
CERN

Modelling Update of Flux Concentrators for Linear Accelerator Positron Sources

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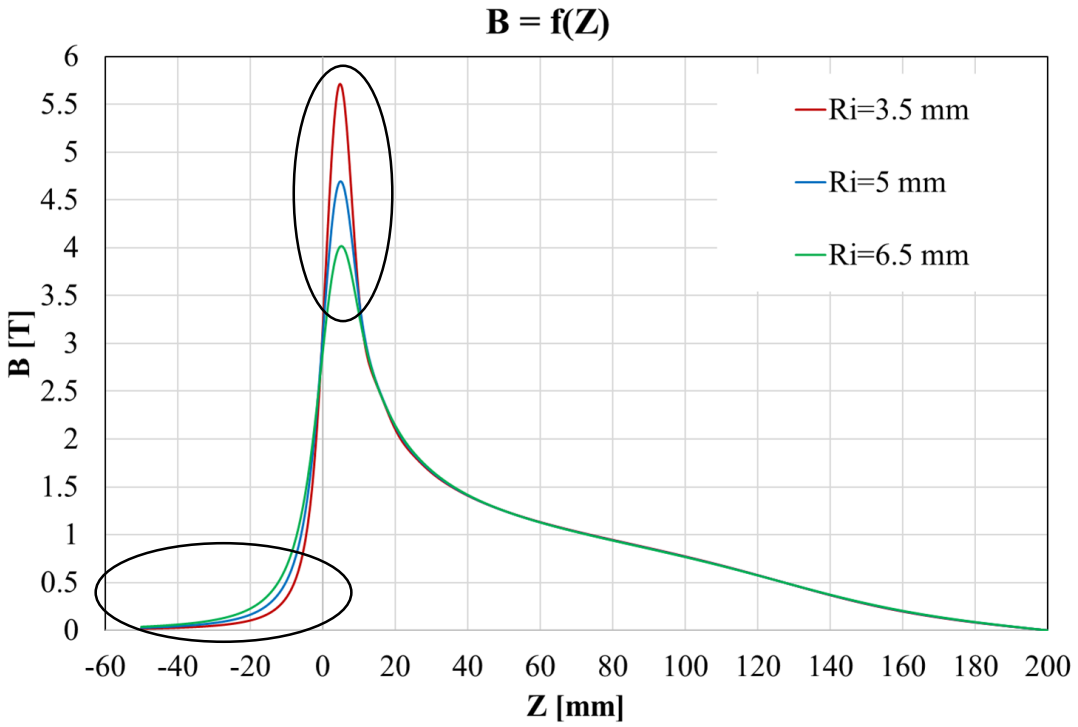
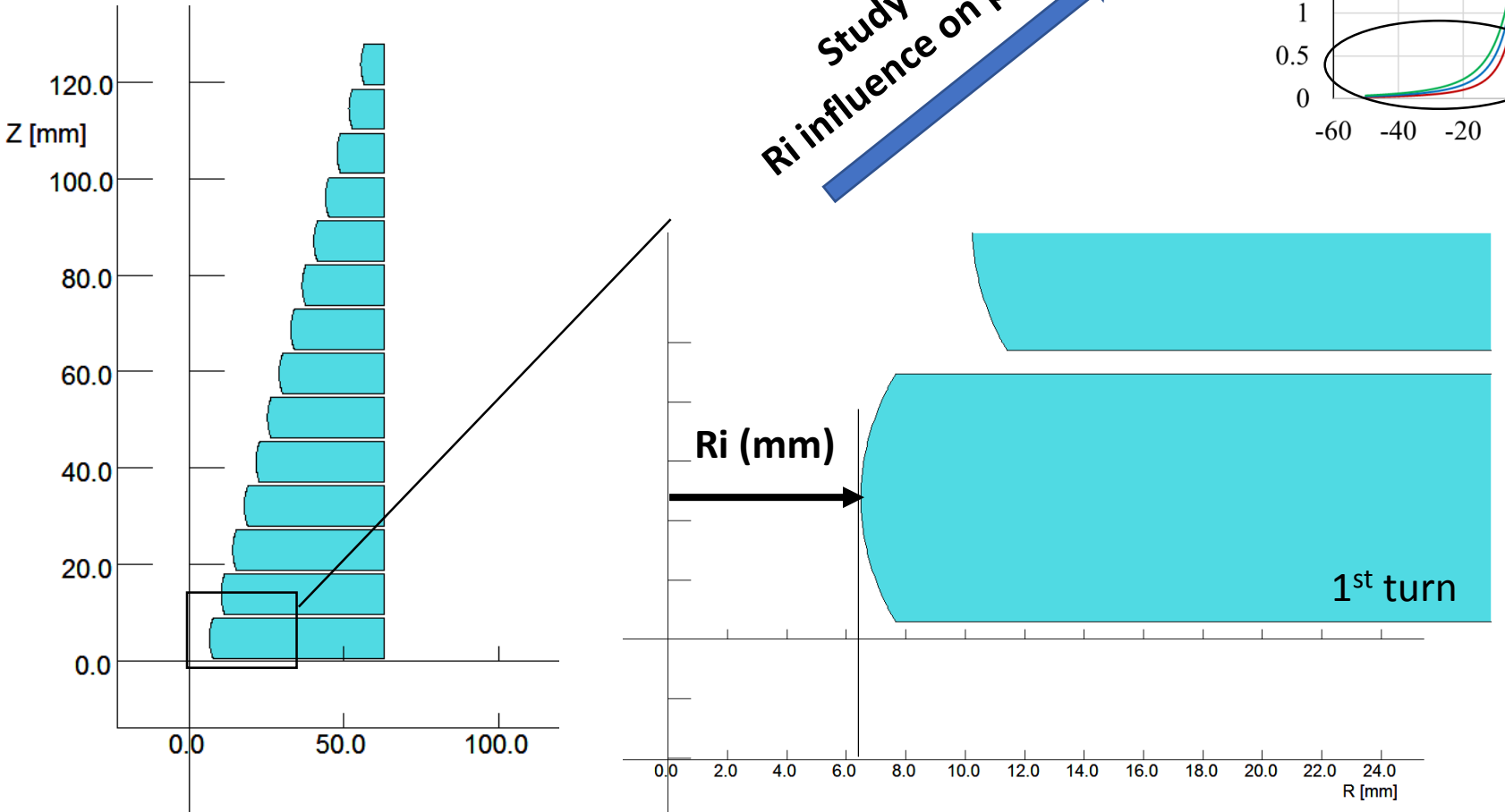
Larger aperture leads to higher positron yield

Optimized design:
L =128 mm
R_o=60 mm | Ri=6.5 mm | Re=55.45 mm| γ=0.450
N=14 turns
gap 0.8 mm
f=25 kHz
σ=5.67 10^7 S/m
refined mesh 10000 points



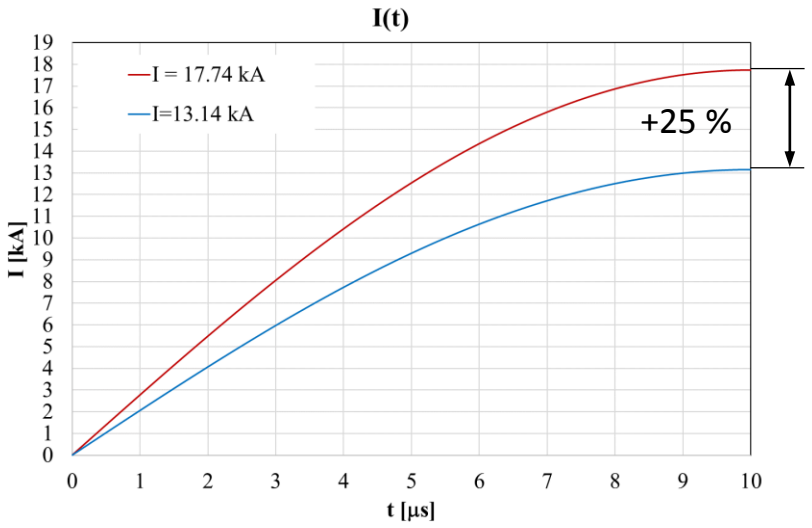
Study of the Ri influence on peak field



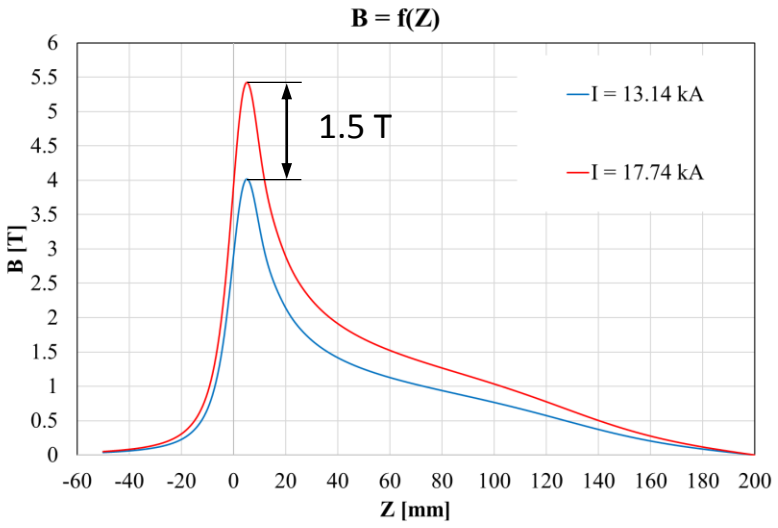
- The peak field decreases with increasing aperture.
- The fringe field enlarges with increasing aperture.

Let us recover the loss of field increasing the current

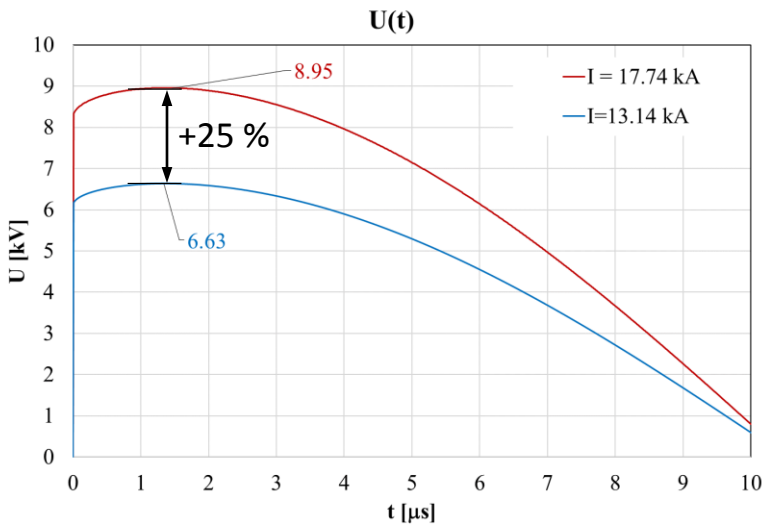
Current increase



Loss of field recovery



Mind the voltage !!



The voltage increases with the aperture size and with the current.

This optimization is not relevant regarding voltage built-up…

Need path forward for voltage optimization

Different shapes for the solenoid profile have been tried:

- 2 profiles with opposite concavities
- to compare with **the linear profile**.

Composition of linear and exponential functions used to position the turns:

Concave downward

$f = \beta * (1 - \exp(\alpha * r)) - \gamma$

With: Ri=3.5 mm

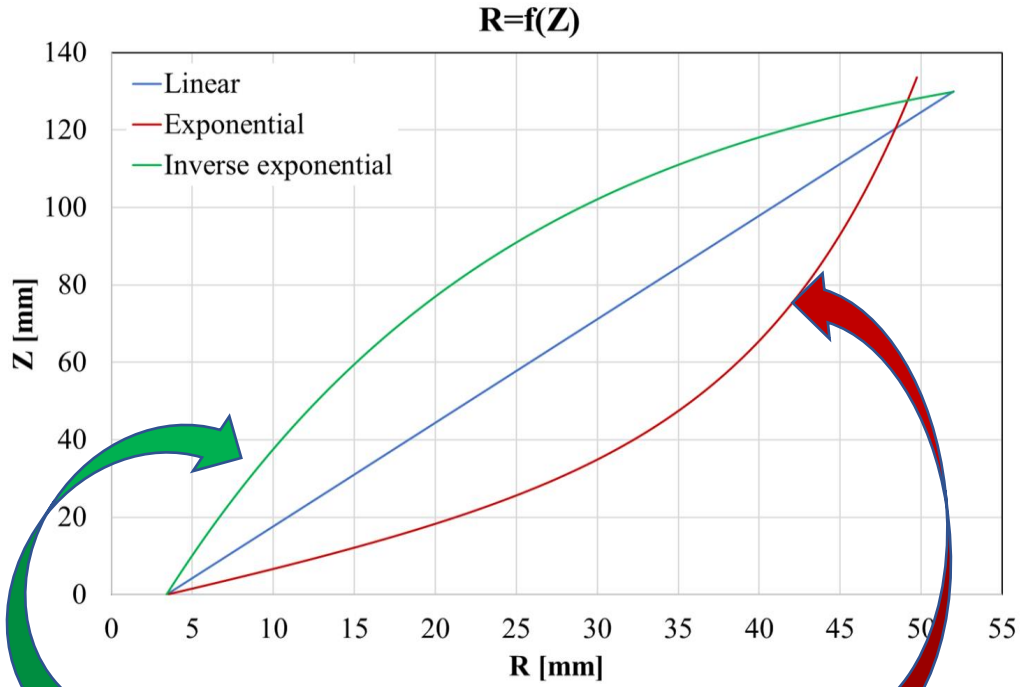
α=-0.045, β =170, $\gamma = \beta * (1 - \exp(\alpha * Ri))$

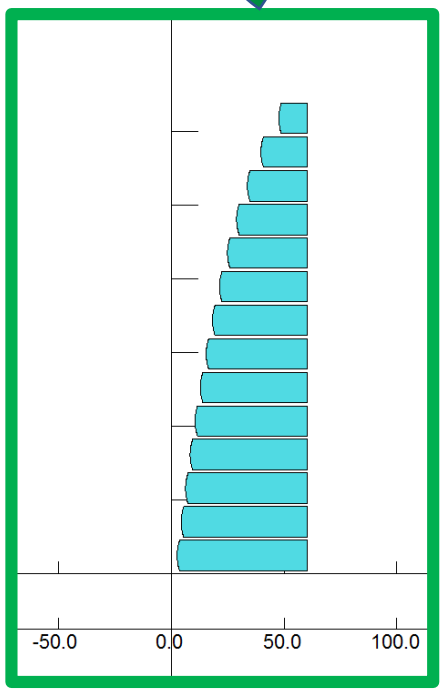
Concave upward

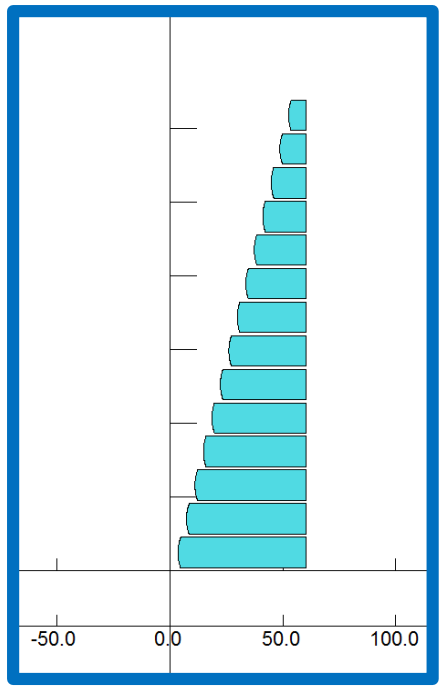
$f = \gamma * (\exp(\alpha * r) - \beta) + \delta * (r - Ri)$

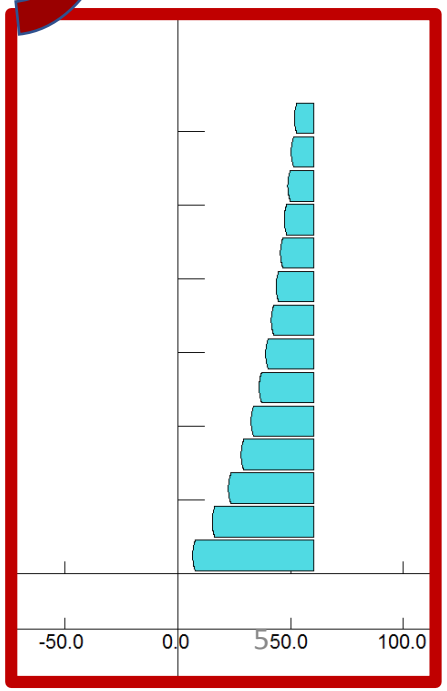
With: Ri=3.5 mm

α=0.105, $\beta = \exp(\alpha * Ri)$, γ=0.0.5, δ=0.9





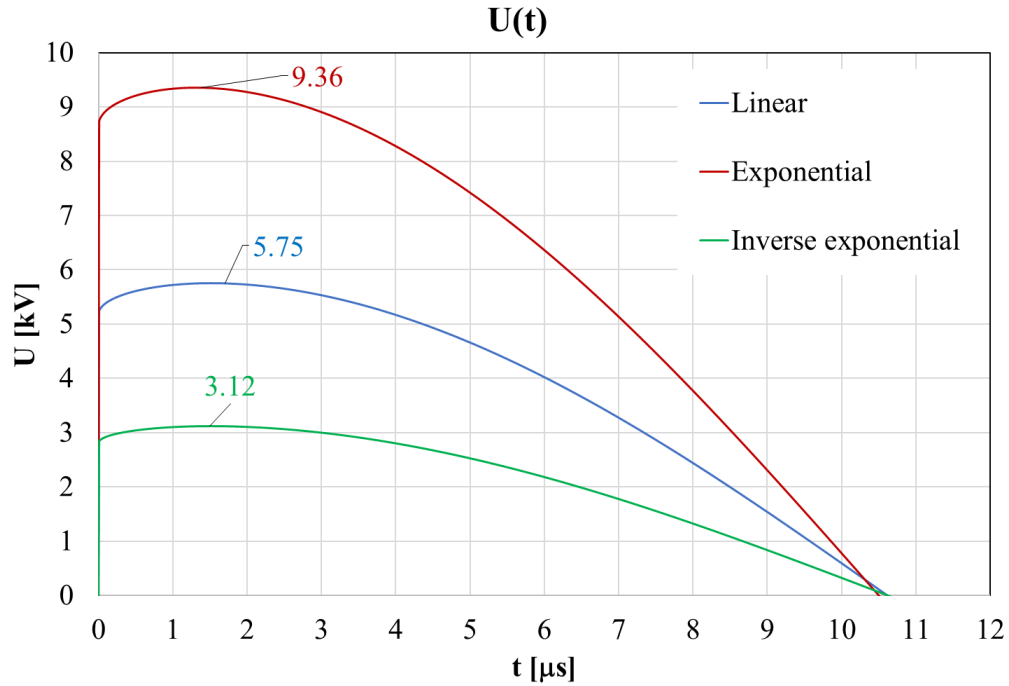


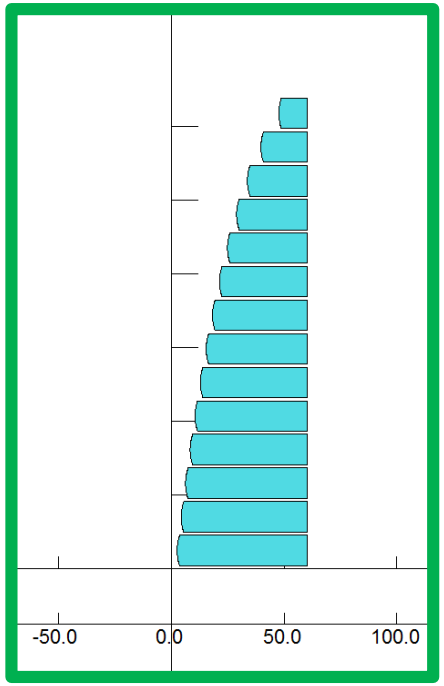


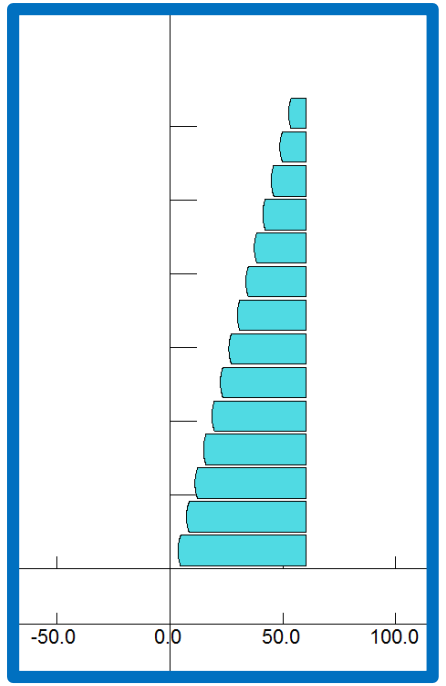
Need path forward for voltage optimization

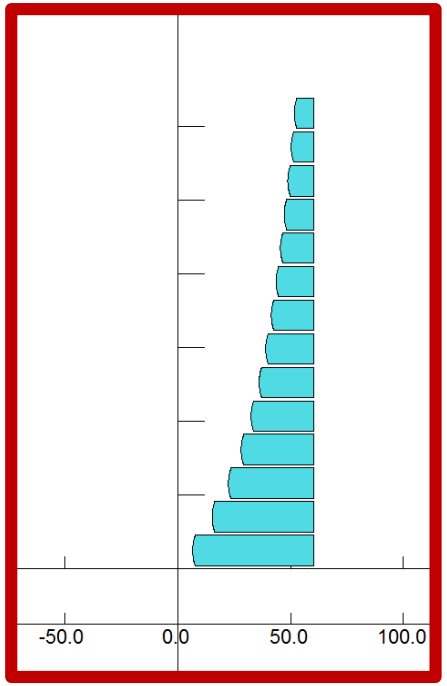
For the same excitation current (13.8 kA):

- ❑ the lowest voltage is obtained for the downward concavity.
- ❑ The upward concavity increases the voltage significantly.
- ❑ The linear profile is in between.





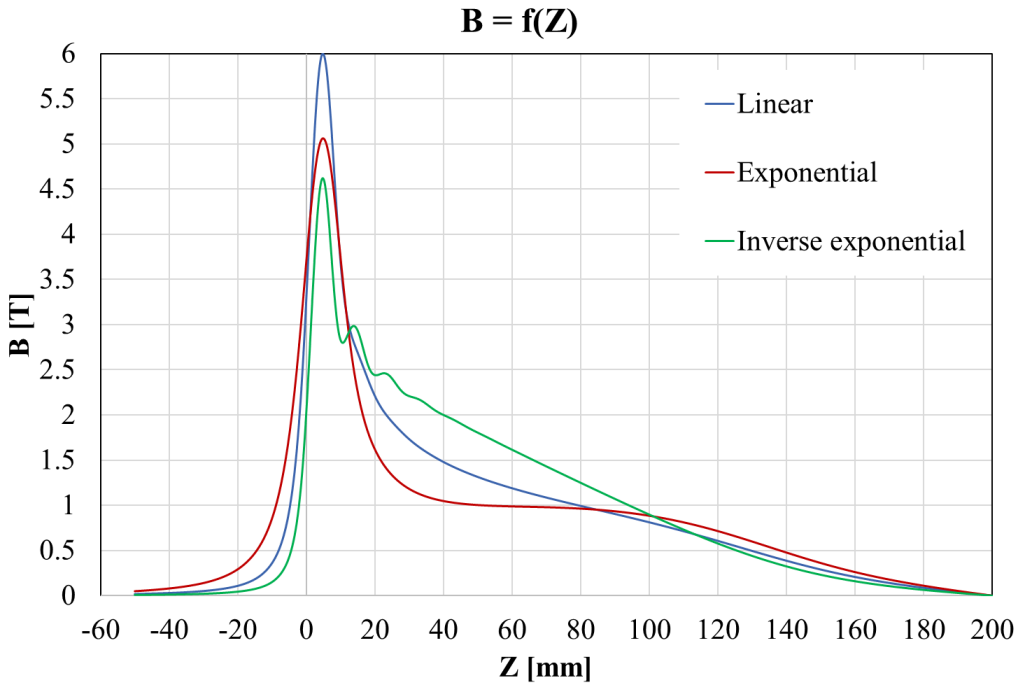


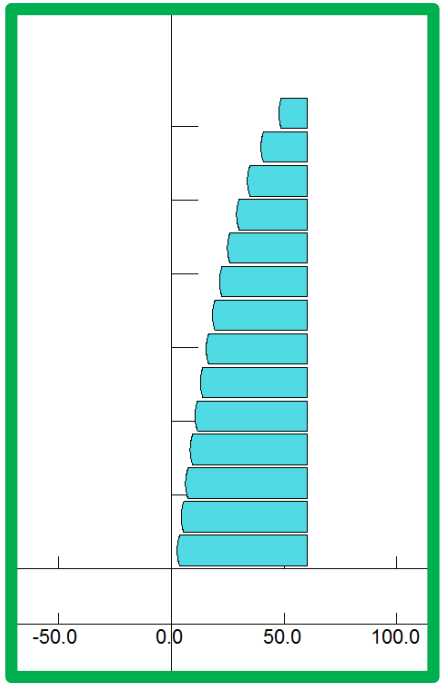


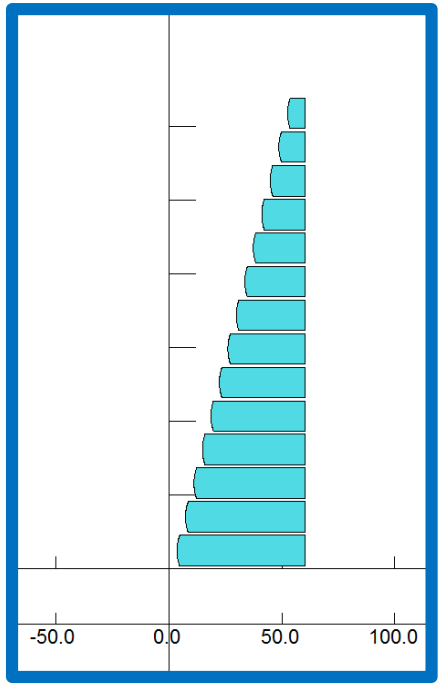
How does the field look like with the new shapes?

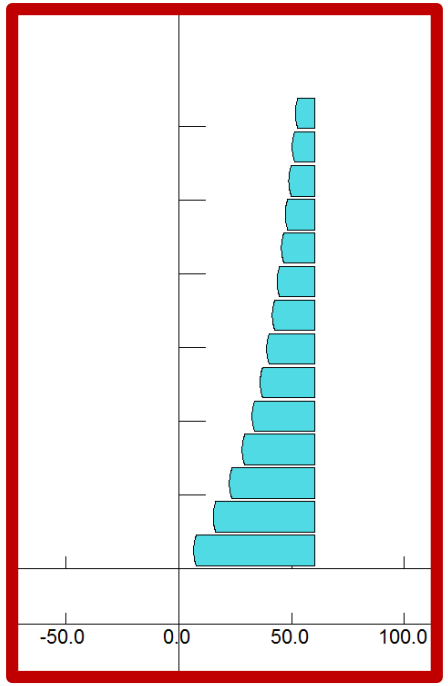
For the same excitation current (13.8 kA):

- ❑ the linear profile gives the highest field.
- ❑ the downward concavity produces the least fringe field on the target side.
- ❑ oscillation is visible on the downward concavity case.
- ❑ the upward concavity gives the narrowest peak.
  … but large fringe field.



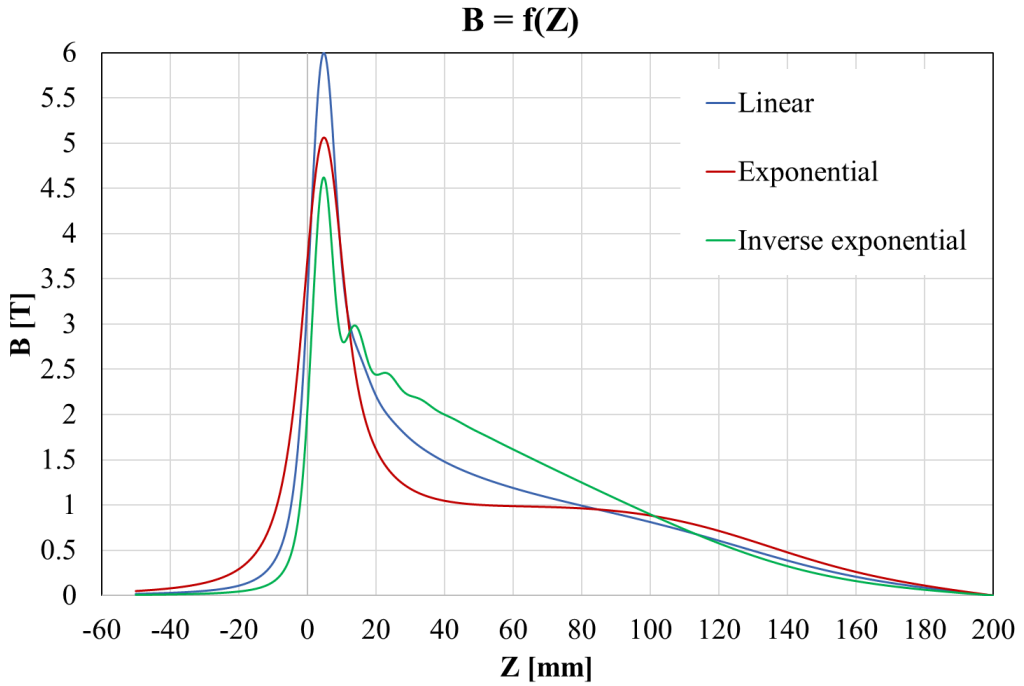


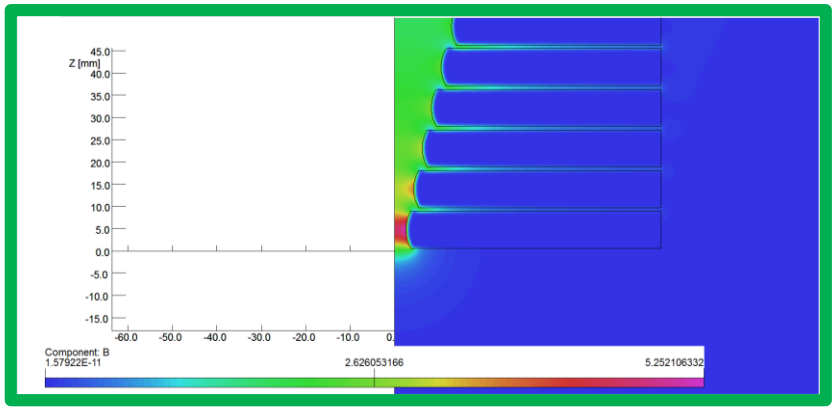


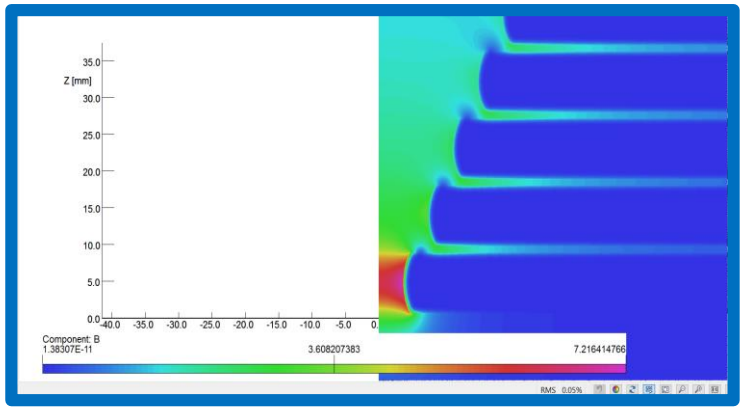


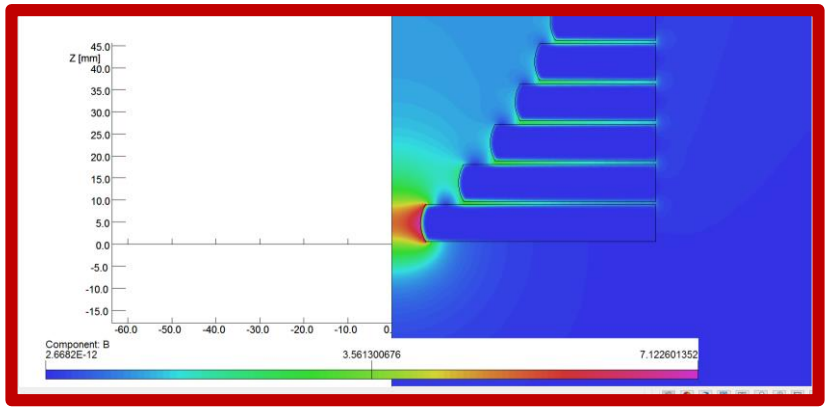
How does the field look like with the new shapes?

Field map produced for Yongke.



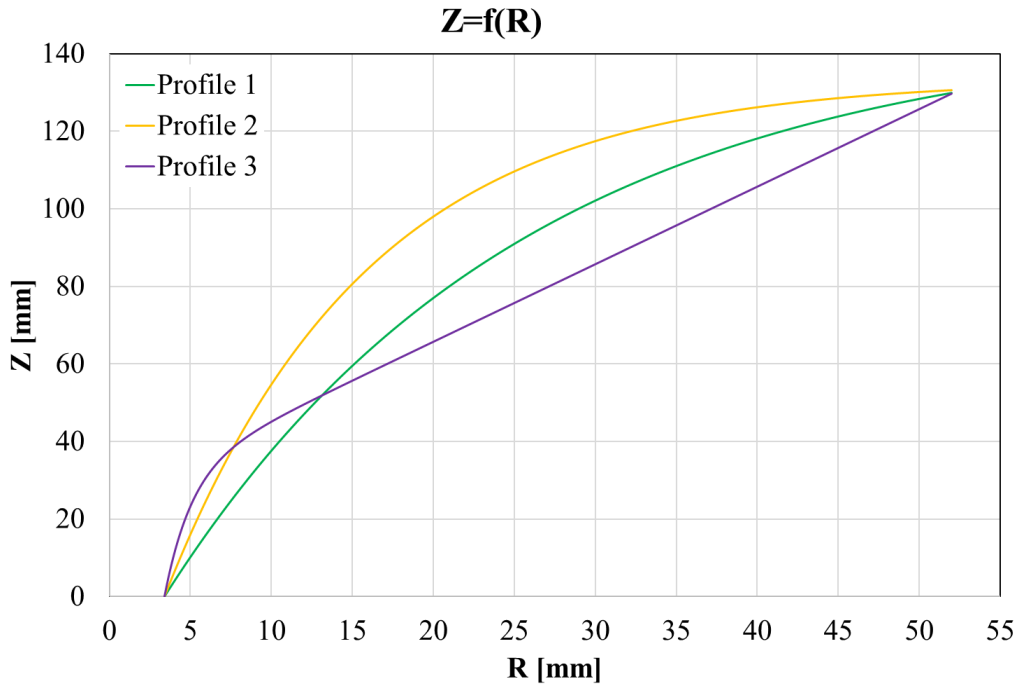


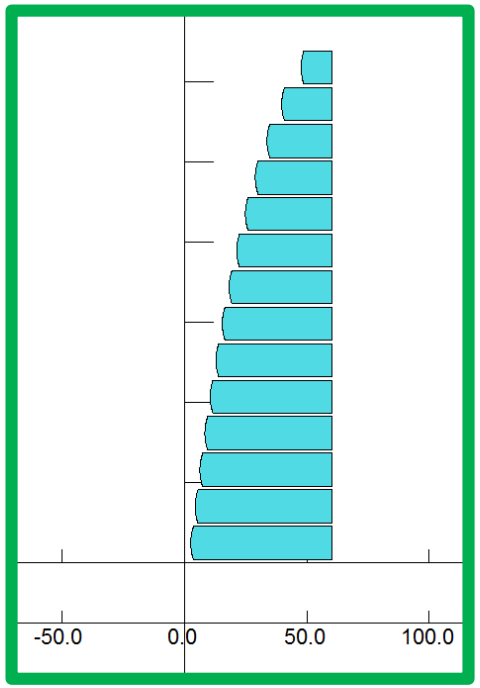


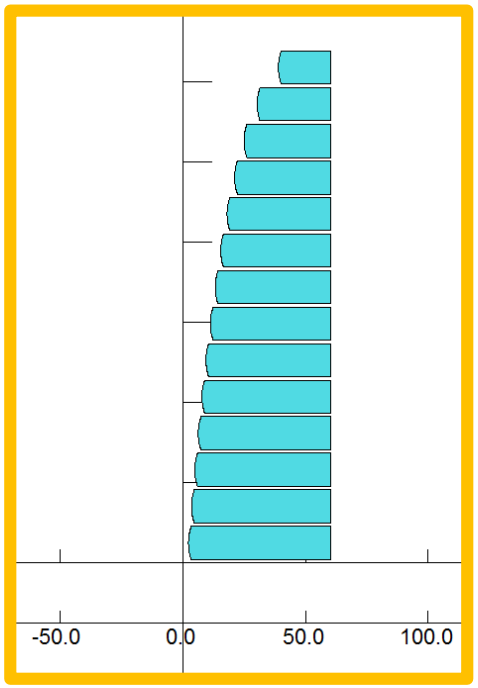


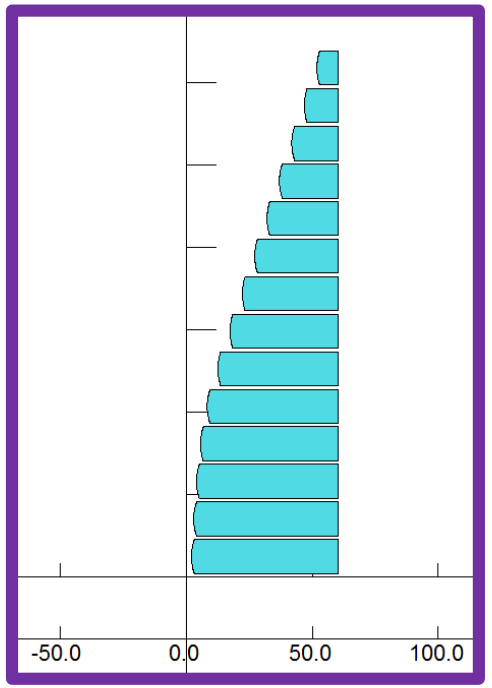
Other FC profiles…

- The program allows to rapidly test new geometries of flux concentrator.



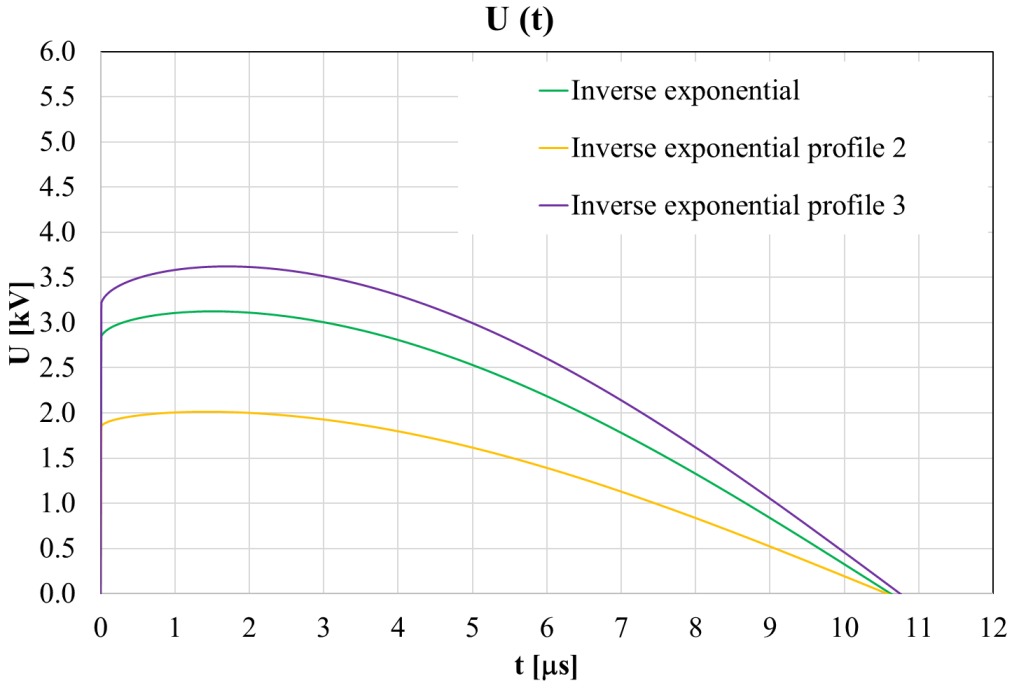


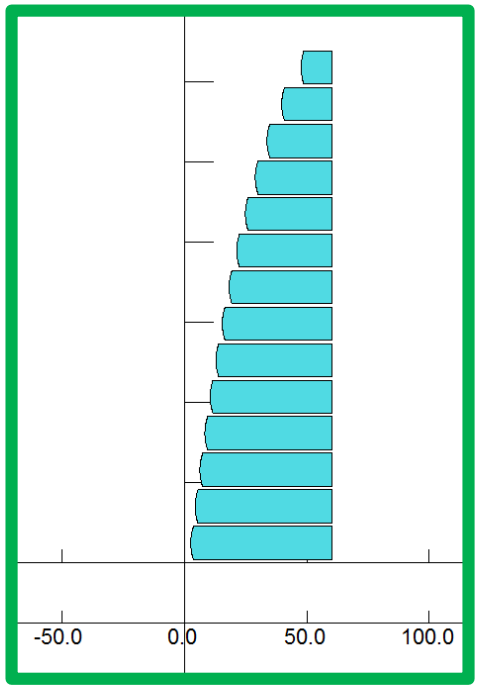


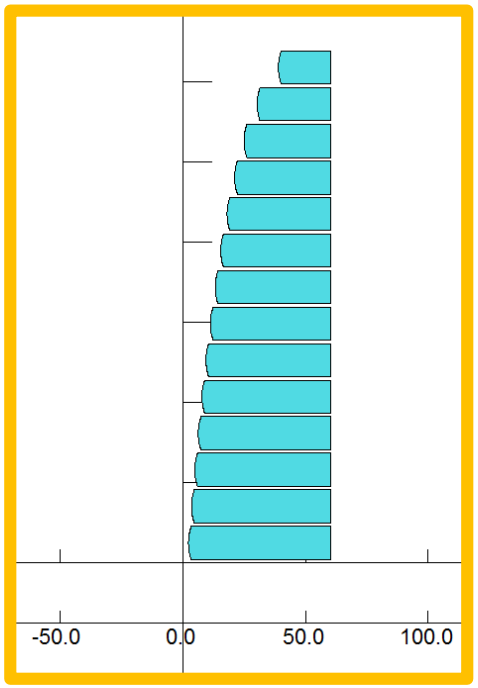


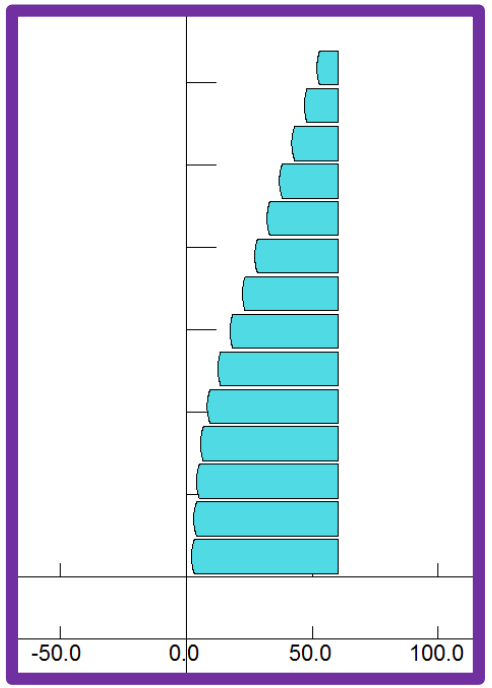
Other FC profiles…

- The voltage can significantly be lowered adapting the shape of the profile.





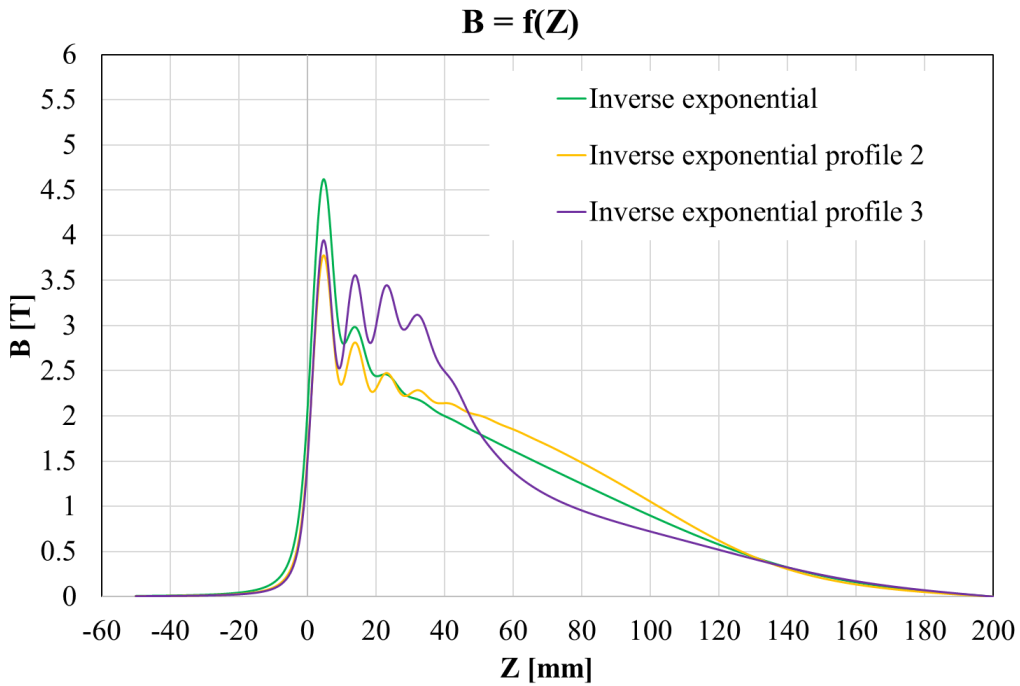


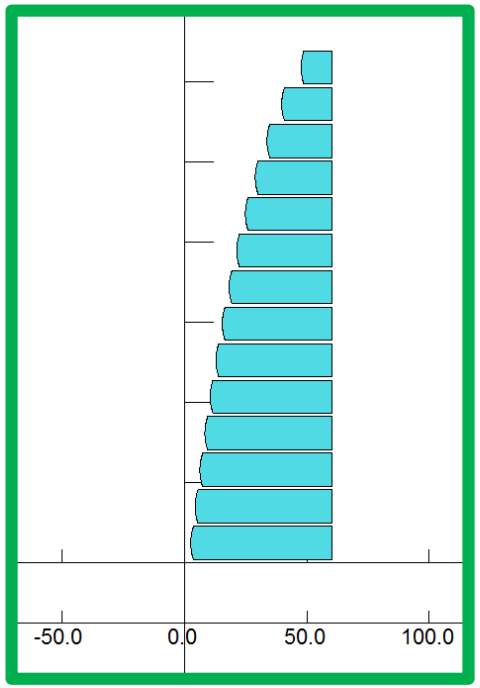


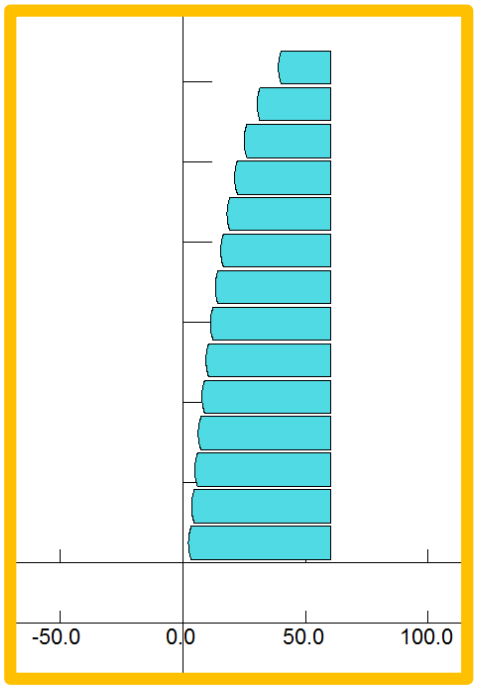
Other field profile…

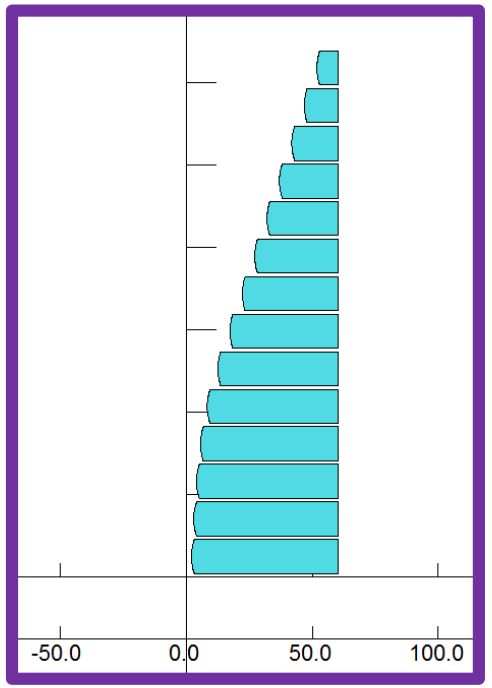
- ❑ The field map is obviously affected by the shape of the FC.

→ We need to determine what is good for positron yield.



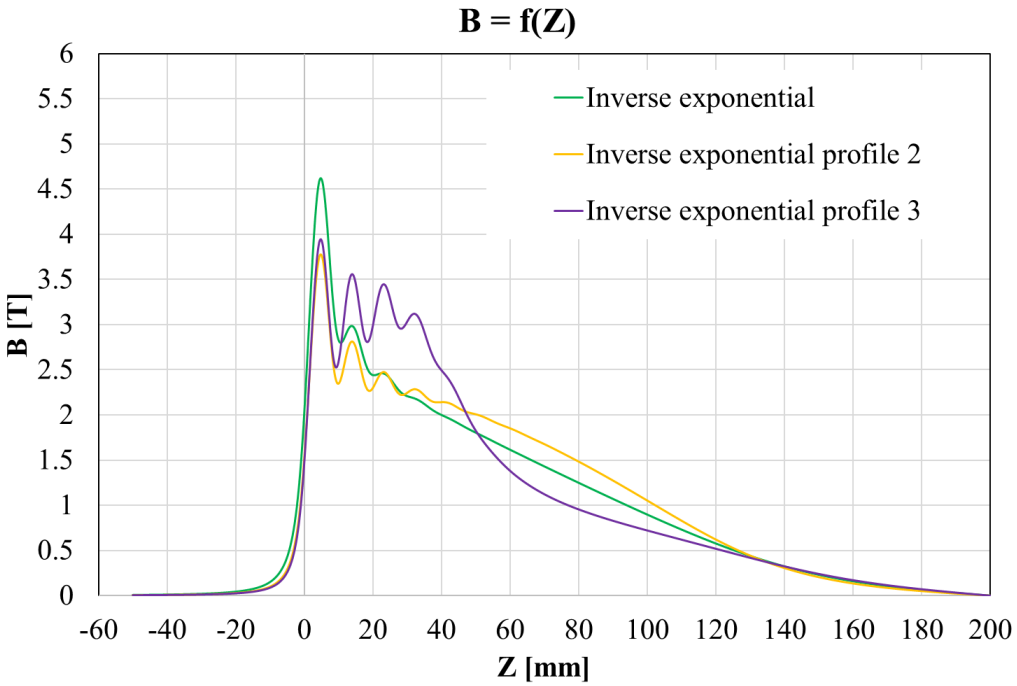


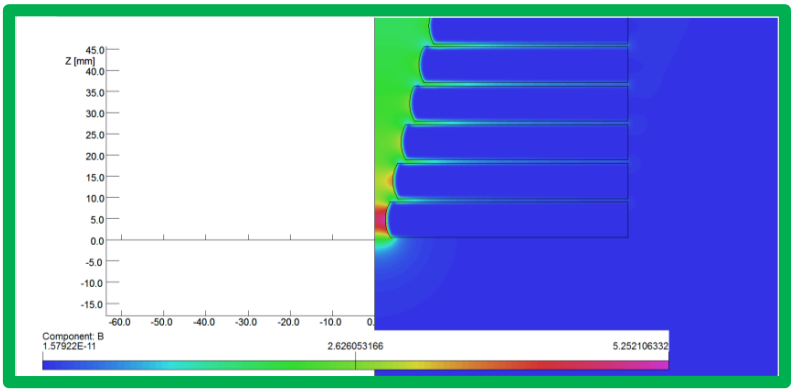


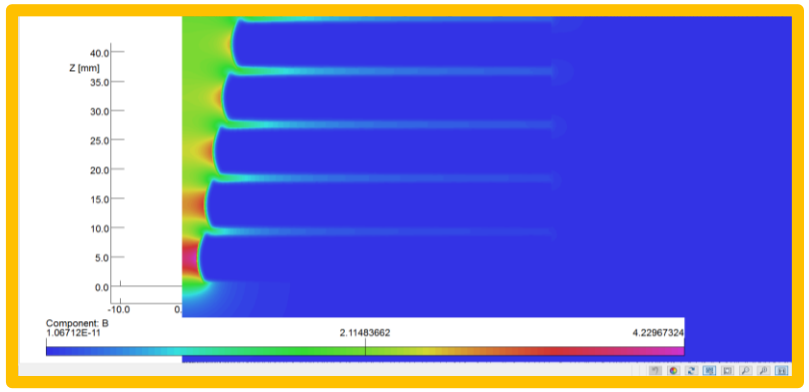


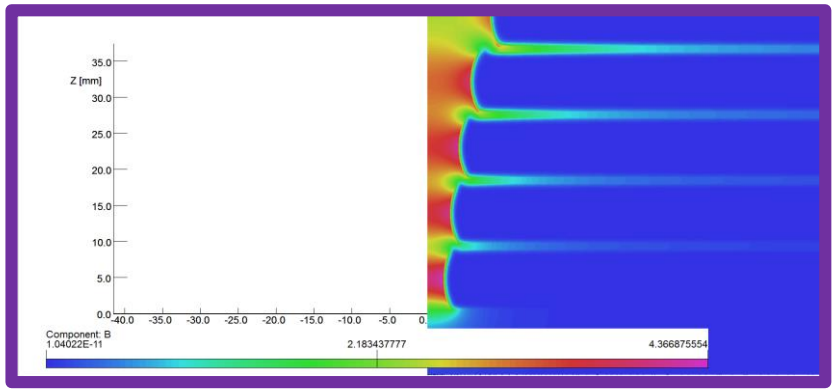
Other field profile…

- The oscillation are still not clear to me and I need to investigate the origin of the phenomenon.









Conclusion

- New field map have been produced for Yongke with FC of different apertures.

- Increasing the aperture requires to increase the current to recover the loss of field… but the voltage rapidly increases with wider aperture.

- New models with *upward* and *downward* concavities using non linear profile have been produced to cope with high voltage issue. Although very preliminary, it gives interesting results.

- Optimization on the voltage and the positron yield can be done accepting to change the shape of the FC.