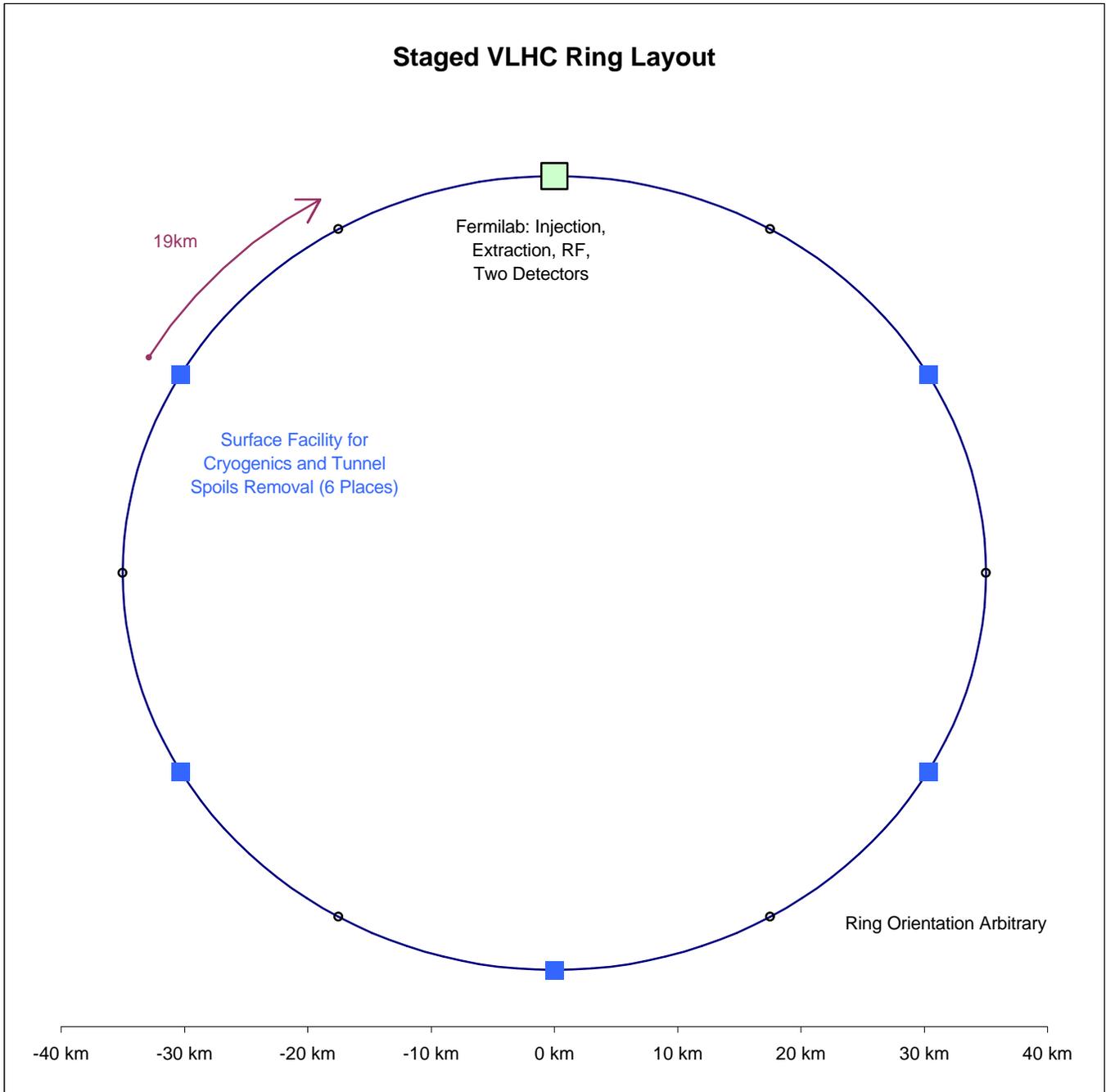


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*****Version 0.2 DRAFT PARAMETERS*****

Please Send Comments/corrections to GWF@fnal.gov

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PRIMARY PARAMETERS

	Phase I		Phase II	
Machine Type	Proton-Proton Collider		Proton-Proton Collider	
Beam Energy	20	TeV	87.5	TeV
Luminosity	1.0E+34	s-1cm-2	2.0E+34	s-1cm-2
Dipole Field	1.96	Tesla	10	Tesla
Circumference	232	km	232	km
Injection Energy	0.9	TeV	20	TeV
Injector	Tevatron		Phase I Machine	
Filling Time	60	mins	1	turn
Acceleration Time	1000	sec	1000	sec
Detectors	Two, on-site @FNAL		Same as Phase I	
Power Consumption	TBD	MW	TBD	MW

BEAM PARAMETERS

Revolution Frequency	1294	Hz	1294	Hz
Bunch Frequency	53.1	MHz	53.1	MHz
Bunch Spacing	18.8	ns	18.8	ns
# Bunches	41048		41048	
Bunch Intensity	2.89	x1E10	1.38	x1E10
Protons/Beam	11.84	x1e14	5.66	x1e14
Beam Current	245	mA	117	mA
Stored Energy/beam	3.79	GJ	7.93	GJ

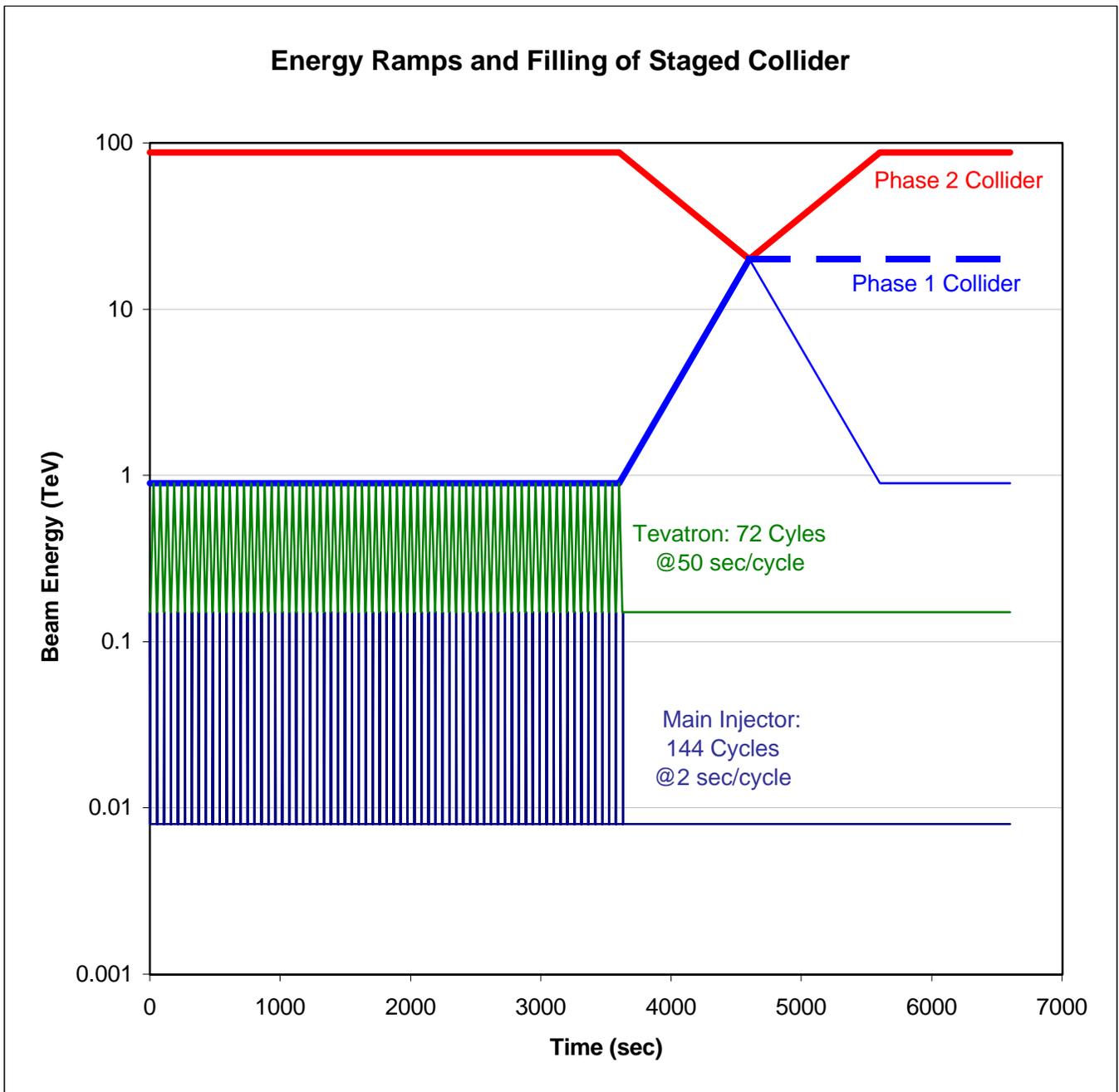
COLLISION PARAMETERS

Transv. Emittance (1-sigma norm)	3	Pi um-rad	1.5	Pi um-rad
Beta*	0.25	m	0.25	m
Head-on BB Tune Shift	0.001		0.001	
Crossing Geometry	Horizontal		Vertical	
Crossing Angle	TBD	urad	TBD	urad
Inelastic Cross Section	130	mbarns	150	mbarns
Interactions/crossing	24.5		56.5	int/xing
Interactions/cm	1.87	#/cm	6.23	#/cm
IR Power from Collision Debris	4.16	kW	42	kW

SYNCHROTRON RADIATION

Synchrotron Radiation Loss/turn	0.03	MeV	12.37	MeV
Synchrotron Radiation Power/beam	8	kW	1,450	kW
Synchrotron Radiation Power/meter/beam	0.038	W/m	6.592	W/m
Longitudinal Damping Time	inf.		1.5	hours

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LATTICE

	Phase I		Phase II	
	Combined Function		Separated Function	
Magnet Type				
Bore Separation in Arcs	15	cm	18-29	cm TBD
# of Half-cells	1710		1710	
Integer Tune	214	nu	214	nu
Fractional Tune	TBD		TBD	
Slip Factor Eta	2.19	x1e-5	2.19	x1e-5
Average Beta	233	m	270	m
Avg. Dipole Field in Arcs	1.90	Tesla	8.33	Tesla
Dipole Filling Factor (Arcs)	97%		83%	

ARC CELLS

Number of half-cells in Arcs	1568		1568	
Half Cell Length	135.5	m	135.5	m
Phase Advance/cell	90	deg	90	deg
Dipoles Per Halfcell	2		7	
Dipole Length (magnetic)	65.75	m	17	m
Bend Angle per halfcell	3.9	mrاد	3.9	mrاد
Sagitta in Halfcell	6.5	cm	6.5	cm
Beta Max	412	m	460	m
Beta Min	87	m	81	m
Beta Avg	233	m	270	m
Dispersion Max	1.35	m	1.4	m
Dispersion Avg.	1.03	m	1.1	m

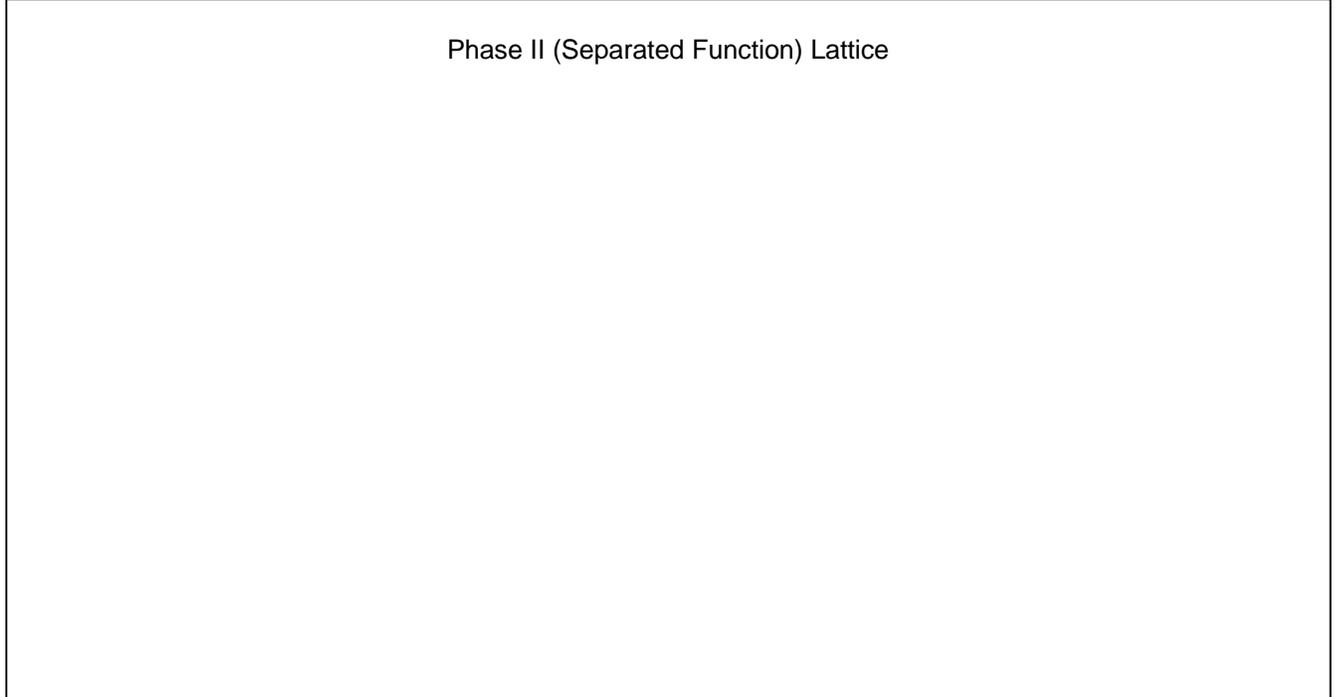
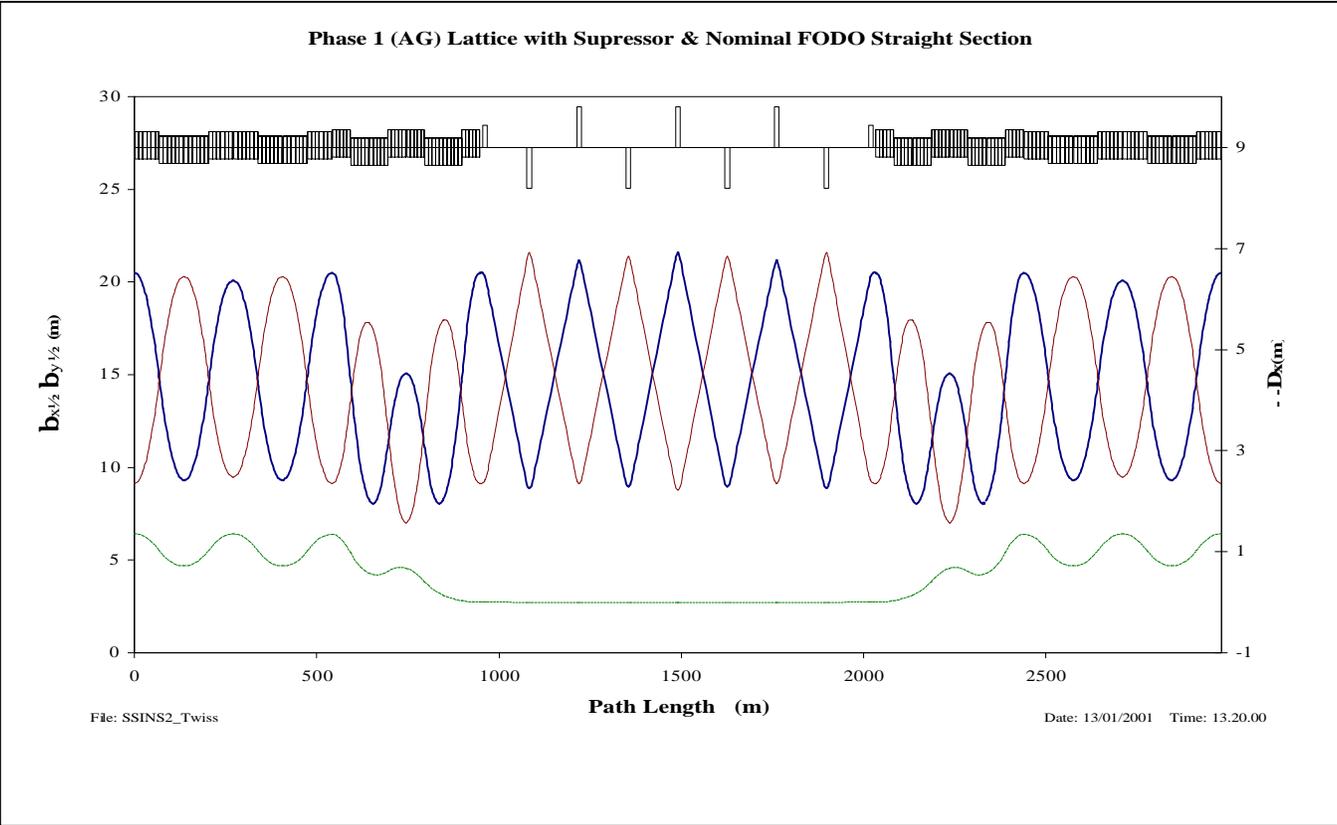
SUPPRESSOR CELLS

Number of 1/2 Cells	80		80	
Half Cell Length	101.6	m	101.6	m
Phase Advance/cell	90	deg	90	deg
Dipoles Per Halfcell	2		5	
Dipole Length (magnetic)	48.8	m	17	m
Bend Angle per halfcell	2.6	mrاد	2.6	mrاد
Sagitta in Halfcell	2.5	cm	2.5	cm
Beta Max	412	m		m
Beta Min	50	m		m
Beta Avg	231	m		m
Dispersion Max	1.35	m		m
Dispersion Avg.	0.675	m		m

STRAIGHT SECTION CELLS (Nominal FODO)

Number of 1/2 Cells	80	TBD	80	
Half Cell Length	135.5	m	135.5	m
Phase Advance/cell	90	deg	90	deg
Beta Max	460	m	460	m
Beta Min	81	m	81	m
Beta Avg	270	m	270	m

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	Phase I		Phase II
UNDERGROUND CONSTRUCTION			
Collider Tunnel			
Tunnel Depth (Avg.)	120	m	
Finished Diameter	3.75	m	12 ft
Arc Radius of Curvature R_Arc	35	km	
Arc Circumference	220	km	
Straight Sections (number)	10		
Straight Section (Total length)	12	km	
Circumference overall	232	km	
Maximum Line-of-sight in Tunnel	1025	m	
Number of Muck removal Sites	6		
Distance Between Mucking Sites	38	km	23.6 mi
Tunnel Drive Lengths	19	km	11.8 mi
Emergency Egress for Construction	4.75	km	3.0 mi
Emergency Egress for Operations	9.5	km	5.9 mi
Excavated Volume per Site	419,697	m ³	20,985 Truckloads
Collider Tunnelling Schedule (Target)			
Arc Tunnel Construction time	7.5	yr	
Number of Simultaneous TBM Sites	3		1 Bypass Line
Site Prep and Shaft Excavation	0.5	yr	0.5 yr
TBM Setup & Boring (first Drive)	1.5	yr	0.5 yr
TBM Setup & Boring (2nd Drive)	1.5	yr	0.5 yr
Demobilization	0.25	yr	0.25 yr
Total Time at One Site	3.75	yr	1.75 yr
On-Site Underground Construction			
Transfer Line Length (CW+CCW)	7	km	-
Abort Line Length	2x3	km	-
Bypass Line Length	-		6 km
Number of On-site Shafts	TBD		TBD
Detector Cavern Dimensions (2)	30x40x80	m	30x40x80 m
Beam Absorber Hall Dimensions	16x16x40	m	16x16x40 m
RF Klystron Gallery Dimensions	4x5x20	m	4x5x20 m
Power Supply Room Dimensions	4x5x20	m	4x5x20 m
Transfer Lines / Equipment Ramps			
Number	2		
Length	3	km	
Location	FNAL	on site	
Occupancy with Tevatron Running	unlimited		
Max. Slope	4	%	
Minimum Radius of Curvature	1	km	

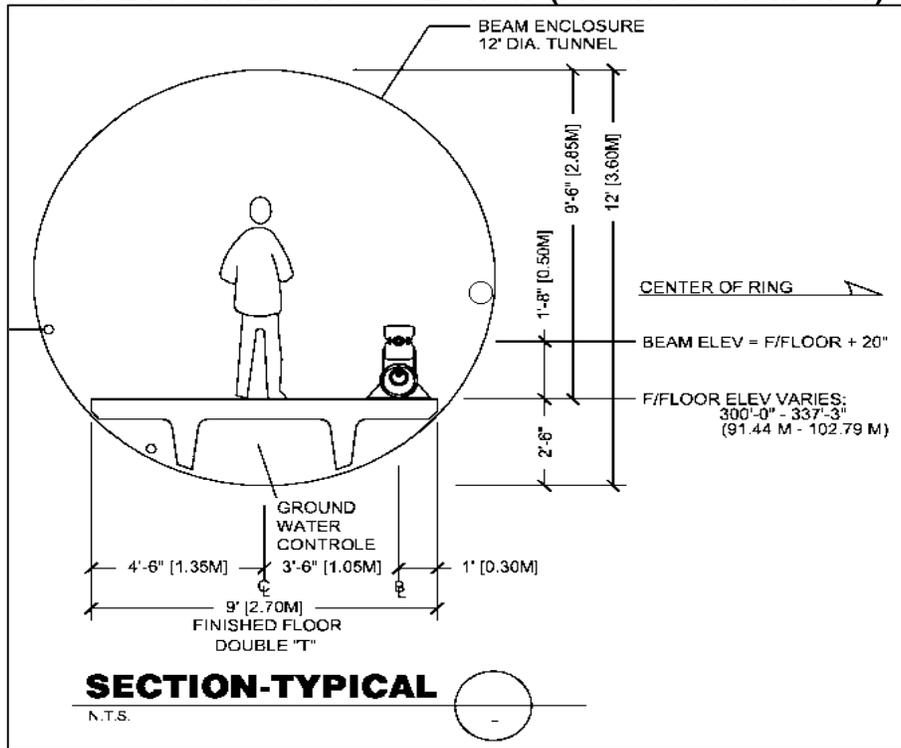
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	Phase I	Phase II
TUNNEL UTILITIES		
Collider Tunnel		
Nominal Finished Diameter	m	
Guaranteed Clear ID WRT ideal	m	
Floor Elevation	m	
Floor Width	m	
Alignment & Survey		
monument spacing (half-cell)	135 m	
site riser spacing (during construction)	5 km	
site riser spacing (after construction)	10 km	
monument accuracy		
over 1km length	0.25 mm RMS	
over 10km length	2 mm RMS	
ring-wide	20 mm RMS	
Electrical Power		
Cryoplant Power Feed	from surface grid	from surface grid
Ramping Power Supplies	FNAL on-site	from surface grid
Welding Supplies	on Installation Vehicles	on Installation Vehicles
Work Lighting	on Installation Vehicles	on Installation Vehicles
Emergency Lighting	at quad locations	at quad locations
HVAC	TBD	
Arc Instrumentation Power		
nominal avg	1 kW/quad	
installed	2 kW/quad	
Tunnel Air Circulation		
De-Watering		
contractual maximum water inflow		
nominal water inflow		
sumping method		
spacing		
locations		
AC power for sumps (nominal)		
emergency sump volume		
max time of power loss without flooding		
Emergency Lighting		
location		at quad locations
type		battery backup fluorescent
recharging		arc instrumentation power
time of installation		BOD
Fire Detection		
method	MI-style Waxed cable	
readout spacing		
time of installation		
ODH detection		
method		
readout spacing		
time of installation		

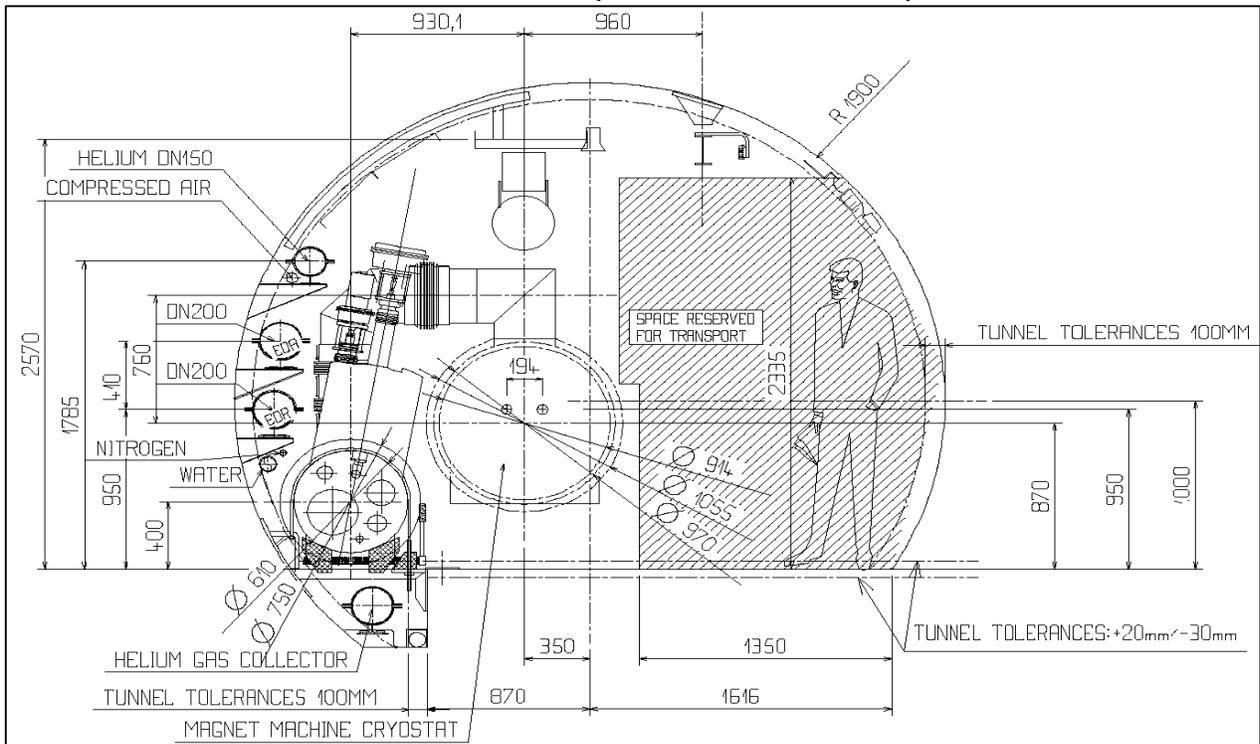
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PHASE I TUNNEL CROSS SECTION (Placeholder from 3TeV)



PHASE II TUNNEL (Placeholder from LHC)

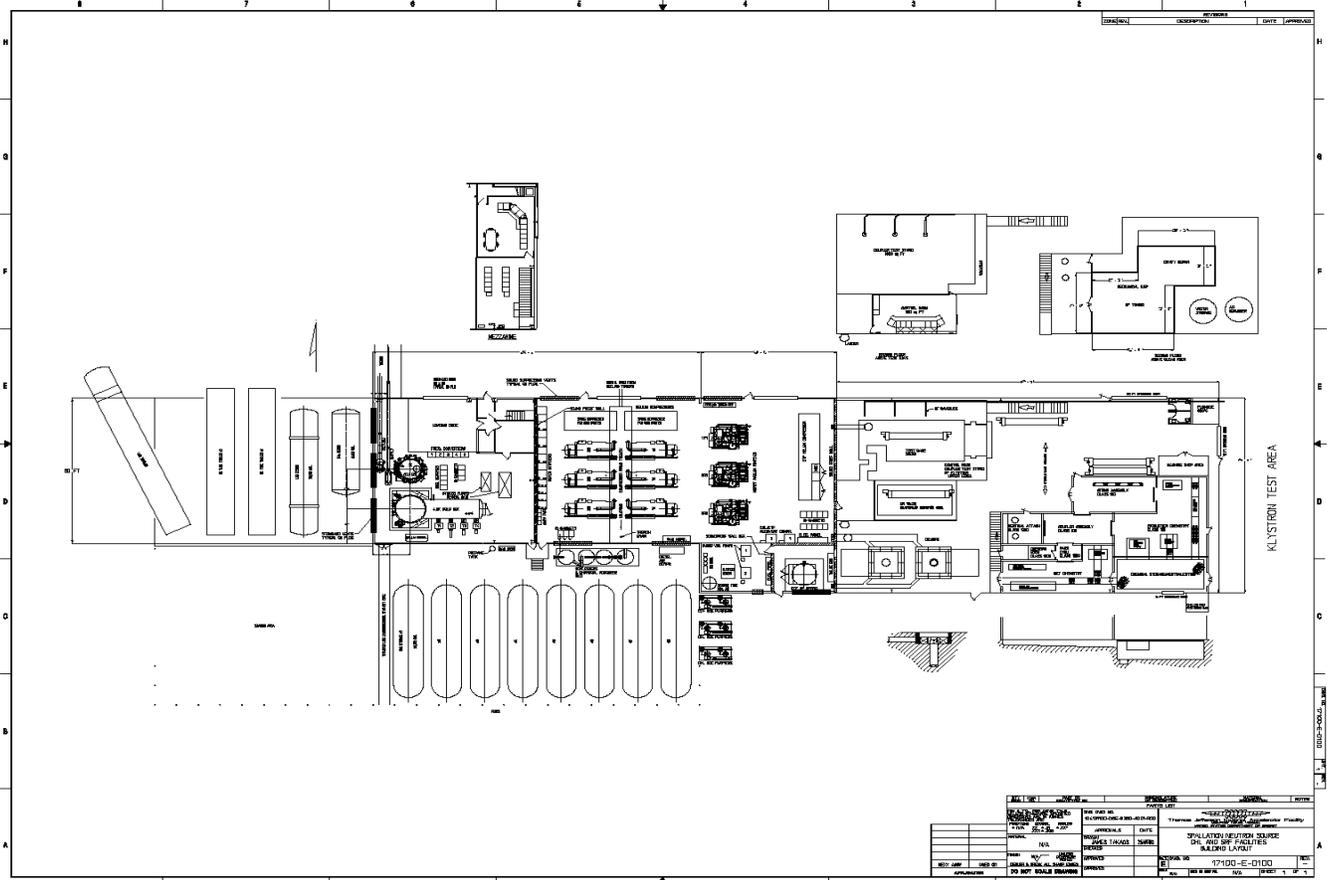


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OFF-SITE FACILITIES

	Phase I	Phase II
Number of Off-site Surface Facilities	5	5
Off-Site Surface Facility Footprint	50 acres	50 acres
Buildings	1 cryoplant	5 cryoplant
Sq. ft. Total	12,000 sq. ft.	162,000 sq. ft.
Number of Access Shafts	2	2
Equipment Access Shaft Diameter	20 m TBD	20 m TBD
Manned Access Shaft Diameter	3 m TBD	3 m TBD
AC Power per Site	2 MW	25? MW
Cooling Ponds	2 acres	25? Acres
Cryo Tank Farms	TBD 25k gal tanks	TBD 25k gal tanks

PHASE I CRYOPLANT (Placeholder from SNS)



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ON-SITE FACILITIES

Detector Surface Assembly Halls

Number of Detectors	2	
Assembly / Crane Bldg sq. ft.	10,000	sq. ft
Collaboration Offices Occupancy	200	
Parking Lot Size	100	cars

Magnet Assembly Building / Ramp Headhouse

Location	CW Transfer Line ramp	
Dimensions	TBD	

Auxiliary Installation Ramp Headhouse

Location	CCW Transfer Line ramp	
Dimensions	TBD	

On-Site Cryo/Power Headhouse

Location	Beam Crossover	
Dimensions	TBD	
Number of Access Shafts	2	
Equipment Access Shaft Diameter	20	m TBD
Manned Access Shaft Diameter	3	m TBD

Beam Absorber Shaft Headhouse

Location	Shaft Above Beam Absorber	
Dimensions	TBD	
Number of Access Shafts	2	
Equipment Access Shaft Diameter	20	m TBD
Manned Access Shaft Diameter	3	m TBD

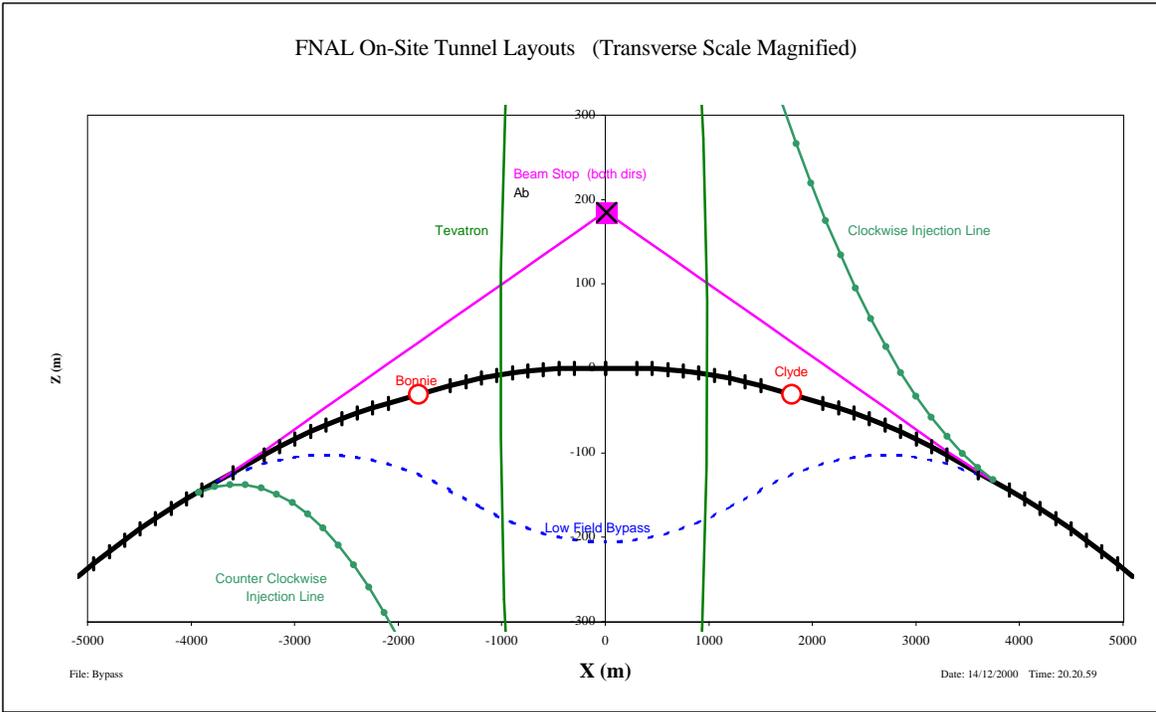
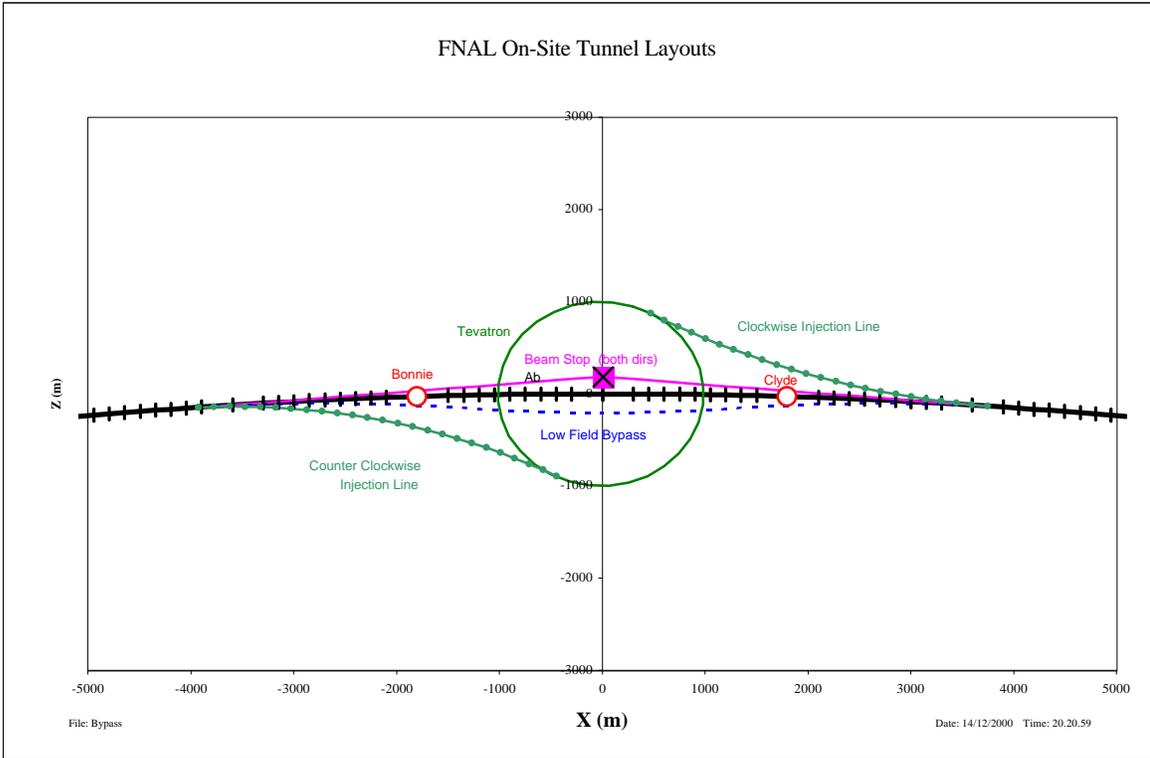
Utility Straight Shaft Headhouse

Number	2	
Locations	Above Utility Straight on site boundary	
Dimensions	TBD	
Number of Access Shafts	2	
Equipment Access Shaft Diameter	20	m TBD
Manned Access Shaft Diameter	3	m TBD

Bypass Line Headhouse (Phase 2)

Location		Midpoint of Bypass Line
Dimensions		TBD
Number of Access Shafts	2	
Equipment Access Shaft Diameter	20	m TBD
Manned Access Shaft Diameter	3	m TBD

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POWER CONSUMPTION

	Phase I		Phase II	
Main Injector (5% Duty Cycle)	2	MW	2	MW
Tevatron (Cold standby)	10	MW	12	MW
Ring Cryoplants	9	MW	110	MW
Detectors & IR's incl. Cryo	5	MW	10	MW
Power Supplies (ramping)	5	MW	200	MW
Power Supplies (collision)	0.3	MW	2	MW
RF(ramping)	20	MW	40	MW
RF(collision)	10	MW	20	MW
Tunnel HVAC	TBD	MW	TBD	MW
Tunnel Sumps, etc.	TBD	MW	TBD	MW
Peak Ramping Power	TBD	MW	TBD	MW
Avg. Power During Collisions	TBD	MW	TBD	MW

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MAGNETS

ARC DIPOLE MAGNETS

	Phase I		Phase II	
Number of Magnets in Ring	3136		10976	
Bend Field	1.96	Tesla	10	Tesla
Arc Dipole Magnet Length	65.75	m	17	m
Gradient	+/-9.3	T/m	0	T/m
Sextupole	+20/-155	T/m ²	0	T/m ²
Magnetic Aperture (H x V)	30 x 20	mm	30 x 30	mm
Physical Aperture (H x V)	28 x 18	mm	28 x 18	mm
Operating Current	100	kA	25	kA
Number of Turns(both Bores)	1		TBD	
Inductance (both Bores)	2.9	uH/m	2800	uH/m
	0.19	mH/dipole	47.6	mH/dipole
Stored Energy (both bores)	15	kJ/m	875	kJ/m
	0.95	MJ/dipole	14.88	MJ/dipole

DISPERSION SUPPRESSOR DIPOLE MAGNETS

Number of Magnets in Ring	160		400	
Bend Field	1.76	Tesla	10	Tesla
Gradient	+/-16.7	T/m	0	T/m
Sextupole	0	T/m ²	0	T/m ²
Dispersion Suppressor Magnet Length	48.8	m	16	m
Magnetic Aperture (H x V)	30 x 20	mm	30 x 30	mm
Physical Aperture (H x V)	28 x 18	mm	28 x 18	mm
Operating Current	100	kA	25	kA
Number of Turns(both Bores)	1		TBD	
Inductance (both Bores)	2.9	uH/m	2800	uH/m
	0.14	mH/dipole	44.80	mH/dipole
Stored Energy (both bores)	15	kJ/m	875	kJ/m
	0.71	MJ/dipole	14.00	MJ/dipole

QUADRUPOLE MAGNETS

Number of Magnets in Ring	85		1700	
Gradient	TBD	T/m	400	T/m
Quadrupole Magnet Length	10.0	m	10	m
Magnetic Aperture (H x V)	30x20	mm	30 x 30	mm
Physical Aperture (H x V)	25x25	mm	25 x 20	mm
Operating Current	100	A	25	kA
Number of Turns(both Bores)	TBD		TBD	
Inductance (both Bores)	TBD	uH/m	2800	uH/m
	TBD	mH/dipole	28.00	mH/dipole
Stored Energy (both bores)	TBD	kJ/m	875	kJ/m
	TBD	MJ/dipole	8.75	MJ/dipole

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RING CRYOGENICS

	Phase I		Phase II	
Superconductor Temperature	4.5-6	K	4.5-5.5	K
Shield Temperature	40-60K	K	40-60K	K
Beam Screen Temperature	(Warm bore)		75-85	K
Refrigeration (4.5K equiv)	(nominal)	kW		kW
	(Installed)	kW		kW
AC Power (nominal)		MW		
Cryo Plant Efficiency (fraction of Carnot)	0.3		0.3	
Cold Mass (5K)				
Cold Mass (50K)				
Helium Inventory				
Cool Down Time				
Number of Ring Cryoplants	6		24	
Number of Cryoplant locations	6		6	
Number of Cryoplants per location	1		4	
Cryoplant Size (4.5K equivalent)	8	kW	25	kW

Ring Cryogenic System Totals

Nominal Cryogenic Load (4.5K equivalent)	48	kW	600	kW
Nomnal AC Power for Cryogenics	10.7	MW	133.3	MW
Efficiency (% of Carnot)	30%		30%	
AC Power Per Location	1.8			

Cryoplant

Contingency + Overhead Factor			1.5	
Nominal Cryogenic Power		kW@4.5K equiv		
Nominal Refrigeration Power		kW@4.5K equi	150	kW@4.5K eqi

5K Flow System

Coolant	Supercritical He	
Operating Temperature	4.5-6	K
Operating Pressure	2.5-5	Bar

Heat Inflow

Shield Flow System

Beam Screen Flow System

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IR CRYOGENICS

Phase I

Phase II

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	Phase I		Phase II	
POWER SUPPLIES				
Magnetic Stored Energy	3.1	GJ/ring	160.4	GJ/ring
Ramping Time	1000	sec	1000	sec
Ramping Power per Ring	3	MVA/ring	160	MVA/ring
ARC DIPOLE POWER SUPPLY				
Number of Supply Locations	1	at FNAL	6	at cryoplants
Number of Supplies Per Location	1		4	
Total Number of Supplies	1		24	
Ramping Power per Supply	3.1	MVA	6.7	MVA
Power Supply Voltage	62	volts	535	volts
Power Supply Current	100	kA	25	kA
Holding Voltage per Supply	4.69	V	4.67	V
Current Leads	0.18	V	0.1	V
Series Pass SCR's	2	V	2	V
Bus Work & Filters	1	V	1	
Holding Supply Internal Losses	1.5	V	1.5	V
SC Splice Drops	0.013	V	0.067	
Holding Power Per Ring	469	kW	2800	kW
ARC QUADRUPOLE POWER SUPPLY				
Magnetic Stored Energy	0		10.0	GJ/ring
Ramping Time	-		1000	sec
Ramping Power/ring	0		10.0	MVA
Number of Supply Locations	0		6	at cryoplants
Number of Supplies Per Location	0		2	
Number of Supplies	0		12	
Ramping Power per Supply	-		0.8	MVA
Power Supply Voltage	-		33	volts
Power Supply Current	-		25	kA
Corrector Magnet Supplies				

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	Phase I	Phase II
BEAM VACUUM SYSTEM		
Vacuum Requirements for Initial Operations		
Beam Lifetime from Vacuum	20 hrs	20 hrs
Luminosity Lifetime from Vacuum	10 hr	10 hr
Operating Current	100% of design	100% of design
Fraction of Beam Loss Power into 5K	5%	100%
Cryogenic Heat Load into 5K	0.02 W/m	TBD W/m
Fraction of 5K Cryo Load from Beam Loss	40%	TBD
Vacuum Requirements after 6 Months		
Beam Lifetime	200 hr	TBD hr
Luminosity Lifetime from Vacuum	100 hr	TBD hr
Operating Current	100% of design	TBD of design
Fraction of Beam Loss Power into 5K	5%	TBD
Cryogenic Heat Load into 5K	0.002 W/m	TBD W/m
Fraction of 5K Cryo Load from Beam Loss	4%	TBD
Beam Pipe		
Operating Temperature		
Continuous Pumping Method		
pumping speed		liters/sec/m
Distributed Pumping		
Spacing		
Speed		
Photodesorption		
critical energy		
photon flux		
synch rad power		l/sec/m N2 equiv

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	Phase I	Phase II
QUENCH PROTECTION		
Length of Quench Protection Cell	Whole Ring	19 km
Quench Heaters	at Dump Resistors	on each magnet
Peak Temperature in Quench	270 degK	TBD degK
Voltage to Ground	+/-2.5 kV to ground	+/- 1 kV to ground
Peak Pressure in Quench	30 Bar	TBD Bar
System Relief Pressure	40 Bar	TBD Bar
Recovery Time	2 hours	TBD Hours
QUENCH DETECTION		
Quench Detection Method	Voltage Balance	Voltage Balance
Quench Detection Locations	One, at Power Supply	Each Halfcell
Redundancy	3 fold	2 fold
Number of Circuits	3 per Ring	3136 per ring
Quench Detection Threshold	1 V	1 V
Inductive Bucking Voltage	62 V	4.0 V
Response Time	0.1 sec	0.01 sec
ENERGY DUMP RESISTORS		
Number of Dump Resistors	24	24
Location	Every 10km in arcs	At Power Supplies
Energy Per Dump	129 MJ	6681 MJ
Inductance per dump	0.03 H	60 H
Dump Voltage	+/-2.5 kV to ground	+/- 1 kV to ground
Dump Time	1 sec	250 sec
Dump Switch Type	Cryogenic (quench switch)	Room Temp SCR Switch
Dump Resistor Coolant	Helium	Water Cooled
Forward Voltage Drop	10 uV	2 V
CURRENT LEADS (ARCS)		
Number of Lead Pairs	1	36
Operating Current	100 kA	25 kA
Total Superconducting Leads	100 kA-pair	900 kA-pair
Lead Type	Normal	HTS
LHe Consumption/kA	2 l/hr/kA-pair	0.25
LHe Consumption (all leads)	200 liters/hr	225 liters/hr
50K Heat Load / kA	0 Watts/kA	
50K Heat Load (all leads)		
Cryo Wall Power (all current leads)	kW	kW

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ARC INSTRUMENTATION

Arc Instrumentation Modules

	Phase I	Phase II
Location	Each "quad location"	Each "quad location"
Spacing	135.5 m	135.5 m
Number in Ring (including straights)	1648	1648
Packaging	Module in Hole-in-Wall	Module in Hole-in-Wall
Hole Diameter	0.4 m	0.4 m
Hole Depth	2 m	2 m
Module Length	0.8 m	0.8 m
Module Power Dissipation	200 W max	200 W max
Cooling	Tunnel Air	Tunnel Air
Module Power Consumption (incl load)	1200 W max	500 W max
Maintenance Method	"Black Box"	"Black Box"
Fault Tolerance	Ring OK if module dead	Ring OK if module dead

Cable Plant

Location	on Magnet	Cable Trays
Harness Fabrication	Commercial Vendor	In Tunnel
Installation & Test	at Factory	In Tunnel

Beam Position Monitor

Pickup Type	X-Y Buttons	X-Y Buttons
Beam RF Structure	53 MHz Burst/DC	53 MHz Burst/DC
First Turn Capability	Yes	Yes
Number of Channels	4 (+/-X, +/-Y)	4 (+/-X, +/-Y)
in-situ Calibration	60dB all channels	60dB all channels
Cable Length to Electronics	5 m	5 m
Technology	Log Amp	Log Amp
Readout	Sum & Difference of logs	Sum & Difference of logs
Resolution	12 bits	12 bits
	0.01 dB	0.01 dB
	50 microns	50 microns
Input Filter Bandwidth	40-60 MHz	40-60 MHz
Triggering	Ext. Synch or self-triggered	Ext. Synch or self-triggered
Input Impedance	50 Ohms	50 Ohms
Input Protection/clamping	TBD V	TBD V

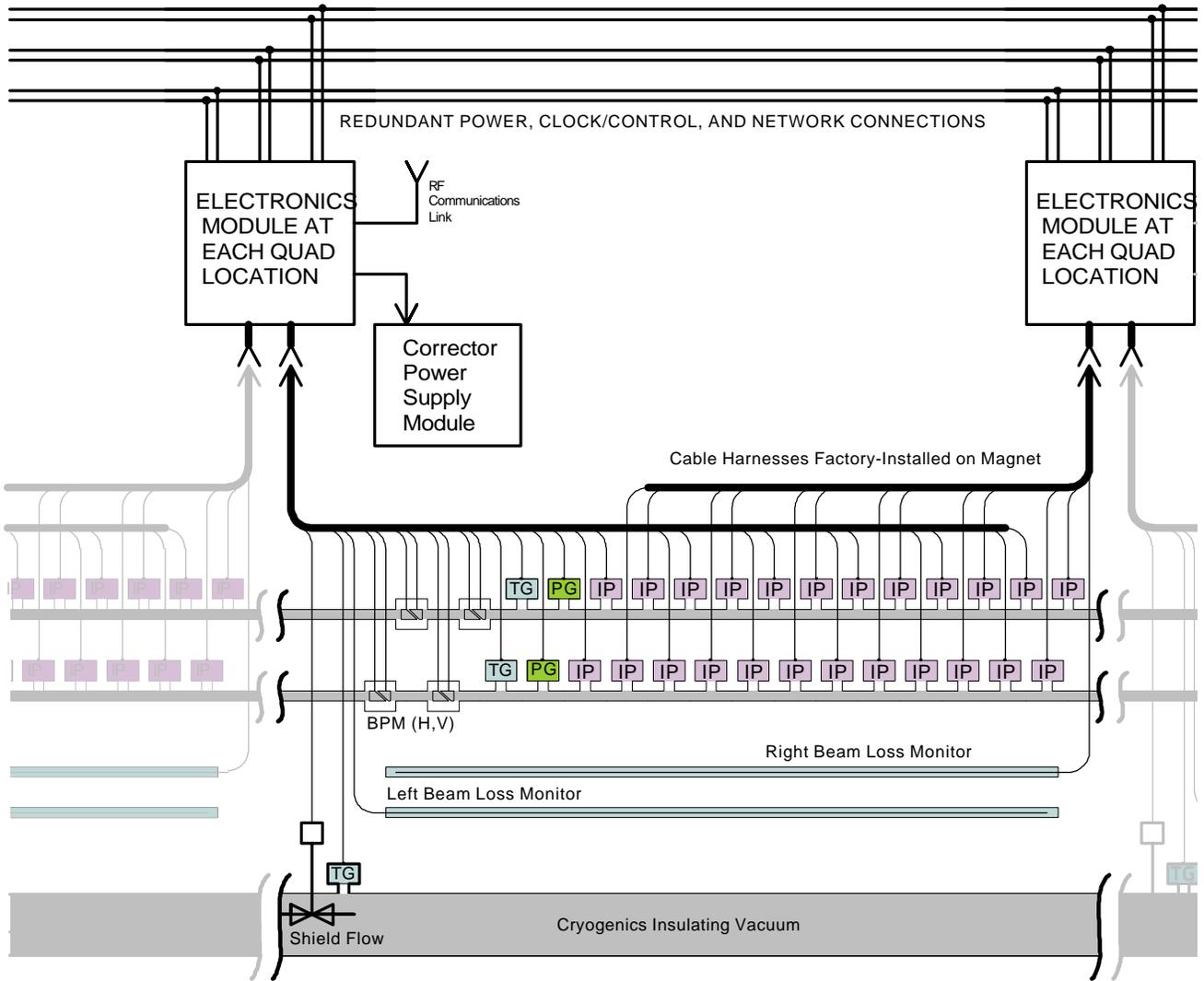
Beam Loss Monitor

Technology	Ionization Chamber	Ionization Chamber
Operating gas	Ar, permanently sealed	Ar, permanently sealed
Operating HV	2.5 kV	2.5 kV
Mechanical	Alum. Wall Coax Cable	Tevatron (bulb) Style
Location	Full Length of Magnet	Quad Locations
Number per Quad Location	2 (1/bore)	1
Redundancy	yes, x2	no (magnet quenches)
Recalibration Interval	>5 yrs	>5 yrs
Recalibration Method	drive thru with source	drive thru with source
Readout	resettable integrator	resettable integrator
Adjustable Gain	x10,x100	x10,x100
Max Digitization Rate	53 MHz	53 MHz

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ARC INSTRUM. (cont'd)	Phase I	Phase II
Ion Pump HV		
Voltage	3.5 kV	-
Number of Channels	12	-
Bulk Supply Current	150 mA	-
Power during Startup	100W to 5 pumps	-
Power during Operation (all channels)	~0.5 W	-
Shutdown (HV Reed relay)	independent per pump	-
Current Readback	independent per pump	-
Full Scale Current	100 mA	-
Resolution (LSB)	1 uA	-
Redundancy	link to adjacent halfcell	-
Beam Vacuum Monitoring		
TC Gauge	2 per halfcell	2 per halfcell
Ion Gauge	2 per halfcell	2 per halfcell
Insulating Vacuum Monitoring		
TC Gauge (magnet pipe)	1 per halfcell	1 per halfcell
TC Gauge (cryo service pipe)	1 per halfcell	1 per halfcell
Cryo Temperature Monitors		
Temperature Measurement	1 per halfcell	10 (2 per dipole)
Location	Shield Flow outlet	SR absorbers
Cryo Valve Controls		
Location	every other halfcell	10 (2 per dipole)
Function	shield flow control	SR Absorber Flow
Stepping Motor Control		
Function		SR absorber positioning
Number of Channels		10 (2 per dipole)
Limit switches and/or LVDT readback		10 (2 per dipole)
DAQ/Signal timing Functions		
Beam Extraction Synch on same cable?		
Modules individually addressable w/ redundant network links		
DAQ data collection of BPM/BLM following each beam transfer (every 30 seconds)		
Miscellaneous functions:		
Tunnel Temperature readout		
RF Link for Tunnel Communications		
Microphone/speaker		
Integrated radiation dose readout	0-10 Mrad	
uncommitted digital A/D I/O?	TBD	
expandability	daughter card	

ELECTRONICS MODULE AT EACH ARC HALF-CELL (~1



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	Phase I		Phase II	
RADIO FREQUENCY SYSTEM PARAMETERS				
Long Emittance eLrms	2	eV-sec	2	eV-sec
RF Multiple of 53MHz	9		9	
RF Frequency fRF	477	MHz	477	MHz
RF Harmonic Number hRF	3.69E+05		3.69E+05	
Acceleration Voltage/turn	15.5	MV/turn	67.6	MV/turn
Acceleration Power (both beams)	7.6	MW	15.9	MW
Synchronous Phase		deg		deg
RF at Injection				
RF Voltage VRFinj	50	MV	50	MV
Synch Tune NuSynchInj	8.45	x10-3	1.79	x10-3
Synch Freq fSynchInj	10.93	Hz	2.32	Hz
Bucket Area AbucketInj	5.0	eV-S	23.7	eV-S
Bunch Length SigmaSinj	14.2	cm	6.6	cm
Momentum Spread dPPinj	149	x1e-5	15	x1e-5
RF at Collision				
RF Voltage VRF	50	MV	50	MV
Synch Tune NuSynch	1.79	x10-3	0.86	x10-3
Synch Freq fSynch	2.32	Hz	1.11	Hz
Bucket Area Abucket	23.7	eV-S	49.6	eV-S
Bunch Length SigmaS	6.6	cm	4.5	cm
Momentum Spread dPP	15	x1e-5	5	x1e-5
Synchrotron Power (both beams)	17	kW	2899	kW

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INJECTION LINES

Phase I

Phase II

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BEAM ABORT	Phase I	Phase II
Number of abort Lines	2	
Number of Beam Absorbers	1 (shared)	
Beam Line Length (each line)	3 km	
Beam Absorber Location	on site at FNAL	
Beam Absorber Depth Underground	120 m	
Maximum Stored Energy Per Beam	3.8 GJ	
Minimum Beam Emittance (RMS norm)	1.0 pi mm-mr	
Recovery Time at full energy	2.0 hr	
Power Extracted During Recovery	0.5 MW	
Typical (Decelerated) Beam Energy	0.2 GJ	
Typical Rep Rate (shots per day)	6	
Average Beam Power	13 kW	
Absorber Configuration	Main Injector Style Two absorber cores in shared shield	
Overall Sarcophagus Dimensions	10x10x25 m	
Enclosure Inside Dimensions	16x16x40 m	
Enclosure Concrete Wall Thickness	1 m	
Beam Sweeper		
Pattern	circular fixed radius	
Number of Sweepers	2 X+Y	
Angular Kick	0.3 mrad	
Sweep Radius at Absorber	1 m	
Sweep ratio	2 sweeps/rev	
Sweep Frequency	2587.194 Hz	
Sweep Speed on Dump	16256 m/s	
Sweep Radius at Beam Window	0.05 m	
Tesla-meters	20	
Sweeper Bend Field at Full Energy	1 Tesla	
Number of Modules	10	
Module Length	2 m	
Redundancy	8 of 10 modules OK	
Sacrificial Plug for Sweeper Failure		
Material	pyrolytic Graphite	
Distance Downstream of Sweeper	160 m	
Sweep radius Around Plug	80 mm	
Plug Diameter	50 mm	
Plug Length along Beamline	10 m	

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	Phase I	Phase II
BEAM ABORT (cont'd)		
Beam Window		
Distance Downstream of Sweeper	150 m	
Sweep radius at Window	45 mm	
Beam Spot Size at Window	0.5 mm	
Material	Inconel	
Peak Temperature Rise	TBD	
Result of Sweeper Failure	hole <5mm	
Vacuum Protection Backup	redundant automatic gate Valve	
Absorber Core		
Material	pyrolytic Graphite	
Radius	1.5 m	
Length	10 m	
Peak Temperature Rise	TBD degC	
Absorber Shield Iron Thickness	1.5 m	
Concrete Thickness	2 m	
Heat Exchanger Loop		
Location	inside enclosure	
Water Flow Rate	TBD GPM	
Water Volume	TBD Gal.	
Environmental & Monitoring Systems		
groundwater		
Chilled Water		
Tunnel Air		
Air Hold Time After Full-Energy Dump		mins

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	Phase I	Phase II
BEAM STABILITY		
TMCI		
Pipe Half-size aPipe	9 mm	9 mm
TMCI Threshold (Inj)	1.80 x1e10	4.98 x1e10
TMCI Safety Factor(inj)	0.6	3.6
TMCI Threshold (flattop)	5.77 x1e10	8.67 x1e10
TMCI Safety Factor	2.0	6.3
Non-Negotiable		
Proton Mass mp	938 Mev	
Electric Charge	1.60E-19 Coulomb	
Classical Radius Proton	1.53E-18 m	