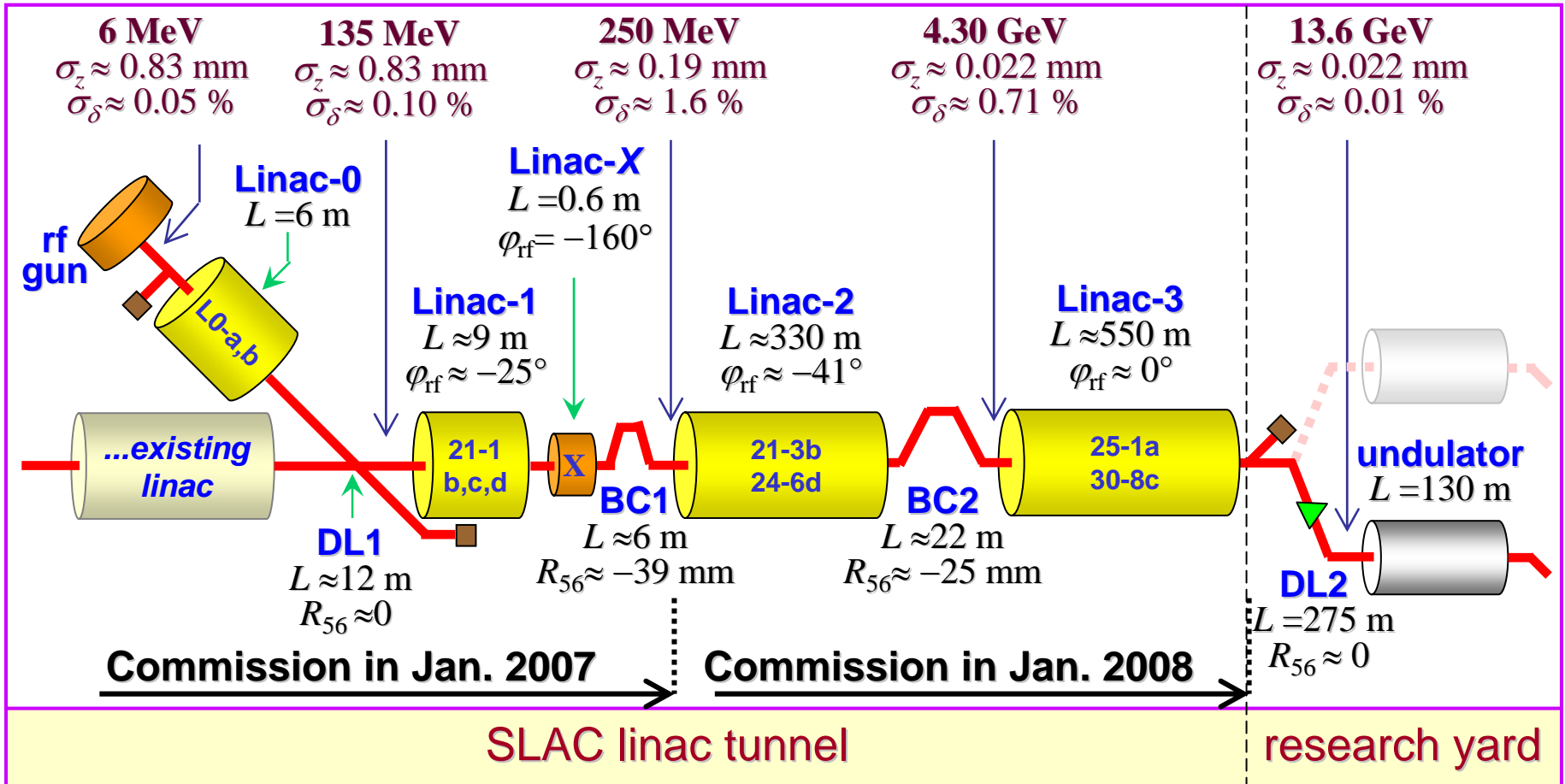
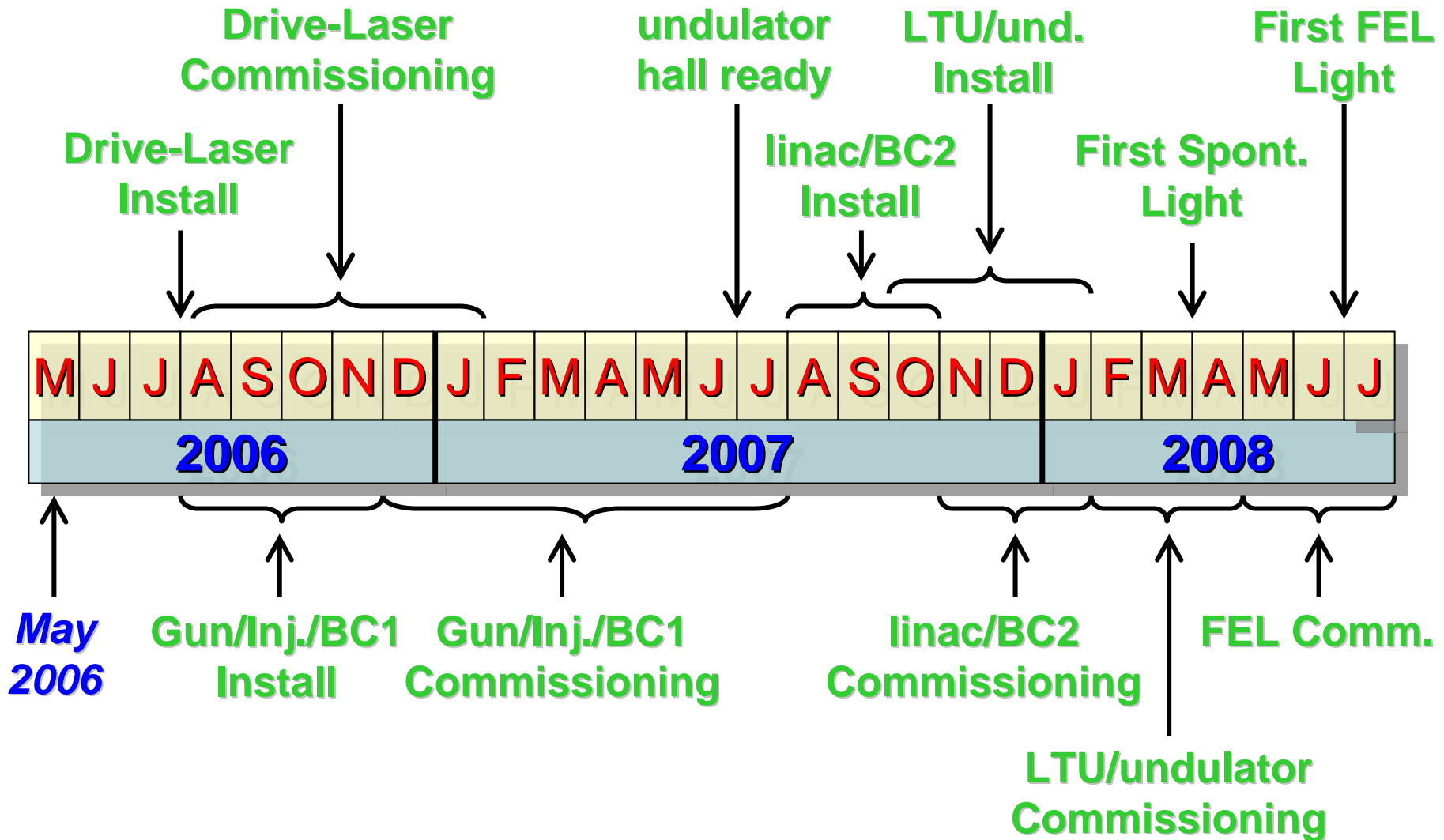


# LCLS Accelerator

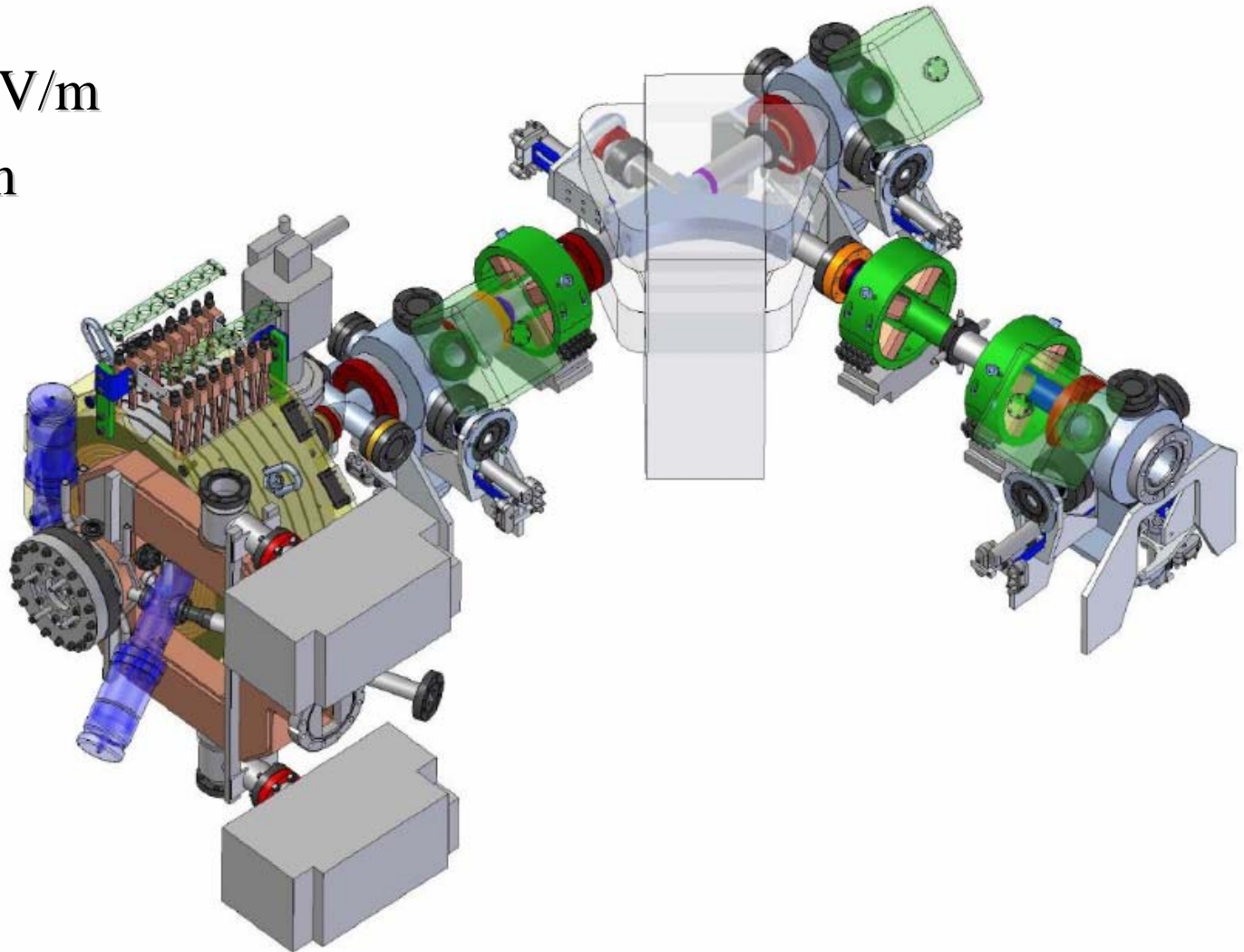


# LCLS Installation and Commissioning Time-Line

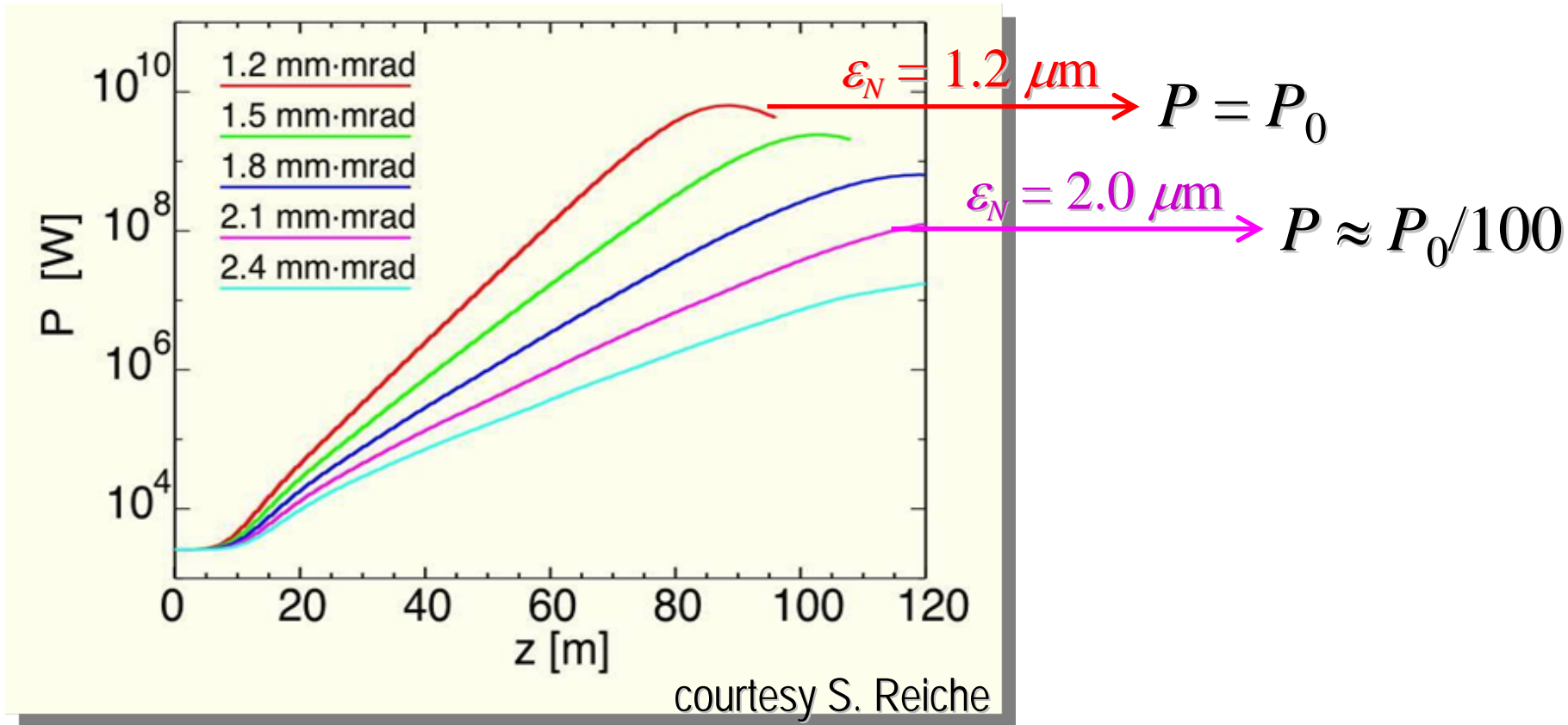


# RF Photo-Cathode Gun

- $Q = 1 \text{ nC}$
- $f = 120 \text{ Hz}$
- $G = 120 \text{ MV/m}$
- $\gamma\epsilon_{x,y} = 1 \text{ }\mu\text{m}$
- $\Delta t = 10 \text{ ps}$
- $I = 100 \text{ A}$

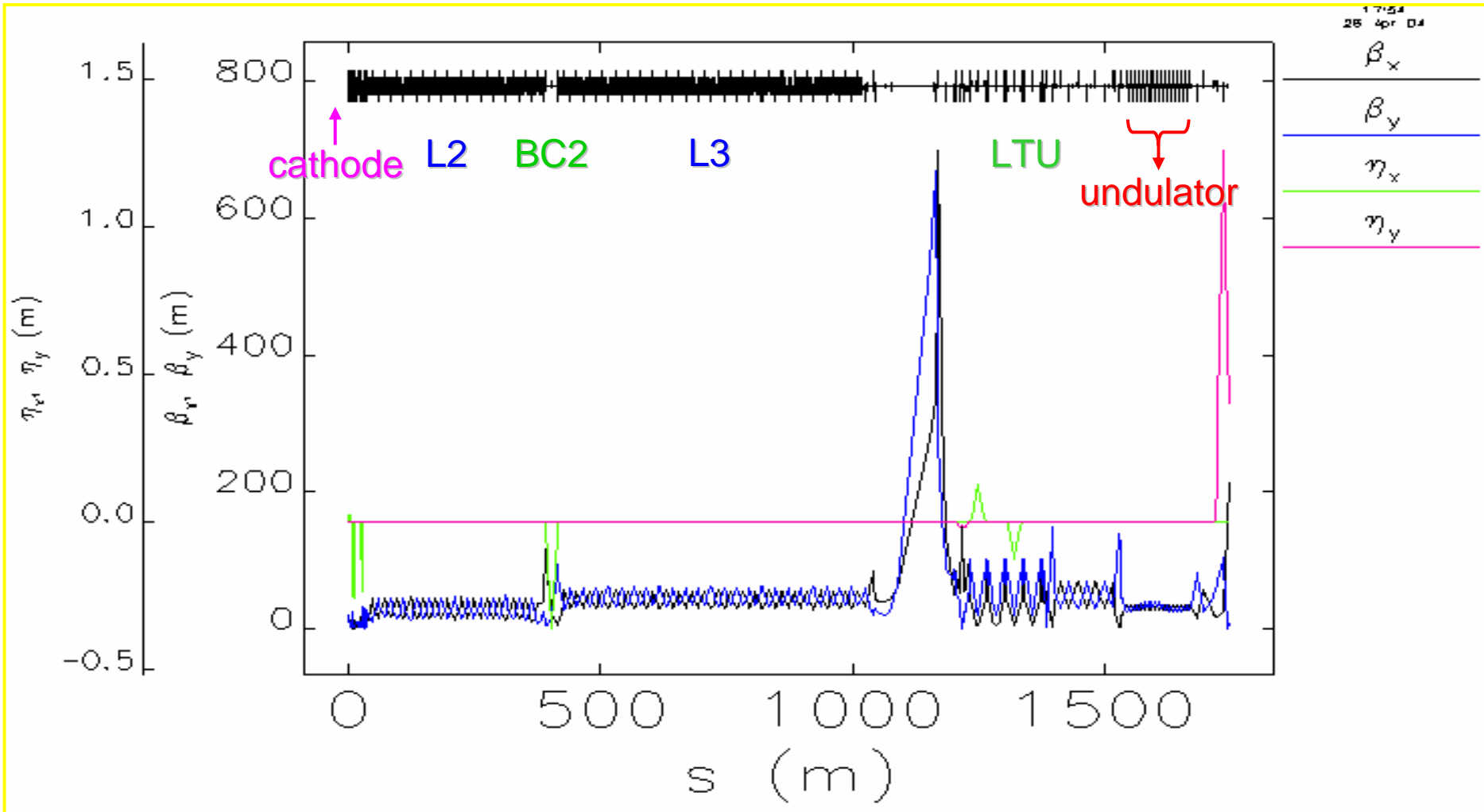


Slice emittance  $> 1.8 \mu\text{m}$  will not saturate



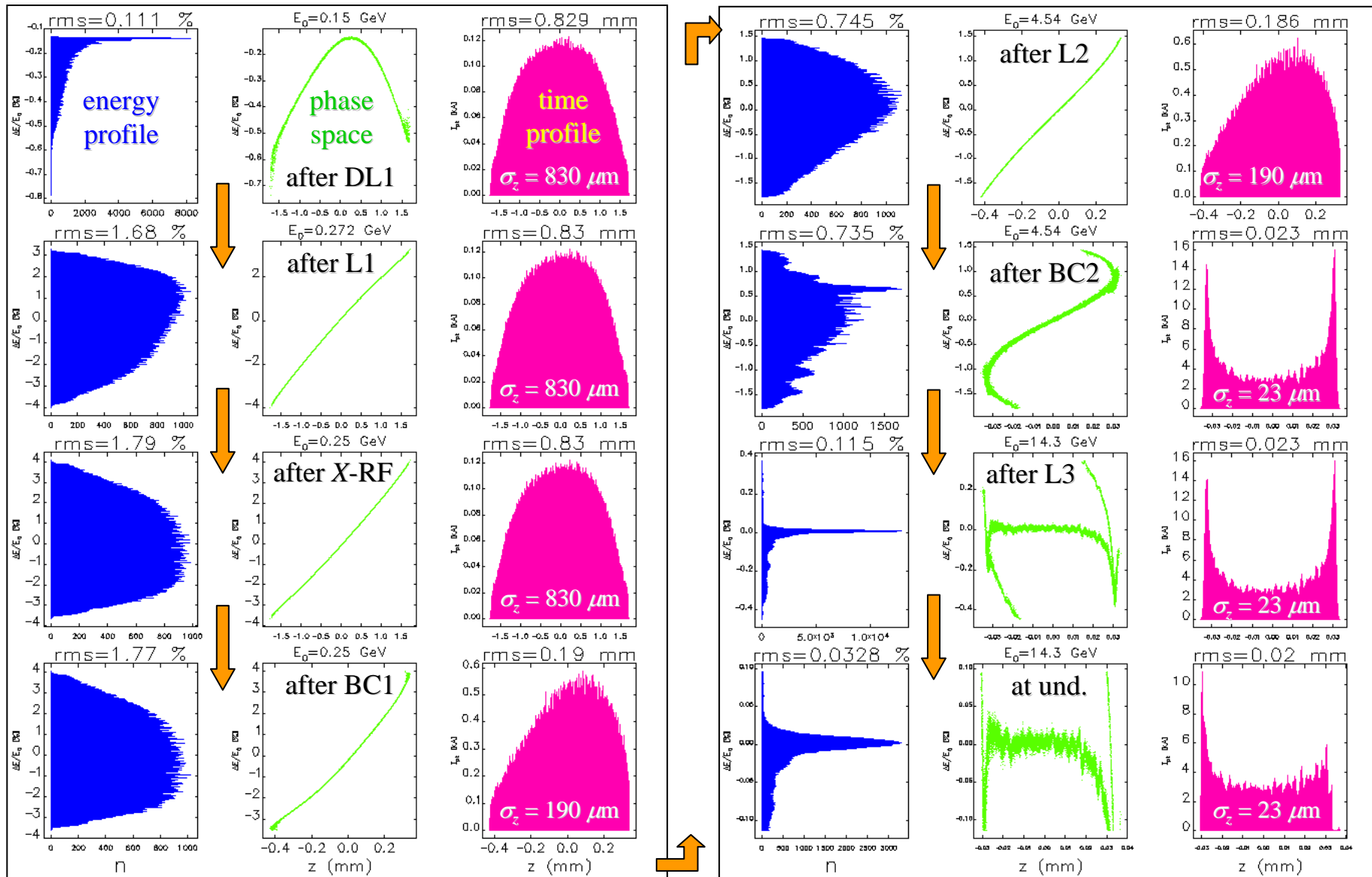
electron beam must meet brightness requirements

# Complete & Detailed Design (cathode to dump)



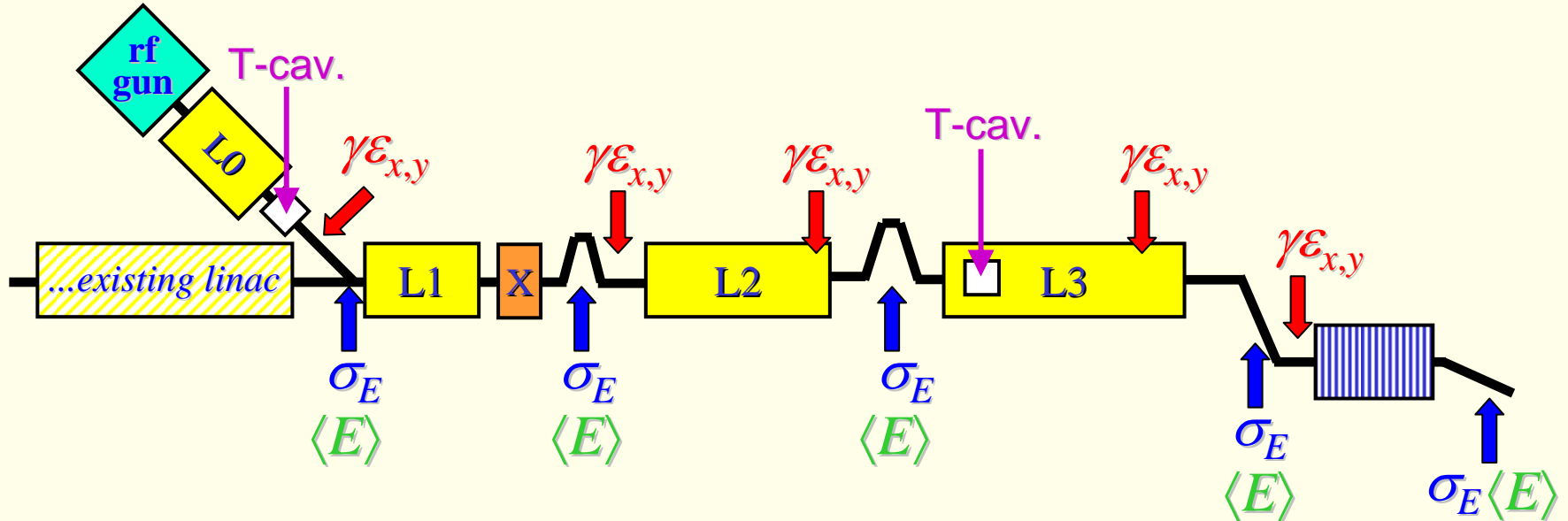
Full MAD deck at: <http://www-ssrl.slac.stanford.edu/lcls/linac/optics/lcls.txt>

# Bunch Compression Progression



# Location of Main Linac Diagnostics

- 5+ energy spread meas. stations (optimized with small  $\beta$ )
- 5+ emittance meas. stations designed into optics ( $\Delta\psi_{x,y}$ )
- BPMs at or near most quadrupoles and in each bend system.
- RF deflectors for slice  $\varepsilon$  and  $\sigma_E$  measurements (L0 & L3)



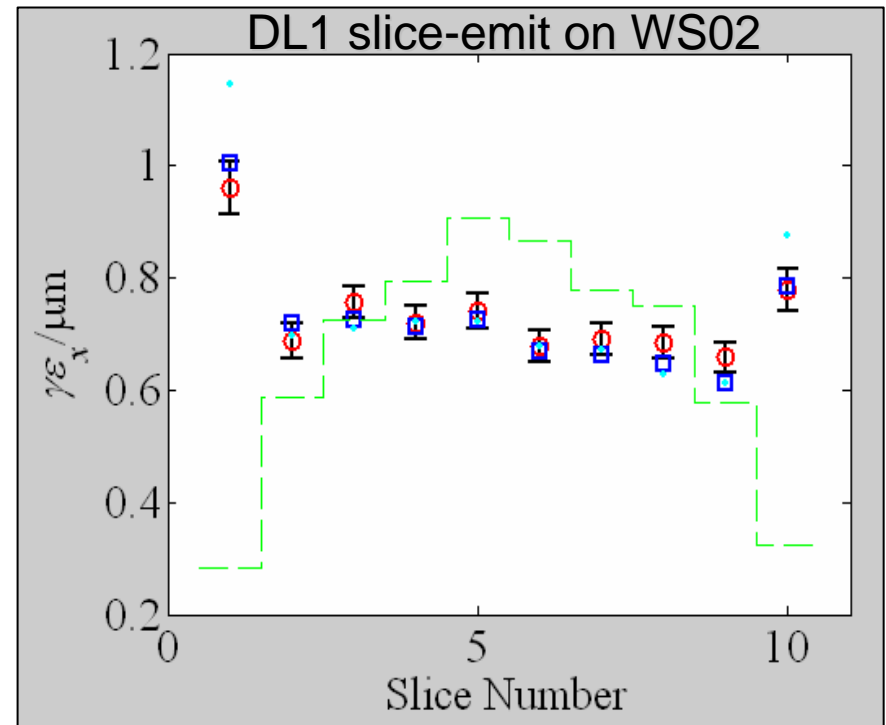
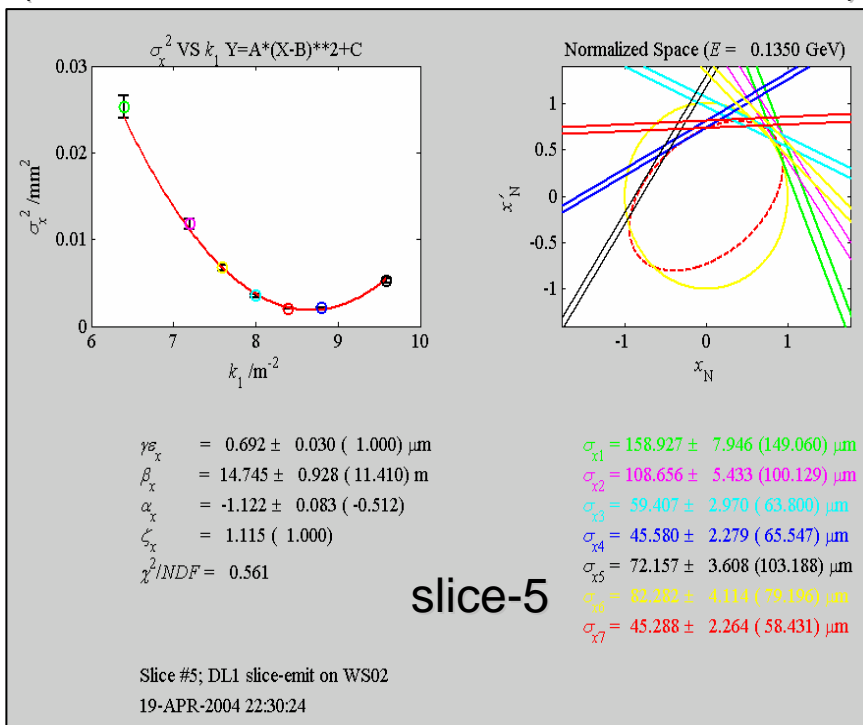
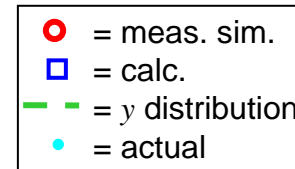


# Slice-Emittance Measurement Simulation

## Injector (135 MeV) with S-band RF-deflector at 1 MV

(same SLAC slice- $\varepsilon$  code used at BNL/SDL)

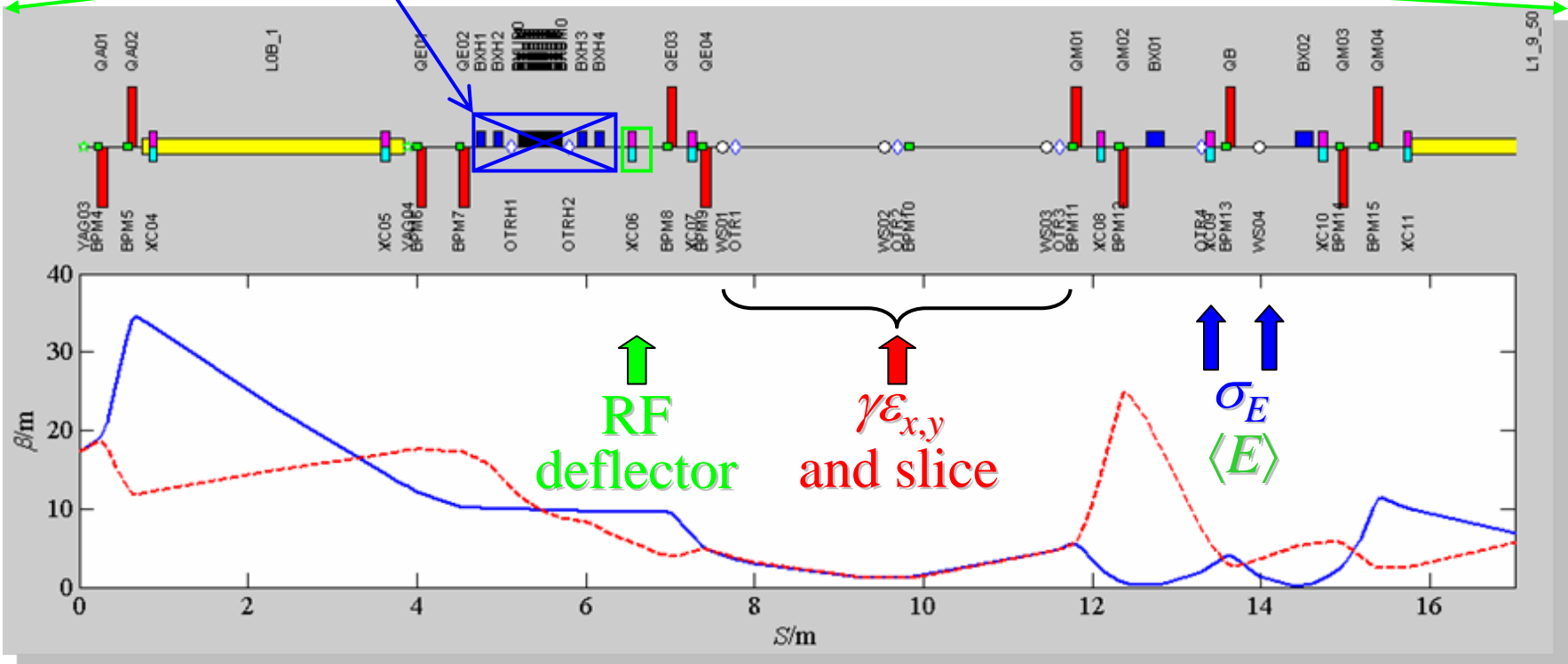
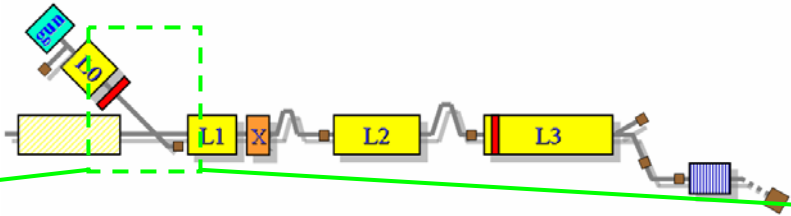
(slice-y-emittance also simulated in BC1-center)



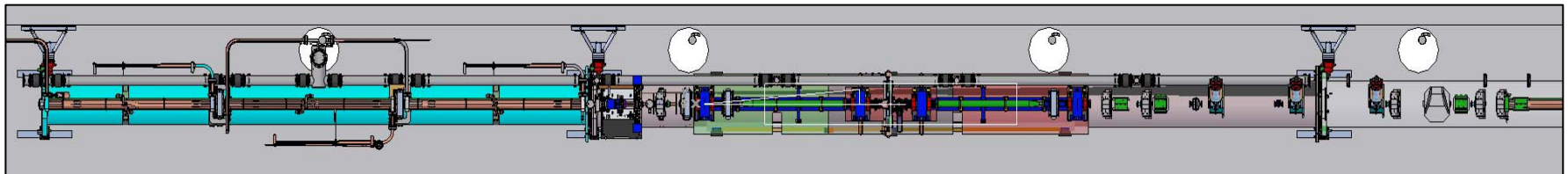
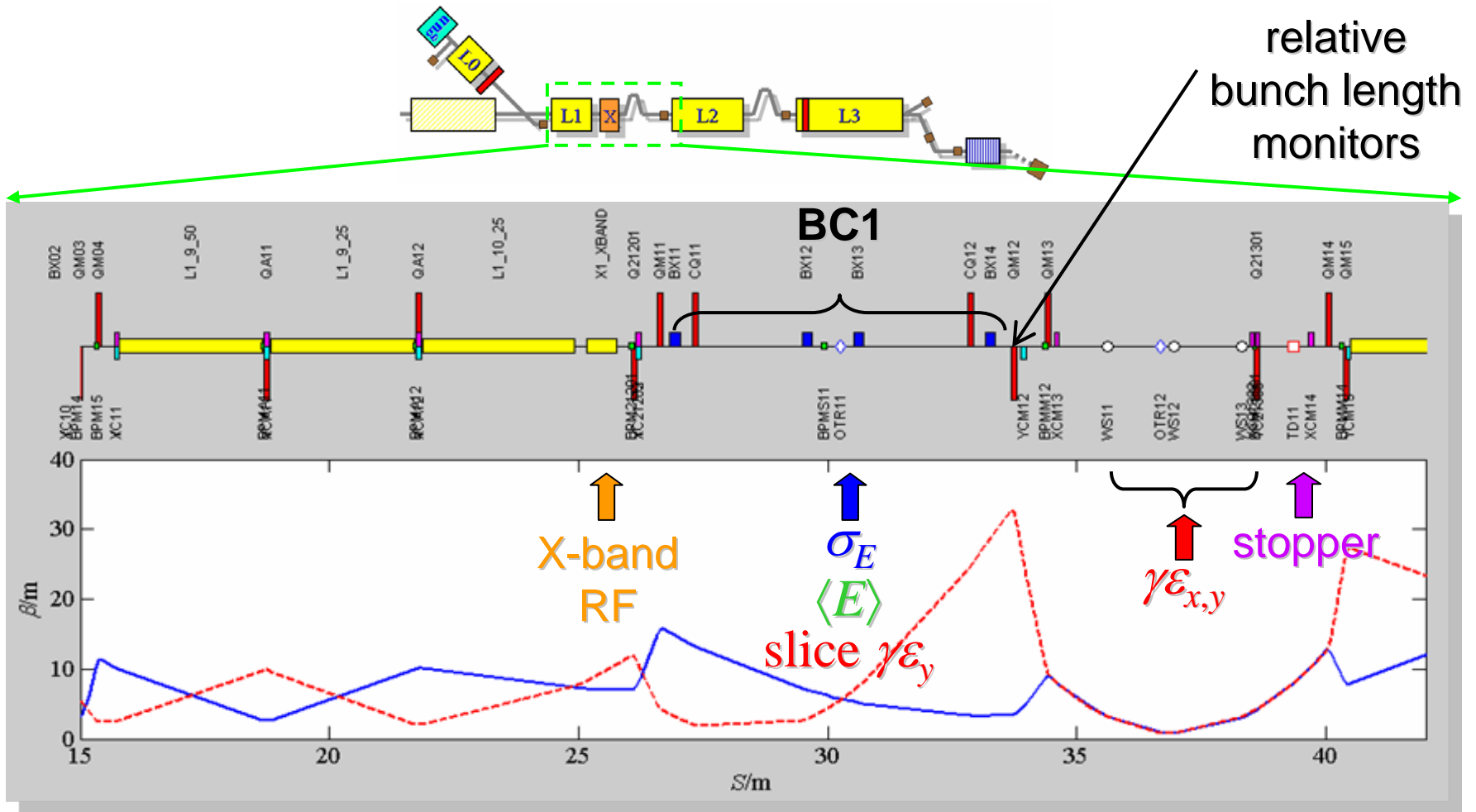


# Injector Through BC1 Commissioning

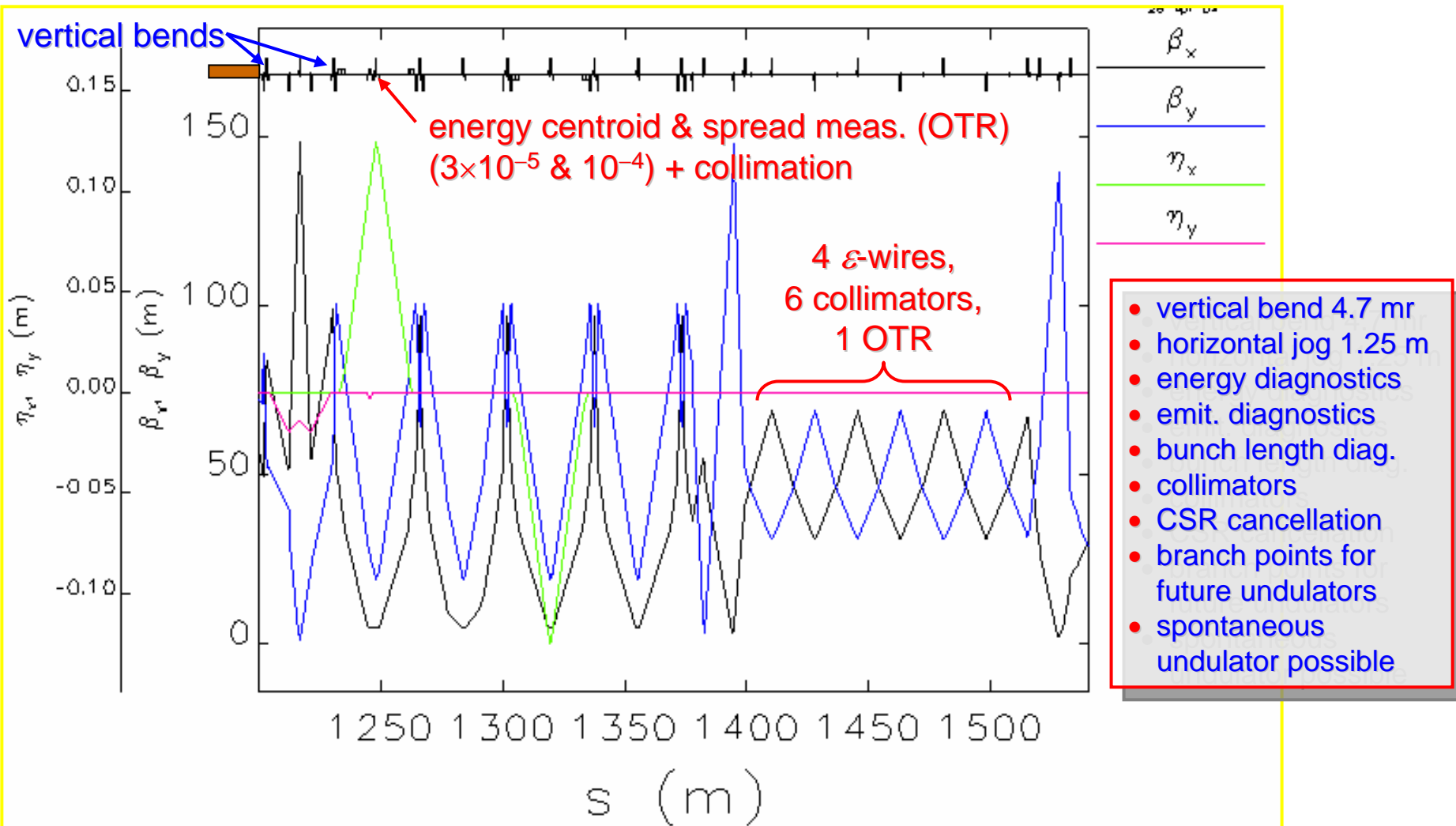
no laser-heater  
until 2007



# Injector Through BC1 Commissioning (2)

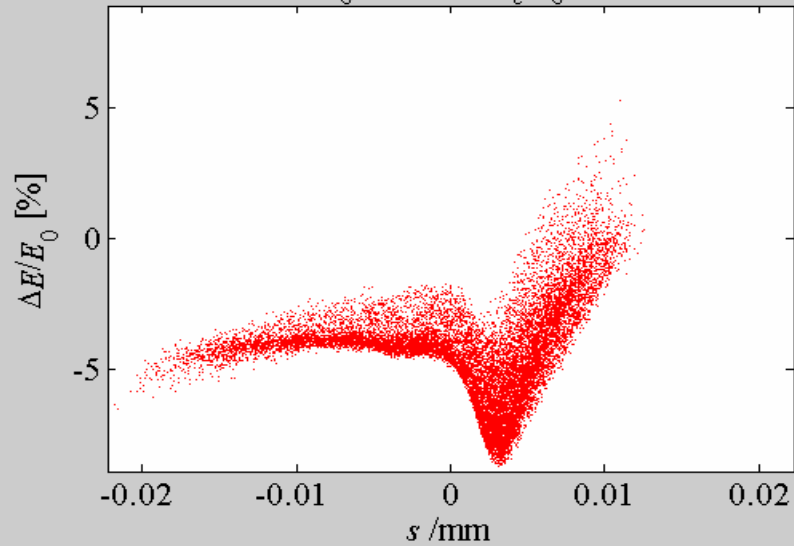


# Linac-To-Undulator (LTU)

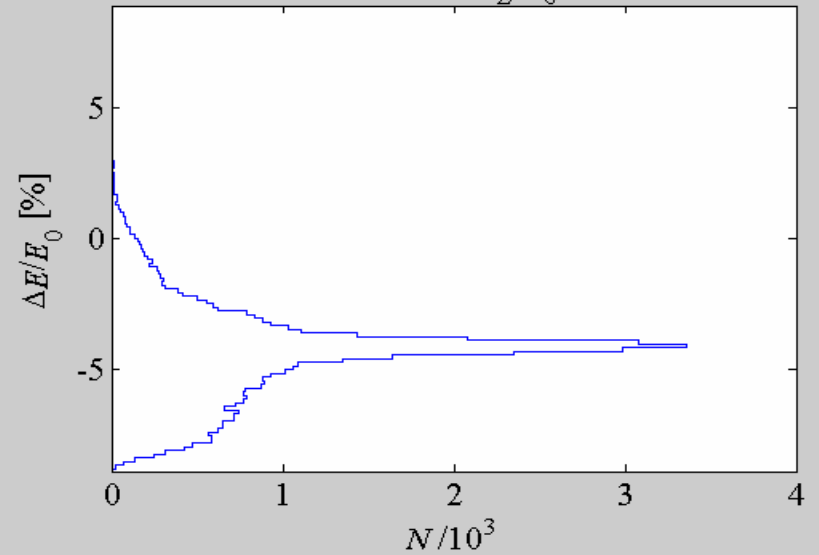


# Enhanced CSR in BC1

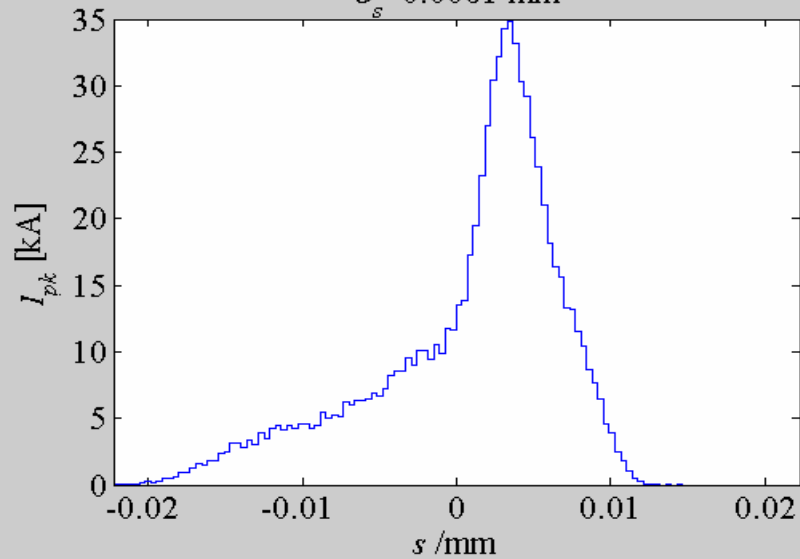
Final:  $s/\varepsilon_0 = 29.694$ ,  $\varepsilon_c/\varepsilon_0 = 19.966$



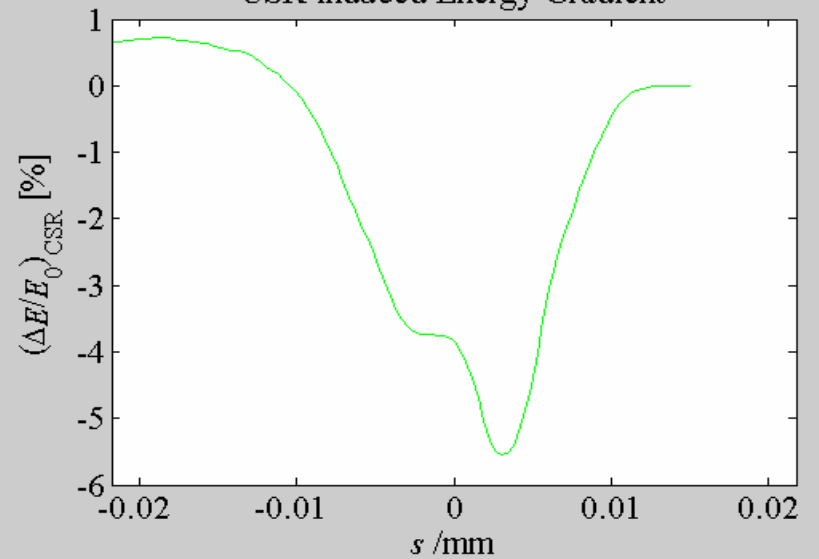
Energy distribution ( $\sigma_E/E_0 = 1.8889\%$ )



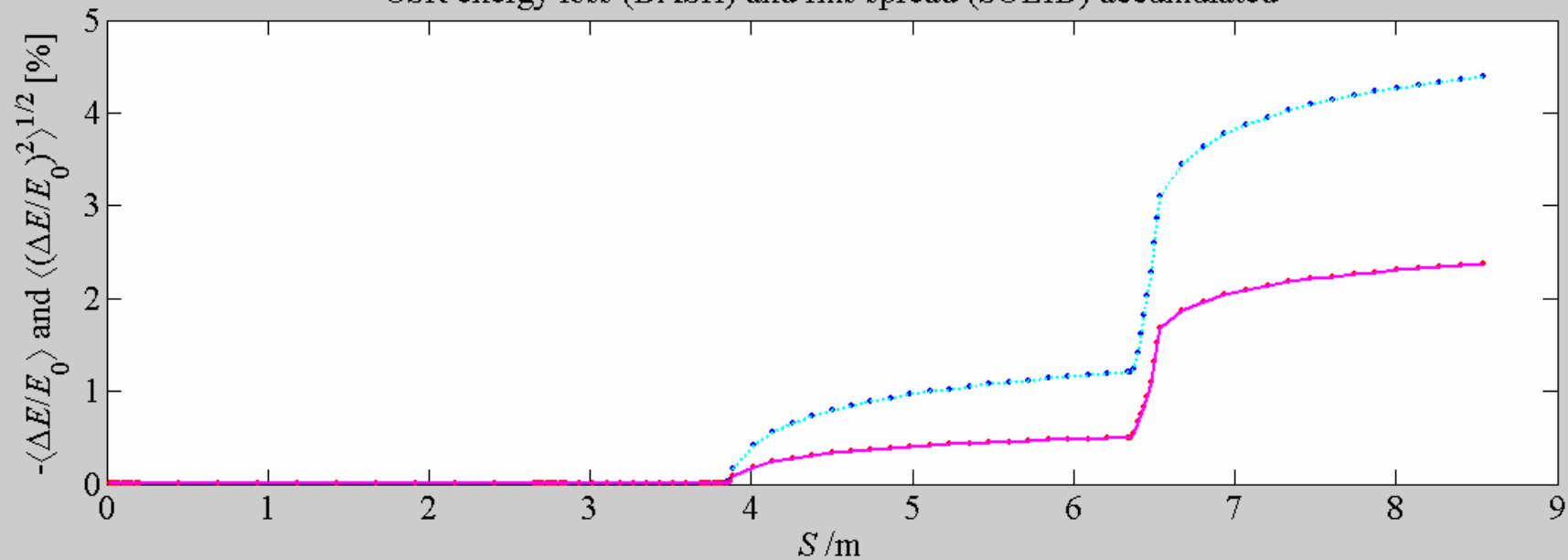
$\sigma_s = 0.0061$  mm



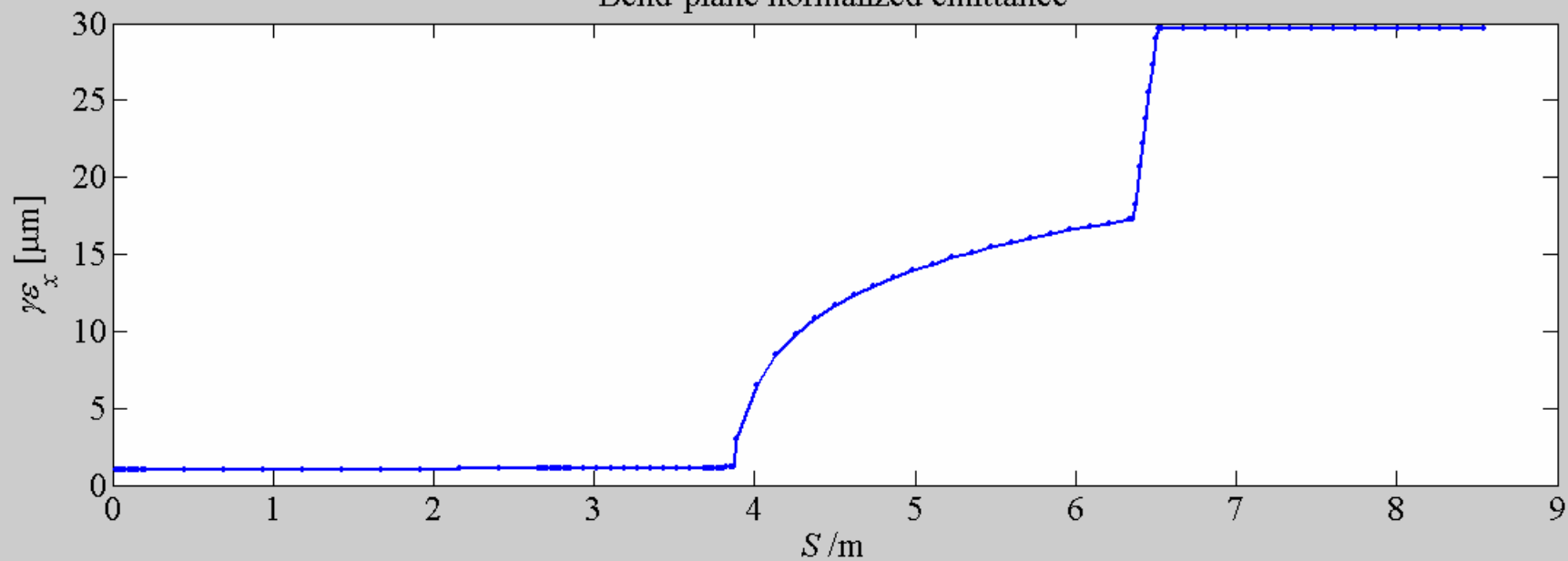
CSR-induced Energy Gradient



CSR energy loss (DASH) and rms spread (SOLID) accumulated



Bend-plane normalized emittance



- **Emittance of RF Photo-Cathode Gun**
- **Micro-Bunching Instability**
- **Bunch Length Monitors**
- ***CSR in BC1 and BC2***
- **Impedance in BC2 Vacuum Chambers**
- **Space-Charge Effects in BC1 Region**
- ***Chromatic Correction for Highly Chirped Beams***
- ***Improved LTU Lattice***
- **Undulator Wakefields**
- **FEL Commissioning and Tuning**
- **Start-to-end Simulations and Integration with LCLS Controls**
- ***ESASE/Replicator***
- **Optical Klystron Gain Enhancement**
- **Seeded and Self-Seeded FEL for Next Phase of LCLS**
- **Development of an X-band Transverse RF Deflector**
- **Multi-bunch LCLS and Regenerative Amplifier FEL**
- **Harmonic Afterburner**