High Energy Photon Source Control System Design

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Abstract: A 6-GeV high energy synchrotron radiation light source is being built near Beijing, China. The accelerator part contains a linac, a booster and a 1360-m circumference storage ring, and fourteen production beam-lines for phase one. The control systems are EPICS based with integrated application and data platforms for the accelerators and beamlines. The number of devices and the complexity level of operation for such a machine is extremely high, therefore, a modern system design is vital for efficient operation of the machine. This paper reports the design, preliminary development and planned near-future work, especially the databases for quality assurance and application software platforms for high level applications.

HEPS Main Parameters:

<table>
<thead>
<tr>
<th>Main Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
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<tbody>
<tr>
<td>Top beam energy</td>
<td>6</td>
<td>GeV</td>
</tr>
<tr>
<td>Main Ring circumference</td>
<td>1360.4</td>
<td>m</td>
</tr>
<tr>
<td>Emittance</td>
<td>&lt;60 (&lt;40 with anti-bend)</td>
<td>pm-rad</td>
</tr>
<tr>
<td>Beam current</td>
<td>200</td>
<td>mA</td>
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<tr>
<td>Brightness</td>
<td>&gt;10^12</td>
<td>Phs/mm^2/mrad/0.1%BW</td>
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<tr>
<td>Injection</td>
<td>Top-up</td>
<td></td>
</tr>
<tr>
<td>Bunch structure</td>
<td>680 (high-brightness mode), 63 (timing mode)</td>
<td></td>
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</tbody>
</table>

Introduction
HEPS Control System Design principles:
- Data centric approach
- Top-down architecture design: understanding the big picture
- Distributed control systems
- Integrated development tools (GUI code editors, repository management...) for higher software quality
- Choosing advanced yet matured technologies
- Using industrial standards, choosing commercially available products first for lowering costs
- Considering expandability at design, balancing the price and performance while satisfying physics requirements
- Collaborating with other accelerator projects
- Possible commercialization for R&D results

Database Work

Planned Database work:
- Design Parameter List DB
- Naming Convention DB
- Magnet DB
- Equipment DB
- Lattice & Model DB

Accelerator Control

3-tier architecture:
- Device layer
- Middle layer
- Presentation layer

Magnet Power Supply Control:

- FOB Topology
- FOB PS Control
- Timing System:
  - MRF-based event trigger
  - Distributed RF reference lines
  - 12 ns kicker pulse width
  - Swap-out top-up injection
  - Considering MicroTCA EVR

Swap-out injection scheme

Beamline Control

- Similar to Accelerator Control
- Considering EPICS v7
- In conjunction with DAQ, Computing

Software Platforms:

- Control system API: CS-Studio API
- Physics and general-purpose API: Open XAL
- Machine Learning: under development
- Support Java and Python

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