

**Pulsed Power Supply for the Kicker Magnet
with SI-Thyristors**

**H. Sato, E. Nakamura, S. Murasugi, S. Yamanaka and T. Kawakubo
KEK PS**

**T. Mimashi and H. Nakayama
KEK B**

**T. Hatano and N. Shimizu
NGK Insulators LTD**

and

**A. Tokuchi
Nichicon Corporation**

SI-thyristors are expected as a solid-state high power switch for the kicker magnet in the circular accelerators. Preliminary results of the proto-type power supply of 20kV-120ns, although the intention is 75kV-100ns, for the hadron accelerator and the performance of the SI-thyristor switch of 20kV-2ms pulse width in the KEK-B collider are presented.

Pulsed Power Supply for the Kicker Magnet at the KEK-PS and JHF

	KEK-PS		JHF		
	Extraction Kicker KEK-12GeV PS	Extraction Kicker 500MeV BSTR	Extraction Kicker JHF-3GeV-RCS	Injection Kicker JHF-50GeV-PS	Abort Kicker JHF-50GeV-PS
Voltage(kV)	+70~-40	65	80	80	40
Current(kA)	+6~-3	1.3	8	8	8
Pulse width(μs)	1.1	0.12	1.2	1.2	6
Current Rise(ns)	80	40	80	70	1,100
Field Rise(ns)	150	70~80	250	250	1,100
Field Fall(ns)		70~80			
Flatness(%)	± 1	± 1	± 1	± 1	
Repetition(Hz)	1/2.2	20	25	25pps x 4bursts	1/3.6
Impedance of magnet (Ω)	12.5	25 (distributed magnet)	10	10	2.2 μ H / 5 Ω (lumped magnet)

Performance test of SI-Thyristor

Single dI/dt test : 283kA/ μ s (RT103, Toyo Denki-NGK)

45kV klystron modulator (RT103, Toyo Denki-NGK) test for kicker
(M. Akemoto)

R&D module (RS1600PA40T1-NGK) under collaboration, KEK-NGK-
Nichikon

Aim of R&D

Charged voltage : 70kV

Output current : 7kA

Impedance : 5 Ω

Rise : < 120ns

Pulse width : 1.1 μ s

Repetition : 25Hz

1st Goal

20-40kV

depends on load

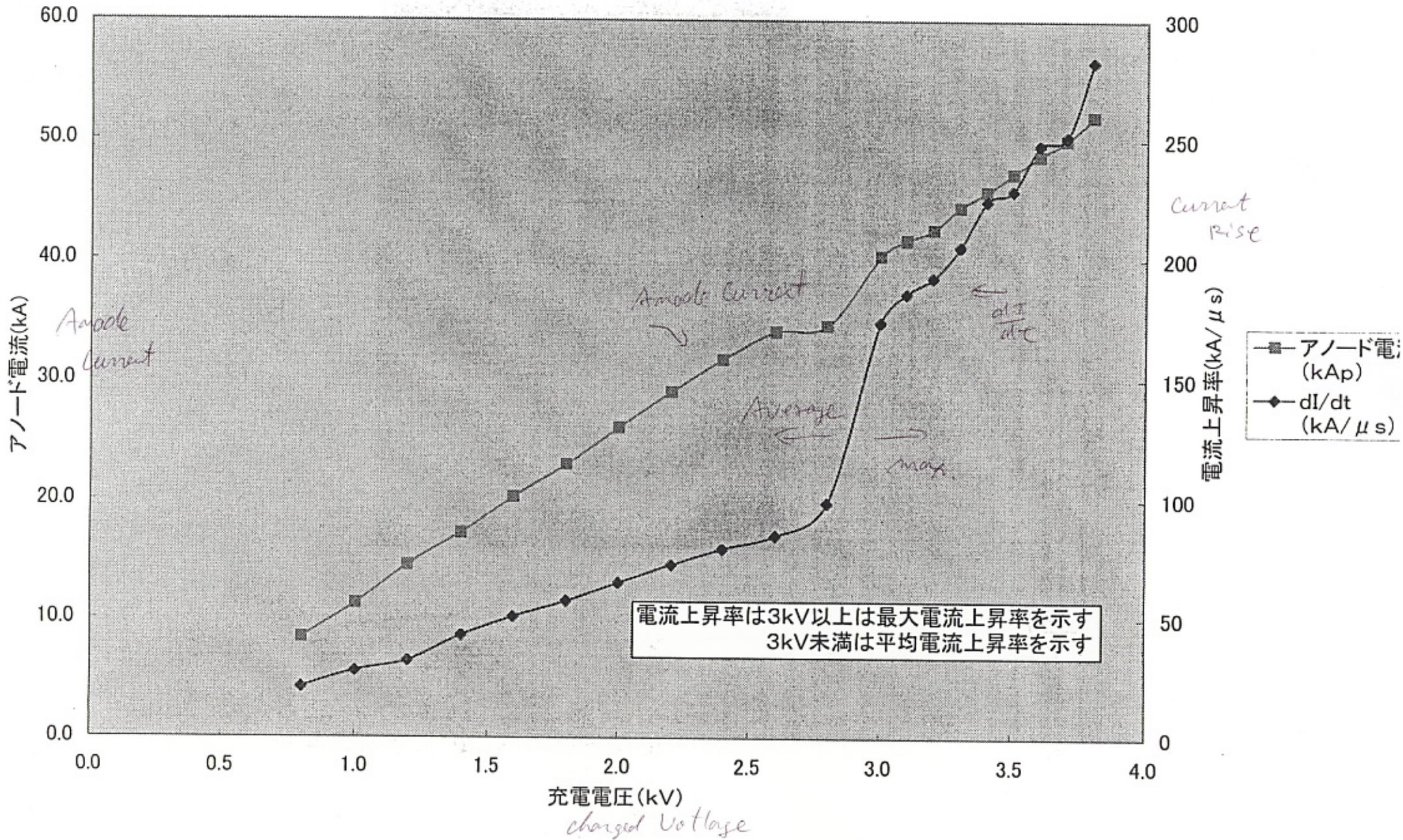
50 Ω , 10 Ω

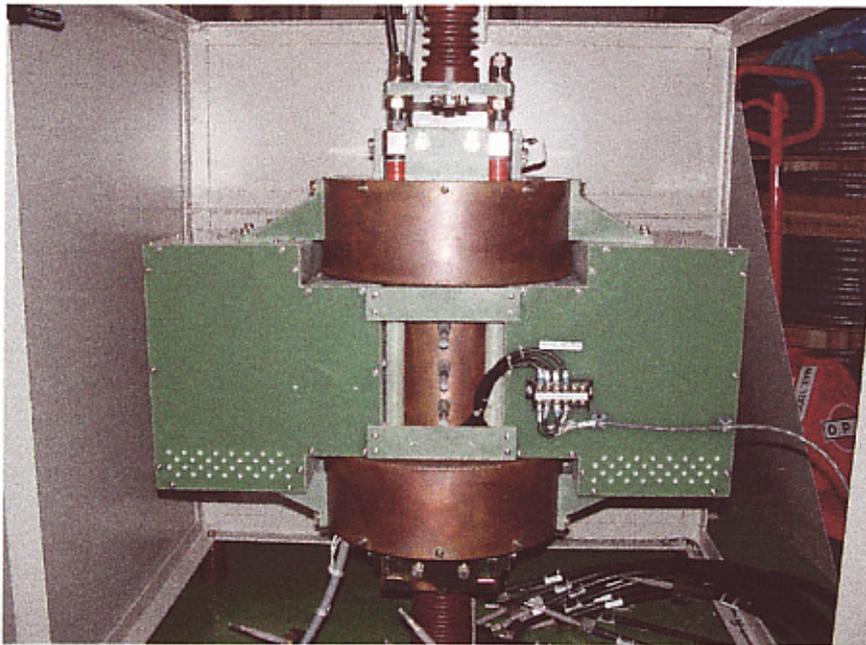
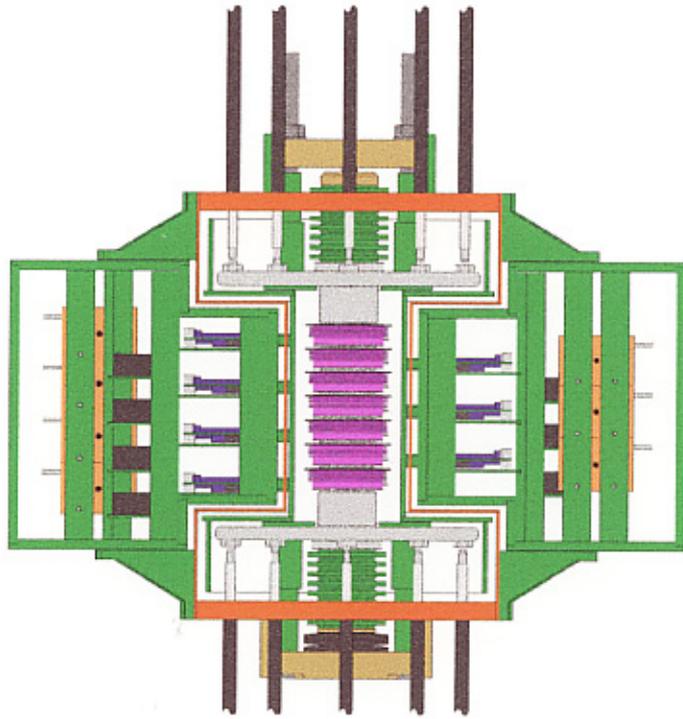
< 120ns

Feasibility of the SI-thyristor for the trapezoid pulse kicker magnet was confirmed.

Need high speed diode to cut the reflection.

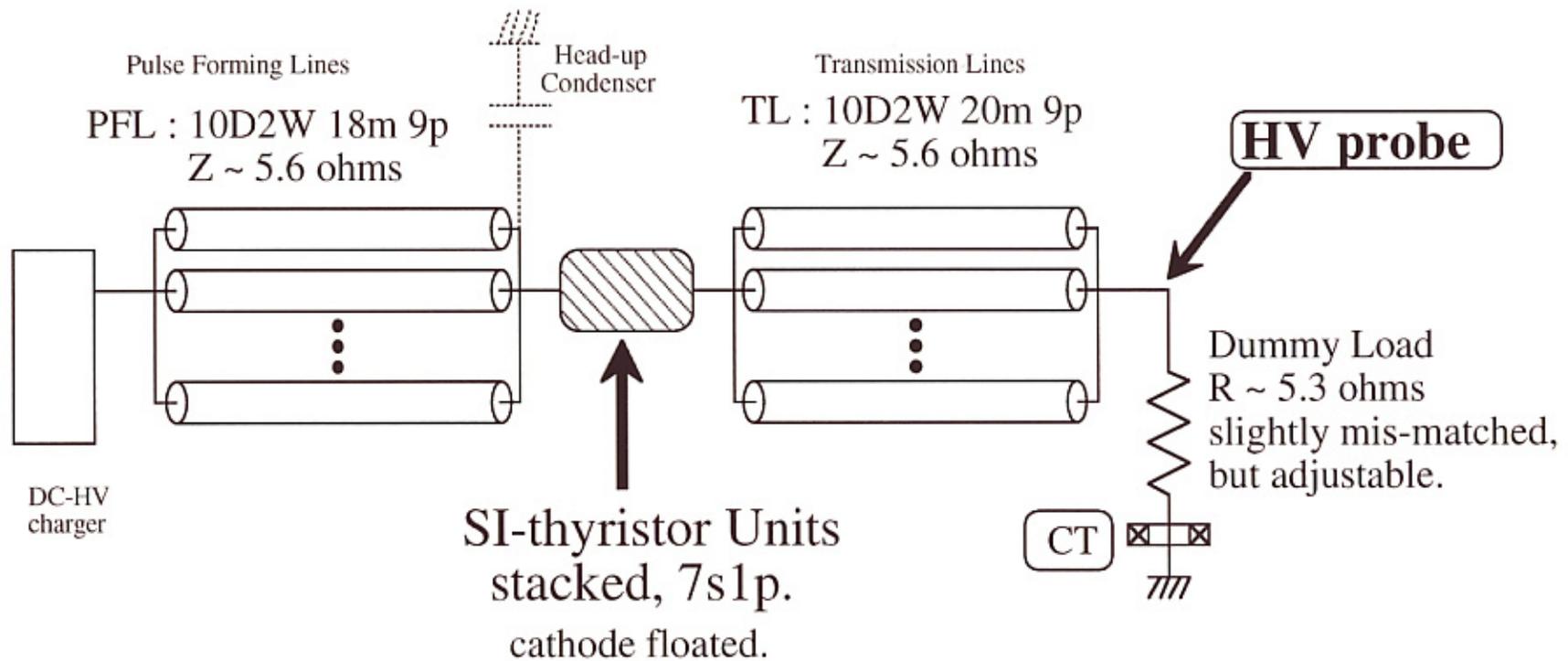
SIサイリスタパルス通電特性





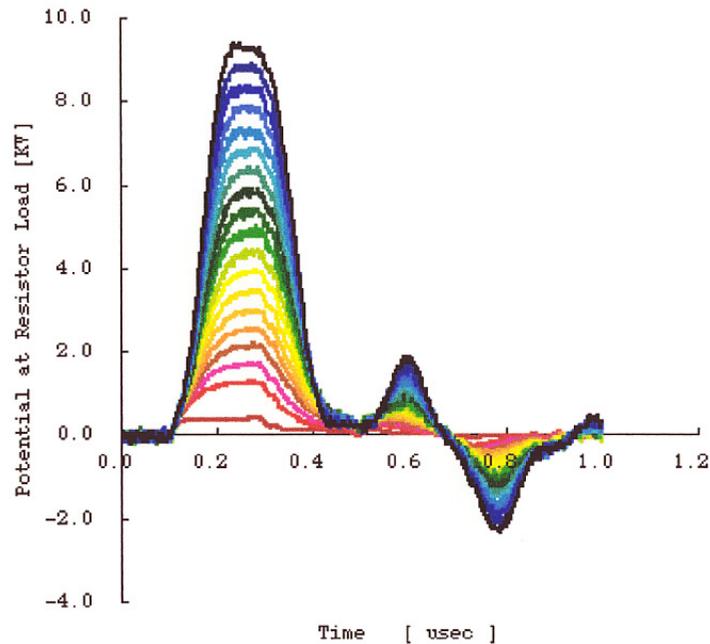
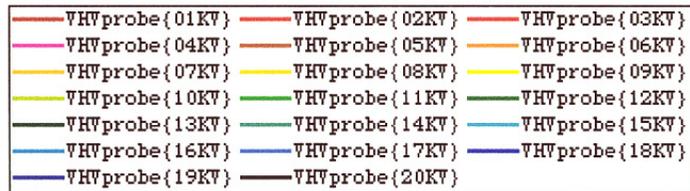
Overview of the Demonstrated Modulator to produce Trapezoid Pulse

* Simple lines with floated cathode SI-thy. unit.

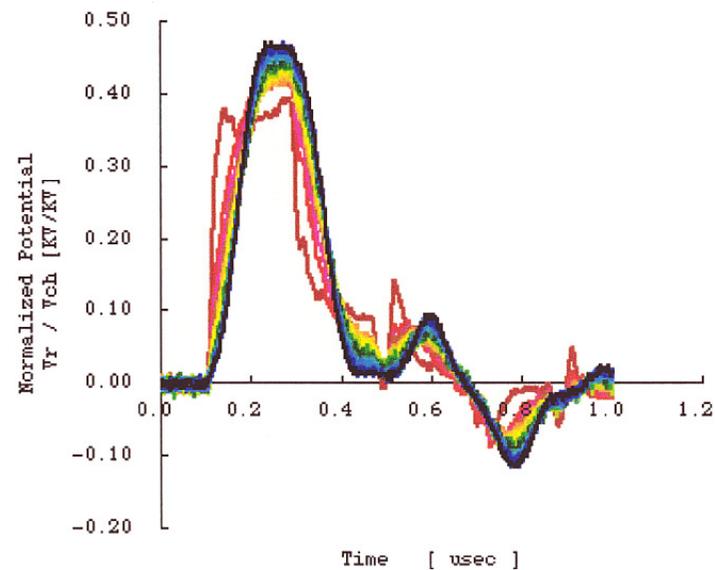
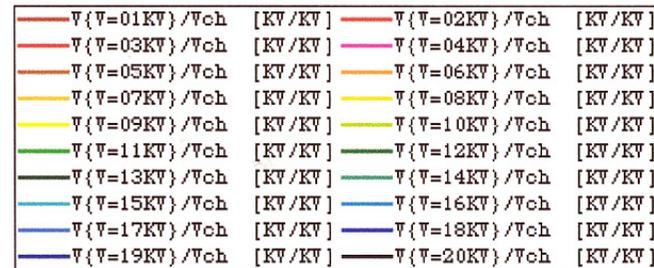


Load Potential : 120 nsec rise achieved, equivalent to 15 KA/ μ sec.

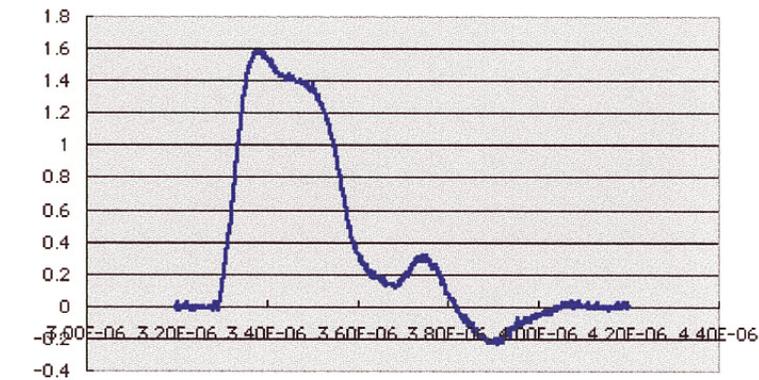
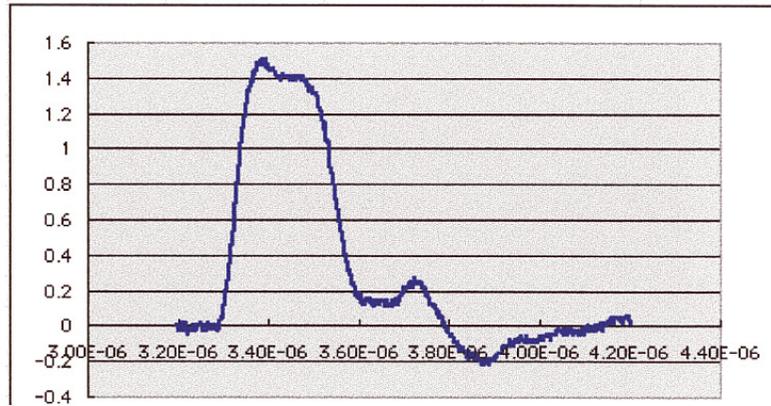
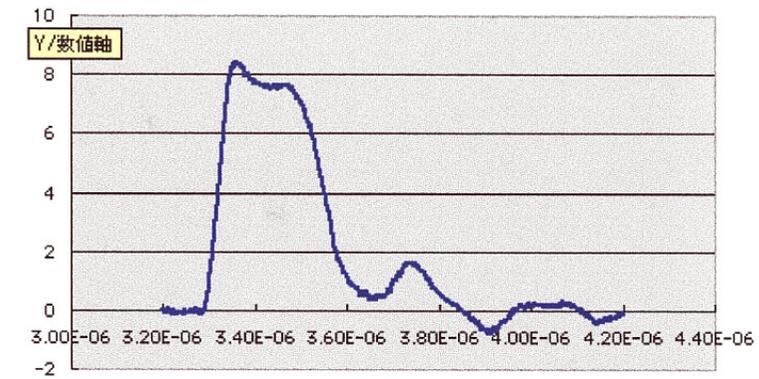
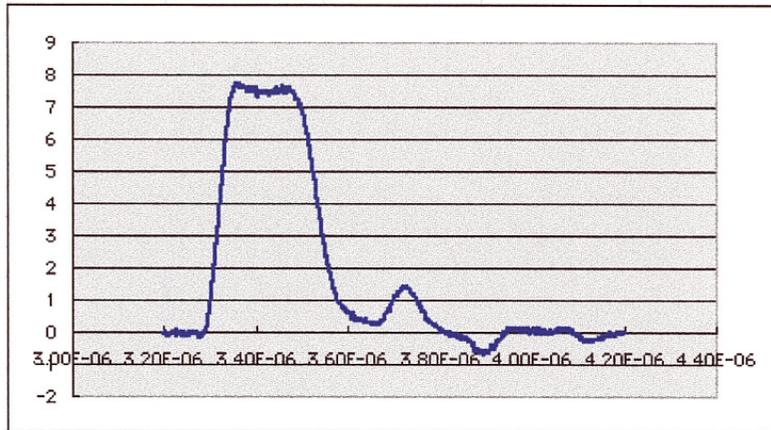
Static Induction Thyristor Trail to Trapezoid
Pulsed Power Supply



Static Induction Thyristor Trail to Trapezoid
Pulsed Power Supply

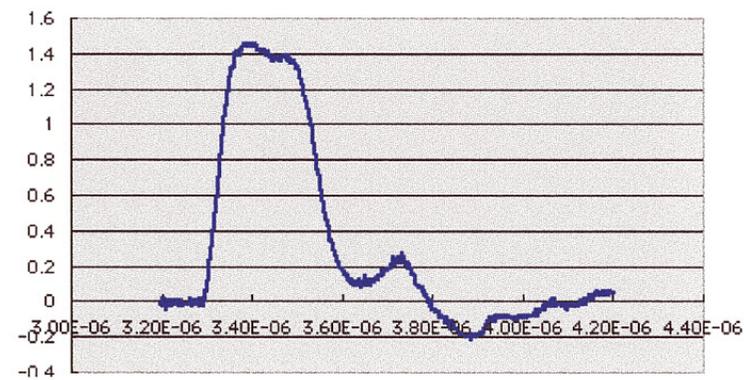
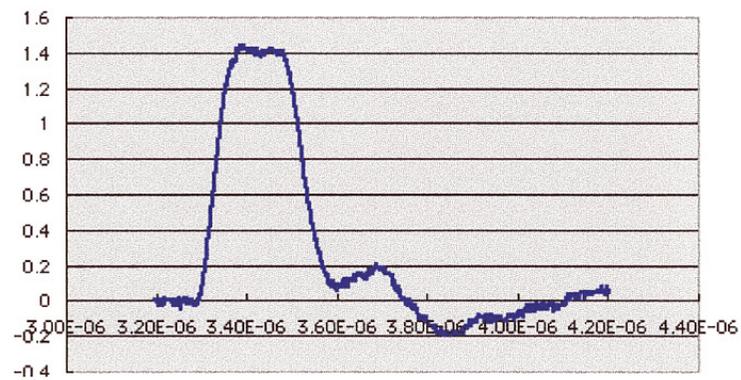
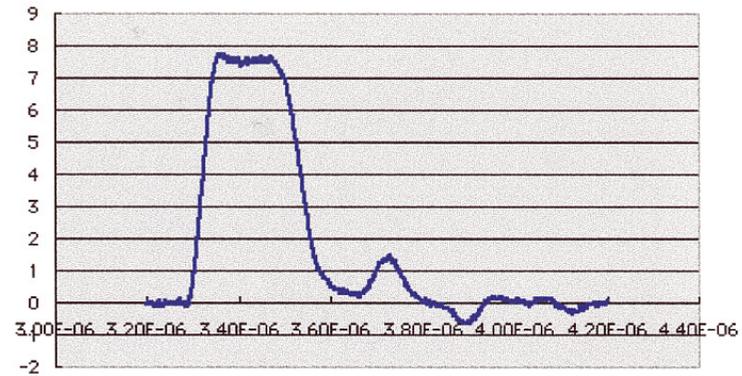
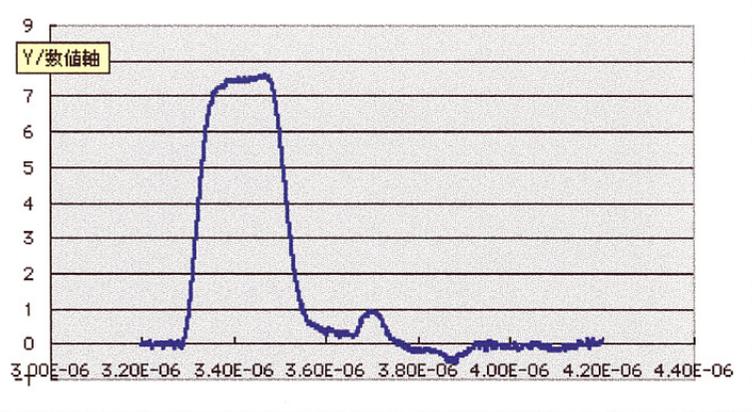


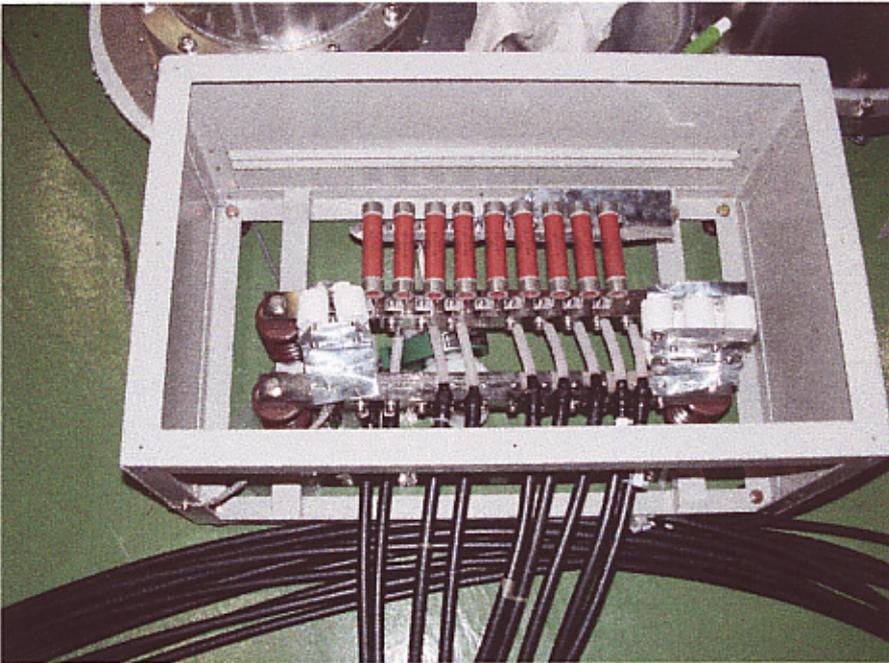
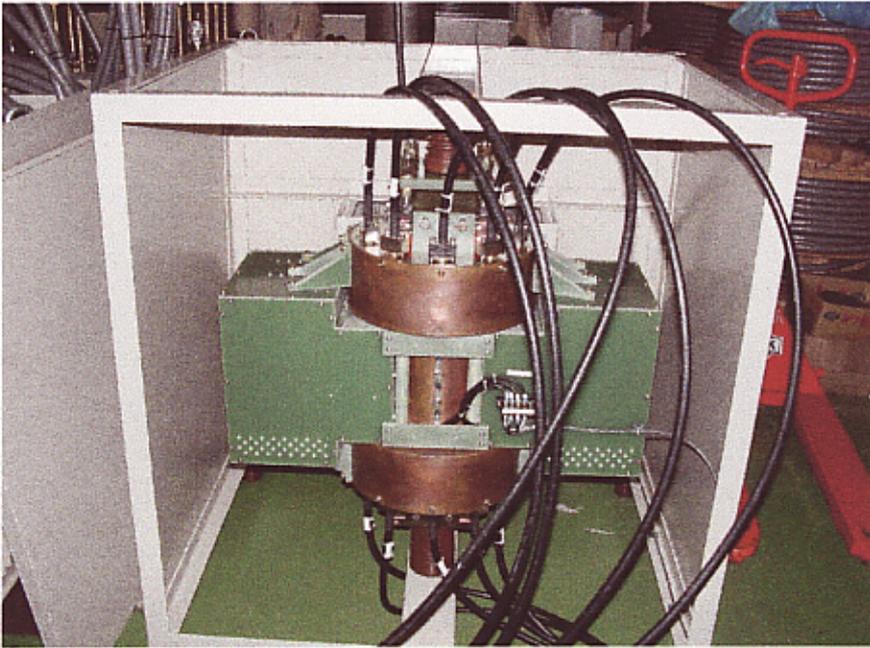
Left two waves are with 309pF ceramic condensers.
Right two waves are with 620pF ceramic condensers.



Modification Trial of Head-up Condensers to PFL of $Z = 50$ ohms.

Left two waves are with no condensers : upper is current measured with CT and lower is potential.
Right two waves are with 349pF co-ax. cables attached.





Performance of SI-Thyristor kicker power supply at the KEK-B

(EPAC2002, Paris, June 3-7, T. Mimashi, et. al)

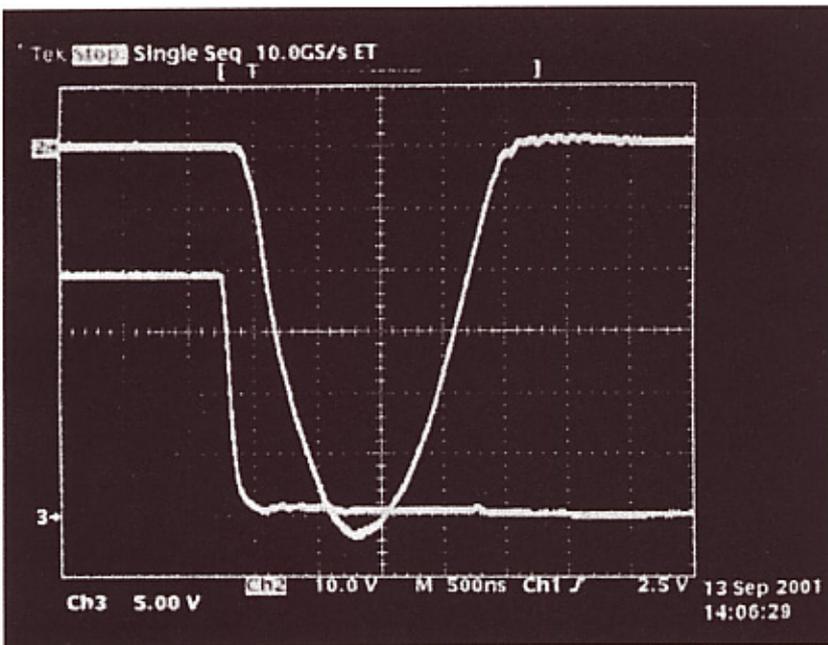
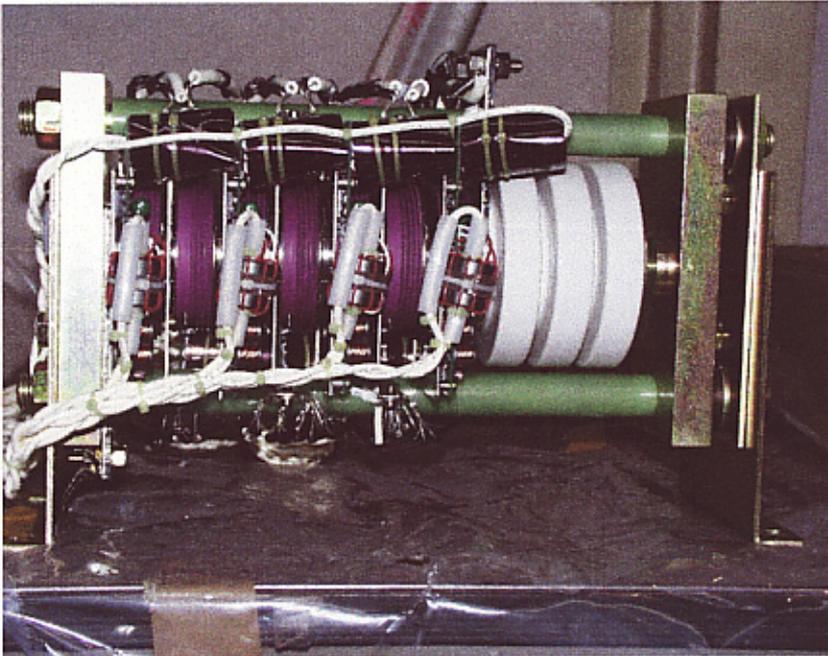
**KEKB injection kicker magnet : conventional window-frame ferrite
core kicker magnet**

Maximum voltage and current : 35kV and 2000A (500 gauss)

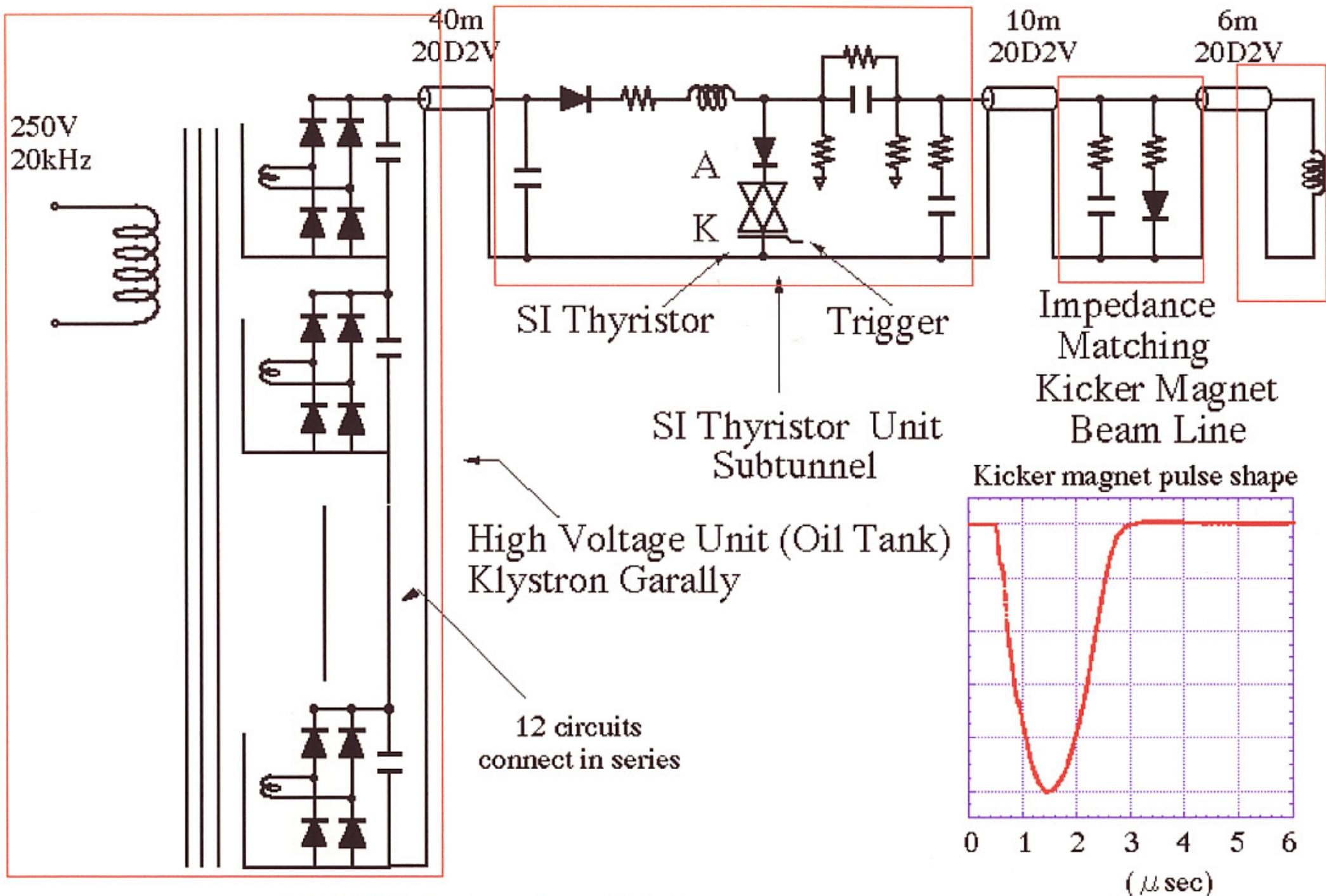
Thyratron Power Supply : 16-20kV in HER, 10-16kV in LER

**Seven SI-thyristors has been assembled in series for the LER kicker
magnet power supply.**

**LER kicker magnet is pulsed about 3 hours a day and applied voltage
is about 10kV and operating successfully.**



Anode voltage (7 series) and the output current.
500nsec/div, 5kV/div , 200A/div



KEKB Injection Kicker system power supply

Conclusion

20kV R&D SI-thyristor switch test has been performed.

Impedance study

Speed up capacitor study

Next aim : Application for the 50GeV abort kicker power supply with high speed diode to cut the reflection.

Performance in the operating machine.

SI-thyristor switch, which has been assembled for the KEKB LER kicker magnet power supply is operating successfully. No trouble has occurred, then SI-thyristor is usable for the conventional window-frame ferrite core kicker magnet.