

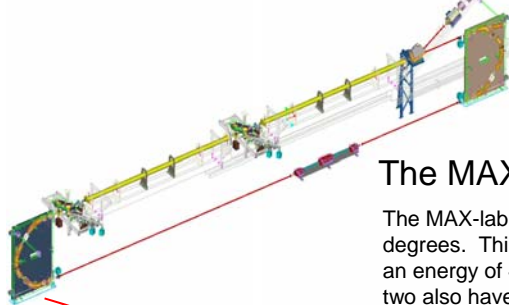
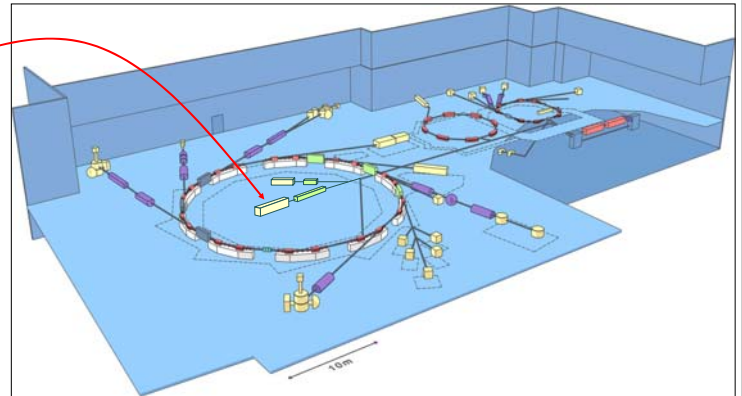
Studies of bunch compression in the MAX-lab recirculator system



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BESSY collaboration within EUROFEL

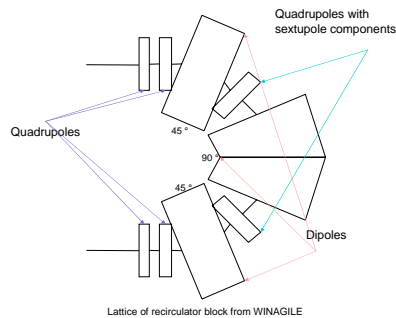
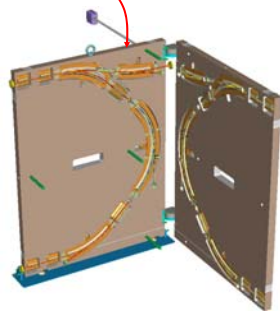
Introduction

The EUROFEL project at MAX-lab will be a one step HGHG FEL constructed in collaboration with BESSY. The electron bunches will be created in the existing MAX-lab injector and transported to the inside of the MAX II ring where the FEL undulators will be located.



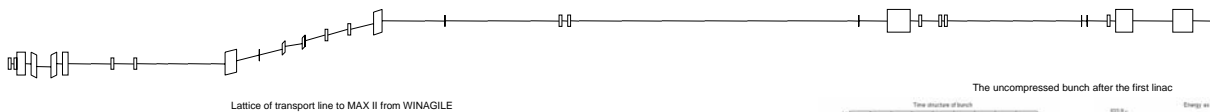
The MAX-lab injector

The MAX-lab injector consists of two linacs followed by two recirculator blocks that each bend the beam 180 degrees. This 360 degree bend lets the electrons go through the linacs a second time which in the end produces an energy of 400 MeV. These bending blocks comprise three bending magnets and six quadrupoles of which two also have a sextupole component.



Bunch compression

In the injector a laser pulse of 10 ps will hit a copper cathode which will give electron bunches of the same length. The phase of the field in the linacs will be chosen so that an energy chirp will be induced and the magnets in the recirculator blocks will then be used to compress the bunches. The dipoles and quadrupoles will introduce an energy dependent path difference that will straighten up the chirp from the linacs. The second order effects that occur can be compensated with the sextupole components. The desired properties for the electron bunches after compression are that they be as short as the seed laser pulse (300 fs) with a flat top, small energy spread and a high charge and peak current. Simulations of this have been performed using ELEGANT and DIMAD.



Lattice of transport line to MAX II from WINAGILE

Results

It is very hard to compress and form the pulse in the shape that is required. The time structure of the bunch will be very pointy and have a long tail. This means that the flat top is hard to achieve as well as the high charge within the area of interest (300 fs). The ideal would be to straighten out the E(t) curve as and push all the electrons into a short time slot, but this has proven to be difficult and leads to other side effects such as the transverse beam size blowing up and the tail becoming extremely long.

The plots on the right show simulation results from ELEGANT where I have tracked 2000 particles for different settings on the magnets in the recirculator. The upper graphs show the input particles received from gun simulations in ASTRA and the two lower ones show the particles after going through the recirculator and second time through the linacs. The middle setting is with no sextupoles and the bottom one is how the compression looks with sextupoles. The red curves show the ideal case and I have not yet figured out a way to get the pulse shape to resemble this.

The pulse will also be transported in the transport line up to the MAX II ring where it will enter the FEL undulators which will be the next step to simulate.

