

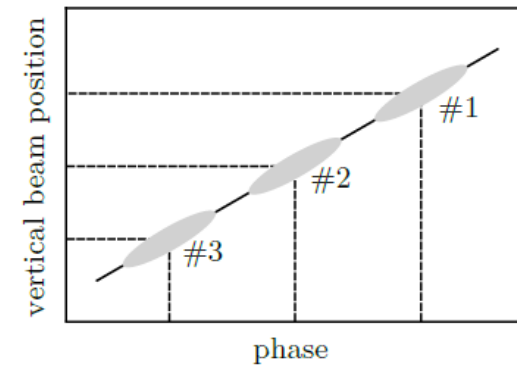
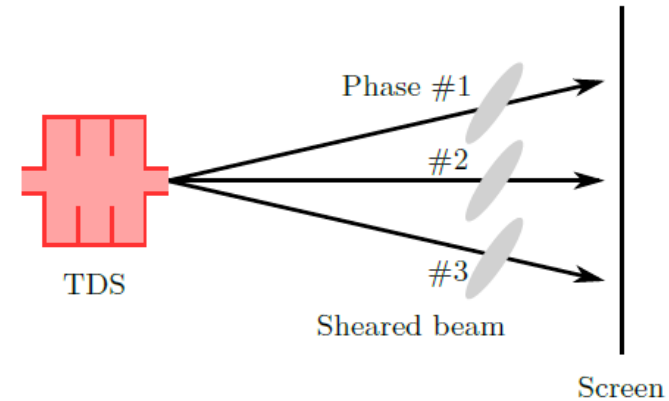
Bunch profile reconstructions

Reconstructing bunch profiles of beams with arbitrary vertical correlations

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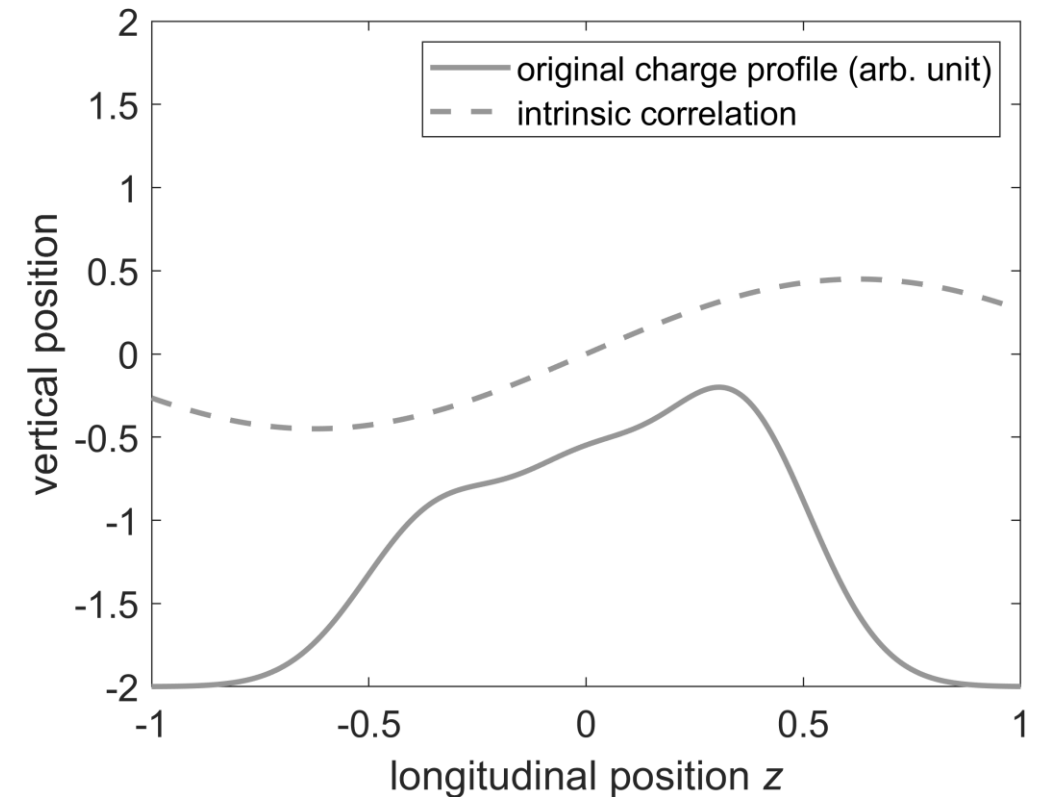
TDS measurement

- Mapping *temporal coordinate* to *transverse plane*
- Shear parameter is (linear) mapping parameter: $y = S \cdot z$
- Different rf phases \rightarrow different net streak
- Change of mean position vs. change of TDS phase
- Slope gives streak parameter
- However: Initial y - z correlation can complicate reconstruction
 - Solution described in PRAB **23**, 062801 (2020)



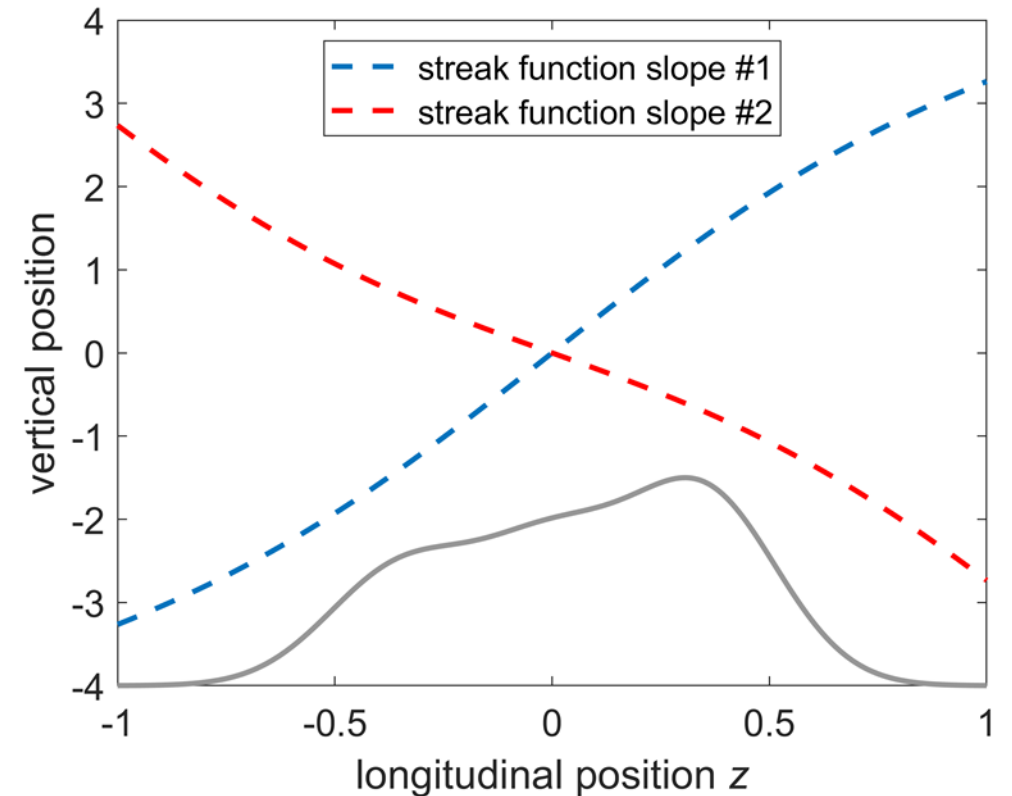
Reconstructions with arbitrary y - z correlations

- Non-linear y - z correlations possible
- Will disturb profile reconstructions
- Example with sinusoidal *intrinsic correlation*
 - Amplitude ~ 0.5



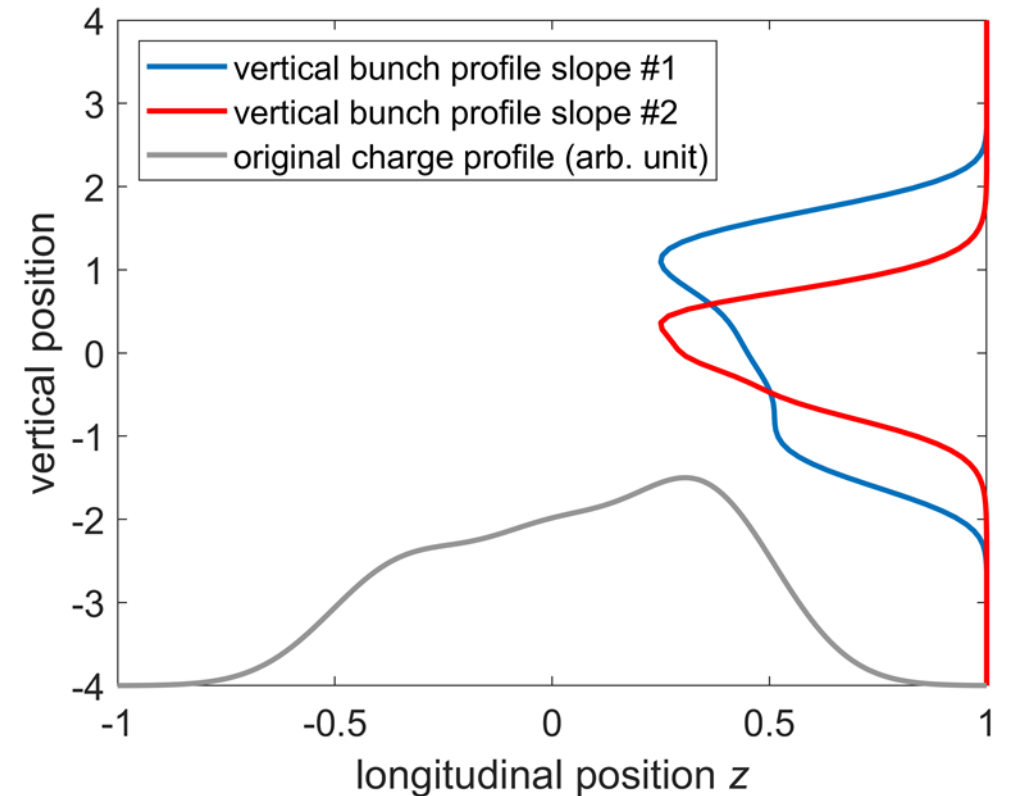
Reconstructions with arbitrary y - z correlations

- Linear TDS streak altered by *correlation function*
- Net shear (*streak function*) shown in red/blue
 - Linear TDS shear (here = +/-3)
- Non-linear mapping of z to y



Reconstructions with arbitrary y - z correlations

- Resulting profiles shown in red/blue
- Quite different profiles & width
- However: Mapping was *injective*
 - Electrons not rearranged on screen
 - Original electron *ordering* not changed by mapping
- Correlation & original profile can be reconstructed



Reconstructions with arbitrary y-z correlations

- Cumulative charge
 - Integrate (normalized) charge along vertical coordinate
 - In both profiles included
 - Correlation function
 - Shear parameter, but with opposite signs
- Averaging cancels out shear parameter contribution

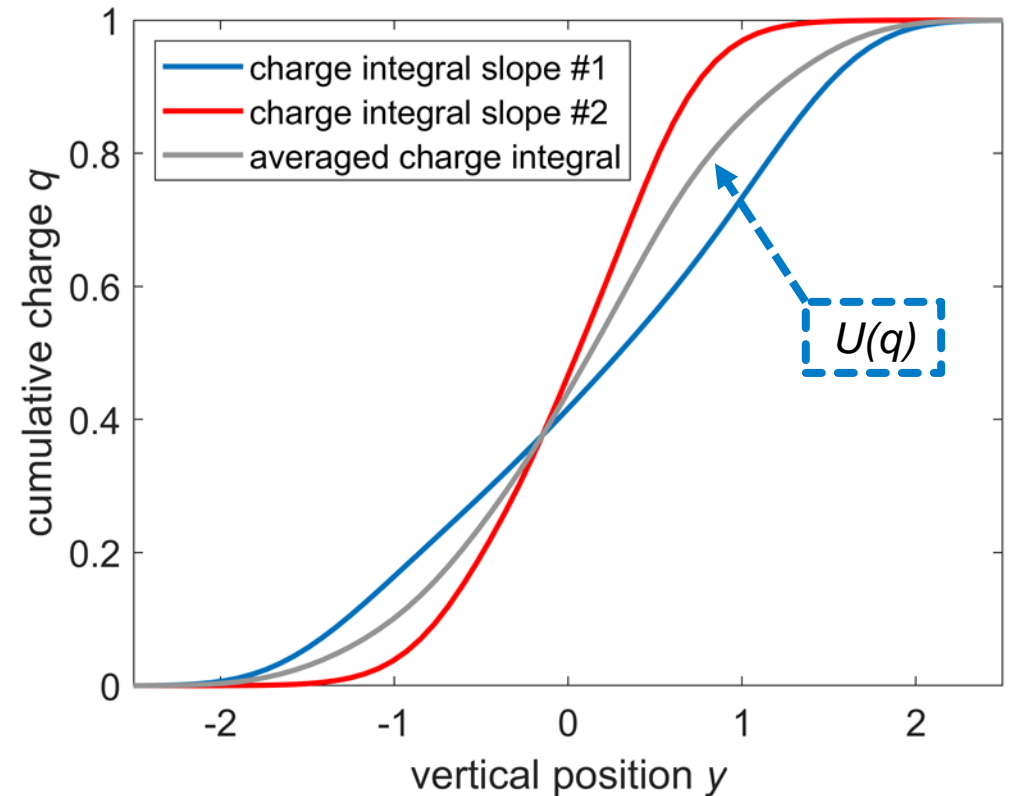
- Allows reconstruction of original charge profile
 - Calculate inversion of average charge integral:

$$Q(u) = U(q)^{-1}$$

- Original charge profile via:

$$\rho_0(\zeta) = S \cdot Q'(S \cdot \zeta)$$

- Initial correlation function reconstructed similarly



$\rho(\zeta)$ = original charge profile
 S = shear parameter
 $Q(u) = U(q)^{-1}$
 $U(q)$ = averaged charge integral

Summary

- Accurate bunch profile measurements
 - Correct profile reconstruction
 - Retrieval of correlation function
- To be tested before application in Chronos.m

- Reconstruction described in PRAB **23**, 062801 (2020)

Thank you

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