Vacuum Issues

K. Kanazawa

KEKB Accelerator Review
23-25 Feb. 2001

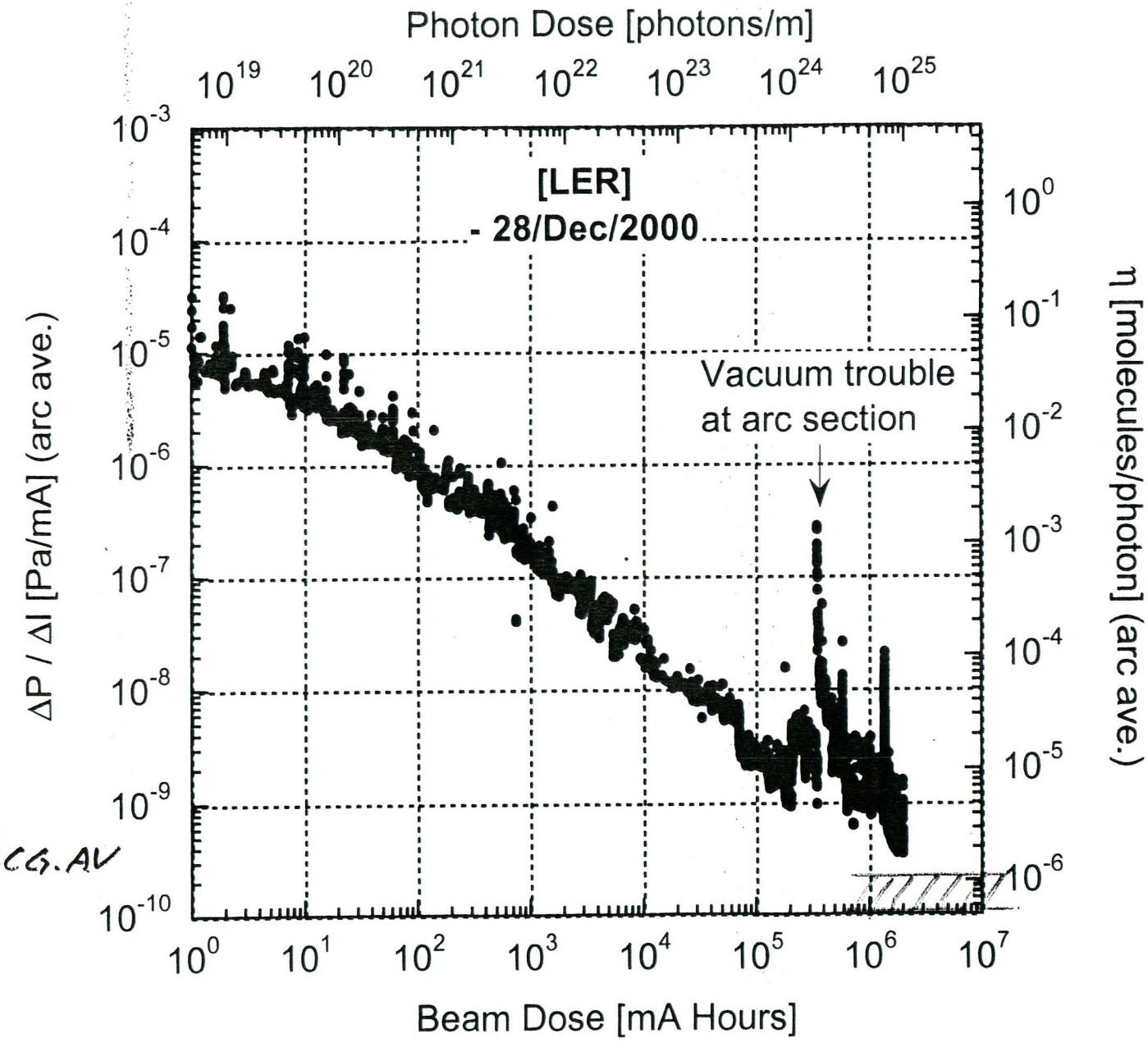
1. General.
2. IR vacuum.
3. Photo electron measurement.

1. General

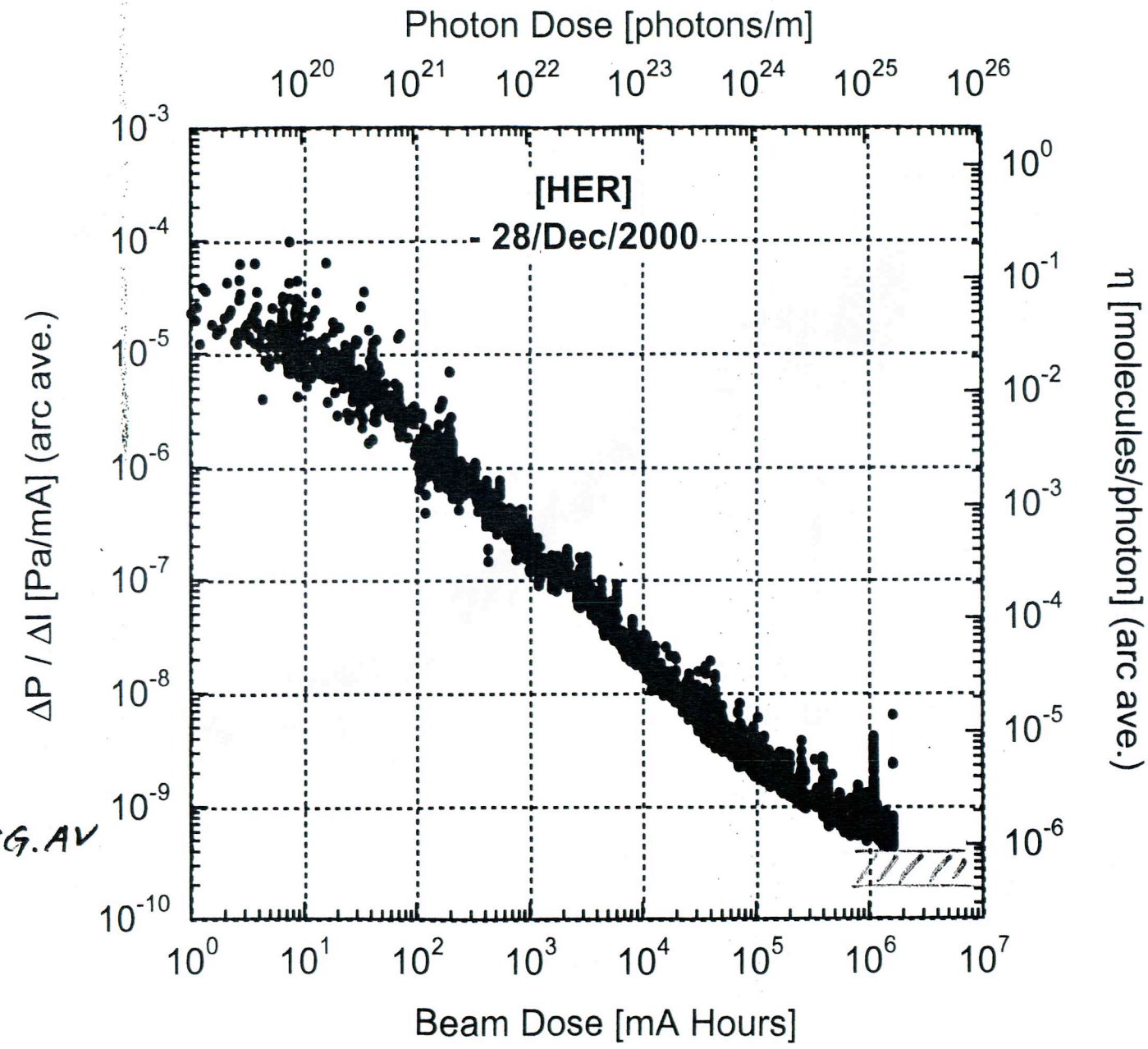
• The average pressure rise ($\Delta P/\Delta I$) of both rings are steadily decreasing. A pressure of 2×10^{-7} Pa (1.5 nTorr) for the design current will be achieved within this year.
The pressure rise in Figures uses 3 × PCCG.AV as an average pressure. If the residual gas is composed of CO only, this pressure is equal to PCO. From the RGA data, however, PCO is estimated between 1 × PCCG.AV to 1.5 × PCCG.AV.

• Heat up of components is observed for movable masks and IR chambers. Their temperatures are always monitored on a display at CCR and can be checked at any time. All temperature signals are connected to the beam abort system with suitable thresholds.

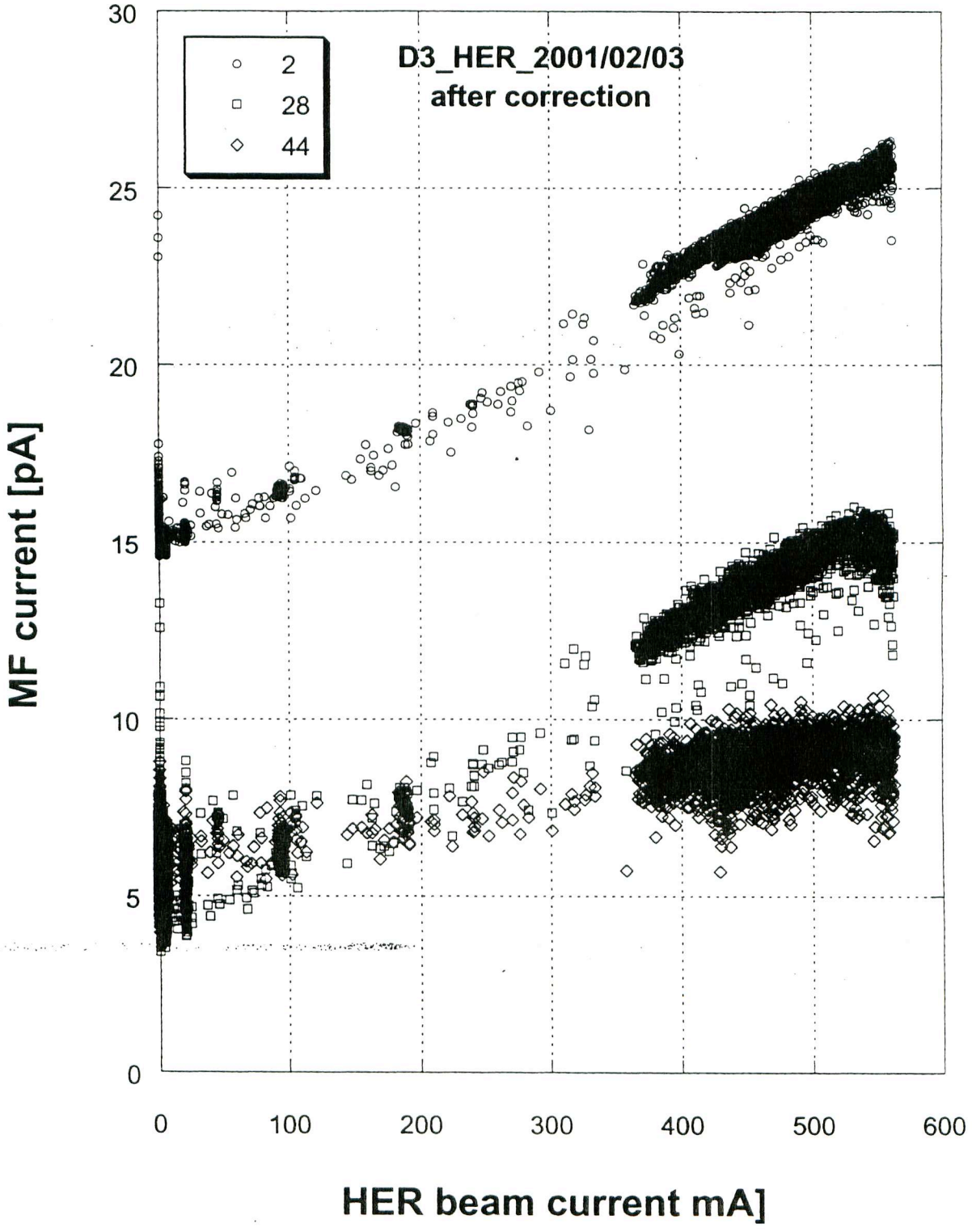
• Vacuum work is now done with considerable care to avoid degradation of vacuum surfaces. Continuous efforts are made by the vacuum group to finish a recovery work as quickly as possible. The replacement of small components typically takes 10 hours from venting to beam on.



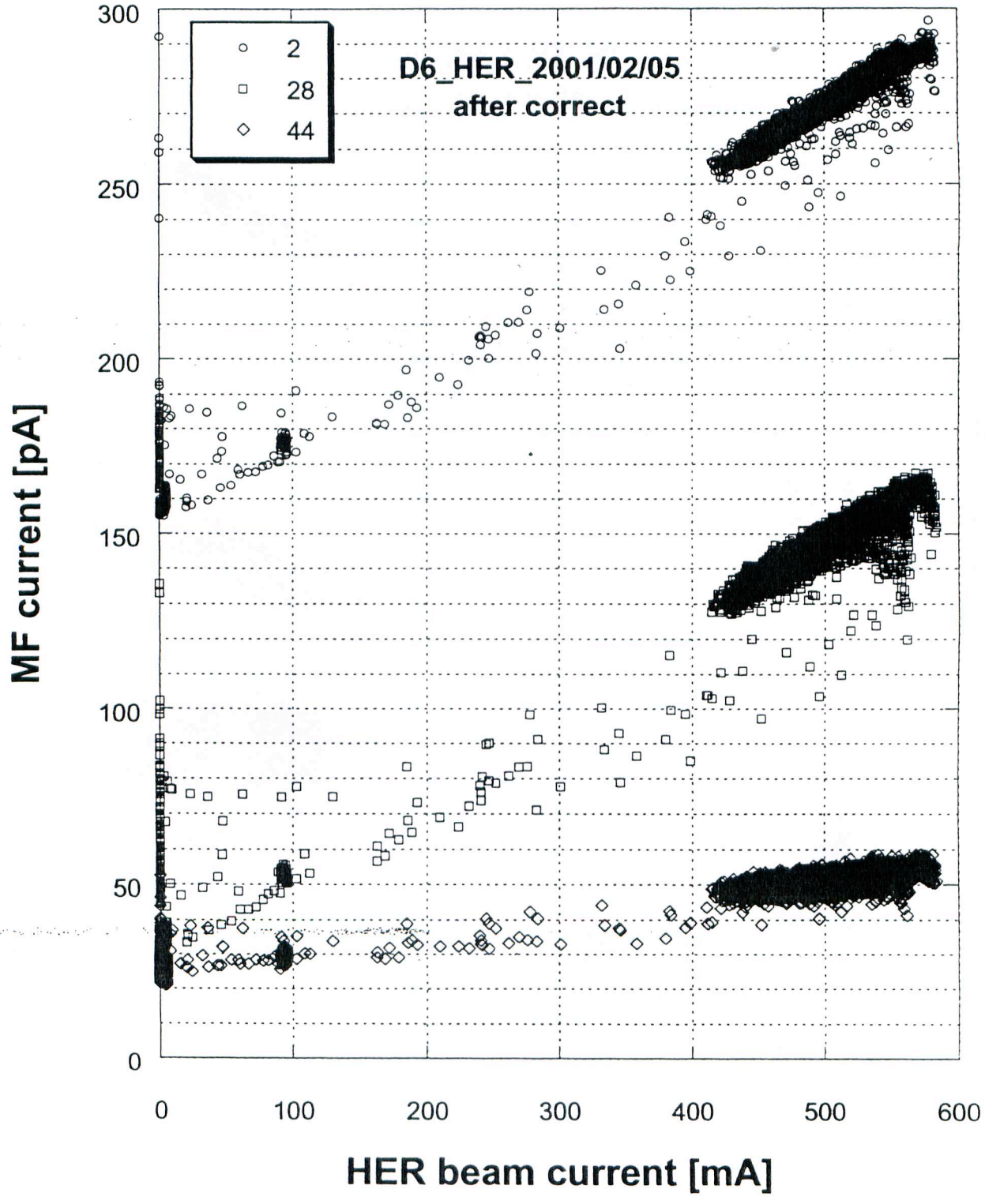
$P = 3 \times P_{CCG.AV}$

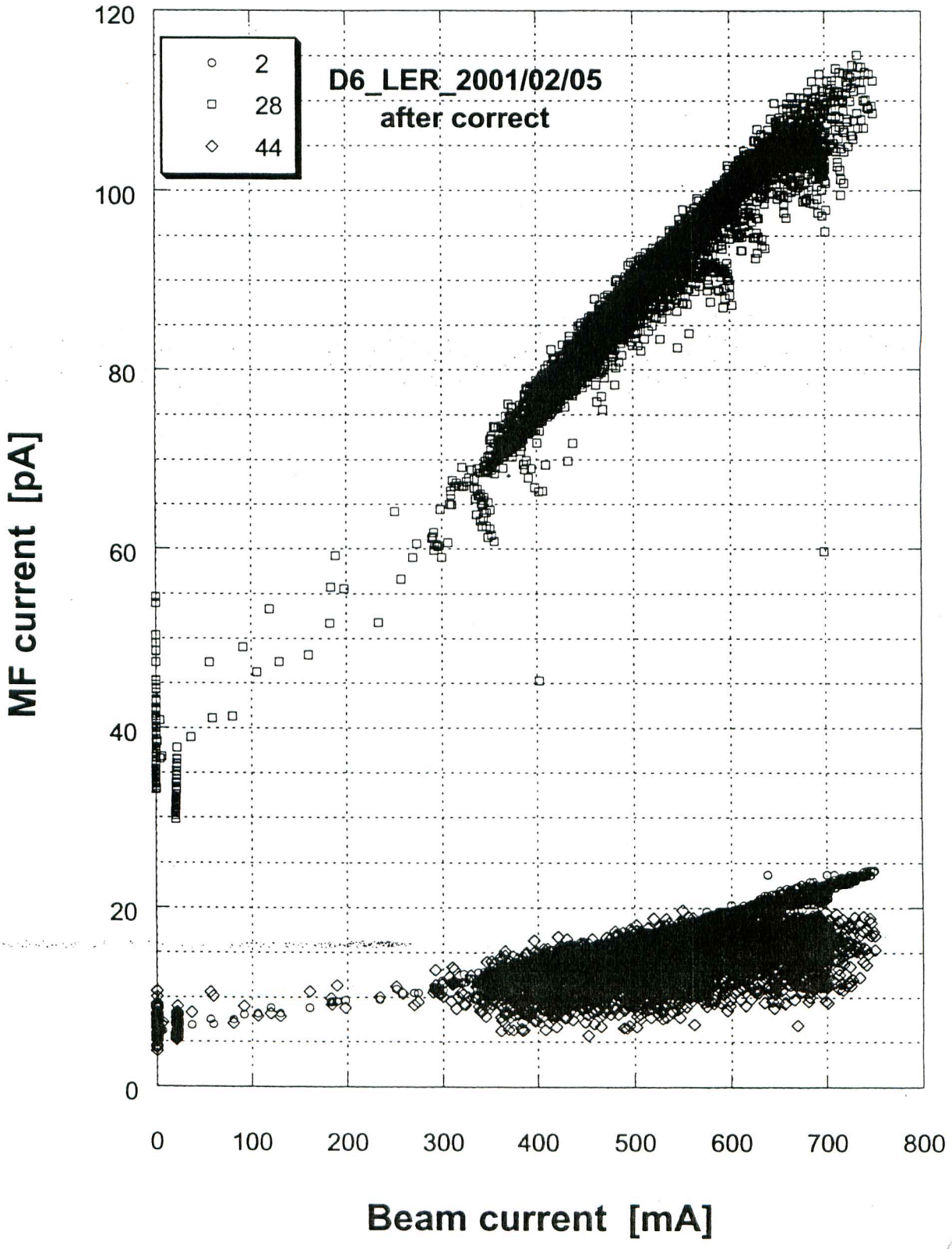


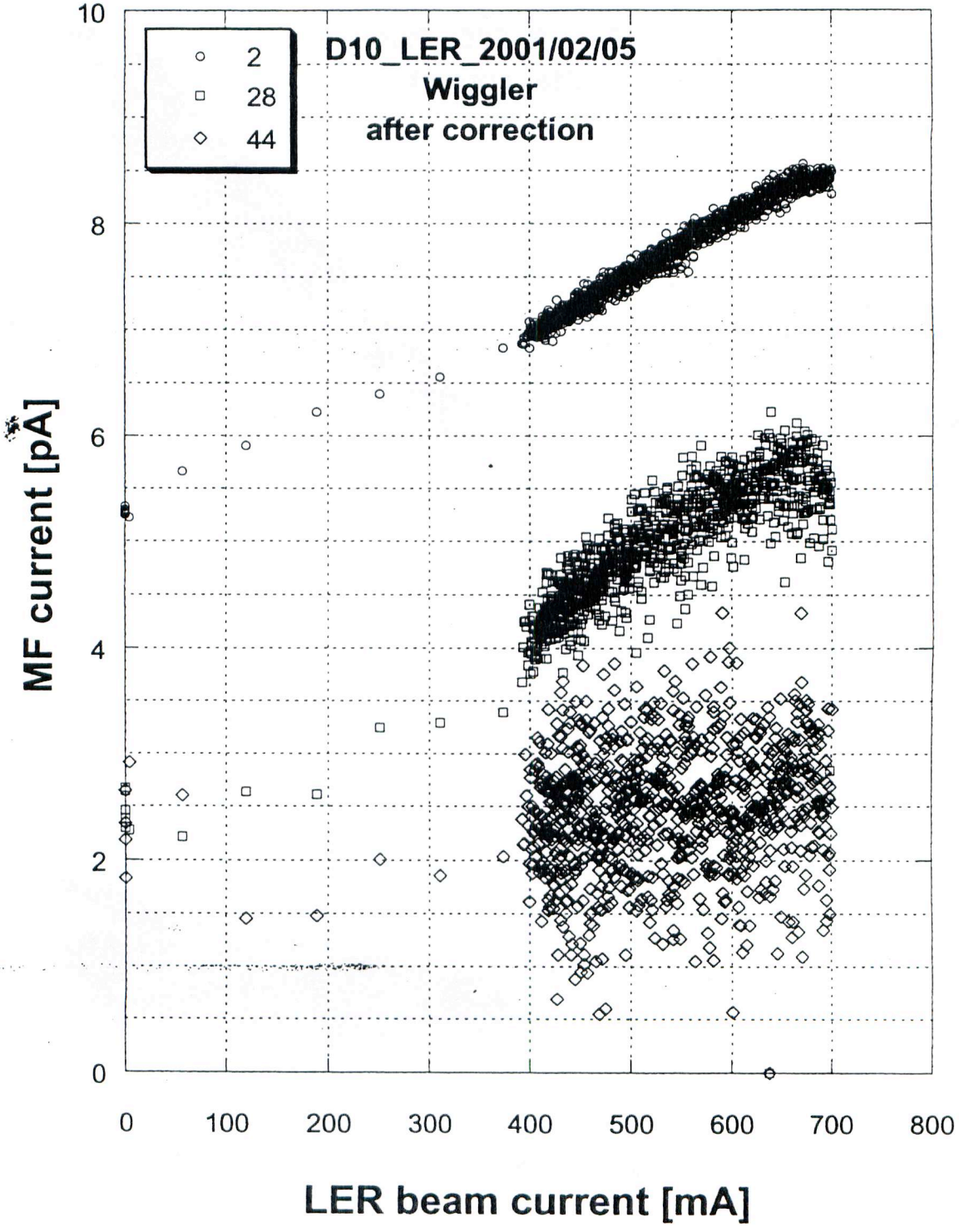
$P = 3 \times P_{CCG.AV}$

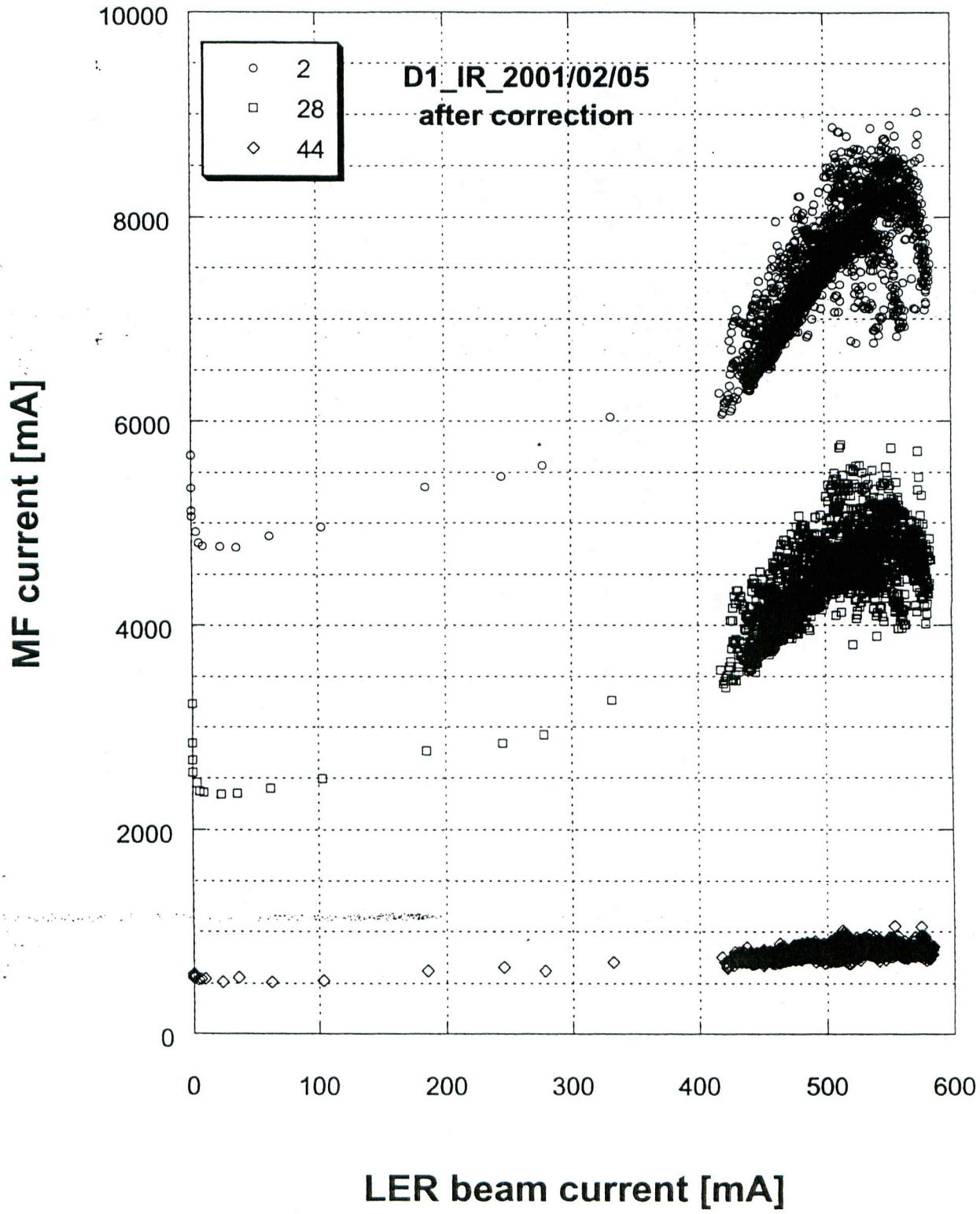

D3_HER_2001/02/03
after correction
2
28
44
MF current [pA]
HER beam current mA]
0
5
10
15
20
25
30
0
100
200
300
400
500
600

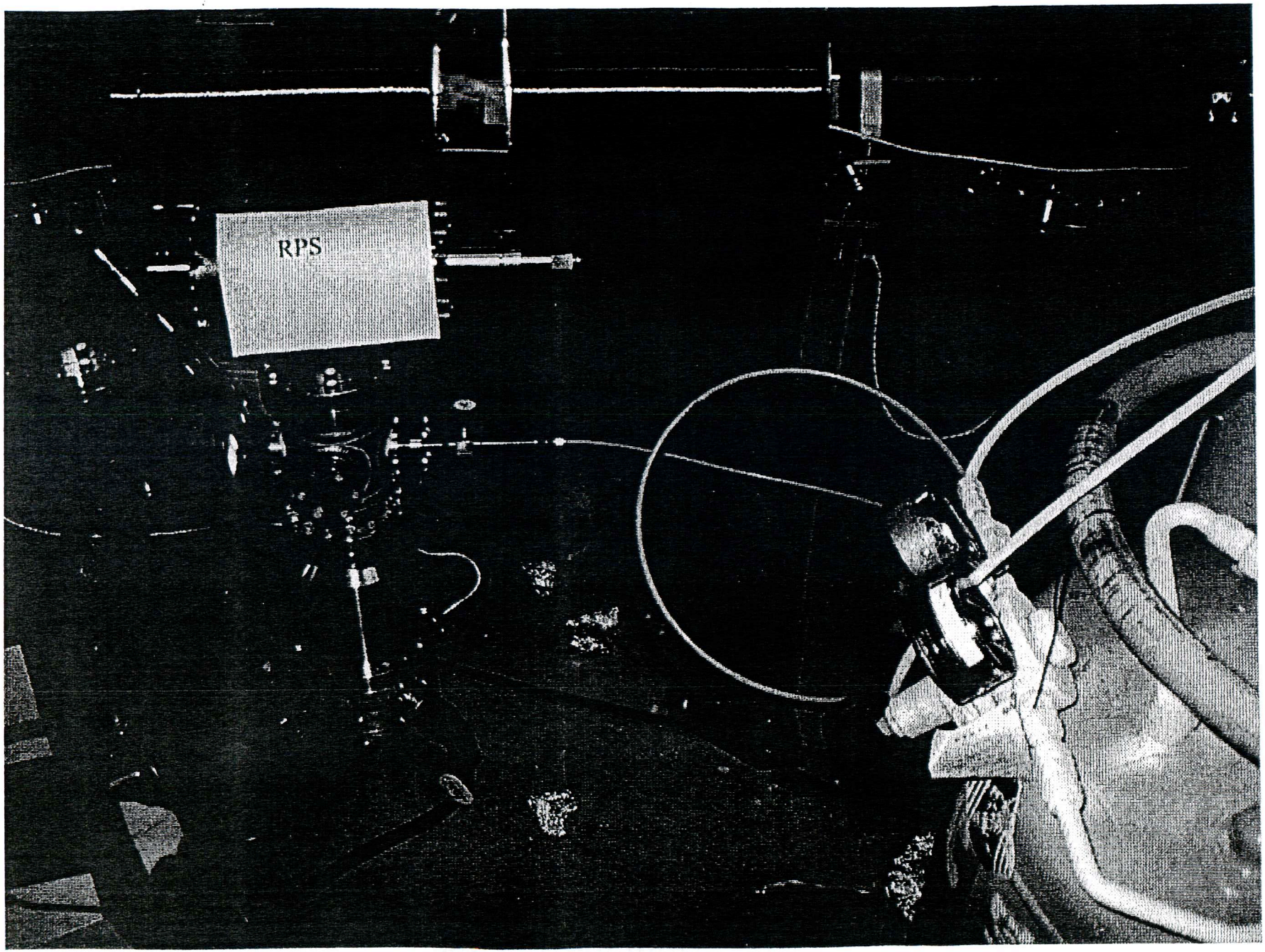
5


D6_HER_2001/02/05
after correct
2
28
44
MF current [pA]
HER beam current [mA]
0
50
100
150
200
250
300
0
100
200
300
400
500
600


D6_LER_2001/02/05
after correct
2
28
44
MF current [pA]
Beam current [mA]
0
20
40
60
80
100
120
0
100
200
300
400
500
600
700
800


D10_LER_2001/02/05
Wiggler
after correction
2
28
44
MF current [pA]
LER beam current [mA]
0
2
4
6
8
10
0
100
200
300
400
500
600
700
800


D1_IR_2001/02/05
after correction
2
28
44
MF current [mA]
LER beam current [mA]
10000
8000
6000
4000
2000
0
0
100
200
300
400
500
600


RPS

2. IR Vacuum

• To reduce temperature rise of the near IR bellows, the front ends of QCS-L and QCS-R chambers were fabricated using copper instead of stainless steal. The bellows units were also replaced with new one which has an enhanced cooling structure. A thermocouple was directly attached to the bellows.
The temperature around the 'octopos' is quite stable now. The temperature of bellows is found to increase with beam.

• An abnormal temperature rise of QCS-R bellows was found to be caused by two faults:

a) Due to the weakness of the support of QCS-R chamber, the chamber was moved by the atmospheric pressure and the bellows was elongated over its design limit. As a result four fingers were damaged.

b) An inner component was weakly welded and might have developed a gap which can be seen by circulating beam.

These faults were corrected.

• By reshaping the QC2RE copper chamber the position of the chamber was adjusted to increase a clearance for the SR from QCS-R. The heat up of this chamber became partly normal.

• Two cooling bars were attached to the QC2RP chamber. The effect is not clear.

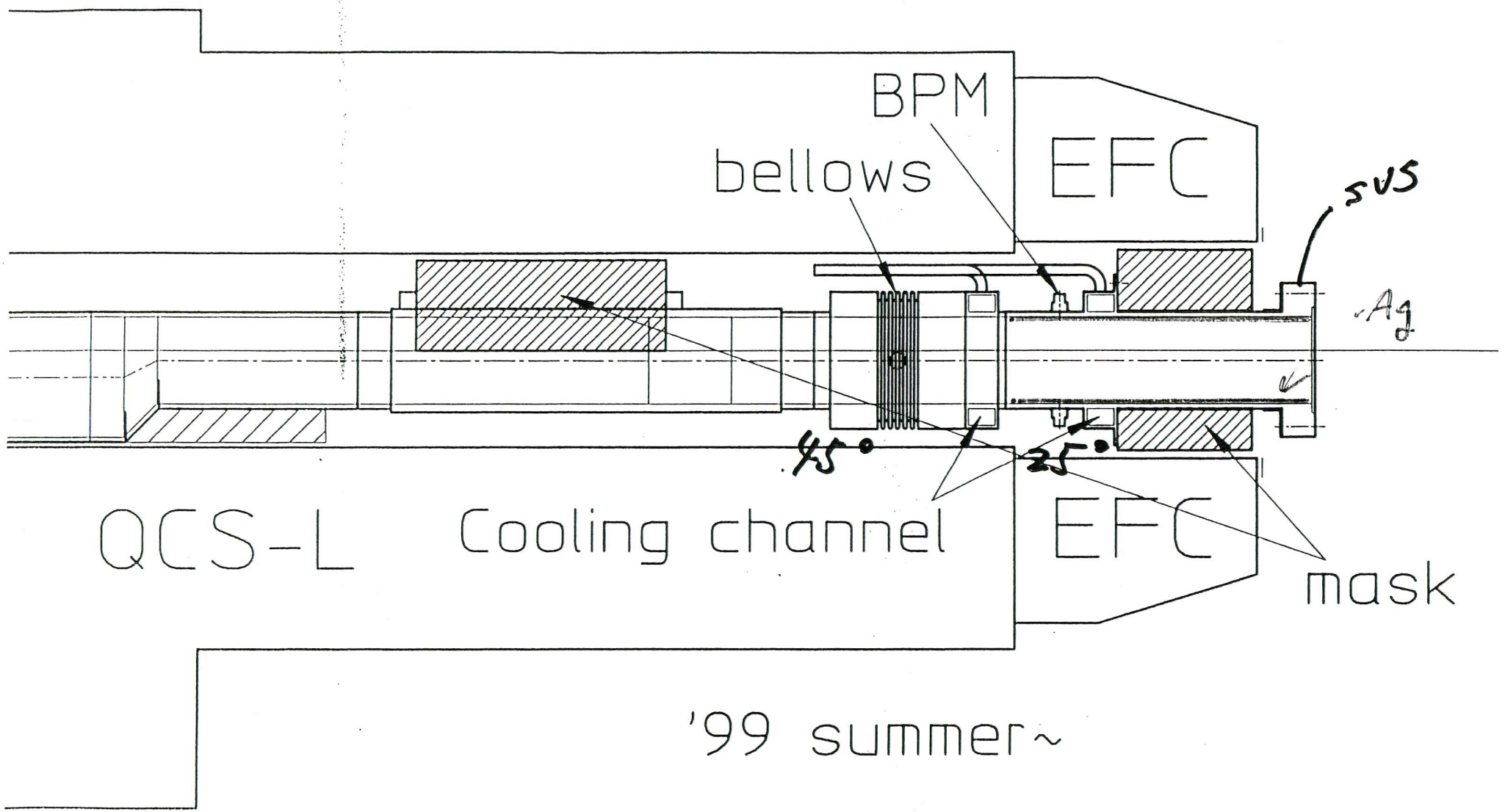
• The independent cooling system for IR chambers was prepared. Sufficient flow rate and cooling capacity are ensured.

••••••••••••••••••

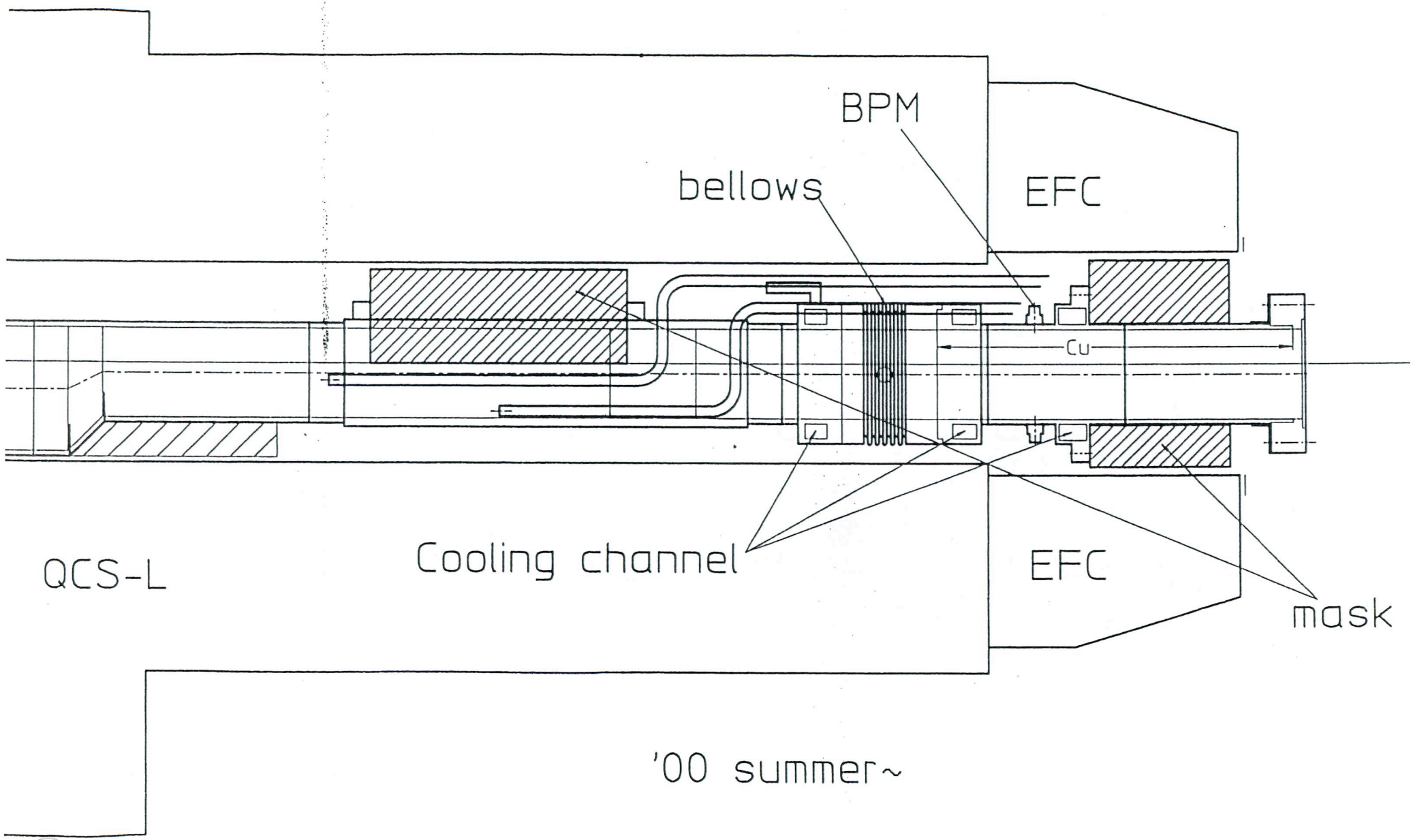
• The reinforcement of pumping capacity was postponed until a reasonable guideline is obtained by the back ground study.

• The temperature rise around 1m mask of QCS chambers will be a problem at an operation with the design current. To add a cooling for this part is difficult because of a limited space. Redesigning of QCS chambers will be necessary.

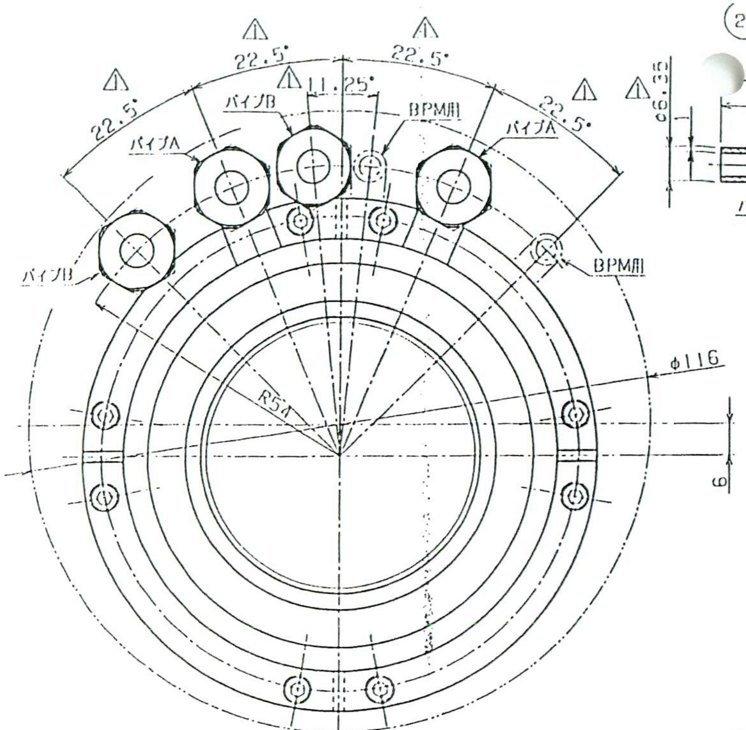
• A newly discovered problem is the motion of QC1RE magnet associated with the temperature rise of QC1RE chamber. Cooling bar will be added on the chamber this summer.

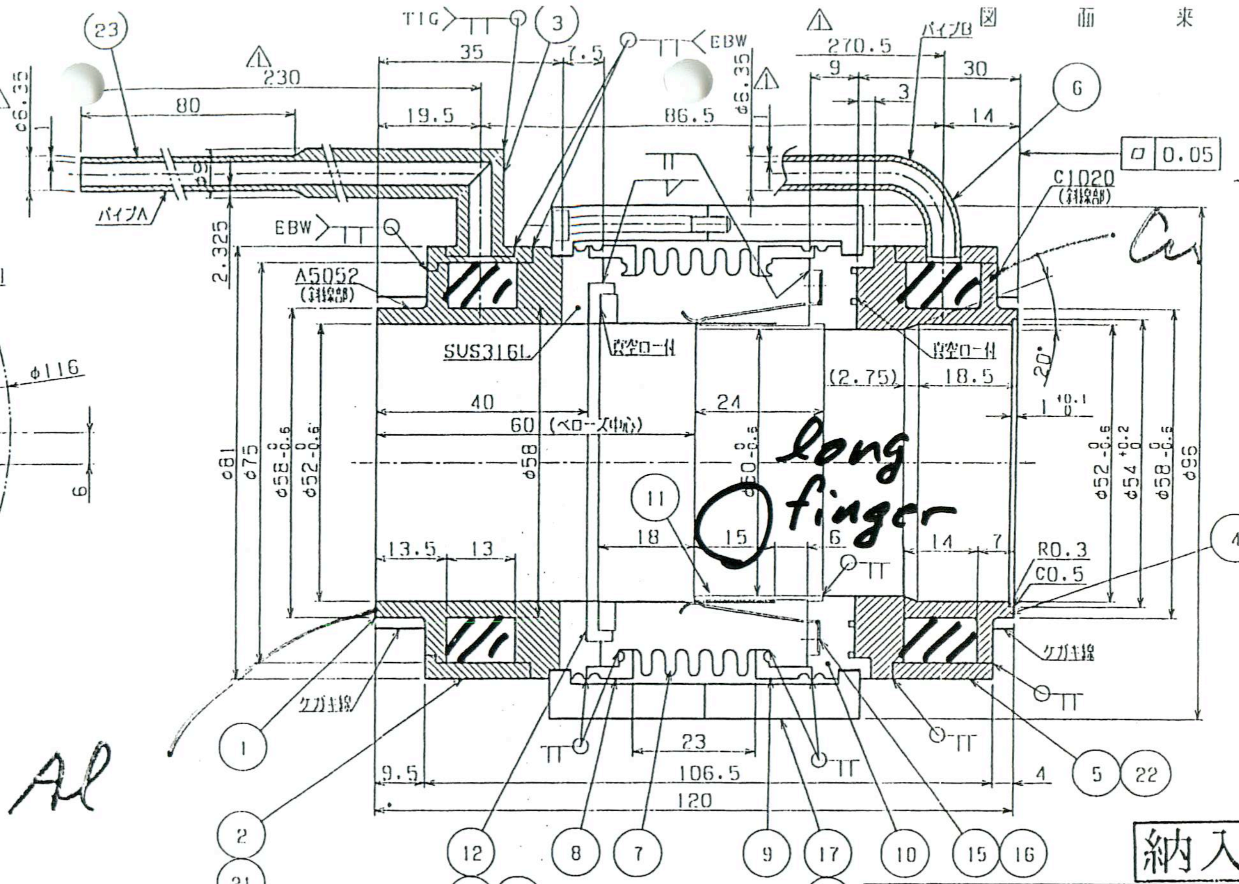


'99 summer~



'00 summer~





仕様

ヘリウムリーク量：1.3×10⁻¹¹ Pa・m³/sec 以下

ベローズ寸法：ID 70× OD 80

ベローズ変位量：曲ゲ方向 20 mrad (1.15° deg)

曲ゲ位置 ベローズ中央

冷却水耐圧：1.22 MPa

透磁率：1.05 以下（真空熱処理炉冷可）

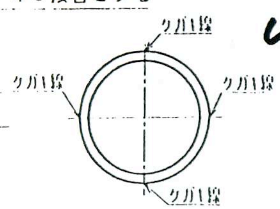
全ての部品を対象とする

真空ロー付：品4・10及び、品12・13・14で接合とする

注．

1．胴外面に製品名称を記入の事。

2．ケガキ線を設ける事。（右図参照・計8ヶ所）



QCS-L Bellows unit.

品番	部品名称	数量	材質	備考
23	冷却パイプAA	2	A5052	
22	仕切版B	1	C1020	
21	仕切版A	1	A5052	
20	ユニオン	4	SUS316L	SS-400-6:Swaglok
19	六角穴付ボルト	4	SUS304	M3X30L
18	カバーB	1	Al	
17	カバーA	1	Al	
16	フィンガー押さえ	1	SUS316L	
15	スプリングフィンガー	1	Inconel-625H	Agメッキ
14	コンタクトフィンガー	1	C1720-1/4H	Agメッキ
13	コンタクト押さえ	1	SUS316L	
12	補強金具	1	SUS316L	
11	内筒	1	SUS316L	Agメッキ

製作台数 1台

品番	部品名称	数量	材質	備考
10	端管C	1	SUS316L	
9	ベローズ金具B	1	SUS316L	
8	ベローズ金具A	1	SUS316L	
7	成形ベローズ	1	SUS316L	
6	冷却パイプB	2	C1220	
5	冷却水路B	1	C1020	
4	端管B	1	C1020	
3	冷却パイプA	2	A5052	
2	冷却水路A	1	A5052	
1	端管A	1	A5052/SUS316L	HIP

納入仕様書

高エネルギー加速器研究機構 殿

承認	審査	製図	尺度
02.6.19	02.6.19	02.6.19	1/1

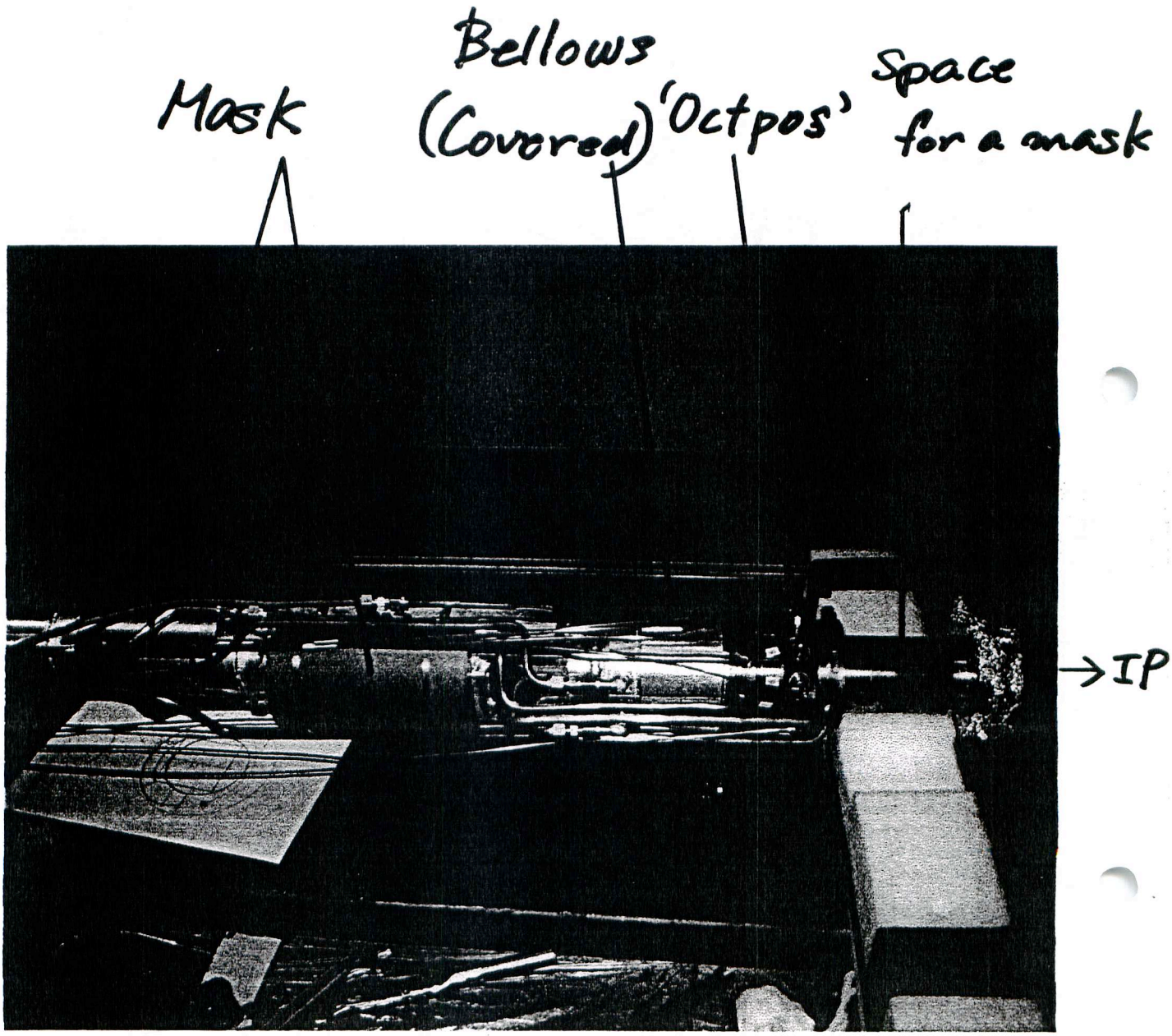
品名：QCS-Lチェンバー用ベローズ 改良品

図番：L0351 REV 1

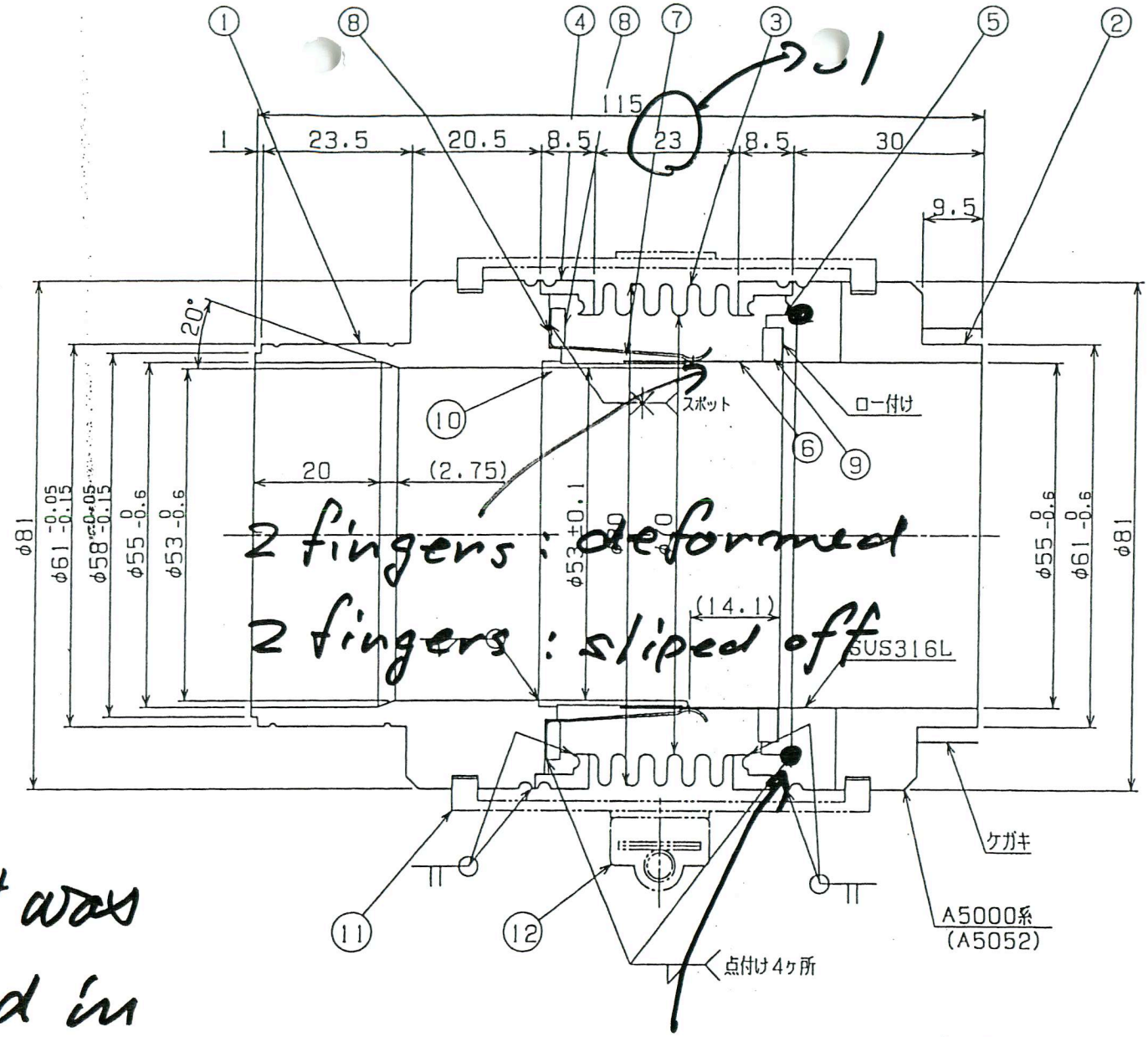
バルカーセイキ株式会社

記号	図面来歴
△×1	アルミ製冷却水路変更
	理由

図面来歴



Front end of QCS-L chamber



2 fingers : deformed

2 fingers : sliped off

weak welding

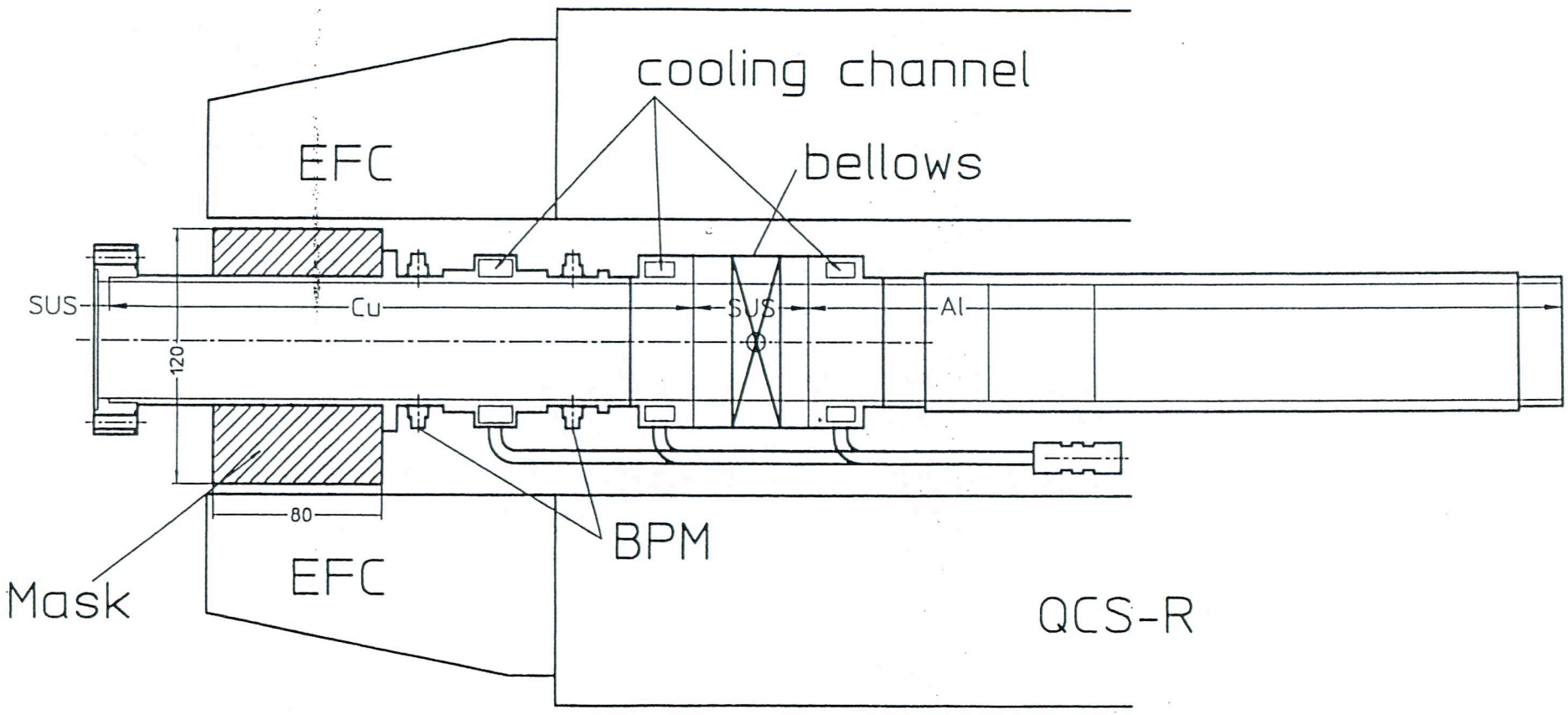
What was found in QCS-R bellows. (2 Aug. 2000)

ベロー
ベローズ

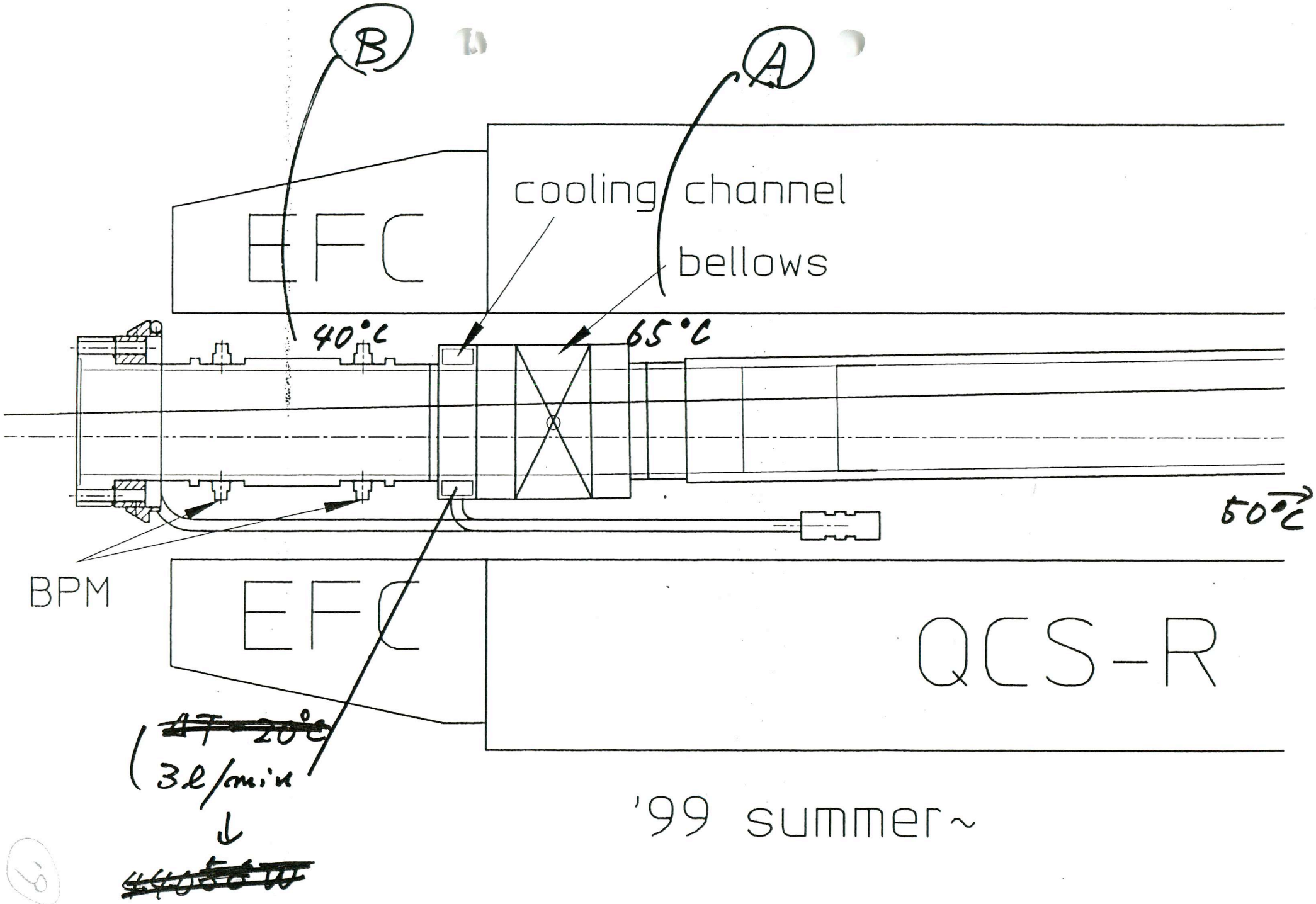
品番5・6

注.
梱包外面に
ケガキ線を
(計4ヶ所)
1個は単品

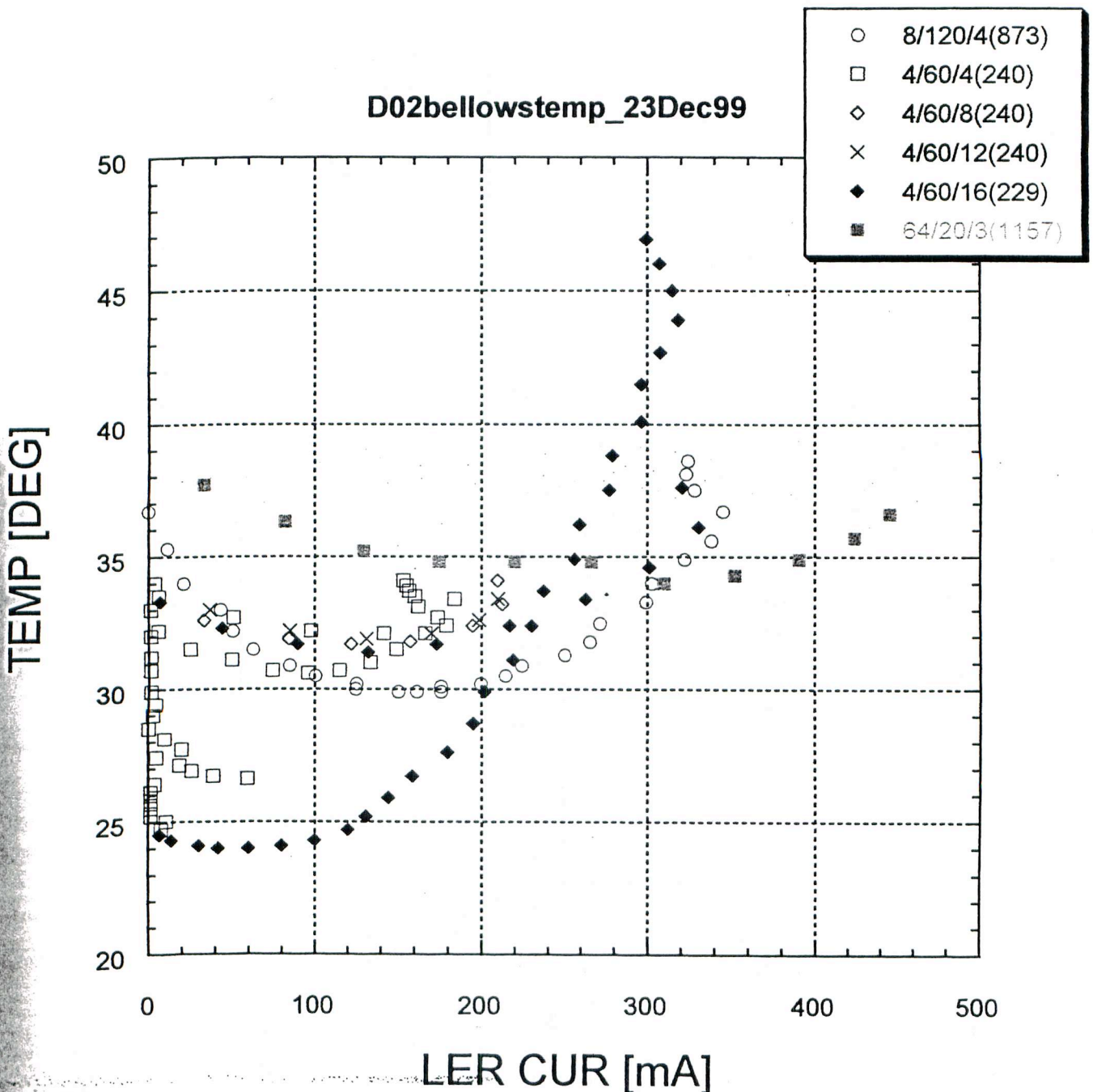
(品番11、12


cooling channel
EFC
bellows
SUS
Cu
SUS
Al
120
80
BPM
Mask
EFC
QCS-R

'00 summer~


B
A
EFC
cooling channel
bellows
40°C
65°C
50°C
BPM
EFC
QCS-R
~~47~~ ~~20°C~~
3ℓ/min
↓
~~4 4 0 0 0 0~~

'99 summer~

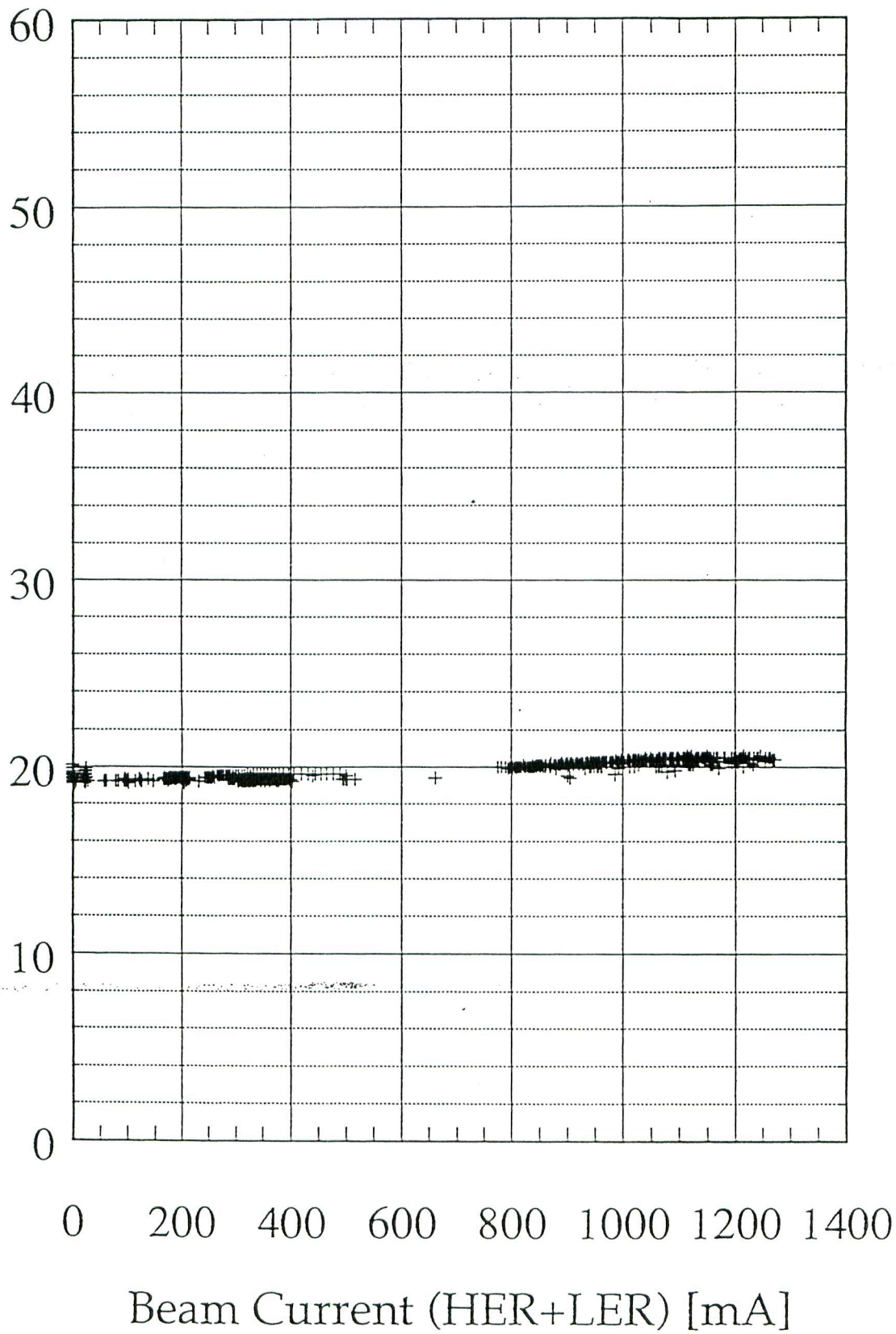


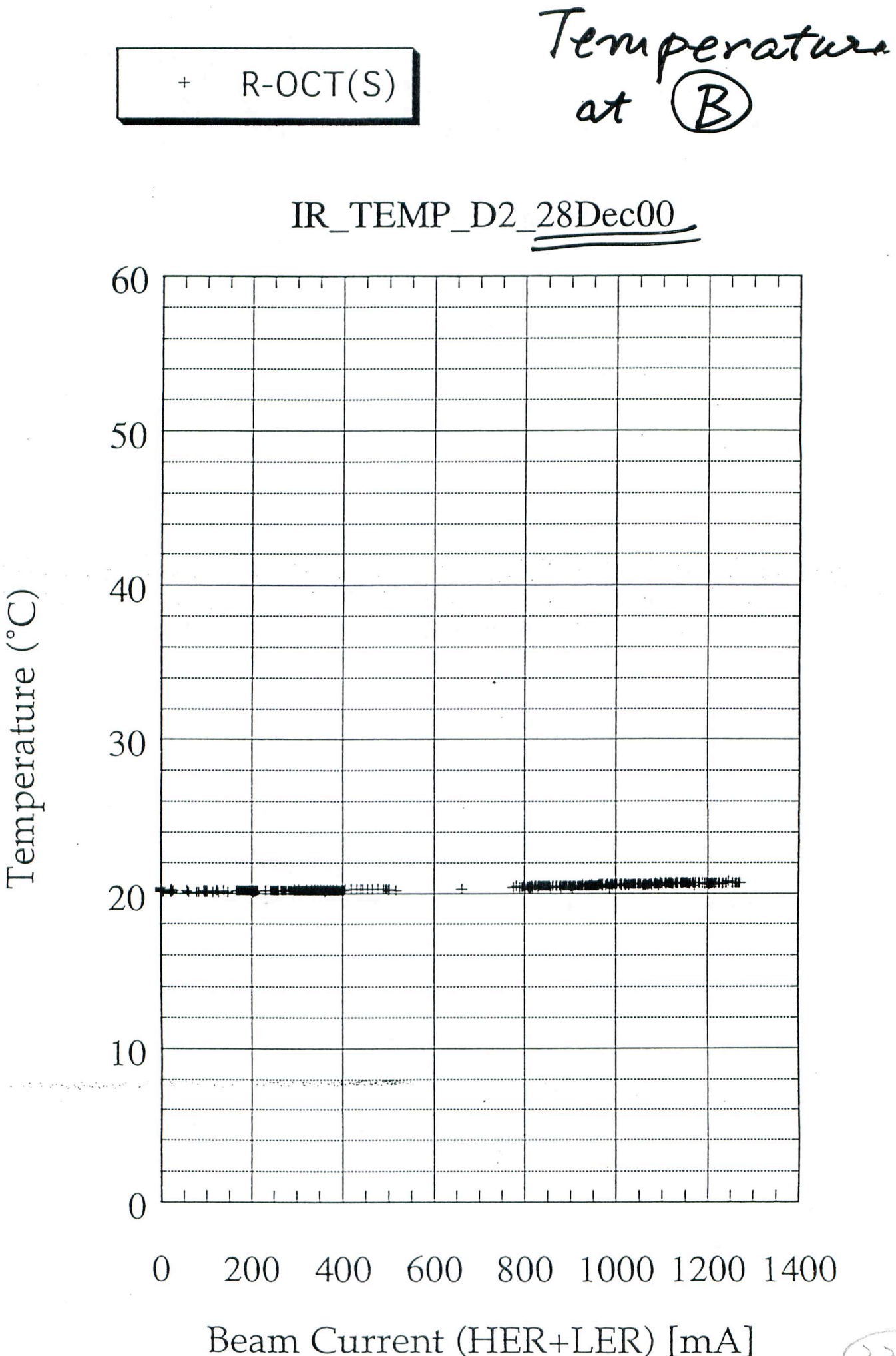
Temperature at (A)
(Dec. '99)

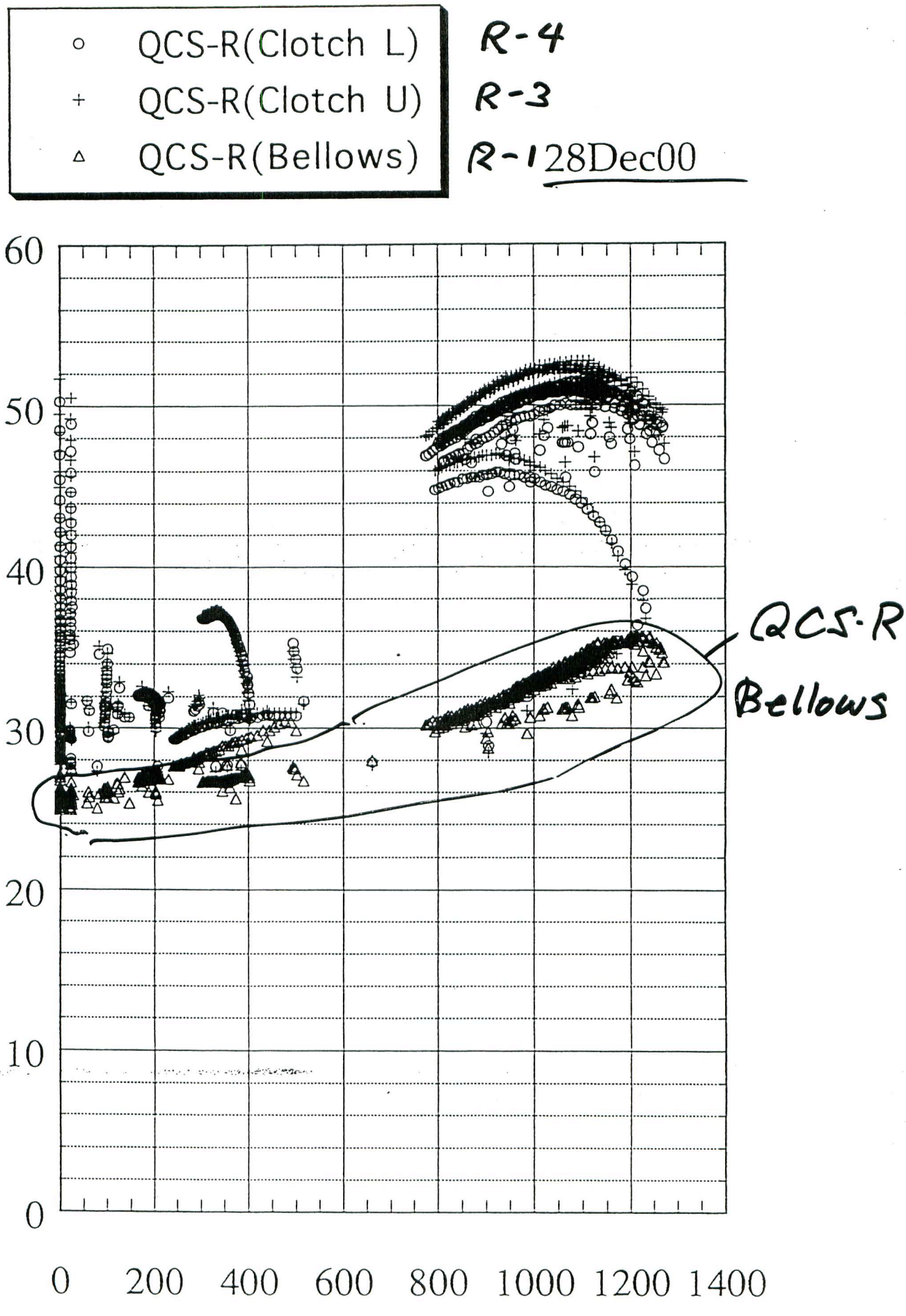
+ Bellows (Al end)

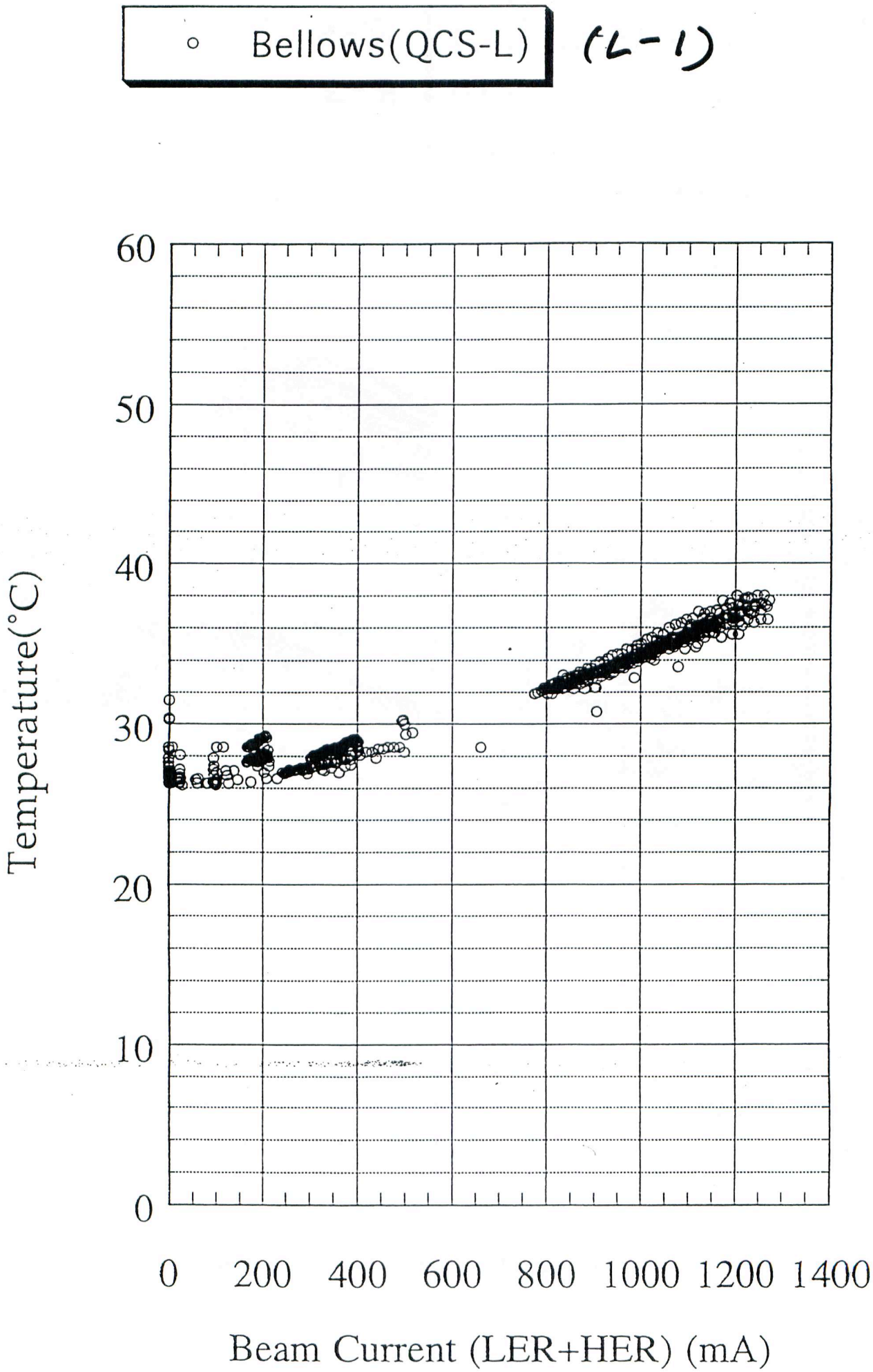
Temperature at (A)

IR_TEMP_D2_28Dec00

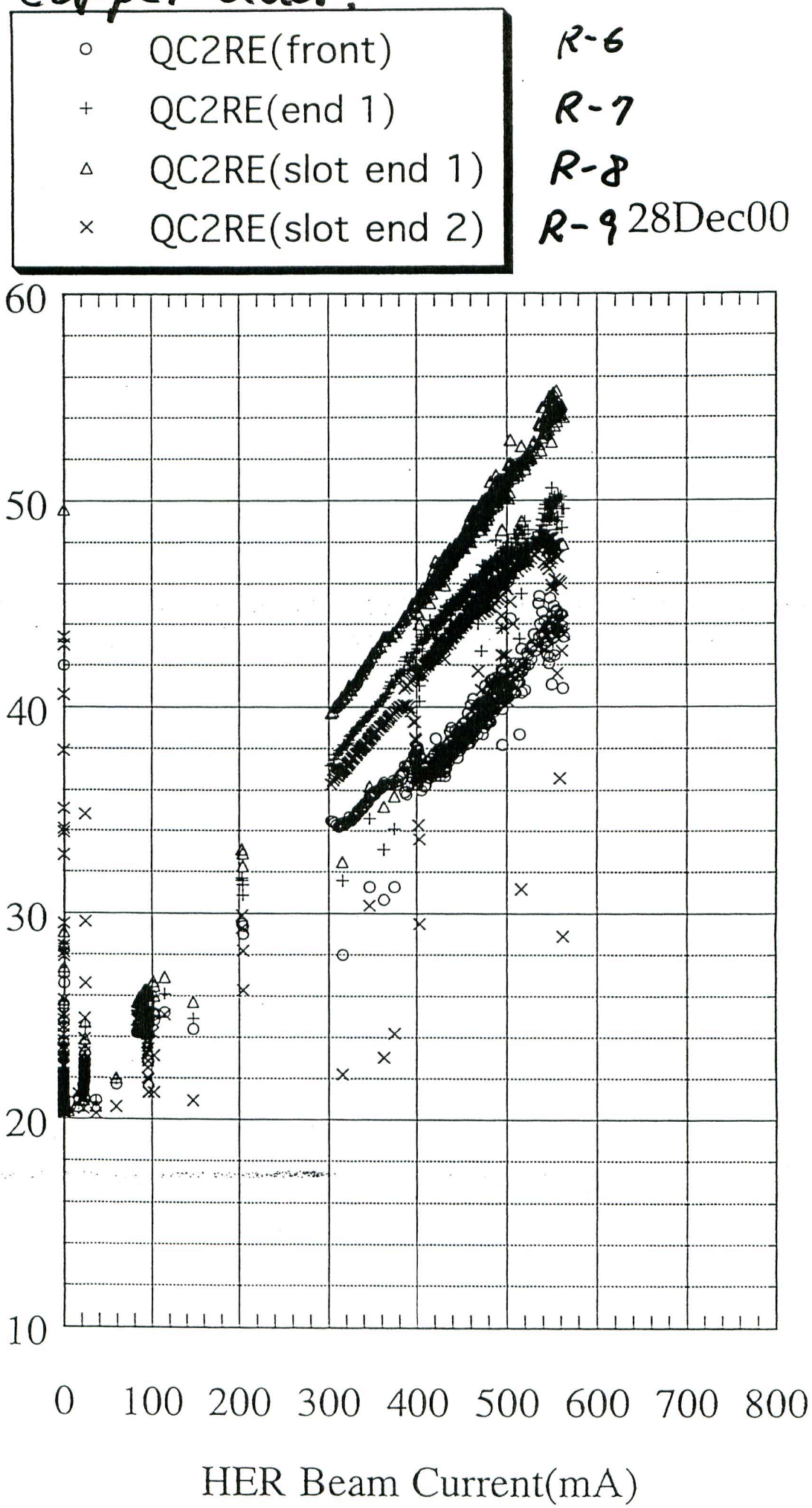


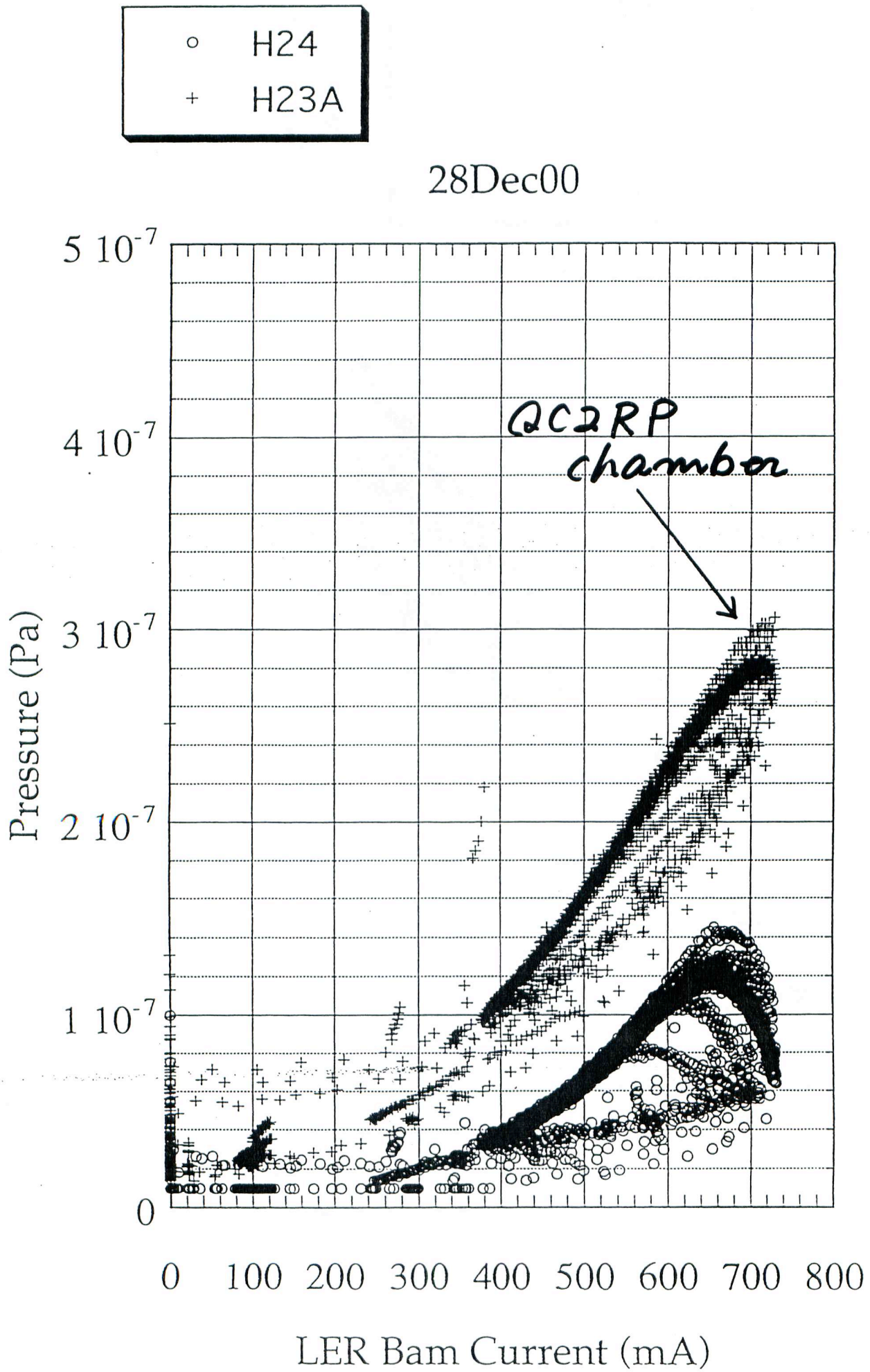

+ R-OCT(S)
Temperature at (B)
IR_TEMP_D2_28Dec00
60
50
40
30
20
10
0
Temperature (°C)
0
200
400
600
800
1000
1200
1400
Beam Current (HER+LER) [mA]

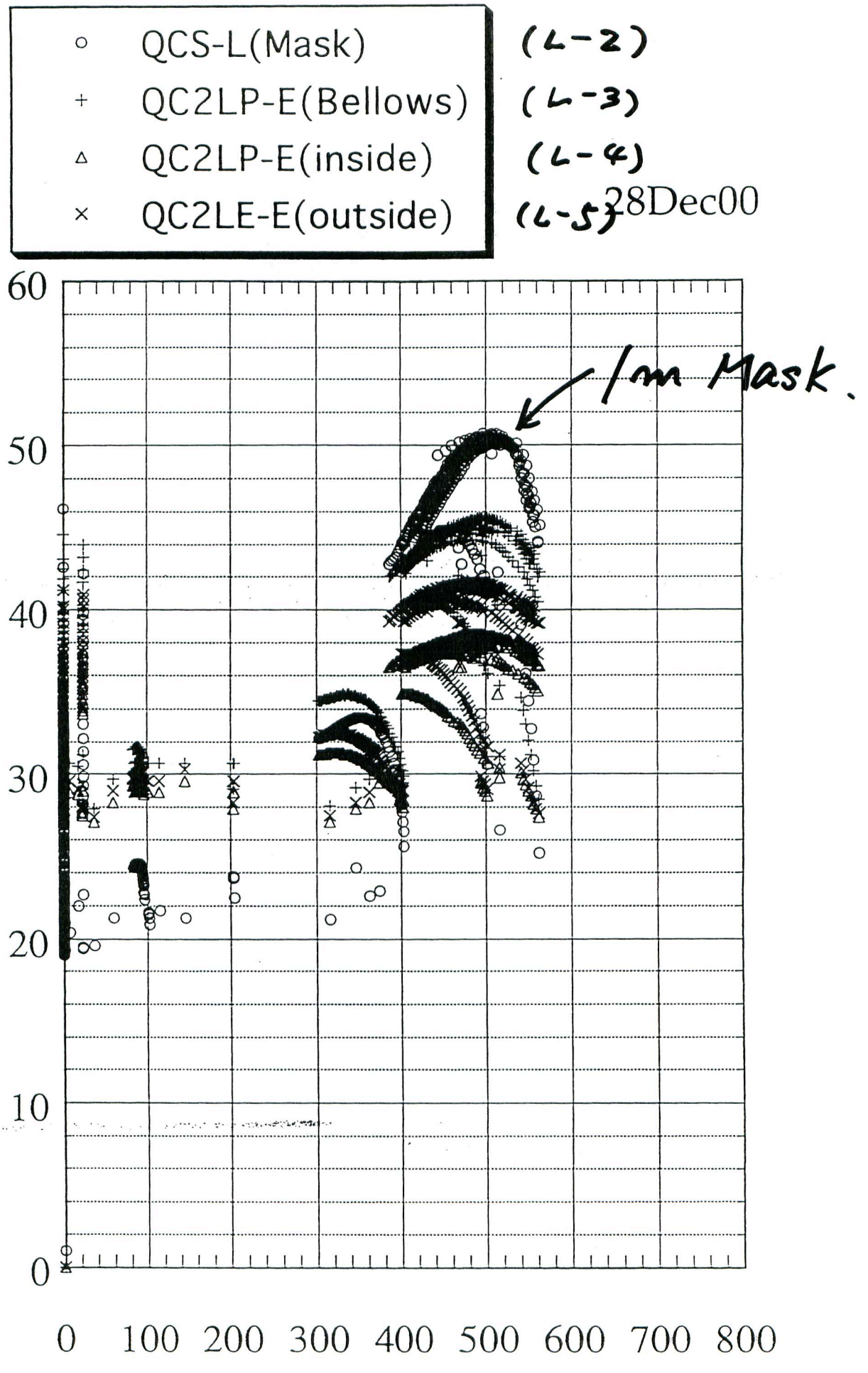

○ QCS-R(Clotch L)
+ QCS-R(Clotch U)
△ QCS-R(Bellows)
R-4
R-3
R-1 28Dec00
60
50
40
30
20
10
0
Temperature(°C)
QCS-R
Bellows
0
200
400
600
800
1000
1200
1400
Beam Current (LER+HER) (mA)

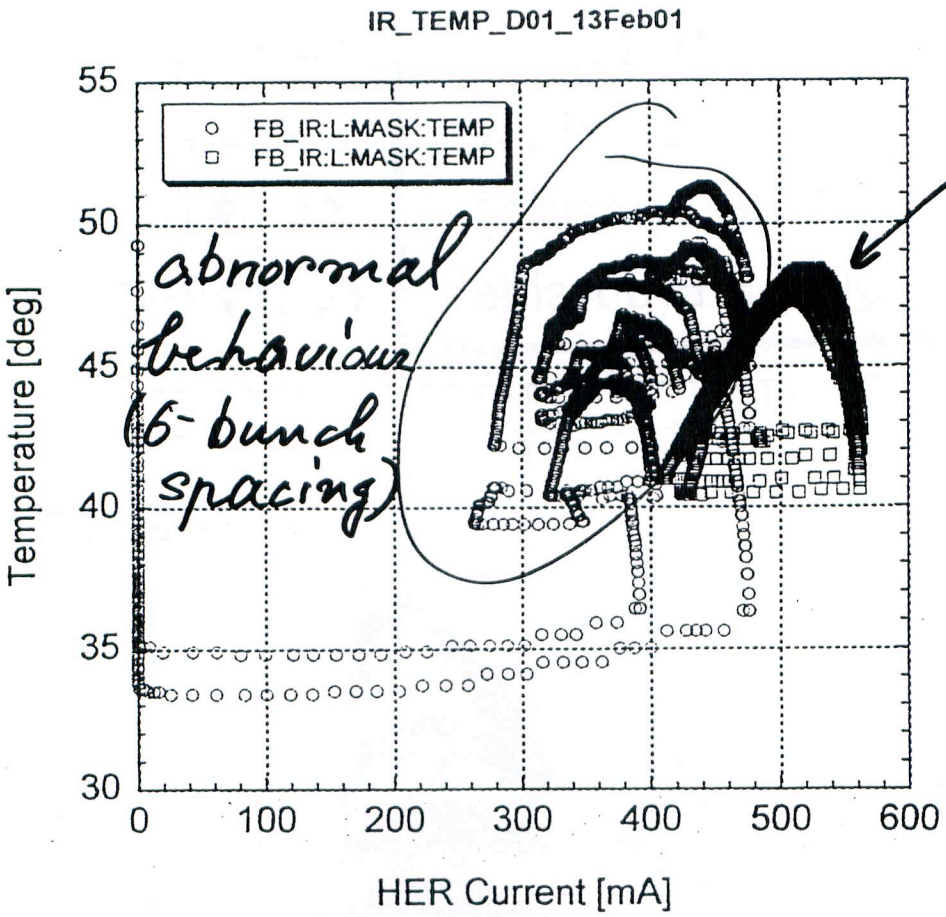

○ Bellows(QCS-L)
(L-1)
60
50
40
30
20
10
0
Temperature(°C)
0
200
400
600
800
1000
1200
1400
Beam Current (LER+HER) (mA)

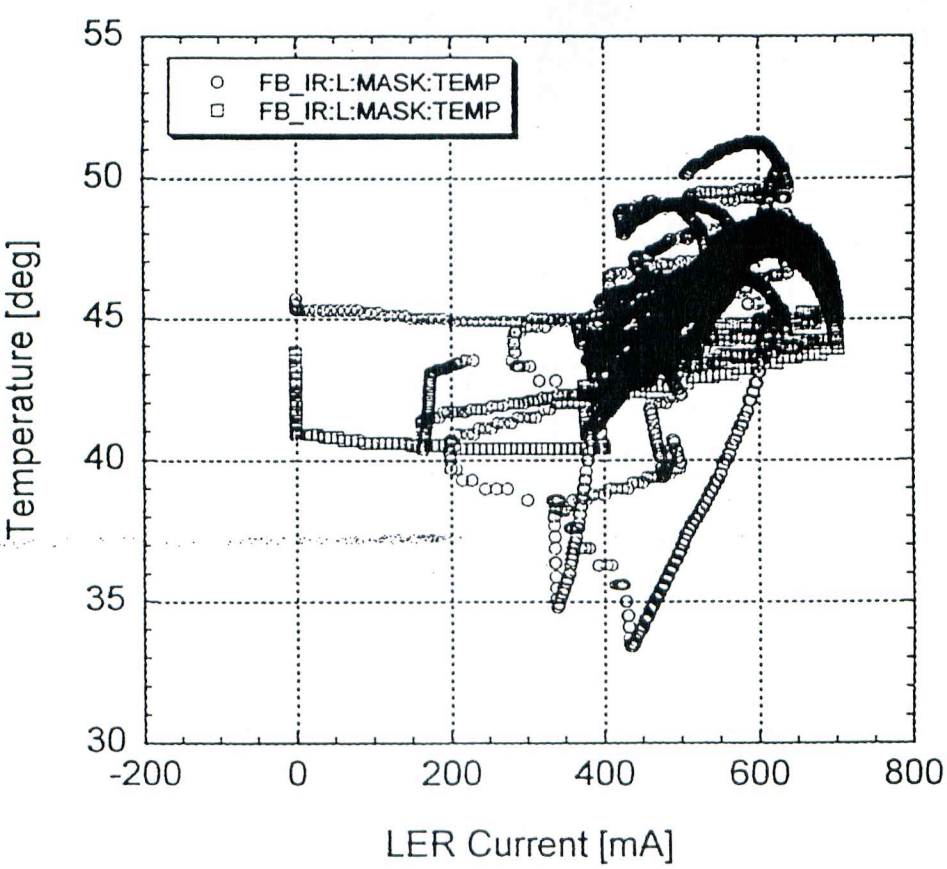
Copper duct.


QC2RE(front)
QC2RE(end 1)
QC2RE(slot end 1)
QC2RE(slot end 2)
R-6
R-7
R-8
R-9
28Dec00
60
50
40
30
20
10
Temperature(°C)
0
100
200
300
400
500
600
700
800
HER Beam Current(mA)

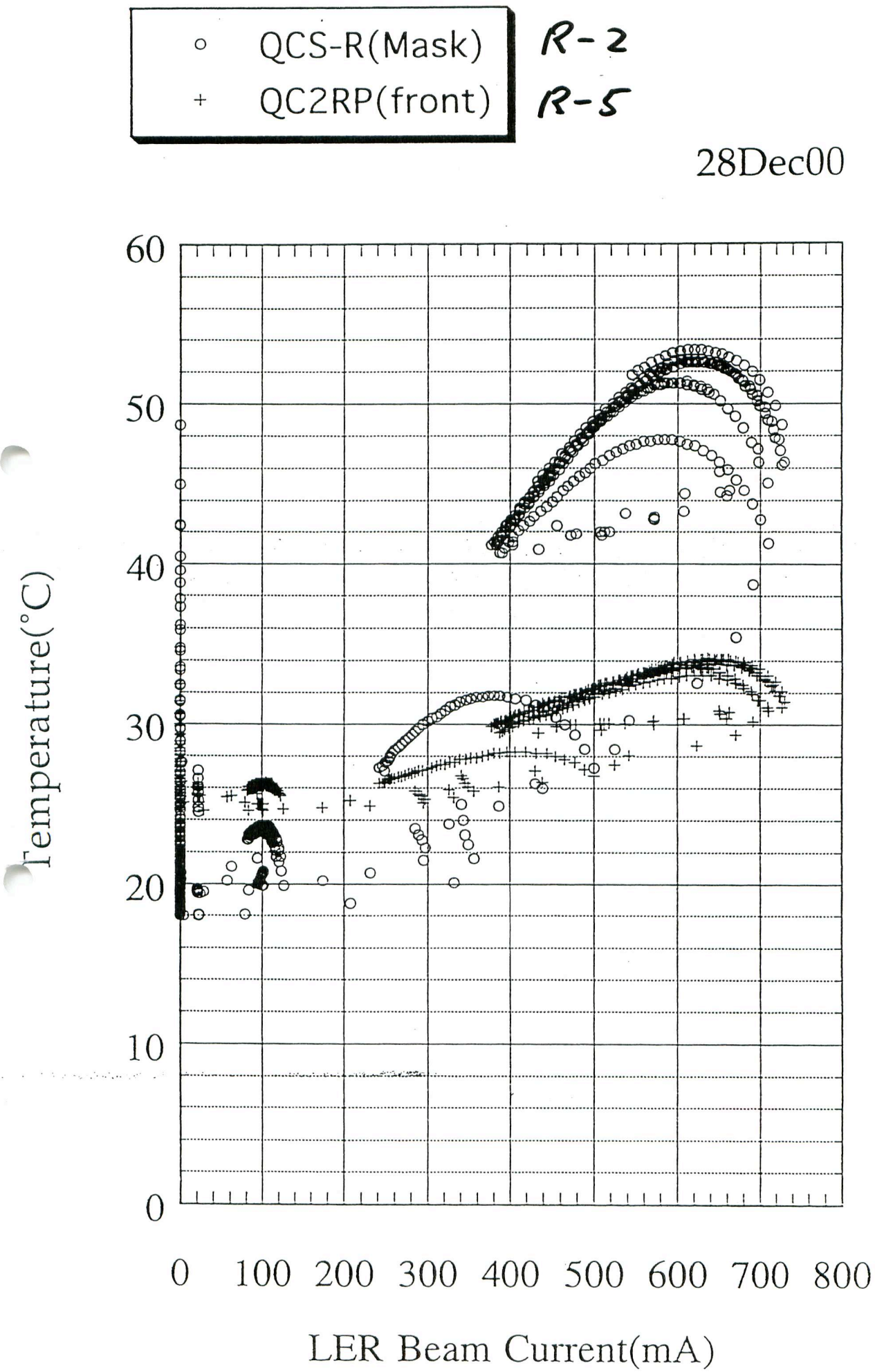

H24
H23A
28Dec00
5 10-7
4 10-7
3 10-7
2 10-7
1 10-7
0
QC2RP
chamber
Pressure (Pa)
0
100
200
300
400
500
600
700
800
LER Bam Current (mA)

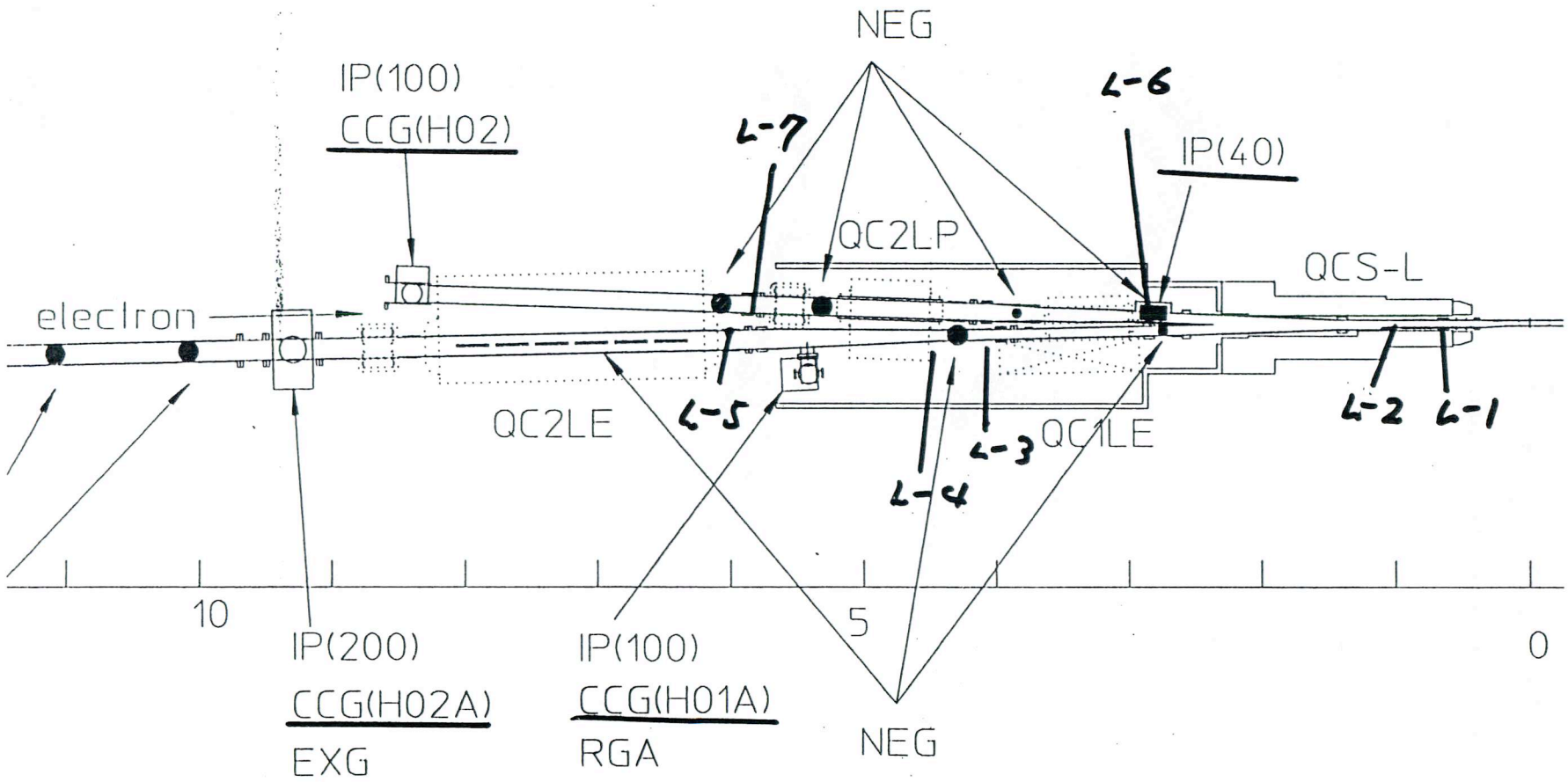

QCS-L(Mask) (L-2)
QC2LP-E(Bellows) (L-3)
QC2LP-E(inside) (L-4)
QC2LE-E(outside) (L-5)
28Dec00
1m Mask.
60
50
40
30
20
10
0
Temperature(°C)
0 100 200 300 400 500 600 700 800
HER Beam Current(mA)



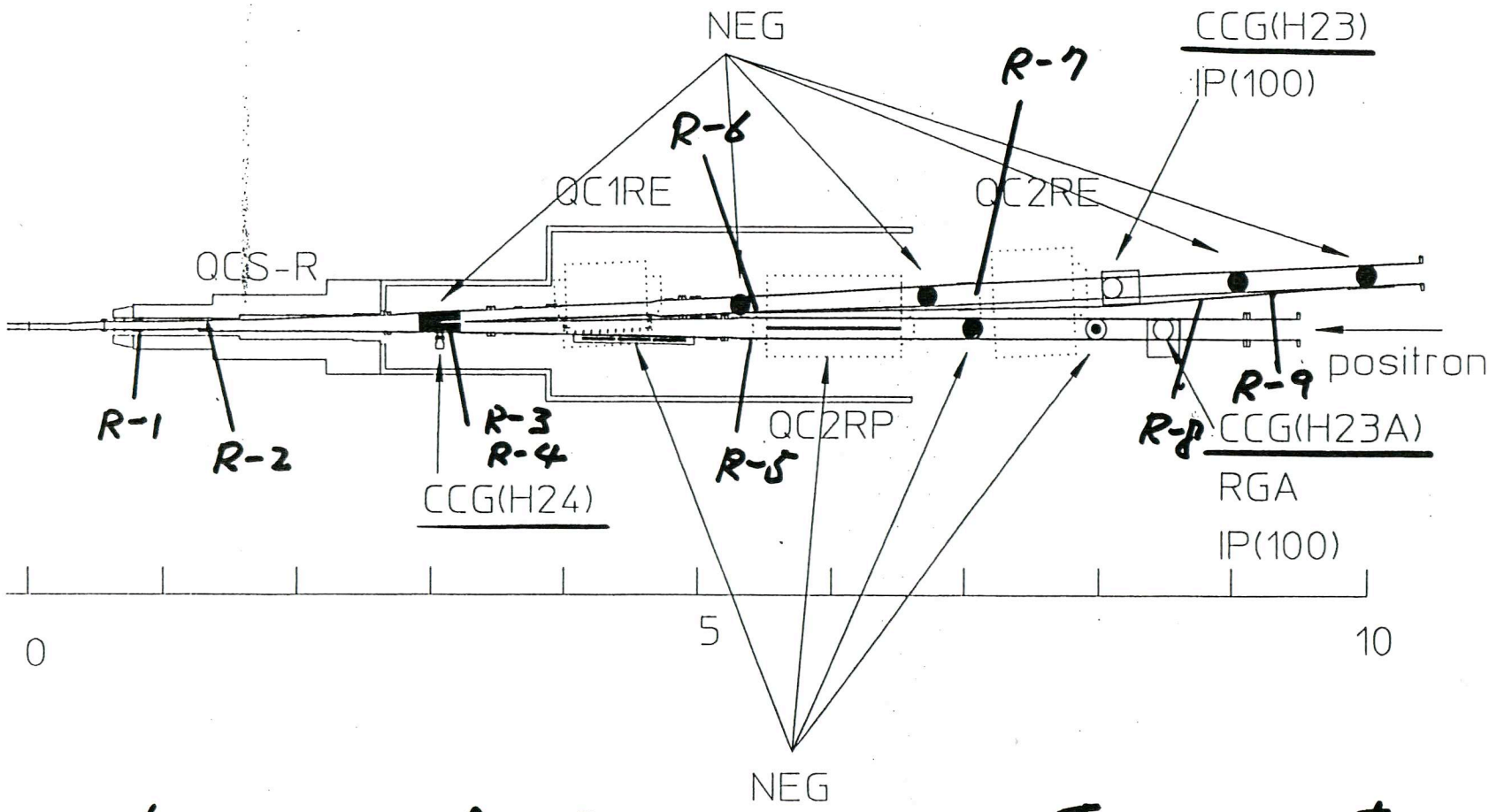


Temperature of QCS-L Im Mask

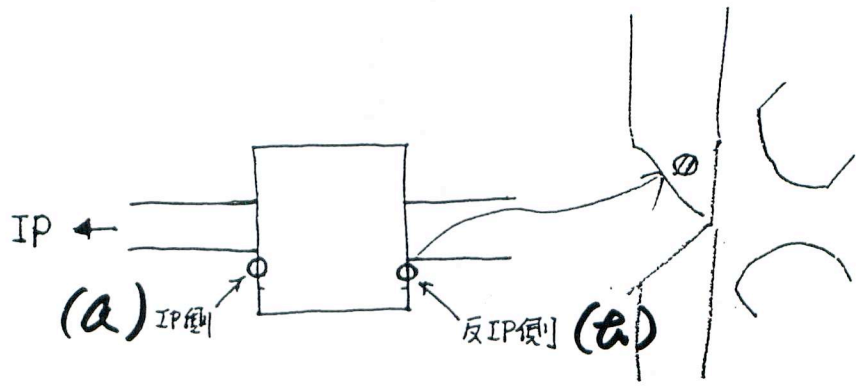

QCS-R(Mask)
QC2RP(front)
R-2
R-5
28Dec00
60
50
40
30
20
10
0
Temperature(°C)
0
100
200
300
400
500
600
700
800
LER Beam Current(mA)



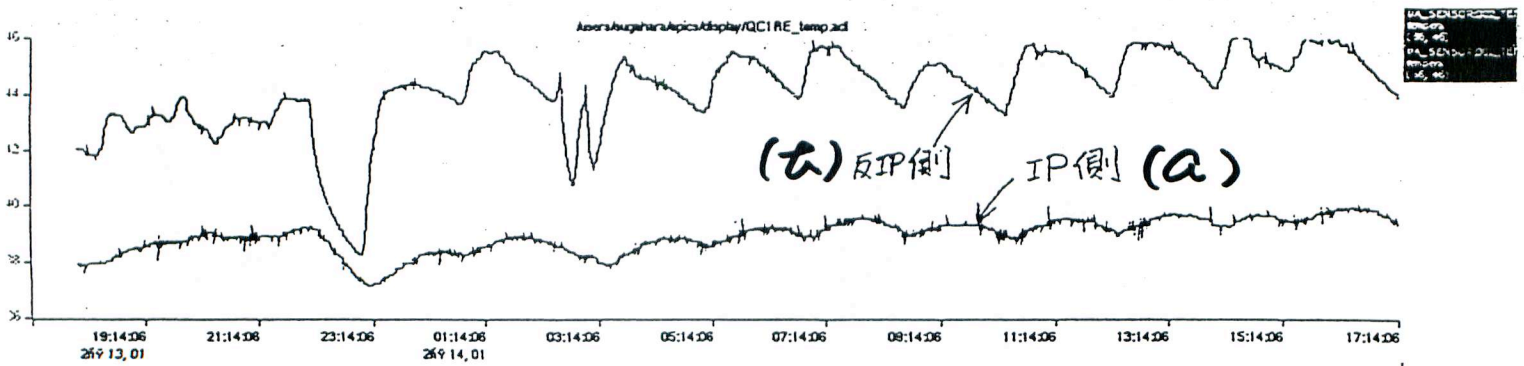
Location of Pressure and Temperature monitor (L-side)

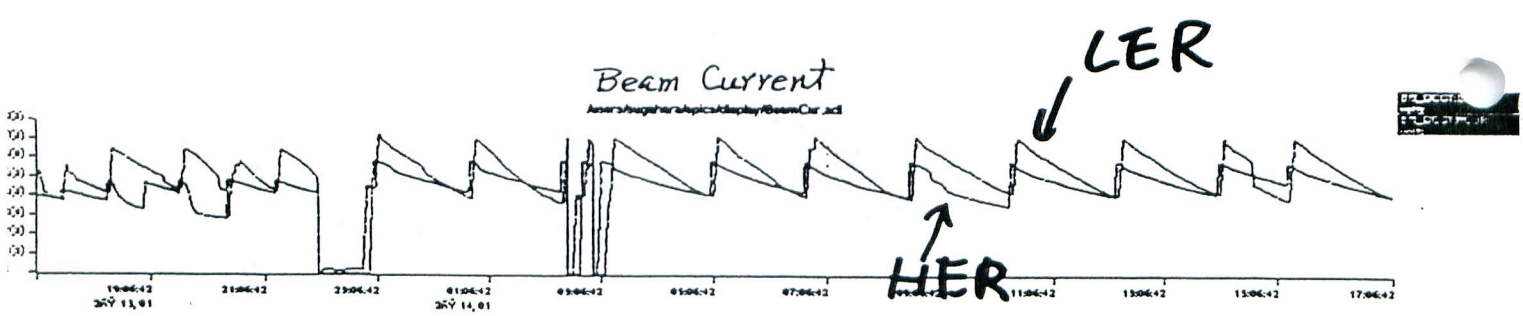


Location of Pressure and Temperature Monitor (R-side)



Temperature of QC1RE 2001.2.14

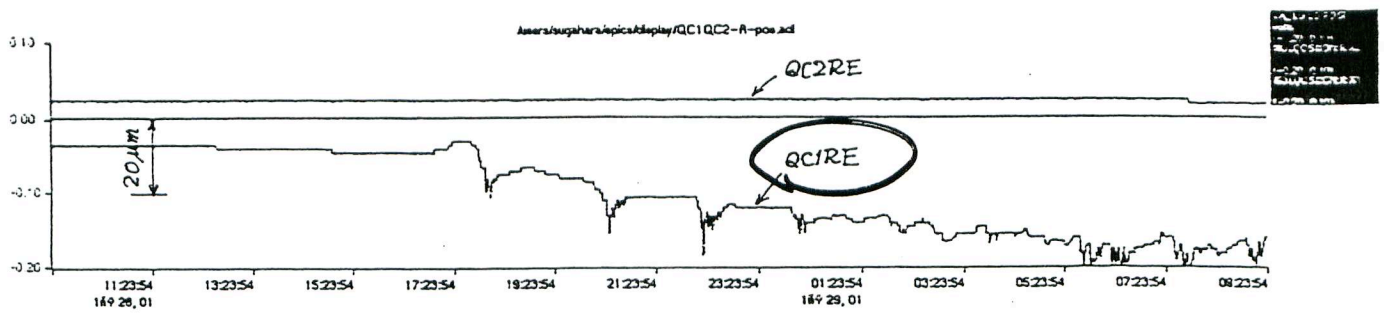




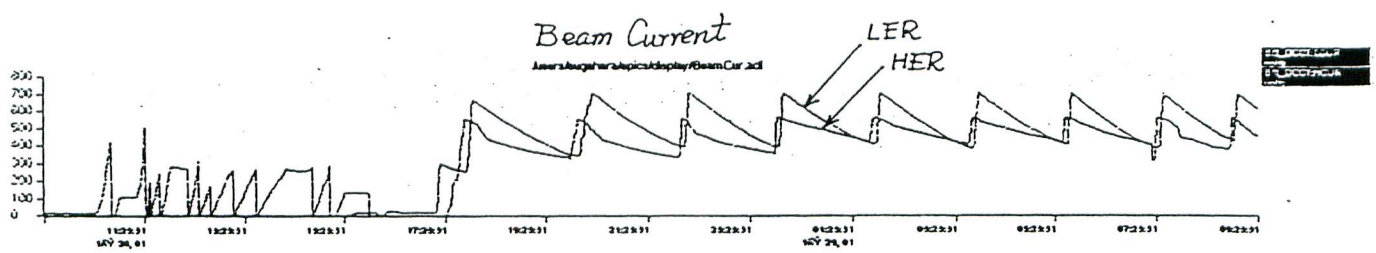
(R. Sugahara, M Tawada)

Transvers Motion of QC1RE

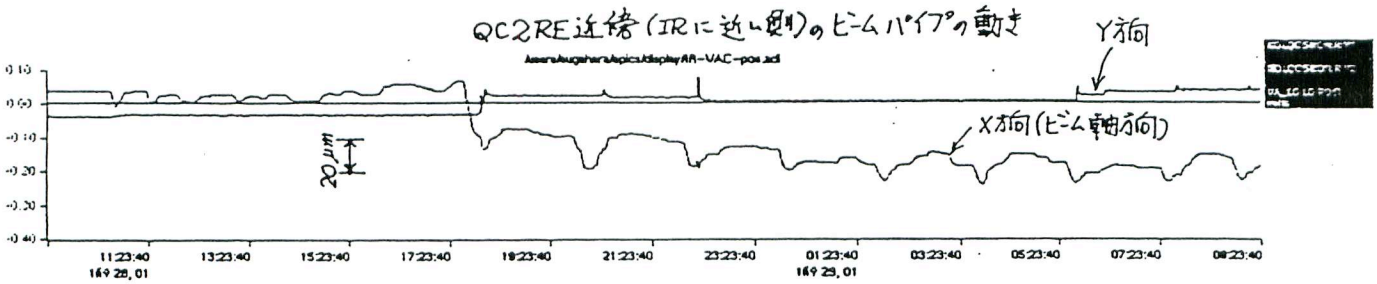
QC1RE, QC2RE の Y方向(ビーム軸に直角水平)の動き



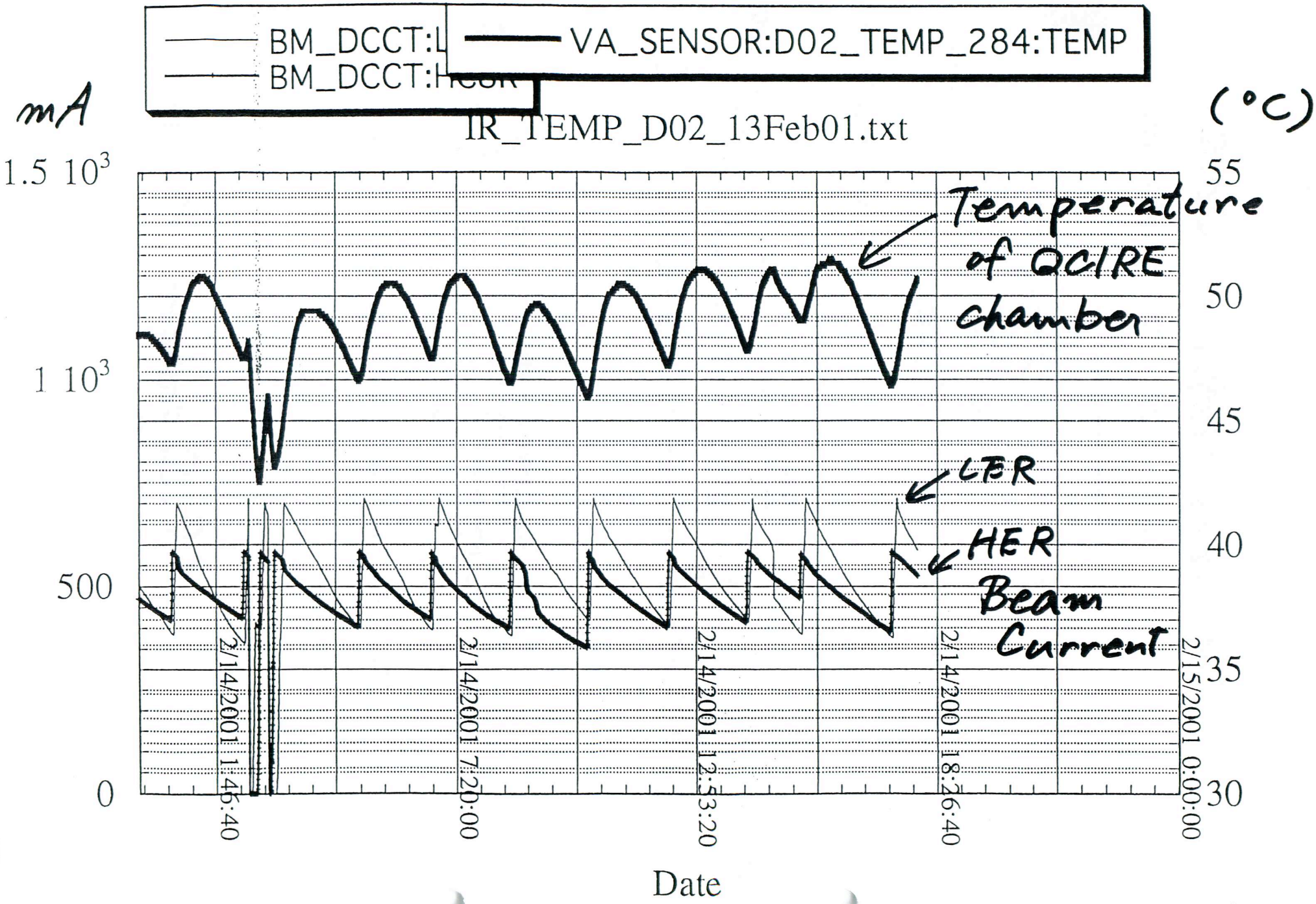
Jan 29. '01



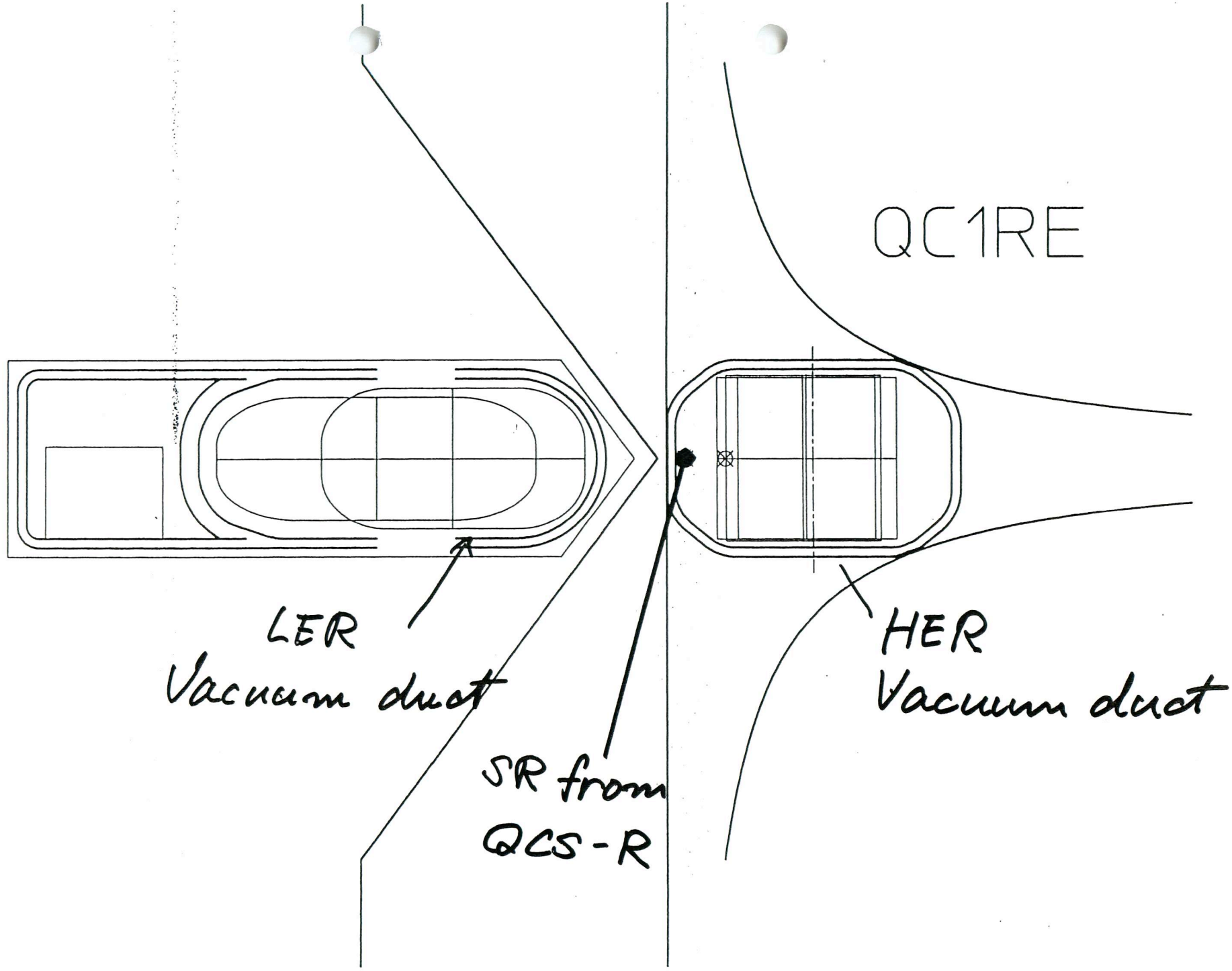
QC2RE近傍(IRに近い側)のビームパイプの動き



(R. Sugahara, M. Tawada)

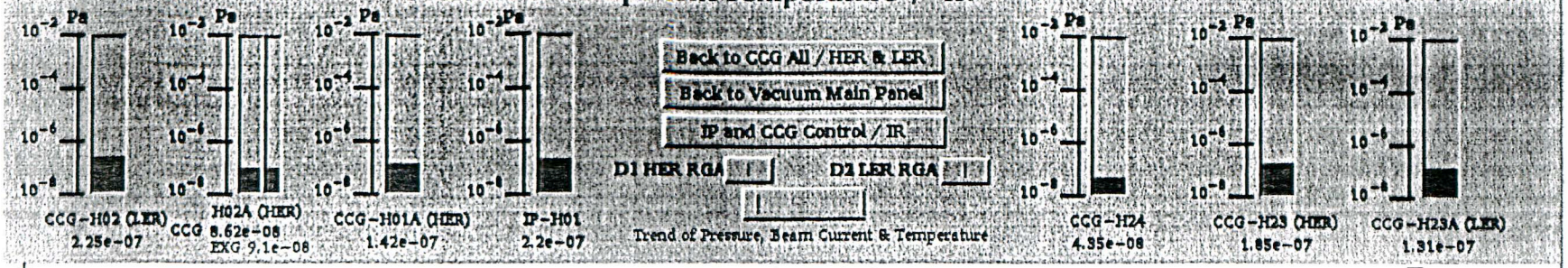

BM_DCCT:L
BM_DCCT:HER
VA_SENSOR:D02_TEMP_284:TEMP
mA
(°C)
IR_TEMP_D02_13Feb01.txt
1.5 10^3
1 10^3
500
0
55
50
45
40
35
30
Temperature of QCIRE chamber
LER
HER
Beam Current
2/14/2001 1:46:40
2/14/2001 7:20:00
2/14/2001 12:53:20
2/14/2001 18:26:40
2/15/2001 0:00:00
Date

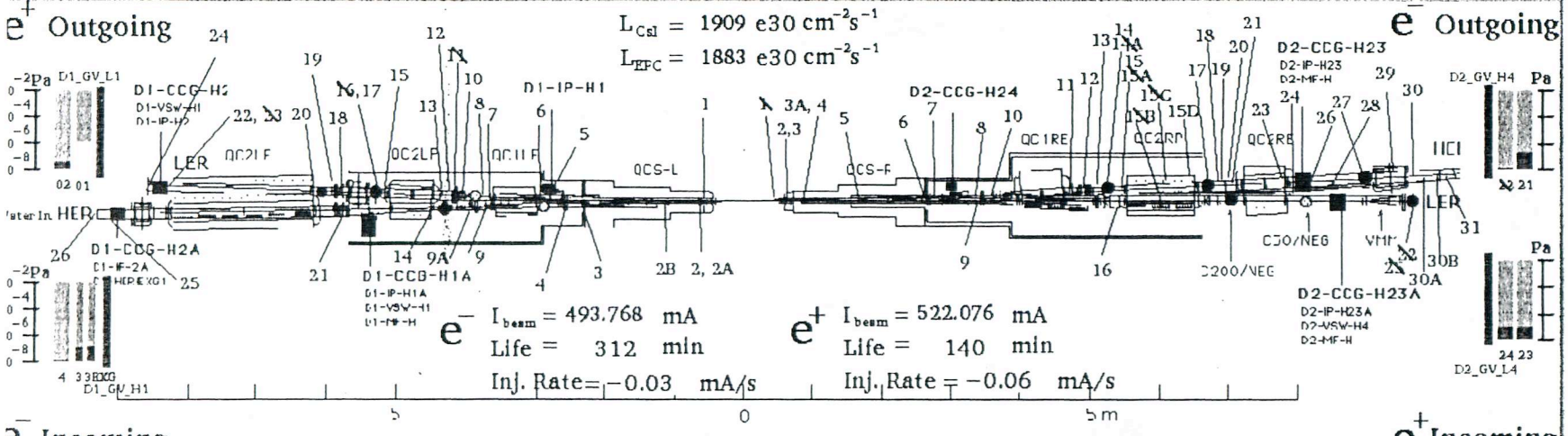
34


QC1RE
LER
Vacuum duct
SR from
QCS-R
HER
Vacuum duct

Pressure & Component Temperature / IR

2001/02/19 11:47:!





e- Incoming

1	21.0	OctoPos, Upper	14	39.0	Chamber, Side(in) 299
2	34.3	Bellows, Upper 280	15	24.7	Chamber, Upper 298
2A	20.9	Bellows Backward, Upper	16		NEG Port, Side(in)
2B	47.8	Mask, Upper	17	22.5	Chamber, Side(in) 213
3	26.3	Chamber, Upper 295	18	26.4	Chamber, Side(in) 300
4	26.3	Chamber, Side(in) 296	19	39.5	Bellows, Side(in) 212
5	28.9	Chamber, Side(in) 1	20	22.6	Chamber, Side(in) 282
6	24.8	Chamber, Upper 89	21	42.1	Bellows, Side(out) 284
7	31.9	Chamber, Side(in) 94	22	25.5	Chamber, Lower 281
8	32.2	Chamber, Upper 92	23		Chamber, Upper
9	39.3	BPM, Upper 297	24	24.7	Bellows, Side(in) 283
9A	46.2	Bellows, Upper 93	25	32.3	Dummy Chamber, Upper 285
10	28.9	Bellows, Side(in) 90	26	27.8	Bellows, Upper 95
11		Chamber, Side(in)			
12	22.5	Chamber, Side(in) 211			
13	34.0	BPM, Upper 91			

Alarm Set

Max. Temperature HER Cur. LER Cur. (mA
51.3 529.624 627.851
Fri Feb 9 13:06:48 2001
Sensor No.2B
clear

e+ Incoming

2	21.0	OctoPos, Upper	15D	28.5	Chamber, Side(out) 299
3	20.6	OctoPos, Side	16	33.2	Chamber, Upper 170
3A	31.9	Bellows	17	26.5	Chamber, Side(out) 300
4	21.1	Bellows Backward, Upper	18	23.6	Chamber, Side(in) 298
5	51.0	Mask, Side(in)	19	22.8	BPM Upstream, Side(out) 281
6	36.2	Chamber, Upper 240	20	22.6	BPM Downstream, Side(out) 282
7	29.7	QCS-R Flange, Side(out) 168	21	22.7	Chamber, Side(out) 283
8	33.6	BPM, Upper 169	22		Mask, LER
9	36.0	BPM, Lower 171	23	25.5	Chamber, Upper 277
10	42.6	HER Chamber, Side(in) 239	24	24.1	Chamber, Side(in) 279
11	49.3	BPM, Lower 286	25		Mask, LER
11A	50.8	BPM, Upper 284	26	23.5	Chamber, Upper 278
12	27.5	Chamber, Side(out) 288	27		Chamber, Lower
13	25.4	Chamber, Upper 287	28	32.7	Chamber, Side(in) 271
14	39.8	Chamber, Side(in) 289	29	35.0	Chamber, Side(out) 273
14A		Chamber, Upper 13	29A	33.7	Chamber, Upper 276
15	31.8	Chamber, Upper 290	30	49.3	Chamber, Upper 274
15A		Chamber, Lower 193	30A	51.1	Chamber, Lower 272
15B		Chamber, Side(in) 194	30B	47.1	Chamber, Side(out) 275
15C		Chamber, Side(out) 195	31	34.6	Chamber, Upper 175

Max. Temperature HER Cur. LER Cur. (m
56.9 572.280 691.495
Thu Feb 15 18:46:29 2001
Sensor No.9A
clear

3. Photo electron Measurement

Photo electron monitors were installed in the arc and in the straight section.

- The result of DC measurement

[by H. Hisamatsu (KEKB Vac.)]

1) The electron current is not linear with respect to the beam current.

2) The electron current is not proportional to the photon number.

3) Most of the electron have an energy less than 25 eV. But electrons with fairly high energy (~keV) exist.

4) Even if there is no direct photon, the electron current is observed. In this case the electron current seems to increase exponentially with respect to the beam current.

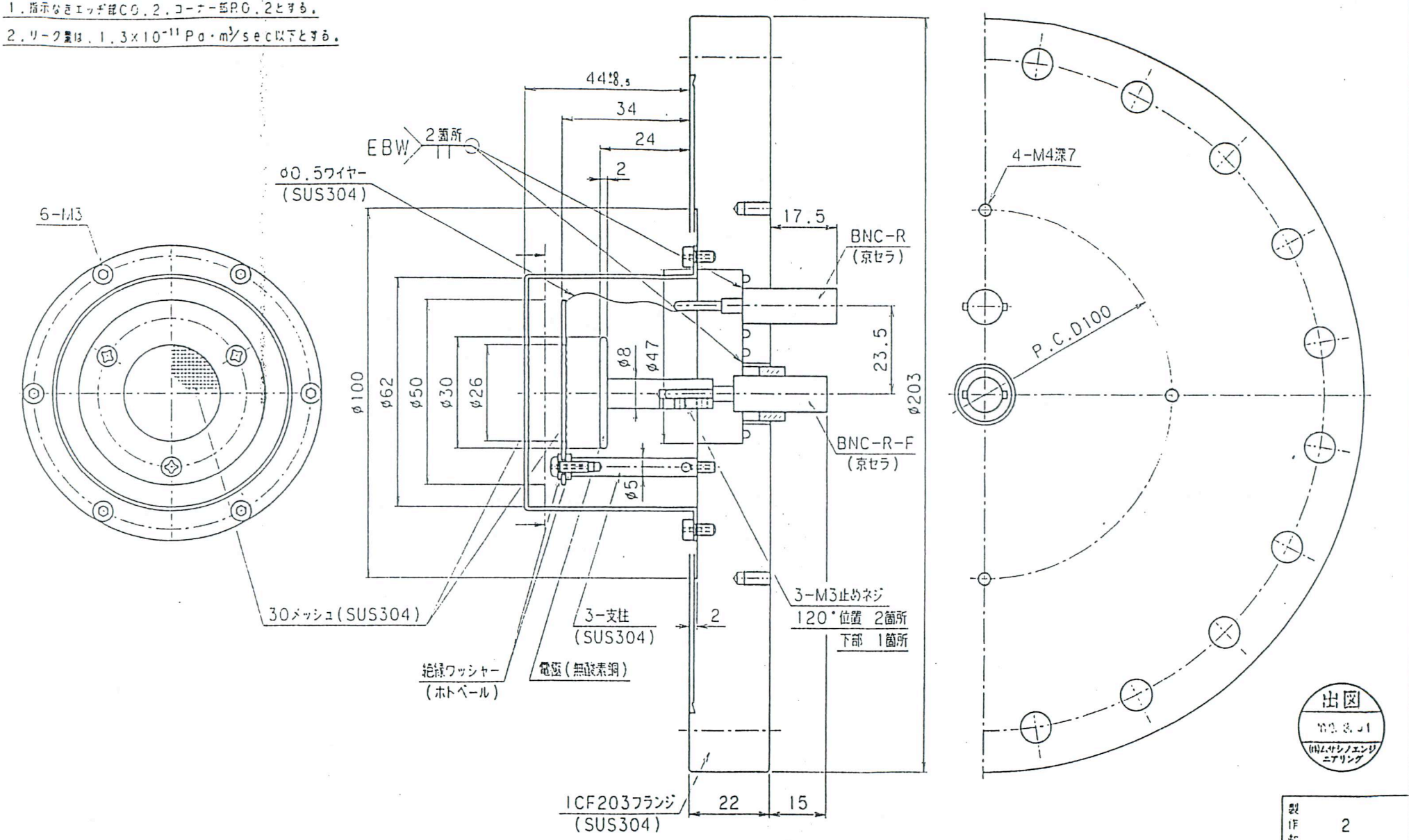
5) The behavior of the electron current with respect to the beam current is similar to the variation of the local pressure.

6) There is no sign which corresponds to the beam blow up threshold.

注記

1．指示なきエッヂ部C0．2，コーナー部R0．2とする。

2．リーク量は，1．3×10^{-11} Pa・m^3/sec以下とする。



出図

H12.8.31

(株)ムサシノエンジニアリング

製作数 2

仕上げ記号	
～	指示なし
▽	100S
▽▽	25S
▽▽▽	6.3S
▽▽▽▽	0.8S

記号	内容	日付	担当

無記号寸法公差(JIS-B0408-m)	
寸法区分	寸法差
0.5以上6以下	±0.1
6を超え10以下	±0.2
10を超え120以下	±0.3
120を超え400以下	±0.5
400を超え1000以下	±0.8
1000を超え2000以下	±1.2
無記号角度公差(JIS-B0408-m)	

表面処理

承認	検図	設計	製図
	佐藤		石橋

H12年 2月2

熱処理 HRC

材質 SUS304／他

仕上 1台数

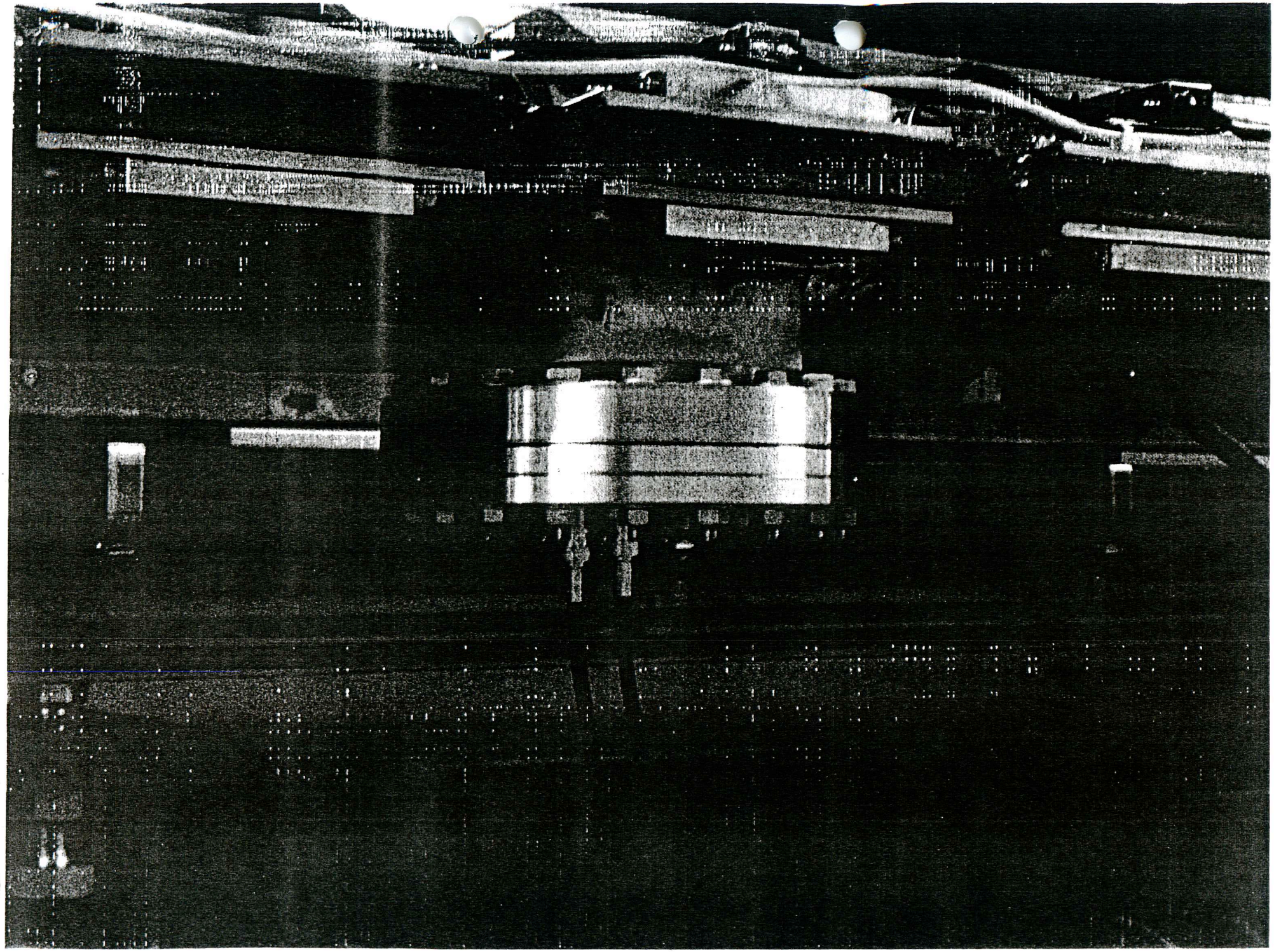
尺度 1／1 シート

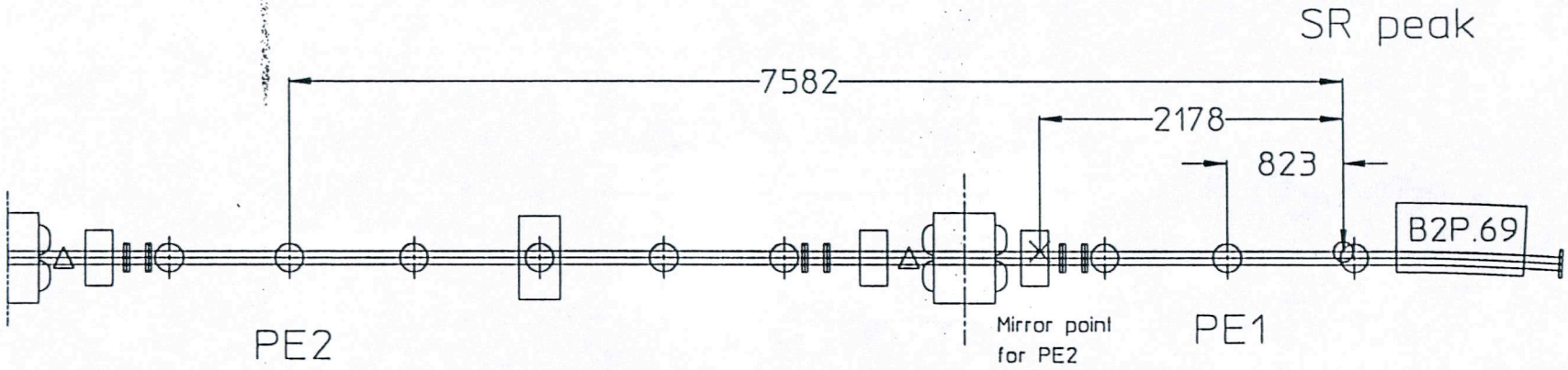
形式

品名 光電子検出装置

図番 K

(株)ムサシノエンジニアリング A3



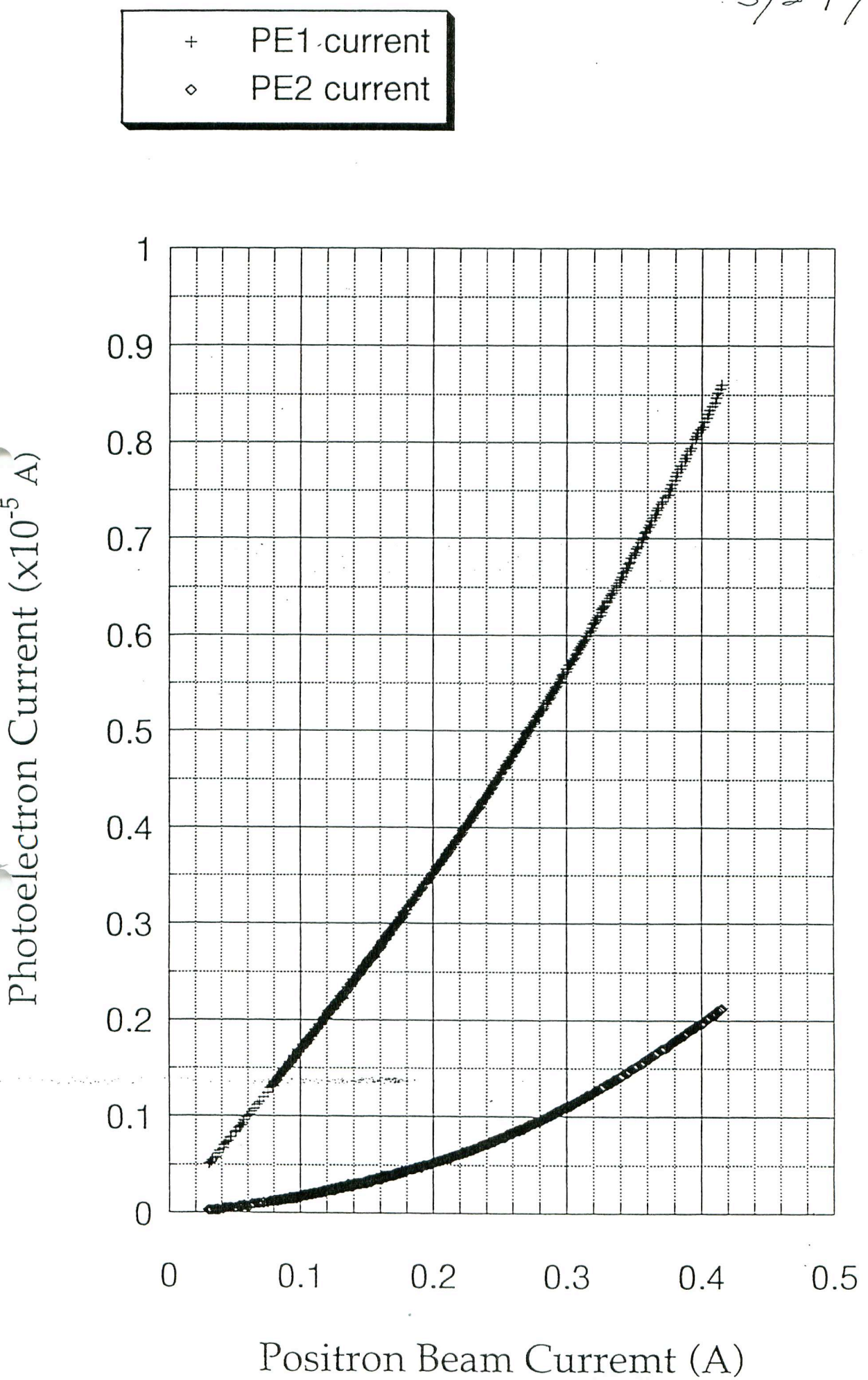


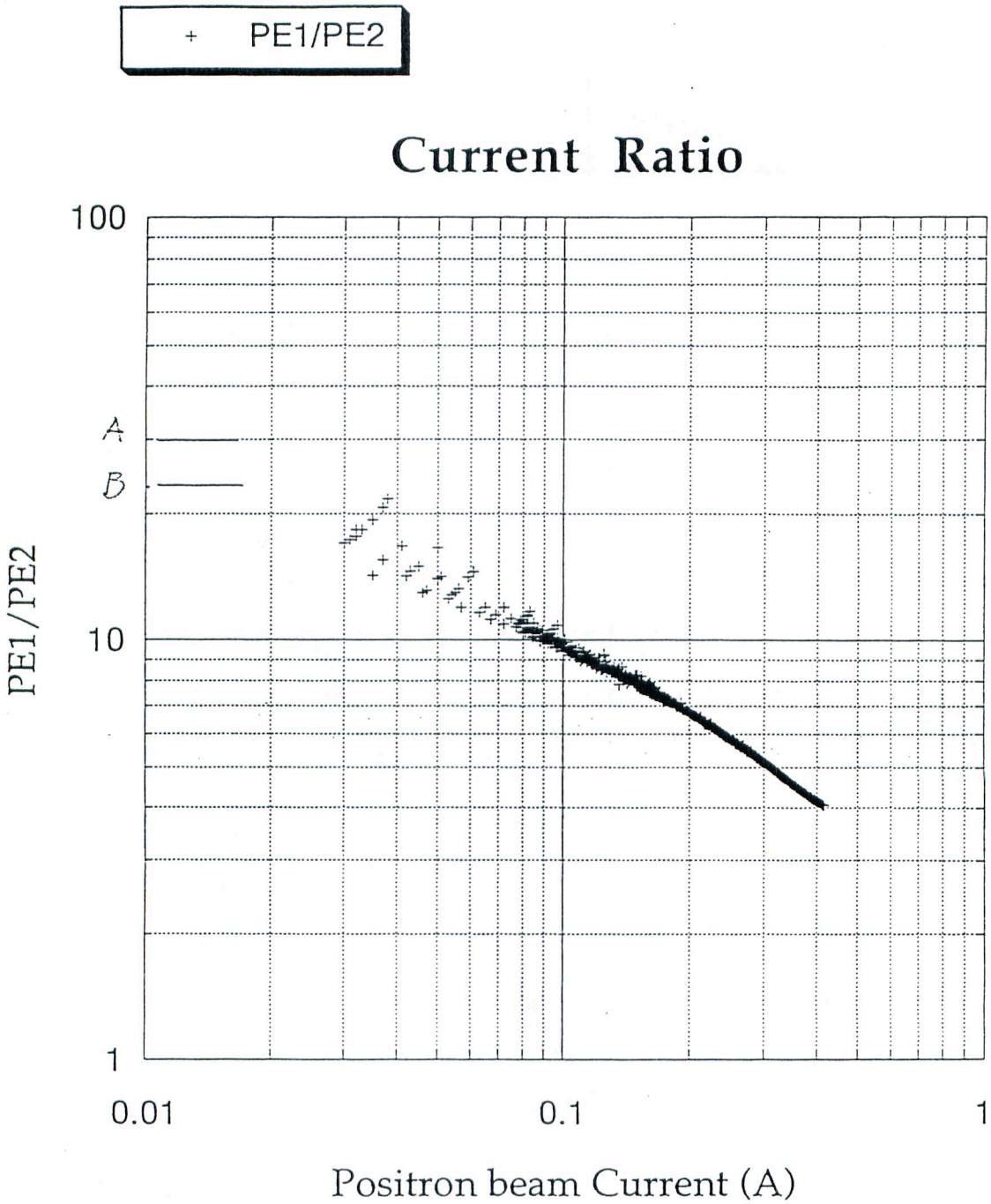
e^+ ←

Location of Photoelectron Monitor

(Arc)

3/29/00


PE1 current
PE2 current
Photoelectron Current (x10^{-5} A)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
Positron Beam Curremt (A)



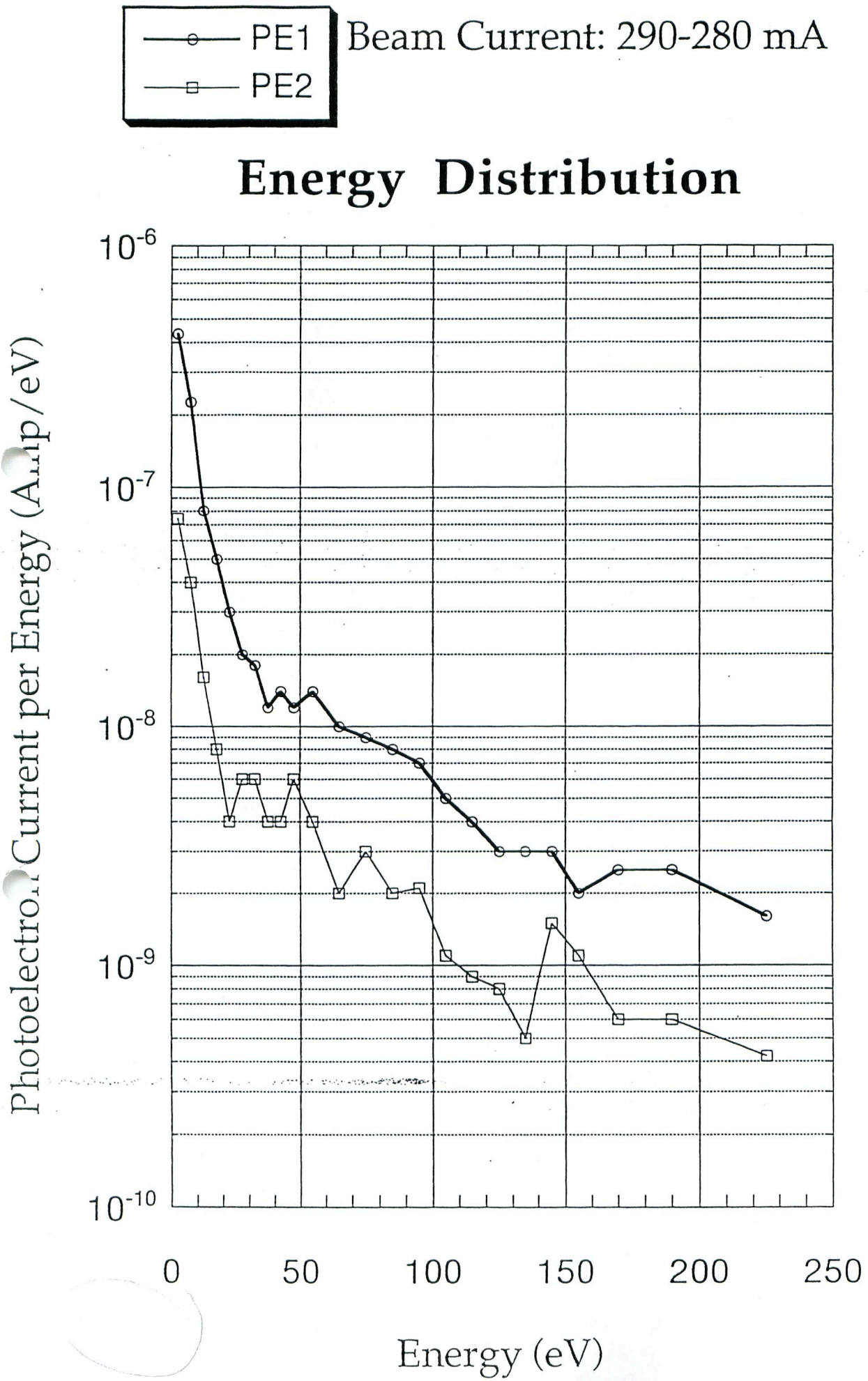
A　1次光のイオン化できる量の比

B　PE2で1回反射まで考えた時の比

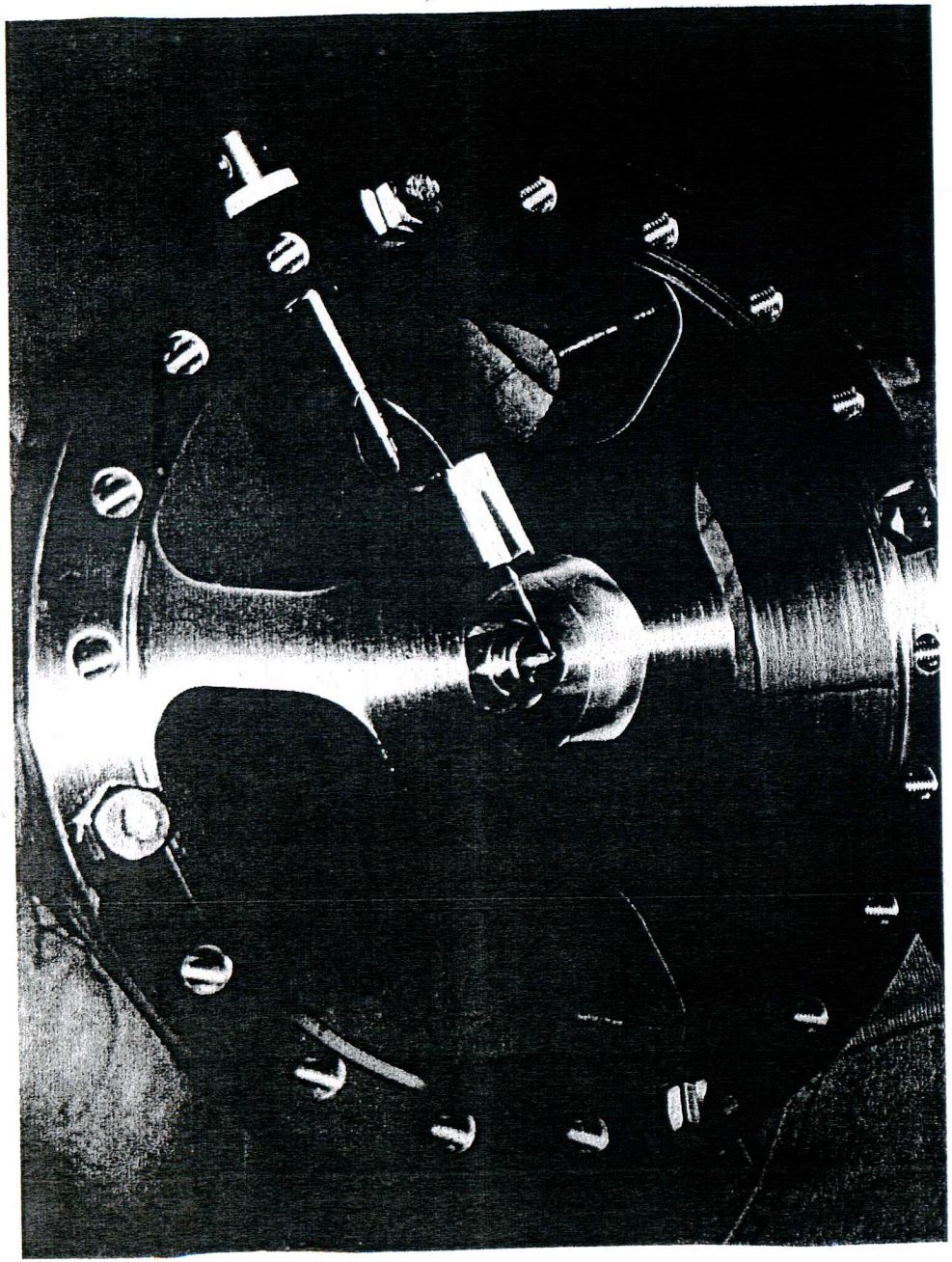
A, B　Photon Number Ratio

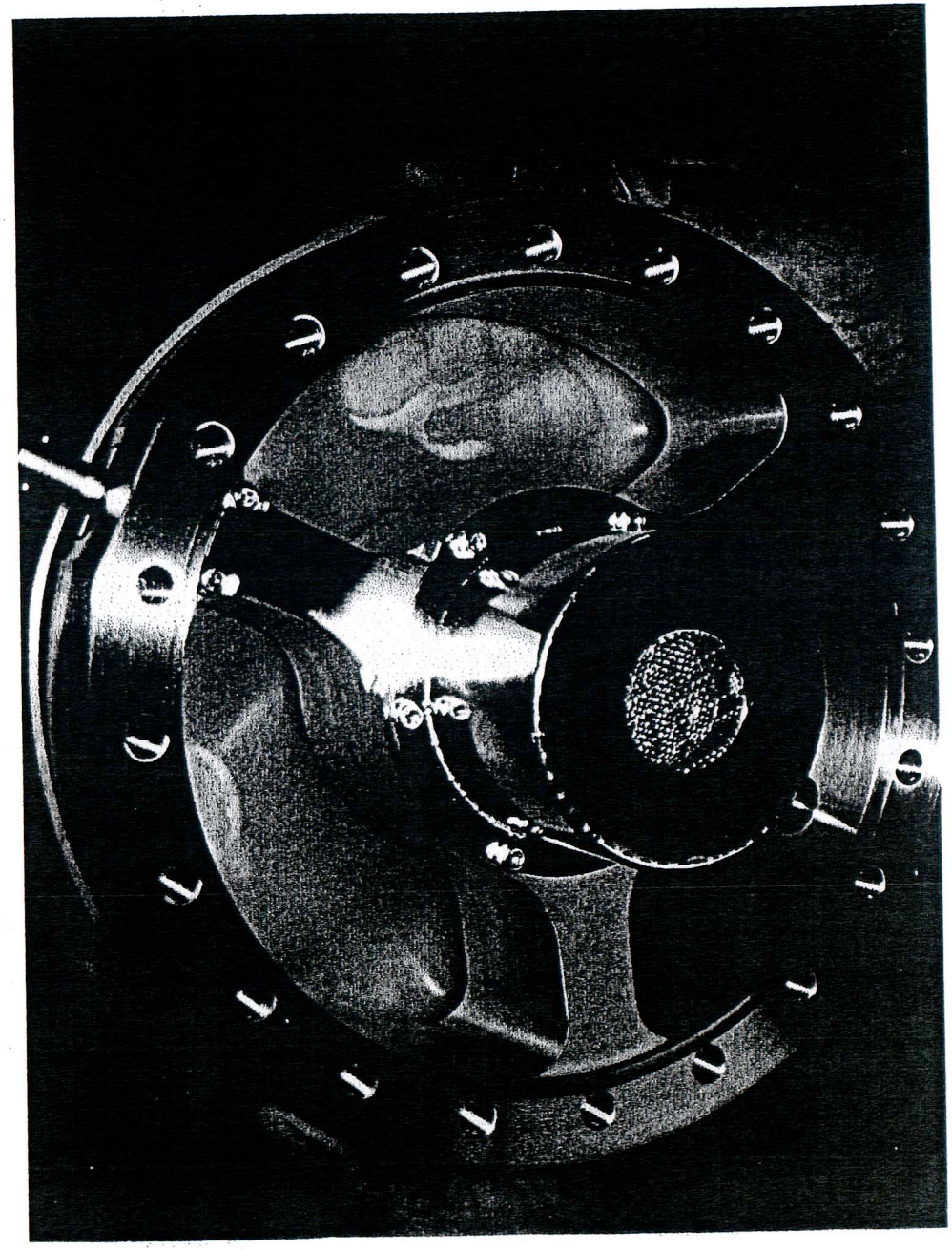
A: direct photon only

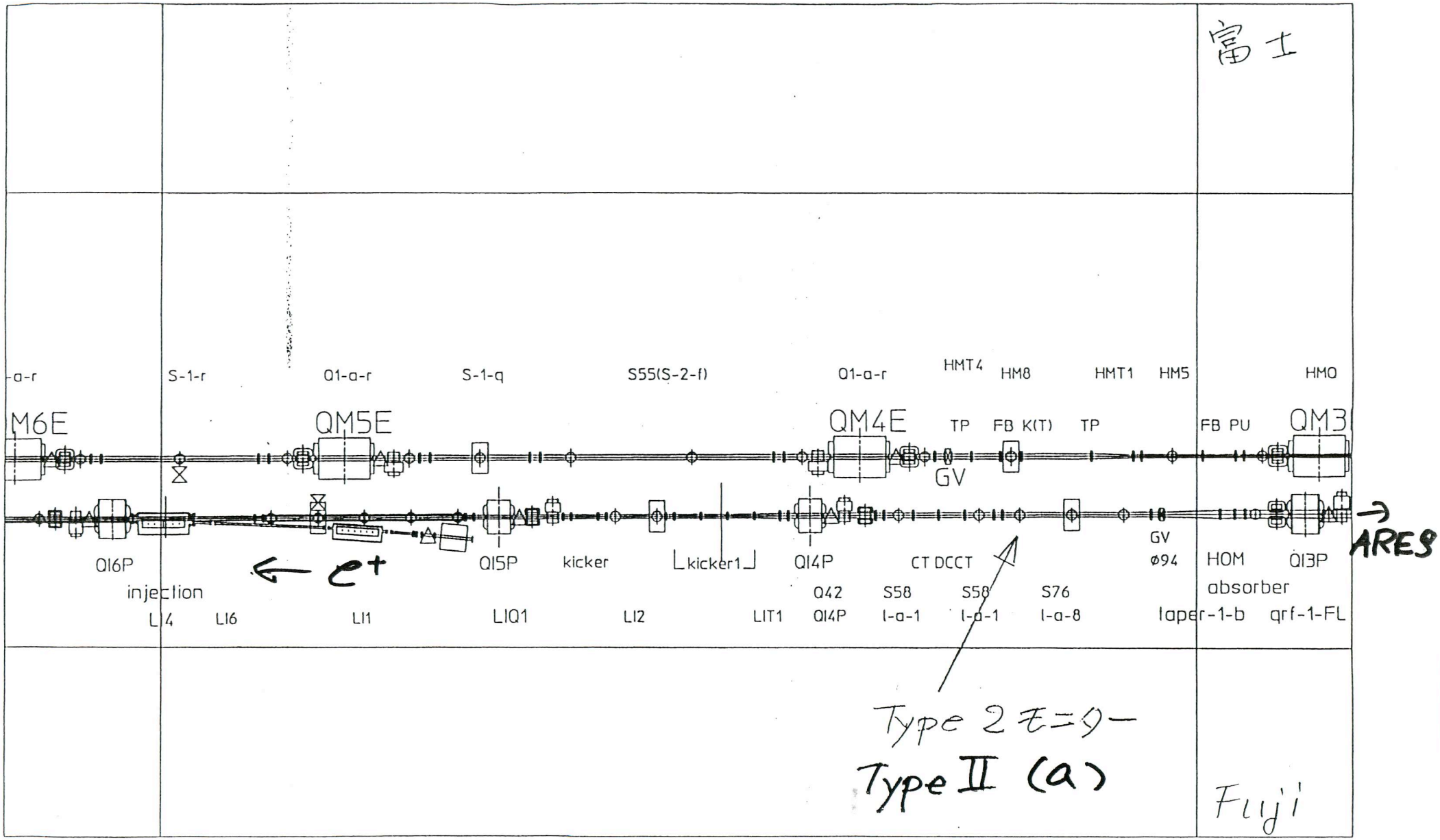
B: at PE2, reflected photon included.


PE1
PE2
Beam Current: 290-280 mA
Energy Distribution
Photoelectron Current per Energy (Amp/eV)
10-6
10-7
10-8
10-9
10-10
0
50
100
150
200
250
Energy (eV)

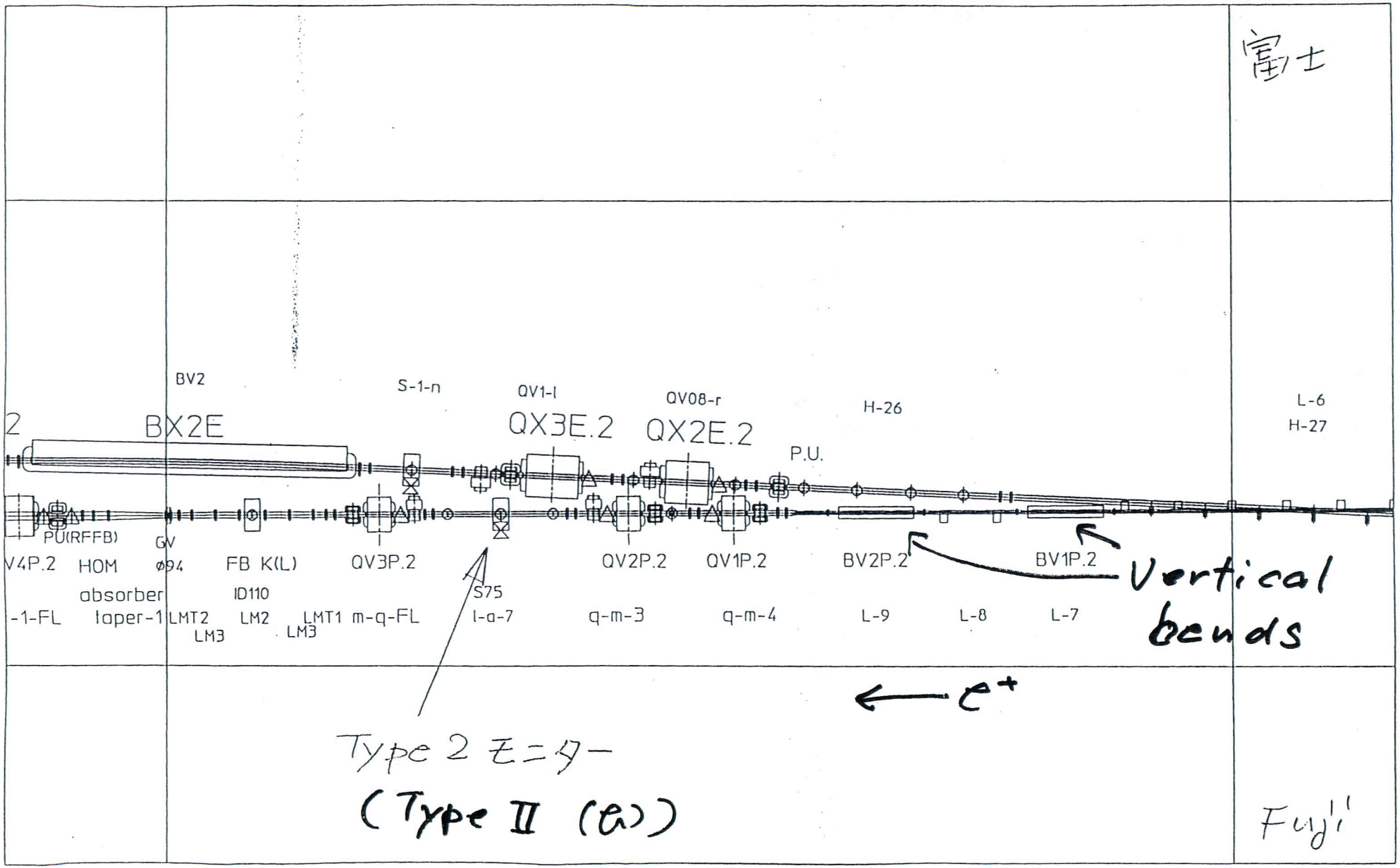
Type II Photo electron Monitor

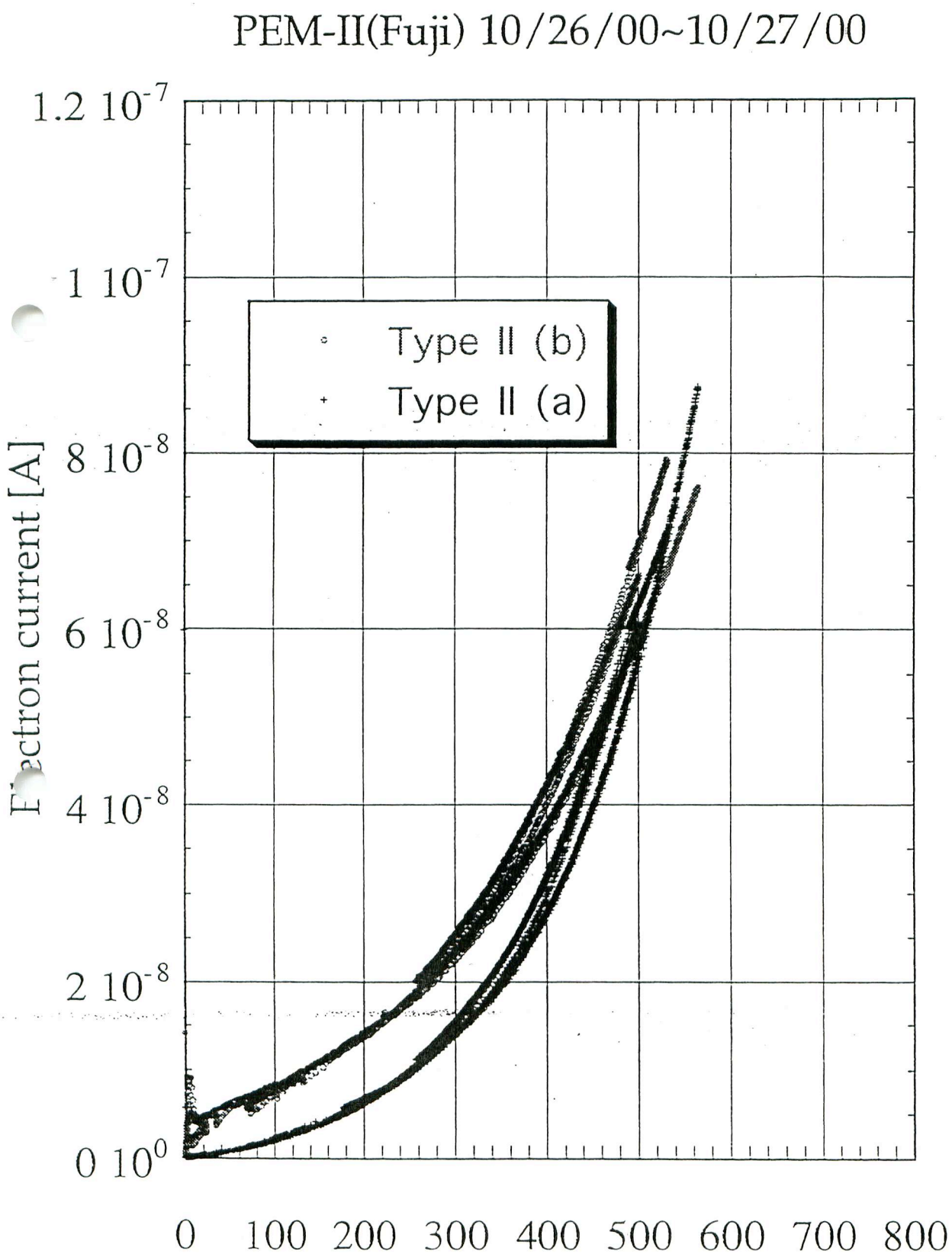




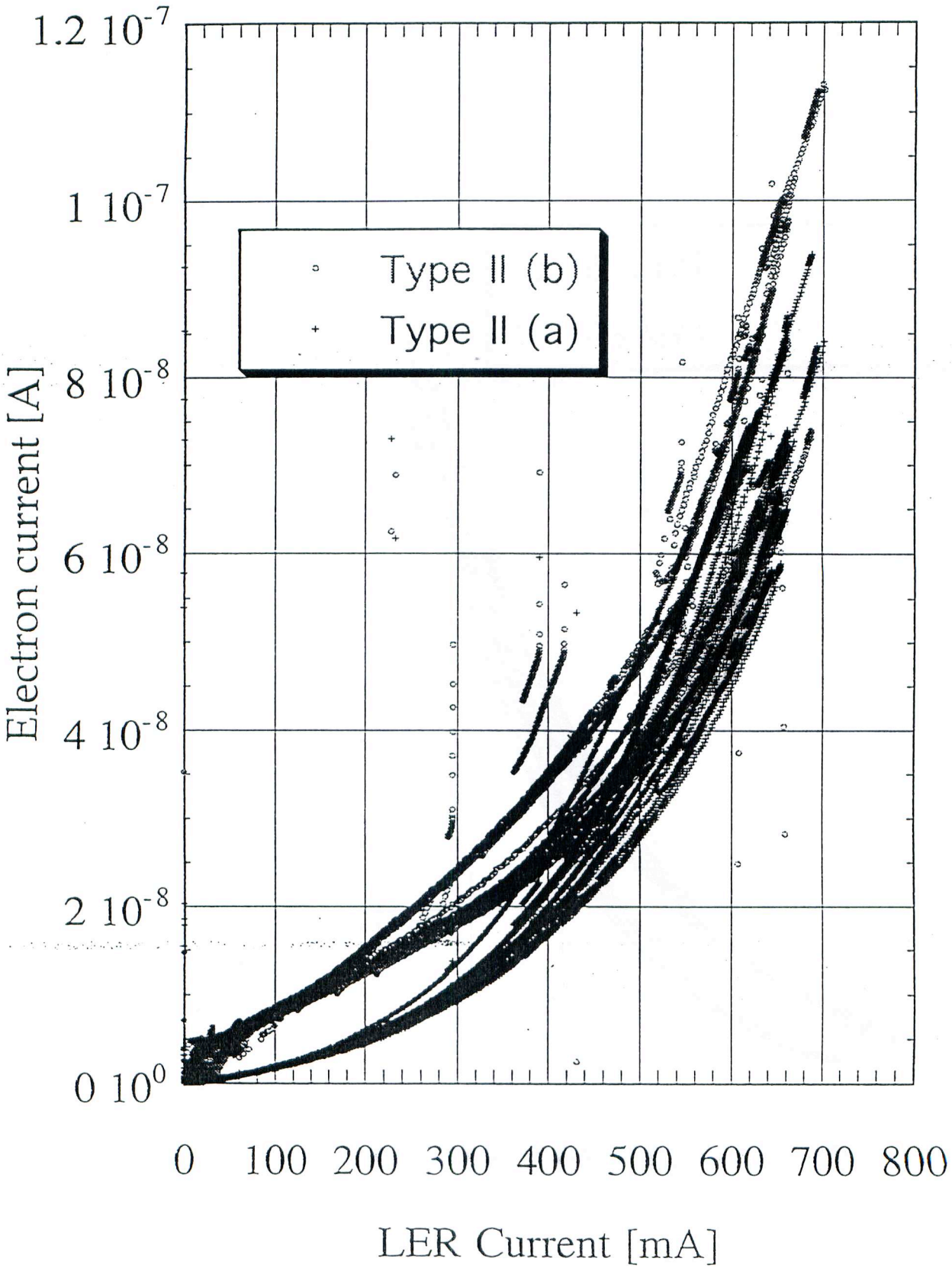


no direct photon

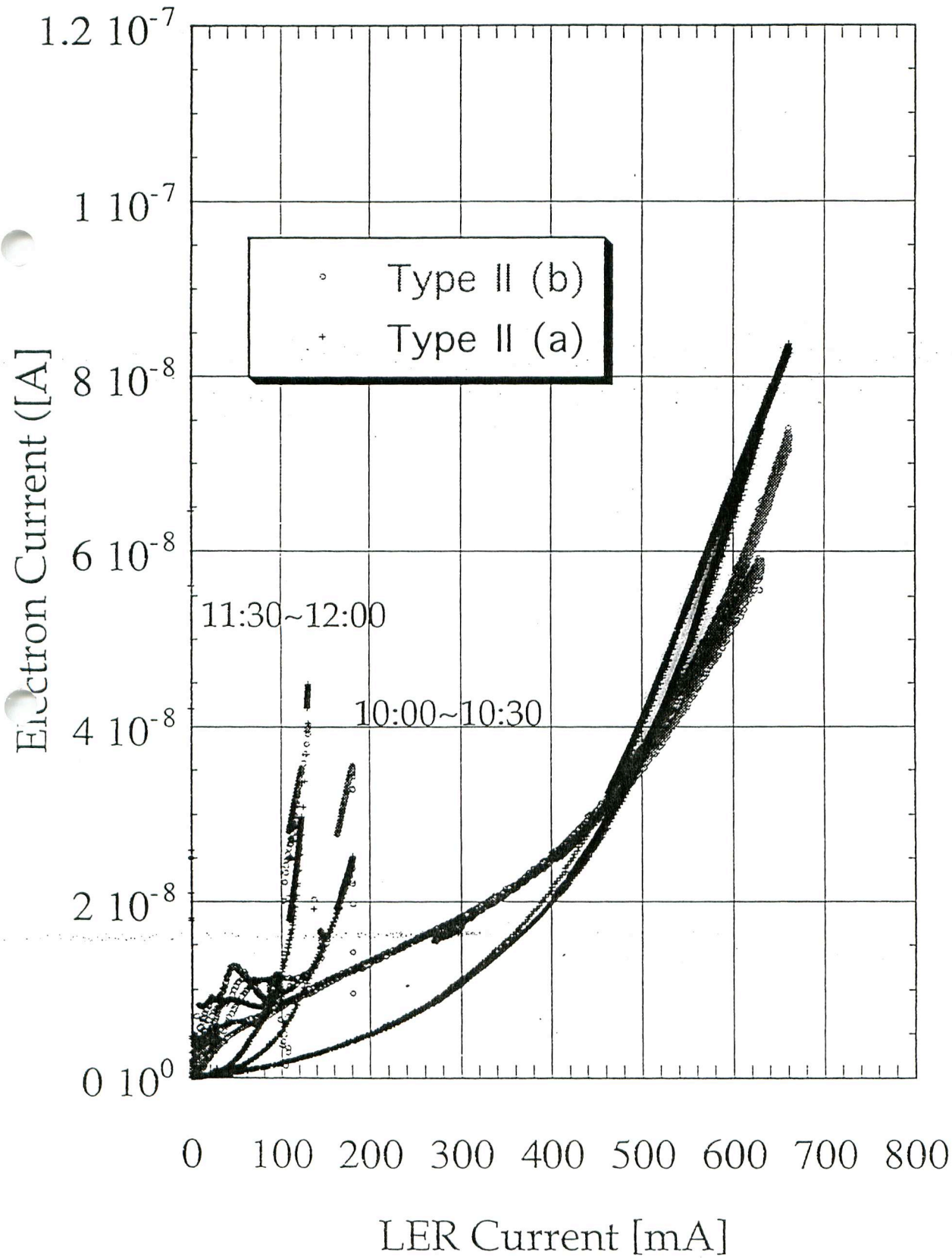

富士
BV2
S-1-n
QV1-I
QV08-r
H-26
L-6
H-27
2
BX2E
QX3E.2
QX2E.2
P.U.
PU(RFFB)
GV
V4P.2
HOM
ø94
FB K(L)
QV3P.2
QV2P.2
QV1P.2
BV2P.2
BV1P.2
Vertical bends
absorber
ID110
S75
-1-FL
taper-1
LMT2
LM2
LMT1
m-q-FL
I-a-7
q-m-3
q-m-4
L-9
L-8
L-7
LM3
LM3
e+
Type 2 モニター
(Type II (a))
Fuji


PEM-II(Fuji) 10/26/00~10/27/00
1.2 10-7
1 10-7
8 10-8
6 10-8
4 10-8
2 10-8
0 100
Type II (b)
Type II (a)
Electron current [A]
0 100 200 300 400 500 600 700 800
LER Current [mA]

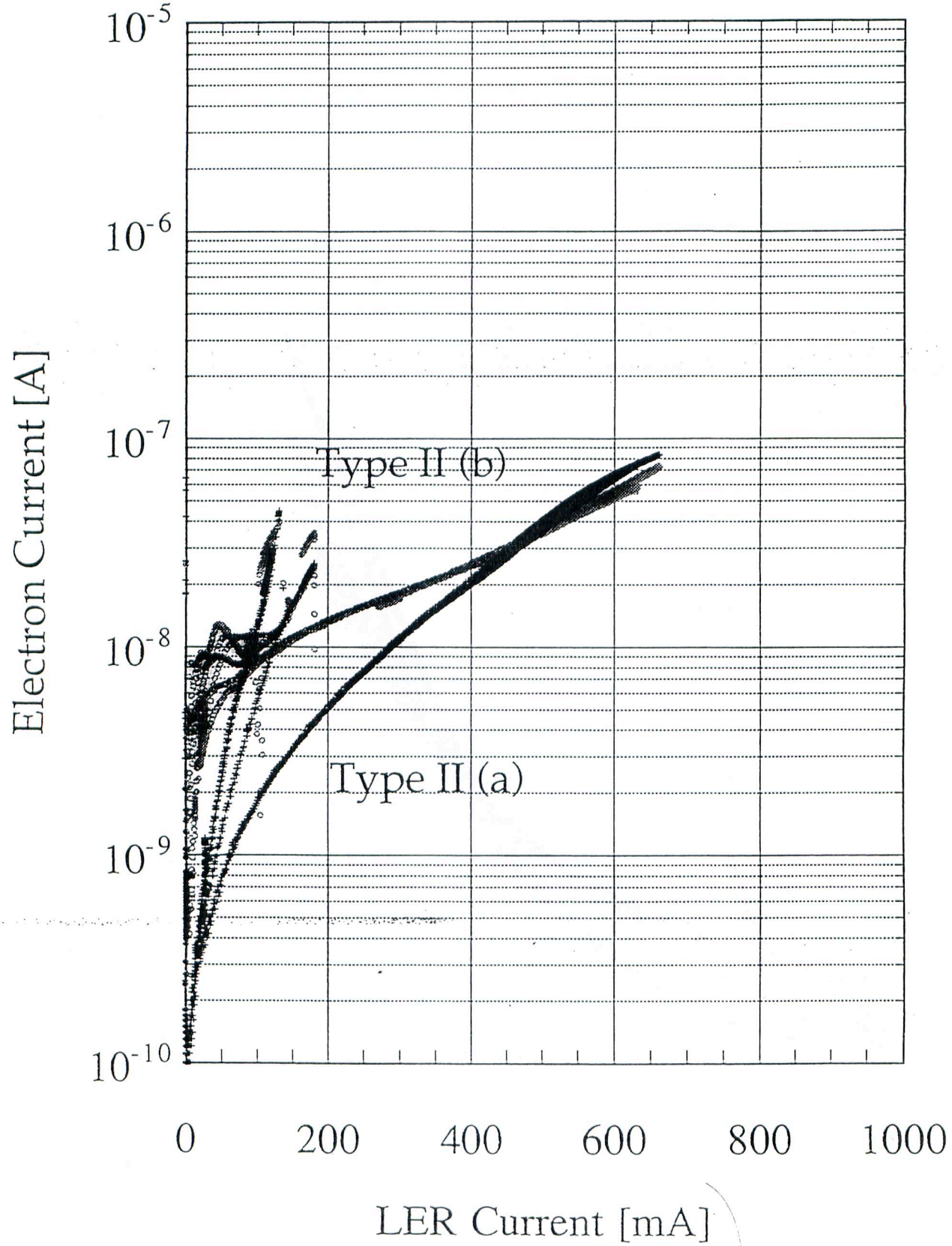
PEM110300e


1.2 10-7
1 10-7
8 10-8
6 10-8
4 10-8
2 10-8
0 10^0
Electron current [A]
Type II (b)
Type II (a)
0
100
200
300
400
500
600
700
800
LER Current [mA]

PEM110300d

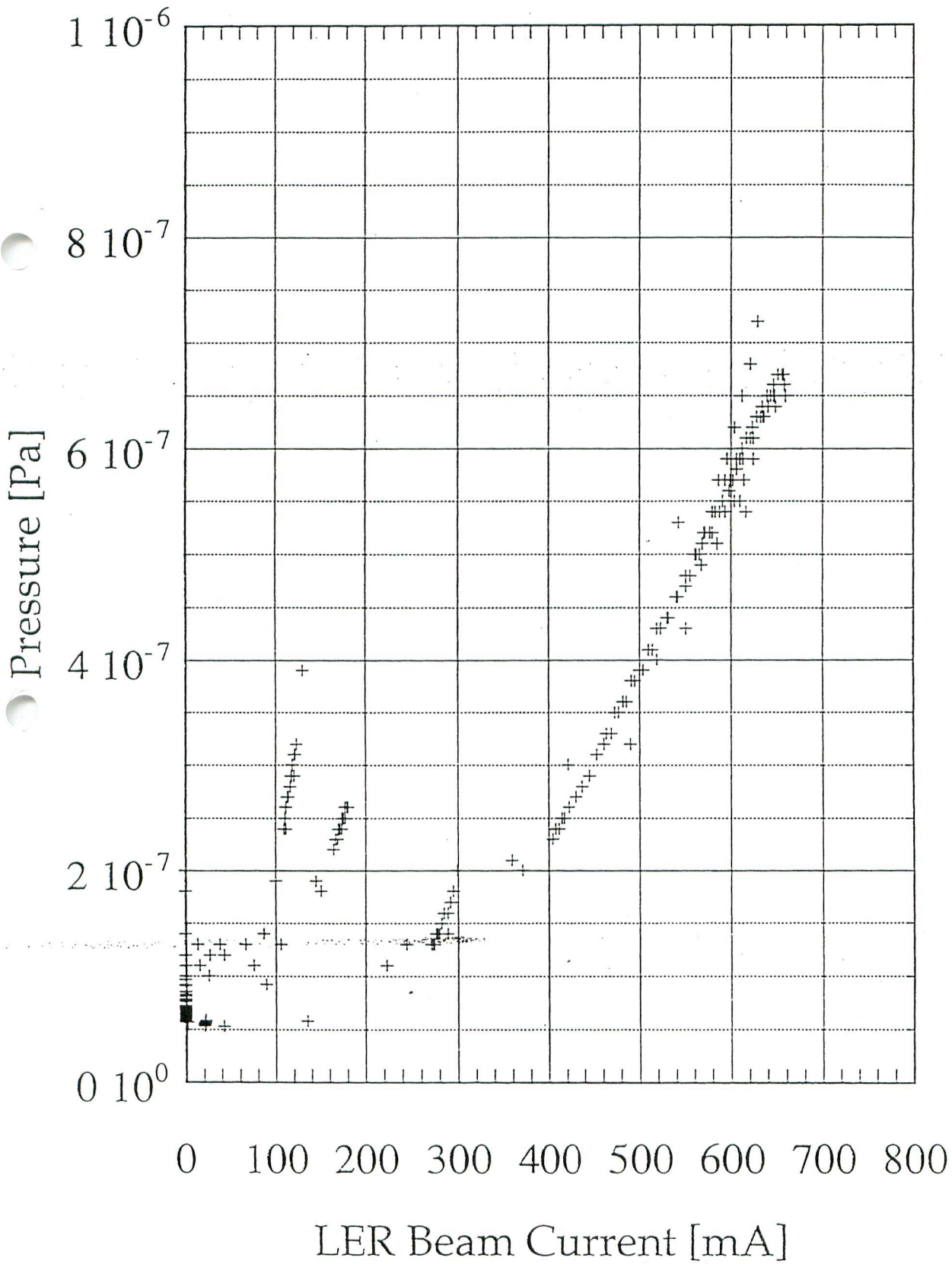

1.2 10-7
1 10-7
8 10-8
6 10-8
4 10-8
2 10-8
0 10^0
Electron Current ([A]
Type II (b)
Type II (a)
11:30~12:00
10:00~10:30
0
100
200
300
400
500
600
700
800
LER Current [mA]

PEM110300d

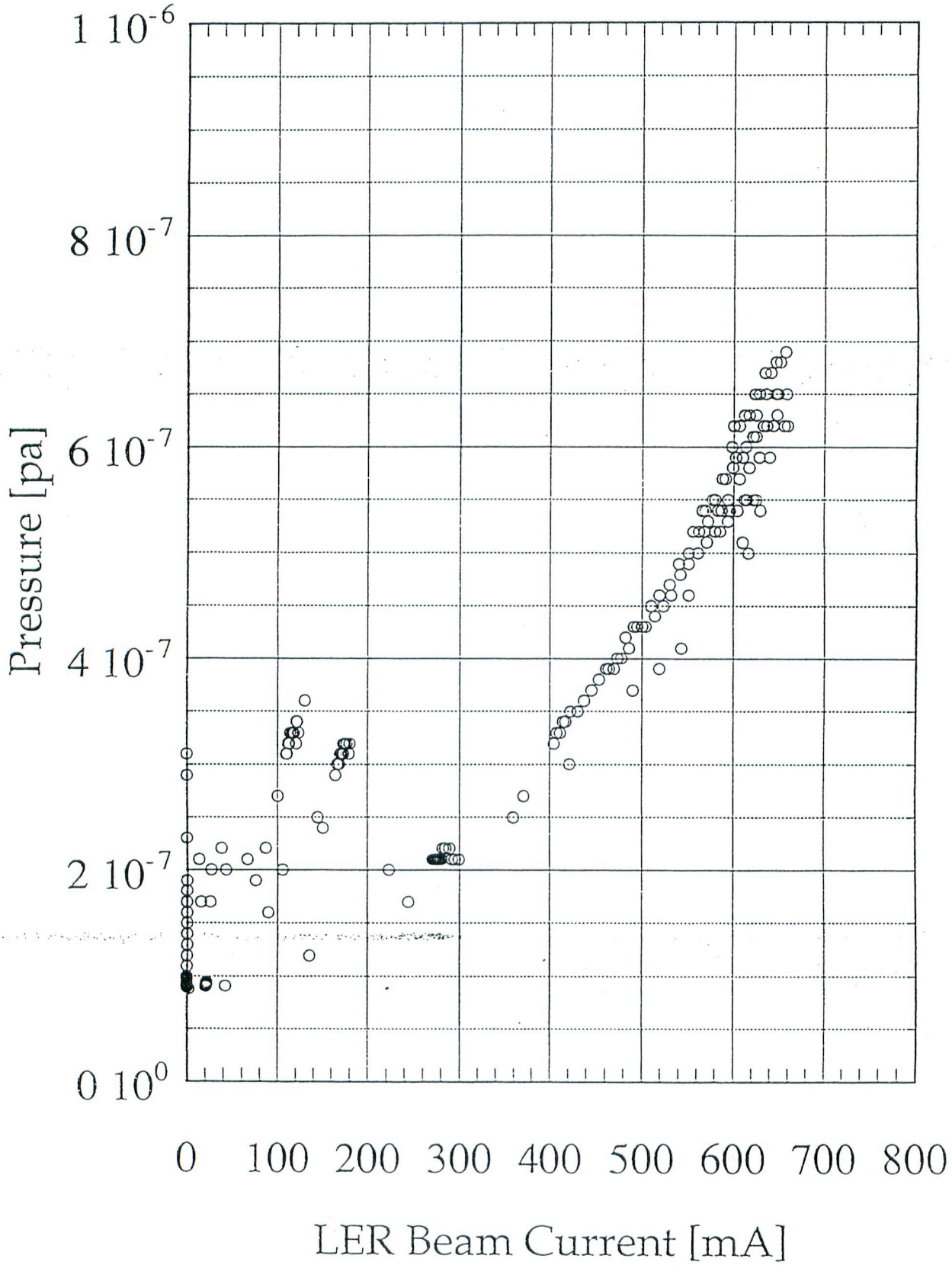


57

Pressure near Type II (a) Photo Electron Monitor
3 Nov. 2000



Pressure near Type II (b) Photo Electron Monitor
3 Nov. 2000



• The result of AC measurement in the arc

[by Y. Onishi (KEKB accel.), M Tanaka, and T. Murakami (Belle)]

1) The electron current is associated with the bunch train.

2) The peak height is proportional to the average charge density in the train.

3) No threshold behavior, but almost unique peak height can be specified for the threshold beam currents in different bunch patterns.

Blow up Threshold Observation

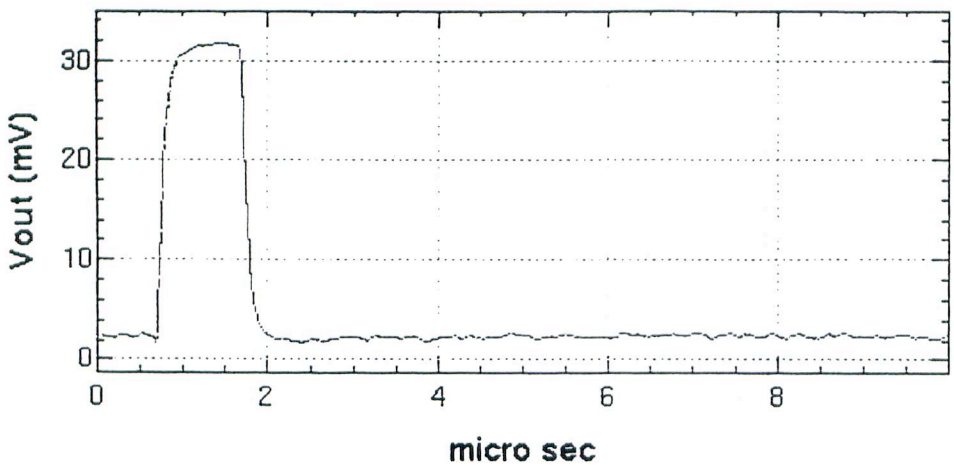
Bunch Pattern	Beam current at [mA]	Peak height of electron current [mV]	Average beam current in the train [mA/bucket]
[16, 80, 4]	440	25	0.09
[4, 60, 8]	175	24	0.09
[4, 60, 4]	104	24	0.11
[4, 60, 2]	70	27	0.15

Bunch Pattern: [No. of train, No. of bunch in the train, Bunch Spacing]

File Edit Window 12/02/2000 13:23:41 Help

Photo-electron Monitor

Current: 524.40 mA Peak to Peak: CH1 30.917 mV CH2 17.761 mV



500 nsec

Channel 1

10 mV

Channel 2

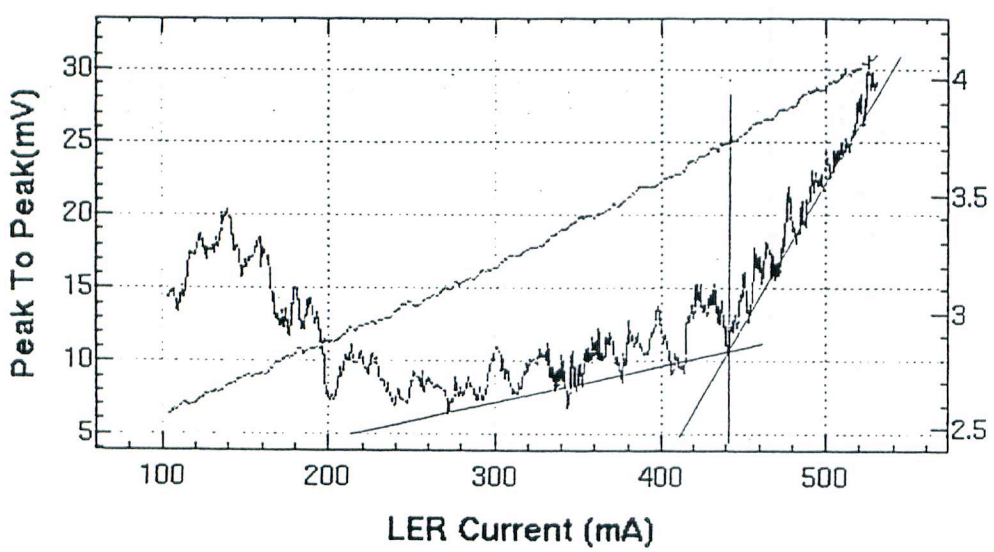
5 mV

Average Mode

Average: 0

128

Set



Select Plot:

Ch 1

Save to File:

Save

Clear

STOP

START

ve to:/vdata2p/PEM/PEM12_02_2000_13:21:38

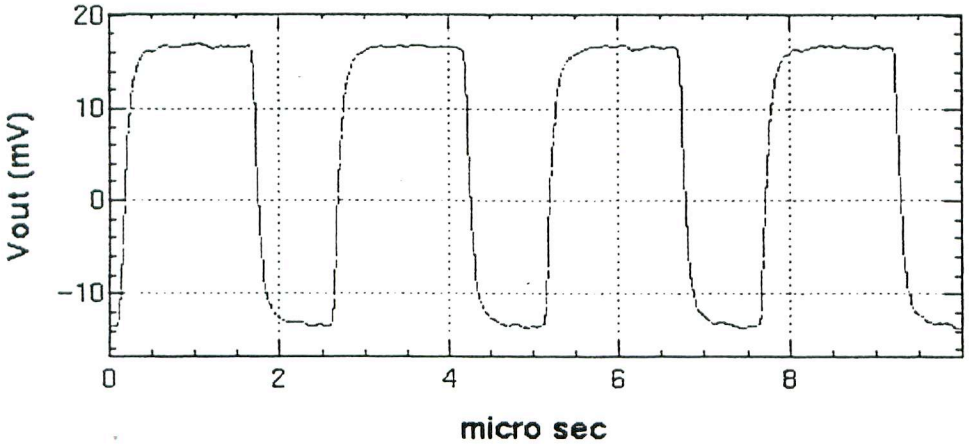
(16.80.4)

Solenoid off

File Edit Window 12/02/2000 14:16:17 Help

Photo-electron Monitor

Current: 223.24 mA Peak to Peak: CH1 31.631 mV CH2 22.241 mV



500 nsec

Channel 1

10 mV

Channel 2

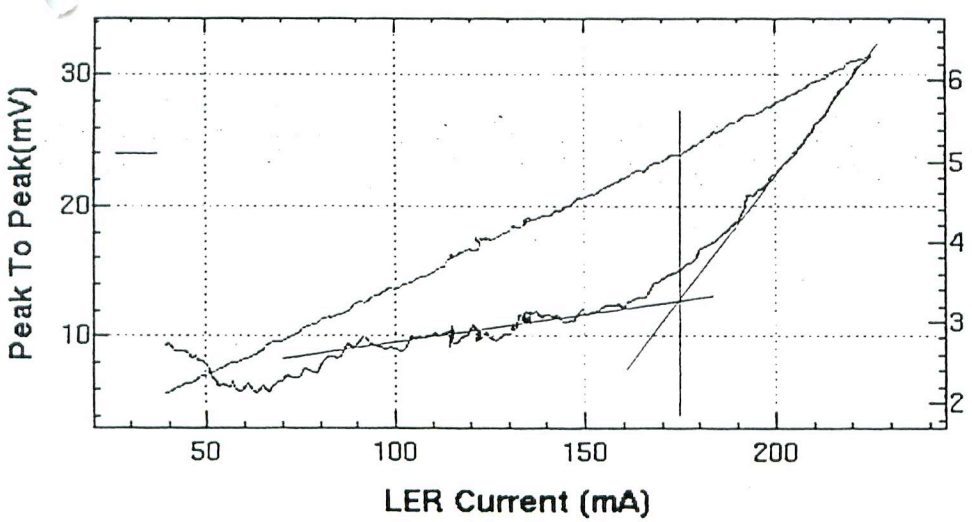
5 mV

Average Mode

Average: 0

128

Set



Select Plot:

Ch 1

Save to File:

Save

Clear

STOP

START

ve to:/vdata2p/PEM/PEM12_02_2000_14:13:49

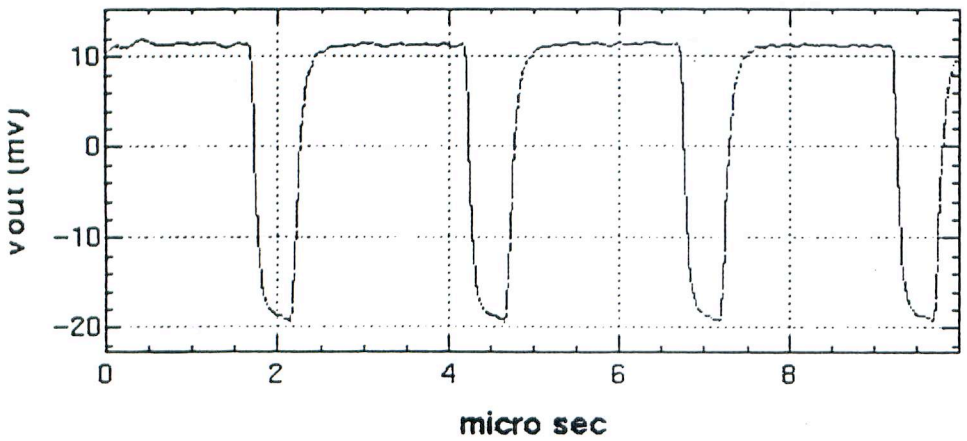
(4.60.8)

Solenoid off

File Edit Window 12/02/2000 13:59:31 Help

Photo-electron Monitor

Current: 145.66 mA Peak to Peak: CH1 32.428 mV CH2 23.371 mV



500 nsec

Channel 1

10 mV

Channel 2

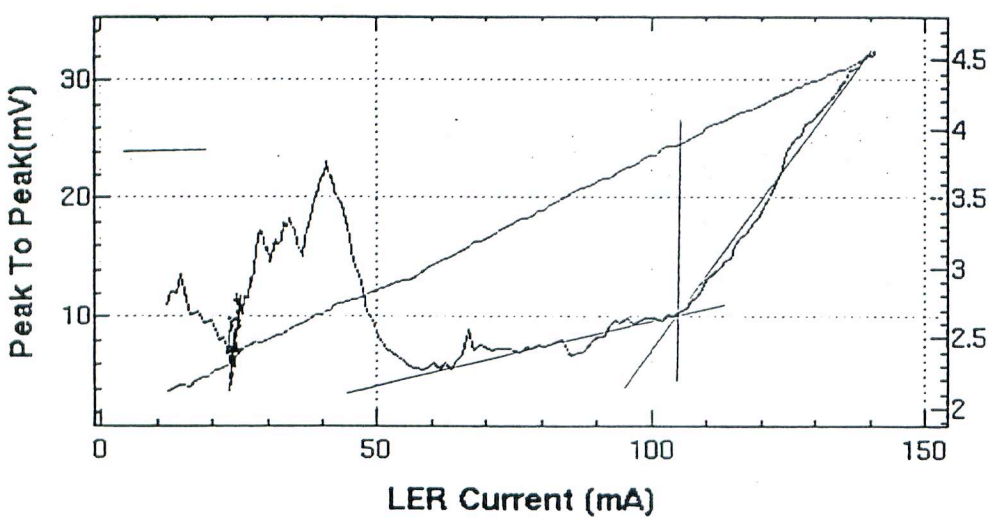
5 mV

Average Mode

Average: 0

128

Set



Sigma Y at IP(micron)

Select Plot:

Ch 1

Save to File:

Save

Clear

STOP

START

e to:/vdata2p/PEM/PEM12_02_2000_13:57:58

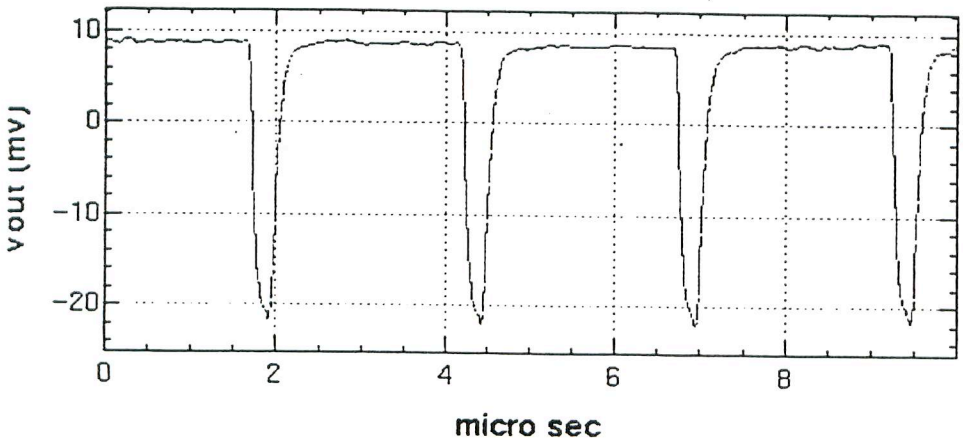
(4.60.4)

Solenoid off

File Edit Window 12/02/2000 14:23:32 Help

Photo-electron Monitor

Current: 86.47 mA Peak to Peak: CH1 32.105 mV CH2 14.435 mV



500 nsec

Channel 1

10 mV

Channel 2

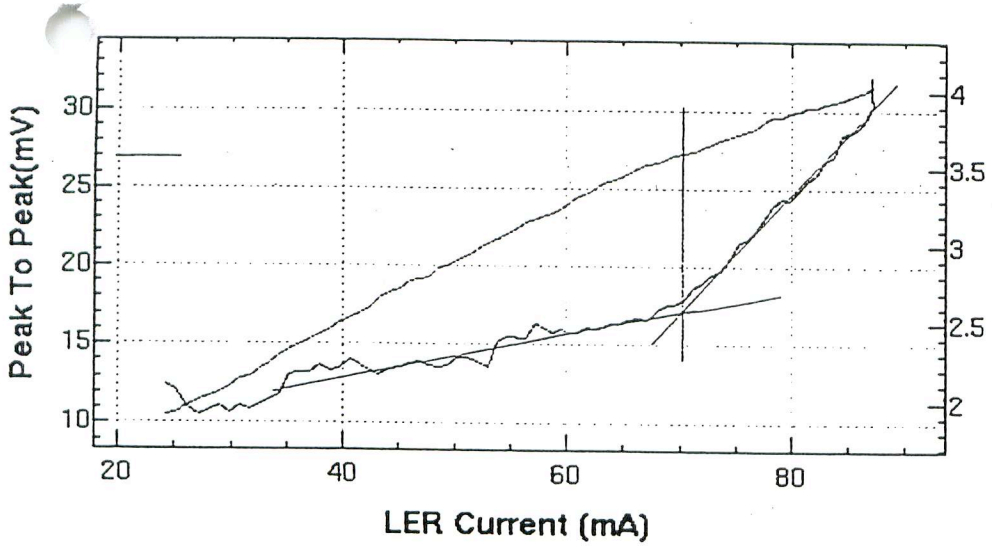
5 mV

Average Mode

Average: 0

128

Set



Select Plot:

Ch 1

Save to File:

Save

Clear

STOP

START

e to:/vdata2p/PEM/PEM12_02_2000_14:22:45

(4, 60, 2)

Solenoid off