Dynamique de la propagation d'impulsions dans les Lasers à Électrons Libres VUV/X

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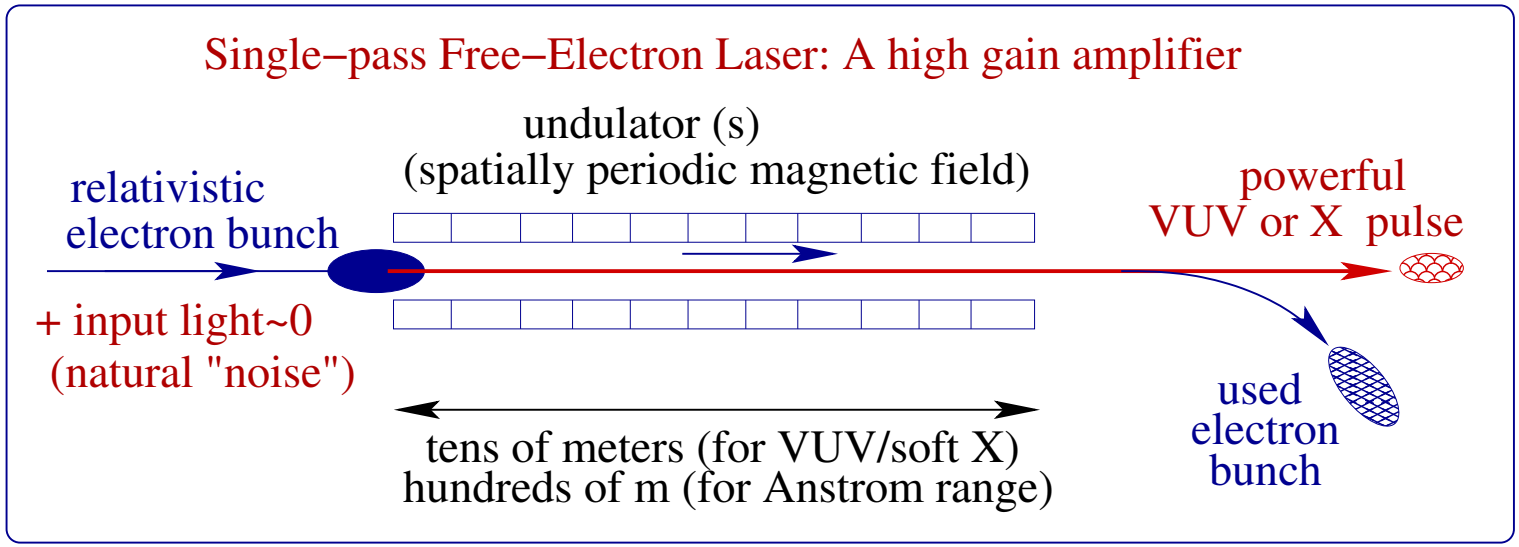
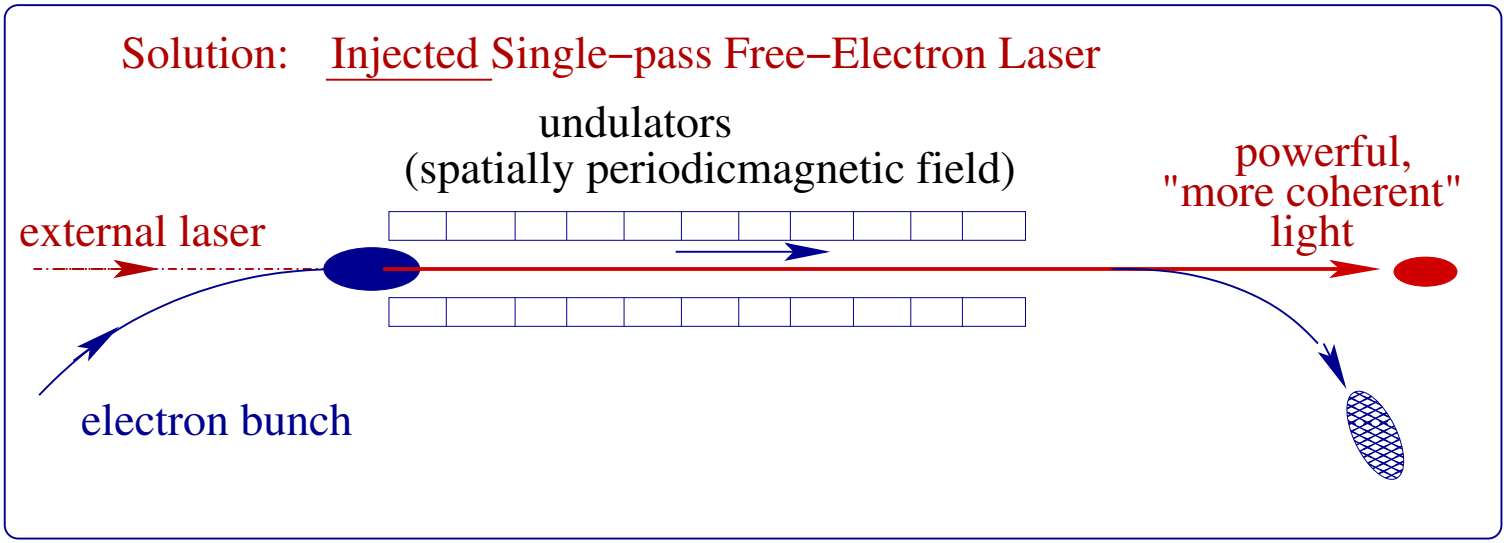
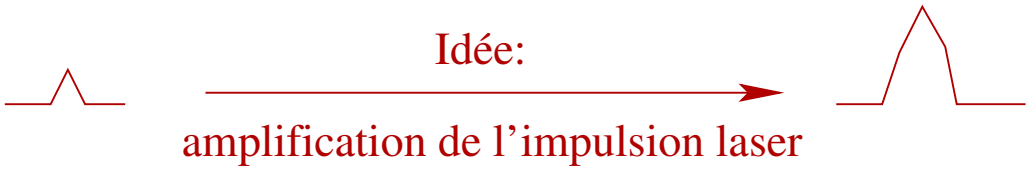


Note: 2009 "milestone" 1.5 Angstrom, ~2 mJ, <100 fs at LCLS (USA)

Startup from spontaneous emission ⟶ bad coherence properties

Solution: Injected Single–pass Free–Electron Laser





Experiments: SCSS (Japan), SPARC (Italy), FLASH (Germany).

Modeling: Vlasov equation + laser pulse progation

electrons in phase space

$$\frac{\partial \phi_j}{\partial \bar{z}} = p_j,$$

$$\frac{\partial p_j}{\partial \bar{z}} = -[A(\bar{z}, \tau)e^{i\phi j} + \text{c.c.}],$$

$$\left(\frac{\partial}{\partial \bar{z}} + \frac{\partial}{\partial \tau}\right) A(\bar{z}, \tau) = \chi(\tau) b(\bar{z}, \tau).$$

Laser propagation

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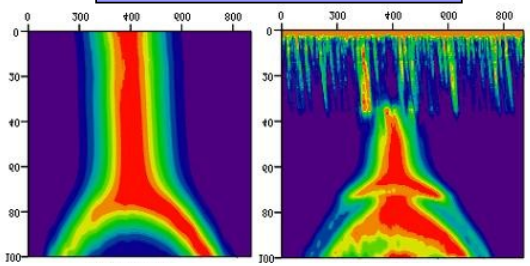
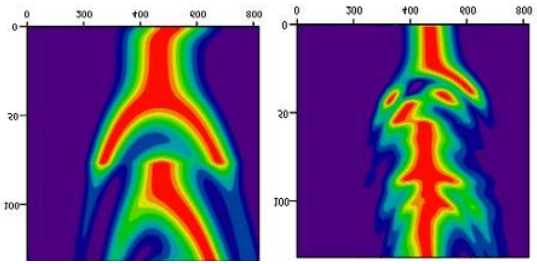
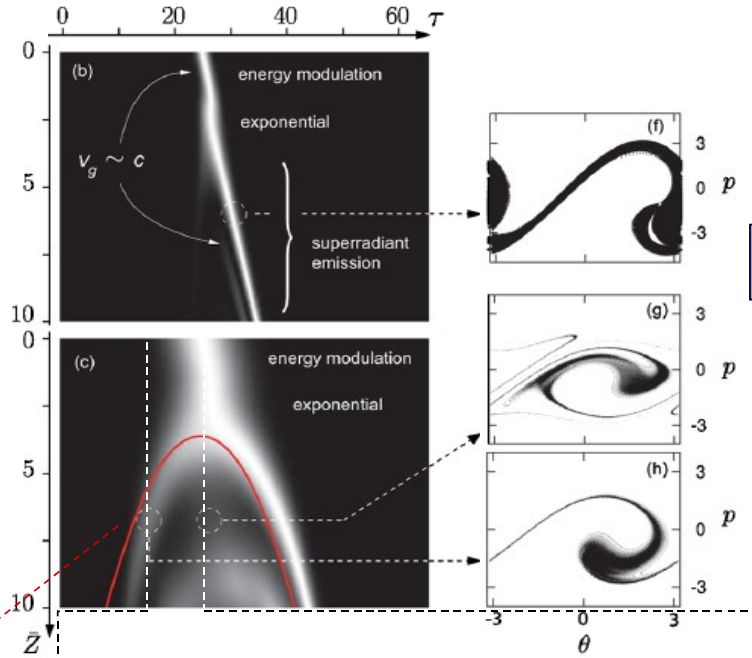
Expériences à SPARC (Italie) ?



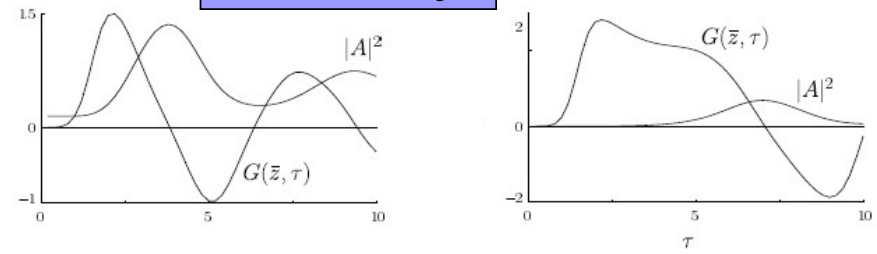
Expériences à FERMI (Italie) ?





Dynamique des particules Dans l'espace des phases

Saturation locale du gain



Equation de saturation

$$z_{sat}(t) = \frac{1}{\sqrt{3}} ln[\frac{9\times1.4}{|A|^2(z=0,t)}]$$