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SUMMARY OF THE FEL ELECTRON BEAM OPTICS AND SIMULATION RESULTS

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Optimal parameters of focusing elements such as solenoids and quadrupoles are presented on this report.

1). Assumption of a 45 kV electron gun voltage [1]:

The optimal currents of the focusing solenoids (Table 1) are presented in the Table 2. This optimization is based on an assumption of $\varepsilon=22\pi$ mm*mrad beam emittance on the screen S2 (after the acceleration tube). This emittance is a result of the simulation of acceleration through the acceleration tubes to 1.4MeV. It corresponds to normalized emittance $\varepsilon_n=79.3\pi$ mm*mrad

Solenoids:

Table 1.

Solenoid	Average radius, mm	Position along z-axis, mm	Number of turns
C1	73.2	241	200
C2	142	474	420
C3	142	1188	420
C4	142	1530	420

Quadrupoles:

-effective length is 140mm;

$$\left.\frac{\partial B}{\partial r}\right|_{I=3.7A} = 5.632 Gs/mm \qquad \frac{\partial^2 B}{\partial r \partial I} = 1.522 \frac{Gs}{mm * A}$$

Positive gradient for a guadrupole focuses beam in x-direction (direction of the wiggling).

Optimal values of current in Amps for solenoids (C) and quadrupoles (Q) in Amps and of beam envelope diameter on screens (S) in mm are presented in Table 2. These data were taken from [2].

Beam current in these simulations is 1.75A.

Table 2.

C1	C2	S1	C3	C4	S2	Q1	Q2	Q3	Q4	S3
7.25	-3.75	∅13	3	2	∅10	1.36	-1.14	1.35	-0.81	∅ 7.5

S4	Q5	Q6	Q7	Q8	S5*	C5
∅ 5.5	0.65	-1.3	1.23	-1.9	∅ 7.5	5.5...6

Results of the beam dynamic simulations from the electron gun up to the diagnostic screen S2 are shown in Fig.1 and Fig.2.

* Screen S5 will be constructed.

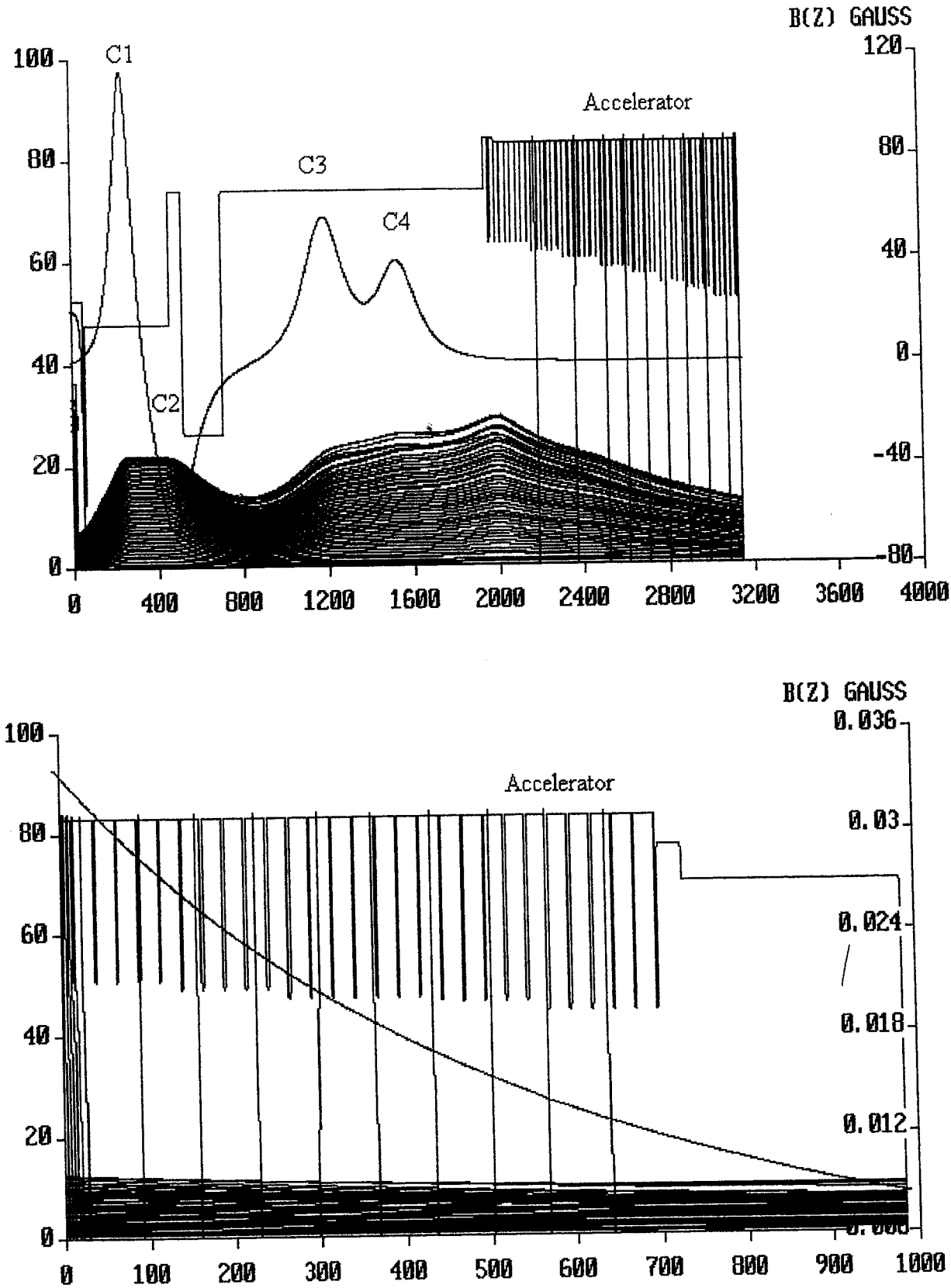


Fig.1. Beam trajectories on the region from the electron gun up to the diagnostic screen S2 position.

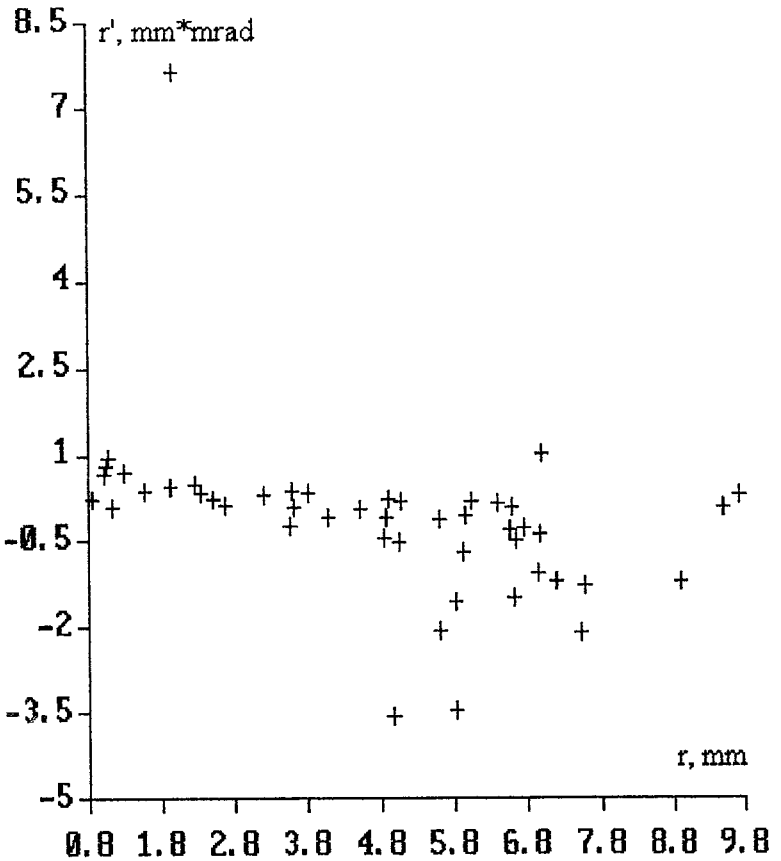


Fig.3. Phase space of the beam on the screen S2.

2). Assumption of a 60 kV electron gun voltage:

Beam dynamics for 1.5A beam current was simulated. Simulations for initial part of the injection (up to the first screen S1) without focusing solenoids show decrease of beam emittance with e-gun voltage increasing.

Simulations were done for the 90keV e-gun also. Optimal parameters for focusing solenoids not achieved, but recommended parameters for experiment are as follow:

	I(C1), Amp	I(C2), Amp	I(C3), Amp	I(C4), Amp
I	9.85	-4.28	3.54 ÷3.57	2
II	1.25	-4.05	0	0

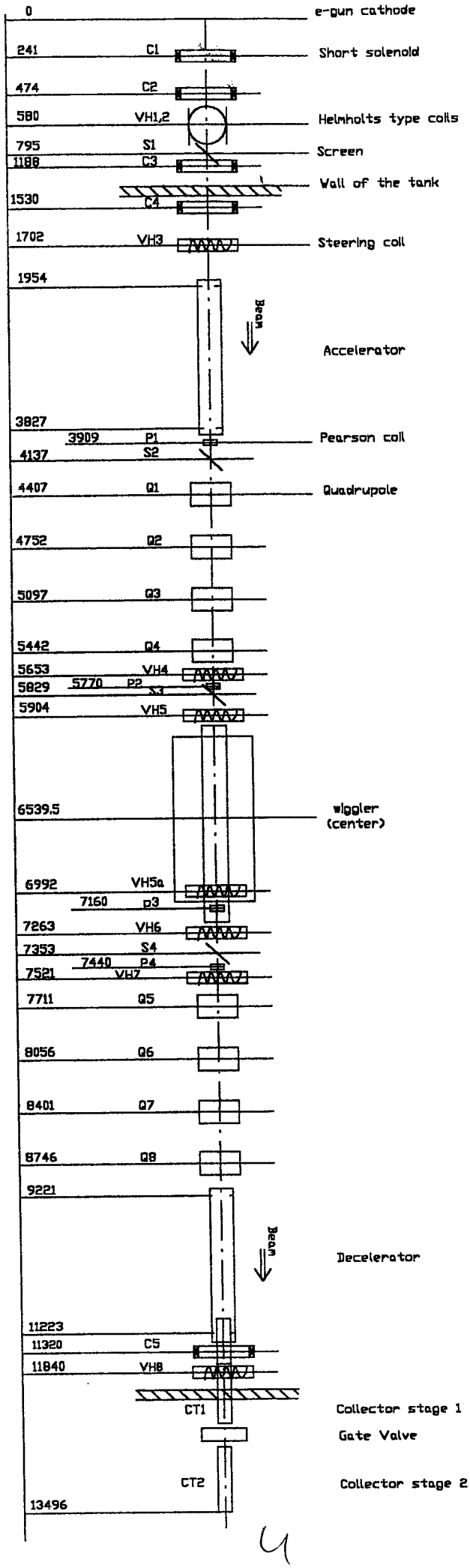
For the case II 29mm*mrad beam emittance is obtained. For case II 16mm*mrad emittance is achieved, but 1-2% beam losses on the beam scrapper on the injection part takes place. This case is interesting to check experimentally.

3). Assumption of a 90 kV electron gun voltage:

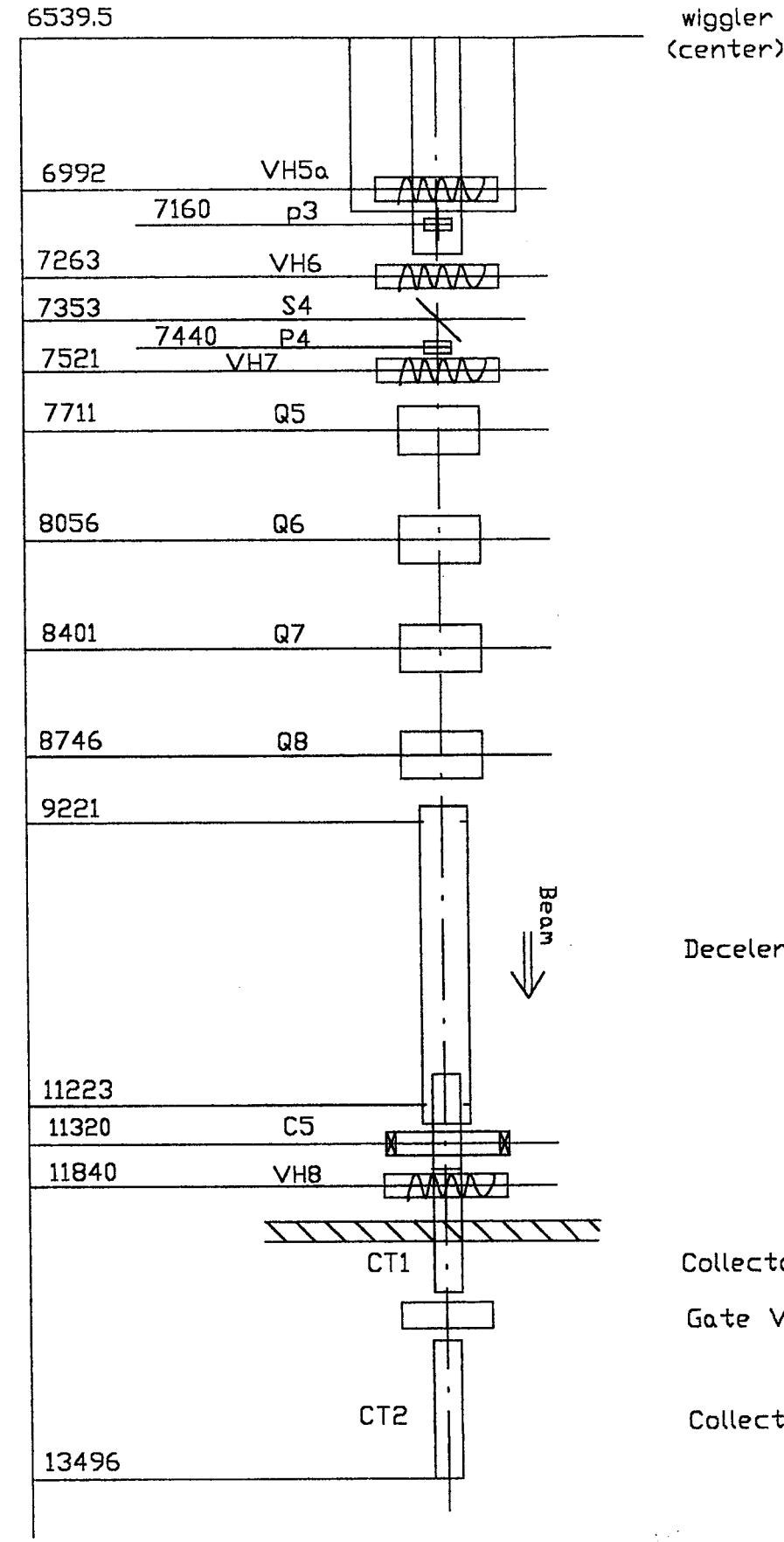
Beam trajectories from electron gun with 90kV cathode-anode voltage (was simulated by a two stage acceleration scheme 45kV+45kV) to screen S1 were simulated. These simulations without focusing solenoids show decrease of beam emittance with e-gun voltage increase, same as for 60kV e-gun voltage.

References:

[1]. S.Efimov, Internal Report N19 (01.01.1998);
[2] A.Abramovich et al, Internal Report N20.


0
e-gun cathode
241
C1
Short solenoid
474
C2
580
VH1,2
Helmholts type coils
795
S1
Screen
1188
C3
Wall of the tank
1530
C4
1702
VH3
Steering coil
1954
Beam
Accelerator
3827
3909
P1
Pearson coil
4137
S2
4407
Q1
Quadrupole
4752
Q2
5097
Q3
5442
Q4
5653
VH4
5829
5770
P2
S3
5904
VH5
6539.5
wiggler
(center)
6992
VH5a
7160
p3
7263
VH6
7353
S4
7440
P4
7521
VH7
7711
Q5
8056
Q6
8401
Q7
8746
Q8
9221
Beam
Decelerator
11223
11320
C5
11840
VH8
CT1
Collector stage 1
Gate Valve
CT2
Collector stage 2
13496

4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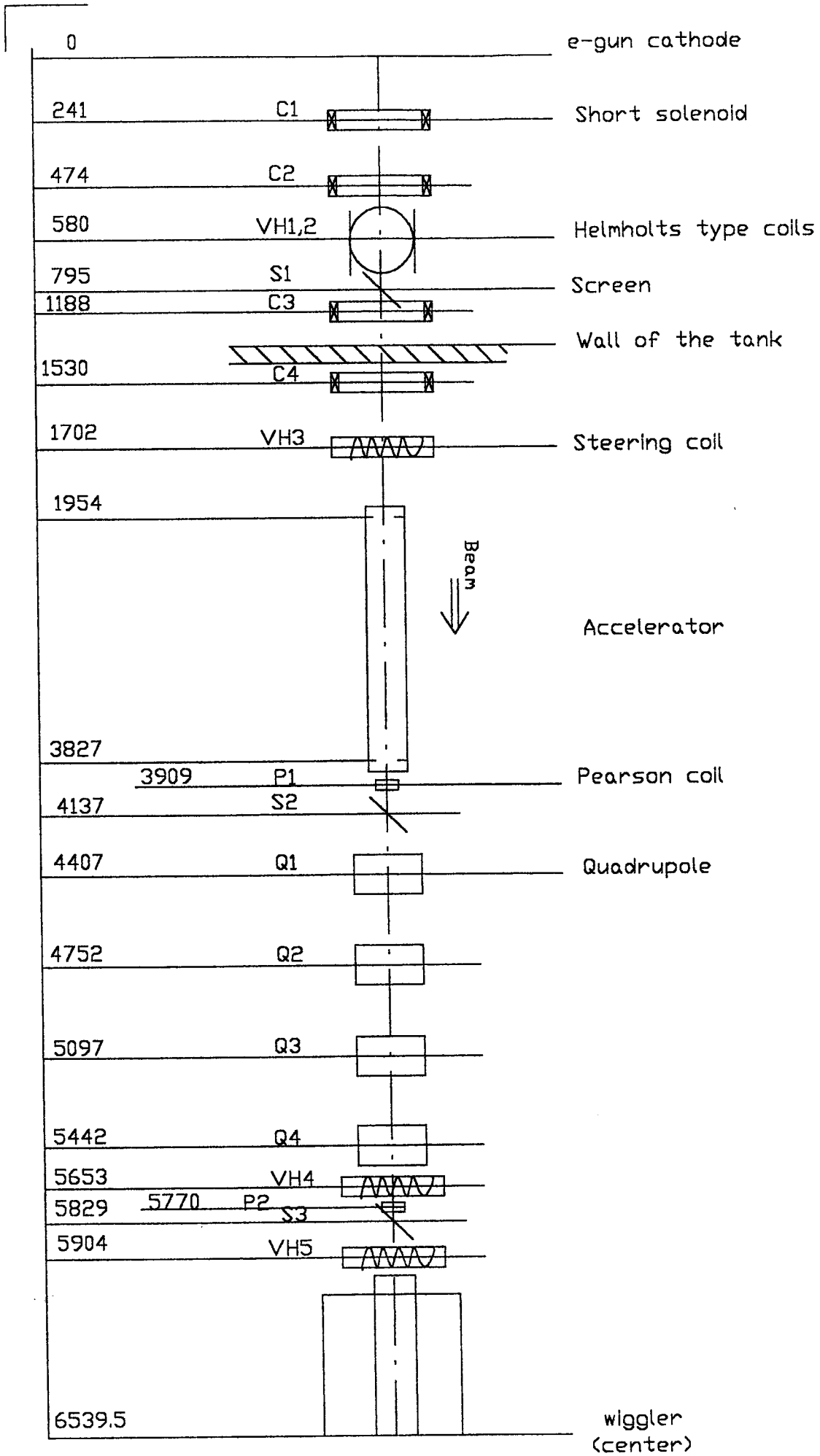
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