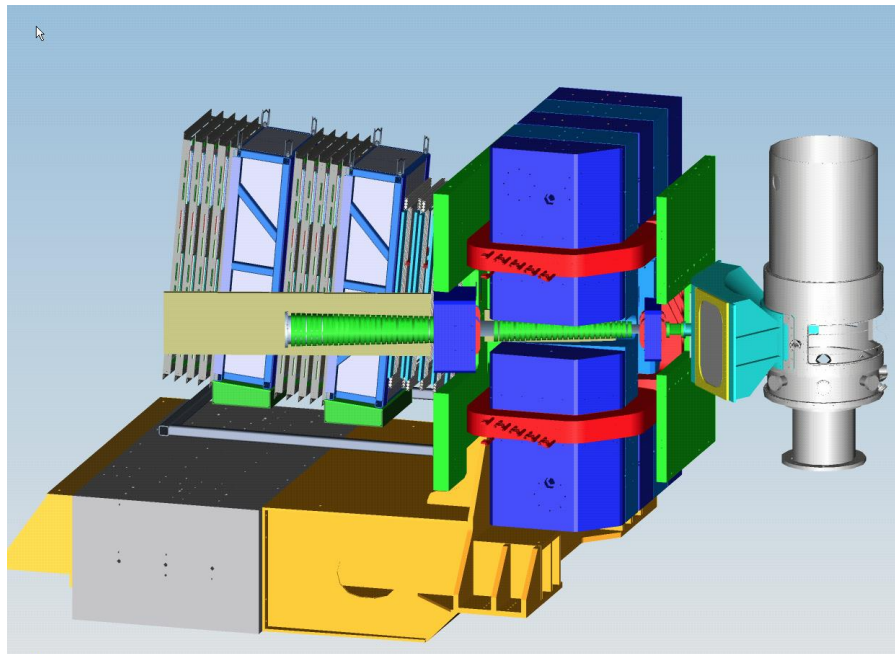


Super-Bigbite-Spectrometer (SBS)

Monthly Progress Report

October 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 46th 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.

- The CDet frame was delivered to Jefferson Lab on Oct 4th. This completes that final purchase for the contract with Idaho State University and the contract will be closed in the next month.

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 Sept 7, 14 and 21st. 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):

- The CDET frame was delivered to JLab on Oct 4th. This completes all the purchases needed for the CDet.

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

- The beam-line corrector magnet support tower is the final machining process and delivery will be at end of October. The beamline shielding assembly is expected at JLab in middle of October.
- The contract for the SBS detector support for the GEM frames was awarded. The completion date of the contract is middle of November.
- The UVa shop built one frame. A test fit was completed and modifications are needed to improve the rigidity. The design will be sent to procurement by middle of October.

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 10/1/2016: \$1192K (88%).

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

Level	Milestone	Scheduled Date	Expected date 10/1/2016	Expected date 11/1/2016	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			Completed 7/15/2016
2	Coordinate Detector assembled	6/30/2016			Completed 8/31/2016
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 Sept 7, 14 and 21st. 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

- Present status for completion of 40 GEM modules:

GEM module #	Status
35	Under construction, 3 GEM foils and 1 RO board at UVa and passed QA tests
36	3 GEM foils and 1 RO board at UVa and passed QA tests
37	2 GEM foils at UVa and passed QA tests 1 GEM foil at UVa and 1 RO board shipped in Oct
38	3 GEM foils at UVa and 1 RO board shipped in Oct
39	1 GEM foil at UVa 2 GEM foils and 1 RO board shipped in Oct
40	3 GEM foils and 1 RO board shipped in Oct

- The frame coating varnish ordered from Switzerland arrived at UVa on October 3rd. The fabrication of module #35 was resumed immediately after that. This module is expected to be completed by October 7th.
- During the wait for varnish, the other chamber components were prepared for the modules up to #40. Given the preparation, the module production can proceed faster. UVa expects to complete 40 modules by the end of November.
- Five GEM foils were delivered in September.
- Module #34 was tested with x-rays. Initial tests showed that all sectors are operational.

WBS 3.2 GEM electronics

- All 57 MPD modules were successfully tested.
- All APV front ends cards have been built and are ready to ship from EES. Five of the 5-card back planes showed delamination and are being rebuilt.

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 10/1/2016: \$1635K (94%).

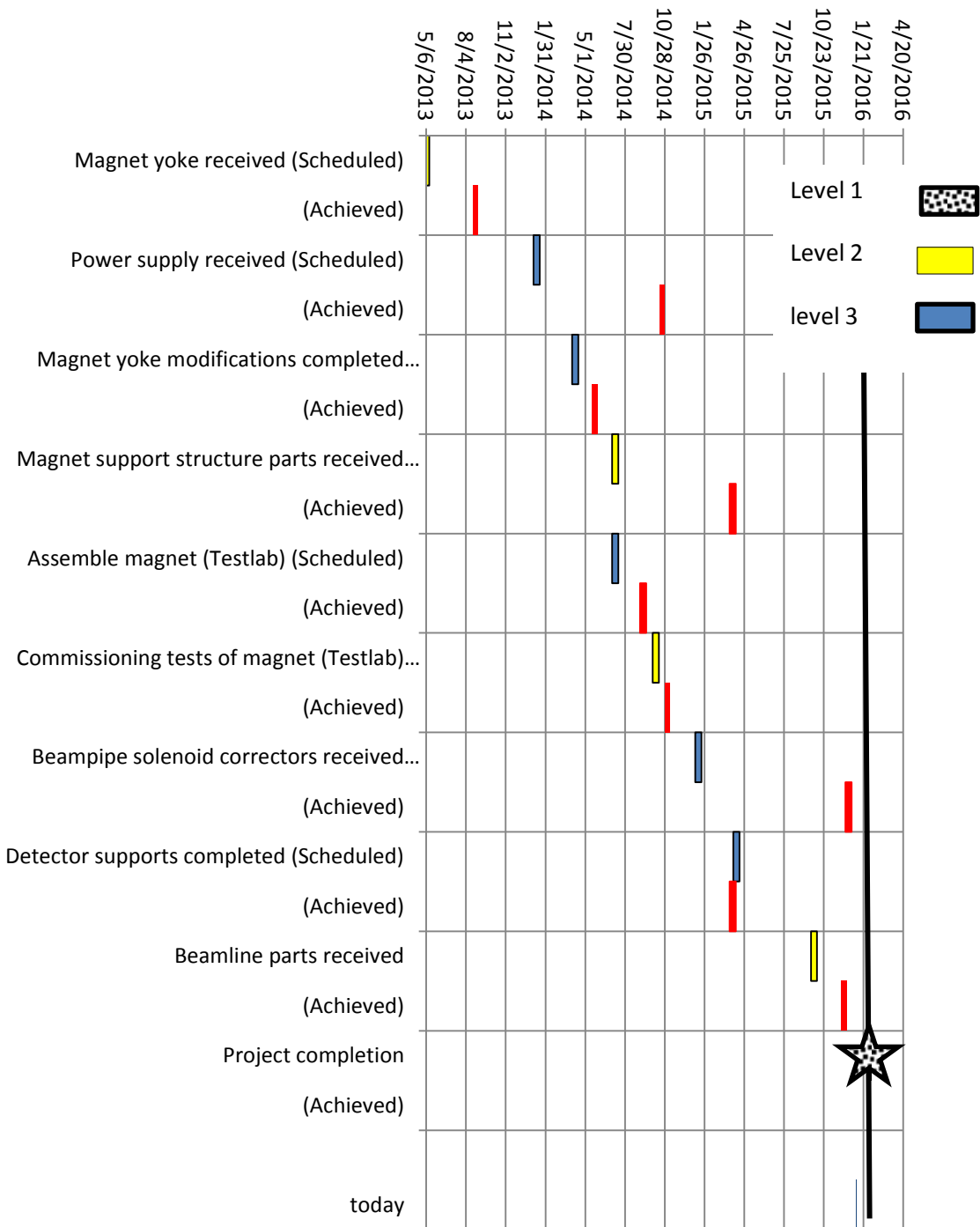
WBS 3.01 Milestones: (see [Appendix 1](#) for a graphic view of the milestones)

Level (ID#)	Milestone	Scheduled Date	Expected date 10/1/2016	Expected date 11/1/2016	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	11/30/2016	11/30/2016	
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	

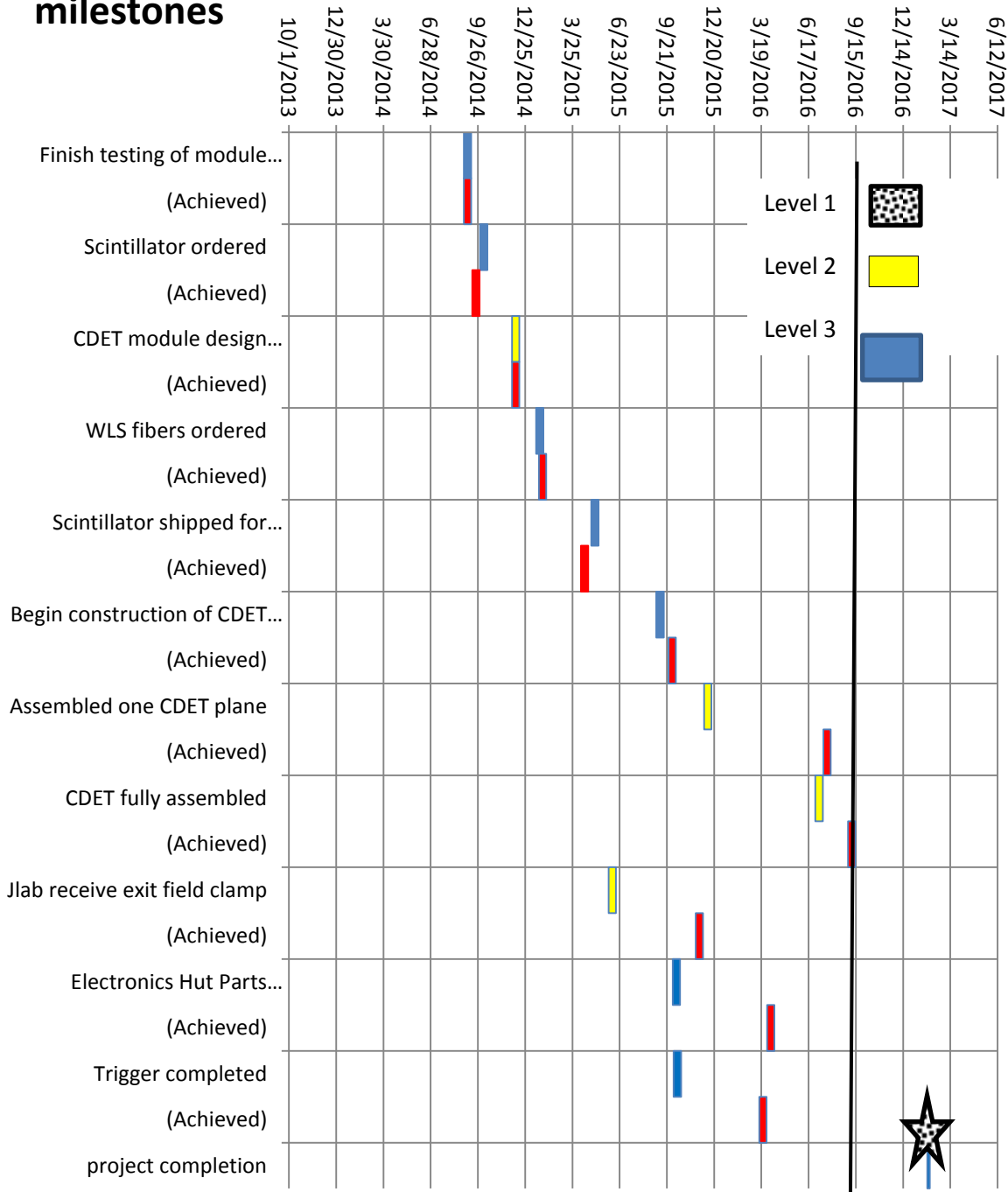
Appendix I

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).

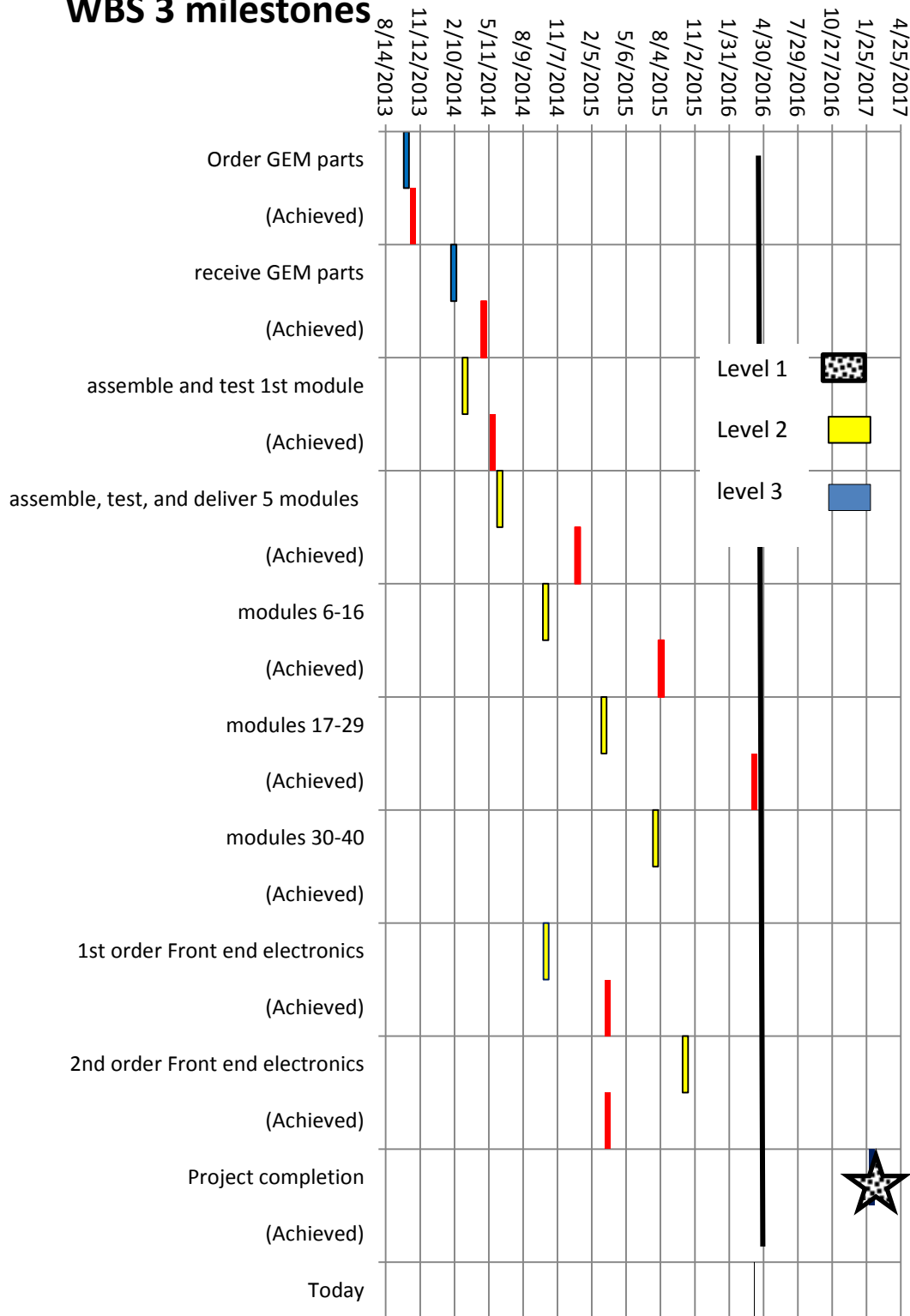
WBS 1 Milestones



WBS 2 milestones



WBS 3 milestones



Appendix II

GRINCH from W&M/NCCU/JMU (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 Dec 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 Dec 2016
Vessel completely assembled	Mar 15, 2016	Completed Sept 2016
GRINCH ready for installation	Jun 15, 2016	Expected Jan 2017
Final analysis software complete	Jun 15, 2016	Expected Mar 2017

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 Dec 2016
GEM chambers 5 and 6 completed	Dec 2016	Expect in May 2017

Status update:

- Four GEM modules have been constructed and are being setup at Rome for quality assurance tests using a cosmic ray test stand. For front tracker , there are 3 GEM modules per chamber.
- The delivery of GEM modules for chamber 3 and 4 to Jefferson Lab is delayed until Dec 2016.

HCal-J from CMU/INFN-Catania (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	Expected in Feb 2017

Status update:

- Module production is ongoing. Have produced 200 modules (169 modules at JLab) of the total of 288 modules in HCal.
- 16 modules were produced in September. This rate of about 1 per day is on track for completion by Feb 2017 as reported last month.

Ecal from JLab/SBU/JMU (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 Jan 2017
C200 assembly completed and testing begins	Jan 15 2016	Completed Jan 2016
C200 report results, recommendations completed	June 1 2016	Completed Oct 2016
Design of ECAL frame/oven started	July 1 2016	Delay until Nov 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:

- The C200 report will be part of the prebriefing material for the November review.
- C200 tests were continued at StonyBrook. Tests were done with two configurations of heating elements and blocks were done. The measurements compared well to COMSOL calculations. A

test of the air cooling in the region of the light guides was completed. The test demonstrated that the mechanical techniques developed for distributing the air flow works. Figure 1 shows a schematic of the cooling concept. A manifold consisting of 1/2" ID tubing with eight 3.5 mm diameter holes per tube was built. Each tube was placed near the end of the light guides and blew air between the light guides transverse to the light guide cylinder. Figure 2 is a plot of the temperature along the length of the light guides. The desired temperature profile across the 15cm length of the light guide of 185° C at the lead glass block and dropping to 50°C at the PMT was achieved.

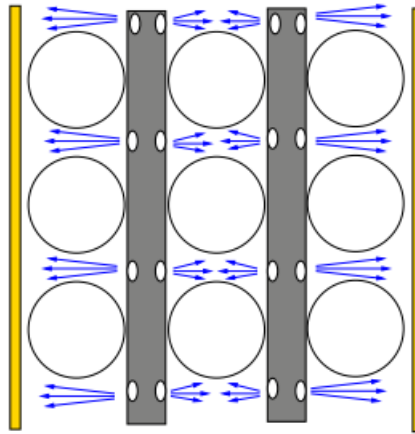


Figure 2 Schematic drawing of the airflow from the silicon tubing placed between the light guides viewed from the PMTs.

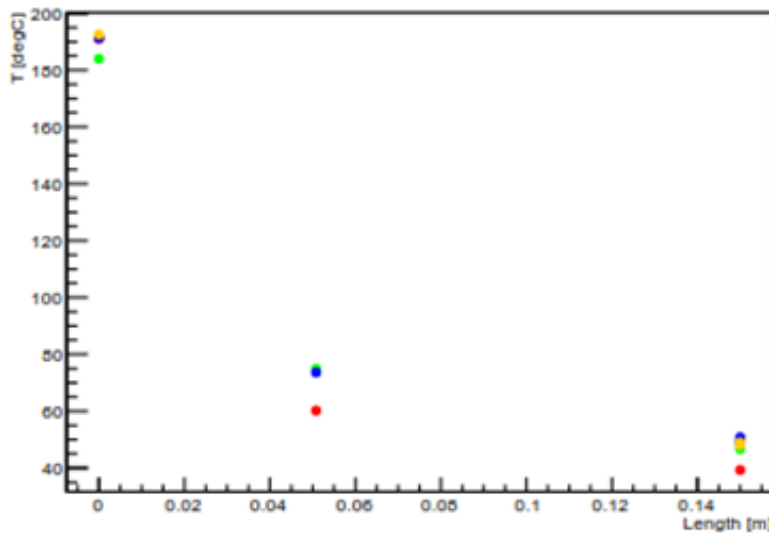


Figure 1 Plot of temperature versus longitudinal position along the light guide for different light guides. The light guide is 15cm long.

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	Completed Aug 2016
Conceptual design frozen	June 2016	Completed Oct 2016
Test of glass/metal technology complete	June 2016	Completed July 2016
Begin engineering and design	July 2016	Completed May 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:

- The CDR of the polarized target was completed and will be included in the prebriefing materials for the SBS DOE November review.
- A second 3 liter glass cell has been made and delivered to UVa so that the bench testing of the 3 liter glass convection target can continue.
- A brief update on the work done at by the Hall A engineers and designers. The mechanical aspects for the laser optics and it's enclosure, the magnetic shielding and the holding field have been worked out for all neutron form factor kinematics.

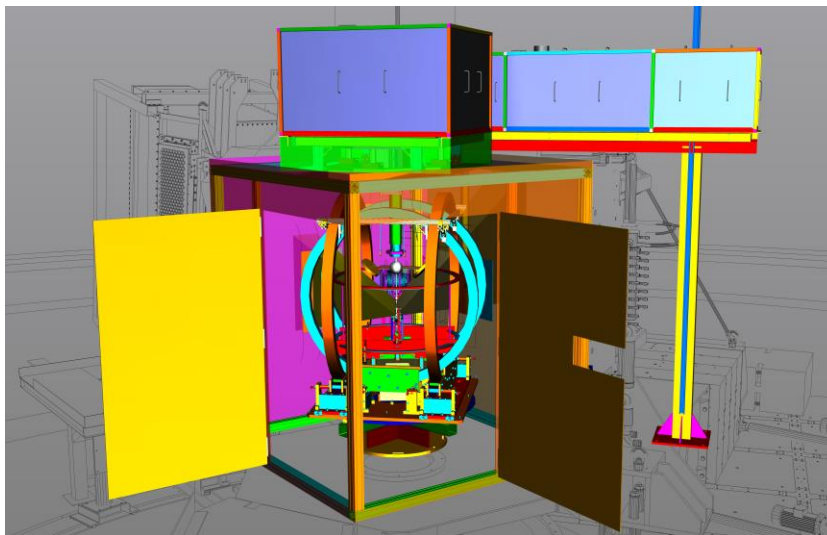


Figure 4 View of polarized target looking down the beam line towards the beam dump. The enclosure for the laser optics are on top. The doors to the magnetic shielding are open showing the Helmholtz coils, target and mirrors. The BigBite and SBS magnets are shown behind the polarized target in black and white.

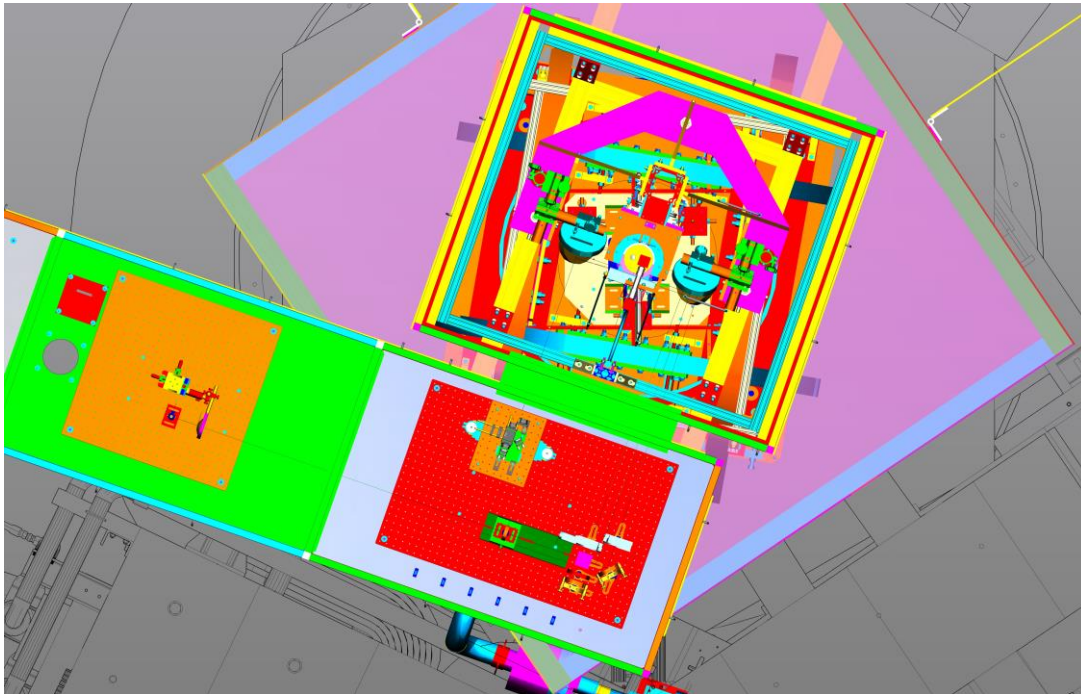


Figure 5 Top view of the polarized target which shows the inside of the laser optics enclosure in addition to inside the target region.