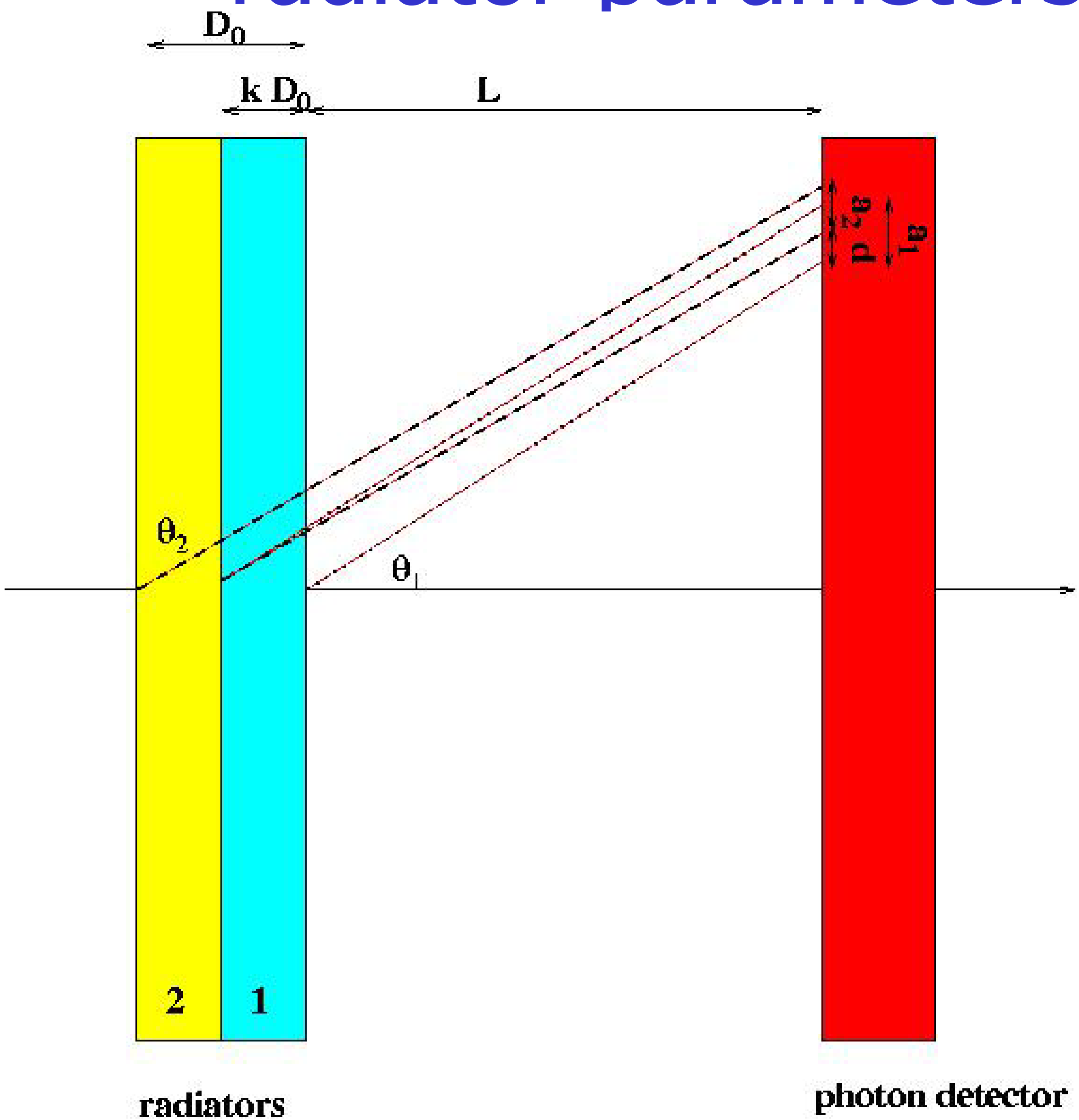
Multiple radiator: Optimisation of radiator parameters - revisited



Dual radiator: three parameters (if fixed space available)

- Difference in n
- Ratio of radiator thicknesses
- Total radiator thickness

Minimized: error per track

$$\sigma_{track} = \frac{1}{\sqrt{N_{\det}}}\sqrt{\sigma_{emp}{}^2 + \sigma_{\det}{}^2 + \sigma_{rest}{}^2}$$

$$\frac{1}{(L + D0/2)}$$

Distance to photon detector

$$\sqrt{\left(\frac{1}{(N1 + N2)}\right.}$$

Number of photons

$$\left(\frac{1}{12\,(N1 + N2)^2}\right.$$

$$\left(-3\,(a1\,N1 + (a2 + 2\,d)\,N2)^2 + \right.$$

$$\left.4\,(N1 + N2)\,\left(a1^2\,N1 + \left(a2^2 + 3\,a2\,d + 3\,d^2\right)\,N2\right)\right) +$$

Emission point error

$$\left.\left.pad\hat{}2/12\right)\right)$$

Pad size contribution

Now assume σ_{rest}=0.006

Minimize track error vs.

Relative radiator thickness k and refractive index difference dn and total thickness D_0

Transm. length 3cm	Transm. length 4.5cm
dn=0.0046	**dn=0.0053**
k=0.43	**k=0.44**
D_0 = 2.7 cm	**D_0 = 3.0 cm**
σ at minimum 0.0047	σ at minimum 0.0044

Available space in front of photon detector: 20cm

σ_{rest}=6mrad

Triple radiator

Transm. length 3cm, σ_{rest}=6mrad

dn1=0.0033

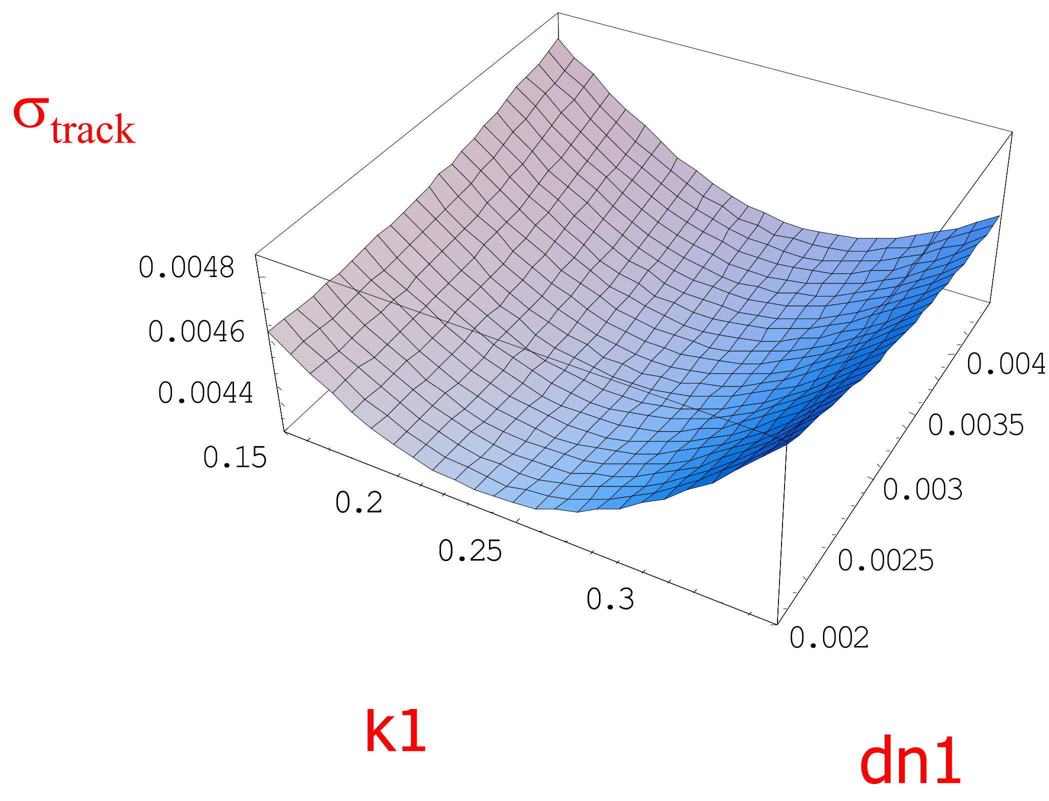
dn2=0.0081

k1=0.25

k2=0.34

D_0 = 3.4 cm

σ at minimum 0.0043



Quadruple radiator

Transm. length 3cm, σ_{rest}=6mrad

dn1=0.0020

dn2=0.0062

dn3=0.0105

k1=0.16

k2=0.24

k3=0.28

D_0 = 3.9 cm

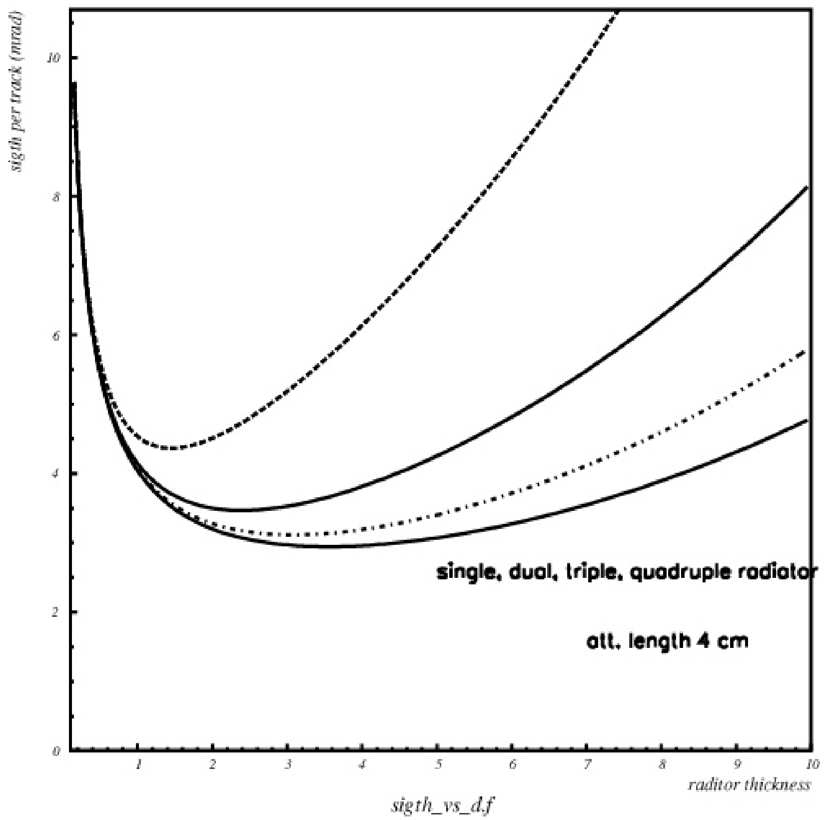
σ at minimum 0.0041

Lower ref. index -> smaller emission point error at same thickness-> optimal if upstream radiators thicker

A simple model of what happens when we go from the single layer to focusing multilayer arrangement:

If the indices are well adjusted, the error in emission point goes down by a factor of two in the dual radiator case etc

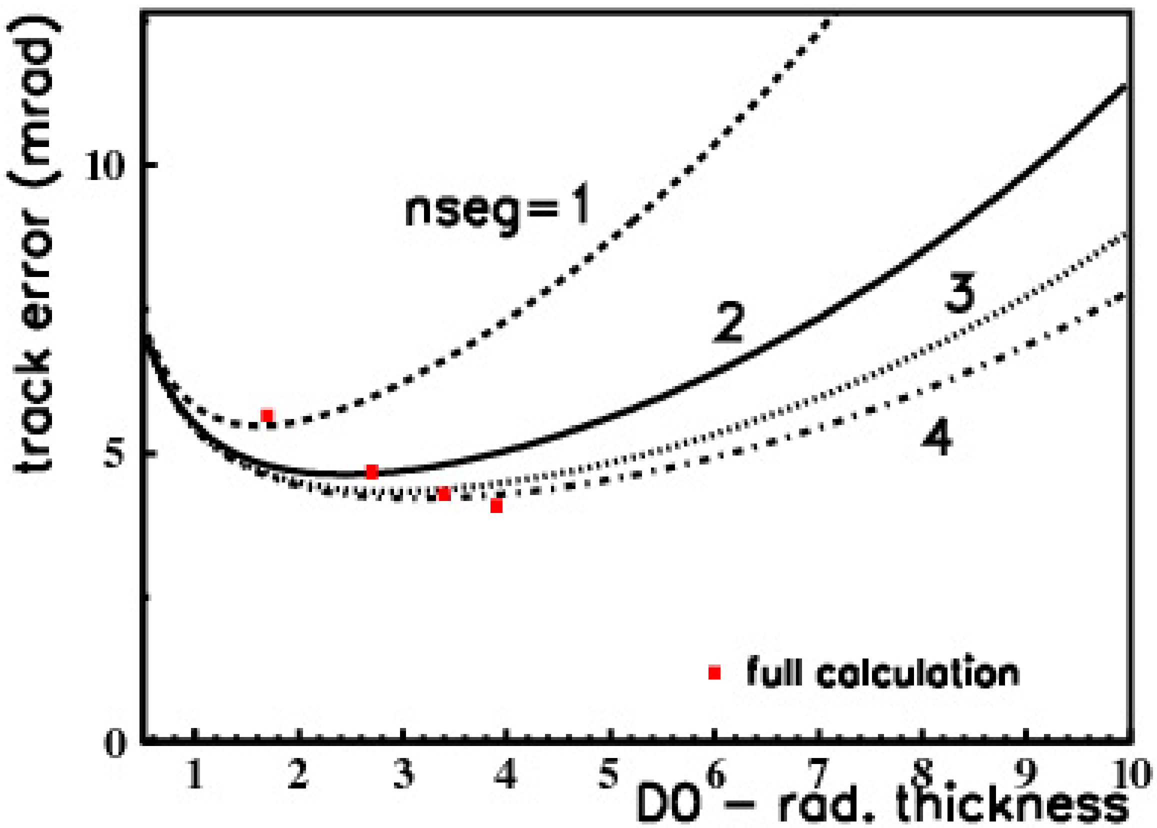
σ_{track}



D_0(cm)

Simple model

How good is this simple model? Contrast it with the full calculation

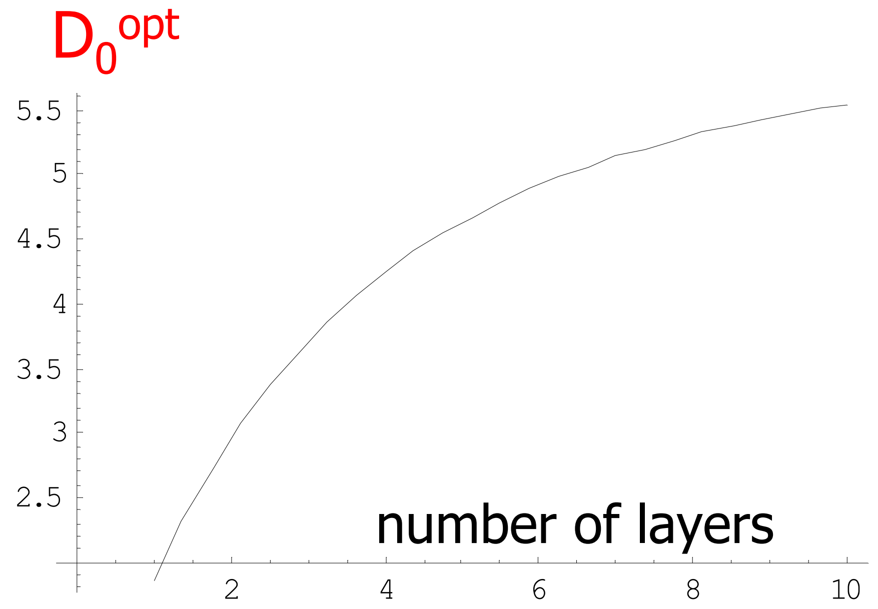


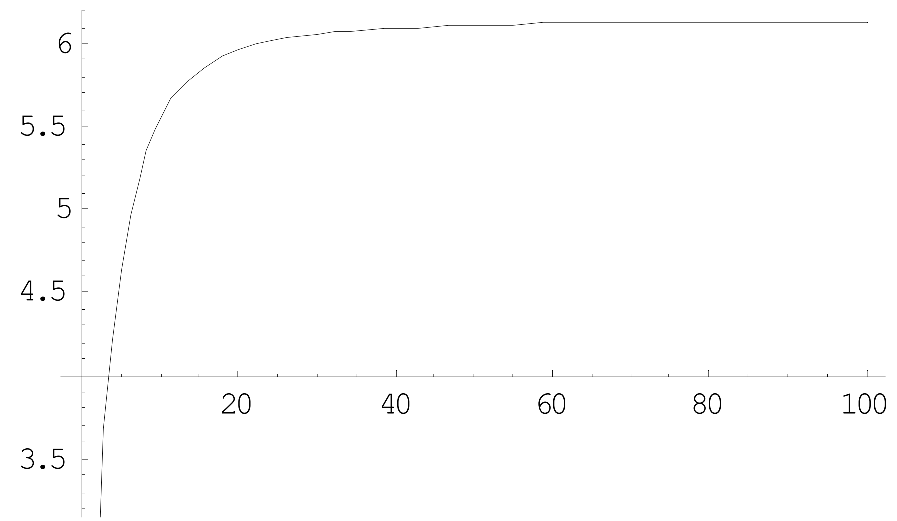
Curves: simple model
Points: full calculation

Half a year later, results revisited.

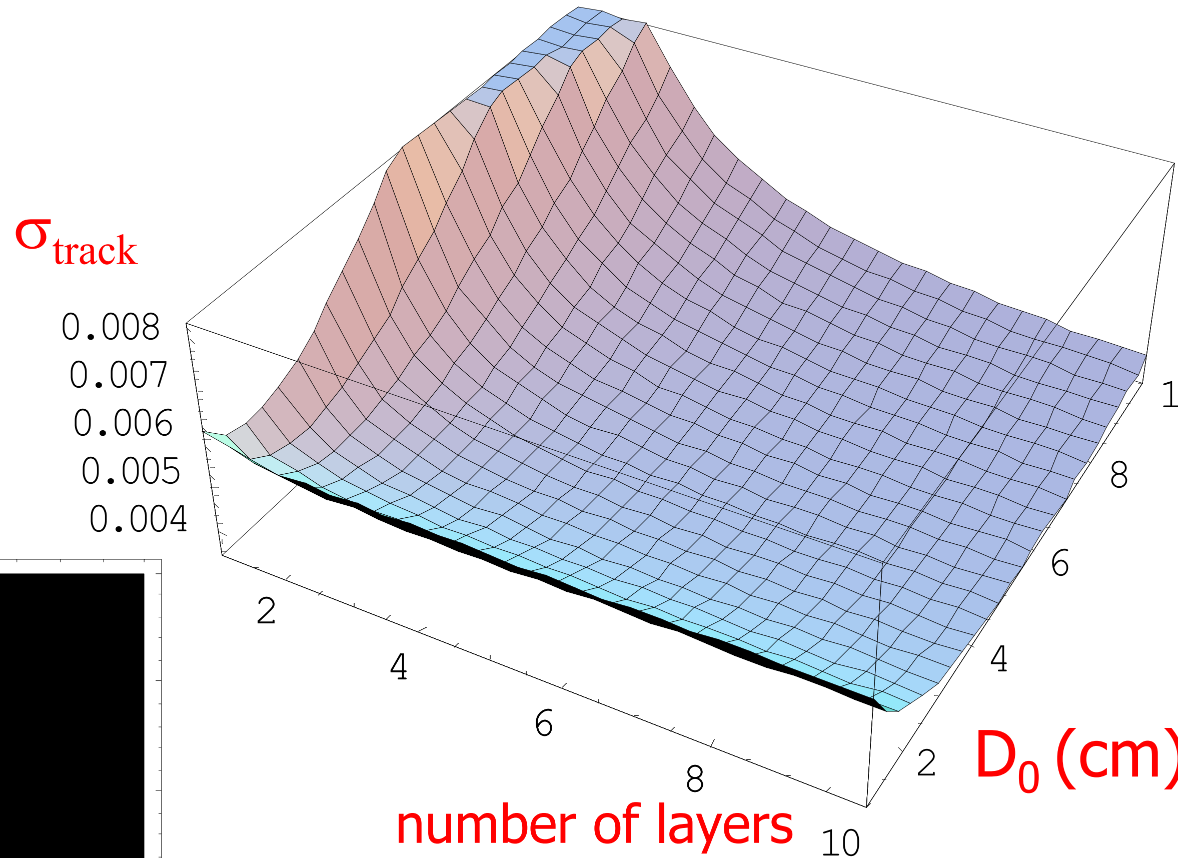
Minimize the expression (sigma per track) vs. to total radiator thickness D, x=number of layers

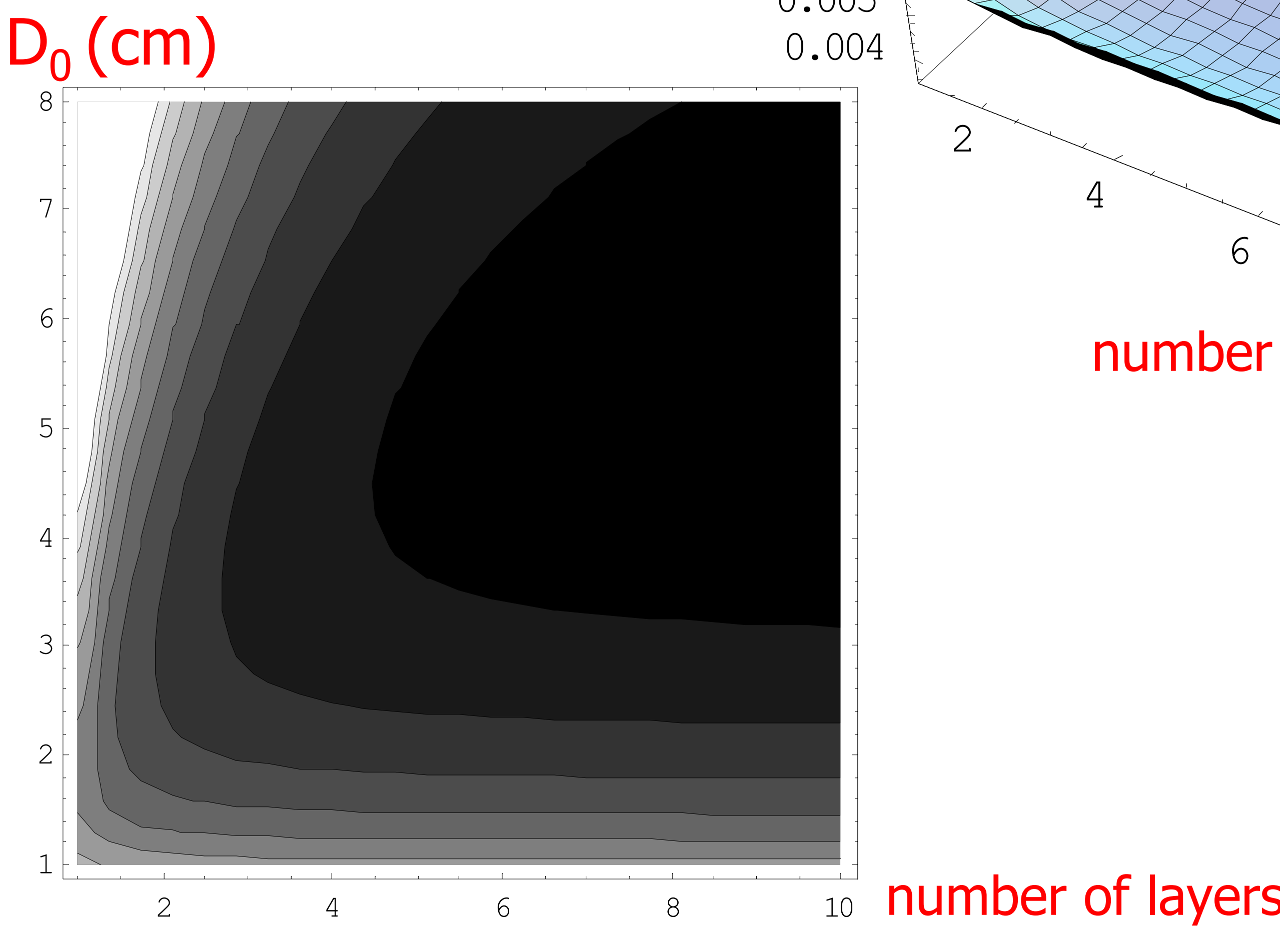
Plot as a function of the number of layers for standard values: Lam=4cm, sigre=7mrad, L=20cm, a=0.6cm, theta=0.3



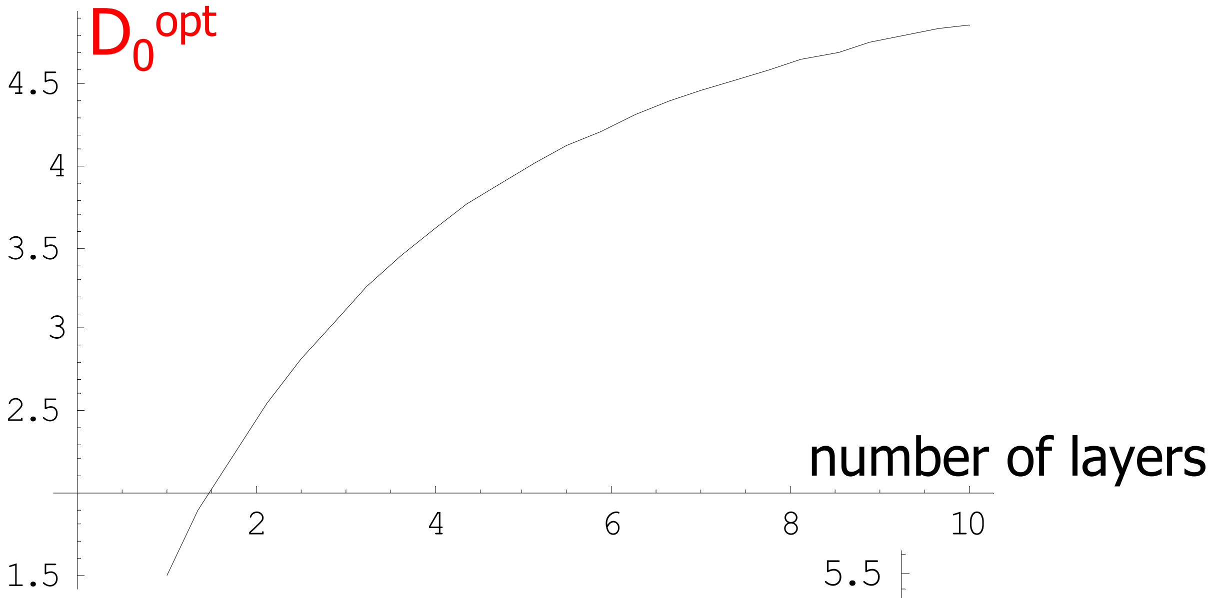


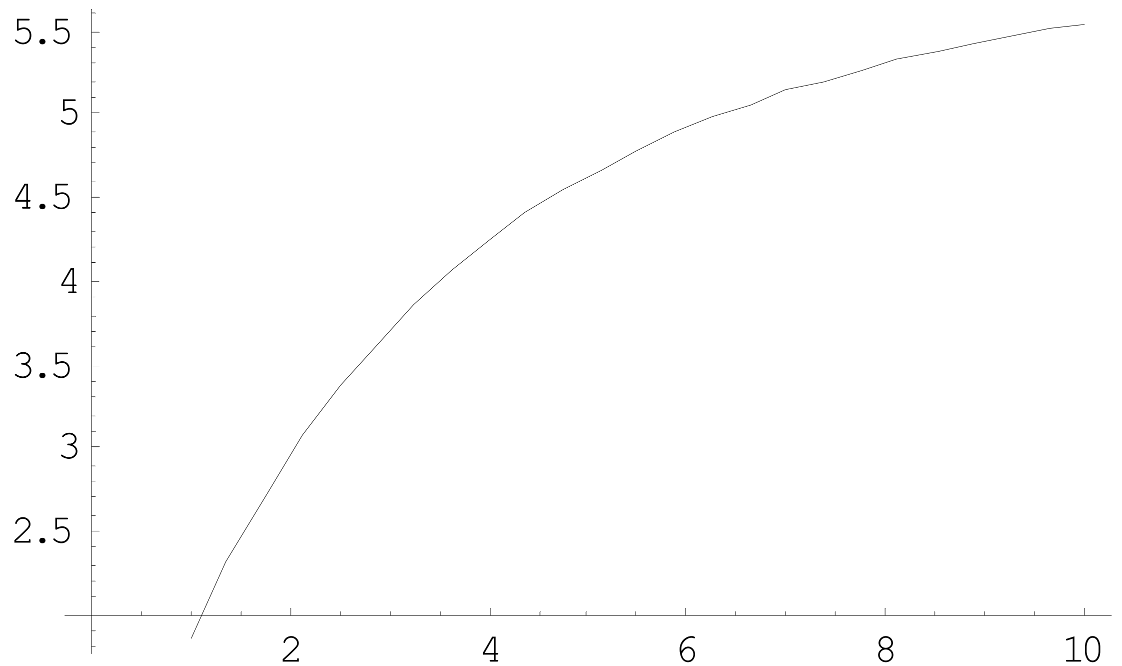
σ_{track} vs number of layers and D_0



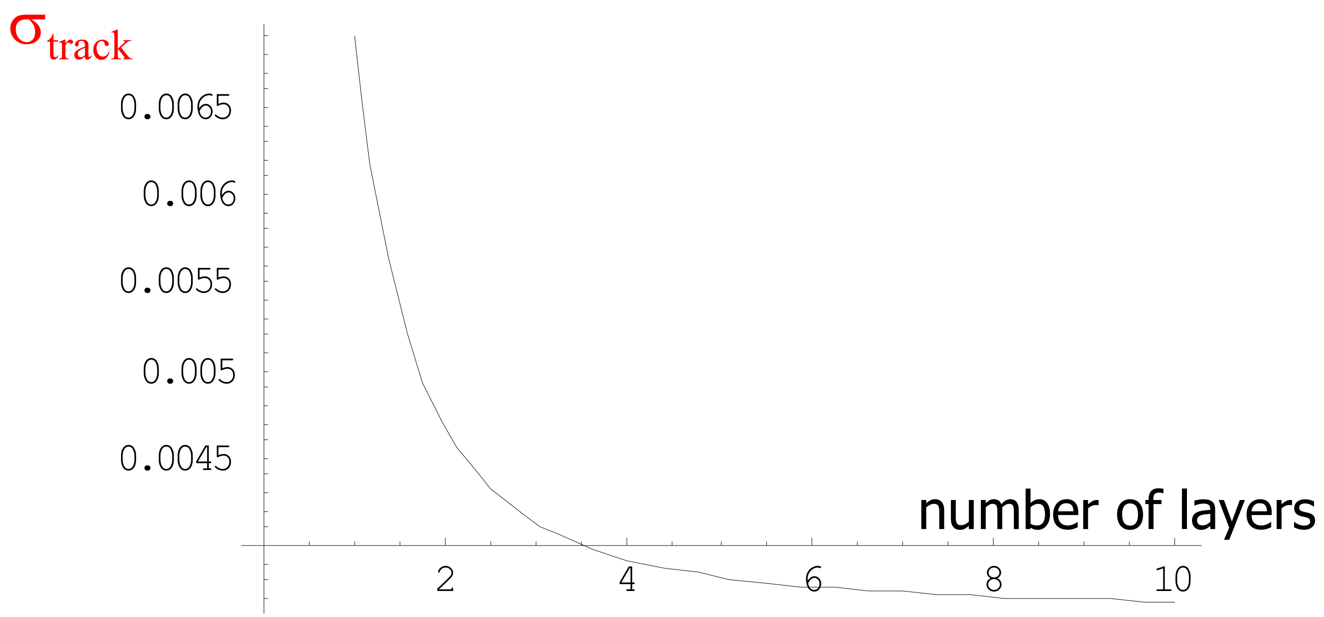


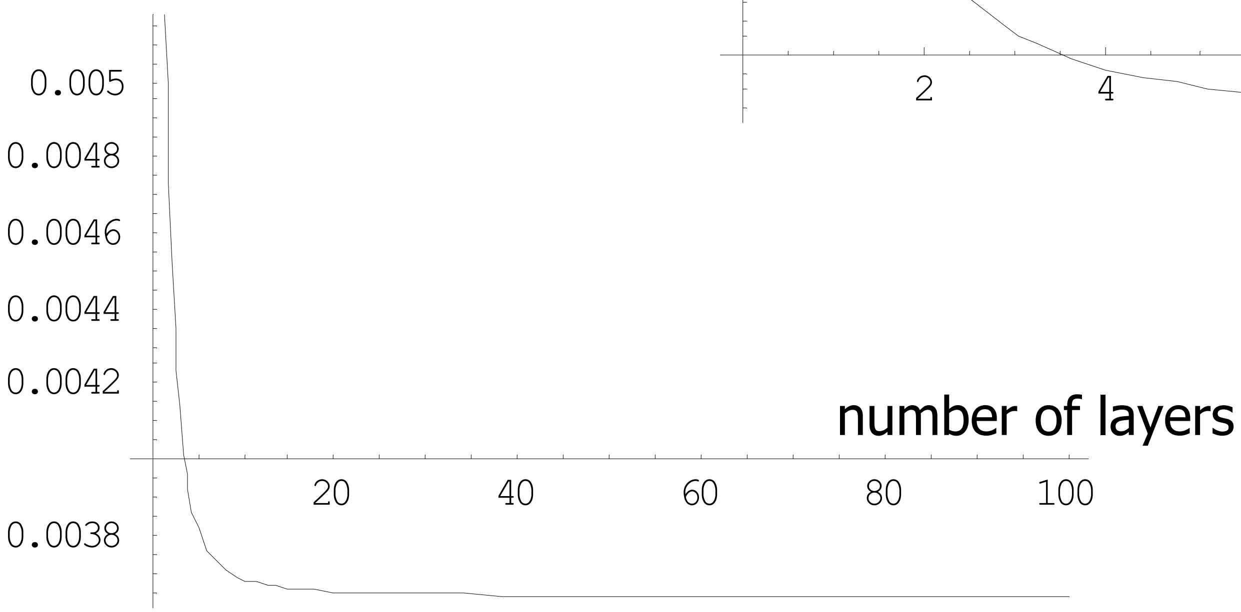
D_0^{opt} for sigre=0 compared to sigre=7mrad (bottom right)



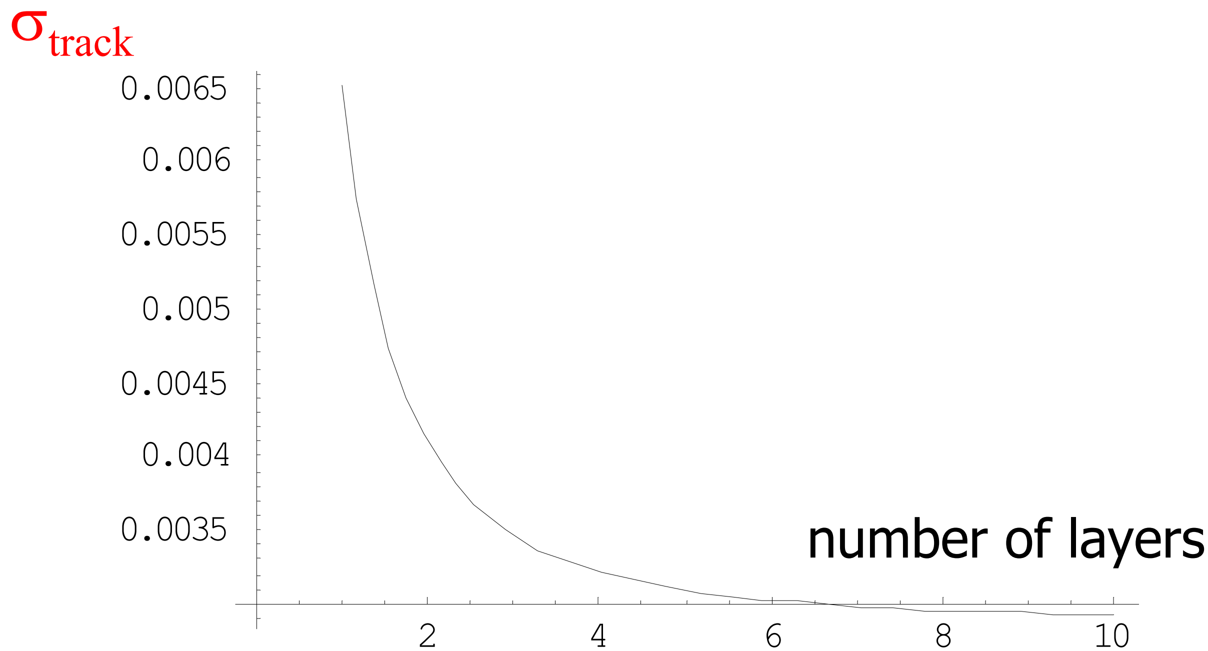


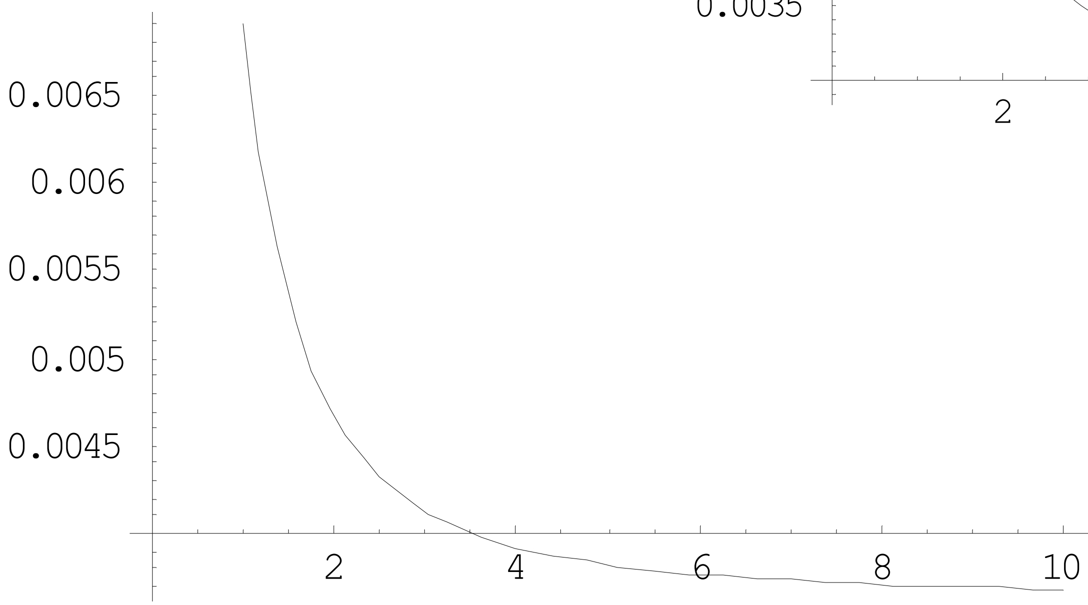
Now fix D=4cm, vary number of layers x



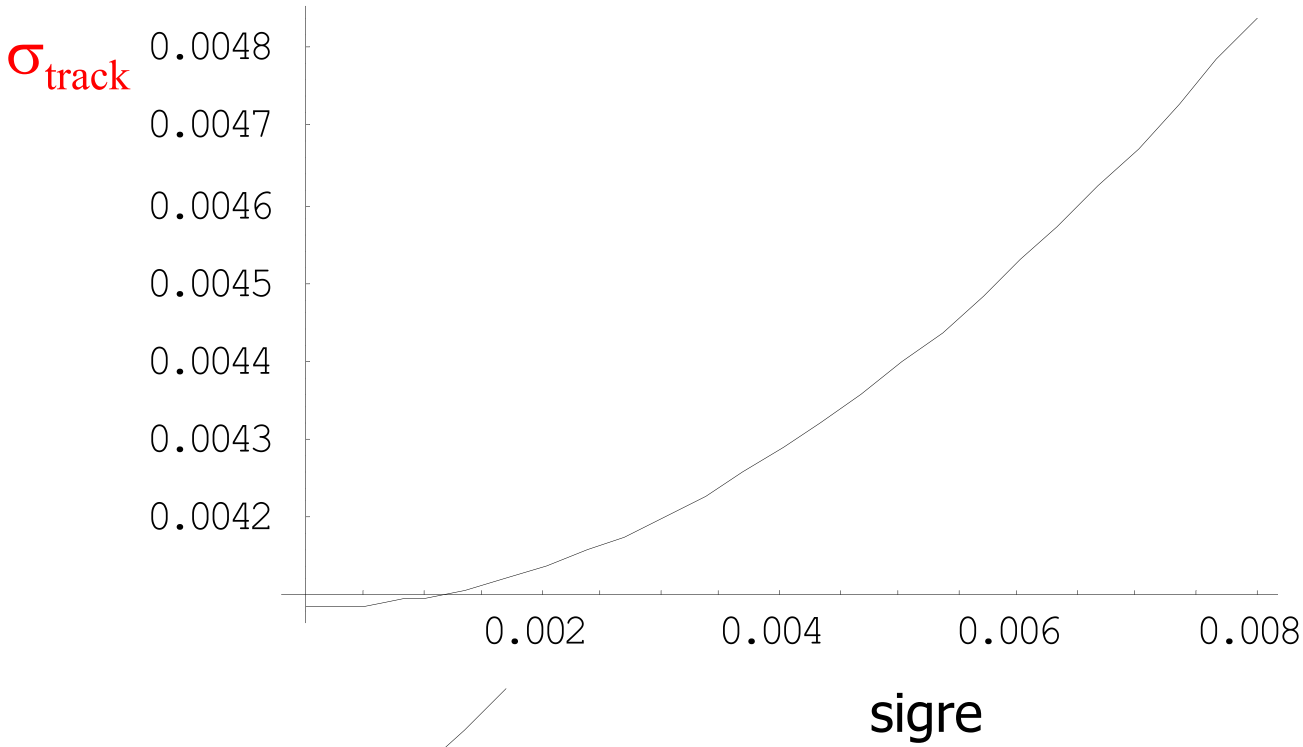


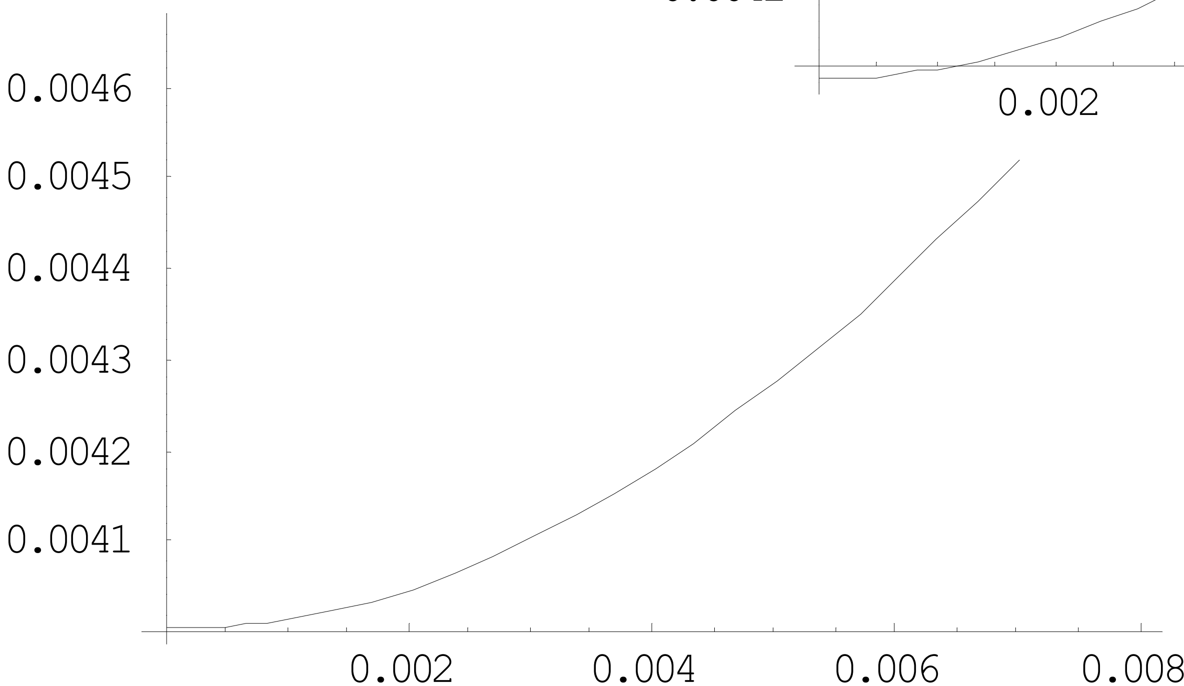
Same, for sigre=0 compared to sigre=7mrad (bottom left)





Variation with sigre for 4cm, 2 layers and 6cm, 3 layers (bottom)





Impact of σ_{rest}

At 4cm:

σ_{track} from 4.1mrad -> 4.8mrad

$\sigma_{rest}=0$ $\sigma_{rest}=8$mrad

σ_{track} from 4.7mrad -> 4.1mrad

2 layers 3 layers

-> Have to understand the origin of σ_{rest}!