Proposed Outline Draft

3.5 RF Power and Distribution Systems
- 3.5.1 RF Power Requirements
- 3.5.2 RF Power Production
  - 3.5.2.1 Marx Modulator
  - 3.5.2.2 10 MW Multi-Beam Klystron
- 3.5.3 RF Power Delivery
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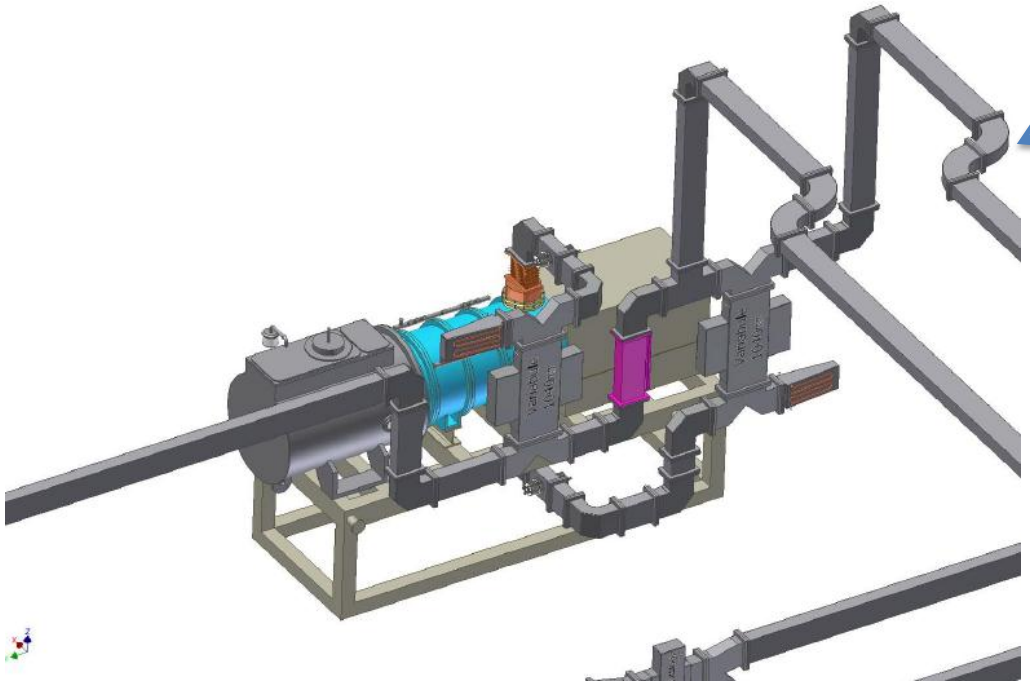
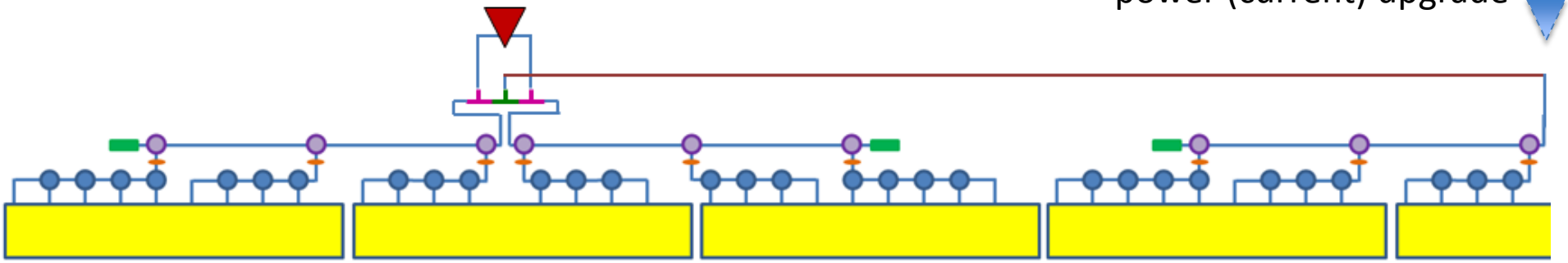
    - 3.5.3.1.1 Layout in Kamaboko Tunnel
    - 3.5.3.1.2 Waveguide to Cryomodules
  - 3.5.3.2 Klystron Cluster Scheme (KCS)
    - 3.5.3.2.1 Overview and Layout
    - 3.5.3.2.2 Main Waveguide and Special Components
- 3.5.4 RF Local Power Distribution System (PDS)
  - 3.5.4.1 Layout and Functionality
  - 3.5.4.2 Components



Jog in feedthrough waveguides to prevent radiation leakage.

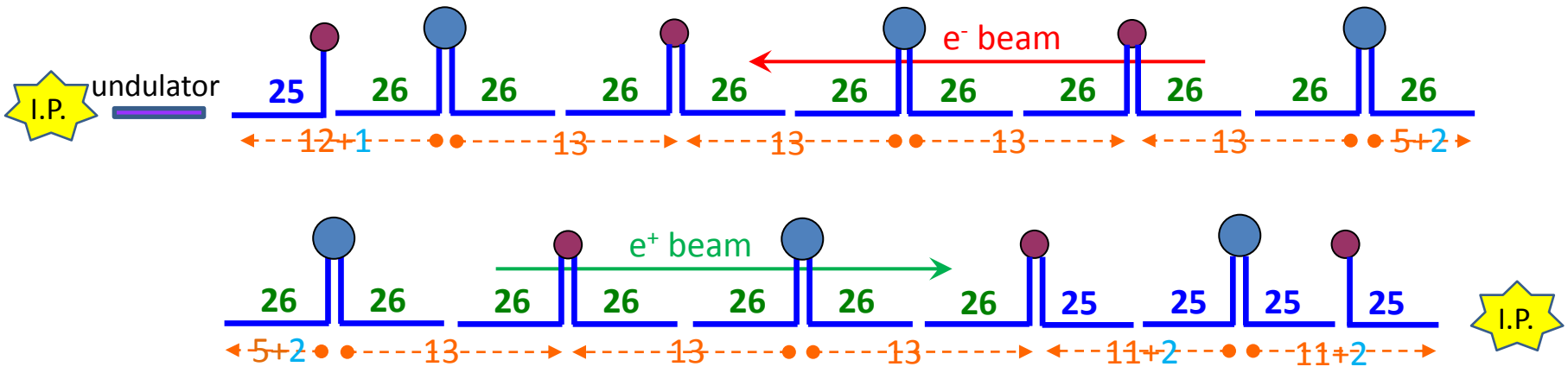
space for 50% more power sources for power (current) upgrade



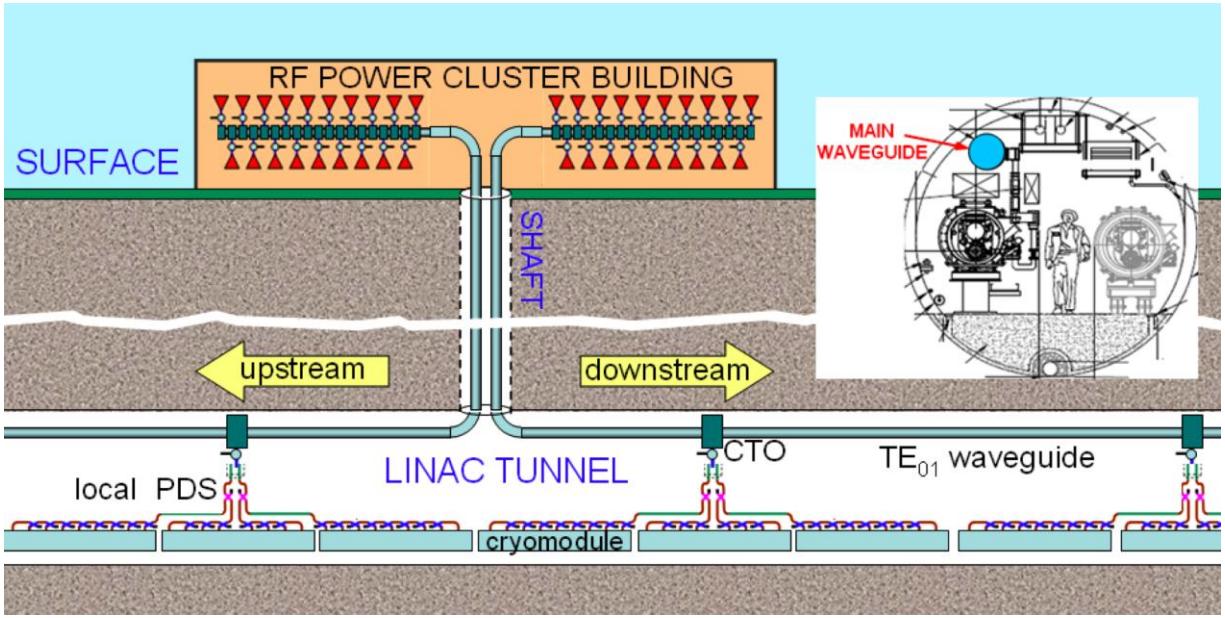
KCS Shaft Layout

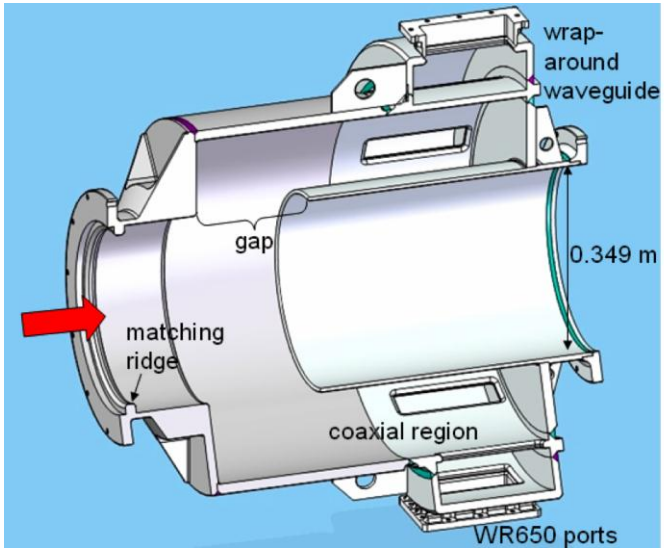
-- main facilities shaft
-- additional KCS shaft
-- cryogenic systems

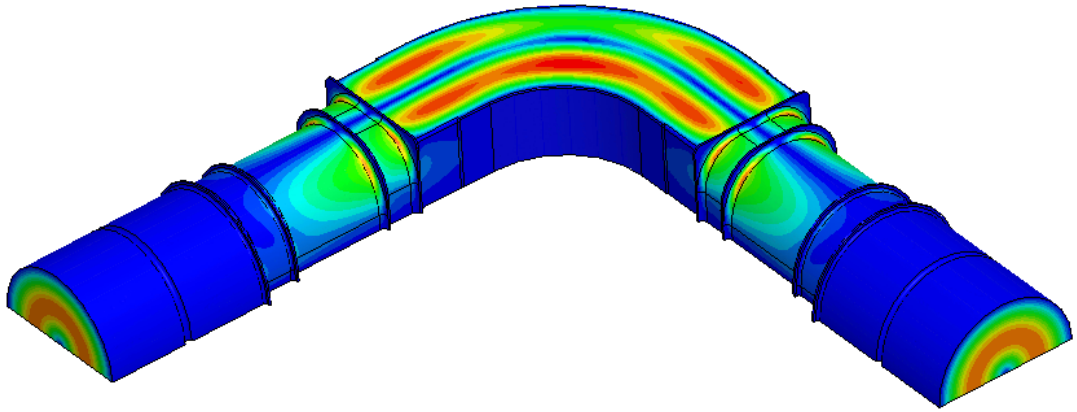
-- 3-CM rf units
-- 4-rf unit cryostrings
-- 3-rf unit cryostrings



main linac totals: **12 shafts**
22 KCS's
567 rf units (285+282)
1,701 cryomodules
14,742 cavities


RF POWER CLUSTER BUILDING
SURFACE
SHAFT
MAIN WAVEGUIDE
upstream
downstream
LINAC TUNNEL
CTO
TE_{01} waveguide
local PDS
cryomodule


wrap-around waveguide
gap
0.349 m
matching ridge
coaxial region
WR650 ports

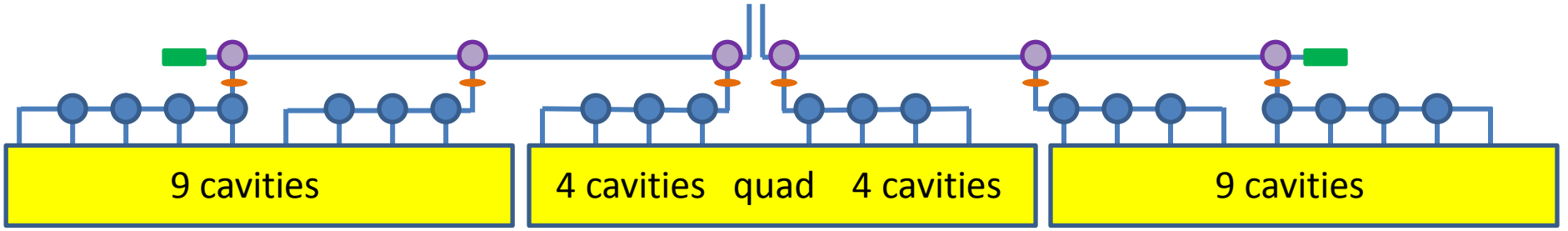


Local PDS

– pressurizable, 0-100%, phase stable
– non-press., limited range
– pressure window
– 5 MW load

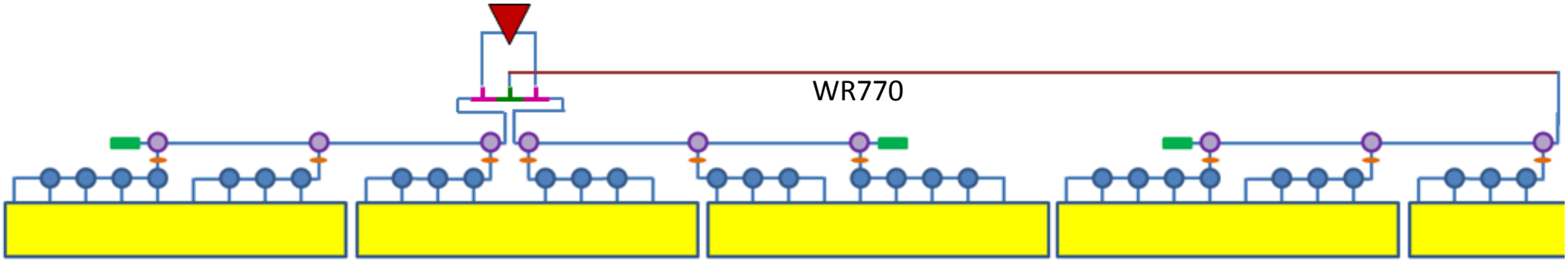
Unused power can be dumped to the loads

Power to ½ CM's fully adjustable without affecting phases.

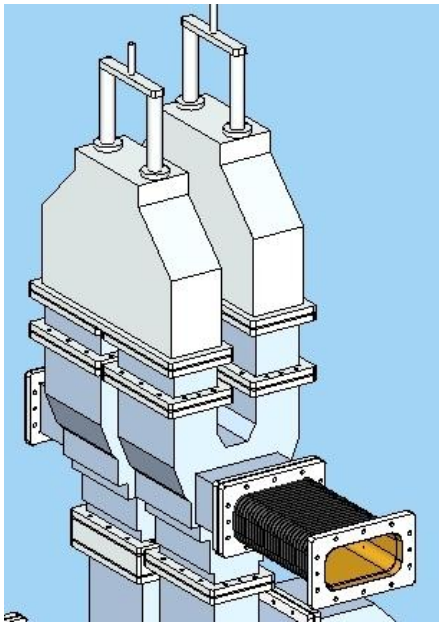


phase shifter on each feed, as well as isolator, bi-directional coupler, and flex guide.

RF UNIT: 3 cryomodules (26 cavities)



For low power **Kamaboko** Tunnel option, one klystron powers 1 ½ rf units or 4 ½ cryomodules (39 cavities).



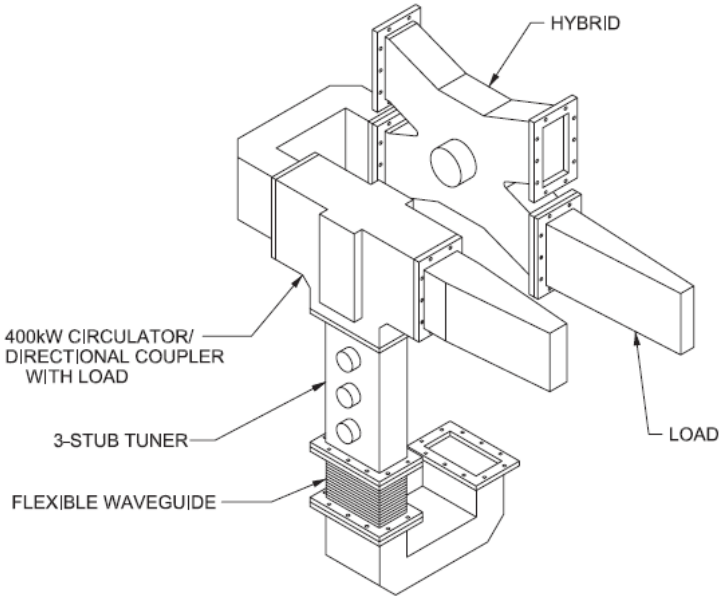

HYBRID
400kW CIRCULATOR/
DIRECTIONAL COUPLER
WITH LOAD
3-STUB TUNER
FLEXIBLE WAVEGUIDE
LOAD

TABLE 2.6-2
RF unit parameters.

Parameter	Value	Units
Modulator overall efficiency	82.8	%
Maximum klyston output power	10	MW
Klystron efficiency	65	%
RF distribution system power loss	7	%
Number of cavities	26	
Effective cavity length	1.038	m
Nominal gradient with 22% tuning overhead	31.5	MV/m
Power limited gradient with 16% tuning overhead	33.0	MV/m
RF pulse power per cavity	293.7	kW
RF pulse length	1.565	ms
Average RF power to 26 cavities	59.8	kW
Average power transferred to beam	36.9	kW

TABLE 2.6-3
RF unit cryogenic heat loads and installed AC cryogenic plant power to remove the heat.

	40–80 K		5–8 K		2 K	
	Static	Dynamic	Static	Dynamic	Static	Dynamic
Heat load (W)	177.6	270.3	31.7	12.5	5.1	29.0
Installed power (kW)	4.4	6.2	9.6	3.5	8.1	28.5

TABLE 2.6-4
Subdivision lengths and numbers in the two main linacs. Total linac lengths exclude the length of the positron production insertion and the coasting length at the end of each linac.

Subdivision	Length (m)	Number
Cavities (9 cells + ends)	1.326	14,560
Cryomodule (9 cavities or 8 cavities + quad)	12.652	1,680
RF unit (3 cryomodules)	37.956	560
Cryo-string of 4 RF units (3 RF units)	154.3 (116.4)	71 (6)
Cryogenic unit with 10 to 16 strings	1,546 to 2,472	10
Electron (positron) linac	10,917 (10,770)	1 (1)

TABLE 2.6-5
AC power consumption of the two main linacs.

System	AC Power (MW)
Modulators	81.4
Other RF system and controls	8.4
Conventional facilities	25.7
Cryogenic	33.8
Total	149.3

TABLE 2.6-6
Cavity Parameters.

Parameter	Value	Units
Type	9 cell, π-mode	
R/Q of fundamental mode	1036	Ω
Iris diameter	70	mm
Cell-to-cell coupling	1.9	%
Average Q_0	1.0×10^{10}	
Average Q_{ext}	3.5×10^6	
Fill time	596	μs
Cavity resonance width	370	Hz

TABLE 2.6-7
Main Linac Beamline Components.

Component	Number (total)
Cavities	14,560
SC quadrupole magnets	560
X-correctors	560
Y-correctors	560
SRF BPMs	560
Laser wire scanners	7