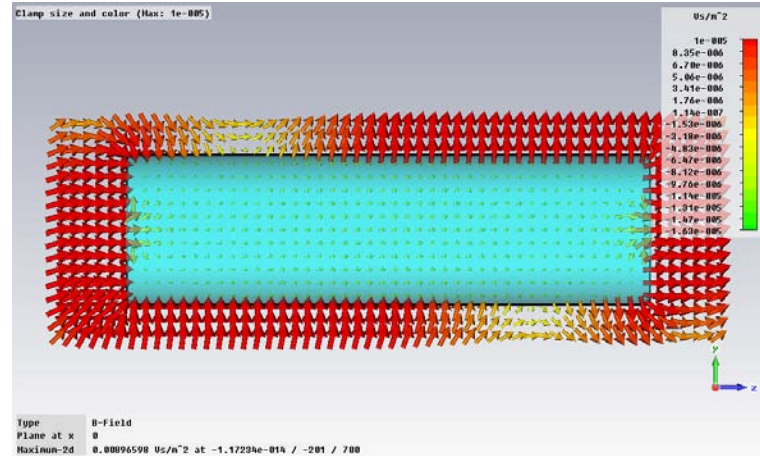
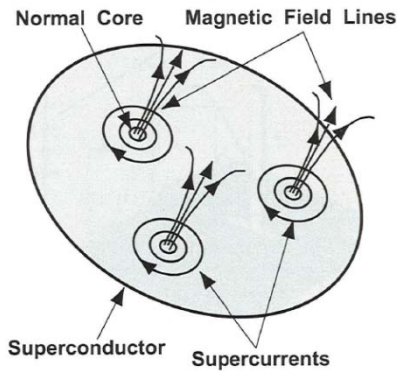


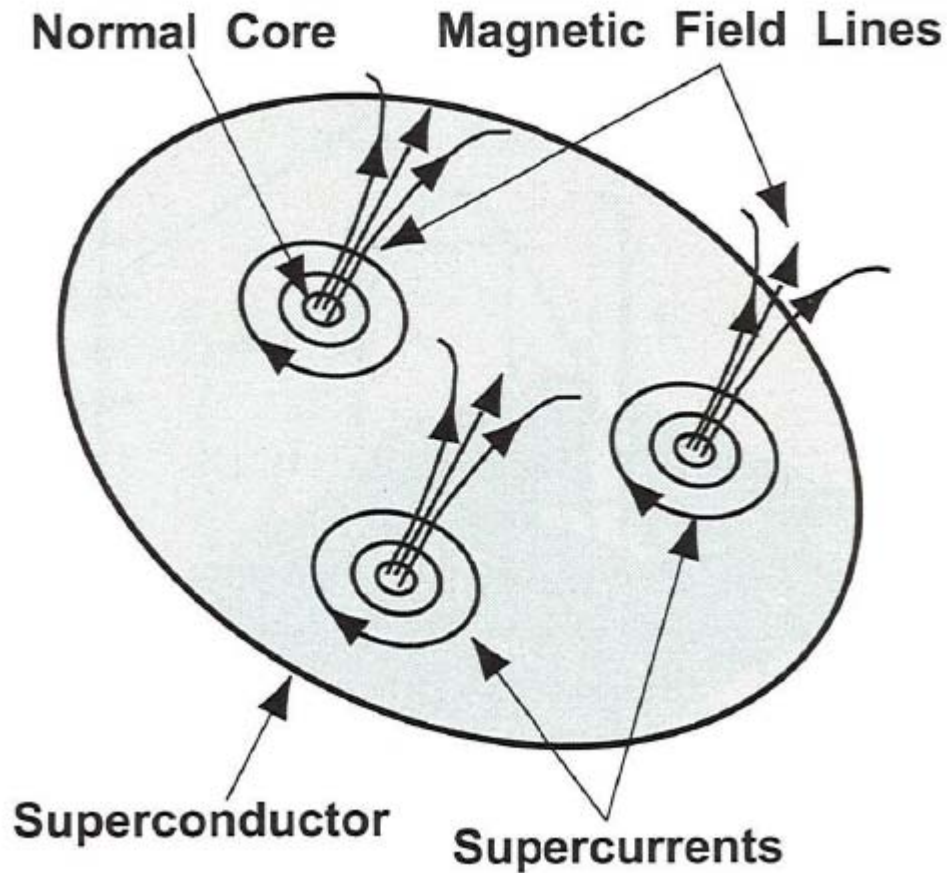
Magnetic shielding for SPL cavities

Electromagnetic Simulations



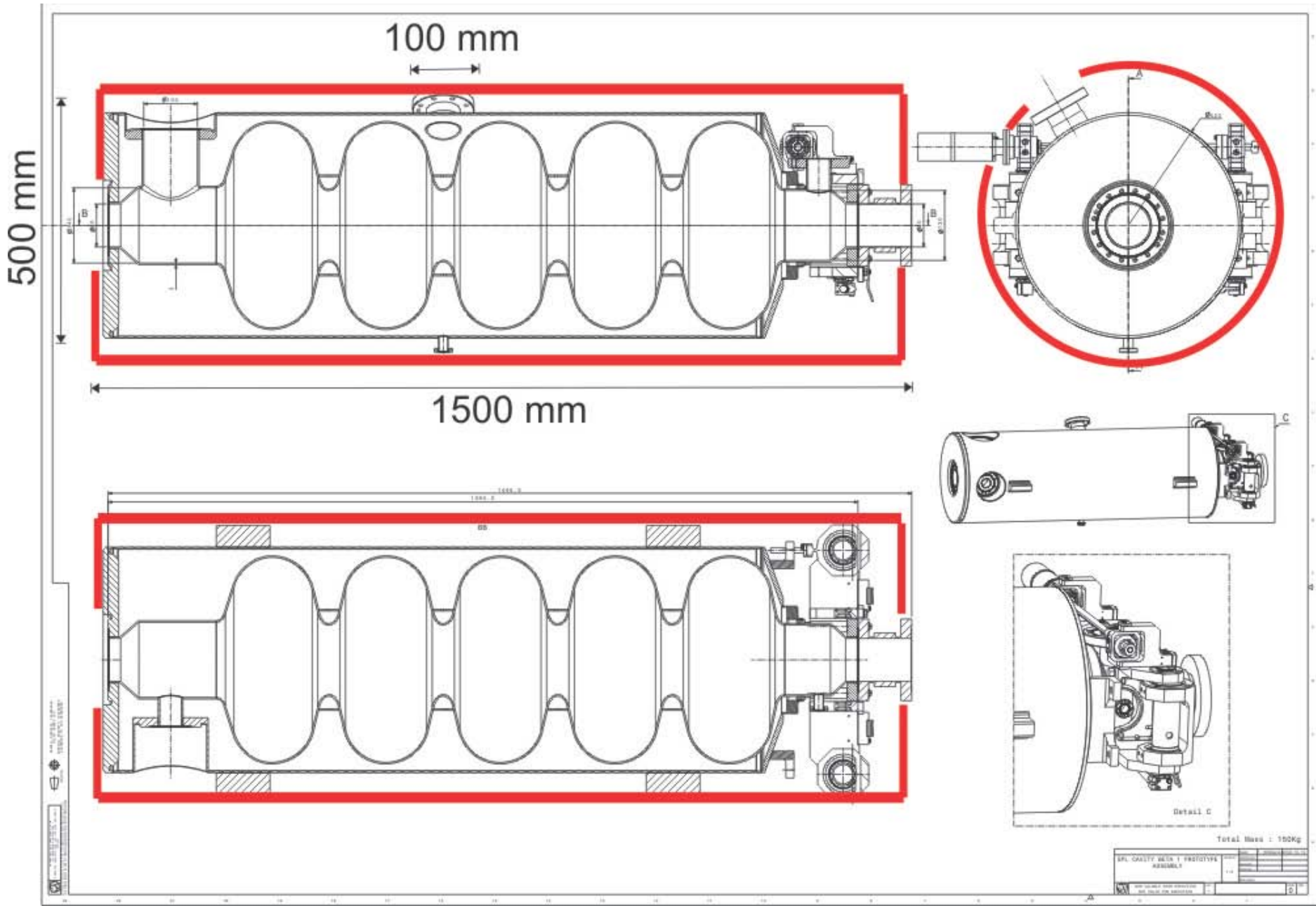
Tobias Junginger

Tobias.Junginger@quasar-group.org

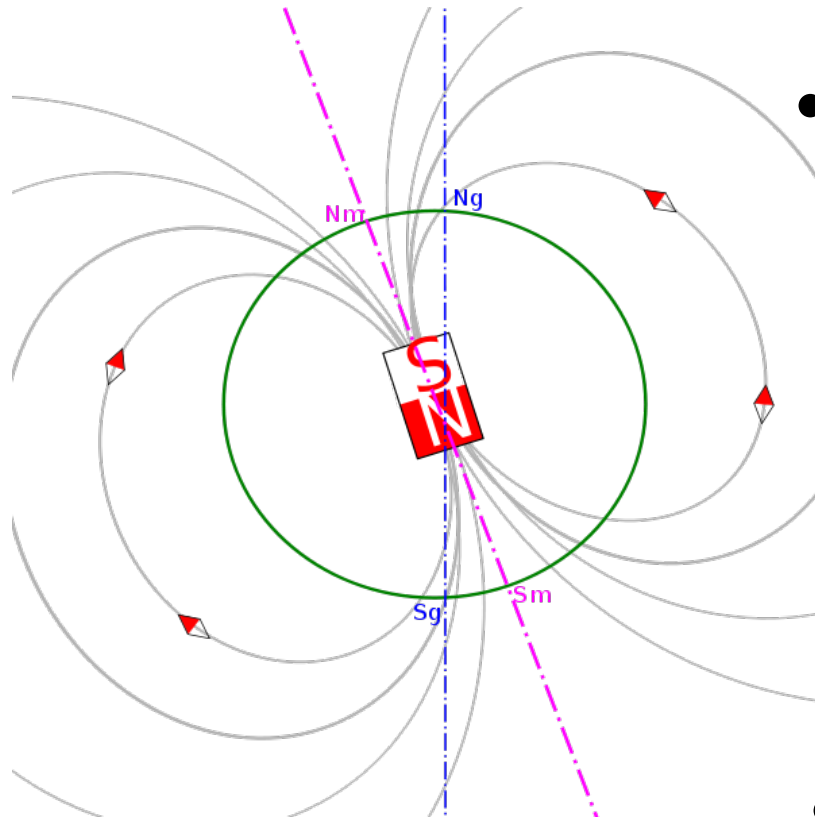


$$R_{mag} = \frac{H_{ext}}{2H_{c2}} R_n$$

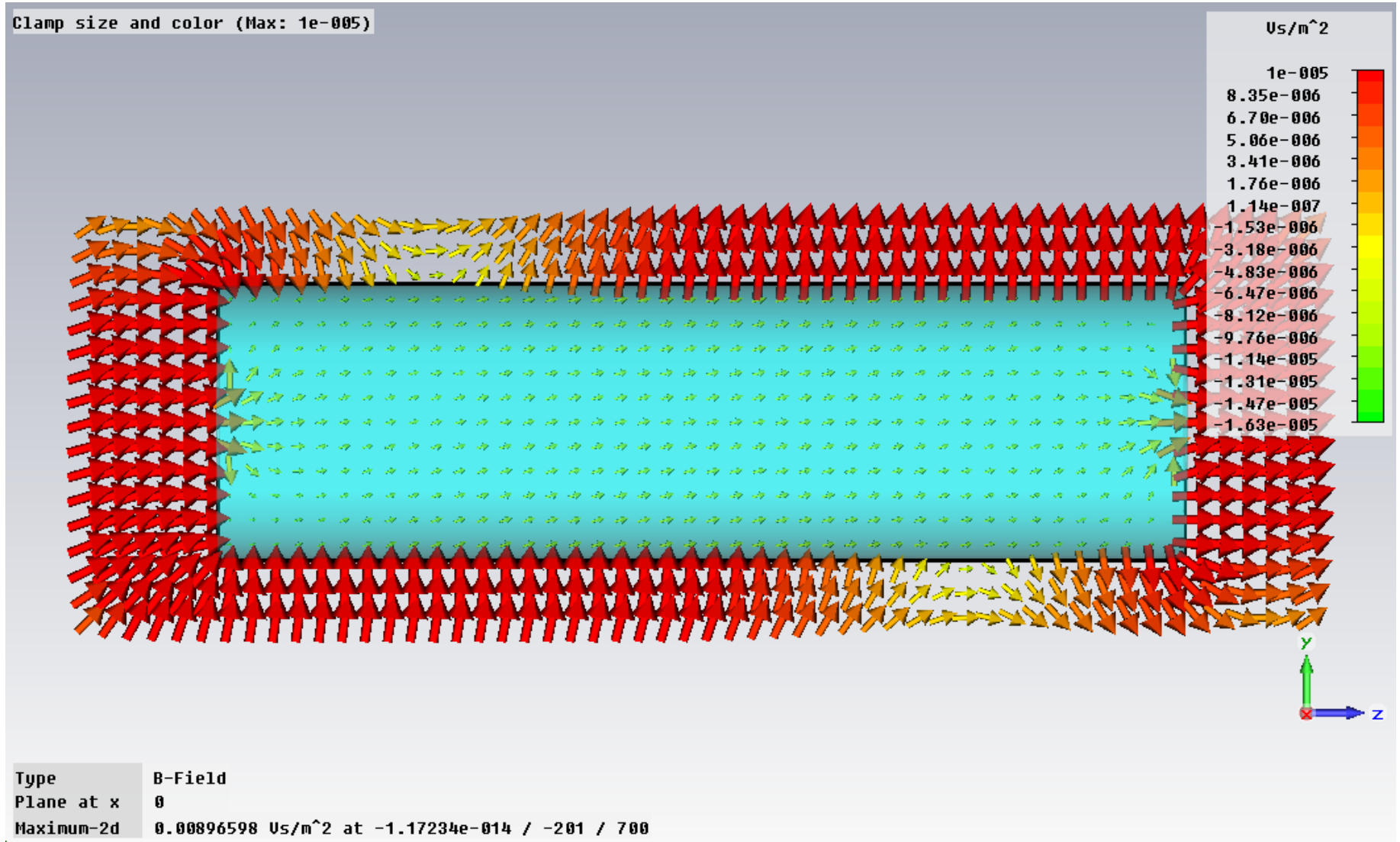
$$R_{mag} [n\Omega] = 3H_{ext} [\mu T] \sqrt{f [GHz]}$$



- Material: Cryoperm 10
- Thickness of sheet: 1 mm
- 206 Cavities
- 500 m² sheet
- 4.5 t of material ($\sigma=9$ kg/l)
- 450 kCHF (100 CHF/kg)



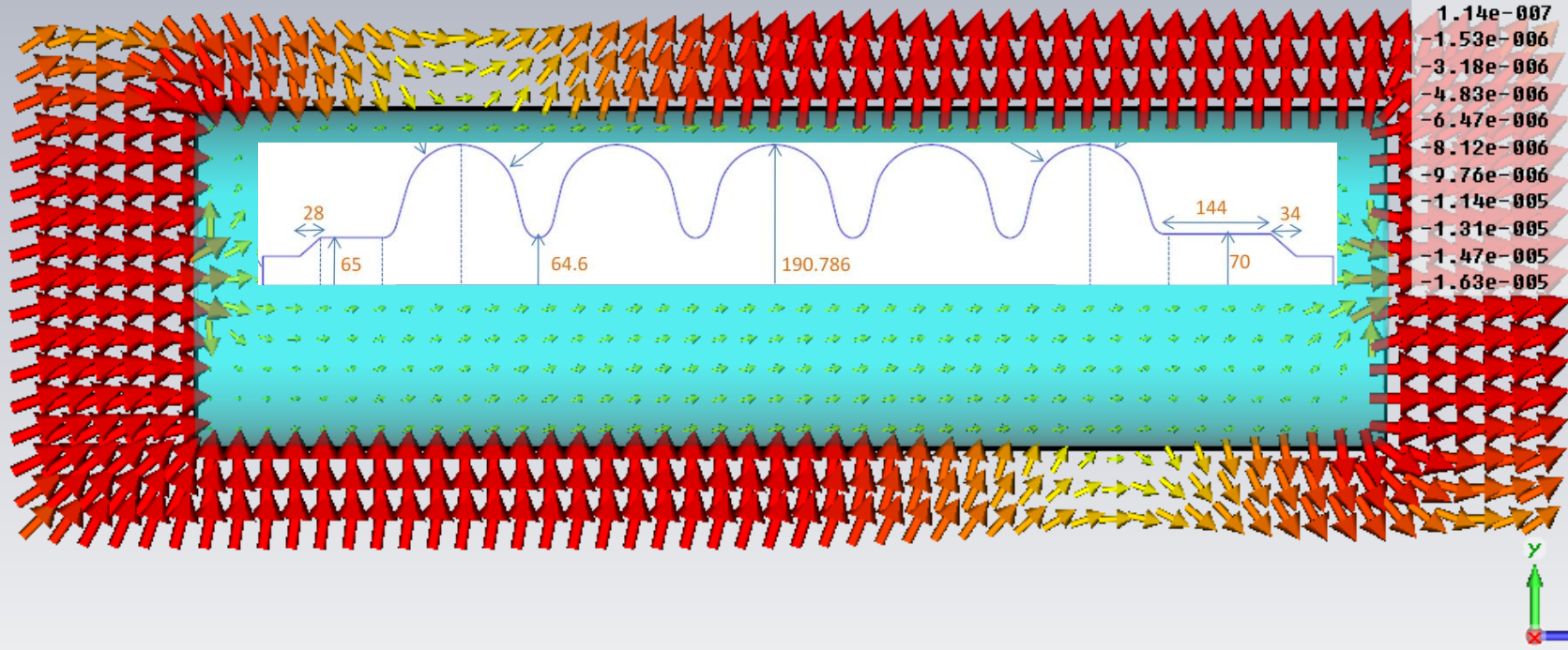
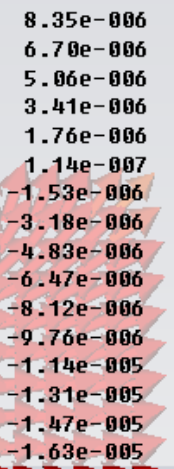
- Assumptions
 - SPL goes straight from the South to the North
 - Magnetic field $50 \mu\text{T}$, 45°
- Requirement
 - Less than $1 \mu\text{T}$ on cavity surface



Clamp size and color (Max: 1e-005)

Us/m^2

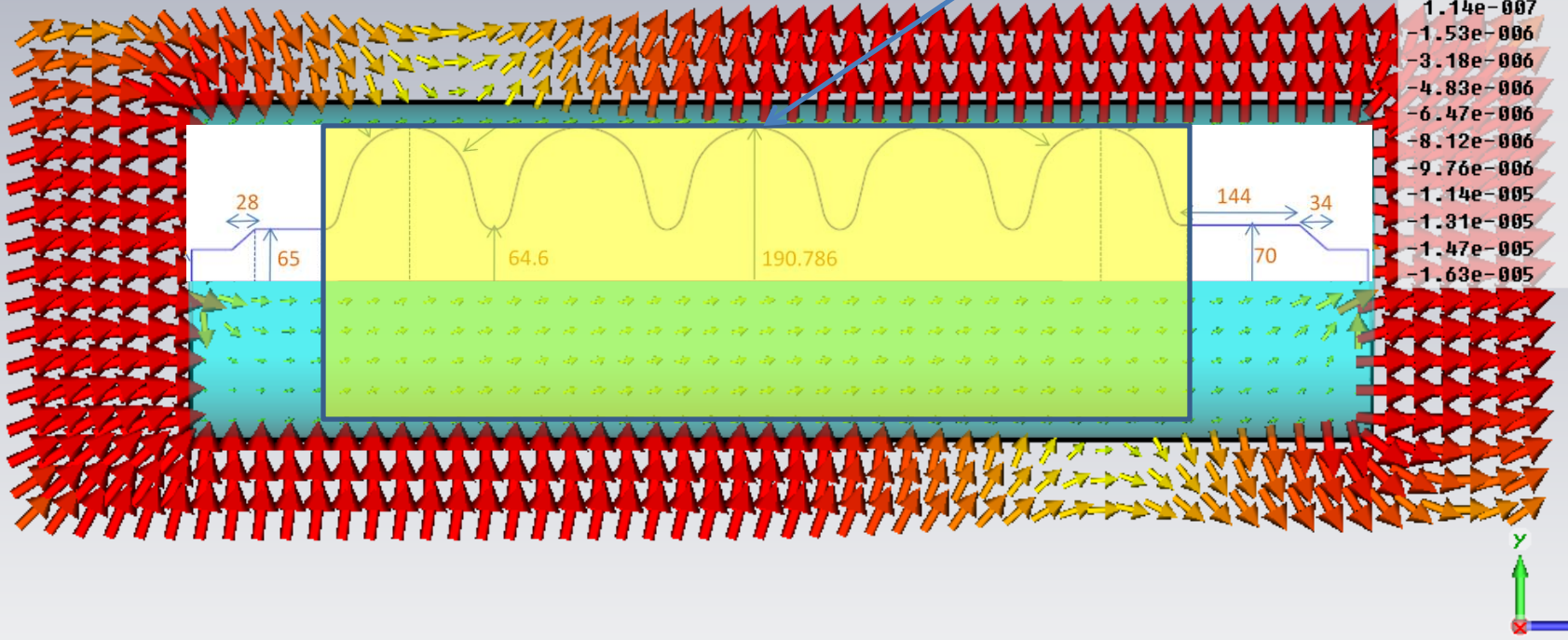
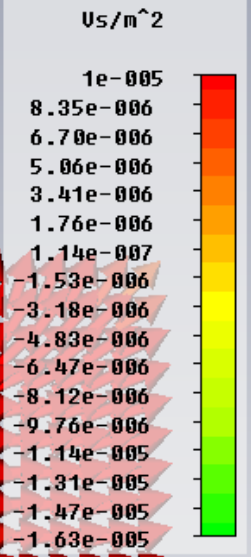
1e-005



Type B-Field
Plane at x 0
Maximum-2d 0.00896598 Us/m^2 at -1.17234e-014 / -201 / 700

Clamp size and color (Max: 1e-005)

Area of Interest

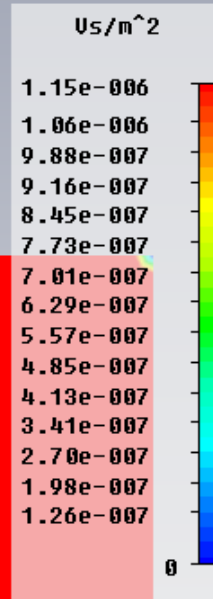
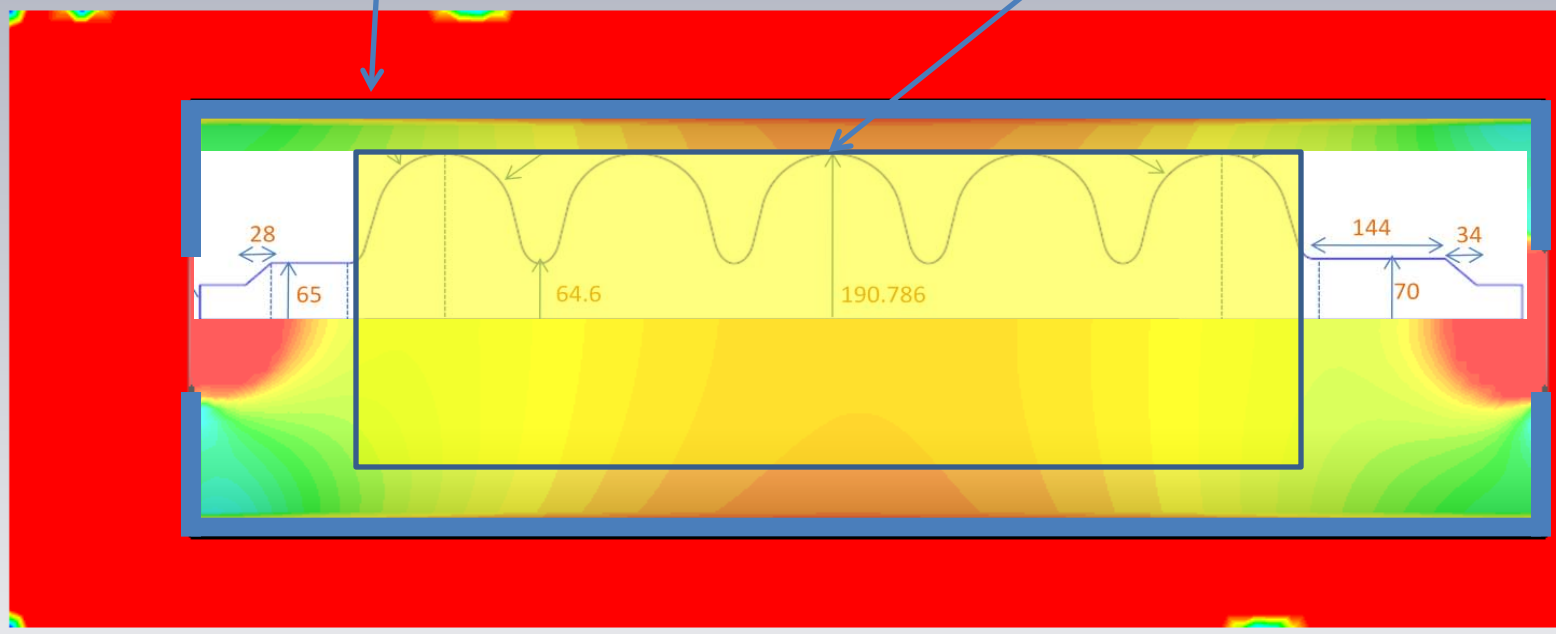


Type B-Field
Plane at x 0
Maximum-2d 0.00896598 Us/m² at -1.17234e-014 / -201 / 700

Clamp to range: (Min: 0/ Max: 1.15e-006)

Magnetic Shield

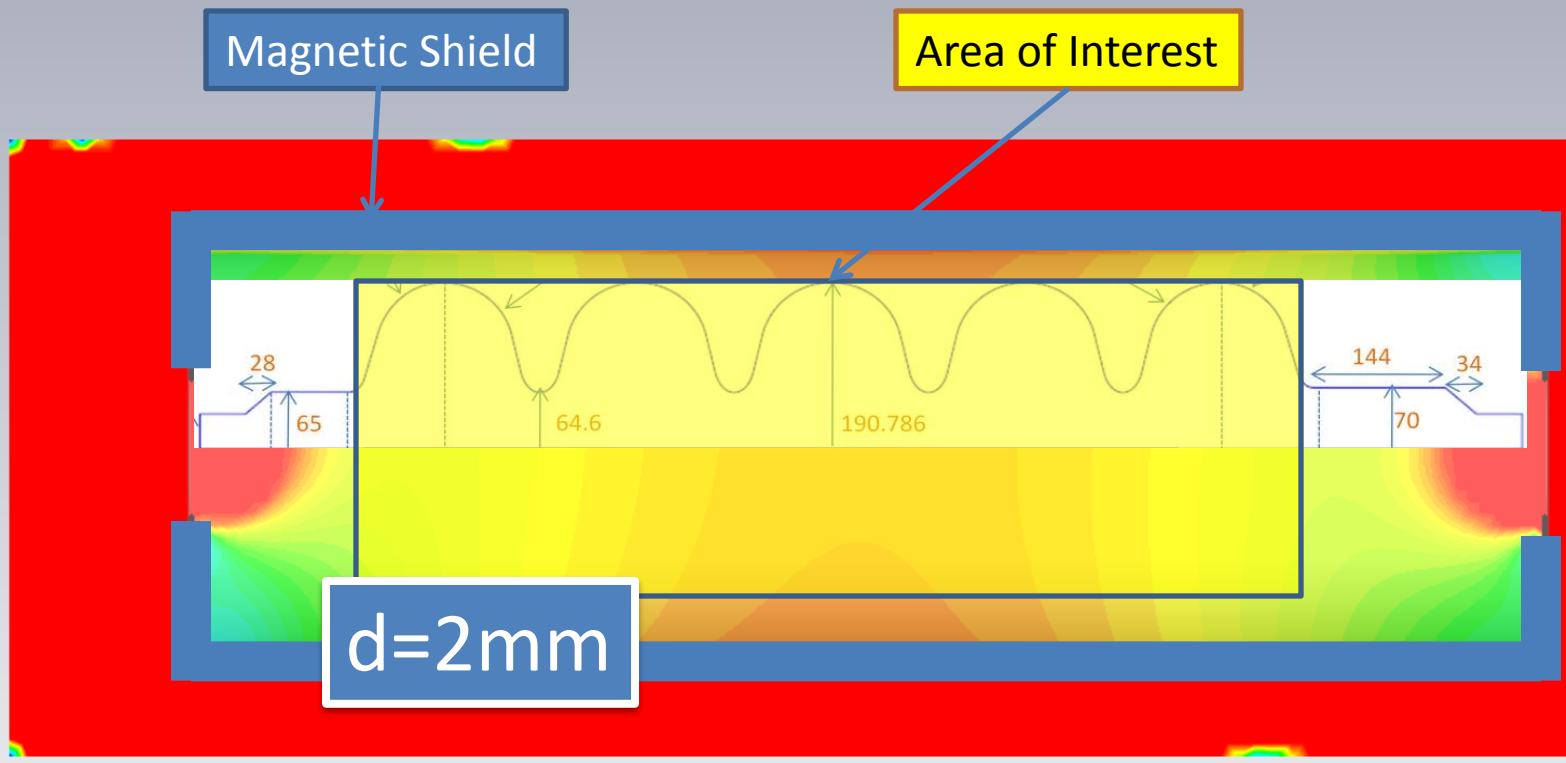
Area of Interest



Type	B-Field
Component	Abs
Plane at x	0
Maximum-2d	0.00514044 Us/m ² at -1.40915e-014 / 240 / 759.274

$$\mu_r = 10890$$

Clamp to range: (Min: 0/ Max: 1.15e-006)



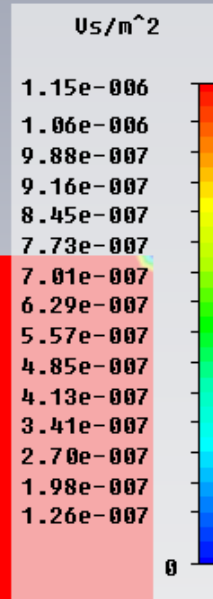
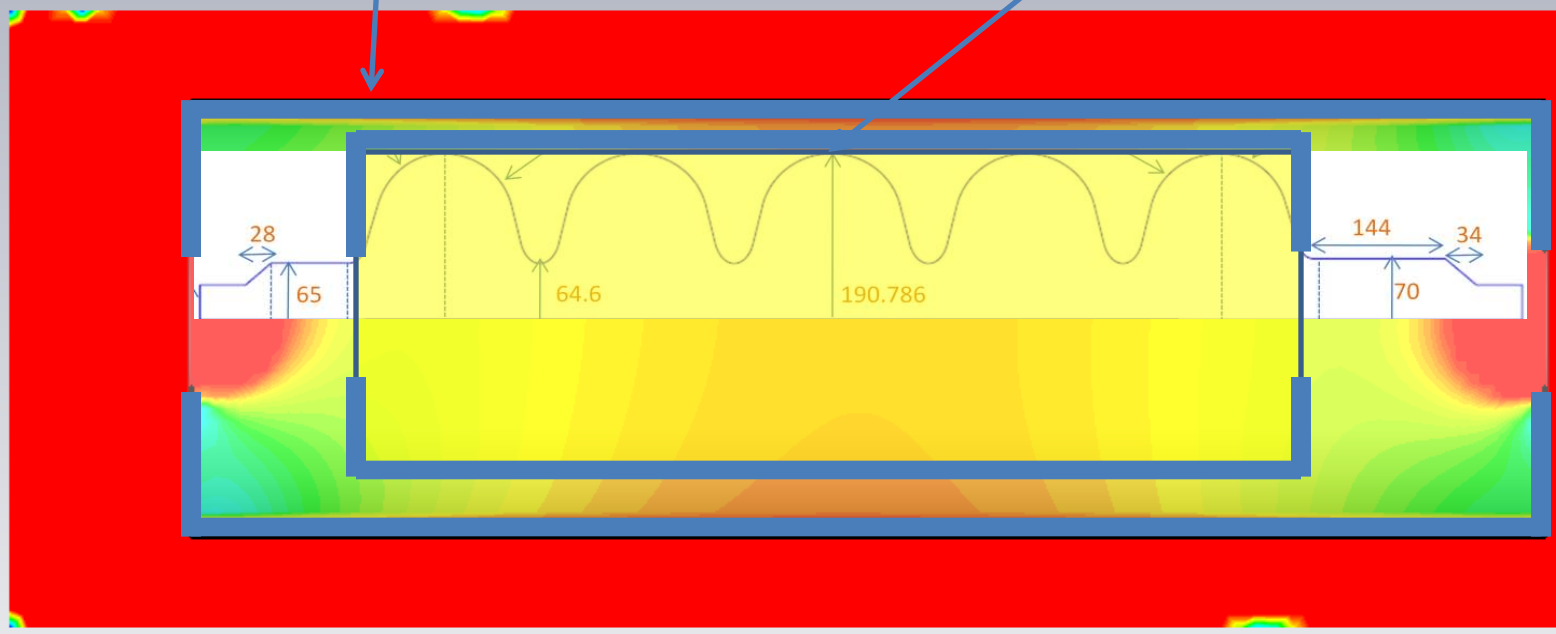
Type	B-Field
Component	Abs
Plane at x	0
Maximum-2d	0.00514044 Us/m ² at -1.40915e-014 / 240 / 759.274

$$\mu_r = 5445$$

Clamp to range: (Min: 0/ Max: 1.15e-006)

Magnetic Shield

Area of Interest



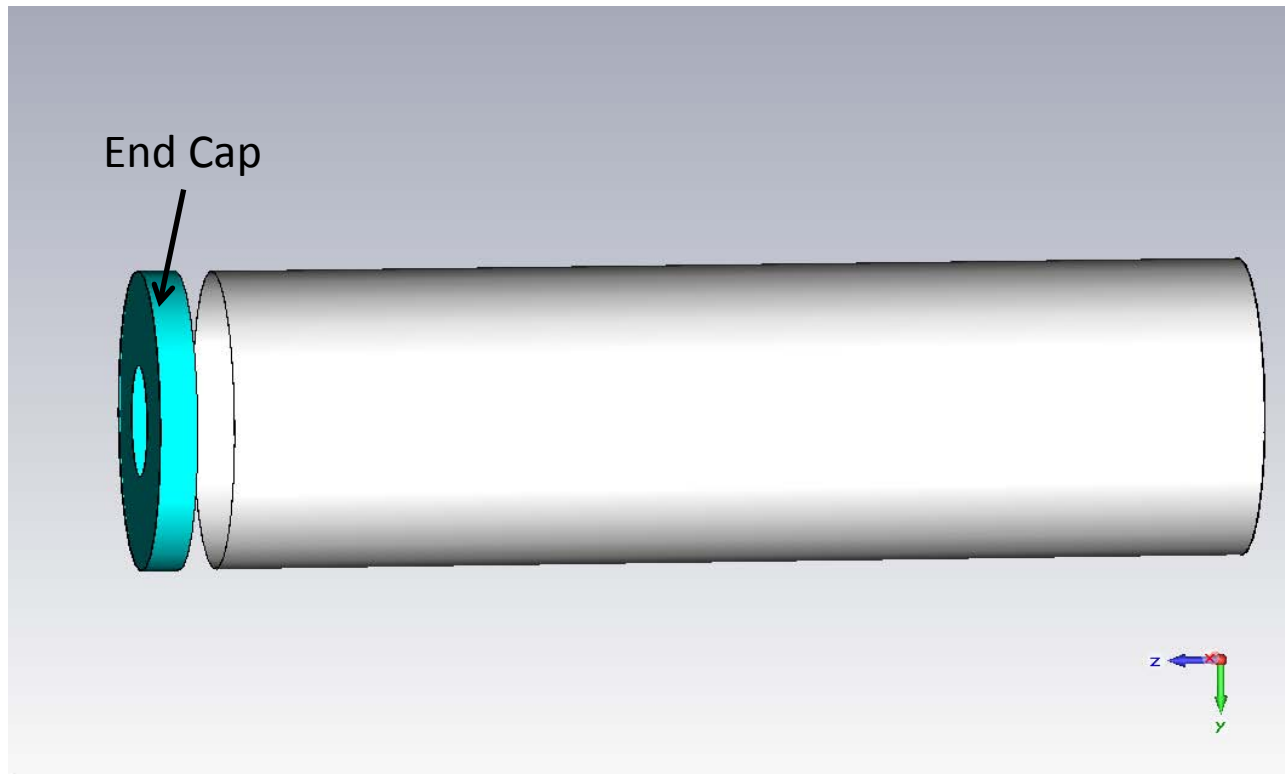
Type	B-Field
Component	Abs
Plane at x	0
Maximum-2d	0.00514044 Us/m ² at -1.40915e-014 / 240 / 759.274

$$\mu_r = 4200$$

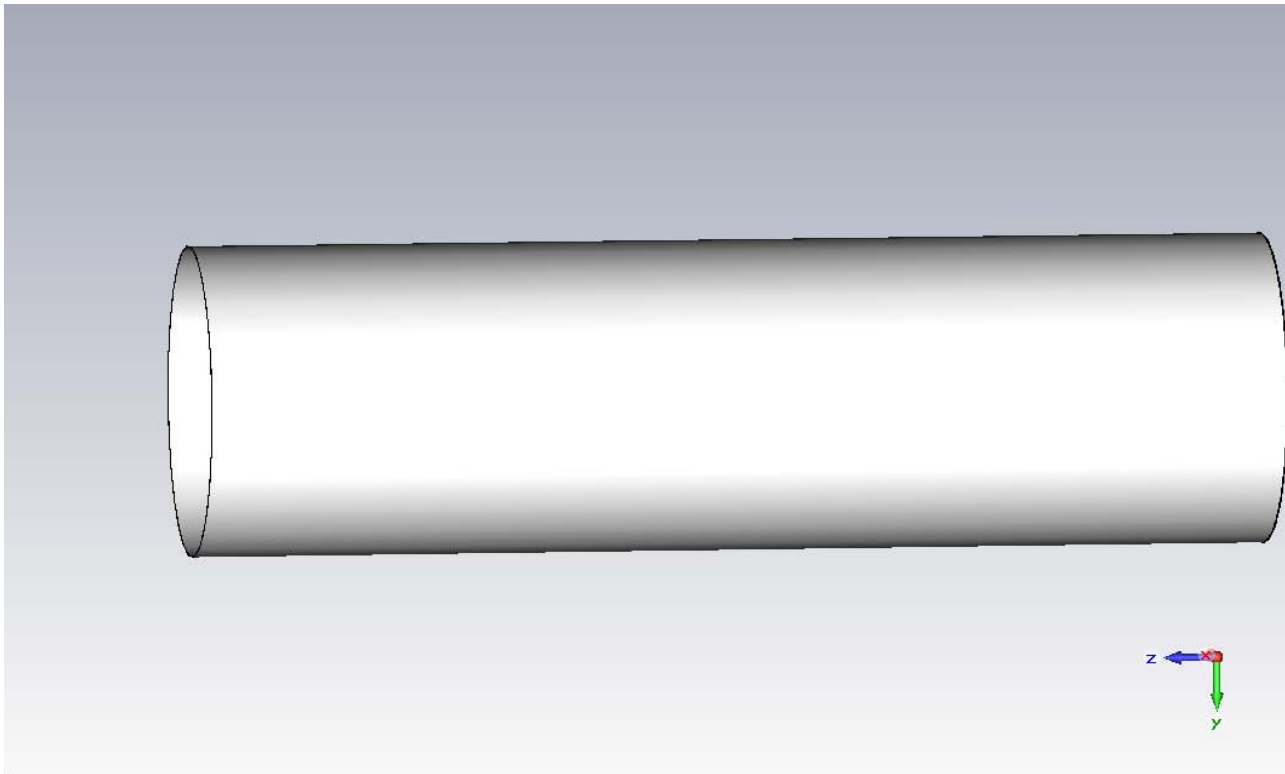
- Further Simulations

- μ_r at the end caps 5 times smaller

- No change in minimum Value for μ_r

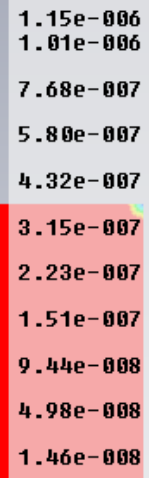
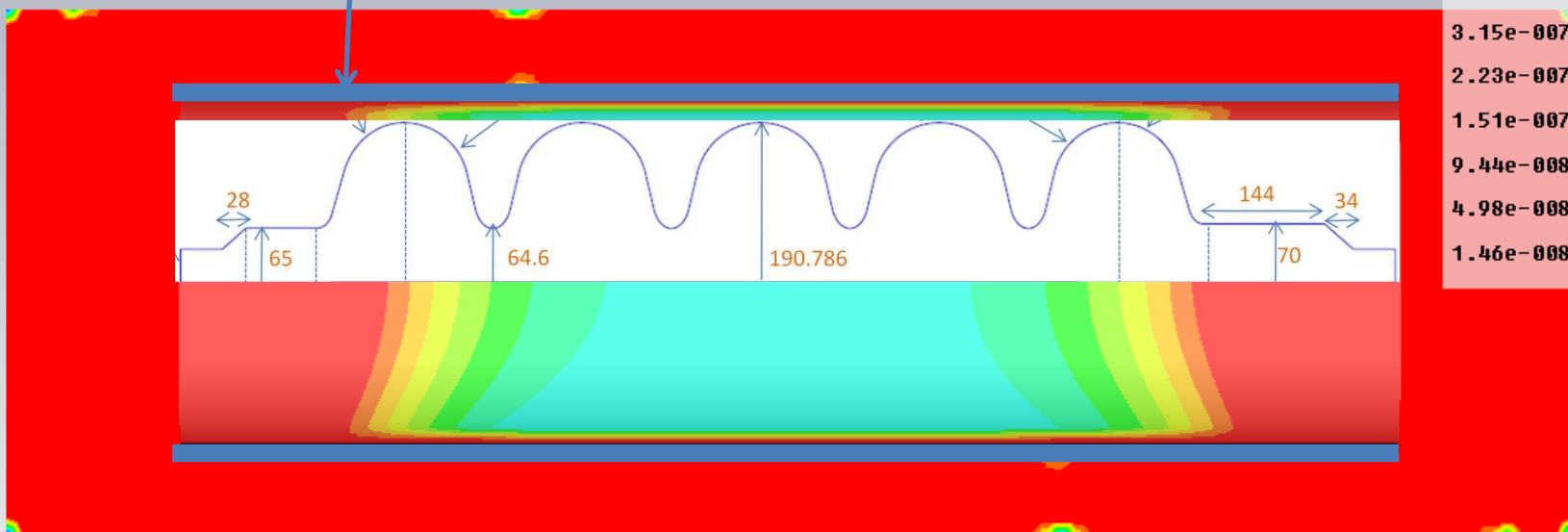


- Further Simulations
 - No end caps
 - $\mu_r > 100.000$



Clamp to range: (Min: 0/ Max: 1.15e-006)

Magnetic Shield



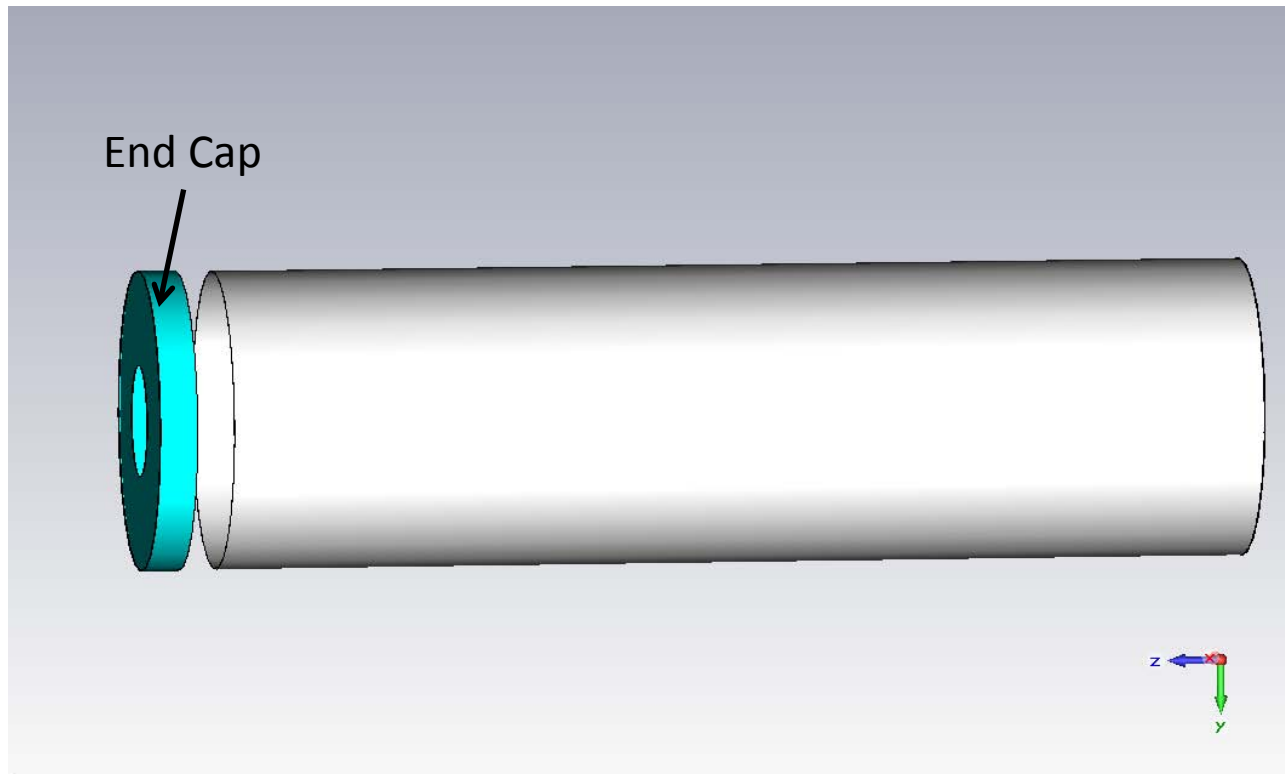
Type	B-Field
Component	Abs
Plane at x	0
Maximum-2d	0.0108551 Us/m ² at 0 / -201 / 700

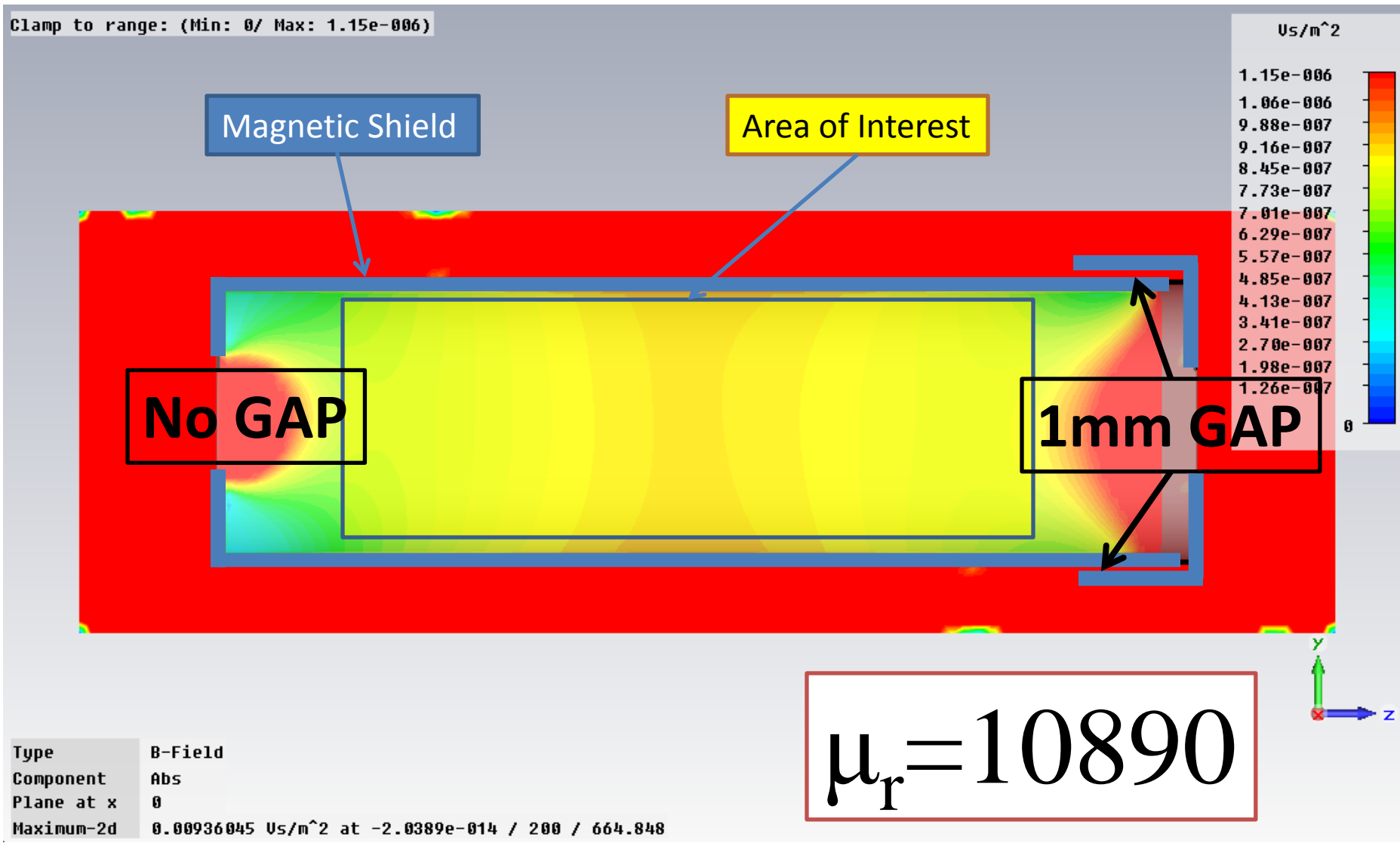
$$\mu_r = 100.000$$



- Further Simulations

- 1 mm gap between cylinder and End Cap

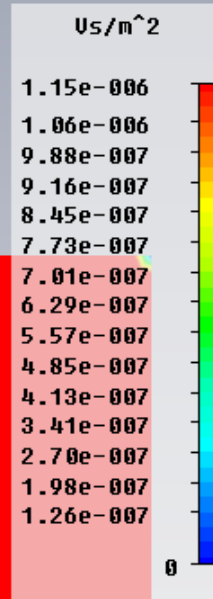
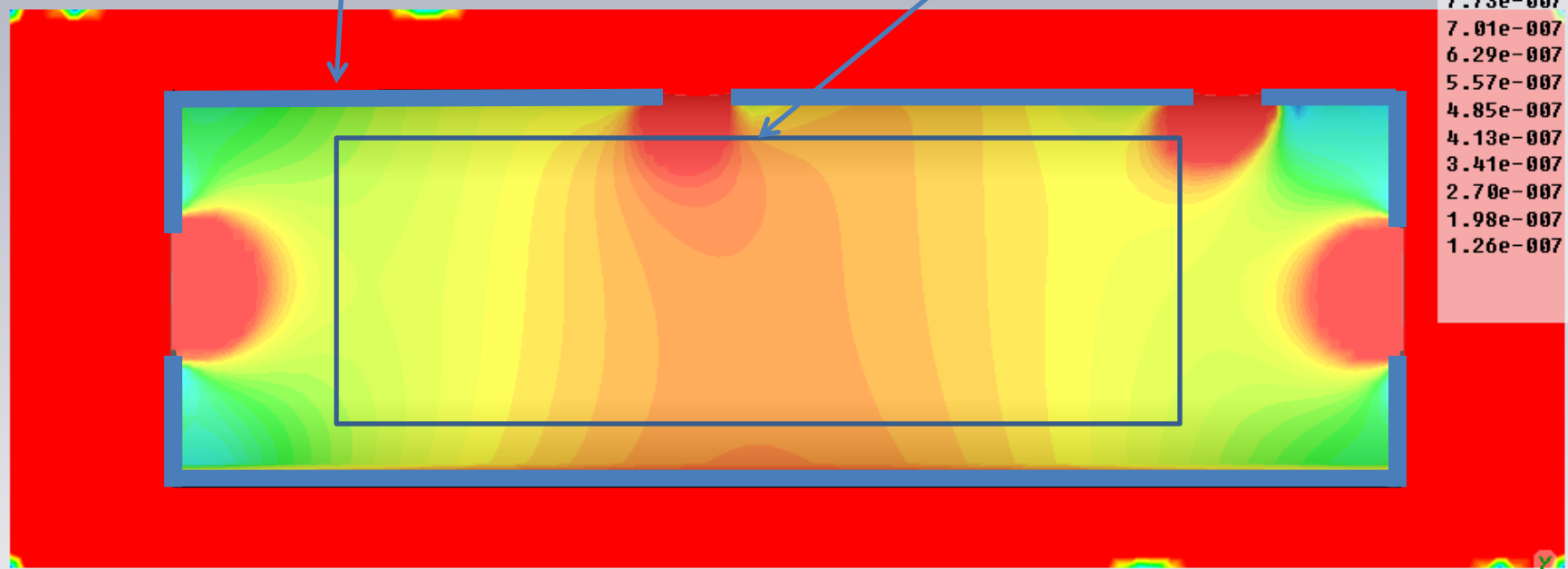




Clamp to range: (Min: 0/ Max: 1.15e-006)

Magnetic Shield

Area of Interest



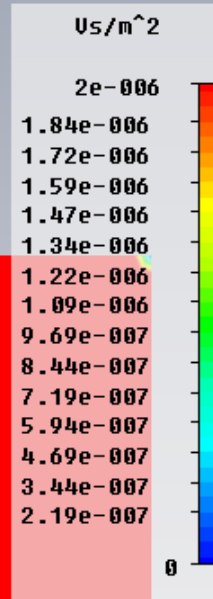
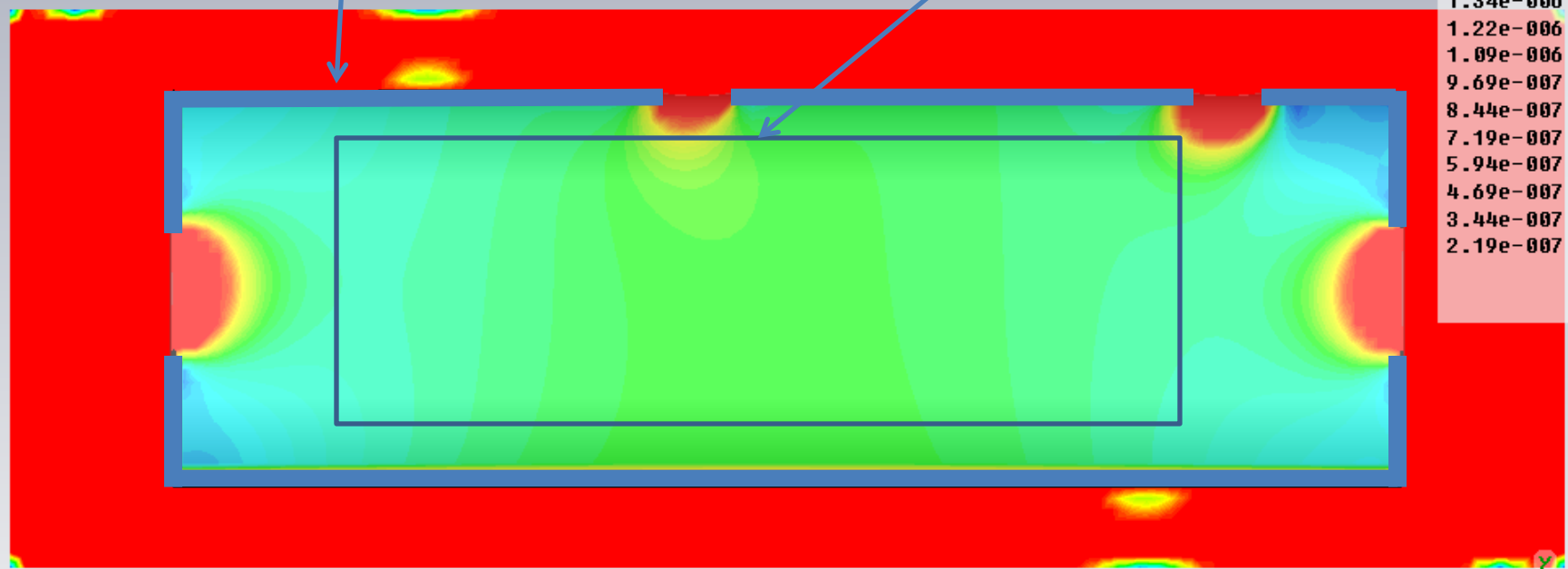
Type	B-Field
Component	Abs
Plane at x	0
Maximum-2d	0.0101551 Us/m^2 at -1.42109e-014 / -241 / 686.579

$$\mu_r = 10890$$

Clamp to range: (Min: 0/ Max: 2e-006)

Magnetic Shield

Area of Interest



Type	B-Field
Component	Abs
Plane at x	0
Maximum-2d	0.0101551 Us/m^2 at -1.42109e-014 / -241 / 686.579

$$\mu_r = 10890$$

- $\mu_r = 11.000$ needed for the whole temperature range for 1 mm sheet
- Lower μ_r at end caps is not a problem
- End caps are necessary
- Holes lead to higher field values than $1\mu\text{T}$ in spots of approximately their size

- $\mu_r = 11.000$ needed for the whole temperature range for 1 mm sheet
- Lower μ_r at end caps is not a problem
- End caps are necessary
- Holes lead to higher field values than $1\mu\text{T}$ in spots of approximately their size

My recommendations:

- External Shield of Cryoperm (1 mm)
- As close as possible to the helium tank
- Annealing of tubes but not of end caps