12 GeV Upgrade Project

Upgrade is designed to build on existing facility: vast majority of accelerator and experimental equipment have continued use

Scope of the project includes:
• Doubling the accelerator beam energy
• New experimental Hall and beam line
• Upgrades to existing Experimental Halls

The completion of the 12 GeV Upgrade of CEBAF was ranked the highest priority in the 2007 NSAC Long Range Plan

Maintain capability to deliver lower pass beam energies: 2.2, 4.4, 6.6....
12 GeV Scientific Capabilities

Hall D – exploring origin of confinement by studying exotic mesons

Hall B – understanding nucleon structure via generalized parton distributions

Hall C – precision determination of valence quark properties in nucleons and nuclei

Hall A – form factors, future new experiments (e.g., SoLID and MOLLER)
12 GeV Upgrade Status

- **Civil Construction essentially complete:**
  - Cooling towers; Tunnel Air Conditioning in FY15

- **Accelerator Construction complete:**
  - Operation during project commissioning of Halls B & C remaining

<table>
<thead>
<tr>
<th>#</th>
<th>System</th>
<th>Technical Definition</th>
<th>PEP Date</th>
<th>ACTUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Accelerator</td>
<td>12 GeV capable 5.5 pass machine installed</td>
<td>Dec 2014</td>
<td>June 2014</td>
</tr>
<tr>
<td>2</td>
<td>Accelerator</td>
<td>11 GeV capable beamline to Halls A/B/C installed</td>
<td>Dec 2014</td>
<td>June 2014</td>
</tr>
<tr>
<td>3</td>
<td>Accelerator</td>
<td>12 GeV capable beamline to Hall D tagger area installed</td>
<td>Dec 2014</td>
<td>April 2014</td>
</tr>
<tr>
<td>4</td>
<td>Accelerator</td>
<td>Accelerator commissioned by transporting a &gt; 2 nA electron beam at 2.2 GeV (1 pass)</td>
<td>Dec 2014</td>
<td>Feb 2014</td>
</tr>
<tr>
<td>5</td>
<td>Civil</td>
<td>New experimental Hall and Counting House: &gt; 10,500 sq. ft.</td>
<td>Dec 2014</td>
<td>June 2012</td>
</tr>
</tbody>
</table>

Received CD-4A Approval ahead of schedule; ESAAB July 30, 2014

‘Accelerator Project Complete and Start of Operations’
5.5 Pass: 10.5 GeV to Hall D Tagger

Arc 10

5.5 pass 10.5 GeV

Hall D Beamline

Hall D Tagger Magnet/Dump

Hall D Tagger Dump

23:42
May 7, 2014
Physics Construction Progress (non-magnet)

- **Detectors and electronics** at 97% complete
  - Hall D complete

- **DAQ/Computing** (software/firmware) at 82%
  - Halls C, D complete
  - Hall B plans procurements FY2015

- **Beamline** at 82%
  - Hall D at 98%
  - Halls B & C plan procurements/assembly FY2015/2016

- **Infrastructure** at 83%
  - Hall D complete
  - Halls B & C have major installations in FY2015/2016
Hall D: Detector Complete

BCAL installed
(UR)

FCAL installed
(IU)

TOF Installed
(FSU)

CDC installed
(CMU)

FDC inside BCAL bore!

Start Installed

See E. Chudakov’s talk
Hall D Key Performance Parameter

Commissioning run: 3 weeks in Oct-Dec 2014:

Detector operational: events recorded with a > 2 nA electron beam at > 10 GeV beam energy (5.5 passes)

KPP Demonstration:
1. Detector running for ~one shift recording data from all subsystems.
2. Snapshots of beam status screens and/or accelerator elog entries demonstrating the electron beam current and energy.
3. Plots showing relative timing (coincidence) of the signals in TAGx, TOF, BCAL, FCAL, ST, PS (with TAGx).
4. Event displays showing correlations of particle hits in the CDC, FDC, ST, TOF, BCAL, FCAL.
5. Plots of reconstructed particle trajectories showing target position.
6. Particle identification plots using signals from calorimetry and timing detectors (e.g. FCAL, BCAL, TOF).
Hall D – Key Performance Parameter

KPP achieved – December 2014!
Thanks to dedicated effort by Accelerator Ops, Engineering, Hall D staff, and GlueX Collaboration

Remaining Project scope: Diamond radiator (UConn) – In progress
Hall C: Detector Progress

- PreShower Counters
  - Complete

- Shower Counters (ANSL)
  - Complete

- Scintillator Hodoscopes (JMU)
  - Complete

- NGC Layout (UVa)
  - Complete

- Drift Chambers (HU)
  - Complete

- HGC Cerenkov (UR)
  - Complete

- Quartz Hodoscope (NCA&T)
  - Complete

See S. Wood’s talk
Hall C: SHMS Magnet Progress

Q1 – at Norfolk loading dock

HB – due date March 12th

D – wound & potted; due Dec 2015

Q2 – wound; due Jan 2016

Q3 – winding start; due March 2016
Hall C: SHMS Progress

Prepared for first magnet arrival in January 2015.

ERR required to operate Q1 magnet is scheduled for Jan 21st.
Hall B: Detector Progress

- Complete
- Drift Chambers (ODU, ISU, JLab)
- FTOF 1-a, 1-b Installed (USC)
- HTCC Full Mirror Complete
- CTOF Counters Ready for PMTs
- PCAL Installed (OU)
- SVT Region 1, 2, 3 Under Test
- See V. Burkert’s talk
Hall B CLAS12 Magnet Progress

**Torus** – FNAL epoxy problem resolved; now in production; 2 (of 6) coils delivered to JLab and passed our QA tests. Cryostat factory in full operation.

**Solenoid** – Everson Tesla in PA completed practice coil; passed MRR in Dec 2014; start of production coil winding this month. *Project critical path.*
### Key Upcoming Dates

<table>
<thead>
<tr>
<th>Hall</th>
<th>Key Event</th>
<th>Projected Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Torus 1&lt;sup&gt;st&lt;/sup&gt; Coil Cold Mass Arrives</td>
<td>November 2014</td>
</tr>
<tr>
<td>B</td>
<td>Torus 6&lt;sup&gt;th&lt;/sup&gt; Coil in Cryostat Done</td>
<td>June 2015</td>
</tr>
<tr>
<td>B</td>
<td>Torus Installation</td>
<td>October 2014 (‘spit’) – May 2016</td>
</tr>
<tr>
<td>B</td>
<td>Solenoid Coil Winding</td>
<td>January 2015 – September 2015</td>
</tr>
<tr>
<td>B</td>
<td>Solenoid Arrives</td>
<td>March 2016</td>
</tr>
<tr>
<td>B</td>
<td>Detector Commission with Beam</td>
<td>~January 2017</td>
</tr>
<tr>
<td>C</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Magnet (Q1) Arrives</td>
<td>January 2015</td>
</tr>
<tr>
<td>C</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Magnet (HB) Arrives</td>
<td>March 2015</td>
</tr>
<tr>
<td>C</td>
<td>Last Magnet (Q3) Arrives</td>
<td>March 2016</td>
</tr>
<tr>
<td>C</td>
<td>Last Magnet Tested</td>
<td>May 2016</td>
</tr>
<tr>
<td>C</td>
<td>Detector Commission with Beam</td>
<td>~August 2016</td>
</tr>
</tbody>
</table>
Physics Construction Cost Summary

**Hall B**
- 1.4.2.7 New Magnet Vendor 35%
- 1.4.2.6 Infrastructure 7%
- 1.4.2.5 Beamline 1%
- 1.4.2.4 Fast Electronics 5%
- 1.4.2.3 Computing 3%
- 1.4.2.2 Detector 39%
- 1.4.2.1 Magnet 9%
- 1.8.2.2 Pre-Ops Hall B 1%

**Hall C**
- 1.4.3.6 Infrastructure 31%
- 1.4.3.5 Beamline 3%
- 1.4.3.4 Fast Electronics 1%
- 1.4.3.3 Computing 0.2%
- 1.4.3.2 Detector 3%
- 1.9.5 & 1.9.7 WFO Detector/Infrastr. 12%
- 1.8.2.4 Pre-Ops Hall D 2%
- 1.5.1 Solenoid 7%
- 1.5.7 Spare Solenoid 0.1%
- 1.5.6 Infrastr. 14%
- 1.5.5 Beamline 11%
- 1.5.4 Electronics 19%
- 1.5.3 Computing 6%

**Hall D**
- 1.8.2.3 Pre-Ops Hall C 1%
- 1.4.3.1 Magnet 61%

**Hall A**
- 1.5.2 Detectors 29%
- 1.5.3 Computing 6%
- 1.5.4 Electronics 19%
- 1.5.5 Beamline 11%
- 1.5.6 Infrastr. 14%

Halls:
- **Hall B**: $60,755K
- **Hall C**: $30,539K
- **Hall D**: $46,633K
- **Hall A**: $682K
Estimate-To-Complete ($M)  (as of 1-Oct-2014)

- Hall B: $14.6M, 48%
- Hall C: $7.1M, 23%
- Hall D: $0.4M, 1%
- Civil: $2.0M, 7%
- Pre-Ops (incl Proj Office): $3.7M, 12%
- Pre-Ops (excl Proj Office): $2.8M, 9%
- Accelerator & Hall A: $0.0M, 0%

Total: $30.6M

[$13.7M contingency]
<table>
<thead>
<tr>
<th>Hall C D/Q2/Q3 – Sigma Phi</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Transition from Dipole to Quad winding (S)</td>
<td>Retired</td>
</tr>
<tr>
<td>Agreement on Dipole collaring temperature (T,C,S)</td>
<td>Retired</td>
</tr>
<tr>
<td>Dipole collaring (S)</td>
<td>2QFY15</td>
</tr>
<tr>
<td>Cryostat assembly (S)</td>
<td>4QFY15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hall B Torus – Fermilab and JLab</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Potting procedure recertification (T,C,S)</td>
<td>Retired</td>
</tr>
<tr>
<td>Additional cost contingency usage (C)</td>
<td>2QFY15</td>
</tr>
<tr>
<td>Design and installation integration issues (C,S)</td>
<td>3QFY16</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Hall C HB – MSU</th>
<th></th>
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<tbody>
<tr>
<td>Additional cost contingency usage (C)</td>
<td>2QFY15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hall C Q1 – Scientific Magnetics and JLab</th>
<th></th>
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<tbody>
<tr>
<td>Additional shield leaks develop (C,S)</td>
<td>2QFY15</td>
</tr>
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</table>

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<tr>
<th>Hall B Solenoid – ETI</th>
<th></th>
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<tbody>
<tr>
<td>Winding and potting process verified (T,C,S)</td>
<td>1QFY15</td>
</tr>
<tr>
<td>Field quality (T,C)</td>
<td>1QFY15</td>
</tr>
<tr>
<td>Transition into production (T,C,S)</td>
<td>2QFY15</td>
</tr>
<tr>
<td>Cryostat assembly (S)</td>
<td>1QFY16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>All Magnets – Reaching full design field (T)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TOTAL POSSIBLE</td>
</tr>
<tr>
<td></td>
<td>~3-12 months</td>
</tr>
<tr>
<td></td>
<td>~$6M</td>
</tr>
</tbody>
</table>
Cost & Schedule Performance

Director’s Review, OPA Review, both in November 2014.

Conclusion: Cost and Schedule Performance are an issue.

- 12 GeV ETC did not reflect ‘known’ future costs and schedule delays, therefore contingency was not as healthy as it might appear.
  - $13.7M - $6M (possible hit) = $7.7M or ~25% Cost Contingency
  - Cost contingency use has been ~$0.4M - $1M per month in FY2014
  - 13 months – 12 months (possible hit) = 1 month Schedule Contingency
  - Lost between 4 and 8 months on all SC magnets Mar to Sep 2014

- Deadline January 19th to complete update of Project plan capturing the ‘most likely’ hits on cost and schedule. Team is working hard ………

Summary

Project 92% Complete, 96% Obligated

- Accelerator (100%); Physics Hall D (100%)
- Civil (93%); Halls B/C (78%)

Challenges

- Taken major schedule hit on each of the 7 SC Magnets
- Cost and Schedule performance puts completion within Plan at risk

Next steps

- ETC Update followed by DOE Review
- Strategize/prioritize resources to improve Project performance

Accelerator Complete!!

Hall D KPP!!

2-day running period: 50-100nA, 10.08 GeV e-
BACK-UP SLIDES
Physics Construction Cost Summary

- **1.4.1. Hall A**: 0.5%
- **1.4.2. Hall B**: 43%
- **1.4.3. Hall C**: 23%
- **1.5. Hall D**: 29%
- **1.9.5 & 1.9.7 WFO Detector/Infrastr.**: 4%
- **1.8.2 Pre-Ops Physics**: 1.5%
- **1.9.5 & 1.9.7 WFO Detector/Infrastr.**: 4%

Experimental Halls:
- **B**: 1.4.2. Hall B (43%)
- **D**: 1.5. Hall D (29%)
- **C**: 1.4.3. Hall C (23%)
- **D**: 1.4.1. Hall A (0.5%)