- ILC-Japan Working Group 1 report
- ILC Beam Parameter
- Beam dynamics (Simulation study)

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ILC-Japan Working Group 1 report

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- Re-structuring of WGs
  - from ‘Overall design’
  - to ‘Low Emittance Transport (LET) Beam Dynamics’
- What we tried to do and what have been done.
- Future plans
  - For Snowmass Workshop
  - For BCD (Baseline Configuration Document: in 2005)
  - For CDR (Conceptual Design Report: in 2006)

Re-structuring of WGs

- Restructuring of WGs recently (early July).

Old:

WG1 covers ‘Overall design’

New:

WG1 covers ‘Low Emittance Transport (LET: From extraction of DR to IP) Beam Dynamics’

KEKではJapanese-WG1から「全体設計」を切り離すことが２月末　WG1-convener によって提案されたが却下された。

「WG1 は「全体設計」に責任を持つべし」

What we tried to do.

（１）パラメーター

- 各sub-system設計のため、暫定的パラメーターの提案（International）
- 各WGの活動がこれと整合して進められるよう、説明、情報交換。

（２）全体設計上の重要な検討項目について

- 国内のグループの検討が国際的な全体設計上の課題と整合性を保てるよう情報交換に努めていく。（具体的な検討は他のWG。）

（３）日本以外のアジアとの協力

- ILC-Asia (KEK、IHEP、PAL) TV meeting の組織

（４）ビームダイナミクス

- 国際的なILC beam dynamics group の中で貢献する。
- 当面は主ライナックのシミュレーションによる検討を進める。

- ＊＊　多くの仕事は、WG1独自で進める課題でなく、他のクループとの協力。

What have been done.

（１）パラメーター

– “Suggested ILC Beam Parameter Range” was published.
– There has not been problems in communications, we hope.

（２）全体設計上の重要な検討項目

- 国内のグループの検討が国際的な全体設計上の課題と整合性を保てるよう情報交換に努めていく。
  – It is not clear whether our work was effective or not.

（３）日本以外のアジアとの協力

- ILC-Asia (KEK、IHEP、PAL) TV meeting の組織
  – Done. (every 2 ~ 4 weeks)

（４）ビームダイナミクス

– Some simulations with new tuning methods, etc., have been done and tolerances of main linac components were roughly estimated.

Future plans of WG1

WG1 is for LET(Low Emittance Transport: DR exit to IP)
Beam Dynamics.

There is no ‘Japanese team’ or ‘Asian team’
for LET beam dynamics.
Everyone works as a member of the international group.

Followings are plans up to BCD.
(Baseline Configuration Document: in 2005)

Future plans of WG1

What should be done in 2005:

- Make ‘Standard’ design of LET:
  from bunch compressor to IP.
- Complete preliminary ‘Standard’ beam tuning algorithms. Need crosscheck by different codes and persons.
- List up (select) possible options, further developments.
- Contribute to determine beam parameters, beam line layout of BCD.
- Give rough specifications of hardware components.

Future plans of WG1

Major tasks and what will (can) be done by Asia:

- Design of Bunch Compressors
  Contribution from Korea.
  (No Japanese activity right now.)
- Simulation study of beam tuning
  Major contribution for Main Linac from KEK.
  Cross check can be performed.
  Using simulation code: SAD, CAIN, SLEPT

ILC Beam Parameter

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- Requirement by ILCSC
- Suggested ILC Parameter Range

Requirement by ILCSC

Base line

- Main stage: 200-500 GeV cms, 500 fb^{-1} (at 500GeV) in 4 years
- A few weeks for large energy change
- A few shifts for small energy change
- Electron polarisation > 80%
- Two experiments (one with crossing angle)
- Energy known to 0.1%
- Z for calibration

Upgrade

- 1 TeV (1ab^{-1} in 3-4 years)
- 1ab^{-1} (500 GeV in 2 more years)

Option

- Z factory
- WW factory
- e-e-
- e-gamma
- gamma-gamma
- Positron polarisation 50%

Important Requirements

- ECM 200GeV – 500 GeV, e+ e- collider
- >500 fb^{-1} in 4 years, after 1 year commissioning
- Up gradable to ECM 1000 GeV

Suggested ILC Parameter Range

Published in 2005 Feb. by International WG1 conveners
+ Working Group Coordinating Committee (Go3)

Sub-system should be designed for this parameter range.

Will be updated.
Web Discussion Board was set up.

Suggested ILC Parameter Range

Luminosity

Required integrated luminosity:

500 fb^{-1} at 500 GeV in 1st 4 years of physics run.

(after one year of commissioning run)

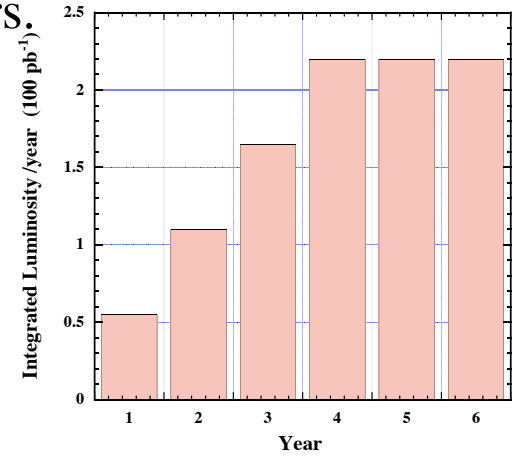
→ Design Luminosity:

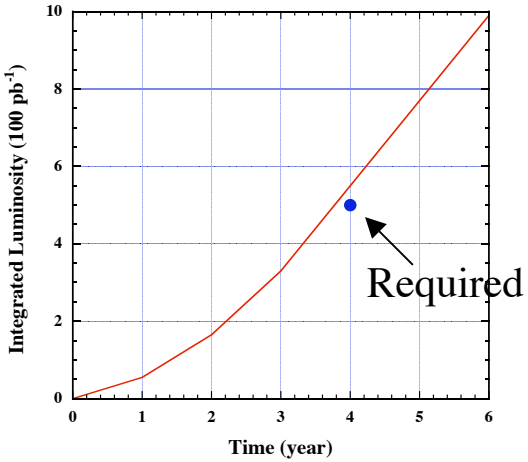
2.0E34 /cm^2/s at 500 GeV

1.1E7 s (127 day) physics run/year

25%, 50%, 75% and 100% of peak luminosity

in the first four years.





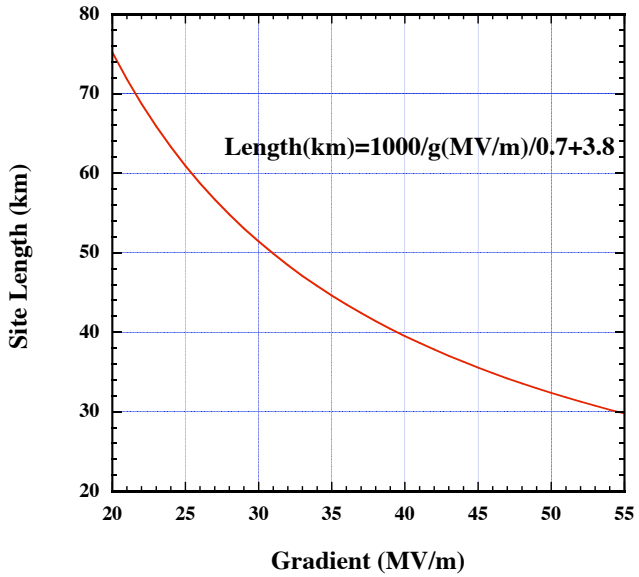
Gradient

- 30, 35, 40 MV/m are considered.
- 30 MV/m is chosen for the parameter sets.

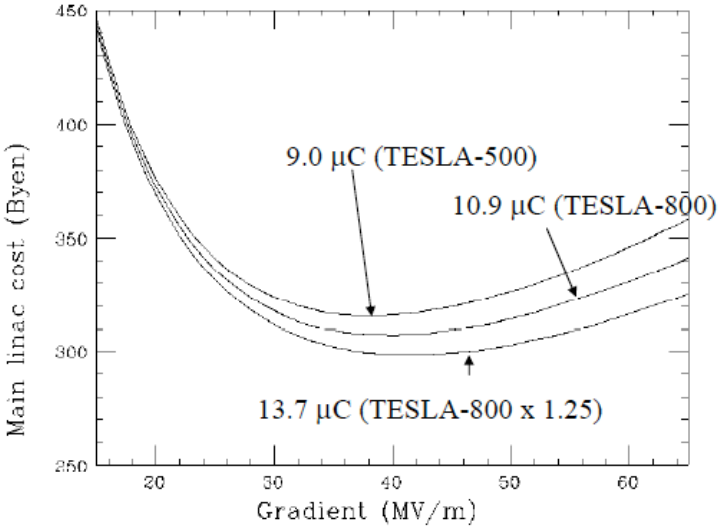
  Should be reviewed in the future.

  No big impact to other beam parameters.

Length vs. Gradient



Cost vs. Gradient



RF source

- Klystron

  10 MW, 1.5 ms, (5 Hz)

  – No major R&D will be necessary.(?)
  – Almost done for TESLA, XFEL.

- Number of Cavities/klystron depends on gradient (16, 20 or 24)

  – Total number of klystrons will be almost fixed.
  – Assuming (nearly) fixed beam parameter.

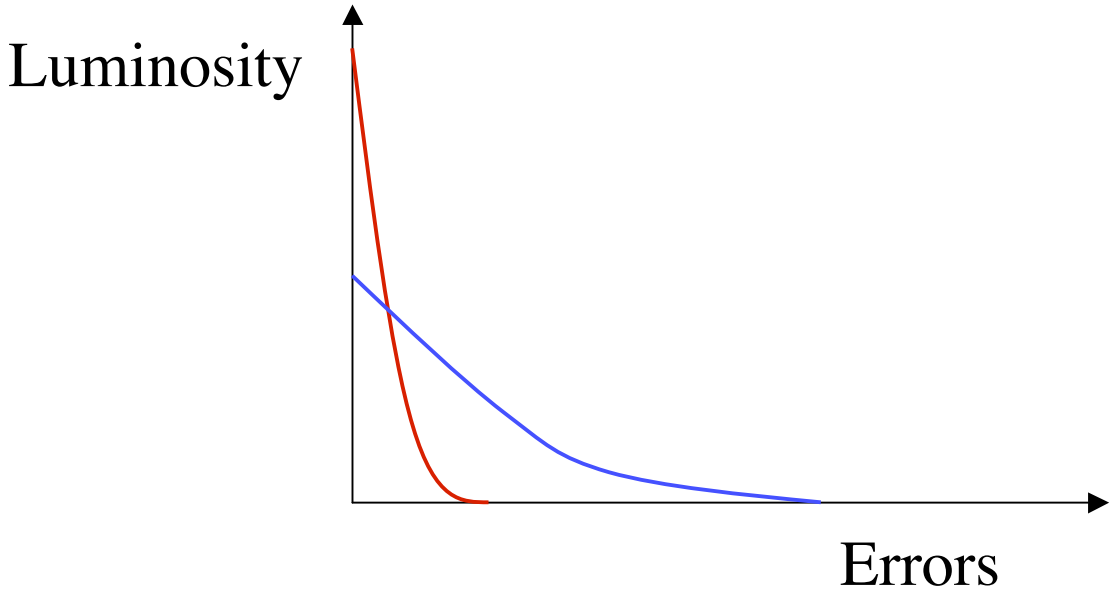
Energy upgrade, 0.5 --> 1 TeV

- Require no modification of injectors.
- Assume the same gradient.

  If higher gradient is available, higher energy (than 1 TeV) will be possible.

Why Beam Parameter "Range"

• Parameters for high luminosity without errors, luminosity tends to decrease rapidly with errors.
• It may be better to choose parameters less sensitive to errors, even if they have lower luminosity without errors.
• It is impossible to know exact errors.
→Design should allow us to try various (broad) parameters.



Suggested Parameter sets

- Nominal
- Low Q (half charge/bunch)
  Double bunches/pulse, smaller beam size (x,y,z)
  Relax space charge in DR, wakefield in ML, IP disruption.
- Large Y (large vertical beam size at IP)
  Smaller horizontal size
  Allow larger vertical emittance.
- Low P (less bunches/pulse)
  Smaller beam size
  Relax limitation of beam power, DR bunch spacing.

All sets have similar luminosity (2E34 /cm^2/s)

Nominal and Non-Nominals are all required, not options!

- High Luminosity
  Combine most difficult parameters for high luminosity

Suggested ILC Parameter Range

Parameters (selected) for 500 GeV Ecm

	Nominal	Low Q	Large Y	Low P
N/bunch	2E10	1E10	2E10	2E10
Nb/pulse	2820	5640	2820	1330
Tsep(ns)	307.7	153.8	307.7	461.5
I_b (mA)	10.4	10.4	10.4	6.9
γεy (E-4m)	4.0	3.0	8.0	3.5
β*x (mm)	20	12	10	10
β*y (mm)	0.4	0.2	0.4	0.2
σx (nm)	655	495	495	452
σy (nm)	5.7	3.5	8.1	3.8
σz (mm)	0.3	0.15	0.5	0.2
Dy	18.5	10.0	28.6	27.0
δB	0.022	0.018	0.024	0.057

Possible problems of 'Nominal' parameter

- 5.64E13 particles/pulse may be too large

  Positron source (target damage).

  Collective effect in DR
- 2E10 particles/bunch may be too large

  Space charge effect in DR

  Beam-beam interaction at IP (Background)

(Reducing number of particles/pulse decrease Power efficiency in main linac.)

Major Impacts of non-nominal sets to Sub-System

- Damping Ring

  "Low Q" need twice bumber of bunches/pulse.

  Bunch spacing in the rings should be half and short rise-fall time of kickers is required. (or huge ring)

- Bunch Compressors

  Bunch length should be flexible (0.15 ~ 0.5 mm).

- Beam Delivery System

  "Low Q" and "Low P" require smaller βy and σy at IP.

  All non-"Nominal" sets require smaller βx and σx at IP.

  "Low Y" and "Low P" have larger Dy.

  "Low P" has larger δB.

Beam dynamics
(Simulation study in Japan)

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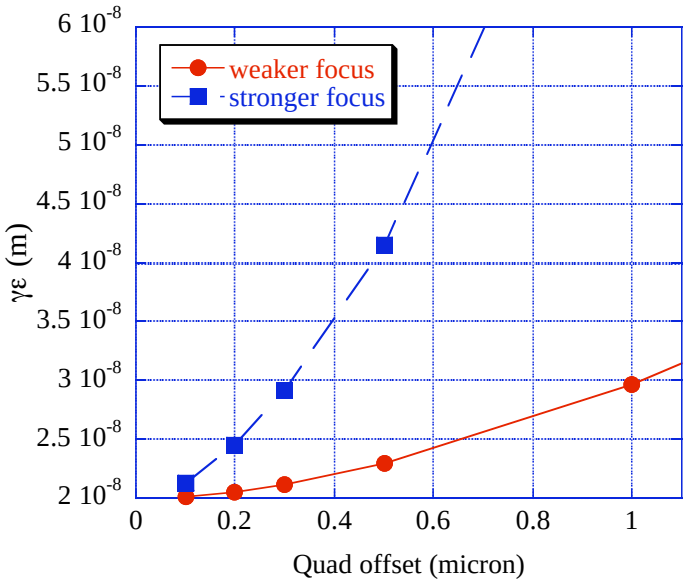
Simulation using the code 'SLEPT' for low emittance preservation in ILC main linacs.

Rough tolerances of main linac components were given, which should be considered in hardware design.
For further study, realistic error model should be given by hardware designers.
(We expect to agree on the rough tolerances and the realistic error model during Snowmass workshop.)

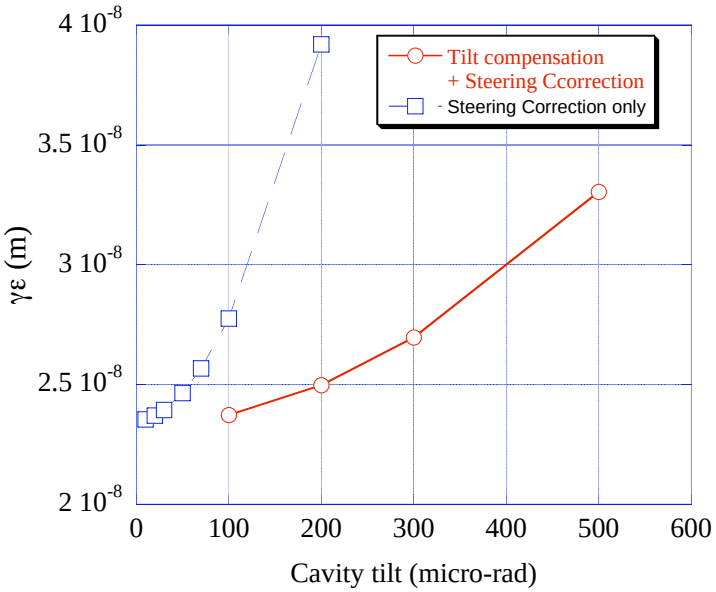
Beam parameter

Initial and final beam energy	5 GeV → 250 GeV
Gradient	35 MV/m
Bunch intensity	2E10
Bunch length	0.3 mm (rms)
Initial momentum spread	2.8 % (rms)
Initial normailized emittance	2E-8 m

No correction



Quad 0.3 mm, cavity 0.3 mm, BPM 20 μm, offset error.
Steering correction, Tilt compensation.



ILC Main Linac Rough tolerances.

Static misalignment (Slower than the correction in the main linac) [additional 5% emittance dilution]	
Quad offset	400 μm
Cavity offset	1 mm
Cavity tilt	150 μrad
Quad - BPM offset	15 μm
Fast movement (Faster than the correction in the main linac but slower than the orbit feedback at IP) [10% emittance dilution]	
Quad offset	0.4 μm
Cavity offset	600 μm
Cavity tilt	2 μrad
Mmeasurement by measurement [additional 5% emittance dilution]	
BPM Resolution	10 μm