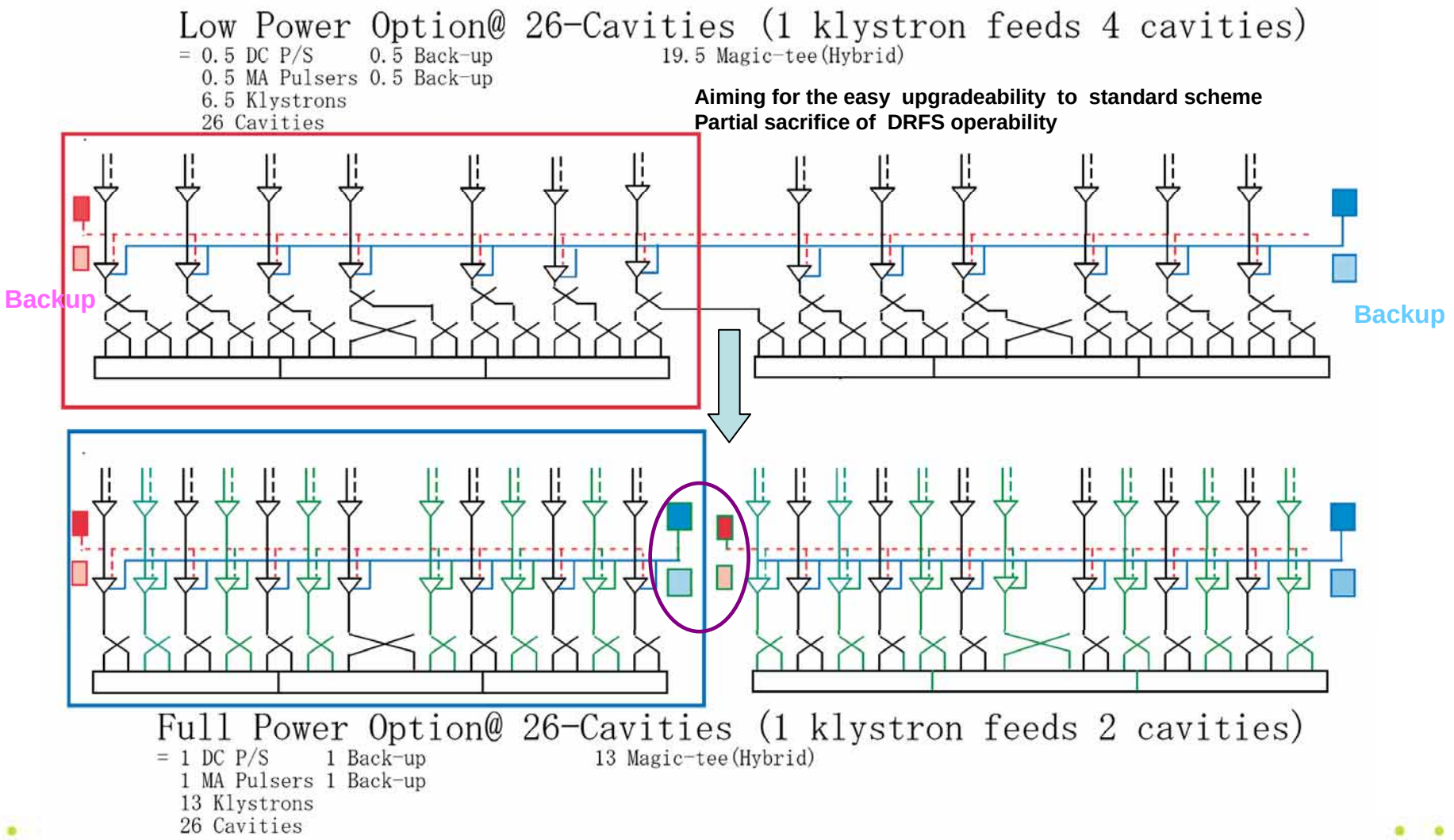
DRFS Main Linac Heat Load

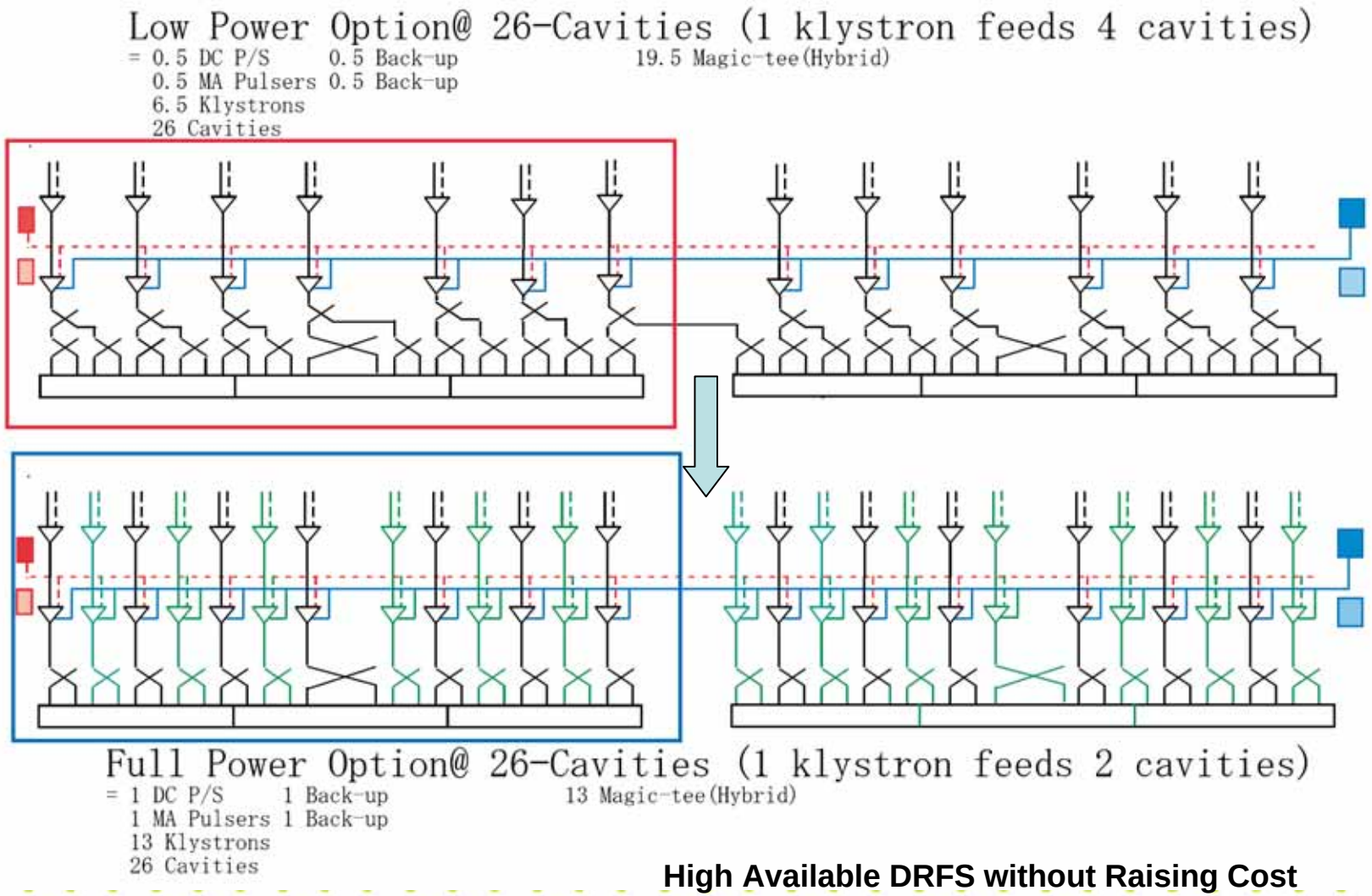
S. Fukuda
KEK

DRFS Configuration

Low Power Option of DRFS and Full Scheme I



Low Power Option of DRFS and Full Scheme (II)



High Available DRFS without Raising Cost

Comparison between BCD and DRFS (Full)

BCD			
Beam			
Current	9 mA	RF Duty	0.0078
Electric Field	31.5 MV/m	Beam Duty	0.0049
Length	1.0377 m		
Power	Peak Power	Av Power	
P/cav	294.2 kW		
For 26 Cavities	7648.9 kW	37.10 kW	
10% Overhead	8413.8 kW		
PDS loss(%)	8.52 %	6.26 kW	
Service tunnel		1.18 kW	
Penetration		1.00 kW	
Acc Tunnel		2.61 kW	
Circulator		1.67 kW	
Error for Split/Ref	2 %		
Kly Out	9385 kW	73.44 kW	
Loss at Perfect Match		22.76 kW	
Loss at Imperfect		30.06 kW	
Klystron			
Voltage	115.7 kV		
Current	133.0 A		
Kly Beam Power	15388 kW	125.44 kW	
Po Lower Limit'(*)	8500 kW	66.51 kW	
Collector Dissipation	6888 kW	58.93 kW	
(*) Efficiency 10% Lower=55%			

DRFS				
Beam				
Current	9 mA			RF Duty 0.0078
Electric Field	31.5 MV/m			Beam Duty 0.0049
Length	1.0377 m			
Power	Peak Po for 2 cavity	Av Po for 2 cavity	Peak Po for 26 cavi	Av Power
P/cav	294.2 kW			
For 2 Cavities	588.4 kW	2.85 kW	7649.2 kW	37.10 kW
10% Overhead	647.2 kW		8414.1 kW	
PDS loss(%)	1.05 %	0.05 kW		0.69 kW
Service tunnel		0.00 kW		0.00 kW
Penetration		0.00 kW		0.00 kW
Acc Tunnel		0.05 kW		0.69 kW
Circulator		0.00 kW		0.00 kW
Error for Split/Ref	0 %			
Kly Out	647.3 kW	5.07 kW	8414.9 kW	65.85 kW
Loss at Perfect Match		1.75 kW		22.76 kW
Loss at Imperfect		2.16 kW		28.06 kW
Klystron				
Voltage	67.4 kV		67.4 kV	
Current	17.5 A		227.5 A	
Kly Beam Power	1180 kW	9.62 kW	15333.5 kW	119.98 kW
Po Lower Limit'(*)	590 kW	4.81 kW	7666.75 kW	59.99 kW
Collector Dissipation	590 kW	4.81 kW	7666.75 kW	59.99 kW
(*) Efficiency 10% Lower=50%				

Numbers of Components in DRFS (Only RF Related)

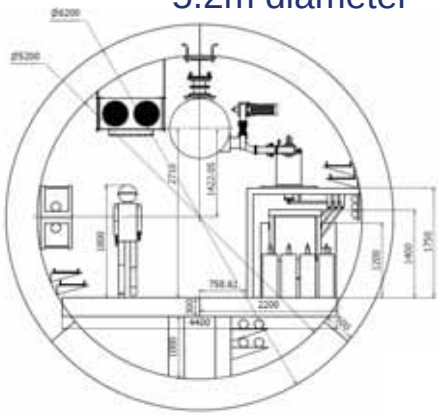
Item	Low P DRFS	Back-up	Full P DRFS	Back-up	BCD
Cavity	26		26		26
Directional Coupler	26		26		26
Magic Tee (Hybrid)	19.5		13		32
Load	39		13		24
700kW Klystron	6.5		13		
MBK					1
Focusing PM (EM)	6.5		13		1
Coil P/S	0	0	0		1
Heater P/S	1	1	1	1	1
Pre Amp	6.5		13		1
LLRF	6.5		13		1
Interlock module	6.5		13		1-26
Trigger Module/depend on fanout					1
MA Modulator	0.5	0.5	0.5	0.5	
DC P/S	0.5	0.5	0.5	0.5	
Modulator					1
Pulse Transformer					1

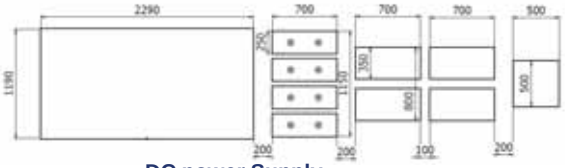
Layout of DRFS including All Required

DRFS Full Power Scheme Layout

Components Size

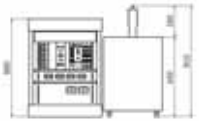
5.2m diameter





DC power Supply

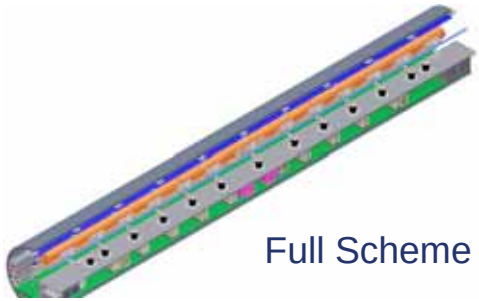
LLRF Rack



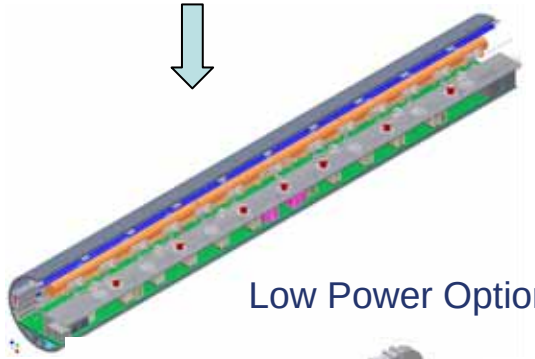
MA Modulator Rack

Control Rack

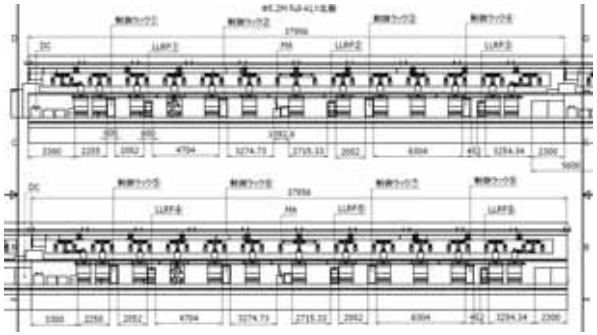
Full Scheme to Half Option



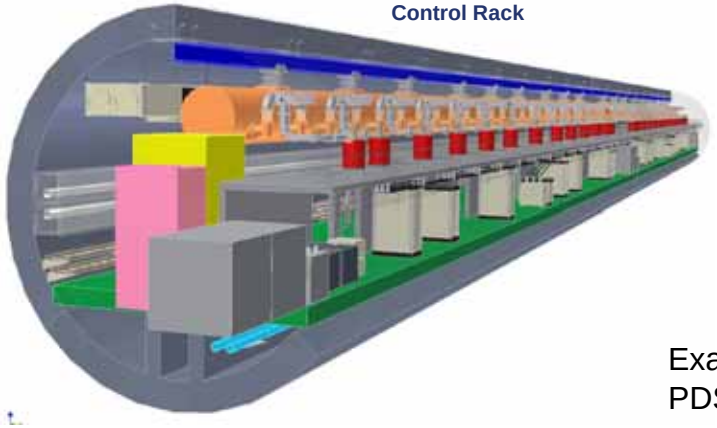
Full Scheme



Low Power Option

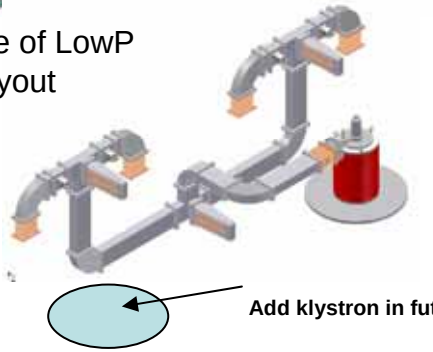


2 RDR-RF units Layout



3D View of DRFS

Example of LowP
PDS Layout



Water Cooling Comparison Full Scheme DRFS

Oct 31 2007

WATER AND AIR HEAT LOAD (all LCW) and 9-8-9 ML

MAIN LINAC - ELECTRON & POSITRON					
Components	Quantity Per 36m	Location	Total Heat Load (KW)		
Non-RF Components					
LCW Skid Pump 1 per 4 rf - Motor/Feeder Loss	0.25	Service Tunnel	0.60	0.60	0.60
I^2R Loss and Motor Loss (misc)	1	Service Tunnel	10.92	10.80	10.38
Fancoils (5 ton Chilled Water) 1.5 Hp	2	Service Tunnel	2.92	2.92	2.92
Rack Water Skid	0.25	Service Tunnel	0.20	0.20	0.20
Lighting Heat Dissipation ~1.3W/sf		Service Tunnel	1.64	1.64	1.64
AC Pwr Transformer 34.5-.48 kV	0.25	Service Tunnel	2.00	2.00	2.00
Emerg. AC Pwr Transformer 34.5-.48 kV		Service Tunnel	1.00	1.00	1.00
RF Components					
RF Charging Supply 34.5 Kv AC-BKV DC	1/36 m	Service Tunnel	4.0	4.00	14.0
Switching power supply 4kV 50kW	1/36 m	Service Tunnel	7.5	7.50	
Modulator	1/36 m	Service Tunnel	7.5	7.50	
Pulse Transformer	1/36 m	Service Tunnel	1.0	0.00	0.0
Klystron Socket Tank / Gun	1/36 m	Service Tunnel	1.0	6.50	6.5
Klystron Focusing Coil (Solenoid)	1/36 m	Service Tunnel	5.5	10.00	0.0
Klystron Collector	1/36 m	Service Tunnel	59.8	59.80	59.8
Klystron Body & Windows	1/36 m	Service Tunnel			
Relay Racks (Instrument Racks)	1/36 m	Service Tunnel	10.0	10.00	10.0
Attenuators	2/36 m	Service Tunnel	1.0	0.00	0.0
Waveguide (in service tunnel)	1/36 m	Service Tunnel			
Waveguide (in penetration)	1/36 m	Penetration	0.6	0.00	0.0
Waveguide (in beam tunnel)	1/36 m	Beam Tunnel	4.0		0.8
Circulators With loads (isolator)	26/36 m	Beam Tunnel		0.00	0.0
Loads	24/36 m	Beam Tunnel	22.8	22.80	22.8
Subtotal RF unit Only			109	108	104
Total RF			144	157	133

RDR

DRFS Full Scheme

Assume the same efficiency with J-Parc DC PS. If backup operates, It is doubly high.

No Pulse Transformer

Increase Socket Number from 1 to 13

Permanent Magnet Focusing

Cancel with decrease of PDS loss and Increase klystron collector loss due to The lower efficiency

Slight increase including the 2 MA modulators

Some amount of increases including the13 MA modulators

No circulator

ALCPG09 DRFS Heat Load (S. Fukuda)

20% Overhead

BCD		
Beam		
Current	9 mA	RF Duty 0.0078
Electric Field	31.5 MV/m	Beam Duty 0.0049
Length	1.0377 m	
Power	Peak Power	Av Power
P/cav	294.2 kW	
For 26 Cavities	7648.9 kW	37.10 kW
20% Overhead	9178.7 kW	
PDS loss(%)	8.52 %	7.11 kW
Service tunnel		1.34 kW
Penetration		1.14 kW
Acc Tunnel		2.97 kW
Circulator		1.90 kW
Error for Split/Ref	2 %	
Kly Out	10662 kW	83.43 kW
Loss at Perfect Match		22.76 kW
Loss at Imperfect		40.07 kW
Klystron		
Voltage	118.68 kV	
Current	138.0 A	
Kly Beam Power	16378 kW	128.67 kW
Po Lower Limit'(*)	8500 kW	66.51 kW
Collector Dissipation	7878 kW	62.16 kW
(*) Efficiency 10% Lower=55%		

DRFS				
Beam				
Current	9 mA			RF Duty 0.0078
Electric Field	31.5 MV/m			Beam Duty 0.0049
Length	1.0377 m			
Power	Peak Po for 2 cavity	Av Po for 2 cavity	Peak Po for 26 cavit	Av Power
P/cav	294.2 kW			
For 2 Cavities	588.4 kW	2.85 kW	7649.2 kW	37.10 kW
20% Overhead	735.5 kW		9562.0 kW	
PDS loss(%)	1.05 %	0.05 kW		0.69 kW
Service tunnel		0.00 kW		0.00 kW
Penetration		0.00 kW		0.00 kW
Acc Tunnel		0.05 kW		0.69 kW
Circulator		0.00 kW		0.00 kW
Error for Split/Ref	0 %			
Kly Out	735.5 kW	5.76 kW	9562.02 kW	74.82 kW
Loss at Perfect Match		1.75 kW		22.75 kW
Loss at Imperfect		2.85 kW		37.04 kW
Klystron				
Voltage	68.44 kV		68.44 kV	
Current	17.9 A		232.7 A	
Kly Beam Power	1225 kW	9.62 kW	15925.99 kW	124.62 kW
Po Lower Limit'(*)	613 kW	4.81 kW	7962.994 kW	62.31 kW
Collector Dissipation	613 kW	4.81 kW	7962.994 kW	62.31 kW
(*) Efficiency 10% Lower=50%				

Water Cooling Comparison LowP DRFS

Oct 31 2007

WATER AND AIR HEAT LOAD (all LCW) and 9-8-9 ML

MAIN LINAC - ELECTRON & POSITRON

Components	Quantity Per 36m	Location	Total Heat Load (KW)		
Non-RF Components					
LCW Skid Pump 1 per 4 rf - Motor/Feeder Loss	0.25	Service Tunnel	0.60	0.60	0.60
I^2R Loss and Motor Loss (misc)	1	Service Tunnel	10.92	10.39	5.36
Fancoils (5 ton Chilled Water) 1.5 Hp	2	Service Tunnel	2.93	2.93	2.93
Rack Water Skid	0.25	Service Tunnel	0.20	0.20	0.20
Lighting Heat Dissipation ~1.3W/sf		Service Tunnel	1.65	1.65	1.65
AC Pwr Transformer 34.5-.48 kV	0.25	Service Tunnel	2.00	2.00	2.00
Emerg. AC Pwr Transformer 34.5-.48 kV		Service Tunnel	1.00	1.00	1.00
RF Components					
RF Charging Supply 34.5 Kv AC-8KV DC	1/36 m	Service Tunnel	4.0	14.0	7.0
Switching power supply 4kV 50kW	1/36 m	Service Tunnel	7.5		
Modulator	1/36 m	Service Tunnel	7.5		
Pulse Transformer	1/36 m	Service Tunnel	1.0	0.0	0.0
Klystron Socket Tank / Gun	1/36 m	Service Tunnel	1.0	6.5	3.3
Klystron Focusing Coil (Solenoid)	1/36 m	Service Tunnel	5.5	0.0	0.0
Klystron Collector	1/36 m	Service Tunnel	59.8	59.8	29.9
Klystron Body & Windows	1/36 m	Service Tunnel			
Relay Racks (Instrument Racks)	1/36 m	Service Tunnel	10.0	10.0	10.0
Attenuators	1/36 m	Service Tunnel	1.0	0.0	0.0
Waveguide (in service tunnel)	1/36 m	Service Tunnel			
Waveguide (in penetration)	1/36 m	Penetration	0.6	0.0	0.0
Waveguide (in beam tunnel)	1/36 m	Beam Tunnel	4.0	0.8	1.6
Circulators With loads (isolator)	26/36 m	Beam Tunnel		0.0	0.0
Loads	24/36 m	Beam Tunnel	22.8	22.8	11.8
Subtotal RF unit Only			109	104	54
Total RF			144	133	77

RDR
DRFS Full
DRFS LowP

Assume the same efficiency with J-Parc DC PS. If backup operates, It is doubly high.

No Pulse Transformer

Increase Socket Number from 1 to 13

Permanent Magnet Focusing

Cancel with decrease of PDS loss and Increase klystron collector loss due to The lower efficiency

Slight increase including the 2 MA modulators

Some amount of increases including the13 MA modulators

No circulator

ALCPG'09 DRFS Heat Load (S. Fukuda)

Heat Table for DRFS (Full Power)

Sep 9 2009

WATER AND AIR HEAT LOAD for SB2009 DRFS Full Power Option

MAIN LINAC - ELECTRON & POSITRON						To Dirty Water							To Low Conductivity Water									to Chilled Water	[illegible]		To Fan Coil Chilled Water	
Components		Quantity Per 36m	Location	Total Heat Load (KW)	Average Heat Load (KW)	Heat Load to Water (KW)	Supply Temp Variation (C)	Delta Temperature (C delta)	Water Flow (l / min)	Maximum Allowable Pressure (Bar)	Typical (water) pressure drop Bar	Acceptable Temp Variation delta C	Heat Load to LCWater (KW)	Max Allowable Temperature (C)	Supply Temp Variation (C)	Supply Temp (C)	Delta Temperature (C delta)	Water Flow (l / min)	Maximum Allowable Pressure (Bar)	Typical (water) pressure drop Bar	Acceptable Temp Variation delta C	Heat Load to Rack Chilled Water (KW)	Power fraction to Tunnel Air (p.u.)	Power to Tunnel Air (KW)	Heat Load to Fan Coil Chilled Water (KW)	Max Space Temp (C)
Non-RF Components																										
LCW Skid Pump 1 per 4 rf-group/Header Loss		0.25	Service Tunnel	6.60	6.60	0.00	N/A	N/A		N/A	N/A	None	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0	1.00	6.60	6.60	
PSU Loss and Motor Loss (Hi/Lo)		1	Service Tunnel	[illegible]	[illegible]								0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0	1.00	[illegible]	[illegible]	
Fancoils 15 ton Chilled Water 1.5 Hp		1	Service Tunnel	1.91	1.91	0.00	N/A	N/A		N/A	N/A	None	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0			1.91	
Rack Water Skid		0.25	Service Tunnel	[illegible]	[illegible]	0.00	N/A	N/A		N/A	N/A	None	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0	1.00	[illegible]	[illegible]	
Lighting Heat Dissipation 1.5 W/sf			Service Tunnel	1.65	1.65	0.00	N/A	N/A		N/A	N/A	None	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0	1.00	1.65	1.65	
AC Pwr Transformer 34.5-.48 kV		0.25	Service Tunnel	2.00	2.00	0.00	N/A	N/A		N/A	N/A	None	1.50			35					None	0	0.25	0.50	2.00	
Emerg. AC Pwr Transformer 34.5-.48 kV			Service Tunnel	1.00	1.00	0.00	N/A	N/A		N/A	N/A	None	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0	1.00	1.00	1.00	
RF Components																										
--- High Voltage Circuit Breaker (6.6 kV) ---		1/76 m	Single Tunnel																							
DC Power Supply, 6.6 kV (in), 60 kV, 4 A (Out), 250 kW, 90% eff.	Rack 1	1/76 m	Single Tunnel		25.00								15.00	50.00								0.00	0.40	10.00	10.00	
DC Power Supply, 6.6 kV (in), 60 kV, 4 A (Out), 250 kW, 90% eff. (Backup)	Rack 2	1/76 m	Single Tunnel																							
Modulating Anode Modulator, 6.6 kV (Shunt 1.0 A, then 6 kW heat load)	Rack 3	1/76 m	Single Tunnel		6.00								3.60	50.00								0.00	0.40	2.40	2.40	
Modulating Anode Modulator, 6.6 kV (Shunt 1.0 A, then 6 kW heat load), (Back-up)	Rack 4	1/76 m	Single Tunnel																							
--- AC Transformer to Low Voltage (400/200/100 V) ---		1/152 m																								
Heater P/S, 200V, 36A, 7.2kW	Rack 3	1/76 m	Single Tunnel		1.00									50.00								1.00	0.00	0.00	0.00	
Same as above (Back-up)	Rack 4	1/76 m	Single Tunnel																							
Pulse Transformer		None																								
Klystron Socket Tank / Gun 0.3 kW X 26		26/76 m	Single Tunnel		7.00								6.24	60.00								0.00	0.20	1.56	1.56	
Klystron Focusing x 26 (Permanent Magnet)		26/76 m			0.00																					
Klystron Collector 4.5 kW x 26		26/76 m	Single Tunnel		117.00								113.49	87.00								0.00	0.03	3.51	3.51	85 F (4)
Klystron Body & Windows		26/76 m	Single Tunnel		7.52								5.51	40.00								0				
--- LLRF Racks ---																										
LLRF+Amp +Int, 200V, 1.5A /3 modules	Rack 5	1/76 m	Single Tunnel		0.35									50.00								0.35	0.00	0.00	0.00	
LLRF+Amp +Int, 200V, 1.5A /3 modules	Rack 6	1/76 m	Single Tunnel		0.35									50.00								0.35	0.00	0.00	0.00	
LLRF+Amp +Int, 200V, 1.5A /3 modules	Rack 7	1/76 m	Single Tunnel		0.21									50.00								0.21	0.00	0.00	0.00	
(LLRF+Amp +Int, 200V, 1.5A /3 modules, for full power op.)	Rack 7	1/76 m	Single Tunnel		0.21									50.00								0.21	1.00	0.21	0.21	
(LLRF+Amp +Int, 200V, 1.5A /3 modules, for full power op.)	Rack 8	1/76 m	Single Tunnel		0.35									50.00								0.35	2.00	0.70	0.70	
(LLRF+Amp +Int, 200V, 1.5A /3 modules, for full power op.)	Rack 9	1/76 m	Single Tunnel		0.35									50.00								0.35	3.00	1.05	1.05	
--- Other Racks ---																										
Timing, 200V, 0.5kW	Rack 10	1/76 m	Single Tunnel		0.50									50.00								0.50	0.00	0.00	0.00	
Timing, 200V, 0.5kW	Rack 11	1/76 m	Single Tunnel		0.50									50.00								0.50	0.00	0.00	0.00	
Cavity, 200V, 3 kW	Rack 12	1/76 m	Single Tunnel	3.95	2.05									50.00								2.05	0.00	0.00	0.00	
Cavity, 200V, 3 kW	Rack 13	1/76 m	Single Tunnel	2.95	2.05									50.00								2.05	0.00	0.00	0.00	
Cryogenics, 200V, 1.1 kW	Rack 14	1/76 m	Single Tunnel		2.10									50.00								2.10	0.00	0.00	0.00	
Cryogenics, 200V, 1.1 kW	Rack 15	1/76 m	Single Tunnel		2.10									50.00								2.10	0.00	0.00	0.00	
BPM & Mag, 200V, 5 kW	Rack 16	1/76 m	Single Tunnel		5.00									50.00								5.00	0.00	0.00	0.00	
BPM & Mag, 200V, 5 kW	Rack 17	1/76 m	Single Tunnel		5.00									50.00								5.00	0.00	0.00	0.00	
--- RF Loads ---																										
Attenuator		None																								
Waveguides in service tunnel		None																								
Waveguides in penetration		None																								
Waveguides in beam tunnel		26/76 m	Single Tunnel		1.60								0.00									0.00	1.00	1.60	1.60	
Circulator with load		None																								
RF Loads		26/76 m	Single Tunnel		45.60								44.23										0.03	1.37	1.37	
--- Other Loads ---																										
Pulse motor for input coupler/tuner		(26+26)/76 m		1.79	0.00																		1.00	0.00	0.00	
Vacuum Pumps		(2+2)/76 m			1.26																		1.00	1.26	1.26	
Subtotal RF unit Only					[illegible]								[illegible]									[illegible]			[illegible]	
Total RF						0.0																				

ALCPG09 DRFS Heat Load
(S. Fukuda)

Heat Table for DRFS (Low Power Option)

Sep 9 2009

WATER AND AIR HEAT LOAD for SB2009 DRFS Low Power Option

MAIN LINAC - ELECTRON & POSITRON						To Dirty Water							To Low Conductivity Water									To Chilled Water	[illegible]		To Fan Coil Chilled Water	
Components		Quantity Per 38m	Location	Total Heat Load (KW)	Average Heat Load (KW)	Heat Load to Water (KW)	Supply Temp (variation) (C)	Delta Temperature (C delta)	Water Flow (l / min)	Maximum Allowable Pressure (Bar)	Typical (water) pressure drop Bar	Acceptable Temp variation delta C	Heat Load to LCWater (KW)	Max Allowable Temperature (C)	Supply Temp (variation) (C)	Supply Temp (C)	Delta Temperature (C delta)	Water Flow (l / min)	Maximum Allowable Pressure (Bar)	Typical (water) pressure drop Bar	Acceptable Temp variation delta C	Heat Load to Rack Chilled Water (KW)	Power fraction to Tunnel Air (0-1)	Power to Tunnel Air (KW)	Heat Load to Fan Coil Chilled Water (KW)	Max Space Temp (C)
Non-RF Components																										
LCW Skid Pump 1 per 4 rf Motor/Reader Loss		0.15	Service Tunnel	4.64	4.64	0.00	N/A	N/A		N/A	N/A	None	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0	1.00	4.64	4.64	
P&R Loss and Motor Loss (Misc)		1	Service Tunnel	0.00	12.72								0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0	1.00	12.72	12.00	
Fancoils (5 ton Chilled Water) 1.5 Hp		1	Service Tunnel	3.91	3.91	0.00	N/A	N/A		N/A	N/A	None	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0			3.91	
Back Water Skid		0.15	Service Tunnel	4.44	4.44	0.00	N/A	N/A		N/A	N/A	None	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0	1.00	4.44	4.44	
Lighting Heat Dissipation 1.5W/ft			Service Tunnel	1.65	1.65	0.00	N/A	N/A		N/A	N/A	None	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0	1.00	1.65	1.65	
AC Pwr Transformer 34.5-.48 kV		0.25	Service Tunnel	2.00	2.00	[illegible]	N/A	N/A		N/A	N/A	None	1.50			35					None	0	0.25	0.50	2.00	
Emerg. AC Pwr Transformer 34.5-.48 kV			Service Tunnel	1.00	1.00	0.00	N/A	N/A		N/A	N/A	None	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	0	1.00	1.00	1.00	
RF Components																										
--- High Voltage Circuit Breaker (6.6 kV) ---		1/76 m	Single Tunnel																							
DC Power Supply, 6.6 kV (I), 60 kV, 2 A (O), 125 kW, 90%eff.	Rack 1	1/76 m	Single Tunnel		12.50								7.50	50.00								0.00	0.40	5.00	5.00	
DC Power Supply, 6.6 kV (I), 60 kV, 2 A (O), 125 kW, 90%eff. (Backup)	Rack 2	1/76 m	Single Tunnel																							
Modulating Anode Modulator, 6.6 kV (Shunt 0.5A, then 3 kW heat load)	Rack 3	1/76 m	Single Tunnel		3.00								1.80	50.00								0.00	0.40	1.20	1.20	
Modulating Anode Modulator, 6.6 kV (Shunt 0.5A, then 3 kW heat load), (Back-up)	Rack 4	1/76 m	Single Tunnel																							
--- AC Transformer to Low Voltage (400/200/100 V) ---		1/152 m																								
Heater P/S, 100V,18A, 4kW	Rack 3	1/76 m	Single Tunnel		0.50									50.00								0.50	0.00	0.00	0.00	
Same as above (Back-up)	Rack 4	1/76 m	Single Tunnel																							
Pulse Transformer		None																								
Klystron Socket Tank / Gun 0.3 kW X 13		13/76 m	Single Tunnel		3.90								3.12	60.00								0.00	0.20	0.78	0.78	
Klystron Focusing × 13 (Permanent Magnet)		13/76 m			0.00																					
Klystron Collector 4.5 kW X 13		13/76 m	Single Tunnel		58.50								56.75	87.00								0.00	0.03	1.76	1.76	85 F [illegible]
Klystron Body & Windows		13/76 m	Single Tunnel		3.76								3.76	40.00								0				
--- LLRF Racks ---																										
LLRF+Amp +Int, 100V, 1.5A /3 modules	Rack 5	1/76 m	Single Tunnel		0.35									50.00								0.35	0.00	0.00	0.00	
LLRF+Amp +Int, 100V, 1.5A /3 modules	Rack 6	1/76 m	Single Tunnel		0.35									50.00								0.35	0.00	0.00	0.00	
LLRF+Amp +Int, 100V, 1.5A /3 modules	Rack 7	1/76 m	Single Tunnel		0.21									50.00								0.21	0.00	0.00	0.00	
(LLRF+Amp +Int, 100V, 1.5A /3 modules, for full power op.)	Rack 7																									
(LLRF+Amp +Int, 100V, 1.5A /3 modules, for full power op.)	Rack 8																									
(LLRF+Amp +Int, 100V, 1.5A /3 modules, for full power op.)	Rack 9																									
--- Other Racks ---																										
Timing , 100V, 0.5kW	Rack 10	1/76 m	Single Tunnel		0.50									50.00								0.50	0.00	0.00	0.00	
Timing , 100V, 0.5kW	Rack 11	1/76 m	Single Tunnel		0.50									50.00								0.50	0.00	0.00	0.00	
Cavity , 100V, 3 kW	Rack 12	1/76 m	Single Tunnel	2.95	2.05									50.00								2.05	0.00	0.00	0.00	
Cavity , 100V, 3 kW	Rack 13	1/76 m	Single Tunnel	2.95	2.05									50.00								2.05	0.00	0.00	0.00	
Cryogenics, 100V, 1.1 kW	Rack 14	1/76 m	Single Tunnel		1.10									50.00								1.10	0.00	0.00	0.00	
Cryogenics, 100V, 1.1 kW	Rack 15	1/76 m	Single Tunnel		1.10									50.00								1.10	0.00	0.00	0.00	
BPM & Mag, 100V, 5 kW	Rack 16	1/76 m	Single Tunnel		5.00									50.00								5.00	0.00	0.00	0.00	
BPM & Mag, 100V, 5 kW	Rack 17	1/76 m	Single Tunnel		5.00									50.00								5.00	0.00	0.00	0.00	
--- RF Loads ---																										
Attenuator		None																								
Waveguides in service tunnel		None																								
Waveguides in penetration		None																								
Waveguides in beam tunnel		13/76 m	Single Tunnel		0.80								0.00									0.00	1.00	0.80	0.80	
Circulator with load		None																								
RF Loads		13/76 m	Single Tunnel		22.00								22.12										0.03	0.66	0.66	
--- Other Loads ---																										
Pulse motor for input coupler/tuner		(26+16)/76 m		1.79	0.00																		1.00	0.00	0.00	
Vacuum Pumps		(2+1)/76 m			1.26																		1.00	1.26	1.26	
Subtotal RF unit Only					[illegible]								[illegible]									[illegible]			[illegible]	
Total RF						0.0																				

Comparison between RDR and DRFS: Pro & Con

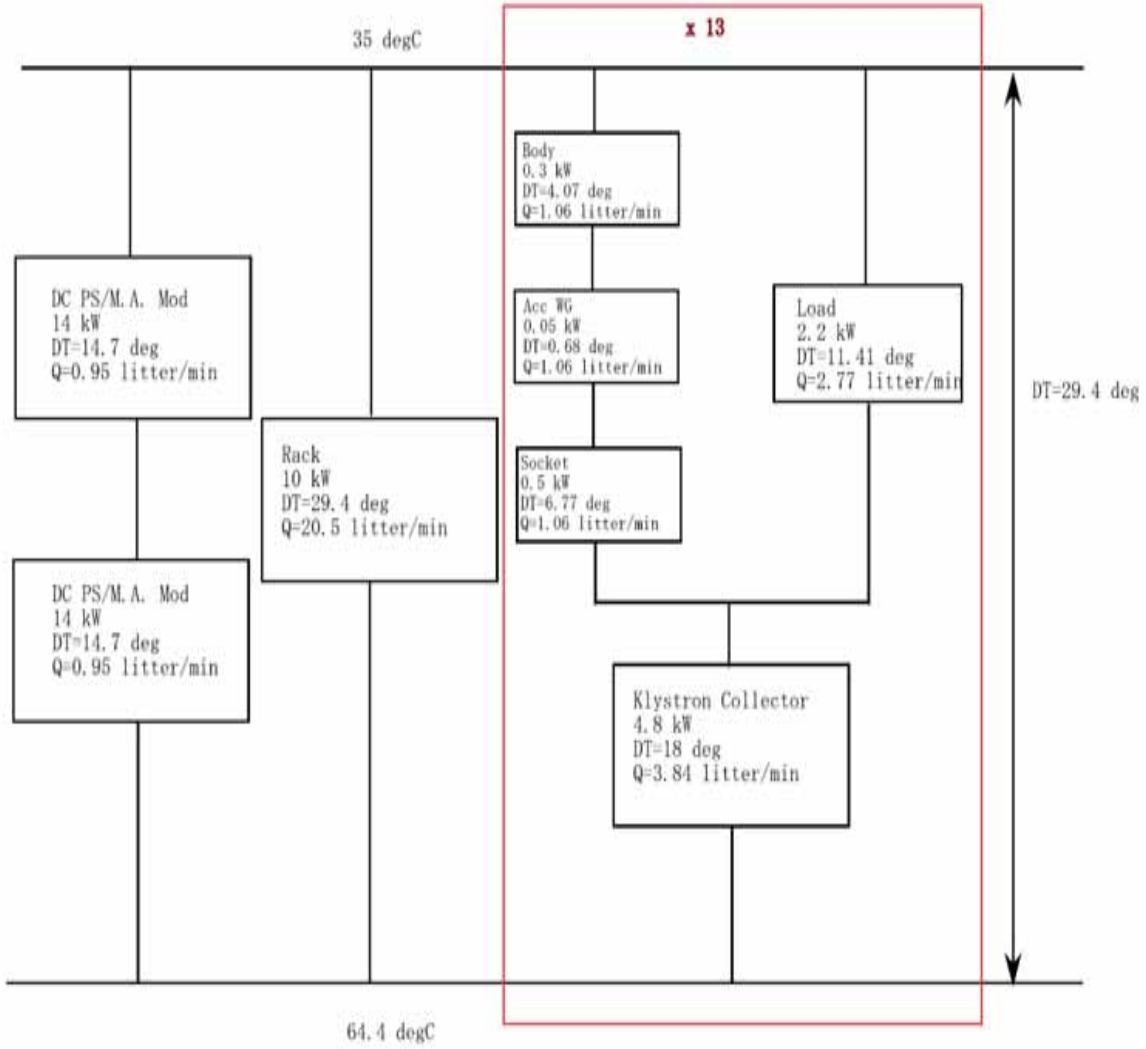
Pro

- **Complete Single Tunnel**
- **Simpler waveguide system, then decrease of heat load in PDS**
- **No klystron magnet cooling by using permanent magnet**
- **Possibly eliminate the circulator**

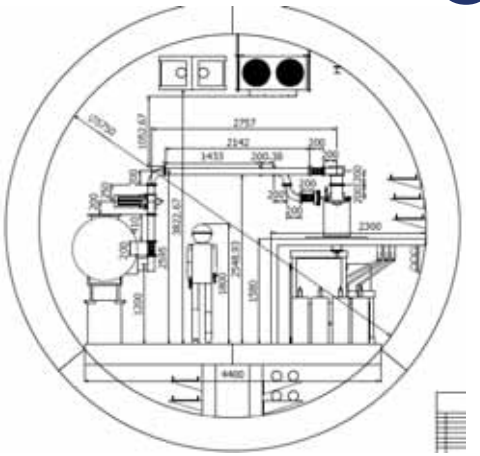
Con

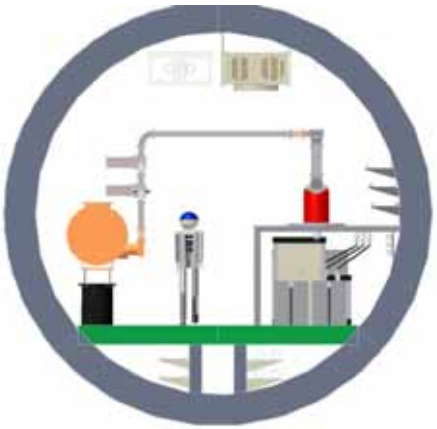
- **Increase of Klystron, namely increase of cooling channel**
- **Little bit complex PDS in low power option**
- **Components in the shield are crowded**
- **Hanging down structure of cryomodule and vibration problem**

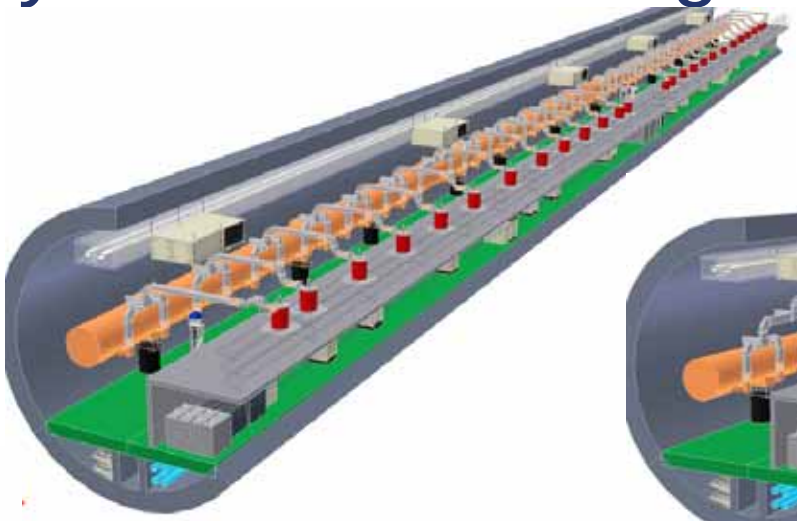
Example of Cooling Scheme



Another Layout of DRFS Cryomodule on the ground

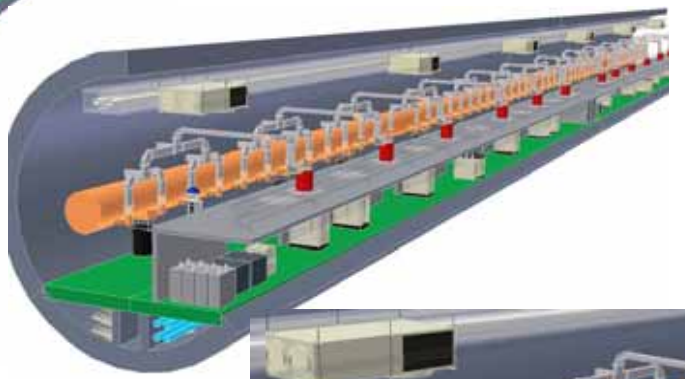


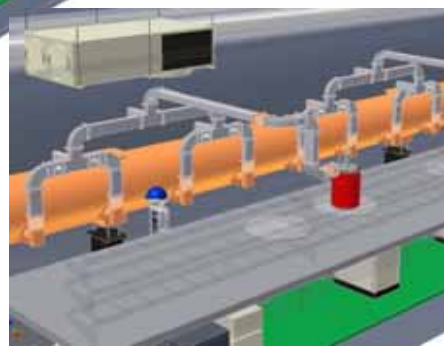




Full Scheme

Low power option





If tunnel diameter is chosen to be 5.75m, it is possible to
Have an enough maintenance/installing space in the center.

Summary

- Proposed DRFS scheme was shown in this presentation.

  This scheme has a redundant MA modulator/DC power supply and it mates to the request for the high availability.
- Layout is also shown.
- Comparison of heat load table between RDR and DRFS are shown.
- Detailed heat tables for full DRFS and low-power-option DRFS are shown.
- High delta T cooling configuration for DRFS is proposed.
- Pro and con comparison
- Another DRFS in which cryomodule is on the ground are also shown as alternative DRFS.