

Tunnel Options

- Consider two main options:
 1. TESLA style: **1** tunnel with modulators in sparse support buildings
 - 2.** **2** full tunnels with virtually all active equipment in the support tunnel
- Each option could be
 - a. In a **deep** tunnel
 - b. Near the **surface** (with support equipment on the surface)

Pros/cons of 1 vs 2

- **Cost: favors 1.** USTOS estimates 1 is 5% cheaper (about \$400M), then add 3% for availability improvements for a net 2%.
- **Availability risk: favors 2.** With same MTBFs, 1 tunnel is down 30.5% (or 22% with robotic repair) instead 17% for 2. Can make better MTBFs, but increases costs and carries risk.
- **Commissioning: favors 2.** Subtle electronics problems that require hands on with a scope and beam to understand will be very slow to solve.
- **Pulse transformers disturb damping rings: favors 2.** only if pulse transformers are used.
- **Commissioning/upgrade: favors 2.** Installation in support tunnel can go on while commissioning/running occurs in accelerator tunnel.
- Unless one wants to improve the cost estimate, no further work is needed to decide on BCD.
- My conclusion: **2**

Pros/cons of deep vs surface

- **Cost: favors surface.** Cut and cover construction is cheaper. I think civil group has numbers. Get them and put them here.
- **Ease of finding site: favors deep.** Sites with right topology and bareness are few and far between. Eased somewhat if can have vertical bends in the linac.
- **My conclusion:**

**Carry both options
until site is selected**

Needed MTBF Improvements

Device	Improvement factor A for 2 tunnel conventional e+ source	Improvement factor B for 1 tunnel undulator e+ source, 6% energy overhead	Improvement factor C for 1 tunnel undulator e+ source, 3% energy overhead	Nominal MTBF (hours)
magnets - water cooled	20	20	20	1,000,000
power supply controllers	10	50	50	100,000
flow switches	10	10	10	250,000
water instrumentation near pump	10	10	30	30,000
power supplies	5	5	5	200,000
kicker pulser	5	5	5	100,000
coupler interlock sensors	5	5	5	1,000,000
collimators and beam stoppers	5	5	5	100,000
all electronics modules	3	10	10	100,000
AC breakers < 500 kW		10	10	360,000
vacuum valve controllers		5	5	190,000
regional MPS system		5	5	5,000
power supply - corrector		3	3	400,000
vacuum valves		3	3	1,000,000
water pumps		3	3	120,000
modulator			3	50,000
klystron - linac			5	40,000
coupler interlock electronics			5	1,000,000
linac energy overhead		3%		3%