12 GeV Upgrade Project

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

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

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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 Approved Experiments by PAC Days

<table>
<thead>
<tr>
<th>Topic</th>
<th>Hall A</th>
<th>Hall B</th>
<th>Hall C</th>
<th>Hall D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Hadron spectra as probes of QCD</td>
<td></td>
<td></td>
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<tr>
<td>(GlueX and heavy baryon and meson spectroscopy)</td>
<td>119</td>
<td></td>
<td>120</td>
<td></td>
<td>239</td>
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<tr>
<td>The transverse structure of the hadrons</td>
<td></td>
<td></td>
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<tr>
<td>(Elastic and transition Form Factors)</td>
<td>144</td>
<td>85</td>
<td>102</td>
<td></td>
<td>331</td>
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<tr>
<td>The longitudinal structure of the hadrons</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(Unpolarized and polarized parton distribution functions)</td>
<td>65</td>
<td>120</td>
<td>140</td>
<td></td>
<td>325</td>
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<tr>
<td>The 3D structure of the hadrons</td>
<td></td>
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<tr>
<td>(Generalized Parton Distributions and Transverse Momentum Distributions)</td>
<td>409</td>
<td>982</td>
<td>108</td>
<td></td>
<td>1499</td>
</tr>
<tr>
<td>Hadrons and cold nuclear matter</td>
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<tr>
<td>(Medium modification of the nucleons, quark hadronization, N-N correlations, hypernuclear spectroscopy, few-body experiments)</td>
<td>114</td>
<td>120</td>
<td>179</td>
<td></td>
<td>413</td>
</tr>
<tr>
<td>Low-energy tests of the Standard Model and Fundamental Symmetries</td>
<td>513</td>
<td></td>
<td></td>
<td>79</td>
<td>592</td>
</tr>
<tr>
<td><strong>Total (as of PAC39)</strong></td>
<td>1245</td>
<td>1426</td>
<td>529</td>
<td>199</td>
<td>3399</td>
</tr>
</tbody>
</table>

More than 7 years of approved experiments
All major detector systems under construction:
• SVT two modules complete; production delay at FNAL due to vendor cable issue
• HTCC & LTCC in progress
• CTOF in progress
• DC RI and RIII on schedule (Idaho State / JLab)
• DC RII complete (Old Dominion U.)
• FTOF ready for installation (U. South Carolina)
• PCAL ready for installation (Ohio U.)
Hall D – Detector Highlights

BCAL (URegina) – Installed, cabling
FCAL (IU) – Installed, cabled
FDC (JLab) – Assembled, cabling test
CDC (CMU) – Assembled, ship to JLab 10/28
TOF (FSU) - 90% complete, ship to JLab Nov
Tagger hodoscope (CUA) – In progress
Tagger microscope (UConn) – In progress
F1TDC testing (UMass) – In progress
Hall C – Highlights

All major systems under construction

- HB LN2 Shield (MSU)
- Dipole prototype coil (Sigma Phi, France)
- SHMS Support Structure (JLab)
- Shield House Wall Pour (JLab)
- HB Helium Vessel (MSU)
Hall C – Highlights

DETECTORS (NSF-MRI funded):

Hampton University – wire chamber assembly completed, testing underway.

Univ of Virginia - manufacturing design detailing for the noble gas Cerenkov continues, PMTs delivered, and mirrors in fabrication.

Univ of Regina - heavy gas Cerenkov counter assembled, mirrors aligned, awaiting installation.
# 12 GeV Spectrometer SC Magnets

## Hall C SHMS:
- HB – Michigan State Univ making progress
- Q1 – Scientific Magnetics, UK all 4 coils built, assembly underway
- D/Q2/Q3 – Sigma Phi, France prototype coil winding underway (1st layer of 2 done)

## Hall B CLAS12:
- Torus – FNAL practice coil winding nearly complete; JLab design effort & cryogenics & cryostat factory making solid progress

## Hall D:
- Solenoid – successfully operated at 1500A, later quench required re-assessment of procedures, successfully operated and mapped at ~1300A in August 2013
12 GeV Cryomodules & RF Zones

East Recombiner

East Arc

CHL Upper Coldbox

CHL Lower Coldbox

Commissioning started – September 2013
Accelerator Status

- **Cryomodules**: ten C100s built, installed, and nine are commissioned
- **RF Power**: zones #1 - #10 complete, commissioning complete except #10
- **Magnet Power**: all hardware required for Accelerator Run I is on site
- **Cryogenics**: CHL2 met the commissioning performance goals
- **Beam Transport**:
  - Accelerator Ring: Installation complete, only punch list left
  - Hall A/Hall B/Hall C: Hall A line reinstalled; B & C underway
  - Hall D: dipoles in, LCW and air headers installed on ramp
- **Extraction**: Complete
- **I&C**: Controls software complete; Safety systems ready for beam
• Cryomodules, Cryogenics, Beam Transport, and Extraction will be complete in CY13
• Power and I&C deliveries extend into CY14 but will not affect commissioning schedule
Rebaseline complete Sept 2013

16-month installation
May 2012 - Sept 2013 **DONE**

Accelerator commissioning start
Oct 2013 **IN PROGRESS**

Hall A commissioning start
Feb 2014

Hall D commissioning start
Oct 2014

Halls B & C commissioning start
Jan/Feb 2016

Project Completion
September 2017
### 12 GeV Upgrade Project - Summary

**Project 82% Complete, 96% Obligated**
- Civil (92%) ; Accelerator (95%) ; Physics Equip (~69%)

**Challenges with spectrometer superconducting magnets**
- All 7 new magnets under contract
- Refurbished Hall D Solenoid successfully tested

**Rebaseline complete and implemented**
- TPC = $338M ; CD-4B September 2017

**Start of beam commissioning November 2013**