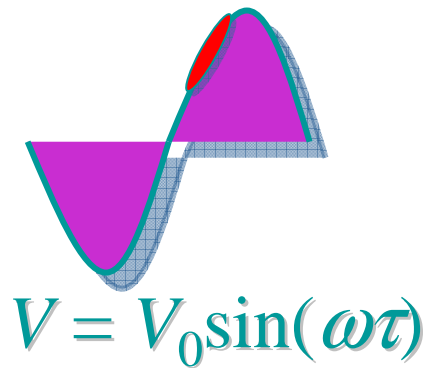
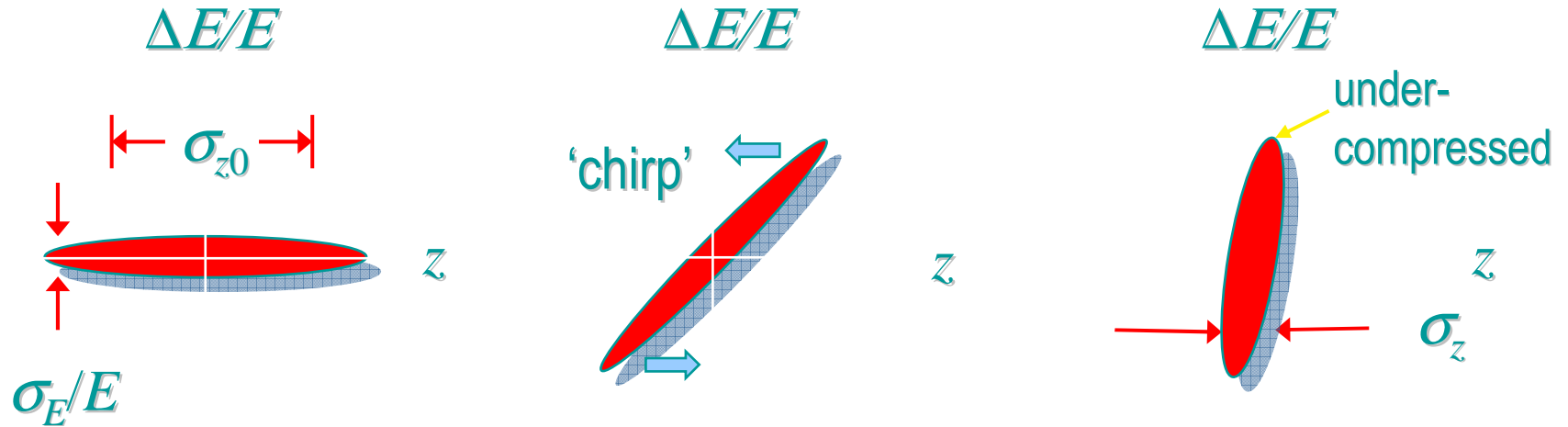




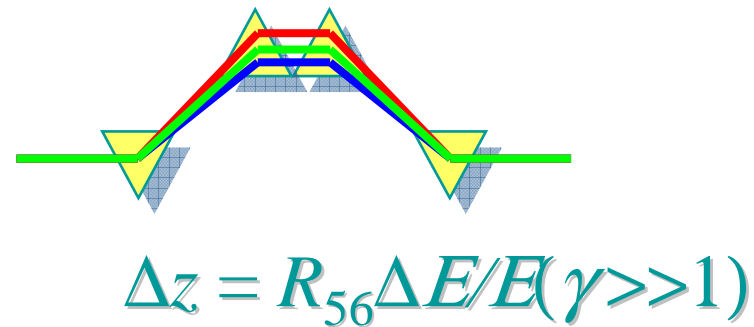
Bunch Compression



CHESS & LEPP



RF Accelerating Voltage



Path Length-Energy Dependent Beamline

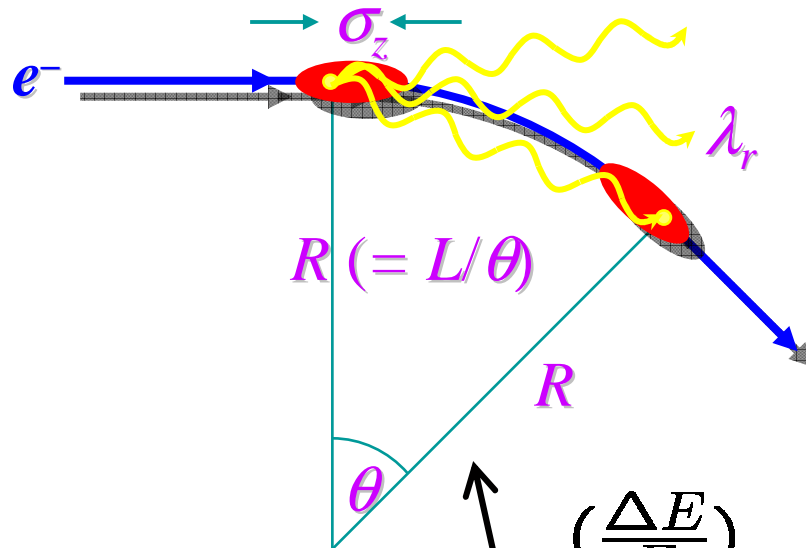
courtesy Paul Emma



CSR in Bunch Compression

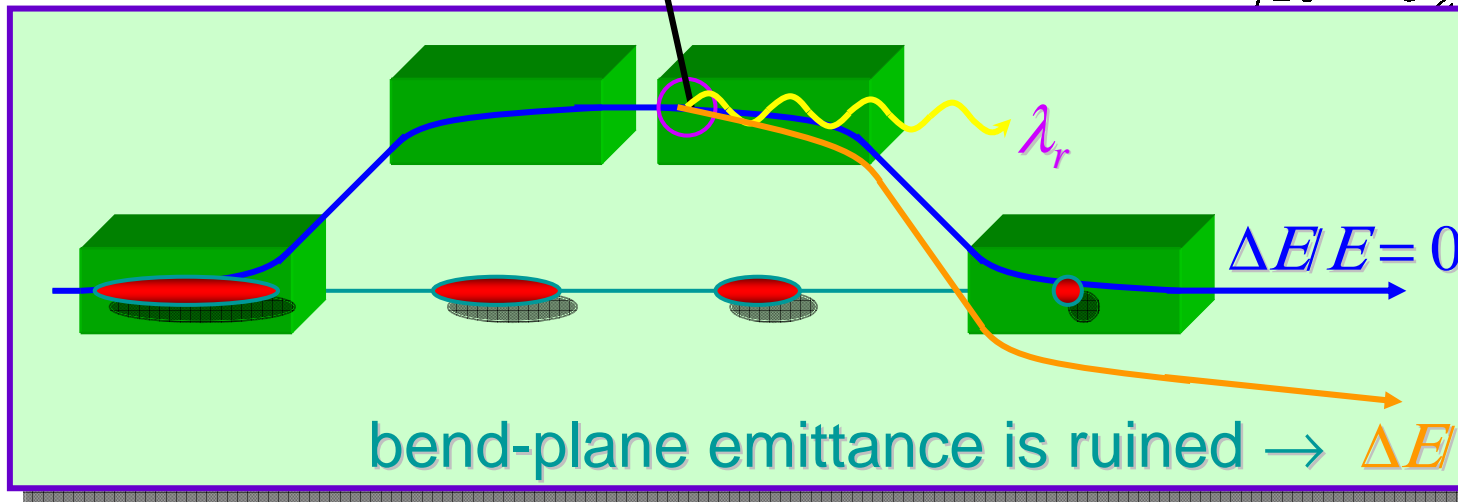


CHESS & LEPP



Coherent radiation for $\lambda_r > \sigma_z$

$$\left(\frac{\Delta E}{E}\right)_{rms} \approx 0.22 \frac{r_e N L}{\gamma R^{2/3} \sigma_z^{4/3}}$$



bend-plane emittance is ruined $\rightarrow \Delta E/E < 0$

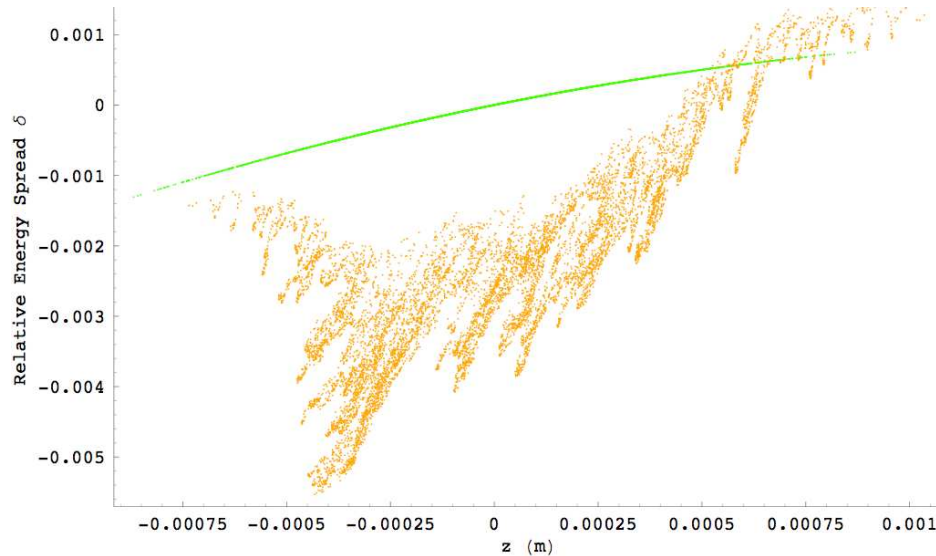
courtesy Paul Emma



Coherent Synchrotron Radiation



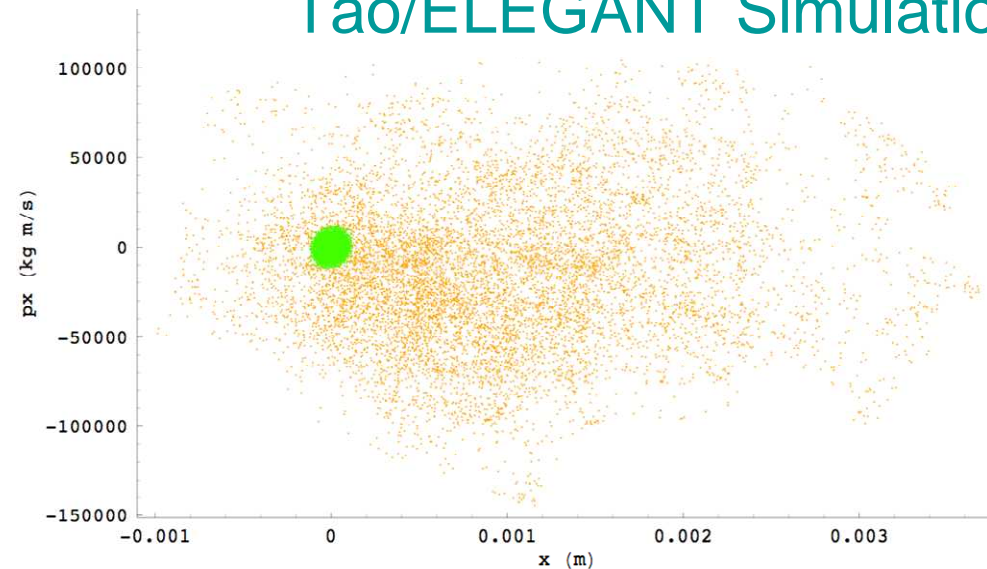
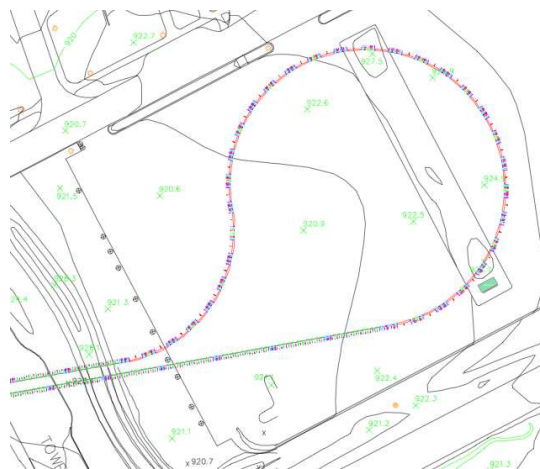
CHESS & LEPP



ERL Turnaround

- 1ps long bunch
- 1nC charge
- 0.3 mm-mrad normalized emittance

Tao/ELEGANT Simulation



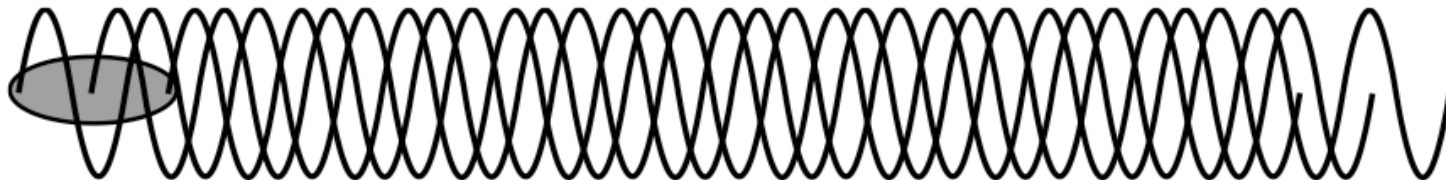
courtesy Chris Mayes



Coherent Synchrotron Radiation



CHESS & LEPP



Addition of fields N stochastically distributed particles: $\vec{E} \propto \sqrt{N} \Rightarrow P \propto N$



In phase addition of fields: $E \propto N \Rightarrow P \propto N^2$

$$\frac{dP^{(N)}}{d\omega} = \left| \sum_{j=1}^N e^{i\varphi_j} \right|^2 \frac{dP^{(1)}}{d\omega} = \left[N + \sum_{j=1}^N \sum_{\substack{k=1 \\ k \neq j}}^N e^{i(\varphi_j - \varphi_k)} \right] \frac{dP^{(1)}}{d\omega}$$

$$\approx \left[N + \int_{-\infty}^{\infty} N \lambda(t_1) \int_{-\infty}^{\infty} (N-1) \lambda(t_2) e^{i\omega(t_1 - t_2)} dt_1 dt_2 \right] \frac{dP^{(1)}}{d\omega}$$

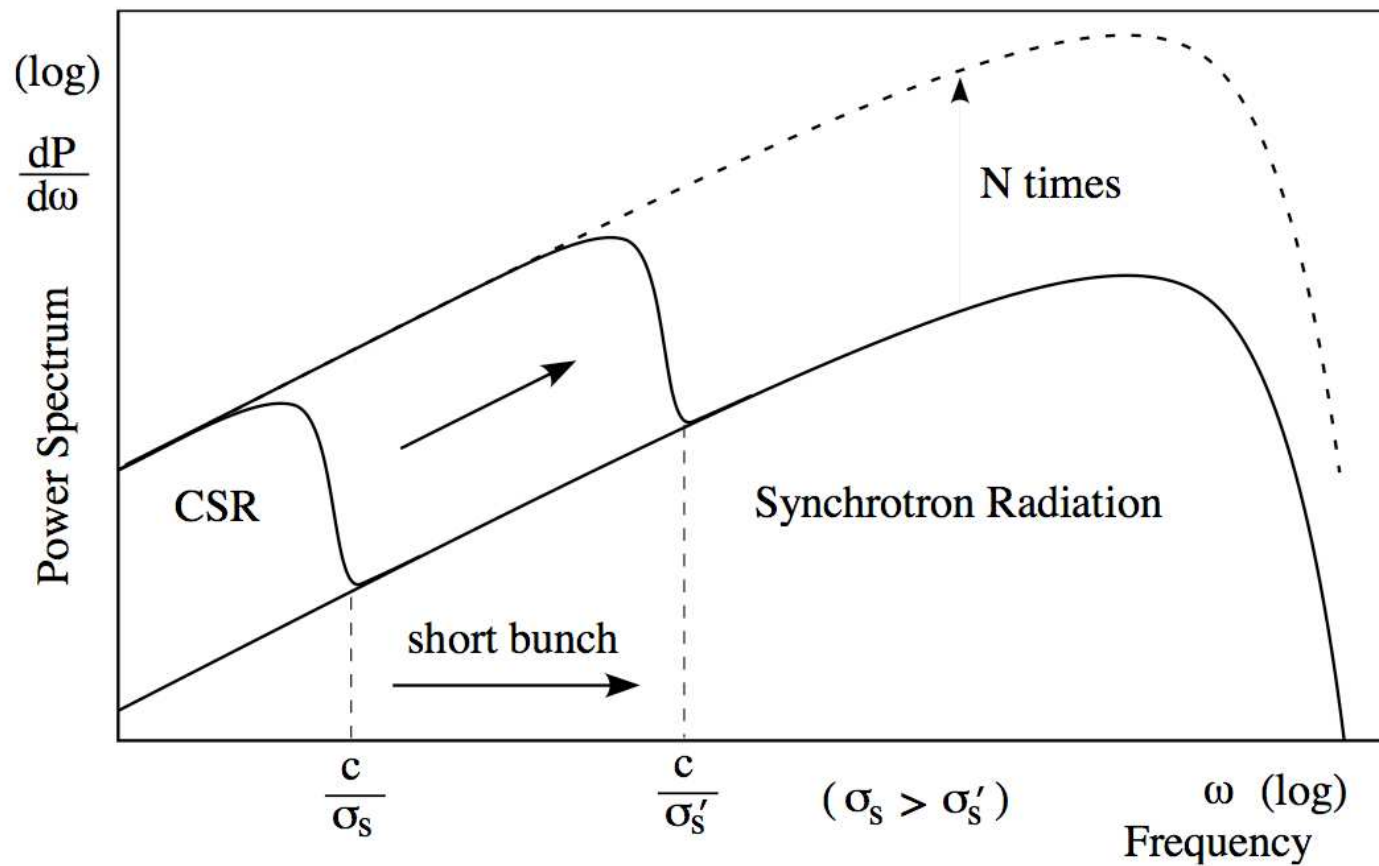
$$\approx N \left[1 + (N-1) \left| \int_{-\infty}^{\infty} \lambda(t) e^{i\omega t} dt \right|^2 \right] \frac{dP^{(1)}}{d\omega}$$



Power Spectrum per Particle



CHESS & LEPP



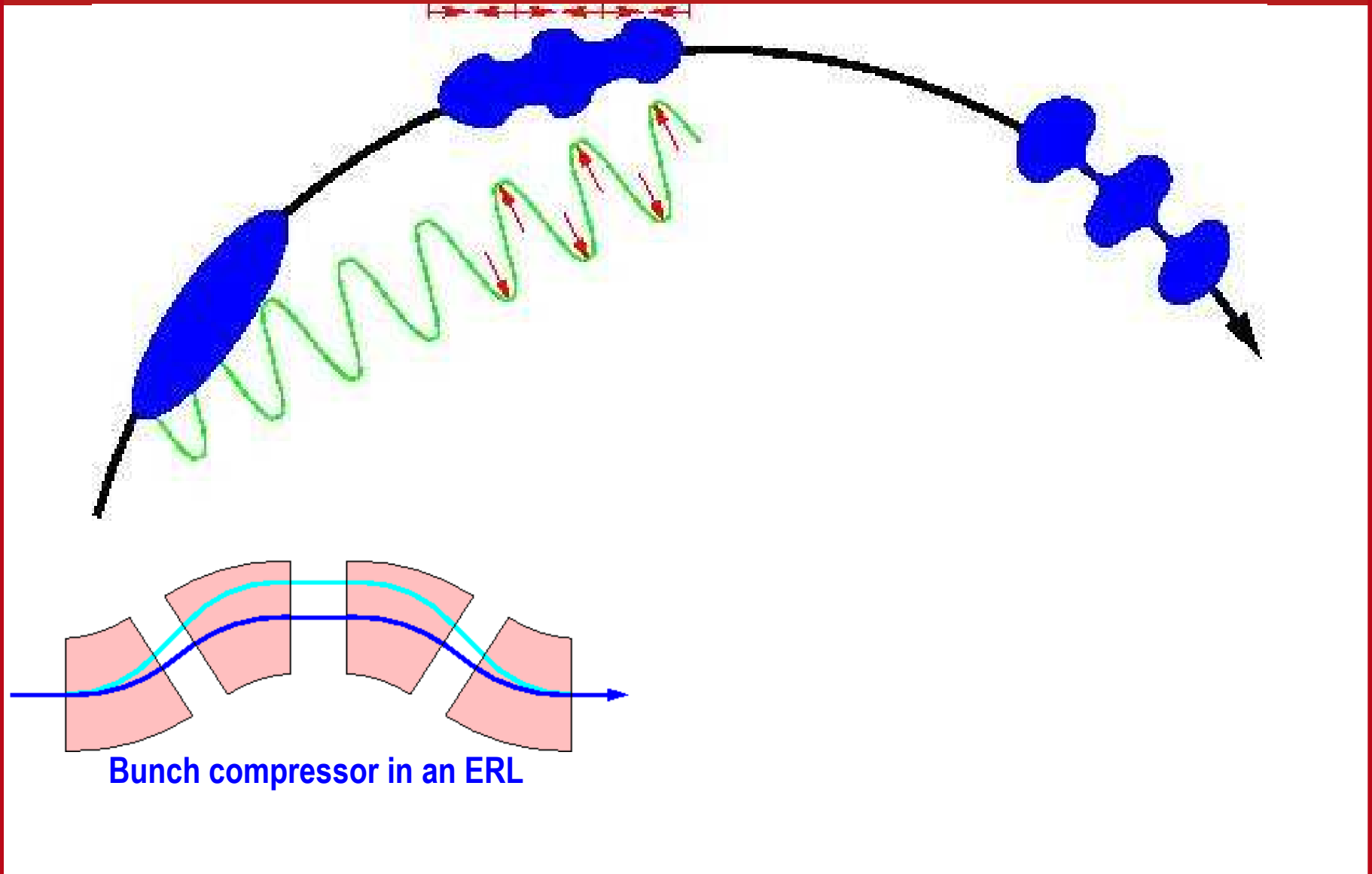
courtesy Chirs Mayes



CSR Micro-Bunching



CHESS & LEPP

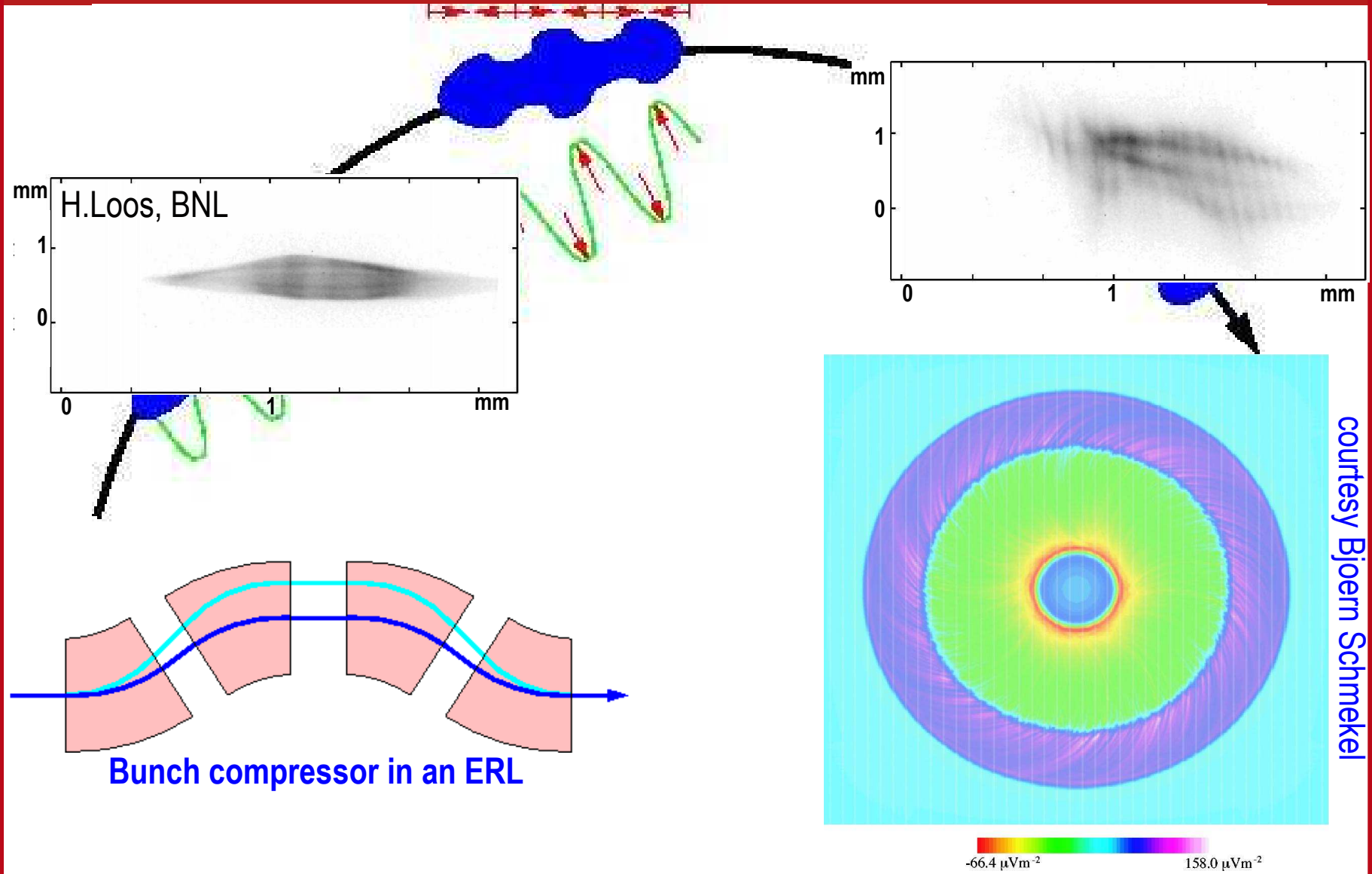




CSR Micro-Bunching Measurements



CHES & LEPP



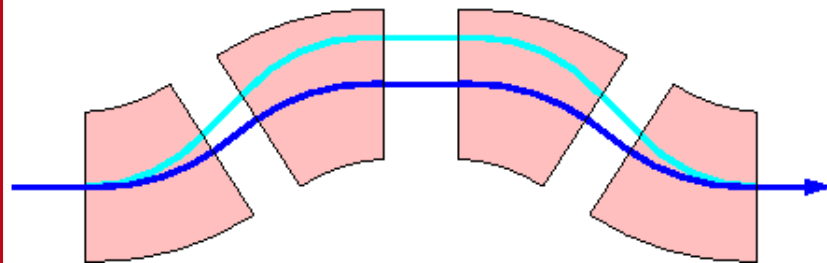
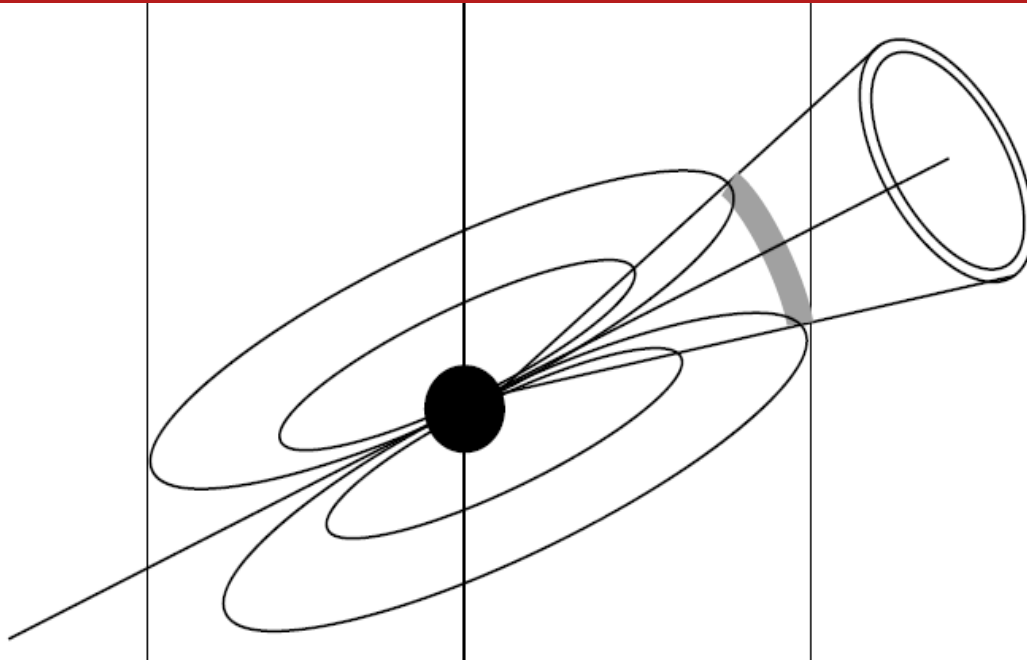
courtesy Bjoern Schmekel



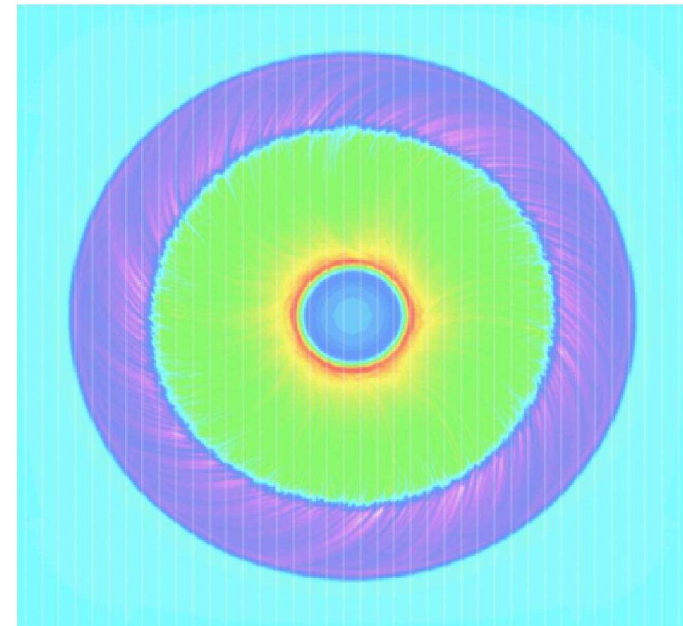
CSR Micro-Bunching in Pulsars



CHES & LEPP



Bunch compressor in an ERL



courtesy Bjorn Schmekel

-66.4 μVm^{-2} 158.0 μVm^{-2}

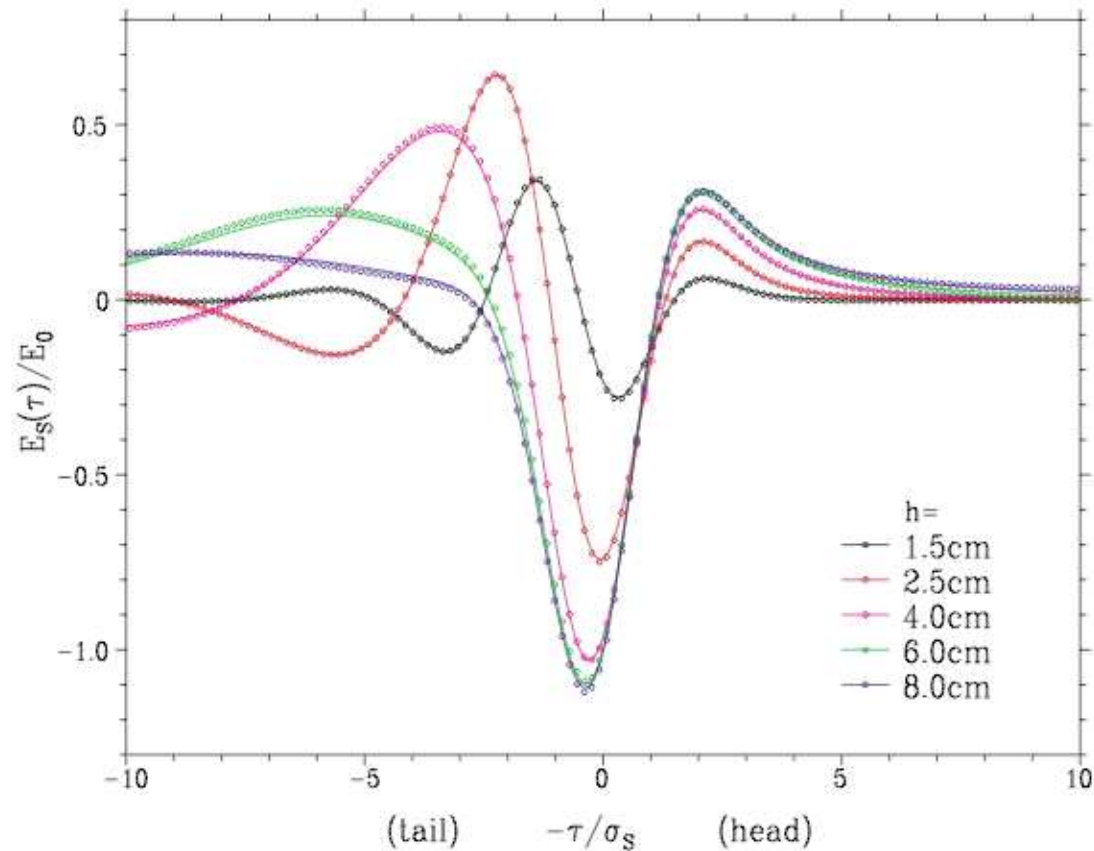


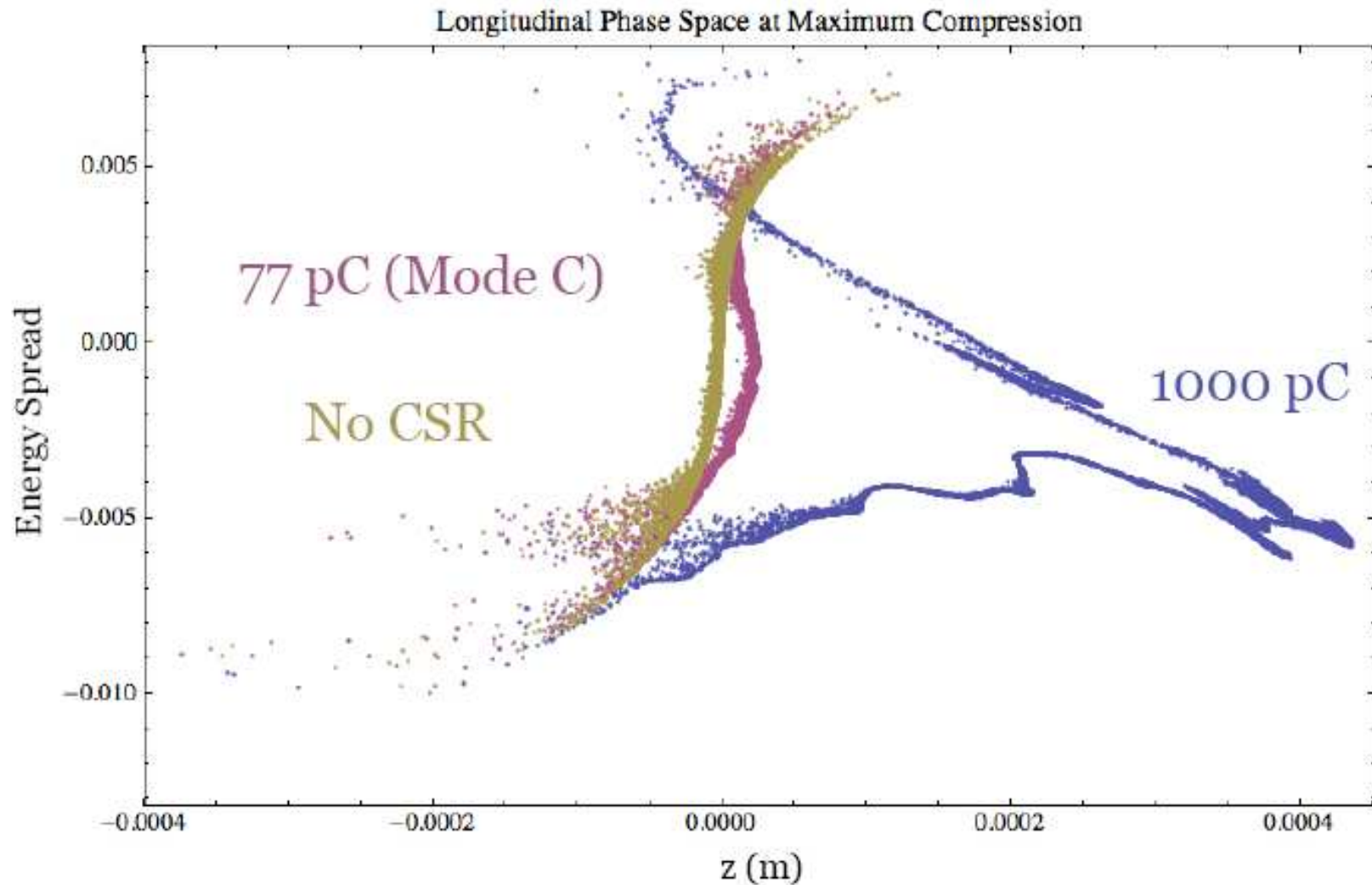
FIG. 2. (Color) The longitudinal electric field E_s in steady state at $x = y = 0$ between infinite parallel plates. Warnock's formula is plotted with solid lines. The dots are the simulation results. The different colors show the gap between the two horizontal parallel plates, $h = 1.5$ cm (black), 2.5 cm (red), 4 cm (magenta), 6 cm (green), and 8 cm (blue), respectively. The width of the chamber is $w = 50$ cm and the length of the magnet is 3 m.



Coherent Synchrotron Radiation



CHESS & LEPP



courtesy Chris Mayes

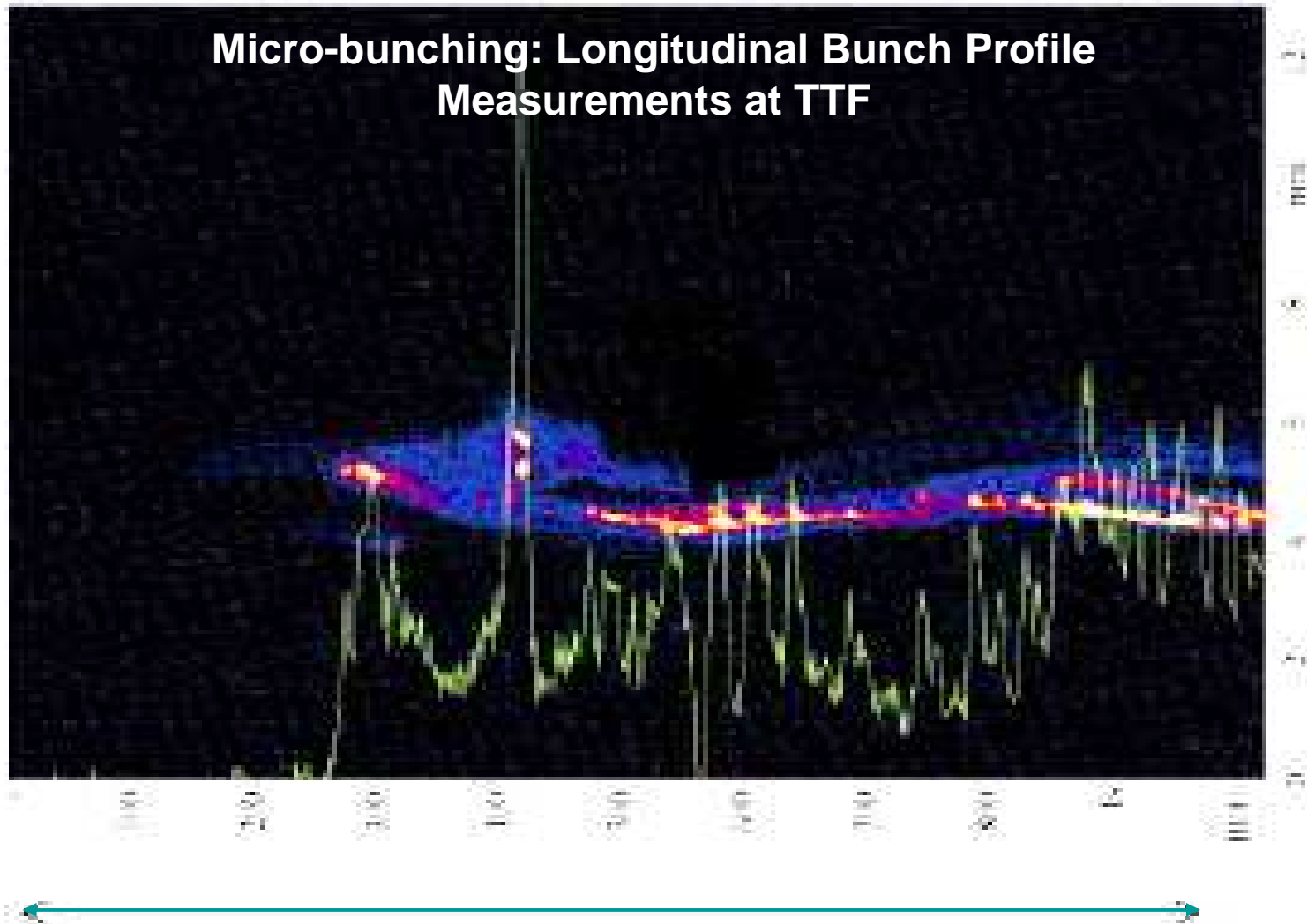


CSR Micro-Bunching Measurements



CHES & LEPP

Micro-bunching: Longitudinal Bunch Profile Measurements at TTF



1 picosecond