Tutorial on ramping power supplies

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NuMI Run Prep Session, 2/16/05

(updated 6/18/07)

Preview

- E38 parameter page – comments on PS control
  - Status bits illustration
- I14 Page – Control ramps
- Photo of 30 A Corrector supplies
- I68 Page – Calculate Ramps
  - Example ramps & ramp shape
  - Popup Windows Illustrated
- Camac Modules used in ramping

E38 - Parameter page

- On, Off, Reset
- Status indicators (e.g. tracking error)
- Digital status--Jump to S35 page & later return
- FTP--fast time plot
- “Knob” Trim Flattop values
  - E38, trms, subpage 1 has trim mults for NuMI-only mode
  - E38, trms, subpage 11 has trim mults for Mixed mode
  - Autotune is changing trim flattop values, dynamically
- View alarm status, limits

Status Bits Illustration

```
General:CAMAC C453 module
Device Name:<E:HT114 >   Device Index:(  186557)   Node MI3    210 11 .

Basic Status Block:
SSDN(0000/0070/E501/0011)
default data size(      4) maximum data size(         4) atomic sz(      4)
Frequency Time Descriptor (FTD) (    1 HZ)               addr mode(      0)
raw status(000800F2)    status text(DT     )
on( NO    )  ready( NO    )  remote(       )  positive(       )  ramp(   )
Basic Status PDB:
on attribute     (00000100)(N) ready attribute   (000000FF)(N)
remote attribute (No Attr )( ) polarity attribute(No Attr )( )
input data length(      4)     ramp/DC attribute (No     )
ON/OFF characters(ED)          READY/TRIPPED char(.T)
REMOTE/LOCAL char(  )          POS/NEG characters(  )
```

D80

```
E:HT114     MI65 Horz Trim @ 114

Stop/Continue Status --- Cont    0 bit-31 ................          0 *On
bit-14 ................          0 bit-30 ................          0 *Off  < D
bit-13 ................          0 bit-29 ................          0 *Reset< T
bit-12 ................          0 bit-28 ................          0 *Pol+
bit-11 ................          0 bit-27 ................          0 *Pol-
bit-10 ................          0 bit-26 ................          0
Calculation Error ------ No      0 bit-25 ................          0  Alarm is
Ramp Enabled ----------- No      0 bit-24 ................          0  BYPASSED
Tracking Error Fault---- No      1 Add Table(s) Mode ------ Disable 0  Speech is
DC Overcurrent Fault---- No      1 Copy Table(s) Mode ----- Disable 0  BYPASSED
Ground Fault------------ No      1 Copy Time to H(i) Mode - Disable 0  Edit
RMS Overcurrent Fault--- No      1 Data Archival Mode ----- Disable 0
Low Input Voltage Fault- Yes     0 Ramp Down Mode --------- Enable  1
External Permit Fault--- Yes     0 Copy Time to G(i) Mode - Disable 0
Overtemp Fault---------- No      1 Power Supply Off Mode -- Disable 0 New  File
Trip Summation Fault---- Yes     0 Stop/Continue Mode ----- Disable 0 Read File
```

S53

```
-E:HT114     MI65 Horz Trim @ 114        0    *   .074  Amps DT
```

E38

Colors inverted to avoid black background

I14 Page - Control ramps

- Enable/Disable ramping
- Enable/Disable clock event
- View active ramp tables (choice of units)
  - NuMI bends & quads use interrupt level F, time table 6
  - Trims use interrupt levels E & F, time tables 5 & 6
  - Two interrupt levels allow for two versions of Autotune, one for Mixed-mode (E) and the other for NuMI-only (F)
  - 64 words per table, so F starts at (5x64)=320
  - Trims are simple ramp, e.g. F level flattop slots are 321 & 322
- Global device menu allows multiple device manipulations

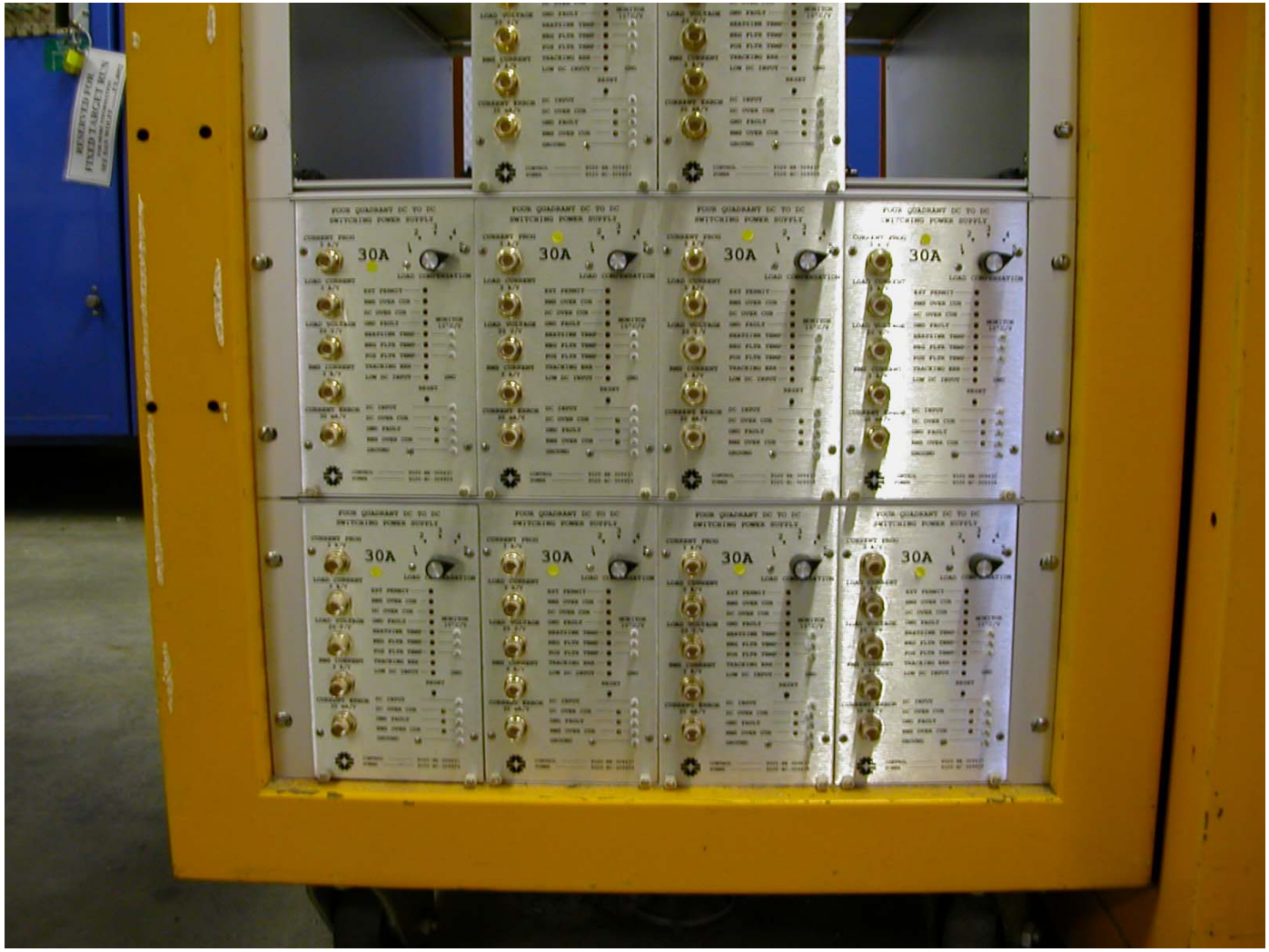
I14 & Scale Factor

```
PA:I14  C4XX RAMP CONTROL<NoSets>
I14                          CAMAC 400 Series Ramp Control                    ·Pgm_Tools·
·Menu·                  Device:   E:H104        466, v1.60      MI3, C=73, S=16

# sf_1 * m_1 * f(t)    + sf_2 * m_2 * g(M_1)    + sf_3 * m_3 * h(M_2)    <     Clock Events     >
A                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
B                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
C                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
D                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
E                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
F sf01 *  1  * f(t):06 +                        +                        <A5,  ,  ,  ,  ,  ,  ,  ,  >
G                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
H                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
I                      +  0000000100000000      +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
J                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
K                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
L                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
M                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
N                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
O                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
P                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
Q                      +                        +                        <  ,  ,  ,  ,  ,  ,  ,  ,  >
                                                 1:17 of 32
                                                 Messages
CNS#155 16:51:31 Completed validity checking
CNS#155 16:51:31   check scale factor * dependent table value
CNS#155 16:51:31     reading 6 FT tables
                                                 1: 3 of 11
```

Scale factors are left fixed.

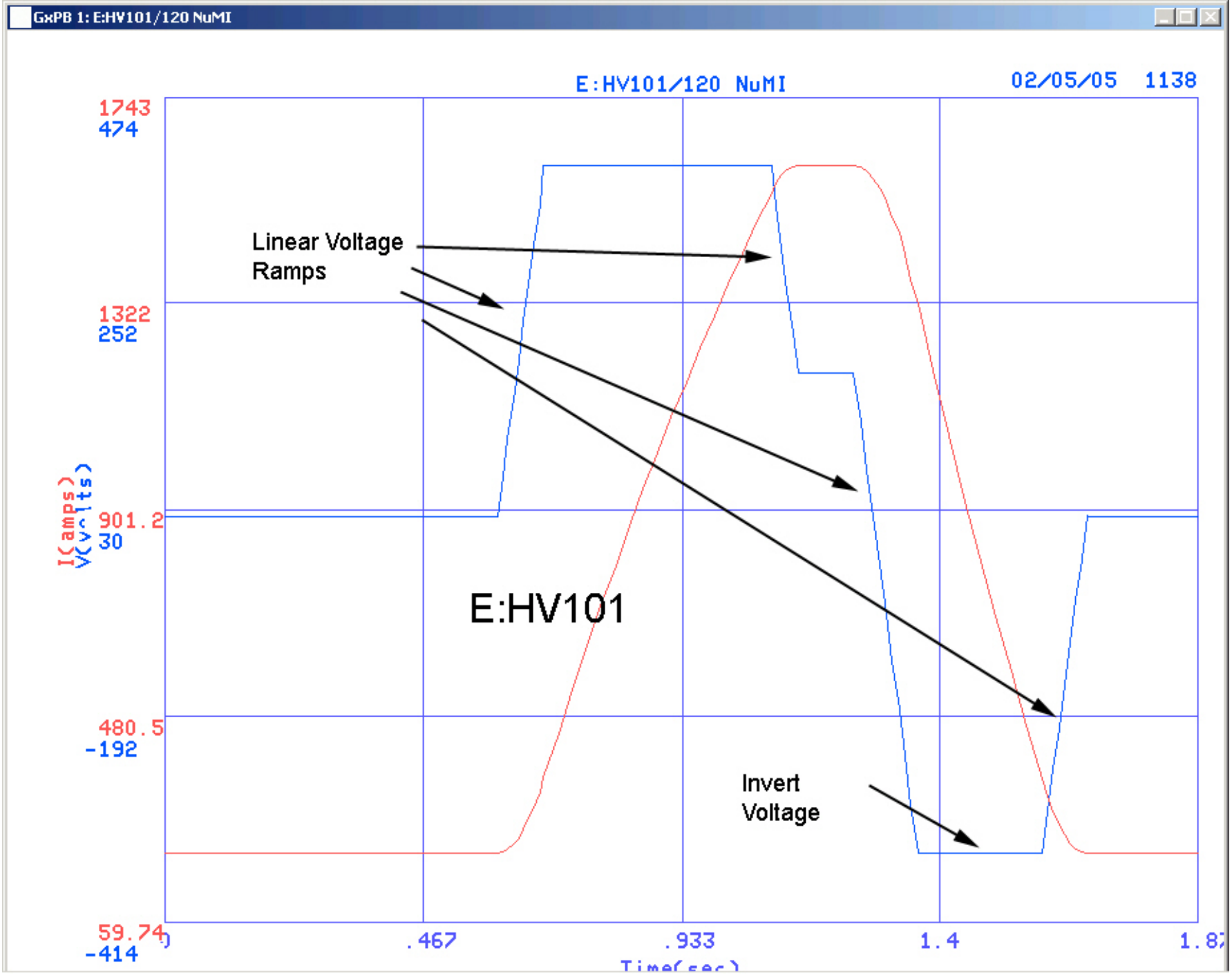
Photo of 30 A Corrector Supplies

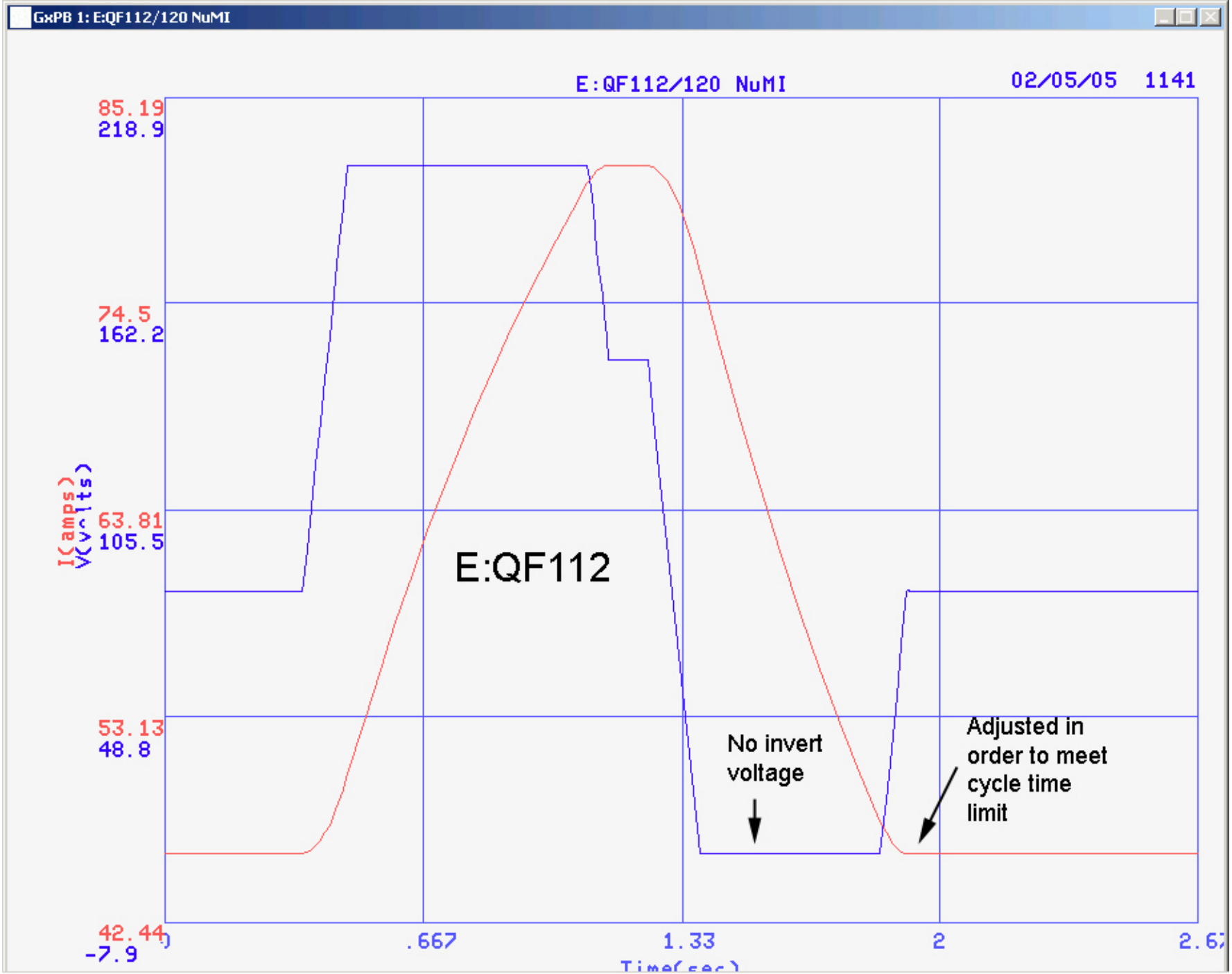


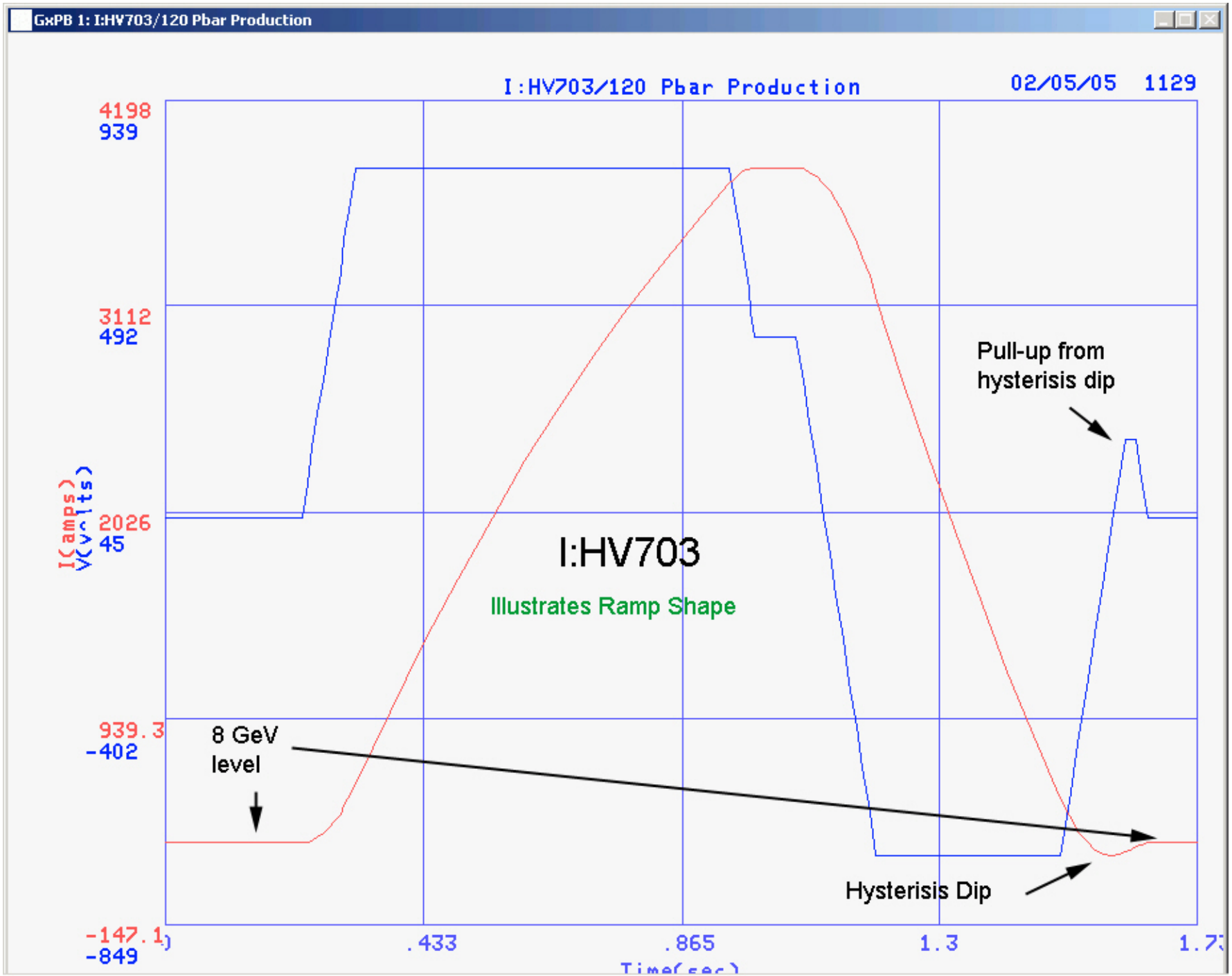
A bulk supply drives these switching units.

I68 - Calculate ramps

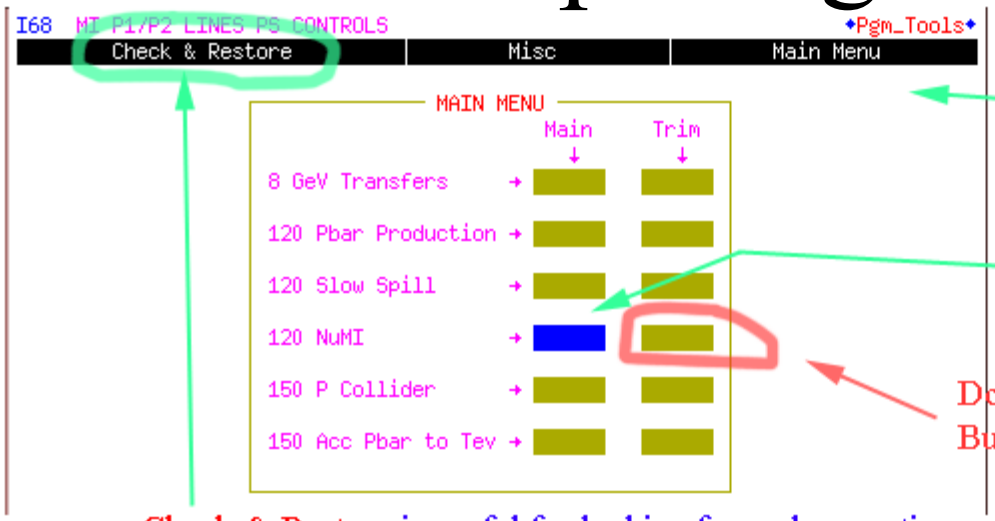
- Calculate ramp tables ("smooth" ramp)
- Send ramp tables to 46X ramp cards
  - *Ramp won't be sent by "Send One" if it hasn't been changed (or if selected file isn't the Active File)*
- Set clock event for ramp start & set flattop extraction time value (95 msec, 5 msec)
- Easy facility for changing flattop value
- local Save/Restore of ramp parameters
- Bends/Quads (not for trims)
  - E:H104 became E:HT104 (corrector supply)
  - E:H104 is a device with no connected PS
- Ramp shape not ideal for NuMI


GxPB 1: E:HV101/120 NuMI
E:HV101/120 NuMI
02/05/05 1138
1743
474
1322
252
901.2
30
480.5
-192
59.74
-414
I(amps)
V(volts)
Linear Voltage
Ramps
E:HV101
Invert
Voltage
.467
.933
1.4
Time(sec)


GxPB 1: E:QF112/120 NuMI
E:QF112/120 NuMI
02/05/05 1141
85.19
218.9
74.5
162.2
63.81
105.5
53.13
48.8
42.44
-7.9
I(amps)
V(volts)
E:QF112
No invert voltage
Adjusted in order to meet cycle time limit
.667
1.33
2
Time(sec)


GxPB 1: I:HV703/120 Pbar Production
I:HV703/120 Pbar Production
02/05/05 1129
4198
939
3112
492
2026
45
939.3
-402
-147.1
-849
I(amps)
V(volts)
.433
.865
1.3
Time(sec)
I:HV703
Illustrates Ramp Shape
Pull-up from hysterisis dip
8 GeV level
Hysterisis Dip

I68 Opening Screen

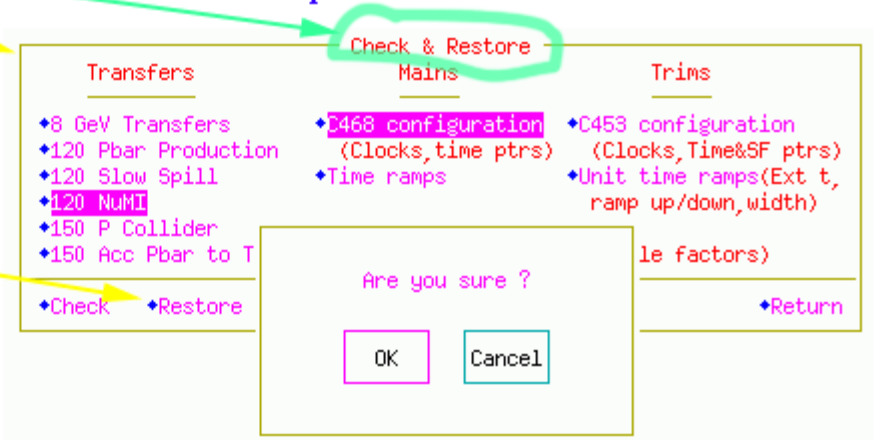


This is the screen seen when I68 is first invoked. The normal next step for NuMI is to mouse click at "120 NuMI", "Main" (tab shown highlighted in the color blue).

Don't Use "Trim" Button

Check & Restore is useful for looking for and correcting problems--e.g. a ramp card in a crate that lost its ac power.

This window appears if the user mouse clicks on "Check & Restore. If one highlights the choices as shown and mouse clicks on *Restore, then the confirmation window appears. The *Restore uses the active file and sends to the ramp cards



The Active File is shown here, initially. See next slide for more on the "Active File".

View/change the ramp parameters/plot ramp

View/change the physical parameters of the magnet & circuit

Save parameters to a file

Restore to session start conditions--sends to ramp cards (currently without any confirmation)

Changes made to these numbers are sent to the ramp cards immediately if immediate send is "Yes".

I68 MI P1/P2 LINES PS CONTROLS ♦Pgm_Tools♦

Transfer: 120 NuMI, Mains

FILE-1 | PARAM | HARDWARE PARAM | SAVE | RESTORE | CONFIG | C468 | MISC | MAIN MENU

♦Check ♦send-one(imme:NO) ♦send-all

Line	Name	♦8 GeV level	♦in current	♦max current
NuMI	LAM60	100	99.999	915
	LAM61	400	399.58	1967
	V100	100	99.999	2806
	HV101	200	199.99	1602.5
	H104	15	14.899	39
	V108	400.89	400	4406
	H117	20	19.999	50
	V118	400.89	400	4125
	QD101	32	31.999	56.25
	QF102	37	36.999	64.63
	QD103	35	34.999	63.57
	QF104	15	14.999	21.85
	QF105	35	34.999	60.04
	QD106	35	34.999	60.04
	QF107	35	34.999	60.04
	QD108	35	34.999	60.04
	QF109	35	34.999	60.04

Messages

```
120 NuMI/file#1 sending failed
Err:td_set_one in ft_sr  DPM_SETLOCK
Checked 120 NuMI,mains c468 config checked ok
Checked 120 NuMI,mains c468 config checked ok
```

1: 4 of 10

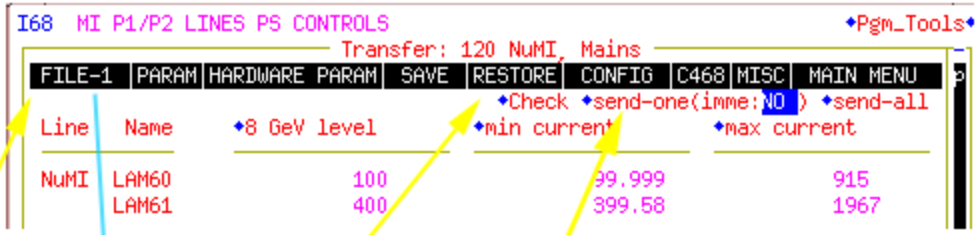
A file dialogue similar to that shown below is used to select a file, save to a file, or copy one file to another.

Transfer 120 NuMI, Select a File

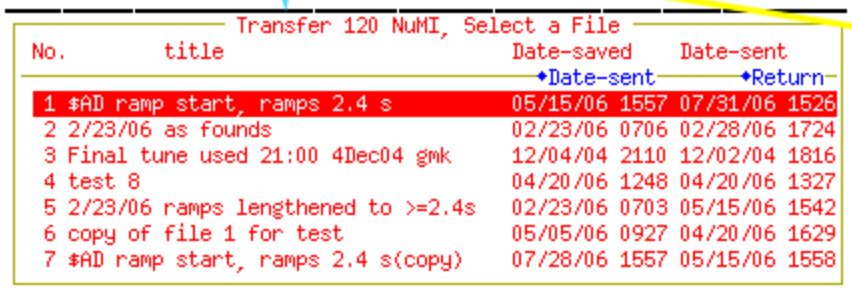
No.	title	Date-saved ♦Date-sent	Date-sent ♦Return
1	$AD ramp start, ramps 2.4 s	05/15/06 1557	07/31/06 1526
2	2/23/06 as founds	02/23/06 0706	02/28/06 1724
3	Final tune used 21:00 4Dec04 gmk	12/04/04 2110	12/02/04 1816
4	test 8	04/20/06 1248	04/20/06 1327
5	2/23/06 ramps lengthened to >=2.4s	02/23/06 0703	05/15/06 1542
6	copy of file 1 for test	05/05/06 0927	04/20/06 1629
7	$AD ramp start, ramps 2.4 s(copy)	07/28/06 1557	05/15/06 1558

I68-Main Working Screen

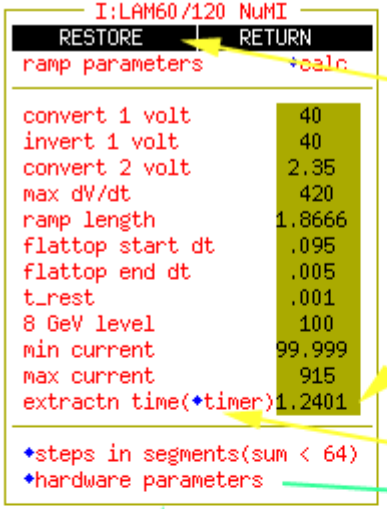
Concept of Active File – I68



Normally the Active File: Changes made to parameters and sent to ramp cards are saved in the active file. RESTORE will reset the active file back to how it was at the start of the session. It will also restore the ramp card tables to what they were at the start of the session. A new file can be selected, but isn't active until it has been sent to the ramp cards. An attempt to do "send one" from an inactive file will result in an error window.

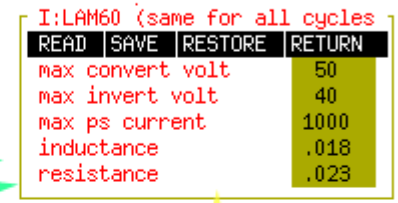


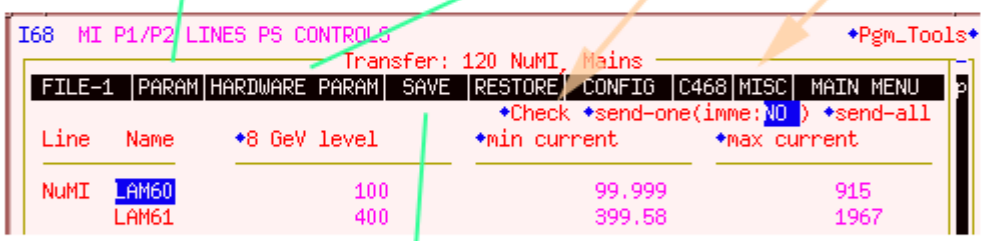
I68 Popup Windows--Example I



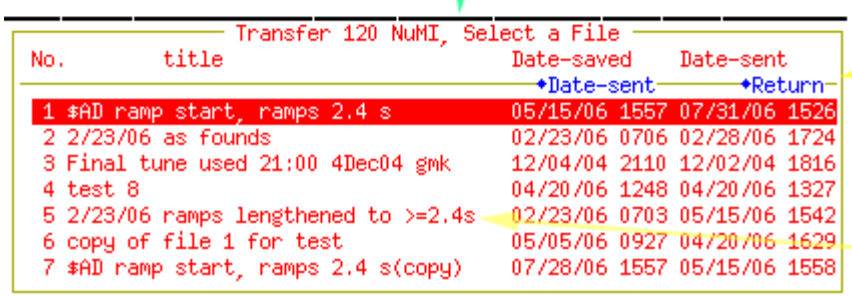
Parameter Window: Used to change ramp parameters. Changes can be "restored" to conditions when window was opened. Extraction time can be temporarily set, for purposes of calculating and plotting a ramp, but is determined by extraction timer in practice.

*Check does a check of file contents versus what is in the ramp cards. The MISC menu has been augmented (8/06) to allow a visual check (see two slides later).





Hardware parameters for a power supply. Are used in calculating ramp. "Restore" undoes changes made since opening this window. "Read" reads values from hardware parameters file.



Save files can be used for multiple purposes. For example, ramp parameters can be modified and saved to a file for sending to the ramp cards at some future date (an example is this file).

I68 MI P1/P2 LINES PS CONTROLS ♦Pgm_Tools♦

Transfer: 120 NuMI, Mains

FILE-1 | PARAM | HARDWARE PARAM | SAVE | RESTORE | CONFIG | C468 | MISC | MAIN MENU

♦Check ♦send-one (imme NO) ♦send-all

Line	Name	♦8 GeV level	♦min current	♦max current
NuMI	LAM60	100	99.999	915
	LAM61	400	399.58	1967

Edit Configuration - Mains c468

READ | SEND TO C468 | CHECK C468 | RESTORE | RETURN

#	Transfer name	Extract Timer	Interrupt Level	Events	f(t) #
		♦get			
1	8 GeV Transfers	I:MIAX	A	♦	1
2	120 Pbar Production	I:MIPBTX	B	♦	2
3	120 Slow Spill	I:MIBLX	C	♦	3
4	120 NuMI	I:MINX	F	♦	6
5	150 P Collider	I:MITCPX	D	♦	4
6	150 Acc Pbar to Tev	I:MITPBX	E	♦	5

Plot Options

plot calc curr&vpltage [TRUE]
plot snapshot current [TRUE]
plot snapshot voltage [TRUE]
snapshot frequency(Hz) [200]
snapshot tclk prefered [0000008E]

Return

Plot Options
Copy files
Card-File Data

New as of 8/06--see next page

Select a transfer to Copy from
(Click on one cycle to select)

#	Transfer name	Extract Timer	Interrupt Level	Events	f(t) #
		♦get			
1	8 GeV Transfers	I:MIAX	A	♦	1
2	120 Pbar Production	I:MIPBTX	B	♦	2
3	120 Slow Spill	I:MIBLX	C	♦	3
4	120 NuMI	I:MINX	F	♦	6
5	150 P Collider	I:MITCPX	D	♦	4
6	150 Acc Pbar to Tev	I:MITPBX	E	♦	5

C468(for main ps) Config

Read | Send | Return

Channel:E:QF121 ♦status: ENA
Main MDAT:(G)M10 (H)M10

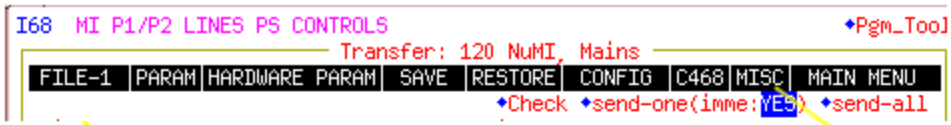
Level	Clocks:								Pointors: F(t)	G(i)	H(i)	sf1	sf2	sf3
↑ 0	FE	FE	FE	FE	FE	FE	FE	FE	0	0	0	0	0	0
1	FE	FE	FE	FE	FE	FE	FE	FE	0	0	0	0	0	0
2	FE	FE	FE	FE	FE	FE	FE	FE	0	0	0	0	0	0
3	FE	FE	FE	FE	FE	FE	FE	FE	0	0	0	0	0	0
4	FE	FE	FE	FE	FE	FE	FE	FE	0	0	0	0	0	0
5	AD	FE	FE	FE	FE	FE	FE	FE	6	0	0	1	0	0
6	FE	FE	FE	FE	FE	FE	FE	FE	0	0	0	0	0	0
7	FE	FE	FE	FE	FE	FE	FE	FE	0	0	0	0	0	0
8	FE	FE	FE	FE	FE	FE	FE	FE	0	0	0	0	0	0
9	FE	FE	FE	FE	FE	FE	FE	FE	0	0	0	0	0	0
10	FE	FE	FE	FE	FE	FE	FE	FE	0	0	0	0	0	0
↓11	FE	FE	FE	FE	FE	FE	FE	FE	0	0	0	0	0	0

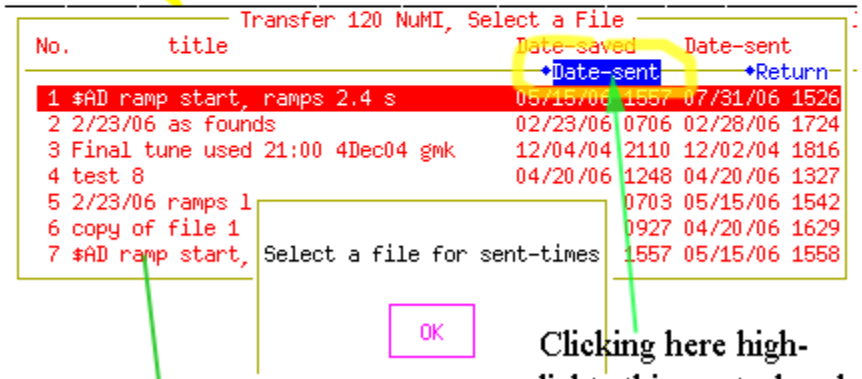
*GII:♦ *HII: *ScaleFactor:

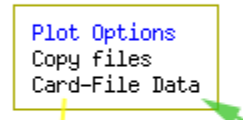
Send...to
Main MDAT
Clocks
GII
HII
Ramp pointors
S.F. pointors
all above

I68 Popup Windows--Example II

New I68 Features--as of 8/06

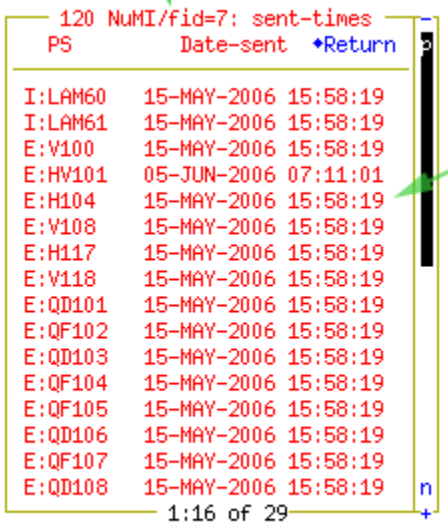


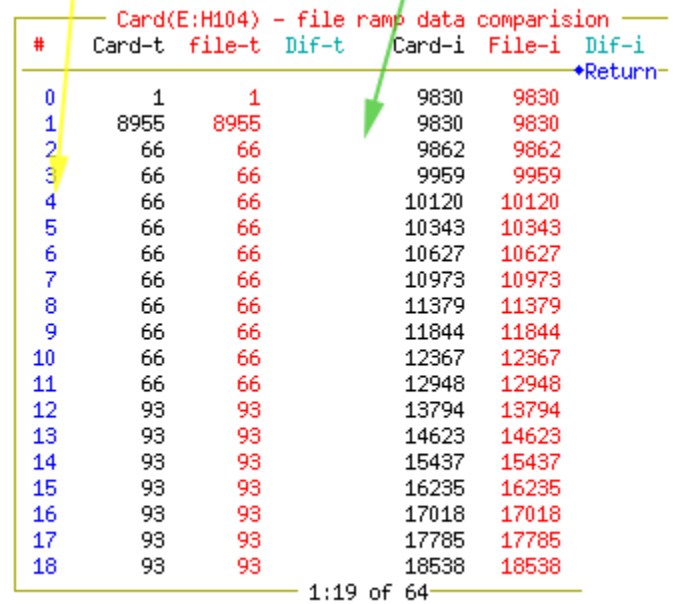




A third line was added to this menu. It allows one to compare the contents of the active file vs the ramp card tables.

Clicking here highlights this control and allows for selecting a file and examining when PS ramps were sent from that file





Camac modules

- 453, quad unit for correctors, shared bulk supplies
- 466 for quads, H117
- 468 for big bends