Stability Upgrade of Injector Linac

Injector linac Group

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Upgrade of Linac Stability

Basic parameters (energy, current etc.):

→reported in the previous talk

Stability (especially for primary electron beam for positron beam production)

→ need improvements

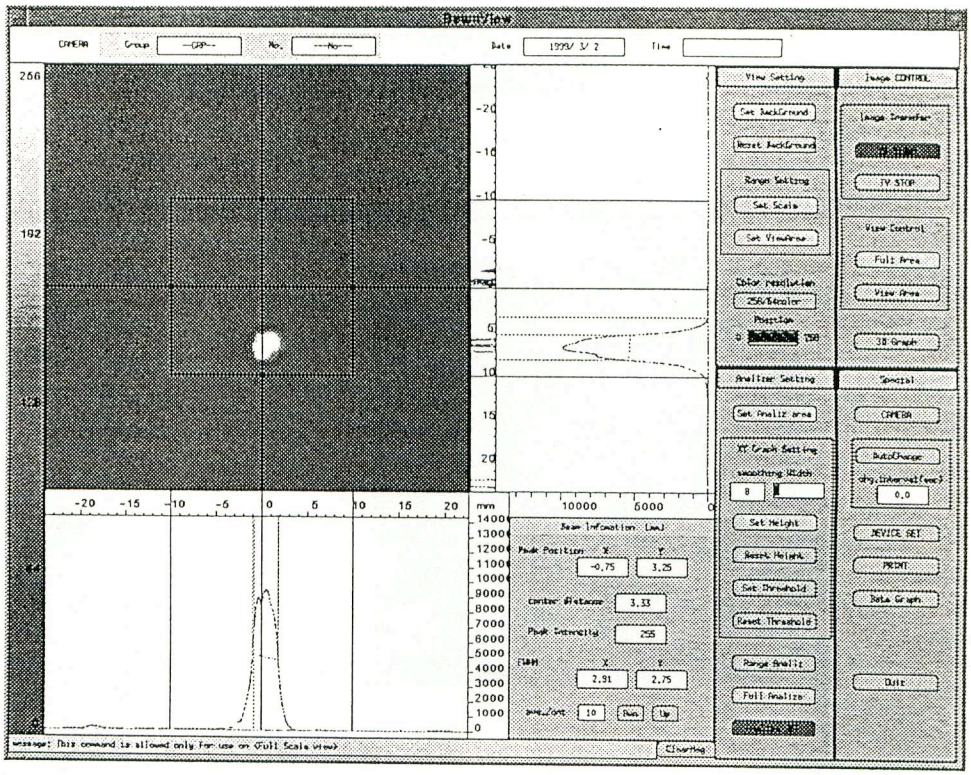
problems

- ○sudden change of beam orbit, current energy spread etc.
- ○many faults
- ○poor reproducibility

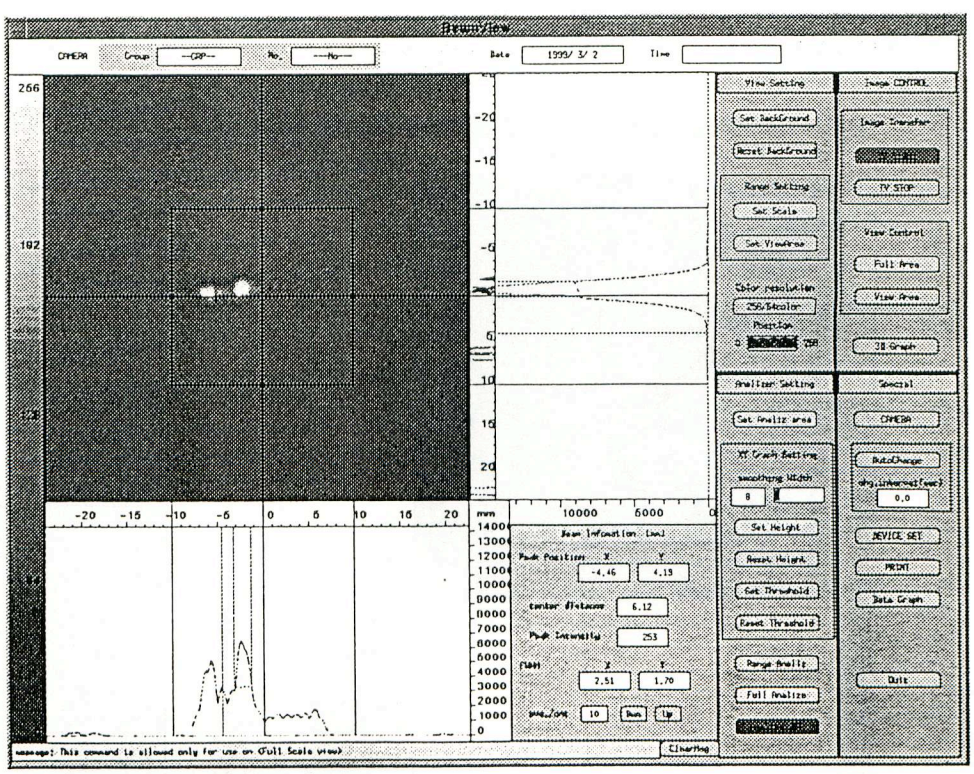
Causes of instability of linac

- ○SHB1 microwave source
- ○SHB2 microwave cavity
- ○A-1(the first unit of the linac) s-band microwave amplifier
- ○microwave monitor
- ○cooling water
- ○stabilize high power pulse voltage etc.

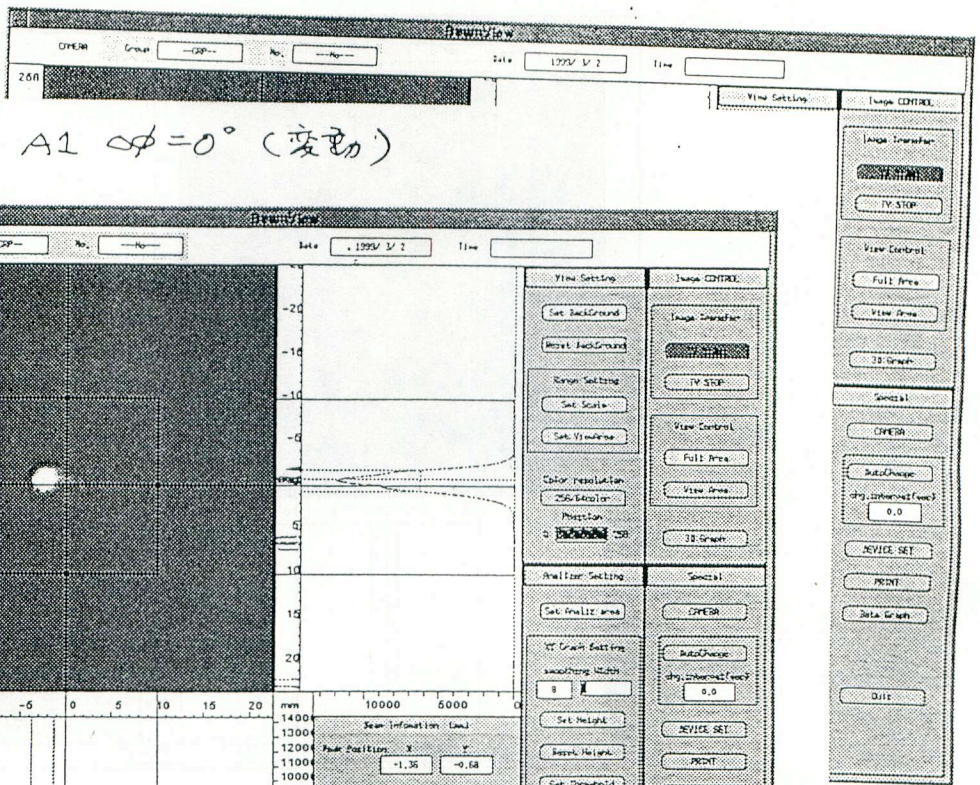
A1 $\Delta\phi = 0^\circ$



A1 $\Delta\phi = -2^\circ$

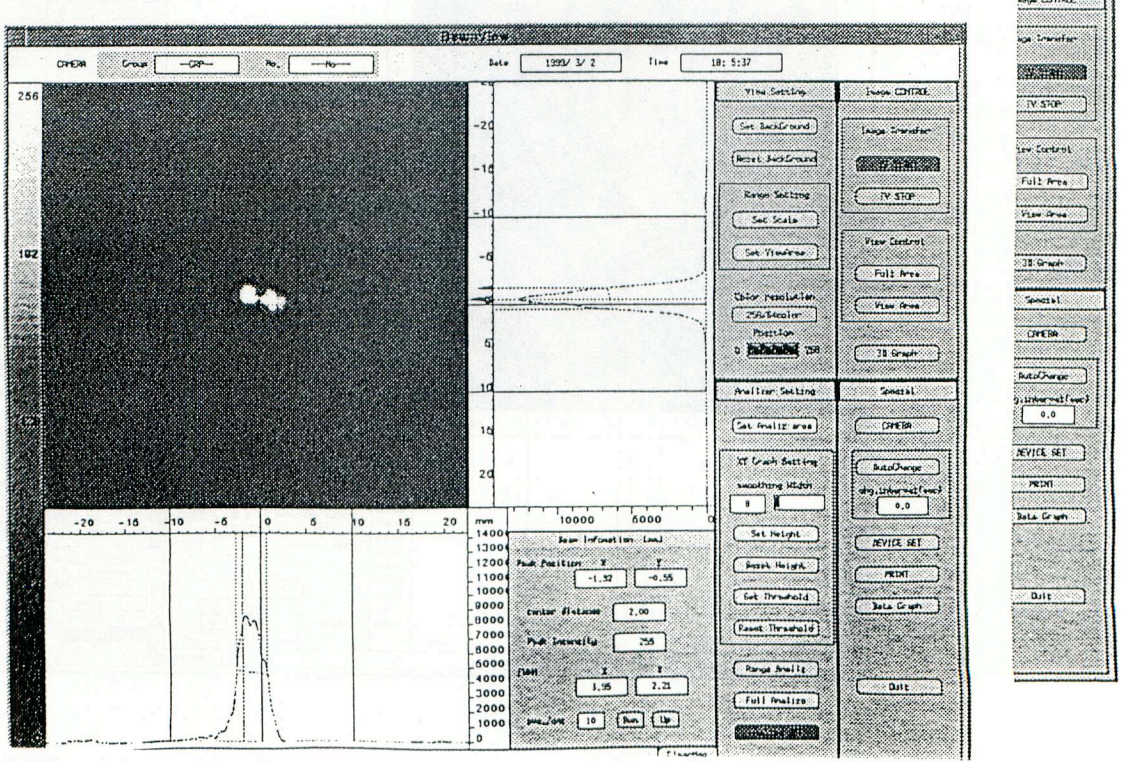


A1 $\Delta\phi = 0^\circ$

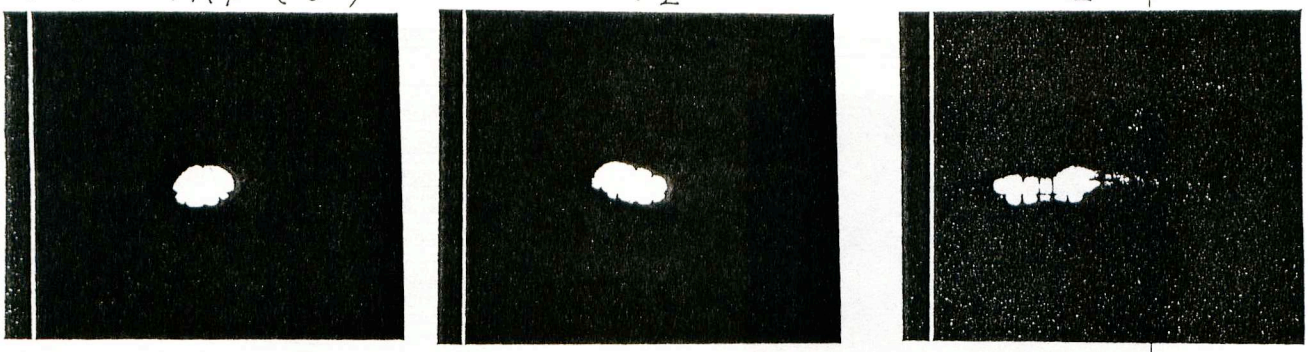


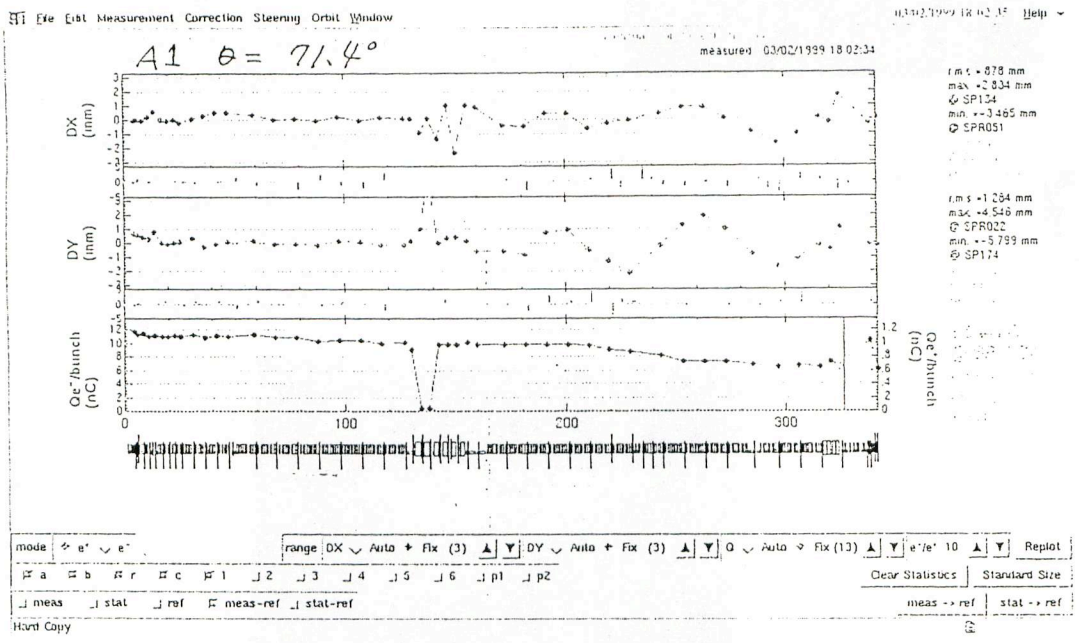
A1 $\Delta\phi = 0^\circ$ (変動)

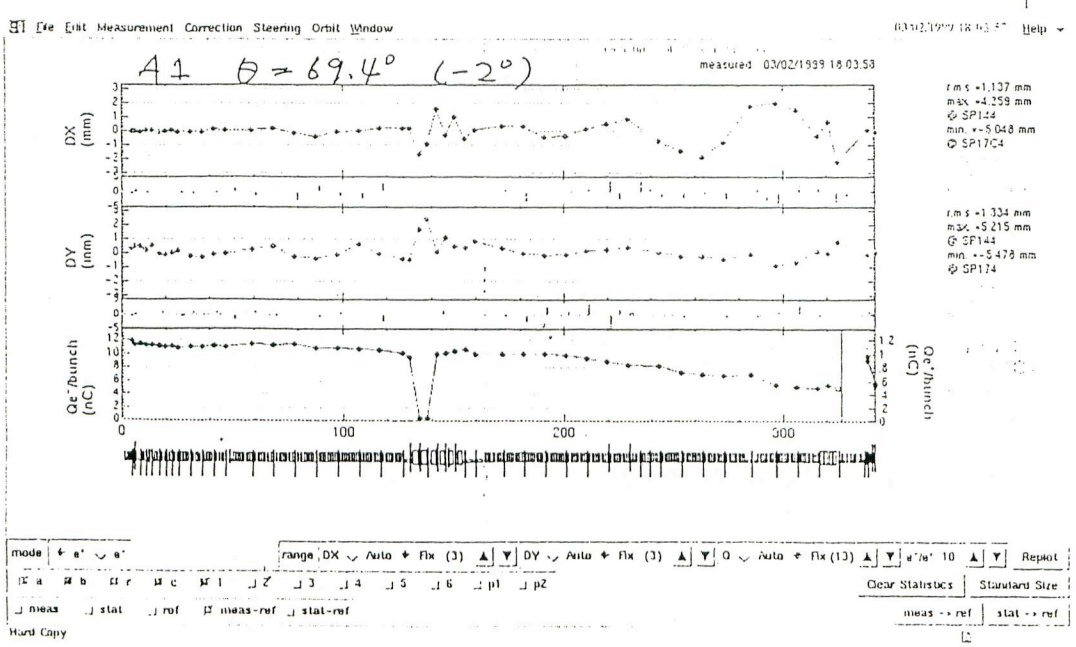
A1 $\Delta\phi = +2^\circ$



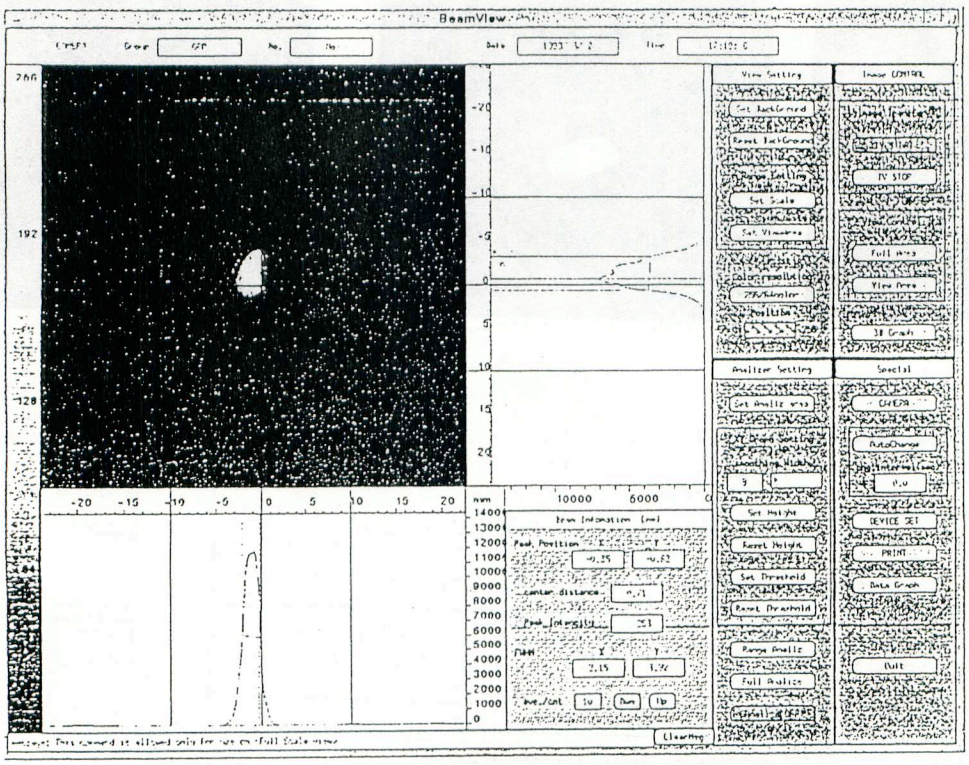
A1 θ = 71.4° (0°) +2° -2°

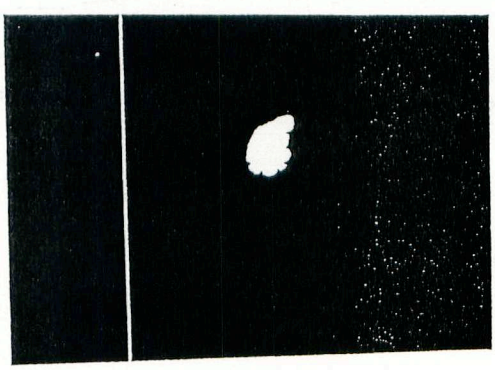


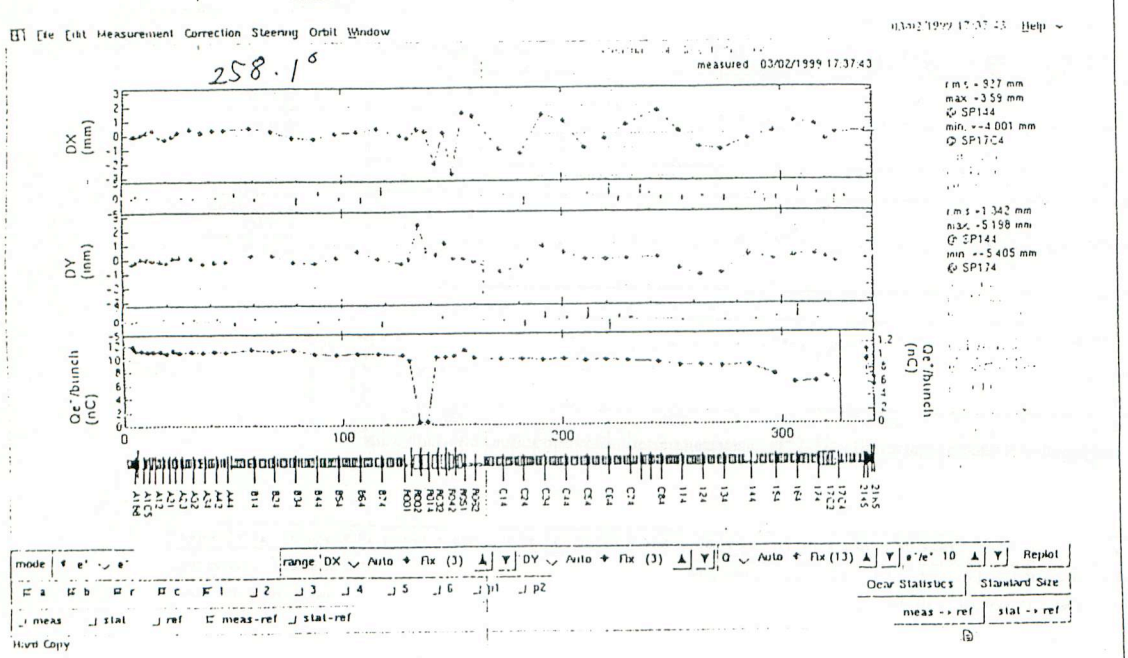

File Edit Measurement Correction Steering Orbit Window
Help
A1 θ = 71.4°
measured 03/02/1999 18:02:34
DX (mm)
DY (mm)
Qe⁻/bunch (nC)
rms =878 mm
max =2.834 mm
@ SP134
min =-3.465 mm
@ SPR051
rms =1.284 mm
max =4.548 mm
@ SPR022
min =-5.799 mm
@ SP174
0
100
200
300
mode
range DX Auto + Fix (3) DY Auto + Fix (3) Q Auto + Fix (13) e⁻/e⁺ 10 Replot
a b r c 1 2 3 4 5 6 p1 p2
Clear Statistics Standard Size
meas stat ref meas-ref stat-ref
meas -> ref stat -> ref
Hard Copy


File Edit Measurement Correction Steering Orbit Window
Help
A1 θ = 69.4° (-2°)
measured 03/02/1999 18:03:58
DX (mm)
DY (mm)
Qe⁻/bunch (nC)
rms =1.137 mm
max =4.259 mm
@ SP144
min =-5.048 mm
@ SP17C4
rms =1.334 mm
max =5.215 mm
@ SP144
min =-5.478 mm
@ SP174
0
100
200
300
mode
range DX Auto + Fix (3) DY Auto + Fix (3) Q Auto + Fix (13) e⁻/e⁺ 10 Replot
a b r c 1 2 3 4 5 6 p1 p2
Clear Statistics Standard Size
meas stat ref meas-ref stat-ref
meas -> ref stat -> ref
Hard Copy

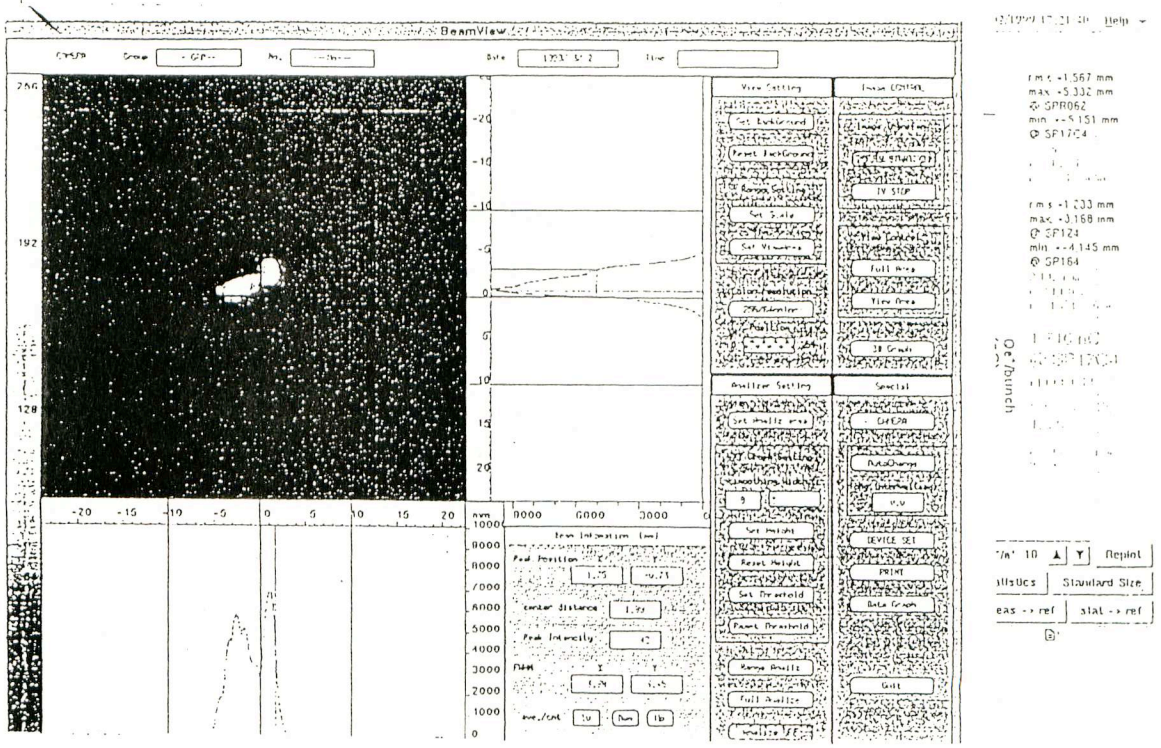
SHB1 258.1°


BeamView
View Setting
Image Control
Analizer Setting
Special
Set Background
Reset BackGround
Set Scale
Set Viewarea
Full Area
View Area
Set Analize area
Set Height
Reset Height
Set Threshold
Reset Threshold
Range Analize
Full Analize
Data Graph
Quit
DEVICE SET
PRINT
Peak Position
Peak Intensity
Center distance

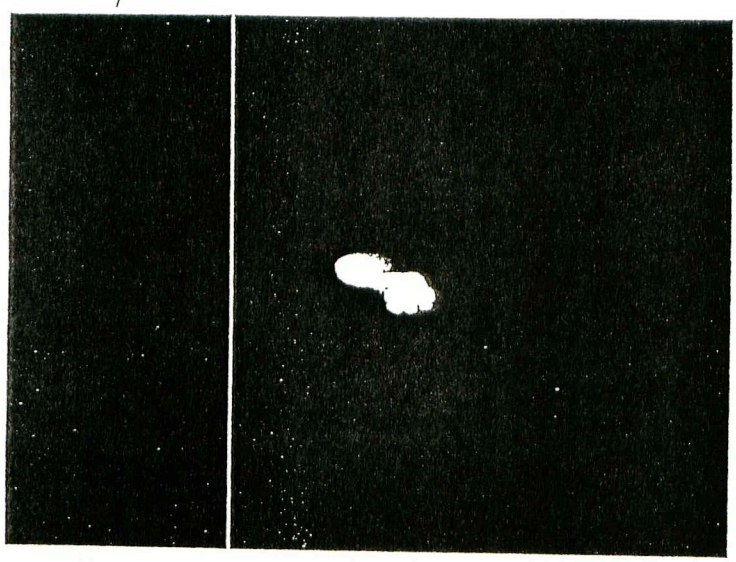


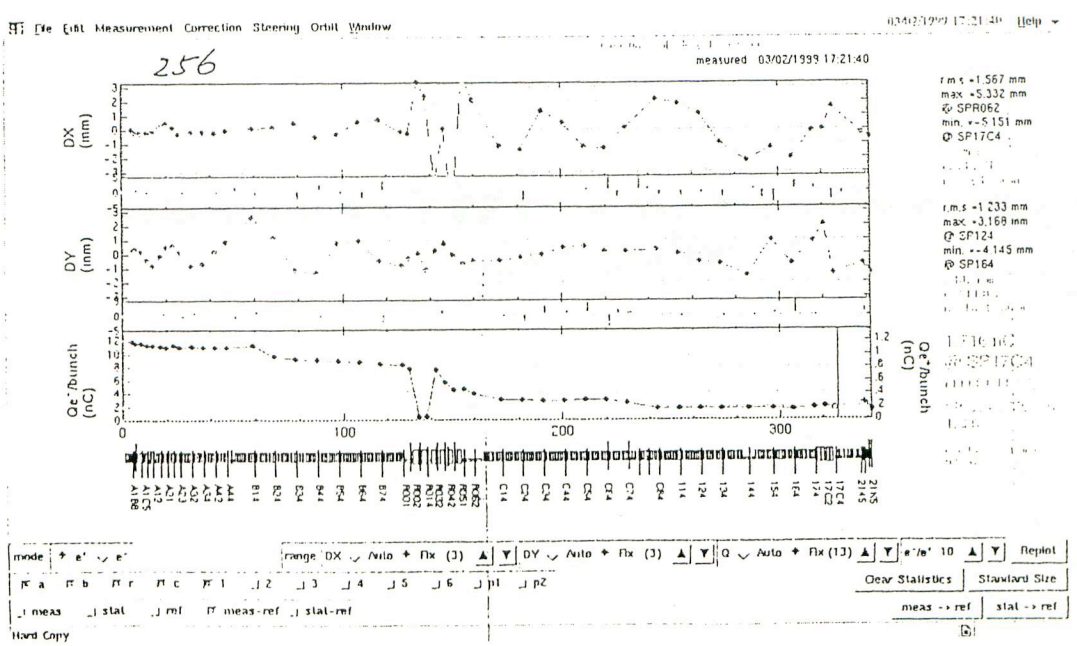

File Edit Measurement Correction Steering Orbit Window
Help
258.1°
measured 03/02/1999 17:37:43
DX (mm)
DY (mm)
Qe-/bunch (nC)
rms =.927 mm
max =3.59 mm
@ SP144
min. =-4.001 mm
@ SP17C4
rms =1.342 mm
max. =5.198 mm
@ SP141
min. =-5.405 mm
@ SP174
mode
range DX Auto + Fix (3) DY Auto + Fix (3) Q Auto + Fix (13)
Replot
Clear Statistics
Standard Size
meas -> ref
stat -> ref
meas
stat
ref
meas-ref
stat-ref
Hard Copy

SHB1 256.1°



SHB1 256.1°





		KLA1SB に空調の風が当たらないようにした=>A1 位相変った
1/19(火)	e+3.5GeV	入射突然不調(BT 放射線)=>原因不明、ECS KL58 位相調整で回復
1/20(水)	e+3.5GeV	早朝：SHB2 パワーダウン（2 回）
		昼間：SHB2 パワーダウン（パルス幅調整で復旧）
		SHB1 アンプ調整 10 分、5Hz だと Y513（放射線）急上昇
1/21(木)	e- 8GeV	朝、リング RF 周波数設定ミスで全クライストロン OFF
		=>SHB1 アンプチューニングずれる
1/22(金)	e- 8GeV	切替直後、QD/F_22,21/2 落ちる
1/23(土)	e- 8GeV	SHB1:Att.Phase Local Controller の Amplitude 設定がゼロ（原因不明）
		SHB2:同様の現象再発、パワーフィードバックはずれる
		SHB2:再発

コミッショニング中故障・不具合頻度（11.30～1.25）

SHB: 16 回
SHB1: 7 回
SHB2: 6 回
IVR: 1 回
IΦA: 1 回
TrigII: 2 回
サイラトロン: 1 回
フィードバック: 4 回
水温: 3 回
多数クライストロントリップ: 7 回
タイミング: 1 回
DeQ コントローラ: 1 回
Qmag: 8 回
電子銃: 2 回

Kly φ をいじると Es がかわる → 特定のものではない
0.8kV ほど上がる.
A1 φ

Sub-harmonic Buncher (SHB1)

114MHz 10kW amplifier

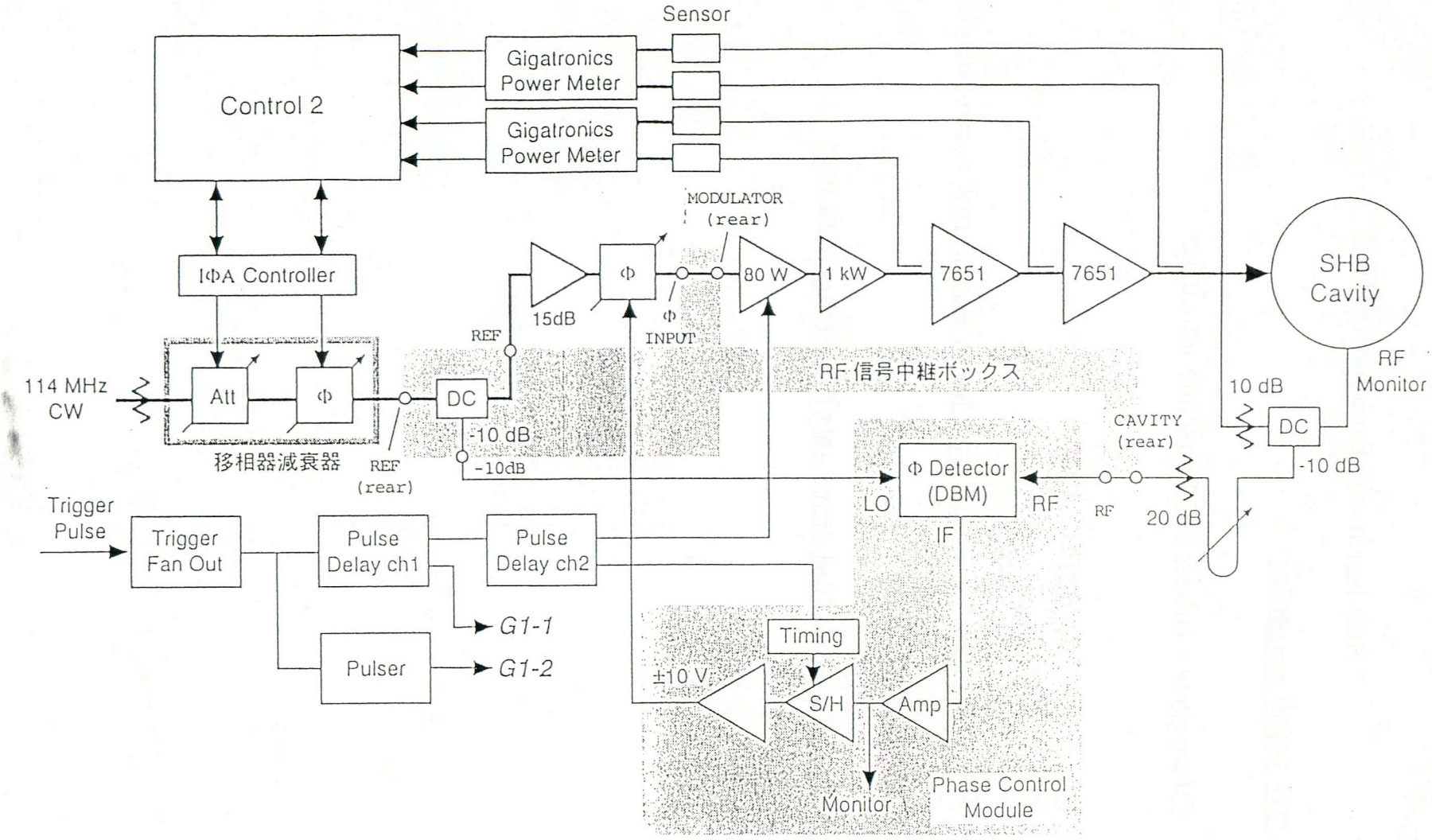
○two power tubes: 7651 cascade amplifier

○has been used since 1985

○very many failures: still have not found cause of this series of trouble

replace with a new solid state amplifier (this summer)

SHB 114 MHz 励振回路構成図



Cavity for Sub-harmonic Buncher (SHB2)

571MHz resonant cavity

tune drift (seems temperature change of inner conductor)

reflection of microwave at input coupler

input coupler will be replaced in March

replace with newly designed one (cooling channel for inner conductor)

this summer

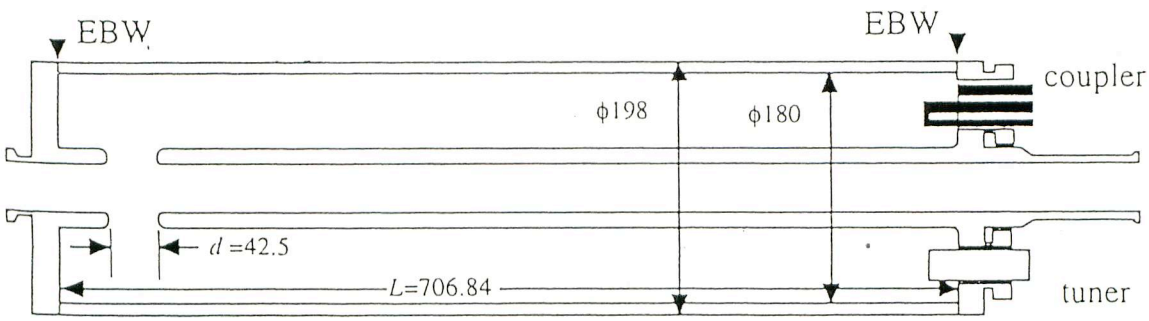


図 4　SHB 空洞の断面図.

A-1 sub-booster

2856MHz Klystron drive microwave (600 watt solid state amp.)

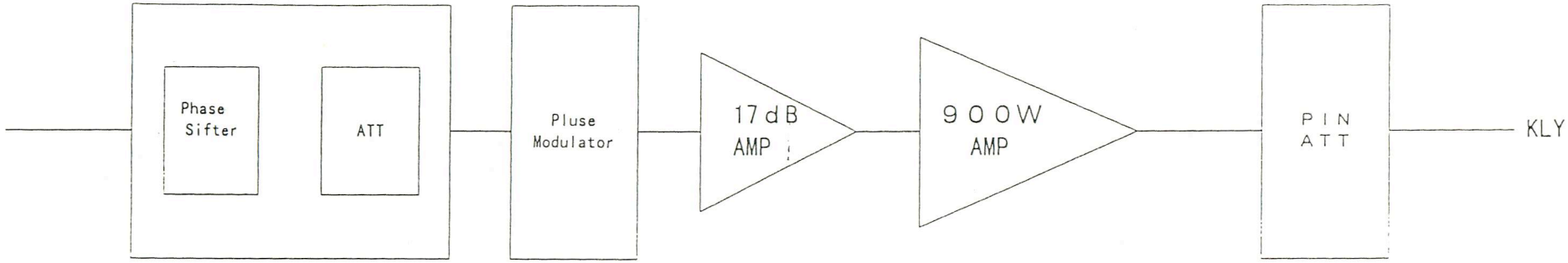
drive only A-1 klystron without SLED
(the first klystron in injector linac)

no phase lock loop

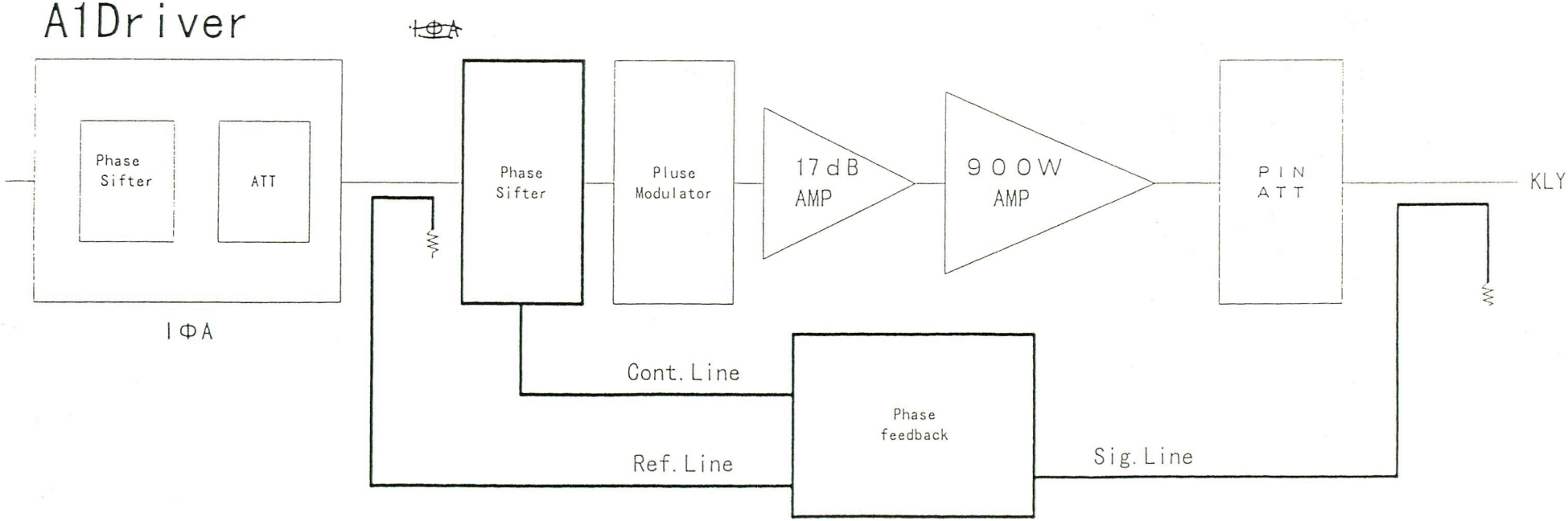
affected with temperature shift of klystron gallery

replace with a newly designed one (April to May)
with phase lock loop

現在の
A1Driver$_{1\Phi A}$



改造後のの
A1Driver



sub-boosters

2856MHz Klystron drive microwave

60kW klystron to drive 8 klystrons

found that large phase shift caused by temperature change of klystron gallery and by a mechanical shock

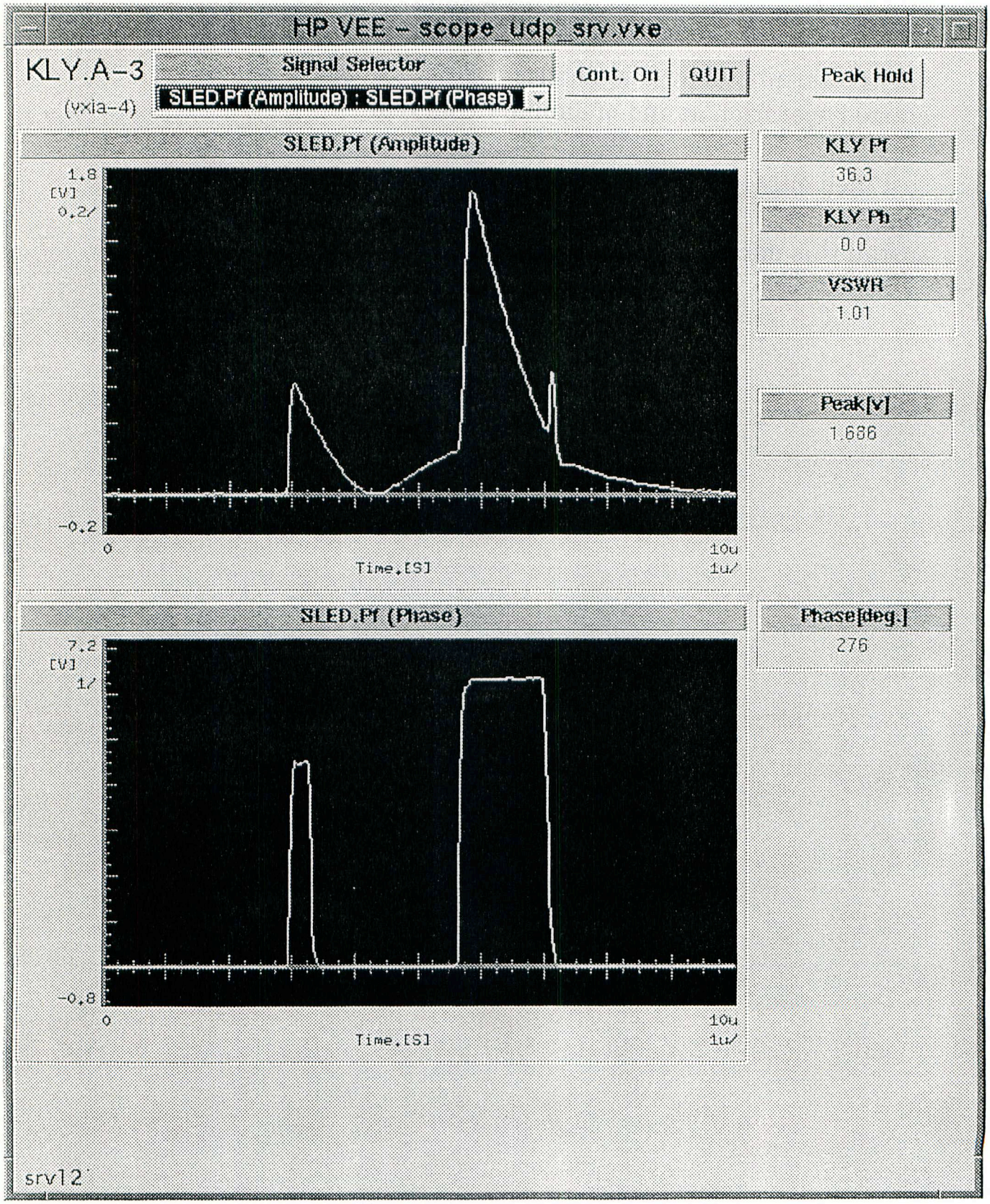
fixed suspicious point(4th March) :expect improvement

microwave monitor

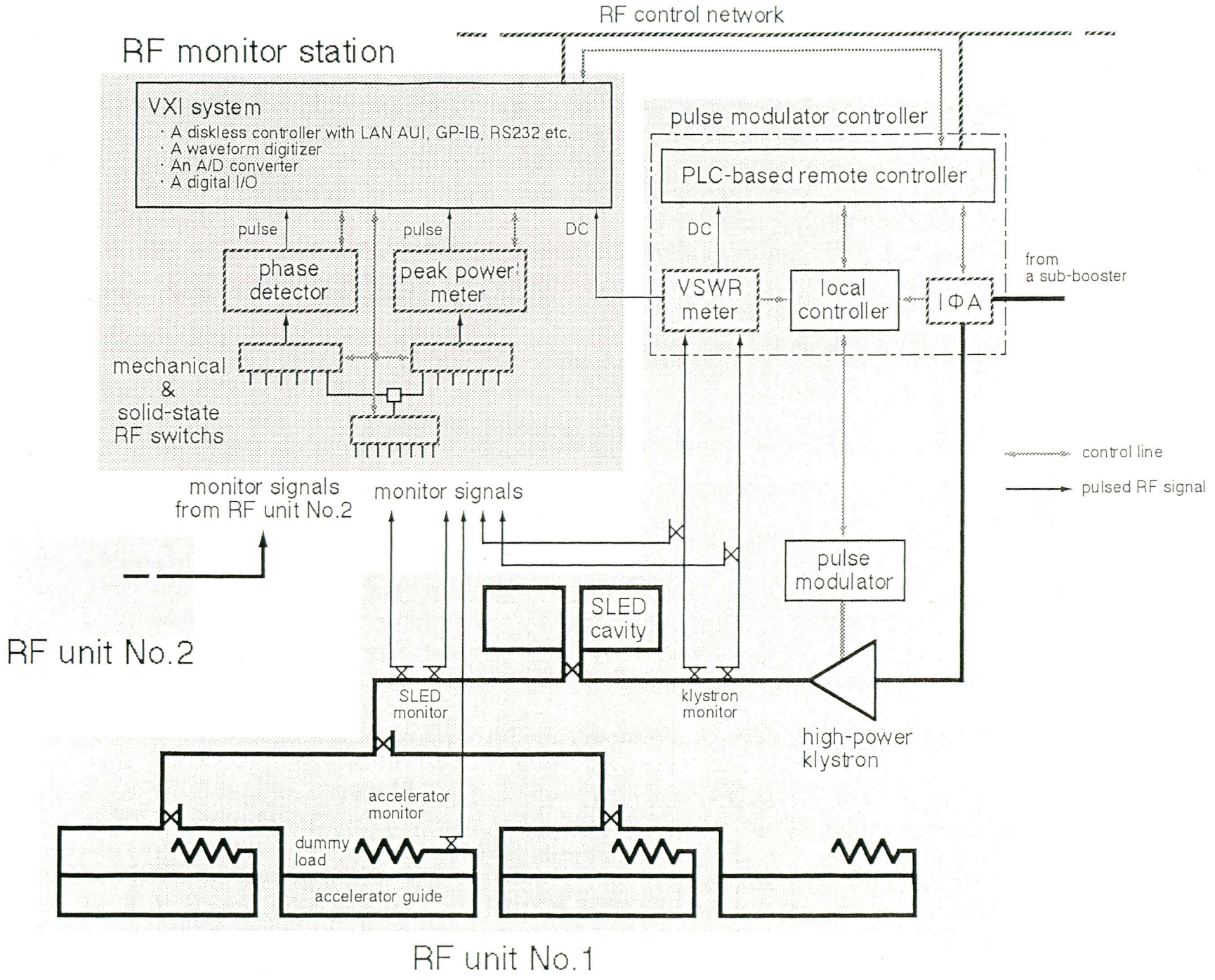
very powerful tool for diagnostics
started operation at end of January this year

installed only in A, B, and a part of C sectors

install this microwave monitor in all sectors up to end of April

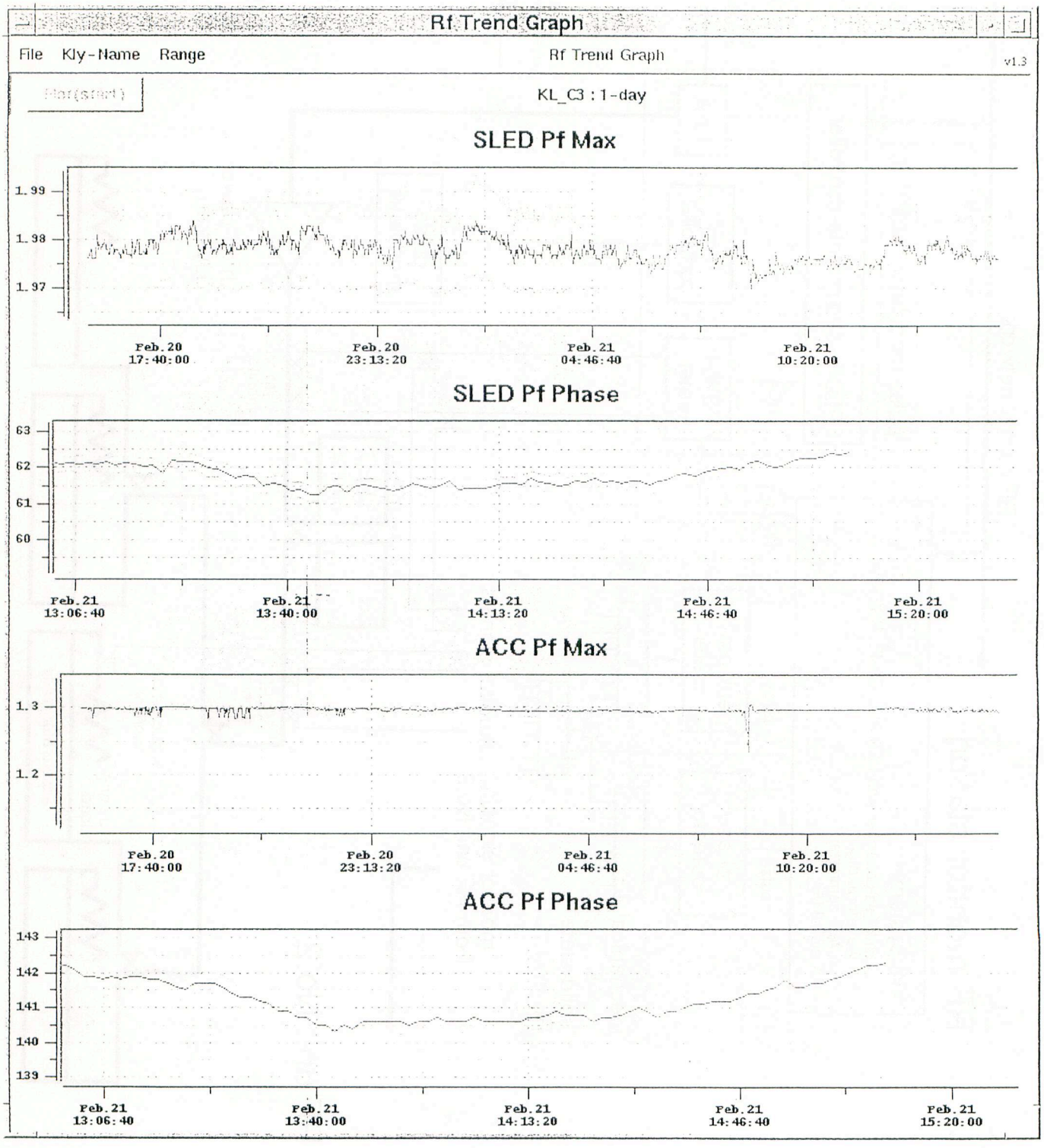

HP VEE - scope_udp_srv.vxe
KLY.A-3
(vxia-4)
Signal Selector
SLED.Pf (Amplitude) : SLED.Pf (Phase)
Cont. On
QUIT
Peak Hold
SLED.Pf (Amplitude)
1.8
[V]
0.2/
-0.2
0
10u
Time,[S]
1u/
KLY Pf
36.3
KLY Ph
0.0
VSWR
1.01
Peak[v]
1.686
SLED.Pf (Phase)
7.2
[V]
1/
-0.8
0
10u
Time,[S]
1u/
Phase[deg.]
276
srv12

RF MONITOR SYSTEM



99. 2. 21(日)

16:46


Rf Trend Graph
File Kly-Name Range
Rf Trend Graph
v1.3
Hor(start)
KL_C3 : 1-day
SLED Pf Max
1.99
1.98
1.97
Feb.20 17:40:00
Feb.20 23:13:20
Feb.21 04:46:40
Feb.21 10:20:00
SLED Pf Phase
63
62
61
60
Feb.21 13:06:40
Feb.21 13:40:00
Feb.21 14:13:20
Feb.21 14:46:40
Feb.21 15:20:00
ACC Pf Max
1.3
1.2
Feb.20 17:40:00
Feb.20 23:13:20
Feb.21 04:46:40
Feb.21 10:20:00
ACC Pf Phase
143
142
141
140
139
Feb.21 13:06:40
Feb.21 13:40:00
Feb.21 14:13:20
Feb.21 14:46:40
Feb.21 15:20:00

stabilize cooling water

Temperature of accelerating structures increased by 1 degree and affected beam stability.

Cause →lack of capacitor of heat exchange

stabilize temperature of cooling water for accelerating structures finished January (1 degree to 0.04 degree).

Recently, heat load for cooling water for klystrons increased then the same problem as that of cooling water for accelerating structures occur

Cause →lack of capacitor of heat exchange

stabilize that for klystrons during March by same process

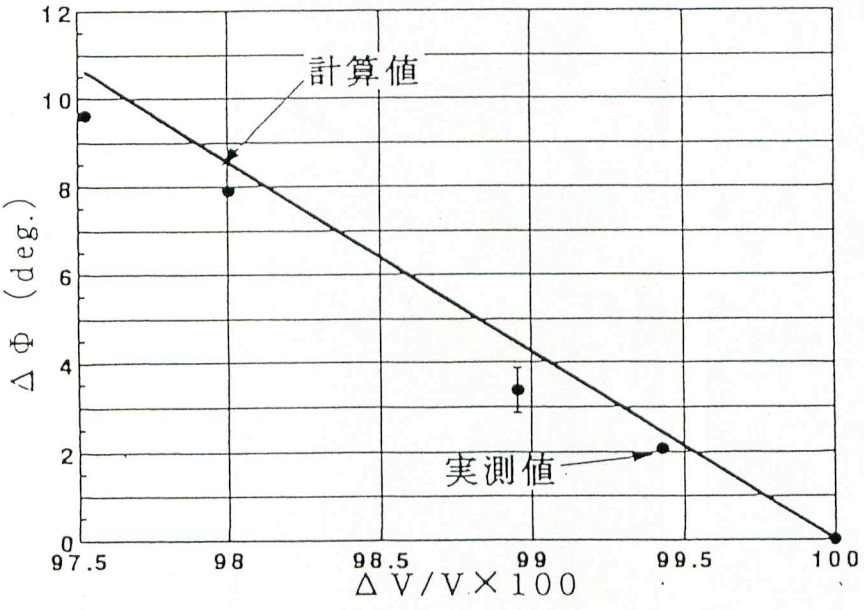
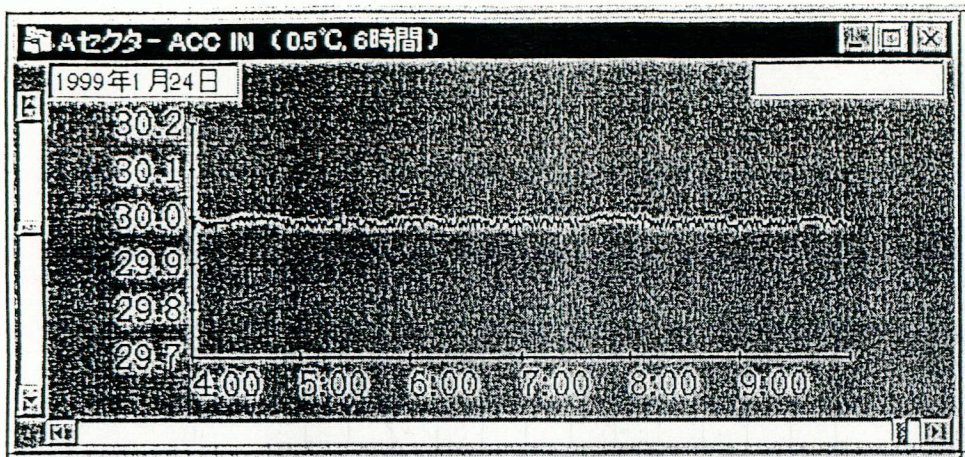
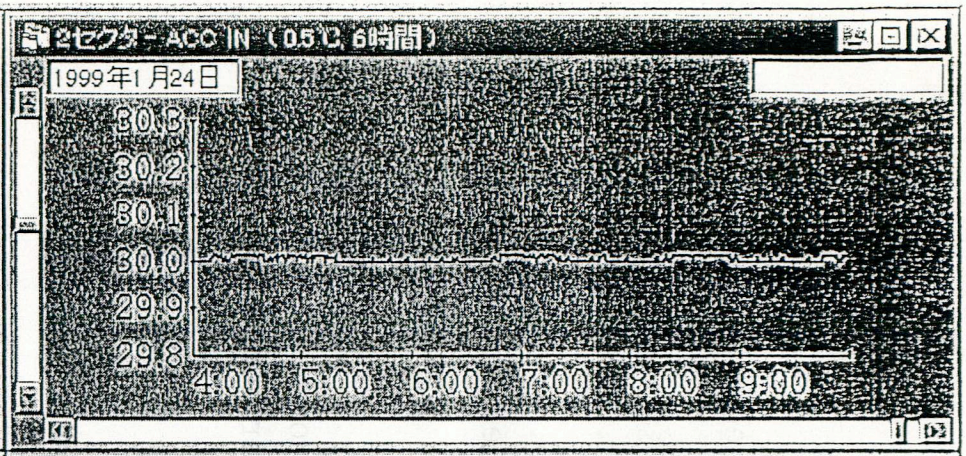
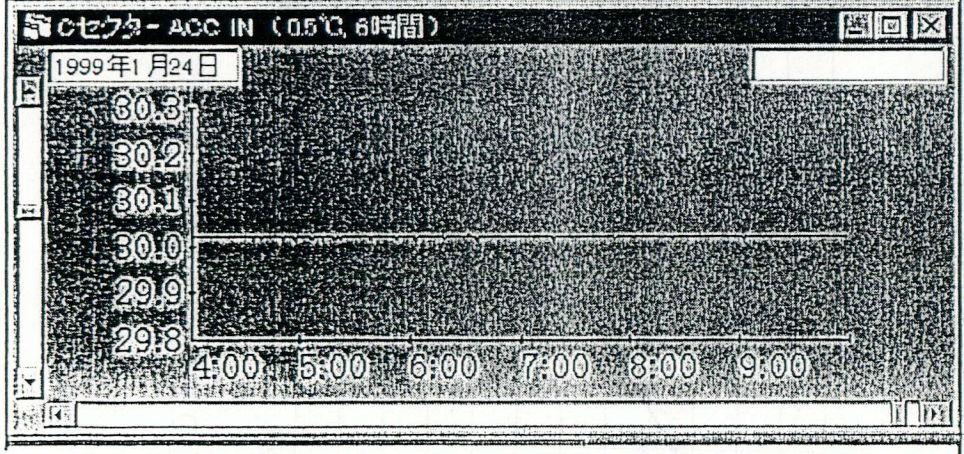
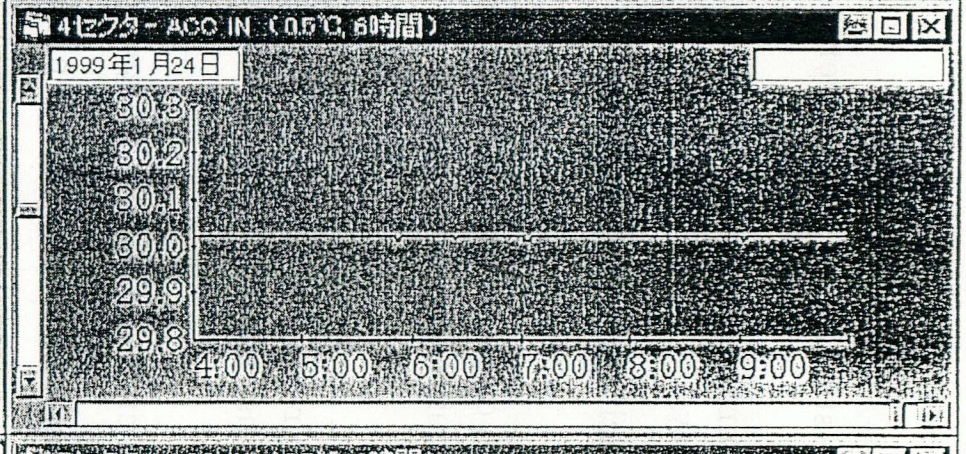


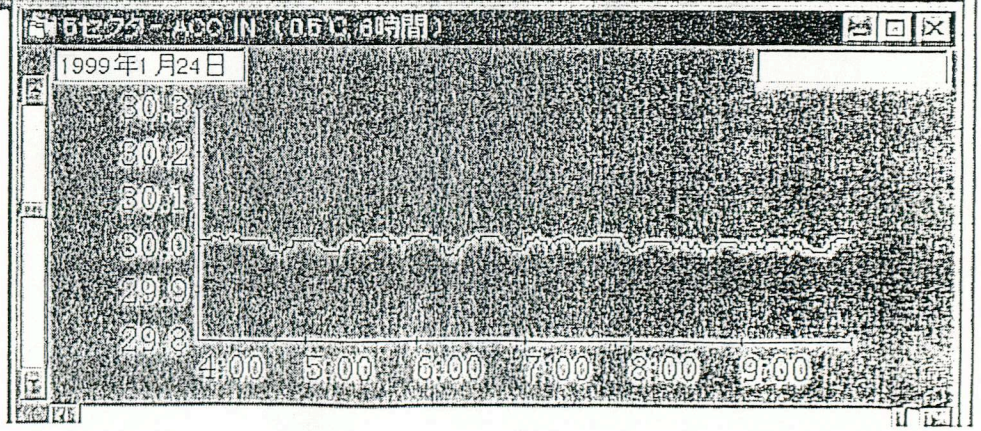
図4 印加電圧の変化率と位相の変化（V=300kV）







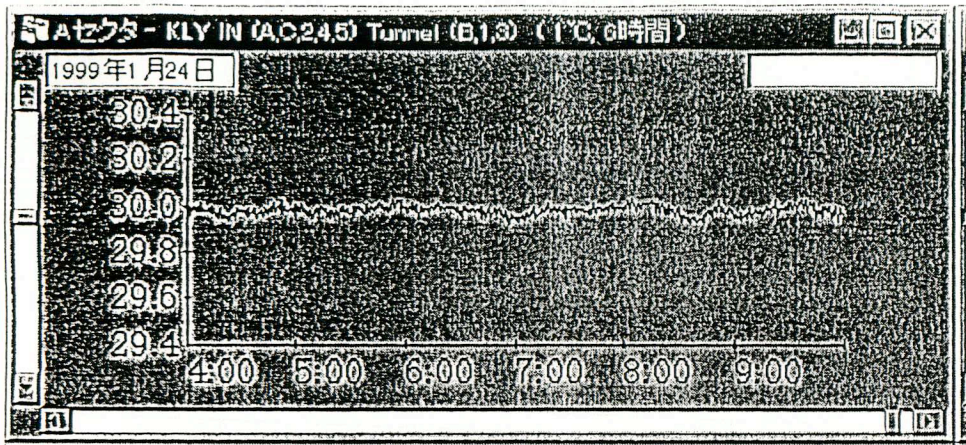


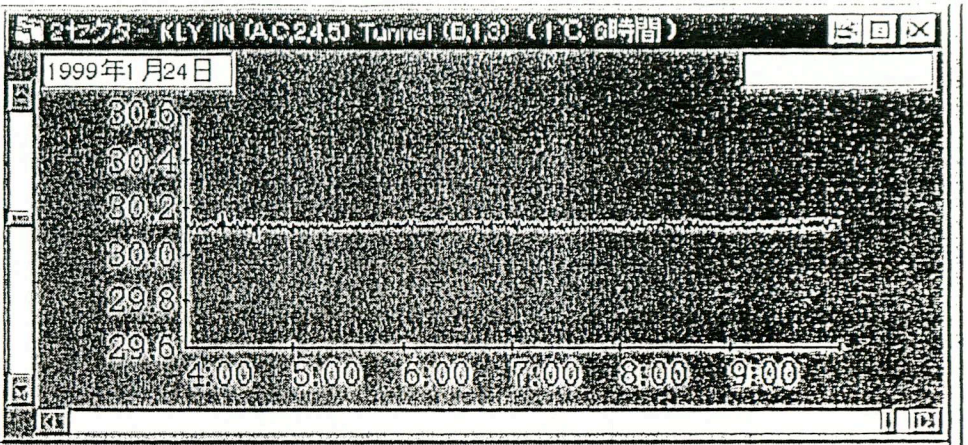


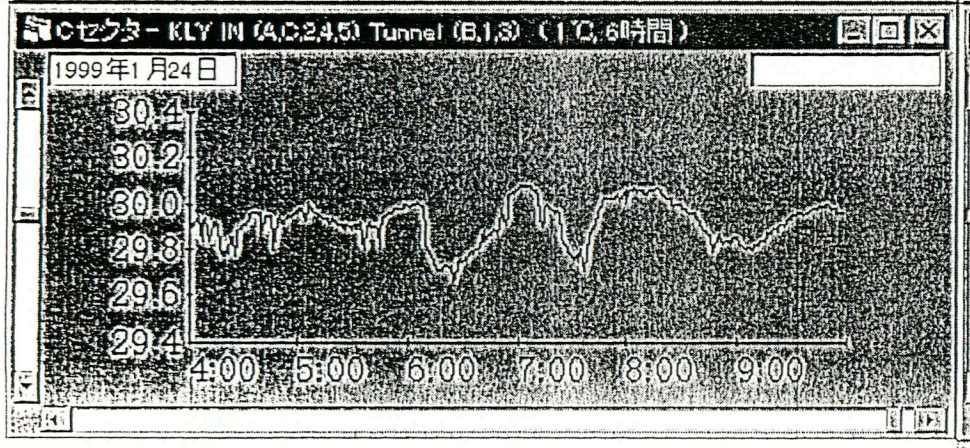
加速管系冷却水温度

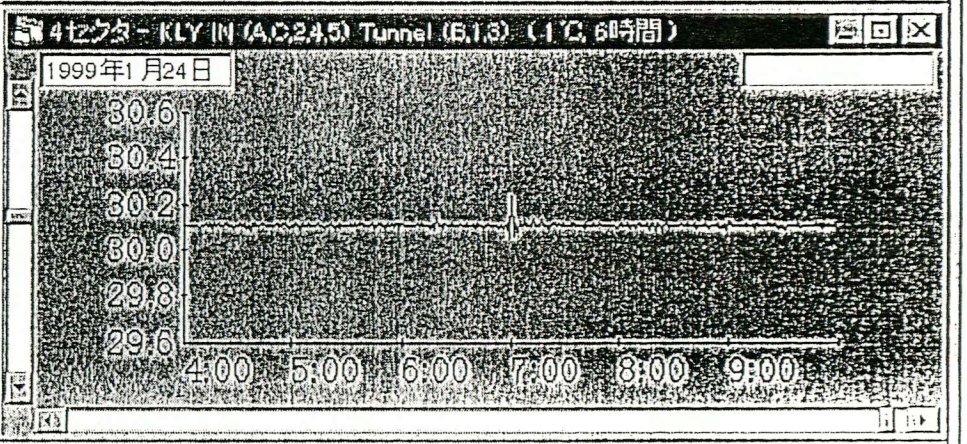
Aセクター	1.2セクター
B·Cセクター	3·4セクター
	5セクター

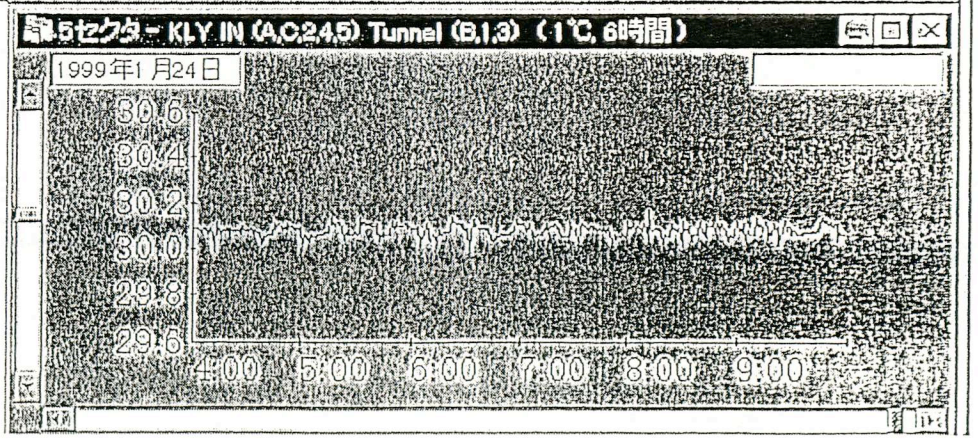
グラフ1









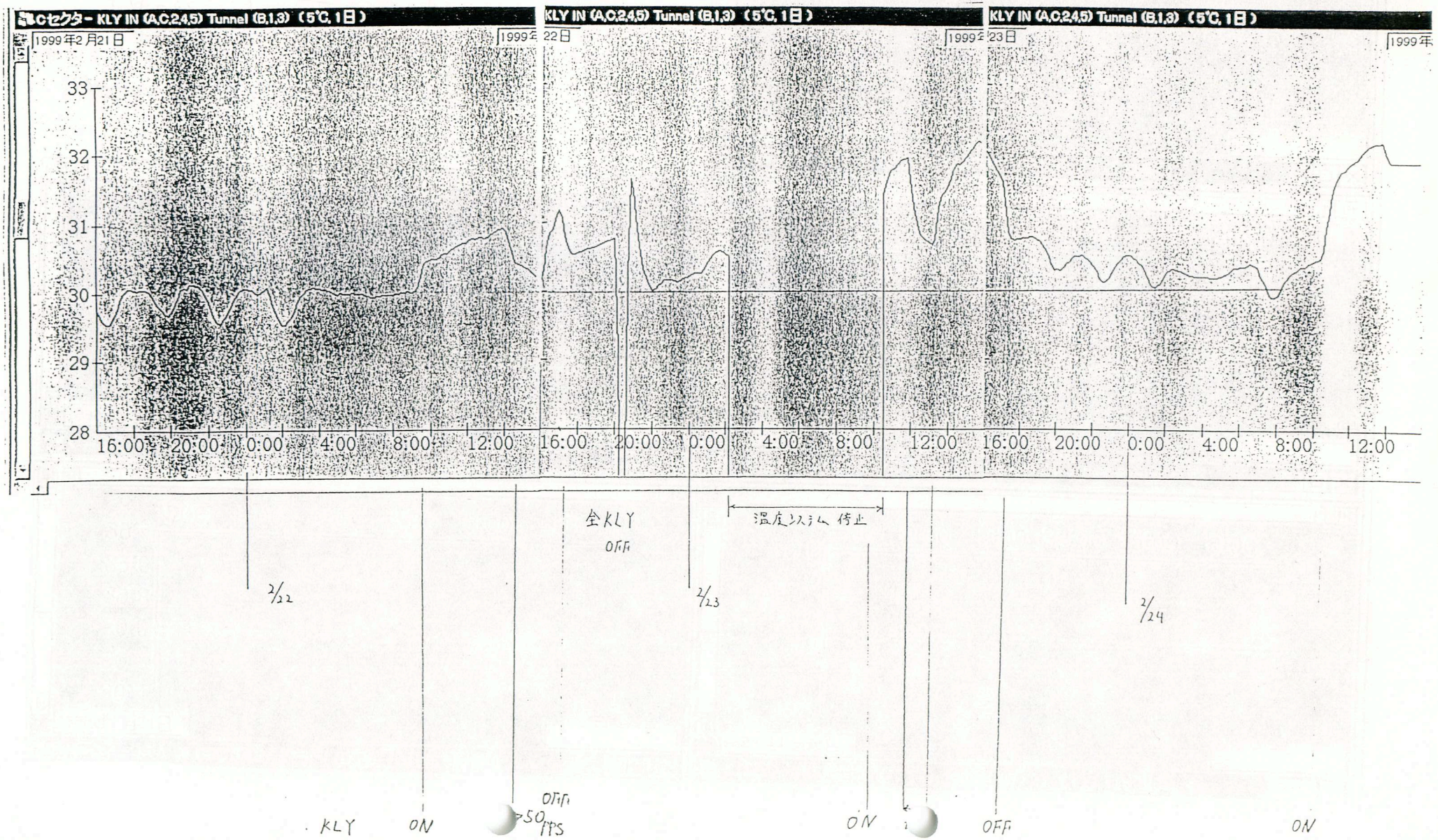


Klystron 系 冷却水温度

A セクター	1・2 セクター
B・C セクター	3、4 セクター
	5 セクター

グラフ2

セクタ B.C
KLY 冷却水



stabilize high power pulse output (injection part)

High power pulse voltage (klystrons, electron gun) is stabilized by De-Q circuit.

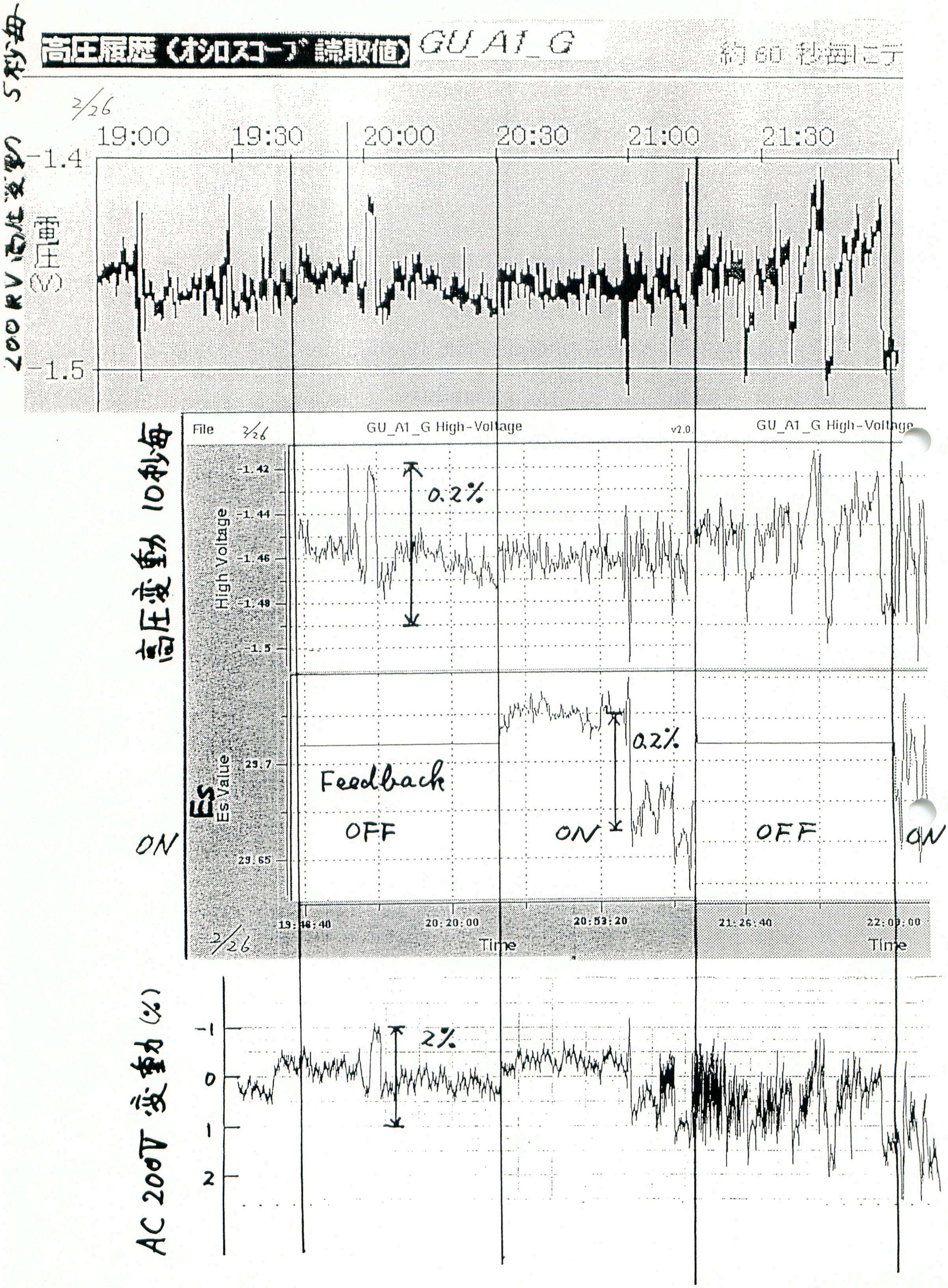
→compression factor is roughly 1/10

If the stability of ac power supply is ±3% then ±0.3% for output

If klystron modulator has same stability

→ about ±1.2 degree phase shift.

start the test in the gun modulator using AVR



高圧履歴（オシロスコープ読取値）
GU_A1_G
約60 秒毎にデ
5秒毎
2/26
19:00
19:30
20:00
20:30
21:00
21:30
-1.4
-1.5
電圧(V)
200kV 高圧変動
File
GU_A1_G High-Voltage
v2.0
高圧変動 10秒毎
High Voltage
-1.42
-1.44
-1.46
-1.48
-1.5
0.2%
Es
Es Value
29.7
29.65
Feedback
OFF
ON
19:48:40
20:20:00
20:53:20
21:26:40
22:00:00
Time
AC 200V 変動 (%)
-1
0
1
2
2%