Implication of Ground Motion on the Site Choice

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1 Introduction

Dynamic effect can signigicantly impact the luminosity performance of the ILC. Many of the noise sources are site independent but ground motion is very site specific. While it may be possible to mitigate the luminosity reduction one can expect for a noisy site by the use of stabilisation equipment, this will lead to higher cost and may need further R&D.

2 Results of Previous Studies

Previously, studies of the effect of ground motion have been carried out for TESLA in the framework of the International Linear Collider Technical Review Committee [1]. Three different ground motion models were used for these studies, each based on measurments on a real site. The site with the lowest ground motion level of ground motion was labelled model A, the intermediate level B and the noisiest model C. Model A corresponds to a tunnel deep in molasse (LEP), model C to a tunnel in sand (HERA). The results fo these studies should be indicative for the ILC since the parameters are roughly comparable; the ILC should be slightly less sensitive to ground motion effects. The studies showed that it is reasonably straightforward to maintain full luminosity in presence of the lower levels pf ground motion. However, in case of the noisy site C, the luminosity can potentially be significantly reduced. Results were presented in [2]. They can be summarised as follows (see table 1):

- If no pulse-to-pulse orbit feedback is present the luminosity is reduced from pulse to pulse.
- Even in presence of a pulse-to-pulse feedback, the luminosity loss remains significant if only an intra-pulse beam-beam position feedback is used.
- The situtation improves if also an intra-pulse angle feedback is applied.
- Further improvement can be obtained if the position and angle feedbacks are each replaced by an intra-pulse luminosity optimisation. Such an optimisation is certainly more complicated to perform than a beam position monitor based feedback.

- Even in presence of intra-pulse luminosity optimisation, a residual loss remains.

It should be kept in mind that ground motion is only one of the contributors to the dynamic effects. Other important sources are vibrations of the quadrupoles in the main linac and in the beam delivery system and RF jitter. However, it seems appropriate to require the ground motion to contribute less than the other noise source to the luminhosity loss since the ground motion not only depends on the location of the tunnel but also on the—often cultural—noise induced in its vicinity. A tunnel close to the surface may thus be affected by the later construction of roads etc.

3 Conclusion

It can be concluded that one expects a noticeable luminosity loss in presence of high levels of ground motion in the ILC. It may be possible to at least partly mitigate this loss by stabilising the elements of the beam delivery system and by using more complex feedback techniques. This will however lead to additional cost and will also increase the risk for the luminosity performance. A carefull study of the implications of the site ground motion levels as well as other noise sources seems thus indicated. The global group on civil engeneering should provide the necessary information to the working group on beam dynamics.

References

[1] G. Loew. Report of the second ILC-TRC. SLAC-R-606.

[2] D. Schulte. An update on the banana effect. Nanobeams 2002.

Table 1: Results for the luminosity loss in TESLA using the ground motion model C. A simplified model of the slow orbit feedback has been used.

correction applied	slow feedback gain			
	0.01	0.02	0.04	0.1
No feedb.	73	71	67	56
offset correction	36	33	29	26
+angle correction.	22	19	16	15
offset optimisation	15.1	11.7	9.3	7.8
+angle optimisation	10.4	7.3	5.7	4.6