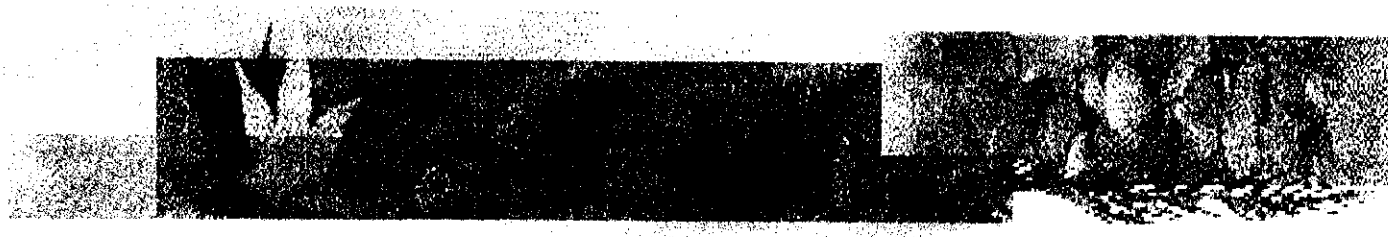


Target and Beam Monitor with Thermocouples

T. Sato

KEK

Kaon Decay Workshop

Feb. 14, 2001

1. **Motivation**
2. **Target Monitor**
3. **Beam Profile Monitor**
4. **Summary**

1. Motivation

E391a

Search for the Rare Decay

$$K^0 \rightarrow \pi^0 \nu \bar{\nu}$$

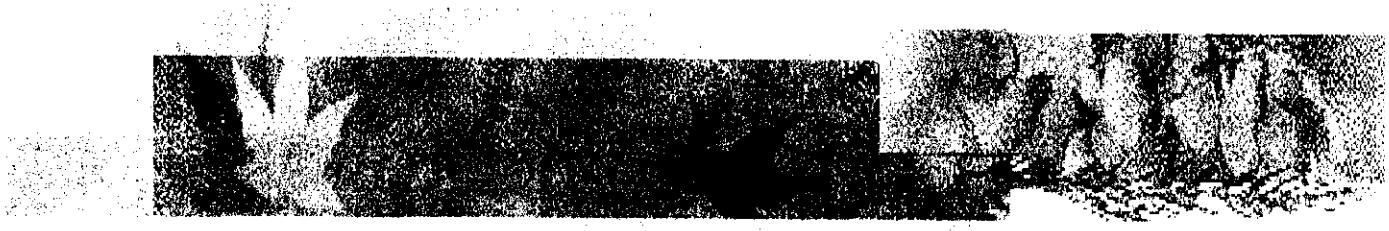
We need a Neutral Pencil Beam Line with less Beam Halo

then

We needed the following.

1. Real time Target Monitoring System.

2. Beam Profile Monitor at the Target point.



Merits of using Thermocouples

- Very simple system.
- Not so expensive.
- Only thermocouples are exposed to the Proton Beam, and this system could be radiation hard.
- Maintenance is very easy.

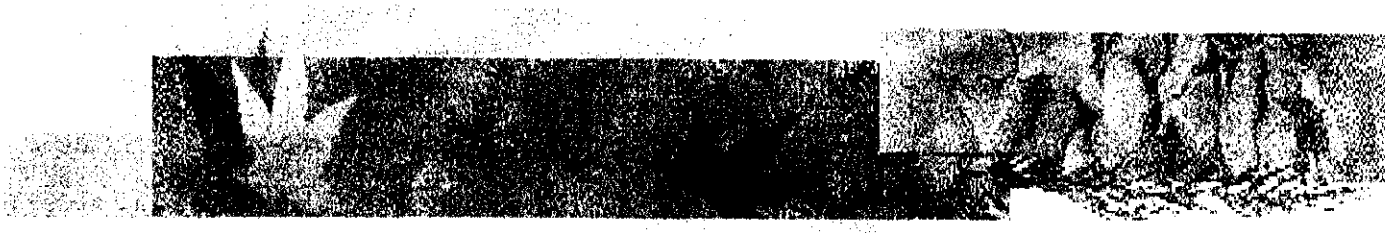
2. Target Monitor

- Monitoring System to keep Proton Beam at the center of the Target.
- A Counter Telescope used to be used for this purpose.
- We need a Real Time Monitoring System

↓

Development of Monitoring System using Thermo Couples.

Measure Target Temperature and Temperature Difference.



Simple Simulation of Temperature Rise

We assumed heat conduction is only the source of energy flow

Target ; 8mm ϕ x60mm Pt

Support ; 0.1x1.0x32 mm3 Al

Beam ; $1x10^{11}$ ppp

Beam cycle ; 4sec

Beam duration ; 2sec

Average current ; $0.25x10^{10}$ p/sec = 4nA

Instantaneous c. ; $0.5x10^{10}$ p/sec = 8nA

Energy Loss in the target ; 5W

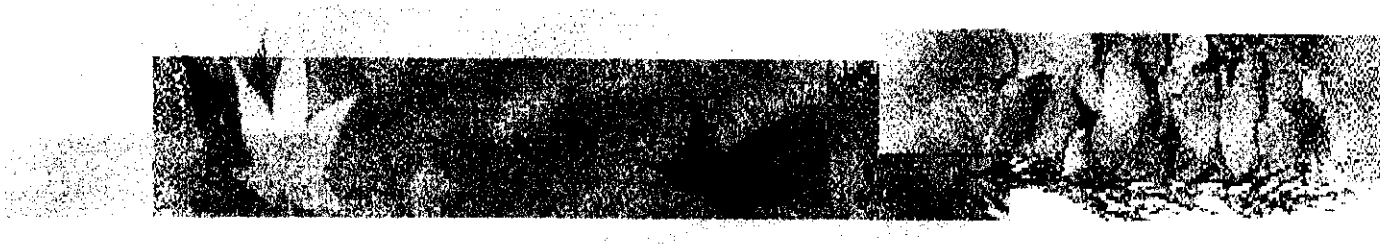
(This corresponds to 4.3 MIP/proton)

at JHF

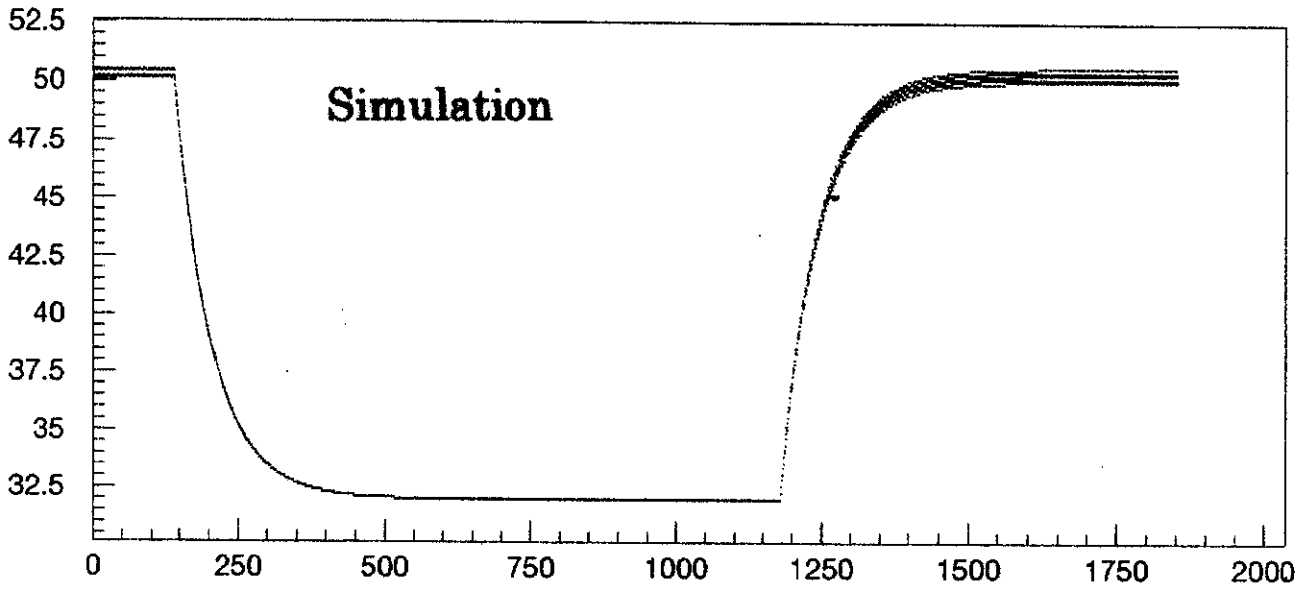
Energy Loss in the target will be 25.5KW assuming

Average Current = 10 μ A

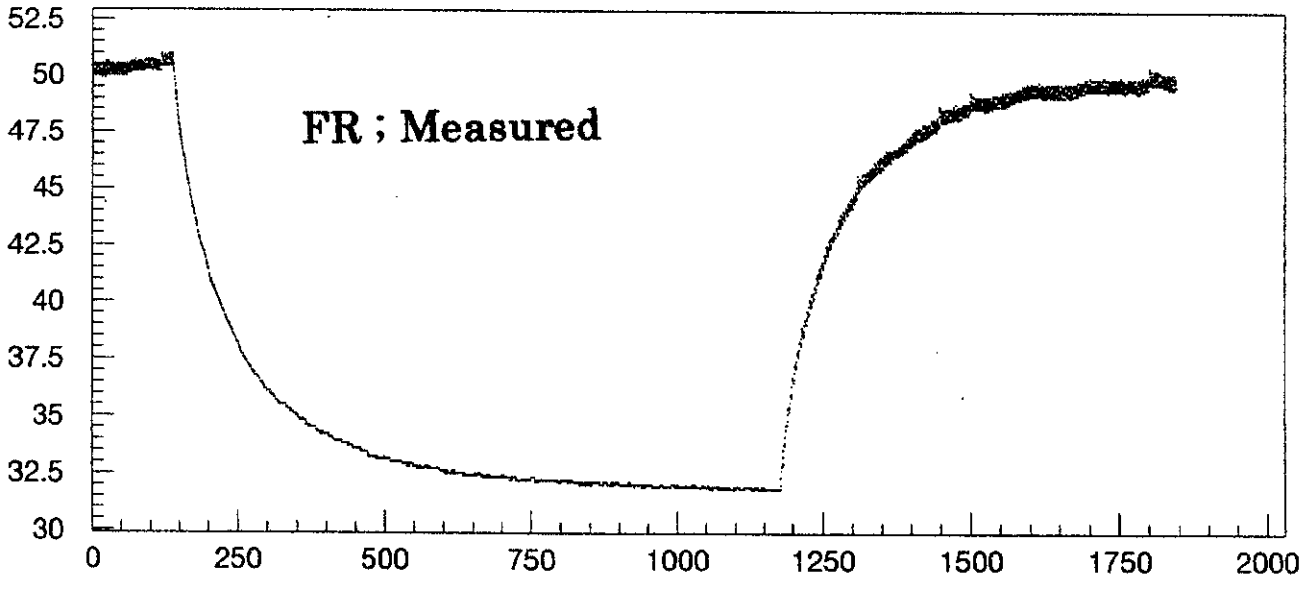
Sqrt(E) multiplicity dependence



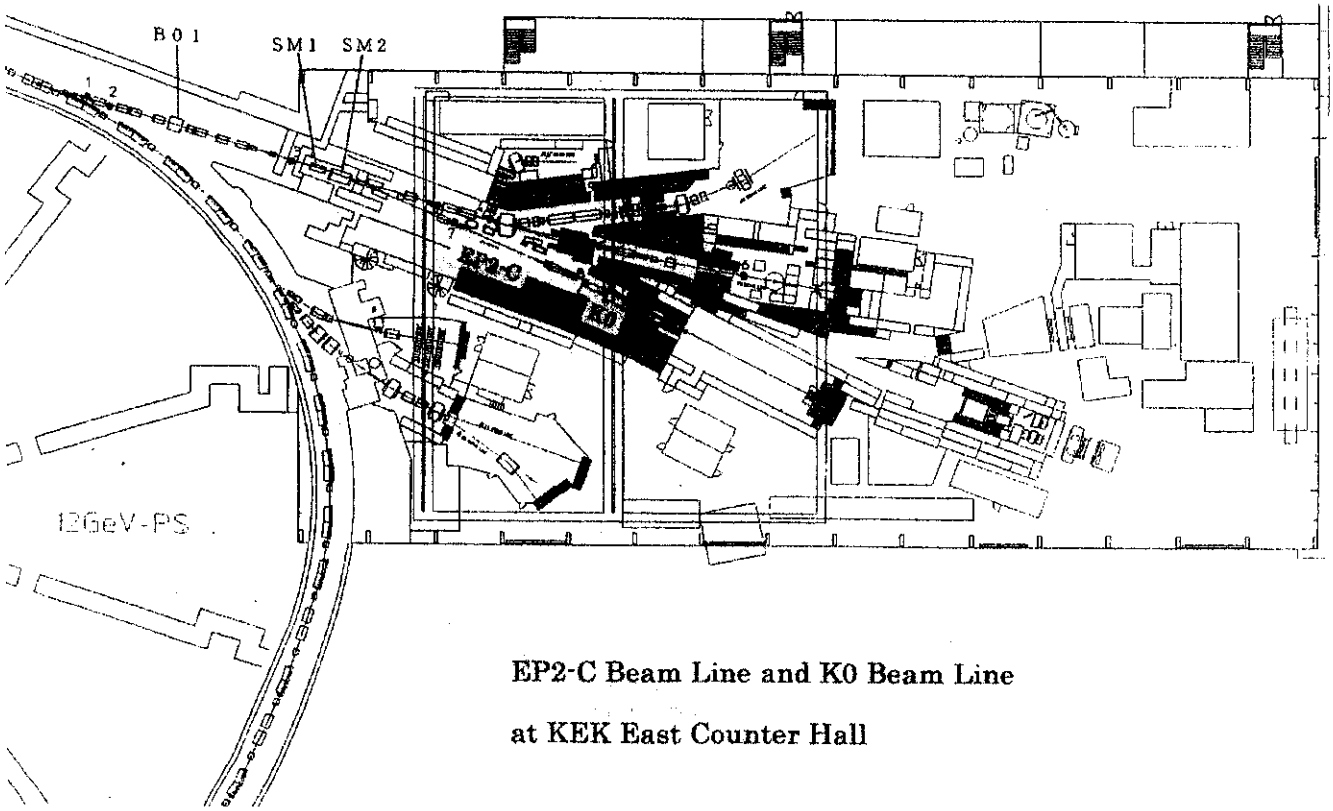
Simulation of Temperature rize for d000426b.dat



TEMP1 VS TIME

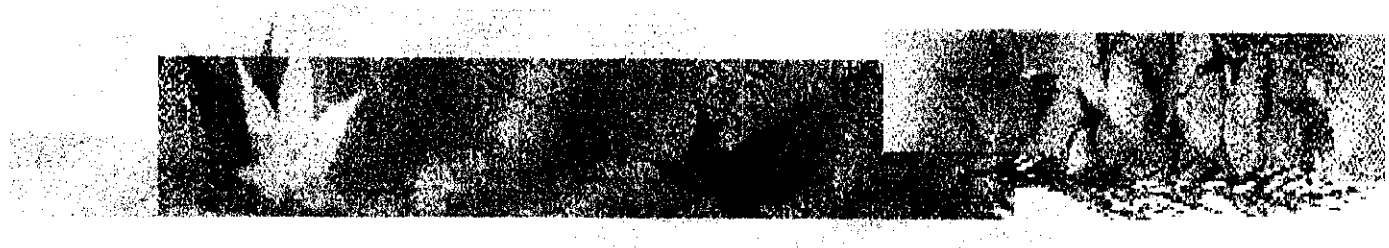


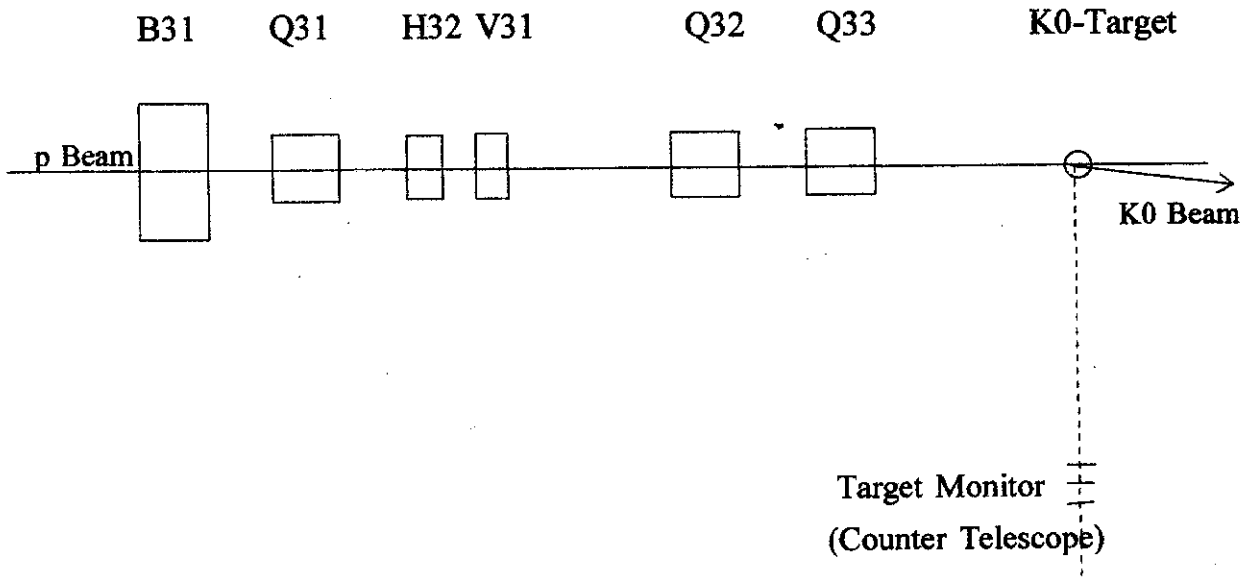
FR VS TIME



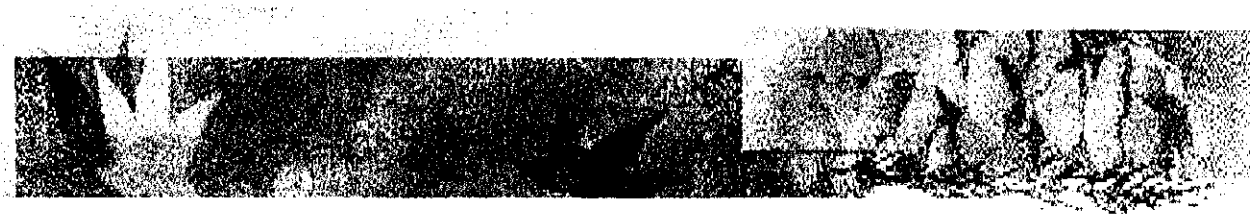
EP2-C Beam Line and K0 Beam Line

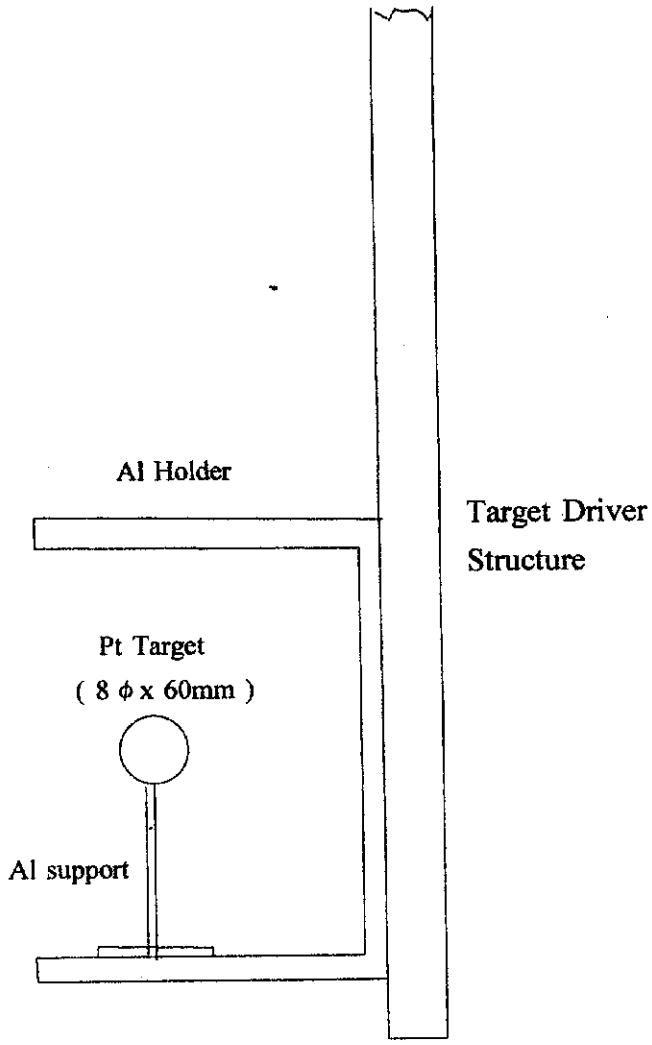
at KEK East Counter Hall





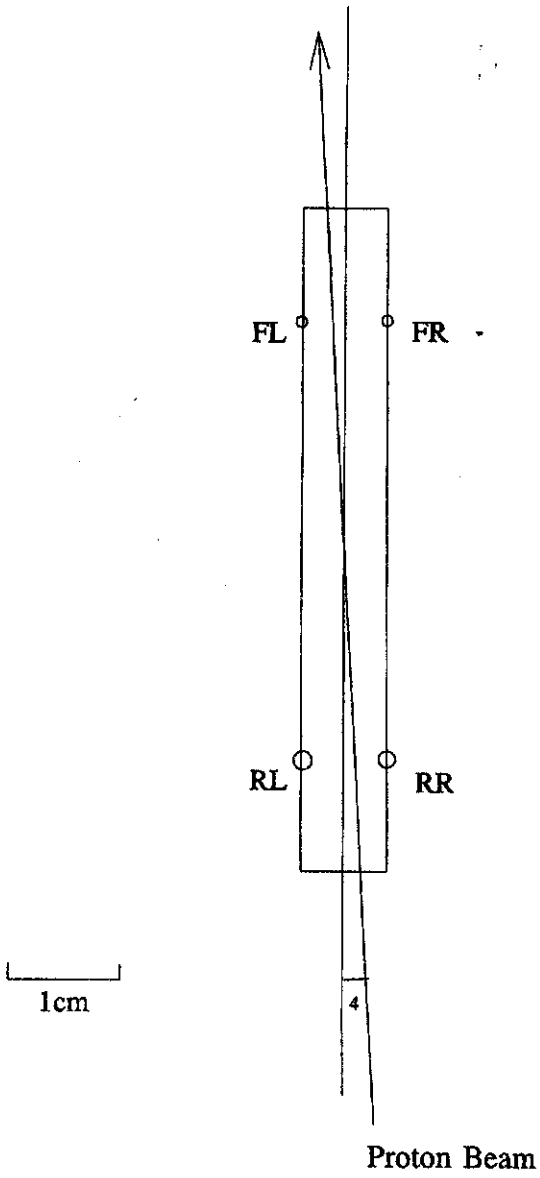
EP2-C Beam Line and K0 target
H32, V31; Horizontal and Vertical steering magnets





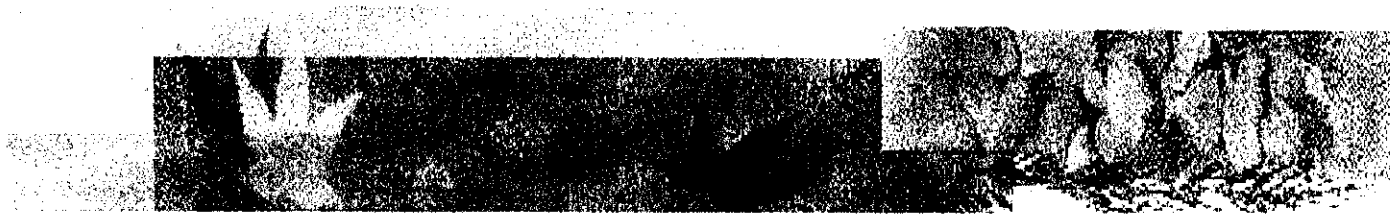
Target Holder and Pt target

Proton Beam hits the target from foreside

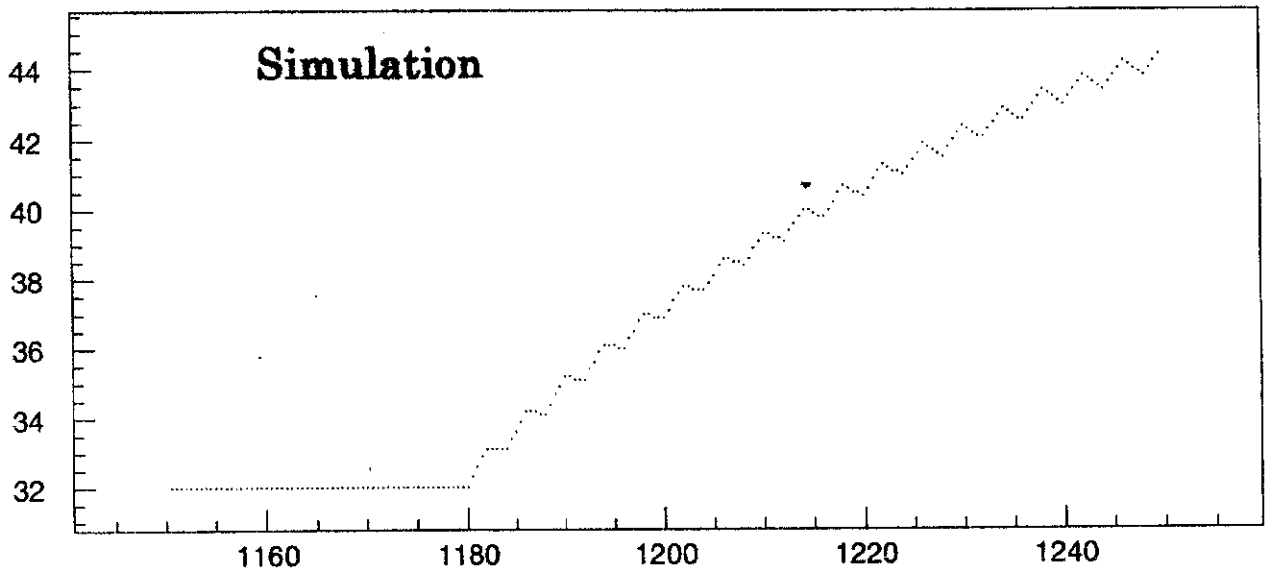


Pt target (8 ϕ x60mm) and Proton Beam

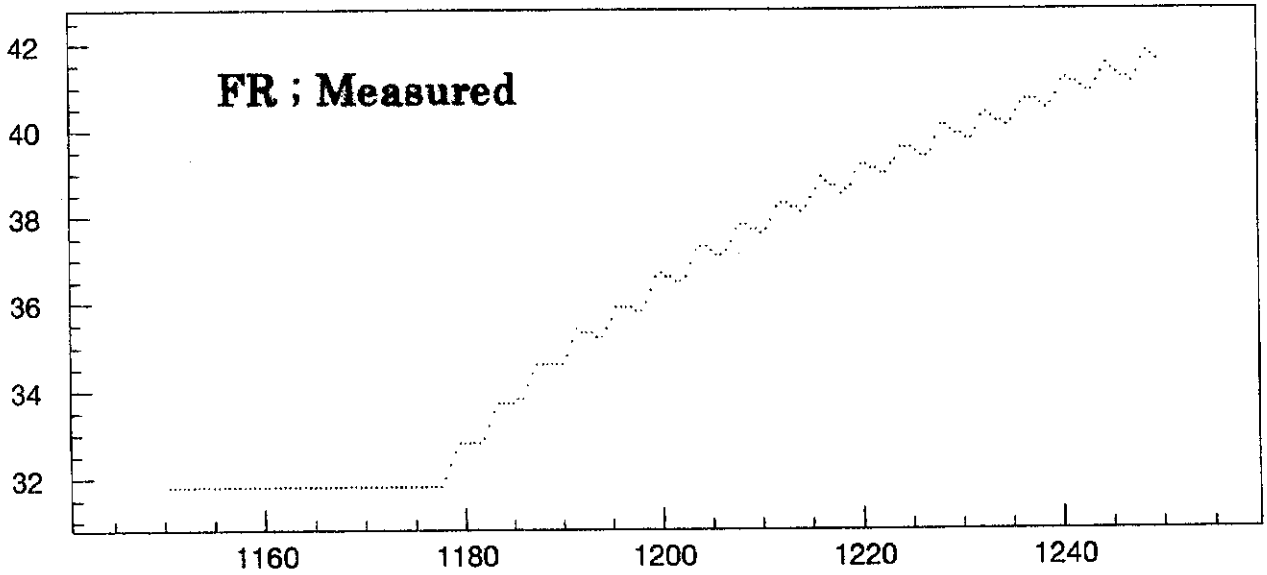
Four K-type thermocouples are welded on the surface points ; FR,FL,RR,RL



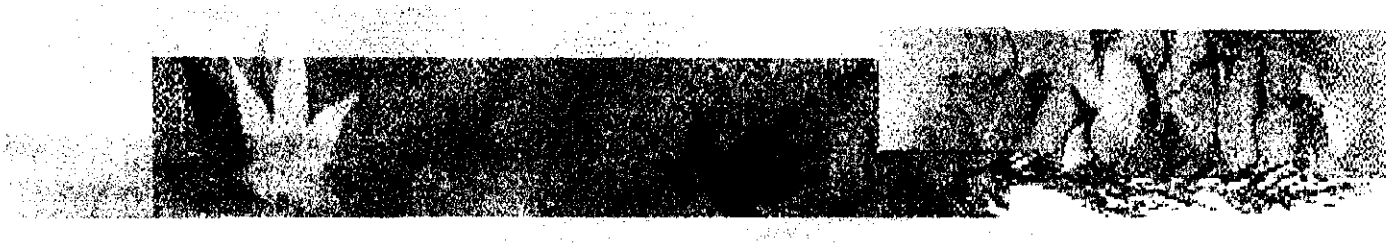
Simulation of Temperature rize for d000426b.dat



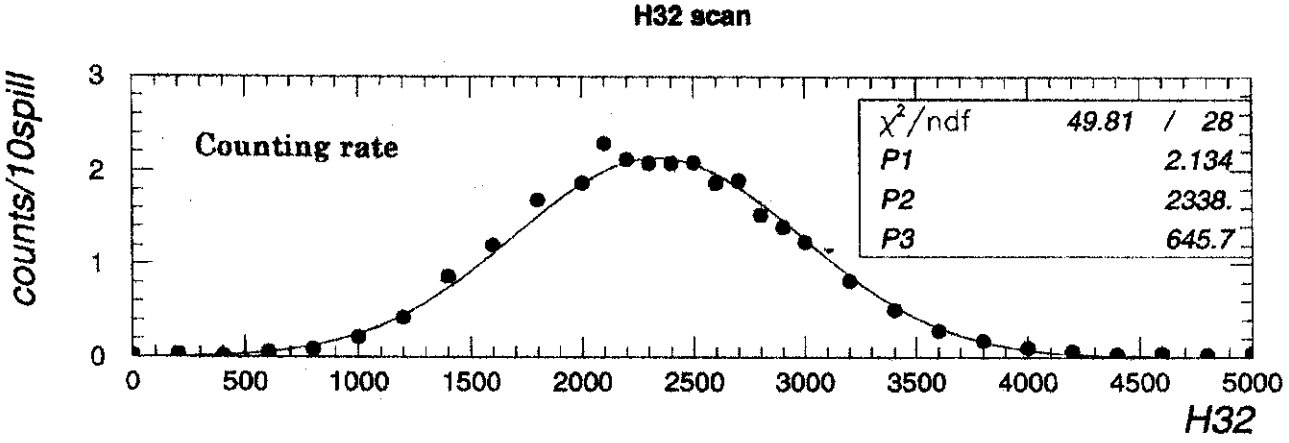
TEMP1 VS TIME

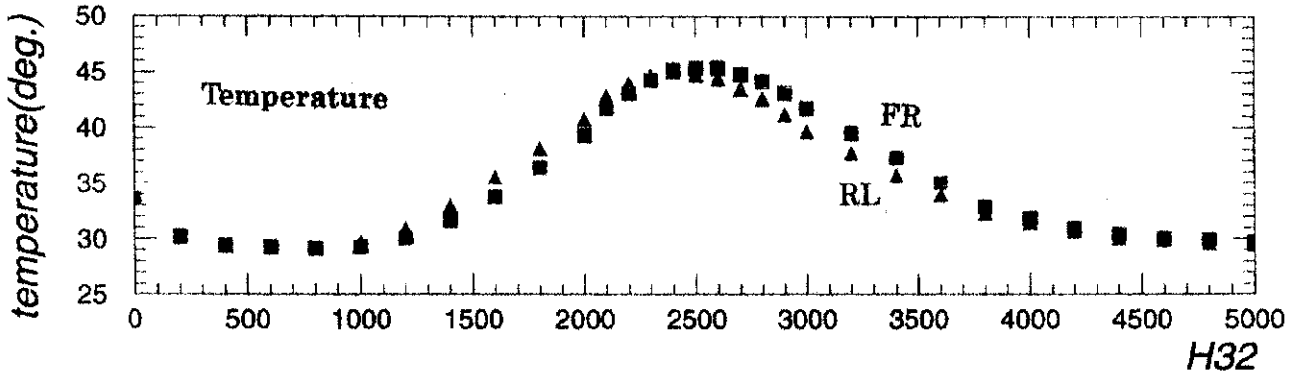


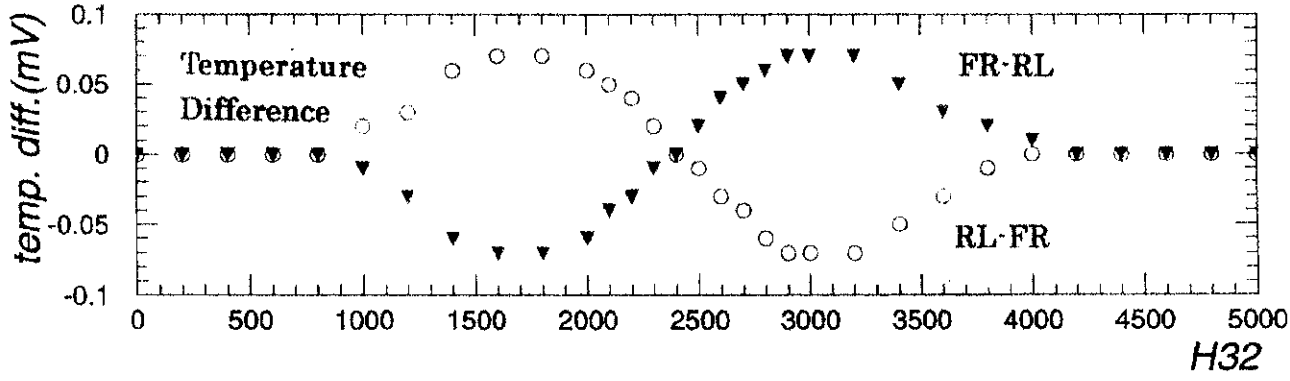
FR VS TIME

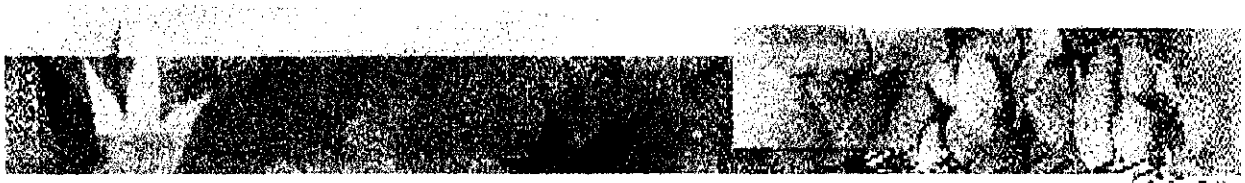


99/05/16 14.44


H32 scan
counts/10spill
Counting rate
χ²/ndf 49.81 / 28
P1 2.134
P2 2338.
P3 645.7
H32

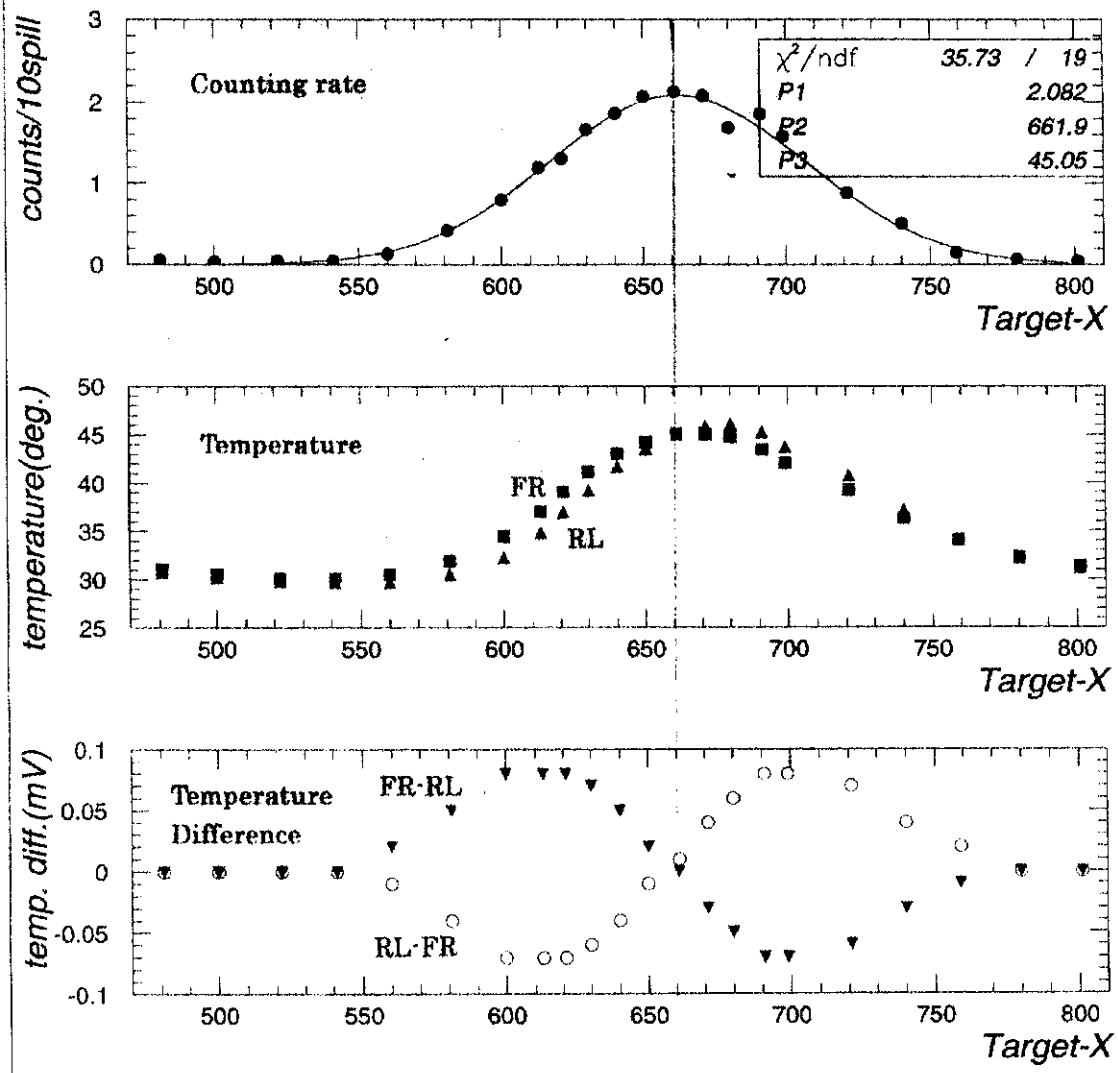

temperature(deg.)
Temperature
FR
RL
H32

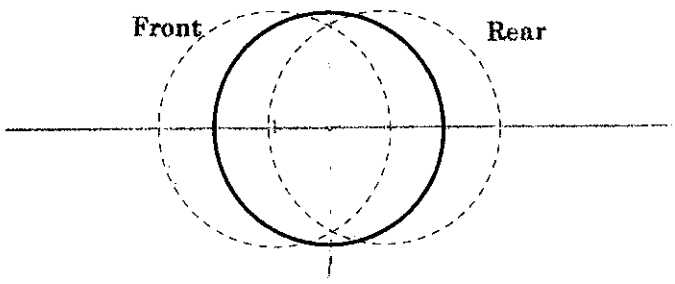

temp. diff.(mV)
Temperature
Difference
FR-RL
RL-FR
H32



99/05/16 14.45

Target-driver x-scan





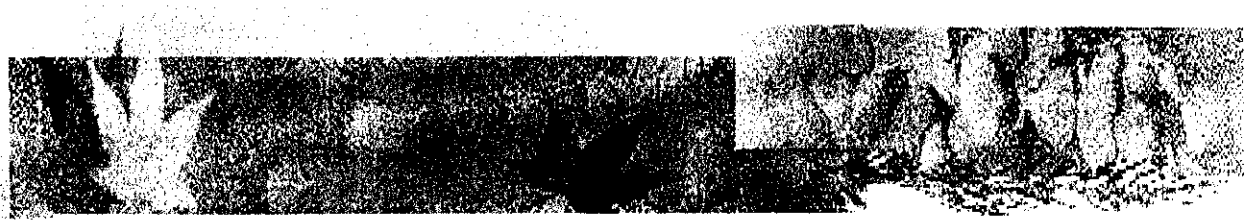
Target Size

3. Beam Profile Monitor

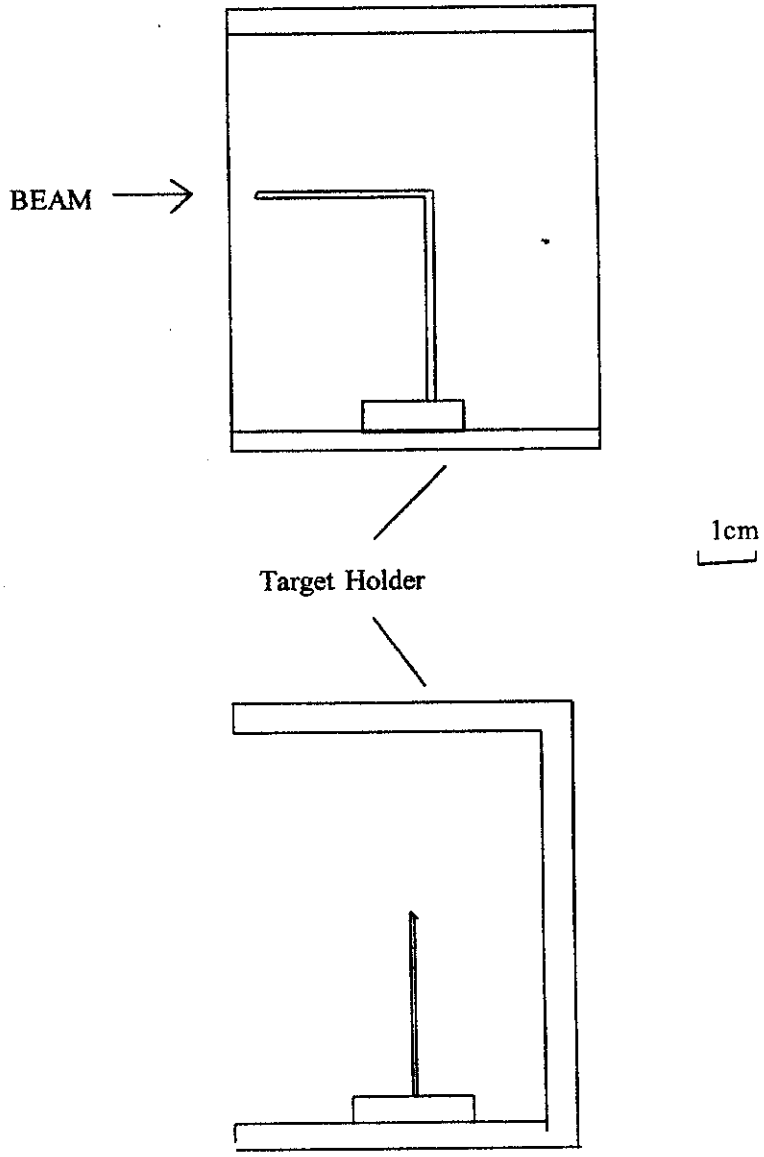
The Target Monitor test suggested. This system could be used for the Beam Profile Monitor.

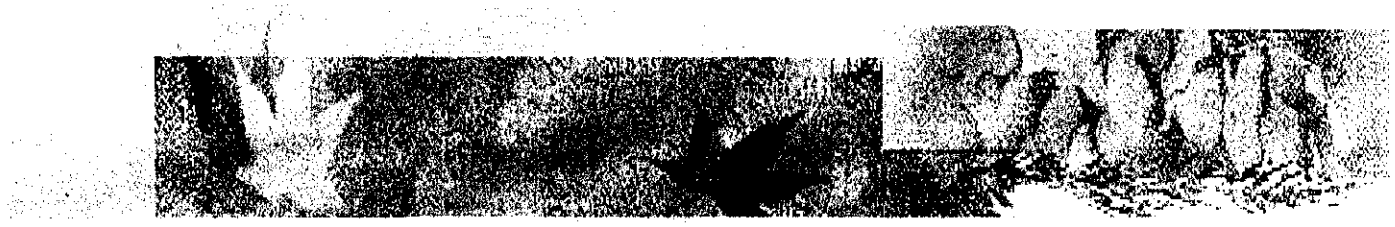
Thin needles(1mm ϕ) with thermocouples were set to the Target Driver.

The scanning of the proton beam was performed to measure the Beam Profile

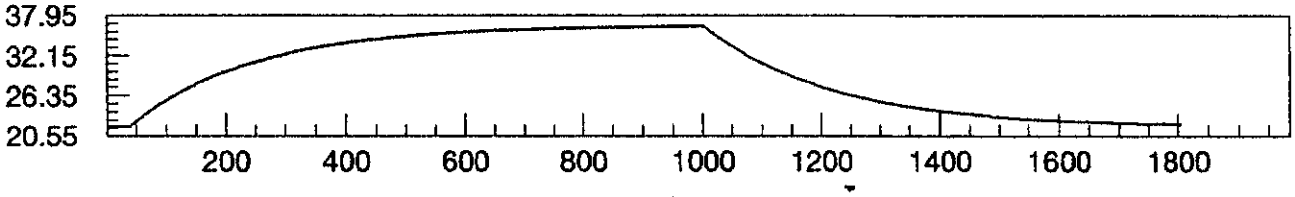


Needle for Beam Profile Measurement

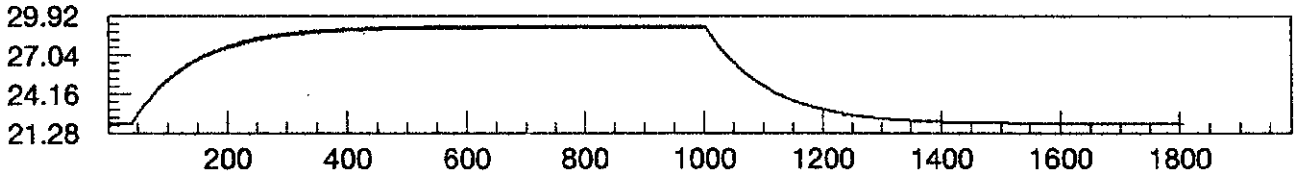




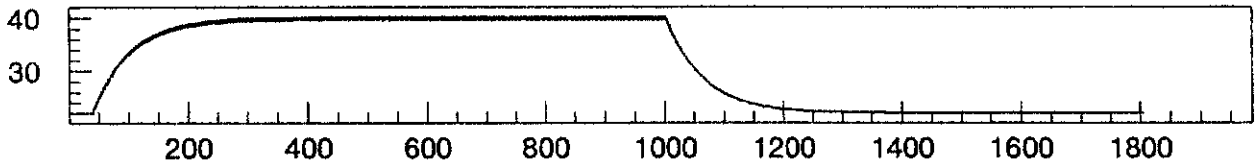
Temperature rize of the needles



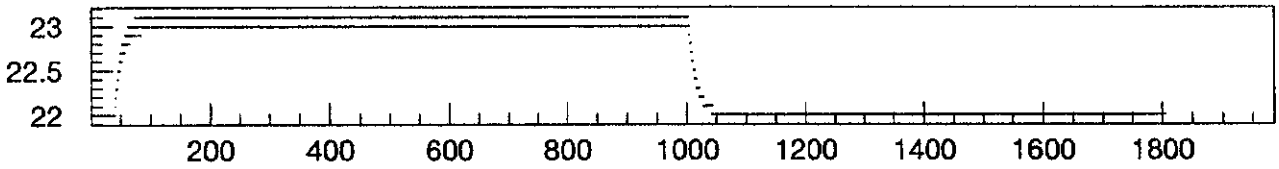
SUS_TEMP VS TIME



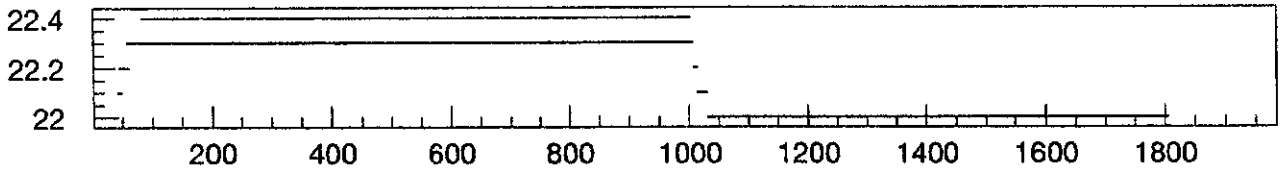
FE_TEMP VS TIME



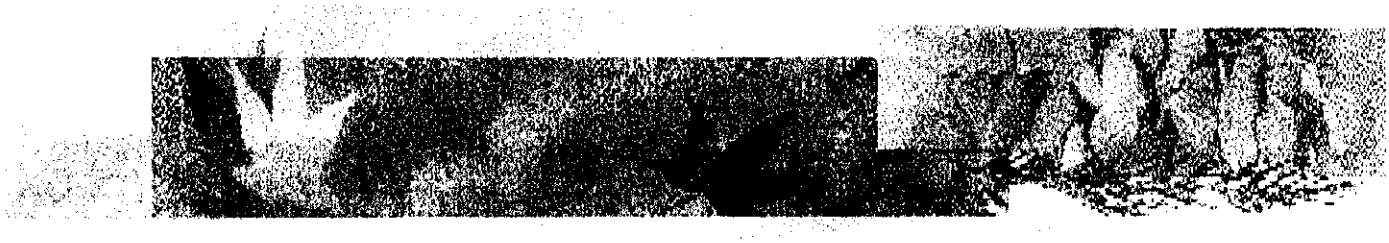
PT_TEMP VS TIME



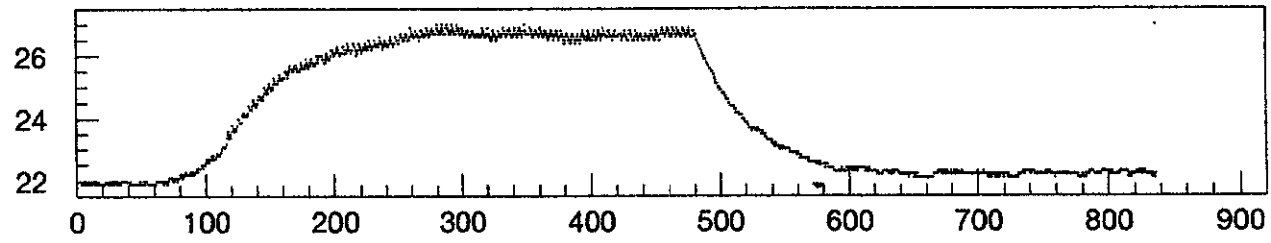
CU_TEMP VS TIME



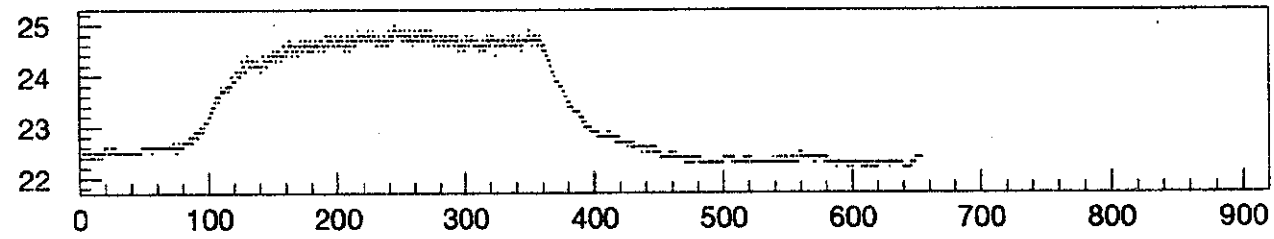
AL_TEMP VS TIME



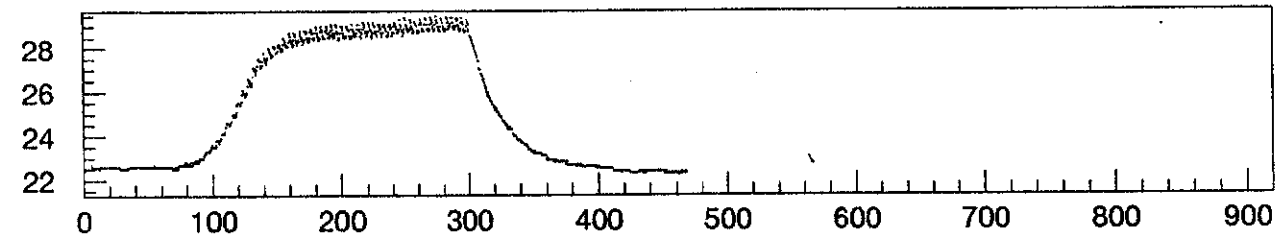
Needle Temperature rize and fall



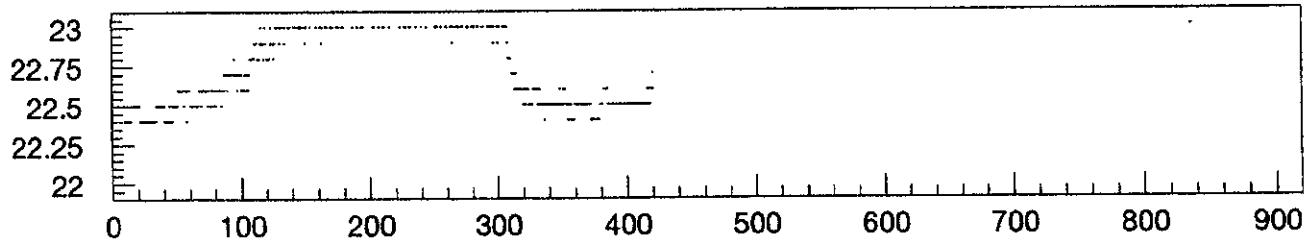
SUS VS TIME



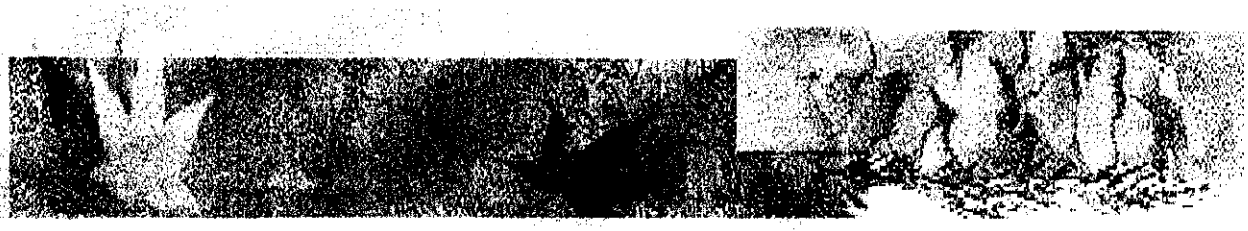
FE VS TIME

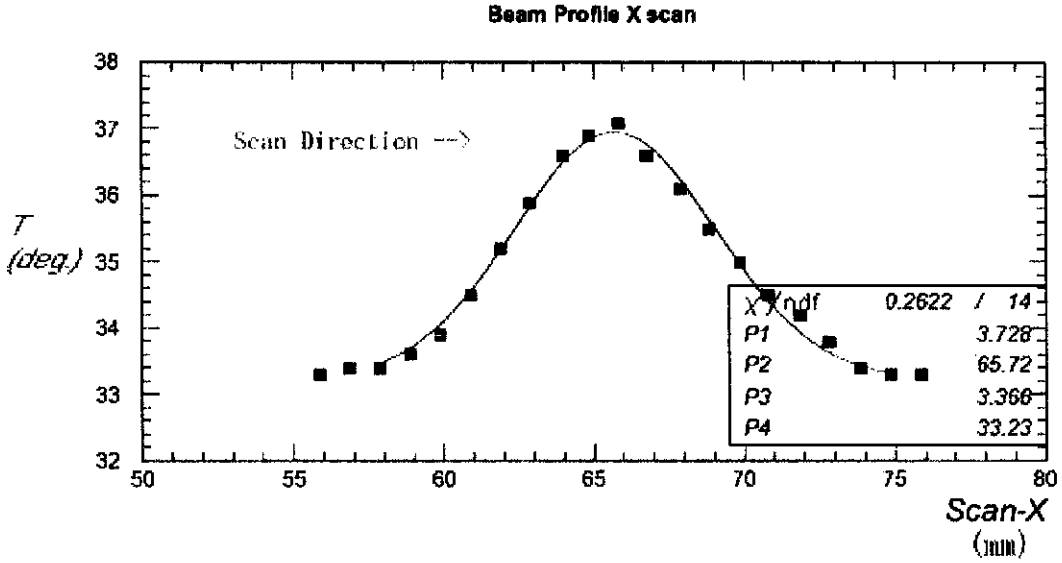


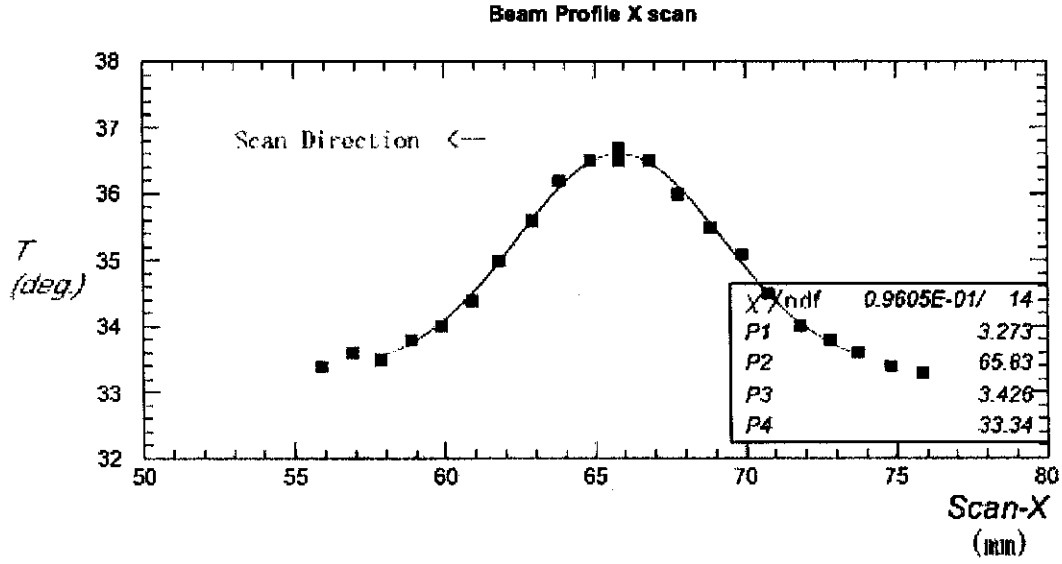
PT VS TIME

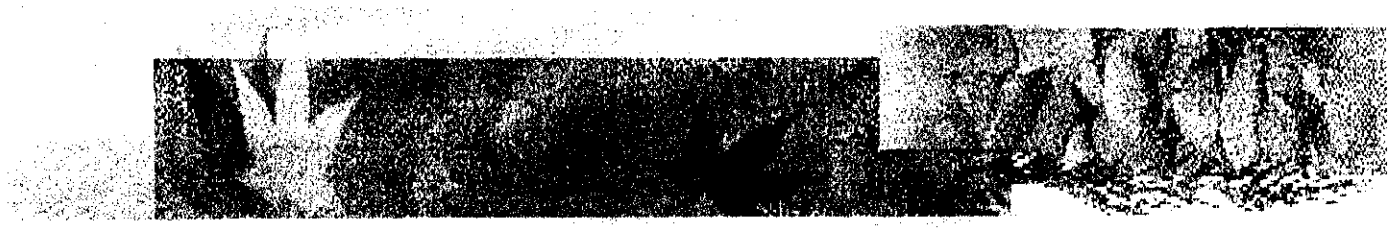


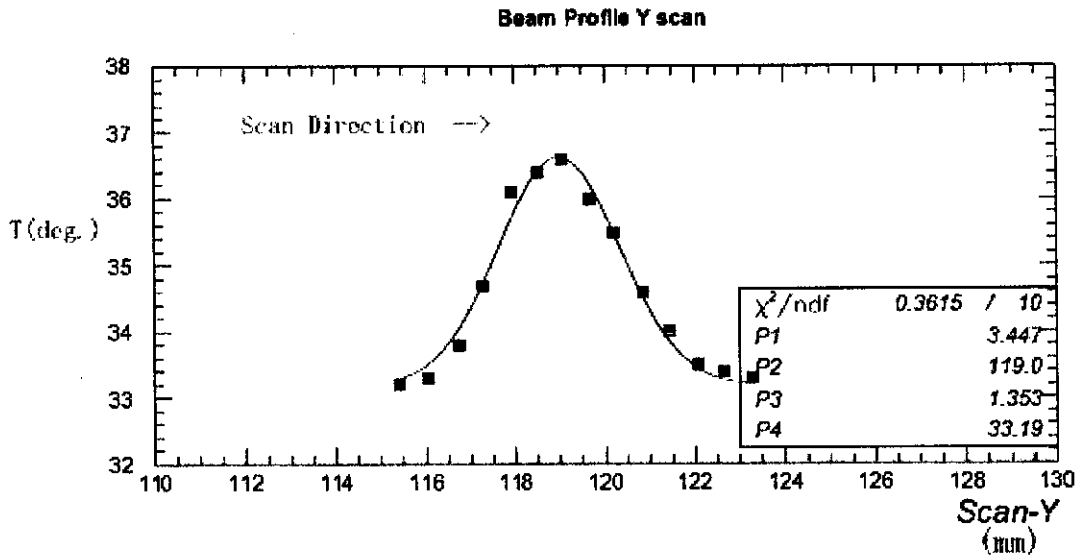
CU VS TIME

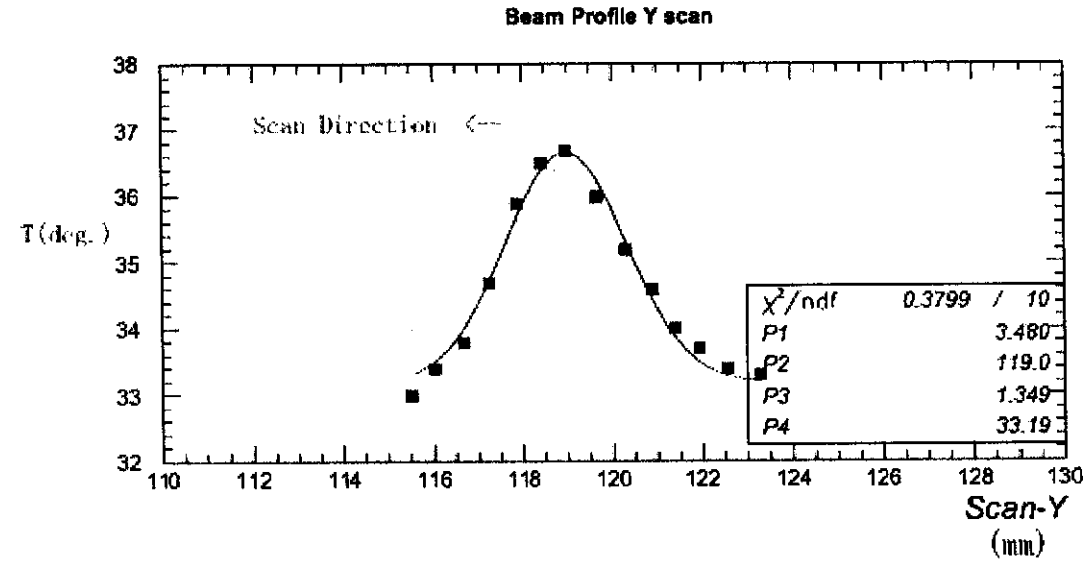


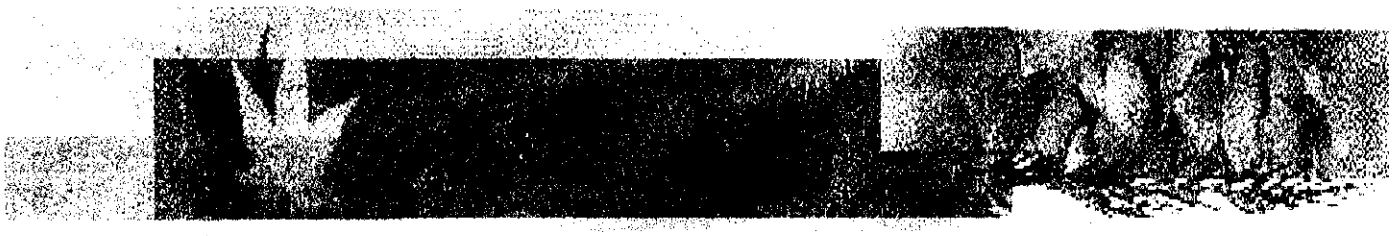

Beam Profile X scan
Scan Direction -->
T (deg.)
Scan-X (mm)
χ²/ndf 0.2622 / 14
P1 3.728
P2 65.72
P3 3.366
P4 33.23


Beam Profile X scan
Scan Direction <--
T (deg.)
Scan-X (mm)
χ²/ndf 0.9605E-01/ 14
P1 3.273
P2 65.63
P3 3.426
P4 33.34




Beam Profile Y scan
Scan Direction -->
T(deg.)
38
37
36
35
34
33
32
110
112
114
116
118
120
122
124
126
128
130
Scan-Y
(mm)
χ²/ndf 0.3615 / 10
P1 3.447
P2 119.0
P3 1.353
P4 33.19


Beam Profile Y scan
Scan Direction <--
T(deg.)
38
37
36
35
34
33
32
110
112
114
116
118
120
122
124
126
128
130
Scan-Y
(mm)
χ²/ndf 0.3799 / 10
P1 3.480
P2 119.0
P3 1.349
P4 33.19



Summary of Beam Profile Scan

1. X-Scan

Material	Scan Direction	Scan Cycle	Peak (mm)	Sigma (mm)	Ty (mm)
SUS	→	3min.	68.3	3.3	407
SUS	←	3min.	67.3	3.2	410
Fe	←	3min.	63.0	3.6	411
Fe	→	3min.	62.8	3.8	411
Pt	←	2min.	58.6	3.3	414
Pt	→	2min.	58.5	3.1	414
Pt	←	1min.	58.3	3.2	414
Pt	→	1min.	58.5	3.4	414
Pt	←	30sec.	57.6	3.1	414
Pt	→	30sec.	58.7	3.2	414

2. Y-Scan

Material	Scan Direction	Scan Cycle	Peak (mm)	Sigma (mm)	Ty (mm)
SUS	↑	3min.	122.3	1.1	670
SUS	↓	3min.	122.2	1.2	670
Fe	↓	3min.	123.3	1.1	630
Fe	↑	3min.	123.2	1.1	630
Pt	↓	2min.	123.8	1.1	580
Pt	↑	2min.	123.8	1.1	580
Pt	↓	1min.	123.8	1.1	580
Pt	↑	1min.	124.0	1.0	580
Pt	↓	30sec.	123.6	1.1	580
Pt	↑	30sec.	124.2	1.1	580

Measurement Time

Pt needle

30sec./point ⇒ 10min./scan

Speed up the measurement

1. **Continuous scan**

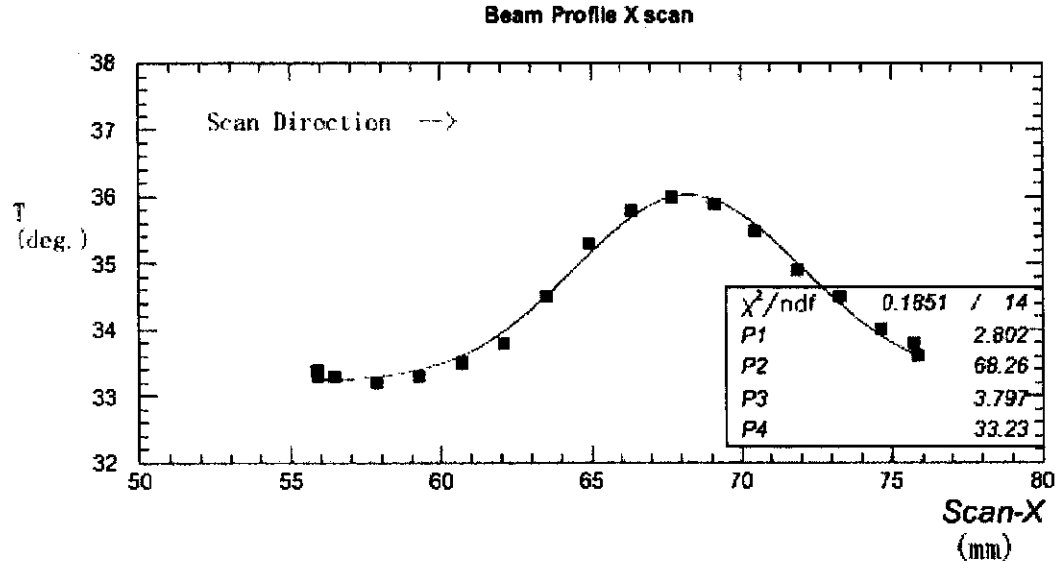
   X-scan ; 400sec./round trip
   (20mm span)
   (0.1mm/sec.)

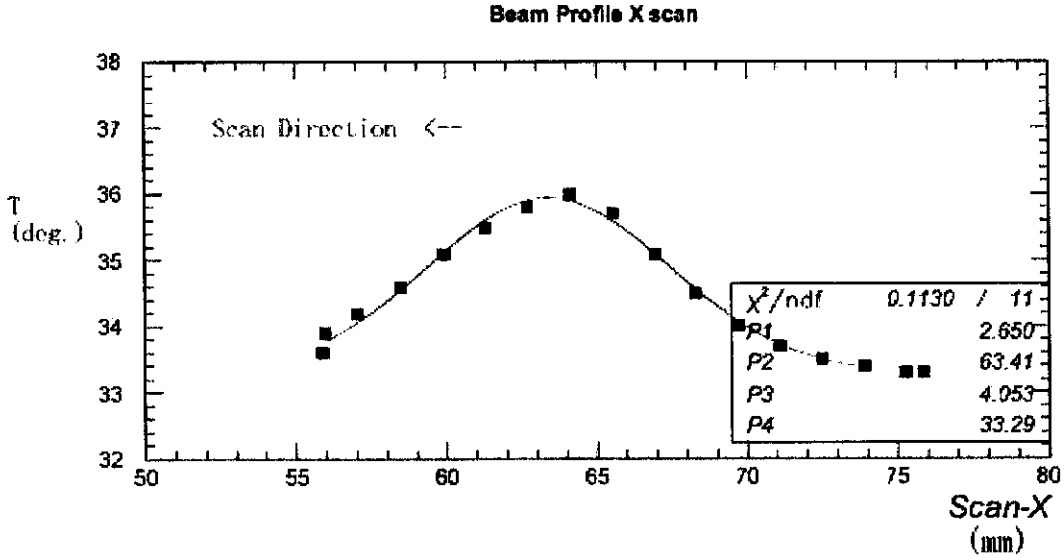
   Y-scan ; 560sec./round trip
   (9mm span)
   (0.03mm/sec.)

2. **Differential Measurements**

   Measure temperature difference between two needles.

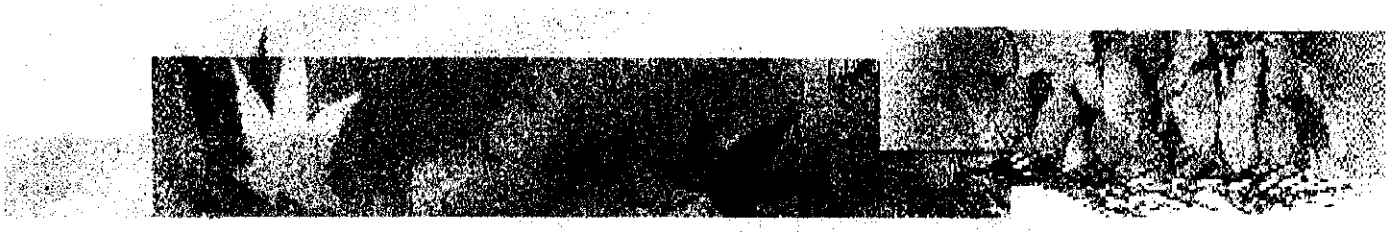
3. **Cu needle ⇒ Higher Intensity**
4. **Multi-needle Measurements**

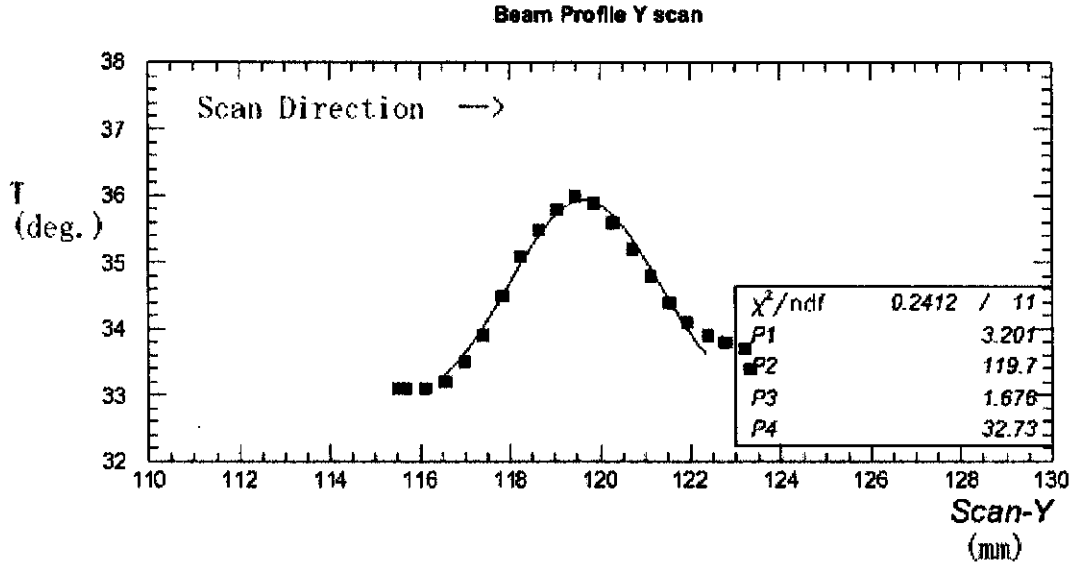


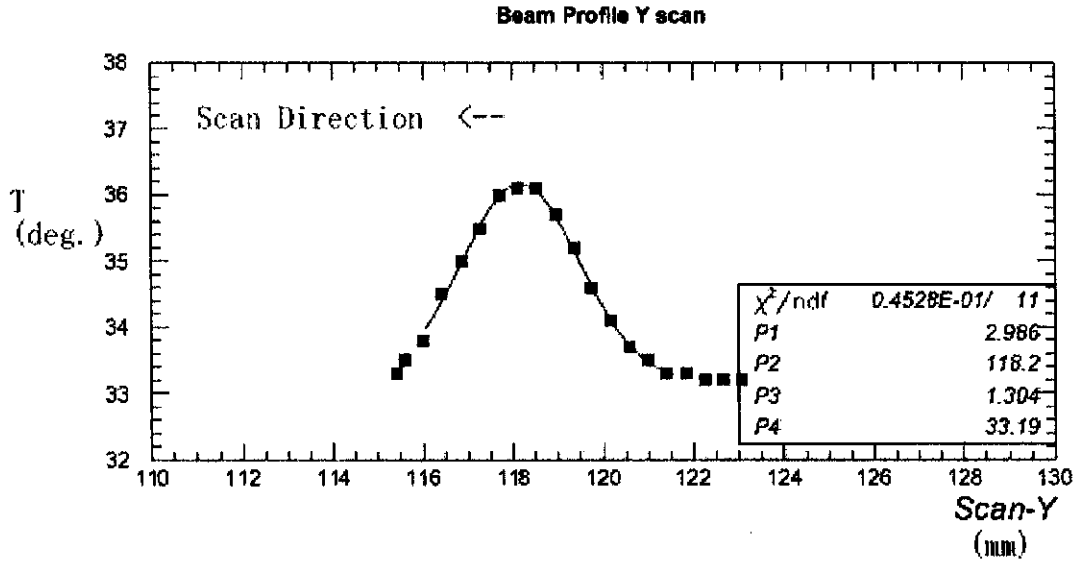


Average Peak = 65.8mm (same with precise measurement)

Width = 4mm (20% larger)



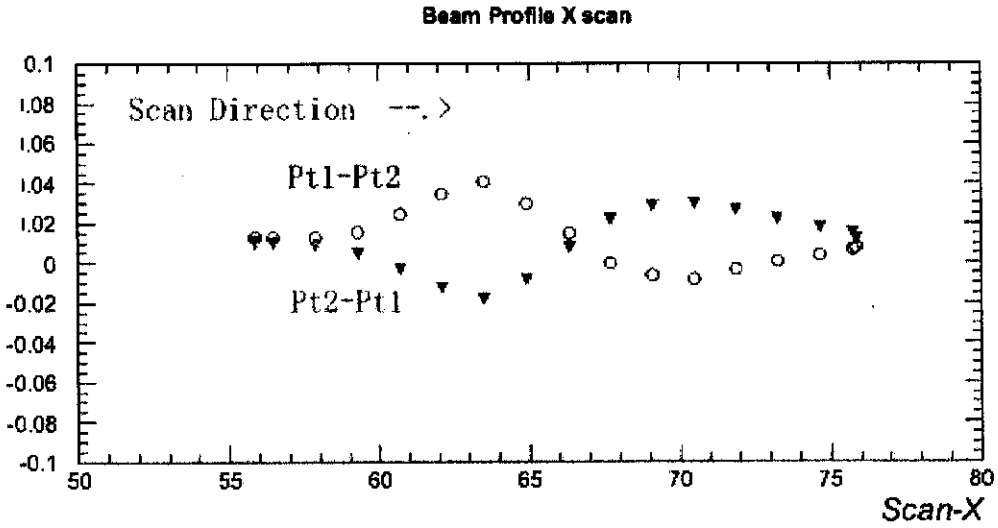


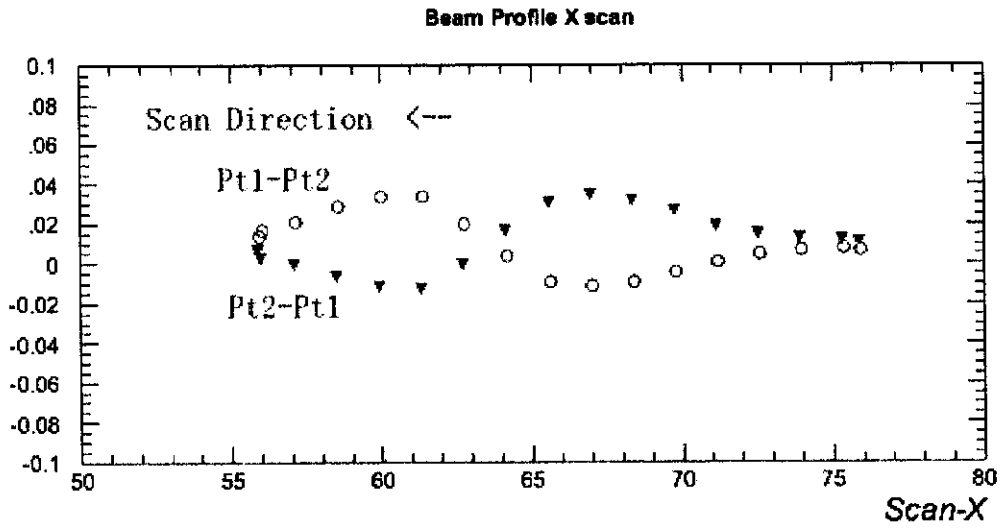


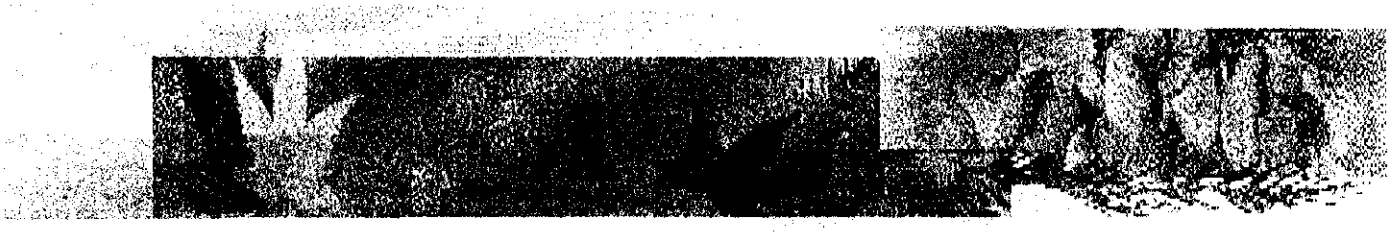
Average Peak = 119,9 (same as precise scan)

Width = 1.3mm (same as precise scan)

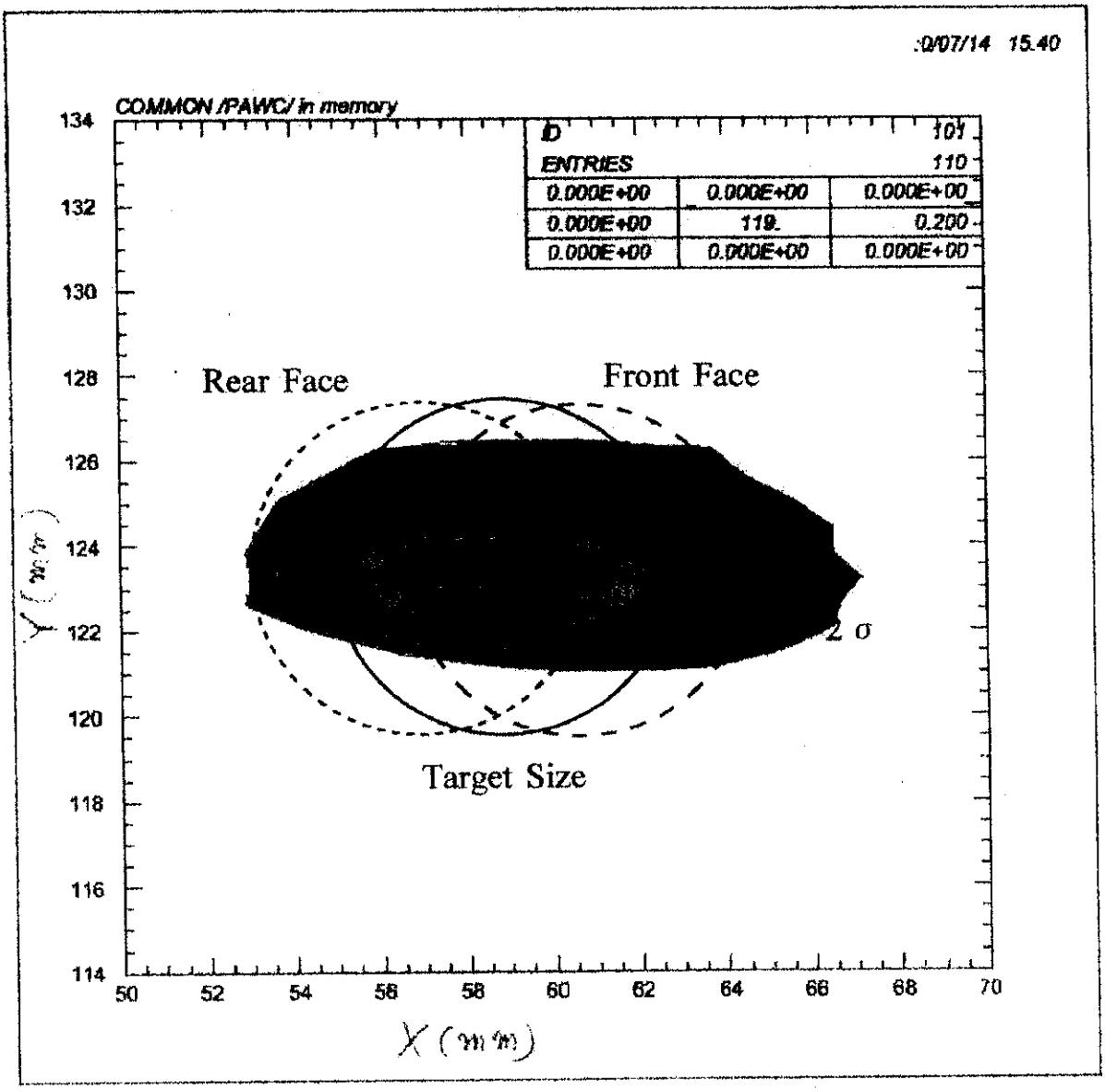
Temperature Difference between two needles (2mm)

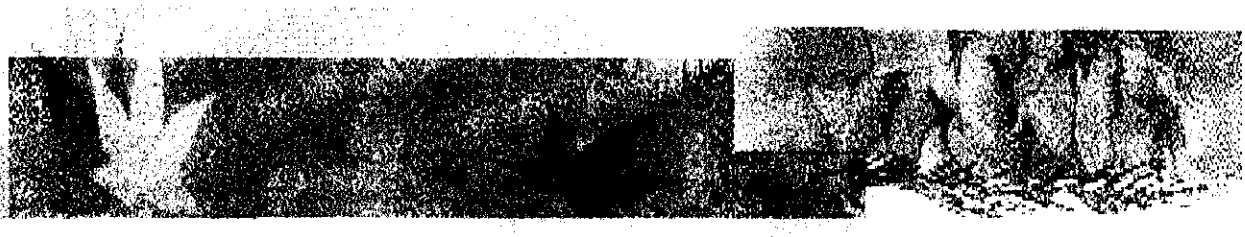






Beam Profile at EP2-C Target





4. Summary

- **The Target Monitor System with Thermocouples were tested.**
- **Real time Target Monitor with this system is now used at newly constructed K0 Beam Line.**
- **Two dimensional Beam profile at the Target position was measured for the first time at KEK 12GeV-PS. And this system is also used at K0 Beam Line**
- **The speed up of the measurements is being studied.**