Workshop on High Energy Density Physics with BELLA-i

Berkeley, Jan 20-22, 2016

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BELLA-i workshop structure

- **workshop charge: what high impact science is uniquely enabled by BELLA-i ?**

- four working group topic areas (with somewhat fluid boundaries)
- five workshop sessions (roughly aligned with working group areas)
- working group leaders/session chairs
  - steer the discussions
  - collect input for the brief workshop report

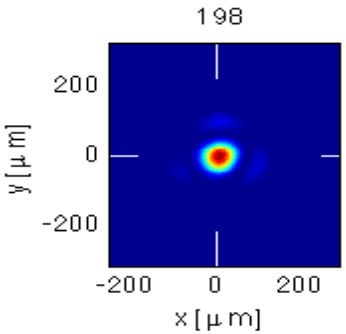
1. **laser-ion acceleration, ...**
   - chairs: B. Manuel Hegelich (U Texas, Austin) and Sven Steinke (LBNL)
2. **secondary radiation generation, high harmonics, ...**
   - chairs: Félicie Albert (LLNL) and Jeroen van Tilborg (LBNL)
3. **nQED, high field physics, nuclear-plasma, ...**
   - chairs: Jonathan Wurtele (UC Berkeley) and Stepan Bulanov (LBNL)
4. **facilities, ...**
   - chairs: Ronnie Shephard (LLNL) and Qing Ji (LBNL)

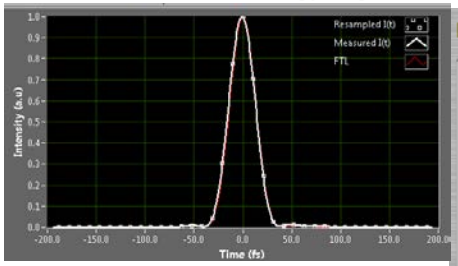
- invited talks 35 min, contributed 20 min, including Q&A
- ample time for discussions at the end of each day

- capacity of our conference room 71-264 is 55 (very crowed for >50)
- overflow room with live stream: 71-233 (just around the corner)
- a ZOOM remote streaming option is also set up

Laser quality and experienced operations team are key to succesfull experimental campaigns

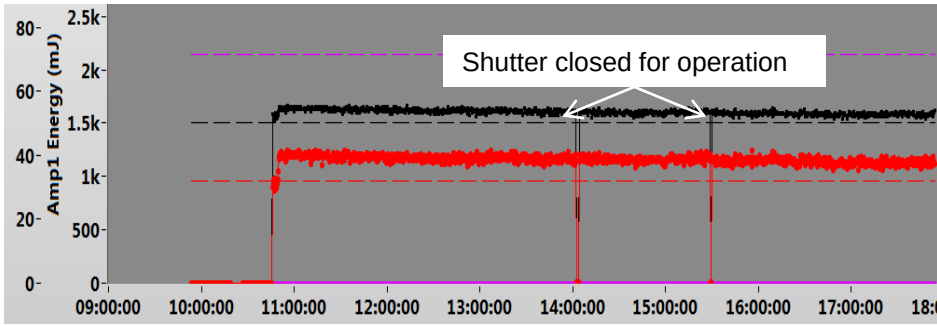
- Experienced team
  - High mode quality
  - Pointing stability
  - Know-how in handling high peak power
- Important improvements:
  - Pulse shaper
  - Ultra-stable oscillator and regenerative amplifier pump

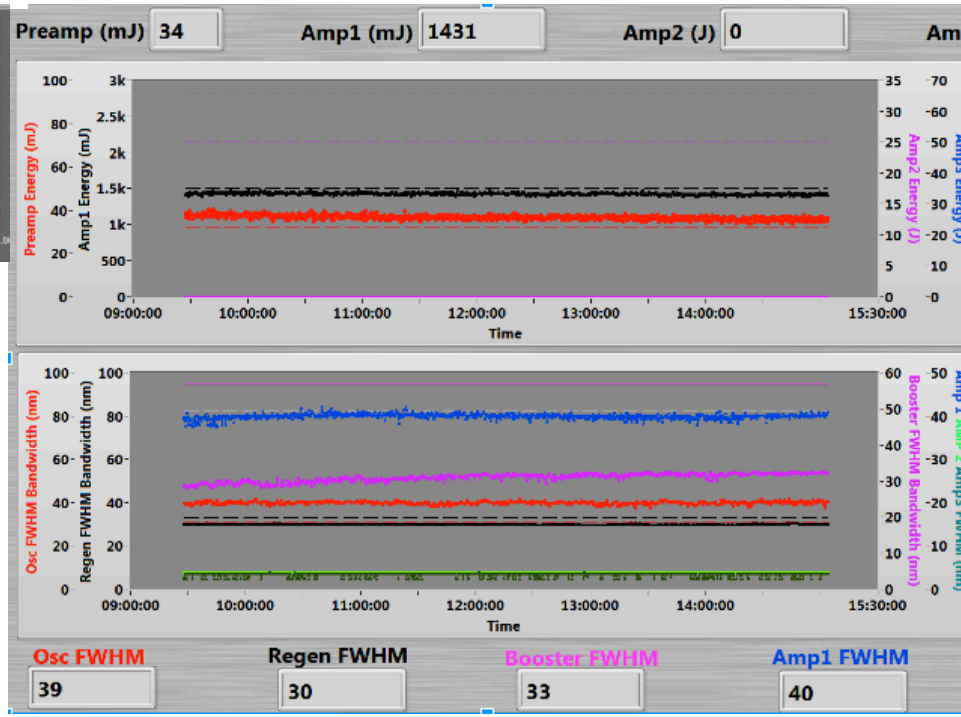




30 TW/J w/ Dazzler

Frontend laser energy stability: Stable >7 hours

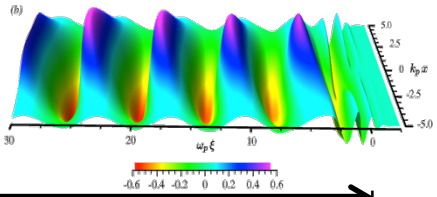




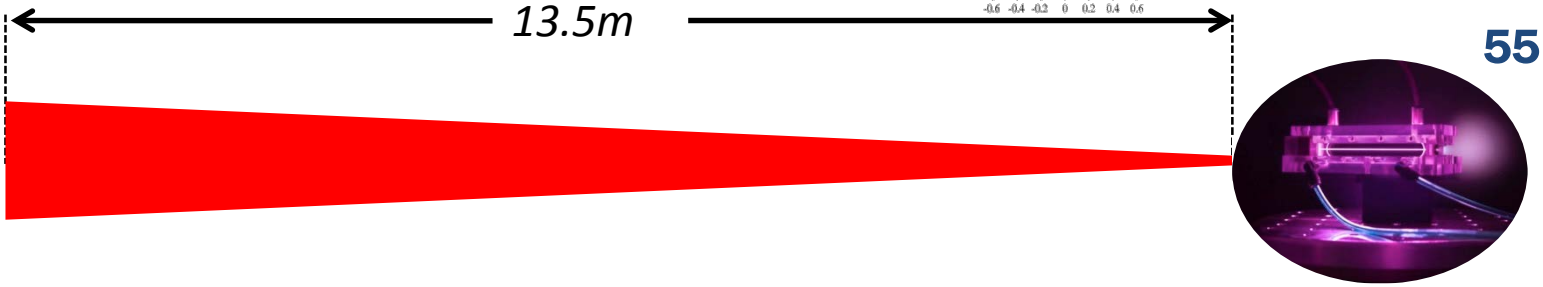
- Development of 10 GeV module
- Collider relevant concepts
- Accelerator stewardship

For electron acceleration, BELLA is focused with long focal length. For ions (etc.) it requires short focal length and plasma mirrors

Electron acceleration



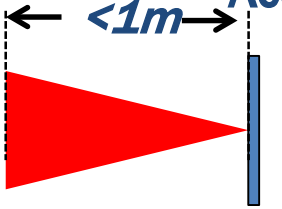
Intensity ~1.5x10^{19} Wcm^{-2}
Acc. fields ~10-50GV/m



55 micron spot

Ion acceleration

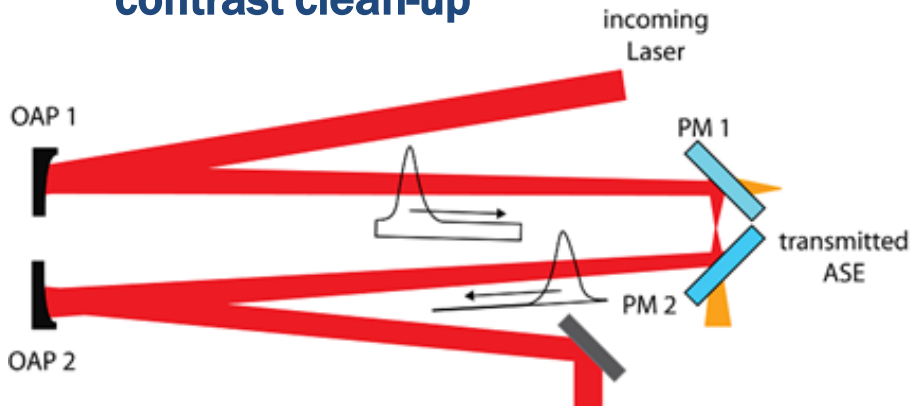
Intensity ~3-5x10^{21} Wcm^{-2}
Acc. fields ~TV/m



4-5 micron spot

+

Plasma mirror technology for contrast clean-up



BELLA-i - a facility for high energy density physics and discovery plasma science at Berkeley Lab

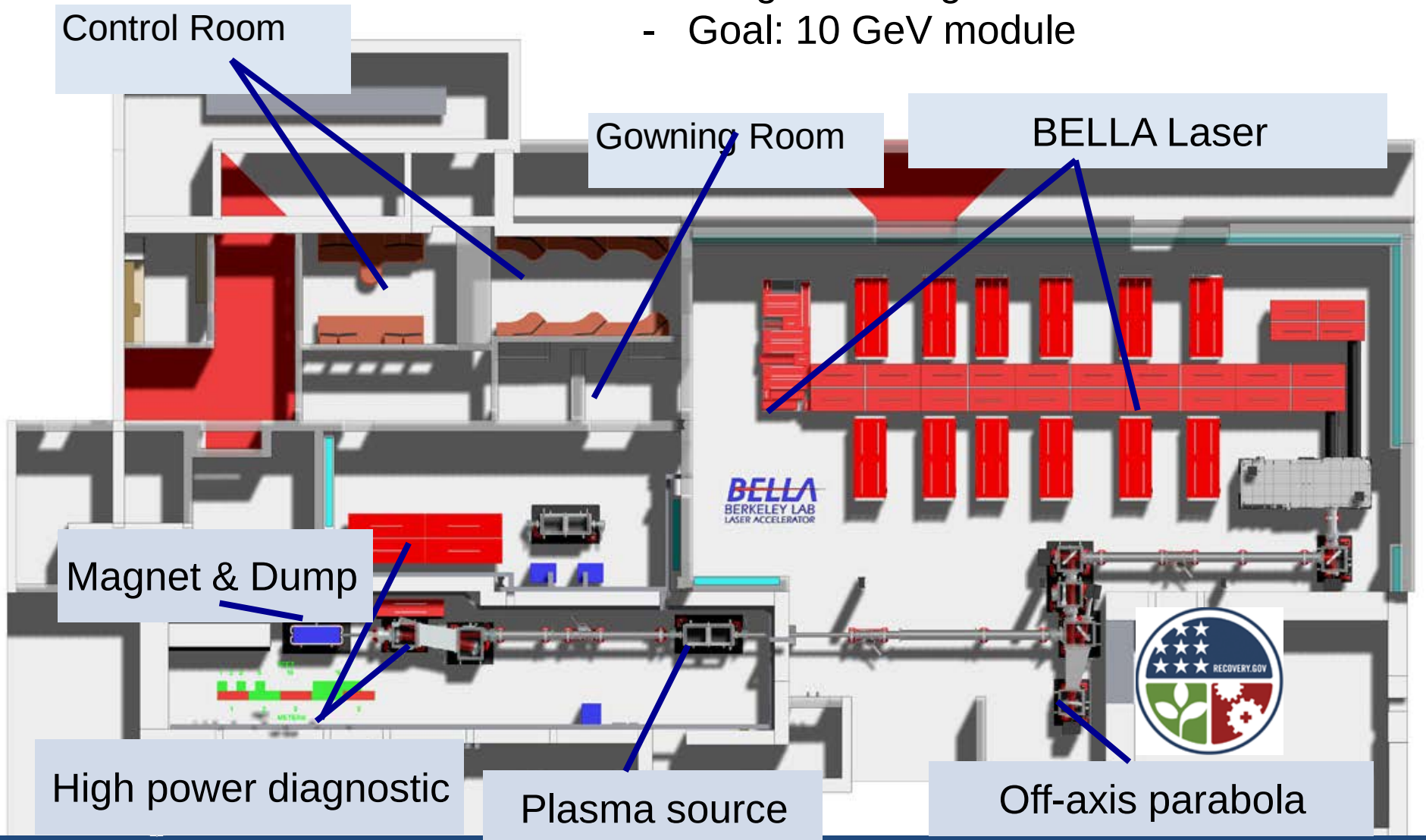
BELLA-i	1-BELLA now	2-two beam BELLA	3-new cave
pulse length	30 fs	30 fs	30 fs
peak pulse energy	40 J	40 J	40 J
laser spot size	55 μm	5 μm	5 μm
peak repetition rate	1 Hz*	1 Hz*	1 Hz
contrast (ns)	10^{-10}	10^{-10}	$>10^{-14}$
diagnostics (details to be determined)	• optical spectrometers • ion and electron spectrometers • …	• optical pump- probe • betatron x-rays • MeV protons • …	• same as 2 • beamline for experiments with laser accelerated ions • …
1st access (estimates)	2017-2018	2018-2019	2019-2020

1. experiments with the existing, long focal length BELLA beamline in the existing cave
2. experiments in the existing BELLA cave with a new dual-beam line
   - * shielding in the BELLA cave limits the repetition rate for experiments with generation of intense pulses of >20 MeV protons
3. experiments in a new cave with improved shielding and with a beam line for laser accelerated ions
   - * improved shielding in a three-times larger experimental area for continuous operation at 1 Hz

- contact: WPLeemans@lbl.gov; http://bella.lbl.gov/

1. Present BELLA PW laser and long focal length beamline

BELLA currently has one beamline
- Long focal length
- Goal: 10 GeV module



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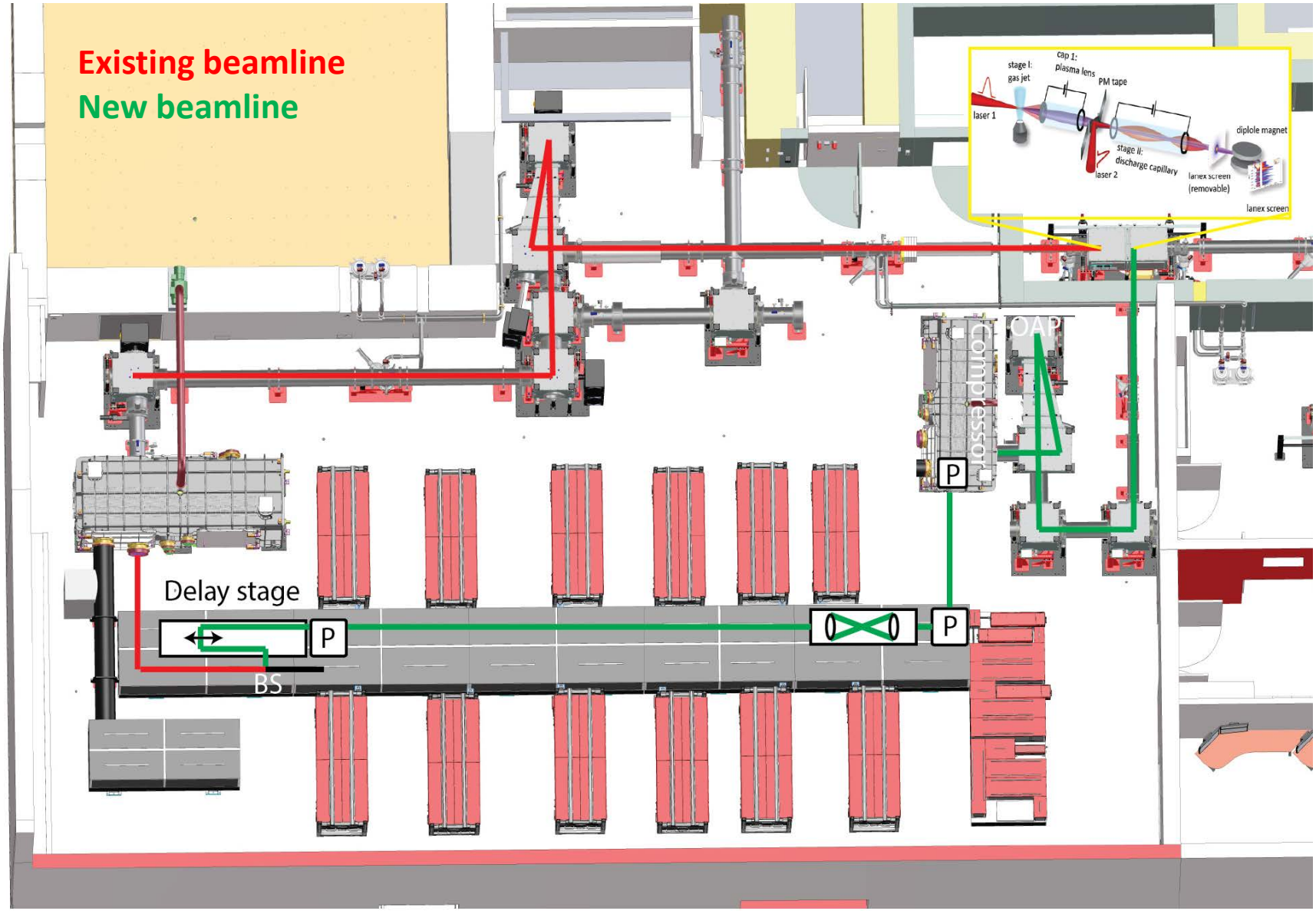
1. experiments with the existing, long focal length BELLA beamline in the existing cave

2. Split BELLA beamlines in the existing cave with a short focal length beamline for staged LPA of electorns and HEDLP



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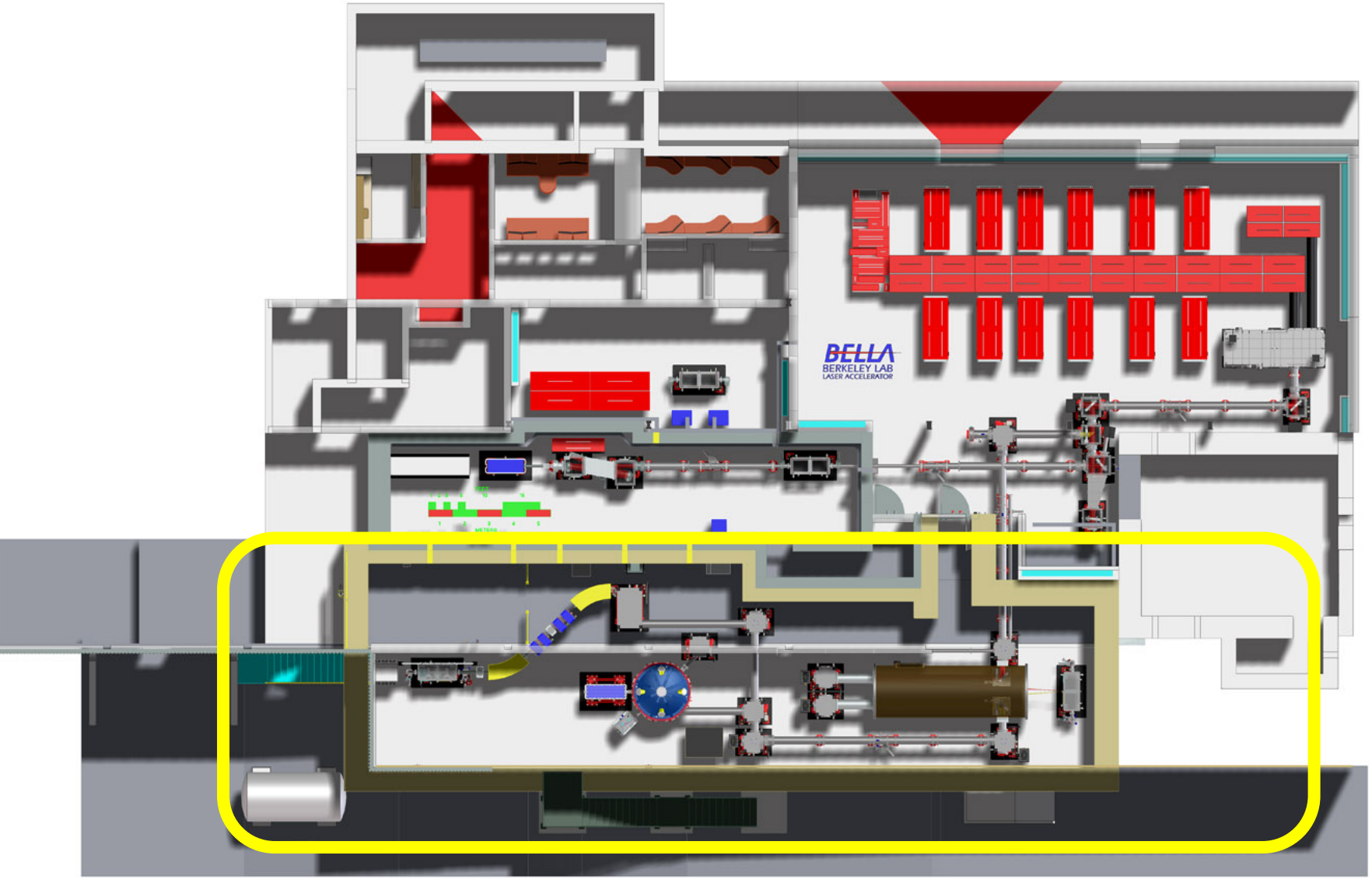
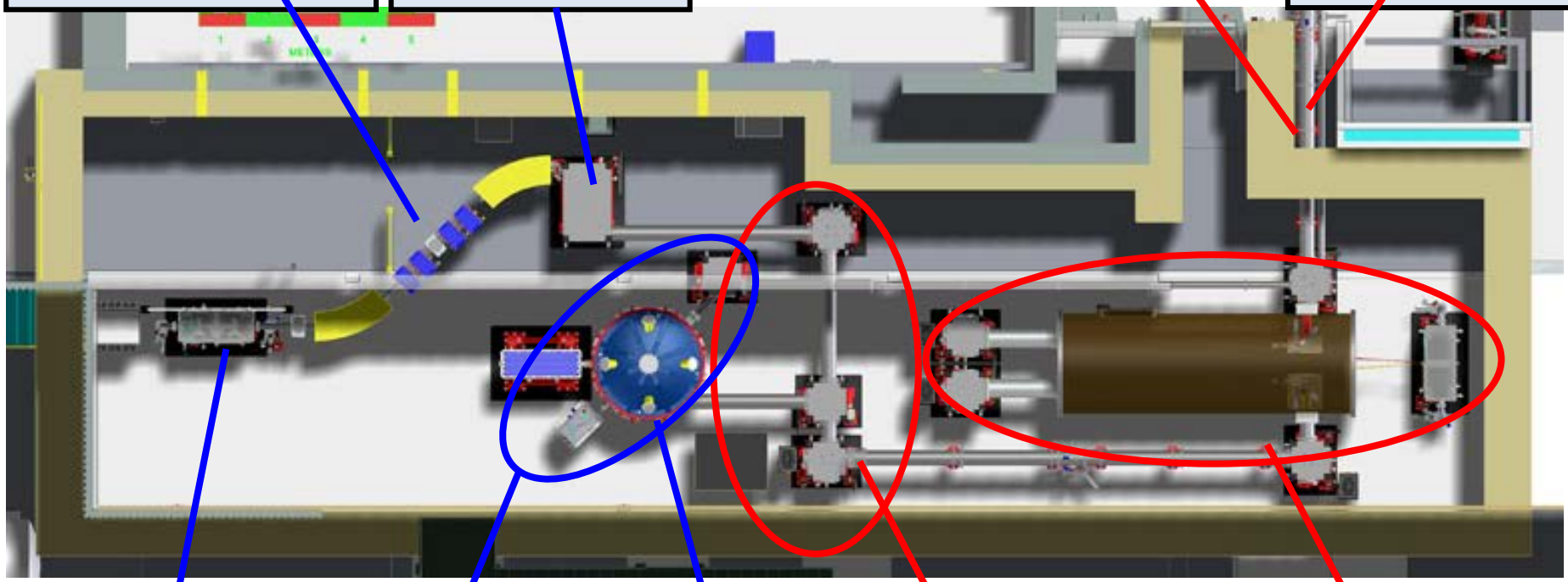
2. experiments in the existing BELLA cave with a new dual-beam line
   - * shielding in the BELLA cave limits the repetition rate for experiments with generation of intense pulses of >20 MeV protons

3. New cave with short focal length beamline



3. We expand the facility by adding short focal length capability for ultra-high intensity



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3. Experiments in a new cave with a beam line for laser accelerated ions
   - * improved shielding in a three-times larger experimental area for continuous operation at 1 Hz

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Context for BELLA-i in our division and at Berkeley Lab

- BELLA center
- Fusion Science and Ion Beam Technology
  - NDCX-II, …
- Berkeley Center for Magnet Technology
- Nuclear Science Division
- The Molecular Foundry
- National Energy Research Scientific Computing Center (NERSC)
- …