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| Beam Lines Beam Position Monitors AIP  **BASIS of ESTIMATE FORM (BoE)** | **Document Number:** Mu2e-doc-1577  **Date of Estimate:** 5/3/12  **Prepared by:**  Peter Prieto, Brian Drendel |

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| WBS Category Number: MuAIP.02.03.02  WBS Category Name: Beam Line Beam Position Monitor  Control Account (number and name): |
| Costing Method:  \_\_\_ Existing P.O. \_\_\_ Prior Experience (source: )  \_\_\_ Catalog Listing / Vendor Quote \_\_\_ Expert Opinion  \_\_\_ Budgetary Estimate \_\_\_ Pre-conceptual Design  \_X\_ Engineering Experience \_\_\_ Other (description: ) |
| External Supporting Documents: B. Drendel, P. Prieto, “Beam Line and Beam Lines BPM upgrades for Mu2e,” Mu2e Documents Database #2230, May 1, 2012 |

Update the Beam Lines Beam Position Monitors to enable beam position measurements for g-2 and Mu2e operations in the P1, P2, M1, M2, M3 and Debuncher Abort beam lines. Modify existing electronics, hardware and cabling to meet updated performance requirements.

**Preliminary Design:**

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| WBS Category Name: Preliminary Design of infrastructure improvements to the beam lines |
| Costing Method:  \_\_\_ Existing P.O. \_\_\_ Prior Experience (source: )  \_\_\_ Catalog Listing / Vendor Quote \_\_\_ Expert Opinion  \_\_\_ Budgetary Estimate \_\_\_ Pre-conceptual Design  \_X\_ Engineering Experience \_\_\_ Other (description: ) |

The preliminary design will continue to develop requirements and specifications for improvements and upgrades to components/hardware and provide data for completing the design effort. The information will also establish data for use by project management to determine a high confidence level in the specifications. Effort will focus on providing documentation to determine if the proposed design meets project requirements.

**Preliminary Design Labor:**  Costing was determined via consultation Accelerator Division Instrumentation Engineers and is detailed in the supporting documentation1. Contingencies follow labor contingency rule #3.

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| **Activity ID** | **Description** | **Resource ID**  **(mu2e-doc-1305)** | **Base Est.**  **(hours)** | **Cont.**  **(%)** | **Base Est. + Cont.**  **(hours)** |
| MuAIP.02.03.02.02 | Engineering design and oversight | FNAD.ENGNRING.PHYST (Engineering Physicist) | 20 | 30% | 26 |
| MuAIP.02.03.02.02 | System Design  (Conceptual Design?) | FNAD.ELTN.DESIGN.EN (Electronics Engineer) | 20.25 | 30% | 26.33 |
| MuAIP.02.03.02.02 | Modify 2.5MHz Transition Board s for use in M1, M2 and M3. | FNAD.ELTN.TECH (Electronics Technician) | 112 | 30% | 145.6 |
| MuAIP.02.03.02.02 | 2.5MHz Transition Boards for DR abort line. | FNAD.ELTN.DESIGN.EN  (Electronics Engineer) | 0.75 | 30% | 0.98 |
| MuAIP.02.03.02.02 | BPM Software design | FNAD.APDEV.SYSTMAYST (Computer Professional) | 200 | 30% | 260 |
| MuAIP.02.03.02.02 | Digital Downconverter software design | FNAD.ELTN.DESIGN.EN (Electronics Engineer) | 2.5 | 30% | 3.25 |

(labor estimates assume 85% efficiency)

**Final Design Labor:**

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| WBS Category Name: Final Design of infrastructure improvements to the beam lines |
| Costing Method:  \_\_\_ Existing P.O. \_\_\_ Prior Experience (source: )  \_\_\_ Catalog Listing / Vendor Quote \_\_\_ Expert Opinion  \_\_\_ Budgetary Estimate \_\_\_ Pre-conceptual Design  \_X\_ Engineering Experience \_\_\_ Other (description: ) |

The final design will provide the documents necessary to repurpose and upgrade required components/hardware. Effort will focus on finalization of documentation.

**Final Design Labor:** Costing was determined via consultation Accelerator Division Instrumentation Engineers and is detailed in the supporting documentation1. Contingencies follow labor contingency rule #3.

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| **Activity ID** | **Description** | **Resource ID**  **(mu2e-doc-1305)** | **Base Est.**  **(hours)** | **Cont.**  **(%)** | **Base Est. + Cont.**  **(hours)** |
| MuAIP.02.03.02.03 | Engineering design and oversight | FNAD.ENGNRING.PHYST (Engineering Physicist) | 20 | 30% | 26 |
| MuAIP.02.03.02.03 | System integration and manufacture | FNAD.ELTN.TECH (Electronics Technician) | 37.5 | 30% | 48.75 |

(labor estimates assume 85% efficiency)

**Implementation:**

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| WBS Category Name: Implementation of infrastructure improvements to the beam lines |
| Costing Method:  \_\_\_ Existing P.O. \_\_\_ Prior Experience (source: )  \_\_\_ Catalog Listing / Vendor Quote \_\_\_ Expert Opinion  \_\_\_ Budgetary Estimate \_\_\_ Pre-conceptual Design  \_X\_ Engineering Experience \_\_\_ Other (description: ) |

Implementation will include the installation of components and hardware necessary to support a fully functioning system. Effort will involve repurpose and refurbishing of components to meet project requirements. Included will be the installation and testing of items to ensure functionality.

**Implementation M&S and Labor:** Costing was determined via consultation Accelerator Division Instrumentation Engineers and is detailed in the supporting documentation1. Contingencies follow labor contingency rule #3. M&S contingencies were determined by M&S contingency rule #5.

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| **Activity ID** | **Description** | **Resource ID**  **(mu2e-doc-1305)** | **Base Est.**  **(hours)** | **Cont.**  **(%)** | **Base Est. + Cont.**  **(hours)** |
| MuAIP.02.03.02.04 | BPM Electronics | FN.M&S.STND | $12.745K | 40% | $17.84K |
| MuAIP.02.03.02.04 | Engineering design and oversight | FNAD.ENGNRING.PHYST (Engineering Physicist) | 25 | 30% | 33 |
| MuAIP.02.03.02.04 | Installation and commissioning | FNAD.ELTN.DESIGN.EN (Electronics Engineer) | 72 | 30% | 94 |
| MuAIP.02.03.02.04 | Installation and commissioning | FNAD.ELTN.TECH  (Electronics Technician) | 19.75 | 30% | 25.7 |
| MuAIP.02.03.02.04 | Documentation | FNAD.ELTN.DESIGN.EN (Electronics Engineer) | 80 | 30% | 104 |

(labor estimates assume 85% efficiency)

**Additional Background Information**

This Basis of Estimate covers

1. P1, P2, M1 (AP1) and M3 (AP3) lines have an Echotek-based BPM system , no software is required for these lines. It is based on detecting 2.5MHz single bunch on a single pass by digitizing at 80 MHz.
2. Hardware changes to the 2.5 MHz channel to handle the input signal level consist on adding an external attenuator at the top plate for each BPM pickup.
3. The Debuncher Abort line has 8 BPM’s. It will require two 2.5 MHz recycler transition boards and two 8 channel echotek boards. It will need 1 VME64X -9 channel slot crate, one MVME5500 processor and one timing board.

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| M&S Totals | | |
|  | Quantity | Total Cost ($) |
| MVME5500 processors | 1 | 3,750.00 |
| VME64X Crates | 1 | 6,000.00 |
| D/ATransition Boards from RR | 2 | 0.0 |
| Accumulator Abort Line Transition Boards | 0 | 0 |
| DeBuncher Abort Line Transition boards | 2 | 600.00 |
| Timing Boards | 3 | 0 |
| Echotek DownConverter Boards | 5 | 0.0 |
| Top Plates for Racks | 1 | 600.00 |
| Cables, Top Plate to Transition Boards | 34 | 510.00 |
| Cables, Transition Boards to Echoteks | 34 | 510.00 |
| Cables, Timing board to Echoteks | 5 | 75.00 |
| Cables, Clock from timing to Echoteks | 4 | 100.00 |
| Miscellanous Connectors, cables |  | 400.00 |
| Parts for P1, P2, M1, M3 , AP3 Transition modules | 390 | 200.0 |
| Totals |  | 12,745.00 |

References:

1. B. Drendel, P. Prieto, “Beam Line and Beam Lines BPM upgrades for Mu2e,” Mu2e Documents Database #2230, May 1, 2012