# NLC BD Magnets and Transport Decks

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NLC CD-1-a-thon, June 25, 1998

1. Update of magnet families in use in BDS
2. Final Doublets for Low and High Energies
3. Bandpass of FF and optimization thereof
4. Luminosity Estimates for present FF
5. The decks
6. Outlook

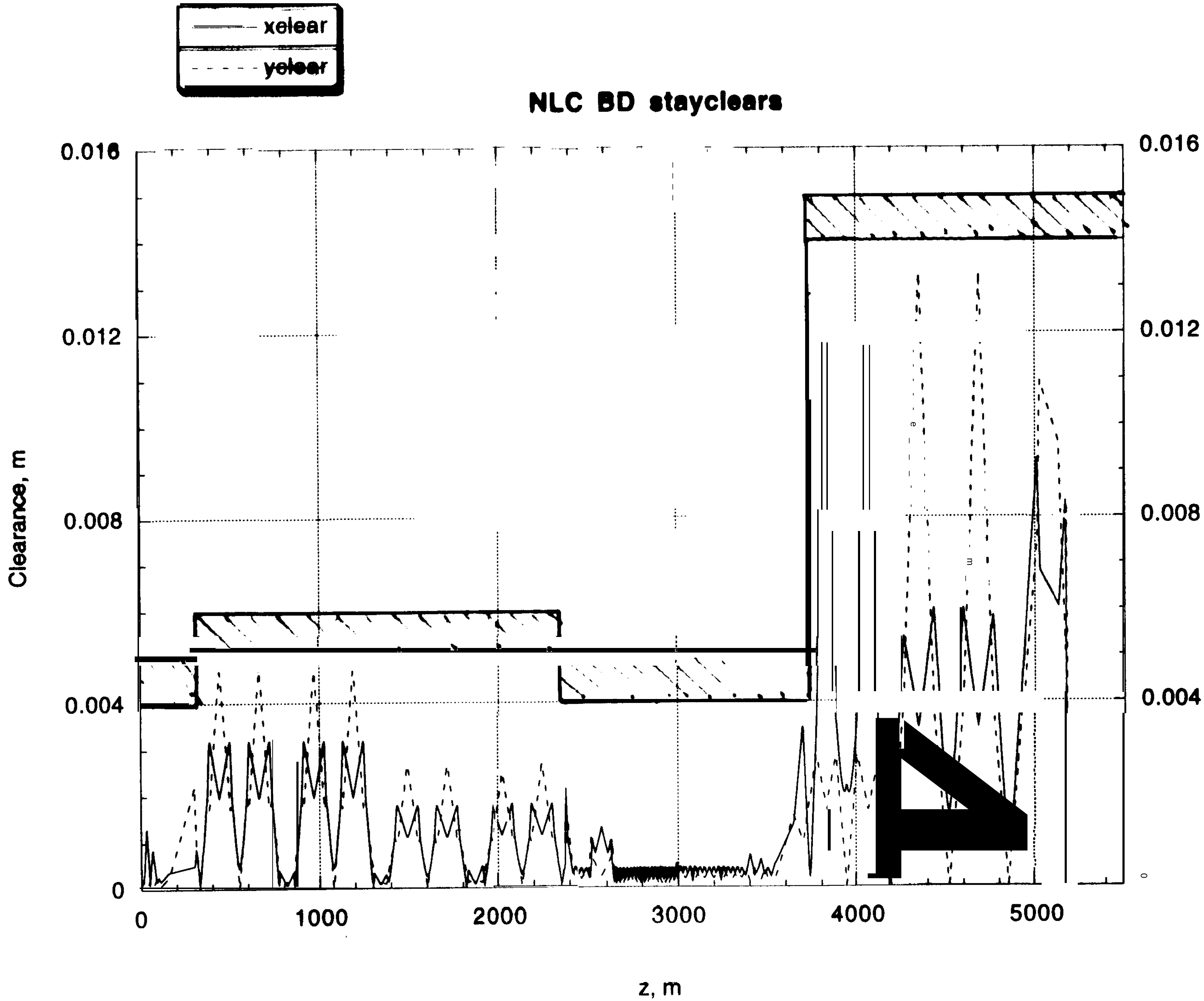
*"Cause and effect go hand in hand*
*And the devil may care but I don't mind..."*

1. Update of families

Number of families reduced to 6 standard quad types, 3 standard sextupole types, and 3 standard bend geometries (with different coil arrangements depending on field needed)

Issues in magnet design:

- Stay-clears in collimation region at least as large as collimation depth for largest beams (5 $\sigma_x$, 36 $\sigma_y$, 4% energy spread); should meet ZDR specs for stay-clears after collimation region (14 $\sigma_x$, 60 $\sigma_y$, 4% energy spread); all for 350 GeV CM, emittances 60 x 1.4 NLC units ( $10^{-7}$ m.rad, normalized)
- Magnets should leave room for 1 mm thick vacuum chamber (except for final doublet, where 0.5 mm thick chamber is used)
- Magnets should be buildable (under 3 m long, realizable fields without resorting to exotic pole-tip materials)



xclear
yclear
NLC BD stayclears
0.016
0.012
0.008
0.004
0
Clearance, m
0
1000
2000
3000
4000
5000
z, m
4

Non-FD quadrupole types:

| Type | Length (m) | Full Bore (cm) | Max $B_0$ @ 1 TeV | Number |
|---|---|---|---|---|
| 1 | 0.5 | 1.2 | 7.65 | 140 |
| 2 | 1.0 | 1.0 | 9.19 | 164 |
| 3 | 2.0 | 1.0 | 7.32 | 62 |
| 4 | 0.5 | 3.0 | 6.06 | 128 |
| 5 | 2.5 | 1.0 | 5.53 | 168 |
| F Trans | 1.0 | 3.0 | 5.71 | 12 |

Bends:

| Type | Length (m) | Full Gap | Max $B_0$@1TeV | Number |
|---|---|---|---|---|
| 1 | 2.5 | 0.5” | 1.02 | 384 |
| 2 | 2.5 | 3 cm | 0.158 | 276 |
| 3 | 3.0 | 0.5” | 0.834 | 1208 |

Sextupoles

| Type | Length (m) | Full Bore, cm | Max $B_0$@1TeV | Number |
|---|---|---|---|---|
| 1 | 0.5 | 1.0 | 5.10 | 4 |
| 2 | 0.4 | 1.2 | 2.44 | 48 |
| 3 | 0.6 | 3.0 | 6.19 | 32 |

2. Doublet Magnets -- for buildability and apertures, build doublet as 5 magnets

Q2 (Fe EMQ, 2 m long, 2 cm bore, 10.2 kG @ 1TeV CM)

30 cm space

Q2 (Fe EMQ, 2 m long, 2 cm bore, 10.2 kG @ 1TeV CM)

30 cm space

**Q1SC** (SC EMQ, 1.5 m long, 2 cm pipe, 3200 kG/m @ 1TeV CM)

30 cm space

**Q1B** (PMQ, 0.5 m long, 5 cm outer diameter)

10 cm space

**Q1A** (PMQ, 1 m long, 4 cm outer diameter)

Because of wide range of energies, need 2 sets of Q1A/B magnets (E,, 350 -> 750 GeV and $E_{CM}$ 750 -> 1000 GeV)

| Magnet | Bore, low E | $B_{PT}$, low E | Bore, high E | $B_{PT}$, high E |
|---|---|---|---|---|
| Q1A | 1.4 cm | 11.58 kG | 1.12 cm | 14.33 kG |
| O1B | 1.6 cm | 12.48 kG | 1.25 cm | 15.00 kG |

Low E magnets are doable with today's technology ; High E magnets require some R & D, prototyping, tests

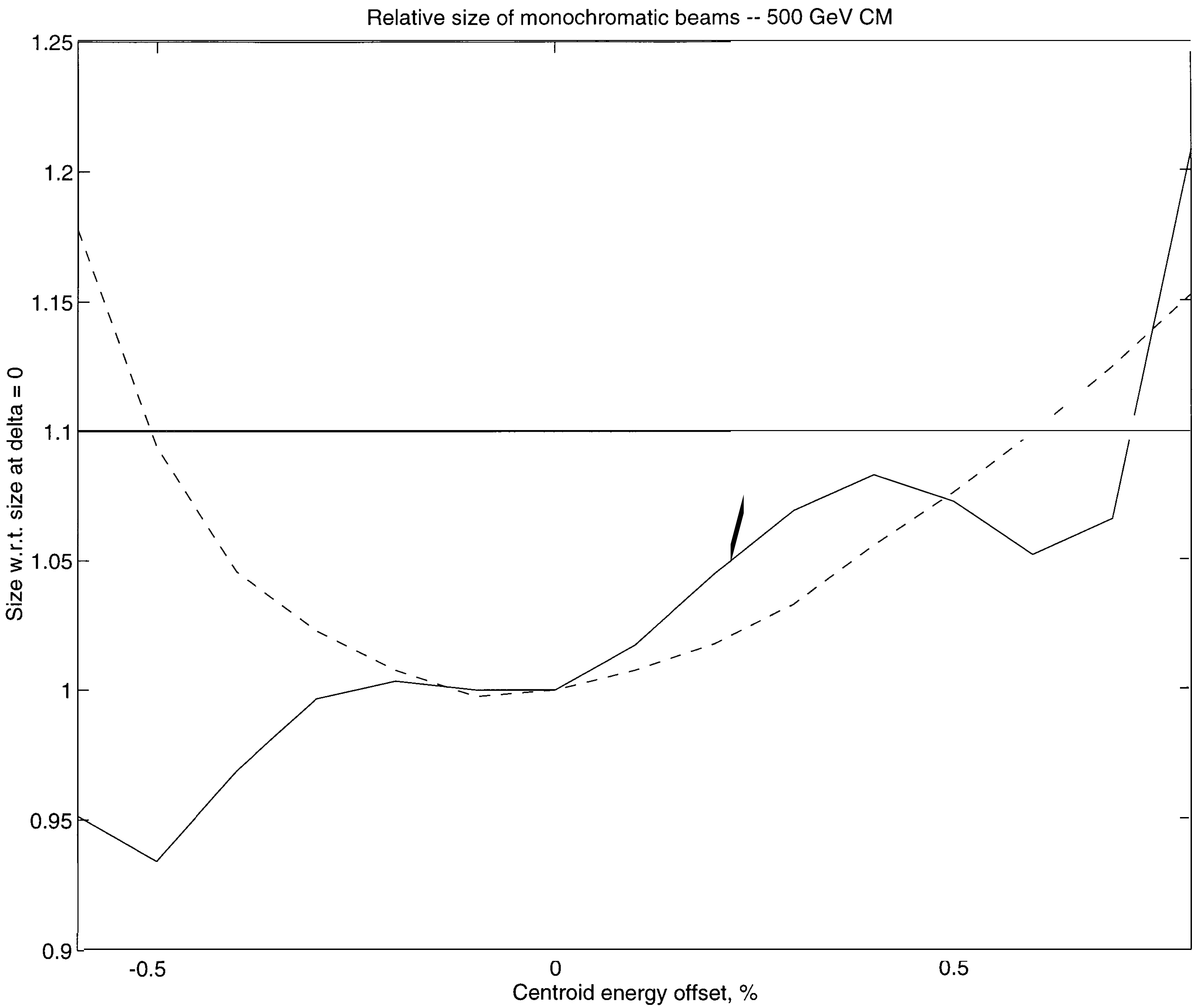
## 3. Bandpass and optimization thereof

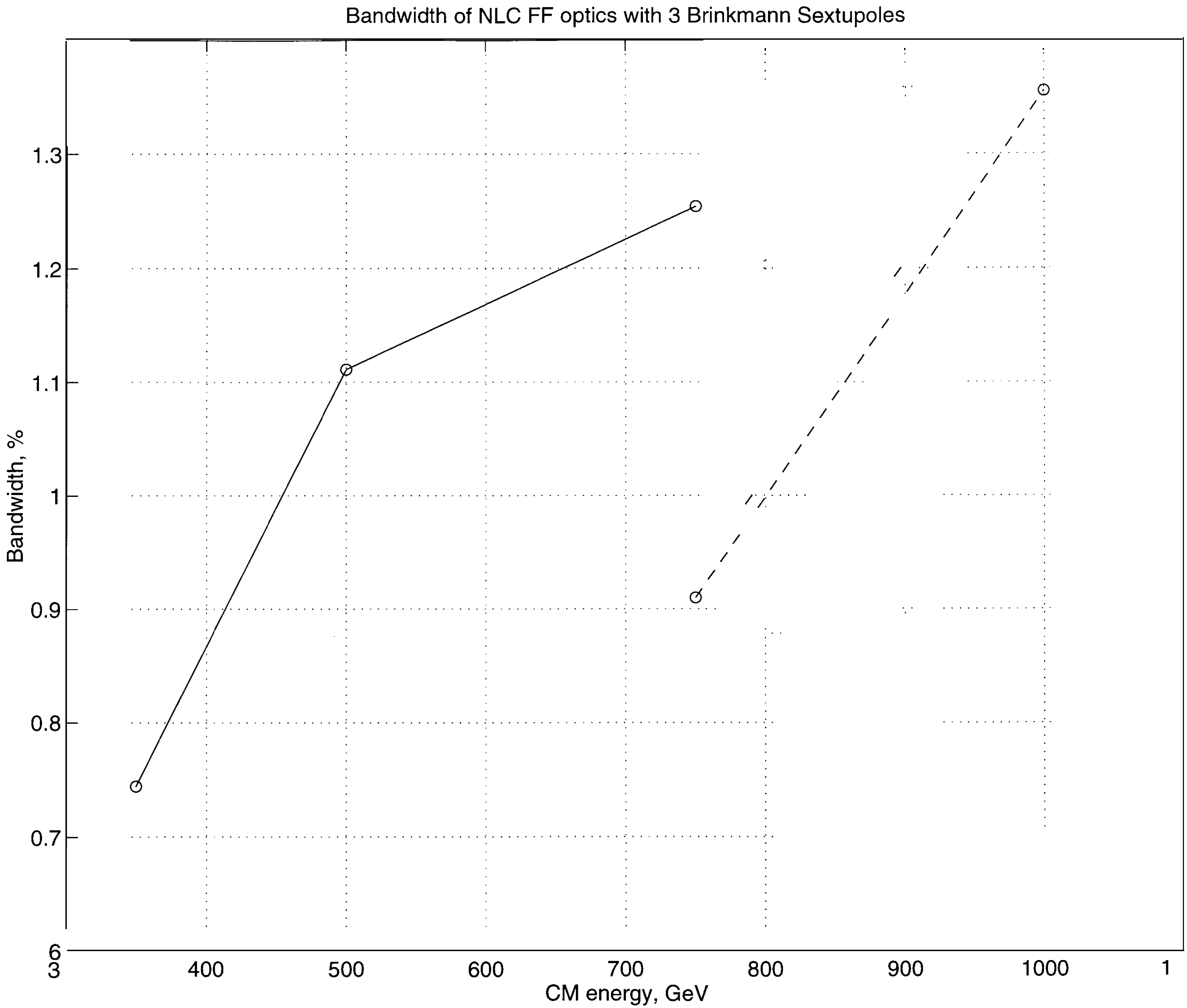
Bandpass optimization is done by tweaking the "Brinkmann sextupoles" --
3 sextupoles at IP images in CCX, CCY, F Transformer Eta suppressor

Following suggestions of Helm et. *al.*, this tweaking can be done by setting up DIMAD to minimize ε's and $\sigma^*$'s as a result of tracking (1000 particles, Gaussian energy spread of 0.25% RMS)

Gives reasonable results, though things are tough at the lowest energy of each doublet optics (350 GeV on low-energy doublet, 750 GeV on high-energy doublet)

Note: Results you are about to see are with Luminosity Equivalent σ's and Case "A" parameters (tightest bandpass)


Relative size of monochromatic beams -- 500 GeV CM
Size w.r.t. size at delta = 0
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
-0.5
0
0.5
Centroid energy offset, %


Bandwidth of NLC FF optics with 3 Brinkmann Sextupoles
Bandwidth, %
1.3
1.2
1.1
1
0.9
0.8
0.7
6
3
400
500
600
700
800
900
1000
1
CM energy, GeV

## 4. Luminosity Estimates

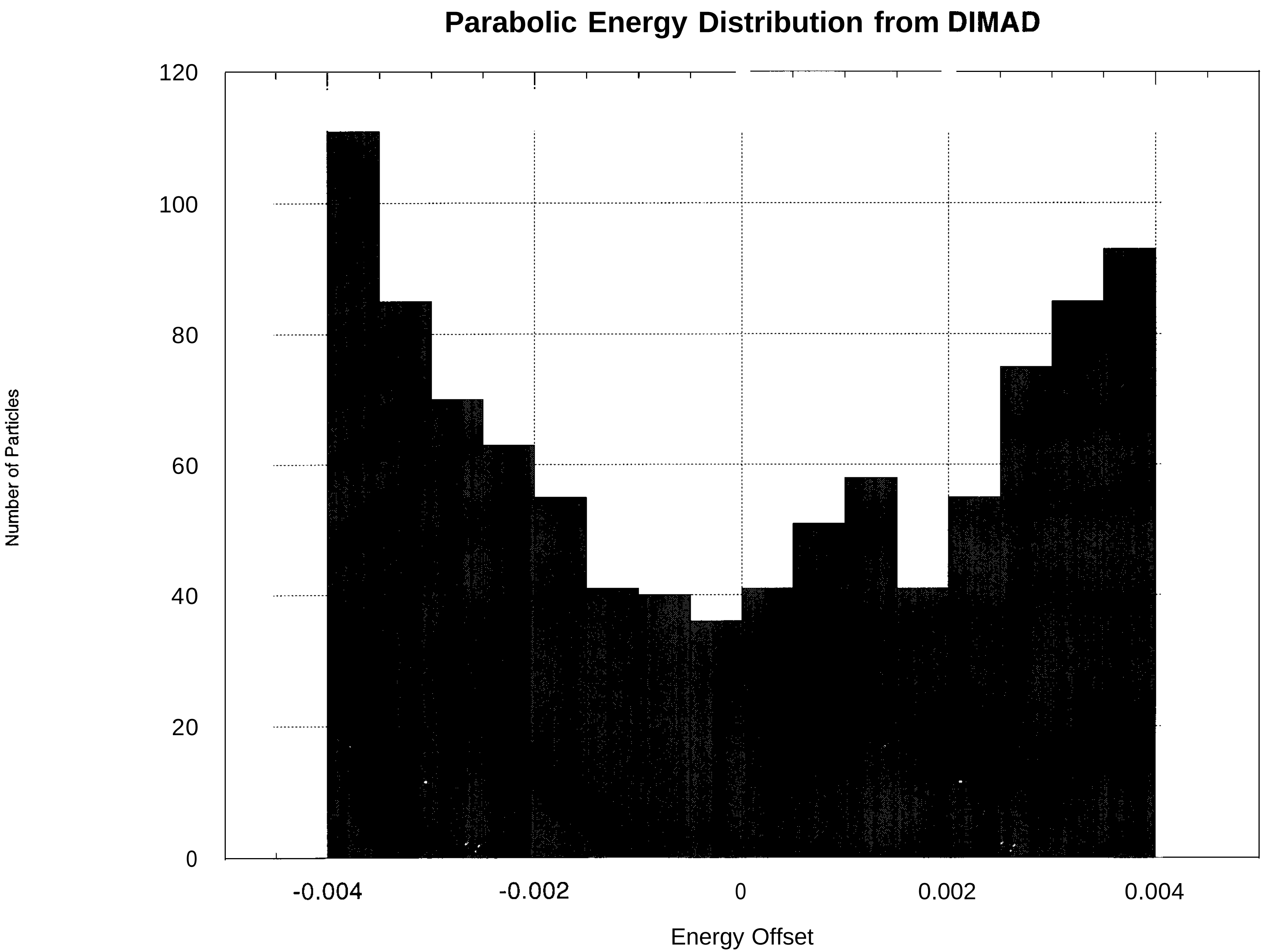
To get reasonable luminosity estimates, need to track many particles (10,000 used here) with appropriate conditions:

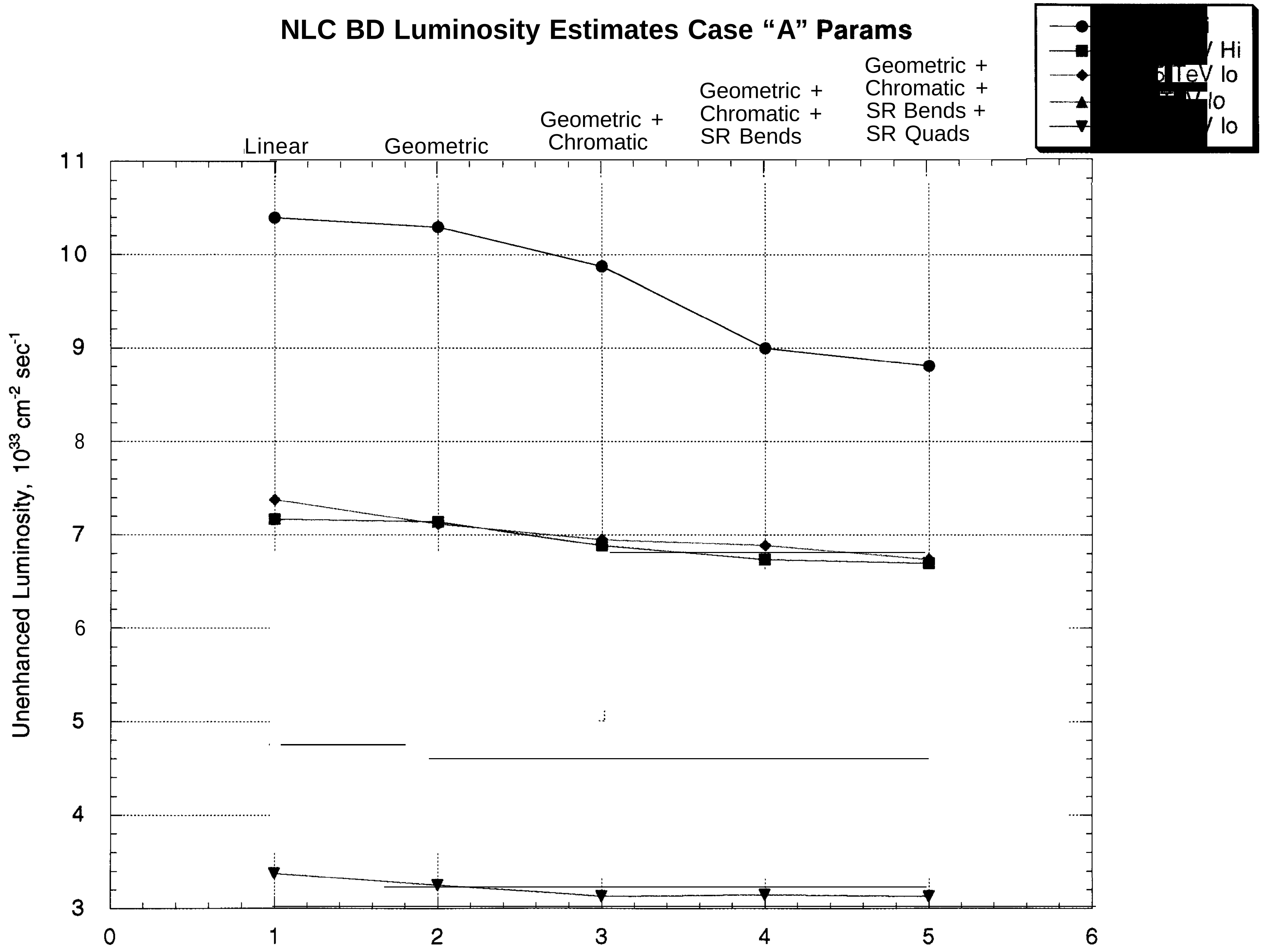
1. Adjust incoming emittances s.t. extracted emittance = Case "A" or Case "C" values

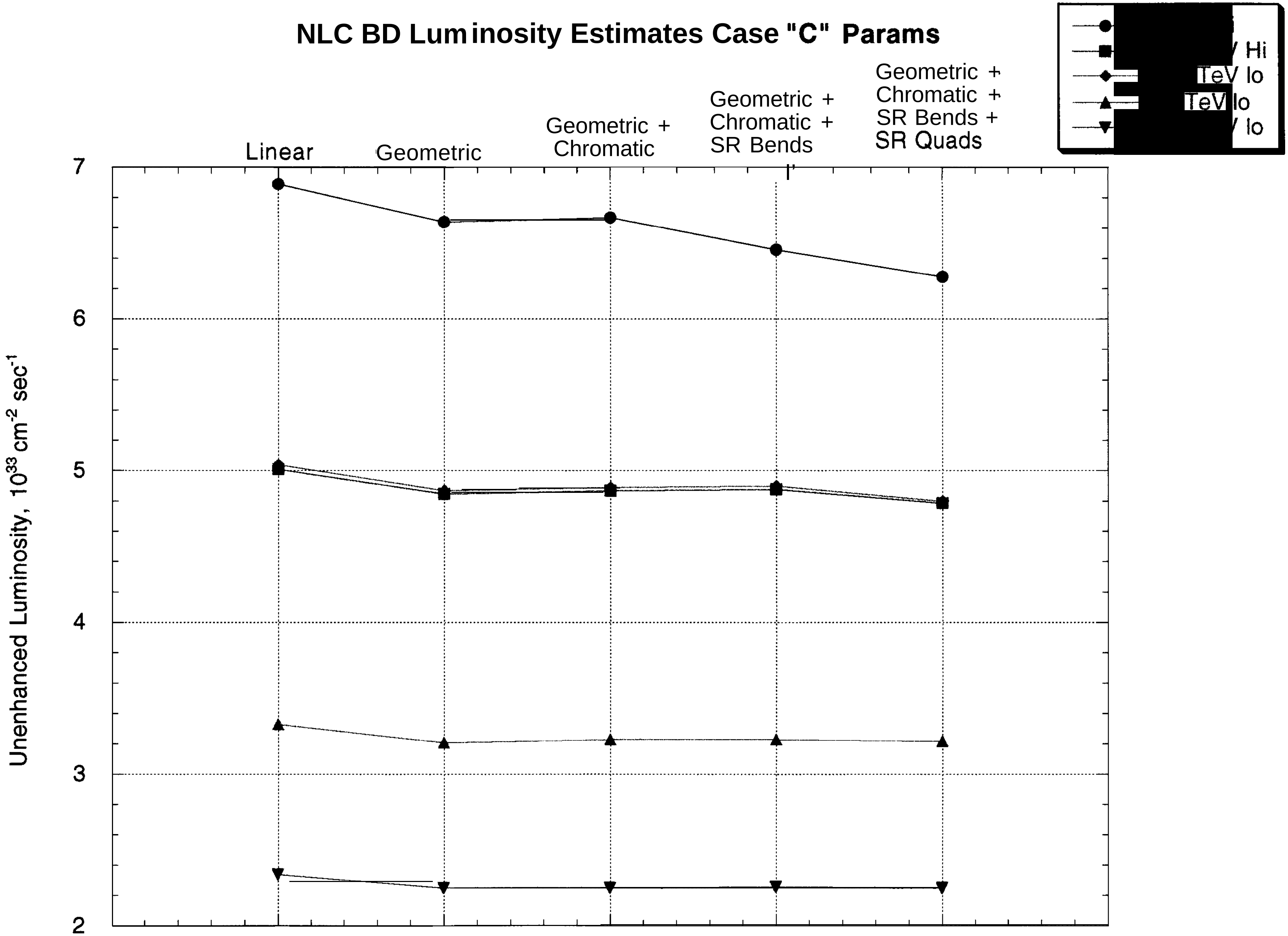
2. Use appropriate distribution of energies (parabolic distribution function, half-width = 0.4%, peak/valley rato = 3.0)

3. Use G. Roy's simulation of SR in bends and quads

Note: Results you are about to see are unenhanced luminosity (parameter list assumes 60% enhancement for all conditions)


Parabolic Energy Distribution from DIMAD
120
100
80
60
40
20
0
-0.004
-0.002
0
0.002
0.004
Energy Offset
Number of Particles


NLC BD Luminosity Estimates Case "A" Params
[redacted]
Linear
Geometric
Geometric + Chromatic
Geometric + Chromatic + SR Bends
Geometric + Chromatic + SR Bends + SR Quads
Unenhanced Luminosity, $10^{33}$ cm$^{-2}$ sec$^{-1}$
11
10
9
8
7
6
5
4
3
0
1
2
3
4
5
6



NLC BD Luminosity Estimates Case "C" Params
[redacted]
[redacted] V Hi
[redacted] TeV lo
[redacted] TeV lo
[redacted] V lo
Linear
Geometric
Geometric + Chromatic
Geometric + Chromatic + SR Bends
Geometric + Chromatic + SR Bends + SR Quads
Unenhanced Luminosity, $10^{33}$ $cm^{-2}$ $sec^{-1}$
7
6
5
4
3
2

## 5. The decks

Dimad deck: afs/slac/g/nlc/lattice/cd1_09-98/beam_delivery/
TLCBD03.DATA

Note: this deck is too big to run in ordinary DIMAD. Use gigantic version in afs/slac/g/nlc/lattice/codes/bin.aix6000 ; for you SUN and NT types, see afs/slac/g/nlc/lattice/codes/dimad for source and makefile.

There is also a set of transport decks which are not quite compatible with the dimad deck, at afs/slac/g/nlc/lattice/zdr/decks ; the decks are:

| | |
|---|---|
| e.d.col_.trns | (collimation region) |
| e.d.bb1_.trns | (big bend) |
| e.d.ff1_.trns | (final focus) |

There are also decks for the positron system (substitute p. for e.), and the second IP (substitute 2 for 1 in bb and ff names).

Nice stuff in the dimad deck:

- “Q” BPM in every normal quad (except Q1SC, Q1B, Q1A)
- “FB” BPMs in select locations (high-q points, near wire scanners)
- All wire scanners (laser and standard) called out
- SBD kickers, SBD septa, tune-up stoppers called out
- Crab cavity called out

Much stuff we are likely to need (feedback correctors of all kinds, collision phase monitors, dumpline, etc.) not yet present...

## 5. Outlook

NLC BD optics are in reasonably good shape for costing, esp. of really repetitive elements

Optics are also in good shape for commissioning and tuning simulations, which have begun

Luminosities are close to those in the parameter list, and reasonable luminosity is available at the Top threshold without resorting to geometry change