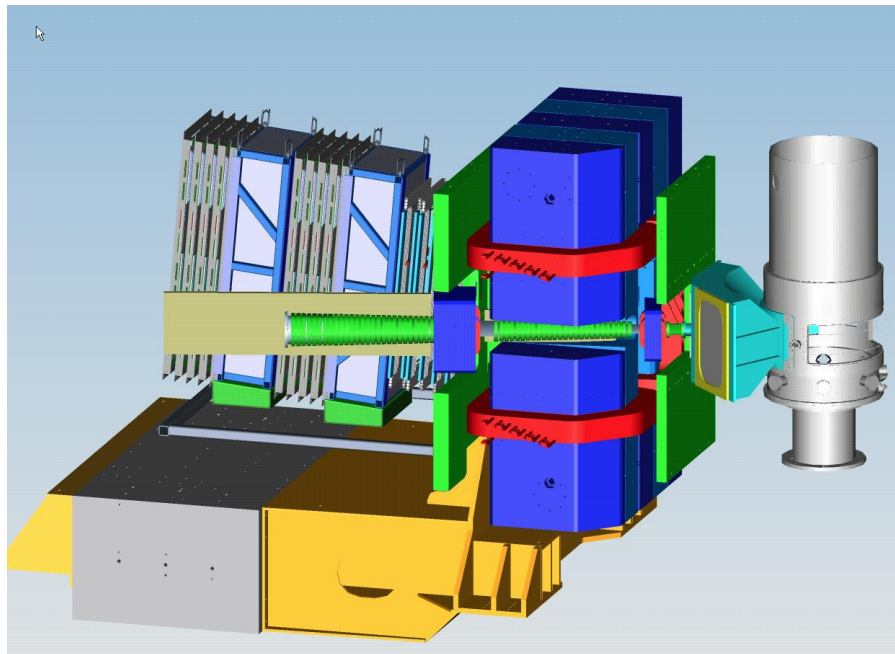


Super-Bigbite-Spectrometer (SBS)

Monthly Progress Report

May 15, 2016



Introduction:

The SBS Program consists of three separate, but interrelated Projects.

- The first Project, **SBS Basic (WBS 1)**, involves the acquisition of an existing magnet and the associated work of preparing it for use during the SBS research program. The effort includes modifications to the magnet, including machining a slot in the yoke for beam passage, field clamps, and a solenoid to reduce the transverse magnetic field on the beam line, the design and development of the infrastructure needed to run the magnet, and the construction of the platform on which it will stand.
- The second Project, **Neutron Form Factor (WBS 2)**, involves the construction of The PMT-based Coordinate Detector (CDet), trigger electronics for the Hadron Calorimeter (HCal) to meet the requirements of the approved neutron form factor measurements.
- The third and final Project, **Proton Form Factor (WBS 3)**, involves the construction of forty GEM detector modules with associated front-end and DAQ modules to meet the requirements of the approved proton form factor measurement.

Project Management Highlights:

This is the 41st Monthly Progress Report for the SBS Program.

The SBS Basic (WBS 1) project started in FY13 and was completed in January 2016. The SBS Neutron Form Factor (WBS 2) started at the beginning of FY14. The SBS Proton Form Factor (WBS 3) started on October 1, 2012.

- For the HCAL dependency, CMU has produced 144 modules (includes 102 modules at JLab) of the total of 288 modules. This completes the milestone of “Module assembly 50% complete”.
- As suggested in the comments in the SBS November 2015 DOE Review report, a workshop concerning the impact and interpretation of the form factor measurements was organized and held April 18-22nd, 2016. The workshop title was “Probing transverse nucleon structure at high momentum transfer” and it was held at the European Center for Theoretical Studies in Nuclear Physics and Related Areas (ECT*), Trento, Italy. The agenda with the links to the talks can be reached at this [website](#).

WBS 1: SBS Basic

WBS 1	SBS Basic: (Hall A Infrastructure)	WBS 1.01	Milestones
		WBS 1.02	Project Oversight
		WBS 1.1	Magnet, power and construction
		WBS 1.2	Magnet/detector platforms
		WBS 1.3	Beam line

WBS1 Project was completed on January 22nd, 2016.

WBS 1 Costs:

- The budget for this WBS for FY15 is \$212K.
- The incremental budget (FY13+FY14+FY15) is \$1,694K.
- At project completion, costed and obligated: \$1738K (103%).

WBS 1.01 Milestones: (see [Appendix 1](#) for graphic view of milestones)

Level (ID#)	Milestone	Scheduled Date	Expected Date N/A	Expected Date N/A	Comment
1 (1.1-01M)	Project start	10/1/2012			Completed 10/1/2012
2 (2-01M)	Magnet delivered to JLab	4/30/2013			Completed 8/21/2013
3	Power supply received	1/4/2014			Completed 10/17/2014
3	Magnet yoke modifications Completed	4/1/2014			Completed 5/22/2014
2 (1.2-10M)	Platform parts received	6/27/2014			Completed 3/24/2015
3	Assemble magnet in Testlab	7/1/2014			Completed 9/4/2014
3	Commissioning test of magnet in Testlab completed	10/1/2014			Completed 10/29/2014
3	Beampipe solenoid correctors received	1/5/2015			Completed 12/11/2015
3	Detector supports completed	4/1/2015			Completed 3/24/2015
2 (1.2-30M)	Beam-line parts received	9/24/2015			Completed 11/30/2015
1 (1.1-10M)	Project completion	1/29/2016			Completed 1/22/2016

WBS 2: Neutron Form Factor

WBS 2	Neutron Form Factor	WBS 2.01	Milestones
		WBS 2.02	Project oversight
		WBS 2.1	Coordinate Detector (ISU)
		WBS 2.2	Electronics Hut, Lead Shielding, Lead platform, and Detector Frames (JLab)
		WBS 2.3	Pole Shims and field clamp (JLab)
		WBS 2.4	Trigger (RU)

WBS 2.02 Project Oversight:

- SBS weekly meetings, via tele and video conference, were held on April 6, 13 and 27th. Participants included Jefferson Lab, University of Virginia, Carnegie-Mellon University, William and Mary, Norfolk State University, University of Connecticut, University of Glasgow, Saint Mary's University, Idaho State University, Christopher Newport University and INFN Rome.
- Project is staffed appropriately for this stage, and includes Jefferson Lab (manager, scientist) and Idaho State University (one scientist).

WBS 2.1 Coordinate Detector (ISU):

- 14-scintillator "group" status:
 - All 168 groups needed for the six modules have been completed. The final 22 groups for module #s 4, 5, and 6 were completed in April.
 - Quality control of groups continues with cosmics using a VME DAQ.
- 16-fiber "bundle" status:
 - Fabrication of fiber bundles has been resumed.
 - Currently, 800+ fibers have been cut to a specific length.
 - Completed 28 bundles for module #1.
 - 14 bundles for module #2 have been machined only on one side.

- Need to produce 140 more bundles for modules #s 2, 3, 4, 5, and 6.
- Production rate is 4 bundles/day.

WBS 2.2 Electronics Hut, Lead Shielding & platform, and Detector Frames:

- The beam line stands for corrector magnets has been revisited to simplify the design. The new design will minimize the number times that the corrector magnets have to be moved along the beam line between kinematic settings. This will decrease the radiation exposure of technicians working on the changeover and the downtime of the experiment.

WBS 2.3 Pole Shims and field clamp

- The pole shims and field clamp are at JLab. Completed.

WBS 2.4 Trigger:

- Completed.

WBS 2 Costs:

- Budget for this WBS for FY16 is \$77K.
- The incremental budget for FY14+FY15+FY16 is \$1,361K.
- Costed and obligated as of 5/1/2016: \$1196K (88%).

WBS 2.01 Milestones: See [Appendix 1](#) for a graphic view of the milestones .

Level	Milestone	Scheduled Date	Expected date 5/1/2016	Expected date 6/1/2016	Comment
1	Project start	10/1/2013			Completed 10/1/2013
3	Finish testing of module prototype	8/30/2014			Completed 8/30/2014
3	Scintillator ordered	9/30/2014			Completed 9/15/2014
2	CDET module design completed	11/30/2014			Completed 11/30/2014
3	Wavelength Shifting Fibers ordered	1/15/2015			Completed 1/20/2015
3	Scintillator shipped for machining	4/30/2015			Completed 4/10/2015
2	JLab receives exit field clamp	6/2/2015			Completed 11/18/2015
3	Begin preparation of WLS fibers	6/15/2015			Completed 7/6/2015
3	Begin construction of CDET modules	9/1/2015			Completed 9/24/2015
3	Assembled one CDET module	10/1/2015			Completed 11/15/2015
2	Electronics hut parts received	10/2/2015			Completed 3/30/2016
2	Trigger completed	10/4/2015			Completed 3/15/2016
3	Assembled one CDET plane	12/1/2015	5/30/2016	5/30/2016	
2	Coordinate Detector assembled	6/30/2016	8/15/2016	8/15/2016	
1	Project completion	1/29/2017	1/29/2017	1/29/2017	

WBS 3: Proton Form Factor

WBS 3	Proton Form Factor	WBS 3.01	Milestones
		WBS 3.02	Project Oversight
		WBS 3.1	GEM's (UVa)
		WBS 3.2	GEM electronics (UVa)

WBS 3.02 Project Oversight:

- SBS weekly meetings, via tele and video conference, were held on April 6, 13 and 27th. Participants included Jefferson Lab, University of Virginia, Carnegie-Mellon University, William and Mary, Norfolk State University, University of Connecticut, University of Glasgow, Saint Mary's University, Idaho State University, Christopher Newport University and INFN Rome.
- Project is staffed appropriately and includes Jefferson Lab (manager, scientist) and UVa (two scientists).

WBS 3.1 GEMs

- The construction of modules #30 and #31 was completed.
- Construction of module #32 is underway.
- Shipment of two readout planes needed for modules #32 and #33 will arrive on May 6th. CERN has agreed to a schedule of shipping two readout planes per month.
- Presently, there are enough GEM foils at UVa to complete three more modules after #32. UVa is in discussion with CERN about the schedule for delivery of more GEM foils.
- The MPD electronics based readout setup at UVa is currently being prepared and is expected to be ready by May 11th. The x-ray testing of modules 27-31 will start once this readout system is complete.

WBS 3.2 GEM electronics

- Procedure for quality assurance tests of the APV cards (for the large production for the UVa-GEM) has been fully automated. The procedure includes: detection of card and successful configuration (by I2C), external pulser to test the quality of the APV bonding (on each channel); internal pulse test, noise measurement as well as detailed test on Histo mode, sync mode.
- Following a visit on April 14th to the electronics manufacture EES, the INFN electronics engineer Paolo Musico reported that the MPD electronics production for SBS is going as scheduled. Following is the expected production/testing and delivery schedule from EES:
 - MPD modules and backplanes should be assembled by end of May and then tested at EES.
 - Front End cards will be ready for bonding by end of May and will be send back to EES after bonding, 150 cards/week starting from 1st week of June (Total of 900 front end cards have been ordered). Testing of APV cards will be done at EES following procedure described above.
 - The 1st batch of 300 front end cards will be shipped to UVa by 20 June and the remaining cards in one additional month.

WBS 3 Costs:

- Budget for this WBS for FY16 is \$309K.
- The incremental budget of FY13+FY14+FY15+FY16 is \$1739K.
- Costed and obligated as of 5/1/2016: \$1669K (96%).

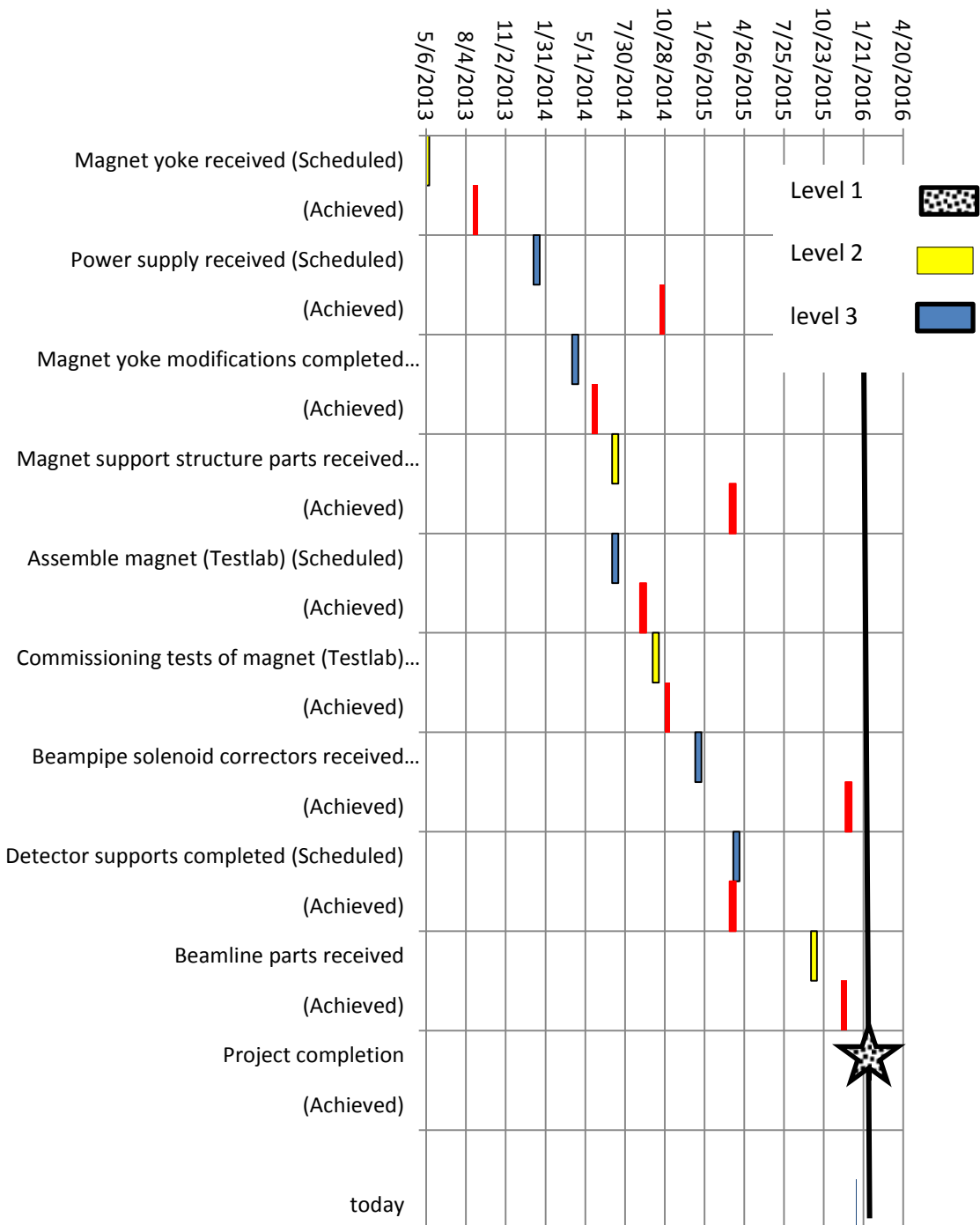
WBS 3.01 Milestones: (see [Appendix 1](#) for a graphic view of the milestones)

Level (ID#)	Milestone	Scheduled Date	Expected date 5/1/2016	Expected date 6/1/2016	Comment
1 (3.1-01M)	Project start	10/1/2012			Completed 10/1/2012
3	Order GEM Parts	10/1/2013			Completed 10/18/2013
3	UVa receives GEM parts	2/3/2014			Completed 4/23/2014
2 (3.2-01M)	First module assembled and tested	3/3/2014			Completed 5/15/2014
2 (3.2-10M)	UVa 5 GEM modules assembled and tested	6/2/2014			Completed 12/23/2014
2 (3.2-20M)	UVa 6-16 GEM modules assembled and tested	9/30/2014			Completed 7/28/2015
2 (3.2-30M)	UVa 17-29 GEM modules assembled and tested	3/2/2015			Completed 3/30/2016
2 (3.2-40M)	UVa 30-40 GEM modules assembled and tested	7/15/2015	9/15/2016	9/15/2016	
2 (3.2-50M)	1st order of Front End Electronics	10/1/2014			Completed 3/5/2015
2 (3.2-60M)	2nd order of Front End Electronics	10/1/2015			Completed 3/5/2015
1 (3.1-10M)	Project completion	2/1/2017	2/1/2017	2/1/2017	

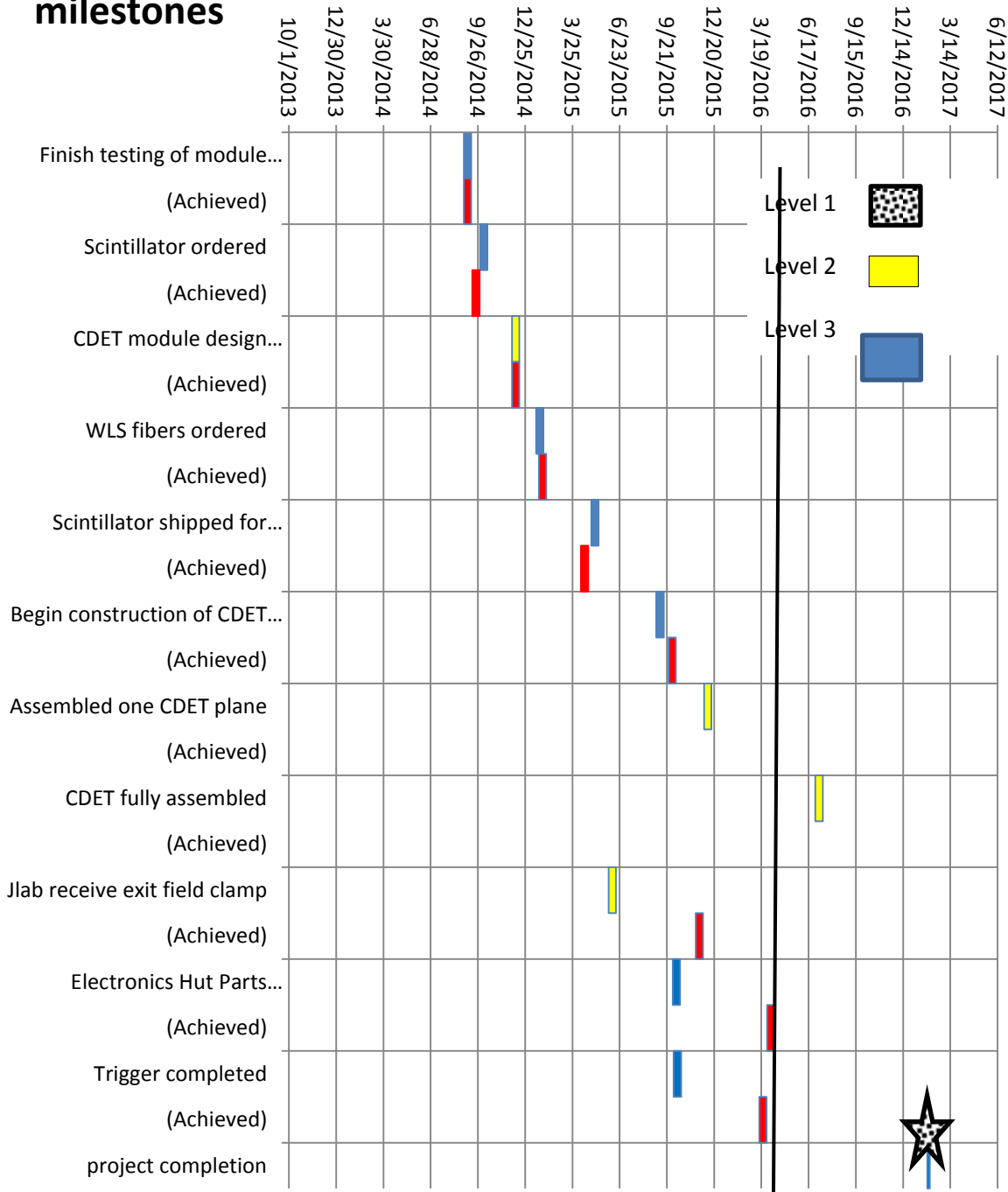
Appendix I

The following are graphical representations of the milestones for SBS Basic (WBS 1), Neutron Form Factor (WBS 2,) and Proton Form Factor (WBS 3), updated on December 1, 2013. Black represents level 1 milestones as specified in the PMP. Yellow represents level 2 milestones from the PMP. Blue represents the new level 3 milestones to allow better quarterly tracking. The black vertical line indicates the day the chart was made. The red bar indicates when the milestone was achieved (e.g. Magnet yoke received).

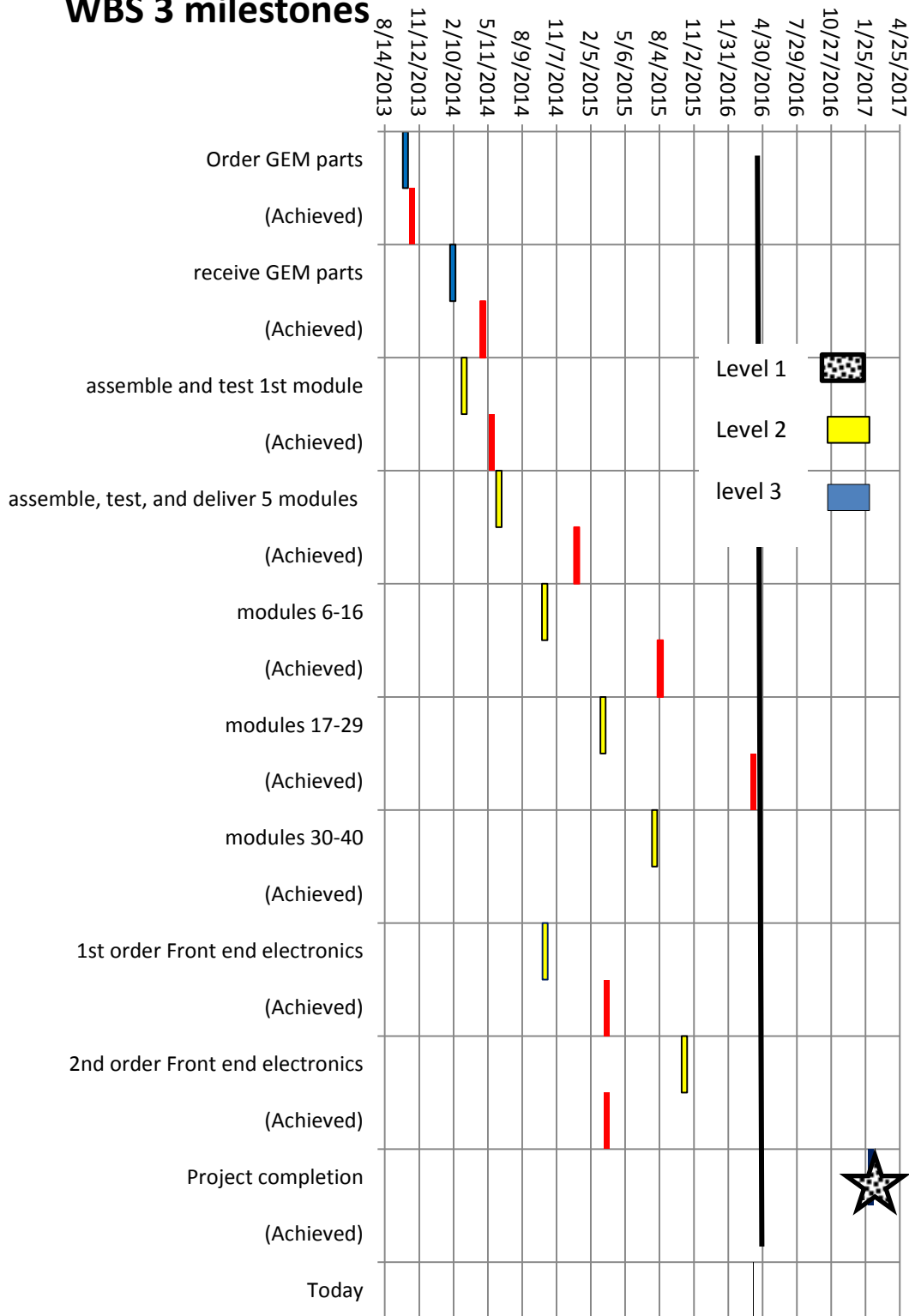
WBS 1 Milestones



WBS 2 milestones



WBS 3 milestones



Appendix II

The Gas Cherenkov detector(GRINCH) from W&M (for GMN and GEN)

Milestone	Scheduled date	Comment
Design and drawings for vessel are complete	Feb 1, 2015	Completed Feb 2015
Photon Detector Array assembled and tested	Aug 1, 2015	Received by JLab in Aug 2015. Testing complete by Aug 2016
NINO chip front end cards system shipped to JLab	Jul 1, 2015	Completed Oct 2015
Purchase order issued for vessel	Oct 15, 2015	Completed Aug 2015
Full DAQ system ready	Dec 1, 2015	Expected August 2016
Vessel completely assembled	Mar 15, 2016	Expected July 2016
GRINCH ready for installation	Jun 15, 2016	Expected Sept 2016
Final analysis software complete	Jun 15, 2016	Expected Sept 2016

HCal-J from CMU (for GMN, GEN and GEP)

Milestone	Completion date	Comment
Detailed design completed	June 2014	Completed July 2014
Design review	Sept 2014	Completed Dec 2014
Module construction initiated	Mar 2015	Completed Mar 2015
Module assembly 25% complete	Sept 2015	Completed Sept 2015
Module assembly 50% complete	Mar 2016	Completed April 2016
Module assembly completed	Sept 2016	

Status update:

- Module production is ongoing. Have produced 144 modules (includes 102 modules at JLab) of the total of 288 modules in HCal. This completes the milestone of “Module assembly 50% complete”.
- The new CMU technician has now learned all phases of the light-guide assembly and gluing processes. The plan is to produce 2 modules per day (on average).
- CMU plans to ship 66 modules to JLab in the beginning of June.

Front Tracker from INFN (for GMN, GEN and GEP)

Milestone	Completion date	Comment
Electronics in production	Sept 2014	Completed Sept 2014
GEM chambers 1 and 2 completed	Sept 2015	Completed Dec 2015
Initial Electronics QA completed	Dec 2015	Completed Dec 2015
GEM chambers 3 and 4 completed	May 2016	Expect delivery in Oct 2016, delay due to manufacturing of carbon frame
GEM chambers 5 and 6 completed	Dec 2016	Expect in March 2017

Status update:

- The three modules for chamber 3 have had gas leaks fixed, been HV trained and under cosmic tests for a month for quality assurance.
- The three modules for chamber 4 have been assembled. Unfortunately for one additional module, the drift foil was damaged during assembly and the module was discarded.
- The carbon fiber design for frames for the remaining chambers has been improved, but availability of the mechanical engineer delayed production of the carbon frames. The new frames are expected by September with chambers 3 and 4 delivered to JLab in Oct 2016.
- Assembly of modules for chambers 5 and 6 continues at a pace of about one module per month.
- The delay in delivery of remaining chambers does not affect the scheduling of the experiments.

ECal from JLab (for GEP)

Milestone	Completion date	Comment
Develop concept of annealing	July 2014	Completed July 2014
Test of annealing with prototype	Nov 2015	Completed May 2015
Fabrication of C200 frame started	Sept 15 2015	Completed Sept 2015
Design of ECAL platform modification started	Dec 1 2015	Delay until Aug 2016
C200 assembly completed and testing begins	Jan 15 2016	Completed Jan 2016
C200 report results, recommendations completed	June 1 2016	July 1 2016
Design of ECAL frame/oven started	July 1 2016	Delay until Aug 2016
ECAL platform in testlab .	Nov 1 2016	Delay until Dec 2016
Installation of lead glass started	Jan 15 2017	
Lead glass installation compete and cabling started	July 15 2017	
Cabling completed and cosmic tests started	Nov 1 2017	
Finished cosmic tests and ECAL is ready to install	Jan 15 2018	

Status update:

- At Stonybrook, the oven for the C200 is basically done with the insulation loaded, the electronics rack completed, and thermocouples welded and the 16 channel readout was tested in our Labview setup. It was decided to group the lead glass blocks in submodules consisting of 9 blocks. Each submodule would be an enclosure with an attached back plane for securing the PMTs to the blocks. GEANT4 studies are being done to determine the thickness of material for the submodule enclosure and a prototype is being prepared to be tested in the oven.
- In addition, the Stonybrook group did heat tests with the C16 and compared to COMSOL calculations.

Polarized ^3He target from UVa (for GEN)

Milestone	Completion date	Comment
Selection of target-cell design for high luminosity	Nov 2014	Completed Oct 2014
Conceptual design document complete	Jan 2016	Completed Mar 2016
Conceptual design review	Mar 2016	Completed Mar 2016
Start bench test of 3 liter glass convection target	April 2016	Expect start in July 2016
Conceptual design frozen	June 2016	
Test of glass/metal technology complete	June 2016	
Begin engineering and design	July 2016	
Bench test of 3 liter glass/metal target	Jan 2017	
Simulated beam test on the bench for full scale 6 liter cell	Sept 2017	
Begin production of full-scale cells	Nov 2017	
Engineering complete	Jan 2018	
Design of target hardware and instrumentation complete	June 2018	After CDR review updated to July 2018
Target is ready for installation	Jan 2019	

Status update:

- Hall A hired two additional designers which increases the workforce available to begin engineering and design for the polarized in July 2016. The Hall A lead engineer reviewed the workforce requirements needs in the conceptual design report. She determined that, with the additional designers, the design of target hardware and instrumentation would be completed by July 2018.
- Drawings for the 3 liter glass convection target have been sent to the glass blower and he expects to start in June. The delay in the start of the bench test of the 3 liter glass convection target does not affect the rest of the schedule.