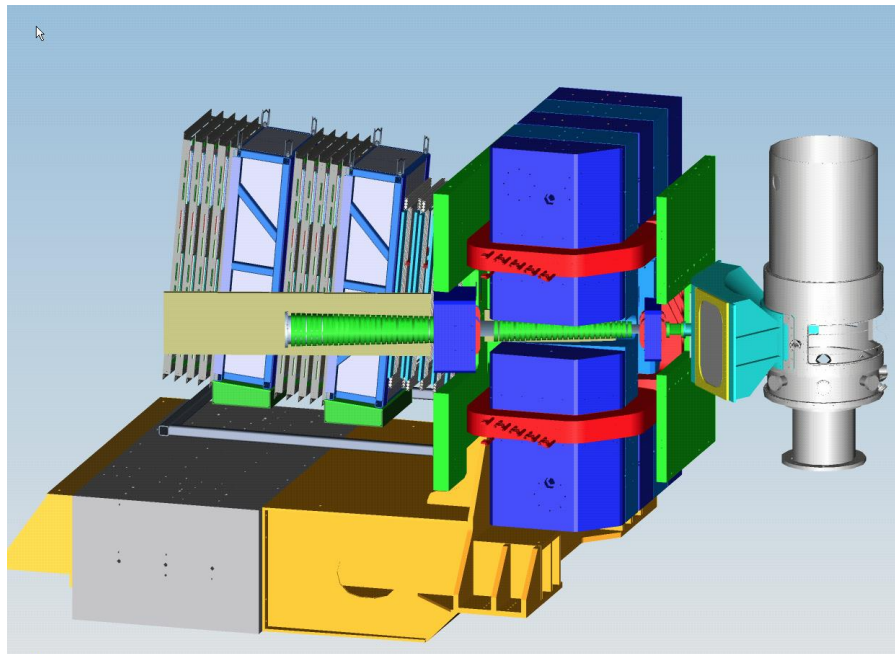


# ***Super-Bigbite-Spectrometer (SBS)***

## **Monthly Progress Report**

**February 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 39<sup>th</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.

- WBS1 project was completed. The vacuum beam line was completed by the JLab machine shop by Jan 20<sup>th</sup> and delivery of the final item (horizontal cylinders for moving the SBS platform) was on Jan 22<sup>nd</sup>.
- At the Hall A Collaboration Winter meeting, five SBS talks on detectors and physics were given. As with past SBS presentations at Hall A meetings, this was an effort to promote the SBS experiments and attract new collaborators.

## 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 January 6<sup>th</sup> and 27<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 is in the TestLab.
- Coils:
  - Racetrack coils: All coils are at JLab.
  - Saddle coil is at JLab.
- The corrector magnet coils and iron cores are at JLab.

### WBS 1.2 Magnet/Detector Platforms:

- The magnet platform and counterweight are at JLab. The floor plates and other equipment (such as horizontal cylinders which arrived on Jan 22<sup>nd</sup> 2016) are at JLab.

## **WBS 1.3 Beam Line:**

- The vacuum beam pipe was completed by January 20<sup>th</sup>.



Figure 1 Completed vacuum pipe

## **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 2/1/2016: \$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			<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			<b>Completed 12/11/2015</b>
3	Detector supports completed	4/1/2015			<b>Completed 3/24/2015</b>
2 (1.2-30M)	Beam-line parts received	9/24/2015			<b>Completed 11/30/2015</b>
1 (1.1-10M)	Project completion	1/29/2016	1/29/2016	1/29/2016	<b>Completed 1/22/2016</b>

## 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 January 6<sup>th</sup> and 27<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):

- Detailed timeline schedule has been developed for the production, assembly and alignment of the scintillator groups and fiber bundles for all six modules. Projected date of CDet assembly (without the PMTs and front-end electronics) completion is July 15, 2016 which is one month before the Level 2 milestone of August 15<sup>th</sup> 2016 for completion of CDet assembly.
- Seven of the 14-scintillator groups were completed in January to give a total of 84 groups completed (enough for 3 of 6 modules).
- Testing of the completed scintillators groups is an ongoing part of quality assurance. So far, 42 of the 84 scintillator groups have been tested with all 42 passing.

- 14 bundles of 16-fibers for module #2 have been machined only on one side. The machine will be unavailable for the month of February. Work will continue on making the 14-scintillator groups.
- 14-scintillator "group" status:
  - Completed 84 groups for module #s 1, 2, and 3.
  - Need to produce 84 more groups for module #s 4, 5, and 6.
  - Production rate is 1.6 groups/day.
- 16-fiber "bundle" status:
  - 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 integrated beam line stands for lead shielding and corrector magnets has been divided into three phases for the form factor experiments. The first phase is when the corrector magnet stands are supported by the magnet. The first phase has completed the production drawings which are now under engineering review. The second phase is when the corrector magnets need a movable support bench. The second phase is in the detailed modeling and layout stage. Production drawing is expected to start Feb 15<sup>th</sup>. The third phase is the support for the lead shielding.
- The inner part of the passive magnetic shielding for the beam line was finished. Work on the outer part of the passive magnetic shielding will be finished in February.
- Shipment of the steel for the roof of the electronic huts has been delayed by the large snowstorm that came in the middle of January. The shipment will be made in February. The posts for supporting the roof were put into purchasing on January 22<sup>nd</sup> and a three week period for bids was given.

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

- The pole shims and field clamp are at JLab.

### **WBS 2.4 Trigger:**

- The nine CPUs for the CDet FASTBUS crates are scheduled for delivery on February 24<sup>th</sup>.
- 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 2/1/2016: \$1,092K (80.2%).



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

Level	Milestone	Scheduled Date	Expected date 2/1/2016	Expected date 3/1/2016	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			<b>Completed 4/10/2015</b>
2	JLab receives exit field clamp	6/2/2015			<b>Completed 11/18/2015</b>
3	Begin preparation of WLS fibers	6/15/2015			<b>Completed 7/6/2015</b>
3	Begin construction of CDET modules	9/1/2015			<b>Completed 9/24/2015</b>
3	Assembled one CDET module	10/1/2015			<b>Completed 11/15/2015</b>
2	Electronics hut parts received	10/2/2015	1/18/2015	2/15/2016	Delay in delivery does not affect other parts of project
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

<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 January 6<sup>th</sup> and 27<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

- The construction of modules #25 and #26 is completed.
- X-ray testing of module #24 is completed: all sectors are operational.
- Construction of module #27 is underway.

### WBS 3.2 GEM electronics

- Progress has been made in the GEM MPD CODA DAQ.
  - The prototype MPD readout system is set up at Jefferson lab, currently taking cosmic ray data using an UVa 50x60 cm<sup>2</sup> GEM module with new front end electronic boards.
  - The RMS pedestal value using MPD electronics is about 20 ADC channels; the average signal ADC value for cosmic data is around 350 ADC channels.
- With the success of the test, a request for a quote for all electronics for all GEM modules will be made in February.

### 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 2/1/2016: \$1,663K (95.7%).

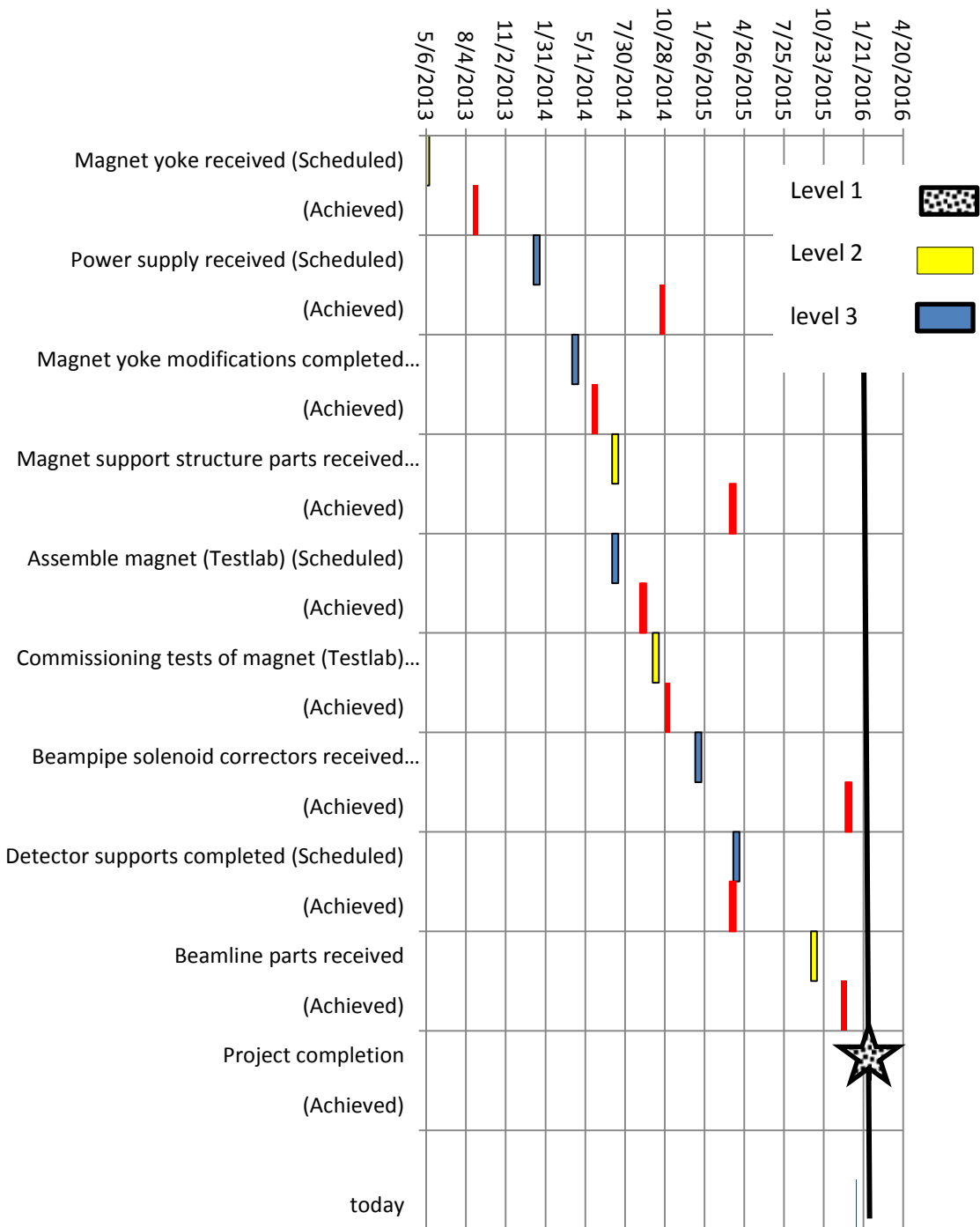
**WBS 3.01 Milestones:** (see [Appendix 1](#) for a graphic view of the milestones)

Level (ID#)	Milestone	Scheduled Date	Expected date 2/1/2016	Expected date 3/1/2016	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			<b>Completed 7/28/2015</b>
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			<b>Completed 3/5/2015</b>
2 (3.2-60M)	2nd order of Front End Electronics	10/1/2015			<b>Completed 3/5/2015</b>
1 (3.1-10M)	Project completion	2/1/2017	2/1/2017	2/1/2017	

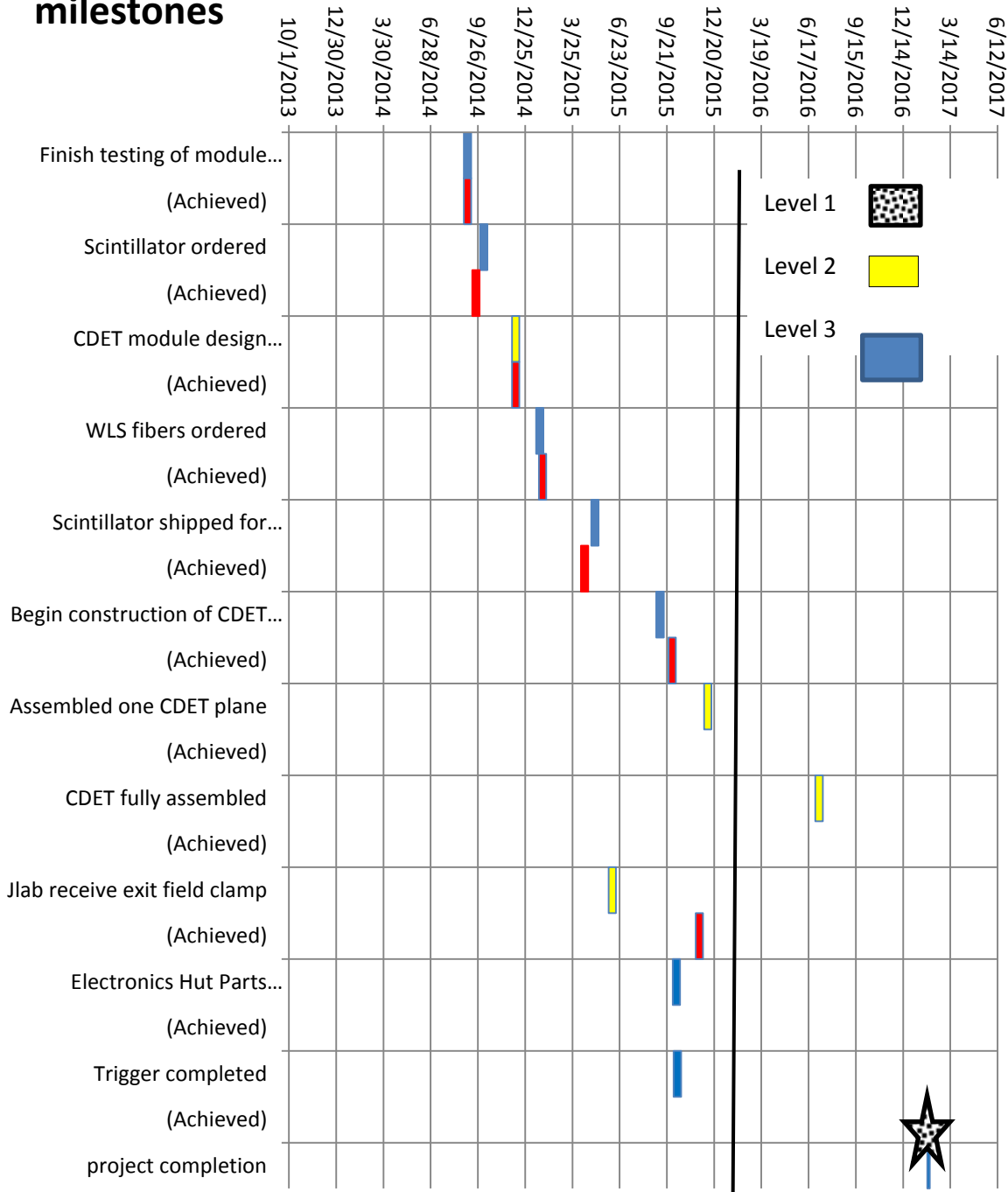
## Appendix I

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).

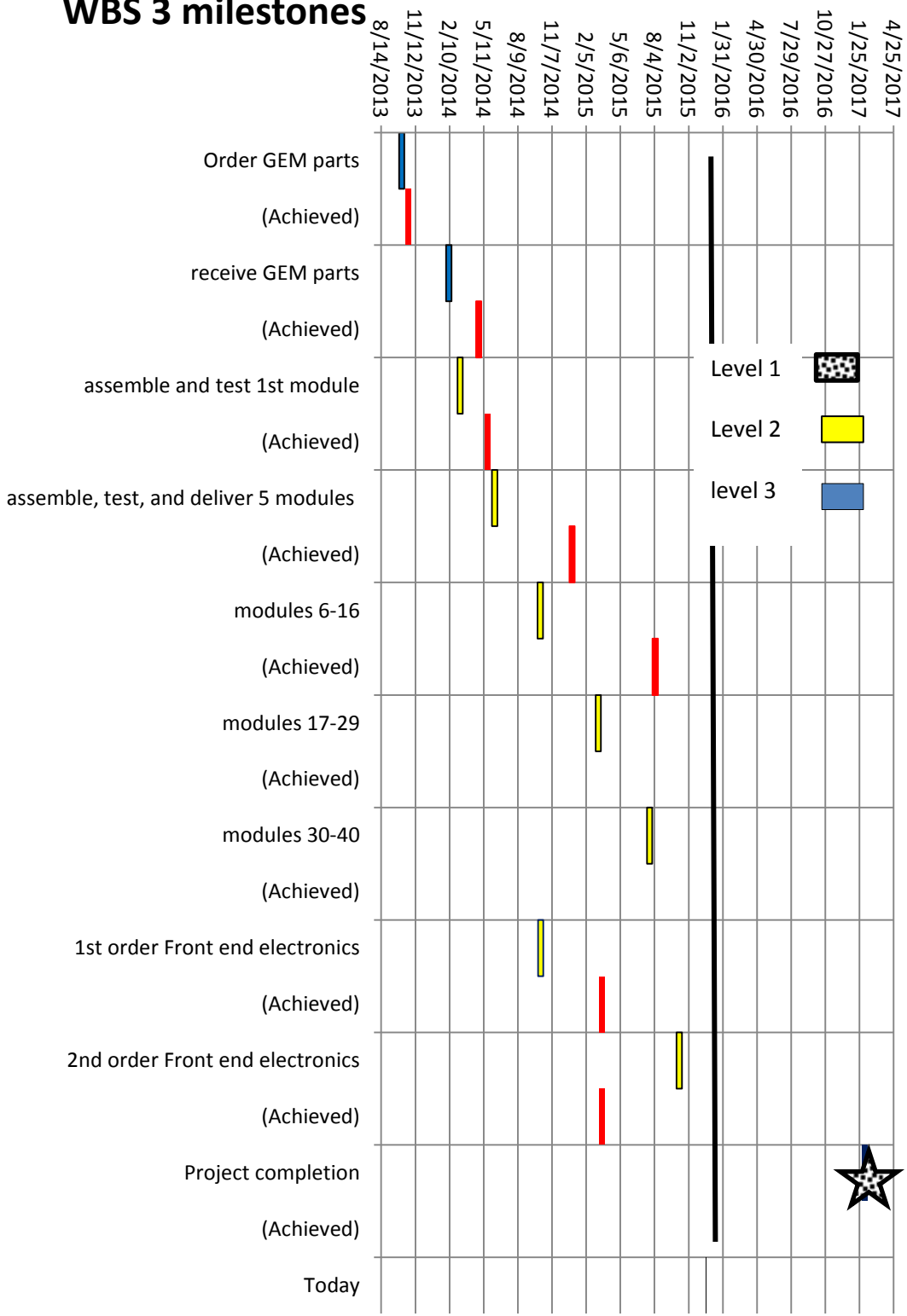
## WBS 1 Milestones



## 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	<b>Completed Feb 2015</b>
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	<b>Completed Oct 2015</b>
Purchase order issued for vessel	Oct 15, 2015	<b>Completed Aug 2015</b>
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 was surveyed in January.
- The Photon Detector Array and the side panels were successfully fitted to the vessel.



- [Figure 2 The GRINCH vessel with view of the front window and the photon detector array](#)

## 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	<b>Completed Sept 2015</b>
Module assembly 50% complete	Mar 2016	
Module assembly completed	Sept 2016	

### Status update:

- Module production is ongoing. Have produced 105 modules (includes 102 modules at JLab) of the total of 288 modules in HCal.
- On January 14<sup>th</sup>, 66 modules were delivered to JLab.
- The milling of the steel end-plates was completed by the CMU Material Science machine shop. This was a significant increase in speed. The drilling and tapping of the plates will be done by the group's machinist.
- Significant progress on the light guide components was made. The remaining 166 straight pieces were diamond machined and the diamond milling of the ends and "ears" of the laser-cut dog-leg pieces was completed. 230 dog-legs were flame polished and the flame polishing of all 600 dog-legs is expect to completed by the second week of February. This means that all light guide components will be ready for assembly other than about 30 short cylinders.
- Unfortunately, the CMU technician will resign her position on Feb 12<sup>th</sup>. The search for replacement has begun. Documentation of the procedures has been done.
- CMU expects to make another shipment by late March. This will meet our goal of 50% (144 modules) by March.

## 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	<b>Completed Dec 2015</b>
Initial Electronics QA completed	Dec 2015	<b>Completed Dec 2015</b>
GEM chambers 3 and 4 completed	May 2016	
GEM chambers 5 and 6 completed	Dec 2016	

## 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>
Fabrication of C200 frame started	Sept 15 2015	<b>Completed Sept 2015</b>
Design of ECAL platform modification started	Dec 1 2015	Delayed until February 2016
C200 assembly completed and testing begins	Jan 15 2016	<b>Completed Jan 2016</b>
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:

- Short reports on the costs, risk factors and experimental figure of method for three different options for ECal will be prepared for next month. The first two options would both use the existing lead glass at JLab. The first option would anneal the radiation damage by UV light and the second option would use thermal annealing. A third option is to modify the lead scintillating fiber calorimeter used in E864 at BNL which recently became a possibility.
- The C200 assembly has been completed. A graduate student has begun to work on Labview-based DAQ to read thermocouples and control the heating elements. Half of the lead glass with glued light guides has been shipped to Stonybrook with the rest shipping in February.

## Polarized $^3\text{He}$ target from UVa ( for GEN)

Milestone	Completion date	Comment
Selection of target-cell design for high luminosity	Nov 2014	<b>Completed Oct 2014</b>
Conceptual design document complete	Jan 2016	Delayed until February
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	

### Status update:

- The conceptual design report will be ready in the beginning of February.