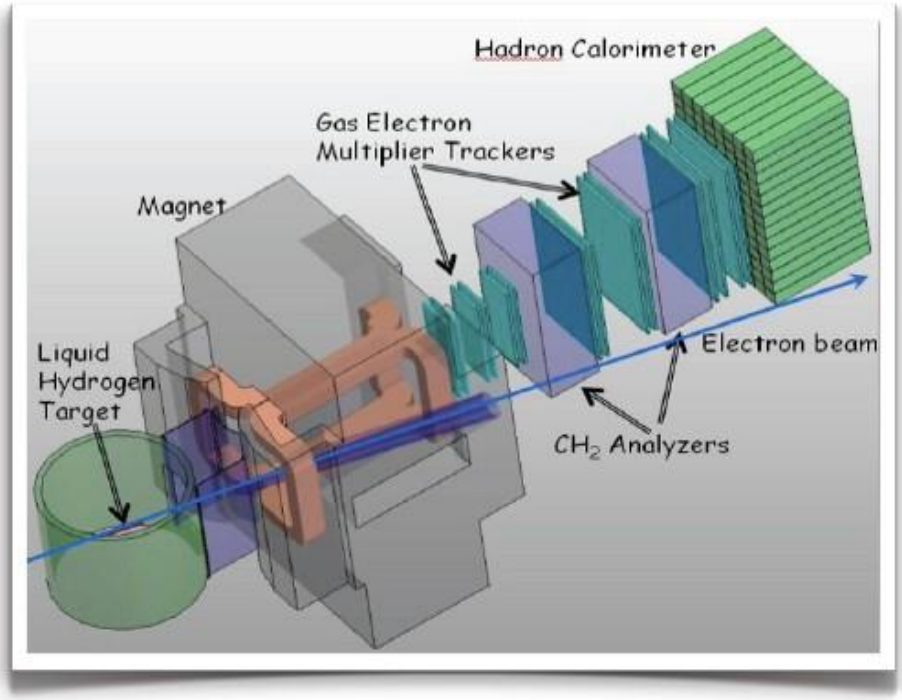
Super-BigBite-Spectrometer (SBS)

Monthly Progress Report

December 15, 2013



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 fifteenth 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.

The entire SBS program underwent its annual review by DOE on November 4-5, 2013. In response to that review a set of milestones for the “off project” endeavors has been compiled and is presented in draft form in Appendix II of this report. Furthermore, work flow plans for GEM construction have been developed and are presented in Appendix III. A new PMP is being prepared to reflect the change from a GEM based to scintillator PMT based coordinate detector, which will improve performance, reduce risk, and add schedule float with no increase in cost.

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 1.01 Milestones:

Id #	Level	Milestone	Scheduled Date	Expected Date 11/1/2013	Expected Date 12/1/2013	Actual Date
1.1-01M	1	Project start	10/1/2012	10/1/2012		**10/1/2012**
1.2-01M	2	Magnet delivered to JLab	4/30/2013	8/15/2013		**8/21/2013**
1.2-10M	2	Platform parts received	6/27/2014	6/27/2014	6/27/2014	
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 November 6, 13, and 20. Participants included Jefferson Lab, University of Virginia, University of Massachusetts, Carnegie-Mellon University, William and Mary, Norfolk State University, St. Mary's University, University of Connecticut, University of Glasgow, 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 machining contract awarded.
- Detail drawings of new coils and procurement specification. (100% completed)
    - Coil bids in final review. Questions out to low price coil vendor.
- Continuing on the magnet assembly drawings and hardware, detailing water cooling system.

WBS 1.2 Magnet/Detector Platforms:

- Continuing on the magnet support structure details and drawings. Internal support structure review is in progress. Expect to be ready for procurement January 2014.

WBS 1.3 Beam Line:

- No activity this month

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 12/1/2013: $?K (?%)

WBS 2: Neutron Form Factor

WBS 2	**Neutron Form Factor**	**WBS 2.01**	Milestones
		WBS 2.02	Project oversight
		WBS 2.1	GEMs (UVa)
		WBS 2.2	GEM Electronics (UVa)
		WBS 2.3	Electronics Hut, Lead Shielding, Lead platform, and Detector Frames
		WBS 2.4	Coordinate Detector

WBS 2.01 Milestones:

ID #	Level	Milestone	Scheduled Date	Expected date 11/1/2013	Expected date 12/1/2013	Actual Date
2.1-01M	1	Project start	10/1/2012	10/1/2012		**10/1/2012**
2.3-1	3	Order GEM Parts			10/15/2013	**10/18/2013**
2.2-01M	2	UVa receives GEM parts	2/3/2014	2/3/2014	2/1/2014	
2.3-2	3	First module assembled and tested			3/3/2014	
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	
2.2-10MB	3	UVa 15 GEM modules assembled and tested			9/30/2014	
2.2-10MC	2	UVa 29 GEM modules assembled and tested	10/17/2014	10/17/2014	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	2/2/2015	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 November 6, 13, and 20. Participants included Jefferson Lab, University of Virginia, University of Massachusetts, Carnegie-Mellon University, William and Mary, Norfolk State University, St. Mary's University, University of Connecticut, University of Glasgow, 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):.

GEM pre-R&D: In October the two 50 cm x 50 cm GEM chambers were tested in actual beam conditions at the test beam facility at Fermilab, along with detectors from Florida Tech, Stony Brook University, Yale University and Brookhaven National Lab. This three week long beam test was highly successful and allowed the testing of the SBS prototype chamber up to particle rates of 10 kHz/cm2. The analysis of test beam data is still underway.

GEMs: Preparing the laboratory to start production upon receipt of the ordered GEM parts

WBS 2.2 GEM Electronics (UVa):

Readout Electronics pre-R&D:

The new 8,000 channel APV25 based SRS electronic system procured from CERN was fully used and tested during the Fermilab beam test. This was the first demonstration of successful use of a large APV-25 SRS system in actual beam conditions. Analysis of the acquired data continues.

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

- No activity this period.

WBS 2.4 Coordinate Detector:

- No activity this period.

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 12/1/2013: $?K (?%)

WBS 3: Proton Form Factor

WBS 3	**Proton Form Factor**	**WBS 3.01**	Milestones
		WBS 3.02	Project Oversight
		WBS 3.1	Magnet Pole shims and exit field clamp
		WBS 3.2	GEM's (UVa)
		WBS 3.3	GEM electronics (UVa)
		WBS 3.4	Trigger (RU)

WBS 3.01 Milestones:

ID #	Level	Milestone	Scheduled Date	Expected date 11/1/2013	Expected date 12/1/2013	Actual Date
3.1-01M	1	Project start	10/1/2013	10/1/2013		**10/1/2013**
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 November 6, 13, and 20. Participants included Jefferson Lab, University of Virginia, University of Massachusetts, Carnegie-Mellon University, William and Mary, Norfolk State University, St. Mary's University, University of Connecticut, University of Glasgow, and INFN Rome.
- Project is staffed appropriately for this beginning stage, and includes Jefferson Lab (manager, scientist), UVa (two scientists).
- An account, entitled SBSPFF, was opened at JLab on November 1, 2013

WBS 3.1 Magnet Pole shims and exit field clamp

No activity this month

WBS 3.2 GEM's

No activity this month

WBS 3.3 GEM electronics

No activity this month

WBS 3.4 Trigger

No activity this month

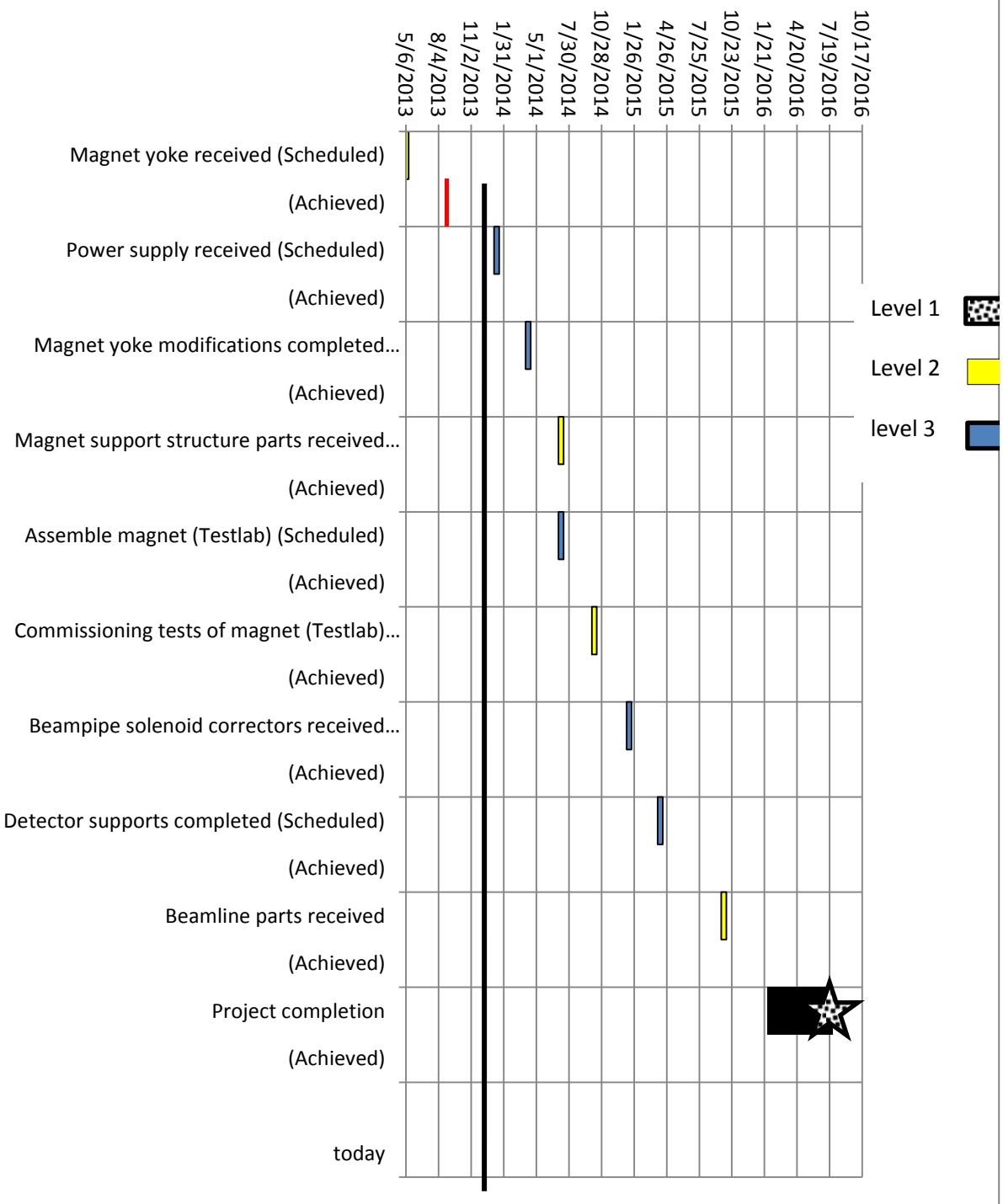
WBS 3 Costs:

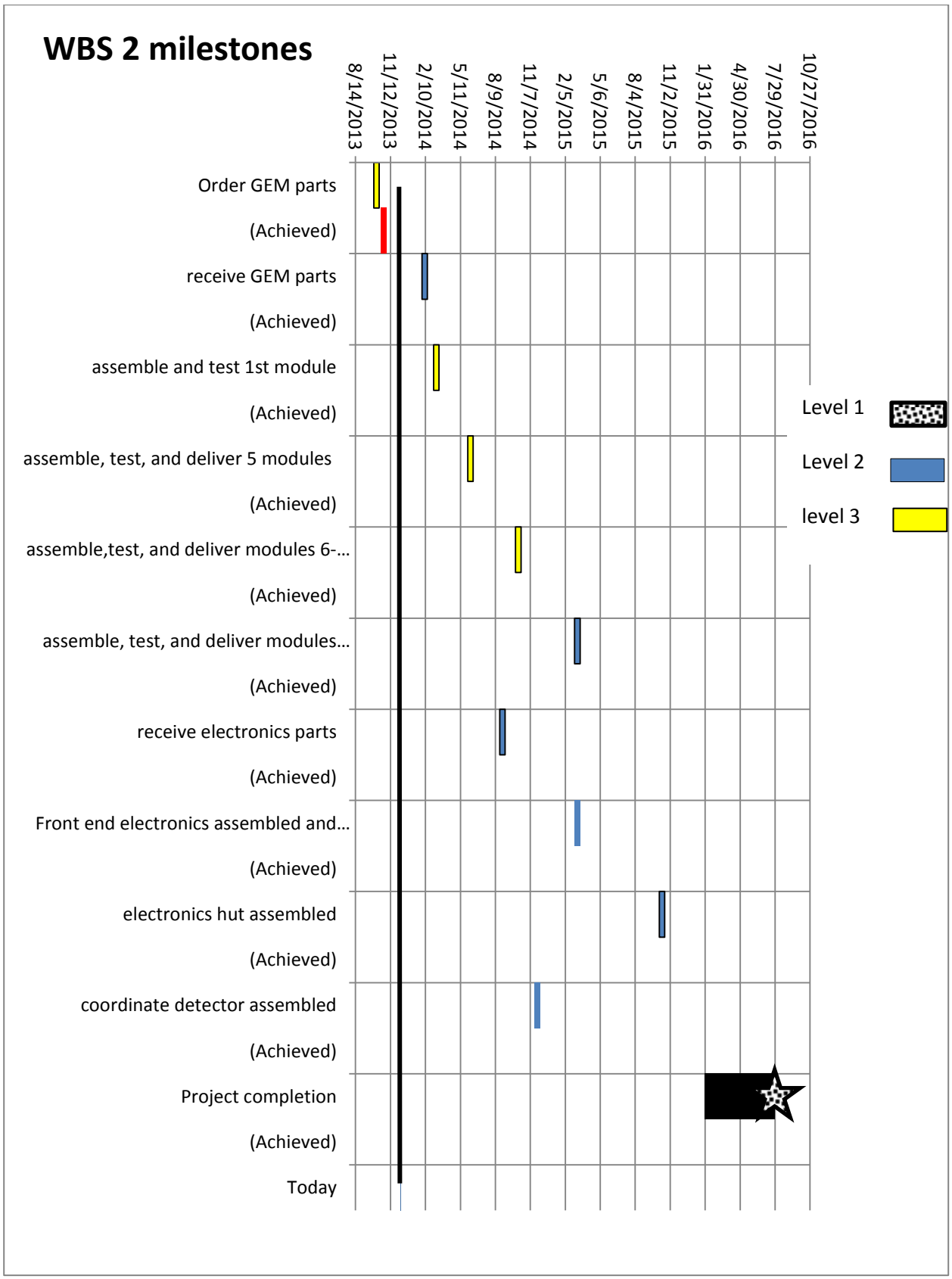
- Budget for this WBS for FY14 is $321K.
- Costed and obligated as of 12/1/2013: $0K

Appendix I

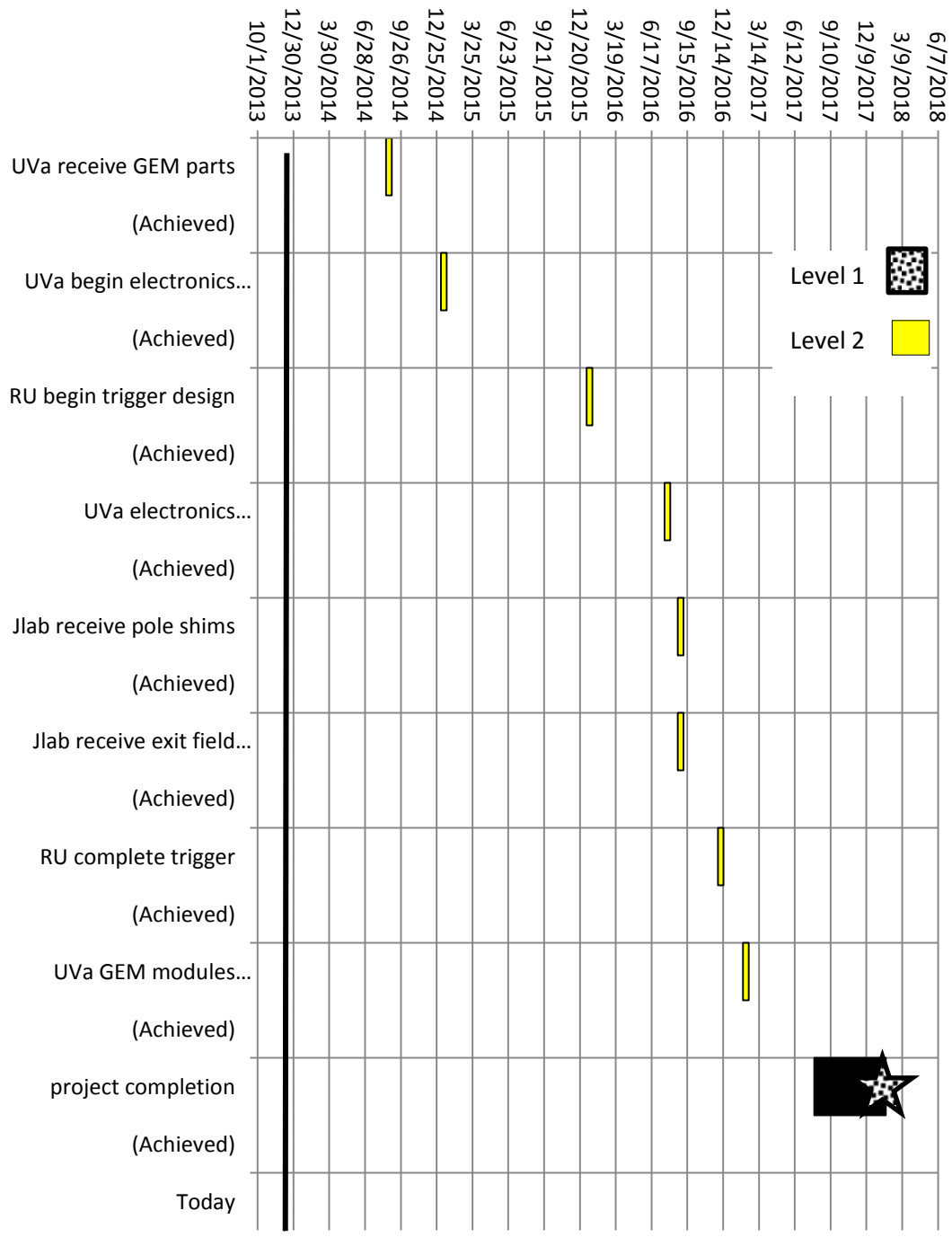
The following are graphical representations of the milestones for SBS Basic (WBS 1), Neutron Form Factor (WBS 2,) and Proton Form Factor (WBS 2), updated on December 1, 2013. Black represents level 1 milestones as specified in the PMP. Yellow represents level 2 milestones from the PMP. Blue represents 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
8/14/2013
11/12/2013
2/10/2014
5/11/2014
8/9/2014
11/7/2014
2/5/2015
5/6/2015
8/4/2015
11/2/2015
1/31/2016
4/30/2016
7/29/2016
10/27/2016
Order GEM parts
(Achieved)
receive GEM parts
(Achieved)
assemble and test 1st module
(Achieved)
assemble, test, and deliver 5 modules
(Achieved)
assemble,test, and deliver modules 6-...
(Achieved)
assemble, test, and deliver modules...
(Achieved)
receive electronics parts
(Achieved)
Front end electronics assembled and...
(Achieved)
electronics hut assembled
(Achieved)
coordinate detector assembled
(Achieved)
Project completion
(Achieved)
Today
Level 1
Level 2
level 3

WBS 3 milestones



WBS 1 Milestone	**date**
Magnet yoke received (Scheduled)	4/29/2013
(Achieved)	**8/21/2013**
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)	

WBS 2 Milestone	**date**
Order GEM parts	9/30/2013
(Achieved)	**10/18/2013**
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)	

WBS 3 Milestone	date
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

Here are compiled a draft list of milestones for the various "off project" endeavors that have been defined as external dependencies for the SBS Program.

Polarized ^{3}He target from UVa

1. Selection of target-cell design for high luminosity: August 2014 (three month 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 He-3 target is ready, June 2017 (6 months float)

The Gas Cherenkov detector from W&M

1. GRINCH detector design complete and components are ordered, August2014 (+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

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

Coordinate Detector from ISU ***(leave out?)***

1. Design review - 1/15/2014 (2 months float)
2. Complete mechanical checkout and light enclosure tests of prototype - 06/15/2014 (4 months float)
3. Place purchase orders for scintillators/fibers - 07/15/2014 (2 months float)
4. Fully instrumented detector planes ready - 05/15/2015 (6 months float)

Appendix III

Here are the requested work flow plans for GEM manufacture at UVa and INFN respectively.

SBS Polarimeter GEM module construction Plan (UVa)

The UVa SBS GEM team includes several members providing training and supervision and the construction team: A, B, C:

The manpower key for the chamber construction work-flow table:

- A: Post-doctoral associate;
- B: Graduate student #1 or graduate student #2;
- C: Research scientist #1 or Research scientist #2.

Day / time	Task	Man power
-5	Sand two sets of frames and clean in Ultra-sonic bath	A, B
-4	Remove from US bath and hang in clean shelf to dry	A, B
week #1		
1 - AM	Test dried frames under HV, if fail return to rack and test again on day 2.	A, B, C
1 - PM	Test all sectors of 2 GEM foils (1.1 and 2.1). If bad sector found, set the foil aside and move to the next foil; continue till two good foils found	A, B
2 - AM	Glue Readout #1 on to base #1; Glue Readout #2 onto base #2	A, B, C
2 - PM	Apply sealant to frames	A, B
3 - AM	Stretch and glue GEM foil 1.1 on to frame	A, B, C
3 - AM	Stretch and glue GEM foil 2.1 on to frame	A, B, C
3 – PM	Test all sectors of 2 GEM foils (1.2 and 2.2). If bad sector found, set the foil aside and move to the next foil; continue till two good foils found	A, B
4 - AM	Remove foils 1.1 and 2.1 from stretcher; test all sectors of both foils	A, B
4 - PM	Glue framed foils 1.1 and 2.1 on to base #1 and base #2.	A, B, C
5 – AM	Stretch and glue GEM foils 2.1 and 2.2 on to frames	A, B, C
5 - PM	Test all sectors of 2 GEM foils (1.3 and 2.3). If bad sector found, set the foil aside and move to the next foil; continue till two good foils found	A, B
week #2		
6 - AM	This time slot is set aside for a group meeting, going over and assesing the completed components and addressing any issues.	All team members
6 - PM	Remove foils 2.1 and 2.2 from stretcher; test all sectors of both foils.	A. B
7 - AM	Stretch and glue GEM foils 1.3 and 2.3 on to frames	A, B, C
7 – PM	Glue framed foils 1.2 and 2.2 on to base #1 and base #2.	A, B, C
8 - AM	Remove foils 1.3 and 2.3 from stretcher; test all sectors of both foils.	A, B
8 - PM	Stretch and glue cathode foils 1 and 2 on frames	A, B
9 - AM	Glue framed foils 1.3 and 2.3 on to base #1 and base #2.	A, B, C
9 – PM	Remove cathode foils 1 and 2 from stretcher and glue on bases.	A, B, C
10 - AM	Stretch and glue gas window foils 1 and 2 on frames	A, B
10 - PM	Remove gas windows 1 and 2 from stretcher and glue on bases.	A, B, C
week #3		
11	Install Gas inlets, apply sealant to both chambers	A, B, C
12	Flush chambers with dry N2 and test all sectors	B, C
13,14,15	Solder resistors, attach HV inputs and mount chambers on test stand. Connect to Ar/CO2 and start flusing	A, B, C
week #4		
16	Sand two sets of frames (for next chamber) and clean in Ultra-sonic bath	A, B
16	Apply HV to the two chambers and strart testing	B, C
17	Remove frames from US bath and hang in clean shelf to dry	A, B
17,18,19,20	Chamber testing and charcterization	B, C

GEM Front Tracker Construction Procedure (INFN)

Personnel:

Catania: Two senior technicians, one senior technician with physics master degree and one senior physicist do provide:

1. Frame preparation
2. GEM foils quality checks
3. GEM Module assembling and gluing
4. Resistors soldering
5. Gas pipe and connectors gluing

Rome: Three senior technicians and one senior researcher do provide:

Electronics testing

1. GEM module and electronics integration
2. Integrated GEM modules cosmic tests

The senior researcher is the coordinator of the GEM Front Tracker project.

In addition a PhD student works (part time) to the track reconstruction algorithm

Lecce: One senior researcher working on the gas system and supporting (part time) the test in Rome

Genova: One senior electronic engineer (designer of the Readout Electronics, hardware and firmware) following the procurement of the electronics, providing the electronics tests (with the support of his team) and general support on the electronics.

Construction work flow

The work flow of the production is summarized in the following flow diagram and detailed in the next subsections.

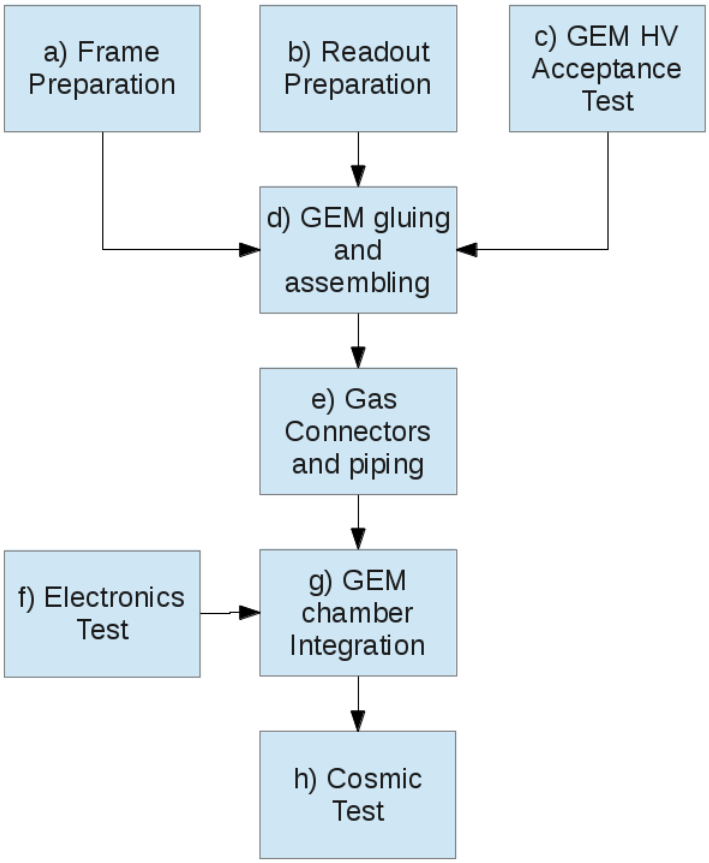


Figure 1: Diagram of the main GEM module assembling phases. Phases on the same row can be performed in parallel.

A time sheet of the activities is reported in the next table, where a relaxed schedule is assumed (people are involved at about 50% of their time). Total expected module assembling time, with most of the activities in series, is about 24 days (including Saturday and Sunday not working days).

We allocated 1 months/module.

The testing of electronics on the completed module is expected to take about 12 days; it is performed in parallel to the assembling procedures.

Table 1: Time Sheet of the GEM Module Assembling and Testing; dark gray represents full day; light gray represent part of the day. Some of the activities can be performed in parallel. The time sheet should somehow represent the “worst” case situation.