"Shielding" Demonstration in a Simplified RFOFO Cell
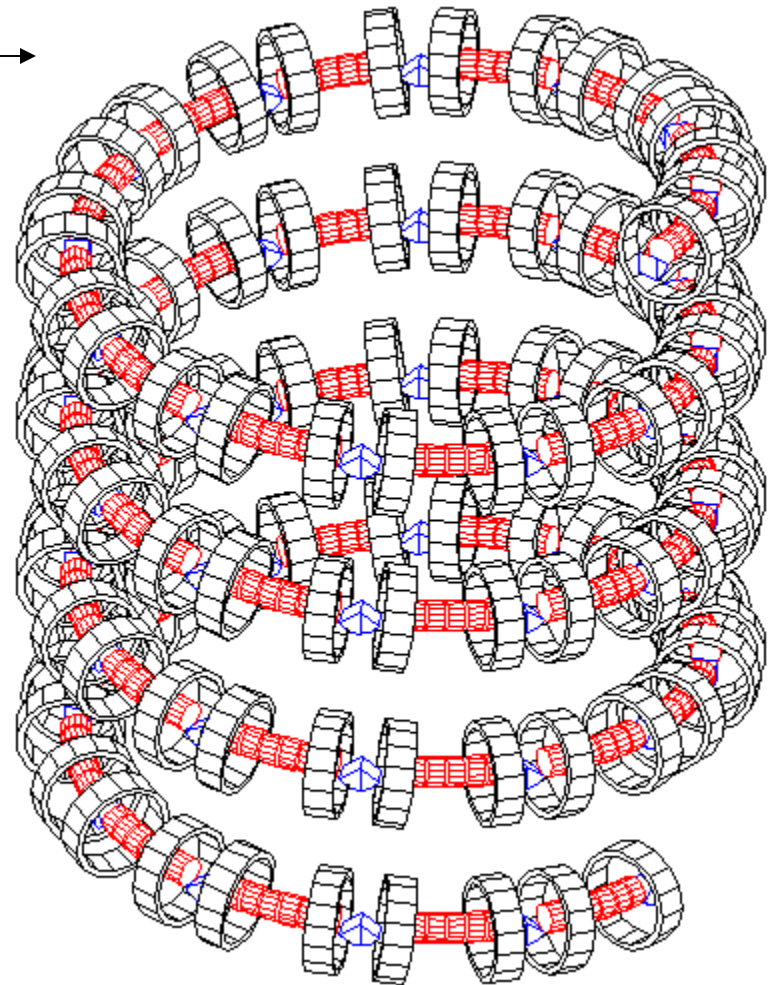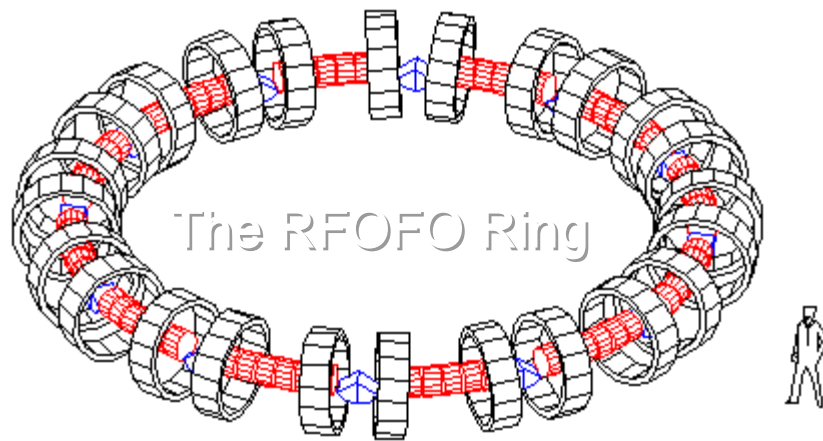
Amit Klier

UC Riverside

Outline

- The Guggenheim RFOFO (a reminder)

- The Simplified RFOFO cell
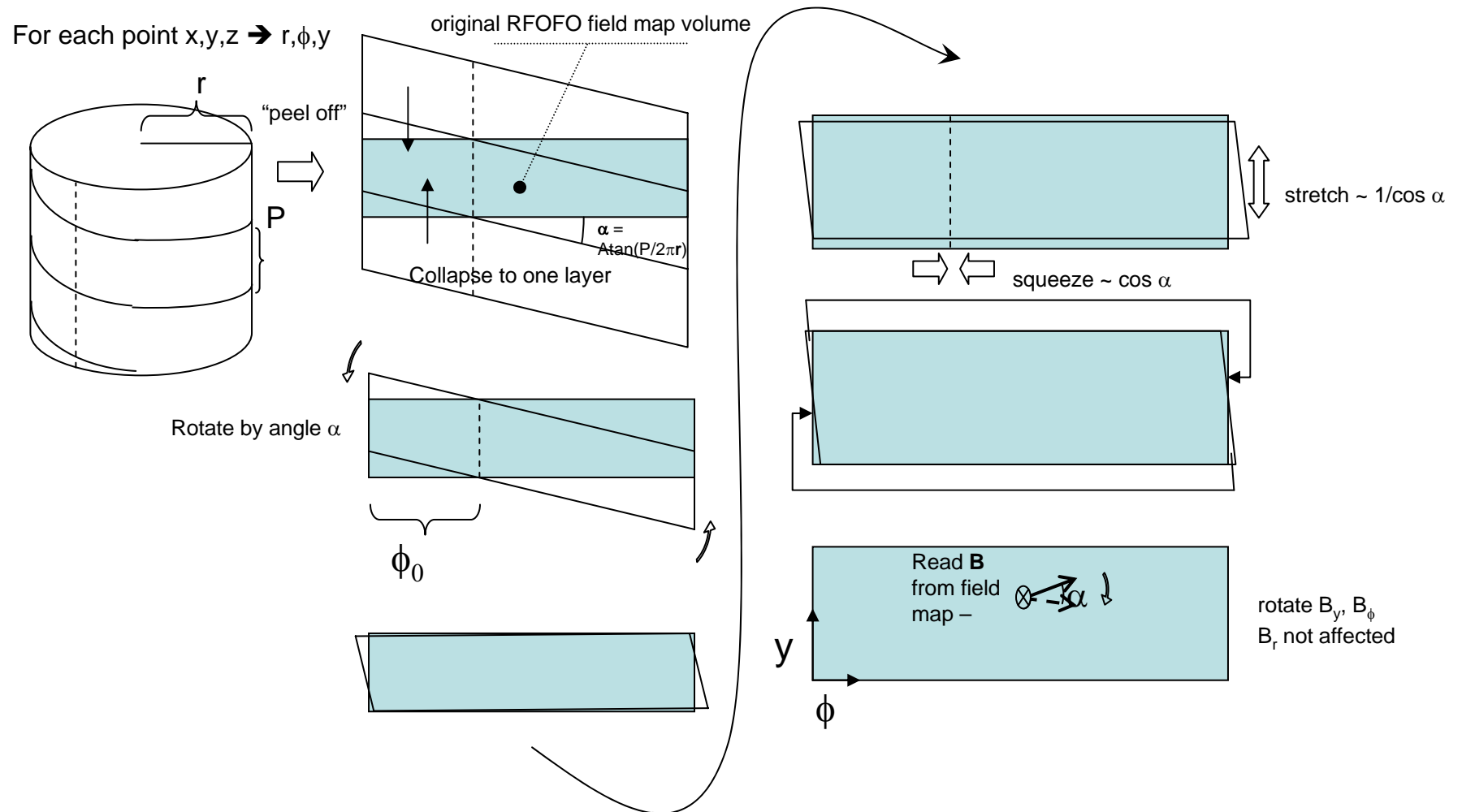
- "Shielding" results from Poisson-Superfish

The idea: change the geometry

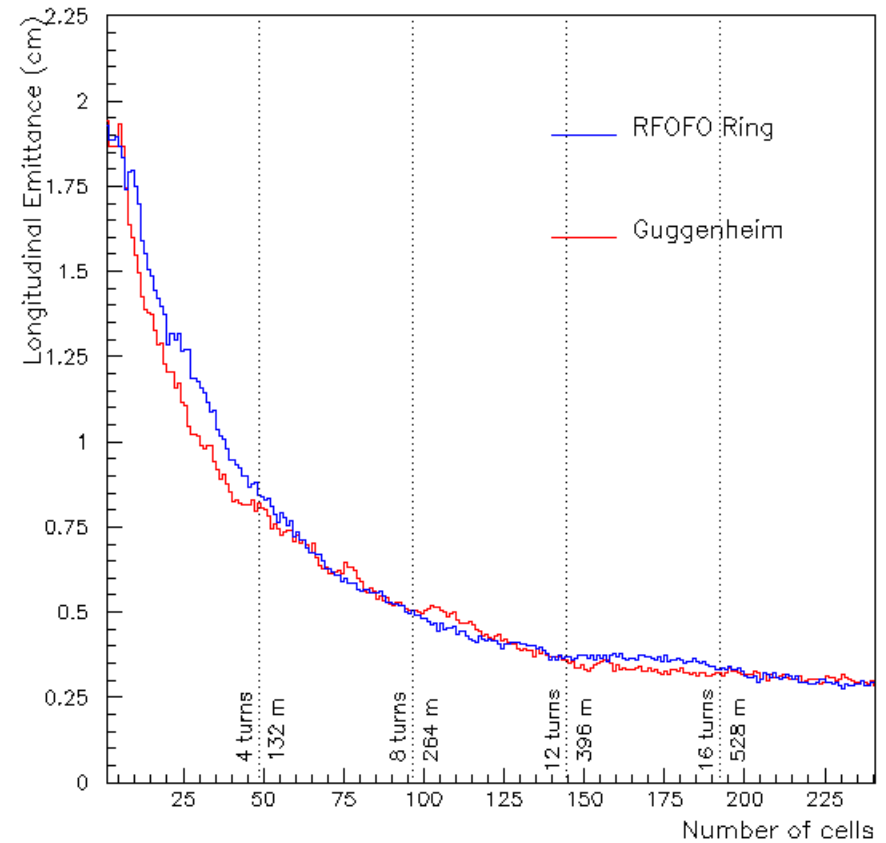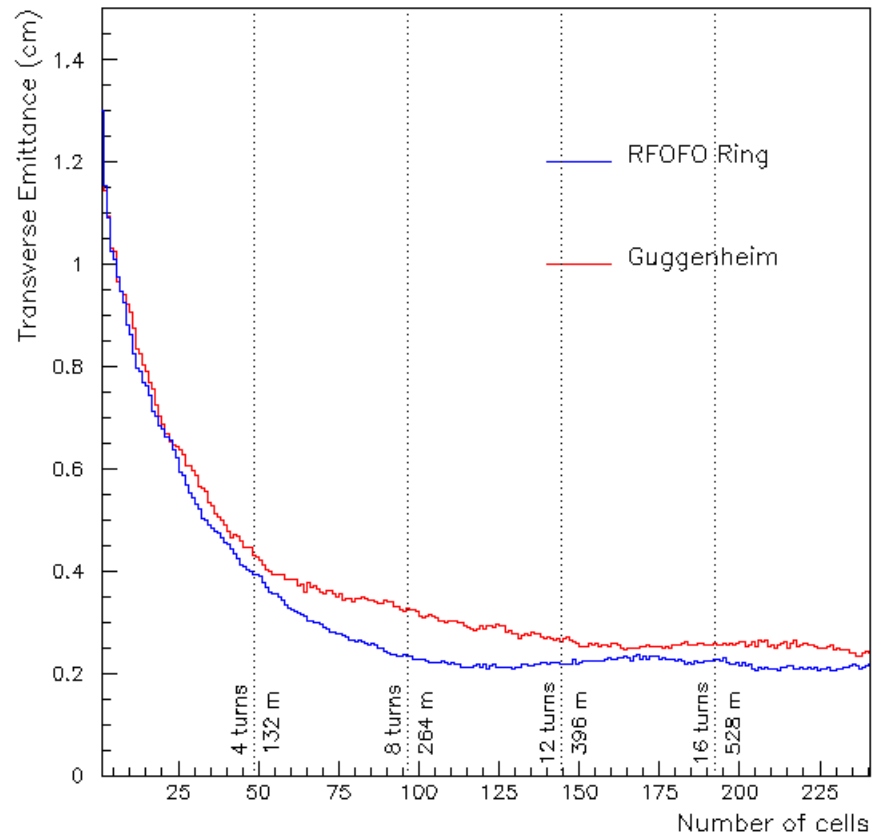Turn this ↓   into this ⟶

The RFOFO Ring

Injection/extraction – not a problem!
Less heating of the absorbers
Tapering possible – more efficient cooling

BUT
Massive, expensive
Magnetic shielding may be necessary

A. Klier - RFOFO Guggenheim   KEK, January 26 2006

Some geometric manipulations

For each point x,y,z ➔ r,φ,y

r

"peel off"

P

original RFOFO field map volume

$\alpha = Atan(P/2\pi r)$

Collapse to one layer

Rotate by angle α

ϕ_0

stretch ~ 1/cos α

squeeze ~ cos α

Read **B** from field map –

rotate B_y, B_ϕ
B_r not affected

y

φ

A. Klier - RFOFO Guggenheim   KEK, January 26 2006

Results

A. Klier - RFOFO Guggenheim   KEK, January 26 2006

The problem

- The geometric manipulations I did are nice as an exercise, but:
  - Not Maxwellian
  - Influence of adjacent cells (above, below) not taken into account
- For a complete simulation:
  - Simulate the actual geometry
  - Try to shield the "rings"

Moving forward in small steps

- First small step was to simulate "shielding" in a very simplified model cell (presented here)

- Next steps will include a full simulation of a "Guggenheim" without any shielding

- Next: more realistic shielding, forces, etc.

The simplified RFOFO cell

The RFOFO cell:

Tilted Solenoids

first half-absorber

6 RF cavities (acceptance)

Second half-absorber
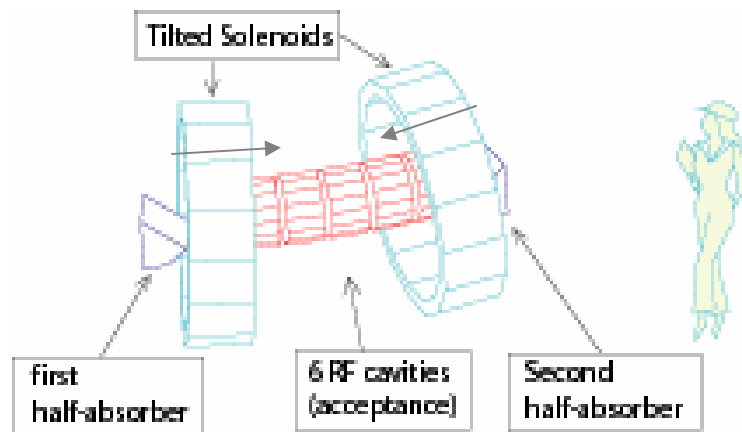
Simplified version:

Cancel solenoid tilting
➔ cylindrical symmetry
Cut in half (at field flip)

Boundary conditions:
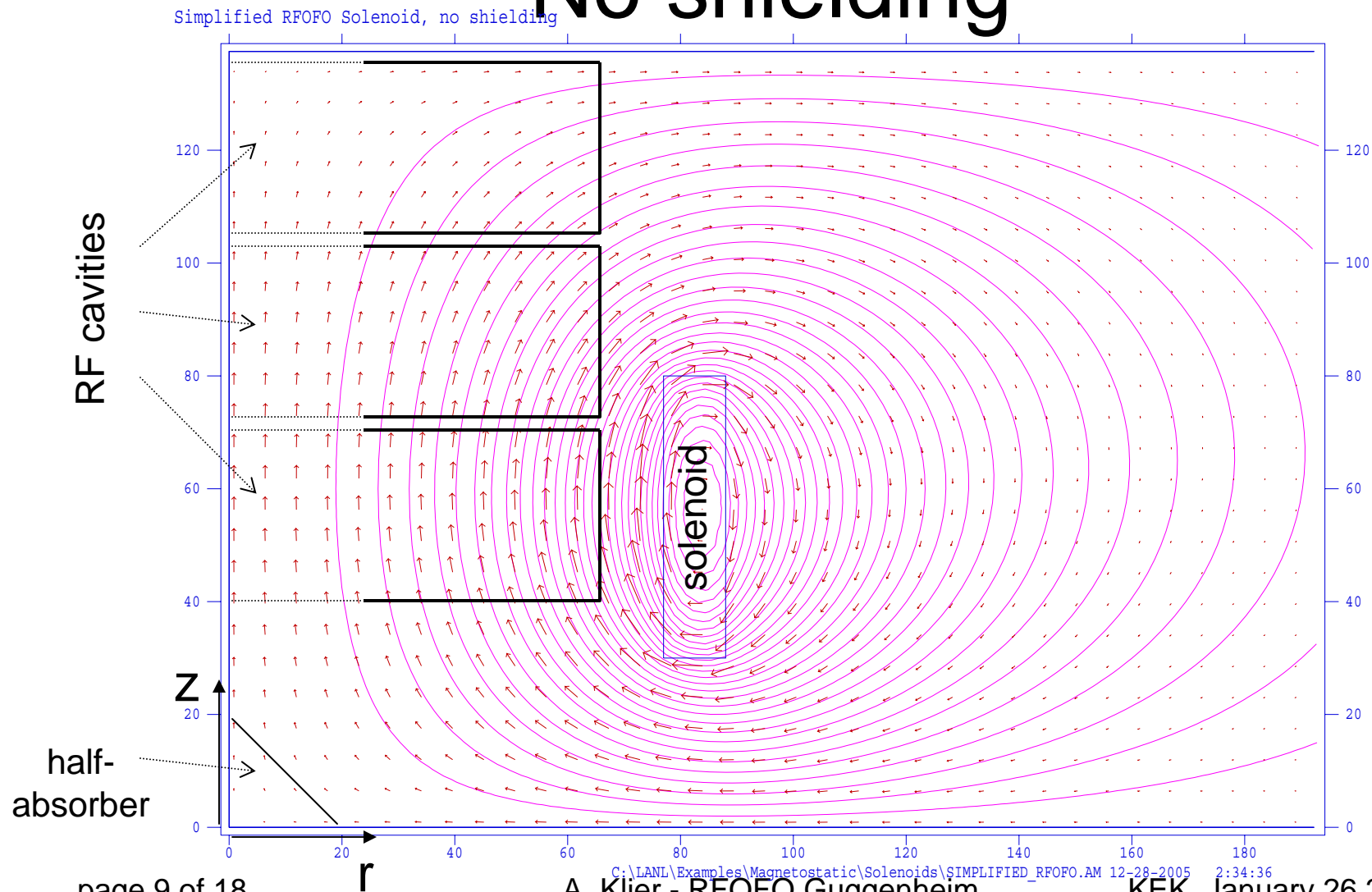$B_z = 0$ at edges
$B_r = 0$ at $r = 0$

"Shielding":
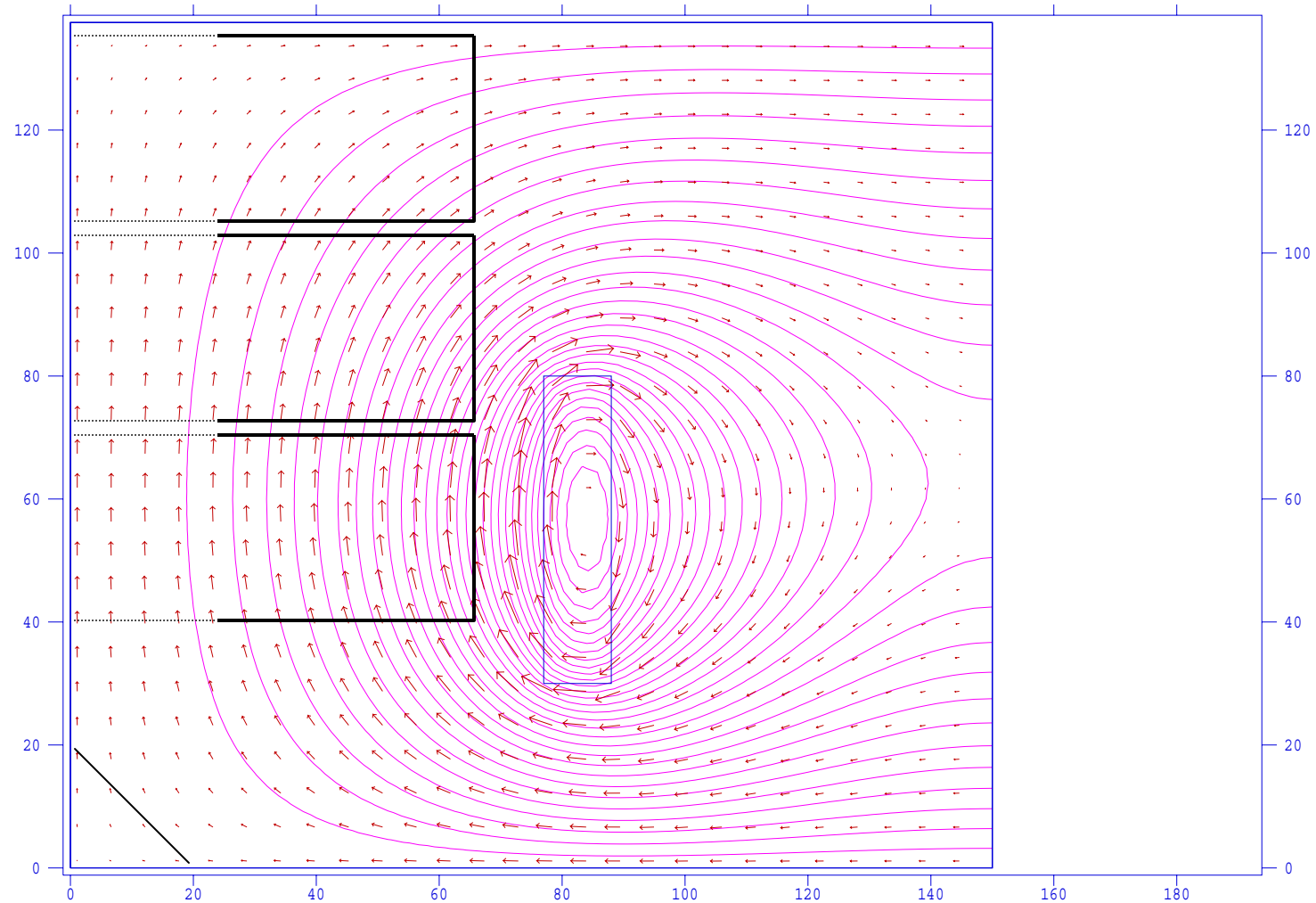$\mathbf{B} \perp$ surface (i.e. $B_z = 0$)
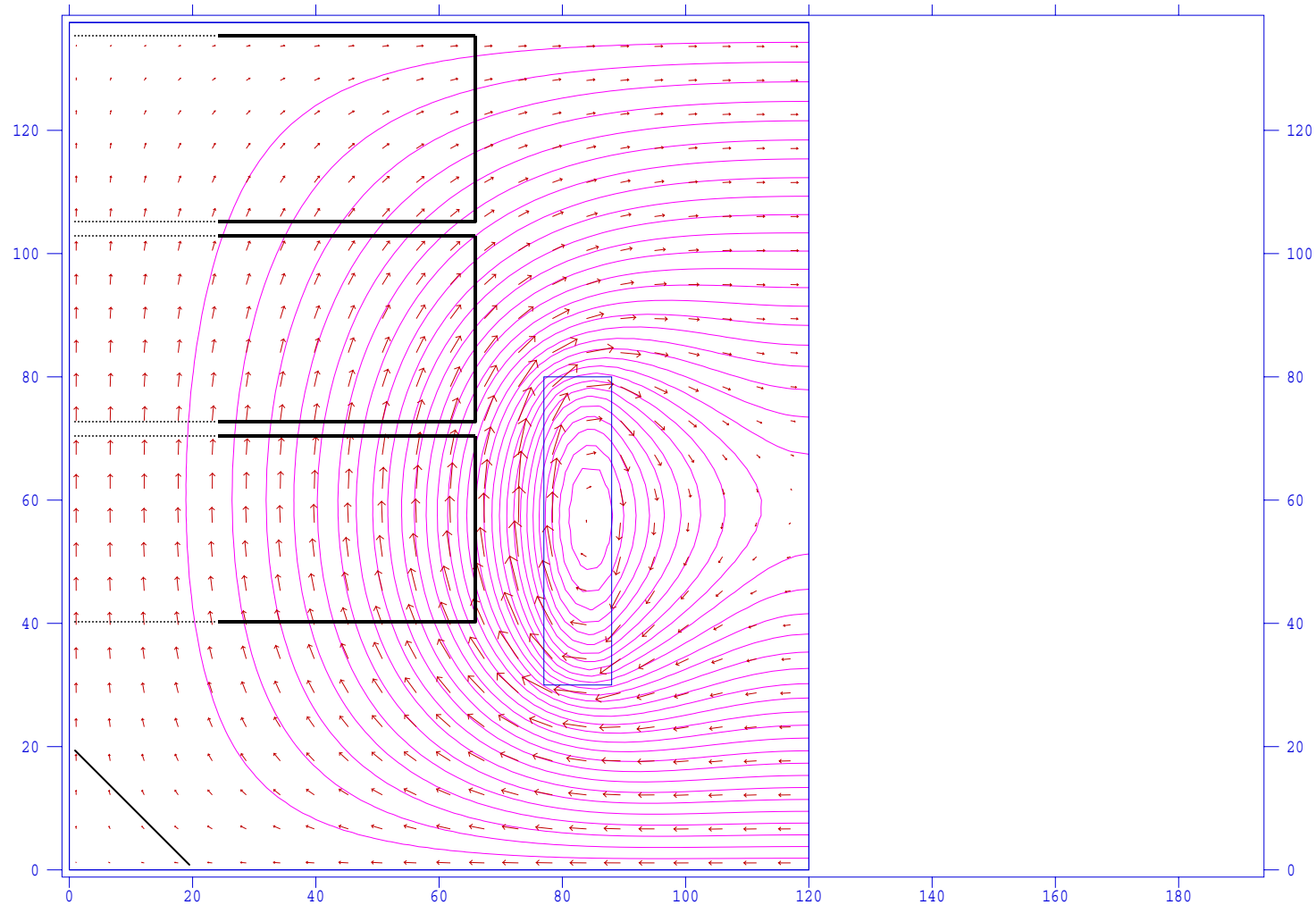at $r = R_{shield}$

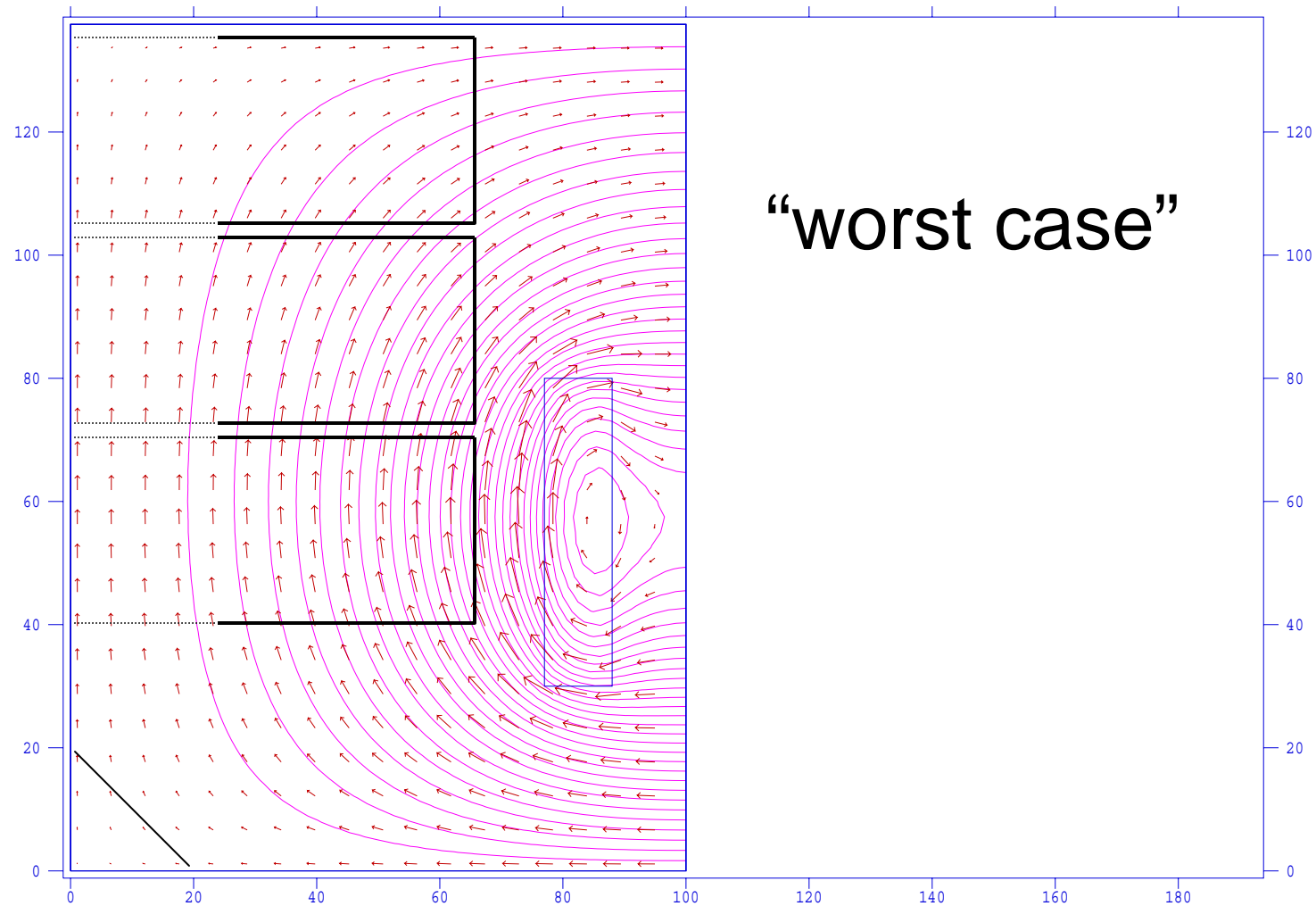# Fields from Poisson-Superfish: No shielding

Simplified RFOFO Solenoid, no shielding

RF cavities

solenoid

half-absorber

z

r

C:\LANL\Examples\Magnetostatic\Solenoids\SIMPLIFIED_RFOFO.AM 12-28-2005 2:34:36

A. Klier - RFOFO Guggenheim

KEK, January 26 2006

Shielding at r = 1.5 m

Simplified RFOFO Solenoid

C:\LANL\EXAMPLES\MAGNETOSTATIC\SOLENOIDS\SIMPLIFIED_RFOFO_IRON1_5.AM 1-01-2006 3:49:30

A. Klier - RFOFO Guggenheim   KEK, January 26 2006

Shielding at r = 1.2 m

Simplified RFOFO Solenoid

C:\LANL\EXAMPLES\MAGNETOSTATIC\SOLENOIDS\SIMPLIFIED_RFOFO_IRON1_2.AM 1-01-2006 3:48:46

A. Klier - RFOFO Guggenheim   KEK, January 26 2006

Shielding at r = 1.0 m

Simplified RFOFO Solenoid

"worst case"

C:\LANL\EXAMPLES\MAGNETOSTATIC\SOLENOIDS\SIMPLIFIED_RFOFO_IRON1_0.AM 1-01-2006   3:47:14

A. Klier - RFOFO Guggenheim   KEK, January 26 2006

Back to no shielding

Simplified RFOFO Solenoid, no shielding

C:\LANL\Examples\Magnetostatic\Solenoids\SIMPLIFIED_RFOFO.AM 12-28-2005   2:34:36

A. Klier - RFOFO Guggenheim   KEK, January 26 2006

Strength of B field at r = 0

R=0, current in coil = 53 A/mm²

Shielding at R = 1.0 m

1.2 m

1.5 m
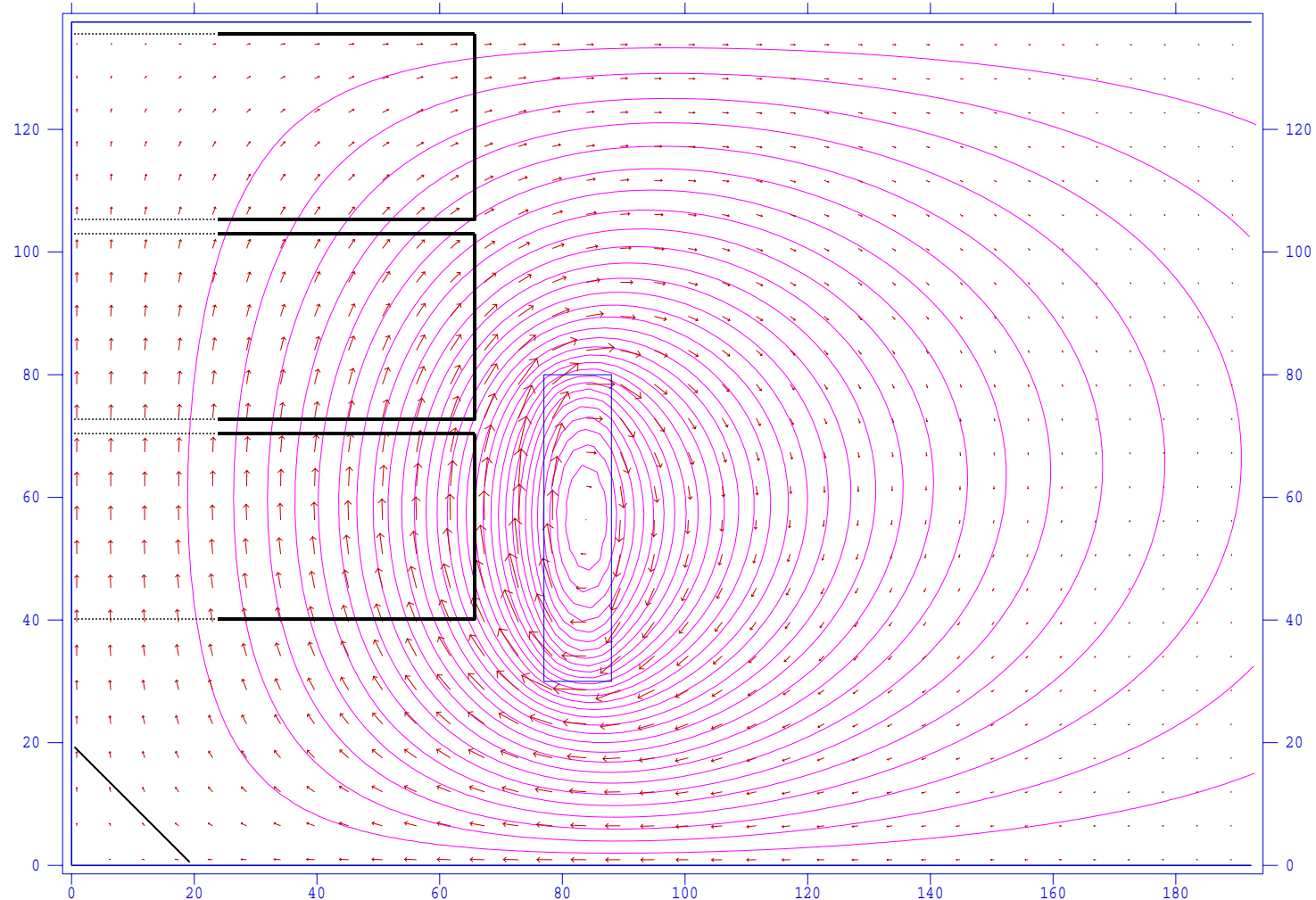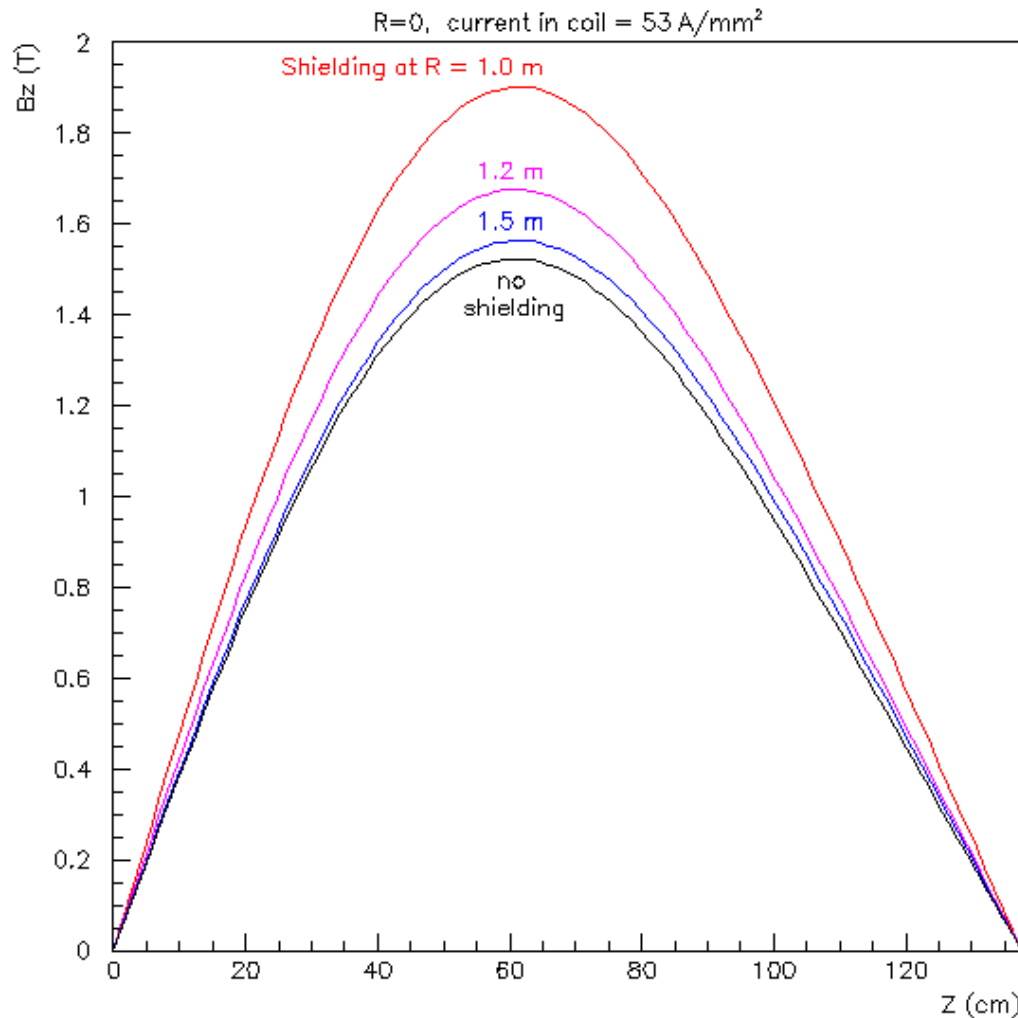
no shielding

For the comparison
I normalized the currents
to match Bz maximum
at r = 0 without shielding

Shielding	Current (A/mm²)
none	53.00
1.5 m	51.66
1.2 m	48.18
1.0 m	42.47

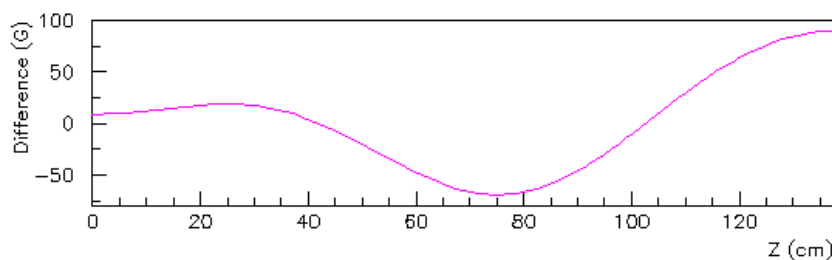A. Klier - RFOFO Guggenheim   KEK, January 26 2006

Comparing no shielding and "worst case" (normalized) at r = 0
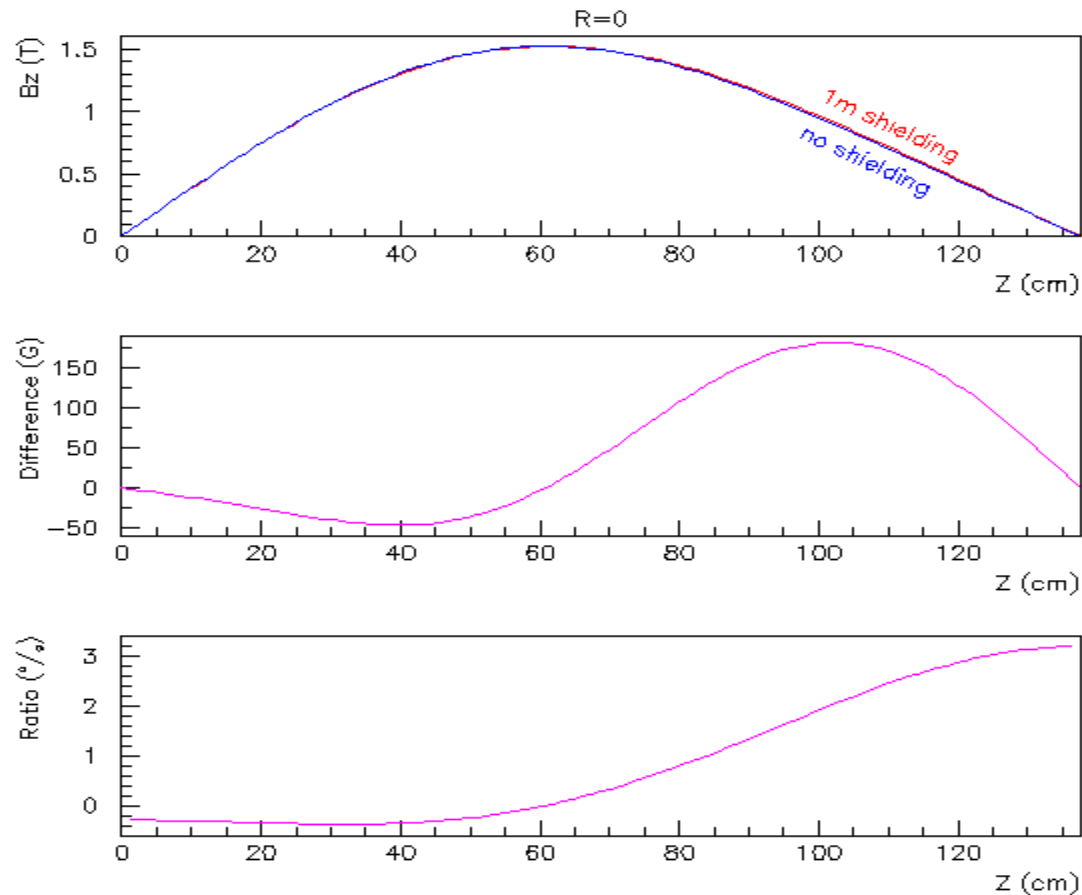
Comparing no shielding and "worst case" (norm.) at r = 10 cm

A. Klier - RFOFO Guggenheim   KEK, January 26 2006
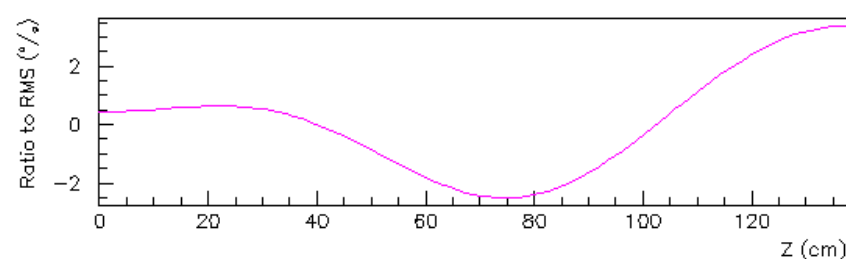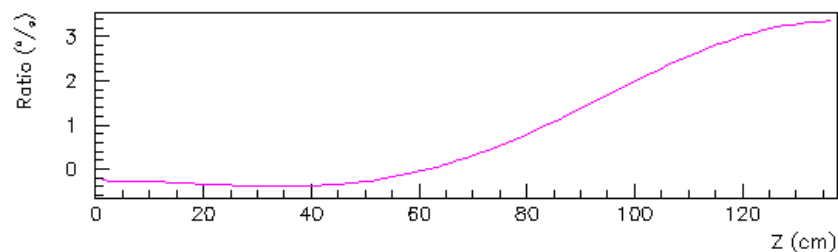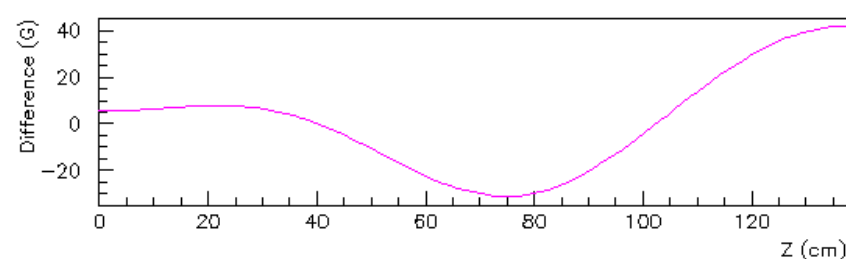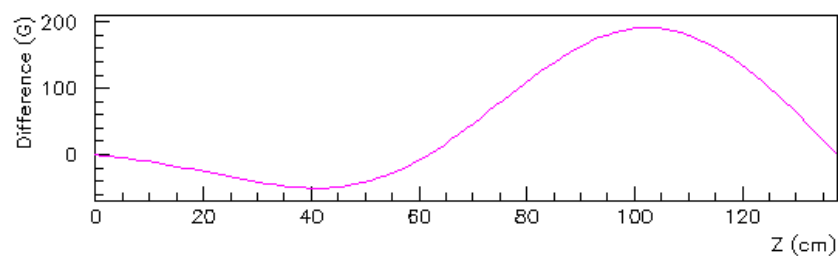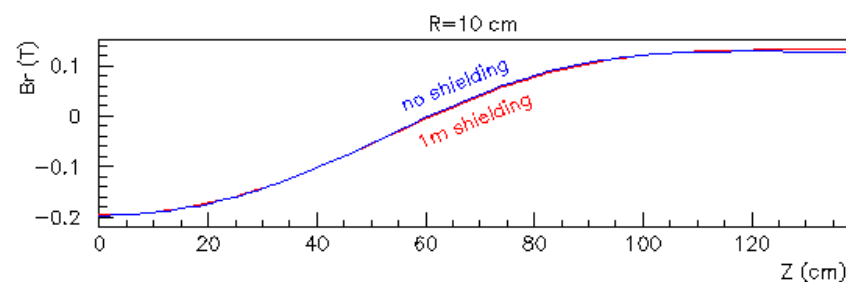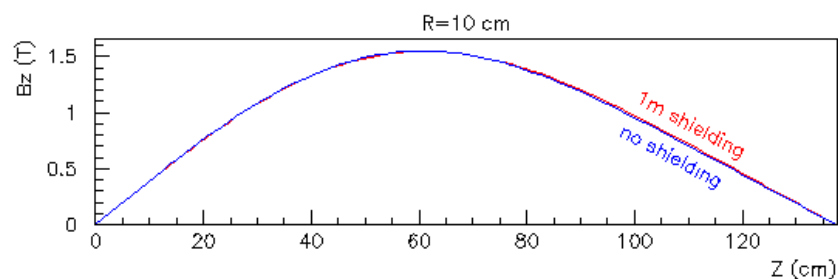
Comparing no shielding and "worst case" (norm.) at r = 20 cm
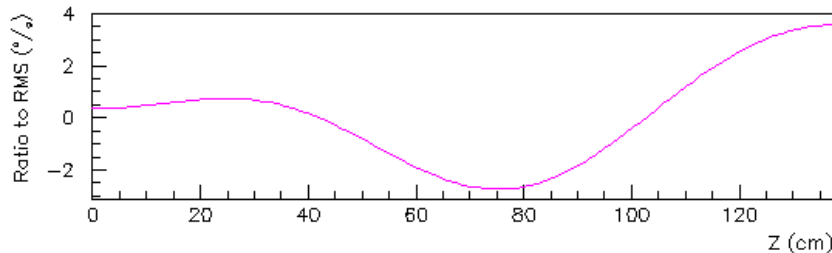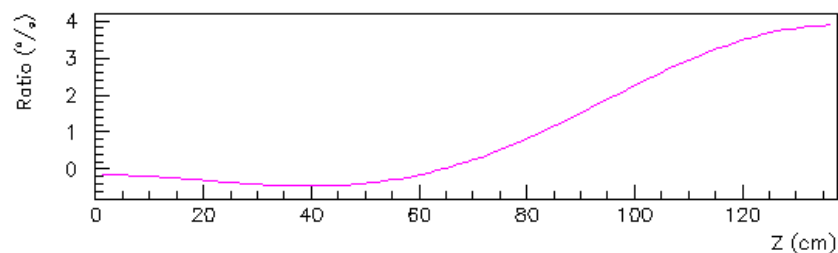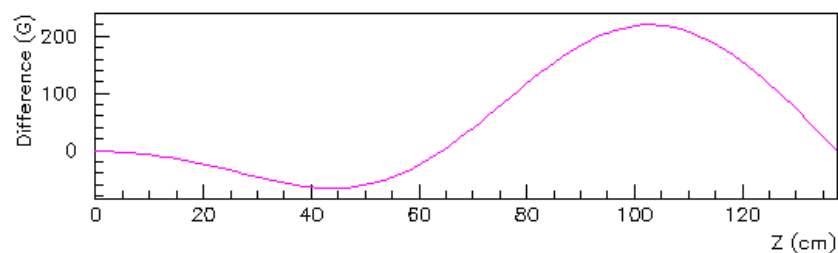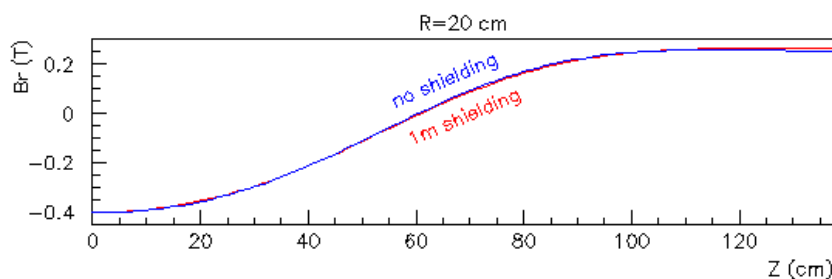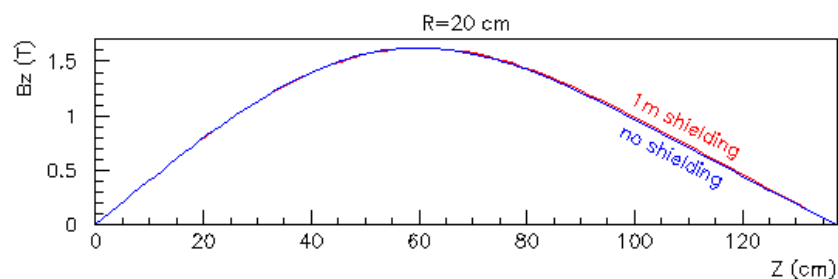
Conclusion

- Shielding affects the magnetic field very little around the beam

- This demonstration is only the beginning

A. Klier - RFOFO Guggenheim   KEK, January 26 2006