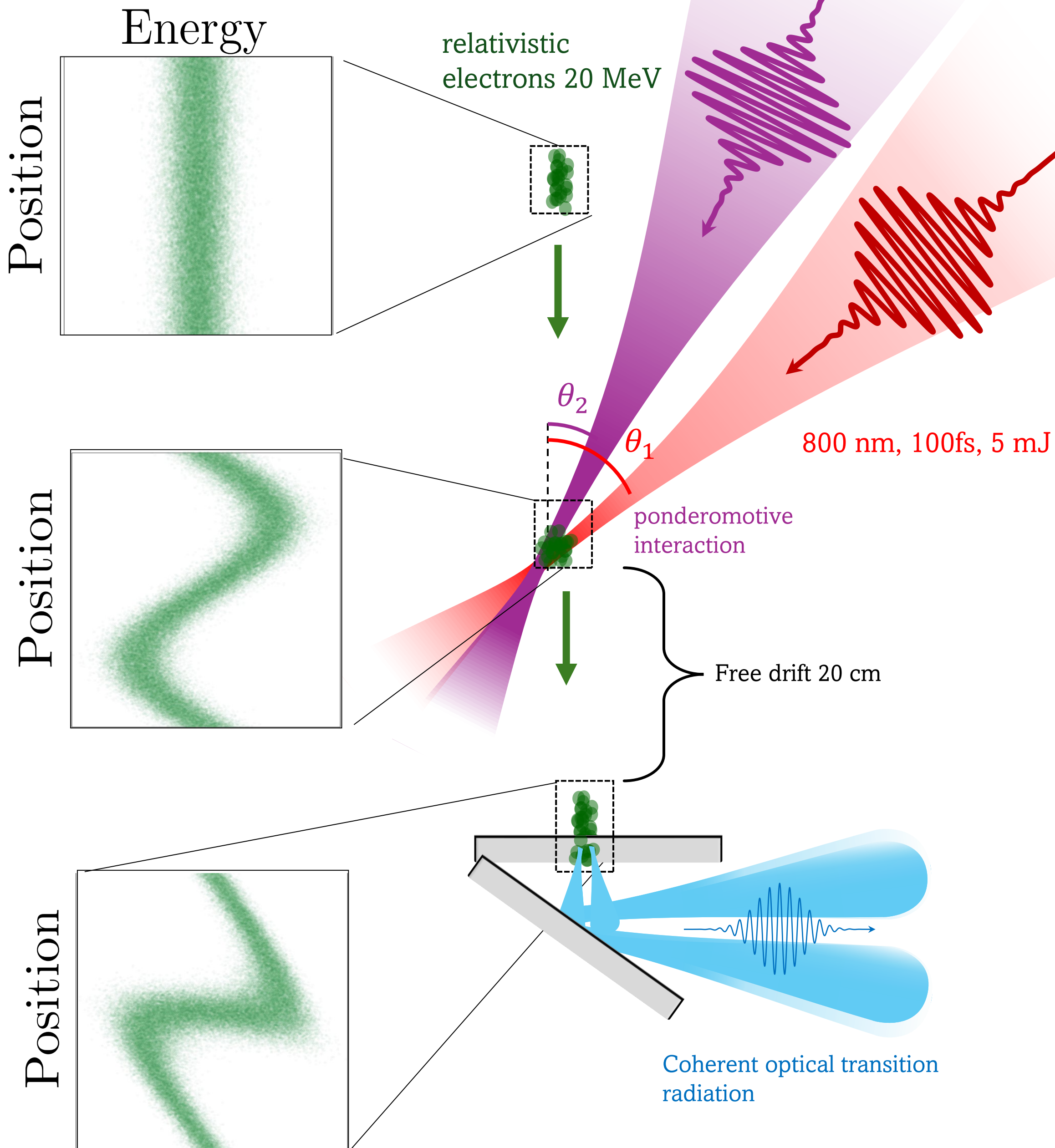


Superradiant Compton Scattering

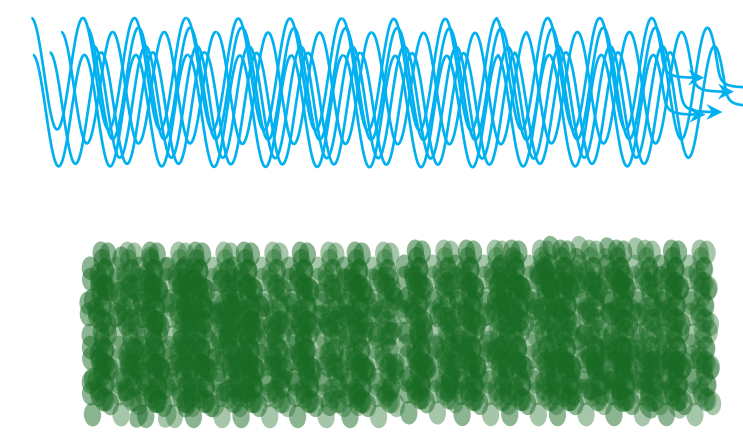
An important challenge for ICS is to overcome the tiny Thomson cross section. One method would be to amplify the radiation using a microbunched electron beam [1], which could be achieved via

Two-Color ponderomotive bunching [2]

This experiment aims to be a proof of principle to create microbunching at 400 nm, using the existing Smart*Light beamline [3].

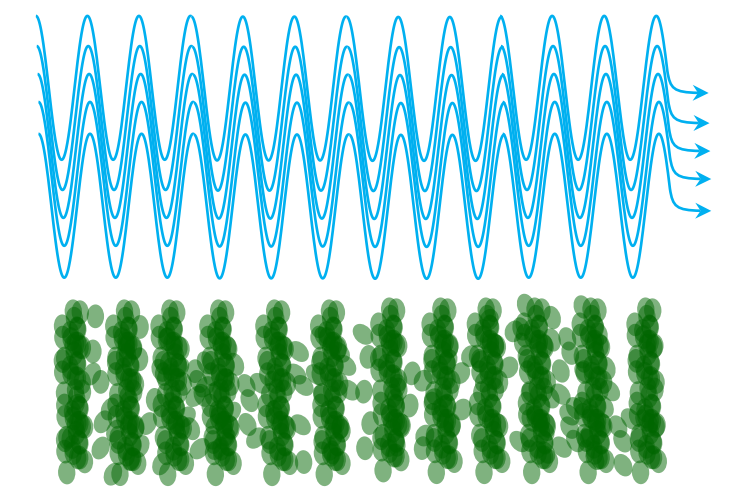


Incoherent $N_X \propto N_e$



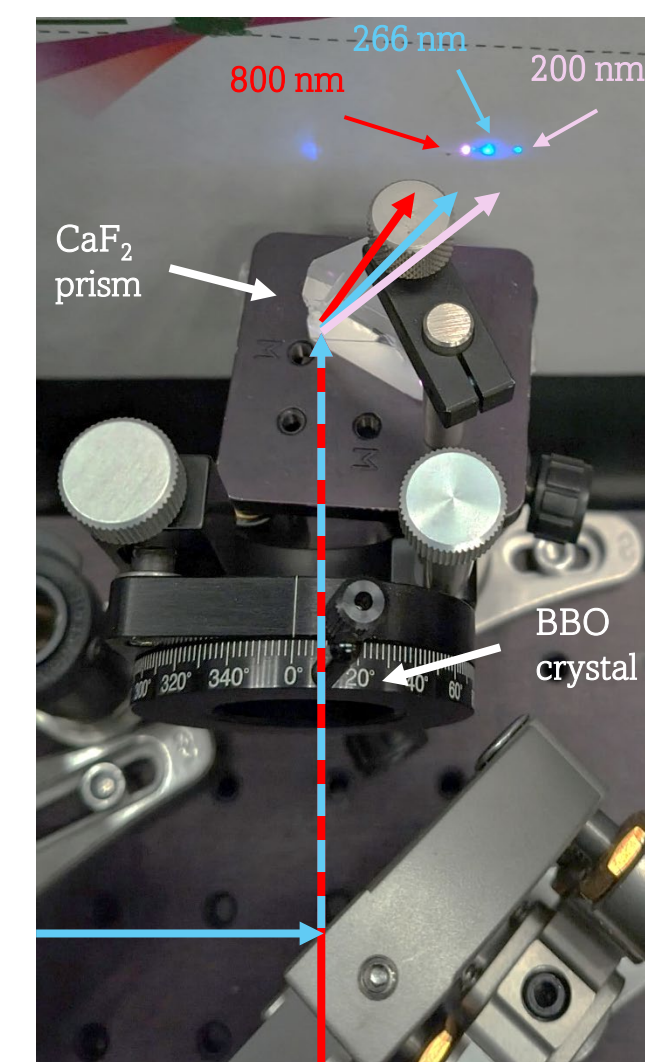
Uniform bunch

Coherent addition $N_X \propto N_e^2$



Microbunched

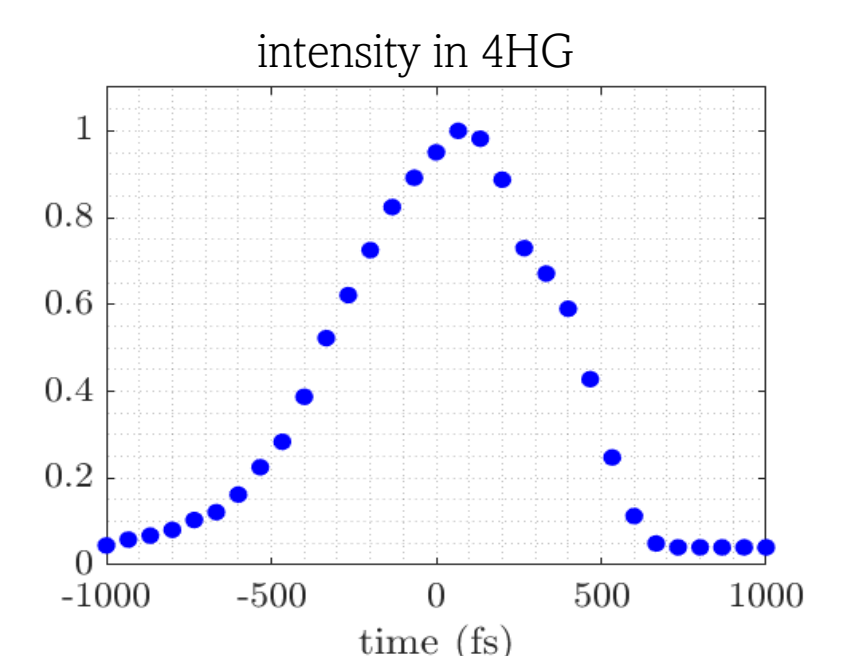
Temporal overlap: 4HG



Temporal overlap between the laser pulses is measured using Fourth Harmonic Generation

$$800 \text{ nm} + 266 \text{ nm} = 200 \text{ nm}$$

$$1\omega + 3\omega = 4\omega$$



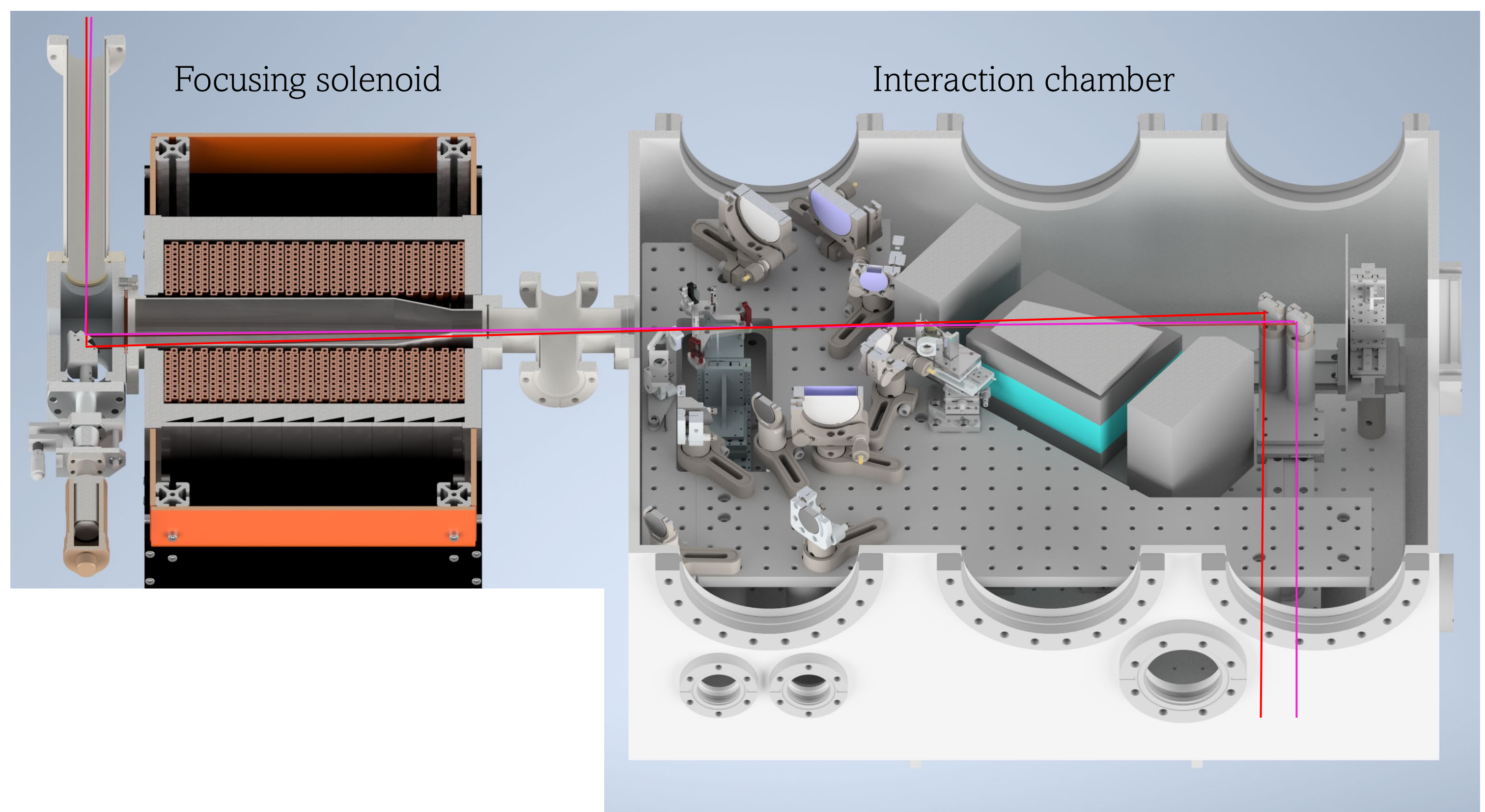
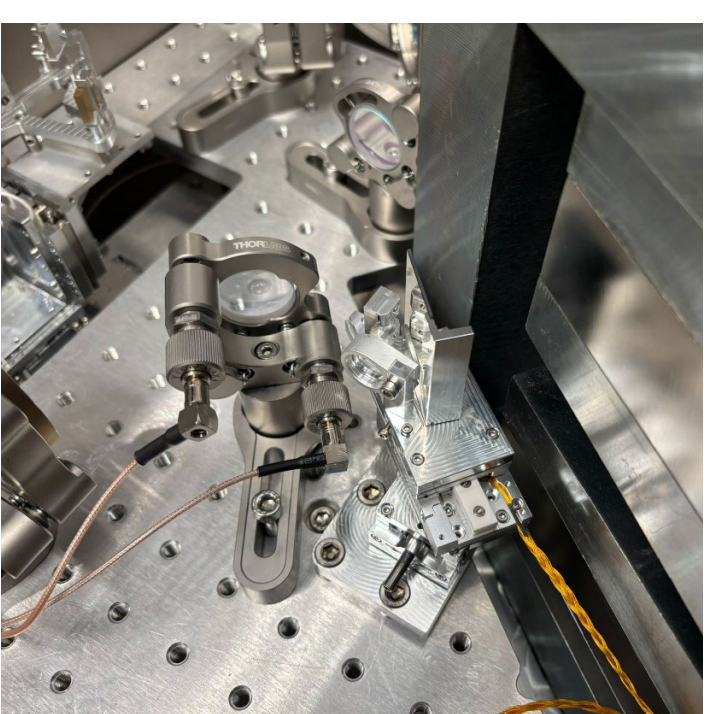
Laser and beam parameters

Parameters of the experiment and expected (coherent) transition radiation yield

Interaction Lasers		
Wavelength	800 nm	266 nm
Pulse energy	5 mJ	100 μ J
Interaction angle θ_1, θ_2	2.5 deg	0.8 deg
Energy mod.	20 keV	
Drift length	20 cm	

Electron beam	
Beam energy	20 MeV
Bunch charge	100 fC
Energy spread	10 keV
Normalized emittance	100 nmrad
Required spot size	$\leq 2 \mu\text{m}$
Required divergence	$\leq 1.5 \text{ mrad}$
Transition radiation	
Wavelength	400 nm
Incoherent ph/s	$2.3 \cdot 10^5$
Coherent ph/s	$2.9 \cdot 10^7$

Squeeze into existing beamline



[1] Schaap, B. H., et al. "Ponderomotive bunching of a relativistic electron beam for a superradiant Thomson source." Phys. Rev. Accel. Beams 26, 074401

[2] Kozák, Martin, et al. "Inelastic ponderomotive scattering of electrons at a high-intensity optical travelling wave in vacuum." Nature Physics 14.2 (2018): 121-125.

[3] van Elk, I. J. M., et al. "First x-rays from a compact and tunable LINAC-based Compton scattering source." Opt. Express 33, 47498-47513 (2025)