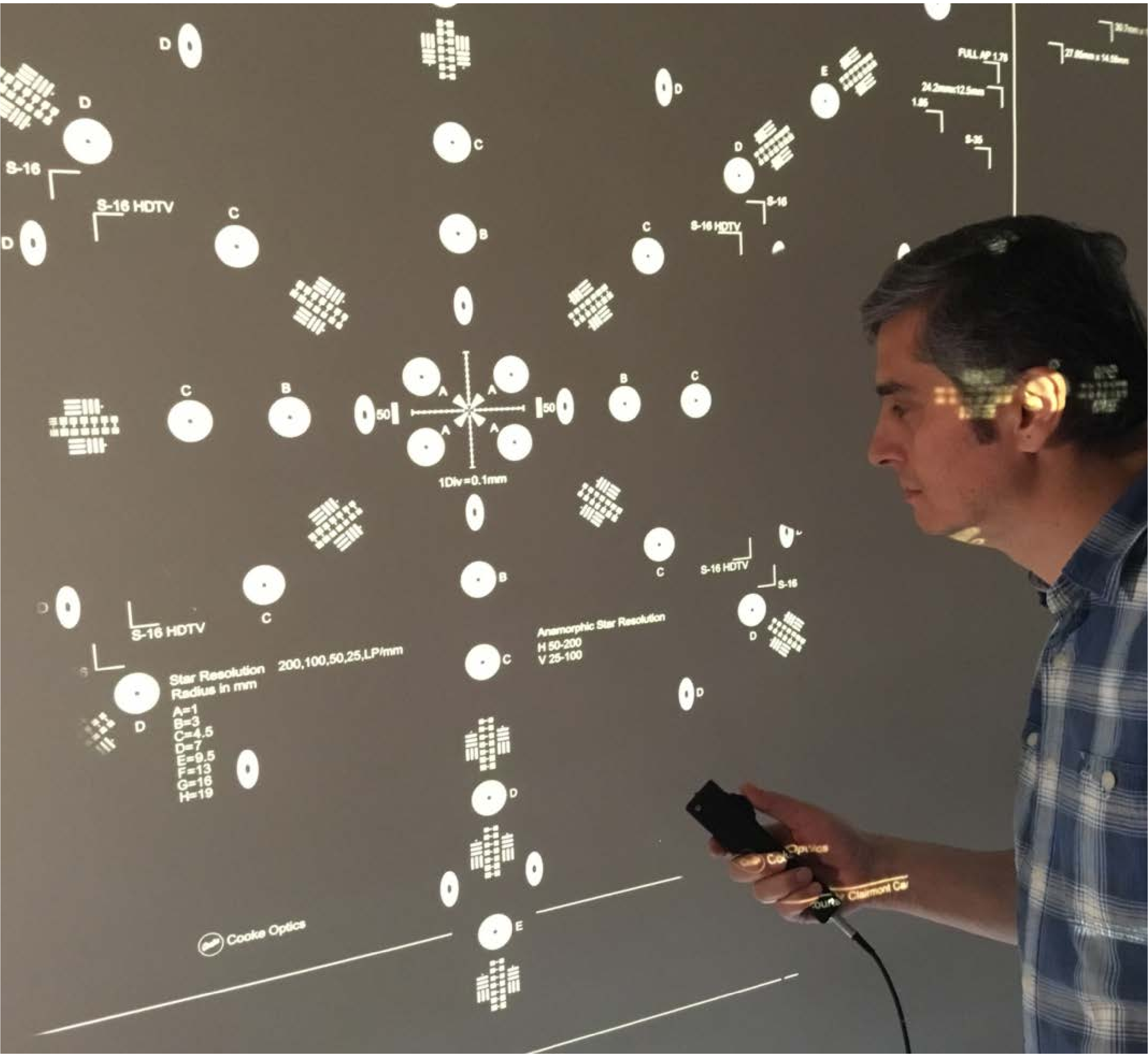
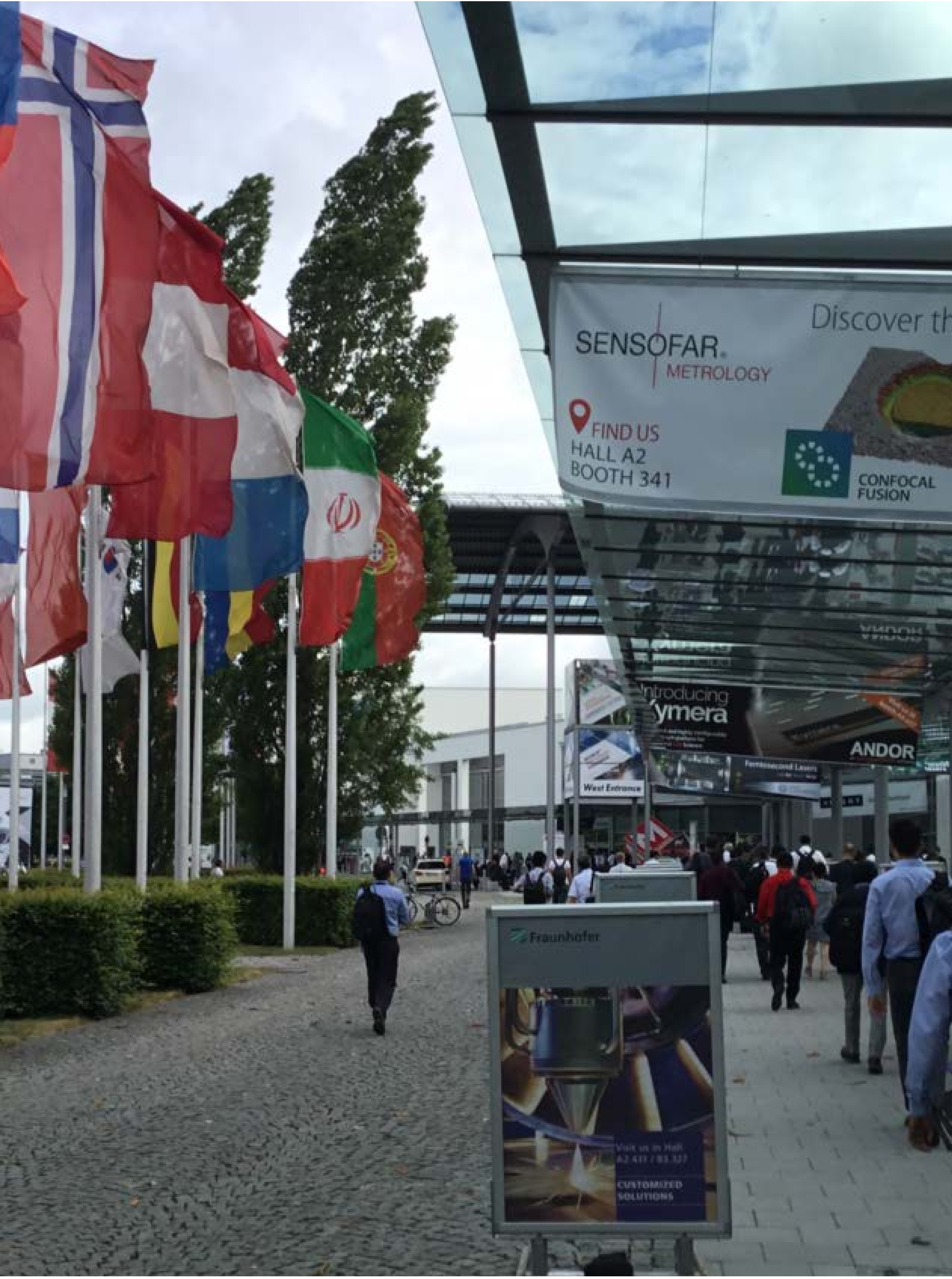
Optomechanix

June-Sep 2017



Technical journal of OMiD, Opto-Mechanical Institute of Design



Entrance to Laser Munich 2017 displays flags of participated countries

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OSA The Optical Society | 100 Since 1916

Member of OSA
Optical Society of America

OMD Opto Mechanical Institute of Design

SPIE.

Member of SPIE
The international Societry for
Optical Engineering

This issue Dedicated to:

Dr. Maryam Mirzakhani, world renown mathematical genius who won the Fields medal in mathematics, for her work on "Dynamics on Moduli Space of Curves". In physics, after Marie Curie who won the Nobel prize in 1903, it took 114 more years for a woman to win an identical award for her achievements in science, and mathematics.

A professor at Stanford University, she came from Tehran's Sharif University, also known for its most talented minds. She passed away at age 40. On her burial ceremony, her six-year-old daughter opened a box of butterflies to symbolize her free spirit, and the poetic view of science she possessed.

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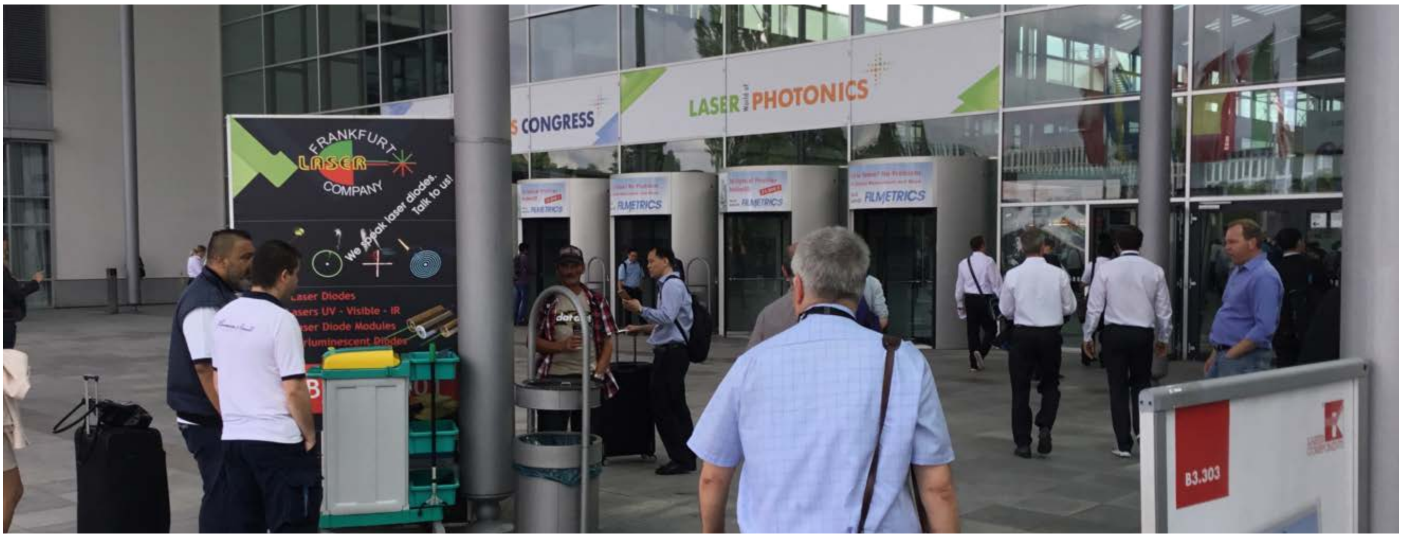
Optomechanix is a quarterly journal of Opto-Mechanical Institute of Design (OMiD), with technical articles for practical, hands-on audience. If you would like to contribute your work, we highly encourage using as many images, and illustrations possible. We believe Inventors can come from anywhere. So we try to increase their knowledge at all educational levels.

Cover page photo: Checking the optical performance of a cinema lens by direct reading of its lines/mm resolution.
Inside page photo: Flags of participating nations at Laser World of Photonics 2017 entrance

Laser Munich Show 2017

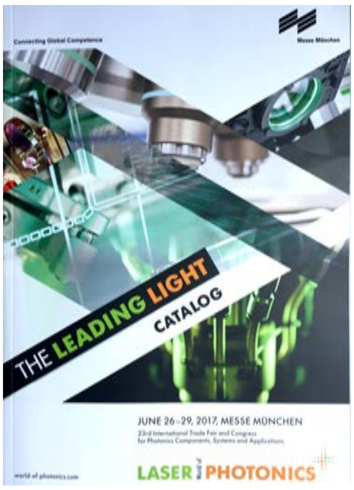
This year's Laser Show in Munich exceeded my expectations. The show had 1,293 participating companies from 90 countries and over 32,000 visitors. I arrived in Munich on 24th of June, only two days before the show. The show had great momentum from the first day to the end. I had visited the show for 20 years, and Munich was warm this year in spite of rainy mornings, and during some of the nights. The manger at Krone hotel, where I stayed at, blamed it on global warming.

Munich transportation offered me a week pass to go from the airport to my hotel, and to the show, then my daily visits to the show, and my return back to the airport the day after the show. As usual, as a small company, I carried my entire arsenal inside three luggages, through the train station, and to my booth! I was carrying the first issue of Optomechanix, and I was able to distribute it around the show to 150 exhibitors. The show was much more than I expected.



Going to a show was like going to a library, and everyone was looking for a particular book or subject. It is by grouping together similar subjects that a show is successful in helping the visitor find new vendors, and products. The first half of the show guide was divided into two major sections: An alphabetical list of companies, and application index of exhibitors from one of 24 different fields from Agriculture to Tool Making, and Mechanical Engineering. The second half was divided into 13 sections by their product and service directory, having 13 different categories ranging from Lasers, and optoelectronics to Security. I am still confused why categorizing twice? This increased the thickness of show guide twice its size.

The major players at the show were Laser 2000, Thorlabs, Opto Sigma, Qoptiq, Linos, Laser Components, Edmund Optics, Polytec, Zygo, Trumpf, Jenoptik, Schott, S&R Optic GmbH, Swaroptic, Franhufer, PI, Limo, and many more. The Munich show had many companies from US, and Europe. Chinese companies had back wall pavilions in B1, B2, and B3. Japan had a small pavilion on B2, and US also had a small pavilion. This is mainly because the Chinese companies get a discount when they exhibit together as a group with their hotel accommodations, and airline expenses. I know at least in America being in the pavilion costs more than being out in open, so many US companies won't join the pavilion, and would arrange with Laser Munich directly for exhibition space.

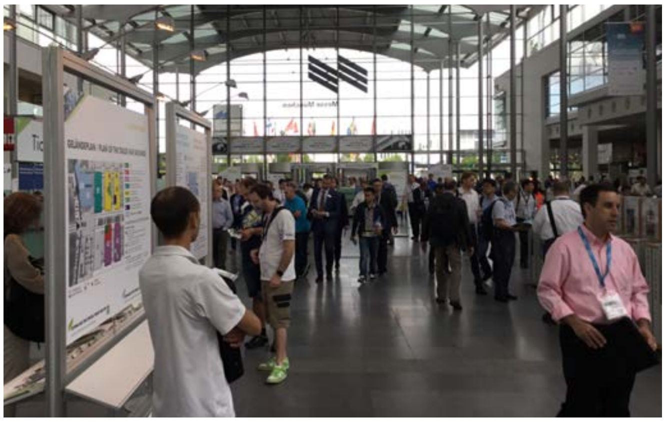


Laser Photonics Guide 2017, with 440 pages in full color. In spite of the highly graphic exhibitor guide, I found it confusing. The guide seemed to repeat itself twice, and I was kind of lost between the two sections where the alphabetical order would start, and where it would end.

Among many shows I attend every year, Laser Munich is really the best to reach the European market. The problem many companies have in getting nothing out of the show is because they come unprepared. Attending a show even if you have the best product, is to be fully prepared for the show. Trade shows create bounds. It also refreshes efforts, and expectations. After the show, there is a celebration, and after that, it's keeping up the good work to prepare for the next show. Products are like a seed that need to be nurtured, and watered to grow, and succeed.

Ali Afshari
OMiD
Opto-Mechanical Institute of Design

Visiting information booth to receive the show guide. A smaller guide alphabetically listed company locations.

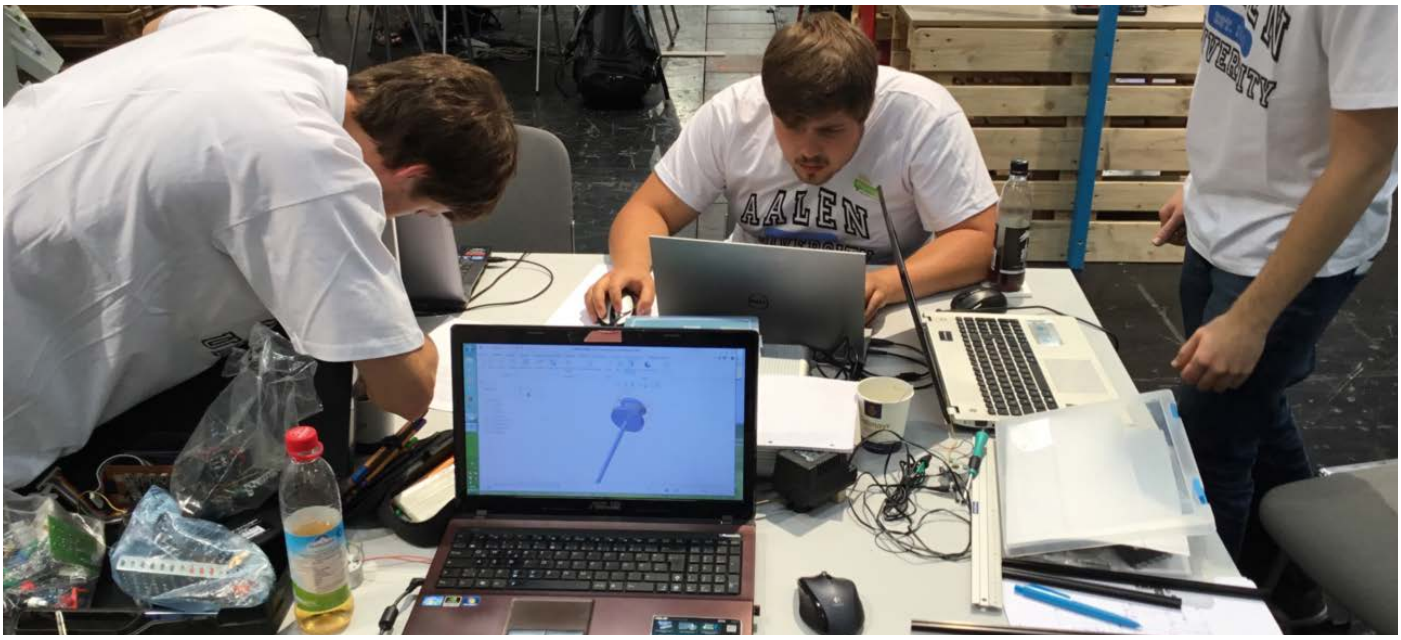


Every morning, at the show entrance, Laser 2000 gave pretzels to every attendee.

Floor map of the show: There were A2, and A3 halls for laser cutting exhibitors, B1, B2, B3 halls for optics.

Trade magazine racks displayed related trade journals for take away by visitors, and I found many new journals.

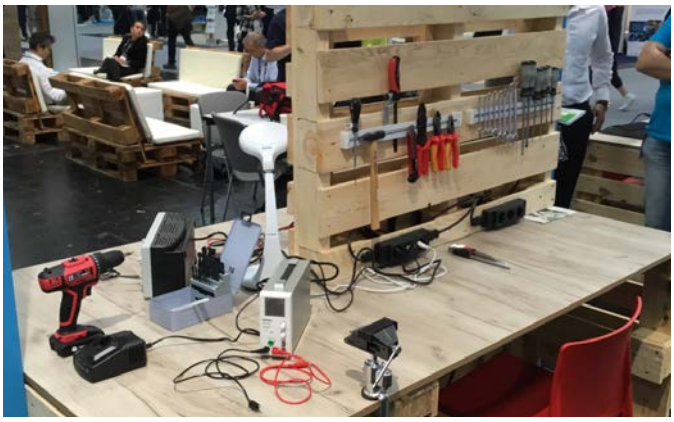
Entry to the show floor through the halls was graceful. As an exhibitor, I found the distances to be convenient to visit show vendors, but it took a 10 minute walk to the exhibitor shop that supplied halogen lamps, drinks, AC cords, etc.



Make Light MAKEATHON Student Competition

79 students compete to design and build an optical device at Make Light initiative staged by German Federal Ministry of Education (BMBF) within 24 hours, to win the photonics award. The winner was a “Smog Dog” robot made by a group of students that smells, and finds smog in a room using optical sensors. The event gathered a huge crowd in hall B3. The judging panel, consisting of industry experts reviewed the designs to select the best project. Every project had a chance to display, and sell its design to the judges, and the crowd.

The work bench consisted of soldering station, a digital ohm meter, and oscilloscope, and hand tools.



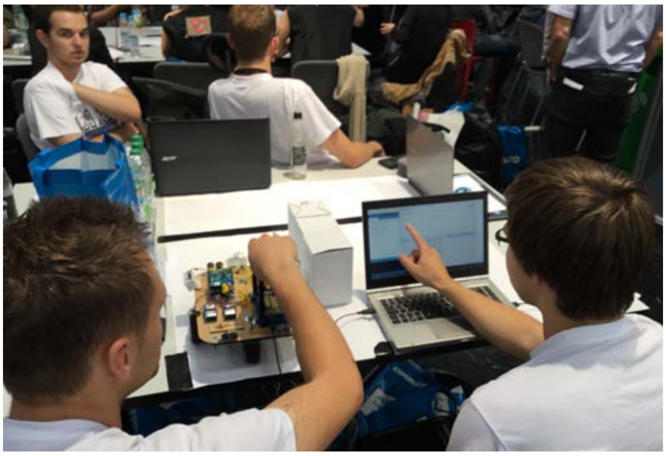
Other hand tools available for students were a power supply, electrically driven tools, drills, bench vice, etc.

The students beginning their design work with their own laptops. Knowledge of four fields joined together to complete the project: Mechanics, electronics, software, and optics. The designer could come frome any of the four backgrounds.

The student groups also included newly graduate engineers. It is very interesting that although the groups had an already designed, and built product in mind, they had to be prepared to do it again during the show. This is different from a writing exam where the subject they are going to write about is unknown to them. In here, they already knew what they were going to build. There was still code writing, and they could download it from a previously uploaded FTP site! So what was really being challenged here? This whole experience taught them team work, and everyone learned about their own strengths in the group. It also taught them to deliver an order on time, and brought out the marketing talent in the team during final presentation.

Some of the devices available for student groups to design, and build their instruments.

Student design group during their design implementation process.



Hardware/software interface of a three-wheel robot.

Audience view of one of the presentations, the student is ending his session with: “Any Questions?”

A student stands in front of the judging panel to present his group project. The actual project lays on the floor, in this case, a smoke detector robot, and is controlled by the rest of the group to prove its functionality, and performance.

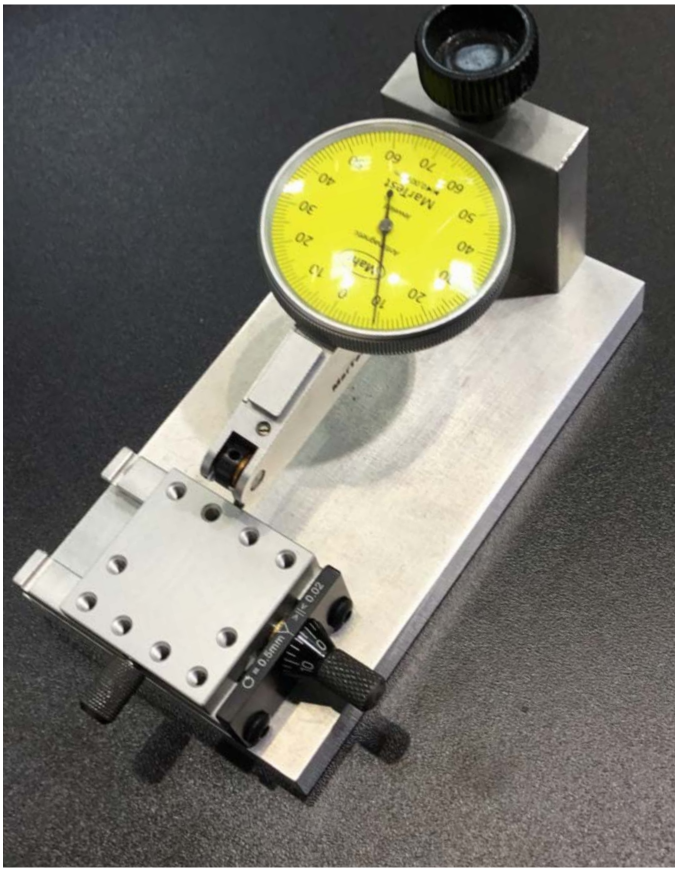
New Trends in Mechanical Stages

By Ali Afshari

The mechanical stage has been around since the Michelson experiment to prove the presence of ether by measuring optical path length with his famous Michelson Interferometer setup. Although his experiment actually failed, today Michelson interferometer has become the most common experiment to prove stability of stages, and mechanical setups. Why is it that optomechanical stages, in spite of their similarity to earlier designs, have been made better, and more linear, with less backlash?

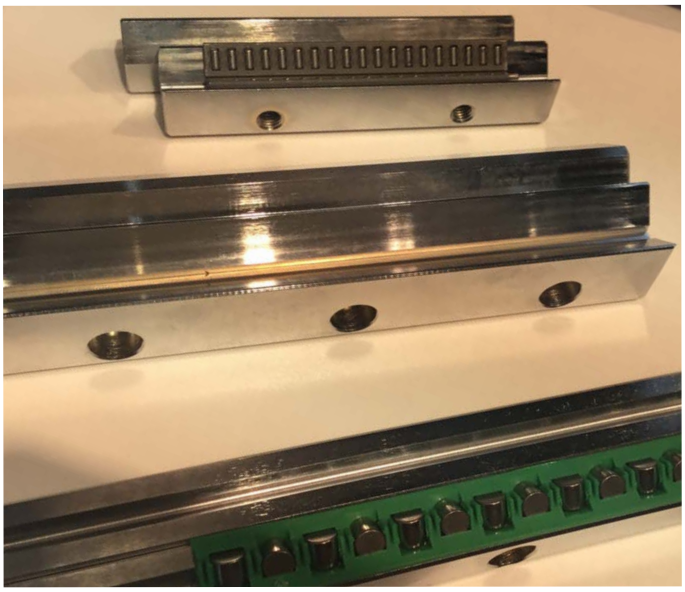
Dovetail design, for example, has been around since the Michaelson experiment but what has improved since then has been the capability of CNC machines in accuracy, and repeatability. The new tightly assembled stages by ERO Fuhrungen made in Germany are a good representation of the tight tolerance capability of newer CNC machines. The highly precision ground dovetail stages (below, right) are made of stainless steel with special coating to reduce friction in their super-tight stage assemblies.

These days, mechanical stage designers are mostly sitting around, having nothing more to do! So they are looking at the new machining capabilities of CNC machines, and are starting to enjoy the design freedom in their Solidworks or

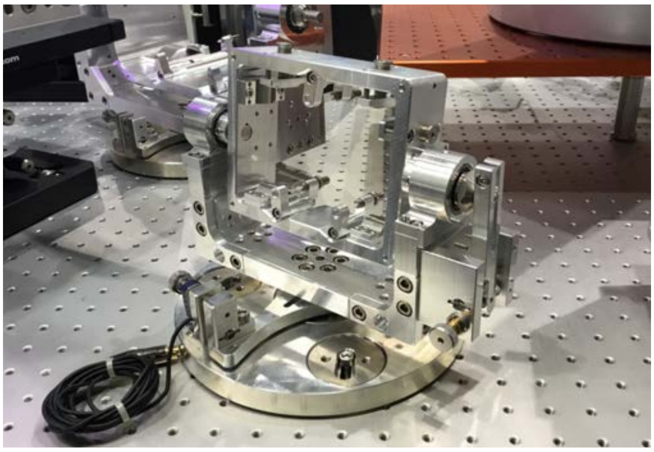


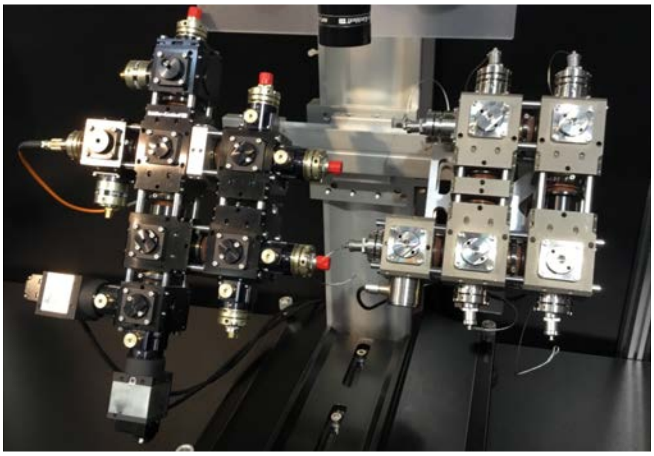
The translation linearity (above) of Fuhrungssystem SVAN Dovetail slide being shown here by a dial indicator. The critical testing of precision stages are actually tested using a Heterodyne Laser Interferometer that measures the optical path length difference at top center, and lower two corners of the stage using Corner Cubess while it is being translated. Light bouncing off of the three Corner Cubes are measured along the traveling range of the stage, and its motion is compared at all three points in sub microns to reveal its parallelism, and linearlity.

A goniometer stage displayed at ERO booth with dovtail rails (below) can carry a much higher load with less play.

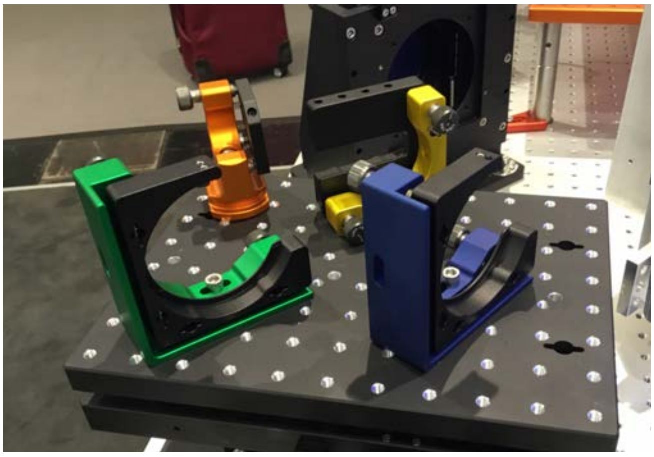


cad workstations. Live tooling CNC turning machines, for example, have enabled Thorlabs' designers to add new contours to their new line of components for their cage system. So new shapes are forming by many companies with more colorful anodizing to bring laboratory setups out of darkness.

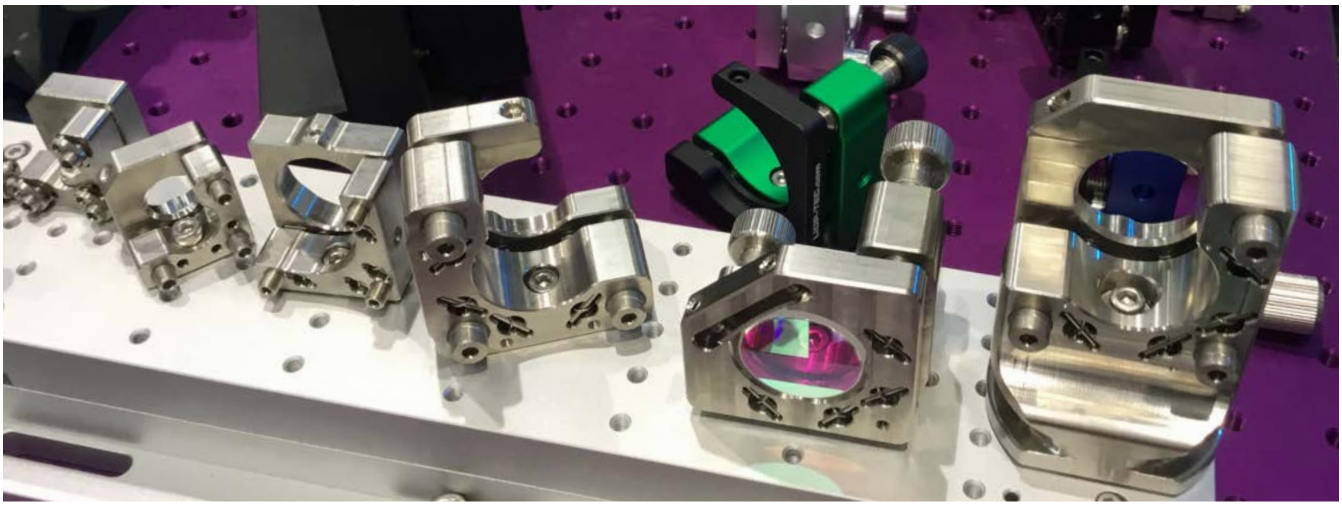




The stage shown above demonstarates the new design approach to large optical mounts to make them lighter, and more compact compared to much bigger, and heavier stages of the past. Precision fiber optics mounts built by Schafter+Kirchoff (above-right) reveals an obsession for rigidity, and precision.



Designers are more and more utilizing the machining capabilities of new generation of CNC machines to create more sophisticated contours in mechanical mounts, and stages. What used to be too expensive to produce by CNC machines, and required more setups, is now part of CNC capabilities of machining ceneters whether used or not.

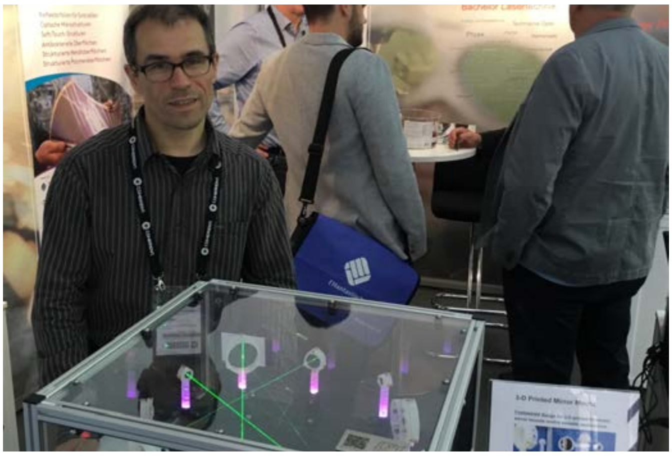


Stainless stages are more difficult to machine than Aluminium mounts. The narrow/deep spring-rod seats in these tilt stages requires high RPM machining centers plus more rigid axis in the CNC machine. These stages are made of a two-piece assembly that are each manufactured in series, each side being machined until the final operation.

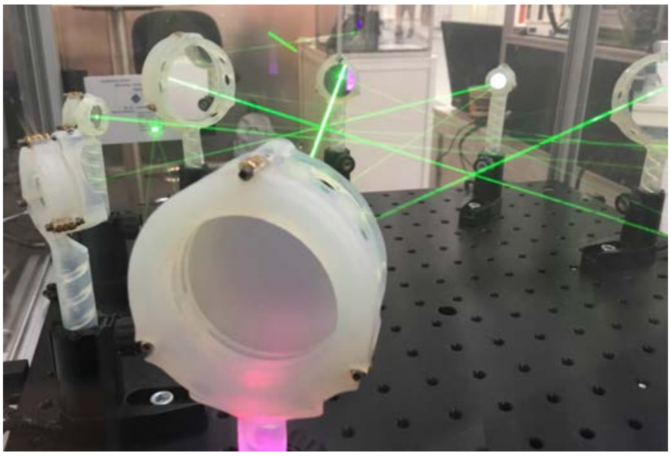
The Best New Ideas I Learned at the Show

By Ali Afshari

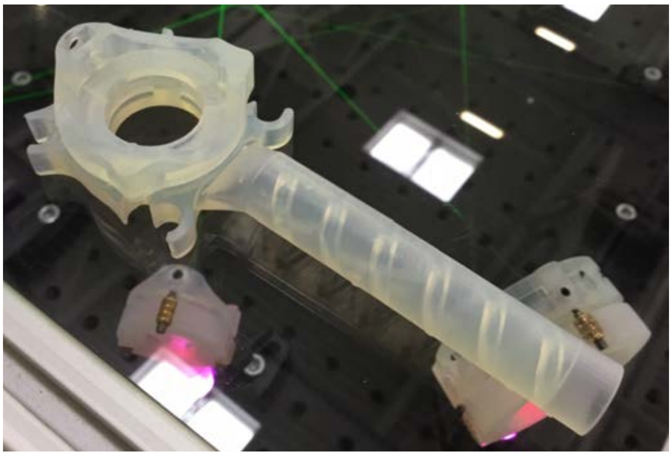
I saw at least three great ideas at the show that made my trip worth while. The best idea was the 3D printed mirror optics mounts at the LFM booth (Laserzentrum Fachhochule Munster) or Center for Applied Sciences at University of Munster. They had developed an inexpensive mirror tilt mount with plastics that was stable enough for a Michelson interferometer. As Jens Hildenhagen, the project engineer explained, their group had studied numerous raw materials to feed a 3D printer for achieving a part with maximum flexibility, and repeatability. They tried making pieces at different angles in the SLA (Stereo Lithography Apparatus) to find which orientation would give the best performance (bottom of page). The end result is a series of optomechanical mounts that are extremely low cost, and enable students to perform similar experiments such as building an interferometer that would otherwise be un affordable.



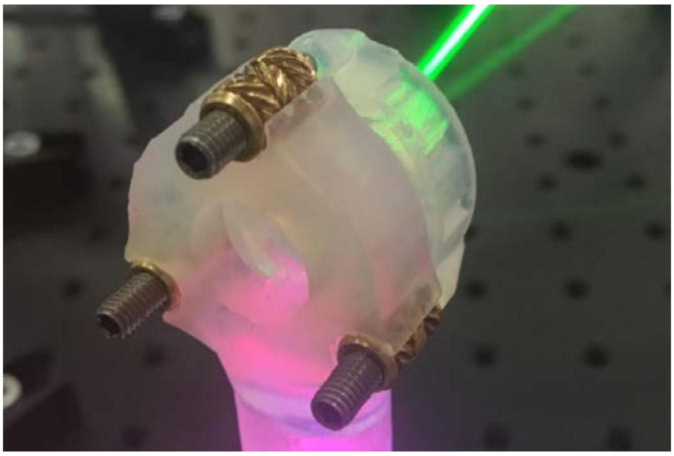
Jens Hildenhagen from University of Applied Sciences at Munsten demonstrating 3D fabricated mirror mounts.



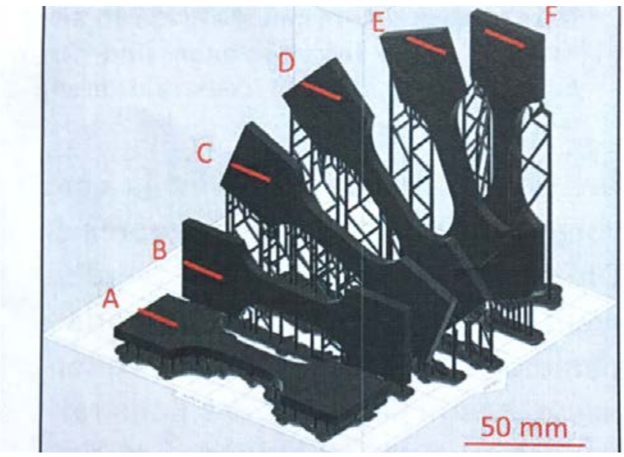
A 50 mm mirror mount fabricated by 3D printing. They studied several materials to find the right ingredients.

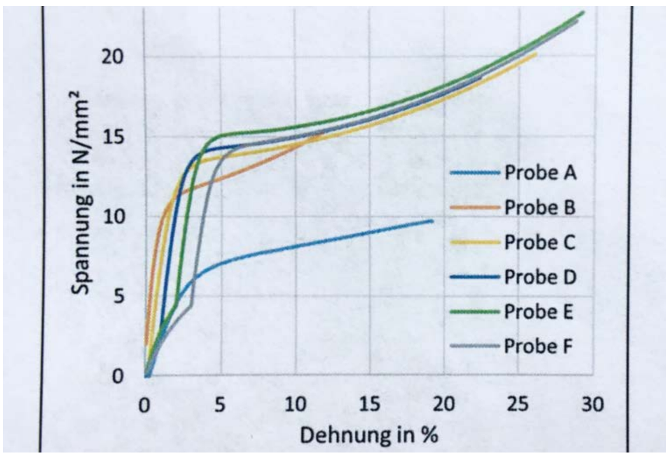


An optics mount compatible with Microbench. This one piece assembly also includes the post mount rod.

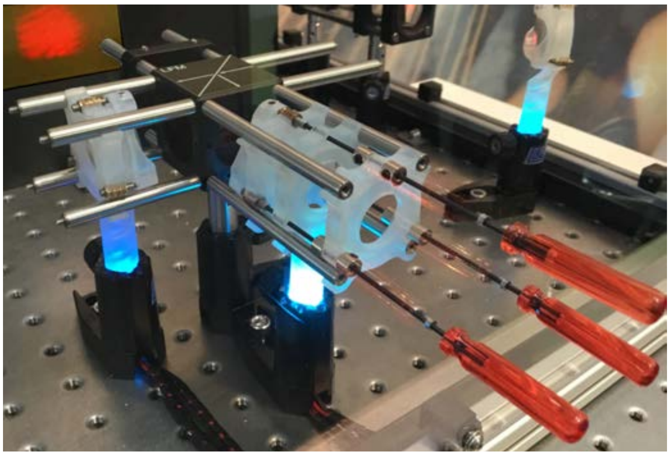


The fine adjustment set screws are secured onto the plastic mount just like the snap-on Microbench rods.

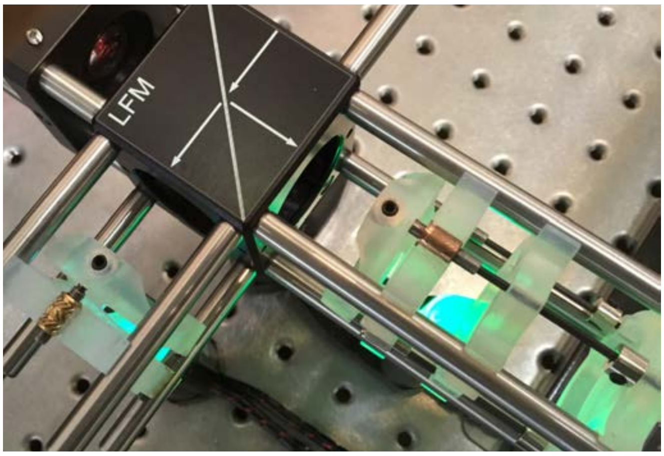




A screen shot of the 3D machine's graphic interface showing the support structure of the test elements fabricated at different angles by the SLA machine. The corresponding curves on the right reveals the element's elastic charasteristics.



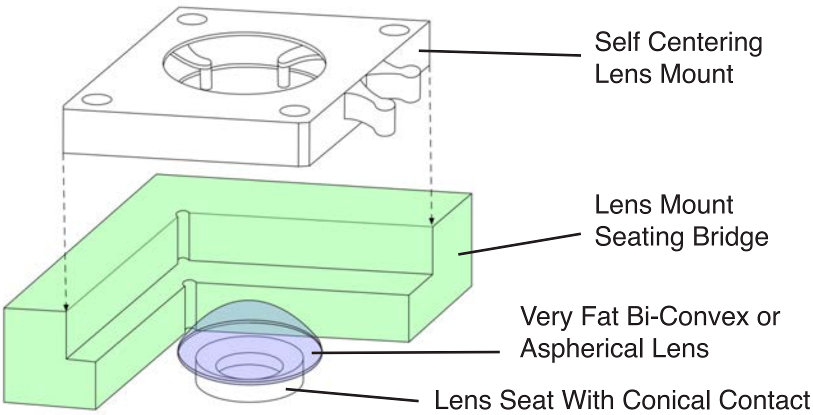
2 mm ball drivers are utilized to turn the fine screw adjustments, and to produce interference fringes on the left.



Close-up of the fine adjustment screws and the insertion of 6 mm rods, in this case, to the Thorlabs cage system.

The second idea was at DIOPTIC Booth: Method of securing optics at their test bench called ARGOS, using an off-the-shelf square shaped lens mount (below). Self centering lens mounts are a quick way to secure optics without having to use the spanner wrench, and finding the right mount for it with an appropriate retaining ring. The only problem is the centering accuracy of these devices are not too reliable, and secondly, the lens may end up slightly tilted. Well, one company has a clever solution to mount a variety of lens sizes, and drastically improve their centration, and parallelism.

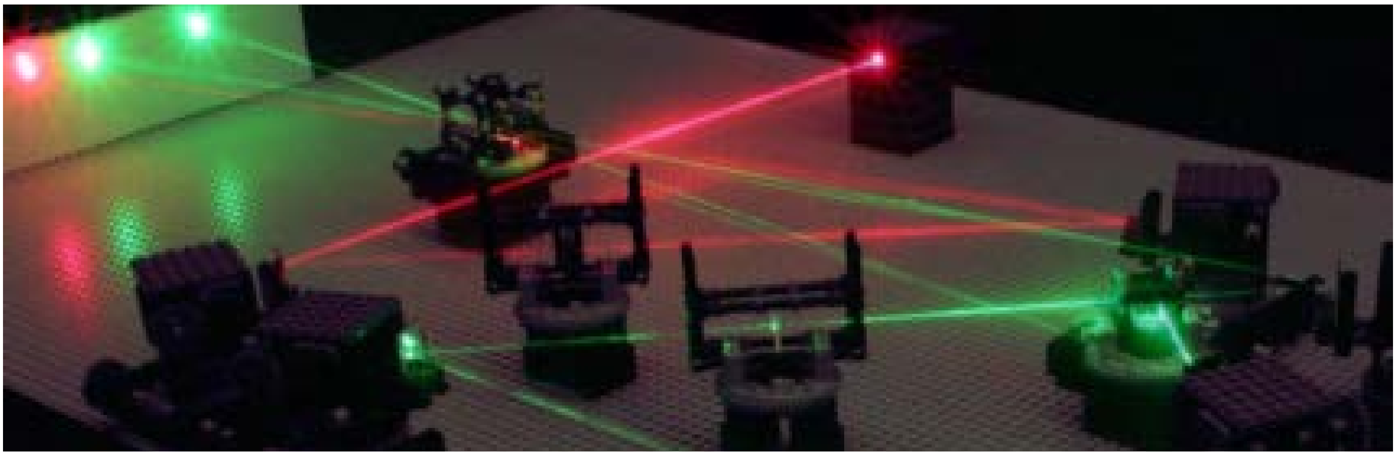
To start with, Thorlabs has developed this nice self centering lens mount for their 60 mm cage system. The idea is to use this mount in conjunction with a fixture to center the lens before it is grabbed by the lens holder's arms (below). When a lens is placed on the conical edge of the lens seat, and the lens holder arms close in, it is automatically centered, and its edges are grabbed in parallel orientation. As long as the lens is not repositioned, its parallelism is maintained.



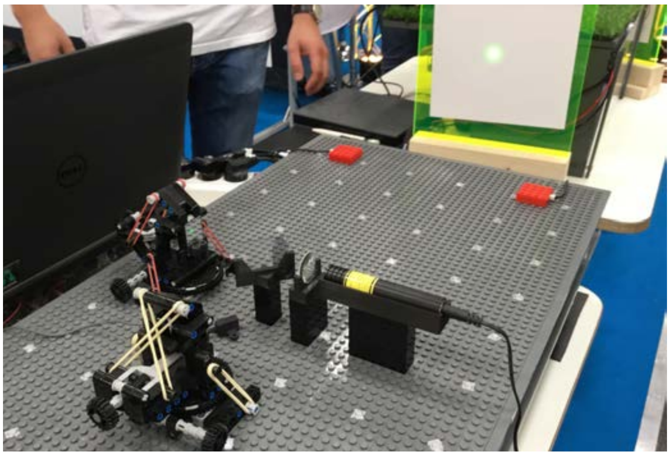
Thorlabs self centering lens holder is utilized in this low cost lens mounting fixture that automatically adjusts its parallelism, and improves its centration. Trioptics stages are far more accurate but here, it is accomplished with much less.

The third idea was at "My Photonics" booth that displayed optical experiments with Lego pieces. The idea was to use plastic Lego blocks to build optical setups stable enough to even do interferometry with them. The overall design of the components was injection molded in the shape of Legos, so they could be mounted onto each other according to Lego concept. Efforts to construct optical experiments with Legos has been going for so many years, as Dr. Micro Imlau explained. One effort was to built optical tables from scratch with Lego pieces, and filling it with same honeycomb structure. Other efforts have been focused on making adjustable mirror mounts with Lego pieces. The result has been posted on YouTube to show their detailed construction.

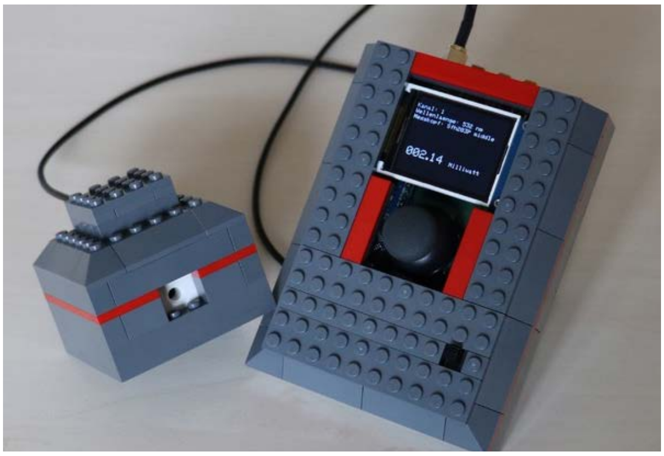
It would be so easy to think that Lego blocks are not a good idea for optomechanics because the Lego concept focuses more on form than function. Furthermore, the Lego blocks have had the ideal shape to construct cubical and rectangular shaped buildings, not for constructing round shaped barrels containing optical elements. The Lego optical table is good for someone who is hooked on Legos but to an outsider, it's doing something so easy the hard way. The desire to build optical instruments has been met much better, and easier with non-Lego style optical kits made of tubes, etc.



Sophisticated laser beam steering on optical tables, constructed with legos (it actually costs the same as a real one). This toy-like setup looks like to be appealing to children.



With Dr. Micro Imlau, head of Ultrafast Laser Research Group at University of Osnabruk. The Michaelson interferometer on the right, demonstrates Lego constructed optical table, and components that project interference fringes on the right.



But what's missing in scientific toys is a sort of fantasy that used to atract children and made them curious to learn more. Now they watch so many colorfull+musical scenary on their mobile phone that everything else diminishes in their appeal. This derail in toy business culture makes toys do things instead of the child doing something with the toy. In contrast with this approach, I think the most influential toy maker today is Playmobil, and for the same reason, I beleive the Lego optical table is also a good idea. Mr. Beck started this philosophy at Playmobil with his hand carved creations.

When we read Shell Silverstein's stories: "The missing piece meets the big O", for example, or "Lufcadio, the lion who shot back", we find that these stories reach us deeper home as adults than they would for children. As adults, we are not qualified to design children toys. I think it would be more honest to create scientific toys that would awaken our own inner child, but then sugar coat them to appeal to youngsters. In case of Shell Silverstein's books, it's his drawings that have that magical appeal to children, while his philosophical tales relate much deeper to the forgotten child within us.

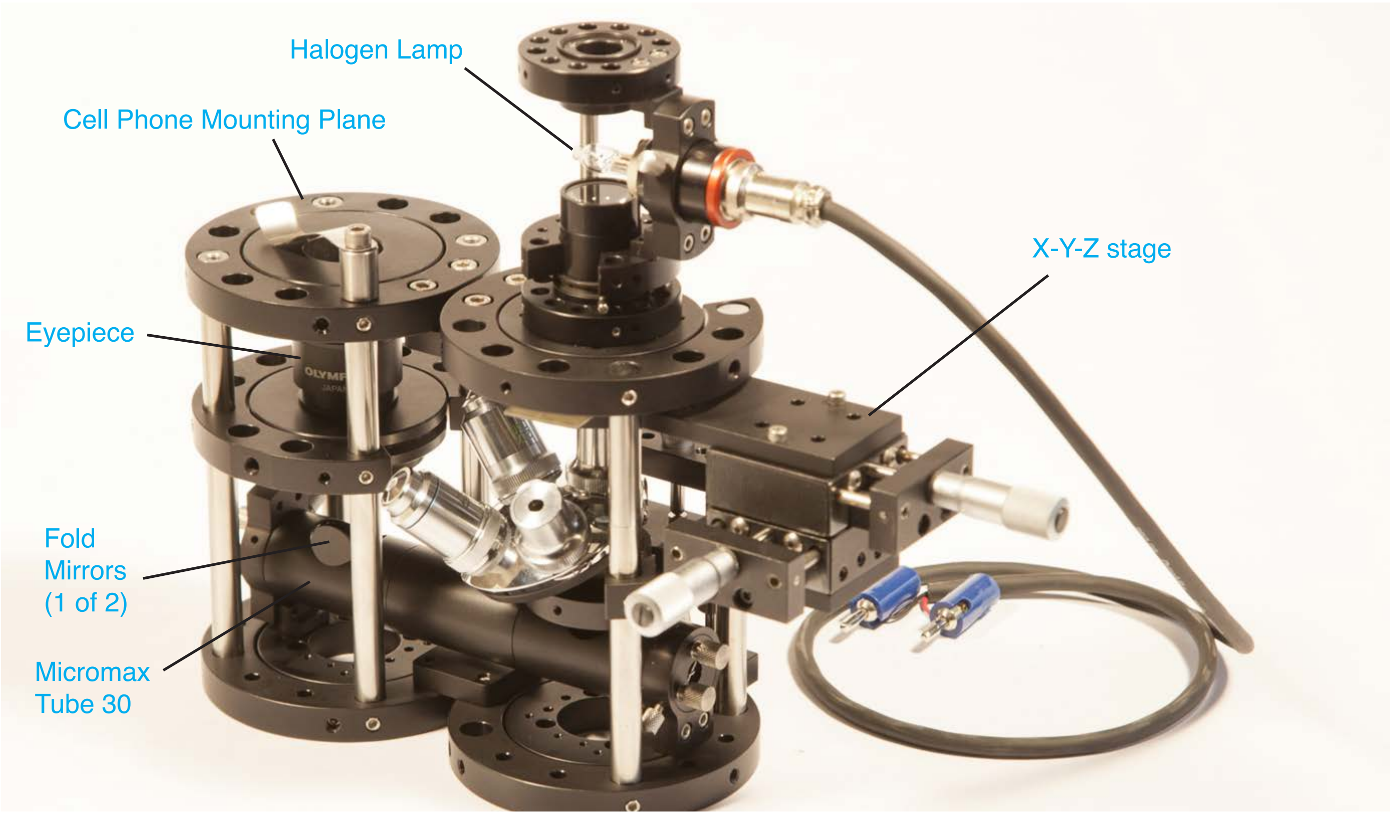
A Microscope for your Mobile Phone or Tablet

By Ali Afshari

In the last issue, I talked about the history of optical erector sets, and its progress to current state of art. In this issue, I will show you how to build an inverted microscope using Optoform. The same beam manipulation can be done with the cage system and Microbench, but I use optoform because it offers larger mounts to build the main body structure, and then use smaller mounts for beam manipulation. Recording an image through microscope is not easy. Even with user friendly cameras. You'd need a trinocular viewing head, plus a digital camera, and then a laptop to capture, and be able to display it.

With a cellphone camera, one can easily take digital photos, and there is no need to use external computers. You could zoom in for better focusing of image, take pictures, or videos, and you could immediately edit them, post them on social media, or email them. The idea is, you could always take photos through a microscope using your cell phone or tablet by adjusting its lens distance with the eyepiece. This distance, and its centration is crucial, and most of these images would come out vignetted, tilted, or decentered. When building a microscope with a cage system, you'd need two mounts to secure the objective, and the eyepiece at a distance of 150 mm from each other (standard tube length). For the cell phone, we could also add a third mounting plate to adjust its distance from the eyepiece. To accomplish this scheme, an inverted microscope would be the preferred arrangement because of its folded tube length. In the normal microscope, the setup would be standing too tall, and it wouldn't be following good rules of optomechanics both for lack of its stability, and user friendliness. So let's build this compact microscope, with inverted optics to make it super low profile. The cell phone could then be placed flat on its platform, and easily centered for taking pictures.

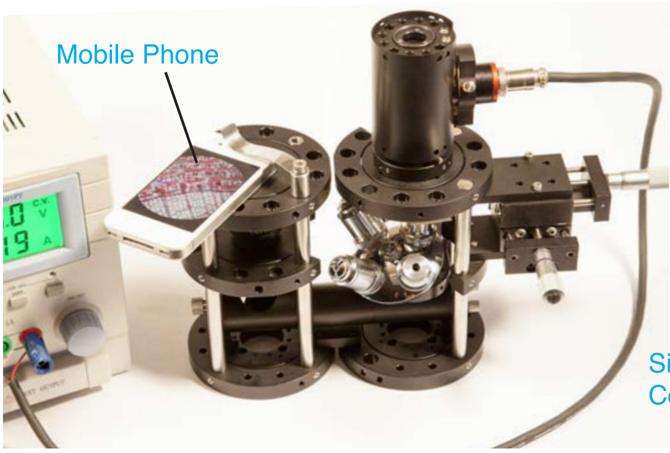
The ideal mount to build this assembly would be to use the Minioptic mount 100. This is because its half diameter is 50 mm, and this is 1/3rd of a standard 150 mm microscope tube length. Therefore, the beam could be folded twice using the Microptic mount 50 (see below) while the larger Minioptic 100 mounts would support the entire assembly.

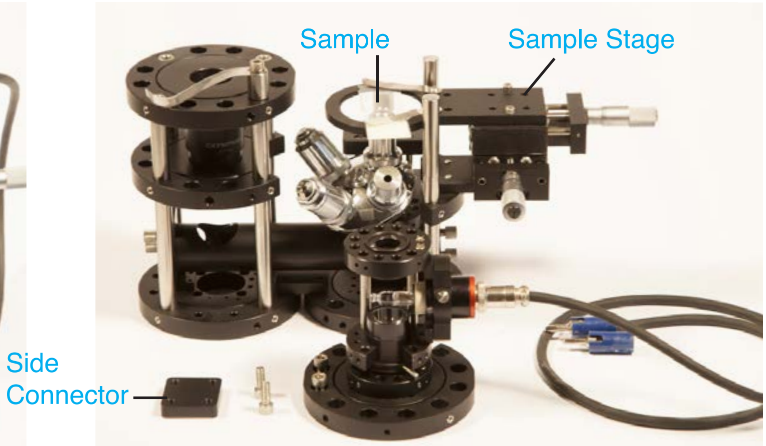


Design scheme of an inverted microscope built with Optoform system. The name Optoform refers to combining form, and function to build an optical instrument. Lamp cover has been removed to reveal condenser lens, and Halogen lamp.

If you notice, the side mounted orientation of mounts in our Optoform setup is arranged for all the hex screws securing the optics to be reachable for their centering adjustments. For square shaped mounts such as Microbench, or Thorlabs, the four-point mounting scheme prevents reaching the screws that are trapped in between the mounting plates. The idea behind using hex ball drivers in Optoform is to be able to reach hex set screws even at slightly tilted angles. In actual practice, you'd find that Allen set-screws can not be inserted easily if inserted from an angle. But after they are inserted, ball drivers would become so handy to adjust them.

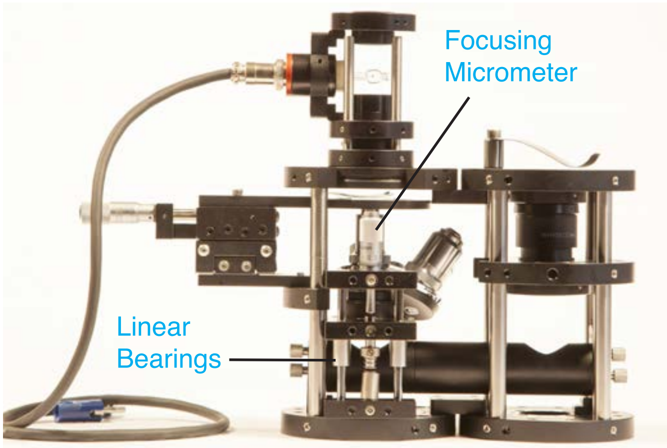
To conclude, Optomechanics is not an easy task. It takes skill, and general knowledge of natural laws governing nature. Knots, and bolts are a good thing! Take them away, and just like Legos, you'll have form but with no rigid function.

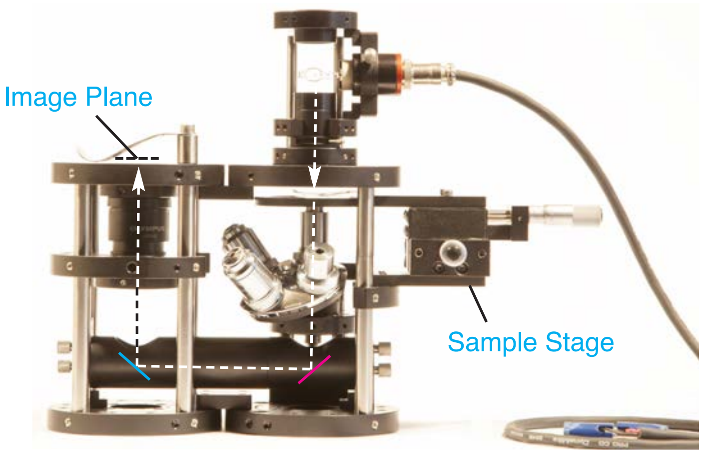




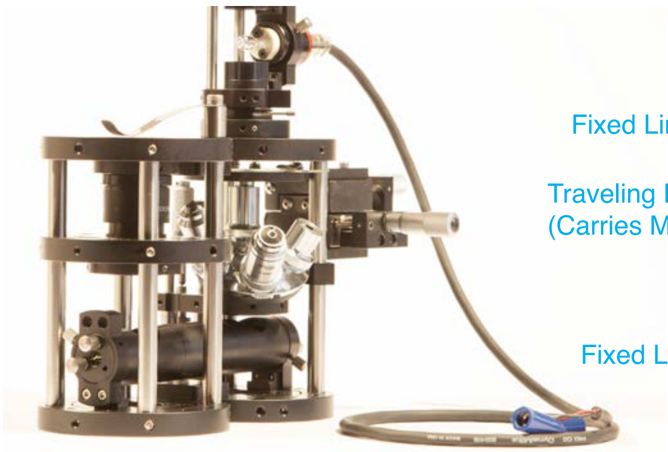
Mobile phone is shown seated above the eyepiece. The image can be centered, zoomed in, and captured.

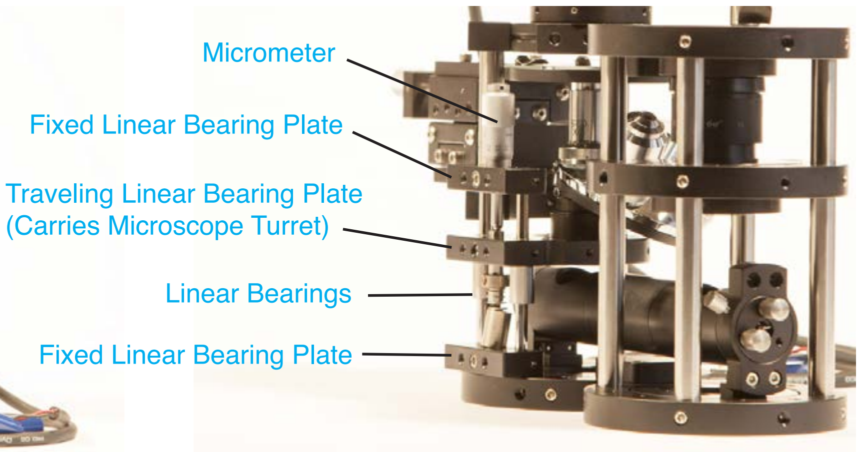
The illumination assembly is removed to reveal the sample holder platform.



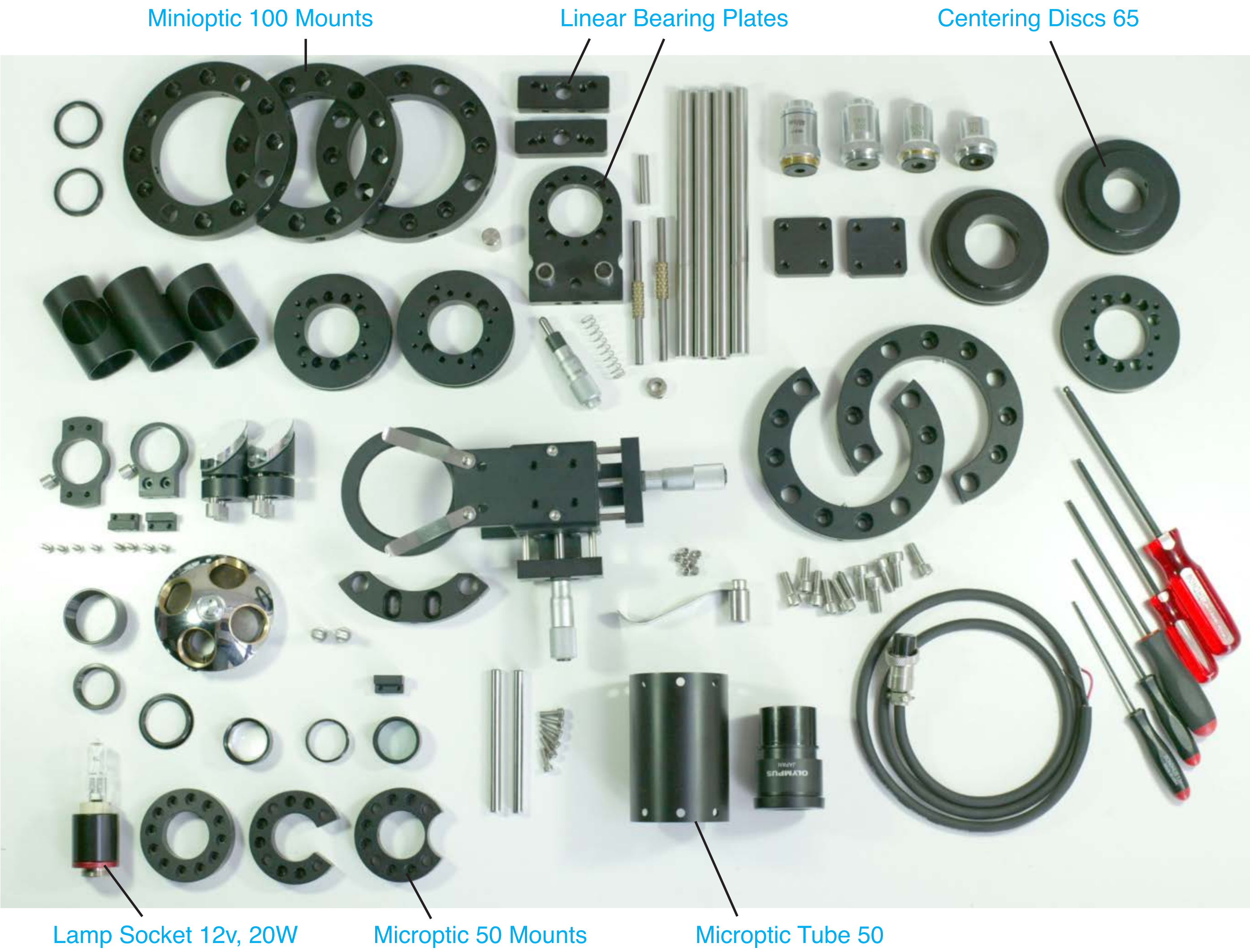


The light path is shown (above, left) emerging from the halogen lamp above the sample, passing through the sample, and reflected off of the first, and 2nd fold mirror, and going through the eyepiece to be focused by mobile phone camera.

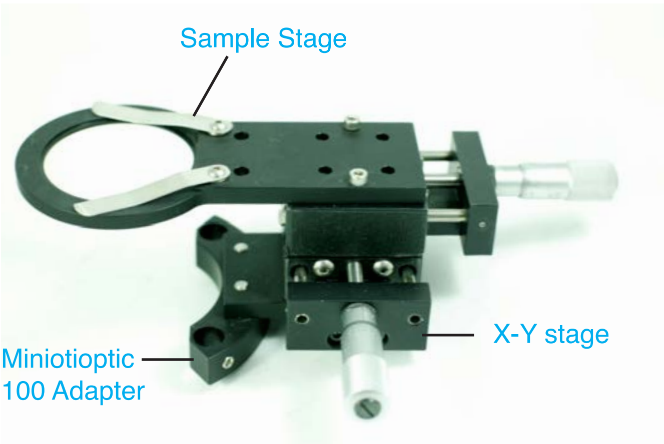


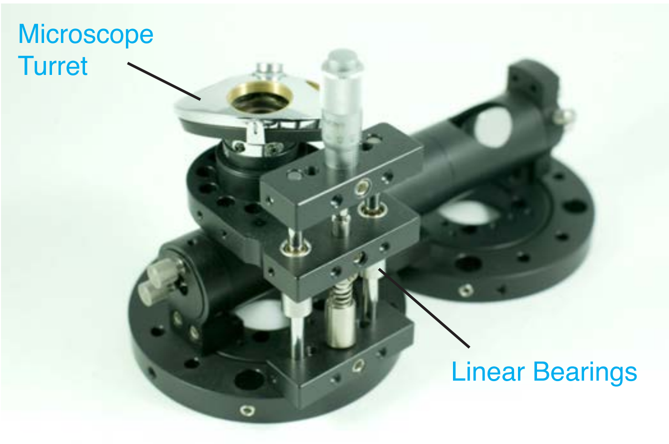


Linear bearing assembly for the Z-Axis is detailed here. The linear bearing is the haert of Optoform's flexibility. This particular assembly utilizes 12 mm Linear Bearings to handle the weight of microscope turret, with four objectives.



The parts list, and pricing for the inverted microscope assembly is available at optoform.com/microscopy. All the parts, and necessary optics are shipped together to the customer except the Microscope Objectives, and the eyepiece. The customer has the choice to add those at the time of placing the order. Microscope objectives have a diverse quality range from a few hundred Euros to a few thousand. The customer should decide the level of quality. The assembly time for the microscope is approximately 20 minutes, and at that point, the end user will become quite familiar with Optoform assembly, and how to change its configuration to build their own design. Additional parts, and accessories can also be added.





The X-Y stage is designed for Optoform's Miniotic system 100 (100 mm O.D. rings). The specimen holder has two securing spring plates, and has clearance for objective turret advancement. The X-Y stages is replacable with motorized stages, with the choice of 12.5 or 25 mm travel range.

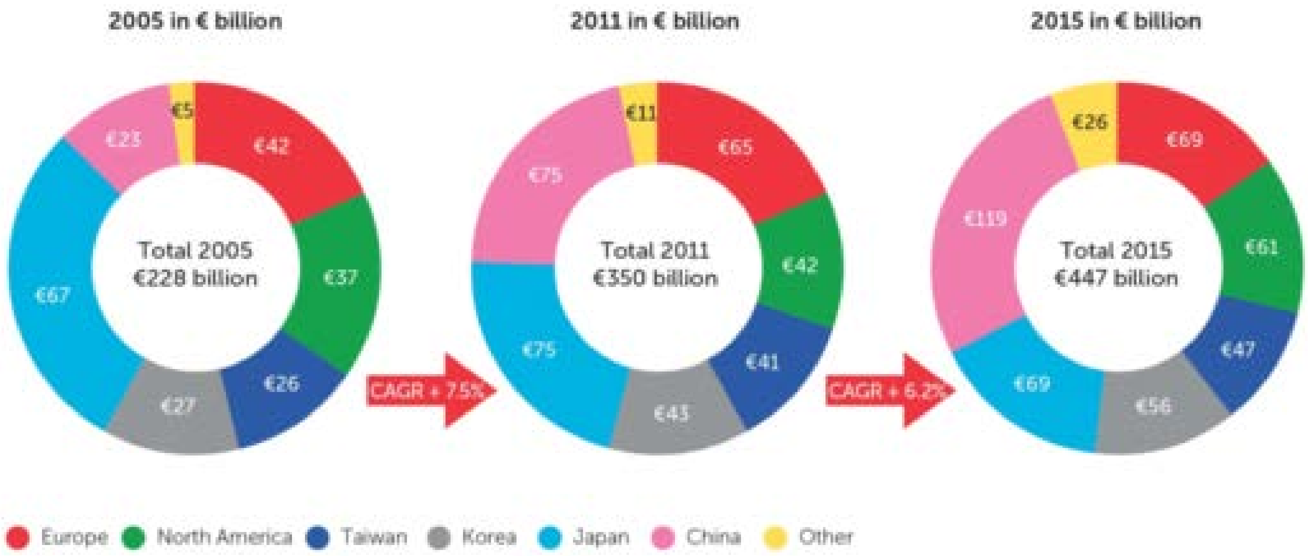
The microscope turret and fold mirrors are positioned in the compact space below the microscope body to reduce height. Thanks to the Z-stage with linear besrings, precise focusing can be achieved. The fold mirrors are covered with Micromax 30 tubing to keep away extraneous light away from the field of view of optics.

Photonics Market Forecast for Engineers

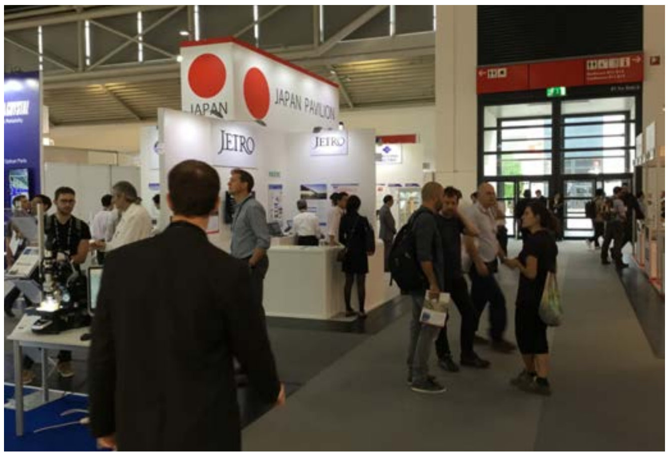
By Ali Afshari

According to final Photonics 2017 figures, there were 1,293 exhibitors from 42 countries, drawing 32,000 visitors, 90 percent of which traveled from outside of Germany to attend the Munich show. The top visitor countries were mostly from France, then UK, Japan, Switzerland, and USA. 60 percent of exhibitors were from outside of Germany.

According to Optec Market Research Study published by Photonics 21, Japan has experienced a significant share erosion in past 12 years, while China has gained Japan's share of the market. So far, China has the 22% share of the 500 billion Euros market while Europe has 18%, and japan has 12% of world market share (see also page 16). As one could easily notice out of these total figures, display technology has 27% of the market, information technology has 15%, while optical components have only 5% of the market share.

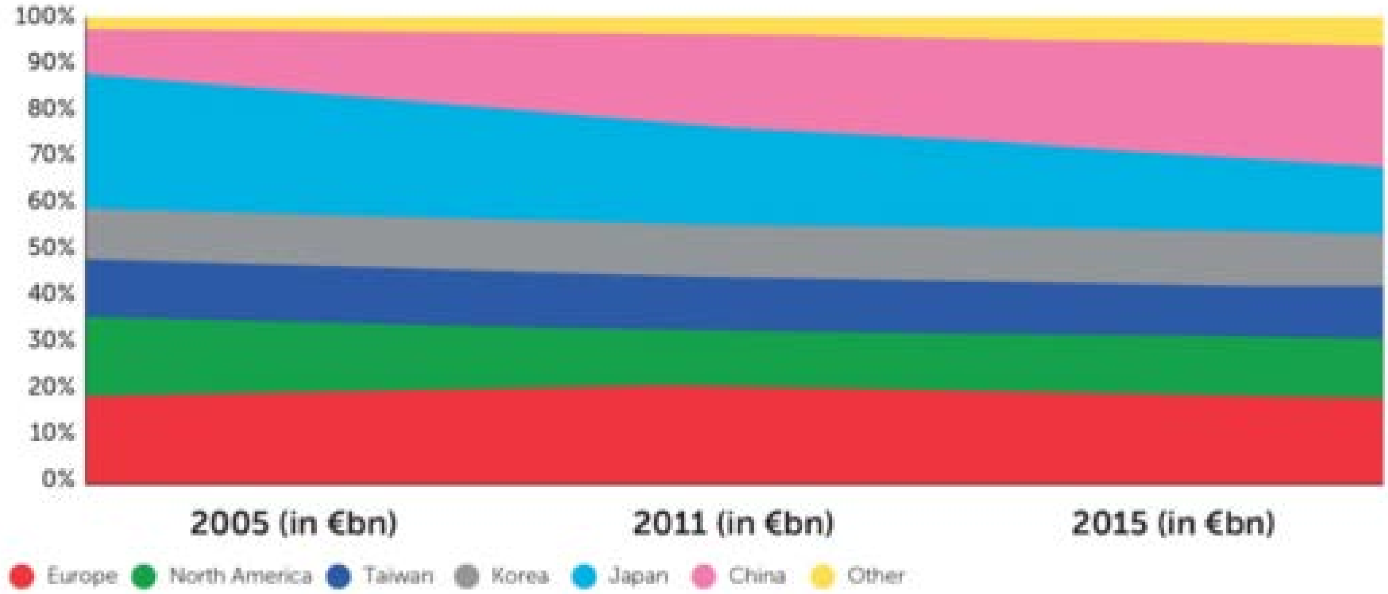


Production Volume on Ero Basis (including photovoltaics which is not subject of PPP) shows solid growth above global GDP: Photonics grew from a 228 Billion Euros industry to a 447 Billion Euros industry in 2015. Source: Photonics 21 market study research 2017. I love their colorful representation of economic charts, that are user friendly to engineers.



Impressive booths (left), dominated the World of Photonics show in 2017. Japan's pavilion (right), many Japanese companies like Toshiba were slow in their R&D, and lost the laser diode market share to much less quality "made in China".

Photonics industry grew from 228 Billion Euros in 2005 to 447 Billion Euros in 2015 (an annual growth of 6.2%). Displays, and information technology have had the largest increase during these 10 years while components has stayed in low bottom without much change. So to all optomechanics lovers, our market share is the lowest (only 5%) of the world market. So many companies I have visited, who sell optomechanics, have a department for information technology to grab a part of its high market share. I visited Laser 2000 this year in Munich, and as expected, they also had a good portion of their building allocated to supporting this market.

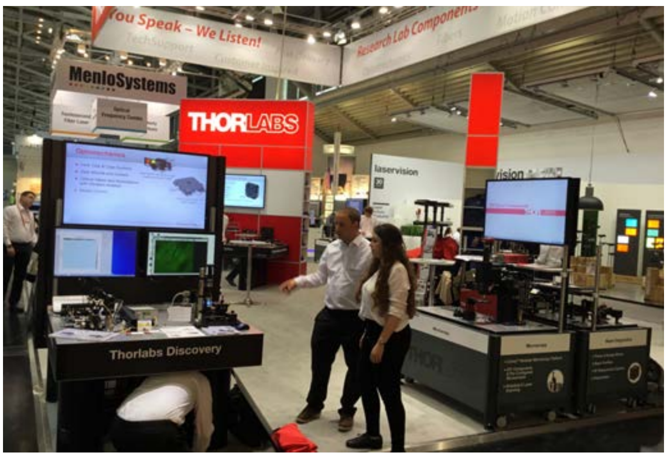


Market share comparison between 2005 to 2015 revealing China's growth vs Japan's decline. Source: Photonics 21

Laser 2000 booth offered free snacks to all attendees entering the exhibition every morning.

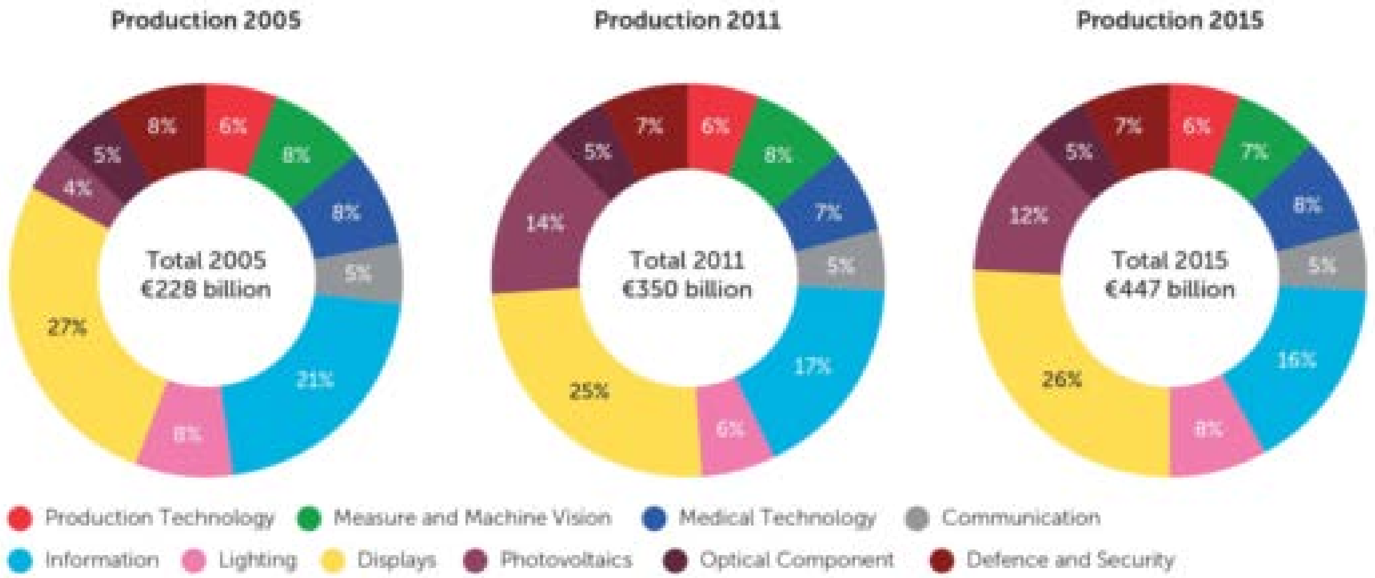
Qoptic booth displayed the Microbench system, still being published as the Linos Catalog.

Thorlabs MacDonald Concept, displayed along their products. Many students order from Thorlabs just to get snaks!



Thorlabs Booth at hall B1 with the over head statement: "You speak - we listen".

Display technology has been one of the three major technologies for Japan's economy (other two being automotive, and digital cameras). This year, China had a big stand to sell their displays to European market.

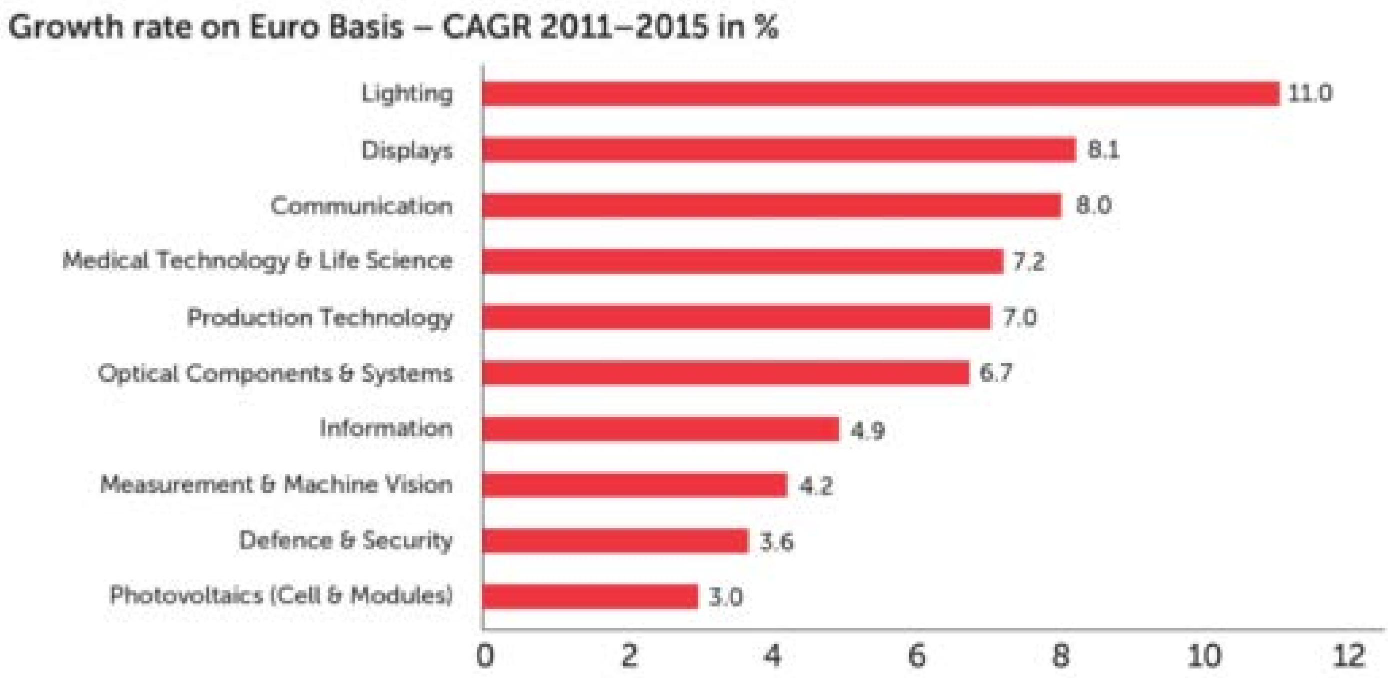


Development of various segments over time. Most fluctuation came from photovoltaics by information technology. Source: Photonics 21. Note the optical components market only occupies 5% of total market.

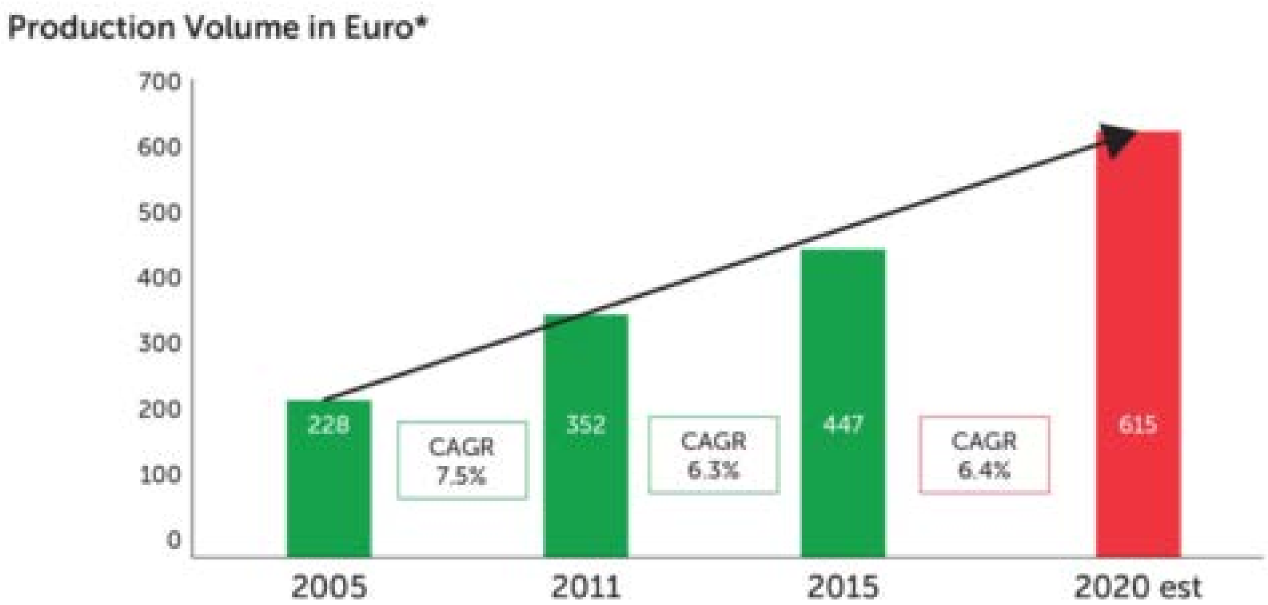
US pavilion costs extra, so many companies were scathered around the show. China, on the other hand, gives so many incentives to Chinese companies to be part of China pavilion. China occupied the back portion of halls B1, B2, and B3.

At OSA booth at the enterance hall way of the show. A Renticular 3-D logo of OSA was given away to visitors.

At PI booth with Lucius Amelung of Micos, maker of precision motorized stages.



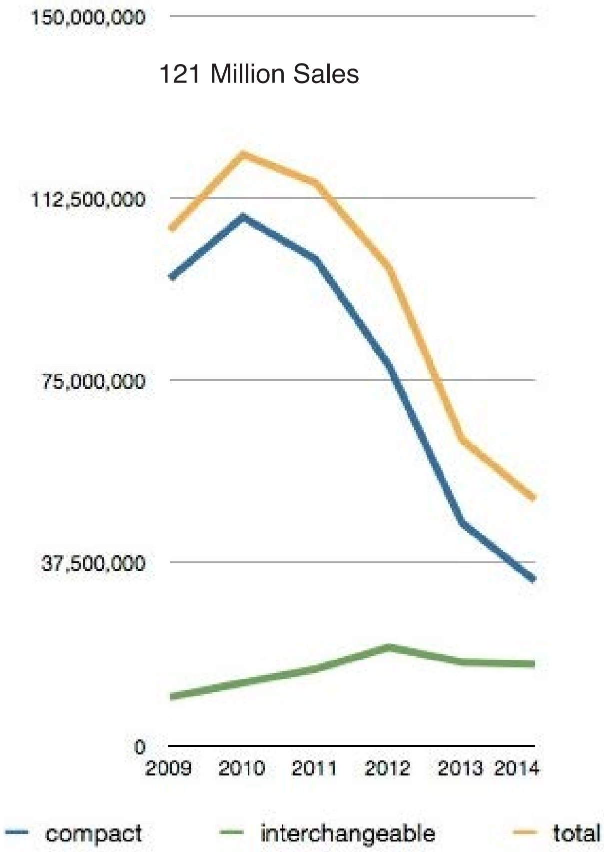
Market growth rate of various photonics segments. Source: Photonics 21. Note the optical components market with 6.7% in market growth, and lighting is by far, the most growing filed in photonics. This is useful in estimating sales forecast in the few upcoming years.

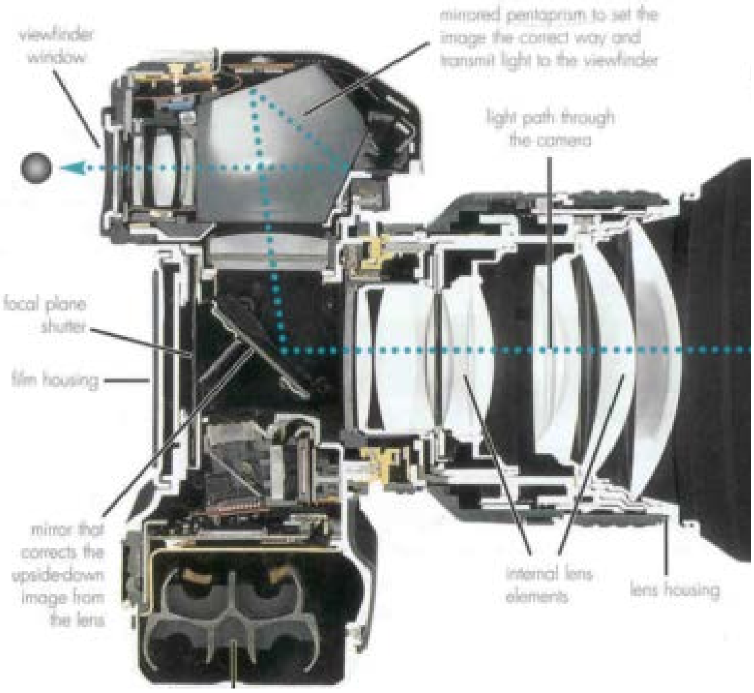


Long term photonics growth forecast until the year 2020. Source: Photonics 21. While the photonics market has a positive growth forecast, see the downfall of digital camera market since 2010, next.

Digital Cameras Sales Forecast, What happened to Konica, and Minolta?

Japan's Camera Sales drop in 5 years (opposite page) shows the real challenge in the industry. Historically, the German camera Leica, Swedish made Hasselblad, Japanese made Mamya, Nikon-F3, and Canon F-1 dominated the pro-photo industry, and just as the film camera industry had reached its highest point in 1996, Casio introduced its first commercialy available digital camera. The digital revolution started with Sony Mavica in 1981 but with a 0.3 MP image quality, and began what is known as one of Japan's three sacred treasures (other two are LCD Technology, and DVD recorder). At least the display technology is being challenged today by China. Chinese made LED display panels by CEDAR Electronics were showcased at Laser Munich 2017 at low prices with impressive dot size, and picture quality.





Canon's optomechancial design backed by Japan's micro-electronics success for over 70 years, broke record sales with their AE-1 in 1976. Their new domination in digital camera market is the culmunation of Japan's leading edge manufacturing.

As for digital cameras, Japan had 90% of the world market, but in 2000, digital camera sales dropped drastically, and many Japanese manufacturers could not make a profit. In 2005, companies like Olympus showed a loss of 23.9 Billion Jpy. The same year, Kyocera, who made point and shoot cameras that were rebranded by companies like Vivitar, discontinued their camera division. Konica, and Minolta who had joined earlier, had to shot down with a loss of Jpy 8.7 billion, and all their digital camera division was sold, and transferred to Sony. Sony bought their camera division for Jpy 20 billion to become a top digital SLR camera maker. Canon had made a similar strategic move in 1999 to acquire NKK Semiconductor in 1999 to fabricate their own sensors. For the surviving companies, 2010 was a top year for camera industry with over 121 million cameras sold world wide (above). In 2013 it was reduced to half, and in 2015 was cut in half

Mirrorless Cameras

Market Share of cameras in 2016:

DSLR Cameras	**13%**
Mirrorless Cameras	**34%**
Compact Cameras	**52%**

Worldwide Camera Sales in 2012:

Japan	**20%**
Asia	**11%**
Americas	**32%**
Europe	**33%**
Other	**4%**

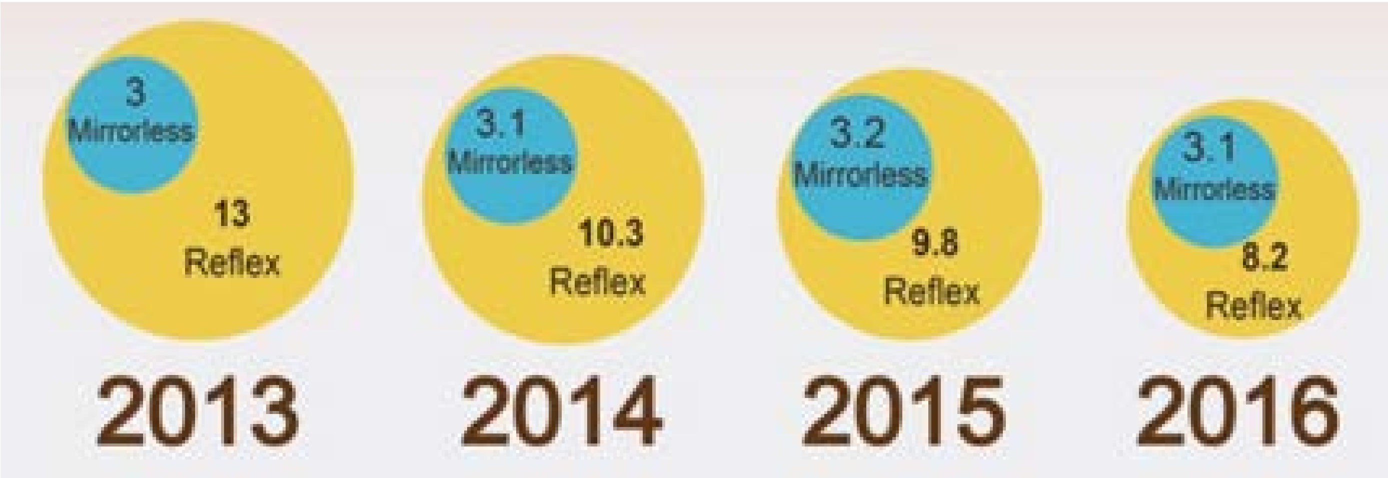
Source: Cameras Sales Data by Alan Griffith

again to only 31 million cameras, and in 2016 was dropped again to 23 million sales. This was mostly due to the decline in sales of compact cameras with non-interchangeable lenses. in 2012, the lens production was at its highest (31 million), and in 2016 it dropped to 19 million.

Smart phones killed the compact camera market with its global sales in 2016, reaching 1.4 billion units. Cameras have become a nostalgic passion of older people! The younger generation are far less interested in photography as a professional hobby, so smart phones are getting better, and replacing even DSLRs. According to Reuters, Nikon announced $222 million loss in sales as high-end camera market stalls, and is laying off 1000 workers.

The forecast for 2017 for digital cameras is around 20 million total sales. Cinema cameras such as RED, and Alexa will experience a great challenge in the coming years. The 4K revolution started with RED-One in 2007, and RED became a Leica or Hasselblad for cinematographers. In 2009, Red introduced their iconic camera design, the Epic, and played hard ball to challenge the giant Sony. With introduction of Blackmagic in 2012, and Sony's F55 in 2013, RED dropped its price from $40K to nearly half to stay in business.

In a second marketing move that displeased many of its devoted users, RED discontinued their upgrade for the 5K Epic line, to promote their new 6K Dragon cameras. Both RED, and Arri are being challenged today because so many film makers think the name brand is really for big budget Hollywood studios, and they could do the same job with Canon 5D Mark III, and C300, or Panasonic HC-X1000.



Digital Camera sales figures in $M shows the decline of the pro-camera sales while the mirrorless is unchanged. Source: CIPA (Camera & Imaging Products Association).

Canon acquired NKK Semiconductor in 1999 to fabricate their own sensors. 14 years later, Canon's C300, and C500 cameras were a big hit at the NAB show with ISO 25,000 sensor for their ability to shoot at low light.

5K RED Epic (right, introduced in 2009), and Sony PMW F55 camera (left, introduced in 2013) went head to head in pro-cinema market. In just four years after it's introduction, RED Epic price was dropped in half to compete with Sony. Many believe RED made its money in those few years.

Optical Testing and Repair for Iranian Cinema

By Ali Afshari

Iranian cinema has flourished in past 50 yeas with big names like director Abas Kiarostami, and two recent Oscars won by Asghar Farhadi. While most studios owned their own equipment in the past, camera rental houses have been around for more than 50 years, and they know almost everything there is to know about the cinematography market. The cinema rental houses have made their fortune in support of Iranian cinema while government owned Farabi, who had supplied most of the gear to Iranian film makers for past 34 years was recently forced to close its doors. All the camera, and lens

Bashirzadeh stands next to his certificate from Zeiss. “We had to change our direction to meet market demands.”

Arri Alexa remains to be the most popular camera in Iranian cinema, with currently around 60 Alexas being rented.

Zeiss proudly displays its Compact Prime lenses at NAB show (left) because it covers new full frame sensors. The sensor size of RED cameras (right) kept increasing as the Resolution went up from 4K to 5K (Mysterium), then to 6K (Dragon), and then 8K (Helium), while 36 MP Nikon D800, and Sony F65 (8K) maintained their sensor size as resolution increased.

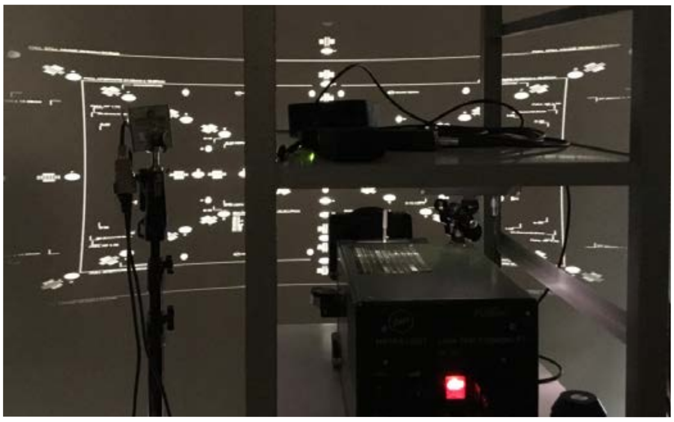
rentals are now in the hands of private owned rental houses. While Arri Alexa, RED Epic, Sony F55 have been typically available from rental houses, Canon 5D Mark III, and C300 have singlehandedly changed the marketplace. This all began with the introduction of RED One camera priced around $18K, and it changed all the rules in the business. Film makers could do a lot more at a lot less.

For the high-end market, the race between RED, and Arri has favored Alexa in Iranian cinema, while RED sales have stagnated behind. In spite of RED camera's high resolution sensor, it hasn't been popular because most film makers weren't happy with camera's user interface. "It wasn't an easy camera to work with," Says Mr. Aladpoush, an experienced camera man, who has worked for many years in Iranian cinema. "Alexa's functions are much easier to set, specially when it comes to setting colors. With a color chart, I could never get it right with RED." After the digital era began, the number of rental houses have dramatically increased in Iran, and today, around 60 Alexas circulate in Iranian movie industry with less than 15 RED cameras that are mostly used at weddings. Along with these cameras, are Zeiss Compact Primes, Ultra Primes, and Master Prime lenses that the movie industry has been using. There are also Cooke optics, and Angenioux depending on a director's personal taste. Iranian cinema has been most up-to-date with its gear, and older Zeiss Super Speeds (pre $25,000 Master Primes) have practically banished from the scene.

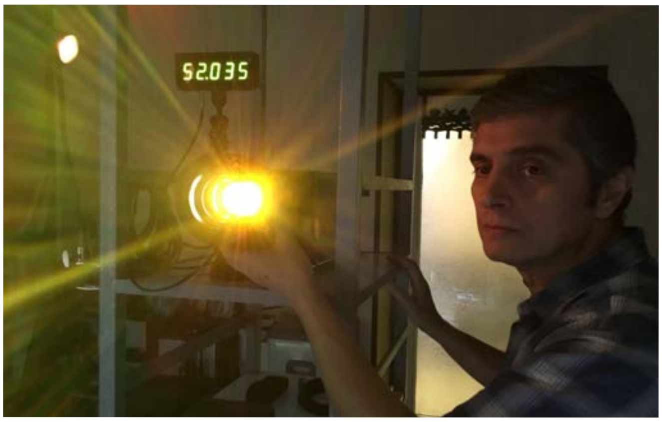
The success of Iranian cinema industry has created the need for highly equipped service centers for their evaluation, testing, and repair. To respond to this need, PD Cine rental house opened its optics shop with the most up-to-date test equipment to check optical performance such as resolution, collimation, and MTF measurements, etc. Evaluating optics for cinematography is really an art. This is because optical characteristics of cine lenses are not just evaluated by their resolution, and MTF tests alone. PD Cine has been in business for 10 years, and has regularly been visited by cinematographers who express their expectations of lenses, and their preference on their optical properties. The right way of using optics, and proper training in use of cameras is essential, and there are also training sessions to cover these areas. Today's digital cinema lenses are designed with higher resolutions in mind. The projection target for the film era had up to 200 lines of resolution lines and today's lens projectors can have the same resolution for testing 5K optics.

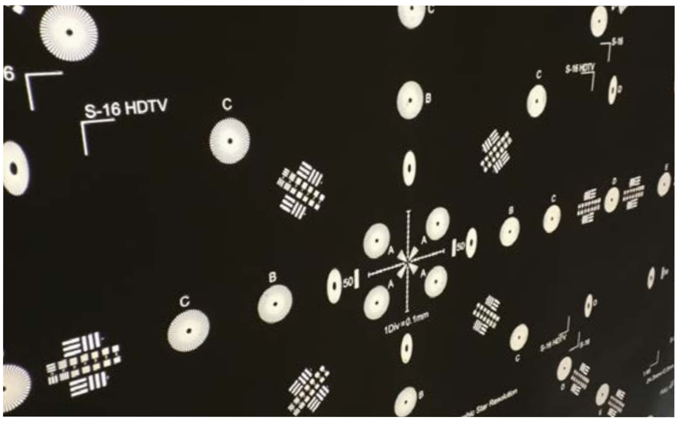
Optical testing is also needed after the lenses are serviced. Iranian cinema industry intends to do everything in house, from lens element replacement, to assembling, and alignment of all elements. For any lenses survived from the film era,

A zeiss Master-prime is installed on Cooke cine projector for direct reading of its lines of resolutuion, and contrast.



An Anamorphic lens test shows pincusion distortion, and visible chromatic abberation, and defocus on the corners.



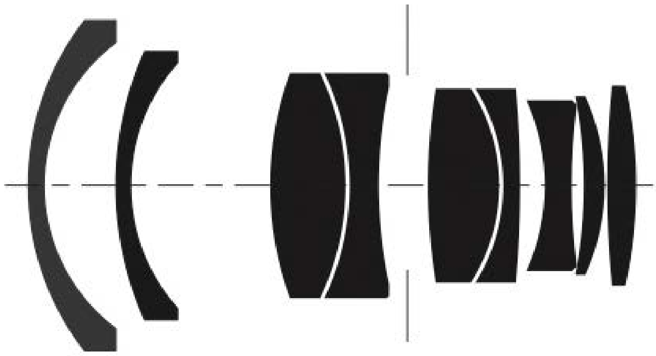


The current lenses designed for 6K, and 8k cinema, require higher than 200 lines/mm test targets that were good enough for 2K/4K/5K optics. The 8K cinema has not been accepted by Iranian film makers yet as a useful or practical format.

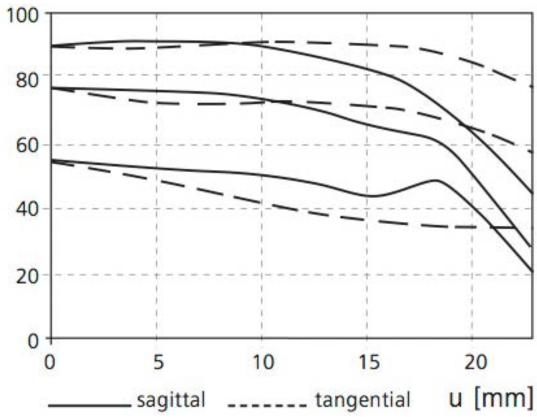
scratched elements are re-polished, and re-coated to keep them going. Cinema lenses for digital age are pricy, and at this center, there is a good collection of cinema optics for buyers to test, and make educated decisions before purchasing new lenses. There is also the more expensive line of Amorphous lenses that can be tried before purchasing.

The initial steps at a lens testing lab are lens cleaning, checking its mechanical alignment, and smoothness of controls. Careful lens cleaning with disposable tissues, and proper cleaning with adequate solvents would come first in lens maintenance. If the lens has been in desert, the first step would be to dust off the sand particles without allowing them to get into the optics. The next step is to view its projection in the darkroom with a resolution projector. Pearl Lens Tester was the standard instrument of the trade, and back in the years that I worked for Vivitar, that was the tester we used. Pearl Lens Projector was also one of the essential tools at Popular Photography's test lab where they are still testing lenses, and publishing their lens test reports. For today's lens testing, I expected a higher line resolution test target but to my

Hossein Jalili testing a Zeiss Master Prime lens with Carl Zeiss tester to verify its MTF performance at PD Cine.



Optical design of Zeiss Compact Prime 35 mm f/2 with 9 elements. Focus range is from infinity to 30 cm.



MTF of Zeiss Compact Prime 35 mm at f/2. MTF is as high as 92% at center, and decreases towards the edges.

Zeiss Compact primes use the same optical elements as their ZE lenses for Cinema use, now being re-designed.

$25K
T1.3

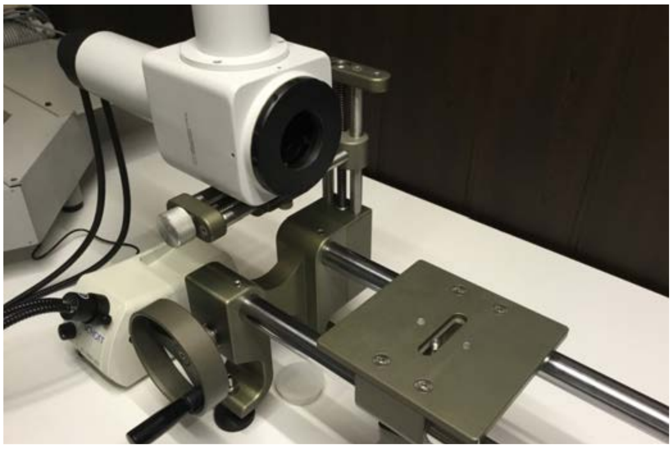
$16K
T1.4

$5K
T2

Zeiss Ultra Primes above, are the work horse in cinema lenses, with an average cost of $16,000. They fall in mid price range among other Zeiss optics, displayed in the mid row at the Zeiss booth (right) at NAB show. Master Primes, on the other hand (upper row), have an average price of $25,000, while Compact Primes, (lower row) cost around $5,000 each.

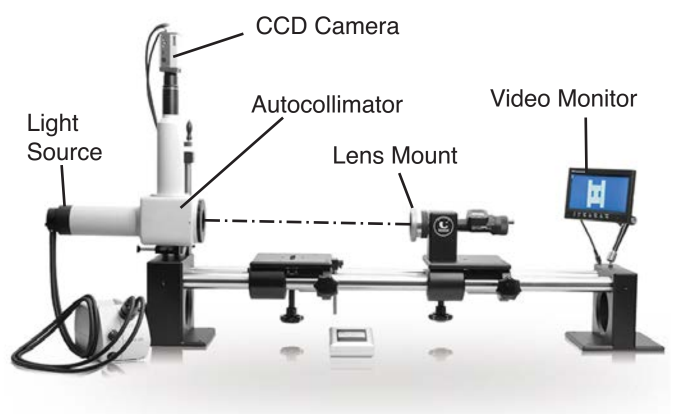
surprise, I found the same 200 lines per millimeter USAF target in their new Cooke projector as it is in our Pearl Projector back at OMiD museum. Some very useful features include motorized focus, and LED display of lens flange position. So many lens faults can be immediately found on the projection screen with the lens projector. Chromatic aberrations, image resolution, coma, pincushion or barrel distortion, and the the actual coverage of the lens. Older cine projectors such as Pearl covers 24.7x13.1 mm Super 35 format. The modern projector target size goes above 24x36 mm full frame format.

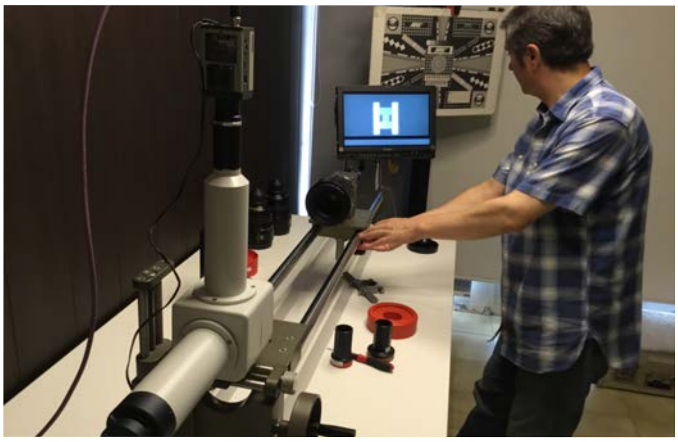
The second important test is MTF testing. PD Cine uses a MTF tester made by Carl Zeiss that measures the lens performance at its center. For those not so familiar with MTF testing, it is accomplished by projecting a number of lines/mm similar to a resolution target, but measuring their contrast on their line edges at the image plane. The line edges between bright, and dark on the test target are called a step function in optics. On the image plane, the step function ends up



Setting up the Gecko-Cam/Moller Wedel Autocollimator by precise centering of the optical projector with the test lens.

Setting the focus scale of test lens to infinity (left), and the back-focus mirror to zero (right). The non-rotating micrometer spindle has a flat mirror face to reflect back the autocollimator image to its CCD camera for infinity focus check.





For a new factory set lens, the two lines on the image are centered (above). Moller Wedel utilizes dual targets in the shape of an “**I**”, and “**I I**” that are focused to infinity. Any deviation in lens back-focus results in a shift in the targets at the image plane. The central target “**I**” also fades to too sharp or less sharp (less focused).

having less sharp edges with less contrast, and it gets worse as the number of lines/mm increase. The sharper are the line edges on the image plane, the higher is the MTF. Page 23 shows MTF across field of view of Zeiss CP2 at f/2.

The final test that is performed on the lens is on its optical collimation, or infinity focus. The Moller Wedel collimator uses two closely spaced targets: One looks like a capital “I”, and the other looks like a Roman number two “I I”. When the image is in perfect focus, both targets would line up, and be centered correctly “III” (opposite page) When the lens back focus isn’t correct, the central “I” on the video screen would move to the right or left. For any deviation from proper back-focus, the lens mount is taken off, and shims are added or taken off to correct it. As all the efforts are made to service cine lenses, and cameras at PD Cine, film makers could rely on their knowledge, and experience to make better films.

Examining the optics before disassembly.

Removal tool for a Zeiss Master Prime frontal lens ring.

Removing the PL mount on a Zeiss Master Prime lens.

Disassembling a Zeiss CP2 lens for general repairs.

Zeiss CP2 lens components taken apart on the lens mat: Zeiss no longer utilizes helical screws in their cine lenses. Helical guides are utilized instead to translate internal lens elements. This design change, makes lenses much lighter but at the same time, more valnurable to drops. A damaged helical guide can not be repaired. It can only be replaced.

Events Calendar

January 2017

Photonics West

US, San Francisco 01/30-02/01

February

Photonics Russia

Russia, 2/27-3/02

March

Photonics China / OFC

Shanghai, 3/14-16 /San Diego 03/13-15

April

May

CLEO

US, San Jose Convention 5/16-18

June

Laser Munich

Munich, Germany 6/26-29

July

Inustrial Export Russia

Yekateringburg, 07/10-12

August

Photonics San Diego

US, San Diego 8/6-10

China Optoelectronic Expo

China, Shenzhen 8/6-9

September

Photonics India

India, Deli 9/14-16

October

November

December