Special magnets for SuperKEKB

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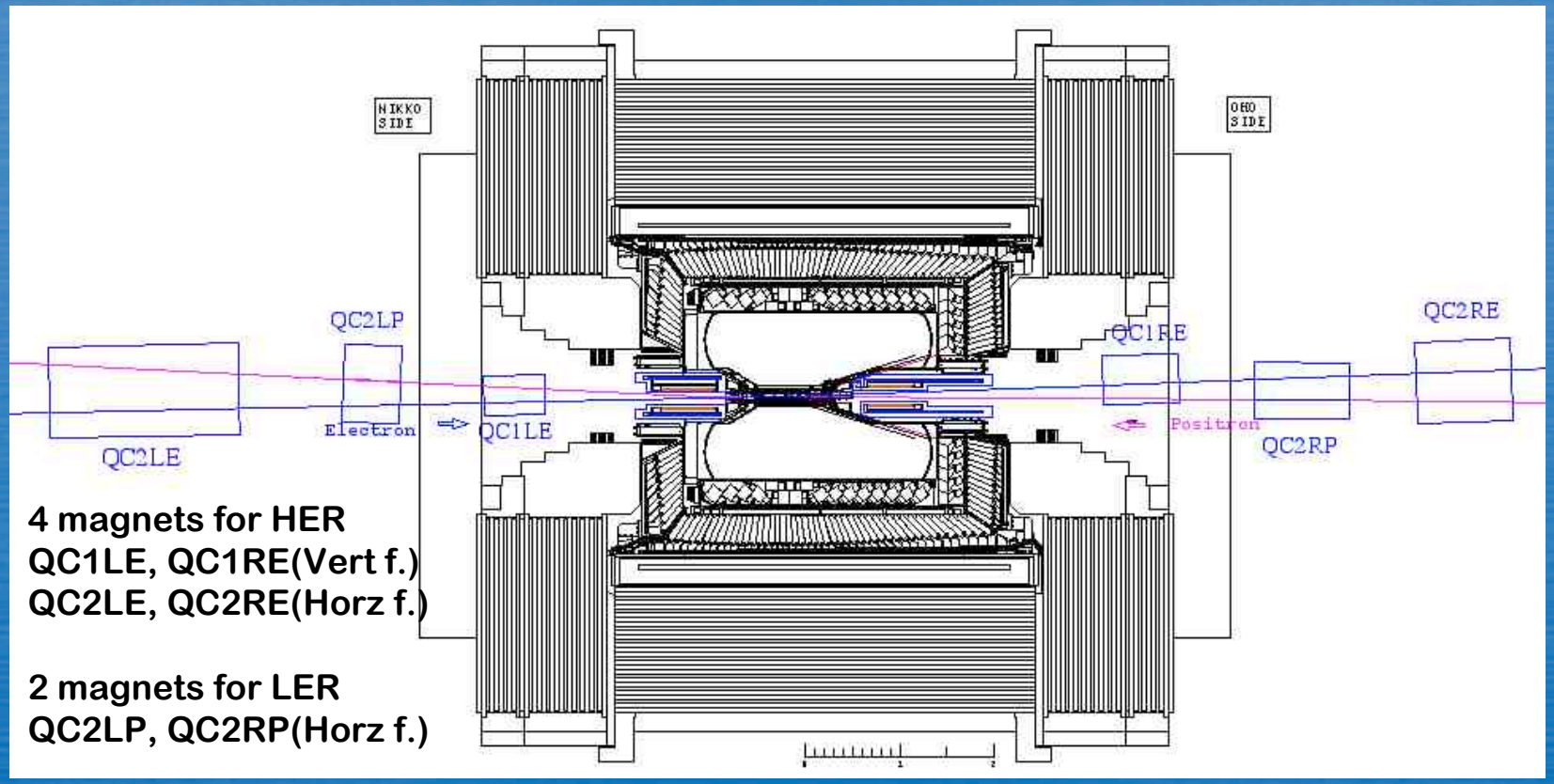
Contents

- Design constraints
- Design of special magnets (normal conducting)
- Belle detector and QC1 magnets
- Further study

IR Magnet configuration



4 magnets for HER
QC1LE, QC1RE(Vert f.)
QC2LE, QC2RE(Horz f.)

2 magnets for LER
QC2LP, QC2RP(Horz f.)

Design constraints

	KEKB	SuperKEKB
longitudinal position of Special magnet		50cm closer to IP
Crossing angle	22mrad	30mrad
β_x/β_y	33cm / 1cm	20cm / 3mm
Damping ring	Unnecessary	Necessary for e+
SR Power (HER/LER)	27kW (1.1A) / 10 kW (2.6A)	194kW(4.1A) / 78 kW(9.4A)
Aperture for SR		w/ COD error w/ dynamic effect
Pole Shape	five septum Q, one half Q	six septum Q

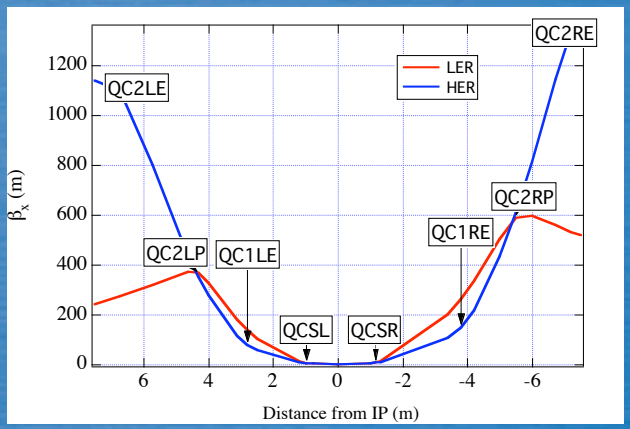
Design constraints

- Beam aperture for β^*_x/β^*_y= 20cm/3mm Optics (by H. Koiso)
- Acceptances (w/ damping ring for e+)
- (by Y. Funakoshi)
  - 8 GeV : 1.9×10^{-6}(Horz) / 8.0×10^{-8}(Vert)
  - 3.5 GeV : 2.6×10^{-6} (Horz) / 1.8×10^{-7} (Vert)
- Aperture for synchrotron radiation (by Y. Funakoshi)
  - COD error + $3\sigma_{x/y}$ (w/ dynamic effect)

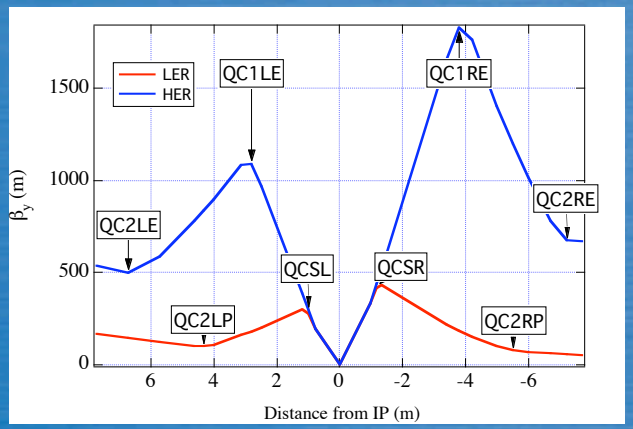
	Angle error at IP	Offset error at IP	Beam size (w/ dynamic effect)
Horizontal	±0.7mrad	±0.4mm	$3\sigma_x$
Vertical	±0.5mrad	±0.2mm	$3\sigma_y$

IR Beta functions, Orbit

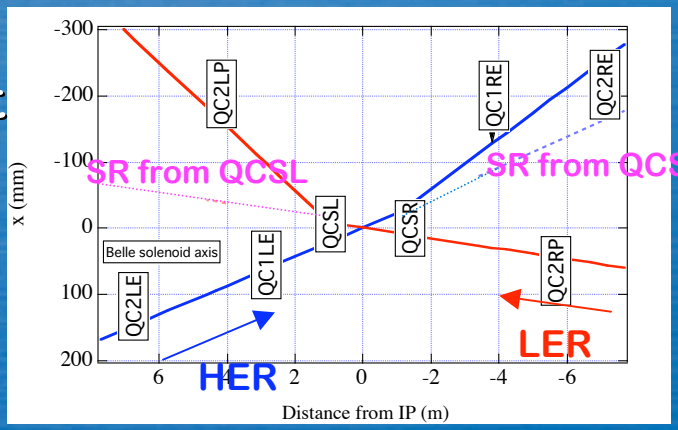
β_x



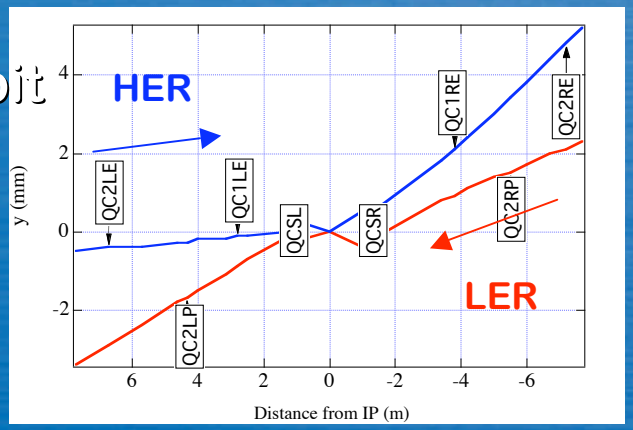
β_y



H-Orbit



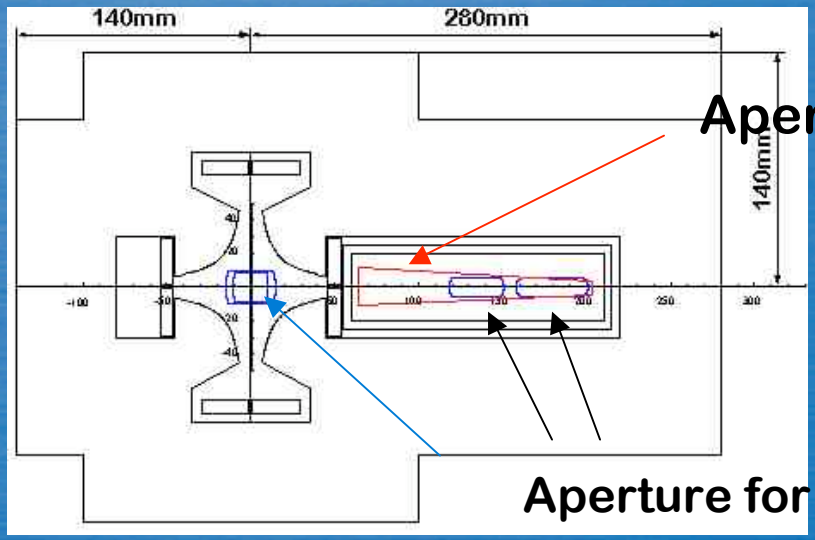
V-Orbit

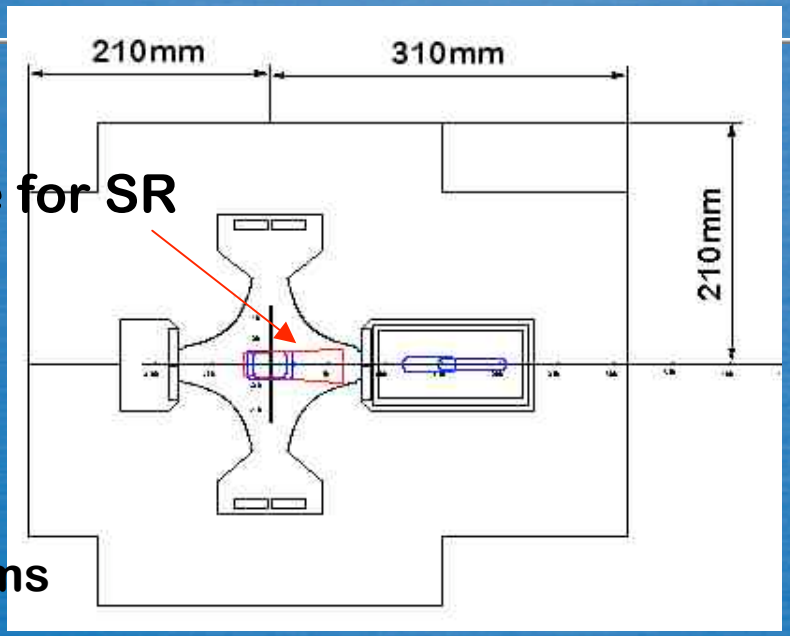


Parameters of special magnets

	Center position from IP(m)	G (T/m)	L (m)	Bore radius (mm)	Space for coil (mm)
QC2LE	6.7	3.37	2.0	50	293
QC2LP	4.3	6.69	0.6	80	189
QC1LE	2.8	15.54 42.9	0.64 0.232	25 31	108 (super)
QCSL	0.969	34.24	0.418	90	
QCSR	1.163	36.01	0.333	90	
QC1RE	3.8	12 34.0	0.75 0.266	48 80	101 (super)
QC2RP	5.5	3.05	1.0	40	148
QC2RE	7.2	8.8	0.8	90	206

QC1LE, QC1RE magnet





QC1LE

G=15.54T/m, L=0.64, R_0=25mm
3turn-8x8-φ5
3920AT, I=1300A, i=30A/mm^2

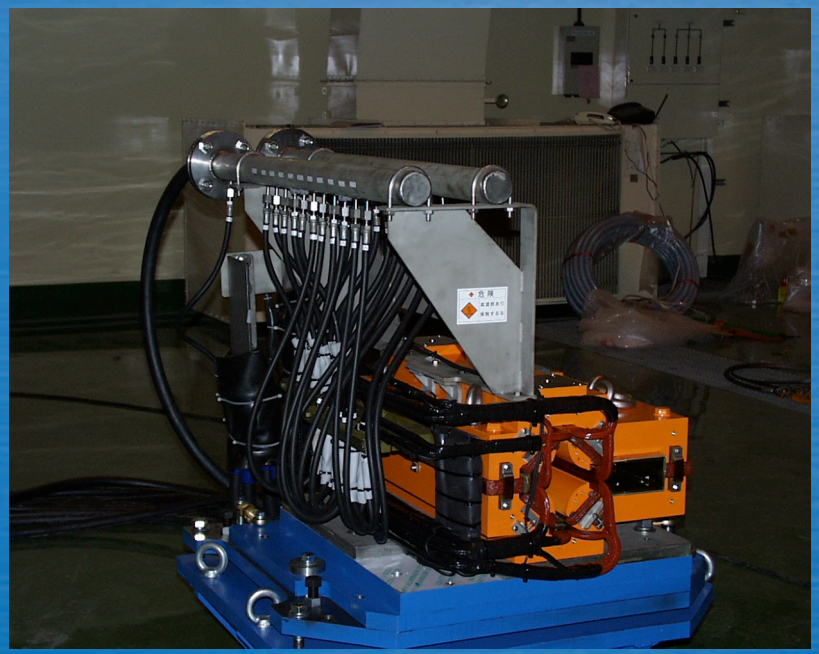
QC1RE

G=12.0T/m, L=0.75, R_0=48mm
3turn-9x9-φ6
11050AT, I=3700A, i=70A/mm^2
P=157kW, water flow: 4m/sec
dT=30℃

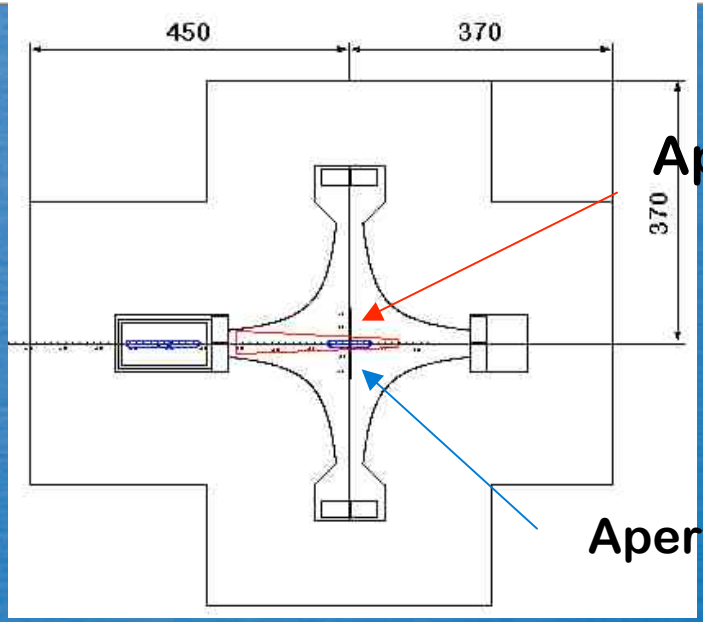
Needs further study

KEKB QC1LE

- Operation current: 2500A
  Current density: 70A/mm^2
- Power 80 kW
- 3 turn coil per pole
- 3 water circuits per pole.
- Water flow speed: 5 m/sec
- Fast protection system against coil burn out.
- Low oxygen water

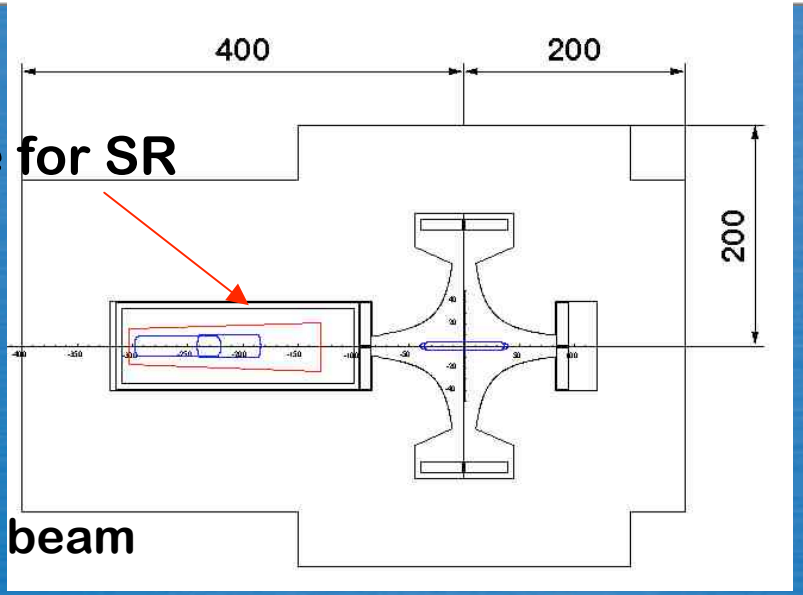


QC2LP, QC2RP magnet



Aperture for SR

Aperture for beam



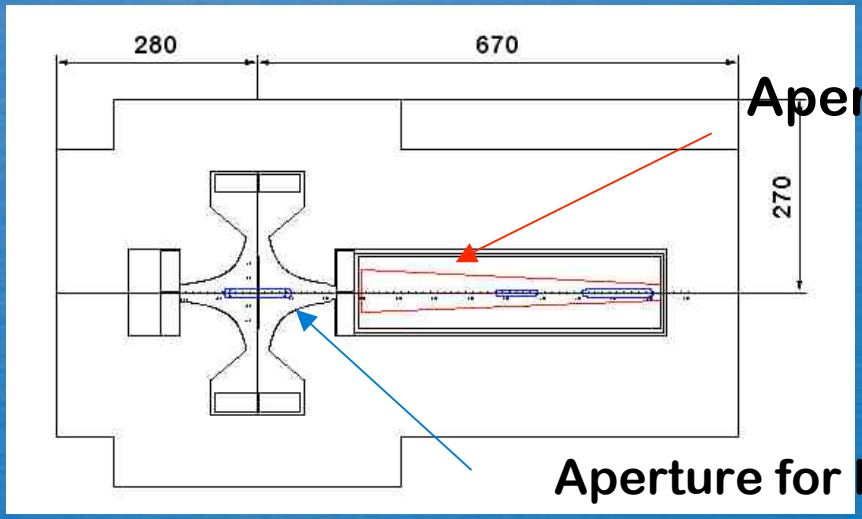
QC2LP

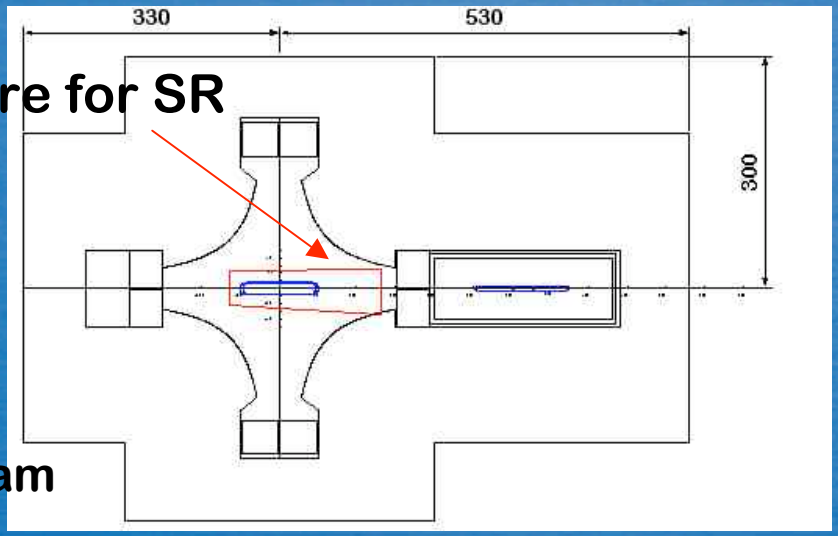
G=6.69T/m, L=0.6, R_0=80mm
15turn-7x7-φ4
17100AT,I=1150A, i=32A/mm^2

QC2RP

G=3.05T/m, L=1.0, R_0=40mm
3turn-8x8-φ5
1980AT, I=660A, i=15A/mm^2

QC2LE, QC2RE magnet





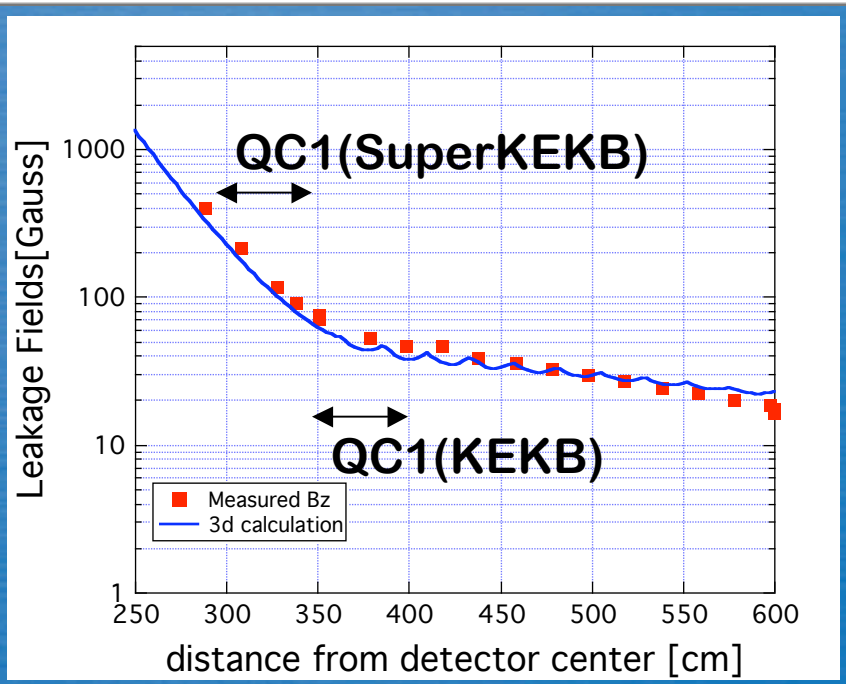
QC2LE

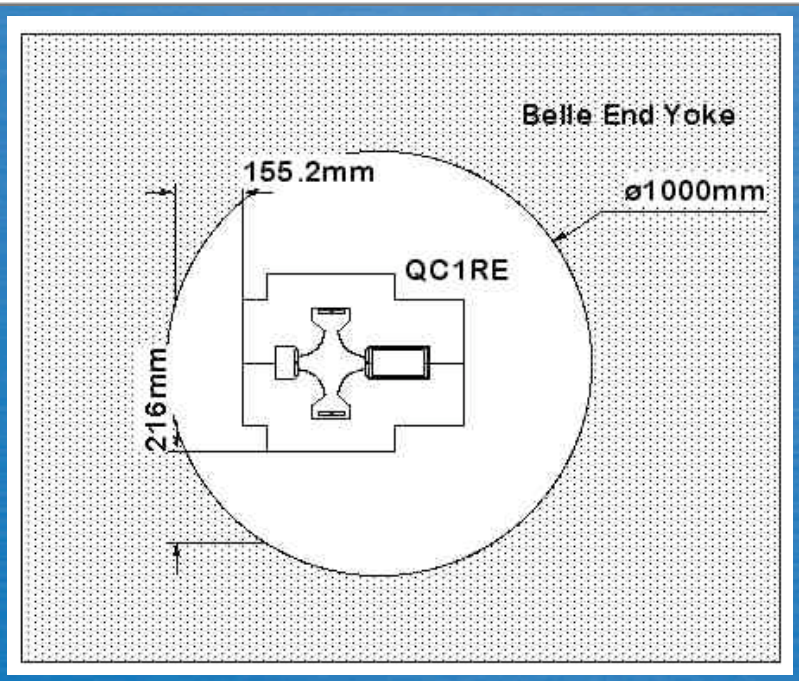
G=3.37T/m, L=2.0, R_0=50mm
8turn-12x12-φ8
3400AT,I=450A, i=10A/mm^2

QC2RE

G=8.8T/m, L=0.8, R_0=90mm
16turn-10x10-φ7
28400AT,I=1800A, i=25A/mm^2

Belle and QC1 magnets





- Leakage fields for QC1
  80 -> 250 Gauss

- Space between QC1 and Belle detector are very tight.
- We need to install He transfer line, support table, vacuum chamber, etc. in this space.

Further study

- Detailed design of QC1 and QC2.
- Estimation of the leakage field effect on QC1 magnets.
- Interference with the vacuum chambers, Belle detector, QCS helium transfer line, supporting system, etc.