SINGLE PASS COLLIDER MEMO

CN- 253

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REPLACES CN#

TITLE: POSITRON ACCELERATION TO 200 MeV

SLAC-CN--253

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1. 200 MeV is the energy that has to be obtained in routine operation. A standard 12m girder with SLED II can give 220 MeV minus a few percent due to not riding at the crest of the wave.
2. In order to have the 200 MeV with only one girder, a klystro at full power all the time would be required - kept brand new.
3. Then, for safety it is necessary to use two klystrons as designated in the SLC design. Having two klystrons gives freedom for the choice of the best arrangement. Since there will be excess rf power, it can be traded against higher gradient, shorter waveguides, larger apertures (lower shunt impedance).
4. There are various schemes:

Scheme a. The one described in the Conceptual Design.

Advantages:

- standard technology

Features:

- the solenoids end at about 60 MeV
- aperture of iris 18 mm.

Scheme b. No SLED; the three first sections have up to 25 MeV each, so work in the 50 - 45 MeV region

- the solenoids end at 90 MeV; aperture 18 mm

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Scheme c. The two first sections are replaced by two resonant wave-guides; shunt impedance about 47 M Ω /m. 2.1 meters long, 94 M Ω (just under the 100 M Ω of the "standard" SLAC sections).

- no SLED
- solenoid end in the 90 MeV region
- aperture 23 mm.

Other advantages of Scheme c.:

- larger aperture: (a) increases acceptance of positrons but also increases the emittance to be transported afterwards; (b) will reduce the wakefield intensity down to two thirds of value for "standard" guide.
- Higher gradient ($\times 1.5$) reduces the phase slip but safe operation with two resonant guides may require staying a little below the maximum 50 MW power.
- Schemes b. and c. push the end of the solenoids from 60 to 90 MeV, which makes the matching to FODO array easier, and reduces quadrupole wakefield effects.
- Schemes b. and c. do not require SLED, b. can accommodate 1.5 to 2 μ sec-long pulses. In Scheme c., the time constant of the resonant structure $Q/\omega = 0.85 \mu$ s, is equal to the "filling time" of the standard SLAC design. But it corresponds to $1 - e^{-\omega t/Q}$ and three time-constants are required to go to 95% of maximum so 2.5 μ sec is required on K_1 however, 2.5 μ sec may make the klystron operation safer than 5 μ sec. Are the advantages of Scheme c. worth making a new design? The saving comes only from the reduction of the solenoid length.

Scheme d.

Involves five sections with resonant waveguides and large aperture. Solenoid focussing all along avoids quadrupole wakefield excitation by the focussing system but requires a temperature control system to maintain the five sections in phase. This must be considered if quadrupole wakefield is still a problem above 90 MeV.

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Approximate dimensions for a $\frac{2\pi}{3}$ resonant line $B = 1$

$Z = 46-48 \text{ M}\Omega/\text{m}$ at 2998 MHz with conventional (non-diamond) tool.

- It is not necessary to scale up the thickness of the irises.
- Twin cavities (8mm) could also not be scaled for length.
- Diamond tool machining increased Z but is more difficult with the tapered shape.

Reference:

Nuclear Instruments and Methods 118 (1974) pp. 349-355,
A. Bensussan, D. Tran, and D. Tronc.

15 cm

6.6 m Solenoids

QUADS

SLCD

middle
phase 30 m

6.6 m Solenoids

QUADS

4.2 m Solenoids

QUADS

10 m Solenoids

(a)

Conceptual design
1980

(b)

(c)

(d)