probe with the corresponding number of hashmarks at the end of each fiber on the boot of the fiber connector (see Figure 18). Proper numbering facilitates proper connection of fibers during the experimental setup. Please do not use adhesive labels or tape as these can fall off during shipment/assembly.

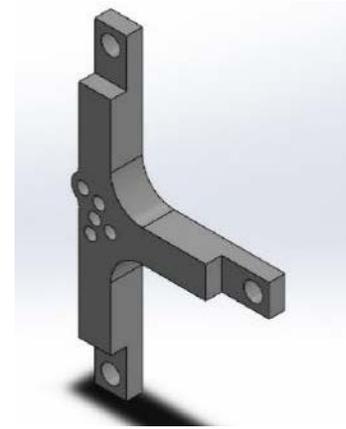


Figure 15. PDV Probe Holder (PDV only)

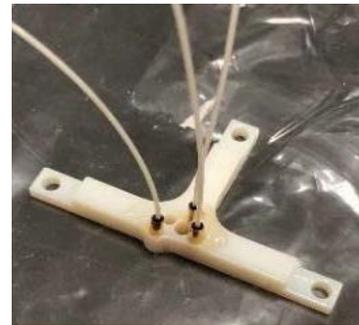


Figure 16. PDV Fibers attached to probe holder

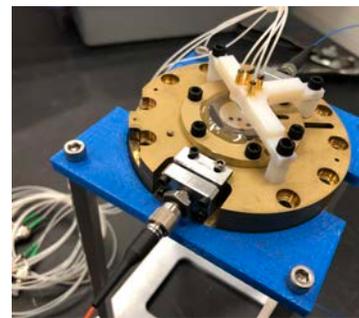


Figure 17. PDV probes attached to target

6. Bundle the fibers neatly (as shown in Figure 19) prior to shipment for ease of installation at the DCS.
 - o Tie the fiber bundle approximately every 6-12 inches, preferably using spiral-cut tubing as shown below.
 - o Please do not bundle with adhesive tape as this is difficult to remove, if needed, without damaging the fibers.
7. Prior to shipping, bundled assemblies may then be placed in individual bags labeled for their respective target.
 - o Spool the bundle such that it will unwind without tangling.
 - o Be sure to include plenty of packing materials to provide strain relief.
 - o When packaging, be mindful to avoid pressure at the connection point of each fiber to the lens assembly. Most breaks in shipping occur at this point. See Figure 20 for an example of how to provide this strain relief for packaging.



Figure 18. PDV probes properly labeled with hash marks on the boot of each connector.

Figure 19. Proper bundling of PDV fibers using spiral-cut tubing.

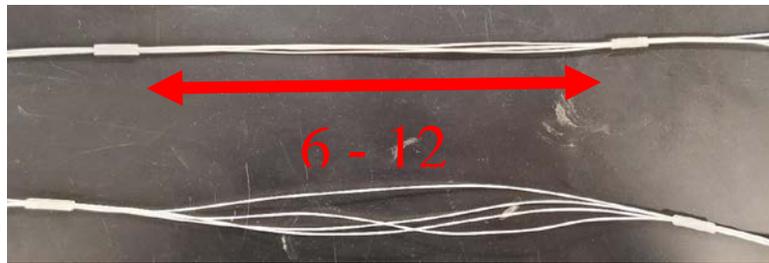


Figure 20. Example for providing strain relief to bundled PDV probe assembly



6.2 Target Plate Assembly for VISAR and PDV Probes

Supplies Needed:

- 5-minute epoxy (All Spec 14250-15093)
- Red Pen Laser (Wilcom F6230A VFL)
- 1.25" polystyrene dish (Fisher Scientific 08-732-112)
- Cotton swabs, Puritan 868WCS (Fisher Scientific 19-120-472)
- 3 PDV probes (AC Photonics 1CL15P020LBC01)
- PDV/VISAR combo probe (see [Section 6.3: PDV/VISAR Combo Probe Assembly](#))
- PDV probe holder with VISAR bypass (4 smaller holes and 1 larger center hole) (see Figure 21 and Appendix C, drawing number DCS-1005-1)
- PDV/VISAR combo probe holder (see Figure 22 and Appendix C, drawing number DCS-1006-1)
- 3 plastic 1/2" socket head cap screws (McMaster-Carr 95868A298)
- 3 of each standoff length: 1" and 3/8" (McMaster-Carr 92745A346, and McMaster-Carr 92745A340 or 92745A341)
- 4-40, 1/4" Set Screw (McMaster-Carr 92311A106)

Note: The example sample target in this section is using 6-32, 3/8" and 6-32, 1" standoffs, and 6-32, 1/2" plastic screws.

Figure 21. Standard PDV probe holder design for PDV/VISAR combo

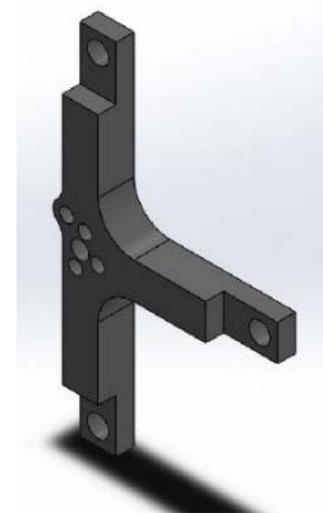
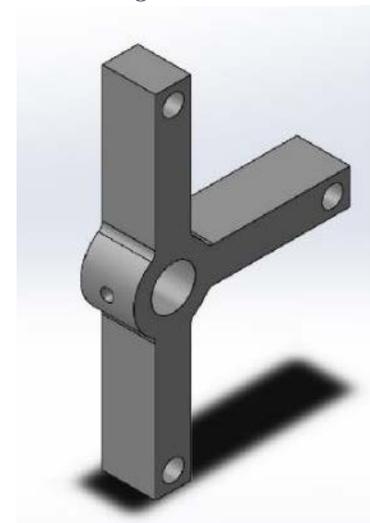


Figure 22. Standard PDV/VISAR combo probe holder design



Steps:

Note: If using non-DCS standard length PDV probe fibers (62.25"), measure and record the fiber lengths for use in the post-shot timing analysis (including the combo probe PDV fiber length).

1. Follow all steps in [Section 6.1: Target Plate Assembly for PDV Probes](#), leaving the larger center hole open for a VISAR beam.
2. Using standoffs and plastic screws, attach the probe holders as pictured in Figure 23. The lengths of standoffs may differ depending on the target setup.
3. Insert the 4-40, 1/4" set screw into the combo probe holder to hold the lens tube in place.

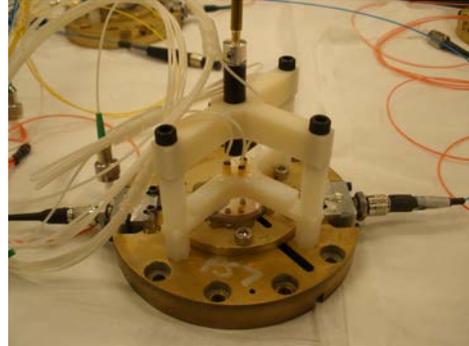


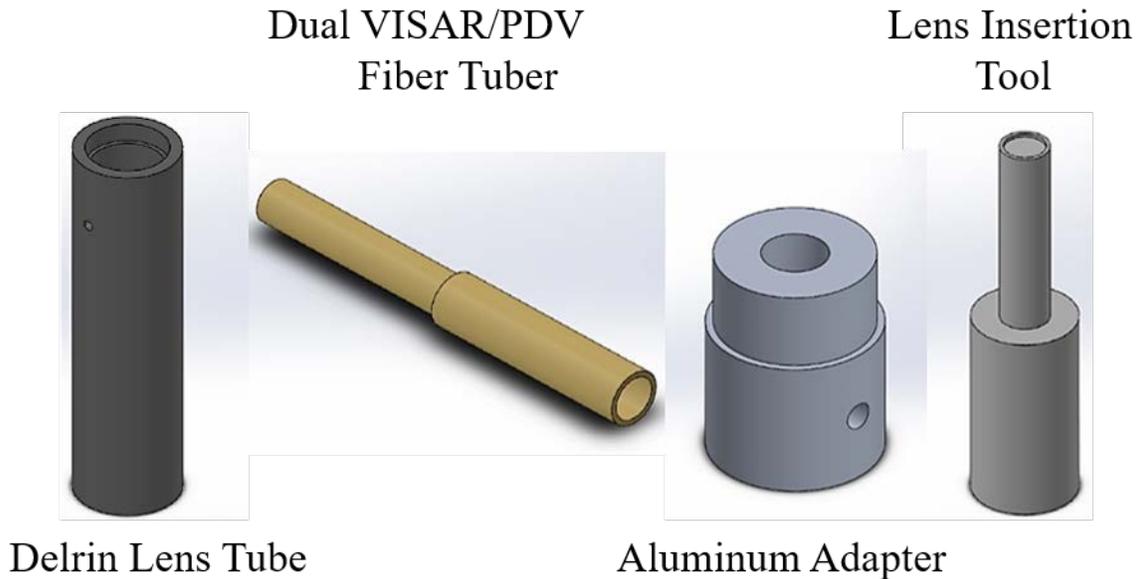
Figure 23. PDV/VISAR combo probe attached to target

6.3 PDV/VISAR Combo Probe Assembly

Supplies Needed:

- 1 each 2-56, 1/8" Set Screw (McMaster-Carr 92311A074)
- 2 each 1.25" polystyrene dish (Fisher Scientific 08-732-12)
- 2 each 10 ml syringe (Fisher Scientific 03-377-23)
- Cotton swabs, Puritan 868WCS (Fisher Scientific 19-120-472)
- Epoxy (5-min) (All Spec 14250-15093)
- 301 Epoxy (hardener and resin) (EpoTek 301/8oz/1lb)
- 1 each 6 mm diameter x 12 mm F.L. plano-convex lens (Edmund Optics 32471)
- 1 each 6 mm diameter x 30 mm F.L. plano-convex lens (Edmund Optics 45119)
- 1 each 3-meter, 900 μ m SM SMF-28 ultra patch cables; 1/2 per shot (Fiber Instrument Sales N97A7AS3FISCU)
- 1 each brass fiber tube (custom built) (see Appendix C, drawing DCS-1008-1)
- 1 each Delrin lens tube (custom built) (see Appendix C, drawing DCS-1007-1)
- 1 each aluminum adapter (custom built) (see Appendix C, drawing DCS-1009-1)
- Lens insertion tool (custom built) (see Appendix C, drawing DCS-1010-1)
- 1 each FC/APC 285 μ m bore connector with boot (Fiber Optic Center 944-602-50285)
- ~70" Custom VISAR graded index fiber (OFS Optics LLC C15863)
- 0.021 mm fiber stripper (MS1-21S-40-FS, blue)
- 0.012 mm fiber stripper (MS1-12S-21-FS, white)
- 0.006 mm fiber stripper (MS1-06S-13-FS, purple)
- Class 2 Red Pen Laser or equivalent (Wilcom F6230A)
- 0.018" reamer (McMaster-Carr 8930A127)
- Class 2 Green laser (Thorlabs CPS532-C2)

Figure 24. PDV/VISAR combo probe component (not to scale)

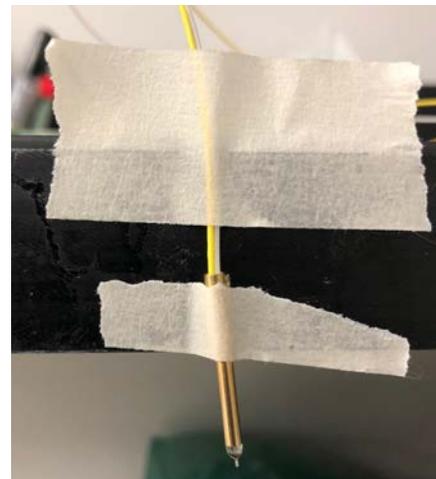


Note: The lens tube material is made from soft Delrin. This is preferred to protect the target chamber window from damage during an experiment. Additionally, note the vent hole located on the side of the lens tube. This is to allow air to escape the assembly when placed under vacuum.

Preparing Fibers

1. Cut the PDV patch fiber cable in half. Only one half is needed so two PDV/VISAR combo probes can be made per one full PDV patch cable.
2. Cut a length of the custom VISAR fiber to the same length as the PDV fiber (about 1.5 m).
3. Strip off 1 inch of the jacket on both ends of the VISAR fiber and the one end of the PDV fiber using the 0.021 mm (blue) fiber stripper.
4. Strip off 1/2 inch of fiber coating on both ends of the VISAR fiber using the 0.012 mm stripper (white).
5. Strip off 1/2 inch of fiber coating on the PDV fiber using the 0.006 mm stripper (purple).
6. Tape the brass fiber tube to the side of a table and carefully insert the cut/stripped PDV fiber followed by a VISAR fiber. Ensure they are fully pushed through the tube and tape fibers down so that they do not shift. See Figure 25 for setup.
 - o Note: If you are having excessive difficulty pushing both fibers through the fiber tube, ream the smallest diameter channel of the fiber tube with a 0.018" reamer.
7. Add both parts of 301 epoxy into a 1.25" polystyrene weighing dish. Use a ratio of 1.5 resin to 6 of hardener by weight. Do this by zeroing the dish on a scale. Then use a 10 ml syringe to add 1.5 g of resin to the dish and then a second syringe to add 6 g of hardener. Mix the epoxy thoroughly for 1-2 minutes.

Figure 25. Taped dual fiber tube with epoxy plug



8. Insert 301 epoxy into the open end of the brass tip. Since the epoxy has low viscosity, use the wooden end of a cotton swab to drip epoxy from the cup. The brass fiber tube should be full of epoxy. 301 epoxy takes 24 hours to fully cure. If the 301 epoxy is coming out of the bottom during filling, then it is suggested to plug the bottom hole with 5-minute epoxy prior to adding 301 epoxy as seen in Figure 25.
9. Use steps 4 through 10 from [Section 3.3: TOBB Return Fiber Assembly](#) to attach one FC/APC 285 μm bore connector with boot onto the exposed end of the VISAR fiber.
10. Once the connector and brass tip have both cured, polish all fiber tips as described in [Section 7 Appendix A: Polishing Fibers](#) Then set aside for later.

VISAR Lens Tube Assembly

1. Mix 10 mL of 5-minute epoxy into a polystyrene dish and apply a light amount to the deeply recessed shelf in the tube.
2. Insert a 12mm focal length lens, convex side inward as shown in Figure 26. Be sure not to get epoxy on the lens. To assist in placing the lens inside the lens tube, place the lens on the lens insertion tool and push the lens tube over and down until it stops. Be careful not to pull the insertion tube out too quickly as it may generate a negative pressure and dislodge the newly inserted lens.
3. Epoxy the aluminum adaptor into same side of tube.
4. Allow the epoxy to cure for 20 minutes.
5. Insert the 2-56, 1/8" set screw into aluminum adaptor. Do not tighten down all the way.
6. Take the polished PDV/VISAR combo probe assembly from the above section, Preparing Fibers, step 10, and insert it into the aluminum adaptor.
7. Insert the VISAR FC fiber connector into a Class 2 green laser (used in the VISAR optimization module in the next section) and turn the laser on.
8. Collimate the beam by pointing the lens tube at a bright, flat surface at a long distance and adjusting the combo probe in and out. Make the resulting laser spot as small as possible. Also rotate the probe so that the beam is mostly circular and does not appear clipped by the lens tube. Furthermore, if the beam has unusual structure, check that no epoxy leaked onto the lens. (Turn the laser off before inspecting the lens!)
9. After the beam is collimated and centered, tighten the set screw to hold the probe in place.
10. Mix 10 mL of 5-minute epoxy and apply to the shelf on the open tube end as pictured in Figure 27.
11. Insert a 30 mm lens onto the shelf with the convex side inwards. Again, be sure to keep epoxy off the lens.
12. Let the epoxy cure for a minimum of 20 minutes.

Figure 26. 12 mm lens insertion

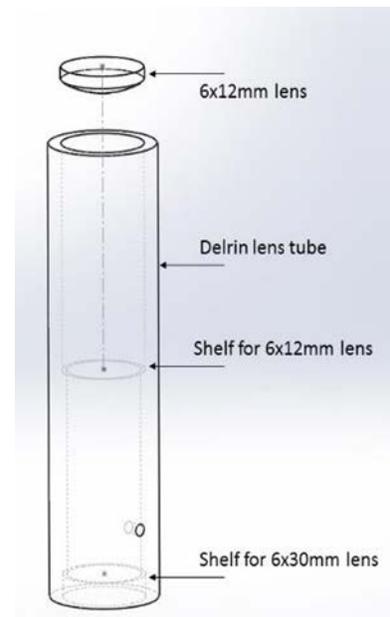
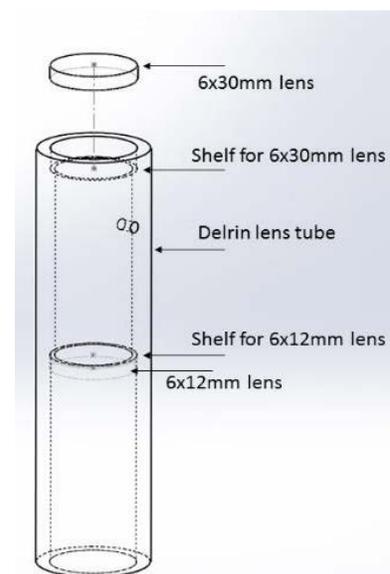


Figure 27. 30 mm lens insertion



6.4 VISAR Probe Optimization

A completed target assembly is required in order to focus the combo probe on the sample. Furthermore, a focused probe is needed to perform the VISAR return optimization.

Supplies Needed:

- Completed target assembly
- Completed PDV/VISAR combo probe
- Optimization module setup (components listed under the category [VISAR Optimization](#) in 8.0 Appendix B: Summary of Components for Target Assembly)
- 5-minute epoxy (All Spec 14250-15093)
- 1.25" polystyrene dish (Fisher Scientific 08-732-112)
- Cotton swabs, Puritan 868WCS (Fisher Scientific 19-120-472)

Note: If the optimization setup needs to be constructed, refer to the overview after the following Steps section.

Steps:

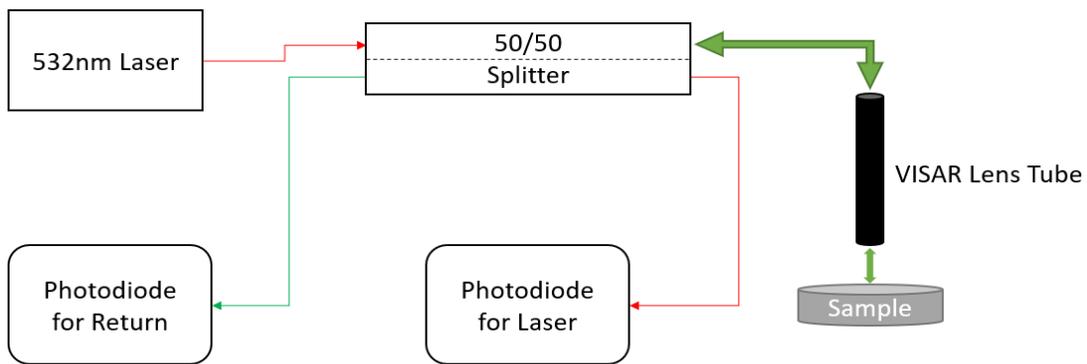
1. Attach PDV/VISAR combo probe fiber to the VISAR optimization setup 50/50 splitter output.
2. Insert the PDV/VISAR probe into combo probe holder.
3. Turn on the laser and let it warm up for at least 30 seconds to stabilize the send signal.
4. Adjust (up, down, rotate) the probe in the holder to maximize the return voltage from target.
5. Tighten the 4-40 set screw in the combo probe holder to hold the PDV/VISAR lens tube in place.
6. Epoxy the probe in place to provide additional security in preventing the probe from slipping during handling.

Note: The output on the VISAR return from the probe should be at least 50% above baseline values. To check, use a piece of paper to cover up the spot on the target. This number is your baseline value. Then remove the paper to get the reflected value.

VISAR Probe Optimization Setup

A simple laser and photodiode are needed to optimize the VISAR return signal from the target, see Figure 28. This section gives a brief overview of how this can be achieved. The 532nm laser is sent into a 50/50 splitter. One leg is sent to a photodiode (gain detector) to provide direct laser output levels. The other leg is sent to the target. Due to the 50/50 splitter, the return from the target is also split. The Class 2 laser is weak enough that the return laser does not damage the laser input. The other leg on the return side is connected to a second photodiode. From this second photodiode reading, we maximize the return level to give optimal signal strength. The photodiodes are connected to a multimeter to read the converted voltage using a BNC cable and BNC banana plug.

Figure 28. VISAR Optimization Setup

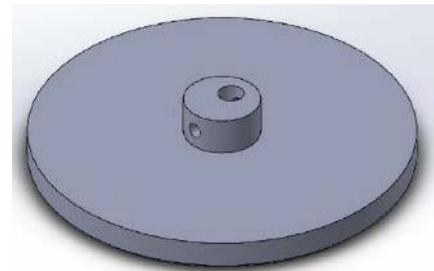


7.0 Appendix A: Polishing Fibers

Supplies Needed:

- Assembled TOBB or VISAR fiber
- Isopropanol
- Kimwipes (Fisher Scientific 06-666A)
- 400-grit sandpaper (McMaster-Carr 4671A32)
- Fiber polishing paper (grit sizes: 30, 9, 5, 1, 0.3 μm) (See Components list for part #'s)
- Flat SMA polishing puck (Thorlabs D50-SMA – SMA)
- Flat plate (can use glass or granite) (Fiber Instrument Sales F19111A)
- Fiber scope (Fiber Instrument Sales VS300)
- Cotton swabs, Puritan 868WCS (Fisher Scientific 19-120-472)
- Cotton swabs, Puritan 823WC (Fisher Scientific 19-062-710)
- Fiber cleaner, type A (Fiber Instrument Sales F16270)

Figure 29. PDV/VISAR combo probe polishing puck



For PDV/VISAR combo probe only:

- Angled FC connector polishing puck (Thorlabs D50-FC/APC)
- PDV/VISAR combo probe polishing puck (see Appendix C, drawing DCS-1011-1)
- Fiber scope/puck adaptor (if fiber scope part # AFL OFS 300-200C is used, see Appendix C, drawing DCS-1012-1)

Once the epoxy for fiber assembly is completely dry (one hour) the fiber needs to be polished using fiber polishing paper and the appropriate puck:

- TOBB fiber connectors need the flat SMA puck to polish
- VISAR fiber connectors need the FC/APC angled puck to polish
- PDV/VISAR combo probes need the custom 10 deg angled puck to polish
- The polishing paper order is 30 μm , 9 μm , 5 μm , 1 μm , and 0.3 μm .

Steps:

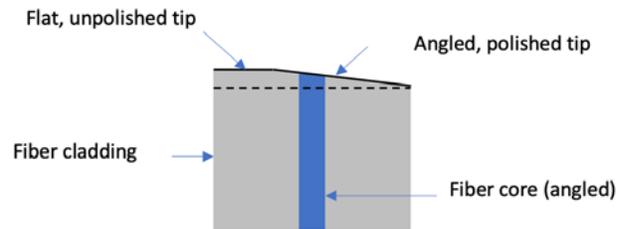
Note: These steps will be repeated, depending where you are in the polishing paper order.

1. Trim any excess fiber down to the epoxy bead on the fiber tip surface.
2. Use a 400-grit sandpaper to remove the epoxy bead, stopping as soon as you are removing metal from the fiber tip.
3. Clean the flat polishing plate with Isopropanol and a Kimwipe to remove any dust and debris.
4. Put a few drops of Isopropanol on the glass plate to hold the polishing paper in place.

Note: Pull a fiber polishing paper from the middle of the package to minimize particulate on the sheets.

5. Place the polishing paper on the plate. Avoid trapping air bubbles underneath the polishing paper. Several drops of Isopropanol are used as a lubricant for the pink and light blue papers to avoid cracking the fiber.
6. Attach the fiber to the polishing puck, making sure the tip is exposed for polishing. Keep in mind which puck is needed.
7. Polish the fiber using a figure 8 motion. If using the FC/APC puck on the VISAR fiber tip, be mindful to leave a small portion of the metal connector tip unpolished. See Figure 30. Diagram of angled polished fiber tip for explanation.
8. If using 1 μm or 0.3 μm grit paper, clean the fiber tip with a cotton swab and Isopropanol.
9. If the fiber tip is not the PDV/VISAR combo fiber, then remove the fiber from the puck and inspect it using the fiber scope. The Fiber will still have scratches at higher grit. However, they should be getting less as grit size decreases. For the PDV/VISAR combo fiber tip, the puck must remain attached until the fiber polish is complete. Due to this, when the tip is inspected with the fiber scope, the custom puck adapter must be installed to the scope.
10. Repeat steps 3 through 9 with decreasing paper grit size. Scratches will slowly disappear with decreasing polishing paper size.

Figure 30. Diagram of angled polished fiber tip



- Note: It may not be necessary to check with a fiber scope after every paper iteration. However, it is suggested to check the fiber tip surface with a fiber scope after the 5 μm , 1 μm , and 0.3 μm papers.
11. Perform a final cleaning with fiber cleaner and place the protective cap back onto the connector tip. No scratches should be observable in the fiber core area.

Figure 31. Fiber scope with custom Puck Adapter (drawing DCS-1012-1



8.0 Appendix B: Summary of Components for Target Assembly

Category	Item	Manufacturer	Part #
Fiber polishing	Cletop Tape Refill Blue for F1-6270 Series	Fiber Instrument Sales	F16271
Fiber polishing	Cletop Connector Cleaner SC,FC,ST, Type A Blue Tape	Fiber Instrument Sales	F16270
Fiber polishing	AngstromLap 30 μm Aluminum Oxide Lapping Film, 3 \times 6" Sheet with 3mil Backing.	Fiber Optic Center	AO30F363N100
Fiber polishing	AngstromLap 9 μm Aluminum Oxide Lapping Film, 3 \times 6" Sheet with 3mil Backing	Fiber Optic Center	AO9F363N100
Fiber polishing	AngstromLap 5 μm Aluminum Oxide Lapping Film, 3 \times 6" Sheet with 3mil Backing.	Fiber Optic Center	AO5T363N100
Fiber polishing	AngstromLap 1 μm Aluminum Oxide Lapping Film, 3 \times 6" Sheet with 3mil Backing.	Fiber Optic Center	AO1T363N100
Fiber polishing	AngstromLap 0.3 μm Calcined Alumina Lapping Film, 5" Disk with 2mil Backing.	Fiber Optic Center	CA03F502N100
Fiber polishing	Isopropanol (2-Propanol), 1 gallon bottle	VWR International	BDH2032-1GLP
Fiber polishing	Kimwipes large.	Fisher Scientific	06-666A
Fiber polishing	Cotton swabs, Puritan 868WCS	Fisher Scientific	19-120-472
Fiber polishing	Cotton swabs, Puritan 823WC	Fisher Scientific	19-062-710
Fiber polishing	Aerosol Duster	Fisher Scientific	23-022-523
Fiber polishing	Sandpaper 400 grit	McMaster-Carr	4671A32
Fiber polishing	FC/APC Connector Polishing Disc	Thorlabs	D50-FC/APC
Fiber polishing	SMA Connector Polishing Disc	Thorlabs	D50-SMA - SMA
Fiber polishing	FIS FC/PC Polish Disc	Fiber Instrument Sales	F16925FC
Fiber polishing	Fiber polishing plate	Fiber Instrument Sales	F19111A
Fiber polishing	Fiber scope	Fiber Instrument Sales	VS300
Sample assembly	Spacer Ring	Custom Built	Drawing# DCS-1001-1
Sample assembly	Sample	Custom Built	
Sample assembly	Plastic 6-32, 1/4" Socket Head Cap Screws	McMaster-Carr	95868A294
Sample assembly	Alignment Dowel Pins 1/16" x 1"	McMaster-Carr	90145A423

Sample assembly	Epoxy (5-min)	All-Spec	14250-15093
Sample assembly	1.25" polystyrene dish	Fisher Scientific	08-732-112
Sample assembly	Cotton swabs, Puritan 868WCS	Fisher Scientific	19-120-472
Sample assembly	Nylon Hexhead Standoff 1/4"	McMaster-Carr	92745A340
Target Plate Preparation	Target Ring	Custom Built	Drawing# DCS-1000-1
Target Plate Preparation	Alignment Dowel Pins 1/16" x 1"	McMaster-Carr	90145A423
Target Plate Preparation	6-32 tap	McMaster-Carr	2522A667
Target Plate Preparation	2-56 tap	McMaster-Carr	2522A663
Target Plate Preparation	1/32" reamer	McMaster-Carr	8930A117
Target Plate Preparation	1/16" reamer	McMaster-Carr	8803A141
Target Plate Preparation	120-grit adhesive-backed silicon carbide sanding disc	McMaster-Carr	4678A172
Target Plate Preparation	Aerosol Duster	Fisher Scientific	23-022-523
Target Plate Preparation	Granite flat	Starrett	G-81803
Target Plate Preparation	Drop gauge	Heidenhain	329 352-01
Target Plate Preparation	Lapping machine with lapping fluid	Lapmaster	
Target Plate Preparation	Isopropanol (2-Propanol) 1-gallon bottle	VWR International	BDH2032-1GLP
Target Plate Preparation	Kimwipes large.	Fisher Scientific	06-666A
Target Plate Preparation	Ultrasonic Cleaner	VWR	97043-988
PDV/VISAR probes	2-56, 1/8" Set Screw	McMaster-Carr	92311A074
PDV/VISAR probes	3.5" polystyrene dish	Fisher Scientific	08-732-113
PDV/VISAR probes	1.25" polystyrene dish	Fisher Scientific	08-732-112
PDV/VISAR probes	Syringe 10 ml	Fisher Scientific	03-377-23
PDV/VISAR probes	Cotton swabs, Puritan 868WCS	Fisher Scientific	19-120-472
PDV/VISAR probes	Epoxy (5-min)	All-Spec	14250-15093
PDV/VISAR probes	301 Epoxy	EpoTek	301/8oz/1lb
PDV/VISAR probes	6 mm diameter x 12 mm F.L. plano-convex lens	Edmund Optics	32471
PDV/VISAR probes	6 mm diameter x 30 mm F.L. plano-convex lens	Edmund Optics	45119
PDV/VISAR probes	900 μ m SMA ultra patch cables, 3 meters, 1.5 per shot	Fiber Instrument Sales	N97A7AS3FISCU
PDV/VISAR probes	Fiber tube Brass	Custom Built	Drawing# DCS-1008-1
PDV/VISAR probes	Lens tube Delrin	Custom Built	Drawing# DCS-1007-1
PDV/VISAR probes	Adapter Aluminum	Custom Built	Drawing# DCS-1009-1
PDV/VISAR probes	FC/APC 285 μ m bore connector	FOCenter	944-602-50285

PDV/VISAR probes	Custom VISAR graded index fiber	OFS	C15863
PDV/VISAR probes	Lens insertion tool	Custom Built	Drawing# DCS-1010-1
PDV/VISAR probes	Fiber scope polishing puck adaptor	Custom Built	Drawing# DCS-1012-1
PDV/VISAR probes	PDV/VISAR Combo Polishing Puck (10 deg)	Custom Built	Drawing# DCS-1011-1
PDV/VISAR probes	Fiber stripper 0.012 mm	Micro-electronics	MS1-12S-21-FS
PDV/VISAR probes	Fiber stripper 0.006 mm	Micro-electronics	MS1-06S-13-FS
PDV/VISAR assembly	3D Printed PDV/VISAR Combo Probe Holder	APS 3D Printer (custom built)	Drawing# DCS1006-1
PDV/VISAR assembly	Nylon Hexhead Standoff 1"	McMaster-Carr	92745A346
PDV/VISAR assembly	4-40, 1/4" Set Screw	McMaster-Carr	92311A106
PDV/VISAR assembly	Plastic 6-32, 1/2" Socket Head Cap Screws	McMaster-Carr	95868A298
PDV Assembly	Probe Assembly	AC Photonics	1CL15P020LBC01
PDV Assembly	3D Printed PDV Probe holder with VISAR bypass (custom built)	APS 3D Printer	Drawing# DCS-1005-1
PDV Assembly	3D Printed PDV Probe holder (custom built)	APS 3D Printer	Drawing# DCS-1004-1
PDV Assembly	Nylon Hexhead Standoff 1/4"	McMaster-Carr	92745A340
PDV Assembly	Nylon Hexhead Standoff 3/8"	McMaster-Carr	92745A341
PDV Assembly	Plastic 6-32, 1/4" Socket Head Cap Screws	McMaster-Carr	95868A294
PDV Assembly	Epoxy (5-min)	All-Spec	14250-15093
PDV Assembly	1.25" polystyrene dish	Fisher Scientific	08-732-112
PDV Assembly	Cotton swabs, Puritan 868WCS	Fisher Scientific	19-120-472
TOBB Optics Assembly	Lens f.l. 4.6mm	Thorlabs	CAY046-100
TOBB Optics Assembly	-003 O-ring	McMaster-Carr	9452K11
TOBB Optics Assembly	SMA jack connector cut to 0.48"	Thorlabs	ADASMA-10
TOBB Optics Assembly	2-56, 3/8" Socket Head Cap Screws	McMaster-Carr	96006A234
TOBB Optics Assembly	Flat Washer, Number 2 Screw Size, NAS-620-C2	McMaster-Carr	90945A705
TOBB Optics Assembly	TOBB lens bracket	Custom Built	Drawing# DCS-1003-1
TOBB Optics Assembly	TOBB lens holder	Custom Built	Drawing# DCS-1002-1
TOBB Optics Assembly	2-56, 3/16" Socket Head Cap Screws	McMaster-Carr	92196A076

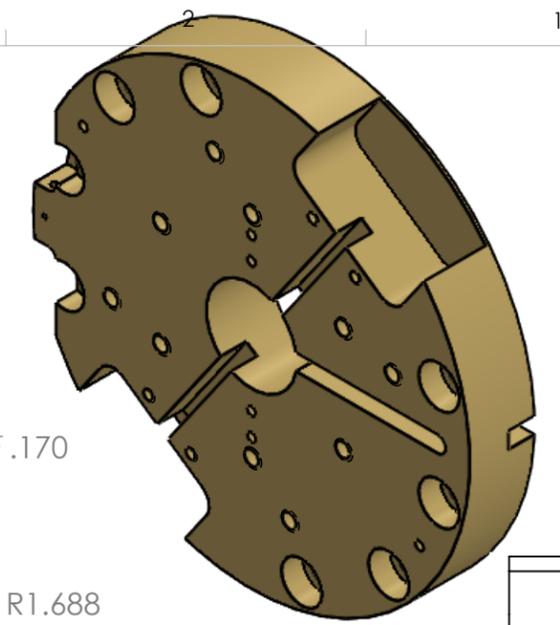
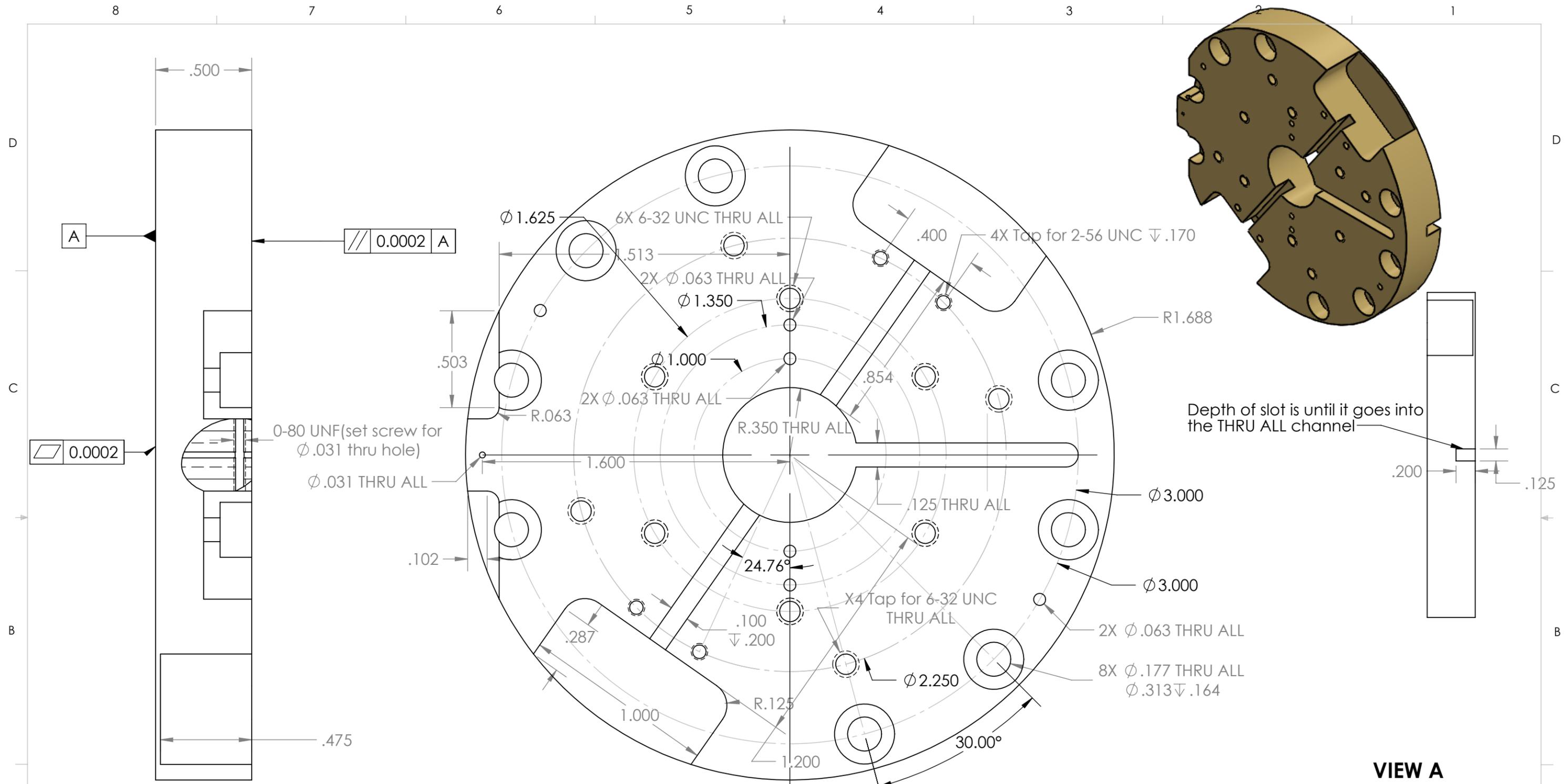
TOBB Optics Assembly	50 µm core fiber assembly N-1-1-7U-M-1.5-FIS-TLC- PL	Fiber Instrument Sales	F104
TOBB Fiber Assembly	435 µm cladding fiber 400 µm core	Thorlabs	FP400URT
TOBB Fiber Assembly	SMA 436 µm bore connector	FOCenter	9051505004
TOBB Fiber Assembly	900 µm Boot	Fiber Instrument Sales	CONN10790025B
TOBB Fiber Assembly	Fiber stripper 0.021mm	Micro- electronics	MS1-21S-40-FS
TOBB Fiber Assembly	Epoxy (5-min)	All-Spec	14250-15093
TOBB Fiber Assembly	1.25" polystyrene dish	Fisher Scientific	08-732-112
TOBB Fiber Assembly	Cotton swabs, Puritan 868WCS	Fisher Scientific	19-120-472
TOBB Fiber Assembly	Masking tape 0.5" x 60 yards	McMaster-Carr	76275A15
TOBB Fiber Assembly	Fiber connector heat oven	Fiber Instrument Sales	F19772
TOBB Fiber Assembly	Fiber patch cable SMA-SMA	Thorlabs	M45L02
Beam Stop Assembly	6" Shaft Dowel Pin 1/32"	McMaster-Carr	1263K11
Beam Stop Assembly	Tungsten Carbide Rod 4mm diameter, 2mm length, 50 mm stock rods	McMaster-Carr	8791A95
Beam Stop Assembly	0-80, 1/8" Set Screw	McMaster-Carr	92311A052
Beam Stop Assembly	Epoxy (5-min)	All-Spec	14250-15093
Beam Stop Assembly	1.25" polystyrene dish	Fisher Scientific	08-732-112
Beam Stop Assembly	Cotton swabs, Puritan 868WCS	Fisher Scientific	19-120-472
Beam Stop Assembly	Diamond Saw, Accutom 100	Struers	
Beam Stop Assembly	0.018" reamer	McMaster-Carr	8930A127
TOBB Optimization and Distance Measurement	Red Pen Laser	Wilcom	F6230A
TOBB Optimization and Distance Measurement	Photodiode	Thorlabs	PDA10A2
TOBB Optimization and Distance Measurement	SMA fiber adaptor cap	Thorlabs	S120-SMA
TOBB Optimization and Distance Measurement	Fluke Multimeter	McMaster-Carr	7093K761
TOBB Optimization and Distance Measurement	BNC cable	Pasternack	PE3067-12
TOBB Optimization and Distance Measurement	BNC banana plug	Pasternack	PE9008
TOBB Optimization and Distance Measurement	50Ω BNC terminator	Pasternack	PE6TR007

TOBB Optimization and Distance Measurement	12V Power supply	Thorlabs	LDS12B
TOBB Optimization and Distance Measurement	PDA Power supply cable	Thorlabs	PDA-C-72
TOBB Optimization and Distance Measurement	2 sets of 5x1" granite flats	Starrett	G-81691
TOBB Optimization and Distance Measurement	Depth gauge	Mitutoyo	329-350-10
TOBB Optimization and Distance Measurement	Depth gauge cylinder	Custom Built	Drawing# DCS-1013-1
VISAR Optimization	Two Si Switchable Gain Detectors, 320 - 1100 nm	Thorlabs	PDA100A2
VISAR Optimization	Two FC/PC adapters	Thorlabs	SM1FC
VISAR Optimization	FC/PC 2x2 Multimode Fiber Optic Coupler	Thorlabs	TM200R5F2A
VISAR Optimization	Class 2 Collimated Laser-Diode-Pumped DPSS Laser, 532 nm	Thorlabs	CPS532-C2
VISAR Optimization	Laser power supply	Thorlabs	LDS5
VISAR Optimization	FC/FC coupler	Thorlabs	ADAFC4
VISAR Optimization	11mm to 1" adaptor for laser mount	Thorlabs	AD11NT
VISAR Optimization	532 nm collimation Package	Thorlabs	F220FC-532
VISAR Optimization	Fluke Multimeter	McMaster-Carr	7093K761
VISAR Optimization	BNC cable	Pasternack	PE3067-12
VISAR Optimization	BNC banana plug	Pasternack	PE9008

9.0 Appendix C: Custom Component Drawings

The following drawings are included in this appendix.

Drawing Name	Drawing Number
Target Plate, View A	DCS-1000-1A
Target Plate, View B	DCS-1000-1B
Spacer Ring	DCS-1001-1
TOBB Lens Holder	DCS-1002-1
TOBB Lens Bracket	DCS-1003-1
Standard Probe Holder for PDV Only	DCS-1004-1
Standard Probe Holder for PDV/VISAR Combo Bypass	DCS-1005-1
Standard Probe Holder Design for PDV/VISAR Combo Probe	DCS-1006-1
PDV/VISAR Combo Delrin Lens Tube	DCS-1007-1
PDV/VISAR Combo Brass Fiber Tube	DCS-1008-1
PDV/VISAR Combo Aluminum Adapter	DCS-1009-1
Lens Insertion Tool	DCS-1010-1
PDV/VISAR Combo Polishing Puck	DCS-1011-1
Noyes Fiber Scope–PDV/VISAR Combo Polishing Puck Adapter	DCS-1012-1
Depth Gauge Cylinder	DCS-1013-1

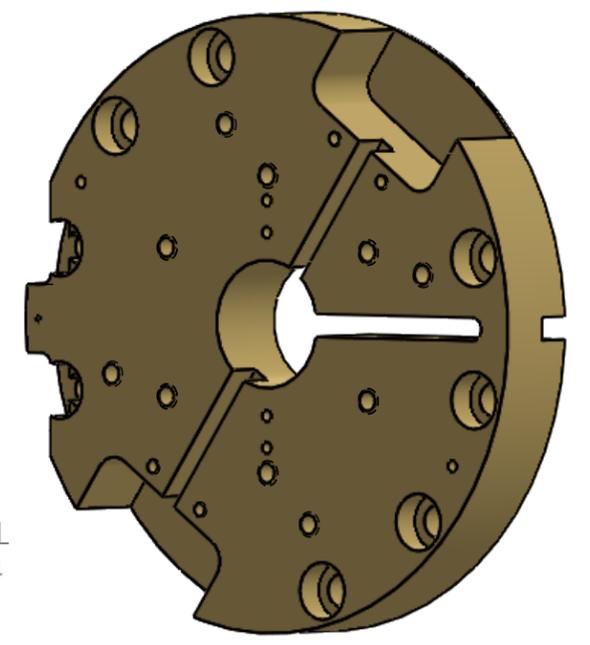
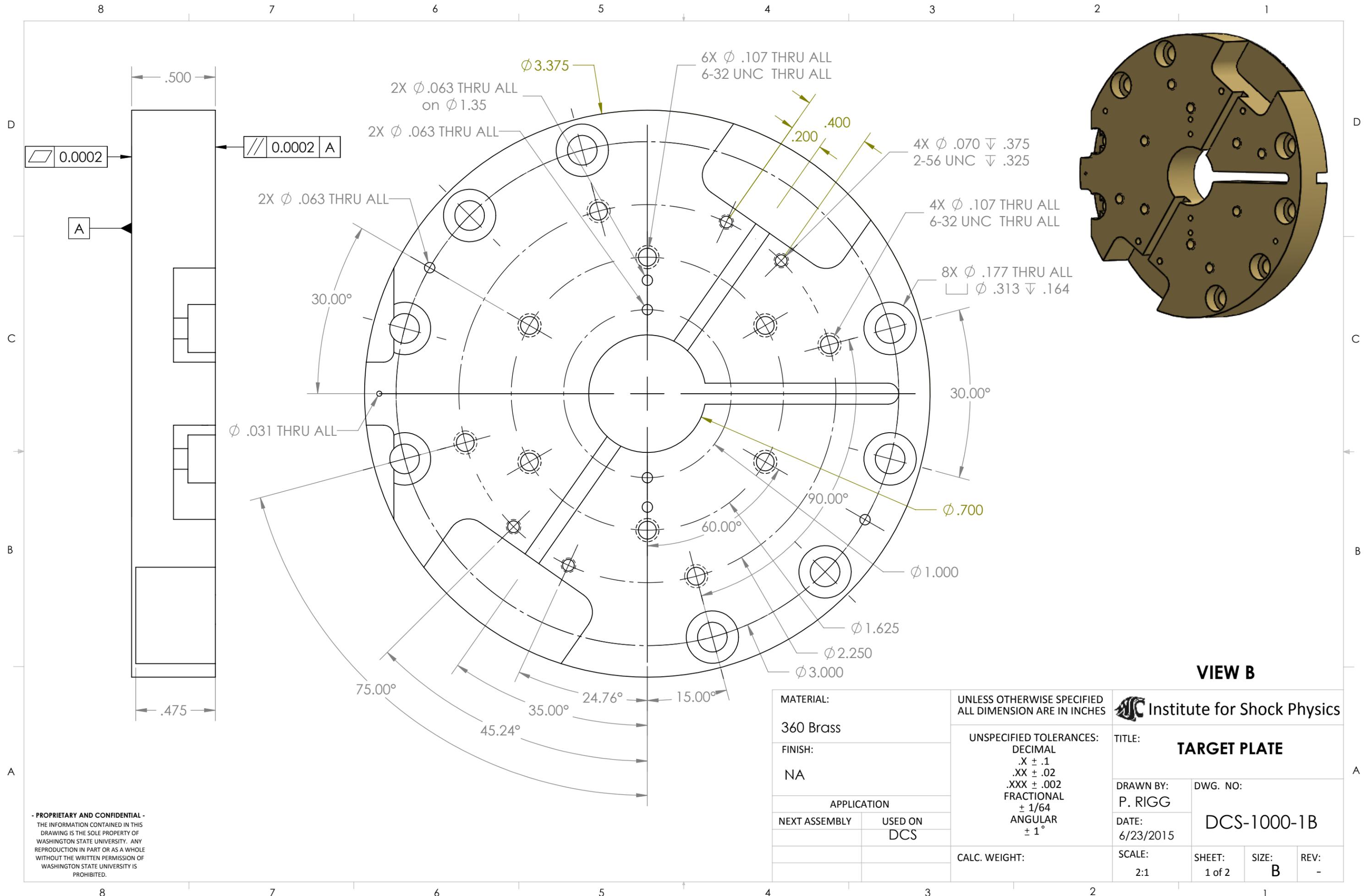


VIEW A

Changes since previous version (DCS-0080-4):
 -Thickness of threads for 0-80 set screw increased
 (i.e. 0.561" cut reduced to 0.503" cut)

MATERIAL: 360 Brass		UNLESS OTHERWISE SPECIFIED ALL DIMENSION ARE IN INCHES		 Institute for Shock Physics	
FINISH: NA		UNSPECIFIED TOLERANCES: DECIMAL .X ± .1 .XX ± .02 .XXX ± .002 FRACTIONAL ± 1/64 ANGULAR ± 1°		TITLE: TARGET PLATE	
APPLICATION		CALC. WEIGHT:		DRAWN BY: B. Williams	DWG. NO: DCS-1000-1A
NEXT ASSEMBLY	USED ON DCS			DATE: 6/23/15	
				SCALE: 2:1	SHEET: 2 of 2
					SIZE: B
					REV:

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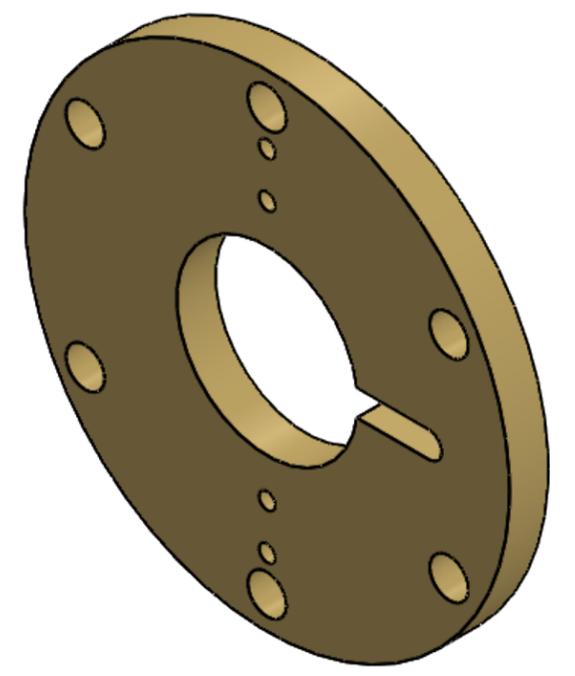
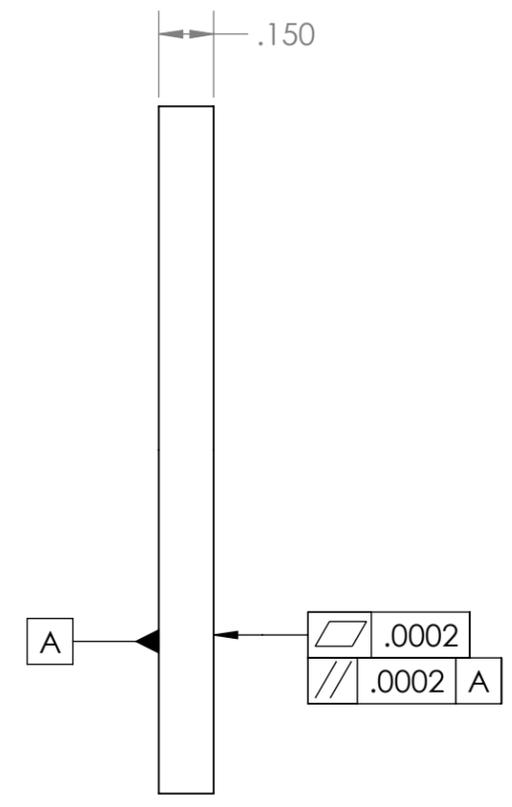
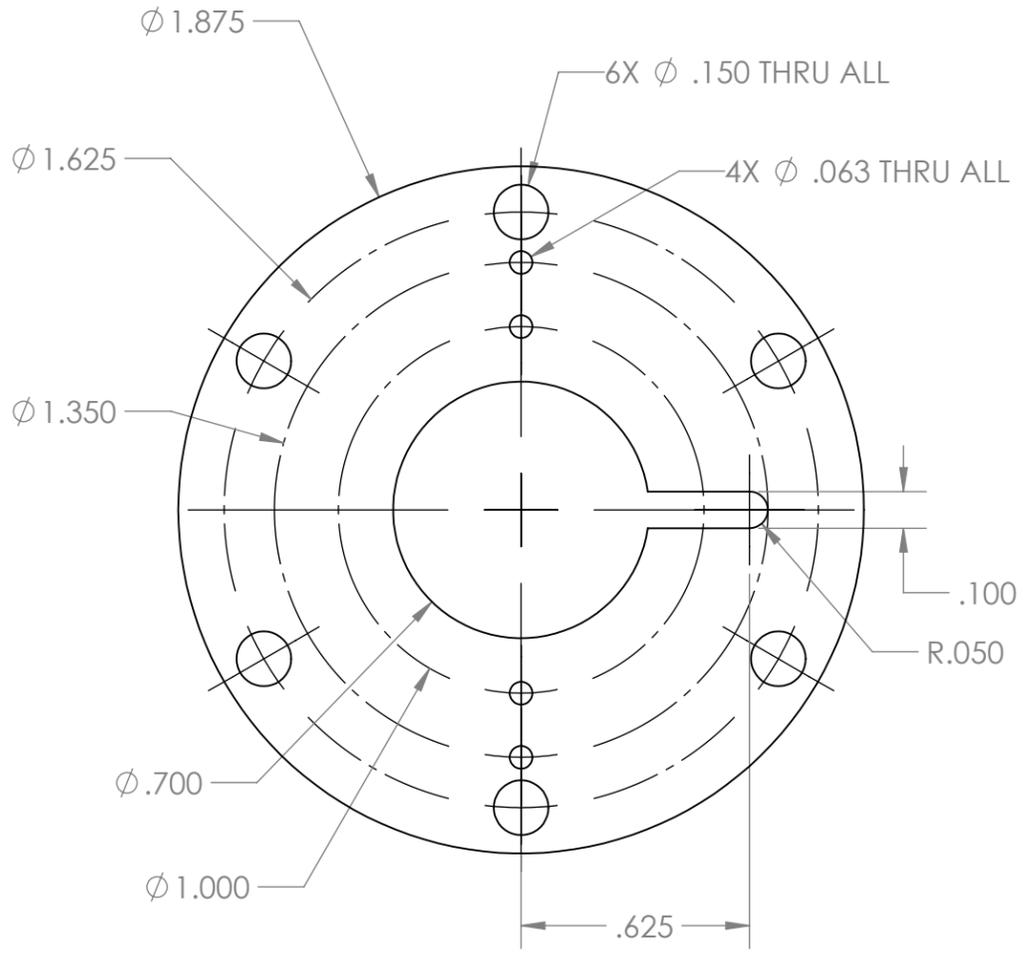
VIEW B

MATERIAL: 360 Brass		UNLESS OTHERWISE SPECIFIED ALL DIMENSION ARE IN INCHES		Institute for Shock Physics	
FINISH: NA		UNSPECIFIED TOLERANCES: DECIMAL .X ± .1 .XX ± .02 .XXX ± .002 FRACTIONAL ± 1/64 ANGULAR ± 1°		TITLE: TARGET PLATE	
APPLICATION		CALC. WEIGHT:		DRAWN BY: P. RIGG	
NEXT ASSEMBLY	USED ON DCS	DATE: 6/23/2015		DWG. NO: DCS-1000-1B	
		SCALE: 2:1	SHEET: 1 of 2	SIZE: B	REV: -

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8 7 6 5 4 3 2 1

D
C
B
A

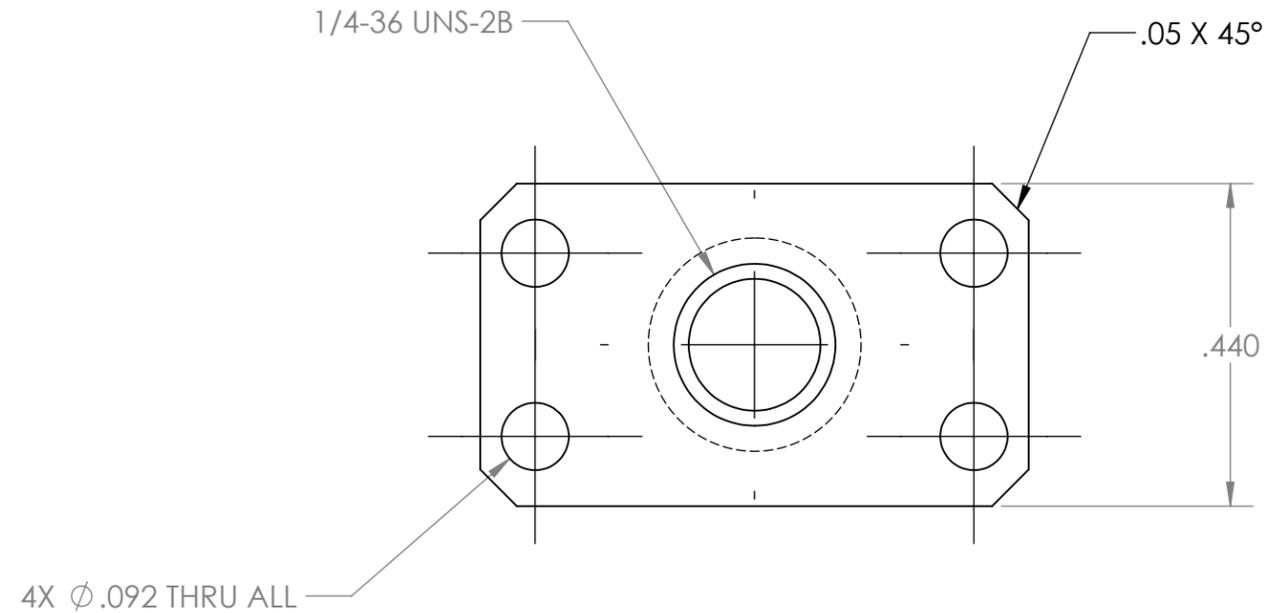
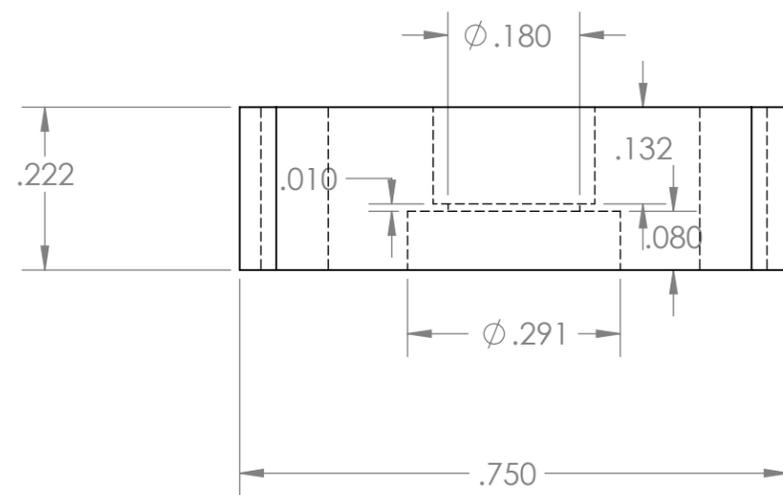
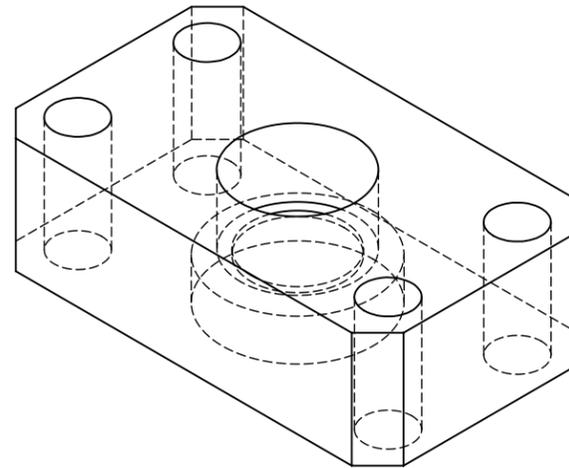


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MATERIAL: 360 BRASS		UNLESS OTHERWISE SPECIFIED ALL DIMENSION ARE IN INCHES		 Institute for Shock Physics	
FINISH: NA		UNSPECIFIED TOLERANCES: DECIMAL .X \pm .1 .XX \pm .02 .XXX \pm .002 FRACTIONAL \pm 1/64 ANGULAR \pm 1°		TITLE: SPACER RING	
APPLICATION		DRAWN BY: P. RIGG		DWG. NO: DCS-1001-1	
NEXT ASSEMBLY	USED ON	DATE: 1/12/2016			
	DCS	SCALE: 1:4		SHEET: 1 of 1	SIZE: B
		CALC. WEIGHT:		REV: -	

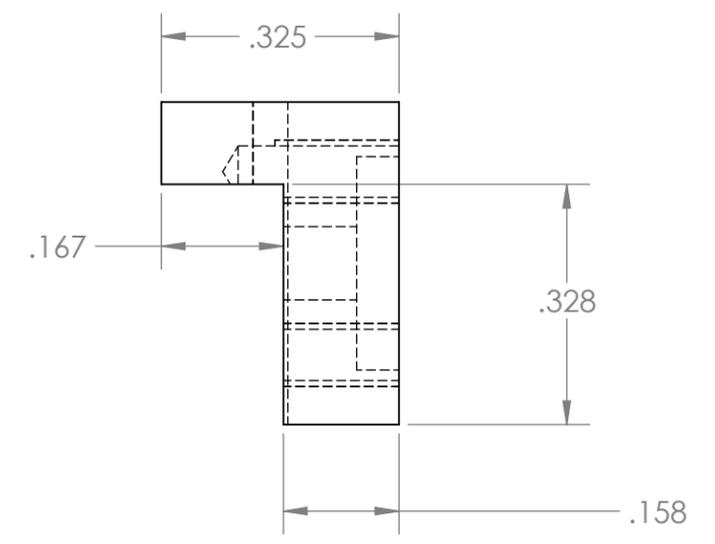
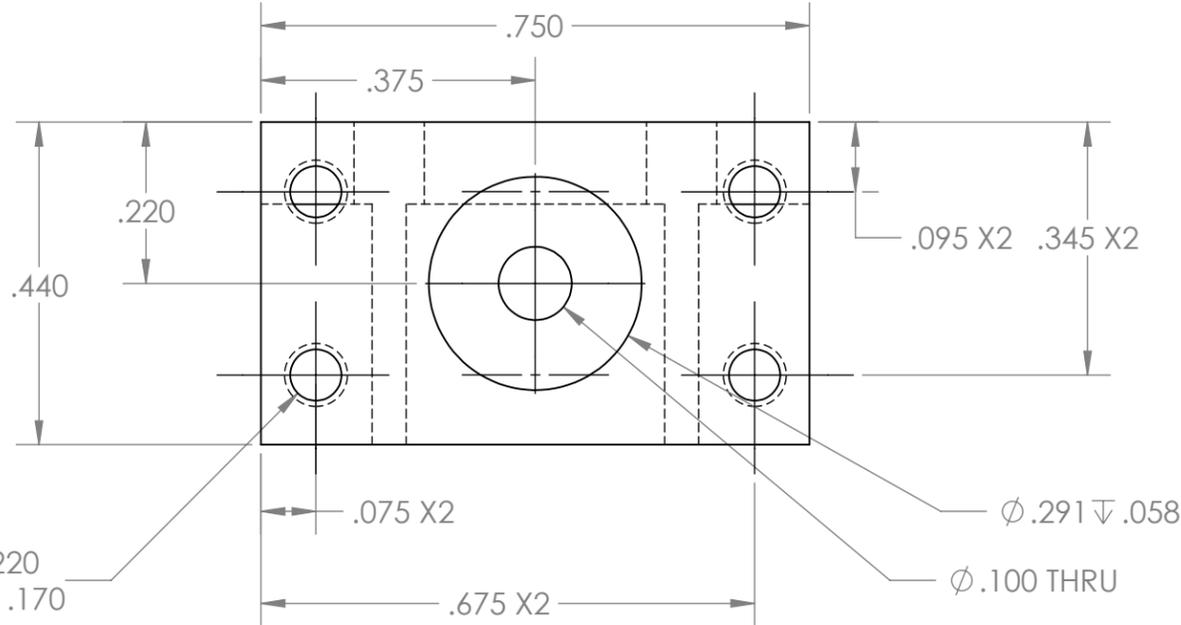
8 7 6 5 4 3 2 1

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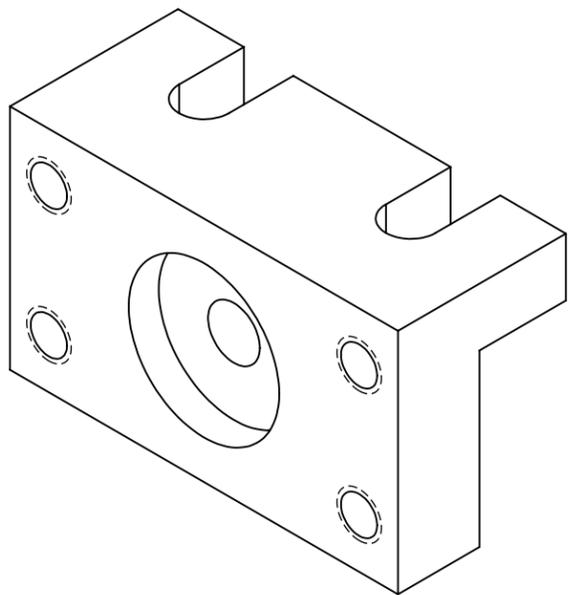
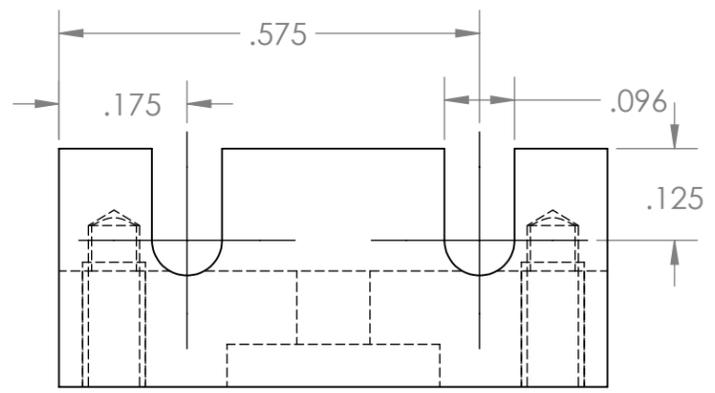


MATERIAL: 6061 Al		UNLESS OTHERWISE SPECIFIED ALL DIMENSION ARE IN INCHES		 Institute for Shock Physics		
FINISH:		UNSPECIFIED TOLERANCES: DECIMAL .X \pm .1 .XX \pm .02 .XXX \pm .002 FRACTIONAL \pm 1/64 ANGULAR \pm 1°		TITLE: TOBB Lens Holder		
APPLICATION				DRAWN BY: B. Williams	DWG. NO: DCS-1002-1	
NEXT ASSEMBLY	USED ON			DATE: 8/6/2015		
		CALC. WEIGHT:	SCALE:	SHEET:	SIZE: REV:	

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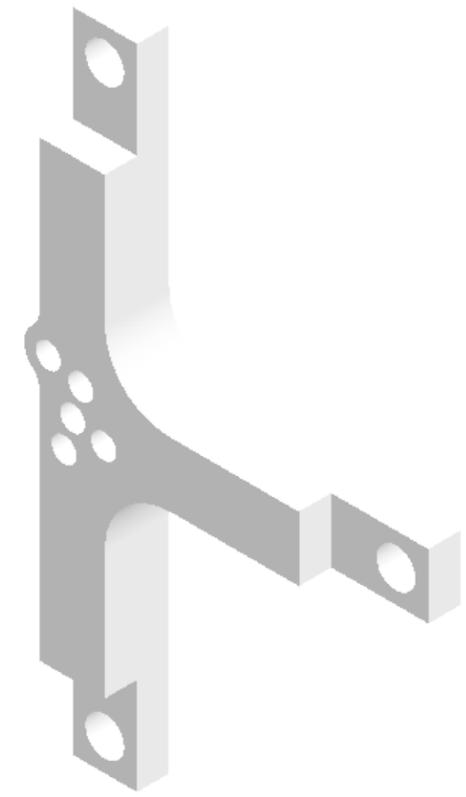
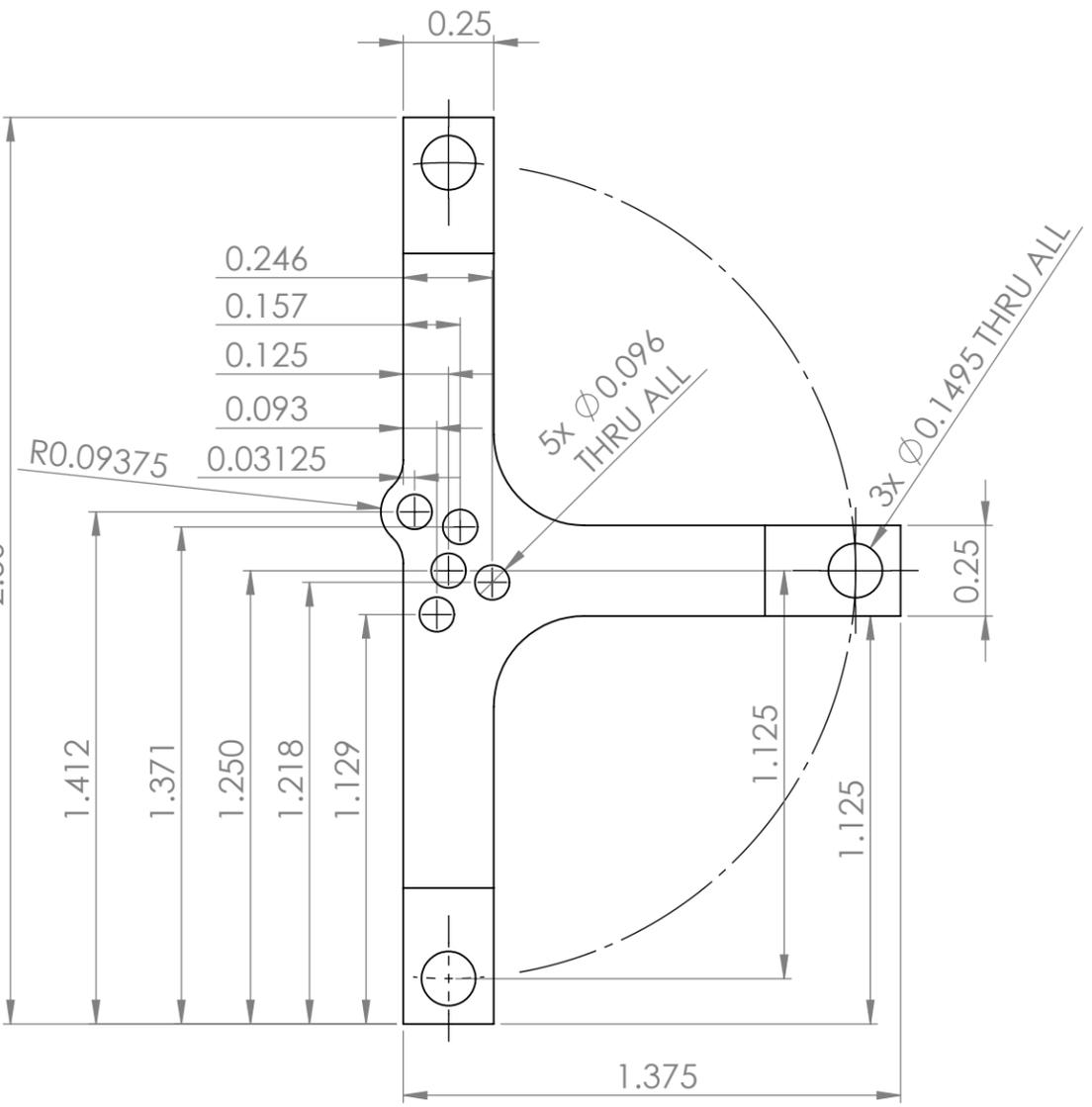
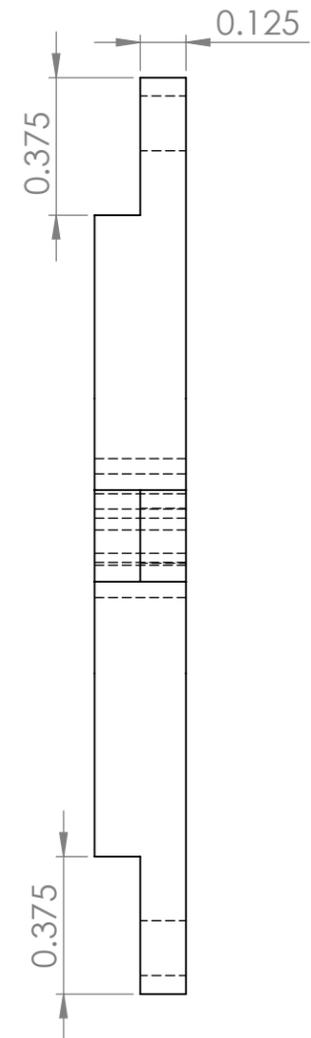
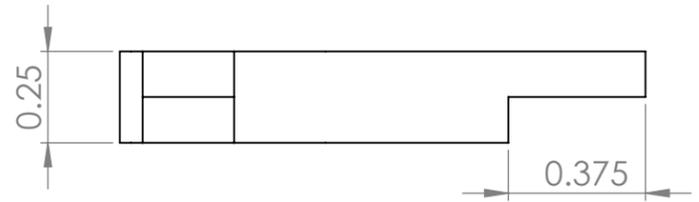
4X $\phi .070 \nabla .220$
 2-56 UNC - 2B $\nabla .170$



MATERIAL: 6061-T6 AL

MATERIAL: 6061 Al		UNLESS OTHERWISE SPECIFIED ALL DIMENSION ARE IN INCHES		 Institute for Shock Physics	
FINISH: NA		UNSPECIFIED TOLERANCES: DECIMAL .X $\pm .1$.XX $\pm .02$.XXX $\pm .002$ FRACTIONAL $\pm 1/64$ ANGULAR $\pm 1^\circ$		TITLE: TOBB Lens Bracket	
APPLICATION				DRAWN BY: B Williams	
NEXT ASSEMBLY	USED ON	CALC. WEIGHT:		DWG. NO: DCS-1003-1	
		SCALE: 4:1		SHEET: 1 of 1	SIZE: B
				REV: -	

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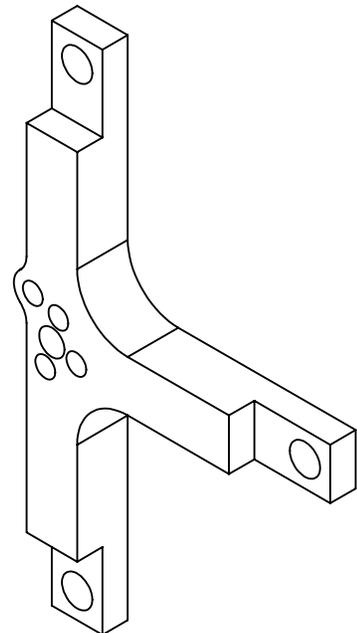
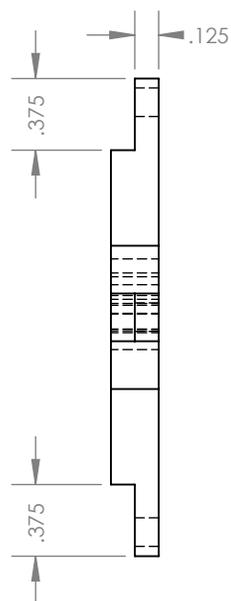
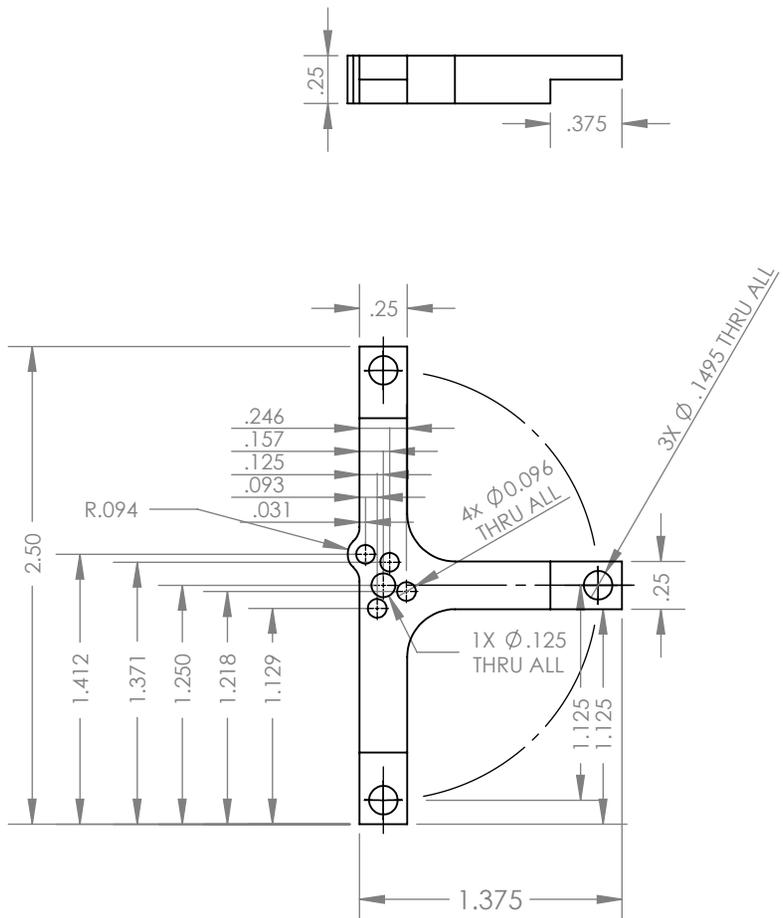
MATERIAL: 3D Printing Plastic		UNLESS OTHERWISE SPECIFIED ALL DIMENSION ARE IN INCHES		 Institute for Shock Physics: Dynamic Compression Sector	
FINISH:		UNSPECIFIED TOLERANCES: DECIMAL .X ± .1 .XX ± .02 .XXX ± .002 FRACTIONAL ± 1/64 ANGULAR ± 1°		TITLE: Standard Probe Holder for PDV Only	
APPLICATION		DRAWN BY: Zill		DWG. NO: DCS-1004-1	
NEXT ASSEMBLY	USED ON DCS	DATE: 1/29/2019		SCALE:	
CALC. WEIGHT:		SHEET: 1 of 1		SIZE:	REV:

2

1

B

B



A

A

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MATERIAL
3D Printing Plastic
 FINISH
 APPLICATION DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES
 UNSPECIFIED TOLERANCES
 DECIMAL
 .X ± .1
 .XX ± .02
 .XXX ± .002
 FRACTIONAL ± 1/64
 ANGULAR ± 1 DEG
 Date: 5/12/2020

Institute for Shock Physics:
 Dynamic Compression Sector
 TITLE:
Standard Probe Holder for PDV w/ PDV/VISAR Combo Bypass
 SIZE DWG. NO. REV
 DCS-1005-1
 SCALE: WEIGHT: SHEET 1 OF 1

2

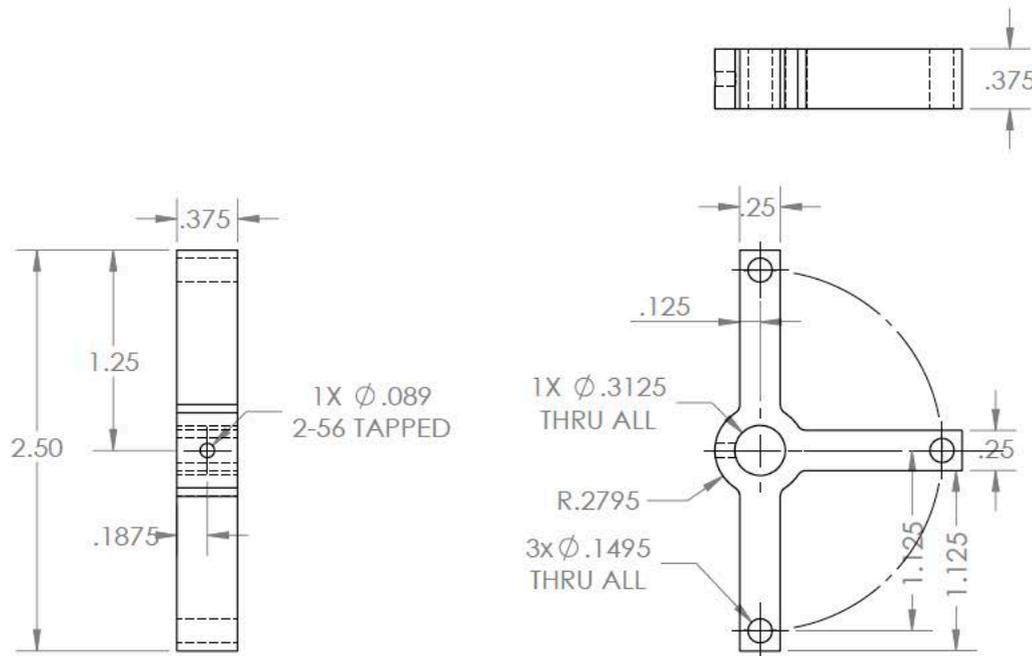
1

2

1

B

B



A

A

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APPLICATION: DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
 ALL DIMENSIONS ARE IN INCHES

UNSPECIFIED TOLERANCES
 DECIMAL
 .X \pm .1
 .XX \pm .02
 .XXX \pm .002
 FRACTIONAL \pm 1/64
 ANGULAR \pm 1 DEG

Date: 5/12/2020

Institute for Shock Physics:
 Dynamic Compression Sector

TITLE:
VISAR Combo Probe Holder

SIZE DWG. NO. REV
DCS-1006-1

SCALE: WEIGHT: SHEET 1 OF 1

2

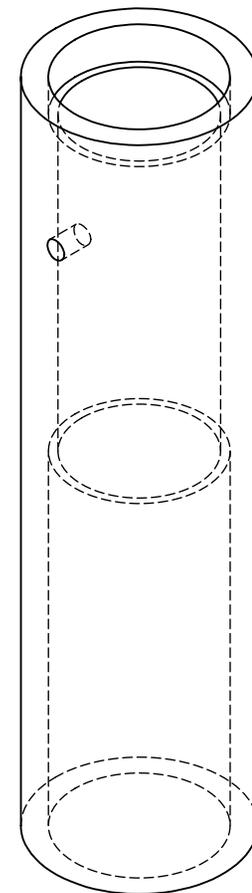
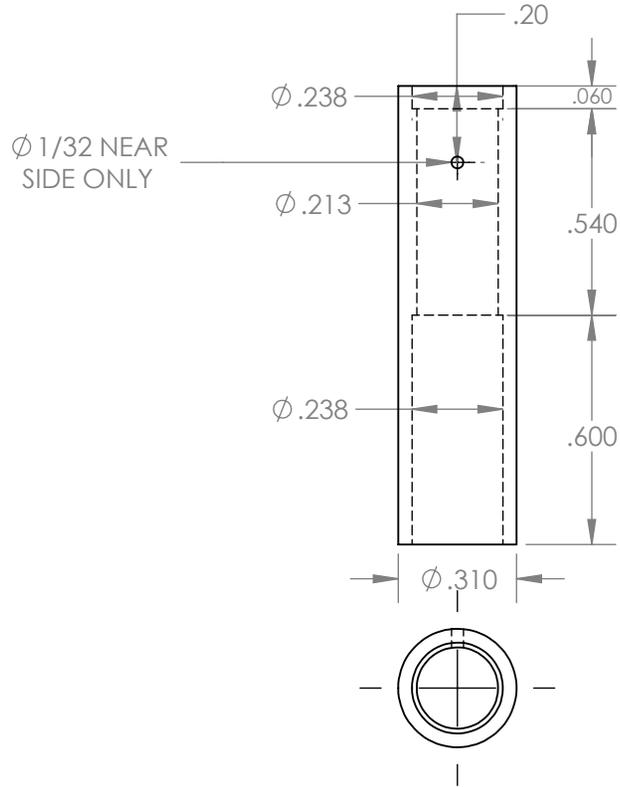
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2

1

B

B



A

A

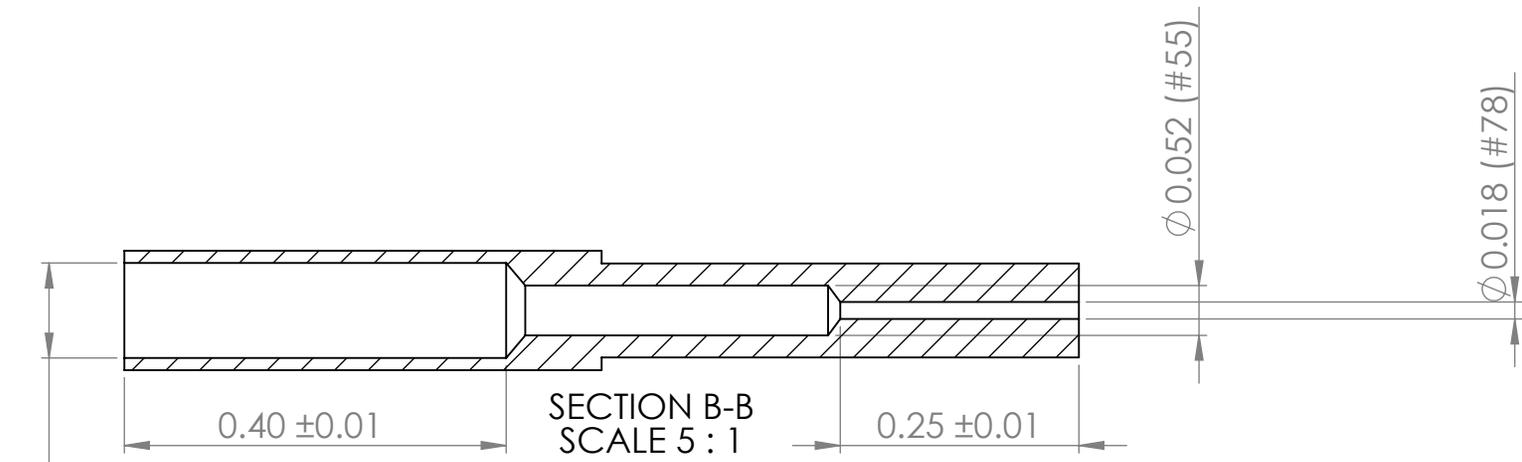
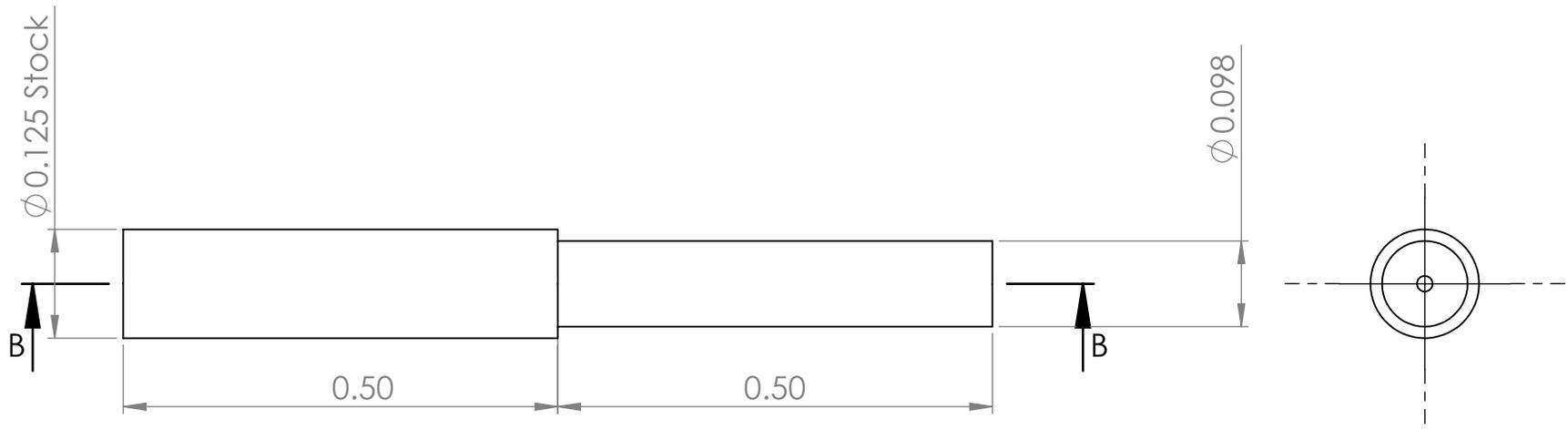
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MATERIAL
Delrin
 FINISH
 APPLICATION
 DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES		Institute for Shock Physics: Dynamic Compression Sector	
UNSPECIFIED TOLERANCES DECIMAL .X $\pm .1$.XX $\pm .02$.XXX $\pm .002$ FRACTIONAL $\pm 1/64$ ANGULAR ± 1 DEG		TITLE: PDV/VISAR Combo Delrin Lens Tube	
SIZE	DWG. NO. DCS-1007-1	REV	
SCALE:	WEIGHT:	SHEET 1 OF 1	

Date: 5/12/2020

1



Institute for Shock Physics

UNLESS OTHERWISE SPECIFIED:
 DIMENSIONS ARE IN INCHES
 TOLERANCES: 0.005
 FRACTIONAL ± 1/32
 ANGULAR: MACH ± BEND ±
 TWO PLACE DECIMAL ± 0.020
 THREE PLACE DECIMAL ± 0.002

MATERIAL
Brass

FINISH

DO NOT SCALE DRAWING

DRAWN	NAME	DATE
YT		10/02/17

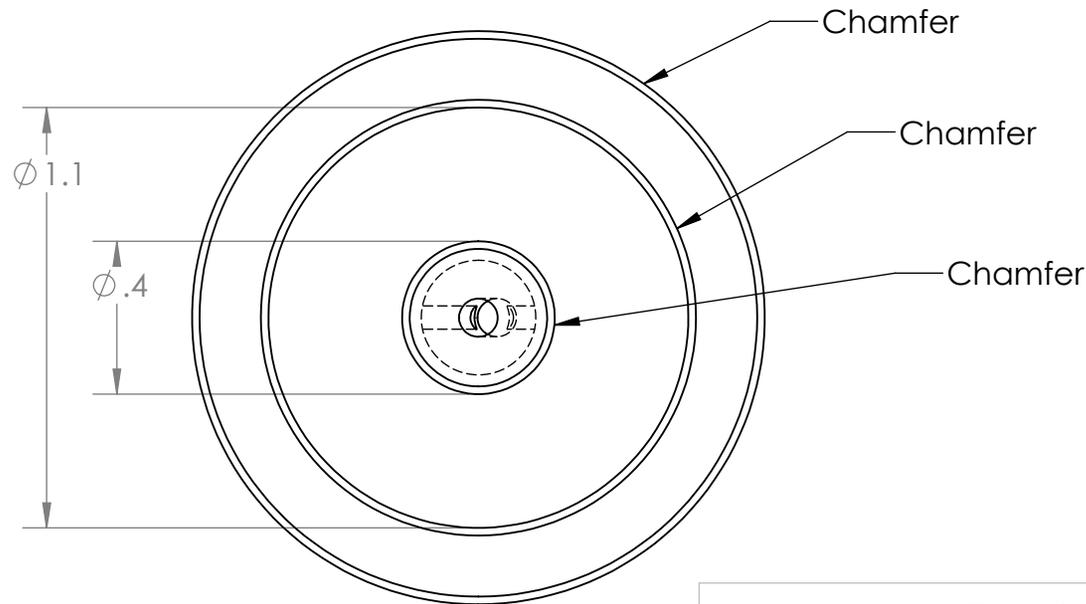
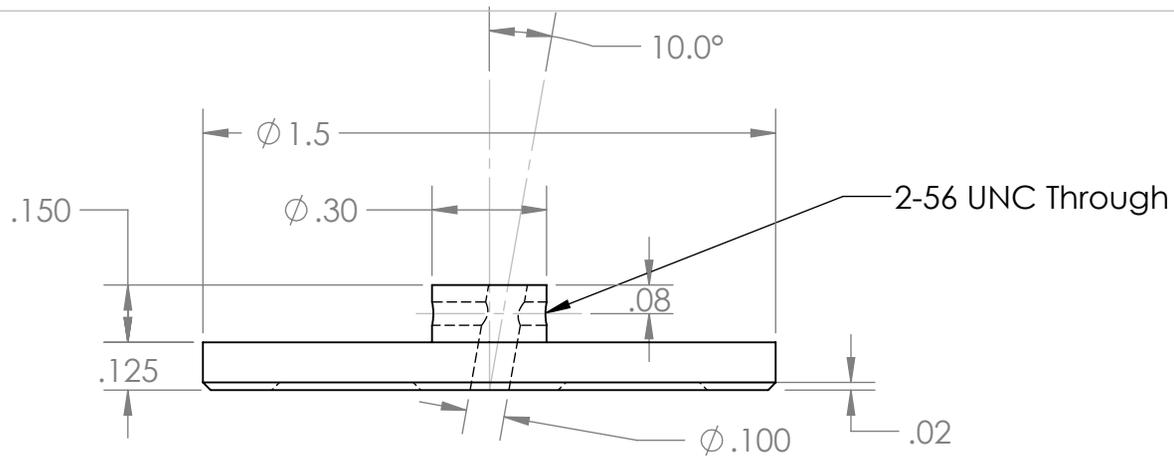
COMMENTS:

PROJECT:

TITLE: **PDV/VISAR Combo Brass Fiber Tube**

SIZE	DWG. NO.	REV
A	DCS-1008-1	

SCALE: 2:1	WEIGHT:	SHEET 1 OF 1
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Institute for Shock Physics

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
 TOLERANCES: 0.005
 FRACTIONAL $\pm 1/32$
 TWO PLACE DECIMAL ± 0.020
 THREE PLACE DECIMAL ± 0.002
 ANGULAR ± 0.1

MATERIAL
 Mild steel

FINISH

DO NOT SCALE DRAWING

DRAWN	NAME	DATE
YT		10/29/15

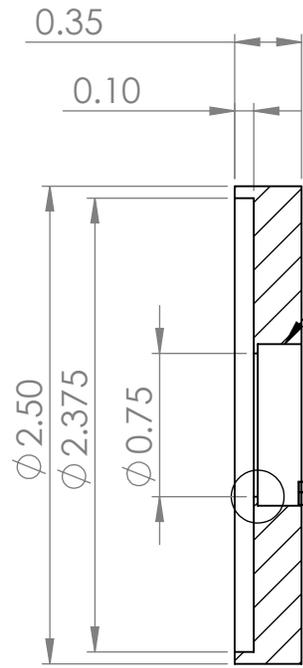
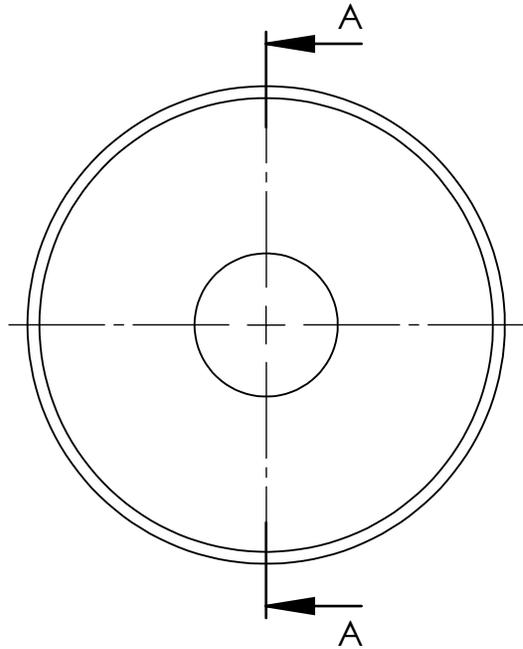
COMMENTS:

PROJECT:

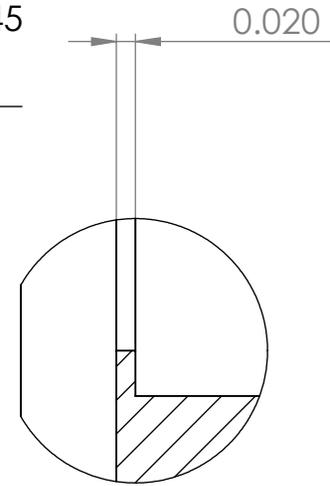
TITLE:
PDV/VISAR Combo Polishing Puck

SIZE A	DWG. NO. DCS-1011-1	REV
------------------	------------------------	-----

SCALE: 2:1	WEIGHT:	SHEET 1 OF 1
------------	---------	--------------



Custom tap:
 Major diameter 0.868
 Minor diameter 0.845
 Thread 28 TPI
 0.230 deep



DETAIL B
 SCALE 5 : 1

SECTION A-A

Institute for Shock Physics

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
 TOLERANCES: 0.005
 FRACTIONAL $\pm 1/32$
 ANGULAR: MACH \pm BEND \pm
 TWO PLACE DECIMAL ± 0.020
 THREE PLACE DECIMAL ± 0.002

MATERIAL

Brass

FINISH

DO NOT SCALE DRAWING

NAME	DATE
DRAWN YT	

COMMENTS:

PROJECT:

TITLE: **Noyes Fiber Scope -
 PDV/VISAR Combo Polishing
 Puck Adaptor**

SIZE
A

DWG. NO.
 DCS-1012-1

REV

SCALE: 1:1

WEIGHT:

SHEET 1 OF 1

