HELMHOLTZ | ASSOCIATION

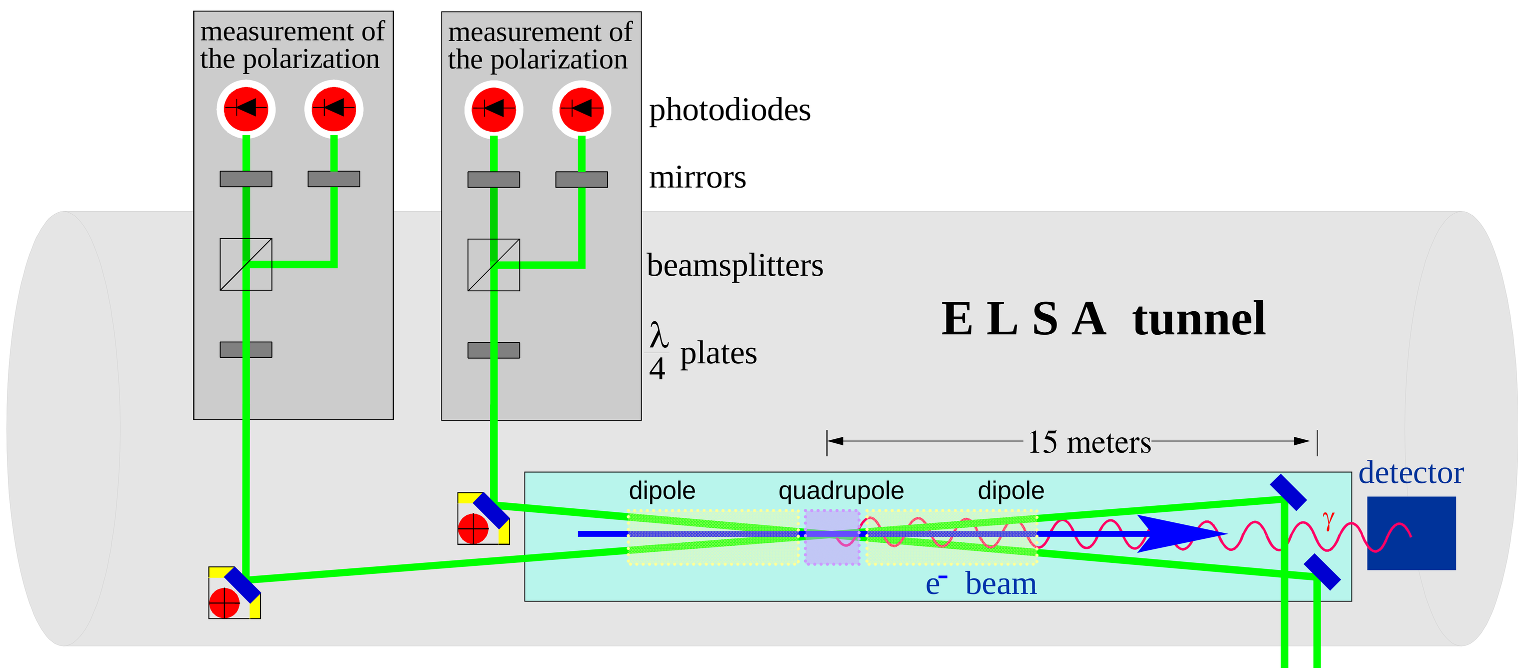
ELSA / Bonn

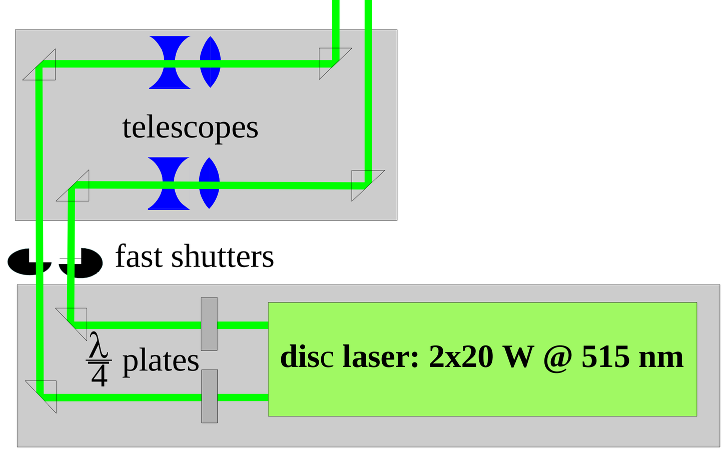
Fabian Klarner, Stefan Patzelt, Jürgen Wittschen, Wolfgang Hillert

PHYSICS AT THE TERA SCALE
Helmholtz Alliance

Compton polarimeter

The electron polarization will be determined by backscattering of circularly polarized photons off the transversely polarized electron beam. The electron beam polarization can be extracted from the shift of the backscattered photon spatial distribution when switching the photon polarization from right-handed to left-handed.
A silicon microstrip detector will be used in order to detect the intensity profile of the backscattered photons. This device will be insensitive to photons with energies in the MeV range. Therefore the photons will be pair converted in a lead converter with a thickness of two interaction lengths, being a compromise for an optimal performance over the whole energy range.
The transversal dimensions of the electron beam at the interaction region can be determined from the width of the intensity profile of the backscattered photons. In addition, sweeping of the laser beam through the horizontal and the vertical dimensions of the electron beam will enable a laser wire operation mode.



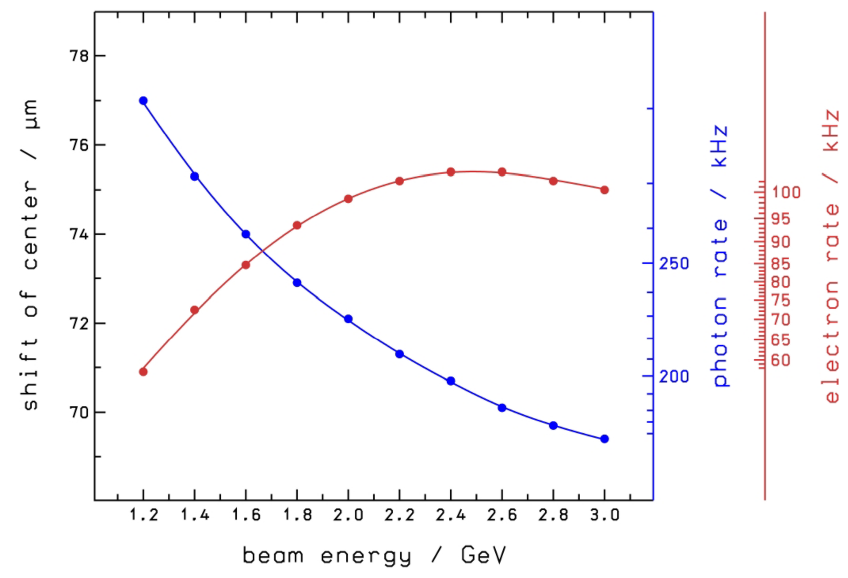


Set-up of the Compton polarimeter

Main features:

- counting silicon microstrip detector
- signal processing with six new developed front-end chips
- FPGA controlled measurement sequence
- diode pumped solid state disc laser, output power 2x20W @ 515 nm

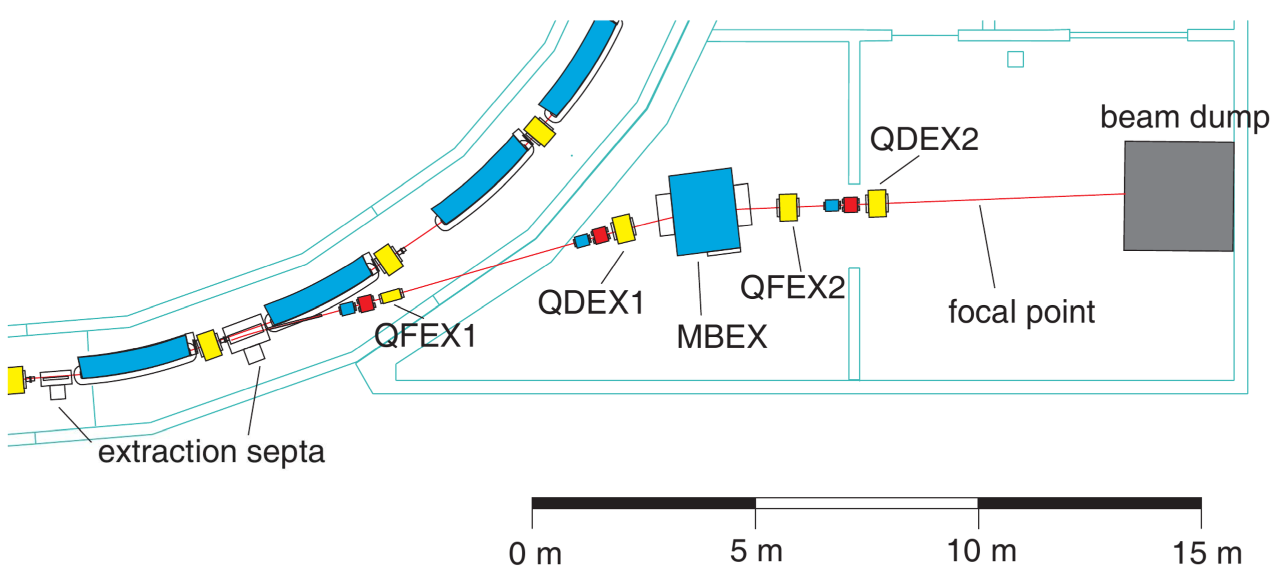
The detector electronics was developed in close collaboration with the ATLAS/SILAB-group of Bonn University.



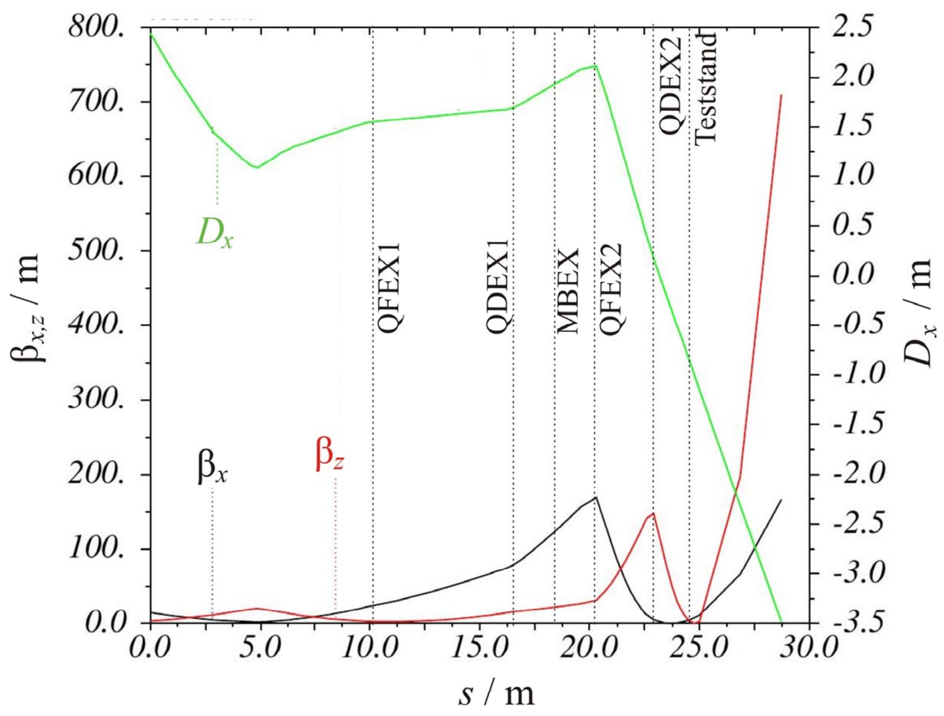
Shift of the center of the profile of the backscatterd photons and the electrons produced by pair conversion in case of switching from right-handed to left-handed circularly polarized laser beam. The polarization of the electron and the photon beam were set to 100%.

A new electron beam line for detector testing

Beside the existing beam lines for hadron physics experiments a new external beam line dedicated for detector testing will be built up and set into operation in 2010. Main advantage is the flexibility in adjusting the beam parameters such as beam energy which can be chosen from 1.0 to 3.5 GeV. The beam line can provide a circular beam. The beam diameter can be adjusted from 1.8 to 5.1 mm at the focal point. The external beam current can be varied from 100 pA down to 1 fA using a resonance extraction based on the excitation of a third-integer resonance.



Schematic layout of the new beam line situated in the former synchrotron light laboratories



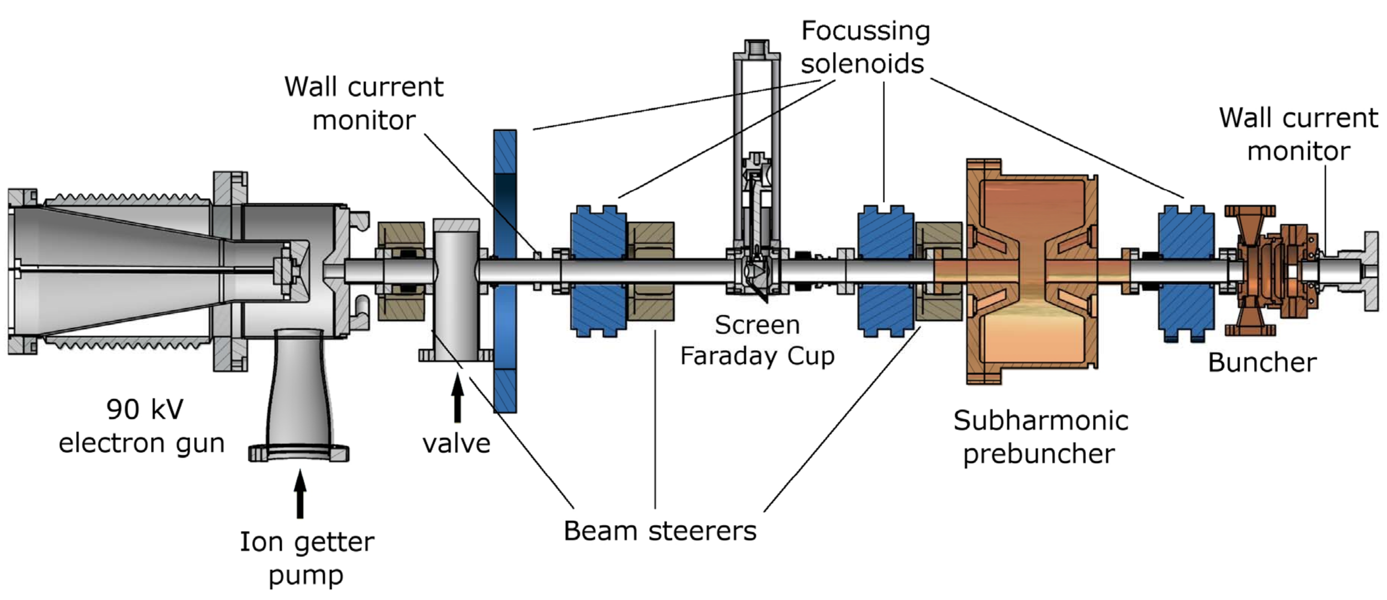
Optical functions derived from numerical simulations using MAD-X

	focussed	enlarged
beam energy	1.0 - 3.5 GeV	
beam current	1 fA - 100 pA	
Beam parameters at 3.5 GeV		
momentum deviation	< 0.88 %	
emittance		
horizontal	616 nmrad	
vertical	31 nmrad	
beam radius		
horizontal	0.95 mm	5.19 mm
vertical	0.92 mm	4.91 mm
beam divergence		
horizontal	0.67 mrad	0.11 mrad
vertical	0.04 mrad	0.01 mrad

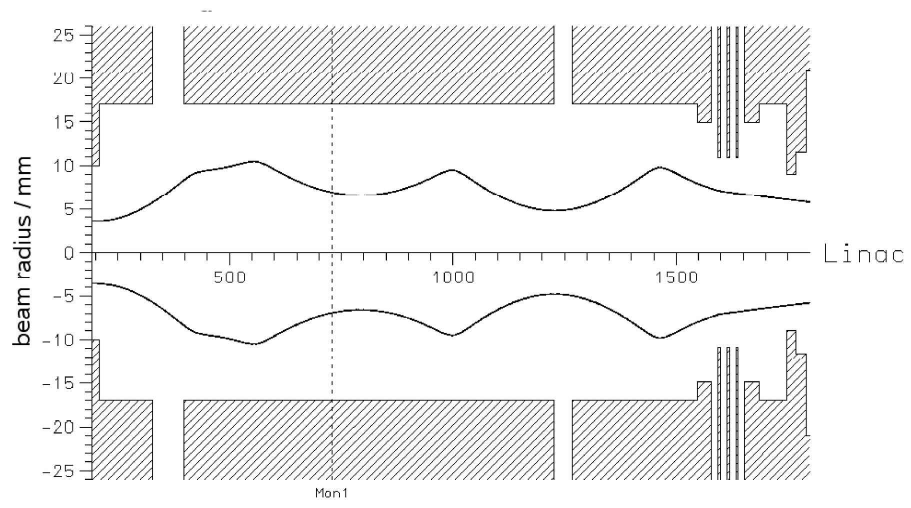
Achievable parameters of the new electron beam line

A new injector for single bunch mode

The new injector at Linac 1 enables a single bunch operation for detailed studies of beam instabilities, single bunch spectroscopy and background studies at the experimental setups. A low current operation for detector testing will be available using this mode. In addition, a 500 mA long pulse mode will be used for fixed target experiments requiring high beam current.



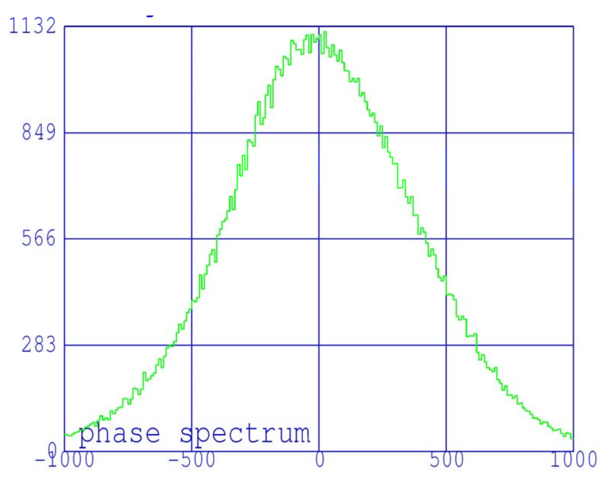
Setup of the new injection system at the linear accelerator Linac 1

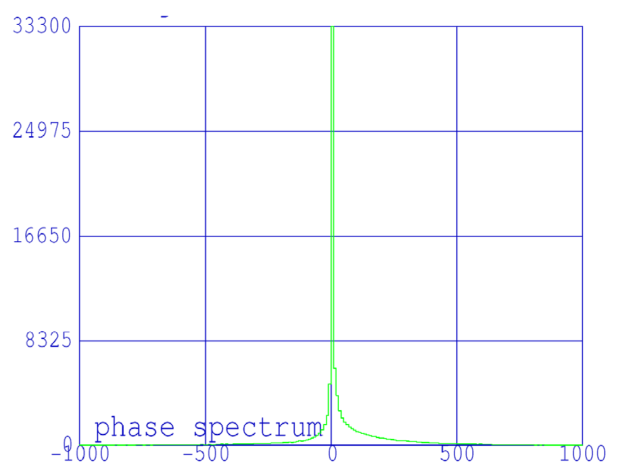


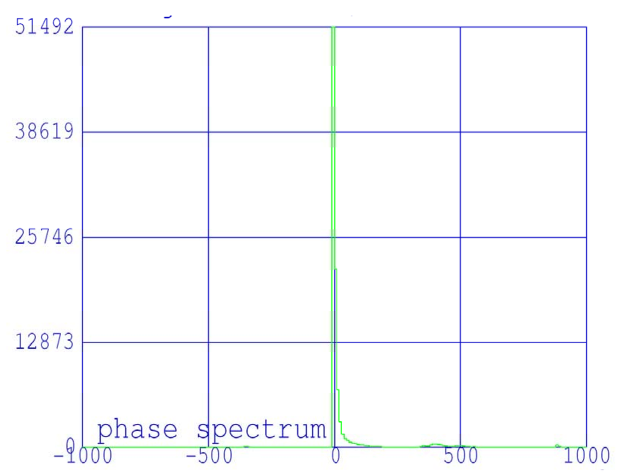
Envelope of a 2 A beam derived from numerical integration of the paraxial differential equation. A starting emittance of 14.7 mm mrad was obtained using the software package EGUN.

Parameters	single bunch	multi bunch
Electron gun		
voltage	- 90 kV	
pulse length	1 ns	0.3 - 3 μs
pulse current	0.1 - 2 A	10 - 500 mA
Prebuncher		
frequency	499.67 MHz	
RF power	400 W	
bunching range	32 cm	
bunch length	< 0.25 ns	
Travelling wave buncher		
frequency	2998 MHz	
RF power	2 - 2.5 MW	
RF pulse length	2 µs	
bunch length	< 0.1 ns	
Linac		
energy	20 - 25 MeV	
frequency	2998 MHz	
RF power	20 MW	
RF pulse length	2 µs	

Main parameters of the new injector at Linac 1







Bunch compression in the injector chain, derived from PARMELA. The figures present intensity profiles at different locations. Left: behind the gun, middle and right: entrance and exit of the travelling wave buncher. The length scale is given as RF Phase offset with respect to the bunch centre, based on a 3 GHz operating frequency of the Linac.

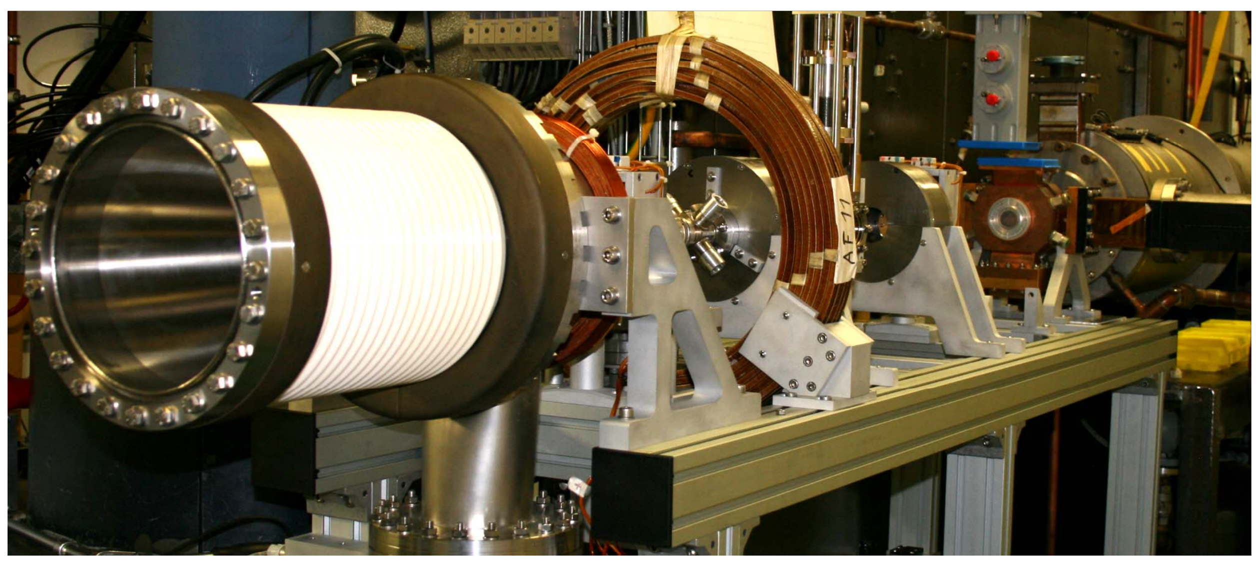


Photo of the assembling status of the new injection system at 11/2009

ELSA

universitätbonn