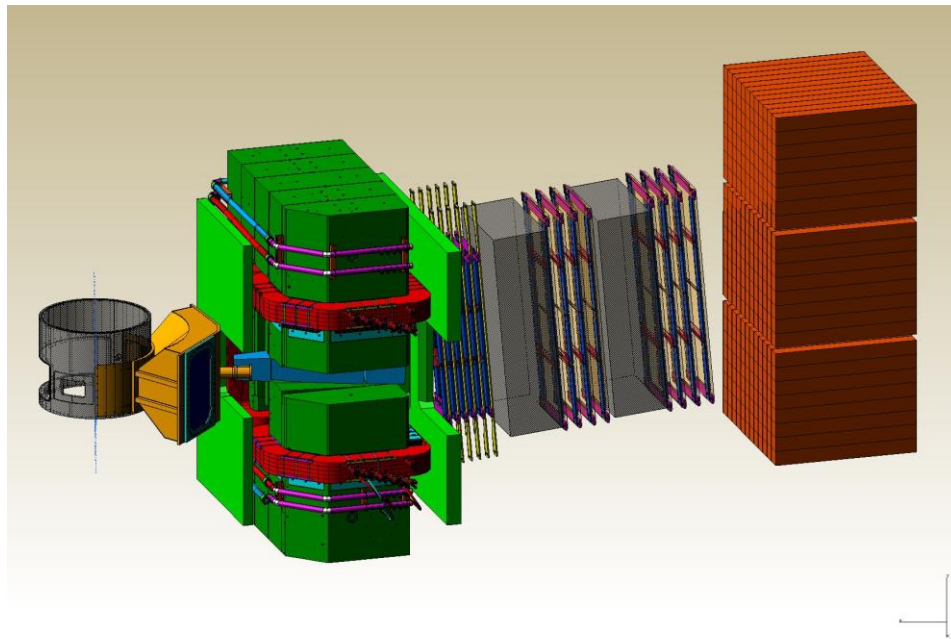


Super-Bigbite-Spectrometer (SBS)

Monthly Progress Report

March 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 30th 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.

- In response to first recommendation of the DOE 2014 Review, an updated PMP was submitted in Jan 15, 2015 monthly report. The updated table with the WBS2 schedule with level 3 milestones is being used. It won't be official until DOE approval. Appendix III has a discussion of the DAQ electronics needed for CDET and other detectors to address the question about the effects of the financial constraints on the DAQ.

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

WBS 1.02 Project Oversight:

- SBS weekly meetings, via tele and video conference were held on February 4th, 11th, 18th and 25th. 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 pole shims have been integrated into the planned work for the modification of SBS magnet which will be sent to procurement in beginning of March. During March, Hall A technicians will dismantle the SBS magnet for shipment to vendor.
- Coils:
 - Racetrack coils: All coils are at JLab.
 - Saddle coil: Buckley has all materials on-hand and is fabricating the tooling for winding the coils. Scheduled for delivery by July 31, 2015.
- Detailed design work on the corrector magnets and exit beam pipe has begun. Studies have led to a reduction in the number of components needed in the passive magnet shielding of exit beam pipe.
- Power supply has been prepared for the power test with a test load. Initial tests of resistance have been completed. The power test will take place in March.

WBS 1.2 Magnet/Detector Platforms:

- JLab contacted the vendor. The vendor was welding the last piece at the end of February with inspection scheduled for the March 5th. Following inspection, the platform and counter weight will be painted with delivery at the end of March.

WBS 1.3 Beam Line:

- The vendor received an extension until March 19th for delivery of the vacuum snout.

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 3/1/2015: \$1167K (69%).

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

Level (ID#)	Milestone	Scheduled Date	Expected Date 2/1/2015	Expected Date 3/1/2015	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	2/27/2015	3/31/2015	Short delay has no impact on project schedule
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	6/1/2015	6/1/2015	This delay has no effect on other parts of the project and still leaves 7 months of float until project completion.
3	Detector supports completed	4/1/2015	2/27/2015	3/31/2015	Detector supports are part of the magnet platform which will be delivered in Mar 2015
2 (1.2-30M)	Beam-line parts received	9/24/2015	9/24/2015	9/24/2015	
1 (1.1-10M)	Project completion	1/29/2016	1/29/2016	1/29/2016	

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 February 4th, 11th, 18th and 25th. 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):

- Sample bars were machined by Eljen and returned to JLab. Quality of machining met the specifications. ISU will make a contract with Eljen for machining of bars.
- Sample bars have been sent to Carnegie Mellon for cutting into final size for further tests.
- Delivery of WLS fiber is expected by end of March.
- Due to weather, production of the scintillator bars was delayed and is scheduled to start March 11th at Fermilab.

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

- INFN has developed a solution for the noise in the HDMI cables used for the GEMs. INFN has ordered a prototype amplifier board and it will be shipped to Jlab by April for a test. A early estimate of the cost of implementing this solution for the rear tracker GEMs is \$20,000 or about 5% of the total electronics contract.
- Plan to start design work on the detector frames in March 2015.

WBS 2.3 Pole Shims and field clamp:

- The pole shim work will be integrated into the procurement for the modification of the SBS magnet.

WBS 2.4 Trigger:

- 2 VXS crates and two CPUS for the trigger electronics were put into procurement.

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 3/1/2015: \$736K (56%).

WBS 2.01 Milestones: See [Appendix 1](#) for a graphic view of the milestones . These are the updated milestones as requested by the DOE Nov 2014 Review. Waiting for final DOE approval.

Level	Milestone	Scheduled Date	Expected date 2/1/2015	Expected date 3/1/2015	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	4/30/2015	4/30/2015	
2	JLab receives exit field clamp	6/2/2015	6/2/2015	6/2/2015	
3	Begin preparation of WLS fibers	6/15/2015	6/15/2015	6/15/2015	
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	10/2/2015	10/2/2015	
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

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 February 4th, 11th, 18th and 25th. 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 at this stage, and includes Jefferson Lab (manager, scientist) and UVa (two scientists).

WBS 3.1 GEMs

- It was discovered that the higher than acceptable over pressure inside the modules at high flow rates was due to the fact that all output gas connectors were connected serially into a single output tube (of 3 mm inner diameter). Arranging the output from each module into two 6 mm tubes reduced the pressure inside the chambers to an acceptable level. Operating the modules at this reduced over-pressure eliminated the need for support struts attached to the two sides of the module to prevent the sides from bending. All chambers which previously required side supports (modules 4, 5 and 6) were re-tested with those supports removed and gas output organized as above; all three modules found to be fully operational in this configuration.
- GEM Module #7 was tested with cosmics: all sectors fully operational.
- GEM Module #8 construction was completed. It is currently under gas flow being prepared for HV testing.
- GEM Module #9 construction is underway.
- Advance preparation work of sanding, varnishing and washing frames has been done while investigation into the HV problems. With the HV issue resolved, this advance preparation will allow the module assembly to proceed at a faster pace.

- The next shipment of 13 GEM foils, 4 drift foils, 3 honey-comb and 3 readouts planes is scheduled to arrive in the 2nd week of March. Presently, material for building 9 GEM modules is on hand at UVA.
- A gas system was setup to flow dry N₂ gas through the modules in storage to keep these modules dry and clean till they are installed in the SBS detector stack. The completed modules currently in storage were connected to this gas supply.
- Data collection and analysis with the x-ray tube setup continues.

WBS 3.2 GEM electronics

- The contract for GEM electronics with UVA was sent to UVA for signatures at the end of February.

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 2/1/2015: \$1424K (84%).

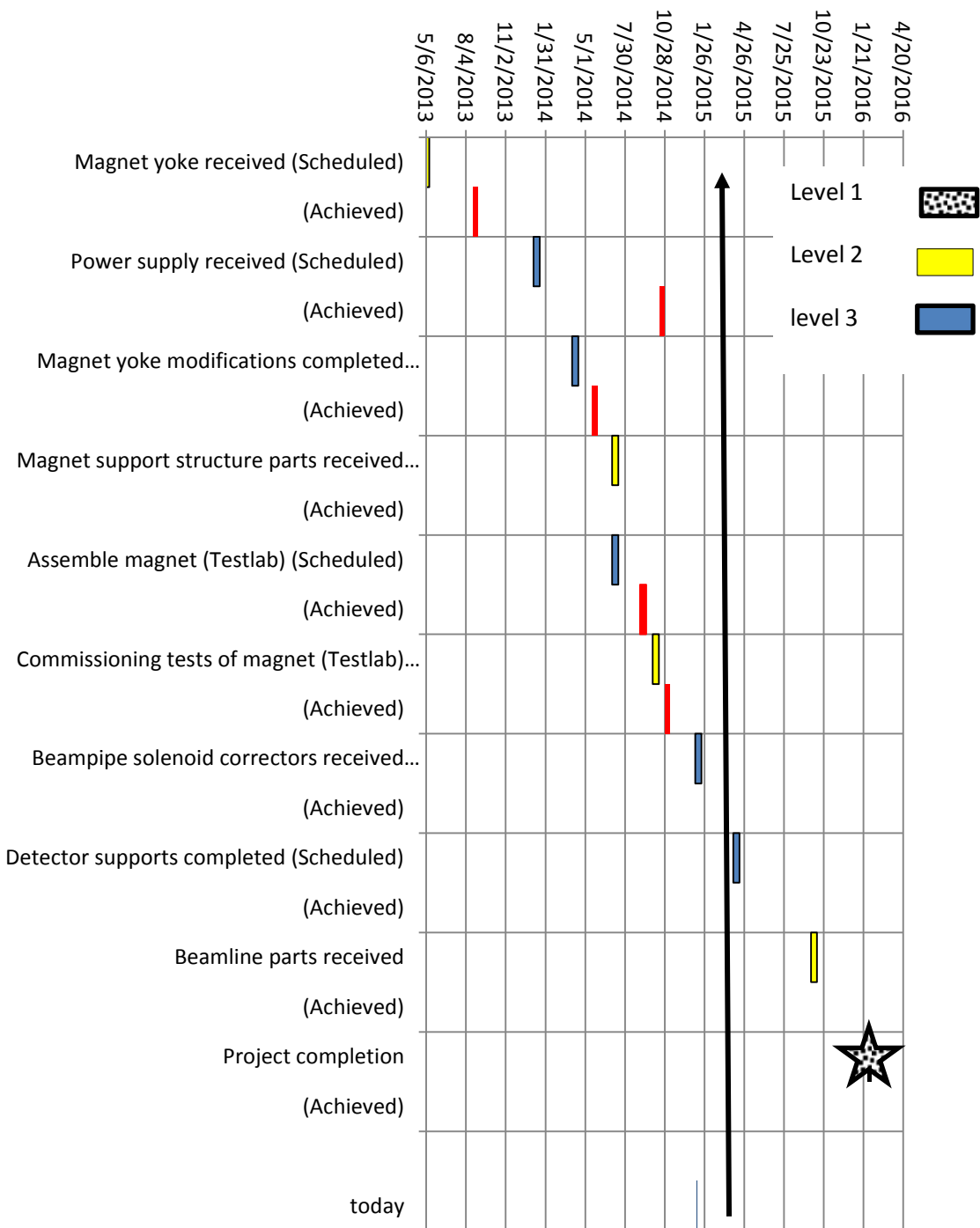
WBS 3.01 Milestones: (see [Appendix 1](#) for a graphic view of the milestones)

Level (ID#)	Milestone	Scheduled Date	Expected date 2/1/2015	Expected date 3/1/2015	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	6/15/2015	6/15/2015	The 2 months delay for diagnosis and fix of HV problem has been integrated into schedule. Leaves 13 months of float.
2 (3.2-30M)	UVa 17-29 GEM modules assembled and tested	3/2/2015	1/1/2016	1/1/2016	
2 (3.2-40M)	UVa 30-40 GEM modules assembled and tested	7/15/2015	6/15/2016	6/15/2016	
2 (3.2-50M)	1st order of Front End Electronics	10/1/2014	2/1/2015	3/15/2015	In final stages of contract with UVa
2 (3.2-60M)	2nd order of Front End Electronics	10/1/2015	10/1/2015	3/15/2015	
1 (3.1-10M)	Project completion	7/31/2017	7/31/2017	7/31/2017	

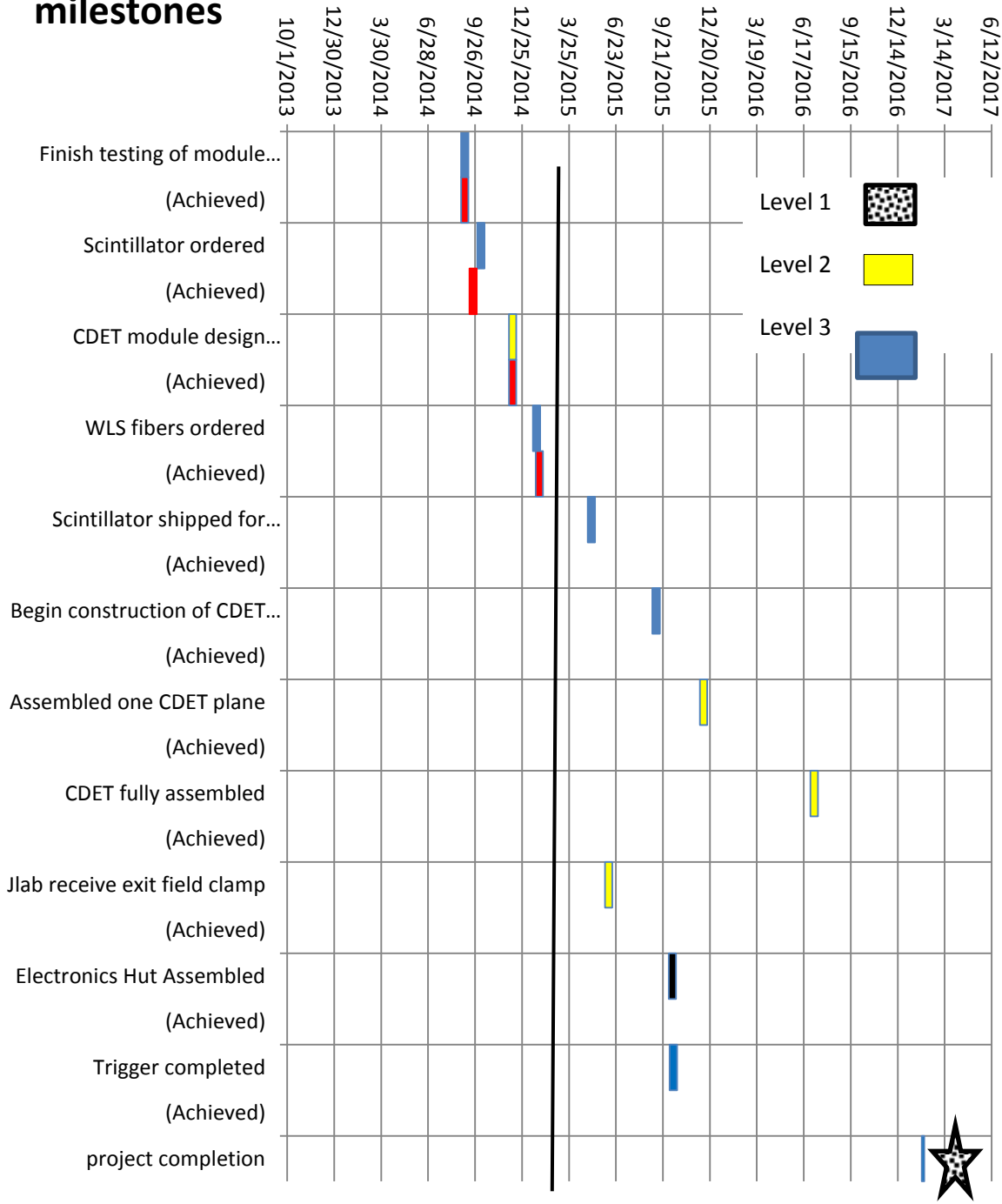
Appendix I

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).

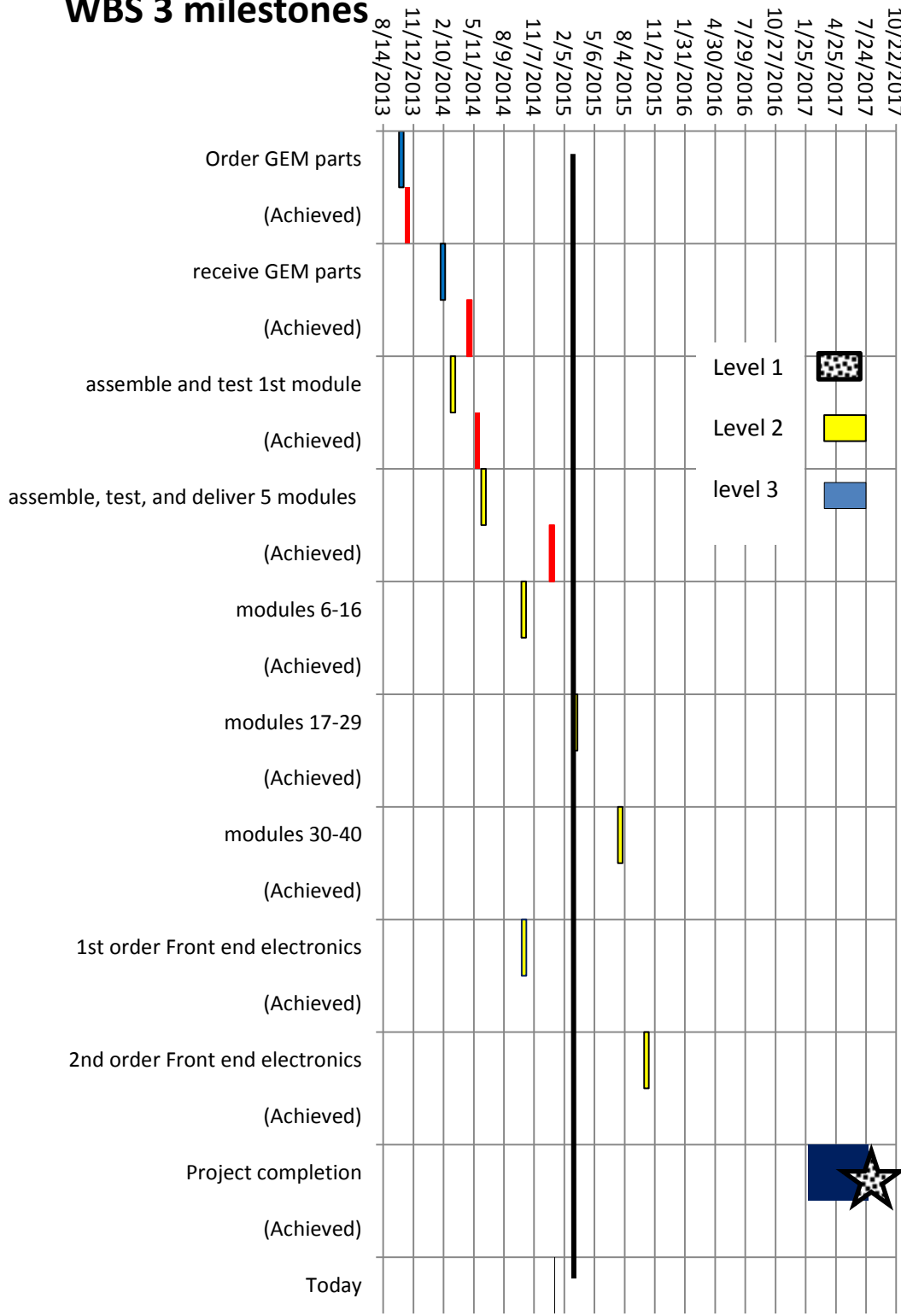
WBS 1 Milestones



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	Completion date	Comment
Design and drawings for vessel are complete	Feb 1, 2015	Completed Feb 2014
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:

- Final prototype of NINO chip front end card has been passed tests and been accepted.
- The plastic light-catchers for the Photon Detector Array have been produced and have been sent to vendor to be mirrored.

HCal-J from CMU (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	
Module assembly 25% complete	Sept 2015	
Module assembly 50% complete	Mar 2016	
Module assembly completed	Sept 2016	

Status update:

- The first module with the final design was tested with cosmic rays and the time resolution was found to be 265ps which is more than a factor of 2 improvement with the new light guide compared to results presented at the Nov 2014 review.
- The vendor that is producing the cans and ribs has done a preliminary production run of 6 cans and ribs which will be inspected before full production. The vendor expects to produce 100 cans per week.
- Once some cans have been produced assembly of the modules will begin, since all other components are on hand. Need to assemble 16 modules per month to meet completion date.

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	
Initial Electronics QA completed	Dec 2015	
GEM chambers 3 and 4 completed	May 2016	
GEM chambers 5 and 6 completed	Dec 2016	

Status update:

- Eight GEM modules have been assembled. From November 2014 to Feb 2015, these modules were being retrofitted with a gas pressure compensation backplane. This work has been completed on six modules (Reminder that for the Front Tracker that 3 GEM modules per chamber). Two modules have gas leaks which are being investigated. Assembling of new GEM modules will restart in March.
- A beam test was done at COSY with a proton beam in Dec 2014. Beam was taking with different gas flow rates in GEM modules. Analysis of data is underway.

ECal from JLab (for GEP)

Milestone	Completion date	Comment
Develop concept of annealing	July 2014	Completed July 2014
Design review	Nov 2015	
Electronics are ready	Nov 2016	
ECAL is ready	July 2017	

Status update:

- A 16 module prototype with heating elements for annealing has been assembled for parasitic test in Hall.

Polarized ³He target from UVa (for GEN)

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

Appendix III

In response to the first recommendation in the DOE 2014 review, an updated PMP with a new schedule for WBS2 was sent with the January 15th, 2015 SBS monthly report. The recommendation states:

“The schedule for WBS should be updated to reflect the realities as presented, namely the change in CDET to a scintillator based detector and the effects of the financial constraints on the DAQ (need to use FASTBUS instead of FADC)”.

Financial constraints combined with the availability of FASTBUS DAQ components at JLab did lead to the decision to have a SBS DAQ which is a mesh between FASTBUS and VME pipeline electronics. The DAQ hardware that is being purchased in WBS2 is for the trigger in the proton form factor, GEp, experiment. The side benefit is that it can also be used for the neutron form factor experiments. Pipelined electronics are necessary for the trigger and readout at the high singles rates of the GEp experiment. The DAQ electronics developed by JLab for Hall-D meets these requirements. The DAQ electronics that are necessary for the trigger have been included in the WBS2 budget and no change in the budget is expected. Purchases of the FADC250, VXS crates and CPUs have already been initiated. The CDET is using FASTBUS TDCs for data readout. The necessary number of Fastbus crates and the TDCs were available from JLab or salvaged from other labs and all have been arranged in crates in the TestLab and tested. The WBS2 budget for the CDET included funds for the CPUs and Trigger Interface modules needed for the Fastbus crates.

WBS3 included funds for the DAQ electronics for the rear GEMs and just recently the contract for the electronics as been sent to UVA for signatures. For the front GEMs, the Italians have already purchased their electronics. In the neutron experiments, the standard preshower/shower and scintillator Fastbus for BigBite spectrometer will be used with their existing Fastbus electronics. For the GRINCH, the Fastbus crate and 6 TDCs that are needed have been identified. For ECAL, the Fastbus crates have been assembled in the TestLab and tested. All the 1881M ADCs need for ECAL have been separately tested and are being installed in the Fastbus crates in the TestLab. A table of the associated electronics for the detectors is given on the next page.

Project Detectors	Channels	Readout	Type	Comment
CDET	2,688	1877s TDC	Fastbus	Existing
Trigger		SSP, GTP, VETROC	VME	WBS2
HCAL electronics	288	FADC250	VME	WBS2, purchased
Rear GEM tracker	61,440	APV25 MPD	VME	WBS3, contracted
Dependency Detectors	Channels	Readout	Type	Comment
ECAL	2,000	1881M ADC	Fastbus	Existing
ECAL sums	204	1877s TDC	Fastbus	Existing
GRINCH	510	1877s TDC	Fastbus	Existing
Front GEM tracker	41,472	APV25 MPD	VME	INFN

Table of detectors and their associated electronics.