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Kicker types for In- and Ejection in the damping Rings of TESLA

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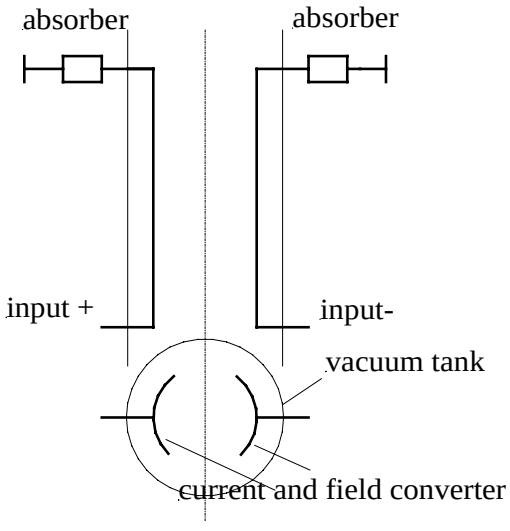
Synopsis

Abstract

In the design of the damping Rings for TESLA and their length is the bunch distance very important. The bunch distance must be wide enough for the in- and ejection of single bunches in different sequences.
Only in this way you can in- and eject in the same time. To fill the damping rings and eject from the ring to TESLA.
This different sequence with big and damped bunches ask for large in- and ejection angle. Fast kickers are the important points for this in- and ejection scheme. This report shows the possible kicker types.

2. Strip line Kicker Fig. 1



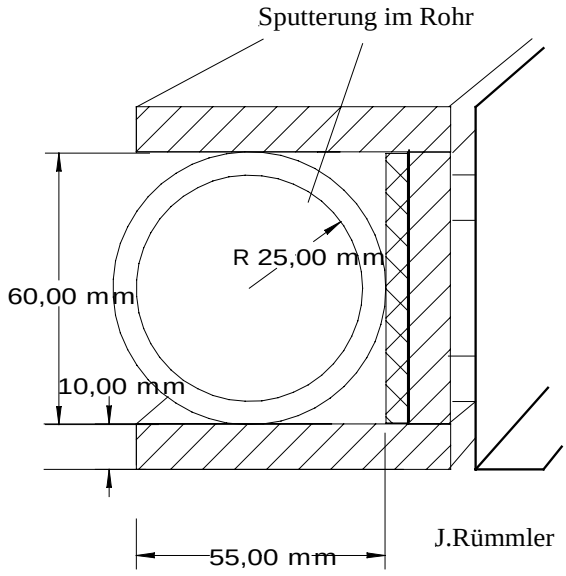
Striplinekicker

2.1 Conception of the kicker type and the advantage

This easy design without ferrite is easy to build but the magnetic field is not high under normal high voltages. This kicker type needs two pulsers.

3. C - yoke ferrite - kickers around a sputtered ceramic tube Fig. 2

3.1 Kickers around a sputtered



Kicker im Schnitt

ceramic tube and the advantage

The advantage of this kicker type is the easy vakuum technics. The kicker without vacuum tank. The disadvantage is the high voltage around the sputter material. The sputter thickness is ca. 1 µ. In order to have the right resistance. That gives the limit of the kicker field.

Because the skin effects of the sputter material against the kicker field must have the sputter layer a resistance of no lower than 20 ohms length the chamber. But from the wall current of the permanent running beam comes a lot of heat in a to high resistance material. This gives the limit of this kicker type .

For small deflection angle like in feedback kickers is this kicker type ideal. Because all kicker parts are outside the vacuum.

3.2 The field build up time is given through the kicker gap and the impedance
3.3 The induction of the kicker is given through the gap and the feed through
3.4 The impedance of the kicker up to 30 MHz is important
3.5 The kicker scheme is according to impedance and field build up time selected

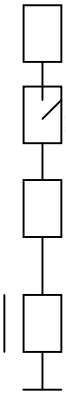
The data of the design.

Energy	5 GeV
Free aperture	50 x 50 mm
C – yoke	60 x 60 mm
Ferrite length	500 mm
Ceramic wall thickness	5 mm
Sputter material V2A	0.5 µ thick
Induction of the kicker	L = 0,7 µH
Kicker impedance	Z = 50 Ω
Field build up time	t = 15 ns
Field running out time	t = 15 ns
Pulse voltage	U = 5 kV
Pulse current	I = 100 A
Deflection 5 GeV	α = 6 E-5 rad
By α = 0.5 mrad	10 kicker magnets.

That are to many.

Without a test magnet there are no sure data results.

Pulse equipment scheme



Power supply: The switches are HTS from Behlke instead of thyratrons. Thyratrons can not switch off.

Switch: A lot of technical parts are to be tested.

Absorber: For single bunches the HTS switches are tested and work well.

Kicker: To reduce of kicker magnets is not so easy.

The absorber comes before the kicker magnet to protect the pulse switch against high current bin case of folds.

Power supply 5 kV / 5 A / 25 kW
Because the high repetition rate the power supply are big.
The power supply must have a very good accuracy and stability. The kicker field must have a better repetition accuracy then the pre fault of the deflection angle of the beam.

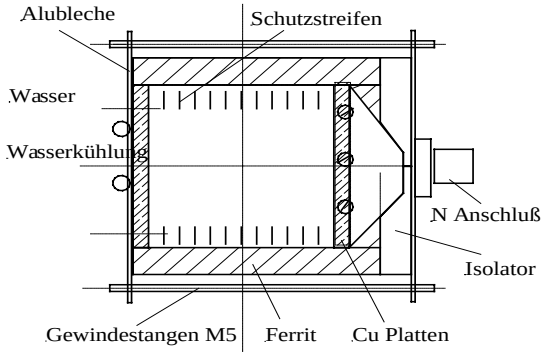
Pulse equipment
Thyratrons switch not in such fast repetition rate. Our design works with fast high voltage transistor switches.
(Behlke**)** Typ. 80-20-UF Option 03 and 07

This equipment with the capacitor and the switch must be built in an coaxial shape. Because the high frequency.

The 50 Ohm absorber is a broadband absorber. And works also as a protection resistor for the pulse equipment. For the high voltage pulses and the 25 kW power dissipation the absorber is oil cooled.

4. Stripe kickers Fig. 3

4.1 Conception of the kicker type and the advantage



D CJoch Testkicker Magnetteil ohne Vakuumtank

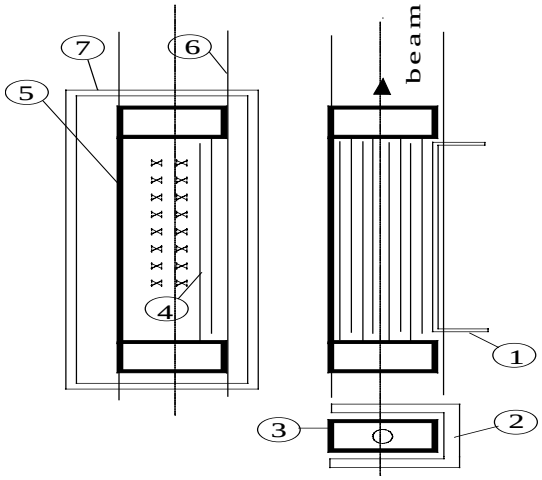
In the DESY machines, in DORIS, PETRA and HERA in- and eject and stabilise a lot of stripe kickers the beam very success-full in a high current mode. Feedback kickers with their quick acting correcting field, stabilise the beam from bunch to bunch.
C - yoke ferrite - kickers with the copper microwave leader, water cooled, through the kicker.

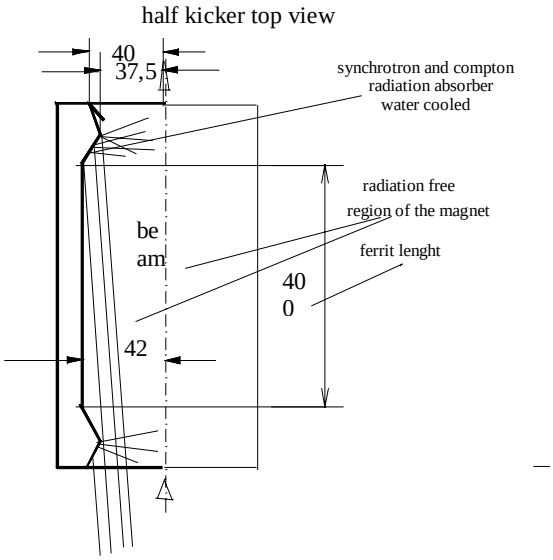
The kicker magnet inside a vacuum tank allows more high voltage as outside the vacuum tank around a ceramic chamber.

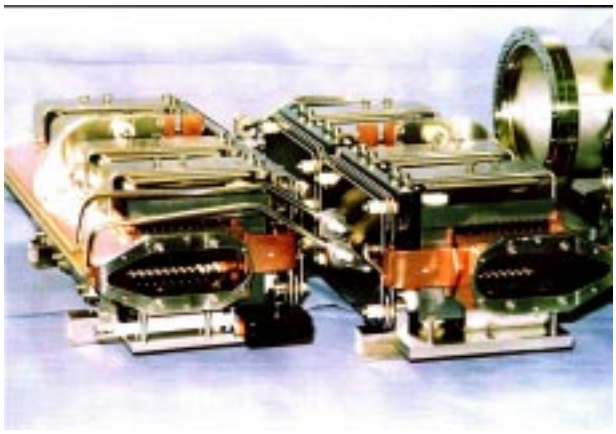
Kicker chamber

1. Current conductor
2. C - yoke ferrite - kickers
3. Hf current conductor
4. Protection stripes
5, Absorber Synchr. and Comptonradia.
6. HERA for example
6. Kicker tank

Kicker top view







4.2 The design of the stripe kicker for the in- and ejection

4.3 The Field build up time come from the kicker aperture, -length and the impedance

4.4 The induction of the kicker is given through the gap and the feed through

4.5 The kicker scheme is according to impedance and field build up time and head resistance selected.

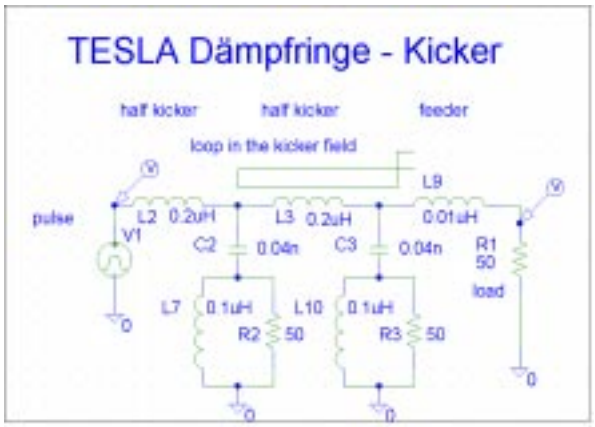
Sputtered ceramic chambers like for the TESLA feedback stand under 100 kW peak power per bunch. (Mr. Dohlus)
This bunch rate gives too much heat.

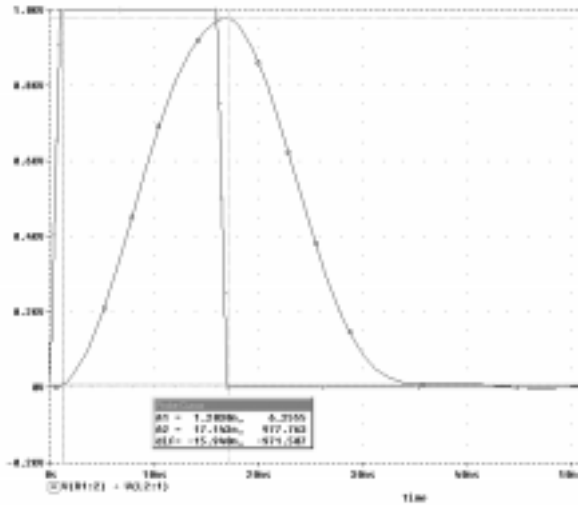
Therefore we must test a stripe kicker

Energy	5 GeV
Free aperture	50 x 50 mm
C – yoke	68 x 50 mm
Ferrite length	400 mm
Induction of the Kicker	L = 0,5 µH
Kicker impedance	Z = 50 Ω
Field build up time	t = 18 ns
Field running out time	t = 18 ns
Pulse voltage	U = 5 kV
Pulse current	I = 100 A
Deflection angle by 5 GeV	α = 4.43 E-5 rad
That means 12 kicker by	α = 0.5 mrad

Ferrite kickers in the TESLA electron rings must be protected against heating by wall currents. The external chamber wall of the kicker, which is metal, lead right through the kicker, guides the wall current of the beam without reflection and also blocks off the synchrotron radiation near a bending magnet.
Stainless steel stripes, copper plated, above and below in the kicker gap is joined to the chamber alternatively to the left and right. Their capacitance close the chamber electro-magnetically to protect the kicker ferrite from the beam fields. For the kicker field, the stripe- capacitance's are in series to prevent the kicker field from being shorted. All inner parts of the chamber are tapered.

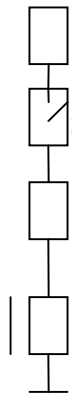
Simulation of the kicker





This simulation shows, this kicker type acts quick enough.
We can test the kicker in the lab.

Pulse equipment scheme



Power supply — The switches are HTS from Behlke instead of thyratrons. Thyratrons can not switch off.

Switch — A lot of technical parts are to be tested.

Absorber — For single bunches the HTS switches are tested and work well.

Kicker — To reduce of kicker magnets is not so easy.

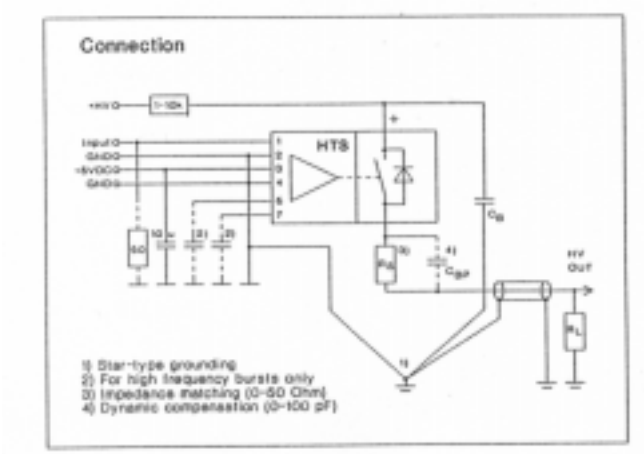
Also here the absorber comes before the kicker magnet to protect the pulse switch by folds against high current.

5. Kicker pulsers for al three kicker types. The stripline-kicker needs a double pulse equipment.

Fast high voltage transistor switch(Behlke)

Switch data Typ. 80-20-UF Option 03 and 07

Max. Operation Voltage	8000	V
Max. Peak Current	200	A
On-time	20	ns



The 50 Ohm absorber is a broadband absorber. And works also as a protection resistor for the pulse equipment. For the high voltage pulses and the 25 kW power dissipation the absorber is oil cooled.

This kicker with the field build up time of t = 20 ns must also have Z = 50 Ω to fill the whole magnet with rectangular field pulses.

Energy		5 GeV
Free gap		50 x 50 mm
C – yoke		60 x 60 mm
Ferrite length		500 mm
Ceramic wall thickness		5 mm
Sputter material V2A		0.5 µ thick
Induction of the kicker		L = 0,7 µH
Kicker impedance		Z = 50 Ω
Field build up time		t = 15 ns
Field running out time		t = 15 ns
Pulse voltage		U = 5 kV
Pulse current		I = 100 A
Deflection at	5 GeV	α = 6 E-5 rad

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