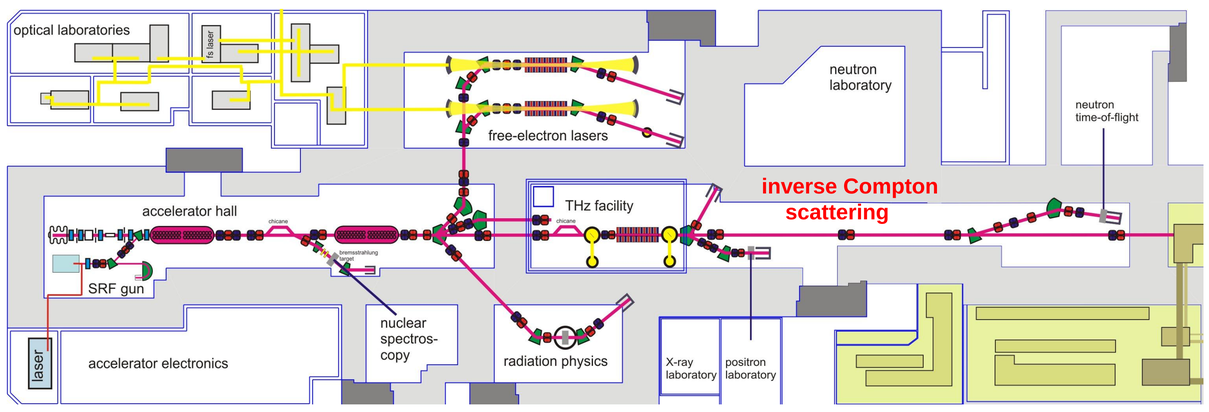
To Develop a High Brightness SRF Photo Injector for Electron-Laser Interaction

P. Lu, H. Vennekate, J. Teichert, A. Arnold, P. Murcek, R. Xiang

Research Overview



Background:

- a 3½-cell SRF gun was developed and commissioned in HZDR
- the SRF gun needs further optimization and refinement

Expected accomplishments :

- optimizing the gun components and operation parameters
- production of very short and high-charge electron bunches
- producing short-pulse, mono-energetic x-rays by inverse Compton scattering (team work)

Project Content:

- electron beam diagnostics
- beam dynamic simulations

} optimization of beam transport

- development and application of laser beam

The SRF Gun at ELBE

History:

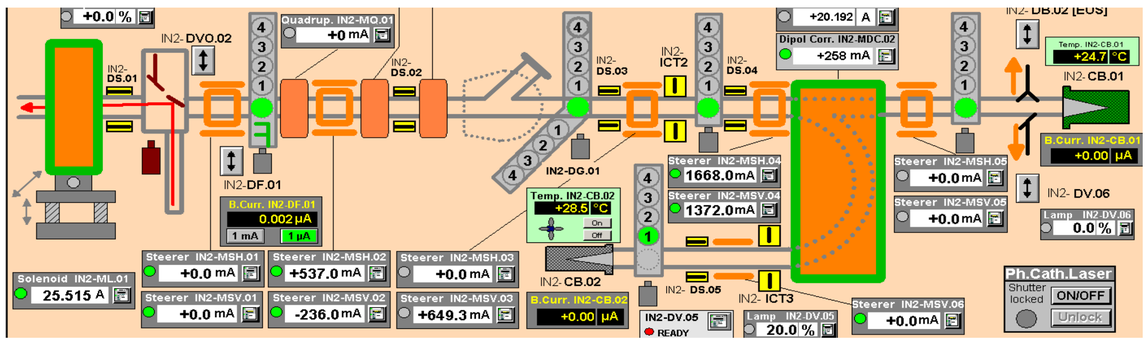
- 1997 start of development at HZDR (FZR)
- 2002 first operating half-cell gun
- 2004 design of 3½-cell cavity
- 2007 first beam with new gun (Nov-12)
- 2008 transfer system for cathodes
- 2010 first beam in ELBE (Feb-5)

Concept:

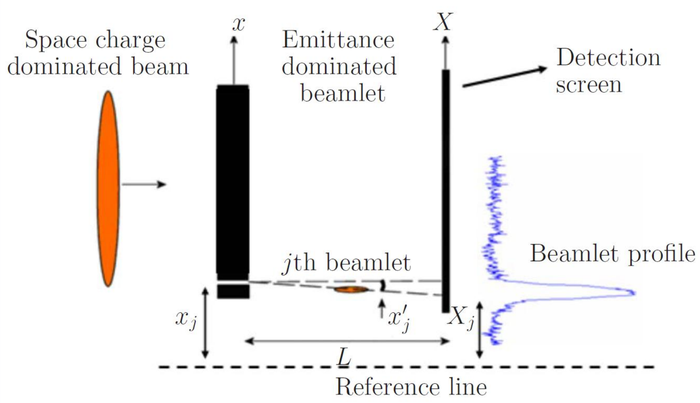
- superconducting cavity including choke filter
- exchangeable photo cathode
- laser (1 W, 262 nm) to generate electron bunches

↪ switch from pulsed to cw mode

Ongoing: Emittance Measurement



Single-slit scanning method :



$$\varepsilon_{n,rms} = \beta\gamma\sqrt{\langle x^2\rangle\langle \dot{x}^2\rangle - \langle x\cdot\dot{x}\rangle^2}$$

Layout:

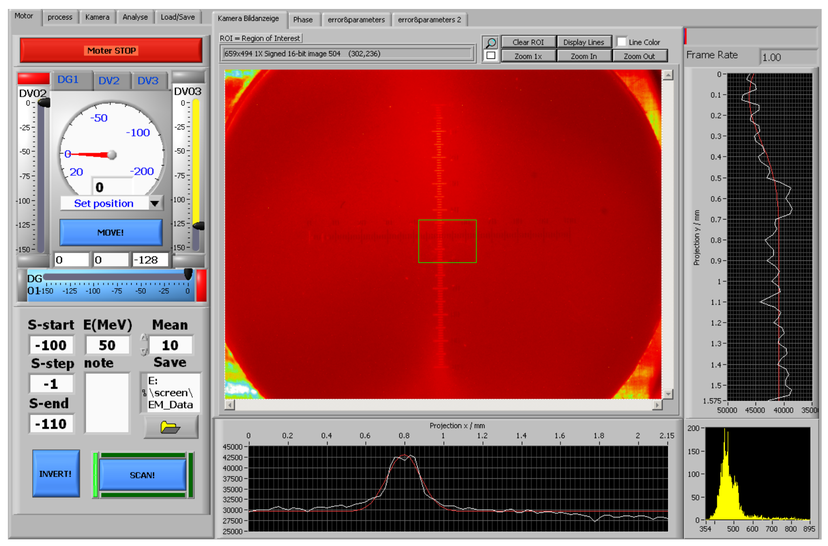
- tungsten slit board at section x
- YAG screen at section X
- camera shielded by lead

Advantages:

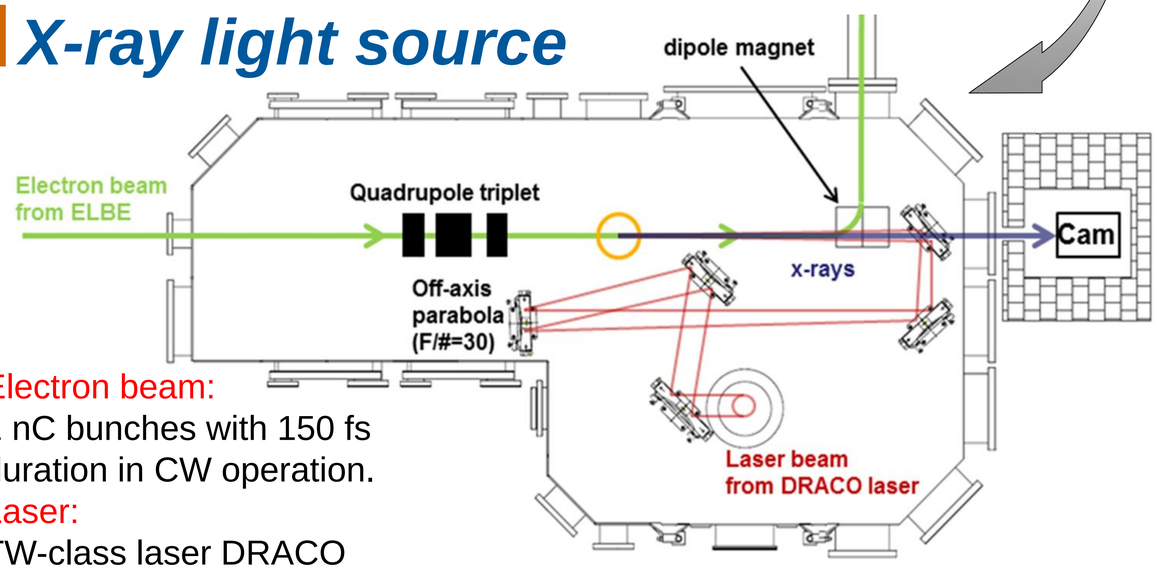
- space charge influence weakened
- data overlap avoided
- high resolution of phase space

Status and working plan:

- ✓ hardware setting
- ✓ labview interface
- ✓ data processing algorithm
- – data acquisition
- – error analyzing
- – comparison with simulations and other methods



X-ray light source



Electron beam:
1 nC bunches with 150 fs duration in CW operation.

Laser:
TW-class laser DRACO

Synchronization:

- short term stability of < 1 ps but several tens of ps of long term drift
- a new system with fs scale stability is under construction

LA³NET Training & Research Plan

- 6 months : first beam dynamic simulation and results presentation (at institute´s WIP seminar)
- 10 months: poster and paper for IPAC 2013
- 12 months: first SRF gun optimization and parameter measurement (presentation on DPG Annual Meeting)
- 18 months : application of beam time for CBS experiments
- 18 months : first journal publication manuscript finished
- 24 months : presentation of outline of PhD work

Acknowledgments

We acknowledge the support of the European Community-Research Infrastructure Activity under the FP7 programme (EuCARD, contract number 227579), as well as the support of the German Federal Ministry of Education and Research grant 05 ES4BR1/8, and the LA³NET funding from the European Comission under Grant Agreement Number GA-ITN-2011-289191.

M.Sc. P. Lu | Radiation Physics | ELBE | TU Dresden | p.lu@hzdr.de