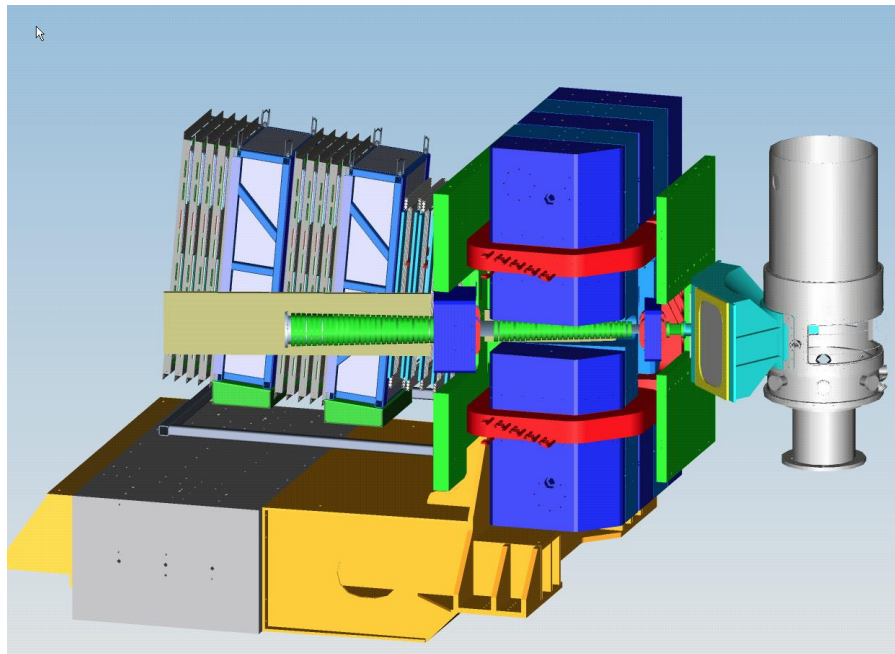


Super-Bigbite-Spectrometer (SBS)

Monthly Progress Report

July 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 43rd 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 polarized target milestone “Test of glass/metal technology complete” was completed on July 8th.

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 June 8, 15 and 29th. 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):

- 14-scintillator "group" status:
 - All 168 groups completed.
- 16-fiber "bundle" status (total of 168 bundles needed for CDet):
 - 162 fiber bundles have fibers inset with epoxy, remaining 6 to be inset.
 - 168 fibers bundles have been machined on PMT side; 110 remain to be machined on the mirror side.
- Assembly of module 2 started in the middle of June.

- The 14-scintillator groups for the first three modules (84 total) have been individually tested and passed QA. With all 14-scintillator groups ready, assembly of module 3 is on track for completion by the middle of July.
- ISU has a contract with a vendor for fabricating the CDet frame. The delivery to JLab is expected by Oct 2015.

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

- The engineering design for the beam-line corrector magnet stands was completed in June and detailed design drawing began. Expect to have beam line support drawings ready for procurement by the 2nd week of August. Beamline lead shielding assembly hardware drawings ready for procurement by 3rd week of August.
- For the SBS detector support, we will have the GEM frames and holders ready for procurement by 1st week of August.

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 7/1/2016: \$1,191K (87.5%).

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

Level	Milestone	Scheduled Date	Expected date 7/1/2016	Expected date 8/1/2016	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	7/15/2016	7/15/2016	
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

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 June 8, 15 and 29th. 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

- The construction of modules #33 and #34 was completed.
- One readout board was received from CERN in June and it was used for module #34.
- The foils and frame for module #35 have been prepared.
- UVa has shipped 15 GEM foils that did not pass initial QA tests back to CERN to be replaced or repaired. UVa is talking with CERN about getting the readout foil production back to 2 per month.

WBS 3.2 GEM electronics

- APV front-ends: All boards are in EES and 500 boards sent for bonding. Bonding company completed 216 boards and testing by ESS will start on July 5th. Remaining boards will be sent next on July 8th and bonding company will deliver 150 boards/week. The order is for 900 total front end cards.
- All 57 MPD modules were delivered to UVa. The MPD modules were tested at the manufacturer as part of the contract. UVa do further testing of the modules in July.
- Backplanes 5 slots: All 73 backplanes were delivered to UVa.
- Backplanes 12 slots: Presently, the backplanes are in assembly for SMD and by July 11th they will be ready for through hole assembly and checking.

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 7/1/2016: \$1,668K (95.6%).

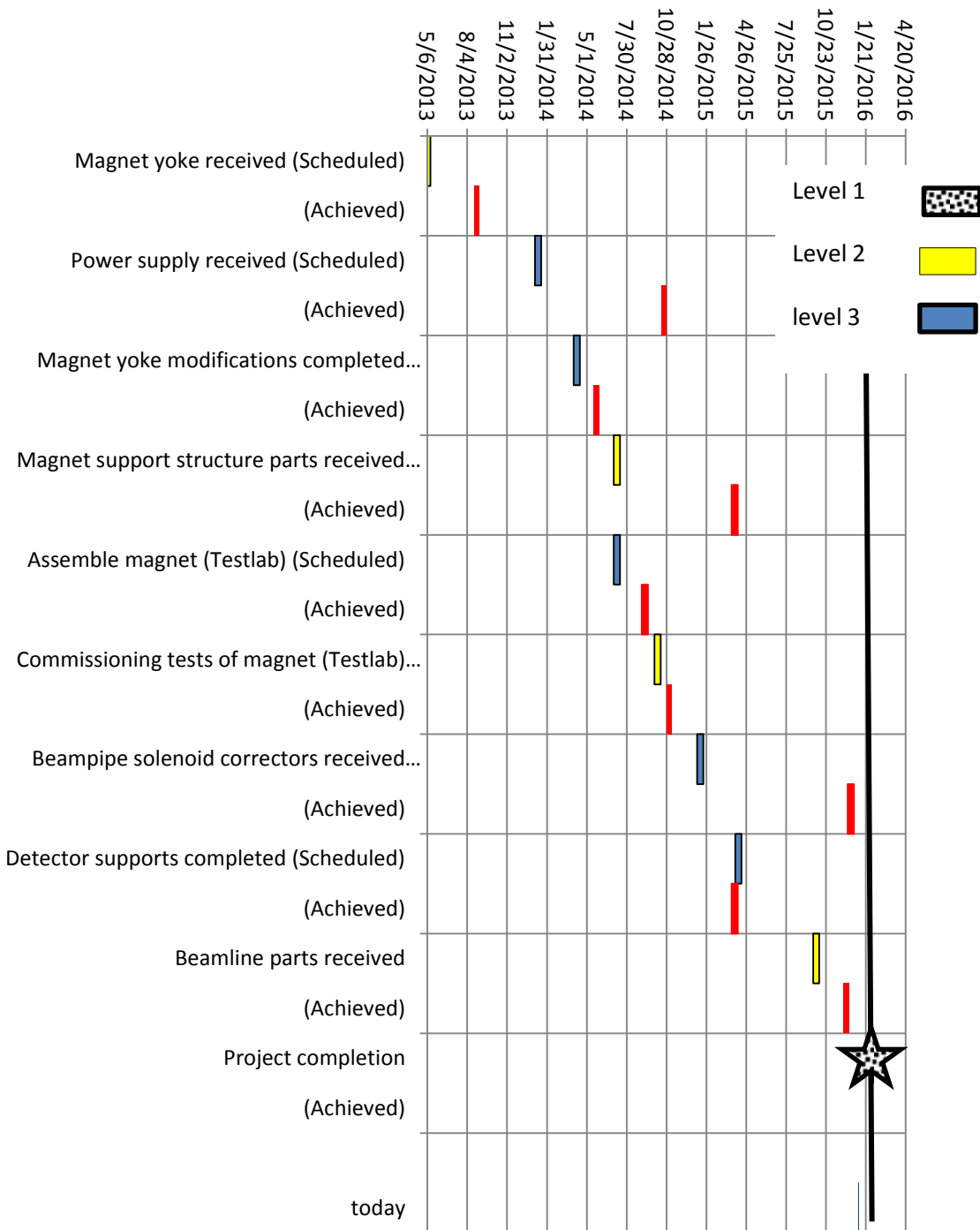
WBS 3.01 Milestones: (see [Appendix 1](#) for a graphic view of the milestones)

Level (ID#)	Milestone	Scheduled Date	Expected date 7/1/2016	Expected date 8/1/2016	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	9/15/2016	9/15/2016	
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	

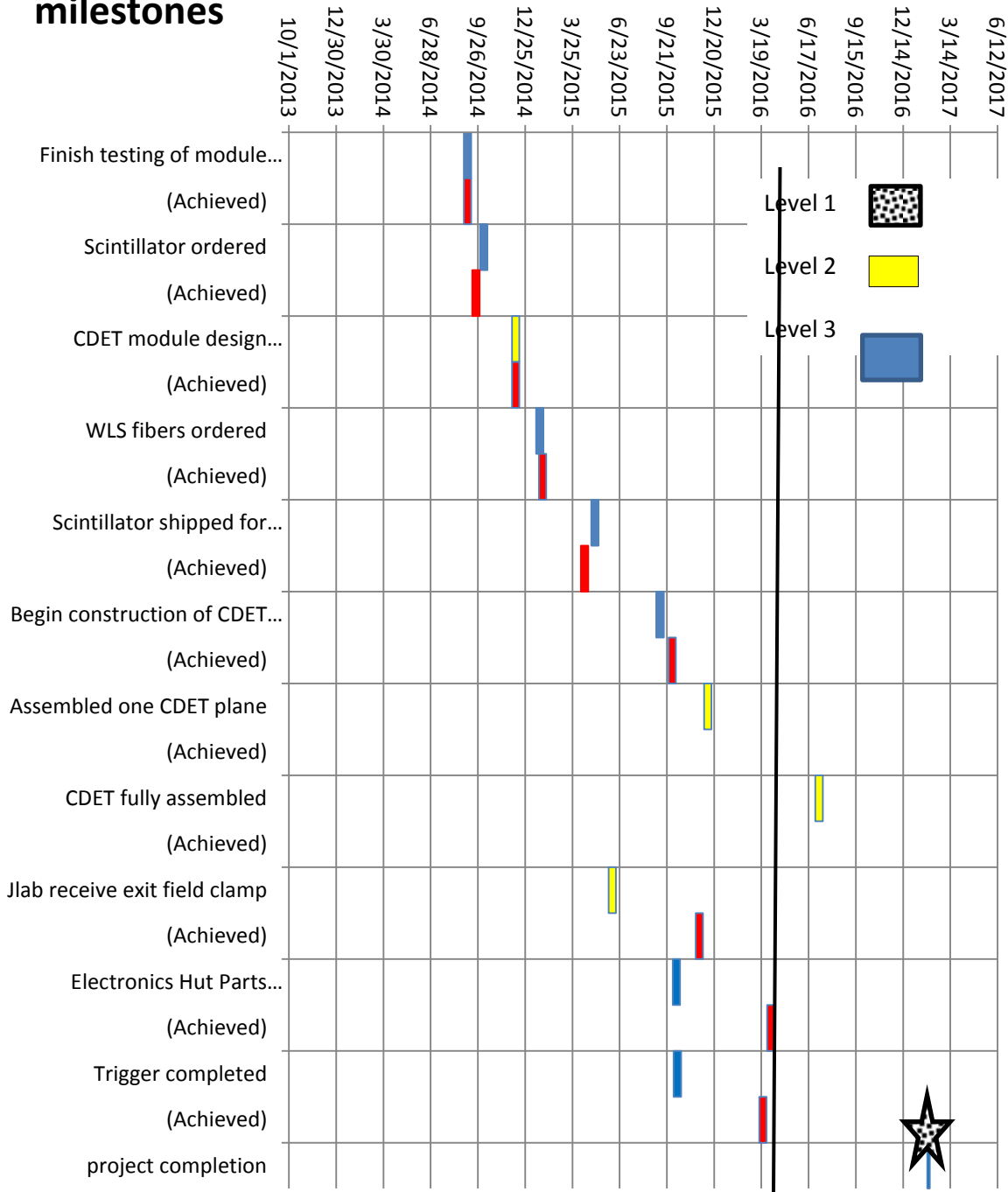
Appendix I

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).

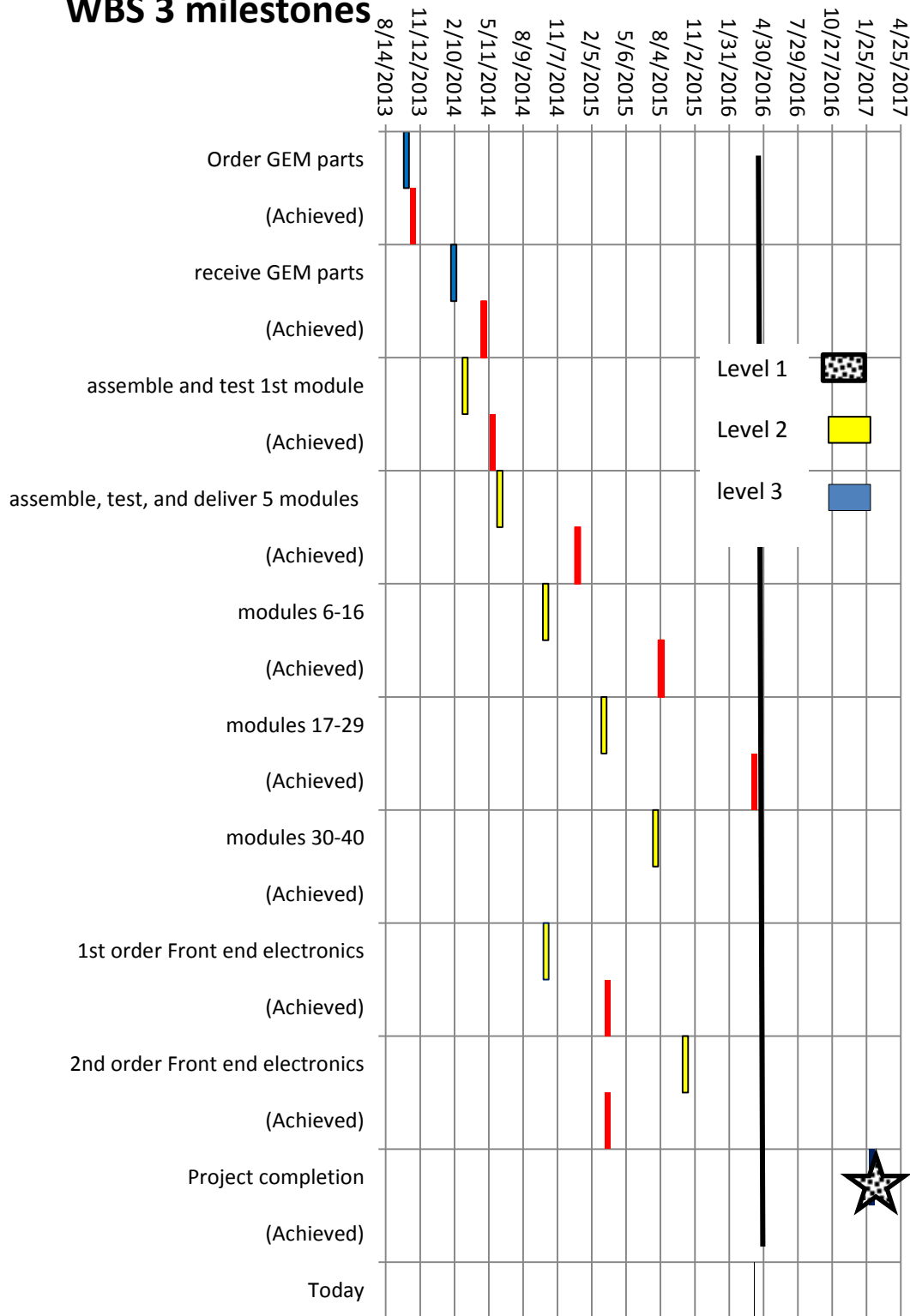
WBS 1 Milestones



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 Aug 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 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	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	

Status update:

- Module production is ongoing. Have produced 171 modules (169 modules at JLab) of the total of 288 modules in HCal.
- CMU has assembled light guides for 66 more modules. In addition, endplates for 66 modules have been drilled, tapped and painted. Work is ongoing for the plastic shims. Mechanical work on the components for the LED pulser system will be done in July.

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 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	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 Aug 2016
C200 assembly completed and testing begins	Jan 15 2016	Completed Jan 2016
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:

- At Stonybrook, the test of one 9-block supermodule in the oven started at the end of June. The first heat cycle test was successful and they are doing more thermal cycle tests. The left photo in Figure 1 shows at top view of the supermodule before being placed in the oven. The right photo in Figure 1 shows a rear view of the supermodule after all nine PMTs have been attached and it is placed in the oven. In Figure 2, the temperature profile as a function of time is plotted for different locations in the supermodule. The initial test was just to heat up and cooldown the supermodule and no attempt was made to achieve a steady state temperatures. The PMT and light guides stayed attached during the heating and cooling. This is a validation of the concept of supermodule. The concept is to minimize stress due to different thermal expansion coefficients by have the PMTs attached in smaller groups. This concept can be scaled to the full

scale version. More tests need to be done with larger number of supermodules, but the outlook is promising. The parts for an additional ten 9-block supermodules will be completed by July 15th so the larger scale testing can be done.

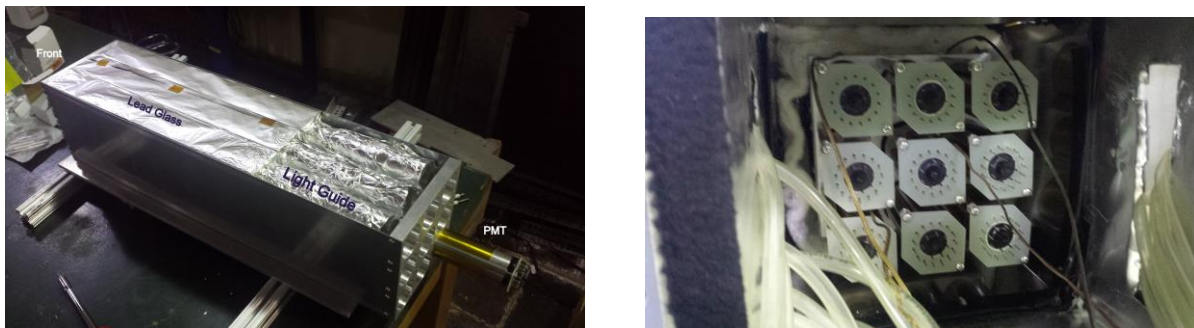


Figure 1 The left picture shows the 9-block supermodule with one PMT attached. The right photo shows a rear view of the supermodule

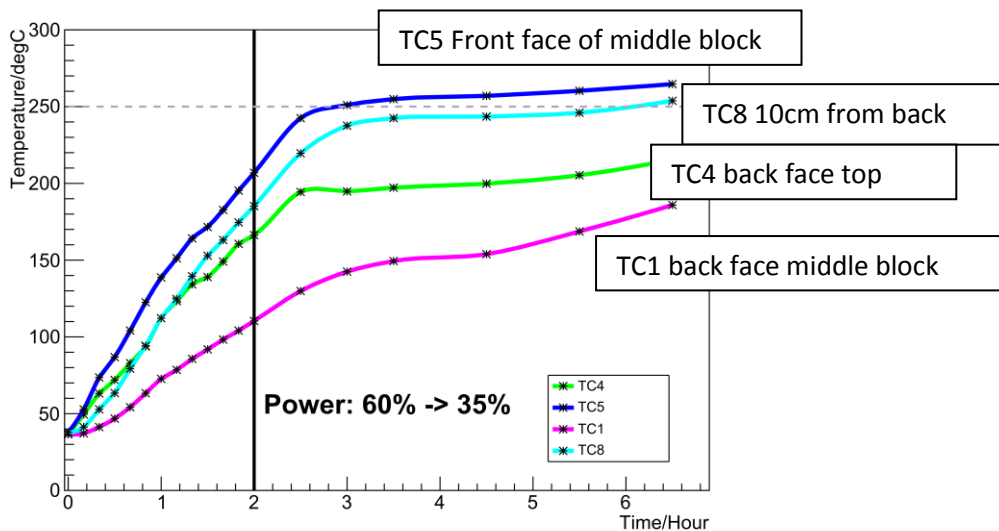


Figure 2 The temperature profile from thermocouples (TC) during the test with one 9-block supermodule. TC5 (TC1) is the thermocouple at the front (back) face of the middle block. TC8 is 10cm from the back face of the middle block. TC4 is at the back face of the top block. After two hours the power to the heater was reduced from 60% to 35%.

- The report which compares the three options for ECal has been completed. To have time to include the latest results from the C200 test in the report, it was decided to send the report to

three SBS annual review committee members on July 15th. The final report that describes the technical design, the schedule, and the financial path forward will be completed by August 15th.

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	Expect start in July 2016
Conceptual design frozen	June 2016	Expect by Aug 1 st
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 milestone “Test of glass/metal technology complete” was completed on July 8th. The UVa has concluded a successful test of a cell made of aluminosilicate glass.
- The Conceptual Design report will be ready by August 1st. Engineering work on the target is ongoing with the close cooperation between the UVa scientists and Hall A engineer and design group.