

- Title

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Permanent Magnet Option for Final Focus Quad

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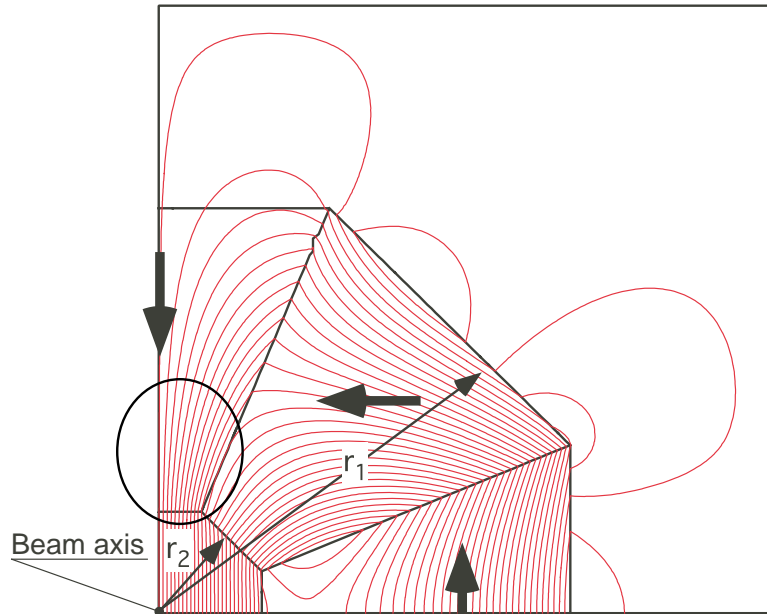
Contents:

- Introduction - Superstrong PMD
- PMQ, iPMQ (saturated iron PMQ)
- 3D calc (preliminary)
- Variable
- XPMQ
- Sketch

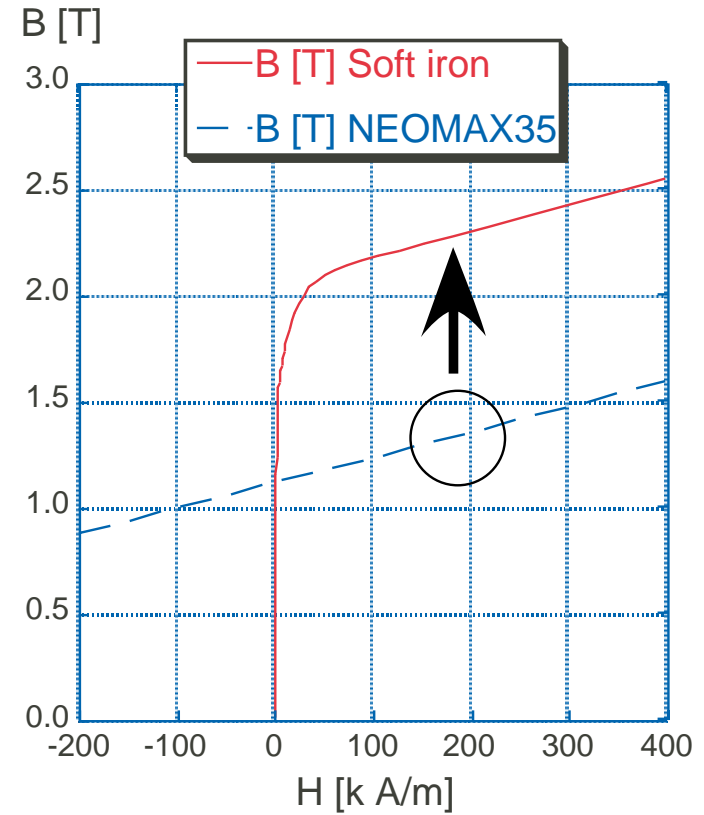
- PMD & B-H curve

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Halbach's dipole REC magnet.



1.37 T @ $r_1, r_2=1\text{cm}, 4\text{cm}$



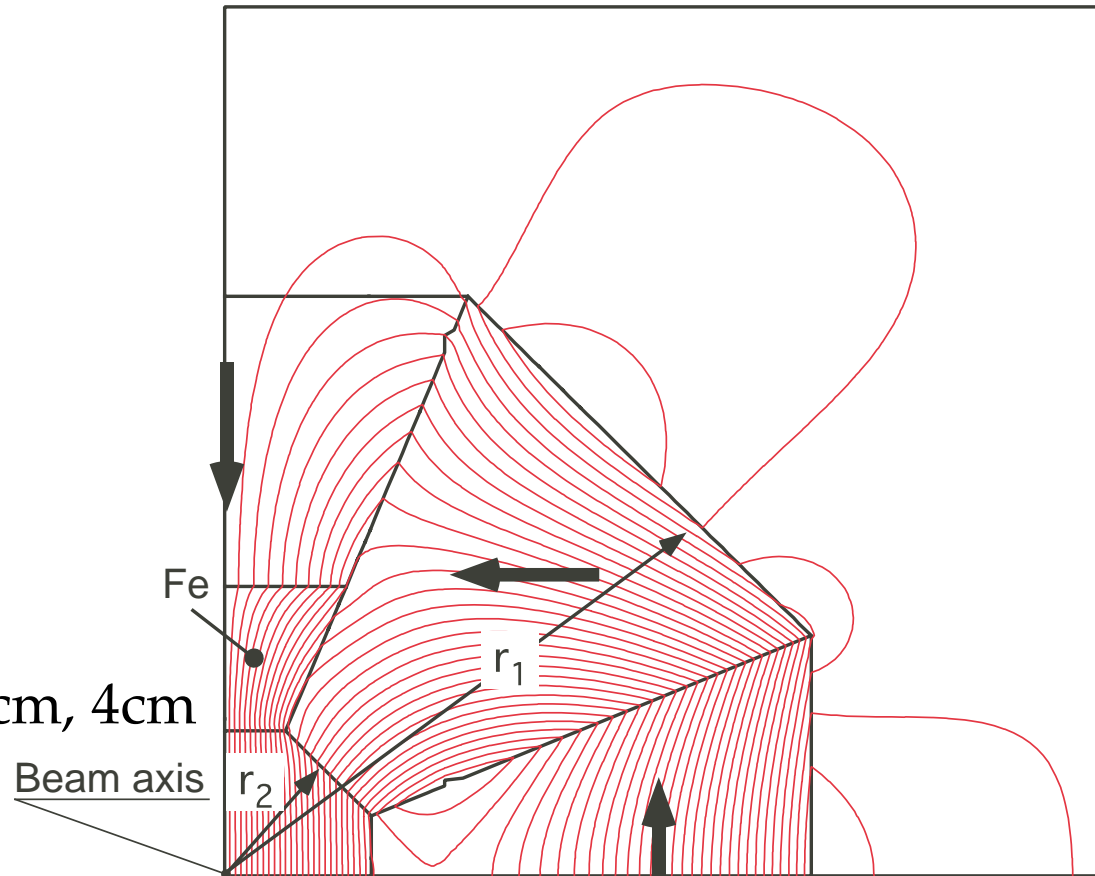
$$B=B_r \ln(r_1 / r_2) \cos(\pi / M) \sin(\pi / M) / \pi$$

- SuperPMD

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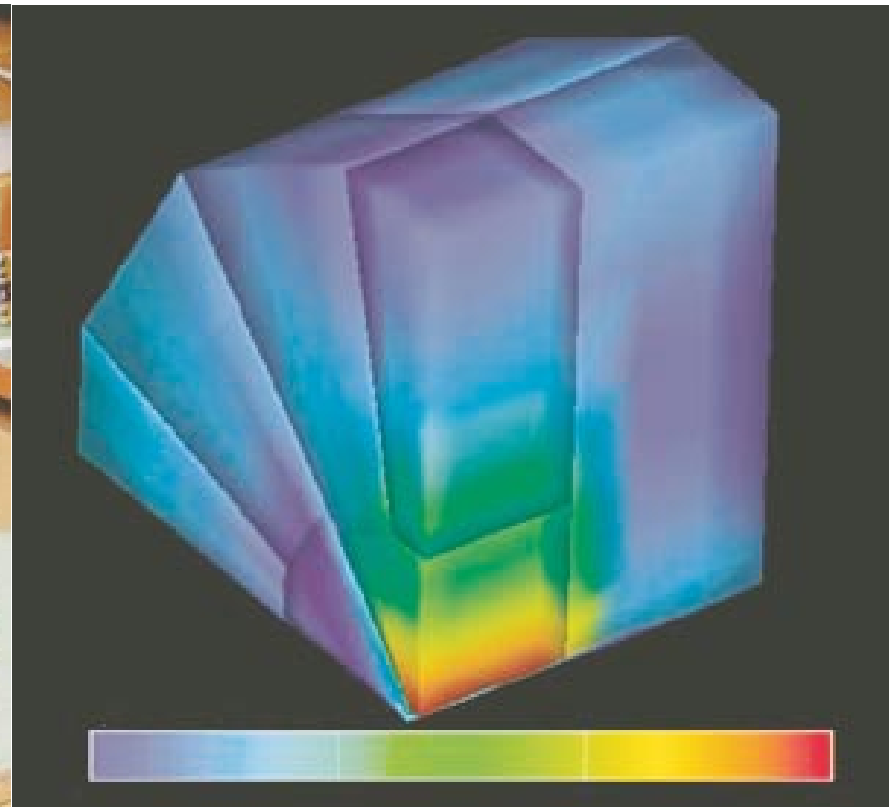
Modified Halbach's magnet.

1.64 T @ $r_1, r_2=1\text{cm}, 4\text{cm}$
(was 1.37T)



- 4.45T Dipole

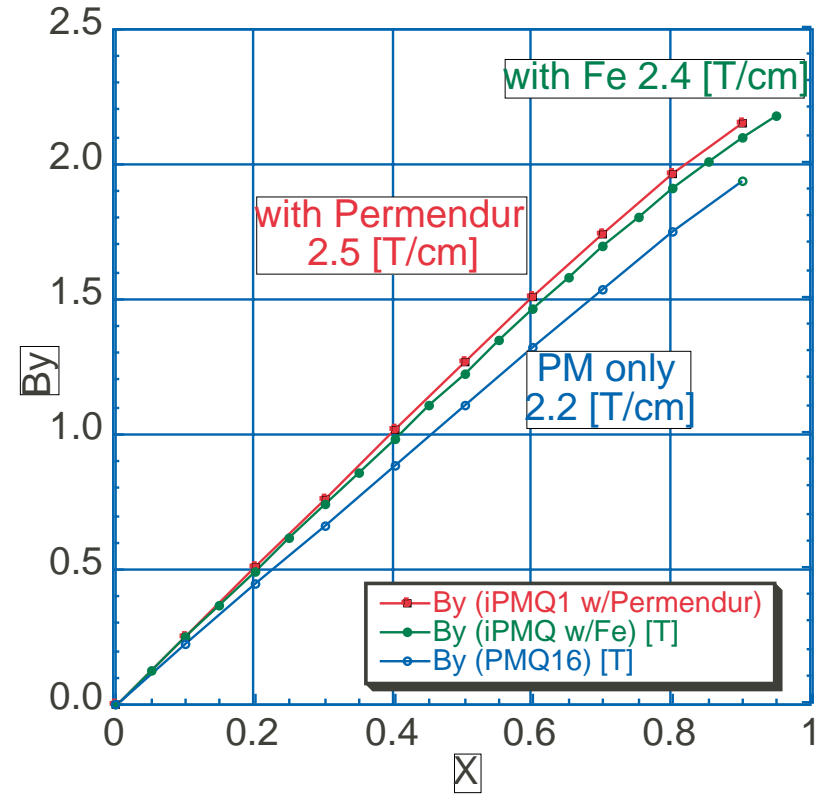
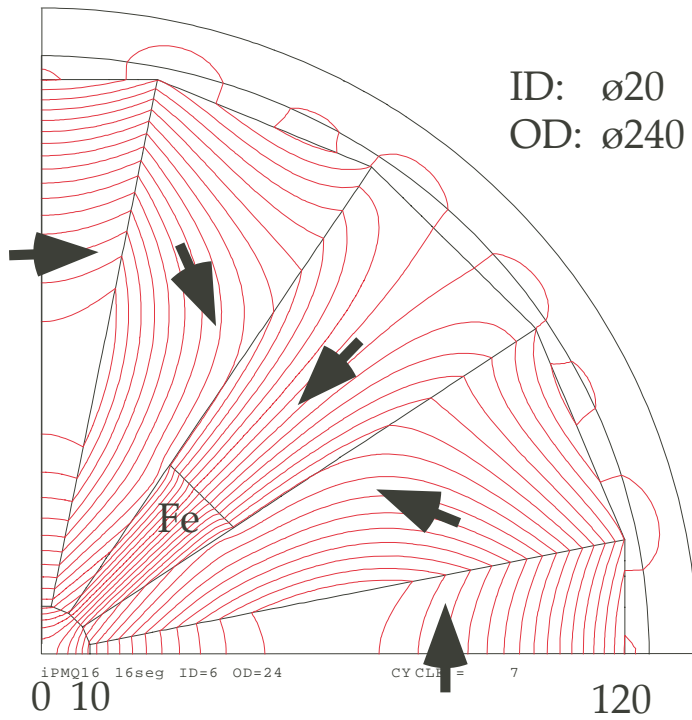
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Achieved 4.45T @-29°C (3.9T @room temperature)

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

• PMQ & iPMQ – Gradient (Field plot)

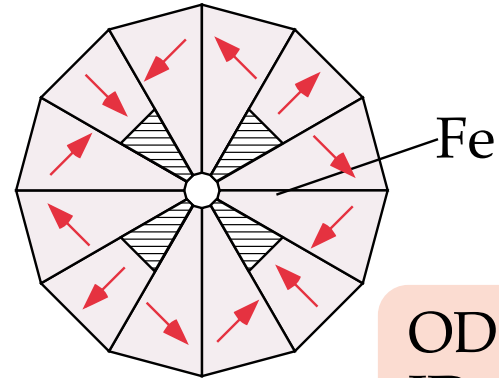
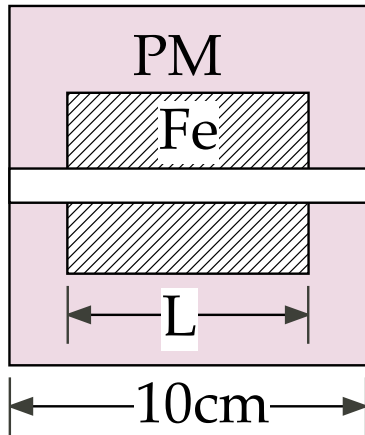


$$B = 2B_r (1 - r_1 / r_2) \frac{\cos^2(\pi / M) \sin(2\pi / M)}{(2\pi / M)}$$

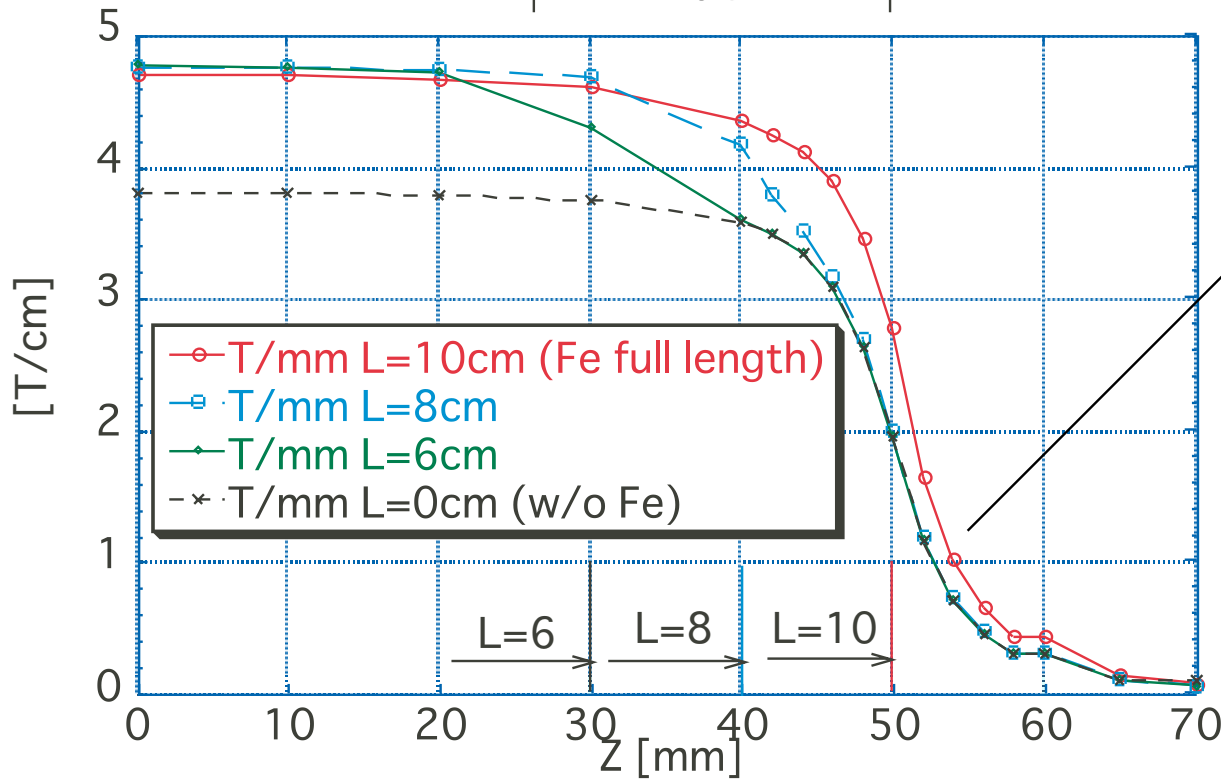
M=8	0.76847
M=12	0.89096
M=16	0.93741

• 3D calculation

12 segments



OD: $\phi 100$
ID: $\phi 10$

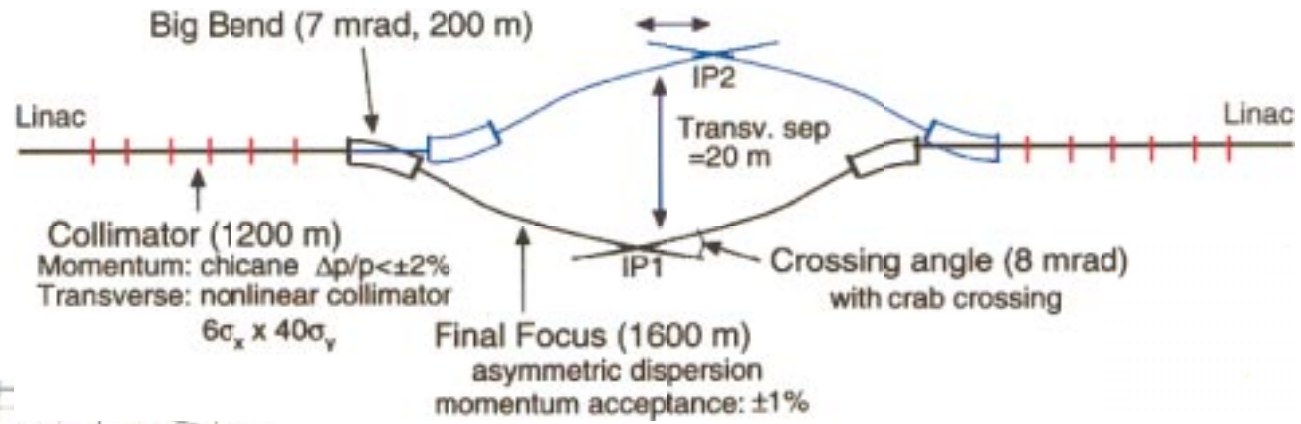


Slightly longer fringe region.

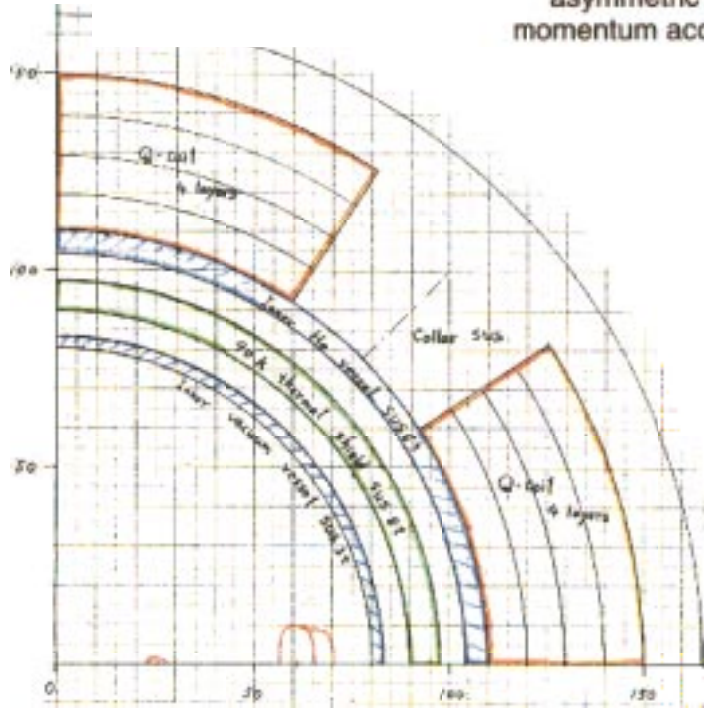
4.8T/cm
12 seg. $\phi 10$

→
~3T/cm
8 seg. $\phi 13.8$

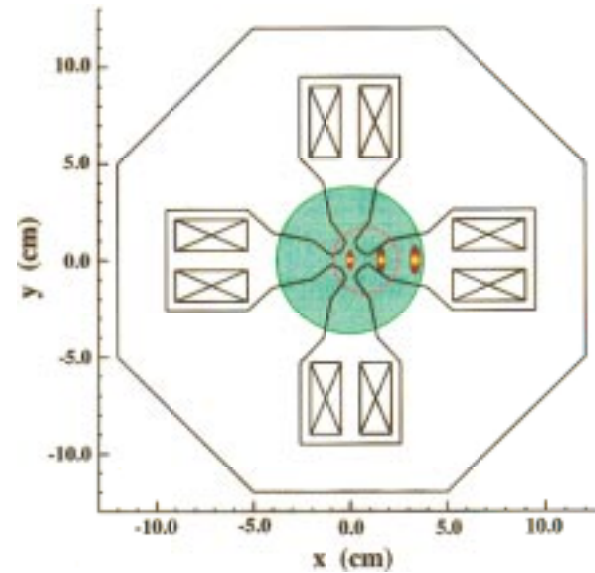
• IP



note: 9cm aperture for super conducting QC1, Jan.2000
 note: 4cm beam pipe just in front of QC1



Superconducting Q

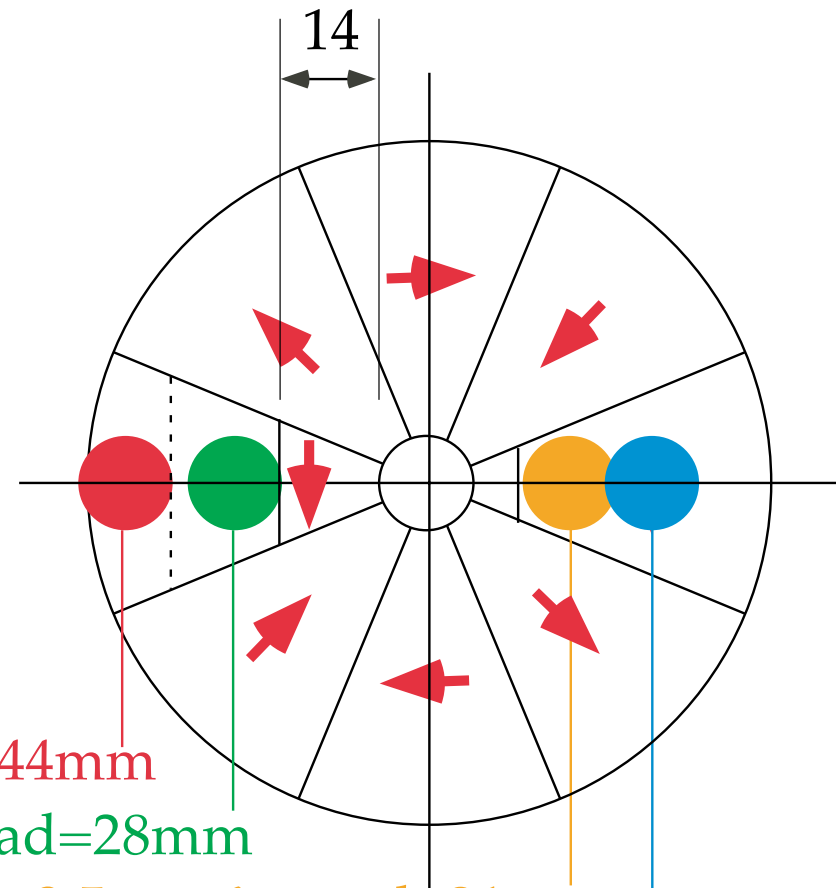


Room temp. Q

- Margin

$L^*=3.5\text{m}$ ID: $\varnothing 13.8$
Xing angle: 6 mrad or
8 mrad ?

At the very beginning part,
the saturated iron scheme
may not work, because of
less magnet space.
(depends on params.)

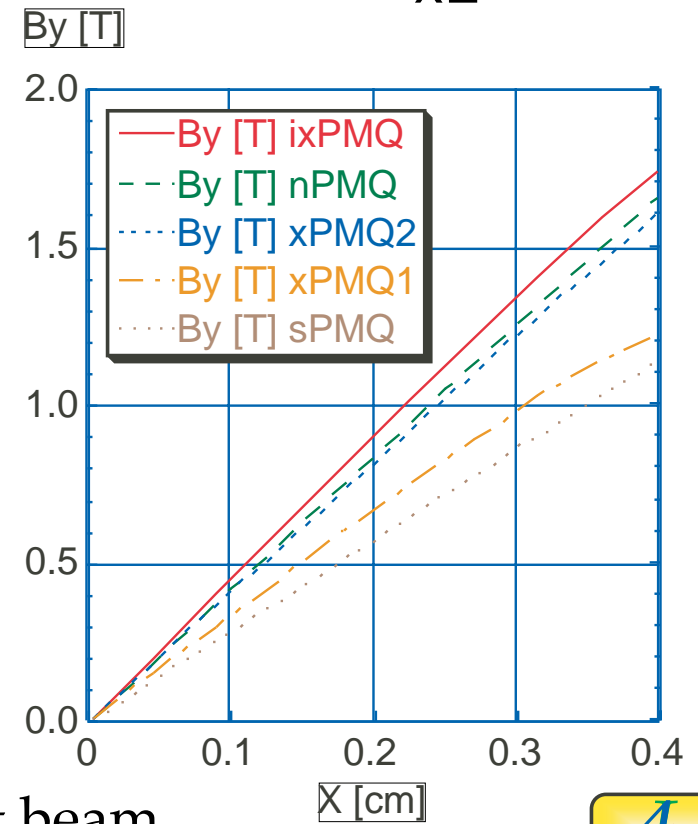
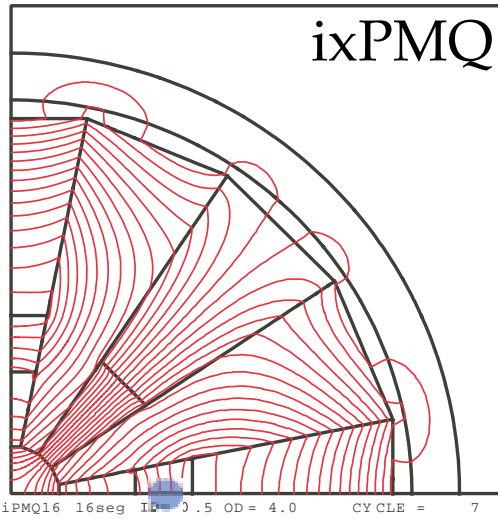
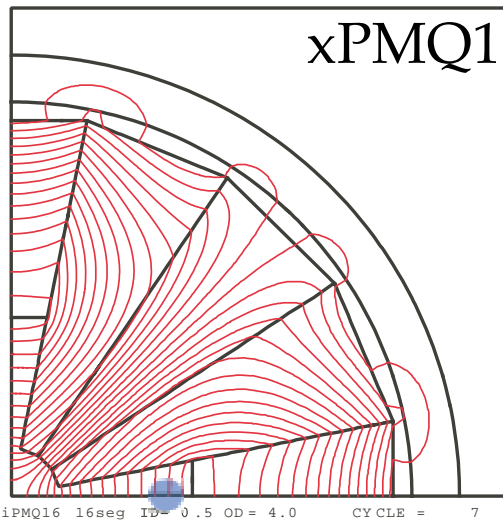
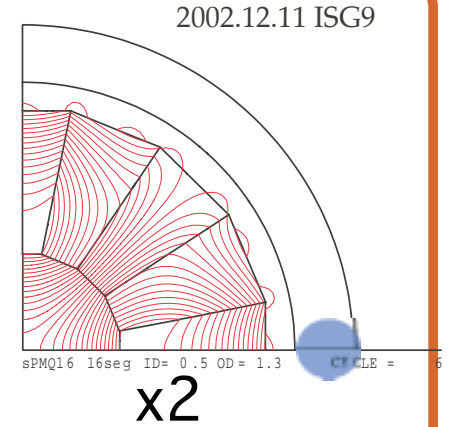
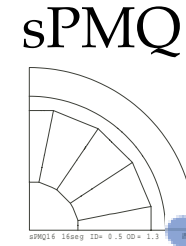
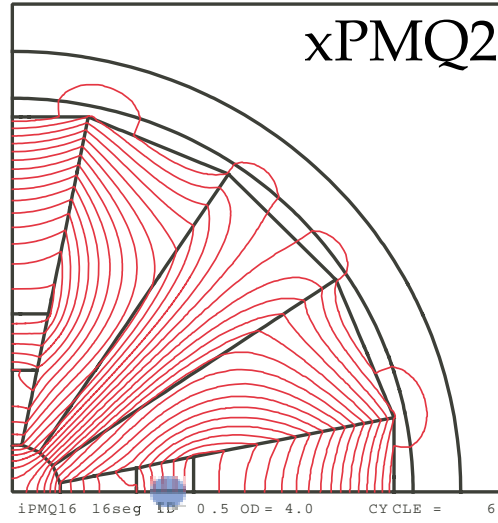
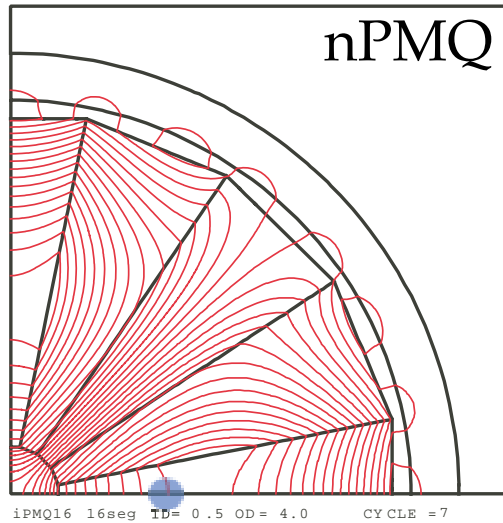


required: $GL=1.48\text{T/cm} \times 2\text{m}$

expected: 2.4T/cm @8 seg., $\varnothing 13.8$, w/o Fe

10~20% less with partial removal at outer area
—> still 2T/m should be available!

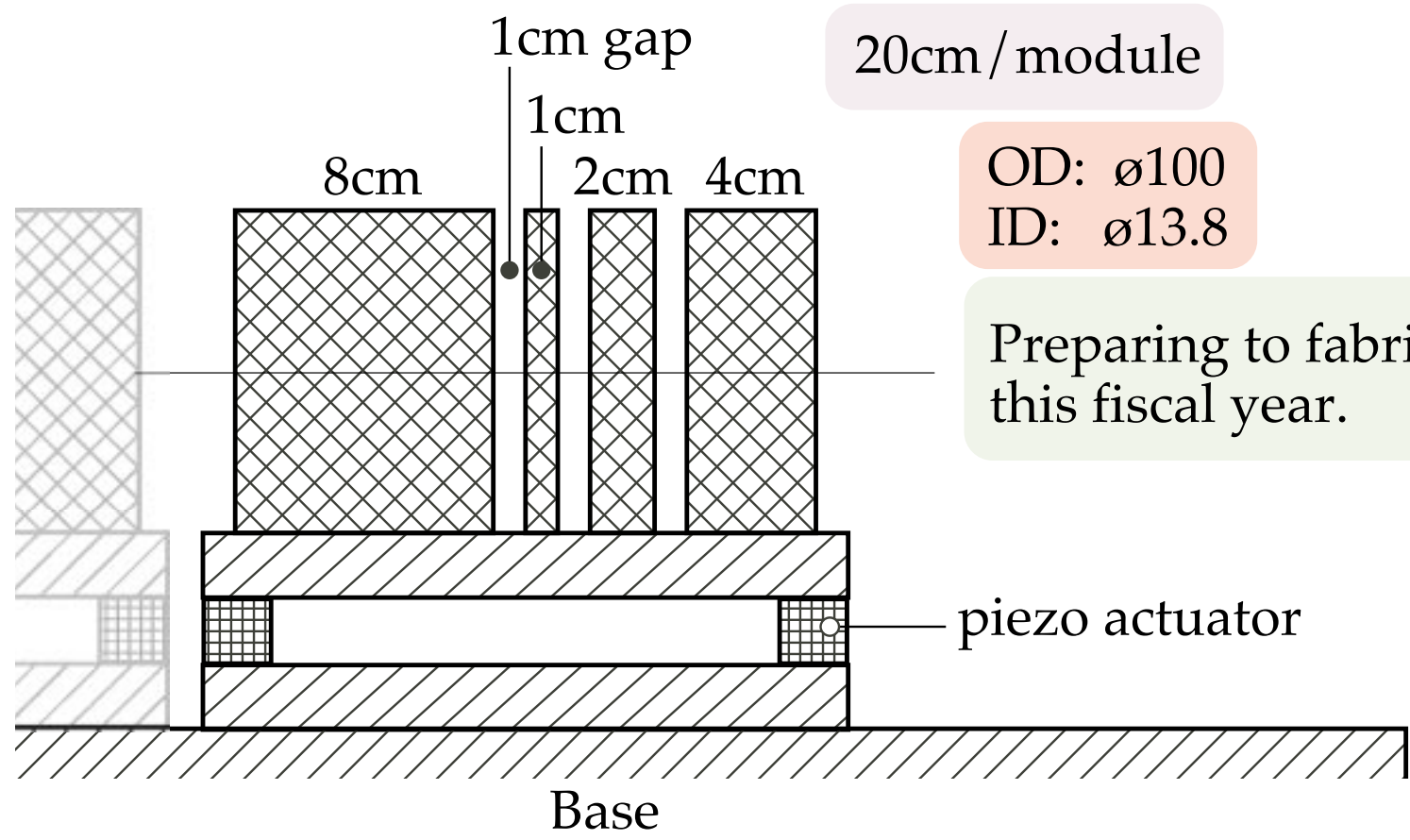
- Let the beam go through



No beam pipe for leaving beam.

- Rough schetch

Binary switch of $F \leftrightarrow D$ by rotating 90 deg.



20cm / module

OD: ø100
ID: ø13.8

Preparing to fabricate this fiscal year.

piezo actuator

Base

- Some issues

- 🍏 Strength 1% OK – by Kuroda-san
- 🍏 Displacement 0.2 nm ?
- 🍏 Rotation (skew) 3μ rad ?

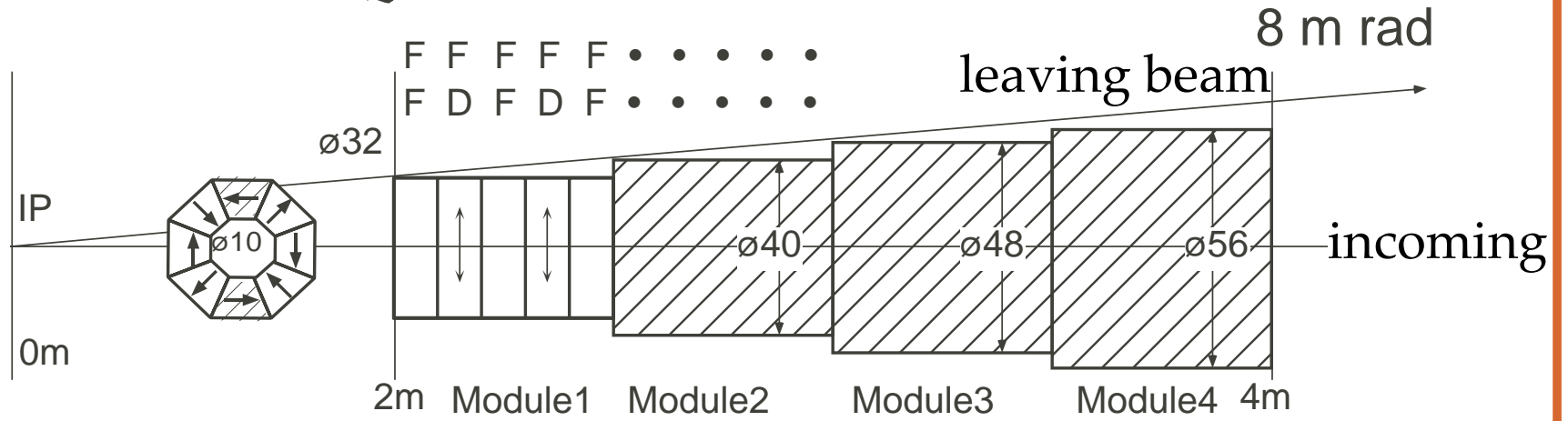
above two needs temperature compensation

- 🍏 Multipole component?
- 🍏 Radiation damage?
- 🍏 temperature coefficient?

- Appendix

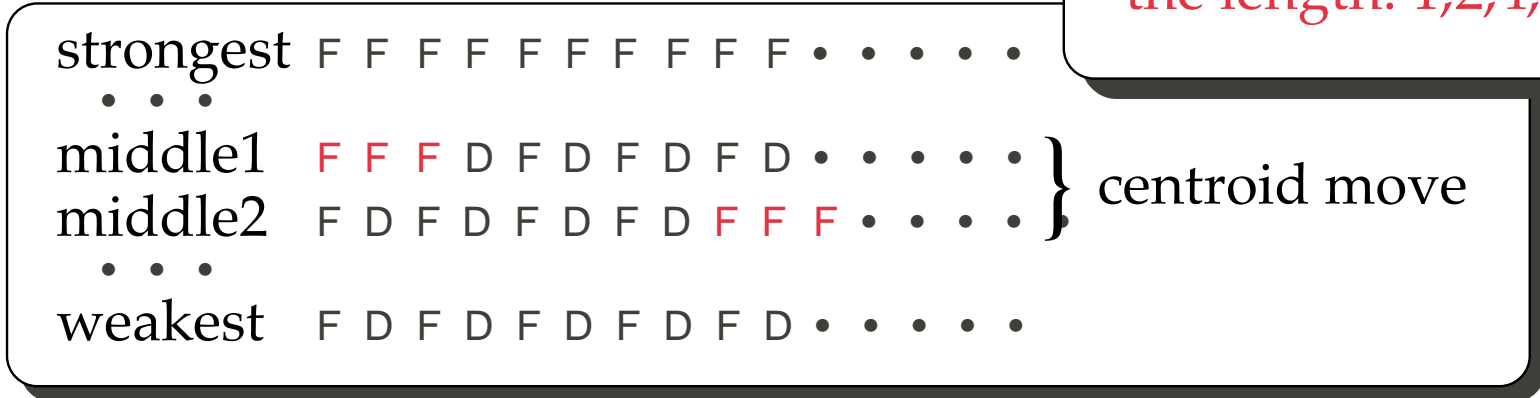
Appendix

• Final Focus vPMQ

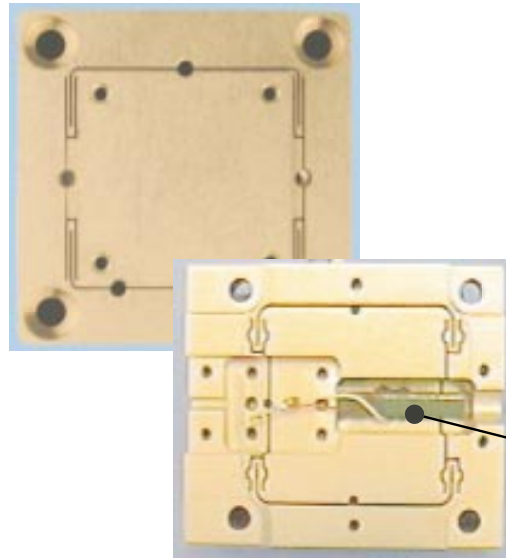
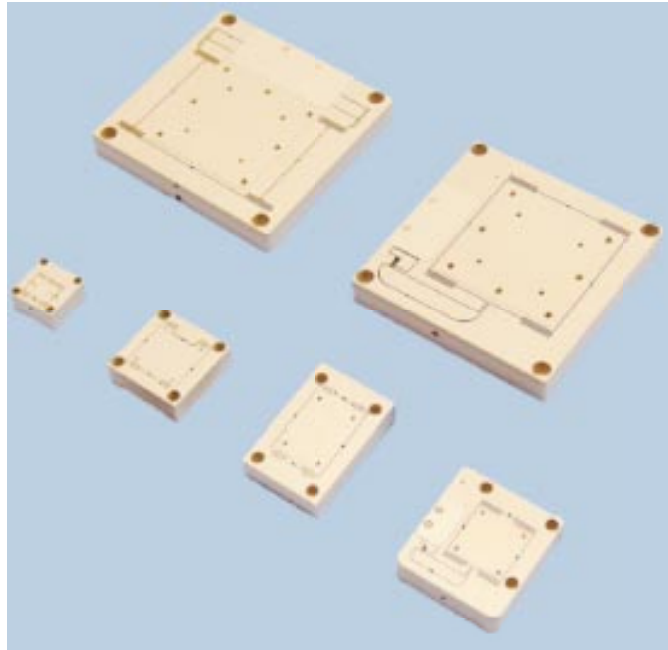


5~10cm/unit → 20~40units/2m
 ... some units may be fixed

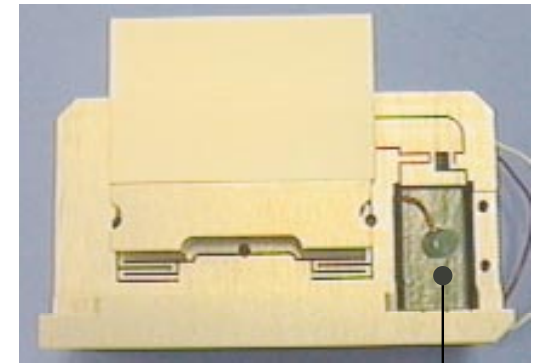
Stepwise variable
 Higher resolution by
 binary increment of
 the length: 1,2,4,... cm



- X-Y stage supplied by NanoControl Co.Ltd.



Piezo Actuator
stroke: $15\mu\text{m} / 2\text{cm}$



Supersonic Motor or Pneumatic system

