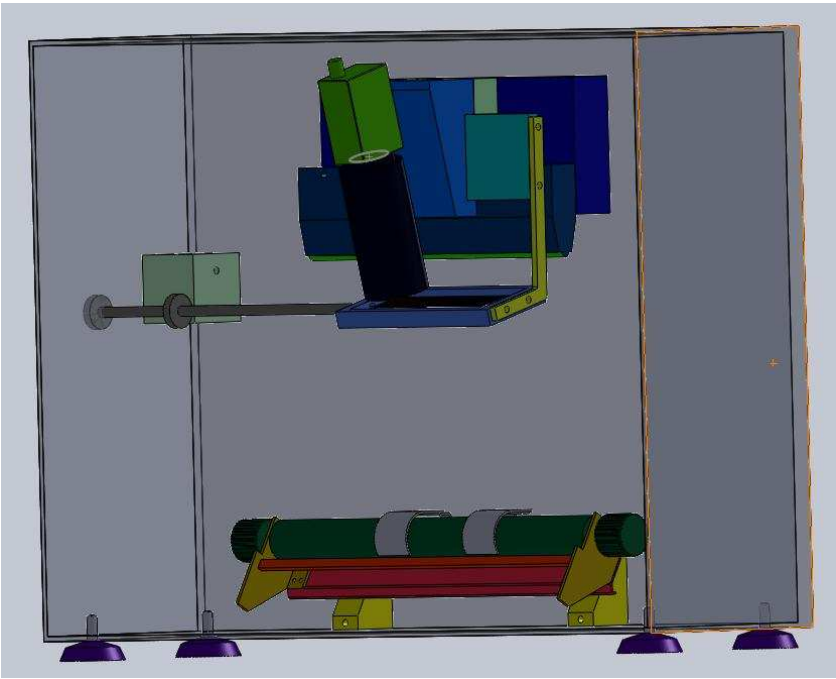
P10541
Micro-Goniophotometer

Assembly & Construction Procedures



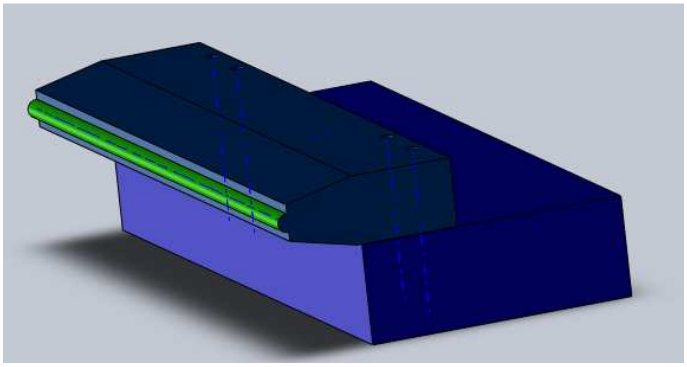
Foreword: This device was designed as an open source open architecture technology. With that in mind the construction of this device was made to be extremely flexible. Multiple different materials could be used to construct the parts anything from wood to plastics can be used as long as structural rigidity is maintained. The most important aspects to consider when constructing this device is to maintain parallelism and alignment. The angles used will highly depend on the camera obtained for use and the paper spool that is chosen.

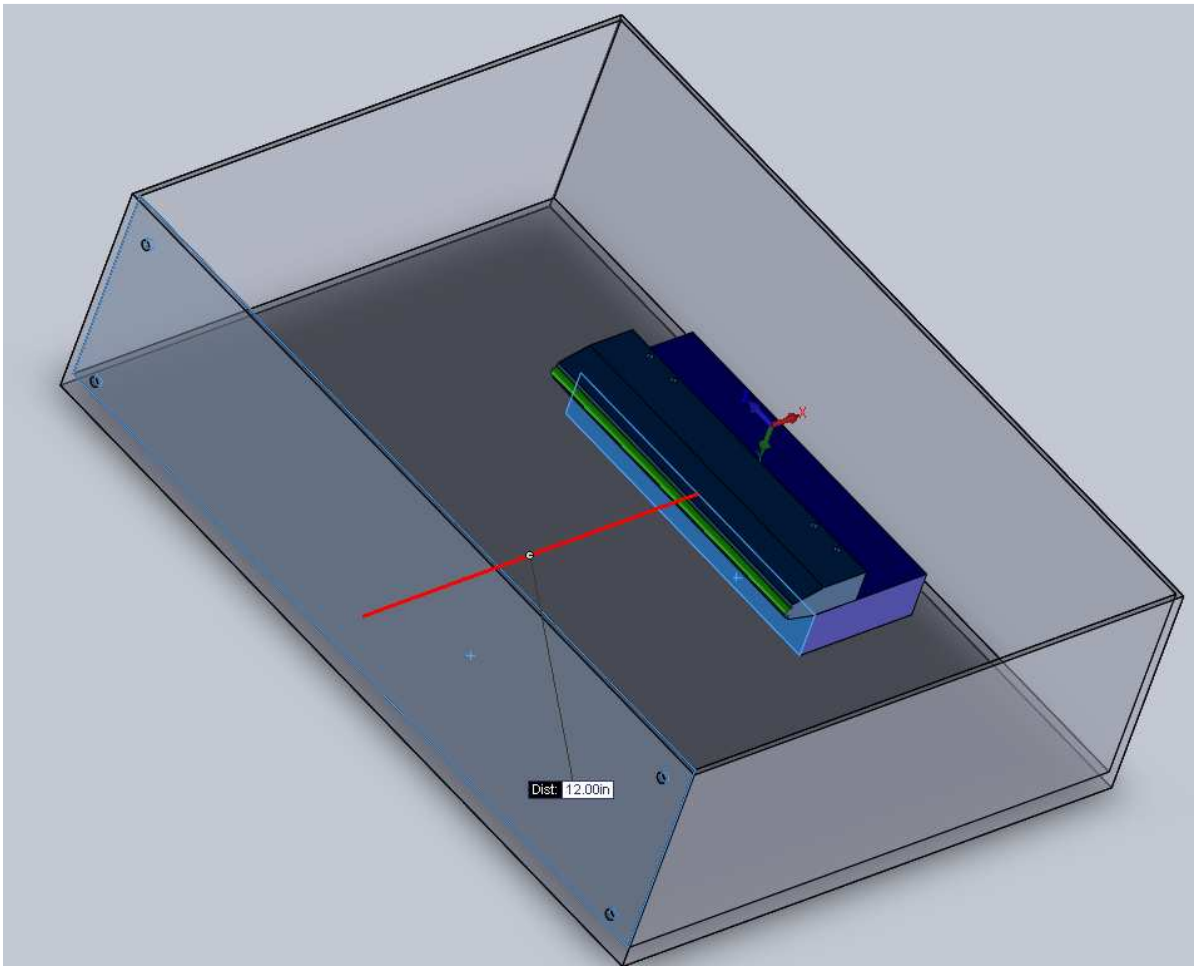
Component List	
Component	**Quantity required**
LED Block	1
15 degree angle block for camera	1
Spacer block	2
Base mounting block	1
Polarizer push Rod	1
Polarizer L bracket spacing block	1
Paper spool device	1
Polarizer L bracket	1
Paper spool 30 degree mounting block	2
90 L brackets for case construction	24
Fiber optic light bar	1
1/8 “ aluminum sheets for case construction	4 for the sides , 2 for the top/bottom
Rubber Feet	4

Note: the exact parts and materials used for the construction of the team preliminary test device can be seen on our Bill of materials for the project.

Construction overview:
The following parts can be manufactured any way the user sees fit. For reference the preliminary device was constructed using a vertical milling machine, Jump sheer, drill press, band saw and belt sander.

1. **Enclosure construction**
    a. Mark the dimensions of the 4 side panels of the device and the lid and base. Using a jump sheer cut the sheet metal to size.
    b. Using a marker, mark the location for the L brackets that will hold the sides of the enclosure together. Using a drill press drill the proper size holes (Hole sizing will vary depending on L brackets used).
    c. The lid of the device does not need to be market for these L bracket holes.
    d. Place the components aside for later assembly.
2. **LED Block**
    a. Using a vertical lathe or similar means, machine the LED block to the proper dimensions.
    b. Depending on how many LED's you want to use for the device bore out the proper amount of holes in the block along with the proper diameter hole for the fiber optic light bar insert.
    c. Drill and tap 2 mounting holes so the block can be secured to the base of the device at a later time.
3. **Base mounting block**
    a. Construct the base mounting block, this piece will form the foundation for the rest of the optics assembly. This piece can be constructed out of any rigid material; nylon was used for the preliminary design.
    b. After the block has been made to the proper dimensions, mark the holes where the fiber optic light bar will attach. Once marked drill and tap with the proper size hardware.
    c. At the 4 corners of the base of the block drill and tap 4 holes. M6 hex head bolts were used for this. These holes will fasten the block to the base of the device.
    d. Once this is complete attach the fiber optic light bar to the block. Now take the base plate that was cut to size in step (1) place the block centered along the wide part of the base piece and 12 inches up from the base edge to base edge of the block. Mark this location and mark and drill the appropriate holes on the base plate to secure the base block to this piece.





4. Spacing and 15 degree angle blocks
    a. Using a milling machine or some other means, machine the 2 spacing blocks that will attach to the base block that was made in step 3. The block made in the preliminary device was made of nylon.

b. Drill and tap 2 through holes in these spacing blocks, mark and drill matching holes on the base block, assuring that the distance between these blocks is not greater than the width of the 15 degree angle block that will be constructed in the next step.
c. Now machine the 15 degree angle block that will mount on top of the spacing blocks and fiber optic light bar. (See picture below for a better understanding of entire assembly).
   (Note: the 15 degree block is guideline not a requirement a lesser angle could be used. The original device used a angle very close to this, and that is why this angle was chosen for this build).
d. On the 15 degree block mark and drill appropriate holes on the block along with the spacing blocks so the 15 degree block can be secured to the entire assembly.

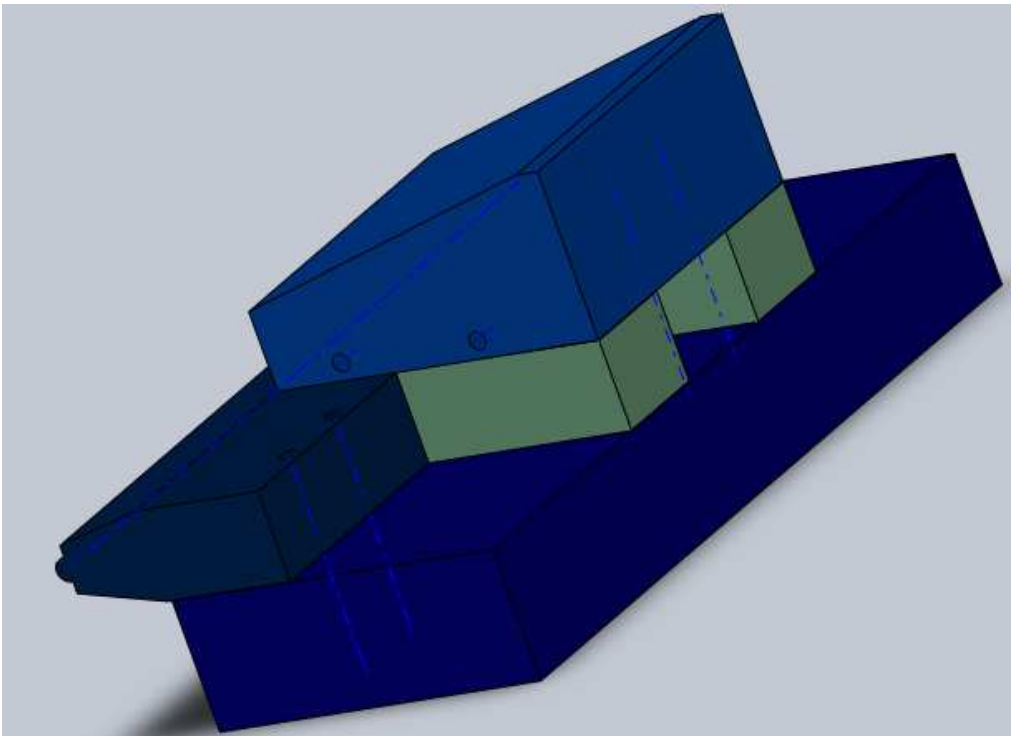
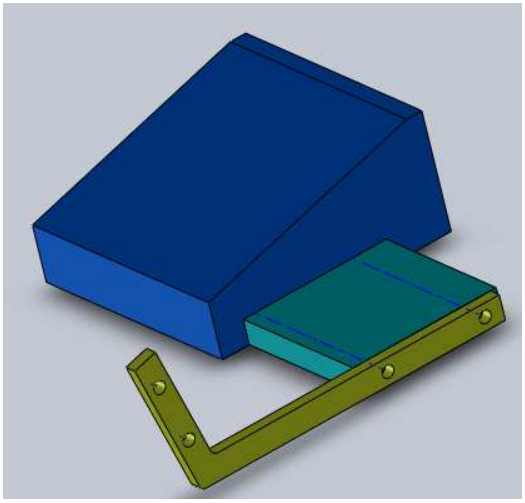


Figure: base block, fiber optic bar, 2 spacing blocks and 15 degree angle block all attached together.

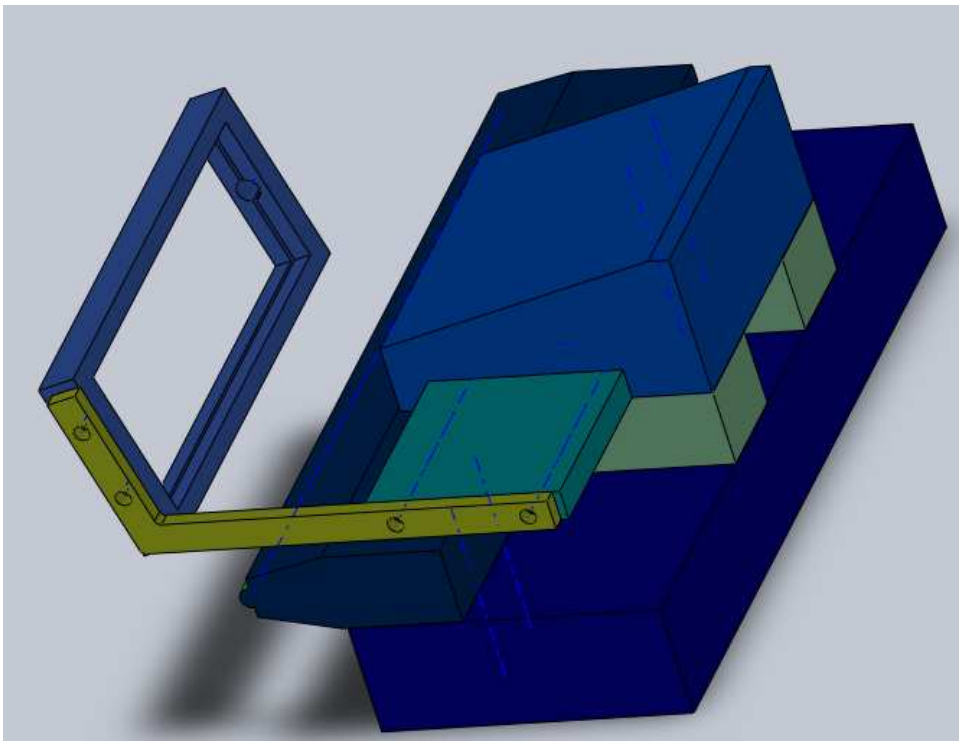
Note: the one final piece to this assembly is not shown above, depending on the camera chosen for use, the user will have to create a piece that will secure the camera to the slant face of the top angle block. Assuring that the camera is level and looking straight forward in the direction of the light source.

5. Polarizer L bracket, polarizer frame and spacer block
   a. Using a band saw and milling machine an L bracket was made. This piece had a 15 degree angle to it so as the polarizer frame will be parallel to the plane of the camera lens face.

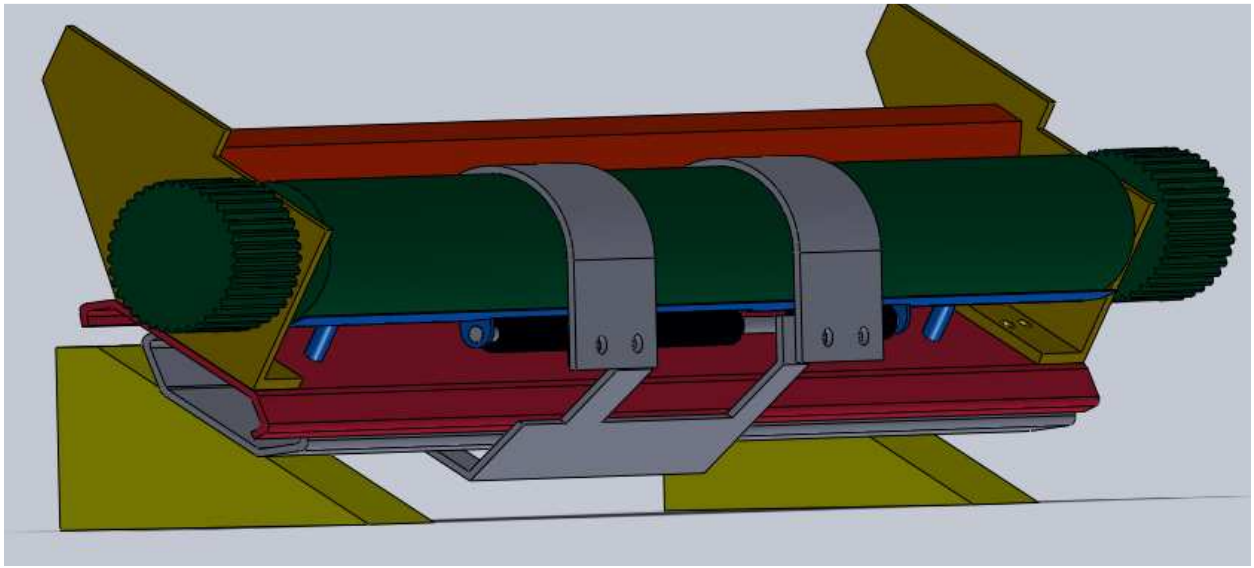
b. Slot the end of the bracket where it attaches to the side of the 15 angle block. This will make assembly easier later on.
c. Machine the spacer piece that will go between the 15 degree angle block and L bracket. Drill and tap appropriate holes to attach the 3 pieces together. (see figure below)

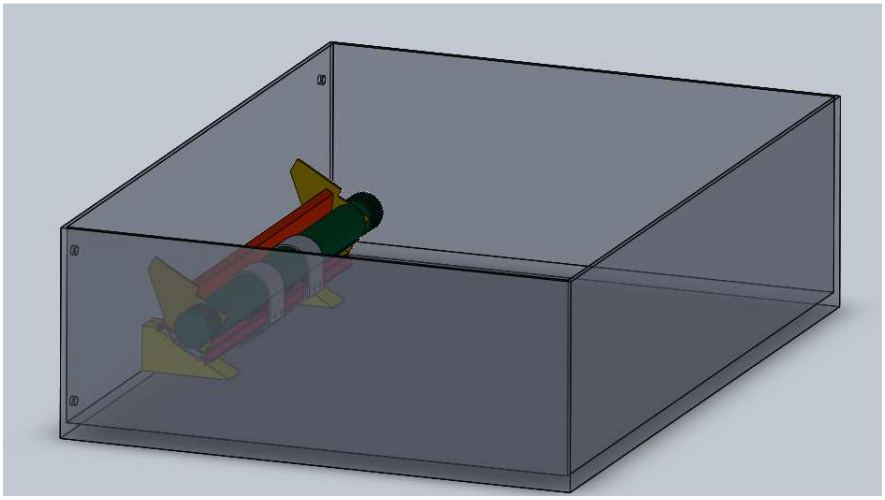


d. For the Polarizer frame, using left over scraps from the case enclosure construct the frame so that a piece of polarizer film can be rigidly slid into the frame yet able to slide back and forth. There are many ways to create this piece; the builder may use any method he sees fit to create this piece. Once complete attach this frame to the side of the L bracket. (See figure below)

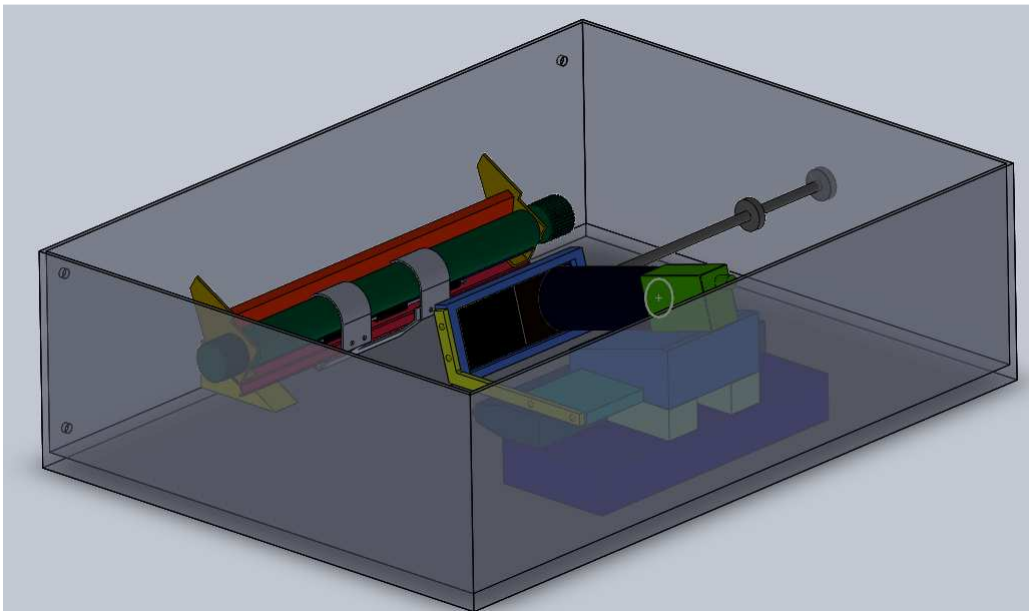


6. 30 degree angle blocks and paper spooling device.(this angle may differ depending on the device used. This angle was chosen so that by tipping the device forward the camera would not be looking at any of the components underneath the spool.)
    a. Machine the 30 degree angle blocks using a milling machine. Assure that they are identical and have a flat surface for the spooling device to mount onto.
    b. Drill and tap appropriate holes on the base of these blocks so it can be secured to the base plate of the device.
    c. For the paper spooling device, a Sears 300 series electric type writer was disassembled and the paper spooling device along with liner slide was extracted for use. The builder may opt to use a different spooling device but must understand that program parameters must change as far as spool diameter so results are accurate.
    d. Mount the bottom of the spooling device (the linear slide base) to the slant face of the 30 degree angle blocks. (see figure below)
    e. Once this is complete center the assembly along the width of the device and secure to the base plate. Assure that the mounting holes in the base plate are slotted to allow for the assembly to slide ether forward or backwards I.e., towards the camera or away from it.



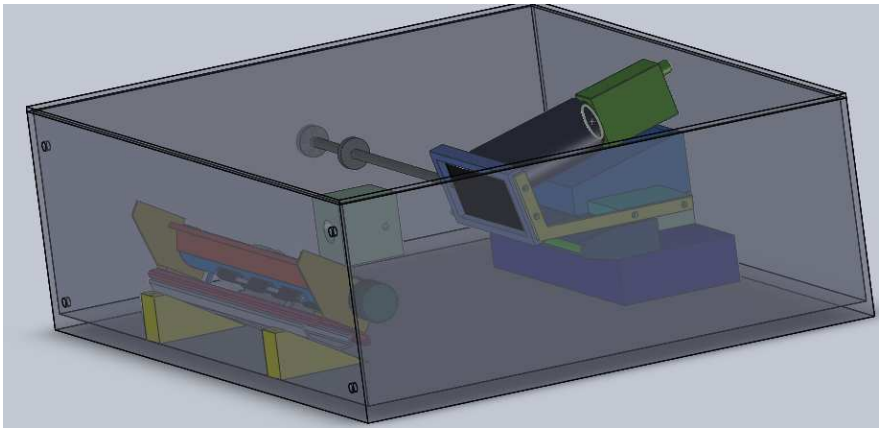


7. Construct the case sides and polarizer push rod
    a. Using a piece of hollow tube, attach one end to the end of the polarizer film/glass that will slide inside the polarizer frame. Drill an appropriately located hole in the side piece of the enclosure.
    b. Once this is complete, using the L brackets for the enclosure mount up the 4 sides of the enclosure to form a box .(see figure below)
    c.



8. Attach lid, rubber feet and LED block
    a. The LED block can now be attached in any location the user sees fit along as it does not interfere with any of the mechanisms.
    b. The lid can be attached any way the user sees fit using 3 standard hinges and some kind of locking mechanism (an air spring can be installed for lift assist of the case lid).

c. Attach the 4 rubber feet to the corners of the base plate.



Final assembly

GENERAL NOTES

- Alignment of the fiber optic light bar with typewriter spool on the horizontal plane is not critical but is recommended. However, alignment of the light bar with the spool in respect to parallelism is important.
- Construction could be modified to decrease the overall size of the device. To do this though the builder will have to sacrifice some features, such as the type writer spooling device. From there all components could be scaled down if proper parts are available.
- Functions of the type writer spool those were important to the design.
    - Liner slide which the sample can move left or right.
    - Rotation of the sample by spinning the knob
    - Sample is held tight when spooled onto the roller
    - De jamming mechanism built in
- Build accuracy was +/- 3 mm on all parts constructed
- To align the image center on the computer screen it is done by sliding the type writer roller forward or back on the slots and making sure parallelism is maintained.