While publishing the resuts of your simulations based on this code please reference M. Kostylev, *J. Appl. Phys.* **112**, 093901 (2012).

Transmission of a plane electromagnetic wave through a bi-layer ferromagnetic film is simulated. The applied field is in the film plane. The wave is incident normally onto the film surface. Areas in front and behind the film are vacuum.
If you need to simulate a single layer film you may set identical magnetic parameters for both layers and *L*1=*L*2=0.5*L*, where *L* is the thickness of the single-layer film you want to simulate. You will also need to set the value of the inter-layer exchange constant A12 to A12=n*A1/(*L*1+L2) .

Enter the number of the mesh steps across the sample thickness:

$n := 80$

Enter the thicknesses *L1 and L2* of the layers. The ferromagnetic layer is closer to the stripline transducer.

$L1 := 20 \cdot 10^{-7}$ $L2 := 70 \cdot 10^{-7}$

Enter Gilbert α (unitless) and frequency-independent part of magnetic losses ΔH_0 (in Oe):

$\alpha H1 := 0.032$ $\alpha H2 := 0.008$

$\Delta H1_0 := 0$ $\Delta H2_0 := 0$

Enter *M*=4πM$_s$ in G, and the gyromagnetic coefficient γ in Hz/Oe (γ is the same for both layers):

$\gamma := 2 \cdot \pi \cdot 2.82 \cdot 10^6$

$M1 := 17500 = 1.75 \times 10^4$ $M2 := 9250 = 9.25 \times 10^3$

Enter exchange constant A in erg/cm:

$A1 := 1.5 \times 10^{-6}$ $A2 := 0.41 \times 10^{-6}$

Interlayer exchange coupling constant (in erg/cm^2)

$A12 := 20$

Enter the conductivity of the metal in $(\Omega \cdot m)^{-1}$

$\sigma 1 := 18 \cdot 10^6$ $\sigma 2 := 4.5 \cdot 10^6$

Enter microwave frequency in rad/s

$\omega_0 := 2 \cdot \pi \cdot 8.865 \cdot 10^9 = 5.57 \times 10^{10}$

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Surface A (facing the microstrip): Surface B (facing away from the microstrip):

unitless pinning constant (0: surface spins are fully unpinned, 1: the spins are fully pinned. Any value between 0 nad 1 is allowed.)

$zsa := 0$ $zsb := 0$

Note that for the in-plane magentised films only the **in-plane** component of dynamic magnetisation can be pinned by the surface normal uniaxial anisotropy (see the paper by Soohoo)

conversion in the conventional pinning constant *d* in cm^{-1}:

$dda := \frac{-\ln(1 - zsa)}{2 \cdot \Delta}$ $ddb := \frac{-\ln(1 - zsb)}{2 \cdot \Delta}$

Coresponding surface easy-axis normal uniaxial anisotropy in erg/cm^2 (which is the same as mJ/m^2):

$Ksa := dda \cdot A1$ $Ksb := ddb \cdot A1$

$Ksa = 0$ $Ksb = 0$

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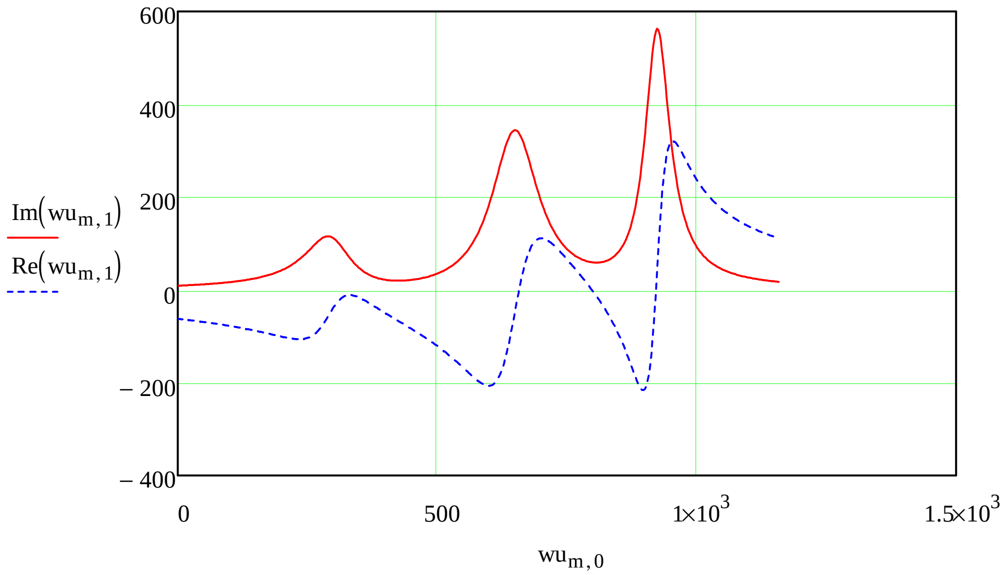
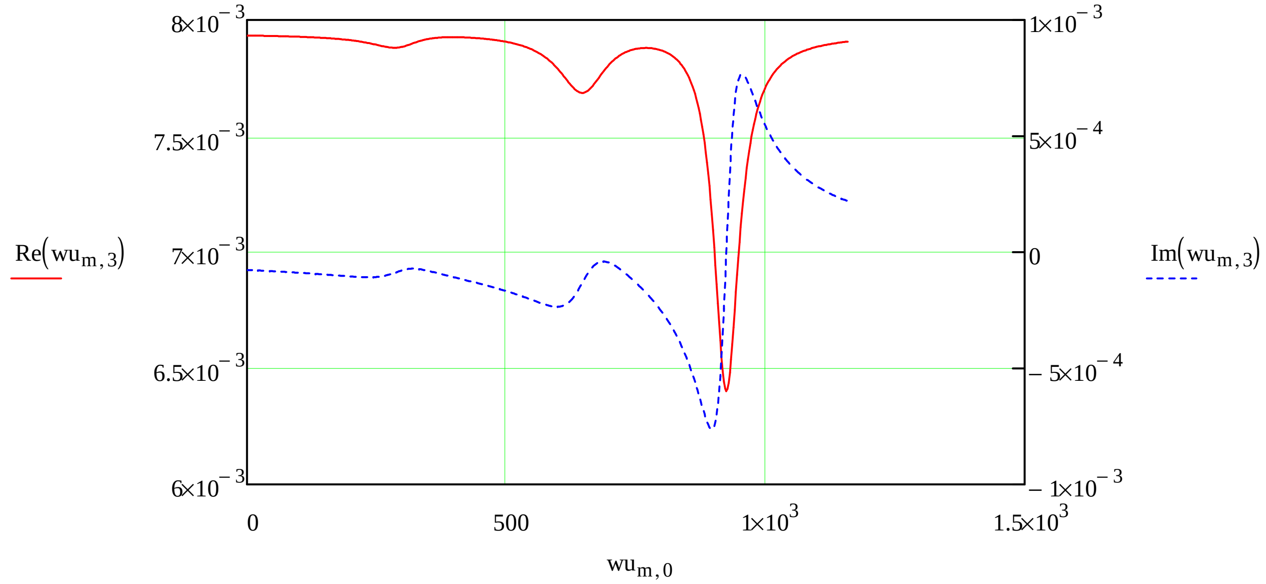
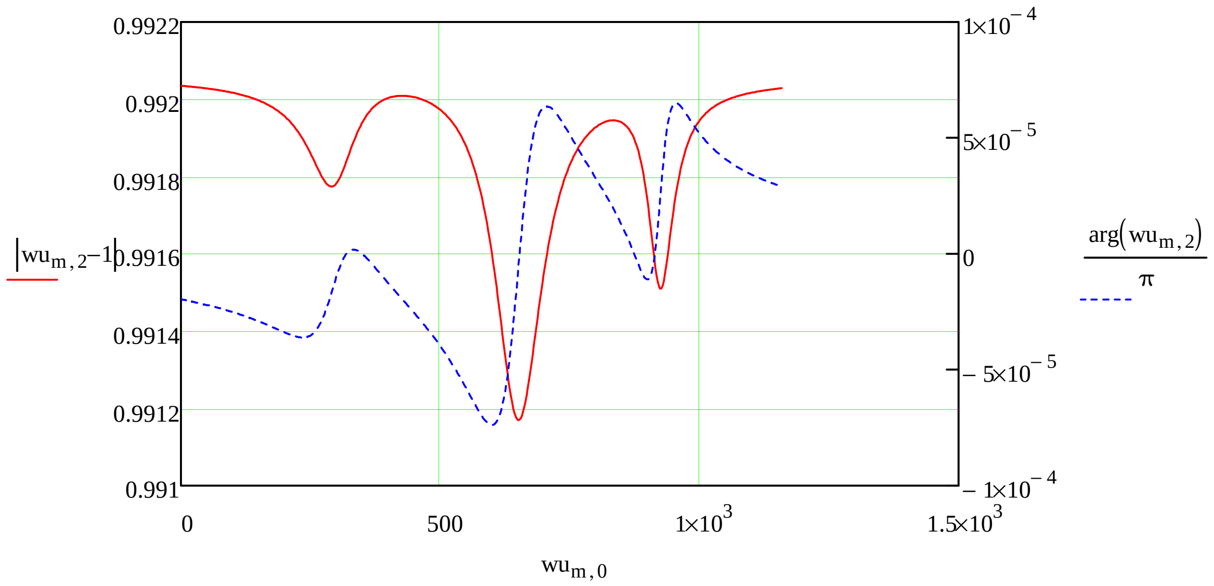
mean value of dynamic magnetisation across the film thickness (arb. unit) vs applied field (Oe):

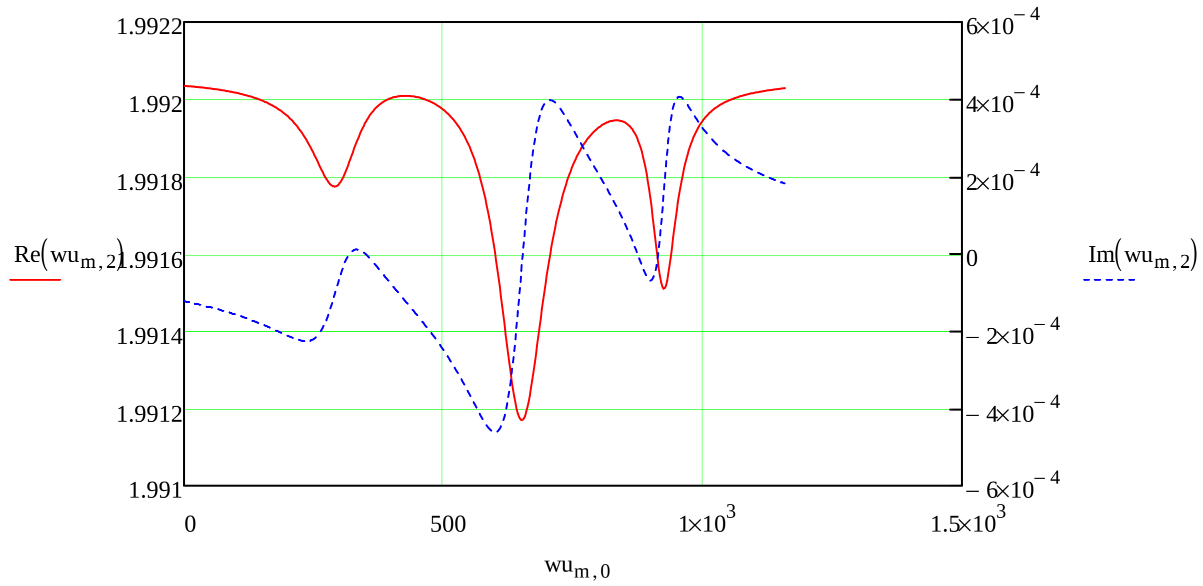


Microwave magnetic field transmitted through the film (the incident field amplitude is 1)

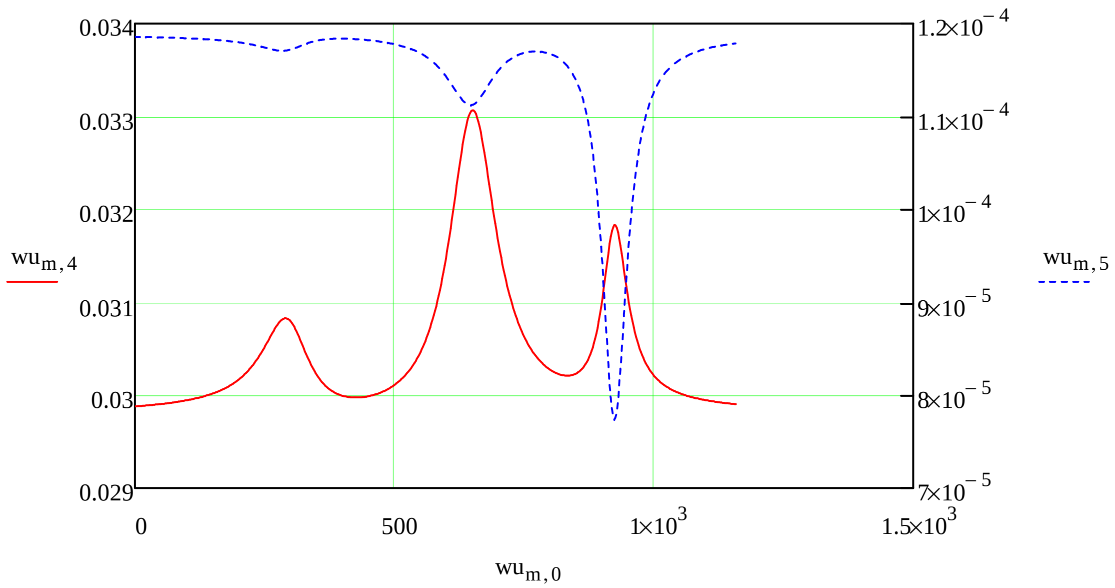


Microwave magnetic field reflected from the front film surface (the incident field amplitude is 1)





Poyting vector in front of the film (left-hand axis) and behind the film (right-hand axis)



Output data tables (for copy-pasting in your grahing software:)

$wu_{m,0} =$

0
2.321
4.643

$|wu_{m,3}| =$

$7.9346858\cdot10^{-3}$
$7.9346035\cdot10^{-3}$
$7.9345201\cdot10^{-3}$

$|wu_{m,2}| =$

1.9920349
1.9920346
1.9920343

$|wu_{m,4}| =$

0.0298794
0.0298803
0.0298813

$|wu_{m,5}| =$

$1.1856993\cdot10^{-4}$
$1.1856751\cdot10^{-4}$

4.643
6.964
9.285
11.607
13.928
16.249
18.571
20.892
23.213
25.535
27.856
30.177
32.499
...

$7.9344353 \cdot 10^{-3}$
$7.9343492 \cdot 10^{-3}$
$7.9342617 \cdot 10^{-3}$
$7.9341729 \cdot 10^{-3}$
$7.9340826 \cdot 10^{-3}$
$7.9339909 \cdot 10^{-3}$
$7.9338977 \cdot 10^{-3}$
$7.9338029 \cdot 10^{-3}$
$7.9337066 \cdot 10^{-3}$
$7.9336087 \cdot 10^{-3}$
$7.9335091 \cdot 10^{-3}$
$7.9334077 \cdot 10^{-3}$
...

1.9920343
1.9920341
1.9920338
1.9920335
1.9920332
1.9920329
1.9920326
1.9920323
1.992032
1.9920317
1.9920314
1.992031
1.9920307
...

0.0298813
0.0298823
0.0298833
0.0298844
0.0298854
0.0298865
0.0298876
0.0298887
0.0298899
0.029891
0.0298922
0.0298935
0.0298947
...

$1.1856505 \cdot 10^{-4}$
$1.1856256 \cdot 10^{-4}$
$1.1856003 \cdot 10^{-4}$
$1.1855746 \cdot 10^{-4}$
$1.1855485 \cdot 10^{-4}$
$1.185522 \cdot 10^{-4}$
$1.185495 \cdot 10^{-4}$
$1.1854676 \cdot 10^{-4}$
$1.1854398 \cdot 10^{-4}$
$1.1854115 \cdot 10^{-4}$
$1.1853828 \cdot 10^{-4}$
$1.1853535 \cdot 10^{-4}$
$1.1853238 \cdot 10^{-4}$
...

Here, additionally, you may calculate thickness profiles for different physical quantities for a particular applied field Hp. (Enter Hp on Oe below)

$$Hp := 817$$

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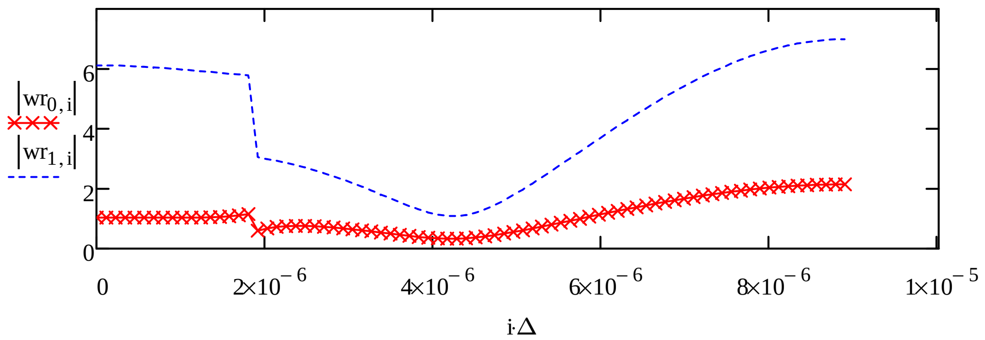
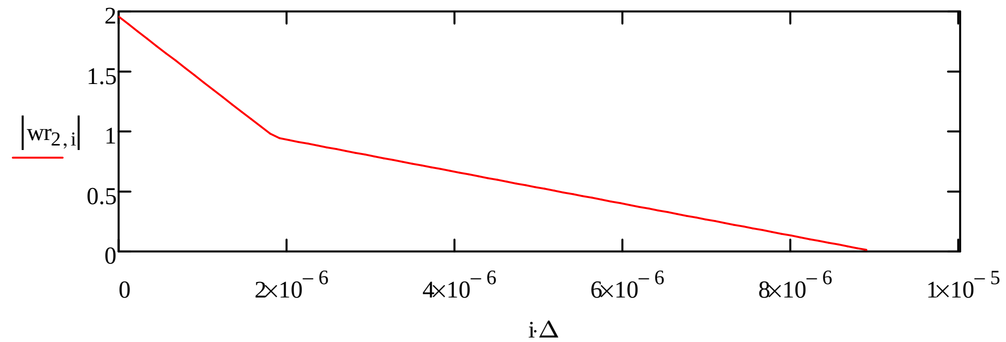
Amplitudes of both in-plane components of dynamic magnetisation vs. co-ordinate (in cm)

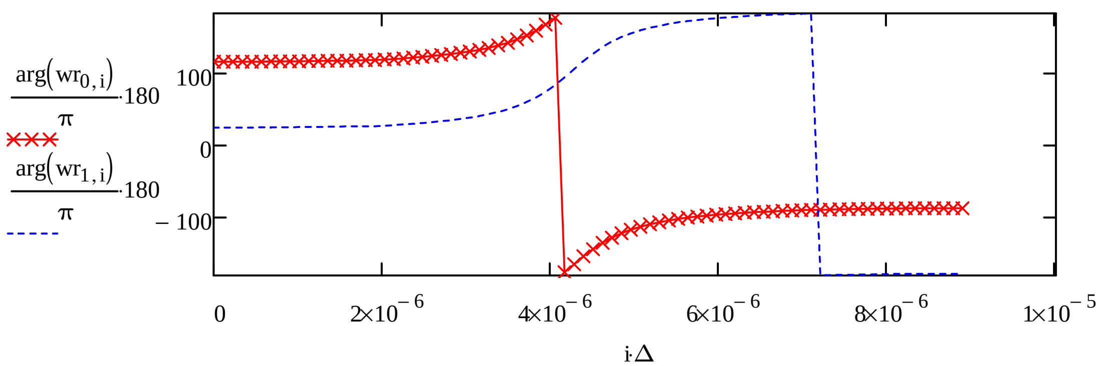


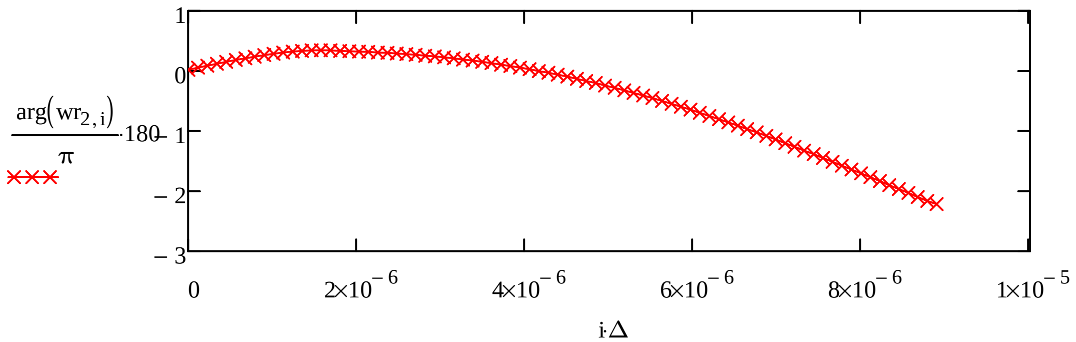
Their phases in angle degrees

The total microwave magnetic field in front of the film

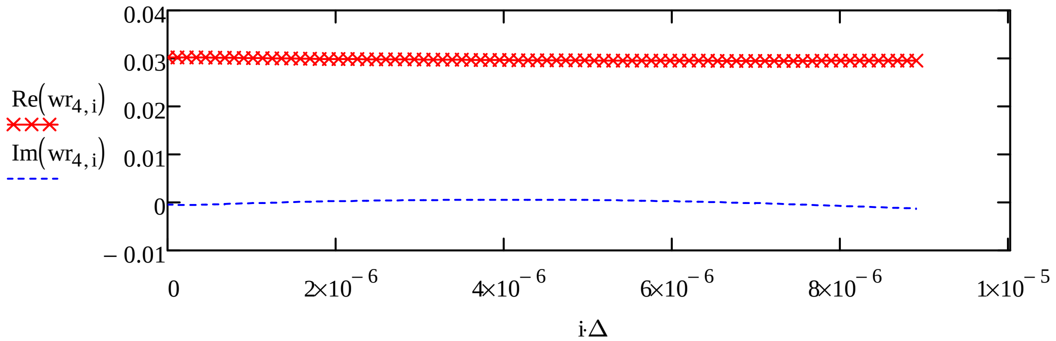


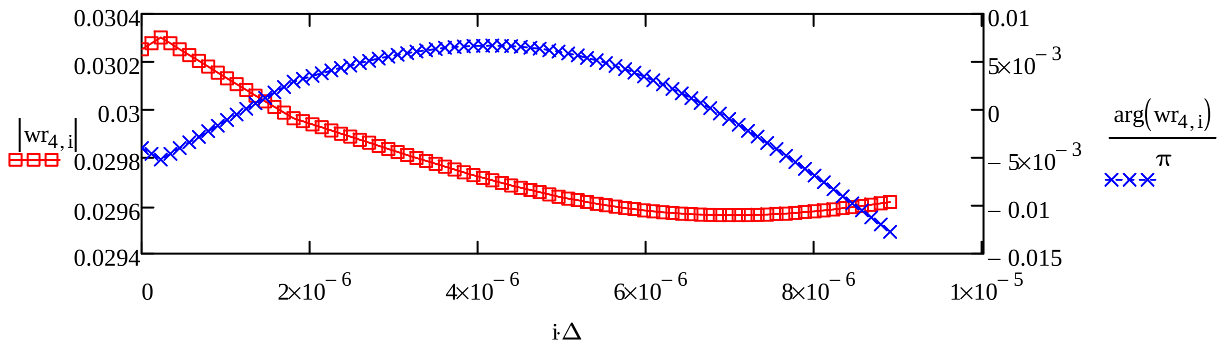
Its phase in angle degrees





Microwave electric field





Poynting vector