Jefferson Lab
Thomas Jefferson National Accelerator Facility

| TITLE: | **ES&H Manual** |
|---|---|

| DOCUMENT ID: | **3310 Appendix T2 Operational Safety Procedure Form** | Click for OSP/TOSP Instructions |
|---|---|---|

**Serial Number:** [Enter Serial Number] PHY-12-022-OSP
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[X] **OSP** [ ] **TOSP**

***Attach the Task Hazard Analysis (THA) related to this procedure**

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| | | | |
|---|---|---|---|
| **Issue Date:** | 3-27-12 [Enter Issue Date] | **Expiration Date:** | 3-27-15 [Enter Expiration Date] |
| **(No more than three years from Issue Date except TOSP which is three months from issue date)** | | | |
| **Title:** | **Test of the Multi-gap Resistive Plate Chamber (MRPC) in Hall A.** | | |
| **Location:** | HALL A | | |
| **Risk classification** (See *ESH&Q Manual Chapter 3210 Appendix T3 Risk Code Assignment*.) | | **Without mitigation measures (3 or 4):** | ~~3~~ 1 BM |
| | | **With mitigation measures in place (0, 1, or 2):** | ~~[Enter Code]~~ 1 |
| **Document Owner(s):** | Alexandre Camsonne, Mehdi Meziane | **Date:** | 11/11/2011 |

**Supplemental Technical Validations:**

| **Hazard Reviewed** (per ES&H Manual 2410-T1): | **Subject Matter Experts Signature:** | | **Date:** |
|---|---|---|---|
| Fire Hazard | John Segal | John Segal | 3-26-12 |
| Electrical Hazards | Charles Hightower | [signature] | 3-22-12 |
| Environmental | Bert Manzlak | Bert Manzlak | 3-27-12 |

| **Approval Signatures:** | **Print** | **Signature** | **Date:** |
|---|---|---|---|
| **Division Safety Officer:** | Javier Gomez ( acting) | [signature] | 3/30/12 |
| **Department or Group Head:** | Robert Michaels | Robert Michaels | 3-26-12 |
| **Safety Warden of Area:** | Ed Folts | Jack Segal (for Ed) | 3-26-12 |
| **Other Approval(s):** | Jennifer Williams | [signature] | 3/26/12 |

**Document History:**

| **Revision:** | **Reason for revision or update:** | **Serial number of superseded document** |
|---|---|---|
| 1 | First revision | 1 |

Expired 03/27/15

**Distribution:** Copies to: affected area, authors, Division Safety Officer, ESH&Q Document Control
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**1. Purpose of the Procedure**

The purpose of this document is to describe how to safely carry out the Multi-gas Resistive Plate Chamber (MRPC) test in Hall A .

**2. Scope** – include operations, people, and/or areas where procedure applies

Hall A staff, people from Duke University and Tsinghua University will participate to the operations. This will include installation of the detector, connection of the electronics and the gas system, start taking data. The electronics will be shared with the GEM test.

**3. Description of the Facility:** (include floor plans and layout of a typical experiment or operation)

The MRPC consists of a stack of resistive plates, spaced one from the other with spacers of equal thickness creating a series of gas gaps. Electrodes are connected to the outer surfaces of the stack of resistive plates while all the internal plates are left electrically floating. A gas mixture which contains 90% of tetrafluoroethane (R134a), 5% iso-butane and 5% Sulfur Hexafluoride (SF6) will be used. A charged particle going through the chamber generates avalanches in the gas gaps. The induced signal is about the average of signals of the different gas gaps. Signals are read out from a copper pickup pads.

The purpose of this test is to characterize the properties of the MRPC prototype which will be used for particle identification in the SoLiD SIDIS experiments. In particularly we will determine the achievable timing resolution in a realistic background in CW beam. The detector will be located at backward angle on a table looking at the target, gas will be provided by premixed cylinders, and high voltage from the beam line crate.

**4. Authority and Responsibility:**

**4.1 Who has authority to implement/terminate**

John Segal

**4.2 Who is responsible for key tasks**

Alexandre Camsonne

**5. Who analyzes the special or unusual hazards (See ES&H Manual Chapter 3210 Appendix T1 Work Planning, Control, and Authorization Procedure)**

Bert Manzlak, Jennifer Williams , Charles Hightower

**6. Personal and environmental hazard controls including:**

**6.1 Shielding**

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**6.2 Interlocks**

**6.3 Other**

High Voltage system will be up to 7 KV but with currents less 1 mA making the device class 1

**7. Monitoring systems**

**8. Ventilation**

The gas will be released in the Hall volume. The central ventilation of the Hall will be sufficient to prevent any buildup of gas in the Hall.

**9. List of safety equipment (i.e: personal protective equipment or special tools)**

Connecting/disconnecting gas bottles to gas delivery system:

- Safety glasses
- Gloves

**10. Associated administrative procedures**

**11. Operating guidelines**

**12. Notification of Affected Personnel (How and Who)**

**13. List of steps required to execute the procedure from start to finish.**

Inspection of cylinder for leaks before moving in the Hall.
Check for leaks of the system using Helium.
Switch to SF6/Freon/Isobutane mix
Turn on HV of MRPC
Check FEE and VME system
Take data

**14. Back out procedures, i.e., steps necessary to restore the equipment/area to a safe level.**

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1. Terminate Beam
2. Turn off DAQ
3. Turn off HV
4. Turn off the flow of premixed gas.
5. Disconnect chamber and seal it
6. Vent chamber out from the hall
7. Store

All equipement will be labeled containing with the gas mix content.

**15. Special environmental control requirements:**

Gas Mixture: tetrafluoroethane 90%, iso-butane 5% and SF6 5%, flow rate 100 mL/min and tetrafluoroethane 95%, iso-butane 5%

**16. Environmental Impacts (See EMP-04 Project/Activity/Experiment Environmental Review**

The gas mixture used during the test will not bioconcentrate and does not contain ozone depleting material. The Freon and SF6 are green house effects gas.
Assuming continuous running at a rate of 100 mL/min we will release during the 2 months of testing 7905 Liters of R134a Freon and 440 Liter of SF6. The Hall having a radius of 53 meters and height of 17 meters this corresponds to about 1.4 Millions of liters of air, so concentration of the two gases will be well below the 1000 ppm limit with values of respectively 54 ppm and 3 ppm.

We will only use one cylinder of gas of volume of 252 Liters at 4.7 atm for beam testing which contains this corresponds to a total volume of gas of about 1200 L . This corresponds to 1140 L of Freon ( density 4.25 g/cm3) corresponding to 4.85 Kg of R134a and 60 L of isobutane (2.51 g/cm3) corresponding to 151 grams.

The Global Warming Potentiontial of R134a is 1300 and it has a 0 Ozone Depletion Potential.
The Global Warming Potentiontial of Isobutane is 3.3 and it has a 0 Ozone Depletion Potential.

The CO2 equivalent for the different gases is thus.
For R134a : 4.85Kg * 1300 = 6298.5 Kg
For Isobutane : 151g * 3.3 = 0.497 Kg

Total amount of CO2 equivalent for this part of the test will be about 6.3 tons of CO2

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equivalent.

We will use a mix containing 90% of R134a, 5% isobutane and 5 % SF6 for the final timing resolution beam test. We will use this mix for about 24 hours at 100 cm3/min which corresponds to 144 Liters. This corresponds to 130 Liters of R134a equals 551 g, 7.2 L of isobutane equivalent to 18 grams of isobutane and 7.2 L of SF6 corresponding to 45.2 grams of SF6.

The Global Warming Potentiontial of SF6 is 23900 and it has a 0 Ozone Depletion Potential.

For R134a : 551g * 1300 = 716.3 Kg
For Isobutane : 18g * 3.3 = 59.4 g
For SF6 : 45.2 g * 23900 = 1080.3 Kg

The final setup will use recirculation eliminate release of gases in the Hall but due to the foreseen cost of such a system ( around 20 K$ ) and the small amount released and the availability of premixed gas, we decided it will be more cost effective and practical to release the gas in the Hall.

The total carbon footprint for this test will be a total of about 8,100 Kg of CO2.

**17. Abatement Steps – Secondary Containment, or Special Packaging requirements**

**18. Training requirements**

Read this OSP and THA.

**19. Unusual/Emergency procedures e.g., Injury, Fire, Loss of power**

In case of fire, shut down gas immediately. The concentration of isobutane would be around 3ppm well under the limit of flammability which is 1.8 %

**20. Instrument calibration requirements, e.g., safety system/device recertification, RF probe calibration**

**21. Inspection schedules**

Initial inspection by EH&S

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|---|
| **22. References/Associated Documentation** |
| |
| **23. List of Records Generated (Include Location / Review and Approved procedure)** |
| |

**Authorized/Trained Individuals**

| Print Name/Signature | Date |
|---|---|
| Alexandre Camsonne | |
| Medhi Meziane | |
| Xingming Fan | |
| Huangshan Chen | |
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| ISSUING AUTHORITY | APPENDIX AUTHOR | APPROVAL DATE | EFFECTIVE DATE | EXPIRATION DATE | REV. |
|---|---|---|---|---|---|
| ESH&Q Division | Harry Fanning | 10/05/09 | 01/01/10 | 10/05012 | 0 |

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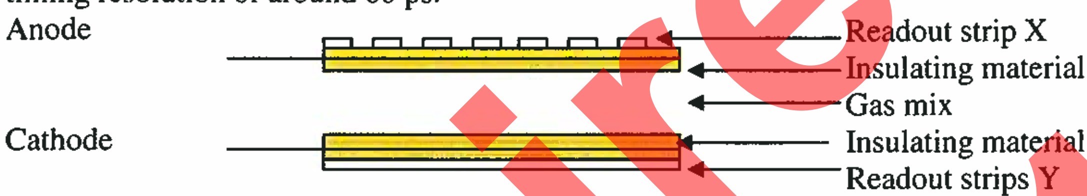
MRPC test overview

A multigap resistive plate chamber is constituted of electrodes separated by an insulating layer with gas between the two. This allows the spark generated by the ionization to be very short allowing very good timing resolution of around 60 ps.




A prototype of a 6 cell MRPC will be brought at Jefferson Laboratory.

The goal of the test will be looking at :

- background and behavior in a CW environment
- test timing resolution achievable at JLab
- get acquainted with detector handling and readout for the futur use of the detector.

The chamber will use a gas mix of 90 % Freon TetraFluoroethane R134a, 5 % isobutane, 5% SF6 which will be flown at about 100 cubic centimeter per minute.
First measurement will be done using a random trigger to determine the accidental background in the detector. Second measurement will be done with a set of trigger scintillators as trigger with reading out the MRPC. The signals go through amplifiers and are sent to TDCs and ADCs.
The gas will be premixed in standard cylinders.
Actual test should take 1 days. Detector will be tested for a few weeks to be sure it is operating correctly with cosmics.

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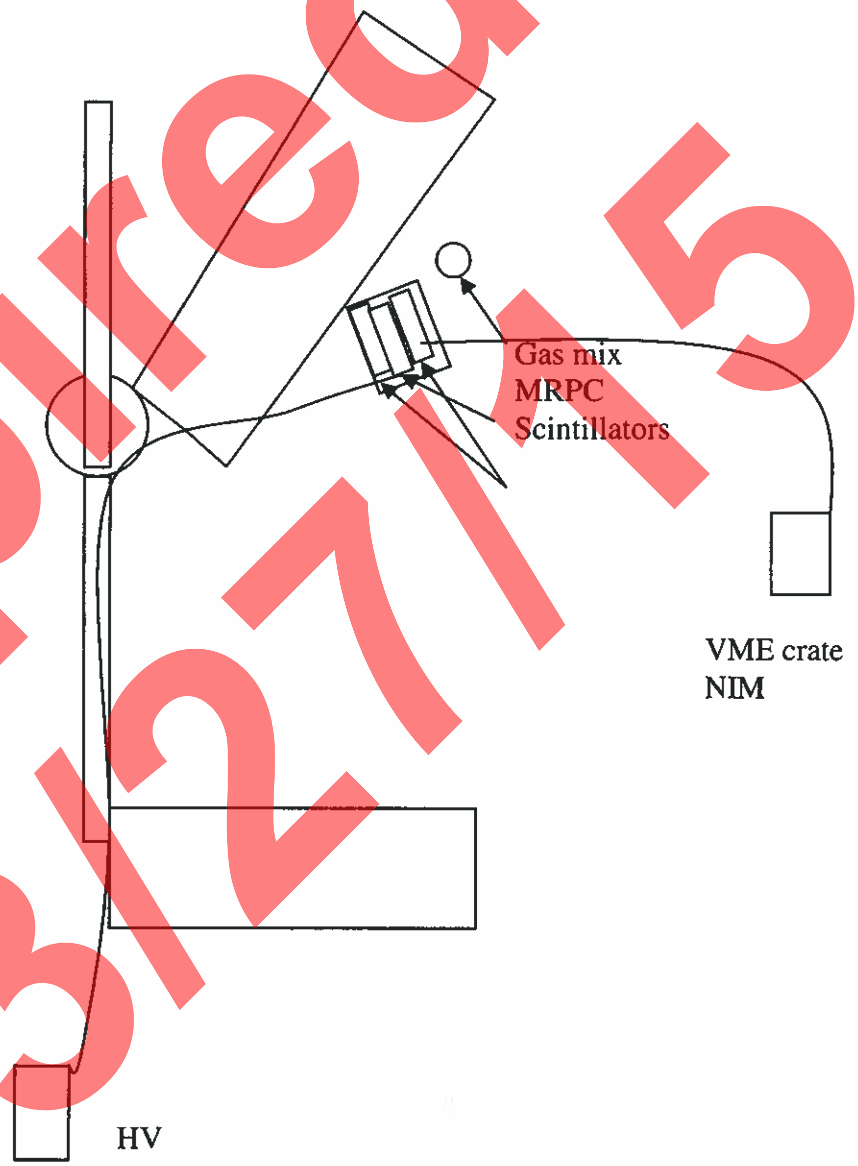
Floor Plan



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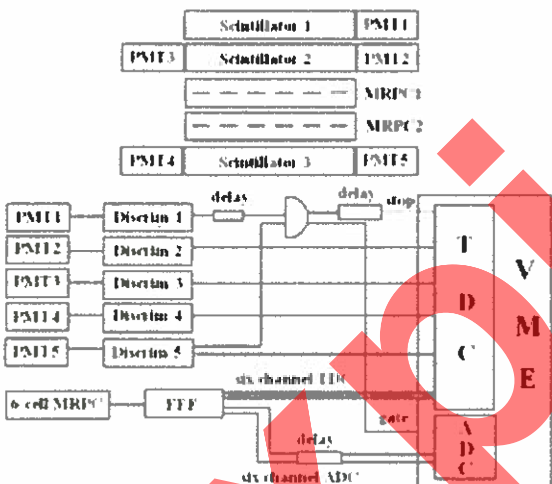
## Cosmic ray test system




- Trigger: PMT1^2^3^4^5
- Reference time: (t2+t3-t4-t5)/4. Time resolution is less than 60ps
- FEE: Maxim3760 (we can bring to Jlab)
- Source for FEE: +-6.5V
- CAEN TDC V775E:35ps/bin
- QDC: V792: 0.1pC/bin
- 150ns delay for each charge signal of MRPC

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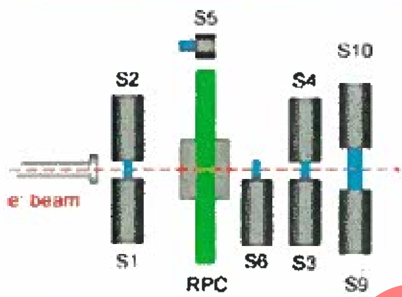
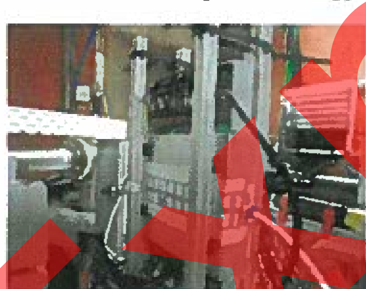
## Experimental setup



- Trigger: S1^S2^S3^S4^S6^RF
- Beam size: 7cm²
- MRPC and S6 are placed on movable columns.
- S6: 35mm*35mm*5mm
- Reference time: RF signal from EIBE
- FEE: Maxim3760
- CAEN TDC 1290 N: 24.5 ps/bin
- QDC: V965: 25 fc/bin
- Efficiency is determined by the scaler. And also can be obtained from data file.

$$Eff = \frac{Counts_{rpc}}{Counts_{trigger}}$$

1

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# 3210Appendix T2
# Task Hazard Analysis (THA) Worksheet

Click For Word Doc

| | | | | | |
|---|---|---|---|---|---|
| **Author:** | Alexandre Camsonne | | | | |
| **Date:** | 03/28/2012 | **Task #:** If applicable | | **Frequency of use:** | once |

**Complete all information. Use as many sheets as necessary**

| | | | |
|---|---|---|---|
| **Task Location:** | Hall A | **Task Title:** | MRPC test |
| **Division:** | Physics | **Department:** | Hall A |
| **Lead Worker:** | Alexandre Camsonne | | |
| **Mitigation already in place:** Standard Protecting Measures Work Control Documents | | | |

| Sequence of Task Steps | Task Steps/Potential Hazards | Consequence Level | Probability Level | Risk Code (before mitigation) | Proposed Mitigation (Required for Risk Code >2) | Safety Procedures/ Practices/Controls/Training | Risk Code (after mitigation |
|---|---|---|---|---|---|---|---|
| 1 | Gas flow in detector / leak | 1 | 1 | 1 | Limit flow and pressure to 100 mL/minute | | 1 |
| 2 | High voltage / electric shock | 1 | 1 | 1 | Sign for HV / full isolation | Turn HV off when detector access / roped area around detector | 1 |
| 3 | Flammabe gas / isobutane | 1 | 1 | 1 | Keep only 1 cylinder / limit flow to 100 mL/minute | Roped and signed area Flammable level always below ignition point | 1 |

| | | | | | |
|---|---|---|---|---|---|
| | **Highest Risk Code before Mitigation:** | 1 | | **Highest Risk Code after Mitigation:** | 1 |

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# 3210Appendix T2
# Task Hazard Analysis (THA) Worksheet

When completed, if the analysis indicates that the Risk Code before mitigation for any steps is "medium" or higher (RC≥3), then a formal Work Control Document (WCD) is developed for the task. Attach this completed Task Hazard Analysis Worksheet. Have the package reviewed and approved prior to beginning work. (See ES&H Manual Chapter 3310 Operational Safety Procedure Program.)

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|---|---|---|---|---|---|
| ESH&Q Division | Harry Fanning | 10/05/09 | 01/01/09 | 10/05/12 | 0 |

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