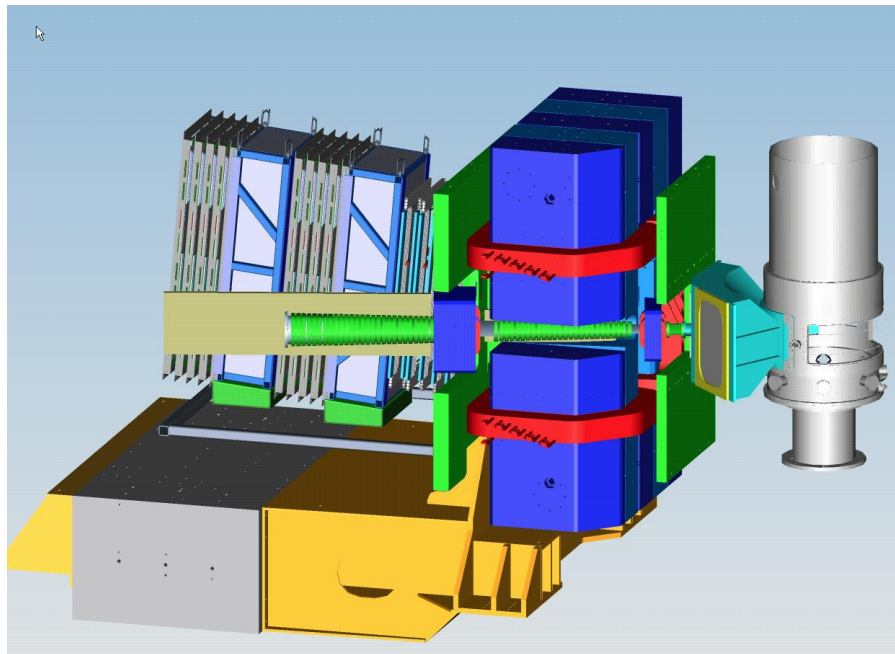


# ***Super-Bigbite-Spectrometer (SBS)***

## **Monthly Progress Report**

**December 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 48<sup>th</sup> 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 DOE annual review was held on Nov 7 and 8<sup>th</sup>.
- Design of the oven and frame for ECal started in November. This completes a milestone for this dependency.

## 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

**WBS1 Project was completed on January 22<sup>nd</sup>, 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

<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>	Coordinate Detector (ISU)
		<b>WBS 2.2</b>	Electronics Hut, Lead Shielding, Lead platform, and Detector Frames (JLab)
		<b>WBS 2.3</b>	Pole Shims and field clamp (JLab)
		<b>WBS 2.4</b>	Trigger (RU)

### WBS 2.02 Project Oversight:

- SBS weekly meetings, via tele and video conference, were held on November 3<sup>rd</sup> and 17<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, 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):

- Completed

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

- Spacer strips for the beamline magnetic shielding are expected by Dec 22<sup>nd</sup>.
- The SBS detector support for the GEM frames was delivered on November 29<sup>th</sup>.
- The UVa GEM frames are being made by the JLab machine shop. The job is 95% complete with completion is expected by December 9<sup>th</sup>.

## **WBS 2.3 Pole Shims and field clamp**

- Completed.

## **WBS 2.4 Trigger:**

- Completed.

## **WBS 2 Costs:**

- The total budget for WBS2 is \$1,372K.
- Costed and obligated as of 12/1/2016: \$1,331K (97%).

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

Level	Milestone	Scheduled Date	Expected date 11/1/2016	Expected date 12/1/2016	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

<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>	GEM's (UVa)
		<b>WBS 3.2</b>	GEM electronics (UVa)

### WBS 3.02 Project Oversight:

- SBS weekly meetings, via tele and video conference, were held on November 3<sup>rd</sup> and 17<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, 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	Constructed and passed final QA
36	Constructed and passed final QA
37	Constructed and prepared for final QA
38	3 GEM foils and 1 RO board at UVa
39	3 GEM foils and 1 RO board at UVa
40	1 RO board at UVa, waiting for shipment of GEM foils

- Module #36 has passed the final QA.
- Module #37 is prepared for final QA with X-ray source.
- Module #38 will be completed by Dec 15<sup>th</sup>.
- Module #39 will be completed by end of December.
- If the next shipment of GEM foils does not arrive in time to be used to build module #40, then a prototype module that passed QA tests will be used as module #40.
- UVa received shipment of 4 GEM foils, 4 RO boards and 6 drift foils on Nov 28<sup>th</sup>. The 3 GEM foils that had the HV connection problem were fixed by CERN and passed the initial QA. The fourth GEM foil did not pass the initial QA.

## **WBS 3.2 GEM electronics**

- All electronics have been delivered to UVa.

## **WBS 3 Costs:**

- The total budget for WBS3 is \$1781K.
- Costed and obligated as of 12/1/2016: \$1,753K (98%).

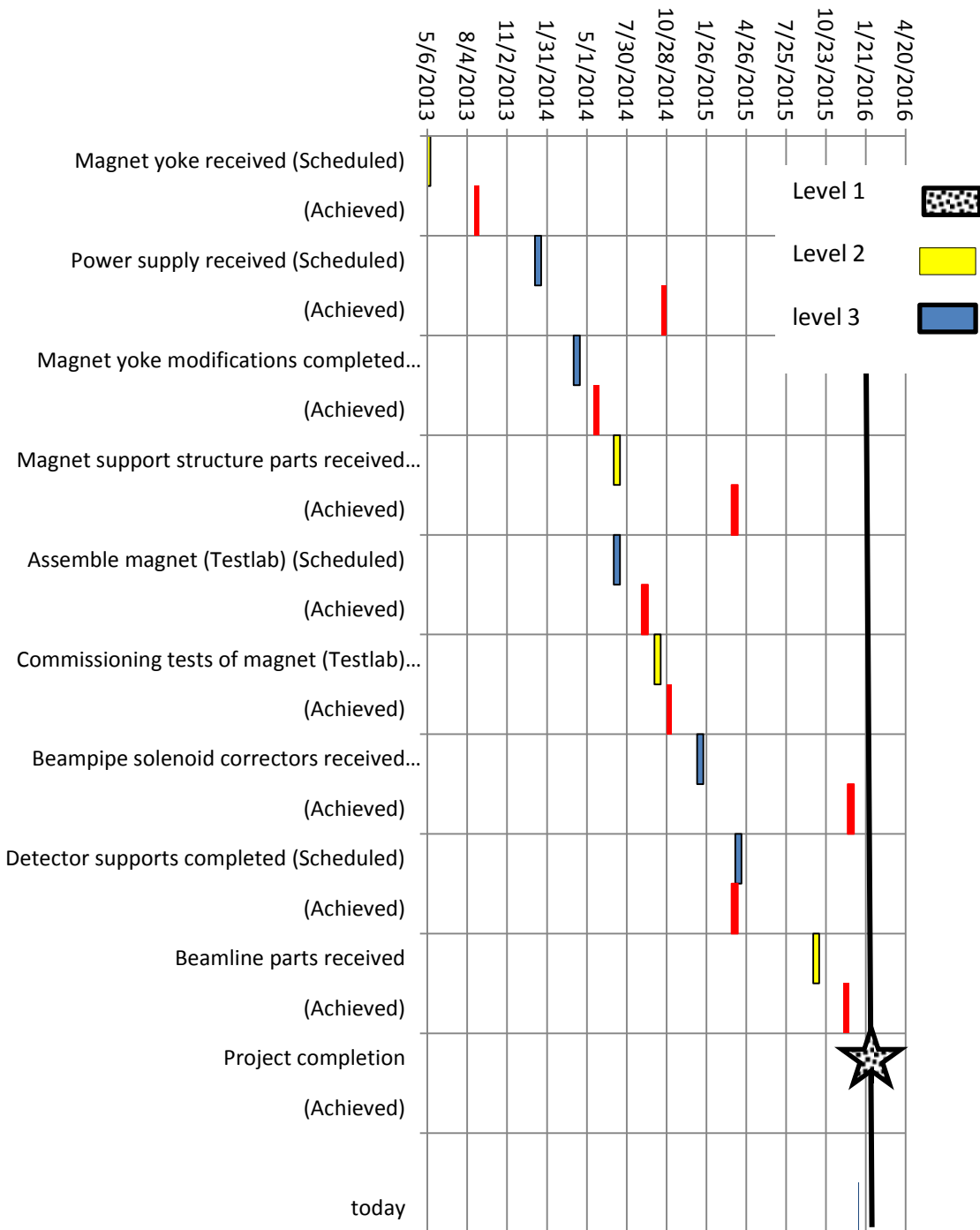
**WBS 3.01 Milestones:** (see [Appendix 1](#) for a graphic view of the milestones)

Level (ID#)	Milestone	Scheduled Date	Expected date 11/1/2016	Expected date 12/1/2016	Comment
1 (3.1-01M)	Project start	10/1/2012			<b>Completed 10/1/2012</b>
3	Order GEM Parts	10/1/2013			<b>Completed 10/18/2013</b>
3	UVa receives GEM parts	2/3/2014			<b>Completed 4/23/2014</b>
2 (3.2-01M)	First module assembled and tested	3/3/2014			<b>Completed 5/15/2014</b>
2 (3.2-10M)	UVa 5 GEM modules assembled and tested	6/2/2014			<b>Completed 12/23/2014</b>
2 (3.2-20M)	UVa 6-16 GEM modules assembled and tested	9/30/2014			<b>Completed 7/28/2015</b>
2 (3.2-30M)	UVa 17-29 GEM modules assembled and tested	3/2/2015			<b>Completed 3/30/2016</b>
2 (3.2-40M)	UVa 30-40 GEM modules assembled and tested	7/15/2015	1/15/2017	1/15/2017	
2 (3.2-50M)	1st order of Front End Electronics	10/1/2014			<b>Completed 3/5/2015</b>
2 (3.2-60M)	2nd order of Front End Electronics	10/1/2015			<b>Completed 3/5/2015</b>
1 (3.1-10M)	Project completion	2/1/2017	2/1/2017	2/1/2017	

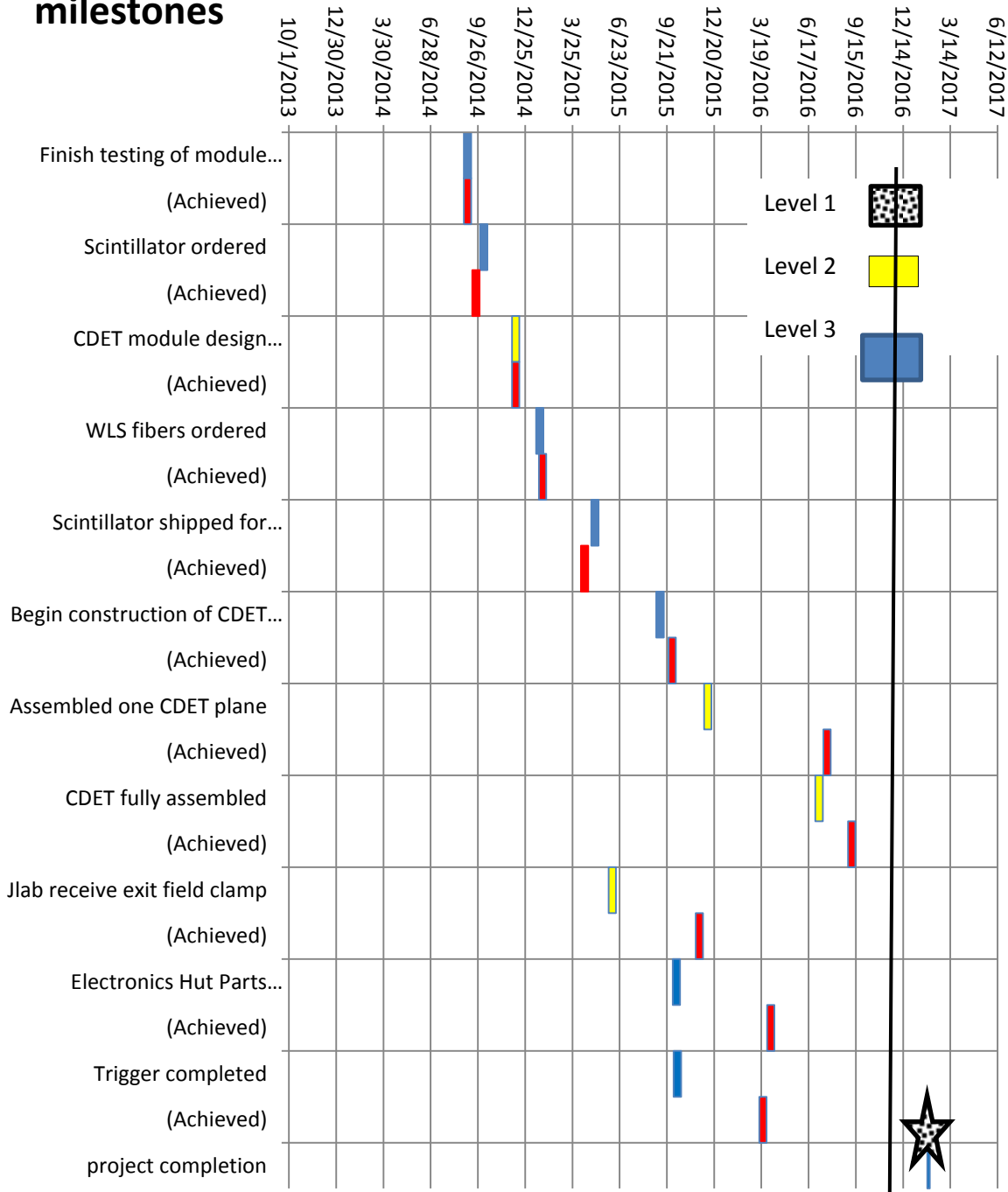
## Appendix I

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).

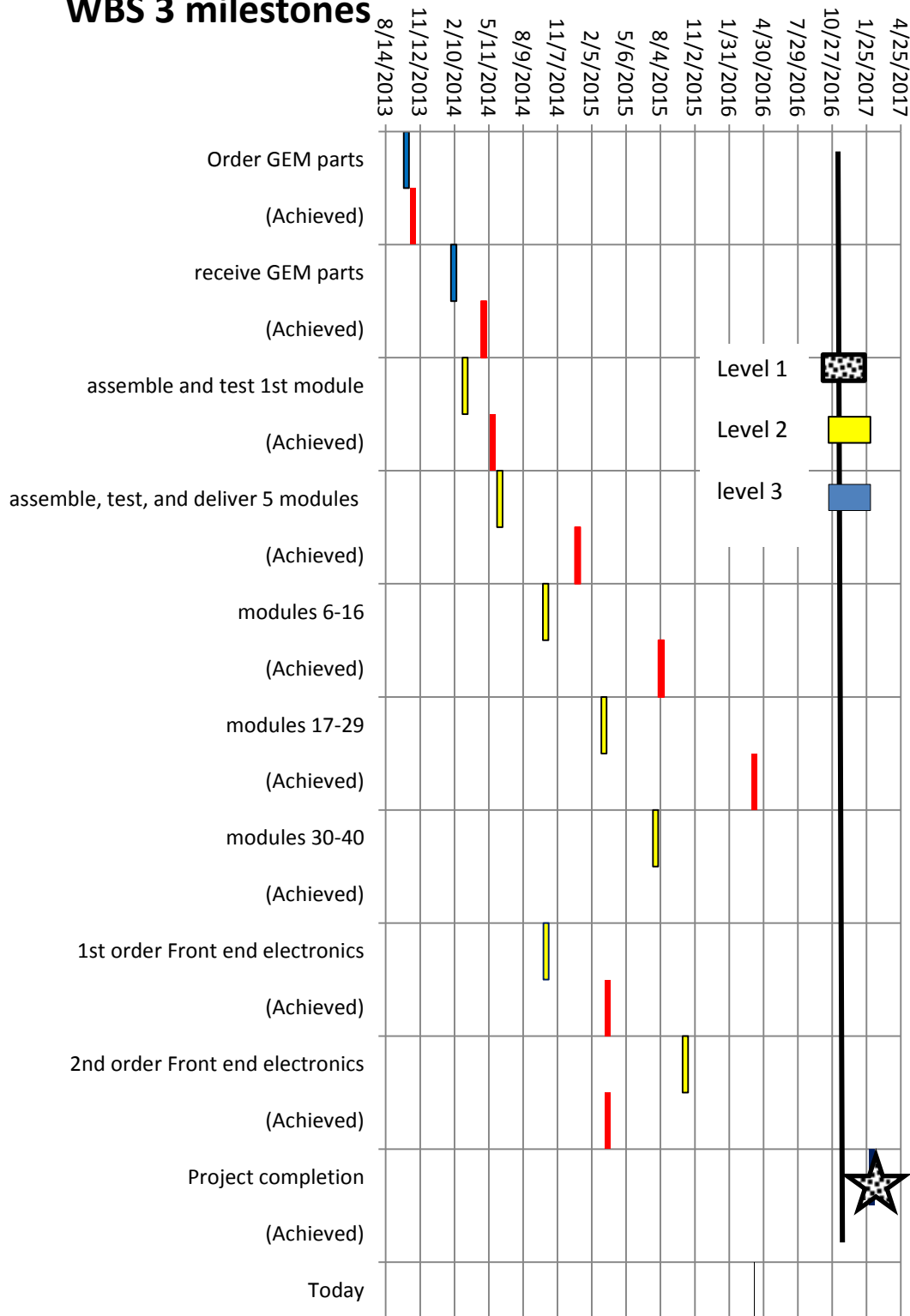
## WBS 1 Milestones



## 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	<b>Completed Feb 2015</b>
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	<b>Completed Oct 2015</b>
Purchase order issued for vessel	Oct 15, 2015	<b>Completed Aug 2015</b>
Full DAQ system ready	Dec 1, 2015	Expected Dec 2016
Vessel completely assembled	Mar 15, 2016	<b>Completed Sept 2016</b>
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	<b>Completed Sept 2014</b>
GEM chambers 1 and 2 completed	Sept 2015	<b>Completed Dec 2015</b>
Initial Electronics QA completed	Dec 2015	<b>Completed Dec 2015</b>
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

### HCal-J from CMU/INFN-Catania (for GMN, GEN and GEP)

Milestone	Completion date	Comment
Detailed design completed	June 2014	<b>Completed July 2014</b>
Design review	Sept 2014	<b>Completed Dec 2014</b>
Module construction initiated	Mar 2015	<b>Completed Mar 2015</b>
Module assembly 25% complete	Sept 2015	<b>Completed Sept 2015</b>
Module assembly 50% complete	Mar 2016	<b>Completed April 2016</b>
Module assembly completed	Sept 2016	Expected in Feb 2017

#### **Status update:**

- Module production is ongoing. Have produced 238 modules (169 modules at JLab) of the total of 288 modules in HCal.
- Delivery of 66 modules to JLab is scheduled for middle of December.
- 18 modules were produced in November. 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	<b>Completed July 2014</b>
Test of annealing with prototype	Nov 2015	<b>Completed May 2015</b>
Fabrication of C200 frame started	Sept 15 2015	<b>Completed Sept 2015</b>
Design of ECAL platform modification started	Dec 1 2015	Delay until Jan 2017
C200 assembly completed and testing begins	Jan 15 2016	<b>Completed Jan 2016</b>
C200 report results, recommendations completed	June 1 2016	<b>Completed Oct 2016</b>
Design of ECAL frame/oven started	July 1 2016	<b>Completed Nov 2016</b>
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 design of the ECal frame/oven was started in November by NCCU. This completes a milestone for this dependency.



## Polarized <sup>3</sup>He target from UVa ( for GEN)

Milestone	Completion date	Comment
Selection of target-cell design for high luminosity	Nov 2014	<b>Completed Oct 2014</b>
Conceptual design document complete	Jan 2016	<b>Completed Mar 2016</b>
Conceptual design review	Mar 2016	<b>Completed Mar 2016</b>
Start bench test of 3 liter glass convection target	April 2016	<b>Completed Aug 2016</b>
Conceptual design frozen	June 2016	<b>Completed Oct 2016</b>
Test of glass/metal technology complete	June 2016	<b>Completed July 2016</b>
Begin engineering and design	July 2016	<b>Completed May 2016</b>
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 bench test of the 3 liter glass convection target is going well and the cell is being characterized. Figure 1 is a plot of the target spin down which measures the target lifetime and taking into account AFP losses the lifetime is greater than 48 hours.

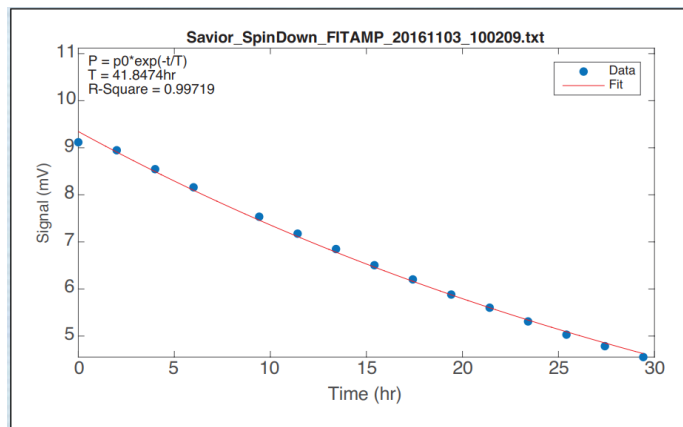


Figure 1 Plot of the target cell spin down