ILC parameters revisited

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Parameters 2003 (1)

1. **Baseline Machine**

The maximum centre-of-mass energy should be 500 GeV
with energy range for physics between 200 GeV and 500 GeV, i.e.
the collider has also to allow for energy scans at all centre-of-mass energy values between 200 GeV and 500 GeV.

Luminosity and reliability of the machine should allow the collection of
app. 500 fb-1 in the first four years of running, not counting year zero
which is assumed to mainly serve for machine commissioning.

The time needed for the change of energy values should not exceed about 10% of the actual data-taking time. Therefore, the down-time for switching between energy values should not exceed a few shifts within a particular scan, and should not take more than a few weeks when changing between different energy scans. Full scan of 100 fb-1 may take a year.

Beam energy stability and precision should be below the tenth of percent level, in the continuum as well as during energy scans.

Parameters 2003 (2)

1. **Baseline Machine (cont'd)**

Electron polarisation of at least 80%.

Two interaction regions should be planned, with space and infrastructure provided for two experiments. Two experiments are desired to allow independent measurement of critical parameters and to provide better use of the beams thereby maximizing the physics output.
At least one interaction region should allow a crossing angle compatible with a $\gamma\gamma$ interaction region.

The machine should allow for an energy range for calibration that extends down to 90 GeV.

Parameters 2003 (3)

2. Energy Upgrade beyond the Baseline Machine

The energy of the machine should be upgradeable to approximately 1 TeV.

The luminosity and reliability of the machine should allow the collection of order of 1 ab-1 (equivalent at 1 TeV) in about 3 to 4 years.

The machine should have the capability for running at any energy value for continuum measurements and for threshold scans up to the maximum energy with the design luminosity ($\sqrt{s}$ scaling assumed).

Beam energy stability and accuracy should be as stated for the baseline machine.

Parameters 2003 (4)

3. Options beyond the Baseline Machine

Doubling the integrated luminosity to a total of 1 ab-1 within two additional years of running, without requiring an additional shutdown.

Running as an e-e- collider at any energy value up to the e+e- maximum energy. Positron polarisation at or above 50% is desirable in the whole energy range.

Running at the Z^0 with a luminosity of several 10^{33} /cm2/s (GigaZ running)
Running at the WW threshold with a luminosity of several 10^{33} /cm2/s

Several physics measurements are uniquely enabled through collisions of (polarized) photons, or electrons and photons, from backscattered laser beams. High polarization of both electron beams is required. This option will require transformation of one interaction region to run as a γγ or eγ collider at any energy up to 80% of the e+e- maximum energy, with reduced luminosity (some 30-50%) with respect to the e+e- luminosity.

Mandate 2006

The ILCSC sub-group on parameters is asked to

Revisit the Baseline Machine performance and Energy Upgrade parameters it had established two years ago, taking into account possible new insights and developments

Discuss, together with the GDE and WWS, all areas of the RDR design optimisation affecting the performance parameters

Revisit the Options Beyond the Baseline Machine it had established two years ago, and provide clear cost versus performance guidance as its effects the initial machine configuration

Make report (and interim report if necessary) well in phase of the development of RDR

Questions to Working Groups

The parameter Group issued a few questions to the working groups in all regions mainly addressing the issues of integrated luminosity, energy, beam energy spread, and positron polarisation.
WG's were asked to specifically address the following issues:

At what amount of integrated luminosity are systematic effects becoming dominant?

Is there any impact of decreasing (increasing) beamstrahlung by a factor of two relative to the standard parameters, i.e. trading off luminosity vs background?

Is there any benefit from electron plus positron polarisation (80 and 60%) or from increased electron polarisation in the absence of positron polarisation?

Are there other accelerator parameters strongly influencing the measurement?

Questions to Working Groups

Higgs WG:

Q1

Assuming a Higgs mass of 120 GeV, what is the achievable precision for the mass measurement?

Please provide information for three energies:

a) threshold scan, b) at the maximum of the ZH cross section, c) 500 GeV.

assuming the same amount of integrated luminosity for b) and c).

Q2

What is the expected precision for the measurement of the Higgs branching ratio to tau-pairs?

Q3

What is the expected precision achievable for the measurement of the triple Higgs coupling? Center of mass energies of 500 GeV and 1TeV.

Questions to Working Groups

SUSY WG:

Q1

What is the achievable precision for the measurement of sparticle properties (in particular the masses)? Please consider the lightest stau in the co-annihilation region assuming a mass difference to the LSP of 5 GeV. How much luminosity is needed to reach a precision comparable to the one expected from the measurements with the Planck satellite?

Q2

What is the achievable precision for the measurement of sparticle properties (in particular the masses) assuming the case of neutralino production chi1chi2.

Please use a parameter point with masses and mass differences best suited for you to answer the questions in time.

Questions to Working Groups

Top WG:

What is the achievable precision for the top mass measurement? Please provide information for two energies: threshold scan, 500 GeV

How much luminosity is needed to reach the expected level of theoretical uncertainties?

New Physics WG:

What is the achievable precision for the measurement of a Z'?

Please give in particular the expected error on g_V and g_A, at two different energies: 500 GeV and 1 TeV.

Summary of Answers (1)

Higgs:

1- all measurements are statistically limited at least up to 500 fb-1

2- increasing beamstrahlung by factor 2 results in at least 40% more luminosity required for achieving same accuracy for M_H

3- 60% positron polarisation gains 30% lumi ($H \rightarrow$tautau) or accuracy (ZHH at 1TeV)

4- maximum energy depends on M_H, for the presently favoured (ew fits) low Higgs mass scenario, optimal running is far below 500 GeV (even below 350 GeV)

However: ZHH and, in particular, ttH need energy at or beyond 500 GeV

$\rightarrow$ lowering max. energy below 500 GeV not adviseable

Top:

Rather independent of (moderate) changes in accelerator parameters

but:

Measurement of ttH needs at least 500 GeV and profits from low beamstrahlung (up to 40% change in cross section)

Summary of Answers (2)

SUSY:

1- General: Wide range of SUSY models makes clear predictions difficult
but
2- essentially all measurements are statistically limited at least up to 500 fb-1
there are, however, scenarios (e.g. stau-coannihilation channel) where 300 fb-1 at 600 GeV already match Planck accuracy (2%)
→ max energy and luminosity desirable
3- beamstrahlung is not an issue for endpoint method contrary to threshold scans for the determination of masses
4- positron polarisation helps, may even be important for some scenarios

New Physics (here: Z‘):

1- At 500 GeV at least 500 fb-1 (800 fb-1) with 60% (w/o) positron polarisation required to exceed sensitivity expected for LHC
2- beamstrahlung should be no problem

→ Taking into account also other important channels (e.g. TGC‘s) calls primarily for E and L, positron polarisation beneficial in all cases studied

Preliminary Conclusions (1)

Luminosity

what's behind the statement in the 2003 document
"app. 500 fb-1 in the first four years of running, not counting year zero"

- Assuming design luminosity of $3x10^{34}$ /cm2/s running for a snowmass year of 10^7 s yields 300 fb-1 of integrated luminosity.
- Note: 10^7 s correspond to 120 (240) days running with 100% (50%) efficiency

In 2003 we assumed design luminosity only in year 4 and took 250 fb-1 for that year.
We assumed a steady increase in instantaneous luminosity from
year 0 (0% of design lumi) to year 1 (10%), year 2 (30%) and year 3 (60%) to year 4.
Result: 500 fb-1 in the first four years of running, not counting year zero

The statement
"Doubling the integrated luminosity to a total of 1 ab-1 within two additional Years"
is a natural consequence of having achieved design luminosity in year 4

Preliminary Conclusions (2)

Luminosity

All measurements are statistically limited, lowering luminosity by a factor 2 results in doubling the running time. Since we are interested in **integrated luminosity:**

Q1: Can we assume a longer running time per year?

Q2: Is cost saving possible by running with lower current but w/o reducing the number of bunches? Reduces luminosity and beamstrahlung so that some effects cancel:

The assumptions in 2003 were (reasonable?) estimates.
However, these assumptions indicate that the loss in integrated luminosity is not dramatic if one starts with lower design luminosity and/or reduced number of bunches in the first few (0 to 2 ?) years provided the design luminosity is (successively) re-established in the following years.
A steeper increase in luminosity performance than anticipated in the 2003 document through successive installation of the remaining parts could then still deliver the desired integrated luminosity within the anticipated time frame.

Nonetheless:
Reducing luminosity should be the very last option.
Staging in the first few years to be discussed.
No permanent de-scoping.

Preliminary Conclusions (3)

Beamstrahlung

Most measurements suffer from increased beamstrahlung
thus requring more luminosity for achieving same accuracy

On the other hand reduced beamstrahlung results in luminosity gain

Reduced beamstrahlung equivalent to some luminosity gain dependend on physics channel (e.g. M_H at E=350 GeV)
Consequence:
→ with reduced beamstrahlung slightly lower current acceptable

Higher beamstrahlung undesirable (to be quantified)

Preliminary Conclusions (4)

Energy

Highest possible energy is called for but at present there is no known measurement which could not be done at slightly reduced energy.

Removing safety margins in energy reach is acceptable. Max. lumi not needed at the top energy (500 GeV), however, 500 GeV should be reachable assuming nominal gradient before knowing more about physics scenarion realised

Positron Polarisation

Many measurements gain from positron polarisation, thus also requiring less luminosity for same accuracy.

Positron Polarisation is very beneficial in many scenarios, including SM scenarios → this option mandatory to be kept open

Note: Recently the possibility of initial positron polarisation as high as 30% was mentioned for the ILC baseline configuration (eq. to 10% lumi gain?)
Assuming this, a slight reduction in luminosity seems acceptable
→ to be verified and quantified by the physics groups

Preliminary Conclusions (5)

Number of IRs

Two experiments are required.

If large cost saving with one IR: Push-Pull could be an option.

However:

- reasonably short switch over times (1week or so?) in order not to loose much lumi
- frequent moves desired (every 2-3 months?) in order to treat both exp‘ts equally

Two detectors <u>highly desired</u>, one IR feasible
→ See report by the push-pull task force

Energy upgrade to approx. 1TeV

An option mandatory to be kept open

Preliminary Conclusions (6)

Gamma-Gamma
Should be kept as an option for the reasons given in the 2003 document.
However:
more realistic studies plus possibly investments are required.

Giga-Z
to be kept as an option for the reasons given in the 2003 document

Outlook

Parameter group meeting here in Valencia

to

produce a preliminary written version of conclusions
taking into account **YOUR** comments and discussions with GDE