

# Welcome to the FermiLab Main Control Room



# What is the MCR

- Central control point of the Accelerator Complex
- All accelerators are monitored and controlled from the MCR
- Controls access to the accelerator enclosures
- There are other remote accelerator control consoles on site but none are routinely manned around the clock

# Who is in the MCR

- Manned around the clock, 7 days a week, 365 days a year by a crew of ~5 operators and under supervision of a Crew Chief
- Multi-year training program for the operators
- Also used by scientists, engineers, technicians, and anyone else that needs to interact with the accelerators

# Why a Control System aka Accelerator Controls NETWORK aka ACNET

- Setting and Reading of Devices
  - Logging of Devices
  - Alarming of Devices
    - Feedback Loops
  - Finite state machines
- Sequencing of instructions

# Control Console

- The console is where you interact with the various devices that make up the accelerator
- Located in MCR, other locations on site, or even offsite
- Can be read-only, or provide various different classes for allowing settings



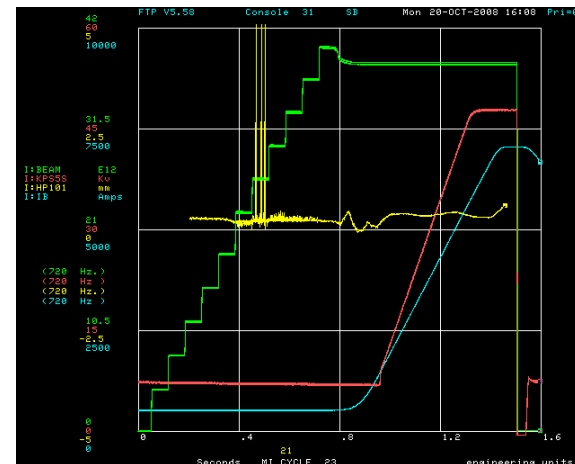
# What is a Console

- Multiply Displays
- Keyboard and mouse to interact with the computer
  - Trackball and Knob
  - Beam switch box
- May be other equipment unique to each location

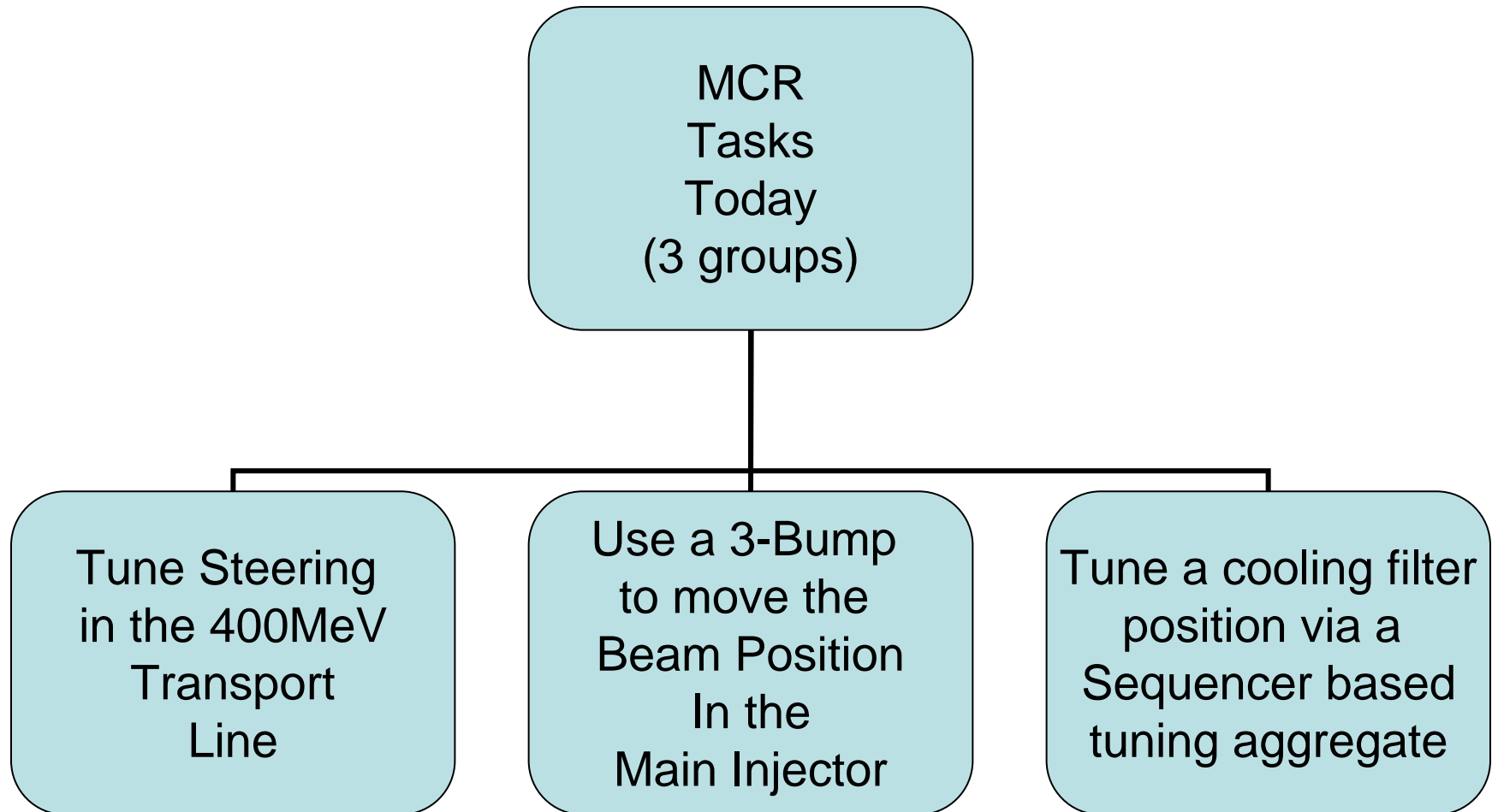
# Interacting with the Console

- Index page is used to start various different programs, or a single program configured many different ways
- Various display and plotting packages to show what is happening with the complex

```
P P-Bar Index                               ♦Cmnds♦Pgm_Tools♦
  Pbar RF                                     Stochastic Cooling      Beam Position
2 NEW RF CURVE LOAD                          25                               48 Beamlines BPM
3                                             26                               49 Debuncher BPM Pre
4                                             27 COOLING OVERVIEW            50 Debuncher BPM
5                                             28                               51 ACCUMULATOR BPM
6                                             29                               52
7 DRF1 TUNING                                30                               53 BPM TEST
8 RF PARAMETERS                              31 NETWORK ANALYZER           54 BPM/BLM Plots/List
9                                             32                               55
10 RF Overview                               33                               56 SEM GRID DISPLAY
11 Target Station                            34 TWT STATUS PAGE            57 BPM PARAMETERS
12 TARGET PARAMETERS                         35 SWITCH TREE                58 PBAR SEM GRIDS
13                                             36 STOCHASTIC PARAM'S        Power Supplies
14                                             Diagnostics                  60 POWER SUPPLY PARAM
15                                             38 DIAGNOSTICS PARAMS        61 DIGITAL STATUS
16 Vacuum I                                  39 DAMPER GRAPHICS           62 C165 Ramp Control
17 PBAR VACUUM PLOTS                         40                               Miscellaneous
18 PBAR VACUUM                               41 SANALYZER DOWNLOAD        64 Sequencer
19                                             42 SANALYZER DISPLAY          65
20                                             43 MEASURE TUNES             66 MISC PARAMETERS
21                                             44 SPECTRUM ANALYZER         67 BEAM PERMIT STATUS
22 Kicker Timing                             45 Pbar Global Health         68
23                                             46 RING LOSS MONITORS        69 STACK/LIFETIME SA
Messages
```



# What are we doing today





# Time for our MCR Tasks

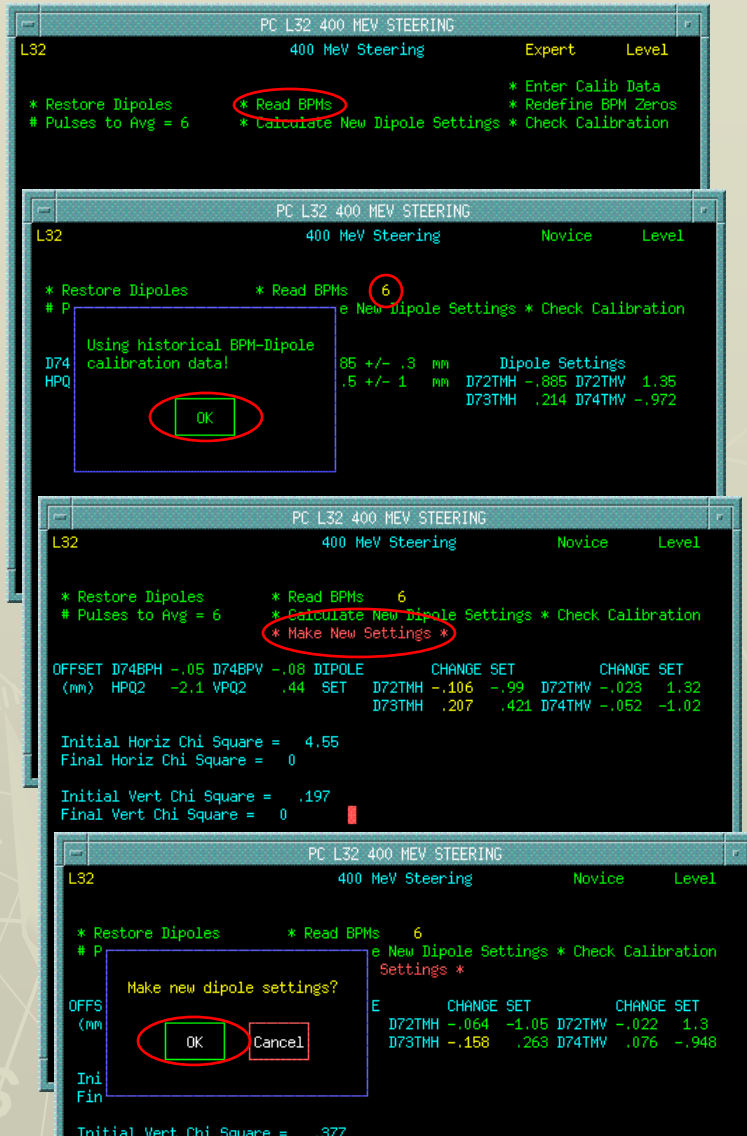
Break in to three groups  
Each group will be assigned  
a position in the MCR  
and given directions for  
their task

# Linac Steering

Directing beam from Linac to  
Booster



# Linac 400 MeV Steering Program



The purpose of the 400MeV steering program is to use four dipole corrector trims at the end of Linac to put the beam in “nominal” positions for it’s trip through the 400MeV line to the Booster accelerator. The algorithm samples BPM data in the downstream end of the Linac and calculates the horizontal and vertical corrections for the trim magnets.

- ▶ Using L32
- ▶ Interrupt on **Read BPMs**
- ▶ Turn on Studies pulses using the BSSB switch.
  - Wait for 6 pulses.
- ▶ Interrupt: **Calculate New Dipole Settings**
  - and take the “OK”
- ▶ L32 calculates trim changes vertically and horizontally
  - Interrupt: **Make New Settings** and interrupt “OK” to implement the new changes

# Monitoring Linac

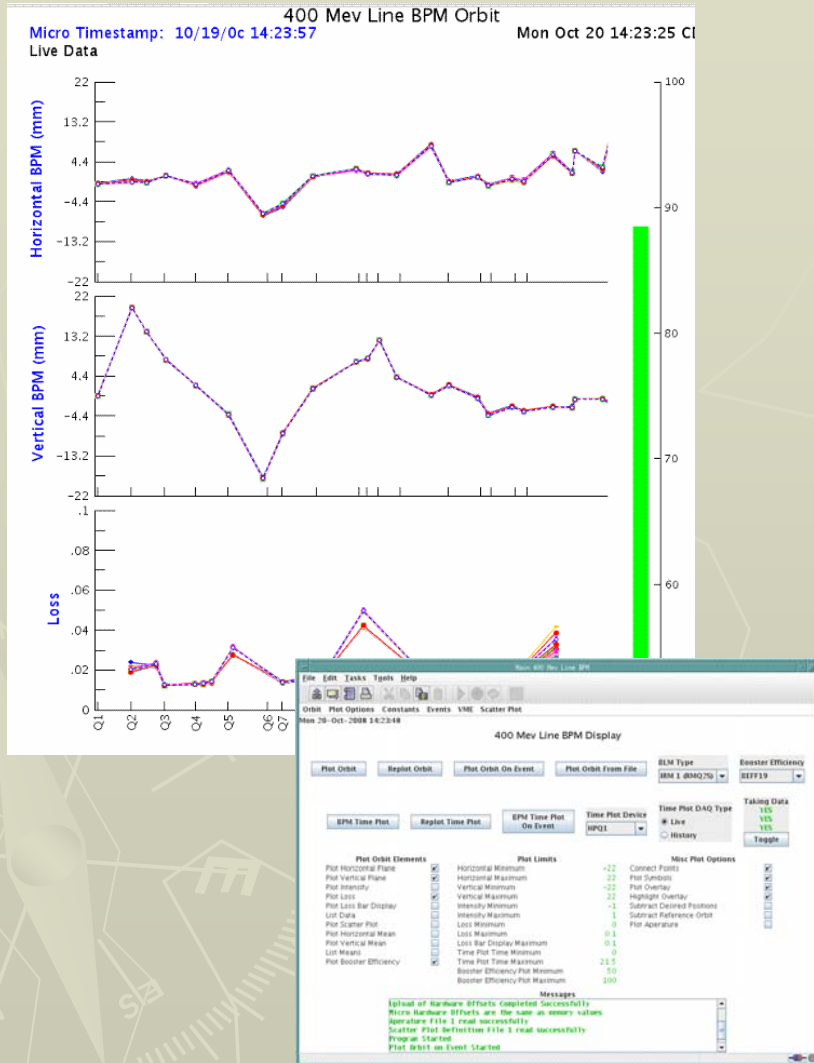


L11 program is used to monitor beam intensities and losses as beam is transmitted through Linac

- ▶ From L11 parameter page
  - Verify Torroid scale = 70MA
  - Verify Losses scale = 10 mA
- ▶ Interrupt: **Launch Linac Toroid/BLM plot**
  - Interrupt: **HERE** to start plot
- ▶ Beam intensities are on the upper graph
- ▶ Beam Losses are on the lower graph

# Monitoring 400MeV Line

We use a Java Program to monitor beam transmission in the 400 MeV line from Linac to Booster



- ▶ Using a Java application to monitor beam position and losses in the 400MeV line.
  - Refresh the plot by interrupting on **Replot Orbit**

# Monitoring 400MeV Line

```

PB L8 HE DEVICES<NoSets>
L8 400 MEV STEERING DIPOLES SET D/A A/D Com-U ♦PTools♦
-<FTP>+ *SA♦ X-A/D X=TIME Y=I:BEAM ,F:MT6SC1,S:F1SEM /I:BEAM21
COMMAND BL-- Eng-U I= 0 I= 0 , 0 , 0
-< 5>+ r_31 15_Hz F= 6 F= .4 , 100000 , 1.0E+12
tuning wires bpm/1m TRIMS quads lossmon bpms vacuum
L:BSTUDY Linac Beam Req. ON OFF * 0 *

! THESE ARE THE DIPOLES USED FOR THE 400 MEV
! STEERING PROGRAM

! D74BPH: 0.0, HPQ2: 4.3
L:D74BPH BPM 74-H Averag Position * -.006 MM
L:HPQ2 BOOSTER H POS B Q2 * 3.25 MM
! D74BPV: .55, VPQ2: 87.0
L:D74BPV BPM 74-V Averag Position * .656 MM
L:VPQ2 BOOSTER V POS B Q2 * 83.09 MM
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
-L:D72TMH Trim Magnet at M7-2 -.692 -.645 A
-L:D73TMH Trim Magnet at M7-3 .24 .334 A
!
-L:D72TMV Trim Magnet at M7-2 1.359 1.401 A
-L:D74TMV Trim Magnet at M7-4 -1.063 -.983 A
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
-L:Q71 M7 Q1 PEAK CURRENT 165.8 164.6 A
-L:Q72 M7 Q2 PEAK CURRENT 156 154.4 A
-L:Q73 M7 Q3 PEAK CURRENT 131.7 130.2 A
-L:Q74 M7 Q4 PEAK CURRENT 118.2 115.8 A

-L:TUNRAD TUNING RAD MONITR 70.19 185.5 MRH
L:400SCA LABYRINTH RAD MON .147 R/H

L:DELM1 Loss Mon: Lambertson Out * 1.425 MV
L:DELM2 Loss Mon: Spectrometr In * 2.292 MV
L:DELM3 Loss Mon: Straight Dump * 2.234 MV
L:DELM4 Loss Mon: Momentum Dump * 2.618 MV
L:400SCA LABYRINTH RAD MON .147 R/H
L:D7LMSM Sum of Loss Monitors * 10.18

B:BL400M 400 MeV bunch length .824 nsec
!.865

L:HPQ2 BOOSTER H POS B Q2 * 3.25 MM
L:VPQ2 BOOSTER V POS B Q2 * 83.09 MM
    
```

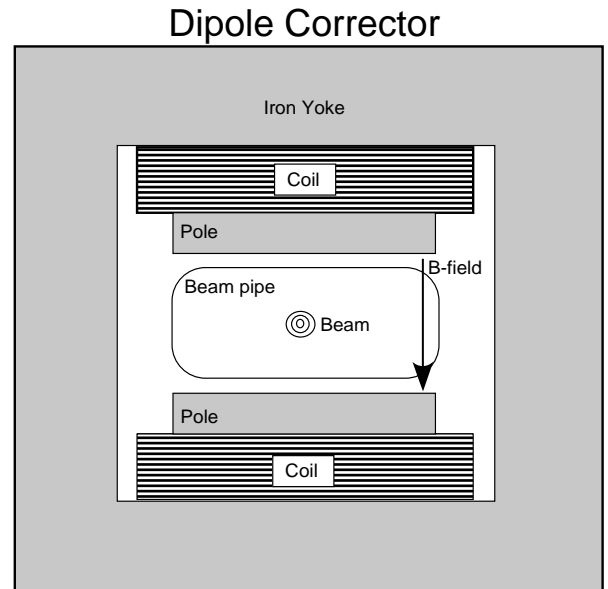
We use parameter pages to keep track of changes and enable us to return to initial condition.

- ▶ L8 400 MeV Steering Dipoles
  - Subpage <5> Trims
  - Horizontal changes are made to :
    - ▶ D72TMH
    - ▶ D73TMH
  - Vertical changes are made to :
    - ▶ D72TMV
    - ▶ D74TMV

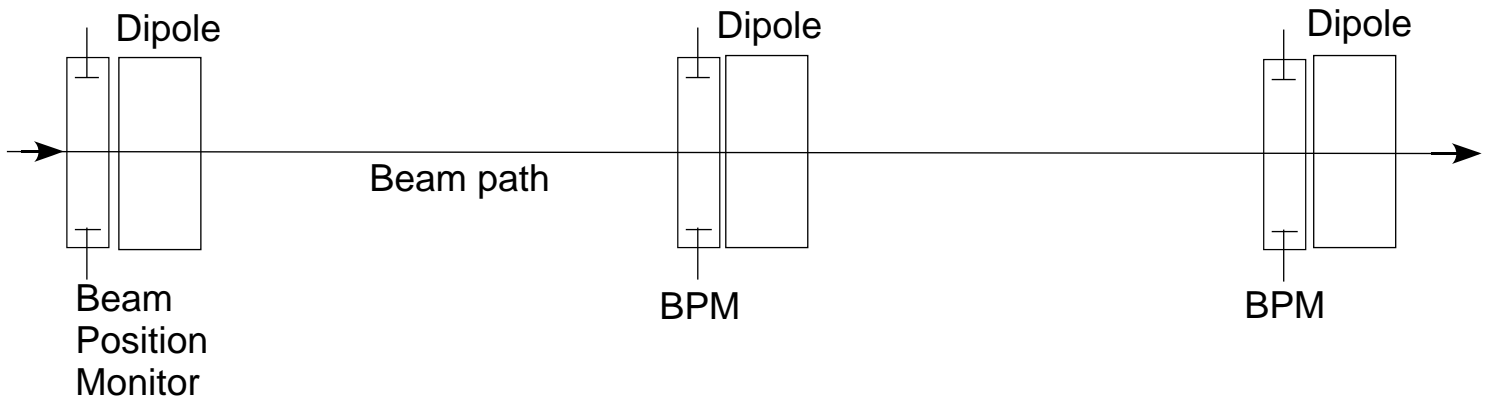
# Beam steering in circular machines

When it is desired to move the beam path (or orbit) at one location in the accelerator, Dipole Correctors are used. These are small electromagnets that are controlled individually, each producing an angular change in the beam path. The dipoles must be used in organized groups to create a local displacement. The most basic of these is called a Three-Bump.

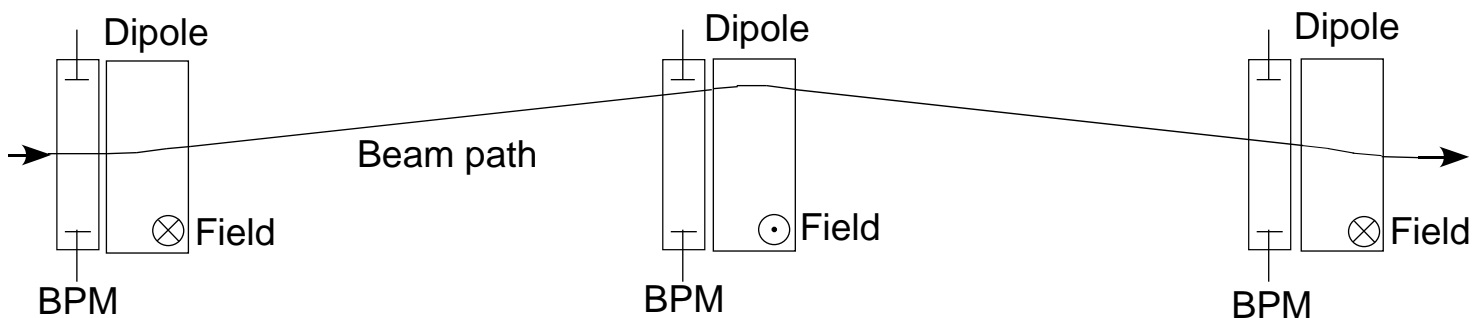
We will be making a three bump in the Main Injector and observing the effect on the beam position.



Corrector currents at zero



A "Three-bump" produces a local beam displacement



## Making and measuring corrections to the beam orbit in the Fermilab Main Injector

We will be performing a local orbit bump of the proton beam in the Main Injector, using the principles outlined on the previous page. The procedure will be outlined in general terms here:

First we will launch the beam position measuring application known as Page I39. The instructor will explain how to launch application pages.

Next we will launch a second application called a “parameter page” which allows the reading and setting of any of the accelerator devices. The parameter page we are using will contain pre-defined “three bumps” which will allow us to create orbit displacements at chosen location in the Main Injector.

We will then examine a saved orbit measurement and verify that the current beam orbit matches this file, which we will be using as a reference.

The instructor will then suggest reasonable values the guests may enter for the three bump and allow them to “knob” the corrector currents accordingly and observe that the three magnet settings are ganged together to a specific ratio to produce a local displacement.

The instructor will then describe how to measure the new orbit, allowing the guests to perform this measurement. The measured orbit positions will then be subtracted from the reference file, allowing the recent changes to be clearly observed.

If time allows, we may perform this operation in both horizontal and vertical planes.

Questions about this procedure will be welcomed at any point, and we expect this to be a very interactive and informal session.



# Tune the Debuncher Momentum Filter

The Antiproton Source Debuncher has a Momentum Stochastic Cooling system.

There is a notch filter to insure we only amplify the proper signal. It is checked once a shift for proper alignment.

# Start the Sequencer Program

- The sequencer program allows for group of commands to be executed along with providing instruction for the task

```
P64 PBAR OPS SEQUENCER LOCKED DB 23-OCT-08 14:33:07 Pgm_Tools
mode edit log status files help
aggregate commands - Tune Deb DP Filter Position -
::: When To Run Tuning Aggregates? p
::: ***** While In Standby *****
::: Deb Cooling Filter Alignment
::: Check Accumulator Tunes
::: Center Core H & V Pickups
::: Core Signal Suppression
::: ***** Run Once A Shift *****
::: Check Accumulator Tunes
::: Time Deb Injection Kicker
::: Tune Deb DP Filter Position
::: Tune Deb Cooling Power
::: Acc & Deb Energy Alignment n
41: 60 of 102 +
Messages
SEQUENCER: (mode 19) begins on console 31 slot PC in READ-ONLY access
SEQUENCER: mode 19 locked by console 1 slot PB
```

# Load the Analyzer

- Load a spectrum analyzer with the correct setup to look at the filter.
- This includes switching the proper signal into the instrument.

```
P188 PBAR Instrument GPIB Command Editor Program
```

Command Editor | Set Timers | Device Editor | Recall Record | Save Record | Send

Record titles

Record Number	Date	Title
>136	28APR08	0912 DEB HORZ REV FREQ USING HB1
135	28APR08	0911 DEB VERT REV FREQ USING VB2
134	23APR08	0756 DEB VERT TUNE USING VB1 (ZOOM LOWER SIDEBAND)
133	23APR08	0748 DEB VERT TUNE USING VB1 (ZOOM UPPER SIDEBAND)
132	23APR08	0746 DEB HORZ TUNE USING HB1 (ZOOM LOWER SIDEBAND)
131	23APR08	0742 DEB HORZ TUNE USING HB1 (ZOOM UPPER SIDEBAND)
130	03AUG07	1104 TESTING ONCE AGAIN 123
129	26APR07	1801 STOP STATIC MEAS TO SP24-PF5
128	27MAR07	1732 ALIGN DEB DP NOTCH FILTER WITH PB1 PICKUP
127	16MAR07	1218 SP24-PF3 TO SA2 FOR STOP STATIC MEAS (LEG 12)

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Messages

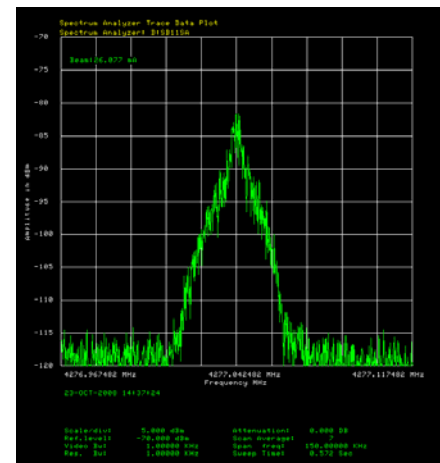
```
Recall Record menu item selected
Recalling record number: 128
Reading data record
Recall Record menu item selected
```

1:4 of 7

# Look at the Data

- Look at the data and save the starting position.
- This can also be looked at on the cable TV system.

```
P44 ACC/DEB Spectrum Analyzer SB11:20,SB31:20,SB12:21,SB13:22 10/23/08 1433 Pgm_Tools
Measurements Options A: IBEAM: 26.077 D: IBEAM: -.17986 mA
Measurement is done
DATABASE: <OPER><TEST> DIR SA parameters
RECORD NUMBER: <  > AUTHOR:
TITLE:
SEND TO: SPECTRUM ANALYZER: D: SB11SA -<1 >+
READ/EDIT: COMMANDS COMMENTS TITLE
SAVE DELETE HIGH SCALE CHANNEL POWER
PLOT: <NEW><ADD> TRACE: <A><B><C>
GET TRACE VIDEO OUTPUT SA SIGNAL INPUT
TRIGGER: <FREE RUN><EXT. TRIG> MUX SWITCH SA1/2
FILE = -< 1>+ READ WRITE DIR -< 1>+
```



# Change the filter position

- Using the parameter page called up by the sequencer, we will correct the filter position and then copy the new position.

```
P36 TUNE MOMENTUM COOLING SET D/A A/D Com-U PTools
-<FTP>+ *SA X=A/D X=TIME Y=T:HPA11 ,D:LCWTO,T,D 95WSP ,D 95WRP
COMMAND ---- Eng-U I= 0 I=-5 , 0 , 100 , 0
-<54>+ One+ AUTO F= 60 F= 5 , 200 , 200 , 100
stack_t_mo stack_t_be core_m_&b DEBUN_COOL misc_hrdwr lab-4

D:P1PS Deb Mom Band 1 PIN Sw
-D:P1TM1 Deb Med Lvl Tbone 650ps < > 293.9 psec ...
-D:P1PA Deb Mom Band 1 PIN Atten 6.5 * 7.875 dB A

D:P2PS Deb Mom Band 2 PIN Sw
-D:P2TM1 Deb Med Lvl Tbone 650ps < > 257.3 psec ...
-D:P2PA Deb Mom Band 2 PIN Atten 4.5 * 5.875 dB A

D:P3PS Deb Mom Band 3 PIN Sw
-D:P3TM1 Deb Med Lvl Tbone 650ps < > * 334.1 psec ...
-D:P3PA Deb Mom Band 3 PIN Atten 1 * 1 dB M

D:P4PS Deb Mom Band 4 PIN Sw
-D:P4TM1 Deb Med Lvl Tbone 650ps < > * 282.8 psec ...
-D:P4PA Deb Mom Band 4 PIN Atten 6 * 7.375 dB A

-D:SA11T Trigger for D:SB11SA .449999 .449999 secs ...-
-D:DPPSDF Off Event for DP pin 1 1 1 secs ...

D:R2HLSC DRF2 Hi Lvl Stat/Cntrl
D:R2HLFB DRF2 Fanback Voltage 233.7 Volt

! THIS IS THE TBONE FOR 'TUNE DEB FILTER POSITION'
! AGGREGATE IN SEQUENCE
-D:PTMF Deb Mom Optical Notch < > 134.1 psec ...+
-D:POTMF Optical Delay Line MD 124 124 pSec ..
-D:DPPSDN On Event for DP 1.05 1.05 secs ..
-D:DPPSDF Off Event for DP pin 1 1 1 secs ..

-D:SA11T Trigger for D:SB11SA .449999 .449999 secs ...-

-D:P02TDL Deb Mom 2T Sw Delay .8 .8 Sec
D:P02T12 Optical 2T Switch * A
D:P02T1 Optical 2T Switch A
-D:POTMF Optical Delay Line MD 124 124 pSec ..
```

# Put the analyzer back

- Restore the spectrum analyzer back to its default configuration
- If this was being done for operations, we would also document the change in a log book.

```
P188 PBAR Instrument GPIB Command Editor Program
Command Editor Set Timers Device Editor Recall Record Save Record Send

Record titles
Record Number Date Title
>136 28APR08 0912 DEB HORZ REV FREQ USING HB1
135 28APR08 0911 DEB VERT REV FREQ USING VB2
134 23APR08 0756 DEB VERT TUNE USING VB1 (ZOOM LOWER SIDEBAND)
133 23APR08 0748 DEB VERT TUNE USING VB1 (ZOOM UPPER SIDEBAND)
132 23APR08 0746 DEB HORZ TUNE USING HB1 (ZOOM LOWER SIDEBAND)
131 23APR08 0742 DEB HORZ TUNE USING HB1 (ZOOM UPPER SIDEBAND)
130 03AUG07 1104 TESTING ONCE AGAIN 123
129 26APR07 1804 STOP STATIC MEAS TO SP24-PFS
128 27MAR07 1732 ALIGN DEB DP NOTCH FILTER WITH PB1 PICKUP
127 16MAR07 1218 SP24-PFS TO SA2 FOR STOP STATIC MEAS (LEG 12)
1: 10 of 136

Messages
Recall Record menu item selected
Recalling record number: 128
Reading data record
Recall Record menu item selected
1: 4 of 7
```

