Luminosity reduction in the ILC head-on scheme from parasitic collisions

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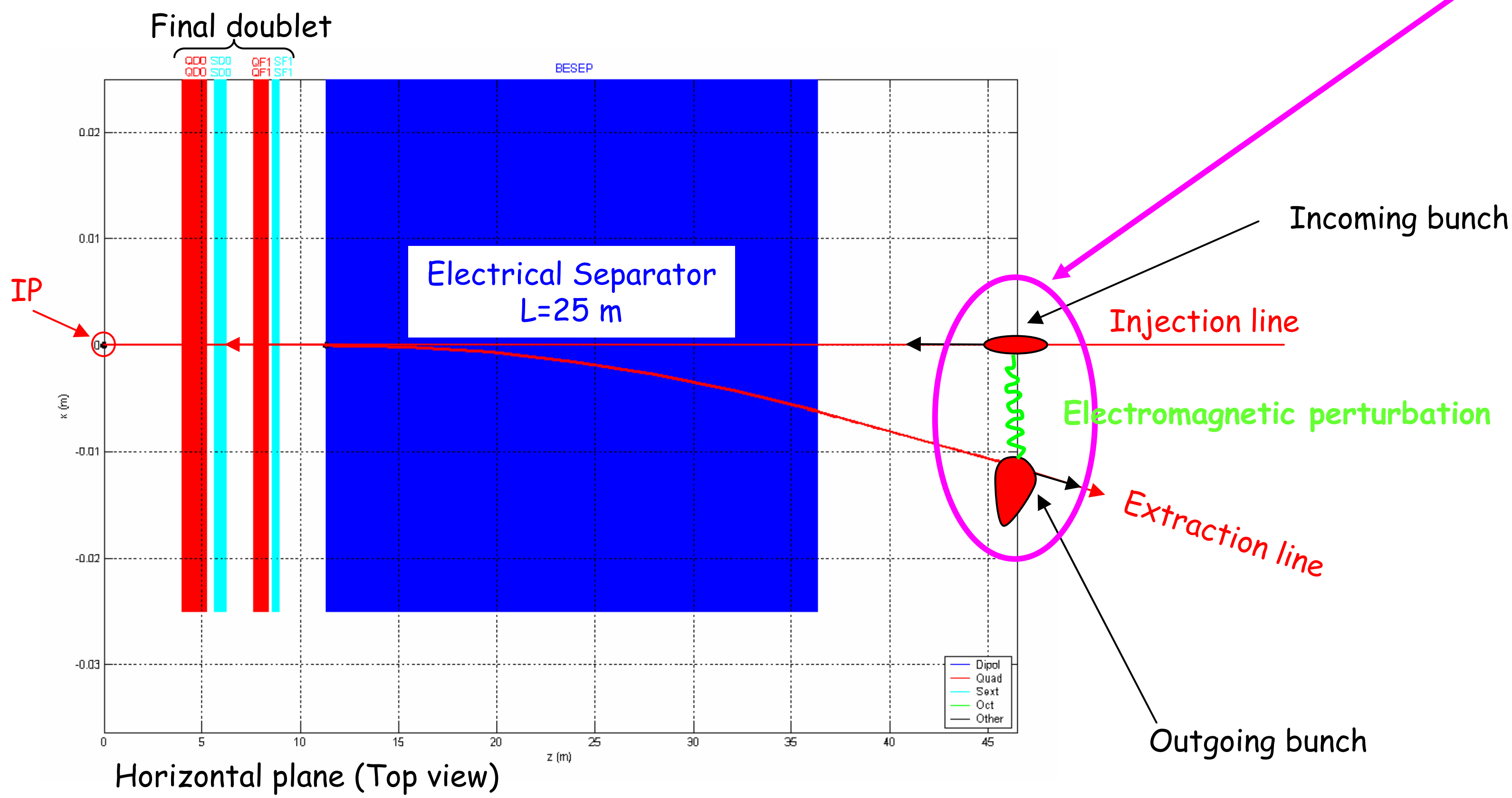
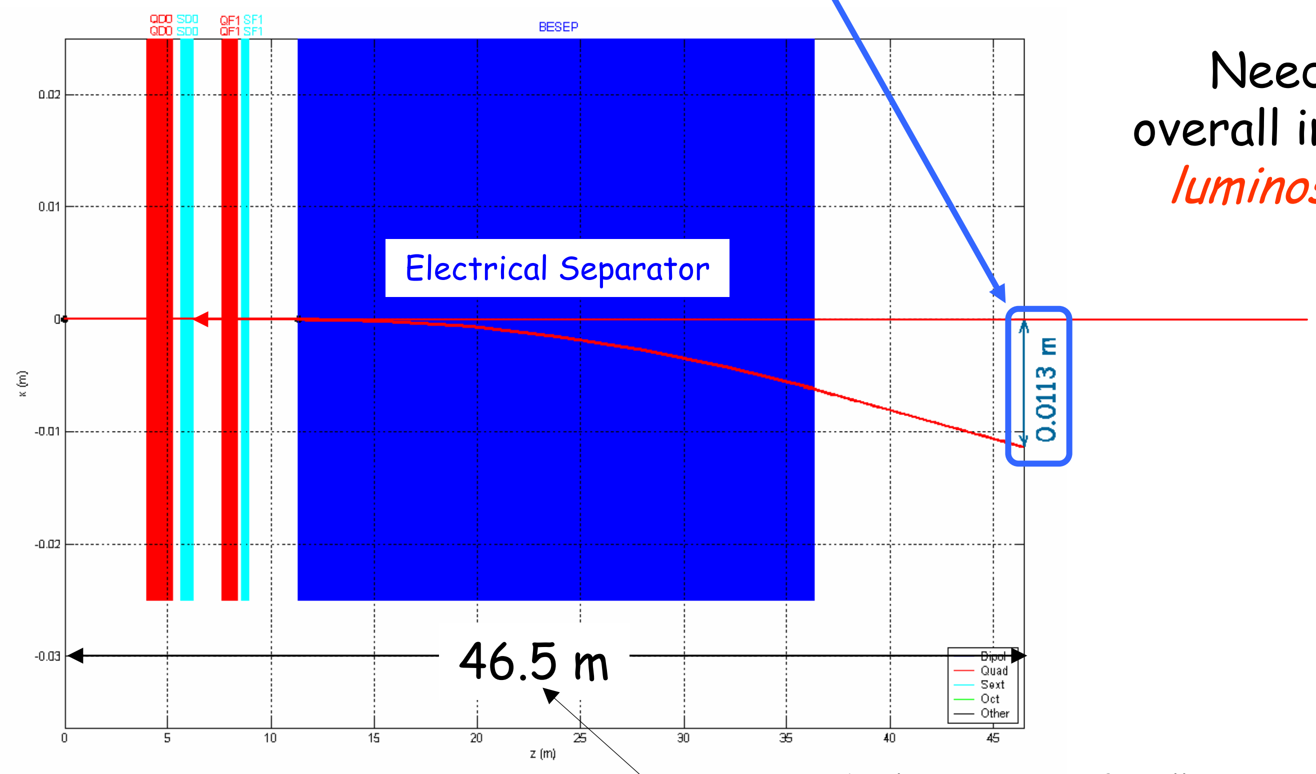
Residual random motion (jitter) not corrected by the feedback loop can reduce the luminosity in any IR arrangement. In the head-on scheme, the kick from the (first) parasitic crossing can amplify this reduction. Must ensure that this amplification is negligible by making the horizontal separation large enough.



Is the horizontal separation at the parasitic crossing large enough to induced a negligeable MBKI perturbation ?

Is the *strength of the electrical separator* strong enough ?

Need to compute the overall impact on *integrated luminosity* over the 2820 bunches



Approximated value. Not true for all parameter sets !

This study is performed for :

- the head-on scheme definition presented at EPAC 2006*
- nominal parameter set
- E_{bunch}=250 GeV
- e+/e- collision

Given the flat aspect ratio of the bunches at the IP, only vertical effects are analysed

A matlab® code as been developed for this purpose.

For the moment, the incoming and outgoing bunches are both represented by point-like particles

The upgrade to real particles distribution is under construction

* J. Payet & al. : http://accelconf.web.cern.ch/AccelConf/e06/PAPERS/MOPLS060.PDF

The particle tracking in the injection and extraction lines is performed using linear MAD matrix (R) transfert.

The full tracking with non-linear and chromatic effects (T matrix,…) will be added in the future to treat real particles distributions

At the parasitic crossing, the electromagnetic effect is performed using long-range perturbations for the vertical angular kick

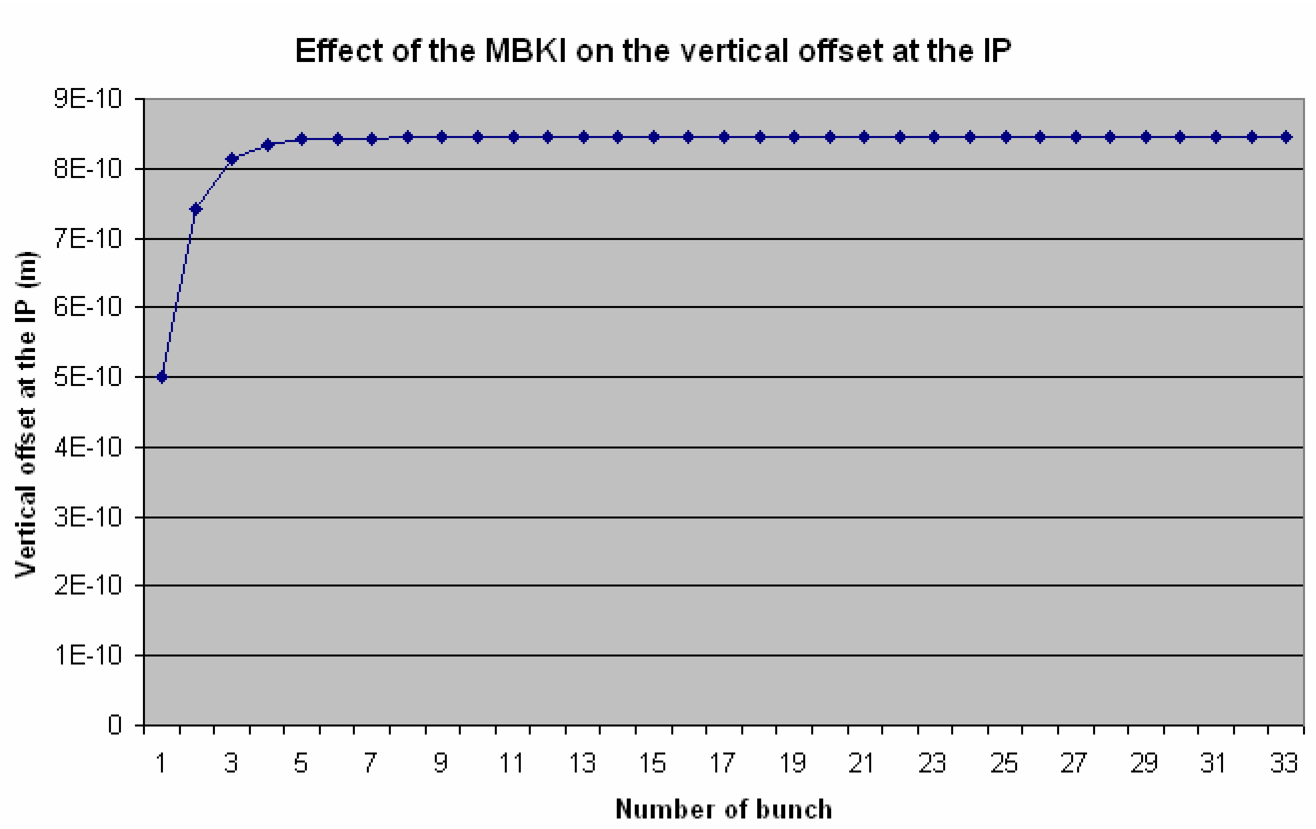
For each initial y-offset at the IP, the average luminosity over the 2820 bunches is computed for a system :

- without MBKI effect
- without MBKI effect and vertical jitter*
- with MBKI effect
- with MBKI effect and vertical jitter*

*The vertical jitters are randomly distributed between -1 and +1 nm at the IP. In this case, the average luminosity is estimated after 100 bunches.

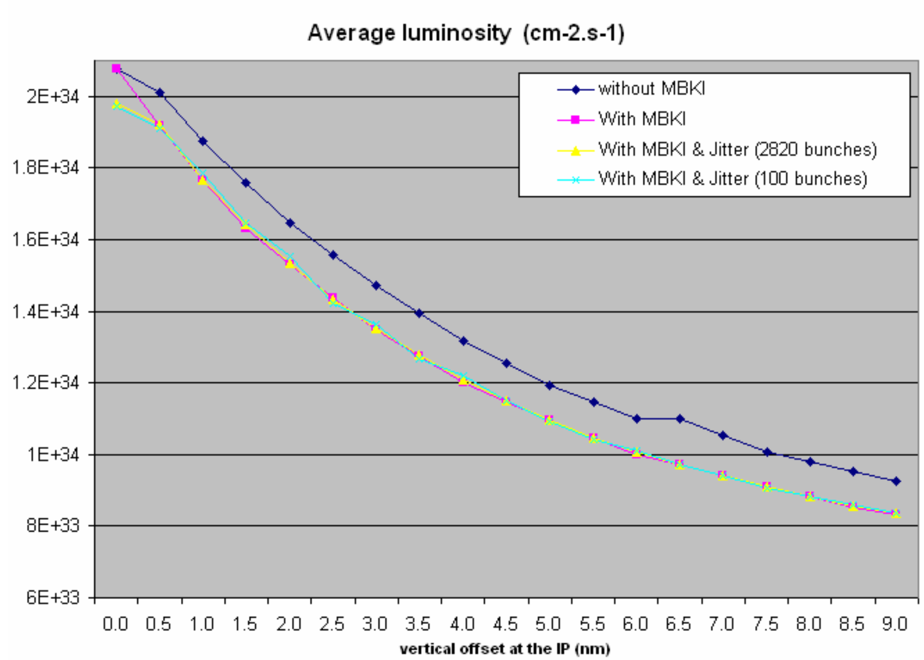
The electromagnetic perturbation at the first parasitic crossing induces a change in the vertical offset at the IP, which very rapidly reaches an assymptote (in the absence of jitter)

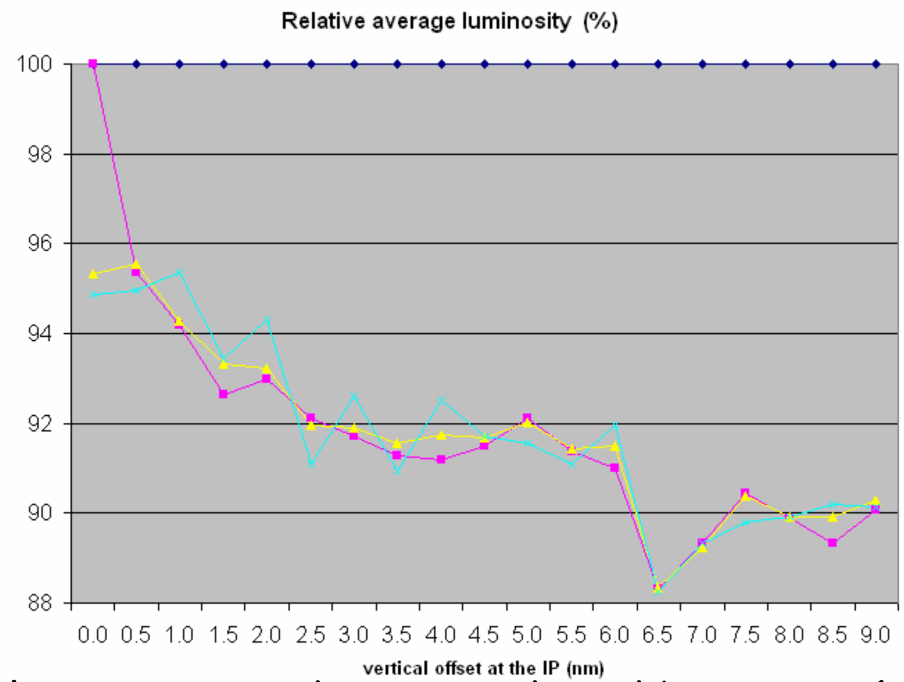
Example : for an inital vertical offset of 0.5 nm, the offset induced by MBKI is 0.844 nm after the 10th bunch.



When vertical jitters are present, then the vertical offset at the IP is always changing. Thus, a fully stabilized vertical offset is not really reached.
After a sufficent number of bunches, the average luminosity can be estimated with small error.

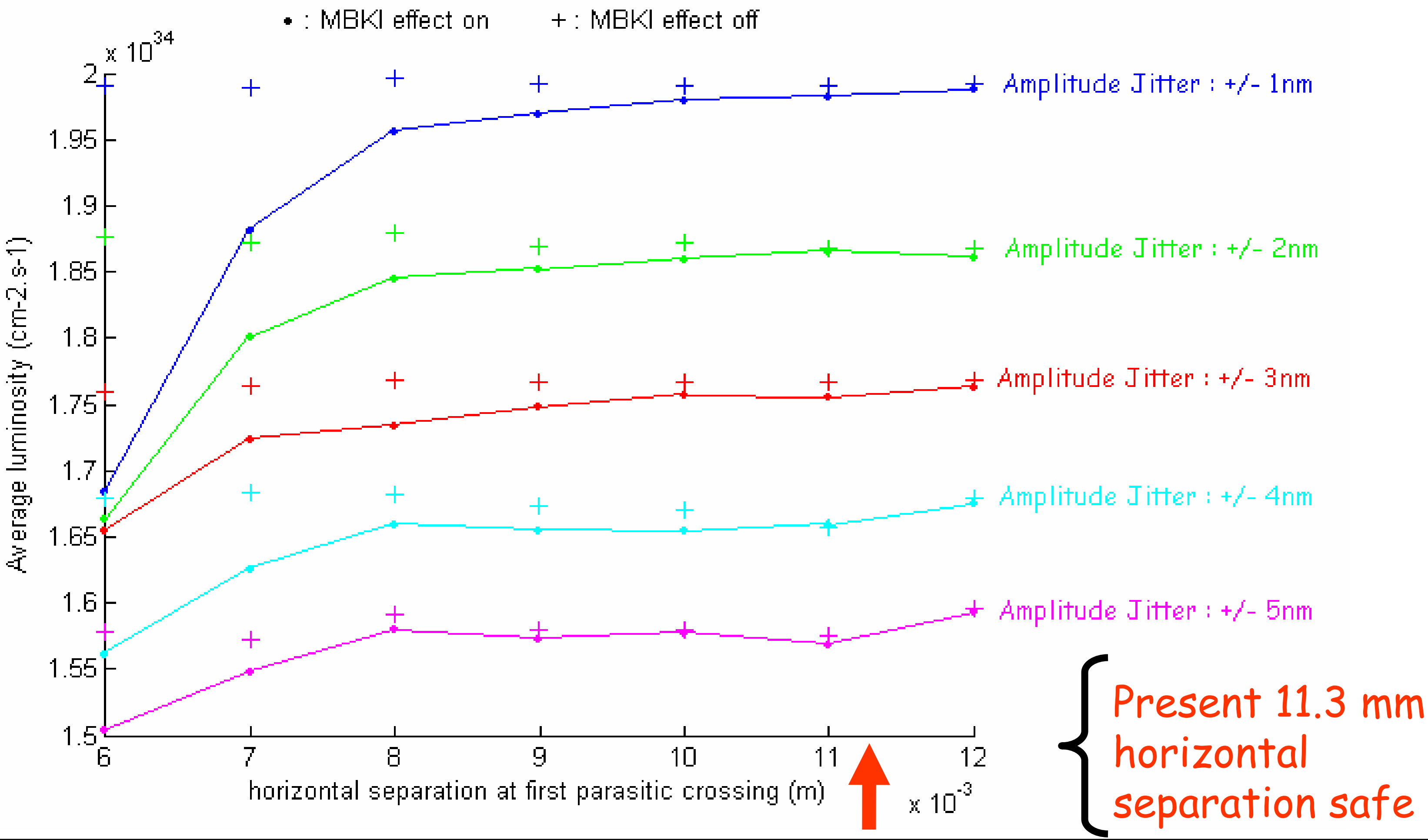
Example : for inital vertical offset between 0 and 9 nm, the average luminosity can be correclty estimated after 100 bunches.





When no offset is present at the IP, the luminosity reduction induced by jitter (-/+ 1nm at the IP in this study) is about 5%. The parasitic crossing doesn't induce important additional luminosity reduction.

Assuming that initial constant offsets have been corrected by feedback, the average luminosity reduction from jitter can be compared with/without parasitic crossings, as function of the jitter amplitude and of the horizontal separation.



Main present conclusion: parasitic crossings in the head-on scheme not a problem in the design with a 11.3 mm horizontal separation, using point-like charges to approximate both in-coming and out-going beams.

Future work :

A more accurate analysis is planned to check this conclusion using :

- real particle distributions
- tracking using DIMAD software
- beam-beam collision using Guinea-Pig.
- the latest version of the head-on extraction line.