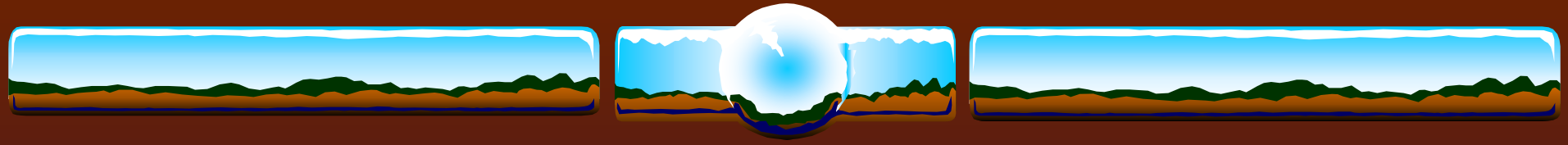
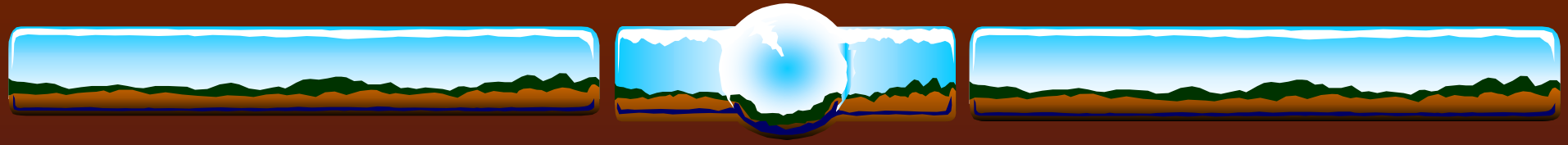


NuMI Beam line Power Supplies

- The supplies in the line is detailed
  - Main Ring Style……..…1
  - PEI/Transrex 500Kw……10
  - PEI 20Kw……..21
  - PEI 240Kw……..2
  - MI Correction elements……..……19



Series Regulation

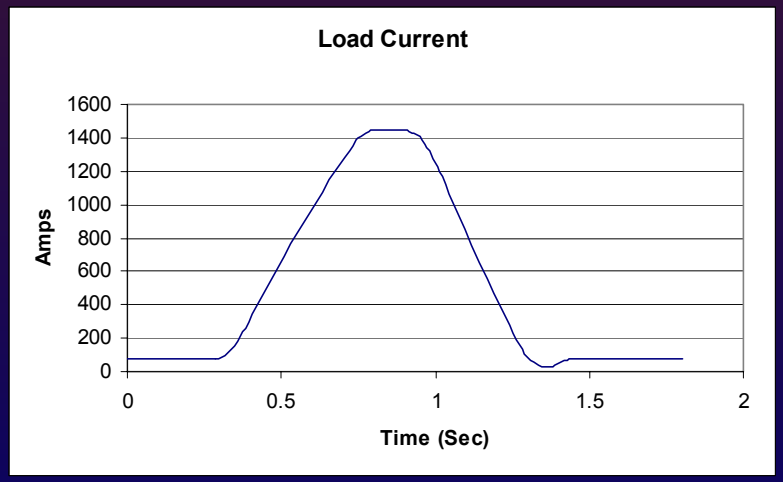
- The groups of supplies will be regulated by one current regulator. (E:HV101,E:V118A,E:V118B)
- Each supply will have an SCR Unit with a closed voltage loop, the same as the single supplies.
  - All the supplies act as if they are one.
  - The supplies will all receive the same voltage reference.
  - A ramping computer to improve Power Factor is an option.
- The P1 and A1 lines have a TWO supply configuration in operations now.

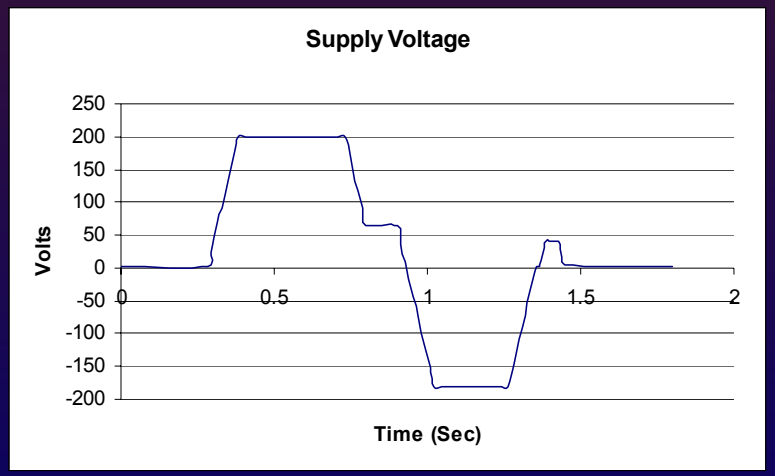
Upgrades

- Reused “Main Ring SCR Unit”.
  - Better Voltage control.
  - Maintenance techs have experience and knowledge.
  - Little or no down time due to these chassis.
  - Need new current loop added to the chassis.
  - Added a filtered voltage monitoring card to the chassis.
- New Gate Firing circuits.
- Two Quadrant operation. (Invert).
  - Remove Diodes in the Bypass and add SCRs.

Ramp Calculator

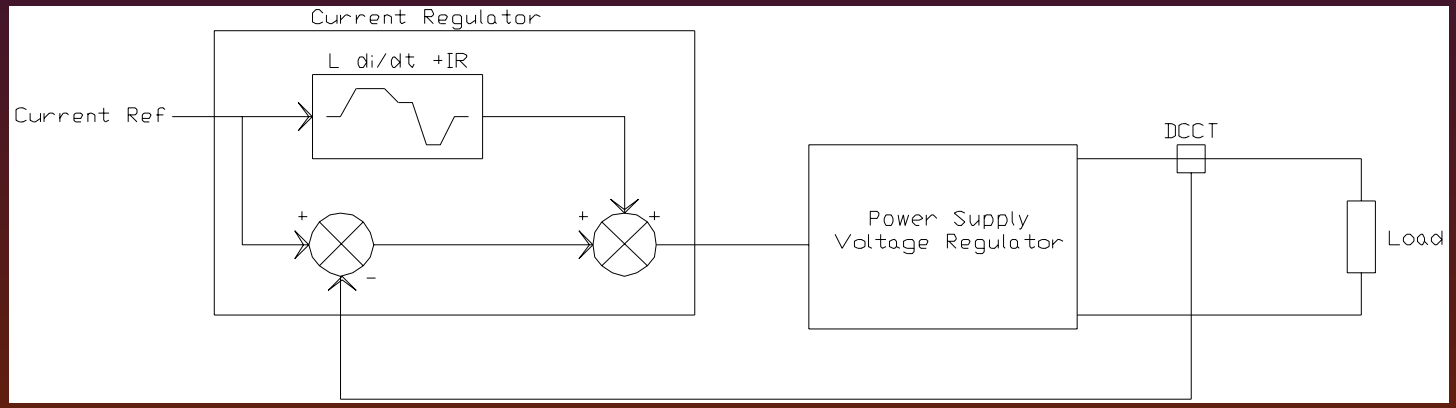
- Each Load Will Use the Max P.S. Voltage.
  - Operation will have only one data point to adjust.
  - Same control as the P1,P2,P3 and A1 lines





Power Supply Controls

- C468 Ramp Generators: Current Reference.
  - Each magnet load will have one current reference.
  - Voltage reference feed forward created by P.S. reg.
    - L di/dt +IR and Integrator

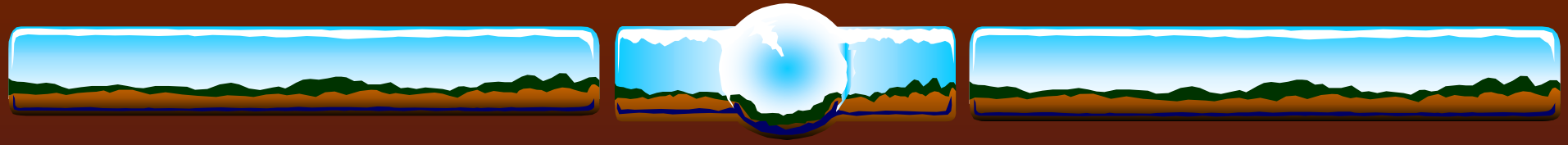


MI Regulation Improvements

- The C468 card's DAC output has too much noise and drift.
  - We are installing a local DAC in the current regulation system to improve the noise.
  - The local DAC has better temperature drift numbers but is not in a better environment.
- Additional improvement will be installed as needed.
  - Temperature regulation of the DAC.
  - Flattop correction for magnet temperature. (JITTER)
  - Low Beta/MI style Current regulator.
  - BμLB Learning system.

NuMI Beamline Regulation

- The re-use of the SCR units will require a stand alone DAC chassis for the current loop.
  - E:HV101, E:V108, E:V118A and E;V118B will all need a stand alone DAC chassis.
  - These loop will have filters installed.
  - We will start with out temperature regulation on the DAC card.
  - This is the same chassis used for the best DAC system and to upgrade to the next level will be simple.



Series Power Supply Controls

- The reuse of existing equipment requires a series connection of two or three supplies on each of three magnet loops.
- The operations interface needs to be simple.
  - Looks like only one supply to the operations crews.
  - Controlled turn on and off.
  - Access for maintenance needs to be simple.

Beam Loss Issues

- The current regulation system has an absolute value circuit on the current error and will abort the beam in the MI if the supply is out of regulation.
- For the more critical loads an independent window detector will not allow the beam to leave the MI if the current is not within the window at flattop time.
- Three of the supplies at MI-60 have critical device controllers installed.

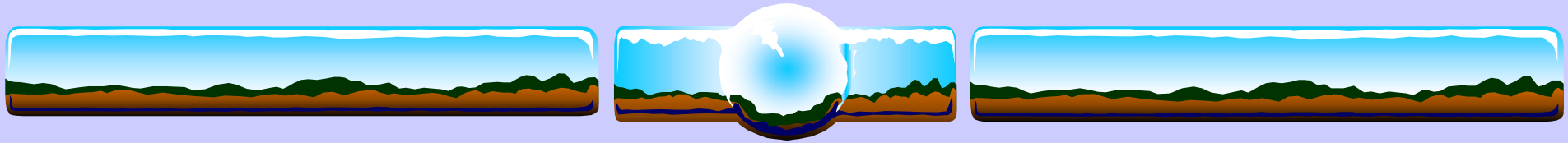
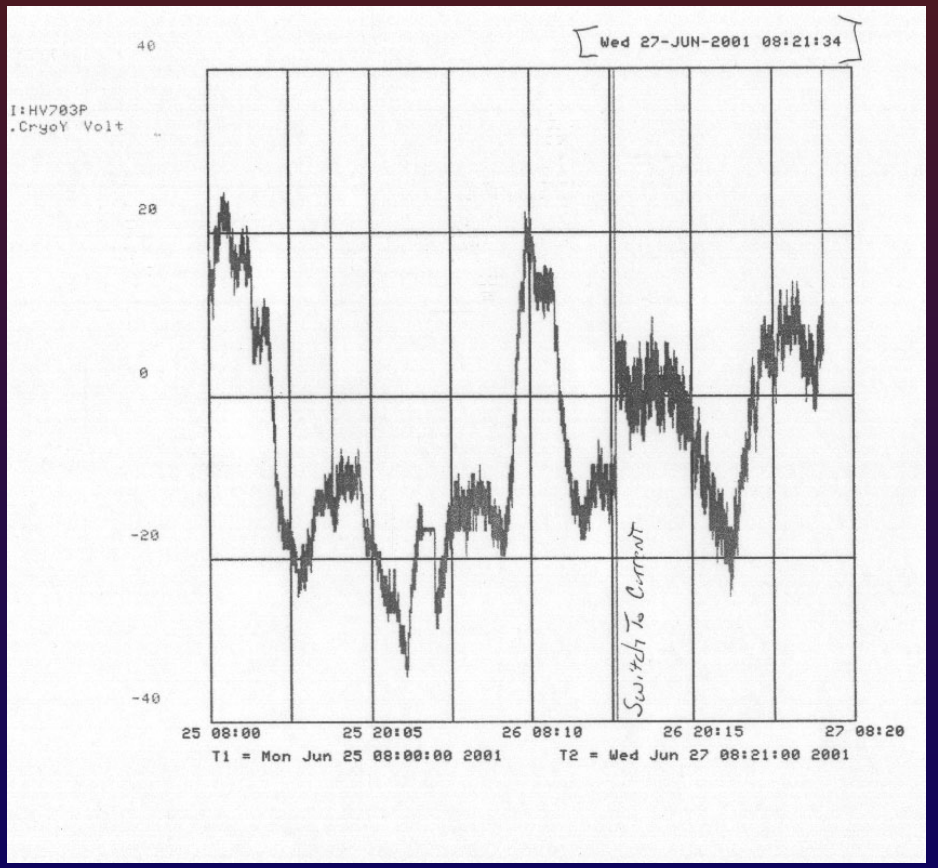


Table Regulation Review

String	Maximum Current of PS	Peak Current (amps)	Target RMS in microns	Allowed Instability in ppm	Variation due to 720 Hz in ppm with no Filter Chokes (FC)	Variation due to 720 Hz in ppm with Filter Chokes	Instability in ppm with FC & HOLEC & Special Electronics
Lam60	2500	1445	240	200	298	21	173
V100	5000	2786	200	400	660	25	179
HV101	2500	1449	250	65	214	14	173
V104	2500	1449	75	200	248	21	173
V105	5000	4254	170	60	254	7	100
V109	1250	880	250	200	216	23	142
V110	2500	1210	250	55	207	17	207
The DCCT is rated at 5000amps full scale.							

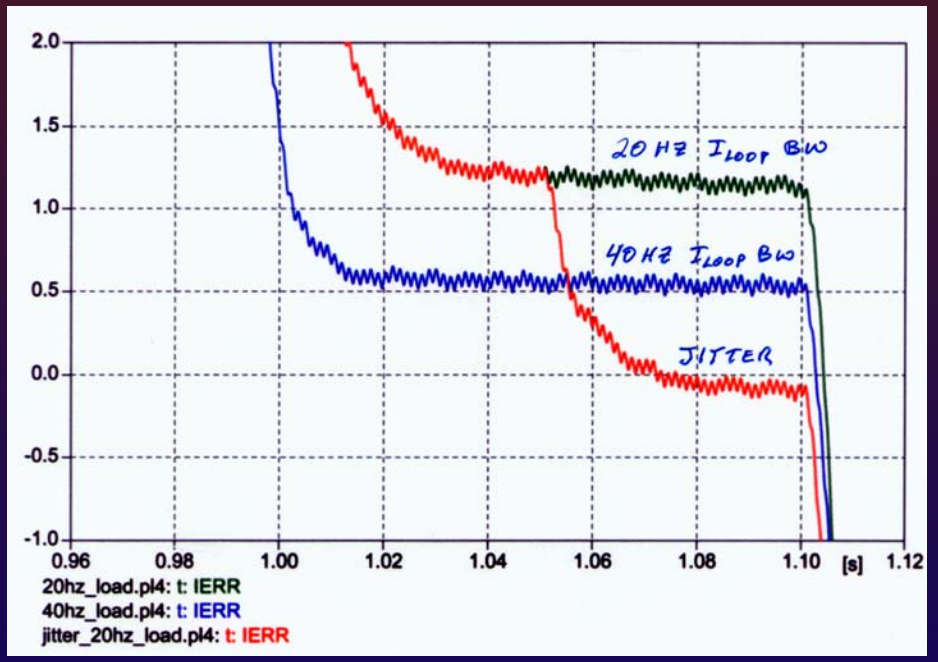
I:HV703 Regulation

- P1 Line main bend dipole
- All measurements were taken at flattop.
- The left side is the reference.
- The scale is 2 parts in 10,000/div
- The right side is the current with the notable difference in the pulse to pulse “noise” being larger on the current.



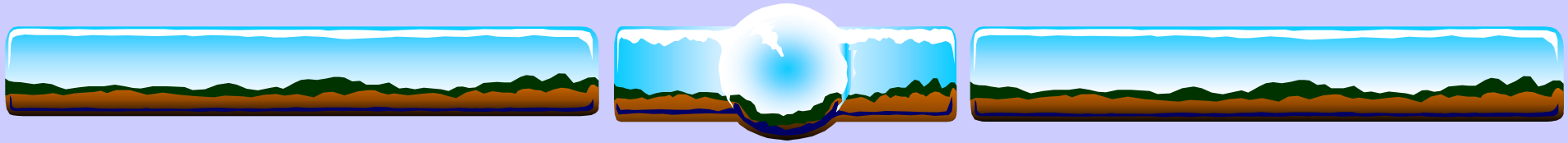
I:HV703 Model of Resistance Effect

- The magnet load and power supply regulation is modeled and this plot shows the effect of a 5% change in magnet resistance.
- Better Bandwidth helps.
- "JITTER" will make a just in time error correction.



NuMI Regulation Improvements

- Any improvements to the MI beamline regulation system will be added to the NuMI line supplies.
- The improved flattop regulation will be added after we have proven it in the MI lines.
- Improved current feedback in terms of DCCTs will be added as needed for each loop.
- The Low Beta/MI ring current regulation chassis will be added for even better current reference as needed.
- The BμLB regulation system will be used only if necessary.



Summary of as built

NAME	FILTER	CURRENT FEEDBACK	FULLSCALE	Stability
E:LAM60	none	PEI Internal	2500	250ppm
E:LAM61	none	PEI Internal	2500	250ppm
E:V100	none	PEI Internal	5000	250ppm
E:HV101	PRAGUE	LEM	2500	100ppm
E:V108	DAMPED MR STYLE	LEM	5000	100ppm
E:V118A	PRAGUE	LEM	5000	100ppm
E:V118B	PRAGUE	LEM	5000	100ppm
QUADS	none	LEM Internal to supply	100/200	500ppm
CORRECTOR	PRAGUE	LEM Internal to supply	15	100ppm