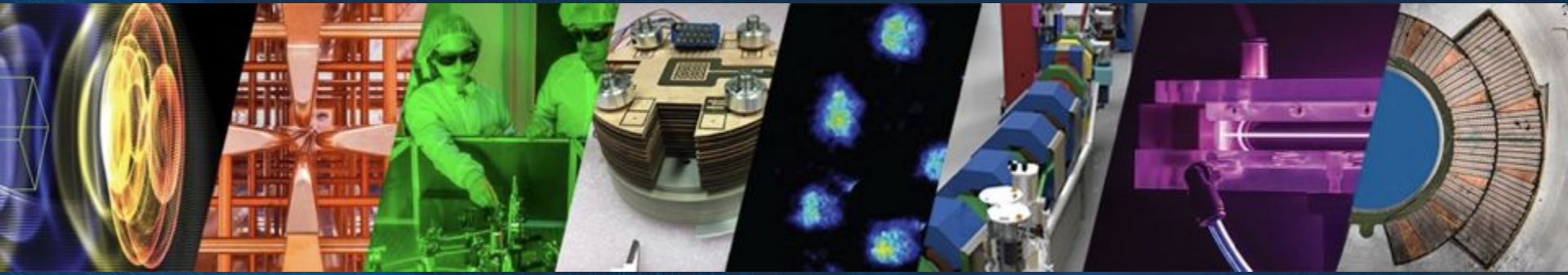
Accelerator safety @ LBL BELLA Laser Wakefield Accelerators



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ATAP Division, Lawrence Berkeley National Lab.

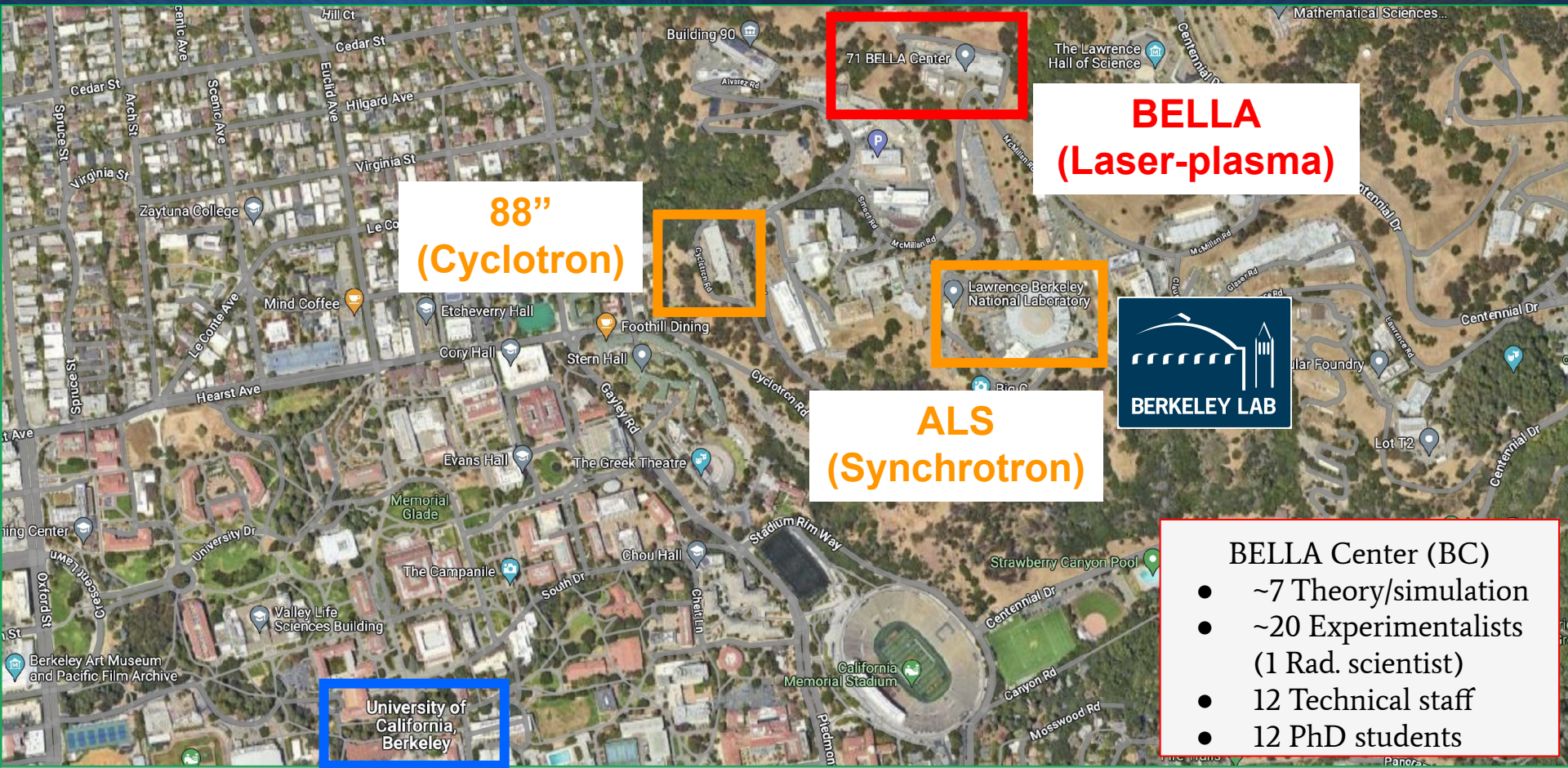
DOE Accelerator Safety Workshop (ASW), October 2024, Brookhaven National Laboratory, NY

BERKELEY LAB

ACCELERATOR TECHNOLOGY & APPLIED PHYSICS DIVISION ATAP

U.S. DEPARTMENT OF ENERGY | Office of Science

BELLA Center: one of the three major accelerator facilities at LBNL

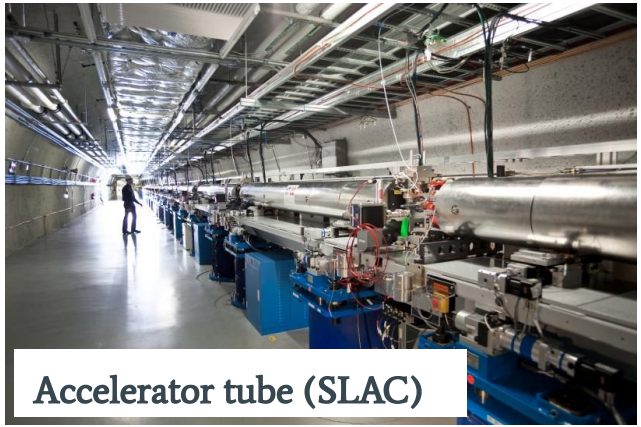


BELLA Center (BC)

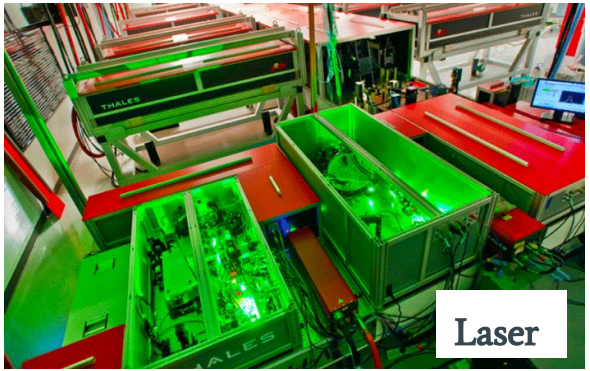
- ~7 Theory/simulation
- ~20 Experimentalists (1 Rad. scientist)
- 12 Technical staff
- 12 PhD students

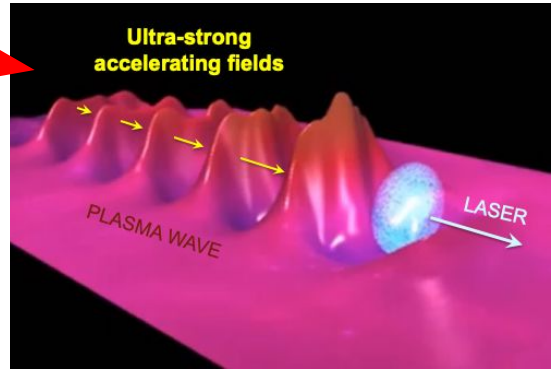
Laser Plasma Acceleration (LPA) of electrons: Laser to drive acceleration Ultrahigh gradient to realize compact accelerators

Conventional rf linear accelerator



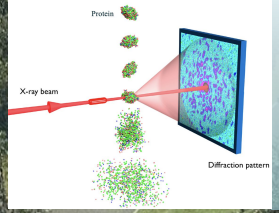
Laser-plasma (linear) accelerator





Three Laser Systems, 2 Total Exclusion Areas (TEAs), 2 pairs of SAD / ASE

BELLA HTW SAD / ASE (2006~)

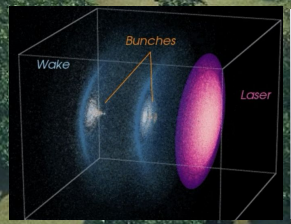


BELLA-HTU,
3 Joule in 30fs (100 TW @ 5Hz)
- 1 GeV class Electron Accel.
- Undulator Radiations
- Beam Transport

BELLA-HTT
3 Joule in 30fs (100 TW @ 5Hz)
- 1 GeV class Electron Accel.
- Monochromatic gamma rays
- Pump-probe X-rays

PW-TEA
PW Laser
HTW-TEA
HTW Lasers

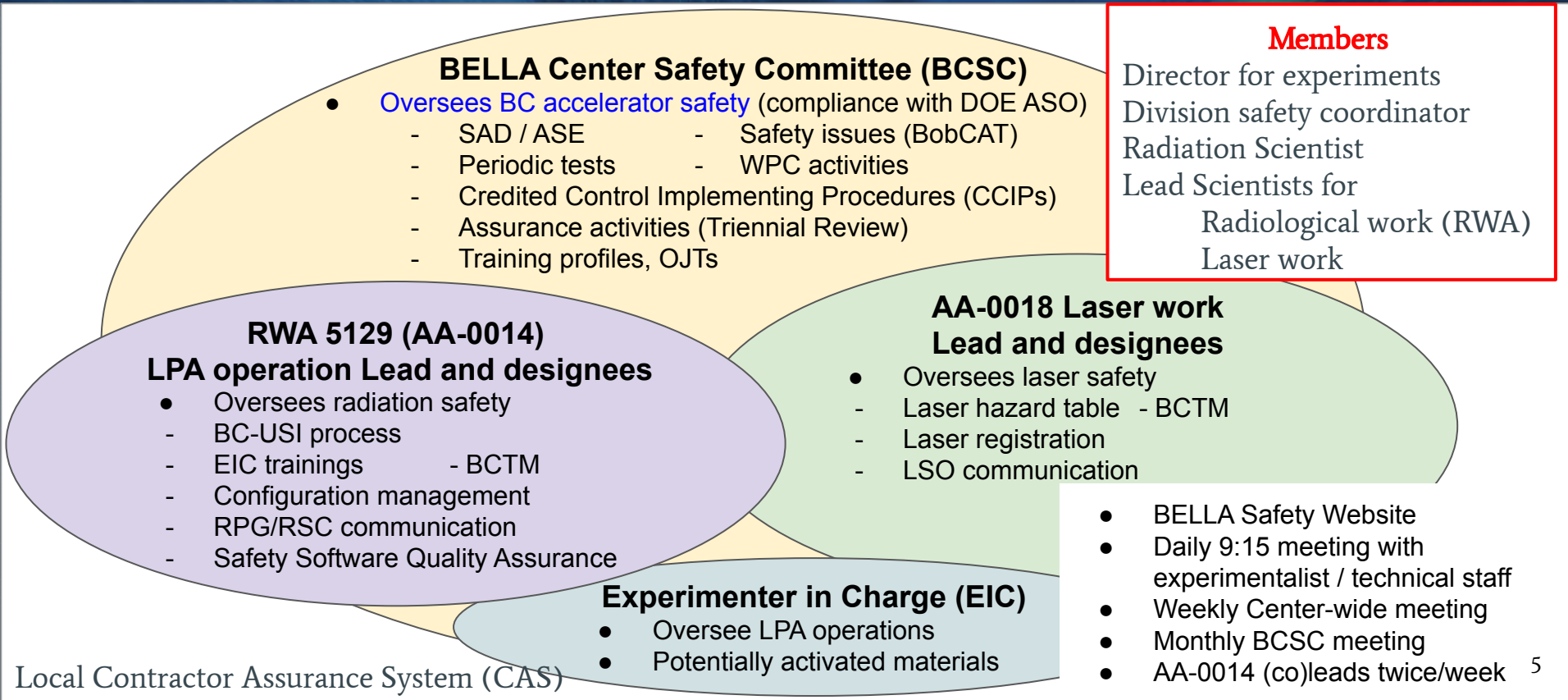
BELLA PW SAD / ASE (2012~)



BELLA-PW 1st and 2nd beamlines
40 Joule in ~40 fs (1 PW @ 1Hz)
Two interaction points (iPs)
- iP1: 10 GeV class Electron Accel.
- iP2: 100 MeV class Proton Accel.

Not under SAD / ASE
1 kHz a few mJ system to drive a few MeV e-beam
5 kHz ~100 mJ fiber laser system under construction

Internal Safety Committee to Lead ASO Compliance Efforts



- BELLA Safety Website
- Daily 9:15 meeting with experimentalist / technical staff
- Weekly Center-wide meeting
- Monthly BCSC meeting
- AA-0014 (co)leads twice/week

Local Contractor Assurance System (CAS)

BELLA Center works closely with ATAP, Engineering, EHS divisions and BSO to support mission and safe operations

DoE BSO:
Berkeley Site Office

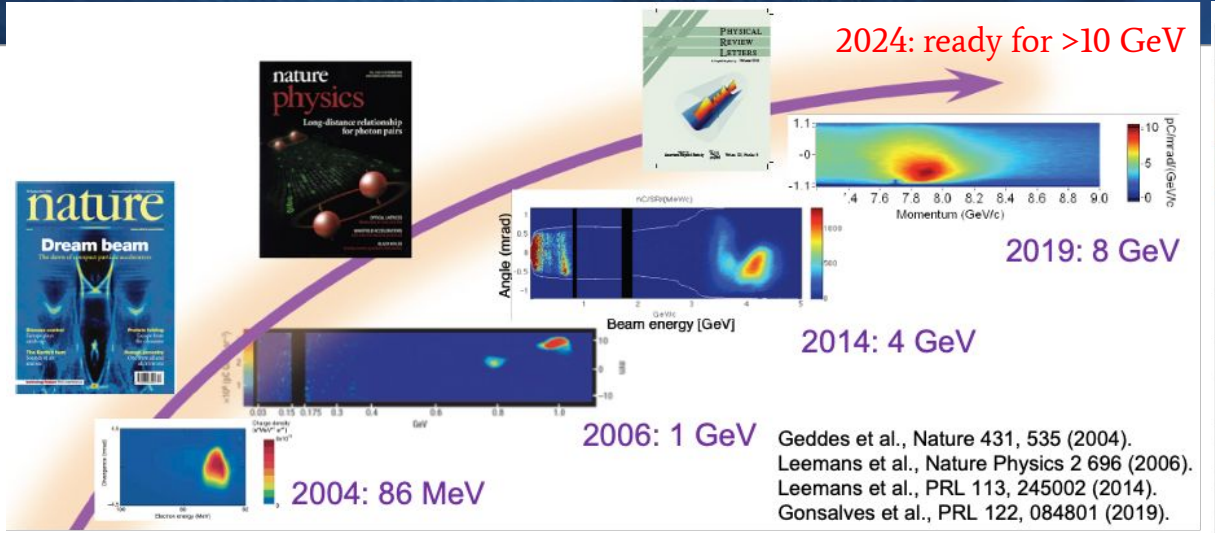
LBNL: Environment, Health & Safety Division

LBNL: Engineering Division

LBNL: ATAP Division
BELLA Center

- keeps close communication with BSO through RPG for accelerator safety,
- works closely with EHS especially with RPG, LSO, and EHS Liaison helping to address mitigation strategies for new hazards (e.g. weekly communication with HP),
- collaborates with engineering division for projects and safety implementations,
- applies ISM integrated with ATAP with support from Division Safety Coordinator,
- utilizes lbl-wide Work Planning and Control (WPC) system for effective implementation of ISM

Research on acceleration physics, structure, mechanisms, etc.: challenges to support fast changes



USI Log

#	planning started	in-action finished	Result	Folder
8	4/30/2024		RSI w/ new hazard	2024 0425 PW Laser Power Credited Control
7	9/12/2023			2024 9999 Am
6	1/2/2023		USI-Negative	2023 1101 A-cave kHz RGD
5	5/13/2024	5/24/2024	RSI no new hazard	2024 0513 Neutron Detector
4	4/2/2024	4/13/2024	Non-USI	2024 0412 Probe Laser Line
3	2/22/2024	2/27/2024	RSI no new hazard	2024 0222 PW incorrect ebam analysis
2	2/1/2024	2/1/2024	Non-USI	2024 0201 HTW
1	1/22/2024	1/23/2024	Non-USI	2024 0123 HTT magnet
13	11/1/2022	1/6/2023	USI-Negative	2023 0105 iP2 1Hz
12	5/1/2018	11/2/2022	USI-Negative	2022 1025 HTU
11	10/3/2022	10/5/2022	USI-Negative	2022 1005 iP2
10	9/6/2022	9/8/2022	USI-Negative	2022 0906 PW gamma
9	8/22/2022	8/25/2022	USI-Negative	2022 0822 PW Gamma

It is critical to have well-thought ASE/SAD and to maintain RPG/BSO well-informed to support our mission

- Introducing new technologies (new hazards) are part of the mission.
- External user experimental campaigns (LaserNetUS, BeamNetUS): a few campaigns in ~1 year cycle.
- Many projects (grants) are a few years.

USI/RSI can be frequent

- USI/RSI processes, SAD revisions are usually multi-month long process (SoW, HA, implementation plan, reviews...)
- ASE revision can be a year-long process (ARR).

Accelerator Safety elements can be the main cost and time driver for new projects

Currently working towards PW-ASE revisions: Replacing one of the credited controls to support mission better

One of the current Credited Control for PW ASE

(5)…the electron energy is limited to 10 GeV +/- 5%.

Limit with accelerated beam parameters.

Proposing…

(5) Laser Facility Power: The particle beam power delivered by the Laser-Plasma Accelerator is constrained by the facility's available laser power.

Limit with accelerator driver (laser) available power

Timeline

- 2023: Initiate conversations with RPG / BSO.
- 4/2024: USI / RSI started, RSI w/ new hazard.
- 4/2024: Radiation Hazard Analysis beyond 10 GeV while conserving the particle beam power.
- 8/2024: Technical review on Radiation Hazard Analysis above.
- 10/2024: Accelerator Radiation Safety Committee to review SAD / ASE revisions.

Note: the change stems from >12 year operation (long-term relationship) and mutual understanding among the facility, RPG and BSO.

Summary

- The BELLA Center is one of three major accelerator facilities in LBL, with ~50 people working.
- The BC facility houses 3 laser systems to drive LPAs and two TEAs, each with own ASE / SAD pair.
- The BC has an internal safety committee to lead ASO compliance efforts.
- The BC work closely with BSO, EH&S-RPG, and Engineering to support mission and safe operations.
- There are challenges to support fast-changing accelerator research.
- Safety is a culture, and there is always room for improvements. Long-term relationships with RPG and BSO are also important to support mission in timely manner.

Back up

Mission: atap.lbl.gov