Optomechanix

Optoform 105 User's Guide

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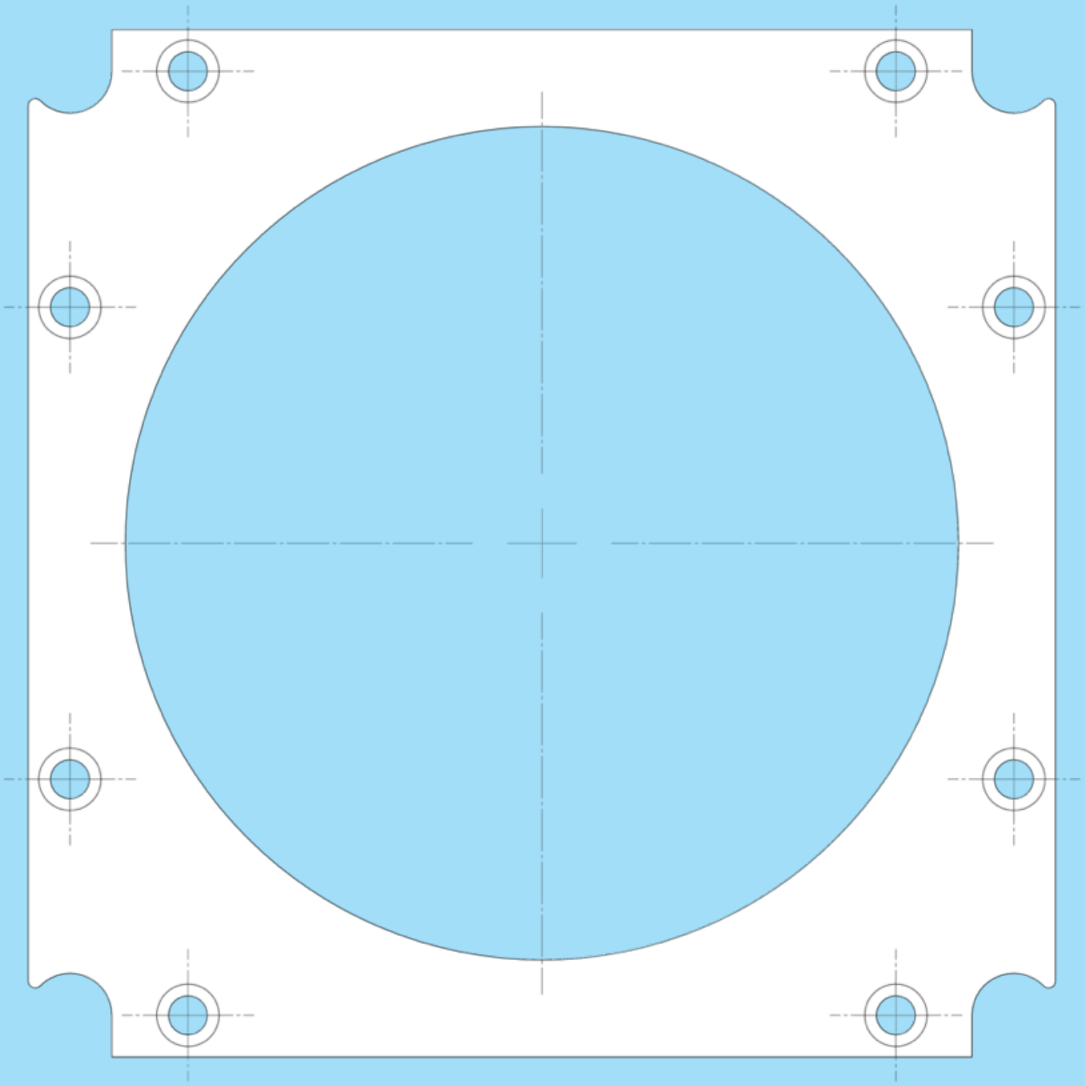
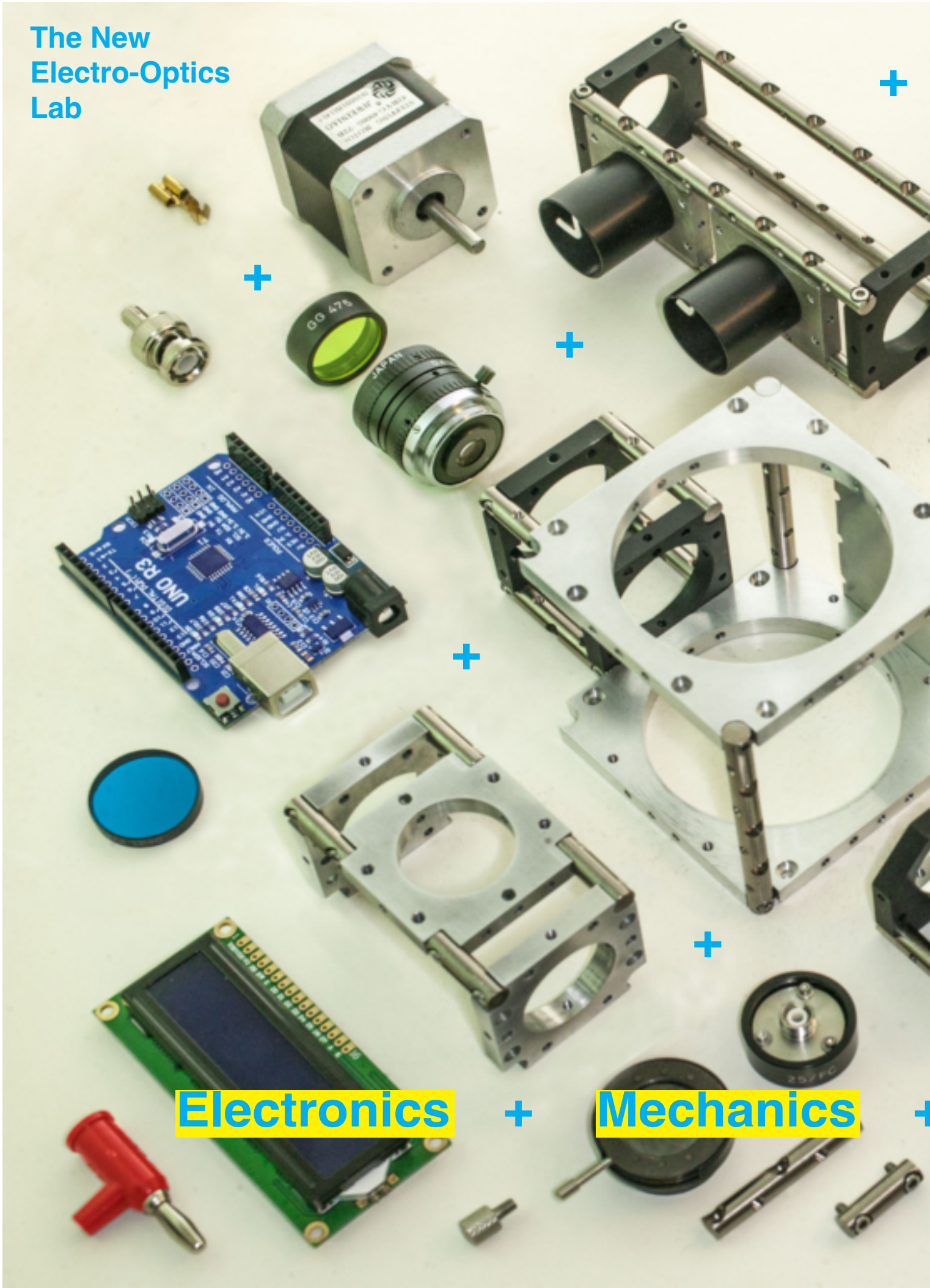
New Optoform II Cage System



PCT Patent Pending US2019/020863
European WO 2020/180307, China 2021

Be Different. Think Different. Do it with Taste. Make it a better Product

The New Electro-Optics Lab

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A bit of History

For me, it all began by purchasing my first Microbench kits in late 80's, and I couldn't take my hands off it. But optical kits have been around since 1920's made by Alfred Carlton Gilbert who is known as the father of Erector Set.

Microbench

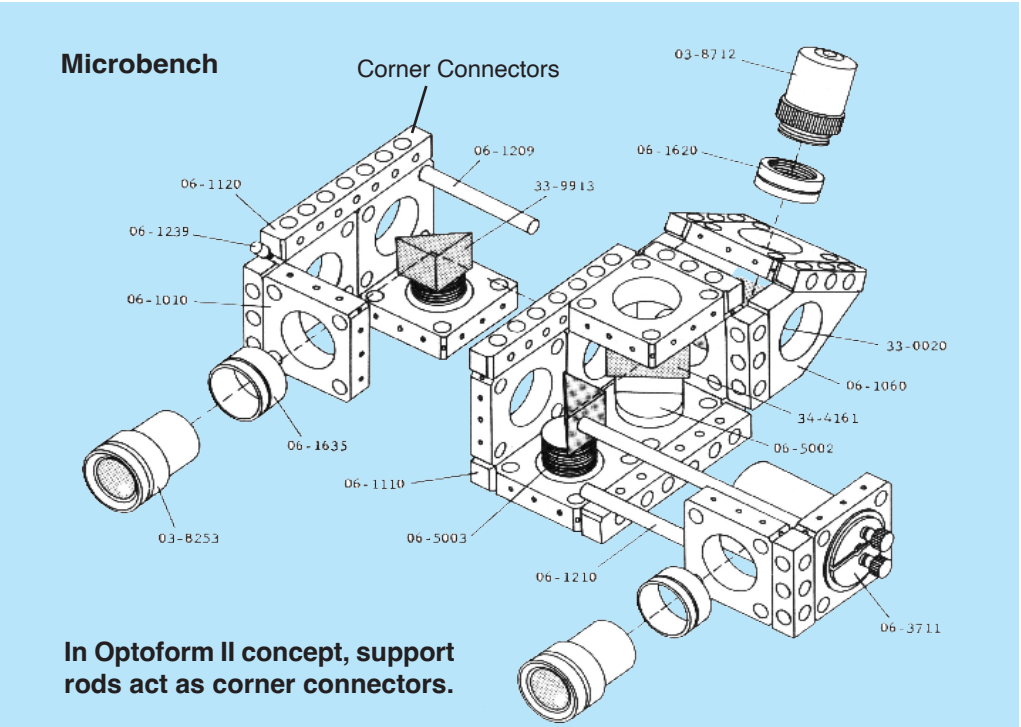
An optimized construction of a binocular head (right) with Microbench system built by author using minimum number of parts. I have always felt Microbench didn't succeed as much as its Thorlabs' counterpart was because it lacked an easy to understand user's manual for its end users. Microbench's use of corner connectors made it capable of solving far more complex problems than its simplified Thorlabs counterpart.

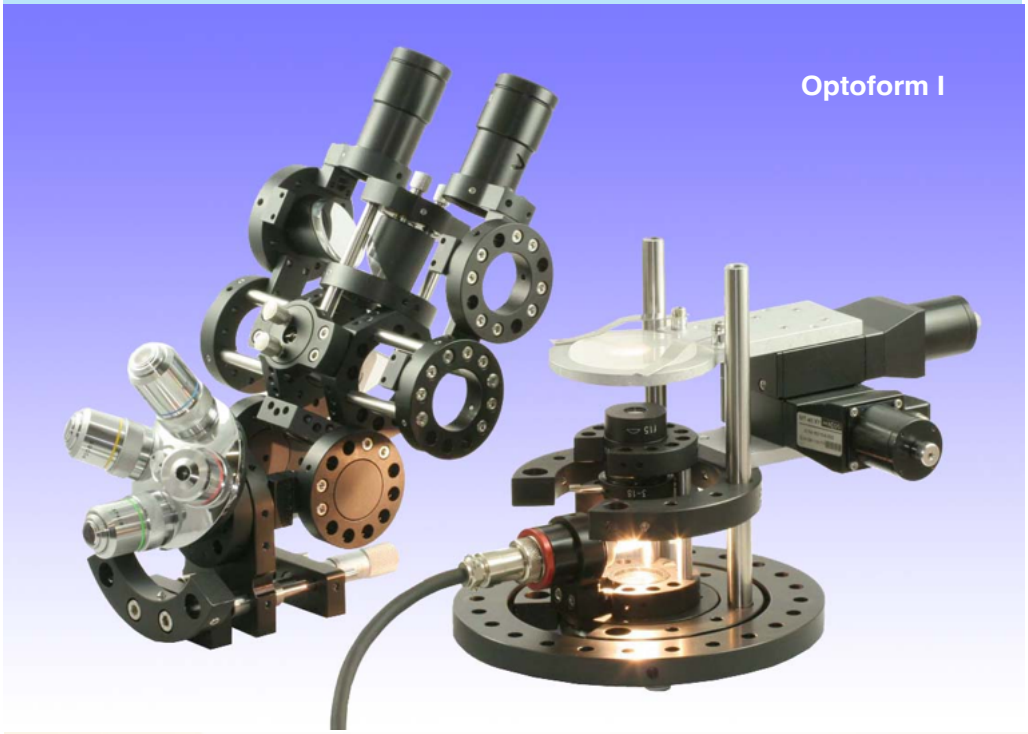
In Optoform II concept, support rods act as corner connectors. We'll build a binocular head with Optoform II to compare its flexibility, and cost.

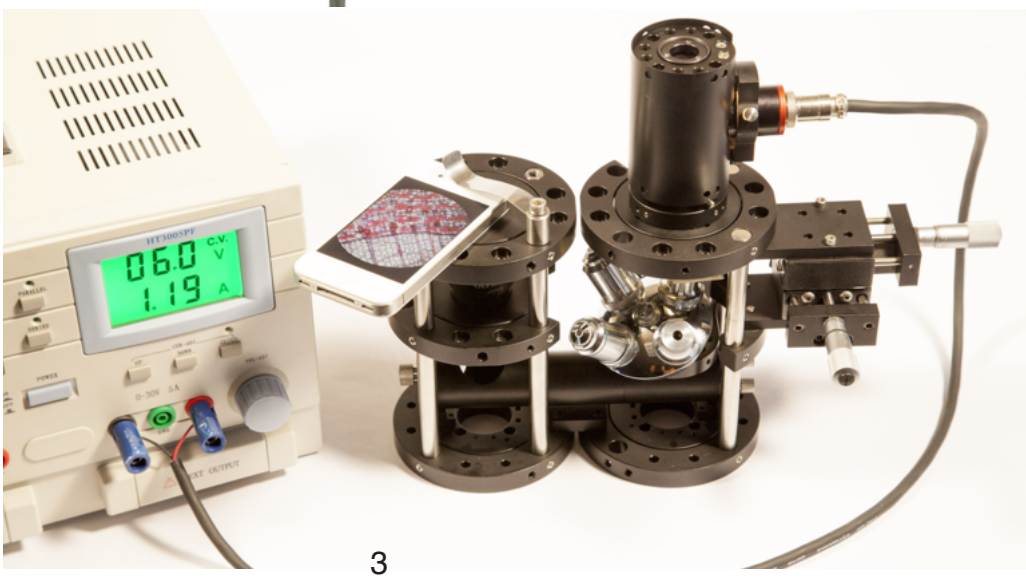
Optoform I

I invented, and filed a PCT patent for Optoform in 1993, hoping to offer a lower cost system than Microbench. Right, a motorized Biological binocular microscope built with original Optoform utilized concentric circular building blocks from 25 to 150 mm in diameter.

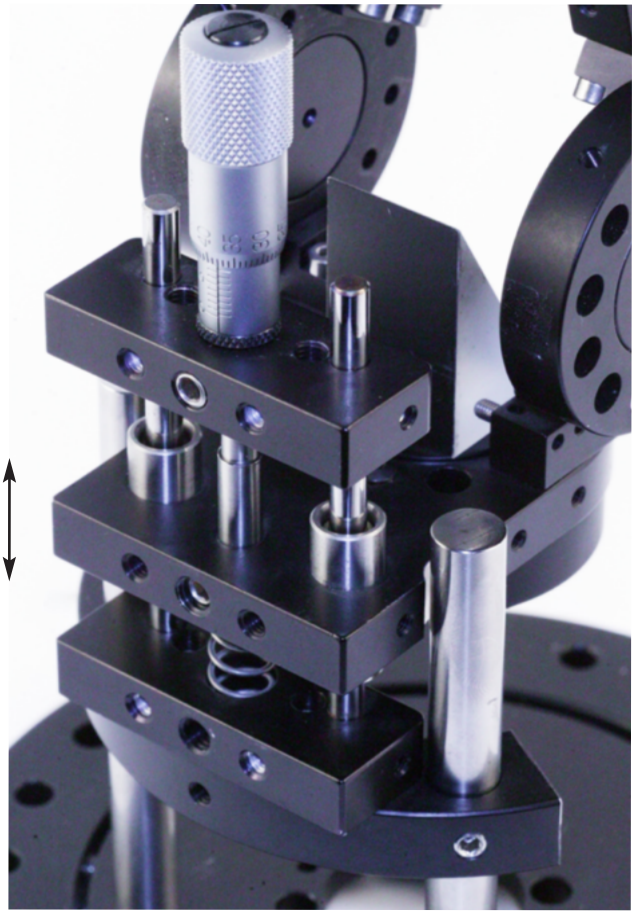
The capabilities of Optoform have been known by many research centers, and universities around the world. Complex optical cage systems are difficult to get started with, but those who do master it, can't live without it. Optoform I is still one of the most versatile erector sets offered to optial engineers, and optics lab technicians alike.



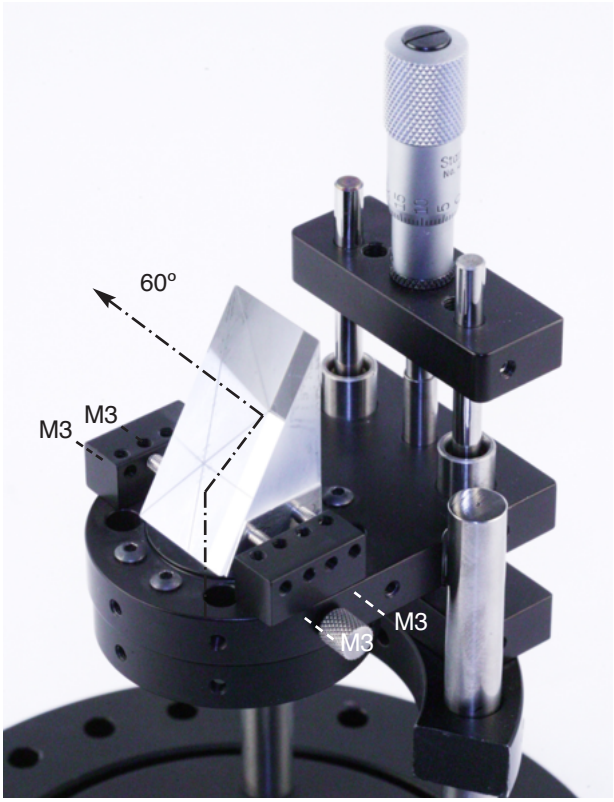


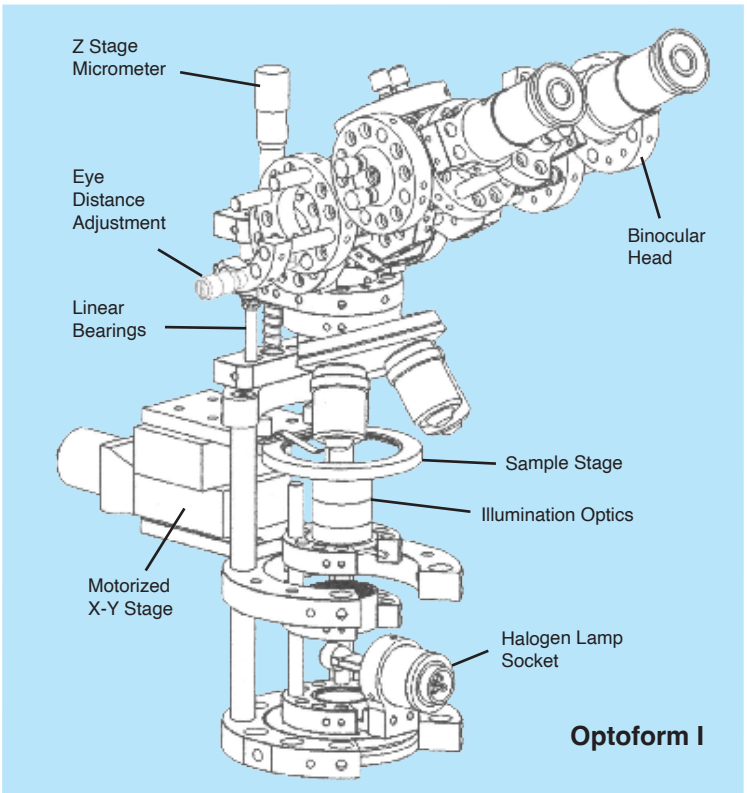


Optoform I is 30 years old



Optoform I introduced linear bearings: It consits of a stationary plate, and a translation pate pushed by micrometer.





It introduced up and down compatability between the mounts: Close up view of Littrow prism mounting screws (left) utilizing corner connectors . Opto-mechanics is all about details, and Optoform I handled every detail pretty well.

We have come a long way with Optoform II

The new generation of optical Cage System

When visiting trade shows, and observing so many new products, I have often offended some sales people by telling them their product isn't genuine. An optical cage system should bring something new, and honest to its end users. If you think you could just take off one rod, or change anodization colors, people will say no to it. Although a one-rod or three rod cage system is not as good as a 4-rod arrangement that's an engineering decision, not an innovative one.

So after nearly 30 years past my original design of Optoform in 1993, I said Optoform II better be something phenomenal or I won't spend time on it. Luckily, the new idea I had about making them cheaper, and more versatile, led me to design a new form that could be produced out of extruded Aluminum - a drastic reduction in manufacturing cost.

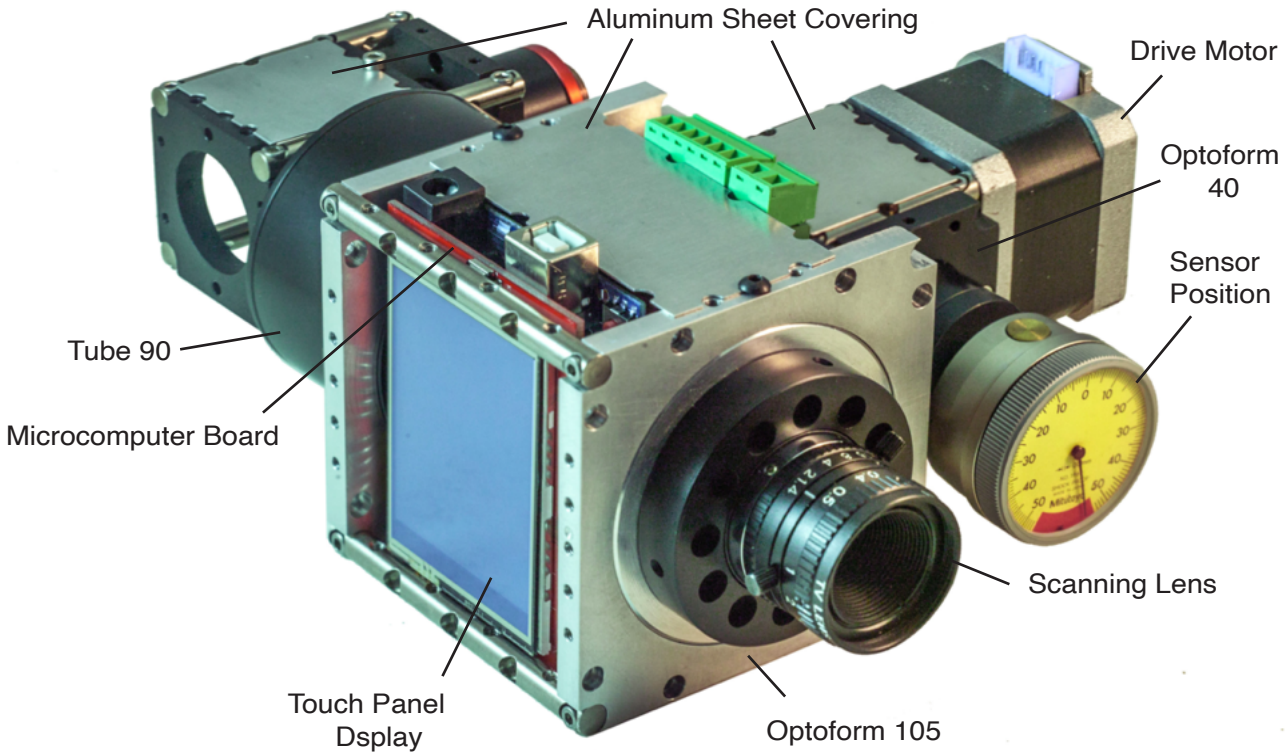
Before signing off an M&A agreement with Edmund Optics to hand over Optoform I, we had been manufacturing it for 18 years. I know it takes a 5-axis CNC machine around 5 minutes to produce each mount. This drives the price to $30 each. New Optoform II can be produced in about half that time, and half the cost.

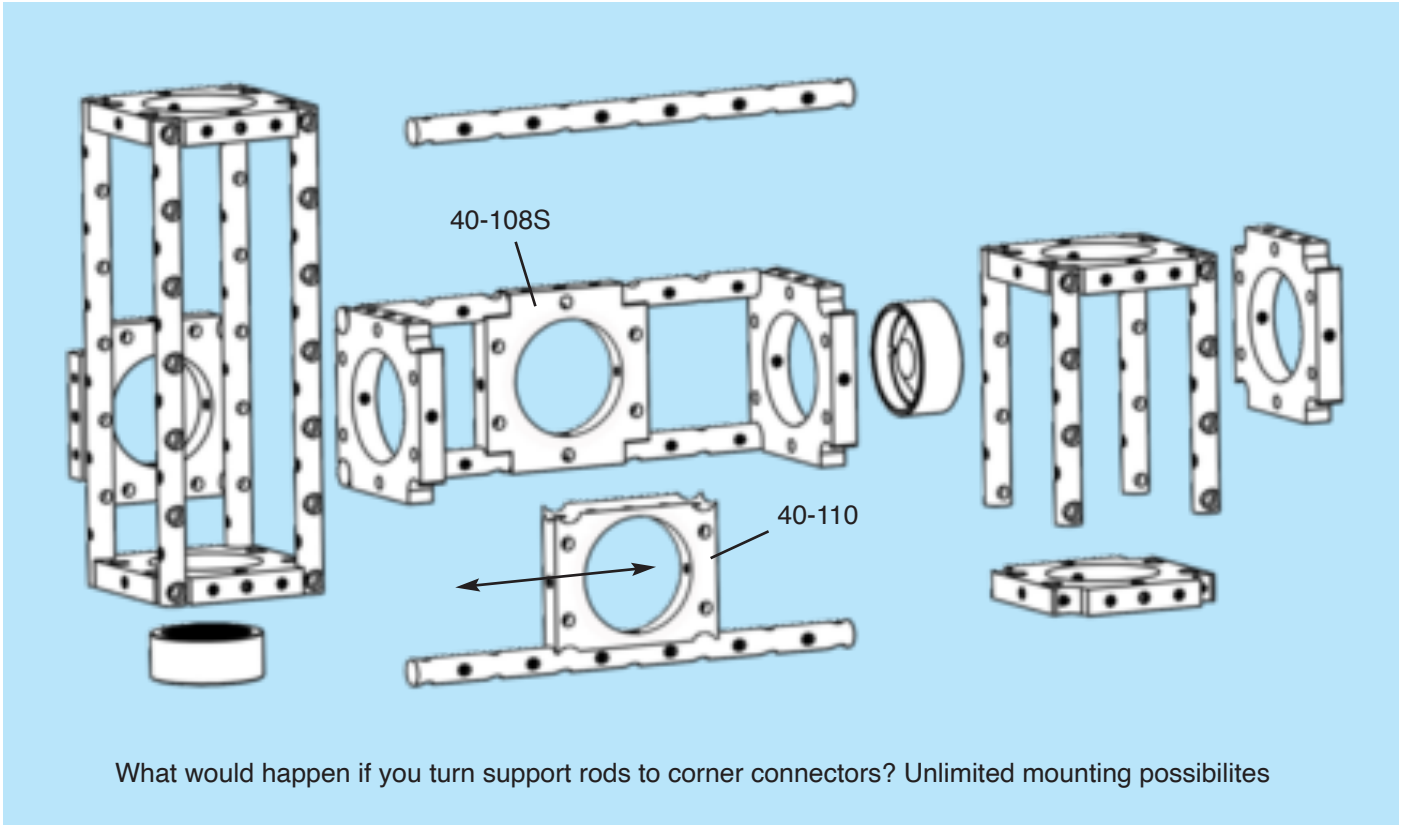
Since Optoform II is less expensive, thinner, and lighter, you could divide your setups into sub-assemblies. Optoform II offers space frame components so you could build complete housings, and portable instruments. In upcoming pages, we'll review some real applications, and see how the new Optoform building blocks can be helpful in constructing them. These are culmination of many applications notes previously published in our quarterly magazine at optomechanix.org.

Ali Afshari
CEO, Optomechanix

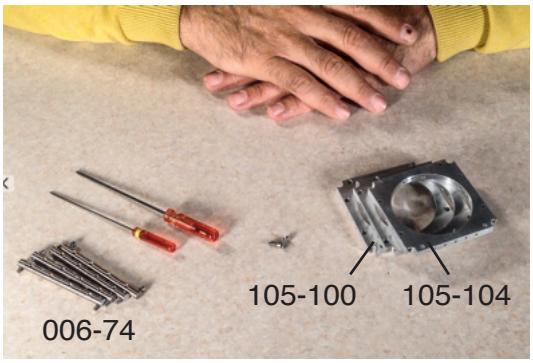
You give it form, it will function

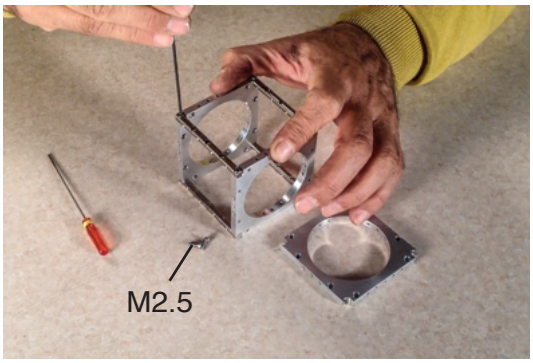
From idea to working optical instrument — without touching a machine shop





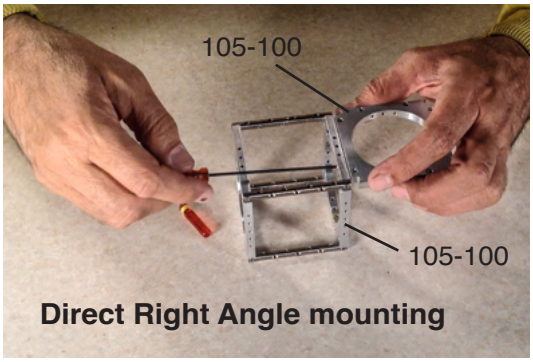
What would happen if you turn support rods to corner connectors? Unlimited mounting possibilites

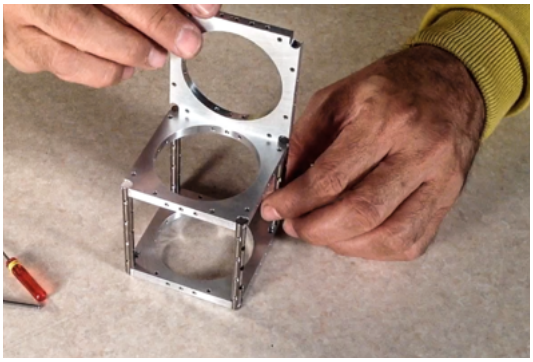




Constructing a cube

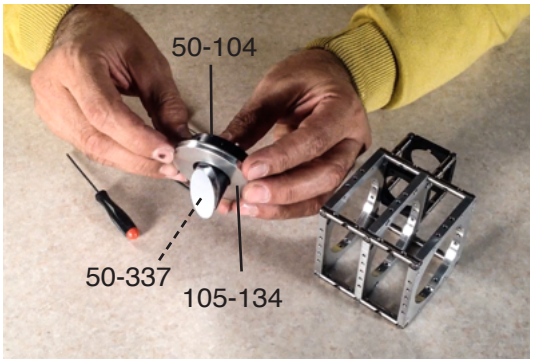
Using Optoform 105 mounts: In real practice, you'll only do this once. Cubes are your basic elements to construct 3D structures. The height could range from 12 to 142 in 17 mm increments.

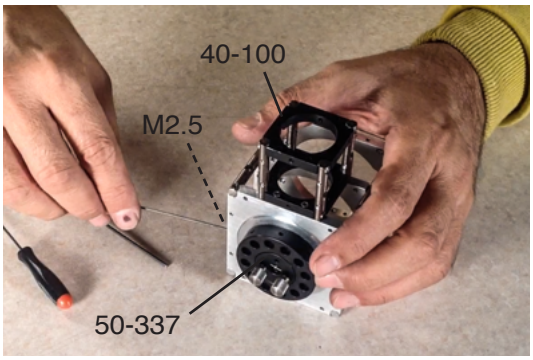




Securing mounting plates at right angles

Using counter-bores on the face of 105-100, and equally spaced M2.5 bores on the side of 105-100 or 105-104, two mounts may be joined together at right angles.

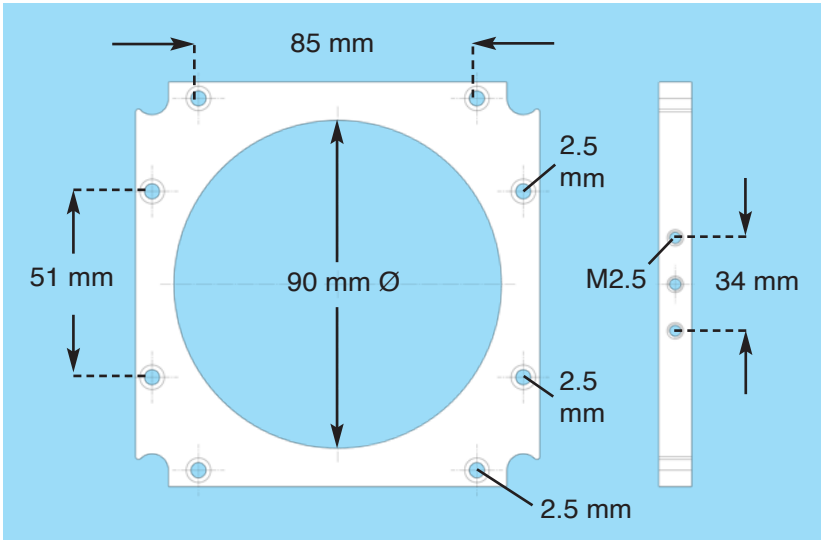


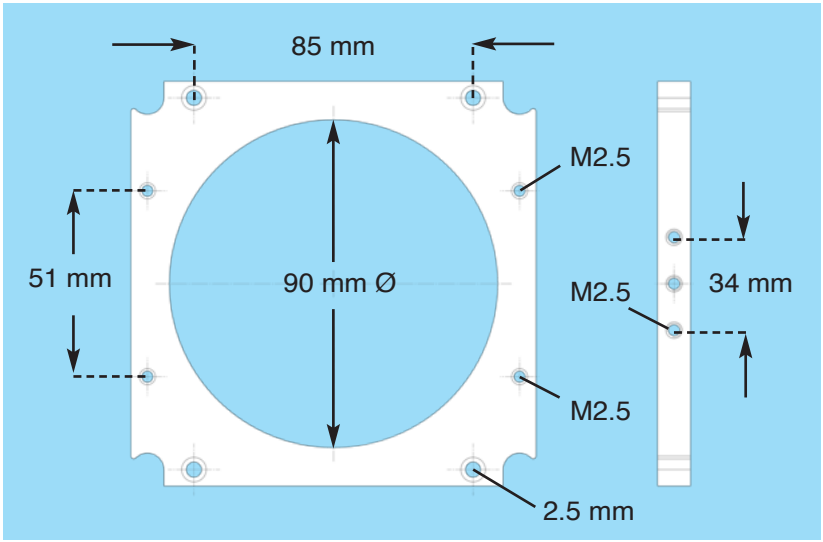


Using Optoform Accessories:

Utilizing 50-104 to secure 45° mirror mount **50-337** on mounting adapter **105-134.** This centering disc is held at 3 points via M2.5 set screws (right).

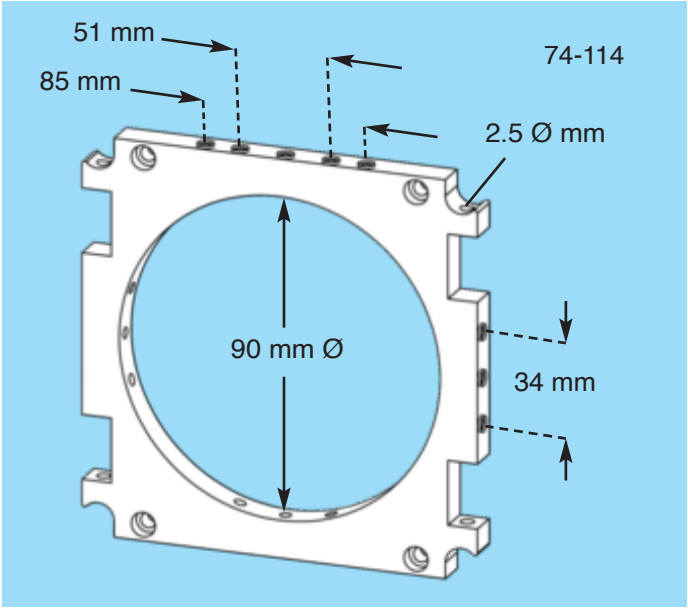
Optoform 74 mounts





105-114 Side Mount 105

Identical to 105-100, and 105-104, but with portions removed to allow securing it to rods internally rather than externally via M2.5 screws. This mount could be secured anywhere along 2, 3, 4 rods.



105-100 Standard Mount 105

Mounting plate 74-100, and 74-104 have matching 2.5 mm counter-bores, and tapped bores, 51 mm apart, to allow securing them face to face, i.e., for joining two sub-assemblies.

The 17 mm spaced mounting bores on its side will mate directly with Optoform 40 mounts. The 34 mm spaced mounting bores are to interface to other 74 mouns, or side mounts 40-124, and 40-126.

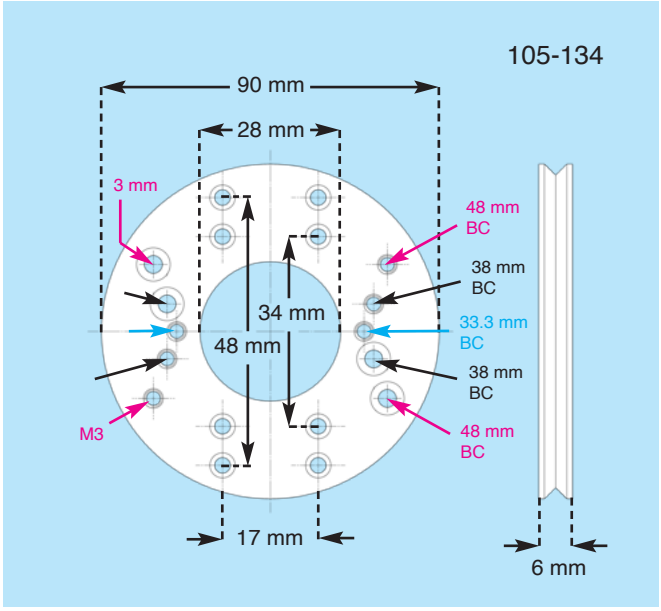
Will secure 60 mm mounted optics, and centering discs. Accepts Optoform 40 mounts on its M2.5 side bores.

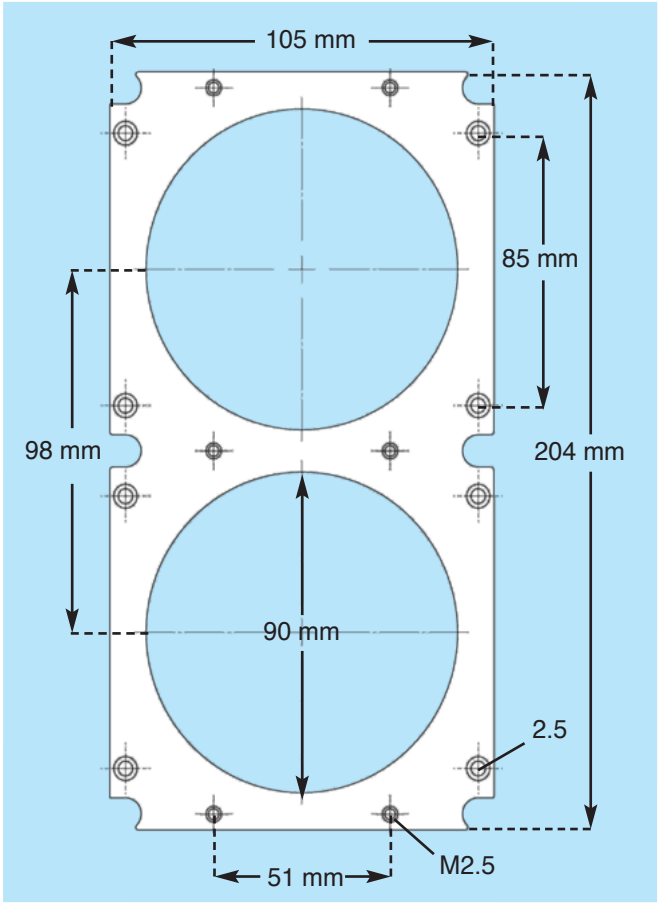
105-104 Mating plate 105

Identical to 74-100 but with 51 mm spaced threaded bore pattern to mate face to face. This orients the rods on the top, and bottom of the mounts for easy assembly. For side bore pattern, please refer to 74-114 description.

105-134 Mounting Adapter 60

Accepts Optoform 40 mounts, Microptic 50 (38 mm BC), or 2x2 mounts (48 mm BC) to integrate full range of classic Optoform accessories. It is secured in place via four M2.5 screws, 90 degrees apart, and is not intended for centering. The hole pattern is complex but it's much easier during use.

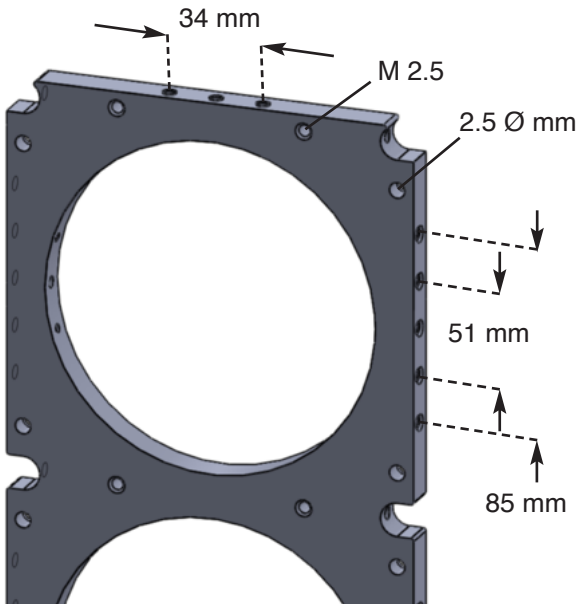


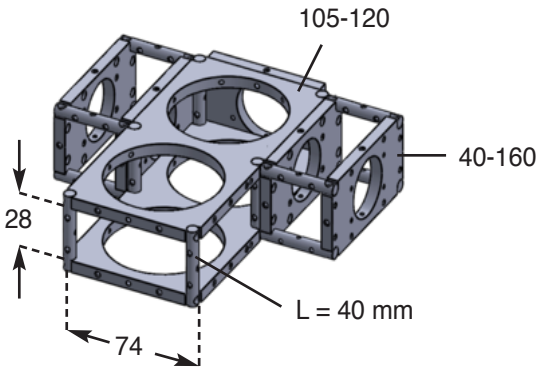


Instrument base constructed with 105-120, 40-160, and 006-40 rods (right). The sides of this assembly may be covered by our Aluminum sheets with hole patterns that match the side bore patterns on the mounts. Aluminum sheets provide structural rigidite, light seal, and dust protection for the inner optics.

105-120 Combination Mount 105x142

Combines two optical 105 mounts, 98 mm apart. Accepts Optoform 40, and 74 mounts on its sides, i.e. 40-160 to create instrument platforms (below).

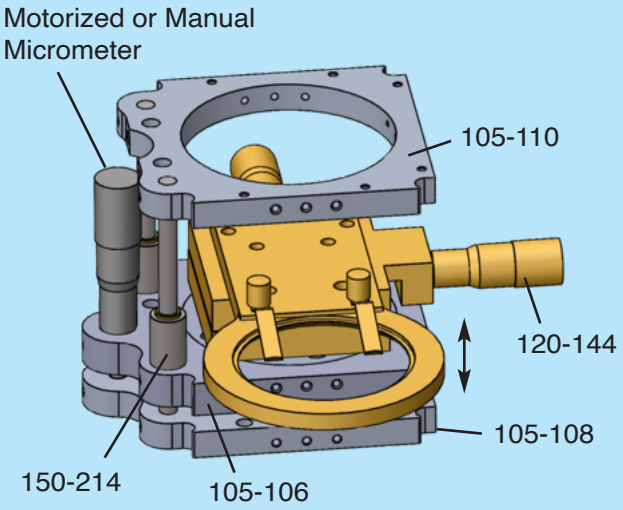


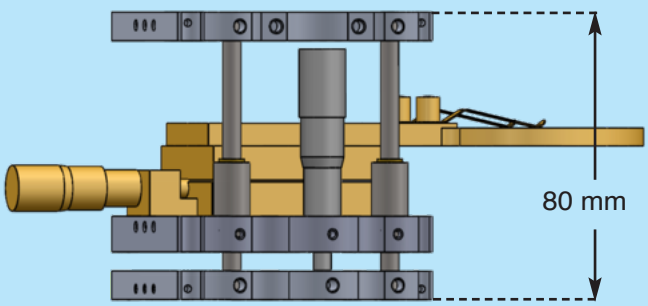


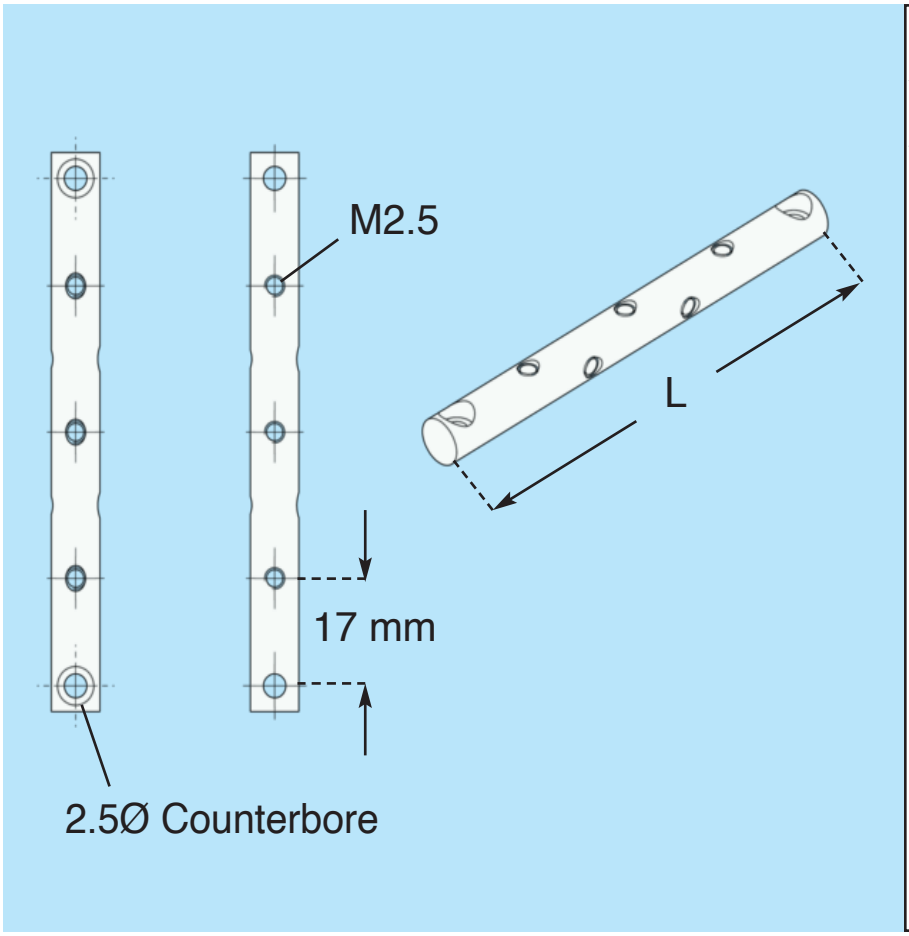
105-106 Focusing Module

Focusing module consists of three mounting plates 105-106, -108, and -110. Two linear bearings guide the stage, while a motorized or manual micrometer positions the stage along its 80 mm precision ground guide rails. The focusing stage is put together with four Aluminum rods, and structurally reinforced by thin sheet covering.

X-Y stage 100-200 may be secured on its translating plate (105-108) to consruct a X-Y-Z stage for microscopy applications.



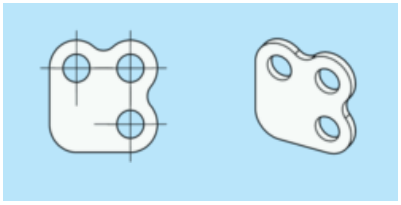




Support Rods

Aluminium Alloy	Stainless S
006-12, L= 12 mm	Special Order
006-20, L= 20 mm	
006-23, L= 23 mm	
006-40, L= 40 mm	
006-50, L= 50 mm	
006-57, L= 57 mm	
006-65, L= 65 mm	
006-74, L= 74 mm	**006-74S**
006-80, L = 80 mm	**006-80S**
006-108, L= 108 mm	**006-108S**
006-128, L= 128 mm	**006-128S**
006-142, L= 142 mm	**006-142S**

Mounting Hardware



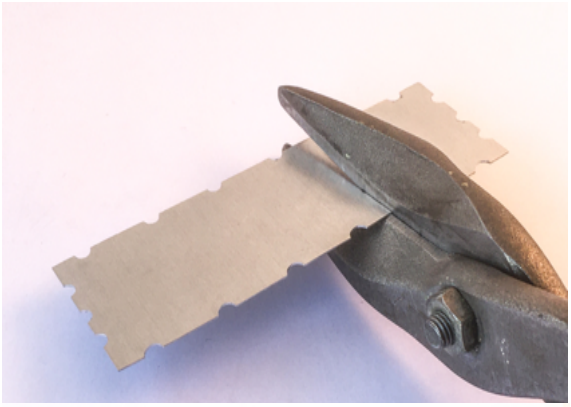
00 - 300 End connecting Adapter for Rods

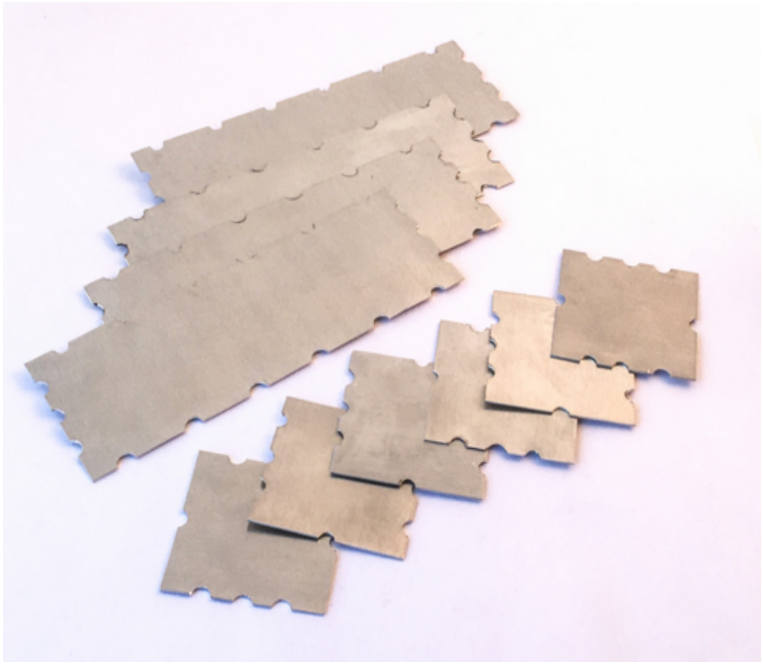
For end connecting specially made 6 mm rods 006-40F with M2.5 mm threaded ends, to provide linear guides for sliding filter holder 40-150, and sliding beamsplitter holder 50-148.

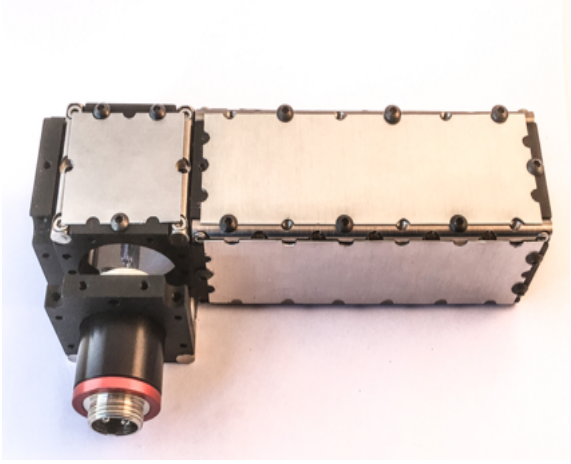
00-116	M2.5x10 Thumb screws, pack of 5	For securing accessories on M2.5 threaded bores
00-120	M2.5x10 Low profile, 25 pcs	For securing two mounts face to face
00-125	M2.5x6 Socket screws, 100 pcs	Standard rod securing screw
00-126	M2.5x3 Set screws, pack of 100	Optics securing screws, L = 3 mm
00-128	M2.5x6 Set screws, pack of 100	Optics securing screws, L = 6 mm
00-129	M2.5x4 low profile, 25 pcs	For sheet covering around Optoform 40 assemblies
00-222	M2.5 Nut, set of 10	For securing accessories along M2.5 set screws
00-248	Ball driver set 1.27, 1.5, 2 mm	For constructing Optoform 40, and 74 assemblies
006-40F	6 mm rod, L = 40 mm, set of 12	Special 6 mm rods with M2.5 threaded ends, with detent

Cover Plates

Sheet covering in Optoform may be easily cut to size by household shears. There are also nibling tools available to provide clearance notches for mounting screws.

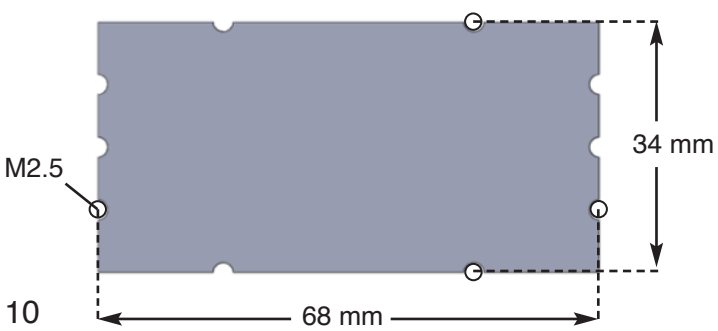






00-500	14 X 34 mm, 0.3 mm Thickness	For covering 20 X 40 space frames
00-502	34 X 34 mm, 0.3 mm Thickness	For covering cube 40 X 40 faces
00-504	34 X 51 mm, 0.3 mm Thickness	For covering 40 X 57 space frames
00-506	34 X 68 mm, 0.3 mm Thickness	For covering 40 X 74 space frames
00-508	34 X 102 mm, 0.3 mm Thickness	For covering 40 X 108 space frames
00-510	34 X 136 mm, 0.3 mm Thickness	For covering 40 X 142 space frames
00-512	68 X 68 mm, 0.3 mm Thickness	For covering cube 74 X 74 space frames
00-514	68 X 102 mm, 0.3 mm Thickness	For covering 74 X 108 space frames
00-516	68 X 136 mm, 0.4 mm Thickness	For covering 74 X 142 space frames
00-518	68 X 120 mm, 0.4 mm Thick, Set of 2	Special 74 X 126 binocular head's top cover
00-520	68 X 102 mm, 0.4 mm Thickness	For covering 74 X 80 linear bearing assembly

Cover plates are cut at the center-line of M2.5 screw bore pattern around their periphery. This allows cover plates to lay side by side around the space constructed by mounting plates, and support rods. In opto-electronics projects, cover plates may be drilled, and nibbled to secure electronics connectors, and switches. The standard color for cover plates is anodized light gray. Unanodized version of cover plates are also available to take any desired color.



Designing, and Building a Binocular Microscope

Building complex opto-mechanical instruments requires preassembled sub-modules, otherwise you'll be spending days designing it with solidworks or catia. Optoform speeds up the process with direct upward/downward compatible modules. If you decide to assemble them in a computer, you'd be putting together predesigned sub-assemblies.

You can order this viewfinder, as it will be an available module for the system. To adjust for the eye distance in a binocular head, sliding mounts 40-110 are designed to perform this task. The optical path inside the viewfinder is first bent 30 degrees via a Littrow prism for inclined viewing, and is split into two paths via a beamsplitter (Fig. 1). Three additional right angle prisms produce the proper separation between the two beams for binocular viewing. A pair of specially designed 40-120, and 40-126 mounts will be utilized to construct this assembly in its bent form. Sliding mounts 40-110 ride on two 128 mm support rods, that construct this compact 128 x 40 x 114 mm assembly.

While designing this somewhat complex arrangement, two new mounts, and a 128 mm long rod must be added. This is not a problem. Each module may contain specially designed mounts to perform a specific function. Mounts 40-126 are designed to be reversible, hence reducing the number of necessary parts. Refer to page 16 for detailed description of these mounts. Figure 1 shows a quick assembly trial to help us conceive its mechanical form.

To create mount 40-126, we'll be folding half of mount 40-120 (Fig. 2) around one of its mid rods. 40-126 is designed specifically to construct the 30 deg. inclined viewing (Fig.3). These basic building blocks will be utilized later to construct the rest of the microscope assembly. The viewing head is now ready to be built.

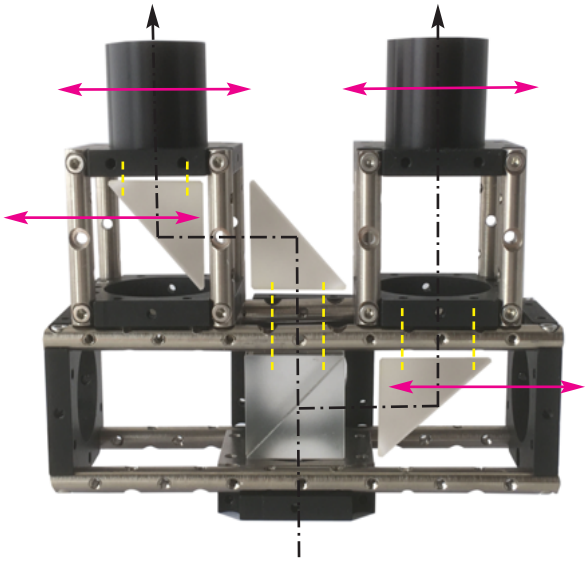
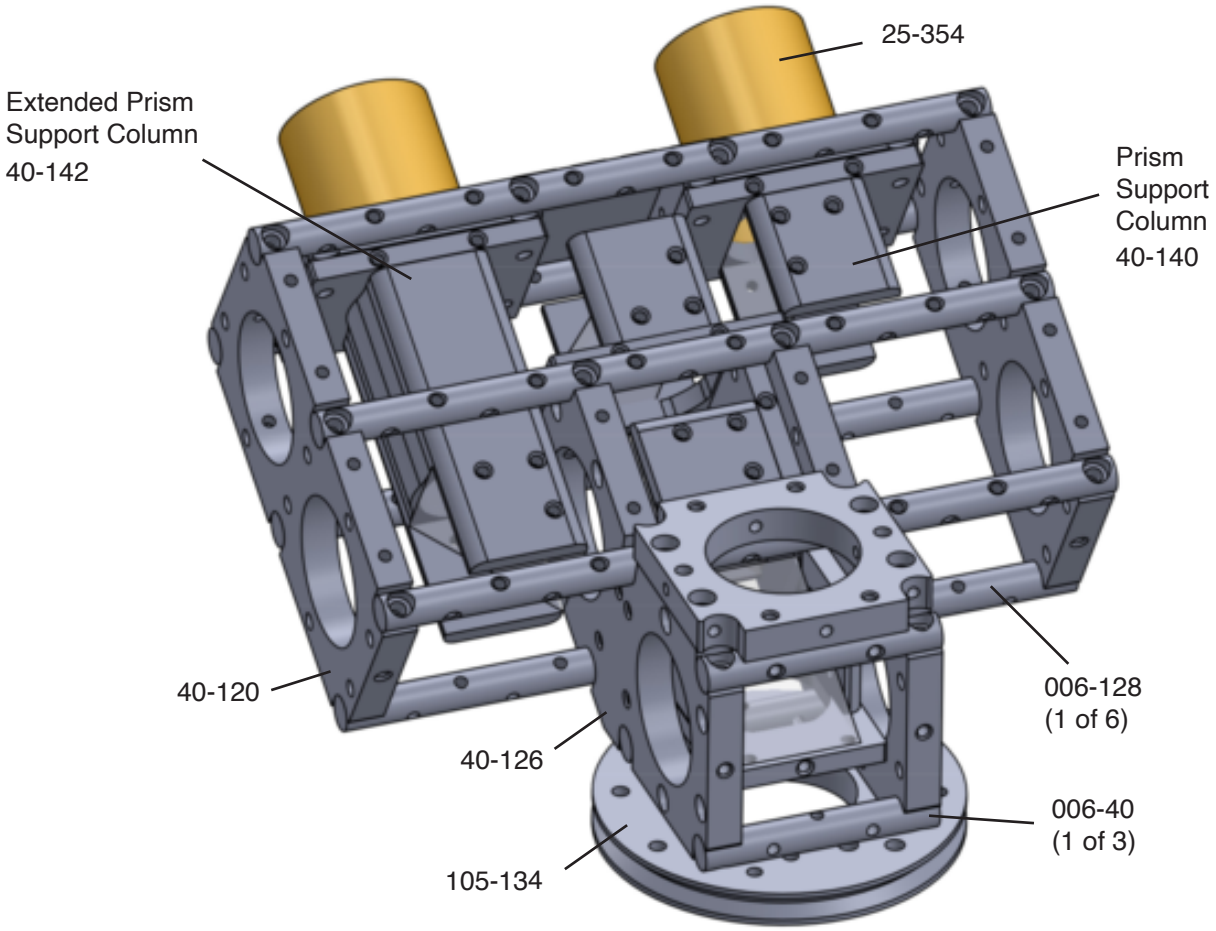


Fig. 1 Preliminary idea of a Binocular Head



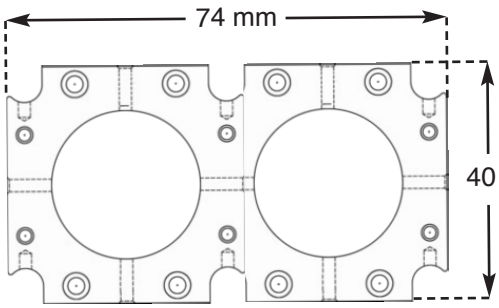


Fig.2 Combination Mount 40 -120

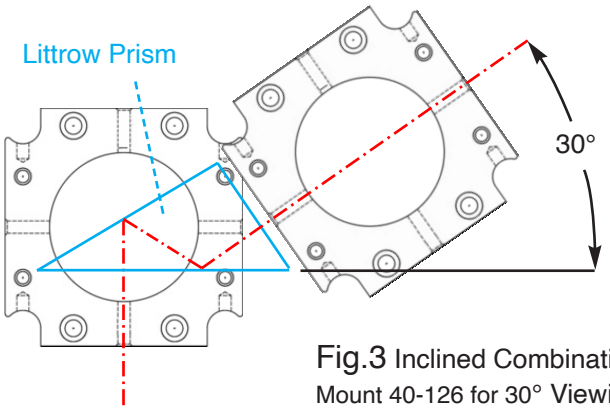
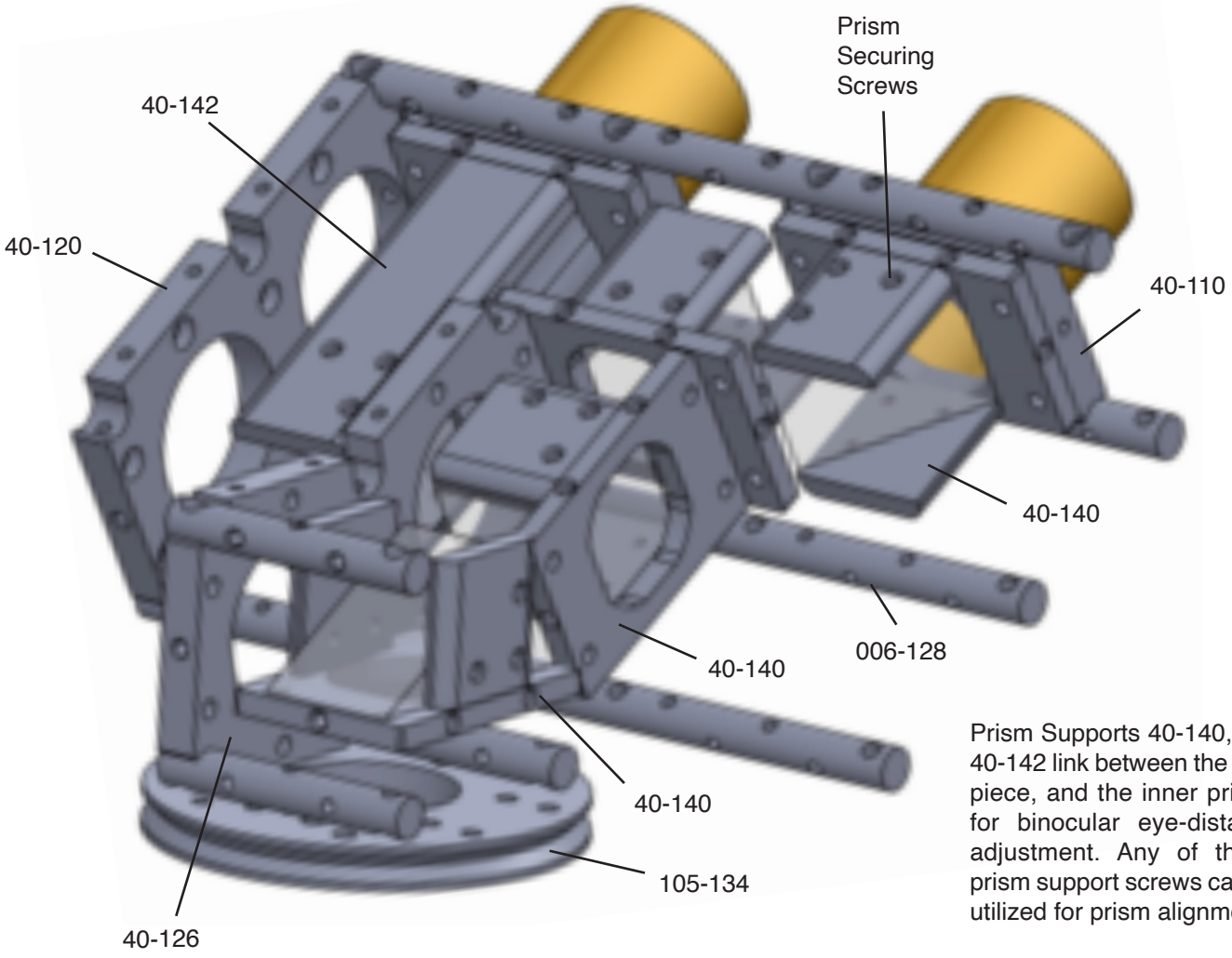


Fig.3 Inclined Combination Mount 40-126 for 30° Viewing

If you are an optics fan, you'd appreciate what we are about to do. We have all used binoculars before but have you ever built one yourself? What it takes is a system capable of constructing it. While we were children, we used the Erector set to make anything we wanted but as we grew up, we were told everything was too complicated. To build a binocular, you'll need to go to Zeiss or Leitz factory, and they'll tell to sit behind an assembly line, or work with machinists to build its already designed parts. With Optoform, you don't have to. If you are able to create form, we'll make it functional. That's really our goal.

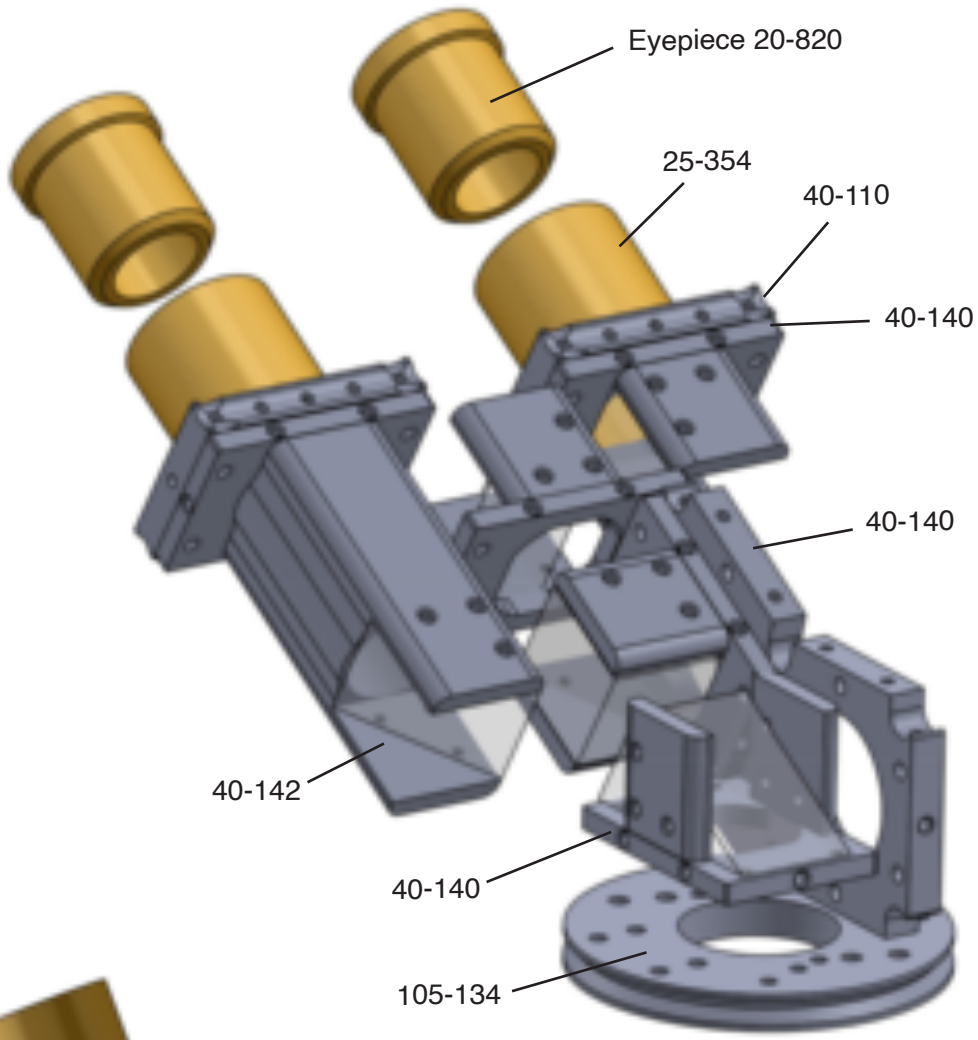


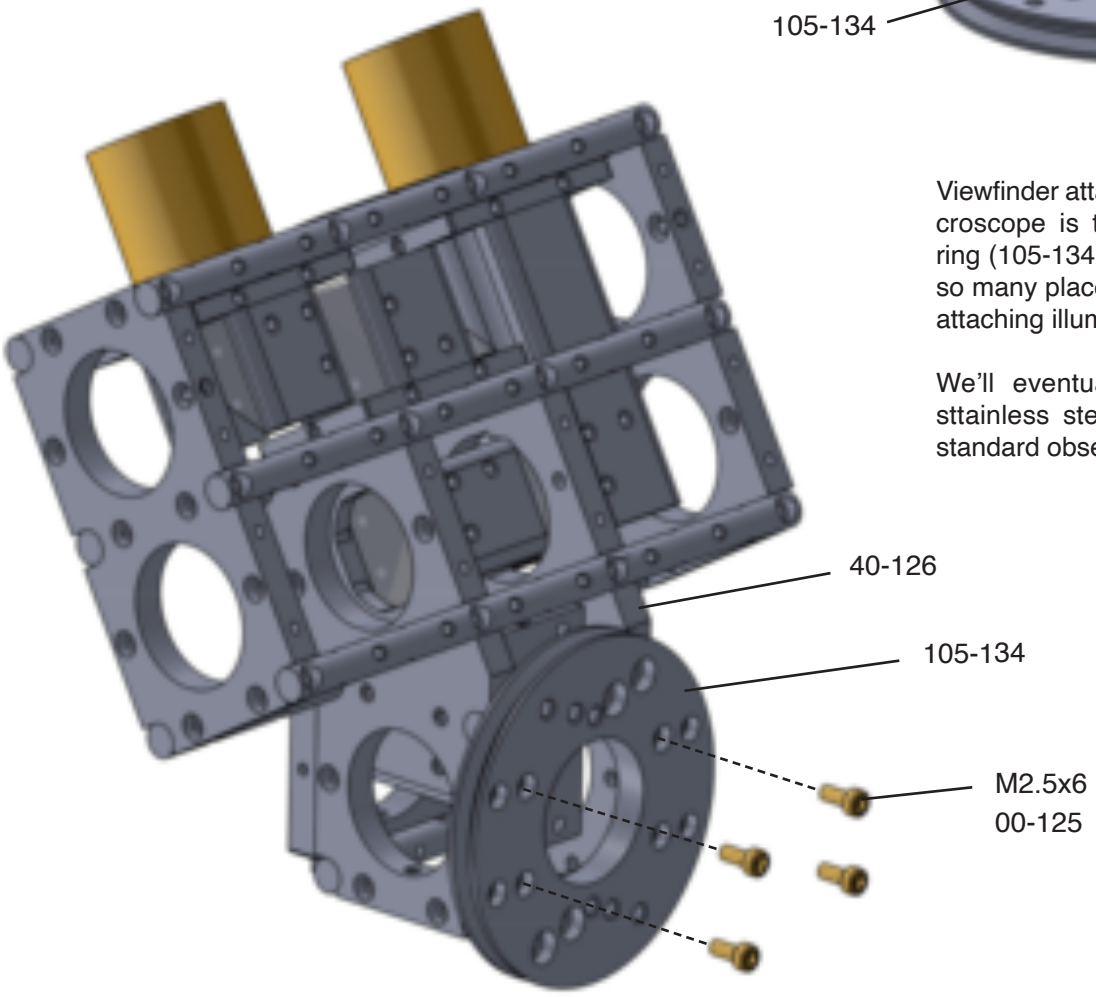
Prism Supports 40-140, and 40-142 link between the eye-piece, and the inner prisms for binocular eye-distance adjustment. Any of the 3 prism support screws can be utilized for prism alignment.

Mounting Prisms

What you experience in this assembly is more playful, and more fulfilling than being an assembler who works at Zeiss or Leica microscope factories. They aren't allowed to play, but you can!

Why not use an off the shelf viewfinder? You sure can, but these compact viewfinders have been replaced with large housings that cost too much. You may also have your own idea of adding a CCD camera inside it, or change the design to something that is more suitable for an upright microscope (light coming from above). In either case, Optoform gives you the freedom to implement it.





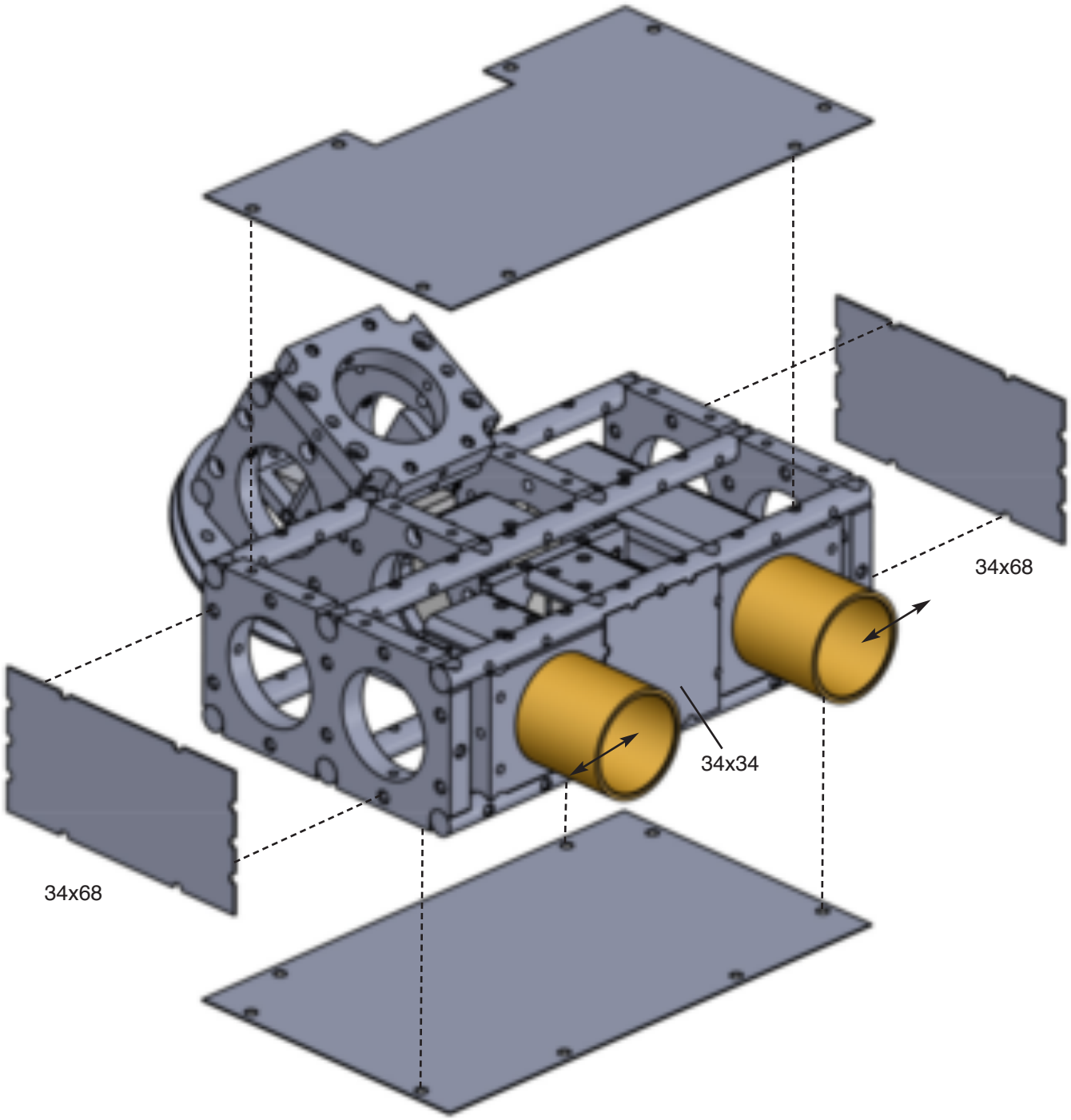
Viewfinder attachement ring to the microscope is this versatile centering ring (105-134). You'll see it utilized in so many places to secure mounts, or attaching illumination sources.

We'll eventually replace it with a sttainless steel dovetail ring like in standard observation heads.

Sheet Covering

The idea is to be able to cut off extraneous light, and to prevent dust from entering the optics. For the moving parts sometimes you get lucky. The two eyepiece holders held by sliding mounts 40-110, can slide beneath a single cover sheet (34x34, below) like an off the shelf viewfinder. You could also see the edges in Optoform 40 assemblies are round. For a list of sheet covering sizes please refer to page 21.

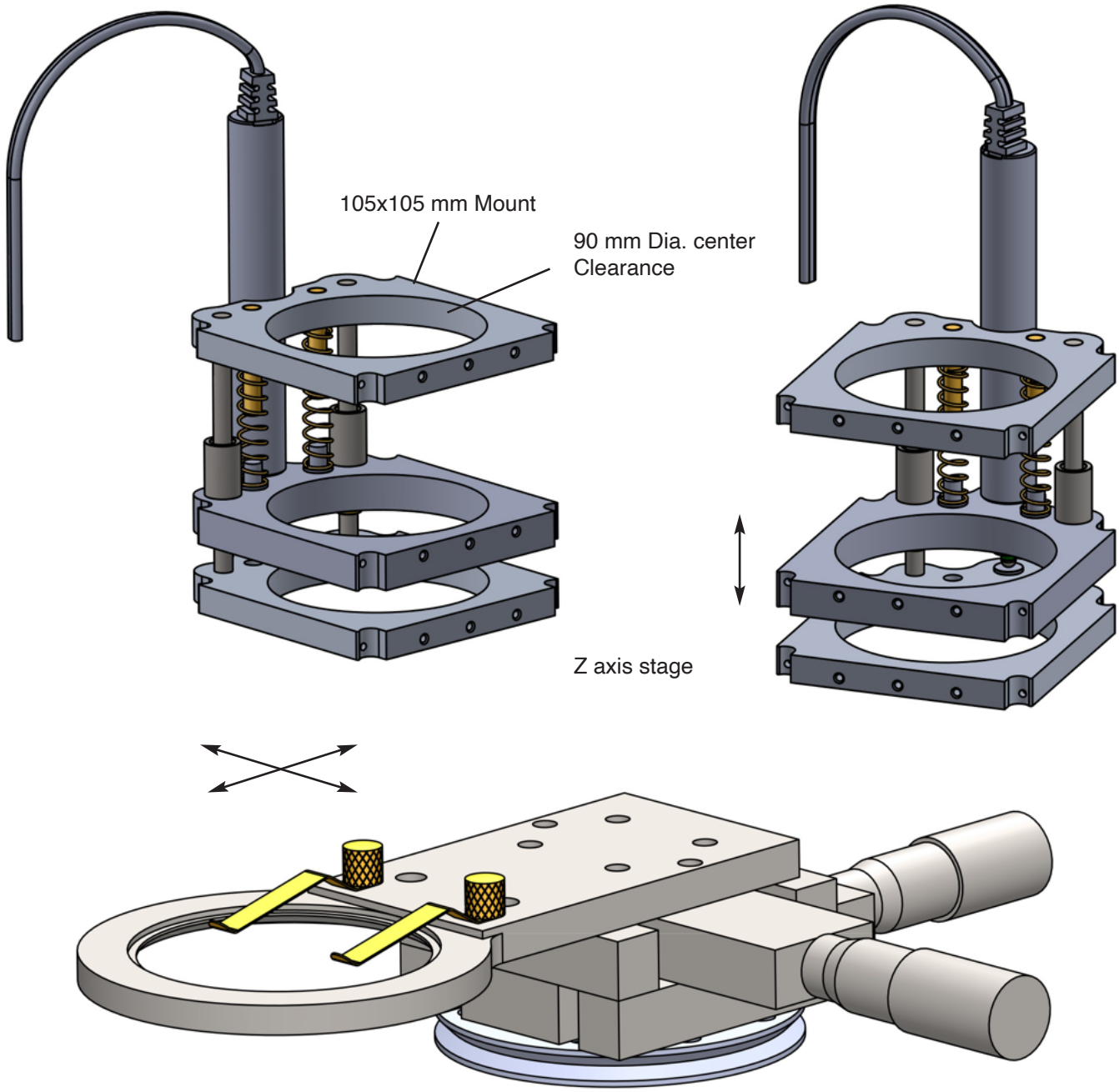
The top, and bottom sheet covers are custom made. We'd offer you the entire unit, and you could either use it as what it is designed for, or disassemble it to make modifications. The prisms are held in place with three set screws which could also be utilized for alignment. There are thin brass sheets to protect the glass, also a thin cardboard packing as cushion.



Designing the focusing Module

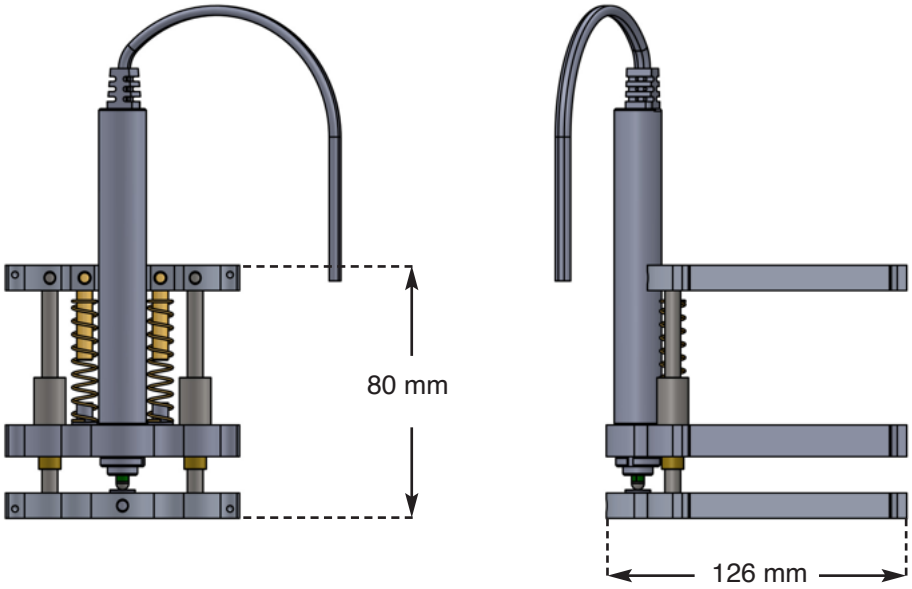
The focusing module is a tricky one. Under high magnification, it should perform precisely without image drift, while under low magnification, it should have a wide travel range to accommodate objectives that are not necessarily parafocal. We will design an elaborate XYZ stage for the sample but for now, let's design a simple, motorizable system (switchable between manual, and motorized micrometers) utilizing classical Optoform's linear bearing concept (see page 4).

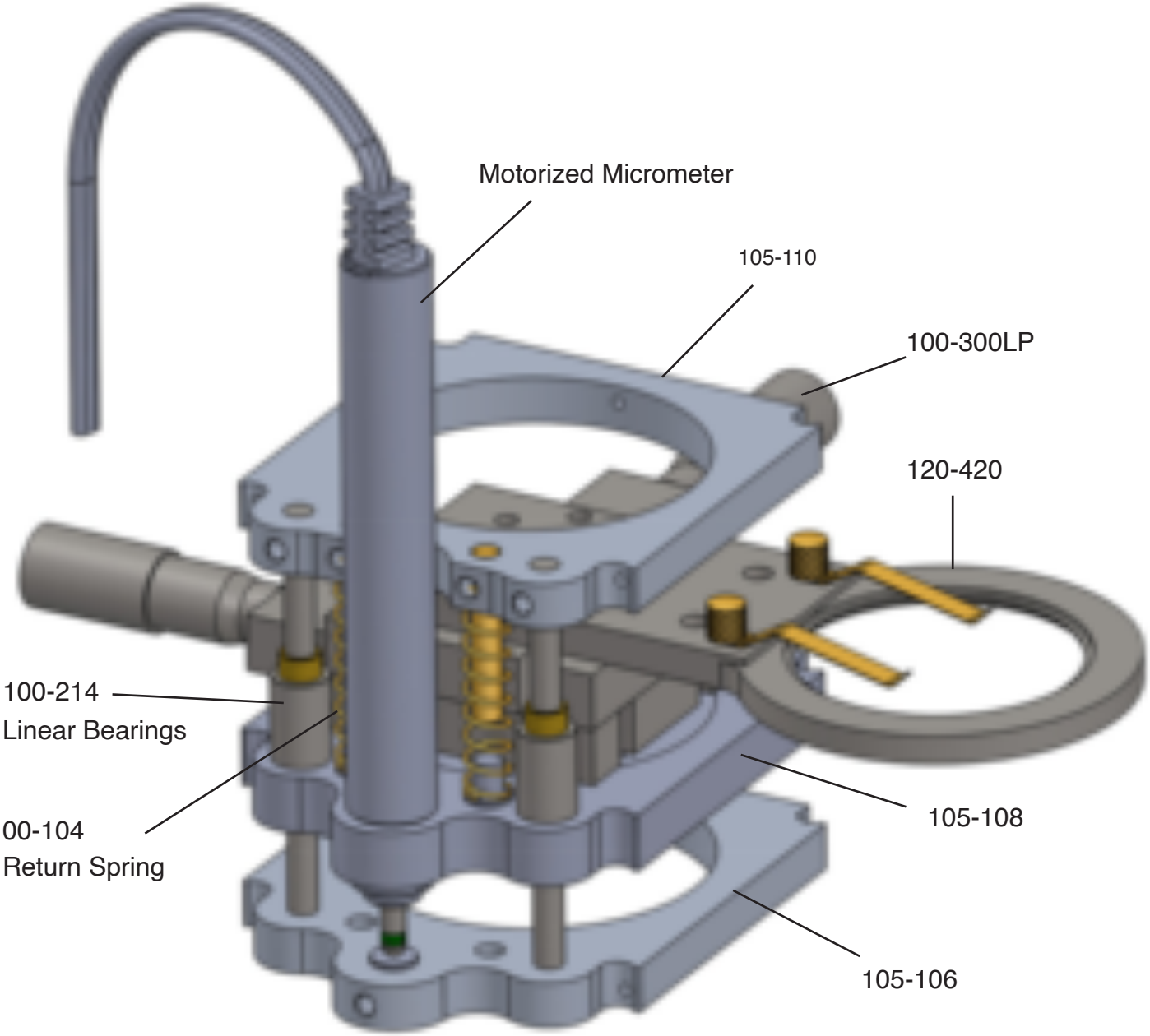
In its classical design, two linear bearings support the sample platform while a combination of a lift micrometer, and a return spring would precisely position the stage. The design is kept symmetrical to provide backlash free Z axis positioning. Four rods, and cover sheets support this 80x126x105 mm module. Because these modules are stackable, and the rods are side mounted, all the mating plates need to be paralleled (identical height on all four corners). With linear bearings, the mounts are already parallel, but for most assemblies it's best to adjust for parallelism. I'll show you how it's done.



Compact XY stage 100-300LP may be motorized by replacing its micrometers.

The XYZ stage assembly will have sheet covering to protect its inner components. The design of new Optoform modules allows chain connections. You'll see how this piece will fit to the rest of the system without any obstruction. The standard configuration is supplied with 13 mm micrometers which may be replaced with motorized micrometers as shown. 80 mm rods 006-80 support the assembly (see page 20 for rod lengths).

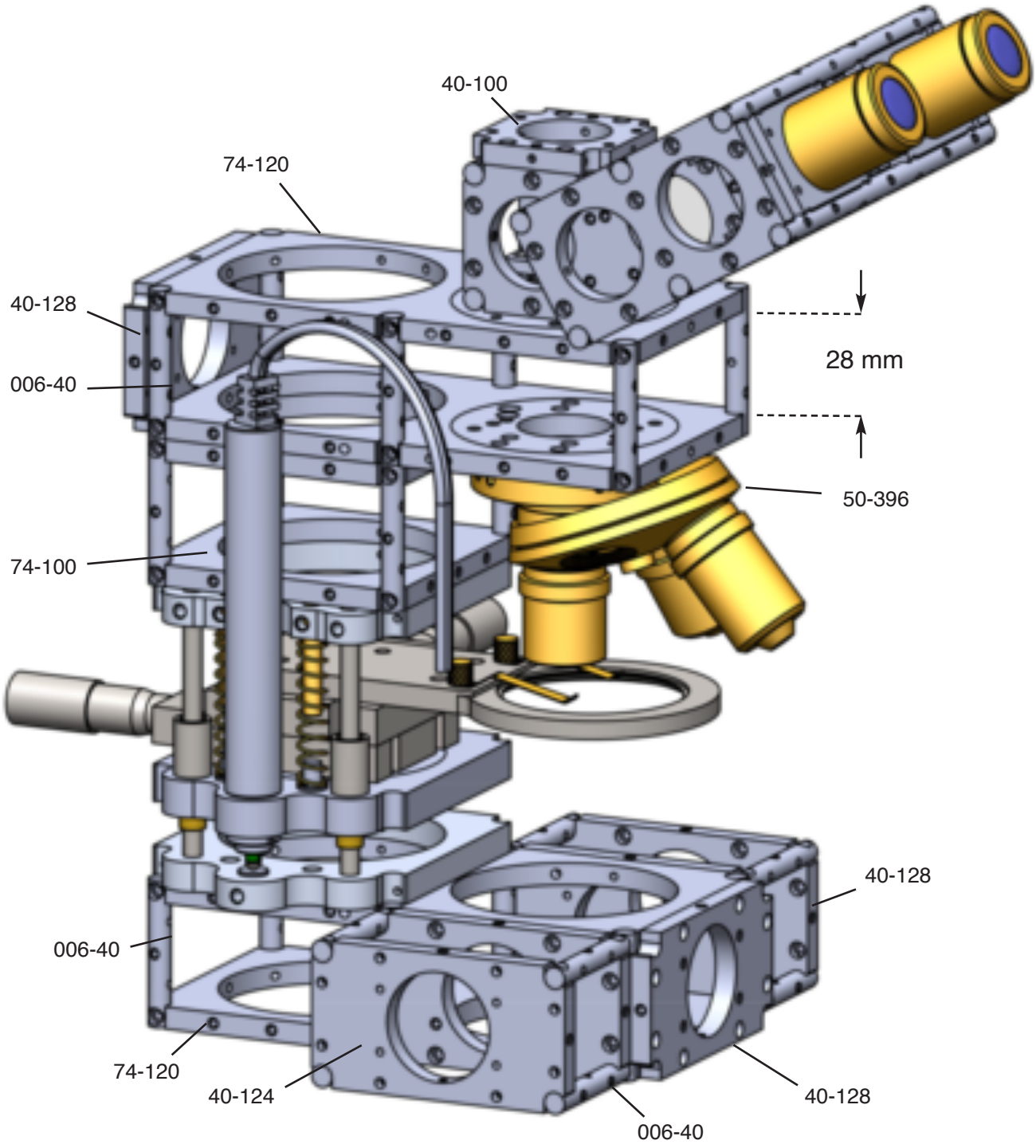


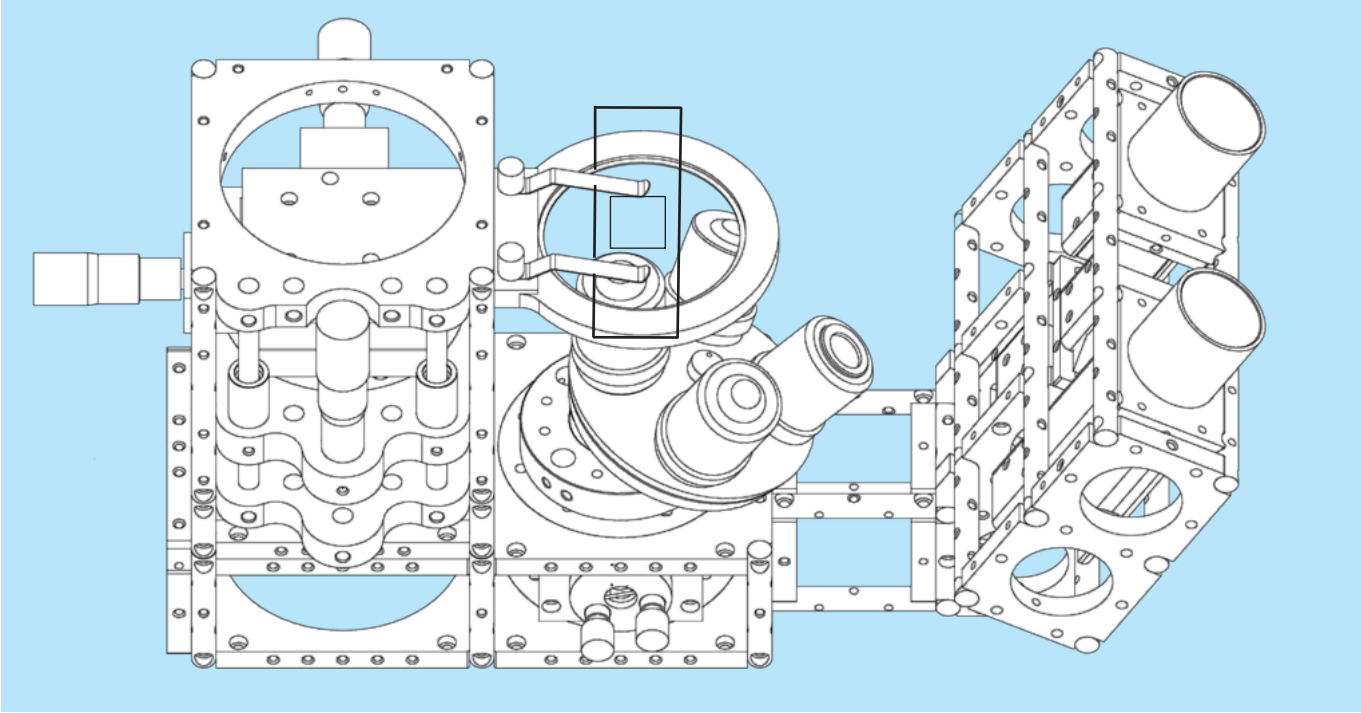


Integrating the Modules

The current configuration allows implementation of both incident, and transmission illumination. The spacing between mounts 74-120 is 28 mm, and a new mount 40-112 is added to fit in between these mounts for securing all the necessary beamsplitters, and optical elements that are utilized in designing a Kohler illumination or an Epi-Luminiscent scheme. Any illumination optics we come up with is a stand alone module that may be taken off from the microscope to be replaced by an alternate design.

The base platform is currently designed in a T-shaped space frame that could hold some electronics. As the mounts get larger, their size to thickness ratio increases, and in larger mounts, they are not any thicker than elctronics enclosures with good heat dissipation. I will have to give you a few examples till you see what I mean by this. But for now, take my word for it: The new Optoform assemblies are perfect for wire routing, and electronic parts integration into the optics housing. I guess the easiest example would be housing a large CCD camera, mounted on 40-100 plate on top of the microscope. We'll construct one later. But what's missing in this microscope is the illumination optics. I'll explain that next. We have designed a special mount 40-128 for this purpose. It is mounted at several places around the microscope to show various light source mounting possibilities.



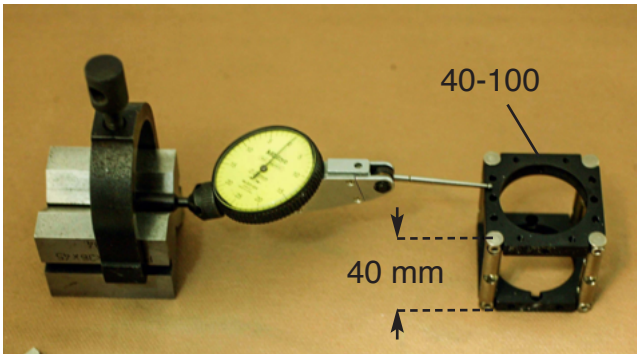


Parallelism

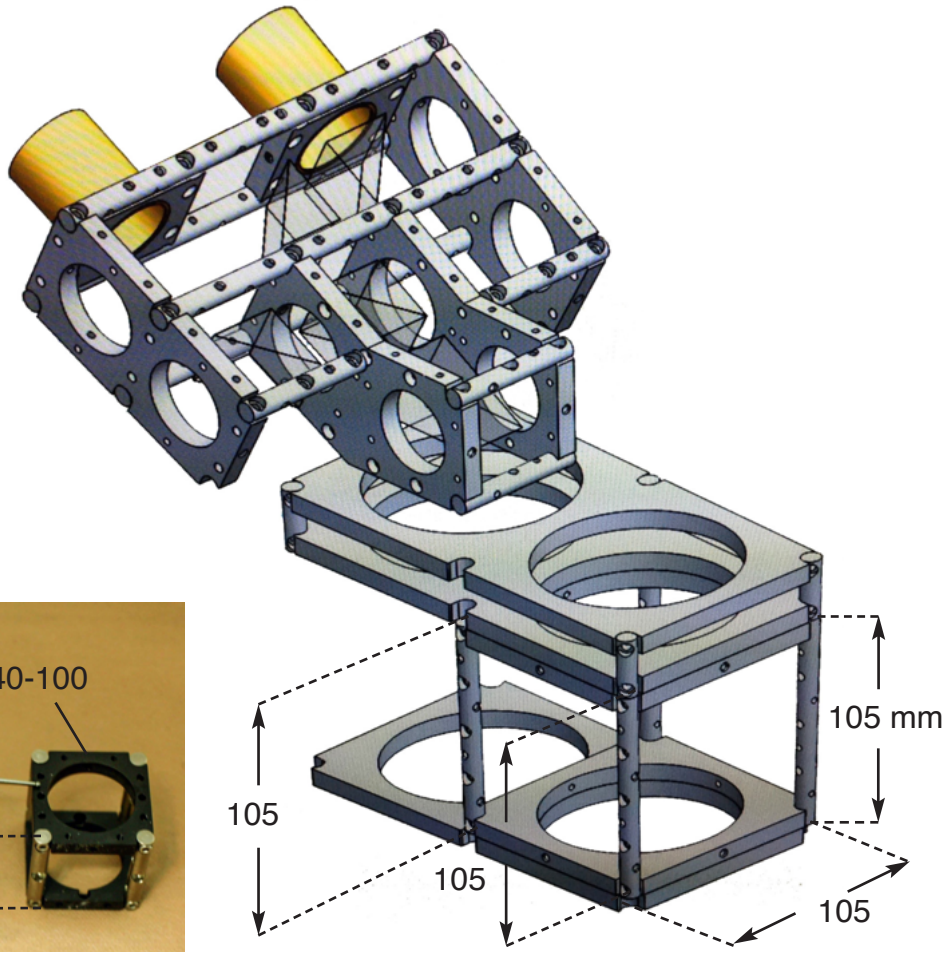
So far, the mechanical geometry of optoform has been 40x40, and now we are adding the larger size: 105 x105 mm. The combination mount for 105 x 105 would naturally be 105 x 204 mm. How would you make all these sides parallel, and not come up with another eiffel tower?!

You could use a digital caliper to measure each side. Rod lengths are made with 0.01 mm accuracy but you could always press the assembly against a flat surface before tightening the screws, and you'll have good parallelism.

You could also use a height gauge or dial indicator as shown below. All four corners could have within 0.02 mm error. The Aluminum cover sheets would give structural rigidity to the assemblies. Before covering the space frame with sheet covering, the plates could be pressed against a flat surface on every corner before tightening rod securing screws.

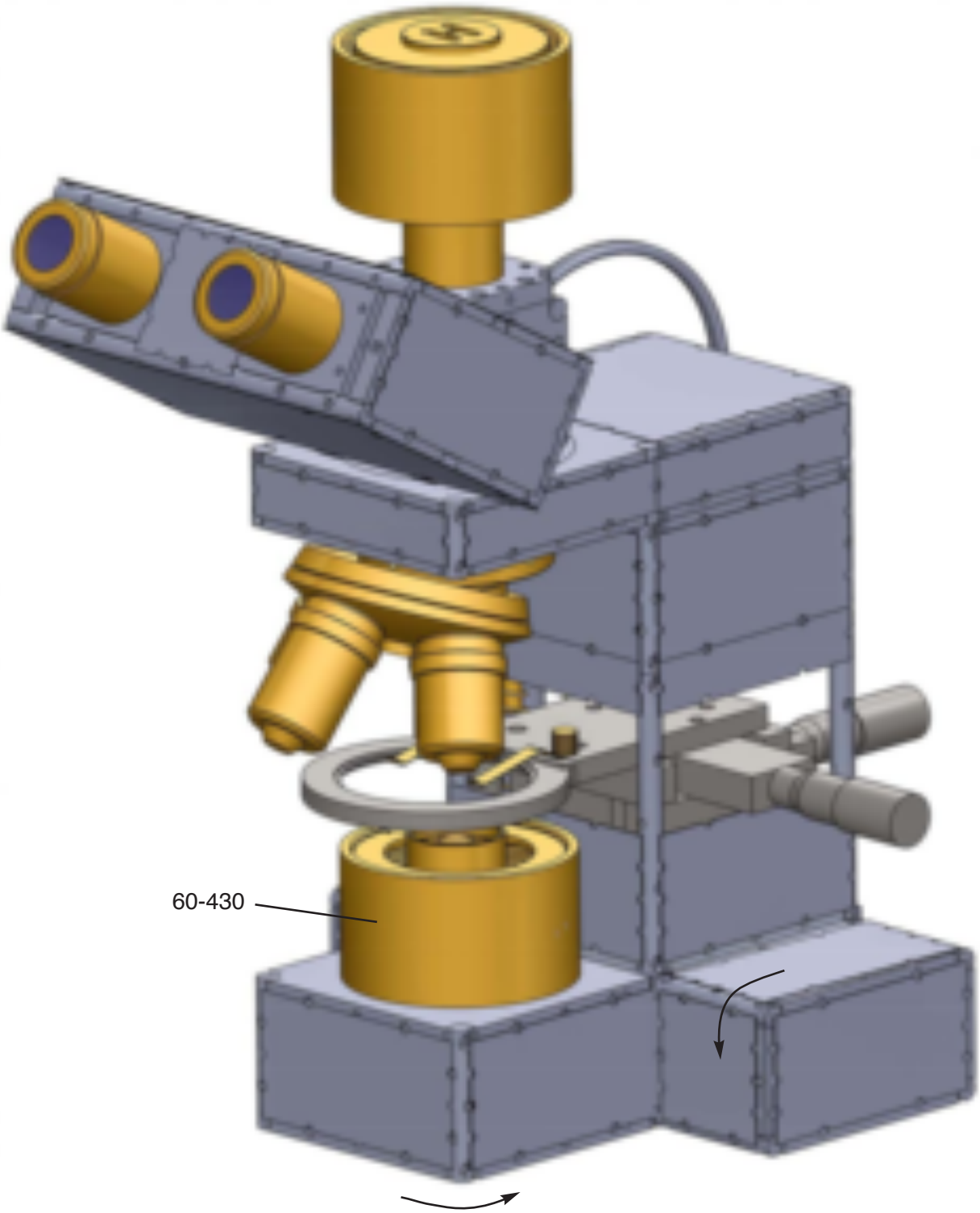


Checking all four sides of a cube with a dial indicator.



Adding Sheet Covering

The final assembly is to cover the instrument with sheet metal shell. With new Optoform this is easy because there are plenty of inexpensive pre-cut anodized Aluminum covers you could get to cover your design. Note where there are vertical rods, there are vertical curves around the body, and horizontal rods would result in horizontal curves on the housing contour. If you have conflict between two cover sheets, just cut the excess off with scissors. They do much better cuts on thin Aluminum sheets than heavy duty cutters. In any case, you'd also notice the condenser housing below the sample (60-430) is built with Micromax 60. This is an exact match to the inside clearance aperture of mount 105's.

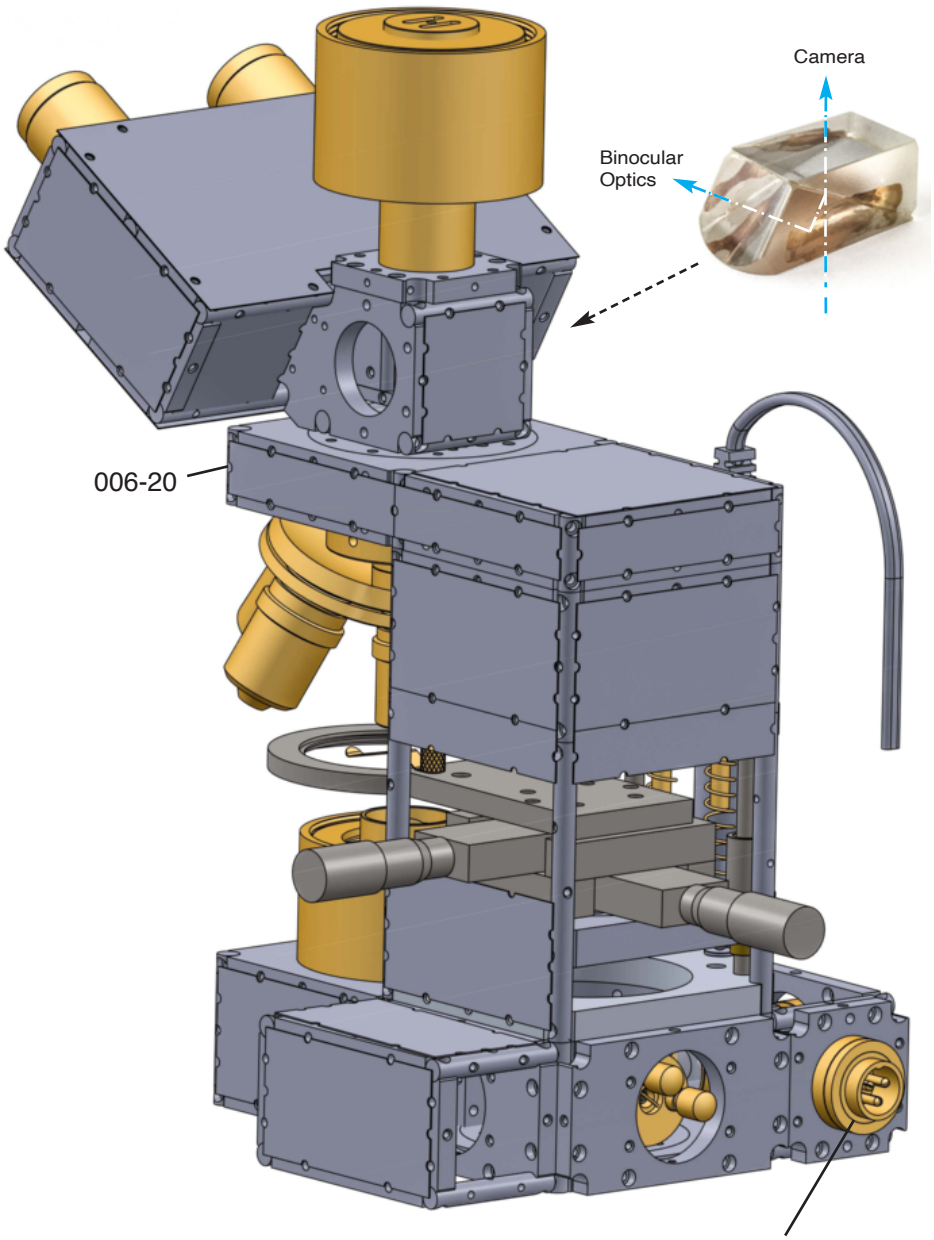


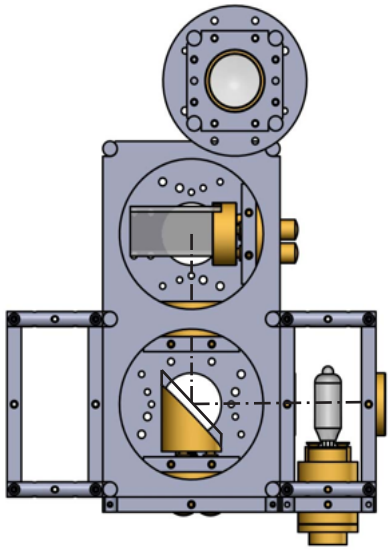
Micromax 60 accommodates much bigger lenses. It is perfect for constructing condenser optics for illumination purposes. The Littrow prism can be replaced with a specially cemented version (right) to convert the binocular head to a trinocular observation head as show in this example.

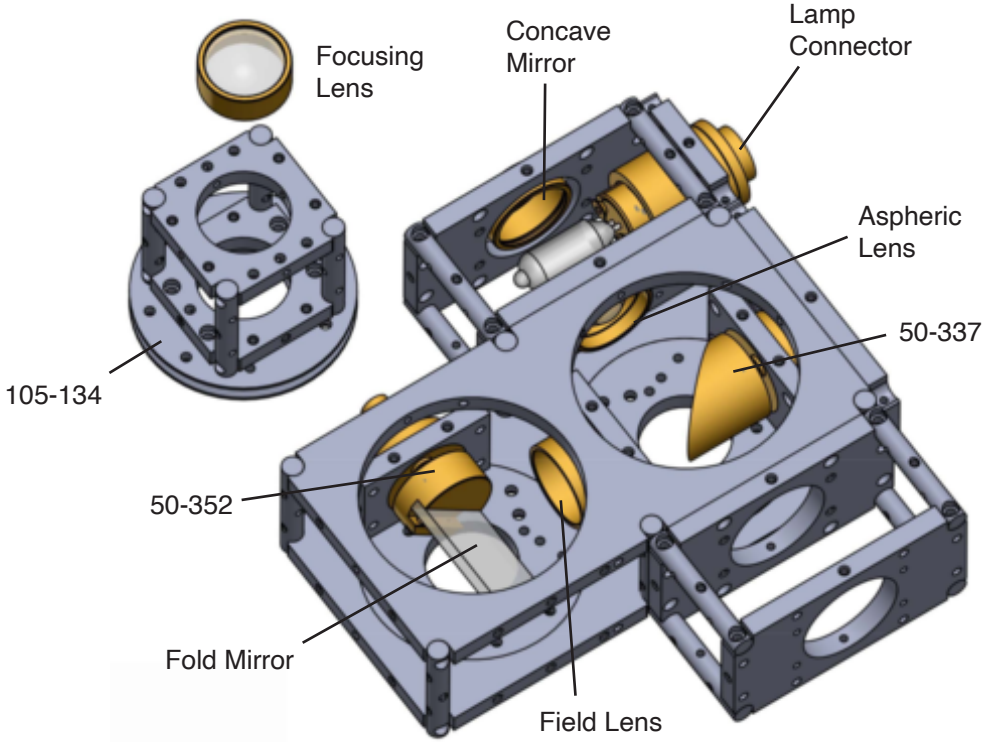
Back Illumination

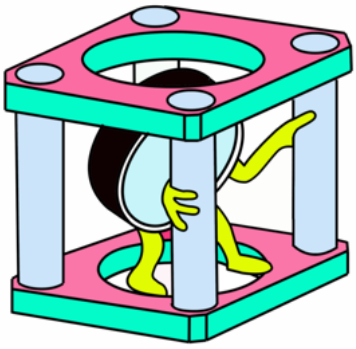
The microscope base in most microscopes are occupied by power supply electronics. This worked well for older generation microscopes because the weight of the power supply with its wire wound transformer would give the microscope a good balance. Today's switching power supplies are so light; they could be housed anywhere.

We haven't reached the electronics part yet, so it's pure optics for now. Most of the components like the lamp housing, mirrors, and tilt stages are borrowed from our classic Optoform parts catalog. Several views of the illumination optics housed inside the microscope's base is shown here. The upper platform securing the trinocular head, and objective turret is built with shorter rods (20 mm) to provide structural rigidity.





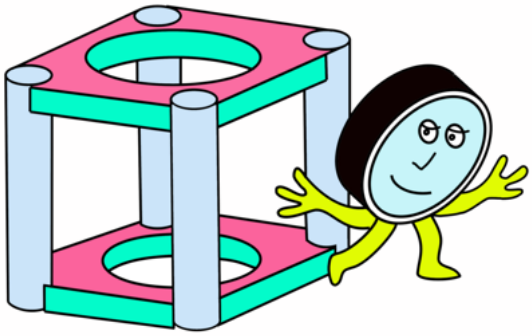




Orther Cage Sysems

Out of the cage system:

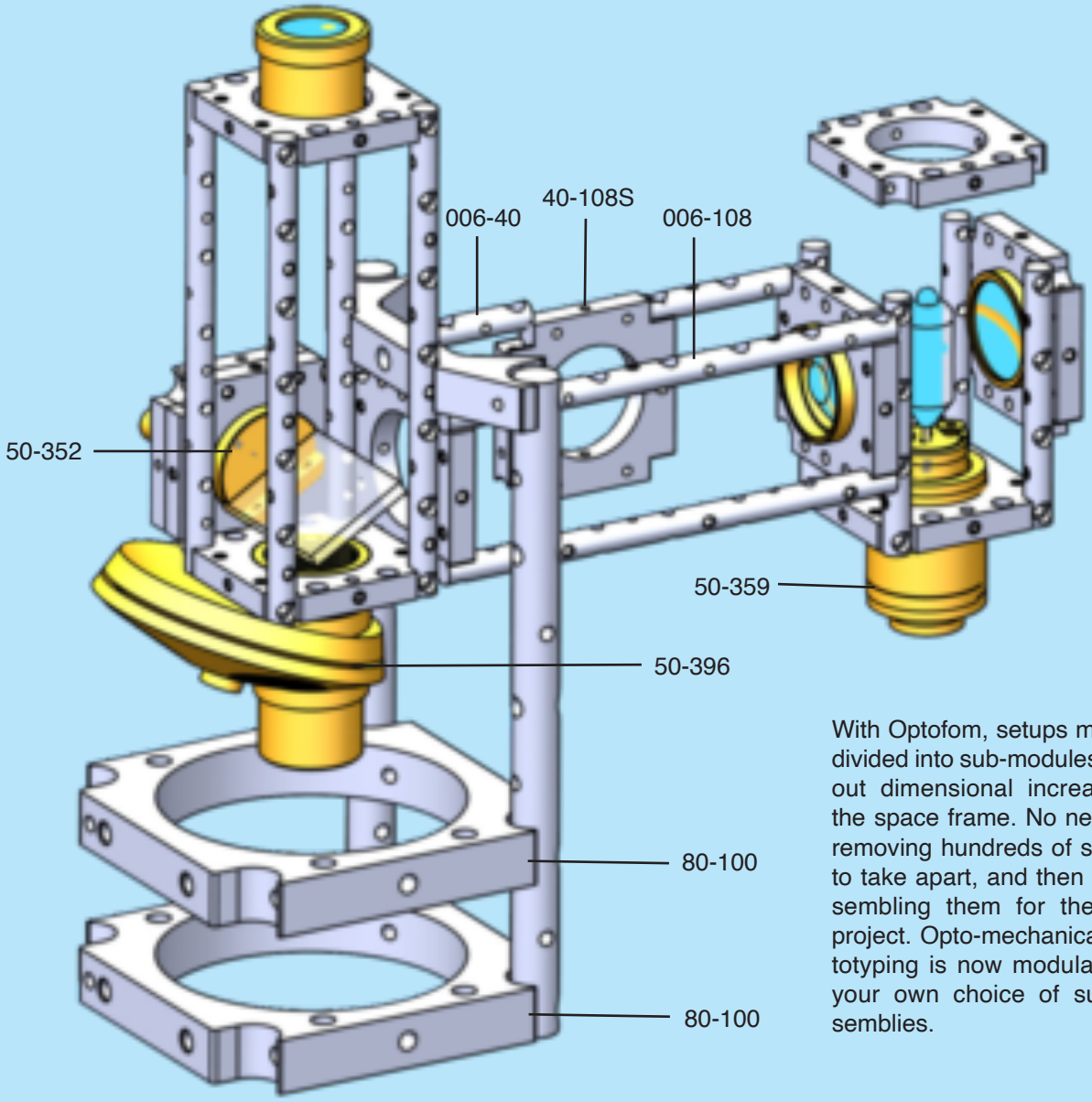
You can now use larger optics



New Optoform

Placing support rods on the outside corners of Optoform mounts allows 25/30 mm mounted optics to be easily inserted, and taken out without obstruction. Up to 40 mm optics may now be fitted in between the rods.

Take apart, and reconfigure your designs with no limits



With Optofom, setups may be divided into sub-modules without dimensional increase of the space frame. No need for removing hundreds of screws to take apart, and then re-assembling them for the next project. Opto-mechanical prototyping is now modular with your own choice of sub-assemblies.