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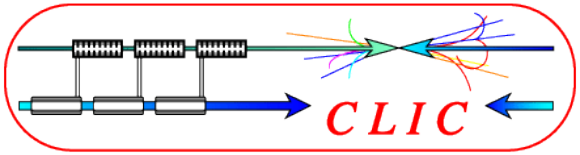

Machine Protection & Electrical Integrity Group
Performance Evaluation Section *Meeting*

November 3rd and 7th, 2011

Compact Linear Collider
Operations and Machine Protection Working Group

Carlos O. Maidana and Michael Jonker
CERN - Technology Department
Machine Protection & Electrical Integrity Group
Performance Evaluation Section

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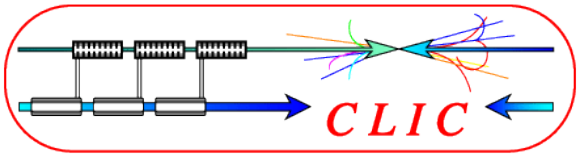
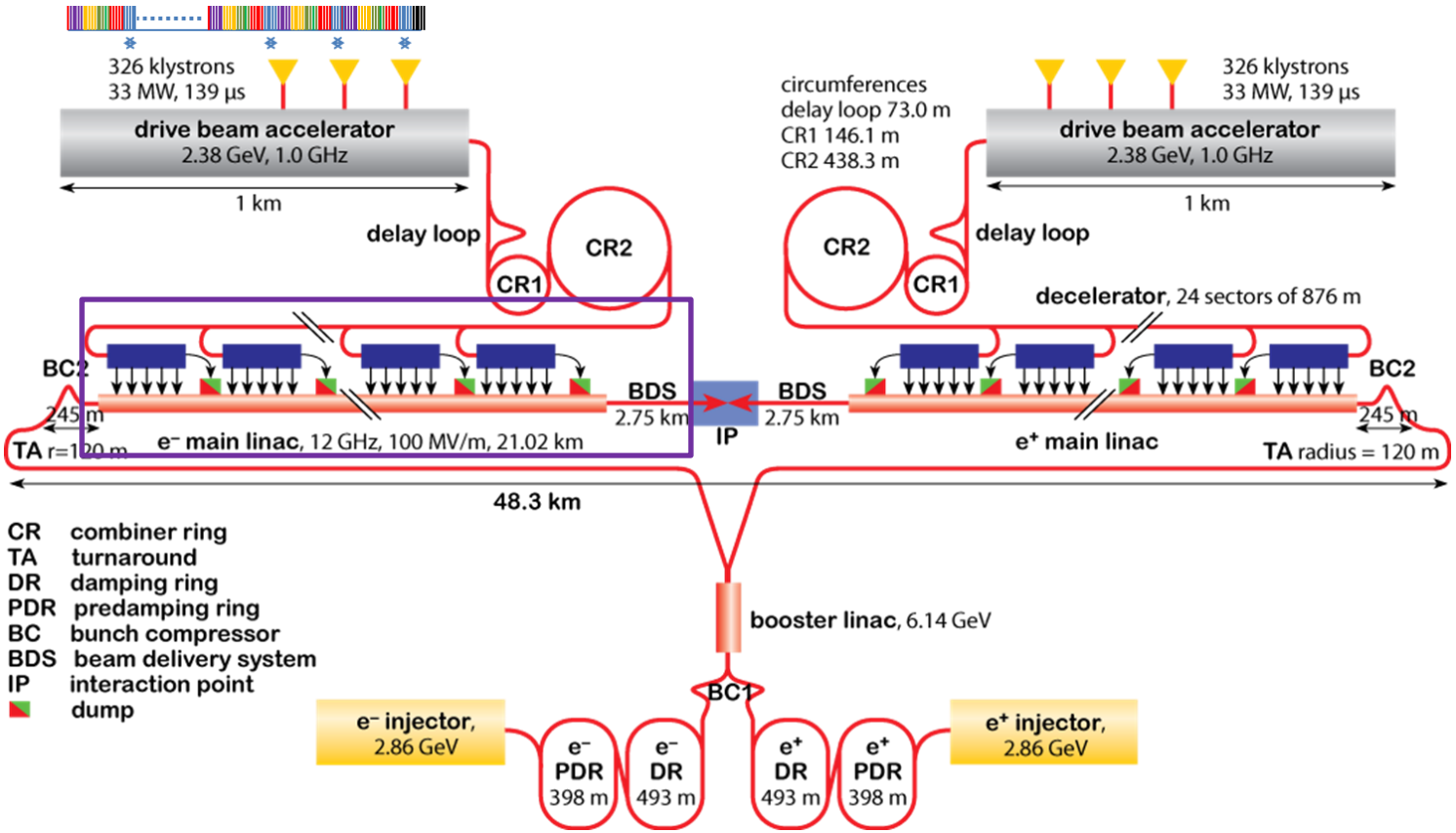
CLIC Layout





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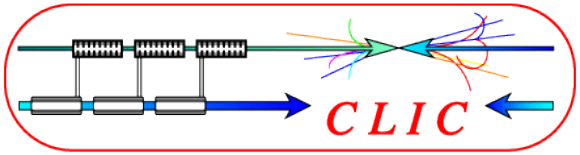
Current tasks being performed under the
CLIC Operations & Machine Protection WG



Perform a systematic failure study

Main Beam LINAC

Beam Delivery System

Drive Beam Deccelerator

Failures of different types → *Kick study* → Different locations

i.e. damage produced for kicks at different locations of the beam line.

- *Quads short*
- *RF breakdown*
- *Etc.*

- *One failing element*
- *Multiple failing elements*

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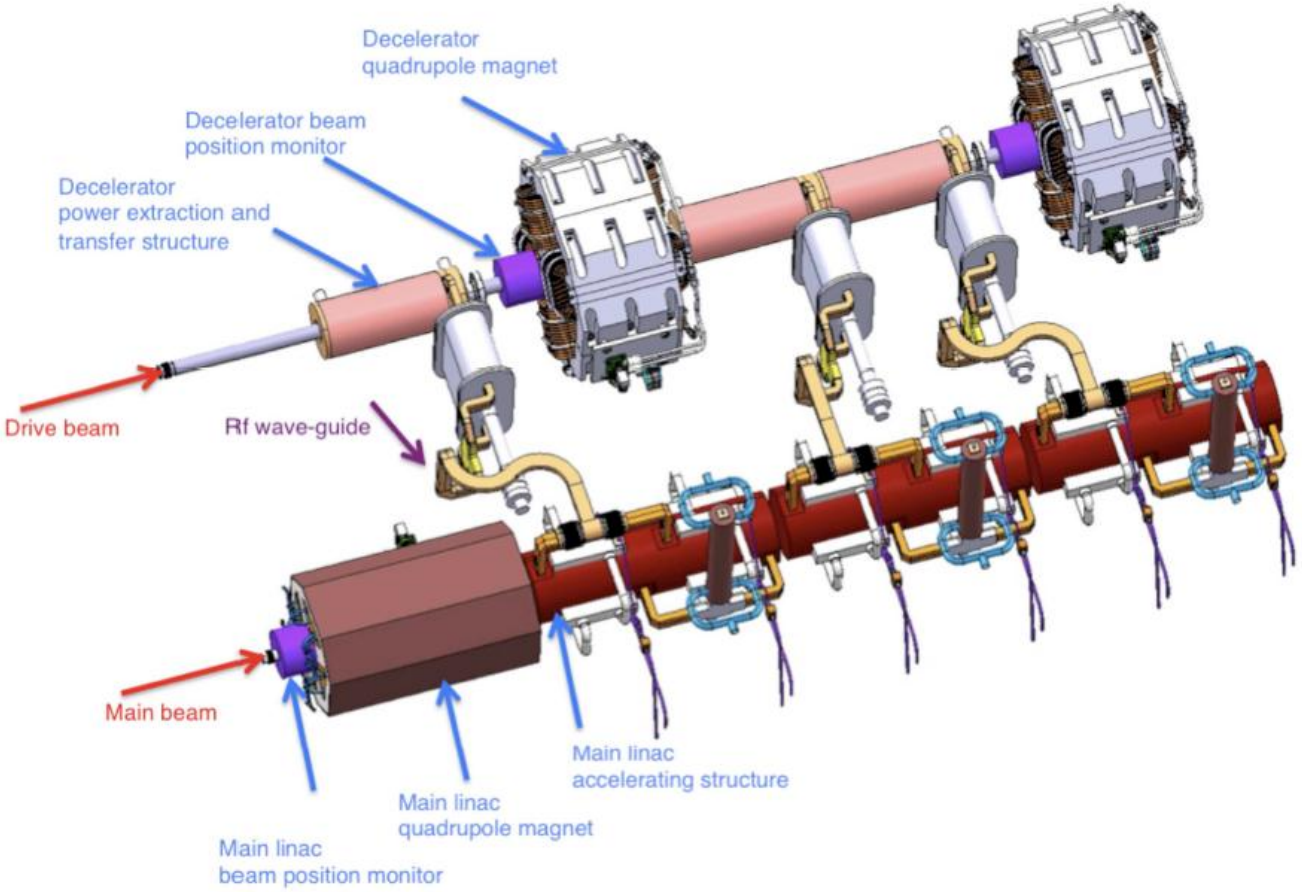
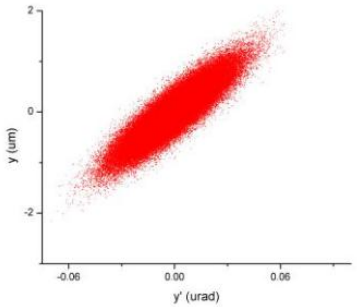
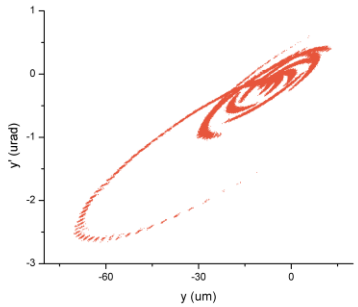


View of a CLIC 12 GHz two-beam module highlighting the CLIC power extraction and transfer principle. One module contains up to four *power extraction and transfer structures* (PETS), where each PETS feeds two accelerating structures. RF waveguides transfer the RF power generated from the PETS into the accelerating structures. Quadrupole magnets are used for strong focusing of both beams. *Picture : CLIC study.*

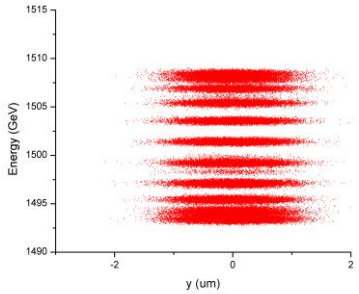
Beam dynamics and Kick studies

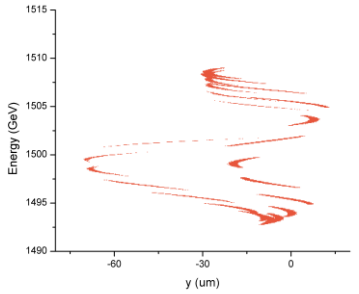


Unperturbed beam

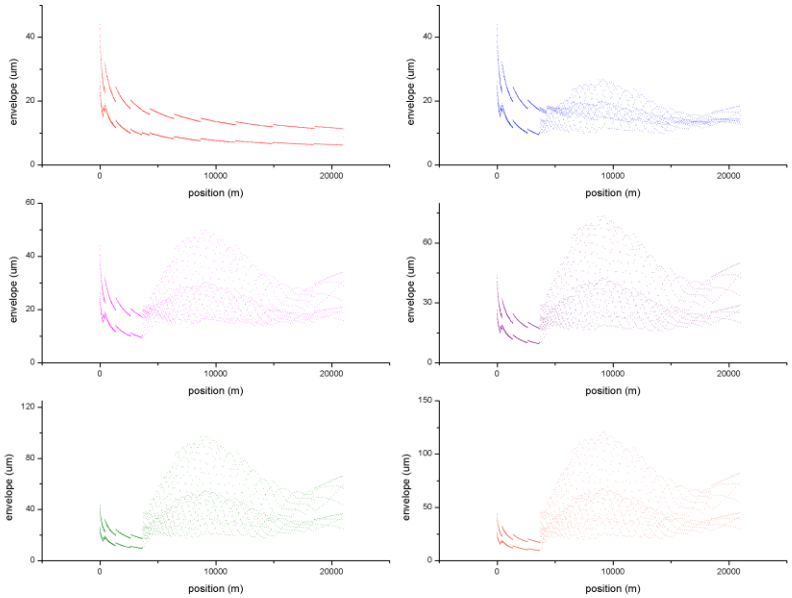


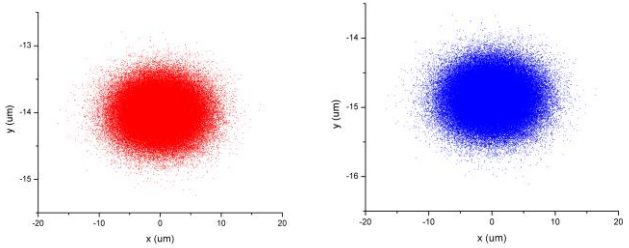
Perturbed beam profile at the main LINAC exit after a kick applied on the 801st Quad.





Linear beam dynamics studies using PLACET-Octave. Shown is the Energy dispersion at the main LINAC exit for the undisturbed beam (right) and for a 20um displacement kick applied over the 801st Quad (left).

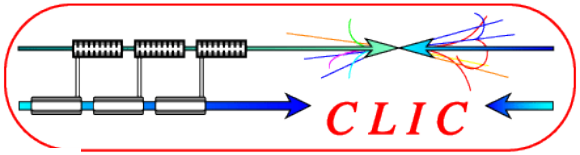




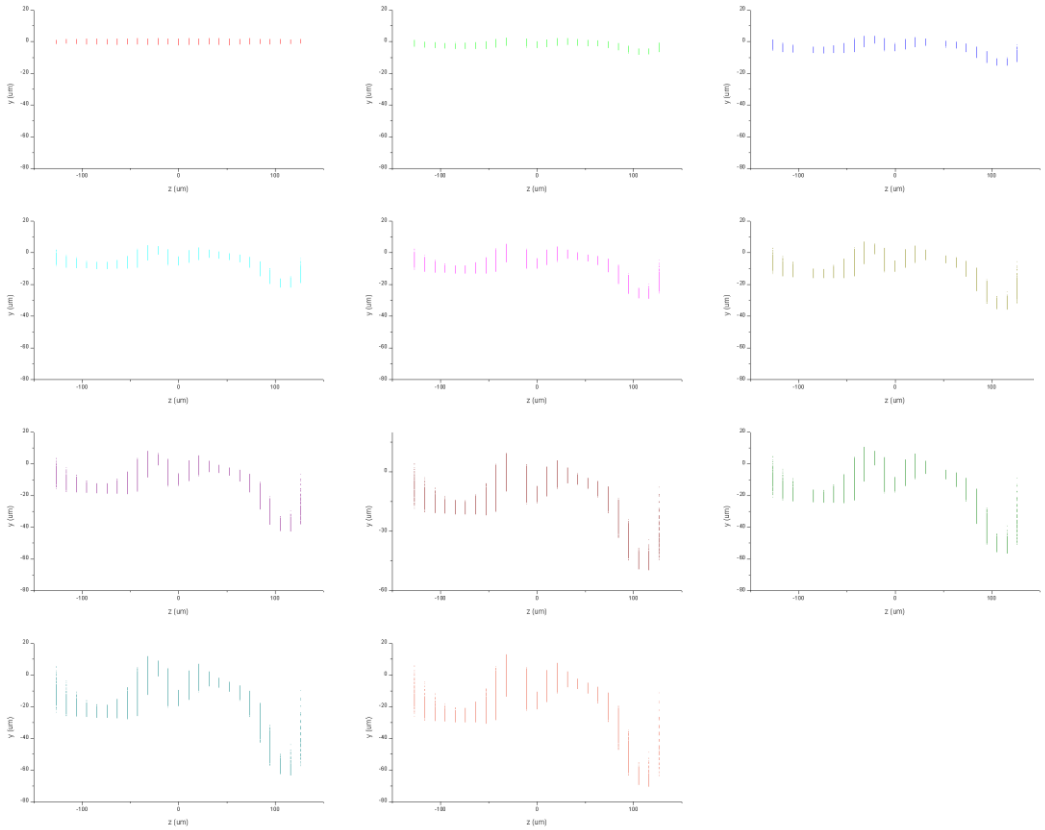
Perturbed beam profile at the entrance –where the kick was applied- (red) and at the exit (blue) on the 1801st Quad.

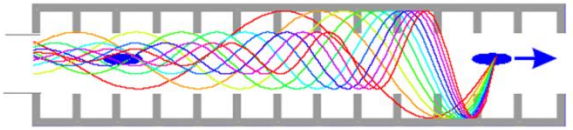
Linear beam dynamics studies using PLACET and Origin Pro. Shown is the average envelope evolution through the main LINAC for different kick strengths applied over the 801st Quad.

Beam dynamics and Kick studies

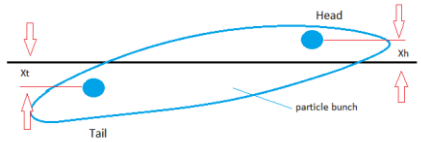


Unperturbed beam





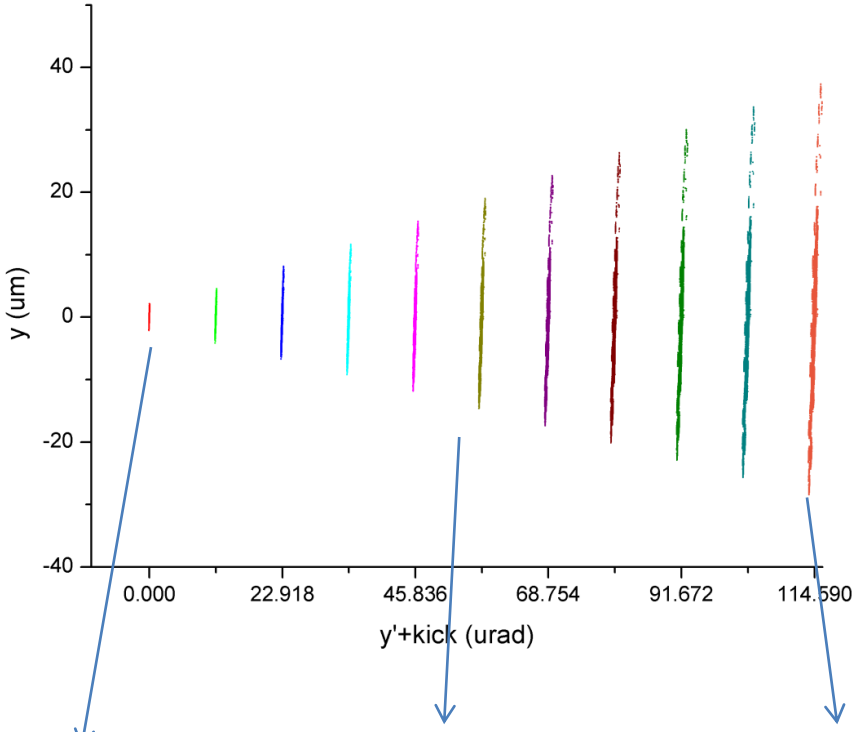
Source: Nick Walker lectures (ILC School, 2007)

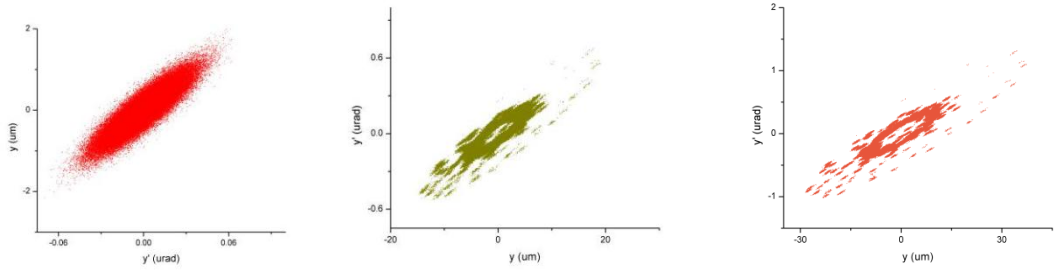


Longitudinal linear beam dynamics studies using PLACET and Origin Pro. Shown is the z-y plane bunch profile at the main LINAC exit for different kick strengths applied over the 801st Quad. The effect of the intra-beam (head-tail) transverse wakefields can be seen.

Kick studies

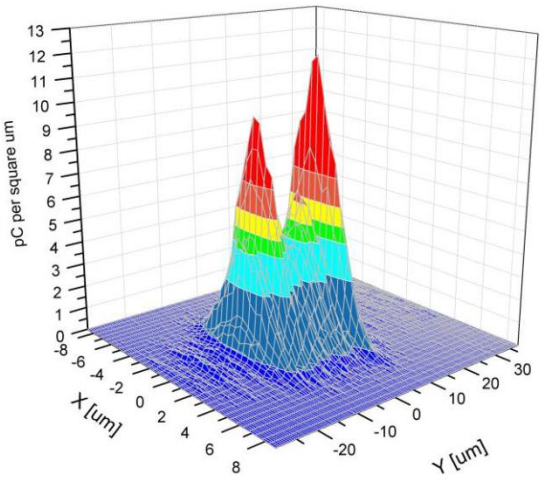
Beam blow up as a function of kick, simulated by a quadrupole displacement using the PLACET code. Shown is the y'-y plane at the LINAC end for various kick strengths on the 9th quad using linear beam optics.

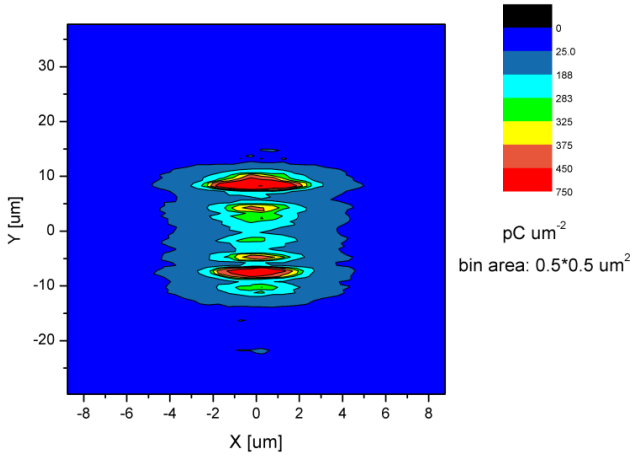




Unperturbed beam

Perturbed beam. Ellipse : dispersion and energy spread. Islands: wake fields





Charge density at the end of the linac for 20 um displacement 9th quad.
Collimator equivalent @ 25 um (tbc)

- Deep blue: safe for copper
- Grey blue, destroys CU, safe for Be, Ti
- Light blue, destroys CU, BE, safe for TI
- Green and above, unsafe for CU, BE, TI

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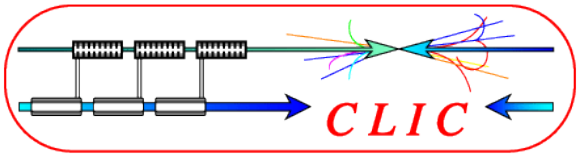
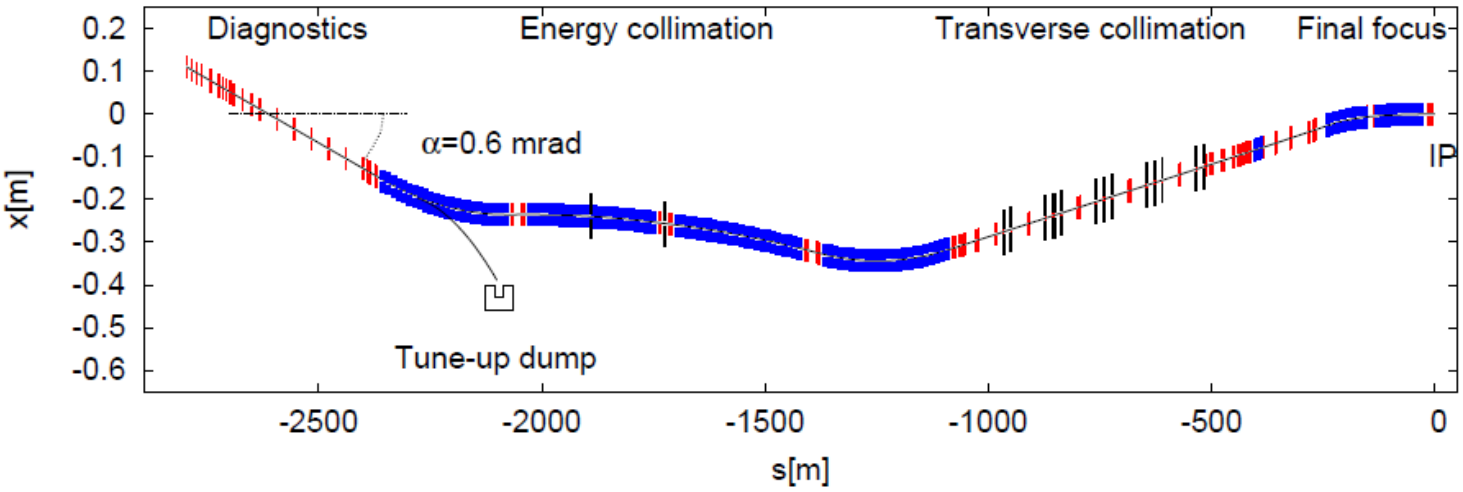
Beam Delivery System (BDS)





CLIC 3 TeV layout. Dipoles, quadrupoles and collimators are shown in blue, red and black, respectively.

The CLIC collimation section fulfills 2 critical functions

- It protects the down-stream beam line and detector against mis-steered beams from the main LINAC.
- Removes the beam halo.

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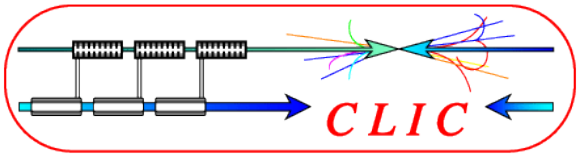
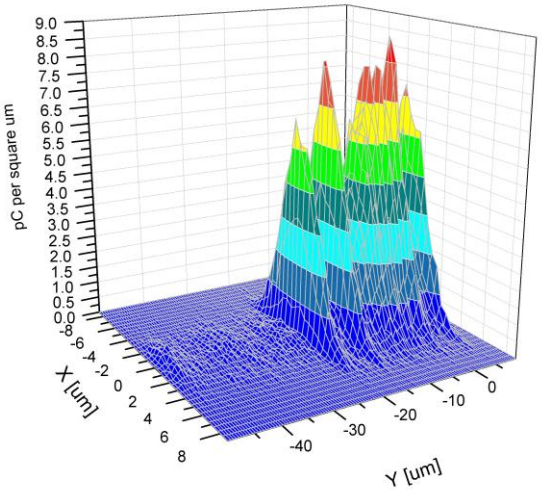
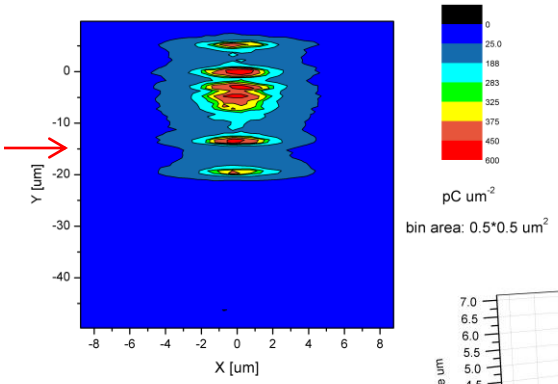
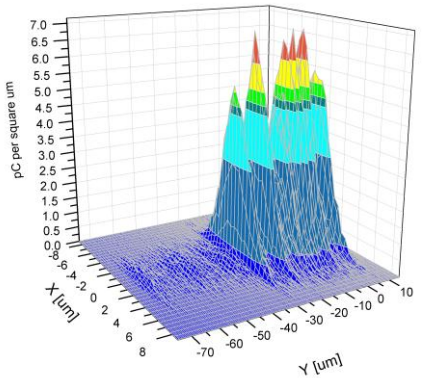
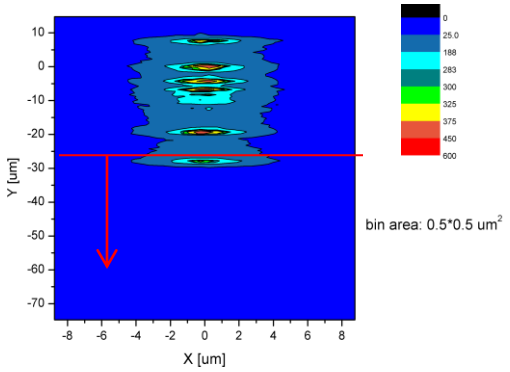
Material damage caused on components











For every condition, we would like to establish the damaged surface in the collimators for materials such as Berillium, TI-alloy, and Copper as well as on other copper structures.

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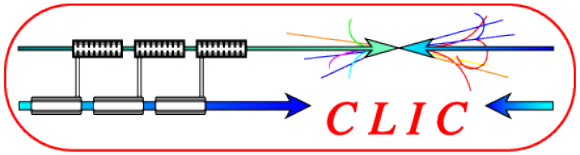
Base computer programs



PLACET

Tracking code w/misalignments
& wakefields considerations

\+ Tcl/Tk → PLACET-DEVELOPMENT

\+ Octave → PLACET-OCTAVE

OriginPro + MatLab +

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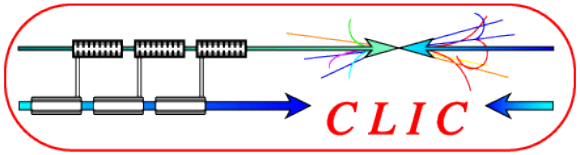

Thank you for your time!

Carlos O. Maidana and Michael Jonker
CERN - Technology Department
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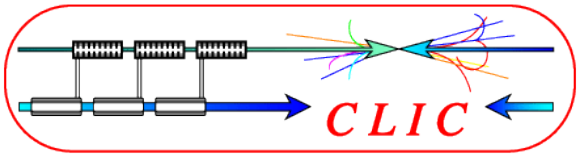


Coupled RF cavity system for energy transfer

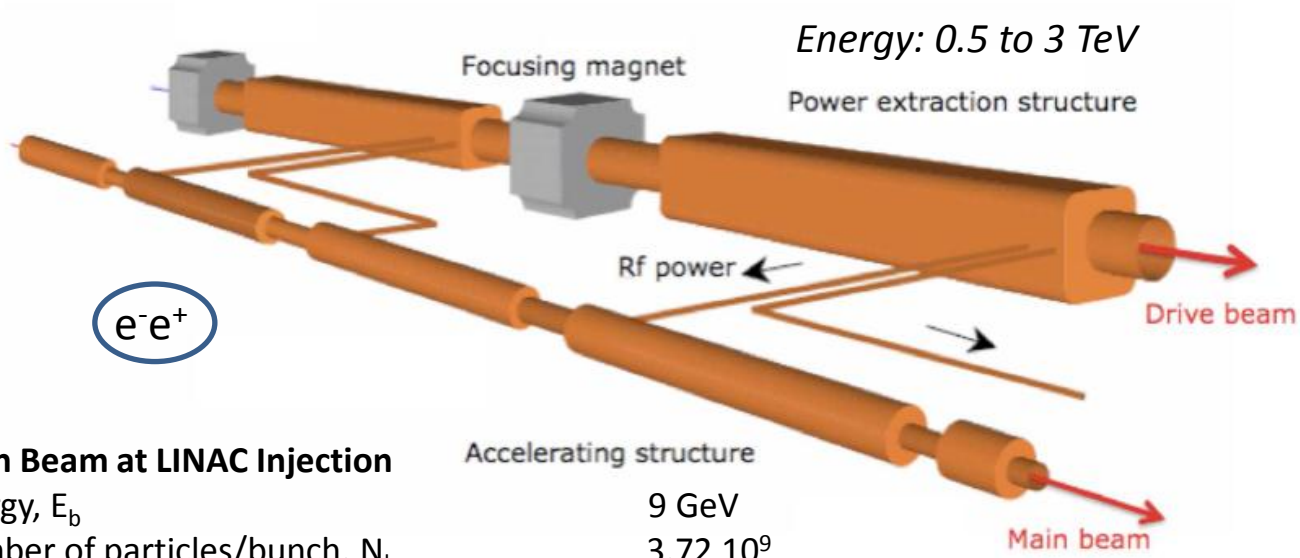
Drive beam

High current, low energy

Main beam

Low current, high energy

Energy: 0.5 to 3 TeV



Main Beam at LINAC Injection

Energy, E_b	9 GeV
Number of particles/bunch, N_b	3.72 10^9
Bunch length, σ_s	44 μm
Energy spread, $\Delta E/E_{0,in}$j	1.3 %
Transverse normalized horizontal emmitance, $\gamma\beta\varepsilon_x$	600 μm mrad
Transverse normalized vertical emittance, $\gamma\beta\varepsilon_y$	10 μm mrad

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