Optomechanix

July-Sep 2019

Hasselblad Moon Camera

Courtesy, NASA

Technical journal of OMiD, Opto-Mechanical Institute of Design


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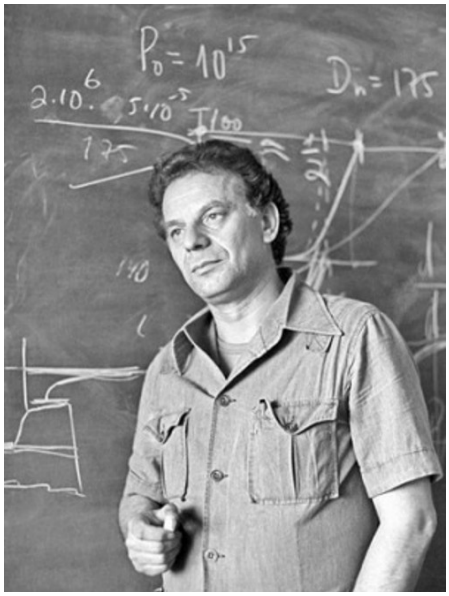
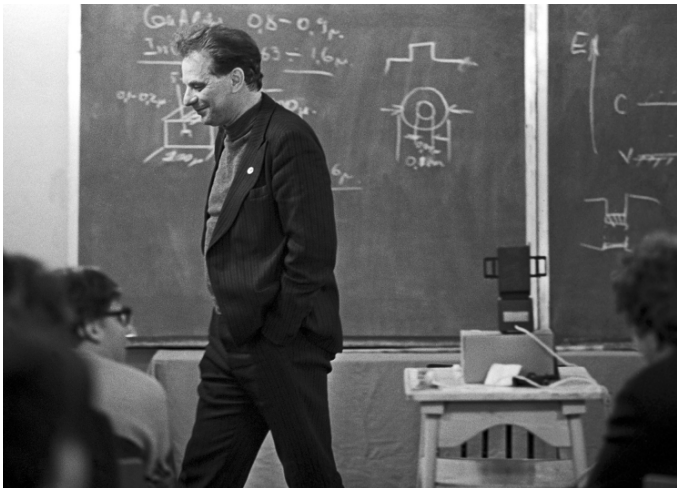


This issue Dedicated to:

Zhores Alferov (1930-2019) was a Soviet and Russian physicist and a Nobel Laureate, died aged 88 in St. Petersburg early this year. He was one of the four Russian scientists who've won the Nobel Prize since 1991. He was awarded the prize in 2000 for the development of semiconductor heterostructures for high-speed optoelectronics.

"Zhores Alferov contributed immensely to modern holography, since his heterostructures allowed scientists to study coherent light. People in all parts of the world use the discoveries of Russian physics daily in varying degrees", says his colleague Sergey Stafeev. Zhores Alferov was a well-rounded individual. He was interested in many things, including politics, social studies, science, and education.

"The results of his research can be used in many areas. Before his discoveries, semiconductor LEDs were extremely fragile; today LED lamps have become part and parcel of our daily routine", Alexander Chirtsov, ITMO.



Photos on this page, Copyright, Zhores Alferov family

"Zhores Alferov preferred a practice-oriented approach, and the results are what we see today in smartphones. These devices are based on semiconductor heterostructures, which really changed our day-to-day lives", remembers his colleague Mikhail Limonov, ITMO University's Faculty of Physics.

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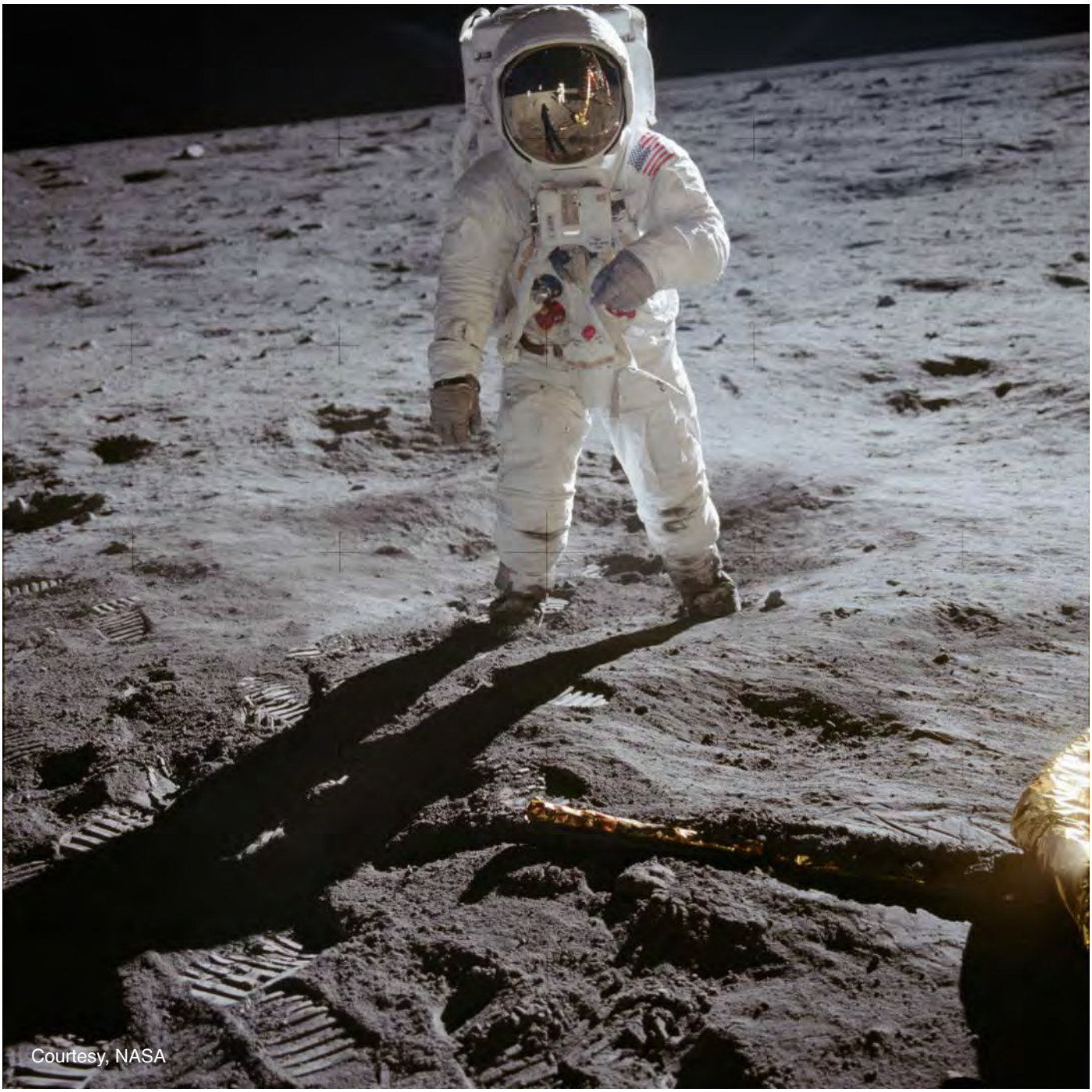
Cover page photo: Hasselblad Moon Camera similar to Apollo 11 Camera
Inside page photo: High class "Gum Shopping Center", Red Square, Mocscow

Moon Landing in 1969 (50th anniversary)

I would like to devote this issue to the Hasselblad camera not only because of my love for cameras, but because this camera has never been explained in much detail inside any other publication. All the images that we have from the moon landing mission (in excess of 1000 pictures were taken) were made by this single camera that if it had failed, it would have been like going to a trade show without any leads. There were actually four passengers on that flight to the moon: Three astronauts, and the fourth one being the Hasselblad. This camera saw, and remembered everything on that mission, which could have been asked later what it saw while everyone else were so occupied by their responsibilities, making sure it would succeed. The first task was to announce to the world “Eagle has landed”, to fullfill the promise of president Kenedy, and the rest was much less pronounced.

This issue also coincided with my visit to Russia, and I think I could now cover this from a less biased pespective. When Armstrong, made his first step on the moon, his statement was inspirational, and it encompassed all the efforts by mankind to acheive it: “One small step for man, a giant leap for mankind”. If you have watched the movie “The Edge”, the statement made at the very end by Anthony Hopkins, when asked what happened to all his friends, was: “My friends



“One step for man, a giant leap for mankind” was the most connecting statement made in 20th century for all humanity.

all gave their lives in order to save mine". What Armstrong said on his first step on the moon had such generosity, and wisdom in it, and it shows how connected we all are as human beings.

Abraham, was without doubt the father of all religions. After he built house of God "Kaaba", he was asked to go on top of a mountain to call out people to its pilgrimage. He wondered: "Who will hear me from up here on the mountains?" God says: "You just call out your invitation, and I will carry your voice to reach the ears of infants who haven't been born yet". I'll tell you about the life changing experience Armstrong's message had on a drug addict whose life had reached the end.

In 1969, a druggie was laying in a street corner, and saw the picture of the moon hanging at a news stand. He asked what it was, and the man behind the Kiosk said: "Don't you know? Man has stepped on the moon"! The man watching the photos of the moon suddenly came to himself: "If mankind could concur the moon, then what could stop me from turning my life around?" So he took the seemingly impossible steps of quitting drugs on his own. He then looked for a job, and was hired as a school teacher. To fill the emptiness in his heart, he began writing poetry. "I read my first poems to my students, and they all laughed at it". I asked them to help me, and they taught me about how poetry has to have rhymes, etc. He ended up becoming a respected contemporary poet in Iran.

I visited Russia just recently, and I was so surprised by its beautiful architecture, and scientific achievements, and friendly people. Living in US for over 40 years had made me so ignorant about Russia's space program because of its biased media. We all know about the dissolution of Soviet Union, but their leadership has somehow brought them back together again. To summarize what I saw there, I could only say something about the folk dance I saw in Moscow where all the factions in Russia had a voice in it, and how they all expressed themselves with such delightful dance, and music. As I rode a rollercoaster in an amusement park in Saint Petersburg, while getting off, I felt my mind had untwisted from so much ignorance. I will share with you my experience in Russia, and why it's a good idea to visit the rest of the world.

Ali Afshari
Editor in Chief

Hasselblad took these beautiful images on the moon surface. The cross hairs are produced by a glass Reseau plate.

Russian Space Museums

Upon the dissolution of Soviet Union on Dec 26th 1991, the Russian space program was interrupted due to lack of funds. Throughout the 70's, and 80's, James Bond movies biased the public's view by often showing some balled headed Soviet dude planning to launch a rocket to destroy the world! Everything you saw in movies those days was about them against us. When I visited the science, and Space museums in Russia, I felt so much at home watching all heir relentless effort, and sacrifice in scientific progress.

Russia has sent as many spacecraft to the moon, to Venus, and Mars, and in many case, before NASA. Soviet's space program was pioneered by a man named Constantine Cheleskovsky who started the space rocket program GIRD in 1931. You could see his picture in every space museum in Russia with his long beard. Every one knows Sputnik 1 was the first earth orbiter launched on Oct 4th, 1957. Sputnik 2 carried a dog named Leica who died because of overheat due to instrumentation failure.

In April of 1957, Yuri Gagarin became the first man put in space. Russians were the first to send a space probe to the dark side of the moon in 1957 to image it with Luna 2 and 3 probes, and were the first to send Venera 1 to reach Venus. They were the first to land a space probe on Mars in 1971. The line scan camera on board Mars-1 recorded images on film, and it had the option of being quick scanned, or high res. scanned to transmit to earth (See page 16). Their first attempt was interrupted by an instrument malfunction. The difference in manned missions was the astronaut ejected from the capsule before it landed on earth! Pieces of Gagarin's capsule is still on display at the space museum in Moscow.

Bhuran space shuttle was completed in 1988. It was the first space shuttle to automatically take off, and land, completely unmanned. Above, a cut section of Russian space rocket at space museum in Moscow, by Vedenkha train station.

I remember after the dissolution; their Mars rover was brought over to JPL by a small team to compete with American made rover to see which one could perform best when passing over rocky terrain. The Russian rover was able to pass over much taller rocks at JPL campus. When I visited their space museum, I was able to find it on one of their displays. It looks more like a vehicle from Flash Gordon comics (bottom, left). Perhaps NASA's criteria was lightness rather than being able to pass through rough terrain, and it has been doing its job perfectly.

It is estimated that around 400,000 people worked on America's moon landing project. I wonder what happened to all those Soviet scientists, and engineers who were involved in their space program after the dissolution.

Front entrance of space museum in St.Petersburg shows an actual space capsule burned through the atmosphere.

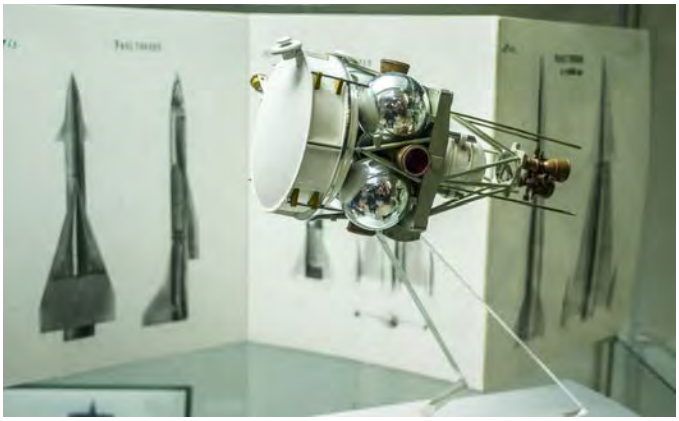
Entry lobby to Vedenkha Space museum, Saint Petersburg. The walkway interior of Cosmos space museum in Moscow

Bhuran project cancelled after soviet dissolution in 1991

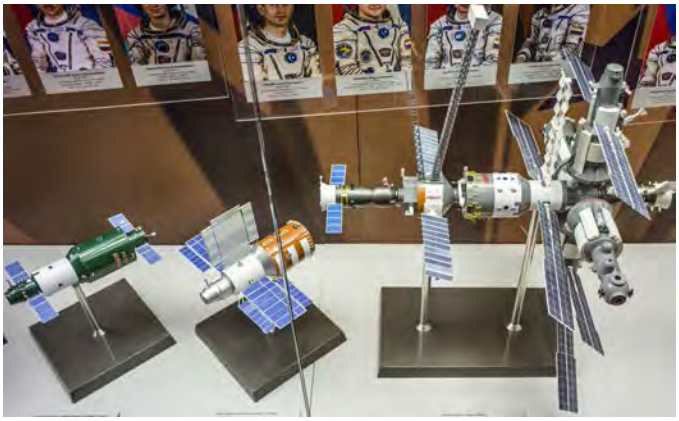
Foton-M3, 2007 has the typical Soviet's capsule design

Russian Mars Rover has two independent suspensions on its front, and back. Right, the real size of space capsule.

Vostok 1963, and Vokhod 2, and their launch vehicles



Polyot 1 space vehicle launched in Nov 1, 1963



Left to right: Vokhod 2 launched in 1965, Soyuz 1967, Salut orbital station 1971, Salyut 7 1986, Mir space station 1986

Landing capsule of Soyuz-16 vehicle with singule seat, and ejection parachute, Yougarin flew in similar capsule.

Interactive screens let you pick educational videos about space, this one shows how to brush your teeth in space.

Museum of Science, and Technology

This was no Munich Museum that I have covered in a few back issues, but it had reasonable number of displays to stoke your curiosity. I specially noticed their serious investment on interactive films for each subject. The films had classic quality with hand drawn graphics, and brought a nostalgic sense in the viewer's mind. I was like watching old scratched up movies. If you have been into a zoo, most of the objects were not on glass displays. The lighting was so dramatic, with spot lights only on the displays.

Good number of cameras were on display but not Sport, the first 35 mm SLR camera invented by Russians in 1934. I have no idea why this camera, which could be a national pride for the Soviets was not on their shelves. May be they were all sold on eBay!

This 2 m Dial mechanical clock stands on the entrance.

There is strong emphesize on interactivel films for each section of the museum. The films are well animated, and proffesionally made. Films like how the movie camera operates, and how the sound is recorded, and played back on film.

There were various clocks, and educational movies about how they work. A good selection of binoculars on display as well as movie projectors, and cinema equipment. Although self reliant, on display were products from all over the world.

Micrososcopy section had a good number of microscopes on display. Plasma globe is a great attention grabber (right).

Hasselblad Moon Camera

The one camera that was trusted to be used for the Apollo 11 mission was Hasselblad, and it became the standard camera for all Apollo missions. Walter Schirra was the one who brought this camera to NASA's attention by taking his model 500C to the orbit, and bringing back very stunnung images. Hasselblad 500 EL, a motor driven version of 500C was specifically developed by Hasselblad to accompany astronauts with high capacity magazines using 70 mm film.

We will examine this camera's operation by first stripping it down, and then studying its inner workings. The Hasselblad prototype for the moon mission (right), had major removal of its body parts for weight reduction. Several modifications were made to allow focusing, setting the aperture, and shutter speed with gloves, and easier interchange of batteries, and film magazines.

Victor Hasselblad, the man behind the camera
Courtesy, Hasselblad

Severe Temperature Variation

There are a few considerations for opto-mechanical design in space. Above all is temperature variations in space: The temperature difference while sunlight is directly hitting on an instrument, and while it's in a shadow is around 300 degrees. Hasselblad painted its cameras the same kind of paint one would find on barbeque ovens.

No Plastics in Space

Electro-static discharge is another concern. No plastics in space! As the astronaut walks on dry surface of the moon, his suit could build up electro-static charge up to a few thousand volts. This build up of static electricity could kill. That's why all the external Hasselblad parts are made of metal. The film is made of gelatin, and around the Reseau plate, there are grounded contacts to prevent electro-static build up.

Space Lubricats

Ordinary lubricants have several bad characteristics that could cause equipment malfunction in space. In vacuum, ordinary lubes will outgas, and fog the optics. It would also boil to a sticky compound, or could spread inside the optical housing and get into shutter blades. Space qualified lubricants that I used in the past cost around $300 an ounce. This grease had dark gray color, and if you applied it on a pinion shaft, and check it a year later, it wouldn't move a tiny bit.

Opto-mechanics in Space

Opto-mechanics in Space, means temperature compensation to undo thermal expansion in the optics assembly. The way Hasselblad handles this is quite smart. There are three invar rods (having low coefficient of thermal expansion) that act as metering rods between the lens flange, and a glass Reseau plate which the film is leaning against. Reseau plate is the glass plate that produces the reticules visible on all moon Hasselblad images. Read the article: "Photographer makes accurate replica of the first Hasselboad in space". In that article, Cole Rise claims he spent four years modifying

Courtesy, NASA

Courtesy, NASA

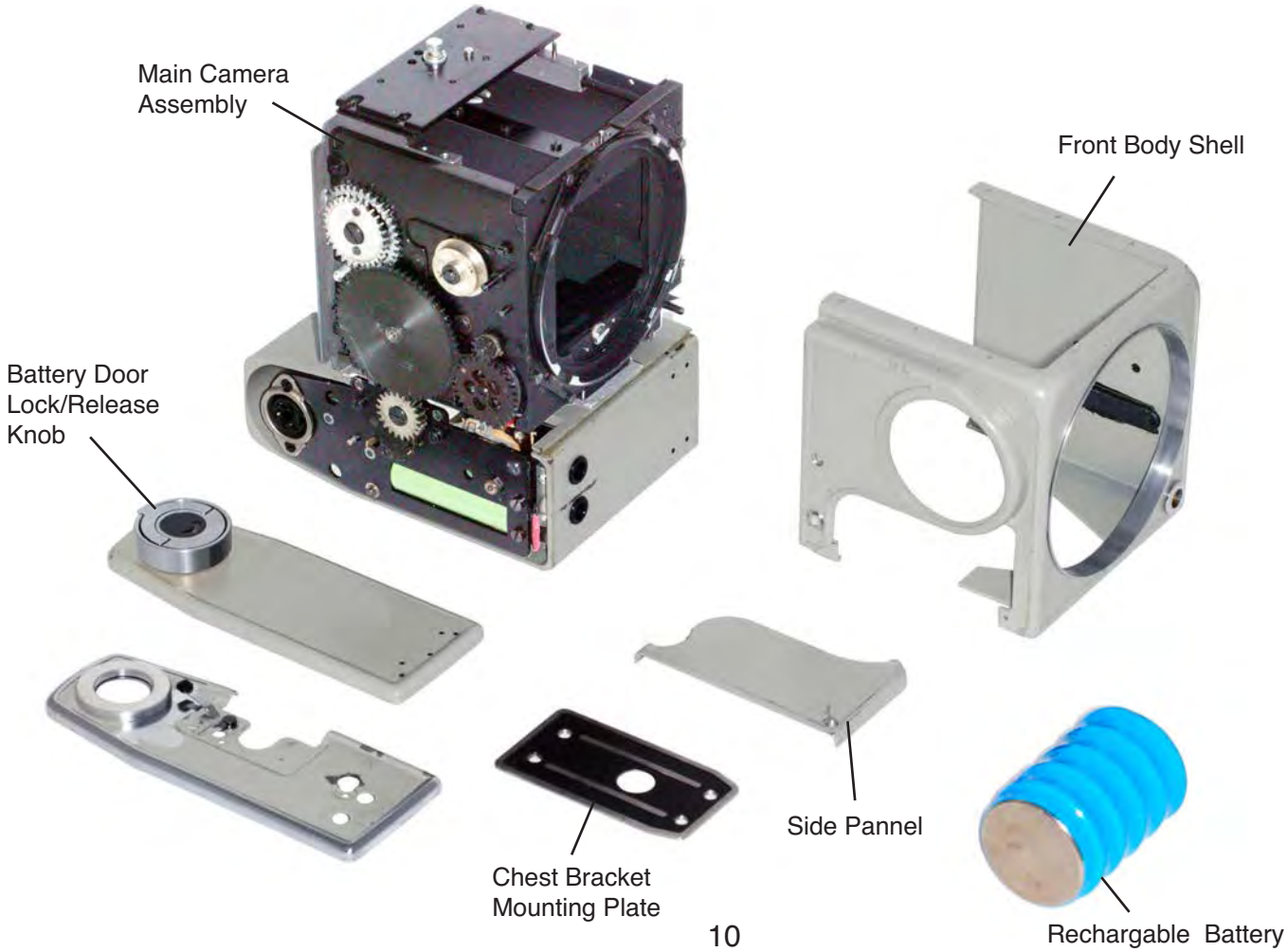
Two very different photos taken with the Moon Hasselblad camera shows the focusing requirement by the astronaut.

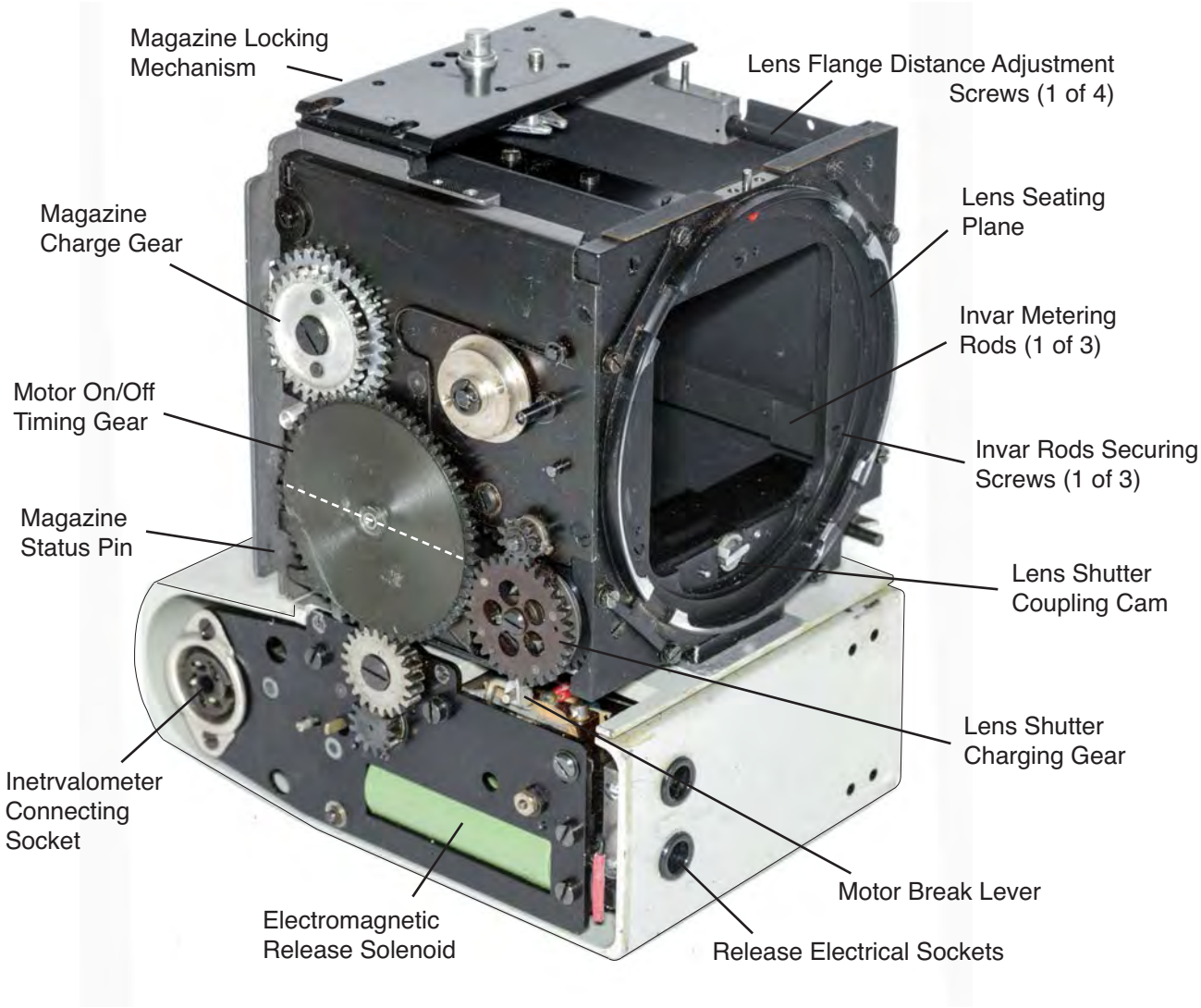
Courtesy, NASA

a Hasselblad MK70 (the civilian version for aerial photography) to make his exact replica of the moon camera. According to Alain Lazzarini, a collector, and author of the book: “Hasselblad, and the moon”, there are around 60 replicas of space Hasselblads out there. Disassembling the moon camera is quite easy compared to most cameras I worked on before. The front body shell pulls out by removing its side panel, and three screws. Hasselblad uses a solenoid for its shutter release. Most motor driven cameras in the 60’s utilized a mechanical release. The advantage of having an electro-mechanical shutter release is the camera could be automatically released by an intervalometer. In fact, a 2nd Hasselblad onboard Apollo did so every 8 or 20 seconds, set by a toggle switch.

Motor Drive Unit

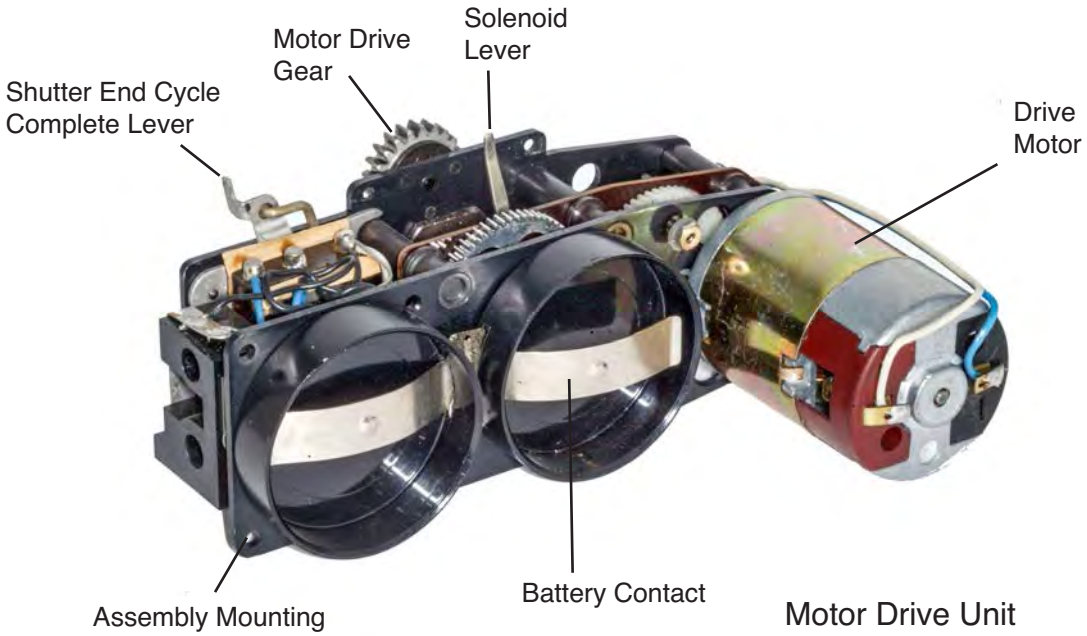
The motor drive unit can be pulled out by removing 4 screws. The basic idea in motor driven mechanisms is the motor can be stopped immediately by shortening its leads. The reason for this is when power is cut off from the motor, it would keep running due to its rotational inertia. In that instant, the motor would turn into a generator, and by shortening its





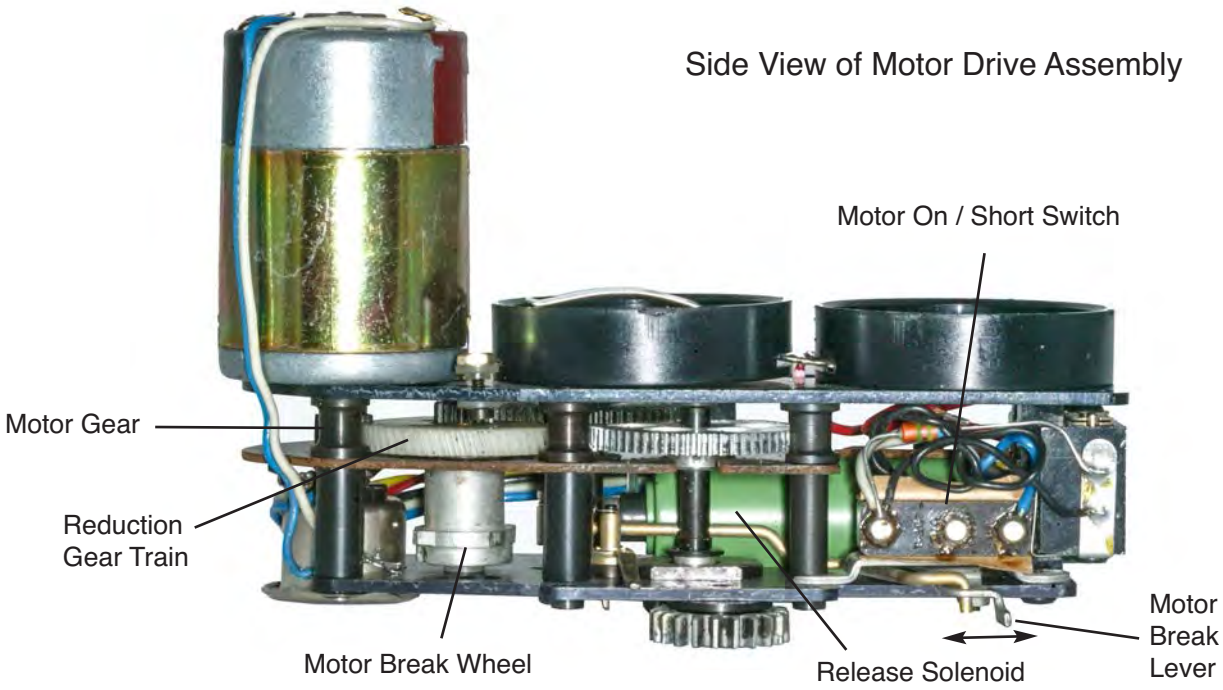
leads, the induced high current would cause an electro-magnetic break. The large gear at the center is actually a timing gear that rotates one half turn to complete each charging cycle (see dotted line, above). With each half turn of the timing gear, the film is advanced by a full frame via magazine charging gear, and the shutter is cocked inside the lens, by means of a lens coupling cam. In addition to electrical break, there is also a physical break

Each half turn of Timing Gear advances one full frame of film via Magazine Charge Gear, and cocks the shutter inside the lens by means of the Lens Coupling Cam. The Lens Coupling Cam rests horizontally at the bottom corner of lens



Motor Drive Unit

Side View of Motor Drive Assembly



flange, allowing lens interchange when the camera is fully charged. The Solenoid Lever pushes out the Magazine Status Pin on the back of the camera body. After the shutter release cycle (1 ~ 1/500 Sec) has ended, and the release button is let go of, the Shutter End Cycle Lever slides back, and the motor starts running. It stops when the Timing Gear rotates 1/2 of a turn.

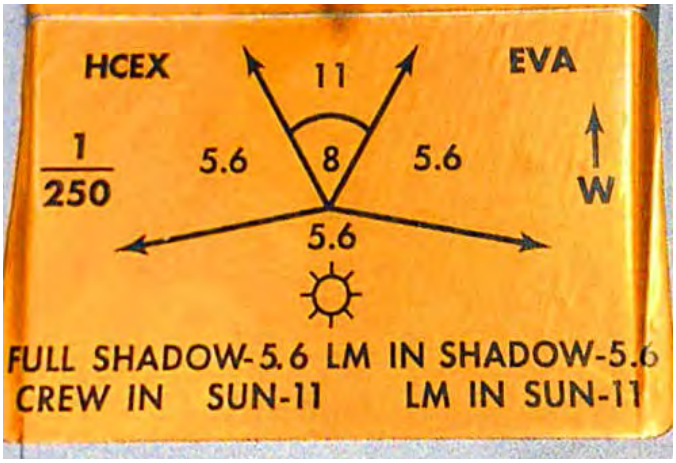
Exposure Accuracy

For the moon landing mission, they used only 2 types of film: Ektachrome 160 ASA color slide film, and ISO 80 B&W Panchromatic film (ISO and ASA are the same). Ordinary film allowed corrections in darkroom but for color slides, the exposure had to be pretty accurate. They used a simple chart to set the exposure.

The exposure chart sticker on top of each magazine (right) suggested the right exposure for the user. The shutter speed is set to 1/250 sec. Obviously; the sun has to be on the back to reduce flare but the f-stop is set to f/11 when the sun hits straight on subject. The lens being used was the 60 mm f/3.5 Zeiss Distagon, and it is purposely closed down to f/5.6 not only because this lens has much better performance at this closed down aperture but also to increase depth of field. The reflex viewing was eliminated form the camera, and the photographer had to guess the distance. All the moon photographs were obviously not useable for being out of focus or having the wrong exposure. If you do a web search, every picture taken on Apollo 11 has been available on Instagram.

Just like every photographer, Neil Armstrong didn't have many pictures of himself on the moon (only his own foot step). Sorry, no selfies with the Hasselblad. He had plenty of practice on earth with the camera before the mission. Later space missions, they took more Hasselblads on the moon, but left them all behind to bring back rocks. On Apolo 15 mission, one camera got jammed. They brought that camera back, and sent it to Hasselblad. They found some moon dust inside the camera which is now kept at a museum in Sweden.

Buzz Aldrin test shooting the camera on earth before the mission. Hasselblad's reflex viewfinder was eliminated since it would have been impractical to look through the camera.



Reseau Plate

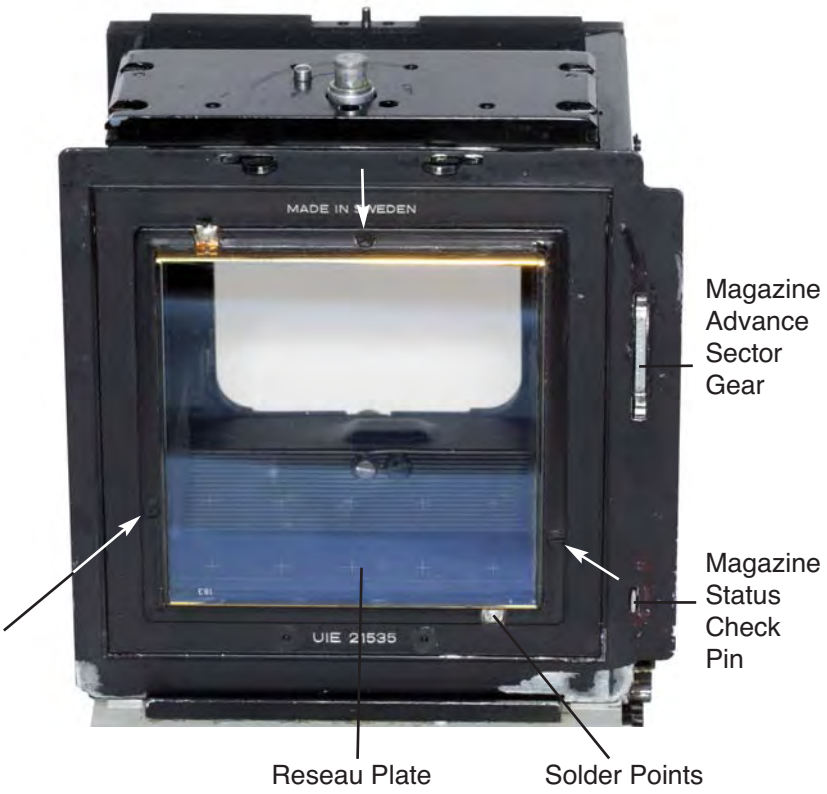
The Zeiss optics designed for Hasselblad required film flatness down to 0.01 mm. This means minimal film wrinkle. Back on earth, they utilized pressure plate suction to flatten the film for aerial photography. Fairchild had so many patents on this for film cameras but back in space, they are not useable. To solve this problem, Hasselblad devised a glass Reseau plate.

Rear view of the camera (right) reveals the Reseau plate with Chrome on glass reticules. In addition to film flatness, this plate ended up having so many functions in the camera:

1) Two soldering joints above, and below the glass plate are to connect the two polished brass stripes above, and below the glass to eliminate any build up of static electricity generated by the film.

2) The three Invar metering rod securing screws visible around the glass plate are to reduce focus shift caused by thermal expansion.

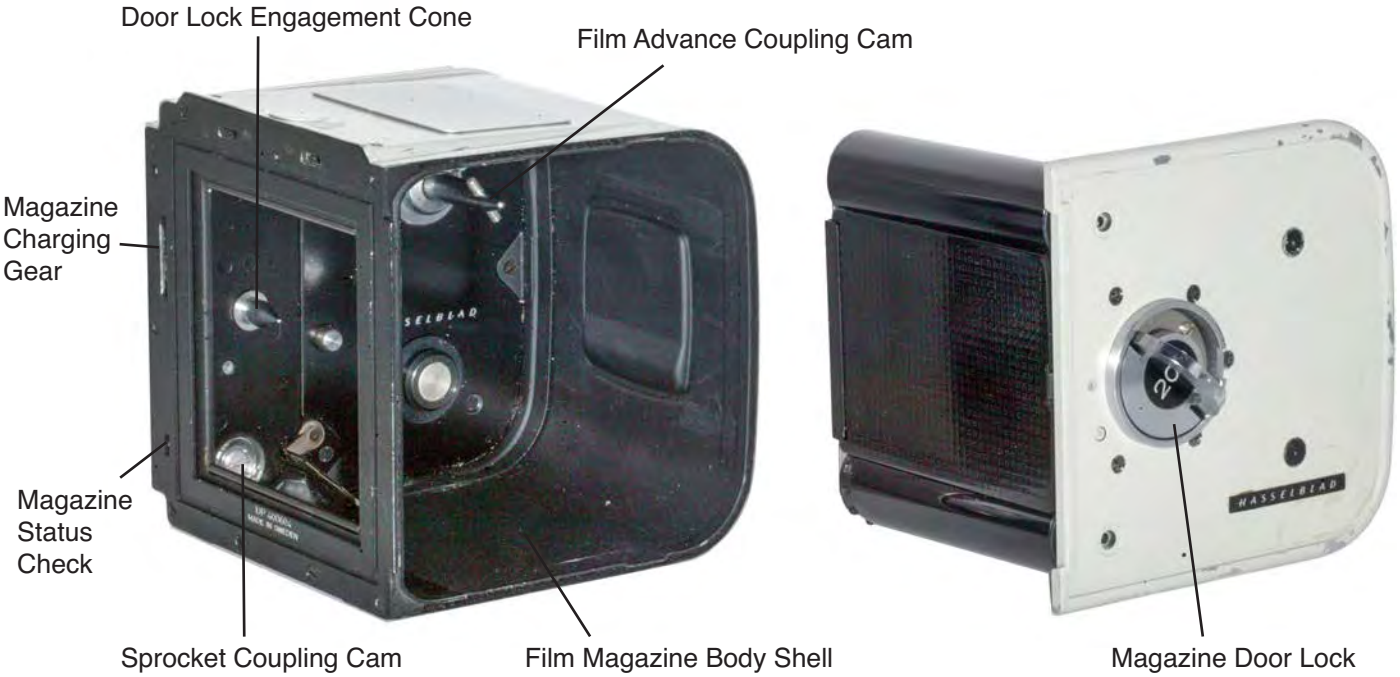
3) The cross hairs were calibrated with each lens to extract distance information from the negatives.

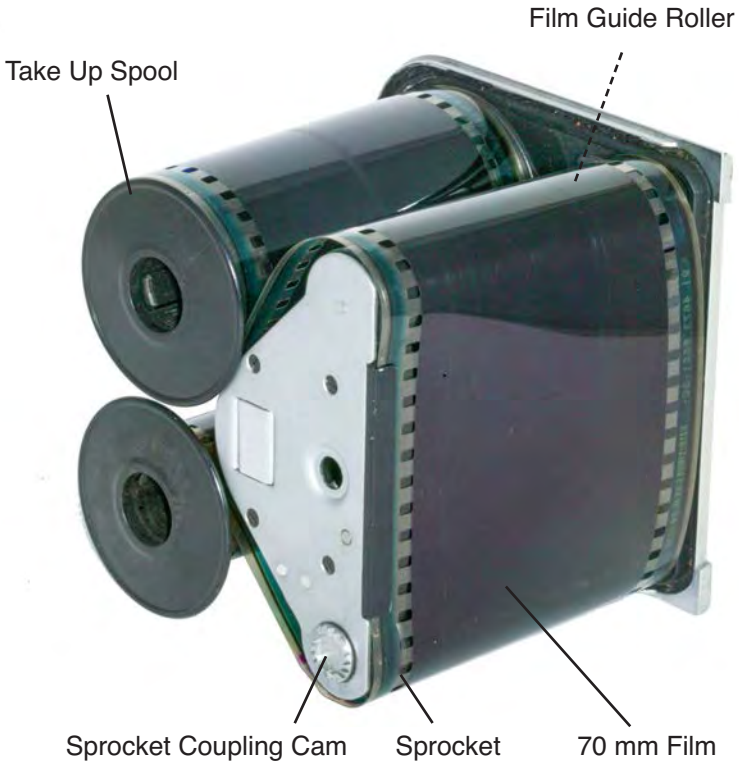


The Body, Lens, and Film Magazine

In Hasselblad cameras, the body, the lens, and film magazine are mechanically linked together, and in motor driven version, there is also a mechanical link between the motor, and the camera. The Magazine Trigger Pin checks if the camera can make any more exposures. When the film footage ends inside the magazine, the trigger pin is blocked, and no more pictures could be taken. While at total silence of the moon, the astronaut could only feel any pictures being taken by sensing the winding vibration of the motor. So no motor vibration, no picture has been taken (load new film magazine).

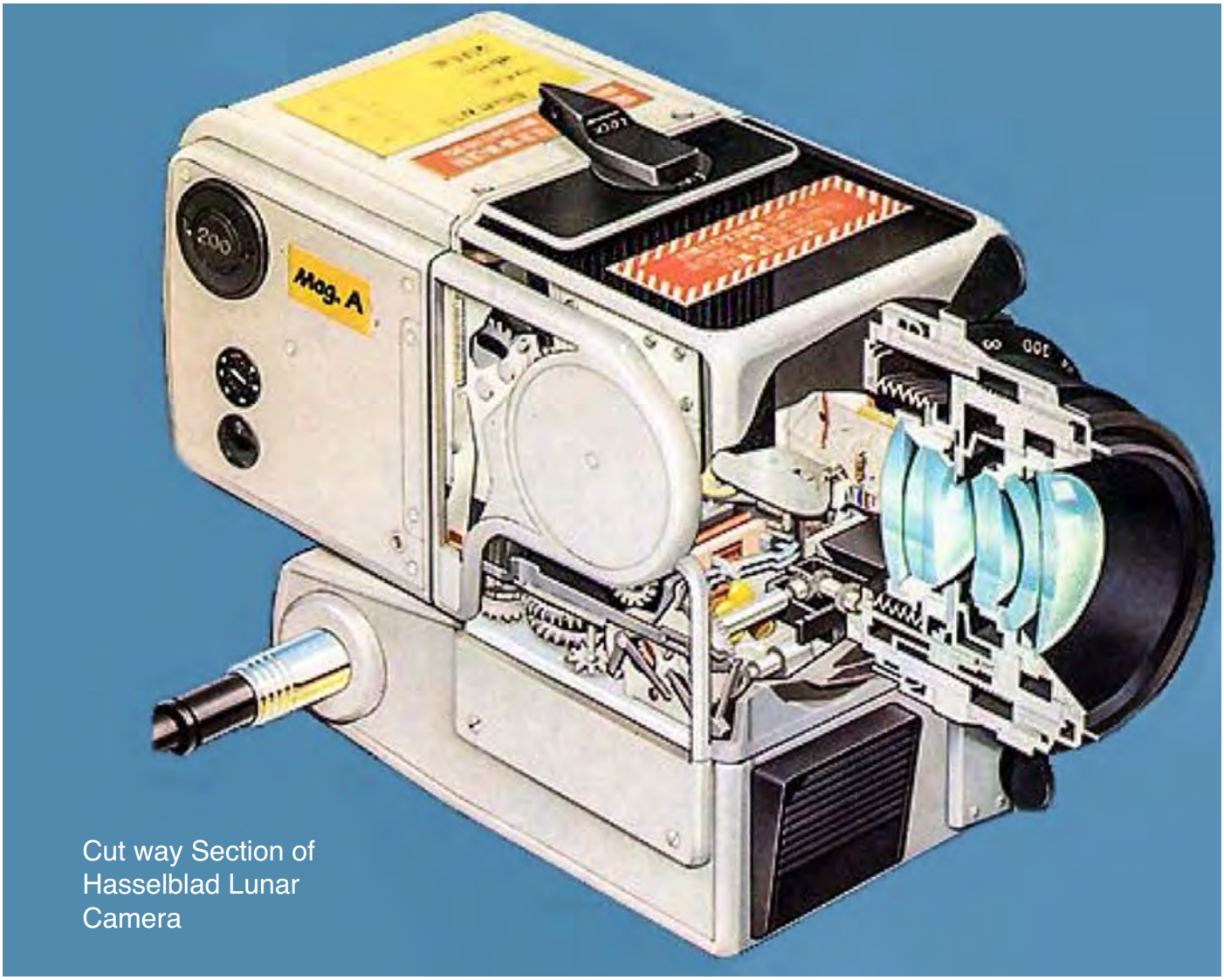
The 70 mm wide perforated film in Hasselblad magazine is advanced by a Sector Gear behind the camera. This gear



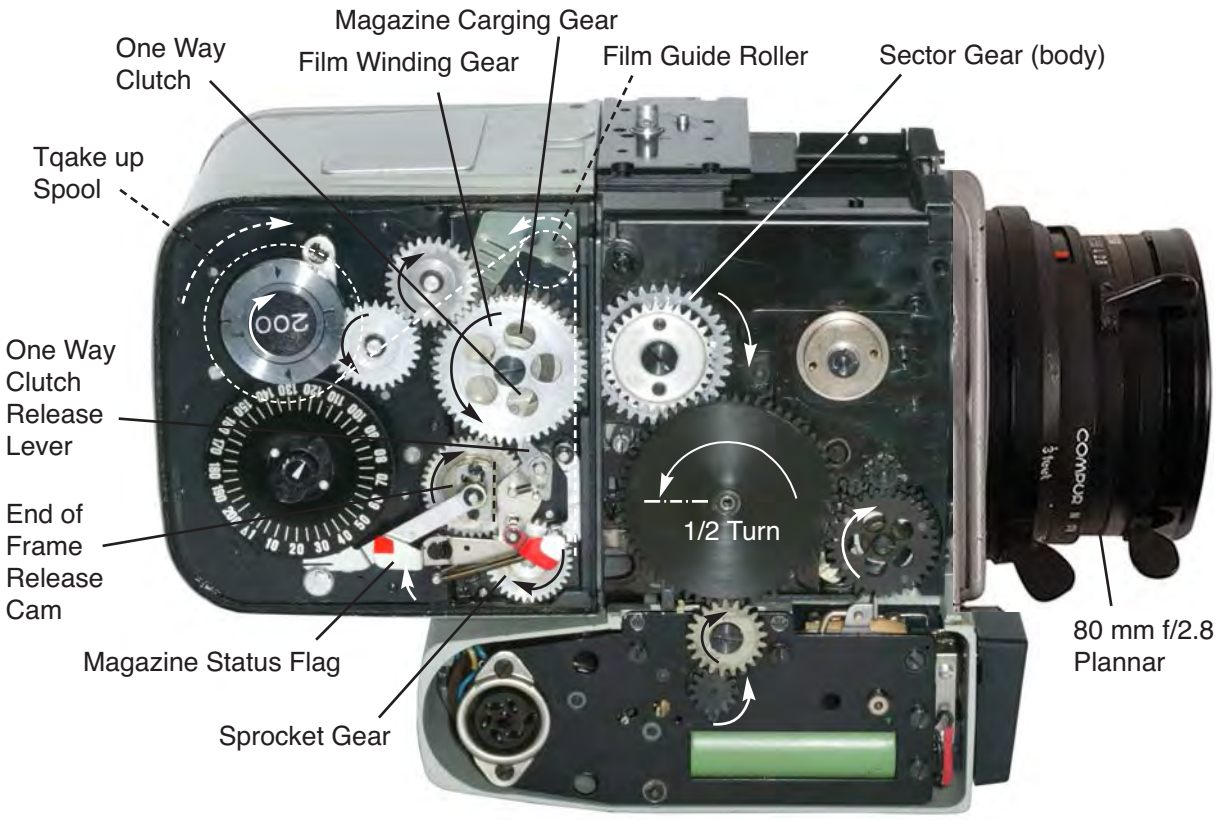


makes a full turn during the charging cycle, and it engages positively to a mating gear inside the film magazine. Although this gear is heavy duty built, it is designed to be flush with the back plane of the body, and be not so noticeable by the eye . This is not intended for the convenience of astronauts. It is because Hasselblad was originally designed to protect a photographer's carrying case from being harmed by the sharp edges of these winding gears (one of the benefits of designing for civilian applications, which Hasselblad started with).

So between the body, the lens, the film, and the motor, there are mechanical linkages that time everything together to allow interchangeability. Other wise, the camera could be functioning perfectly but as soon as the magazine is replaced with another film magazine, the camera's interlock couldn't tell the user if there is still film in the camera on not. The specially made film by Kodak allowed 200 exposures on B&W film, and 160 exp. on color, and switching between different types of film magazines was possibe at mid roll.



Cut way Section of Hasselblad Lunar Camera



I loaded the film magazine with an IMAX film for this article, which was similar to what they used during the moon landing mission. The capacity of this magazine is around 10 meters of film, and turns out to be a lot more than 150 exposures. Just like the 35 mm film, 70 mm films for Hasselblad also come in a cartridge, and I assume that's what they had to do as a back up. It is a lot lighter to carry cartridges than carrying entire magazines but among many other tasks to worry about during that mission, it would have been wise to carry at least five magazines, and some extra film cartridges as a back up.

Film Advance

The operational sequence between the body, and film magazine is quite complex. The basic idea is the Magazine Charging Gear has one tooth missing (above), and when the Advance Gear from the body makes a full turn, it always hits the same gear tooth by passing over the missing tooth. This way, as the two gears start to engage, there is always perfect alignment between them to trasfer the winding torque. After the sector gear on the body rotates beyound its last tooth, the spring loaded magazine charging gear rotates back by a clock spring. The toothed plastic plate visible near the Charging Gear is designed to dampen the quick return of the gear to its home position. The one-way clutch transfers this rotation to the Film Winding Gear to advance the film.

As the film is being advanced, the sprocket roller transfers its rotation to End of Frame Release Cam (there is no engagement between this gear, and Film Winding Gear). When the exact frame length is advanced, the One Way Clutch Release Lever pulls back from the Release Cam, and the Film Winding Gear disengages from Magazine Engagement Gear. While you watch the take up spool turn after each exposure, the Film Winding Gear will turn more in the beginning of film roll, and much less at the end of roll. This is a reliable mechanism that protects film perforation.

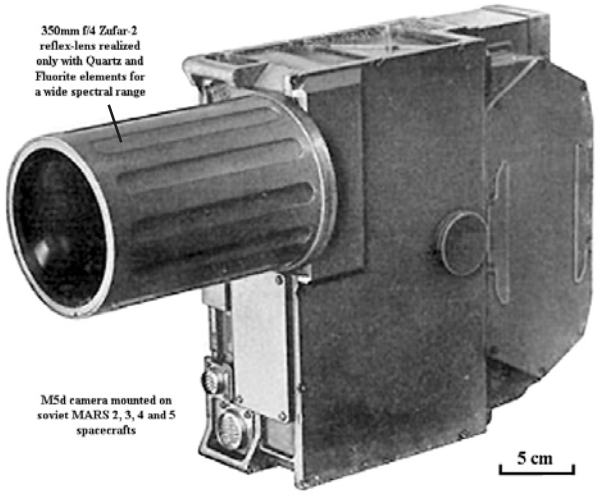
More on Hasselblad
on the next issue

Russian Space Cameras

There isn't much information about what cameras Russians took to space. While I was looking through the space museums in Russia, I was so eager to see what cameras they had on display, and I almost found none. The 6x6 mm format of Hasselblad was appealing to the Soviets, and their counter part was Saliot, which was basically a Hasselblad 1000F replica. Other cameras I researched were in the 35 mm format, namely Kiev six, and Kiev 10. Kiev 10 (right) is one of the most unusual cameras I have worked on. It's focal plane disc shutter folds like a traditional Japanese hand blower. I am surprised how these cameras ended up in space because by no means they are as reliable as the Hasselblad.

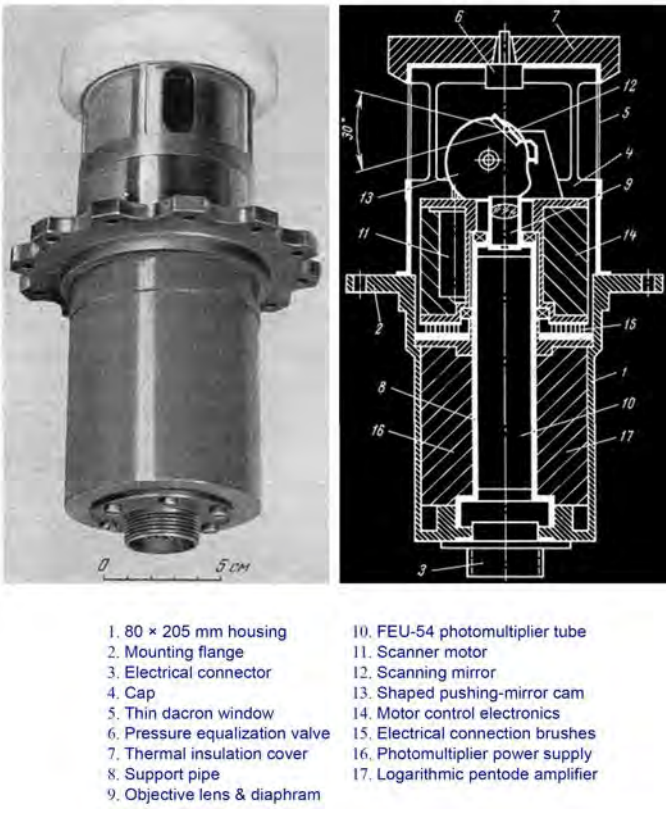
One simple answer is most of the spacecraft sent up by Soviets were unmanned space probes. For their space probes, they developed scanning mirror optics (right) and a single detector such as PMT (Photo Multiplier Tubes). In fact, US took the same ideas to equip their explorer for imaging the surface of Mars. Line scan cameras became popular in Earth observation, and weather satellites in early 70's for both visible, and IR mapping. So the need for hand held cameras was not seriously considered.

For their later manned space missions in 70's to 90's, to work on their MIR space station, there were plenty of reliable hand-held Nikons to use for space photography. The scanning cameras developed by the Soviets had a higher resolution than Vidicon based video cameras developed by RCA during the moon landing mission. The camera only consumed 2.5 watts of power.



M5d cameras used film to record images, then scanned

Kiev 10 35 mm Russian camera with extraordinary complex design utilizing two retractable rotary blade shutters. Standard pentaprism is utilized for reflex viewing.



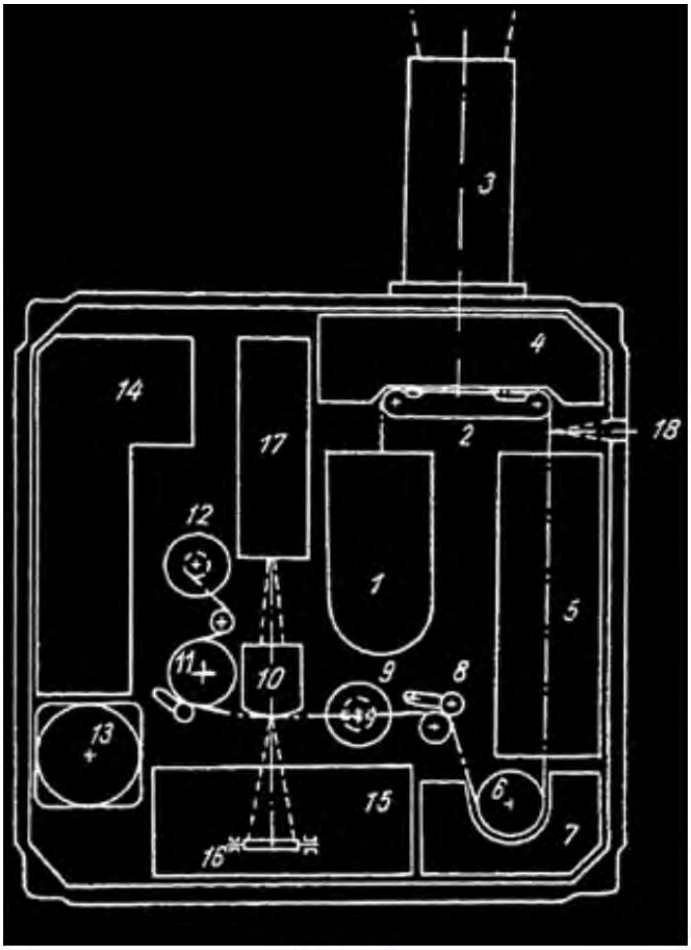
A Soviet probe single detector scan camera with a field of view of 30° x 360°. The idea is similar to how sidewinders of 50's operated using a single detector. On the side winder, the scanning is to center the target but on these cameras, the scanning mirror rotates to image the scene one pixel at a time, and it took 100 min for a full scan.

Commemorating stamps for cameras used in space: Saliot, Kiev rangefinder (middle), and Kiev 10 reflex (right).

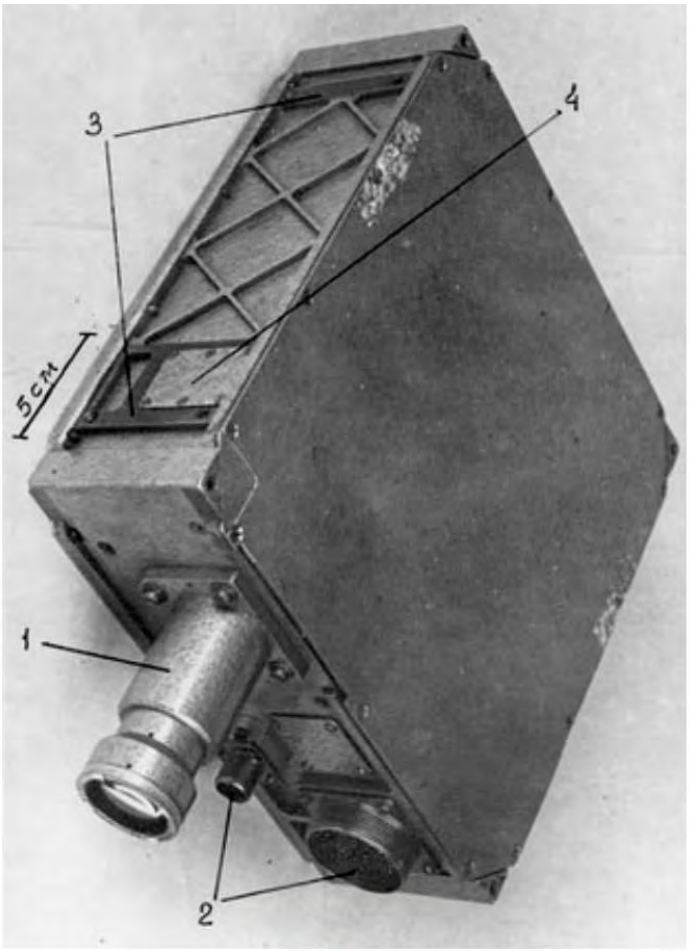
Zone-3 Soviet camera was launched in 1965 to record the dark side of the moon. It employed a 106.4 mm objective lens, taking pictures in both visible (yellow filter), and UV. Images were recorded on film, and developed every 2.35 minutes with alternating 1/100, and 1/300 sec. exposures. A rapid 67 lines/picture scan was first performed, and in high quality mode, images were sent 550 pixels per second, requiring 34 minutes to send a 1100x110 pixel image.

A 3-4 micron coaxial IR spectrometer was also incorporated on Venus missions to investigate thermal balance. My reference: “Soviet Space Cameras”, an excellent article by Don Mitchell.

Far Side of Moon from Zond-3 UV Spectrum



Diagram



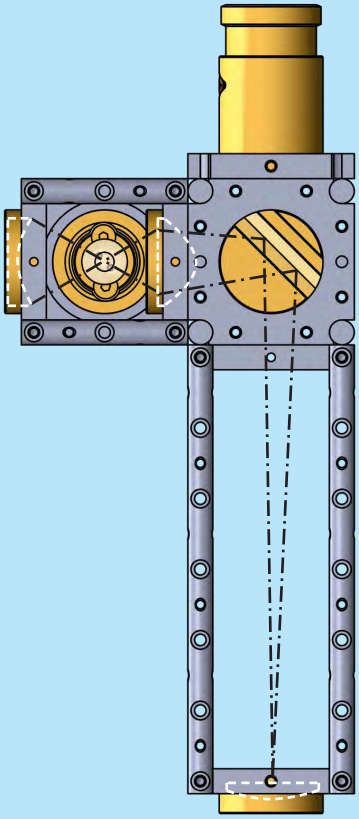
Zond-3 Camera

1. Radiation-Shielded Film
2. Film Gate & Focal Plane
3. 106 mm Objective Lens
4. Film Advance & Lock
5. Heated Film Developer
6. Drying Drum
7. Moisture Absorber
8. Servo Rollers
9. Slot thru Rewind Reel
10. Scanner Window with Condenser
11. Drive Shaft & Tension Roller
12. Take-Up Reel
13. Precision Stepper Motor
14. Control & Video Electronics
15. Stabilized Pinpoint Light Source
16. Oscillating Mirror
17. Logarithmic Photomultiplier (FEU-54)
18. UV Spectrograph Input

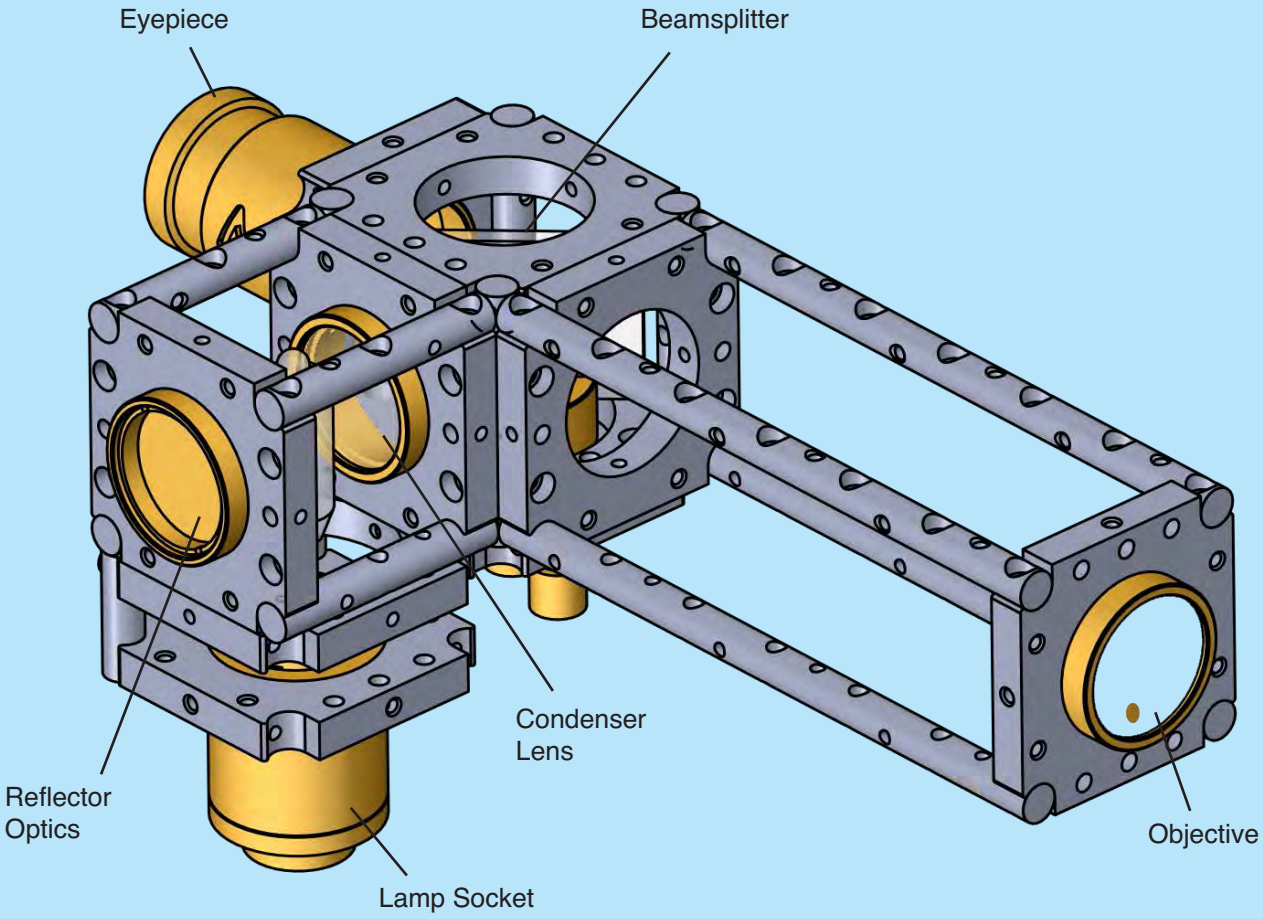
Building an Autocollimator

Building this autocollimator will take us to the next level of Optoform assembly techniques, and that is modularization. With modularization, what you build now as sub-assemblies, you could separate them to build other projects with later. With high cost of existing mounting plates, this wouldn't make a lot of sense but with new Optoform, you can. One good example is the lamp housing which we built before, and we could utilize now. We'll now build similar modules such as a beamsplitter assembly, and a collimating lens tube.

Instead of the usual optical ray path, let's look at the illumination path first. Proper illumination solution for this task is to project the lamp filament on the objective lens. It ensures corner to corner illumination for the reticule while it is viewed through the eyepiece.



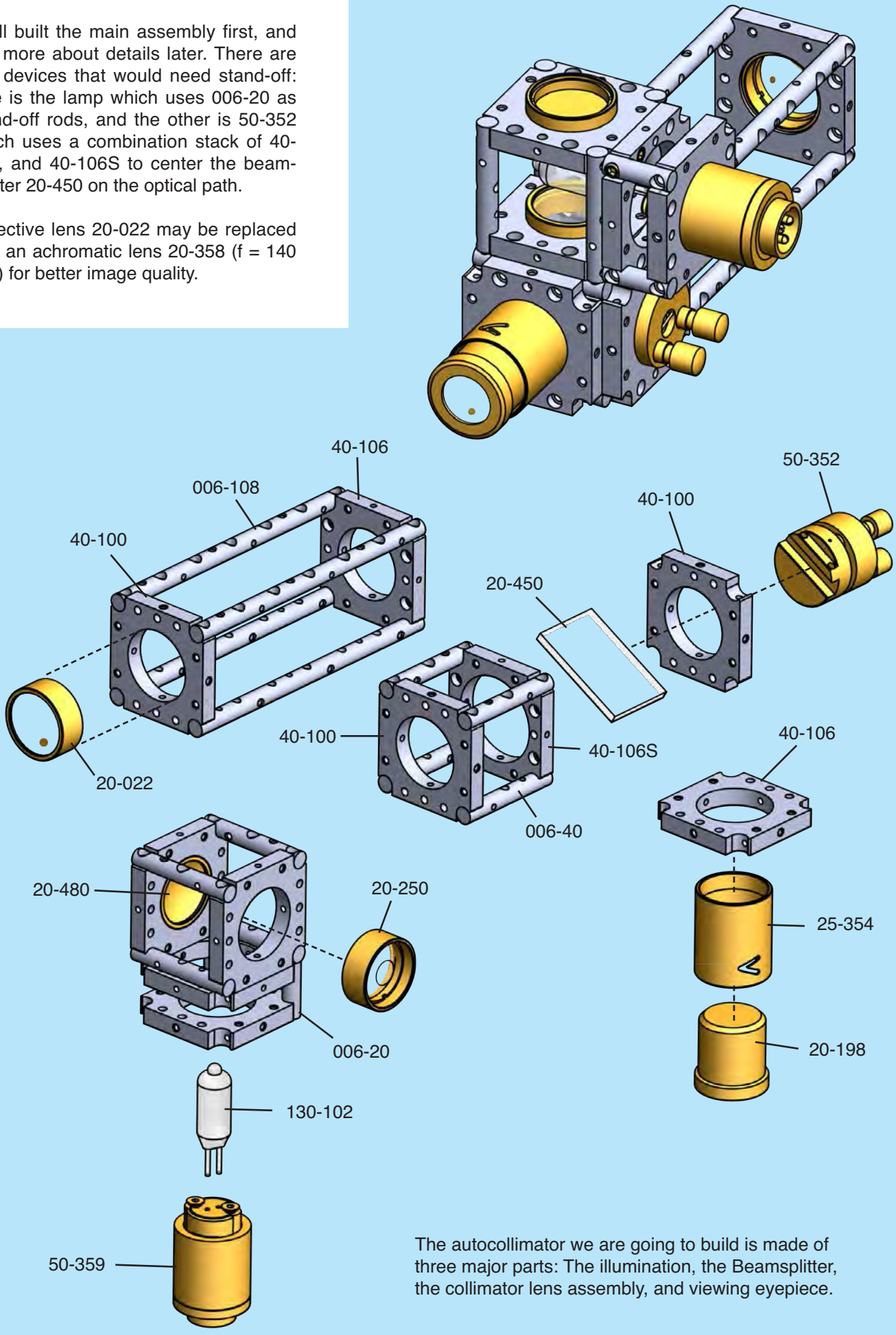
Right, proper illumination path is shown to produce corner to corner illumination for the target. In all projection-type systems, the lamp filament (or the LED) is focused on the objective lens.



Building each module

We'll built the main assembly first, and talk more about details later. There are two devices that would need stand-off: One is the lamp which uses 006-20 as stand-off rods, and the other is 50-352 which uses a combination stack of 40-100, and 40-106S to center the beam-splitter 20-450 on the optical path.

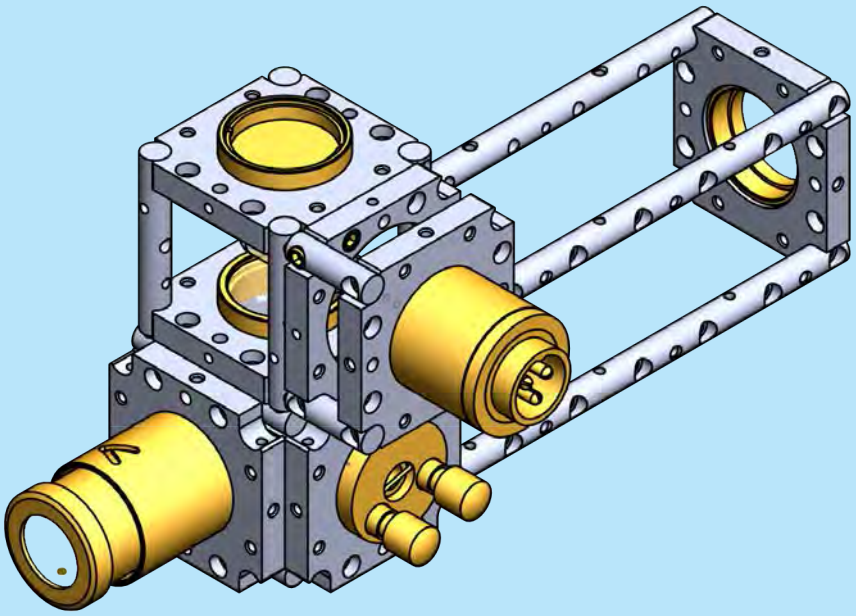
Objective lens 20-022 may be replaced with an achromatic lens 20-358 (f = 140 mm) for better image quality.



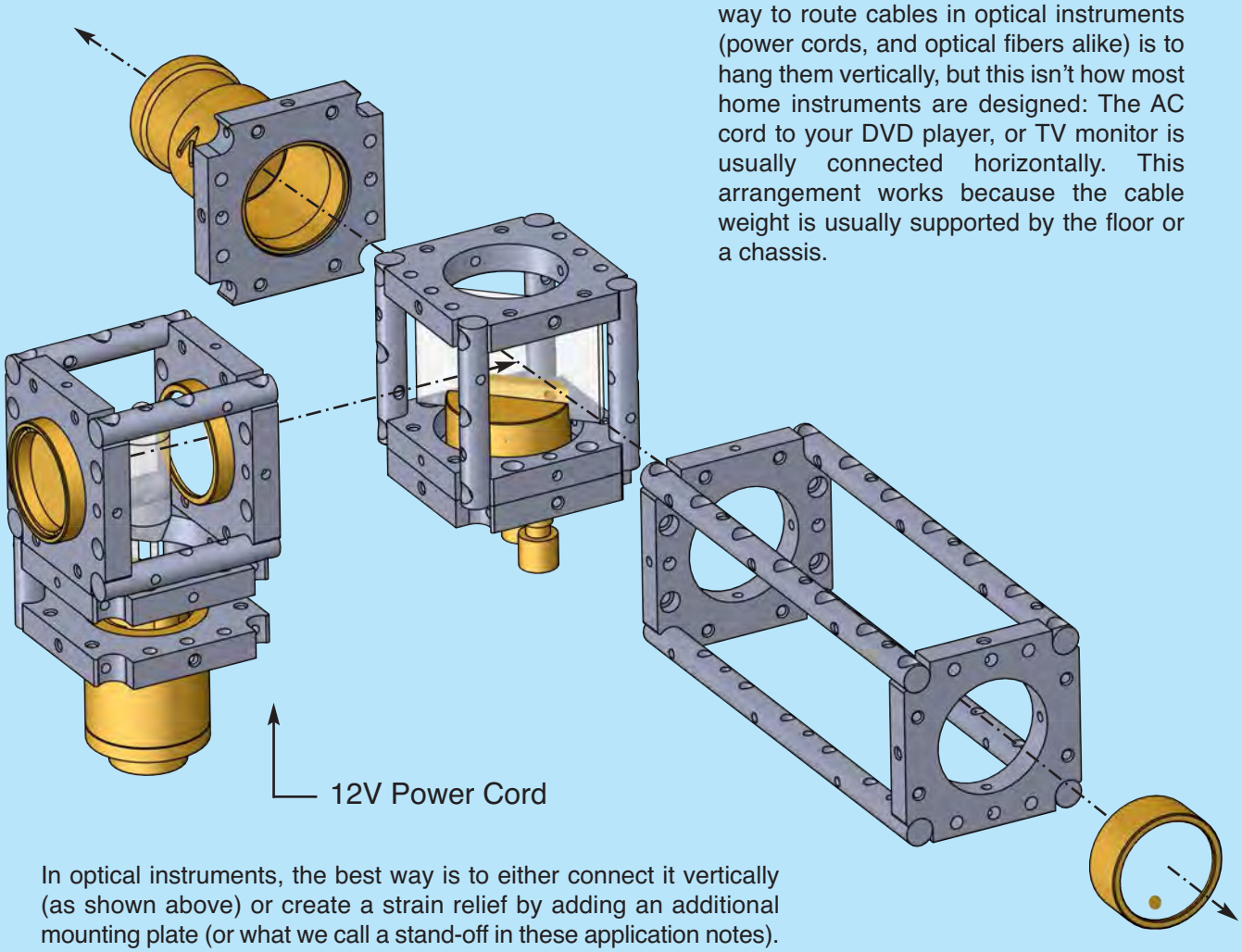
The autocollimator we are going to build is made of three major parts: The illumination, the Beamsplitter, the collimator lens assembly, and viewing eyepiece.

Final Assembly

Now that we have built all the subassemblies, we could arrange them in many ways to construct the autocollimator. For example, the viewing eyepiece could be positioned horizontally, or at 90 degrees. The lamp cable could be oriented to extend from the back or to be attached from the side. All these re-arrangements can be accomplished by removing 6 connecting screws.

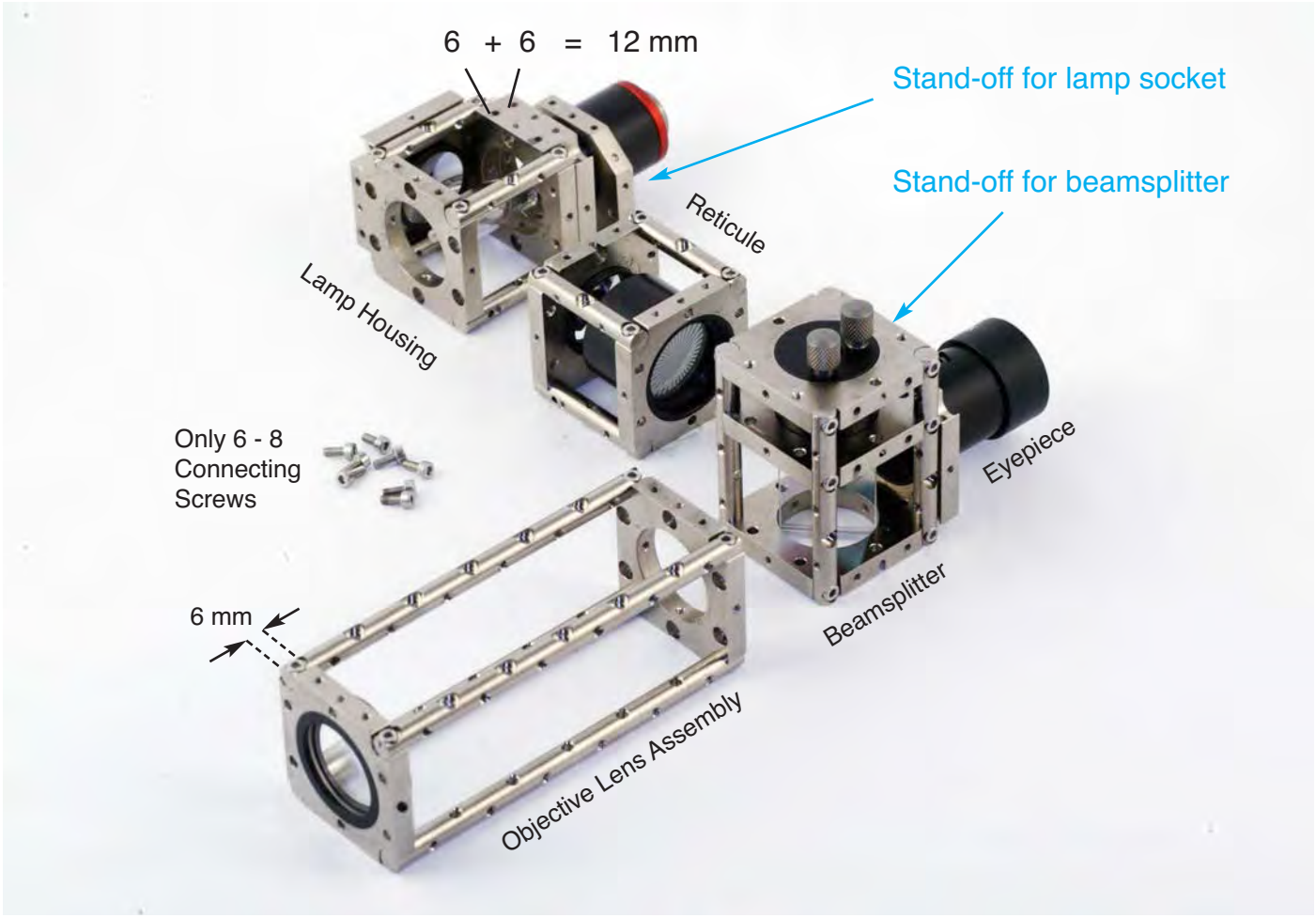


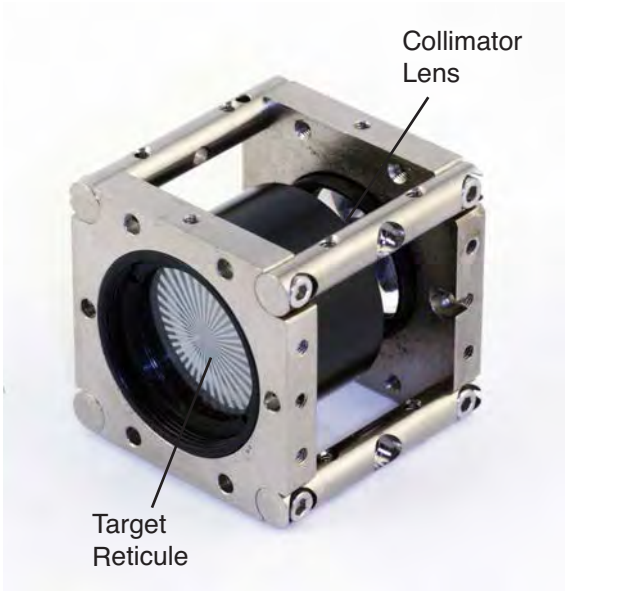
Viewing Orientation

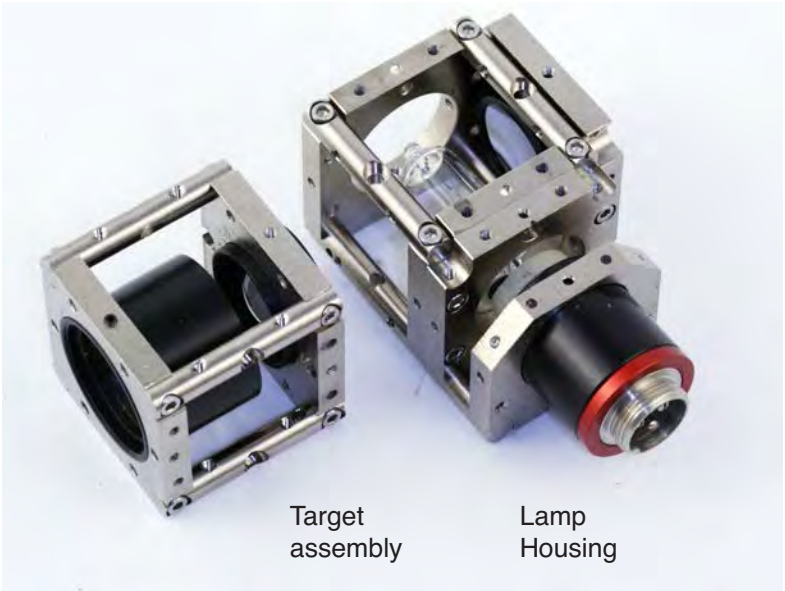


The lamp orientation for this assembly shows a proper way of connecting the power supply cable to the lamp. The best way to route cables in optical instruments (power cords, and optical fibers alike) is to hang them vertically, but this isn't how most home instruments are designed: The AC cord to your DVD player, or TV monitor is usually connected horizontally. This arrangement works because the cable weight is usually supported by the floor or a chassis.

In optical instruments, the best way is to either connect it vertically (as shown above) or create a strain relief by adding an additional mounting plate (or what we call a stand-off in these application notes). Again, a low cost mounting plate would allow you to do that. Mounting plates should be as affordable as electronics hardware.

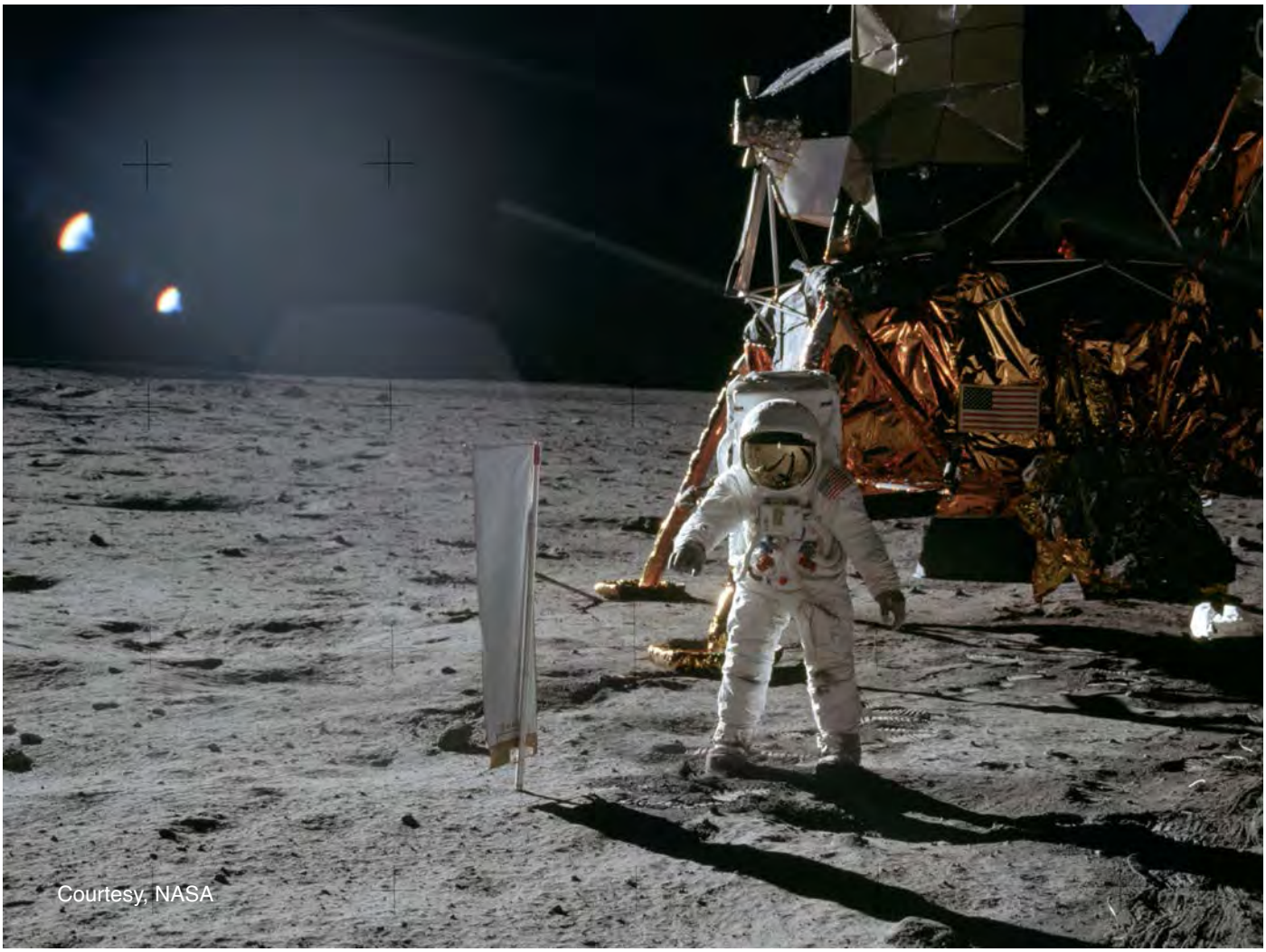






The Reticule Assembly

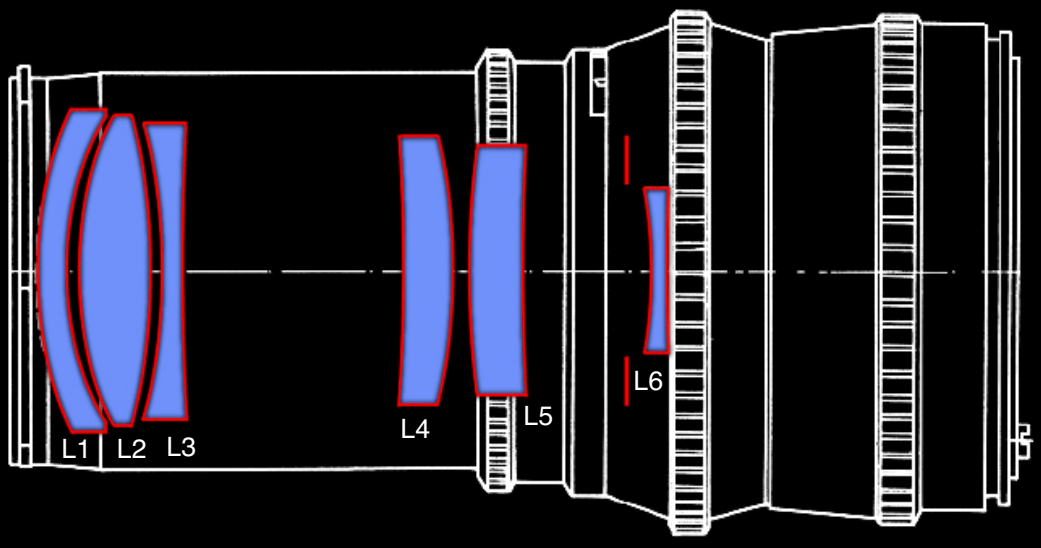
The reticule assembly (above) requires additional optics housed in an additional cube. This cube is attached in between the lamp housing, and the beamsplitter cube. The 40 mm extra length allows the illumination beam to be properly focused, and the target reticule be positioned near the front edge of the cube. This would position the reticule 20 mm away from the beamsplitter mirror, and around 150 mm from the objective lens (108 + 20 + 20 mm).



In spite of flare produced by sun light entering the lens, Zeiss lenses produced high contrast images in the moon shots. Using the reticles from reseau plate, the f/5.6 depth of field of the 60 mm lens, and sharpness zones on this image, one could calculate exactly the distance, and sizes of every object.

Zeiss Sonnar Suprachromat 250 mm f/5.6 for Hasselblad

Designed by Fritz Determann, and Heinz Zajadatz - 02/1972



L1 Schott LaFN8, L2 Fluorite, L3 Schott LaF20, L4 Schott F11, L5 Schott LaF20, L6 Schott LF8

A Tour of Saint Petersburg

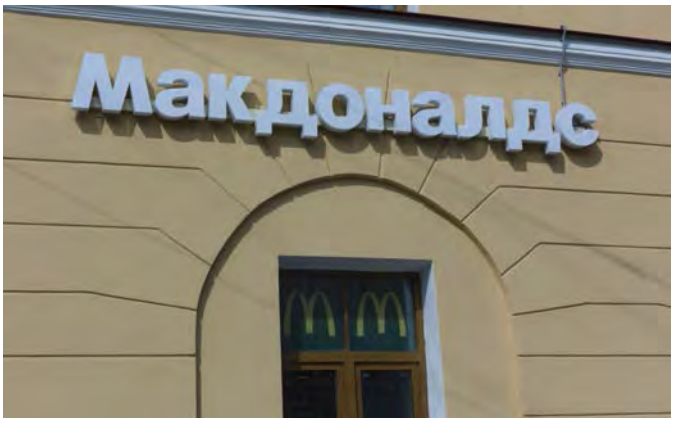
Saint Petersburg is one of the most beautiful cities in the world. I have been to Paris, and Italy, but this city has been designed, and put together so beautifully inside out that makes you wonder if you could ever stay here long enough to see it all. It has design harmony everywhere you look, with pure elegance. There is an abundance of space in this city's architecture, and it is still built with so much delicacy, and detail. There are 42 islands in Saint Petersburg, all connected with 342 bridges! Every night, at 1 a.m., a good number of the bridges go up for cargo ships to pass. It's a scene that tourists buy tickets to watch it on board boats, and wait to see the spectacle with cheers.

Exterior of Eshagh church

Petropovlovsky cathedral stands 122 m high

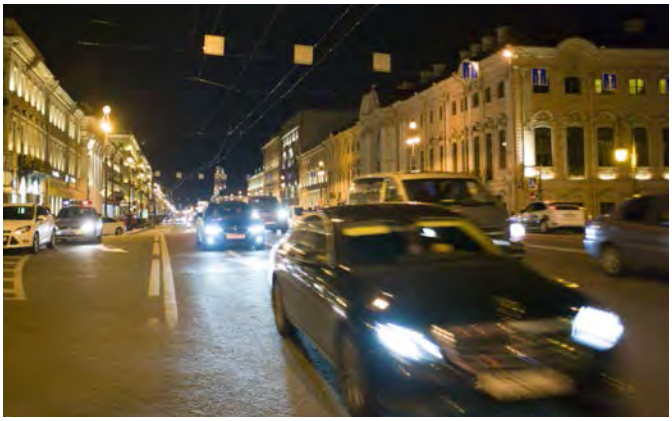
Posing infront of Kazan church with our new toy, Leica Polaroid camera. Interior of Kazan Church on Nevsky street.

2 m high Saint Peter's statute on a chair, you'll find many tall men in Russia. Right, rear view of cathedral pictured above



Here's a good way to learn Russian: Try to figure out how each word sounds like to pronounce MacDonalds. For Burger-bKing, b is B, Y is oo, P is R, r is G, flipped N is I, H is N. Bank is written as bahk. You could easily find your way around.

Entry to Galeria mall, on Nevsky street, everything to shop in Paris, and tthe rest of Europe you could shop in here.

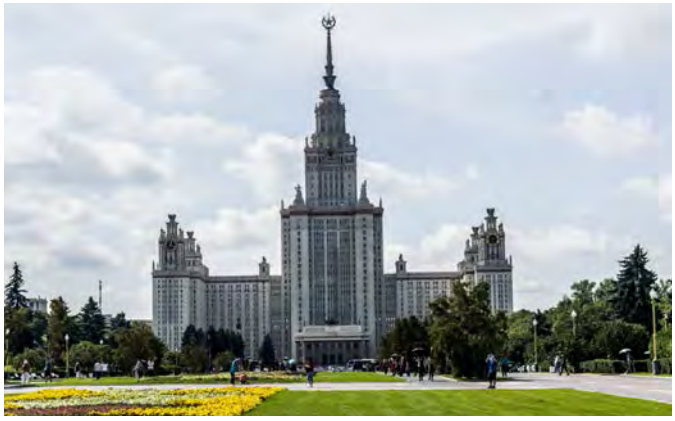


Nevsky street plays central role in Saint Petersburg's daily activities, and night life. Right, night scene of Neva river.

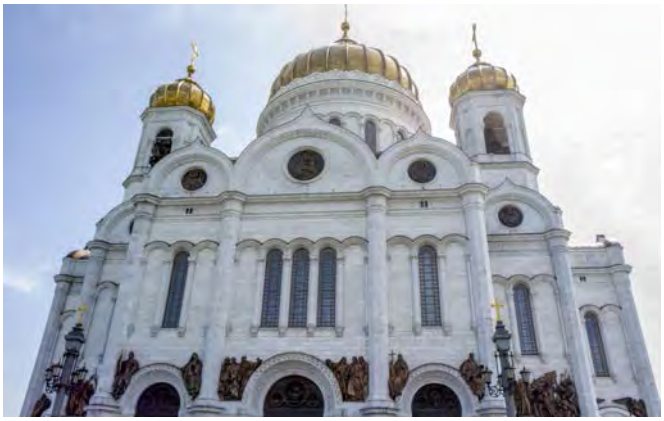
The bridges go up at 1 p.m. for cargo ships to pass, and this brigs a huge number of boats to watch the event.

Moscow

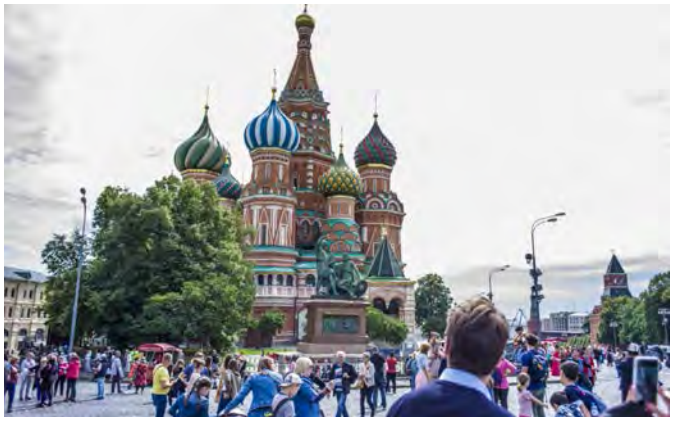
Russia has concurred two major wars: One with Napoleon, and one with Germans. Before studying their history, I thought well, that's so easy. The enemy's soldiers simply froze to death, and there weren't much to fight. I then realized what tactics, and what defiance these people have incurred to survive. Almost 2/3rd of Moscow was burned by Russians themselves so when Napoleon arrived, and sat on his thrown in kremlin, there was nothing to eat, and there was no one to rule! They did the worse thing to Germans. Yet when you visit Moscow, there is no sign of war. Moscow had many high rise buildings while Saint Petersburg had only one newly built major high rise.



MGO University, and campus (Mosgowsky Gasudarstveni Universitete), meaning State University of Moscow.

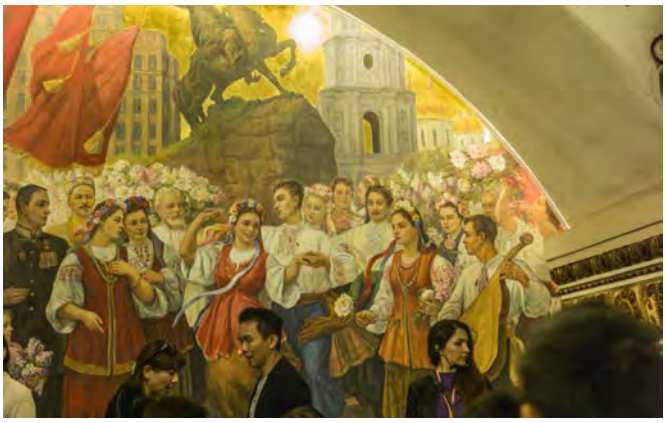


External, and internal view of Monji church. It had been dismantled, and put back together, finally reconstructed in 2001.



Vasili Church (above) inside Red Square is considered the most significant site in Russia. Kremlin palace is near by.

Construction of Vedenkha park was completed after the dissolution, where all diffrent factions in Russia express their unity.



Spectacular views of Moscow train stations. The rail spacing was reduced to prevent Germans from using it during WWII.

Downtown Moscow, Arobot street, where I found some antique stores to buy optics. Statute of Pushkin, Russian writer.

Folk Dance was the most mesmerizing show I had seen in years. Occasionally in Russia, they restricted taking photos

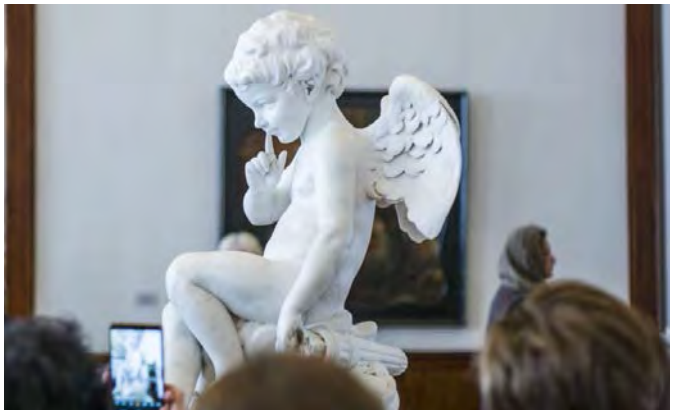
Large statutes display the Russian history during two great wars lead by generals who fought Nopeleon, and Germans.

Hermitage Meuseum

We visited two museums in Saint Petersburg: Space Exploration, Science & Technology museum, inside Petro Powelevsky Castle, that contains a large number of small museums. We then visited the space museum in Moscow. Hermitage museum that we are going to visit now is the largest museum in Russia. It covers mostly Saint Peter, and Catherine the Great's palaces, statutes, and paintings. My main purpose for visiting Hermitage was to see the Peacock clock up close.

One thing about Russia is that it's so big! Everything is done in a big way, and while building materials were transported from all over the world, the real state wasn't an issue when these buildings were being built.

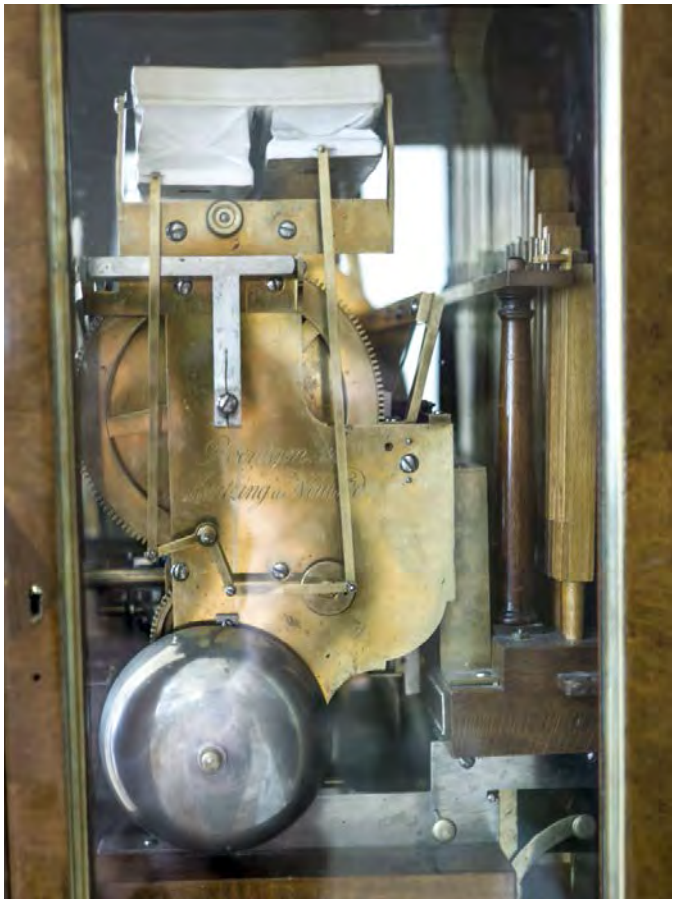
Saint Petersburg was the residence of aristocrats, and is built with 3-4 story buildings, having so many rooms. Hermitage was the residence of Saint Peter, and his family. It was converted into a court museum in 1764 by Catherend the Great.



Sculpture of Lover's angel with gesture of silence, secretly reaching for her arrow to shoot at someone's heart.

Queen Catherene's personal make-up collection, Silver

Queen Catherene's personal make-up collection, Gold

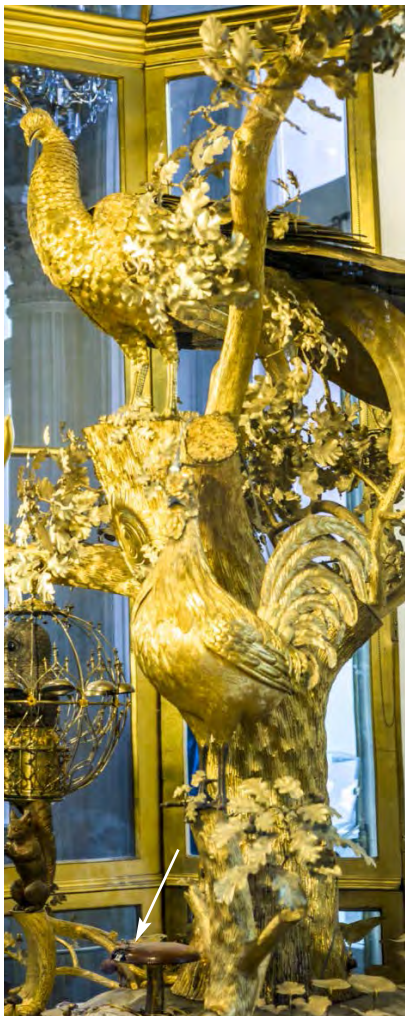


Many of the clocks at the museum are kept in running condition. This is a typical 3-Spring driven clock: One for clock movement; One for hour chime; One for quarter hour chime. The peacock clock isn't wound. They would only show a video of it.

Close up of the owl at the center of spherical cage.

The peacock clock was built by one of the most famous British clock makers of the time, James Cox. Its pieces arrived in Saint Petersburg in 1780, and took 12 years to be put together. With each hour chime, the peacock rotates, spreads her tail feathers, moves her head, and the rooster sings while the owl inside the spherical cage moves her head left, and tight as each bell chimes around her.

There is a white cylindrical display disk at the base (left) that is hidden under the mushrooms. It rotates for telling the hour. All the mechanical pieces are gold coated.



Some 225 paintings by Flemish, and Dutch masters decorate the museum walls. Some say these are duplicates to protect the originals.

Some Egyptian pieces on display at museum's collection (left). Old time keeping instruments were wound by special keys (right). Time keeping pieces were run by a small pendulum inside the case, and could easily be adjusted by its length.

Wooden floors at the museum (left) reflect the design decoration from the ceilings (right).

The metalworks on the chandeliers are extremely detailed. Petersburg's relatively low dust levels preserve wall decorations. That's a real problem with museum show rooms with such huge number of visitors passing through on a daily basis.

Russian Watchmaking

The “President Watch” sometimes worn by Putin, is made by a company called Poljot. This one shown is 0.01 mm gold coated. Russian made watches are not as delicately made as the Swiss made micro-mechanics, but they are certainly better than Russian made opto-mechanics. These two trades go hand in hand, and that’s why we also cover watches in this magazine.

Opto-mechanics in Russia is strangely cumbersome. I have no idea why that is. There are still binoculars sitting on display shelves in Russia that look like WW-II optics. China’s opto-mechanics got much more German-like with the orders they received from Japanese companies like Nikon, and Olympus. As much as the watch making has evolved in Russia, their binoculars, and telescopes have not. Yet they patriotically won’t sell Chinese made binoculars at their stores.

A more complex watch with Miyota movement, Japan

Thick housing in this Poljot watch (above) reminds me of old Patch watches, or those made by Lange & Sohne. Poljot watches are assembled in First Moscow Watch Factory. Today’s watch manufacturers are mostly case manufacturers. The movement could come from anywhere in the world: Swiss, Japan, China or Germany. Rolex used to receive their Chronograph movement from Zenith, until they began making their own.

Most of the watch parts are currently made by CNC, and Wire-EDM machines. It’s the final hand-made polishing that gives a watch its elegance, and selling price. Much of opto-mechanics is learned from watchmaking skills. Hasselblad first manufactured small clocks until their staff were ready to manufacture cameras.

Hand crafts of Russia

Russia souvenirs are a prime example of how authentic hand crafts could survive in today's world. When you take tour buses, they would usually take you to a souvenir shop so you could buy their handcrafts. Back in China (covered in Oct-Dec 2017 issue of Optomechanix), I remember they took us to a stone carving factory, and the factory representative expressed his sorrow why visitors weren't wiling to pay for the hand made items. Well, my wife is pretty good at judging the quality of handcrafts, and she didn't buy any. Back in Russia my eyes were perked up when she bought a Matryoshka for $400 on the first day!

The moral of the story is you can't have it both ways. You can't be a mass producer of goods, and at the same, maintain the integrity of your hand crafted products. Chinese were masters of handcrafts at one time but now their handcraft industry has perished because they concentrated only on mass production rather than offering much culture into their products.

Front

Back

Matryoshka with extraordinary hand painted detail tells the love story between a musician, and a girl.

O Mistress mine where are you roaming?

O stay and hear, your true love's coming,

That can sing both high and low.

Trip no further pretty sweeting.

Journeys end in lovers' meeting,

Every wise man's son doth know.

William Shakespeare
(from Twelfth Night)

Chromic

Automatic Chromozome sorting software

Software features:

Costs under $5k, compatible to most cameras

Online image capture and visualization

Convenient tools for editing metaphase images

One of the best image processing algorithms for enhancement of microscopic images

Last generation Artificial intelligence algorithms for classification of chromosomes

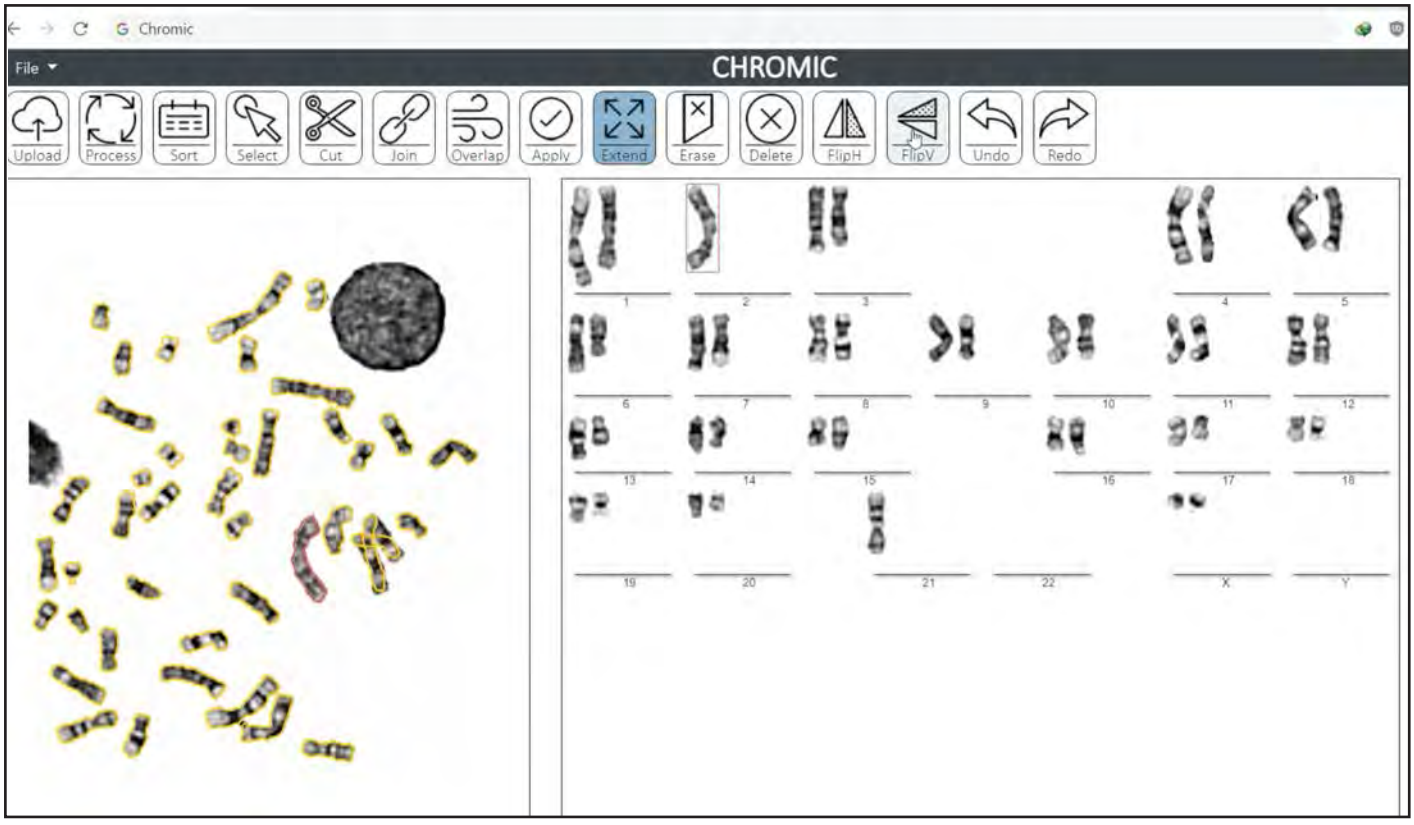
Provides powerful tools for separation of overlapping chromosomes

Exports a report based on examiner's comments on the test results

Optional motorized stage control for metaphase search, and image capture

Competitive advantages of the software:

- ☐ One-year free access to latest software upgrades
- ☐ Personalization options for labs and users
- ☐ High quality and lower cost
- ☐ Technical support



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