

# The MIPP Shift Manual

'I am on shift! What now?'

DON'T PANIC

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## 1.1 Introduction

If you are on shift and don't have a clue what to do, don't panic. This is the MIPP shift manual. To take a shift on MIPP you need nothing but this manual and a towel.<sup>1</sup>

Seriously, this writeup should answer most of your questions and point you to the right resource or person to call if it does not provide the answer.

The first section describes your responsibilities while on shift.

The next sections describe the MIPP run control, online monitoring, and main features of the DAQ that you need to be familiar with to take data.

A brief description of each detector from an operations view follows. How can I turn on the detector if it is off? How can I power down the detector safely if there is a scheduled power outage? Why is that alarm making noise and what should I do about it? Where is the gas supply for this detector and how can I check the pressure gauge? How can I disable this one noisy channel? Well, you get the idea.

The appendix contains a list of phone numbers and references to other documents.

### 1.1.1 Where to get this document

<http://ppd.fnal.gov/experiments/e907/notes/MIPPnotes/public/pdf/MIPP0024/MIPP0024.pdf> contains this document. It is MIPP note 24. The tex source is in the cvs archive under Documents/notes/ShiftManual. An effort is made to keep the note in sync with the tex source.

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<sup>1</sup>If you don't know Douglas Adam's 'Hitchhiker's Guide through the Galaxy', please ignore this sentence.

## 1.2 Your responsibilities while on shift

In general, while on shift you should make sure that data is taken and that the data is of good quality. If this is not possible you should work on getting everything up and running. This will likely require coordination with the shift coordinators and/or detector experts. You should log your activities in the electronic log book.

The experiment can only operate correctly if all detectors have their gas supplied. To this end you must at least once during any day-shift make sure that the bottle rack is accessible outside MC8 (i.e. shovel snow, etc.) and check the pressure in all supply bottles and dewars. If any of the gas is low, you must change gas bottles or dewars. If the number of full bottles in the bottle rack runs low, you must order more gas from the stock room. All this is described in more detail in section 1.14.

## 1.3 Emergency procedures

In case of injury or medical emergency call x3131.

In fire emergencies call x3131 and turn off flammable gas flow with the crash buttons in center of counting house or exterior of gas shed to right of door.

In case of tornado warning evacuate counting house, MC7 and MC8 and seek refuge at the restrooms in MP9, the large blue building northeast of the counting house.

In case of fire or fire drill, collect in the parking area northeast of the counting house for head count.

Emergency call-in list:

- Rajendran Raja (Spokesman): tel. 630-840-4092(O) 630-305-7769(H)
- Peter Barnes: tel. 925-422-3384
- Holger Meyer: tel. 630-840-2997(O) 630-357-6870(H)
- John Chyllo (building manager): tel. Ext.8466

## 1.4 Interlock System at MIPP

This section describes the procedures for interlocking the MIPP experiment to take beam, dropping the interlock for supervised access/open access, and doing a controlled access.

### 1.4.1 Policies

The beam schedule for the experiment is coordinated by the run-coordinators with the external beams division. The contact for all beam to Switchyard120 is Erik Ramberg. Requests for beam also need to be coordinated with Craig Moore.

While the experiment is taking beam (or ready to take beam) the experimental floor is interlocked for radiation safety. Access of less than four hours can be done without dropping the interlocks. This requires at least two people for the controlled access. If work is expected to exceed four hours, the interlocks need to be dropped. With interlocks dropped, access to the experiment is open, i.e. people can work in the area without an interlock key.

If you need to do a controlled access, please contact the run-coordinators.

Policies can be subject to change. If you suspect that the information contained in here is incorrect, please contact the run-coordinators (or spokesperson).

### 1.4.2 Search and Secure

The procedure called *Search and Secure* is needed to satisfy all experimental interlocks (MC7, MC8, and MB7) when any of the interlocks have been dropped. The interlocks get dropped intentionally for a period of open access and may get dropped unintentionally during a controlled access or due to equipment failure. Strong wind pushing on the roll-up doors has caused the interlock switches to open.

When all work in MC7 and MC8 is finished and the experiment is ready to take beam, Search and Secure needs to be requested from the Main Control Room (MCR, x3721). A crew from the MCR will come out to MC7/MC8 and bring up the interlocks. In the process they walk through MC7 and ensure that nobody remains there. We, the experiment, need to make sure that it is safe to operate the analysis magnets. The person on shift must be the last to leave MC7 (except for the S&S crew) and must clean the area around the magnets (on top of the magnet platform) of small metal parts.

The Search and Secure crew will first make sure that the analysis magnets (JGG and Rosie) are turned off. They will then walk through MC7 and MC8 and lock the doors with the interlocks active. After they return keys to the key-tree in the portacamp, the analysis magnets have to be ramped up. The magnets need to be ramped to satisfy the critical device interlock. In other words: There will be no beam until you turn on and ramp up the magnets. The procedure is explained in section 1.17.2.

The critical device for MIPP is the beam line magnet F:MC1D. Once the search and secure crew gets back to the MCR and JGG and Rosie are ramped up, you may see (on Acnet) this device getting powered. At that point you can expect beam.

### 1.4.3 Controlled Access

Controlled Access is an entry into the interlocked experiment. It may not last longer than four hours. It requires two people with controlled access training. You can make a controlled access to do short work on a detector, e.g. swap some electronics module, etc.

To do a controlled access, please start by coordinating people and tasks. Identify the primary reason for the access and additional tasks to be performed. There is a white board in the control room that may list tasks for a controlled access. Identify who will work on each task. At most five people can do a controlled access, limited by the number of keys in the key tree. Each person doing the access must be trained with current *Fermilab Controlled Access* and *Radworker* and must wear a TLD. Check that you have your TLD available before you request an access.

The main control room does require confirmation from the run-coordinators (or spokesperson, if run-coordinators are unavailable) to proceed with the controlled access. Call the one of the run-coordinators to request the CA. The run-coordinator will call the MCR to request the access and then call you back. Specify how long you want to go in. The MCR then needs a few minutes to drop the beam. They will call back when they are ready to hand out access keys. The keys are in a locked, remote controlled box, the key tree, in the center of the portacamp near the door to MC8. A phone is there, too.

Once you have the keys, you should turn off the analysis magnets if your work is close to JGG or Rosie. The magnets should not be ramped unnecessarily, so leave them energized unless you work close to them.

To go into MC7 you need to open the gate in the fence between the portacamp and MC7. Lock it behind you during the access. The downstream door at MC7 has the access boxes inside and outside the door.

Please be careful not to drop the interlock during a CA. It causes downtime for the experiment and the MCR has to send people for search and secure, taking time out of their busy schedule. At least one of the people doing the access should have been on a controlled access to the enclosure before. This person should operate the key on the inside of the enclosure and check the green light on the outside before opening the door.

### 1.4.4 Open Access

For an access longer than four hours or of more than five people the interlocks need to be dropped. Request open access to the run-coordinators. They will call the MCR and then call you back. The MCR will turn off beam. You can then call and get the keys from the key tree. Ramp down the analysis magnets, unless you need them on for some test. To search and secure, they will have to be turned off anyway, so it is safer to do it before people work in MC7. If you want to leave them on during the open access, the area around the magnets needs to be posted as a high magnetic field area. Unlock the gate and doors and leave them open. Return the keys to the key tree.

## 1.5 DAQ/Run Control

The run control is your interface to the DAQ. Here you can select the run configuration and start and stop a run.

### 1.5.1 DAQ Structure

The DAQ, while running, performs four high-level functions: gathering data from hardware, assembling all of this data into events, providing a GUI for both feedback and control to the user, and handling all of the messages among these processes. To these ends the DAQ actually consists of four separate programs: mdd, mippEvtBuilder, rc-GUI, and rcd. Each of these programs will be described briefly in the section on starting the run control.

### 1.5.2 Starting the DAQ/Run Control

#### Overview

Each of these steps will be discussed in more detail, but here's the basic idea:

- Login to e907daq as user: daq, password: (available on whiteboard)
- start run control daemon (rcd)
- start mipp data daemon (mdd)
- start mipp event builder (mippEvtBuilder)
- start run control graphical user-interface (rc-GUI)

When you login on e907daq the saved desktop configuration will start you off with four workspaces and a number of windows open on each. Of concern here are the first two workspaces which are titled "Run Control" and "mdd's" on the taskbar. In the "Run Control" workspace there should appear three terminals titled "rcd," "event builder," and "rc-GUI." In the "mdd's" workspace should appear six terminals titled "richppc," "beamppc," "TPCa-ppc," "TPCb-ppc," "TPCc-ppc," and "TPCd-ppc." From here on I assume that this is the case, and that in all of these terminals the present working directory is /home/daqdaq/.

#### Start rcd

The run control daemon is the program that manages communications among instances of mdd, mippEvtBuilder, and rc-GUI. Since all of these processes look to connect to rcd when starting up, *rcd must be started first*. On "Run Control" workspace, in "rcd" terminal, type

```
rcd config/rcd.xml
```

This should do the trick. If not, knowing that rcd lives in /usr/local/mipp/online/sbin/ and that the correct configuration file lives in /home/daqdaq/config/rcd.xml you can always instead type

```
/usr/local/mipp/online/sbin/rcd /home/daqdaq/config/rcd.xml
```

to start the run control daemon.

*when rcd starts cleanly:* It should give you a number of messages about its configuration file(s), data directories, run schema, and then lastly display **Starting running**.

## Start mdd

The mipp data daemon gathers data from hardware and packages it to be sent to the event builder. MIPP uses six Power PC's (ppc's) for this purpose; they are named beamppc, richppc, tpeppca, tpcppcb, tpcppcc, and tpcppcd. The electronics handled by beamppc involve the trigger, beam chambers, beam  $\hat{c}$ erenkovs, T0 counters, and the  $\hat{c}$ erenkov detector. The electronics handled by richppc involve the RICH, hadron calorimeter, electromagnetic calorimeter, drift chambers, proportional (Iowa) chambers, and the time-of-flight wall. Each of the tpcppc's oversee the readout of one quadrant of the TPC.<sup>2</sup>

On "mdd's" workspace you will first in each terminal connect to the appropriate ppc. E.g.

```
ssh beamppc3 in the first terminal,
```

```
ssh richppc in the second,
```

```
ssh tpcppca in the third, and so on.
```

Next, start mdd on each of the ppc's by typing

```
mdd /etc/mdd.xml
```

The directory structure is the same on all six ppc's, so this command should work in all six windows.

*when mdd starts cleanly:* It should give you a number of messages about it's version, configuration file, and lastly display **Connecting to 192.168.58.2:1111... Done**.<sup>4</sup>

## Start mippEvtBuilder

The mipp event builder (mippEvtBuilder) takes data from each of the mdd's and assembles them into a full event for the data file. To start mippEvtBuilder, go back to the "Run Control" workspace and in the "event builder" terminal type

```
mippEvtBuilder config/event_builder_config.xml
```

---

<sup>2</sup>where you find this information will be covered in the "Configuring a Run" section

<sup>3</sup>sometimes one of the ppc's will prompt you for a password or 'passphrase' – use the same password as on e907daq

<sup>4</sup>be aware that the tpc mdd's take 1:15 to start up (to within a few seconds), whereas the richppc and beamppc mdd's usually only take a few tens of seconds.

*when mippEvtBuilder starts cleanly:* It should give you a number of messages about its version, configuration file, and lastly display Connecting to 192.168.58.2:1111... Done.

## Start rc-GUI

The run control graphical user-interface (rc-GUI) performs two functions: it takes run control commands and information from the user (such as where to store data, detector setup, and which trigger(s) to use) and it displays a modest amount of high-level monitoring information.

To start rc-GUI, on the “Run Control” workspace in the “rc-GUI” terminal, simply type `rc-GUI`

*when rc-GUI starts cleanly:* In the terminal window you will see multitude of ROOT messages – this is the drawing of the GUI window – and then the GUI window should appear along with a prompt to connect to the run control server. If these values are not there type “localhost” in the “rcd Host Name” field and type “1111” in the “rcd Port Number” field, then click “Connect.” At this point you should see all of the status buttons across the top of the GUI window colored blue, indicating that the rcd child processes are all running.

## If this didn't work ...

See Section 1.5.5, “Debugging the DAQ”

## 1.5.3 Configuring a Run

In the rc-GUI menu:Configuration you see three options: Update, Detectors ... , Trigger Prescale ... , and Trigger Logic ... . We won't go through them in this order, though; we will descend from highest-level to lowest.

### Update

This option resets the values in the Detectors..., Trigger Prescale..., and Trigger Logic... dialogs to those currently in use by rcd. I.e. if you make a lot of changes in the windows and want to reset, this button's for you.

### Trigger prescale ...

This brings up a dialog entitled “MIPP Trigger Setup.” There are 20 lines, each with a name, a spinner, and a checkbox labeled “Enable.” *Caveat MIPPer:* the names here are not necessarily tied to the logic in that trigger, they're just the names that some schmoe (possibly you?) chose as a label for their logic.

Prescale Value	Meaning
-1	disable trigger
0	full throughput
1	accept 1 of 2 events
2	accept 1 of 3 events
3	accept 1 of 4 events
4	accept 1 of 4 events
⋮	⋮
$n$	accept $1/(n+1)$ events

Table 1.1: prescale values and their meaning

So, hopefully the names of the trigger look meaningful to you, and they do what you expect<sup>5</sup>. To choose a trigger, simply check the box marked “Enable.” With the “Prescale” spinner you can choose to accept only some fraction of the triggers coming through; table 1.1 explains the meaning of the value in the spinner.

**Detectors ...**

**Trigger logic ...**

### 1.5.4 Starting a Run

**Choosing a trigger**

**Choosing detectors**

### 1.5.5 “What Went Wrong!?”, or “How I Learned to Love Debugging the DAQ”

Here we will systematically go through all of the information that a shifter could be expected to reap from the DAQ, and how they can use that information to diagnose a detector, electronics, or software problem. In general, you will be able to use the output of the DAQ to at least identify which detector is causing problems and relay that information to the appropriate expert<sup>6</sup>. But first,

---

<sup>5</sup>cf. Trigger Logic ...

<sup>6</sup>Please make a log entry any time you have to debug the DAQ

rc-GUI Button Color	Meaning
blue	awaiting input
yellow	changing state
cyan	waiting on other children
green	running
<i>red</i>	<i>error</i> , or mdd not running

Table 1.2: rc-GUI button colors and their meanings

### A confession:

The DAQ crashes. Despite the best efforts of crack programmers, the DAQ crashes. And the DAQ crashes more often than we'd like to admit. Some symptoms of the DAQ crashing are

- the clock in the “rcd update” area freezes, or falls well behind realtime
- the GUI window freezes – plots stop marching across the screen, menus won't appear, &c.
- GUI not frozen, but child processes light up like a Christmas tree and stay there *ad infinitum*
- mippEvtBuilder stops putting out messages every 50th event

### Information from rc-GUI

*Child States:* Across the top of the window you see seven buttons; these will give you status information on each of the seven child processes of rcd: the six mdd's and mippEvtBuilder. The color of a button tell you something about the child's state – these are tabulated in Table 1.2.

It may occur that having started a run, you find rcd waiting for one child: in this case some child process buttons would be cyan (waiting) while one or more stay yellow (changing state) for a long time. There is a 2 minute timeout after which the child should quit its attempt to start a run, and everything will go back to blue.

A red button means that mdd is not running. This may be intentional, but if this is in error, restart the mdd.

If either of these don't work, call Andre; with rcd, mdd, and mippEvtBuilder in their stable states he'd like to know about any real problems with them<sup>7</sup>.

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<sup>7</sup>rc-GUI has issues with ROOT, so it's not as unusual or worrisome for it to crash. When it does, you can restart it mid-run and none of the data should be affected. This has been tested and been found to be true so that you may come to believe.

Detector	Readout time
Trigger	$\sim 1\text{ms}$
Beam Chambers	$\sim 600\mu\text{s}$
BCKov, T0	$\sim 400\mu\text{s}$
Ckov	$\sim 3\text{ms}$
RICH	$\sim?$
HCal	$\sim 200\mu\text{s}$
EMCal	$\sim 3\text{ms}$
DC1	$\sim 800\mu\text{s}$
DC2	$\sim?$
DC3	$\sim 800\mu\text{s}$
DC4	$\sim?$
MWPC	$\sim 500\mu\text{s}$
ToF	$\sim 10\text{ms}$
TPC A	$\sim?$
TPC B	$\sim?$
TPC C	$\sim?$
TPC D	$\sim?$

Table 1.3: characteristic readout times for E907 detectors *ca.* May 2004

*Clocks:* Sure signs of a DAQ malfunction are if the clocks in rc-GUI disagree by more than two seconds or if either clock stops. The upper clock displays system time, as gathered by rc-GUI; the lower clock displays the system time when rcd last gave information to rc-GUI. If the lower clock stops or disagrees wildly with the upper, rcd has erred and you should restart it (which entails restarting all four DAQ processes). If the upper clock stops or disagrees wildly with system time, rc-GUI has erred, and you should restart it (which should not affect any of the other processes). If after this you still have problems, contact Andre.

*Events:* These counts track an event through its life cycle and should always be in sync. If they differ, stop and restart the run. If that doesn't solve the problem, restart mippEvtBuilder and start a new run. If that doesn't work, restart all four processes and start a new run. After that, contact Andre.

*KBytes per event:* There's no set number at which this histogram should peak – which detectors are in affects this greatly – and it may have some spread<sup>8</sup>. However, any anomolous readout times may be indicitave of an error along the data stream.

*Detector readout times:* As with event size, these will vary. However, each detector has a characteristic readout time (*cf.* Table 1.3); a few events in a run may differ from the

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<sup>8</sup>the TPC, especially, with its compression/suppression readout will vary in size from event to event

characteristic, but if you see the whole detector block awry, be concerned. [*what to do then? contact detector software captain?*]

### Information from mippEvtBuilder

mippEvtBuilder should put out a message (in its terminal window) every 50th event listing the number of sub-events, the head event count, and the tail event count. The head and tail event counts should never differ by more than 1 – if they do, stop the run, restart mippEvtBuilder, and start a new run. If this doesn't fix the problem, contact Andre.

On a rare occasion mippEvtBuilder may truly crash: throw a seg fault, output garbage, &c. If this happens be sure to copy the last screen's output to a file – as the event builder crashes it may not log everything – and contact Andre.

### Information from log files

Before a run is completed the logs are kept in `/ppcboot/common/usr/loval/mipp/log/`<sup>9</sup>; after a run has been completed the detector logs are archived (on e907daq) in an archive/subdirectory as gzipped log files for each detector. These log files contain three levels of information: **error**, **info**, and **debug**<sup>10</sup> messages. Many of the **error** messages are descriptive enough that, combined with their surrounding **info** messages, it's easy to localize the problem to a single detector or process. At the very least, the text of these **errors** should go into the logbook and will be of great use to system experts in debugging over the phone.

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<sup>9</sup>The directory `/ppcboot/common/usr/local/mipp/log/` is symlinked in the directory `/home/daqdaq/` as `ppc_log/`

<sup>10</sup>**debug** messages only appear in the log if the “debug” option is checked in the Detector Configuration... window.

## 1.6 Online Monitoring

The online monitoring helps to ensure good data quality. While the online monitoring is automated as much as possible, human supervision of the data taking and human intervention in case of errors is needed.

### 1.6.1 Invocation

#### Icon

On the desktop of e907mon are two icons, labelled “Online Monitoring (disk data 0)” and “Online Monitoring (disk data 1)” – by *single*-clicking on these you can call up onmon loaded with the highest-numbered run file in either of /data/0 or /data/1.

#### command-line

onmon --help will give you a (very) brief synopsis of these options:

```
--help, --dir=[directory], --file=[filename], --run=[run#], --subrun=[subrun#],  
--xml=[xmlfile]
```

--help: as mentioned above, gives a synopsis of these flags

--dir=[directory]: substitute /data/0 or /data/1 to specify which data directory onmon should use. Specifying this flag alone will cause onmon to load the highest-numbered run in that directory. Equivalent to using the desktop icons.

--file=[filename]: requires --dir flag be set, will cause onmon to load the specified file upon starting.

--run=[run#]: requires --dir flag be set, will cause onmon to load the specified run upon starting. It appears that this not only loads the specified, but then proceeds to load higher-numbered runs (each clearing the canvas before it) until onmon reaches the last run in the directory. *Is this how it's supposed to work? If so, how is this useful? Could we rather have an option to specify multiple runs and have all of those data summed?*

--subrun=[subrun#]: untested

--xml=[xmlfile]: untested

## 1.7 High Voltage Monitoring

The high voltage power supplies for the following detectors are controlled using two Lecroy 1440 High Voltage Mainframes:

- T00 and T01 beam counters (TOO)
- Čerenkov Counter (CKOV)
- Beam Čerenkov Counter (BCKOV)
- Time of Flight Wall (TOF)
- Horizontal Trigger Counters (Cosmics)
- Hadron Calorimeter (HCAL)
- Muon Trigger Counters (Muon)
- Time Projection Chamber (TPC)

The mainframes are located in Relay Rack #5 (T00, CKOV, BCKOV, HTC, HCAL, Muon and TPC) and on top of the first analyzing magnet (TOF only). The mainframes use logical address identifiers “1” and “2” respectively and have been connected to physically distinct serial interface ports to prevent accidental reprogramming of the mainframes. In the current configuration the serial interfaces are as follows:

- Mainframe #1 (Rack 5) connected to e907daq port /dev/ttyQ01e6
- Mainframe #2 (TOF) connected to e907daq port /dev/ttyQ01ec

To monitor the voltages maintained by these supplies stand alone monitoring software has been developed. The software is designed to interface with the unique requirements of the 1440 serial line protocol as well as with the MiPP online database.

The high voltage monitoring software is named “hv\_monitor” and is located in the hv\_monitor subdirectory of the generic **daq** account (/home/daqdaq/hv\_monitor). The software runs in any standard terminal window (xterm, vt100, etc...) One, and only one, copy of the software should be running at all times to ensure that the current high voltage levels are monitored and recorded in the data base.

**If the high voltage monitor is NOT running use the following procedure to restart it:**

- Log in as the *daq* user.
- Change to the hv\_monitor subdirectory (cd hv\_monitor)

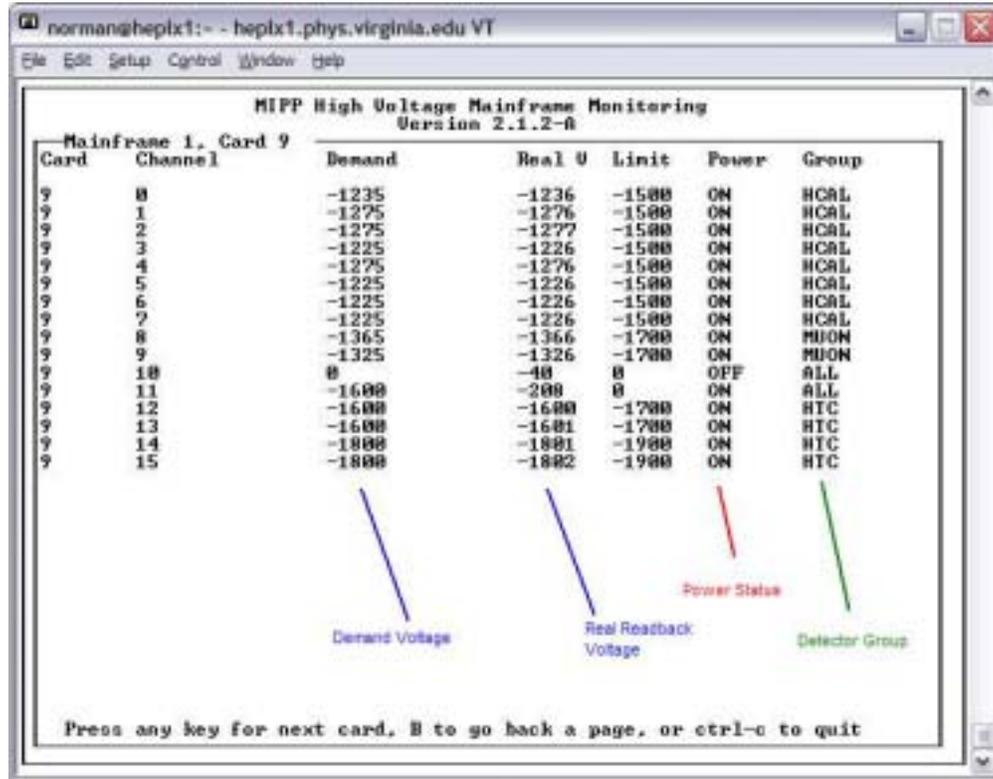


Figure 1.1: High Voltage monitoring interface for E907

- Start the monitor by typing `./hv_monitor`
- Verify that the monitor reads its configuration files and starts up properly.
- Leave the interface running.

While running the monitor system performs periodic queries of both the Rack 5 and ToF mainframes. After each system query, the interface cycles through all the high voltage cards and displays the voltages for each channel on that card. Each mainframe can hold a maximum of 16 high voltage cards, numbered 0-15 with 16 corresponding channels per card, also numbered 0-15. An example of a standard display readout is shown in Fig. 1.1.

### 1.7.1 High Voltage Power States

The high voltage monitor is designed to serve as an automated watchdog to ensure that the detector subsystems operate under nominal conditions. When running the monitor system polls and checks the voltages to all active channels on the Lecroy mainframes and compares the requested and read back voltages to determine potential problems.

The monitor recognizes and reports the following voltage conditions:

1. **ON** The channel is programmed to a non-zero demand voltage and reporting a read back voltage within 20 volts of the set point.
2. **OFF** The channel is programmed to a demand voltage of zero, or the high voltage to the mainframe has been toggled to the off state.
3. **TRIP** The channel is programmed to a non-zero demand voltage, but the read back voltage is more than 300 volts below this setting. This is indicative of a high voltage channel that has either tripped or is grossly unable to come up to the full demand voltage.
4. **Over V- Over Voltage** The given channel has exceeded the demand voltage by 20 volts DC. In this condition channel is considered to be running hot but this condition can be due to slight variations in the output supplied by the 1440 when run near the high end of its available output.
5. **Under V- Under Voltage** The given channel is more than 20 volts DC below its requested set-point. This condition can be a result of variations in the distribution of the load for the given high voltage card across the HV bus.
6. **OCRIT- Critical Over Voltage** The given channel has exceeded the demand voltage by more than 40 volts DC. This condition indicates a failure in the equipment. When an over voltage condition of this type is encountered the monitor will shutdown the voltage to that channel to prevent equipment damage.
7. **UCRIT- Critical Under Voltage** The given channel is more than 40 volts DC under the requested set point. This condition indicates a failure of the equipment. When an under voltage condition of this type is encountered the monitor will shutdown the voltage to that channel to prevent equipment damage.

## 1.7.2 High Voltage Alarms

When the monitor system encounters a channel that is not in the nominal ON or OFF state, it will sound an audible as well as a visual alarm to alert the shift personnel of the condition.

When an alarm is encountered the following steps should be taken:

1. Note the high voltage card, channel number, and voltage condition.
2. Check the condition against the list of “known” problem channels and/or voltage issues. If the channel is in this list follow the instructions listed there.
3. If the channel is not listed in the known problems log, make sure to add a note in the log book.

4. Determine a course of action to deal with the condition. This can include turning off the voltages to that channel, resetting the voltages to that channel, contacting a detector expert, or placing the channel on the pending/ignore list if the condition does not need to be dealt with immediately.
5. Some alarms take automatic actions to protect the experimental equipment. Critical Over and Under voltage alarms will automatically zero the voltage to the affected channels and write a log of this to the database.

While unlikely, it is possible for high voltage alarms to sound if the control software receives a bad serial read back from the 1440 mainframe. If you suspect that the alarm is due to this type of event, stop and then restart the monitoring software. This will reinitialize the interface and perform a fresh read of the mainframe.

### 1.7.3 HV Mainframe Status

In addition to the individual channel read backs, the monitoring software also polls the mainframes for their current operational state. The Lecroy 1440 mainframes have two status indicators that are read out on a regular basis.

- **HV ENABLED/DISABLED** This status indicator reads back the position of the hardware enable/disable toggle located on the front panel of the 1440. When set in the disabled position no high voltage can be supplied from the unit. To changed this setting requires physical access to the unit. The high voltage units are only set in the disabled mode when personnel are working directly with the high voltage cabling and want to ensure that no voltage can be supplied accidentally to their work area. Before a search and secure of the experimental area, both high voltage mainframes should be toggled to the ENABLED mode to allow for remote operation.
- **HV ON/OFF** This status indicator reads back whether the high voltage bus of the 1440 mainframe is energized or not. When set in the OFF position no voltage is supplied to any channels on the mainframe. When set in the ON position the entire high voltage bus is energized and each channel with a non-zero demand voltage is brought up to the programmed set point. When the mainframe is first powered on the HV bus defaults to the non-energized or OFF mode. To changed operational modes of the HV bus see the section 1.8.2.

If the status indicator reads “HV Error” this indicates that the monitoring software was unable to determine the operational state of the mainframes. This most often occurs after a corrupt serial read and can be corrected by either restarting the software, or waiting for the next polling cycle. If this condition persists it most often indicates a problem with the serial interface on the 1440 mainframe. Cycling power to the mainframe will normally reset the serial interface to an operational state.

### 1.7.4 Mainframe Current Limits

Each Lecroy mainframe maintains two register values that represent the maximum current limit for cards supplying positive high voltage, and for cards supplying negative high voltage. The registers have an allowable range from 0 to 255, representing the minimum to maximum current trip sensitivity.

Both the mainframe in relay rack 5 and the time of flight mainframe have been setup to operate at the maximum value for the current trip. If the positive and negative current limits are not set to the value of 255, the mainframe may not supply full demand voltage to channels that draw a high current load.

While unusual, the current limits on the mainframes have been seen to “slip” from their programmed values. If this occurs the high voltage monitoring software will alarm to alert the shift personnel of the condition. Current limits can be reset using the high voltage control interface.

Mainframe 1 (Rack 5)		
HV Card	Card Type	Detectors
0	Empty	-
1	1443 (Positive)	CKOV
2	1443 (Positive)	CKOV
3	1443 (Positive)	CKOV
4	1443 (Positive)	CKOV
5	1443 (Positive)	CKOV
6	1443 (Positive)	CKOV
7	Empty	-
8	1443 (Negative)	T00/T01
9	1443 (Negative)	HCAL Muon HTC
10	1443 (Positive)	-
11	1443 (Positive)	BCKOV
12	1444	TPC
13	1444	TPC
14	1444	TPC
15	Empty	-

Table 1.4: Map of the high voltages cards installed in mainframe #1 (relay rack #5)

## 1.8 High Voltage Control

In the event that the voltages to the different detectors need to be updated or recovered, the shift personnel should use the high voltage control interface to reprogram the Lecroy 1440 mainframes.

The 1440 control software is designed to provide both access to the detector system voltages while limiting the possibility of inadvertently reprogramming other detector sub-systems. Before attempting to reprogram the Lecroy 1440's the shift personnel should know the following:

- Which detector channel/channels need adjustment
- Which Lecroy mainframe those channels receive voltage from
- Which high voltage card (0-16) on the high voltage bus, the channel is supplied from.

Maps of the high voltage card assignments are listed in Table 1.4 and Table 1.5. Individual channel assignments on these cards are available from the individual detector groups.

Mainframe 2 (TOF Wall)		
HV Card	Card Type	Detectors
0	Empty	-
1	Empty	-
2	1443 (Negative)	TOF
3	Empty	-
4	1443 (Negative)	TOF
5	1443 (Negative)	TOF
6	Empty	-
7	1443 (Negative)	TOF
8	1443 (Negative)	TOF
9	Empty	-
10	1443 (Negative)	TOF
11	1443 (Negative)	TOF
12	Empty	-
13	1443 (Negative)	TOF
14	Empty	-
15	Empty	-

Table 1.5: Map of the high voltages cards installed in mainframe #2 (TOF Wall)

### 1.8.1 Starting the HV Control

The high voltage control software is named “hv\_control” and is located in the hv\_control subdirectory of the generic **daq** account (/home/daqdaq/hv\_control). The software runs in any standard terminal window (xterm, vt100, etc...) To start the high voltage control interface:

- Log in as the *daq* user.
- Change to the hv\_control subdirectory (cd hv\_control)
- Start the control interface by typing ./hv\_control

When first initialized the control interface requires the user to log in as the detector subgroup corresponding to the voltage channels they wish to modify. When logged in as a specific detector subgroup you have access to **ONLY** those channels that belong to the specified detector. Access to any other channels is prohibited by the control software to prevent accidental reprogramming of the detectors.

The available detector groups are:

1. **CKOV** Čerenkov Counter
2. **TOF** Time of Flight Wall
3. **TPC** Time Projection Counter
4. **HTC** Horizontal Trigger Counters (Cosmics)
5. **HCAL** Hadron Calorimeter
6. **T00/T01** Trigger Counters T00 and T01
7. **MUON** Muon trigger paddles
8. **BCKOV** Beam Čerenkov
9. **SHIFT** Generic Shift Operator

As a general shift personnel, you should log in as “SHIFT”. This will give you access to the basic operations needed for maintaining the high voltage system.

When logged in as shift you can:

1. *Load the standard high voltage table and program it into the Lecroy 1440.* To do this type “S” and follow the prompts.

2. *Turn ON all the high voltages to the detectors in a safe manner.* To do this type “0” and follow the prompts. Note that when turning on the detectors in this manner, the TPC anodes are left at zero volts to prevent damage to the detector. The TPC anodes will need to be ramped up by an expert.
3. *Turn OFF all the high voltages to the detectors.* To do this type “F” and follow the prompts.
4. *Perform an emergency shutdown.* Type “!” and the high voltage will be instantly disabled to all chambers. This should only be used in an emergency since it does not slowly ramp down some channels.
5. *Display voltages to the entire mainframe or an individual card.* Type “D” or “C” to view the mainframe or a single card.

### 1.8.2 Turn High Voltages ON

If the status indicator reads **HV OFF/ENABLED**, you can energize the high voltage bus using the “Safe Mainframe ON” option from the standard menu. Type the number “0” and follow the prompts. The TPC anode cards are located in Slots 12,13 and 14 of mainframe 1 and should be zeroed out before the high voltage bus is energized. These cards require a slow voltage ramp in order to be brought up correctly to their demand voltage without tripping.

If the status indicator reads **HV ON/ENABLED**, but a channel of interest is at a demand voltage of zero, you can load the appropriate value to bring the channel on by using the “Load Std Voltages” option from the main menu. This command will reload the voltages to all the detectors to their nominal set points as determined by the detector experts. After the set points are loaded from the “standard.hv” voltages file, they are programmed into the mainframe one at a time in order to ensure there is no corruption of the data buffers on any channel. This process can take a few minutes as it reloads the entire mainframe. Once the mainframe is reloaded the user will be prompted to energize the high voltage bus if it is not already live.

### 1.8.3 Turn High Voltages OFF

If the need arises to turn off the high voltages to the experiment, there are two methods for accomplishing this task. If it is not critical that voltages be turned immediately off, the shift personnel should use the “Safe Mainframe OFF” command from the main menu. This will ensure that all channels are ramped down appropriately to a zero voltage.

If the voltages must be immediately terminated, the shift operator should use the “Emergency OFF” option. This option will immediately dump all voltages to zero. Please note that this can cause damage to some chambers that require slow voltage ramping.

#### **1.8.4 Resetting TRIP Conditions**

If a single channel or group of channels experience an over current or over voltage condition, the channel/channels will trip off to prevent damage to the detectors. Because trip conditions are considered a failure mode of the detector system, the shift personnel should not attempt to reset a trip without first contacting the appropriate detector expert.

To ensure that trip conditions are not reset without expert assistance, the high voltage control system will not allow the “SHIFT” operator to reset individual channels or cards.

Please Contact A Detector Expert For Assistance.

## 1.9 Beam Cerenkov operation

The experts for the beam Cerenkov detectors are Win Baker, Mike Heffner, and Holger Meyer.

The beam Cerenkov detectors are read out through two pmts each that operate at a voltage of xxx Volts. There is a nitrogen purge between the pmts and the gas vessel windows to protect the pmts in case of helium use. Initially the gases used as Cerenkov radiators will be  $N_2$  and  $C_4F_{10}$ .

The gas system is controlled through the APACS system in Mtest which communicates with iFIX on the Windows PC which in turn takes commands from the MIPP DAQ. Gas pressures in the vessels range from 0 to 2 atm, or 0 to 150<sup>11</sup> mlb/ft<sup>3</sup>. If the set pressure is below 1 atm and the actual pressure is higher, check the vacuum pumps in MC7.

### 1.9.1 Pressure Curves

*instructions for taking pressure curves ca. May 2004*

For this first set of pressure curves we do not yet have the full data handling system in place, so the procedure is a bit cumbersome.

*Pressures:*<sup>12</sup> For starters, we would like to see pressures ranging from 0 to 100 mlb/ft<sup>3</sup>, in steps of 5 mlb/ft<sup>3</sup>. Determining which data points need to be taken is right now a matter of mining the log book to see what points have been taken<sup>13</sup>. Set the desired density on the iFix PC by going to the BCKOV1 or 2 page and typing it in the “Desired Density” field, pressing RETURN afterwards. You should see the solenoid indicators on the left side of the page spring to life and the calculated density start to change. Don’t forget to set both chambers.

*Trigger:* The triggers we want to use are the 16 logical combinations of [signal|no signal] in the 4 BCKov PMTs. To save you the work of constructing them I’ve saved a config file titled BCKov\_pressure.xml in the config/ directory on e907daq. To load this file select the File menu in rc-GUI, choose Open File . . . , and in the file browser make your way to /home/daqdaq/config/BCKov\_pressure.xml. Open it, and all of the trigger logic and prescale values will load automatically. In fact, the detector choices will load as well, so you don’t even need to worry about reading the next paragraph.

*Detectors:* As you’ll recall from the DAQ section you need to include at least one detector from each of the beamppc and richppc. As of this writing HCAL is the fastest detector in richpps (kudos to Andrew Norman), so we want to enable the Trigger, BCKovs, HCAL, and nothing else.

*Start Run:* Check that the BCKovs have reached your desired pressure, And start the run. Choose “test run”, either data directory, and please use “pcurve  $n_0, n_1$ ” as your start

---

<sup>11</sup>standard density of air is 0.075 lb/ft<sup>3</sup>

<sup>12</sup>of course, we do everything in terms of densities, but . . .

<sup>13</sup>I will try to set up a page somewhere where it will be easy to keep track of this info -mca

comment, where  $n_0$  and  $n_1$  are the densities. Click on “start run” and say “ok” when rc-GUI confirms.

*Log Run:* On a convenient piece of paper make note of the run number, set densities, the HCD rate<sup>14</sup> (to the nearest thousand will be fine), and the start time of the run.

*Length of Run:* Right now we’re only looking for a million particles (not events!) per run, so using your particle rate from the HCD you can estimate how many spills you’ll need to take. Even better, if you have onmon running you can wctch the scaler outputs on the screen. They look something like

```
Scaler 0
82 1 43 1 3 1 3 0 0 0 0 0
Scaler 1
13 1 9 1 1 0 1 0 0 0 0 0
Scaler 2
811 2 428 3 21 1 21 0 0 0 0 0
Scaler 3
127 1 83 2 2 0 2 0 0 0 0 1973
Scaler 4
20309 220 14851 234 1714 92 1604 49 0 0 0 0
Scaler 5
8396 77 8255 127 729 17 784 18 0 0 0 68801
```

except as fixed-width entries. The last channel of scaler 5 will tell you how many *particles* have home in this run – when this passes one million, stop the run.

---

<sup>14</sup>device F:MC7HCD on the Acnet console

## 1.10 Beam Chamber operation

The experts for the beam chambers are David Miller, Pierrick Hanlet, and Holger Meyer.

The beam chambers get HV from Droge supplies in the portacamp, controlled through Acnet. The nominal operating voltage is xxx volts. The gas system flows gas through all beam chambers serially. The commissioning gas is Argon/Ethane. Physics data is taken with magic mix. For long periods of inactivity nitrogen can be used to keep the chambers dry.

## 1.11 TPC

The most important information on operating the TPC is summarized in MIPP note 22, 'E907 TPC On/Off and Emergency Procedures'. The TPC link on the MIPP homepage gives more documentation.

## 1.12 RICH

The RICH detector HV is controlled through Acnet. (RICH experts, write this section when the RICH is up and running again.)

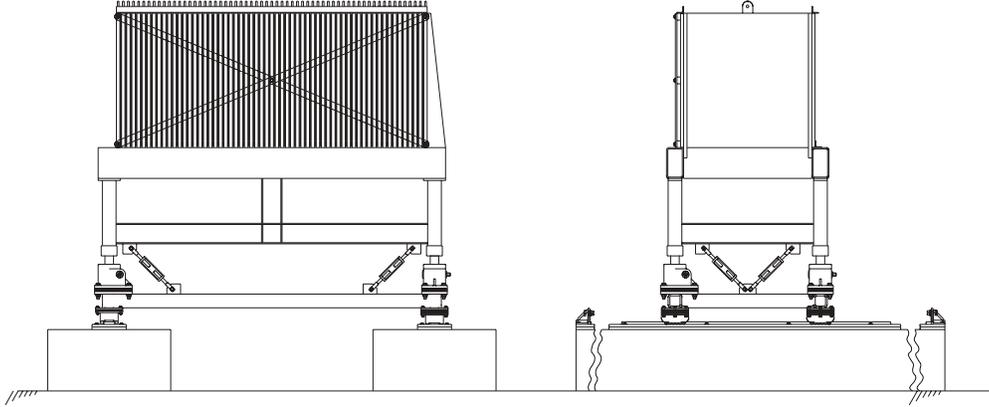


Figure 1.2: Hadron Calorimeter Exterior

## 1.13 Hadron Calorimeter

The hadron calorimeter (HCAL) as shown in FIG. 1.2 is located directly down stream of the Electromagnetic Calorimeter and is the last detector for MIPP. The purpose of the calorimeter is to determine the energy of incident hadronic particle through summing over the energy deposition of the resulting hadronic shower that is initiated as the particles enter the volume and interact with the lead sheets that comprise the majority of the interaction lengths of the detector.

The calorimeter is segmented into 8 readout cells in a 2 by 4 grid, symmetric across the beam axis. The front view of the absorber plate and scintillator/photo-tube readout system for one set of planes is shown in FIG. 1.3. Figure 1.4 shows the positioning of the readout cells as viewed from above the calorimeter.

The eight cells are read out by eight independent phototubes. The photo-tube currents are sent to a set of custom built ADC cards which are read out into the data stream. The high voltage lines and signal cables for the calorimeter are located on the beam right side of the calorimeter. These cables are connected to the main volume of the detector through a light tight patch panel. The connection map for this panel is shown in FIG ??.

It should be noted that the raw photo-tube signals for the calorimeter pass through an ADC driver module which is located in Relay Rack 25, crate 7, slot 2. If this module is not powered on, the signals as read out by the ADCs will appear to be very low. The remainder of the readout electronics are located in Relay Rack 20, crate 2. The readout electronics include an ADC receiver module, 4 two channel ADC cards and the CAMAC readout module. Additionally a Lecroy 2323A delay module is used to time in the gate signal from the primary trigger. All of these modules need to be powered on in order to properly read out the calorimeter.

In its proper running condition the calorimeter should have standard ADC pulse height

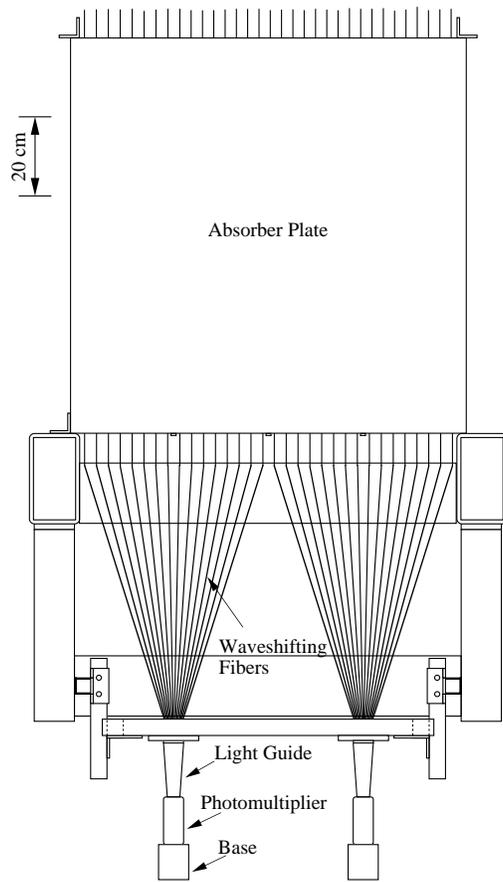


Figure 1.3: Hadron Calorimeter front view showing readout cell layout

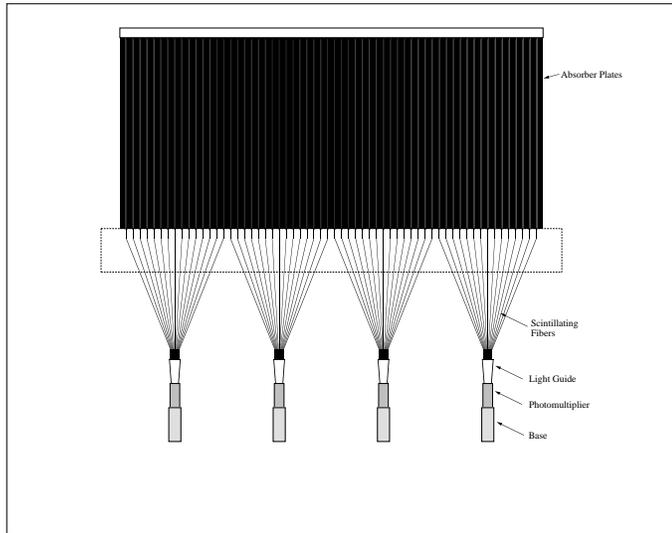


Figure 1.4: Hadron Calorimeter side view showing readout cell layout

distributions. The pedestals for the individual channels will drift slightly with time and temperature variations in the experimental hall, but should reside within the general ADC channel ranges listed in Table 1.6. Similarly the pedestals for each channel should remain narrow and similar to the values listed in Table 1.6.

The typical pulse height spectrum for each channel should consist of the following features as shown in FIG. 1.5:

- A narrow pedestal representing the lower edge of the distribution
- A narrow peak above the pedestal representing the minimum ionizing (muon) band.
- A broad hump extending out and then tailing off near the upper end of the distribution, representing the energy of the hadronic shower.

### 1.13.1 Error Conditions

During normal operation of the hadronic calorimeter, some error conditions may arise. If the raw ADC spectrum for the calorimeter does not appear to match the nominal profile, one or more of the following conditions may be at fault.

These conditions and their symptoms are discussed in the following sections.

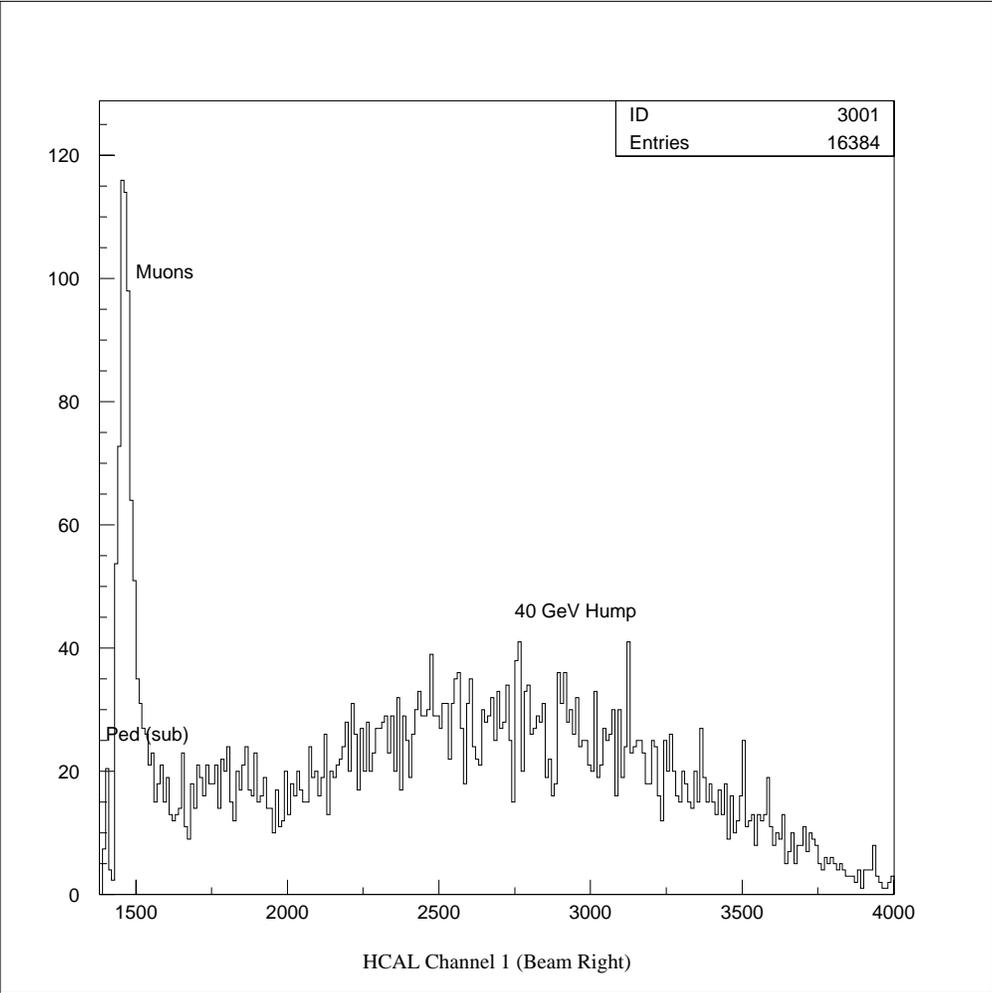


Figure 1.5: Hadron Calorimeter ADC spectrum

HCAL ADC Pedestals			
ADC Channel	Pedestal	Posi- tion	Pedestal Width
1	1402		3.9
2	1013		2.2
3	1242		2.6
4	1416		1.8
5	1349		1.6
6	1307		1.8
7	1302		2.4
8	1183		3.6

Table 1.6: Pedestal positions of HCAL ADC channels under nominal running conditions.

## High Voltage

If the calorimeter appears to have no data peaks, meaning no muon or hadron shower peaks, the most common cause of this condition is that the voltage to the calorimeter's photo-tubes has been shut off. If the calorimeter is run in a mode where no voltage is present on the photo-tubes, only the pedestal will be generated.

To correct this situation the voltages to the calorimeter photo-tubes should be reloaded from the standard run time voltages file "standard.hv" or "hcal.hv". Instructions for reinitializing these voltages is detailed in section 1.8.

## Pedestal Drift

The pedestal position for each ADC channel can vary over time due to changes in ambient temperature and electronics noise. If the pedestal for a given channel drifts substantially it will appear to form a very wide peak ( $\sigma > 4$  chan) or it shifts suddenly, a double peak will form.

In general pedestal drift should be looked for and any cases of extreme shifts should be noted. During normal running the pedestals are calibrated continuously using the out of spill pedestal triggers.

## ADC Gate

The gate used to read out the HCAL ADCs is generated through a Lecroy 2323A gate/delay module. The gate is delayed by 190ns and reshaped to a full 100ns in order to read out all channels in the calorimeter. If the gate delay time shifts the resulting ADC spectrum will appear to have little or no data above the pedestal position, and all events will essentially be read into the pedestal.

If the gate width becomes too narrow, the ADCs will not be fully read out. This will result in a greatly shifted spectrum and a shift in the pedestal position.

To reset either the gate delay or gate width, restart the current run. This will re-read the configuration files and reprogram the Lecroy 2323A located in Rack 20. If this does not fix the problem, a detector expert can be contacted to directly reprogram the module.

### **No ADC Amplification**

If the ADC driver module in Rack 25 is shut off, the signals to the ADC will not be properly amplified, resulting in a greatly shifted ADC spectrum with an apparent pedestal position near zero. To fix this situation, restore power to the CAMAC crate and the ADC driver module.

## 1.14 Gas systems

### 1.14.1 Overview

This section contains information on how to make sure that the *correct* gas is supplied to all detectors. It is part of the shift responsibility to take care of gas bottle changes and contact system experts if problems are found.

There is a separate gas systems manual that has pictures of all the gas panels and a layout of the gas shed. It is provided as a hard copy in the counting house. The gas systems expert for all systems is Terry Tope. There are other experts for the various detectors.

Near the end of this section you can find a table of all gases used in MIPP, what they are used for, and whom to contact if there is a problem with that gas.

### 1.14.2 Safety Issues

- all experimenters must take the Pressure Gas Orientation before working with gas systems<sup>15</sup>
- always wear safety goggles when working with the gas system itemall bottles should be secured at all times: either chained in the holding racks or strapped down when in use
- beware of the many hornets living around the gas shed – you don’t want to be surprised while rolling a bottle!
- during winter, ice will pack on the ground in the area of the bottles – shifters *must* keep the area clear of ice and snow. This is not only for our convenience, but also as drivers will not deliver if there’s no reasonable place to leave the bottles. *Do not use salt in that area – it will corrode the bottles!*
- never handle gas cylinders while wearing sandals – you don’t have good footing to handle heavy cylinders without a closed shoe – get someone else to move the bottle for you

### 1.14.3 Gas Log

The most common task is simply to log the pressures of every input gas for the experiment. This *must* be done at least once per shift. The logs for the gas pressures are kept in the counting house in a binder labelled “MIPP Gas Document” with the current page topmost<sup>16</sup>. In addition, if you have made an entry on the last line of the log you should take an inventory of all full bottles in the racks. Since there are only 20 lines on the log, this will ensure that

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<sup>15</sup>if you have not taken this course, contact a run manager

<sup>16</sup>the log sheet can be found (*ca.* 17 May 2004) at [ppd.fnal.gov/experiments/e907/ShiftDocs/checkListDoc/gas\\_log.html](http://ppd.fnal.gov/experiments/e907/ShiftDocs/checkListDoc/gas_log.html)

we inventory our gas stock weekly – this will be a great help to David Miller as he tries to keep us supplied.

In addition to simply logging pressures, you should, for each supply, look at the last few entries<sup>17</sup>, figure a rough consumption rate, and predict a lifetime for that supply. If your predicted lifetime is less than 48 hours you should notify Dave Miller, the run coordinators, and subsequent shifters, and you should make a log entry noting that “\_\_\_ gas needs to be changed soon.”

#### 1.14.4 Bottle change

The most frequent ‘problem’ with any gas system will be that the supply runs out. When changing a gas bottle, please follow the procedure. Gas systems should not get contaminated with air while changing the supply. Log your activity, so that replacement for empty bottles can be ordered.

In general bottles have a pressure of 2000 psi to 2300 psi when they are full and should be changed when the pressure drops below 50-100 psi. However, some gases come in different bottles at lower pressures; *e.g.* the argon/ethane mixture has a full bottle pressure of 300 psi and can be run to 5 to 10 psi. Regardless of the starting pressure, it is bad practice to let a bottle run empty.

If you find that a bottle needs to be changed, follow these steps:

- If you never changed a bottle before or feel that you cannot do it alone or together with the other person on shift, call the run coordinators and ask for help. Otherwise you most likely already know the following steps. They are listed here as a reminder.
- Confirm that a full bottle is available to replace the empty. If not, contact the run coordinators, make a log book entry, and contact the system experts for the systems connected to the gas that is about to run out. (See the gas manual for a detector gas matrix.)
- Confirm that all tools are available. You usually need a wrench and a bottle of Snoop to leak check the gas connection once the bottle is changed.
- Move the new gas bottle close to the bottle that needs to be replaced. Use the gas bottle cart. Work safely.
- Shut the flow valve to the detectors. Shut the bottle valve. If multiple bottles are hooked up to supply one gas, there may be additional valves to isolate the bottle/bottles you want to change. Close these, too.
- Disconnect the regulator from the bottle, being careful not to place adverse strain on the connections.

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<sup>17</sup>be aware that observed pressures will oscillate as a function of ambient temperature *i.e.* time-of-day

- Put a cap on the empty bottle and mark it empty.
- Exchange the full and empty bottles.
- Take the cap off the full bottle.
- Connect the regulator to the full bottle, again being careful not to place adverse strain on the connections.
- Open the bottle valve. If you hear hissing, close the bottle valve again and fix the connection.
- Open isolation valves (if any) in the line between bottle and vent valve.
- Open vent valve for a few seconds to purge the air in the regulator and gas manifold. Close after a few seconds.
- Open the flow valve to the detectors. All valves should now be in the same configuration as before the bottle change.
- Snoop the regulator to bottle connection and any other connections that you may have stressed when moving the regulator around. If you find problems, tighten the connection. If problems persist, call an expert.
- Move the empty bottle to the gas rack outside. Check that at least one more full bottle of this type of gas is available. If not, notify the run coordinators.
- Log the bottle change and the full bottle pressure in the log book (electronic) and on the log sheet (paper).

When you close a valve, make sure that you close it tight. When you open a valve, open it all the way and then turn it back a quarter turn. To check if a valve is open or closed, just check if the valve can be turned easily.

### 1.14.5 Gas descriptions

In this section we describe one-by-one all of the gas used in this experiment. Some of this information is also tabulated at the end of the section.

**Argon:** Comes from a dewar outside the gas shed, which is backed up passively<sup>18</sup> by bottles next to the dewar. Argon is inert. Argon flows to the P-10 mixer (which feeds both the TPC and the EMCal mixer) and the Magic mixer (and then on to the DCs).

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<sup>18</sup>the output pressure on the regulators to the bottles is a few psi lower than the output pressure on the regulator from the dewar, so as long as gas is flowing from the dewar it will prevent gas from flowing from the bottles

**Argon/CF<sub>4</sub>:** (75% Ar/25% CF<sub>4</sub>) Comes from bottles inside the shed. Nonflammable. Ar/CF<sub>4</sub> flows directly to the MWPCs and will be used during physics runs.

**Argon/CO<sub>2</sub>:** Comes from bottles in the gas shed. Nonflammable. Flows directly to the MWPCs for test runs.

**Argon/Ethane:** In a large cylinder outside the gas shed. Flows directly to the DCs for test purposes. As of Jun 04 no longer in use.

**BC Magic Gas:** (15% isobutane, 3% methylal, balance argon) Comes from large cylinders (40 psi start pressure) in the gas shed. Flows directly to the beam chambers.

**CF<sub>4</sub>:** Comes from bottles in the gas shed. Flows to the EMCal mixer and then on to the EMCal.

**CO<sub>2</sub>:** Comes from bottles outside the gas shed. Nonflammable. Flows directly to the Ckov and RICH. **DC Magic:** (28% isobutane, 3% methylal, balance argon) Comes from a mixer in MC8, backed up from bottles in the gas shed.

**Isobutane:** Comes from bottles in the gas shed. Flows to the magic mixer in MC8 and from there on to the DCs. Isobutane in the bottle is a liquid, with a vapor pressure of about 35 psi, so until all of the liquid evaporates the input pressure will read 35 psi. Once the liquid has evaporated the input pressure will start to drop, and not knowing the flow rate of isobutane, the bottle will last for an indeterminate, and possibly short, time before running out. Currently no method exists for reliably or easily checking the level of the liquid in the isobutane.

**Methane:** Comes from bottles in the gas shed. Flows to the P-10 mixer in MC8, from there to the TPC and the EMCal mixer in MC8.

**N<sub>2</sub>:** Comes from dewars outside the gas shed, with a passive bottle backup. Flows to BCs for purge, BCkov for production, DCs for purge, EMCal for purge, RICH for purge, and TPC for purge.

**P-10:** Comes from a mixer in MC8, backed up by bottles in the gas shed. Flows to the TPC and the EMCal mixer (and from there to the EMCal).

Gas Name	Mixture	Detector	Contact
Ar (bottle)	Ar	passive backup for dewar	
Ar (dewar)	Ar	DC 1-4 (Magic mixer), EMCal (P-10 mixer), TPC (P-10 mixer)	Dave Miller (DC), Terry Tope (P-10, Magic mixer), Dave Northacker (EM- CAL mixer), Peter Barnes (TPC), Durga Rajaram (EMCal)
Ar/CF <sub>4</sub>	75% argon, 25% CF <sub>4</sub>	DC 5-6 (production)	
Ar/CO <sub>2</sub>	80% argon, 20% CO <sub>2</sub>	DC 5-6 (test)	
Ar/Ethane	50.03% C <sub>2</sub> H <sub>6</sub> , balance argon	DC 1-4 (test)	Dave Miller
BC Magic	15% isobutane, 3% metha- lyl, balance argon	BC 1-3	Dave Miller
CF <sub>4</sub>	CF <sub>4</sub>	EMCal (mixer)	Dave Northacker (EMCal mixer), Durga Rajaram (EMCal)
CO <sub>2</sub>	CO <sub>2</sub>	Ckov, RICH	Dave Lange (Ckov), Mark Messier (RICH)
DC Magic	28% isobutane, 3% metha- lyl, balance argon	DC 1-4	Dave Miller
Isobutane	CH(CH <sub>3</sub> ) <sub>3</sub>	DC 1-4 (Magic mixer)	Dave Miller (DC), Terry Tope (Magic mixer)
Methane	CH <sub>4</sub>	TPC (P-10 mixer), EM- Cal (P-10 mixer)	Terry Tope (P-10 mixer), Durga Rajaram (EM- Cal), Peter Barnes (TPC)
N <sub>2</sub> (bottle)	N <sub>2</sub>	passive backup for dewar	
N <sub>2</sub> (dewar)	N <sub>2</sub>	BC 1-3 (purge), BCkov (production), DC 1-4 (purge), EMCal (purge), RICH (purge), TPC (purge)	Dave Miller (BC, DC), Durga Ra- jaram (EMCal), Peter Barnes (TPC)
P-10 (bottle)	10% methane, 90% argon	TPC, (EMCal mixer)	Peter Barnes (TPC), Dave Northacker (EM- Cal mixer), Durga Rajaram (EMCal)

Table 1.7: MIPP gases and their detectors

## 1.15 Apacs / iFix

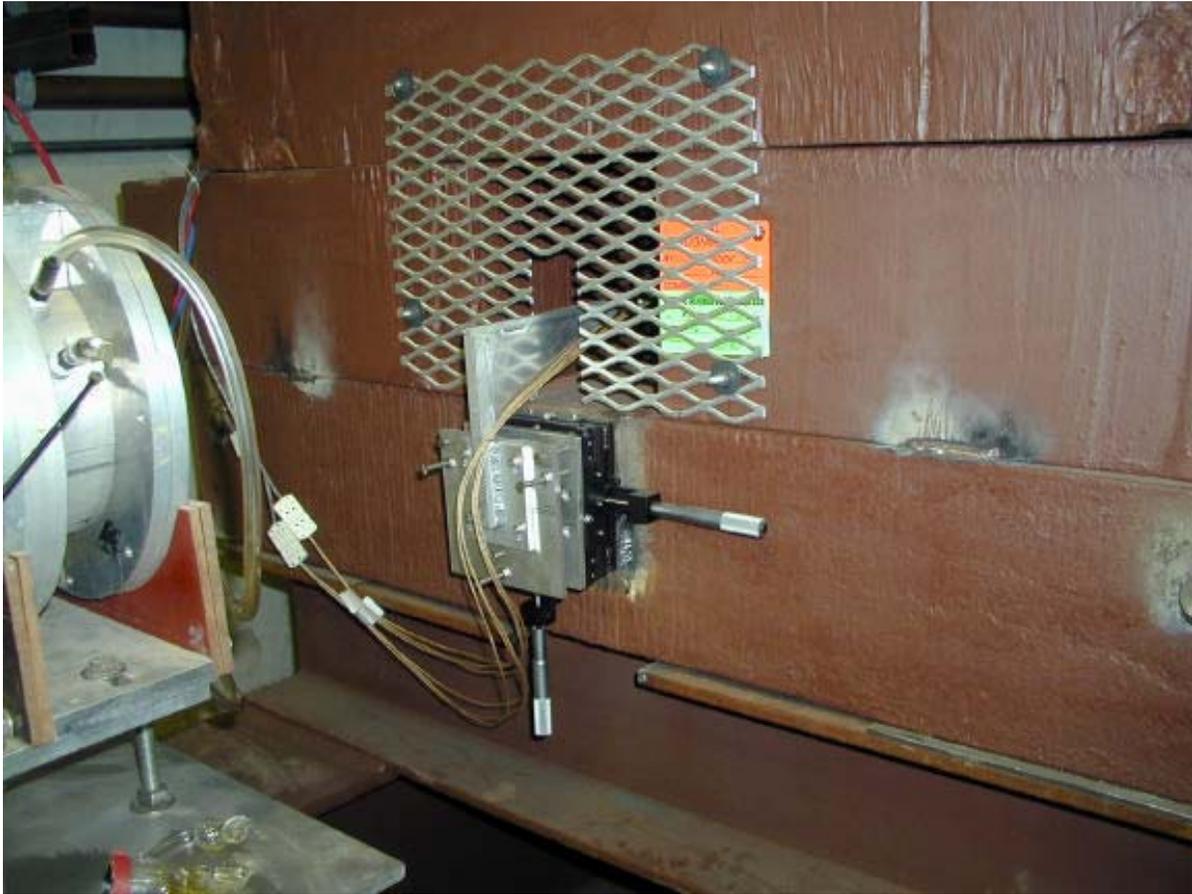


Figure 1.6: Primary target in shielding cage located at the upstream end of Meson building MC6.

## 1.16 MIPP Beamline

The MIPP beamline experts are Carol Johnstone and Rajendran Raja.

Beam to the MIPP experiment is delivered from the Main Injector through SwitchYard 120 which also supplies beam to M-Test.. You have control of the last part of the beam line. Only the Main Control Room (MCR) can initiate sending protons our way. If there are problems with the beam upstream of MC6 and M05, you have to interact with the MCR.

The MIPP beamline consists of two parts. The primary beamline transports 120GeV/c Main Injector protons all the way to our primary target that sits at the upstream end of the Meson building in a target cageas shown in Figure 1.6. The MIPP secondary beamline is shown in Figure 1.7. Before the primary target, the primary beam is bent up by the dipoles MC5U-1,MC5U-2, and MC5U-3. This has the advantage that the uninteracted primary

beam and the muons resulting from its absorption in the shielding are aimed at an upward direction and miss our experimental apparatus.

The secondary beam is bent down and made horizontal after the primary target by a series of dipoles MC6D-1, MC6D-2, MC6D-3 and MC6D-4. All these downward bending dipoles are controlled by a single bus powered by a single power supply MC6D. This current sets our secondary momentum scale.

The primary target is focused on to the collimator MC6Y by the three x focusing quadrupoles MC6Q1-1, MC6Q1-2 (MC6Q1-1 and MC6Q1-2 are on the same supply and will appear in the ACNET beam page as MC6Q1) and MC6Q3. The primary target is focused on to the collimator MC6Y by the 4Q quadrupole MC6Q2. This causes dispersion at the collimator. The collimator jaws can be opened and closed by typing in the number of counts one wants to move the jaws. Typically +100 counts will open the jaws by 2mm. The collimator jaws move vertically, symmetrically about the beam axis and increasing the collimator aperture will increase the MIPP beam flux and its momentum bite  $\delta p/p$ . The collimator opening is displayed in mm in the Acnet page. MIPP has control over the secondary quadrupole currents and the collimator. In order to change the dipole bus current and the trim elements, one has to contact the MCR.

The collimator is then refocused on to the secondary target (our experimental target!) in MC7 by a series of x focusing quadrupoles (MC6Q4 and MC6Q6) and a y focusing 4Q quadrupole MC6Q5. All the quadrupoles are by default the 3Q variety (they have a 3" aperture) and draw typically tens of amps of current. The 4Q quadrupoles draw hundreds of amps of current and have a 4" aperture.

## 1.17 Beam operation

Depending on desired secondary charge sign and beam momentum the primary intensity we desire varies. Beam intensity is adjusted by calling the MCR and demanding a certain number of counts in our beam counter MC7T01 which is also fed into Acnet.

The secondary beam line magnets are controlled from Acnet parameter page S17, 'mipp' subpage, <4> subpage. This page lists all the magnets with polarities, currents, and on/off, trip, and other status.

Eventually the run control will be able to send the magnet currents to acnet based on the setting for secondary beam energy. Currently the set of magnet currents corresponding to each beam energy is not known yet.

The magnet currents in the entire beam line are read into the slow monitoring periodically during data taking.

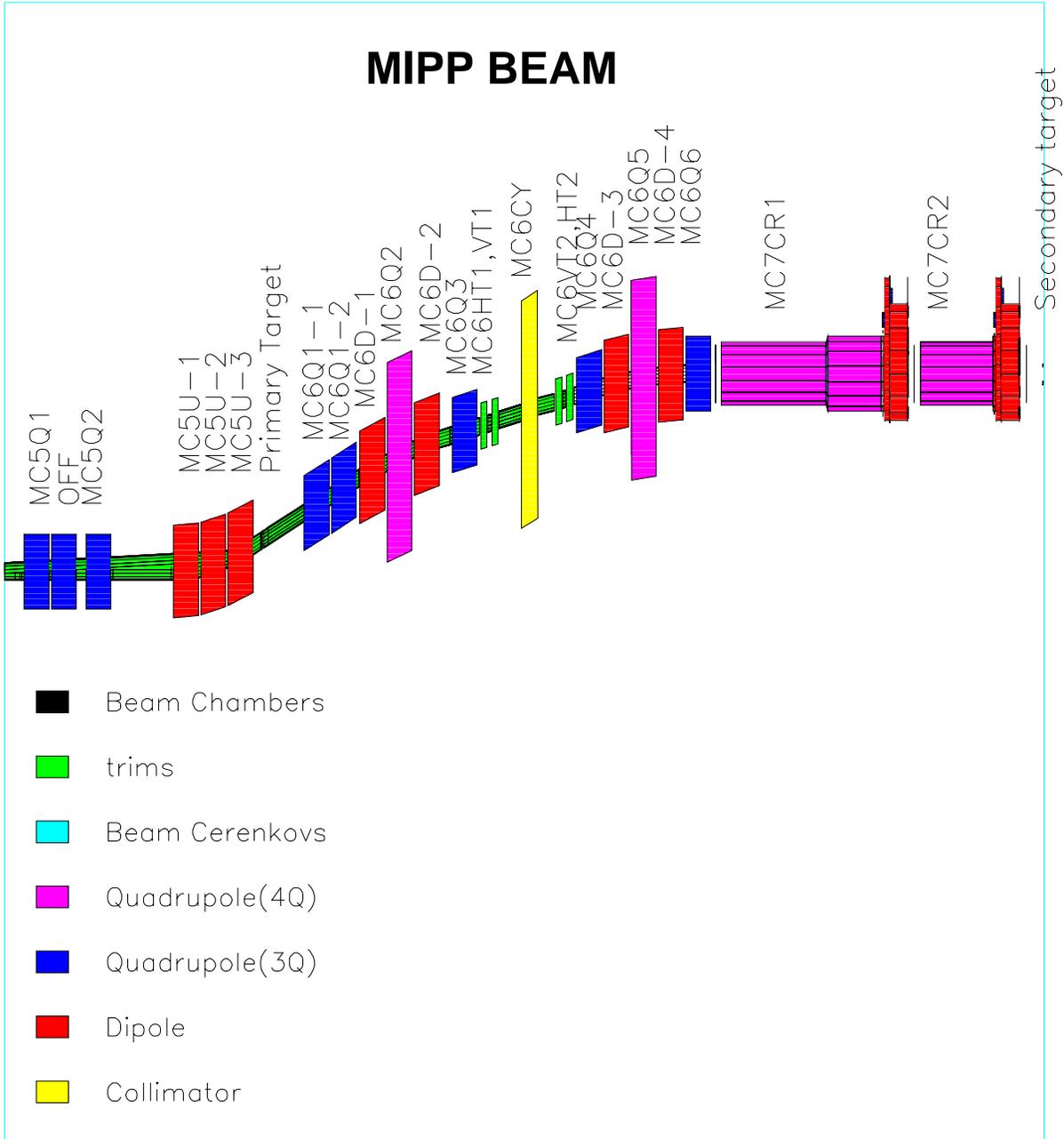


Figure 1.7: MIPP Secondary beamline.

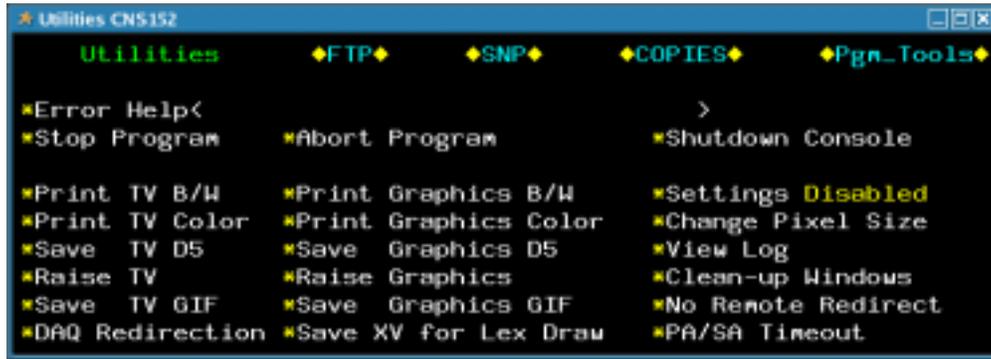


Figure 1.8: The Acnet utility window.

### 1.17.1 Acnet

Acnet is the Fermilab Accelerator Network for slow controls. It is used to control the Magnets in the accelerators and other devices. MIPP uses it for the beamline, the analysis magnets (JGG and Rosie), the drift chamber HV, and some other devices.

Usually you can interact with the devices through the SlowControls interface in the MIPP DAQ. However, in special situations it may be useful to use the Acnet console directly. The Acnet console is an X-terminal connected to the beams division network. MIPP has consoles in the counting house and in MC7 (near the RICH on the west side). If these consoles hang or do not have the Acnet running, you can cycle the power. The console should then boot and show a window that lets you start Acnet.

There are different types of Acnet windows. One, named 'Utilities', allows to shut down the console and *enable settings*. You do not need to enable settings to read back devices. If you try to set a device while you are not enables, Acnet will pop the 'Utilities' window to the front. One item in the list will read 'Settings Disabled'. Click on the word 'Disabled'. Another small window will open and give choices like 'Disable', '10 minutes', '1 hour', '8 hours'. Choose how long you want to set devices and click on that line. You can disable settings in the same way. If you are done and want to leave the console, please disable settings, so that another person cannot change settings by mistake. With settings disabled you can hardly do any harm when exploring Acnet on your own.

The MIPP page is on *S17*. This is noted on a label on the console. You need to type S17 into the upper left corner of a window. The resulting page has a few lines of headers and then devices listed with one line per device. On the fourth line you will find the names of sub-pages, connected with dots. On the right end of the line the MIPP pages (mipp1 and mipp2) are listed. Other pages include mtest. Click on mipp1 or mipp2 to get to our pages.

Each of the mipp1 and mipp2 sub-pages in turn has four sub-sub-pages. In the third line on the left you can cycle through the sub-sub-pages clicking the + and - sign in the +< n>- , where n is the number of the page you are on (1 to 4).

```

S17 ANALYZING MAGNETS          SET      D/A    A/D    Con-U  ♦PTools
-<FTP>+ *SA* X-A/D X=TIME      Y=I:IBEAMM,F:MC7T00,F:MC7T01,F:MC7HCD
COMMAND BL-- Eng-U I= 0      I= 0      , 0      , 0      , 0
-< 4>+ r_21 AUTO F= 2.8      F= 2      , 300000 , 100000 , 200000
mtest1 mtest2 safety. swyard. vac/h20 losses. nippi1 MIPP2
IBEAM LINE
ICF. PPD.FNAL.GOV/EXPERIMENTS/E907/BEAM/BEAM.HTML
-F:MC1D      MC1D      134      132.7  ampsD...C
F:MC6IC      MC6IC      5.378E+10 ppp

-F:MC5Q1     MC5Q1 (151B)  0      54.4   53.83  ampsD...C
-F:MC5Q2     MC5Q2 (151A)  0      66.5   66.04  ampsD...C
-F:MC5V1     MC5V1 (151A)  0      9       8.987  ampsD...C
-F:MC5H1     MC5H1 (151B)  0      2       1.941  ampsD...C
-F:MC5U      MC5U (1151)  998     989.9  989.9  ampsD...C
F:MC1MPA     MC Target temp upstream  30.4   DegC
F:MC1MPB     MC Target temp dstream  31.07  DegC
-F:MC6Q1     MC6Q1 (1151)  26.29   26.21  ampsD...C
-F:MC6Q      MC6Q (151A)  0      289.1  283.4  ampsD...C
-F:MC6Q2     MC6Q2 (151B)  510.3   496.4  ampsD...C
-F:MC6Q3     MC6Q3 (1151)  42.3    42.2   ampsD...C
-F:MC6CV     MC6CV Collimator  0      3.399  mm      "
-F:MC6H1     MC6H1 (1151)  .293    0       .299   ampsD...C
-F:MC6V1     MC6V1 (1151)  .323    .006    .287   ampsD...C
-F:MC6H2     MC6H2 (159)  0      0       -.262  amps ...
-F:MC6V2     MC6V2 (1151)  .391    0       -.446  ampsD...C
-F:MC6Q4     MC6Q4 (1151)  37.09   37.04  ampsD...C
-F:MC6Q5     MC6Q5 (159)  438.3   440.8  438.8  amps ...
-F:MC6Q6     MC6Q6 (1151)  24.51   24.43  ampsD...C

I:IBEAMM     MI DCCT MEDIUM BEAM  0      E12
F:MC7T00     SCALER 9 IN MC7  1E+05  Cnts
F:MC7T01     SCALER 9 IN MC7  31248  Cnts
F:MC7HCD     SCALER 9 IN MC7  90502  Cnts
IJGG 1450, ROSIE 850
-F:MC7AN1    Jolly Green Giant  0      *-5.035  amps *T.
-F:MC7AN2    Rosie  0      *-4.578  amps *T.

```

Figure 1.9: The MIPP beam tuning page. The set values are in magenta. In order to change the values (MIPP can change the quadrupoles and the collimator), one types in the numbers in the D/A (yellow) column. Collimator is changed by typing in the counts one wants to move by (100 counts = 2 mm). The tune shown is for nominal 40 GeV positives.

Starting with the sixth line, each line contains one device. The device name is printed in cyan color in columns 2 to 9. The comment in white gives more information on the device. The green number is the actual read back. The unit is printed in white. Five columns of status information are at the right end of each device line. For devices that can be set there is also a yellow number. This is the demand. You can type a new number over the old yellow number and hit enter to change the setting on a device. To turn devices on or off, click on one of the five status flags. The line will change and in place of the comment it will show in yellow various actions. Click ON or OFF to turn the device on or off.

### 1.17.2 Step-by-step guide to turning on/off the analysis magnets

To check the magnet status:

- Go to the MIPP Acnet page, *S17*.
- Click on *mipp2* sub-page in line 5.
- Click on < in line 4, column 2 to go to sub-sub-page 4.
- Read the green current readback for the devices F:MC7AN1 and F:MC7AN2.

To turn magnets on (follow this procedure for each magnet):

- Check the magnet status (see above).
- In the Utilities window, click on the yellow *Disabled*, then select 1 hour.
- The yellow number (set current) should be zero. If not, enter 0 and hit enter (not return).
- Click on the right-most column in the device line for F:MC7ANn (n is 1 for JGG and 2 for Rosie).
- Click on the yellow word *RESET* in the same line. (This resets a trip condition, if present.)
- Repeat and click on the yellow word *ON* in the same line.
- If you cannot turn on the magnet, the supply may be turned off. Go to MP7 and look at the supplies.
- Move the cursor to the yellow number and type 100. Hit enter.
- Now the green readback should read close to 100.
- Continue to ramp up the current in steps of 100 volts until you reach the nominal current setting.

- In the Utilities window, click on the yellow *Enabled*, then select DISABLE.

To turn magnets off (follow this procedure for each magnet):

- Check the magnet status (see above).
- In the Utilities window, click on the yellow *Disabled*, then select 1 hour.
- In the device line for F:MC7ANn (n is 1 for JGG and 2 for Rosie), enter 100 less than the number shown (e.g. if the yellow number is 850, enter 750) and hit enter.
- The green readback should fall by 100 amps.
- Repeat until you reach zero amps.
- Click on the right most column, then click on OFF.
- In the Utilities window, click on the yellow *Enabled*, then select DISABLE.
- If you enter a long shutdown, walk over to MP7 and turn off the supplies (two per magnet, four total).

### 1.17.3 How to get SWIC plots

To plot SWIC profiles:

- Go to page S45.
- In the first line, click on the first pull down menu. (Usually it says *Meson Line*)
- In the pull down menu, select *Meson Center*
- Click on the devices you want to plot. An asterics next to the device name will mark devices to be plotted. (MC7WC1 and MC7WC2 are the chambers in MC7, next to BC1 and BC3.)
- Click on *Start Plot*
- Click *Plot*
- Customize the parameters. In particular, you must use “positive and negative values” to plot MC7WC1 and MC7WC2. option.. If you have other plots already, it may be useful to select the slot, i.e. the graphics window to use for the SWIC plots. There are three choices, *SA*, *SB*, and *SC*. Plot window *SC* is customarily used in MIPP , and plot “side by side” gives the most convenient presentation of the plots.
- Click on *Plot\_it*. This starts the plot. It may take a while for the plot to update.

Figure 1.10 shows a well tuned MIPP beam consistent with the 40 GeV tune shown in Figure 1.9.

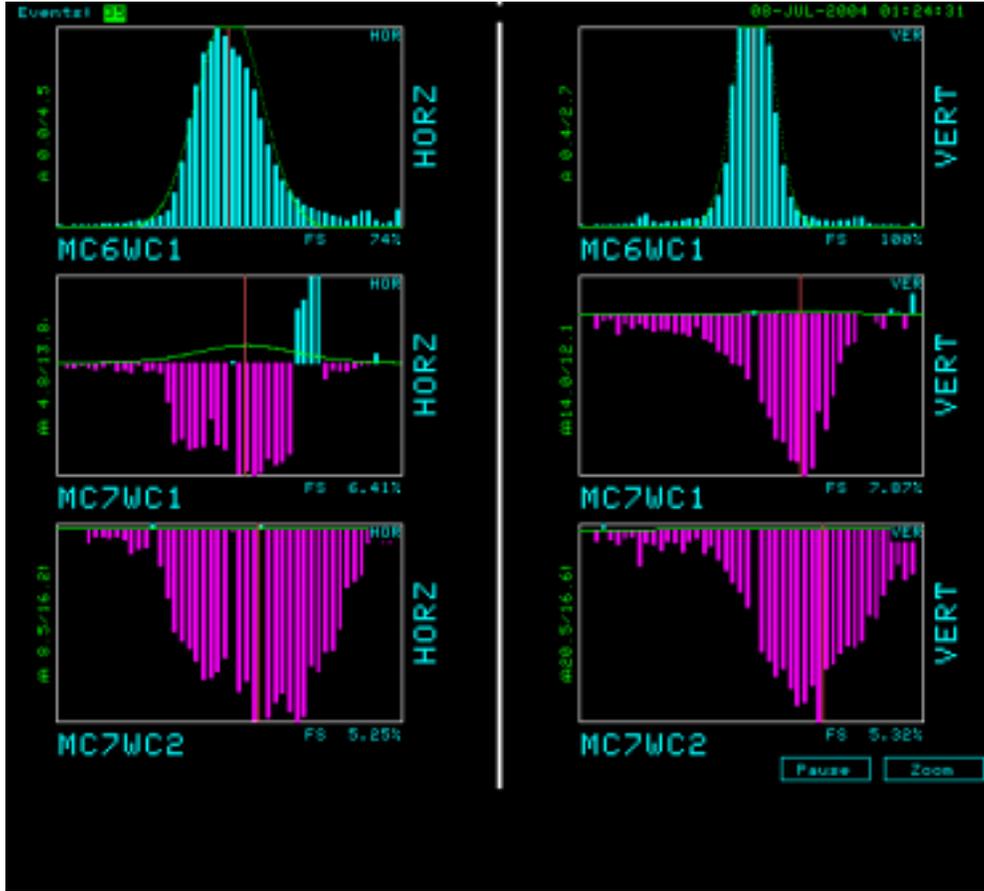


Figure 1.10: The beam profiles for a well tuned beam. The SWIC MC6WC1 shows the x and y profiles of the beam as it impacts our primary target. The full width of the SWIC plot is approximately 2.5". The beam profiles must be centered in both x and y for it to hit our primary target properly. In due course, the width of these profiles is expected to decrease, as our primary beam emittance is brought under control. The device MC7WC1 is placed just upstream of our upstream beam cerenkov close to MIPP beam chamber 1. it is also a PWC, called a "Fenker chamber" named for the physicist who built it. It puts out integrated profiles in the negative. The device MC7WC2 is placed close to our beam chamber BC3 and close to our experimental target. The profiles in MC7WC1 and MC7WC2 should be peaked and centered, for a good beam tune.

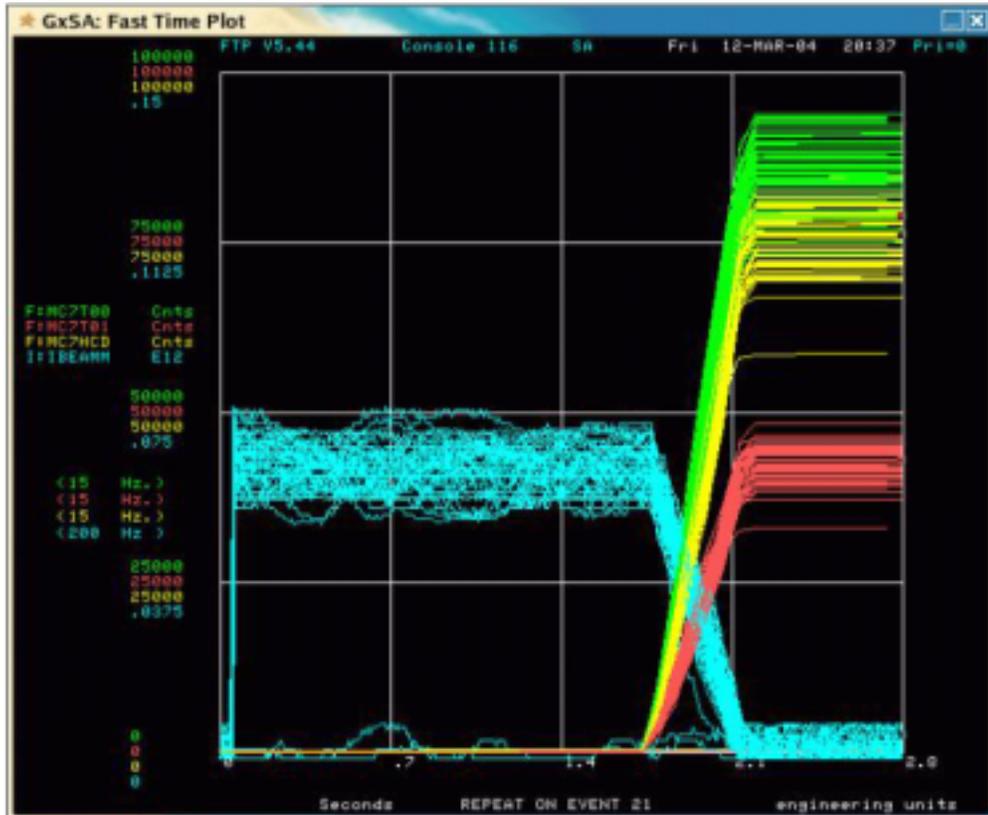


Figure 1.11: Slow Spill into MIPP. When the main injector intensity begins to drop, the slow spill starts and the counts in the scalers begin to rise..

#### 1.17.4 How to plot the slow spill

The T00, T01, and HCD (horizontal cosmics paddles) are fed into Acnet as devices MC7T00, MC7T01, and MC7HCD. These scalers get reset at the beginning of each MI extraction and can be plotted versus time. The beam intensity in the Main Injector can also be plotted. The resulting graph shows how the MI beam slowly loses intensity as the scalers in MC7 see particles.

To make the plot, the device names and ranges have to be entered in the top four lines of page S17. The details are shown in the picture. One needs to trigger the Fast Time Plot (FTP) on event r\_21, which will plot the slow spill. Interrupting on the variable x=TIME, will reset the cumulative plot. The main ring intensity is given by the variable I:IBEAMM. The scalers we plot are F:MC7T00,F:MC7T01,F:MC7HCD. The I and F vectors give the initial and final values (i.e. limits) for all the variables. This plot can be saved using the utilities window and restored or typed in by hand in case some one has set it to some other plot. Figure 1.11 shows a typical slow spill plot.

## 1.18 Data backup/retrieval : How to use Enstore

(Contact: David Lange (lange6llnl.gov, 650 926 8513 or 925 424 3410)

We use the Enstore system to archive the raw data soon after it is written to disk (/data/0 and /data/1 on e907daq). Access to Enstore for Mipp is currently only via e907daq.fnal.gov. Enstore files/directories appear just as normal files/directories under "/pnfs/e907" on e907daq.

### 1.18.1 When are the data disks too full??

If you see that the available space on either of the data disks on e907daq falls below 5 gigabytes, please contact the expert (see above).

### 1.18.2 Getting runs from Enstore

Use /ppcboot/soft/mipp/mippEnstore/ENSgetRun.pl to retrieve a run from enstore.

To retrieve specific files you can access enstore directly:

1. You will likely need to setup the encp product: `setup encp`
2. Then you can use the `encp` command just as you would `cp`. For example
  - `encp /path/to/myfile /pnfs/e907/subdir/`
  - `encp *.root /pnfs/e907/subdir/`
  - `encp /pnfs/e907/test lange6/download/`.
3. More encp options at <http://www.fnal.gov/docs/products/enstore/using.html#48171>

### 1.18.3 Organization of data un /pnfs/e907

Data is organized in Enstore according to run number under the /pnfs/e907/mippData directory. There is one subdirectory for each 1000 runs. For example, to find a run between 4000 and 4999 look in the /pnfs/e907/mippData/00004 directory. Note that the 'ls' command will work like normal.

### 1.18.4 Data backup Scripts

These scripts are found in CVS under mipp/online/Enstore. The production version is /ppcboot/soft/mipp/mippEnstore.

- ENSArchiveFiles.pl: Copies files from specified directory (default = /scratch0) into specified enstore directory (/pnfs/e907/mippData). There are no options at the command line, however there are various controls available in the top part of the script. These include the file ending (.raw), beginning (mipp), minimum age (60 minutes), and the location of the log and output files (/ppcboot/soft/mipp/mippEnstore).
- ENScheckArchivedFiles.pl: Parses the output of ENSArchiveFiles.pl to check that files were copied correctly and have the same size as the original ones. Similar to ENSArchiveFiles.pl, behaviour is controled in the top of the script, primarily the location of the various output files (of both ENSArchiveFiles.pl and ENScheckArchivedFiles.pl) (default = /ppcboot/soft/mipp/mippEnstore).
- ENSmonitorDisk.pl Checks to see if the data disks are full (6Gig or less). If so, then the oldest backed up runs are deleted. As with the other scripts, the behavior is controlled at the top of the script.

## 1.19 Resources

The web page for the MIPP experiment is at <http://ppd.fnal.gov/experiments/e907/>. It contains a lot of information, but not all parts of the site are well structured.

<http://ppd.fnal.gov/experiments/e907/ShiftDocs/MippShiftDoc.html> is linked from the home page. It duplicates some of the information in this document and may have some chapters that are missing here.

If this manual and the sources listed above do not help you solve your problem, contact the expert in the list below.

Name	Phone#	e-mail	Subgroup(s) ([h]ardware/ [s]oftware)
<i>mailing list</i>		e907@fnal.gov	
Abrams, Bob		rabrams@fnal.gov	
Akgun, U			
Austin, Matthew	303-819-2440(c)	matthew.austin@colorado.edu	thin target, BCkov(s)
Aydin, G			
Baker, Win	630-231-0339(h)	winbaker@fnal.gov	BCkov(h)
Barnes, Peter	925-422-3384(o) 510-610-0366(c) 510-526-0365(h)	pdbarnes@llnl.gov	TPC(h)
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Fisyak, Y			
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Godley, Andrew			
Gunaydin, Y			
Gustafson, HR			
Hanlet, Pierrick	630-355-7750(h) 630-697-8758(c)	hanlet@fnal.gov	BC(s), DC(h/s), trigger, run
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Lu, L.C.	434-982-5386(o)		Hcal
Messier, Mark	812-855-0236	messier@indiana.edu	Thick targets, RICH(h), on- line mon, of- fine analysis
Meyer, Holger	630-840-2997(o) 630-357-6870(h)	hmeyer@fnal.gov	Cosmics(s), analysis mag- nets, Droge HV, LV mon, run
Miller, David		demiller@physics.purdue.edu	BC(h), Gas supply
Mishra, SR			
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Park, HK			
Peterson, Jerry		jerry.peterson@colorado.edu	thin target

Name	Phone#	e-mail	Subgroup(s) ([h]ardware/ [s]oftware)
Raja, Rajendran	630-840-4092(o)	raja@fnal.gov	Cosmics(h), Cryo targets, Beam, monte carlo
Rajaram, Durga	630-527-1442(h)		EMCal(h/s)
Ramberg, Eric	630-840-5731(o) 630-406-0412(h) 630-266-0339(p)		Beam SY
Rosenfeld, Carl			
Rubin, H			
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Solomey, Nick		solomey@iit.edu	MWPC(h)
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Stefanski, Ray	630-788-9166		
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