
Proton Driver Machine Overview & Cryomodule Types

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Primary Parameter List (for reference)

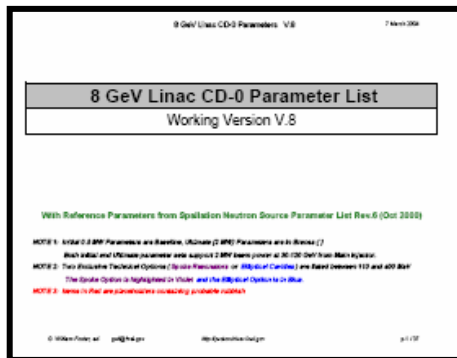
PRIMARY PARAMETERS	8 GeV Initial 0.5 MW {Ultimate 2MW in Brackets}	
Linac beam kinetic energy	8 GeV	
Linac Particle Types	H - ions Protons Electrons	Baseline Mission via foil stripping in transfer line Possible w/upgrade of Phase Shifters & Injector 8 GeV beam power available directly from linac
Linac Stand-Alone Beam power	0.5 {2.0} MW	
Linac Pulse repetition rate	2.5 {10} Hz	
Linac macropulse width	3.0 {1.0} ms	
Linac current (avg. in macropulse)	8.7 {26} mA	
Linac current (peak in macropulse)	9.3 {28} mA	
Linac Beam Chopping factor in macropulse	94 %	For adiabatic capture with 700ns abort gap.
Linac Particles per macropulse	1.56E+14	
Linac Charge per macropulse	26 uC	
Linac Energy per macropulse	208 kJ	
Linac average beam current	0.07 {0.26} mA	
Linac beam macropulse duty factor	0.75 {1.0} %	
Linac RF duty factor	1.00 {1.3} %	
Linac Active Length including Front End	614 m	Excludes possible expansion length
Linac Beam-floor distance	0.69 m =27 in.	same as Fermilab Main Injector
Linac Depth Below Grade	9 m	same as Fermilab Main Injector
Transfer Line Length to Ring	972 m	for MI-10 Injection point
Transfer Line Total Bend	40 deg	two 20-degree collimation arcs
Ring circumference	3319.4 m	Fermilab Main Injector
Ring Beam Energy	8-120 GeV	MI cycle time varies with energy
Ring Beam Power on Target	2 MW	~ independent of MI Beam Energy
Ring Circulating Current	2.3 A	
Ring cycle time	0.2-1.5 sec	depends on MI beam energy & flat-top
Ring Protons per Pulse on Target	1.50E+14 protons	
Ring Charge per pulse on target	25 uC	
Ring Energy per pulse on target	200-3000 kJ	at 8-120 GeV
Ring Proton pulse length on target	10 us	1 turn, or longer with resonant extraction
Linac Wall Power	5.5 {12.5} MW	approx 3 MW Standby + 1MW / Hz

Linac Segment Details (for reference)

Open Technical Choice: 3-spoke or Elliptical

Frequency, MHz
 Energy Range, MeV
 Beta geometrical
 Number of cavities or resonators
 Number of accelerating gaps / cavity
 Epeak, MV/m
 Eacc, MV/m
 Cavity effective length, cm
 Synchronous phase, deg (typ.)
 Length of Segment, m
 Number of Cryomodules
 Cavities per Cryomodule
 Magnetic Focusing Type
 Coupler Power Initial {Ultimate}, kW
 Cavities per Klystron Initial {Ultimate}
 Number of Klystrons Initial {Ultimate}

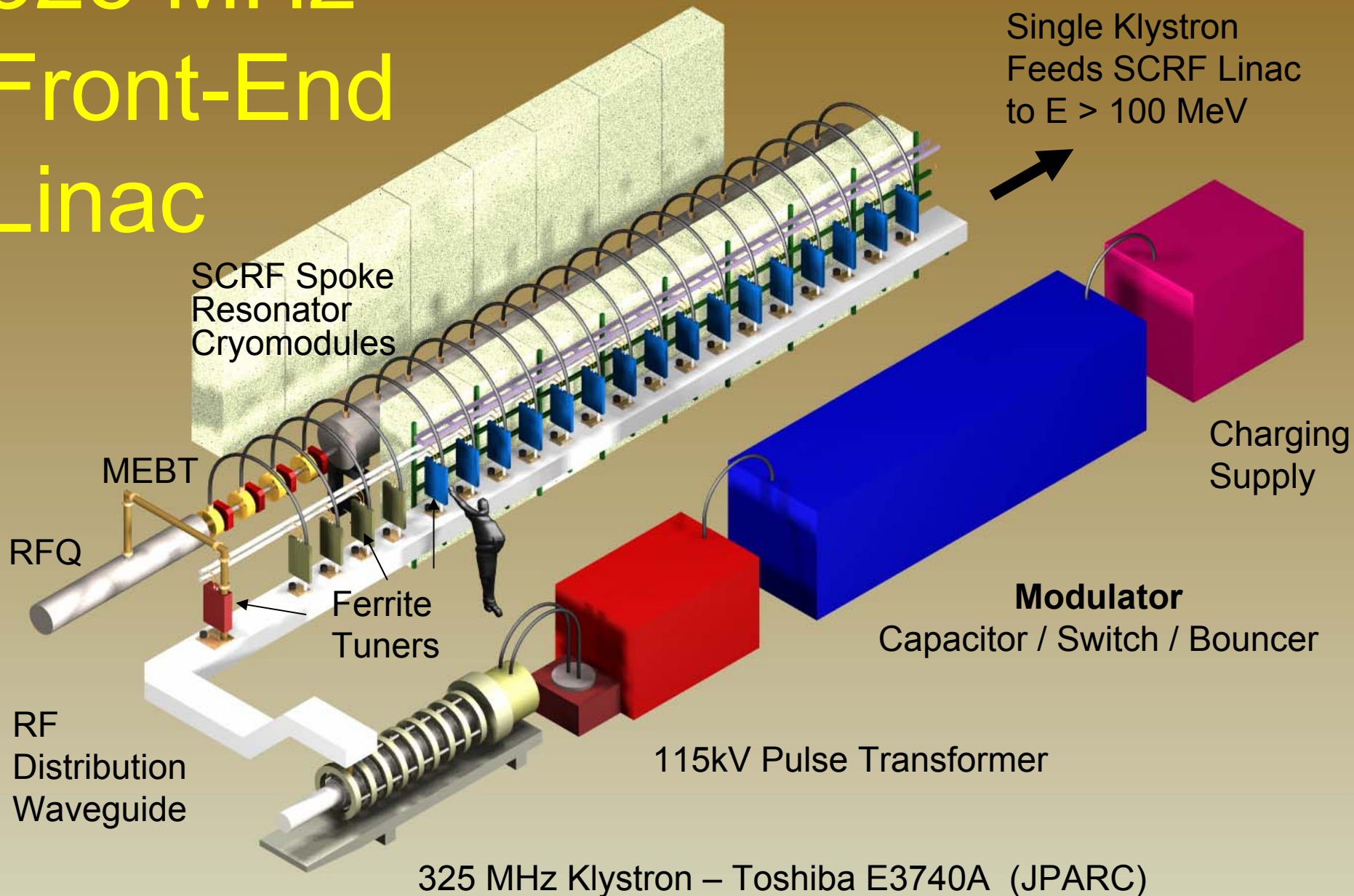
RFQ	Room Temp TSR	SRF		Spoke Option		Elliptical Option		High	TESLA
		1-spoke	2-spoke	3-spoke	Low	Medium			
325	325	325	325	325	1300	1300	1300	1300	
0.065-3	3-15	15-33	33-110	110-400	110-175	175-400	400-1200	1200-8000	
-	0.08 to 0.18	0.21	0.4	0.61	0.47	0.61	0.81	1.00	
4	21	16	28	42	16	32	48	288	
-	4	2	3	4	6	6	8	9	
32.1	TBD	32	32	32	52	52	52	52	
-	2.3 to 3.7	10.67	10.67	10.67	15.2	19.2	23.7	26	
-	15 to 32	13	36.9	85.8	32.5	42.2	74.8	103.8	
-	-40 to -30	-30	-30	-30 to -20	-30	-25	-20	-16	
~4	10.4	12.5	17.2	64	18.8	38.5	70.1	438.3	
-	-	1	2	6	2	4	6	36	
-	-	16	14	7	8	8	8	8	
-	Solenoid	Solenoid	Solenoid	Quad	Quad	Quad	Quad	Quad	
125	40 {54}	9 {26}	34 {102}	80 {238}	42 {125}	72 {214}	133 {398}	220 {660}	
		72 {36}		42 {14}	48 {24}		48 {24}	36 {12}	
		1 {2}		1 {3}	1 {2}		1 {3}	8 {24}	



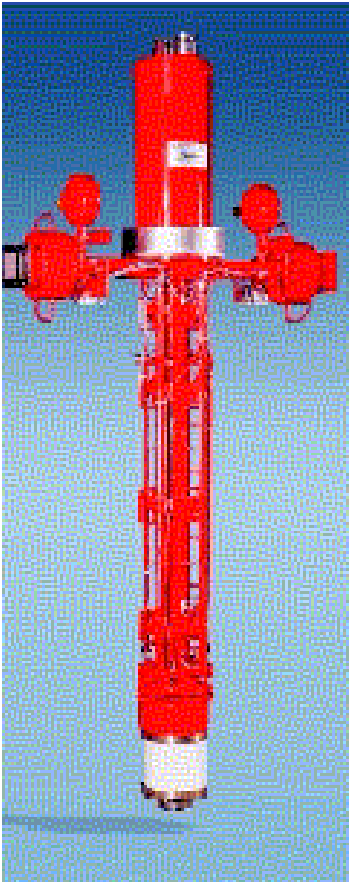
- Parameter List gives subsystem details for technically feasible baseline

http://tdserver1.fnal.gov/8gevlincapapers/ParameterList2005/CD0_Parameter_List_Current_Version.pdf

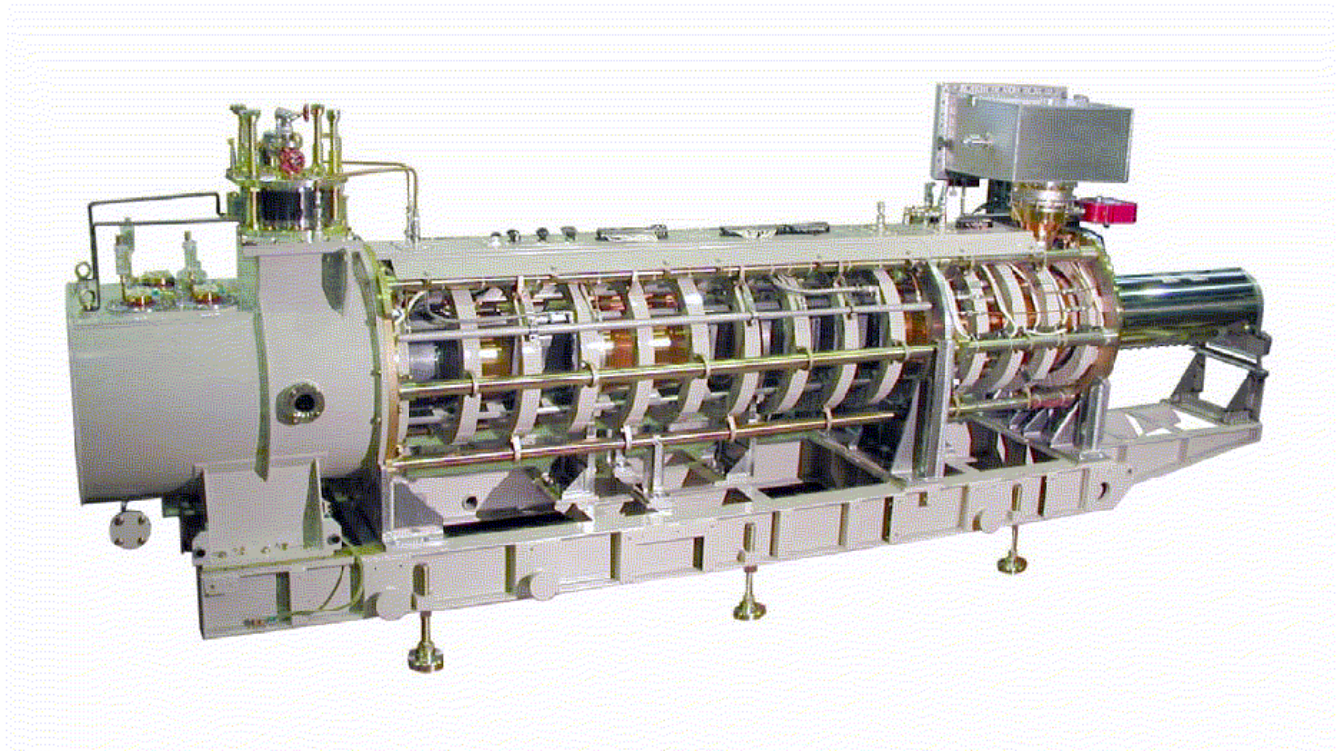
325 MHz Front-End Linac



8 GeV Linac Klystrons – 2 Types



Thales TH1801
1300 MHz
10 MW
3 Delivered,
8 More Ordered

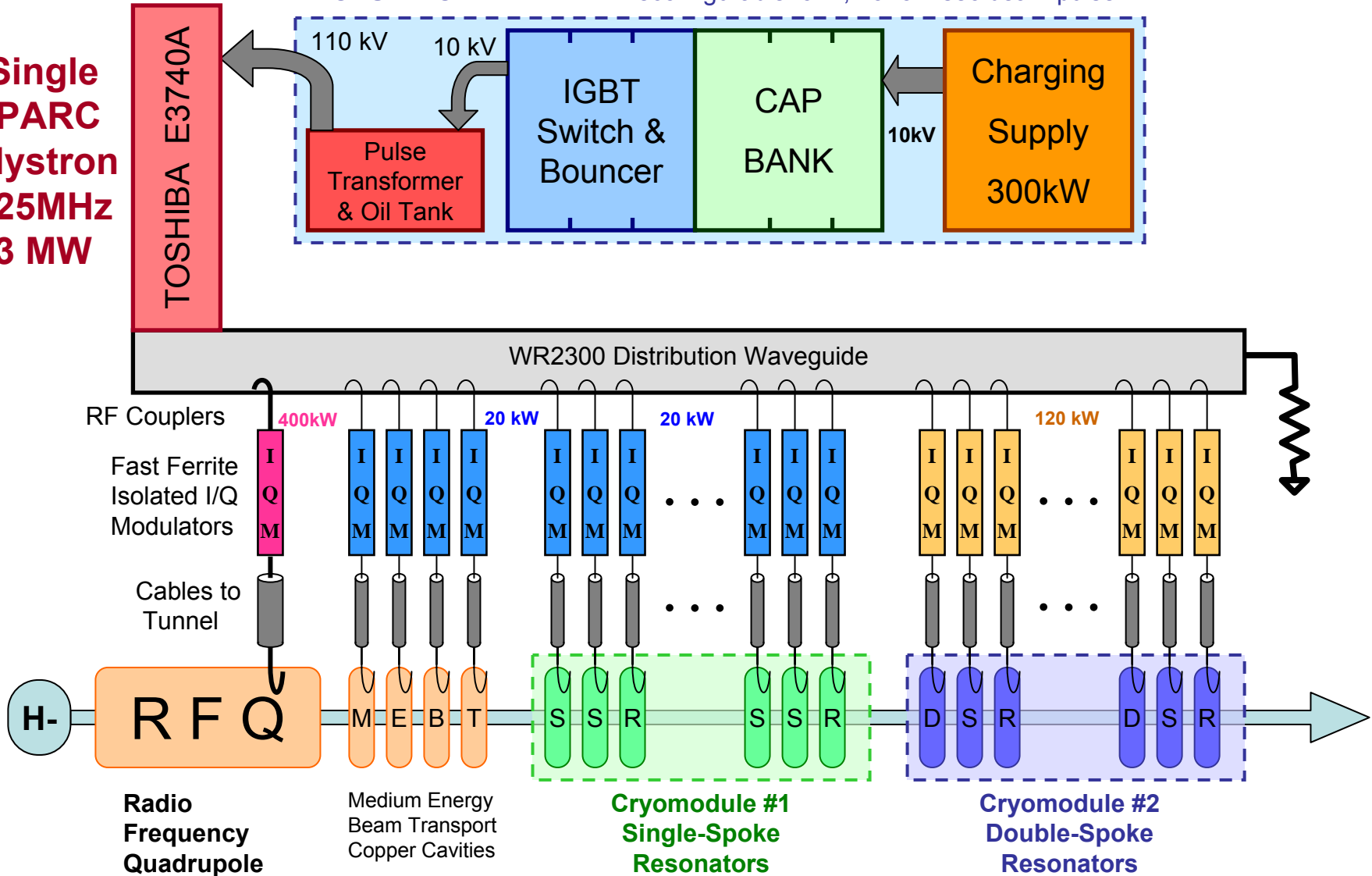


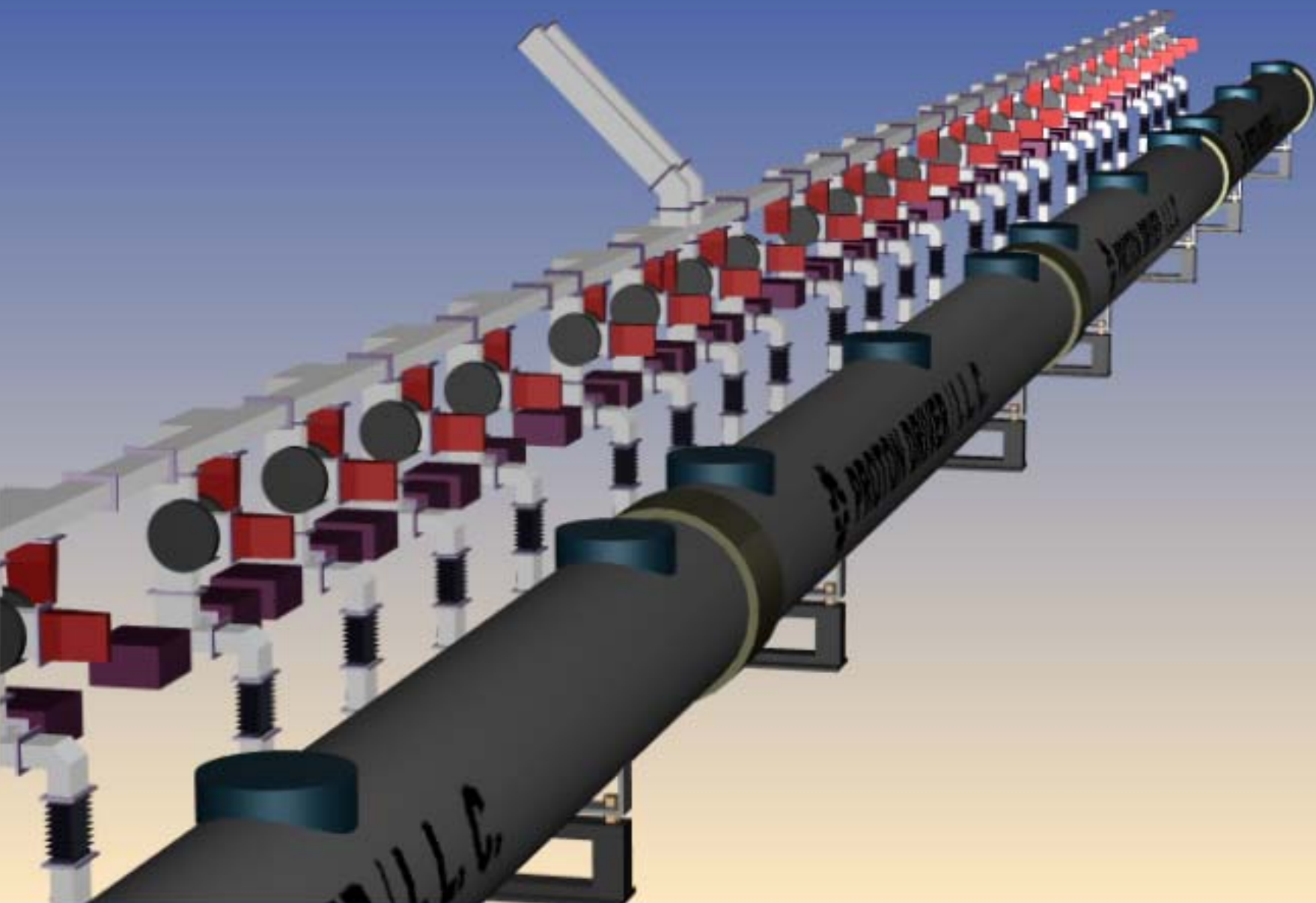
Toshiba E3740A
325 MHz 3 MW
(17 Delivered for JPARC)

325 MHz RF System

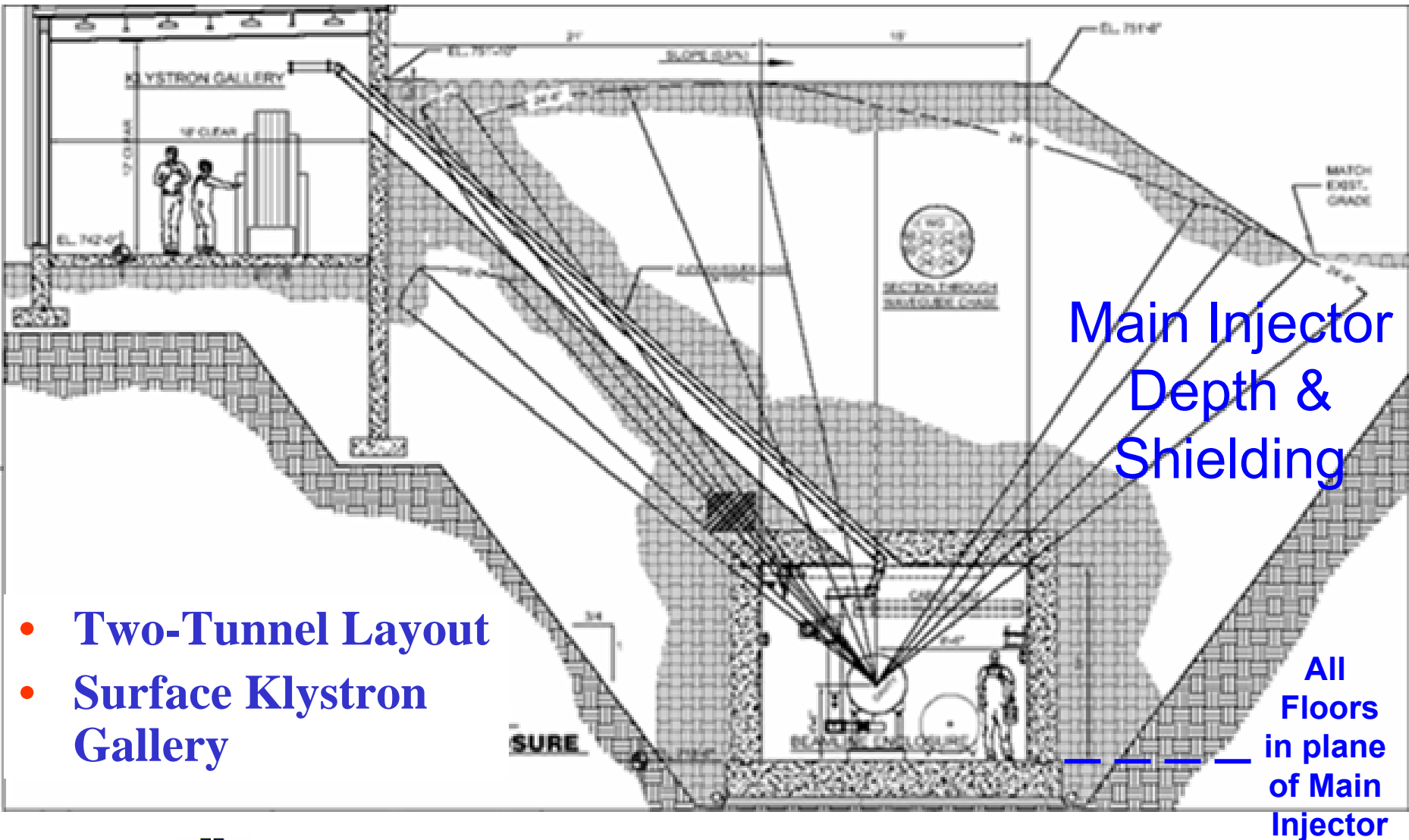
Single
JPARC
Klystron
325MHz
3 MW

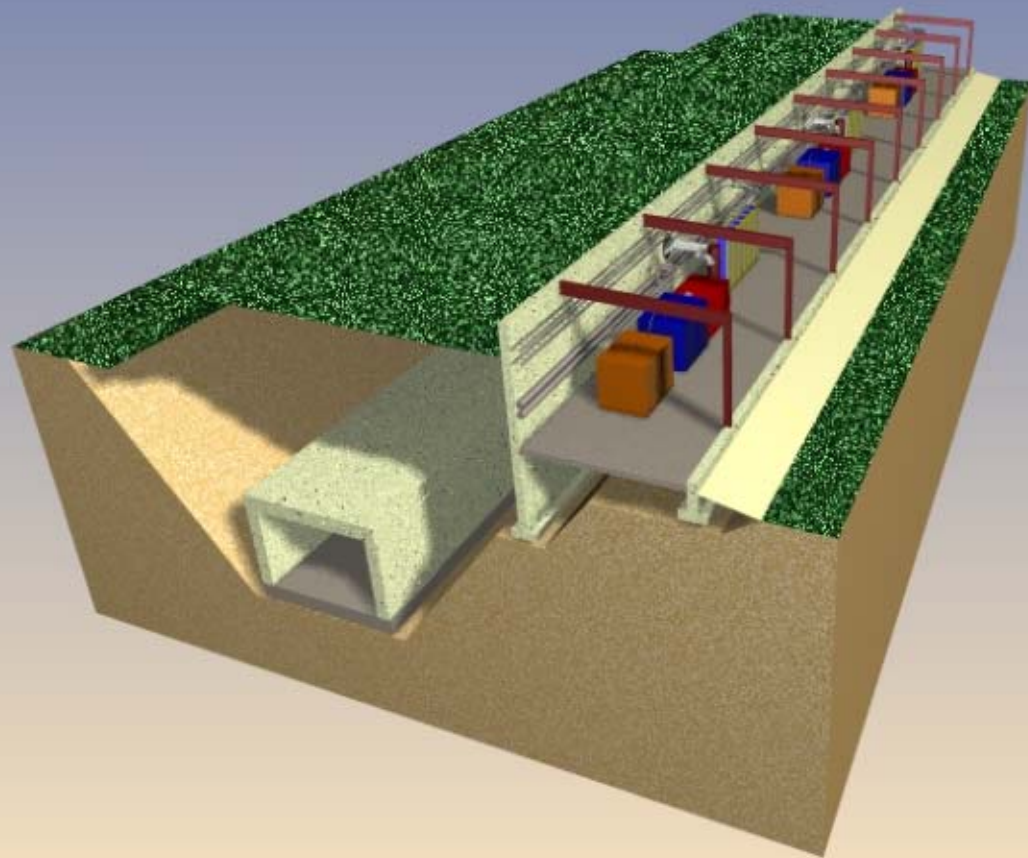
MODULATOR: FNAL/TTF Reconfigurable for 1,2 or 3 msec beam pulse

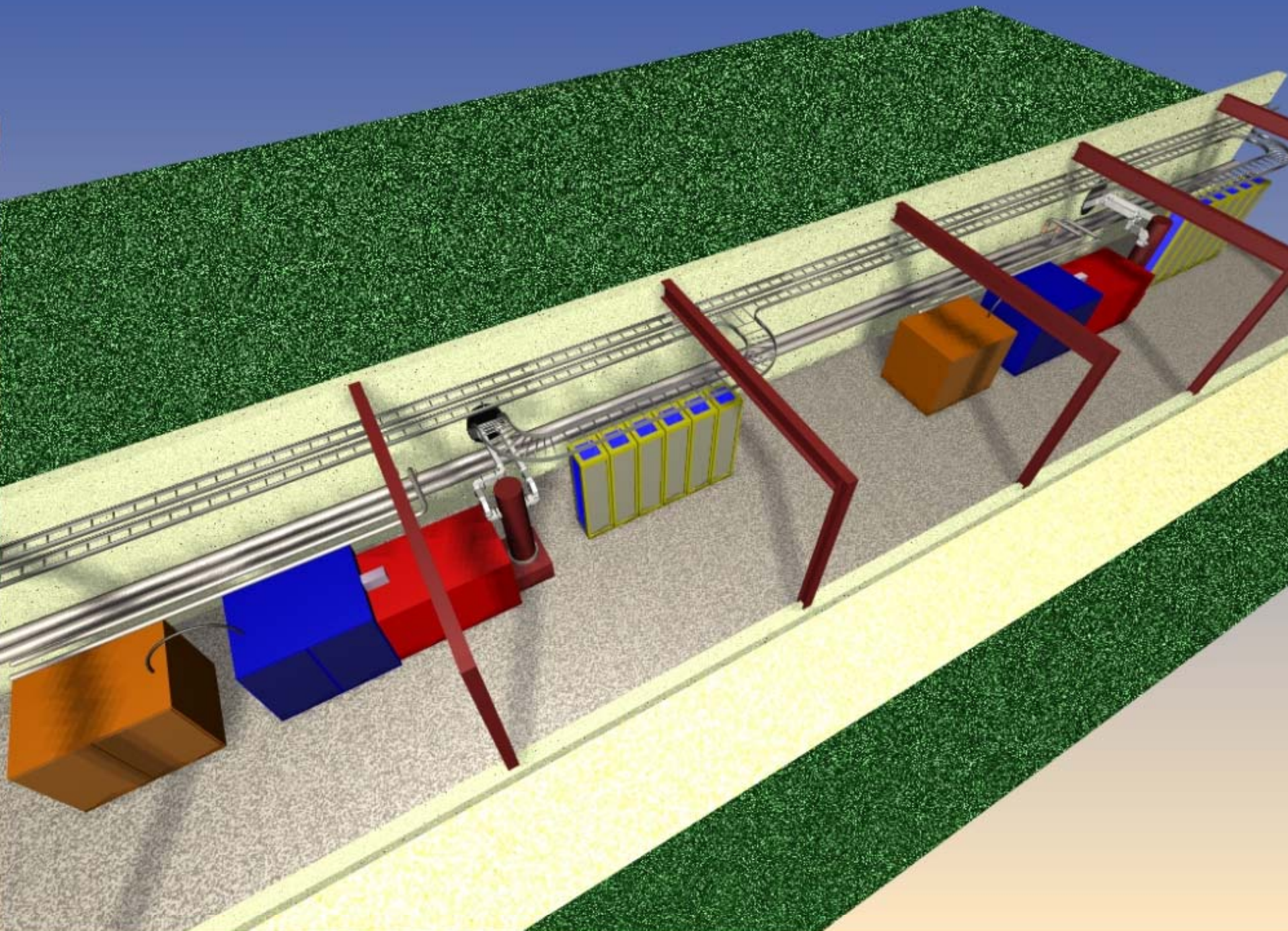


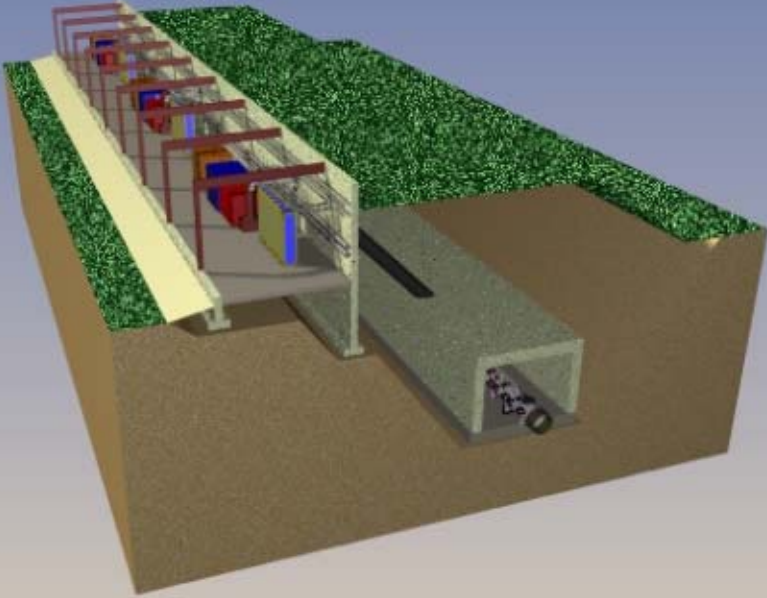


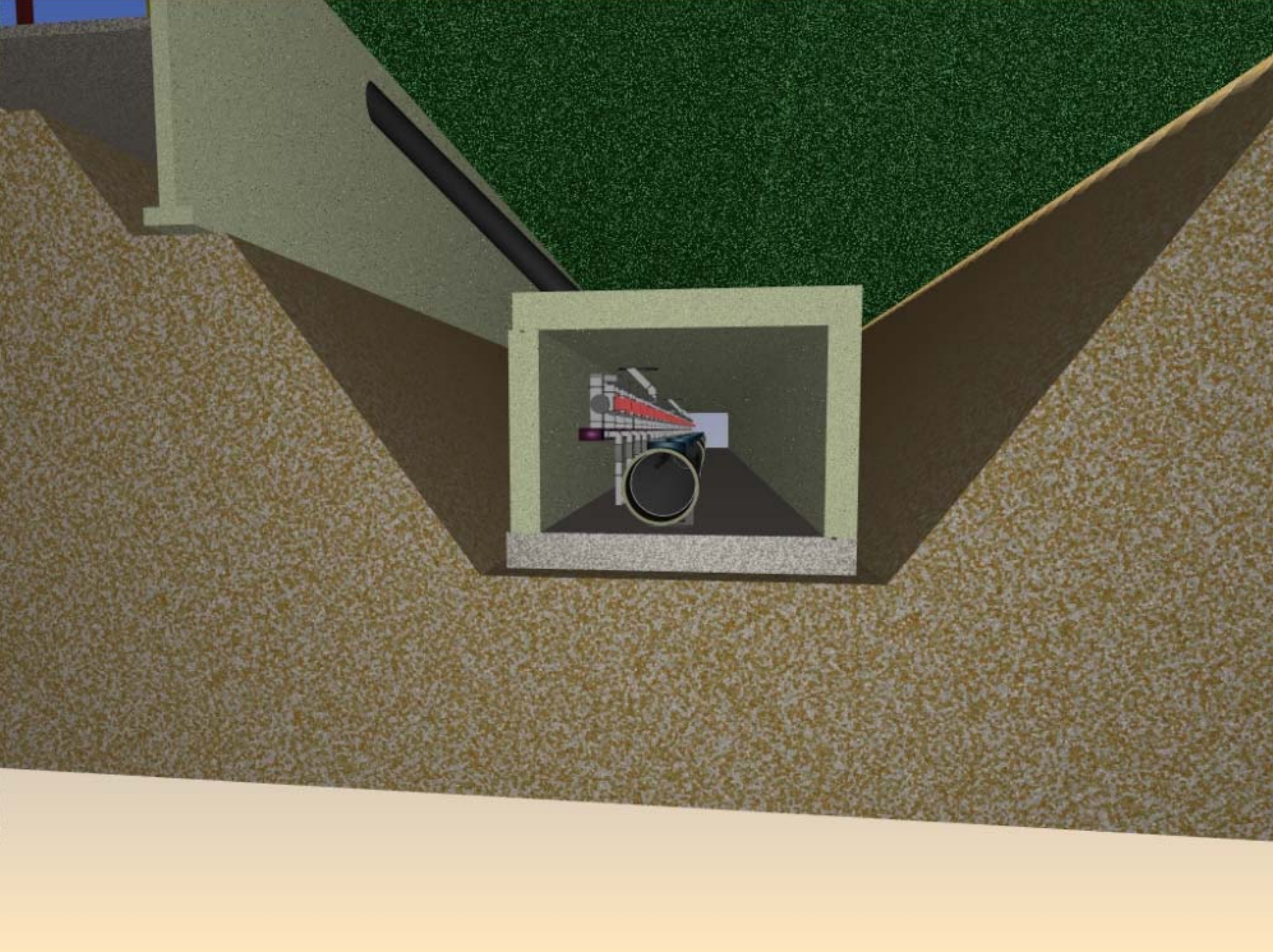
Gallery & Tunnel Cross Sections



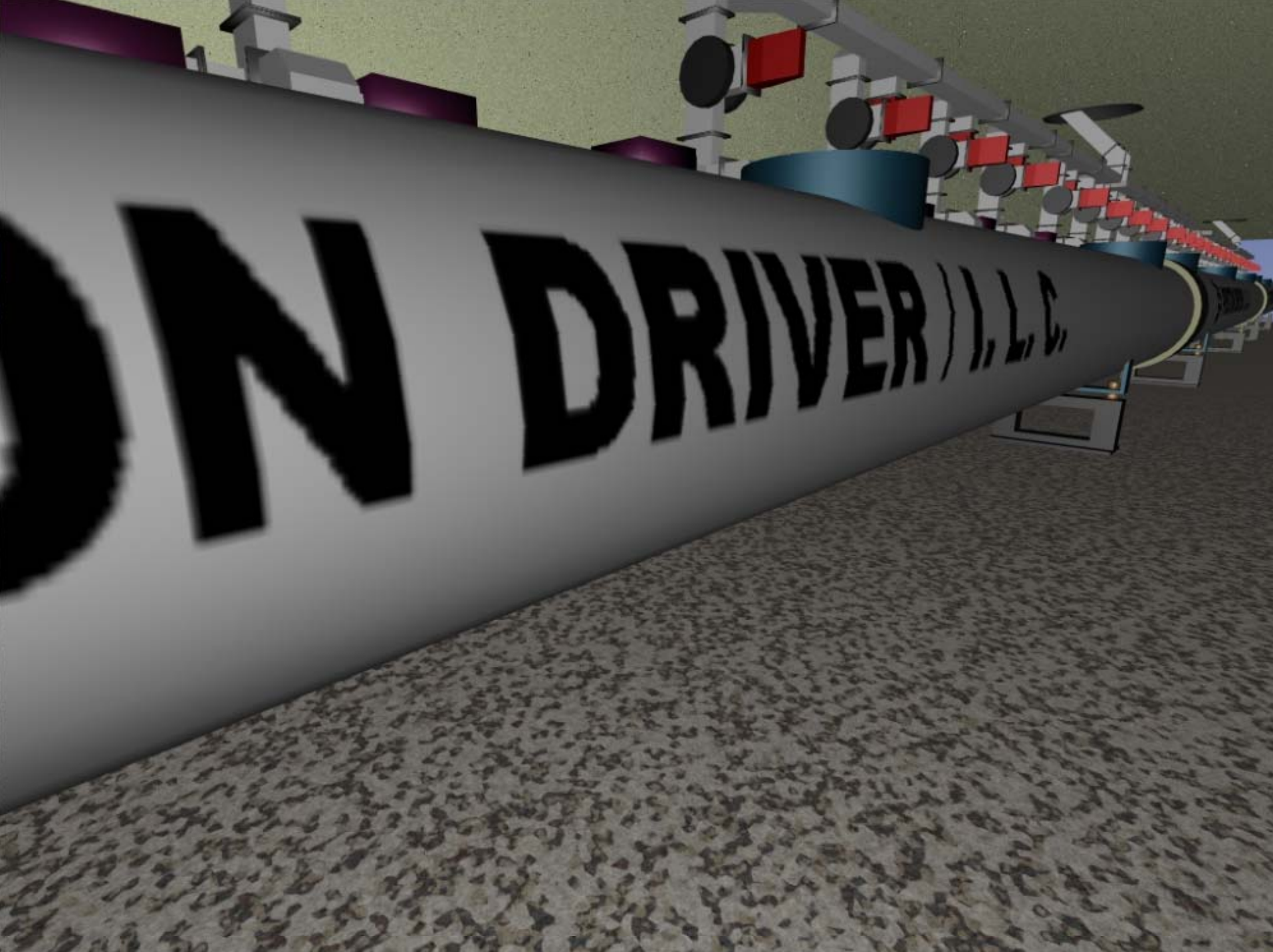




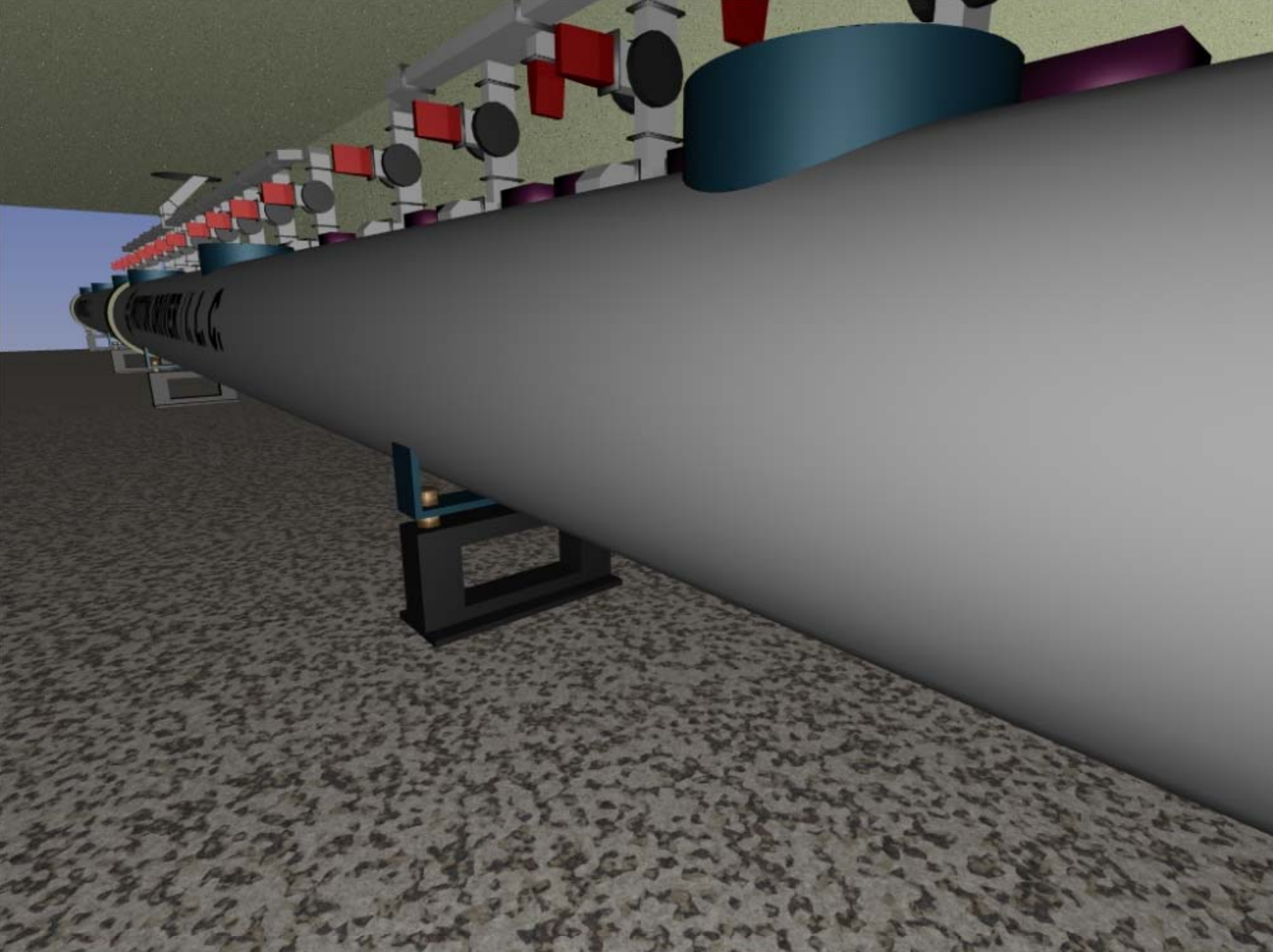








R I L L C



Two Design Points for 8 GeV Linac

Initial: 0.5 MW Linac Beam Power (BASELINE)

$$8.3 \text{ mA} \times 3 \text{ msec} \times 2.5 \text{ Hz} \times 8 \text{ GeV} = 0.5 \text{ MW}$$

Twelve Klystrons Required

Ultimate: 2 MW Linac Beam Power

$$25 \text{ mA} \times 1 \text{ msec} \times 10 \text{ Hz} \times 8 \text{ GeV} = 2.0 \text{ MW}$$

33 Klystrons Required

Either Option Supports:

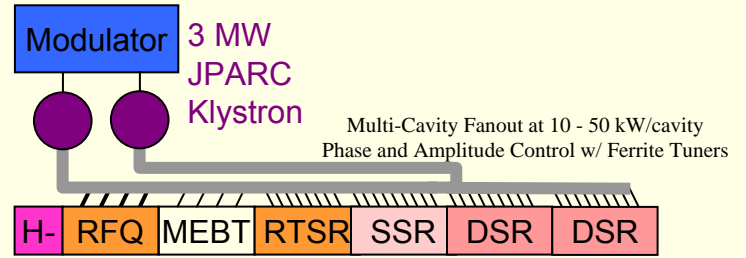
$$1.5E14 \times 0.7 \text{ Hz} \times 120 \text{ GeV}$$

= 2 MW Beam Power from Fermilab Main Injector

2 MW Ultimate
8 GeV Linac
 32 Klystrons (2 types)
 470 Cavities
 53 Cryomodules

"PULSED RIA"
 Front End Linac

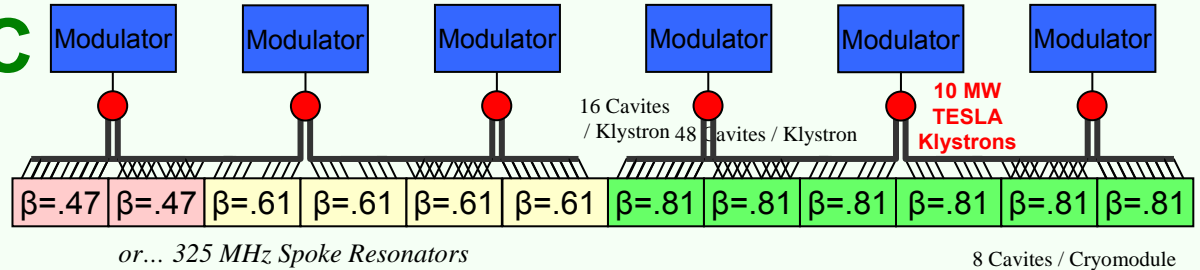
325 MHz
 0-110 MeV



$\beta < 1$ TESLA LINAC

1300 MHz 0.1-1.2 GeV

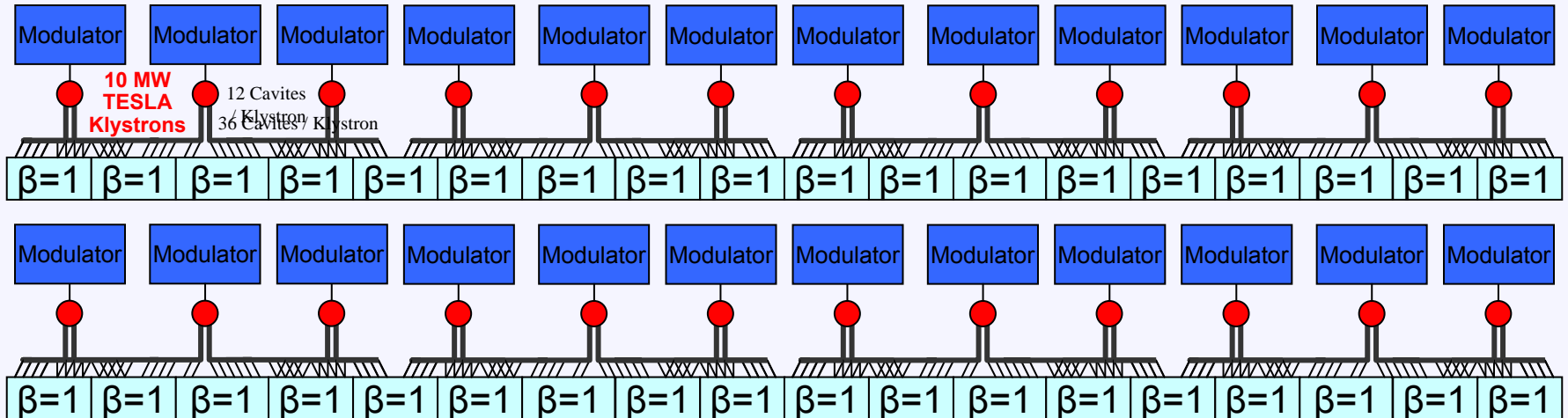
6 Klystrons
 96 Elliptical Cavities
 12 Cryomodules



TESLA LINAC

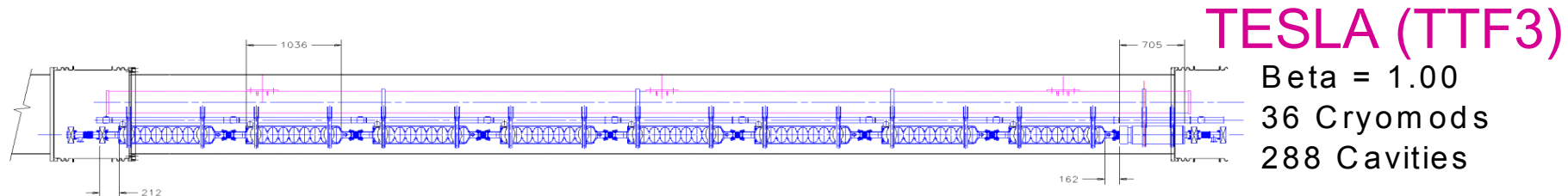
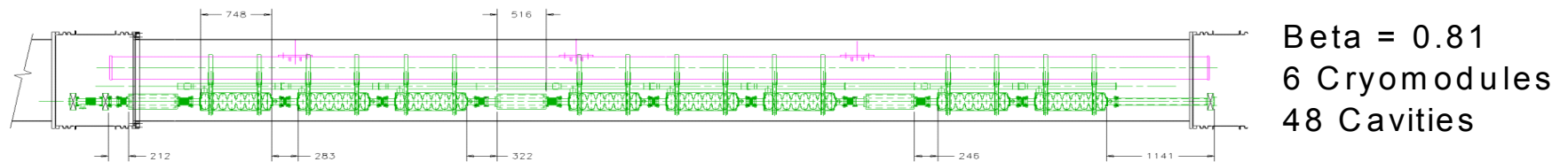
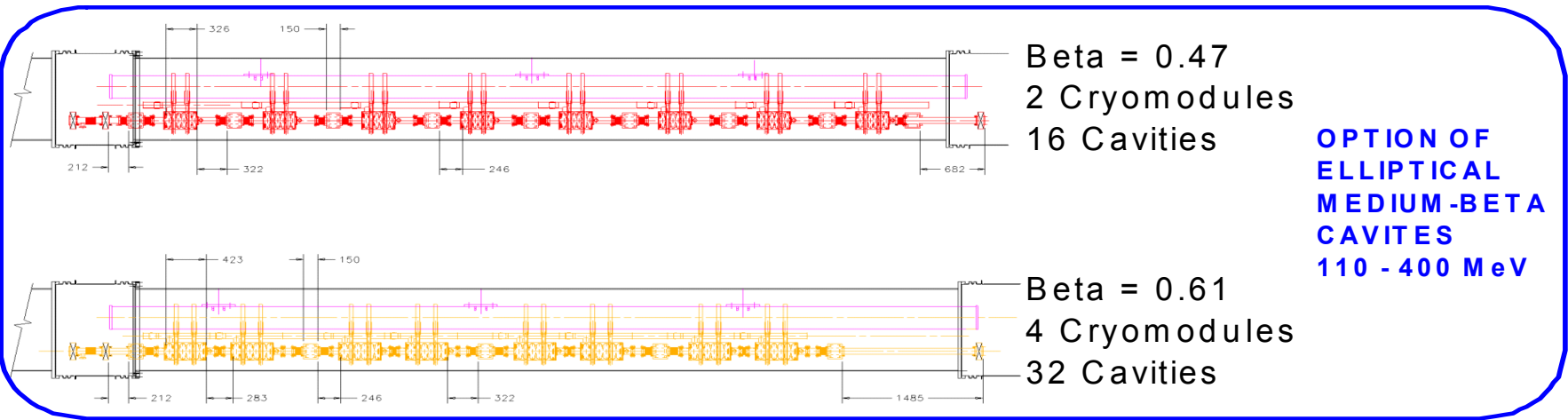
1300 MHz $\beta = 1$

8 Klystrons
 288 Cavities in 36 Cryomodules



1300 MHz Cryomodules

1300 MHz ELLIPTICAL CAVITY CRYOMODULES: 2-4 TYPES

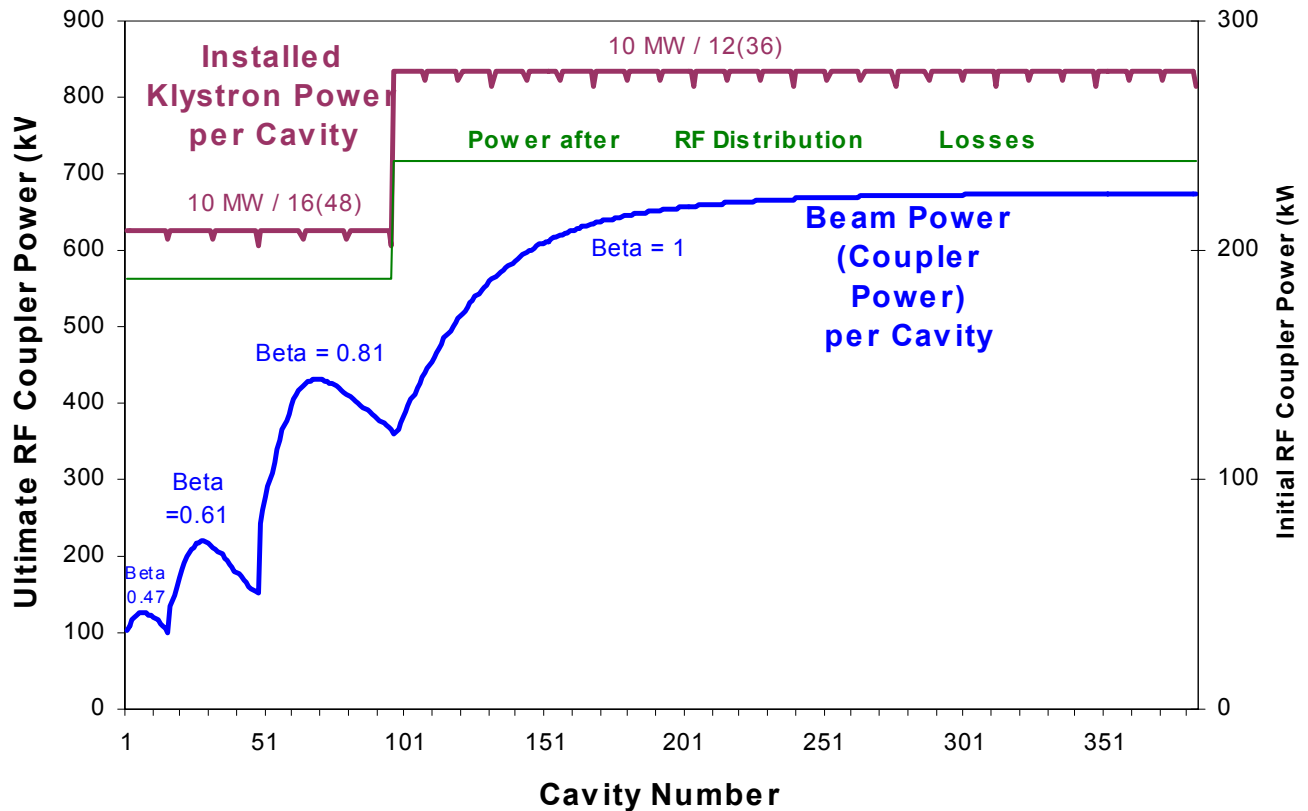


RF Power Couplers – 1300 MHz

Klystron Power per Cavity and RF Coupler (Beam) Power

Epeak = 52MV/m in all cavities, Phi_Synch = -30 to -15 degrees

Beam Current = 26mA Ultimate (8.6mA Intial)



- RF Power Required for “Initial” Scenario is met by TESLA-500 Couplers
- “Ultimate” scenario has same specs as TESLA-800 RF Power couplers