



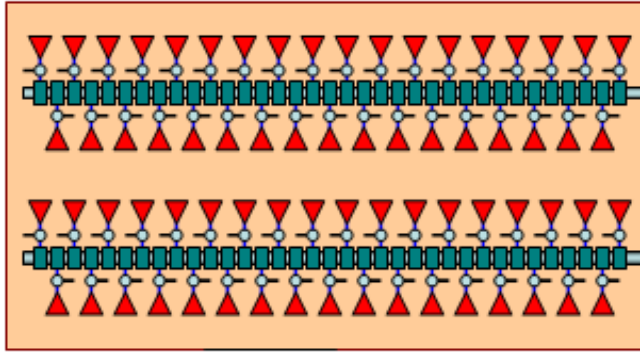
Klystron Cluster System Development

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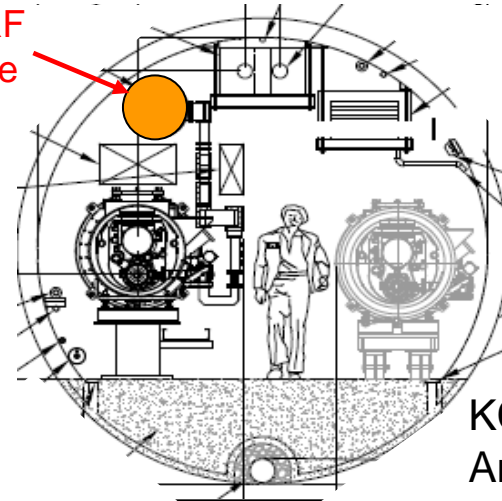
ILC10
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Klystron Cluster Layout

surface rf power cluster building



main HPRF waveguide



KCS option,
American version

surface

- service tunnel eliminated
- underground heat load greatly reduced

shaft

upstream

downstream

accelerator tunnel

CTO

TE₀₁ waveguide

WAVEGUIDE DISTRIBUTION SYSTEM

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WAVEGUIDE DISTRIBUTION SYSTEM

TAP-OFFS

TAP-OFFS

9 CAVITIES

4 CAVITIES QUAD 4 CAVITIES

9 CAVITIES

3 CRYOMODULES

37.956 m

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4 CAVITIES QUAD 4 CAVITIES

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37.956 m

9 CAVITIES

4 CAVITIES QUAD

3 CRYOMODULES

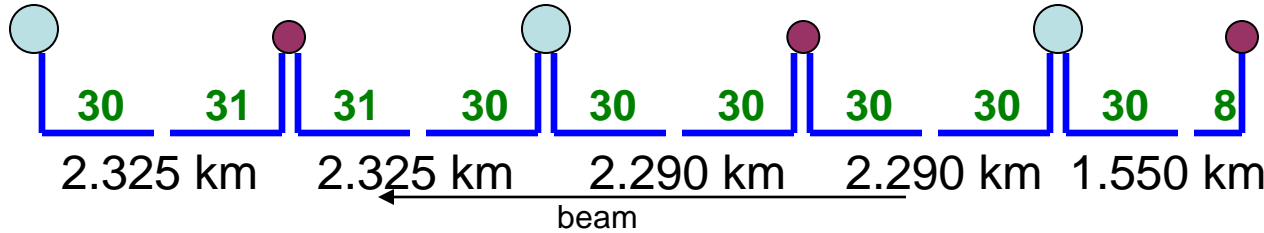
37.956 m

Shaft Location

560 3-CM rf units, 280 per linac

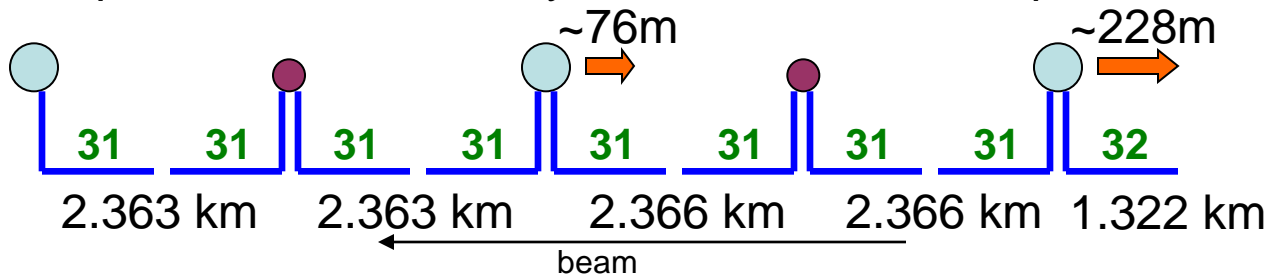
- -- main shaft
- -- additional KCS shaft

The RDR shaft location would require three additional shafts, for a total of 6, for the KCS.

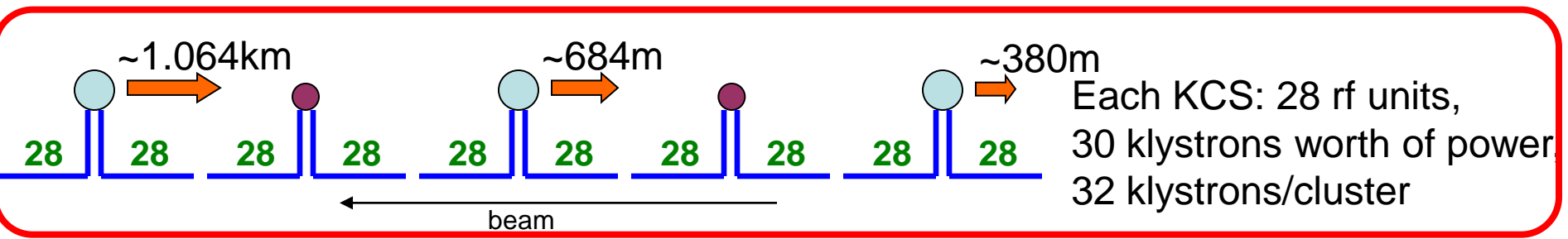


Typical KCS: 30 rf units, 32 klystrons worth of power, 34 klystrons/cluster

Shifting the main shafts would accommodate KCS implementation with only two additional shafts per main linac.



Typical KCS: 31 rf units, 33 klystrons worth of power, 35 klystrons/cluster



Each KCS: 28 rf units, 30 klystrons worth of power, 32 klystrons/cluster

Nominal Parameters

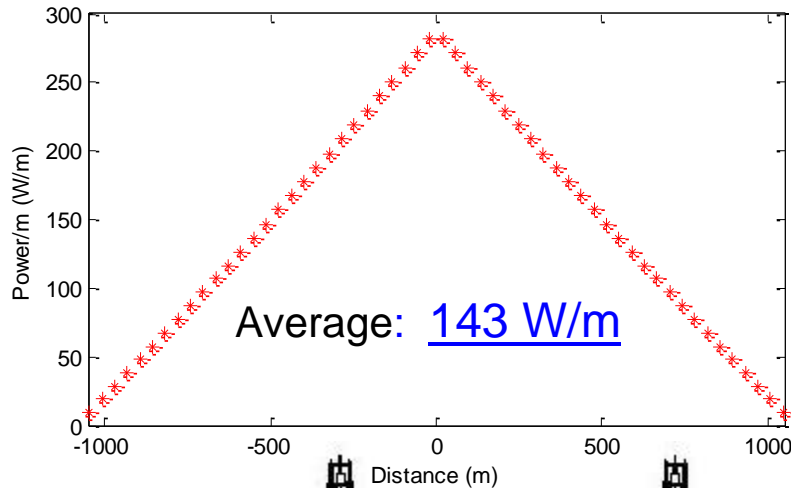
# of shafts per main linac	5 <small>x 2 systems/shaft</small>	
# of KCS systems per main linac	10	
# of rf units (tap-offs) per system	28 (1.064 km) <small>x 3 cryomodules/rf unit</small>	
# of cryomodules per system	84 <small>x 8 2/3 cav.'s/cryomod.</small>	
# of cavities per system	728	1/2 gradient
# of klystrons/modulators per system	32* <small>-2</small>	17*
peak rf power per system (MW)	<small>x 10 MW/klystron</small> 300	150

* One klystron is left off as a spare.

As a result, the combining circuit misdirects an additional klystron's worth of power to loads.

This arrangement allows quick recovery from one failure per cluster by switching on spare.

Tunnel RF Heat Load



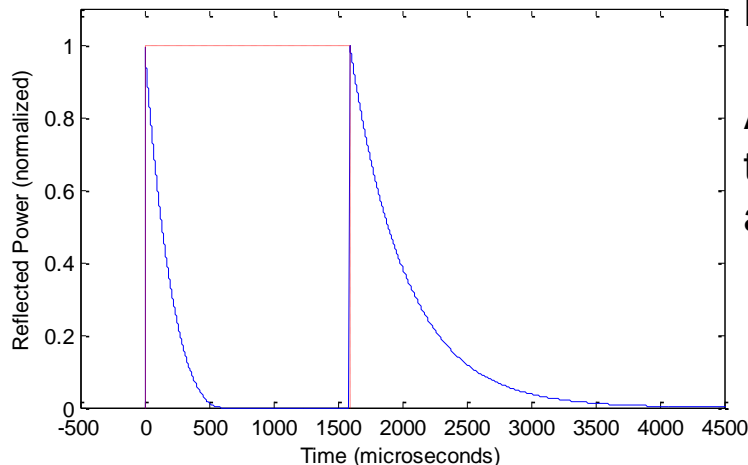
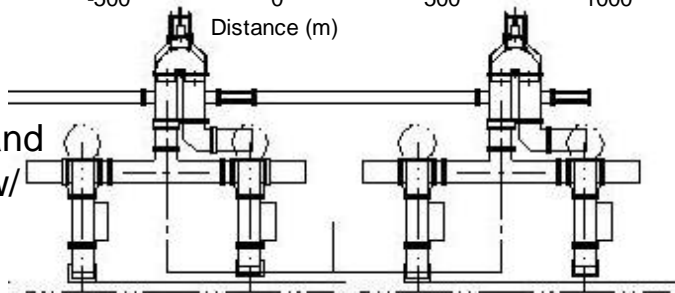
Power dissipation along tunnel in the KCS main waveguide, to either side of a shaft for 10 MW/rf unit, 1.6 ms, 5 Hz.

300 MW at shaft

~6% lost in main waveguide ($\alpha = 5.64 \times 10^{-5} \text{ m}^{-1}$)

Local waveguide distribution (CTO to coupler) attenuation losses ~5% (estimate)

Replace T and circulators w/ hybrid.



Nominal power reflected into load is ~37% of input power.

Additional reflection due to mismatch of available power to gradient limit ($\pm 20\%$ variation), even with tailoring among six matched pairs: ~8% (estimate)

$$0.50(5\% + 37\% + 8\%) \times 10 \text{ MW} / 38 \text{ m} \times 1.6 \text{ ms} \times 5 \text{ Hz} = \sim \underline{1.05 \text{ kW/m}}$$

note

This total of ~ 1.2 kW/m of rf warm heat load in the main linac tunnel is a preliminary estimate. It has $\sim 25\%$ above nominal power reaching each cavity, but it doesn't account for cluster combining inefficiency and transmission losses down to the tunnel.

Additional rf related tunnel warm heat load will come from the low level rf and the main waveguide vacuum system.