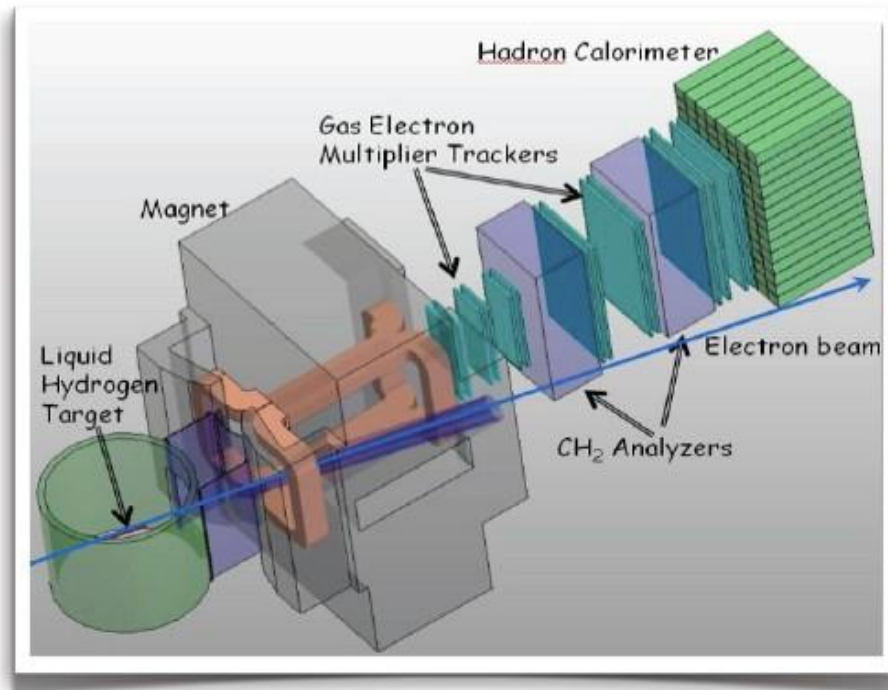


# ***Super-BigBite-Spectrometer (SBS)***

## **Monthly Progress Report**

**March 15, 2014**



## 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 Twenty-nine GEM detector modules with associated front-end and DAQ modules 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 thirty-five GEM detector modules with associated front-end and DAQ modules and the addition of pole shims for increased magnetic field integral to meet the requirements of the approved proton form factor measurements.

## Project Management Highlights:

This is the 18<sup>th</sup> Monthly Progress Report for the SBS Program.

The first and second Projects within the SBS Program, SBS Basic (WBS 1) and Neutron Form Factor (WBS 2), started at the beginning of FY13. The third project SBS Proton Form Factor (WBS 3) started on October 1, 2013.

Updates on HCAL-J and INFN Front Tracker off-project equipment are in Appendix 2.

A slightly modified version of the updated Research Management Plan is in Appendix 3.

The report on the readout electronics pre-R&D is attached in Appendix 4.

**The milestones presented for WBS 2 and 3 are still for the current PMP, until the updated PMP is approved. Milestones for WBS 1 are unchanged.**

## 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 1.01 Milestones:** (see [Appendix 1](#) for an alternate view of the milestones, including level 3 milestones)

<b>Id #</b>	<b>Level</b>	<b>Milestone</b>	<b>Scheduled Date</b>	<b>Expected Date 2/1/2014</b>	<b>Expected Date 3/1/2014</b>	<b>Actual Date</b>
1.1-01M	1	Project start	10/1/2012			<b>10/1/2012</b>
1.2-01M	2	Magnet delivered to JLab	4/30/2013			<b>8/21/2013</b>
1.2-10M	2	Platform parts received	6/27/2014	6/27/2014	9/1/2014	
1.2-20M	2	Magnet assembled on platform	3/19/2015	3/19/2015	3/19/2015	
1.2-30M	2	Beam-line parts received	9/24/2015	9/24/2015	9/24/2015	
1.1-10M	1	Project completion	1/29/2016	1/29/2016	1/29/2016	

### **WBS 1.02 Project Oversight:**

- SBS weekly meetings, via tele and video conference were held on Feb 5 , 12, 19 and 26<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:**

- Magnet Yoke Modifications:
  - Yoke pieces were picked up for machining on February 4<sup>th</sup>. Machining started March 3<sup>rd</sup> and is expected to be completed by April 2014.
- Coils:
  - Racetrack coils: Vendor received conductor material and delivery by May 2014. Two months before the level 3 milestone to assemble magnet in Testlab ( see Appendix 1)
  - Saddle coil: Have budgetary estimate from vendor. Ready for formal bids, but waiting to submit until we have a full beam line design and confirmation of budget estimates.
- The magnet assembly drawings and hardware, detailing water cooling system are 90% complete.

## **WBS 1.2 Magnet/Detector Platforms:**

- Internal support structure review is done.
- Incorporated recommendations and finalized drawings. Ready for bid by end of March.
- Changed expected date of “Platform parts received” to 9/1/2014. This item has a large float, since it is needed only for installation in the hall. The test of the magnet in the TestLab does not require the platform.

## **WBS 1.3 Beam Line:**

- Finalized the full SBS, BigBite and beamline magnet model for GEp.
- Design of the full beam line has started.

## **WBS 1 Costs:**

- The budget for this WBS for FY14 is \$643K. The incremental budget (FY13+FY14) is \$1,481K
- Costed and obligated as of 3/1/2014: \$645K (44%).

## 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>	GEMs (UVa)
		<b>WBS 2.2</b>	GEM Electronics (UVa)
		<b>WBS 2.3</b>	Electronics Hut, Lead Shielding, Lead platform, and Detector Frames
		<b>WBS 2.4</b>	Coordinate Detector

### WBS 2.01 Milestones:

Note that in the updated PMP, the GEM milestones move to WBS 3 and the present PMP milestone 2.2-20M which has the schedule date of 8/20/2014 moves to 10/1/2014.

ID #	Level	Milestone	Scheduled Date	Expected date 2/1/2014	Expected date 3/1/2014	Actual Date
2.1-01M	1	Project start	10/1/2012			<b>10/1/2012</b>
2.3-1	3	Order GEM Parts	9/1/2013			<b>10/18/2013</b>
2.2-01M	2	UVa receives GEM parts	2/3/2014	4/1/2014	4/1/2014	
2.3-2	3	First module assembled and tested	3/3/2014	5/1/2014	5/1/2014	
2.2-20M	2	UVa receives electronics parts	8/20/2014	8/20/2014	8/20/2014	
2.2-10MA	3	UVa 5 GEM modules assembled and tested	6/2/2014	7/2/2014	7/2/2014	

2.2-10MB	3	UVa 15 GEM modules assembled and tested	9/30/2014	9/30/2014	9/30/2014	
2.2-10MC	2	UVa 29 GEM modules assembled and tested	10/17/2014	3/9/2015	3/9/2015	
2.2-40M	2	Coordinate Detector Assembled	11/17/2014	11/17/2014	11/17/2014	
2.2-30M	2	UVa front-end electronics assembled and tested	2/22/2015	2/22/2015	2/22/2015	
2.2-40M10	2	WBS 2.3 completed (Electronics Hut Assembled etc.)	10/5/2015	10/5/2015	10/5/2015	
2.1-10M	1	Project completion	1/29/2016	1/29/2016	1/29/2016	

## **WBS 2.02 Project Oversight:**

- SBS weekly meetings, via tele and video conference were held on Feb 5 , 12, 19 and 26<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), UVa (two scientists), and Idaho State University (one scientist).

## **WBS 2.1 GEMs (UVA):**

**GEMs:** The GEM drawings were finalized. The order for frames was placed and they are expected to arrive by April 1<sup>st</sup> 2014. This date is consistent with the milestone 2.2-01M. Confirmation that the first GEM foils will arrive by April 1<sup>st</sup> 2014 was emailed from CERN. The post-doctoral associate has started working at UVa. Everything is in place to begin production of GEMs once the foils and frames arrive. Testing of prototype GEM chambers continues.

## **WBS 2.2 GEM Electronics (UVa):**

**Readout Electronics pre-R&D:** UVa completed the Readout Electronics pre-R&D report which is attached in Appendix 4. The report concludes that the CERN SRS DAQ system can handle the expected trigger rates for the GEP experiment with the planned upgrade of the SRS DAQ system, but R&D is needed to improve the radiation hardness of one chip in the DAQ system for the system to operate at the expected luminosities of the GEP experiment. At our request, UVa is preparing a report comparing the CERN SRS DAQ system to the DAQ system developed by the INFN group for their GEM detectors.

## **WBS 2.3 Electronics Hut, Lead Shielding & platform, and Detector Frames:**

- No activity this period.

## **WBS 2.4 Coordinate Detector:**

- Internal review held Feb 25<sup>th</sup> and draft review report was produced. Brad Sawatzky (Hall C) was chair of the committee. The other members of the committee were: Stepan Stepanyan (Hall B), who has extensive experience with the extruded scintillator which was used in the CLAS upgrade, and Carl Zorn (Detector Group), who is an expert in multi-anode PMTs. The report concludes that coordinate detector should meet its design goals of 1.8 mm position resolution and 0.8 ns timing resolution. The report did have concerns about the estimation of background rates and the effect on the performance. The Coordinate Detector group, headed by Mahbub Khandaker at Idaho State University, is formulating a response to the draft report with ideas for mitigating their concerns.

## **WBS 2 Costs:**

- Budget for this WBS for FY14 is \$1,137K. The incremental budget (FY13+FY14) is \$1,218K
- Costed and obligated as of 3/1/2014: \$620K (51%).

## 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>	Magnet Pole shims and exit field clamp
		<b>WBS 3.2</b>	GEM's (UVa)
		<b>WBS 3.3</b>	GEM electronics (UVa)
		<b>WBS 3.4</b>	Trigger (RU)

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

ID #	Level	Milestone	Scheduled Date	Expected date 2/1/2014	Expected date 3/1/2014	Actual Date
3.1-01M	1	Project start	10/1/2013	10/1/2013		<b>10/1/2013</b>
3.2-01M	2	UVa receives parts for GEM modules	8/20/2014	8/20/2014	8/20/2014	
3.2-10M	2	UVa begins assembly of electronics	1/5/2015	1/5/2015	1/5/2015	
3.2-50M	2	RU begins trigger design	1/6/2016	1/6/2016	1/6/2016	
3.2-20M	2	UVa electronics assembly and tests completed	7/20/2016	7/20/2016	7/20/2016	
3.2-30M	2	JLab receives pole shims	8/22/2016	8/22/2016	8/22/2016	
3.2-40M	2	JLab receives exit field clamp	8/22/2016	8/22/2016	8/22/2016	
3.2-70M	2	RU completes trigger	12/1/2016	12/1/2016	12/1/2016	
3.2-60M	2	UVa GEM modules assembled (and tested)	2/2/2017	2/2/2017	2/2/2017	
3.1-10M	1	Project completion	7/31/2017	7/31/2017	7/31/2017	



### **WBS 3.02 Project Oversight:**

- SBS weekly meetings, via tele and video conference were held on Feb 5 , 12, 19 and 26<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 beginning stage, and includes Jefferson Lab (manager, scientist), UVa (two scientists).

### **WBS 3.1 Magnet Pole shims and exit field clamp**

- No activity this month

### **WBS 3.2 GEM's**

- In the updated PMP, GEM milestones and activities listed as part of WBS 2.1 will move here and include the building final 10 GEM modules that were in the current PMP for WBS 3.2. Preparations of the contract with UVa for the final 11 modules have begun.

### **WBS 3.3 GEM electronics**

- In the updated PMP, GEM milestones and activities listed as part of WBS 2.2 will move here.

### **WBS 3.4 Trigger**

- No activity this month

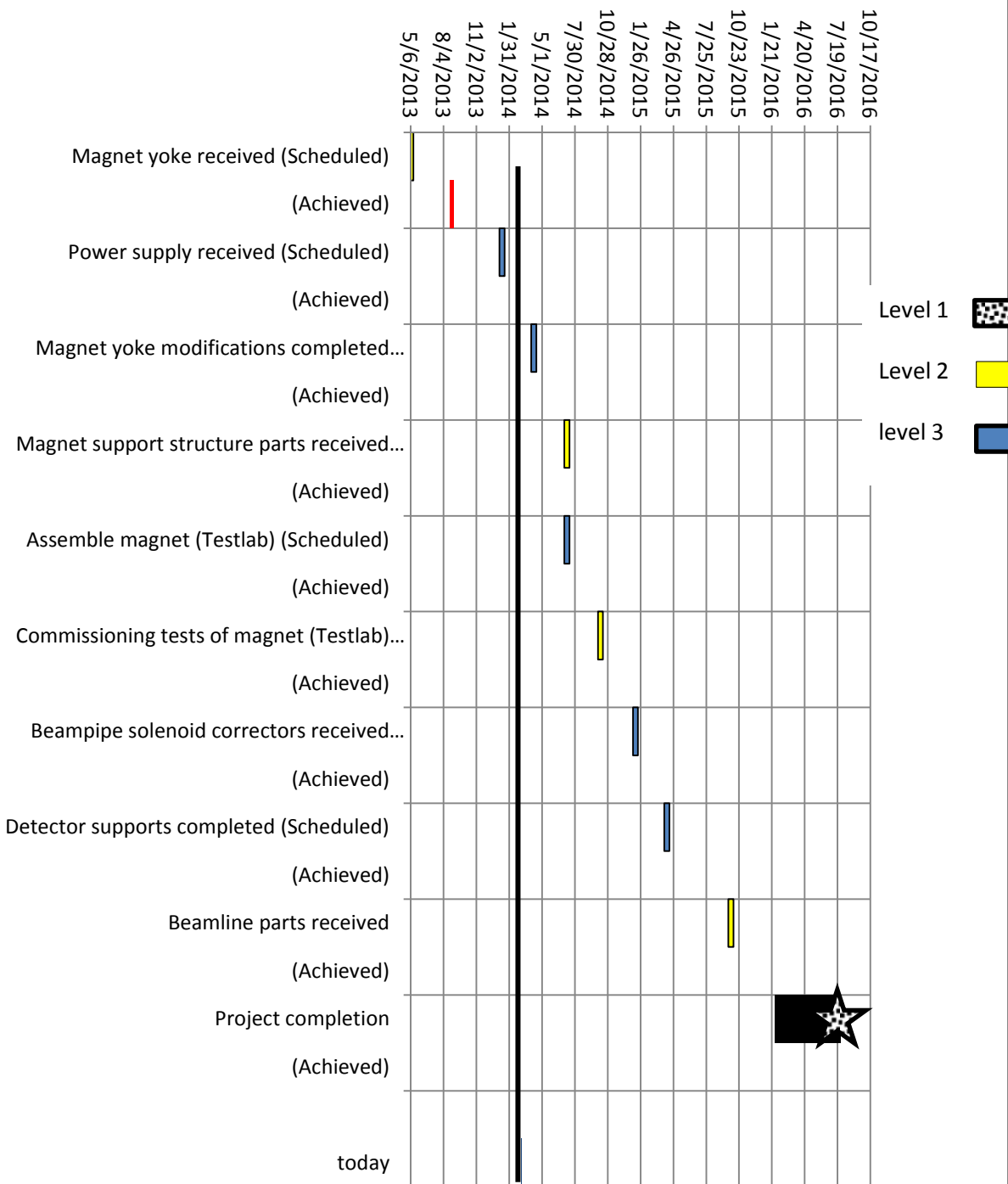
### **WBS 3 Costs:**

- Budget for this WBS for FY14 is \$321K.
- Costed and obligated as of 3/1/2014: \$6.8K (2%)

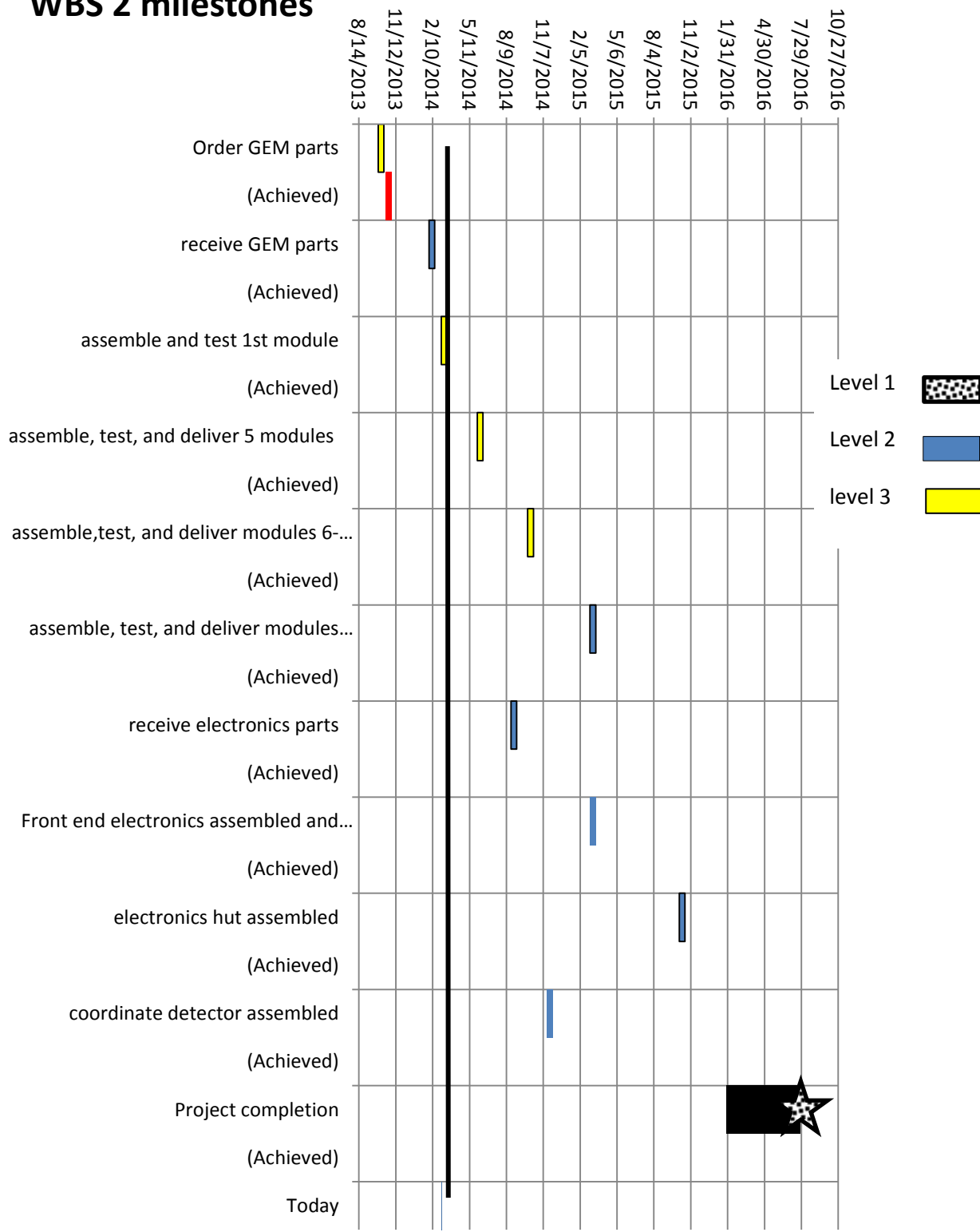
## Appendix I

The following are graphical representations of the milestones for SBS Basic (WBS 1), Neutron Form Factor (WBS 2,) and Proton Form Factor (WBS 2), 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). The milestones are presented in tabular form after the graphic representations.

## WBS 1 Milestones



## WBS 2 milestones



## WBS 3 milestones



<b>WBS 1 Milestone</b>	<b>date</b>
Magnet yoke received (Scheduled)	4/29/2013
(Achieved)	<b>8/21/2013</b>
Power supply received (Scheduled)	1/4/2014
(Achieved)	
Magnet yoke modifications completed (Scheduled)	4/1/2014
(Achieved)	
Platform parts received	6/27/2014
(Achieved)	
Assemble magnet (Testlab) (Scheduled)	7/1/2014
(Achieved)	
Commissioning tests of magnet (Testlab) completed (Scheduled)	10/1/2014
(Achieved)	
Beampipe solenoid correctors received (Scheduled)	1/5/2015
(Achieved)	
Detector supports completed (Scheduled)	4/1/2015
(Achieved)	
Beamline parts received	9/24/2015
(Achieved)	
Project completion	1/29/2016
(Achieved)	

<b>WBS 2 Milestone</b>	<b>date</b>
Order GEM parts	9/30/2013
(Achieved)	<b>10/18/2013</b>
receive GEM parts	2/1/2014
(Achieved)	
assemble and test 1st module	3/3/2014
(Achieved)	
assemble, test, and deliver 5 modules	5/30/2014
(Achieved)	
assemble, test, and deliver modules 6-16	9/30/2014
(Achieved)	
assemble, test, and deliver modules 17-29	3/1/2015
(Achieved)	
Front end electronics assembled and tested	3/1/2015
(Achieved)	
electronics hut assembled	10/5/2015
(Achieved)	
coordinate detector assembled	11/17/2014
(Achieved)	
Project completion	1/29/2016
(Achieved)	

<b>WBS 3 Milestone</b>	<b>date</b>
UVa receive GEM parts	8/20/2014
(Achieved)	
UVa begin electronics assembly	1/5/2015
(Achieved)	
RU begin trigger design	1/6/2016
(Achieved)	
UVa electronics assembled and tested	7/20/2016
(Achieved)	
Jlab receive pole shims	8/22/2016
(Achieved)	
Jlab receive exit field clamp	8/22/2016
(Achieved)	
RU complete trigger	12/1/2016
(Achieved)	
UVa GEM modules assembled and tested	2/2/2017
(Achieved)	
project completion	7/31/2017
(Achieved)	



## 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.**

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

1. Selection of target-cell design for high luminosity: August 2014 (+3 months float)
2. Simulated-beam test (bench test) of selected design: June 2016 (+6 months float)
3. Design for target hardware and instrumentation complete: January 2017 (+6 month float).
4. GEN Polarized  $^3\text{He}$  target is ready, June 2017 (+6 months float)

### **The Gas Cherenkov detector (GRINCH) from W&M** ( for GMN and GEN)

1. GRINCH detector design complete and components are ordered: August 2014 (+4 months float).
2. GRINCH detector fully assembled and tested for gas and light tightness: January, 2015 (+ 4 months float).
3. GRINCH is installed and tested in the BB detector frame: September 2015(+ 6 months float).
4. GRINCH is ready: September 2016 (+ 4 months float).

### **Front Tracker from INFN** (for GMN, GEN and GEP)

1. Electronics in production: September 2014
2. Four GEM chambers completed and available at JLab (each chamber has 3 GEM modules): Feb 2016 (+3 months float)
3. Rest of GEM chambers (Two) completed and available at JLab (each chamber has 3 GEM modules): Sep 2016 (+3 months float)

### **HCal-J from CMU**

1. Detailed design completed: June 2014 (+2 months float)
2. Design review: September 2014 (+3 months float)
3. Module construction initiated: October 2014 (+4 months float)
4. Module assembly 50% completed: March, 2016 (+4 months float)
5. Construction is completed: September 2016 (+9 months float)

### **Ecal from JLab**

1. Develop concept of annealing: July 2014 ( +2 months float)
2. Design review: July 2015(+4 months float)
3. ECAL electronics is ready: May 2016 (+6 months float)
4. ECAL is ready: Sept. 2017 (+9 months float)

## **Updates related to the off-project milestones on the HCal-J from CMU and INFN-Catania and Front Tracker from INFN-Rome**

### **HCal-J from CMU and INFN-Catania**

#### **Activities to achieve milestone of detailed design completed by June 2014**

- Scintillator
  - Extrusion Die for 1.0 cm x 6.9 cm cross section completed (FNAL)
  - 200 meters produced and delivered to CMU (late Dec.)
  - Sample coupled to St. Gobain wavelength shifter
  - Photon output and attenuation lengths meet expectations.
- Mechanical Prototype
  - Prototype completed with 80 acrylic dummy scintillators, dummy WLS, can, ribs, 160 iron absorbers.
  - Tested assembly methods
  - Mechanical Stress tests found less than 0.2 mm bend which is negligible.
- Ongoing work to make functional prototype
  - Chopping FNAL scintillator into 80 pieces
  - Will machine existing St. Gobain WLS to match new design
  - Pieces for lightguide already cut. (Need to be bent)
  - Will load prototype HCal-J with real scintillator.
- Other
  - FNAL nearly finished producing 3.6 km of scintillator.
  - WLS has been delivered.
  - Injection molded waveguide components ordered by INFN.

### **Front Tracker from INFN-Rome**

#### **Activities to achieve milestone of 4 GEM chambers completed by Feb 2016**

- Front end electronic card production has produced 55 new cards with all but 1 passing Quality checks. Proceeding with production of the remaining cards.
- 4th GEM module is being assembled.
- Successful beam test of GEMs at DESY in late January. Detailed analysis underway.

## Appendix III

An updated version of the Research Management Plan is attached.

## Appendix IV

The report on the readout electronics pre-R&D is attached.