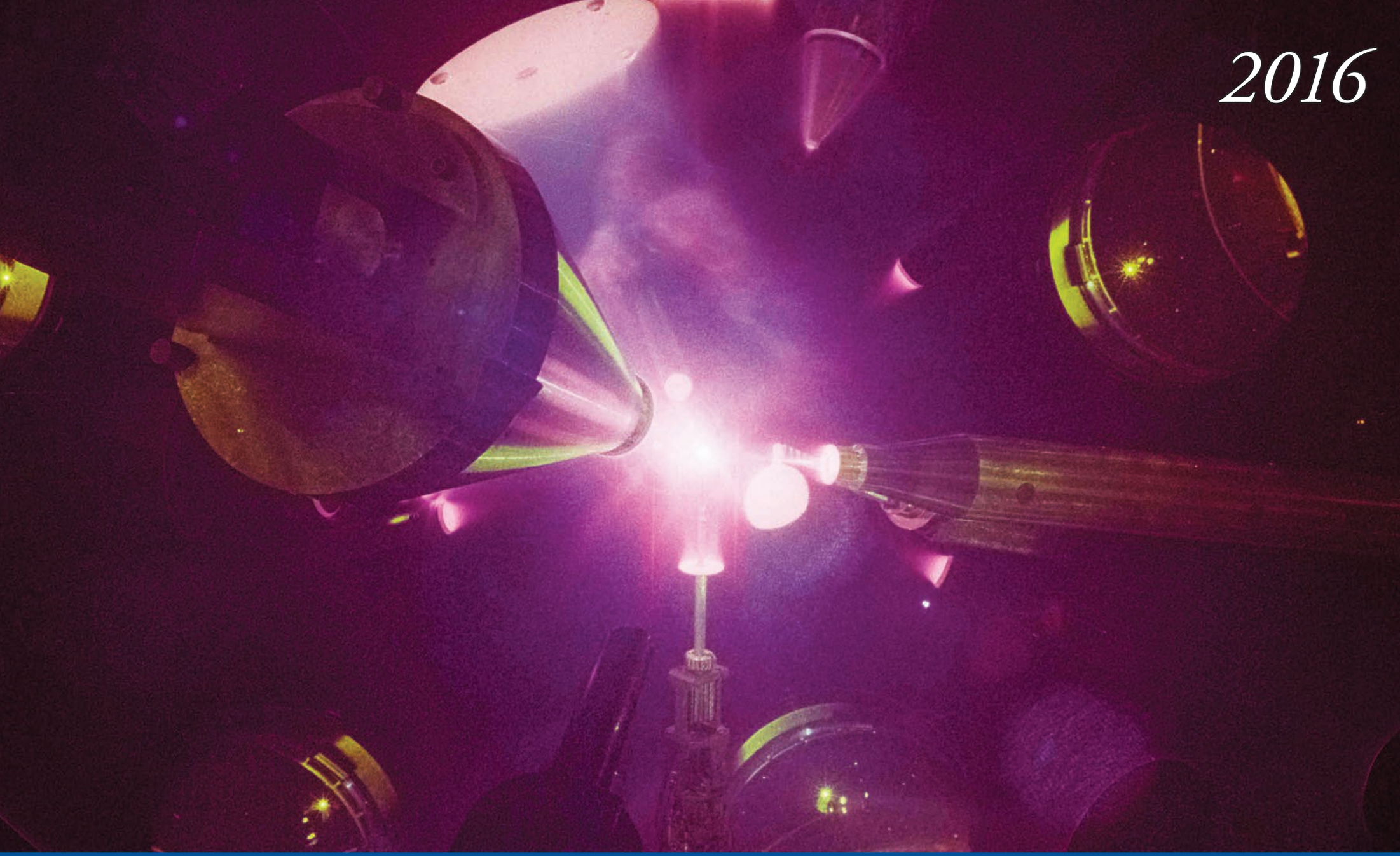

2016

LABORATORY *for* LASER ENERGETICS

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www.lle.rochester.edu

Mission Statement

The Laboratory for Laser Energetics (LLE) of the University of Rochester is a unique national resource for research and education in science and technology. The Rochester area has a history of innovation, providing a unique setting for LLE within a technologically sophisticated community. Established in 1970 as a center for the investigation of the interaction of intense radiation with matter, the Laboratory has a five-fold mission:

1. to conduct implosion experiments and basic physics experiments in support of the National Inertial Confinement Fusion (ICF) Program;
2. to develop new laser and materials technologies;
3. to provide graduate and undergraduate education in electro-optics, high-power lasers, high-energy-density physics, plasma physics, and nuclear fusion technology;
4. to operate the National Laser Users' Facility (NLUF); and
5. to conduct research and development in advanced technology related to high-energy-density phenomena.

The 2016 LLE Calendar contains information about many of the Laboratory's programs. We hope that you enjoy using your copy of the LLE Calendar and wish you a productive and fulfilling 2016.

LLE is funded by the National Nuclear Security Administration (NNSA) to support its Stockpile Stewardship Missions.

Photography by Eugene Kowaluk

National Nuclear Security Administration

Welcome to 2016

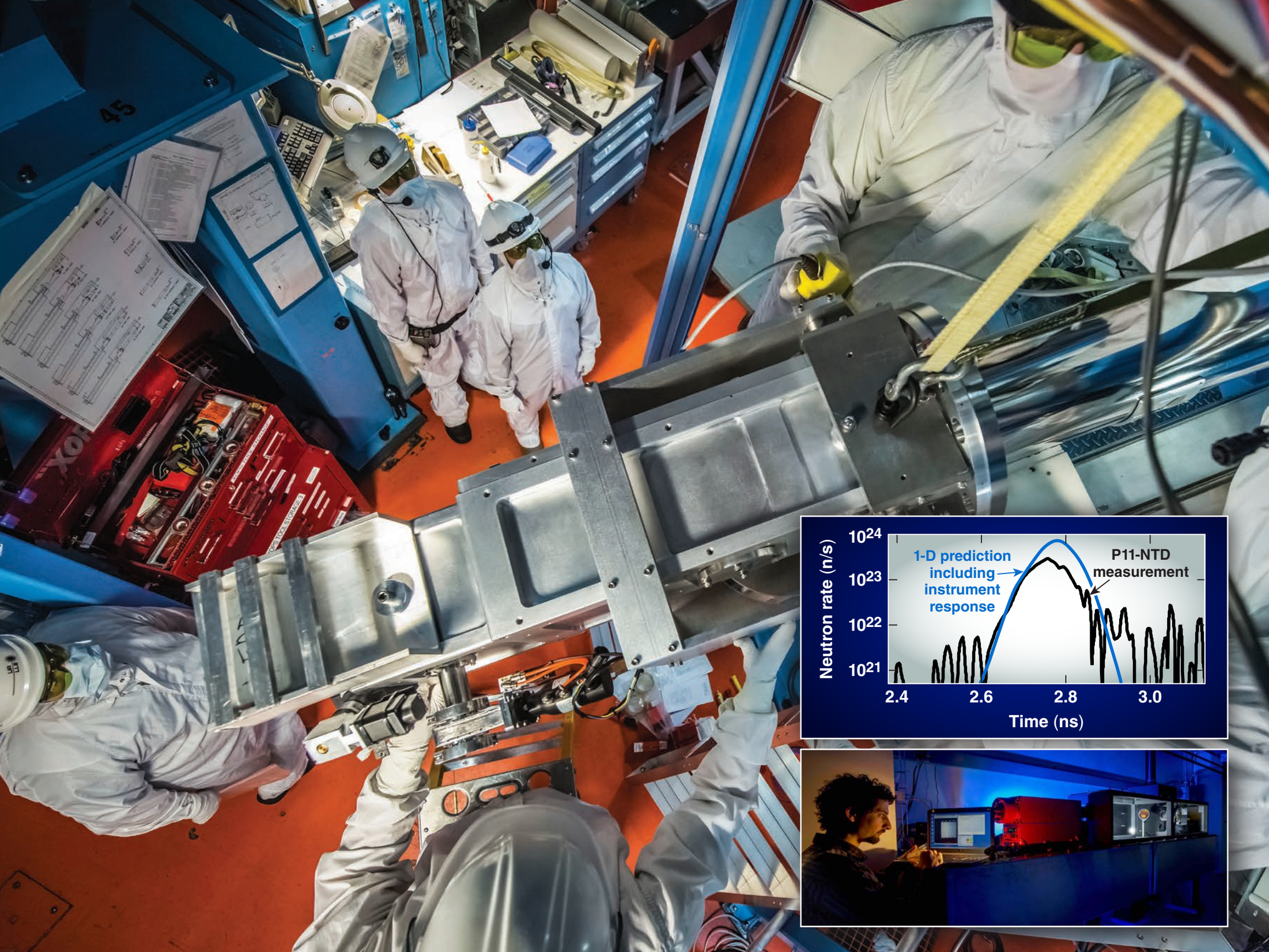
LLE Vision

LLE envisions a secure, environmentally neutral, and inexhaustible energy source for mankind. This future energy source—fusion—is the basis of the sun's energy and is carbon and radioactive-waste free.

2016 will be a year of challenges and opportunities

- Ongoing pursuit of ignition and the development of ignition alternatives
- Polar-direct-drive implosions at the National Ignition Facility
- Omega will remain the premier high-energy-density user facility
- Education and training of students (high school through Ph.D.) is a high priority

Prof. Robert L. McCrory
University Professor
Vice President, Vice Provost, University of Rochester
Director, Laboratory for Laser Energetics


Neutron rate (n/s)
10^{24}
10^{23}
10^{22}
10^{21}
1-D prediction including instrument response
P11-NTD measurement
2.4
2.6
2.8
3.0
Time (ns)

P11-NTD

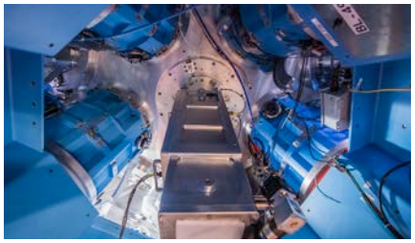
The next-generation neutron temporal diagnostic (P11-NTD) is used for high-yield cryogenic DT experiments. Here, the P11-NTD nose-cone assembly is being installed in the target chamber. The graph shows the predicted and measured neutron histories from a cryogenic capsule implosion. The inset photograph shows Senior Laboratory Engineer, Joe Katz, checking the final alignment of the diagnostic.

DECEMBER 2015

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

FEBRUARY

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29					



SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1 New Year's Day University Holiday	2 ◑*
3	4	5	6	7	8	9
10 ●	11	12	13	14	15	16 ◐
17	18	19	20	21	22	23
24 ○	25	26	27	28	29	30
31						

JANUARY 2016

*The dates of the various phases of the moon and the equinox and solstice dates are from the U.S. Naval Observatory data tables and are based on Universal Time (UT); see: http://aa.usno.navy.mil/data/docs/MoonPhase.php and http://aa.usno.navy.mil/data/docs/EarthSeasons.php, respectively.

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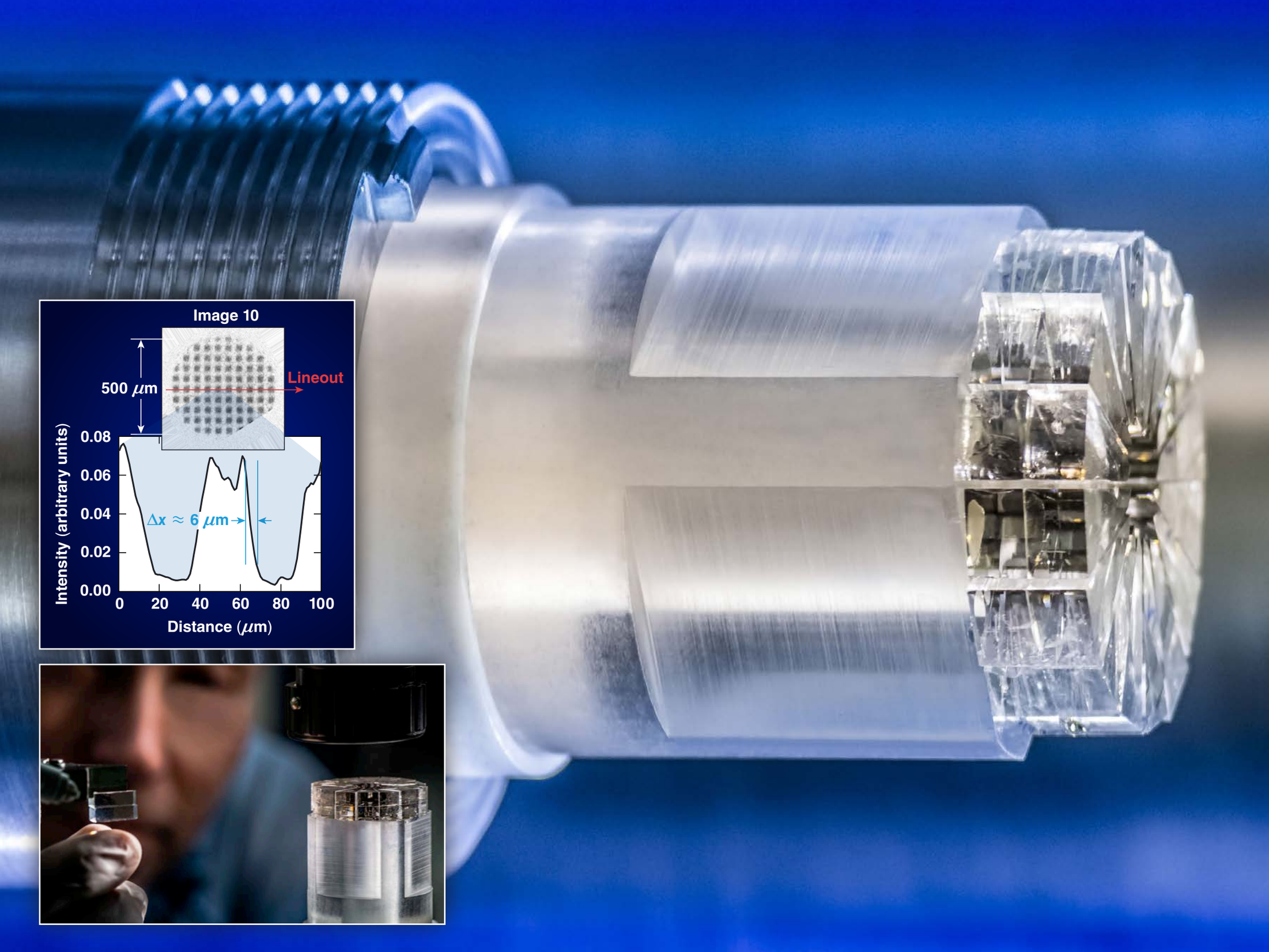
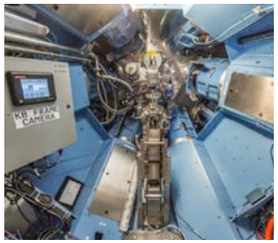
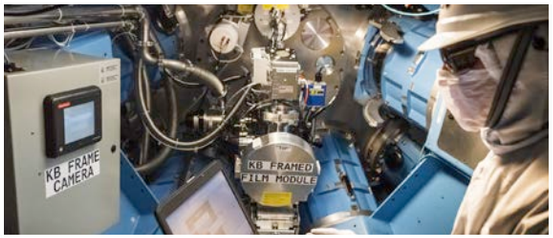
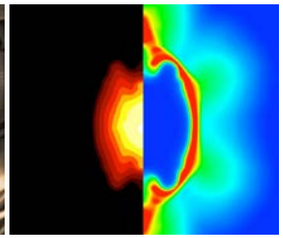


Image 10
500 μm
Lineout
Intensity (arbitrary units)
0.08
0.06
0.04
0.02
0.00
Δx ≈ 6 μm
0
20
40
60
80
100
Distance (μm)

KBframed

The next-generation Kirkpatrick–Baez (KB) 16-image microscope developed by Senior Scientist, Frederic J. Marshall (shown in inset), employs new x-ray optics for use on OMEGA cryogenic target implosions. The measurements from this new time-resolved KB microscope are used to infer the central pressure achieved in the cryogenic implosions—a key performance metric in establishing DT fusion-ignition equivalence with the OMEGA laser.

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1 ◑	2	3	4	5	6
7	8 ●	9	10	11	12	13
14	15 President's Day ◐	16	17	18	19	20
21	22 ○	23	24	25	26	27
28	29					

JANUARY

S	M	T	W	T	F	S
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10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

MARCH

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		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

FEBRUARY 2016

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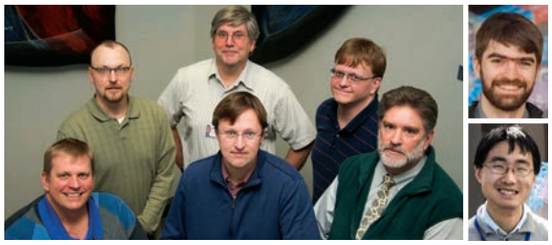
Particle time-of-flight signal
D3He-p ~ 8 × 109
X ray
Signal (V)
Time (ns)
0
1
2
3
4
5
6
0
10
20
30
40

MagPTOF

The magnet-based particle time-of-flight (MagPTOF) diagnostic will measure the shock and compression bang times on a variety of implosion platforms at the National Ignition Facility (NIF). Shown is Senior Manufacturing Engineer, John Szczepanski, with the assembled unit. The inset shows a MagPTOF recording of D^3He protons from NIF shot N150326-001-999—a D^3He–filled glass shell irradiated with 40 kJ of energy.

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1 ◑	2	3	4	5
6	7	8	9 ●	10	11	12
13 Daylight Savings Time Begins	14	15 ◐	16	17	18	19
20 Spring Equinox	21	22	23 ○	24	25	26
27	28	29	30	31 ◑		

FEBRUARY

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29					

APRIL

S	M	T	W	T	F	S
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3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

MARCH 2016

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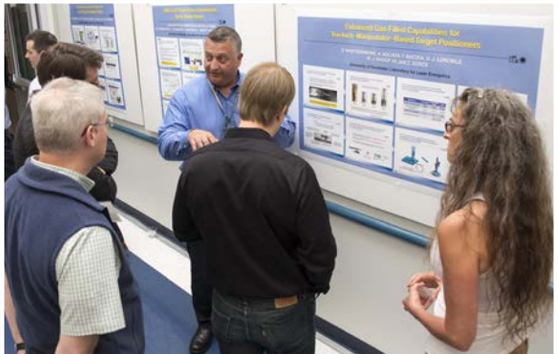

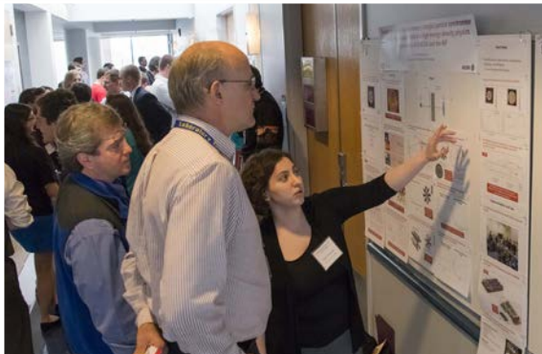

Omega Laser Facility Users Group (OLUG)

The Seventh Omega Laser Facility Users Group Workshop, held 22–24 April 2015, attracted 110 researchers from around the world. Most of the 70 contributed posters were given by students and postdocs in attendance. The next workshop will be held 27–29 April 2016.

MARCH

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
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27	28	29	30	31		

MAY

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1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1	2
3	4	5	6	7 ●	8	9
10	11	12	13	14 ◐	15	16
17	18	19	20	21	22 ○	23
24	25	26	27	28	29	30 ◑

← Omega Laser Facility Users Group Workshop at LLE →

APRIL 2016

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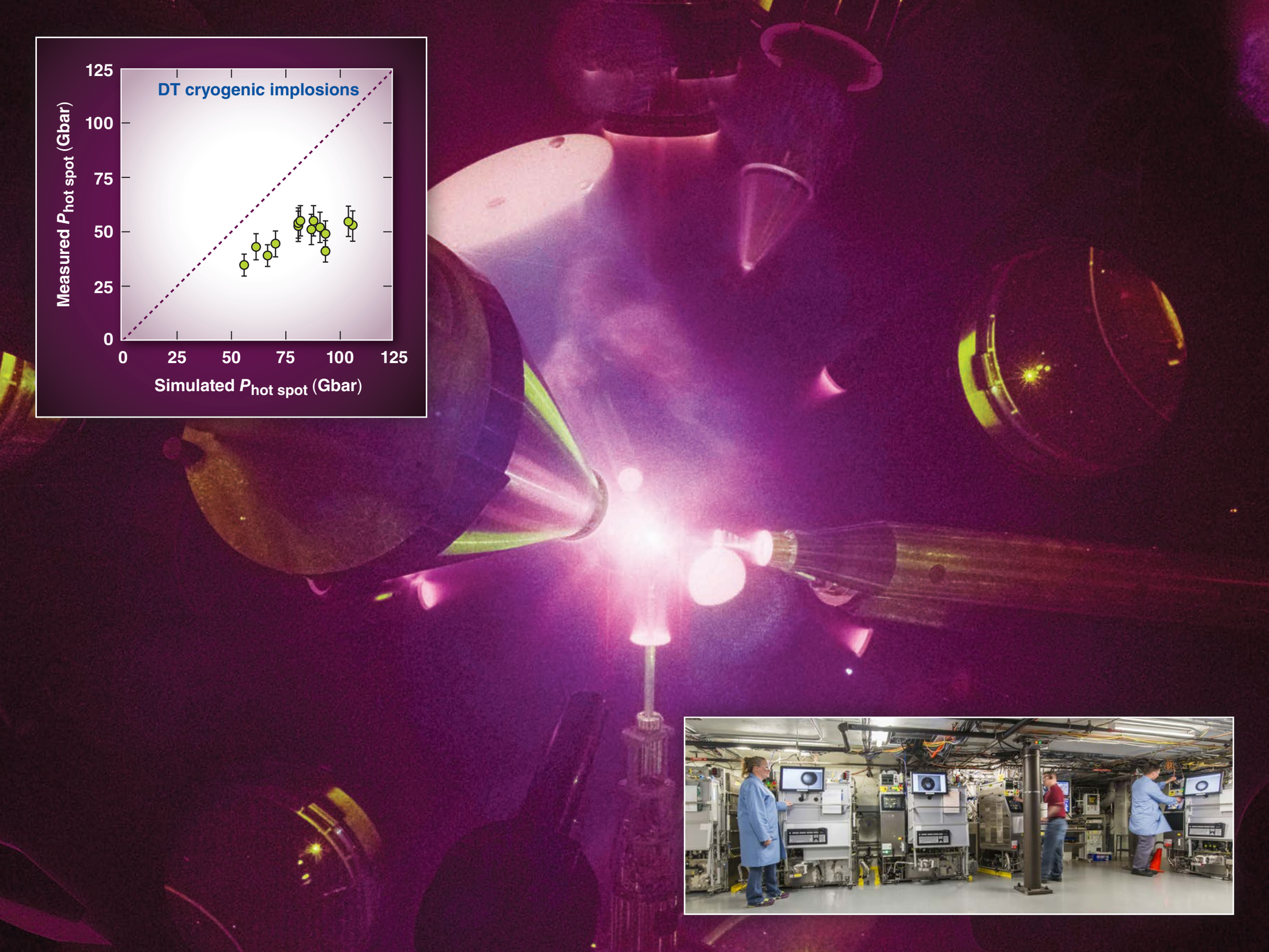
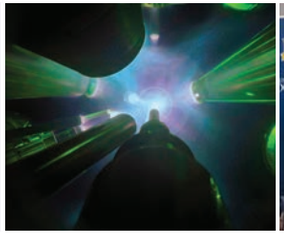

DT cryogenic implosions
Measured $P_{hot\ spot}$ (Gbar)
Simulated $P_{hot\ spot}$ (Gbar)
0
25
50
75
100
125

High-Performance Cryogenic Experiments

A comparison of the measured hot-spot pressure with simulated values showing that >50-Gbar pressure was achieved in direct-drive layered DT cryogenic implosions on OMEGA. A combination of laser and target improvements on OMEGA, as well as upgraded nuclear and x-ray diagnostics, led to the >50-Gbar observation.

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6 ●	7
8	9	10	11	12	13 ◐	14
15	16	17	18	19	20	21 ○
22	23	24	25	26	27	28
29 ◑	30 Memorial Day University Holiday	31				

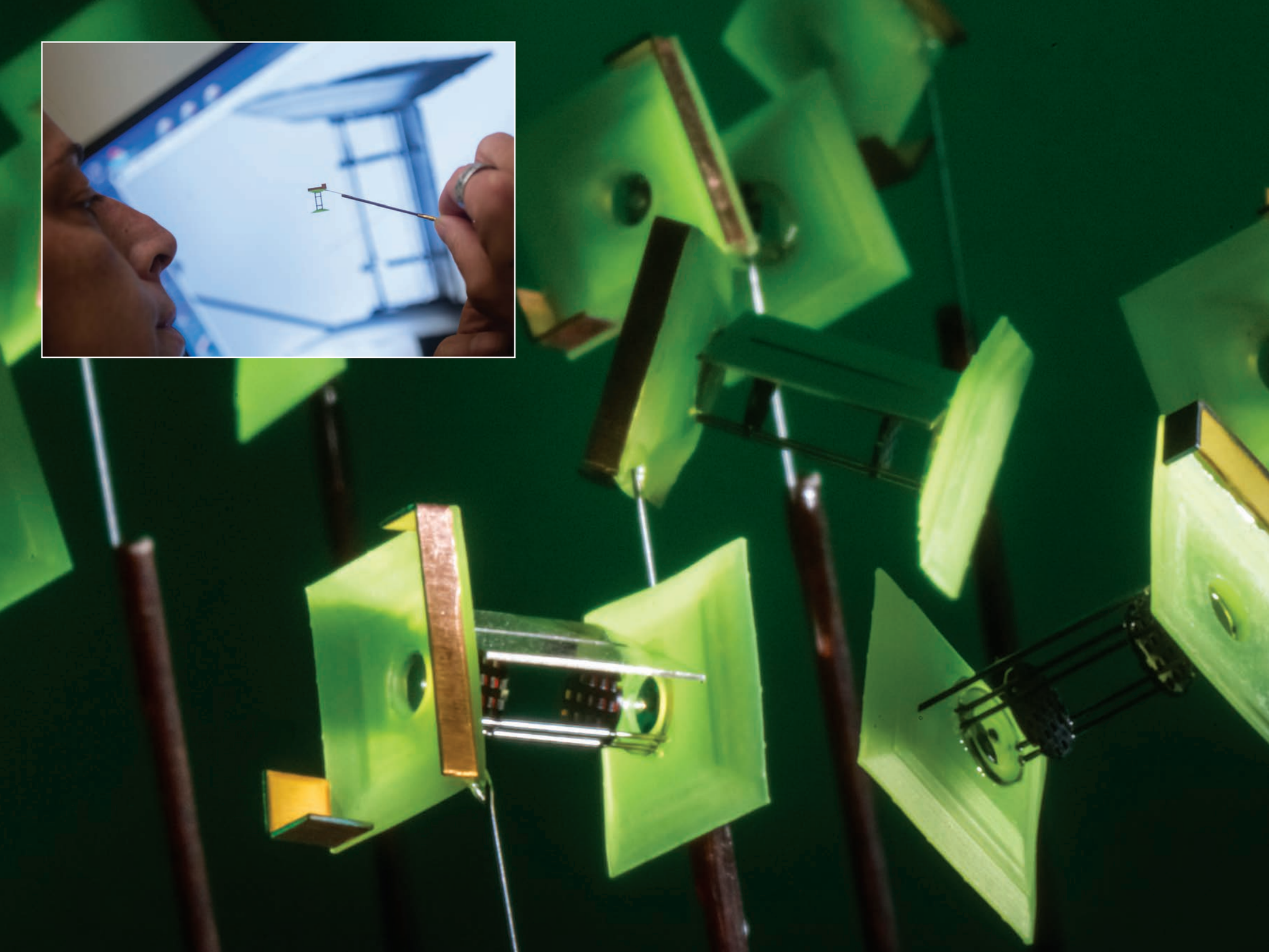
APRIL

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

JUNE

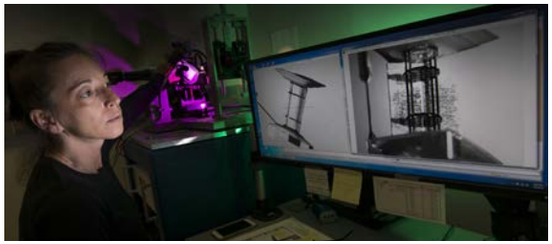
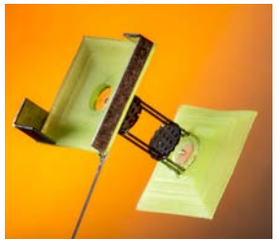
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

MAY 2016



Magnetic-Field Plasma Targets

Targets prepared for the magnetic-field plasma experiments for the National Laser Users' Facility, led by Chicago University to measure magnetic-field amplification in a turbulent medium. Target Fabrication Technician, Michelle Evans, is shown inspecting one of the targets in the inset.

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1	2	3	4
5 ●	6	7	8	9	10	11
12 ◐	13	14	15	16	17	18
19	20 Summer Solstice ○	21	22	23	24 LLE Golf Tournament at Blue Heron Hills	25
26	27 ◑	28	29	30		

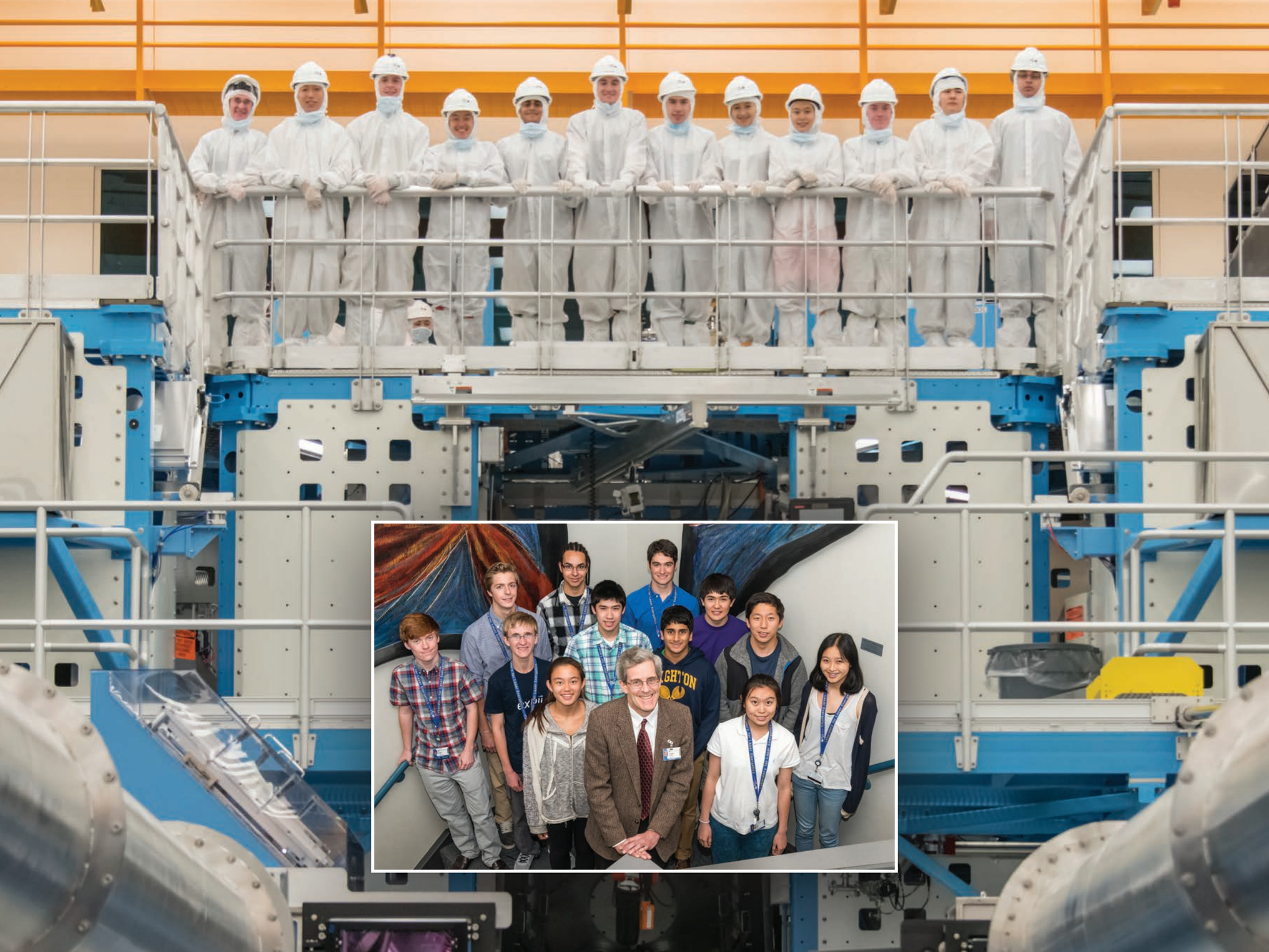
MAY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

JULY

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

JUNE 2016



Summer High School Research Program

Participants in the 2015 Summer High School Research Program. The program provides unique research opportunities to talented regional high school students and is led by Dr. Stephen Craxton.

JUNE

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

AUGUST

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1	2
3	4 Independence Day University Holiday ●	5	6	7	8	9
10	11	12 ◐	13	14	15	16
17	18	19 ○	20	21	22	23
24	25	26 ◑	27	28	29 LLE Golf Tournament at Deerfield	30
31						

JULY 2016

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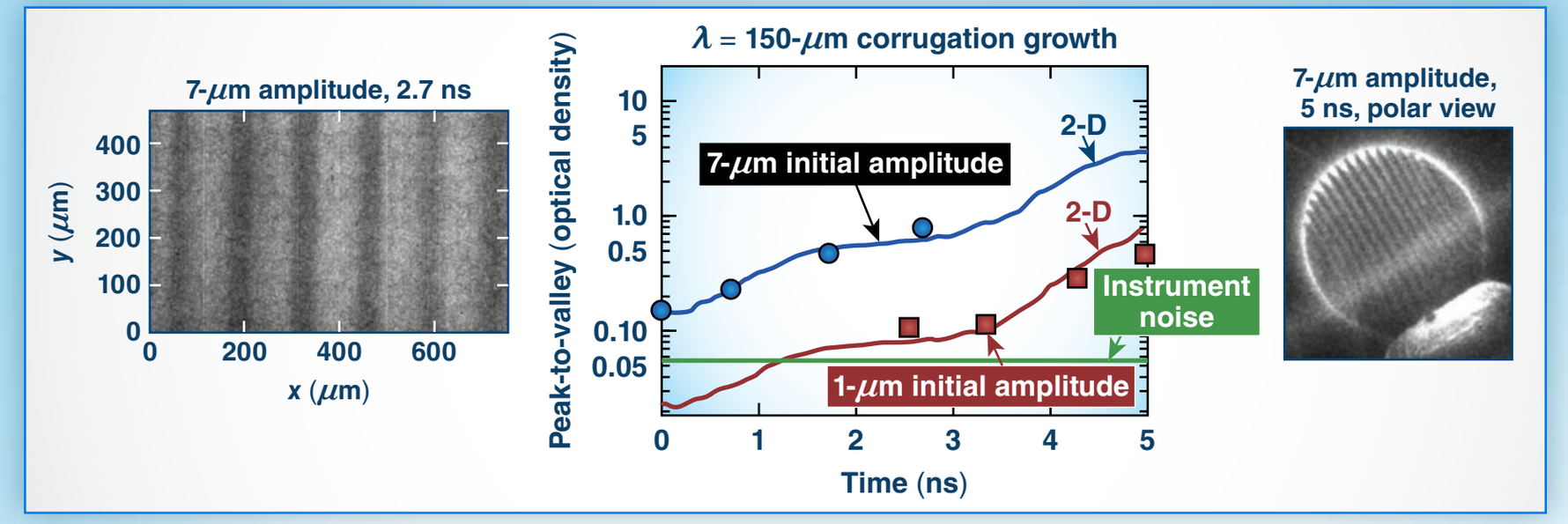
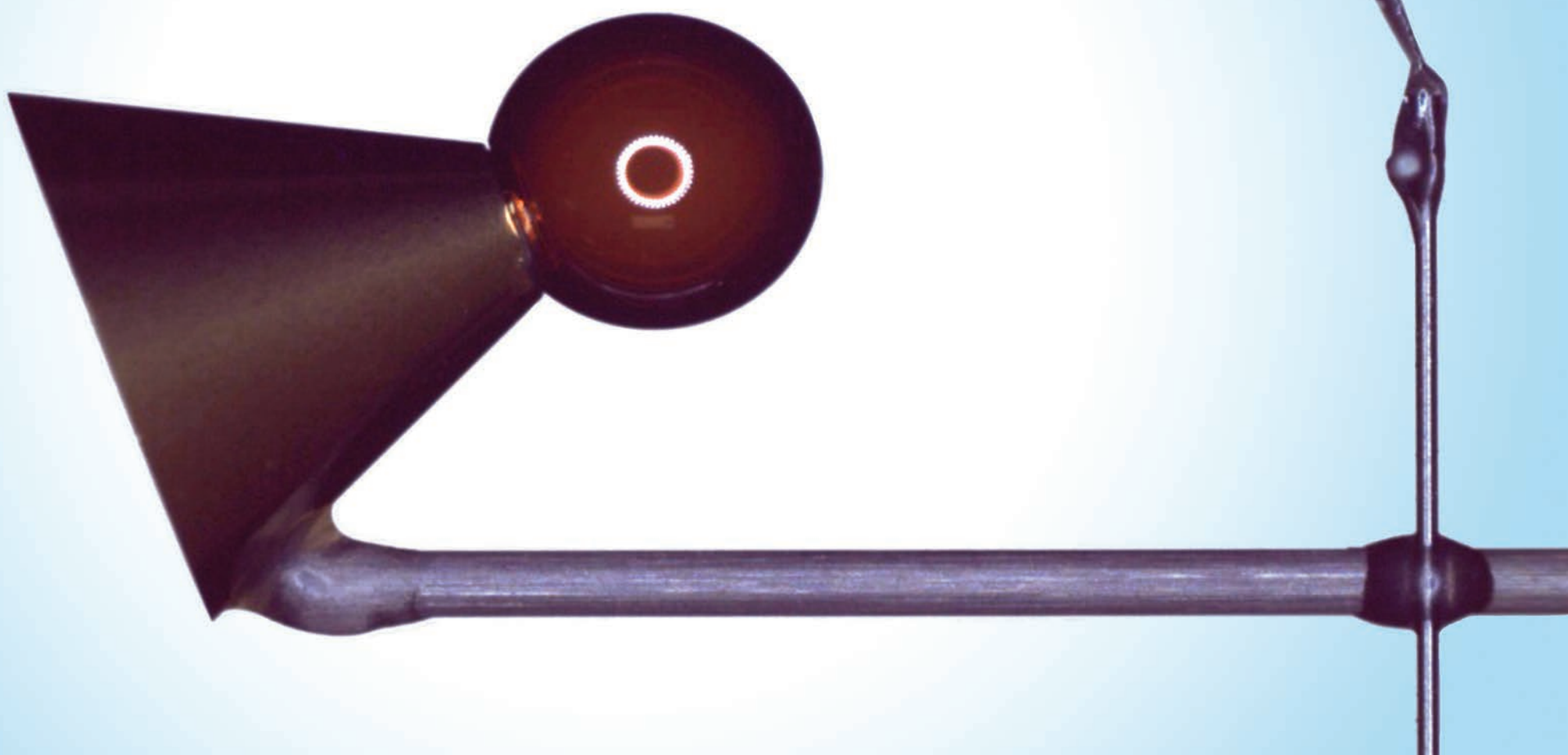
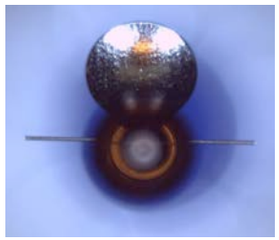

7-μm amplitude, 2.7 ns
y (μm)
400
300
200
100
0
0
200
400
600
x (μm)
λ = 150-μm corrugation growth
Peak-to-valley (optical density)
10
5
1.0
0.5
0.10
0.05
7-μm initial amplitude
2-D
2-D
Instrument noise
1-μm initial amplitude
0
1
2
3
4
5
Time (ns)
7-μm amplitude, 5 ns, polar view



Rayleigh–Taylor Experiments on the NIF

Rayleigh–Taylor instability growth from preimposed modulations is studied at the National Ignition Facility (NIF) with cone-in-shell targets and face-on, x-ray radiography. The inset shows radiography data through a modulated shell, optical-density growth, and a self-emission image of an imploding capsule with imposed surface modulations.

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1	2 ●	3	4	5	6
7	8	9	10 ◐	11	12	13
14	15	16	17	18 ○	19	20
21	22	23	24	25 ◑	26	27
28	29	30	31			

JULY

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

SEPTEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

AUGUST 2016

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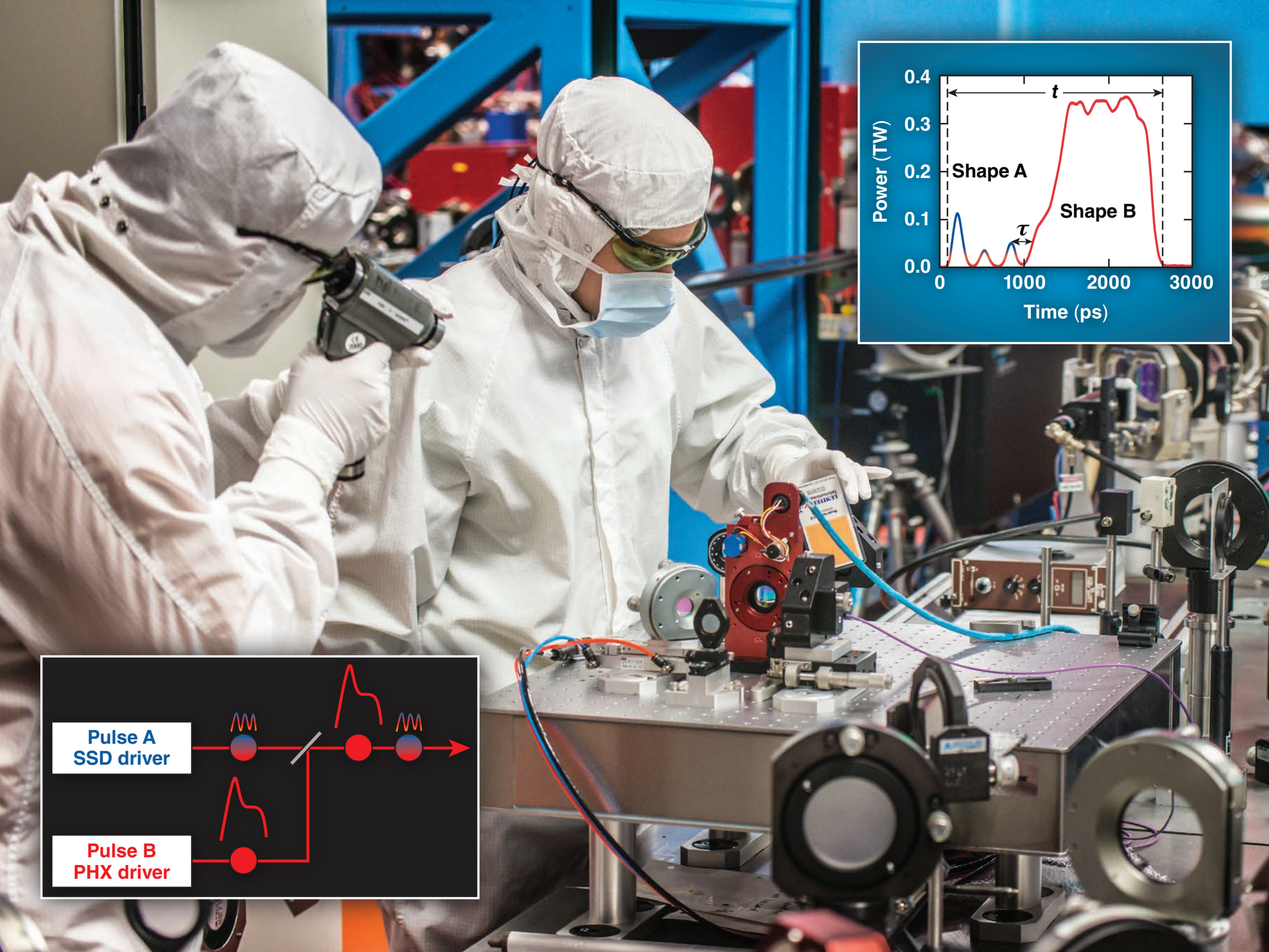
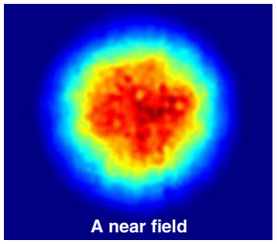
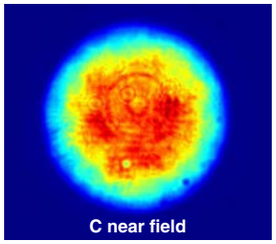
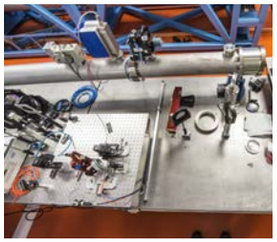
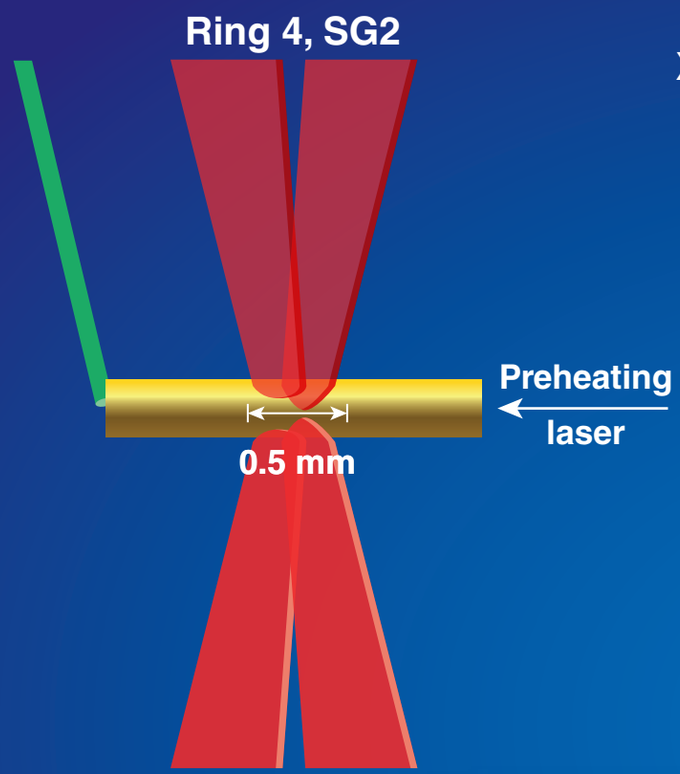

0.4
0.3
0.2
0.1
0.0
Power (TW)
t
Shape A
Shape B
τ
0
1000
2000
3000
Time (ps)
Pulse A
SSD driver
Pulse B
PHX driver

Multiple-Pulse Driver Line

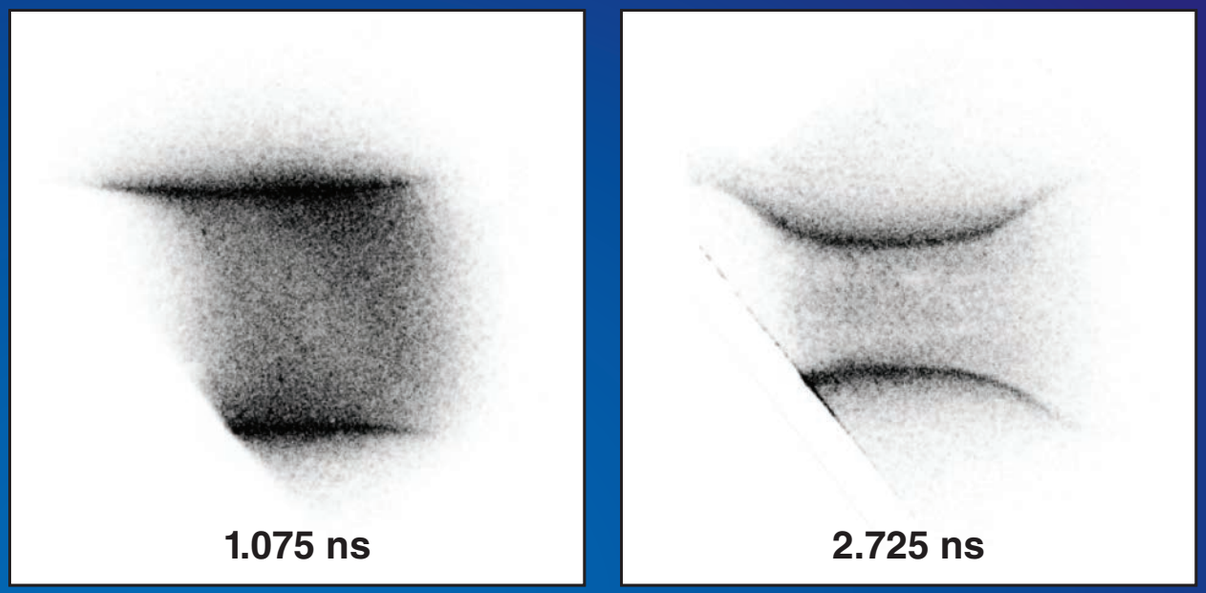
The multiple-pulse driver line (MPD) provides on-shot co-propagation of two separate pulse shapes in all 60 OMEGA beams. Smoothing by spectral dispersion (SSD) bandwidth is applied to the picket pulse shape (pulse A, inset) generated by the SSD driver. No bandwidth is applied to the pulse generated by the Phoenix (PHX) driver (pulse B). Shown aligning a diagnostic upgrade supporting MPD are Laboratory Engineer, Jeremy Zenkar (left), and OMEGA System Scientist, Tanya Kosc (right).

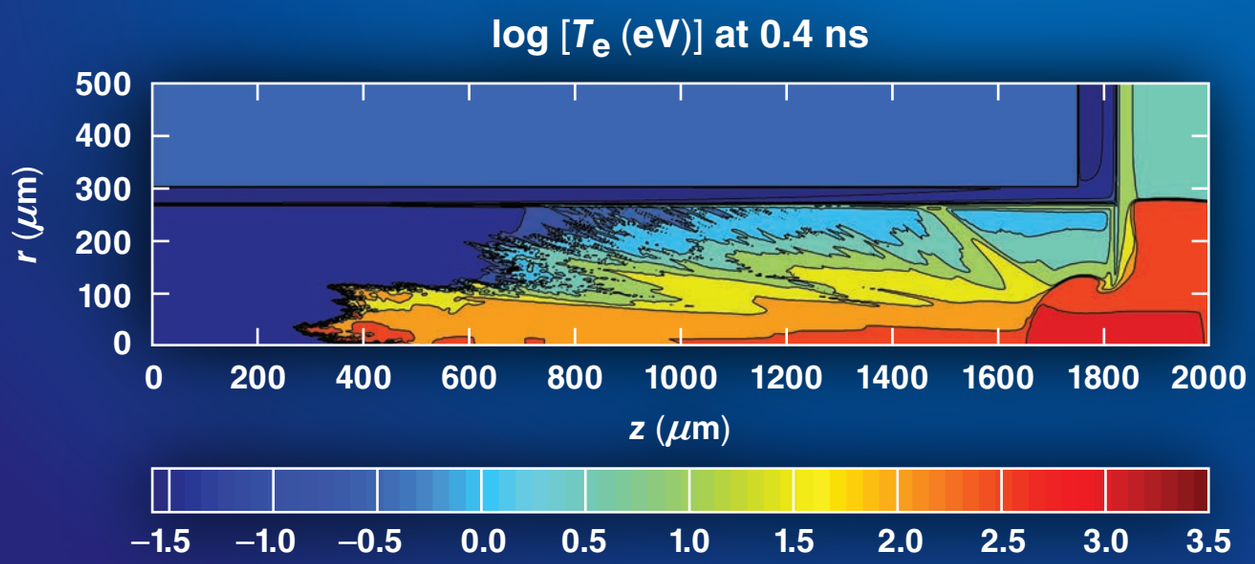
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
AUGUST S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	OCTOBER S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31			1 ●	2 LLE Golf Tournament at Bristol Harbour	3
4	5 Labor Day University Holiday	6	7	8	9 ◐	10
11	12	13	14	15	16 ○	17
18	19	20	21	22 Autumnal Equinox	23 ◑	24
25	26	27	28	29	30	

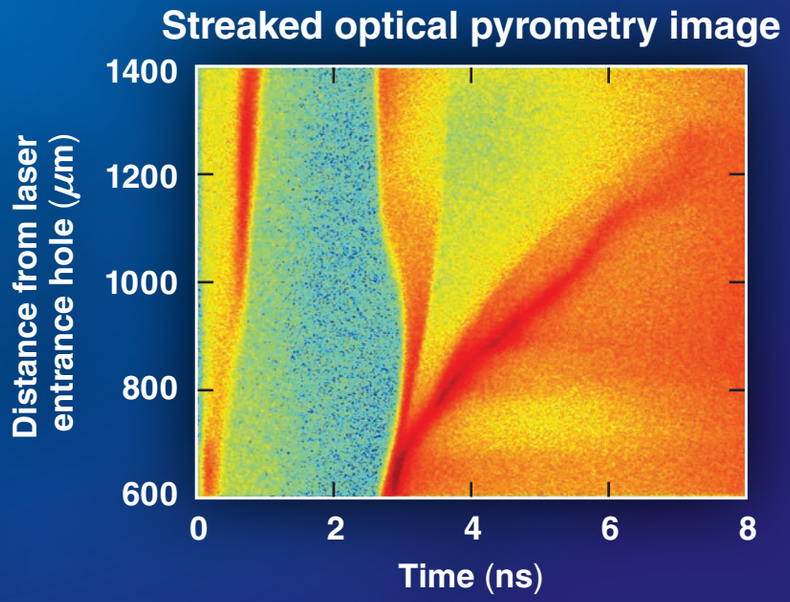
SEPTEMBER 2016



X-ray framing camera images of self-emission from an imploding target







MagLIF

Magnetic liner inertial fusion (MagLIF) is a new fusion scheme. In collaboration with Sandia National Laboratories, a scaled version of MagLIF (small-MagLIF) is being investigated at the Omega Laser Facility to study the physics of the scheme.

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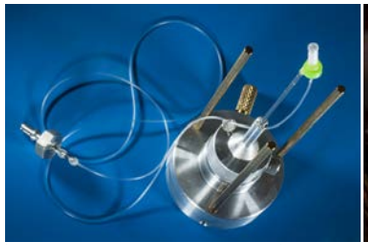
SEPTEMBER S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	**NOVEMBER** S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30					1 ●
2	3	4	5	6	7	8
9 ◐	10 Columbus Day	11	12	13	14	15
16 ○	17	18	19	20	21	22 ◑
23	24	25	26	27	28	29
30 ●	31 58th Annual Meeting of the APS Division of Plasma Physics					

OCTOBER 2016

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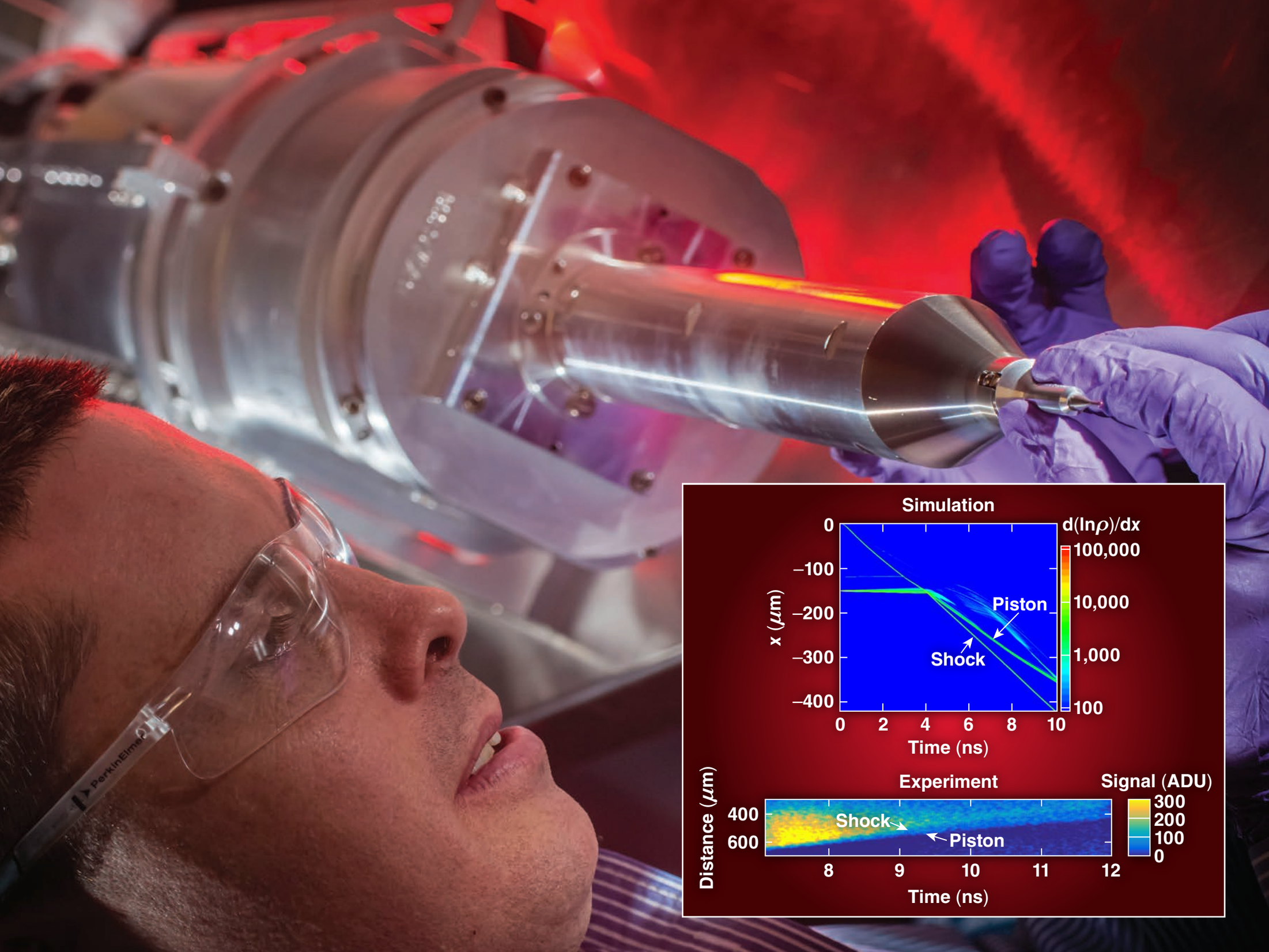
Simulation
d(lnρ)/dx
100,000
10,000
1,000
100
0
–100
–200
–300
–400
x (μm)
Piston
Shock
0
2
4
6
8
10
Time (ns)
Experiment
Signal (ADU)
300
200
100
0
Distance (μm)
400
600
Shock
Piston
8
9
10
11
12
Time (ns)

Direct EOS Measurements

Absolute equation-of-state (EOS) measurements of porous, hydrocarbon-based foams have been carried out on the OMEGA EP Laser System. The experiment used a target composed of a plastic ablator, a metal pusher, and a resorcinol-formaldyhyde foam located inside a plastic tube. Research Engineer, Chad Mileham, is shown mounting the imaging nose cone to the PJX streak camera prior to the experiments.

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
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		← 58th Annual Meeting of the APS Division of Plasma Physics in San Jose, CA →				
6 Daylight Savings Time Ends	7 ◐	8	9	10	11 Veterans Day	12
13	14 ○	15	16	17	18	19
20	21 ◑	22	23	24 Thanksgiving Day University Holiday	25 University Holiday	26
27	28	29 ●	30			

OCTOBER

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DECEMBER

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NOVEMBER 2016

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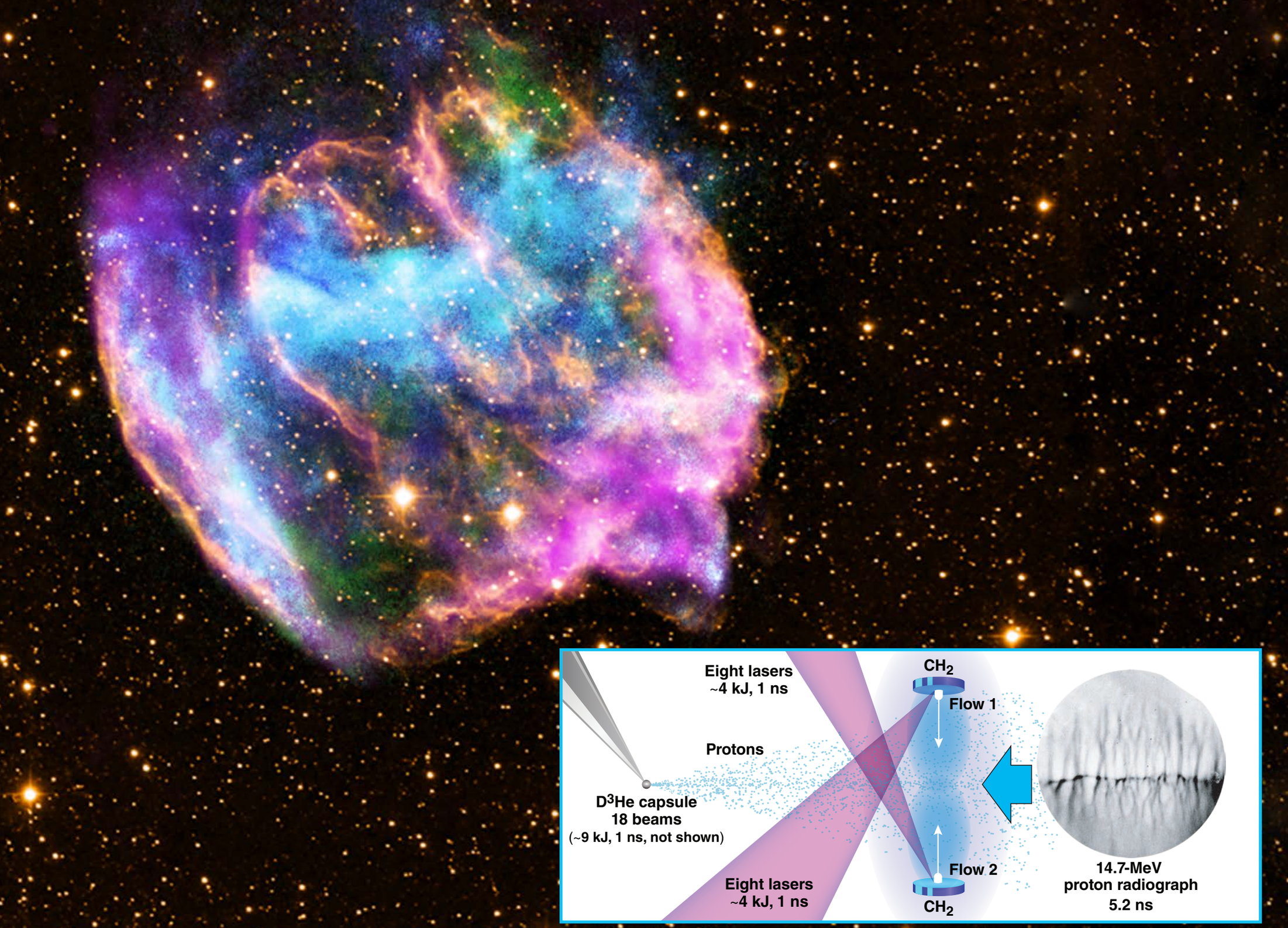

Photo: X-ray: NASA/CXC/MIT/L.Lopez *et al.*; Infrared: Palomar; Radio: NSF/NRAO/VLA

*C. M. Huntington *et al.*, Nat. Phys. 11, 173 (2015).

National Laser Users' Facility

Collisionless shock waves are common in astrophysics. One possible cause for the generation of collisionless shocks is the Weibel instability. National Laser Users' Facility and Laboratory Basic Science experiments* at the Omega Laser Facility (inset) show evidence of Weibel-generated magnetic fields in opposing plasma flows. In the background is a composite x-ray, optical, and radio image of the supernova remnant W49B thought to have been generated by a gamma-ray burst possibly induced by the Weibel instability.

NOVEMBER

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JANUARY 2017

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		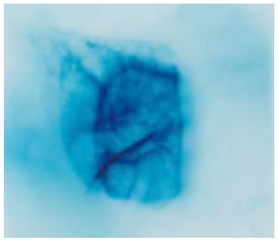	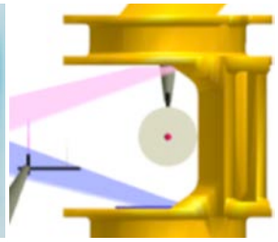	1	2	3
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18	19	20	21 ◑ Winter Solstice	22	23	24
25 Christmas Day	26 University Holiday	27	28	29 ●	30	31

DECEMBER 2016

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2017

JANUARY

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FEBRUARY

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APRIL

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MAY

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JULY

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AUGUST

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SEPTEMBER

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OCTOBER

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NOVEMBER

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DECEMBER

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2018

JANUARY

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FEBRUARY

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MARCH

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APRIL

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JULY

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AUGUST

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OCTOBER

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NOVEMBER

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