CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

IN2P3 INSTITUT NATIONAL DE PHYSIQUE NUCLÉAIRE ET DE PHYSIQUE DES PARTICULES

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

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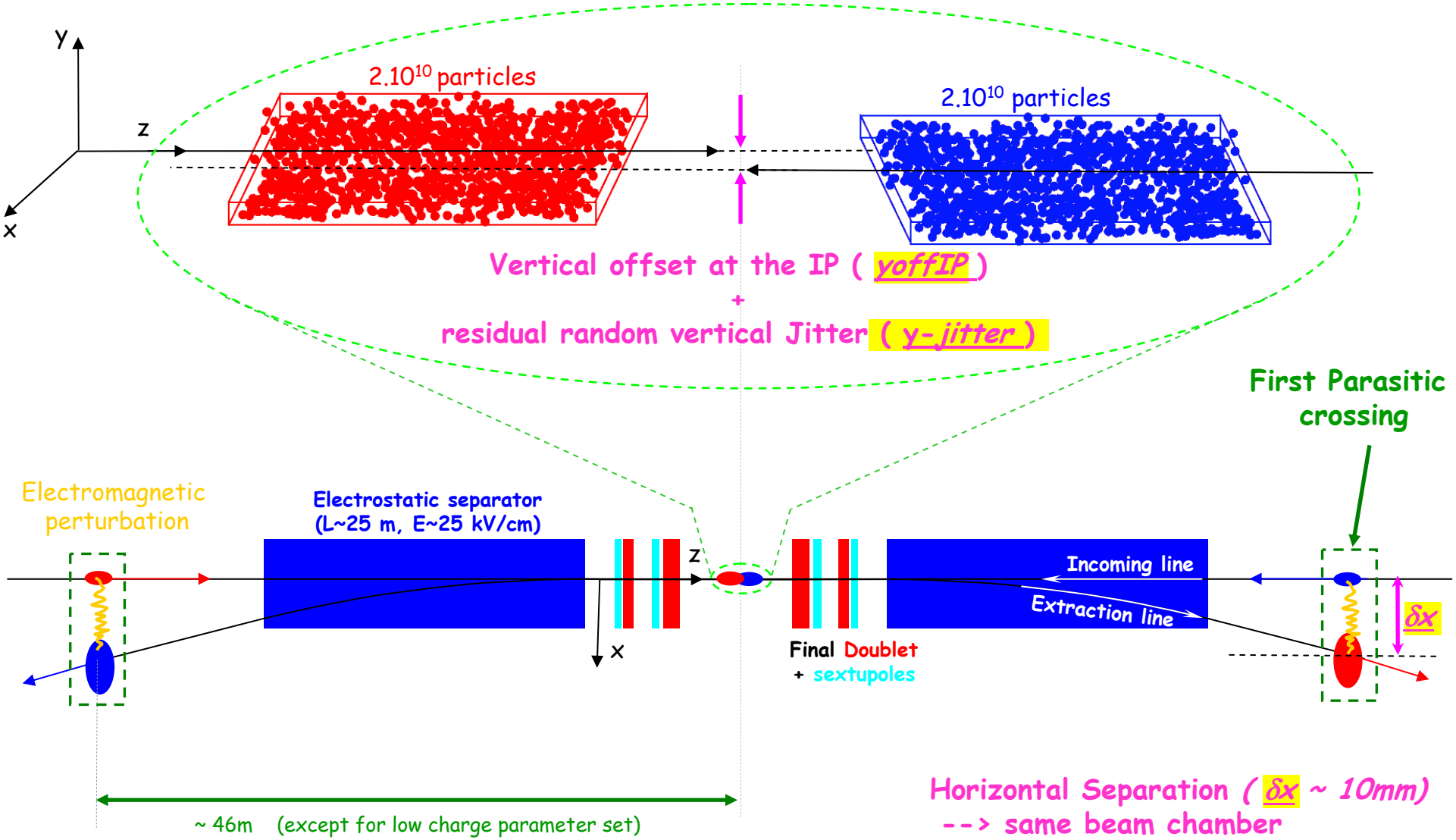
1/ Parasitic crossing and Kink effect

Beam-beam effect = f(E_b; σ_x; σ_y; σ_z; yoffIP ; y-jitter)



Horizontal Separation (δx ~ 10mm)
--> same beam chamber
--> electromagnetic perturbation

2/ Assumptions and limitations of the study

This study is performed for :
- the head-on scheme definition presented at EPAC 2006*
- nominal parameter set
- E_{bunch}=250 GeV and 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 represented by point-like particles

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

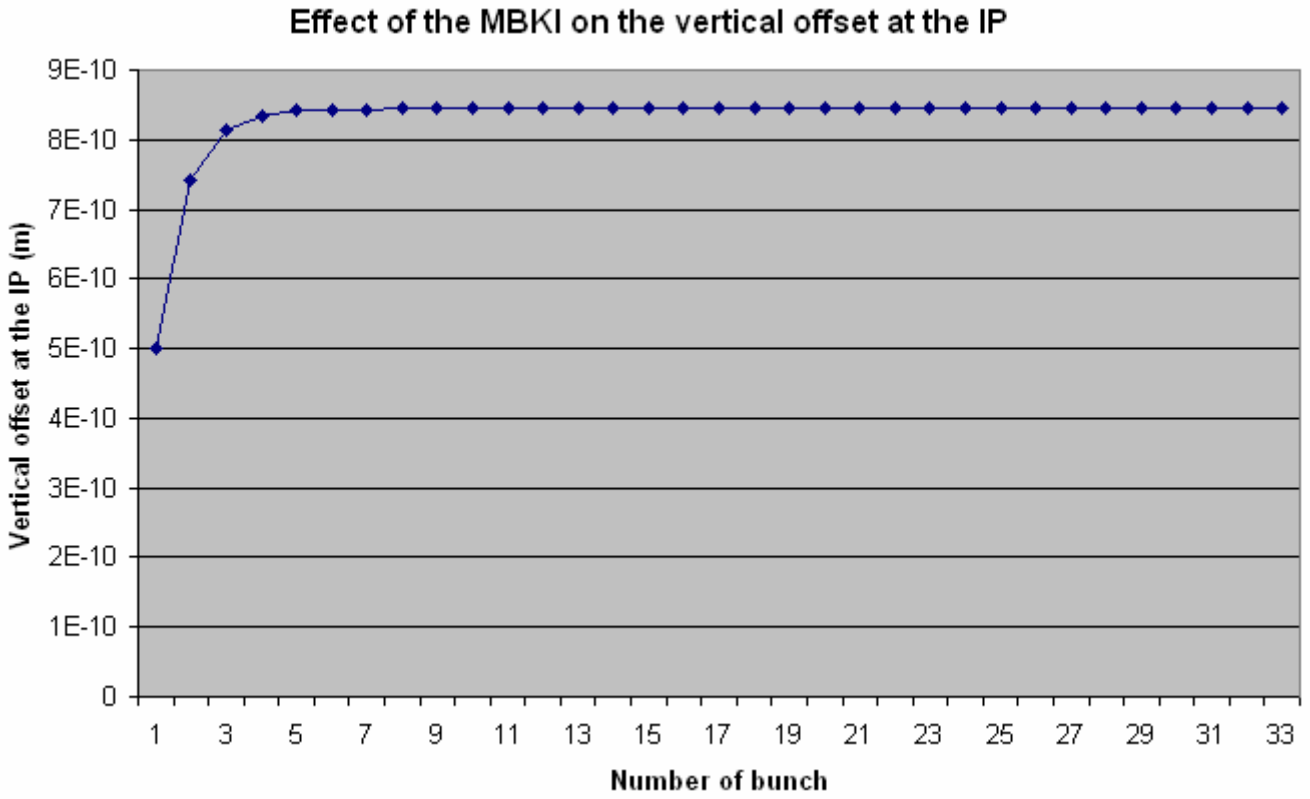
For each initial y-offset at the IP, the average luminosity over the 2820 bunches is computed for a system :
- without Kink effect
- without Kink effect and with vertical jitter
- with Kink effect
- with Kink effect and with vertical jitter

--> The upgrade to real particles distribution is under construction
--> A study for lower energy is also planned (for 200 or even 100 GeV CM).

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

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)

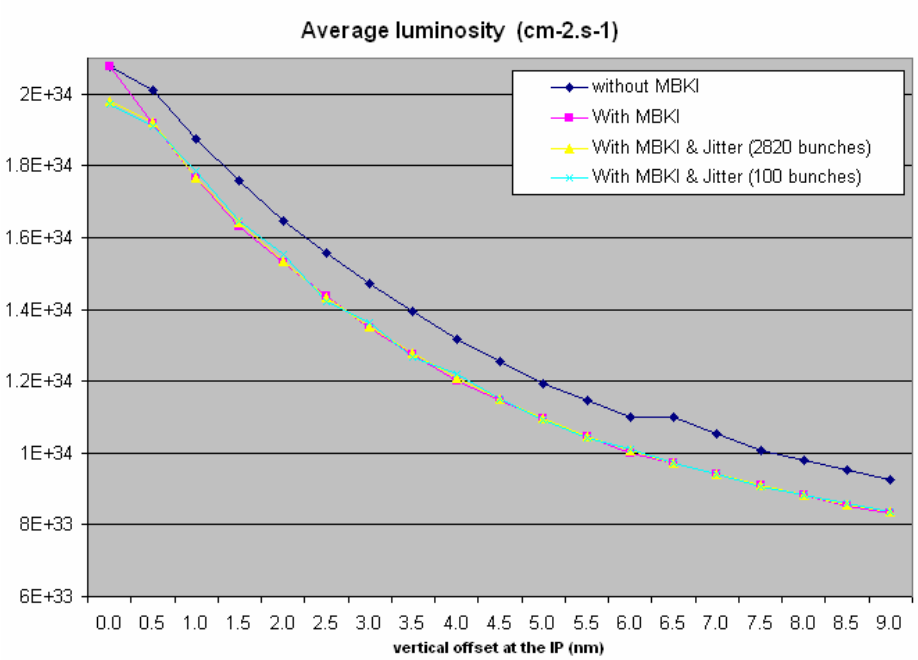
Example : for an inital vertical offset of 0.5 nm, the offset induced by MBKI is 0.844 nm after the 10^{th} bunch.

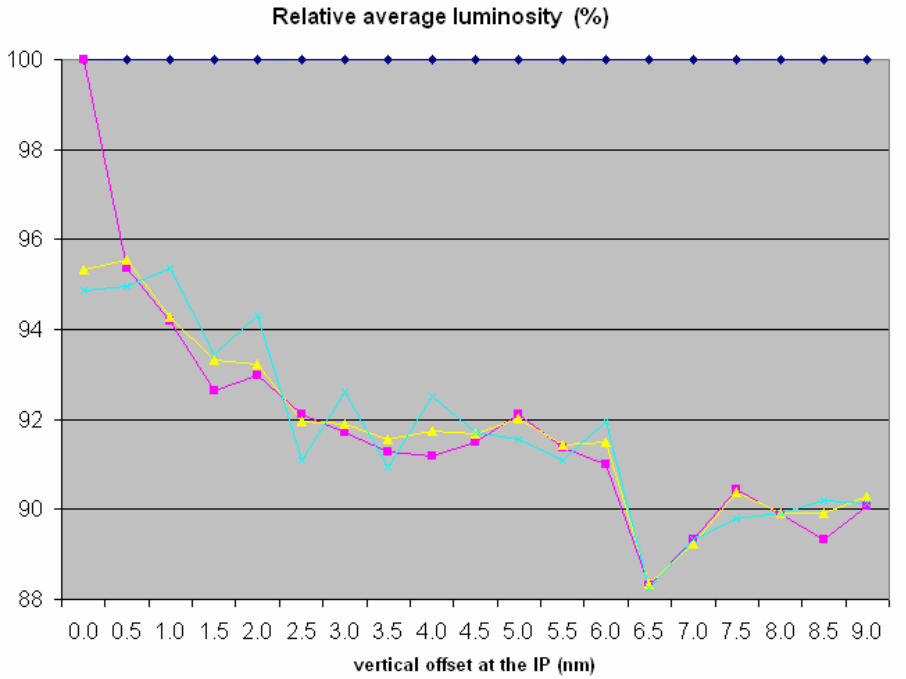


4/ Kink effect with vertical jitter (deltax=11.337 mm)

When vertical jitter is 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 a small error.

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



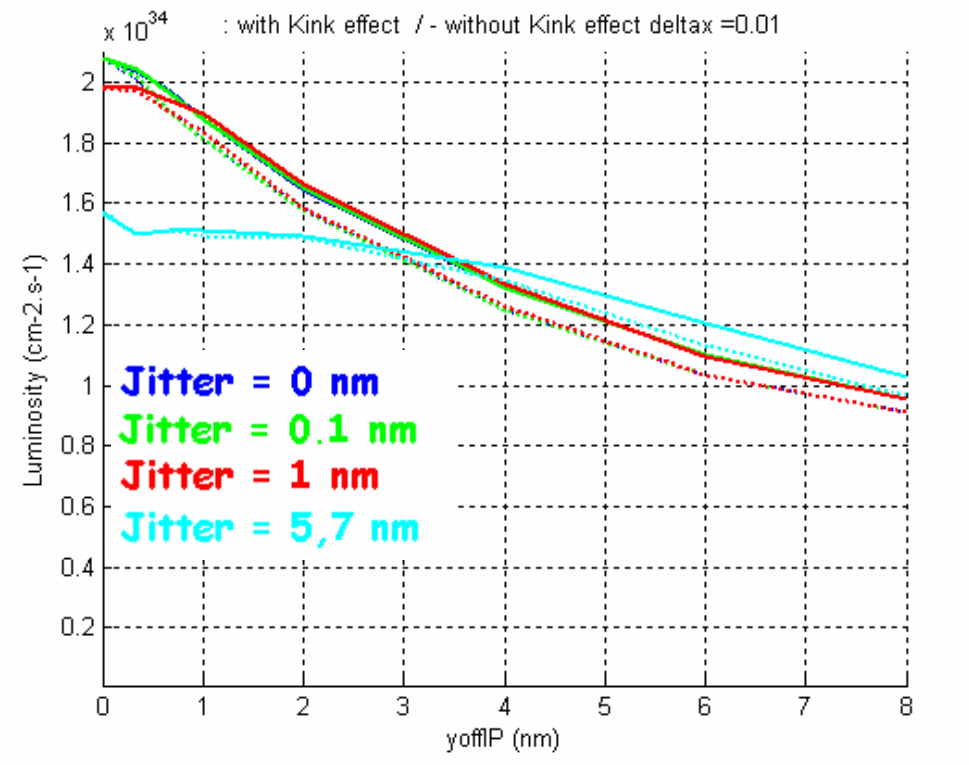


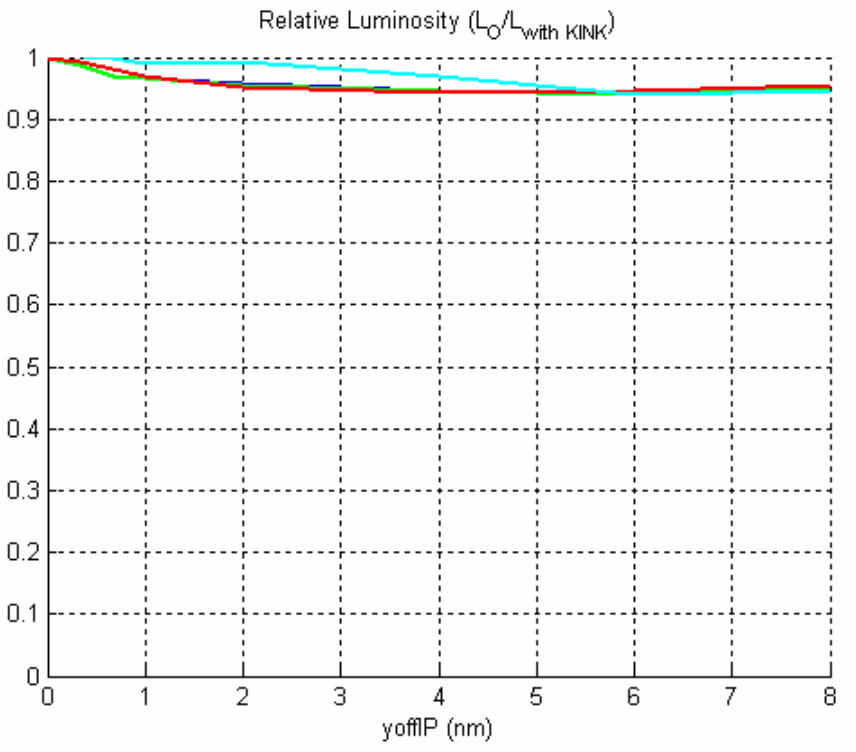
When no offset is present at the IP, the luminosity reduction induced by jitter (-/+ 1nm at the IP in this study) is about 5%.

5/ Results for Deltax =10 mm and Jitter = 0, 0.1, 1 and 5.7 nm

The average luminosity is estimated using 150 collisions.

Deltax= 10 mm

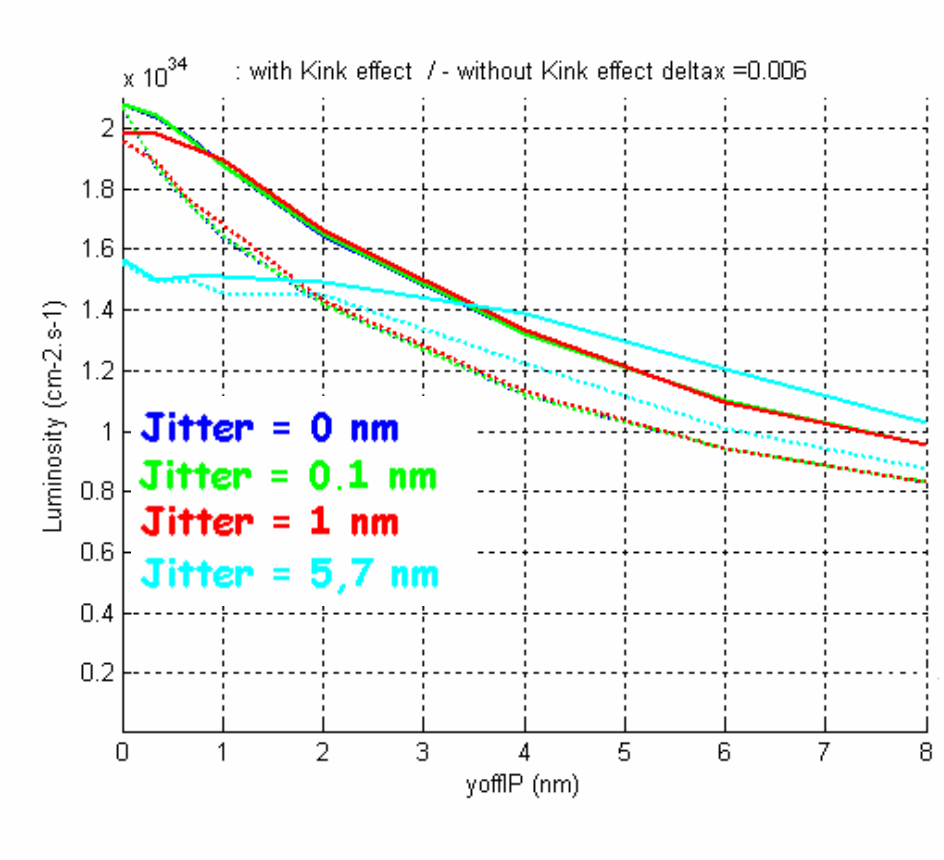


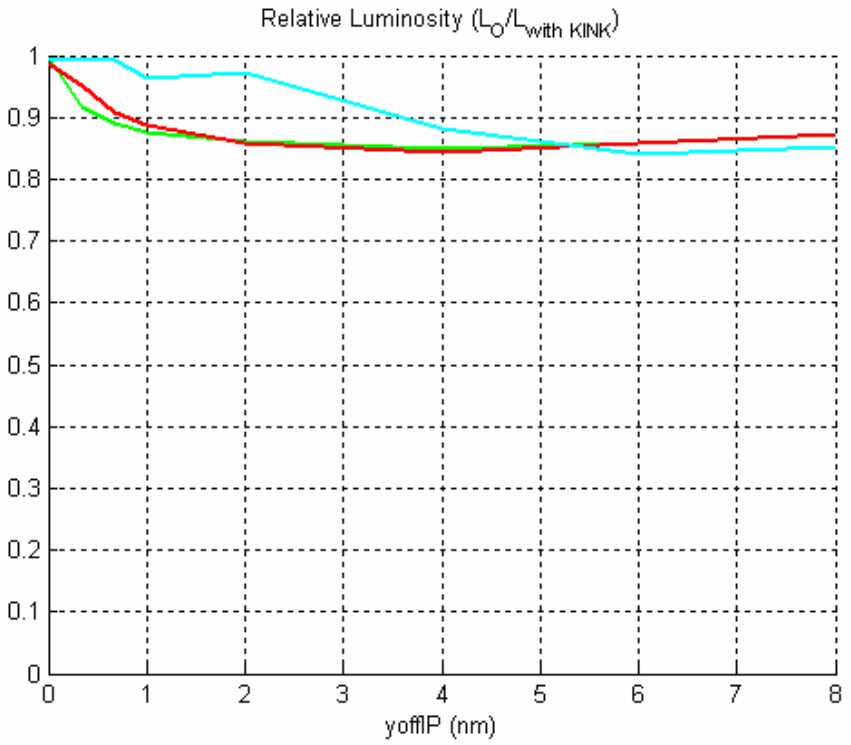


6/ Results for Deltax =6 mm and Jitter = 0, 0.1, 1 and 5.7 nm

The average luminosity is estimated using 150 collisions.

Deltax= 6 mm

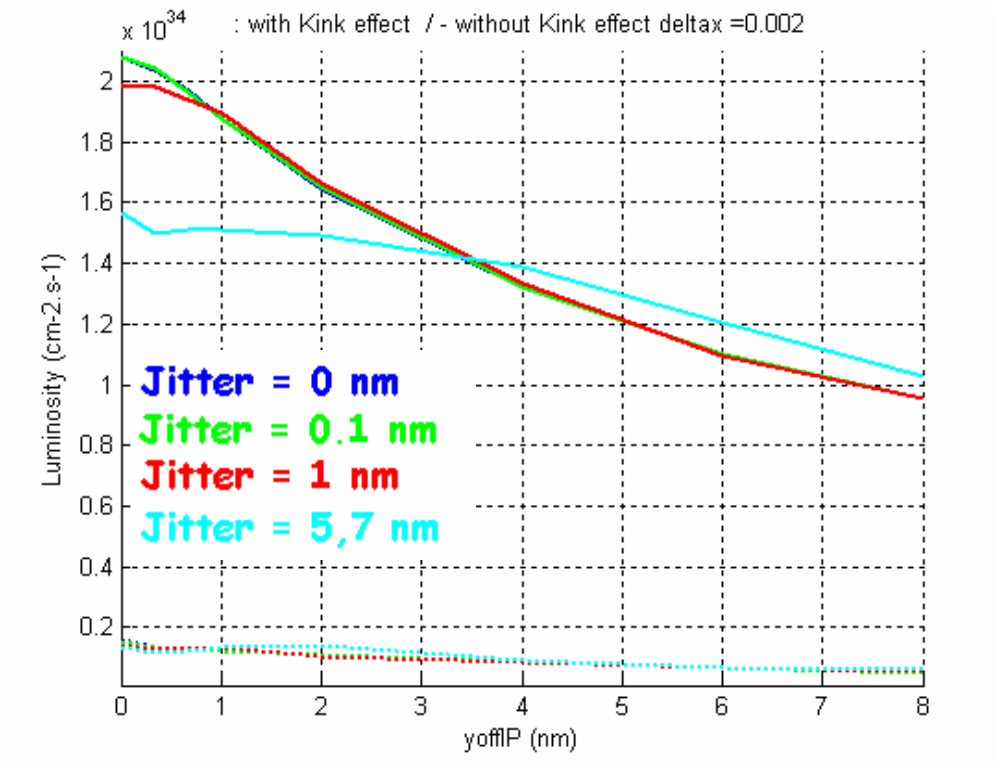


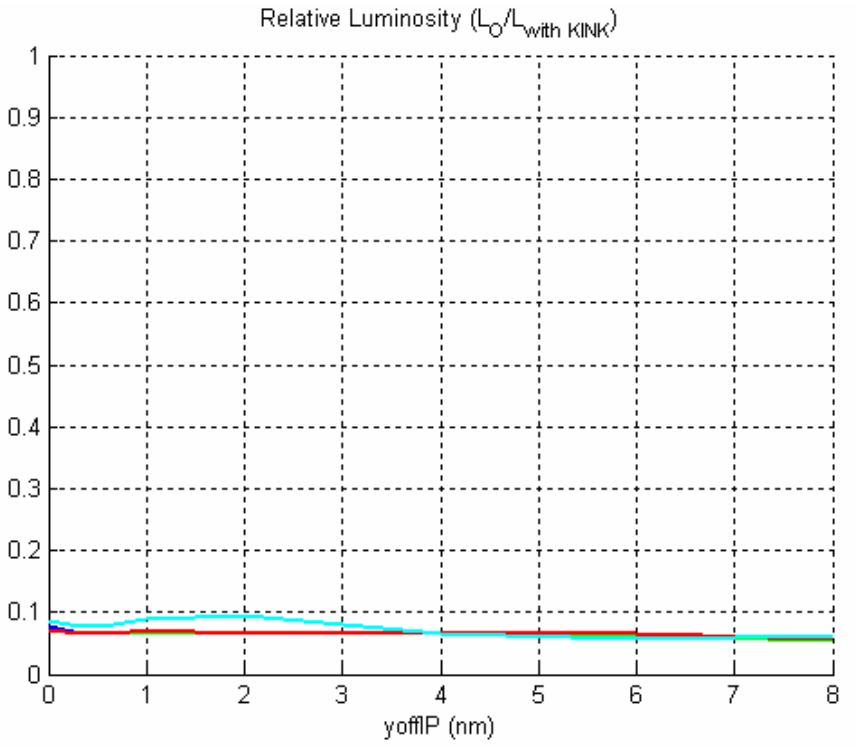


7/ Results for Deltax =2 mm and Jitter = 0, 0.1, 1 and 5.7 nm

The average luminosity is estimated using 150 collisions.

Deltax= 2 mm

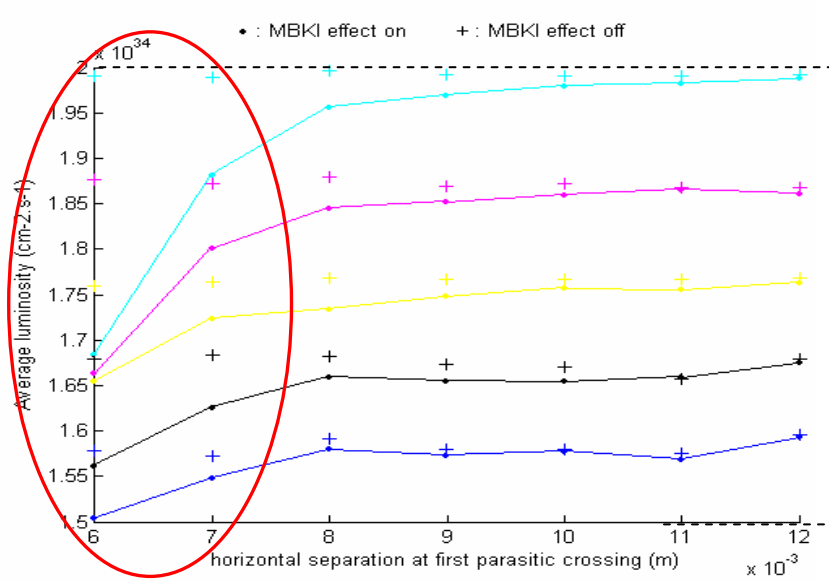


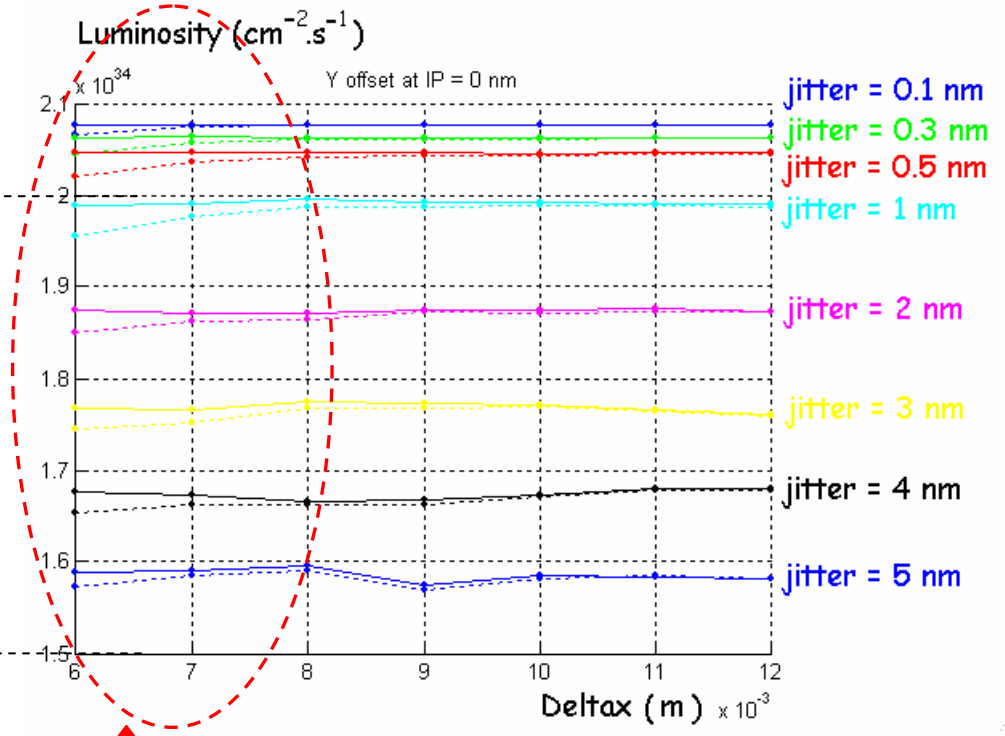


8/ Summary for yoffIP=0 (and deltax >8 mm)

The average luminosity is estimated using 1500 collisions.

Results shown at LC Workshop in Daresbury (8-9 January 2007)





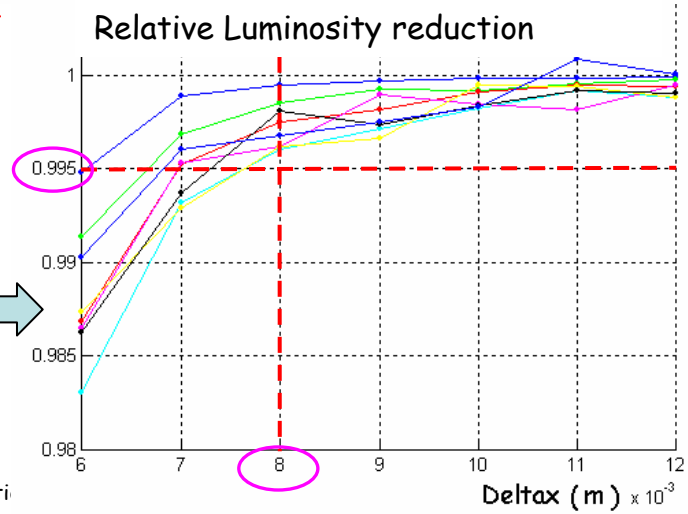
Strange behaviours observed by O. Napoly were induced by an error in the code.

CONCLUSION :

For head-on collision scheme, the luminosity losse due to MBKI effect is - *in the equivalent charge particle model* - lower than 0.5% if :

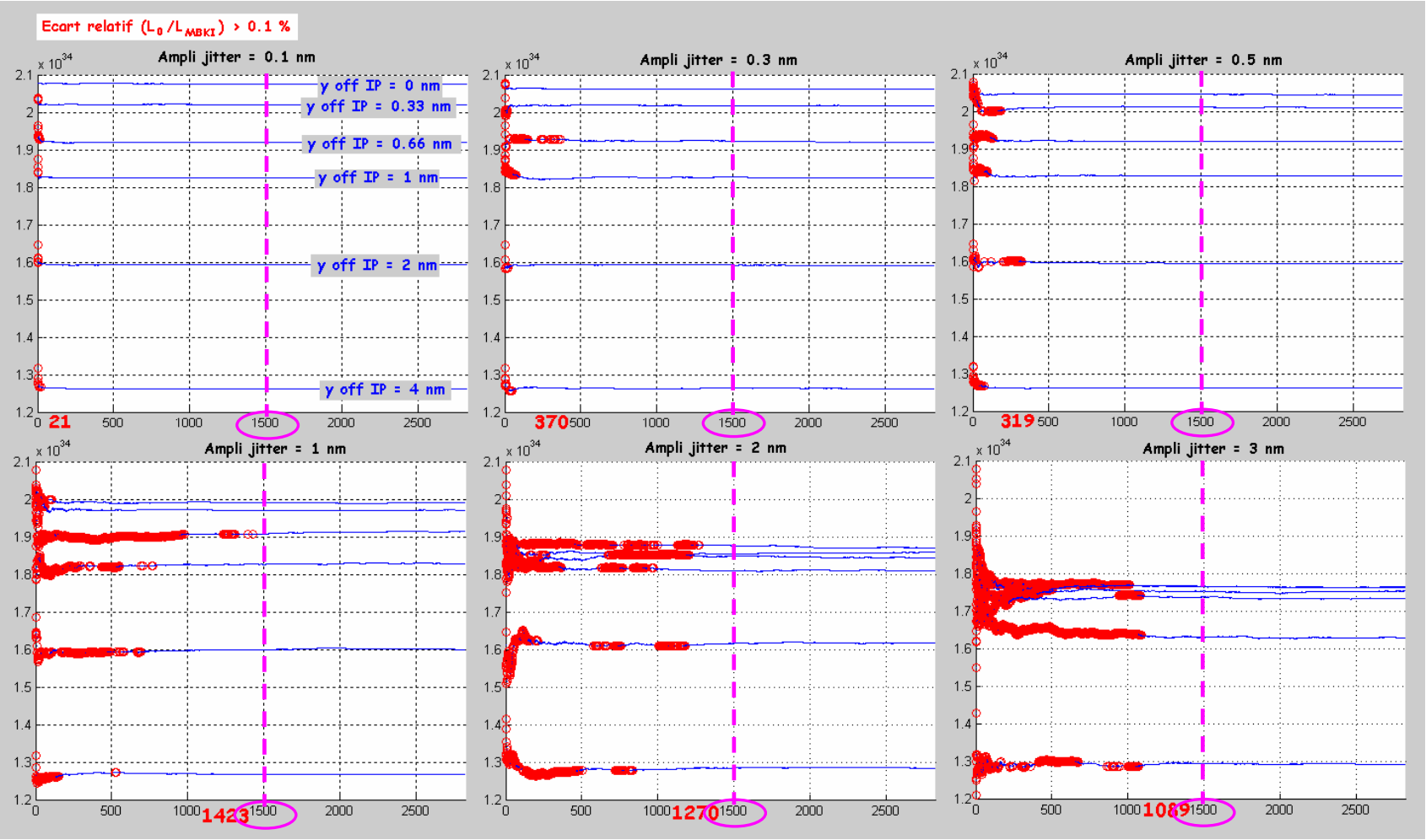
- y-jitter are lower than 3 nm
- Deltax is higher than 0.8 mm

--> But What's happen for a real distribution ?



Transparents supplémentaires

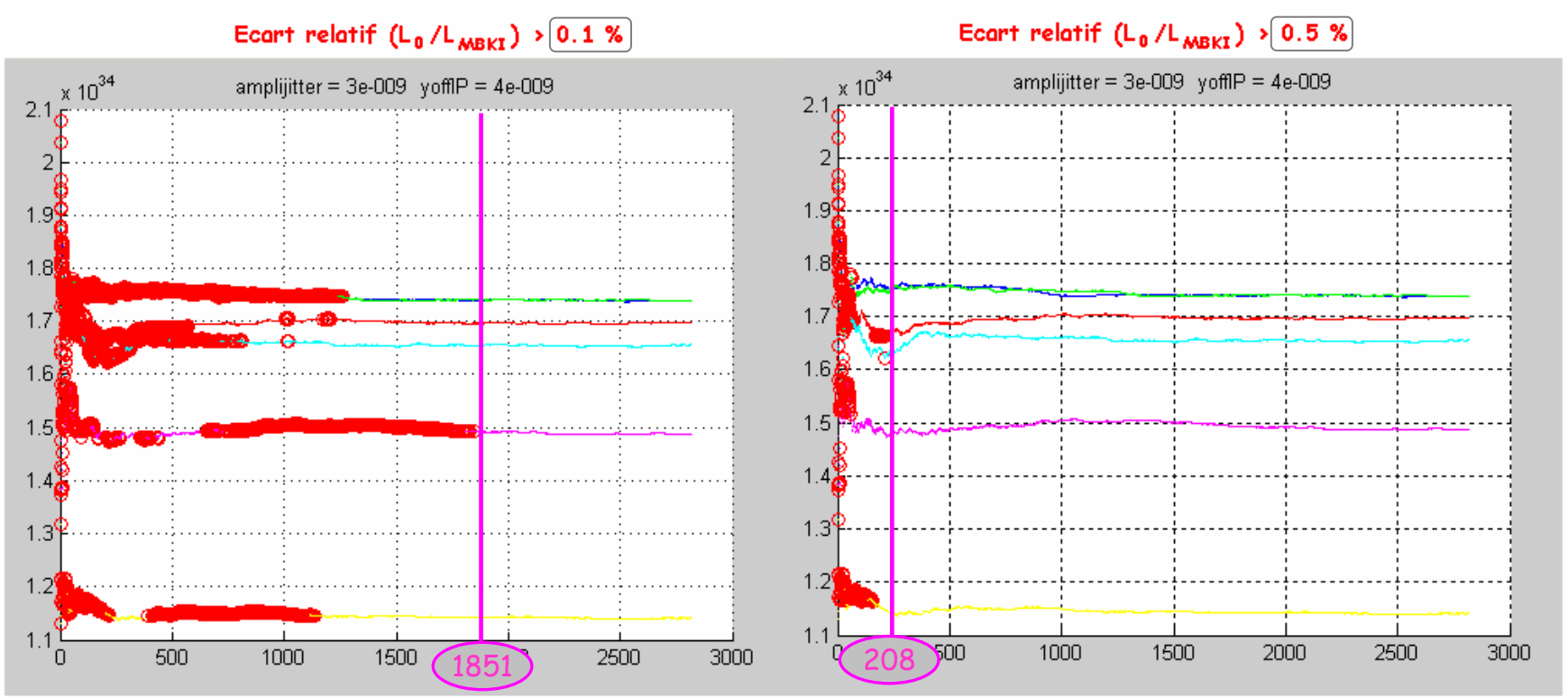
Deltax = 0.011337 m



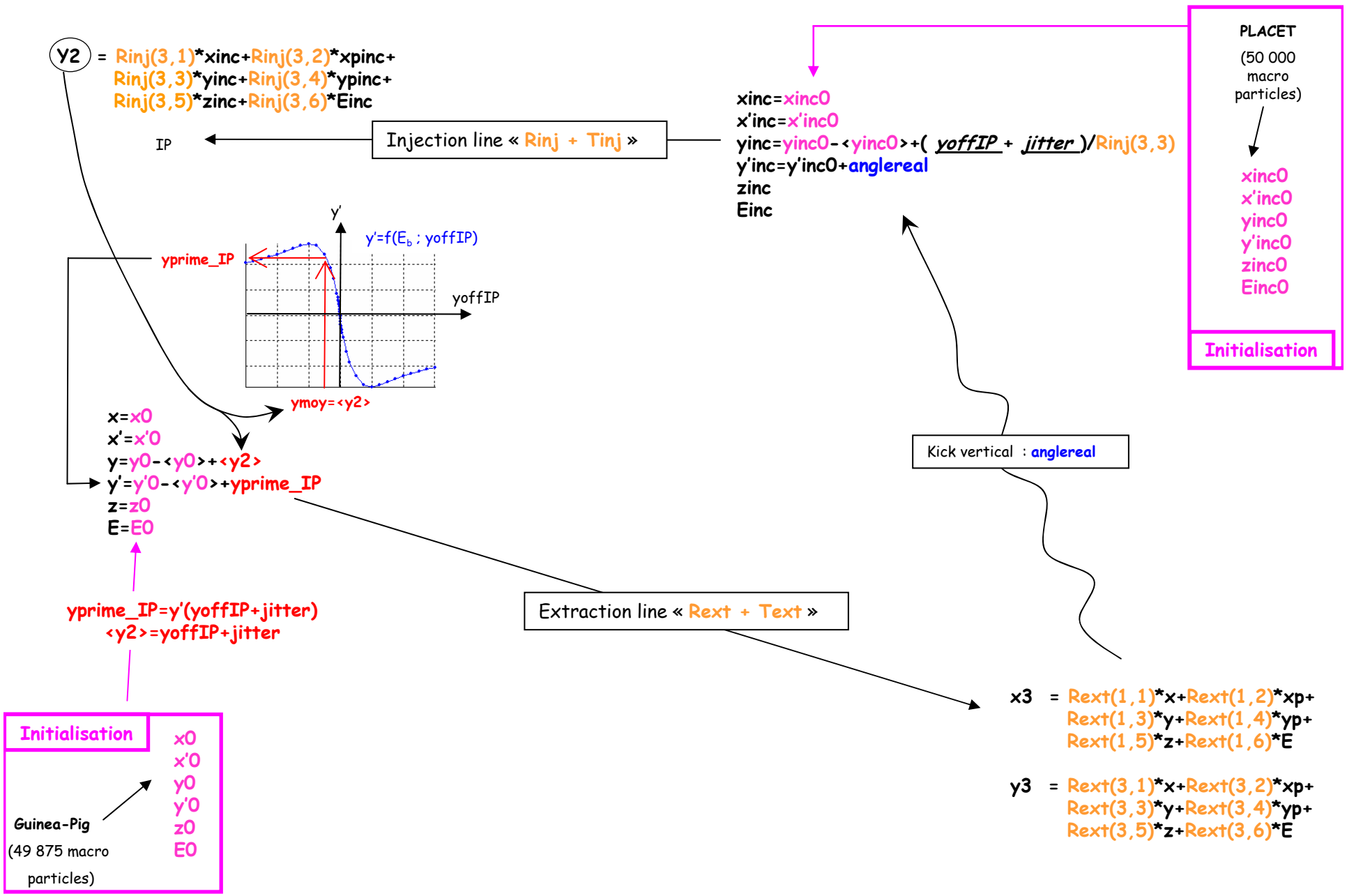
For the equivalent charge particle modelisation and for
- horizontal separation at first parasitic crossing equal to 0.011337 m
- initial vertical y offset at the IP < 4 nm
- vertical jitter amplitude < 3 nm

The average (+/- 0.1 % error level) luminosity (within one train) is reach after 1500 bunches.

Deltax = 0.006 m / Jitter = 3nm / yoffIP = 4nm



When the horizontal separation at the first parasitic crossing is reduce to 0.006 m
Then (for amplijitter = 3 nm and yoffIP=4 nm), the average (+/- 0.1 % error level) luminosity (within one train) is reach after 1851 bunches.
By relaxing the error level to 0.5%, then the average luminosity is reach after 208 bunches.
Thus, instead of computing the average luminosity using 2820 bunches collisions, we will consider 1500 collisions
Thus the error on the average luminosity is about 0.3 %
Using such apprioximation, the time computing is reduced by a factor 2.


Y2 = Rinj(3,1)*xinc+Rinj(3,2)*xpinc+
Rinj(3,3)*yinc+Rinj(3,4)*ypinc+
Rinj(3,5)*zinc+Rinj(3,6)*Einc
IP
Injection line « Rinj + Tinj »
xinc=xinc0
x'inc=x'inc0
yinc=yinc0-<yinc0>+(yoffIP + jitter)/Rinj(3,3)
y'inc=y'inc0+anglereal
zinc
Einc
PLACET
(50 000 macro particles)
xinc0
x'inc0
yinc0
y'inc0
zinc0
Einc0
Initialisation
y'
y'=f(E_b ; yoffIP)
yprime_IP
yoffIP
ymoy=<y2>
x=x0
x'=x'0
y=y0-<y0>+<y2>
y'=y'0-<y'0>+yprime_IP
z=z0
E=E0
Kick vertical : anglereal
yprime_IP=y'(yoffIP+jitter)
<y2>=yoffIP+jitter
Extraction line « Rext + Text »
x3 = Rext(1,1)*x+Rext(1,2)*xp+
Rext(1,3)*y+Rext(1,4)*yp+
Rext(1,5)*z+Rext(1,6)*E
y3 = Rext(3,1)*x+Rext(3,2)*xp+
Rext(3,3)*y+Rext(3,4)*yp+
Rext(3,5)*z+Rext(3,6)*E
Initialisation
Guinea-Pig
(49 875 macro particles)
x0
x'0
y0
y'0
z0
E0