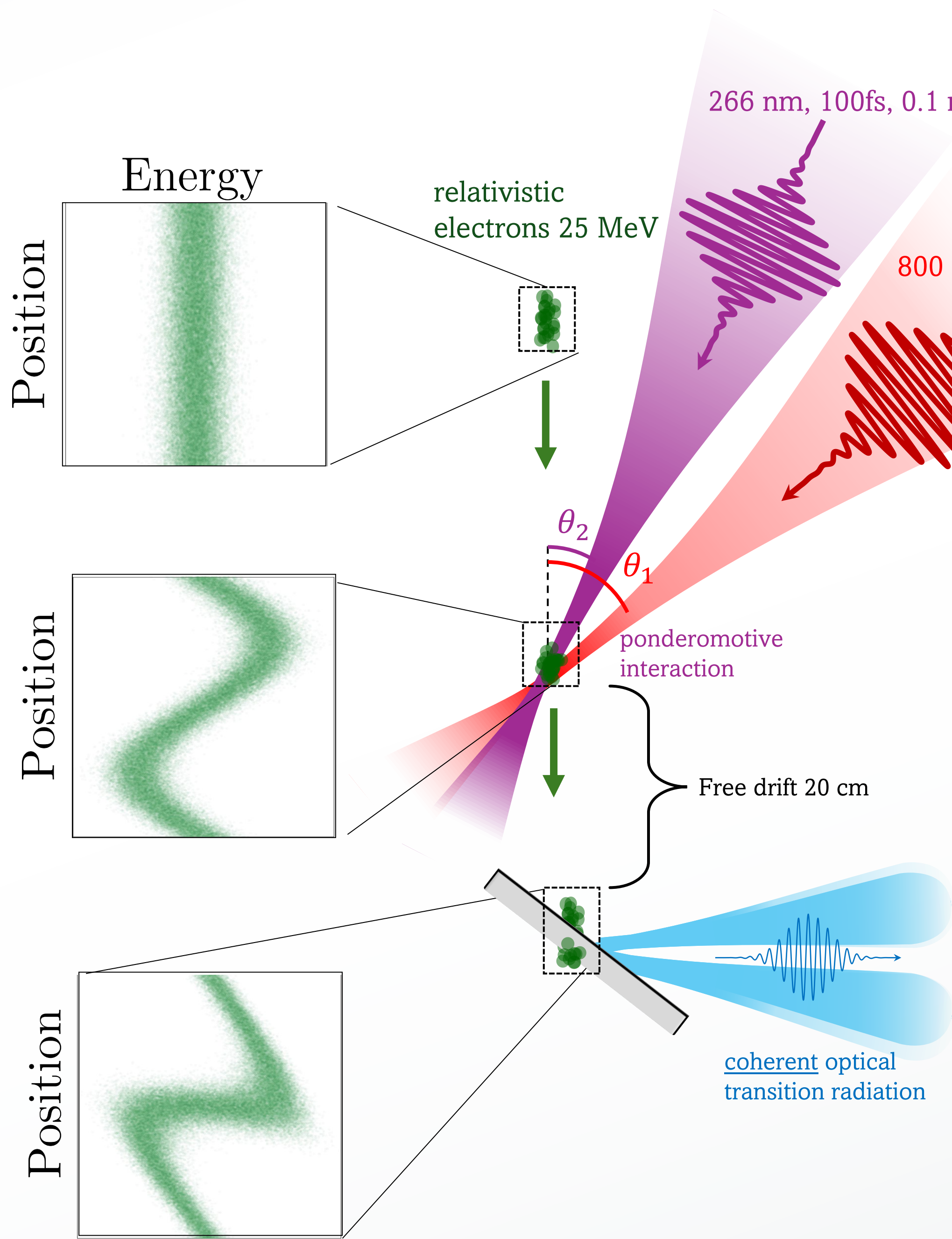


Superradiant Compton Scattering

Compact sources offering high-brightness radiation in the EUV to x-ray regime are highly desired. Inverse Compton scattering (ICS) in which an electron beam colliding with a laser pulse produces radiation, is a source of x-rays of increasing prevalence in modern labs.

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]

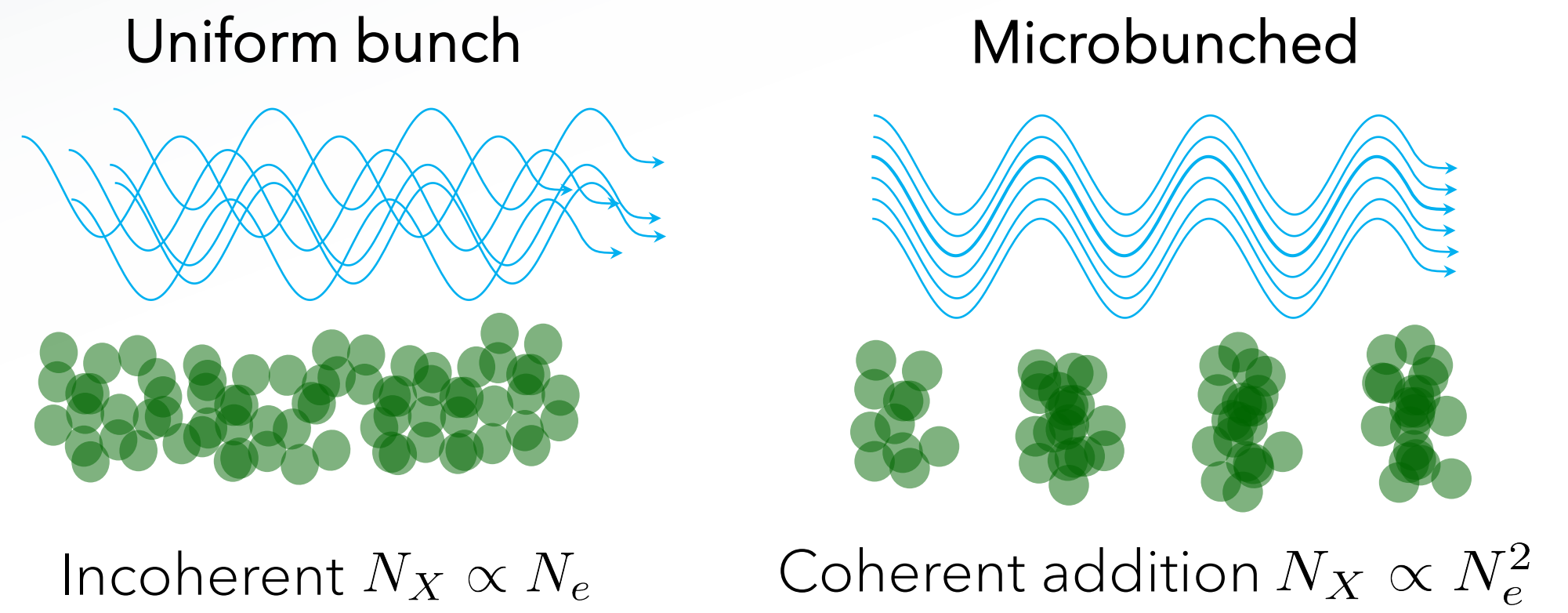


Laser and beam parameters

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	250 fC
Energy spread	10 keV
Normalized emittance	100 nmrad
Transition radiation	
Wavelength	400 nm
Incoherent ph/s	$9 \cdot 10^5$
Coherent ph/s	$4 \cdot 10^7$



Two-Color ponderomotive bunching

We propose an experiment similar to the work presented by Kozák et. al. [2]. But modified for relativistic electron beams.

Microbunching is created in two steps:

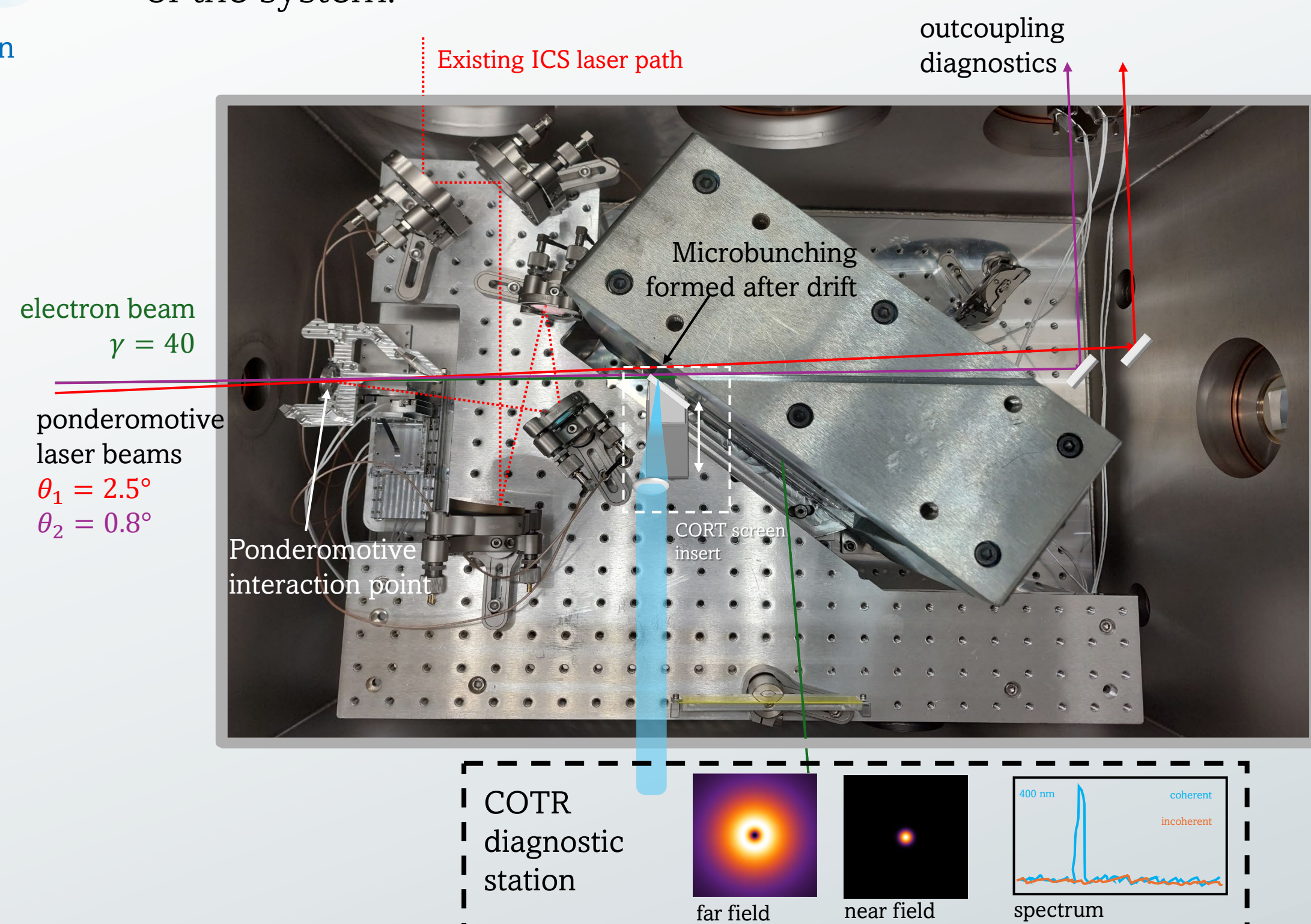
1. The electron beam interacts with the beat wave of 2 laser pulses, which imposes an energy modulation.
2. After a short drift, the energy modulation is transformed into **Microbunching**

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

Utilizing the echo effect, similar to [4], would allow for coherent Compton scattering at soft x-ray wavelengths

Squeeze into existing beamline

This experiment will be carried out using the existing SmartLight ICS beamline. This has the unique challenge adding laser paths and diagnostics without losing the ICS capabilities of the system.



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

[3] van Elk, I. J. M., et al. "First x-rays from a compact and tunable LINAC-based Compton scattering source." arXiv preprint arXiv:2504.11897 (2025).

[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.

[4] Stupakov, G. (2009). "Using the beam-echo effect for generation of short-wavelength radiation". Phys. Rev. Lett. 102, 074801