SINGLE PASS COLLIDER MEMO CN-282*

SLAC-CN--282

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TITLE: Notes on the RF System for the SLC Positron Source.

1. General Layout of the RF System.

The proposed arrangement of accelerator structures, waveguide feeds and klystrons is sketched in Fig. 1.

A 50 MW klystron at 20-3C will provide power for the high-field capture section immediately following the target. About 1 meter downstream of this section there will be a standard girder of four 3.05-meter SLAC constant gradient acceleration sections. These will be powered by a klystron at station 20-3D. Current thinking is that this will also be a 50MW tube, but 35 MW might well be sufficient. Both stations will be SLEDded.

The length of the rectangular waveguide feed to the capture section will be approximately 132 ft, and the attenuation will be about 0.97 db. The corresponding numbers for the feed to the standard girder are 153 ft and 1.07 db.

2. The High-Field Capture Section.

In CN-268 dated 6/22/84: "Positron Source: First 50 Nanoseconds," K. Moffeit shows that good positron acceptance requires very high accelerating fields (on the order of 70 MV/m) in the first meter following the target. Various ways of approaching this gradient in a 1-meter section have been examined.

The alternatives considered are all 29-cavity structures (total length 1.015 m) operating in the $2\pi/3$ mode at 2856 MHz. All expressions used are taken from Chapter B.1.1, "Accelerating Structures," by G. A. Loew and R. B. Neal, in "Linear Accelerators" edited by P. M. Lapostolle and A. L. Septier, North Holland, 1970.

Cases considered are as follows:

Traveling Wave = TW, Standing Wave = SW,
Recirculating = Rec, Constant Gradient = CG,
and Constant Impedance = CI

1)	First 29 cavities of SLAC CG structure	TW
2)	First 29 cavities of SLAC CG structure	Rec
3)	Last 29 cavities of SLAC CG structure	TW
4)	Last 29 cavities of SLAC CG structure	Rec
5)		TW
6)	29 CI cavities like cavity 1 of SLAC CG structure	SW
7)		Rec

MASTER

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8)		TW
9)	29 CI cavities like cavity 21 of SLAC CG structure	SW
10)		Rec
11)		TW
12)	29 CI cavities like cavity 63 of SLAC CG structure	SW
13)		Rec
14)		TW
15)	29 CI cavities like cavity 84 of SLAC CG structure	SW
16)		Rec

Parameters are tabulated below:

**PARAMETERS FOR SOME 1.015-METER
CAPTURE SECTIONS**

	Constant Gradient		Constant Impedance					
Disk	26.22	22.22						
Aperture	to	to	26.22	25.00	23.49	21.66	19.24	
Diameter (mm)	24.46	19.24						
	.0202	.0111						
v_g/c	to	to	.0202	.0168	.0134	.0099	.0065	
	.0165	.0065						
R_0 M Ω /m	53.0	57.7						
	to	to	53.0	54.75	56.5	58.25	60.0	
	55.3	60.0						
	14200	13530						
Q	to	to	14200	13950	13700	13450	13200	
	13870	13200						
	.104	.195						
α (nepers)	to	to	.104	.128	.162	.225	.348	
	.138	.349						
r (nepers)	.119	.258	.106	.130	.165	.228	.354	
(dB)	1.03	2.25	.919	1.13	1.44	1.93	3.08	
Filling time (T_f) ns	188	389	168	201	253	342	520	
SLED Acceleration								
Voltage	2.38	2.19	2.40	2.38	2.33	2.26	2.11	
Gain Factor								
SLED RF								
Power Gain	6.47	6.40	6.48	6.47	6.45	6.42	6.35	
Factor								
Non-SLED Energy (MeV)								
35MW klystron	18.1	26.0	17.0	18.9	21.2	24.6	29.3	
(28MW into Section)								

**PARAMETERS FOR SOME 1.015-METER
CAPTURE SECTIONS (Continued)**

	Constant Gradient				Constant Impedance			
Non-SLED Energy (MeV)								
50MW klystron (40MW into Section)	21.6	31.0	20.3	22.5	25.4	29.4	35.0	
SLED Energy								
35MW klystron (MeV)	43.1	56.9	40.8	45.0	49.4	55.6	61.8	
SLED Energy								
50MW klystron (MeV)	51.4	67.9	48.7	53.0	59.2	66.4	73.9	
Peak Power into Section (MW with 50MW klystron)								
	259	256	259	259	258	256	251	
*Peak Power at end of Section (MW) T_f later								
	204	152	210	200	185	163	125	
*Peak Input Cavity Field (MV/m)								
	53.4	75.9	53.4	60.3	68.9	81.9	103.0	
*Input Cavity Field (MV/m) T_f later								
	48.3	61.6	48.8	51.1	60.2	68.1	77.0	
*Output Cavity Field (MV/m) T_f later								
	55.8	79.8	48.0	52.9	58.4	65.2	72.3	
*Energy (MeV)								
50MW klystron recirculating	46.9	48.8	46.4	47.0	47.9	48.6	49.1	
*Input Cavity Field (MV/m)								
50MW klystron Recirculating	46.9	48.8	48.0	49.5	51.2	53.5	57.4	
*Energy (MeV)								
50MW klystron SW			34.5	35.3	36.5	38.0	40.2	
*Input Cavity Field (MV/m)								
50MW klystron SW			42.0	47.4	54.3	64.8	81.7	

*50 MW klystron

Some fields and energies are plotted in Fig.2.

It turns out that the highest gradient structure (C1 with cavity dimensions equal to the last cavity of the SLAC 3.05 m section) is also the easiest and quickest to design and build. Obviously, both couplers would be the same as the SLAC output coupler. However, as wake-field effects are a strong inverse function of the iris aperture diameter, it might be prudent to choose a slightly larger diameter, such as 21.66 mm. This reduces the filling time and the input cavity peak field, and requires a modified coupler design.

Standing-wave structures, either uniform or triperiodic, do not seem advantageous.

3. The Standard (CG) Girder.

The energy contribution of the four CG DLWG sections, fed in parallel by one SLEDded 50 MW klystron, will be 240 MeV. If a 35 MW tube were used, the energy would be 200 MeV.

4. Special Drive Requirements for 20-3C and 20-3D.

It is certain that klystron 20-3C, driving the capture section, will need a drive system independent of Sector 20 Sub Booster. In order to achieve maximum energy gain, the peak SLED field must enter the section one filling time before the beam. The selected filling time will be between 168 ns and 520 ns, compared to 830 ns for the standard sections in Sector 20. Also, the rectangular waveguide group delay will be about 96 ns longer than it is in the standard configuration. Additionally, separate phase and amplitude controls will be necessary. Thus a separate Solid-State Sub-Booster (SSSB) with its own phase-shifter, attenuator and PSK switch will be required.

The beam arrival time at the four CG sections would be about 60 ns before the end of the RF pulse, if the Sector 20 drive were used for 20-3D. This would lower the energy by about 7%, which might be acceptable. However, separate phase and amplitude controls will be desirable, so another SSSB is the preferred solution.

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FIG. 1:
WAVEGUIDE LAYOUT
FOR SLC POSITION BOOSTER.

FIG. 2.