TECHNISCHE UNIVERSITÄT DARMSTADT

Institut für
Theorie Elektromagnetischer Felder

Lab Report

TEMF - TU Darmstadt

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T. Lau, W.F.O. Müller, S. Setzer,
T. Weiland, I. Zagorodnov

TESLA Collaboration Meeting
DESY, Zeuthen, 01/21/04

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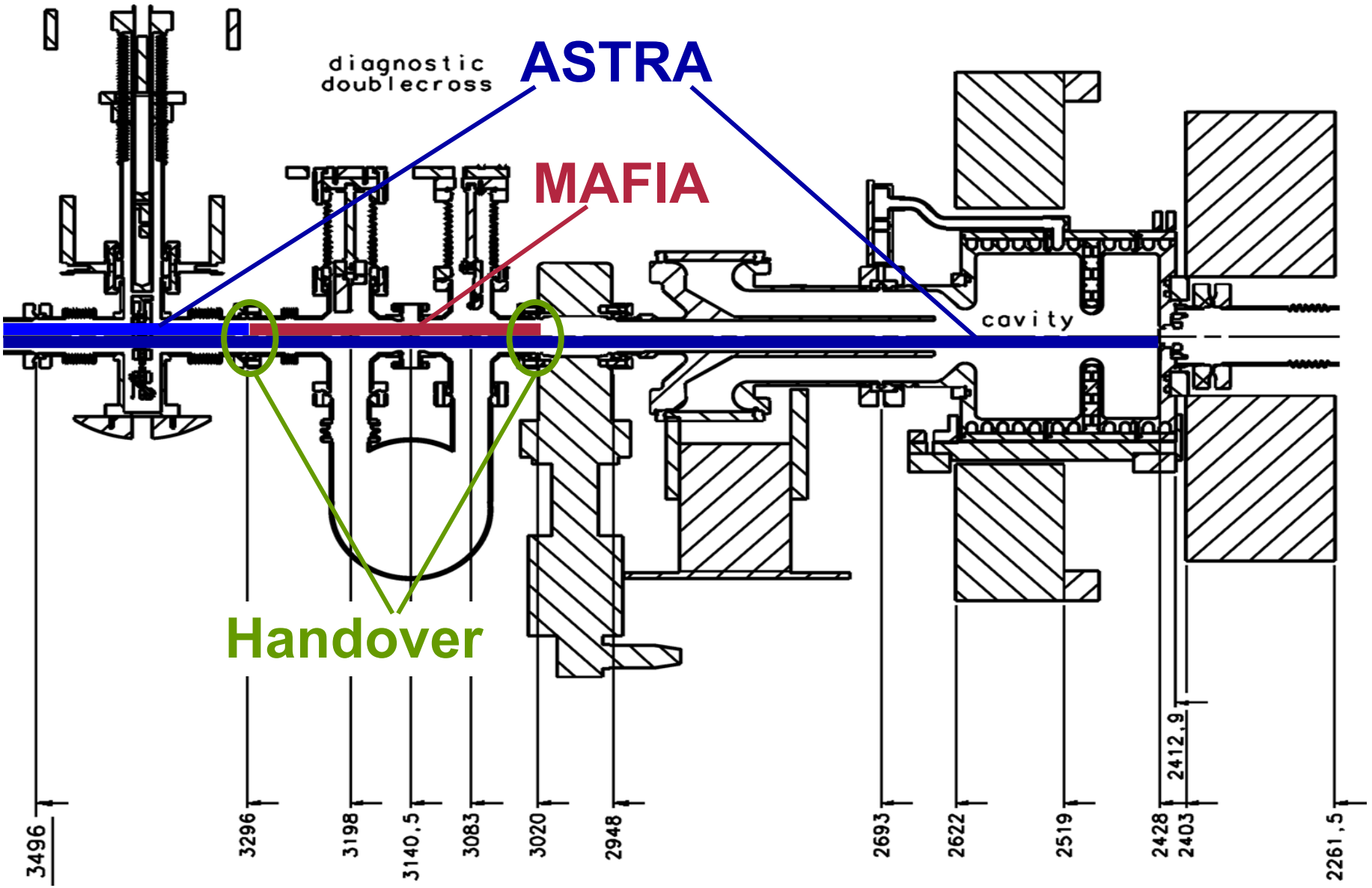
Outline

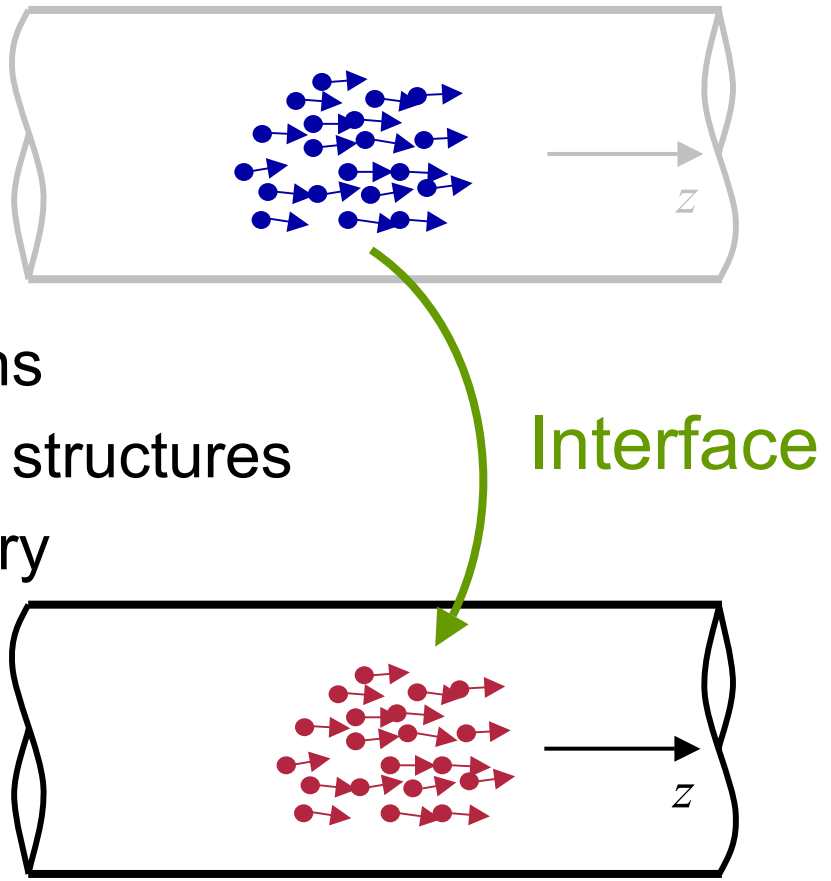
- Wakefield Simulations for the PITZ-Injector (W. Ackermann, S. Setzer)
- Wakefields in the 3rd Harmonic Structure (I. Zagorodnov)

Gun Layout


diagnostic
doublecross
ASTRA
MAFIA
cavity
Handover
3496
3296
3198
3140,5
3083
3020
2948
2693
2622
2519
2428
2412,9
2403
2261,5

ASTRA to MAFIA Interface

- ASTRA
  - fast & efficient
  - no interaction between boundary and beam
- MAFIA
  - full set of Maxwells equations
  - interaction with surrounding structures
  - limited by cpu time & memory



Parameters used for Simulations (1)

- Solenoid Settings

$B_z = 175\ \mathrm{mT},\ z = 0.275\ \mathrm{m}$

- RF-Gun Settings

$E_{Acc} = 42\ \mathrm{MV/m},\ \varphi = 33°$

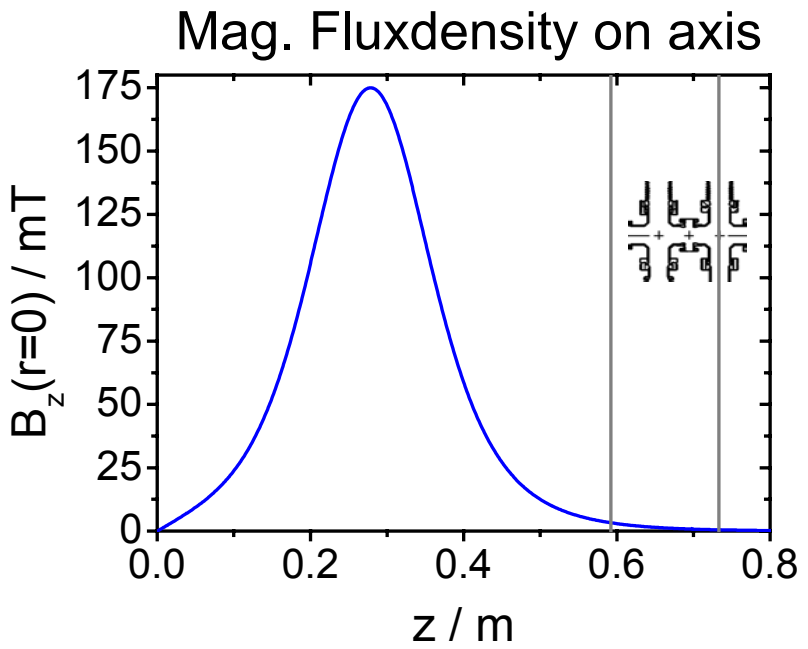
- Bunch Parameters

$T_{FWHM} = 20\ \mathrm{ps},\ T_{Rise} = 5\ \mathrm{ps}$ (Flat-Top)

$x,y_{RMS} = 0.5\ \mathrm{mm}$

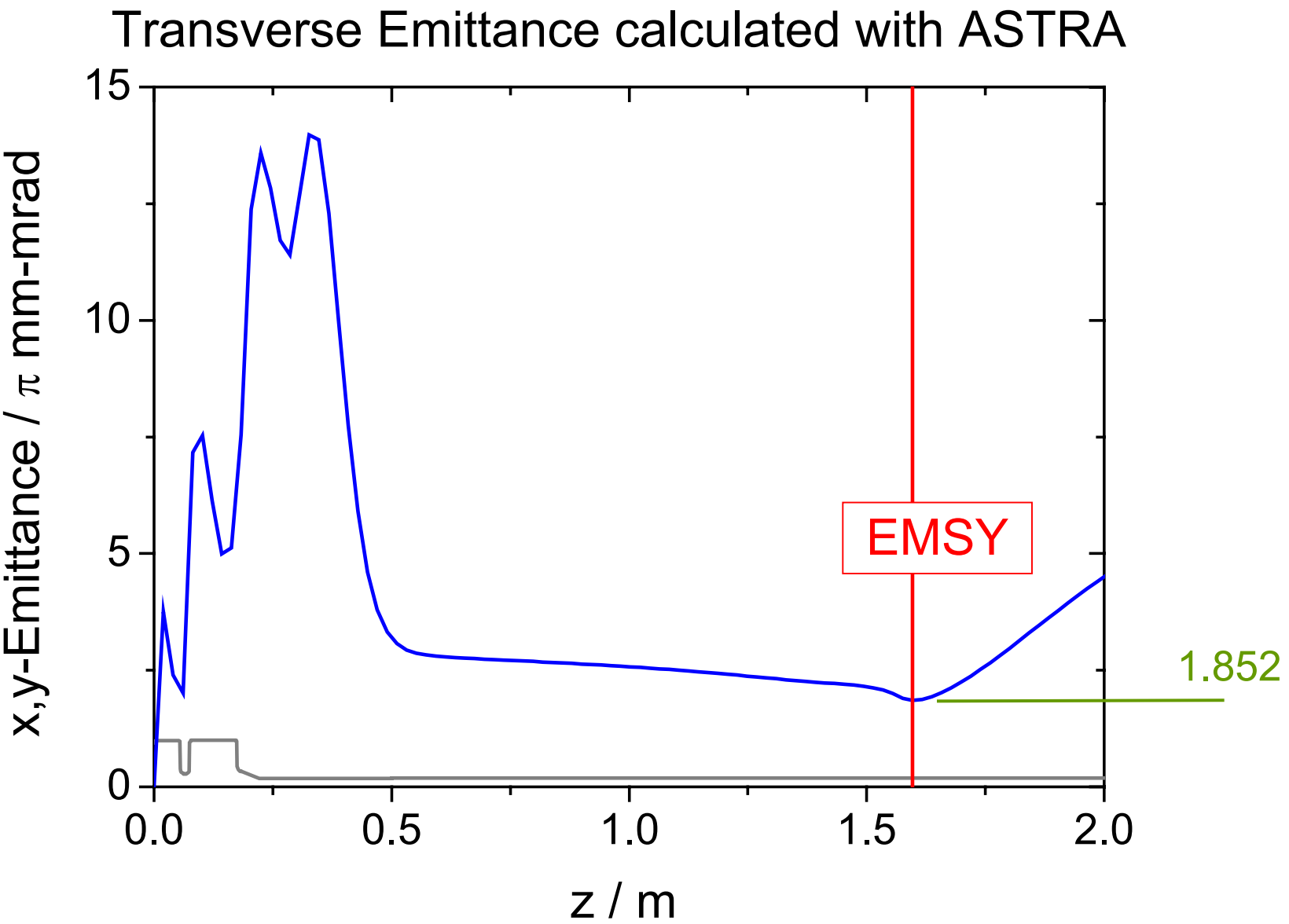
$Q = 1\ \mathrm{nC}$

50.000 Macroparticles

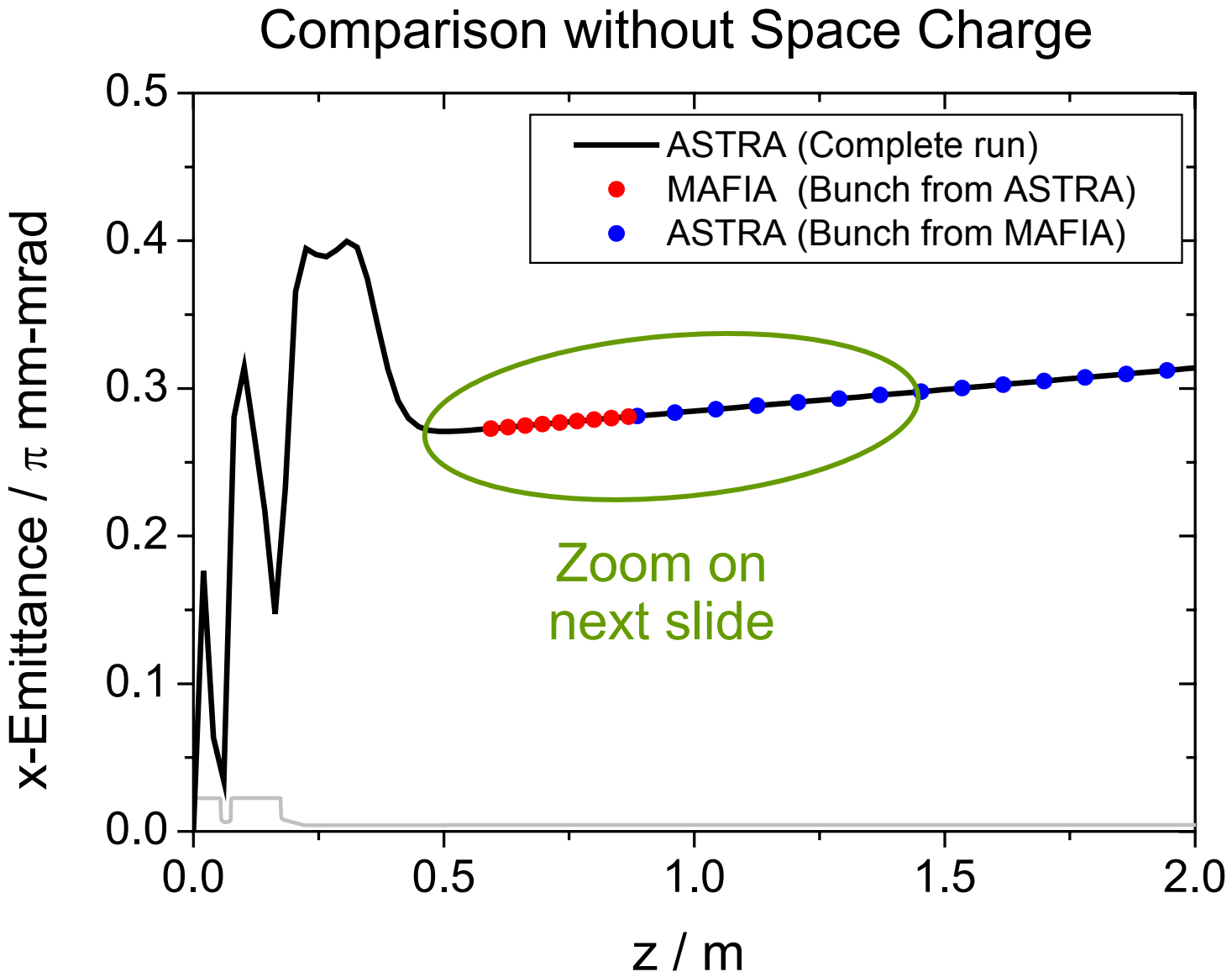


These parameters result in minimum transverse emittance @ EMSY

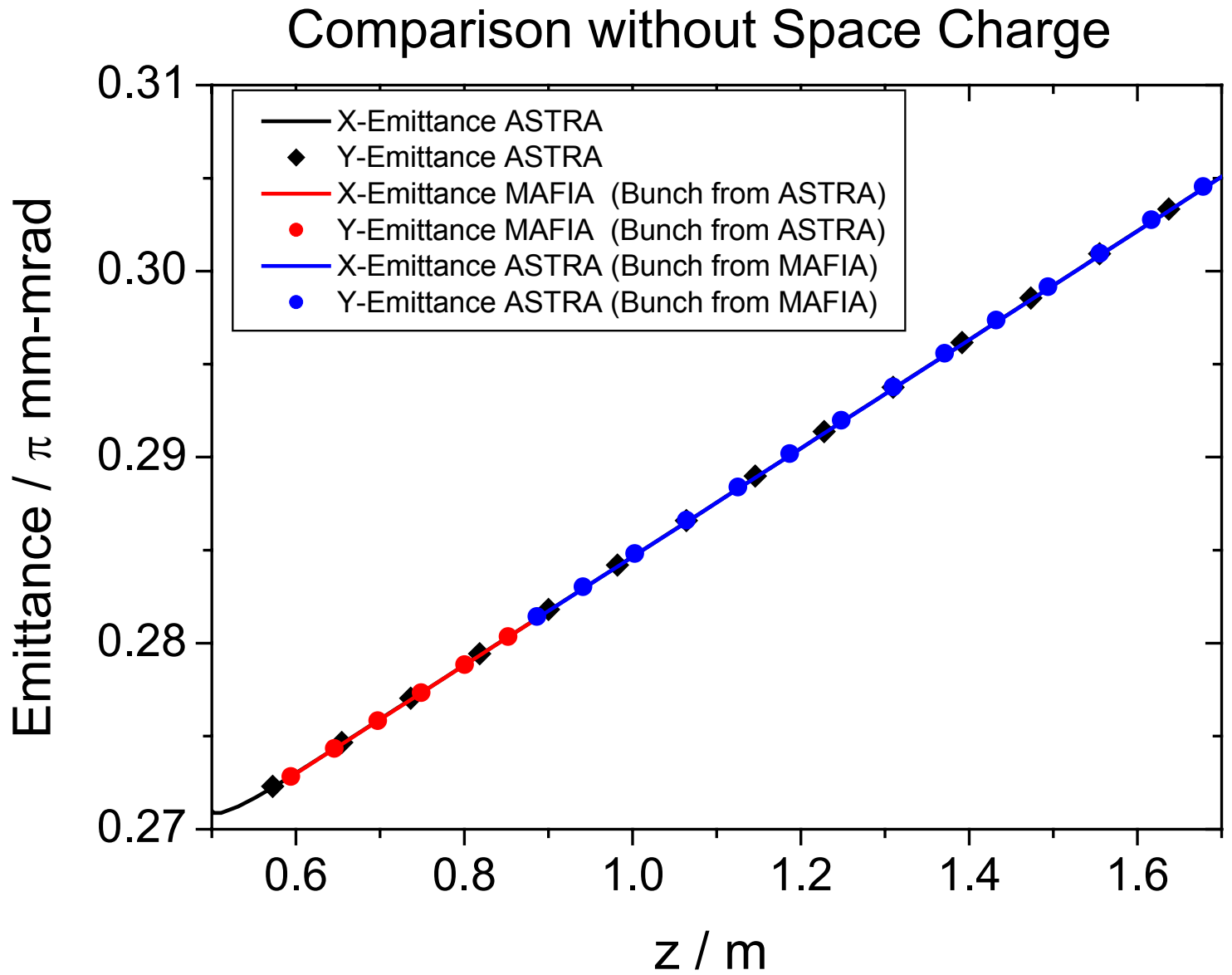
Parameters used for Simulations (2)



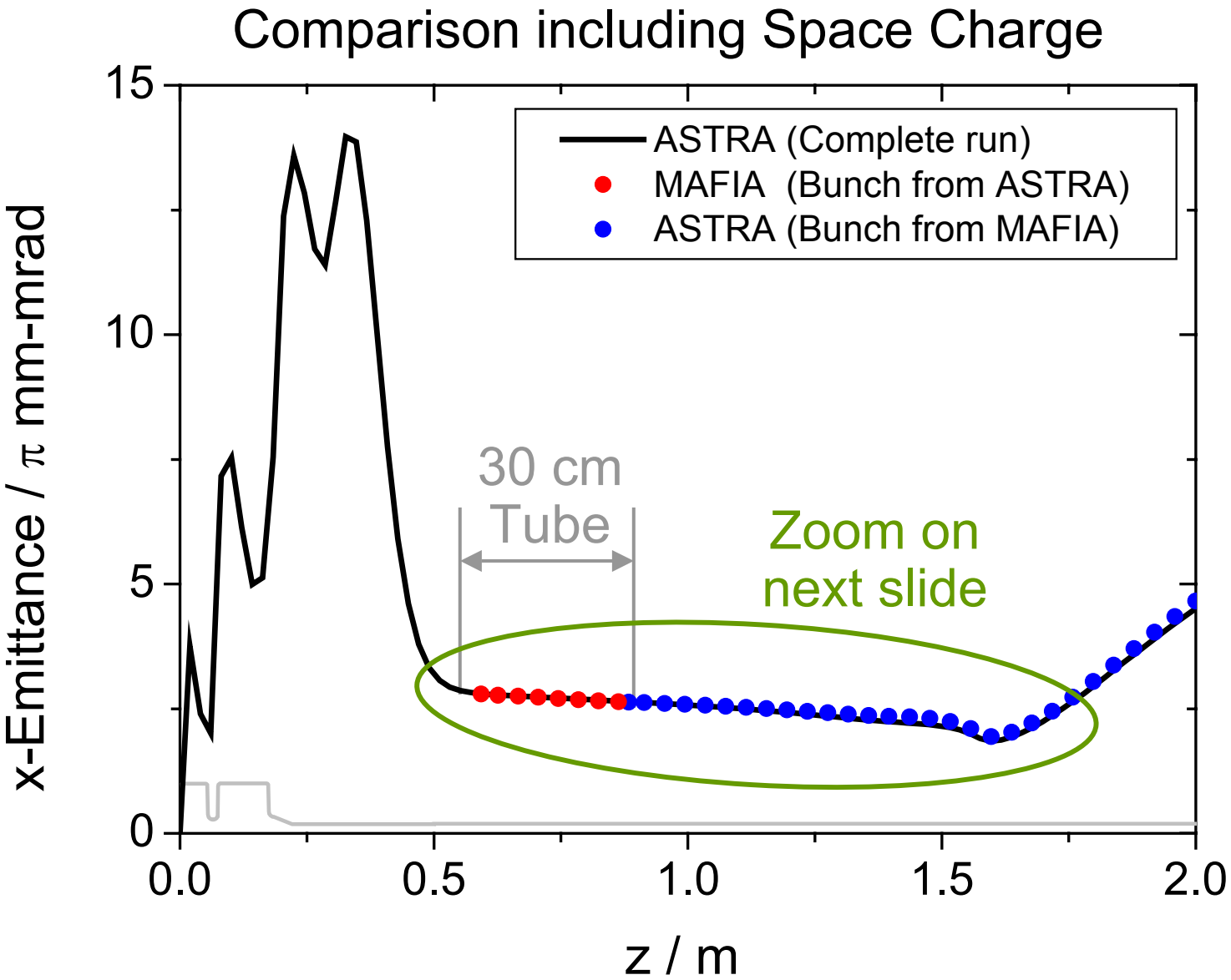
Interface Validation (1): Drift Tube



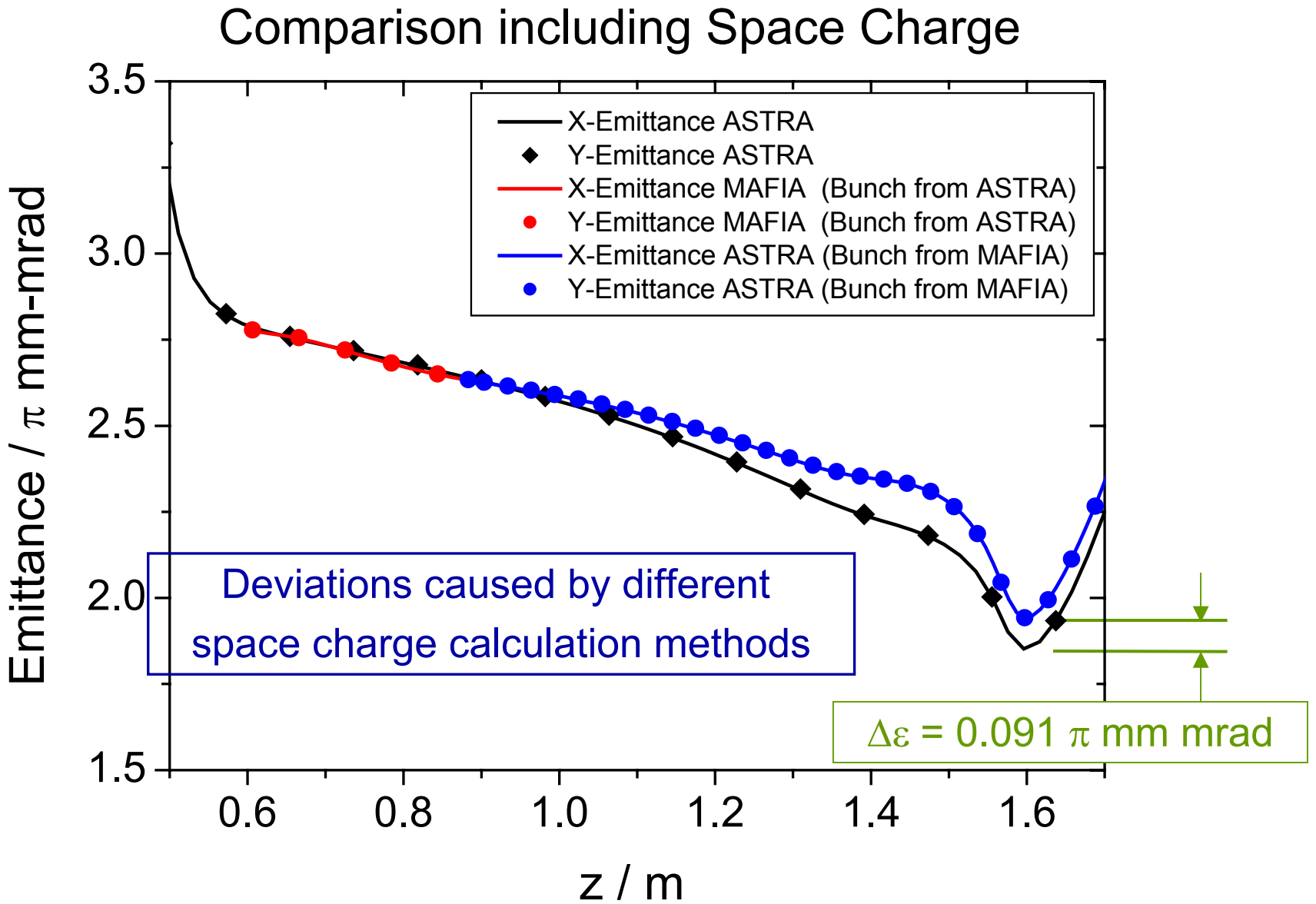
Interface Validation (1): Drift Tube



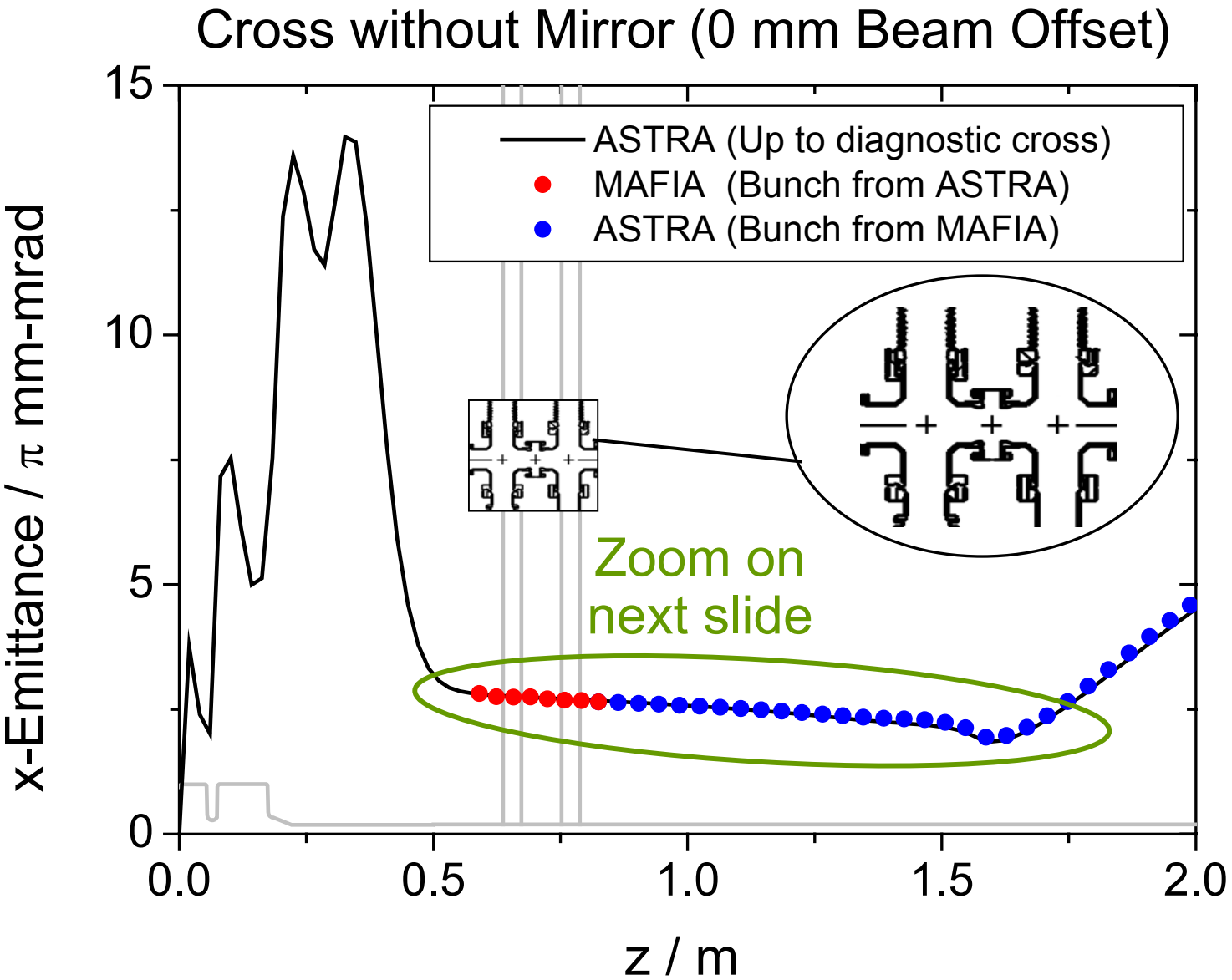
Interface Validation (2): Drift Tube



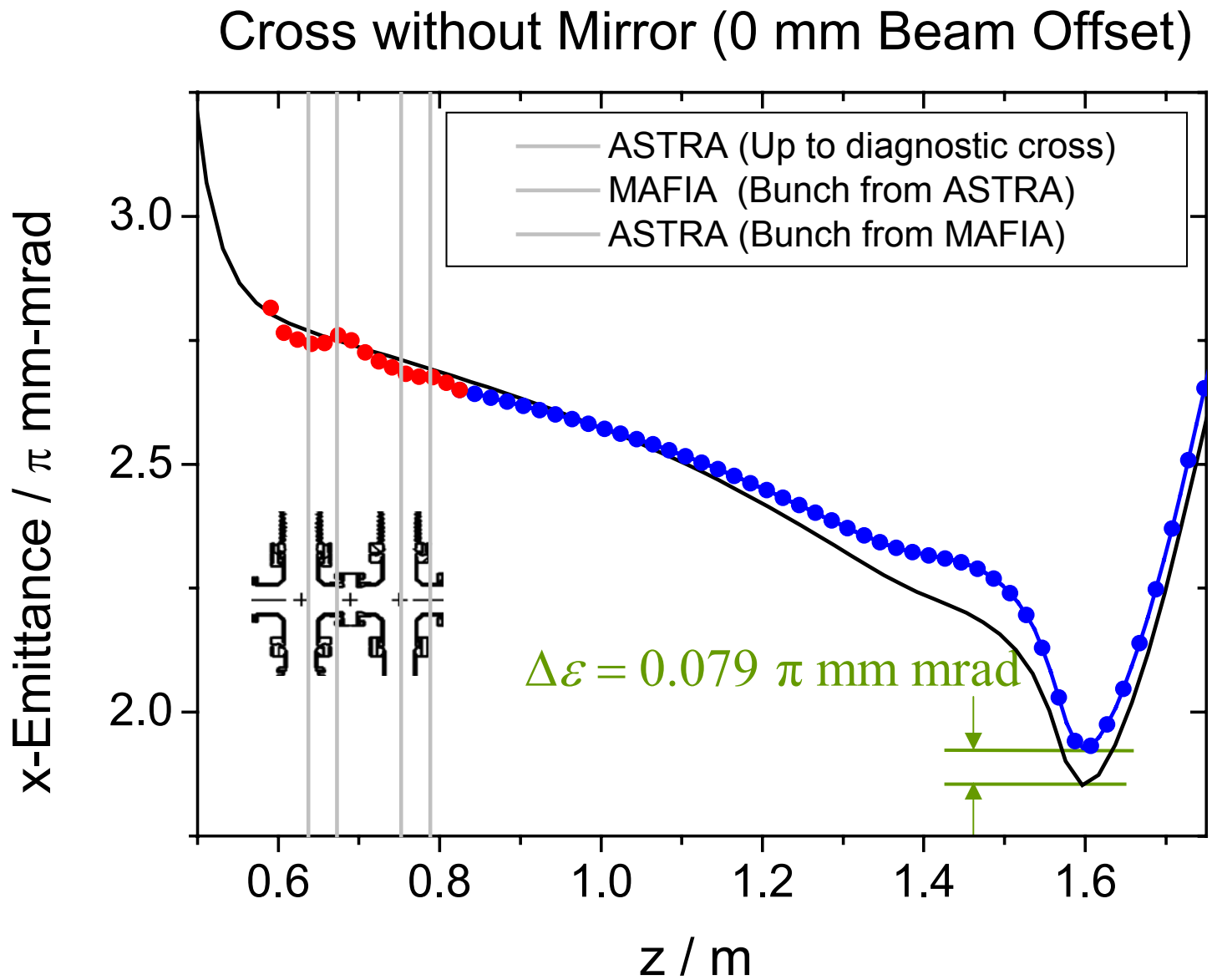
Interface Validation (2): Drift Tube



Influence of Diagnostic Doublecross (1)

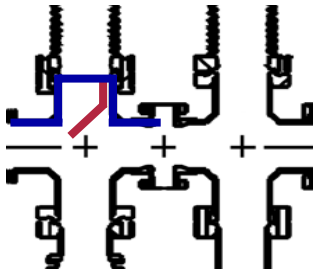


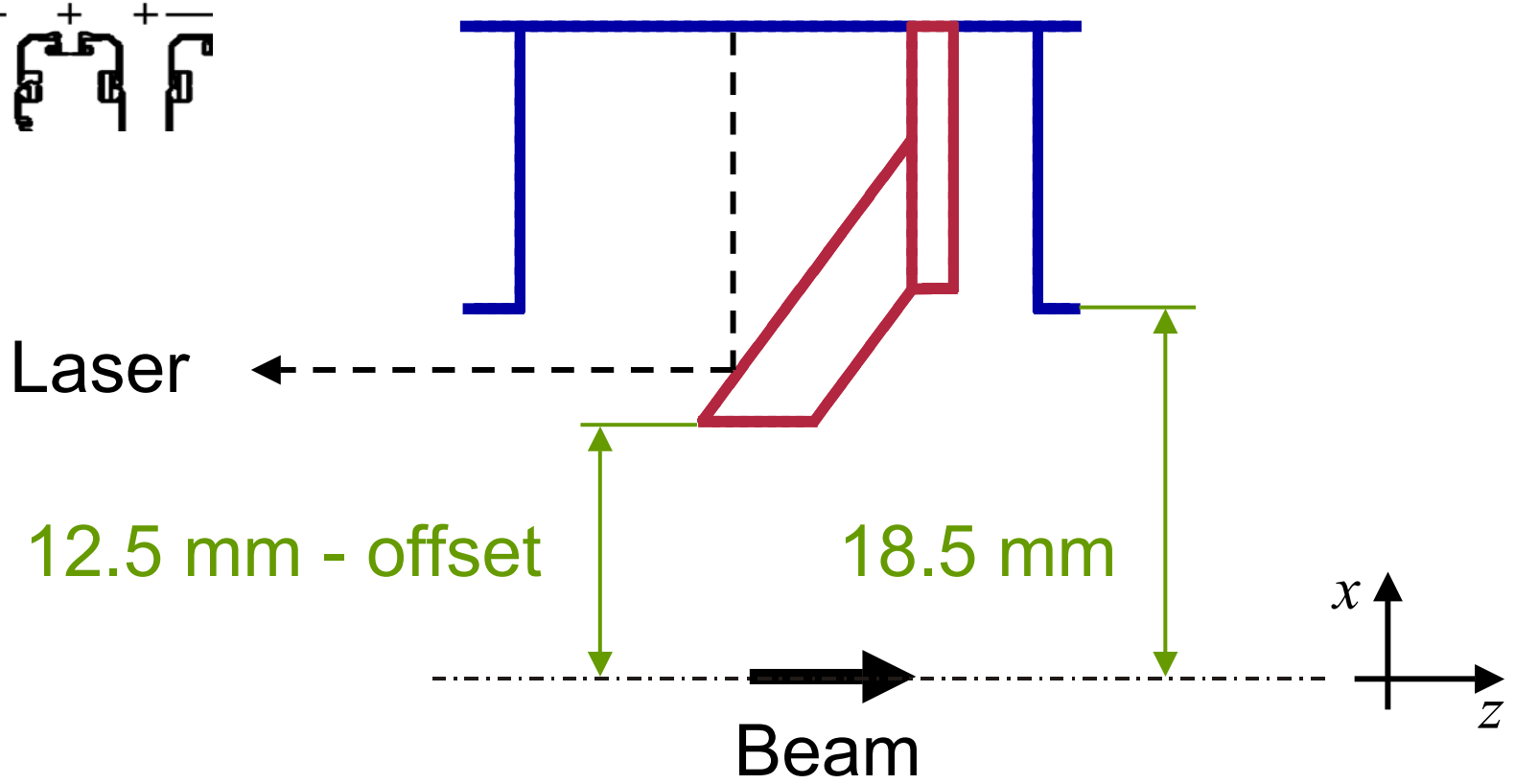
Influence of Diagnostic Doublecross (1)



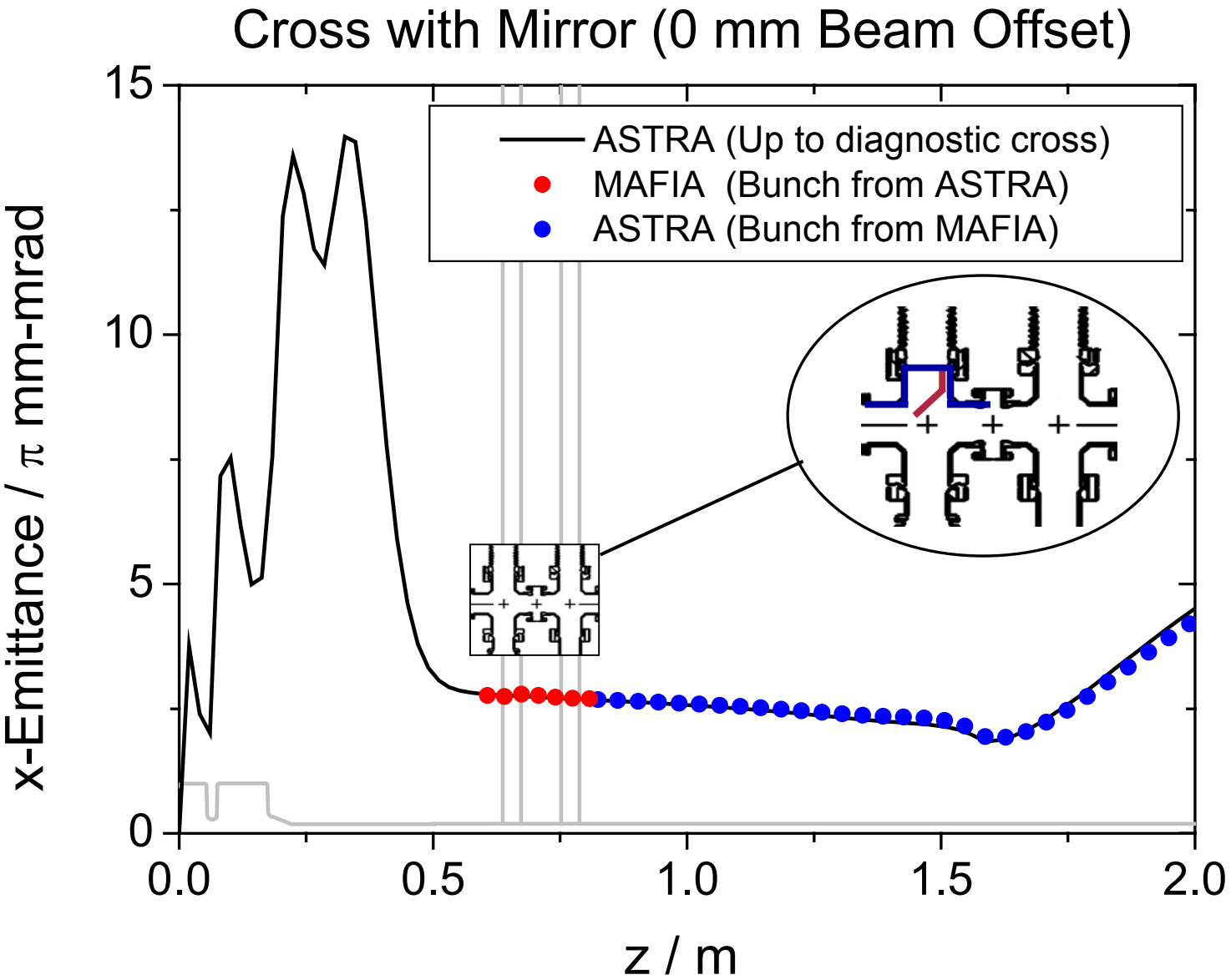
Influence of Laser Mirror

- Model of Laser Mirror

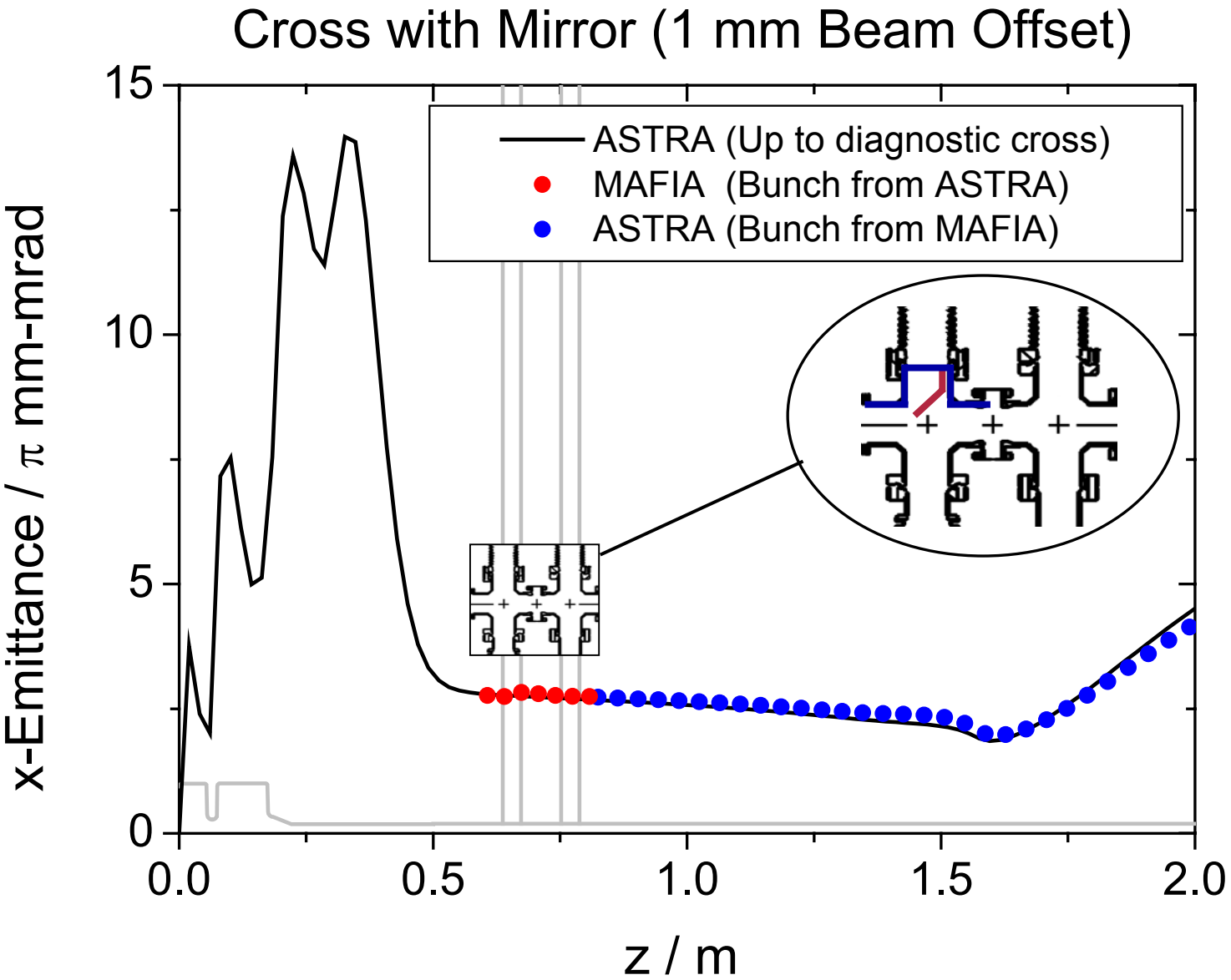




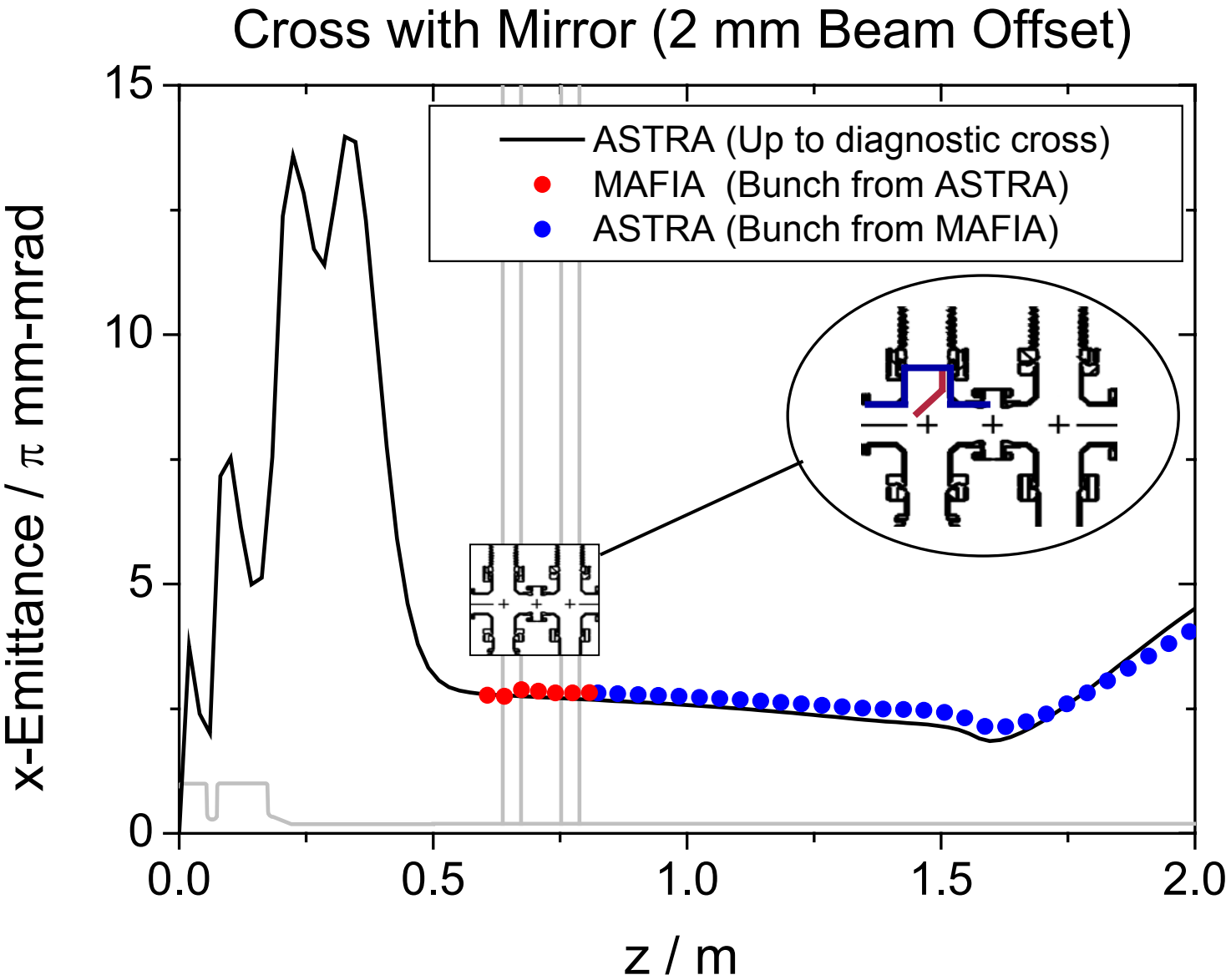
Influence of Diagnostic Doublecross (2)



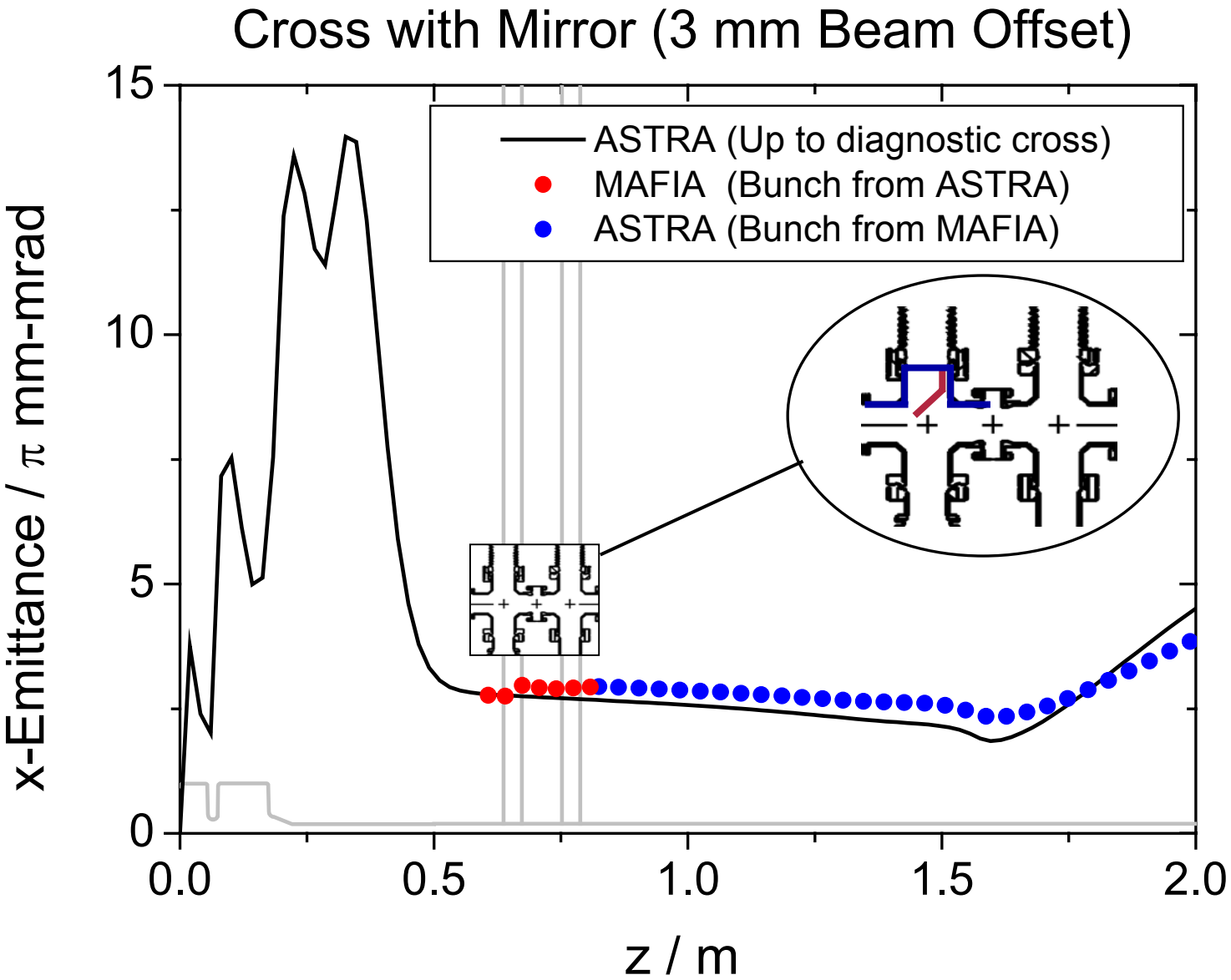
Influence of Diagnostic Doublecross (3)



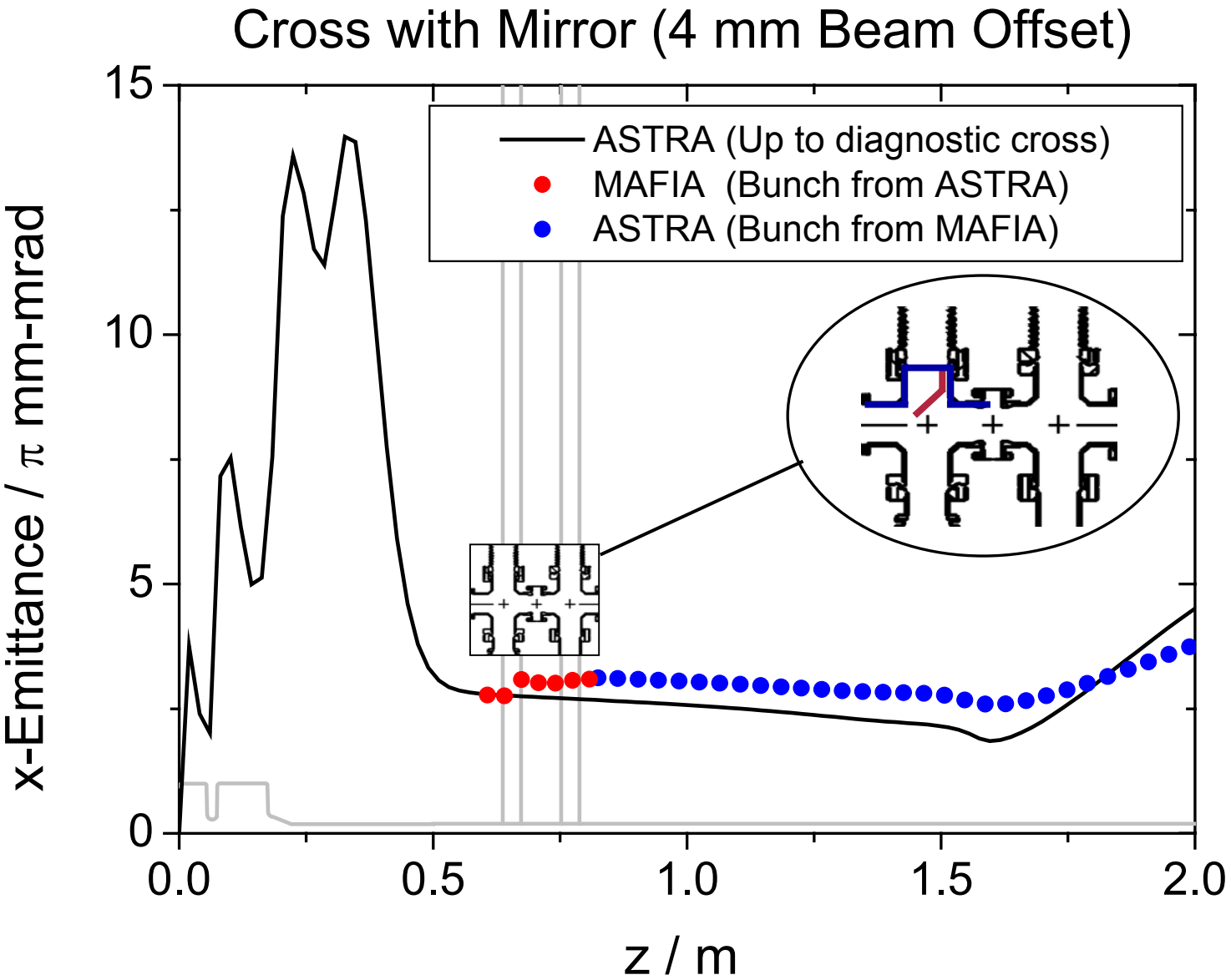
Influence of Diagnostic Doublecross (4)



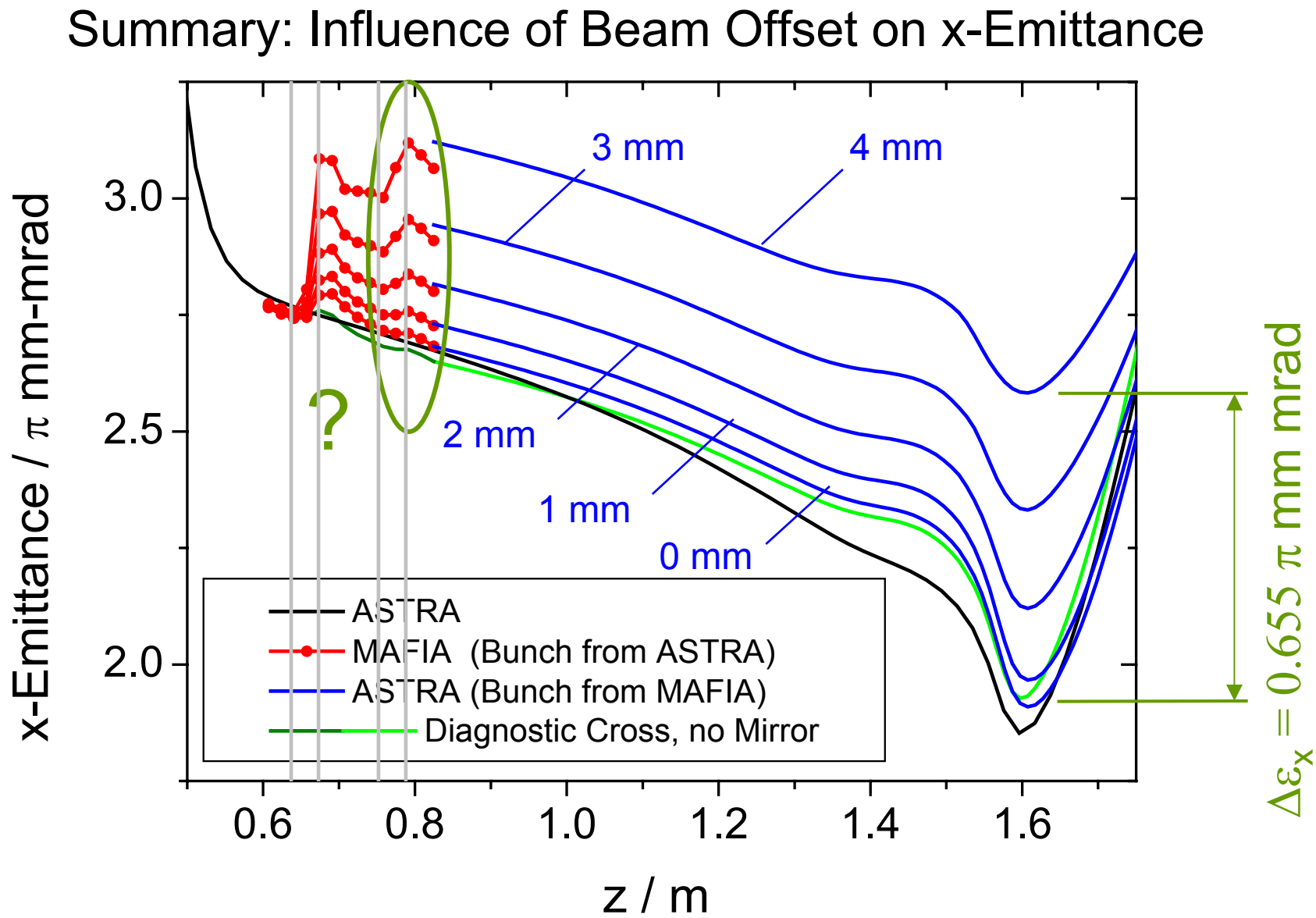
Influence of Diagnostic Doublecross (5)



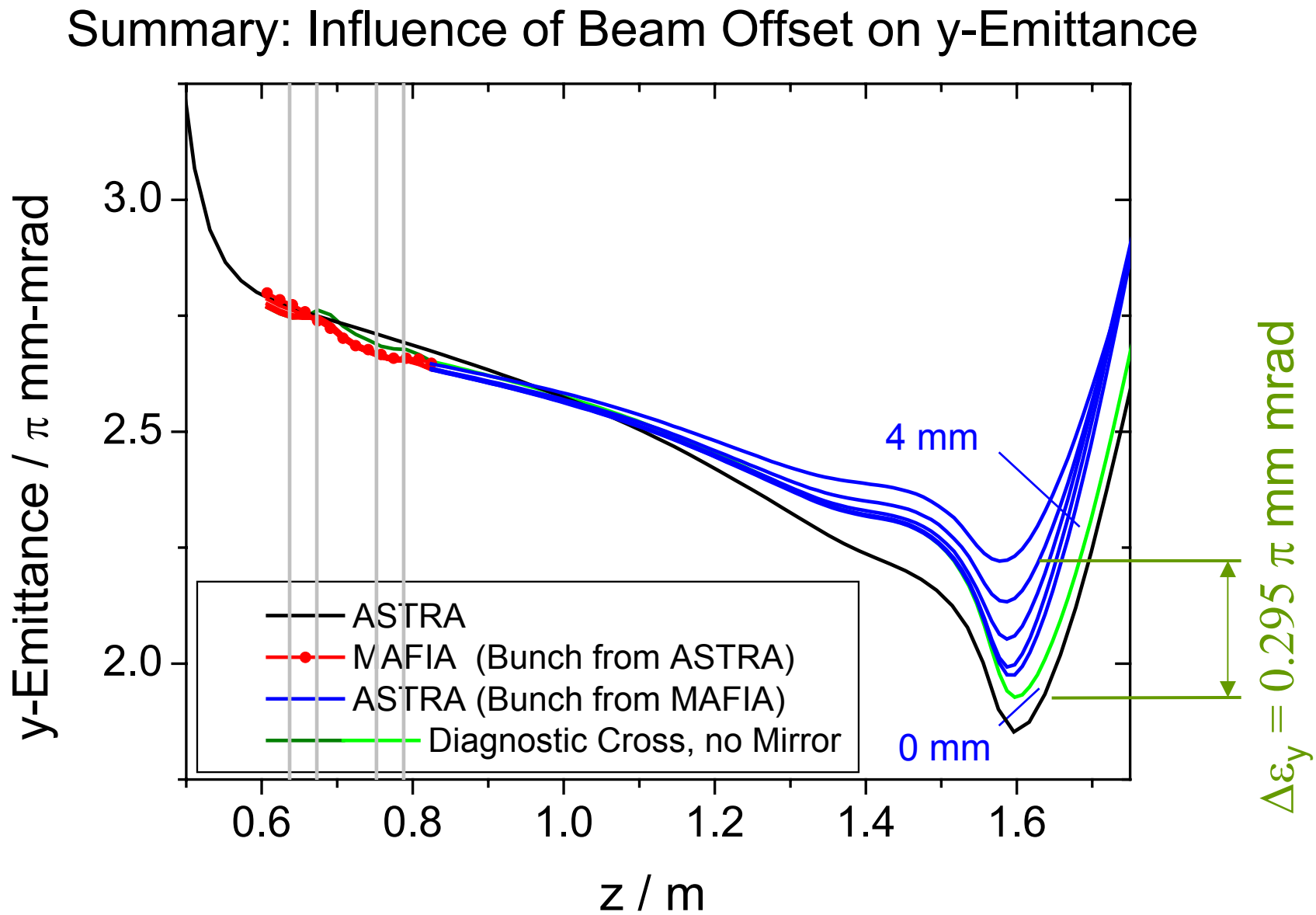
Influence of Diagnostic Doublecross (6)



Influence of Diagnostic Doublecross (7)



Influence of Diagnostic Doublecross (8)



- „ MAFIA ↔ ASTRA“ interface implemented
  - MAFIA TS3 bunch can be used as starting condition for ASTRA at any position along the beam line (and vice versa)
  - Validated by reference runs (with and without Space Charge)
- Simulation results
  - Optimal simulation parameters used

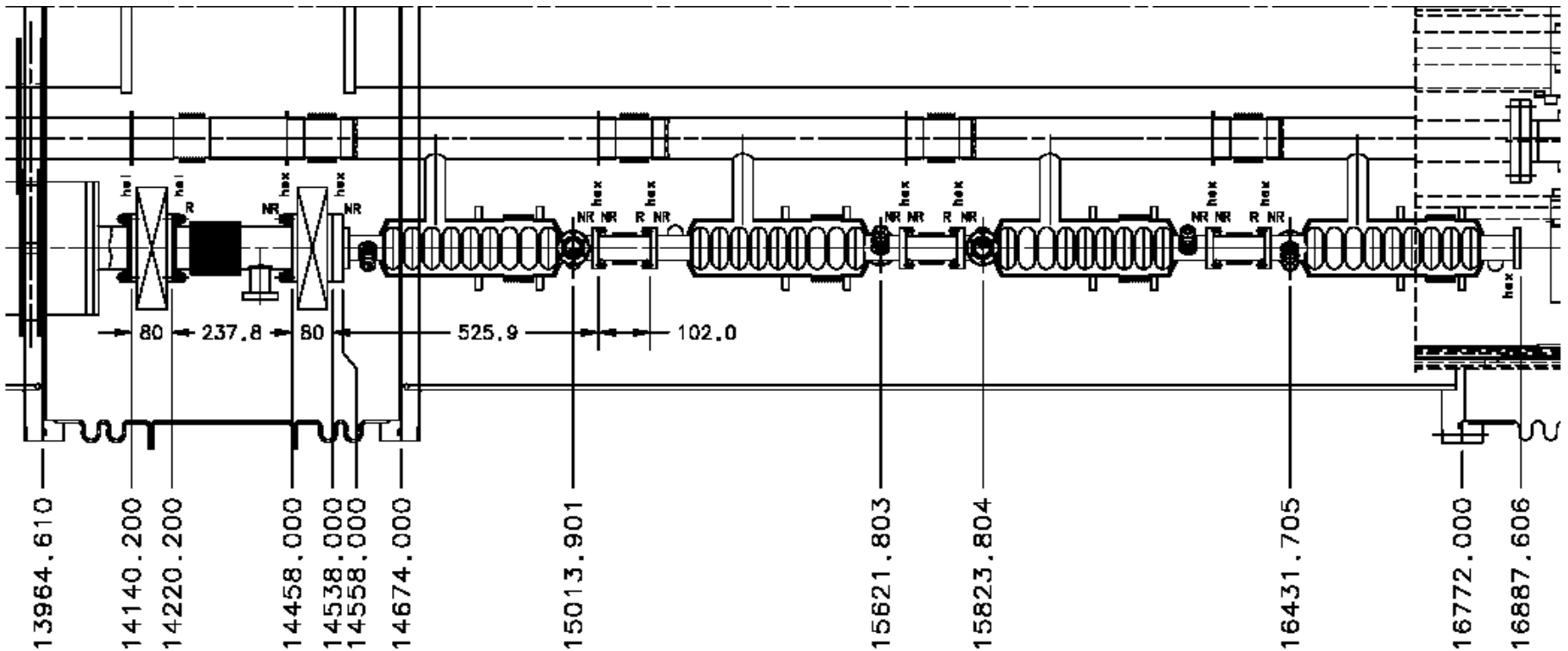
    (min. emittance @ EMSY)
  - Effect of the diagnostic doublecross on the transverse beam emittance @ EMSY (1.618 m) is about 0.08 π mm mmrad
  - Effect of the laser mirror on the transverse beam emittance depends on the beam offset
  - 4 mm Offset causes emittance growth @ EMSY

    $\Delta\varepsilon_x$ = 0.655 π mm mrad ; $\Delta\varepsilon_y$ = 0.295 π mm mrad

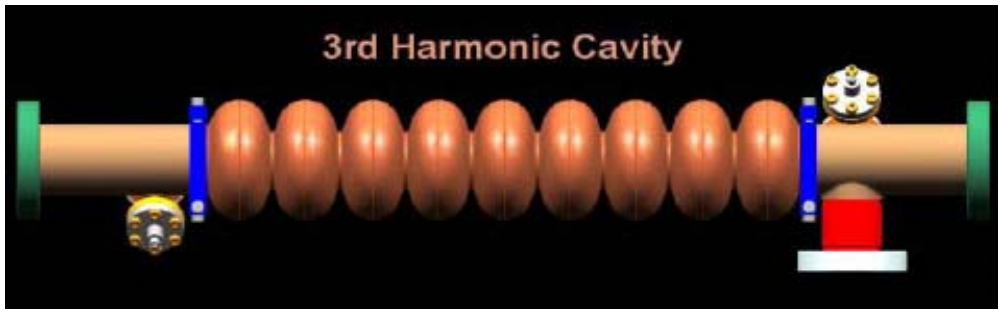
Outline

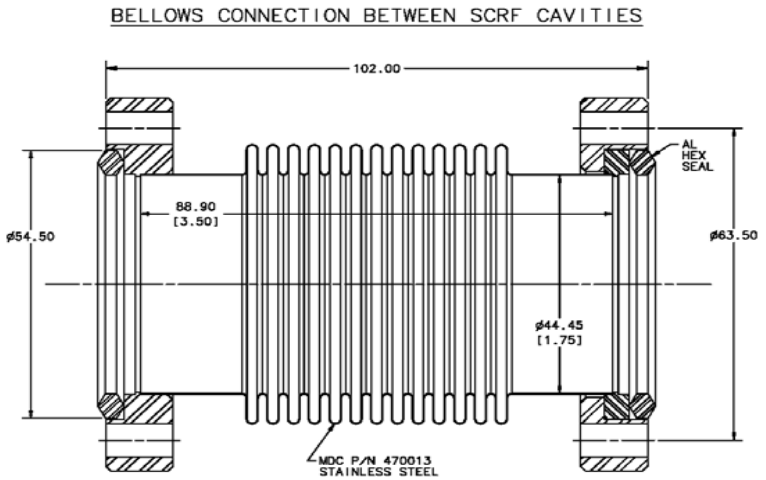
- Wakefield Simulations for the PITZ-Injector (W. Ackermann, S. Setzer)
- Wakefields in the 3rd Harmonic Structure (I. Zagorodnov)

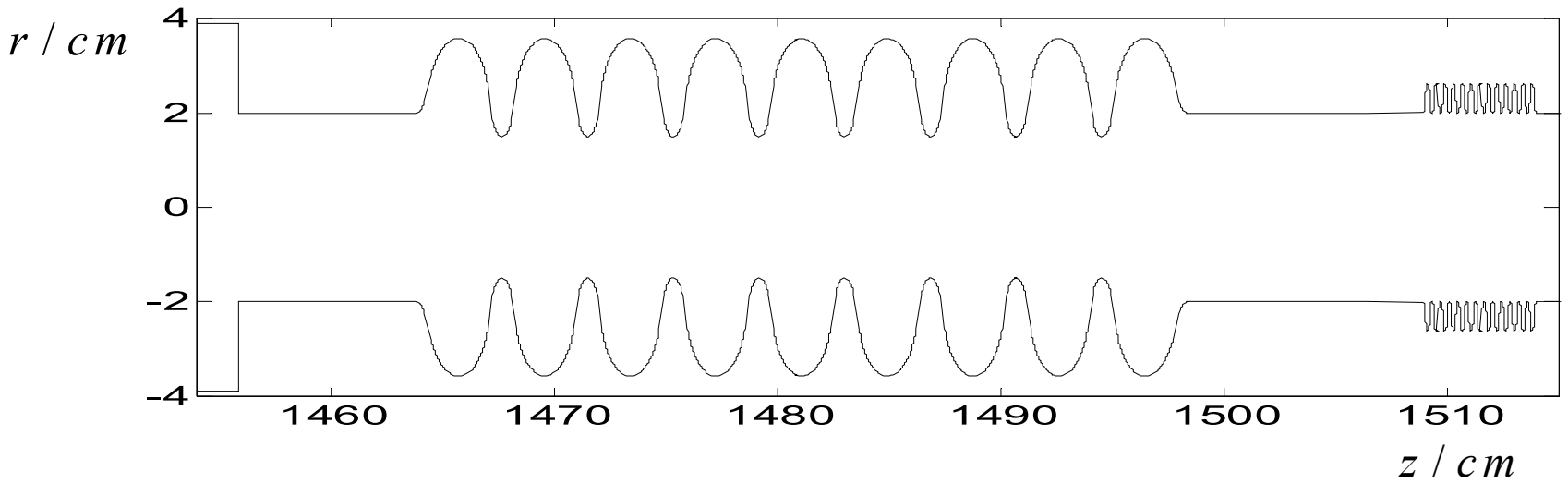
Wake functions of the 3rd Harmonic Section



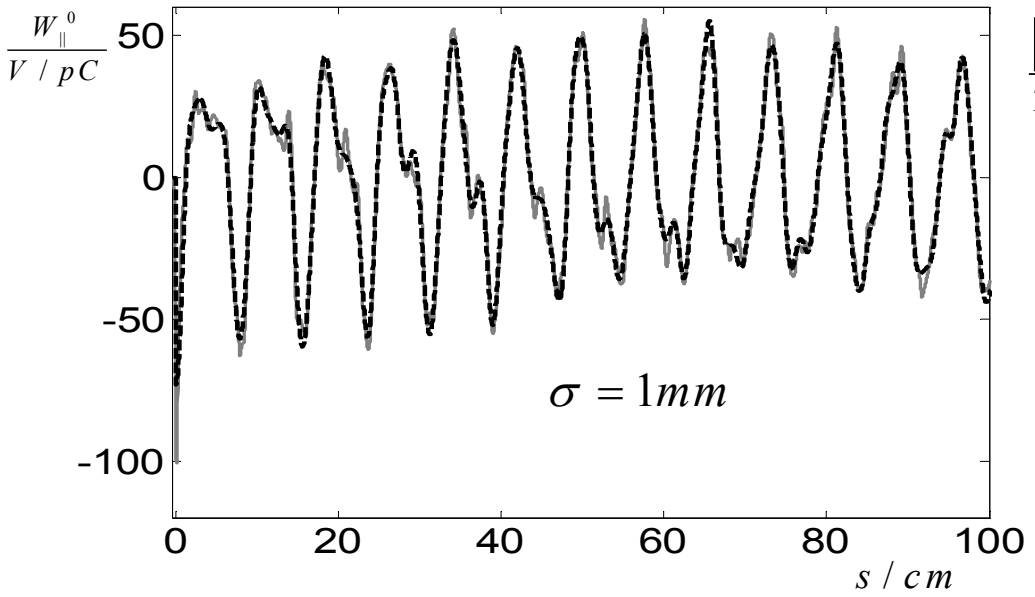
Geometry

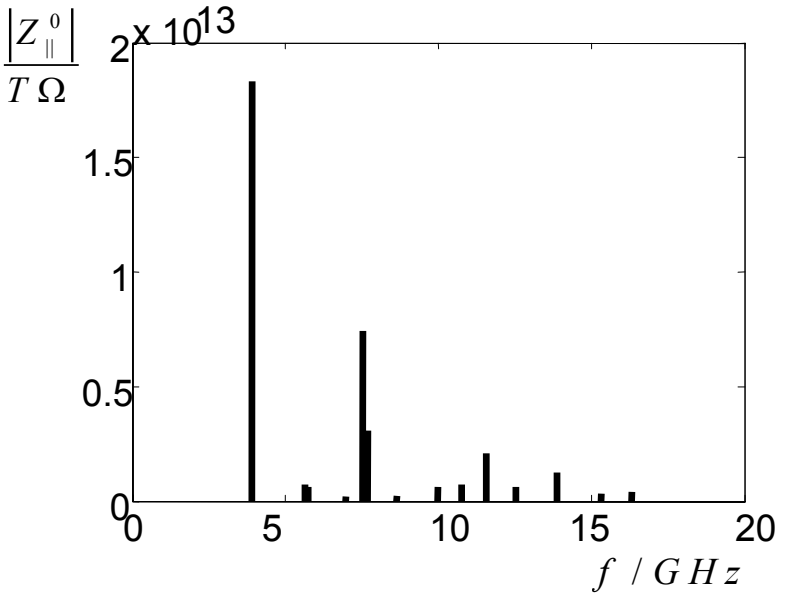

3rd Harmonic Cavity


BELLOWS CONNECTION BETWEEN SCRF CAVITIES
102.00
AL HEX SEAL
88.90
[3.50]
ø54.50
ø63.50
ø44.45
[1.75]
MDC P/N 470013
STAINLESS STEEL


r / cm
4
2
0
-2
-4
1460
1470
1480
1490
1500
1510
z / cm

Long Range Wake Function





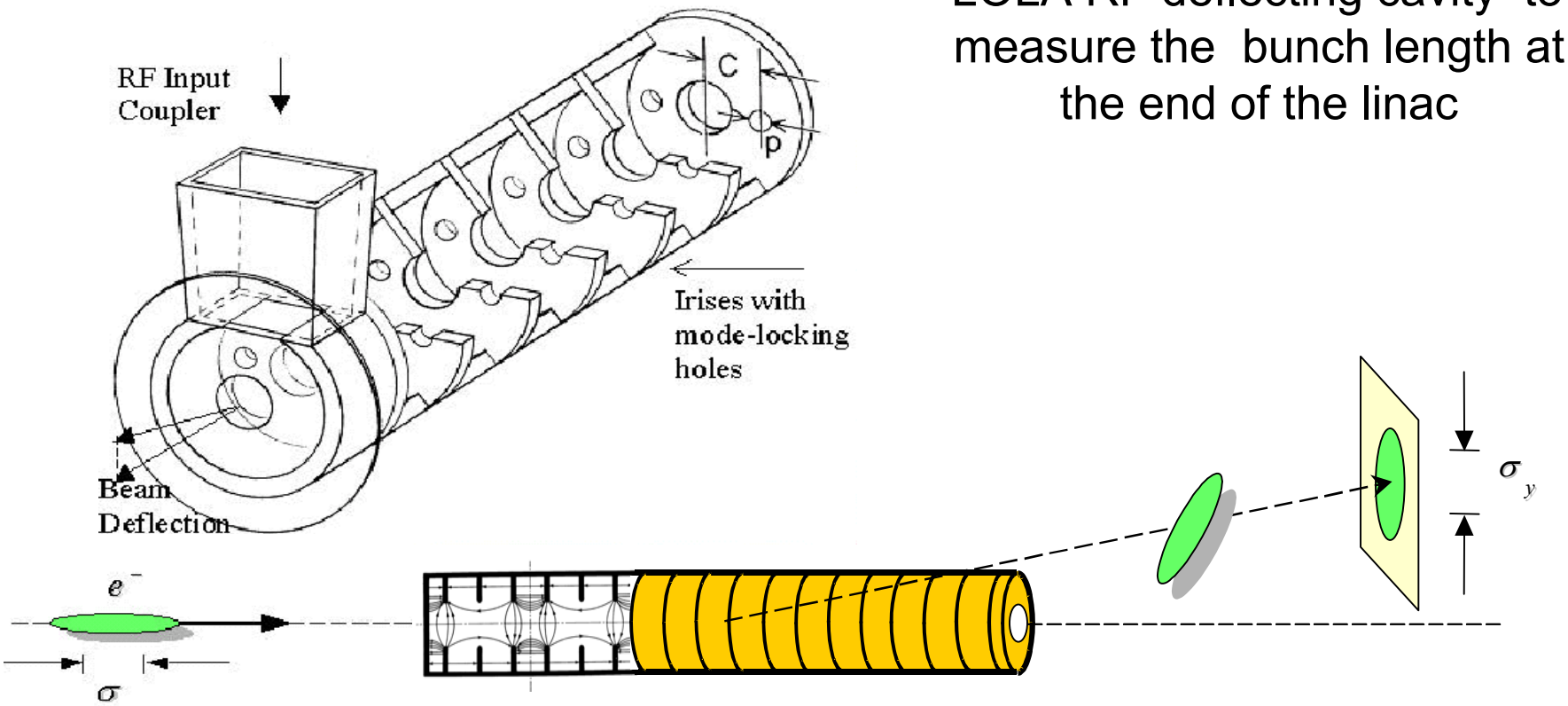
$$w_{\parallel}(s) = 2\,\theta(s)\sum_{i=1}^{14} K_i \cos\left(\frac{2\pi}{c} f_i\, s\right)$$

f_i / GHz	3.90	5.65	5.73	6.97	7.54	7.69	8.65
K_i /(V/pC)	18.3	0.73	0.61	0.20	7.44	3.08	0.22

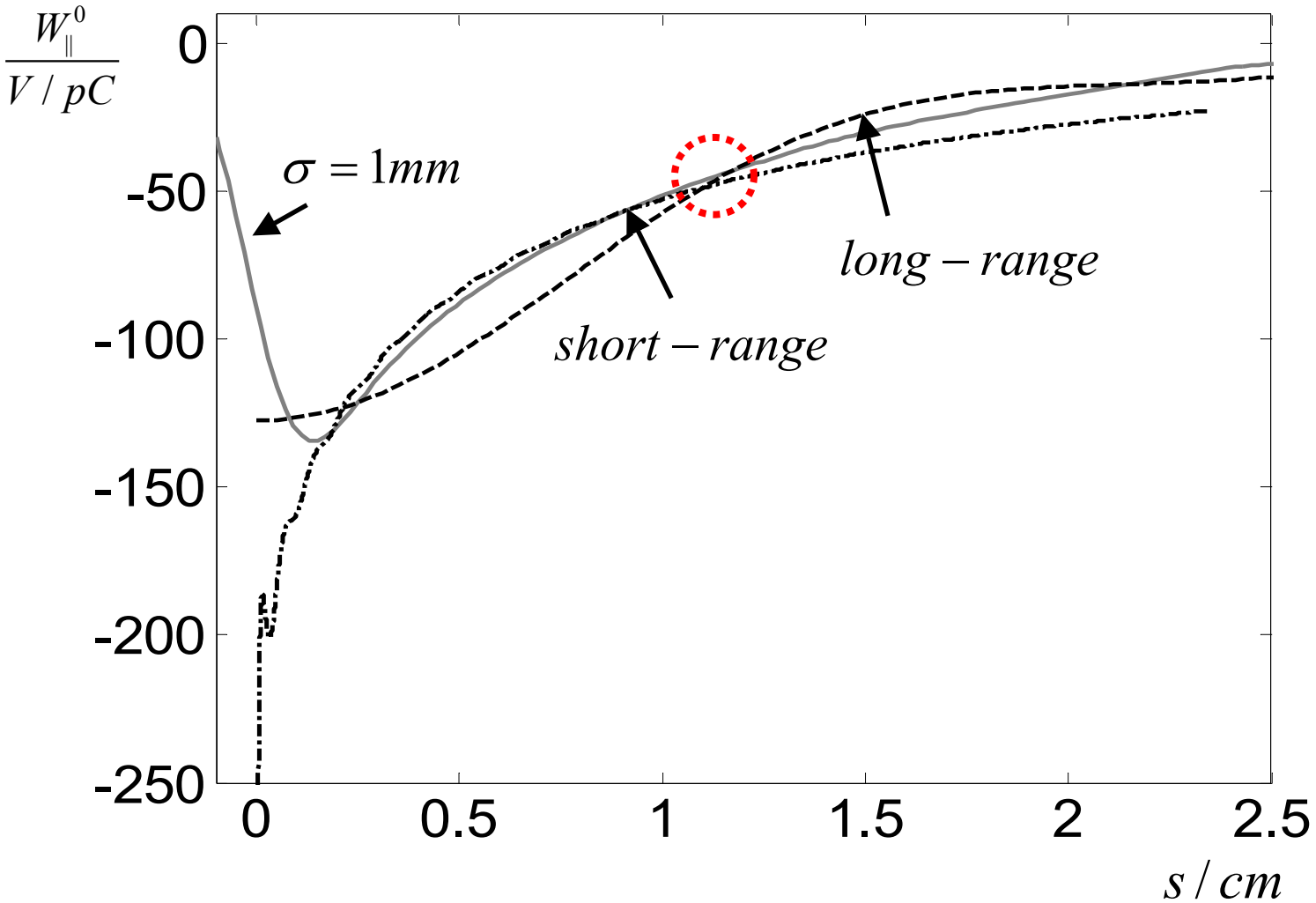
f_i, GHz	9.98	10.7	11.6	12.5	13.9	15.3	16.3
K_i /(V/pC)	0.63	0.72	2.08	0.60	1.25	0.34	0.41

LOLA Cavity

LOLA RF deflecting cavity to measure the bunch length at the end of the linac



Wake Function of the LOLA Cavity



The short-range (dashed line) and long-range (dot-dashed line) longitudinal wake functions