Prototype Barrier RF System Design (Rev. 2, Sept 12, 2002)

A. System Specifications:

- To provide ±6 kV pulses at a frequency up to1 MHz.
- Using five FT-3M Finemet cores (ϕ500mm) and two HTS 161-06-GSM switches.

B. Finemet Core Calculations:

1. Core dimensions:

Finemet core OD:	OD = 500 mm
Finemet core ID:	ID = 139.8 mm
Finemet core thickness:	t = 25 mm
Stainless steel mandrel OD:	ID (mandrel) = 139.8 mm
Stainless steel mandrel ID:	ID (mandrel) = 133 mm
Mandrel thickness:	t (mandrel) = 3.4 mm

2. Measured inductance (series representation) at 1 MHz: (from KEK ϕ700mm cores)

$\mu_s' = 2{,}000$

$\mu_s'' = 3{,}700$

3. Converting to parallel representation:

$Q = \mu_s' / \mu_s'' = 0.54$

$\mu_p' = \mu_s' \times (1 + 1/Q^2) = 8{,}800$

$\mu_p'' = \mu_s'' \times (1 + Q^2) = 4{,}800$

4. Calculating equivalent parallel LR circuit:

$L_p = \mu_0 \times \mu_p' \times (t/2\pi) \times \ln (OD/ID) = 56\ \mu H$ (per core)

$R_p = \omega \times L_p \times Q = 190\ \Omega$ (per core)

5. Parallel inductance and resistance of 5 cores:

$L_p = 280\ \mu H$

$L_p = 950\ \Omega$

C. Switch Calculations:

1. Required voltage waveform across the cores:

A pulse of V = +6 kV for T = 0.3 μsec, followed by a zero-voltage gap, then by a pulse of V = –6 kV for T = 0.3 μsec, then by another zero-voltage gap, repeating every 11.1 μsec for 200 ms. This burst repeats every 2 sec.

2. Required peak current through the inductance:

$I(L) = V \times T / L_p = 6.4$ A

3. Peak current through the resistance:

$I(R) = V / R_p = 6.3$ A

4. Total current through the cores:

$I = I(L) + I(R) = 12.7$ A

5. HTS 161-06-GSM switch data (2 switches in one case):

Max operating voltage:	2 × 16 kV (or 2 × ± 8 kV)
Max peak current:	2 × 60 A
Max burst frequency:	2.5 MHz
Min pulse width:	200 ns