

# IR Special Magnets

Mar. 6, 1998

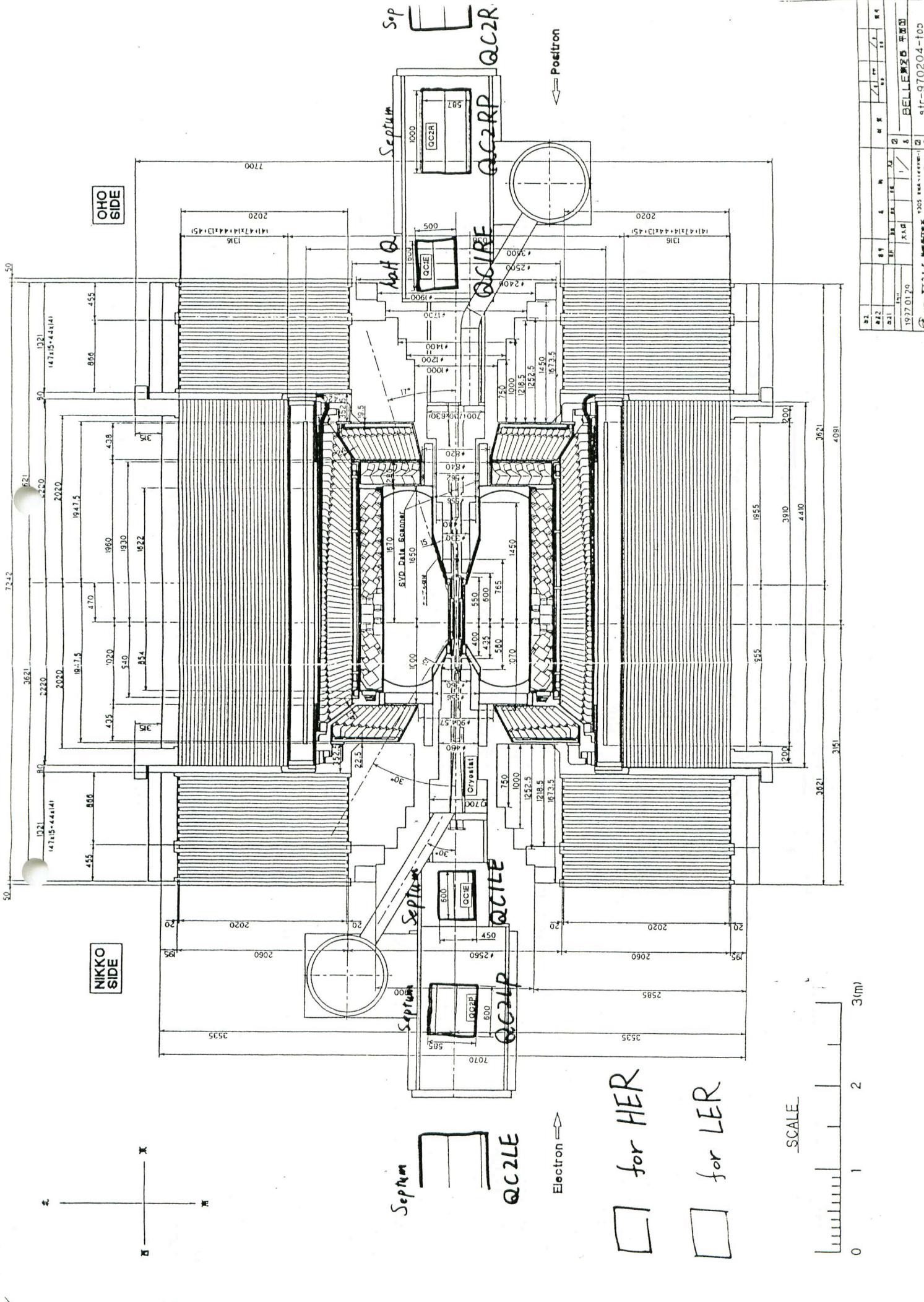
M.Tawada

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# 1. IR Special Magnets

- ◇ Five septum and one half quadrupole(QC1RE) magnets are designed and parameters for these magnets are almost fixed.
- ◇ The IRQ has an asymmetric pole shape. It accompanies higher order multipole components. We will use end-shims and trim coils and backleg coils to reduce higher order multipole components .
- ◇ Present Status
  - QC1LE · · · excitation test
  - QC1RE · · · under fabrication
  - QC2LP, QC2RP, QC2LE, QCRC · · · under engineering design



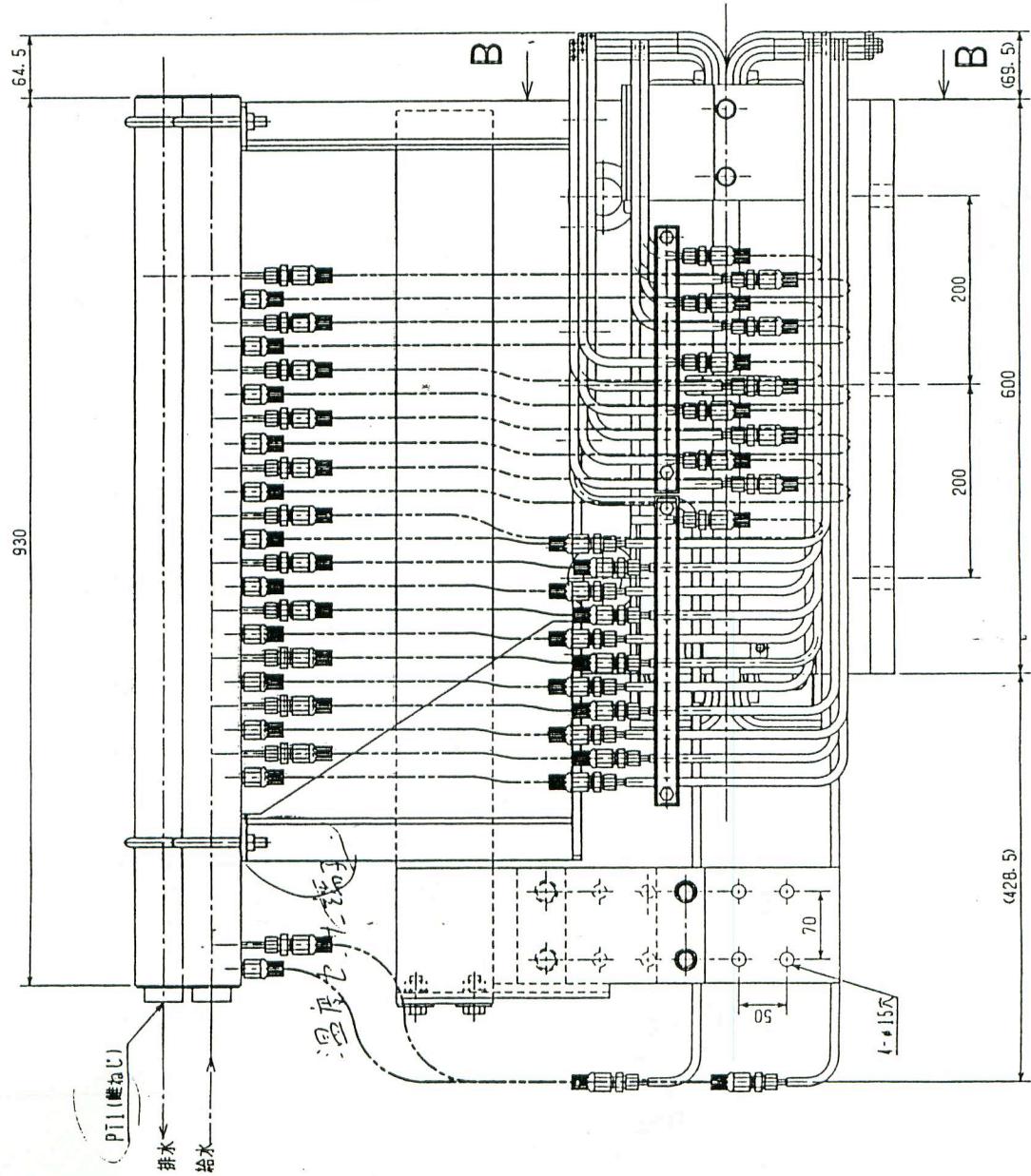
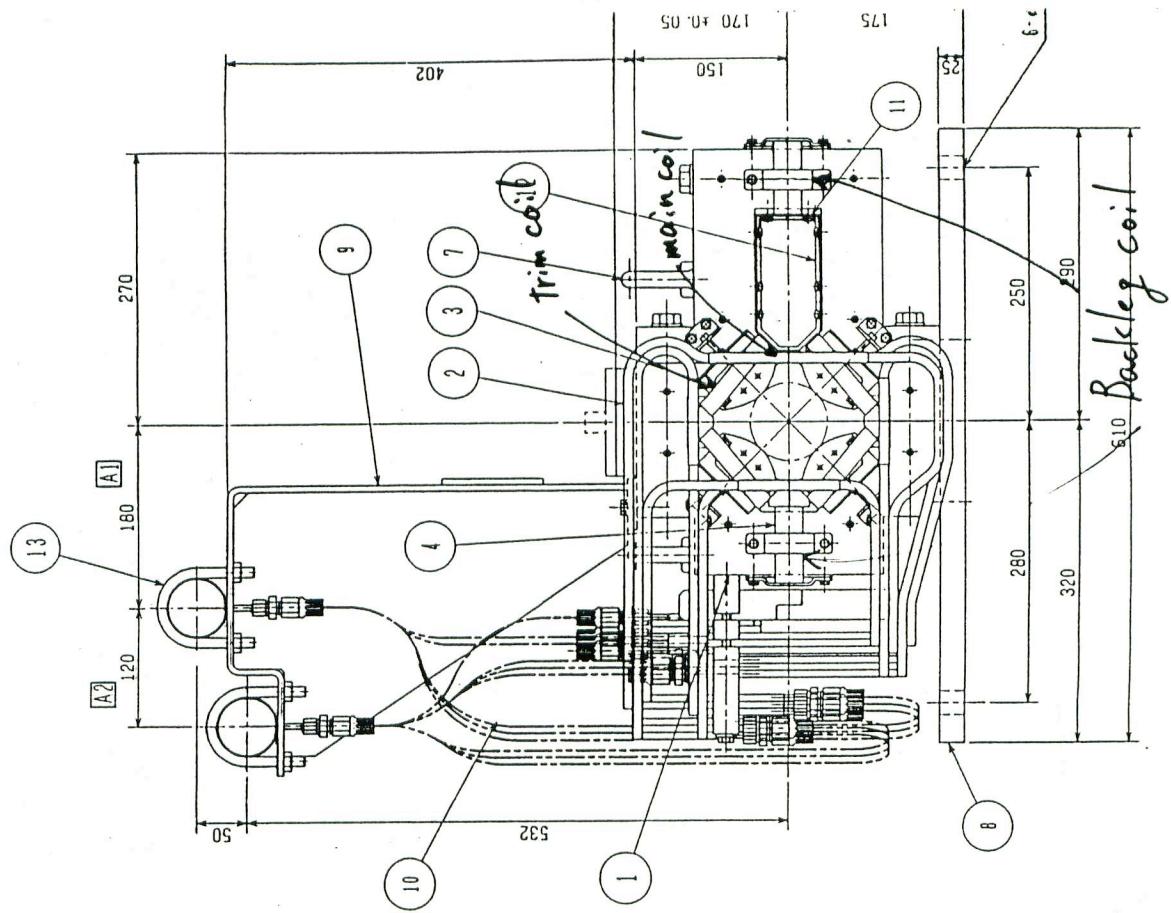
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BELLE 2004-01-20

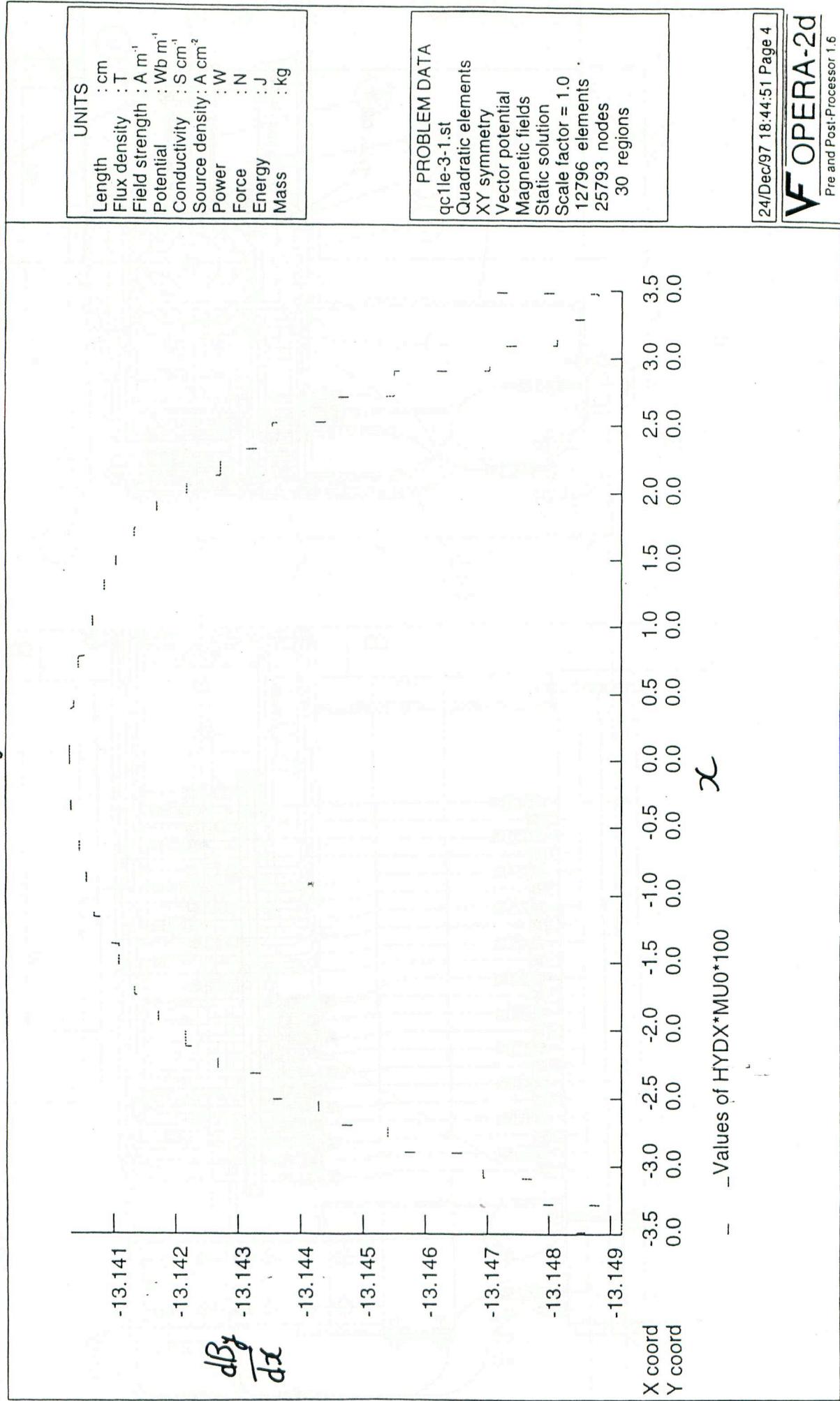
slr-970204-100

item	symbol	unit	QC1LE	QC1RE	QC2LE	QC2RE	QC2LP	QC2RP
field gradient (for 8.4&3.7GeV)	g	T/m	13.14	11.69	3.11	9.99	6.11	2.88
x_aperture(Q field)		T/m	13.80	12.28	3.27	10.49	6.46	3.05
y_aperture(Q field)		mm	30	90	75	80	65	75
bore radius	R0	mm	21	27	14	20	13	16
pole length	LP	mm	38	70	60	60	45	42
yoke shape			600	2,000	600	600	600	1,000
current density	i	A/mm^2	85#	11.5	8.1	30	17.1	20.5
current	N	A turn/P	9,000	25,520	4,950	15,840	5,500	2,250
conductor		mm	6x8 - φ4	10x10 - φ7	8.5x8.5 - φ6	9x9 - φ6	8x8 - φ6	8x8 - φ6
turn	N	turn/P	3	36	18	10	9	3
max. current	I <sub>max</sub>	A	3000#	709	275	1,584	611	733
max. voltage	V <sub>max</sub>	V	41.5#	27.4	38.3	39.4	18.2	10.6
resistance(50°C)	R	mΩ	13.8(55°C)	39	139	25	30	14
power	W	kwatt	124.5#	19.4	10.5	62.5	11.1	7.9
cooling			water	water	water	water	water	water
temparture rise of coil	Δθ c	°C	50#	40	20	40	20	15
water input temparture	θ w	°C	30	30	30	30	30	30
water	Qw	/min	35.6	7.0	7.5	22.3	7.9	7.4
water lines	nw		12	2	4	4	4	4
pressure drop	Δpw	kg/cm^2	2.9	2.7*	2.7*	3.6*	0.5*	0.2*
magnet size	width	mm	600	500	800	900	580	600
	height	mm	830	800	500	700	410	320
	length	mm	1,098	750	2,157	742	716	1,080
weight	Wt	kg	600	1,170	4,710	1,870	1,060	1,310
iron material	SUYP-1		SUYP-1	XCO6	S10C modify	S10C modify	design	design
status			test	fabrication	design	design	design	design
	#for g=15.6T/m		*	pressure drop by header unit is not included.				

( 9000AT , 3 turn coil )



$$\frac{\Delta \theta}{g} \approx 6 \times 10^{-4}$$



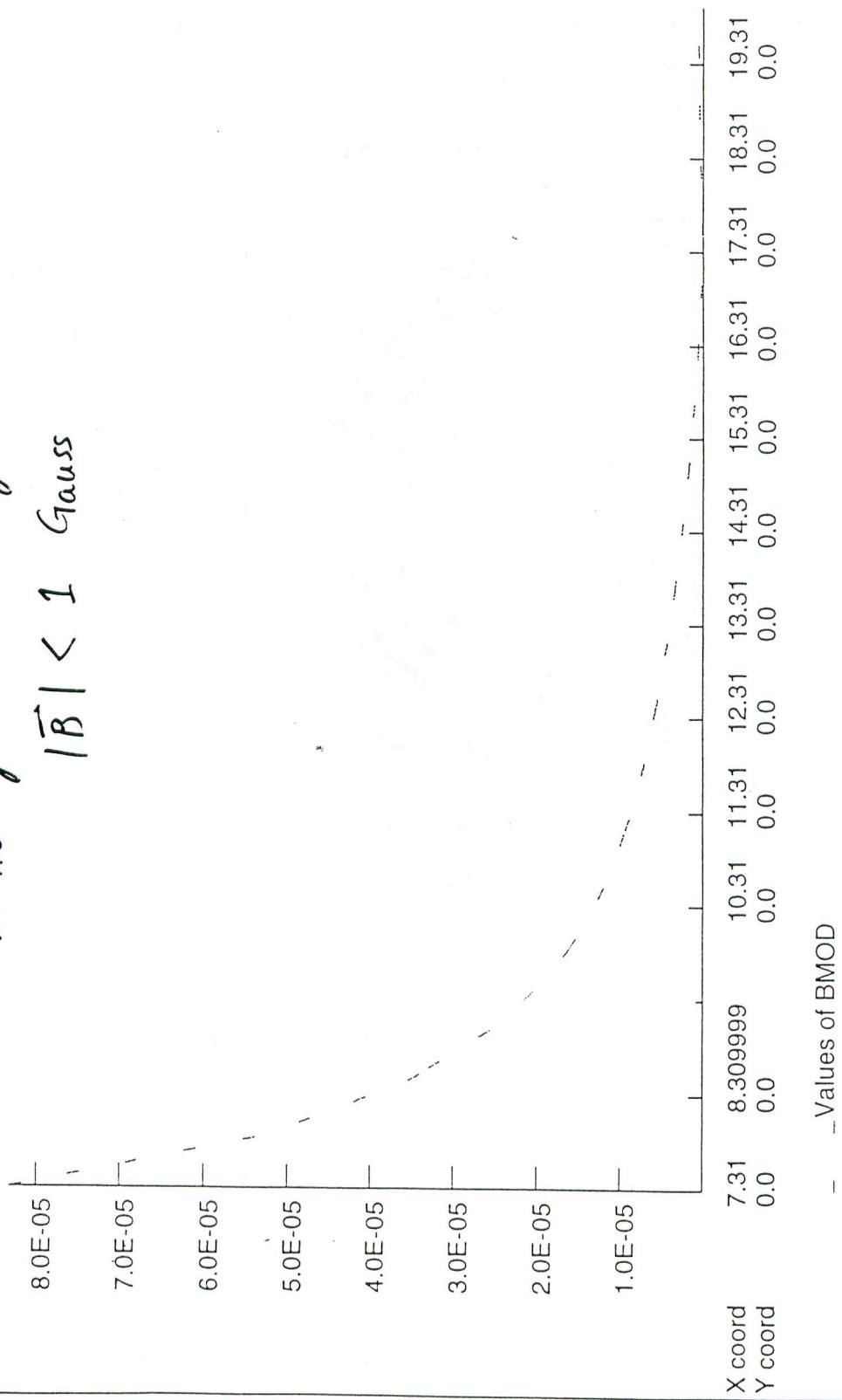
UNITS	
Length	: cm
Flux density	: T
Field strength	: A m <sup>-1</sup>
Potential	: Wb m <sup>-1</sup>
Conductivity	: S cm <sup>-1</sup>
Source density	: A cm <sup>-2</sup>
Power	: W
Force	: N
Energy	: J
Mass	: kg

PROBLEM DATA	
qc1fe-3-1.st	
Quadratic elements	
XY symmetry	
Vector potential	
Magnetic fields	
Static solution	
Scale factor = 1.0	
12796 elements	
25793 nodes	
30 regions	

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in the magnetic shield region

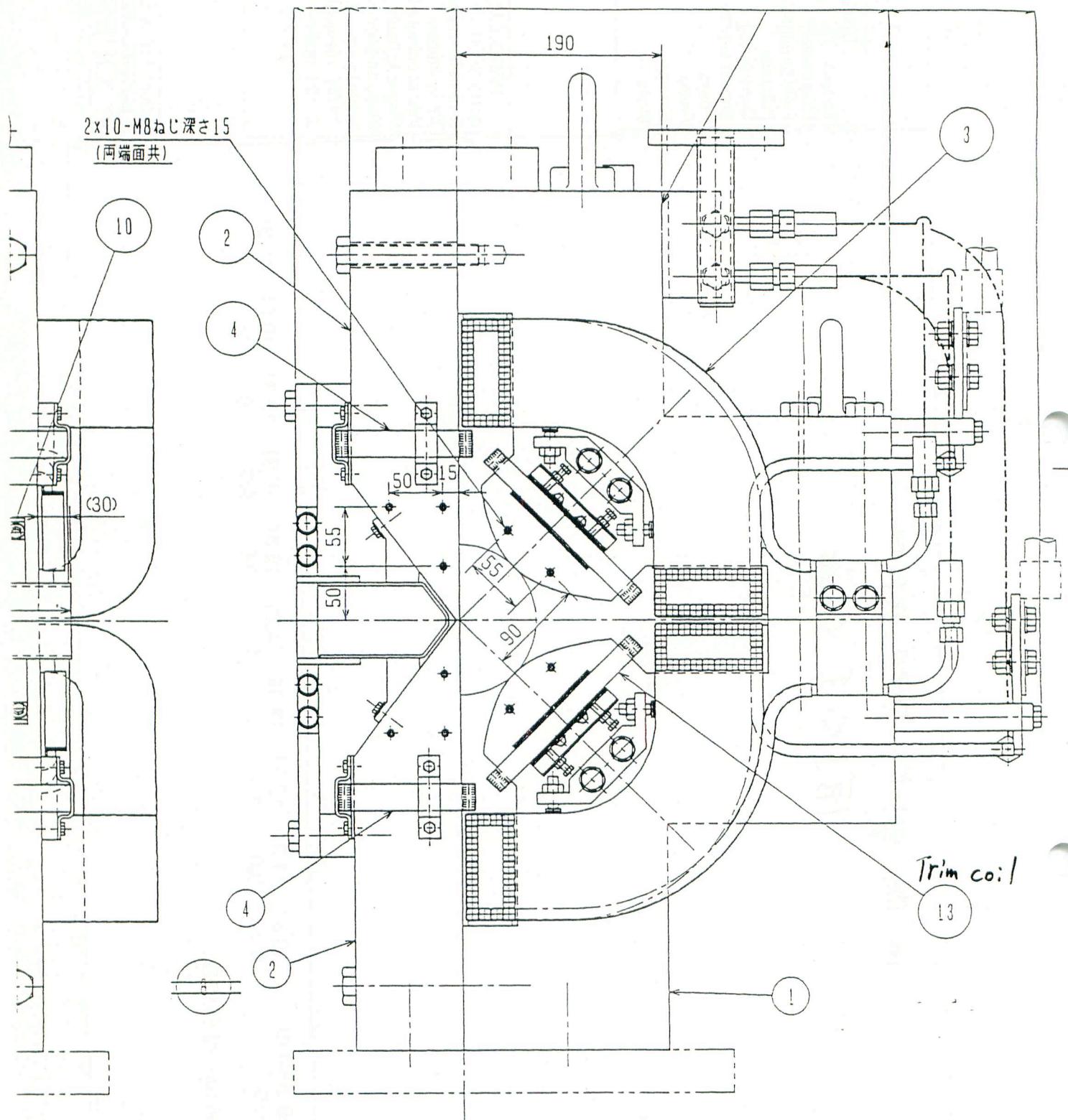
$$|\vec{B}| < 1 \text{ Gauss}$$



UNITS	
Length	: cm
Flux density	: T
Field strength	: A m <sup>-1</sup>
Potential	: Wb m <sup>-1</sup>
Conductivity	: S cm <sup>-1</sup>
Source density	: A cm <sup>-2</sup>
Power	: W
Force	: N
Energy	: J
Mass	: kg

PROBLEM DATA	
qc11e-3-1.st	
Quadratic elements	
XY symmetry	
Vector potential	
Magnetic fields	
Static solution	
Scale factor = 1.0	
12796 elements	
25793 nodes	
30 regions	

# QC1RE (halt Q)



# Q CIR E ( half Ø )

$$\mathcal{J} = \frac{dR}{dx}$$

$$\frac{\Delta \theta}{g} \approx 2 \times 10^{-4}$$

UNITS	
Length	cm
Flux density	T
Field strength, A.m	
Potential	Wb/m
Conductivity	S/m
Source density, A.cm	
Power	W
Force	N
Energy	J
Mass	kg

PROBLEM DATA	
qc1re-4.st	
Quadratic elements	
XY symmetry	
Vector potential	
Magnetic fields	
Static solution	
Scale factor = 1.0	
15070 elements	
30367 nodes	
21 regions	

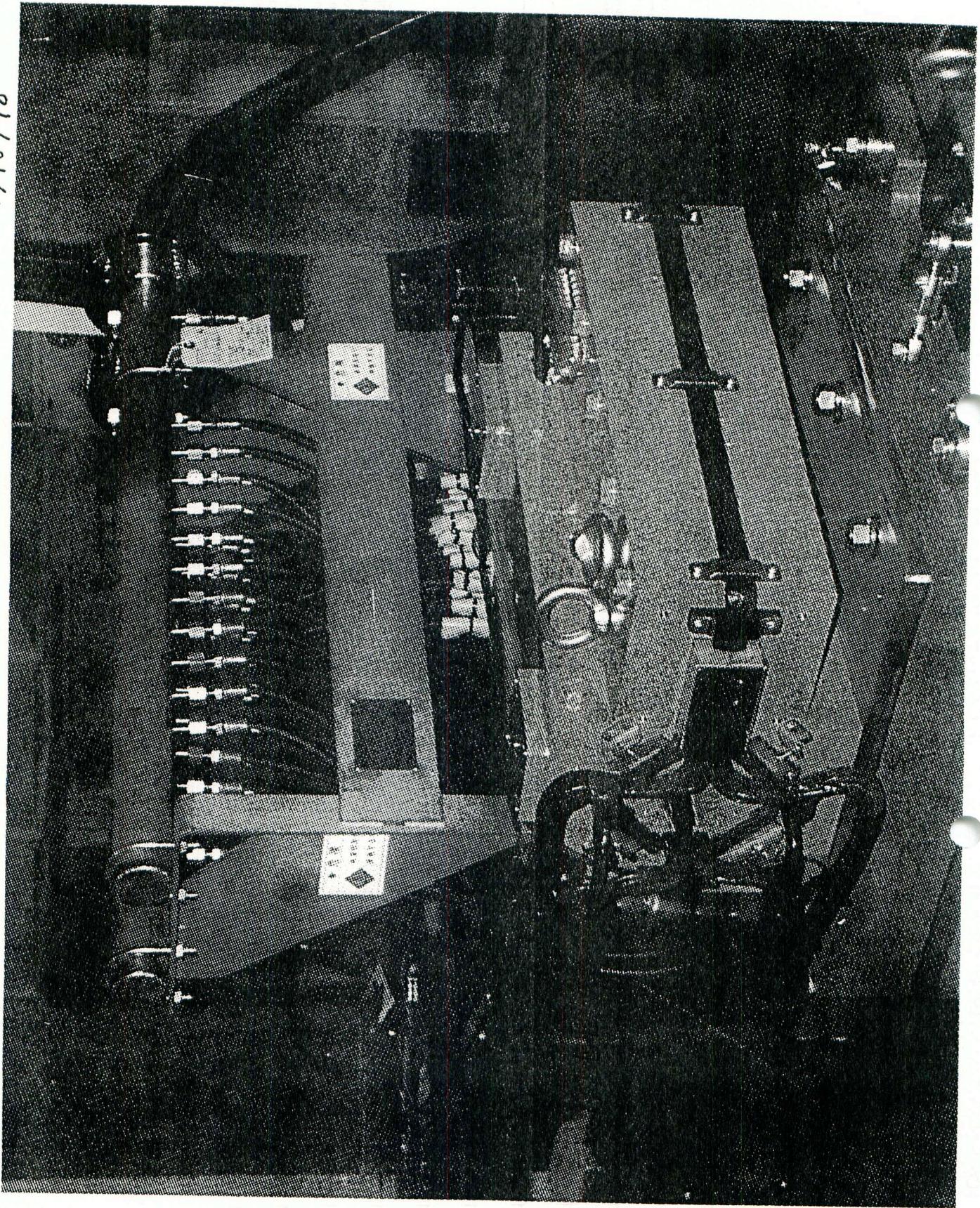
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Y coord 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

- - Values of HYDX\*MU\*100

$\chi$

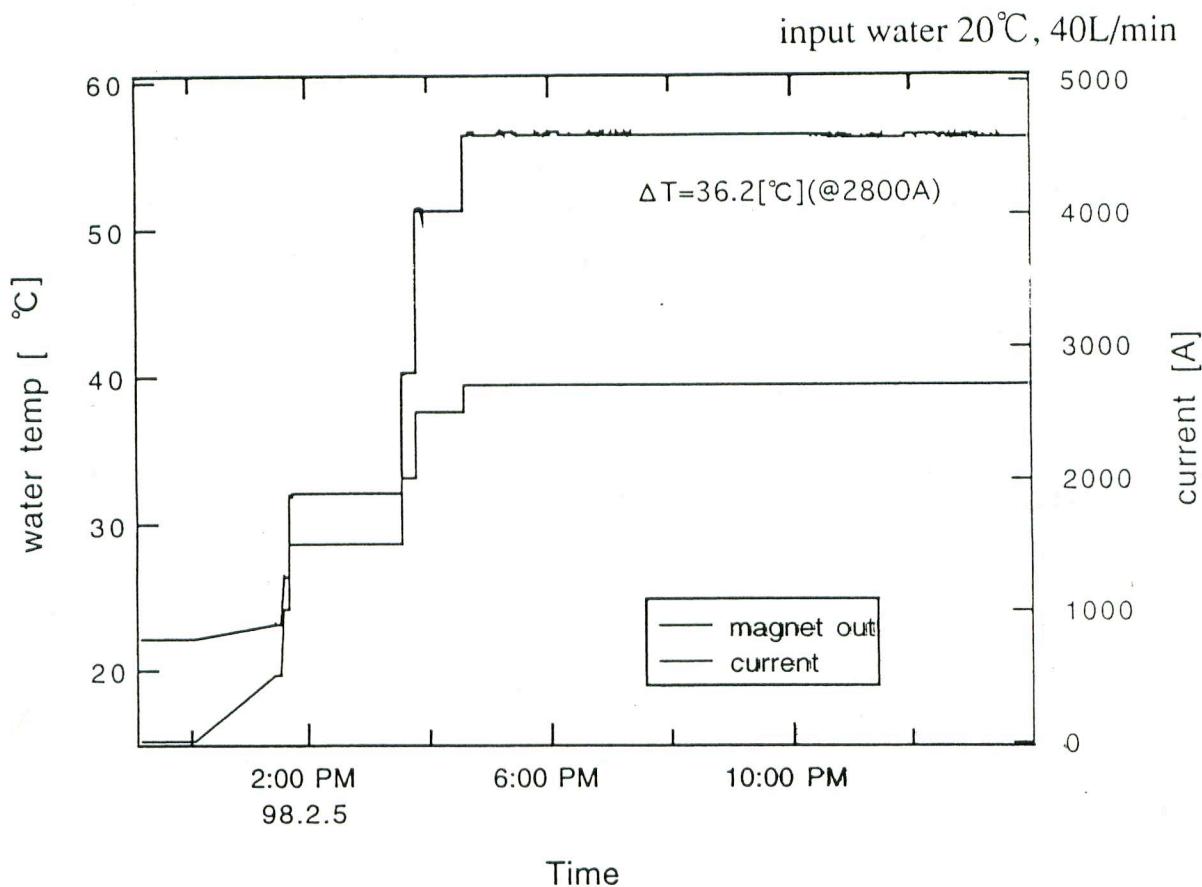
QC1LE

1/16/98



## 2. QC1LE fire test

The current density of QC1LE is too high (about 79A/mm<sup>2</sup>@2800A).



- ◊ The currents of 2800 A is enough for required field gradient.
- ◊ The multipole field will be measured by harmonic coil soon.
- ◊ When QC1LE is excited at 2800A, there is the temperature difference of about 30°C between water channels. This is because hollow conductors which is connected to the power supply is about 1.5 times longer than the others.  
→for excitation of QC1LE @3000A, we need some modifications.

### 3. Belle & QC1RE(LE) magnetic field coupling

QC1LE & QC1RE are placed in the Belle's fringe field ( $\sim 100$  Gauss). The multipole components might arise due to the magnetic field coupling.

We are trying to estimate the magnitude of the multipole components.

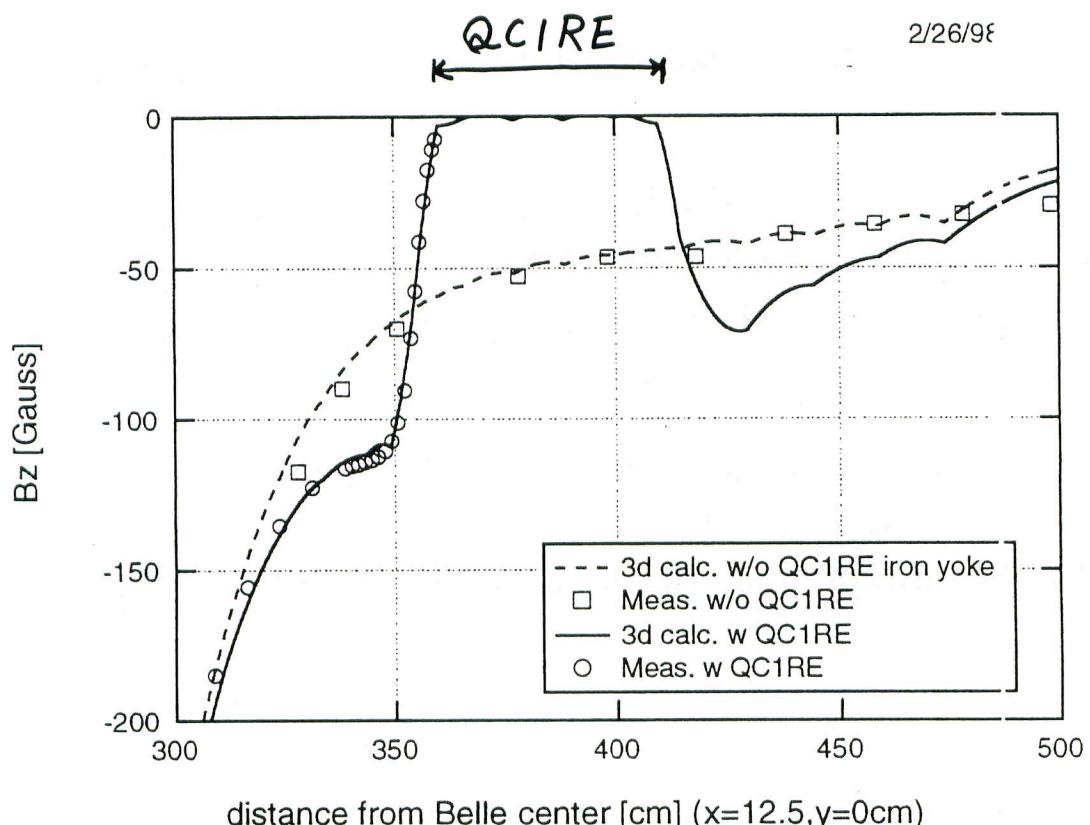
- ◇ Field maps are measured by 3-axis Hall probe with iron yoke.
- ◇ Simulations are done by OPERA-3d(Tosca).  
(w & w/o QC1's coil )

Next →

- ◇ Magnitude of multipole components will be estimated .

## Belle&QC1RE magnetic fields coupling

2/26/98



Field map was measured by 3-axis Hall probe.

→ We will estimate the magnitude of multipole components of QC1 in the Belle's fringe fields.

## 4. Summary

- ◇ QC1LE was succeed in excitation for required field gradient.
- ◇ We will measure the multipole by harmonic coil and try to reduce higher multipole components of IRQ with end shims, trim coils and backleg coils.
- ◇ The coupling field between QC1 and Belle was measured by hall probe and simulated by OPERA-3d.  
The multipole components of magnetic field will be estimated.

## 5. Schedule

- ◇ Fabrication of QC1RE will be completed at the end of March.
- ◇ Fabrication of QC2LP, QC2RP, QC2LE, QC2RE will be completed at the end of July.
- ◇ Measurement of the multipole components of QC2s & install . . . . . August /?