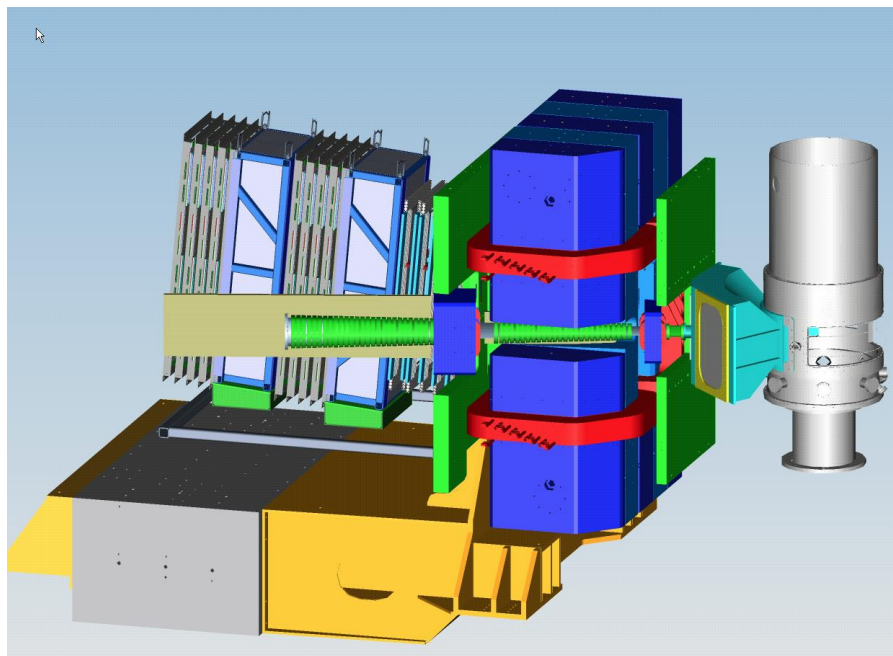


Super-Bigbite-Spectrometer (SBS)

Monthly Progress Report

December 15, 2015



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 37th Monthly Progress Report for the SBS Program.

The SBS Basic (WBS 1) project started in FY13. 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.

- The DOE SBS Review was held November 16th and 17th.
- For WBS1, all beam-line parts were received by the end of November which completes a Level 2 milestone.
- For WBS1, to ensure completion of the vacuum pipe before the project completion data, we authorized an additional labor cost which brought the WBS1 budget (including overhead) to a total of \$1714K which is \$20K above the budget of \$1694K in the PMP. Constructing the vacuum pipe is the only remaining item under construction and further increases in the beam pipe cost are not anticipated. Under the guidelines in the PMP, the program manager is allowed to increase the budget, since the increase is below \$100K.
- For WBS2, the exit field clamp was received in the middle of November which completes a Level 2 milestone.
- For WBS2, the first CDet module was completed in the middle of November which completes a Level 3 milestone.
- For WBS3, the project completion date in the Table 3.01 Milestones was changed to 2/1/2017 to match the date in the PMP.

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

WBS 1.02 Project Oversight:

- SBS weekly meetings, via tele and video conference, were held on Nov 4th and 11th. 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, and INFN Rome.
- Project is staffed appropriately for this stage, and includes a Jefferson Lab manager, scientist, and magnet engineer.

WBS 1.1 Magnet, Power and Construction:

- The SBS magnet is in the TestLab.
- Coils:
 - Racetrack coils: All coils are at JLab.
 - Saddle coil is at JLab.
- The clamp supports were delivered to JLab in late November.
- The sieve slit assembly was delivered to JLab in the beginning of November.
- The front field clamp was delivered to JLab in the beginning of November.
- The corrector magnet iron cores were delivered to JLab at the end of November. All eight of the corrector magnet coils are cast and will be shipped the week of December 7th. Delivery expected by December 18th.

WBS 1.2 Magnet/Detector Platforms:

- JLab engineers have contacted the vendor of the floor plates and the vendor is on schedule for delivery by Dec 9th.

WBS 1.3 Beam Line:

- The materials for the vacuum beam pipe have been ordered and delivered. The first section of the vacuum beam pipe has been made.

WBS 1 Costs:

- The budget for this WBS for FY15 is \$212K.
- The incremental budget (FY13+FY14+FY15) is \$1,694K.
- Costed and obligated as of 12/1/2015: \$1734K (102%).
- A mistaken charge of \$20K was placed on the SBSBAS budget. This charge will be removed in the next monthly budget.
- For WBS1, to ensure completion of the vacuum pipe before the project completion data, we authorized an additional labor cost which brought the WBS1 budget (including overhead) to a total of \$1714K which is \$20K above the budget of \$1694K in the PMP. Constructing the vacuum pipe is the only remaining item under construction and further increases in the beam pipe cost are not anticipated. Under the guidelines in the PMP, the program manager is allowed to increase the budget, since the increase is below \$100K.

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

Level (ID#)	Milestone	Scheduled Date	Expected Date 12/1/2015	Expected Date 1/1/2016	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	12/04/2015	12/18/2015	The coils will be shipped the week of Dec 7 th .
3	Detector supports completed	4/1/2015			Completed 3/24/2015
2 (1.2-30M)	Beam-line parts received	9/24/2015	12/11/2015		Completed 11/30/2015
1 (1.1-10M)	Project completion	1/29/2016	1/29/2016	1/29/2016	

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 Nov 4th and 11th. 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, 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):

- Construction of 14-scintillator groups and 16-fiber bundles for the CDet modules is continuing. 28 groups of 14-scintillators and 28 bundles of 16-fibers for one module has already been completed by the time the 2015 DOE Review took place. This completes a Level 3 milestone.
- 20 additional groups of 16-scintillators have been completed for the second module and fabrication of the fiber bundles is continuing.
- Extensive tests with the scintillators and WLS fibers together with the multi-anode PMTs and the NINO cards were performed at JLab. Many studies of the threshold (using a TDC), signal cross talks in the maPMTs, signal for 4 cm long path in the scintillator, and more important studies with the NINO card have been completed. The results of the tests are all positive and confirmed

that we can use the NINO-based front-end electronics with HV just at 700 V (the maximum supply voltage for the PMTs is 1000 V). The best way to do signal integration still needs to be formulated. However, a 180 pF capacitor in the equalizer board is sufficient for such purposes.

- Kieran Hamilton, a student from University of Glasgow, is carrying out quality control tests of each of the completed 14-scintillator groups individually. A measure of the gain of each pixel and the relative quantum efficiency of the maPMTs were determined by placing a Ru-109 source in a light-tight box along with the WLS fibers connected to the PMT. Analysis of the collected data is in progress.

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

- Detailed design of the integrated beam line stands for lead shielding and corrector magnets has begun.
- A purchase order has been made for shipping the steel from BNL to JLab that will be used as the roof for the large electronics hut and the small GEM electronics hut.

WBS 2.3 Pole Shims and field clamp:

- The shim has been completed at the local vendor and will be delivered to JLab in the middle of December. The shim insertion device was delivered in November.
- The rear field clamp was delivered in early November. This completes a Level 2 milestone for WBS2.

WBS 2.4 Trigger:

- Work continues on integration of the FASTBUS, pipelined VME and GEM MPD electronics DAQ.

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 12/1/2015: \$998K (73%).

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

Level	Milestone	Scheduled Date	Expected date 12/1/2015	Expected date 1/1/2016	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	11/18/2015		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	9/15/2015		Completed 9/24/2015
3	Assembled one CDET module	10/1/2015	10/15/2015		Completed 11/15/2015
2	Electronics hut parts received	10/2/2015	12/18/2015	12/18/2015	
2	Trigger completed	10/4/2015	2/1/2016	2/1/2016	
3	Assembled one CDET plane	12/1/2015	3/15/2016	3/15/2016	
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 Nov 4th and 11th. 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, 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 # 23 was completed.
- X-ray testing of modules # 21 and 22 was completed: all sectors are operational.
- Construction of module #24 is underway.

WBS 3.2 GEM electronics

- The integration of MPD-APV GEM readout system into CODA is ongoing with work proceeding on block readout to speed data transfer.
- The new UVa 5 front end APV25 card back plane was successful readout in a cosmic test. Tests of the 12 front end APV25 card back plane are ongoing.

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 12/1/2015: \$1659K (95%).

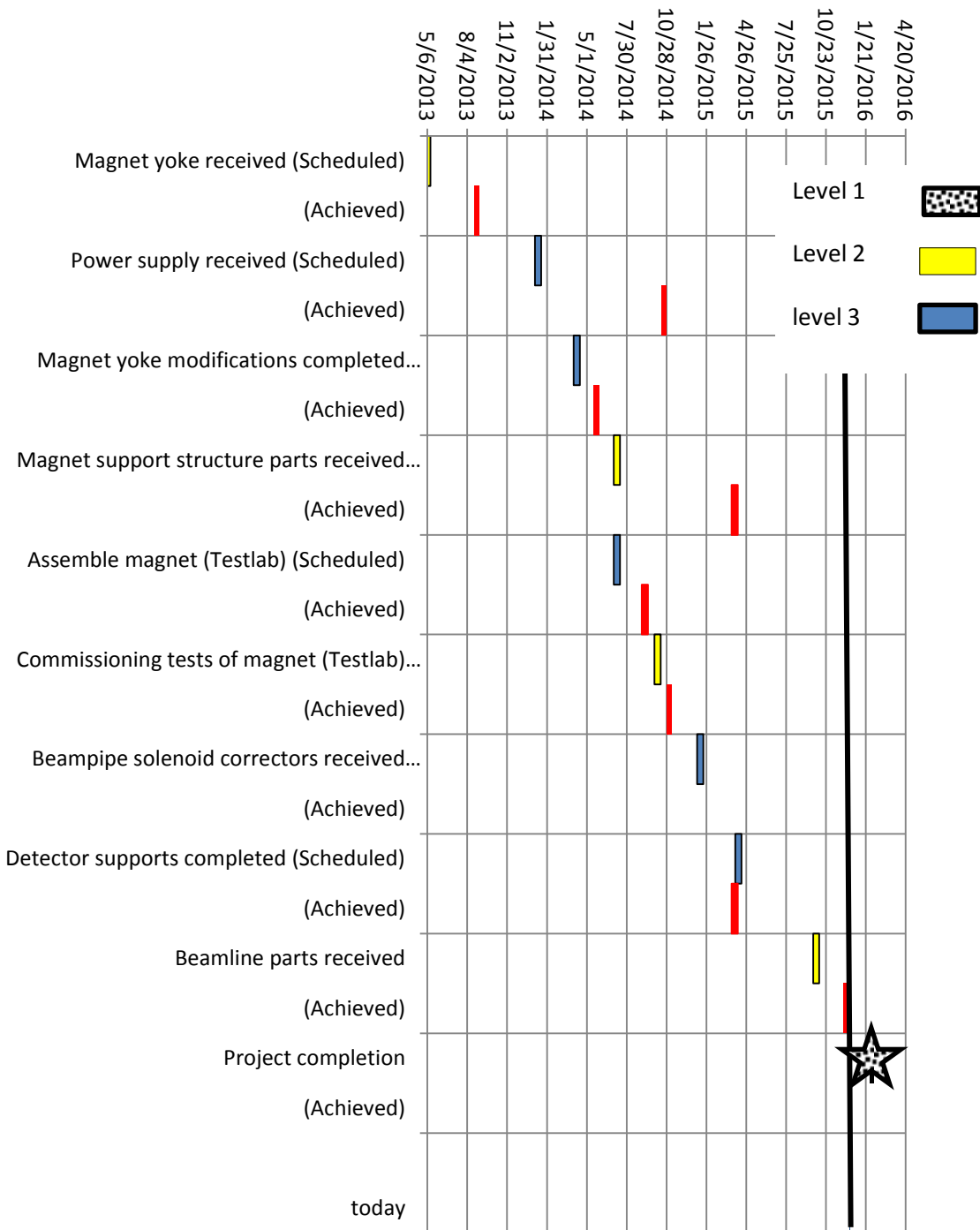
WBS 3.01 Milestones: (see [Appendix 1](#) for a graphic view of the milestones)

Level (ID#)	Milestone	Scheduled Date	Expected date 12/1/2015	Expected date 1/1/2016	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	3/15/2016	3/15/2016	
2 (3.2-40M)	UVa 30-40 GEM modules assembled and tested	7/15/2015	8/1/2016	8/1/2016	
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	

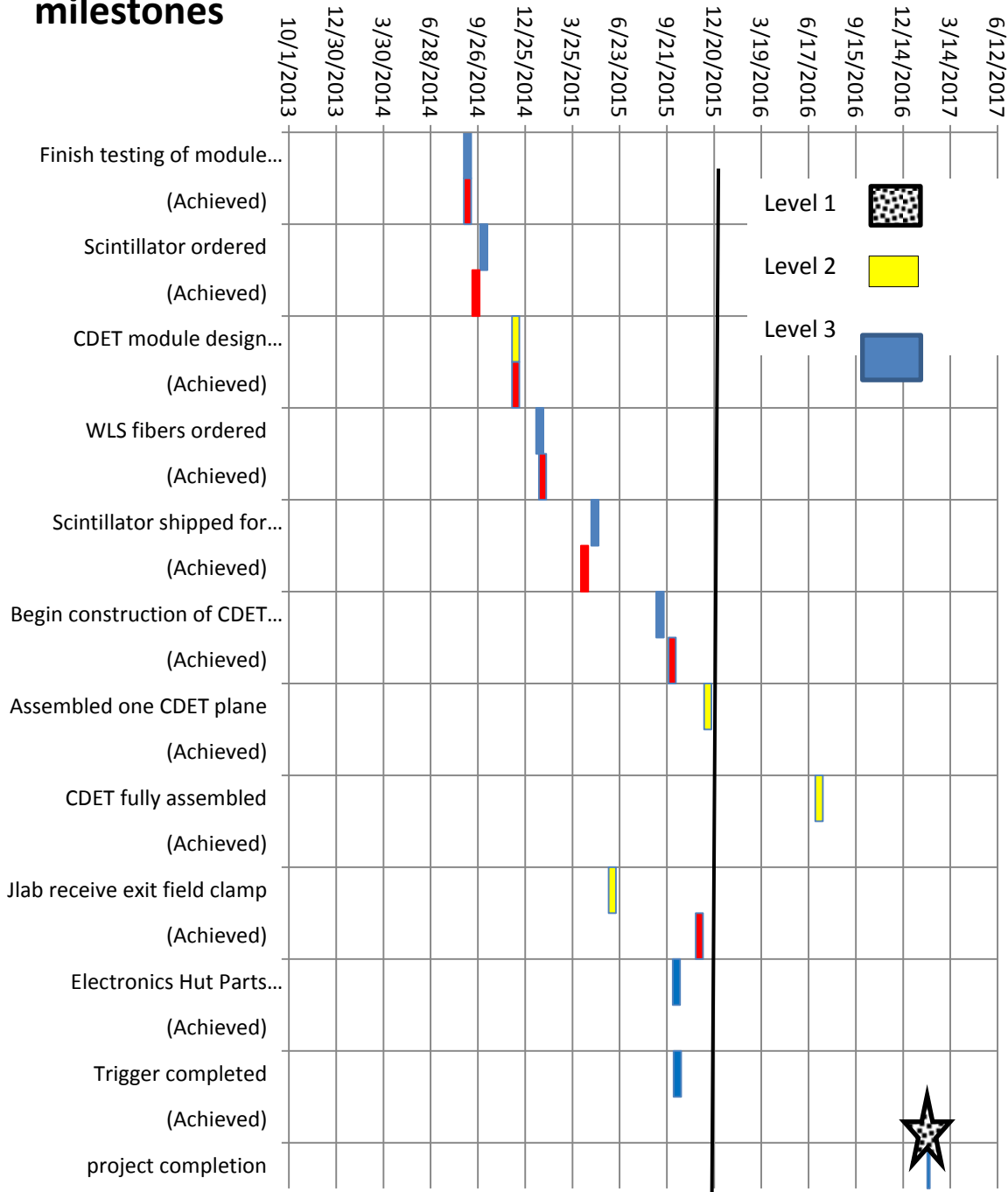
Appendix I

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).

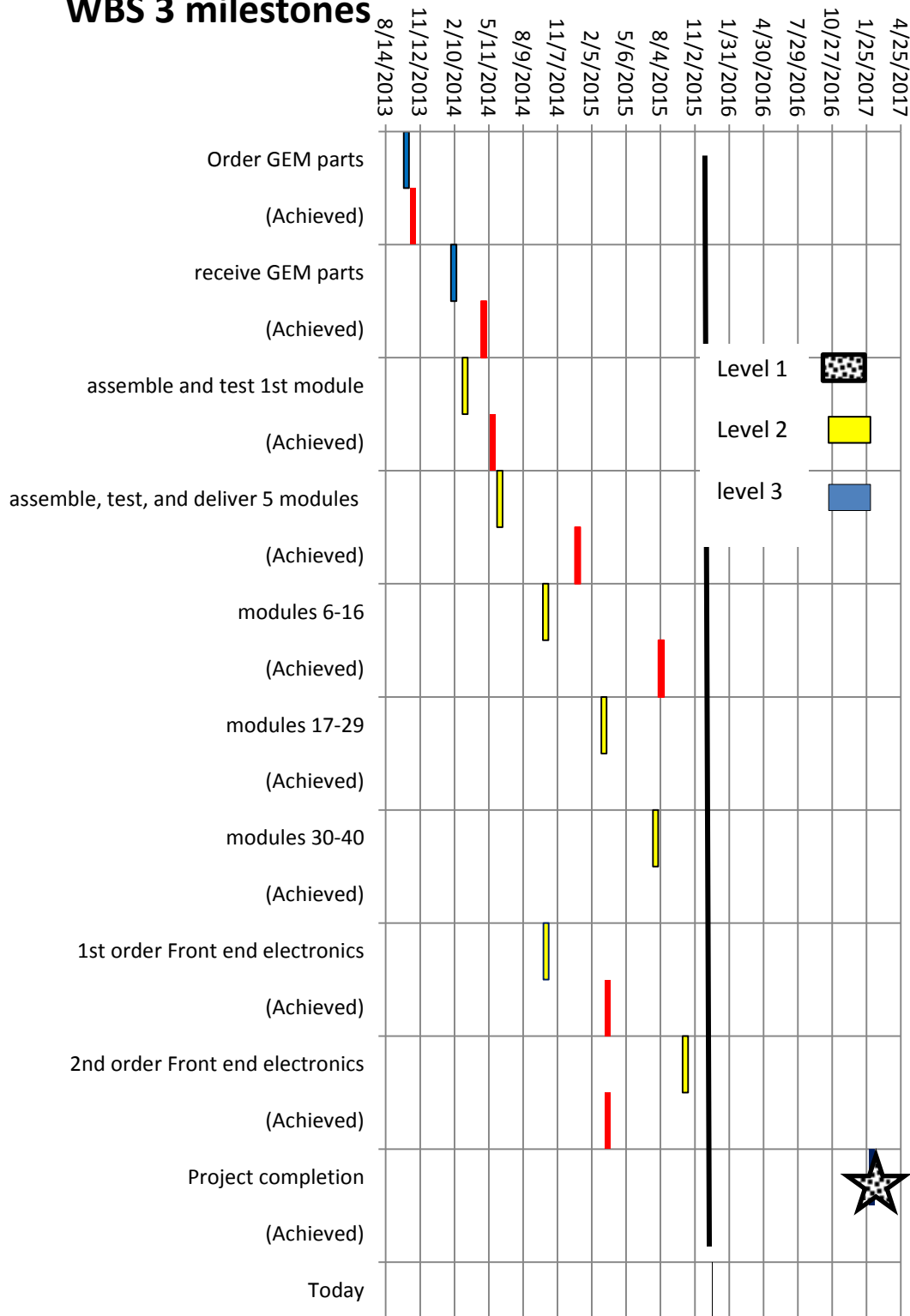
WBS 1 Milestones



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	Cards and cables finished at Glasgow. Shipment in October
Purchase order issued for vessel	Oct 15, 2015	Completed Aug 2015
Full DAQ system ready	Dec 1, 2015	Expected March 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

Status update:

- The vessel is expected to be delivered to JLab on December 18th.

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	
Module assembly completed	Sept 2016	

Status update:

- Module production is ongoing. Have produced 75 modules of the total of 288 modules in HCal.
- The month of November was mostly devoted to the production of the aluminum back plates and steel front plates. Assembly of the modules was not initiated until the last few days of the month.
- The machining of the steel front plates was going significantly slower than we had originally anticipated, taking about 3 hours per piece for the milling. The remaining 150 steel plates will be produced by another Carnegie Mellon shop using a machine better suited to machining hard

steel. We anticipate that this will reduce the machine time of these pieces from 3 hours to 1 hour.

- We expect to have a shipment of 66 modules ready for shipment in the last half of December. We plan to delay this shipment until early January to avoid complications with the winter holidays. Counting the 36 modules already at JLab, we will thus have 102 completed modules at JLab by the end of January. We expect to make another shipment by late March. This will meet our goal of 50% (144 modules) by March.
- 16 channel NIM summing modules have been obtained from Hall B.

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	Chamber 1 is at JLab Expect 2 nd chamber end of Nov 2015
Initial Electronics QA completed	Dec 2015	
GEM chambers 3 and 4 completed	May 2016	
GEM chambers 5 and 6 completed	Dec 2016	

Status update:

- The second chamber was shipped in the 3rd week of November with delivery in the middle of December. The INFN group is visiting JLab in December to setup the 2nd chamber and work on DAQ.

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	
C200 assembly completed and testing begins	Jan 15 2016	
C200 report results, recommendations completed	June 1 2016	
Design of ECAL frame/oven started	July 1 2016	
ECAL platform in testlab .	Nov 1 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:

- Progress has been made in constructing the main outer frame of the C200.

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	
Conceptual design review	Mar 2016	
Start bench test of 3 liter glass convection target	April 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	
Target is ready for installation	Jan 2019	