Permanent Final Focus Magnet
— Based on the SuperStrong PM —

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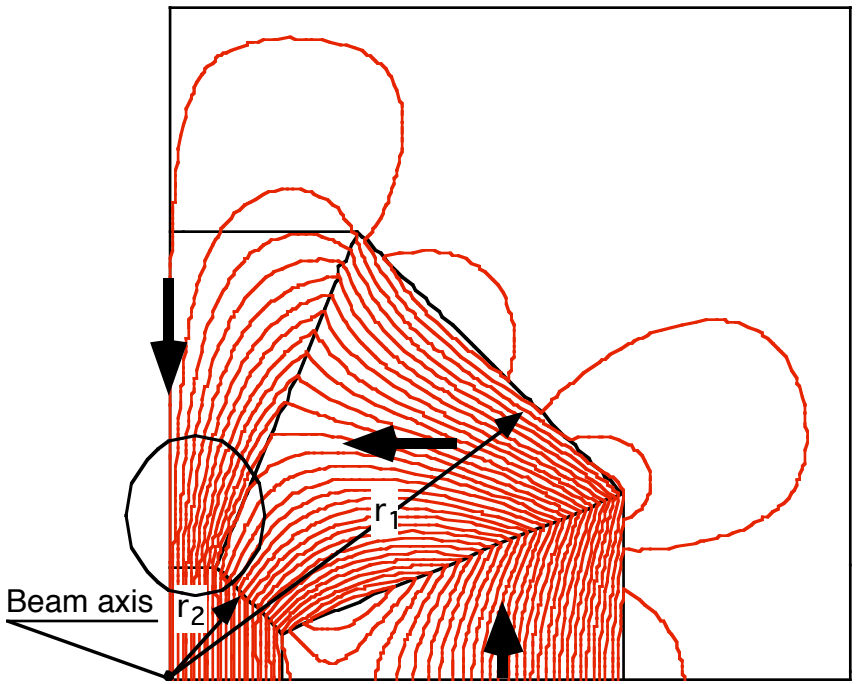
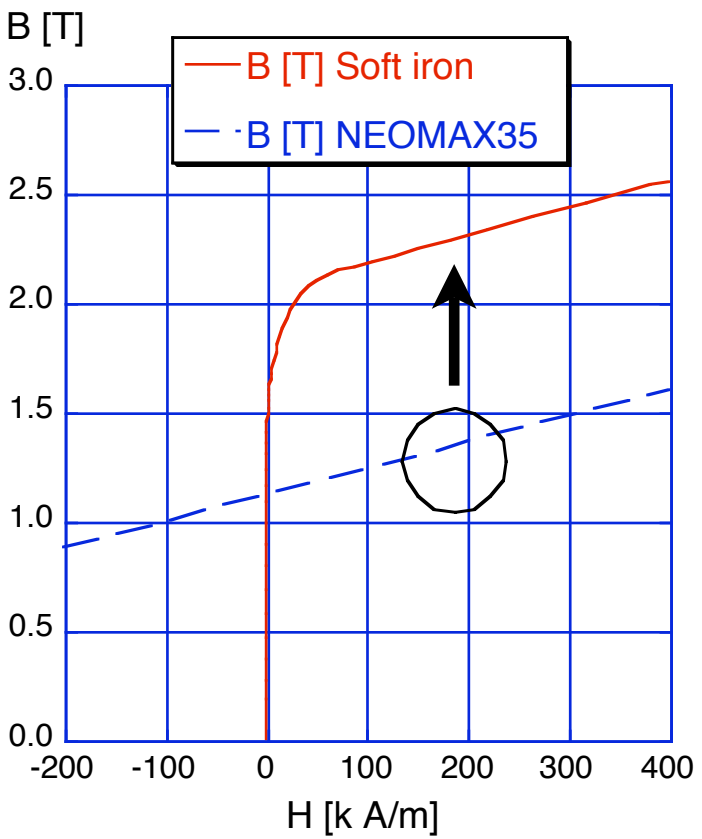
Contents

- Modified Halbach's magnet configuration
  (basics of SuperStrong PM)
- SuperStrong PMQ
  (First model — demonstration of the highest gradient)
- Thermal compensation
- Strength Adjustable PMQ (Second model)

• Permanent Magnet Dipole & B-H curve

Halbach's dipole REC magnet.





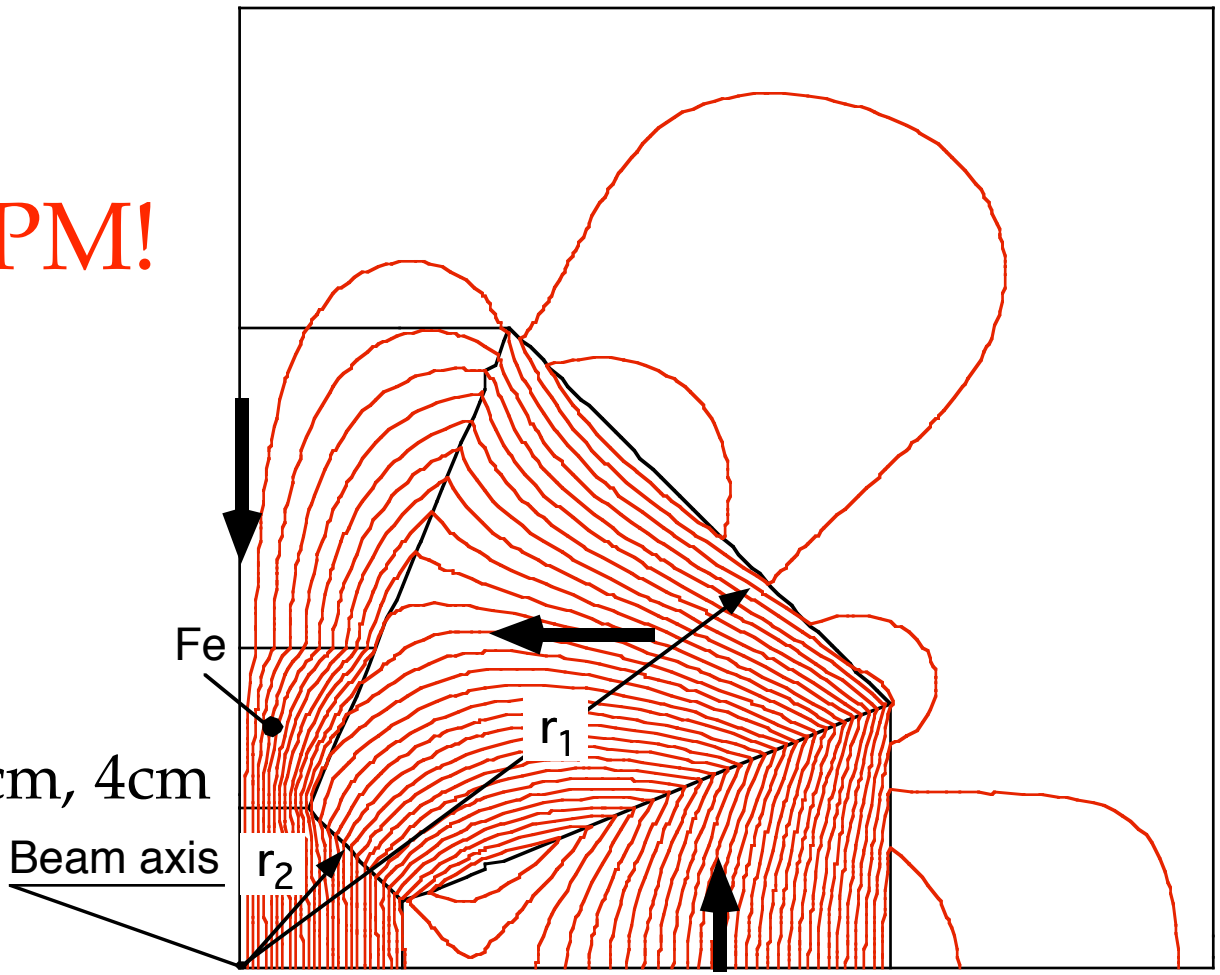
1.37 T @r1, r2=1cm, 4cm

$$B = Br \ln(r1/r2) \cos(\pi/M) \sin(\pi/M)/\pi$$

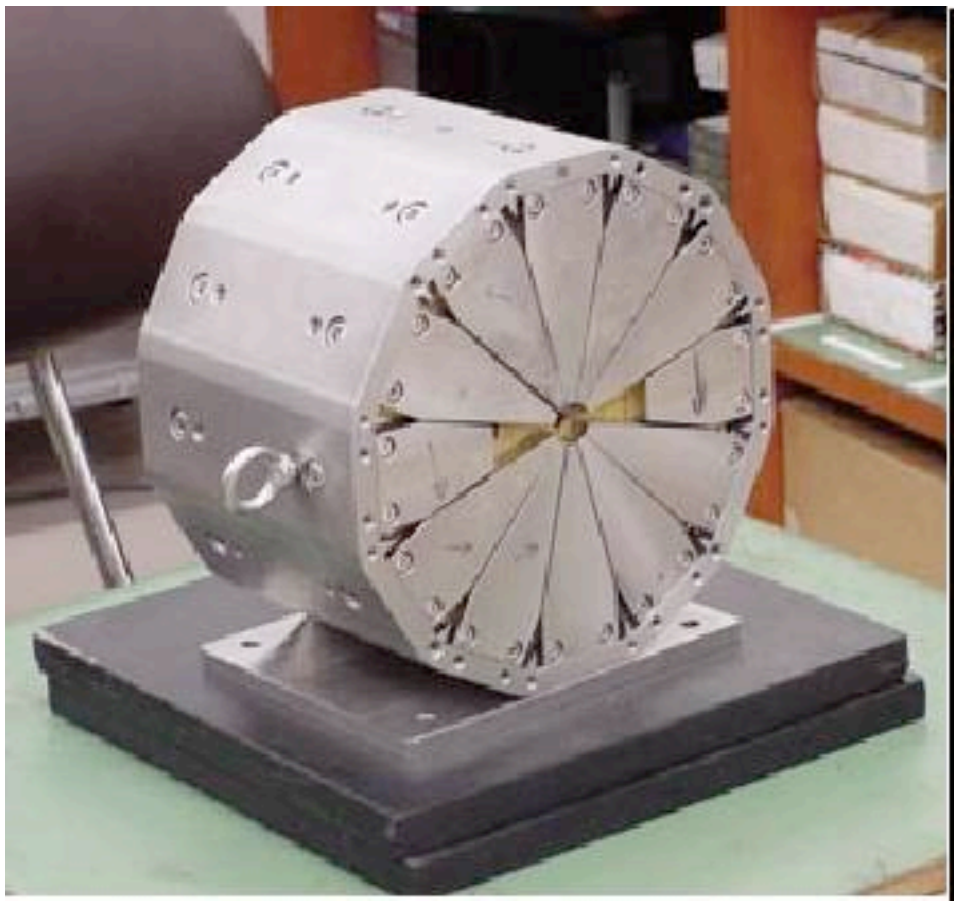
Modified Halbach's magnet.

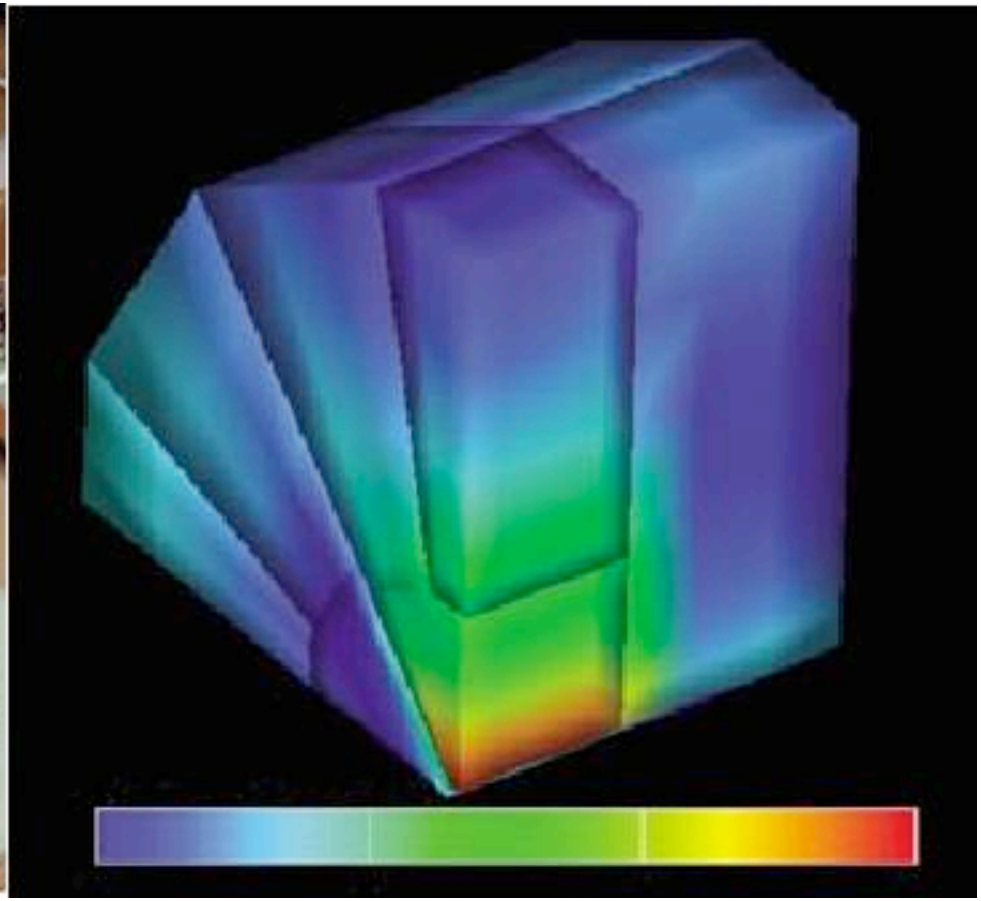
SuperStrong PM!

1.64 T @r_1, r_2=1cm, 4cm
(was 1.37T)



- 4.45T Dipole

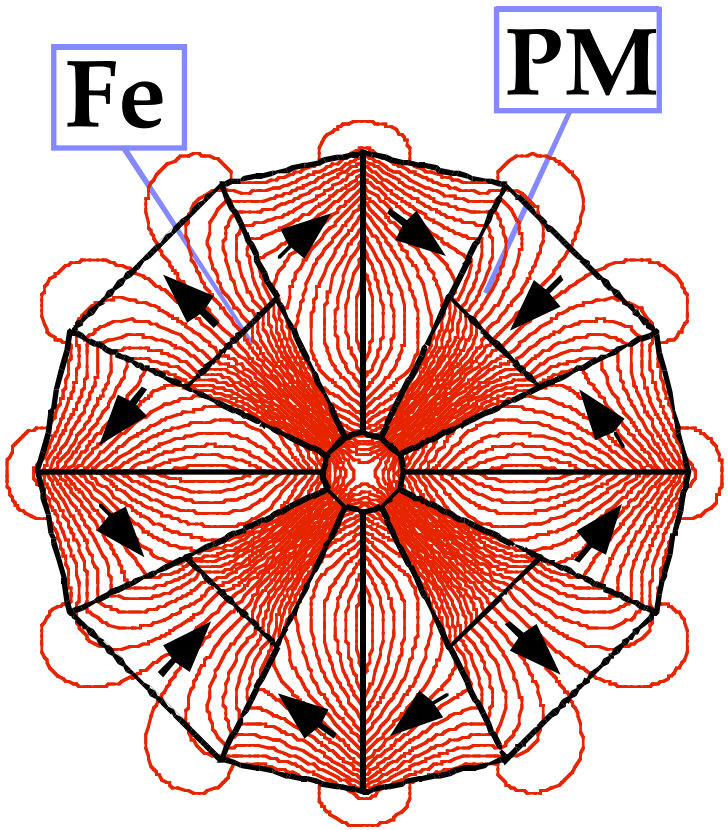




Achieved 4.45T @-29°C (3.9T @room temperature)

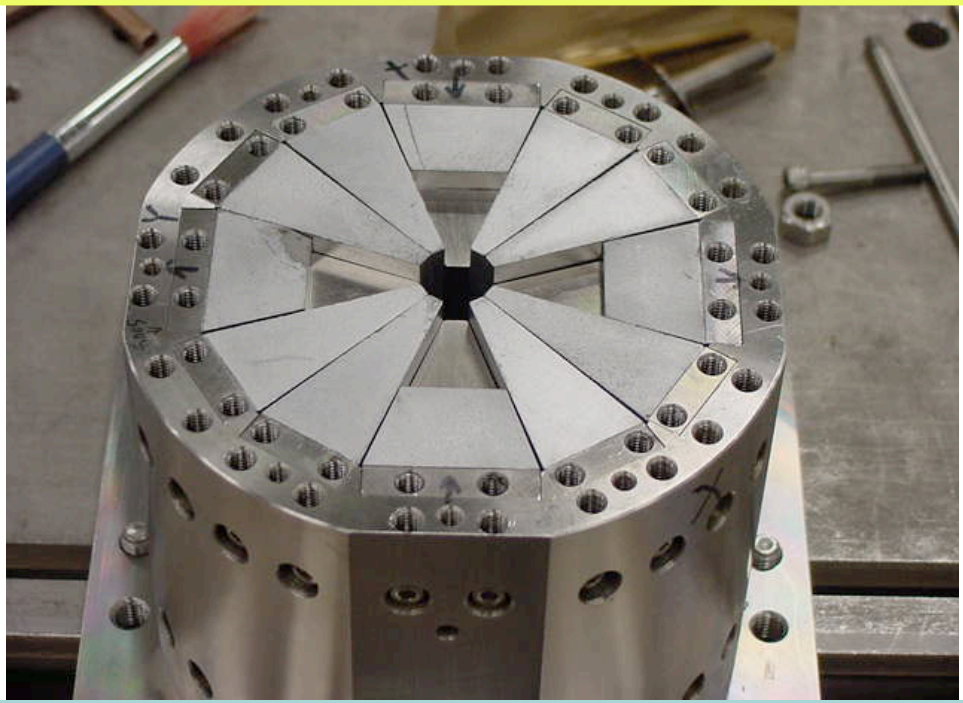
M. Kumada et al., CERN Courier, vol. 41, no.7,Sep. 2001, p. 9

PMQ with modified Halbach's



Based on 12 segment PMQ

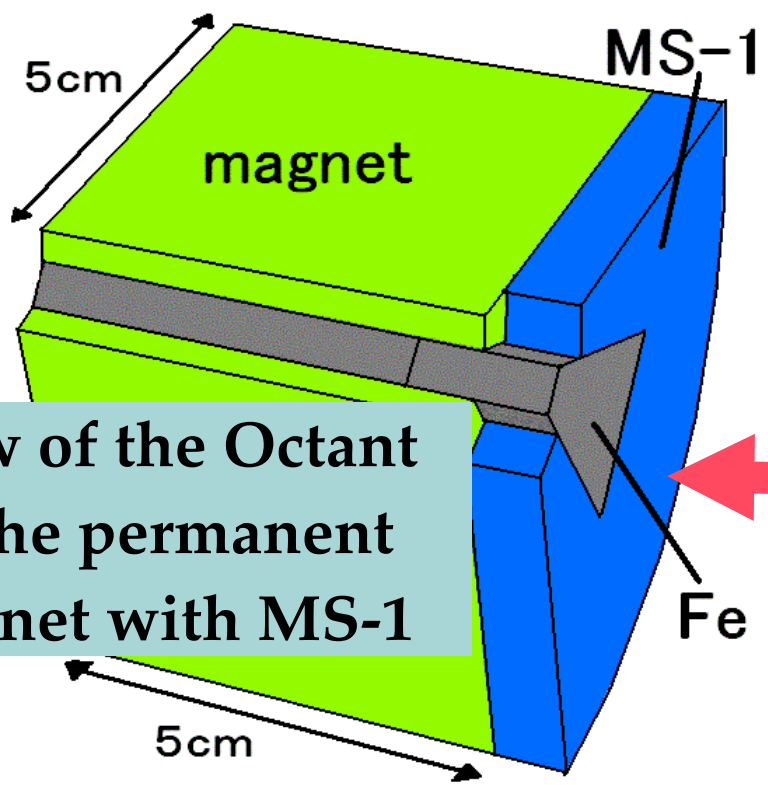
Measured GL value was 28.5T
(calculated value 29.7T)
@ L=100mm, Ø14mm
(Gmax=300T/m, Bmax=2T@boreR)



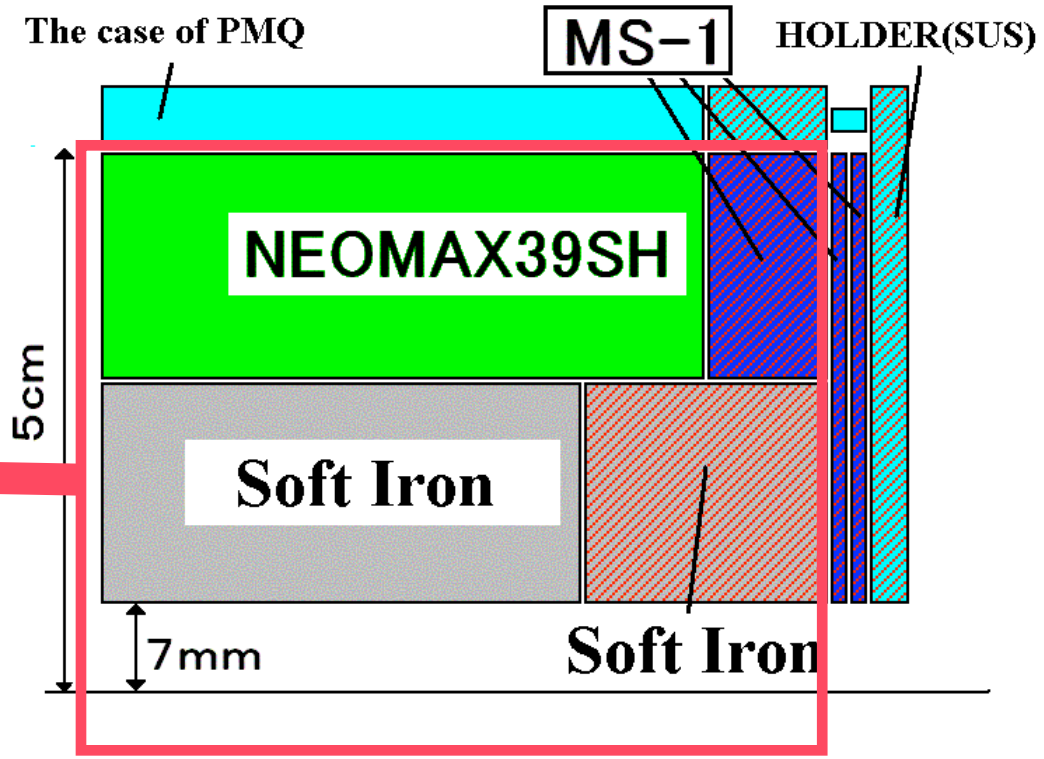
saturated iron in PMQ (iPMQ)

Temperature compensation

In order to stabilize strength, compensation material ‘MS-1’ is used

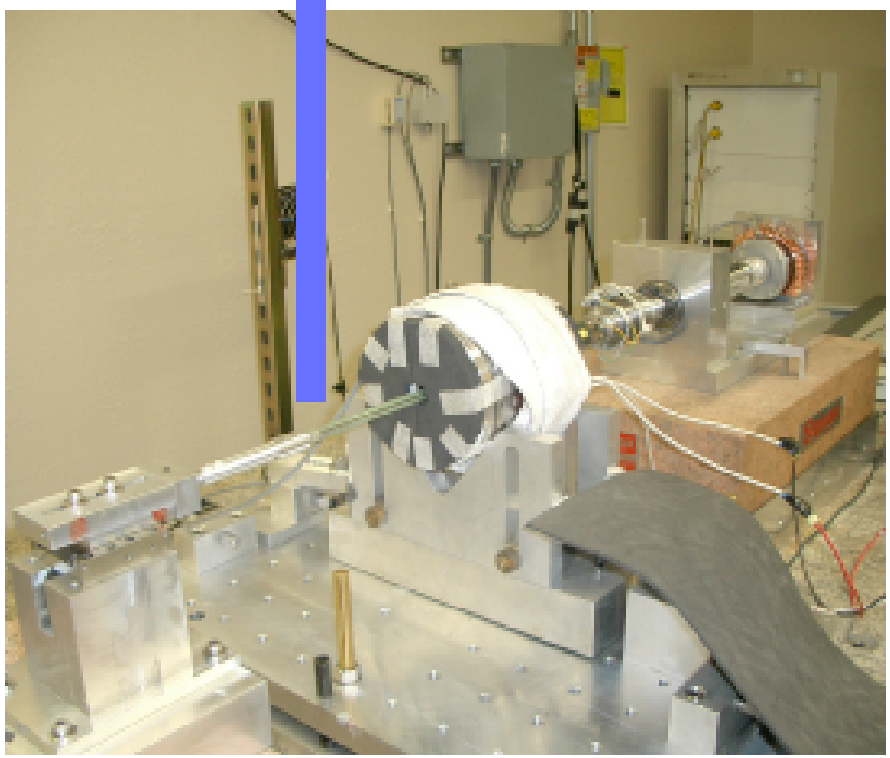


View of the Octant of the permanent magnet with MS-1

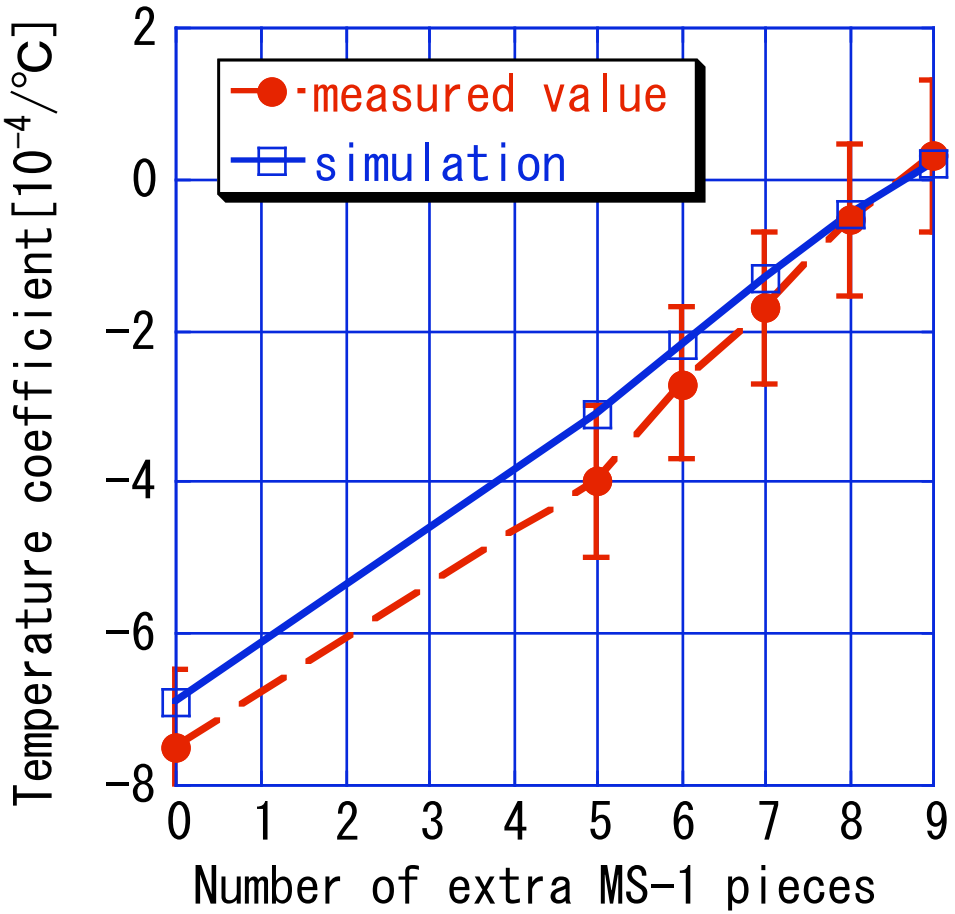


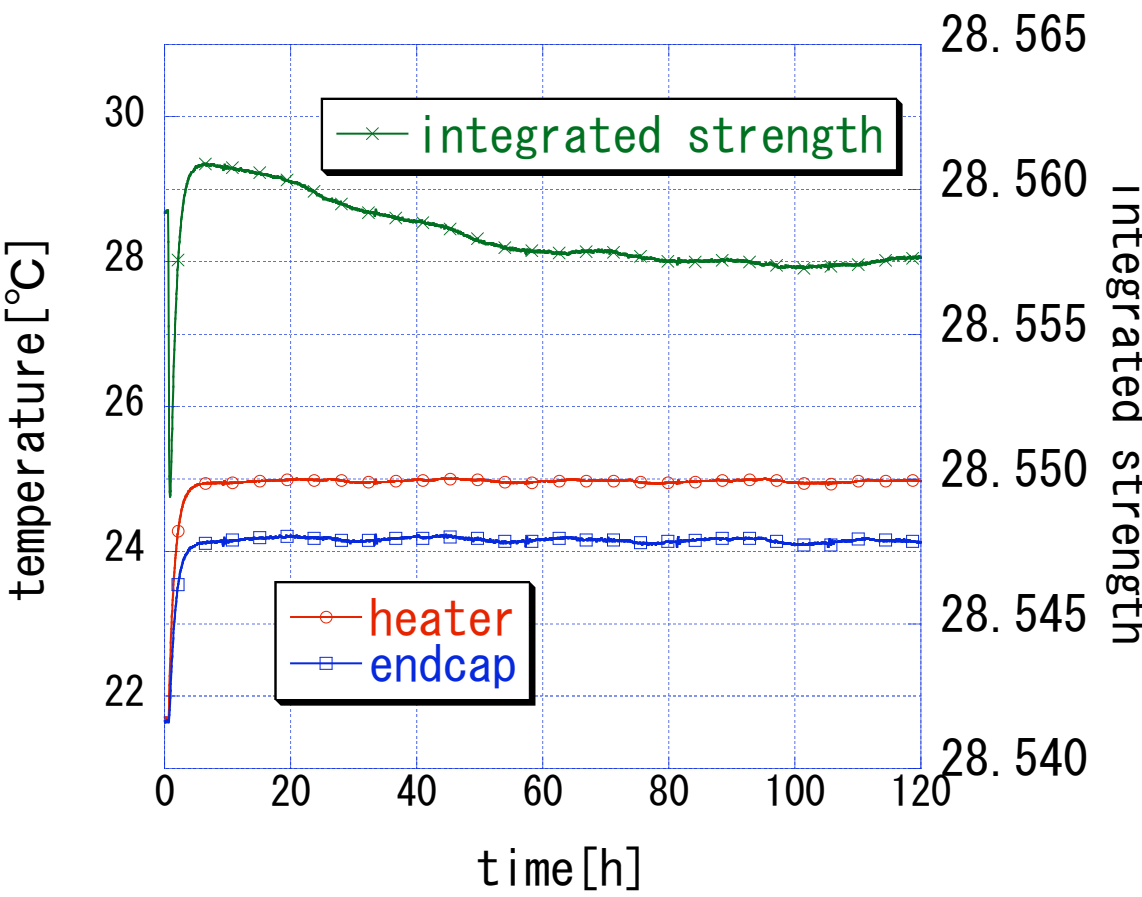
Marked region corresponds to left figure.

Fabricated parts and Measurement



Compensated Result

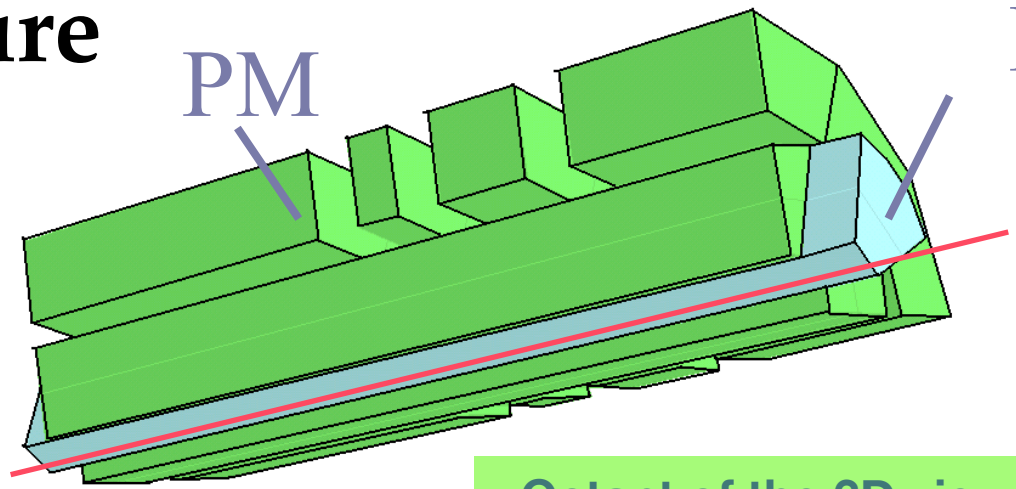




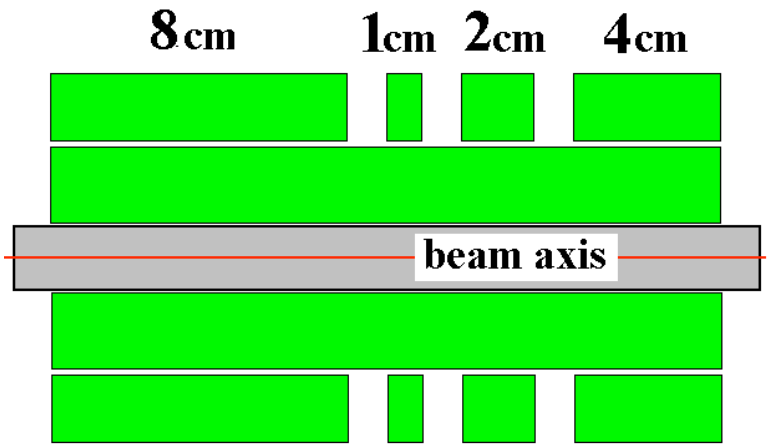
Strength Adjustability

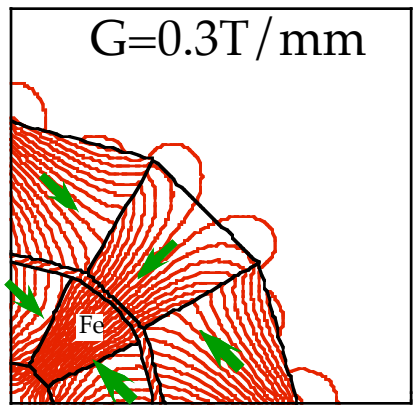
Double ring structure

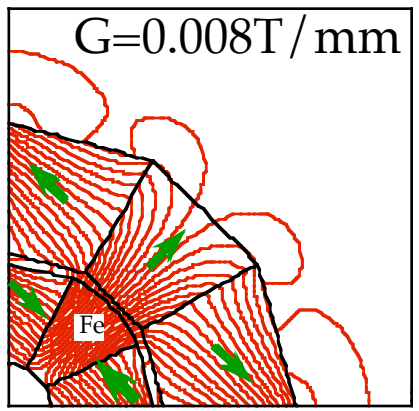
Skew 1/60
Shift of axis 1/10



Octant of the 3D view of double ring structure



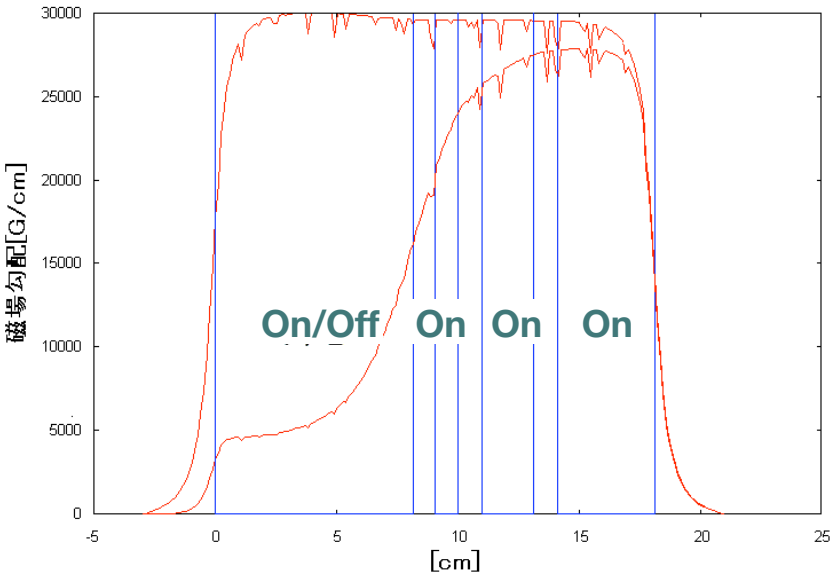




Switches between 0°-90°

Large torque is anticipated.

Total strength on switched length and gradients

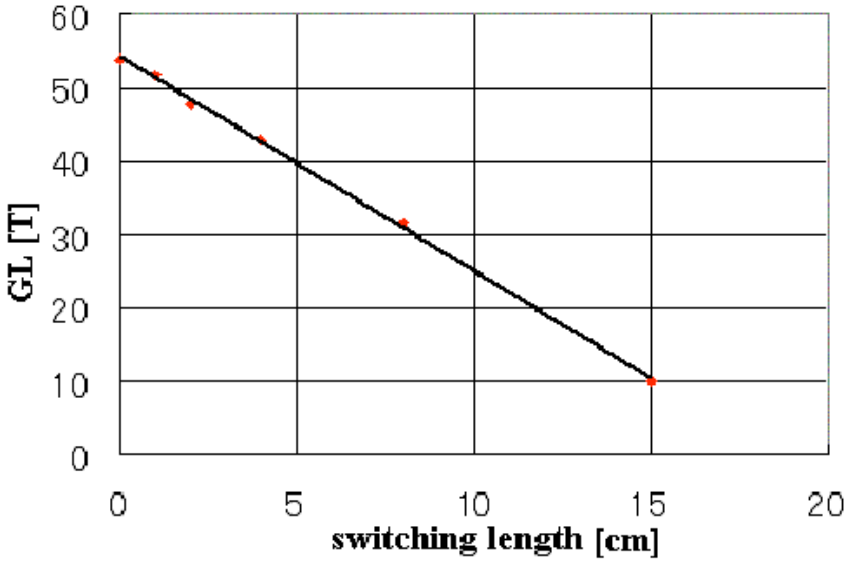


Left figure shows that the integrated strength is proportional to the switched length.

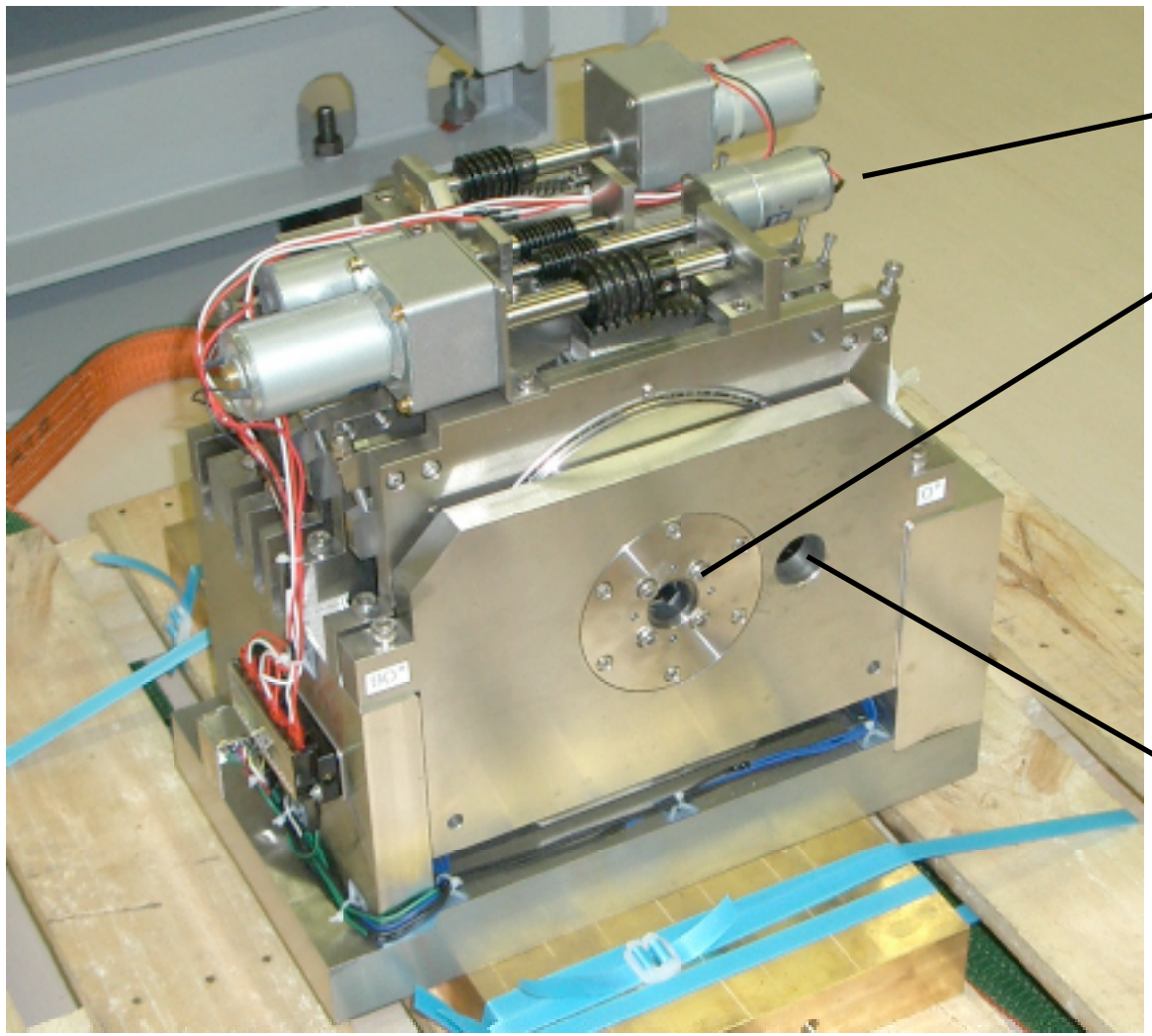
In this case, total strength can be reduced to 20 % of the maximum value.

Right figure shows the gradient of double ring structure along the axis.

On/Off corresponds to normal position (the strongest) and rotated position.



The second model of PMQ



Motors for rotation

Beam hole — Ø20

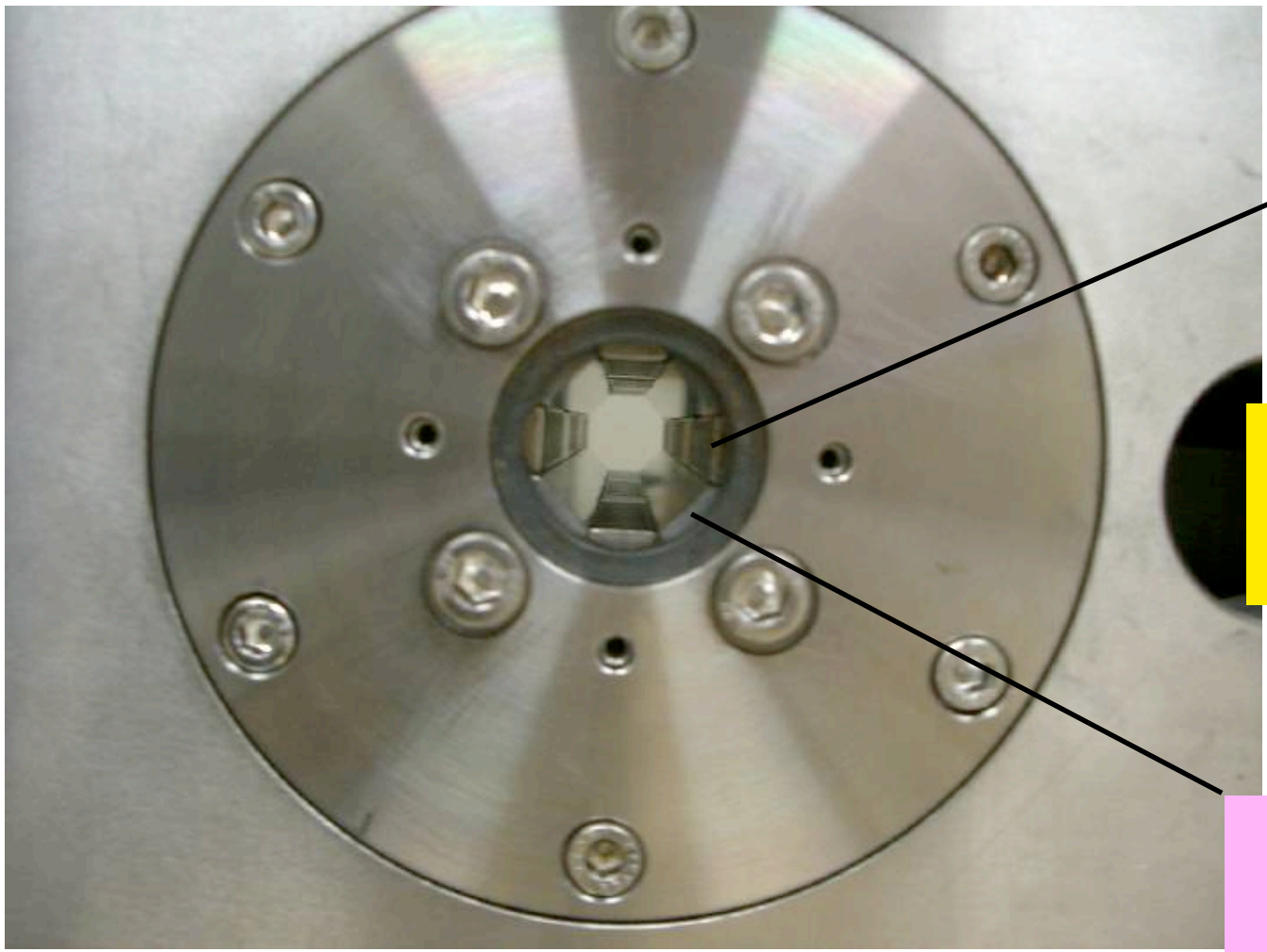
Designed value:
GL_{max}=33.4T
GL_{min}=9.8T
ΔGL=1.6T
(preliminary value)

Beam hole for outgoing beam

L*=3.5m, 20mrad
—> 140mm

Length=23cm

The second model of iPMQ



Measurement room

Summary and Discussions

- **300T/m PMQ was achieved with a bore radius 7mm.**
- **Temperature compensation parts reduced PMQ's temperature coefficient to 5% of its original value.**
- **2nd prototype of PMQ with double ring structure was fabricated.**
- **Radiazion damage will be investigated.**
- **Long term stability will be investigated.**