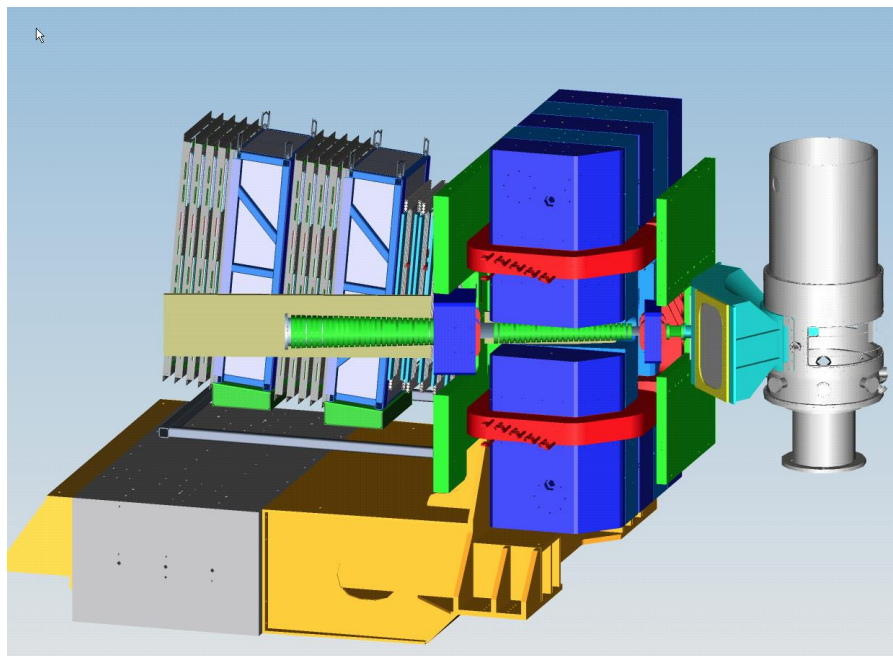


# ***Super-Bigbite-Spectrometer (SBS)***

## **Monthly Progress Report**

**August 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 44<sup>th</sup> 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.

- A level 3 milestone for the WBS 2.01 Coordinate Detector of assembling one plane was completed on July 15<sup>th</sup>.
- SBS Annual Collaboration meeting has held on July 21 and 22<sup>nd</sup>. The [agenda](#) covered the full range of the SBS projects and experiments with over 35 talks.

## 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

**WBS1 Project was completed on January 22<sup>nd</sup>, 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

<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 meeting, via tele and video conference, was held on July 6<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, 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):

- A Level 3 milestone of assembling one plane of the Coordinate Detector was completed with the assembly of modules 2 and 3 by July 15<sup>th</sup>.
- 14-scintillator "group" status:
  - All 168 groups completed.
- 16-fiber "bundle" status:
  - All 168 bundles completed.
- The 14-scintillator groups for modules 4 and 5 were individually tested and passed QA. Assembly of modules 4 and 5 is underway. The 14-scintillator groups for module 6 are

undergoing QA tests and the tests will be completed in August. This puts the CDet on track to complete the Level 2 milestone of “Coordinate Detector assembled” by end of August.

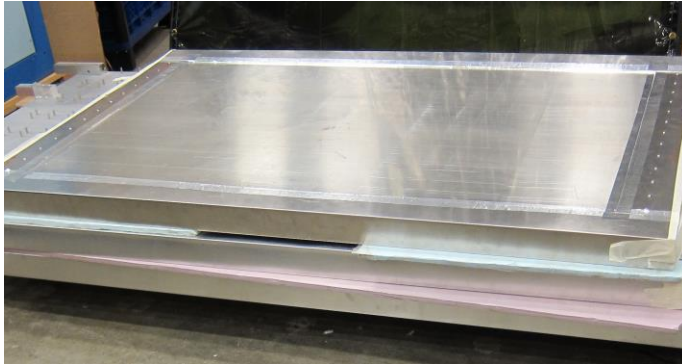


Figure 1 Left photo is the stack of CDet modules 2 and 3 which have been covered and enclosed. The right photo shows the electronics connected module 1 that is under going cosmic testing.

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

- The detailed design drawing for the beam-line corrector magnet stands was completed in July. It will be reviewed and then sent to procurement by the 2<sup>nd</sup> week of August. Beamline shielding assembly hardware drawings will be ready for procurement by 3<sup>rd</sup> week of August.
- For the SBS detector support, the GEM frames and holders were designed and they were reviewed by the INFN and UVA groups in July. The detailed design work will be completed by the end of August and will be sent to procurement.

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

- 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 8/1/2016: \$1194K (88%).

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

Level	Milestone	Scheduled Date	Expected date 8/1/2016	Expected date 9/1/2016	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			<b>Completed 3/30/2016</b>
2	Trigger completed	10/4/2015			<b>Completed 3/15/2016</b>
3	Assembled one CDET plane	12/1/2015	7/15/2016		<b>Completed 7/15/2016</b>
2	Coordinate Detector assembled	6/30/2016	8/30/2016	8/30/2016	
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 meeting, via tele and video conference, was held on July 6<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, Christopher Newport University and INFN Rome.
- Project is staffed appropriately and includes Jefferson Lab (manager, scientist) and UVa (two scientists).

### WBS 3.1 GEMs

- GEM module production was on hold during July while the UVa group was waiting for readout boards to arrive from CERN. 34 out of 40 GEM modules have been constructed. UVa consulted with CERN and a schedule for delivery of the GEM and readout foils was setup. This will allow completion of the Level 2 milestone, "UVa 30-40 GEM modules assembled and tested", by the end of October. The remaining scope is three months of work with three months of float left in the schedule.
- Three new readout boards arrived from CERN at the end of July. With the 9 GEM foils at UVa work on the chambers will resume in August.
- The next shipment of 3 readout planes is scheduled for middle of August. In August, CERN will start repairing the 15 GEM foils that UVa returned to CERN at the beginning of July. The expectation is that most of the GEM foils will be shipped back to UVa at the end of August with the rest to follow in September.
- X-ray testing of modules 31, 32 and 33 were completed. All sectors in all three modules are operational.

- The shipment of a GEM foils and readout planes for five more spare modules will be in October and November.

### **WBS 3.2 GEM electronics**

- 540 of the 900 APV front end cards and 32 of the 42 12-slot backplanes arrived at UVA at the end of July. The rest will be shipped in August.

### **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 8/1/2016: \$1669K (96%).

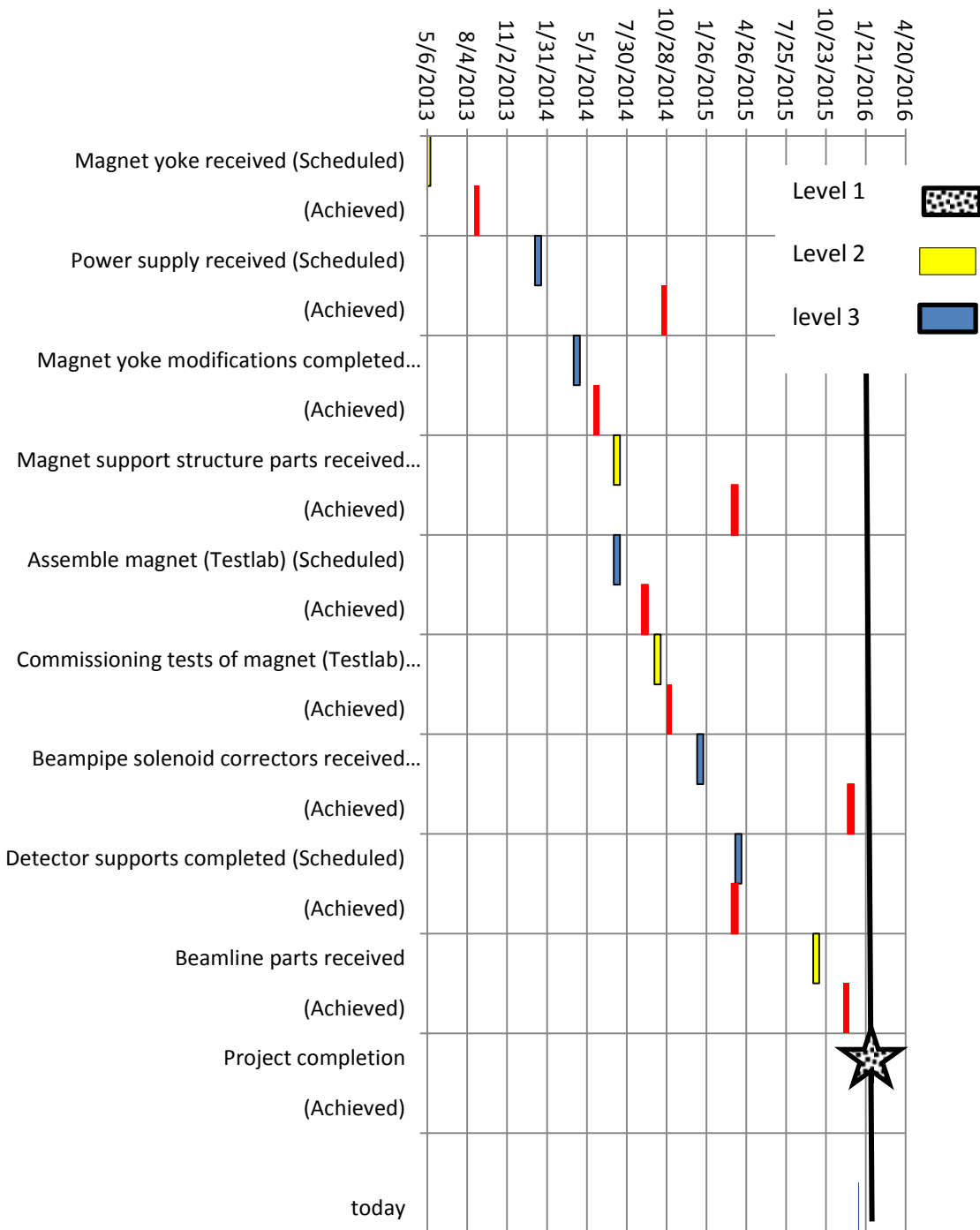
**WBS 3.01 Milestones:** (see [Appendix 1](#) for a graphic view of the milestones)

Level (ID#)	Milestone	Scheduled Date	Expected date 8/1/2016	Expected date 9/1/2016	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			<b>Completed 3/30/2016</b>
2 (3.2-40M)	UVa 30-40 GEM modules assembled and tested	7/15/2015	9/15/2016	10/30/2016	
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	

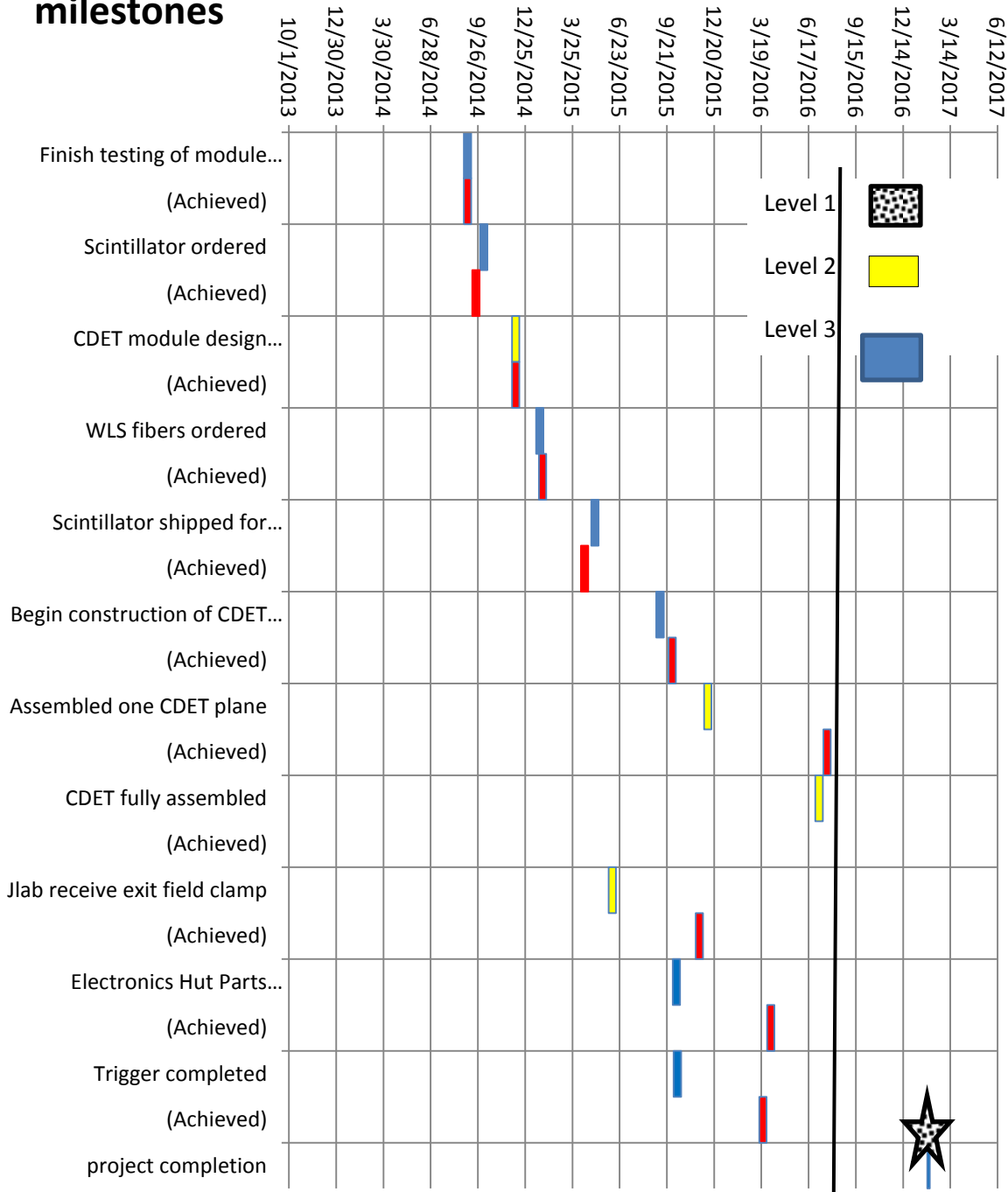
## Appendix I

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).

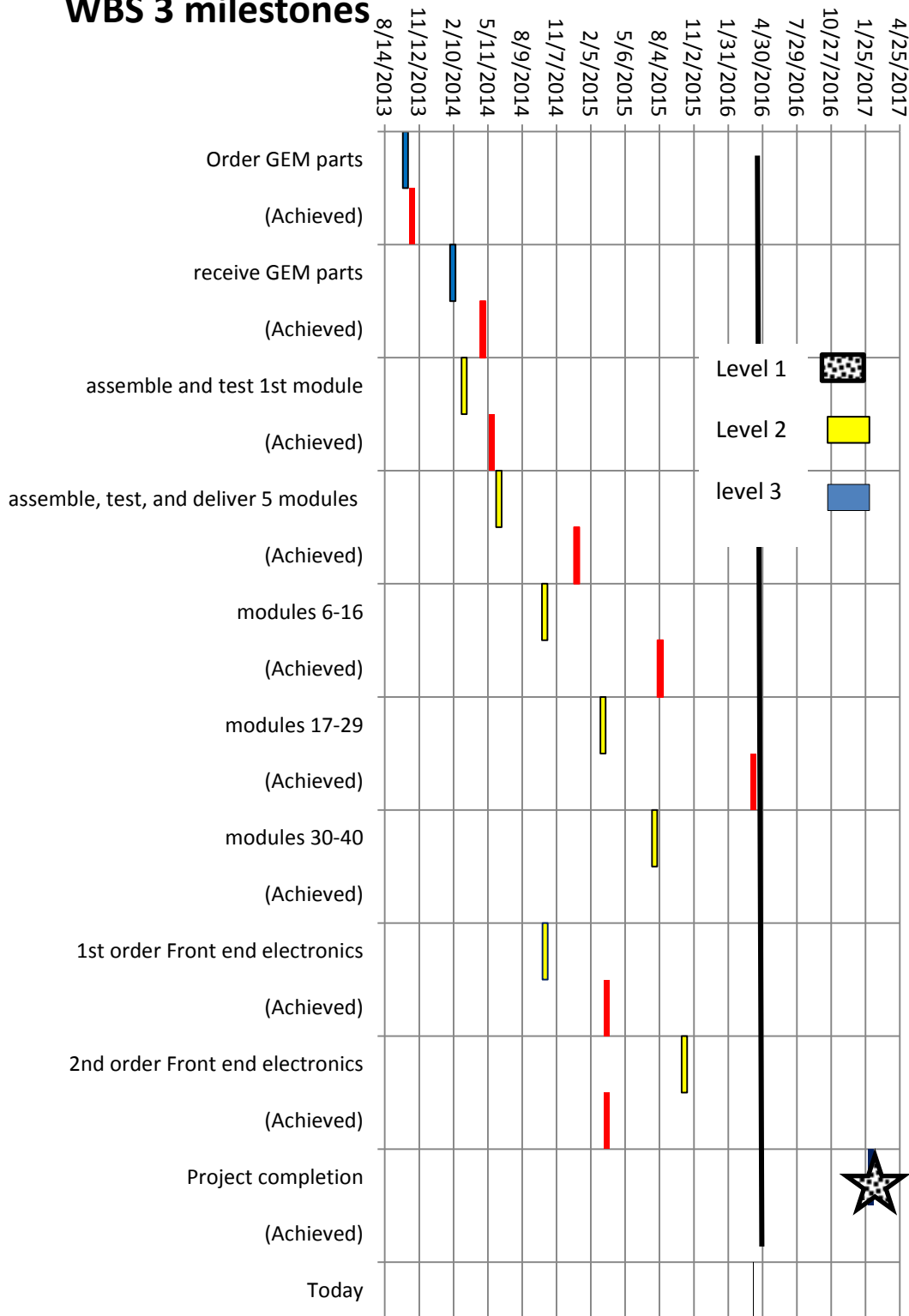
## WBS 1 Milestones



## WBS 2 milestones



### WBS 3 milestones



## Appendix II

### GRINCH from W&M/NCCU/JMU ( 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 August 2016
Vessel completely assembled	Mar 15, 2016	Expected August 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/INFN-Catania (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	<b>Completed April 2016</b>
Module assembly completed	Sept 2016	

#### **Status update:**

- Module production is ongoing. Have produced 184 modules (169 modules at JLab) of the total of 288 modules in HCal.
- 13 modules were produced in July.
- Work was done on the LED/fiber 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	<b>Completed Dec 2015</b>
Initial Electronics QA completed	Dec 2015	<b>Completed Dec 2015</b>
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

### ECal from JLab/SBU/JMU ( 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	Delay until Aug 2016
C200 assembly completed and testing begins	Jan 15 2016	<b>Completed Jan 2016</b>
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 complete 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:

- The report which compares the three options for ECal was sent to three members of the DOE SBS Review Committee on July 24<sup>th</sup>. This is in response to one of the recommendations in the 2015 DOE SBS review report. The reviewers were requested to respond with their advice and comments by mid-August. The final report that evaluates the ECal project including the technical feasibility of the annealing solution with the ECal project cost and schedule will be ready by the end of August.
- At Stony Brook U, ten supermodule frames were completed in mid-July and assembly of the 10 super modules in the large oven is underway.

## 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	<b>Completed Mar 2016</b>
Conceptual design review	Mar 2016	<b>Completed Mar 2016</b>
Start bench test of 3 liter glass convection target	April 2016	Expect start in Aug 2016
Conceptual design frozen	June 2016	Expect by Aug 1 <sup>st</sup>
Test of glass/metal technology complete	June 2016	<b>Completed July 2016</b>
Begin engineering and design	July 2016	<b>Completed May 2016</b>
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:

- The glass blower finished the 3 liter glass convection cell on July 25<sup>th</sup> and was shipped to UVa. Bench tests will start in August.
- UVa did a first test of dual direction pumping on a 3.25" diameter spherical cell at about a pressure of one atmosphere. They measured a polarization of 75.8%. This test was with a low pressure cell (the ratio of laser power to cell volume is similar to the ratio to be used for the SBS Gen target) and demonstrates that higher polarization is possible with dual pumping.
- The CDR will be finished in August.