DESY III - Dump System with one fast Kicker

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Abstract.

The dump system works at an injection momentum of 350 MeV/C. The kicker, with a rise time of t = 90ns and a variable pulse length up to t = 3 µs, can eject the entire DESY III beam or only a section into the dump. For test runs DESY III can operate with only a few proton bunches. Beam loss at high energies results then in minimal radioactivitiy in DESY III, the transport channel and in PETRA. Short pulse operation of the kicker can also cut one out of the ten bunches into the dump. This gap protects the ejection septum from irradiation.

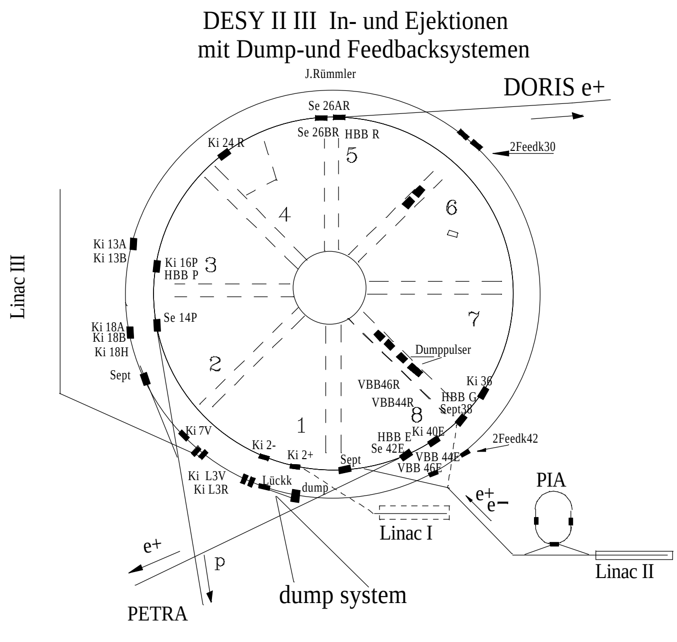

Fig.1

Fig.1 shows the location of the dump system in DESY III.

The optical specifications at the ejection point from DESY III to PETRA apply also to the dump system.

At a momentum of 350 MeV/C the beam deposits little radioactivity, but as an additional safety precaution, both sides of the dump chamber are shielded by 5 cm thick lead walls.

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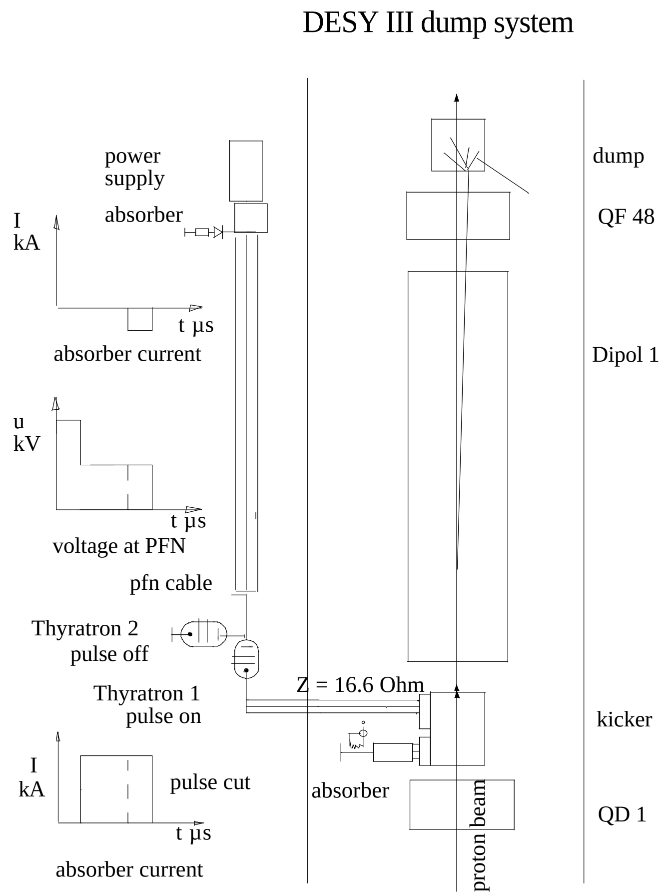


Fig.2

The overview of the dump system shows how the kicker magnet near QD1 ejects the beam. The beam then runs through dipole 1 and QF 48 into the dump chamber.

The kicker pulser stands outside the ring in radial tunnel 7 and can be accessed during DESY operation.

The kicker pulse system, shown in fig.2, functions as a cable discharger via three parallel cables. The kicker pulse current is lead through the pulser by switch-on and off thyratrons. And by means of further parallel cables the pulse current runs to the kicker and absorber in the ring tunnel.

On the left side of fig.2 three diagramms show the electronic characteristics of the pulser.
The pulse current in the kicker, the high voltage at the switch-on thyratron and the reflected pulse current after pulse shortening.

Pulse System.

The required right-angular pulse in the kicker consists of a broad range of frequencies down to the d.c. in the pulse.

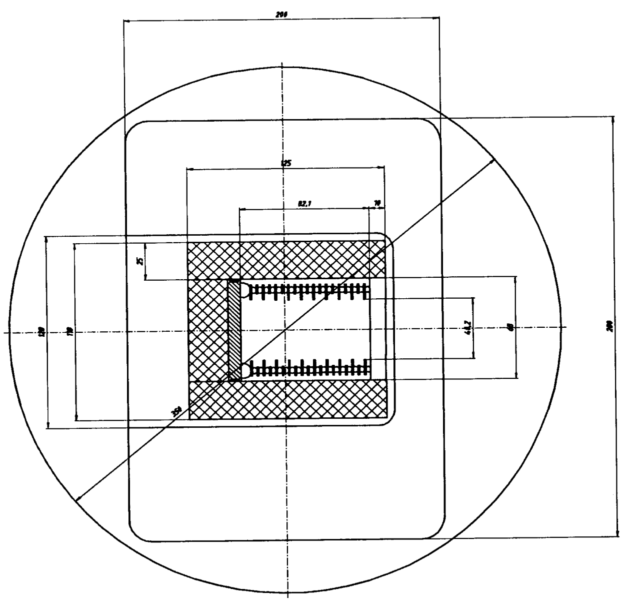
For all the frequencies in the right-angular pulse the system has an impedence of Z =16.6 Ω. Three parallel cables drive the kicker pulse.

Two CX 1154 thyratrons switch the pulse on and off, and also enable variation of the pulse length. From the moment of switching off, Thyratron 2 works as a reflection point and sends the remaining charge back to the start of the cable and over a diode into the absorber.

Kicker Magnet.

Operation with right-angular pulses requires that the kicker has an impedence of Z = 16.6 Ω. Only such a construction can lead all the component frequencies of the right-angular pulse through the kicker to the absorber without reflection or pulse deformation.

Ferrite pieces, in the C- kicker, lead the magnetic field to the gap. 28 parallel capacitive plates divide the kicker into 28 LC- parts. In the absence of unwanted inductance these plates lead capacitive currents on both sides directly to the gap.



Kicker cross section Fig.3

Plate kickers can be built, according to their operation, with or without stripe chambers, as shown in fig.3.

Stripe chambers separate the beam from the kicker magnet. Without stripe chambers, short electron bunches in a beam of over 7 Gev/c would cause wall currents which would heat up the ferrite.

This is especially important to know as ferrite has a low thermal conductivity and furthermore a low Currie point of t = 250° C

The above cross section, fig 3, shows the stripe chamber in the c - yoke of the kicker. The shaded section of the c - yoke is ferrite.

To save costs, the DESY III Kicker can be operated without stripe chambers. This is possible because DESY III operates with long proton bunches. The circumference of the capacitive plates is shown. The plates are alternitavely connected to ground and high voltage.

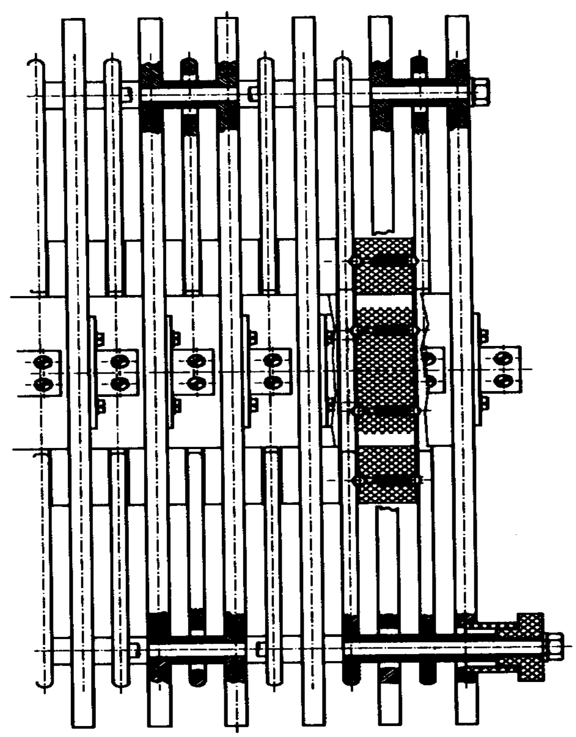


Fig.4

Fig.4 shows the plate kicker without the surrounding vacuum tank. The beam runs from the right into the middle of the kicker as shown in the kicker cross section diagram, fig 3.

The plates are held in position by means of ceramic tubes. The ferrite is held in place under compression by springs and ceramic spheres.

The surface of the plates must be very smooth and the corners rounded. This avoids hv- ionisation between the plates.

To avoid the danger of an excessively high voltage, occuring due to the difference in ε between the ferrite and the vacuum, the ferrite is insulated on only one side by ceramic supporters.

Further kicker information

Momentum	GeV/C	0.350
Displacement angle	mrad	9.45
Gap width	mm	60
Gap height	mm	56
Magnet length	m ca	1
Beam displacement at the dump	mm	72

The pulser is driven by a discharge through 3 cables in parallel.

Current pulse shape	right - angular	
Pulse length (triggered by thyratron 2)	µs	0.095 - 3
Cable length from pulser to magnet	ca	100
Kicker voltage	kV	15
Charge voltage	kV	30
Power supply	kV	40
Kicker impedence	Ω	16.6
Absorber impedence	Ω	16.6

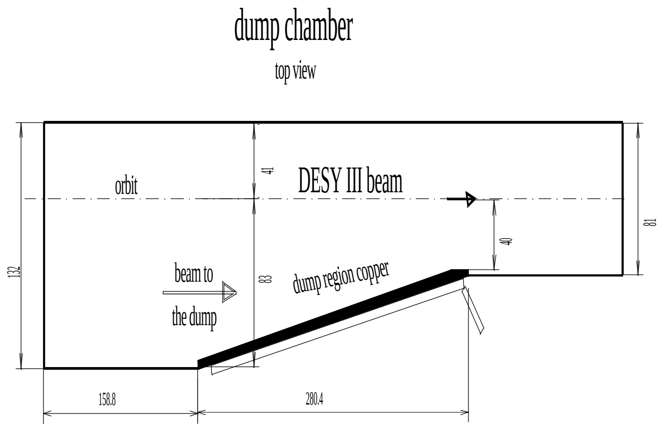
The pulse rise time and shape can be measured by a special transformer.

Dump chamber.

The vacuum chamber is built from stainless steel and the dump region, inside the chamber, from a welded copper plate.

The angled dump region smoothly tapers the chamber. This avoids high-frequency standing waves, which would be produced by sharp angles in the chamber, and also gives the beam a larger area on which to disperse its energy.

Outside the chamber are two square water cooled pipes. This forms the first self shielding material of the dump.



Dump chamber top view Fig.5

Dump chamber shielding

For safety reasons the dump performance was calculated at a momentum of 350 MeV/C and for 10E12 protons every 4 seconds. The calculations for emission rates were taken from the book " Induced Radioactivity " by M. Barbier.

The equivalent dose applies for a distance of 1 m from the absorber.

The results are for an excitation time of 5000 days.

The conditions for the results are:

Wall thickness for the dump region	Cu	5	mm
1. Additional lead shielding on both sides of the chamber	PB	50	mm
Dose after a time	t = 0	350	mrem/h
	t = 1h	250	mrem/h
	t = 24h	180	mrem/h
2. Additional lead shielding on both sides of the chamber	PB	100	mm
Dose after a time	t = 0	19	mrem/h
	t = 1h	15	mrem/h
	t = 24h	11	mrem/h

Even for 5000 days continuous operation at a momentum of 350 MeV/ C there are only minimal dose rates outside the dump shielding.

References:

[1] Volker Büscher "Abschätzung der Strahlen-belastung durch induzierte Radioaktivität in einem Protonendump.

[2] Marcel Barbier "Induced Radioactivity"

[3] J.Ruemmler, "HERA e- injection with septum and kicker technology" EPAC 92 Berlin