Advanced Light Source Upgrade (ALS-U) Project Update

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BES Basic Research Needs reports identified need to understand, predict, and control emergent material and chemical properties

1. High chemical and material contrast
2. Nanoscale spatial sensitivity
3. Broad temporal sensitivity to nanoscale motion

We need high soft x-ray brightness and coherent flux
Today’s ALS serves a broad and diverse user community from IR to harder x-rays but is optimized for soft x-rays.

- 40 beamlines
- 2,000+ users/year

ALS provides most of the soft x-ray capacity in the US.

- 925+ publications/year
- 20% in high-impact journals
ALS-U Project will upgrade the ALS to provide users with highest brightness, coherent light in the soft x-ray region

**Features**
- World-leading soft x-ray brightness and capabilities
- More than 100x increase in soft x-ray brightness and coherent flux compared with today’s ALS
- Excellent IR and hard x-ray capabilities

**Impact**
- Enable scientific advances in a diverse range of fields, improving our economy, healthcare, and national security
- Continue the ALS tradition of serving a large and scientifically diverse user community
ALS-U Project parameters

Scope:
• New 2 GeV, high-brightness storage ring fed by new full-energy accumulator ring in the existing ALS storage-ring tunnel
• Suite of 2 new and 2 upgraded world-leading undulator beamlines
• 2 new full-length undulators
• Realignment of existing beamlines

Cost: Estimated total project cost (TPC) at CD-1 – $368M

Timeline: Early finish – 2Q FY26
ALS-U accelerator scope

New full-length **undulators** optimized for high coherent flux

- New 2.0 GeV **accumulator ring** for full-energy swap-out injection and recovery of bunch trains
- New 2.0 GeV 9BA **storage ring** in existing tunnel optimized for low emittance and high soft x-ray brightness and coherent flux

**Plan to install and commission the accumulator ring early to minimize risk and duration of the main dark period**
The ALS-U Project scope includes 4 new and upgraded undulator beamlines that were selected in January 2019

**MAESTRO upgrade**
- Angle-resolved photoemission spectroscopy (ARPES)

**COSMIC upgrade**
- STXM and ptychography

**New soft x-ray beamline**
- Nano – RIXS & RSoXS
- X-ray photon correlation spectroscopy (XPCS)

**New tender x-ray beamline**
- Tender-nanoprobe and coherent scattering
Ptychographic imaging at the upgraded COSMIC beamline

- Significantly enhanced spatial and temporal resolution for operando imaging of chemical states
- Access to the meso-time gap, allowing studies on time scales of industrial interest
NanoARPES at the upgraded MAESTRO beamline

**Today**
- Electronic structure maps with ~100 nm spatial resolution
- Lack the ability to resolve inhomogeneity in quantum states across a sample

**Future**
- Increased brightness will enable electronic structure maps with ~10 nm spatial resolution
- Inhomogeneities can be better measured
Strong budgets in FY18 and FY19 have allowed the project to accelerate its progress

- Rapidly completed the conceptual design and achieved CD-1 approval in Sept. 2018
- Doubled FTEs in last 12 months
- Efficiently advancing the preliminary design
- Completed the beamline selection process
- Increased focus on the accumulator ring to allow early installation and commissioning
- Anticipate readiness for some long-lead procurements starting in early FY20
Quickly advancing the preliminary design: Some examples

- Testing fast injection pulsers and kickers
- Prototyping key storage ring magnets
- Testing coherent preserving optics
- Storage ring sector and supports
- Accumulator ring sector and transfer line
The ALS-U Project is on track

The appropriated funding in FY18 and FY19 has allowed us to:

• Successfully obtain CD-1 approval
• Advance the preliminary design towards CD-2 approval in 4Q FY20
• Be ready to begin some long-lead procurements in early FY20, more than a half a year ahead of schedule
Thank you for your attention