The Members of

The KEKB Commissioning Team

2/2/1999

K. Akai, N. Akasaka, A. Enomoto, J. Flanagan,
H. Fukuma, Y. Funakoshi, K. Furukawa, S. Hiramatsu,
K. Hosoyama, N. Huan, T. Ieiri, N. Iida, T. Kamitani,
S. Kato, M. Kikuchi, E. Kikutani, H. Koiso, M. Masuzawa,
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K. Ohmi, Y. Ohnishi, S. Ohsawa, N. Ohuchi, M. Oide,
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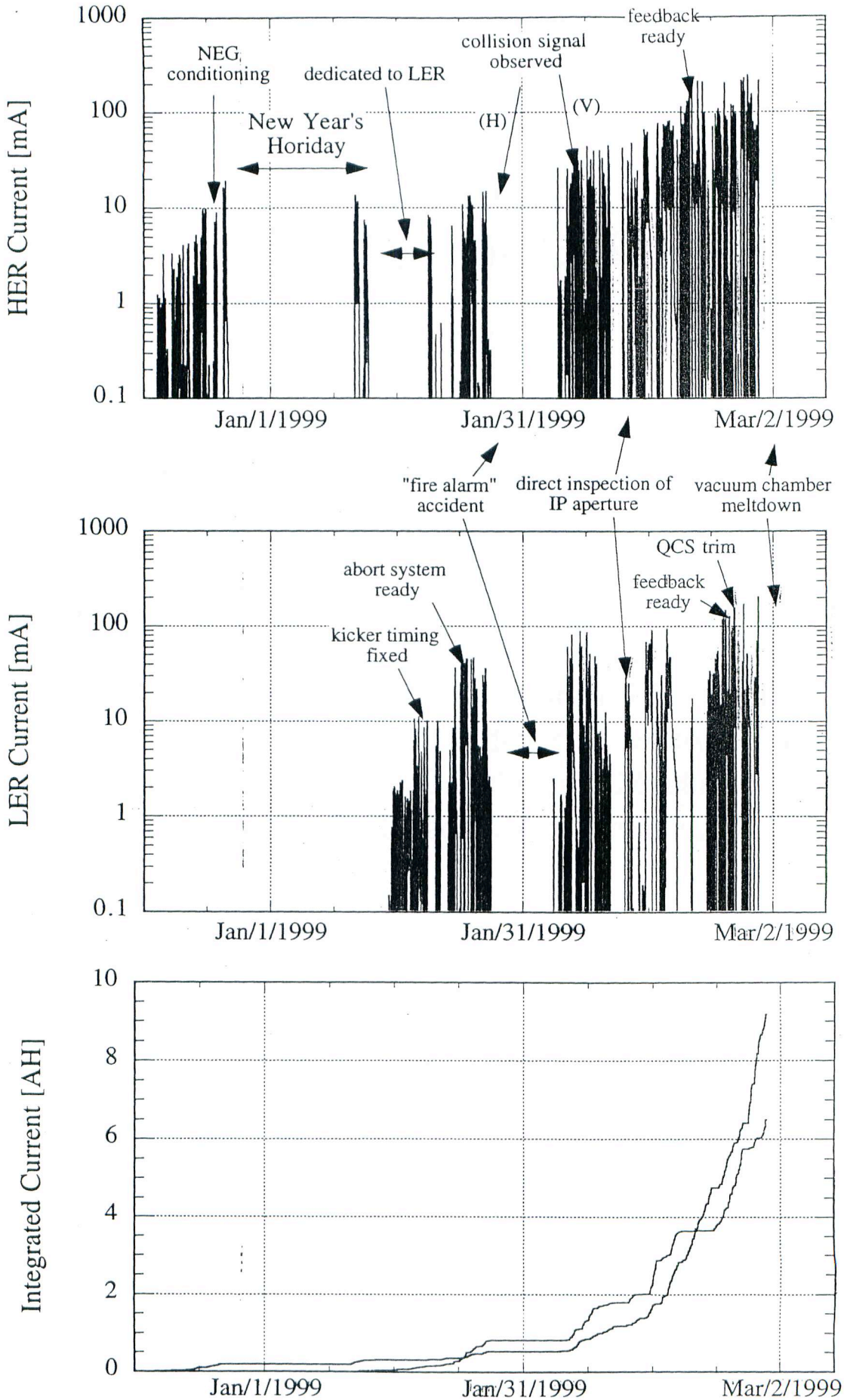
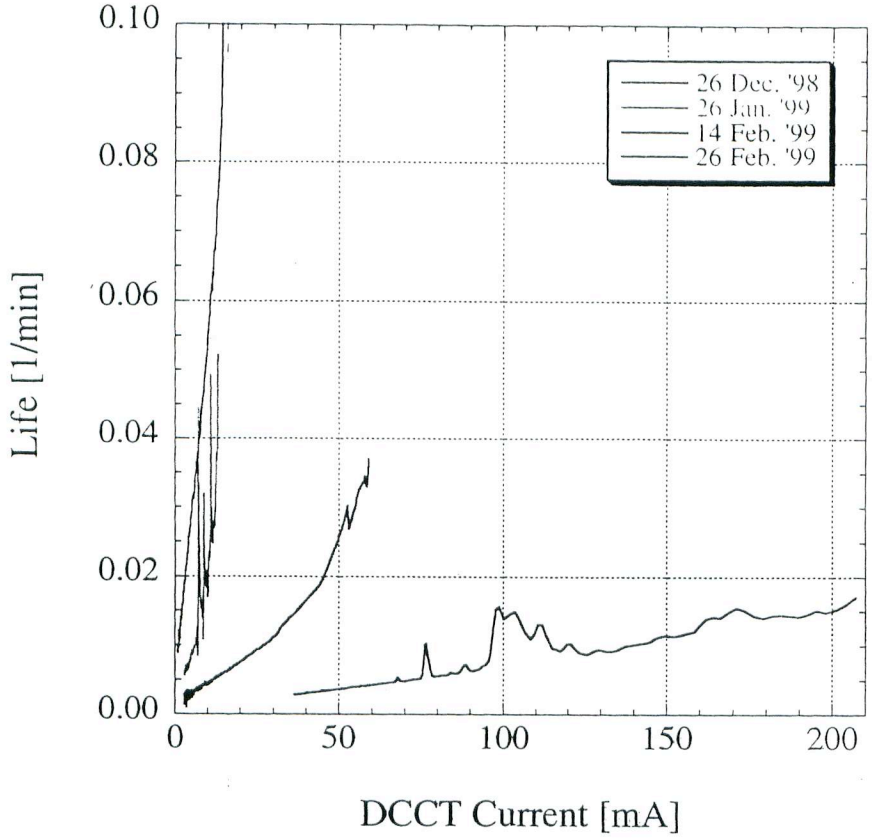
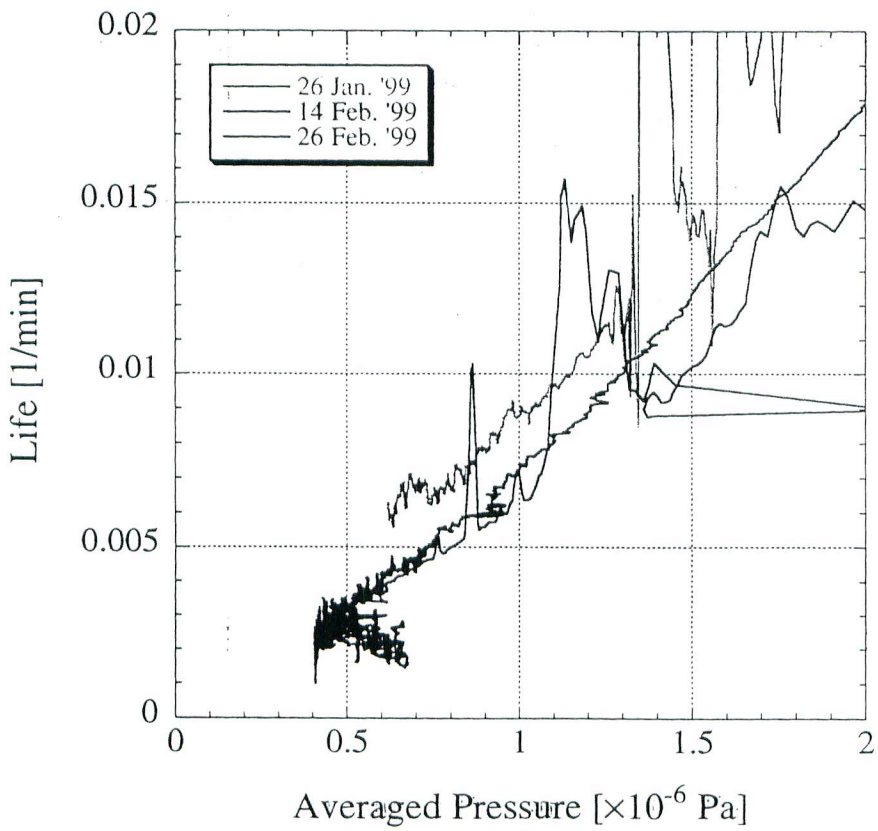
N. Yamamoto, M. Yoshida, S. Yoshimoto

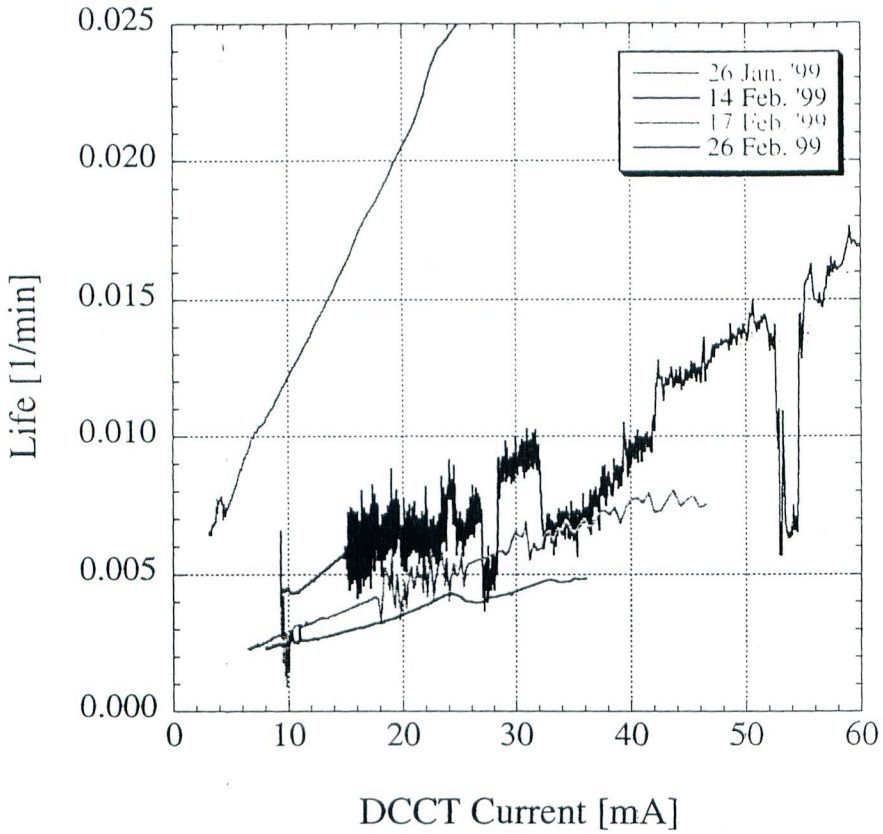

HER Current [mA]
1000
100
10
1
0.1
NEG conditioning
New Year's Horiday
dedicated to LER
collision signal observed
(H)
(V)
feedback ready
Jan/1/1999
Jan/31/1999
Mar/2/1999
"fire alarm" accident
direct inspection of IP aperture
vacuum chamber meltdown
LER Current [mA]
1000
100
10
1
0.1
abort system ready
kicker timing fixed
QCS trim
feedback ready
Jan/1/1999
Jan/31/1999
Mar/2/1999
Integrated Current [AH]
10
8
6
4
2
0
Jan/1/1999
Jan/31/1999
Mar/2/1999

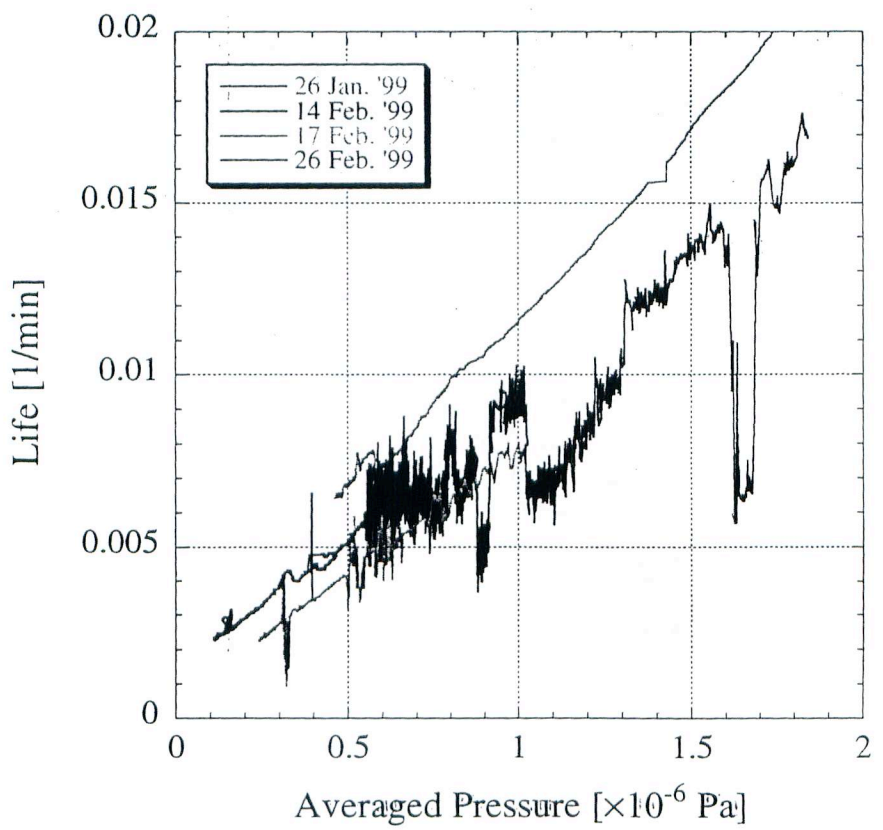
HER


0.10
0.08
0.06
0.04
0.02
0.00
Life [1/min]
0
50
100
150
200
DCCT Current [mA]
26 Dec. '98
26 Jan. '99
14 Feb. '99
26 Feb. '99

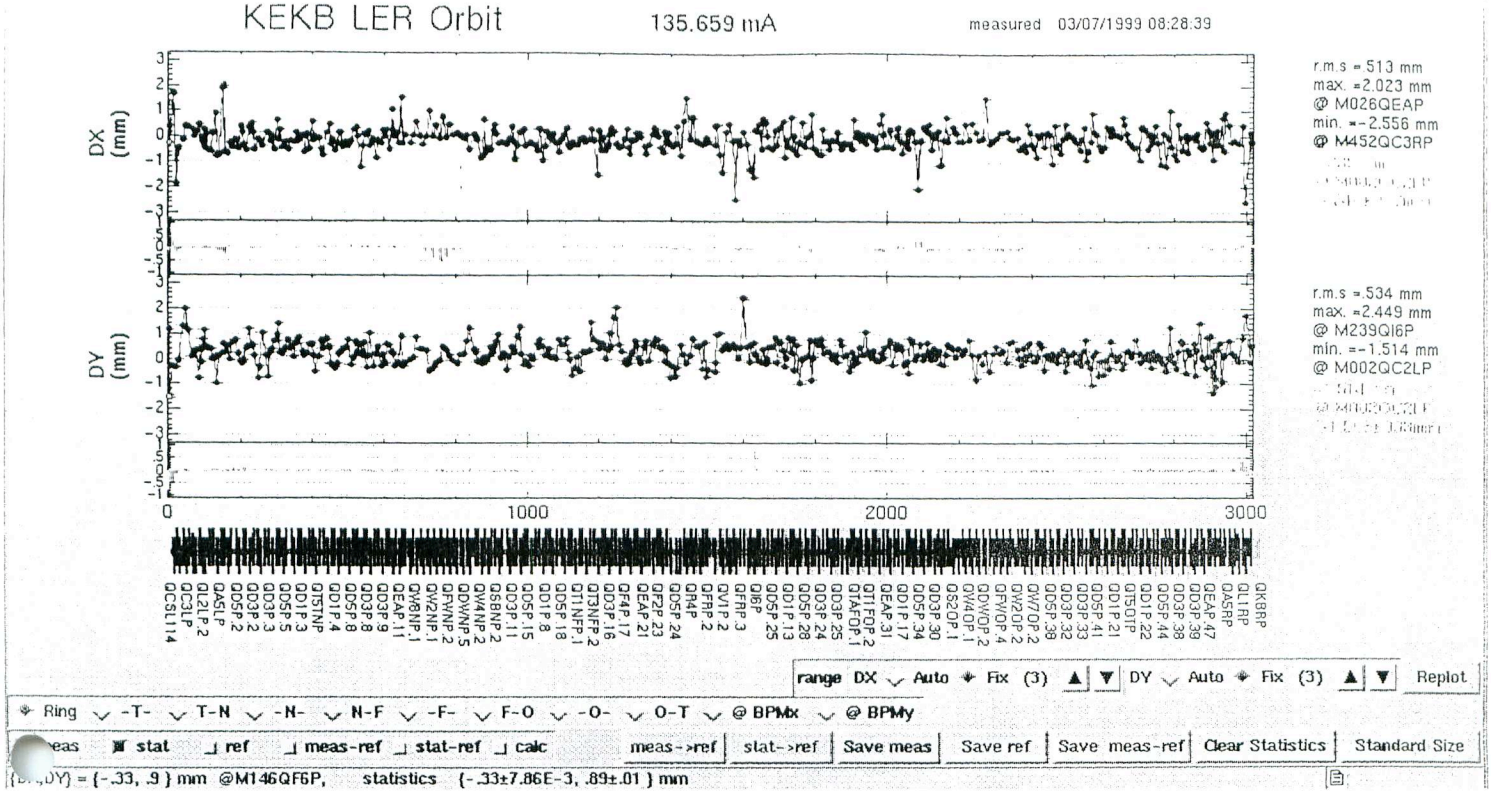

0.02
0.015
0.01
0.005
0
Life [1/min]
0
0.5
1
1.5
2
Averaged Pressure [×10-6 Pa]
26 Jan. '99
14 Feb. '99
26 Feb. '99

LER


0.025
0.020
0.015
0.010
0.005
0.000
Life [1/min]
0
10
20
30
40
50
60
DCCT Current [mA]
26 Jan. '99
14 Feb. '99
17 Feb. '99
26 Feb. '99


0.02
0.015
0.01
0.005
0
Life [1/min]
0
0.5
1
1.5
2
Averaged Pressure [×10-6 Pa]
26 Jan. '99
14 Feb. '99
17 Feb. '99
26 Feb. '99

File Edit Measurement Correction Steering Orbit Window Help



range DX Auto Fix (3) DY Auto Fix (3) Replot

Ring -T- T-N -N- N-F -F- F-O -O- O-T @ BPMx @ BPMy

meas stat ref meas-ref stat-ref calc meas->ref stat->ref Save meas Save ref Save meas-ref Clear Statistics Standard Size

{DX,DY} = {-.33, .9 } mm @M146QF6P, statistics {-.33±7.86E-3, .89±.01 } mm

Ler single bunch injection short beam

injection filling pattern 5/1/1/1/0

injection rate 0.026 mA/S. 1.22 mA.

single turn injection $K_1 = 0.9$ mrad $K_2 = 0$

1.1 1.3 1.5 → $K_1 = 0.95$.

Change injection phase

122°

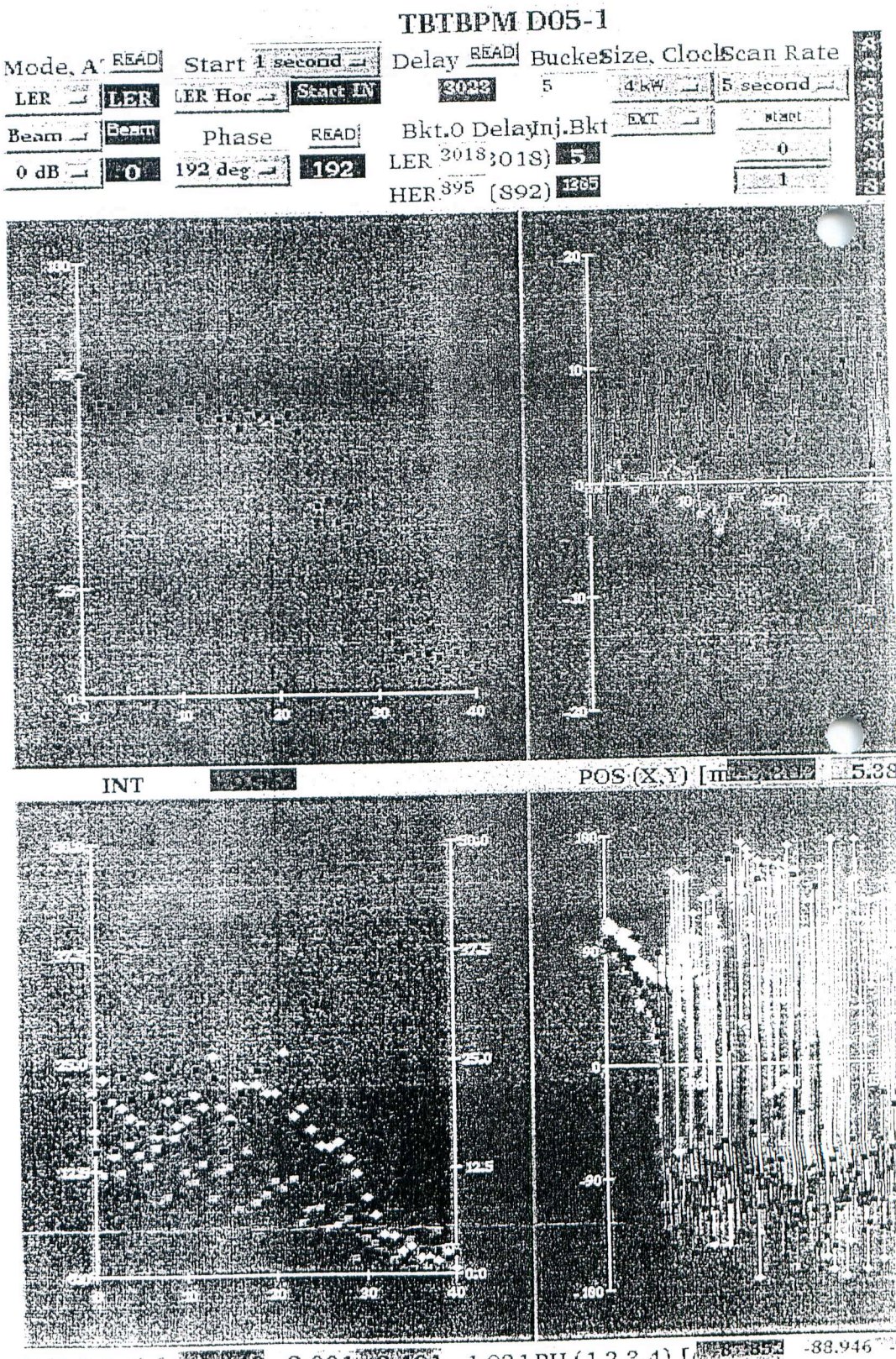
↓

132°

Beam loss

phase Lock go down.

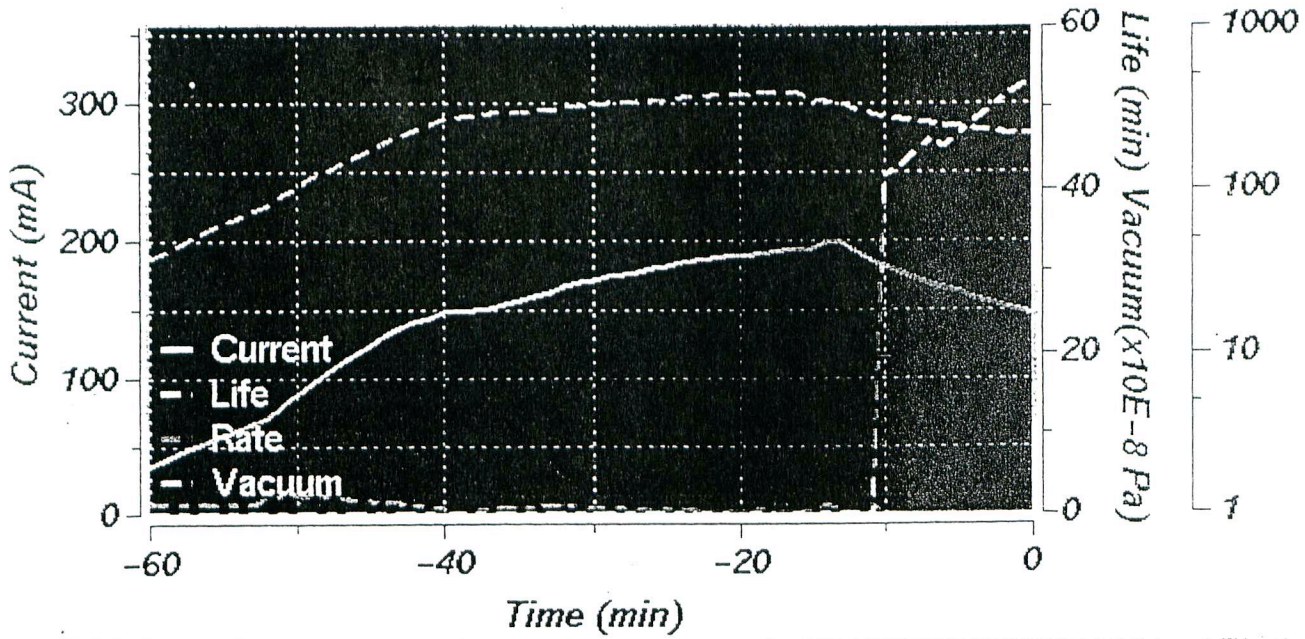
reset phase lock



RF PLL が
はずれていた.
→

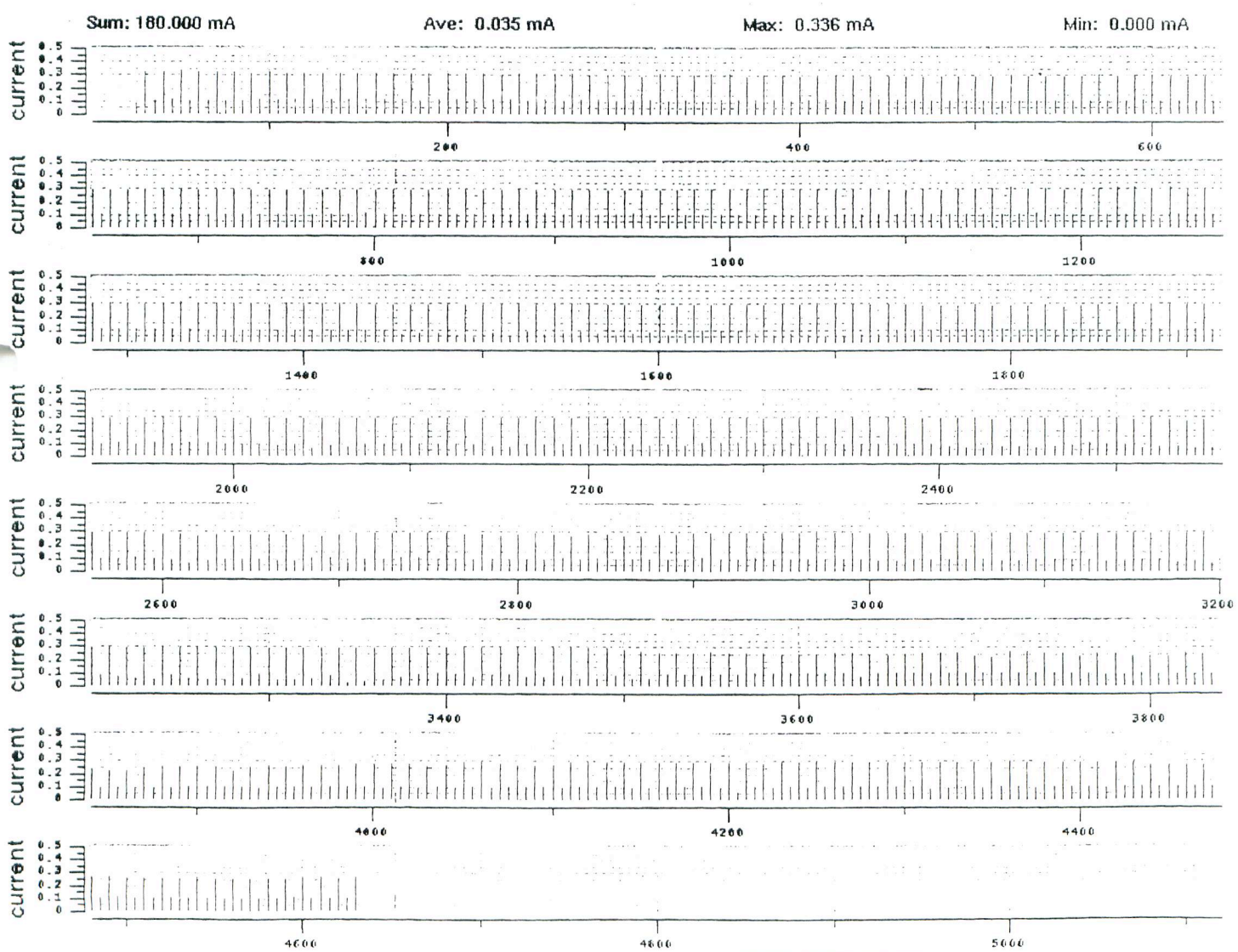
60 sec 10 min 60 min

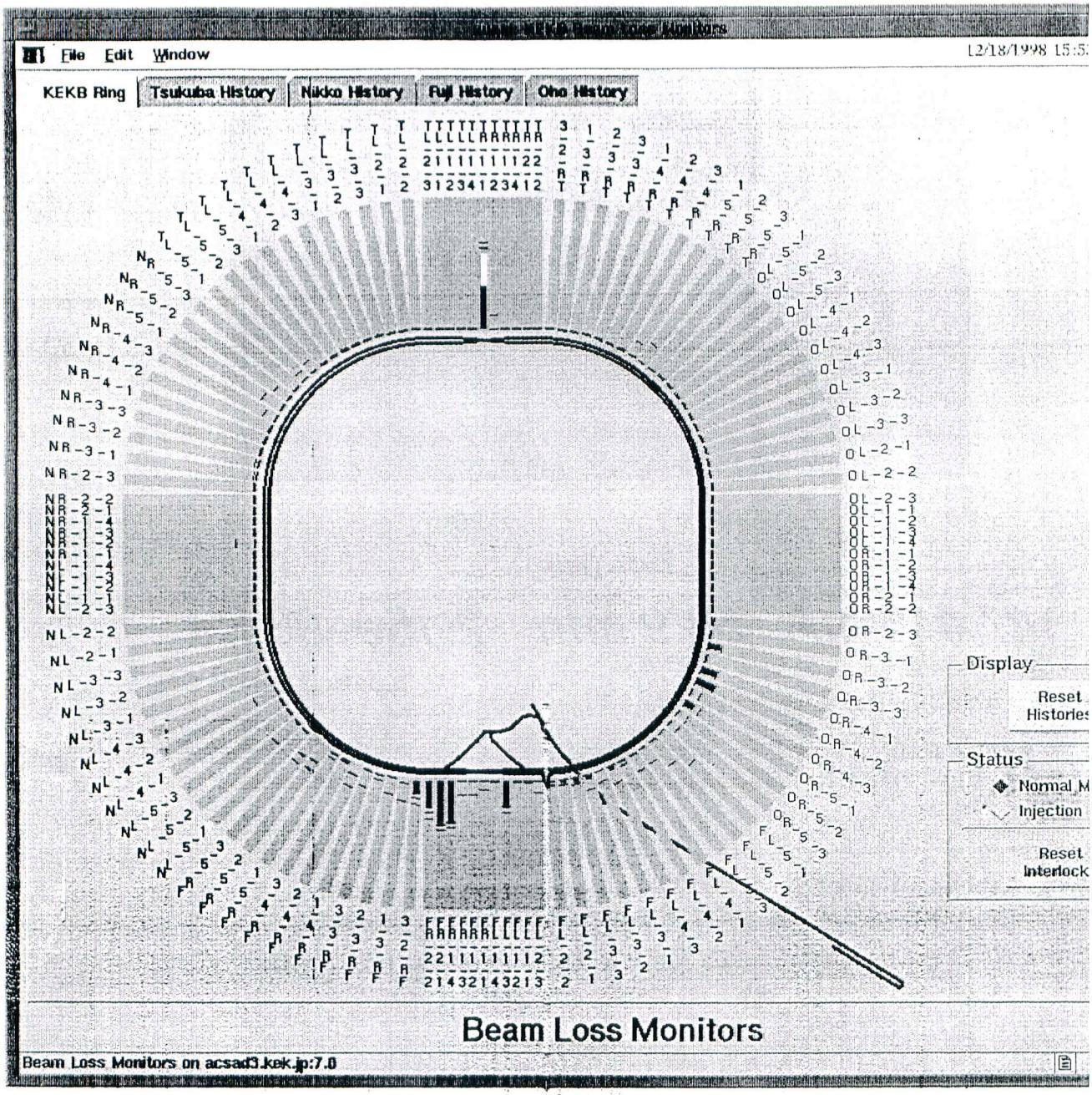
LER KEKB Status



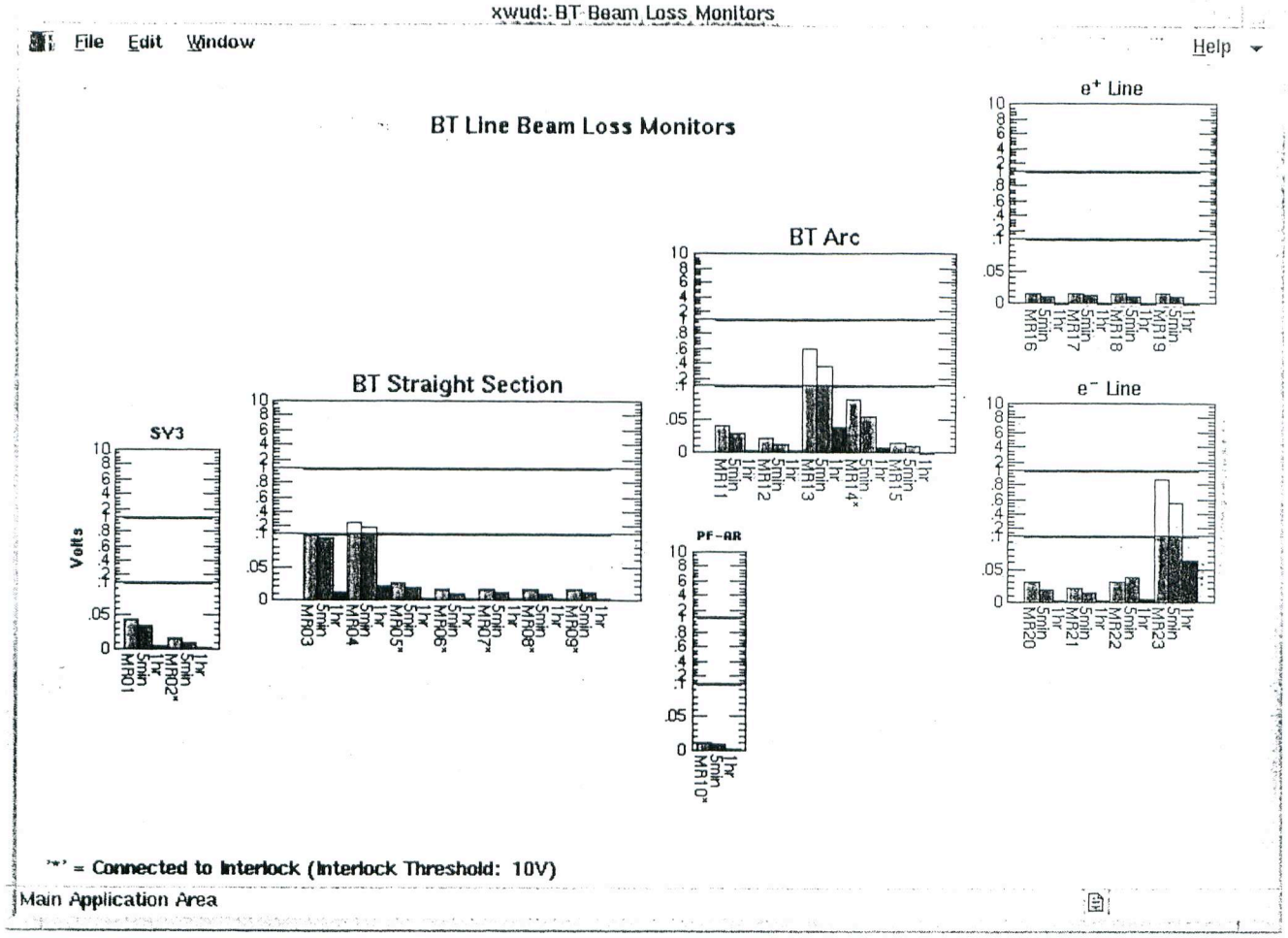
147.416 mA 53.9 min 2.15e-06 Pa

Sun Feb 28 05:19:33 1999



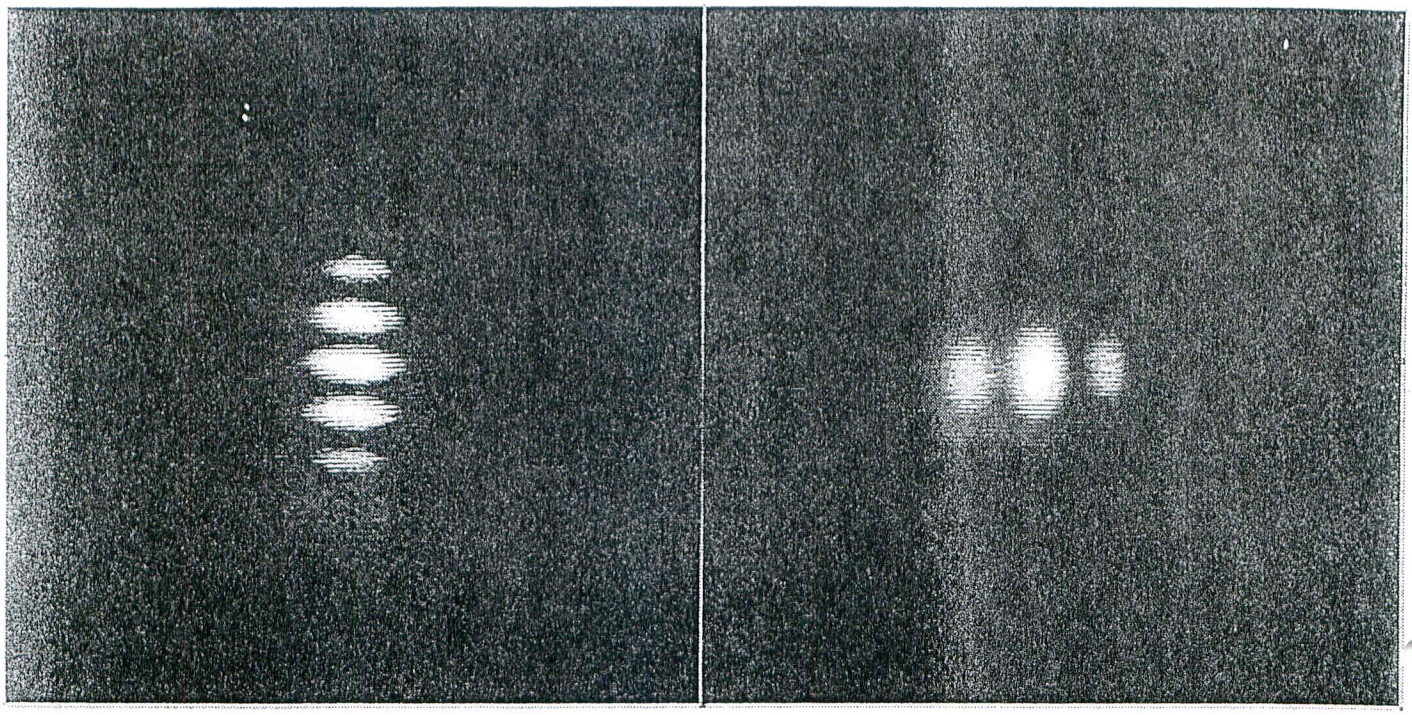

File Edit Window
12/18/1998 15:5
KEKB Ring
Tsukuba History
Nikko History
Fuji History
Oho History
Display
Reset Histories
Status
Normal M
Injection
Reset Interlock
Beam Loss Monitors
Beam Loss Monitors on acsad3.kek.jp:7.0

J. Flanagan


xwud: BT Beam Loss Monitors
File Edit Window
Help
BT Line Beam Loss Monitors
e+ Line
BT Arc
BT Straight Section
e- Line
SY3
Volts
PF-AR
'*' = Connected to Interlock (Interlock Threshold: 10V)
Main Application Area

J. Flanagan

Beam Size Measurement via SR Interferometry



Vertical Horizontal

$$\sigma_{beam} \cong \sqrt{\frac{\lambda^2 f^2}{2\pi^2 D^2} \ln(\frac{1}{\gamma})}$$

λ = wavelength (500 nm)

f = optical pathlength

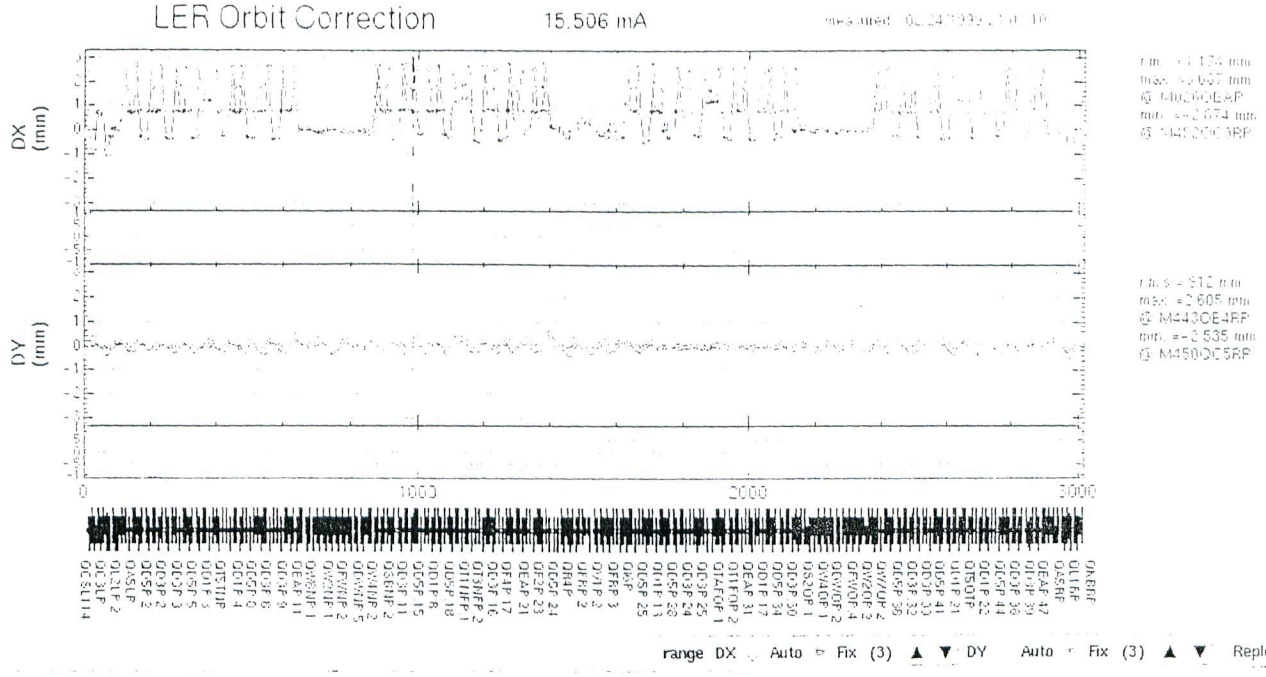
D = slit separation

γ = visibility $\equiv \frac{peak - valley}{peak + valley}$

- Corrections:
  - Magnification due to mirror curvature
  - Field depth effect
  - Instrumental function

Mitsuhashi / Flanagan

File Edit Measurement Correction Steering Orbit Window 02/24/1999 Help



range DX Auto Fix (3) DY Auto Fix (3) Replot

Ring -T- T-N -N- N-F -F- F-O -O- O-T @ BPMx @ BPMy

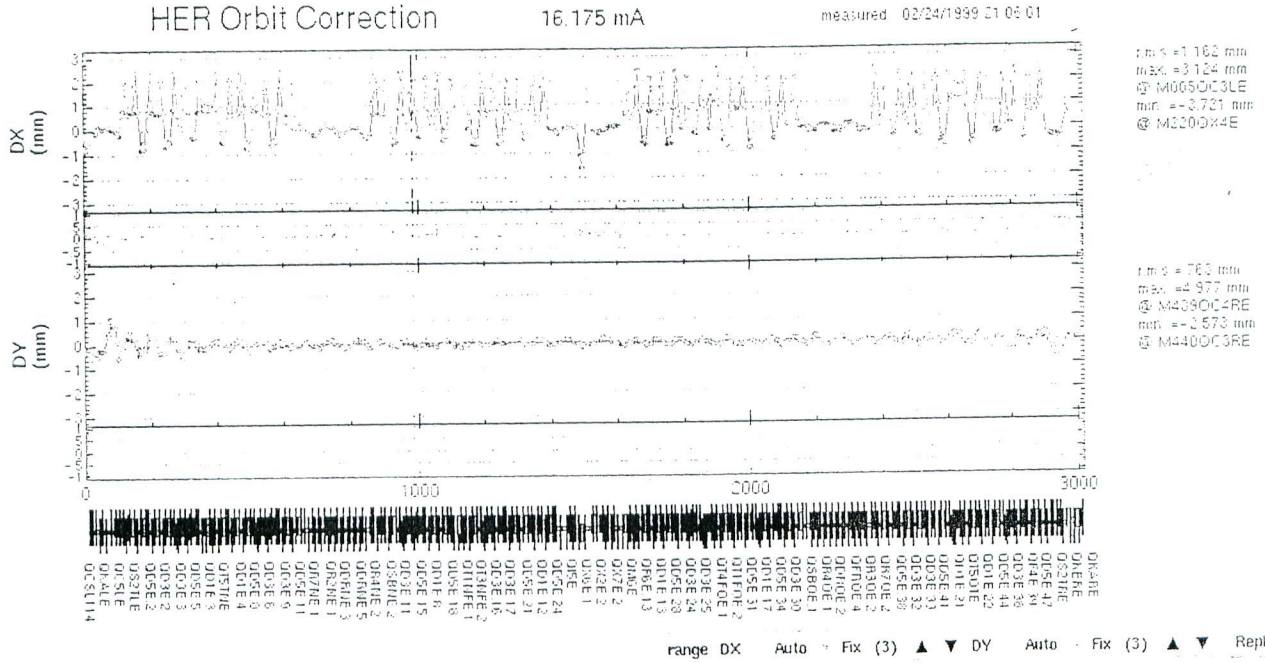
meas stat ref meas-ref stat-ref calc meas->ref stat->ref Save meas Save ref Save meas-ref Clear Statistics Standard Size

Conditions Steering Orbit

meas meas-ref Reset Measure

Horizontal Vertical

File Edit Measurement Correction Steering Orbit Window 02/24/1999 21:07:31 Help



range DX Auto Fix (3) DY Auto Fix (3) Replot

Ring -T- T-N -N- N-F -F- F-O -O- O-T @ BPMx @ BPMy

meas stat ref meas-ref stat-ref calc meas->ref stat->ref Save meas Save ref Save meas-ref Clear Statistics Standard Size

Conditions Steering Orbit

meas meas-ref Reset Measure

Horizontal Vertical Back Recall->meas

Recall->ref

SVD MICADO

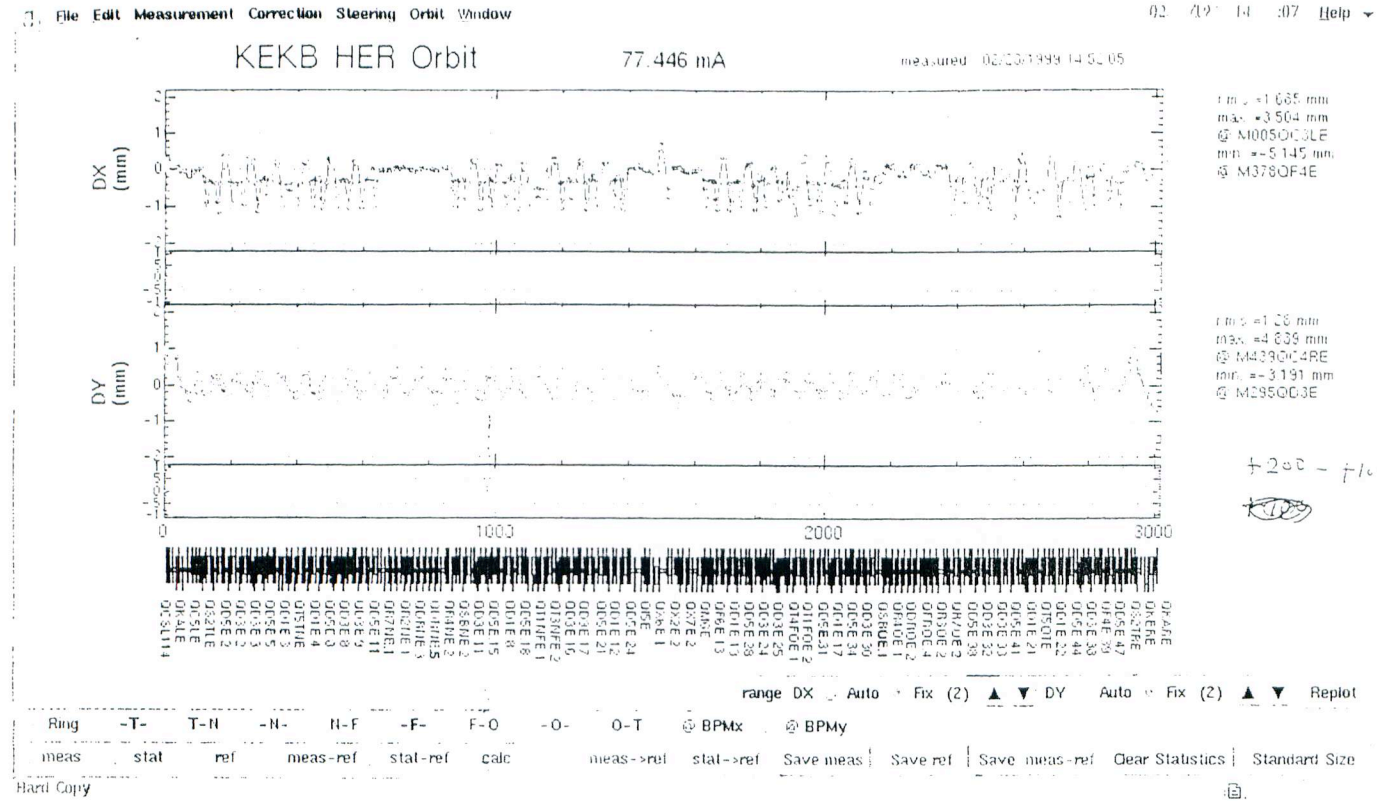
Correction

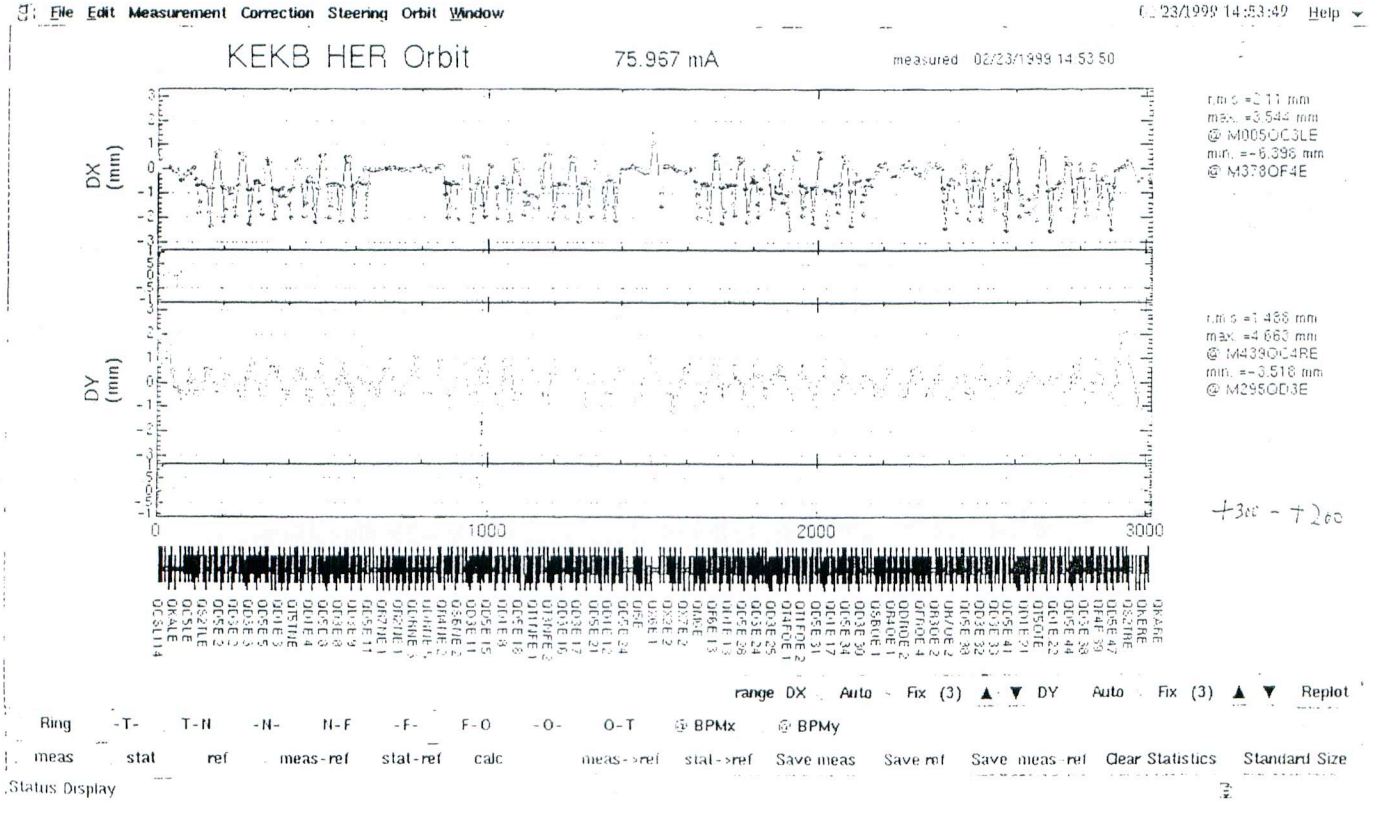
Tolerance .01

Damping Factor 1

44.50717 -44.62874 44.50717

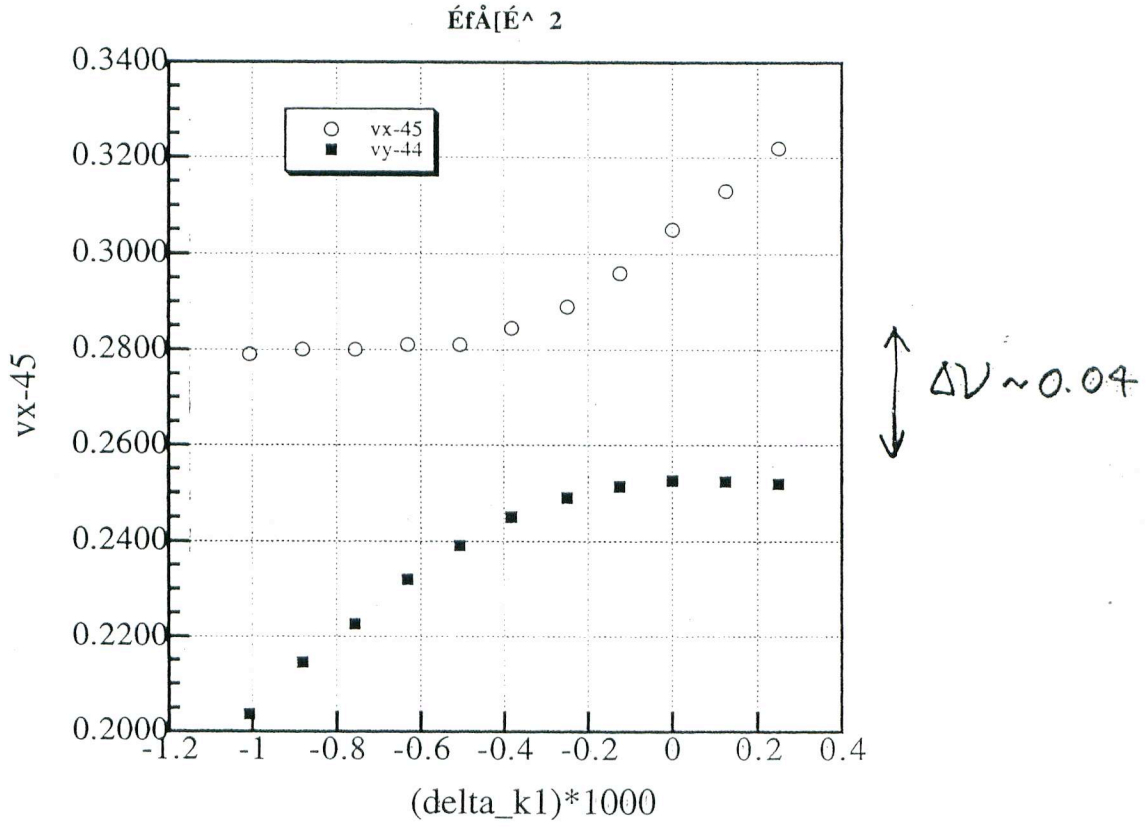
42.26782 -42.19158 42.26782

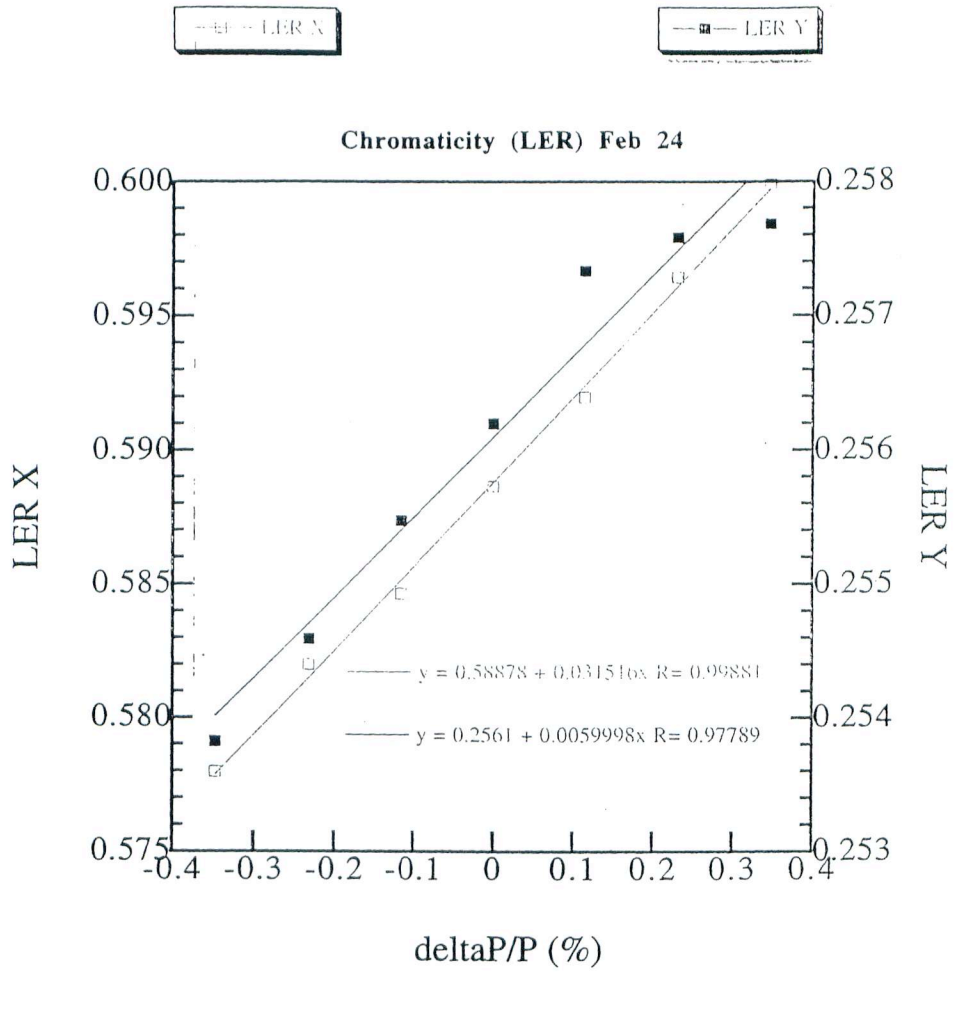


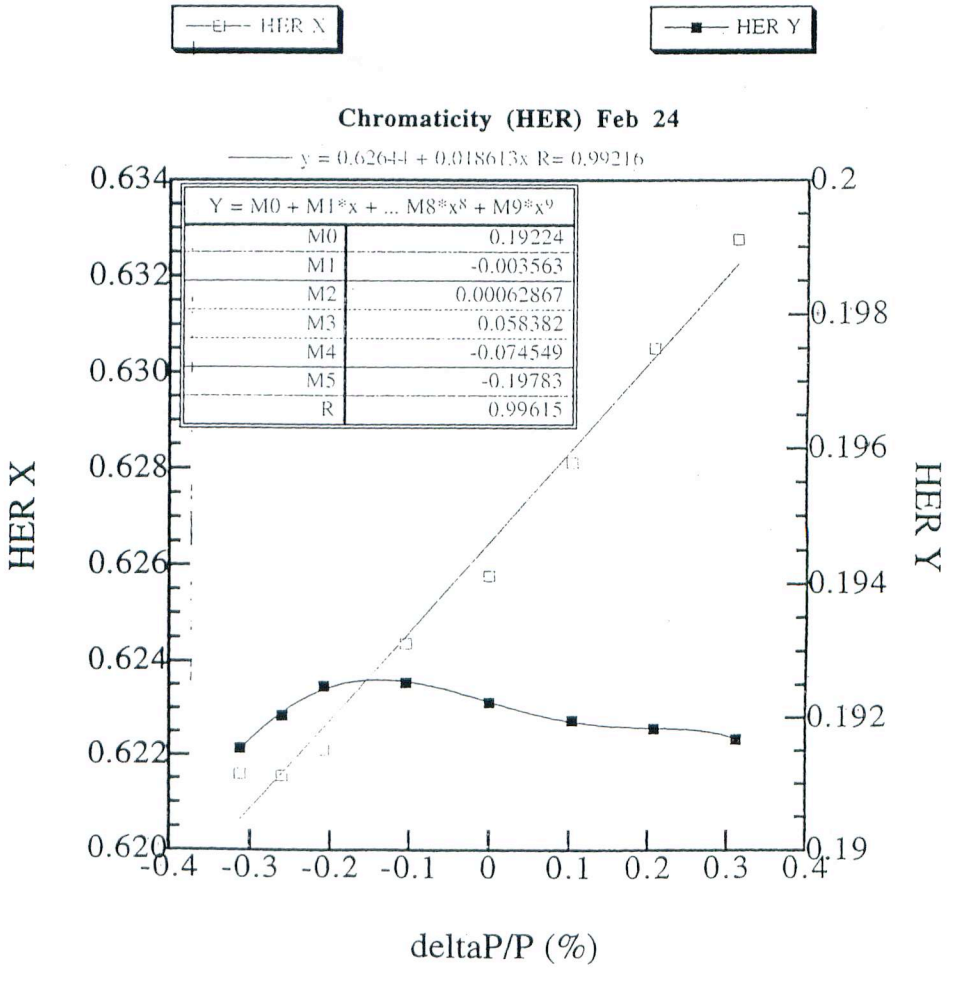


↑ HER dispersion DIFF_02-23_1999_14:55:

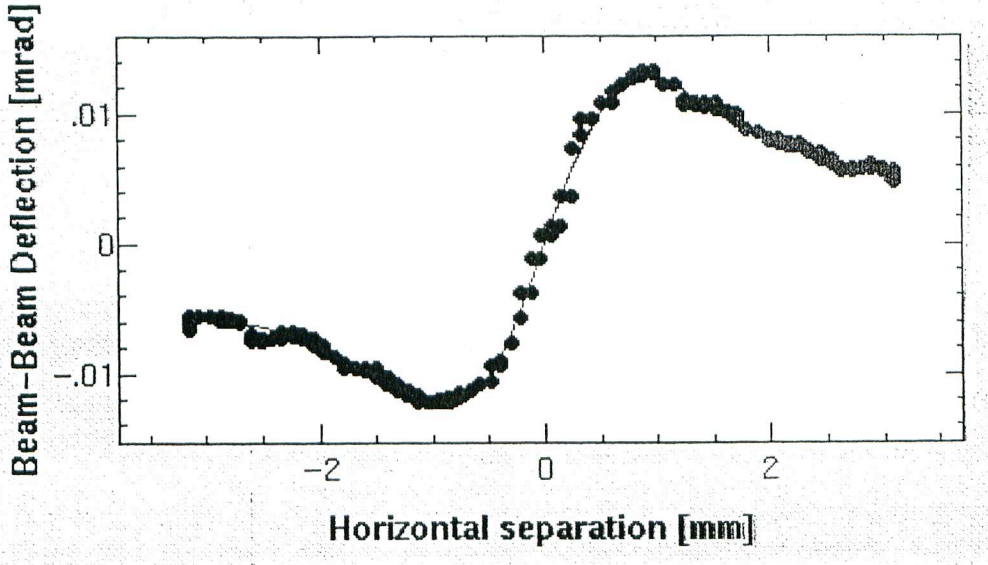
Global X-Y coupling



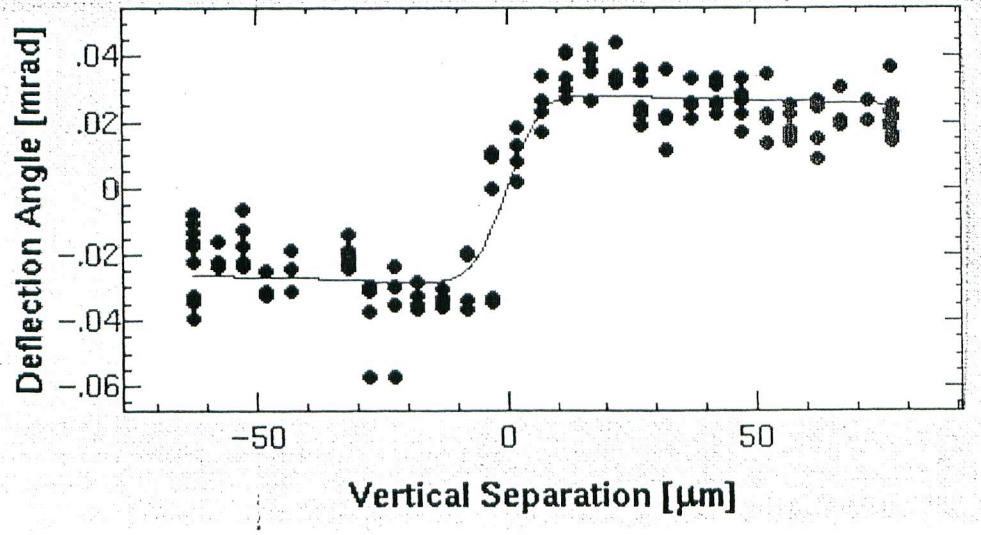

LER X
LER Y
Chromaticity (LER) Feb 24
0.600
0.595
0.590
0.585
0.580
0.575
0.258
0.257
0.256
0.255
0.254
0.253
LER X
LER Y
y = 0.58878 + 0.031510x R= 0.99881
y = 0.2561 + 0.0059998x R= 0.97789
-0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4
deltaP/P (%)


HER X
HER Y
Chromaticity (HER) Feb 24
y = 0.62644 + 0.018613x R= 0.99216
Y = M0 + M1*x + ... M8*x8 + M9*x9
M0 0.19224
M1 -0.003563
M2 0.00062867
M3 0.058382
M4 -0.074549
M5 -0.19783
R 0.99615
0.634
0.632
0.630
0.628
0.626
0.624
0.622
0.620
0.2
0.198
0.196
0.194
0.192
0.19
HER X
HER Y
-0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4
deltaP/P (%)

ChiSquare = 1.02E−4 Goodness = .48866
k = .12694 +/− .00276 sigmax = .65403 +/− .00592 b1 = .00586 +/− 5.31E−5



ChiSquare = .02008 Goodness = .48741
k = .01000 +/− .00178 yof = −.00637 +/− .64903 sigmax = 385.055 +/− 10.639
b2 = −5.2E−5 +/− 6.63E−4



Funakoshi, Flanagan

Summary of Commissioning
Dec. 1998 - Mar. 1999

3/8/1998 K. Oide

1. e- Linac/BT

	Design	Achieved	
Beam Energy	8	**8.5**	GeV
Charge/bunch @ end of BT	2	**1**	nC
Transmission	100	**80 - 100**	%
Repetition	50	**5 - 25**	Hz
emittance	< 0.1	**0.06**	μm

2. HER

	Design (model)	Achieved	
Beam Energy	8	**8**	GeV
Beam Current	1100	**243**	mA
Single bunch current	0.22	**4**	mA
Number of bunches	5000	**640**	
βy @ IP	1 (2)	**2**	cm
νx/νy	(44.51/42.29)	**44.62/42.21**	
rf voltage	max. 20	**9**	MV
νz @ 8 MV	0.0119	**0.0114**	
Bunch length @ 0 mA, 8MV	5.6	**5.6**	mm
Injection efficiency @ 5 Hz	100	**70-100**	%
ave. pressure @ 40 mA(2/18)	<1	**10**	nTorr
life time @ 40 mA (2/18)		**90**	min.

3. e+ Linac/BT

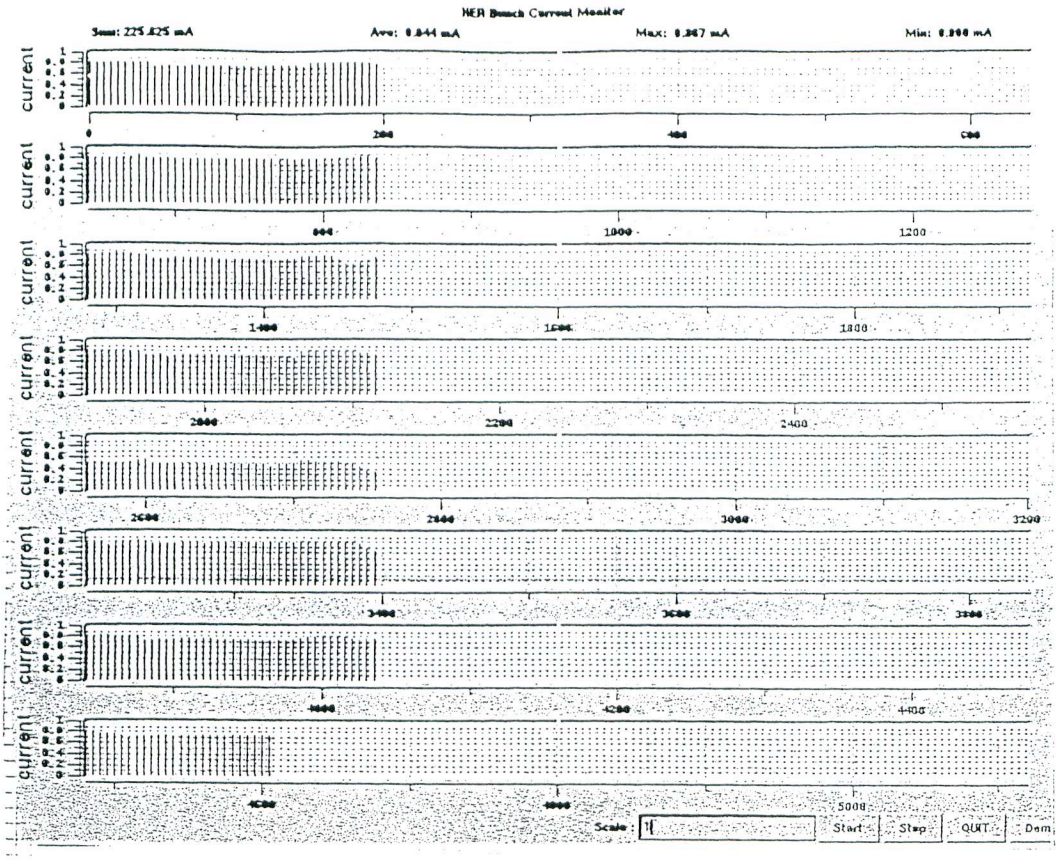
	Design	Achieved	
Beam Energy	3.5	**4**	GeV
Charge/bunch @ end of BT	0.64	**0.18**	nC
Transmission	100	**70**	%
Repetition	50	**50**	Hz
emittance	< 0.25	**0.4**	μm

4. LER

	Design (model)	Achieved	
Beam Energy	3.5	**3.5**	GeV
Beam Current	2600	**270**	mA
Single bunch current	0.52	**2.3**	mA
Number of bunches	5000	**1024**	
βy @ IP	1 (2)	**2.0**	cm
νx/νy	(45.71/44.49)	**45.57/44.26**	
rf voltage	max. 8	**4**	MV
νz @ 4 MV	0.0118	**0.0110**	
Bunch length @ 0 mA, 4 MV			mm
Injection efficiency @ 5 Hz	100	**50-70**	%
ave. pressure @ 22 mA (1/23)	<1	**30**	nTorr
life time @ 22 mA (1/23)		**20**	min.

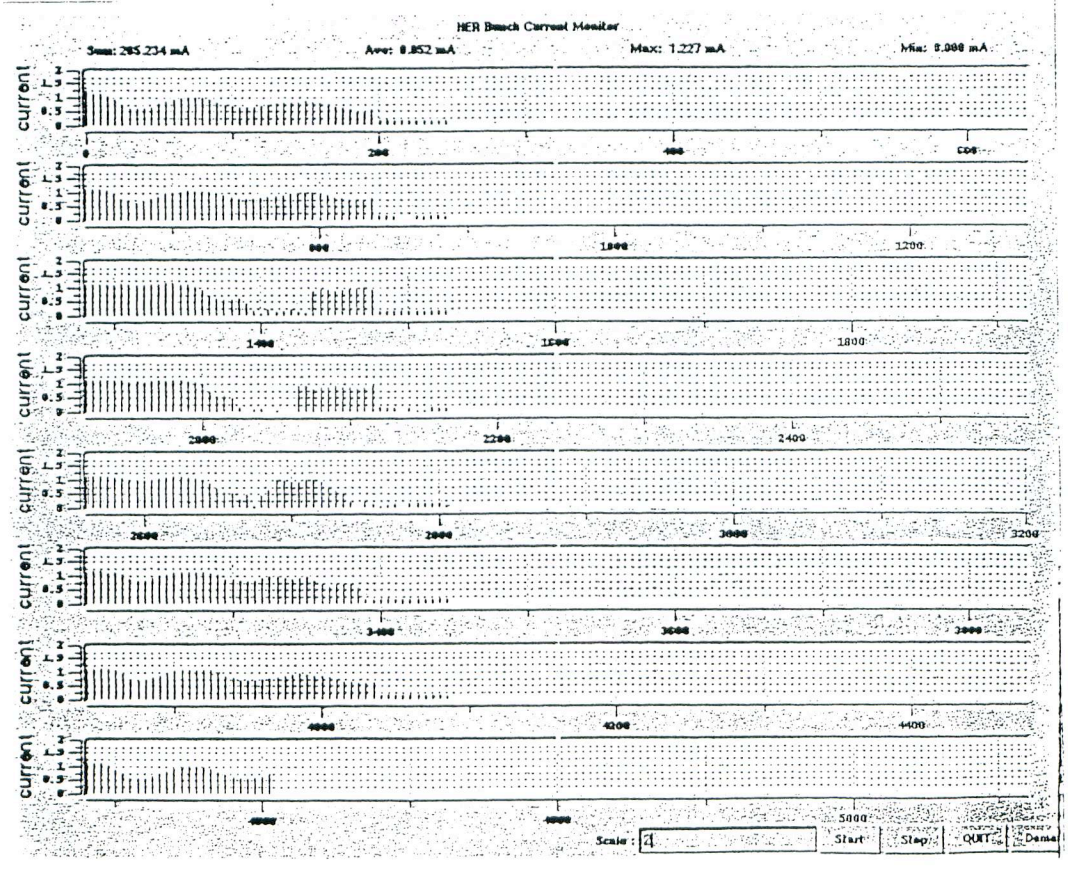
Problems

Subject	phenomenon	reason	cure
Area Radiation at Tsukuba	e- inj. rate is limited at 5 Hz	Bremsstrahlung at IP ? Higher pressure at IP ?	• More shields (IP and vacuum chamber) • Improve IP pressure
Injection efficiency	e+: 50-70% @50Hz e-: 70% @5Hz	High x-y coupling ($\Delta k \approx 0.002$)? BT-Ring mismatch? Momentum acceptance?	• x-y coupling correction • BT matching • Sextupole optimization
Multibunch instabilities	e+: Strong instability with short bunch spacing (<8ns)	Photo-electron instability?	• Bunch by bunch feedback • Bunch gap
	e-: Tail of train is lost	Fast ion?	
Orbit drift	typically 1 mm/hour @ QCS (vertical)	• Motion of IP quads? • Temperature change in Tsukuba Hall?	• More correlation data. • Thermal isolation of IR support structure? • Turn off Air-conditioning? • IP/Global orbit feedback.
	Change with stored current (HER horizontal)	• Synchrotron ligth hits the QC2RE chamber • Resonant mode in the QC2RE chamber	• Water-cooled chamber • HOM damper?



HER
I ~ 200mA

FB ON



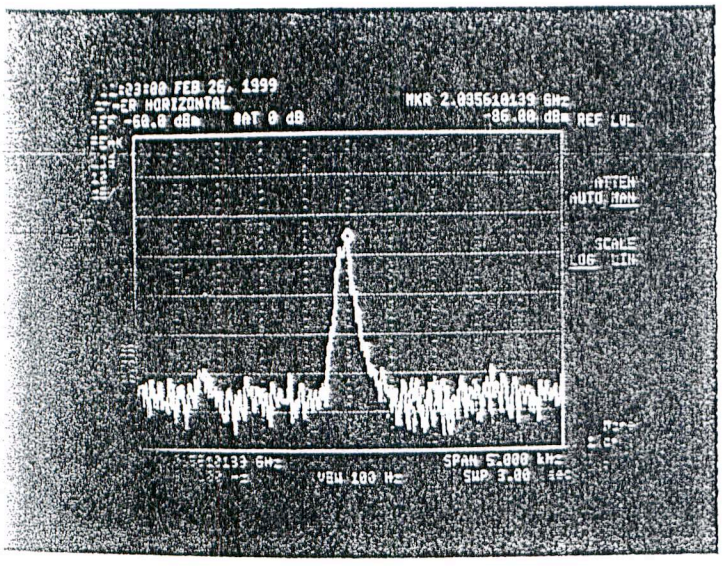
HER

I ~ 190mA

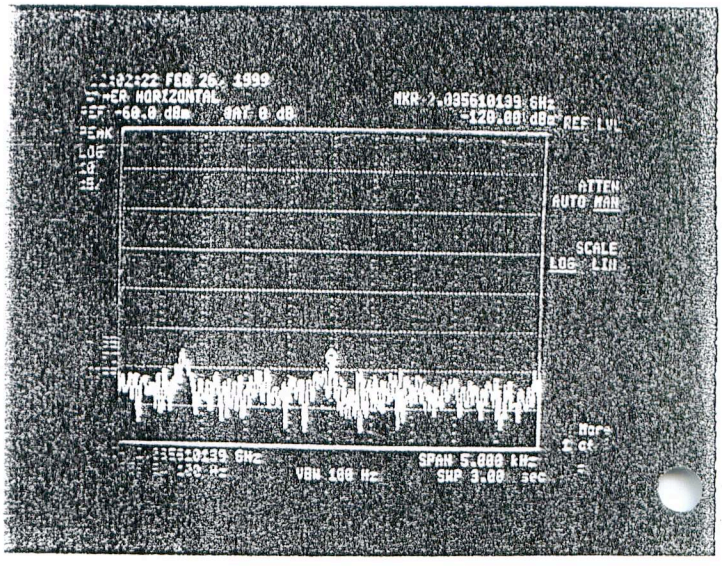
V FB OFF
→ ON

M. Tobiyama

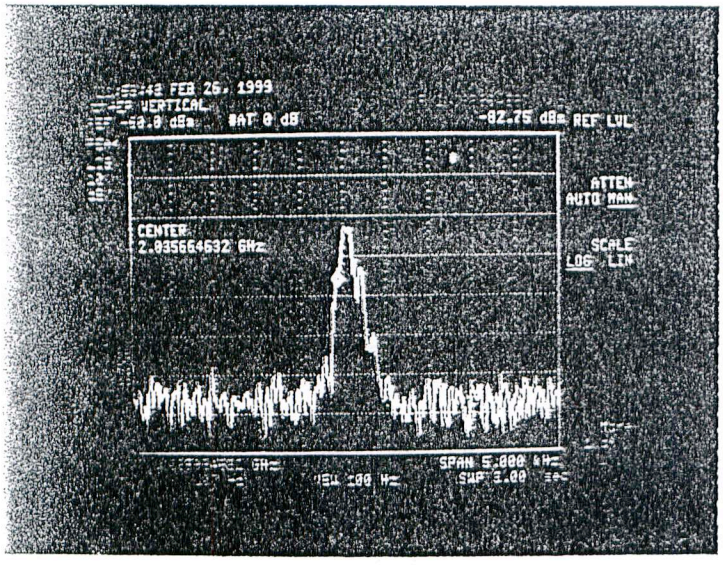
HER ~ 100mA



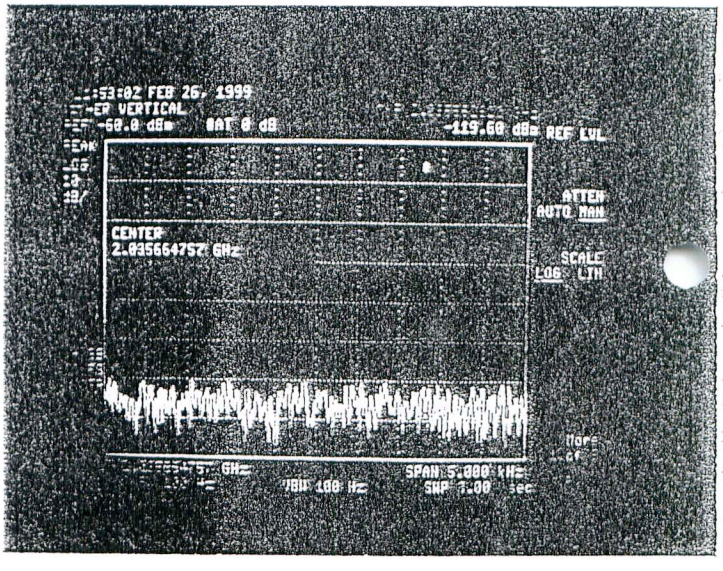
Horizontal FB gain -7dB



Horizontal FB ON

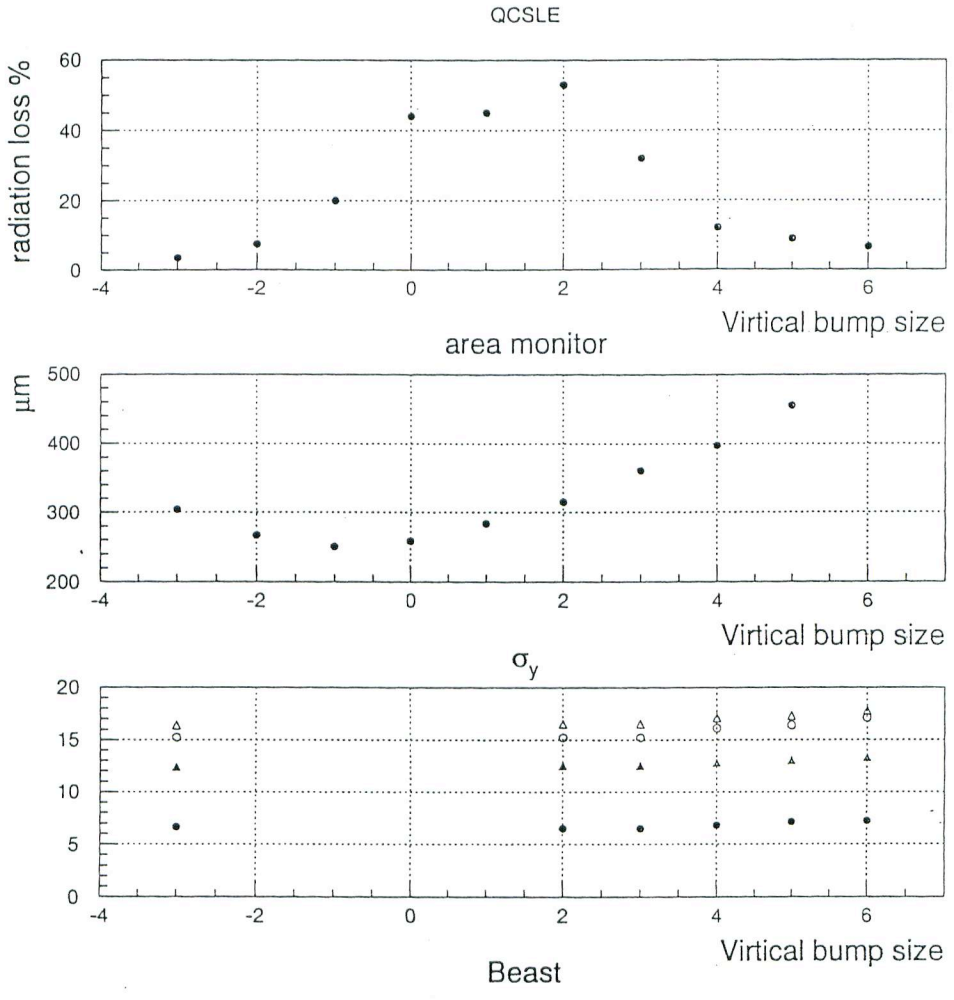


Vertical FB gain -16dB



Vertical FB ON

M. Tobiyama



@CSLE Local bump 結果.

14:22 gate close 69mA (HER) Life : 226min

loss rate : 5.7%/h

軌道を再現している.

光モニタ : σ_y = 304 μm (ほぼ同じ)

o Local Bump

@CSLE −1mm (I= 67.6mA, Life: 228.8min)

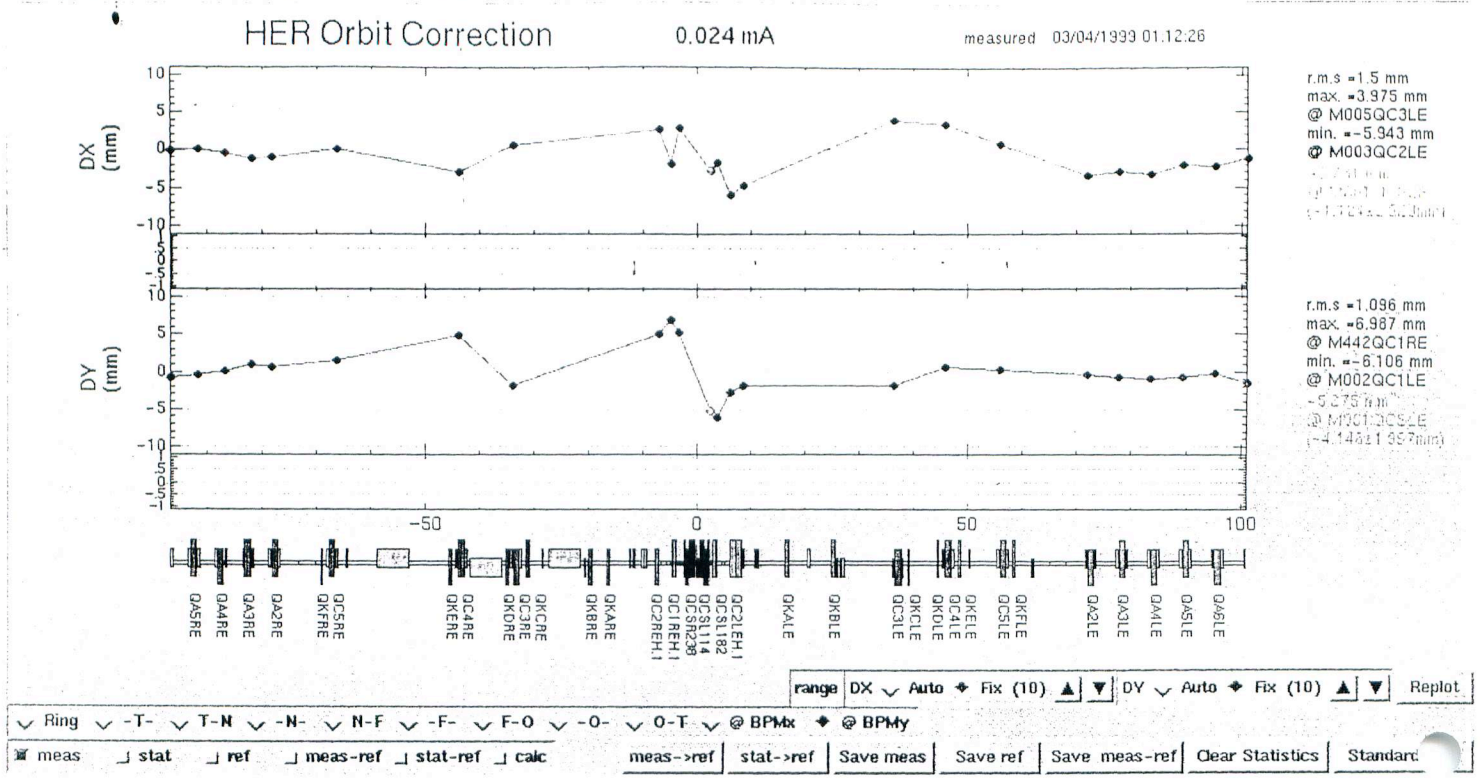
loss rate : 20%/h 光モニタ: σ_y = 251 μm

beast ← 表示が変になってデータなし

−2mm (65.1mA, Life : 252.8min) 光モニタ: σ_y = 267 μm

loss rate : 7.5%/h

File Edit Measurement Correction Steering Orbit Window Help



range DX Auto Fix (10) DY Auto Fix (10) Replot

Ring -T- T-N -N- N-F -F- F-O -O- O-T @ BPMx @ BPMy

meas stat ref meas-ref stat-ref calc

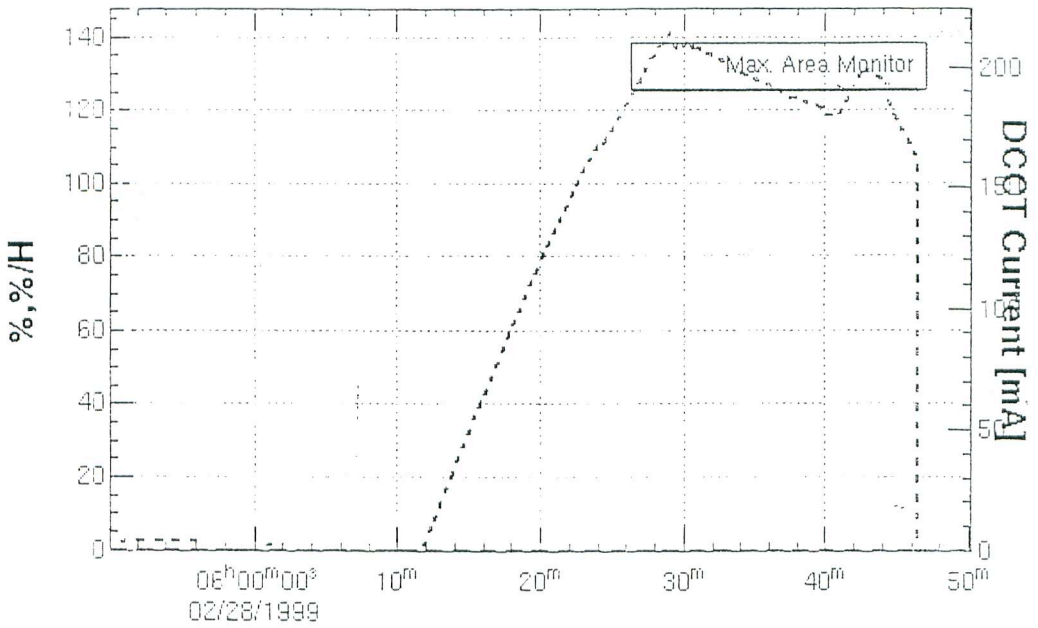
meas->ref stat->ref Save meas Save ref Save meas-ref Clear Statistics Standard

File Edit Window Help

Display Setting

KEKB Area Monitor [Max: 140.% @YEL:504]

(Rate: 1.43%/H)



Hard Copy

① Masks @ Arc don't work.

② No corrolation with σ_y

③ ⇓

. Source is generated by Core of beam.

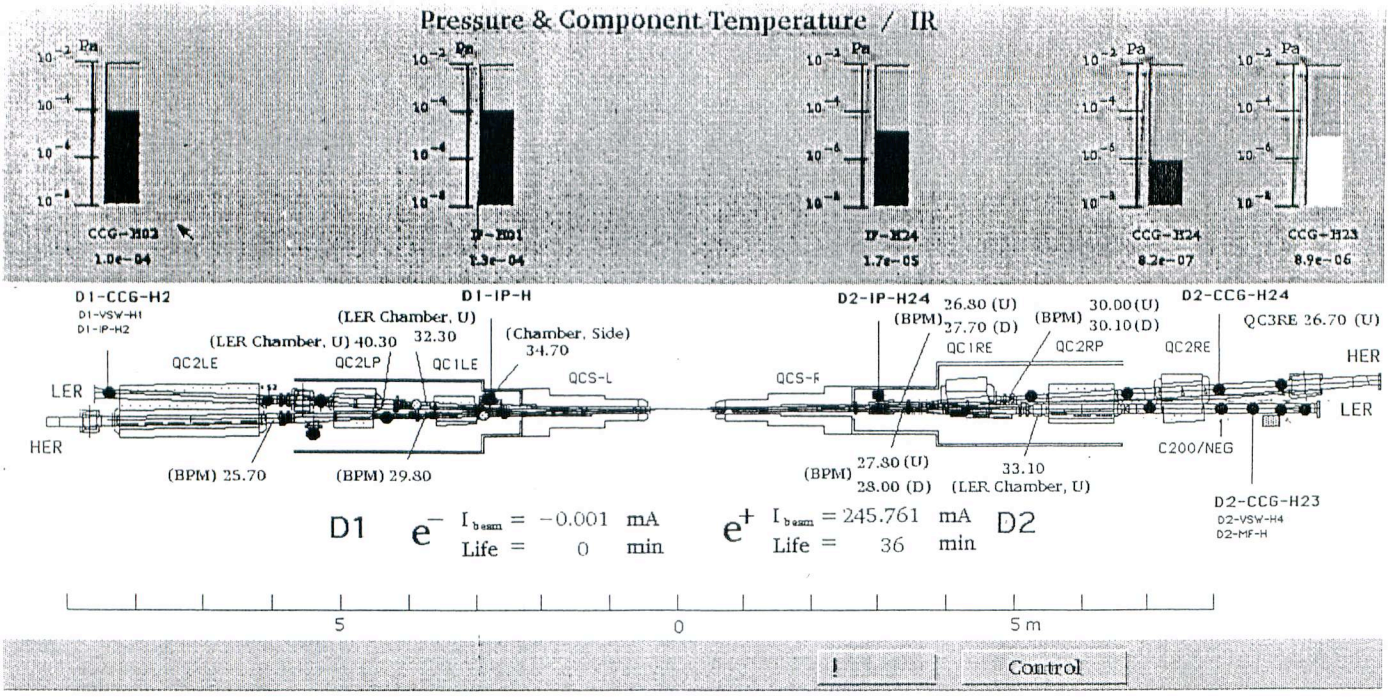
⇓

③ Large angle bump @IP reduces area monitor

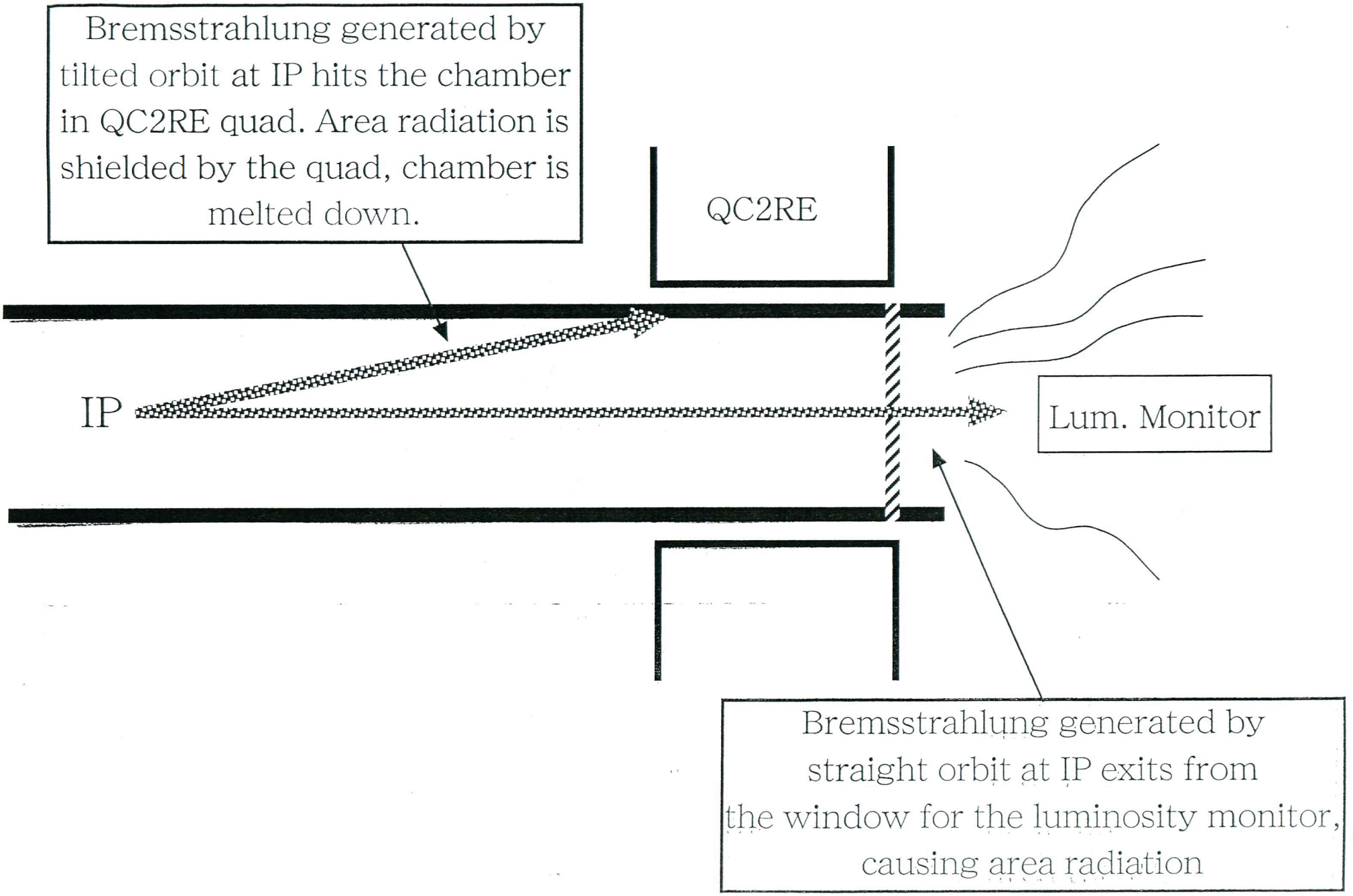
⇓

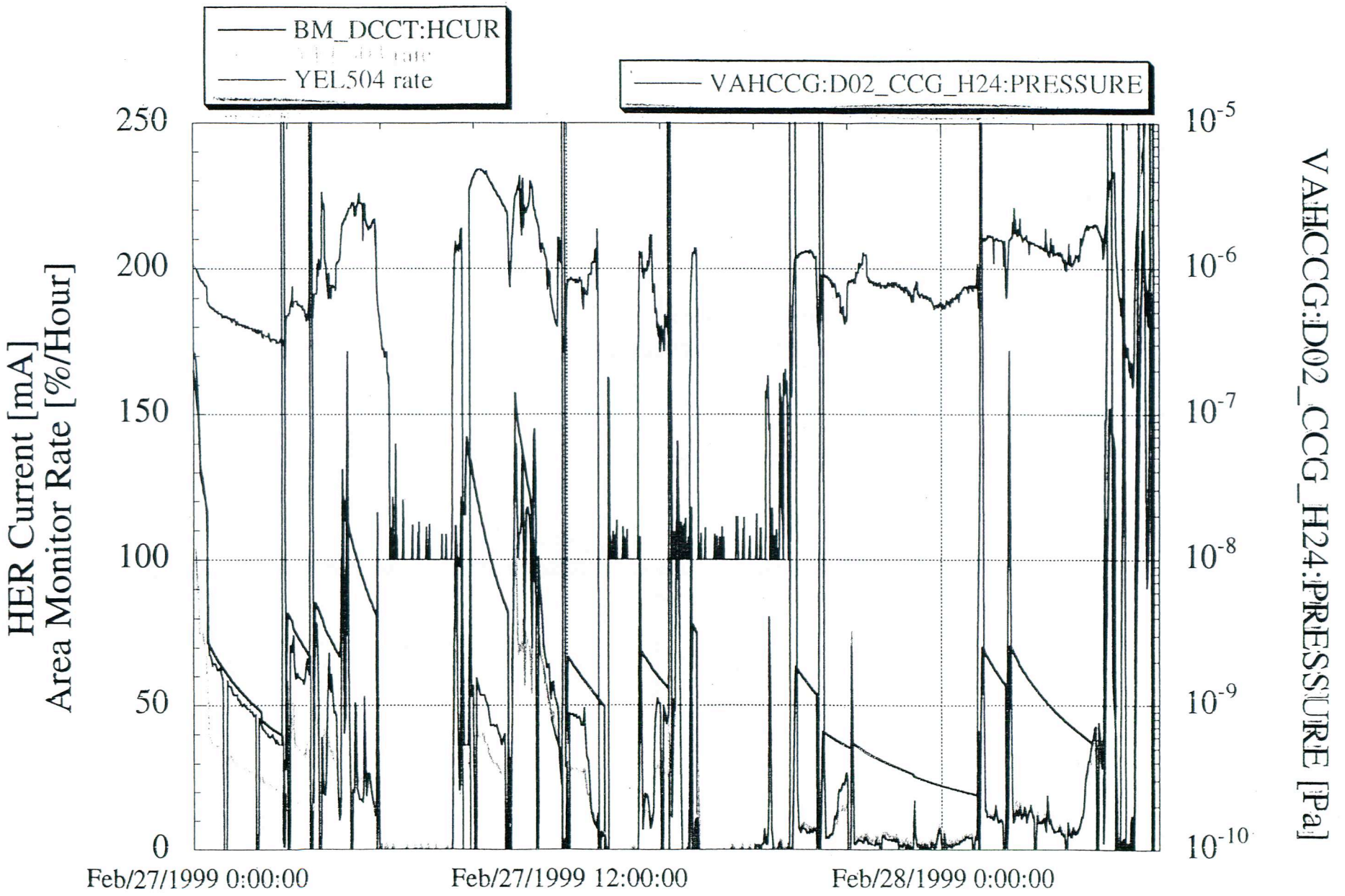
Bremsstrahlung @ IP ??

- Ip pressure?
- Injection?

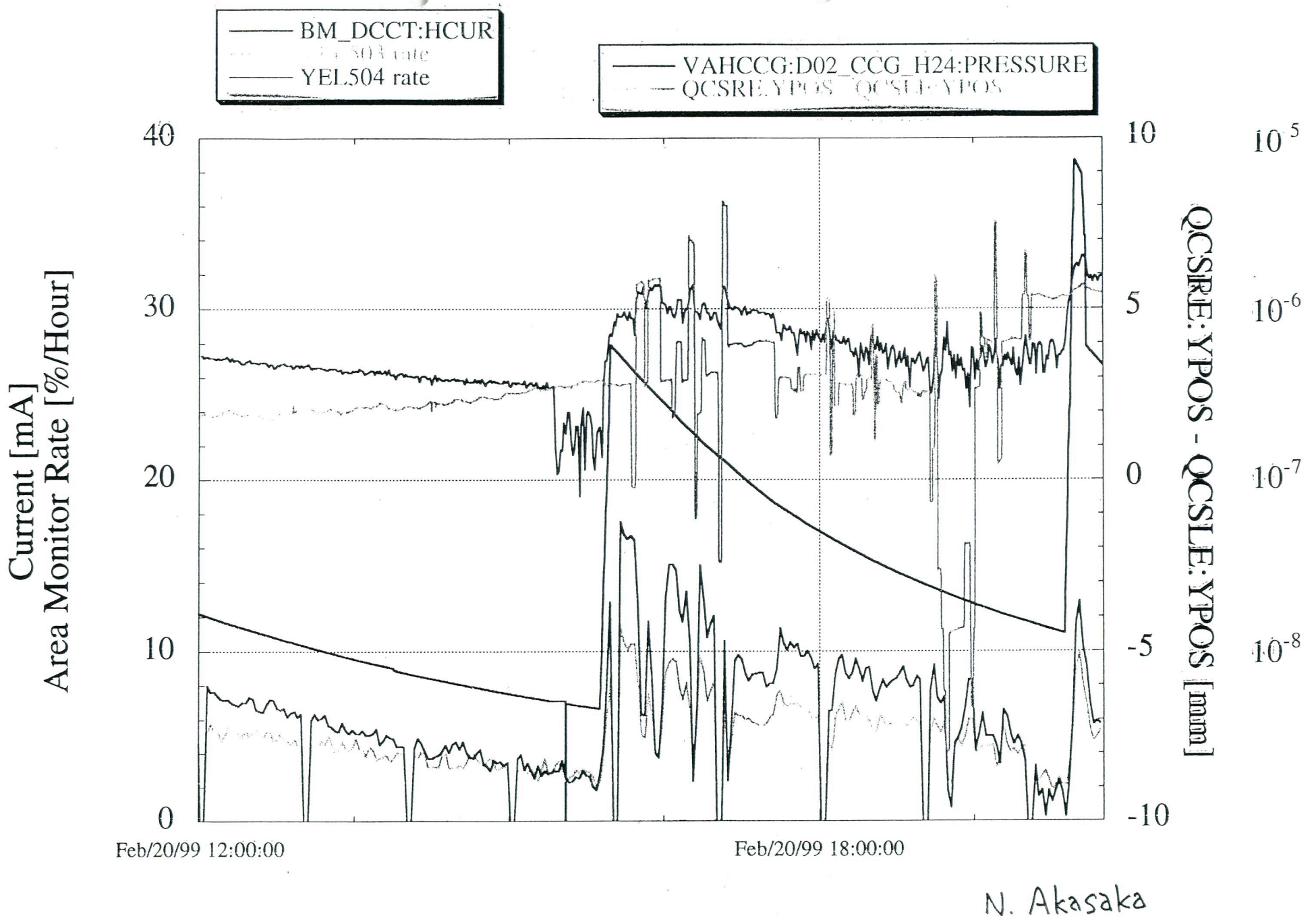

Pressure & Component Temperature / IR
CCG-H02
1.0e-04
IP-H01
1.3e-04
IP-H24
1.7e-05
CCG-H24
8.2e-07
CCG-H23
8.9e-06
D1-CCG-H2
D1-VSW-H1
D1-IP-H2
D1-IP-H
(LER Chamber, U)
(LER Chamber, U) 40.30
32.30
(Chamber, Side)
34.70
QC2LE
QC2LP
QC1LE
QCS-L
LER
HER
(BPM) 25.70
(BPM) 29.80
D2-IP-H24
(BPM) 26.80 (U)
27.70 (D)
(BPM) 30.00 (U)
30.10 (D)
D2-CCG-H24
QC3RE 26.70 (U)
QC1RE
QC2RP
QC2RE
QCS-R
HER
LER
(BPM) 27.30 (U)
28.00 (D)
33.10
(LER Chamber, U)
C200/NEG
D2-CCG-H23
D2-VSW-H4
D2-MF-H
D1
e⁻ I beam = −0.001 mA
Life = 0 min
e+ I beam = 245.761 mA
Life = 36 min
D2
5
0
5 m
Control

Y. Suetsugu


Bremsstrahlung generated by tilted orbit at IP hits the chamber in QC2RE quad. Area radiation is shielded by the quad, chamber is melted down.
QC2RE
IP
Lum. Monitor
Bremsstrahlung generated by straight orbit at IP exits from the window for the luminosity monitor, causing area radiation


BM_DCCT:HCUR
YEL504 rate
VAHCCG:D02_CCG_H24:PRESSURE
HER Current [mA]
Area Monitor Rate [%/Hour]
VAHCCG:D02_CCG_H24:PRESSURE [Pa]
250
200
150
100
50
0
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
Feb/27/1999 0:00:00
Feb/27/1999 12:00:00
Feb/28/1999 0:00:00

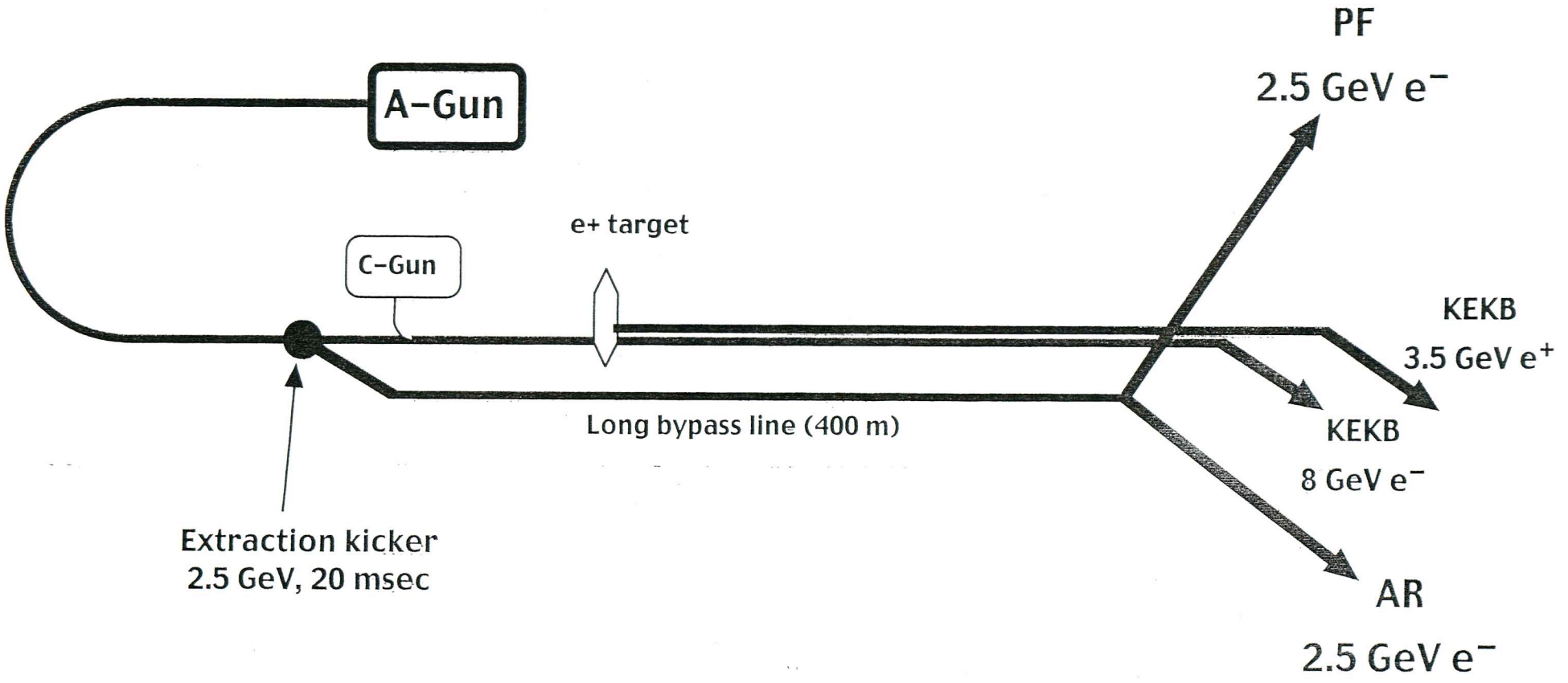
N. Akasaka


BM_DCCT:HCUR
YEL.503 rate
YEL.504 rate
VAHCCG:D02_CCG_H24:PRESSURE
QCSRE:YPOS - QCSLE:YPOS
Current [mA]
Area Monitor Rate [%/Hour]
QCSRE:YPOS - QCSLE:YPOS [mm]
40
30
20
10
0
10
5
0
-5
-10
10^{5}
10^{-6}
10^{-7}
10^{-8}
Feb/20/99 12:00:00
Feb/20/99 18:00:00

N. Akasaka

Subject	phenomenon	reason	cure
Linac	Hard to reproduce after a break of each mode over several hours	Too many parameters for different modes (KEKB e-, e+, PF, AR)	• More monitors • More feedbacks • More reliable components • "Bypass Scheme" for PF/AR injection ?
BT	e+: Transmission easily degrades down to 50%	• Linac/BT mismatch • mismatch between arcs ? • momentum spread?	• Quick diagnostics by wires.
BEAST/Belle Background			• Dedicated tuning

"Bypass Scheme"
for
PF & AR 2.5 GeV e^- Beams



3/7/1999 K. Oide

Commissioning before Belle (114 shifts)

1. Optics (20)

    $\beta y^* = 1$ cm, chromaticity (10)
    emittance/x-y coupling tuning (10)

2. High current (62)

    rf/vacuum/temperature (6)
    Feedback (10)
    degas (46)

3. Collision (26)

    multibunch collision (10)
    collision/orbit feedback(6)
    BEAST background (10)

4. Linac/BT (6)