Fast Transverse Phase Space Measurement System for GunLab
- a compact Test Facility for SRF Photoinjectors -

Motivation
SRF photoinjectors are promising electron sources for high brightness accelerators with high average current and short pulse duration like FELs and ERLs. GunLab will be an independent test facility to test and commission different SRF photoinjectors, optimize the beam performance and examine photocathode materials. Furthermore different fast phase space measurement systems will be developed and tested at GunLab.

Layout of GunLab

Slit-Scanner (transverse phase space)
- the transverse phase space can be observed directly with a peep-look (slit-scan)

- slit scan: moving the beam over the slit and measuring the position and beam width of the beamlets on a view screen
- two scanner coils change their B-field simultaneously
- same absolute field amplitudes but different sign
- Scanner magnets are cosθ-coils:
  - produce dipole fields and suppress higher magnetic multi-poles
  - did not have remanent magnetic fields

- cosθ magnets consist of 2n identical coils arranged azimuthally distributed in 180°/n steps
- each with an opening angle θ and thickness d
- the end caps have a 2d elliptical shape with a and b
  - a is the principal axes
  - b, d and θ are independent parameters for the optimal coil design
  - covering coil radius: a
  - dipole design
  - quadrupole design

- definition of coil parameter (b, d, θ)
  - field calculation by MATLAB
  - field tracking as 3d field in ASTRA
  - b, d and θ was optimized by the minimization of phase space distortions by the magnet fields

- coil length L depends on b, d and θ and beam tube radius r₀, are given parameters
  - r₀ = 15 mm

Optimization of design parameters (example of the dipole magnet)
- minimum of:
  - normalized emittance
  - # of particles

- numerical test of a slit scanner measurement
  - differences between emittance values reconstructed by slit scanner and original bunch are dominated by numerical uncertainties and systematic errors of the method (finite slit width)

Outlook
- final designs for dipole magnets (scanner magnets) and quadrupole magnets are fixed
- final calculations to suppress numerical uncertainties are work in progress
- construction, field measurement and test with electron beams are planned for the next 6 month
- First beam in GunLab is planned for summer 2015