Linac Coherent Light Source –II Status Update

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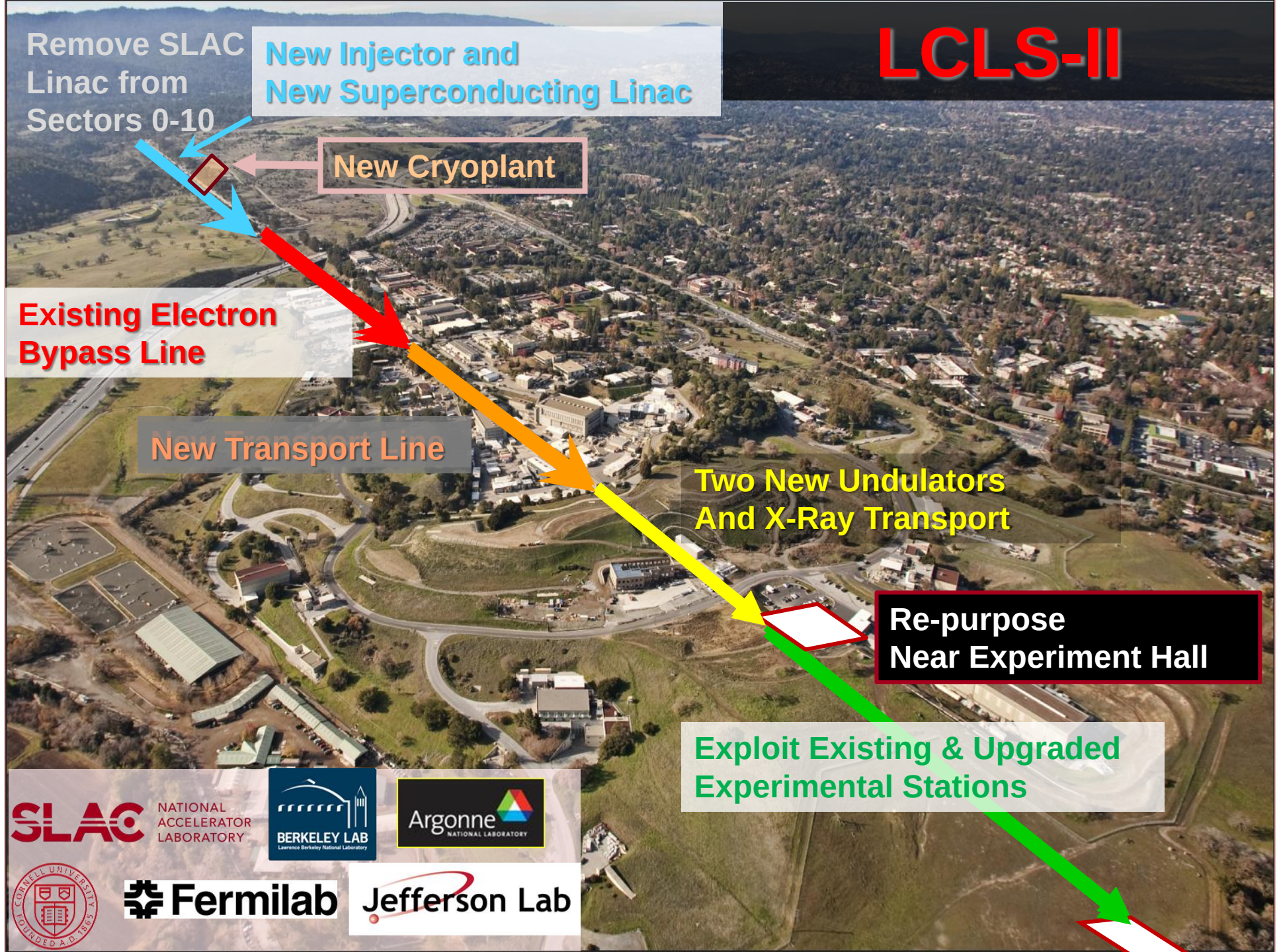
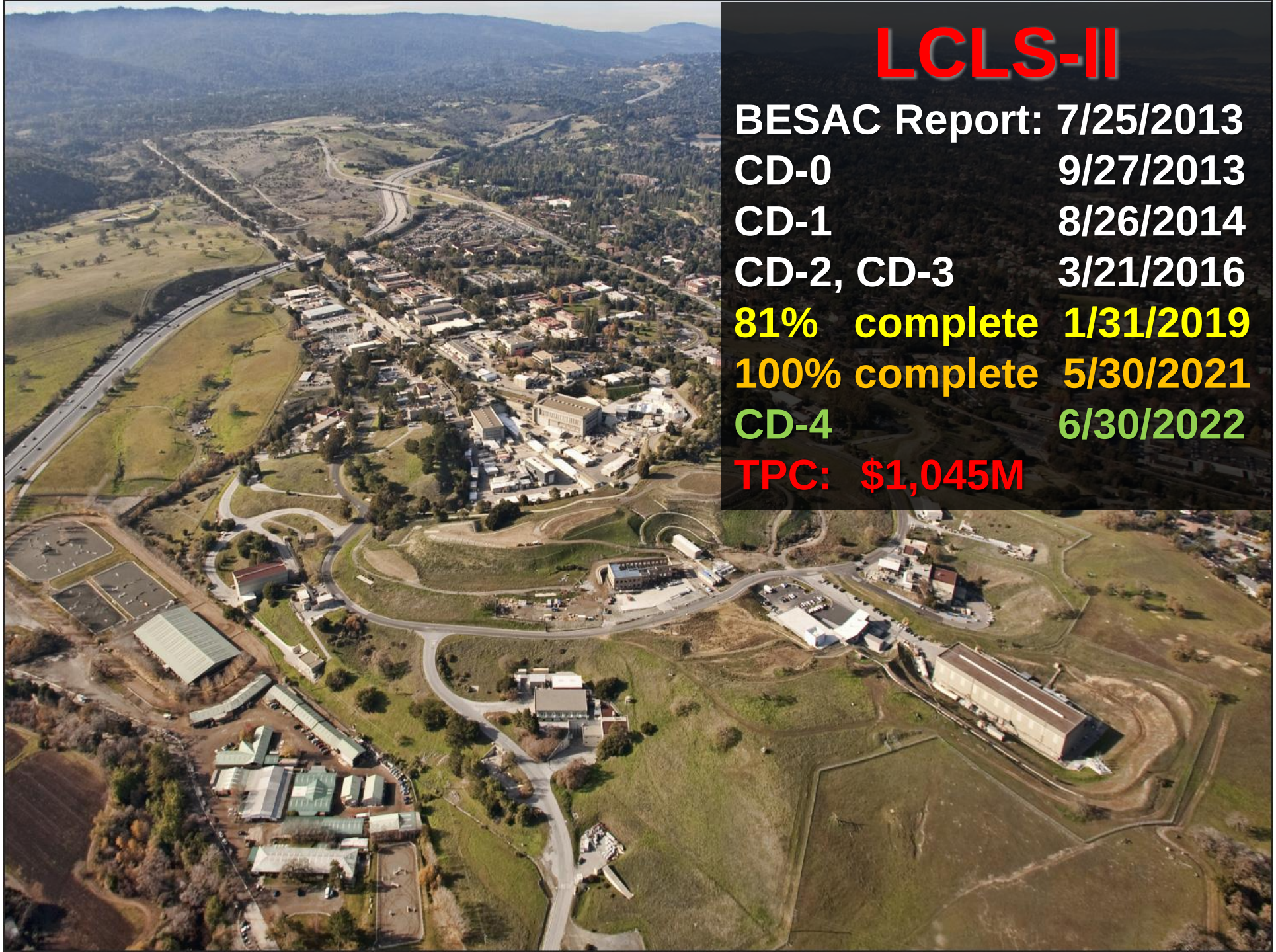
March 8, 2019


LCLS-II
Remove SLAC Linac from Sectors 0-10
New Injector and New Superconducting Linac
New Cryoplant
Existing Electron Bypass Line
New Transport Line
Two New Undulators And X-Ray Transport
Re-purpose Near Experiment Hall
Exploit Existing & Upgraded Experimental Stations
SLAC NATIONAL ACCELERATOR LABORATORY
BERKELEY LAB
Argonne NATIONAL LABORATORY
Fermilab
Jefferson Lab



LCLS-II

BESAC Report:	7/25/2013
CD-0	9/27/2013
CD-1	8/26/2014
CD-2, CD-3	3/21/2016
81% complete	1/31/2019
100% complete	5/30/2021
CD-4	6/30/2022

TPC: $1,045M

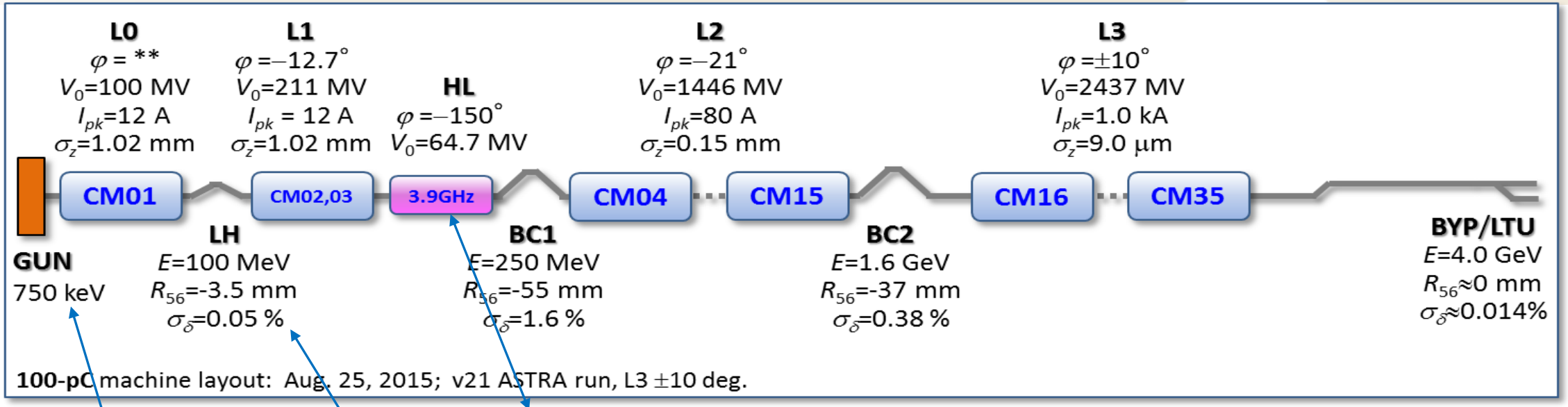
LCLS-II Project Key Performance Parameters

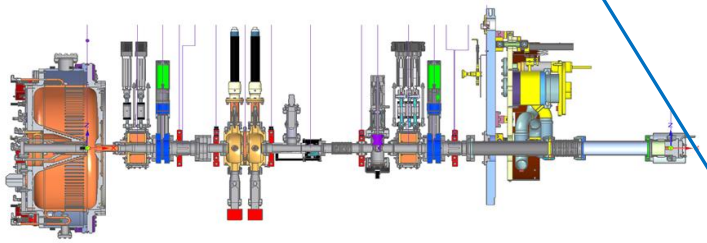
Performance Measure	Threshold	Objective
Variable Gap Undulators	2 (SXR & HXR)	2 (SXR & HXR)
Super Conducting Linac Based FEL System		
Super Conducting Linac Energy	3.5 GeV	≥ 4 GeV
Electron Bunch Repetition Rate	93 kHz	929 kHz
Super Conducting Linac Charge per Bunch	0.02 nC	0.1 nC
Photon Beam Energy Range	250-3,800 eV	200-5,000 eV
High Repetition Rate Capable End Stations	≥ 1	≥ 2
FEL Average Power (10^-3 BW)	5×10^{8} (10x spontaneous @2,500 eV)	$>10^{11}$ @ 3,800 eV
Normal Conducting Linac Based FEL System		
Normal Conducting Linac Electron Beam Energy	13.6 GeV	15 GeV
Electron Bunch Repetition Rate	120 Hz	120 Hz
Normal Conducting Linac Charge per Bunch	0.1 nC	0.25 nC
Photon Beam Energy Range	1,000-15,000 eV	1,000-25,000 eV
Low Repetition Rate Capable End Stations	≥ 2	≥ 3
FEL Photon Energy (10^{-3} BW[a])	10^{10} (lasing @ 15,000 eV)	$> 10^{12}$ @ 15,000 eV

LCLS-II Mission Need and Key Performance Parameters Based on Findings of the

Report of the BESAC Subcommittee on Future X-ray Light Sources

The Linac: 35 1.3 GHz cryomodules Required





"HL" = two cryomodules with 3.9 GHz cavities to shape energy vs. position of electrons in the bunch

CM01-CM35 each with eight 9-cell XFEL cavities

16MV/m produces 4.25 GeV acceleration

Usable gradient of cryomodules tested to date: **18.5 MV/m**

Good margin for reliable running at 16 MV/m

Laser "heater" to control energy spread of electron bunch
Two bunch compression chicanes

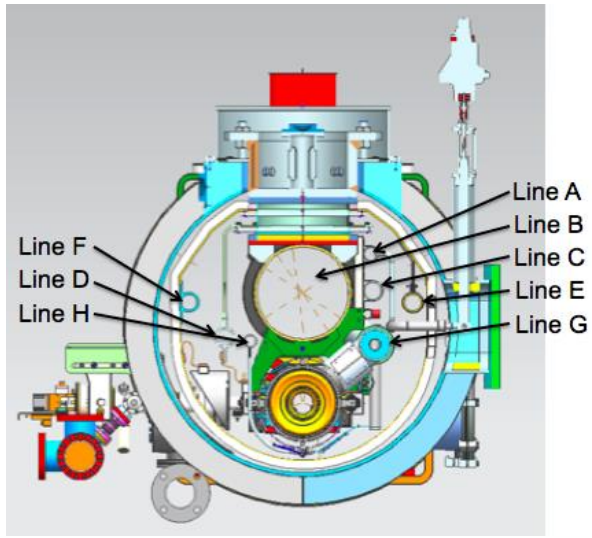
Copper linac removed---Superconducting accelerator and supporting infrastructure being installed

Out with copper,

In with niobium

1.3 GHz Cryomodules: 7 of 35 (+5 Spares) Delivered

A. 2.4 K subcooled supply
B. Helium gas return pipe (HGRP)
C. Low temperature intercept supply
D. Low temperature intercept return
E. High temperature shield supply
F. High temperature shield return
G. 2-phase pipe
H. Warm-up/cool-down line



Circuit (Line)

"Nitrogen doping" increases Q(cavity "quality factor") and reduces heat load on helium refrigeration system

High Q Nitrogen Doped Cavities

- ~**3X** improvement in “quality factor” Q (hence 1/3 power required to create the desired gradient) with nitrogen-doped superconducting RF cavities (Martinello, et al) A. Grassellino group Fermilab

- Cooling requirement for CW operation is reduced dramatically

- Average for cryomodules so far: <Q> nearly $3x10^{10}$

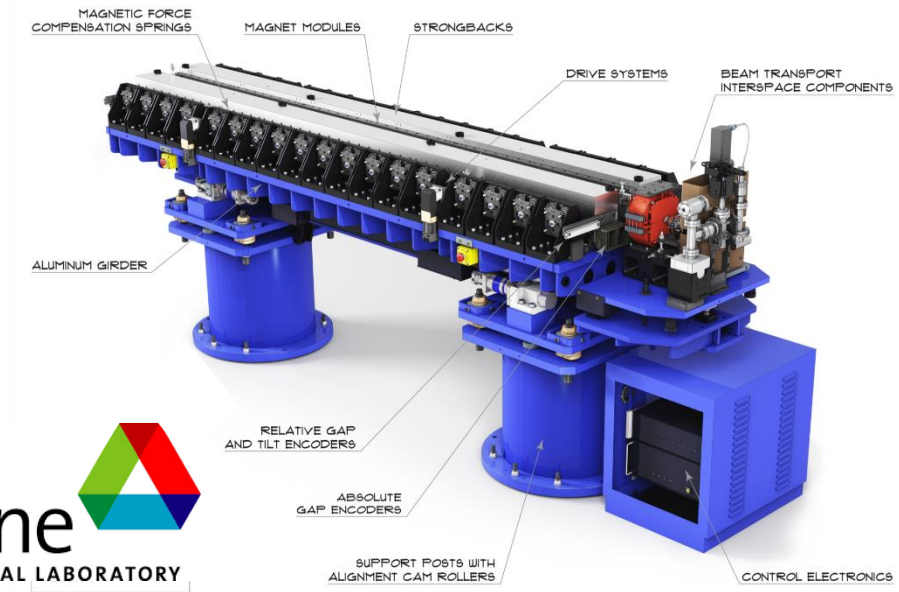
JLAB-Designed Cryoplants
Subsystems Installation Underway

Jefferson Lab
Thomas Jefferson National Accelerator Facility

X-Ray Undulators

- All Soft XR undulators now @ SLAC

Hard XR undulators being prepared for installation by ANL, LBNL, SLAC



- "First light" from these undulators will be demonstrated using the LCLS "copper" linac
- Reestablishment of FEL operation begins **1/2020**

Equipment Removal is Complete from the Near Hall and FEE

LCLS-II Coming to Life

- Electron gun & its laser - checkout completion now
- New Hard X-Ray Undulator online February 2020 with electrons from the LCLS copper linac
- Cryomodules installed April 2020
- Cryoplant #1 commissioning April 2020
- “First light” using SC linac March 2021

Thank You

SLAC and DOE for the opportunity to work on LCLS-II

LCLS-II collaboration for dedication and resourcefulness

Experts from across the National Lab system for invaluable information and advice

DESY and XFEL for advice & help
in all areas superconducting