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# **M4 BEAMLINER POWER SUPPLIES**

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M4 Beam Line Technical Design Review

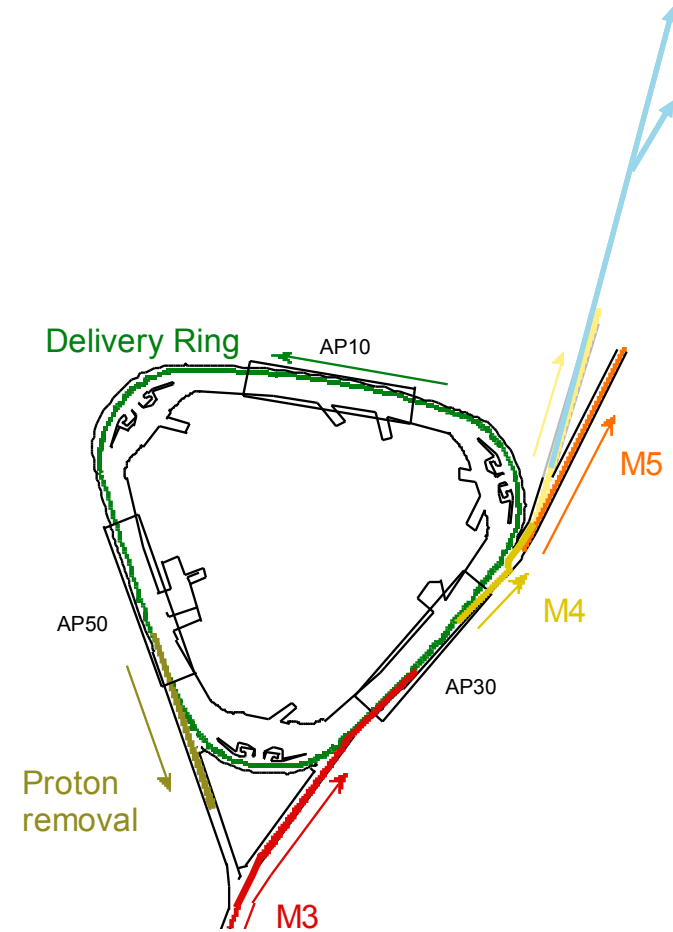
October 6 2015

## Plan for constructing the M4D beam line

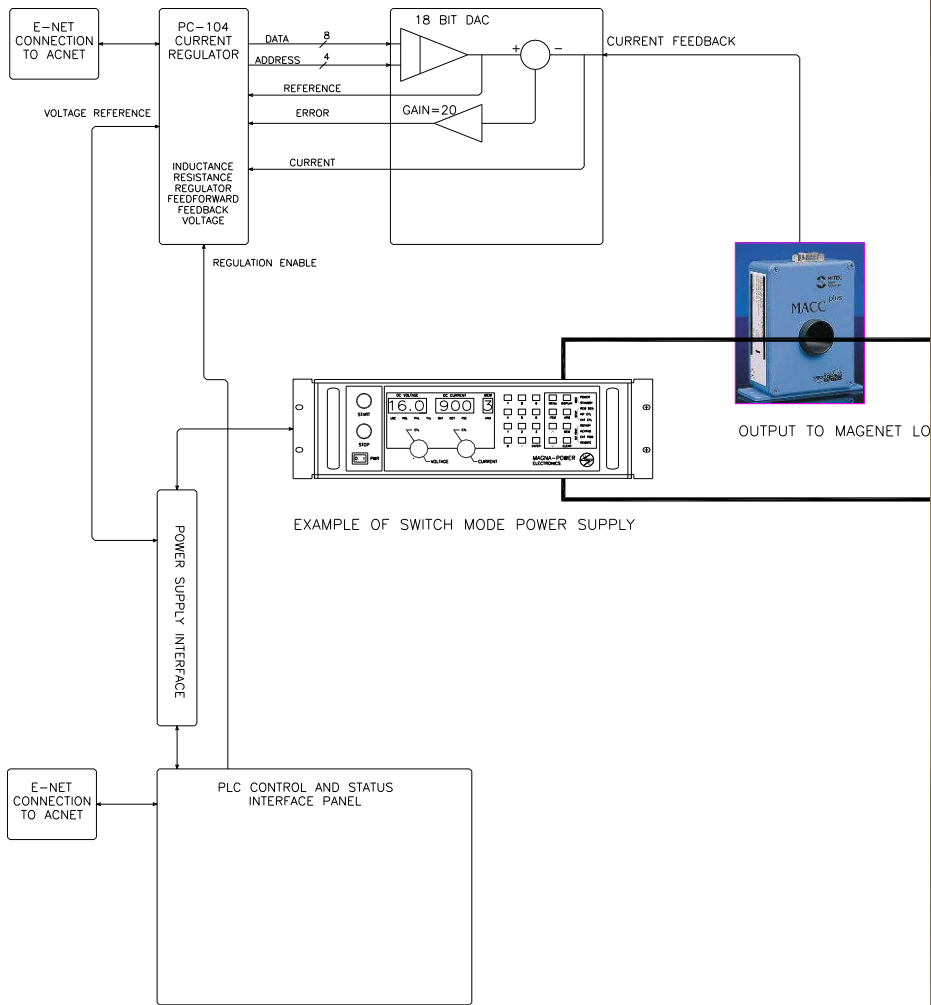
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- All magnet systems operate in DC mode.
- Re-use as much existing equipment as is reasonable.
  - All Switch Mode supplies will be new
  - One new SCR 140kW power supply (same as a present procurement for M3 beam line)
- Build systems using existing designs
  - Current regulation system PSRAC
  - PLC for status and control
  - Shared hardware design with other beam lines NO new designs

NAME		MAGNET LOAD				
P.S. CIRCUIT	MAGNET	M4 - Mu2e Beamline	MAGNET	#	MAG.	MAG.
NAME	TYPE	Magnet(s) Name(s) & Distance along beamline (ft)	MODEL	MAGs	IND.	RES.
D:Q908	Quad.	Q908 116'	SQA	1	0.0430	0.0323385
D:Q909	Quad.	Q909 124'	SQA	1	0.0430	0.0323385
D:Q910	Quad.	Q910 136'	SQC	1	0.0660	0.0415561
D:H910	Dipole	H910 150', H911 166', H912 182', H916 218', H917 232', H918 249'	SDFW-SDF	6	0.0567	0.0454900
D:Q911	Quad.	Q911 155', Q918 237'	SQC	2	0.0660	0.0415561
D:Q912	Quad.	Q912 170', Q917 221'	SQA	2	0.0430	0.0323385
D:Q913	Quad.	Q913 187', Q916 206'	SQD	2	0.0779	0.0463569
D:Q914	Quad.	Q914 190', Q915 202'	SQD	2	0.0779	0.0463569
7 Circuits						
D:Q919	Quad.	Q919 256' thru Q923 325'	SQA	5	0.0430	0.0323385
D:Q924	Quad.	Q924 345'	SQA	1	0.0430	0.0323385
D:Q925	Quad.	Q925 362'	SQA	1	0.0430	0.0323385
D:Q926	Quad.	Q926 365'	SQA	1	0.0430	0.0323385
D:Q927	Quad.	Q927 387'	SQA	1	0.0430	0.0323385
D:Q928	Quad.	Q928 416'	SQB	1	0.0602	0.0392517
D:Q929	Quad.	Q929 436'	SQA	1	0.0430	0.0323385
ACDipole						
ACDipole						
D:Q930	Quad.	Q930 463"	SQA	1	0.0430	0.0323385
D:Q931	Quad.	Q931 480"	SQA	1	0.0430	0.0323385
D:Q932	Quad.	Q932 533"	SQA	1	0.0430	0.0323385
D:Q933	Quad.	Q933 556"	SQB	1	0.0602	0.0392517
D:HDA1	Dipole	HDA1 571' Absorber 5 degree dipole magnet	MDCE	1	0.0107	0.0490000
D:QDA01	Quad.	QDA01 600' Absorber quadrupole 1	3Q120	1	0.1234	0.1690000
D:QDA02	Quad.	QDA02 600' Absorber quadrupole 2	3Q120	1	0.1234	0.1690000
D:Q934	Quad.	Q934 592'	SQB	1	0.0602	0.0392517
D:Q935	Quad.	Q935 609'	SQE	1	0.0430	0.0646385
D:Q936	Quad.	Q936 617'	SQB	1	0.0602	0.0392517
17 Circuits						
Shield Wall						
D:V936	Dipole	V936 672'	CDA	1	0.0107	0.0270000
D:Q937	Quad.	Q937 675', Q943 770'	LQC	2	0.0304	0.0081833
D:Q938	Quad.	Q938 686', Q942 760'	LQD	2	0.0344	0.0087892
D:Q939	Quad.	Q939 702', Q941 743'	LQC	2	0.0304	0.0081833
D:Q940	Quad.	Q940 722'	SQA	1	0.0430	0.0323385
D:HT940	Dipole	HT940 729'	CDA	1	0.0107	0.0270000
D:VT940	Dipole	VT940 735'	CDA	1	0.0107	0.0270000
D:VT942	Dipole	VT942 766'	CDA	1	0.0107	0.0270000
D:V943	Dipole	V943 776'	CDA	1	0.0107	0.0270000
D:HT943	Dipole	HT943 782'	CDA	1	0.0107	0.0270000
10 Circuits						



# Example of a single Switch Mode power supply system



# PSRAC (Power Supply Regulator and Controller)

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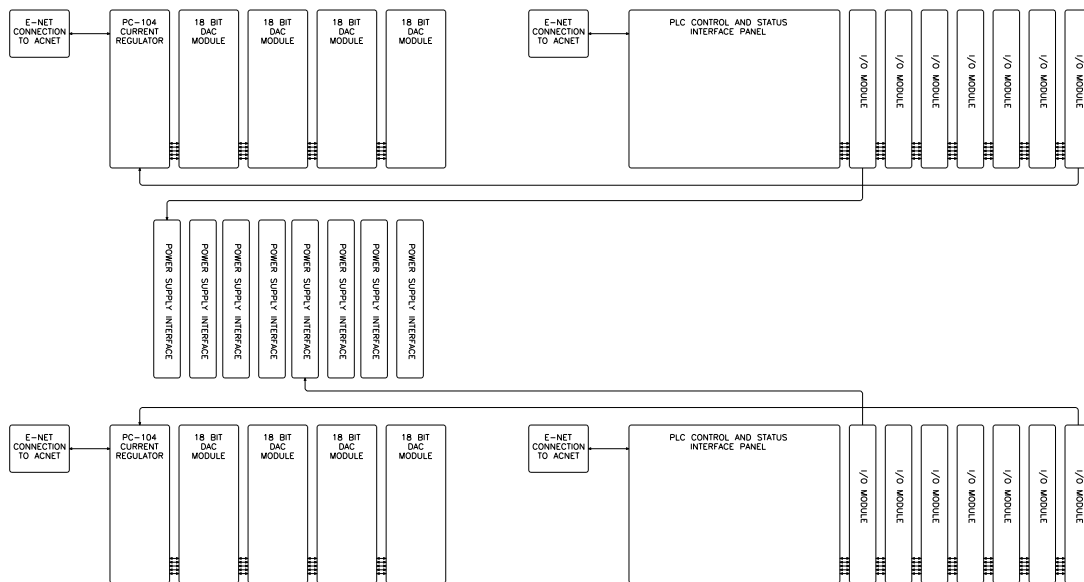
- Stand alone Embedded System for up to 4 power supplies
  - PC-104 base processor
  - Provides connections to ACNET data base for the control
  - Collects status and control from any power supply through a PLC base power supply interface system
  - Provides closed loop current regulation
    - Built in feedforward
    - Built in fast feedback
    - Built in window detection of Reference, Current and Current Error.
  - Provides transient recording of operating signals.
- Uses an 18 bit temperature regulated DAC for the reference
- Only Limited by the quality of the feedback DCCT
- 82 power supplies in operation using these regulators

# PLC and Interface chassis

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- Programmable Logic Controller
  - Commercial unit
  - Collects data and provides control to any power supply design
    - Older reused equipment uses 15 or 24 VDC control
    - Newer equipment often used TTL 5 VDC control
  - The PLC connect all the status an makes it available to the PC-104
    - The PC-104 reads and writes via an either net connection
    - This reduces the amount of control cable and cost of installation
    - Provides and independent Over Current monitor
- Interface chassis
  - Provides signal fan-out (most manufacture provide all signals in one connector) This chassis breaks the signals out to the different place it needs to go (PLC PC-104)
  - Provides analog independent Over Current and Over Voltage limits.

# Example of grouped regulation and power systems



M5 beam line MC-1

There will be 16 Switch Mode circuits in MC-1 for the M4D beam line and will be assemble like The M5 beam line equipment. One reused SCR supply will also be installed in MC-1

# SUMMARY

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- Proven Design with many similar installations
  - Developed for the NuMI/Nova upgrade
  - Muon Campus beam lines use the same design
  - All circuits require 100ppm to 300ppm regulation and will not exceed the design of this regulation system
- More copies of the equipment will need to be assembled and installed
- Most of the assembly will be done by a local assembly house
- Final testing and installation will be done by FNAL Techs