Faster Kickers and Other Nuggets

Injection/Extraction Fast Kicker Magnets for the TESLA Damping Rings

- Need to store 2820 bunches in each damping ring (one full bunch train).
- The closer the bunches can be spaced in the damping ring, the smaller the circumference of the damping ring.
  - The circumference of the ring is ~17 km for ~20 ns bunch spacing.
- The injection and extraction from these kinds of rings has been done with a "fast kickers" which have transverse electric and magnetic fields.
- The rise and fall of these fields has to not disturb preceding and succeeding bunches.

Kicker Information provided by Chris Jensen Fermilab BD/EE Support

Faster Kickers

ID: 80 **project_size:** Large **skill_type:** physicist

short project description: Very fast injection/extraction kickers for TESLA damping ring

Detailed project description: The 800 microsecond-long ‘macropulse’ of TESLA is equivalent to a length of 200 km, while the circumference of a damping ring is an order of magnitude less. The 0.3 microsecond spacing of TESLA bunches becomes 30 ns in the damping rings. So to inject or extract a single bunch, the kicker pulse must be limited to this time period. The current design concept is that each kicker consist of 20-40 individual modules, for a total of up to 160 modules in the two damping rings. Each unit would be about 0.3 m in length, with individual excitation. A number of kicker designs have been looked at and are considered feasible candidates. The challenge lies in the pulsers – namely the rise time, stability, ringing, and power requirements. Pulser development currently needs both manpower and money, and a partner (or partners) to play a significant role is (are) welcome, as are new ideas. Voltage and current levels are moderately high at 5kV and 100 Amperes respectively for present kicker module designs. Documentation is available upon request.

Needed by who: TESLA **present status:** In progress, help needed **Needed by date:**

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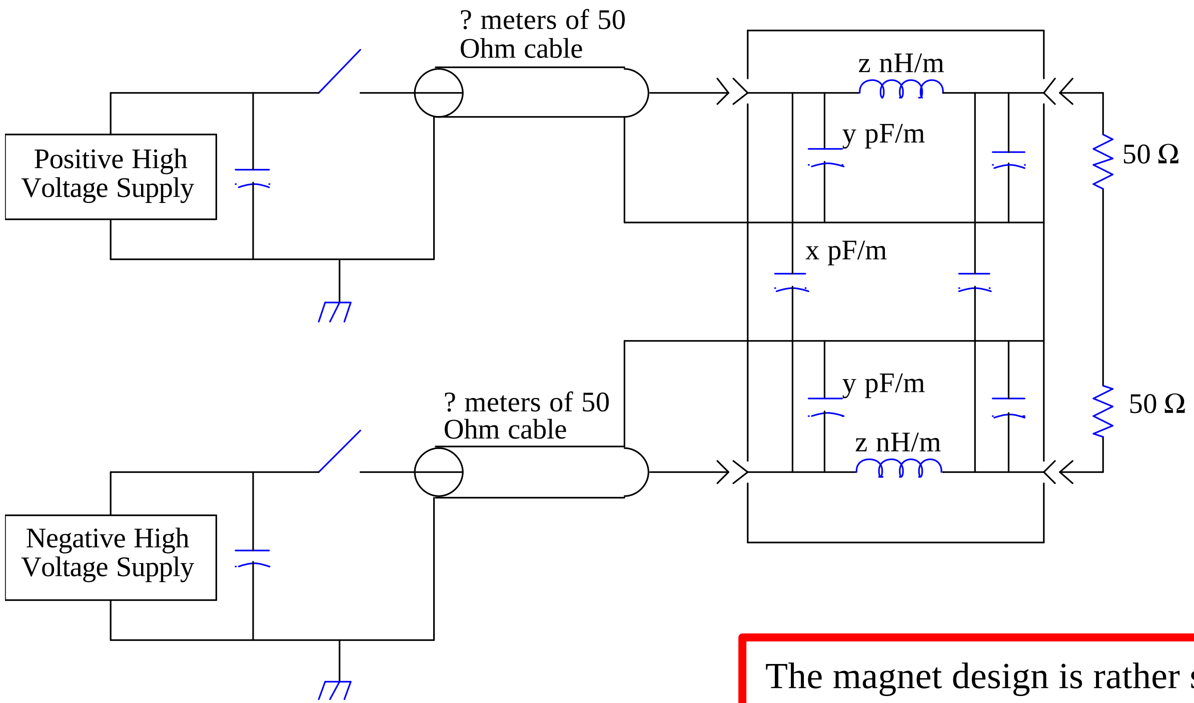
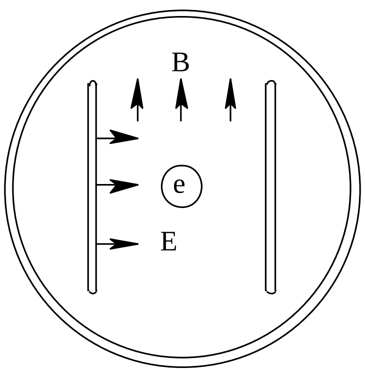
The Switch Is The Challenge

- The standard design requires a very fast switch that turns on and off.
- Most standard switches now available have a rise and fall time of the order of 10 ns.
- The rise and fall of these fields has to not disturb preceding and succeeding bunches.

Typical Electrical Hookup and Cross Section of Magnet





The magnet design is rather simple.

No ferrites, no manufactured capacitors in beam vacuum, all parameters are free space geometry.

Best Yet, and Desired Future

- A magnet design which has been built works up to 15 kV (at BINP).

- A switch design which has been built works up to 5 kV (at DESY).

- Reducing the circumference by a factor of 2 or 3 would represent cost savings, and the present desire is to reduce the switching time by a factor of 2 to 3.

Fast Kickers … Today and Desired Requirements (DESY and BINP)

Specification	Best Achieved	Desired
Burst Rate / # in Burst / Time between bursts	? / 100's / 199 ms	3 MHz / 2820 / 199 ms
Rise/Fall Time (0.07% to 99.93%)	~ 10 ns rise / ~ 10 ns fall	~ 3 ns rise and fall
Flattop (+/- 0.05% over jitter time)	~ 2 ns (20 ns – rise – fall – fill)	~ 2 ns (12 ns – rise – fall – fill)
Capacitor Voltage Stability	±0.02% over burst time	±0.02% over burst time
Pulse Width Stability (Pulse Width to Amplitude conversion)	Not done	±0.5% over burst of 2800 (assumes a constant charging current)
System Timing Jitter	± 1 ns, (better reduces flattop length)	± 0.5 ns
Impedance Match (Cable to Magnet)	~ 5 % reflection	~ 2.5 % reflection (two bounces comes at multiple of 3 bunch spacing, < .07%)
Impedance Match Stability (Cable to Magnet)	±0.05 %	±0.05 % (amplitude of main pulse would be different)
Reliability (1 down day every 3 weeks) Components in accelerator enclosure	Single Manufacturer, at or near rating, a few components	Multiple Manufacturers, 30 % derating, not too many parts

Other Kicker Ideas

- Some other ideas
  - Existing FETs work at 10 nsec. (Field effect transistor.)
  - An IGBT is probably not fast enough.
  - FID (Field Ionization Device) works at 1 nsec … Russia … clearly at the research level … searching for reliability
  - Photoconductor switches (GaAs) are very fast (1 nsec) but don’t last long …
  - None of the above are fast and then flat to 0.07% on flat top and after being “off”

Surface Physics … polarized electrons

ID: 106 **project_size:** medium **skill_type:** physicist

short project description: surface physics of GaAs cathodes

Detailed project description: : Polarized sources employ strained GaAs as the emitting surface. RF photoemission guns offer the possibility of higher gradient and higher energy than DC guns; these features are consistent with better beam quality. Thus far, experiments with strained GaAs in RF guns have lead to rapid deterioration of cathode perfomance; a brief overview may be found in Fermilab Technical Memorandum 2165, Dec ember 2001. This project consists of an initial theoretical study leading to recommendations for improved cathode preparation procedures. This step should lead to experimental activity at either a university laboratory already suitable for photoluminescence studies or a national laboratory. For background, see for instance S. Hufner, 'Photoelectron Spectroscopy: Principles and Applications', Springer-Verlag Series in Solid State Science: 0082, 1995..

Needed by who: generic accelerator **present status:** Idea of how to do it **Needed by date:**

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Remote Operation

ID: 96 **project_size:** small **skill_type:** physicist

short project description: Remote operation of Photoinjector Laboratory (FNPL) at Fermilab

Detailed project description: Setup remote control station and become familiar with aspects of the linac control and beam analysis. Currently not enough people to manage multiple shifts at FNPL. A description may be found in Fermilab Technical Memorandum 2167, located at http://fnlib2.fnal.gov/MARION?key=Fermilab-TM-2167&ind=R. Although this activity does not by itself identify a particular component for a linear collider, participation in operation and measurement may well identify aspects of beam diagnostics, control, or analysis systems for specific contribution. This activity gives one an introduction to linac systems and operation in a simplified environment. The potential exists for planning and carrying out beam experiments and characterization or development and test of diagnostics and rf control systems

Needed by who: generic accelerator **present status:** In progress, help needed

Needed by date:

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Surface Physics … better main linac cavities

ID: 90 **project_size:** large **skill_type:** physicist

short project description: Surface treatments for structures and cavities

Detailed project description: Surface treatments to suppress field emission and raise the breakdown and quench (SC case) gradient need investigation. Oxides may play an important role. Better understanding of the required surface conditions should help in obtaining better performance at reduced time and effort. Possible surface treatments might include high pressure rinsing, etching, gettering, electropolishing, and baking. These are of interest for both warm and cold structures/cavities.

Needed by who: NLC and TESLA **present status:** **Needed by date:**

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Dark Current

ID: 86 **project_size:** medium **skill_type:** physicist

short project description: Simulations of dark current transport

Detailed project description: Much of the background produced by the SLC came from a beam halo of unknown origin. This halo may have been due, in part, to dark current from the linac transported all the way to the IP. Dark current transport also has implications for diagnostic devices.

Needed by who: NLC and TESLA **present status:** **Needed by date:**

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Also dark current calculations for photocathodes is of interest.