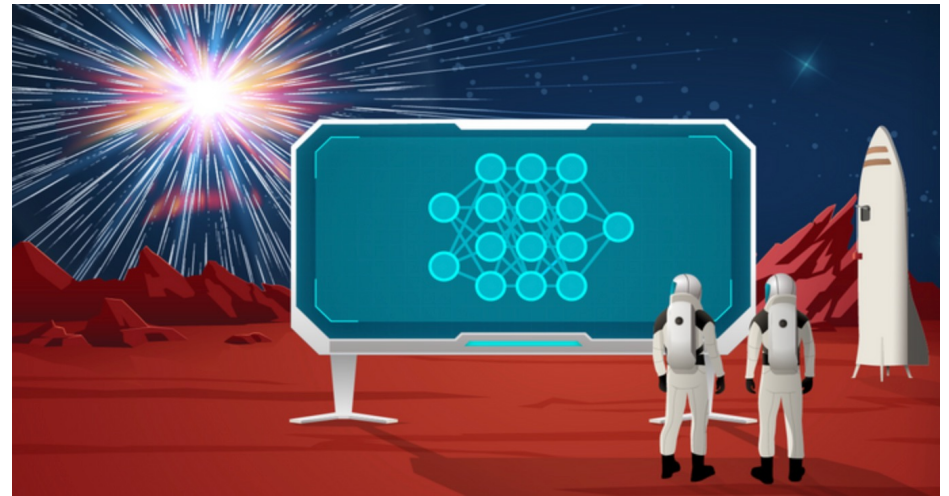
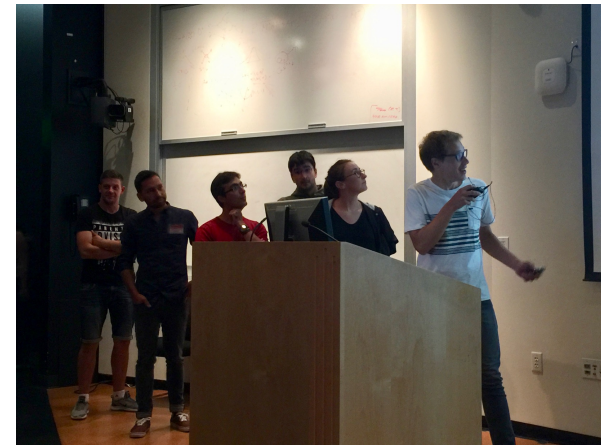
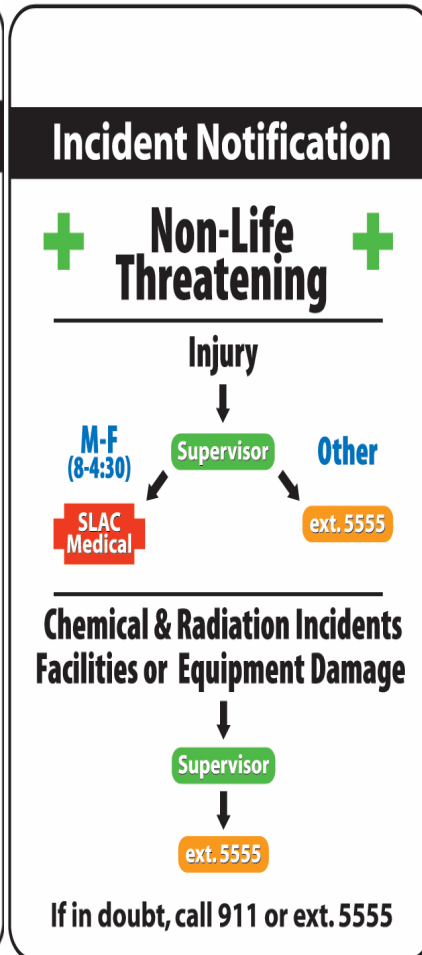


Welcome to the 2023 SLAC SUMMER INSTITUTE !



In case of an emergency



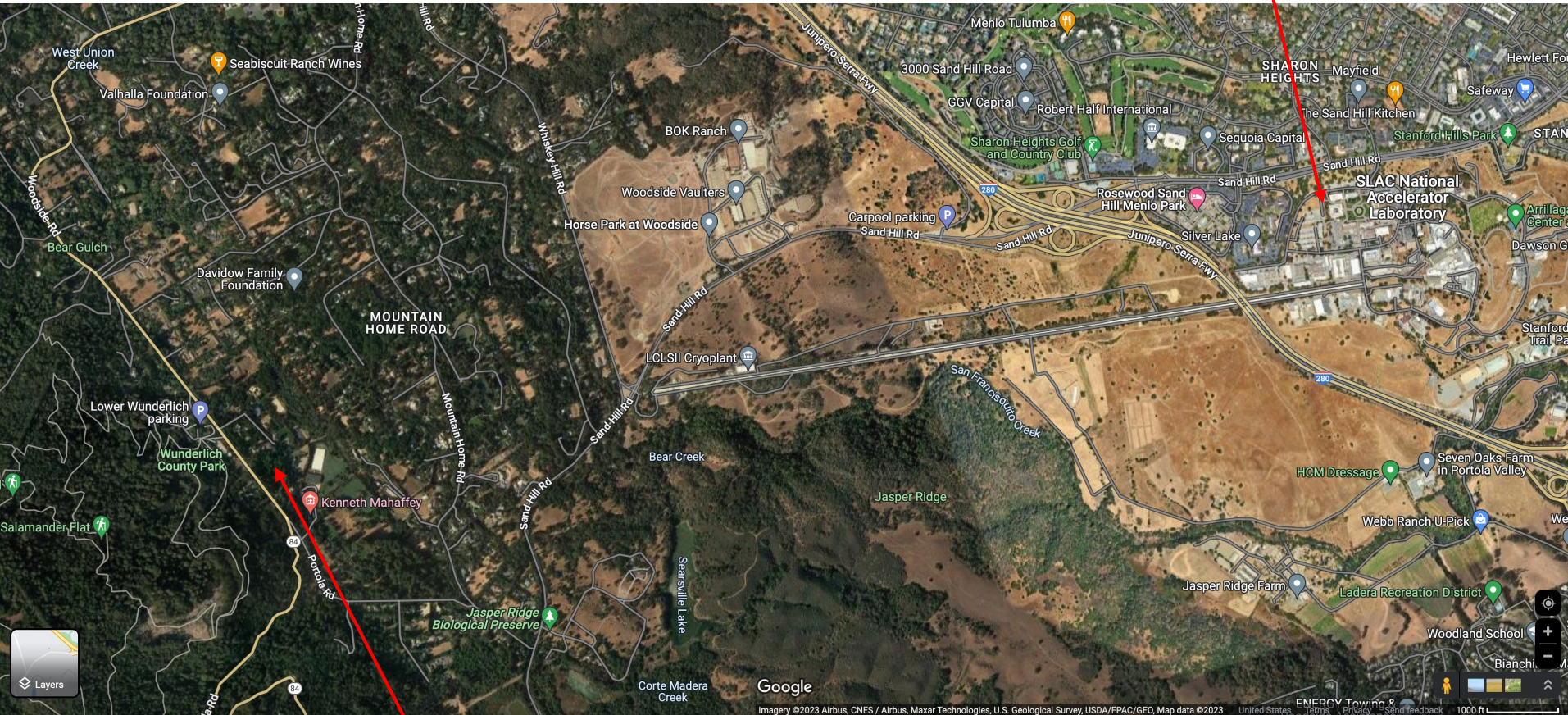
Fire

- Evacuate. Be aware of building exits
- Follow building residents to the assembly area
- Do not leave until you are accounted for, and have been instructed to leave.

Earthquake

- Remain in building: Duck, cover, and hold position
- When shaking stops: Evacuate building via a safe route to the assembly area
- Do not leave until you are accounted for, and have been instructed to leave.

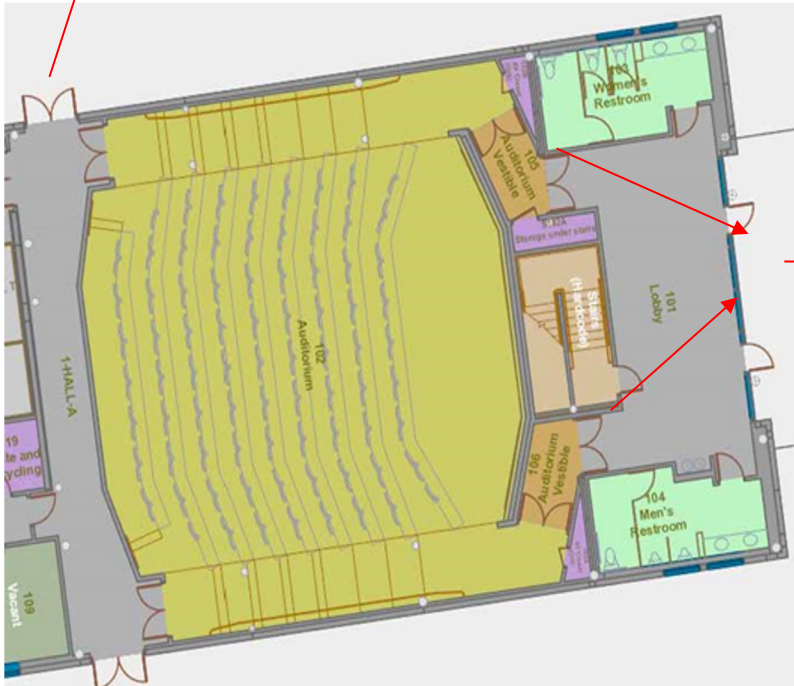
You are here



The San Andreas Fault is here



Bldg 051-Kavli Auditorium

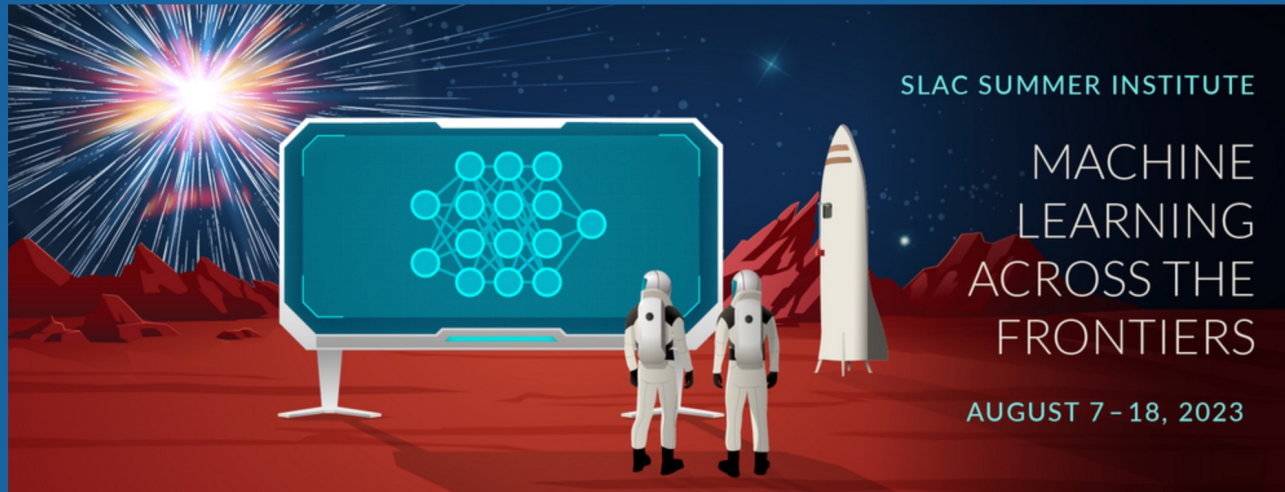


Emergency
Assembly Area

SSI2023 is the 51st SLAC Summer Institute

**After 3 years of being Zoom-only, we're happy
to be back in a hybrid mode !**

Hopefully everything you need to know is on the SSI webpage.. but let's go through a few things.....



51st SLAC Summer Institute (SSI 2023)

7-18 August 2023
SLAC
America/Los_Angeles timezone

Overview

Program

Poster Session

Registration

Conference Fee Payment
Link

Dinner Information

Participant List

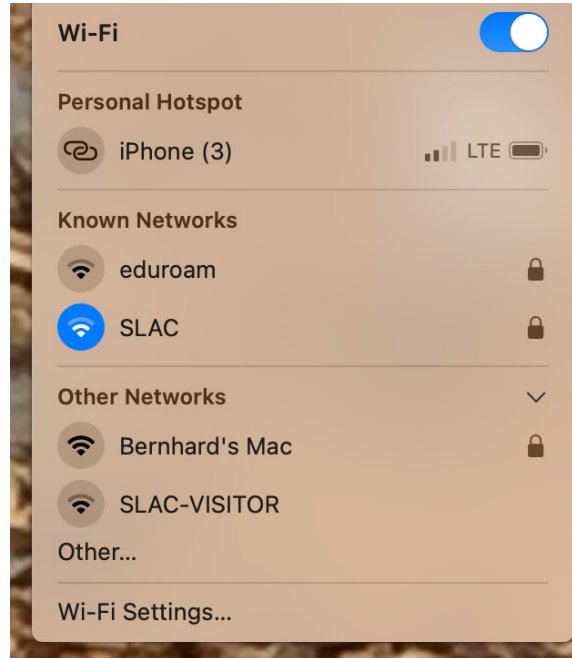
My Conference

My Contributions

The SLAC Summer Institute (SSI) is an annual two-week-long Summer School tradition since 1973. The theme of the 51st SLAC Summer Institute is "Artificial Intelligence in Fundamental Physics". These SSI lectures will introduce methods for Artificial Intelligence and Machine Learning and their successful applications across the fundamental physics. This SSI intends to inspire invigorated efforts for new revelations on how the rapidly developing field of Artificial Intelligence can change the ways that data is analyzed in fundamental physics. SSI is especially targeted for graduate students and postdocs while senior researchers are also welcome.

For SSI logistics questions, please use the [contact us](#) link.

Please use eduroam or SLAC-VISITOR networks for wifi



<https://it.slac.stanford.edu/support/KB0010023>

<https://confluence.slac.stanford.edu/display/NetMan/Eduroam+service+at+SLAC>

People on Zoom: Just in case, please keep your microphones & cameras **turned off** – raise your hand at the end of the lecture to ask a question.

Please read & act accordingly !

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My Contributions

Visa Information

Accommodations

Code of Conduct

Land Acknowledgement

Support

✉ ssi@slac.stanford.edu

Code of Conduct



The SLAC Summer Institute is a community event intended for networking and collaboration as well as learning. We value the participation of everyone and want all attendees to have an enjoyable and fulfilling experience. Accordingly, all attendees are expected to show respect and courtesy to other attendees and to abide by the following Code of Conduct. Any issues can be brought to the confidential attention of the organizers and we thank you for helping make these events welcoming and friendly event.

CODE OF CONDUCT

The community of participants of the SLAC Summer Institute is made up of members from around the globe with a diverse set of skills, personalities, and experiences. It is through these differences that our community experiences success and continued growth. We expect everyone in our community to follow these guidelines when interacting with others both inside and outside of our community. Our goal is to keep ours a positive, inclusive, successful, and growing community.

As members of the community,

- We pledge to treat all people with respect and provide a harassment- and bullying-free environment, regardless of sex, sexual orientation and/or gender identity, disability, physical appearance, body size, race, nationality, ethnicity, and religion. In particular, sexual language and imagery, sexist, racist, or otherwise exclusionary jokes are not appropriate.
- We pledge to respect the work of others by recognizing acknowledgment/citation requests of original authors. As authors, we pledge to be explicit about how we want our own work to be cited or acknowledged.
- We pledge to welcome those interested in joining the community, and realize that including people with a variety of opinions and backgrounds will only serve to enrich our community. In particular, discussions relating to pros/cons of various technologies, programming languages, and so on are welcome, but these should be done with respect, taking proactive measure to ensure that all participants are heard and feel confident that they can freely express their opinions.
- We pledge to welcome questions and answer them respectfully, paying particular attention to those new to the community.
- We pledge to be conscientious of the perceptions of the wider community and to respond to criticism respectfully. We will strive to model behaviors that encourage productive debate and disagreement, both within our community and where we are criticized. We will treat those outside our community with the same respect as people within our community.
- We pledge to help the entire community follow the code of conduct, and to not remain silent when we see violations of the code of conduct. We will take action when members of our community violate this code such as notifying a workshop organizer or talking privately with the person.

This code of conduct applies to all community situations online and offline, including the meetings themselves, mailing lists, forums, social media, social events associates with the conference, and one-to-one interactions.

Participants asked to stop any harassing behavior are expected to comply immediately. Attendees violating these rules may be asked to leave the event at the sole discretion of the organizers.

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✉ ssi@slac.stanford.edu

Land Acknowledgement



We recognize that Stanford sits on the ancestral land of the Muwekma Ohlone Tribe. This land was and continues to be of great importance to the Ohlone people. Consistent with our values of community and inclusion, we have a responsibility to acknowledge, honor and make visible the university's relationship to Native peoples.

- Stanford Land Acknowledgement

First Peninsula Inhabitants - [Facts about the Ohlone people](#)

Stanford's Relationship with Native Peoples - [Honoring Our Relationship](#)

More information about the Stanford University Land Acknowledgement can be found [at this web page](#).

The schedule is available as both a spreadsheet & in **full** detail on Indico

- The morning lectures will be here in the Kavli Auditorium
- The tutorials will be in the Redwood, Madrone & Cedar(wk1)/Sonoma(wk2)
- The afternoon Q&A and the Project sessions : Redwood Rooms in ROB
- The reception toninger is on the patio outside of the Redwood Rooms

| SSI 2023: Machine Learning Across the Frontiers | | | | | | | | | | |
|---|------------------------------|---|---|--|--|--|--|---|---|---------------------------------|
| Time / Date | 7-Aug Monday | 8-Aug Tuesday | 9-Aug Wednesday | 10-Aug Thursday | 11-Aug Friday | 14-Aug Monday | 15-Aug Tuesday | 16-Aug Wednesday | 17-Aug Thursday | 18-Aug Friday |
| 9:00–10:00 | Welcome (Tom Rizzo) | ML Basics 3 (Lukas Heinrich) | Challenges in AI/ML at the Intensity Frontier (Tartree Wongjirad) | Graphs (Javier Duarte) | Challenges in Acc. and AI/ML (Auralee Edelen) | Anomaly Detection Intro & Applications 1 (David Shih) | Generative Models (Gilles Louppe) | Gen. Model Applications 3 (Tartree Wongjirad) | Fast ML 2 (Jennifer Ngadiuba) | Symmetries and ML (Andreas Ipp) |
| 10:00–10:30 | Morning Break | | | | | Morning Break | | | | |
| 10:30–11:30 | ML Basics 1 (Lukas Heinrich) | Challenges in AI/ML at the Energy Frontier (Ben Nachman) | Computer Vision (Saul Alonso) | Graph Applications 1 (Javier Duarte) | Bayesian Optimization (BO) & Reinforcement Learning (RL) intro & Applications 1 (Auralee Edelen) | Anomaly Detection Applications 2 (Maria Elena Monzani) | Gen. Model Applications 1 (Francois Lanusse) | Simulation-Based Inference (SBI) Intro & Applications 1 (Gilles Louppe) | Challenges in Theory and AI/ML (Tilman Plehn) | Future of AI/ML (Surya Ganguly) |
| 11:30–11:45 | Morning Break | | | | | Morning Break | | | | |
| 11:45–12:45 | ML Basics 2 (Lukas Heinrich) | Challenges in AI/ML at the Cosmic Frontier (Simone Ferraro) | CV Applications (Ligh Whitehead) | Graph Applications 2 (Francois Driessma) | DEI and Ethics in AI for HEP (Savannah Thais) | Fast ML (Jennifer Ngadiuba) | Gen. Model Applications 2 (David Shih) | SBI Applications 2 (Francois Lanusse) | ML Emulation in CF Theory (Joe DeRose) | Future of HEP (JoAnne Hewett) |
| 12:45–13:30 | Lunch | | | | | Lunch | | | | |
| 13:30–14:00 | Tours | | | | | Tours | | | | |
| 14:00–14:30 | Tours | | | | | Tours | | | | |
| 14:30–14:45 | Tours | | | | | Tours | | | | |
| 14:45–15:45 | Tutorial: ML Tools | Q&A | Tutorial: Unconference | Q&A | Tutorials: Unconference | Q&A | Tutorials: Fast ML & Applications | Q&A | Project Presentations | |
| 15:45–16:00 | Afternoon Break | | | | | | | | | |
| 16:00–17:00 | Projects | Projects | Projects | Projects | Projects | Projects | Projects | Projects | Projects | Projects |
| 17:00–17:30 | Projects | | | | | Projects | | | | |
| 17:30–18:00 | Projects | | | | | Projects | | | | |
| 18:00 | Reception | | Poster Social | | | Dinner | | Soccer Game | | Dinner |

51st SLAC Summer Institute (SSI 2023)

7 Aug 2023, 09:00 → 18 Aug 2023, 19:00 America/Los_Angeles

SLAC

Charles Young (SLAC), Faith Chow (SLAC), Glenna Paige (SLAC), Grzegorz Madejski (SLAC), Kazuhiro Terao (SLAC), Michael Kagan (SLAC), Philip Marshall (SLAC), Thomas Rizzo (SLAC)

Description: The SLAC Summer Institute (SSI) is an annual two-week-long Summer School tradition since 1973. The theme of the 51st SLAC Summer Institute is "Artificial Intelligence in Fundamental Physics". These SSI lectures will introduce methods for Artificial Intelligence and Machine Learning and their successful applications across the fundamental physics. This SSI intends to inspire invigorated efforts for new revelations on how the rapidly developing field of Artificial Intelligence can change the ways that data is analyzed in fundamental physics. SSI is especially targeted for graduate students and postdocs while senior researchers are also welcome.

For SSI logistics questions, please use the [contact us](#) link.

For SSI community discussions, please connect with SSI on Facebook: <https://www.facebook.com/SLACSummerInstitute>

Registration: You are registered for this event. [Modify registration](#)

Participants: Aditi Pradeep, Adriano Testa, Agnès Ferté, Alejandro Oranday, Alessandra Lucà, Alessandro Melchiorri, Alex Toldaiev, Alexander Tewsley-Booth, Ambar Rodriguez Alica, Amol Patwardhan, Andre Antoine, Andreas Ipp

Support: ssi@slac.stanford.edu

MONDAY, 7 AUGUST

09:00 → 12:45 Lectures 51/1-102 - Kavli Auditorium

09:00 Welcome and Introduction to SSI 1h
Speaker: Thomas Rizzo (SLAC)

10:00 Break 30m

10:30 ML Basics I 1h


The indico agenda will have links to lecturer's slides, the video of the presentation (eventually) as well as to the Q&A google docs...


11:40

CP Violation & Matter/Anti-matter Asymmetry I (Theory)

Speaker: Jure Zupan (U. Cincinnati)

 1st_Lecture_SSI202...

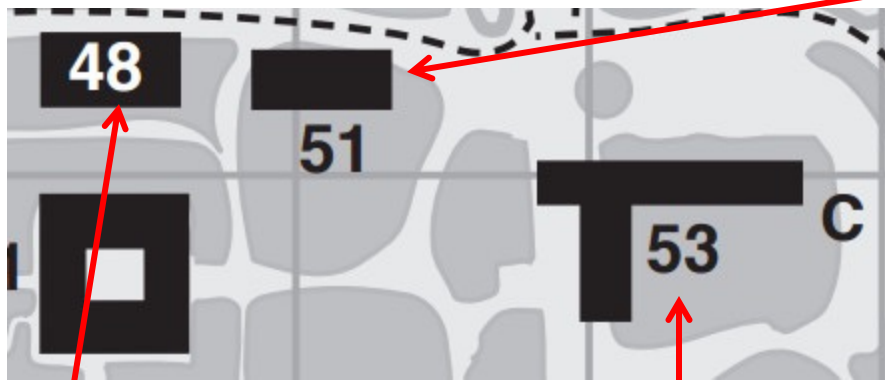
 Video - CP Violation.

 Submit questions

Dinners

- We are 'restructuring' the catered dinners as our previous plans were inadequate & too \$\$\$ after Covid (that's the Bay Area ...)
- We'll refund all those that paid already (including me..)
- Tomorrow's dinner is **cancelled** BUT we will have signup info on our webpage for dinners next Mon & Thurs at MUCH lower prices via take-outs. These will still take place on the patio outside of ROB.
- Wine, beer, soda, etc. will be covered..
- Sign up will be thru the SSI website

Kavli



- The poster session will be in the SUSB lobby (on 8/9)



ROB

SUSB
Lunch

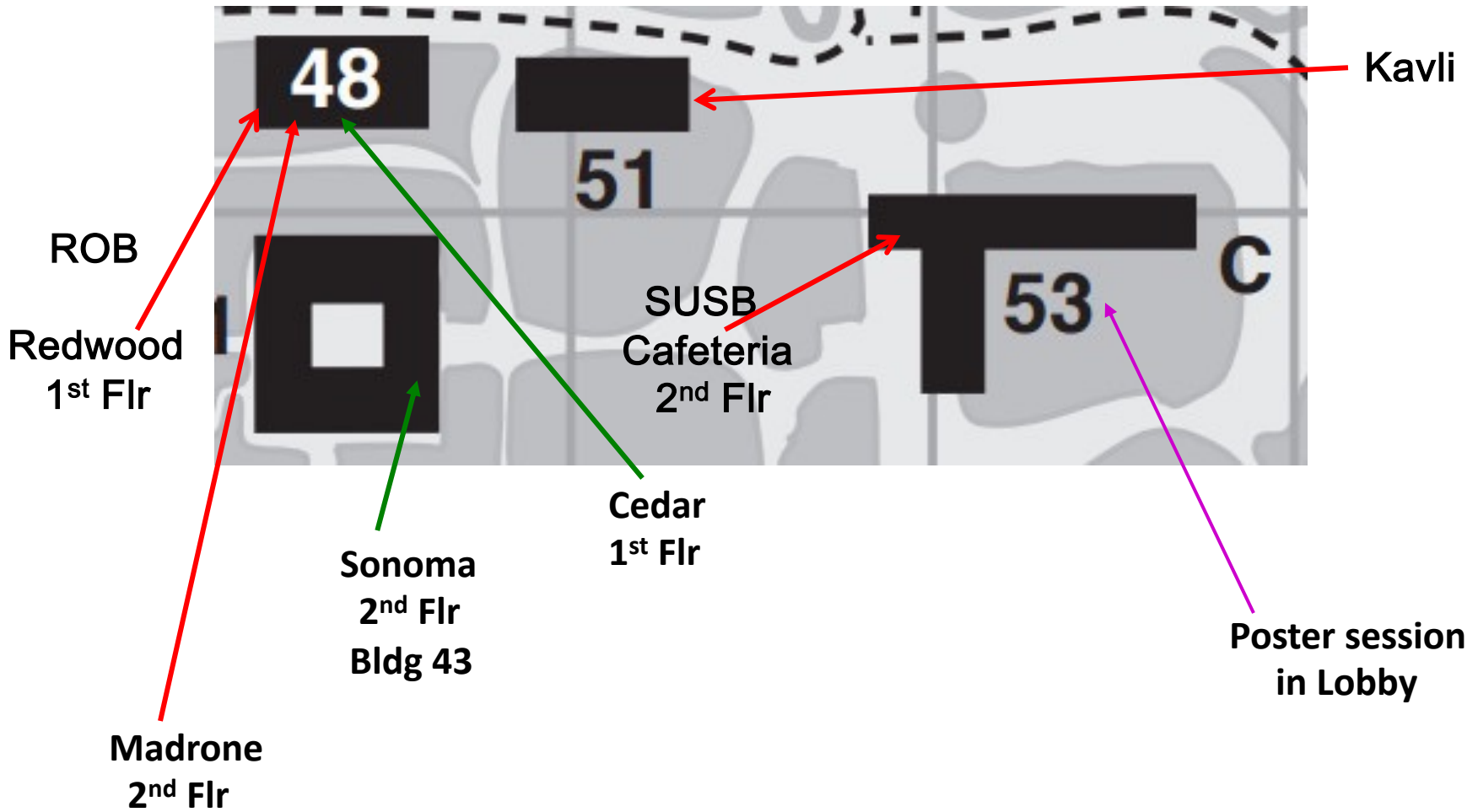
→ The Contest Question: Every year we ask the students to answer a 'light', broad-based question depending on the SSI subject. This year the question is:

“What experimental/observational discovery would be the greatest impetus for the further use of ML in astro/particle physics?”

→ Place your answers in the **pink box (by 4 PM 8/17)** & the organizers will pick a winner who will get a bottle of fine CA bubbly on Friday



To get the flavor: <https://indico.cern.ch/event/701949/contributions/3008157/attachments/1699889/2737334/SSI18-Contest.pdf>



SSI locations in a bit more detail....

PM Q&A Sessions



- These are intended for extensive questions. Those immediately afterward the lectures should be kept short & to the point. Of course, other questions can also be addressed to the speakers directly during the breaks.
- Note that questions can **also** be submitted (anonymously) with GoogleDocs via individual links on the SSI program indico agenda & will be answered, given the time limitations, at the end of each talk, in the Q&A sessions or by written answers that will appear within a few days from the lecturer

Projects:



- Since 2013 we have incorporated projects conducted by teams of students into SSI
- Some info already exist on the SSI website & more later today
- These will very likely require in-person attendance
- Teams form around a specific project & try to address the issues
- Teams will present their results on the final TH afternoon (8/17) in Kavli...take a look at past years efforts!

E.g., <https://indico.slac.stanford.edu/event/134/timetable/?view=standard>

SSI 2023 T-Shirts are available for sale !

Only \$23 !

(see Glenna out front)



Odds & Ends

- Sign up for the different tours on the SSI webpage (see the schedules for times)
- Be aware of next week's soccer game ... sign up via the SSI webpage to play or to watch

<https://indico.slac.stanford.edu/event/7540/page/73-soccer-game>

- Check the SSI “Practical Information” page for info wrt ATMs, after hours access, shuttle buses, Bay Area touring, etc.



Some Tour Details

NOTE: There will be 2 different tours BUT you'll need to sign up for them as numbers are restricted – first come, first served

Klystron Gallery: 1 hour tour on each of both days limited to 25
Choose 1 of these tours only ! Closed toe shoes required!

Vis Lab: Two 30 min tours on each of both days limited to 20
Choose 1 of these tours only!

More info on the SSI webpage. If interested, please sign up for these ASAP to reserve your spot !

<https://indico.slac.stanford.edu/event/7540/page/72-tours>



Stanford Linear Accelerator

12 min
950m

SLAC National Accelerator Laboratory

Kavli Building

Sand Hill Rd

Parking Lot Rd

Loop Rd

Loop Rd

Loop Rd

Deutsche Telekom Capital Partners

TriplePoint Capital

Gold Star Chimney Service

Morgan Stanley (Menlo Park Office)

ChargePoint Charging Station

Silver Lake

Administration and Engineering Bldg (A&E)

Test Laboratory

Central Utility Bldg

Central Laboratory

Fire Station

Communications Office

pepFOVERa Construction

Building 137

GISM Laboratory

Chemical Storage Bldg

Heavy Fabrication Bldg

Sector 30 Guard House

Computer Bldg (SCS)

SLAC Cryo-EM Facility

General Services Bldg (Shipping and Receiving)

Auxiliary Control Bldg

Metal Stores Shelter

Master Substation

Beam Switch Yard Access

SLC Engineering Trailer South (Fort Apache)

Main Control Center (MCC)

Central Hazardous Waste Management Area

Power Conversion

Pep Interaction Region 8 (Ir-8)

Pep Control Room





Group photo at ~10AM today after this presentation

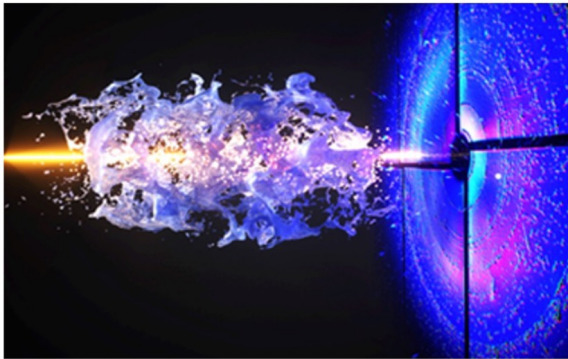
Follow Glenna!



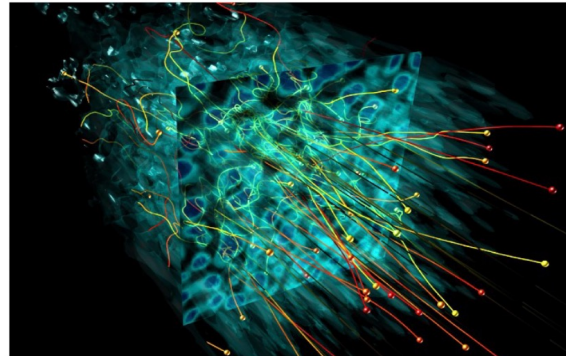
Before we start, a few words on SLAC and SSI...

SLAC is a DOE multi-purpose laboratory ...

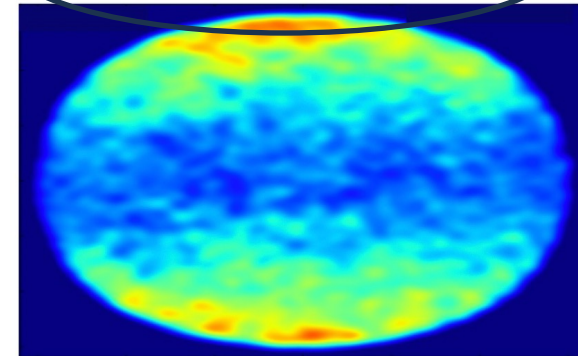
Lead the world in X-ray and ultrafast science



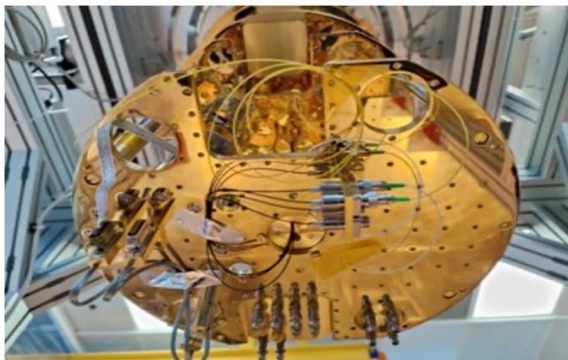
Transform high energy density science



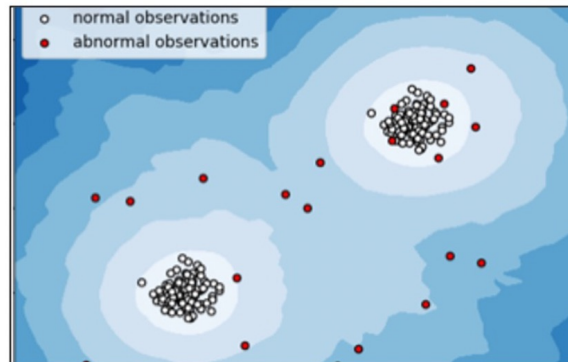
Foster a frontier program in the physics of the universe



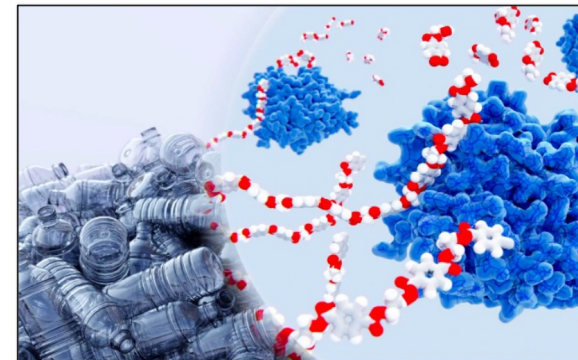
Build new capabilities for transformative quantum information science technologies



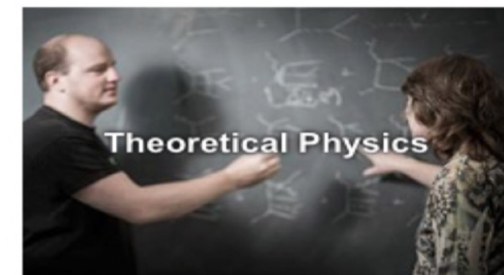
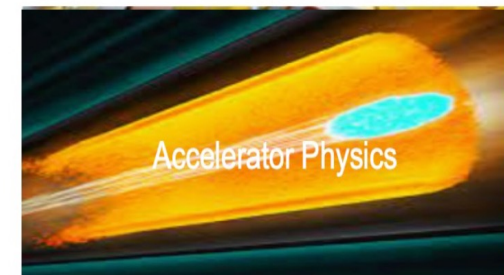
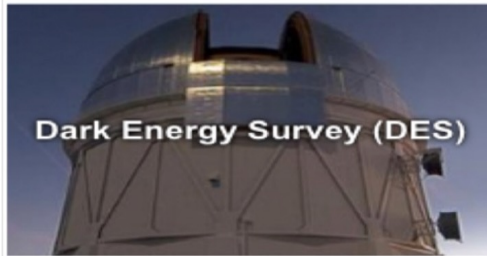
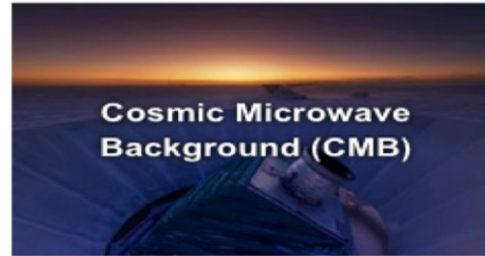
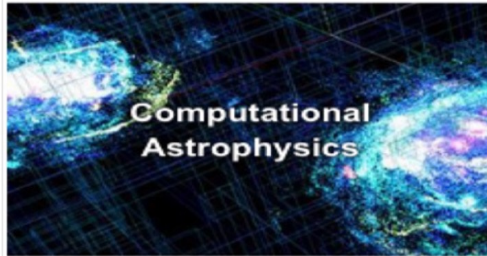
Innovate massive-scale data analytics



Drive biological, chemical, and material science for sustainability



The SLAC HEP Program itself is quite diverse...



50 years of SSI !

SSI has a long history..
...beginning in 1973

| Year | Title | Organizers | |
|------|--|------------------------|--------|
| 1973 | Deep Inelastic Electroproduction | | |
| 1974 | The Strong Interactions | Leith, Blankenbechler | |
| 1975 | Deep Hadronic Structure and the New Particles | "" | |
| 1976 | Weak Interactions at High Energy and the Production of New Particles | "" | |
| 1977 | Quark Spectroscopy and Hadron Dynamics | Leith, Gilman | |
| 1978 | Weak Interactions - Present and Future | Gilman, Leith | |
| 1979 | QCD | Feldman, Gilman, Leith | |
| 1980 | The Weak Interaction | "" | |
| 1981 | The Strong Interactions | "" | |
| 1982 | Physics at Very High Energies | "" | 10th |
| 1983 | Dynamics and Spectroscopy at High Energy | Gilman, Leith | |
| 1984 | The Sixth Quark | Feldman, Gilman, Leith | Famous |
| 1985 | Supersymmetry | "" | |
| 1986 | Probing the Standard Model | "" | |
| 1987 | Looking Beyond the Z | "" | |
| 1988 | Probing the Weak Interaction: CP Violation and Rare Decays | "" | |
| 1989 | Physics at the 100 GeV Mass Scale | "" | |
| 1990 | Gauge Bosons and Heavy Quarks | Feldman, Leith | |
| 1991 | Lepton-Hadron Scattering | Burke, Dixon, Leith | |
| 1992 | The Third Family and the Physics of Flavor | "" | |
| 1993 | Spin Structure in High Energy Processes | "" | |
| 1994 | Particle Physics, Astrophysics and Cosmology | "" | |
| 1995 | The Top-Quark and the Electroweak Interaction | "" | |
| 1996 | The Strong Interaction, from Hadrons to Partons | "" | |
| 1997 | Physics of Leptons | "" | 25th |
| 1998 | Gravity: From the Hubble Length to the Planck Length | Burke, Dixon, Prescott | |
| 1999 | CP Violation In and Beyond the Standard Model | "" | |
| 2000 | Neutrinos: From the Lab, the Sun, and the Cosmos | Dixon, Jaros, Prescott | |
| 2001 | Exploring Electroweak Symmetry Breaking | "" | |
| 2002 | Secrets of the B Meson | "" | |

It began before:
NC's, AF, charm, τ , b, W/Z,..

Its history reflects the
evolution of HEP itself..

| | | | |
|----|---|--|------|
| 33 | 2003 Cosmic Connections | Hewett, Jaros, Kamae, Prescott | |
| 34 | 2004 Nature's Greatest Puzzles | "" | |
| 35 | 2005 Gravity in the Quantum World and the Cosmos | "" | |
| 36 | 2006 The Next Frontier: Exploring with the LHC | "" | |
| 37 | 2007 Dark Matter: From the Cosmos to the Laboratory | Hewett, Jaros, Kahn, Kamae | |
| 38 | 2008 Cosmic Accelerators | Blandford, Jaros, Kamae, Peskin | |
| 39 | 2009 Revolutions on the Horizon: A Decade of New Experiments | Hewett, MacFarlane, Madejski...I think Abel? | |
| 40 | 2010 Neutrinos: Nature's Mysterious Messengers | Dorfan, Hewett....don't know who else!! | |
| 41 | 2011 History of the Universe | Hewett, SuDong, and perhaps Abel here??? | |
| 42 | 2012 The Electroweak Scale: Unraveling the Mysteries at the LHC | Funk, Hewett, Rizzo, SuDong | 40th |
| 43 | 2013 Journeys Through the Frontier | Funk, Hewett, Rizzo, SuDong | |
| 44 | 2014 Shining Light on Dark Matter | Hewett, Partridge, Rizzo, SuDong, Wechsler | |
| 45 | 2015 The Universe of Neutrinos | Convery, Partridge, Rizzo, SuDong, Wechsler | |
| 46 | 2016 New Horizons on the Energy Frontier | Partridge, Rizzo, Schwartzman, SuDong | |
| 47 | 2017 Cosmic Opportunities | Allen, Irwin, Partridge, Rizzo, SuDong | |
| 48 | 2018 Standard Model at 50: Successes and Challenges | Convery, Kaufman, Madejski, Partridge, Rizzo, SuDong, Tompkins, Young | |
| 49 | 2019 Menu of Flavors: Exploring the Weakly Coupled Universe | Altmannshofer, Convery, Kaufman, Madejski, Partridge, Rizzo, SuDong, Young | |
| 50 | 2020 The Almost Invisibles | Convery, Kaufman, Madejski, Partridge, Rizzo, SuDong, Young | |
| 51 | 2021 The Higgs State Fair | Convery, Kaufman, Madejski, Partridge, Rizzo, SuDong, Young | |
| 52 | 2022 Golden Opportunities | Convery, Madejski, Partridge, Rizzo, SuDong, Young | 50th |
| 53 | 2023 Machine Learning Across the Frontiers | Kagan, Madejski, Marshall, Rizzo, Terao, Young | |
| 54 | | | |

SSI has always covered a very broad set of topics of general interest...

SSI Topics over the years

| Topic | 1970's | 1980's | 1990's | 2000's | 2010's | 2020's |
|--------------------------------------|------------|----------------|----------------|------------|----------------|--------|
| Electroproduction | 73,75 | | 91 | | | |
| QCD | 74, 77, 79 | 81, 83 | 96 | | | |
| Weak Interactions & Z Physics & EWSB | 76,78 | 80, 86, 87, 89 | 90 | 01 | 12 | 21 |
| General Overview | | 82 | 93 | 04, 09 | 13, 16, 18, 19 | 20, 22 |
| Flavor Physics | | 84, 88 | 92, 95, 97, 99 | 02 | | |
| BSM | | 85 | | 06 | | |
| Astrophysics & Cosmology | | | 94 | 03, 07, 08 | 11, 14, 17 | |
| Gravity | | | 98 | 05 | | |
| Neutrinos | | | | 00 | 10, 15 | |

ML

23

This year ML has been added into the mix !

ML begins after the break

Please be back by 10:30 !