QUALITY ASSURANCE AND ACCEPTANCE TEST PLAN FOR THE TAGGER MICROSCOPE AND ACTIVE COLLIMATOR

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The GlueX experiment is a long-term research program based in Hall-D at the Thomas Jefferson National Accelerator Laboratory (JLab) in Newport News, Virginia. The University of Connecticut's Nuclear Physics group, a member of the multinational GlueX collaboration, is tasked with the design, construction, and installation of the project's Tagger Microscope (TM) and Active Collimator (AC) under a construction MOU that was signed by both parties in February, 2012. This document describes the critical procedures required to ensure a high precision and quality product.

I. TAGGER MICROSCOPE DETECTOR

1. Scope

The quality of the finished TM is judged on its efficiency for detection of high energy electrons moving along the fiber axis, its immunity to background radiation and dark current, and the time resolution of the signals it produces when operating at a rate of several MHz per fiber. Detection efficiency and time resolution depend critically on the number of photons per charged track that are detected by the photosensor, which is a primary issue in quality assurance during the fabrication process. Immunity to background radiation and dark current in the photosensor is addressed at the installation stage, which is outside the scope of this document.

Simulations have shown that the desired goal of 200ps rms time resolution in the TM can be achieved if the average number of pixels that fire in the photosensor per passing electron is at least 350, or equivalently a most-probable count of 200 pixels. Cosmic ray tests with a single fiber bundle prototype have shown that this goal can be achieved with the custom electronics readout designed at UConn for the TM, provided that care is taken to produce a clean optical joint between the scintillating fiber and the light guide, and good alignment between the fiber and the photosensor at the end of the light guide. The key features to be examined in the quality assurance process are: end-to-end light transmission from the scintillating fiber to the photosensor, uniformity of response across the different electronic outputs to a standard injected light pulse, and optical/electronic isolation between neighboring channels.

Document D0000-19-02-S002 - *Specification of the tagger microscope and the readout electronics*, contains the detailed specifications for the components of the

TM which is subsequently referenced in this document. This document will be revised, as the TM is built at UConn, to reflect the updated methods and procedures used in construction.

2. Component Inspection Plan

2.1 Inspections for the Tagger Microscope

The first concern in the fabrication of the TM is the transverse dimensions of the scintillating fibers and light guides delivered from the manufacturer. A significant portion of the geometrical precision of the TM is dependent upon the optical fibers having dimensions within the specified limits. After the scintillating fiber and light guide segments are initially cut from their respective spools, measurements of their transverse dimensions will be performed and recorded in a logbook, at the intervals specified below, to ensure that they fall within the stated limits listed in the aforementioned specification document. All non-conforming fiber sections will be rejected at this stage and noted in the logbook.

- Scintillating fiber rough-cut segments:
    - Measured at the center of each segment (approximately every 3cm)

- Light guide rough-cut segments:
    - Measured 4cm from each fiber end
    - Measured at 3 other evenly spaced locations (40cm apart)

Upon completion of the fusing process, an inspection of the joint using a magnifying glass and a visual comparison of light transmission compared to a reference fiber will be executed as an initial check. Measurements of the transverse dimensions at the center of the fused joint will be taken to ensure they fall within the stated limits. These data along with the comparison results will be recorded in a logbook as a go/no-go checklist. The fibers that pass the initial inspection will be stored in a dark-box for further processing. Non-conforming fibers will be set aside for further testing and possible re-fusing if necessary.

In addition to the numerous naked-eye and magnified visual inspections by technicians throughout construction, UConn has designed a dark-box testing unit which will be housed in an on-site clean-room. This testing facility provides the ability to measure the efficiency of light transmission through both individual straight fibers and bent fiber bundles. This testing unit will be used to measure the light transmission through every fiber bundle, once their assembly is complete, and also to test every preamplifier board for uniformity of response and pulse shape, and for crosstalk. Dark box testing will be executed at the construction stages listed below:

- After the fiber splicing stage on:
    - All fused fibers that appear marginal in the visual comparison tests
    - 15% of the non-suspect fibers (selected at random)

- After fiber bundling:
    - Each fiber in the 5 x 6 bundle

- After assembly of the full detector on the bench:
    - Readout of cosmic ray pulses based on an internal cosmic trigger

The pulse heights detected by the Silicon Photomultiplier (SiPM) for the light transmitted through the individual spliced fibers will be collected and the mean and variance calculated and recorded. At the beginning of every testing session, approximately every 30 fibers, a calibration of the dark box will be performed using a reference fiber. The values recorded for the reference fiber will be used as a standard for the evaluation of the subsequent optical fibers that are tested. All non-conforming fibers will be rejected at this stage and noted in the logbook. If problems are found with a significant number of the fibers prior to bundling, the dark box will be instrumented with a remotely triggered camera to examine points along the fiber where loss of light is occurring.

2.2 Records

Throughout the construction and testing phase, various logbooks will be maintained by the UConn technicians. To ensure that the inspection data and recordings of all operator work sessions are readily traceable and available to JLab, UConn has established the following wiki page:

http://zeus.phys.uconn.edu/wiki/index.php/Tagger_Microscope_%26_Active_Collimator_Constructio
n

This single web page contains:

- Links to:
    - Safety Information containing information on:
        - MSDS

        - Emergency contact information
        - Lab training
    - Construction Plan
    - Quality Assurance and Acceptance Test Plan (this document)
    - Technical drawings
    - Construction logbooks (Google document) containing information on:
        - Reported defects
        - Inspection data
        - Testing data
        - Construction progress
- Material certifications & analyses
- Production schedules
    - Table of milestones
    - Baseline schedule

3. Process Quality Plan

3.1 Construction Plan

The Construction Plan developed by UConn for the tagger microscope and active collimator contains step-by-step instructions for the different manufacturing processes needed during construction. This document and the web page previously mentioned contain detailed safety information and procedures for the operators to be aware of and follow during the construction and testing phase. Additionally the Construction Plan gives specific details on how to report mechanical defects and problems during the manufacturing process. The technicians are provided with both paper and electronic logbooks to record their work sessions and related job data, which can then be easily submitted to JLab electronically as required.

3.2 Methodology towards meeting the specifications during construction

Alignment of the fibers during the fusing of the scintillating sections to the light guides, and their transmission efficiency after fusing and bending are of particular concern. To address the alignment concern, a set of tools have been developed to allow for consistent fusing, alignment, bending, and gluing of fibers. These tools have been manufactured at UConn based on the dimensions of the different parts as detailed in the applicable drawings. The aforementioned tools will allow different technicians to construct the components in a consistent and efficient manner.

A high precision end-mill, located in the physics machine shop at UConn, will be used to cut the optical fibers to final length. This highly accurate machine virtually eliminates fiber cladding flare during the cutting process and thus allows for a much more compact assembly of the 5 x 6 fiber bundles. Special care has been taken in the design of the fiber holding apparatuses for the scintillating fibers (SciFi's) and light guides. The unique design of the SciFi holding collar allows for optimal positional stability in the end-mill, while only exposing a few millimeters of the fiber ends to ambient light.

The fiber fusing process will be performed using equipment specifically designed for this purpose. The complete scintillating fiber and part of the light guide will be encapsulated by a glass ferrule to maintain shape and alignment throughout the procedure. The fibers that pass inspection will be stored in a dark-box for further processing.

To maximize light transmission and minimize crosstalk of the optical fibers several procedures have been adopted. Throughout the manufacturing process cleanliness is of utmost importance. At each step in the construction which requires manipulation of the optical fibers, powder-free gloves will be worn by the technician. Additionally, a lint-free cloth dampened with ethyl alcohol and compressed air or a vacuum hose (as appropriate) will be used to clean the fibers. This will help to eliminate contamination by foreign debris in the fusing and bundle gluing processes and maximize the adhesion of paint used to prevent crosstalk between fibers.

The construction of a finished fiber bundle will require two separate heat treating phases, one to take out the residual bend from the manufacturer's spool, and a second to bend the fiber to its final shape. A LabView program has been developed that continuously monitors and regulates the water temperature of the heat treating unit. This heat treating system is designed with numerous fail-safe systems to prevent damage to equipment and injury to personnel.

Throughout the construction process, emphasis will be placed on minimizing fiber exposure to UV light. Whenever possible, steps will be taken to minimize the time and intensity of exposure. Once a fiber bundle has successfully passed all tests, it will be stored in a light tight shipping box. The shipping boxes are specifically designed with a foam interior to support the individual bent fibers during prolonged storage and shipping. Additionally, these containers provide a light tight seal to maximize fiber lifetime.

Construction of the TM will be carried out in three adjacent access-controlled laboratories at UConn. In addition to the mandatory campus lab safety training program, all technicians will complete a thorough introductory training of all equipment prior to starting work in the lab.

4. Responsibilities

The construction of the TM will take place at UConn. By construction of the TM we mean the fusing and painting of fibers along with gluing and bending of fiber bundles. Tests will then be made of the fiber bundles and electronics. The upper and lower enclosures (fiber enclosure and electronics enclosure, respectively) will then be fabricated and all components will be assembled for analysis and testing. The microscope will then be disassembled and packaged for shipping to JLab, where it will be installed in the GlueX Tagger Hall and tested.

UConn will be responsible for organizing and supervising the needed manpower and the completion of all phases of construction. The assembly and testing of the TM will be overseen by James McIntyre. He will be the construction manager for the TM. Support in construction, testing, and quality assurance will be provided by UConn laboratory technician Ann Marie Carroll and by undergraduate students under her supervision. Machining of fiber ends and custom parts for the construction of the TM will be carried out in the UConn Physics machine shop. Overall project supervision will be provided by Prof. Richard Jones.

The overall responsibility for the quality assurance and acceptance of the TM for shipment to JLab lies with the UConn group. Any quality problems identified by UConn and reported to JLab, will be resolved by consultation. Problems that can be rectified by UConn will be corrected prior to shipment. If the problems or non-conformance to specifications cannot be easily corrected, the course of action to be taken will be determined in consultation between UConn and JLab.

5. Document Control

Several pieces of documentation are needed during construction. To begin with, documentation indicating the progression of the construction of the 20 fiber bundles, along with testing data indicating whether all design specifications have been met, will be maintained. Once a bundle has been completed, documentation certifying that it has passed the minimum specifications and a list of any deviations from the nominal values will be recorded. After assembly of the TM is complete, documentation recording the results of bench tests will be collected for submission to JLab, along with the finished detector. Documentation will also be maintained on all procedures that were used during the construction. A detailed photographic record of the construction of the TM will be maintained. All of the aforementioned documentation will be made available in electronic form on UConn's wiki page.

6. Procurements

Procurement of parts for the TM are detailed in a separate document. All incoming material will be inspected and the results will be recorded in electronic form.

7. Quality Records

7.1. Inspection Records

Records will be maintained on all tests conducted throughout the construction and testing phase of the TM. These inspection records will be made available in electronic form on UConn's wiki page.

7.2. Calibration

The main calibration issue has to do with tracking the light yield of the laser diode pulses transmitted through the reference fiber. The reference fiber light yield will be recorded in terms of the mean pulse height observed with this fiber being read out by a particular readout channel in the dark box testing unit which employs the full-scale TM electronics. Fibers to be tested will be placed in the same fixture after the reference fiber is removed, so that all other gain factors (pulser amplitude, SiPM bias, amplifier gain, etc.) are common to both the test and reference measurements except the fibers themselves.

8. Personnel Qualification

The construction manager (James M^{c}Intyre) and lead technician (Ann Marie Carroll) will train the personnel involved in the construction and testing of the TM. The UConn group will establish training procedures for all repetitive tasks during the TM construction. Such tasks will include inspection, cutting, cleaning, fusing and bending of fibers, and light transmission tests. The fusing and bending steps include risk of burns to personnel, so specific safety equipment and training are devoted to this. Other training will be added as the UConn group sees fit.

In addition to the specialized training provided by the construction manager and lead technician, all personnel granted access to the construction labs are required to pass all training courses mandated by UConn Occupational Health & Safety which are applicable to the hazards found in these labs.

9. Non-Conforming Items

Since there are potential sources of non-conformity related to the mechanical tolerances and specifications of the TM, numerous parts will be checked and cataloged as previously stated. All non-conformities to the project will be reported to JLab and solutions will be sought by consultation.

10. Updates

This document will be revised, as the TM is built at UConn, to reflect the updated methods and procedures used in construction. A link to the updated version of this Google document will be maintained at:

http://zeus.phys.uconn.edu/wiki/index.php/Tagger_Microscope_%26_Active_Collimator_Construction

II. MICROSCOPE PREAMPLIFIER

1. Component inspection

1.1 Visual exam

Once the boards have been received from the manufacturer we will perform a visual exam to make sure all the components are properly attached and there are no obvious issues. This includes tombstoned components, missing components and solder bridges. A microscope will be used during the examination. The visual exam will not require measuring each component value but will require a pass/fail to be recorded in the Excel inspection spreadsheet.

1.2 Material certification and analyses

- The SiPM location tolerance is 0.2mm from the silkscreen outline**.**
- The low-voltage power supplies must be regulated to less than 10mV 60 Hz ripple at full operating current.
- The power supply used for the bias voltages must be able to supply at least 100 V at 1mA per channel with a 60 Hz ripple less than 50 mV.

2. Measuring the regulated voltages on the preamplifier board

2.1 Overview

This will be performed once the Eurocard and SiPMs have been soldered to the preamplifier. Power is supplied to the board through the Eurocard connector from the digital control board and backplane, and it is controlled by the voltage reference circuit. The circuit is designed to take the supplied voltage (VCC) and distribute the proper voltages (VCC_amp and VCC_sum) to their respective circuits.

2.2 Procedure

- Set the bias voltage for every SiPM to zero.
- Turn on the power supply.
- Set the power supply voltage to 5.84V.
- Use the Smart PDF of the circuit as a guide.
- Measure the voltage of the VCC via in the voltage reference sub-circuit. It should read 5.73V.
- Measure the VR1 via. It should read 3.65V.
- Measure the VR2 via. It should read 4.04V.
- Record in the Excel inspection spreadsheet whether the board passed or failed.
    - Any failed board must be inspected further and corrected. This process must be repeated until the board passes or an issue is found that is beyond the capabilities of UConn to resolve.

3. Measuring the dc operating points in the preamp circuit

3.1 Overview

The circuit board has been designed to have specific dc voltages to bias the transistors. If the dc level is wrong then the circuit will not work as planned and a pulse will not be amplified correctly. The measured values are to be compared with the provided values and are only to be recorded if there is a significant discrepancy; otherwise record that the board passes.

3.2 Procedure

- Once the power to the board is correct proceed to measure the crucial voltage points of both the individual and summing circuits.
- Use the Smart PDF of the circuit as well as the dc operating points Excel

spreadsheet containing expected voltages.

- For the individual channels measure Ampref first. It should match the value measured for VR1 in the previous section. If this value does not agree check the power supply voltage and see if it has changed.
- For the summed channels measure Sumref first. It should match the value measured for VR2 in the previous section.
- Proceed to measure the rest of the dc levels in both the individual and summer circuits. Record only values that differ greatly from the provided values. If all of the values agree record that the board has passed.
- If the levels differ significantly from the Excel sheet troubleshoot the board.
    - If the discrepancy is contained to one channel check the components of that channel. Compare resistor and capacitor values with other correct channels.
    - If all of the channels have the same discrepancy check the voltage reference circuit voltages.
    - Continue to troubleshoot until the board agrees with the provided values.

4. Low gain mode pulse shape

4.1 Overview

Low gain mode is the operational mode of the board. An input signal should produce a smooth peak with little to no overshoot on the return to the baseline.

4.2 Procedure

- Set the gain mode of the circuit to 5V (low gain mode).
- Set the bias voltage to the proper value for the first SiPM and leave the others set to zero. The bias voltages are listed in the supplied documentation.
- Attach the pulser circuit to the testing chamber.
- Supply 1.5V to drive the pulser circuit.
- Measure the output from both the single and summed output LEMO connectors. The signal should be well above the noise level. The rise and fall times should be approximately 2.0 +/- 1.0 ns and 12.0 +/- 3.0 ns, respectively.
- Repeat for each SiPM.

5. High gain mode pulse shape

5.1 Overview

The purpose of the high gain mode is in the preamplifier is to make it possible to see individual peaks corresponding to different numbers of pixels firing. The dark rate and cosmic ray measurements are conducted in this mode because the pixel statistics for these signals are small.

5.2 Procedure

- Install the x10 light attenuator over the pulser.
- Set the gain mode to 10V (high gain mode).
- Set the proper bias voltage for the first SiPM and set the others to zero.
- Using the pulser circuit measure the output from the summed output LEMO connector. The amplitude should be approximately the same as seen in low-gain mode, when the attenuator was not in place. The ratio of high/low gains seen with the pulser should be 10 +/- 1.
- The single pixel pulse height should be 12 +/- 2 mV.
- Repeat for each SiPM.

6. Electronic Crosstalk

6.1 Overview

Electronic crosstalk comes from circuits inducing currents in neighboring circuitry. This can affect the pulse shape and prevent the true signal from being measured.

6.2 Procedure

- Set the gain mode to 10V.
- Set the proper bias voltage for one SiPM and leave the others set to 0V.
- Measure the output from the neighboring un-biased SiPMs on the backplane, looking at the individual-channel outputs (using test pads on the backplane.)
- The signal should not change in the un-biased circuit when the pulser is turned on and off.
- If the signal changes when the pulser is turned on and off, note the amplitude of the change in the Excel spreadsheet.

7. Performance test

7.1 Overview

The first performance test requires measuring cosmic rays. This is performed to verify that enough pixels are firing in the SiPMs.

Due to the high current draw on the circuit each board when running in the tagger at high rate, all boards must be tested running at maximum draw for an extended period of time. This test will be carried out with a low-level dc light source in the fully assembled dark box, with the light level adjusted to simulate the average rate seen in the tagger when running at nominal intensity of 10^9 pixels/s/SiPM.

7.2 Cosmic ray test

- Bias every SiPM.
- Set the gain mode to 10V (high gain mode).
- Using the provided Labview program run a cosmic test, saving the data as a .dat file.
- Using the software developed at UConn, analyze the data using root.
- Verify that the most probable voltage corresponds to 150mV.

7.3 Final performance test

- Bias every SiPM.
- Set the gain mode to 5V (low gain mode).
- Turn on the regulated light source inside the fully instrumented dark box.
- Let it run for a month and check to see if all components continue to work properly after continuous operation.

III. BIAS CONTROL BOARD

1. Component inspection

1.1 Visual exam

Once the boards have been received from the manufacturer we will perform a visual exam to make sure all the components are properly attached and there are no obvious issues. This includes tombstoned components, missing components and solder bridges. A microscope will be used during the examination. The visual exam will not require measuring each component value but will require a pass/fail to be recorded in the Excel inspection spreadsheet.

1.2 Material certification and analyses

- The DAC must be capable of the following:
  - all channels should give the same voltage out in response to agiven DAC value to within +/- 0.1 V at zero current.

  - all channels should be able to supply up to 200 microAmps of current without sagging by more than 0.2 V from the level at zero current.
  - all channels should be able to supply up to 700 microAmps of current without sagging by more than 1.0 V from the level at zero current.
  - clock frequency should be 20 +/- 2.0 MHz.

2. Sending a packet to the FPGA

2.1 Overview

A packet is sent to the FPGA to configure the voltages supplied to the preamplifier board. This is sent via ethernet and the values are contained in a script titled *VbiasBoard#.rb*, where # corresponds to the board number.

2.2 Procedure

- Turn on all power supplies to their proper values supplied in the provided Excel spreadsheet.
- Run the provided file titled *StartPktLog.bat* in Windows command prompt.
- Using Cygwin terminal, navigate to the folder containing the scripts *sendpacket.rb* and *VbiasBoard#.rb*.
- To query the FPGA, type the following into the terminal: ./sendpacket.rb -q
- To set the voltage values, type the following into the terminal: ./sendpacket.rb -f VbiasBoard#.rb
- Once either command is sent a message should appear in the command prompt window providing the queried statistics or the voltage values, depending on which script was executed.
- If the packets are unsuccessful, check the voltages on the control board.

IV. MICROSCOPE READOUT BACKPLANE

1. Component inspection

1.1 Visual exam

Once the boards have been received from the manufacturer we will perform a visual exam to make sure all the components are properly attached and there are no obvious issues. This includes tombstoned components, missing components, bent pins and solder bridges. The backplane does not have many components and can be examined quickly. The visual exam will not require measuring each component value but will require a pass/fail to be recorded in the Excel inspection spreadsheet.

2. Visually examine the lemo connectors

2.1 Overview

The lemo connectors carry the output signal of the preamplifier board.

2.2 Procedure

- Once the lemo connectors have been soldered visually examine the pins on the bottom of the board.
- A properly soldered connector will have solder completely filling the well.

V. ACTIVE COLLIMATOR

1. Scope

The quality of the finished AC is judged by the quality of the electrical connection between the tungsten wedges and the external cabling, and the electrical isolation of the wedges from each other and the detector housing. Both of these features will be measured on the bench by injecting a small electrostatic charge from an external source onto each individual wedge, and measuring the decay time of the signal on the selected channel, and checking for any signals on the other channels that might appear due to crosstalk.

Document: D0000-19-02-S003 - *Specification of the active collimator and electronics*, contains the detailed specifications for the components of the AC which are subsequently referenced in this document. This document will be revised, as the AC is built at UConn, to reflect the updated methods and procedures used in construction.

2. Component Inspection Plan

2.1 Inspections for the Active Collimator

Upon receipt of the tungsten pincushions fabricated at FSU, technicians will perform a visual inspection of each wedge. The visual inspection will look for:

- Broken pins
    - Indicate the number of broken pins in the logbook

- Defects in the machined surfaces

In addition to the visual inspections, measurements will be taken and recorded in a logbook for the following dimensions/locations:

- Thickness
    - Along the center of the 4 sides (not including the pins)
    - Including the height of the pins

- Width
    - At both the narrow and wide ends

- Inner and outer radius difference
    - At each boundary and the center

After the assembly of each wedge in the ashtray, a visual inspection will be conducted to make certain that the wedge is positioned properly and the pins will not come in contact with the top lid.

2.2 Records

Throughout the construction and testing phase, various logbooks will be maintained by the UConn technicians. To ensure that the inspection data and recordings of all operator work sessions are readily traceable and available to JLab, UConn has established the following wiki page:

http://zeus.phys.uconn.edu/wiki/index.php/Tagger_Microscope_%26_Active_Collimator_Constructio
n

3. Process Quality Plan

3.1 Construction Plan

The Construction Plan developed by UConn for the active collimator contains step-by-step instructions for the different manufacturing processes needed during construction. This document and the web page previously mentioned contain detailed safety information and procedures for the operators to be aware of and follow during the construction and testing phase. Additionally the Construction Plan gives specific details on how to report mechanical defects and problems during the manufacturing process. The technicians are provided with both paper and electronic logbooks to record their work sessions and related job data, which can then be easily submitted to JLab electronically as required.

3.2 Methodology towards meeting the specifications during construction

The construction procedure for the AC has been well established with several tungsten wedges having already been installed and tested. Special care will be taken in regards to handling of the tungsten wedges to prevent damage to the brittle "pincushion" portion of the newly machined wedges.

In addition to the mandatory campus lab safety training program, all technicians will complete a thorough introductory training of all equipment prior to starting work in the lab.

4. Responsibilities

The construction of the AC will take place at UConn, where all tungsten wedges will be assembled and bench tests will be performed. Upon successful completion of testing, the unit will be transported to JLab for installation in Hall D and final testing.

UConn will be responsible for organizing and supervising the needed manpower and the completion of all phases of construction. The assembly and testing of the AC will be overseen by James M^{c}Intyre. He will be the construction manager for the AC. Support in construction, testing, and quality assurance will be provided by UConn laboratory technician Ann Marie Carroll and by undergraduate students under her supervision. Overall project supervision will be provided by Prof. Richard Jones.

The overall responsibility for the quality assurance and acceptance of the AC for shipment to JLab lies with the UConn group. Any quality problems identified by UConn and reported to JLab, will be resolved by consultation. Problems that can be rectified by UConn will be corrected prior to shipment. If the problems or non-conformance to specifications cannot be easily corrected, the course of action to be taken will be determined in consultation between UConn and JLab.

5. Document Control

Several pieces of documentation are needed during construction. After assembly of the AC is complete, documentation recording the results of bench tests will be collected for submission to JLab, along with the finished detector. Documentation will also be maintained on all procedures that were used during the construction. A detailed photographic record of the construction of the AC will be maintained. All of the aforementioned documentation will be made available in electronic form on

UConn's wiki page.

6. Procurements

Procurement of parts for the AC are detailed in a separate document. All incoming material will be inspected and the results will be recorded in electronic form.

7. Quality Records

7.1. Inspection Records

Records will be maintained on all tests conducted throughout the assembly and testing phase of the AC. These inspection records will be made available in electronic form on UConn's wiki page.

8. Personnel Qualification

The construction manager (James M^{c}Intyre) and lead technician (Ann Marie Carroll) will train the personnel involved in the construction and testing of the AC. The UConn group will establish training procedures for all tasks during the AC construction.

In addition to the specialized training provided by the construction manager and lead technician, all personnel granted access to the construction labs are required to pass all training courses mandated by UConn Occupational Health & Safety which are applicable to the hazards found in these labs.

9. Non-Conforming Items

Since there are potential sources of non-conformity related to the mechanical tolerances and specifications of the AC, numerous parts will be checked and cataloged as previously stated. All non-conformities to the project will be reported to JLab and solutions will be sought by consultation.

10. Updates

This document will be revised, as the AC is built at UConn, to reflect the updated methods and procedures used in construction. A link to the updated version of this Google document will be maintained at:

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