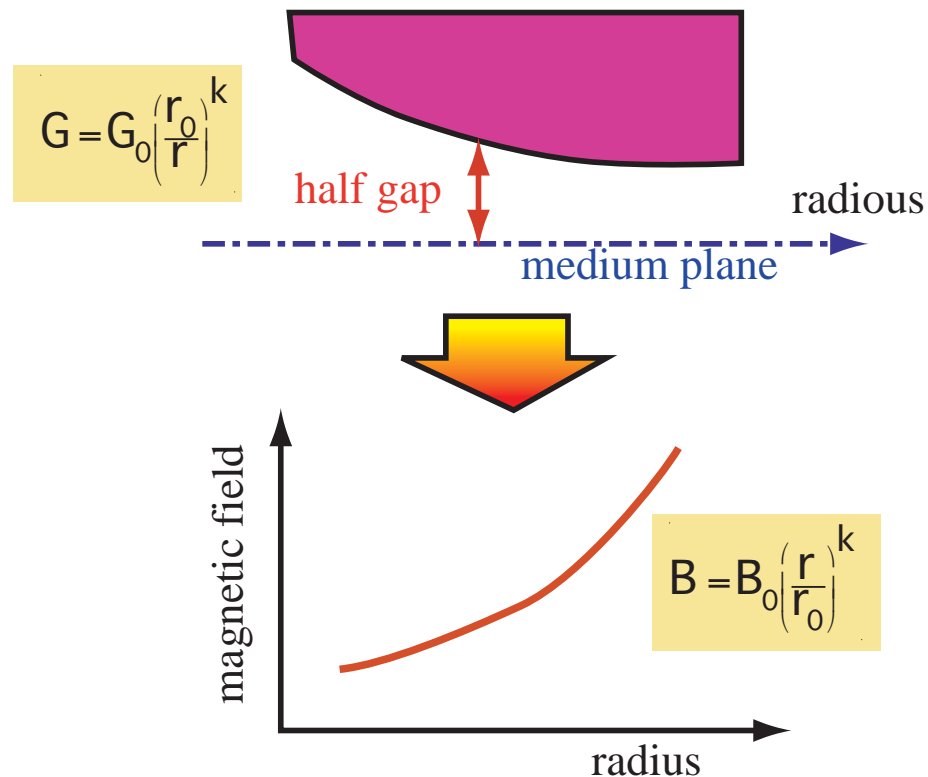


# The pole shape type

The field can be made by the pole shape!

for example : PoP-FFAG, & 150MeV-FFAG



merit vs demerit ?

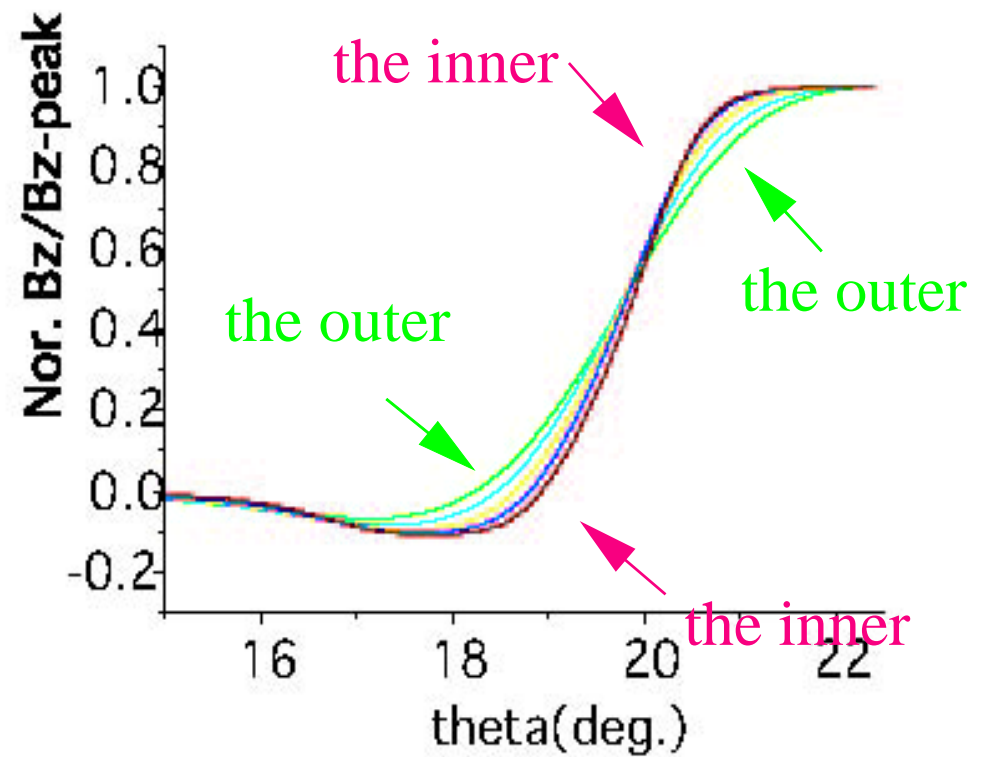
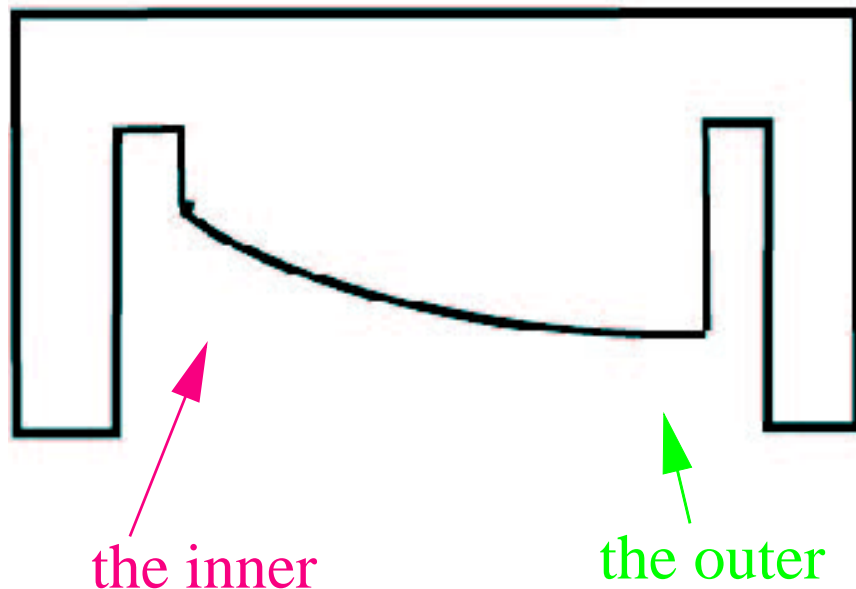
merit : - easy design !  
- easy operation !

demerit : - impossible to change the k-value !  
- impossible to make the long pole !  
( fringing fields at the edge is different between the inner and the outer )  
- impossible to make the high field !  
( the field in the ion is saturated )

It is difficult to use this method to large gap magnets !!

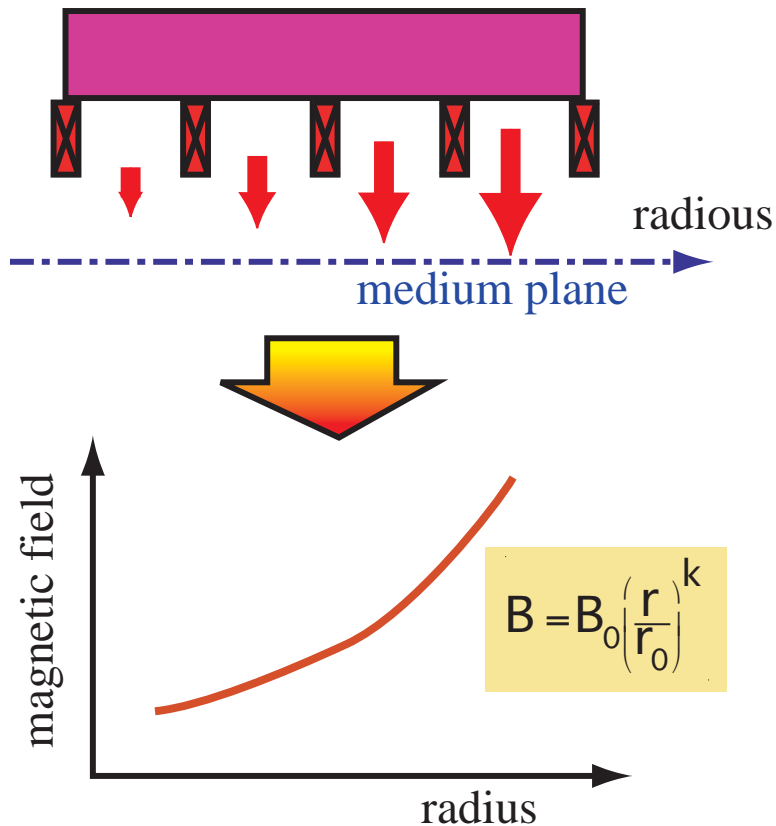
## Normalized Field on Median Plane

( Typical results of the field made by the shape of the pole )



# The distributed coil type

The field can be made by the distributed coil!



merit vs demerit ?

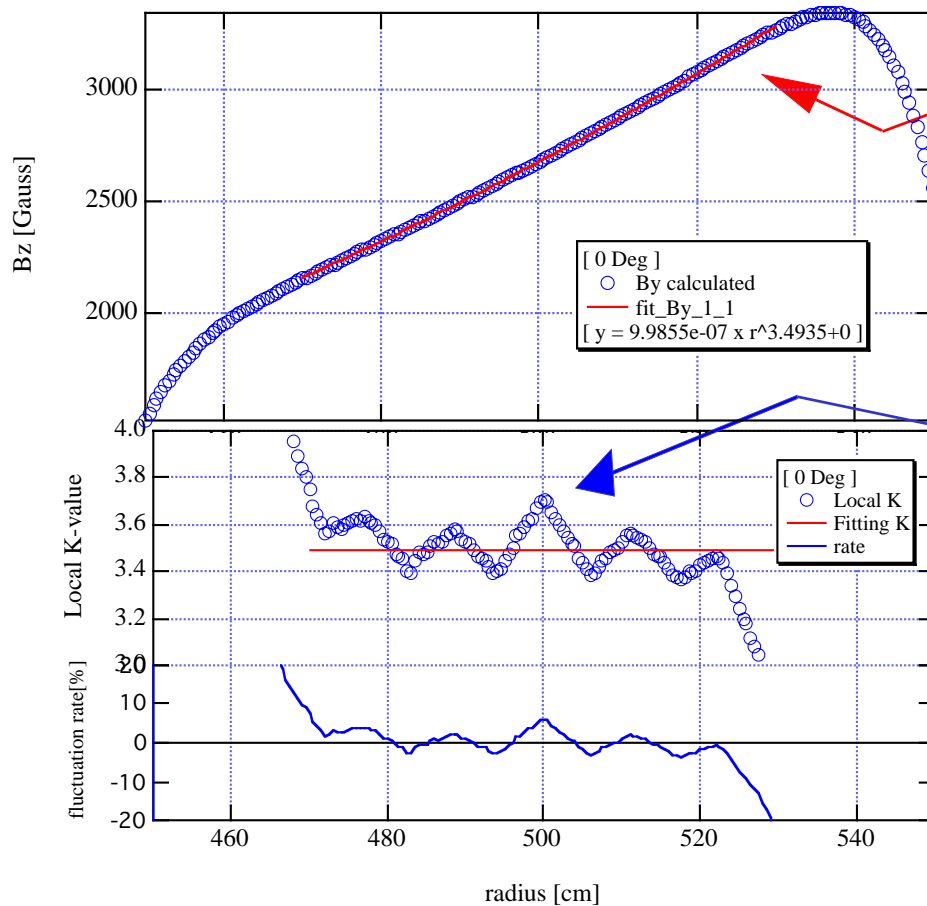
merit : - possible to change the k-value !  
- possible to make the long pole !  
- possible to make the high field !

demerit : - complicated operation !  
( each coil is needed to set a different current )  
- the field quality is not so good !  
( the field swings according to the distribution of the coils )

**We should take careful to design the magnet with this method!!**

# fitting k-value and local k-value

typical results of the field calculated  
by the distribution of the coils



k\_fitting

$$\text{fit : } y = a * r^b$$

with Levenberg-Marquardt algorithm

$$k_{local} = \frac{\Delta B r}{\Delta r B}$$

$$B = B_0 \left( \frac{r}{r_0} \right)^k$$

$$\frac{\Delta B}{\Delta r} = k \frac{B_0}{r_0} \left( \frac{r}{r_0} \right)^{k-1}$$

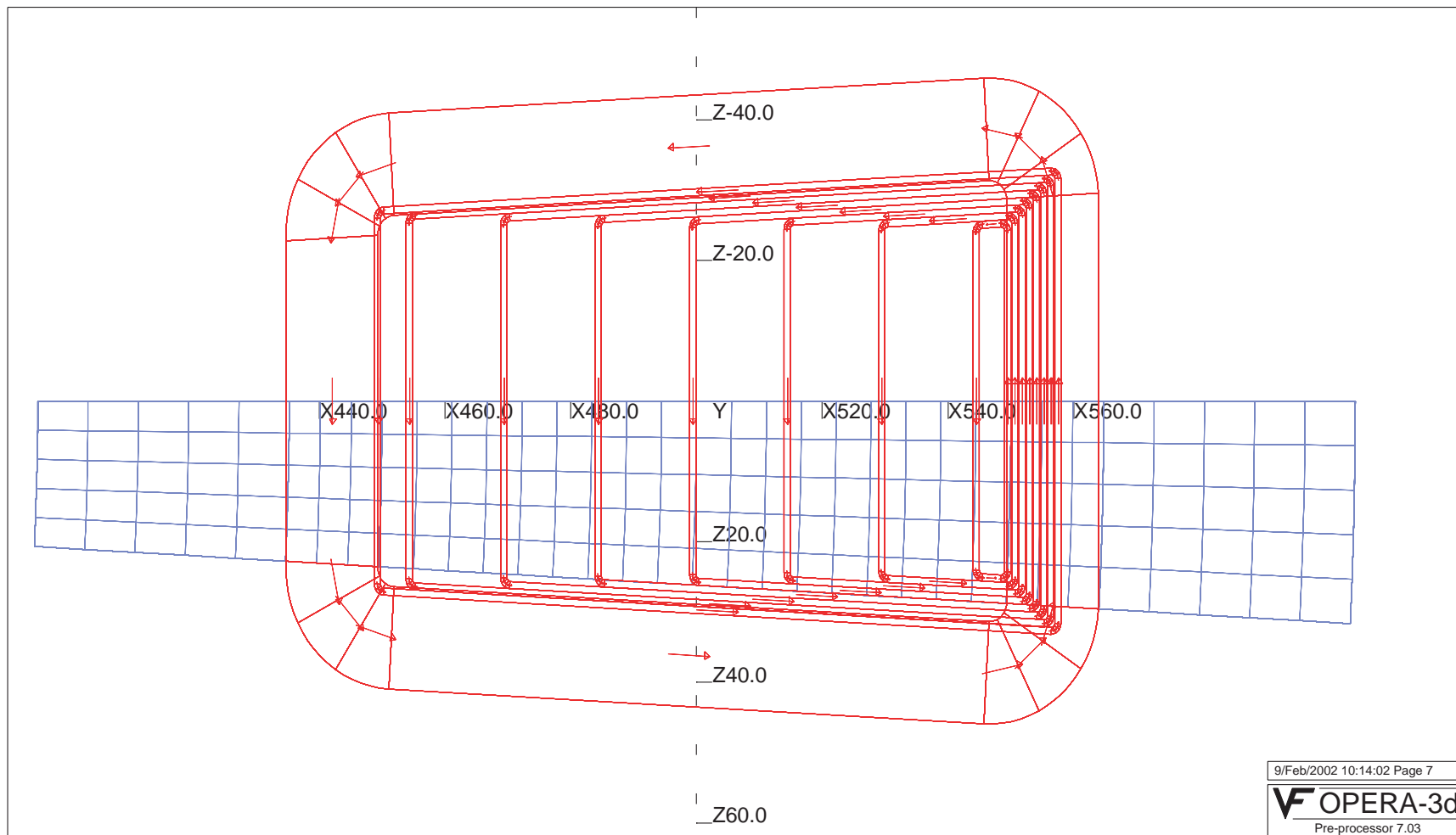
$$= k \frac{B_0}{r_0} \left( \frac{r}{r_0} \right)^k \frac{r_0}{r}$$

$$= k \frac{B_0}{r} \frac{B}{B_0}$$

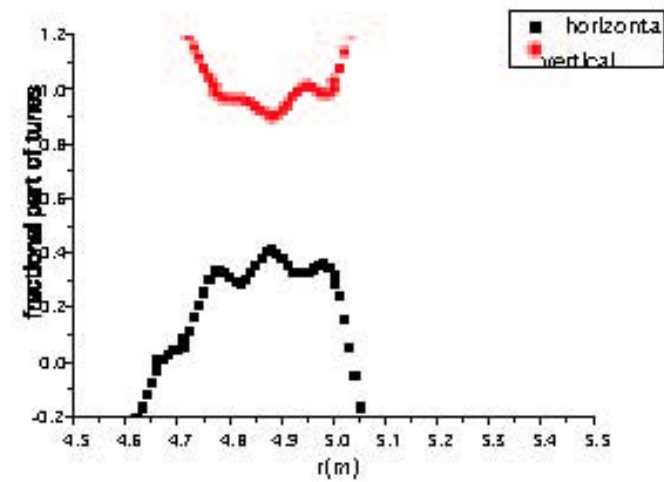
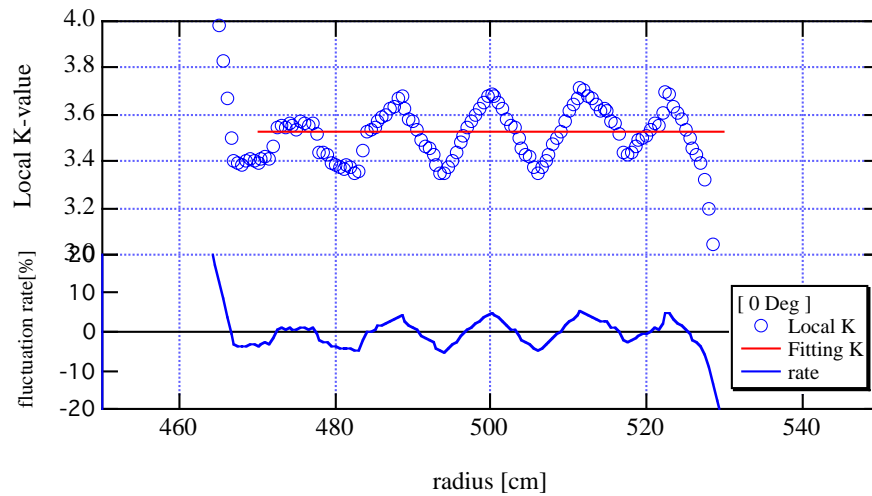
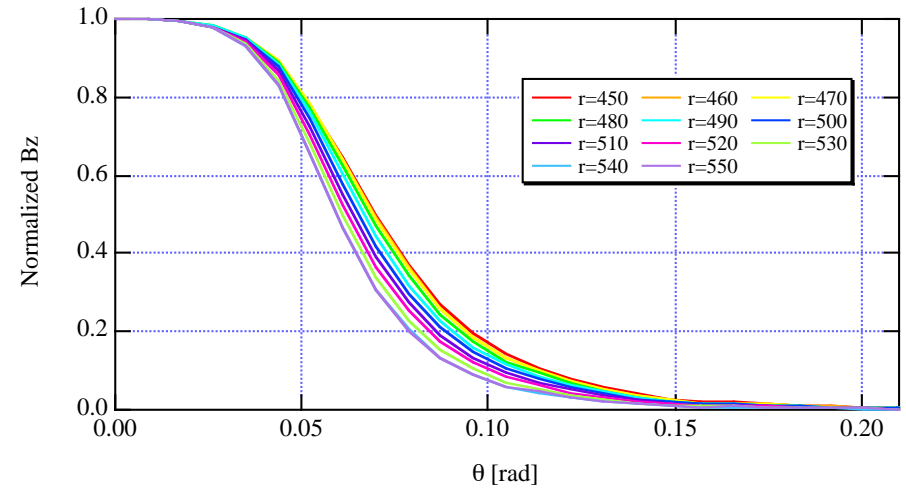
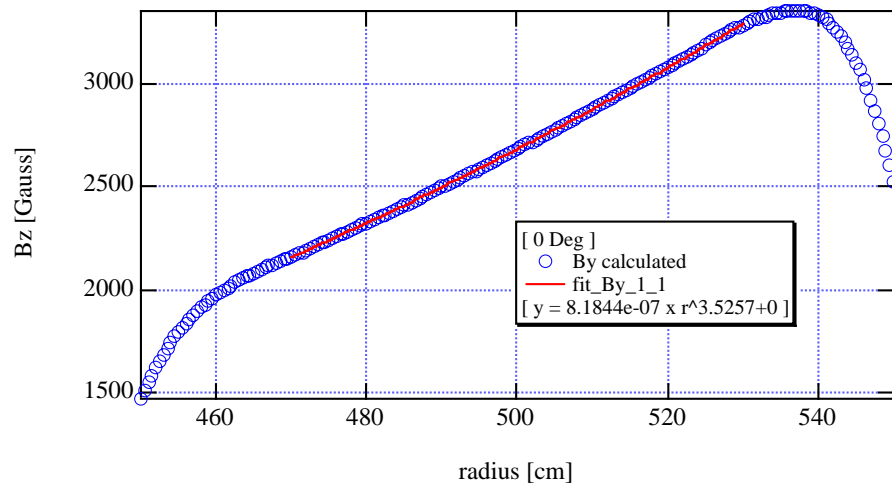
$$= k \frac{B}{r}$$

The field quality is judged by k\_local/k\_fitting !

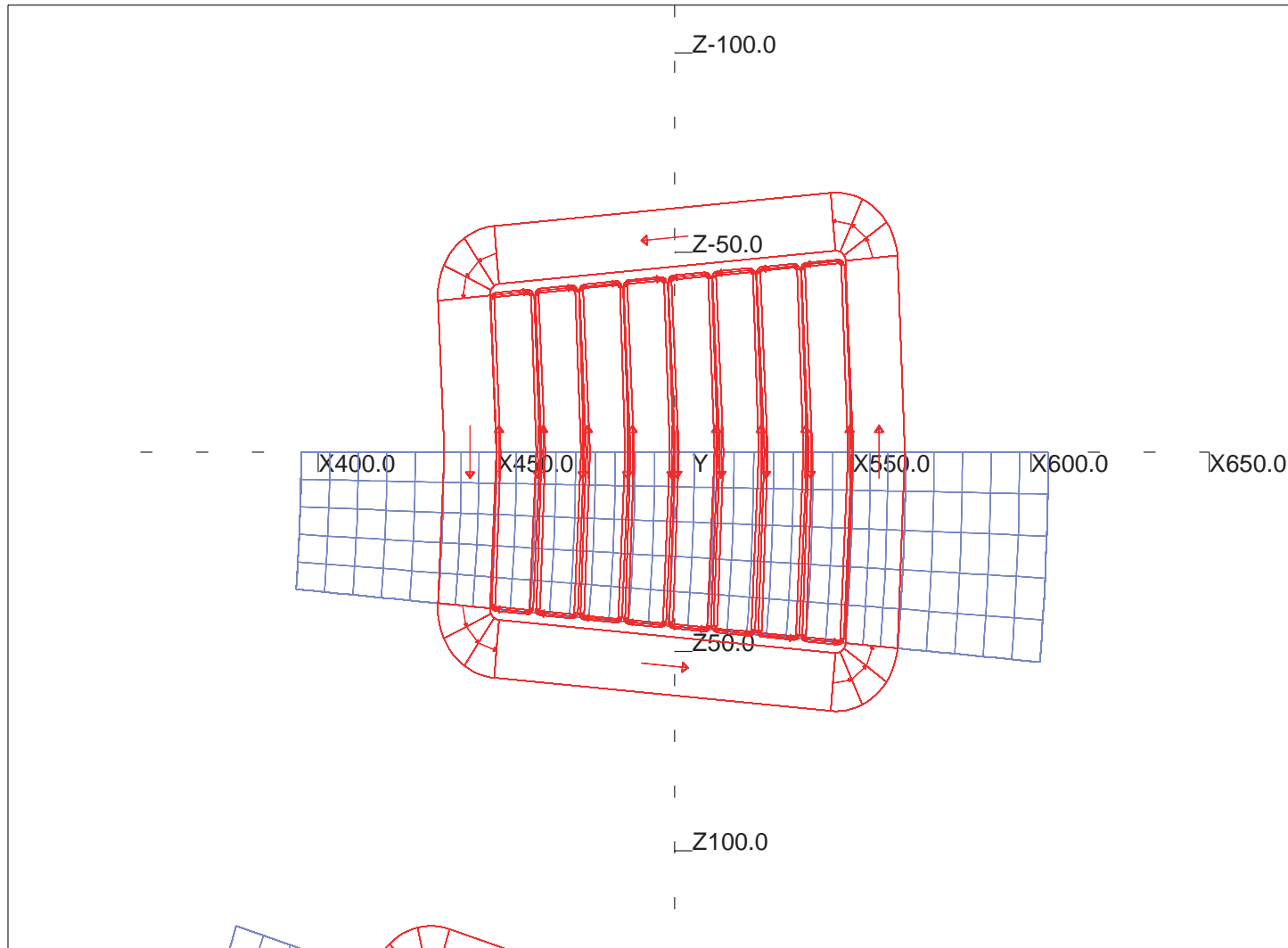
# distributed coils type 1



# distributed coils type 1



# distributed coils type 2



UNITS	
Length	: cm
Magn Flux Den	: gauss
Magnetic field	: oersted
Magn Scalar Pot:	oersted-cm
Magn Vector Pot:	gauss-cm
Elec Flux Den	: C cm <sup>2</sup>
Electric field	: V cm <sup>-1</sup>
Conductivity	: S cm <sup>-1</sup>
Current density	: A cm <sup>-2</sup>
Power	: W
Force	: N
Energy	: J

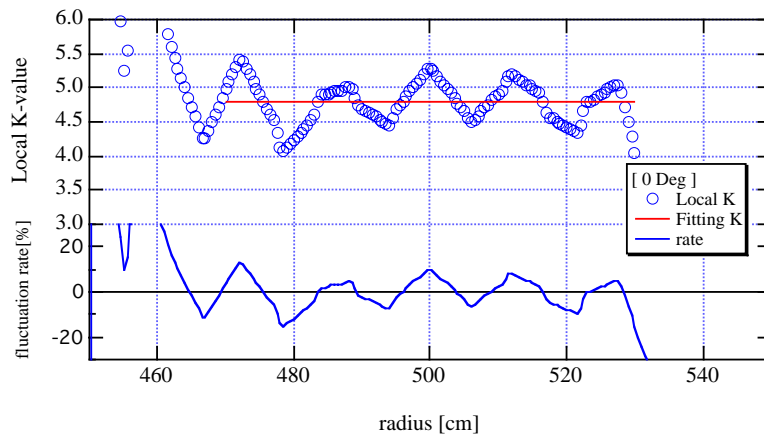
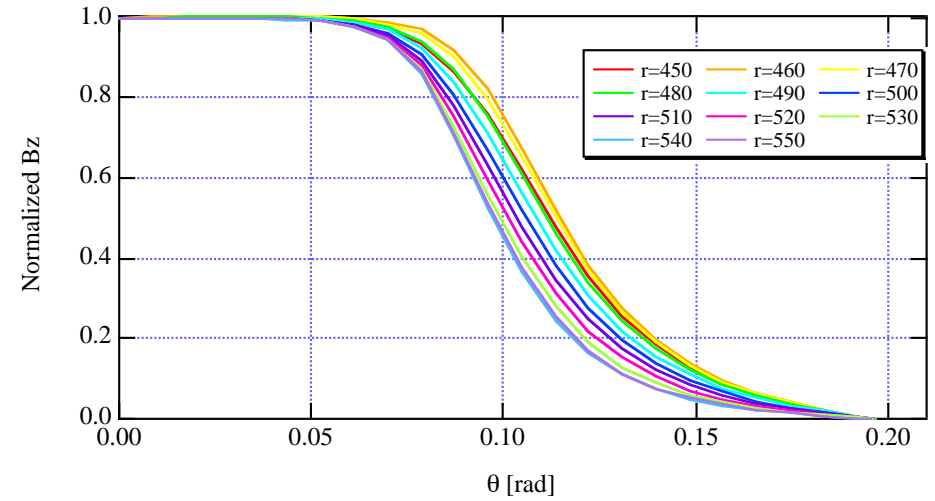
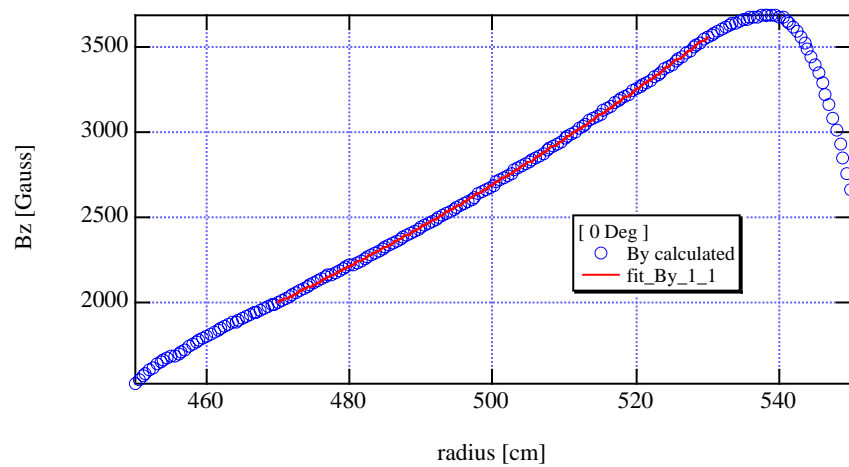
**PROBLEM DATA**  
NRadial\_r1.op3  
TOSCA  
Magnetostatic  
Non-linear materials  
Simulation No 1 of 1  
29440 elements  
127613 nodes  
Nodal fields

**LOCAL COORDS.**  
Xlocal = 0.0  
Ylocal = 0.0  
Zlocal = 0.0  
Theta = 0.0  
Phi = 0.0  
Psi = 0.0

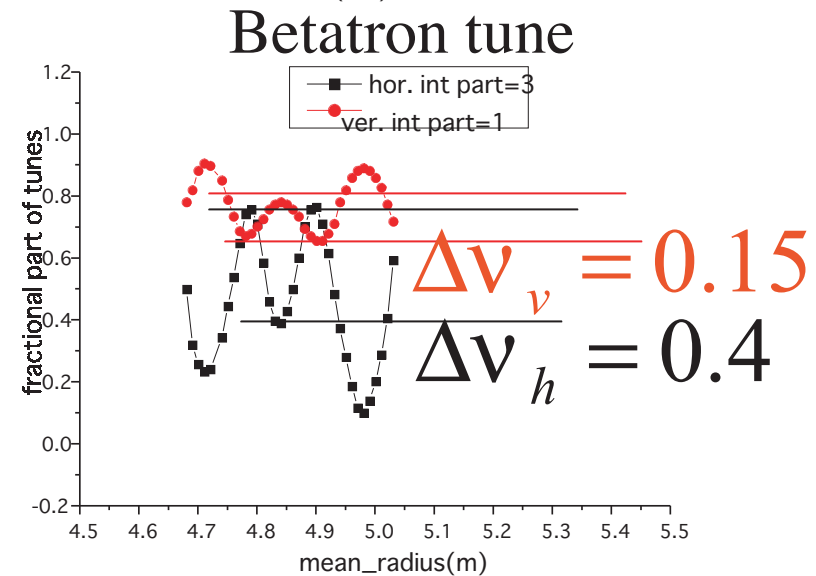
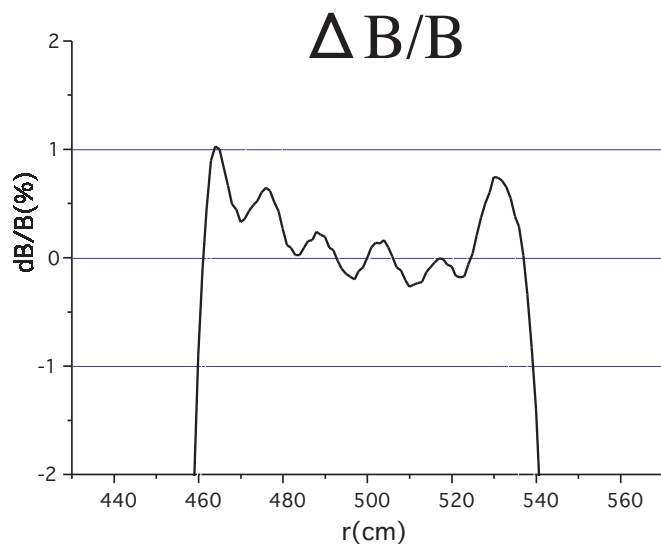
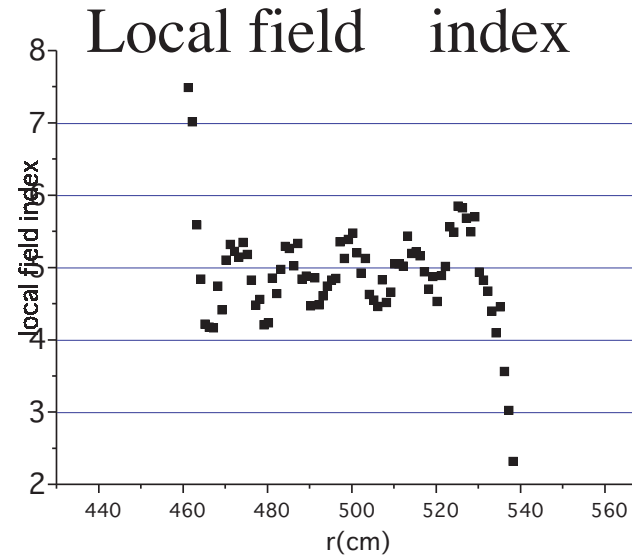
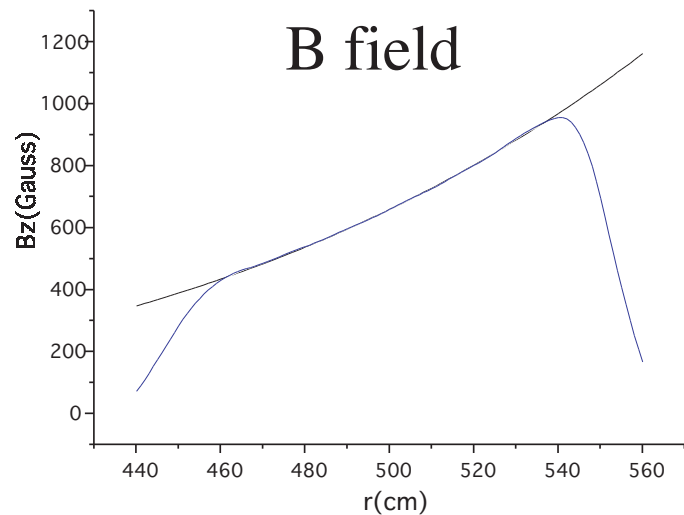
6/Feb/2002 02:54:24 Page 10

**OPERA-3d**  
Post-Processor 7.03

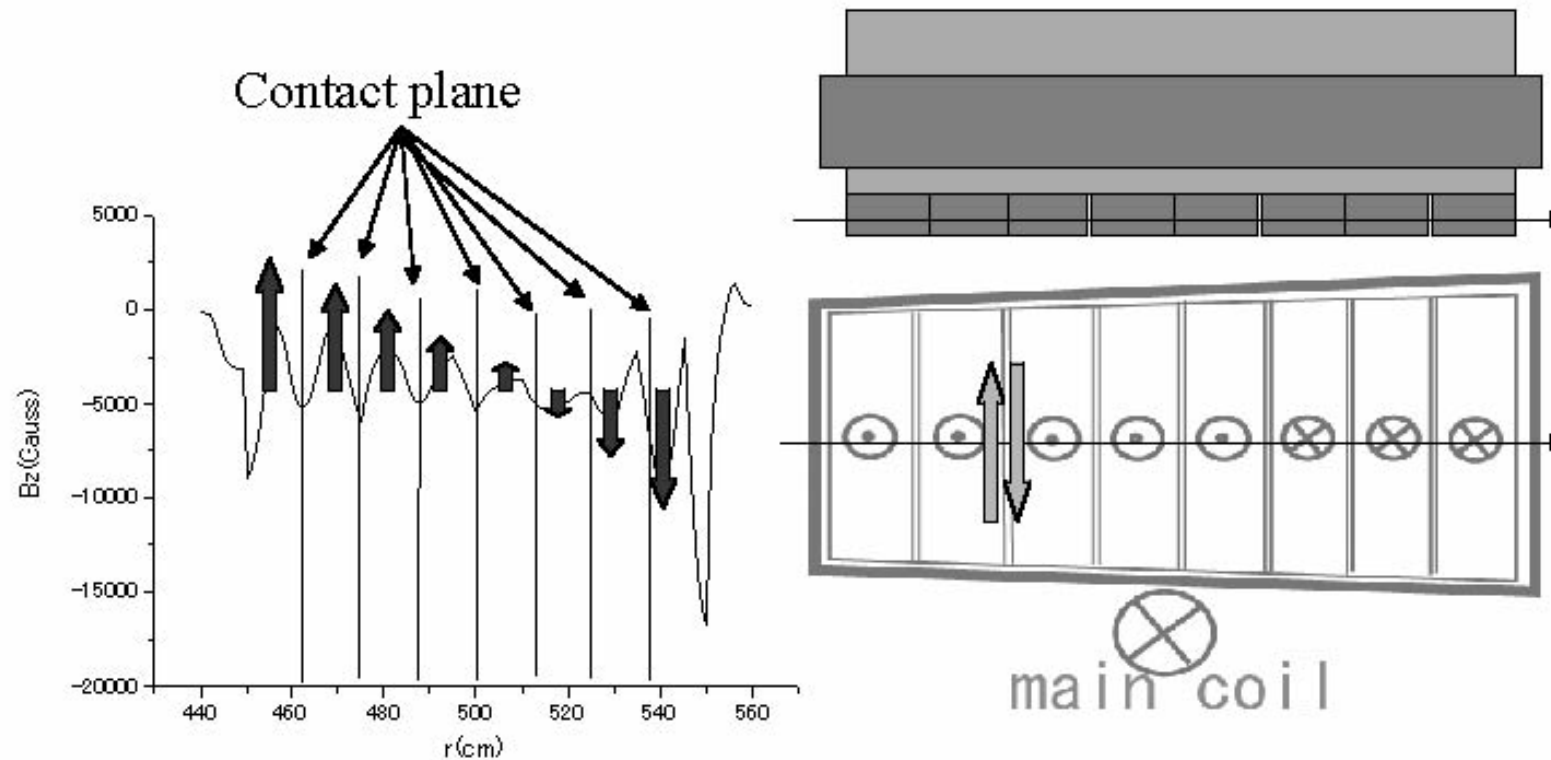
# distributed coils type 2



# Results of Field Calculation and Tracking (separated push-pull)



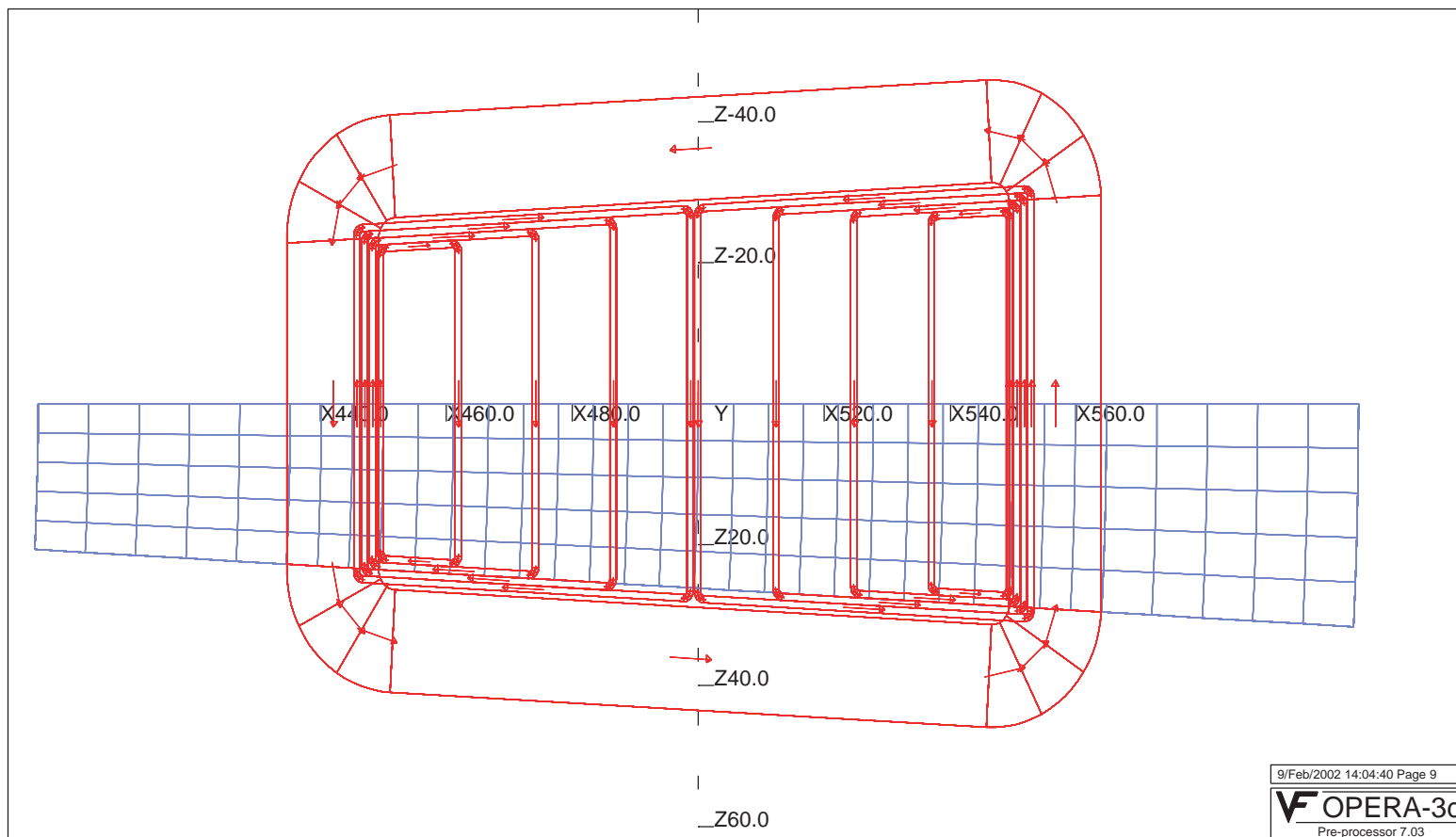
# distributed coils type 2



$B_z$  @coil plane of F-center

Opposite direction of current makes the kink

# distributed coils type 3



# distributed coils type 3

