R. Wanzenberg March, 2011

2nd Note on the: Transient Heating of Vacuum Components of the OLYMPUS experiment due to Wakefields

In a first note (April 26, 2010) mainly the wakefields of the Moeller chamber have been investigated. In this note some wakefield calculation of the Olympus target tell region are summarized. Often a simplified model for the components has been used.
The geometry is shown in the following Figures:

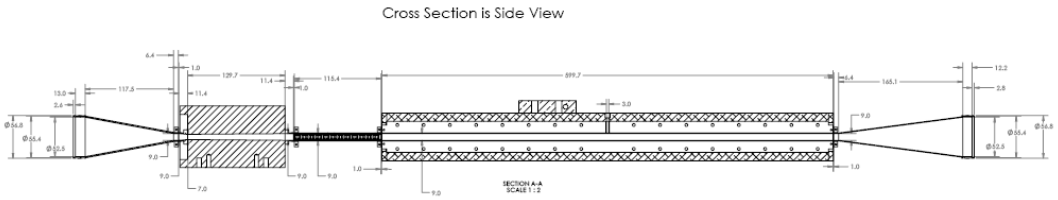


Fig. 1 Cross section of the target cell (side view)

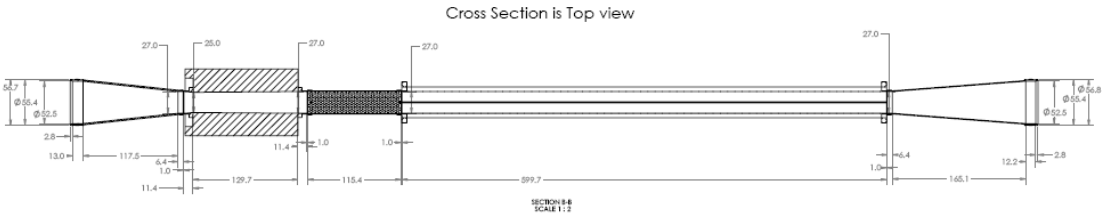


Fig. 2 Cross section of the target cell (top view)

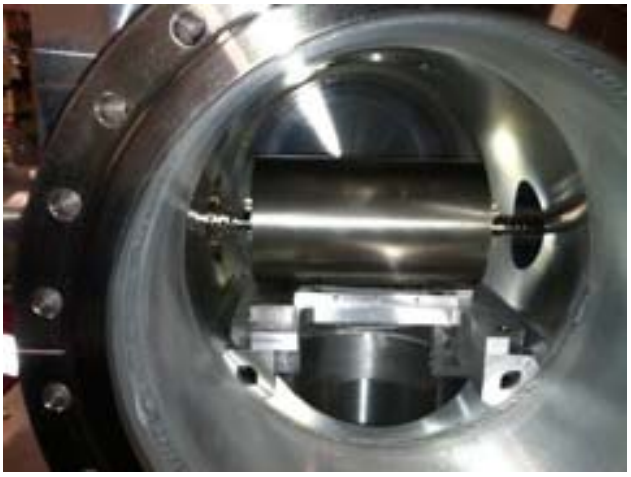


Fig. 3 Photo of the collimator

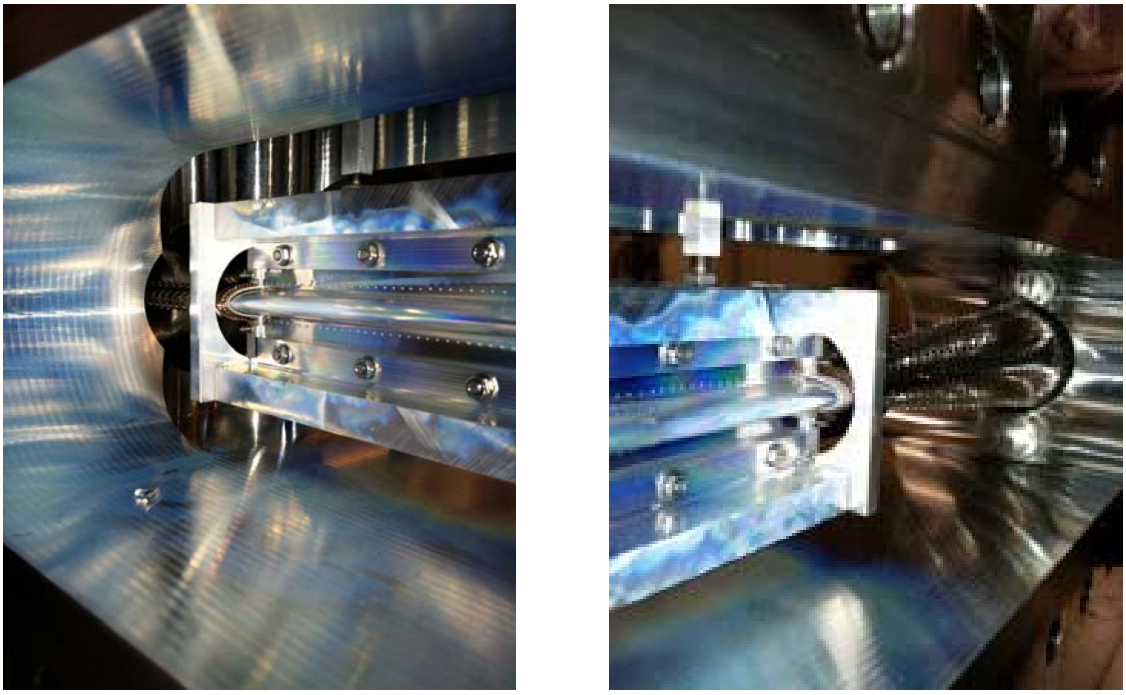


Fig. 4 Two photos of target cell (upstream and downstream)

Fig. 5 Photo of tapered transition with rf-fingers

The computer codes CST Microwave/Particle Studio, MAFIA and ECHO2D have been used to calculate the Wakefields. From the longitudinal wakefield a total loss parameter

k_{tot} is obtained as an integral of the longitudinal wake potential and the charge distribution $\lambda(s)$ of the bunch:

$$k_{tot} = \int ds\ \lambda(s)\, W_{\parallel}(s)$$

The energy loss of one bunch with bunch charge q is $q^2 k_{tot}$. The total energy loss depends on the details of the filling pattern in the ring.

Transient heating due to wakefields

The total dissipated power is:

$P_{tot} = N\ f_0\ q^2\ k_{tot} = I\, q\, k_{tot}$

with

N = number of bunches

f_0 = revolution frequency

q = single bunch charge

k_{tot} = loss parameter (units V/C)

I = total beam current

P_{tot} is the total power loss of the beam. The power may be dissipated over a larger area of the vacuum chamber. Therefore the total dissipated power is only a rough estimate for local losses and the subsequent heating of vacuum components.

The factor $N\ f_0\ q^2$ is given in Table 1 for different assumptions on the beam parameters of DORIS. Furthermore the peak beam current is also include in the table for a rms bunch length of 10 mm or 20 mm.

	DORIS	DORIS, 10 bunch
N_b (# bunches)	5	10
f_0 / kHz	1037.0	1037.0
q / nC	27.2	13.6
N / 10^{10}	17	8.5
I_{tot} / mA	140	140
$N_b f_0 q^2$ / W nC/V	**3.85**	**1.92**
Bunch length (σ_z) /mm	10 or 20	10 or 20
Peak current / A	325 or **162**	**162** or 81

Table 1: Different parameter sets for DORIS and the factor $N\ f_0\ q^2$ and the peak current.

The peak current is calculated as:

$$I_{peak} = \frac{c \cdot q}{\sigma_z \sqrt{2\,\pi}}$$

A simple 2D model of the Olympus chamber / calculations with ECHO2D

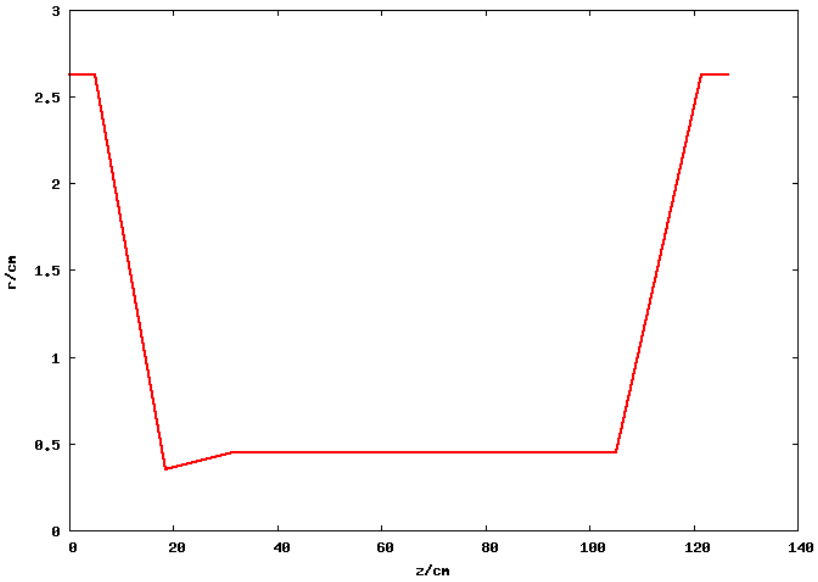


Fig. 6 Geometry Olympus target region

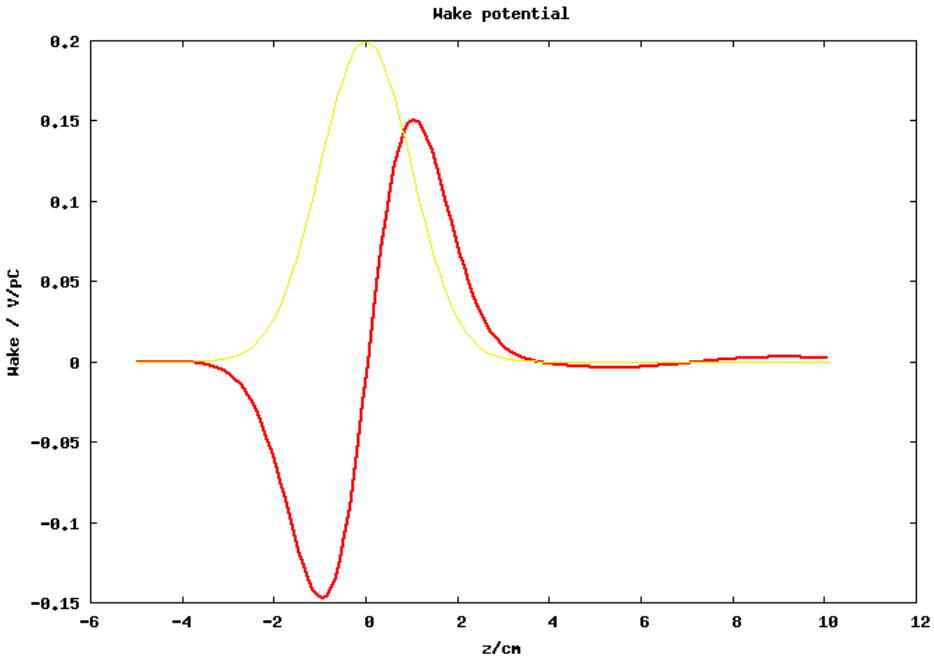


Fig. 7 Wake potential / Olympus target region calculated with ECHO2D.

A very simple 2D model of chamber / calculations with ECHO2D

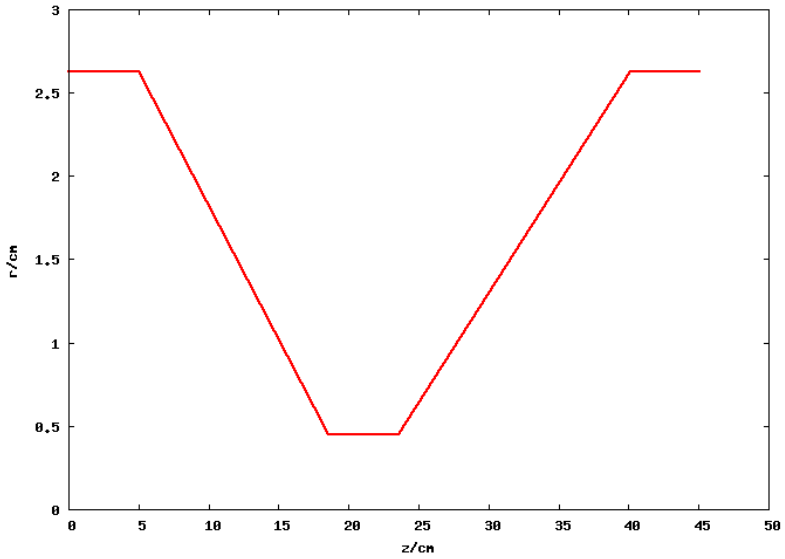


Fig. 8 Geometry taper

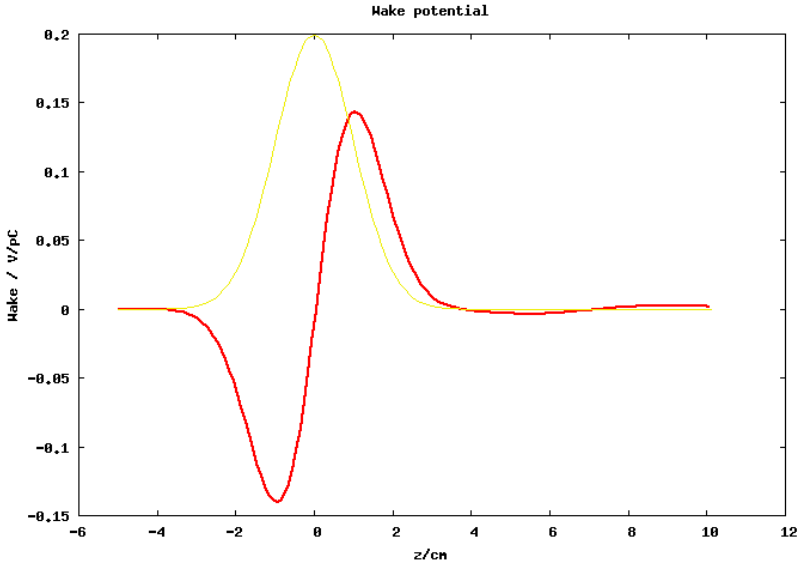
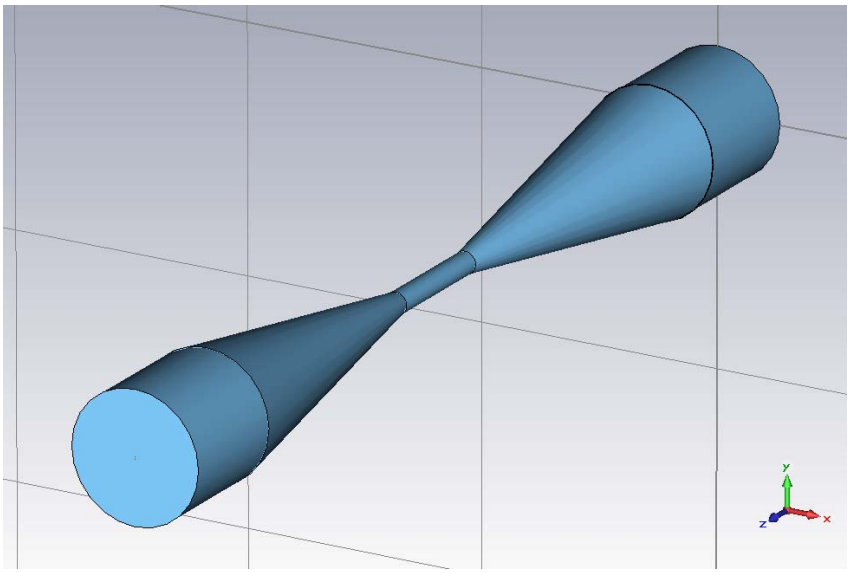
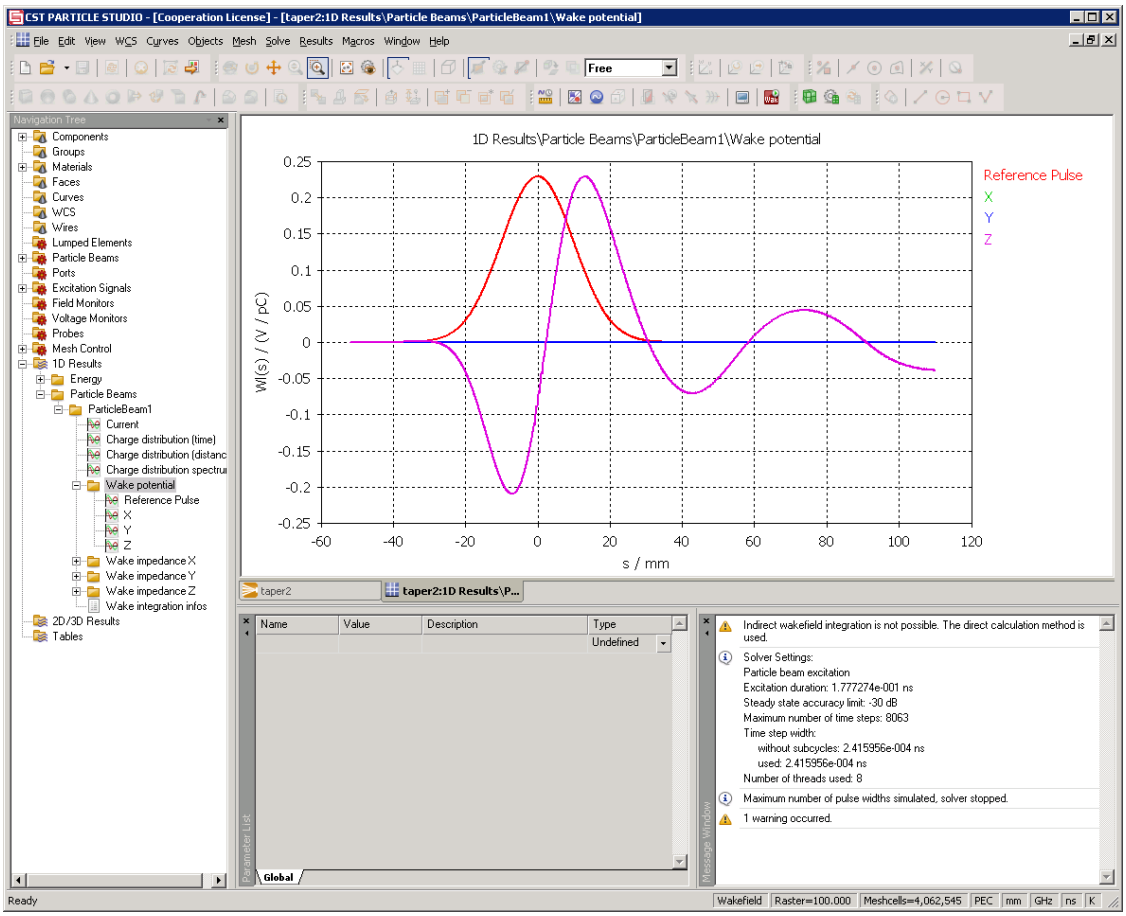
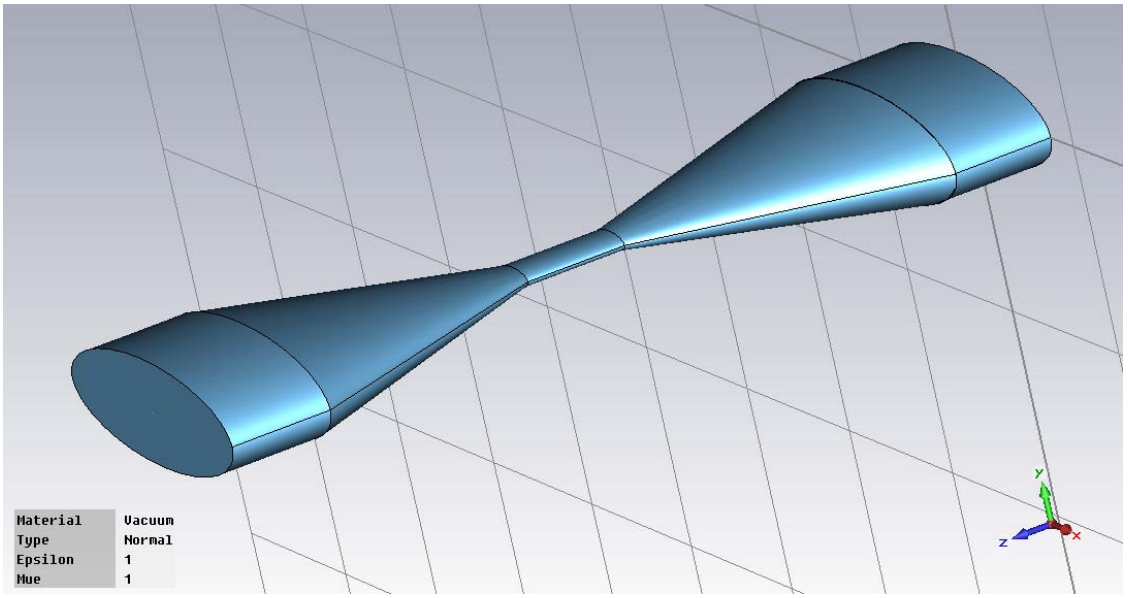


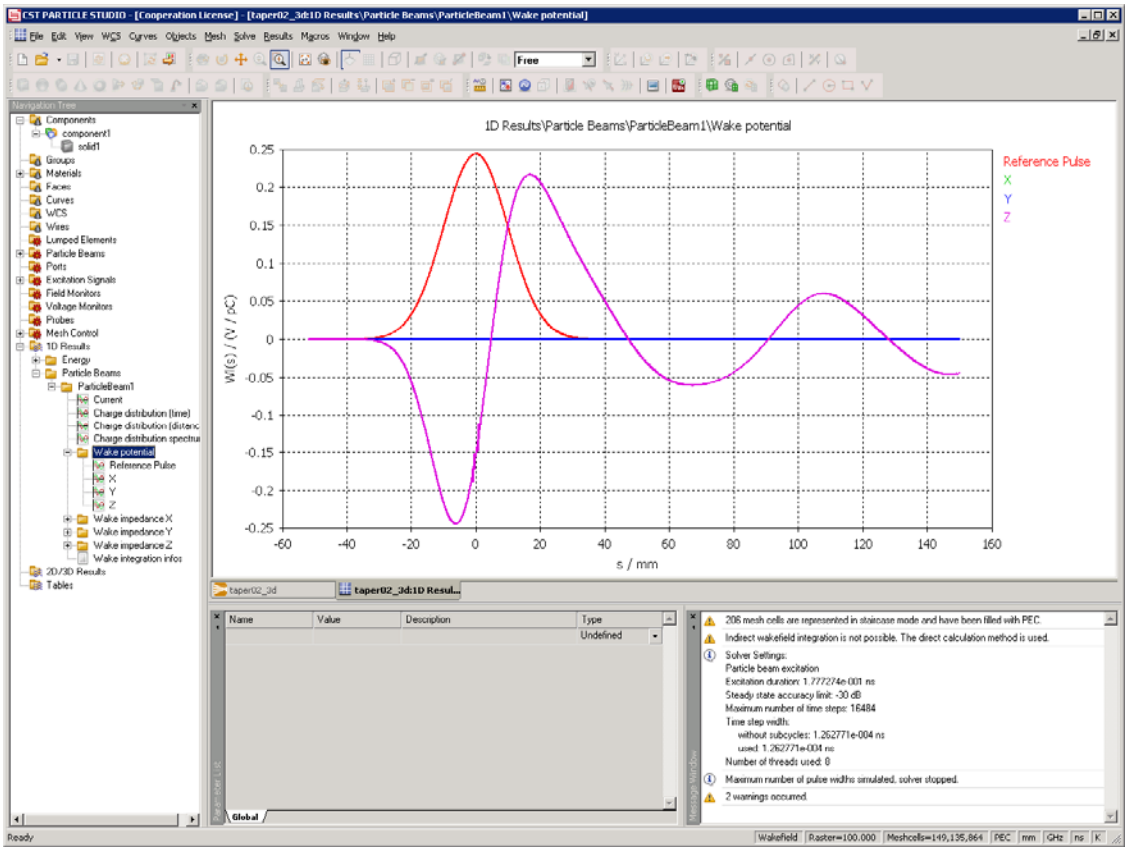
Fig. 9 Geometry taper

2D model versus 3D model of chamber / calculations with CST Micro-Wave-Studio

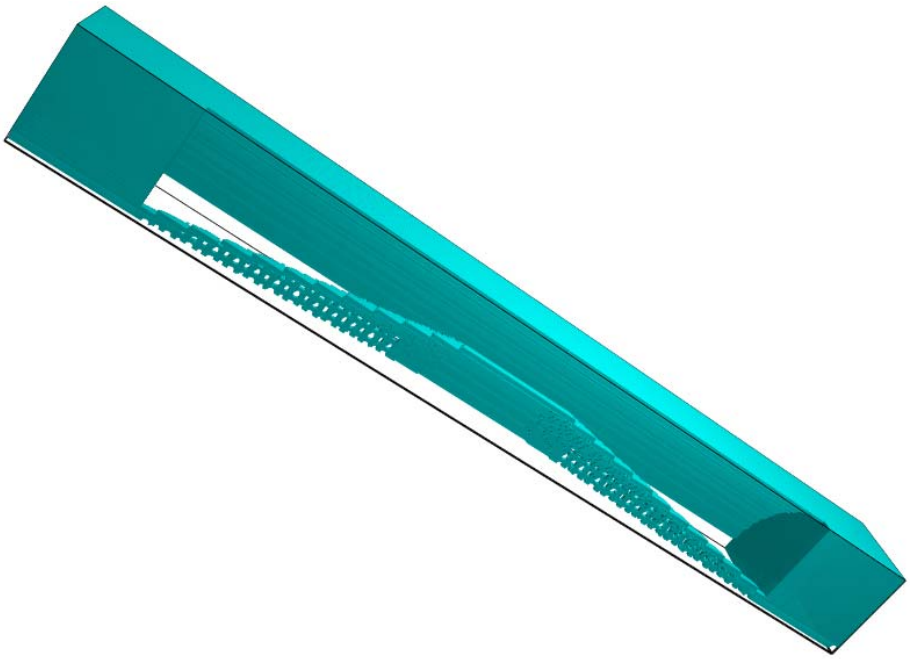


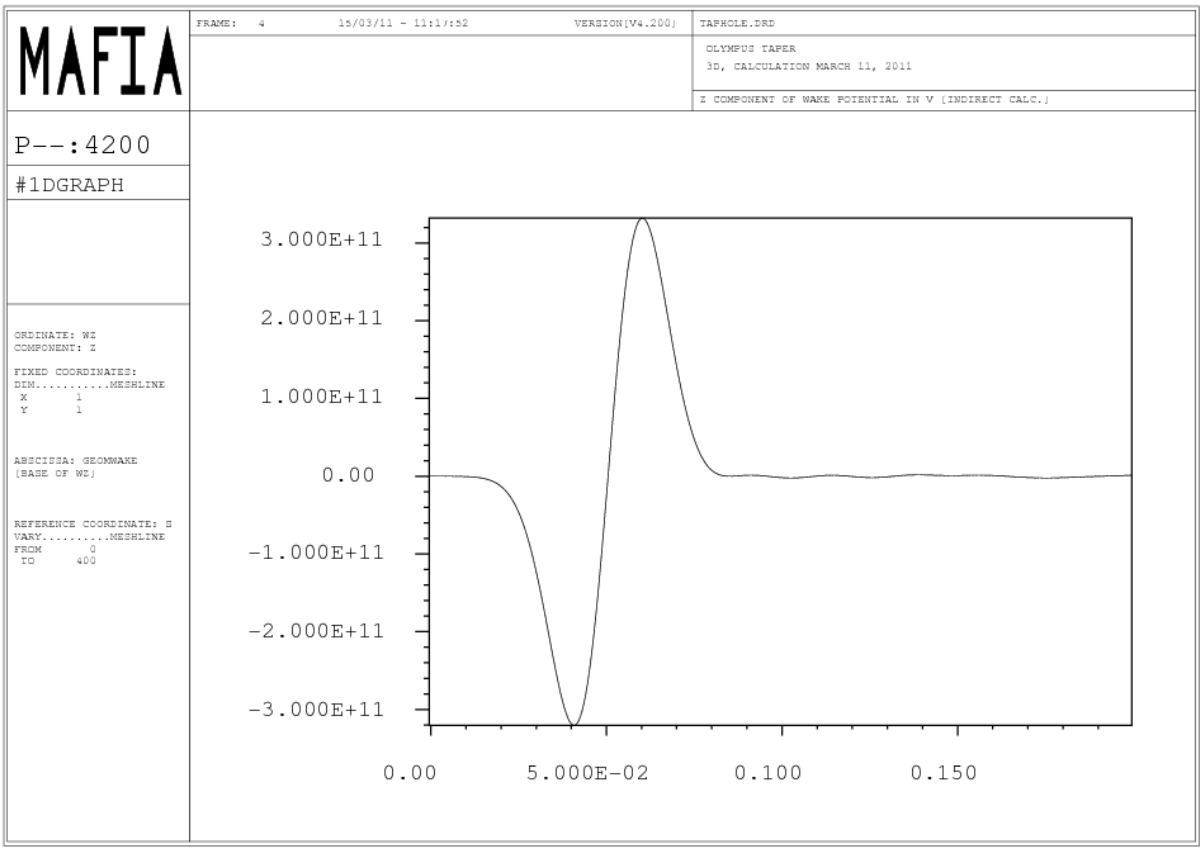


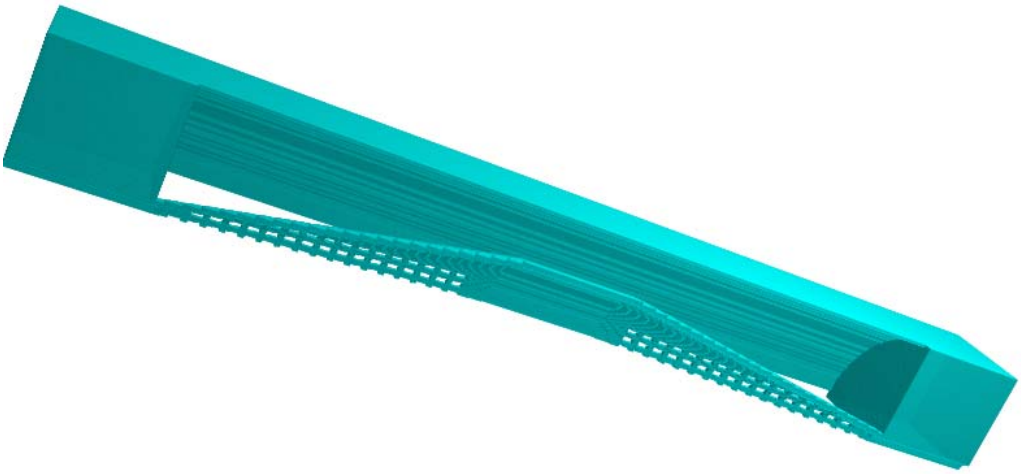

Material Vacuum
Type Normal
Epsilon 1
Mue 1
Y
Z
X


CST PARTICLE STUDIO - [Cooperation License] - [taper02_3d:1D Results\Particle Beams\ParticleBeam1\Wake potential]
1D Results\Particle Beams\ParticleBeam1\Wake potential
Reference Pulse
X
Y
Z
W(s) / (V / pC)
s / mm
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-60
-40
-20
0
20
40
60
80
100
120
140
160

Taper with pumping holes / calculations MAFIA







MAFIA

FRAME: 4 16/03/11 - 14:35:32 VERSION[V4.200] TAPHOLE.DRD

OLYMPUS TAPER
3D, CALCULATION MARCH 11, 2011

Z COMPONENT OF WAKE POTENTIAL IN V (INDIRECT CALC.)

P--:4200

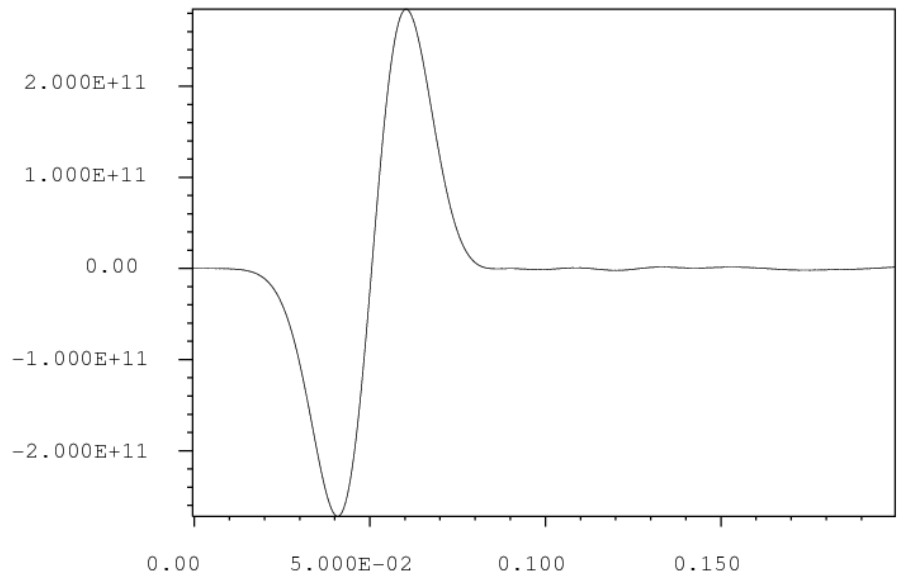
#1DGRAPH

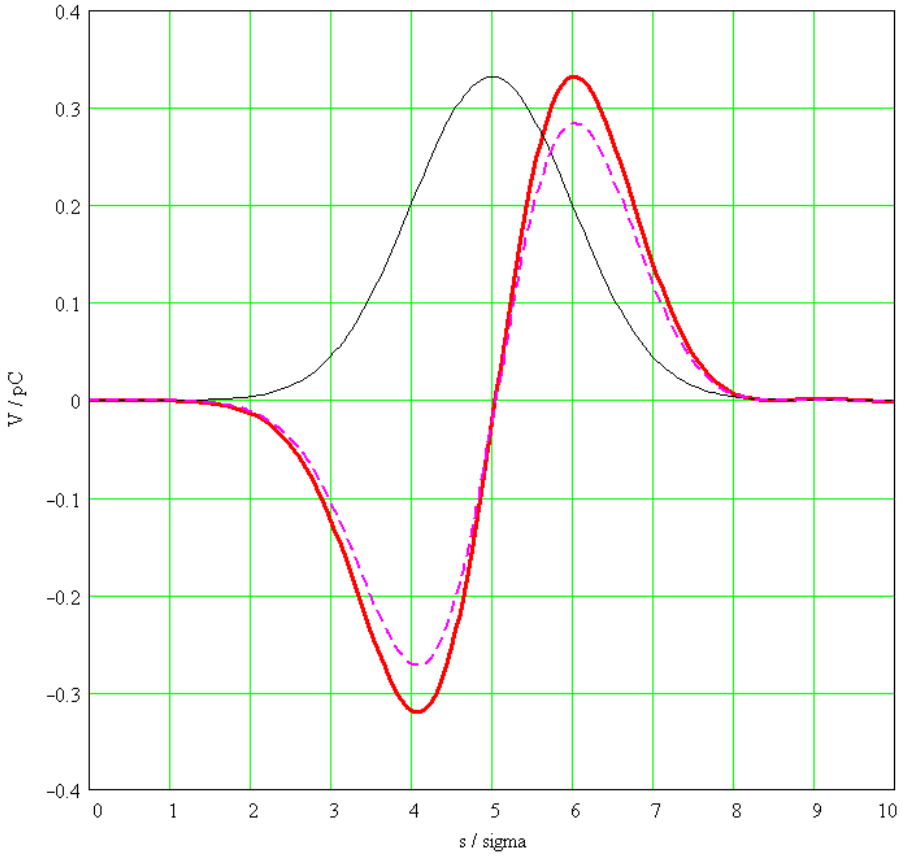
ORDINATE: WZ
COMPONENT: Z

FIXED COORDINATES:
DIM.....MESHLINE
X 1
Y 1

ABSCISSA: GEOMWAKE
(BASE OF WZ)

REFERENCE COORDINATE: S
VARY.....MESHLINE
FROM 0
TO 400





Factor 1.16 (Max)

MAFIA

FRAME: 4 21/03/11 - 14:10:07 VERSION[V4.200] TAPHOLE.DRD

OLYMPUS TAPER
3D, CALCULATION MARCH 11, 2011

Z COMPONENT OF WAKE POTENTIAL IN V (INDIRECT CALC.)

P--:4200

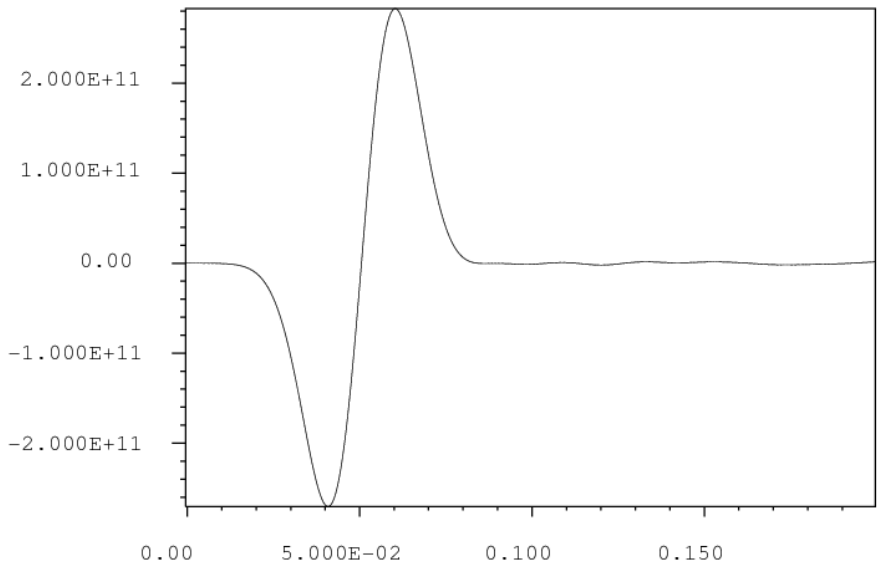
#1DGRAPH

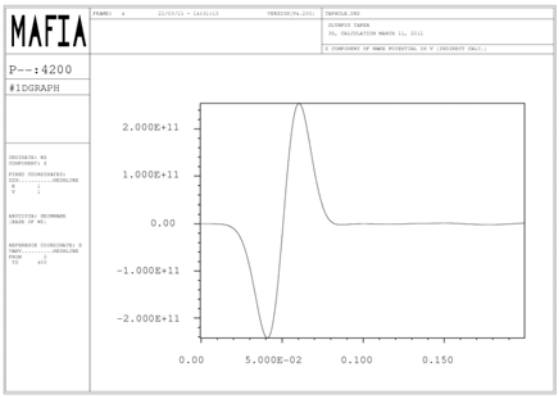
ORDINATE: WZ
COMPONENT: Z

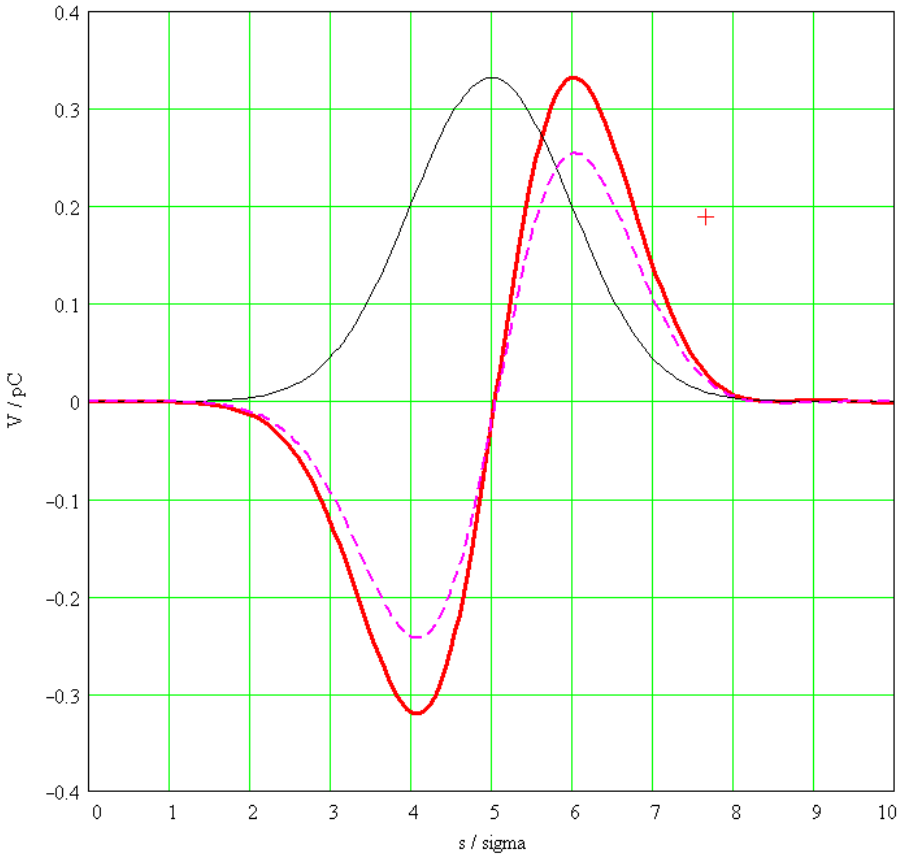
FIXED COORDINATES:
DIM.....MESHLINE
X 1
Y 1

ABSCISSA: GEOMWAKE
(BASE OF WZ)

REFERENCE COORDINATE: S
VARY.....MESHLINE
FROM 0
TO 400







Red: Taper with round holes, Magenta (dashed) Solid Taper