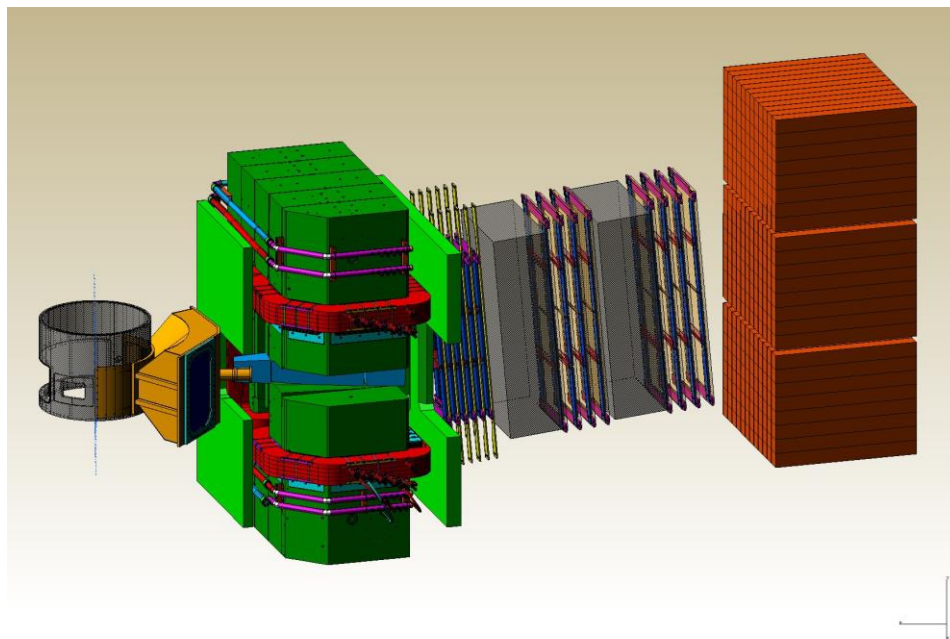


# *Super-Bigbite-Spectrometer* *(SBS)*

## Monthly Progress Report

**June 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 33<sup>rd</sup> 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.

- SBS magnet delivered to JLab after the minor modifications that allow the SBS magnet to be placed on beam right were completed.
- For the Coordinate Detector, the machining of the scintillator bars was completed with outside funds provided by Saint Mary's University, Canada. The bars were shipped to Carnegie Mellon for the final cut to 51cm length.

## WBS 1: SBS Basic

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

### WBS 1.02 Project Oversight:

- SBS weekly meetings, via tele and video conference were held on May 6 and 20<sup>th</sup>. 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 was delivered back to the JLab in the beginning of May and is in the TestLab.
- Coils:
  - Racetrack coils: All coils are at JLab.
  - Saddle coil: Vendor was contacted. The coil is in the winding process. The vendor expects shipment by the end of July with delivery time of four weeks. JLab is having discussions with vendor to expedite the delivery.
- Initial design work on the sieve slit that is needed for magnet optics is complete. The sieve slit is after the front magnet clamp. Work had to be done to modify the front clamp design to accommodate the sieve slit. The front clamp will be sent to procurement by June 15<sup>th</sup>. The clamp supports will be sent to procurement by June 29<sup>th</sup>.
- More design time was needed for the corrector magnets due to conflicts of the coil leads with the front field clamp and beam line shielding. Additional work was done to modify the design of

one corrector coil so all four corrector magnets can reuse power supplies that are no longer needed by accelerator. The correct magnets will be sent to procurement by June 15<sup>th</sup>.

## **WBS 1.2 Magnet/Detector Platforms:**

### **WBS 1.3 Beam Line:**

- The vacuum snout did not meet specifications because of warping during welding. Agreement on how to fix the problem was made between JLab and vendor. The vendor has corrected the problem and the snout passed inspection. The vendor will be machining mating flanges in the beginning of June with delivery by end of June.
- The shielded beam pipe concept is done and checked for interference with the corrector magnets, field clamps and sieve slit. Detailed design work will be done in June and anticipate that the beam pipe will be ready for procurement by the end of July.

### **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 6/1/2015: \$1230K (73%). The overhead cost was reduced from 49% to 47%.

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

Level (ID#)	Milestone	Scheduled Date	Expected Date 5/1/2015	Expected Date 6/1/2015	Comment
1 (1.1-01M)	Project start	10/1/2012			<b>Completed 10/1/2012</b>
2 (2-01M)	Magnet delivered to JLab	4/30/2013			<b>Completed 8/21/2013</b>
3	Power supply received	1/4/2014			<b>Completed 10/17/2014</b>
3	Magnet yoke modifications Completed	4/1/2014			<b>Completed 5/22/2014</b>
2 (1.2-10M)	Platform parts received	6/27/2014			<b>Completed 3/24/2015</b>
3	Assemble magnet in Testlab	7/1/2014			<b>Completed 9/4/2014</b>
3	Commissioning test of magnet in Testlab completed	10/1/2014			<b>Completed 10/29/2014</b>
3	Beampipe solenoid correctors received	1/5/2015	9/28/2015	9/28/2015	4 months of float until project completion.
3	Detector supports completed	4/1/2015			<b>Completed 3/24/2015</b>
2 (1.2-30M)	Beam-line parts received	9/24/2015	10/16/2015	10/16/2015	3 1/2 months of float until project completion.
1 (1.1-10M)	Project completion	1/29/2016	1/29/2016	1/29/2016	

## WBS 2: Neutron Form Factor

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

### WBS 2.02 Project Oversight:

- SBS weekly meetings, via tele and video conference were held on May 6 and 20<sup>th</sup>. 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):

- Precision machining of the top and bottom surfaces of 700 220-cm long extruded scintillator strips has been completed by Eljen Technology on May 14. Eljen has shipped the strips to Carnegie Mellon University where they will be cut into 51-cm long bars for building the CDET. Funds for the machining project were provided by Saint Mary's University.
- All engineering drawings for the CDET Modules have been checked and finalized. They have been approved by the JLab Engineering Group for production. A purchase requisition for procurement of the Module structures is being processed at Idaho State University and a purchase order will be issued by the second week in June.

- An equalizer board for adjusting gain variations of the PMTs has been manufactured. Dr. Vitaly Baturin has been hired by ISU and is preparing the setup for adjusting the gain variation of individual pixels of all multi-anode PMTs. Two students from Saint Mary's University are working with Dr. Baturin on this project.
- Two of the NINO-based A/D cards for the CDET front end electronics are under production in Glasgow. After verification and testing of the cards in Glasgow, they will be delivered to JLab by the second week in June. The equalizer boards will be used together with these cards to do the gain matching of individual pixels of the PMTs.
- To use the manpower supplied by Saint Mary's University, priority was given to preparing the setup for adjusting the gain variation of PMTs. This will delay the beginning of preparation of the WLS fibers and it has been conservatively estimated that this is a one month delay.

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

- The updated layout of the electronics hut was sent for radiation calculations. The calculations should be done by end of June.
- The plastic to be used as the analyzer for the GEp experiment arrived at JLab. The design of the two frames to hold the plastic analyzer has been completed. Procurement will be done in June.
- The layout of the corrector magnets, the passive magnetic shielding beam pipe and field clamps was given to collaborators for GEANT detector background simulations to design the layout of the lead shielding.

### **WBS 2.3 Pole Shims and field clamp:**

- The pole shims have been sent to procurement. Decided to postpone the procurement of device to insert pole shim until design of other nearby devices completed.
- The rear clamp will be sent to procurement by June 22<sup>nd</sup>. The procurement was delayed to resolve issues with the interference with the corrector coils.

### **WBS 2.4 Trigger:**

- The JLab DAQ group completed modifications of the firmware on the Trigger Supervisor module. The modification will allow that Trigger Supervisor to support a trigger scheme to allow better and simpler integration of the FASTBUS and pipelined VME DAQ systems.

### **WBS 2 Costs:**

- Budget for this WBS for FY15 is \$710K.
- The incremental budget for FY14+FY15 is \$1,309K.
- Costed and obligated as of 5/1/2015: \$815K (62%).



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

Level	Milestone	Scheduled Date	Expected date 5/1/2015	Expected date 6/1/2015	Comment
1	Project start	10/1/2013			<b>Completed 10/1/2013</b>
3	Finish testing of module prototype	8/30/2014			<b>Completed 8/30/2014</b>
3	Scintillator ordered	9/30/2014			<b>Completed 9/15/2014</b>
2	CDET module design completed	11/30/2014			<b>Completed 11/30/2014</b>
3	Wavelength Shifting Fibers ordered	1/15/2015			<b>Completed 1/20/2015</b>
3	Scintillator shipped for machining	4/30/2015	4/30/2015		<b>Completed 4/10/2015</b>
2	JLab receives exit field clamp	6/2/2015	7/31/2015	7/31/2015	
3	Begin preparation of WLS fibers	6/15/2015	6/15/2015	7/15/2015	
3	Begin construction of CDET modules	9/1/2015	9/1/2015	9/1/2015	
3	Assembled one CDET module	10/1/2015	10/1/2015	10/1/2015	
2	Electronics hut assembled	10/2/2015	12/18/2015	12/18/2015	
2	Trigger completed	10/4/2015	10/4/2015	10/4/2015	
3	Assembled one CDET plane	12/1/2015	12/1/2015	12/1/2015	
2	Coordinate Detector assembled	6/30/2016	6/30/2016	6/30/2016	
1	Project completion	1/29/2017	1/29/2017	1/29/2017	

## WBS 3: Proton Form Factor

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

### WBS 3.02 Project Oversight:

- SBS weekly meetings, via tele and video conference were held on May 6 and 20<sup>th</sup>. 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

- Module # 11 cosmic tests completed; all sectors fully operational.
- Module #12 cosmic tests completed; one sector at the edge of the chamber was observed to draw high current and was disconnected. All other 29 (out of 30) sectors fully operational.
- Module #13 construction was completed. Module currently being prepared for HV testing.
- Module #14 construction starts this week.
- Work on the GEM construction was delayed about two weeks for investigations into the issue with the gas window reported last month. The issue has been resolved as described below.
- Delivery of 10 GEM planes, 3 RO foils, 15 Drift planes and 3 honeycomb planes was received on May 27<sup>th</sup>.
- Extensive testing was carried out with a 50 cm x 50 cm prototype chamber to address the gas window to Cathode foil attachment issue reported in the previous report. The gas window of this prototype chamber is made of aluminized Kapton with the Aluminum layer on the outside of the chamber. The tests indicated that when this Aluminum layer is electrically connected to the Cathode window through a large (1 G $\Omega$ ) resistor so that it is at the same voltage as the cathode, the gas window did not attached itself to the cathode window, even after extensive charging of the chamber with x-ray running. This test was repeated a few times with the Aluminum layer

electrically connected and disconnected from the cathode; the problem occurred every time when disconnected and never when connected. Based on this conclusive result, all future SBS modules will be constructed with gas windows made out of aluminized Kapton (the aluminum layer is 0.1 mm thick and is on the outer surface of Kapton), with the aluminum layer connected to the cathode voltage across a 1 G $\Omega$  resistor. Having this aluminum layer also ensured that Kapton foil is sealed against humidity contamination, as was pointed out in the last report.

- The technician who was working on SBS construction left at the end of May as planned. Unfortunately the new technician who was being trained to fill the vacancy also resigned due to a family relocation issue. A search for a new technician is being conducted now. The two technicians did prepare a number of frame sets which is the most labor intensive part of the construction process. Two students are being trained and will help fill in the gap while looking for a new technician. The expectation is that the production rate of 2 per month can be maintained. To help maintain the production schedule, an additional assembly template will be ready by the middle of June.

### **WBS 3.2 GEM electronics**

- The design of the back plane for readout electronics was finalized. The order for one set of backplanes (sufficient to instrument one SBS module) was placed.

### **WBS 3 Costs:**

- Budget for this WBS for FY15 is \$371K.
- The incremental budget of FY13+FY14+FY15 is \$1,440K.
- With the addition of the moving the \$209K plus contingency forward from FY16 makes an incremental budget of \$1,687K.
- Costed and obligated as of 6/1/2015: \$1,427K (85%).

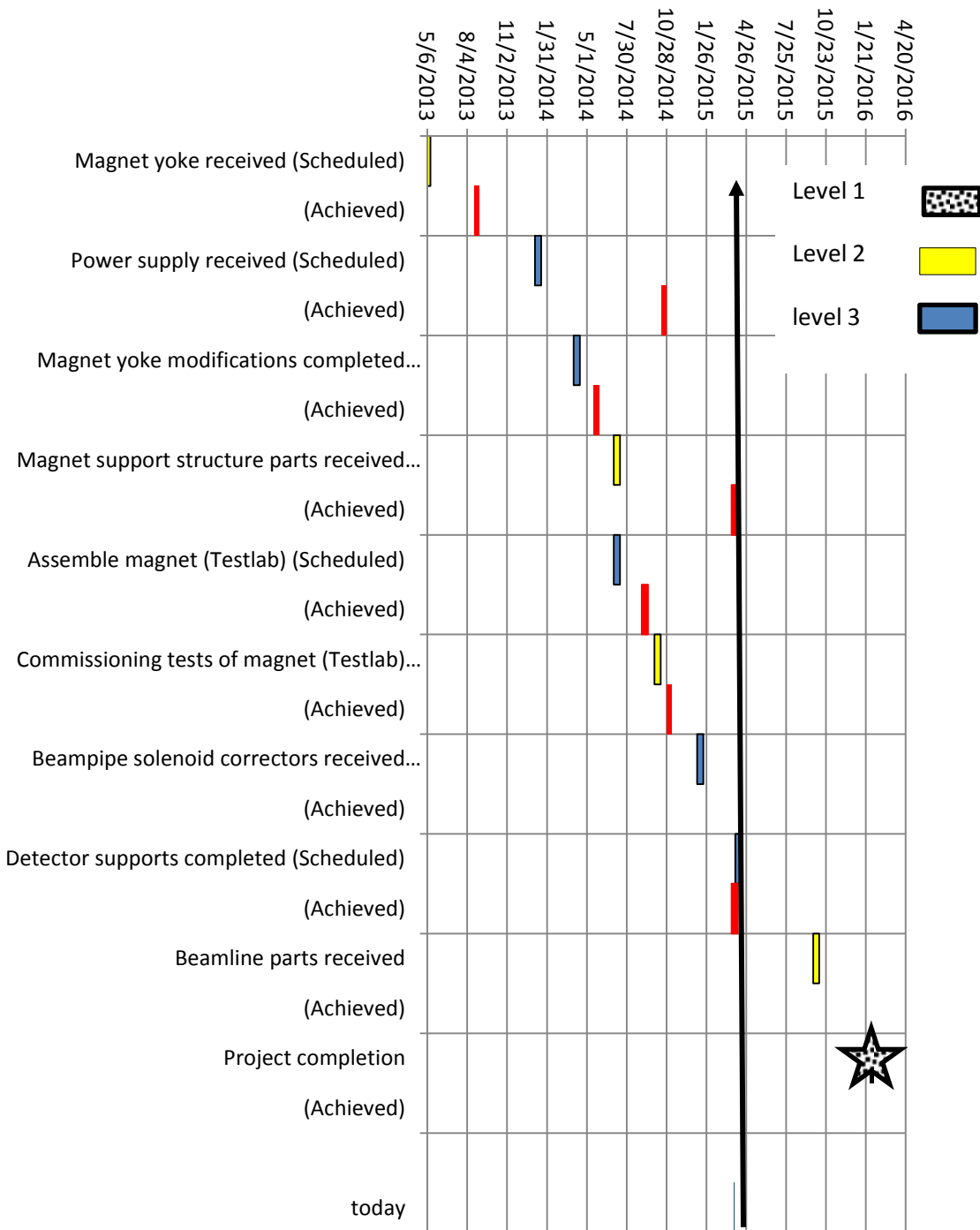
**WBS 3.01 Milestones:** (see [Appendix 1](#) for a graphic view of the milestones)

Level (ID#)	Milestone	Scheduled Date	Expected date 5/1/2015	Expected date 6/1/2015	Comment
1 (3.1-01M)	Project start	10/1/2012			<b>Completed 10/1/2012</b>
3	Order GEM Parts	10/1/2013			<b>Completed 10/18/2013</b>
3	UVa receives GEM parts	2/3/2014			<b>Completed 4/23/2014</b>
2 (3.2-01M)	First module assembled and tested	3/3/2014			<b>Completed 5/15/2014</b>
2 (3.2-10M)	UVa 5 GEM modules assembled and tested	6/2/2014			<b>Completed 12/23/2014</b>
2 (3.2-20M)	UVa 6-16 GEM modules assembled and tested	9/30/2014	6/15/2015	7/15/2015	
2 (3.2-30M)	UVa 17-29 GEM modules assembled and tested	3/2/2015	1/1/2016	3/15/2016	
2 (3.2-40M)	UVa 30-40 GEM modules assembled and tested	7/15/2015	6/15/2016	8/1/2016	
2 (3.2-50M)	1st order of Front End Electronics	10/1/2014	3/15/2015		<b>Completed 3/5/2015</b>
2 (3.2-60M)	2nd order of Front End Electronics	10/1/2015	3/15/2015		<b>Completed 3/5/2015</b>
1 (3.1-10M)	Project completion	7/31/2017	7/31/2017	7/31/2017	

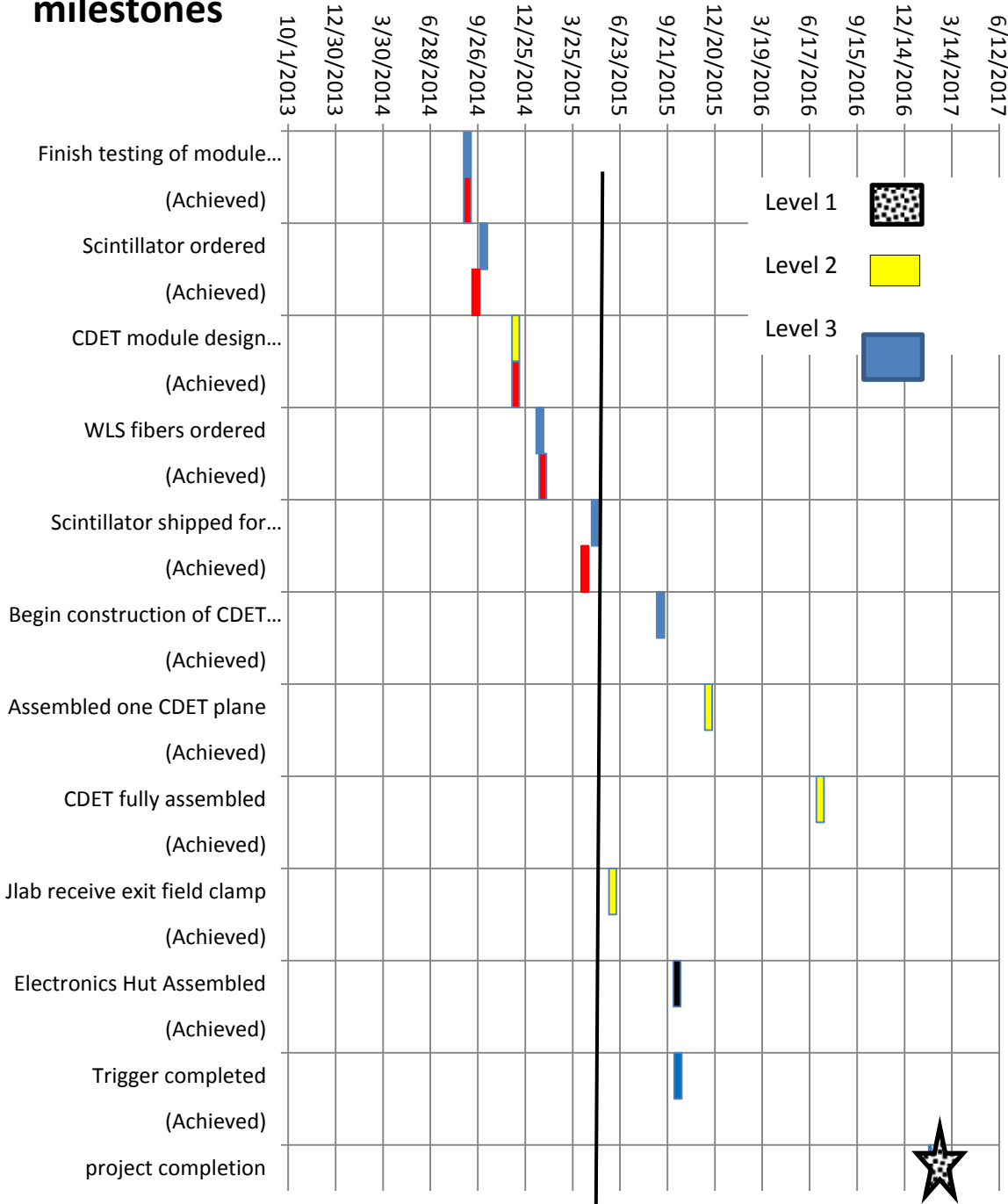
## Appendix I

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).

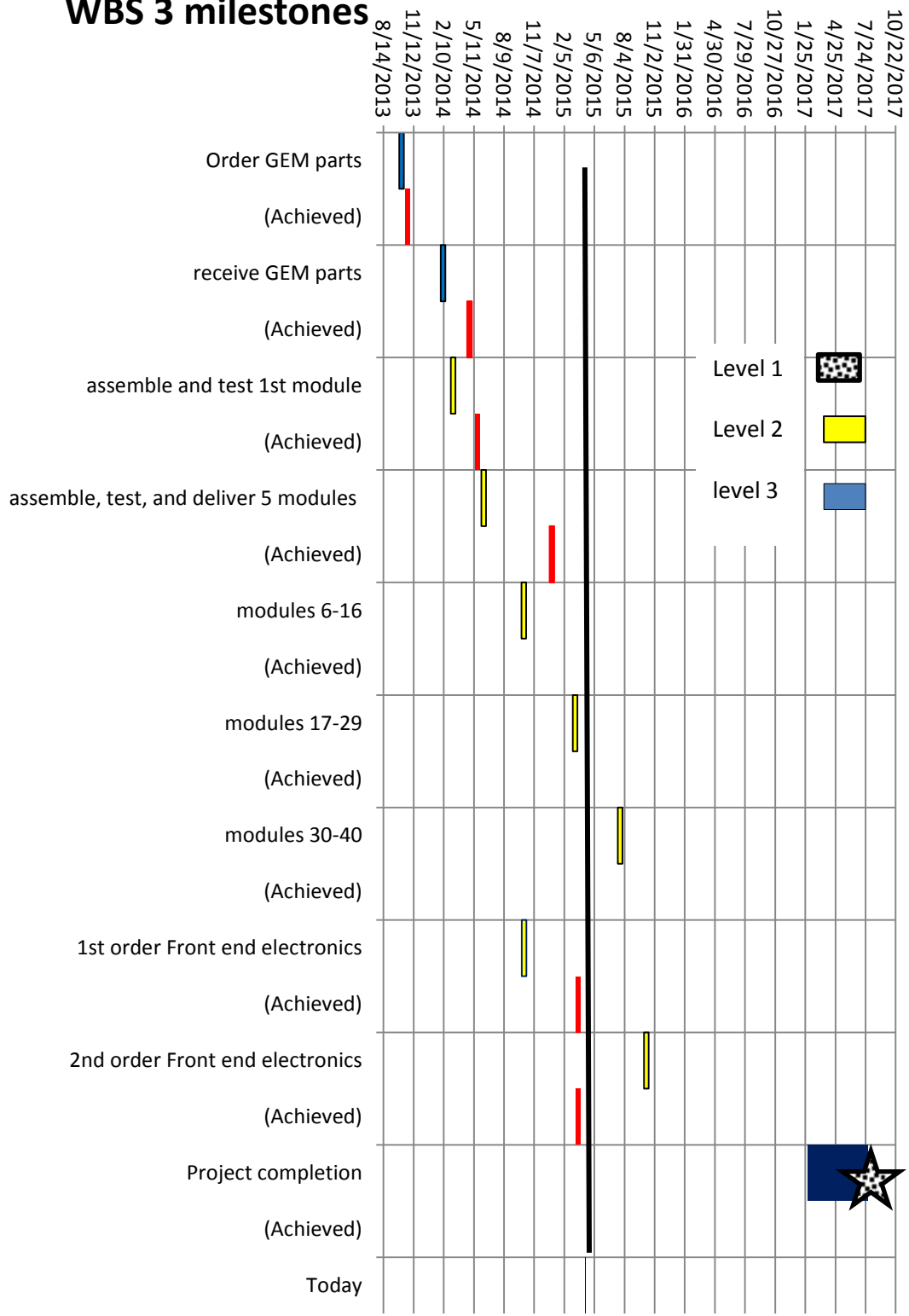
## WBS 1 Milestones



## WBS 2 milestones



## WBS 3 milestones





## Appendix II

**List of integration milestones for all equipment off-project, as well as key JLab readiness and safety reviews. For each milestone the additional float is indicated.**

### 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	<b>Completed Feb 2015</b>
Photon Detector Array assembled and tested	Aug 1, 2015	
NINO chip front end cards system shipped to JLab	Jul 1, 2015	
Purchase order issued for vessel	Oct 15, 2015	
Full DAQ system ready	Dec 1, 2015	
Vessel completely assembled	Mar 15, 2016	
GRINCH ready for installation	Jun 15, 2016	
Final analysis software complete	Jun 15, 2016	

#### **Status update:**

- The Photon Detector Array is being constructed by the vendor and is expected to ship to JLab by Aug 2015. At JLab, the assembly with phototubes will be done. All phototubes have already been tested by James Madison University.
- Two NINO chip front end cards will be sent to JLab by June 17<sup>th</sup>. The full set of NINO chip front end cards will be ready by Jan 2016. This delay will not affect the rest of the project schedule.

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

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

#### **Status update:**

- Module production is ongoing. Have produced 21 modules of the total of 288 modules in HCal.
- Have built 10 custom transport dollies for holding 6 modules at a time.

- Two graduate students working on DAQ with JLab FADCs
- Undergraduate student working on the pulser system.

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

Milestone	Completion date	Comment
Electronics in production	Sept 2014	<b>Completed Sept 2014</b>
GEM chambers 1 and 2 completed	Sept 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 first GEM chamber ( 3 modules) delivered on May 15<sup>th</sup> and are in the TestLab.

### Ecal from JLab ( for GEP)

Milestone	Completion date	Comment
Develop concept of annealing	July 2014	<b>Completed July 2014</b>
Test of annealing with prototype	Nov 2015	<b>Completed May 2015</b>
Design review	Nov 2015	
Electronics are ready	Nov 2016	
ECAL is ready	July 2017	

### Polarized <sup>3</sup>He target from UVa ( for GEN)

Milestone	Completion date	Comment
Selection of target-cell design for high luminosity	Nov 2014	<b>Completed Oct 2014</b>
Simulated-beam test (bench test) of selected design	Dec 2016	
Design for target hardware and instrumentation complete	July 2017	
GEN Polarized <sup>3</sup> He target is ready	Jan 2018	