The NSRRC Photo-injector Diagnostic Tools for Initial Beam Test

國家同步輻射研究中心
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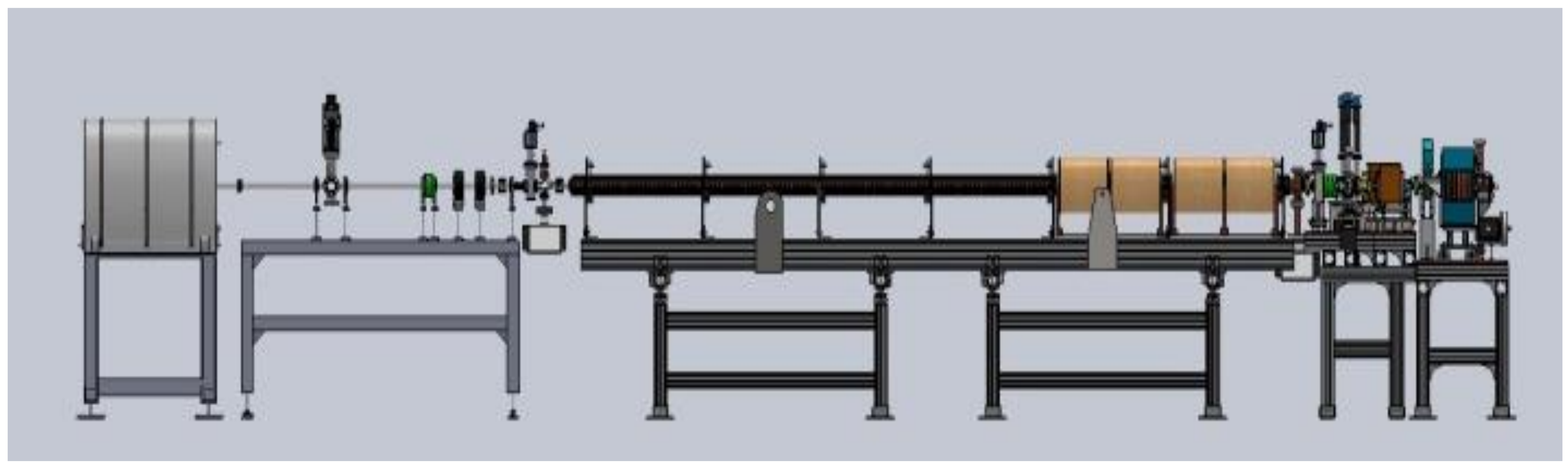
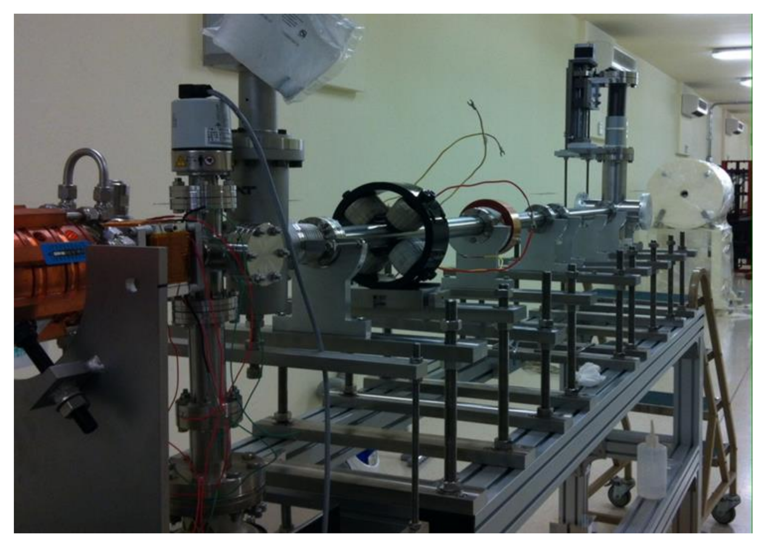
Abstract

The High brightness injector project at NSRRC aims to develop a100 MeV photo-injector system for light source R&D at NSRRC. This photo-injector system equipped with a photocathode rf gun, a solenoid for emittance compensation, an S-band linac as well as various beam diagnostic tools is designed for operation in two different modes. One is to generate high brightness electron beams for future free electron laser experiments. The other is to produce ultra-short electron bunches by velocity bunching. It also allows us to perform inverse Compton scattering experiment for generation of fs x-ray. In the beginning of this project, the photocathode rf gun was installed in the booster room of TLS at NSRRC. The normalized beam transverse emittance is 5.5 mm-mrad at ~250 pC with Gaussian laser pulse. Recently, a 100 MeV photo-injector system is being installed in the 38 m by 5 m tunnel of the NSRRC linac test laboratory. The rf gun, the 35 MW high power microwave system and a 5.2 m lina has been set up. The UV driver laser system will be set up in the new temperature controlled clean room in the linac test laboratory. For initial beam test, beam diagnostic tools for energy measurement (dipole magnet) and transverse emittance measurement (multi-slit) are installed.

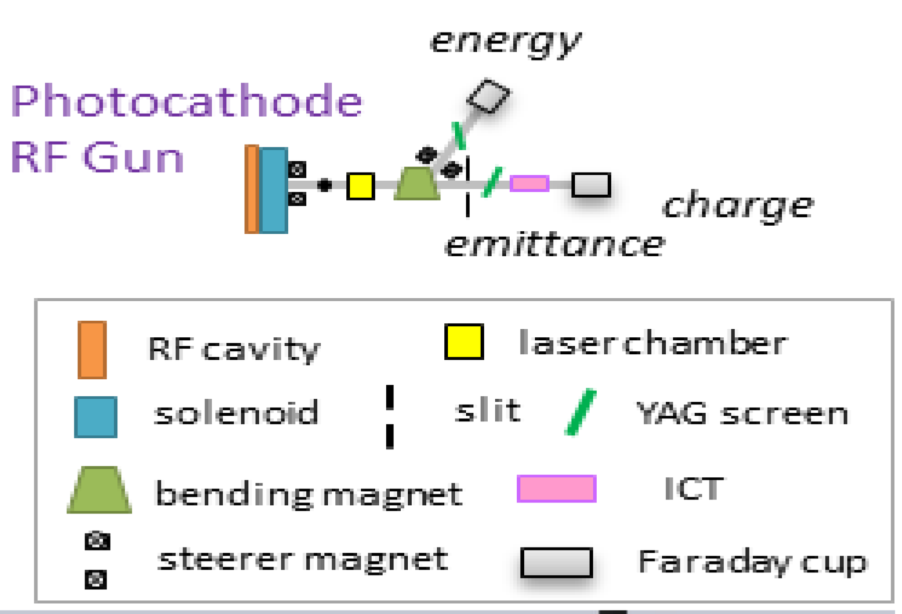
Photo-Injector System

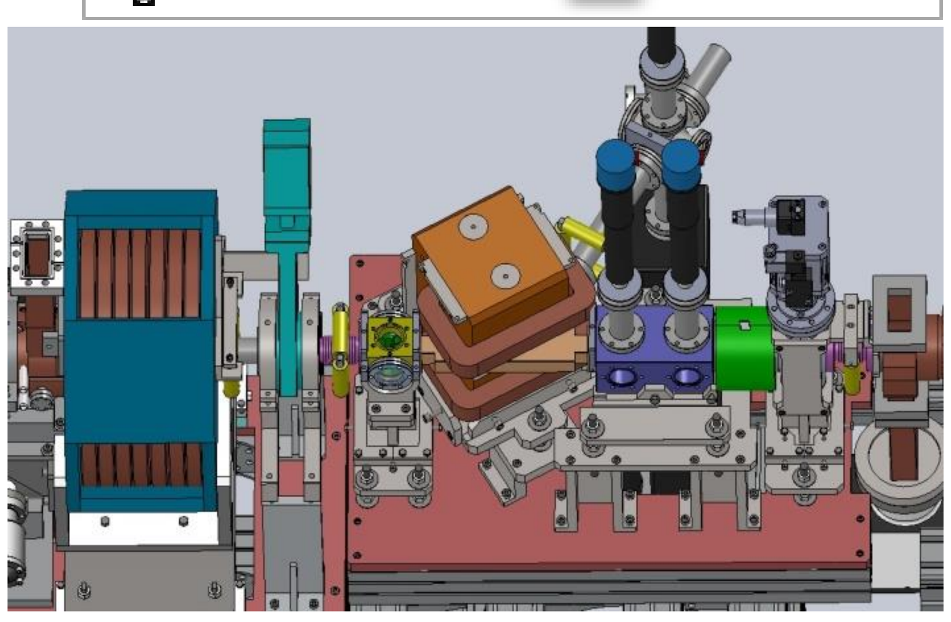
Initial beam parameters at cathode:	
Peak E field in the rf gun	70 MV/m
Laser injection phase	23° (GPT setting)
Initial beam radius	0.6 mm
Initial bunch length	6 ps (FWHM)
Initial beam profile	Uniform cylindrical
Initial beam charge	100 pc
B field of solenoid	1400 Gauss
Beam parameters at the entrance of the linac :	
Beam energy	3.54 MeV
Projected energy spread	37 keV
Projected relative energy spread	1.0 %
Sliced energy spread	0.55 keV
Charge	100 pC
Bunch length	2.25 ps (rms)
Normalized emittance	0.98 mm-mrad

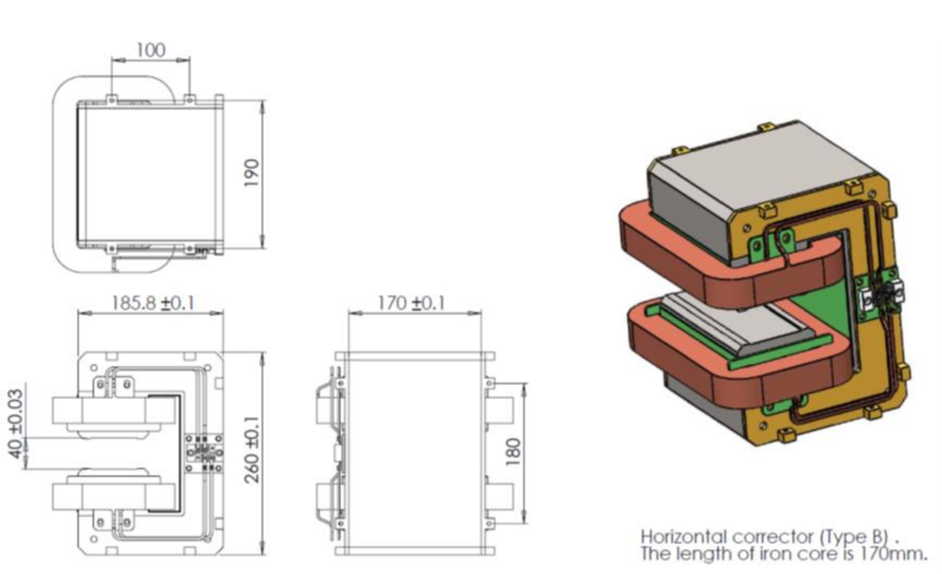




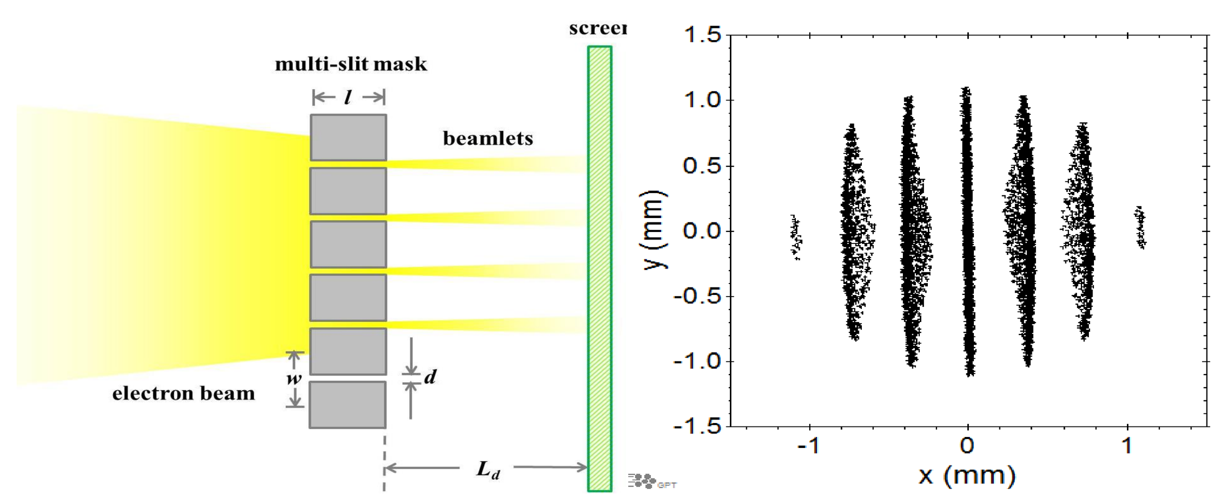
Beam Diagnostic Tools







Bending angle,θ	60∘
Bending radius, ρ	170.00 mm
R_{opt}(optimum resolution)	0.044 % @ d =0.33 m
σ_x@ R_{opt}	103.4 um
σ_y@ R_{opt}	1.550 mm
η@ R_{opt}	0.4661 m

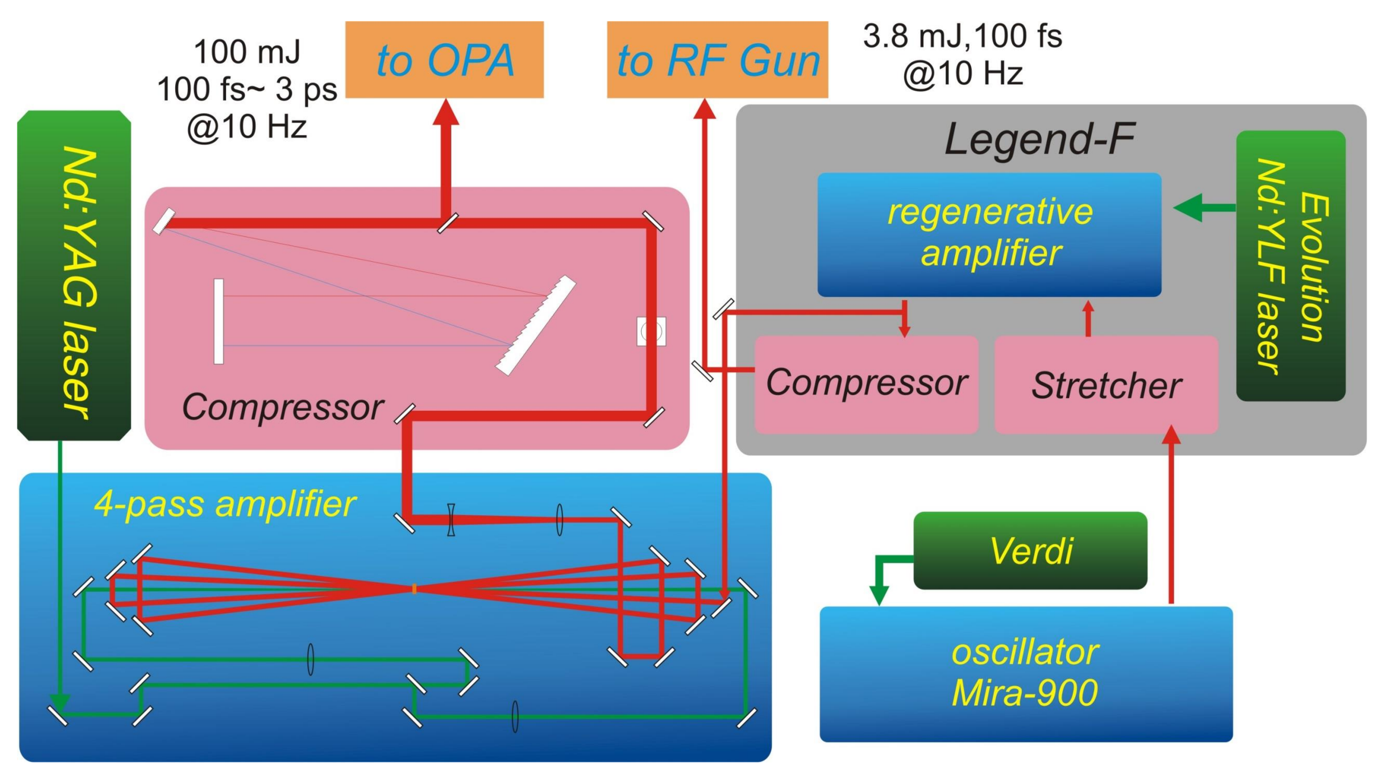


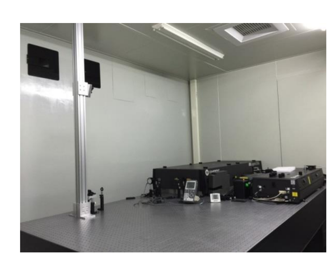
Slit position	z = 0.95 m from cathode
Slit material	Stainless-steel
Slit width	50 µm
Slit separation	500µm, 300µm
Slit depth	5 mm
Screen position	z = 0.1 m from slit
Screen type	YAG:Ce
Screen diameter	11 mm
Screen thickness	50 µm

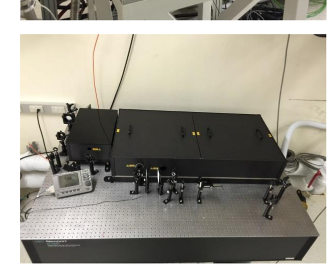
Ultrafast Laser System

Table: Specifications of the upgraded laser system.

rep. rate 10 Hz	for RF gun		for seeding FEL (under construction)	
	IR	UV	IR	UV
Wavelength	800 nm	266 nm	800 nm	266 nm
Pulse energy	3.8 mJ	150 µJ (before the RF gun)	100 mJ	300 µJ (after OPA)
Pulse duration	100 fs	0.8 – 10 ps (ajustable)	0.1 – 3 ps	1.5 ps







The photo-injector system for the THz/VUV FEL is being built at NSRRC. The installation has been started in January 2015 and will be finished at the end of 2015. In the first phase, the objective is to generate the ultrashort electron beam via velocity bunching in the 5.2 m linac for THz coherent radiation. Before installing the undulator, the parameters of beams generated by the photocathode rf gun will be measured. The quadrupole scan is used to measure the transverse emittance and the coherent transition radiation is used to measure the bunch length after electron beams exit the linac. Then, the RTR experiment will also being carried out . Besides, producing ultrashort x-ray sources through the inverse Compton scattering is to be considered since the 100-MeV electron beam and the 100-mJ laser pulse are ready.