BUNCH FEEDBACK SYSTEMS
&
RELATED SYSTEMS

KEKB Accelerator Review

5 March 1988

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1. Introductory comments
2. a low-Q cavity for long. kicker
3. status of hardware construction
4. Related systems
5. Installation
6. Control

Feedback-Related Machine Parameters

RF frequency	: 509 MHz
revolution frequency	: ~100kHz (h=5120)
# of bunches	: ~ 5000
minimum bunch spacing	: ~2ns (f_{bunch}=~250MHz)
betatron frequency	: 5kHz~45kHz
synchrotron frequency	: ~1kHz
radi. damp. time (long)	: 23ms
bunch current	0.5mA/0.2mA (LER/HER)

Feedback Components

- Specially designd button electrodes

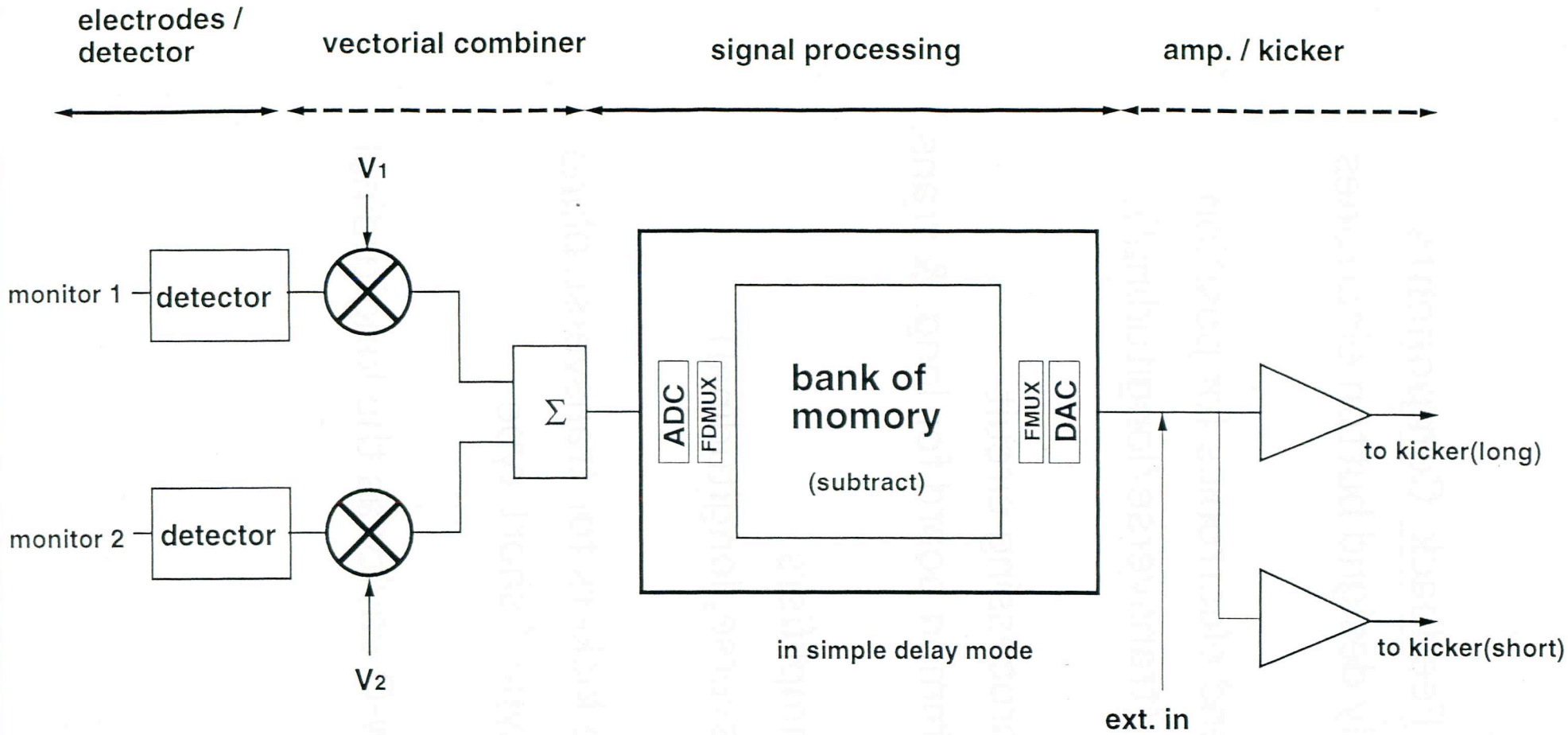
- Front-end electronics for position detection (transverse/longitudinal)

- Signal processing circuit
  (a common board for long. & trans.)

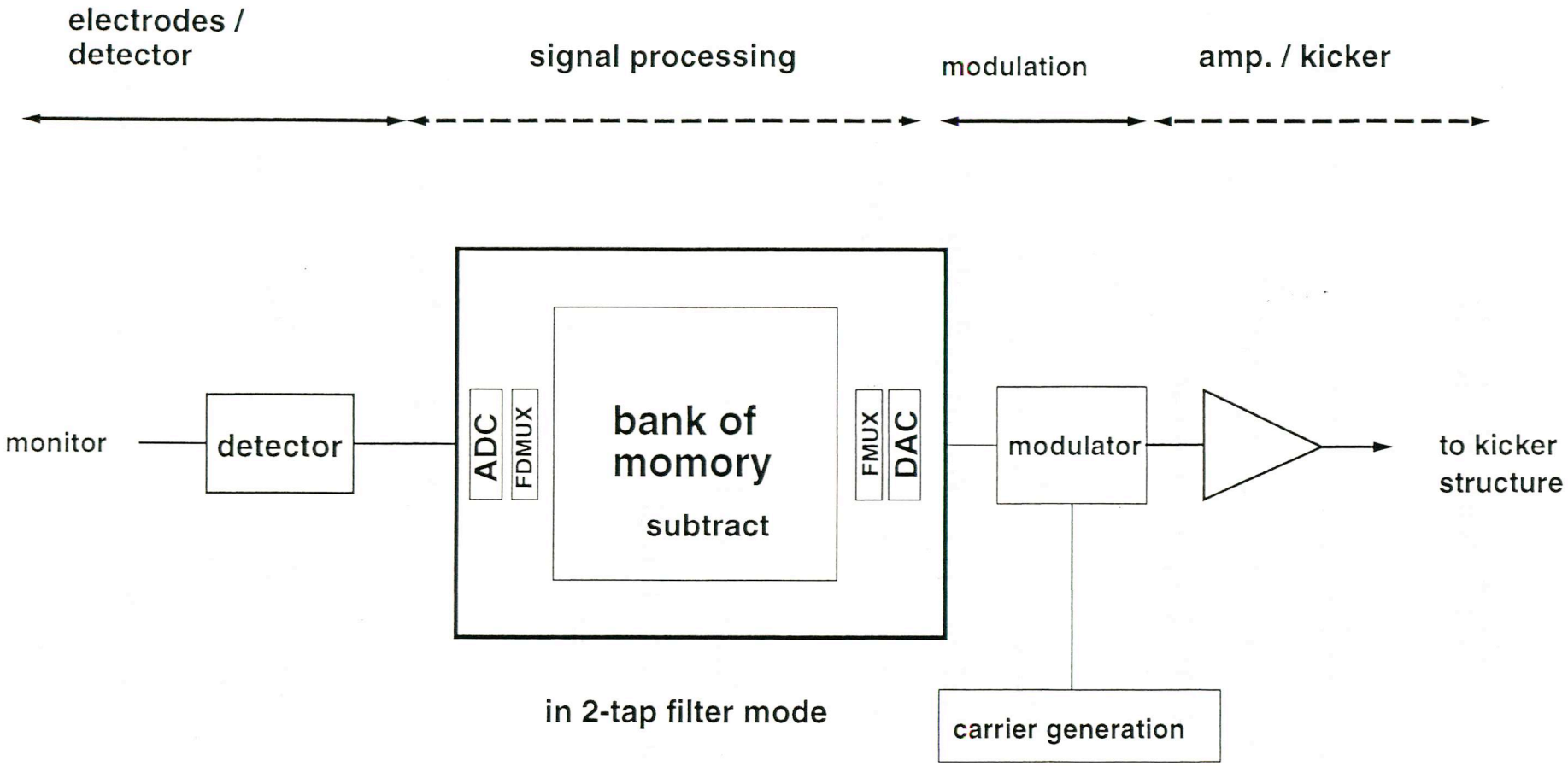
- Power amplifiers
  (transverse, longitudinal)

- Stripline kickers for transverse plane
  long type / short type

- Very low-Q cavity as the longitudinal kicker



Blockdiagram of the Transverse Feedback System



Blockdiagram of the Longitudinal Feedback System

On the longitudinal kicker .....

Since the last KEKB accelerator reviews held in the last year, we have not made big modifications on the feedback design.

But we decided to use the *very low-Q cavities* (like those in used in DAΦNE) for the longitudinal kicker in the commissioning.

The drift-tube kicker is the second candidate for the kicker.

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comparison of the two types of the kicker

	drift tube	low-Q cavity
shunt imp.	~320Ω	~600Ω
structure	complex	less complex

Modification of the DAΦNE-type Kicker

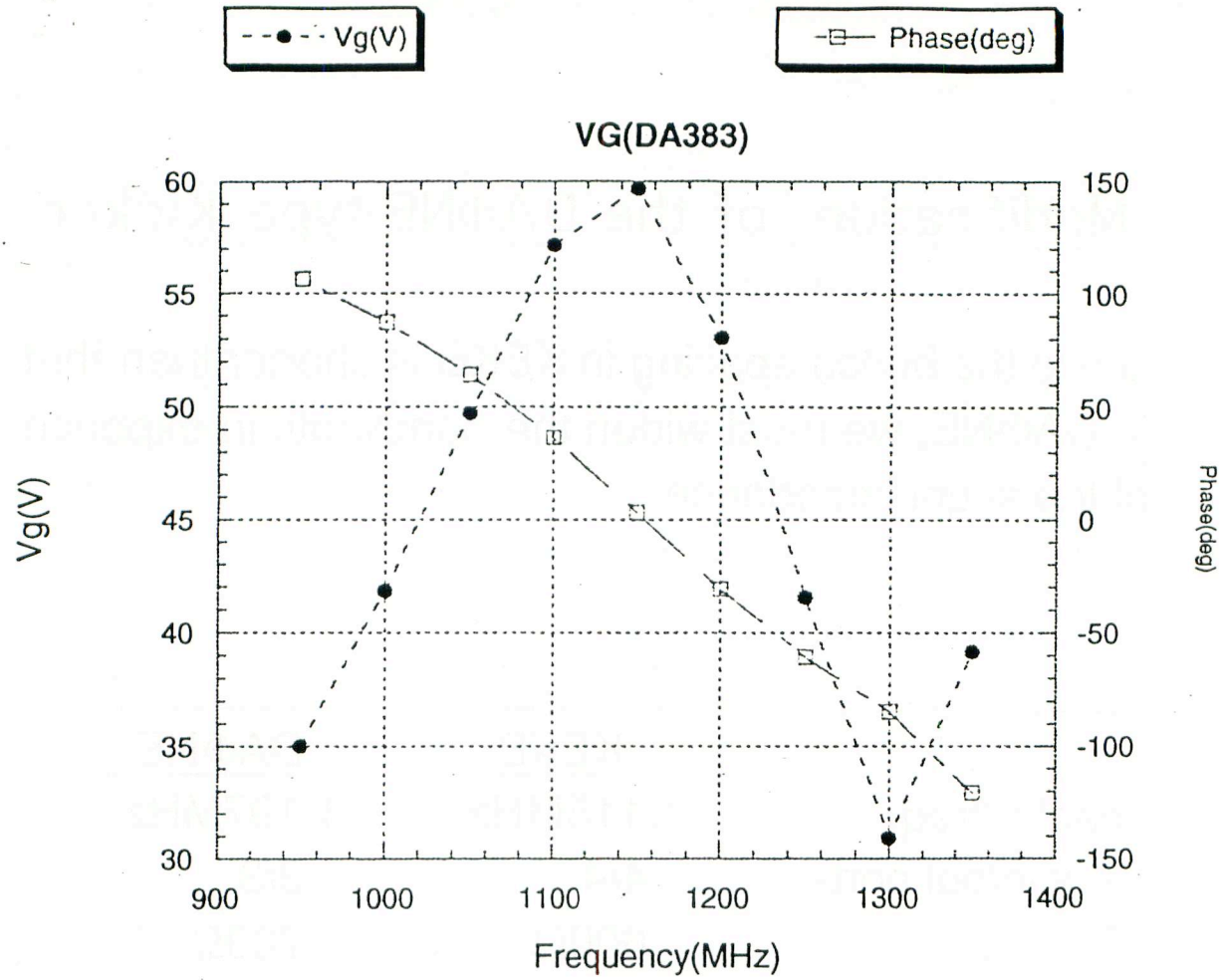
Since the bunch spacing in KEKB is shorter than that in DAΦNE, we must widen the bandwidth in expence of the shunt impedance.

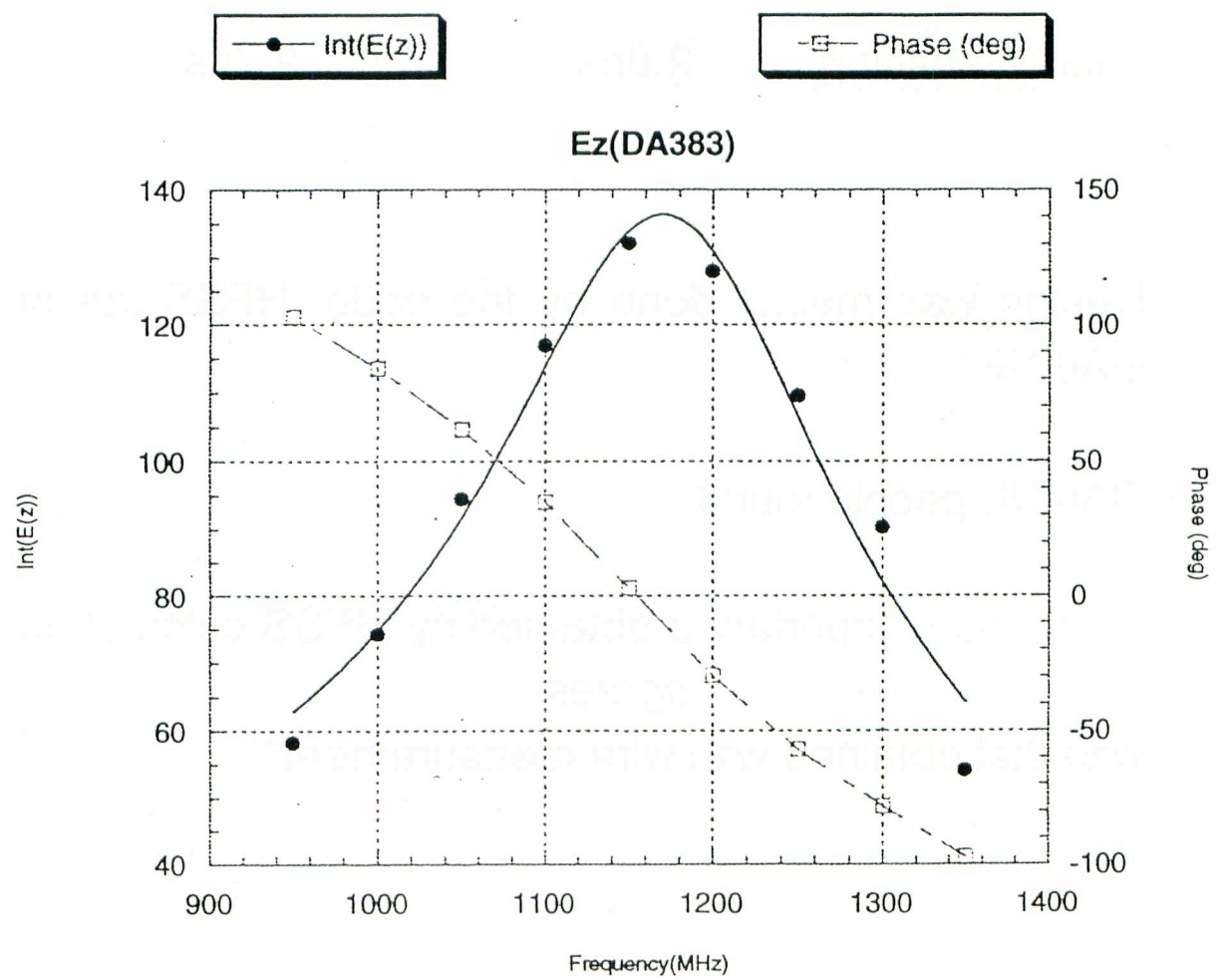
	KEKB	DAΦNE
center freq.	1.115MHz	1.197MHz
# of in/out ports	4/4	3/3
R_s	600Ω	780Ω
Q	~5	~7
bunch spacing	2.0ns	2.7ns

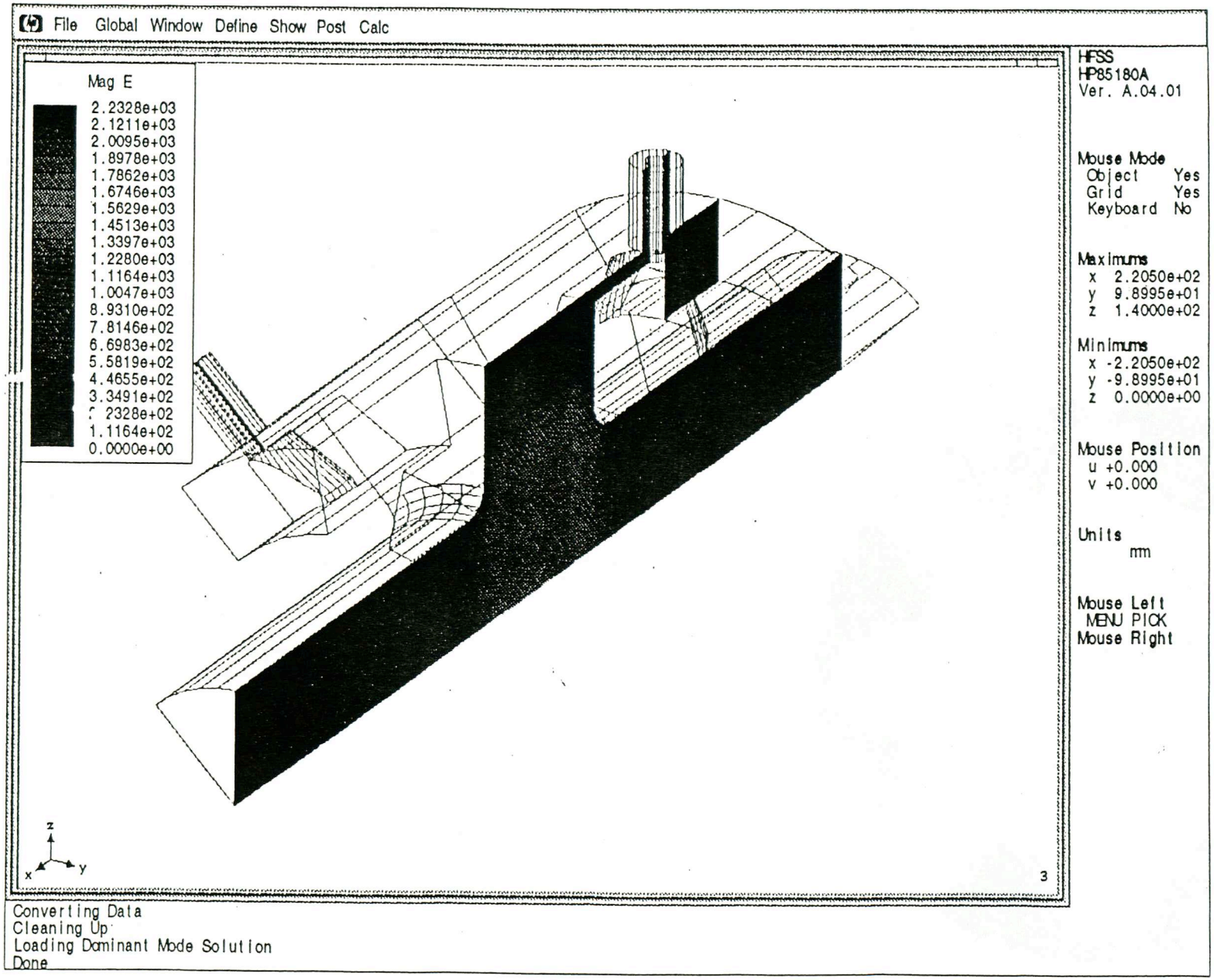
Design was mainly done by the code, HFSS, as in DAΦNE.

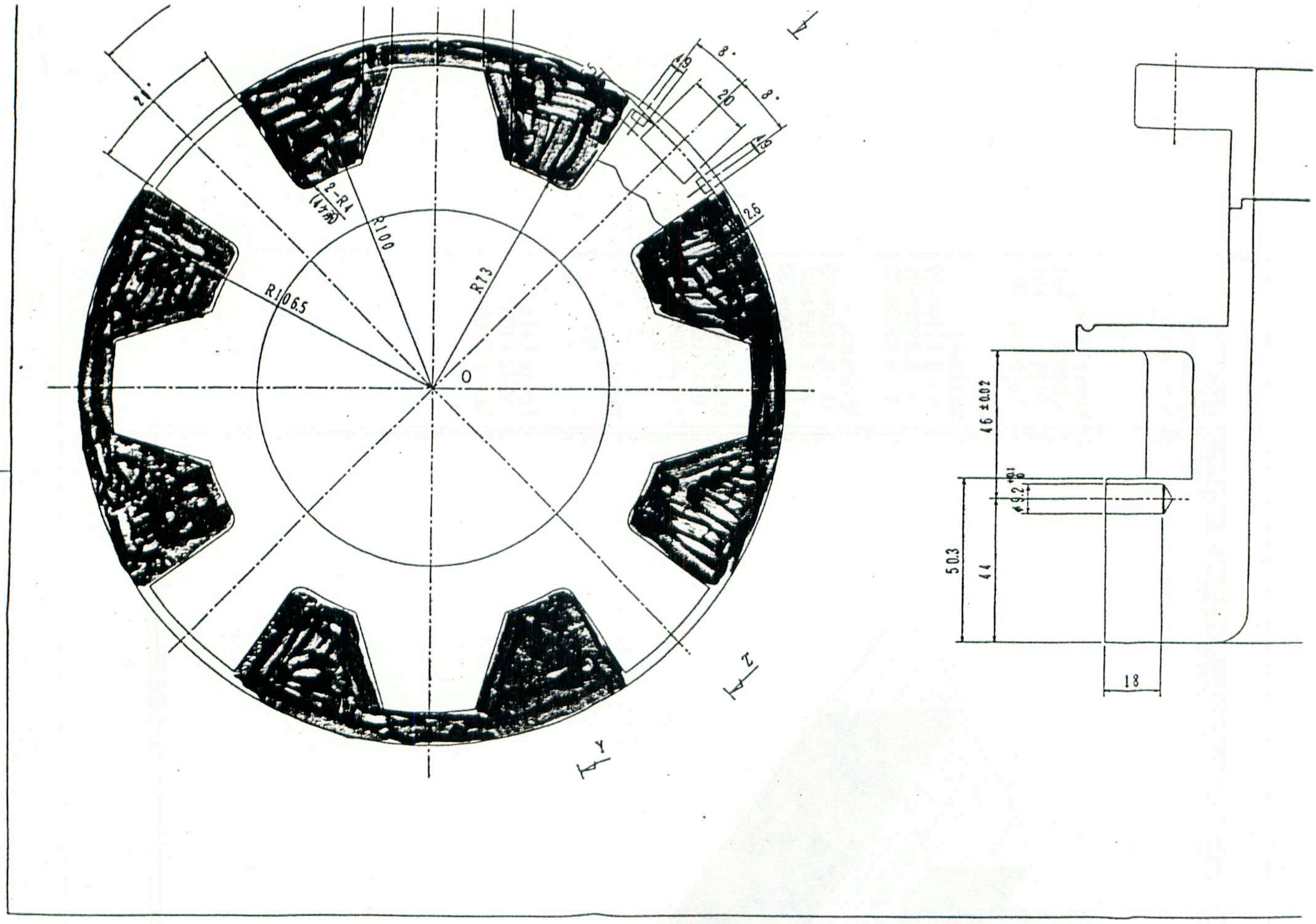
DAΦNE people found

" the shunt impedance obtained by HFSS calculation *agrees* with that obtained with wire measurement".

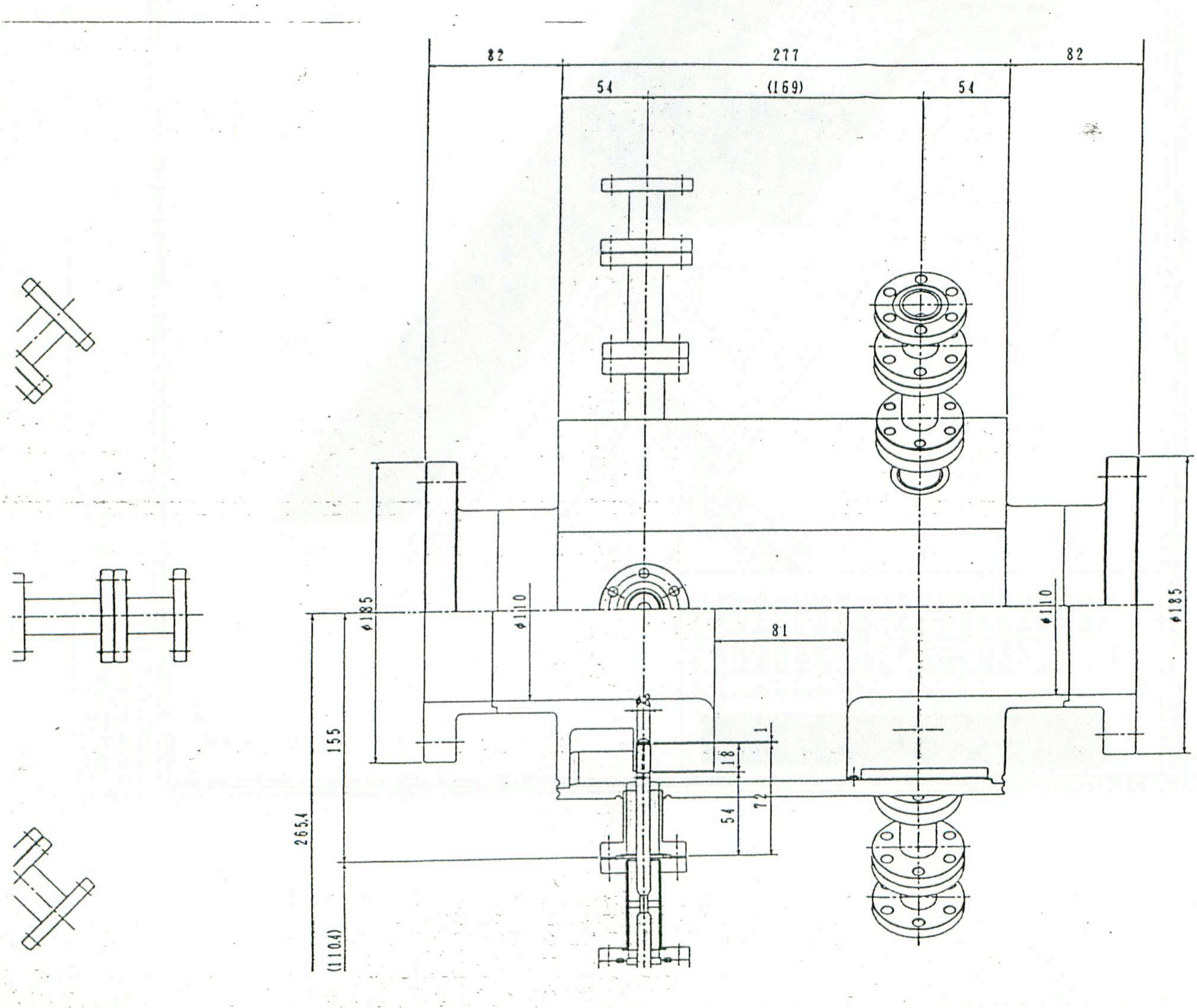

Vg(V)
Phase(deg)
VG(DA383)
Vg(V)
Phase(deg)
Frequency(MHz)
60
55
50
45
40
35
30
150
100
50
0
-50
-100
-150
900
1000
1100
1200
1300
1400


Int(E(z))
Phase (deg)
Ez(DA383)
Int(E(z))
Phase (deg)
Frequency(MHz)
140
120
100
80
60
40
150
100
50
0
-50
-100
900
1000
1100
1200
1300
1400

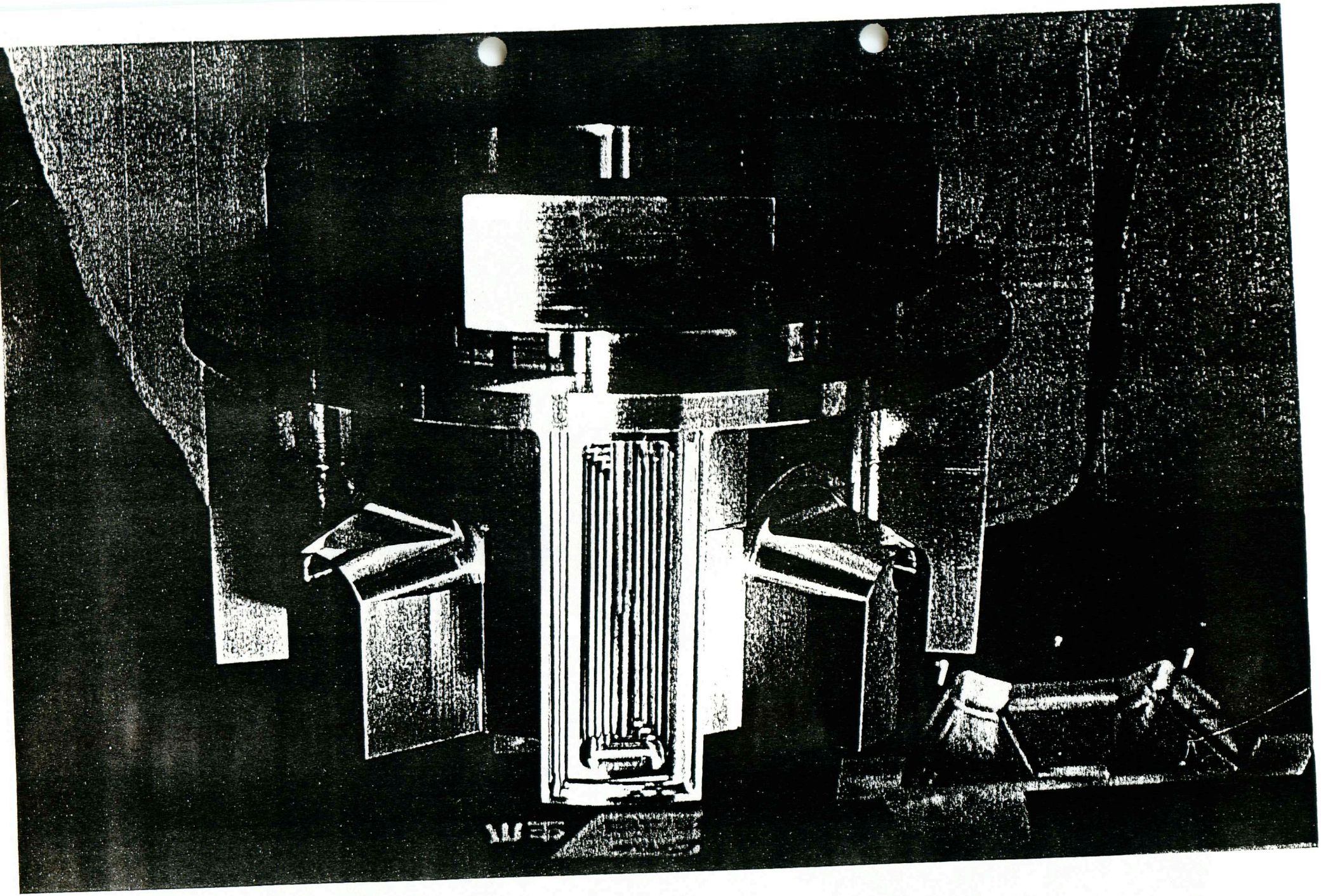

File Global Window Define Show Post Calc
Mag E
2.2328e+03
2.1211e+03
2.0095e+03
1.8978e+03
1.7862e+03
1.6746e+03
1.5629e+03
1.4513e+03
1.3397e+03
1.2280e+03
1.1164e+03
1.0047e+03
8.9310e+02
7.8146e+02
6.6983e+02
5.5819e+02
4.4655e+02
3.3491e+02
2.2328e+02
1.1164e+02
0.0000e+00
z
x
y
3
HFSS
HP85180A
Ver. A.04.01
Mouse Mode
Object Yes
Grid Yes
Keyboard No
Maximums
x 2.2050e+02
y 9.8995e+01
z 1.4000e+02
Minimums
x -2.2050e+02
y -9.8995e+01
z 0.0000e+00
Mouse Position
u +0.000
v +0.000
Units
mm
Mouse Left
MENU PICK
Mouse Right
Converting Data
Cleaning Up
Loading Dominant Mode Solution
Done



R106.5
R100
R73
O
2-R4
20
2.6
Y
Z
46 ±0.02
50.3
44
18



82
277
82
54
(169)
54
φ185
φ110
81
φ110
φ185
155
18
54
72
265.4
(110.4)



Present Status of the Hardware construction

- vacuum componets
  under fabrication -- will complete at the end of March
  (by the end of this fiscal year)

- power amplifiers
  transverse (higher/wide band)
  : will be delivered by comming summer
  transverse (lower/narrow band)
  : will be deliverd by the end of March
  longitudinal
  for 1 kicker (4 amplifiers)
  : will be delivered by the end of March
  others: by comming summer

Present Status of the Hardware construction (cont'd)

- Signal processing electronics

2-tap filter	4(completed)+4(summer)
memory board	5(completed)+4(summer)

- low level electronics parts

  waiting for delivery at present

  April ~ start assembling

Feedback-Related Systems

1. Tune monitors

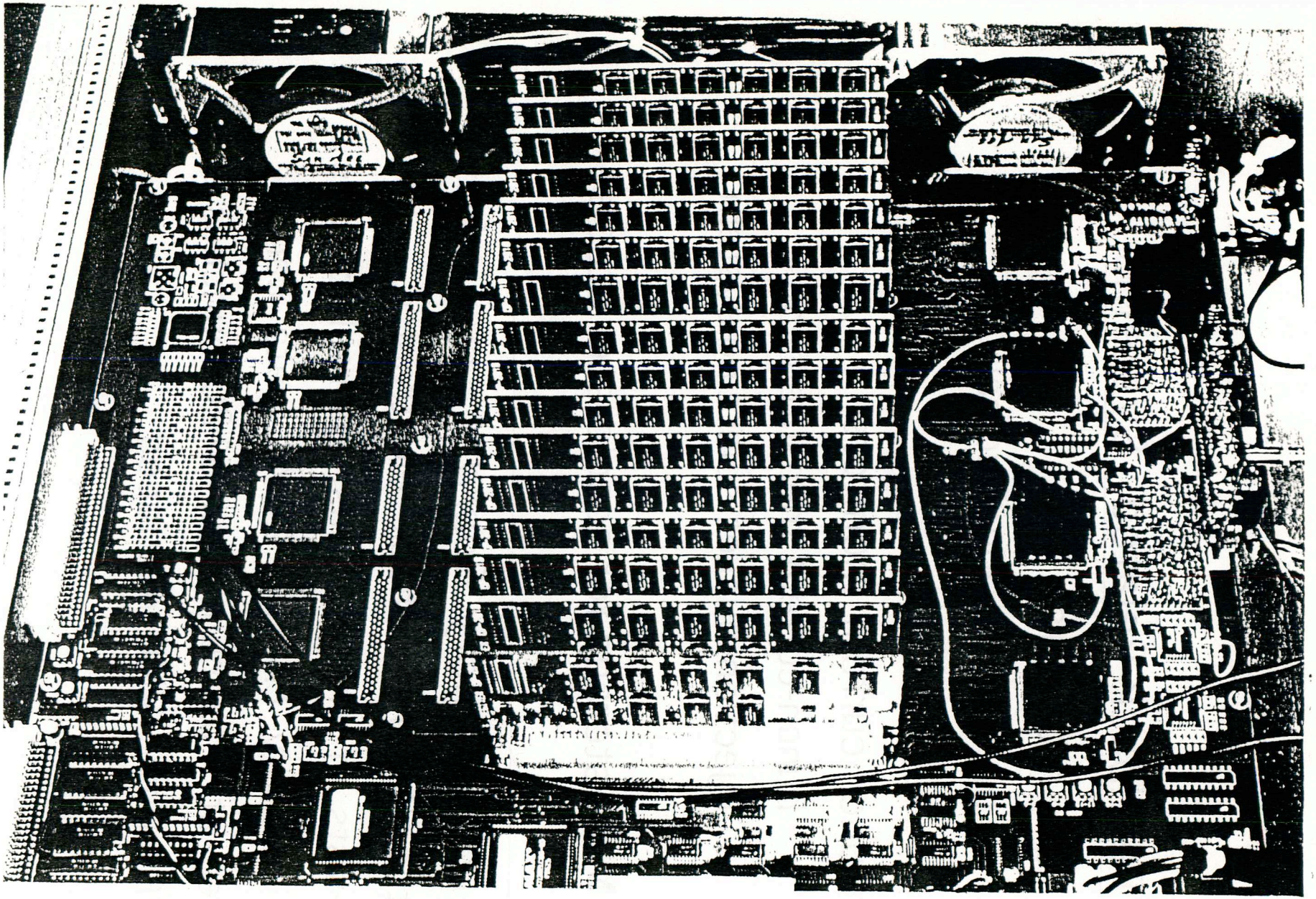
   transverse, (longitudinal)

2. Bunch current monitors

   bunch-current measurement +
   injection-bucket selecting system

3. Mass storage for accelerator studies

We use *"Memory Board"*, a by-product of the Bunch-feedback electronics. It con-sists of an ADC, fast de-multiplexers and memory chips. 20MB data can be stored at maximum, i.e., 5120 bunches x 4096 turns. VME-interfaced.



Tune Measurements

◆ Excitation

exciting betatron oscillation through the feedback kicker

source : a spectrum analyzer (+ tracking generator)

◆ Observation

-- Data from the spectrum analyzer

-- FFT analysis of the *bunch-by-bunch* position information stored in the memory board * (256~1024 tunrs)

* We also prepare the momory boards for the longitudinal tune mesurement.

Bunch Current Monitor

Front-end circuit + Memory board

- Front-end circuit is essentially the same as the longitudinal pickup for the feedback (phase of the reference signal is shifted)
- An output of the front-end is A-to-D converted、Resolution : 8 bit
- Only relative value is obtained: absolute value is calibrated with the DCCT data
- can measure the current every 2 nsec

(6 4 or 1 2 8 turn-average)

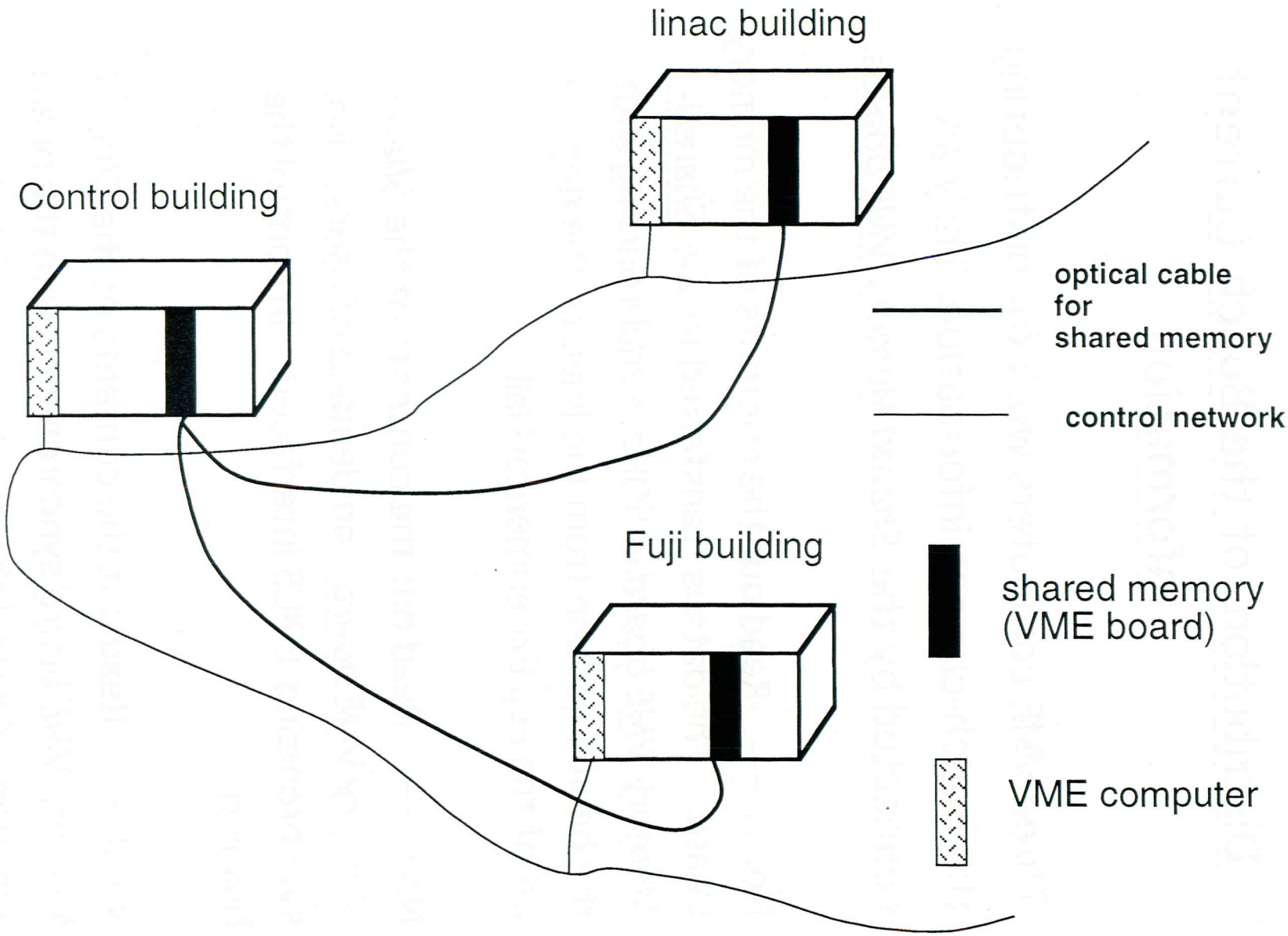
Distribution of the Bunch Current Information

Three VME computers work for distributing the bunch-current information. They are connected by the *Shared Memory VME boards.*

No. 1. --- Read out the contents of the memory board. The data is transferred to the *Shared-Memory VME board* in 50Hz, synchronizing with the beam injection from the linac to the ring. In B4 of the Fuji Experimental Hall.

No2. --- Read out the contents of the *Shared Memory VME board* on demand of users. Non synchronizing. EPICS interfaced. In control the building.

No. 3 --- Read out the contents of the *Shared Memory VME board* synchronizing with the beam injection. Control the injection timing (select ring-bucket). In the linac building.



KEKB bucket selection system

The Shared Memory System

Double-height VME modules connected with optical fiber cables.

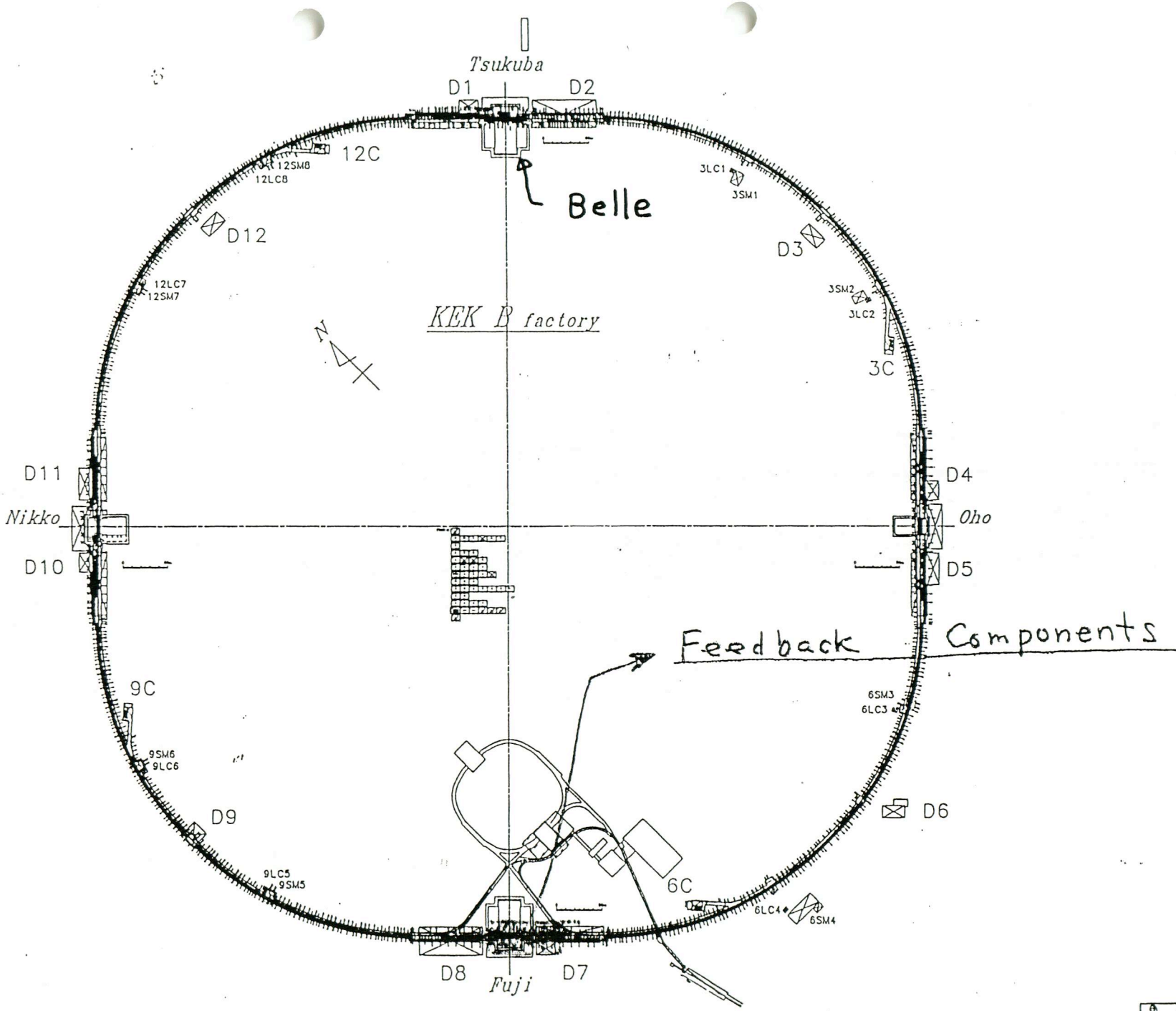
bit rate	: 250 Mbit/s
max. # of nodes	: 255
max. distance	: 1000 meters
memory capacity	: 128 Mbytes ~ 8 Mbytes

by Advanet Inc. Japan

Installation

All the feedback components is installed in Fuji Experimetal Hall (or near) , which is the opposite position to the Tsukuba Exp. Hall for the Belle Detector.

-- Beam line is in the B3 level
-- Electronics (low-level and high power) are set in the B4 level


Tsukuba
D1
D2
12C
12SM8
12LC8
Belle
3LC1
3SM1
D12
D3
12LC7
12SM7
KEK B factory
3SM2
3LC2
3C
N
D11
D4
Nikko
Oho
D10
D5
Feedback
Components
9C
6SM3
6LC3
9SM6
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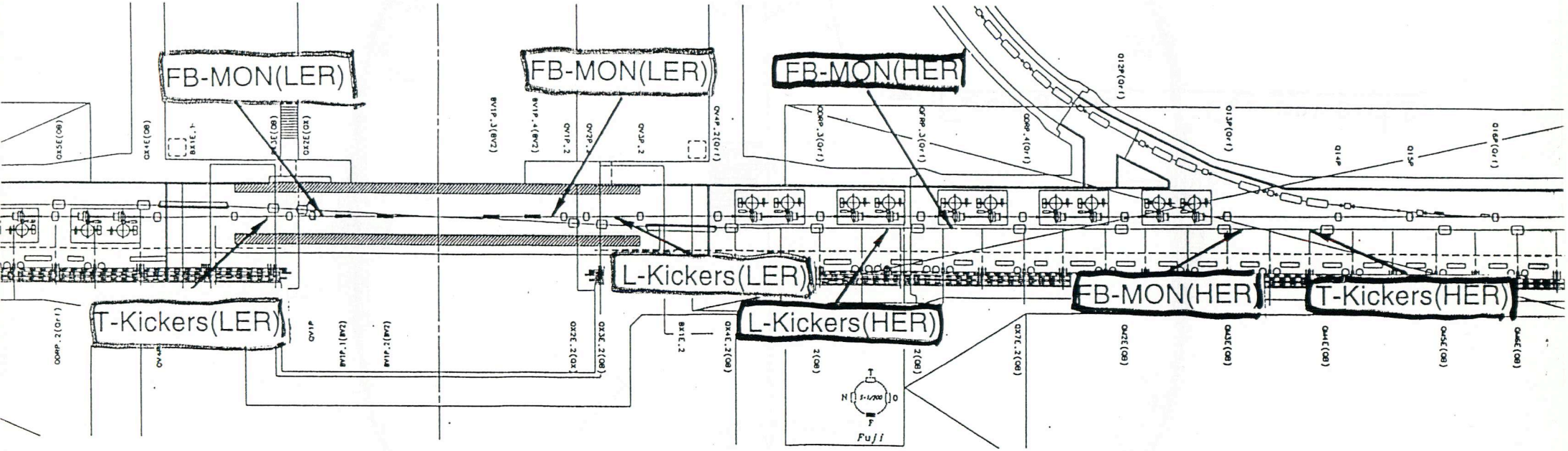
6C
6LC4
6SM4
D8
Fuji
D7

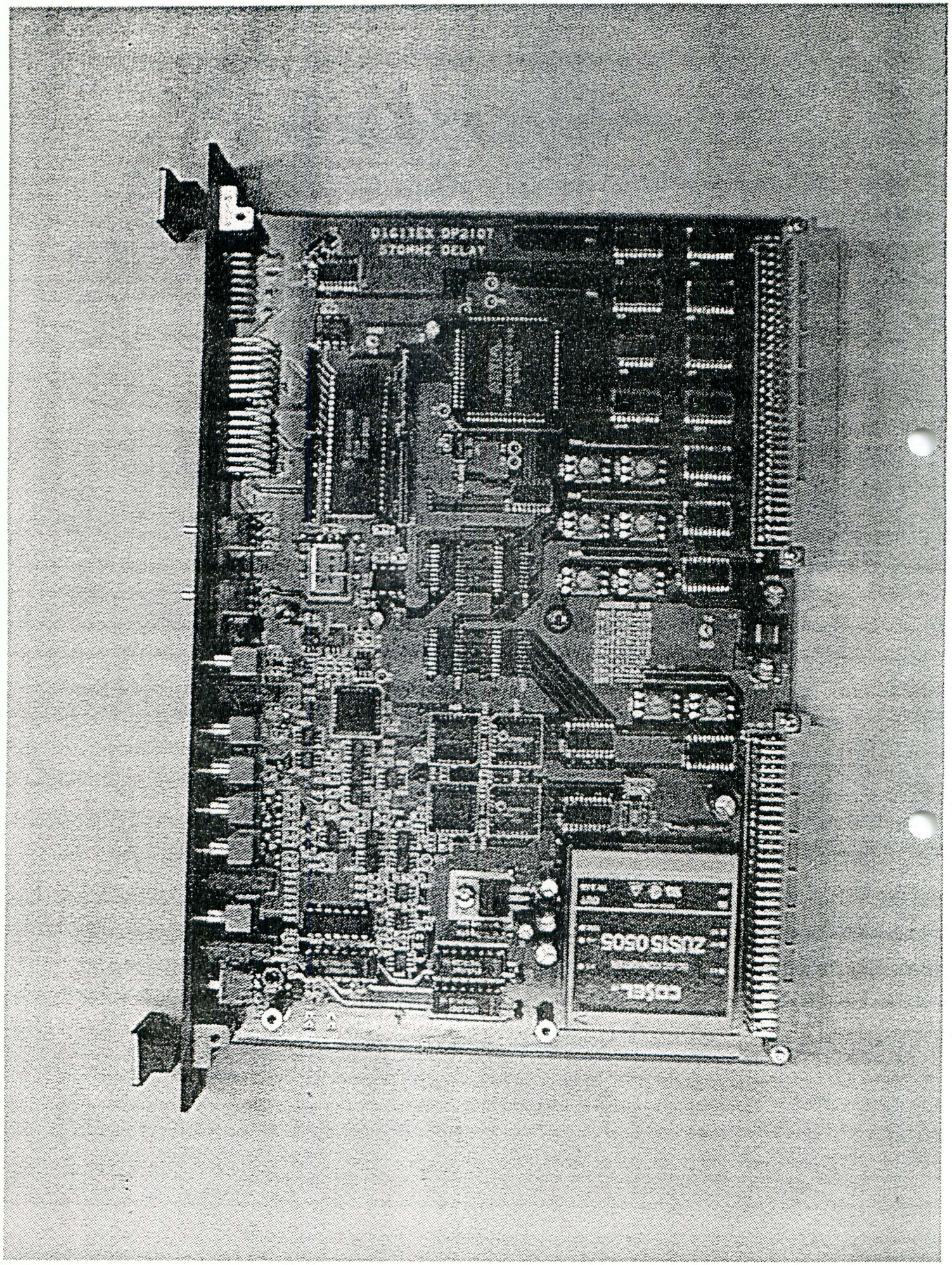
富士実験室

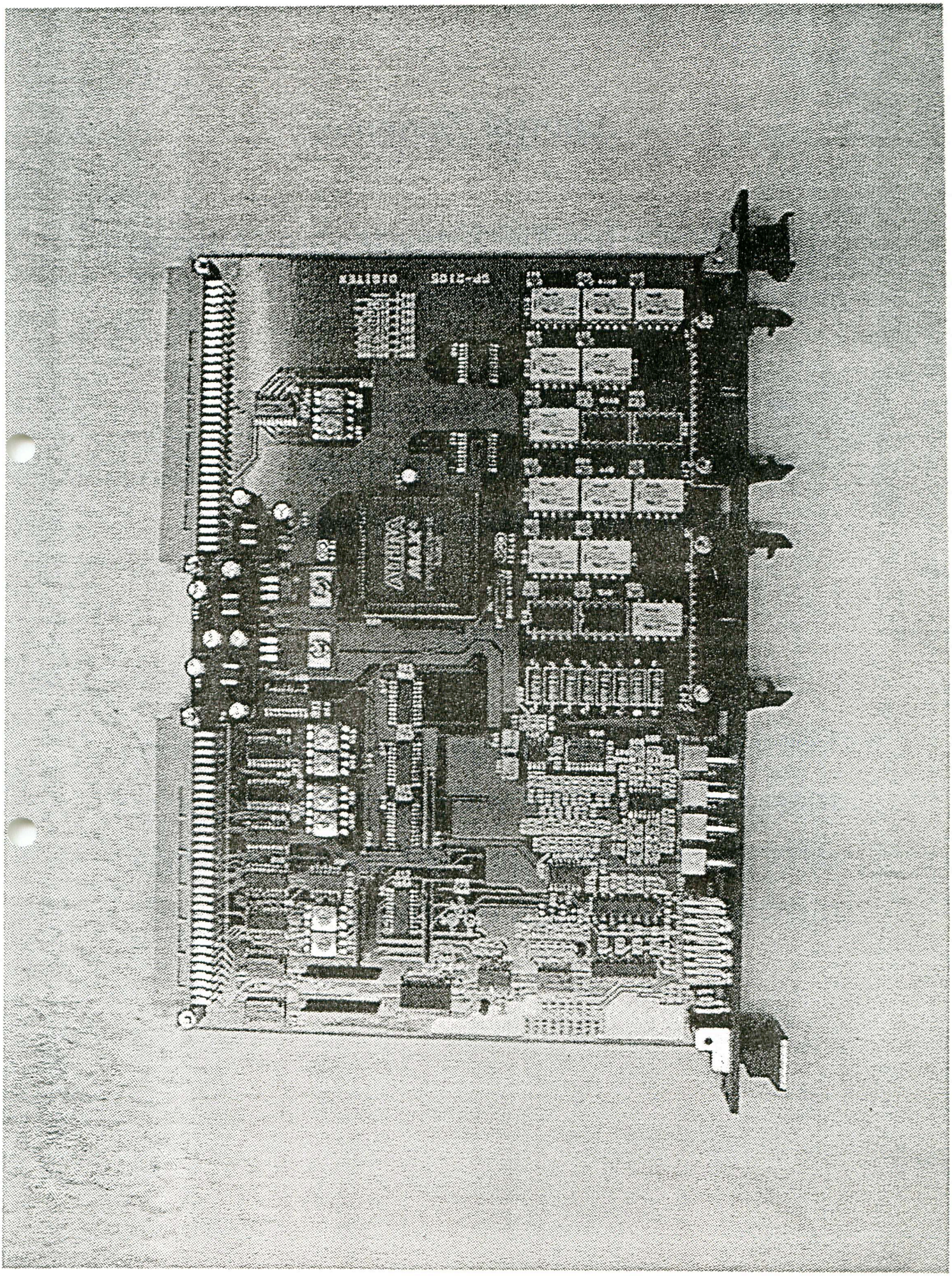

FB-MON(LER)
FB-MON(LER)
FB-MON(HER)
L-Kickers(LER)
T-Kickers(LER)
L-Kickers(HER)
FB-MON(HER)
T-Kickers(HER)
Fuji

Control Software

Hardware Components to be accessed:

- Two-tap Filter Boards *and* Memory Boards (VME)
- Power-amplifier controllers (VME)
- Digital delay modules, "*TD4V*" (VME)
- Spectrum analyzers (GPIB)
- Recorders for monitoring temp. etc. (GPIB)


DIGITEX DP210T
STORAGE DELAY



Control Scheme

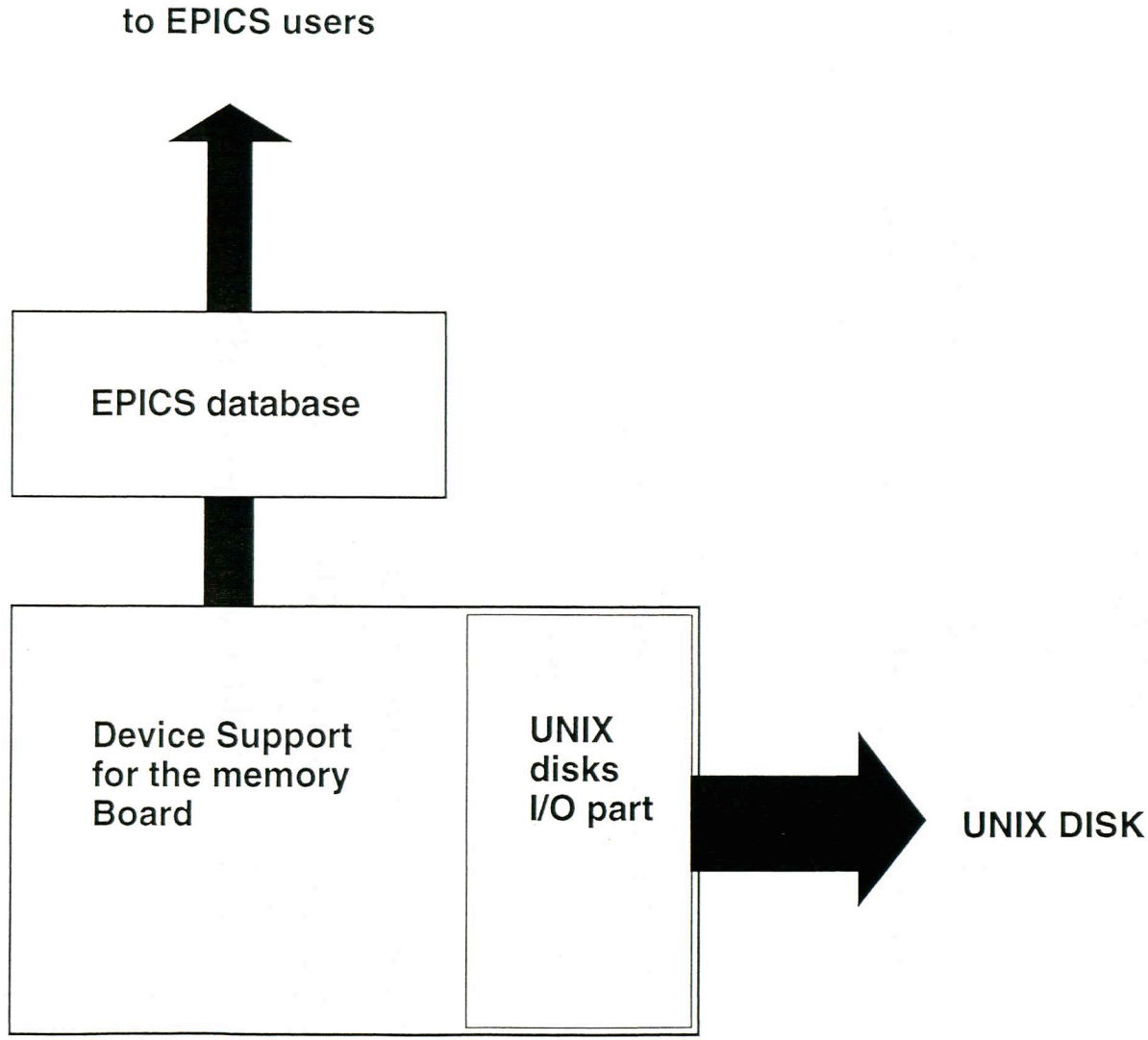
Basically the feedback devises are controlled under the EPICS environment.

➡ need to code " device support"

➡ need to code user interface
(MEDM or other interface)

but

For date with very large size (stored in the memory board), we will prepare tools for directly-accessing the UNIX data files. This is outside of the EPICS environment


to EPICS users
EPICS database
Device Support
for the memory
Board
UNIX
disks
I/O part
UNIX DISK

Summary

1. We adopt the low-Q cavity as the longitudinal kicker, because of its higher shunt impedance.

2. All the feedback components will be delivered by the comming summer.

3. Design of the bunch-current monitor and the tune meter ended. Their construction is in progress in parallel with the feedback components.

4. All the feedback component will be installed in the Fuji building. Preparation for the installation is in progress.

5. Development of the software is in progress.

Band Asignment of the Transverse Feedback Systems

5 kHz ~ 1MHz	200W amp.	1.2 m kicker
5k Hz ~ 250MHz	250 W amp.	40cm kicker