Assembly and Testing Procedures for RPC Components and Subassemblies in the RPC Factory

PHENIX Procedure No. PP-2.5.2.15-03

Revision: _A______ **Date: 1/30/2008_**

Hand Processed Changes

HPC No.	Date	Page Nos.	Initials

Approvals

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PHENIX S E & I Date

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Cognizant Scientist/Engineer /Activity Manager Date

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PHENIX QA/Safety Date

REVISION CONTROL SHEET

LETTER	DESCRIPTION	DATE	AUTHOR	APPROVED BY	CURRENT OVERSIGHT
A	First Issue	1/30/08			

1.0 Purpose

The purpose of this document is to define the procedures for the Resistive Plate Chamber (RPC) gap, module and half-octant assembly and/or the testing of their functionality in the RPC factory in Bldg. 912. These procedures will ensure:

1.1 the safety of all personnel from risks associated with the assembly and testing of RPC gaps, modules and half-octants,
1.2 prompt notification of the appropriate CA-D and ES&H specialists,
1.3 the maintenance of appropriate CA-D emergency status,
1.4 the preservation and protection of the environment, and
1.5 the protection of BNL facilities and equipment.

2.0 Responsibilities

The first level of responsibility rests with the personnel that carries out the RPC module or detector assembly and its testing in the RPC factory. All personnel is required to obey the "two man rule".

Before and during detector tests, the responsibilities of factory personnel are:

2.1 read all safety and work planning documents, including this document, that are posted at the RPC factory and be aware of all possible hazards,
2.2 test incoming RPC gaps for gas leaks and popped spacers as described below,
2.3 assemble RPC modules out of RPC gaps as described below,
2.4 test the dark current rates of RPC gaps,
2.5 test the efficiency of the produced modules in the cosmic ray test stand and operate the test stand
2.6 Assemble the half-octants out of the produced detector modules.

The second level of responsibility rests with the RPC experts. It is the responsibility of the RPC experts to:

2.7 maintain safe operation and testing condition. This includes:

2.7.1 setting, adjusting, and checking the HV and LV power supplies,
2.7.2 posting special instructions and notifications as required, and
2.7.3 responding to irregular operation conditions and emergencies, as described in the procedures section of this document.

3.0 Standard Operating Procedures

3.1 Assembly of RPC modules

3.1.1 Parts used for the Assembly

- Al Detector module box and cover
- 2 RPC gaps, 1 Top and 1 Bottom Gap of a certain RPC Station and Module type (ie RPC2A_top, RPC2A_bot)
- Readout plane
- Mylar foil
- Cu foil
- Coax cables cut to length for each readout strip
- CPE cables with male connector on one side
- ¼" stainless steel gas pipes and flexible plastic gas pipes
- Grounding strip
- Front End electronics (FEE) board(s) and connector board

3.1.2 Assembly

- Place Cu foil and Mylar foil on top of the lower Al Detector module box
- Place bottom gap onto foils into the module box
- Place Readout plane on top of bottom gap
- Place top gap onto readout plane
- Feed gap HV and Ground lines through foils and wrap foils
- Tape Cu foils with Cu tape and solder Ground lines along ID and OD of module
- Solder signal cable to readout strip and grounding of signal cable to ground line
- Join HV lines and isolate them by shrinkwrap
- Screw HV Grounds and Ground lines to Al frame
- Insert steel gaslines into Al frame
- Add upper module cover

3.2 Testing of RPC gaps and modules

3.2.1 Gas leakage and popped spacer test

Before installation of the gaps their gas tightness has to be tested. For this purpose an overpressure of ~20 mbar is applied to each gap using either the simple gas gauge using liquid or using any of the precise pressure gauges on top of the distribution panel.
A gap will be discarded if the pressure decreased several mbar within 10-30 minutes.

To test that all spacers inside the gap are in place and intact the template containing the positions of spacers in a particular gap has to be overlayed. At each spacer position additional pressure is applied manually.

A gap will be discarded if the additional pressure applied changes the reading in the pressure gauge.

3.2.2 Dark current test

An important test is wether a certain gap can opearate at the nominal high voltage without too high dark currents or even high voltage trips. The Gaps have to be completely within a shielded container to perform this test. This can either be a completed RPC module or a dedicated container for the dark current tests. As HV is going to be applied to the Gap the mixed gas flow has to opened for the gap. To ensure that mixed gas is evenly distributed in the gap the HV may only be started after a waiting period of more than 30 minues.

The high voltage will be raised according to the HV procedure:

Procedure for ramp up:

- ✓ Monitor output current value and wait to stabilize RPC gap/detector (< 30 min) between steps
- ✓ Each 1000 V/step (0-8000 V)
- ✓ Each 100 V/step (8000-11000 V)

During the ramping, at each step (after currents have stabilized) the following variables have to be read out and logged in the database entry for the corresponding gap ID:

Time from startup of ramping, Voltage and Current

A gap is going to be discarded if the dark current reaches more than 2 μA at any point during the test.

3.2.3 Module efficiency test

After a module is assembled its efficiency over the whole active area has to be tested. For this purpose the fully assembled module is placed into the cosmic muon test stand and HV and Gas lines are connected. The readout cables will be connected to the patch panel. The FEE output channels are connected to the TDCs in the electronics rack and the LV power is connected.

After starting the gas flow and waiting for more than 30 minutes the HV may be ramped according to the HV procedures until the operating voltage of 8500-9500 V is reached.

A test run will be taken to ensure the data acquisition software and the trigger logic are working. At least a few strips of the RPC to be tested should also have hits.

The main test accumulates a reasonable amount of statistics in each of the modules strips. The distribution should be approximately equally distributed over all stips of same length and correspondingly less for shorter strips. In an offline analysis the efficiency of each strip and along each strip is tested an logged in the database. Modules with efficiencies less than 90% are discarded.

3.3 Assembly of Half octants

3.3.1 Parts used for the Assembly

- 4” Al C-frames
- Connecting Al braces between modules
- 1 RPC module A,B,C (and D for RPC2)
- 1/8” Al plates to cover half octants
- Conectors for signal cables, HV, LV, gas
- LV cables internal to half-octant
- Gas lines internal to half-octant
- Signal lines internal to half-octant

3.3.2 Assembly

- All C-frames except C frame from OD are assembled and first support brace is slid in
- Module A is slid in and services (Gas, HV, LV and signal) are connected to ID C frame with corresponding connectors
- Next brace is slid in, followed by Module B and the corresponding services
- Next brace is slid in, followed by Module C and the corresponding services
- For RPC2 half octants: Next brace is slid in, followed by Module D and the corresponding services
- Final brace is slid in and fixed
- Al plates are screwed onto support frame

Appendix A: List of RPC experts
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