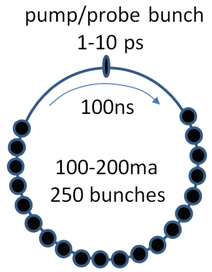
SPEAR3 HIGH REPETITION RATE PUMP-PROBE SCIENCE AT SSRL

An Overview

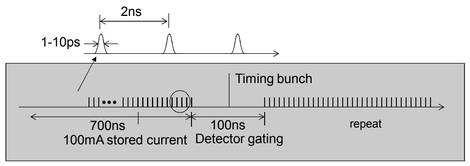
SPEAR3 can operate in a short-bunch (low-alpha) configuration to generate 1-10ps x-ray pulses for ultrafast pump-probe applications at a 1MHz rate. The laser-pump/x-ray probe technique has been used on 4 beam lines to date and with visible beam cross-correlation to measure pulse length.
A synchronous 500fs fiber laser can deliver IR, green and UV pump pulses with up to 2uJ in the IR. A second laser in the procurement phase will operate at 500kHz and 5uJ in the IR. In 'hybrid mode' the total beam current is 100-200mA enabling multiple flux-based experiments to work in parallel.

Hybrid Mode Operation



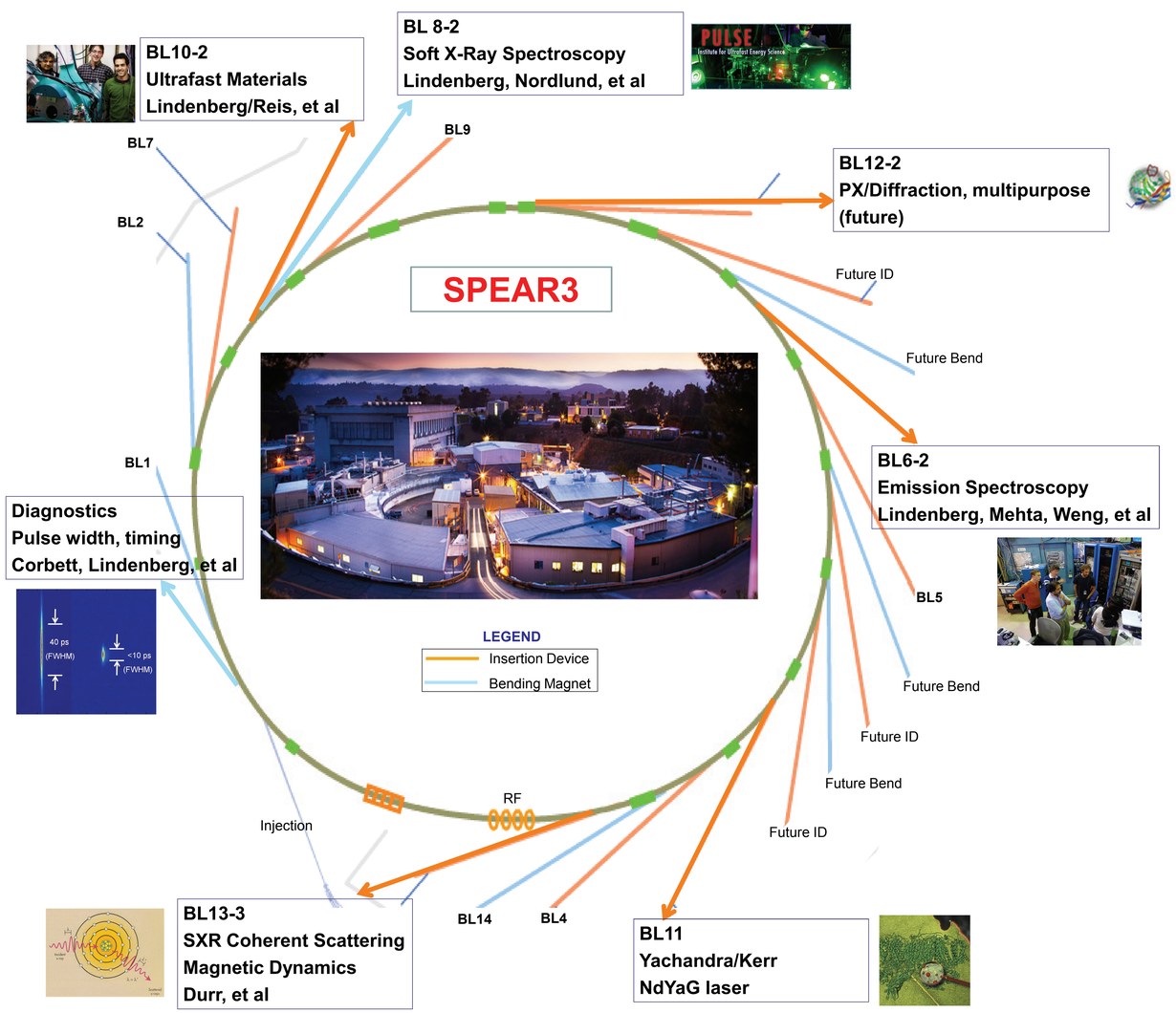
Nominal current: 350ma
Hybrid mode: 100-200ma
Factor ~2 sigma-x increase
Hybrid mode ~2 months
Other beam lines take data
Top-up injection

X-Ray Beam Properties

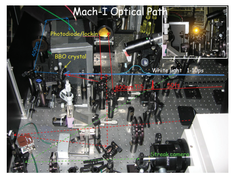


Parameter	Value
Pulse repetition rate	500MHz – 5MHz-1MHz
Pulse separation	2ns - 200ns – 1us
Pulse length	1-100ps*
X-rays /Pulse	~1-10
X-ray/sec	10^6 -10^7
Spectrum	0.25 – 20$^+$ keV
Other	polarization state, partial coherence, top-up

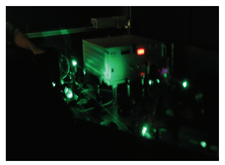
Pump-probe beam lines



Laser systems



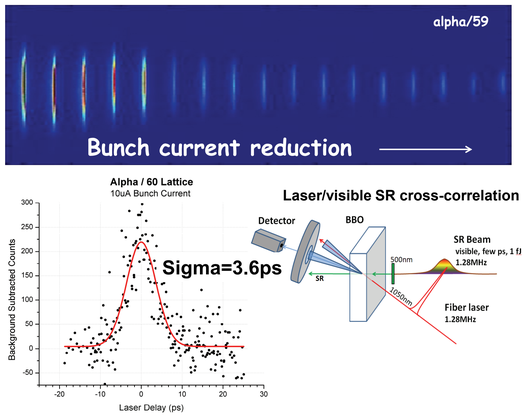
First experiments
5MHz, 200fs
800/400/266nm
Ti:Sapphire



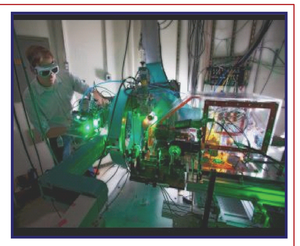
Present System
1.28MHz 500fs, 2uJ
1030/515/343nm
(fiber laser, Calmar)

In procurement –
Second fiber laser (5uJ, 500kHz)

Low-α electron bunch length



SPEAR3 operation in low-alpha mode



- **low-α yields short-pulse, high rep rate x-rays (MHz)**
- **pulse width <10 ps FWHM, 1-10 photons/pulse**
- **hybrid mode with 100-200mA for multiple SSRL users**
- **hybrid mode operation scheduled ~every 2 months**
- **growing infrastructure (timing, lasers, detectors, staff)**
- **SSRL/LCLS ultrafast science program synergy**

The SPEAR3 Lightsource is operated through Stanford University for the U.S. Department of Energy