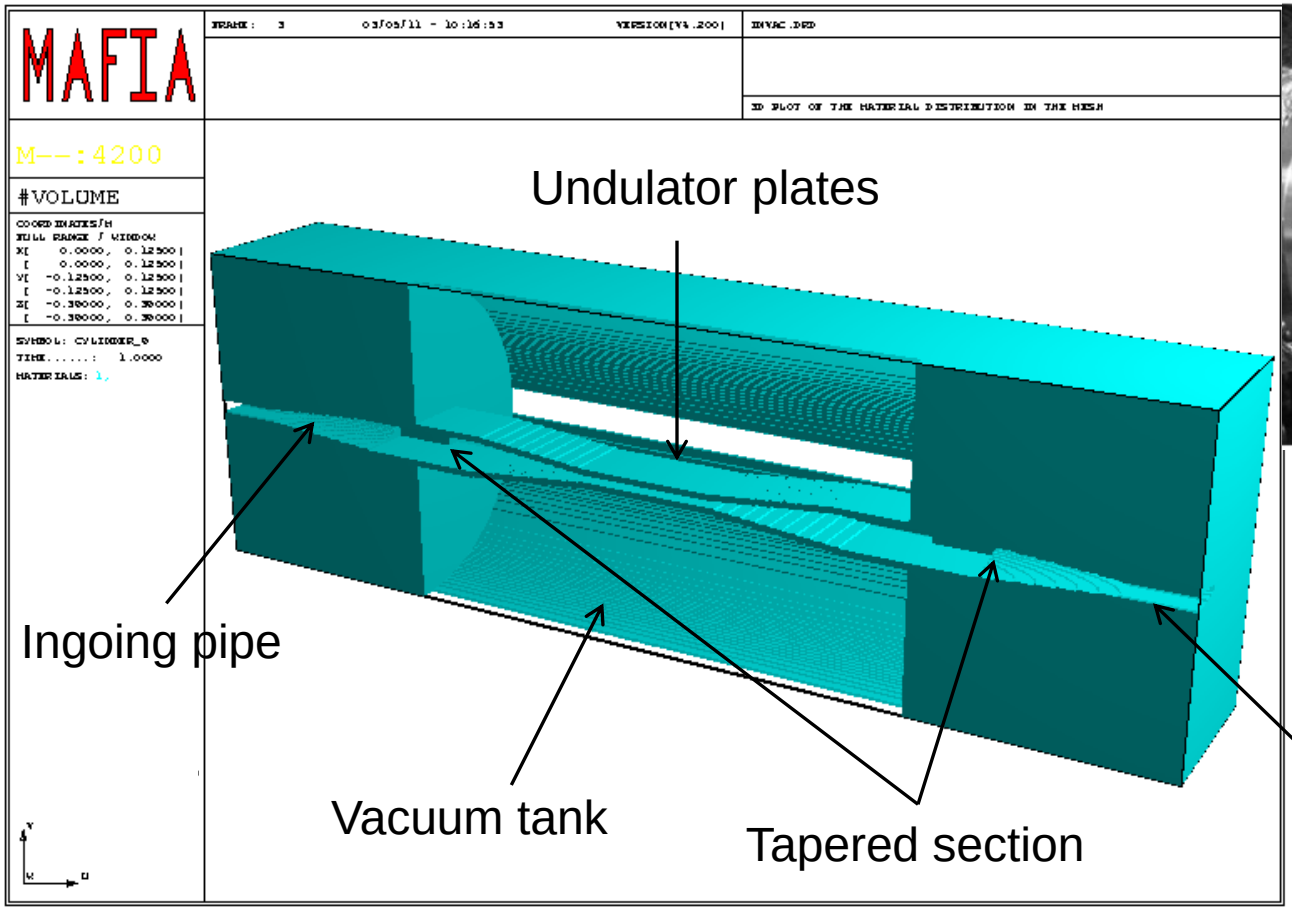
Wakefield computation of PETRAIII taper section

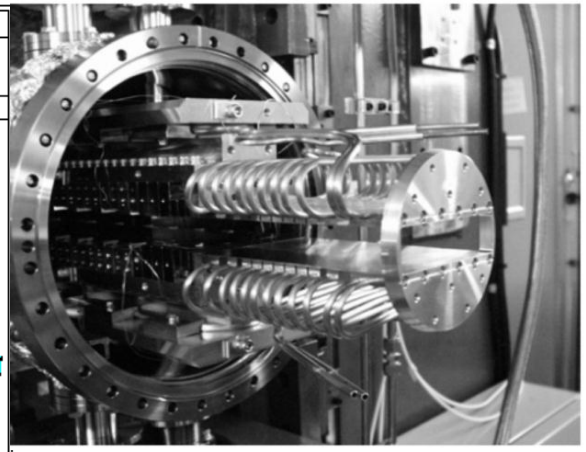
Laura Lünzer

TECHNISCHE UNIVERSITÄT DARMSTADT

Geometry of tapered structure

TECHNISCHE UNIVERSITÄT DARMSTADT

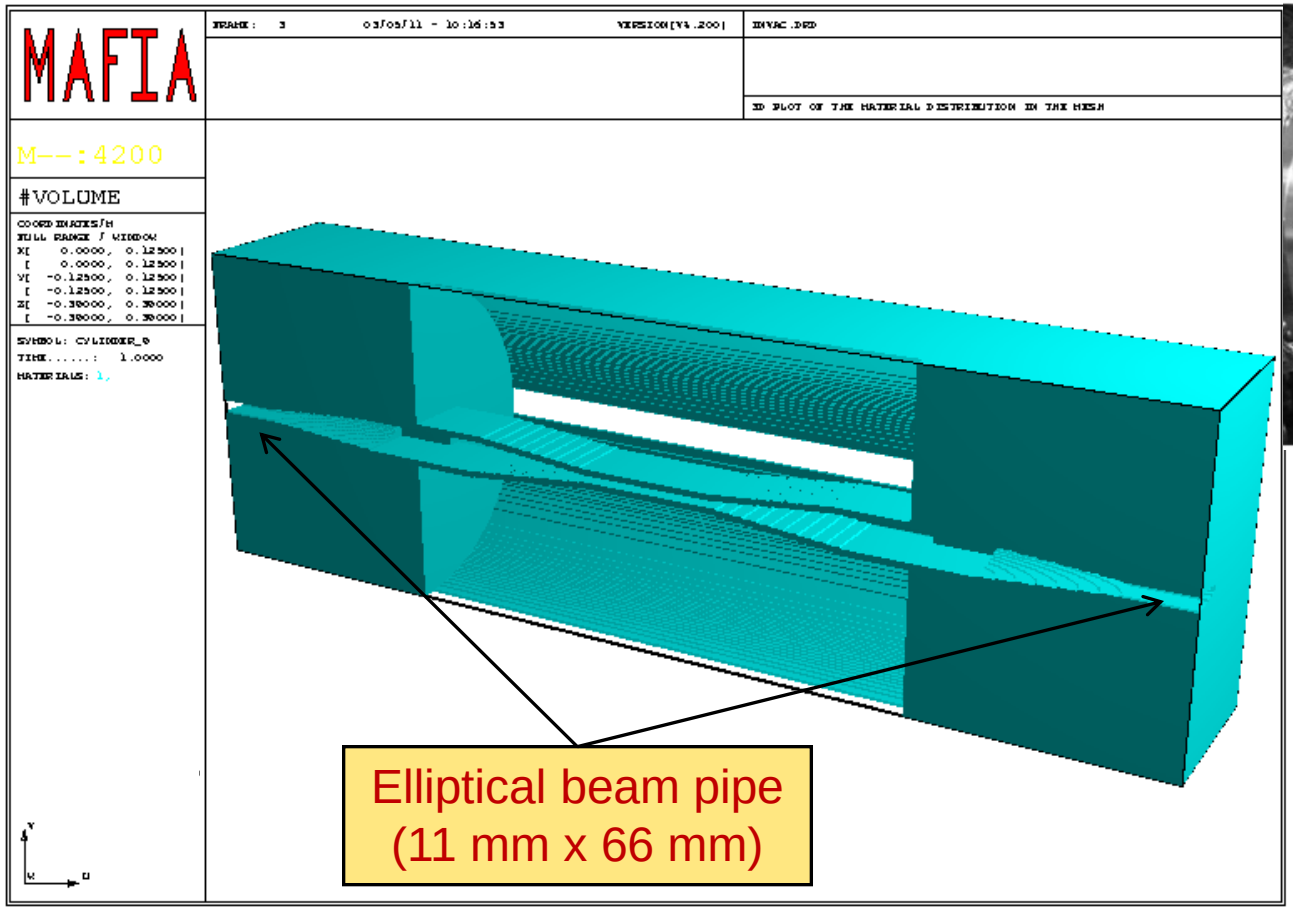


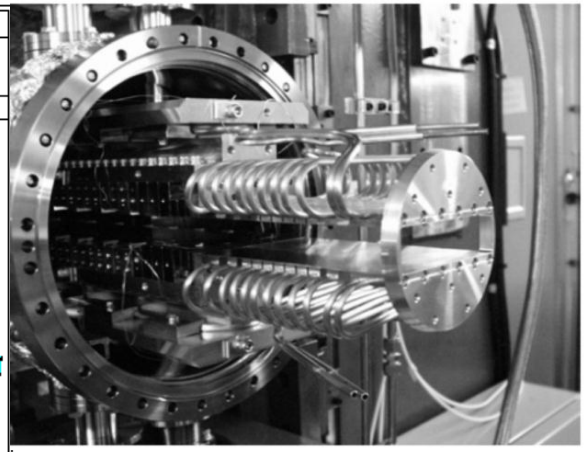


Source: R. Wanzenberg

Geometry of tapered structure

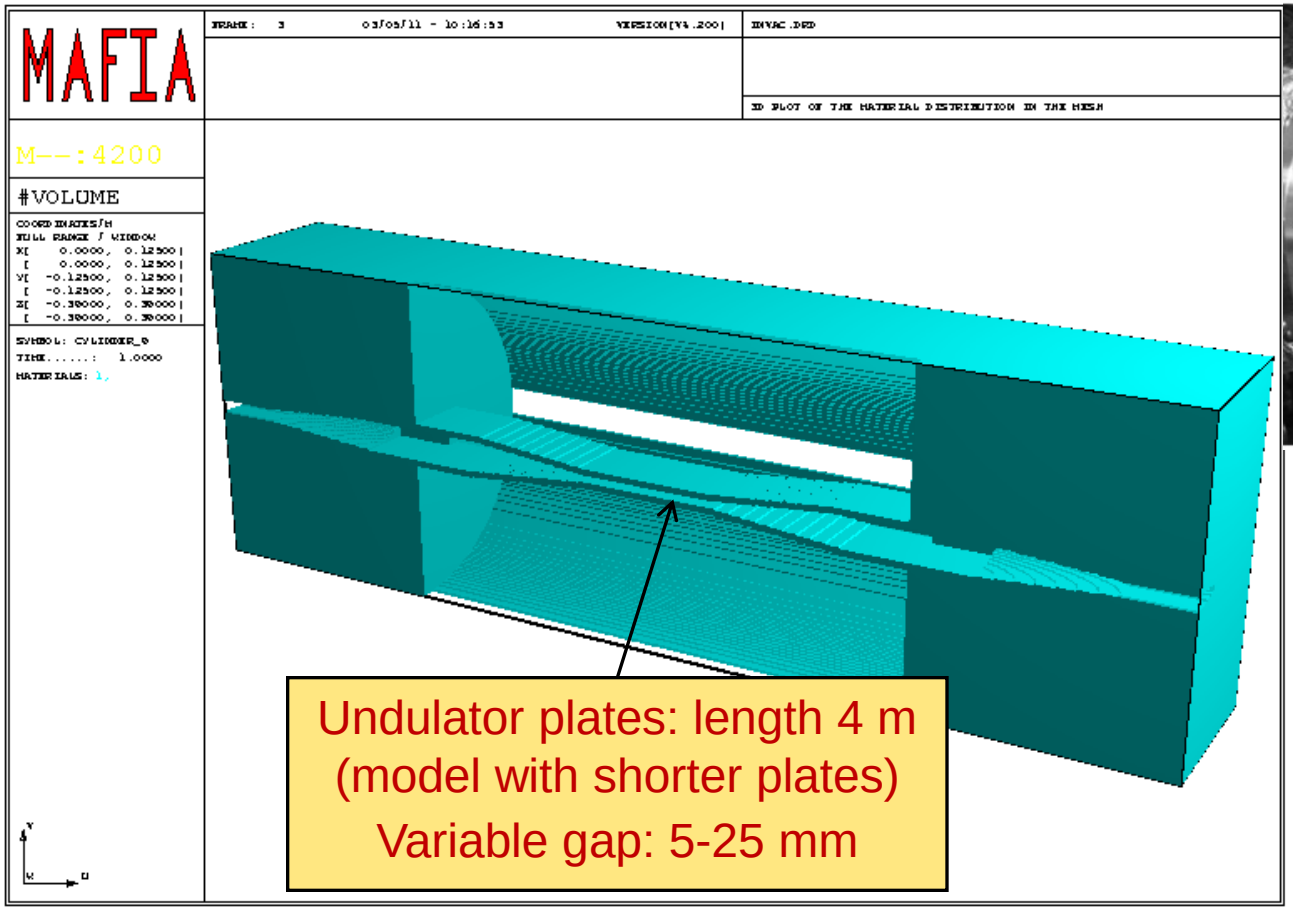
TECHNISCHE UNIVERSITÄT DARMSTADT

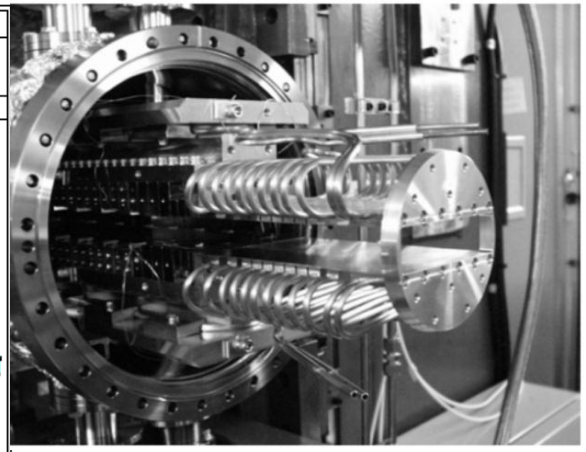




Source: R. Wanzenberg

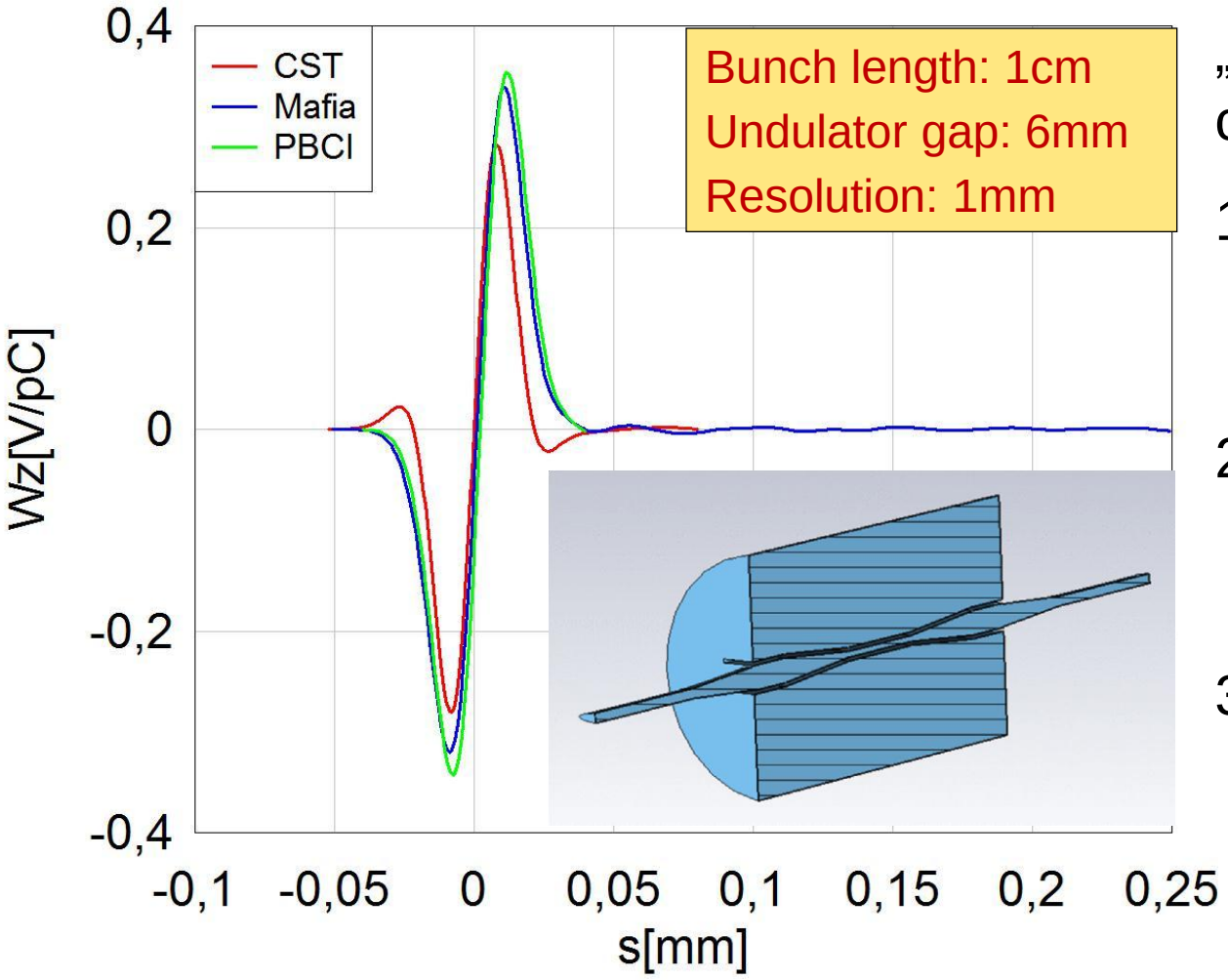
Geometry of tapered structure





Source: R. Wanzenberg

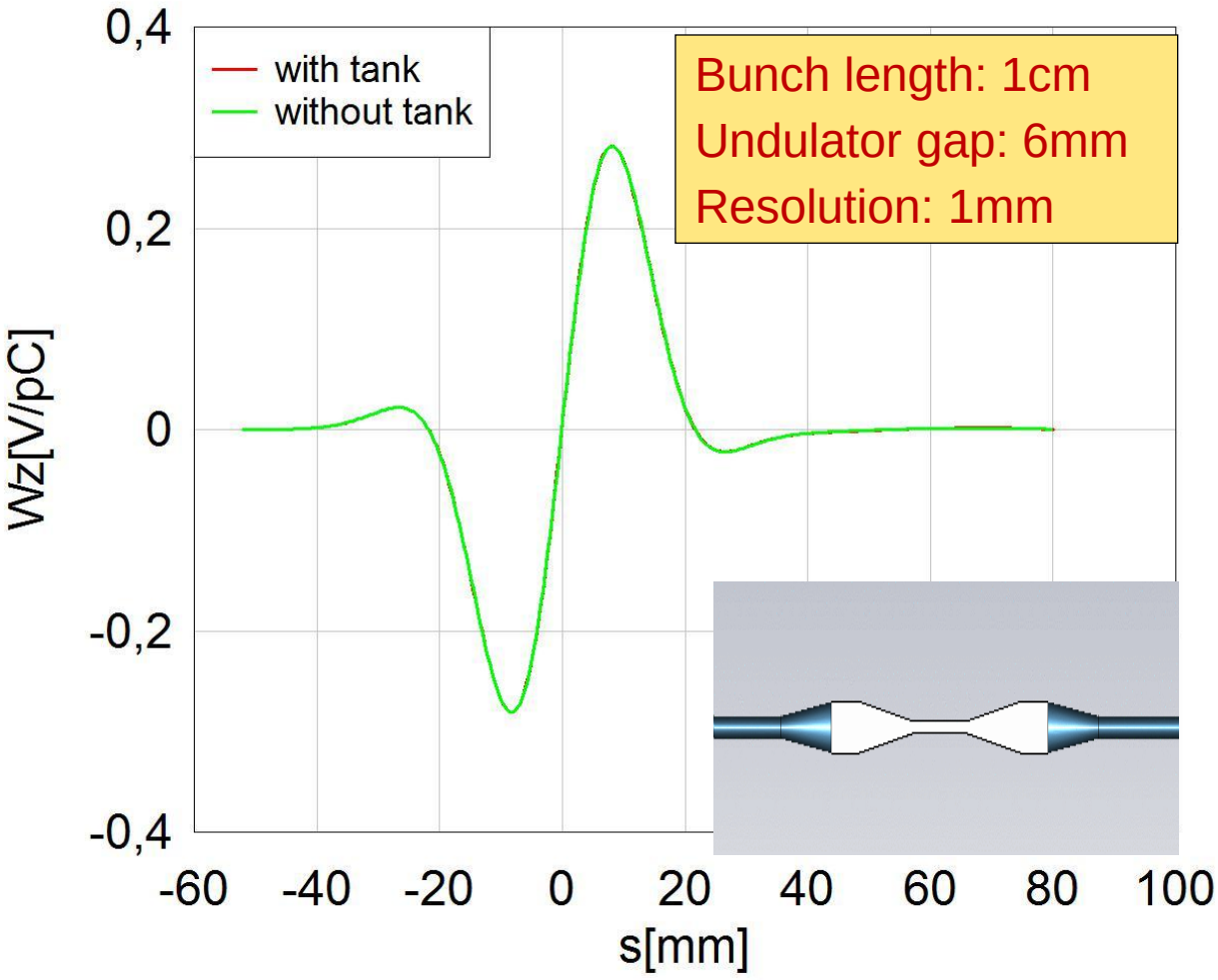
Wake potential calculations



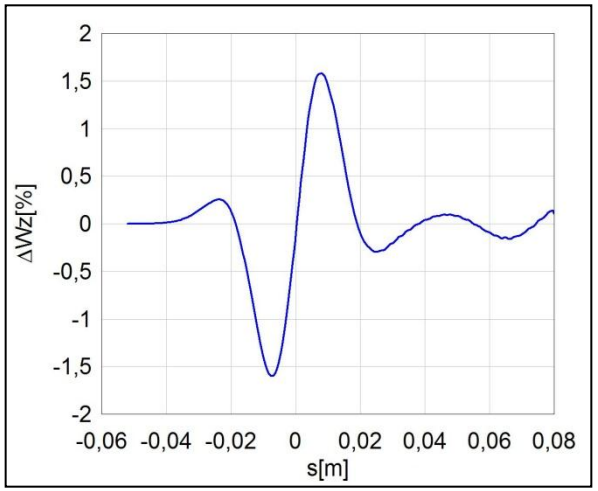
„Standard“ parameter calculations:

1. Large differences in longitudinal wake potential
2. Transversal grid resolution very critical
3. Usual 10 lines / sigma rule appears to be misleading

Structure simplification (CST PS)

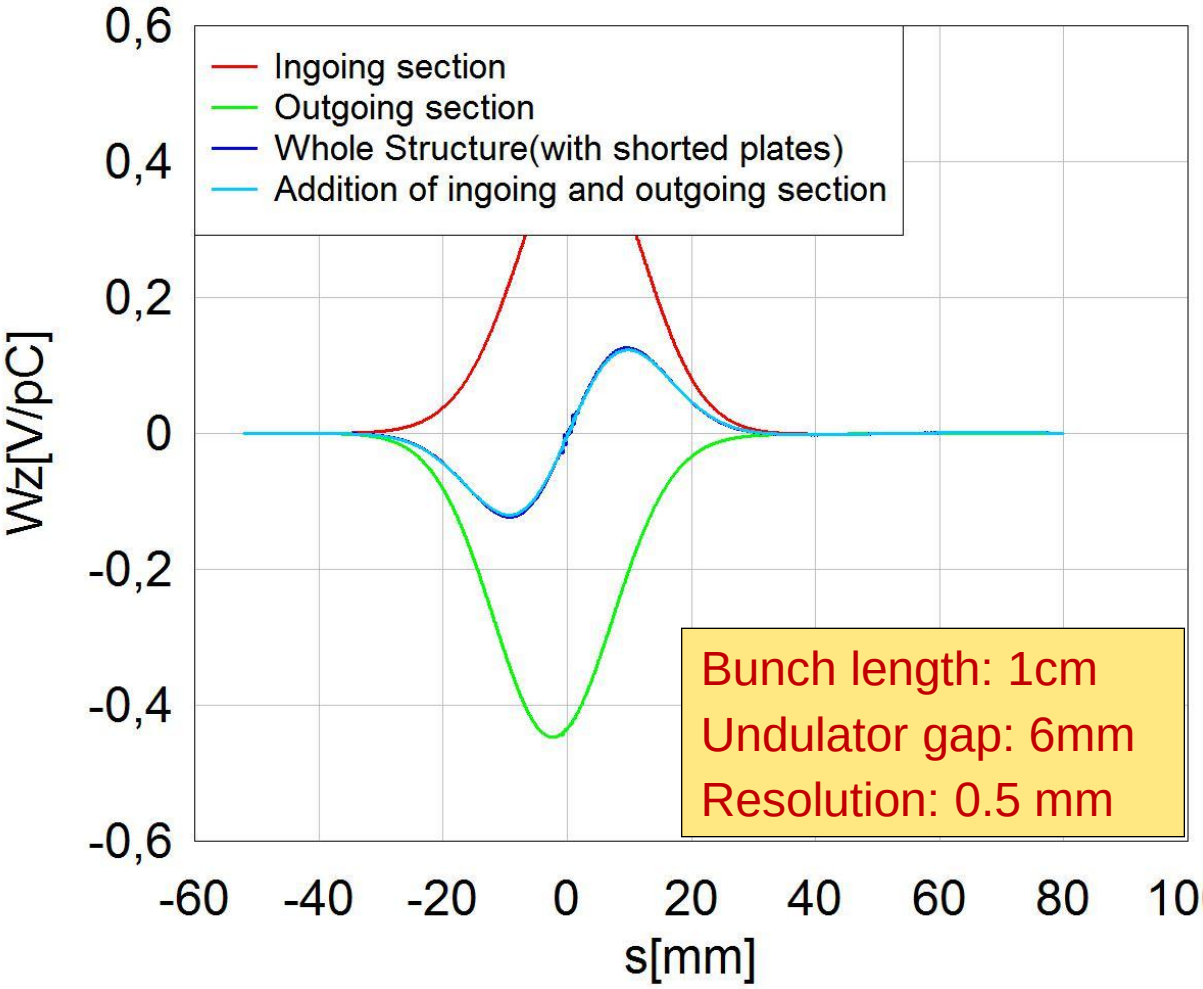


Influence of vacuum tank

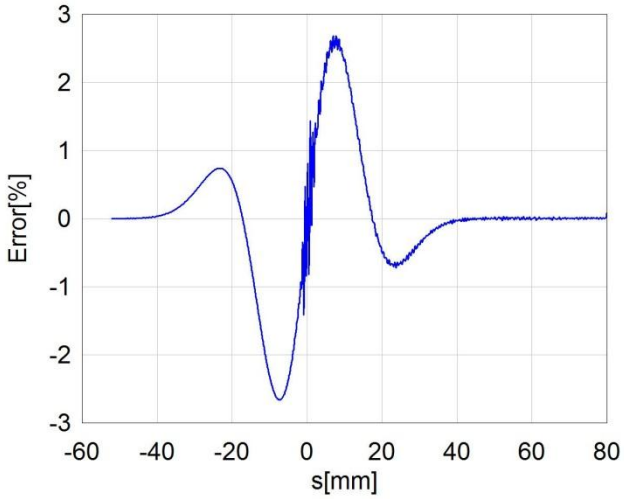


Structure simplification with less than 2% difference in long. wake potential.

Simulation simplification (CST PS)

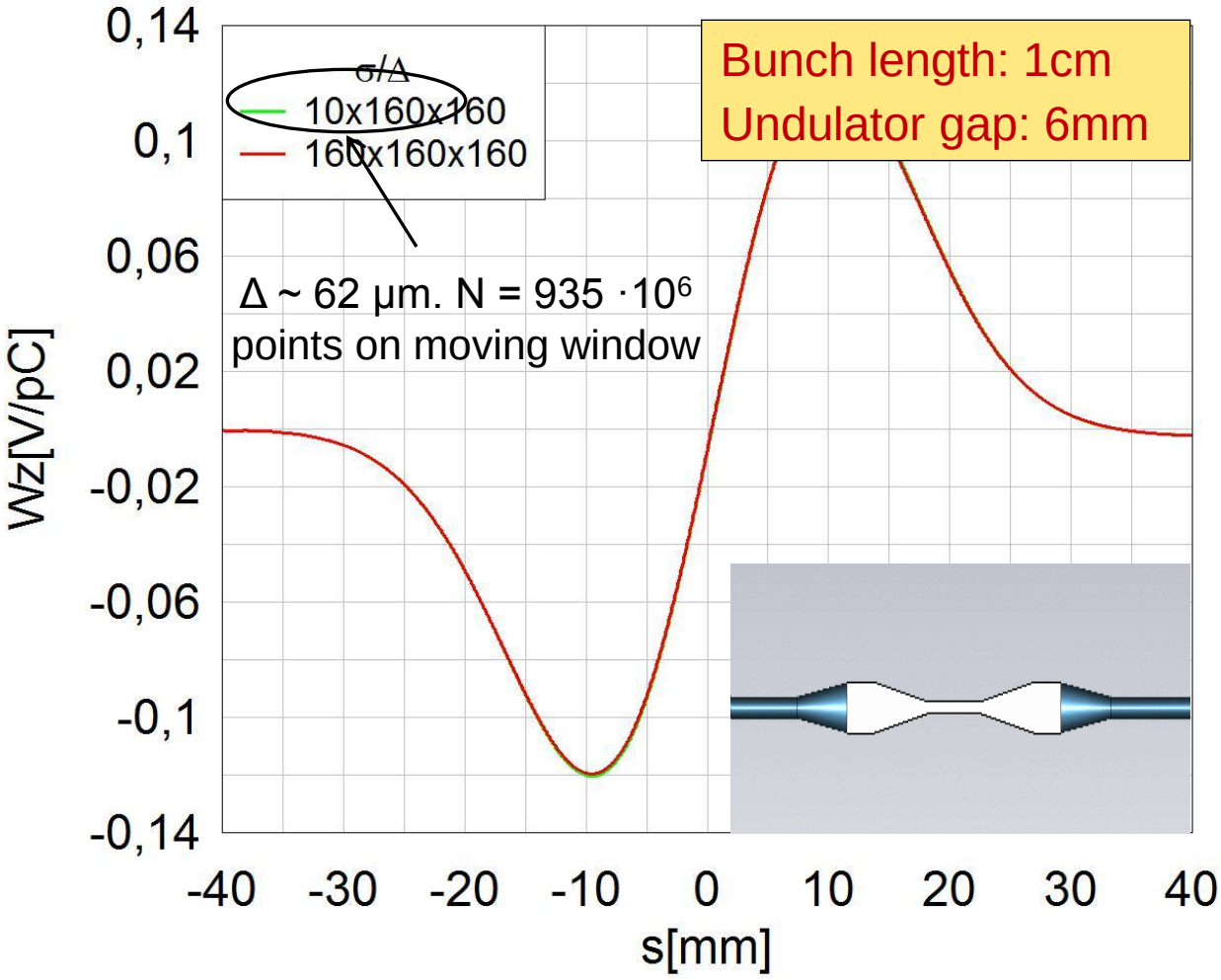


Influence of undulator plate length

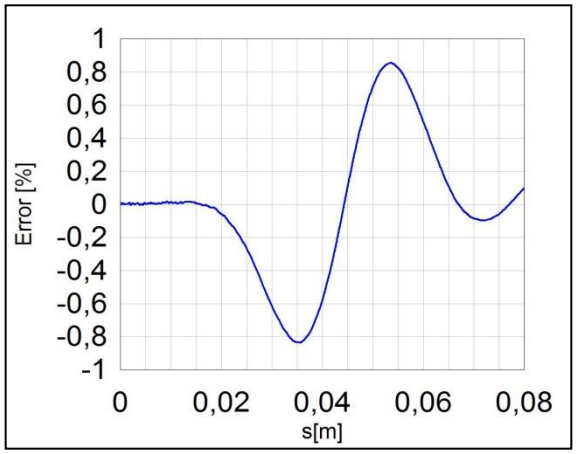


Structure simplification with less than 3% difference in long. wake potential.

Mesh simplification (PBCI)



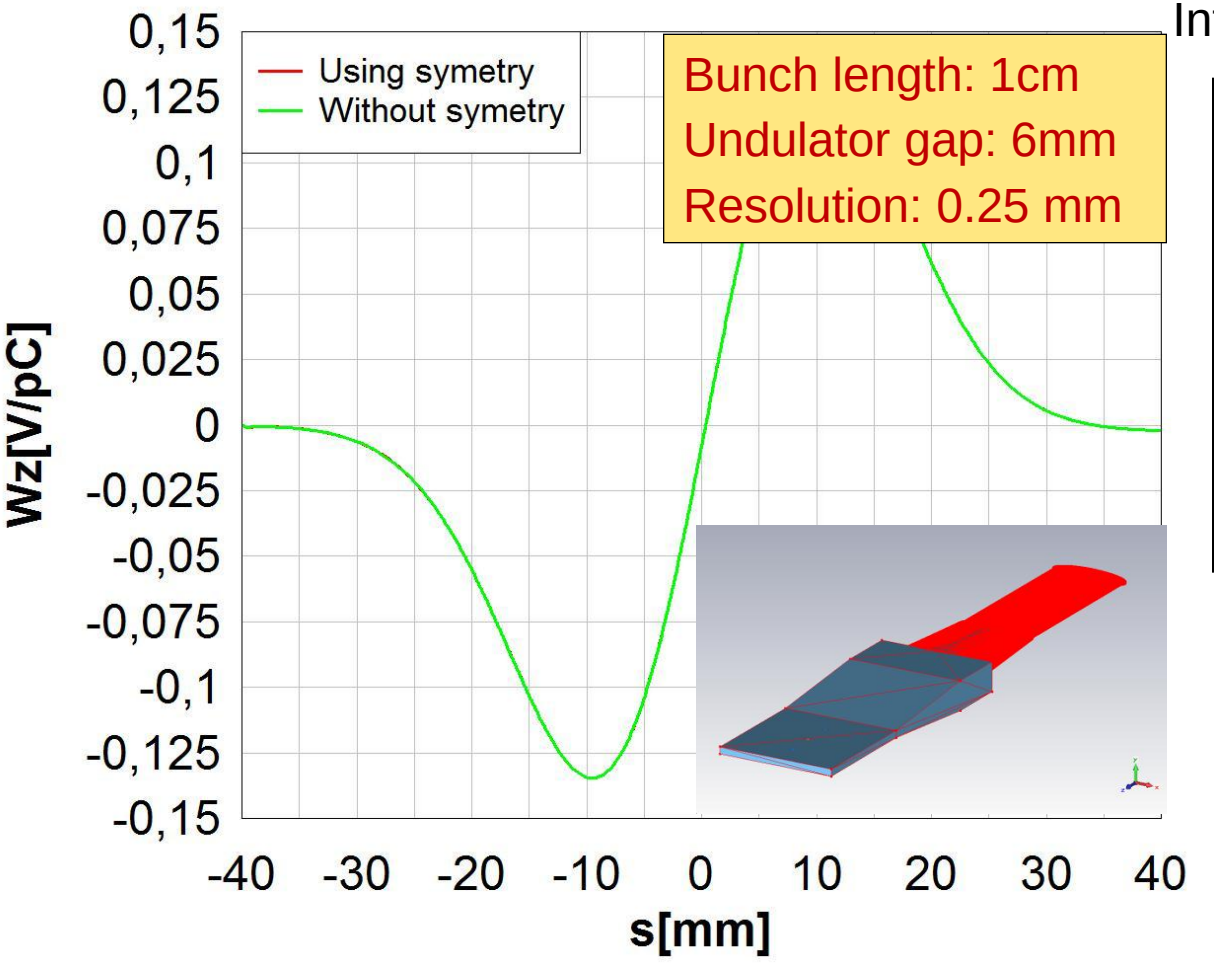
Influence of anisotropic mesh



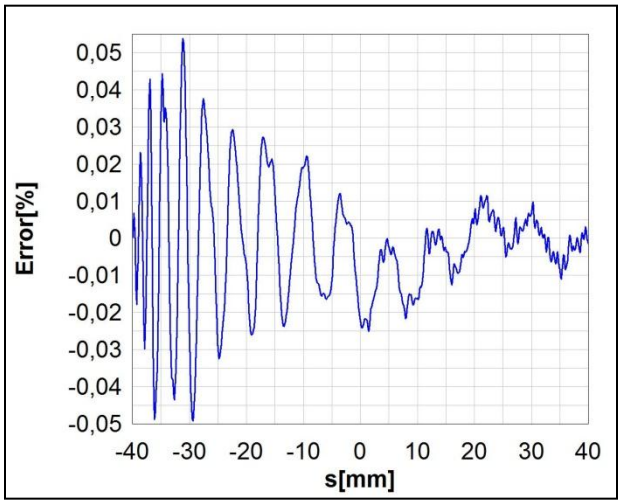
Mesh refinement only in critical direction (small side of pipe)

Less than 1% error with simplified mesh

New in PBCI: Symmetry boundary condition



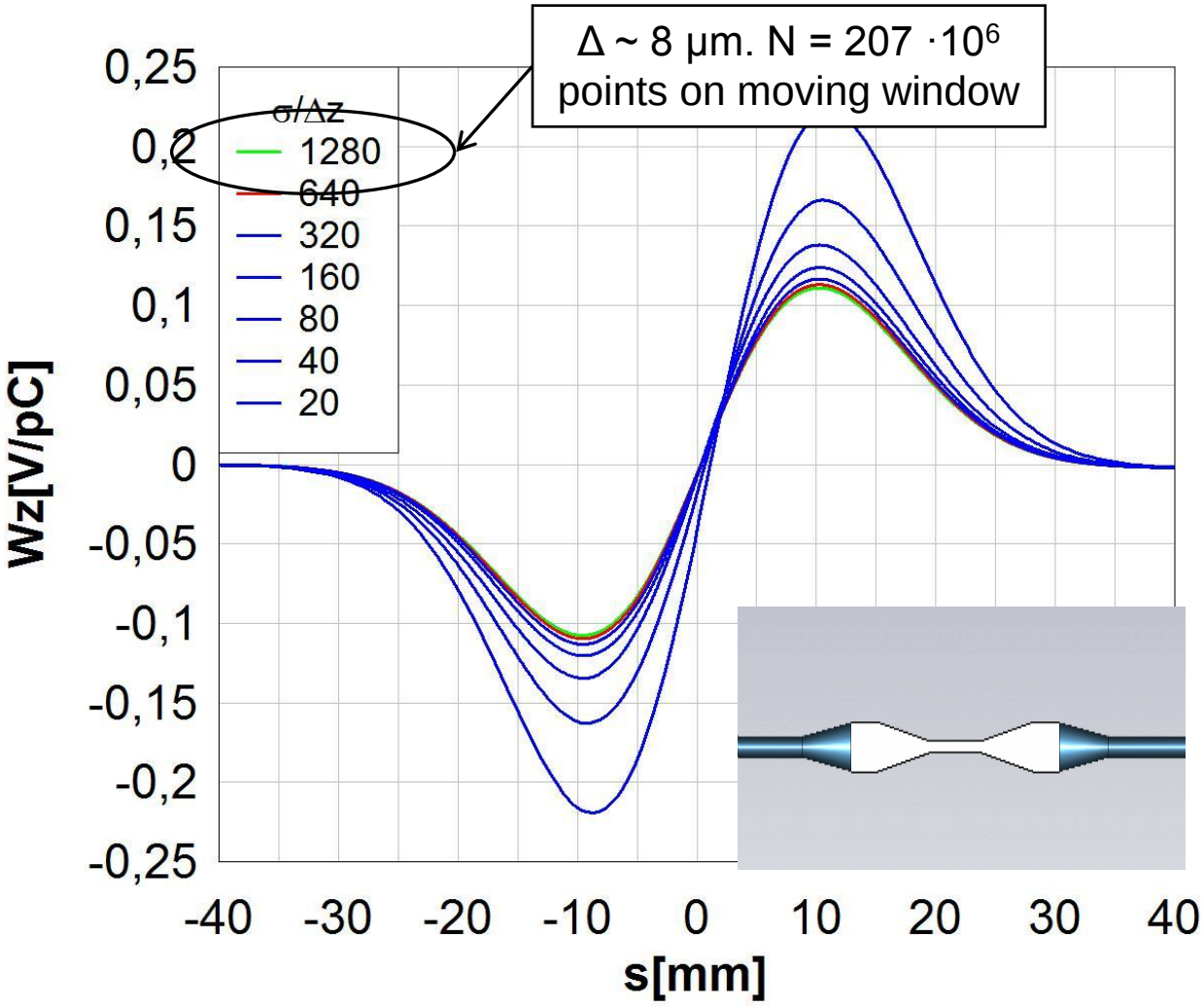
Influence of symmetrized problem



Calculation of only ¼ of the structure

Less than 0,05% error with symmetric boundary

PBCI calculations

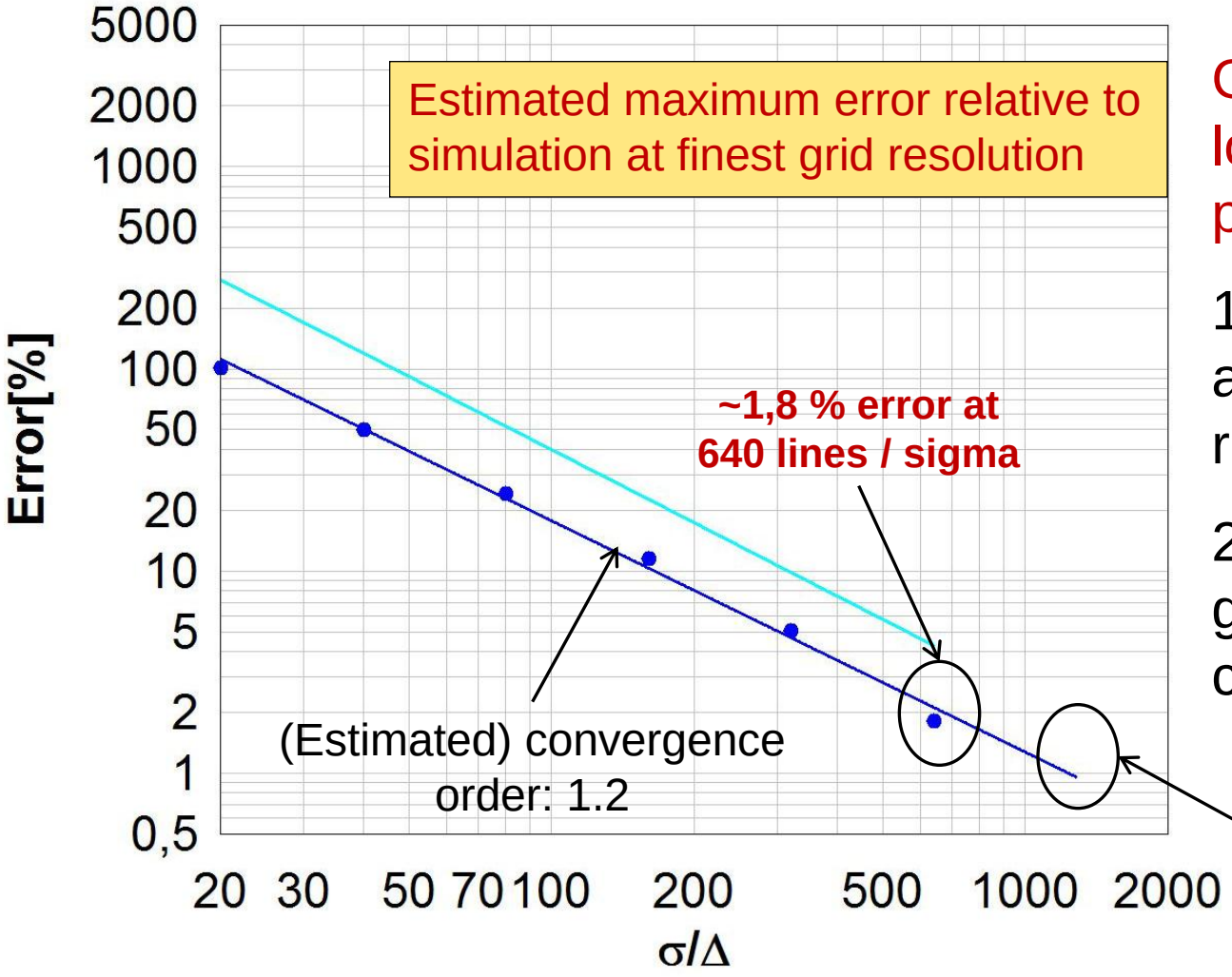


Slow convergence for longitudinal wake potential:

1.Only possible with anisotropic mesh refinement and symmetry boundary condition

2. Sim. time at finest grid: ~ 56 hrs on 2040 cores

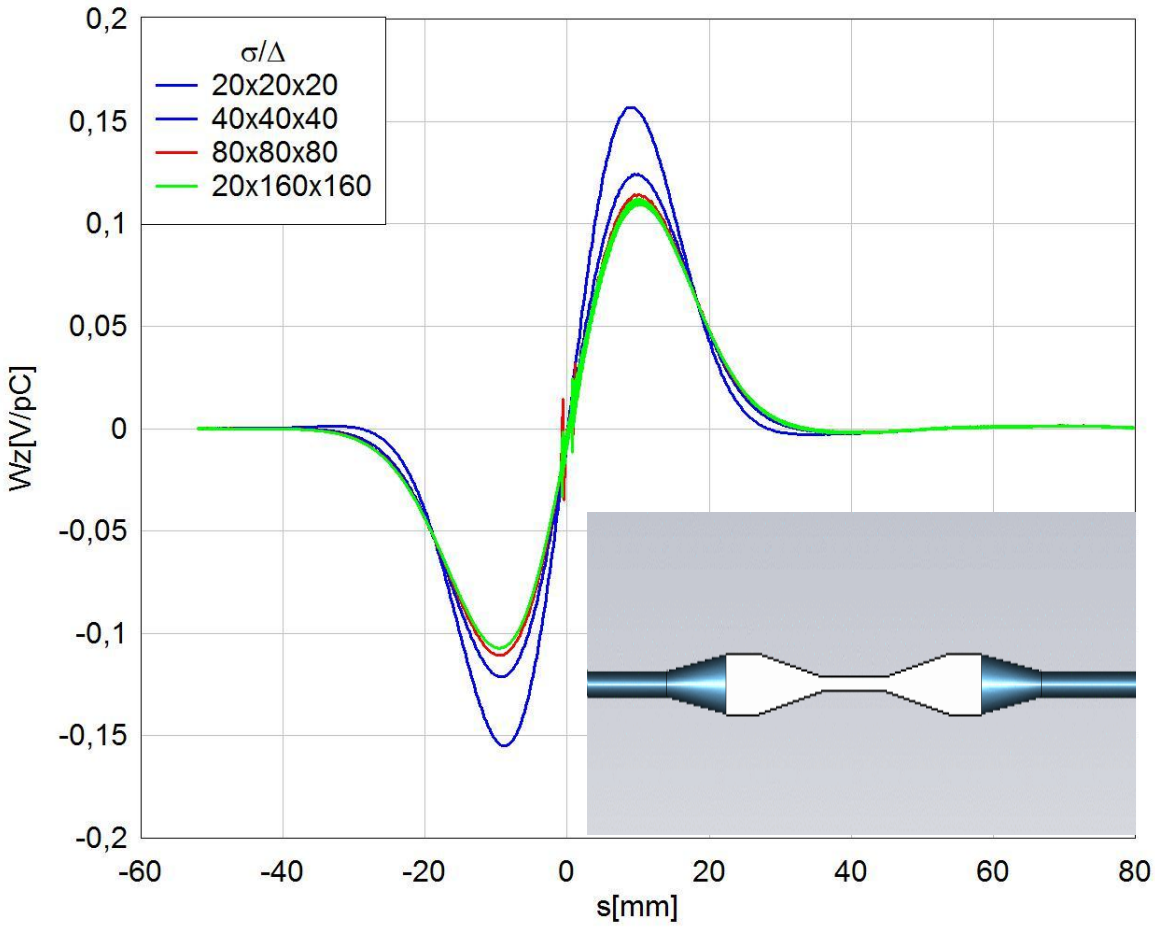
PBCI calculations



Grid convergence of longitudinal wake potential:

1. Only possible with anisotropic mesh refinement
2. Sim. time at finest grid: ~16 hrs on 2040 cores

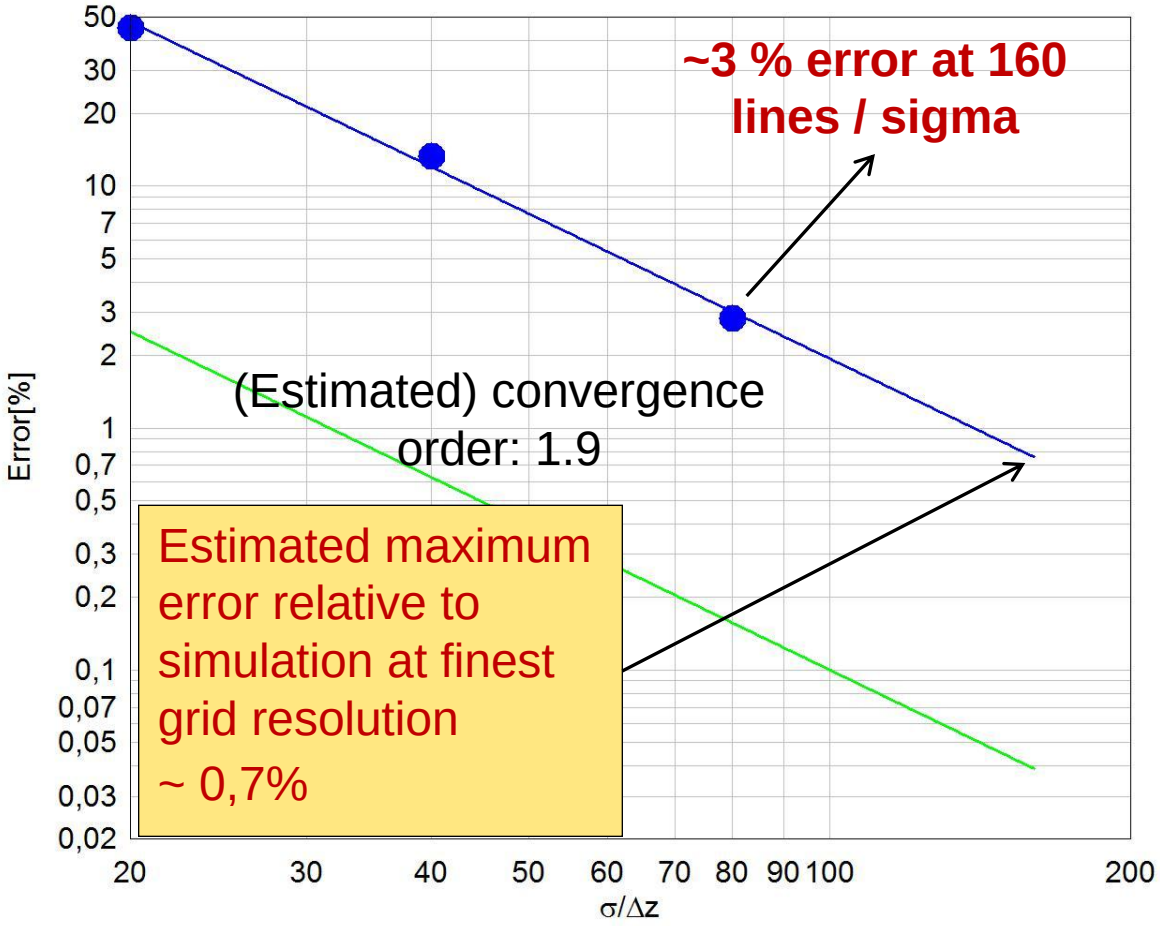
CST-PS Simulations



Grid convergence of longitudinal wake potential:

1.Sim. time at finest grid (~160 $\cdot 10^6$ grid points): ~15 hrs

CST-PS Simulations



Grid convergence of longitudinal wake potential:

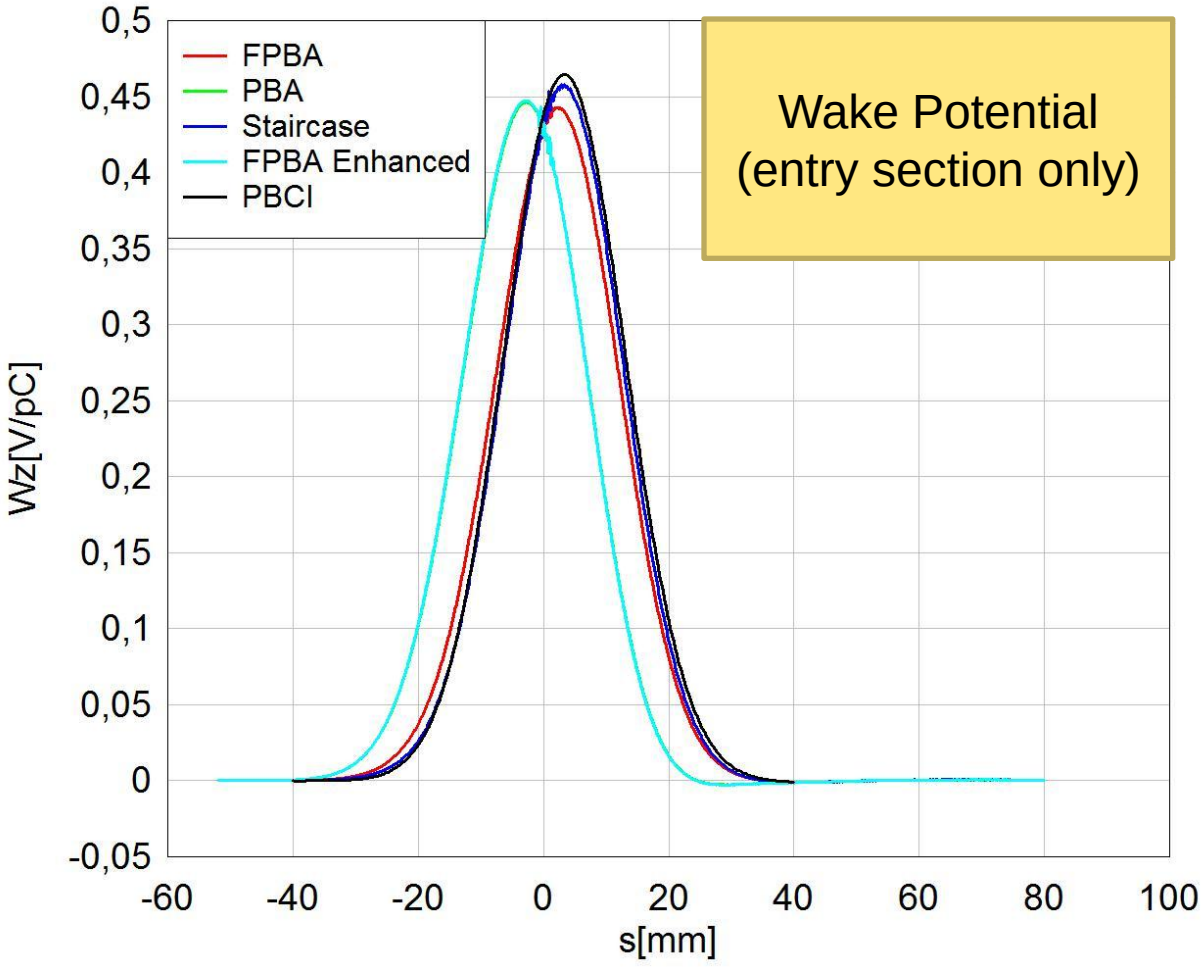
1. Sim. time at finest grid (~160 $\cdot 10^6$ grid points): ~15 hrs
2. Finer simulations possible

Boundary Approximation

TECHNISCHE UNIVERSITÄT DARMSTADT

- Problem is stronly geometry dominated
  - Slower convergence in PBCI (and MAFIA)
  - Better convergence in CST PS
  - Nevertheless, absolute accuracies obtained in both cases are comparable due to the higher resolution in PBCI
  - Simulation issues in CST PS
    - Different behavior for different PBA types
    - Stability problems for high grid resolution

Boundary Approximation



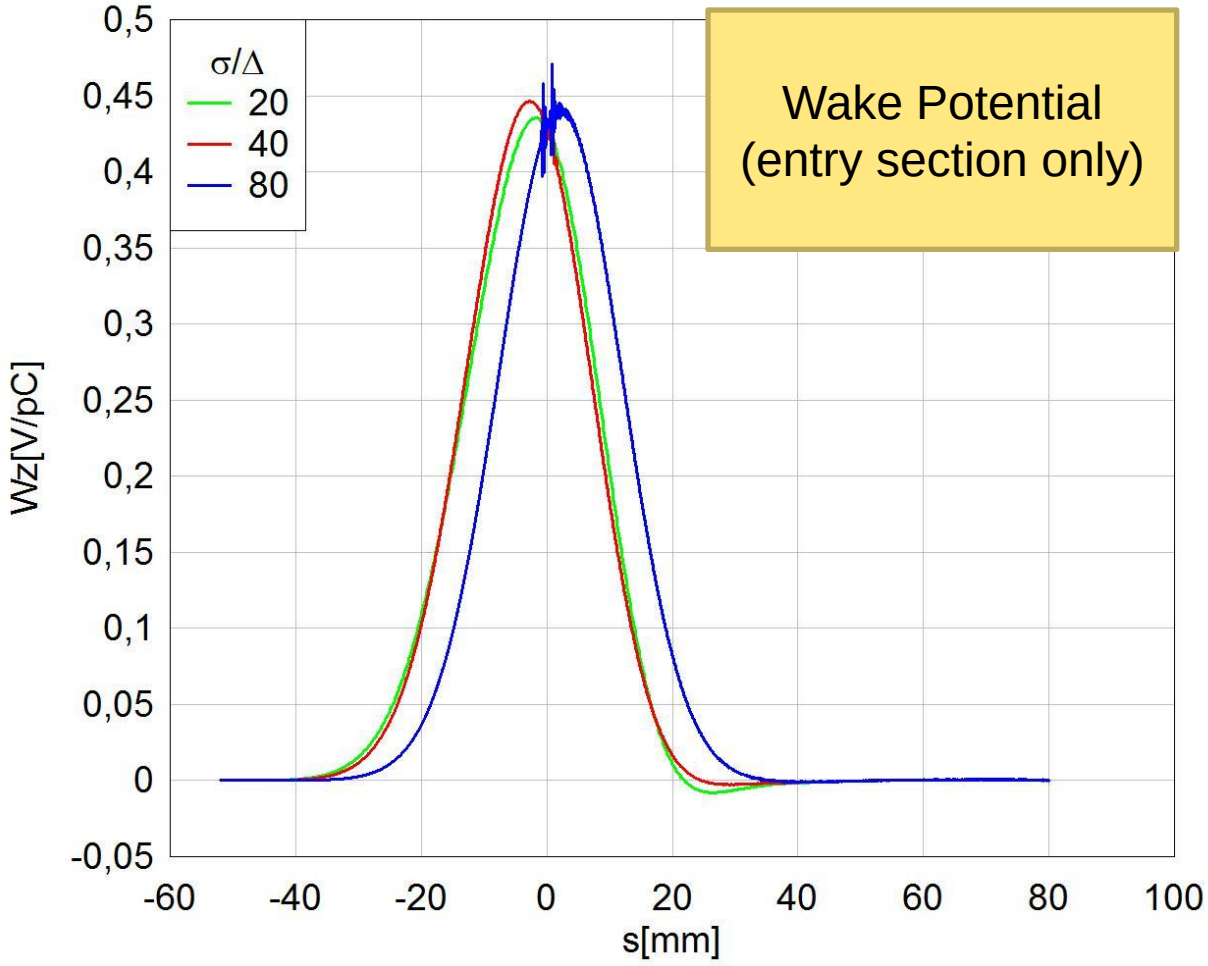
Wake Potential
(entry section only)

Perfect Boundary Approximation:

1. large differences for different PBA at fixed resolution

2. Obvious mesh problem (error?) in PBA and FPBA-E results

Boundary Approximation

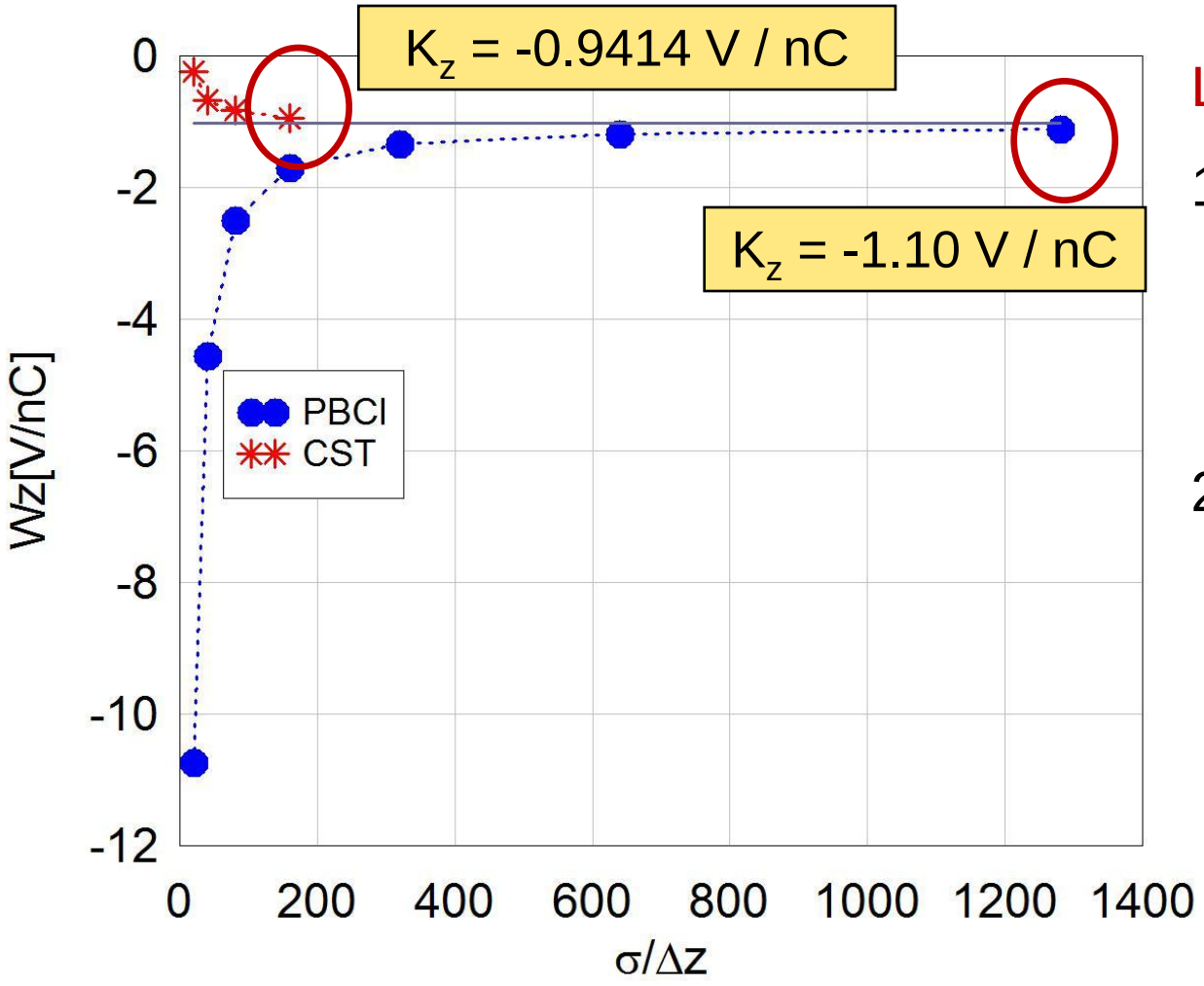


Wake Potential
(entry section only)

Perfect Boundary Approximation:

1. leads to different results for low resolutions
2. behavior changes suddenly at higher resolutions
3. strange oscillations at high resolution. Stability problem?

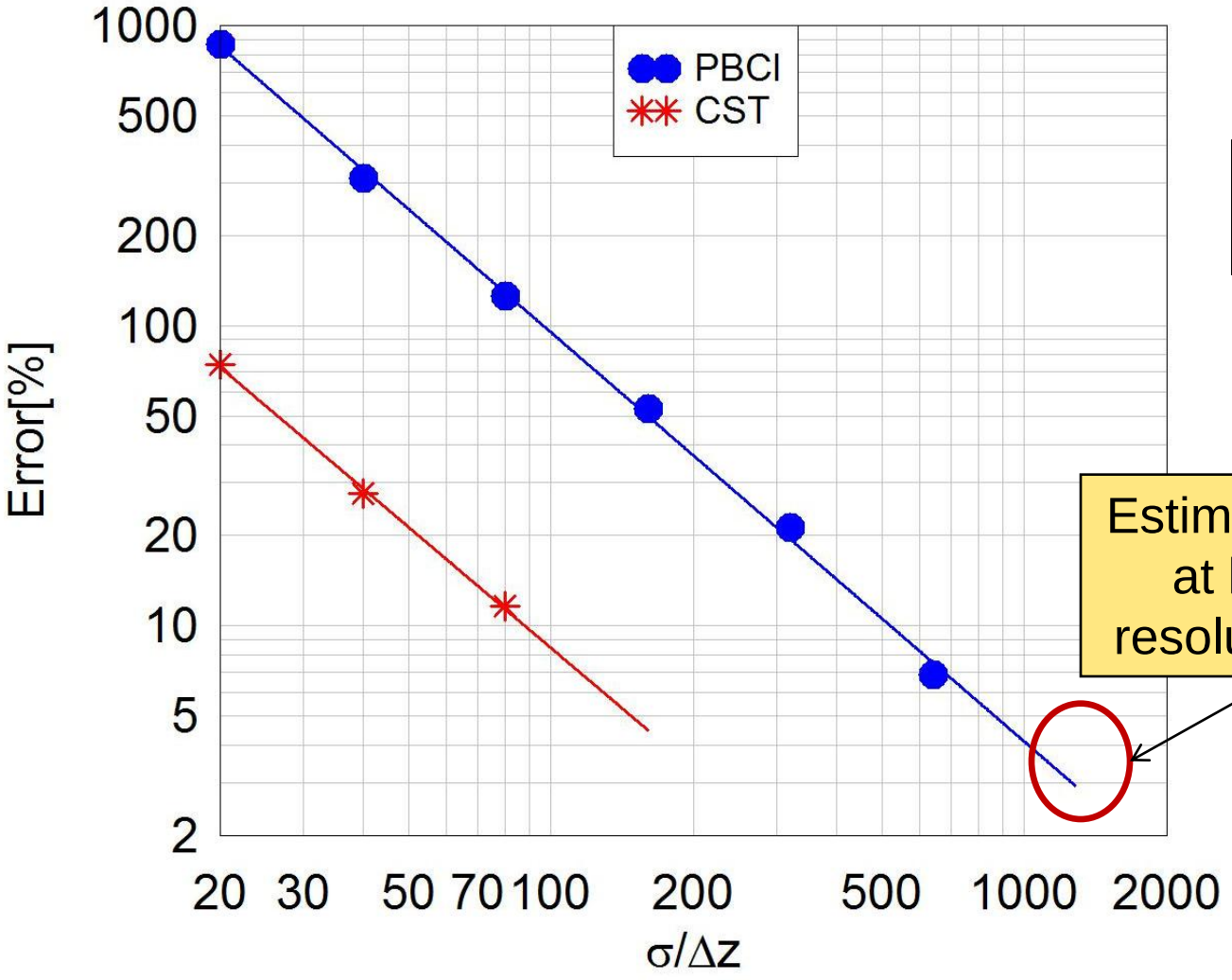
Loss Factor



Loss Factor calculation:

1. PBCI and CST calculations converge from different sides
2. Upper and lower estimation possible

Loss Factor

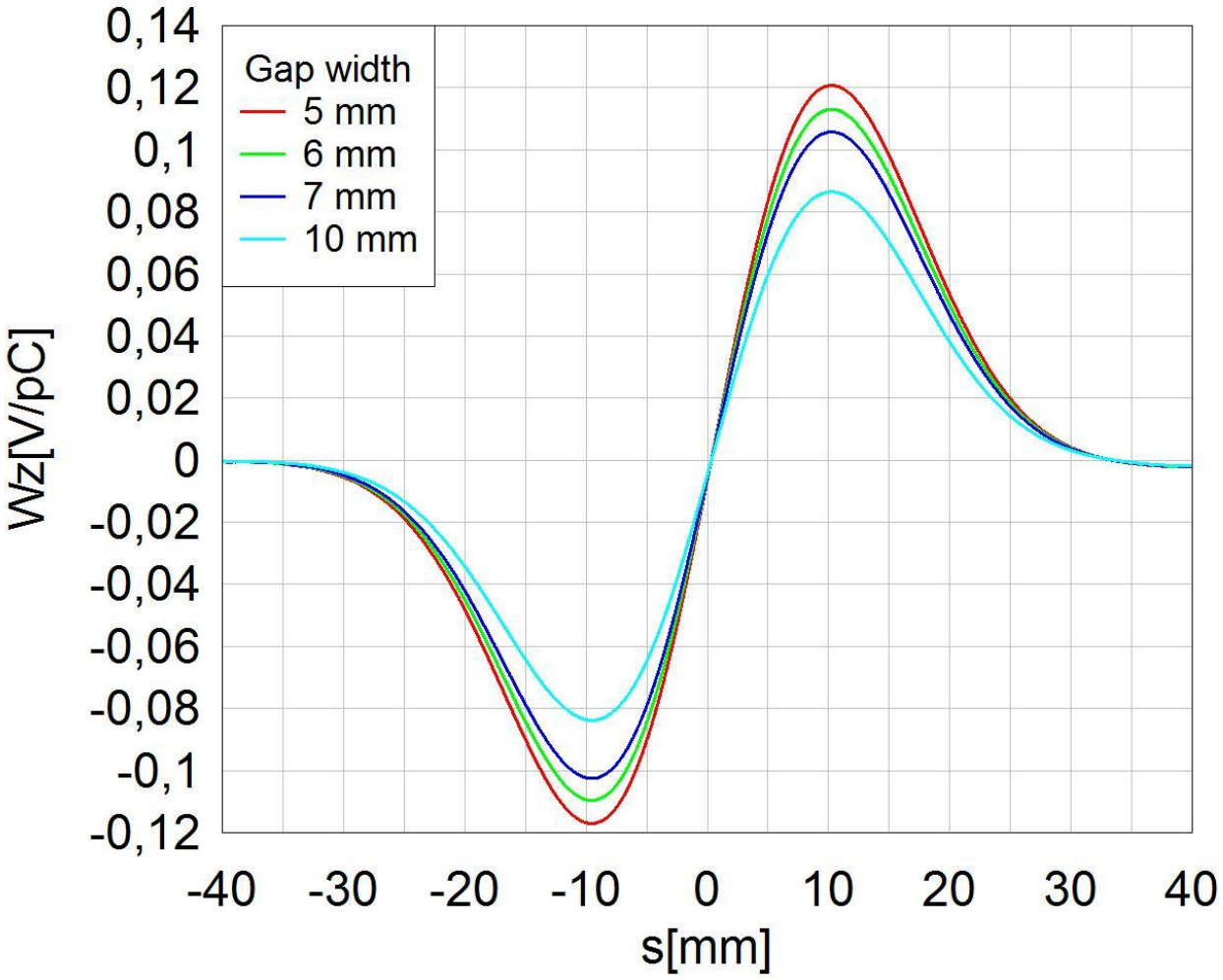


K_z = -1.18 V / nC

Bunch length: 1cm
Undulator gap: 6mm

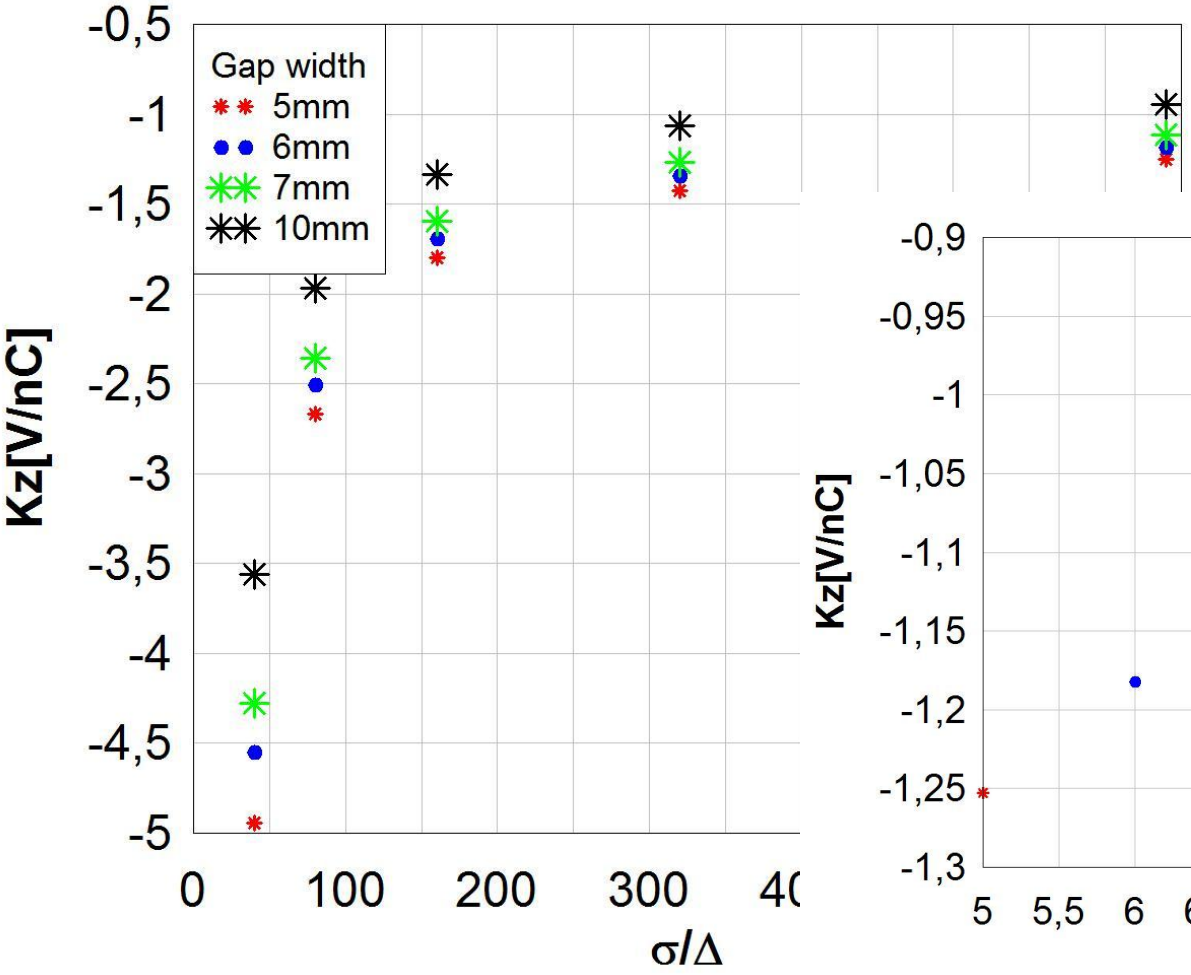
Estimated Error at highest resolution ~3%

PBCI simulations

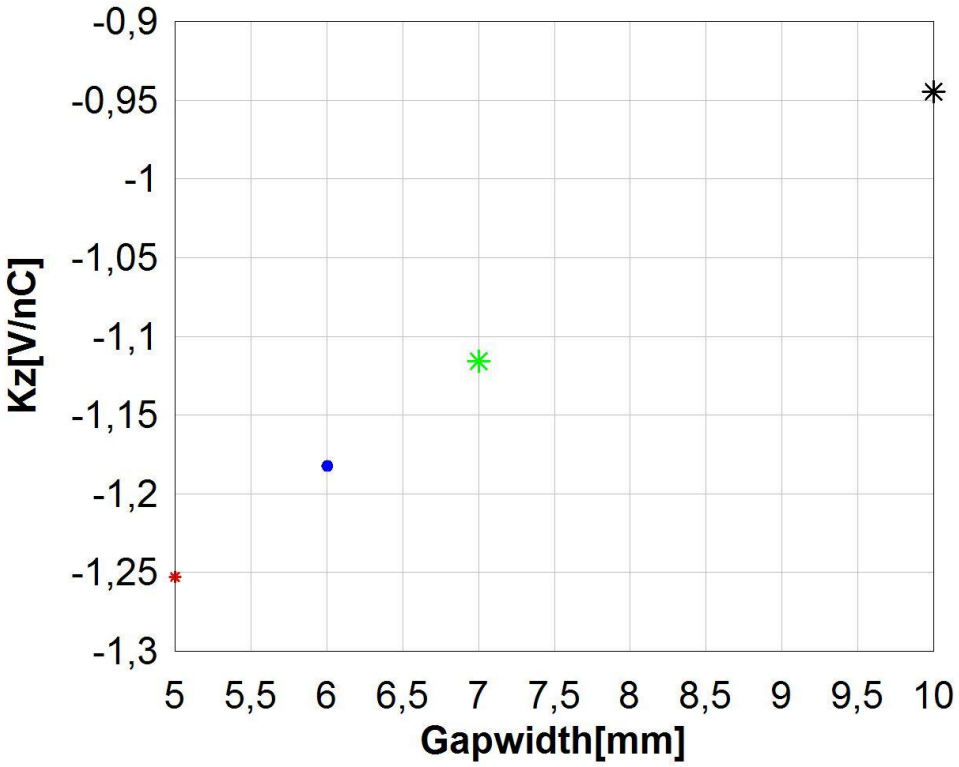


Longitudinal wake potential for different gap widths

PBCI simulations



Loss factors for different gaps



Thank you very much for your attention