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ILC Running Scenarios

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Abstract

We need some running scenarios...

1 Introduction

Here will go charge, definition of stages, ...

2 Total integrated luminosity and polarisation splitting

	$\int \mathcal{L}dt$ total	fraction with $\mathrm{sgn}(P(e^-), P(e^+))$ = (-,+)	(+,-)	(-,-)	(+,+)
$\sqrt{s}$	[fb^{-1}]	[%]	[%]	[%]	[%]
250 GeV	2000	67.5	22.5	5	5
350 GeV	200	67.5	22.5	5	5
500 GeV	5000	40	40	10	10
1 TeV	5000	40	40	10	10
90 GeV	100	40	40	10	10
160 GeV	500	67.5	22.5	5	5

Table 1: Total target integrated luminosities per center-of-mass energy and relative sharing between beam helicity configurations.

	integrated luminosity with $\mathrm{sgn}(P(e^-), P(e^+))$ = (-,+)	(+,-)	(-,-)	(+,+)
$\sqrt{s}$	[fb^{-1}]	[fb^{-1}]	[fb^{-1}]	[fb^{-1}]
250 GeV	1350	450	100	100
350 GeV	135	45	10	10
500 GeV	2000	2000	500	500
1 TeV	3200	3200	800	800
90 GeV	40	113	25	25
160 GeV	338	40	10	10

Table 2: Integrated luminosities per beam helicity configuration resulting from the fractions in table 1.

3 Running Scenarios

The total integrated luminosities presented in the previous section can be collected at different stages of the machine in a different periods of time. We will give here a few examples of running scenarios. In this we apply the following guidelines/restrictions:

- The main parameter to vary is the integrated luminosity to be collected at $\sqrt{s} = 250\,\mathrm{GeV}$ with an inital staged 250GeV machine. We will consider 4 cases in the tables below: A) $250\,\mathrm{fb}^{-1}$, B) $500\,\mathrm{fb}^{-1}$, C) $50\,\mathrm{fb}^{-1}$ D) $1250\,\mathrm{fb}^{-1}$, which corresponds to A) 2, B) 4, C) 0.4, D) 10 years of running of the inital 250 GeV staged machine before upgrading it to 500 GeV.

- All scenarios assume that an integrated luminosity of $200\,\mathrm{fb}^{-1}$ will be collected at the top threshold near $\sqrt{s} = 350\,\mathrm{GeV}$. We assume that this will be done with the 500 GeV machine operated at a reduced gradient. We leave it open whether this happens before or after the first data-taking at $\sqrt{s} = 500\,\mathrm{GeV}$ since this does not influence the total running time or the installation scheme.

- All (but one) scenarios assume that ultimately an integrated luminosity of $5000\,\mathrm{fb}^{-1}$ will be collected at $\sqrt{s} = 500\,\mathrm{GeV}$.

- We include both a possible luminosity upgrade and an energy upgrade in order to give a complete picture of the longterm potential of the ILC. However the exact details of the longterm program will depend on future developments at previous stages of the ILC, at the LHC and possibly other scientific results. Thus we do not speculate here about all the possible variations of the more long-term program, in particular the LumiUp and 1TeV runs.

- It should be noted explicitely that further discoveries, in particular at ILC-500, will change the details and might add the neccessity to run at additional intermediate energies, either for scanning production thresholds of new particles, or for disentangling several states close by in mass (eg. in SUSY measure the $\tilde{\tau}$ mixing angle in $\tilde{\tau}_1\tilde{\tau}_2$ mixed production below the $\tilde{\tau}_2\tilde{\tau}_2$ pair production threshold).

- At each $\sqrt{s}$, the total integrated luminosities given below should be understood to be split up between the four possible beam helicity configurations as specified in section 2.

- We do not list here physics running at the Z-pole or at the WW-threshold. However we note that their physics program should be done at some point, where the timing will depend on the outcome of an inital running at $\sqrt{s} = 500\,\mathrm{GeV}$.

- We don't list either runtime on the Z-pole for calibration. This will be needed at least twice per year for detector calibration (eg of the momentum scale of the tracking detectors). Here, more precise specifications from the experiments are needed to assess systematically the amount of data needed for which level of calibration precision.

- In this section, we will only use a simplistic translation of integrated luminosity into years of operation at peak design luminosity for purpose of illustration. Realistic time lines for these scenarios including ramp-up and upgrade-installation times will be presented in section 4.

3.1 Running Scenarios with fixed final integrated luminosities

Here we present four running scenarios which all end up in the final integrated luminosities as given in section 2. Thus the benchmark to compare is the run time needed to collect the datasets, as well as the time development of the physics results discussed in section 5.

	Stage	250	500			500 LumiUP		1000
Scenario	$\sqrt{s}$ [GeV]	250	350	500	250	500	250	1000
A1 (a)	$\int \mathcal{L}dt$ [fb^{-1}]	250	200	1000	750	4000	1000	5000
	time [years]	2	1	4	3	8	2	10
B1 (g)	$\int \mathcal{L}dt$ [fb^{-1}]	500	200	1000	500	4000	1000	5000
	time [years]	4	1	4	2	8	2	10
C1 (h)	$\int \mathcal{L}dt$ [fb^{-1}]	50	200	1000	950	4000	1000	5000
	time [years]	0.4	1	4	3.8	8	2	10
D1	$\int \mathcal{L}dt$ [fb^{-1}]	1250	200	1000	-	4000	750	5000
	time [years]	10	1	4	-	8	1.5	10

Table 3: Four running scenarios with the same final integrated luminosities. Not included: ramp-up, installation, calibration runs physics runs at Z pole and WW-threshold, new physics thresholds.

3.2 Running Scenarios with fixed total running time

In this section we adjust the four above scenarios such that they all feature the same total run time before the upgrade to 1 TeV as scenario A1, namely 20 years. This obviously results in different total luminosities, in particular at $\sqrt{s} = 250\,\text{GeV}$.

	Stage	250	500			500 LumiUP		1000
Scenario	$\sqrt{s}$ [GeV]	250	350	500	250	500	250	1000
A2 (a)	$\int \mathcal{L}dt$ [fb^{-1}]	250	200	1000	750	4000	1000	5000
	time [years]	2	1	4	3	8	2	10
B2 (g)	$\int \mathcal{L}dt$ [fb^{-1}]	500	200	1000	250	4000	1000	5000
	time [years]	4	1	4	1	8	2	10
C2 (h)	$\int \mathcal{L}dt$ [fb^{-1}]	50	200	1000	1150	4000	1000	5000
	time [years]	0.4	1	4	4.6	8	2	10
D2	$\int \mathcal{L}dt$ [fb^{-1}]	1250	200	1000	-	2500	-	5000
	time [years]	10	1	4	-	5	-	10

Table 4: Four running scenarios with the same total run time before the upgrade to 1 TeV as scenario A1. Not included: ramp-up, installation, calibration runs physics runs at Z pole and WW-threshold, new physics thresholds.

3.3 Total running time and total integrated luminosities

Table 5 summarizes the "naive" run times of the scenarios defined in tables 3 and 4, where the scenarios A1 and A2-D2 have the same running times by construction. The comparison of scenarios A1-D1 shows that longer initial running at a staged 250 GeV machine leads to an overall longer time in order to accumulate the same final integrated luminosity. This is expected since a staged 250 GeV machine provides significantly lower instantaneous luminosity than the 500 GeV baseline machine operated at $\sqrt{s} = 250$ GeV.

	total run time *before*			total
	500 GeV	Lumi upgrade	TeV upgrade	
Scenario	[years]	[years]	[years]	[years]
A1	2	10	20	30
B1	4	11	21	31
C1	0.4	9.2	19.2	29.2
D1	10	15	24.5	34.5
A2	2	10	20	30
B2	4	10	20	30
C2	0.4	10	20	30
D2	10	15	20	30

Table 5: Cummulated running times for the 8 scenarios. Not included: ramp-up, installation, calibration runs physics runs at Z pole and WW-threshold, new physics thresholds.

Table 6 summarizes the total integrated luminosities accumulated at the end of the overall program of the eight running scenarios. Scenarios A1-D1 and A2 give the same amount of data by construction. Longer running of a staged 250-GeV machine reduces the total amount of data which can be collected in a fixed time. This is visible in particular in scenario D2, where the data sets with $\sqrt{s} = 250$ and $\sqrt{s} = 500$ each are reduced by 30-40% compared to A2.

4 Timelines of the running scenarios

here go the actual real time estimates from Nick

5 Time Development of Physics Results

here goes the physics output vs time (Higgs, top, TGCs, WIMPs - other?)

	final integrated luminosity at $\sqrt{s} =$			
	250 GeV	350 GeV	500 GeV	1 TeV
Scenario	[fb^{-1}]	[fb^{-1}]	[fb^{-1}]	[fb^{-1}]
A1	2000	200	5000	5000
B1	2000	200	5000	5000
C1	2000	200	5000	5000
D1	2000	200	5000	5000
A2	2000	200	5000	5000
B2	1750	200	5000	5000
C2	2200	200	5000	5000
D2	1250	200	3500	5000

Table 6: Total integrated luminosity at each energy after the full program. Not included: ramp-up, installation, calibration runs physics runs at Z pole and WW-threshold, new physics thresholds.

6 Additional Parts of the ILC Program

here go additional needs:

- Z-pole for calibration, Z-pole for physics, WW-threshold
- 550 GeV for $t\bar{t}H$
- model-independency of $ZH \to q\bar{q}H$

7 Conclusions

Here will go the conclusions...

Acknowledgement

References

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