Conference Grant Report
January 4, 2019

Submitted to the

Office of Fusion Energy Science
Attn: Dr. Kramer Akli

By the

University of California, San Diego
9500 Gilman Drive
La Jolla, California 92093

On behalf of the

High Energy-Density Science Association (HEDSA) and University of California San Diego

July 30 – August 11, 2017 in San Diego, USA

Performance Period: 1 June 2017 to 30 May 2018

Principal Investigator

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I. Background

The High Energy Density Science Association (HEDSA) in collaboration with the University of California San Diego (UCSD), hosted the High Energy-Density Science Summer School from July 30 – August 11, 2017 on the UC San Diego campus. The goal of the Summer School series is to introduce new talent to the breadth of the U.S. High Energy Density Science (HEDS) community through lectures, engaging workshops, and discussion sessions with leaders in academia and the national laboratories. The objectives are to inspire young scientists to pursue graduate and professional careers in the fields of high energy density science, teach them fundamental HED science and critical skills, and grant them the opportunity to network with leading academic and national laboratory researchers. Our focus was to attract promising early-career students from across the country.

This was the fourth time the Summer School was held at UC San Diego, and the first time its duration was extended to two weeks with added hands-on experiences. Throughout the first week, the mornings consisted primarily of classroom-based teaching and the afternoons offered tutorials in one of three workshop tracks in computational modeling or experimental design. The second week included fewer lectures to allow students more workshop time, where they were encouraged to practice code modeling under the guidance of School leadership. The lecture format covered HEDS fundamentals, multidisciplinary links, and state-of-the-art science in these areas. Students were also able to attend portions of the community organized workshop on HEDS, hosted at UC San Diego during the last two days of the Summer School for additional knowledge-building and networking opportunities.

II. Meeting Report

Program Format

The HEDS field encompasses HED astrophysics, HED laboratory plasmas, and ultra-fast/ultra-intense laser-matter interactions. HEDS also spans fundamental topics from strong-field physics to creating new states of matter including radiation-dominated, strongly coupled, quantum and relativistic plasmas. Important applications of HEDS research include basic science, inertial fusion, material science, and advanced HED technologies research and development.

This year's curriculum focused on the following topics (see attached program schedule for details):

- Material science and planetary physics
- Inertial confinement fusion physics
- Atomic physics in plasmas and radiation spectroscopy
- Laser-driven hydrodynamics and shocks
- Intense laser plasma physics and particle acceleration
- Kinetic vs. fluid effects
- Laboratory astrophysics
- Magnetized plasma dynamics and instabilities

Lectures on the above topics were given by experts affiliated with the Sandia National Laboratories (SNL), Lawrence Livermore National Laboratory (LLNL), and the Laboratory for

Laser Energetics (LLE), flagship universities namely, University of California San Diego (UCSD), University of California Davis, University of Nevada Reno (UNR), University of Rochester (UR), University of Nebraska Lincoln (UNL), and industry (Polymath Research, Inc. (Polymath), Prism Computational Sciences, Inc. (Prism), and General Atomics (GA). Besides these, the School presented special sessions including:

- Kinetic computational modeling tools workshop with various Vlasov and PIC codes
- Fluid computational modeling workshop with radiation hydrodynamics code, FLASH
- Spectroscopic analysis workshop with PrismSPECT atomic physics code
- Diagnostics for HED experiments
- Current and future high-power laser technology talks
- Target fabrication capabilities for HEDS experiments
- Communications presentation for effective oral talks
- Panel discussion on career options in HEDS
- Oral and poster sessions for students and postdocs
- Tours at HEDS experimental and target fabrication facilities at UCSD and GA, respectively

The three workshops were led by Bedros Afeyan (Polymath), Petros Tzeferacos (University of Chicago) and Roberto Mancini (UNR) with support from Brad Shadwick (UNL), Jeff Hittinger (LLNL), Rick Sydora (University of Alberta), Frank Tsung (University of California Los Angeles), Igor Golovkin (Prism), Chris McGuffey (UCSD), Stephanie Hansen (SNL), Dustin Froula (UR), David Meyerhofer (Los Alamos National Laboratory), and Farhat Beg (UCSD). Students who chose the kinetic modeling workshop were taught about differential equation solvers, particle-in-cell code construction, and were assigned a plasma physics phenomenon to study with one of various Vlasov or PIC codes. Students in the fluid modeling workshop were introduced to a one-dimensional (1-D) radiation hydrodynamic code and then guided in the use of the 2-D code FLASH by its steward. They were assigned plasma physics phenomena to explore using the code. Students in the spectroscopy workshop were first taught atomic physics, notation, and spectroscopic considerations in plasma. Then they were introduced to optical and x-ray spectroscopy devices and experimental implementations of spectroscopic techniques. They were granted short-term access to the commercial atomic physics code, PrismSPECT, and atomic data for low-Z materials and assigned experimental design tasks. At the end of the School, the students of the three workshops united to share their experiences. Each group of 3-5 students working on related topics assembled a short presentation showing what they learned, which they presented to the whole student body on the last day.

The panel discussion on career options in HEDS included four panelists with work history at SNL, LLNL, LLE, academia, and industry. The panelists fielded a variety of questions from the students and postdocs.

Supported students were required to present either an oral talk or poster on the second Monday. This gave them an opportunity to be actively engaged in the discussion of collaborative experiments and present their work to colleagues and potential employers. It was the first such opportunity in the HEDS field for a few of the students.

Lectures from the School have been made available in PDF and video format to participants online via a password-protected section of the School website.

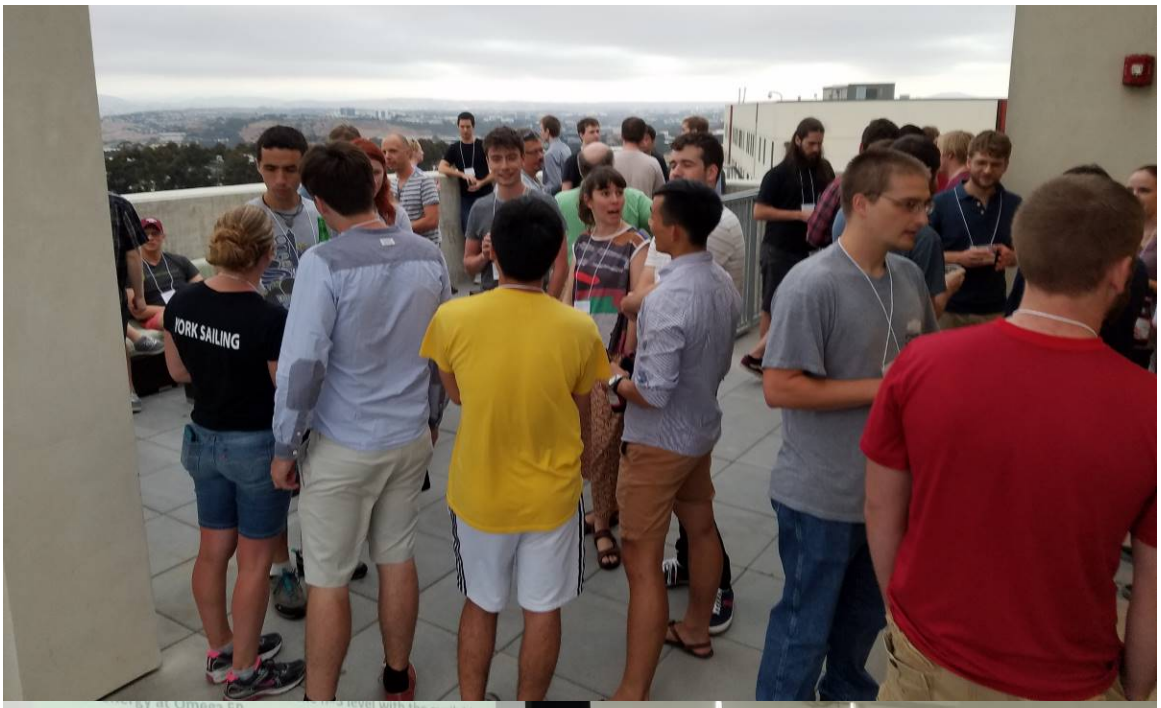
Program Participation

One hundred fourteen (114) participants attended the 2017 HEDS Summer School, including 27 lecturers, 14 postdoctoral scholars, 58 graduate students and 5 undergraduate students. There were 21 lectures and 12 hands-on sessions delivered during this event. Four (4) students gave oral presentations and seventy-eight (78) participants presented posters.

Eighty-four (84) applications were submitted for student travel and accommodations funding support, and of these, 61 were offered support, with preference given to early-track students at U.S. institutions. Most applicants from a non-U.S. institution were not offered support. However, 6 from the United Kingdom, 1 from Japan, and 2 from the University of Alberta were awarded support for domestic expenses only, if their research was closely collaborated with LLNL or SNL research or filled an HED topic of interest to the labs that was not well represented by the domestic applicants (such as spectroscopy and pulsed power). These countries have historically collaborated on projects with and have been recruiting sources for the national laboratories. Student travel funding applications were judged by the Steering Committee of the High Energy Density Science Summer School (C. McGuffey, F. Beg, B. Afeyan, and M. S. Wei), based on resumes and two letters of recommendation. Fifty-nine (59) students were funded by this grant with lodging in the dormitories, meals in the cafeteria, and domestic travel up to $500 covered. A list of supported students is attached.

III. Appendix

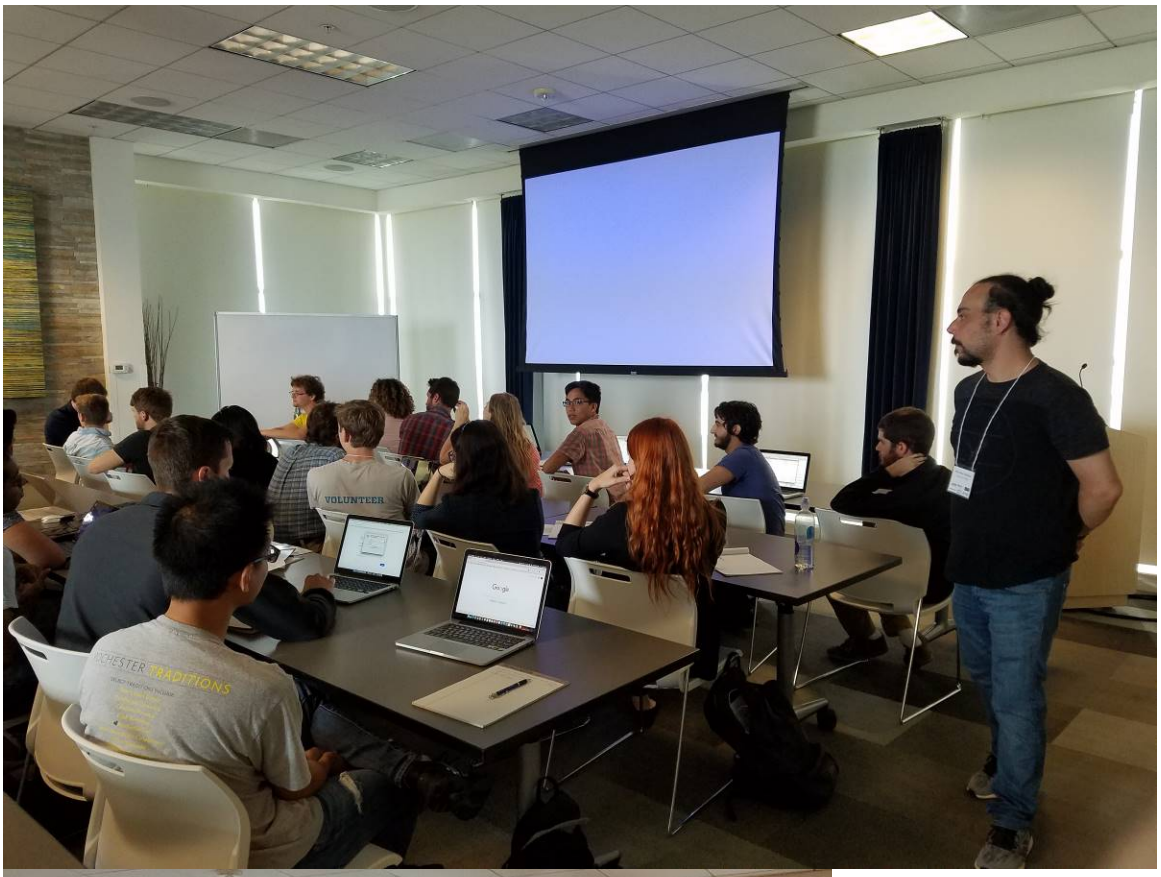
Photos

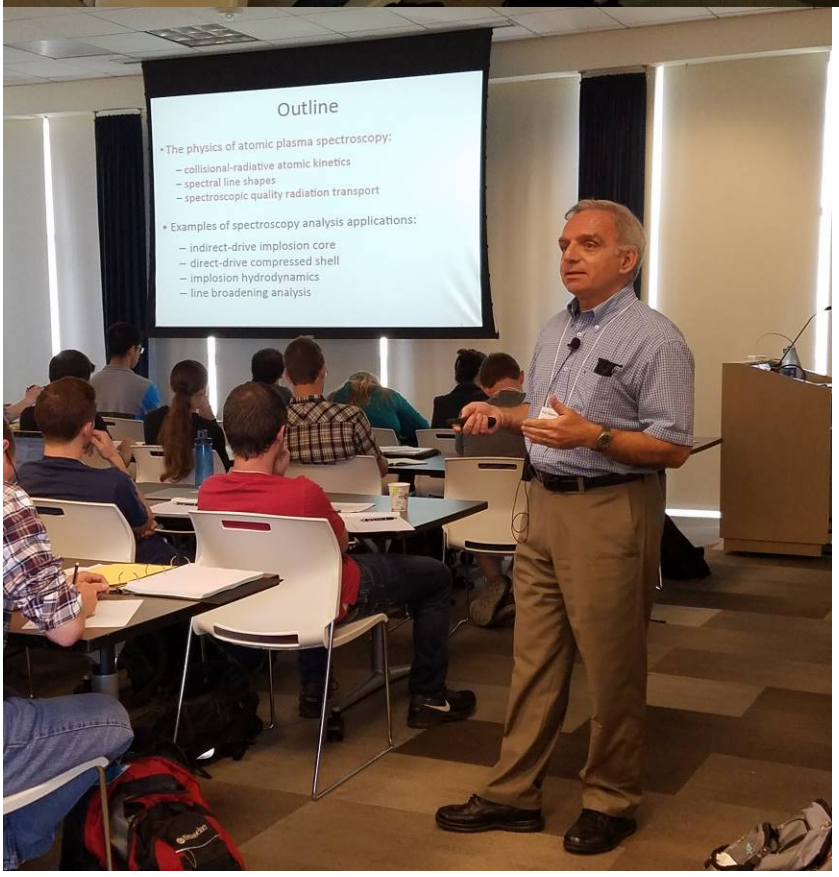

YORK SAILING


Potassium requires a significantly less compression to ionize the 3p (7.4 g/cm³ or 587 GPa)


Electron driver III

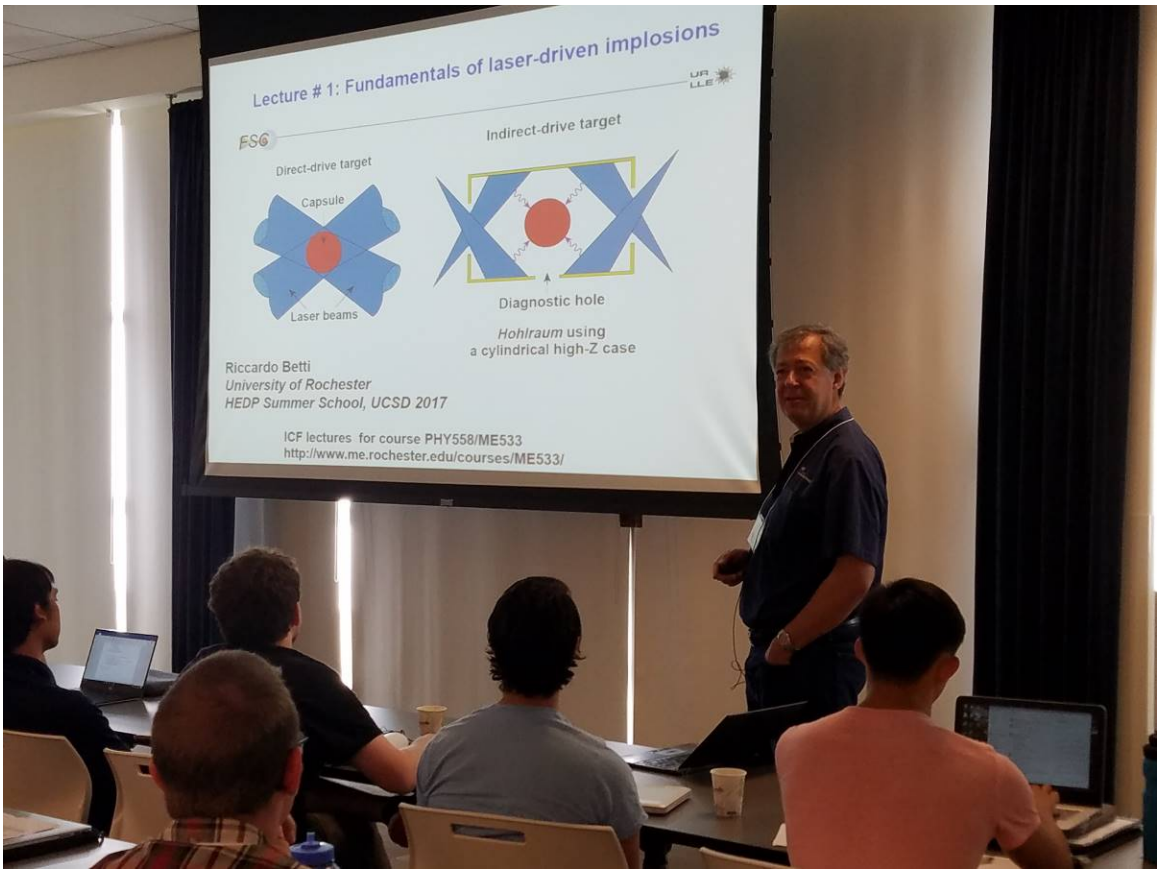

Hydrodynamics Workshop
HEDS Summer School 2017
Petros Tzeferacos, University of Chicago
Igor Golovkin, Prism Computational Sciences, Inc.
UC San Diego campus, La Jolla, CA, August 2017
PRISM


VOLUNTEER
TRADITIONS

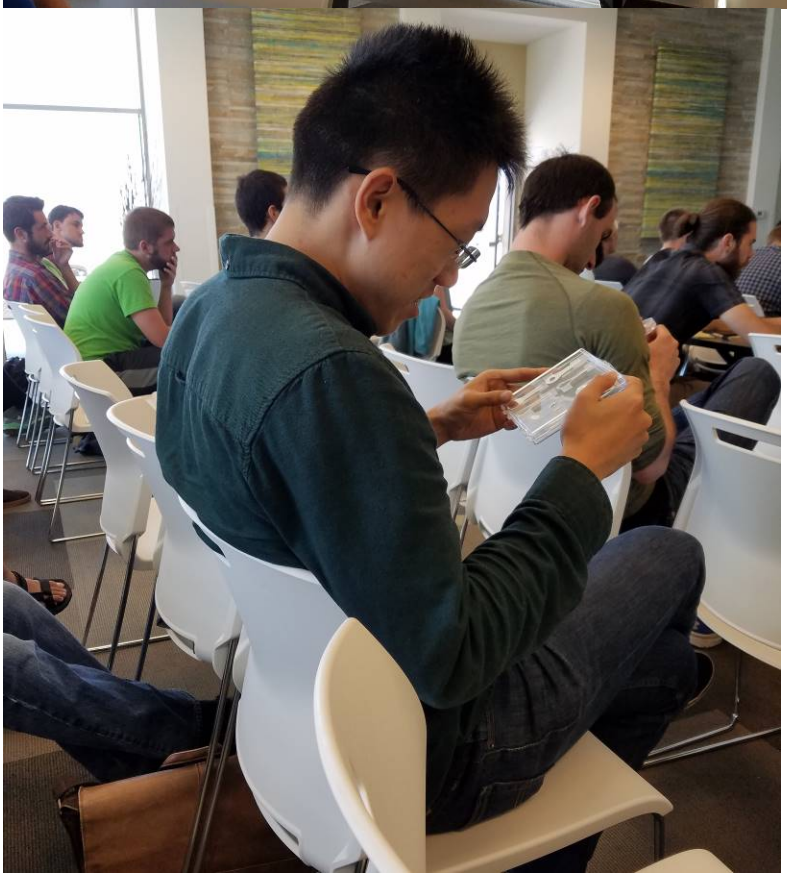

Outline
• The physics of atomic plasma spectroscopy:
– collisional-radiative atomic kinetics
– spectral line shapes
– spectroscopic quality radiation transport
• Examples of spectroscopy analysis applications:
– indirect-drive implosion core
– direct-drive compressed shell
– implosion hydrodynamics
– line broadening analysis


Two major high intensity petawatt laser projects at LLNL
Advanced Radiographic Capability (ARC)
High repetition-rate Advanced Petawatt Laser System (HAPLS)
>30 J
30 fs
10 Hz
>1 PW
TBD
2017
World's most energetic Petawatt laser
World's highest rep-rate Petawatt laser (10 Hz)
12,000 J in 10 ps, 1 shot/2 hours
< 2W
30 J in 30 fs, 10 shots/second
300W
1 Petawatt = 10^15 Watts = 1,000,000,000,000,000 Watts
Slide Courtesy C. Haefner
NNSA


Developing lasers and applications at the frontiers of science and technology is a core focus at NIF & Photon Science
Advanced Radiographic Capability System (ARC)
High-rep-rate Advanced Petawatt Laser System (HAPLS)
Main mission: HED backlighter
Main mission: Secondary Source driver for basic and applied science at ELI Beamlines
Two major short pulse laser, high intensity lasers built at LLNL


Lecture # 1: Fundamentals of laser-driven implosions
UR LLE
FSC
Direct-drive target
Capsule
Laser beams
Indirect-drive target
Diagnostic hole
Hohlraum using
a cylindrical high-Z case
Riccardo Betti
University of Rochester
HEDP Summer School, UCSD 2017
ICF lectures for course PHY558/ME533
http://www.me.rochester.edu/courses/ME533/


Studying Turbulent Dynamos



Schedule

	The Village		Village West 15th floor	Village West 15th floor	Village West 15th floor	Village West 15th floor
Time	**Sunday, July 30**	**Time**	**Monday, July 31**	**Tuesday, August 1**	**Wednesday, August 2**	**Thursday, August 3**
	Reading and writing early assignments	08:00-08:45	Breakfast in Café Ventanas	Breakfast	Breakfast	Breakfast
		09:00-10:15	Fundamental plasma physics I: structure of plasma theory [Shadwick, UNL]	Fund. plasma physics II: linear waves, scattering, radiation [Froula, UR]	Fund. plasma physics III: waves and instabilities in HED plasmas [Afeyan, PRI]	Fund. plasma physics IV: Effects of magnetic fields and relativistic intensities [Sydora, UAlberta]
		10:15-11:30	HED frontier experiments with short-pulse lasers [Shepherd, LLNL]	Atomic and radiation physics [Mancini, UNR]	Taming the physics of high energy, high peak power lasers [Link, LLNL]	Introduction to ICF I: a hydro perspective [Betti, UR]
		11:30-12:00	Break	Break	Break	Break
		12:00-13:15	Laser particle acceleration [Roth, TUD]	~~Results in High Pressure Physics [Hemley GWU]~~	Fundamentals of effective oral presentation [Fox, UCSD]	Introduction to ICF II: a hydro perspective [Betti, UR]
		13:15-14:30	Lunch in Café Ventanas	Lunch	Lunch	Lunch
		Parallel workshop threads 14:30-17:30 with break 15:45-16:15	Room 15A: math/physics for HED crash course I [Afeyan, Sydora, Hittinger, Shadwick], computational methods and data analysis tools [Golovkin, Tzeferacos]	Rm 15A: hydrodynamic modeling crash course cont'd [Golovkin, Tzeferacos]	Rm 15A: hydrodynamic modeling crash course cont'd [Golovkin, Tzeferacos]	Rm 15A: hydrodynamic modeling recommended projects [Golovkin, Glinsky, Tzeferacos]
				Rm 15B: Spectroscopy crash course [Mancini, Beg]	Rm 15B: Spectroscopy crash course [Mancini, Meyerhofer]	Rm 15B: Spectroscopy/data analysis recommended projects [Mancini, McGuffey, Meyerhofer]
16:00 +	Checkin for on-campus housing (open 24/7)		Room 15B: Experimental tools: Thomson Scattering and Spectroscopy [Froula]	Rm 15C: kinetic modeling crash course cont'd [Afeyan, Hittinger, Shadwick, Sydora]	Rm 15C: NLO of plasmas- SRS, SBS, TPD, FIL, CBET [Afeyan, Hittinger, Shadwick, Sydora]	Rm 15C: kinetic modeling recommend projects [Afeyan, Hittinger, Sydora]
18:00-19:00	Dinner in Café Ventanas	17:30-18:00	free	free	free	free
19:00-20:00	Dessert & Drinks / registration Village West 15th Floor	18:00-19:00	Dinner in Café Ventanas	Dinner	Dinner	Dinner

	Sanford Roth Auditorium
Time	Friday, August 4
08:00-08:45	Breakfast
09:00-10:15	Modern Tools HEDP Computational Modeling [Hittinger, LLNL]
10:15-11:30	Laser particle interaction in the relativistic regime [Arefiev, UCSD]
11:30-12:00	Break
12:00-13:15	Material science in extreme environments [Sarah Stewart, UCD]
13:15-14:30	Lunch
14:30-15:45	The theoretical description of HED Matter [Graziani, LLNL]
15:45-18:00	Work on your individual projects!
18:00-19:00	Dinner

	Village West 15C	Village West 15C
Time	Saturday, August 5	Sunday, August 6
08:00-08:45	Breakfast	Breakfast
09:00-13:00	Office Hours [workshop leads by appointment]	Office Hours [workshop leads by appointment]
	Work on your individual projects!	Work on your individual projects!
13:15-14:30	Lunch	Lunch
	Work on your individual projects!	Work on your individual projects!
18:00-19:00	Dinner	Dinner

	Village West 15th floor	Village West 15th floor
Time	Monday, August 7	Tuesday, August 8
08:00-08:45	Breakfast	Breakfast
09:00-10:15	Advanced laser systems of today and the future [Haefner, LLNL]	Laser particle acceleration: electrons and photons [Fuchs, UNL]
10:15-11:30	Introduction to magnetized ICF [Peterson, SNL]	Target fabrication for the NIF [Nikroo, LLNL]
11:30-12:00	Break	Break
12:00-13:15	4x student invited oral talks (15+3 min)	Target fabrication capabilities for HED science at General Atomics [Farrell, GA]
13:15-14:30	Lunch	Lunch
14:30-17:30	Poster session, rooms 15A-B	General Atomics tour (if listed on your name badge, board bus on Scholars Drive by 14:30 sharp!) or UCSD walking tour (meet on grass in front of Café Ventanas at 14:30)
	Break	
	Poster session cont'd	
18:00-19:00	Dinner	Dinner

Rady Beyster Auditorium

Time	Wednesday, August 9
08:00-08:45	Breakfast
09:00-10:15	Advanced magnetized HED: MHD instabilities in Z-pinches [J Hammer, LLNL]
10:15-11:30	New physics of matter under extreme pressures [Collins, LLE]
11:30-13:15	Individual projects with workshop leads' supervision [Tzeferacos, Hansen, Afeyan]
13:15-14:30	Lunch
14:30-15:45	Career Panel
15:45-18:00	Individual projects with workshop leads' supervision [Tzeferacos, Hansen, Afeyan]
18:00-19:00	Dinner

Faculty Club/Rady 1E106

Time	Thursday, August 10
08:00-08:45	Breakfast
09:00-10:30	Frontier Presentations @ Community Wksp (Faculty Club)
10:30-10:45	Break
10:45-12:30	Frontier Presentations @ Community Wksp (Faculty Club)
12:30-13:15	Return to Village
13:15-14:30	Lunch in Café Ventanas
14:30-18:00	Work as a team to improve best project (Rady)
18:00-19:00	Dinner

Sanford / Faculty Club

Time	Friday, August 11
08:00-08:45	Breakfast
09:00-12:00	18x 8 minute group presentations (Sanford Roth Auditorium)
12:00-13:00	Lunch in Café Ventanas
13:00-17:00	Observe Community Workshop (Faculty Club) [bus loop Faculty Club <-->Sanford 16:30-20:30]
17:00-18:00	Dinner in Café Ventanas
18:00-20:30	Closing social (Sanford Bella Vista patio)

Café Ventanas

Time	Saturday, August 12
08:00-08:45	Breakfast
13:15-14:30	Lunch in Café Ventanas

List of supported students

First Name	Last Name	Travel supported?	Housing supported?	Gender	Country of citizenship	Institution	Student status
Andrew	Belt	Yes	Yes	Male	US	Michigan State University	1st-2nd Year Graduate
Eleanor	Forbes	Yes	Yes	Female	United States	University of Washington	1st-2nd Year Graduate
Varchas	Gopalaswamy	Yes	Yes	Male	India	University of Rochester	1st-2nd Year Graduate
Alec	Griffith	Yes	Yes	Male	United States	Princeton University	1st-2nd Year Graduate
Yingchao	Lu	Yes	Yes	Male	China	Rice University	1st-2nd Year Graduate
Peter	Heuer	Yes, UCOP	Yes, UCOP	Male	USA	UCLA	3rd-4th Year Graduate
Andrew	Longman	Yes	Yes	Male	United Kingdom	University of Alberta	3rd-4th Year Graduate
Joshua	Ludwig	Yes	Yes	Male	Canada	University of Alberta	3rd-4th Year Graduate
Pierson	Guthrey	Yes	Yes	Male	USA	Iowa State Univeristy	5th Year + Graduate
Archis	Joglekar	Yes, UCOP	Yes, UCOP	Male	United States	University of California, Los Angeles	Postdoc
Brant	Bowers	Yes	Yes	Male	United States of America	University of Texas at Austin	1st-2nd Year Graduate
David	Chin	Yes	Yes	Male	USA	University of Rochester	1st-2nd Year Graduate
Jason	Chou	Yes	Yes	Male	Taiwan	Stanford University	1st-2nd Year Graduate
Yanhao	Ding	Yes	Yes	Male	Chinese	University of Rochester	1st-2nd Year Graduate
Catalina	Garcia Botero	Yes	Yes	Female	Spain	Imperial College London	1st-2nd Year Graduate
Alexander	Seaton	Yes	Yes	Male	United Kingdom	University of Warwick	1st-2nd Year Graduate
Jeff	Woolstrum	Yes	Yes	Male	United States of America	University of Michigan	1st-2nd Year Graduate
Adam	Higginson	Yes	Yes	Male	UK	University of Strathclyde	3rd-4th Year Graduate
Matsuo	Kazuki	Yes	Yes	Male	Japan	Institute of Laser Engineering Osaka University	3rd-4th Year Graduate
Kyle	Jensen	Yes	Yes	Male	United States	University of Nebraska - Lincoln	1st-2nd Year Graduate
Owen	Mannion	Yes	Yes	Male	United States	University of Rochester	1st-2nd Year Graduate

Robert	Masti	Yes	Yes	Male	United States	Virginia Polytechnic Institute and State University	1st-2nd Year Graduate
Sam	Miller	Yes	Yes	Male	USA	University of Rochester	1st-2nd Year Graduate
Will	Riedel	Yes	Yes	Male	USA	Stanford University	1st-2nd Year Graduate
Brian	Kraus	Yes	Yes	Male	USA	Princeton University	3rd-4th Year Graduate
Rebecca	Roycroft	Yes	Yes	Female	USA	University of Texas at Austin	3rd-4th Year Graduate
Anna	Szczekutowicz	Yes	Yes	Female	USA	University of Texas at Austin	3rd-4th Year Graduate
Mohamed	Zaghoo	Yes	Yes	Male	Egypt	Harvard University	5th Year + Graduate
Adrianna	Angulo	Yes	Yes	Female	United States	University of Michigan	1st-2nd Year Graduate
Paul	Campbell	Yes	Yes	Male	USA	University of Michigan	1st-2nd Year Graduate
Mary Katharine	Ginnane	Yes	Yes	Female	United States of America	University of Rochester	1st-2nd Year Graduate
Kyle	Miller	Yes, UCOP	Yes, UCOP	Male	USA	University of California, Los Angeles	1st-2nd Year Graduate
Iman	Datta	Yes	Yes	Male	United States & Canada	University of Washington	3rd-4th Year Graduate
John	Oliver	Yes	Yes	Male	United States of America	Purdue university	3rd-4th Year Graduate
Jonathan	Halliday	Yes	Yes	Male	United Kingdom	Imperial College London	1st-2nd Year Graduate
Aaron	Hansen	Yes	Yes	Male	United States	University of Rochester	1st-2nd Year Graduate
Heath	LeFevre	Yes	Yes	Male	United States of America	University of Michigan	1st-2nd Year Graduate
Kevin	Ma	Yes	Yes	Male	United States	University of Michigan	1st-2nd Year Graduate
Avram	Milder	Yes	Yes	Male	USA	University of Rochester	1st-2nd Year Graduate
Stephanie	Miller	Yes	Yes	Female	United States of America	University of Michigan	1st-2nd Year Graduate
Tam	Nguyen	Yes, UCOP	Yes, UCOP	Male	United States of America	University of California, Irvine	1st-2nd Year Graduate
Gabriel	Pérez Callejo	Yes	Yes	Male	Spain	University of Oxford	1st-2nd Year Graduate
Matthew	Stanfield	Yes, UCOP	Yes, UCOP	Male	USA	University of California, Irvine	1st-2nd Year Graduate

Alex	Wilhelm	Yes	Yes	Male	United States	Colorado School of Mines	1st-2nd Year Graduate
Apsara	Williams	Yes, UCOP	Yes, UCOP	Female	Trinidad and Tobago	University of California, San Diego	1st-2nd Year Graduate
Kelli	Humbird	Yes	Yes	Female	United States	Texas A&M University	3rd-4th Year Graduate
Theodore	Lane	Yes	Yes	Male	USA	West Virginia University	3rd-4th Year Graduate
Maximilian	Schneider	Yes	Yes	Male	United States	Virginia Polytechnic Institute and State University (Virginia Tech)	3rd-4th Year Graduate
Thomas	Underwood	Yes	Yes	Male	USA	Stanford University	3rd-4th Year Graduate
Anas	Bouzid	Yes	Yes	Male	USA	University of Nebraska-Lincoln	5th Year + Graduate
Alex	Englesbe	Yes	Yes	Male	United States	University of Michigan	5th Year + Graduate
Dustin	Fisher	Yes	Yes	Male	USA	University of New Mexico	Postdoc
Pawel	Kozlowski	Yes	Yes	Male	United States	West Virginia University	Postdoc
Maxime	Perin	Yes	Yes	Male	France	University of Nebraska-Lincoln	Postdoc
Eleanor	Tubman	Yes	Yes	Female	UK	Imperial College London	Postdoc
Ou	Zhang	Yes	No	Female	P.R.China	University of Texas at Austin	Postdoc
Andrew	Bishop	Yes, FES	Yes, FES	Male	United States	Harvey Mudd College	Undergraduate
Manh	Le	Yes, FES	Yes, FES	Male	USA	The Ohio State University	Undergraduate
Jacob	McLaughlin	Yes, FES	Yes, FES	Male	United States of America	West Viriginia University	Undergraduate
Manuel	Stoeckl	Yes, FES	Yes, FES	Male	Germany	University of Rochester	Undergraduate