ERAF projekts Nr.1.1.1.1/16/A/259

ERAF projekta zinātniskās grupas vizīte ASV

2018.gada 3. - 22. aprīlis

10.05.2018. LU ASI seminārs

Aigars Atvars

NACIONĀLAIS ATTĪSTĪBAS PLĀNS 2020

EIROPAS SAVIENĪBA
Eiropas Reģionālās attīstības fonds

IEGULDĪJUMS TAVĀ NĀKOTNĒ

Saturs

1. Losandželosas apgabals
2. Kalifornijas Universitāte Losandželošā
   - Chee Wei Wong grupa, laboratorija
   - Chee Wei Wong pētījumi
3. NASA Reaktīvās kustības laboratorija
   - Ivana Grudinina pētījumi
4. Mājupceļš

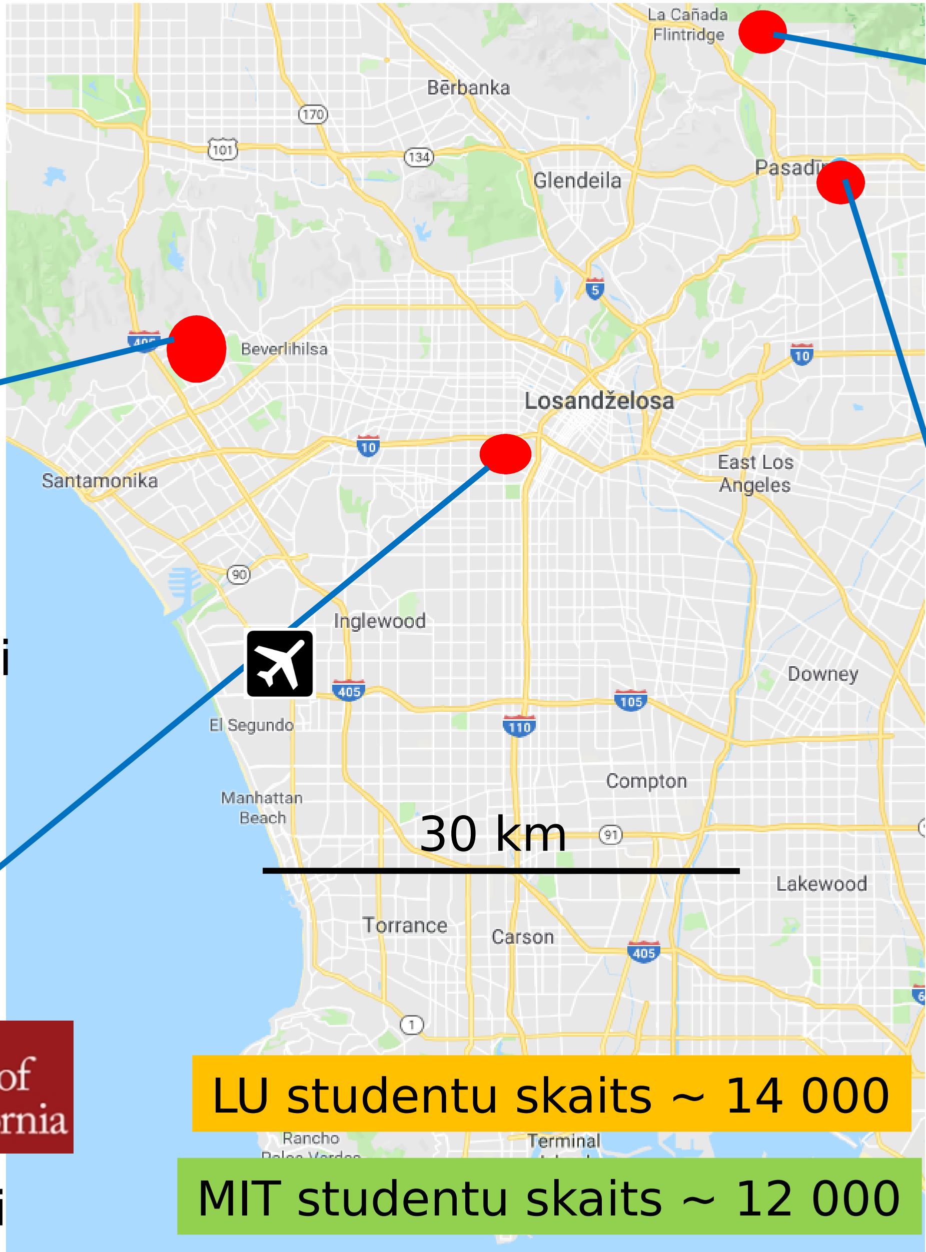
Losandželosas apgabals (~ 13 MILJONI CILVĒKU)

University of California Los

~ 45 000 studenti

University of Southern California (Armani)

~ 44 000 studenti



LU studentu skaits ~ 14 000

MIT studentu skaits ~ 12 000

NASA
Jet Propulsion Lab
~ 15 000 darbinieki

California Institute of Technology

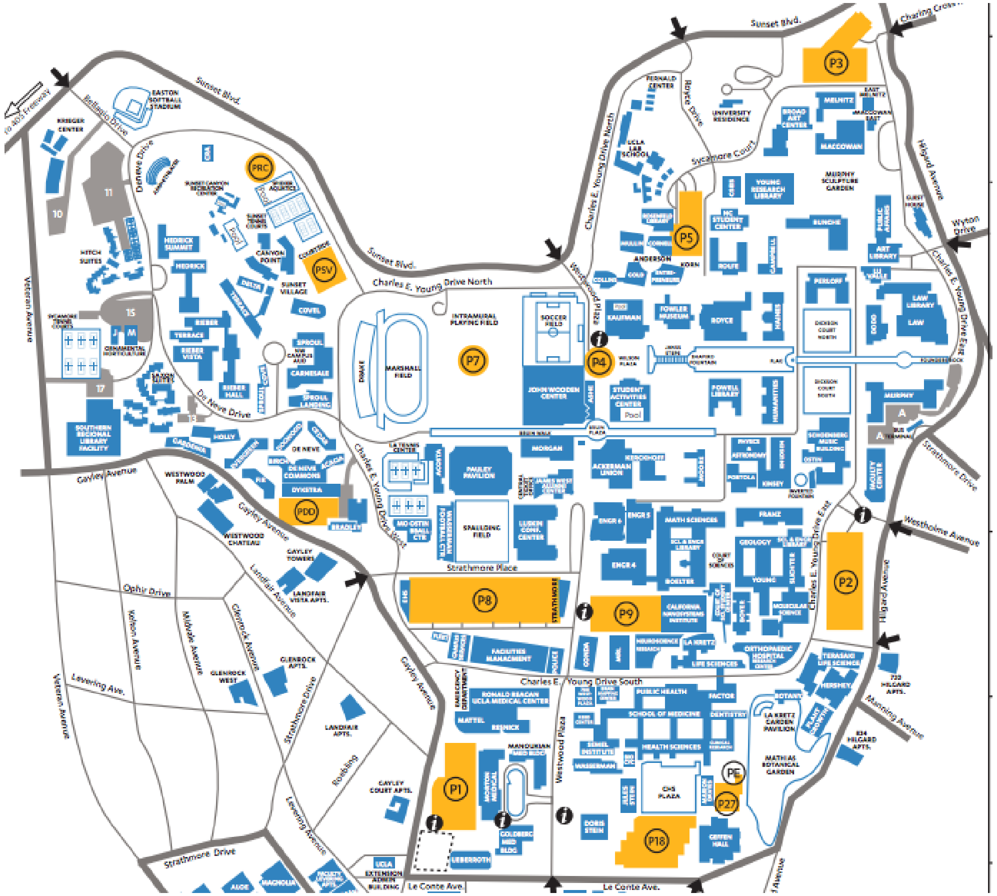
~ 2 300 studenti

Kalifornijas Universit
Losandželošā

~ 45 000 studenti

University of California Los Angeles

UCLA



Vidējā alga universitātē: $64 138
Vidējā alga Losandželosā: $62 563
~ 4 416 EUR/mēnesī

https://www.payscale.com/research/US/Location=Los-Angeles-CA/Sala

University of California Los Angeles,
http://www.ucla.edu/

Electrical and Computer Engineering Department,
https://www.ee.ucla.edu/

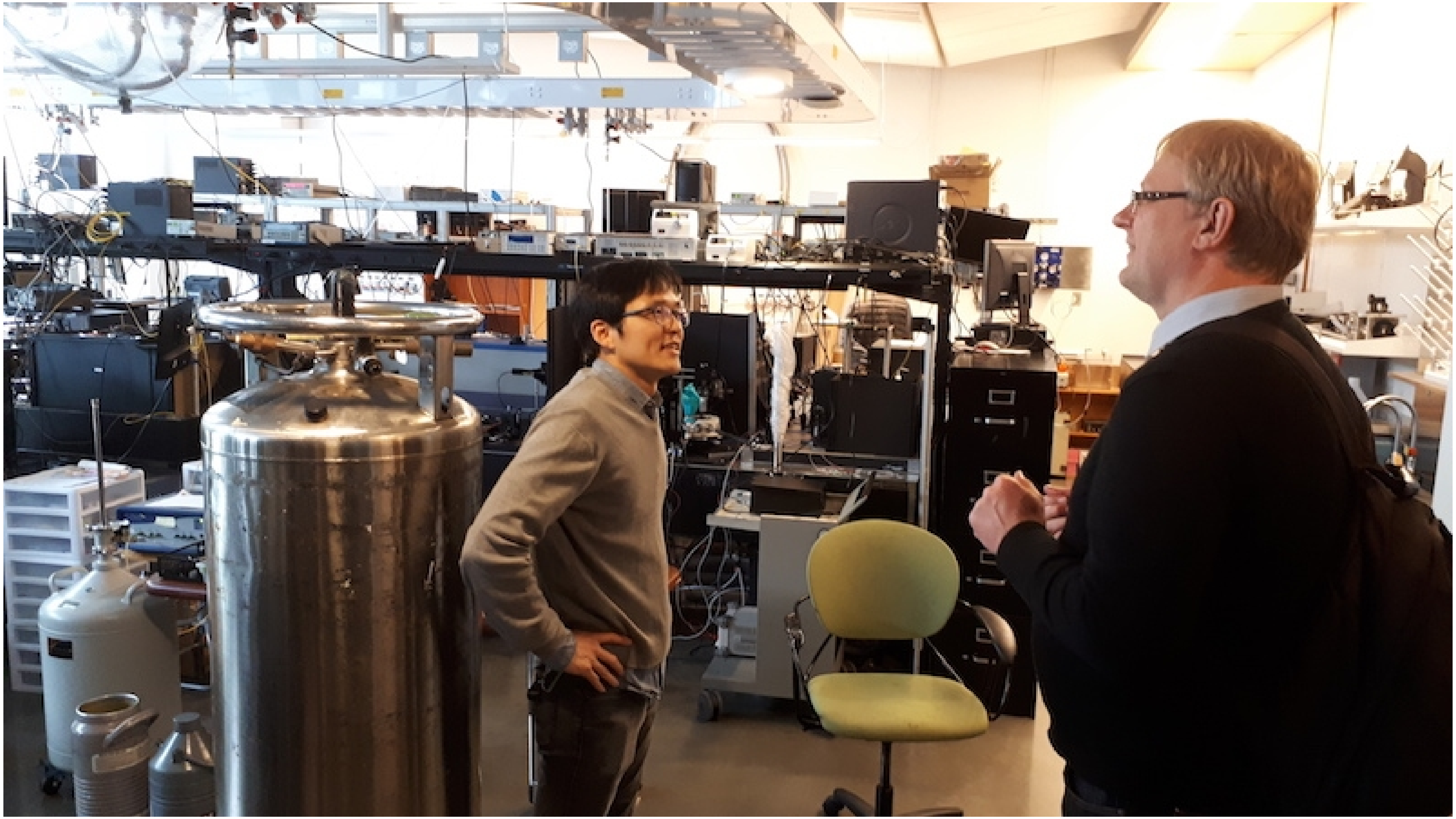
Mesoscopic Optics and Quantum Electronics Laboratory

http://oqe.ee.ucla.edu/index.html

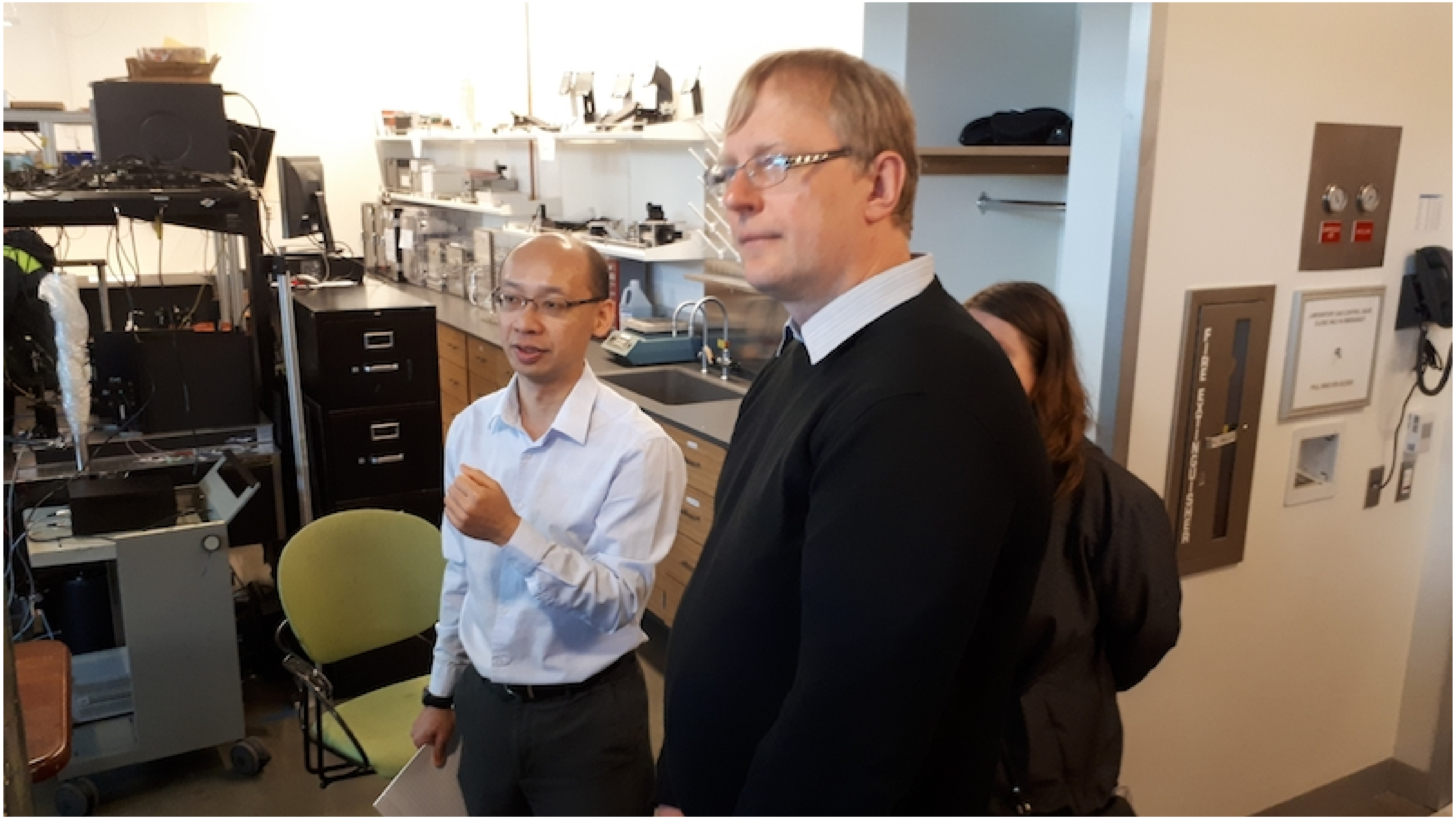

ENGINEERING


Quantum frequency combs
Graphene controls frequency combs
Let There Be Light (and Thus, Time)
DANGER


SCIENTIFIC REPORTS
Optics Letters
SCIENTIFIC REPORTS
SCIENTIFIC REPORTS



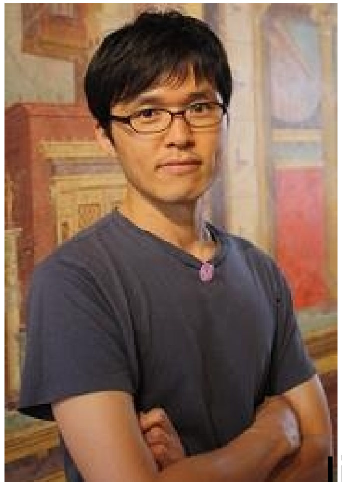
Jinkang Lim,
Postdoc



Prof. Chee Wei Wong

Grupa,
http://oqe.ee.ucla.edu/people.html

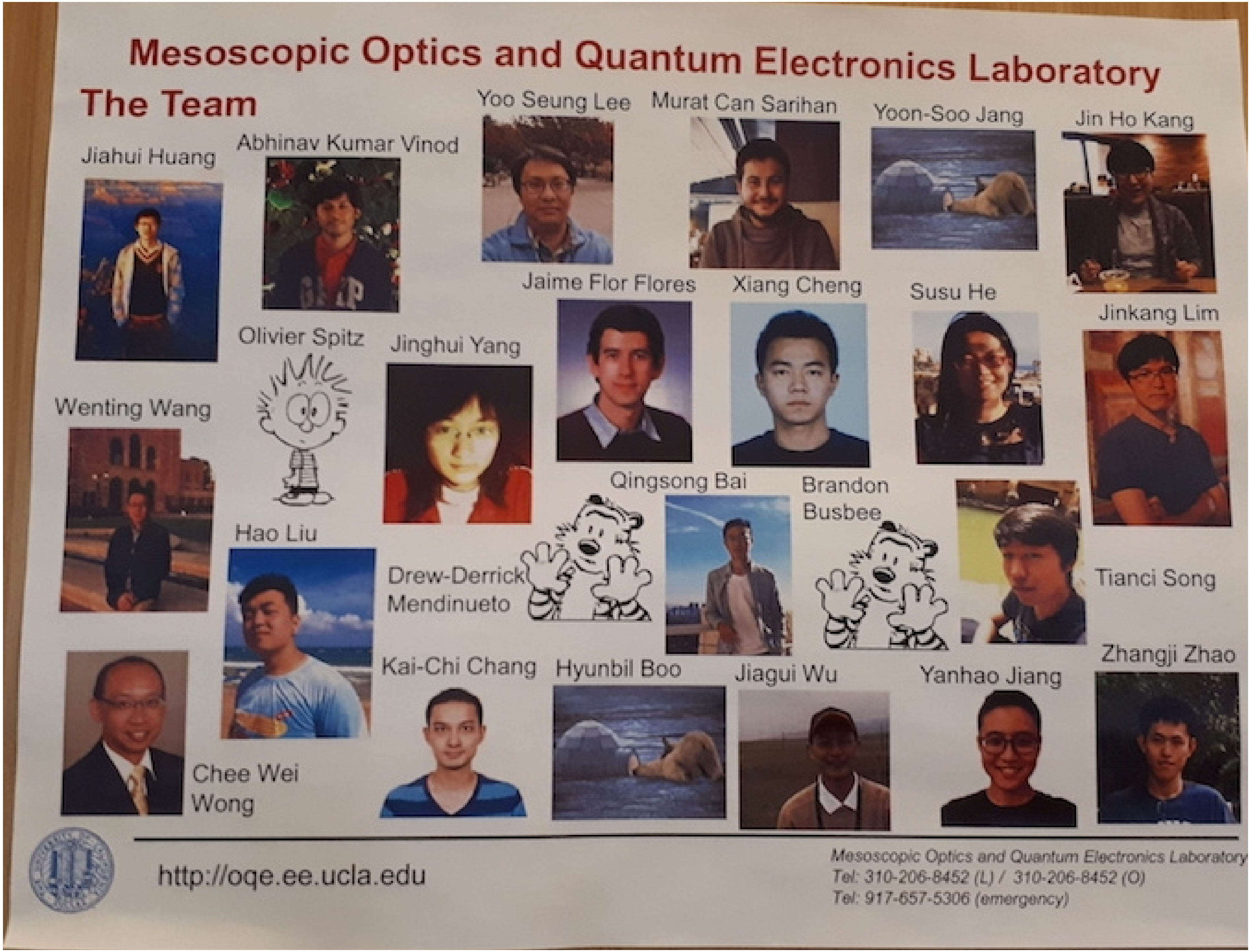
Prof. Chee Wei Wong, (SCOPUS – 360 documents, H-index: 32; annual number of publications since 2008: 25)
Professor of Electrical and Computer Engineering
Fang Lu Mesoscopic Optics and Quantum Electronics Laboratory
& Faculty Executive Committee, School of Engineering.
Sc.D. MIT 2003,
M.Sc. MIT 2001
B.Sc. and B.A. UC Berkeley 1999.

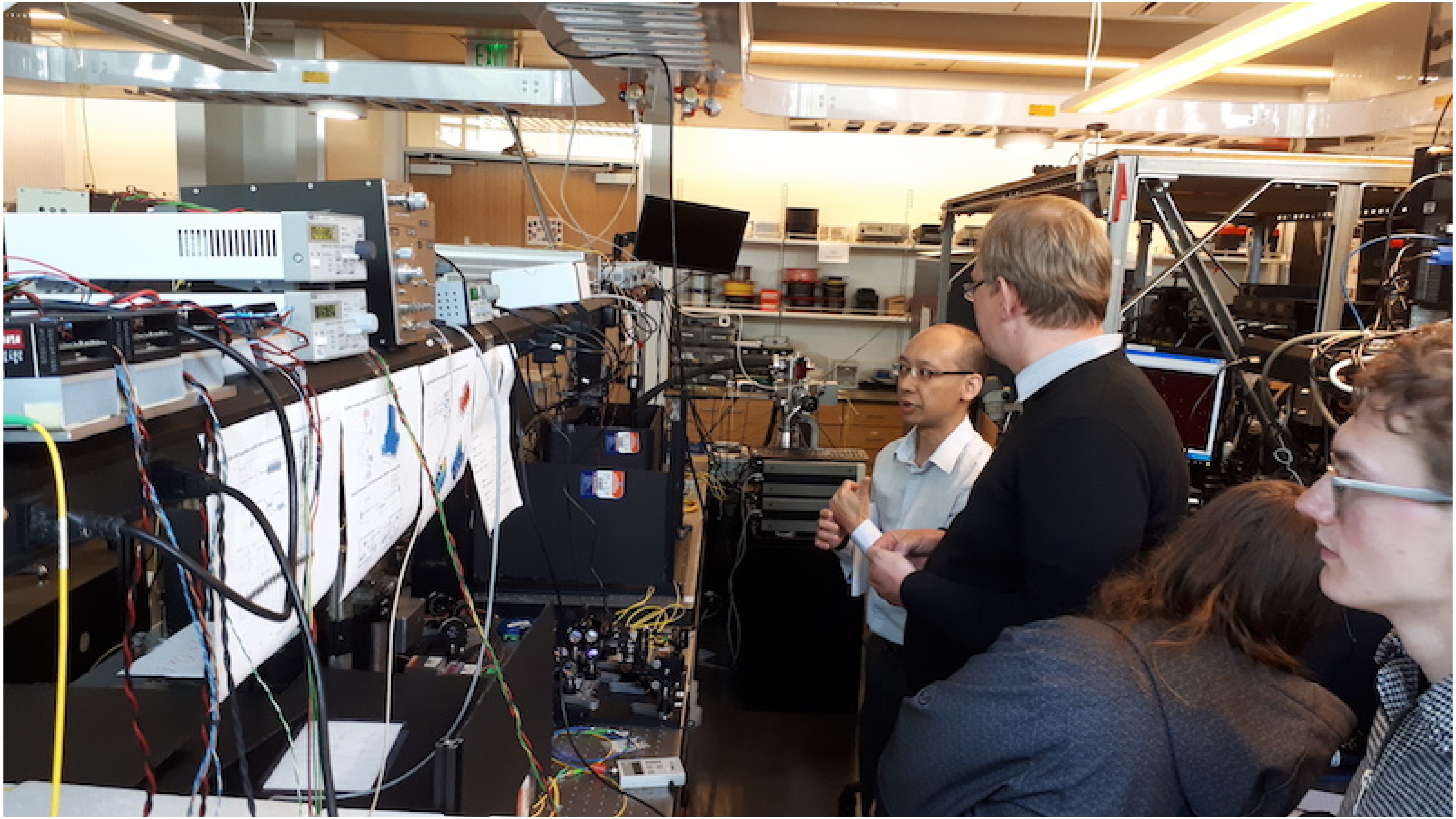


inkang Lim,
Postdoc, MIT 2014.

Jinghui Yang, Lab Manager /
Postdoctoral Research Scientist
Ph.D. UCLA 2017 Ultrafast Optics

Post-doc


Mesoscopic Optics and Quantum Electronics Laboratory
The Team
Jiahui Huang
Abhinav Kumar Vinod
Yoo Seung Lee
Murat Can Sarihan
Yoon-Soo Jang
Jin Ho Kang
Jaime Flor Flores
Xiang Cheng
Susu He
Jinkang Lim
Olivier Spitz
Jinghui Yang
Wenting Wang
Qingsong Bai
Brandon Busbee
Hao Liu
Drew-Derrick Mendinueto
Tianci Song
Kai-Chi Chang
Hyunbil Boo
Jiagui Wu
Yanhao Jiang
Zhangji Zhao
Chee Wei Wong
http://oqe.ee.ucla.edu
Mesoscopic Optics and Quantum Electronics Laboratory
Tel: 310-206-8452 (L) / 310-206-8452 (O)
Tel: 917-657-5306 (emergency)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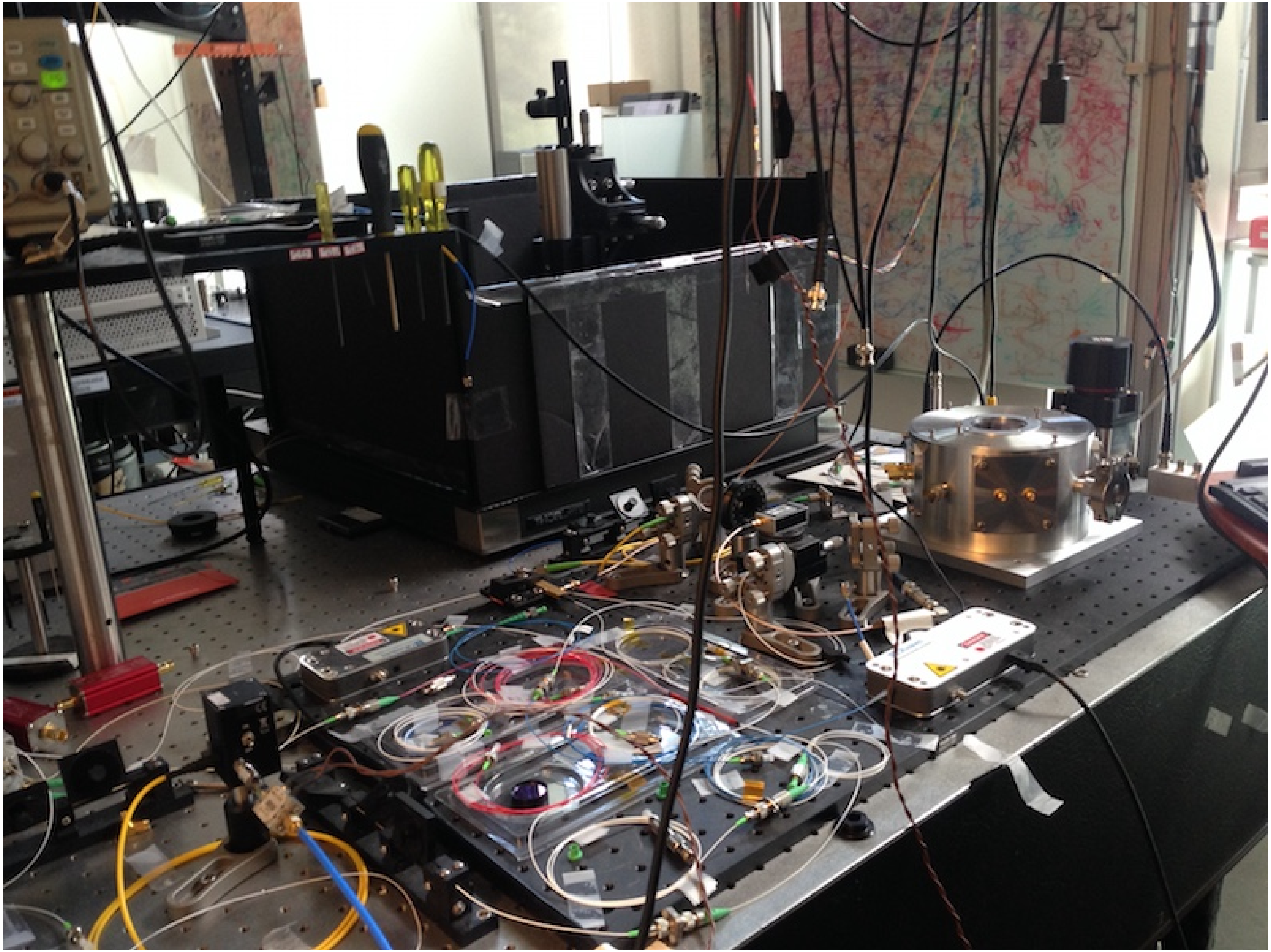
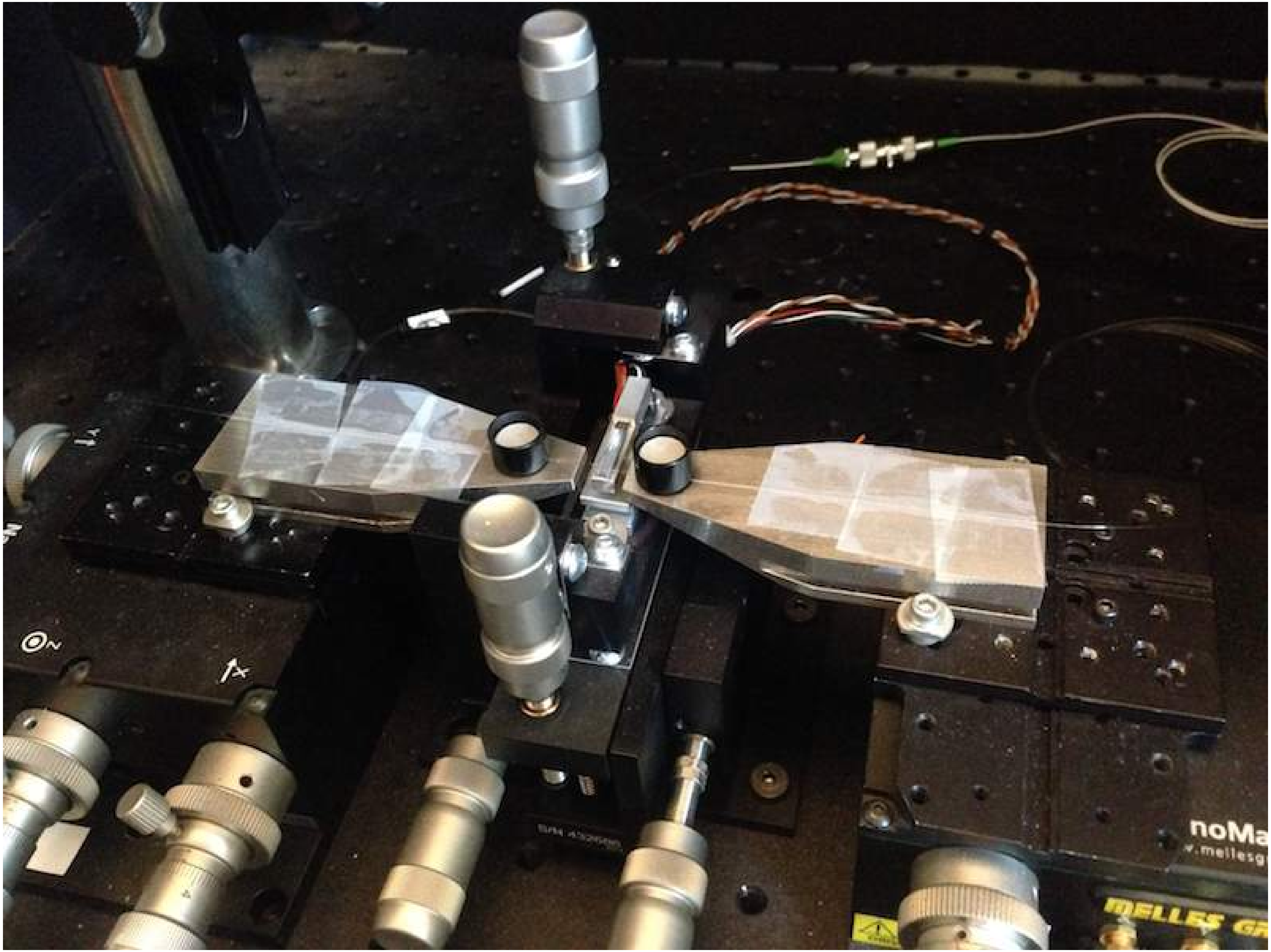
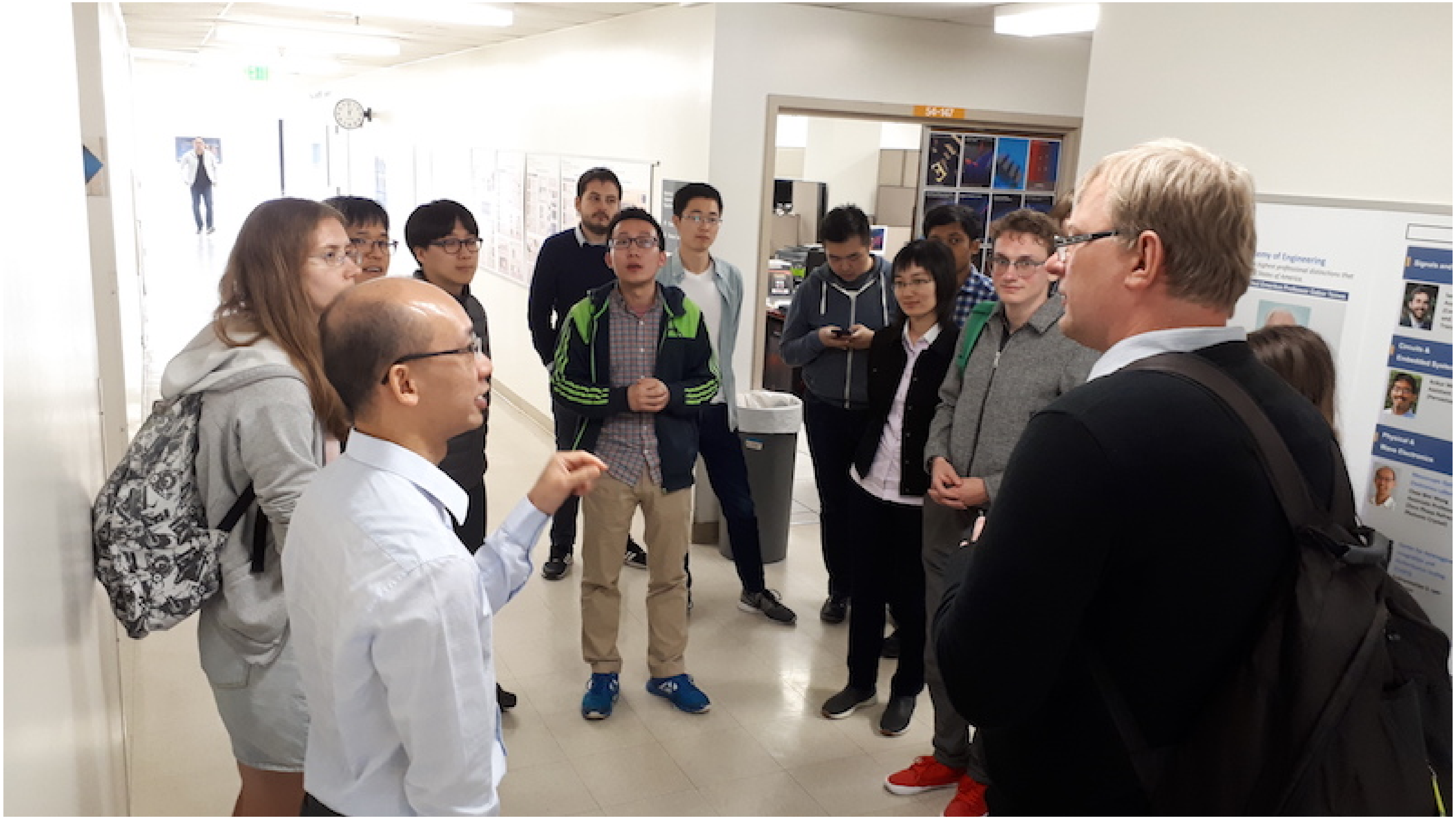



noMa
MELLES GR


requency comb
Precision measurement system of light frequency

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600 CAL
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920 CAL
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BOWLS
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970-980 CAL
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TERIYAKI CHICKEN BOWL
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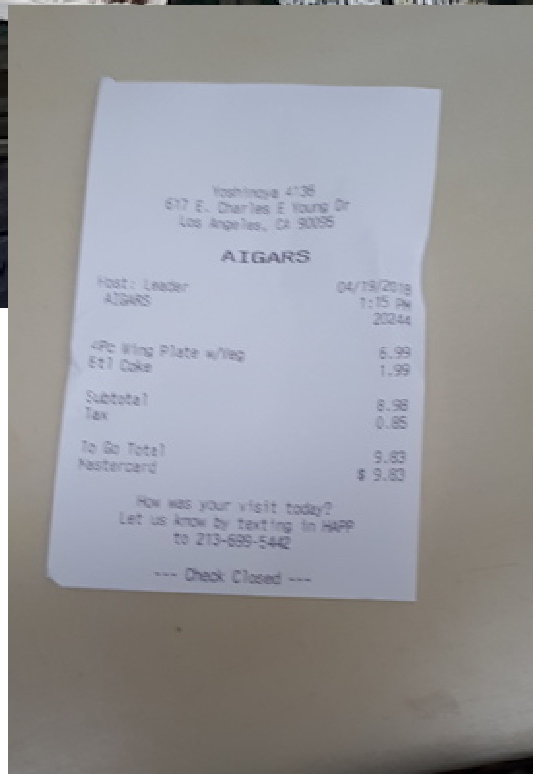
Yoshinoya 4136
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Los Angeles, CA 90095
AIGARS
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20244
4Pc Wing Plate w/Veg 6.99
Rtl Coke 1.99
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Tax 0.85
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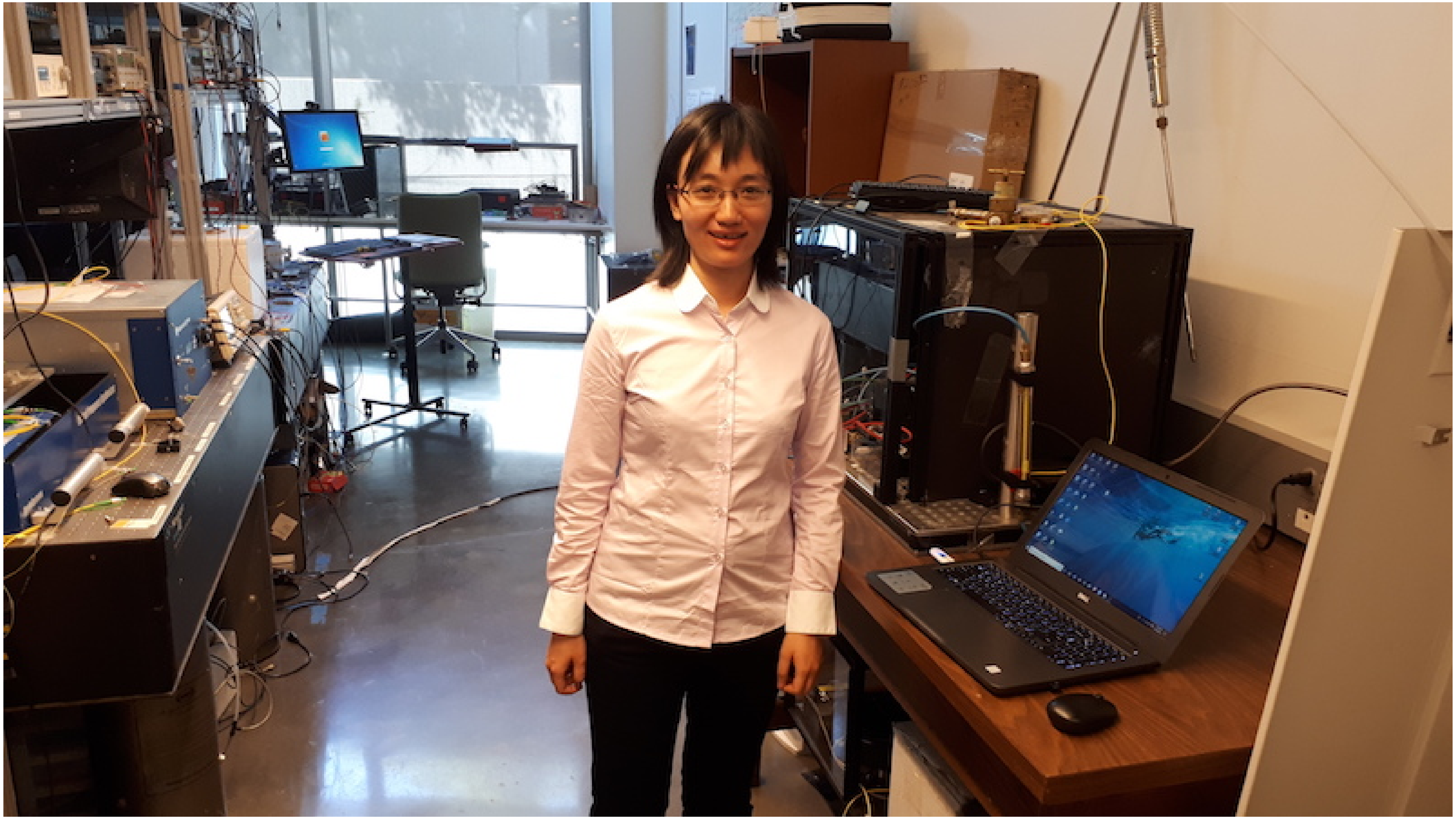


Jinghui Yang, Lab Manager / Postdoctoral Research Scientist
Ph.D. UCLA 2017 Ultrafast Optics

Pētījumu lauks

- "Controlling photons in mesoscopic structures"

(mezoskopisks – no atomu izmēriem (0.1 nm) līdz mikrometriem)

- "Our focus is at the intersection of **optical physics, device optoelectronics, and solid-state science and engineering**."

- "We concentrate on two regions across the continuum: **fundamental breakthroughs** in basic optical physics and sciences, and concentrated optoelectronic **applications in the industry**"

- Nonlinear Optics
- Ultrafast Optics
- Quantum Optics
- Precision measurements

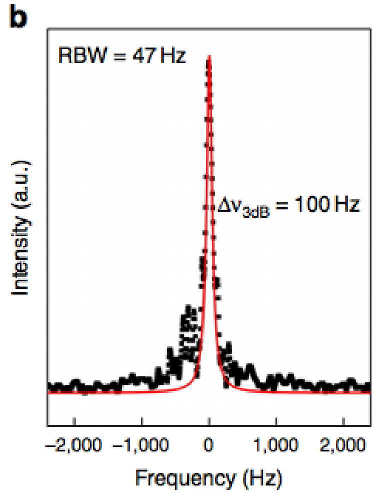
(http://oqe.ee.ucla.edu/research.html)

ARTICLE

DOI: 10.1038/s41467-017-00021-9 OPEN

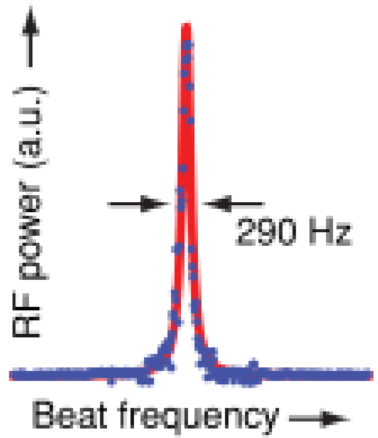
Chasing the thermodynamical noise limit in whispering-gallery-mode resonators for ultrastable laser frequency stabilization

Jinkang Lim[1], Anatoliy A. Savchenkov[2], Elijah Dale[2], Wei Liang[2], Danny Eliyahu[2], Vladimir Ilchenko[2], Andrey B. Matsko[2], Lute Maleki[2] & Chee Wei Wong[1]



Here, we show the noise characteristics of whispering-gallery-mode resonators and demonstrate a resonator stabilized laser at this limit by compensating the intrinsic thermal expansion, allowing a **sub-25 Hz linewidth** and a 32 Hz Allan deviation.

14. Alnis, J., Matveev, A., Kolachevsky, N., Udem, Th & Hänsch, T. W. Subhertz linewidth diode lasers by stabilization to vibrationally and thermally compensated ultralow-expansion glass Fabry-Pérot cavities. *Phys. Rev. A* 77, 053809 (2008).

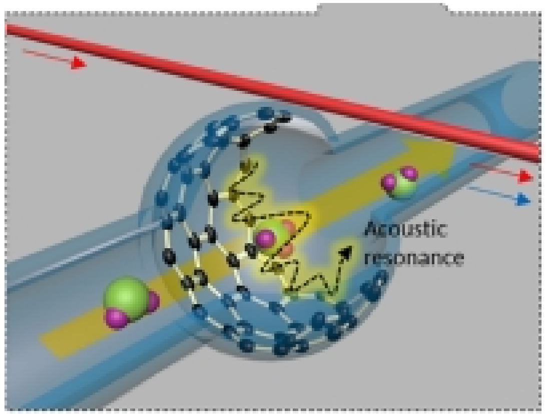


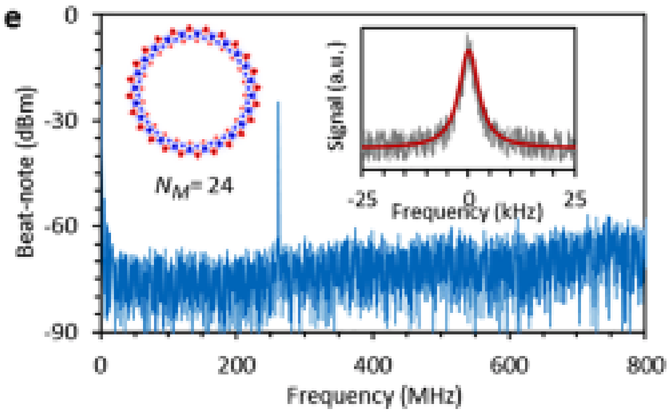
Funding support is provided by Air Force Research Laboratory under contract FA9453-14-M-0090.

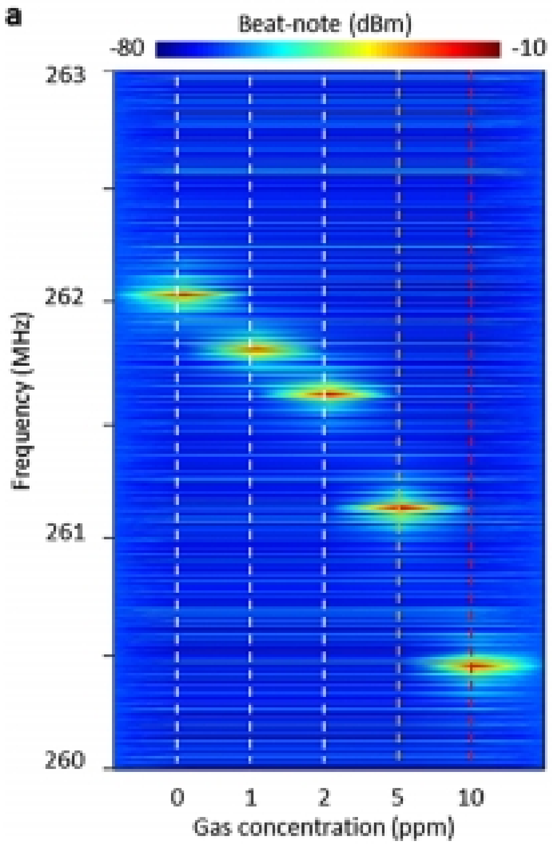
NANO LETTERS
Letter
pubs.acs.org/NanoLett

Graphene-Enhanced Brillouin Optomechanical Microresonator for Ultrasensitive Gas Detection

Baicheng Yao,*[†,‡,§] Caibin Yu,[†] Yu Wu,[†] Shu-Wei Huang,[‡] Han Wu,[†] Yuan Gong,[†,∥] Yuanfu Chen,[⊥] Yanrong Li,[⊥] Chee Wei Wong,[‡] Xudong Fan,[∥] and Yunjiang Rao*[,†]



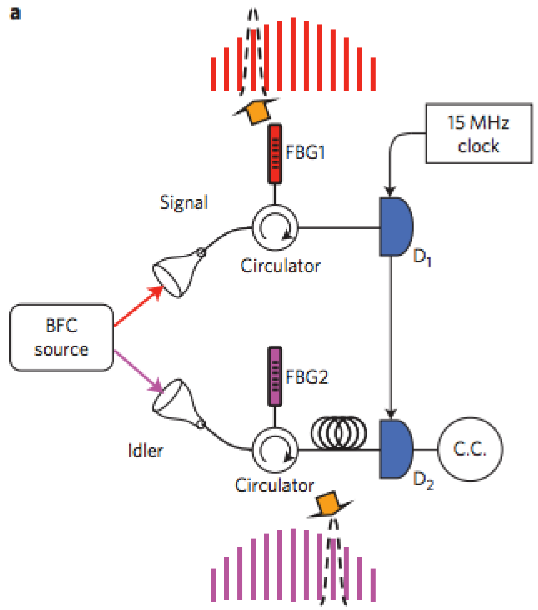




ARTICLES
PUBLISHED ONLINE: 29 JUNE 2015 | DOI: 10.1038/NPHOTON.2015.110
nature photonics

Harnessing high-dimensional hyperentanglement through a biphoton frequency comb

Zhenda Xie[1,2]*, Tian Zhong[3], Sajan Shrestha[2], XinAn Xu[2], Junlin Liang[2], Yan-Xiao Gong[4], Joshua C. Bienfang[5], Alessandro Restelli[5], Jeffrey H. Shapiro[3], Franco N. C. Wong[3] and Chee Wei Wong[1,2]*



On the other hand, a biphoton state with a comb-like spectrum could potentially serve for high-dimensional entanglement generation and take full advantage of the continuous variable energy–time subspace. Based on this state, promising applications have been proposed for **quantum computing**

High-dimensional entanglement in quantum frequency combs (Conference Presentation)

Author(s): Chee Wei Wong; Zhenda Xie; Xiang Cheng; Kai-Chi Chang; Yoo Seung Lee; Xuan Cui; Alvin Peizhe Li

Paper Details

Date Published: 14 March 2018
PDF
Proc. SPIE 10547, Advances in Photonics of Quantum Computing, Memory, and Communication XI, 105470D (14 March 2018); doi: 10.1117/12.2292463
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Published in SPIE Proceedings Vol. 10547:
Advances in Photonics of Quantum Computing, Memory, and Communication XI
Zameer Ul Hasan; Philip R. Hemmer; Alan E. Craig; Alan L. Migdall, Editor(s)

Finansētāji

Our efforts are enabled by kind support from

- NSF,
- DARPA,
- DoE, Department of Energ
- DoD, Department of Defer
- NIH,
- New York State,
- Intel,
- the intelligence community,
- 3M,
- and others.”

Mesoscopic Optics and Quantum Electronics Laboratory

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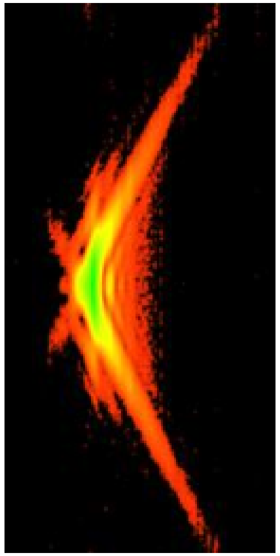
Join



Research positions are immediately available in the Wong group, for post-doctoral associates, Ph.D. and M.Sc. students. Our projects advances nanomaterial and device physics for nonlinear, ultrafast, quantum and precision optical measurements.

A background in electromagnetics is helpful. Experience with cleanroom fabrication, optical experiments, or numerical computation is a strong plus. Undergraduates interested in pursuing research opportunities are also welcome. This is also an area where creative students will do well !

Interested post-doctoral and graduate applicants should send their resume , along with a description of their research interests, to cheewei.wong@ucla.edu. Well-balanced snow-boarders are welcome.

[Electrical Engineering] [California NanoSystems Institute]
[School of Engineering and Applied Science]
Room 56-147D, 420 Westwood Plaza, Los Angeles, CA 90095.

http://oqe.ee.ucla.edu/join.html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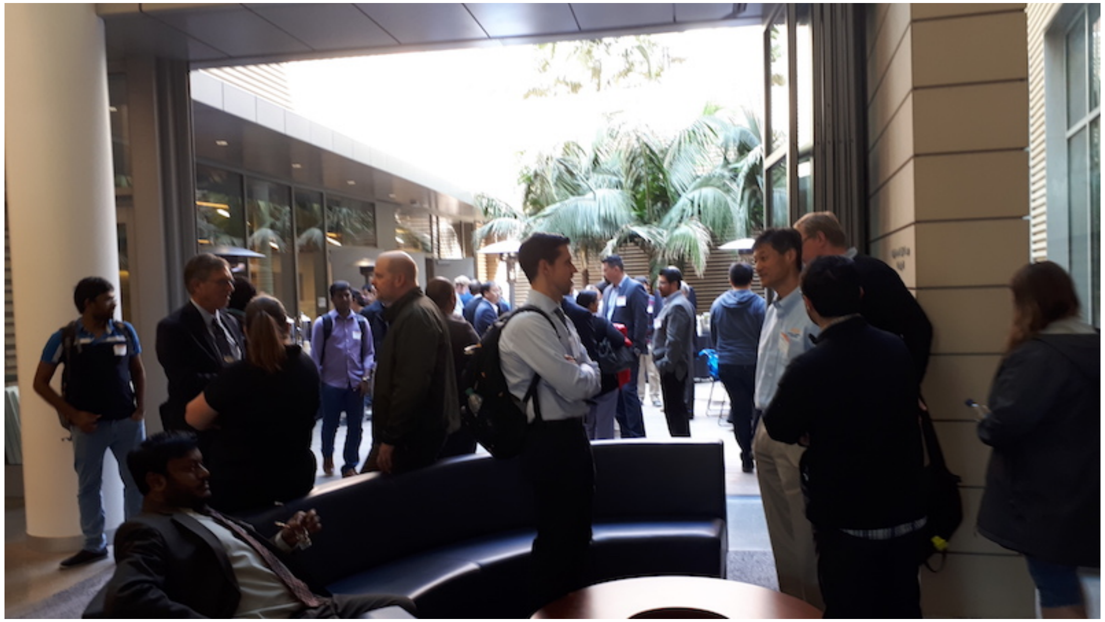



EXIT

EXIT

NASA Jet Propulsion Lab

NASA Jet Propulsion Lab

Personāls PLE ~ 5800

The Jet Propulsion Laboratory is a unique national research facility that carries out **robotic space and Earth science missions**.

JPL helped open the Space Age by developing **America's first Earth-orbiting science satellite**, creating the first successful interplanetary spacecraft, and sending robotic missions to study all the planets in the solar system as well as asteroids, comets and Earth's moon.

In addition to its missions, JPL developed and manages **NASA's Deep Space Network**, a

https://www.jpl.nasa.gov/about/

Jet Propulsion Laboratory
California Institute of Technology

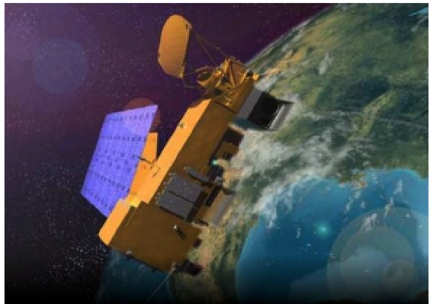
Current Missions

ASTER
Advanced Spaceborne Thermal Emission and Reflection Radiometer

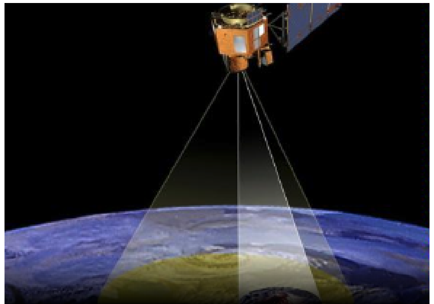
ASO
Airborne Snow Observatory

AVIRIS-NG
Airborne Visible-Infrared Imaging Spectrometer - Next Generation

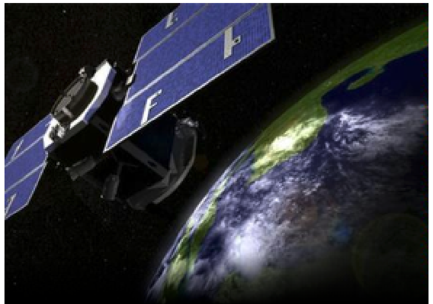
AVIRIS
Airborne Visible/Infrared Imaging Spectrometer



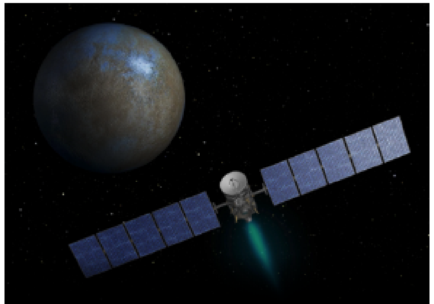
AIRS
Atmospheric Infrared Sounder



ASE
Autonomous Sciencecraft Experiment



Cloudsat

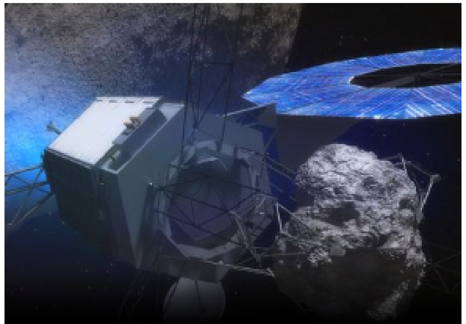


Dawn

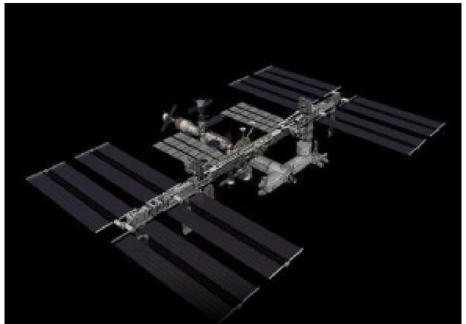
...

Jet Propulsion Laboratory
California Institute of Technology

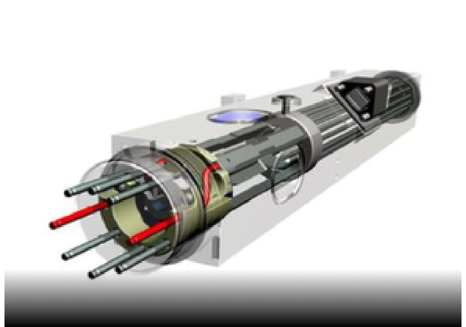
Future Missions



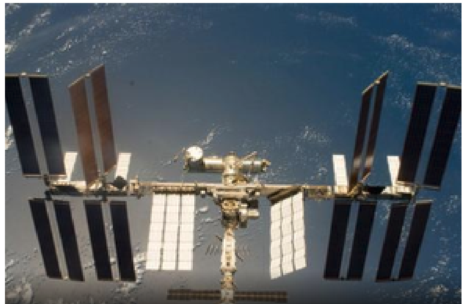
ARRM
Asteroid Redirect Robotic Mission



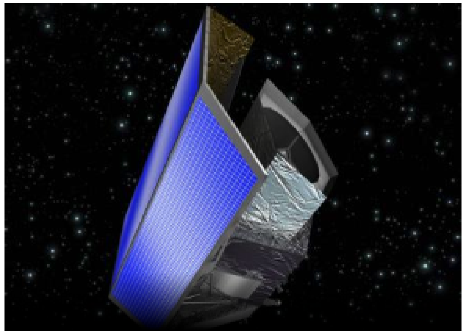
CAL
Cold Atom Laboratory



DSAC
Deep Space Atomic Clock



ECOSTRESS
ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station



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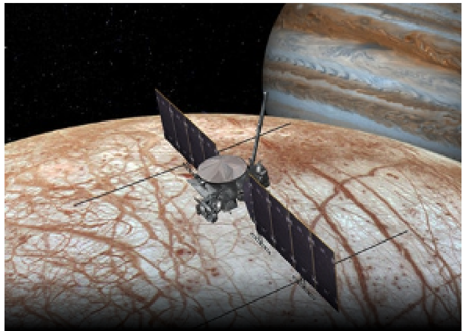
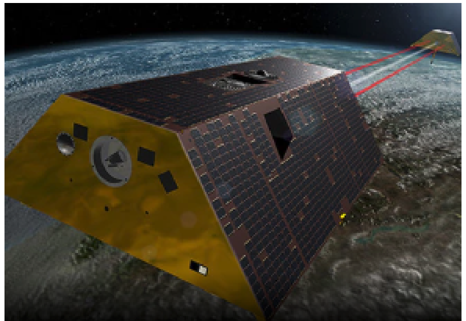
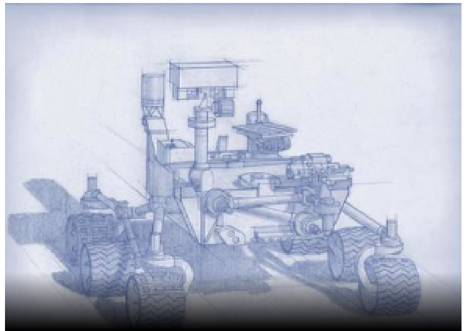


Europa Clipper



GRACE-FO
Gravity Recovery and Climate Experiment Follow-On



Mars 2020

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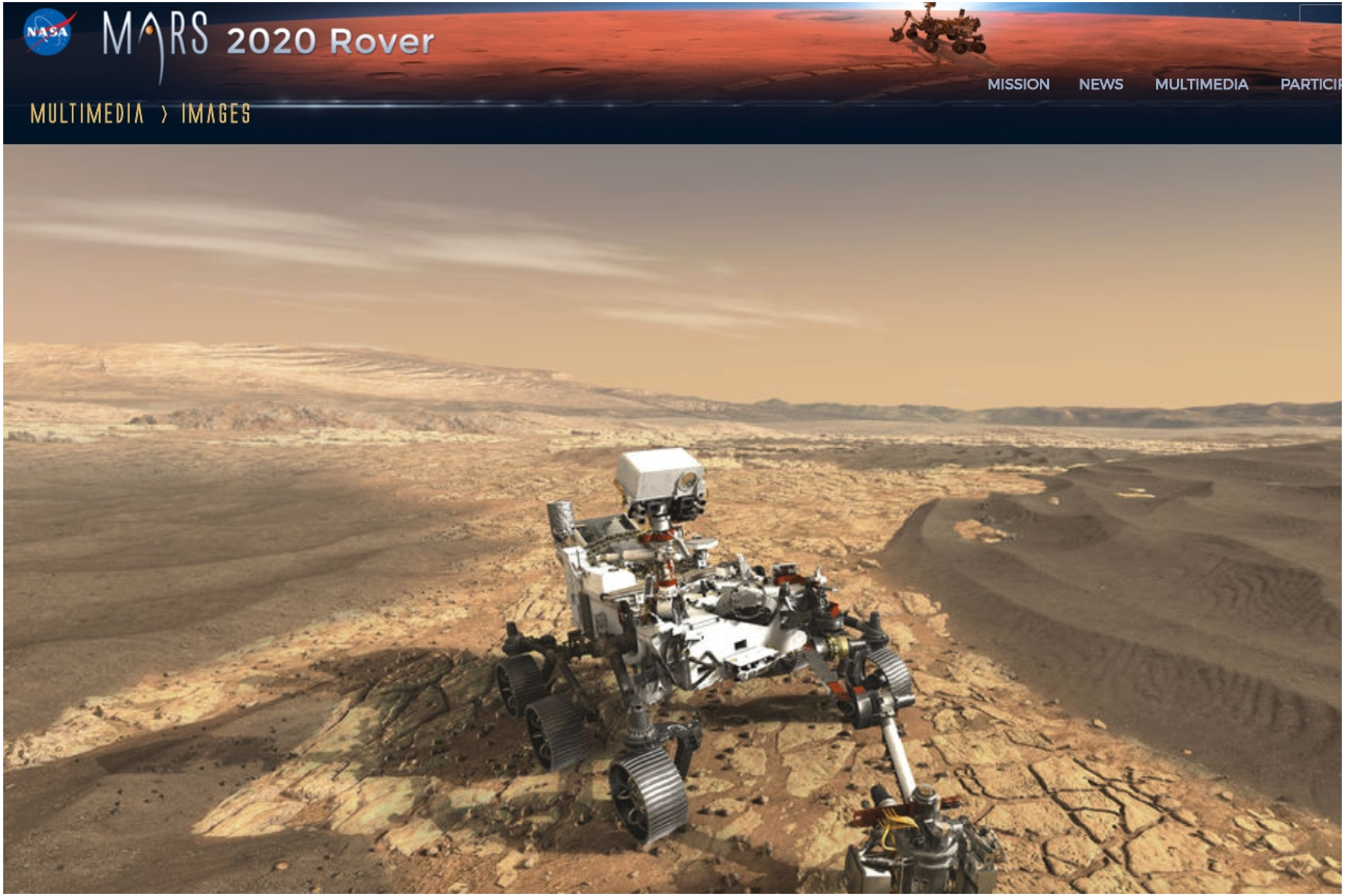
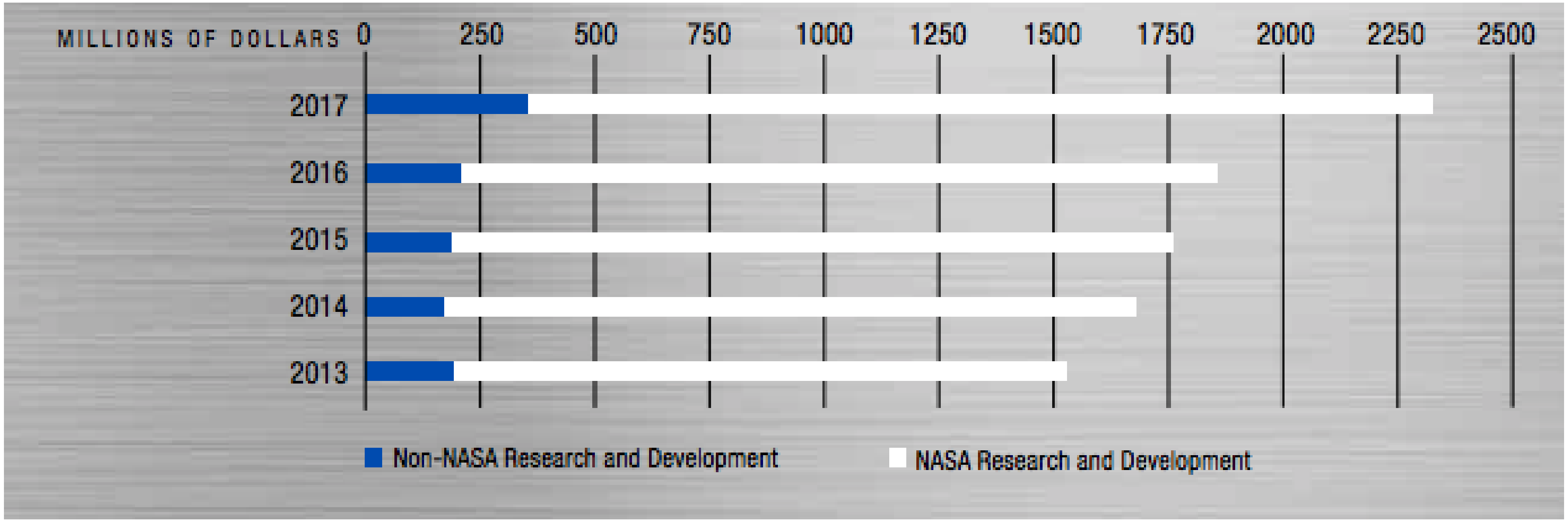
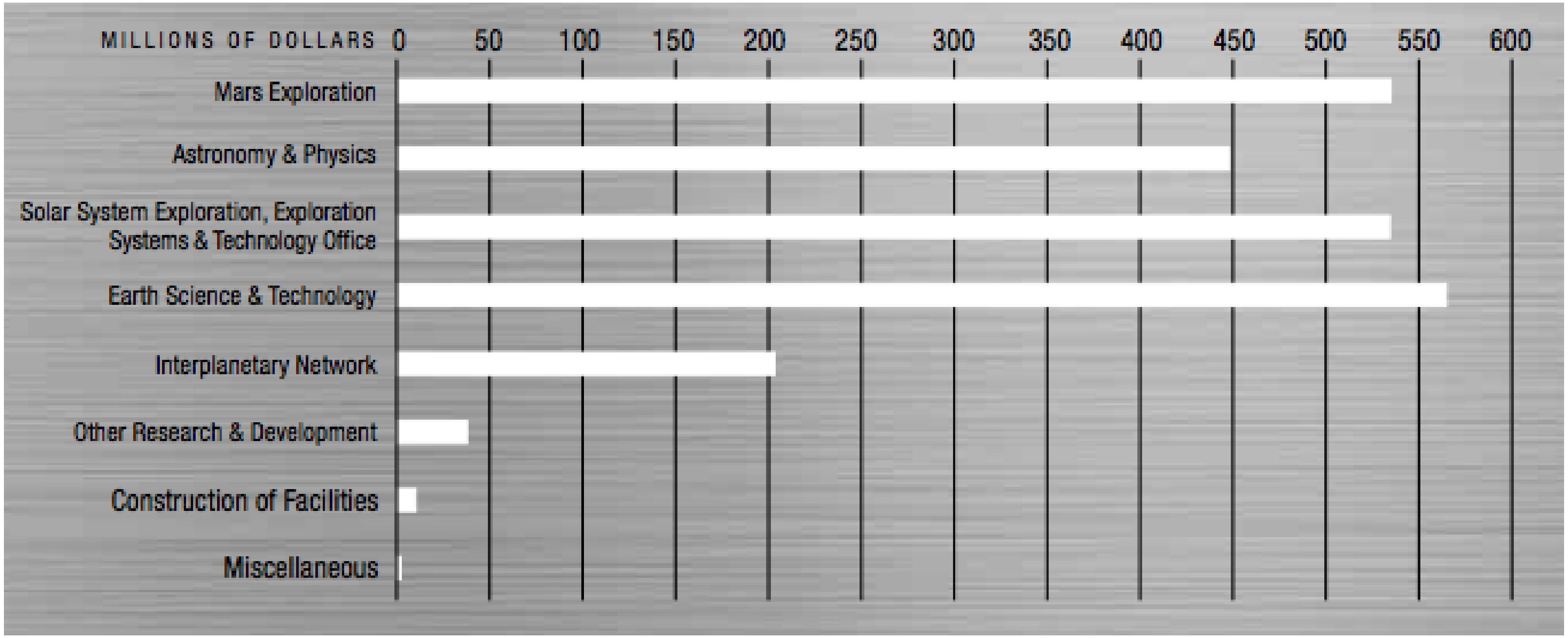
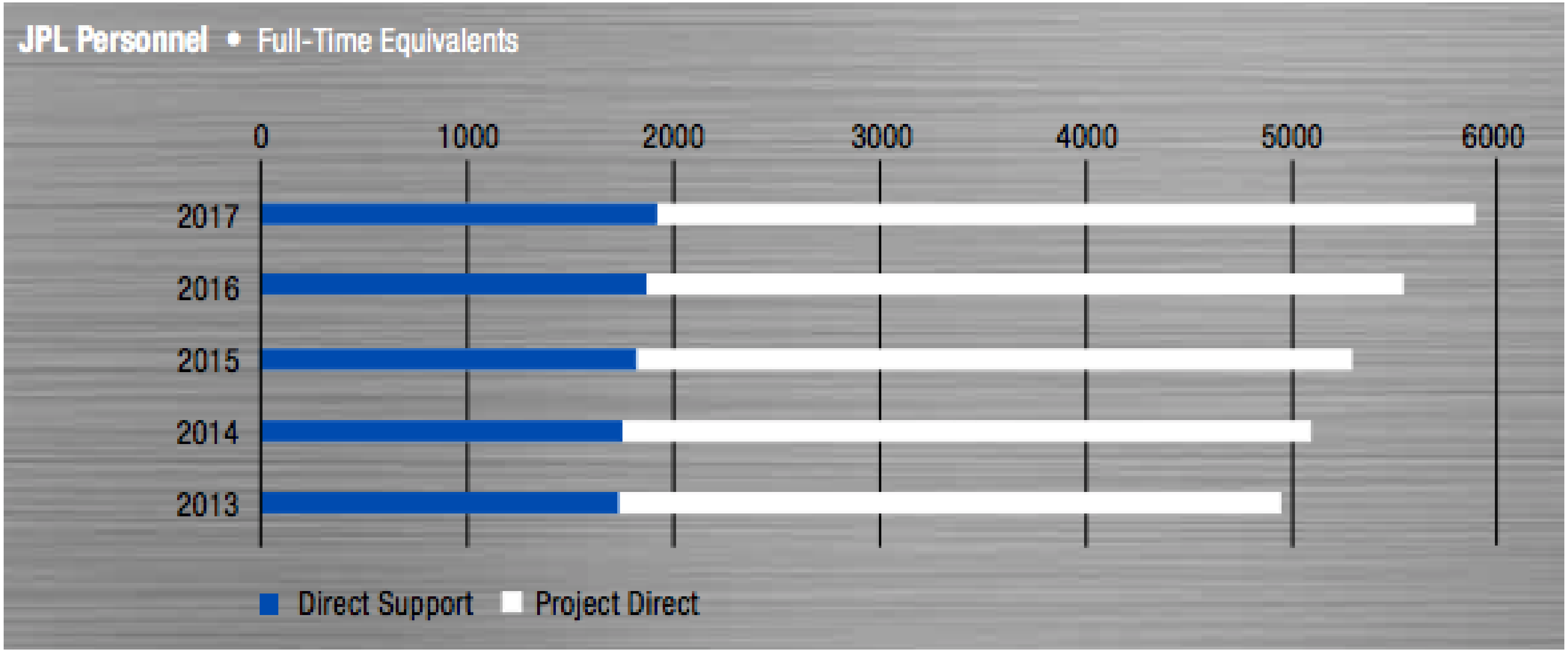


https://mars.nasa.gov/mars2020/multimedia/images/





https://www.jpl.nasa.gov/report/2017.pdf



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ORX 35 110/09:45 110/16:50
MSL 36 110/17:20 110/19:10
VGR1 43 110/16:20 110/21:25
TESS 54 110/09:30 110/21:10
SOHO 65 110/14:20 110/17:00
2018/110-17:04:19 UTC
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VGR1 T+ 40 228/04:08
M01O T+ 17 013/02:02
MER1 T+ 14 287/13:46
STF T+ 14 238/11:29
MRO T+ 12 252/05:21
DAWN T+ 10 206/05:21
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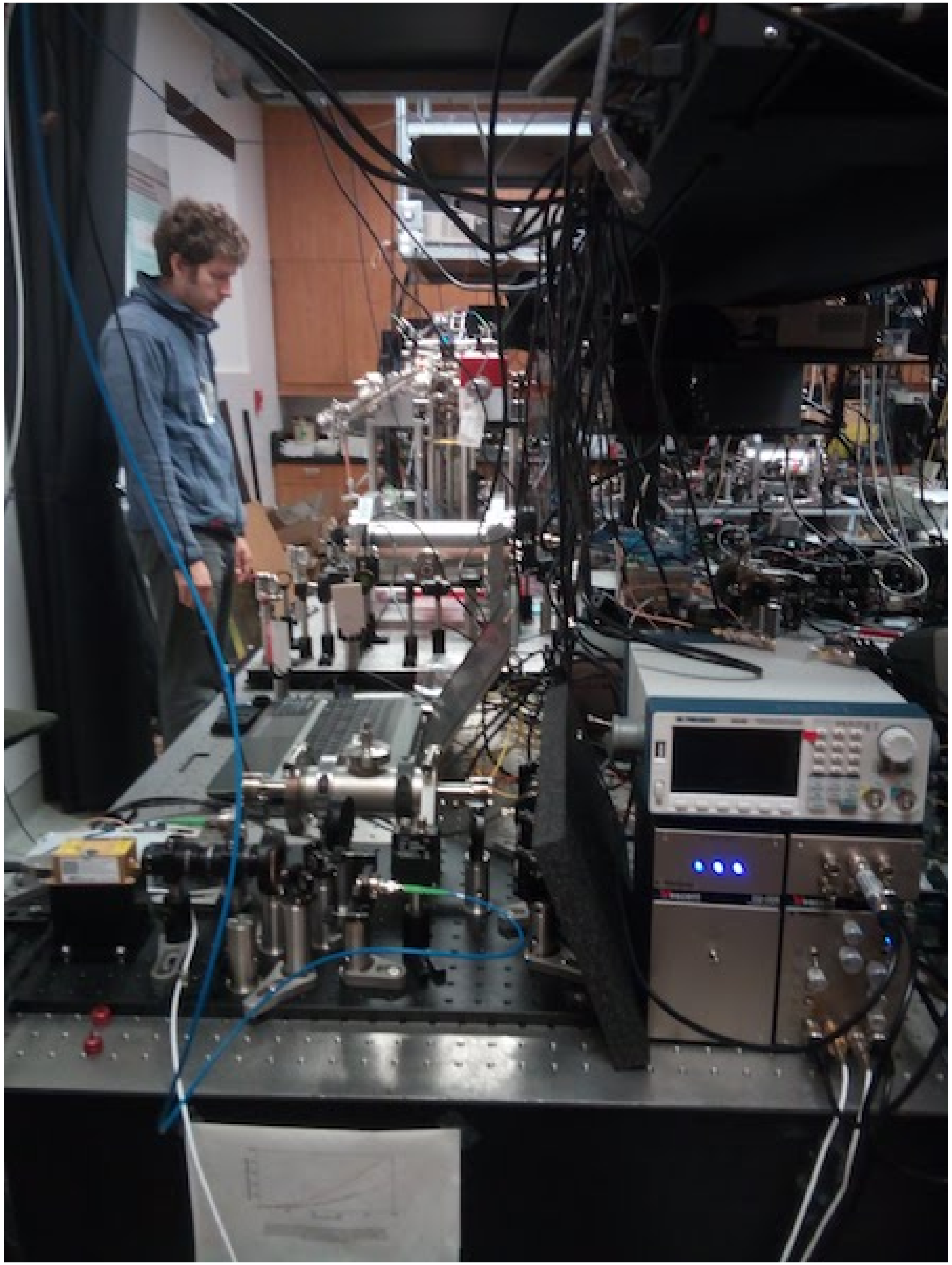
MSL T+ 06 147/01:43
MAVEN T+ 04 152/22:36
TESS T+ 00



Ivan Grudinin

SCOPUS publications – 53
Hirsch index – 18.
http://grudinin.com/

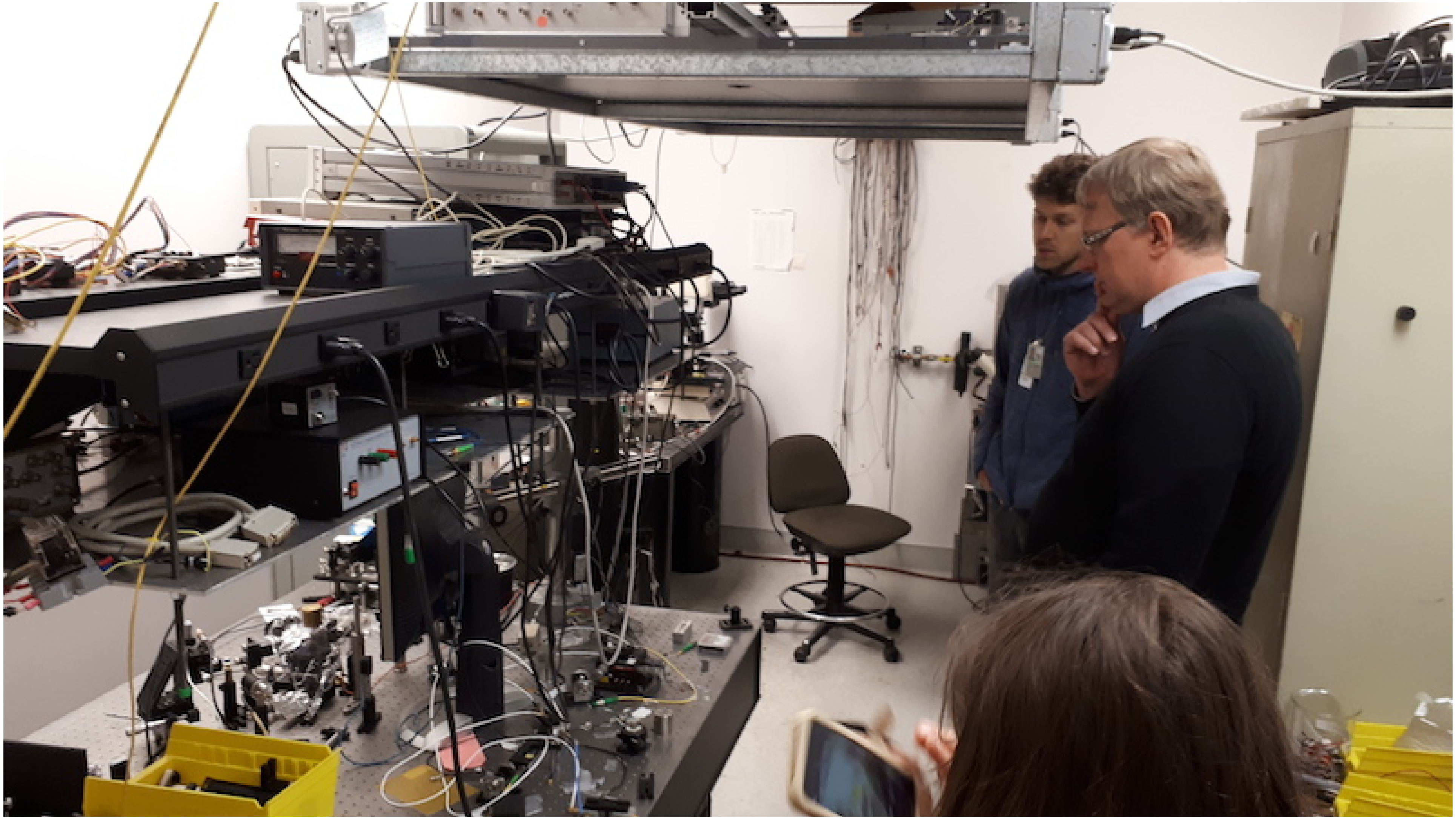
PhD Caltech (2008)

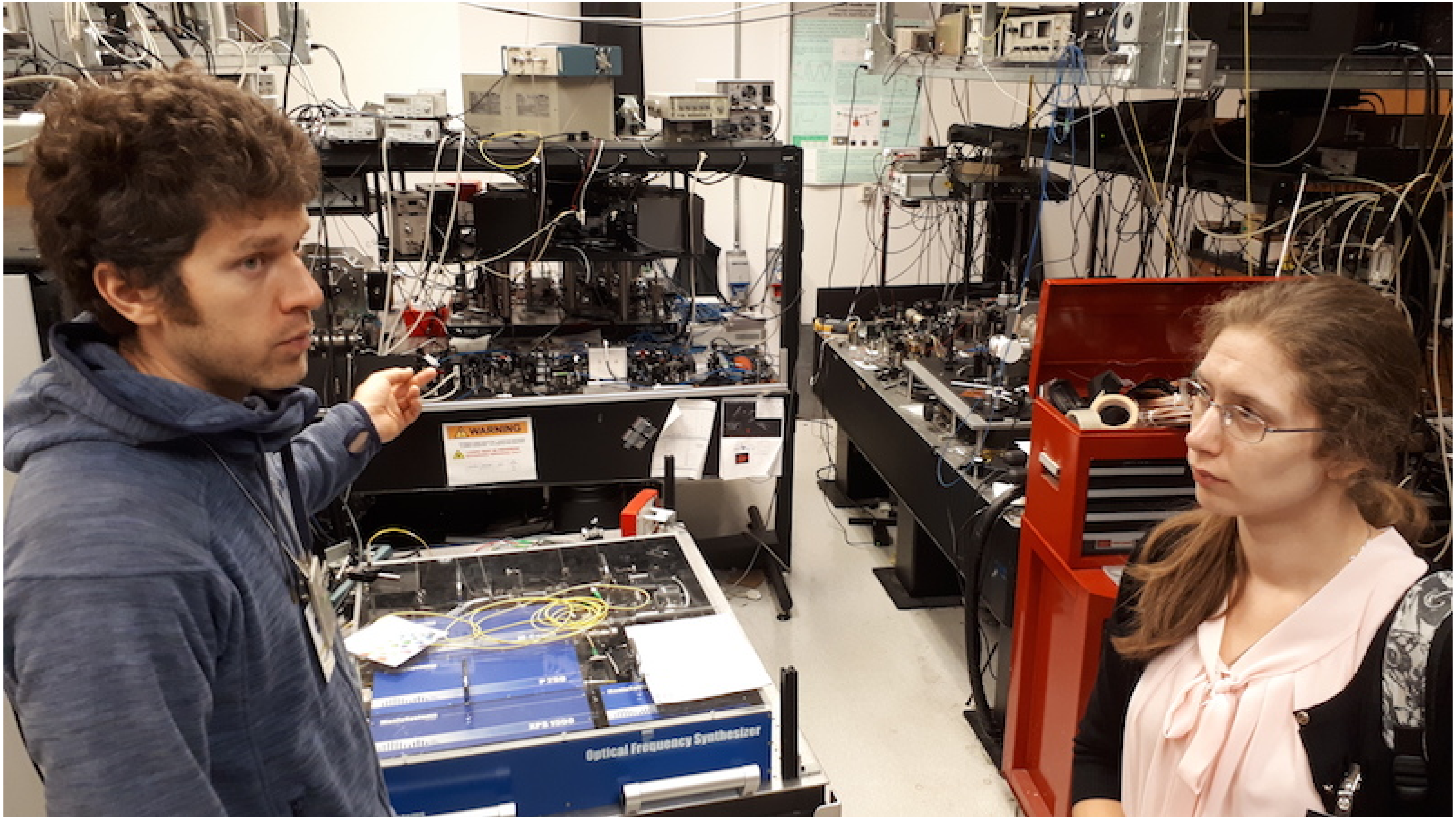
(J.Alnis: SCOPUS – 63,
Hirsch index – 19)

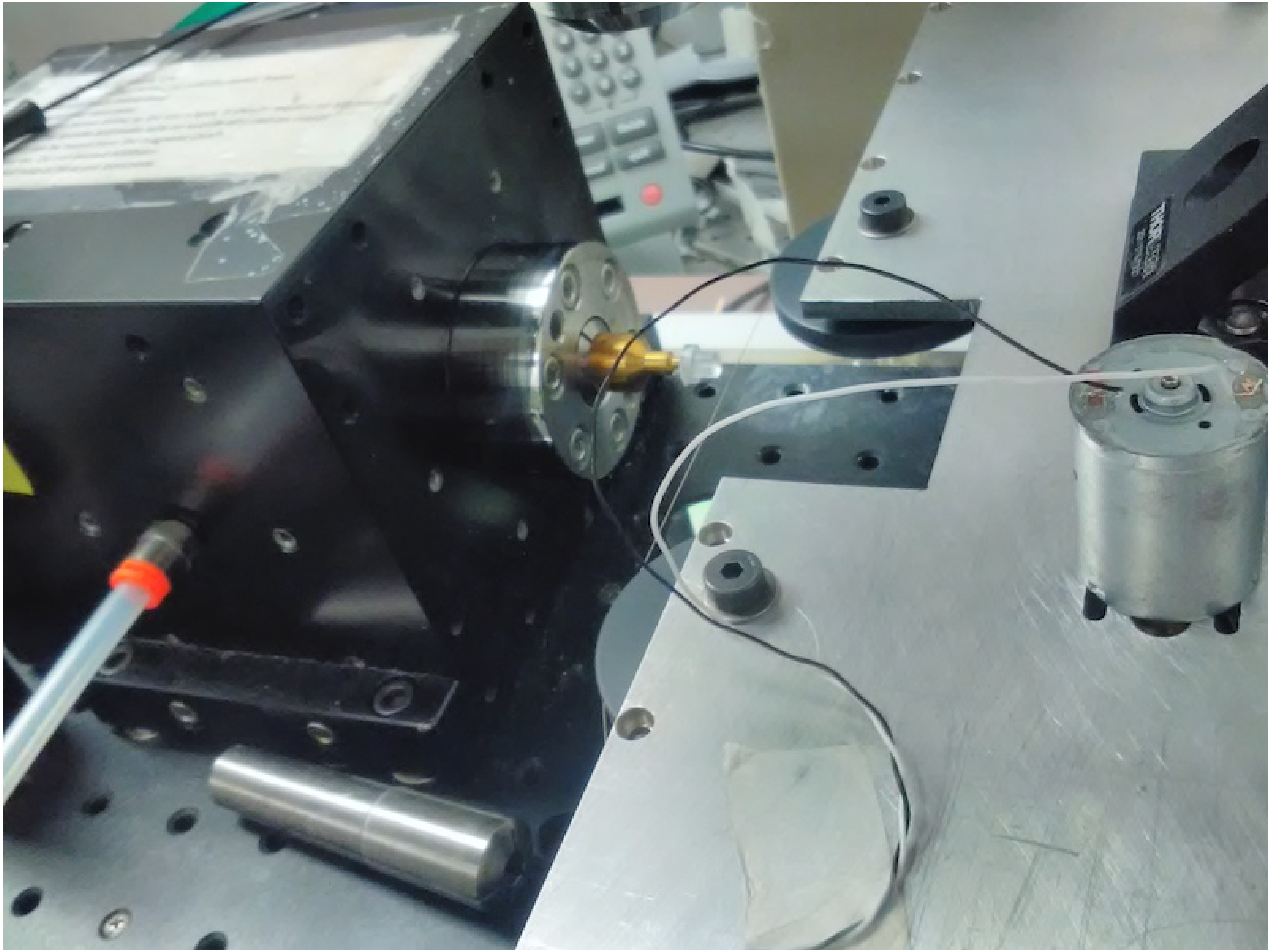
I am currently with the
“Quantum Science and Techn
ology”
group at
NASA Jet Propulsion Laborato
ry
.

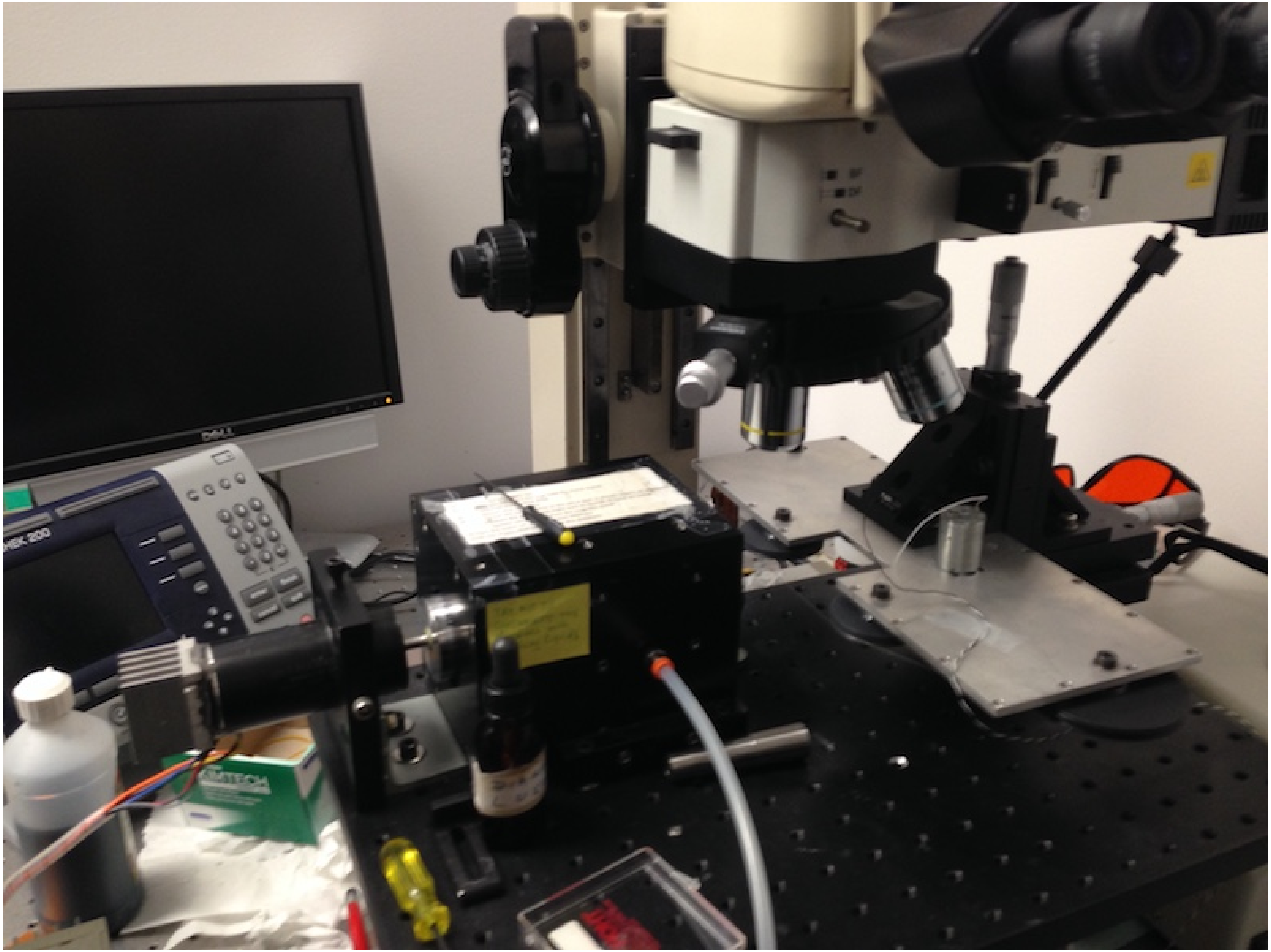
The
laboratory’s primary function

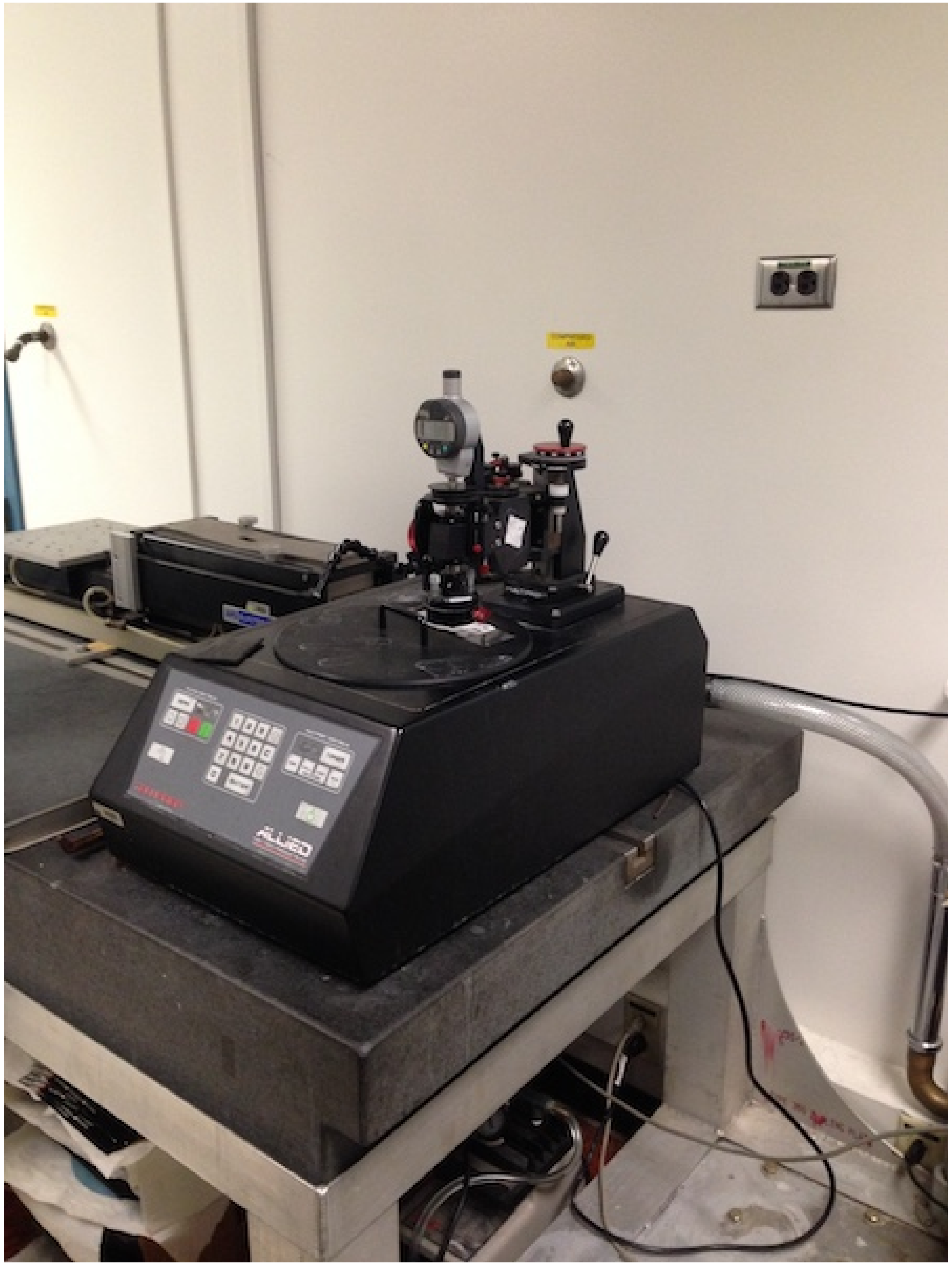
is the construction and




WARNING
Optical Frequency Synthesizer




KIMTECH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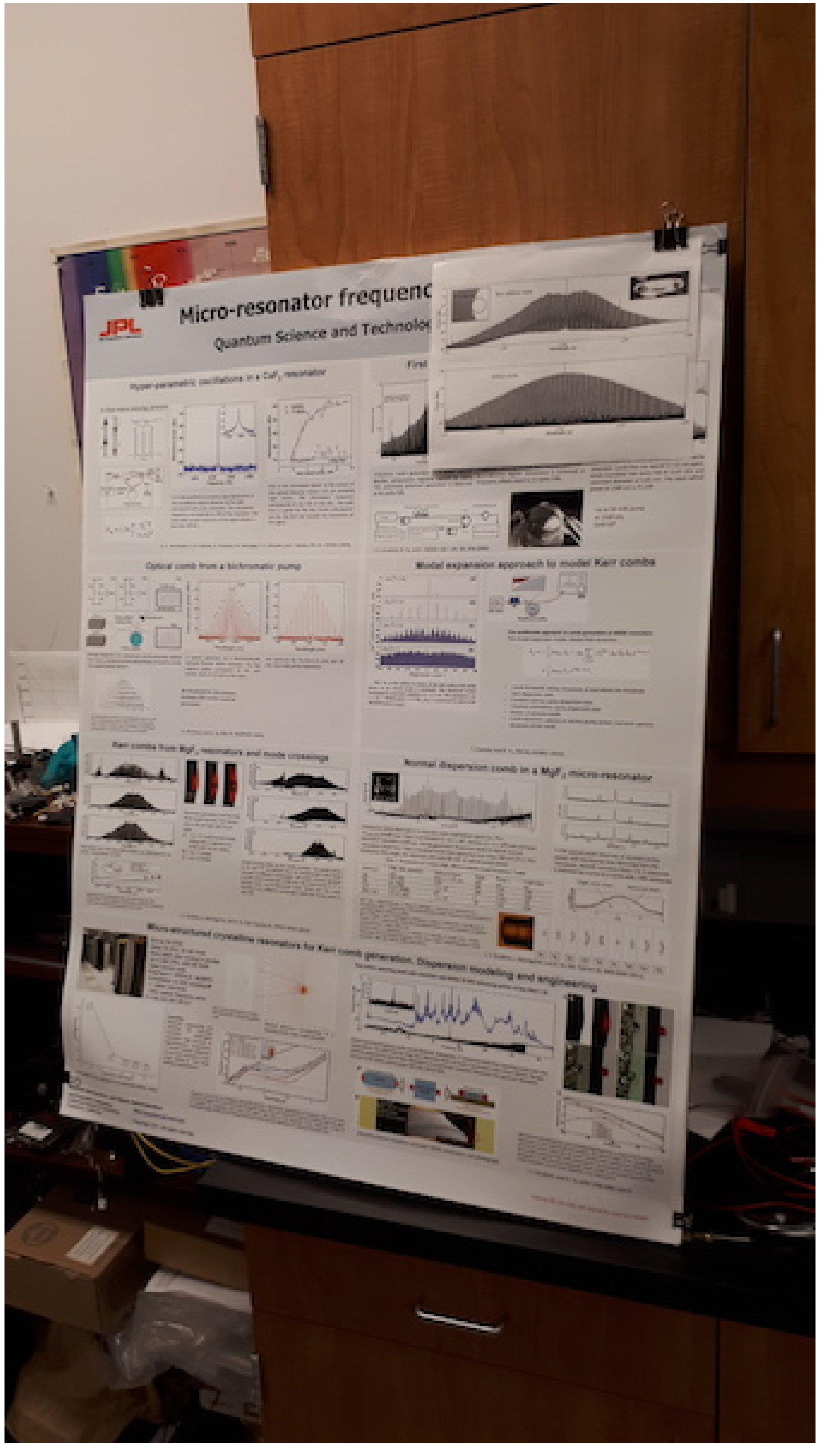
JPL
Micro-resonator frequenc
Quantum Science and Technolog
Optical comb from a bichromatic pump
Modal expansion approach to model Kerr combs
Normal dispersion comb in a MgF2 micro-resonator

Letter Vol. 2, No. 3 / March 2015 / Optica 221

optica

Dispersion engineering of crystalline resonators via microstructuring

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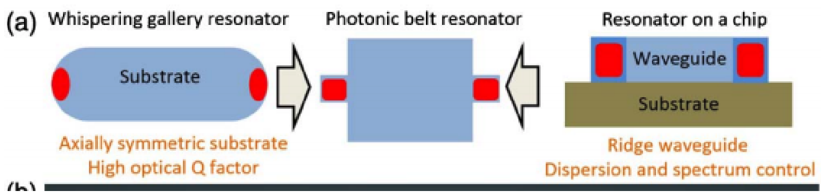
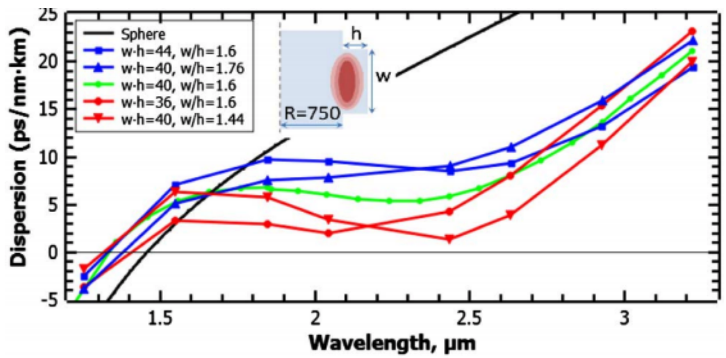
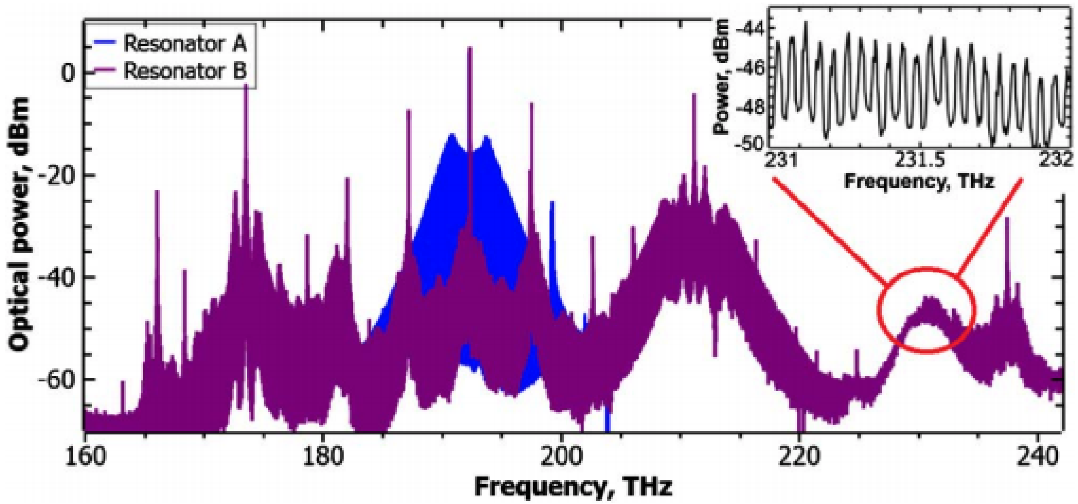
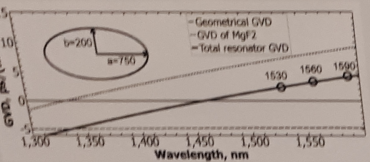
**Corresponding author: grudinin@jpl.nasa.gov*







pump. Pump power is 9 mW.



Dispersion of the ellipsoidal resonator with radius of 750 micrometers. Points indicate wavelength at which the frequency comb was experimentally pumped in this work.

in "A" and "B" are derived from the fundamental mode family pumped at different wavelengths. The mode crossing signature is at the same wavelength (1500 nm). The comb shown in "C" is derived from non-fundamental mode family and the mode crossing is at a different wavelength (1590 nm). Pump power is 100 mW.

I. S. Grudinin, L. Baumgartel, and N. Yu, Opt. Express 21, 26929-26935 (2013).

[8]	68 (1000)
[13]	34.67 (2000)
This work	172.44 (403)

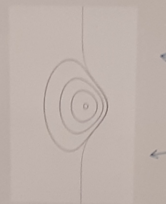
[8] T. Herr, J. Riemensberger, C. Wang, K. Hartinger, E. Gorodetsky, and T. J. Kippenberg, "Universal dynamic microresonators," arXiv:1111.3071.

[9] C. Y. Wang, T. Herr, P. Del'Haye, A. Schliesser, J. Hofe Picqué, and T. J. Kippenberg, "Mid-infrared optical frequ microresonators," arXiv:1109.2716.

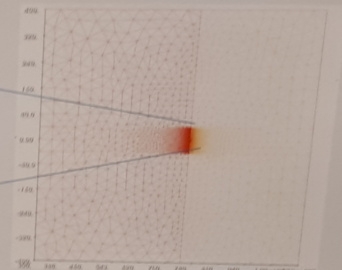
[13] W. Liang, A. A. Savchenkov, A. B. Matsko, V. S. Ilchen "Generation of nearinfrared frequency combs from a MgF resonator," Opt. Lett. 36(12), 2290–2292 (2011).

Micro-structured crystalline resonators for Kerr comb generation. Disper

SGI ALTIX 3700
Using 16 CPU, 32 GB RAM
Many batch jobs running in parallel,
Up to 200 CPU, 400 GB RAM
Open source code:
FreeFem++, ARPACK, MUMPS
Compilation on SGI, scripting➔
~1 million elements
~1khz optical frequency error:
F=192,343,567,801±1

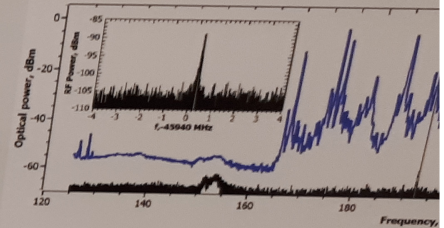


FEM solution showing lines of equal field intensity for a whispering gallery mode

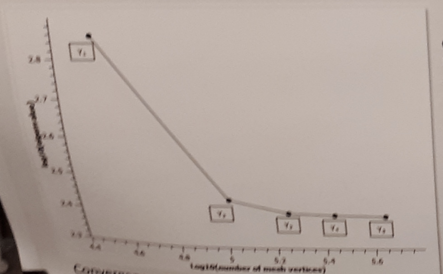


Meshed geometry corresponding to a Gaussian profile single mode resonator

First octave spanning comb with repetition rate

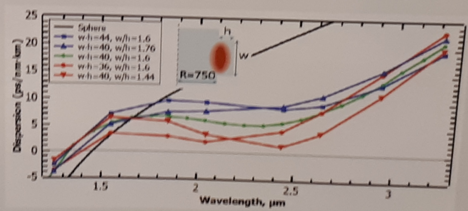


Octave spanning frequency comb and its beatnote. Waveguide octave (blue). The noise level for large laser detuning where no c could be explained by near-IR fiber absorption or by particular re intrinsic Q=50 million, pump power 600 mW, FSR 46 GHz.

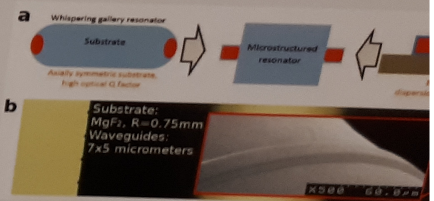


Convergence of a solution to its precisely known value

Capability:
Dispersion engineering and modeling for mm-sized crystalline birefringent resonators. High precision of eigenfrequency computation is needed because dispersion of mm-sized resonators is very small, leading to ~kHz mode spacing unequidistance.



Dispersion fine-tuning by changing waveguide geometry. Wavelength dependence of resonator GVD can be fine-tuned by changing the micro-structured waveguide shape. Here, the results of numerical modelling show the effect of changing the waveguide area (w×h) and aspect ratio (w/h) on the dispersion curve. Dispersion curves of birefringent MgF2 MCRs with R=750 μm are shown along with the dispersion of a sphere of the same size.



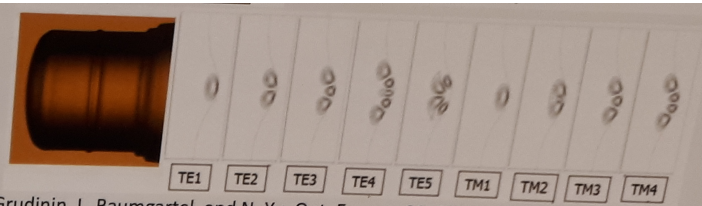
Microstructured crystalline resonator (MCR) schematics an

National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California
http://quantum.jpl.nasa.gov

...(1550 nm). Pump power is

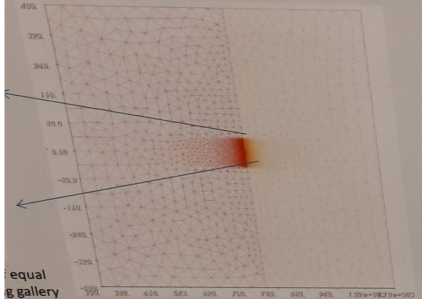
..., 26929-26935 (2013).

[8] T. Herr, J. Riemensberger, C. Wang, K. Hartinger, E. Gavartin, R. Holzwarth, M. L. Gorodetsky, and T. J. Kippenberg, "Universal dynamics of kerr frequency comb formation in microresonators," arXiv:1111.3071.
[9] C. Y. Wang, T. Herr, P. Del'Haye, A. Schliesser, J. Hofer, R. Holzwarth, T. W. Hänsch, N. Picqué, and T. J. Kippenberg, "Mid-infrared optical frequency combs based on crystalline microresonators," arXiv:1109.2716.
[13] W. Liang, A. A. Savchenkov, A. B. Matsko, V. S. Ilchenko, D. Seidel, and L. Maleki, "Generation of nearinfrared frequency combs from a MgF2 whispering gallery mode resonator," Opt. Lett. 36(12), 2290–2292 (2011).



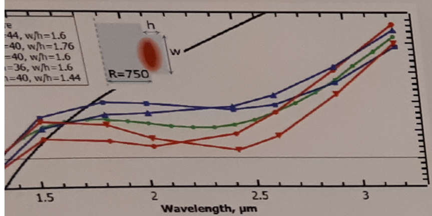
I. S. Grudinin, L. Baumgartel, and N. Yu, Opt. Express 20, 6604-6609 (2012).

...sonators for Kerr comb generation. Dispersion modeling and engineering



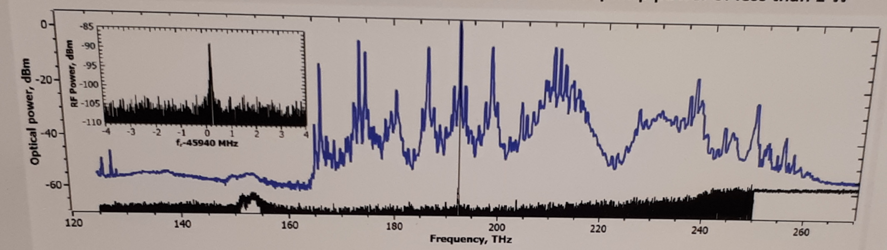
...equal ...g gallery

Meshed geometry corresponding to a Gaussian profile single mode resonator

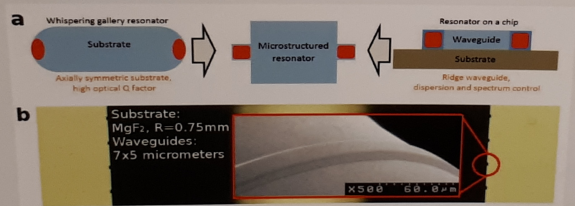


...anging waveguide geometry. Wavelength dependence of resonator GVD can be fine- ...-structured waveguide shape. Here, the results of numerical modelling show the effect ... area (w×h) and aspect ratio (w/h) on the dispersion curve. Dispersion curves of ...h R=750 µm are shown along with the dispersion of a sphere of the same size.

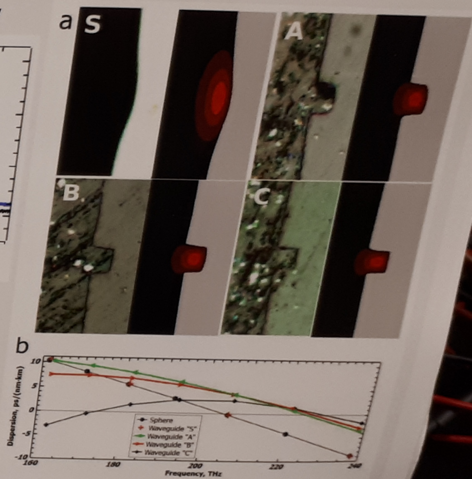
First octave spanning comb with repetition rate below 50 GHz and pump power of less than 1 W



Octave spanning frequency comb and its beatnote. Waveguide "C" produced comb lines spanning across over one octave (blue). The noise level for large laser detuning where no comb is generated is also shown (black). The gap could be explained by near-IR fiber absorption or by particular resonator dispersion and spectrum. Resonator intrinsic Q=50 million, pump power 600 mW, FSR 46 GHz.



Microstructured crystalline resonator (MCR) schematics and photograph.



Microstructured waveguides and corresponding dispersion. **a**, Each of the 8 images represents an area sized 25x45 micrometers. The optical images of the waveguide cross sections are shown along with the mode intensity maps obtained with FEM modelling. **b**, Numerically computed total cavity dispersion for the waveguides shown in a). The waveguide "S" with Gaussian waveguide shape, similar to previously reported single mode resonators, has the same dispersion as an ideal sphere.

I. S. Grudinin, and N. Yu, arXiv:1406.2682 (2014)


STEMlab
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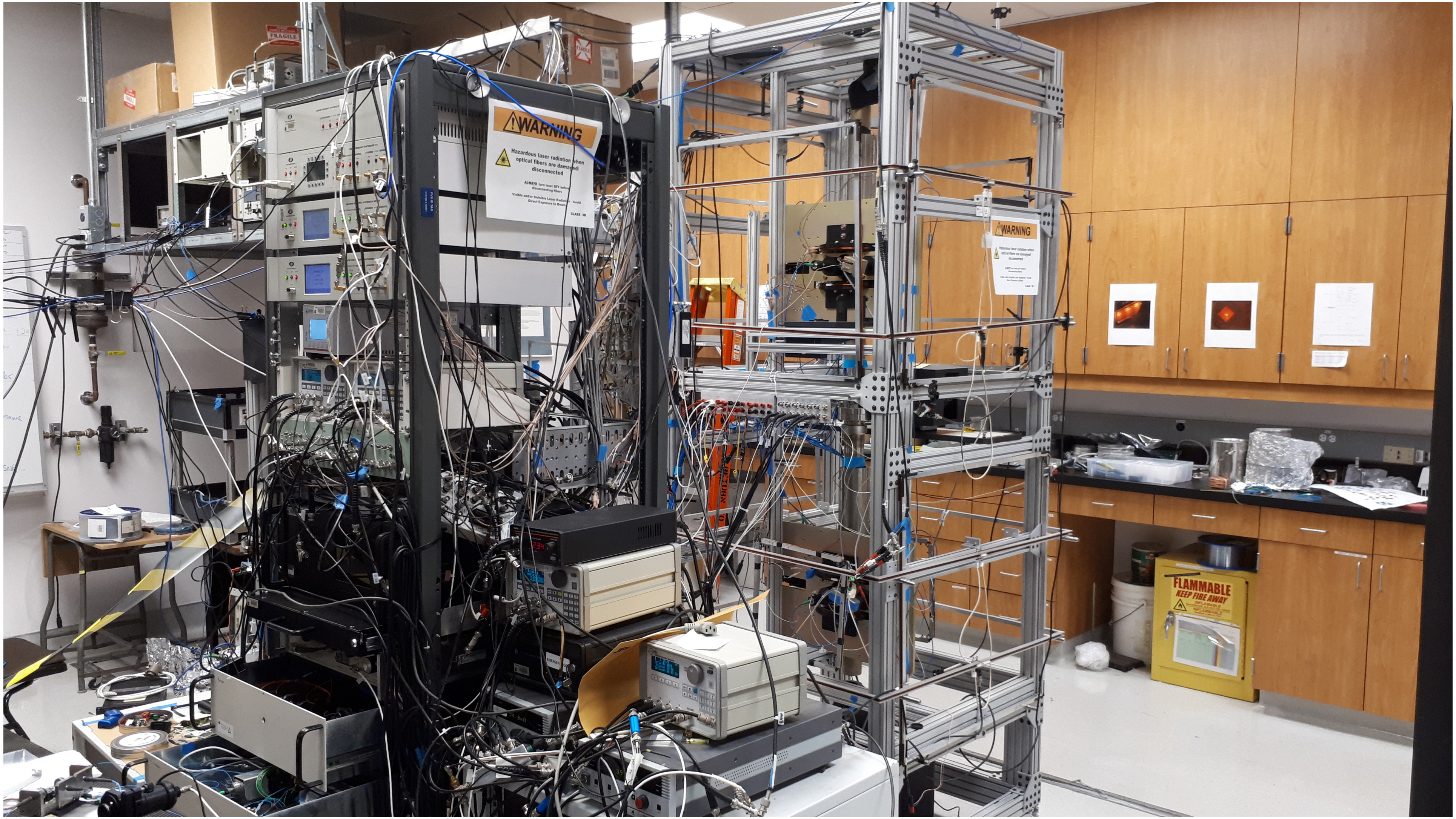
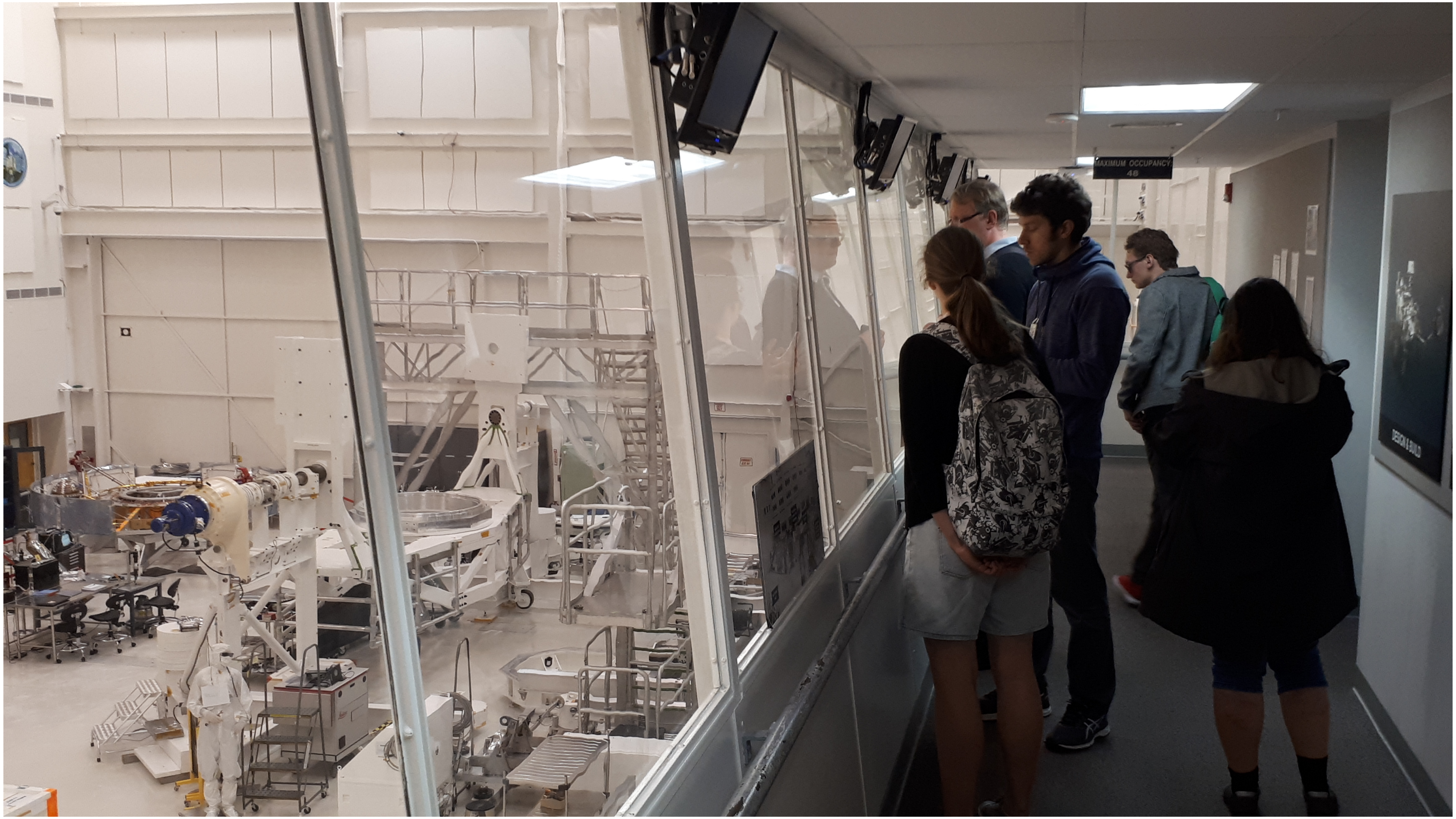

WARNING
FLAMMABLE
KEEP FIRE AWAY
FRAGILE


MAXIMUM OCCUPANCY
48