PMQ for Final Quad

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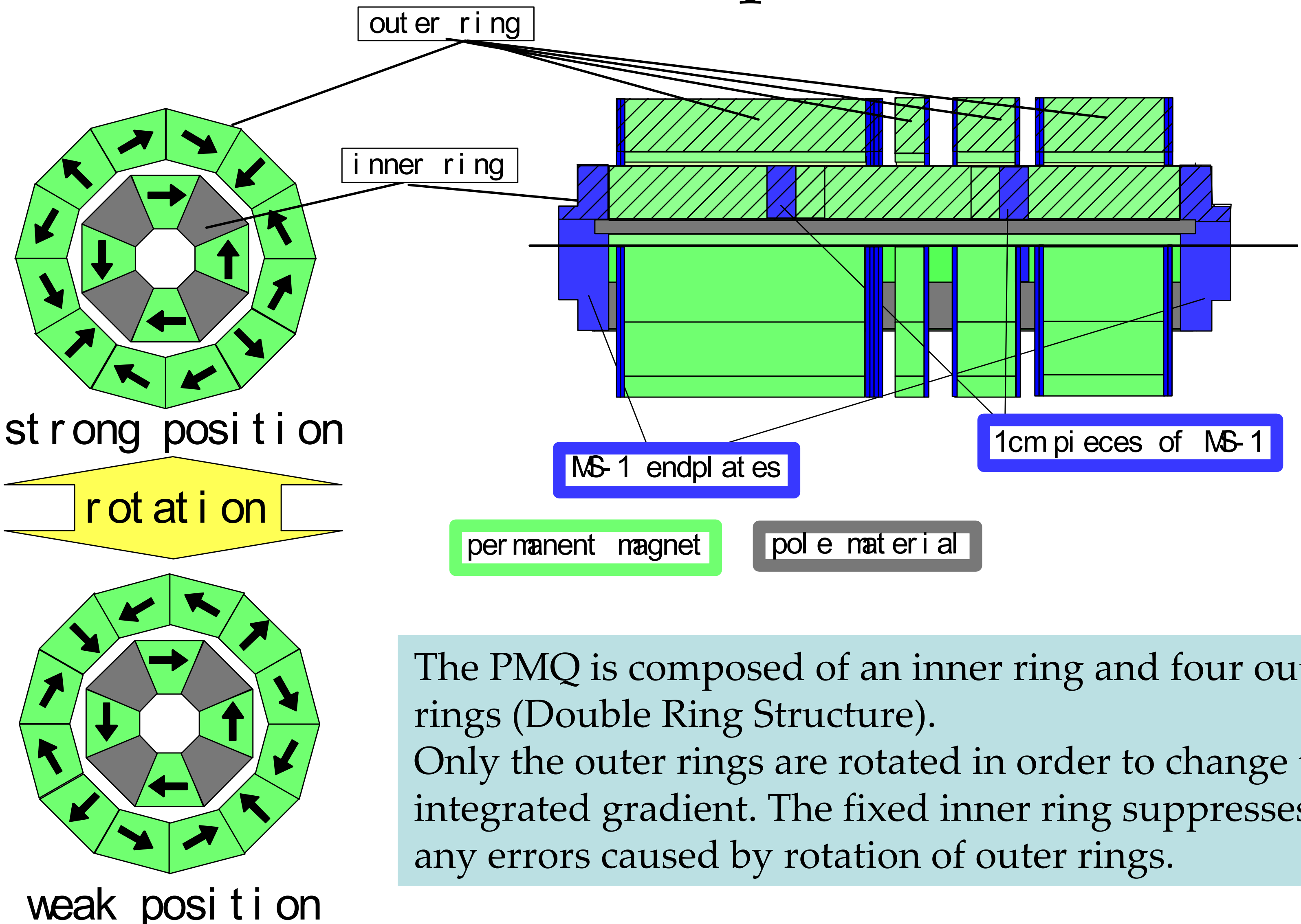
merit/demerit

- Strong field gradient. (>120T/m is achieved with ϕ20mm bore diameter and ϕ100mm magnet size.)
- small size ,light weight (our PMQ weighs about 100kg with 40cm x 40cm x 23cm)
- Less power consumption
- No vibration source (power cable, cooling water, or He pipe, etc…)
- Edge of effective length equals to L* (Super-Q needs 20cm more space for thermal shield)
- Temperature dependency (It can be compensated with temperature compensation alloys.)
- Radiation damage (10^{-3}tio)
- Time dependency (0.5%/year on NEOMAX30H)

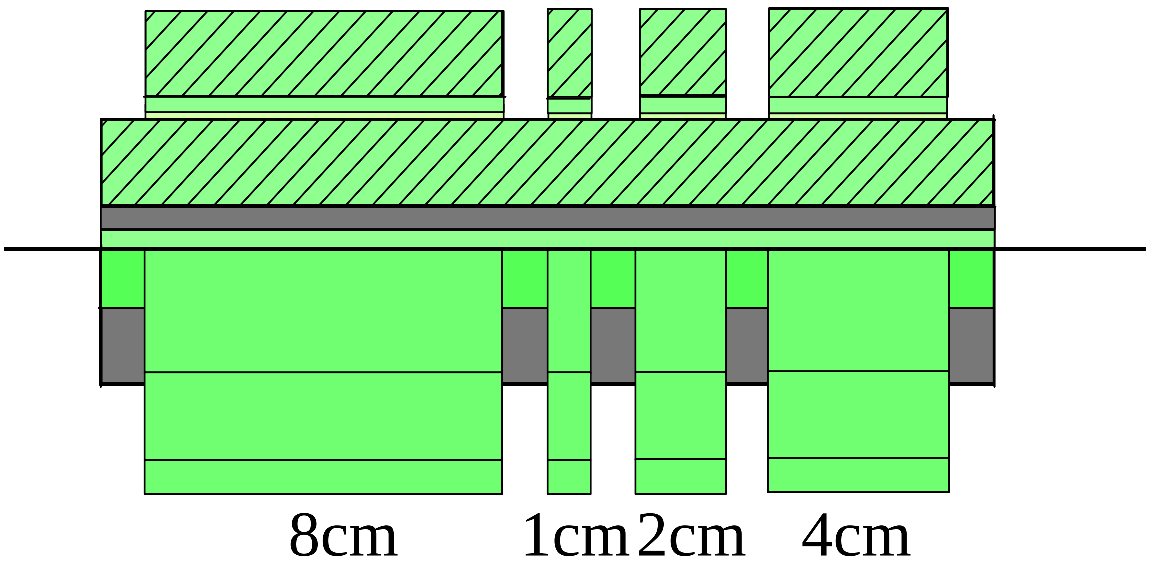
Adjustable Permanent Magnet Quadrupole



The PMQ is composed of an inner ring and four outer rings (Double Ring Structure).
Only the outer rings are rotated in order to change the integrated gradient. The fixed inner ring suppresses any errors caused by rotation of outer rings.

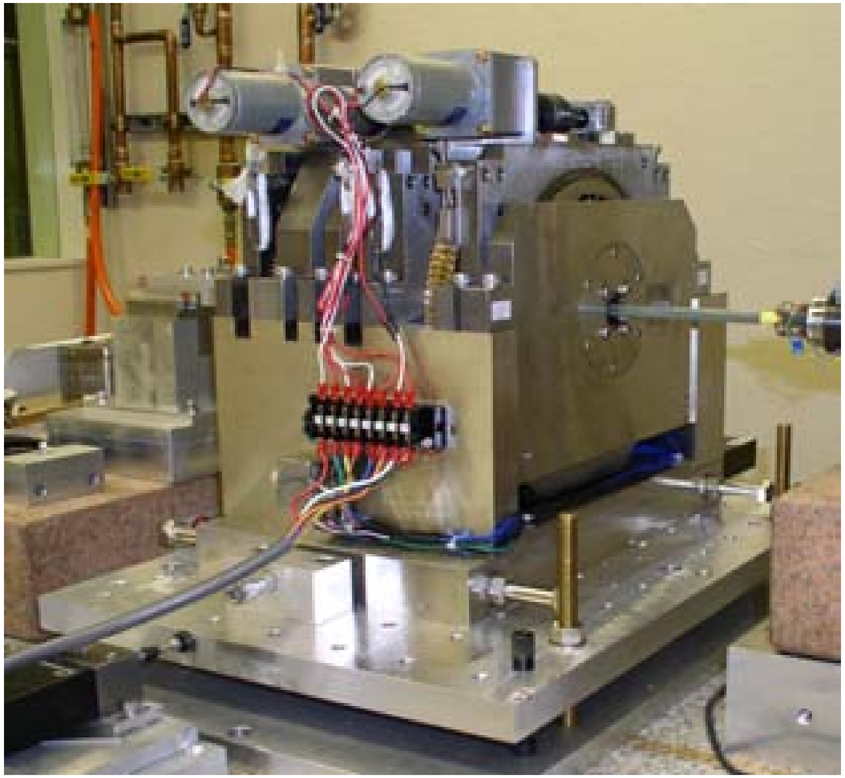
Summation of switched on length (SWL) is proportional to the strength of PMQ.

16 variations in the positions of the outer rings.

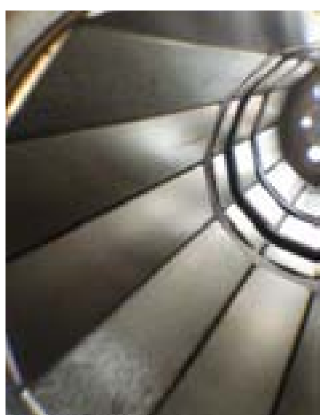


SWL	8cm	4cm	2cm	1cm
15	on	on	on	on
14	on	on	on	off
13	on	on	off	on
12	on	on	off	off
11	on	off	on	on
10	on	off	on	off
9	on	off	off	on
8	on	off	off	off
7	off	on	on	on
6	off	on	on	off
5	off	on	off	on
4	off	on	off	off
3	off	off	on	on
2	off	off	on	off
1	off	off	off	on
0	off	off	off	off

This figure shows only the pm material and Permendur poles.

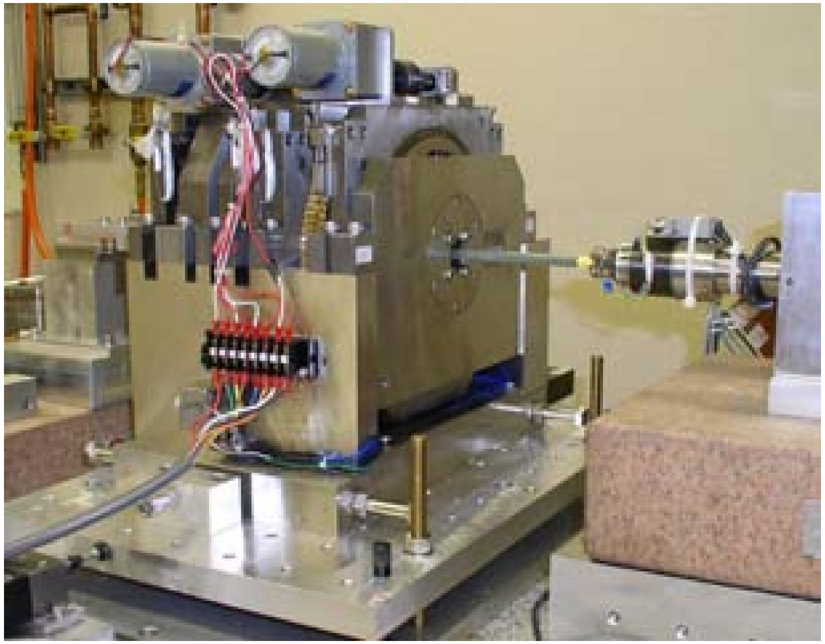


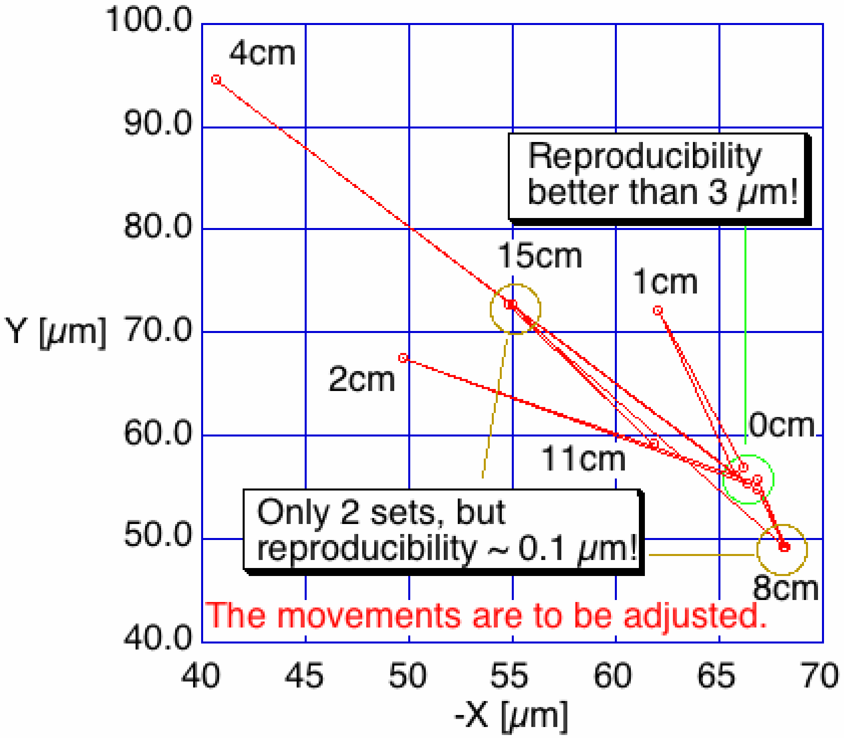
Bore radius	1cm
Inner ring radii	In 1cm out 3cm
Outer ring radii	In 3.3cm out 5cm
Outer ring section length	1cm, 2cm, 4cm, 8cm
Physical length	23cm
Pole material	Permendur
Magnet material (inner ring)	NEOMAX38AH
Magnet material (outer ring)	NEOMAX44H
Integrated gradient (strongest)	24.2T
Integrated gradient (weakest)	3.47T
Int. gradient step size	1.4T



Making of the PMQ

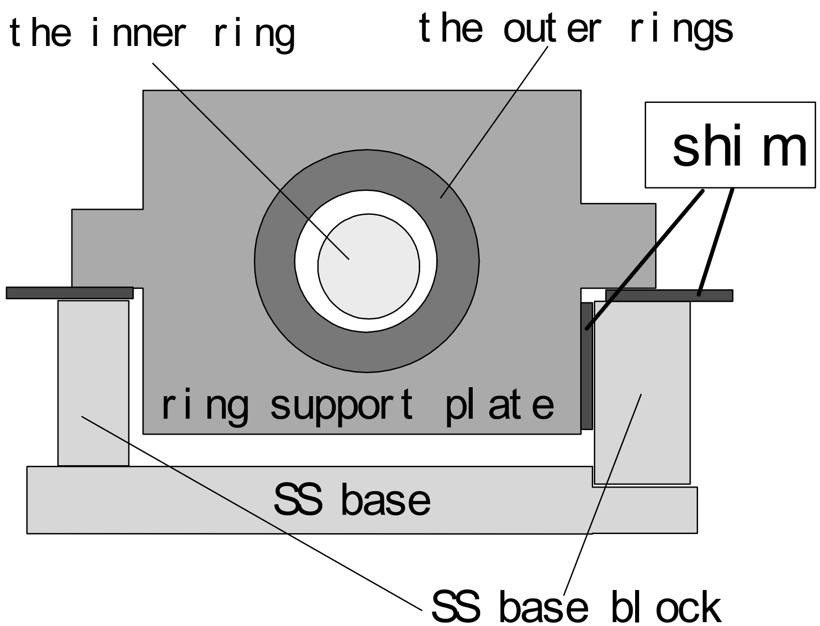
Latest measurement of our PMQ





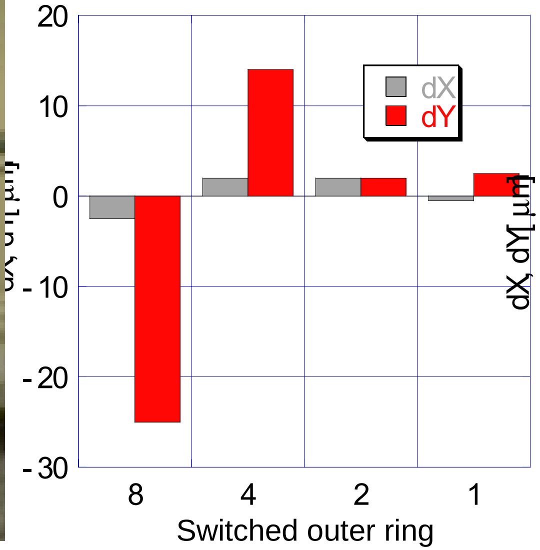
Magnetic Center moves by tens of micron when the strength was changed. (already shown on11/04)

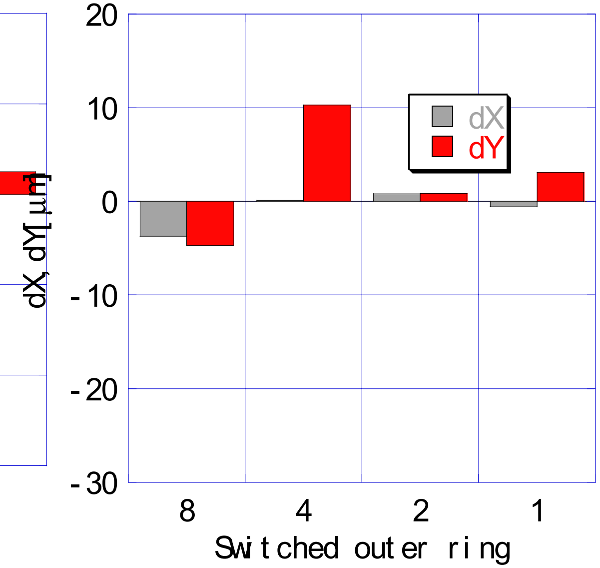
Center Adjustment by Shimming



Inserting several 24.5micron shims moves the outer ring up.

Results of shim adjustment





25.4μm shim.

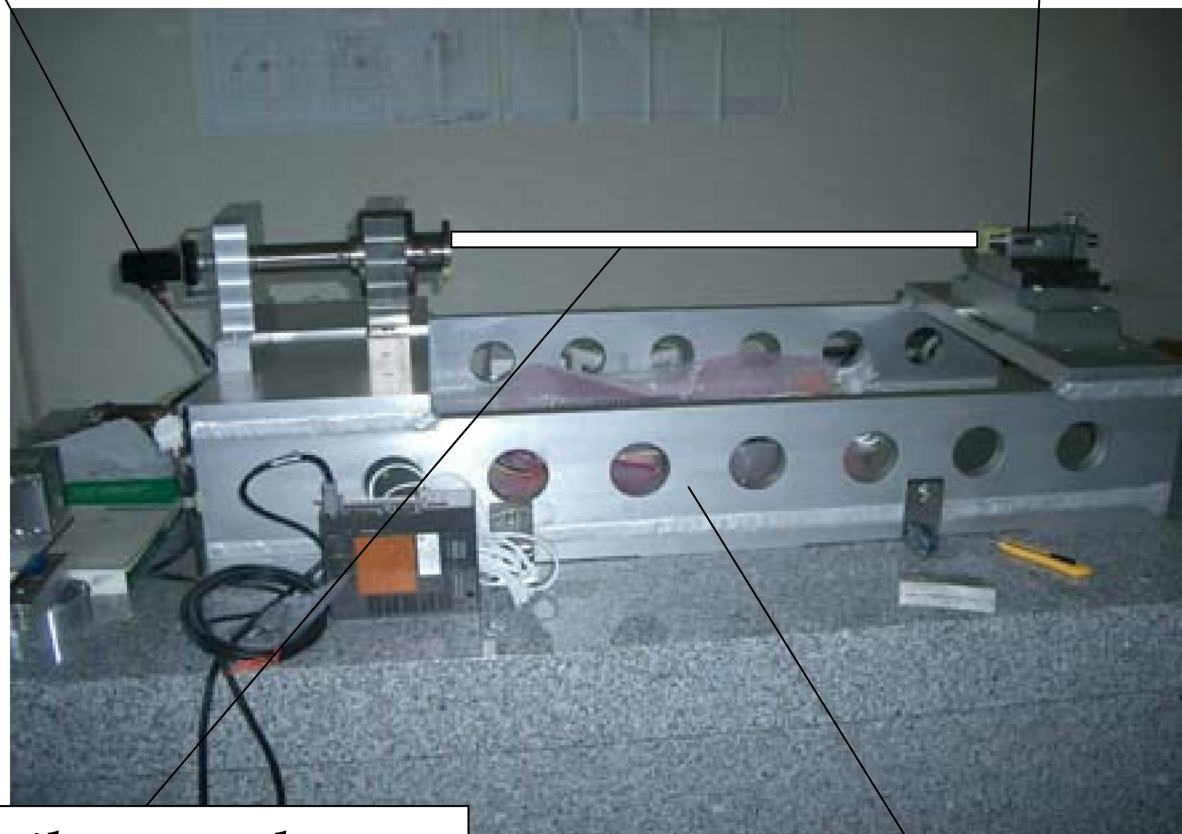
8cm ring was lifted up by 76μm and 4cm ring moved 51μm in the -X direction

Center shift of the Y coordinate by switching 8cm ring successfully reduced from over 20 μm to less than 5 μm by shimming.

Measurement preparation

AC servo motor

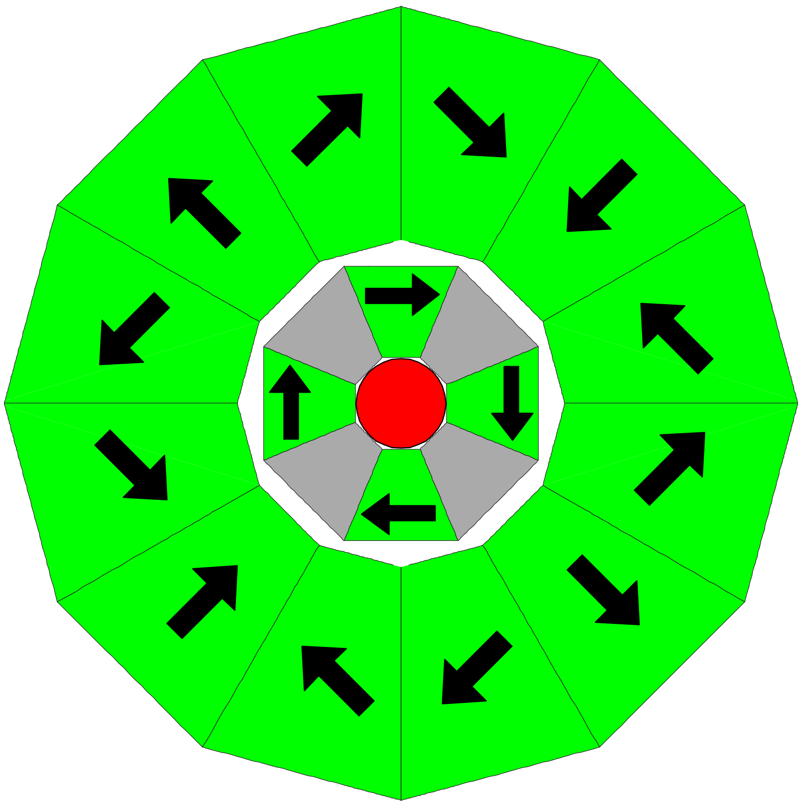
(Air) Bearing



Grass rod coil comes here

Duralumin frame

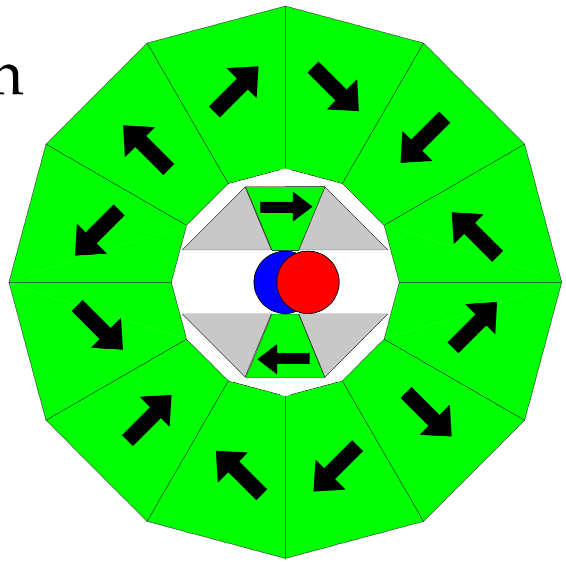
PMQ for Head-on



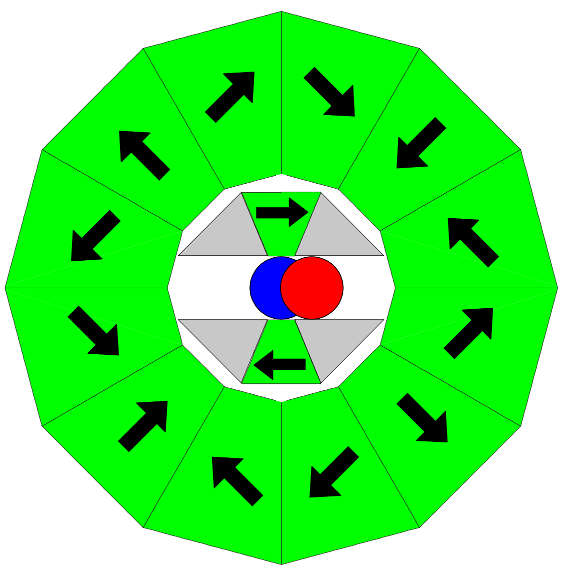
Outer diam	ϕ180mm
Bore diam	ϕ20mm
Grad. With ϕ20mm bore	180T/m(max) -20T/m (min)
Grad. With ϕ14mm bore	250T/m

PMQ for 2mrad(L*=3.5 ~ 5)

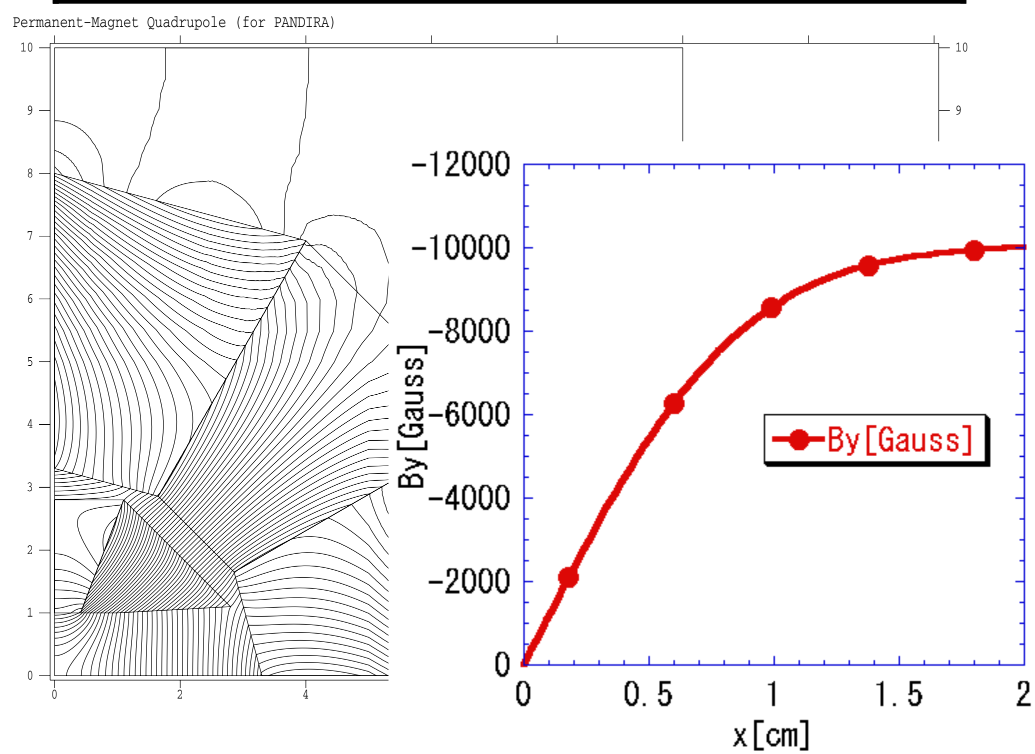
L*=3.5m



L*=5m

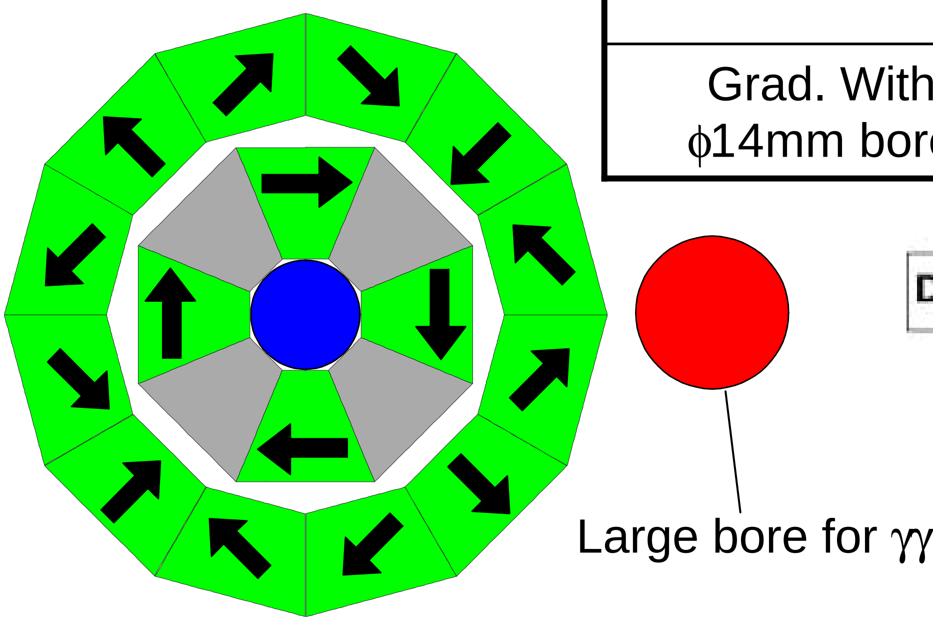


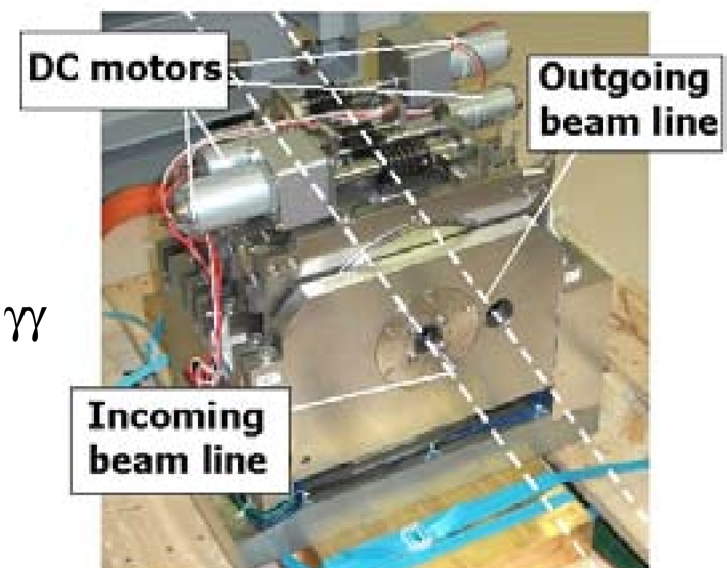
Outer Diam	ϕ180mm
Grad. With ϕ20mm bore	130T/m (max) -60T/m (min)
Grad. With ϕ14mm bore	190T/m



PMQ for 20mrad,L*=3.5m

Outer diam.	ϕ100mm
Bore diam.	ϕ20mm
Grad. With ϕ20mm bore	*120T/m(max) 8T/m(min)
Grad. With ϕ14mm bore	220T/m





*160T/m without temp. compensation.

longer L* means stronger PMQ.

R&D

- We have tested the strength adjustable PMQ. 120T/m field gradient is achieved with ϕ20mm bore. A case of Off center in changing strength over 20mm is reduced to 5mm by shimming.
- ~12/05 Inner ring and temperature compensation parts will be renewed until Jan. 05
- ~03/06 Measurement of renewed PMQ.

  PMQ design for final focus in ATF2.

  Baseline Configuration Design
- ~03/07 Measurement of PMQ in ATF2

  Reference Design Report
- ~03/09 PMQ design for final focus in ILC.

  Technical Design Report

Demagnetization by Radiation

Energy deposit

	GLD	SiD	SiD(by Takashi)	neutron
BeamCAL	17mW	13mW	29mW	
QD0	94mW	97mW	147mW	10^5 [n/cm^{2}s]
SD0	11mW	11mW	11mW	
QF1	16mW	18mW	15mW	
SF1	0.4mW	0.3mW	1mW	

very preliminary results by T.Abe (university of Tokyo), in private communication

Demagnetization by 14MeV neutron

Magnet	Demag. ratio [/1x10^{13}n/cm^2]	iHc [Oe]
47H	10.2%	
44H	1.8%	16
39SH	0.7%	21
32EH	0.3%	30

http://nacci.tokai.jaeri.go.jp/inex/paper/kawakubo/
permmag_damage.pdf

Continuous 1 hour operation causes about 0.01[%] of (reversible?) demagnetization of NEOMAX 32EH.