Production of 120 MeV Gamma Ray Beams at Duke FEL and HIγS Facility

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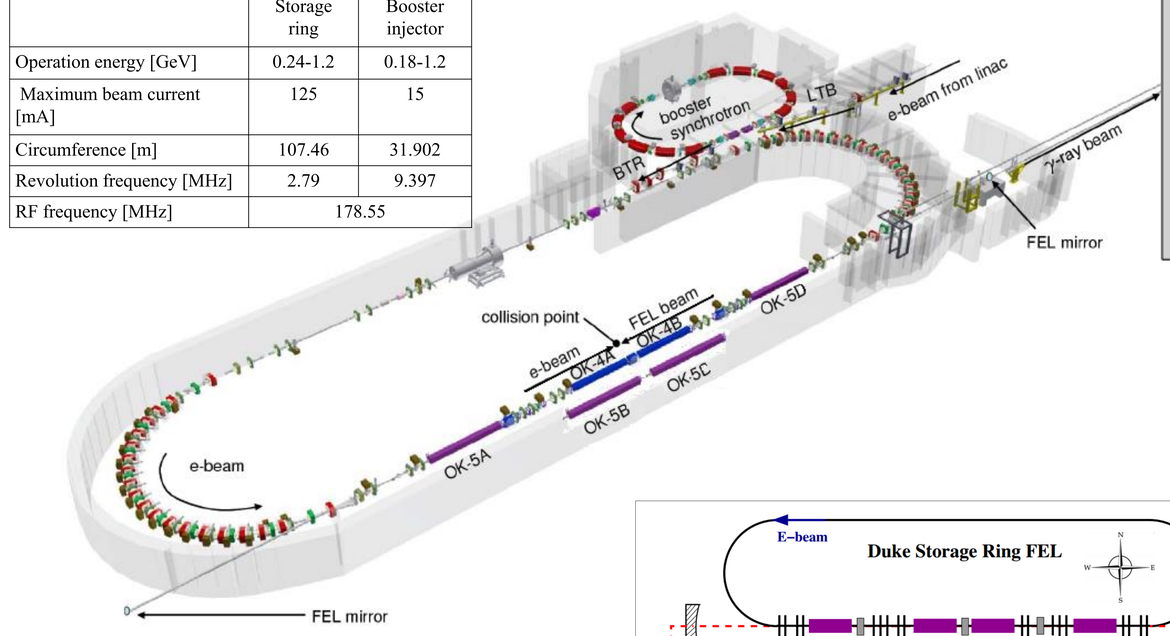
ABSTRACT

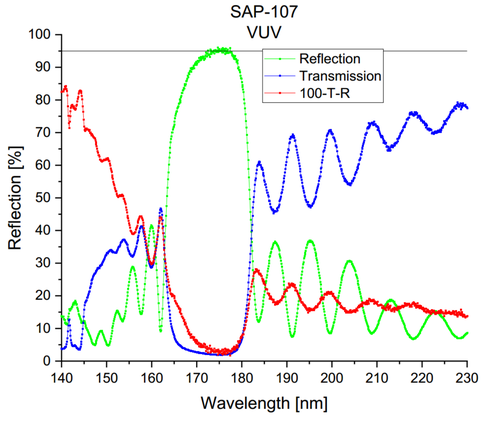
We report extension of the operational energy of the gamma ray beams produced at Duke High Intensity Gamma-ray Source (HIGS) up to ~120MeV, opening up a new high energy region of gamma rays for photonuclear physics research. This achievement is based upon development of radiation robust, thermally stable, high-reflectivity fluoride (LaF3/MgF2) multilayer VUV FEL mirrors, enabling us to maintain stable high intensity FEL lasing at the wavelengths of around 175nm. We discuss the challenges of HIGS operation at high gamma and high electron beam energies with the downstream FEL mirror exposed to extremely hush radiation.

Duke FEL/HIγS accelerators

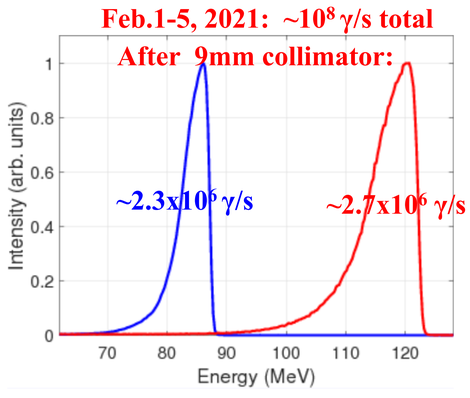
	Storage ring	Booster injector
Operation energy [GeV]	0.24-1.2	0.18-1.2
Maximum beam current [mA]	125	15
Circumference [m]	107.46	31.902
Revolution frequency [MHz]	2.79	9.397
RF frequency [MHz]	178.55	



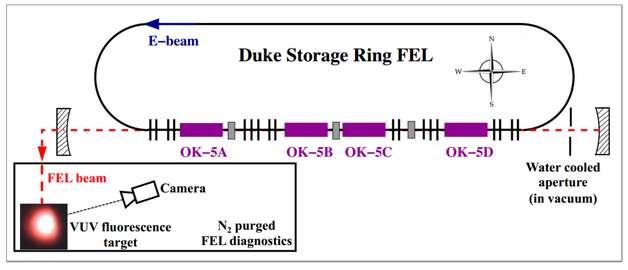
Facility/Project: High Intensity Gamma-ray Source (HIGS)
Institution: TUNL
Country: US
Energy (MeV): 1–120
Accelerator: Storage Ring, 0.24–1.2 GeV
Laser: FEL, 1060 – 175 nm (1.17–7.08 eV)
Total flux: 10^7–$3x10^{10}$g/s (max ~10 MeV)
Status: User Program
Research: Nuclear physics, Astrophysics, National Security



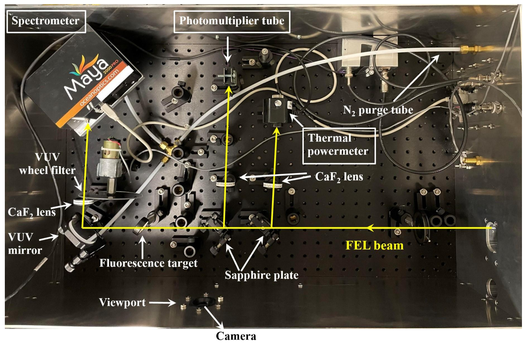
Measured performance of a new 175 nm fluoride FEL mirror (serial number SAP-107). Sapphire substrate is used to provide for a thermal stability and efficient cooling.



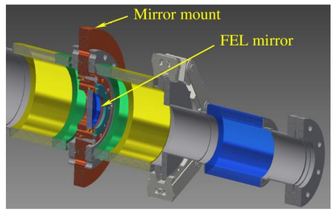
Energy spectra of 86 MeV and 120 MeV gamma-ray beams produced using 0.936 GeV and 1.11 GeV electron beams. Gamma ray beams were produced for an experimental test run using a 12C target, part of the electromagnetic polarizability research program at the HIGS.



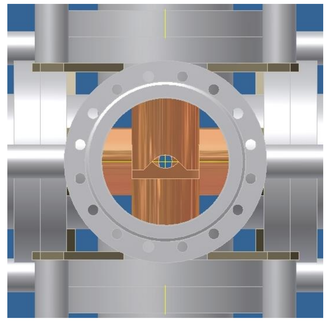
FEL and gamma production set-up for 175 nm operation. An in-vacuum water-cooled aperture system downstream the undulators is used to block most of off-axis higher harmonic radiation. A diagnostic system enclosed in a nitrogen purged box is used to characterize the VUV FEL beam.



VUV optical diagnostics board.



Copper mirror holder and mount for downstream FEL mirror is actively cooled from outside using a compressed air vortex chiller.



In-vacuum mirror protection water-cooled horizontal and vertical apertures in fully inserted position.

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