RADIATION DAMAGE TO PERMANENT MAGNETS-
Accelerator R&D

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I. OVEVIEW

Permanent magnets have found strategic uses at present day accelerators as quadropole focusers, wiggler magnets, in recycler rings, etc. Cost cutting designs for damping rings and other applications are intended for the NLC. With this in mind, the radiation hardness of these magnets comes in to question. The bulk of the synchrotron radiation will be in in the MeV range where information from radioactive sources will be important. In addition slow neutron production by photonuclear interaction can be appreciable. The bulk of damage may well come from these low energy radiations associated with impurity knock-on processes.

Below we list common permanent magnet materials and some specifications.

	Cost Index	Bhmax MGOeHci	Coercivity (KOe)	Tmax (^{o}C)	Machinability
Nd-Fe-B (sintered)	65%	<45	<30	180	Fair
Nd-Fe-B (bonded)	50%	< 10	< 11	150	Good
Sm-Co (sintered)	100%	< 30	< 25	350	Difficult
Sm-Co (bonded)	85%	< 12	< 10	150	Fair
Alnico	30%	< 10	< 2	550	Difficult
Hard Ferrite	5%	< 4	< 3	300	Fair
Flexible	2%	< 2	< 3	100	Excellent

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A comprehensive study of the damage to different permanent magnet materials under a variety of conditions, eg. γ, n radiation is advisable as well as more energetic sources. .

Radiation Facility

We have two types of gamma dose facilities which are under our direct control and possible neutron howitzer.

(1) A Cs137 source is housed in our accelerator building, near the physics department.
(2) We have free access to a Co^{60} GammaCell housed in Chemistry.
(3) A neutron howitzer is available.

Source	E(KeV)	Dose Rate	
Cs 137	662 KeV γ	15 Rad/hr	open @ 1m
		174 Rad/hr	absorber in @ 1m
Co 60	1.16 MeV γ	80 Rad/hr	(inner chamber)
Howitzer	few MeV n		

II. WORK, GOALS, DELIVERABLES

We propose to study radiation damage characteristics of Nd-Fe-B, Sm-Co , Hard Ferrite dipoles in a modest γ-radiation field of about 20 Rad/hr. at 1m. Particular attention will be paid to light element impurity levels.

Permanent magnet dipoles will be fabricated and/or sent from Fermilab. They will be exposed to γ and n radiations . Periodic in-situ measurements will be performed by Hall probe. Ambient temperature will be monitored during exposure. To achieve good accuracy of the analogue Hall Probe, a calibration scheme will be employed correcting for temperature and possible non-linear effects. Similar irradiations will take place in Co^{60} and neutron facilities.

These results will be correlated with more energetic accelerator proton and electron irradiations and damage constants produced over the full energy range.

II. FUTURE

Gamma irradiations will continue in to FY03-04 and attention will turn to slow neutron damage. Neutron Irradiations will continue via howitzer and/or proton booster area at Fermilab and at SLAC.

III. BUDGET

	FY02	FY03	FY04
Materials, & Supplies	$ 5K	$ 5K	$ 5K
Dosimetry	$ 2K	$ 2K	$ 2K
Equipment	$ 3K		
Labor	$ 3K	$ 3K	$ 3K
Travel	$ 2K	$ 2K	$ 2K
	$15K	$12K	$12K