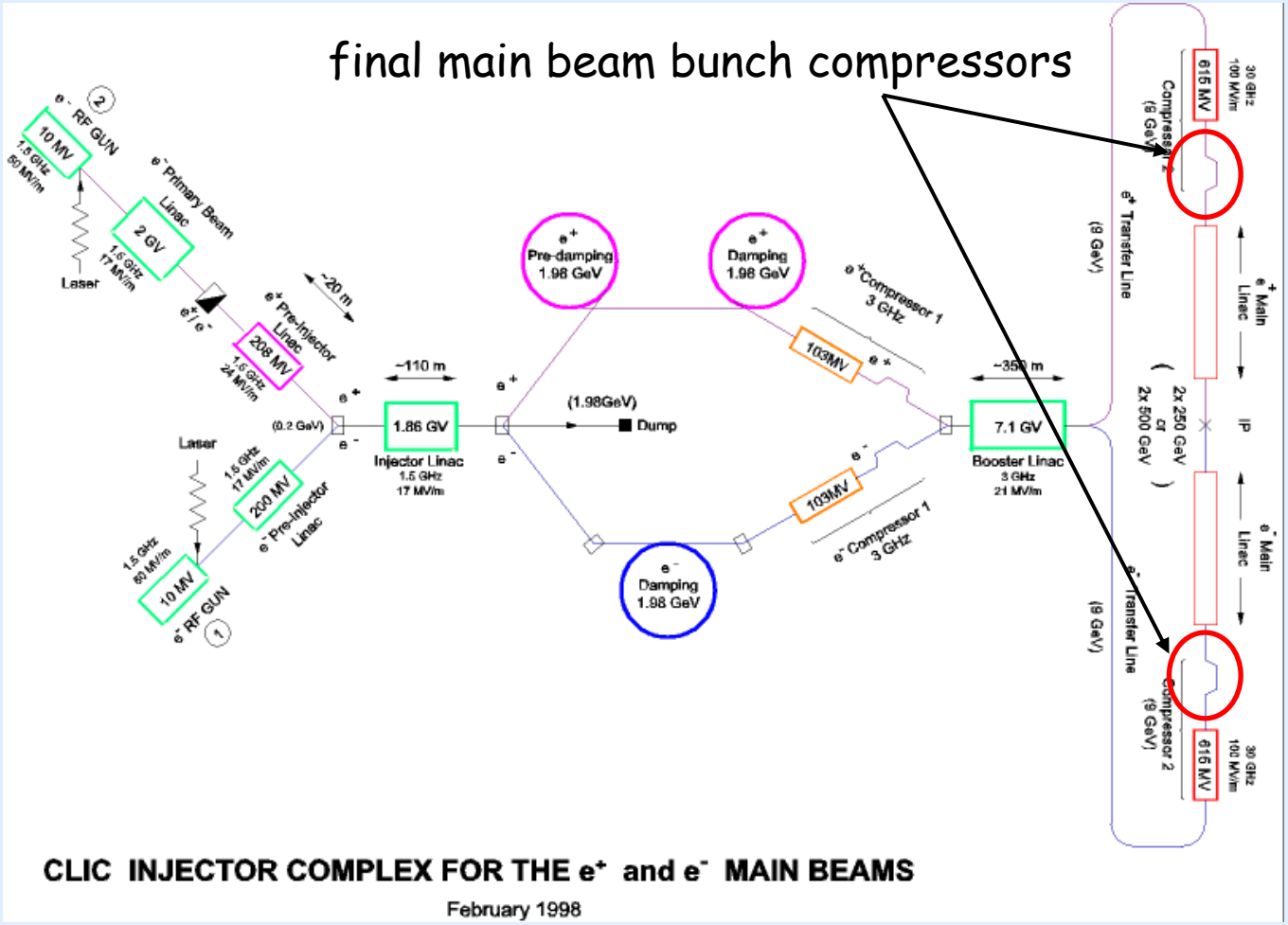
Latest results for the final CLIC Main Beam Bunch Compressor

- Results of Parameter Scans
- BC2 Layout
- Influence of Shielding
- CSR Microbunch Instability
- Jitter Studies
- Summary and Outlook

The final Main Beam Bunch Compressor



The final Main Beam Bunch Compressor

$E_0 = 9\ \text{GeV}$

$Q_0 = 0.41\ \text{nC}$

$\sigma_{s,i} = 250\ \mu\text{m}$

$I_{peak} = 200\ \text{A}$

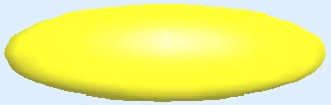
$\varepsilon_{n,x} = 570\ \text{nm rad}$

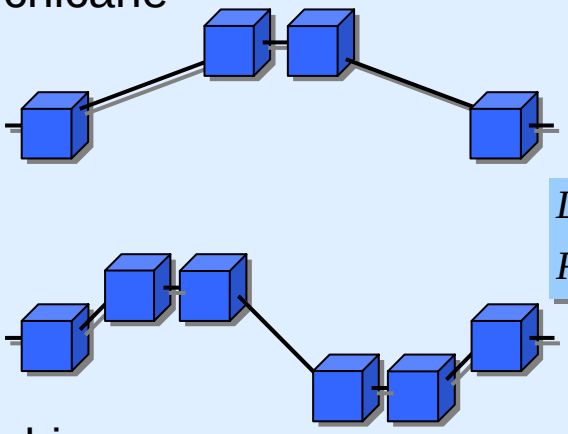
$\varepsilon_{n,y} = 4\ \text{nm rad}$

$\frac{\sigma_{E,unc}}{E_0} = 2 \cdot 10^{-3}$

$\frac{1}{E_0}\frac{dE}{ds} = -70.5\ \text{m}^{-1}$

$\Rightarrow \frac{\sigma_{E,tot}}{E_0} \approx 1.8\,\%$





$L_{tot} = 40\ \text{m}$

$R_{56} = -14\text{mm}$

$\sigma_{s,i} = 30\ \mu\text{m}$

$I_{peak} = 1670\ \text{A}$

$\varepsilon_{n,x} < 600\ \text{nm rad}$

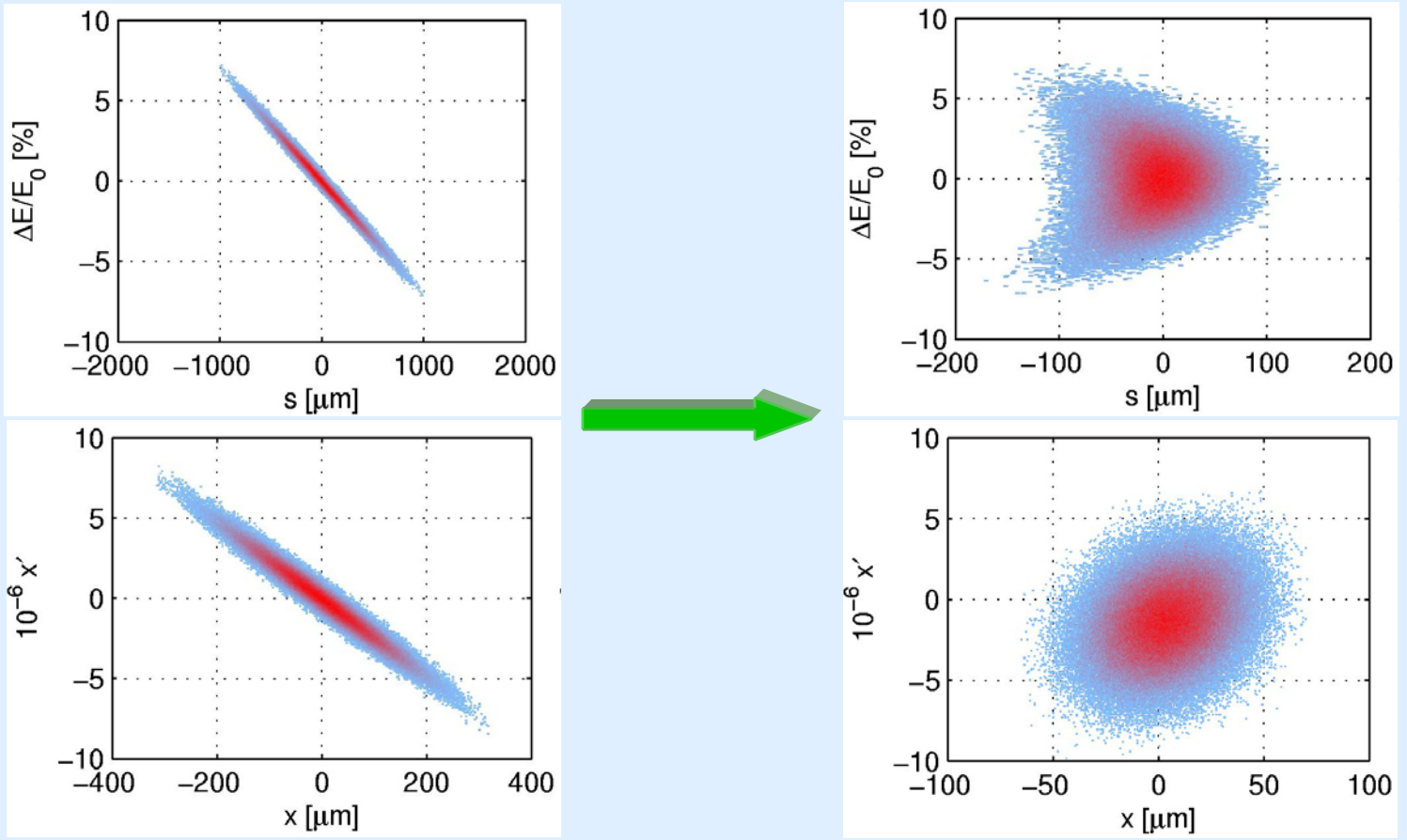
$\varepsilon_{n,y} < 5\ \text{nm rad}$

$\frac{\sigma_{E,tot}}{E_0} < 2\,\%$

1D CSR Simulations, no Shielding

- longitudinally and transversally Gaussian charge distribution
- initially linear energy chirp in longitudinal phase space distribution

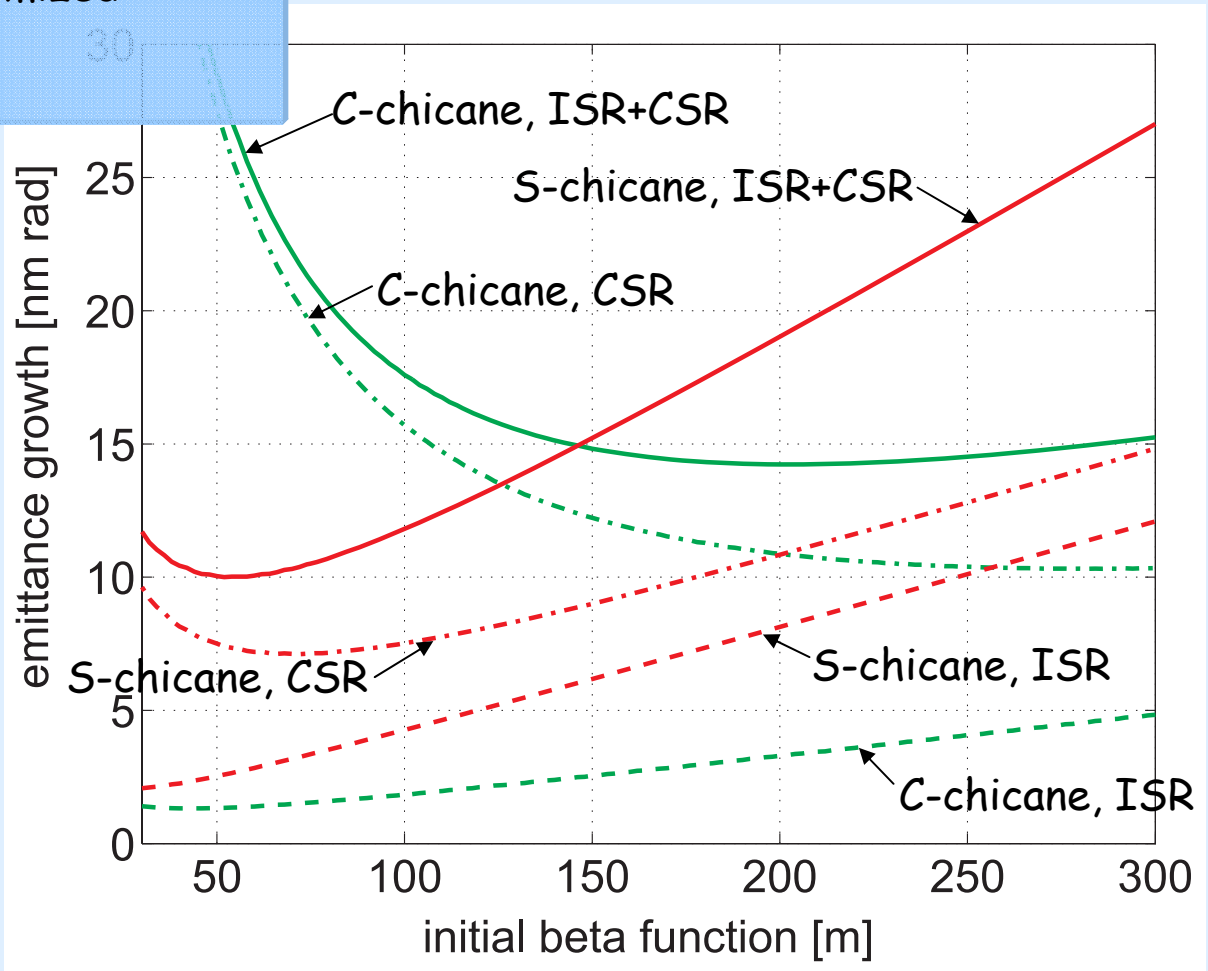
- shape of final profile is dominated by uncorrelated energy spread
- small wings due to T_{566}



1D CSR Simulations, no Shielding

Dependence of ISR and CSR emittance growth on the initial beta function.

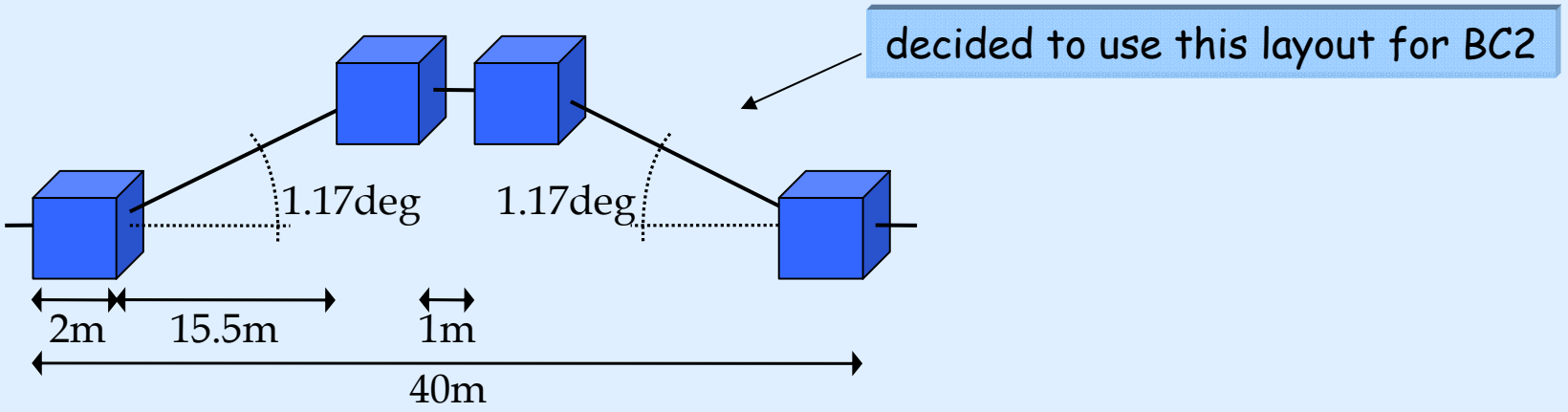
- symmetric C- and optimized S-chicane layouts
- best values for alpha

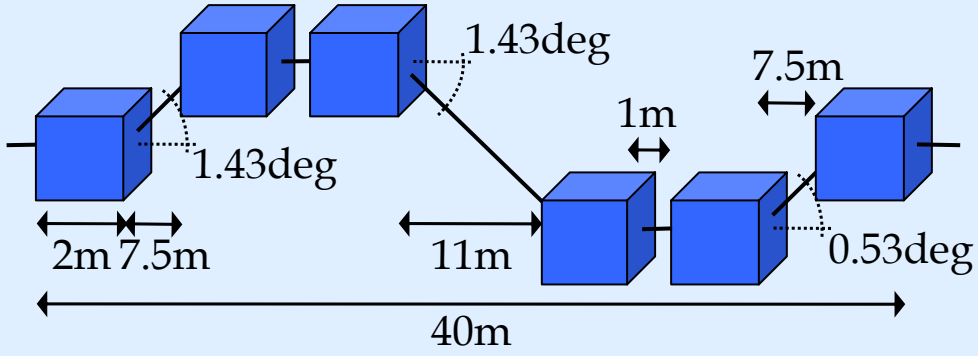


symmetric C-chicane:
$\Delta\varepsilon_{C,min}$ = 14 nm rad
@$\beta_{C,ini}$ = 200 m, $\alpha_{C,ini}$ = 4.8

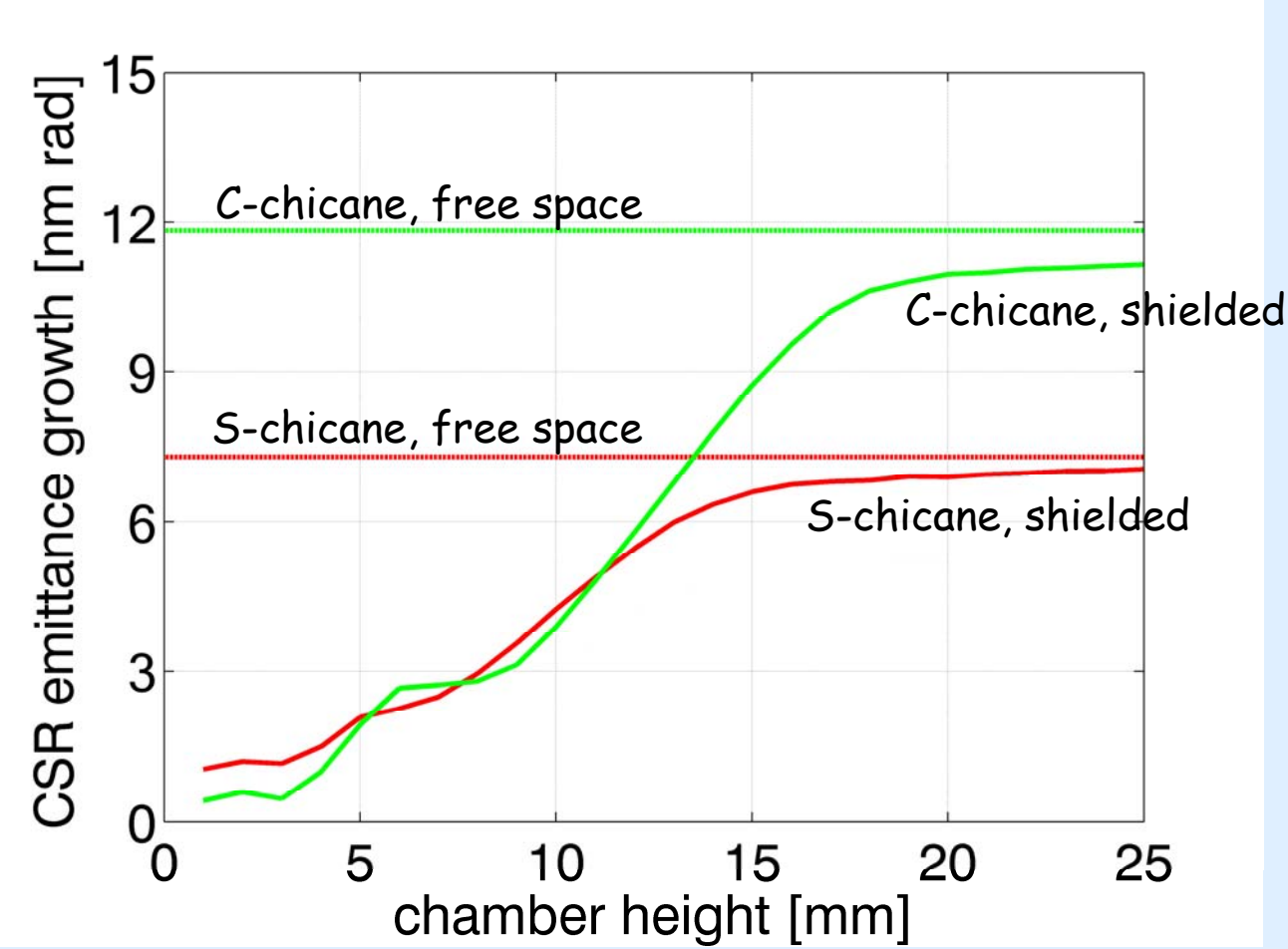
optimized S-chicane:
$\Delta\varepsilon_{S,min}$ = 10 nm rad
@$\beta_{S,ini}$ = 52 m, $\alpha_{S,ini}$ = 1.6

Optimized Chicane Layouts

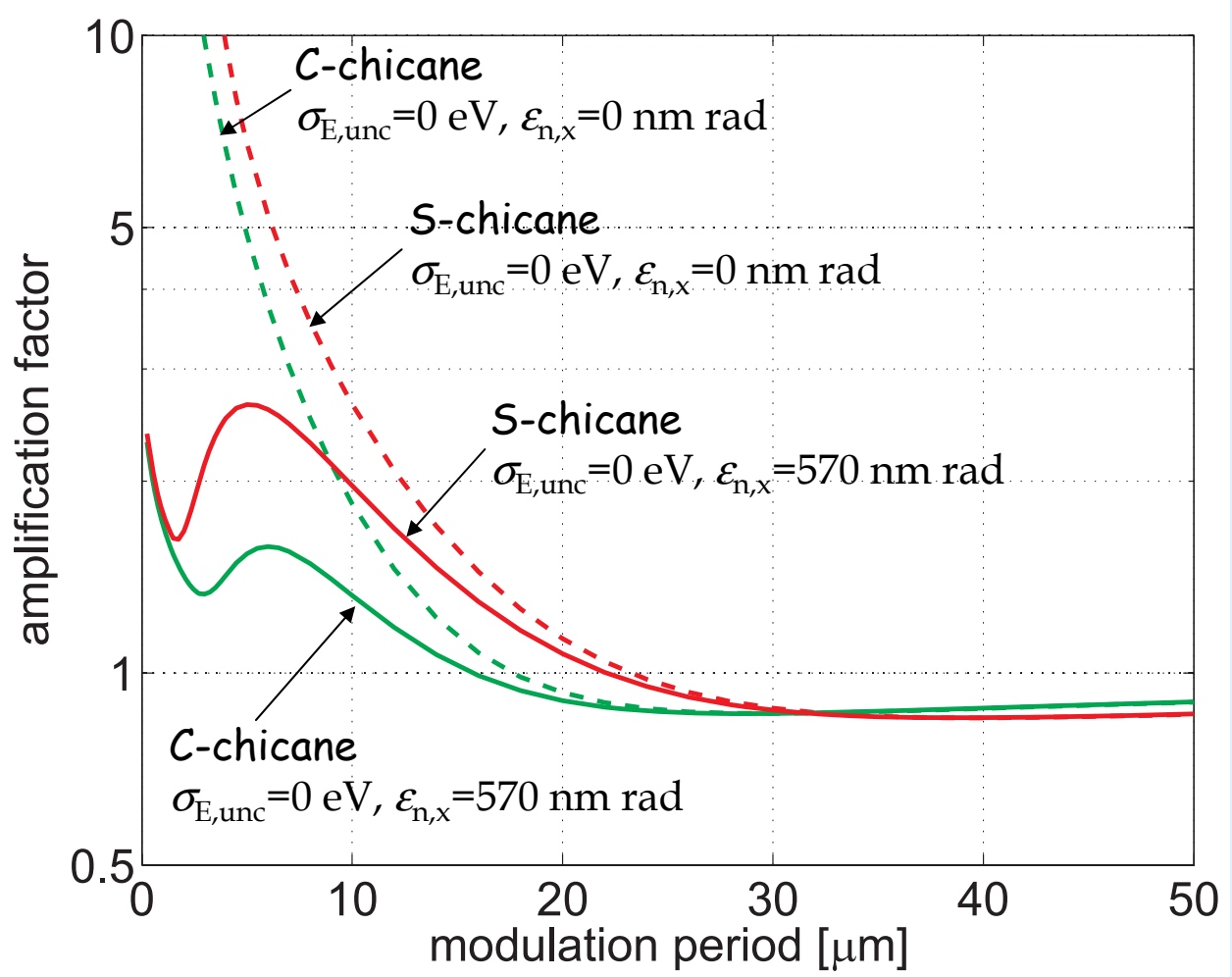




Shielding Effect (parallel plates)



CSR Microbunch Instability



The high uncorrelated energy spread suppresses the amplification completely!

Jitter Studies

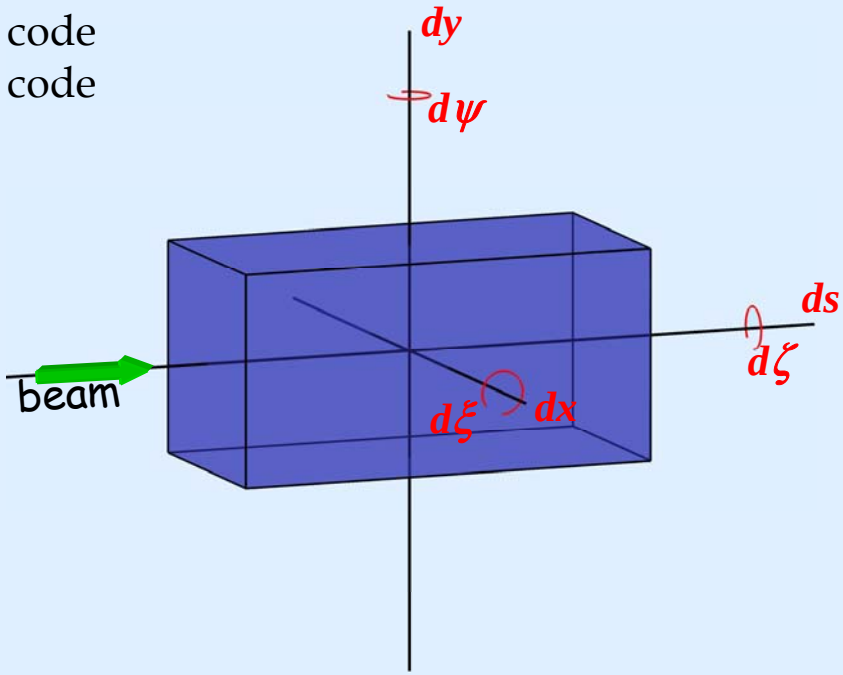
Error Sources:

- dipole position
  - longitudinal ds, ±100 µm
  - horizontal dx, ±100 µm
  - vertical dy, ±100 µm

- dipole tilt
  - roll $d\zeta$ ±1 mrad
  - pitch $d\xi$ cannot be included in code
  - yaw $d\psi$ cannot be included in code

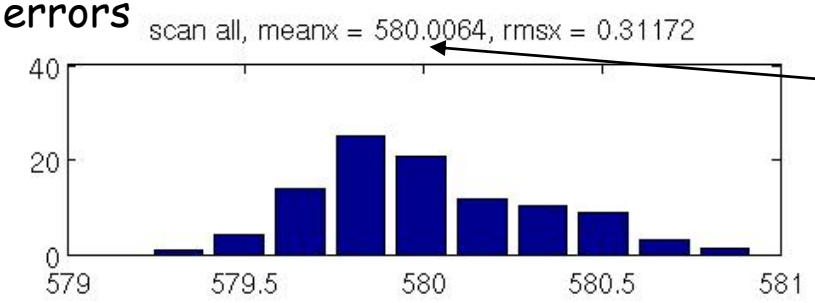
- dipole strength, $\pm 10^{-3}$ % correlated
  $\pm 10^{-3}$ % uncorrelated

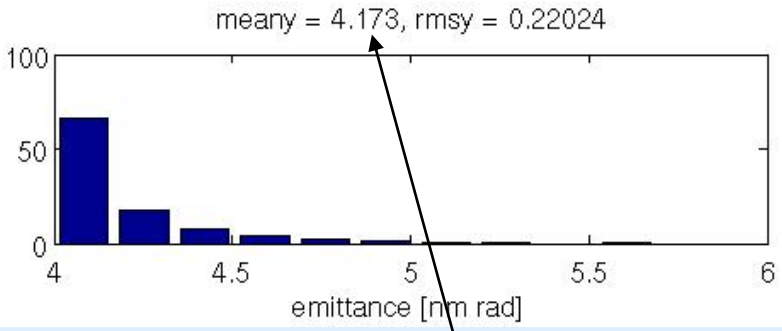
- RF amplitude not yet included
- RF phase not yet included



Jitter Studies, including CSR

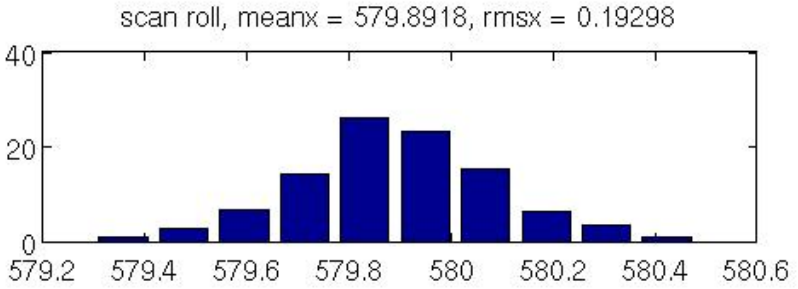
all errors

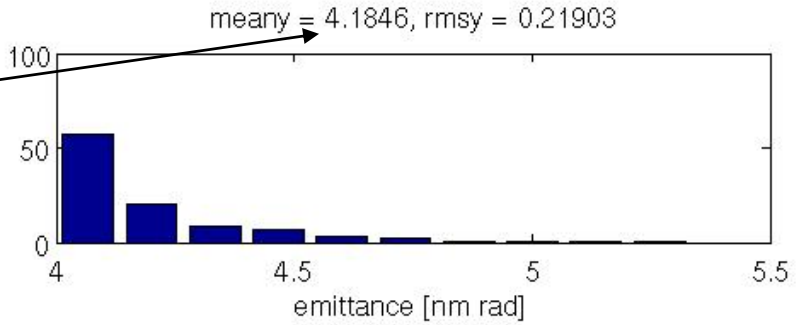




emittance growth induced by CSR

only roll error





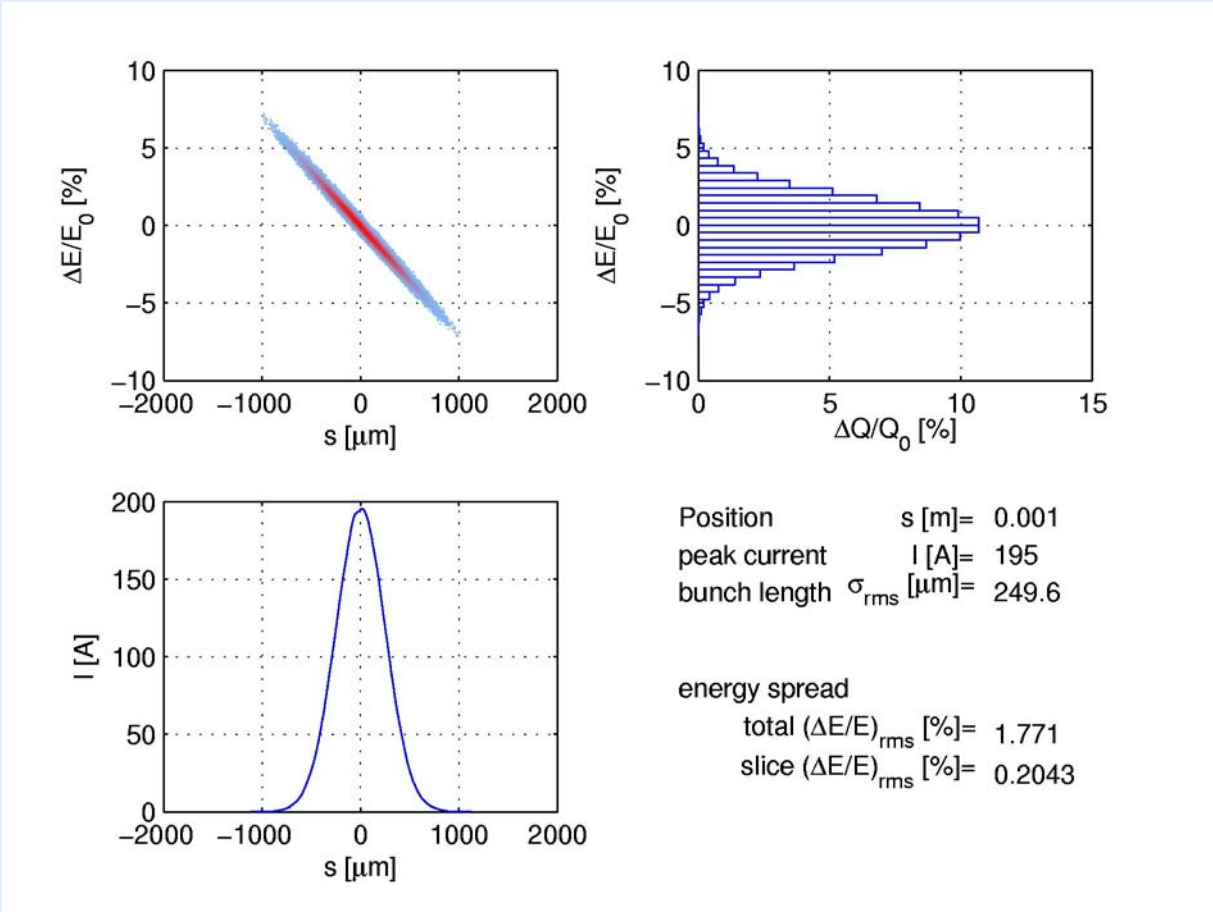
emittance growth induced by coupling

Summary and Outlook

- Parameter scans for different chicane layout have been performed.
- Symmetric C-chicane with optimized optics meets specifications:
  $\Delta\varepsilon_C = 14$ nm rad, @ $\beta_{C,ini} = 200$ m, $\alpha_{C,ini} = 4.8$
- The best values are achieved in an asymmetric S-chicane:
  $\Delta\varepsilon_S = 10$ nm rad, @ $\beta_{S,ini} = 52$ m, $\alpha_{S,ini} = 1.6$
- Shielding can improve the CSR emittance growth if the chamber is narrower than 20 mm.
- The CSR Microbunch Instability is not an issue due to the high uncorrelated energy spread.
- Jitter Studies show that roll angle is the main concern.

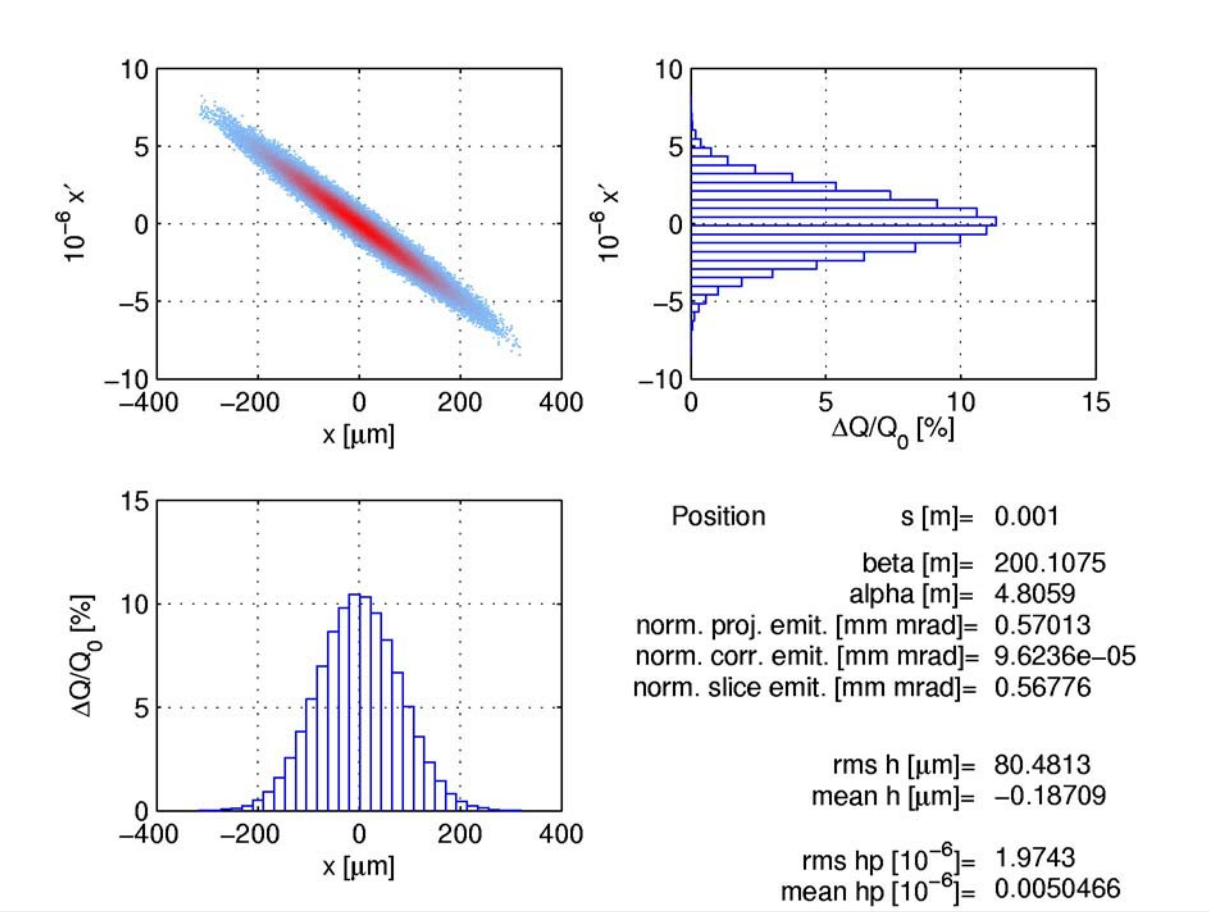
- Studies of RF amplitude and phase jitter remain to be performed.
- Find possible R_{56} and energy spread range (flexibility).
- Use more realistic initial phase space distribution (incl. RF curvature, non Gaussian profile,...).
- Add resistive wall wake fields in chicane.
- Perform 3D simulations.

Main Beam Bunch Compressor, 1D CSR Simulations



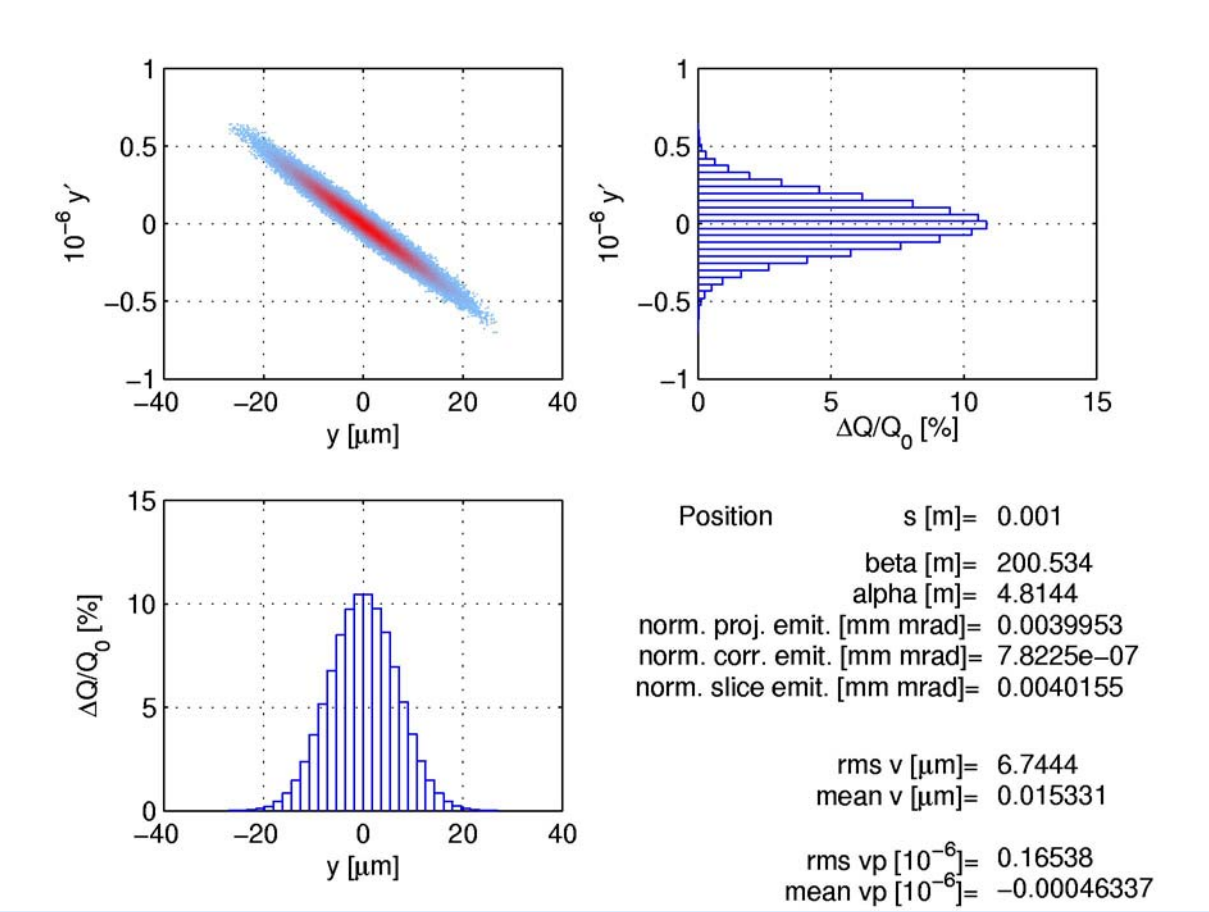
initial longitudinal phase space

Main Beam Bunch Compressor, 1D CSR Simulations



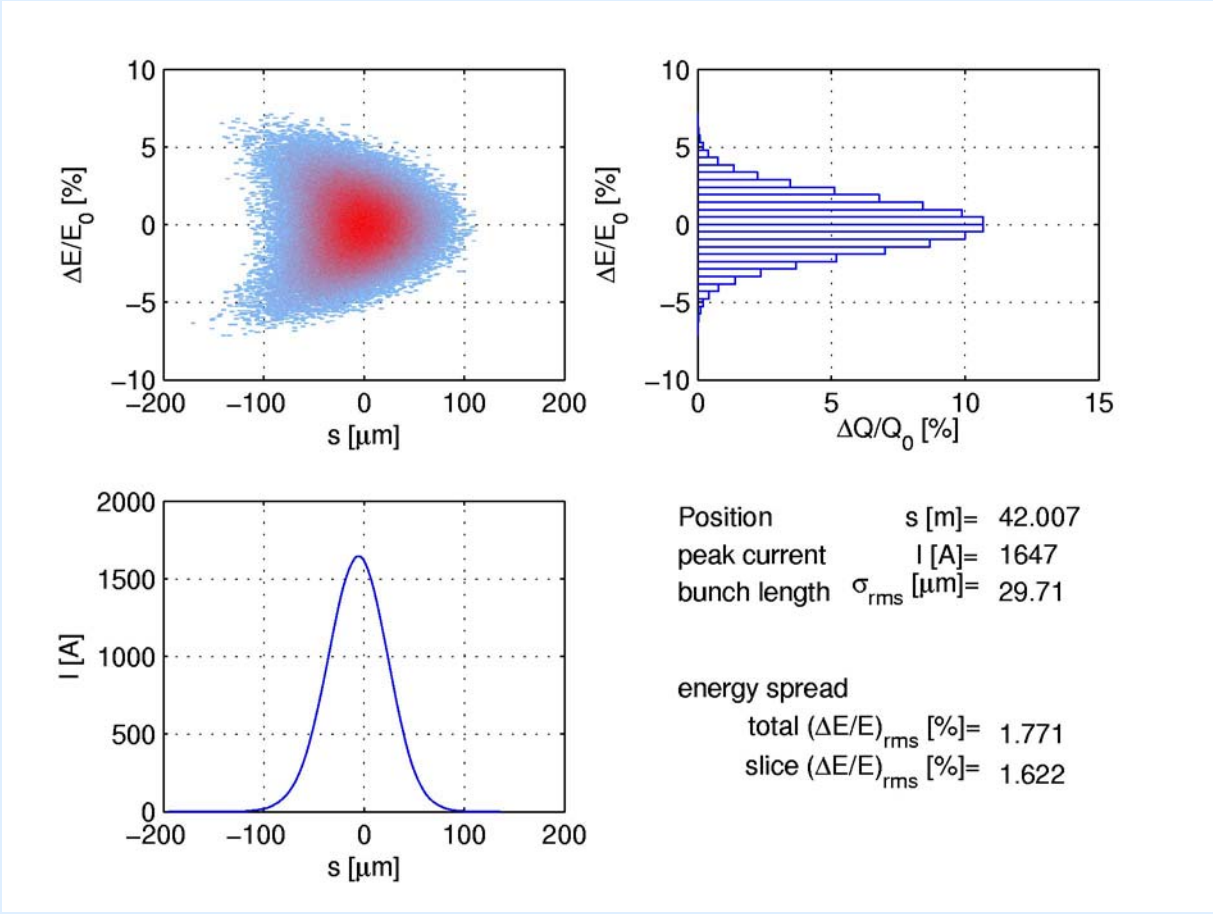
initial horizontal phase space (for symmetric C-chicane)

Main Beam Bunch Compressor, 1D CSR Simulations



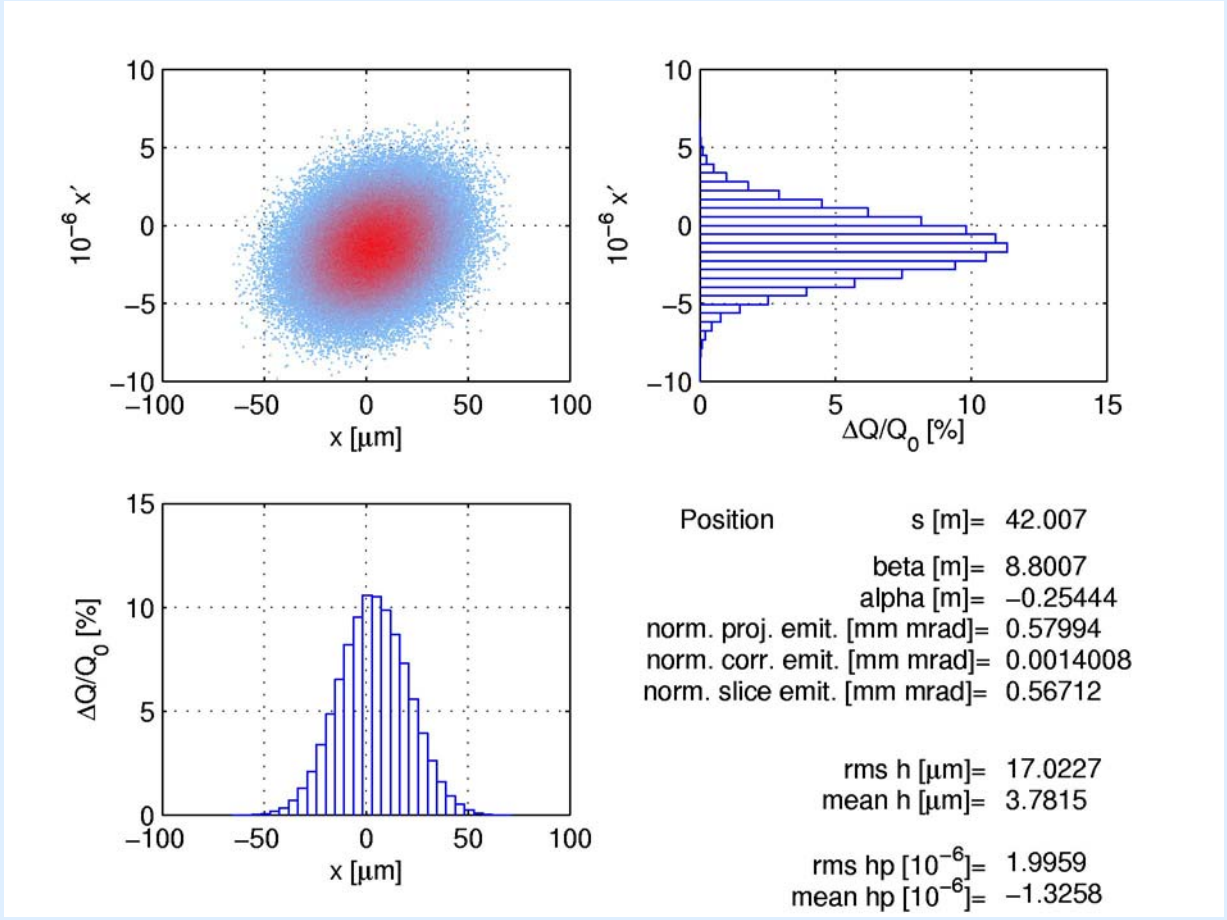
initial vertical phase space (for symmetric C-chicane)

Main Beam Bunch Compressor, 1D CSR Simulations



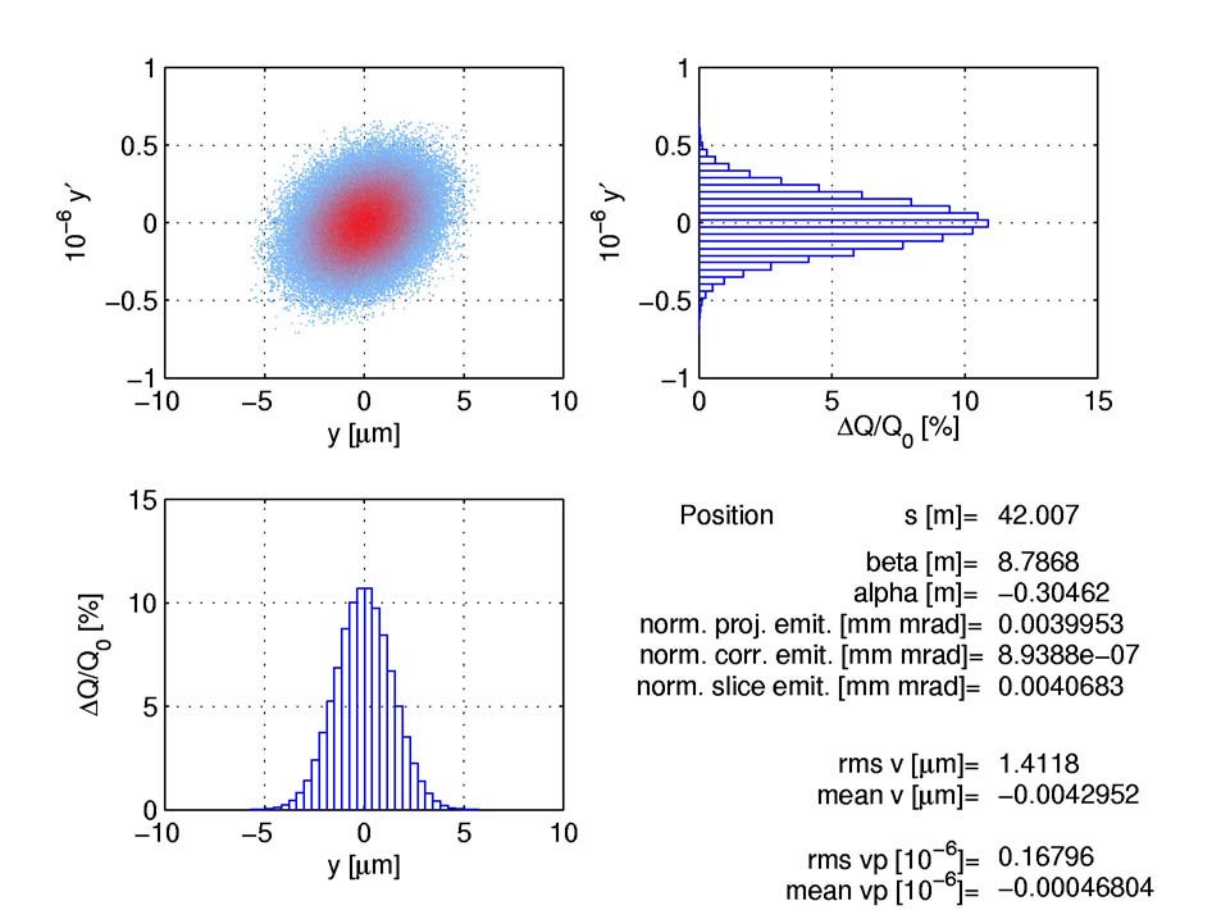
final longitudinal phase space (behind symmetric C-chicane)

Main Beam Bunch Compressor, 1D CSR Simulations



final horizontal phase space (behind symmetric C-chicane)

Main Beam Bunch Compressor, 1D CSR Simulations



final vertical phase space (behind symmetric C-chicane)