Nufact'00 W.S.
Monterey, May 25, 2000

High field, high repetition rate kicker

Shirakabe, Takagi, Muto, Ishi, and Mori
KEK

Aimed for :

Injection & Extraction of PRISM/FFAG muon beam

Injection & Extraction of 50 GeV proton beam

Requirements :

- Large aperture
  - →50 GeV : Gap height 100mm
  - →PRISM/FFAG : Gap height 200mm ?
- High field
  - →50 GeV : 1 kGauss or more (if possible)
  - →PRISM/FFAG : 0.5kGauss ?
- High repetition rate
  - →PRISM/FFAG : 1 kHz
- Simple and maintenance-free system
  - .
  - .
  - .

Near-future R&Ds for PRISM/FFAG Kickers

for Higher Voltage :
for Higher Current :

---> more IGBT modules. (possible)

Shorter Rise-time:
(esp. for PRISM extraction, ~100nsec)

---> use of MOS-FETs.
(faster, but more module should be used)

---> use of magnetic pulse compression circuits?

Extraction Kicker Power Supply

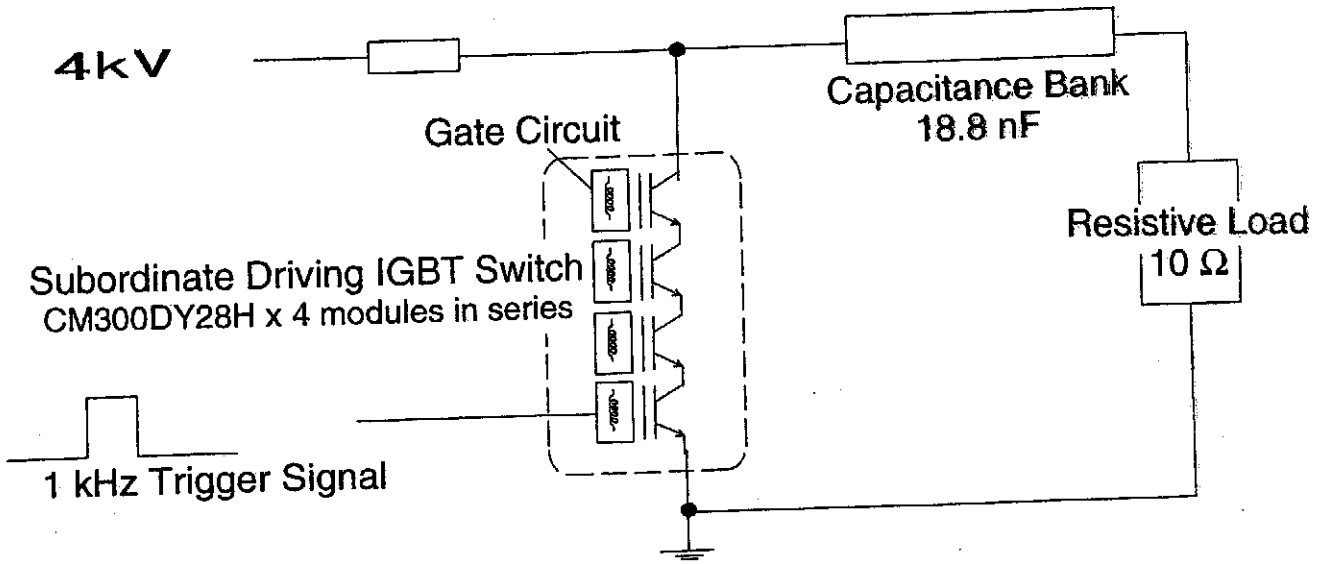
with 1 kHz Operation

---now on construction (for other purpose)

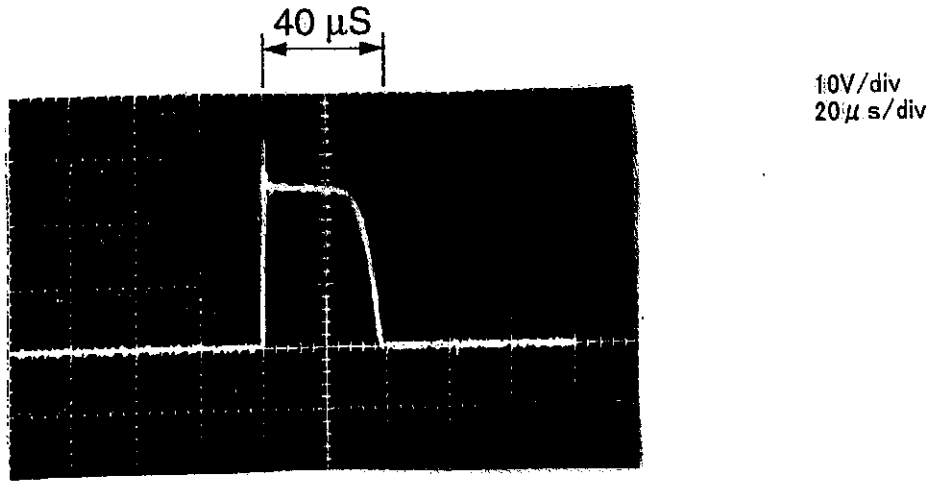
Field strength	: ~1 kGauss
Rise-time	: 250 ~ 300nsec
Flat-top	: 200 nsec
Field flatness	: ±2.5 %
Output voltage	: 35 kV (Max.)
Output current	: 750 ~ 1000 A
Impedance	: 25 Ω
IGBT module	:

CM75DY-28H (1400V/300A)

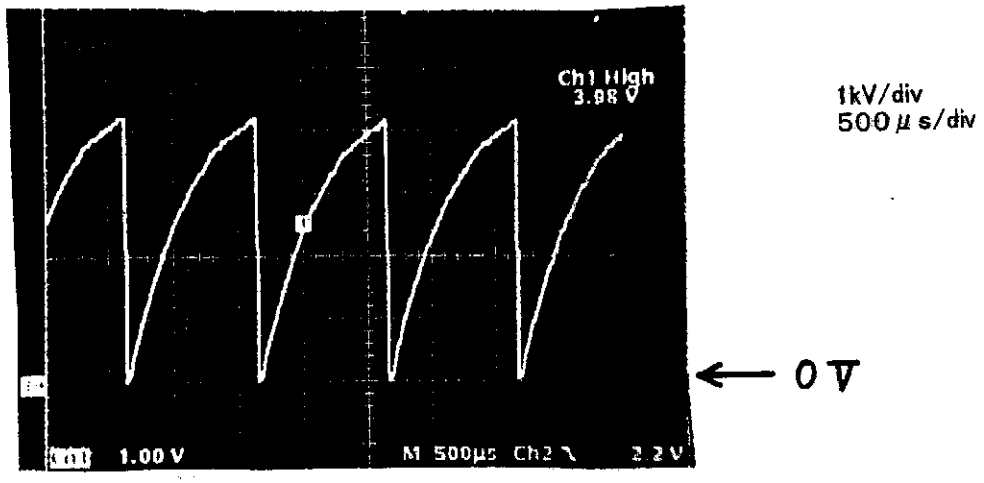
x 36 in series x 4 in parallel



Test Circuit

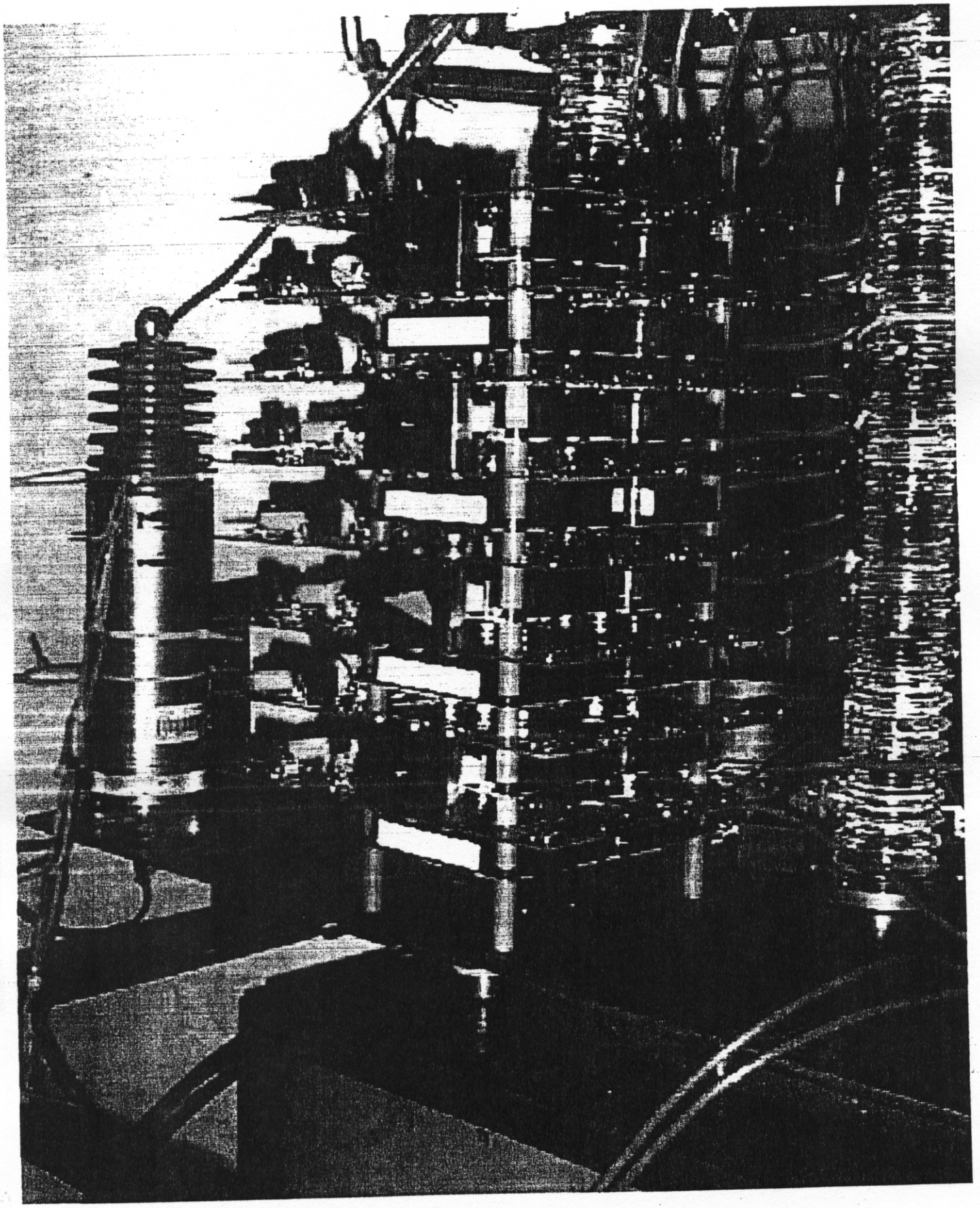


Trigger Signal Waveform

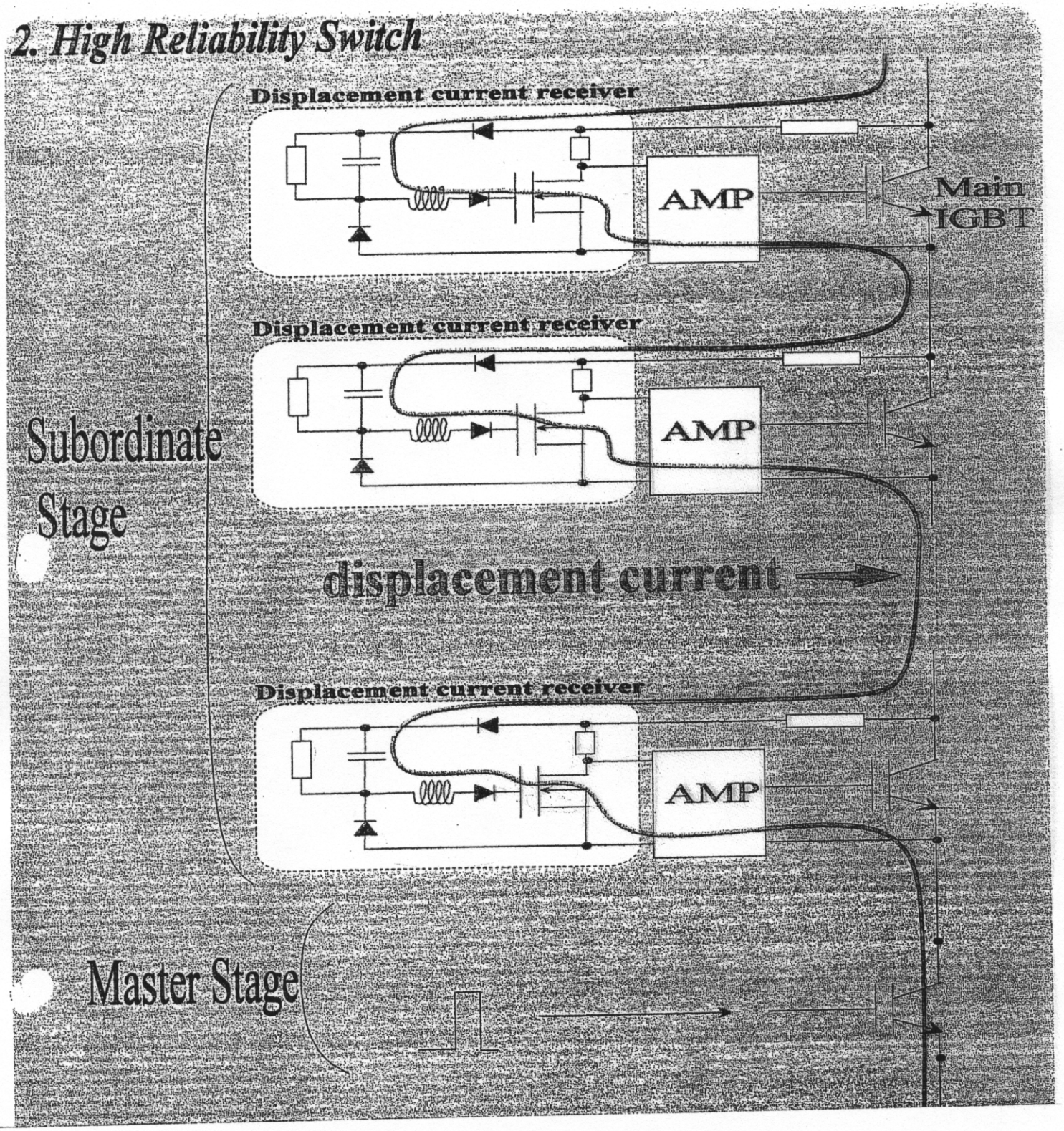


Voltate across 4-Series IGBTs

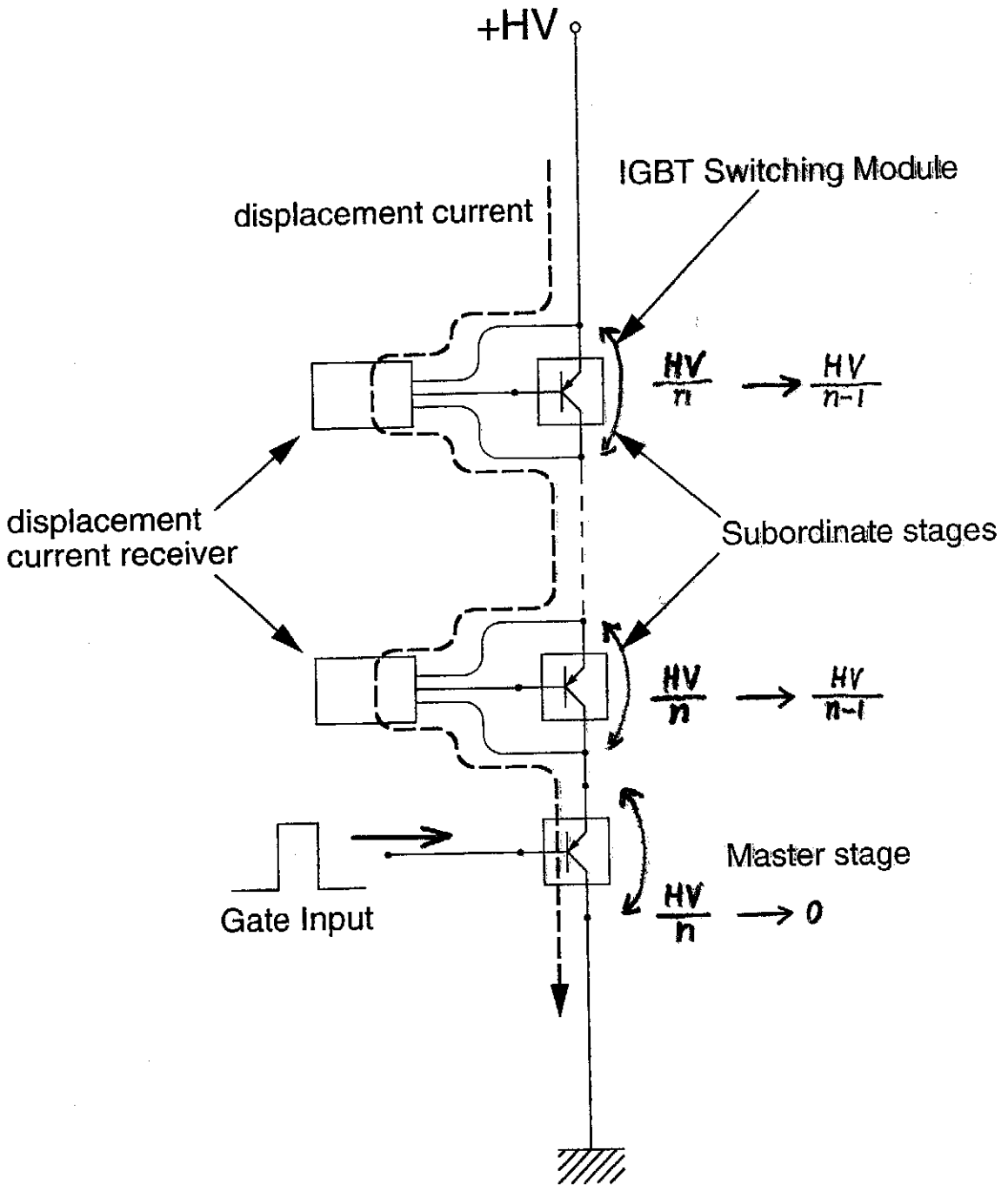
1 kHz Operation Experiment



2. High Reliability Switch

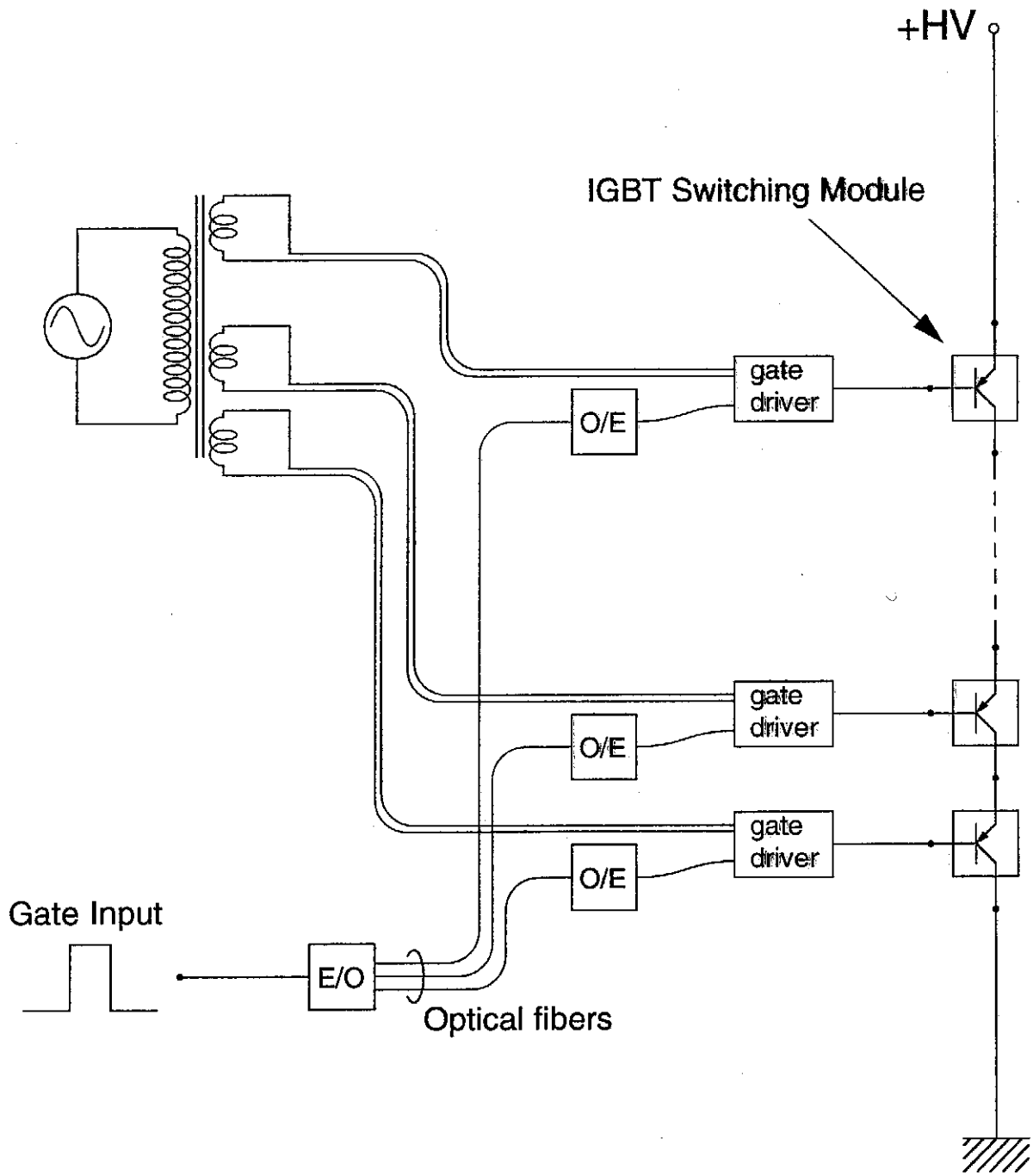


Subordinated Multi-stage Gating Circuit



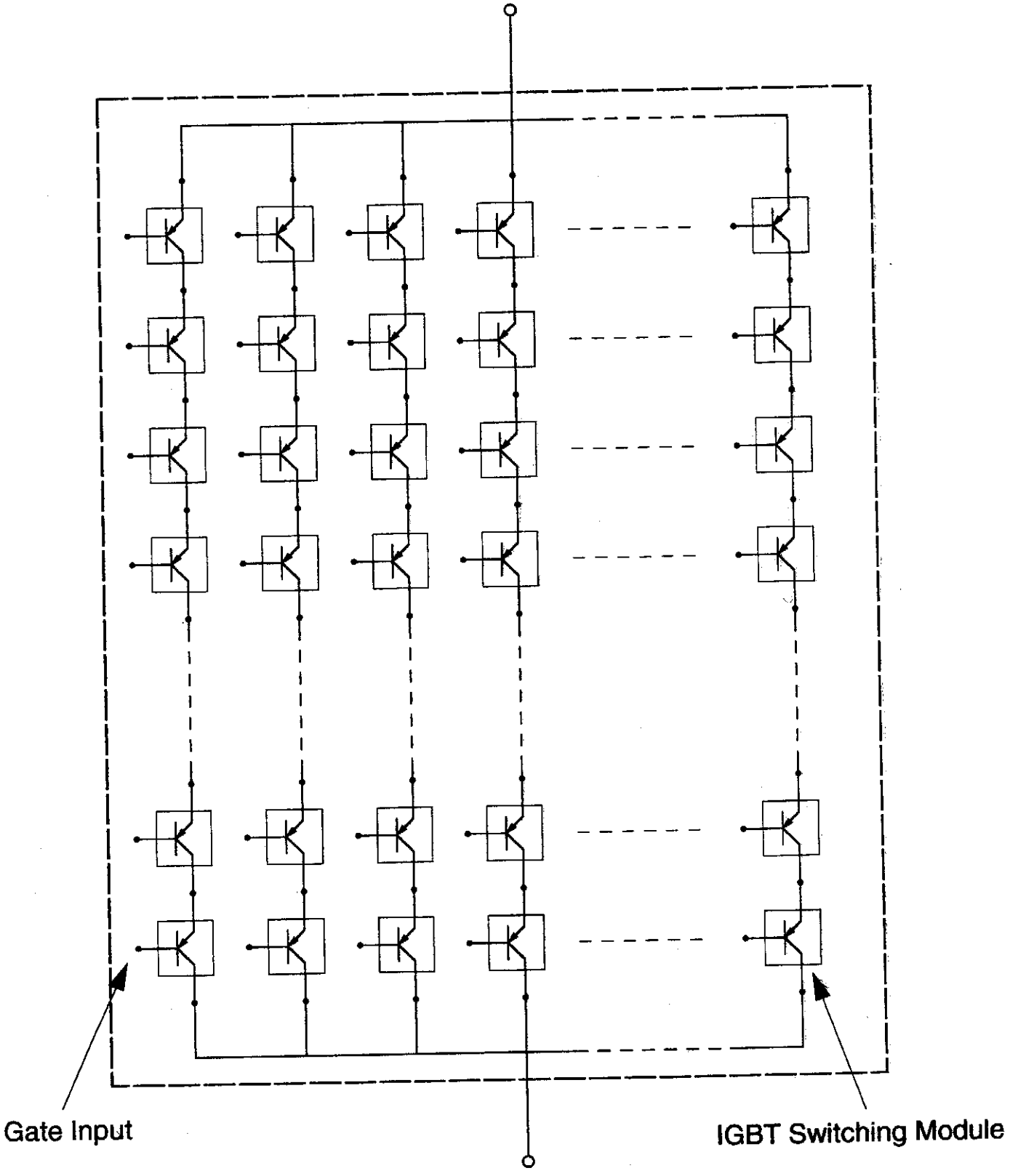
==> Simple and reliable

Conventional Multi-stage Gating Circuit



==> Complex gating circuit system
==> Insulation problems at the transformer

High Voltage Switch with Massive Parallel/Series Stages of IGBT Modules



R & D items :

In order to allow a higher voltage and higher current switching :

In order to allow a higher repetition rate switching :

---> Use of IGBT (Insulated Gate Bipolar Transistor) switching modules.

---> Use of a Subordinate-Driving switching system for a multi-stage turning-on.

In order to allow a stronger kicker field :

---> Use of Magnetic-Alloy as a return yoke.

Simple Evaluation of Basic Parameters

50GeV:

Gap Height : h = 0.1 m

Field Strength : B = 0.1 T

==> Kicker Current : $I = B \cdot h / \mu_0 =$ 8 kA

PRISM/FFAG:

Gap Height : h = 0.2 m

Field Strength : B = 0.05 T

==> Kicker Current : $I = B \cdot h / \mu_0 =$ 8 kA

PFN/Transmission-cable Impedance: $R_0 = 12.5\ \Omega$

==> PFN Charging Voltage:

$E = I \cdot R_0$

$= 100$ kV

(Lumped type, with a full voltage-reflection at the terminal-end.)