

Finger Lakes Instrumentation

A History of Engineering Excellence

Experience

Finger Lakes Instrumentation has been supplying high performance imaging solutions to a wide variety of markets for 20 years. We began designing and manufacturing cooled CCD cameras in 1998. We incorporated in 2000. Since that time we have shipped thousands of cameras to over 50 countries worldwide.

Our first cameras were designed for astronomy and astrophotography, but we soon found customers in other applications, including fluorescence imaging, TEM, chemiluminescence, x-ray, forensics, and spectroscopy.

We have designed CCD cameras for more than 50 different CCDs from ON Semi, e2v, Sony, Hamamatsu, and Fairchild. We currently manufacture cameras using more than 40 different CCDs. In January 2018 we introduced our first cooled scientific CMOS cameras. We also develop best-in-class accessories for imaging, including high speed filter wheels and precision focusers.

Customers

The majority of our sales are sold to life science instrumentation companies who integrate our cameras and filter wheels into their products. In the past, many customers saw FLI as an "astronomy camera" company because of the award-winning images taken by our astronomy customers. Astrophotography pushes the boundaries of image acquisition and processing and is ideal for showing the virtues of our cameras.

Electrophoresis gels and microtubing plates are not as photogenic. In addition, companies using our cameras in their products normally want to remain anonymous.

Sensors optimized for one market quickly find homes in other applications. Eliminating channel cross-talk in a multi-channel astronomy camera benefits life scientists using the same sensor. Increased frame rates developed for life scientists were quickly adopted for space-related applications needing higher time resolution.

Markets

Every FLI product is designed and manufactured in New York, USA. The majority of our products however are exported! We supply to OEMs in North America, Asia, the Middle East, and Europe. Our customers have the confidence to install our products in remote automated observatories from Finland to the equator to Antarctica, all around the globe.

FLI is ready to assist you with your camera requirements whether you need hundreds of cameras with consistent batch to batch performance or a single camera optimized for a unique application.

FLI is a registered trademark of IDEX Health & Science LLC.



Eta Carina, courtesy Wolfgang Promper. ProLine PL16803 Camera.

Cooled Cameras

Why Cool the Sensor?

Cooling improves the signal-to-noise ratio and minimizes cosmetic defects in sensors.

Kepler Cameras

FLI's new Kepler series of cooled cameras supports higher throughput, up to 35 channels, and a variety of new sensors, including scientific CMOS. The Kepler KL400 has high sensitivity (95% peak quantum efficiency) coupled with low noise (1.5 electrons) even at video frame rates. The KL4040 is a high QE front illuminated camera with a generous 52mm imaging diagonal. The game changing KL6060 will feature a 38MP, 87mm diagonal sensor (Q4 2019). The KL400 & KL6060 are available with front or back illuminated sensors.

Modularity

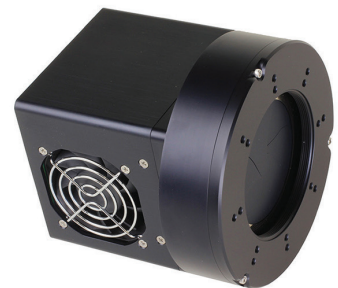
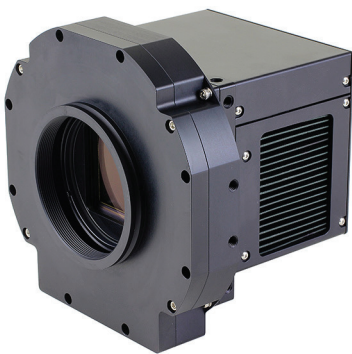
The majority of FLI cameras are exported; to minimize shipping costs, Kepler's shutter, fans, and digital board have all been designed to be user-replaceable.

ProLine CCD Cameras

ProLine cameras offer the deepest cooling of our standard cameras, and provide two power and two USB connections for FLI accessories. A complete imaging system (camera, filter wheel and focuser) can be controlled with a single power and USB cable from your PC. High and low data rates are optimized using independent analog to digital converters. Both the inner and outer chambers are sealed for harsh environments.

MicroLine CCD Cameras

MicroLine cameras cover a broad range of possibilities, from small interline transfer sensors with a C-mount front flange to the massive 50-megapixel ML50100. Despite being smaller and lighter than ProLine cameras, standard MicroLines cool within a few degrees of their larger sibling, and substantially deeper than competitive models. With the optional copper heatsink, MicroLine cooling meets or exceeds ProLine cooling. Smaller sensors have a shorter back focal distance than ProLine cameras. MicroLines support dual and quad channel readout with some sensors.



Kepler Cooled CMOS Cameras

One Giant Leap Forward

Higher Speeds, More Channels, New Sensors

Kepler is FLI's new series of cooled cameras, providing high throughput, high dynamic range, high quantum efficiency, and low noise.

FLI began shipping the Kepler KL400 and KL4040 cameras in 2018. Both models feature a high quantum efficiency, low-noise, high frame-rate cooled sCMOS sensor. The KL400 is one of the most sensitive cameras in existence (1.5 e- read noise, 95% QE). The KL4040 is a high QE front illuminated camera with a generous 52mm imaging diagonal. KL6060s feature a 37.7 megapixel, 87mm diagonal sensor, available front or back illuminated.

16-Bit Performance

For maximum speed, some Kepler cameras provide a single read at 12 bits. For 16 bit dynamic range, Keplers read twice at two different gains. The two images are merged using FLI's proprietary algorithms to create an exceptionally linear 16 bit image.

Optional QSFP Fiber Interface

USB 3.0 is the standard interface for Kepler cameras. The optional QSFP interface offers maximum throughput, long distance, and electrical isolation.

Simplified Service

For customer convenience, Kepler's shutter, fans, and digital board have all been designed to be user-replaceable. Camera firmware is field-programmable from anywhere in the world.

Extreme Reliability

FLI's proprietary sealing technology guarantees a long trouble-free life with no need to change or service desiccant packs or periodically pump down the camera.



KL400 with Optional 45mm Shutter

Camera Applications:

Orbital Debris Detection
ExoPlanet Research
Photocell Inspection

Software Support

MicroManager
MATLAB
LabVIEW
ASCOM



Kepler cameras include Pilot Control Software

Kepler Model	KL400 FI, KL400 BI	KL4040 FI, KL4040 BI	KL6060 FI, KL6060 BI
Sensor Type	Front & Back illuminated	Front & Back illuminated	Front & Back illuminated
Resolution	2048 x 2048	4096 x 4096	6144 x 6144
Pixel Size	11 x 11 microns	9 x 9 microns	10 x 10 microns
Imaging Area	22.5 x 22.5 mm	36.9 x 36.9 mm	61.4 x 61.4 mm
Sensor Diagonal	31.9 mm	52.1 mm	86.8 mm
Maximum Frame Rate	48 fps (24 fps HDR)	23 fps (QSFP)	FI 19 fps / BI 11 fps (HDR; QSFP)
Read Noise (High Gain)	FI 1.5 e- / BI 1.6 e-	FI 3.7 e- / BI 2.3 e-	FI 4.2 e- / BI 3 e-
Full Well Capacity (e-)	FI 120000 / BI 90000	FI 70000 e- / BI 39000 e-	FI 130000 / BI 100000
Dynamic Range (HDR)	FI 96 dB / BI 93 dB	FI 86 dB / BI 84 dB	FI 89 dB / BI 90 dB
Shutter	Rolling	Rolling (Both) / Rolling with Global Reset (FI Only)	Rolling
Peak QE	FI 58% / BI 95%	FI CMT 74% / BI 90%	FI 72% / BI 95%
Cooling	45°C Below Ambient	40°C Below Ambient	45°C Below Ambient
Dark Current @ -20C	FI 0.2 eps / BI 0.6 eps	FI 0.15 eps / BI 0.4 eps	0.1 eps

Specifications subject to change without notice.

Kepler Cooled CMOS Cameras

QSFP Kit

High Speed Interface for Kepler CMOS Cameras

FLI's QSFP (Quad Small Form factor Pluggable) high speed fiber interface provides up to 20 Gbits/sec data transfer for high resolution imaging at high frame rates.

The kit includes two transceivers, a 30m fiber optic cable, and PCIe interface card. One transceiver plugs into the back of Kepler cameras, and the other plugs into the PCIe card.

For the Kepler KL4040 camera, the QSFP Kit increases the potential frame rate from about 6 frames per second (fps) with USB 3.0 to 23 fps. The QSFP kit also allows for significantly longer and electrically isolated connections.

The QSFP Kit requires M.2 memory because of the significant amount of data being transferred. Typical SSD memory with a SATA connection does not provide sufficient bandwidth to use the full capabilities of the QSFP. If an M.2 connection is not included on the motherboard of the computer, a PCIe to M.2 adapter card is required which will use a second PCIe port.

Minimum Requirements

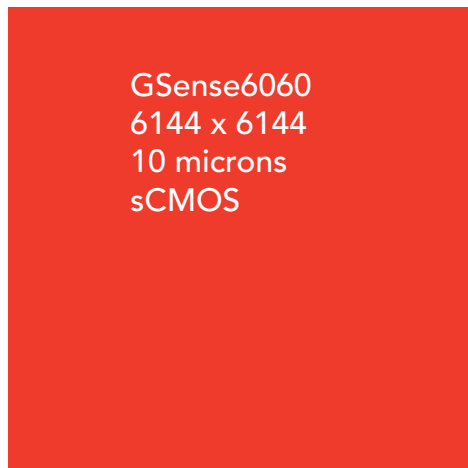
- Windows 10 x86 or x64
- FLI Pilot v1.2.90.110 or later
- 7th gen i7 Core CPU
- Motherboard with either {1 M.2 port and 1 PCIe port} or {2 PCIe ports}
- 1 PCIe to M.2 adapter (only required if the motherboard does not have an M.2 port)
- 250GB M.2 memory
- 32GB of DDR3 or DDR4 RAM



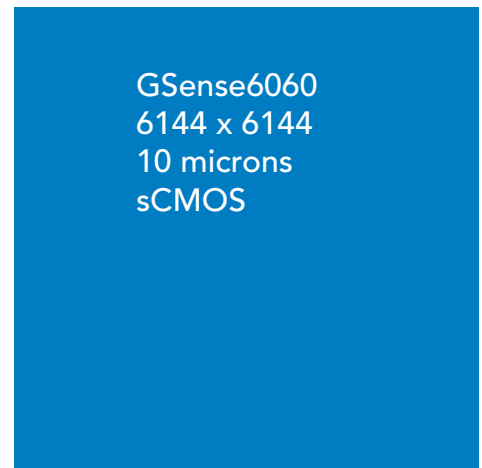
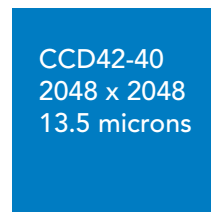
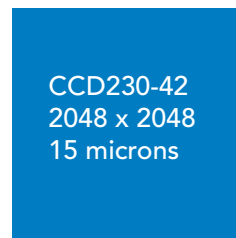
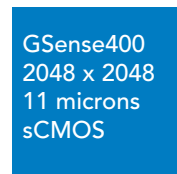
Supported Sensors

Sensor Source	Sensor	Sensor Type	Pixels X	Pixels Y	Pixel microns	Array Size (mm)		Area (mm ²)	Diag (mm)	Pixels	Full Well
						X	Y				
Front-illuminated Sensors											
GPixel	GSense6060	CMOS	6144	6144	10	61.4	61.4	3775	86.9	37.7M	135K
GPixel	GSense4040	CMOS	4096	4096	9	36.9	36.9	1359.0	52.1	16.7M	70K
GPixel	GSense400	CMOS	2048	2048	11	22.5	22.5	507.5	31.9	4.2M	120K
Interline Transfer CCDs											
Sony	ICX695	CCD	2750	2200	4.54	12.5	10.0	124.7	16.0	6.0M	17K
Sony	ICX285/825	CCD	1360	1024	6.45	8.8	6.6	57.9	11.0	1.4M	21K
Back-illuminated Sensors											
GPixel	GSense6060	CMOS	6144	6200	10	61.44	61.44	3775	86.9	37.7M	102K
e2v	CCD230-42	CCD	2048	2048	15	30.7	30.7	943.7	43.4	4.2M	150K
e2v	CCD42-40	CCD	2048	2048	13.5	27.6	27.6	764.4	39.1	4.2M	100K
GPixel	GSense400	CMOS	2048	2048	11	22.5	22.5	507.5	31.9	4.2M	92K
e2v	CCD47-20	CCD	1024	1024	13	13.3	13.3	177.2	18.8	1048K	100K
e2v	CCD47-10	CCD	1024	1024	13	13.3	13.3	177.2	18.8	1048K	100K

Front-illuminated Sensors



Back-illuminated Sensors



Interline Transfer CCDs



Sensors are shown actual size.

Cameras Under Development

The following cameras are currently under development.
Specifications below are preliminary. Please contact roclisales@idexcorp.com for current status.

Model	BL492	BL533	BL571	BL455	KL2020FI	KL2020BI
Sensor Manufacturer	Sony	Sony	Sony	Sony	GPixel	GPixel
Sensor Technology	CMOS	CMOS	CMOS	CMOS	sCMOS	sCMOS
Sensor	IMX492	IMX533	IMX571	IMX455	Gsense2020	GSense2020
Megapixels	46.4 Mp		27 Mp	61.2 Mp	4.2 Mp	4.2 Mp
Sensor Architecture	Back Illum.	Back Illum.	Back Illum.	Back Illum.	Front Illum.	Back Illum.
Shutter Type	Rolling; Global Reset	Rolling; Global Reset	Rolling	Rolling	Rolling	Rolling
Peak QE	90%	90%	90%	90%	72%	95%
Pixel Size	2.315 u	3.76 u	3.76 u	3.76 u	6.5 u	6.5 u
Array Size	8240 x 5628	3003 x 3003	6244 x 4168	9568 x 6380	2048 x 2048	2048 x 2048
Imaging Area	19 x 13 mm	11.3 x 11.3 mm	23.5 x 15.7 mm	35.9 x 23.9	13.3 x 13.3 mm	13.3 x 13.3 mm
Diagonal (mm)	23 mm	16 mm	28.3 mm	43.1 mm	18.8 mm	18.8 mm
Full Well	15ke-	50ke-	50ke-	50ke-	45ke-	54ke-
Bit Depth	12	12/14	12/16	12/16	Dual 12	Dual 12
Dark Current	0.0005 eps @ -10C	0.0002 eps @ -20C	0.002 eps @ -20C	0.0002 eps @ -20C	0.2 eps @ -20C	0.2 eps @ -20C
Read Noise	1e-	1 to 3.5 e-	1 to 3.5 e-	1 to 3.5 e-	1.6 e-	2.0 e-
Frame Rate	25 fps	27 fps	7 fps	4 fps	47 fps (HDR)	43 fps (12 bit)
Cooling	delta 45C	delta 45C	delta 45C	delta 50C	delta 50C	delta 50C
Interface	USB3	USB3	USB3	USB3	USB3	USB3

Filter Wheels

Leading Edge Accessories

All filter wheels use unmounted filters only. All use a stepper motor and magnetic Hall-effect homing device.

FLIFilter software is included in the FLI Software Installation Kit on <https://www.flicamera.com/software/index.html>.

For additional detail regarding mechanical specifications, please see drawings at <https://www.flicamera.com/cfw/index.html>

For most materials, subtract 1/3 of the thickness of any filter (e.g. subtract 1mm for a 3mm thick filter) as well as 1/3 of the thickness of any cover glass on the sensor.

Model	CFW2-7	CFW5-7	CFW9-5	CL-1-10	CL-1-14
Number of Wheels	1	1	1	2	2
Thickness ¹ (inch / mm)	0.822 (20.88)	0.85 (21.59)	0.595 (15.11)	1.10 (27.94)	1.10 (27.94)
Weight (lbs / kg)	2.9 (1.32)	4.3 (1.95)	3.2 (1.45)	4.3 (1.95)	4.3 (1.95) ⁷
Filter Positions	7	7	5	10 (8) ⁷	14 (12) ⁸
Filter Size ²	2" / 50 mm ⁵	50 mm SQ	65 mm SQ	50 mm SQ	2" / 50 mm
Filter Thickness	1-5 mm				
Camera Side	FLI Dovetail	FLI Dovetail	10-32 BP ⁶	CL ZTA	CL ZTA
Optics Side	2" 24 tpi	3" 24 tpi	M92-1	CL ZTA	CL ZTA
OBFD KL ³	36.4 mm	37.1 mm	30.6 mm	43.4 mm ⁹	43.4 mm ⁹
OBFD KL65 ⁴	41.7 mm	42.4 mm	35.9 mm	48.7 mm ⁹	48.7 mm ⁹

Notes:

1. Front to back thickness of the filter wheel excluding motor, in inches (mm).
2. Filters are round unless followed by SQ, indicating square.
3. KL OBFD = OBFD for Kepler camera with no shutter, 25mm shutter, or 45mm shutter with FLI dovetail + filter wheel.
4. KL65 OBFD = Optical back focal distance (image plane of CCD to optics side of filter wheel) for KL camera with 65 mm shutter.
5. Carousel will accept either 2" or 50 mm filters.
6. BP = bolt pattern. Mates directly to ProLine, MicroLine, or Kepler with optional front plate.
7. Because the carousels overlap, one position in each is normally left open. For example, eight + two open positions for the CL-1-10.
8. CL ZTA = CenterLine Zero Tilt Adapter™
9. Assumes CL ZTA flange on front of camera.

Kepler cameras with the standard FLI dovetail flange mate directly to the CFW2 and CFW5 filter wheels without adding back focal distance.

Kepler cameras with the CFW9 flange bolts directly to the CFW9.

Kepler cameras with the CL ZTA flange mate directly to the CenterLine CL-1-10 and CL-1-14 filter wheels without adding back focal distance.

Customers

Abastumani Observatory (Georgia) · Academia Sinica (China) · Adiyaman University (Turkey) · Adler Planetarium · Aerospace Corporation · Aiglon College (Switzerland) · Air Force Research Laboratory · Aix Marseille Université (France) · American Museum of Natural History · Anadolu University (Turkey) · Andor Technology (UK) · Andrushivka Observatory (Ukraine) · Appalachian State University · Argonne National Lab · Arizona State University · Artem Observatory (Russia) · Auburn University · Austin College · Australian Astronomical Observatory · Australian Defence Science & Technology Organisation (DSTO) · Australian National University · Azdeniz University (Turkey) · Baader Planetarium (Germany) · Baku State University (Azerbaijan) · Ball Aerospace · Ball State University · Beijing Institute of Technology (China) · Beijing University (China) · Binghamton University · Boeing · Boston University · Brigham Young University · Butler University · California Institute of Technology · Carl Zeiss Jena · Carlton University (Canada) · Carnegie Institution for Science · Carnegie Observatories · Catholic University of America · Centro de Estudios de Física del Cosmos de Aragón (Spain) · Center for Research and Advanced Studies of IPN (Mexico) · Charité - Universitätsmedizin Berlin (Germany) · China Academy of Space Technology · CICESE (Mexico) · City College of New York · Civil Aviation University (China) · Colby College · Connecticut College · Colgate University · Collepardo Observatory (Italy) · Colorado State University · Columbia University · Copernicus Foundation for Polish Astronomy · Cornell University · CSIR - Council for Scientific and Industrial Research (South Africa) · Cukurova University (Turkey) · Dartmouth College · DESY Deutsches Elektronen Synchrotron (Germany) · Drexel University · Duquesne University · Durham University (UK) · Edmund Optics · Embry-Riddle Aeronautical University · Emirates Mobile Observatory (Abu Dhabi) · Emory University · EOS (Australia) · ETH Zürich (Switzerland) · European Molecular Biology Laboratory (Germany) · European Neuroscience Institute · European Southern Observatory (Germany) · Food & Drug Administration · Florida International University · Fordham University · Freie Universität Berlin (Germany) · Fudan University (China) · Geneva Observatory (Switzerland) · George Washington University · Georgia Institute of Technology · Georgia Public Health Lab · Getty Museum · Gissar Observatory (Tajikistan) · Goodrich · Guang Xi University (China) · Harvard University · Hefei Institute (China) · Helmholtz Centrum Geesthacht (Germany) · Hitachi · Horiba · Howard Hughes Medical Institute · Humboldt University of Berlin (Germany) · Institute of Molecular and Cell Biology (Singapore) · Institut d'Astrophysique de l'Université de Liège (Belgium) · Institut de Planetologie et Astrophysique de Grenoble (France) · Institute of Astronomy, Hawaii · Institute of Fluid Physics (China) · Institute of Mechanics, Chinese Academy of Sciences (CAS) · Institute of Physics (CAS) · Instituto de Astrofísica de Andalucía (Spain) · Instituto de Astrofísica de Canarias (Spain) · Instituto de Estudios Espaciales de Cataluña (Spain) · IPICYT (Mexico) · ITT Space Systems · IUCAA Pune University (India) · Japan Aerospace Exploration Agency (JAXA) · Jenoptik · Jet Propulsion Laboratory · Johns Hopkins University · Karlsruhe Institute of Technology (Germany) · Kitab Observatory (Uzbekistan) · Konkoly Observatory (Hungary) · Kopernik Observatory and Science Center · Korea Astronomy and Space Science Institute (KASSI) · Krasnojarsk Observatory (Russia) · Langkawi National Observatory (Malaysia) · Las Campanas Observatory (Chile) · Las Cumbres Observatory Global Telescope Network · Lawrence Berkeley Lab · Lawrence Livermore National Laboratory · LG Electronics (South Korea) · Lick Observatory · Leibniz Institute for Plasma Science (Germany) · Lockheed Martin · Lohrman Observatory (Germany) · Los Alamos National Laboratory · Lowell Observatory · Macquarie University (Australia) · Maidanak Observatory (Uzbekistan) · Marine Biological Laboratory · Mauna Kea Observatory · Max Planck Institute (Germany) · Mayaki Observatory (Ukraine) · Mayo Clinic · McDonald Observatory · Memorial University of Newfoundland (Canada) · Miami University · Middlebury College · Milkovo Observatory (Russia) · Mississippi State University · MIT · MIT Lincoln Laboratory · Mondy Observatory (Russia) · Montana State University · Mt. Sinai School of Medicine · NASA Ames · NASA Goddard · NASA Johnson · National Astronomical Observatories of China · National Astronomical Research Institute of Thailand/NARIT · National Institute of Aeronautics and Space (Indonesia) · National Institute of Health · National Renewable Energy Laboratory · National Taiwan University · National University of Ireland · Nauchnyy Observatory (Ukraine) · Naval Ordnance Test Unit · Naval Research Laboratory · New Mexico State University · New Mexico Tech · New York State Dept. of Health · New York University · Nikon · NIST · Northrop Grumman · Northwestern Polytechnical University (China) · Northwestern University · Novosibirsk State University (Russia) · Observatoire de Ouakmeden (Morocco) · Observatorio Astronómico Nacional (Bolivia) · Observatory Hamburg (Germany) · Olympus · Oxford University (UK) · Palomar Observatory · Paul Scherrer Institute (Switzerland) · Pennsylvania State University · Physical Research Lab (India) · Pontificia Universidad Católica de Chile · Princeton University · Pulkova Observatory (Russia) · Purdue University · Purple Mountain Observatory (China) · Qatar Foundation · Raytheon · Reial Acadèmia de Ciències i Arts de Barcelona (Spain) · Rheinisch-Westfälische Technische Hochschule (Germany) · Rochester Institute of Technology · Royal Melbourne Institute of Technology (Australia) · Sandia National Laboratories · Sanglok Observatory (Tajikistan) · Scripps Research Institute · Seoul National University (South Korea) · SETI Institute · Shan Dong University (China) · Shanghai Institute of Technical Physics (China) · Shanghai Observatory (China) · Shumen University (Bulgaria) · Siding Spring Observatory (Australia) · Siemens · Simon Fraser University (Canada) · SLAC National Accelerator Laboratory · South African Large Telescope (SALT) · St. Francis Xavier University (Canada) · Stanford University · STFC (UK) · Sydney University (Australia) · Tarleton University · Technical Universities of Darmstadt, Dresden, and Ilmenau (Germany) · Technion University (Israel) · Tel Aviv University (Israel) · Tenagra Observatories · Terskol Observatory (Russia) · Texas A&M University · Texas State University · The Ohio State University · Tiraspol Observatory (Moldova) · Tubitak National Observatory (Turkey) · Turksat University (Turkey) · Tuskegee University · Universidad Nacional Autónoma de México · Universidad Nacional de La Plata (Argentina) · Università di Roma (Italy) · Universitat de Barcelona (Spain) · Universitat de València (Spain) · Université de Montréal (Canada) · Universiteit Leiden (Netherlands) · Universities of Alabama, Alaska, Arizona, California, Central Florida, Chicago, Hawaii, Illinois, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Nevada, New Mexico, North Carolina, North Dakota, Notre Dame, Pittsburgh, Rochester, South Carolina, Texas, Virginia, Washington, and Wisconsin · Universities of Bremen, Duisburg, Freiburg, Göttingen, Heidelberg, Kiel, Konstanz, Magdeburg, Potsdam, and Würzburg (Germany) · University College Dublin (Ireland) · University Observatory Munich (Germany) · University of Bern (Switzerland) · University of Bradford (UK) · University of Calgary (Canada) · University of Dresden (Germany) · University of Jena (Germany) · University of Lethbridge (Canada) · University of Munich (Germany) · University of the Pacific · University of Quebec at Montreal, UQAM (Canada) · University of Newcastle (UK) · University of Queensland (Australia) · University of Toronto (Canada) · University of the Virgin Islands · University of Warwick (UK) · University of Western Australia · University of Western Ontario (Canada) · Upsilon Observatory (Czech Republic) · UPJS Institute of Physics (Slovakia) · US National Park Service · Ussurijsk Observatory (Russia) · Utah State University · Uzhgorod Observatory (Ukraine) · VA Hospital San Francisco · Victoria University of Wellington (New Zealand) · Virginia Tech · Washington and Lee University · Washington University in St. Louis · Wayne State University · Western Kentucky University · Wheaton College · Whitehead Institute of Biomedical Research · Whitman College · Williams College · Xi'an Institute of Optics and Precision Mechanics of CAS (XIOPM) · Xi'an University of Technology (China) · Xidian University (China) · Yale University · YBJ Observatory (Tibet) · Yunnan Observatory (China) · Zvenigorod Observatory (Russia)