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Electron-Ion Collider, Brookhaven National Laboratory			
Doc No.	Author:	Effective Date: April 08, 2026	Review Frequency: None
Individual Quality Control Plan for WBS 6.03.01.04.01			Revision: 0

# Individual Quality Control Plan for WBS 6.03.01.04.01 (Backward Electromagnetic Calorimeter)

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### **REVISION HISTORY**

<b>Revision #</b>	<b>Effective Date</b>	<b>Additional Reviewers</b>	<b>Summary of Change</b>
00			Initial release.

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### **LIST OF ACRONYMS**

BNL	Brookhaven National Laboratory
EIC	Electron-Ion Collider
FRD	Functional Requirements Document
GRD	General Requirements Document
JLAB	Thomas Jefferson National Accelerator Facility
MIP	Manufacturing Inspection Plan
PRD	Performance Requirements Document
QC	Quality Control

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## Individual Quality Control Plan for WBS 6.03.01.04.01 (Backward Electromagnetic Calorimeter)

### 1. BACKGROUND & PURPOSE

Individual product Quality Control Plans are an extension of the overall Detector Systems Product Quality Control Plan and provide detailed descriptions of the quality control factors that are relevant to a specific product. Like all Quality Control Plans, they are required by the EIC Requirements Management Plan and are used to ensure that a system or deliverable will satisfy all pertinent requirements and specifications.

The plan should be developed in accordance with the requirements of the EIC Project Plans and Documents referenced in Table 1.

*Table 1. EIC Project Plans and Documents*

Document Name	Document Number
Integrated Safety Management Plan (ISMP)	EIC-ESH-PLN-007
Global Requirements Document (GLRD)	add document number
<a href="#">Requirements Management Plan (RMP)</a>	EIC-SEG-PLN-016
<a href="#">General, Functional, and Performance Requirements for the EIC Detector Systems</a>	EIC-SEG-RSI-007
Interface Requirements for the EIC Detector Systems	EIC-SEG-RSI-064
Interface Management Plan (IMP)	add document number
<a href="#">EIC Code of Record</a>	EIC-ORG-RSI-026
<a href="#">Configuration Management Plan</a>	EIC-ORG-PLN-025
EIC Quality Assurance Plan	EIC-QAG-PLN-002
Detector Systems Product Quality Control Plan	
<a href="#">Pressure Systems Design Authority</a>	JLAB ES&H Manual 6151
JLAB Conduct of Engineering Manual	ENG-AD-01-001

#### 1.1. Responsibilities

Per the Quality Assurance Plan, L3 Managers are responsible for developing Quality Control (QC) Plans for their areas of responsibility and are to ensure that:

- the plans are available and controlled,
- teams are working in accordance with the plans, and
- plans are review at an adequate frequency to identify need for change, or to support advance planning of acquisitions and procurements (whether tangible or services, like designs) from other providers (Vendors, In-Kind Contributors, Partners)

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## 1.2. Categories of Producers

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In general, all sub-systems and components in the Detector System will be obtained from one of three possible sources: vendor contract, institutional partner, or in-house construction. These sources are described in detail in the Detector Systems Product Quality Control Plan.

## 2. SCOPE OF QUALITY CONTROL PLAN

This Individual Quality Control Plan addresses the components within WBS 6.03.01.04.01 (Backward Electromagnetic Calorimeter) that require supplemental documentation beyond what is provided in the Detector Systems Product Quality Control Plan. This section will identify the pertinent components or assemblies within the WBS that are covered by this plan, and will identify the category of provider (vendor contract, institutional partner, or in-house construction), and the approach for quality assurance that will be used for that product.

### 2.1. Lead Tungstate Crystal

---

This component is composed of multiple sub-components, each of which has their own quality assurance requirements which are detailed in this document. These include:

- Manufacturing
- Acceptance Testing
- Extended Testing (20%)

#### **The following quality control measures are required:**

- |                                                        |             |
|--------------------------------------------------------|-------------|
| ▪ In-Process Inspection and Test                       | Section 4/5 |
| ▪ Incoming Inspection and Acceptance Test              | Section 6   |
| ▪ Travelers, Procedures, and Checklists                | Section 7   |
| ▪ Verification Plans, Methods, and Activities          | Section 8   |
| ▪ Deliverable Documentation and Records                | Section 9   |
| ▪ Serialization and Material Traceability Requirements | Section 12  |
| ▪ Planned Partner and Vendor Communication & Visits    | Section 13  |
| ▪ Control of Nonconformances                           | Section 14  |
| ▪ Packaging/Transportation/Shipping                    | Section 15  |

### 2.2. Silicon Photomultipliers

---

This component is composed of multiple sub-components, each of which has their own quality assurance requirements which are detailed in this document. These include:

- Manufacturing
- Acceptance Testing

#### **The following quality control measures are required:**

- |                                           |             |
|-------------------------------------------|-------------|
| ▪ In-Process Inspection and Test          | Section 4/5 |
| ▪ Incoming Inspection and Acceptance Test | Section 6   |

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- Verification Plans, Methods, and Activities Section 8
- Deliverable Documentation and Records Section 9
- Serialization and Material Traceability Requirements Section 12
- Control of Nonconformances Section 14
- Packaging/Transportation/Shipping Section 15

### 2.3. SiPM Board

This component is composed of multiple sub-components, each of which has their own quality assurance requirements which are detailed in this document. These include:

- Board Assembly
- Acceptance Testing

#### **The following quality control measures are required:**

- In-Process Inspection and Test Section 4/5
- Incoming Inspection and Acceptance Test Section 6
- Travelers, Procedures, and Checklists Section 7
- Verification Plans, Methods, and Activities Section 8
- Deliverable Documentation and Records Section 9
- Serialization and Material Traceability Requirements Section 12
- Control of Nonconformances Section 14
- Packaging/Transportation/Shipping Section 15

## 3. REQUIREMENTS TRACEABILITY

Requirement traceability will be accomplished as described in Section 3 of Detector Systems Product Quality Control Plan.

## SPECIFIC QUALITY CONTROL MEASURES

### 4. IN-PROCESS INSPECTION AND TEST

In-process inspections and tests for components **built in-house** provide a mechanism for detecting non-conformances in materials, components, or assemblies during fabrication and assembly. This allows problems to be identified and corrected as early as possible, minimizing the impact of manufacturing deficiencies.

Test plans, technical reports, test results, and other documentation resulting from these inspections and tests will be compiled into a report and placed in the central data repository. The document will be referenced through the document index on the EIC Systems Engineering portal.

#### 4.1. Lead Tungstate Crystal

This component is composed of multiple sub-components/activities which have independent quality control parameters.

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#### 4.1.1. Acceptance Testing

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- In Process Inspections

This component will be constructed in-house and is subject to in process inspections. Details are provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

- Documentation Deliverables

Test plans, technical reports, test results and other documentation will be produced from the inspections and tests, and must be provided to the project. Details are provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

#### 4.1.2. Extended Testing (20%)

---

- In Process Testing

This component will be constructed in-house and is subject to in process testing. Details are provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

- Documentation Deliverables

Test plans, technical reports, test results and other documentation will be produced from the inspections and tests, and must be provided to the project. Details are provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

#### 4.2. Silicon Photomultipliers

---

This component is composed of multiple sub-components/activities which have independent quality control parameters.

##### 4.2.1. Acceptance Testing

---

- In Process Inspections

This component will be constructed in-house and is subject to in process inspections. Details are provided in the reference: Silicon Photomultiplier Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/SiPM/SiPM-ITP.pdf>

### 5. OUTSOURCING: VENDOR/PARTNER/CONTRIBUTORS IN-PROCESS

In-process inspections and tests for outsourced components will be addressed differently for each category of providers. In all cases that tests and inspections are required, a test plan will be developed and approved by the project.

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Test plans, technical reports, test results, and other documentation resulting from these inspections and tests will be compiled into a report and provided to the project as part of the deliverable. This report will be reviewed, validated, and then placed in the central data repository. The document will be referenced through the document index on the EIC Systems Engineering portal.

### **5.1. Lead Tungstate Crystal**

---

This component is composed of multiple sub-components/activities which have independent quality control parameters.

#### **5.1.1. Manufacturing**

---

This component will be produced as part of a vendor contract and the inspections and tests are identified in the Statement of Work. Additional information is provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

### **5.2. Silicon Photomultipliers**

---

This component is composed of multiple sub-components/activities which have independent quality control parameters.

#### **5.2.1. Manufacturing**

---

This component will be produced as part of a vendor contract and the inspections and tests are identified in the Statement of Work. Additional information is provided in the reference: Silicon Photomultiplier Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/SiPM/SiPM-ITP.pdf>

### **5.3. SiPM Board**

---

This component is composed of multiple sub-components/activities which have independent quality control parameters.

#### **5.3.1. Board Assembly**

---

This component will be produced as part of a vendor contract and the inspections and tests are identified in the Statement of Work. Additional information is provided in the reference: SiPM Board and Daughter Board Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/ECAL/EEEMCal%20SiPM%20Board%20and%20Daughter%20Board%20ITP.pdf>

#### **5.3.2. Acceptance Testing**

---

This component will be produced by an industry partner using in-kind labor and the inspections and tests are identified in the Work Agreement. Additional information is provided in the reference: SiPM Board and Daughter Board Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/ECAL/EEEMCal%20SiPM%20Board%20and%20Daughter%20Board%20ITP.pdf>

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## 6. INCOMING INSPECTION AND ACCEPTANCE TESTS

Incoming inspections and acceptance tests are used to confirm that materials or products provided by a vendor or partner institution have been produced in accordance with the plans and specifications, and meet all system requirements. These plans should be developed in conjunction with the transportation and shipping plans to account for potential impacts of moving items between locations.

Incoming inspections and acceptance tests will be addressed differently for each category of providers. These documents identify the schedule and frequency of such tests, how the results will be reported, and which material and documentation should be supplied to the project with the deliverable.

Test plans, technical reports, test results, and other documentation resulting from these inspections and tests will be compiled into a report and placed in the central data repository. The document will be referenced through the document index on the EIC Systems Engineering portal.

### 6.1. Lead Tungstate Crystal

---

This component is composed of multiple sub-components/activities which have independent quality control parameters.

#### 6.1.1. Manufacturing

---

This component will be produced as part of a vendor contract and the inspections and tests are identified in the Statement of Work. Additional information is provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

### 6.2. Silicon Photomultipliers

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This component will be produced as part of a vendor contract and the inspections and tests are identified in the Statement of Work. Additional information is provided in the reference: Silicon Photomultiplier Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/SiPM/SiPM-ITP.pdf>

### 6.3. SiPM Board

---

This component will be produced by an industry partner using in-kind labor and the inspections and tests are identified in the Work Agreement. Additional information is provided in the reference: SiPM Board and Daughter Board Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/ECAL/EEEMCal%20SiPM%20Board%20and%20Daughter%20Board%20ITP.pdf>

## 7. TRAVELERS, PROCEDURES, AND CHECKLISTS

For every item that is manufactured, the manufacturer will be responsible for maintaining records (travelers) of all raw material that are used in the fabrication process, and document the processes and procedures that were used for production. The resultant documentation will be compiled into a report and will be provided to the project as part of the deliverable. This report will be reviewed, validated, and then placed in the

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central data repository. The document will be referenced through the document index on the EIC Systems Engineering portal.

## 7.1. Lead Tungstate Crystal

---

This component is composed of multiple sub-components/activities which have independent quality control parameters.

### 7.1.1. Manufacturing

---

- In Process Inspections

The project will require records of how the materials were acquired, transported, maintained, or disposed. Details are provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

- Production/Fabrication Process Records

The project will require records for the production, fabrication, or manufacturing process. Details are provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

## 7.2. SiPM Board

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- In Process Inspections

The project will require other travelers, procedures, or checklists that are not covered in the preceding sections. Details are provided in the reference: SiPM Board and Daughter Board Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/ECAL/EEEMCal%20SiPM%20Board%20and%20Daughter%20Board%20ITP.pdf>

## 8. VERIFICATION PLANS: METHODS AND ACTIVITIES

Verification plans are used to coordinate the orderly scheduling of events by providing equipment specifications and organizational requirements, the test methodology to be employed, a list of the test materials to be delivered, and a schedule for user (tester) orientation and participation. Finally, it provides a written record of the required inputs, execution instructions, and expected results of the system test.

The resultant documentation will be compiled into a report and will be provided to the project as part of the deliverable. This report will be reviewed, validated, and then placed in the central data repository. The document will be referenced through the document index on the EIC Systems Engineering portal.

### 8.1. Lead Tungstate Crystal

---

This component is composed of multiple sub-components/activities which have independent quality control parameters.

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### 8.1.1. Acceptance Testing

---

- In-House Verification

This component will be produced in-house and will be subject to an internal verification. Details are provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

### 8.1.2. Extended Testing (20%)

---

- In-House Verification

This component will be produced in-house and will be subject to an internal verification. Details are provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

## 8.2. Silicon Photomultipliers

---

- In-House Verification

This component will be produced in-house and will be subject to an internal verification. Details are provided in the reference: Silicon Photomultiplier Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/SiPM/SiPM-ITP.pdf>

## 8.3. SiPM Board

---

- External Verification

This component will be produced as part of a vendor contract and the verification plans are identified in the Statement of Work. Additional information is provided in the reference: SiPM Board and Daughter Board Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/ECAL/EEEMCal%20SiPM%20Board%20and%20Daughter%20Board%20ITP.pdf>

### 8.3.1. Acceptance Testing

---

- External Verification

This component will be produced by an industry partner using in-kind labor and the verification plans are identified in the Work Agreement. Additional information is provided in the reference: SiPM Board and Daughter Board Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/ECAL/EEEMCal%20SiPM%20Board%20and%20Daughter%20Board%20ITP.pdf>

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## 9. DELIVERABLE DOCUMENTATION AND RECORDS

Documentation and records that must be provided to the project is specified in the Statement of Work, Project Planning Document, work agreement, or work planning documents identified in the preceding sections. All testing and inspection data that is collected as part of the validation, verification and testing plan will be provided to the project as part of the final report.

## 10. ASSOCIATED EQUIPMENT

Associated equipment describes tools, parts, materials, components, fixtures and assemblies that are independent of the final product. Any associated equipment that must be delivered to the project is identified in the Statement of Work, Project Planning Document, work agreement, or work planning documents identified in the preceding sections. Conditions of acceptance of this material will be described in the validation, verification and testing plan.

Associated equipment that is required for in-house testing is as follows:

**This section is not applicable.**

## 11. CALIBRATION PLANS

Vendors, partners, and employees shall calibrate any measuring and test equipment used in production or testing against certified standards that are traceable to national standards such as the National Institute of Standards and Technology (NIST), or an international standard, or a physical constant. Specific requirements for calibration plans are described in the Detector Systems Product Quality Control Plan.

**This section is not applicable.**

## 12. SERIALIZATION AND MATERIAL TRACEABILITY REQUIREMENTS

Requirements for serialization of parts and materials are as described below.

### 12.1. Lead Tungstate Crystal

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This component is composed of multiple sub-components/activities which have independent quality control parameters.

#### 12.1.1. Manufacturing

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Serialization of this component is required by Contract. Documentation can be obtained from the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

#### 12.1.2. Acceptance Testing

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This component cannot be serialized because it would degrade overall detector performance. No serialization will be performed.

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Doc No.	Author:	Effective Date: April 08, 2026	Review Frequency: None
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### **12.1.3. Extended Testing (20%)**

This component cannot be serialized because it would degrade overall detector performance. No serialization will be performed.

## **12.2. Silicon Photomultipliers**

Serialization of this component is required by Contract. Documentation can be obtained from the reference: Silicon Photomultiplier Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/SiPM/SiPM-ITP.pdf>

### **12.2.1. Acceptance Testing**

This component cannot be serialized because it would degrade overall detector performance. No serialization will be performed.

## **12.3. SiPM Board**

Serialization of this component is required by Contract. Documentation can be obtained from the reference: SiPM Board and Daughter Board Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/ECAL/EEEMCal%20SiPM%20Board%20and%20Daughter%20Board%20ITP.pdf>

### **12.3.1. Acceptance Testing**

This component cannot be serialized because it would degrade overall detector performance. No serialization will be performed.

## **13. PLANNED PARTNER AND VENDOR COMMUNICATION & VISITS**

Periodic program technical and progress telecommunications and/or meetings between the vendors/partners and project leaders will be conducted to discuss work progress, technical and contractual questions, presentations of analysis or testing results, troubleshooting, material status, tooling status, resources, and manufacturing issues. The schedule and frequency of these communications is described below.

In addition to the information provided here, technical updates and progress reports may also be provided at the regularly scheduled detector collaboration meetings. The schedule is available at <https://indico.bnl.gov/category/402/calendar>.

### **13.1. Lead Tungstate Crystal**

This component is composed of multiple sub-components/activities which have independent quality control parameters.

#### **13.1.1. Manufacturing**

The communication schedule for this component is provided in the Statement of Work. Additional information is provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

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## 14. CONTROL OF NONCONFORMANCES

Vendors, partners, and in-house providers are responsible to provide items which conform to the requirements of the contract or work agreement, regardless of any assessments, surveillances, inspections and/or tests that are conducted as part of the validation and verification process. Non-conformances, significant variations in quality, recalls, and alerts will be reported to the project.

## 15. PACKAGING/TRANSPORTATION/SHIPPING

In preparation for shipping, a packaging plan will be developed that will be reviewed and approved by the project prior to shipment. Preservation, packaging, and packing for shipment or mailing of all work deliverables shall be in accordance with standard commercial practice and adequate to insure acceptance by common carrier and safe transportation at the most economical rates.

Packaging plans must comply with the standards established in the Detector Systems Product Quality Plan.

### 15.1. Lead Tungstate Crystal

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This component is composed of multiple sub-components/activities which have independent quality control parameters.

#### 15.1.1. Manufacturing

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The packaging plan for this component is included in the Statement of Work. Additional information is provided in the reference: Lead Tungstate Inspection and Test Plan, which is available from the link below:

[https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4\\_ITP.pdf](https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/PbWO4/PbWO4_ITP.pdf)

### 15.2. Silicon Photomultipliers

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The packaging plan for this component is included in the Statement of Work. Additional information is provided in the reference: Silicon Photomultiplier Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/GEN/SiPM/SiPM-ITP.pdf>

### 15.3. SiPM Board

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The packaging plan for this component is included in the Statement of Work. Additional information is provided in the reference: SiPM Board and Daughter Board Inspection and Test Plan, which is available from the link below:

<https://eic.jlab.org/Documents/DET/Quality/ITP/ECAL/EEEMCa%20SiPM%20Board%20and%20Daughter%20Board%20ITP.pdf>

#### 15.3.1. Acceptance Testing

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The packaging plan for this component is included in the Formal Agreement. Additional information is provided in the reference: SiPM Board and Daughter Board Inspection and Test Plan, which is available from the link below:

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<b>Electron-Ion Collider, Brookhaven National Laboratory</b>			
<b>Doc No.</b>	<b>Author:</b>	<b>Effective Date:</b> April 08, 2026	<b>Review Frequency:</b> None
<b>Individual Quality Control Plan for WBS 6.03.01.04.01</b>			<b>Revision:</b> 0

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