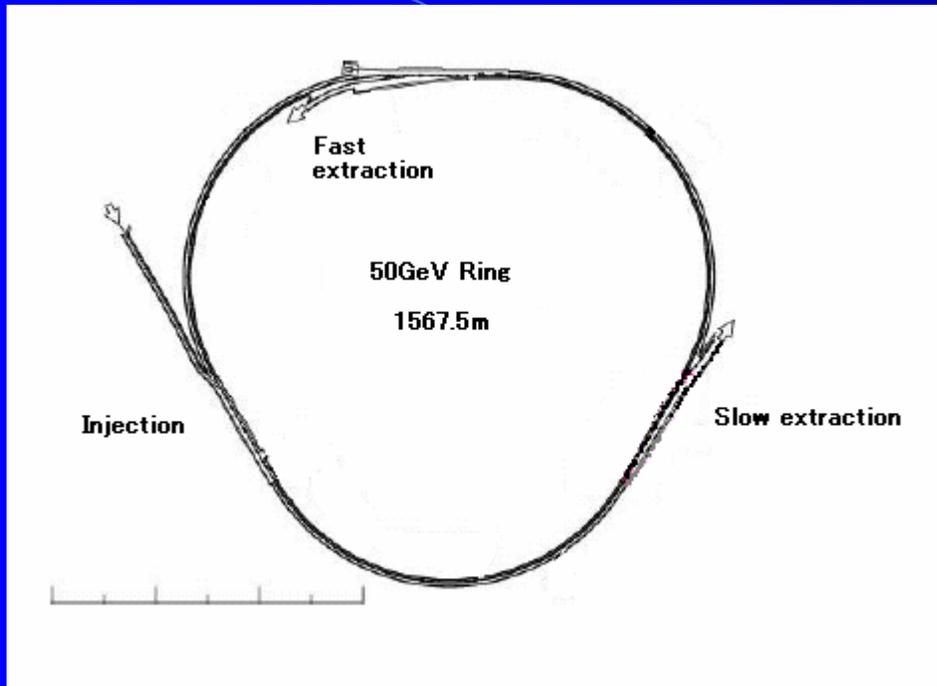


Design of wide aperture/thin septa of extraction system for J-PARC-50GeV ring

1. The outline of septa system for 50GeVring
2. Designing of thin septa and medium thin septa for fast/slow extraction

The extraction septa for 50GeVring



Layout of 50GeVring

Septa for fast extraction

Number of septa 14

Current 4.0kAmps~6.5kAmps

Pattern operation

Septa for slow extraction

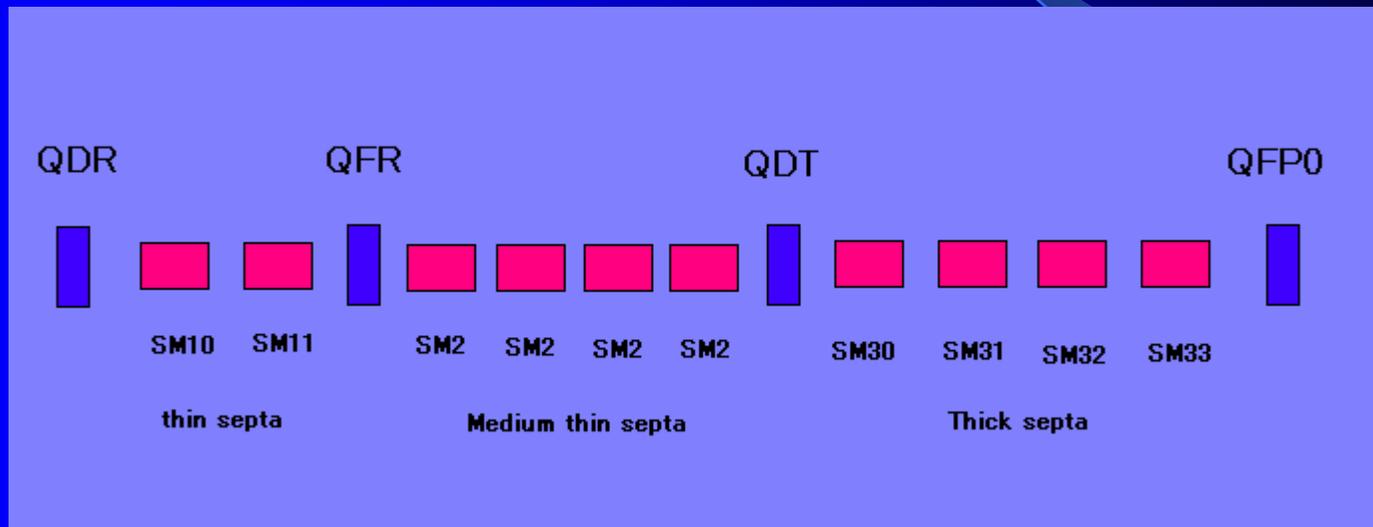
Number of septa 10

Current

4.5kAmps~5.0kAmps

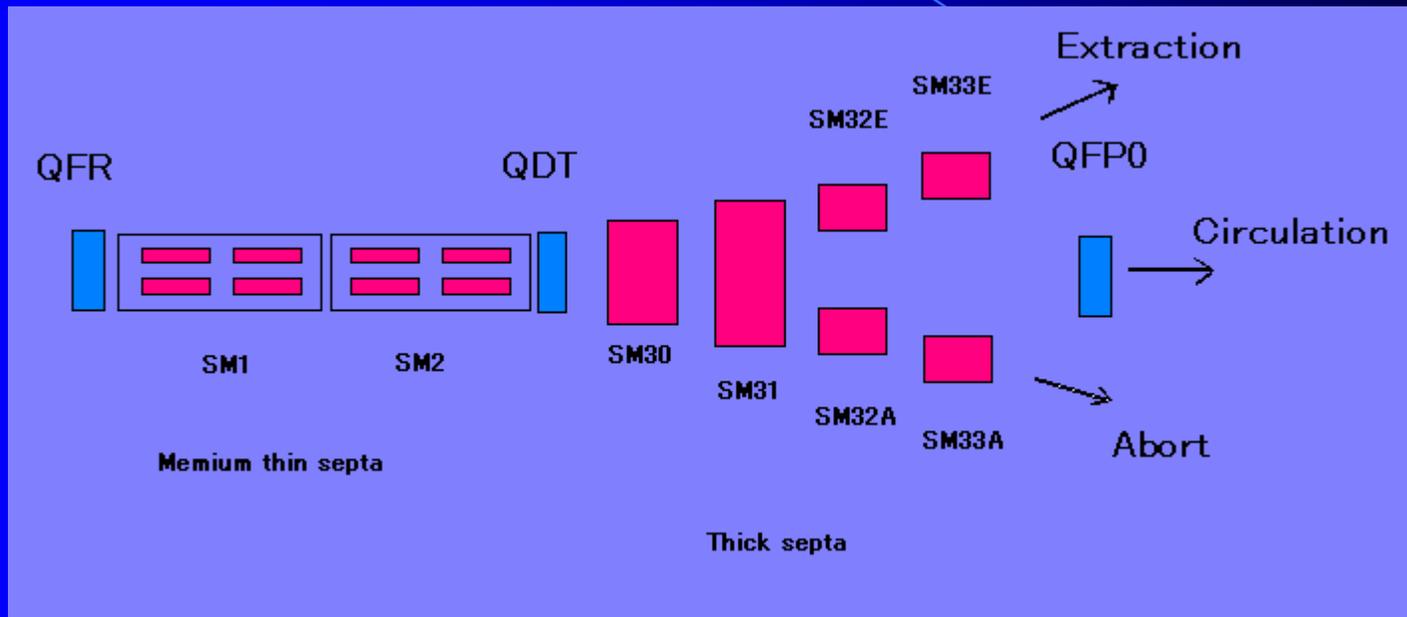
CD operation

Configuration of magnetic septa for slow extraction



Thickness	Field
thin septa 1.5mm and 3.5mm	0.114T
Medium thick septa 7.5mm	0.528T
Thick septa 30mm~62mm	1.4T~1.66T

- Configuration of septa for fast extraction



Thickness

Medium thick septa 9mm

Thick septa 30mm~62mm

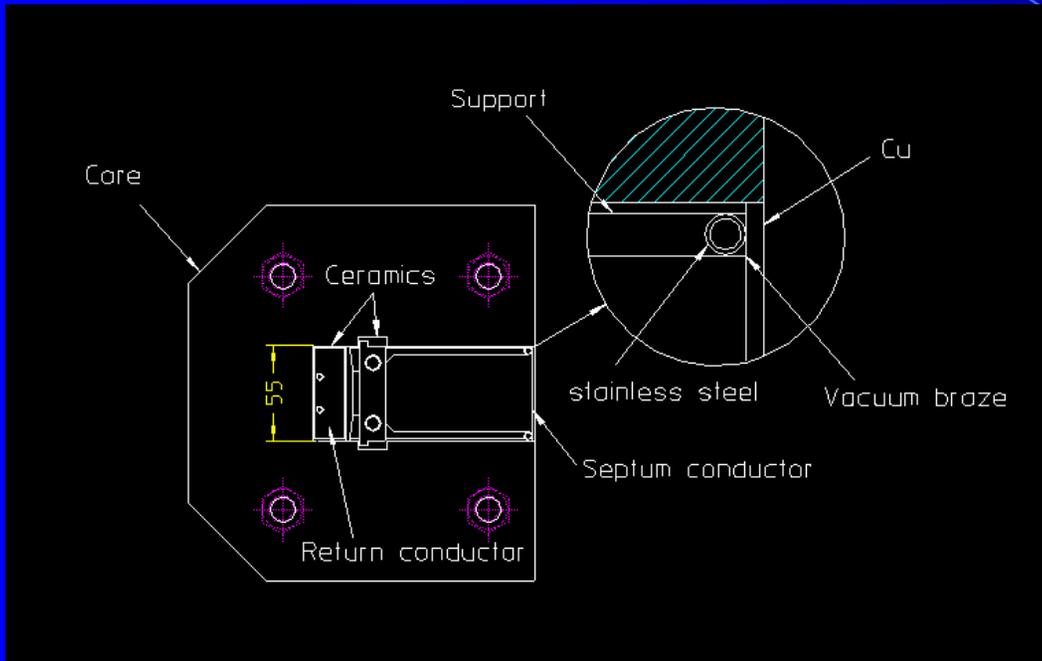
Field

0.459T

1.38T~1.66T

Patten operation $0.17s(\text{FB}) + 1.9s(\text{Rise}) + 0.1(\text{Top}) + 0.87s(\text{Fall}) = 3.04s$

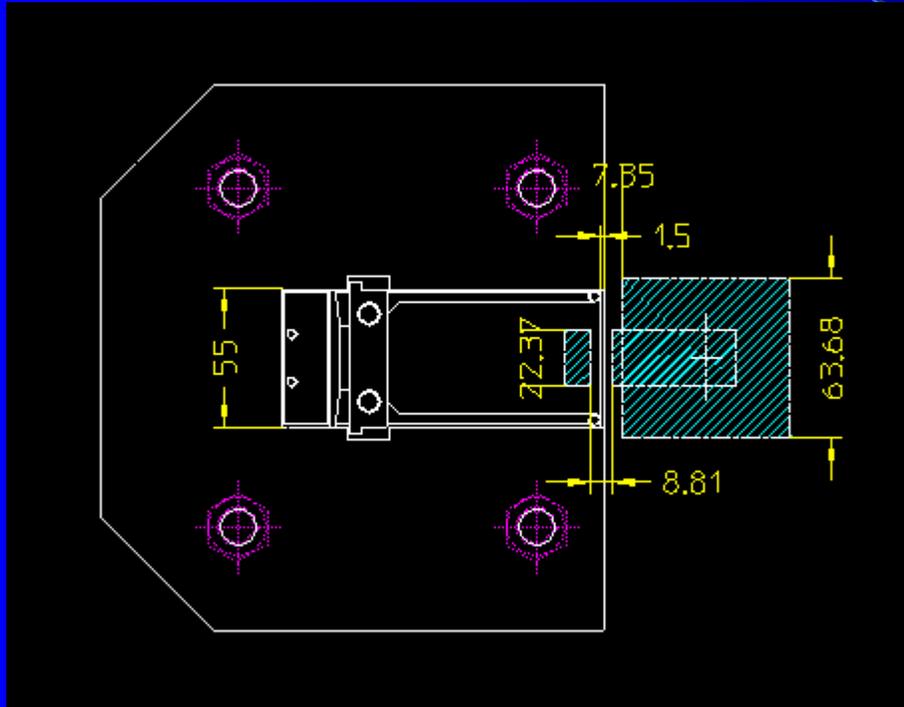
- The structure of SM10



Field 0.114T
Current 5kAmps
Magnet length 1.5m

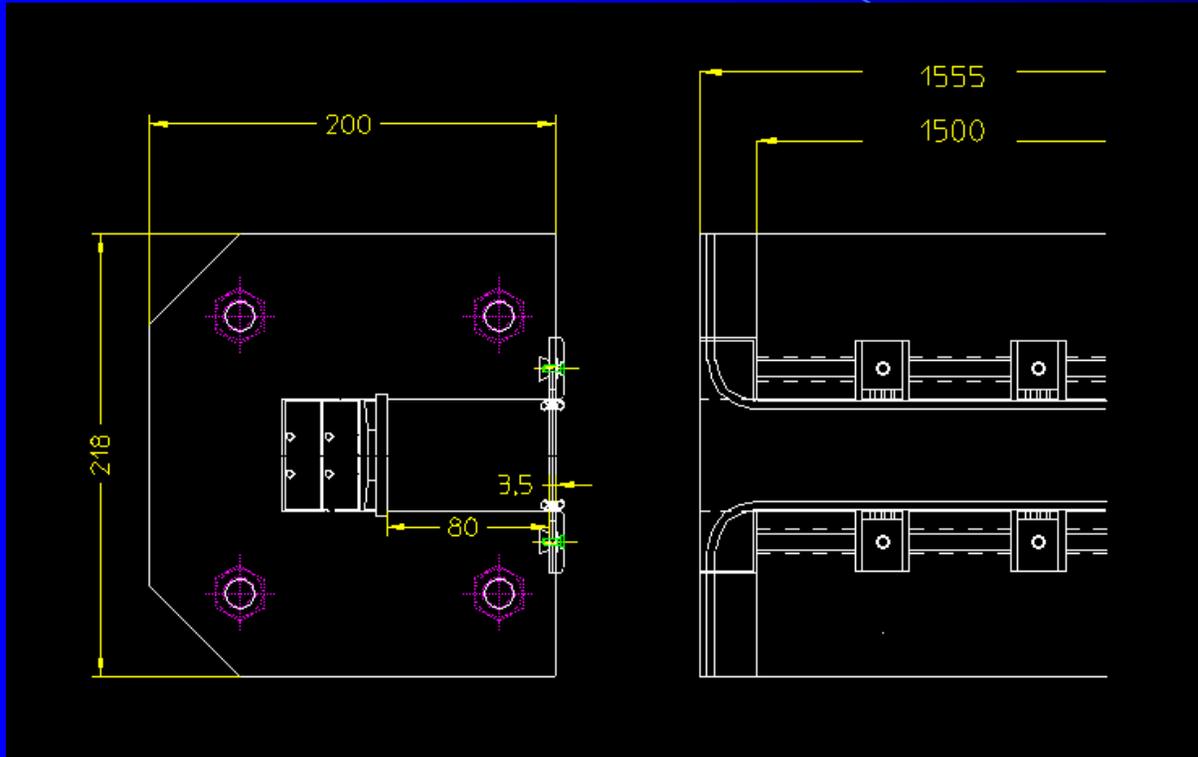
The septum conductor is touched to the core in order to decrease the leakage flux. The core is laminated core.

- Clearance of Beam and septum



Since injection beam is close to core, inner support of septum conductor is adopted.

- The structure of SM11



The conductor is a centipede structure for fixing the coil,
The core is laminated core.

The heat calculation of SM10

Thickness 1.0mm

Current 5000A

Current density $91\text{A}/\text{mm}^2$

Generation of heat 18.2kW

Water

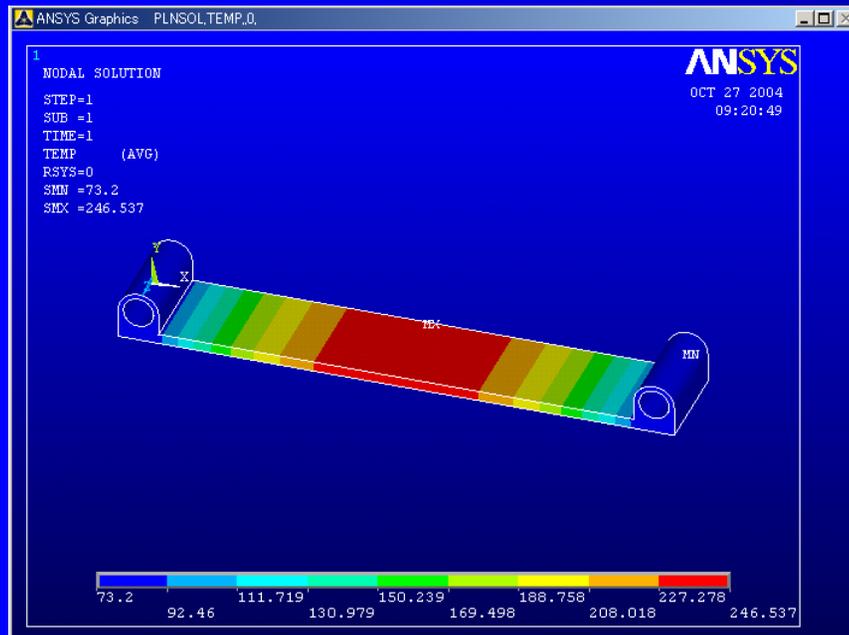
Water speed 7m/s

$T_{in} = 25^\circ\text{C}$ $T_{out} = 70^\circ\text{C}$

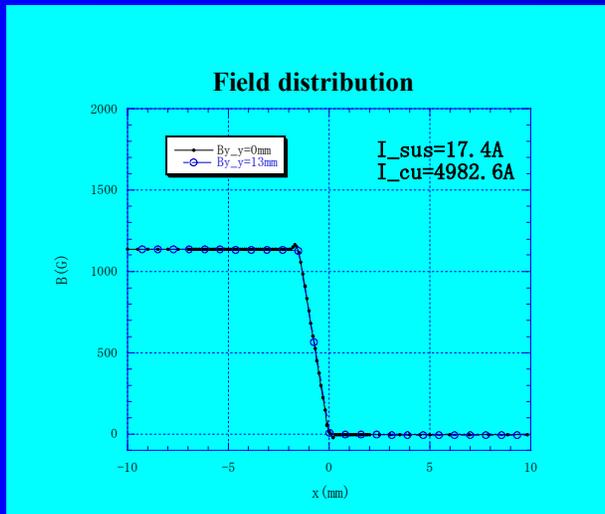
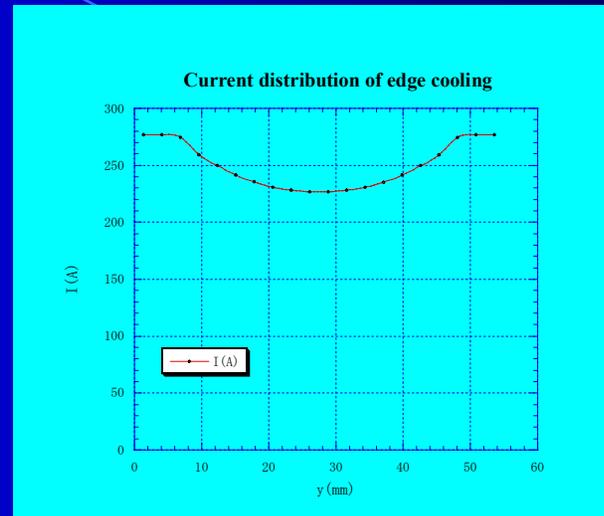
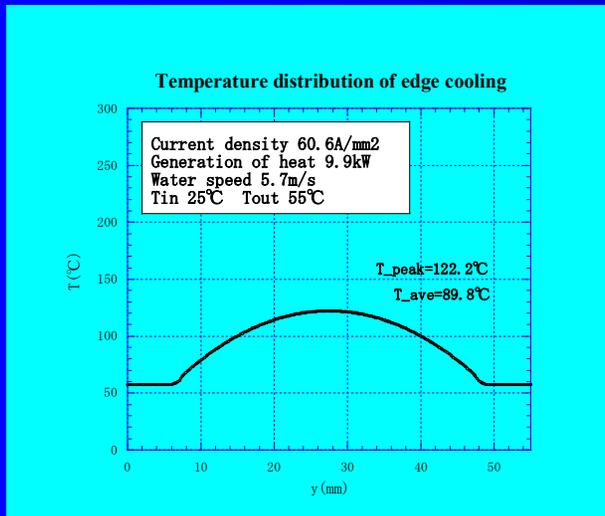
Conductor

$T_w = 73^\circ\text{C}$

$T_{max} = 247^\circ\text{C}$



● The field calculation of SM10



Thickness 1.5mm

Flatness

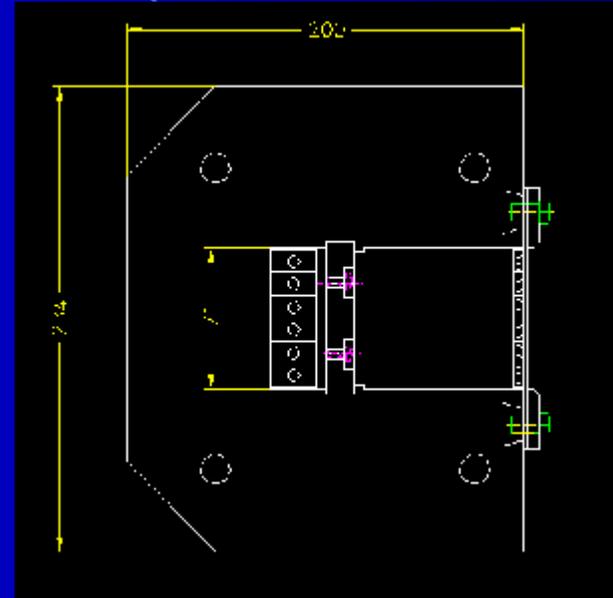
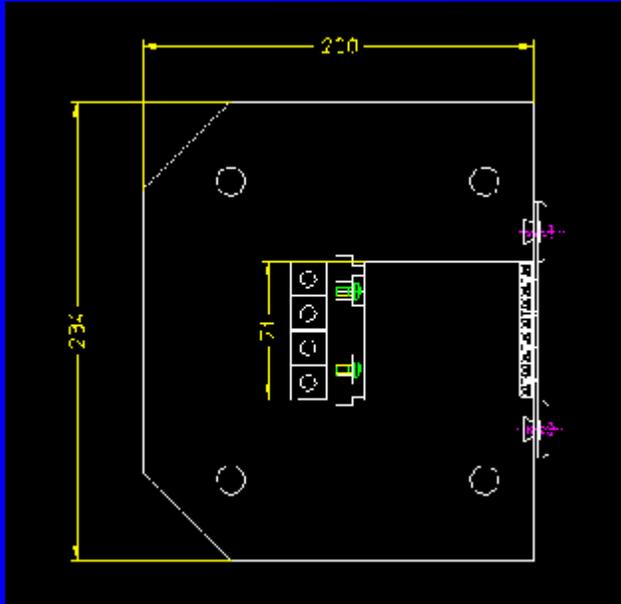
$\Delta B/B_0=0.25\%$ at $y=0$

$\Delta B/B_0=0.5\%$ at $y=13\text{mm}$

Leak field

Less than 10G

- Medium thin septa SM2



Fast extraction

Thickness of septum 9mm

$B_0=0.459T$

Magnet length 0.875m

4 turn

Slow extraction

Thickness of septum 7.5mm

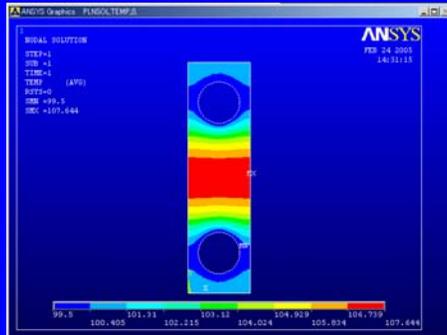
$B_0=0.528T$

Magnet length 0.875m

6turn

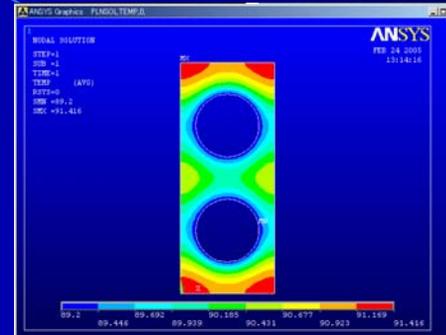
Heat calculation of SM2

4turn (I=7458A)

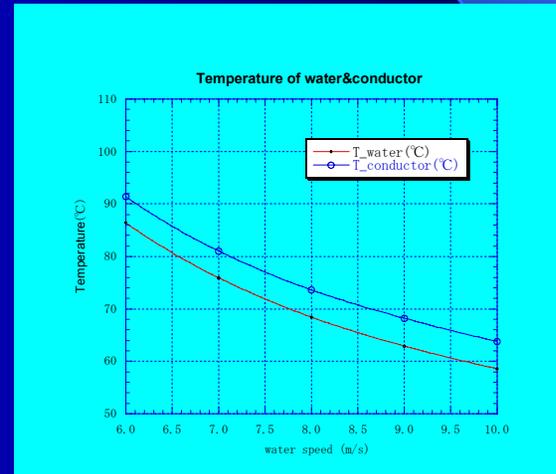
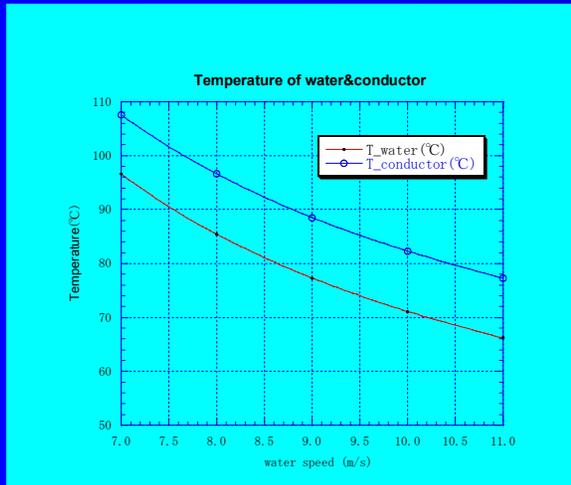


Size 4.5mmx
16.6mm
Hole ϕ 3mm

6turn(I=4972A)

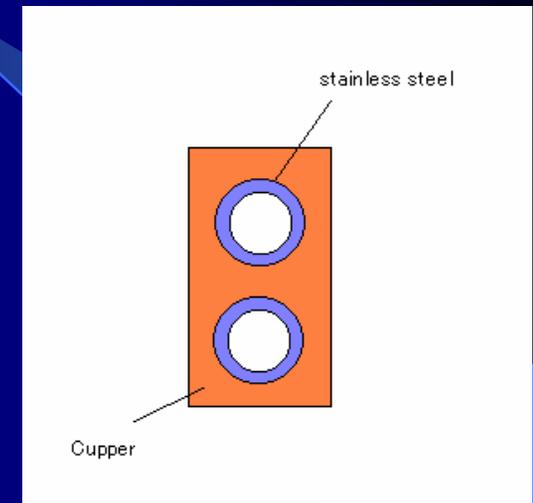
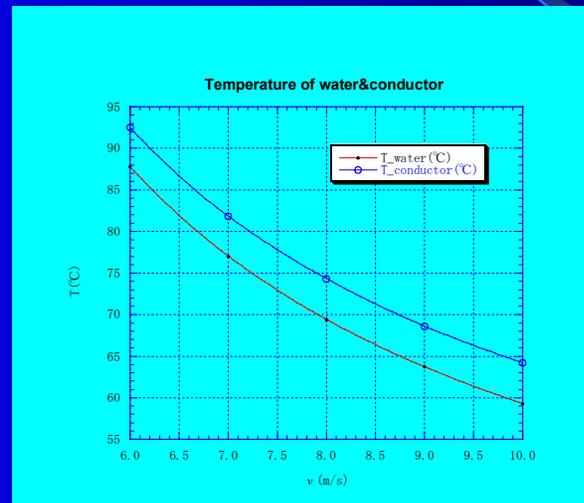
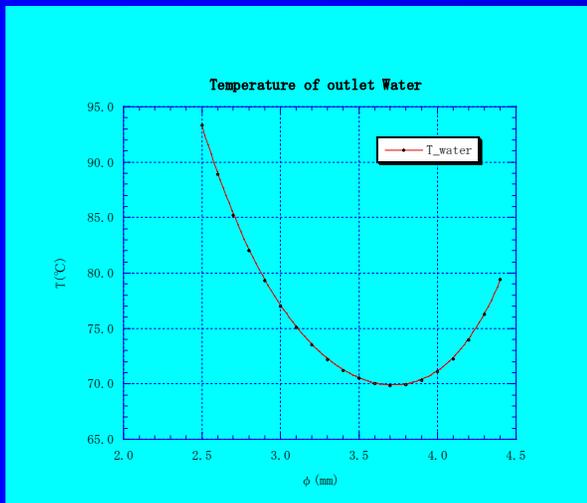


Size 4.5mmx
11mm
Hole ϕ 3mm



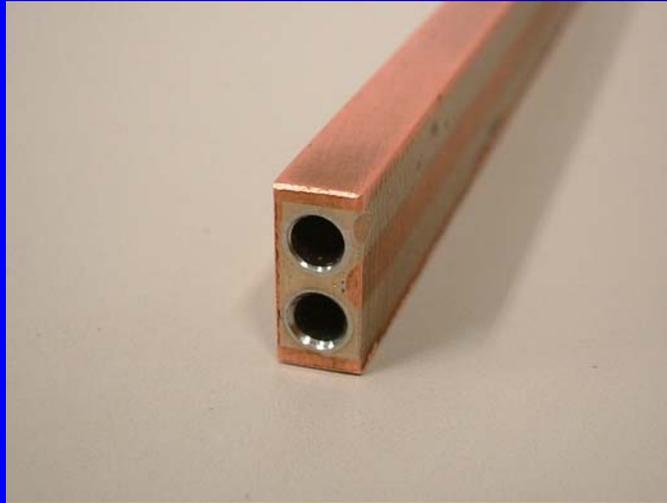
Water speed is too high and it's dangerous considering cavitation of hollow conductor

Optimization of cooling pipe (thickness 7.5mm)



The calculated temperature in case of containing stainless steel pipe are shown, When the diameter of pipe is 3.7mm, temperature is minimized. Thickness of pipe are chosen to be 0.3mm.

- Test piece of conductor



Conductor size
5mmx11mm
Diameter of holes
 ϕ 3mm
Silver brazing

In order to reduce the risk of erosion and corrosion,
Steel pipes are put into copper conductor.

- Test piece made by HIP(Hot Isostatic Pressing)



Size
4.5mmx17mm
Thickness of
Stainless pipe
is 0.5mm

The two stainless pipes are put into the copper plate,
then added pressing and heat.
Finally machining to required shape and dimension.

- Summary

Field calculation of thin septa for slow extraction has performed and obtained a flatness of field within 0.5%.

For the medium thin septa, A test piece of optimized conductor was made for the 6turn coil septum.

Hereafter, R&D test will be done to ensure the fabrication.