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| **Project Name:** | **sPHENIX Time Projection Chamber** | **Date Issued:** | **11/08/2022** |
| **WBS/Control Account Number:** | **WBS 1.2** | | |
| **Control Account Manager Name (CAM):** | **Thomas Hemmick** | | |
| **Control Account Title:** | **Time Projection Chamber** | | |

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| **Purpose:** |
| The purpose of this form is to document acknowledgement by authorized Control Account Manager and Project Manager that work has been completed as defined in the WBS Dictionary for the above Control Account and the corresponding system KPPs (defined in PEP/PMP) are met.  By answering YES to the following questions, you acknowledge all work has been completed and reconciles with the WBS Dictionary. Sign, date and return this form to Project Controls attention Chris Herbst, Bldg 490.  If NO is checked, please use the space below to provide details on all required modifications (additions and deletions) to the WBS Dictionary. Sign, date and return this form to Project Management Center (attention Chris Herbst, Bldg 490.) |

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| **Scope Baseline:** |
| WBS Dictionary (as per latest baseline): The Time Projection Chamber For The sPHENIX Experiment At RHIC.  The Time Projection Chamber (TPC) is organized as one large gas volume with a central high voltage membrane and two endcaps containing signal amplification chambers, realized using Gaseous Electron Multiplier (GEM) chambers. The GEM chambers are organized in 12 azimuthal sectors per endcap, with three radial segments. Each GEM includes 4 amplification stages and a highly-segmented readout cathode. The cathode segmentation is realized with a zig-zag strip pattern to better interpolate position of incident signal electrons. The cathodes include signal feedthroughs connecting to electronics readout cards, each of which processes 256 electrode channels. The overall segmentation results in 6,8 and 12 readout cards needed for the first, second and third radial segments per azimuthal sector, for a total of 26 readout cards per sector, 312 readout cards per endcap, or 624 readout cards total, for a total of 159,744 readout channels. The readout cards include 8 copies each of a preamp/amplifier/FADC chip known as SAMPA which was customized from an existing design and mass-produced for the TPC. The readout cards communicate via high-speed fiber optic digital cables to high-speed interface card, denoted the FELIX card, which was developed for another experiment (ATLAS at the CERN LHC) and mass produced in quantity for the TPC readout. The FELIX cards in turn are hosted by commercial PCs with high speed busses, the Event-Buffering-and- Data Compression computers, or EBDCs, located in the Bldg. 1008 rack room. The TPC requires a controlled gas mixture which is delivered from the sPHENIX gas house via an existing gas-mixing panel which was adapted for the sPHENIX experiment. The electronics cards on the TPC are cooled by custom cooling plates that fit to the edges of the readout electronics cards and are cooled by fluid circulated and chilled by a dedicated chiller system. The calibration of the TPC position is monitored by a system of 8 “line lasers” which can direct laser beams through a system of custom optics, light-beam steering and light pipes to most parts of the TPC internal volume though a set of optical ports on the two TPC endcaps. |
| System KPPs (Objective and Threshold; as per latest baseline)  Live channels: (preinstall, bench tests)  Threshold: ≥90% live channels based on laser, pulser, cosmics  Objective: ≥95% live channels based on laser, pulser, cosmics  Ion back flow (preinstall, bench tests):  Threshold: ion back flow ≤2% per GEM module avgd over active area of ea GEM module  Objective: Same  Single hit efficiency (preinstall, bench tests w/ cosmics)  Threshold: ≥90% single hit efficiency/mip track, averaged over active TPC volume  Objective: ≥95% single hit efficiency/mip track, averaged over active TPC volume  Cross talk (preinstall, FEE stand alone bench tests)  Threshold: Cross talk of ≤2% per channel averaged over all channels  Objective: Same |

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| **KPPs achieved:** |
| Explain the KPPs achieved and how it is demonstrated. (Attach test results/ reports where applicable)  (See attached slides) |

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| **Cost Baseline:** | | | | | | | | |
| Control Account Baseline Cost: $5,676,429 | | | | | | | | |
| Control Account Actual Cost: $5,359,653 | | | | | | | | |
| Control Account CPI: 1.05 | | | | | | | | |
| Estimate to Complete: $2,327 | | | | | | | | |
| Summary of cost overrun/ underrun:  The CV currently appears to be positive by some $279K. However, there are currently some $214K of unpaid invoices which will reduce this to more like +$65K, resulting in a final CPI of 1.02. | | | | | | | | |
| **Questions: [*Check Yes or No]*** | | | | | | | |
| 1. Is all work scope for this Control Account complete (all activities per the project baseline attached to this form) | | | | | | | |
|  | Yes | | |  | | No | [If NO, indicate required actions in the below table] |
| 2. Does the WBS Dictionary accurately represent the work completed? | | | | | | | |
|  | Yes | |  | | No | | [If NO, explain in the below table] |
| 3. Any scope (affecting system KPPs) removed from project baseline after necessary approvals? | | | | | | | |
|  | Yes |  | | | No | | [If NO, reference the baseline change document in the table below] |
| 4. Any scope (not affecting the system KPPs) removed from project baseline after necessary approvals? | | | | | | | |
|  | Yes |  | | | No | | [If NO, reference the baseline change document in the table below] |

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| **Notes and Required Actions:** |
| 1. Activities required to complete all work in this Control Account, with expected finish dates: The high voltage cards must be installed onto the TPC main chamber. Then all 624 FEE cards must be installed and checked sector by sector, 26 cards per sector and 24 sectors in all. The chamber must then be operated with its fill gas to measure minimum ionizing particles to complete the third KPP noted above. After this the TPC must be moved to BNL. |
| 1. WBS Dictionary requires the following changes: None |
| 1. The following scope (affecting system KPPs) has been removed from project baseline (Note: Prior approval required, refer baseline change documentation): None |
| 1. The following scope (not affecting system KPPs) has been removed from project baseline (Note: Prior approval required, refer baseline change documentation): The diffuse laser and its coupling fiber bundle were removed from the RLS via PCR-034A, to remove the scope, and PCR-035A, to remove the cost from the Total Project Cost, in July and August of 2022, respectively. The diffuse laser system is a backup calibration system added for calibration redundancy earlier in PCR-031A in March of 2022. |

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| **Acknowledgements:** | | | | |
| I acknowledge all work is complete as defined in the WBS Dictionary and the system KPPs have been met for this Control Account.  Any remaining cost on this Control Account has been estimated thoroughly and documented in this report. | | | | |
| **Acknowledgement by CAM** | |  | **Acknowledgement by Project Manager** | |
| **CAM Name:** | **Thomas Hemmick** | **Project Manager:** | Glenn Young |
| **Signature:** |  | **Signature:** |  |
| **Date:** |  | **Date:** |  |

Attachments:

1. P6 baseline
2. Current working file (with baseline attached)
3. Test results/ reports (if applicable)