Parameters

	TESLA	*JLC/NLC*	*CLIC*
Energy (TeV)	0.5	1.0	3
Luminosity (10^{34})	3.4	3.4	10.0
Rf Frequency (GHz)	1.3	11.424	30
RF cavity Q	10^{10}	5000	3500
Rf cavity R/Q	1000Ω/m	1800Ω/m	1800Ω/m
Rep. Rate (Hz)	5	120	75
# Bunch / Pulse	2820	190	154
Bunch Spacing (ns)	337	1.4	0.666
Bunch Charge (10^{10})	2.0	0.75	0.4
s_x / s_y at IP (nm)	553 / 5	190 / 2.1	40 / 0.6
Site Length	33	30.6	30

Inherent differences between approaches NC and SC: (1)

1. NC needs roughly 1 amp average current versus few mA in SC
   Arises because of difference in cavity Q
   - Short bunch spacing
     - More difficult long-range wakefield? Probably not
     - More difficult detector design
     - More difficult intra-train feedback
     - Little difference for machine protection system (MPS)
       - Single bunch will damage cavities
     - Crab crossing is required
       - Crab crossing eases extraction line design and allows diagnostics in extraction line

Inherent differences between approaches NC and SC: (2)

1. Continued
   - Large peak power in rf pulse
     - Difficult rf sources (modulator, klystron, rf distribution)
     - Limits bunch train length
       - More difficult intra-train feedback
       - Easier damping rings and positron sources
     - High repetition rate
       - Easier beam-based feedback systems (TESLA MUST use the intra-train feedback while NLC can find a reasonable site and does not need to rely on this)
       - easier MPS

2. SC has higher rf to beam efficiency
   - Don’t know if this is fundamental but is true in current cases
   - Higher luminosity for similar beam parameters

Inherent differences between approaches NC and SC: (3)

2. SC structures are in cryostat
   - Filling factor for NC can be higher
     - Larger geographic gradient for given acc. Gradient
   - SC cavities are act as cryo-pumps
     - Can be easily contaminated
   - NC girders are easier to align also easier to move using BBA
   - Girder amplification can be much less in NC than SC
     - Very important source of vibration

3. Both NC and SC require large cooling flow
   - Don't know respective flow rates but possible vibration sources

4. NC gradients can be higher
   - SC operates well over dark current capture
     - Possible problem with radiation and heating
   - Linac length etc.

Inherent differences between approaches high f versus low f:

1. High frequency allows higher gradients (not verified)
   - Breakdown limit thought to scale with f
   - Optimal rf pulse length is shorter also reducing breakdown
   - Dark current capture gradient increases with frequency
   - Shorter linac with smaller emittance dilution

2. High frequency has larger wakefields
   - Tolerances scale as 1/f NOT $1/f^3$ as has been implied
   - Need to design in BBA -- demonstrated most of required diagnostics and controls
   - Need to reduce LR wakefields -
     - demonstrations at ASSET are close enough for NLC
     - Dipole modes are a potential problem for TESLA
   - Must run off rf crest - increases potential energy jitter and reduces effective acceleration by 4% and energy spread of roughly 0.3% versus 0.1% in SC design

Luminosity vs. Maury

$$L = \frac{f_{rep}}{4p}\frac{n_b N^2}{s_x s_y} H_D \quad \Rightarrow \quad L = \frac{2P_b}{4p\ E_{cms}}\frac{N}{s_x}\frac{H_D}{s_y}$$

In a linear collider

- P_b is the beam power
- H_D is the luminosity enhancement
- (N / s_x) is roughly proportional to the beamstrahlung (backgrounds)

$$L \propto \frac{P_b}{E_{cms}}\sqrt{\frac{d_B}{ge_y}}H_D$$

⇒ WAIT! δ_B is not really proportional to just (N / s_x)
Do not use this ‘scaling’ formula for calculations!

Luminosity Spectrum

- n_γ is the number of photons radiated while δ_B is the average energy lost to beamstrahlung
- Luminosity spectrum is described (fairly well) by n_γ and δ_B
  - Luminosity near the cms energy is determined by n_γ
  - The tail is described by δ_B
- NLC luminosity is listed with 10% loss for jitter and tuning
- TESLA luminosity is too low in calc because of extreme disruption

	NLC 500	TESLA 500
L0	2.2e34	2.8e34 (3.4e34)
L100%	35%	25%
L99%	52%	50%
L95%	77%	78%
L90%	89%	91%
δ_B / n_γ	4.7% / 1.15	(3.2%) / 1.51 (1.62)
H_D	1.41	1.71 (2.05)
Y	0.12	0.05
D_y	14	25

John Jaros Questions

1. Structure development:
   - Expect to take one year to develop full prototype with wakefield damping after gradient checks (end of 2002)
2. Evidence for emittance preservation
   - SLC and FFTB are really the only sources of evidence
3. The beam fields can be a problem in SC structures and can be a problem during beam collimation
4. Ugh! It really comes to a cost trade off.
5. The SLED-II system in the Test Lab has operated with 500 MW peak power and 150 μs pulse lengths. The NLCTA is presently operating with 400 MW in 250 μs pulse lengths. We want 600 MW peak power and 400 μs pulse lengths.

John Jaros Questions

6. The beam tube was not cooled (Dave will cover this)
7. If you are going to build the full tunnel at **some** point, I think this makes the most sense. To move the injection point will require new injection transport lines, new 270 deg arc tunnel and moving the beam line, moving all structure girders, adding new pedestals, moving magnets. The TBM may also not be consistent with beam operation.
8. Yes - the LCLS is aiming for 20 mm with smaller X emittance (the X is the plane where most dilutions will occur). A compressor at the APS is producing 200 fs pulses with the expected emittance dilutions.
9. Yes, look in the TDR