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MEDIUM ENERGY PROTON ACCELERATOR FOR THERAPY

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We are designing a small synchrotron to make low-current adjustable-energy proton beams for radiotherapy. We hope to build this machine within the next three years. The following specifications will probably change somewhat, but should serve to define the general character of the machine.

Gross Specifications

adjustable 50 to 250 MeV (2 - 38 cm water)
0.1 microamp average, in 10 pulses/sec
size 6 x 6 meters, weight 5 tons
prototype cost about $400 K

Magnet

field on design orbit 1 KGauss (injection)
12 KGauss (250 MeV)
four quadrant alternate-gradient
4 x (0 d F D F d 0) lattice
bending radius 2 m, gross radius 3.2 m
four 2 m straight sections
split H laminations
steel and coil under vacuum
aperture 1.5 x 4.5 cm
$Q_h \sim 1.6$, $Q_v \sim .6$
$\gamma_{tr} \sim 1.4$ (above operating range)
β_H (max) 5.4 m
β_v " 6.3 m
α_p " 1.8 m

Magnet Coil

about 20 turns, single coil per quadrant
strip-wound, edge-cooled
effective area .0007 m^2
I (max) 720 A
V " 182 V (ignoring inductance)
R .25 ohm
W " 130 KW
energy 5 KJ
L 19 mHy
$\tau = L/R$ .07 sec
ΔT 30 °C

Radio Frequency

fifth harmonic, Δf 5 to 50 MHz
one ferrite-loaded cavity
peak voltage ~ 3 KV
power less than 1 KW

Injector

RFQ linac, matched to DC beam both ends
20 mA for .5 μsec every .1 sec
50 KV ion source
2 MeV output energy
partly lumped resonator
driven by Y690A planar triodes

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