Tracking with Collimator Wake-Fields through the CLIC BDS

A.Latina, G.Rumolo, D.Schulte

CLIC Meeting - May 19th, 2006

- Motivation
- Implementation of the COLLIMATOR in PLACET
- Simulations and Results
- Conclusions and Outlook

Motivation

- Collimators in the CLIC BDS could cause luminosity reduction through the action of single-bunch wake fields.

- Studying the effect of the wake fields is important to determine the features of the needed collimation system

- A module for collimator wake field calculation has been constructed

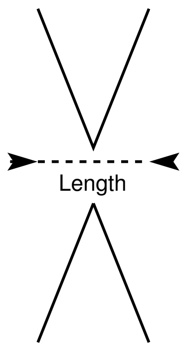
- This module has been implemented in the tracking code PLACET to study the direct effect of collimator wake fields on luminosity performances

Implementation

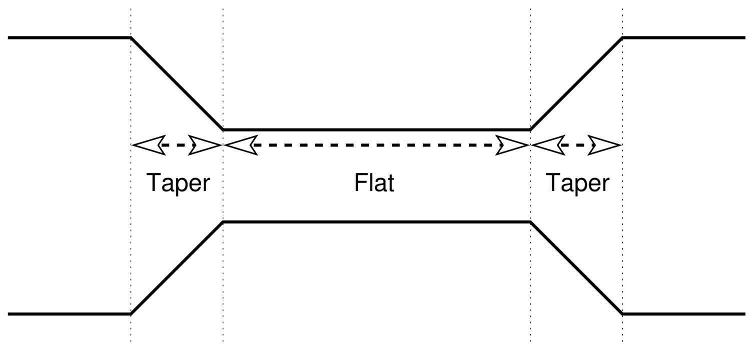
- Created the object **COLLIMATOR** (lattice definition)
  - Input parameters:
    - geometry of the collimator (width, initial and final height, taper length, . . .)
    - properties of the material (conductivity σ, relaxation time τ)
    - type (spoiler/adsorber, vertical/horizontal)
  - Output:
    - the KICK in μrad, particle by particle
- Computation:
  - geometric and resistive components are evaluated
  - inductive or diffractive for the geometric wake fields, short- or long-range, intermediate regimes
  - the bunch is subdivided into slices
  - the KICK depends both on the longitudinal and the transverse coordinates of the particles
  - speed-up using tables of precalculated integrals

Description of the Simulation

- Nominal CLIC bunch through the Main Linac + Beam Delivery System
  - Linear Collimation System in the BDS (lattice by Rogelio Tomás and Javier Resta)
  - jitters in x, x', y, y' ranging in $[-\sigma, \sigma]$ introduced before the BDS
  - Only flat collimators have been considered
- Assumptions
  - tapering angle 30 mrad
  - length of the spoiler 177 mm (corresponding to $\sim 0.5 \;\; \lambda_{\mathrm{Be}}$)
  - length of the adsorber 712 mm (corresponding to $\sim 20 \;\; \lambda_{\mathrm{Cu-Ti}}$)



(spoiler)



(adsorber)

Parameters at the entrance and at the IP of the CLIC Beam Delivery System.

Lattice lengths	
FF length	0.5 km
CS length	2.0 km
BDS length	2.5 km

BDS entrance		
Nominal beam energy	E	1500 GeV
Hor. beta function	β_x	64.171 m
	α_x	-1.951
Ver. beta function	β_y	18.244 m
	α_y	0.606
Hor. emittance	$\gamma\epsilon_x$	680 nm
Ver. emittance	$\gamma\epsilon_y$	10 nm
Bunch length	σ_z	35 μm

Collimation	
Energy collimation depth	0.013
β_x collimation depth	$10\sigma_x$
β_y collimation depth	$80\sigma_y$

IP		
Hor. beta function	β_x^*	7 mm
Ver. beta function	β_y^*	90 μm
Hor. beam size	σ_x^*	40.12 nm
Ver. beam size	σ_x^*	0.55 nm

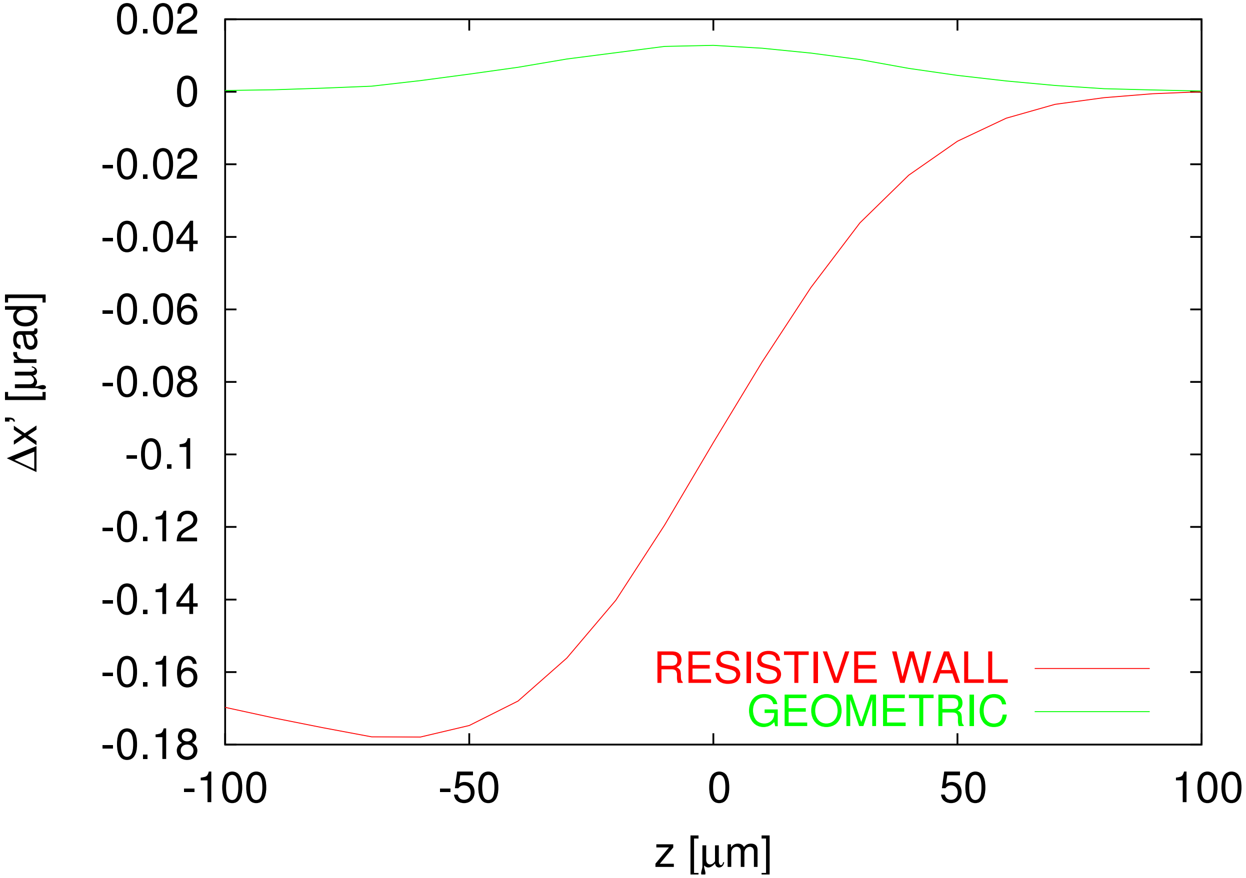
BDS Collimator Parameters

s[m]	Name	β_x[m]	β_y[m]	D_x[m]	a_x[mm]	a_y[mm]	Geometry	Material
566.502	ENGYSP	1406.33	70681.9	0.27	3.51	25.4	rect	Be
731.502	ENGYAB	3213.03	39271.5	0.417	5.4	25.4	rect	Ti(Cu coated)
1490.28	YSP1	114.054	483.253	0.	10.	0.102	rect	Be
1506.1	XSP1	270.003	101.347	101.347	0.08	10.	rect	Be
1583.3	XAB1	270.102	80.9043	0.	1.	1.	ellip	Ti(Cu coated)
1601.12	YAB1	114.054	483.184	0.	1.	1.	ellip	Ti(Cu coated)
1603.12	YSP2	114.054	483.188	0.	10.	0.102	rect	Be
1618.94	XSP2	270.002	101.361	0.	0.08	10.	rect	Be
1696.14	XAB2	270.105	80.9448	0.	1.	1.	ellip	Ti(Cu coated)
1713.96	YAB2	114.055	483.257	0.	1.	1.	ellip	Ti(Cu coated)
1715.96	YSP3	114.054	483.253	0.	10.	0.102	rect	Be
1731.78	XSP3	270.003	101.347	0.	0.08	10.	rect	Be
1808.98	XAB3	270.102	80.9043	0.	1.	1.	ellip	Ti(Cu coated)
1826.8	YAB3	114.054	483.184	0.	1.	1.	ellip	Ti(Cu coated)
1828.8	YSP4	114.054	483.188	0.	10.	0.102	rect	Be
1844.63	XSP4	270.002	101.361	0.	0.08	10.	rect	Be
1921.83	XAB4	270.105	80.9448	0.	1.	1.	ellip	Ti(Cu coated)
1939.65	YAB4	114.055	483.257	0.	1.	1.	ellip	Ti(Cu coated)

(see "*Beam Collimation System Performance for CLIC at 1500 GeV*", Javier Resta Lopéz)

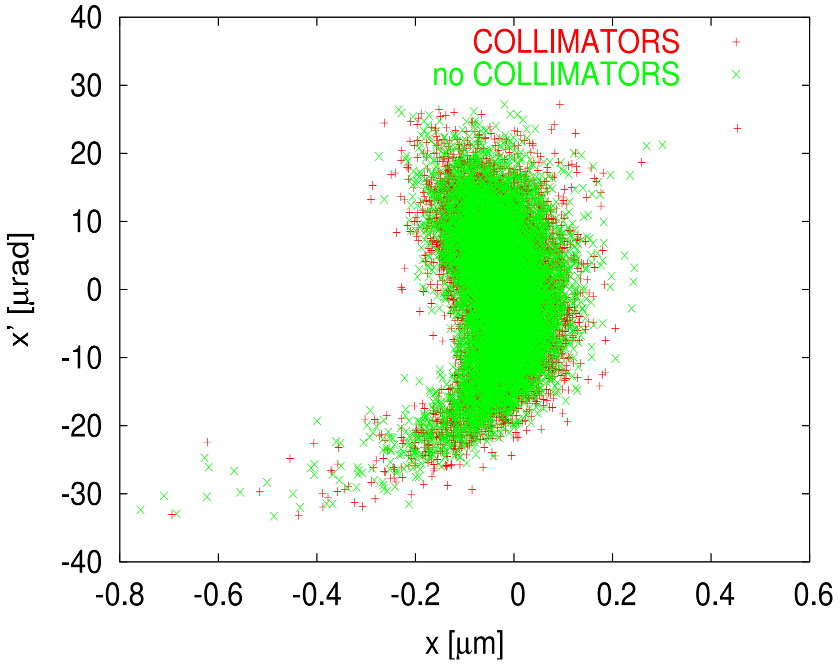
Results (I)

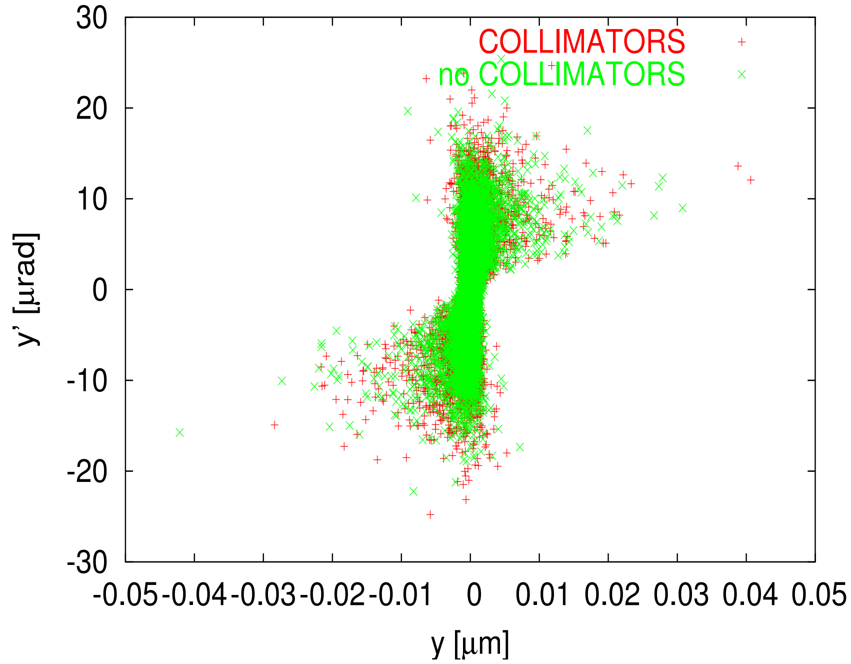
Example of Collimator Wake Fields calculated inside PLACET



Results (II/1)

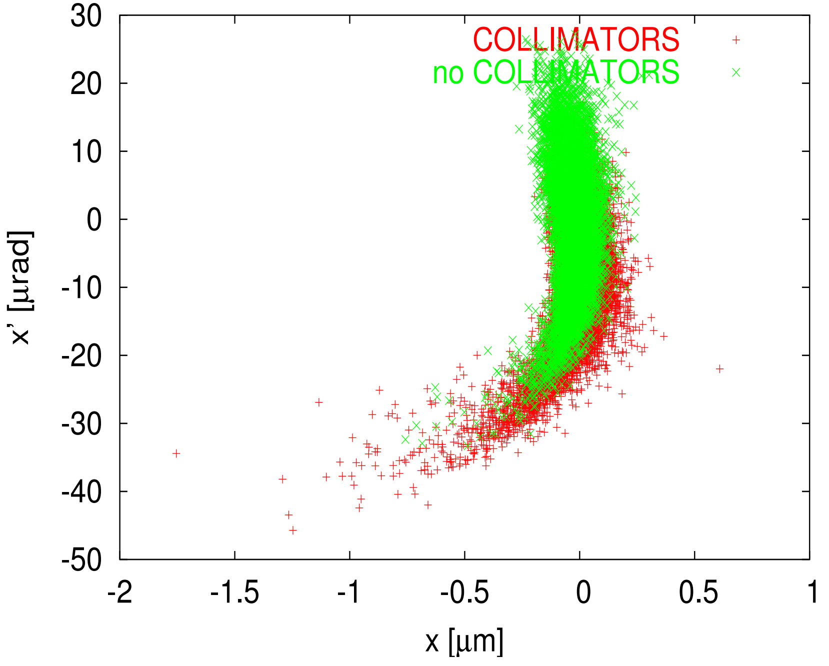
Phase Space Portraits at the end of the BDS w and w/o Collimator Wake Fields

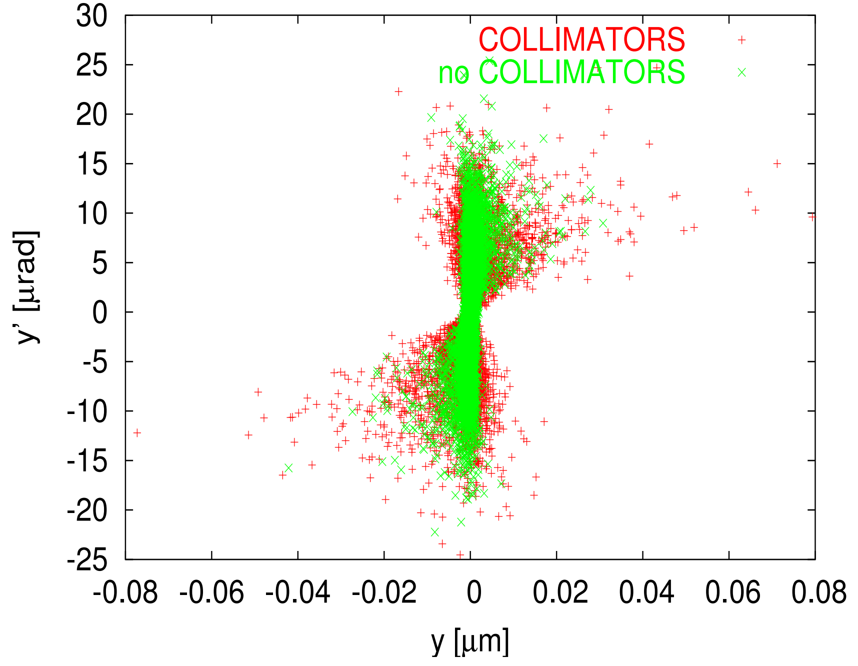




Results (II/2)

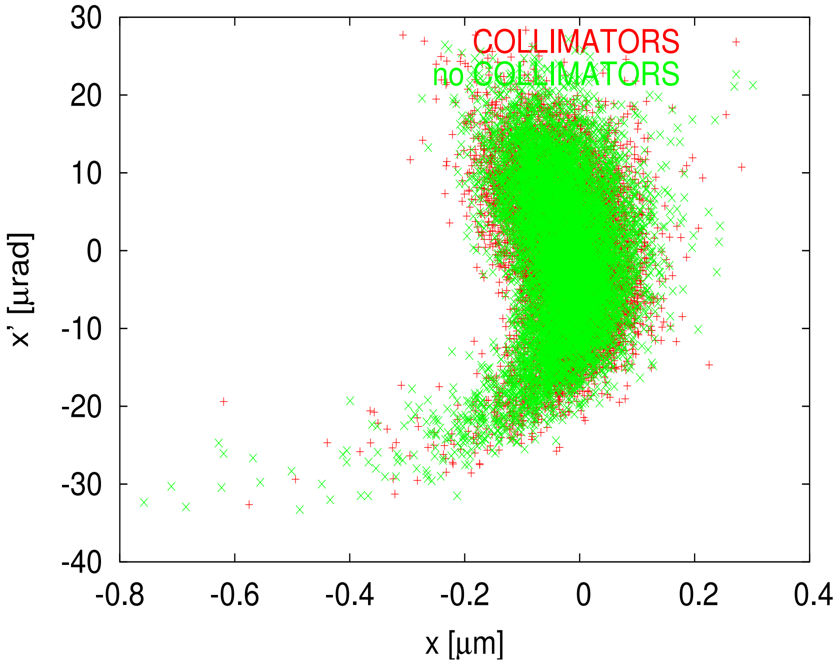
Phase Space Portraits at the end of the BDS w and w/o Collimator Wake Fields (x offset $= 1\,\sigma$)

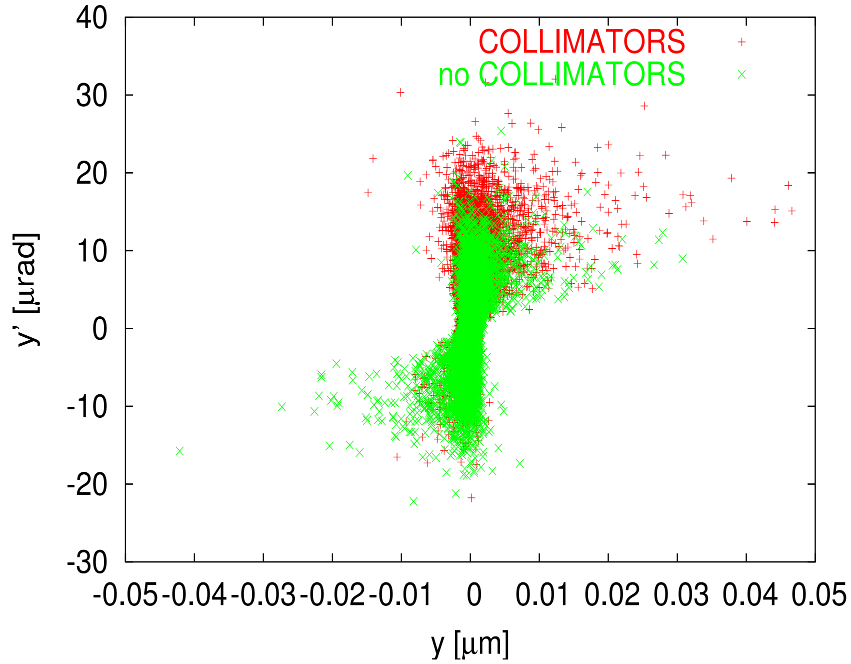




Results (II/3)

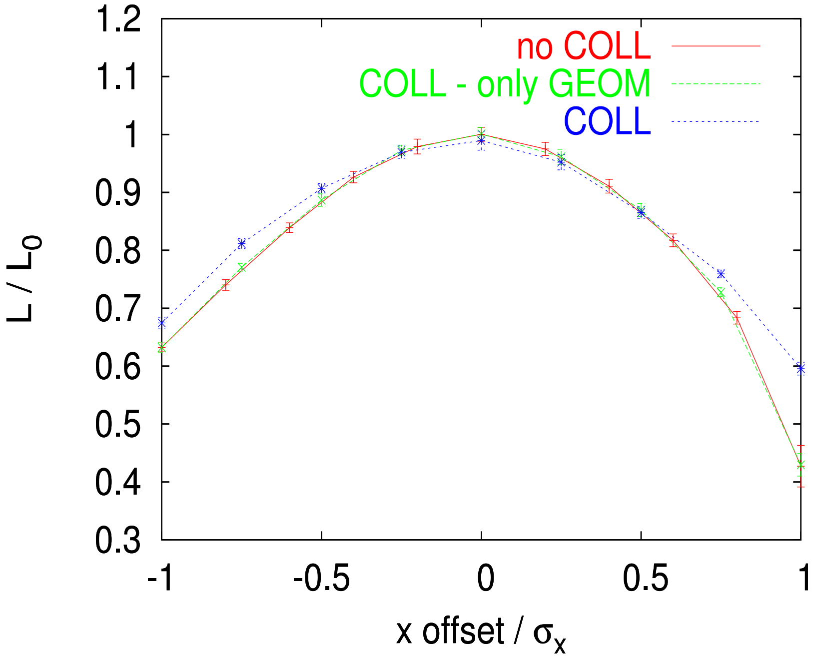
Phase Space Portraits at the end of the BDS w and w/o Collimator Wake Fields (y offset $= 1\,\sigma$)

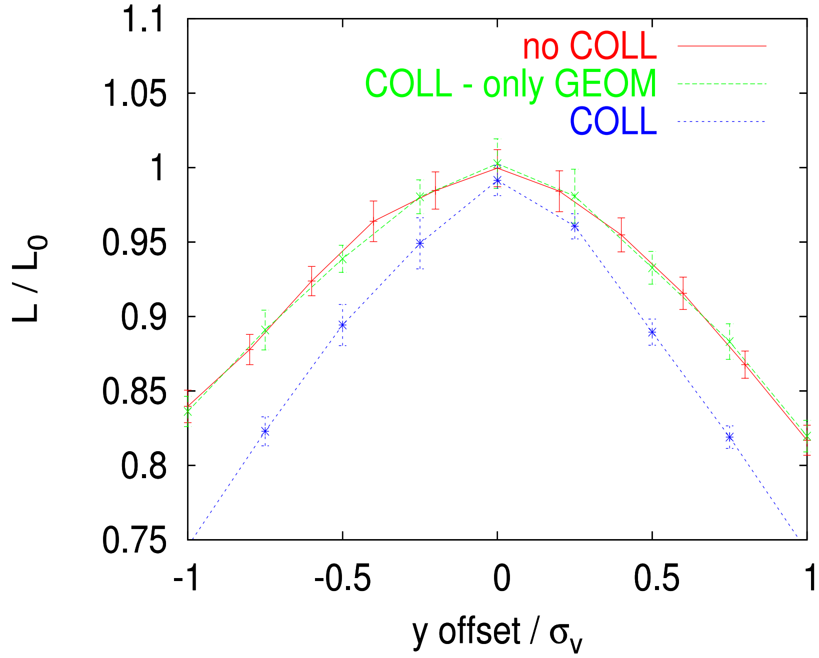




Results (III)

Luminosity Reduction (?) Curves due to jitter in x and y





Conclusions and Outlook

- Model symmetric collimators in x and y (and track with the full set of collimators from the list)
- Study the effect of different jitters in angle
- Parameter studies: change bunch length or bunch charge (up to factors 2-3) and check whether there would be any significant difference in the resulting luminosity reduction curves
- Study the dependence on the collimator gap
- Look for possible coherent effects along the bunch
- Perform a full simulation including the Bunch Compressor