

① Load Impedance of
an Output Cavity.

② On the difference
between
Two Output Ports.

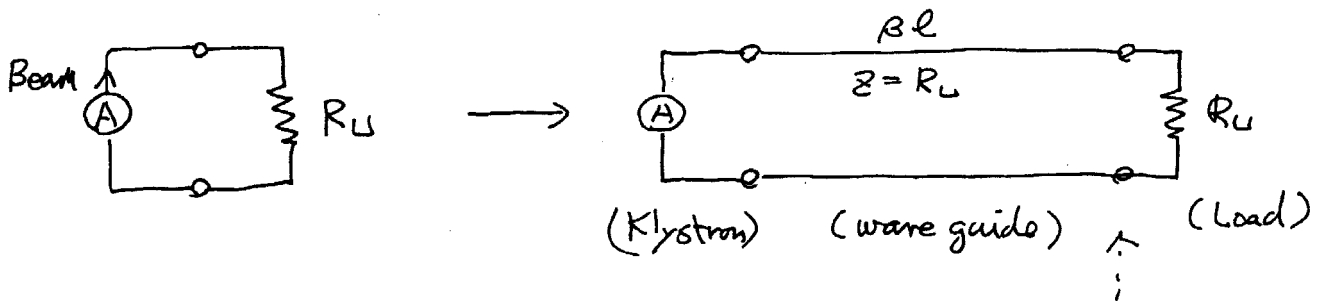
2000/Nov

ISG. Workshop
"KEK"

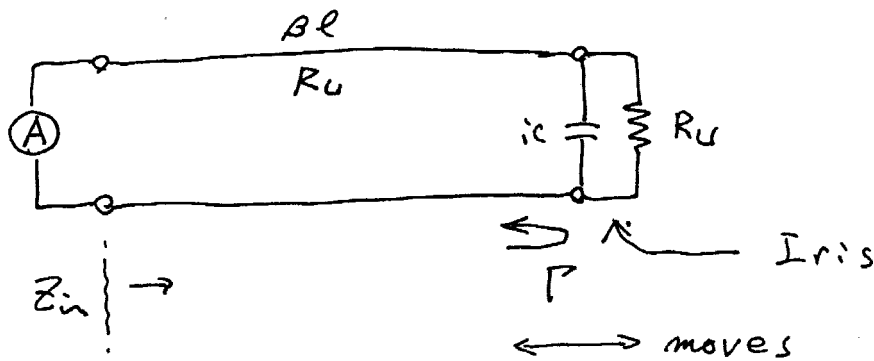
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K. Ohya
S. Tokumoto
S. Matsumoto
Y. Chi

Load Impedance of a Klystron Output-Cavity

On Resonance \rightarrow Pure Resistance.



with "Iris" (Reflection) Load Impedance changes.



$$Z_{in} = \frac{1 + \rho e^{i\theta}}{1 - \rho e^{i\theta}} = \frac{1 - \rho^2}{1 + \rho^2 - 2\rho \cos\theta} + j \frac{2\rho \sin\theta}{1 + \rho^2 - 2\rho \cos\theta}$$

Real Component " $R(\theta)$ ".

$$\text{Out Put Power "P"} = I_o^2 R(\theta)$$

This can be verified by "Low Power Out Put Condition"

"Low Power Output Condition"

⇒ Klystron RF current
as an "Ideal Current Source"

for Ex. 50 MW 500 kV Beam.

(KEK Klystron)



50 kW 500 kV Beam

RF Voltage $\left(\frac{50 \text{ kW}}{50 \text{ MW}}\right)^{\frac{1}{2}}$ smaller.

∴

$\frac{1}{30}$ of 50 MW case

Therefore this RF voltage is far smaller
than "Beam Voltage"
(Cathode Voltage)



Ideal Current Source

$$P = I^2 R$$

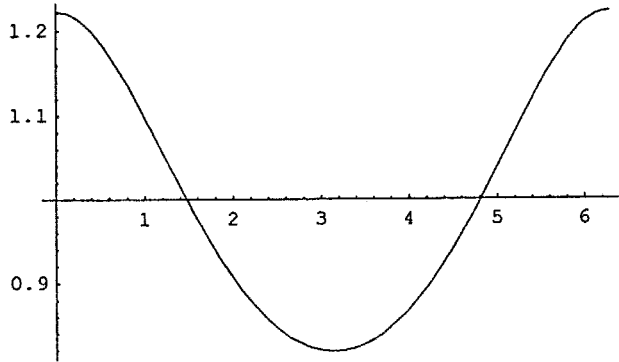
④

In[31]:= f[ρ_, θ_]

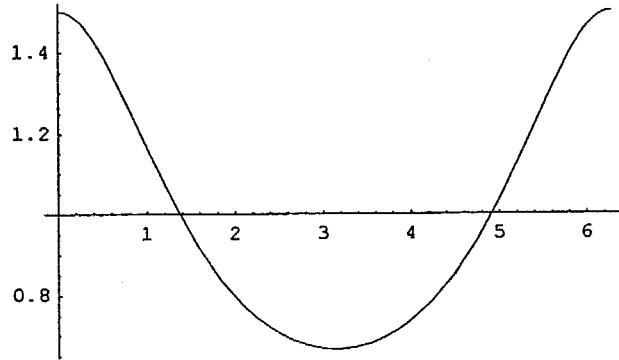
Out[31]= $\frac{1 - \rho^2}{1 - 2 \cos[\theta] \rho + \rho^2}$

In[32]:= f[ρ_, θ_] := $\frac{1 - \rho^2}{1 + \rho^2 - 2 \rho \cos[\theta]}$

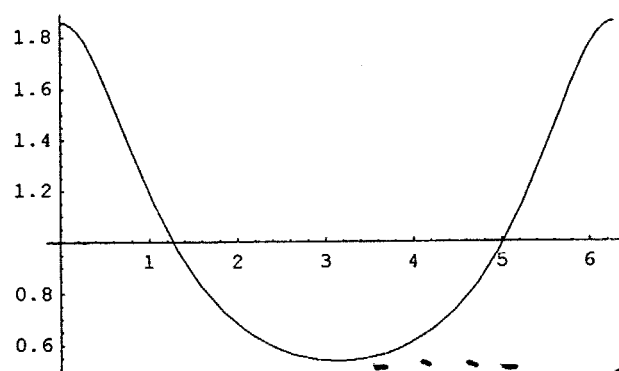
In[36]:= Table[Plot[f[ρ, θ], {θ, 0, 2 π}, PlotRange -> All], {ρ, 0.1, 0.9, 0.1}]



0.1



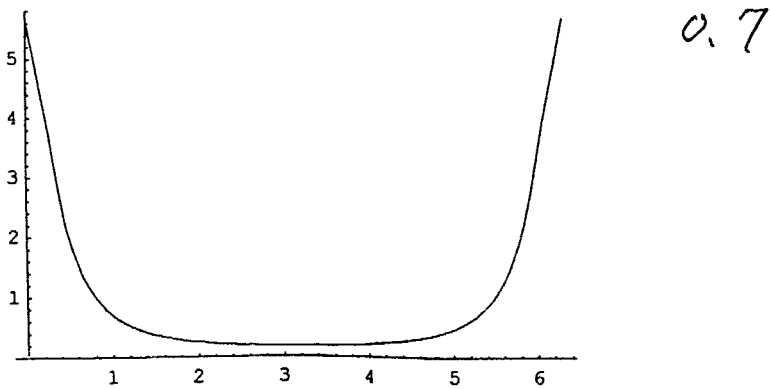
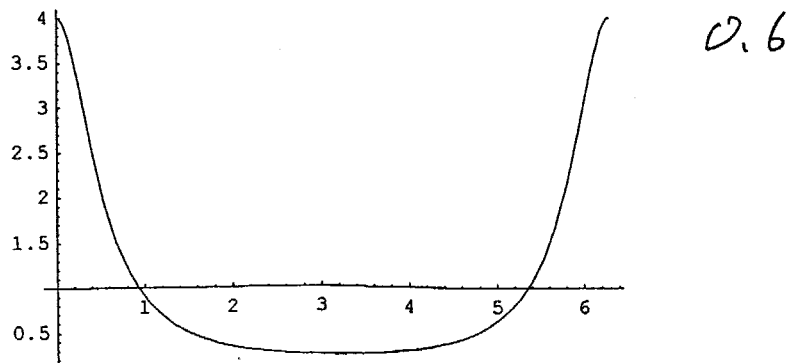
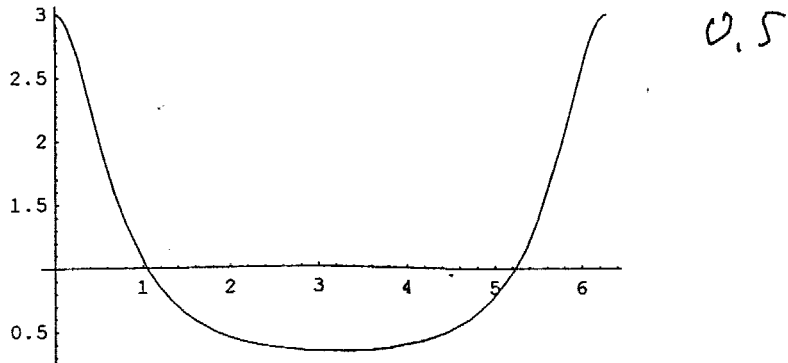
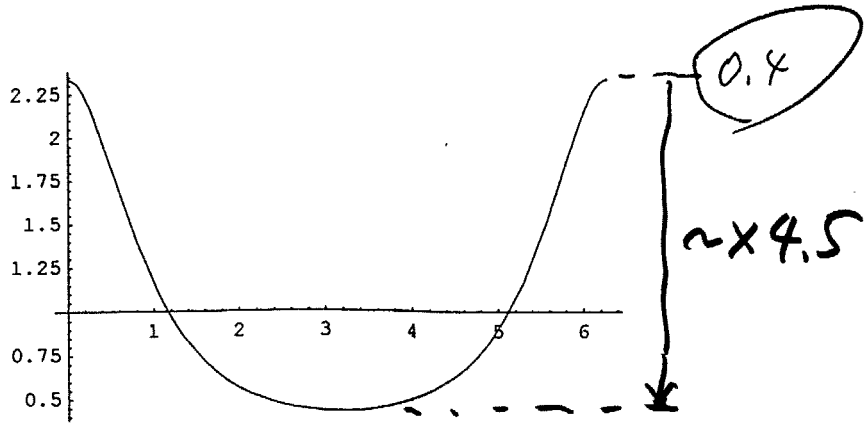
0.2



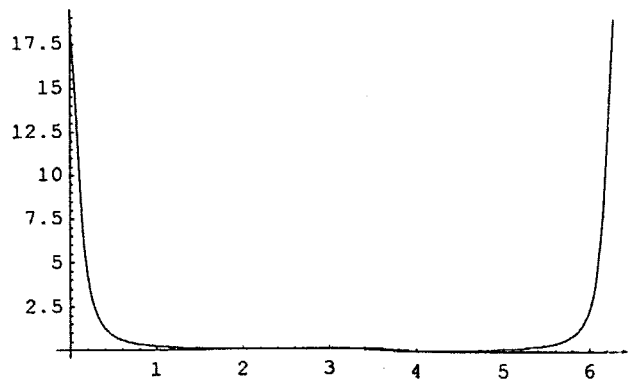
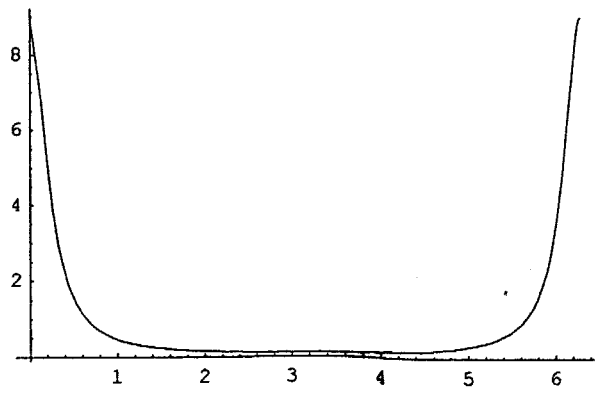
0.3

↑
~x3
↓

(5)



(6)



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Out[36]= {- Graphics -, - Graphics -, - Graphics -, - Graphics -,  
          - Graphics -, - Graphics -, - Graphics -, - Graphics -, - Graphics -}
```

● Low Power Measurement (~50 kW class)

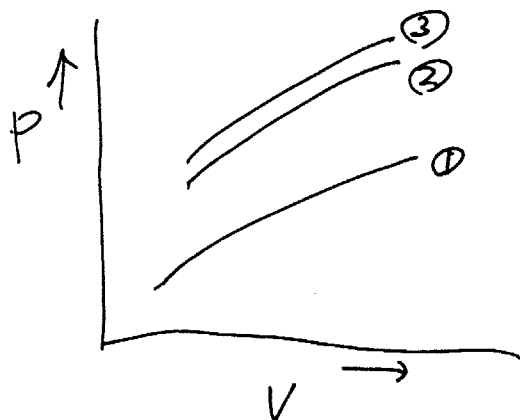
- Input Power → constant
- Iris Position* → every 2mm
(0 ~ 16mm Relative Position)
- Low Power Wave Guide set up
(see "Picture")



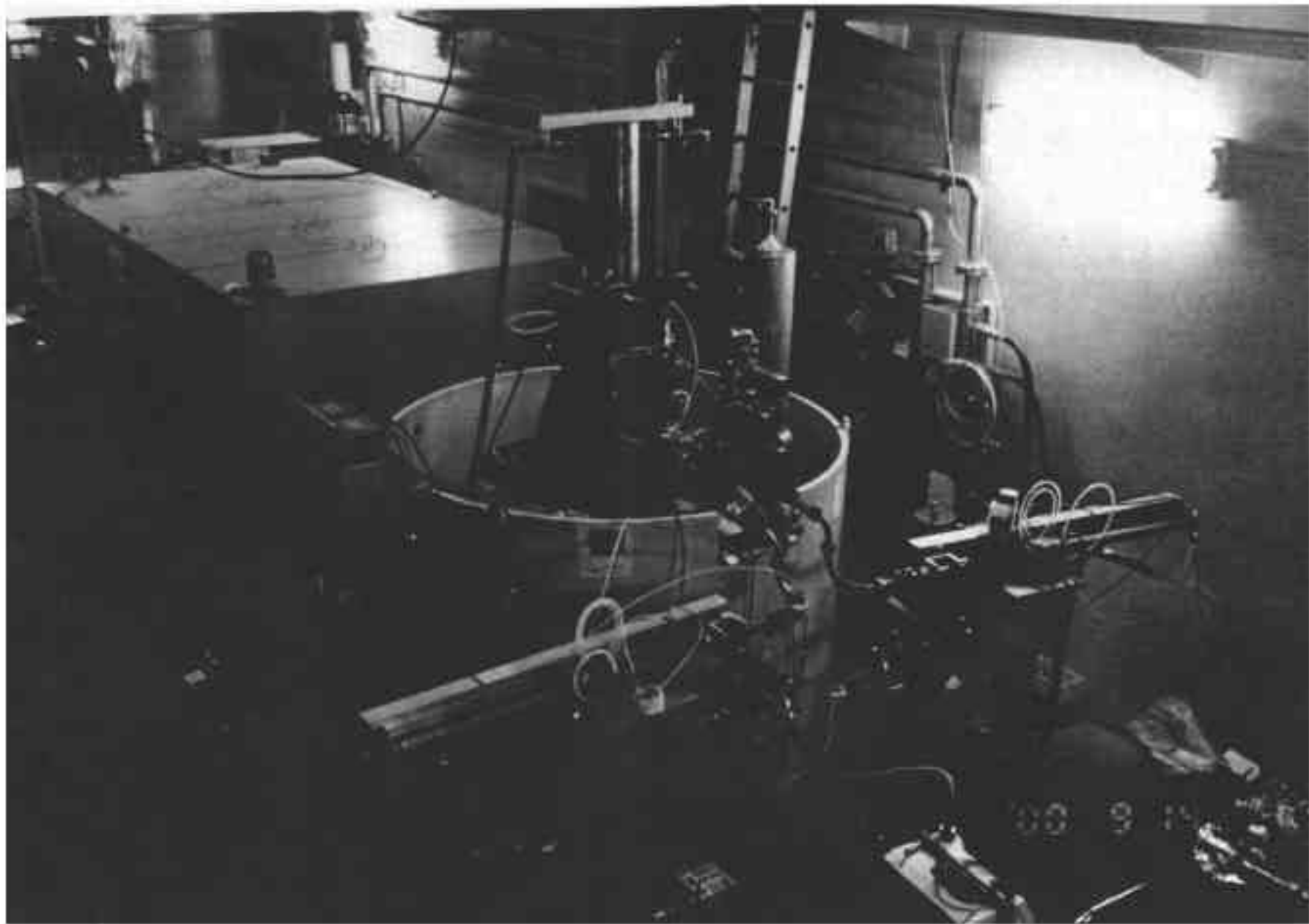
Results : Good Agreement with "Ideal Current Source"

● High Power Measurement ~~set~~

- Iris Position (from *)
 - ① Low Impedance
 - ② Standard
 - ③ High Impedance
- Low Power Meas (check. R)

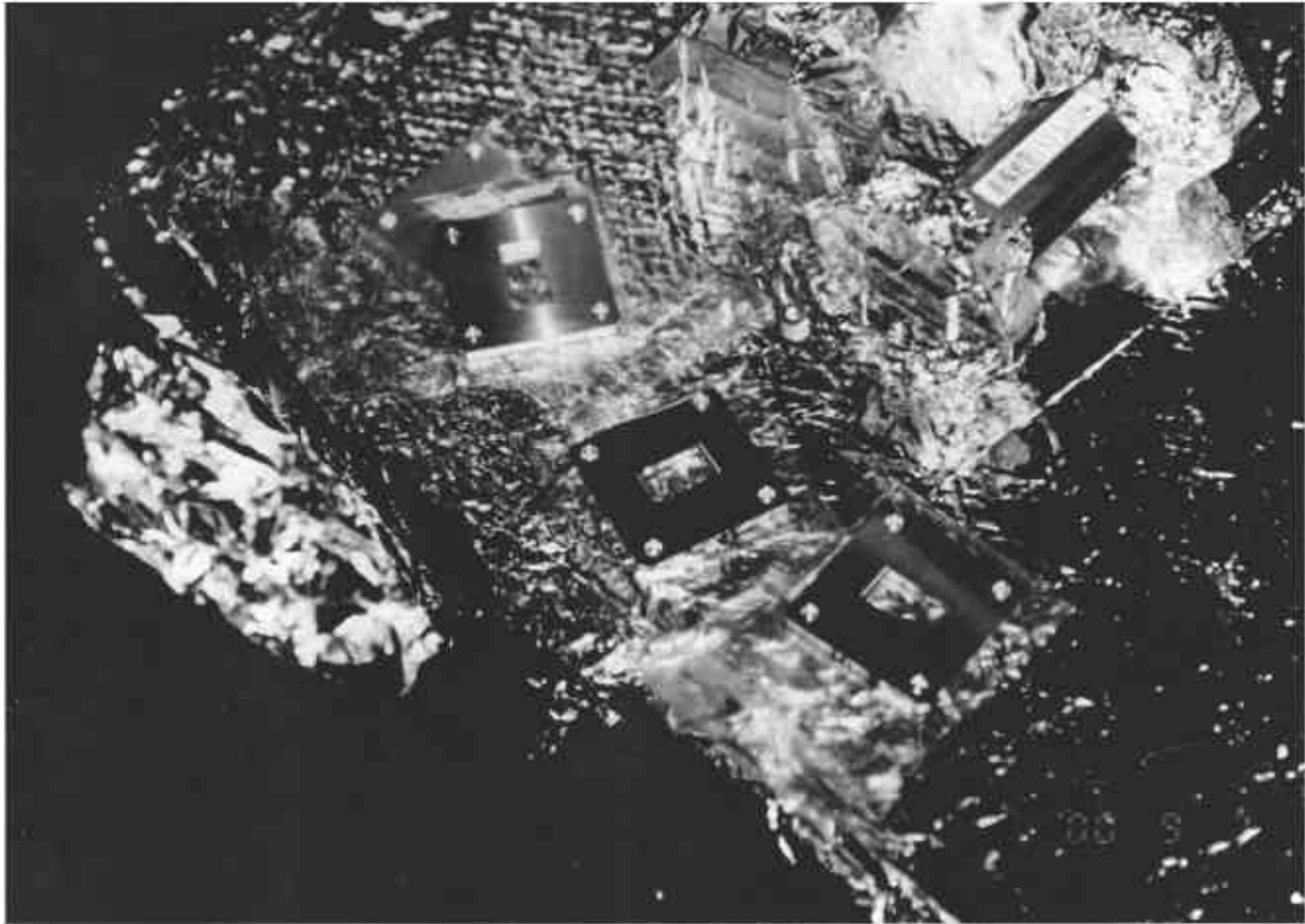


(see ~~Graph~~ Results.)



KEK
PPM
2000/Oct

(5)



Low Power
"Iris"

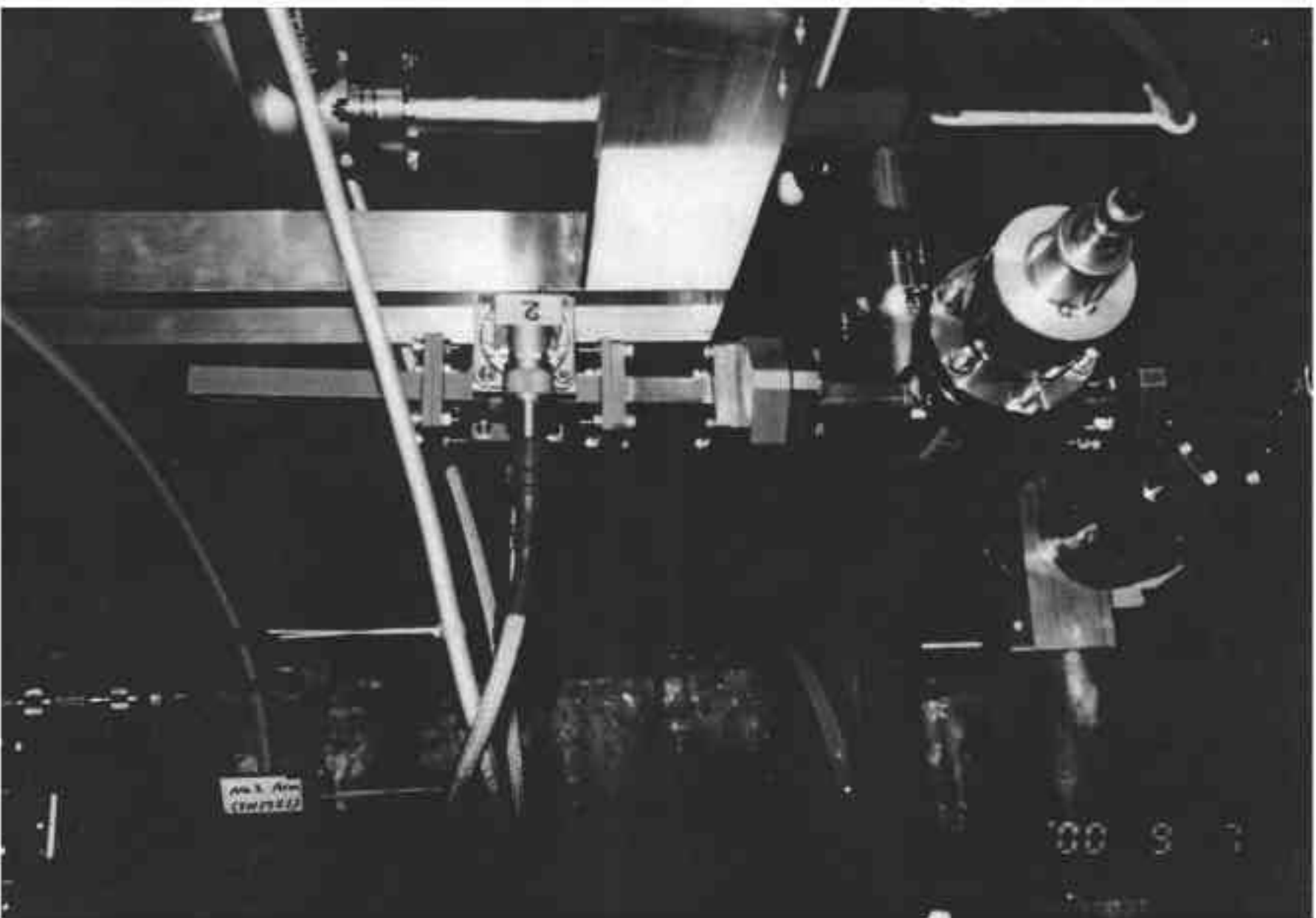
2000/Sep

(6)

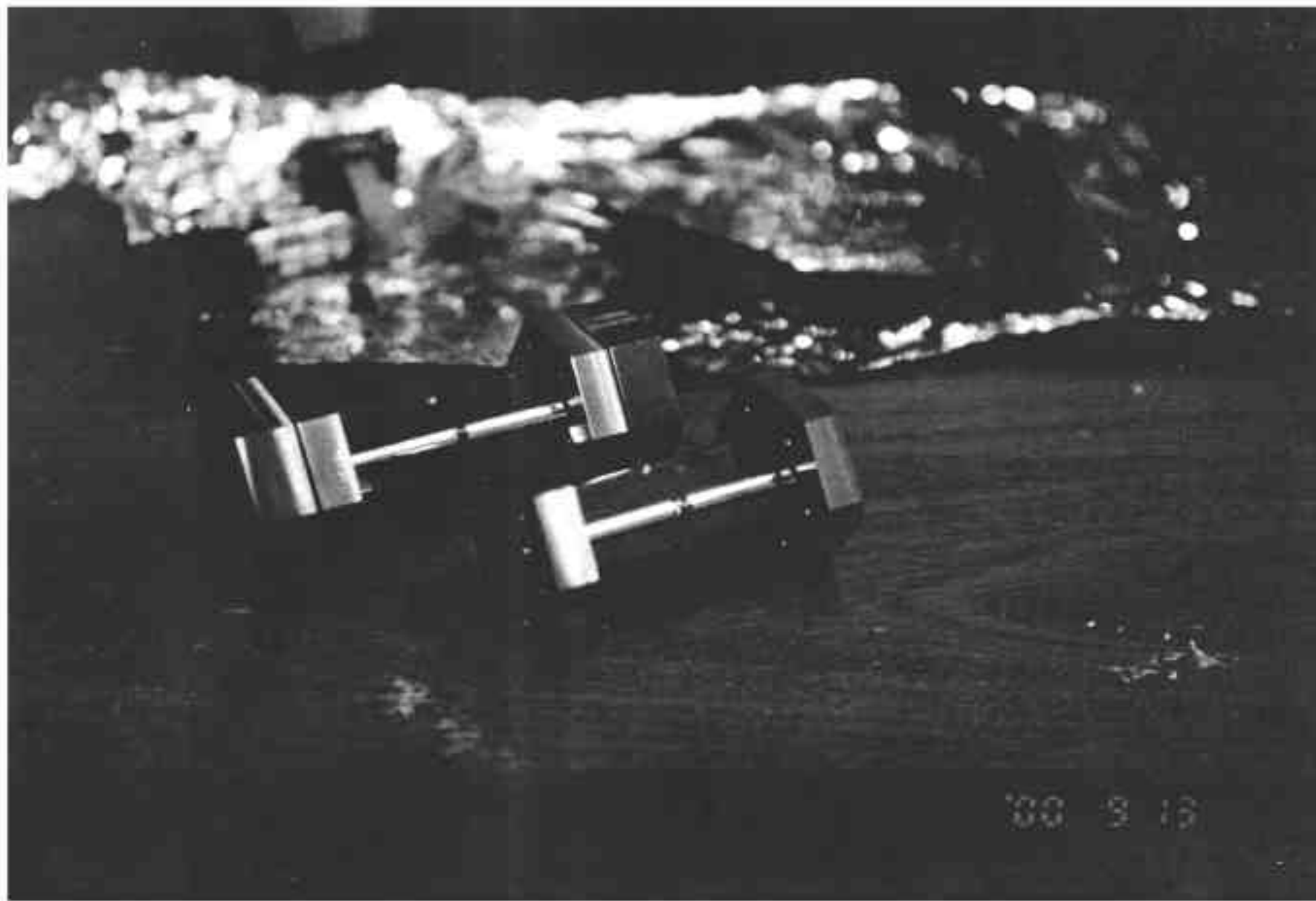
Low Power Set up ~50 kW output

2000/Sept

(10)

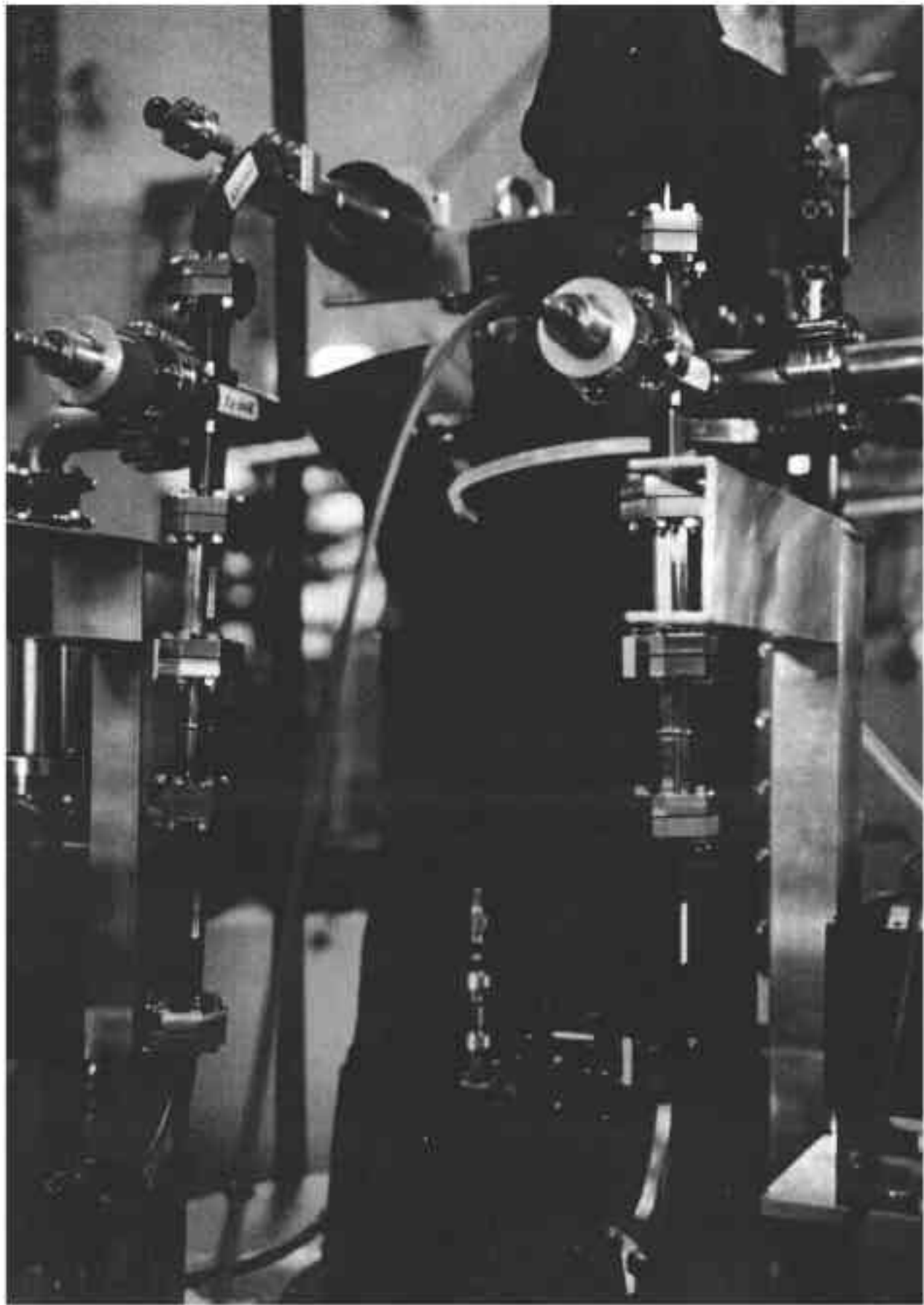


11



High Power Ir:s.

2000/Sept



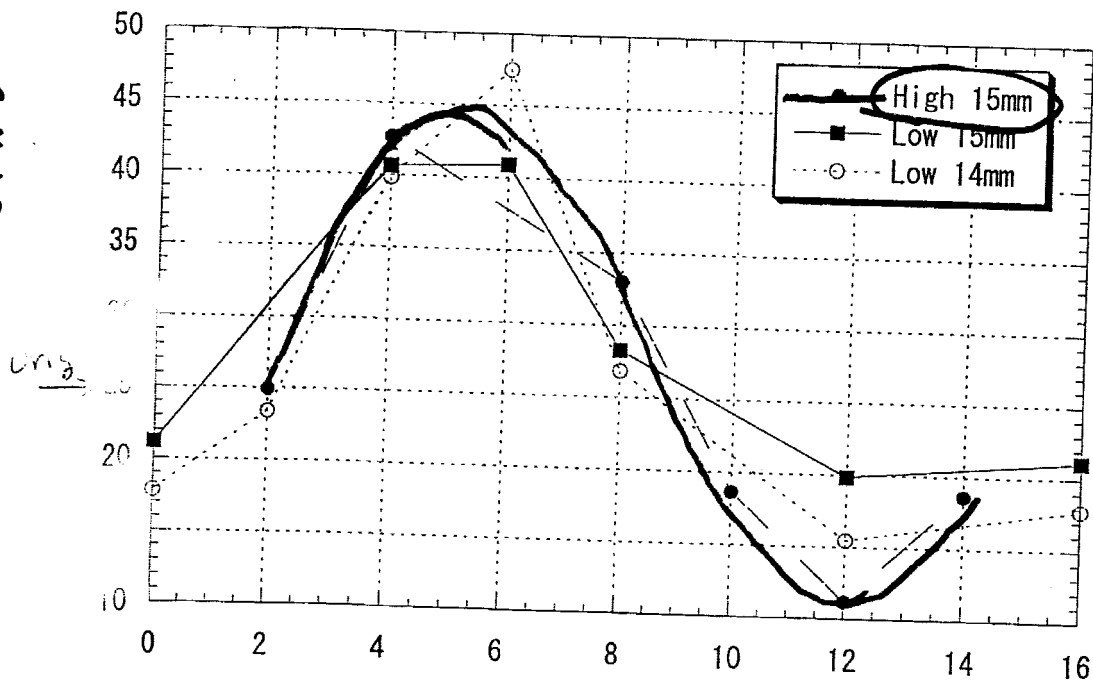
High Power Setup.
Shows "2-Iris" on each W. Guide
2000/Sent

① Iris (Low Power 用)

14 mm - 2.3 (VSWR)
15 - 1.94 ~
16 - 1.65

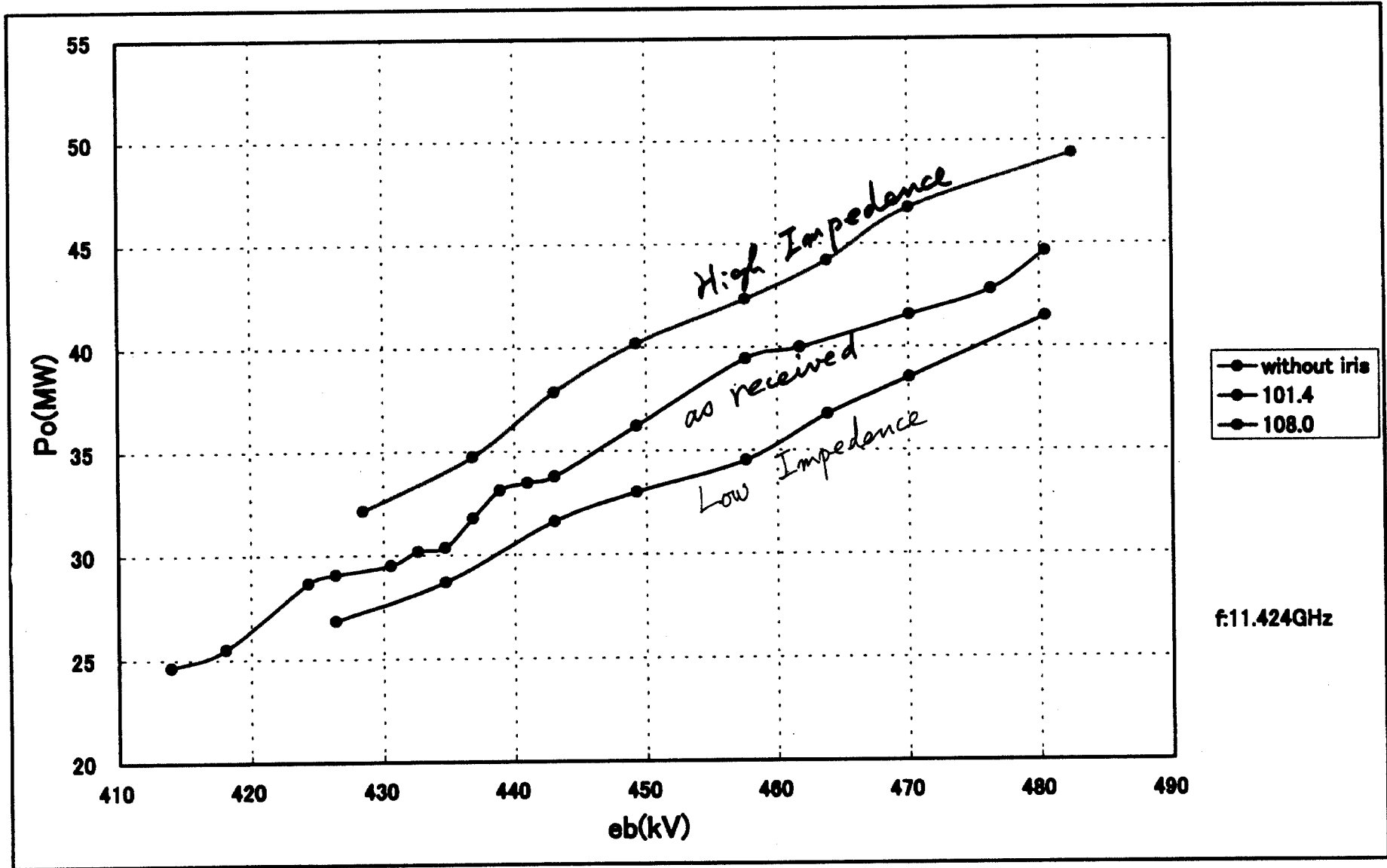
② Iris (High Power 用)
15 mm - 2.06/1.99 (VSWR)

Out Put Power
total 15mm (kW)

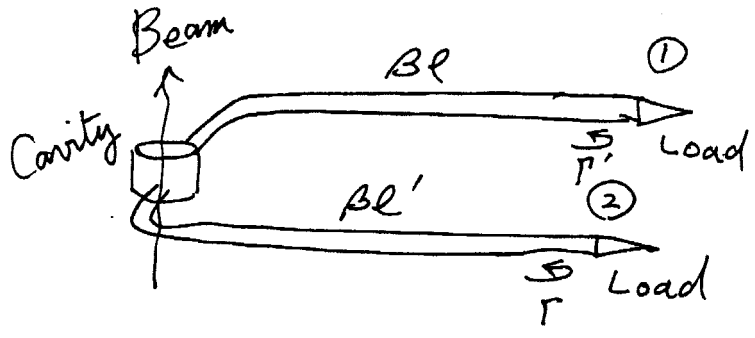


Iris Position 2000/Sept

High Power Test on PPM.

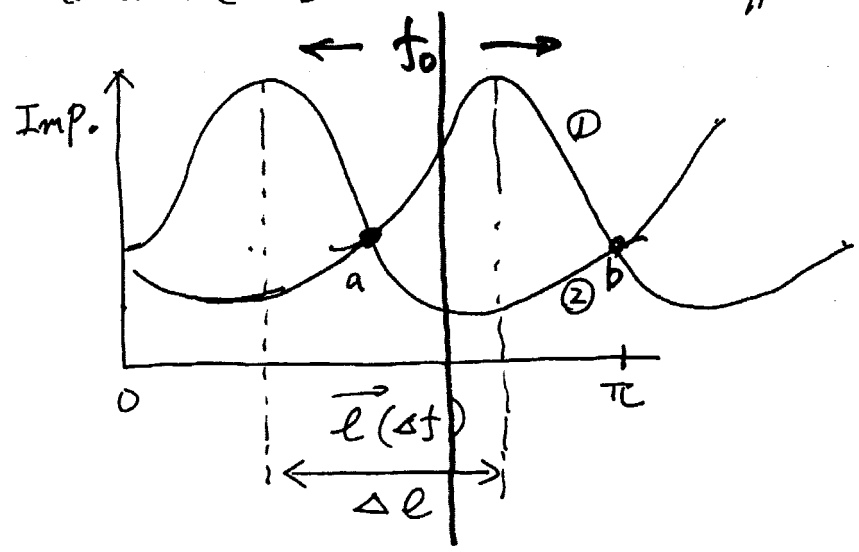


Output RF Power Difference between
 two output W. Guide Ports.



- ① Load has "Reflection" (small and same)
- ② $l \neq l' \Rightarrow l' - l = \Delta l$

① and ② branch has the different "Load Impedance"

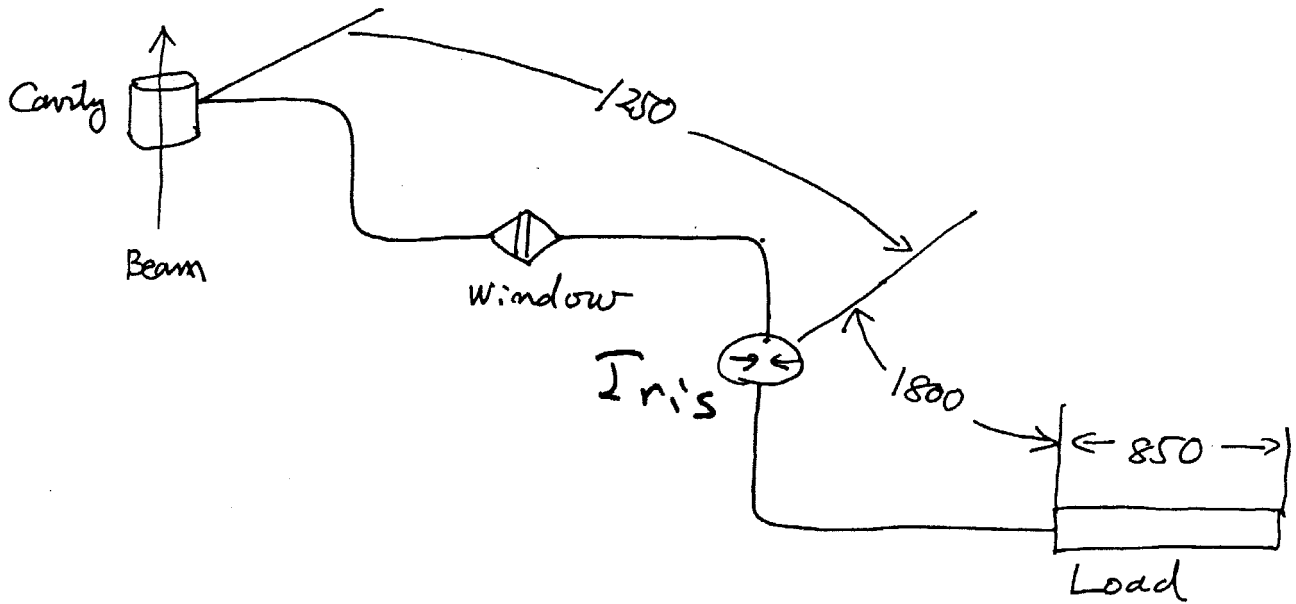


$$\phi = \frac{2\pi l}{\lambda_g} \quad (\lambda_g = v_{ph}/f) : v_{ph} \doteq \text{const}$$

$$= \frac{2\pi f l}{v_{ph}} \quad \therefore \frac{d\phi}{dt} = \frac{2\pi l}{v_{ph}}$$

$\Delta f \rightarrow \Delta \phi \rightarrow$ ① and ② branch shows Output Power change.

PPM Klystron Configuration



up to the end of the Load

Δf

$\rightarrow l=4100 \rightarrow \Delta f \cong 50 \text{ MHz}$

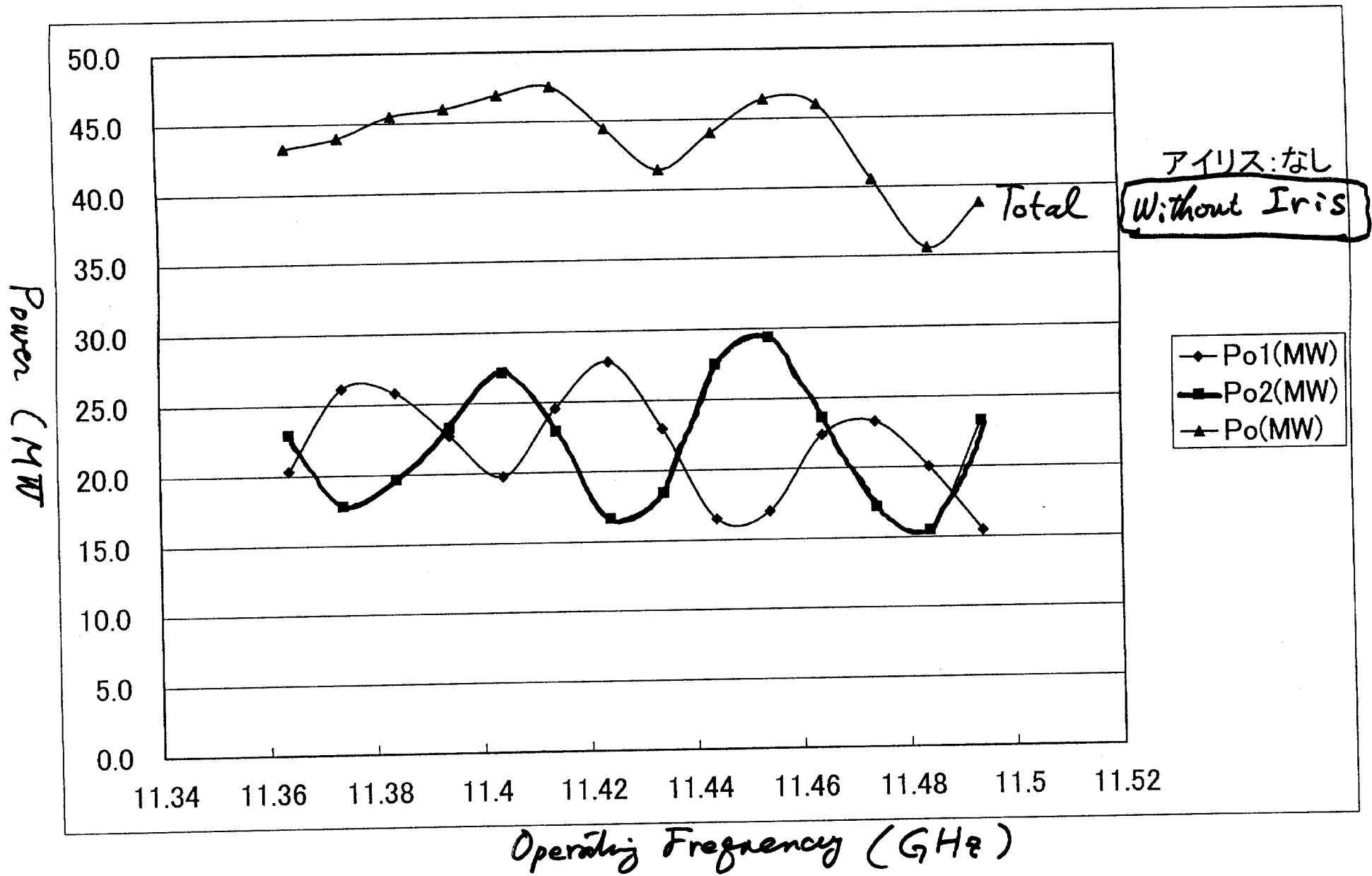
up to the "Iris"

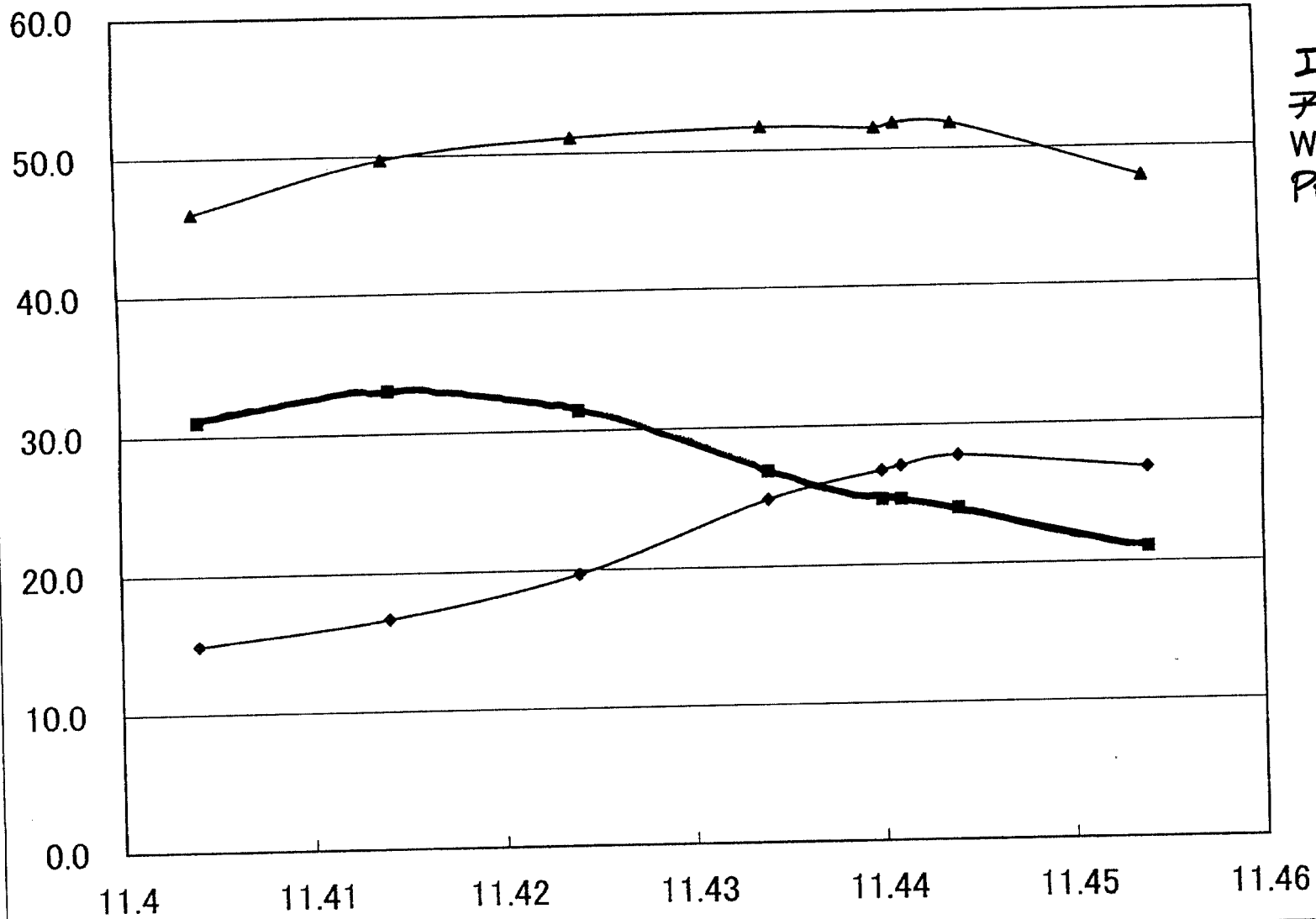
$\rightarrow l=1250 \rightarrow \Delta f \cong 150 \text{ MHz}$

Power Difference

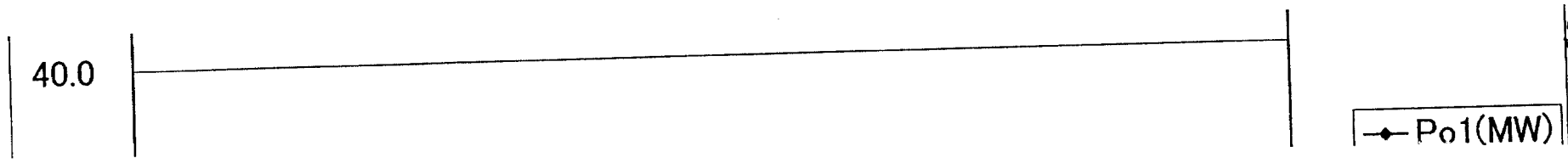
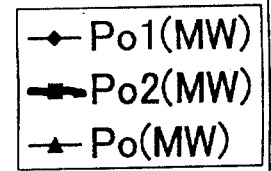
Iris $V_s \cong 2 \rightarrow$ Factor 3

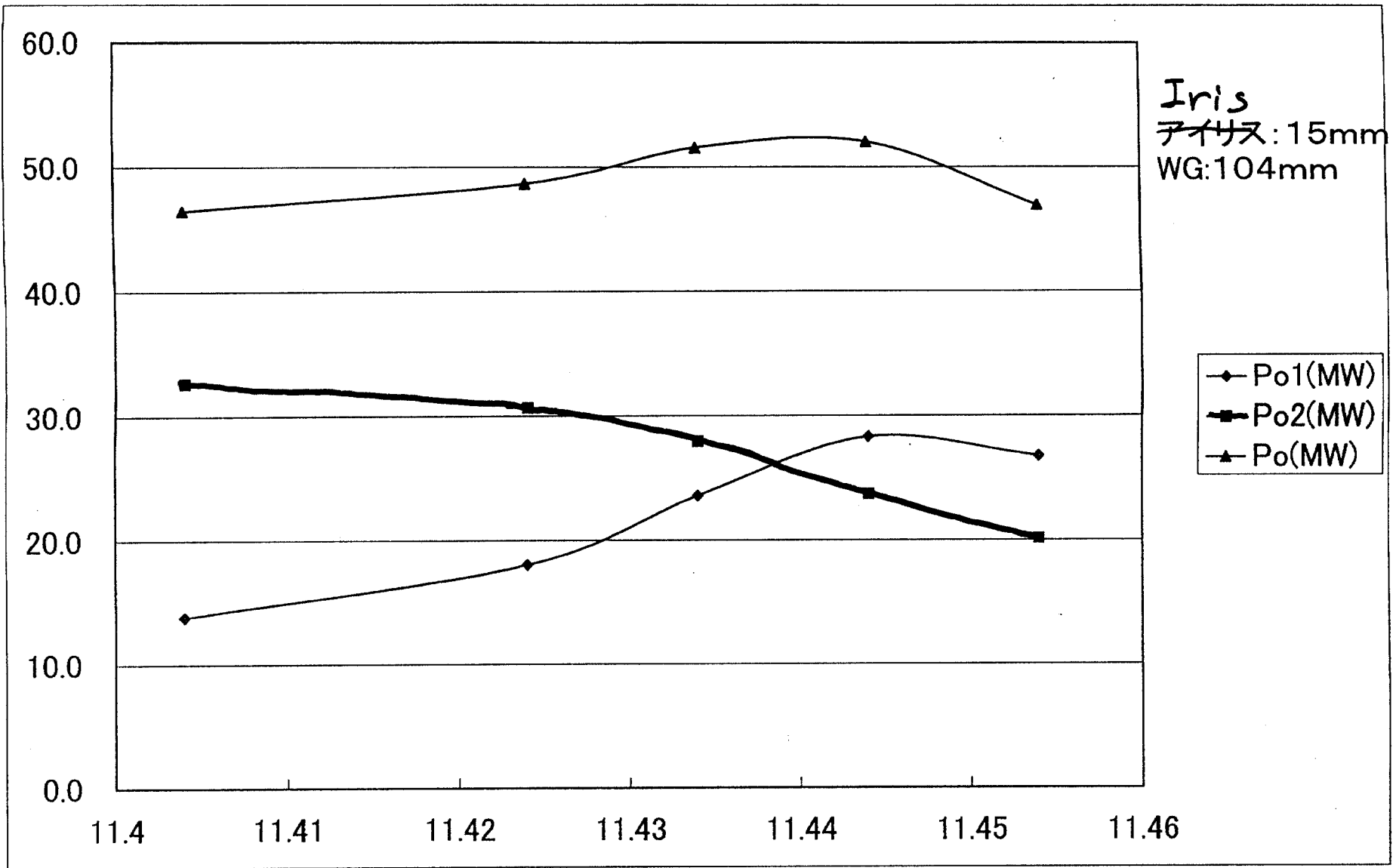
no Iris (Load) $V_s \cong 1.1 \rightarrow$ Factor 1.2
(-25dB) (20~30%)

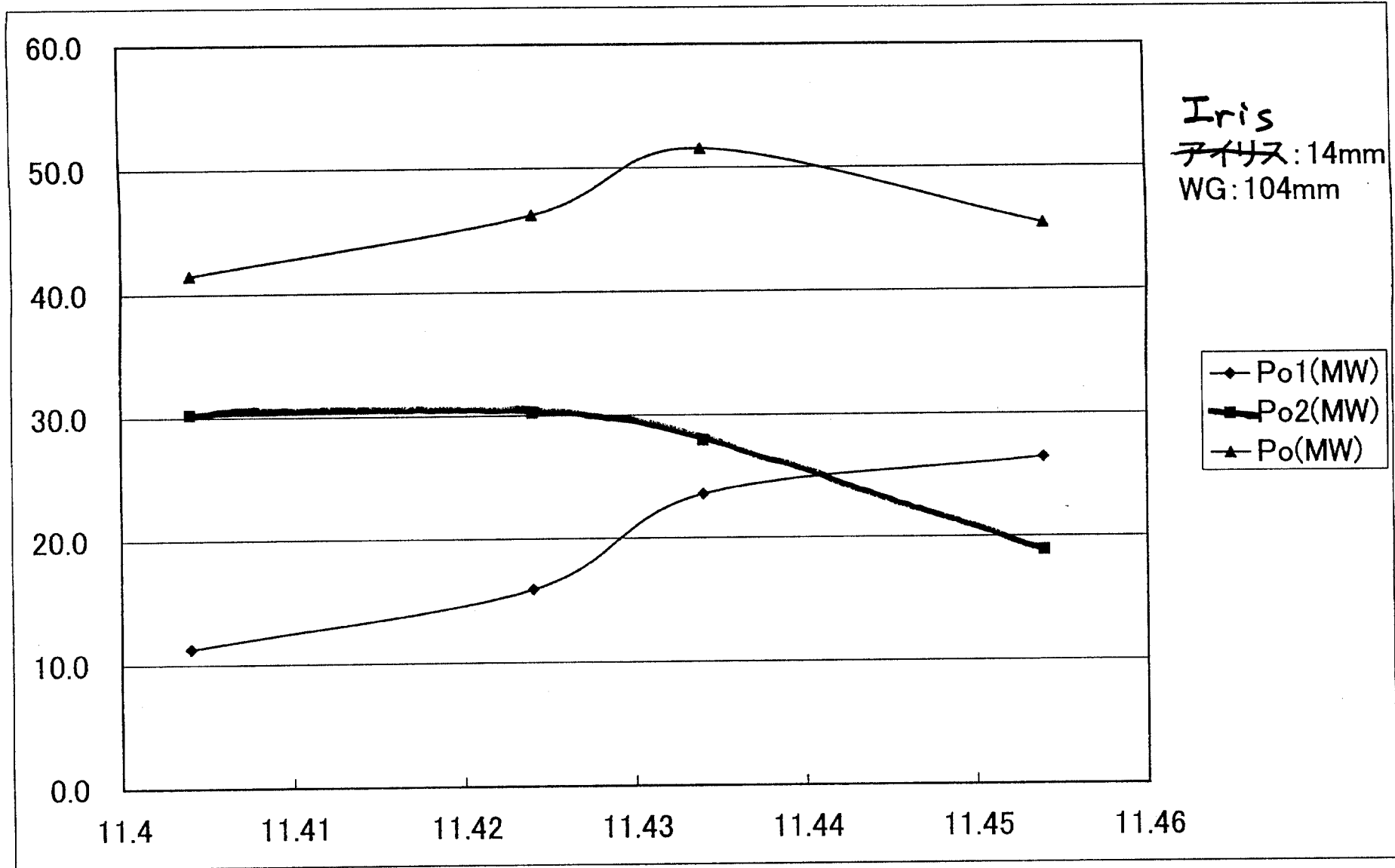




Iris
 子付ス: 16mm
 WG: 104mm
 Position







Results.

① Load Impedance Survey.

a) Low Power Measurement
showed Load Impedance Change.

b) Load Impedance was roughly OK.

(low Impedance \rightarrow low Power)

② Power difference between two ports.
was explained.

If. two part are combined within the
short distance, no problem is expected //