**High Voltage System QA/QC Plan (Insert the subsystem that is covered by this plan in the place of High Voltage System)**

**Purpose and Scope: (Purpose and scope could be to enusre that the the subsystem meet the specification requirements and scope is detailing a description of the magnets.)**

The HVS QA/QC Plan is based on all of the work done in preparation for a large TPC operated in liquid Argon and especially on the experience and lessons learned from development and operation of ProtoDUNE SP at CERN. The components of the ProtoDUNE HV system have been operated continuously and successfully since its initial HV ramp-up in September 2018.

High Voltage requirements consist of:

* Testing of power supplies verifying voltage and current outputs
* Voltage Divider Board resistor and varistor testing of current-voltage measurments at warm

and cold (87 K)

* Visual inspection of all electrical components for mechanical damage
* Visual inspection of all mechanical components for mechanical damage
* Measurements of dimensions ensuring that components are built to design specifications and tolerances
* Use of sequences of temporary coded tags that provide a traceable link of all QC data to a particular installation location in the DUNE cryostat.

**Specifications, Drawings and Procedures: (List of applicable specifications, drawings and/or procedures that includel the QA/QC requirements**)

1. **Components being inspected or tested:**
2. HV Power supply, HV Feedthrough and HV Filters
3. Voltage divider board resistors and varistors at several stages in production and installation
4. Electrical connections
5. Mechanical dimensions and connections
6. **Description of QC inspections and tests:**
7. Power supplies – Initial ramp-up testing of the Power supply. Output voltages and currents are checked on a known load. HV Feedthrough is verified to hold the required voltage in time projection chamber (TPC)-quality liquid argon (LAr) for several days. Testing of filters at operating voltage meets noise requirements (maximum ripple on output voltage).
8. Voltage Divider Boards - All individual resistors and varistors are submitted to a warm and cold (87 K) current-voltage measurement. All measurement values (resistance, clamping voltage) must be within 2 sigma of the mean for the entire sample both in warm and cold tests.
9. Electrical connections

* Torque specifications on all electrical connections are met at production and installation stages
* Visual inspection of all electrical connections is done checking for mechanical damage

These are required and included in checklists on:

* HV Bus cables and connections around the CPA
* Jumper connections between CPA modules, Panels and Planes
* Connections between Field Shaping Strips (FSSs) on CPA
* Connections between CPA and FCs
* Connections between CPA and EWs
* Resistor Divider Board connections on FCs and EWs

1. Mechanical dimensions and connections – included in checklists are:

* Visual inspection of all mechanical components checking for mechanical damage
* Measurements of critical dimensions ensuring that tolerance specifications are met for size, straightness and flatness
* Inspection of mechanical connections of components

1. **Location of inspections and tests: (This may be at a Supplier’s facility, the Institution’s facility and/or upon receipt or installation at Fermi).**
2. Material receiving sites: Power supply, feedthrough and filters, Voltage divider board resistor and varistor, Visual inspections, Mechanical dimensions, Electrical properties (e.g., resistivity of coated parts)
3. Production site: Mechanical dimensions, Electrical connections on components
4. Warehouse site: Only visual inspection of shipping crates is anticipated
5. Cavern clean room assembly: Mechanical dimensions, Electrical connections on and between components
6. Cryostat final position: Power supply feedthrough, Electrical connections between components, Final linked temporary tag identifying position in cryostat and containing links to all previous temporary tags and checklists
7. **Technical justification of inspections and tests: (Describe what is reasoning behind the required inspection and tests).**

* Ensure HV supply specifications of voltage, current, ripple and continuity are met
* Ensure connections on voltage divider boards maintain continuity and that resistors and varistors are of correct value
* Ensure that all electrical connections are present and properly made
* Ensure that mechanical dimensions meet specifications and that all connections are properly made

1. QC Documentation **(Describe how process, inspections and tests are going to be documented, either test reports, travelers, or similar documents. Describe which documents will be provided with shipment.)**