ALS-U: A major upgrade to the ALS

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ALS-U Facility Status

• Outline
  • DOE Approval Status
  • What is ALS-U
  • Strategy
DOE Approval Status

Currently at Conceptual Design stage, Reviews in progress

CD-0
Mission Need
Sept. 2016

CD-1
Conceptual Design
Fall 2018

CD-2
Performance Baseline

CD-3
Start Construction

AR* Install
Dark Period <1 year

CD-4
Completion
~2026

*AR = Accumulator Ring

EPICS Collaboration Meeting, June 2018
What is ALS-U

• 2-3 orders of magnitude brighter than ALS
• Higher coherence due to lower emittance
What is ALS-U

ALS today: triple-bend achromat

ALS-U: multi-bend achromat

Beam Size Comparison
Bunch Train Swap-Out

Swap-out enables:

- Stronger-focusing MBA lattices with smaller dynamic apertures
- Round beams - more useful shape and reduced emittance growth
- Vacuum chambers with small round apertures → Improved undulator performance

Swap-out with full energy accumulator enables:

- Bunch train swap-out and recovery of the stored beam current
  - Lower demand on the injector
  - Very small (~nm) injected emittance
  - More flexibility in fill patterns

Only ALS-U and APS-U plan to include swap-out
Project Scope

What’s New
- Storage Ring (SR)
- Accumulator Ring (AR)
- Booster to AR Transfer Line (BTA)
- AR to SR Transfer Line (ATS)
- SR to AR Transfer Line (STA)

What Doesn’t Change
- Gun
- Linac
- Booster
ALS-U Strategy

• Re-use ALS systems
  – Including recent & upcoming upgrades
• Use Community Contributions
  – EPICS7
  – eTraveller & other tools
  – Archiver Appliance
• Follow other sites’ progress (APS-U)
• Build new stuff when necessary
• Plan for higher device count
  – Possibly >1 million PVs vs. 200k for ALS
  – Networking redesign
Conclusions

- ALS-U is a large and interesting project
- The use of existing tools and expertise will be important for project success
- New development will also be required
  - We need people!
  - [http://jobs.lbl.gov](http://jobs.lbl.gov), search by keyword
Questions?
## Device Count: Power Supplies and Vacuum

### Power Supplies

<table>
<thead>
<tr>
<th>Device Type</th>
<th>SR</th>
<th>AR</th>
<th>TL</th>
<th>Totals</th>
<th>Method of Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual PS / per sector</td>
<td>84</td>
<td>16</td>
<td>52</td>
<td>1252</td>
<td>Ethernet</td>
</tr>
<tr>
<td>Large Series PS / ring</td>
<td>4</td>
<td></td>
<td></td>
<td>4</td>
<td>TBD</td>
</tr>
<tr>
<td>Klixon circuits / sector</td>
<td>84</td>
<td>25</td>
<td>52</td>
<td>1360</td>
<td>PLC</td>
</tr>
<tr>
<td>Rack water flow</td>
<td>6</td>
<td>4</td>
<td></td>
<td>120</td>
<td>PLC</td>
</tr>
</tbody>
</table>

### Vacuum Channels per Sector

<table>
<thead>
<tr>
<th>Component</th>
<th>SR</th>
<th>AR</th>
<th>TL</th>
<th>Totals</th>
<th>Method of Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gauges</td>
<td>8</td>
<td>2</td>
<td>4</td>
<td>124</td>
<td>PLC: Analog (0-10 V, .01 V resolution, 2 Hz)</td>
</tr>
<tr>
<td>Pumps</td>
<td>10</td>
<td>6</td>
<td>6</td>
<td>198</td>
<td>PLC: Analog (0-10 V, .01 V resolution, 2 Hz)</td>
</tr>
<tr>
<td>Gauges</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>62</td>
<td>Ethernet</td>
</tr>
<tr>
<td>Pumps</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>99</td>
<td>Ethernet</td>
</tr>
<tr>
<td>Valves</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>74</td>
<td>PLC: 4 Booleans/Valve</td>
</tr>
<tr>
<td>Thermocouples</td>
<td>42</td>
<td>20</td>
<td>0</td>
<td>744</td>
<td>Slow monitoring</td>
</tr>
<tr>
<td>Thermocouples</td>
<td>50</td>
<td>20</td>
<td>16</td>
<td>856</td>
<td>PLC: Slow monitor &amp; interlock</td>
</tr>
<tr>
<td>RGA</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>Ethernet</td>
</tr>
</tbody>
</table>
Scope of ALS-U

1. **Retain** the existing gun, linac, booster
2. **Replace** the existing triple-bend achromat storage ring with a new, high-performance storage ring based on a multi-bend achromat.
3. **Add** a low-emittance, full-energy accumulator ring in the existing storage-ring tunnel to enable on-axis, swap-out injection using fast magnets.
4. **Replace** the existing transfer line with new lines: BTA, ATS, STA
The ALS-U needs are,

- 192 in the storage ring (16 /sector)
- 72 in the accumulator ring (6 /sector)
- ~20 in the transfer lines

(We can reuse the present ALS SR BPMs (114) with a VCXO change)

160 built: 114 SR, 37 injector, and a few spares.
Fast orbit feedback architecture

MRF: Events / Timing Data (fiber fanouts)
Fast Orbit Feedback Network (Dual 3.125 Gb/s fiber links)
Ethernet – pvAccess or Channel Access

Candidate Fast Power Supply for FOFB (Caen Fast-PS Series)

Per Sector

EPICS Collaboration Meeting, June 2018
Fast Magnet Count

Monitoring and Control Required

- Timing
- Controls
  - HV Power Supplies (Enet)
  - Interlocking (PLC)
- Scopes
  - 6 channels @ 100 MHz
  - 18 channels @ 500 MHz
Standard HW Architecture

Level 1: SCADA support over a distributed network
- SIOC Servers
- Field I/O
- Controls Subnets (VLAN)
- PLC
- Ethernet – pvAccess or Channel Access

Level 2: Operator stations:
- Displays, Archiving, Alarm Management, Strip charts, Save/Restore Utility
- Events / Timing Data

Level 3: Physics or Science Applications Using Stored Data
- Cell Controllers
- RF Systems

Level 0: High Performance Systems over dedicated networks (blue and orange) or slow control over industrial Ethernet

- Timing Master
- CPU
- EVG
- NAD
- PS1
- PS2
- PS3
- PS4
- PS5
- PSn
- BPM1
- BPM2
- BPM3
- BPM4
- BPM5
- BPn
- Fast Feedback Power Supplies
- Beam Position Monitors

PLCs, Slow I/O, High Reliability, Low Accuracy, High Density. Used in Vacuum, slow EPS, non-FOFB PS, Cryo., Waterflow, Magnets, etc.