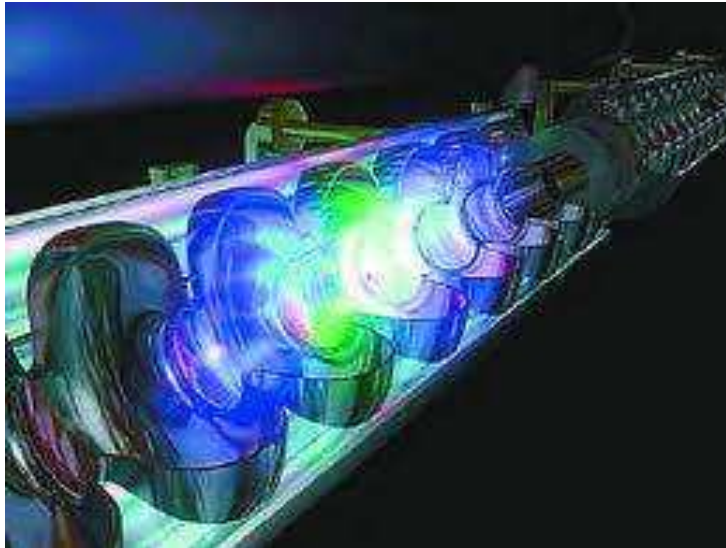


# FEL Simulations of Energy-Chirped Bunches

## Some Numerical Tests



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S2E Meeting

DESY

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# Motivation

$$\lambda_r = \frac{\lambda_u}{2\gamma_r^2} \left( 1 + \frac{K^2}{2} \right)$$

□ transverse field (***slowly-varying envelope approximation***)

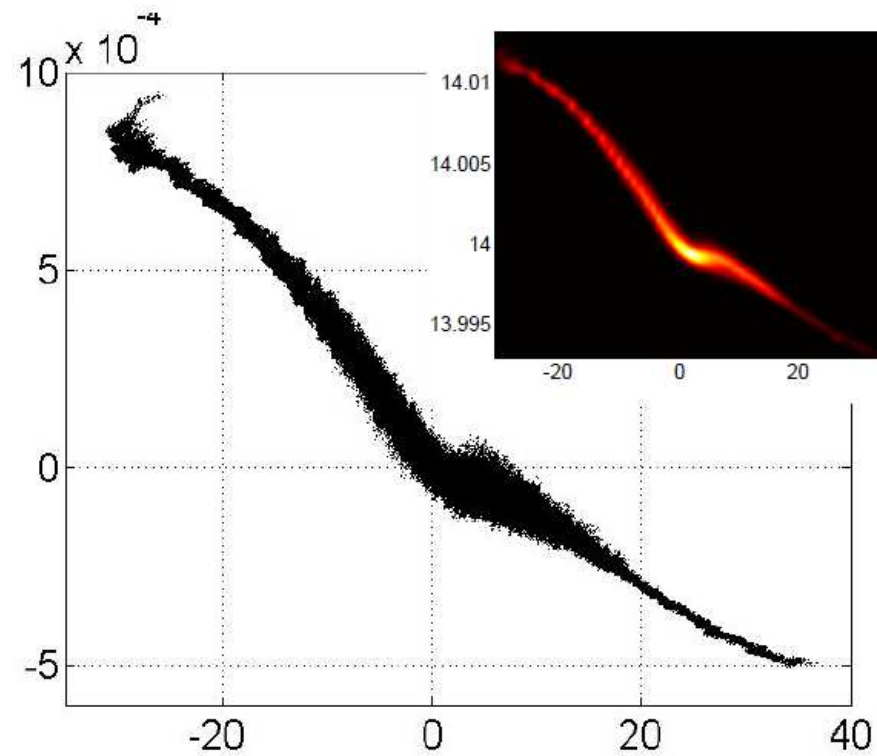
$$E(\vec{r}, t) = \tilde{E}(\vec{r}, t) \exp(ik_0(z - ct)) + c.c. \quad E = E_x + iE_y$$

$$\left[ \nabla_{\perp}^2 + 2ik_0 \left( \frac{\partial}{\partial z} + \frac{1}{c} \frac{\partial}{\partial t} \right) \right] \tilde{E} = ik_0 \mu_0 c \frac{K}{\gamma} \tilde{j}_1$$



# Motivation

$\delta_E$  Phase space  $Q=500$  pC

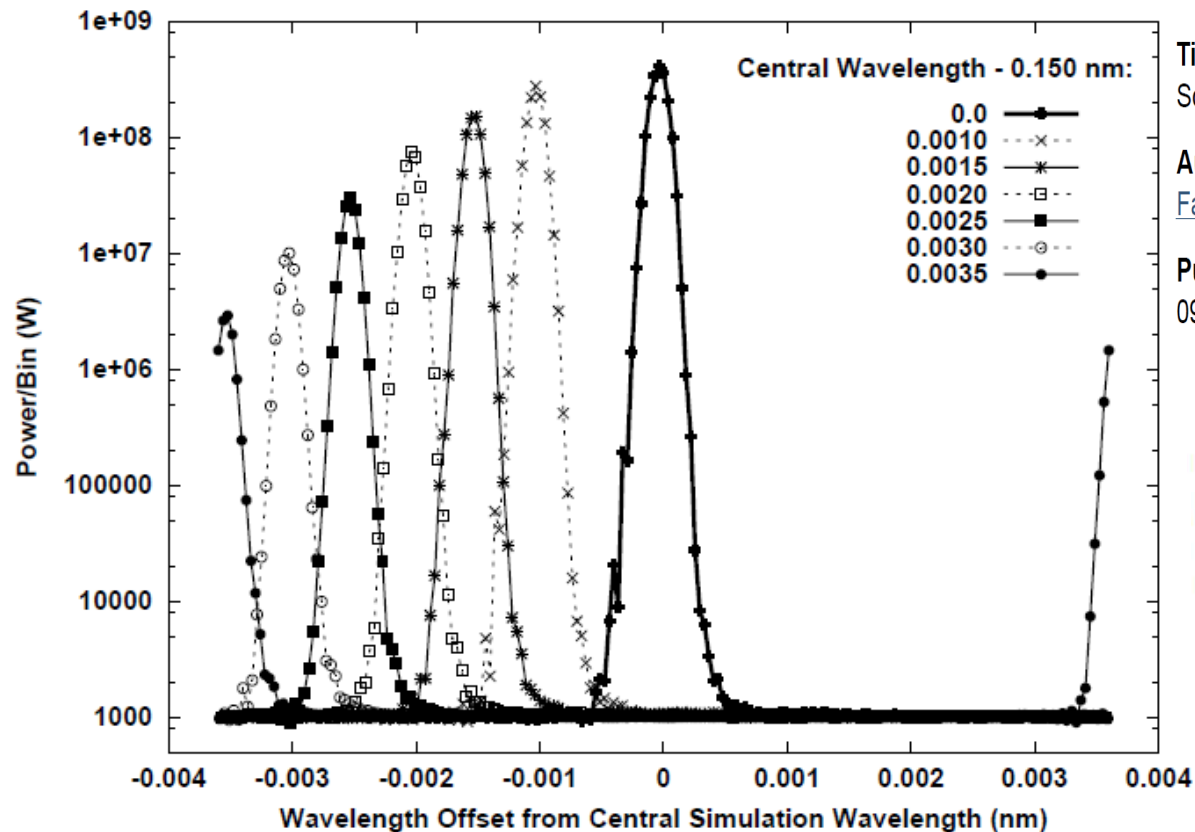


$$\gamma_r = \langle \gamma \rangle ?$$

$$\lambda_0 = \lambda_r ?$$



# Motivation



Title:

Some issues and subtleties in numerical simulation of X-ray FEL's

Author:

[Fawley, William M.](#)

Publication Date:

09-30-2002

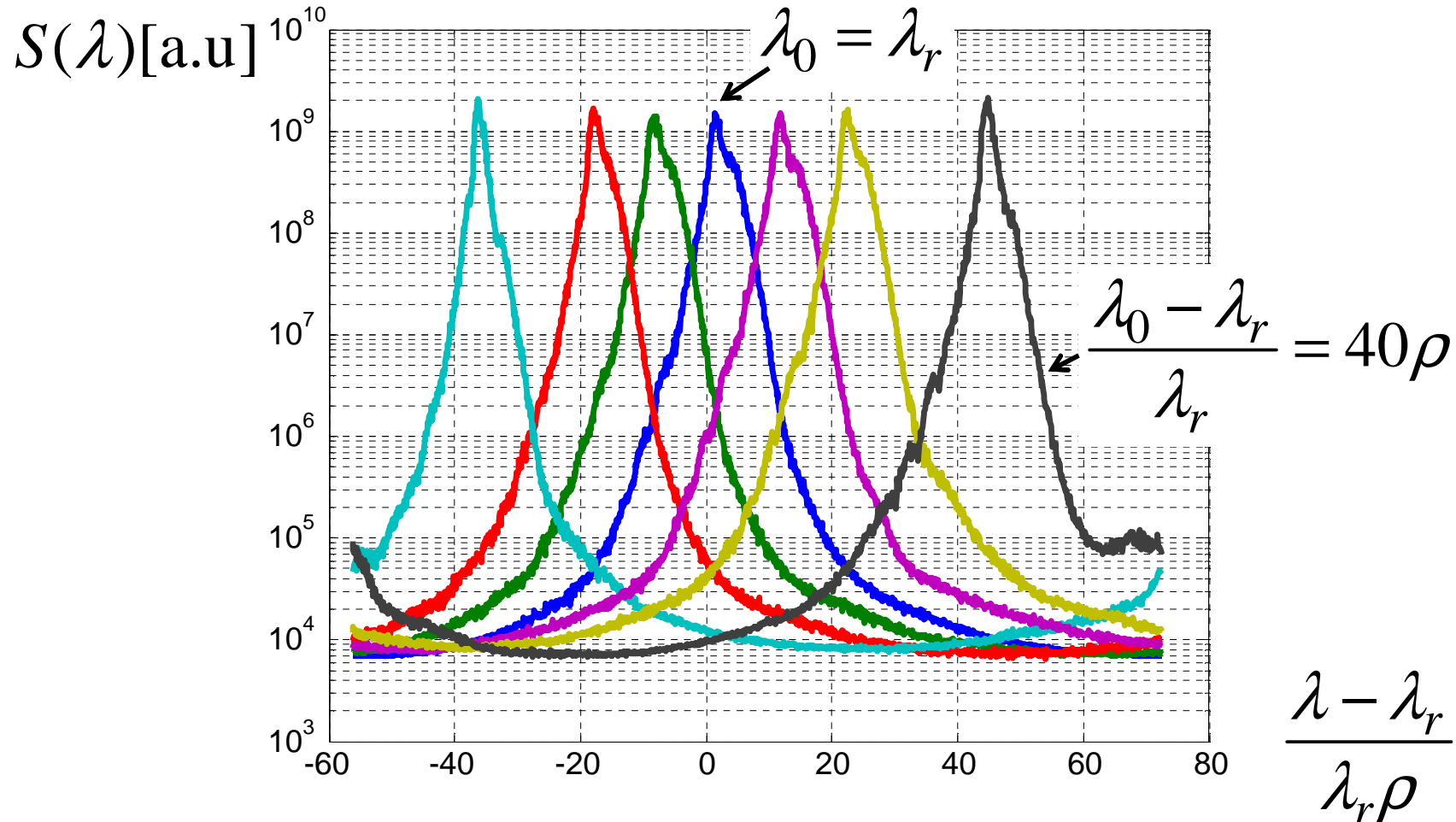
These results indicate that one must be extremely careful when simulating FEL's with energy-chirped beams, such as may well be true for the LCLS and Tesla X-ray FEL either intentionally or due to time-dependent wakefield losses.

Figure 1. Spectral power versus  $\lambda - \lambda_0$  for a series of LCLS-like GINGER simulations for different shifts of  $\lambda_0$  from the wavelength  $\lambda_r$  corresponding to FEL resonance (0.15000 nm for these runs).

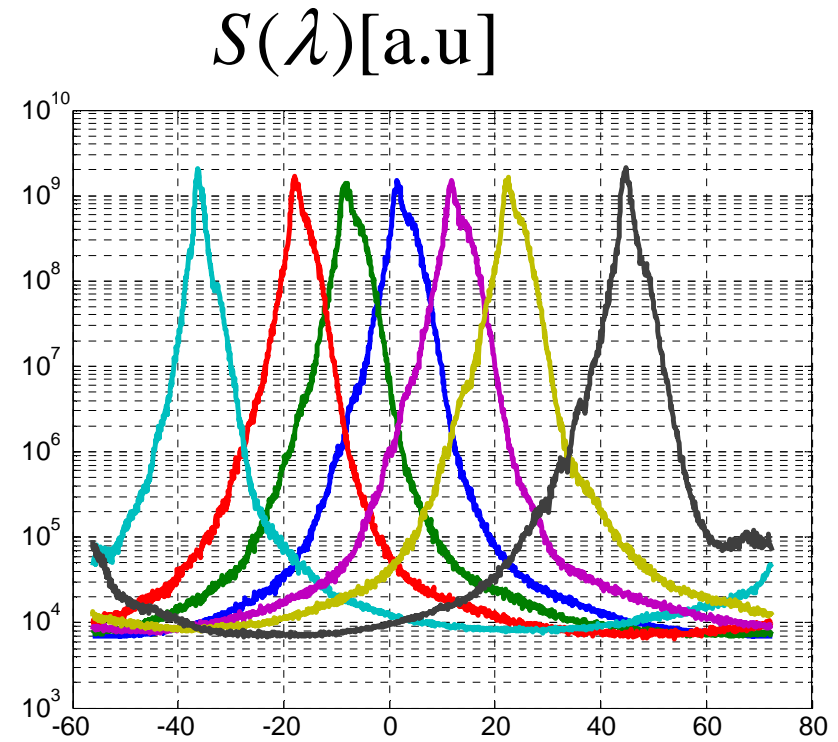
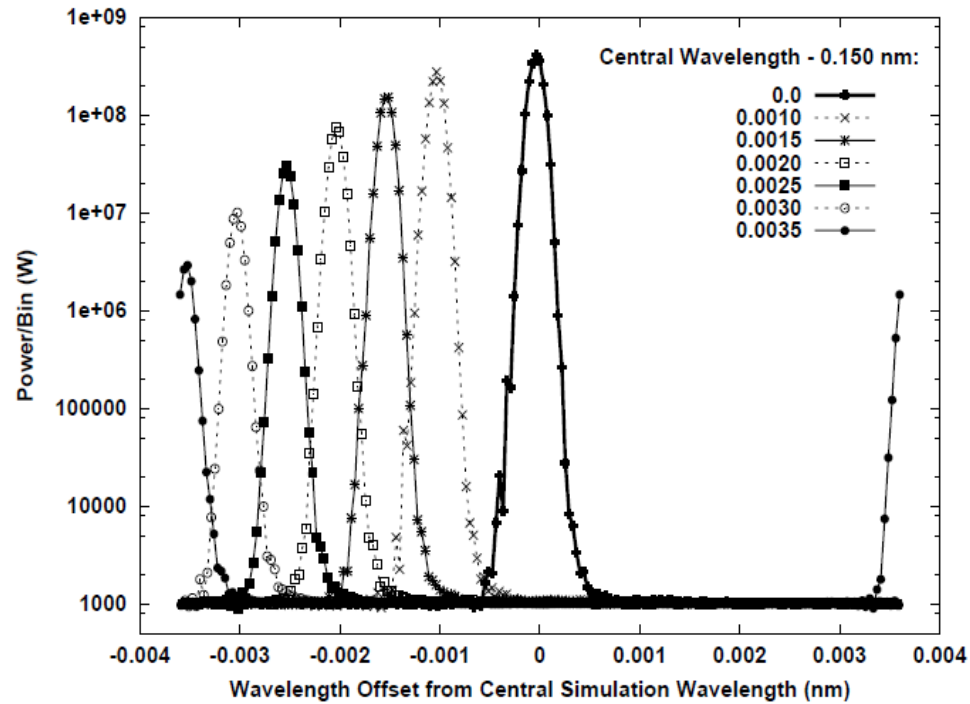


# SASE Simulations (FLASH1 Parameters)

**Spectrum (averaged over 100 shots)**



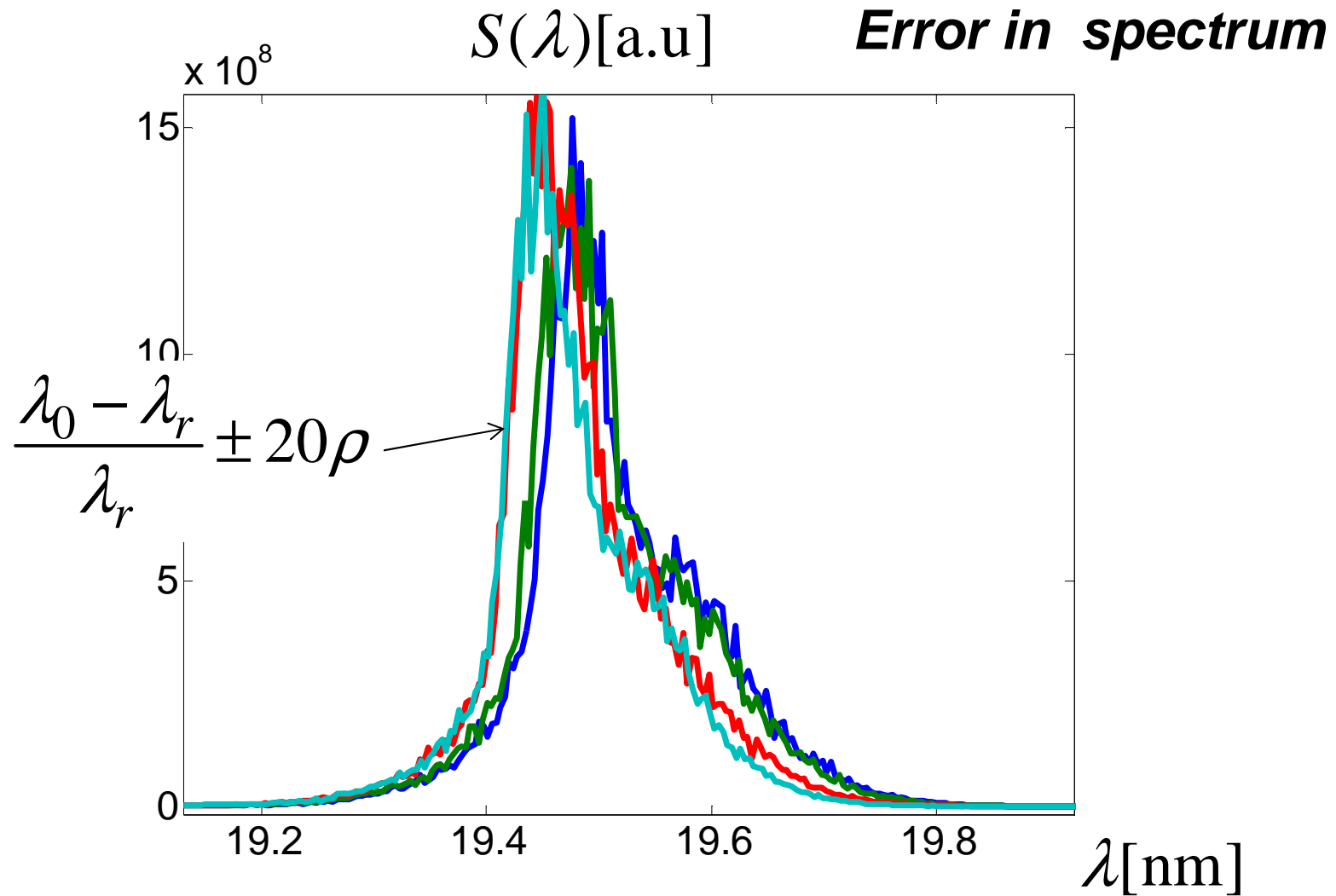
# SASE Simulations



$$\frac{\lambda_r - \lambda}{\lambda_r \rho}$$



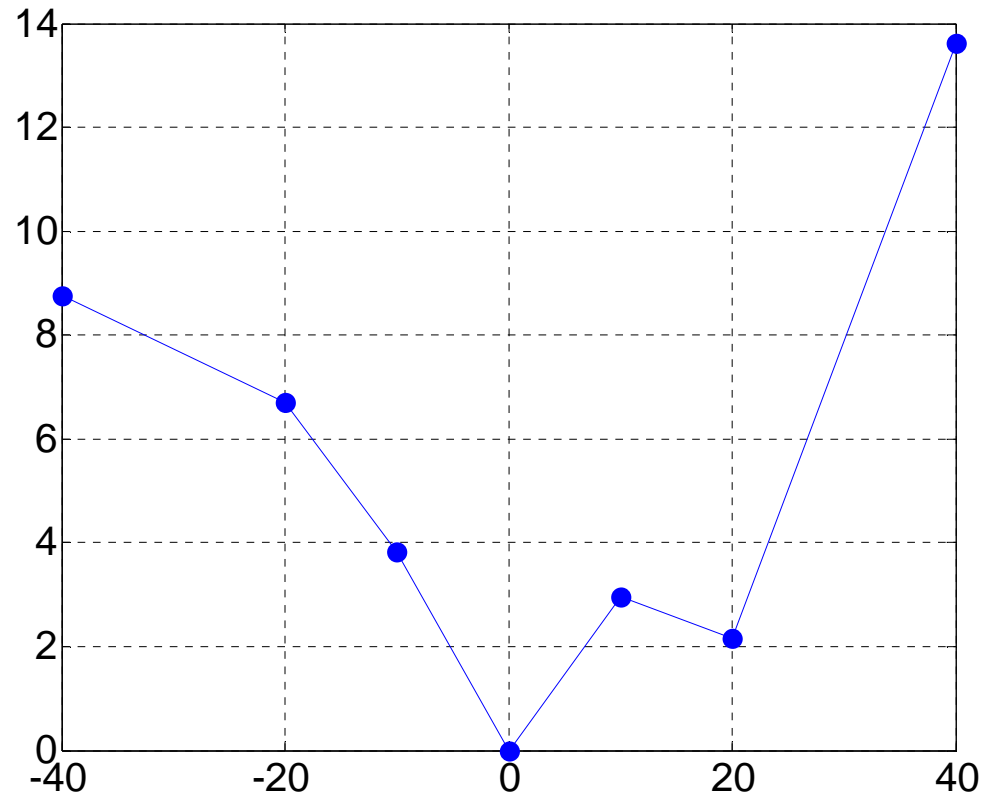
# SASE Simulations



# SASE Simulations

## Error in energy

$$\frac{|W - W_0|}{W_0} [\%]$$



$$\frac{\lambda_r - \lambda_0}{\lambda_r \rho}$$

