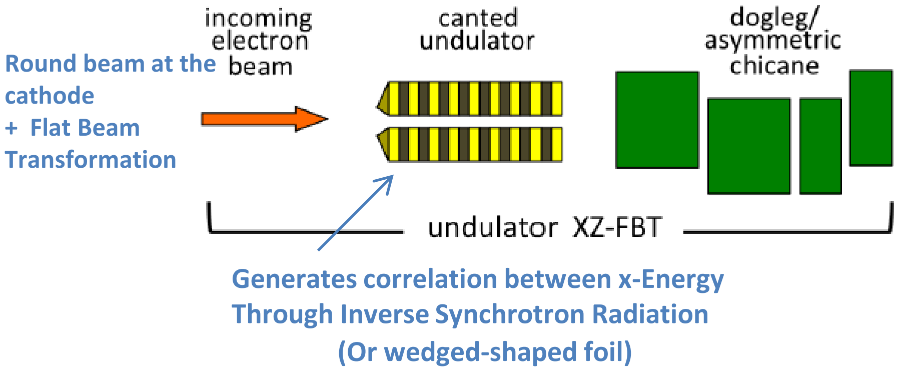
Summary of HBEB workshop

Ultra-High Brightness Electron Beams for X-ray Free Electron Lasers (Bruce Carlsten)

The emittance partitioning (i.e. emittance exchange between planes) is used as an alternative to the laser heater to increase the slice energy spread up to ~20 keV.



- We can control the formation of the eigen-emittances by controlling correlations when the beam is generated (demonstrated in Flat-Beam Transforms (FBTs))
- We recover the eigen-emittances as the beam rms emittances when all correlations are removed

Two Color X-ray FEL at LCLS (Alberto Lutman)

3 schemes discussed.
The first one (the simpler one) presents a SASE process in two subsequent undulators tuned at different wavelengths. The first SASE must reach not the saturation.

High energy gain helical IFEL at Brookhaven National Laboratory

(Joseph Duris)

IFEL: e-bunches are accelerated and bunched by the radiation.
Same setup of a seeded FEL but the undulator setup is different: strong taper (both B period and amplitude)

Helical undulator

Electrons always moving in helix so always transferring energy.

Helical yields at least factor of 2 higher gradient.

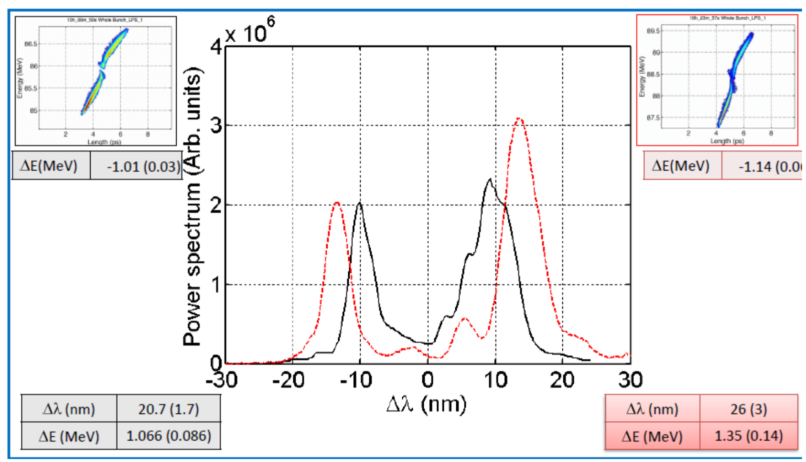
RUBICON

Parameter	Value
Input e-beam energy	50 Mev
Final beam energy	117 MeV
Final beam energy spread	2% rms
Average accelerating gradient	124 MV/m
Laser wavelength	10.3 μm
Laser power	500 GW
Laser focal spot size (w)	980 μm
Laser Rayleigh range	25 cm
Undulator length	54 cm
Undulator period	4 – 6 cm
Magnetic field amplitude	5.2 – 7.7 kG

Two colors FEL driven by a comb-like electron beam distribution

(Enrica Chiadroni)

Comb beam compressed via velocity bunching.



EOS locked seeding system toward FT-limited XFEL pulses (Hiromitsu Tomizawa)

Towards Zeptosecond-Scale Pulses from X-ray FELs (David Dunning)

Few-Cycle Pulse Generation in an X-Ray Free-Electron Laser

D. J. Dunning,[1,2,*] B. W. J. McNeil,[2,†] and N. R. Thompson[1,2,‡]

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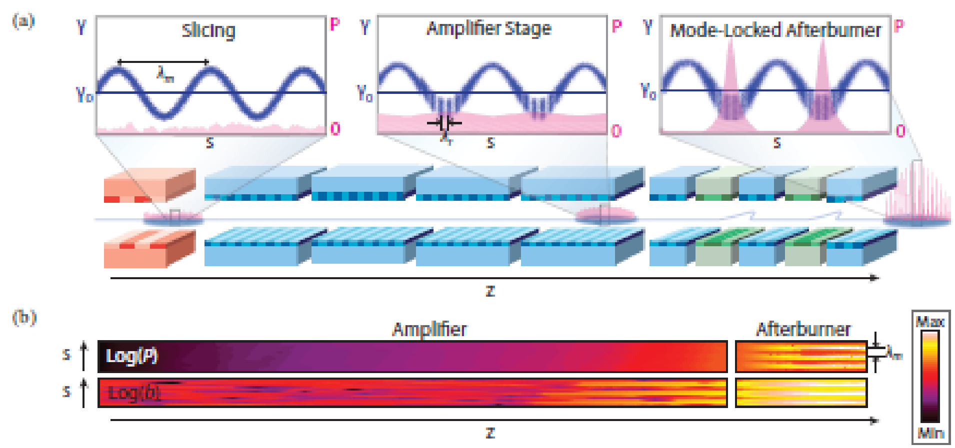
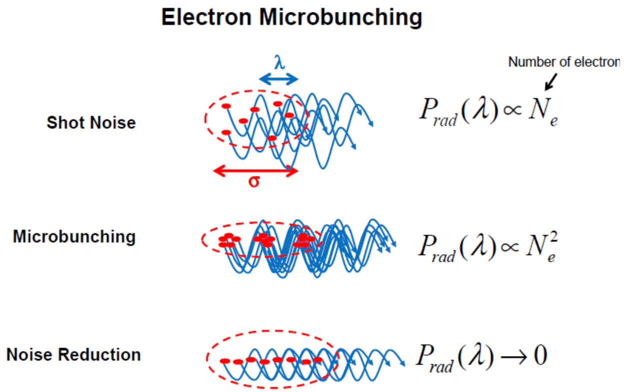
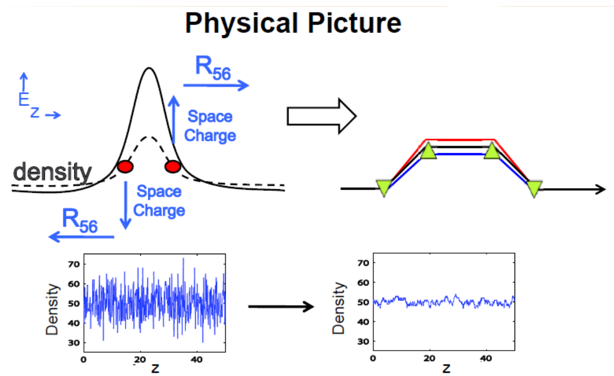
(Dated: December 11, 2012)

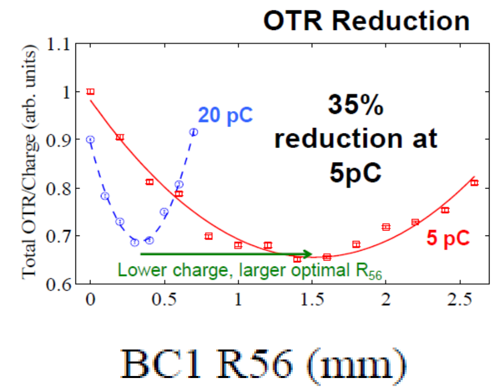


Train of single spike pulses out of 1 e-bunch

Shot Noise Suppression in Linac Beams (Daniel Ratner)



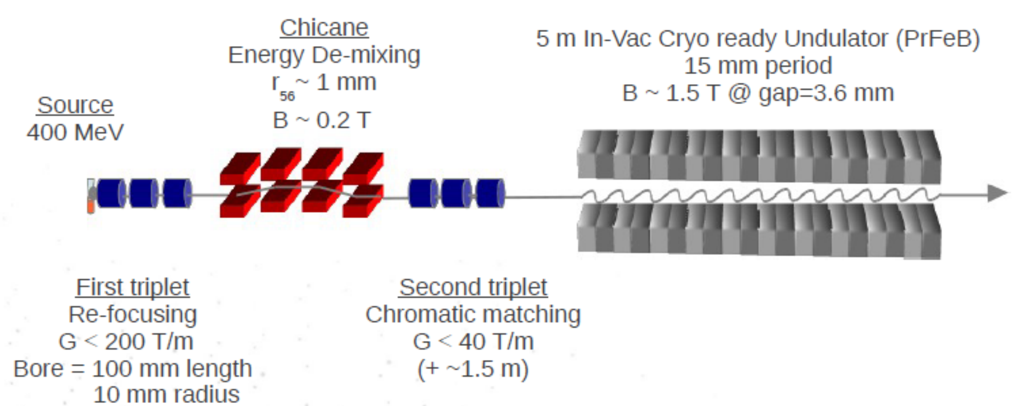




Longitudinal and transverse beam manipulation for compact laser wakefield accelerator based free-electron laser (Alexandre Loulergue)

Beams from laser plasma acceleration need to be manipulated before being injected into the undulator:

- The chicane lengthens the beam and reduce the slice energy spread
- The combination chicane + quadrupoles focuses the beam and corrects the chromaticity



High Brightness SASE operation of X-ray FELs (Neil Thompson)

Chicanes between undulators are inserted so to delay the e-bunch wrt the radiation pulse and increase the slippage (and the cooperation length).

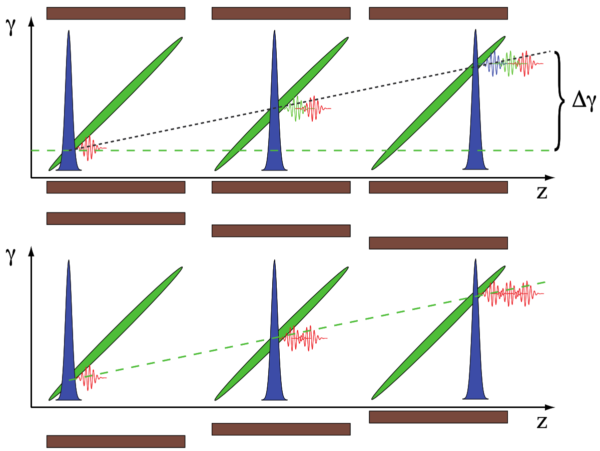
Twisted Photons (Erik Hemsing)

Advancements on Theory and Simulations of FELs (Brian McNeil)

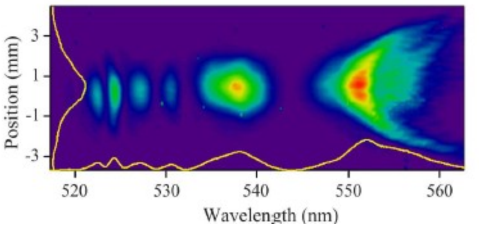
Two-color pulse generation in the FERMI@Elettra FEL for pump-probe experiments (Giuseppe Penco)

Longitudinally coherent single-spike radiation from a SASE FEL

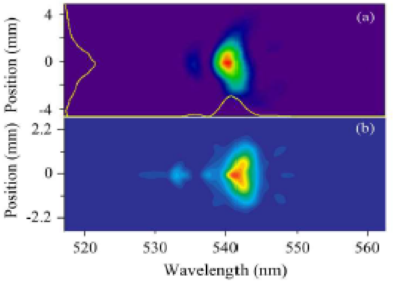
(Gabriel Marcus)



- Single-shot spectrum
  - No taper
- Large projected energy spread
  - Large bandwidth

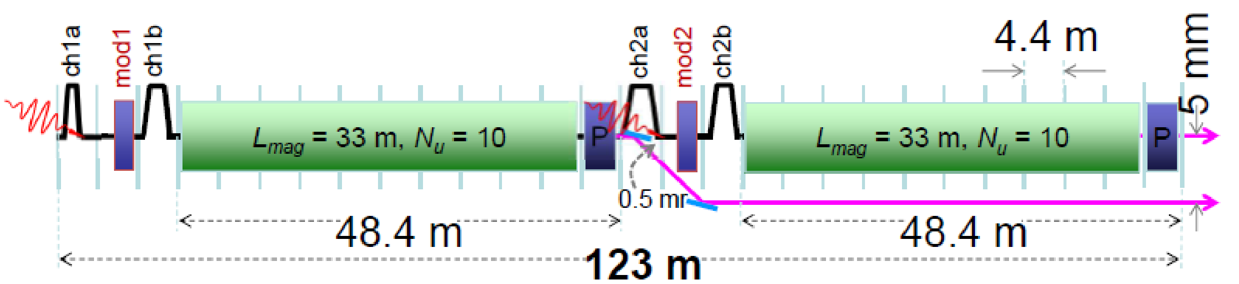


- Single-shot spectrum
  - With taper
- ~50% of shots registered a single spike



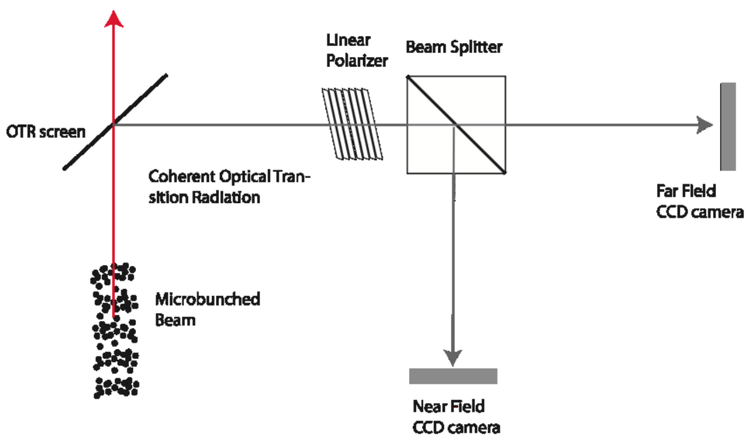
Top: experiment, Bottom: Simulation

Two colors FEL at NGLS



Coherent diffraction imaging of microbunched relativistic electron beams: imaging the microstructure of high-brightness beams

(Agostino Marinelli)



Microbunching is often described as a one-dimensional entity:

$$b(k) = \frac{1}{N}\sum e^{-ikz_n} = \frac{1}{N}\int \rho(x,y,z)e^{-ikz}dxdydz$$

By integrating over x-y we lose track of any transverse dependence of the density modulation

In many applications it is necessary to keep record of the transverse distribution:

$$b(x,y,k_z) = \frac{1}{N}\int \rho(x,y,z)e^{-ik_z z}dz$$ Microbunching in X-space

$$B(k_x,k_y,k_z) = \frac{1}{N}\int \rho(x,y,z)e^{-ik_x x-ik_y y-ik_z z}dxdydz$$ Microbunching in K-space

From a single far field measurement only the amplitude $|B^2(k_x,k_y,k)|$ can be recovered

They developed and checked experimentally an iterative algorithm (SOFIA, Spatially Oversampled Far-field Image Analysis) that reconstruct b.

The final retrieved quantity is the transverse dependence of beam microbunching:

$$b(x,y,k) = \int e^{-ik_x x-ik_y y}B(k_x,k_y,k)\frac{dk_x dk_y}{(2\pi)^2}$$