The ILC Parameter Plane

Tor Raubenheimer
GDE
SLAC

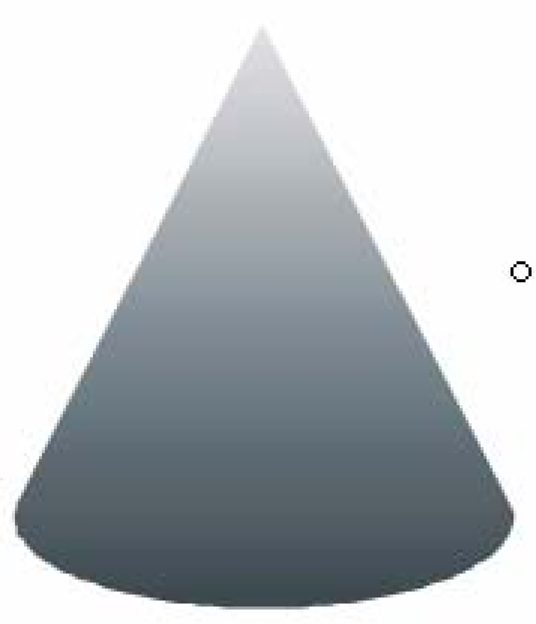
Introduction

- Parameter plane established at KEK ILC mtg
- TESLA TDR pushed parameters:
  - Emittance dilution
  - Disruption and kink instability
  - Luminosity enhancement
- Parameter plane established for flexibility in achieving goal of 500 fb-1 in 4 years
  - Accelerators rarely optimize at design parm.
    - SLC, HERA, PEP-II, KEKB, DAPHNE, …
  - Linear collider has fewer options for optimization
    - Already used most tricks to maximize specific luminosity

Parameters

TESLA peak luminosity

3×10^{34}

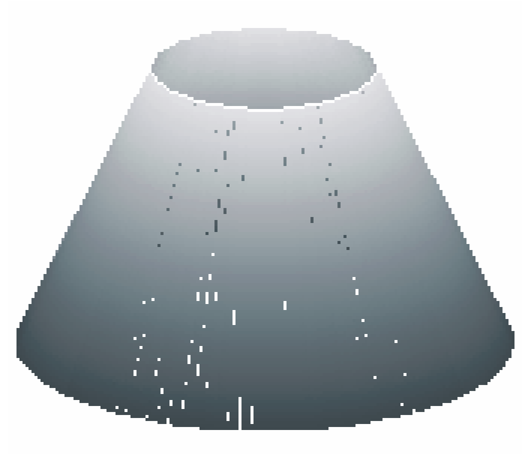


parameter space

- Possible due to very high beam-beam disruption (D_y~25)
- Well into kink-instability regime (unstable)
- Little head room to play with

ILC peak luminosity

2×10^{34}



parameter space

Schematic from Nick Walker, LCWS 2005

Parameter Plane

- Nominal – reduced Dy and more reasonable ε budget → $2x10^{34}$ with similar *L* spectrum
- Provide paths to deal with:
  - **IP: kink instability → Lower Dy (LowN)**
  - **IP: beamstrahlung → Lower dB (LowN)**
  - **Dumps or losses → lower power (LowP)**
  - **RF pulse length → shorter pulse (LowP)**
  - **RF peak power → lower current (LowP)**
  - **LET: emittance preservation → (LargeY)**
  - **DR: SBI → Lower N (lowN)**
  - **DR: CBI or kicker → fewer bunches (LowP)**
  - **DR: bunch length → dual stage BC**

Luminosity Overhead

- Concern that the design has 2.5x *L* overhead
  - **Linear colliders have limited operating space**
  - **Many parameters are already at (over) the limit**
    - Beam power, gradient, DR emittances, …
  - **Additional parameter space is primarily gained by focusing harder**
    - Requires shorter IP bunch lengths or causes a large increase in IP disruption → some cost impact in BC
  - **High luminosity parameters push everything to the design limit – unlikely to achieve *L***
    - Beamstrahlung increases and degrades luminosity cleanliness while complicating BDS operation
  - **Significant cost savings in low Power design**

Parameter Plane Costs

- Four main cost impacts:
  - **Single stage BC (-1%)**
    - Eliminates options of LowP and LowN
    - Increases risk for DR, LET, abd BDS
  - **Reduced RF system (-2% and another -1% civil)**
    - Only allows LowP parameters at full energy
    - Increases risk in LET and BDS but reduces risk in DR
    - Possible to upgrade in quasi-adiabatic manner
  - **Smaller damping ring circumference (-2~4%)**
    - Only allows LowP parameters
    - Increases DR risk – hard to upgrade
  - **Simpler extraction line design → (-0.3%)**
    - Increases risk in BDS; Eliminates option of LowP and limits peak luminosity

Example Parameter Sets

Parameter range established to allow operating optimization

		nom	low N	lrg Y	low P	High L
N	$\times 10^{10}$	2	1	2	2	2
n_b		2820	5640	2820	1330	2820
$\varepsilon_{x,y}$	μm, nm	9.6, 40	10, 30	12, 80	10, 35	10,30
$\beta_{x,y}$	cm, mm	2, 0.4	1.2, 0.2	1, 0.4	1, 0.2	1, 0.2
$\sigma_{x,y}$	nm	543, 5.7	495, 3.5	495, 8	452, 3.8	452, 3.5
D_y		18.5	10	28.6	27	22
δ_{BS}	%	2.2	1.8	2.4	5.7	7
σ_z	μm	300	150	500	200	150
P_{beam}	MW	11	11	11	5.3	11
Lumi	10^{34}	2	2	2	2	5

Summary

- Clear trade for maintaining parameter plane versus adopting lowP parameters
  - **How important is luminosity goal of 500 fb-1 in 4 years?**
    - Personally believe that operating space will be needed to meet design goals but can lower the goals
  - **How important is luminosity spectrum (Hitoshi's talk)?**
    - Which is preferable 7% reduced energy or LowP only?
    - Reduced RF with full DR → L ~ const vs Energy
  - **Still have parameter plane at reduced luminosity of ~1x10^{34} with reduced rf system**
    - Is 50% luminosity worth 3% TPC?
    - Would this be an acceptable option for experimentalists?