Simulations of RF fields in IR region

IRENG07 workshop

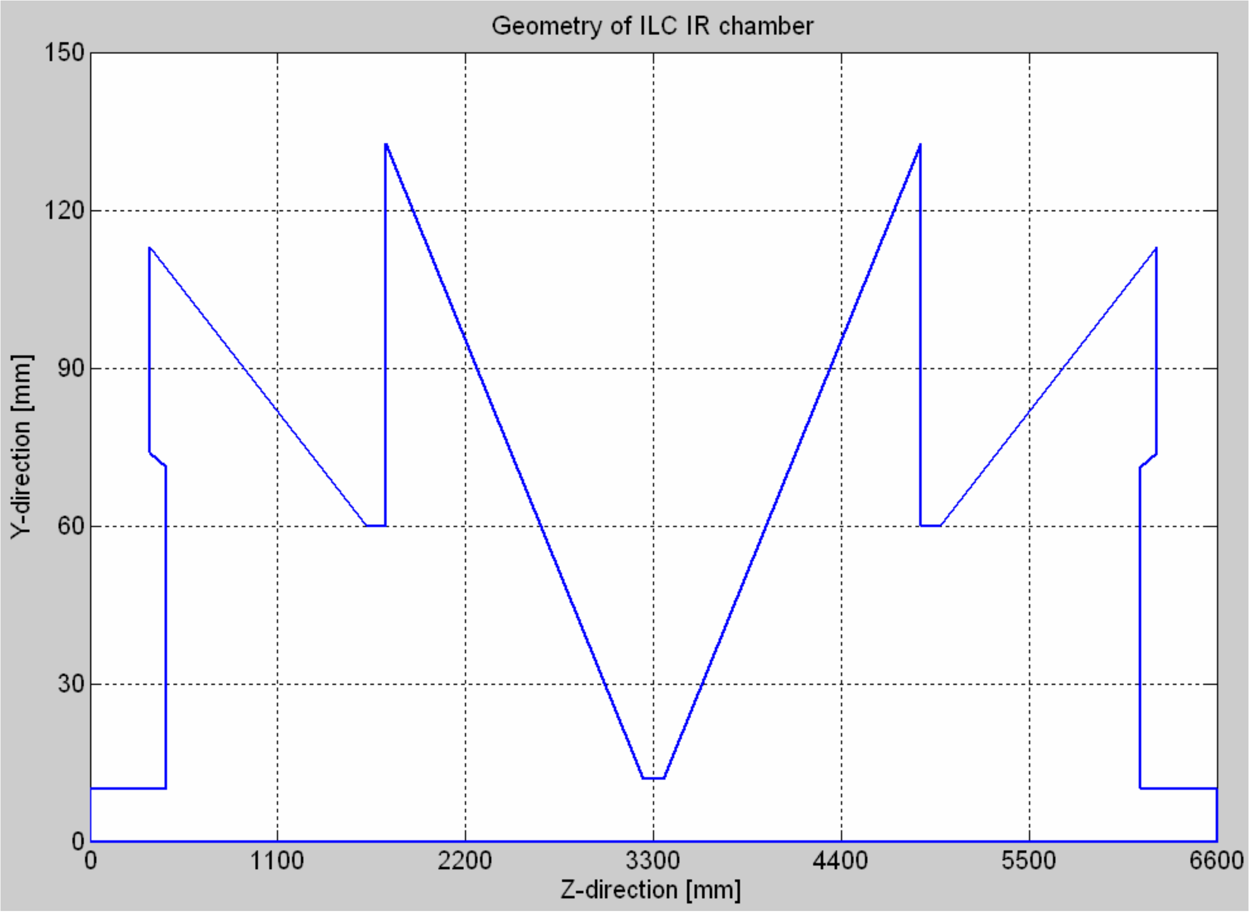
Shilun Pei, Andrei Seryi
SLAC

September 19, 2007

Contents

- Geometry
- Analytical estimation
- ABCI-2D & MAFIA-2D simulations
- Summary of results
- B-field monitoring along the beam pipe
- Next plan

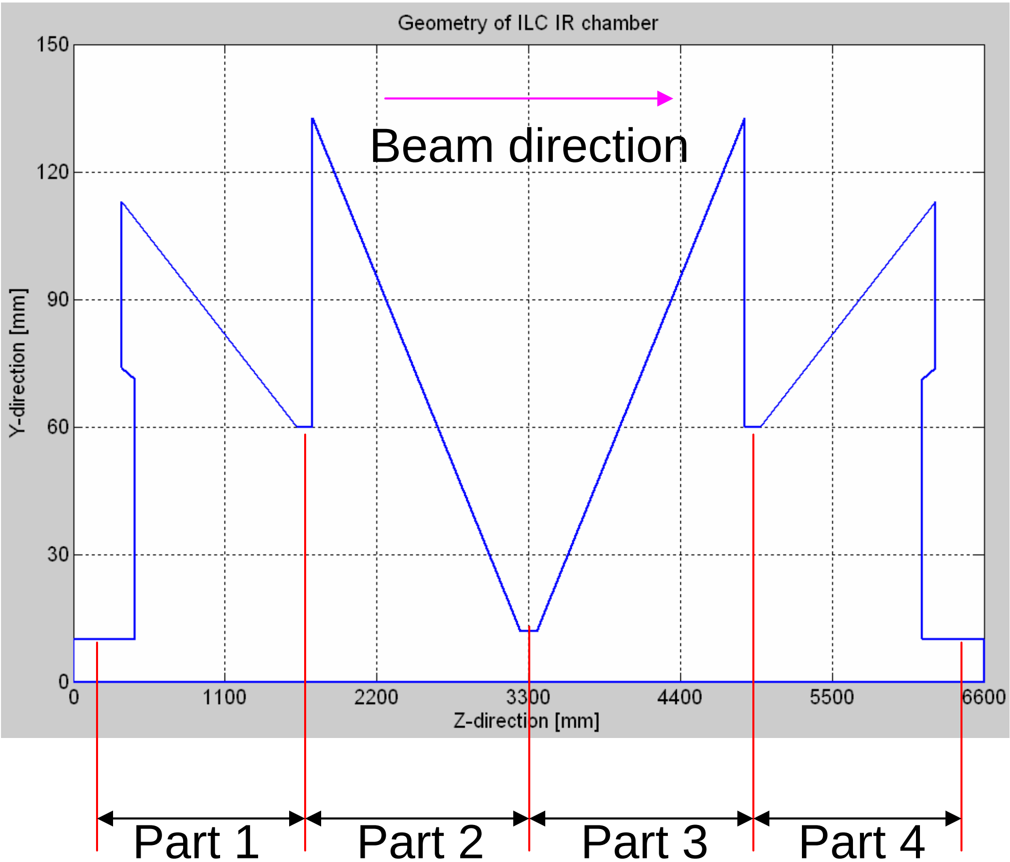
Geometry



ILC BDS Meeting, 15 May 2007.
http://ilcagenda.linearcollider.org/getFile.py/access?contribId=0&resId=1&materialId=slides&confId=1598

Analytical estimation

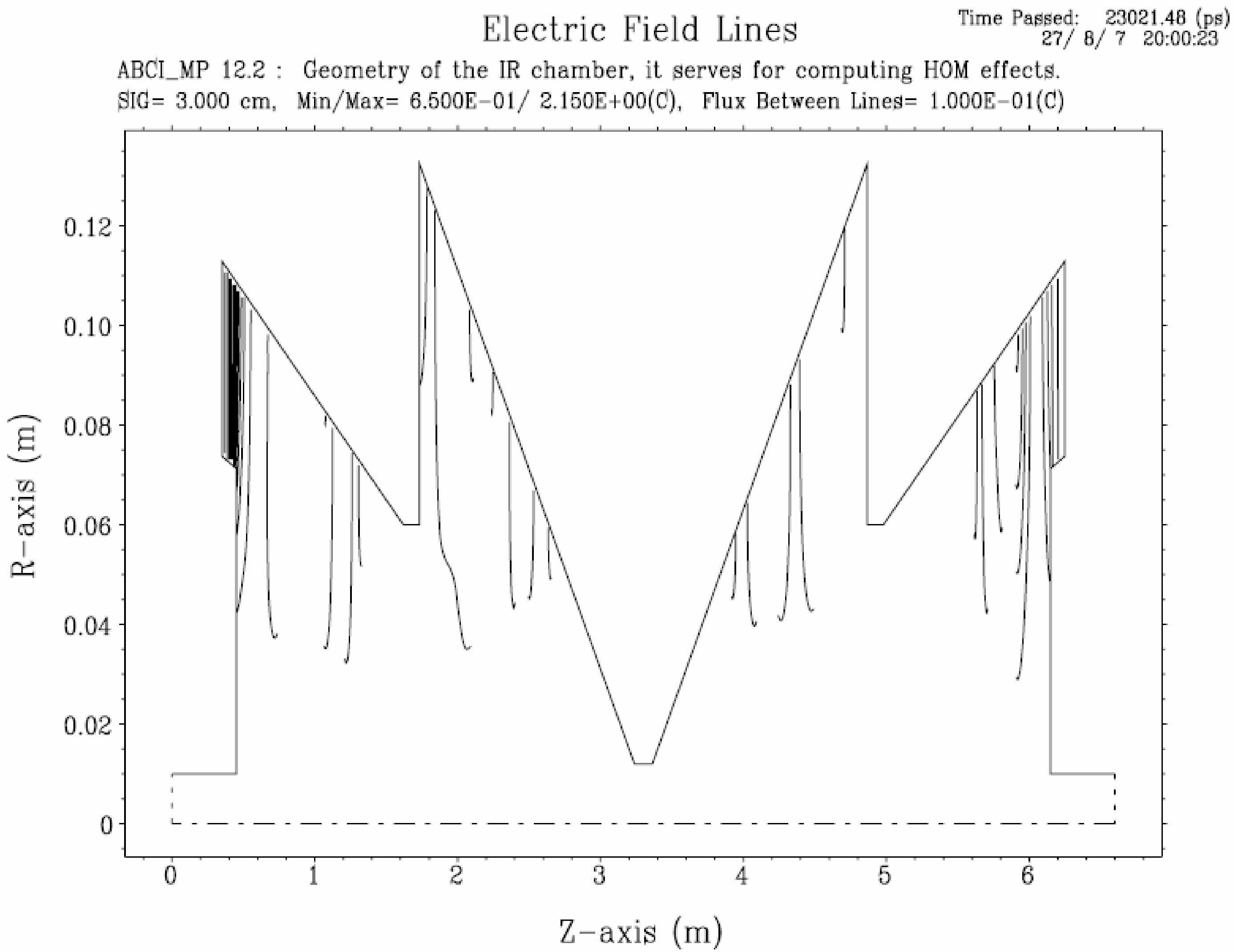
1) Part 1 and Part 3 can be looked as two shallow cavities ($r_{out}>r_{in}$). (Handbook of Accelerator Physics and Engineering, p231)
2) Part 2 and Part 4 can use the relation between diffraction impedance formulae and optical approximation impedance formulae to estimate. (PRST, 10, 054401, 2007)



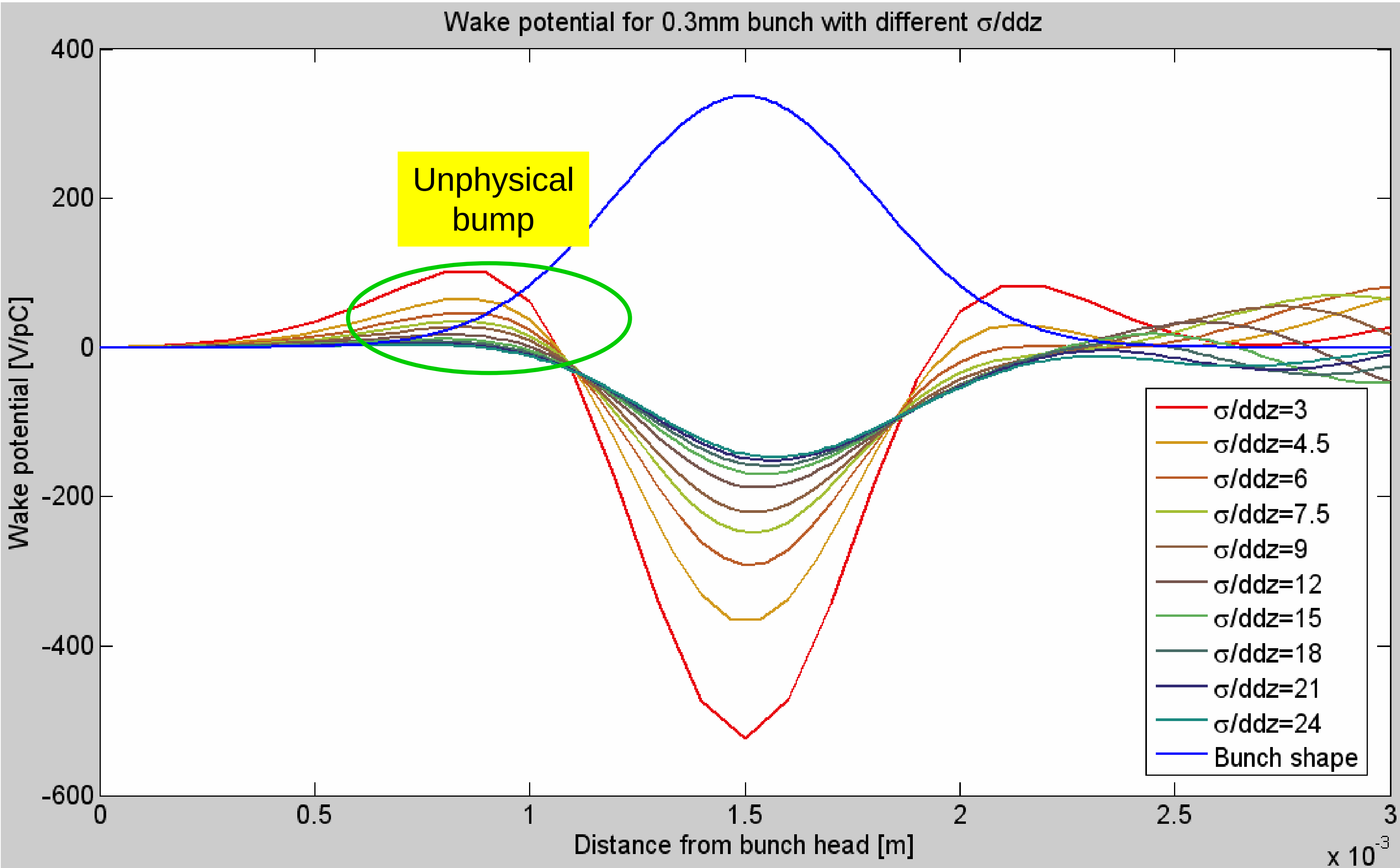
1) The total impedance is estimated to be $4Z_0/\pi$, while loss factor is $2Z_0c/(\pi^{3/2}\sigma)$.
2) For σ=0.6mm, 0.5mm, 0.4mm, 0.3mm, 0.2mm and 0.1mm, the loss factors will be 67.76V/pC, 81.31V/pC, 101.63V/pV, 135.51V/pC, 203.27V/pC and 406.54V/pC.

Field variation (ABCI)

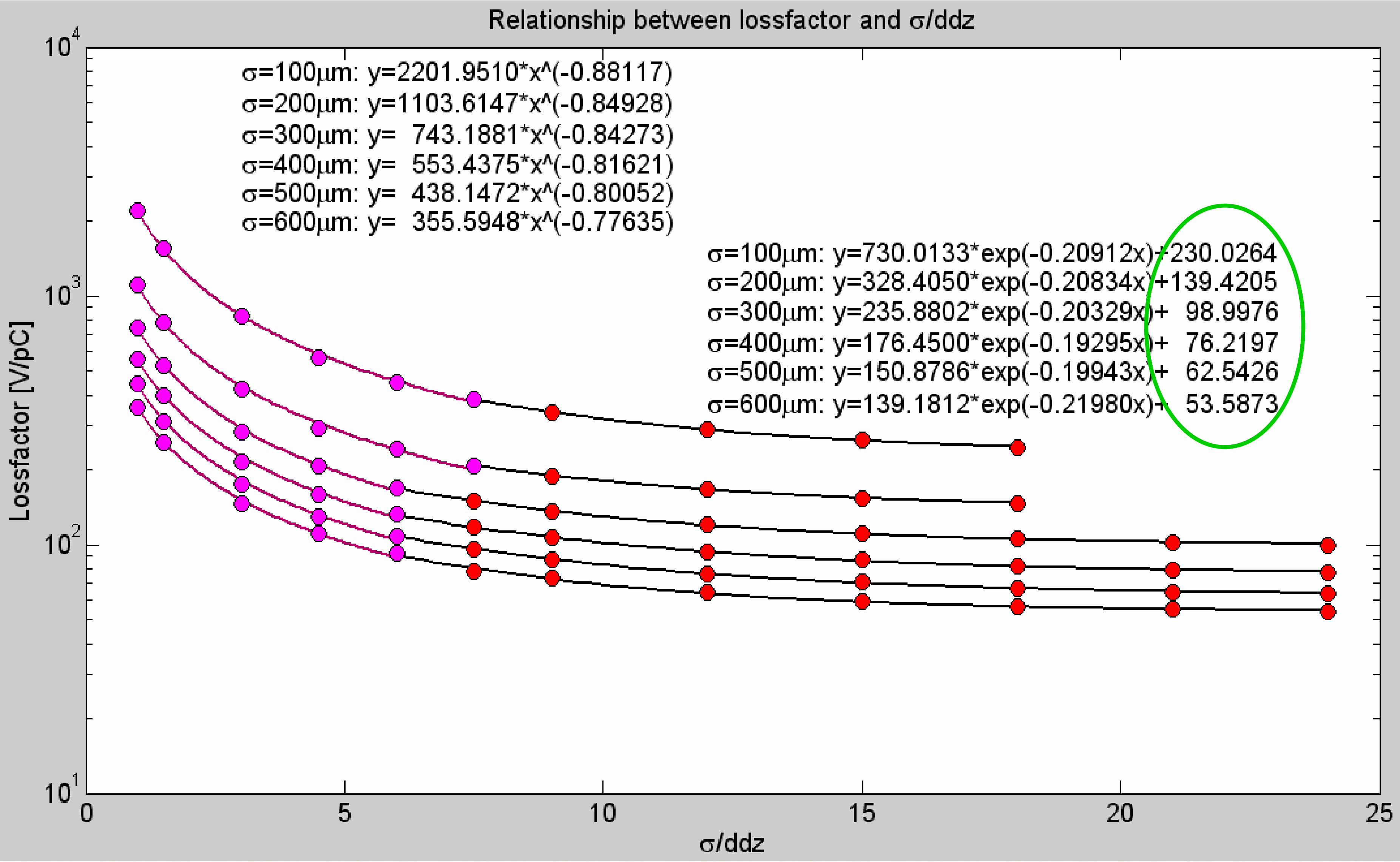
σ=3cm / Only graphics



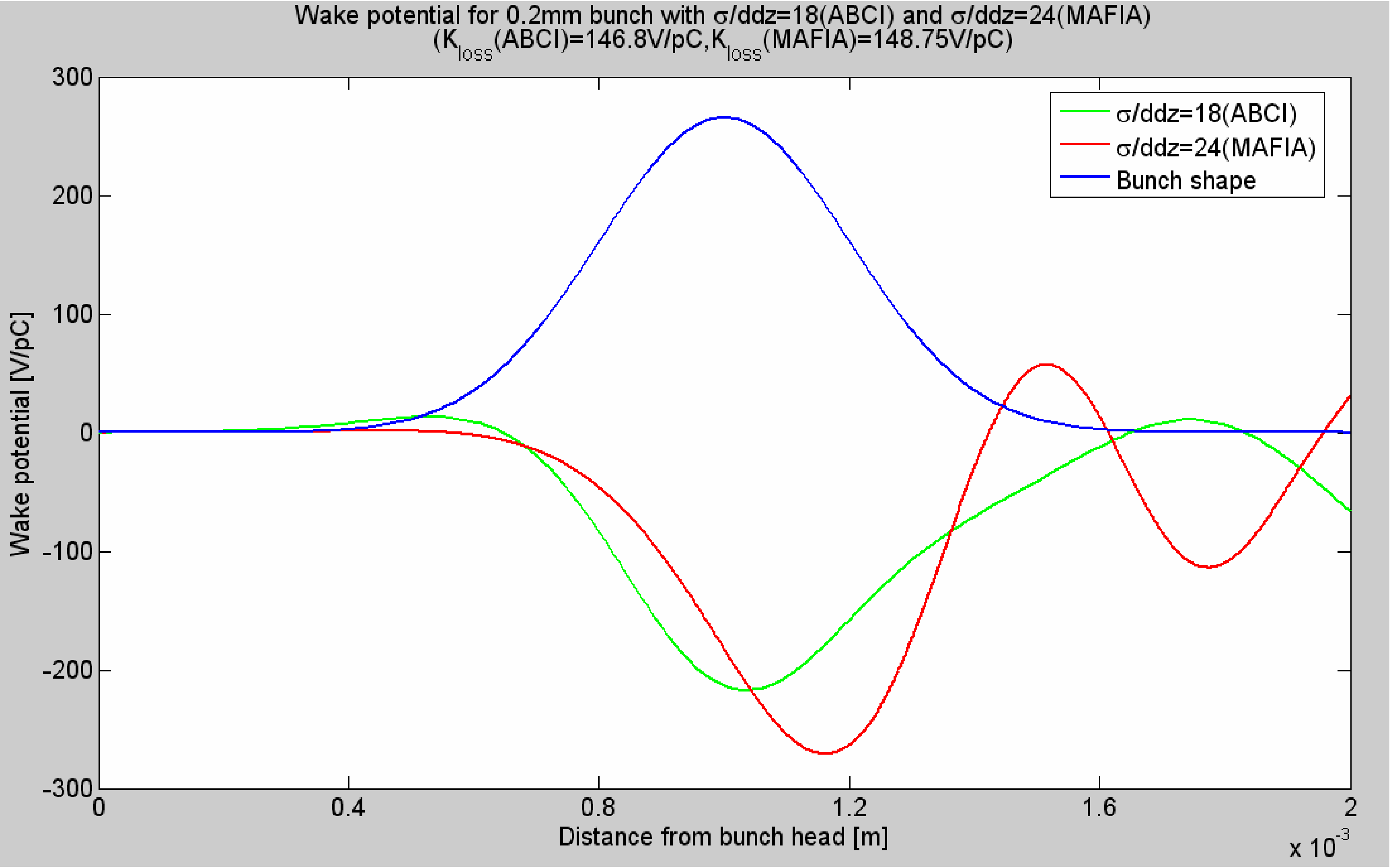
Wake potential for σ=0.3mm (ABCI)



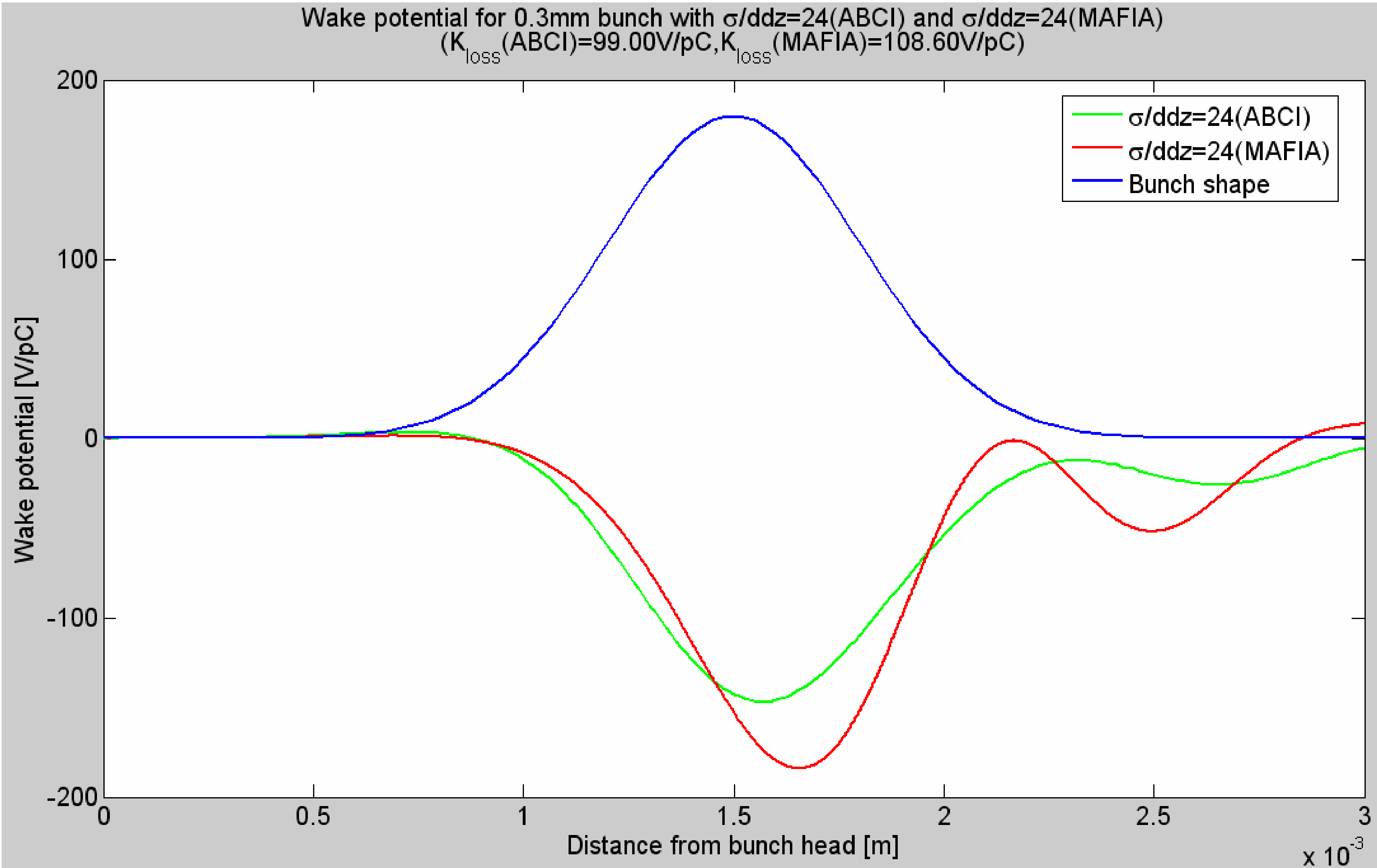
Loss factor calculation (ABCI)



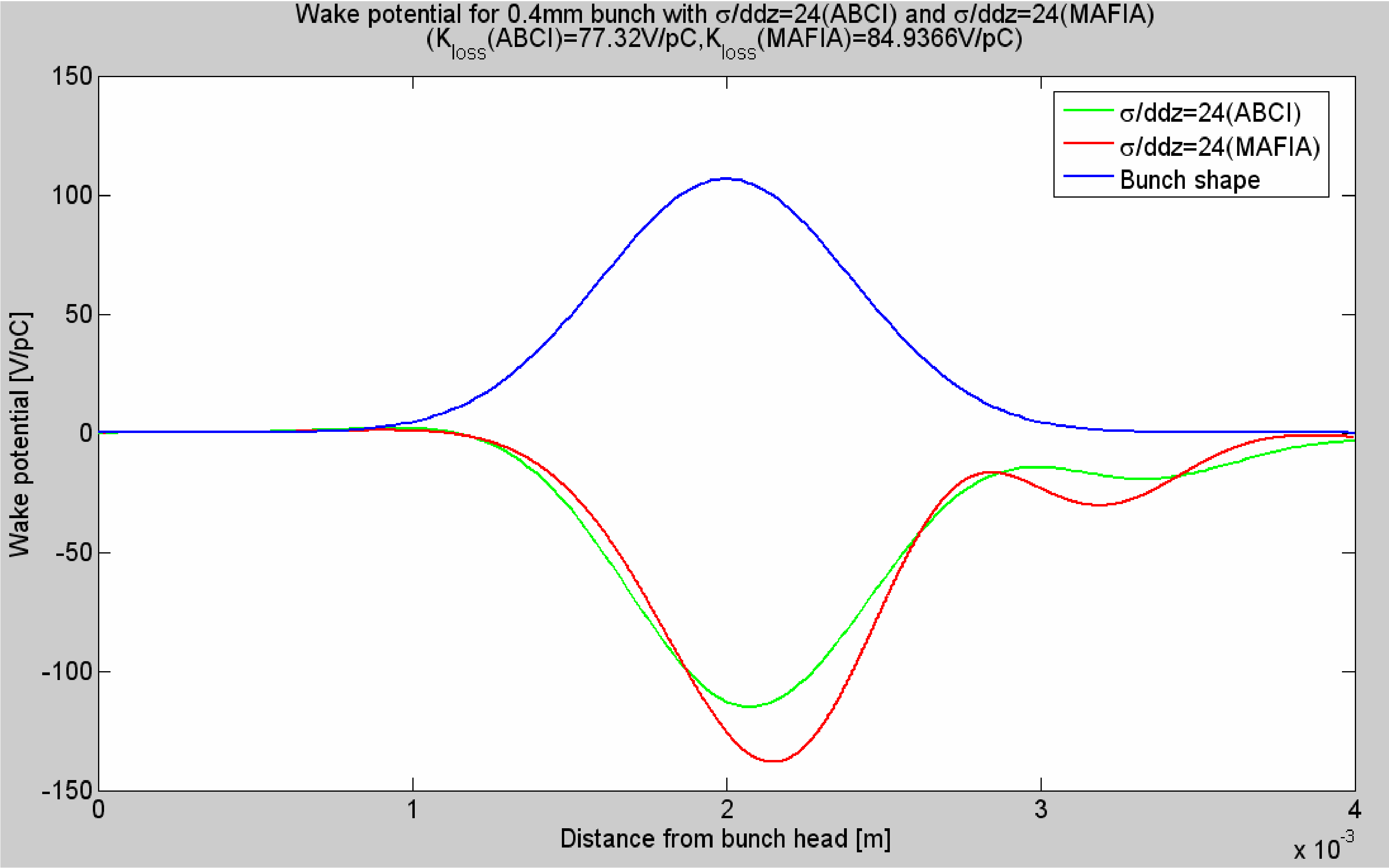
Wake potential for σ=0.2mm



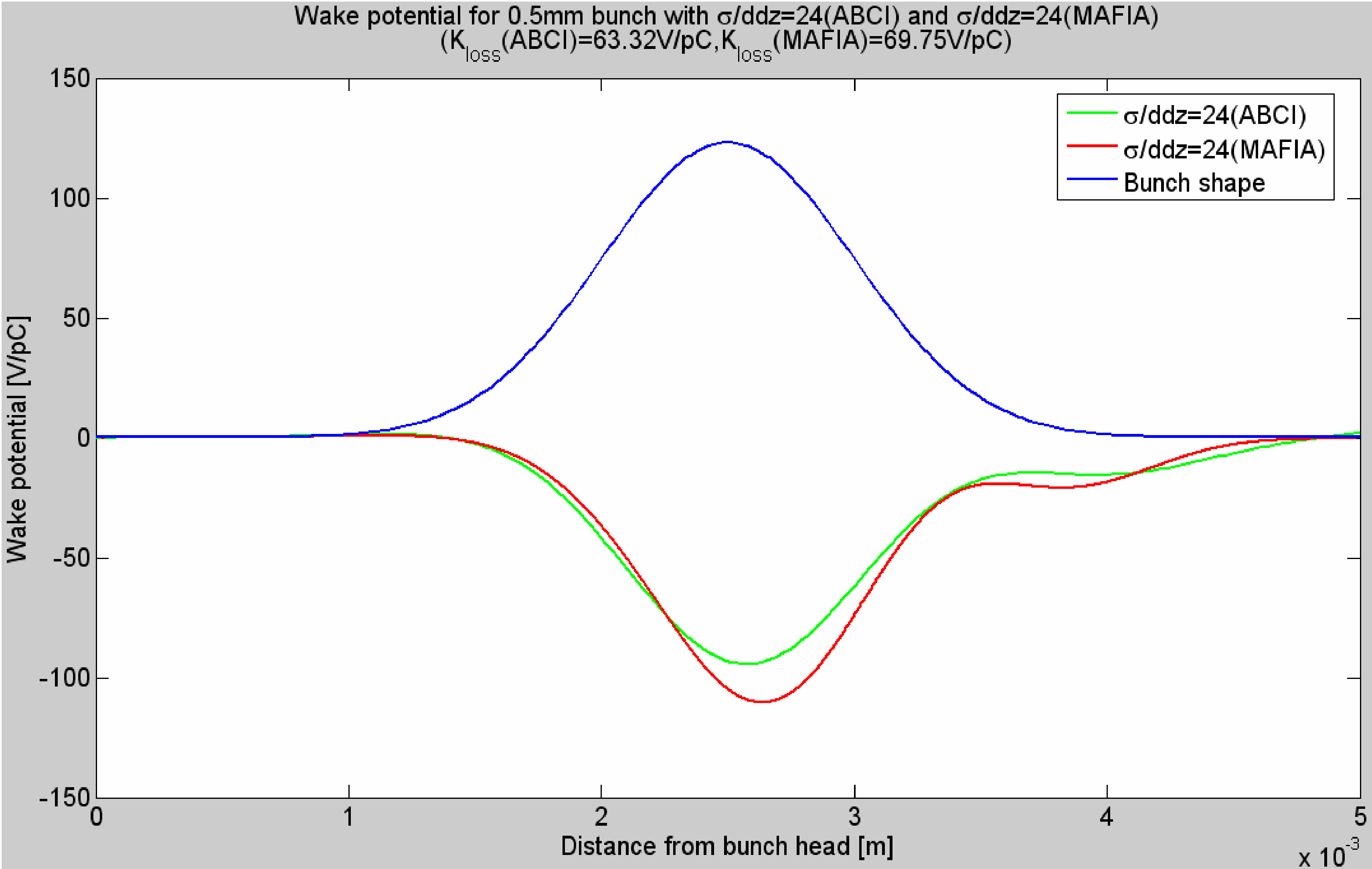
Wake potential for σ=0.3mm



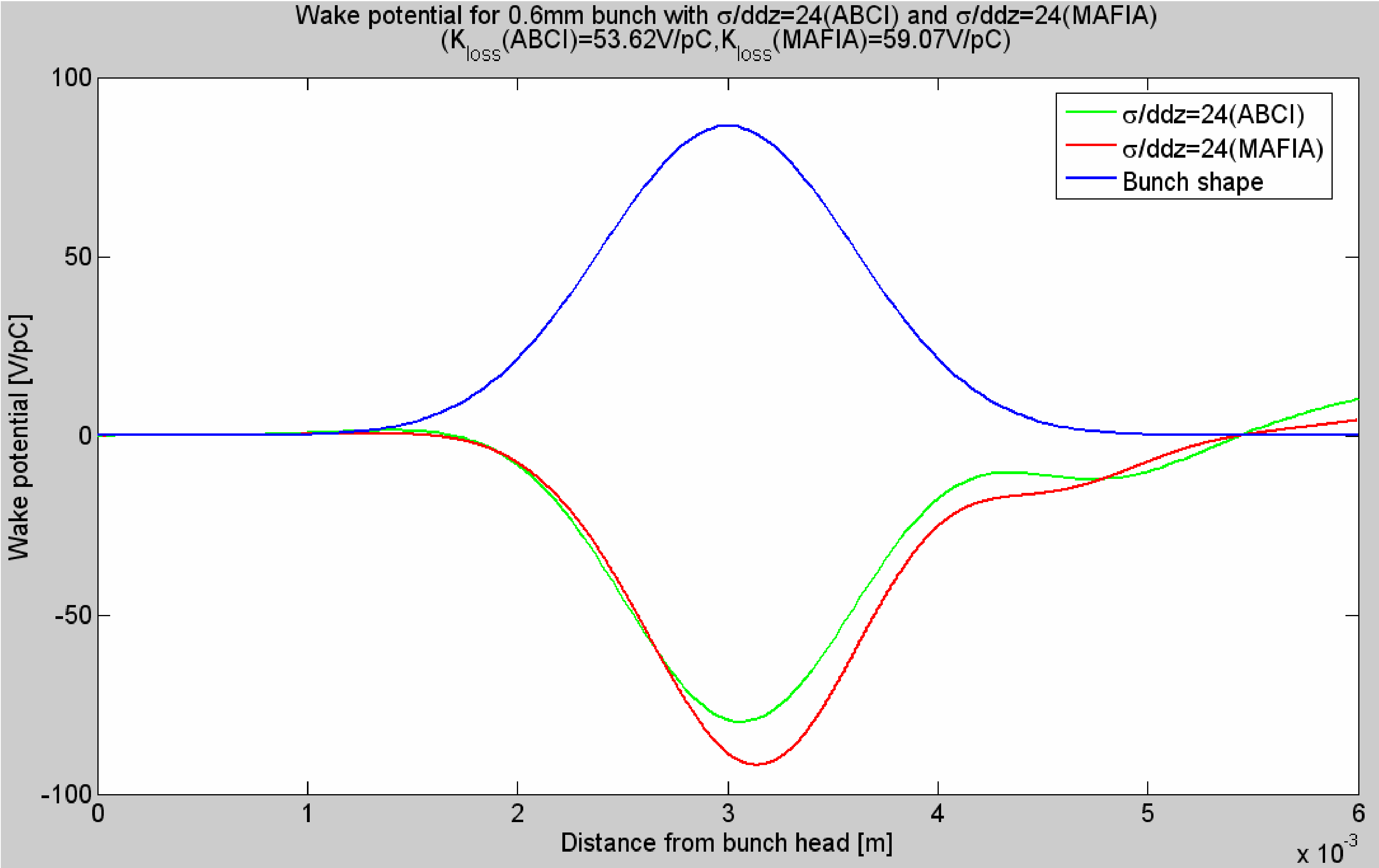
Wake potential for σ=0.4mm



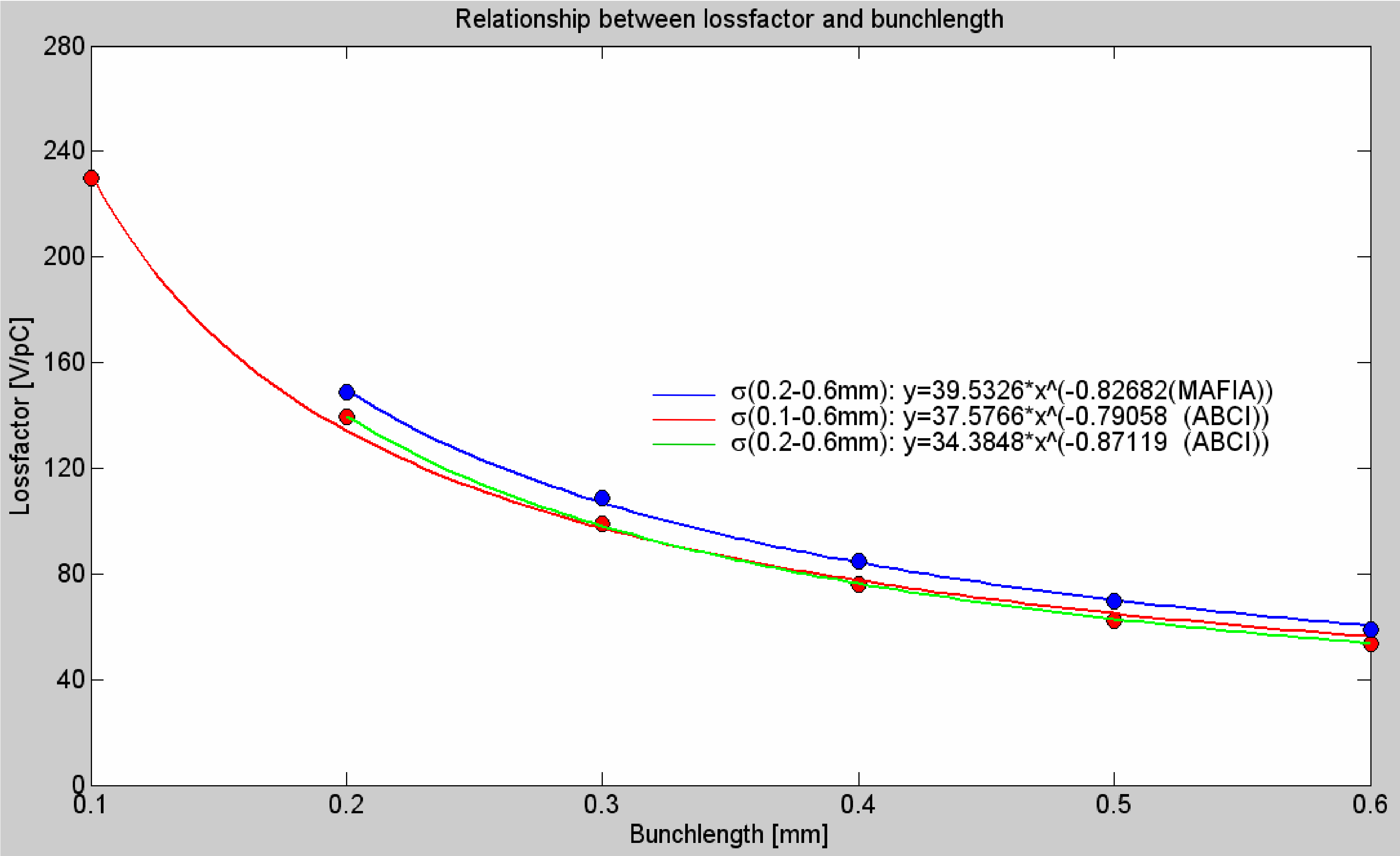
Wake potential for σ=0.5mm



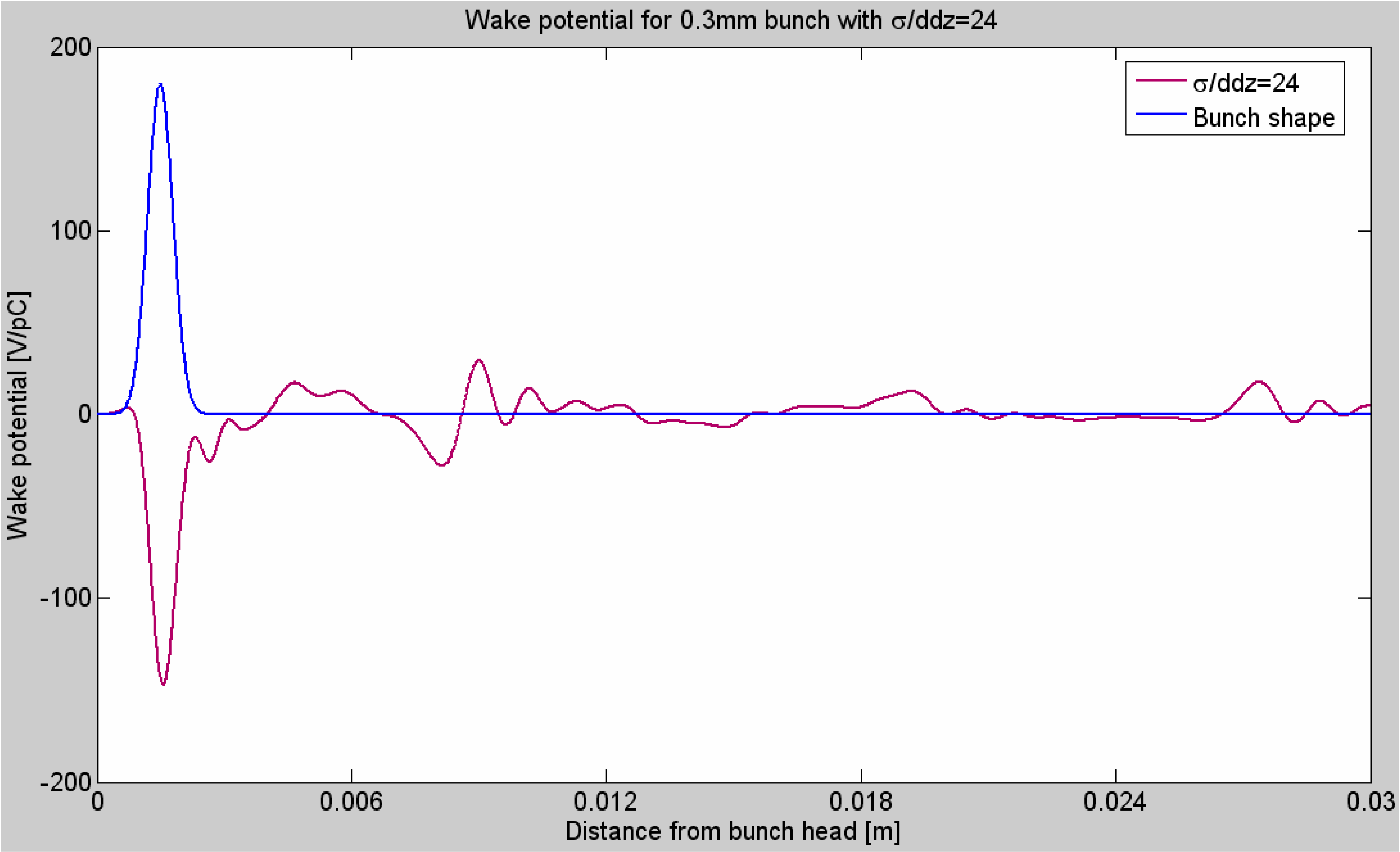
Wake potential for σ=0.6mm



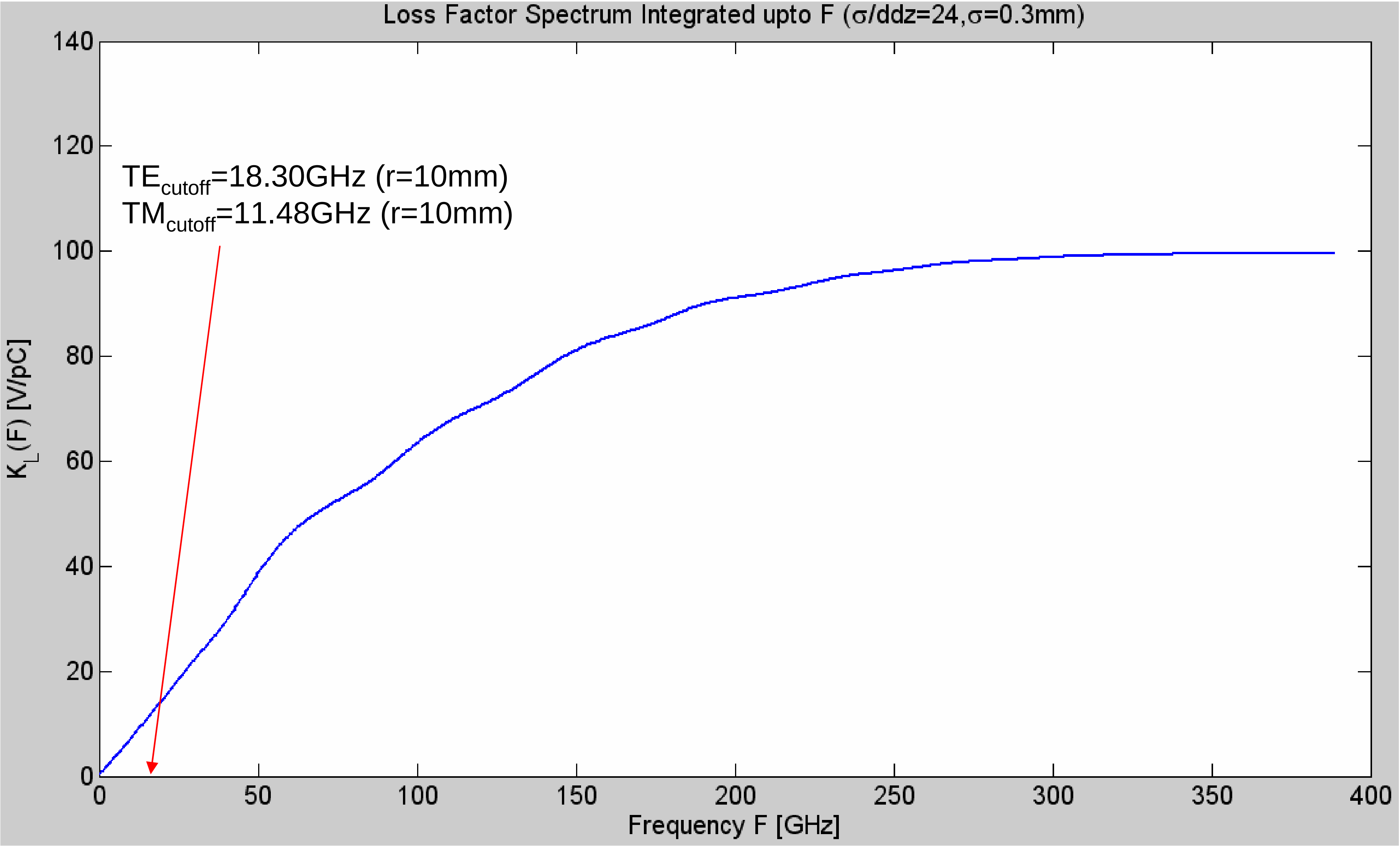
Relation between loss factor and bunch length(ABCI&MAFIA)



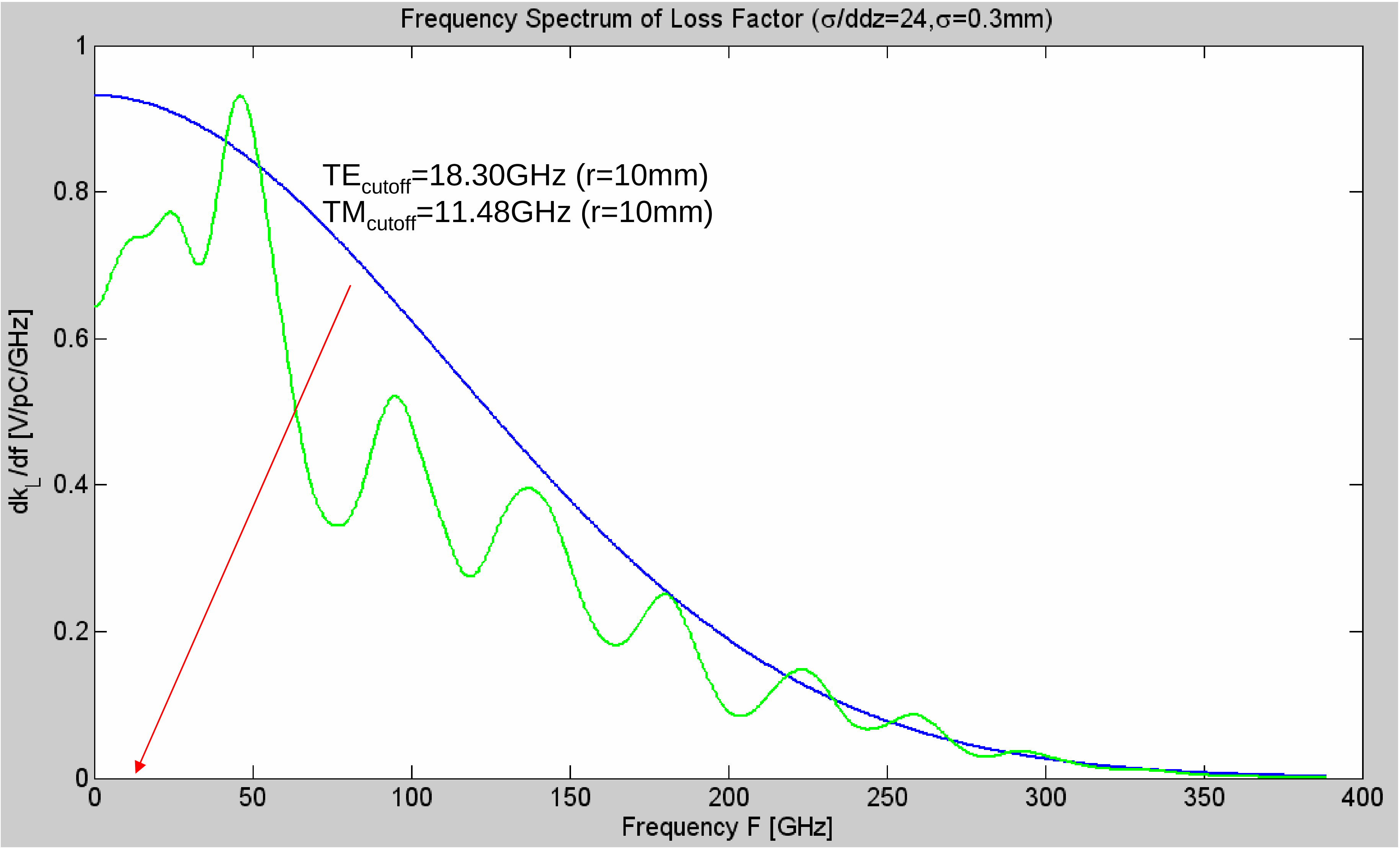
Long range wake potential for σ=0.3mm



Loss factor spectrum integrated upto F



Frequency spectrum of loss factor



Summary of results (1)

Bunch length	Loss factor (Analytical)	Loss factor (MAFIA)	Loss factor (ABCI)
0.6mm	67.76	59.07	53.59
0.5mm	81.31	69.75	62.54
0.4mm	101.63	84.94	76.22
0.3mm	135.51	108.60	99.00
0.2mm	203.27	148.75	139.42
0.1mm	406.54	???	230.03

Summary of results (2)

Incoherent Power

$$P = k\tau_b \left\{ (I_{e^+})^2 + (I_{e^-})^2 \right\}$$

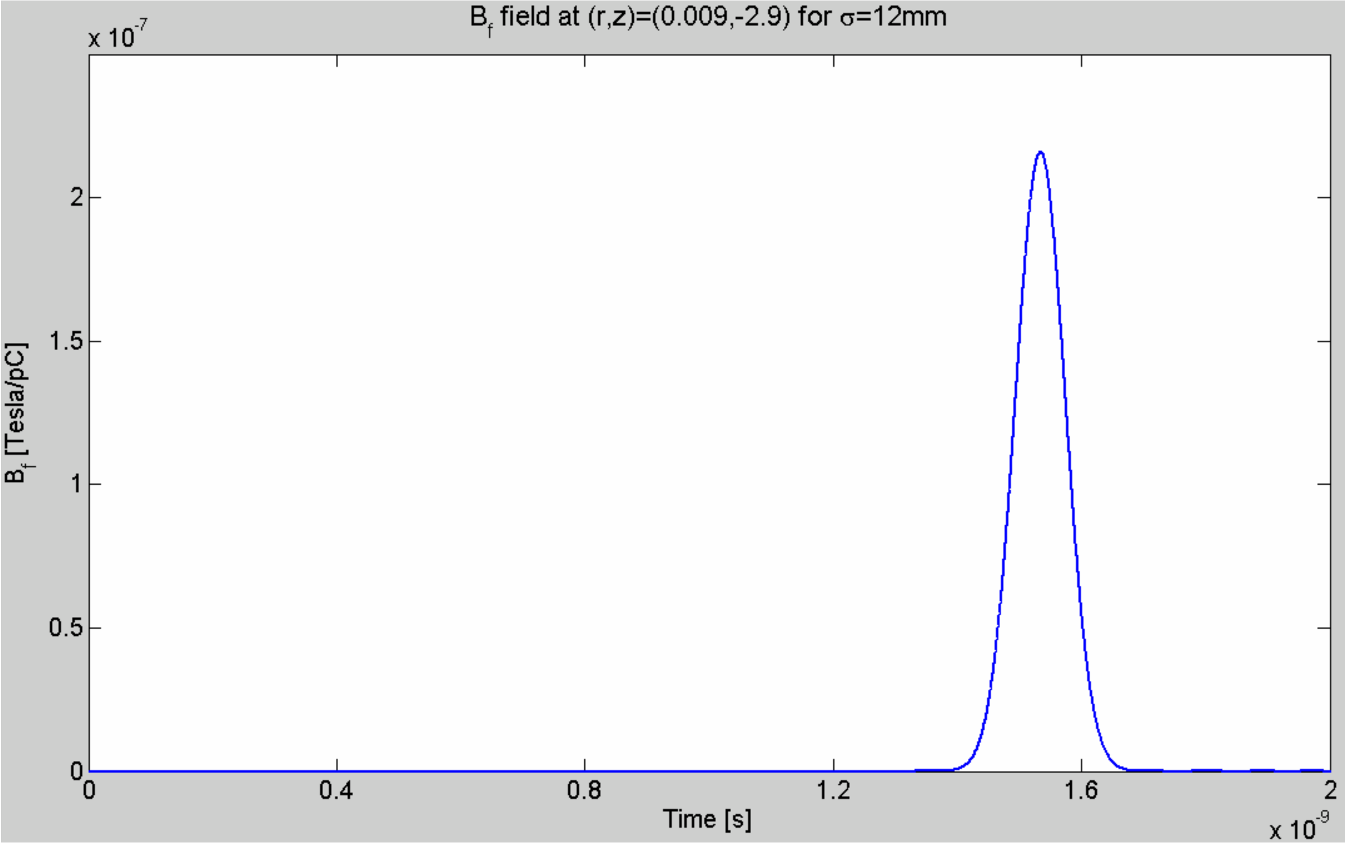
Bunch length	*Power loss (pulse)	*Power loss (average)	*Power going out of the chamber	*Power left in the chamber
0.6mm	2.97kW	7.20W	~80%	~20%
0.5mm	3.47kW	8.40W	~84%	~16%
0.4mm	4.23kW	10.24W	~88%	~12%
0.3mm	5.48kW	13.29W	~91%	~9%
**0.2mm	7.72kW	18.73W	~93%	~7%
**0.1mm	12.55kW	30.43W	~96%	~4%

*For nominal ILC beam parameters with bunch interval of 369ns and bunch population of 2*10^10, calculated from ABCI result.

**Simulation result's accuracy is limited due the limited mesh number.

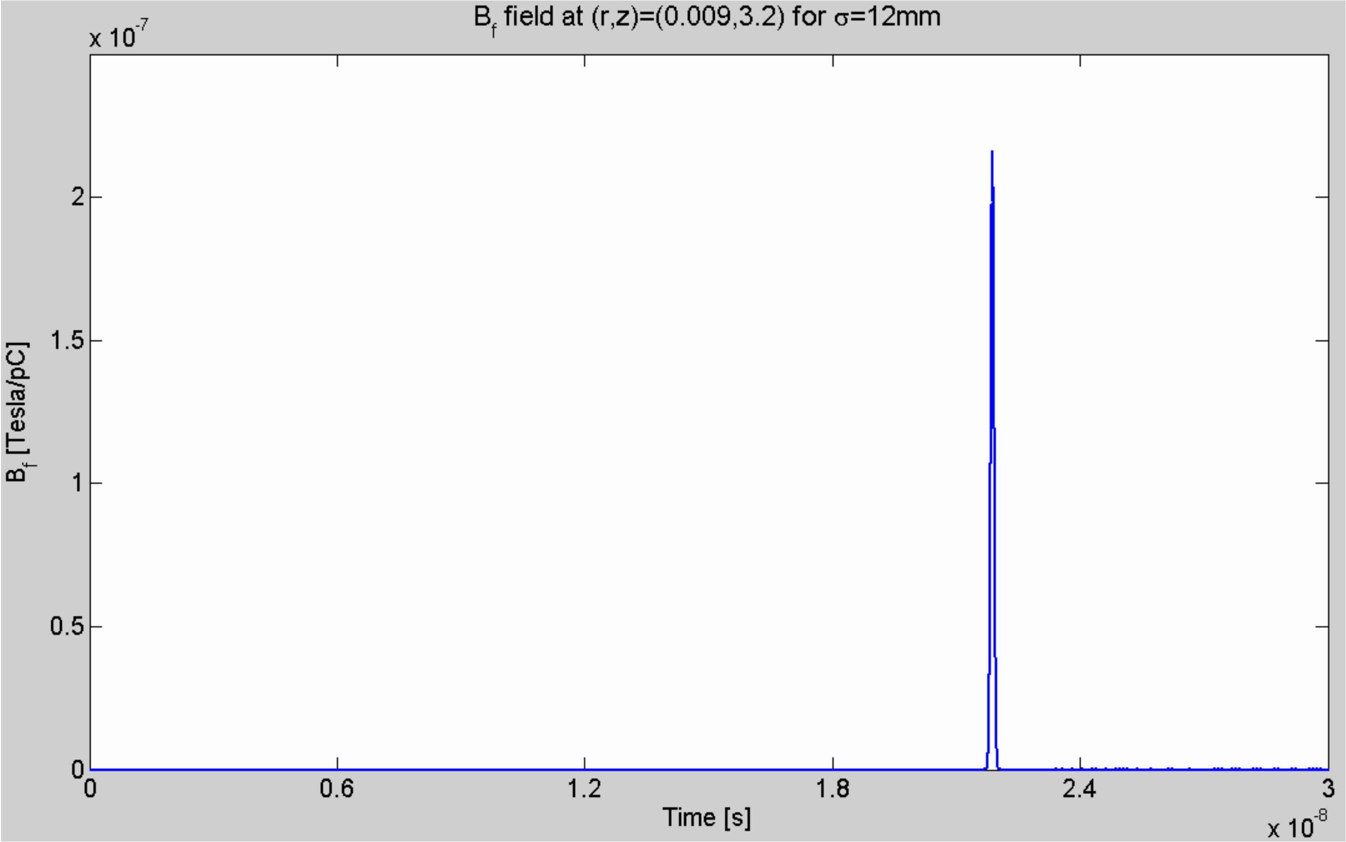
B field monitoring along beam pipe(1)

σ=12mm / MAFIA-2D
Incoming beam pipe



B field monitoring along beam pipe(1)

σ=12mm / MAFIA-2D
Outgoing beam pipe



Further study

- 3-D simulation (including both axisymmetric and nonaxisymmetric cases) with parallel version GDFIDL (in progress).
- Power attenuation analysis along the beam pipe with MAFIA (in progress).
- Trapped modes analysis in the chamber with Analyst, MAFIA or GDFIDL (to be started).
- Analysis including the other components, such as bellows, BPMs, etc.
- Power absorber studies, etc.

Thanks for many discussions with wakefield the group of SLAC.