Masks

(Feb.25　11:35-11:55　Y.Suetsugu)

Present Status of KEKB Movable Masks

25/Feb/2002
KEKB VAC Y.Suetsugu

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- Results of Last Year
  - Ver.4 and Ver.5
- Present Problems
  - Groove on mask head
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- Future Plans
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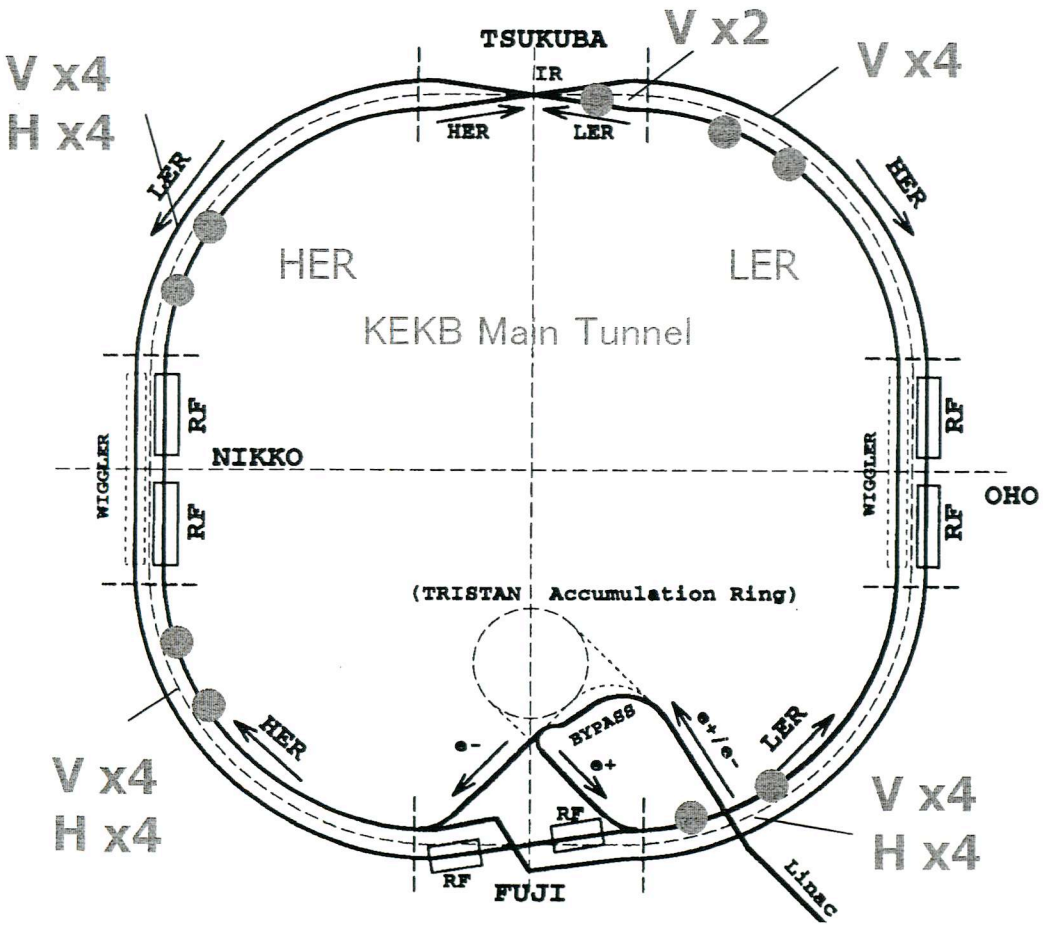
Present Status

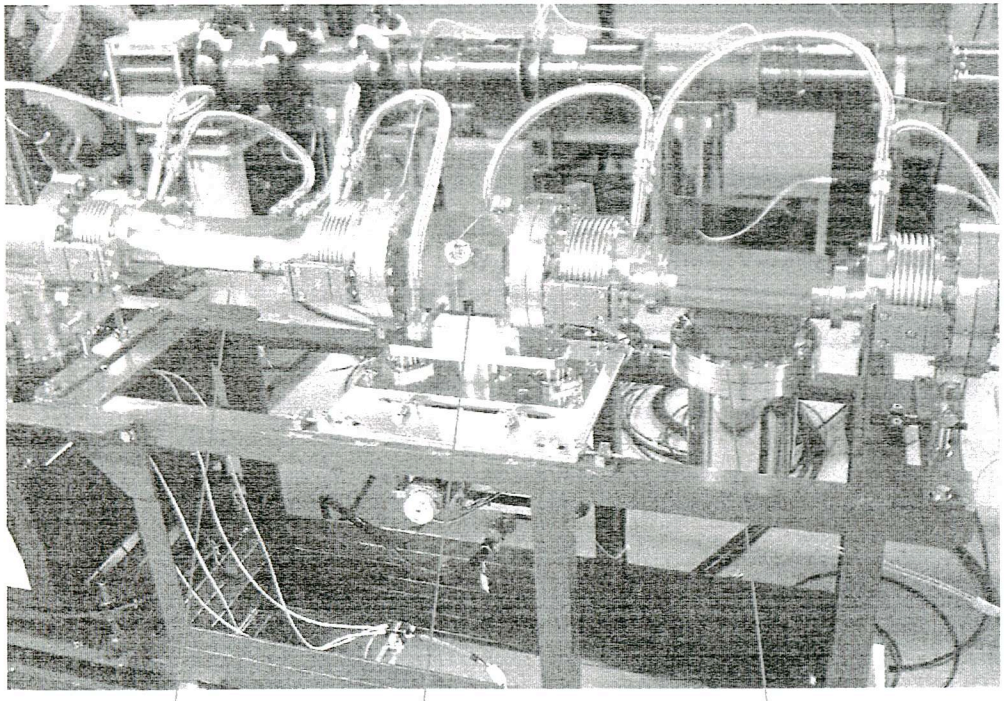
- Installed Movable Masks



- LER : 14
  - Ver.4 (Cu head) V:8 H:4
  - Ver.5 (Cu head) V:2
- HER : 16
  - Ver.3.2 (Cu head) H:4
    - To be replaced to Ver.4.6
  - Ver.4 (Cu head) V:6
  - Ver.4.5 (Cu+Al head) V:2 (a trial)
  - Ver.4.6 (Ti head) H:4

New Masks Installed_1

- Ver.4 (4.5, 4.6)
  - Chamber type
  - Installed at arc section

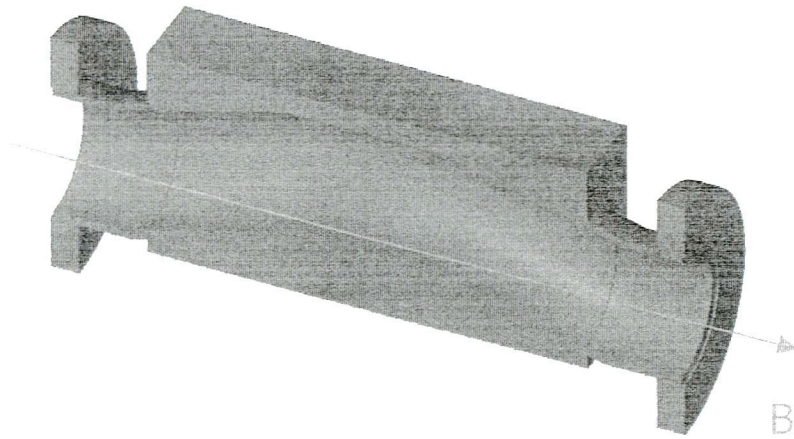


Mask Chamber

Bellows Chamber

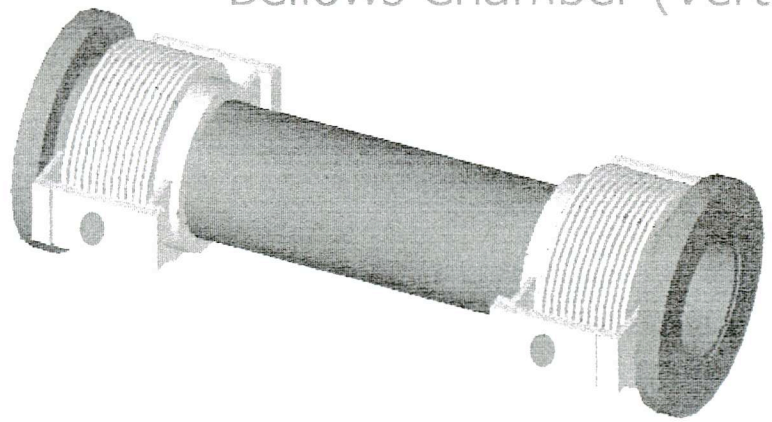
Bellows Chamber

Mask Chamber (Vertical)



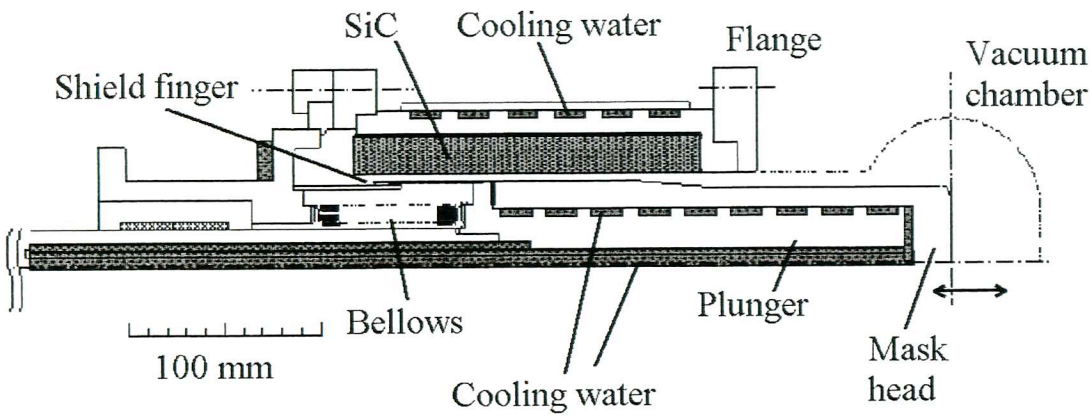
BEAM

Bellows Chamber (Vertical)

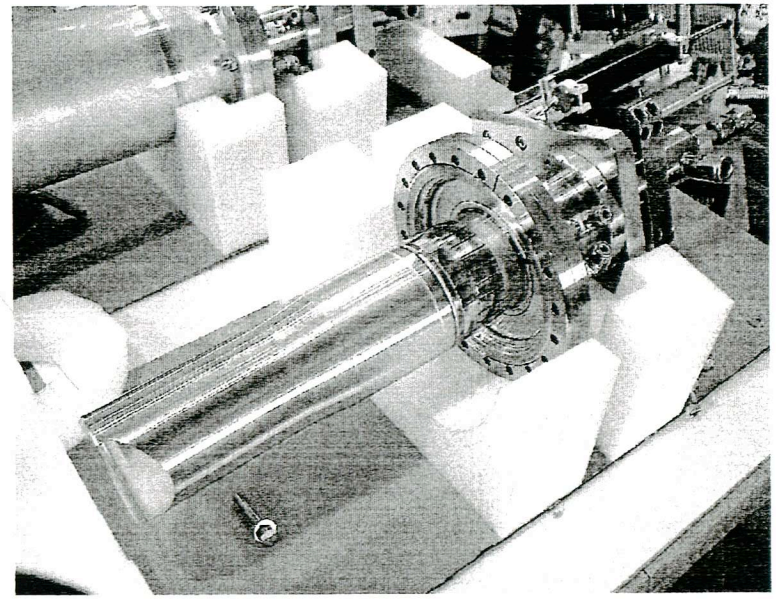


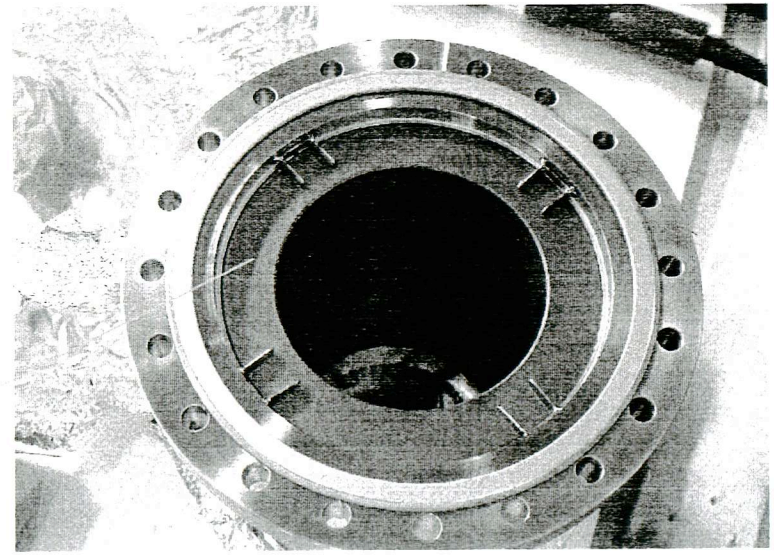
New Masks Installed_2

- Ver.5
  - Plunger Type
  - Installed at IR



Mask Head





SiC Chamber

Results of Last Year

- No vacuum leak
  - Four times leaks in previous versions
- No limitation to stored current
  - HER current has been limited by HOM power absorbed by SiC of Ver.3.2 (V).

But

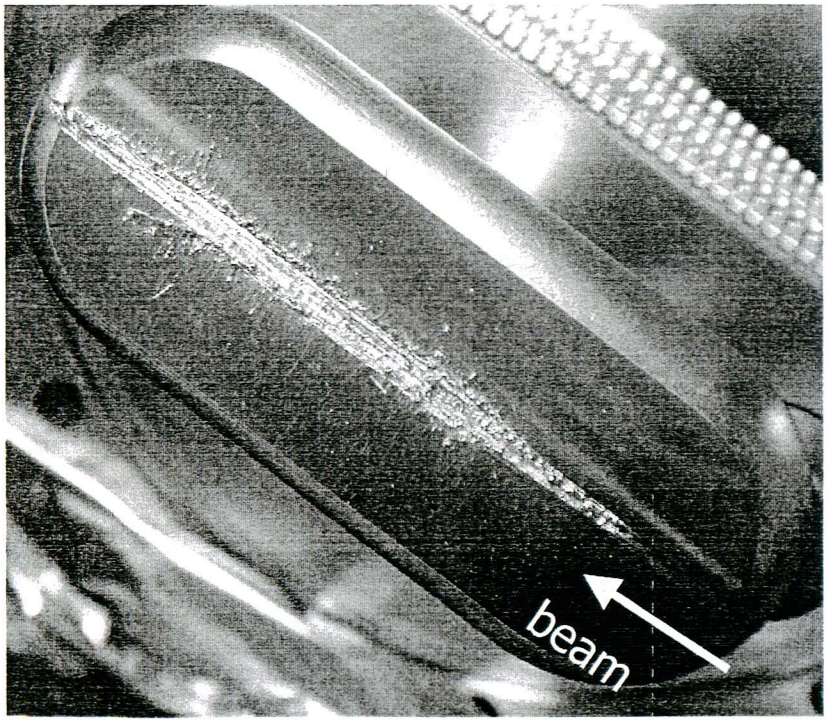
1. Groove was generated on mask head (Cu)*.
   - Whiskers near grooves objected injection beams.
2. Heating of bellows near Ver.4 was observed*.
   - Resonant heating by HOM was found for some filling pattern.
3. Pressure rise near Ver.4 was observed.
   - High pressure worsened the background of BELLE.

*Reported preliminarily last year

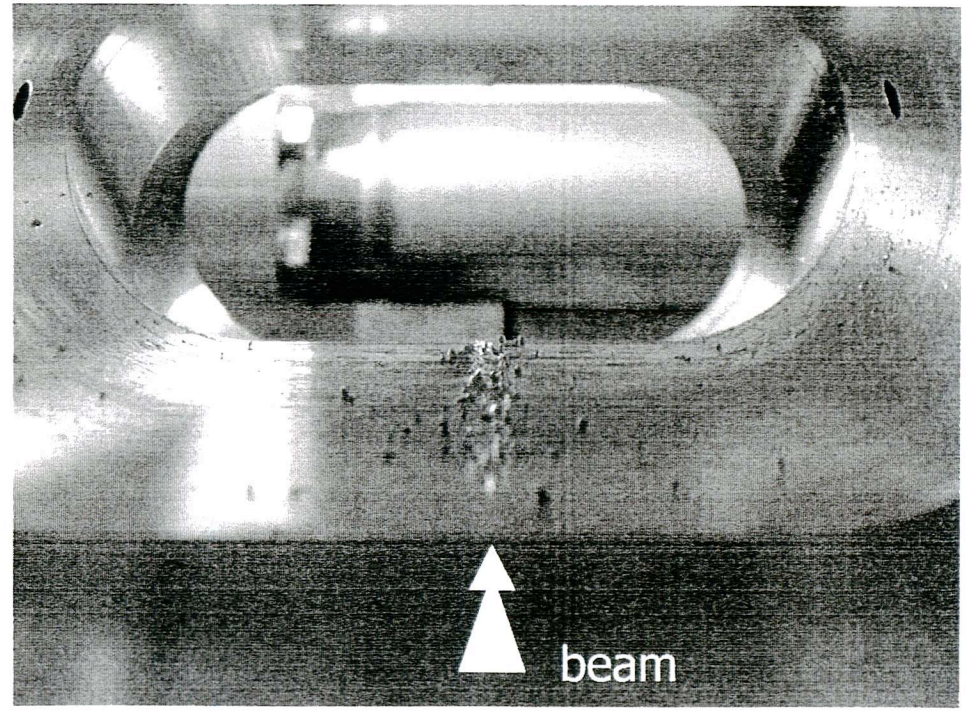
1. Groove on Mask Head_1

- Grooves were observed on Cu mask head. (both for LER,HER)
- The problem has been experienced from old masks.

Ver.3.2 (Cu)



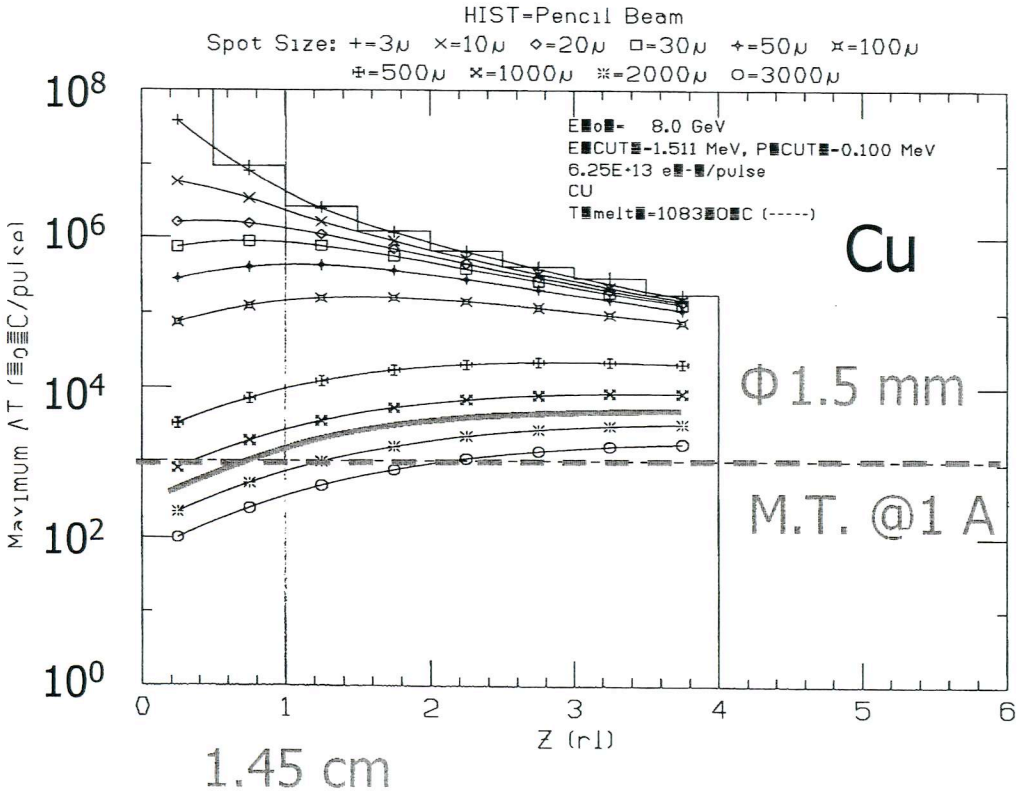
Ver.4 (Cu)



Groove : width 3~4 mm, Depth 1~2 mm

1. Groove on Mask Head_2

- Cause : Some portion of beam attacks mask head in an abnormal beam abort.
  - Pressure burst, loss monitor signal and beam loss were observed.
  - Calculation of temperature by EGS4 program indicated the possibility.



- If 1 A beam hits Cu block, Cu likely heats up to the melting point.
- From observation, the grooves started after about 10 mm from edge of head.

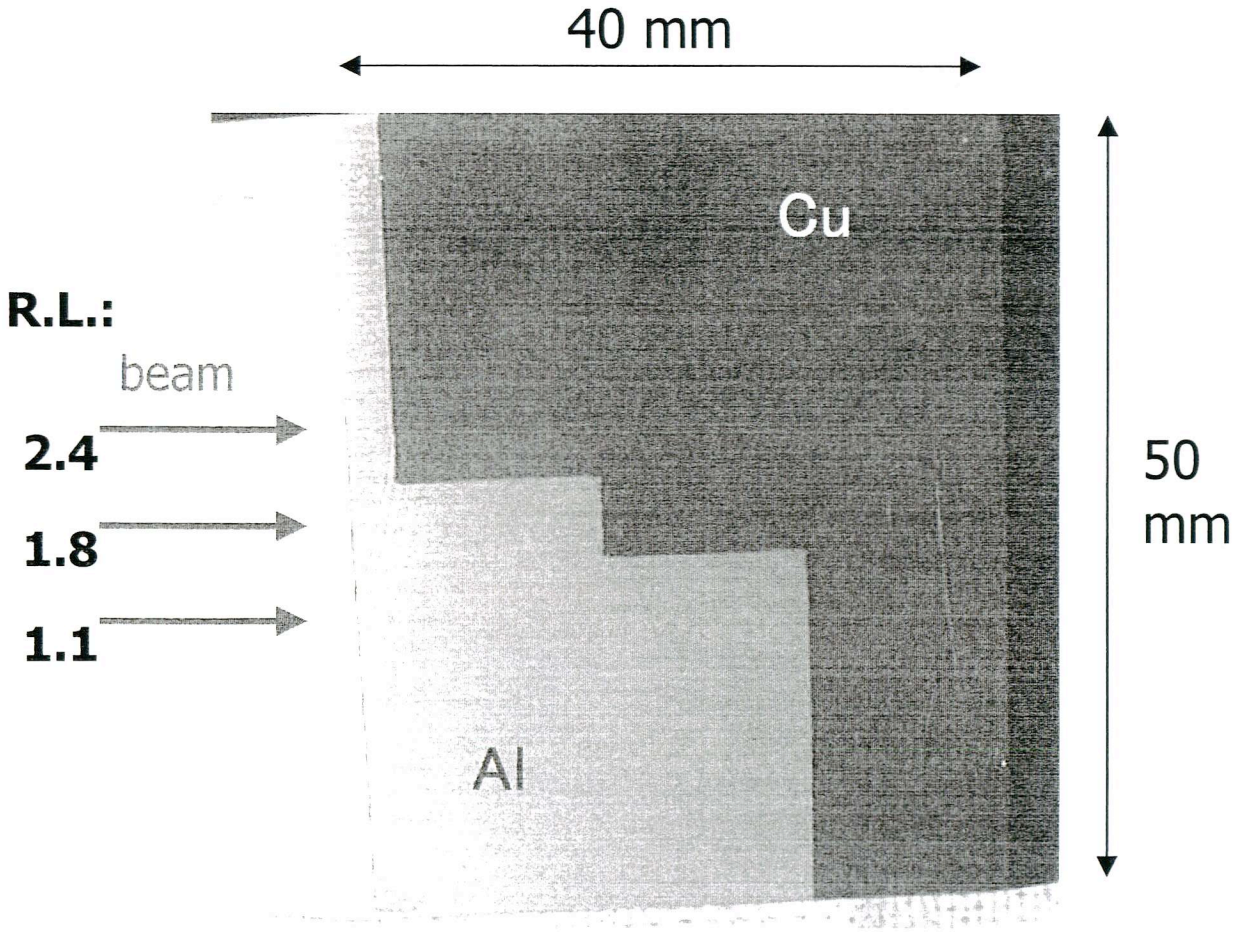
- Estimated beam size is about 1.5 mm.

1. Groove on Mask Head_3

- Effect : Whiskers or particles around the grooves objected injection beam and made beam unstable.
  - Unstable injection
  - High background of BELLE
- Countermeasure 1: Rapid abort system using pin-diode signal of loss monitor or beam phase signal was developed but could not save the mask head completely.
- Countermeasure 2: Change of material of mask head was considered.
  - Find necessary radiation length
  - Search possible material

1. Groove on Mask Head_4

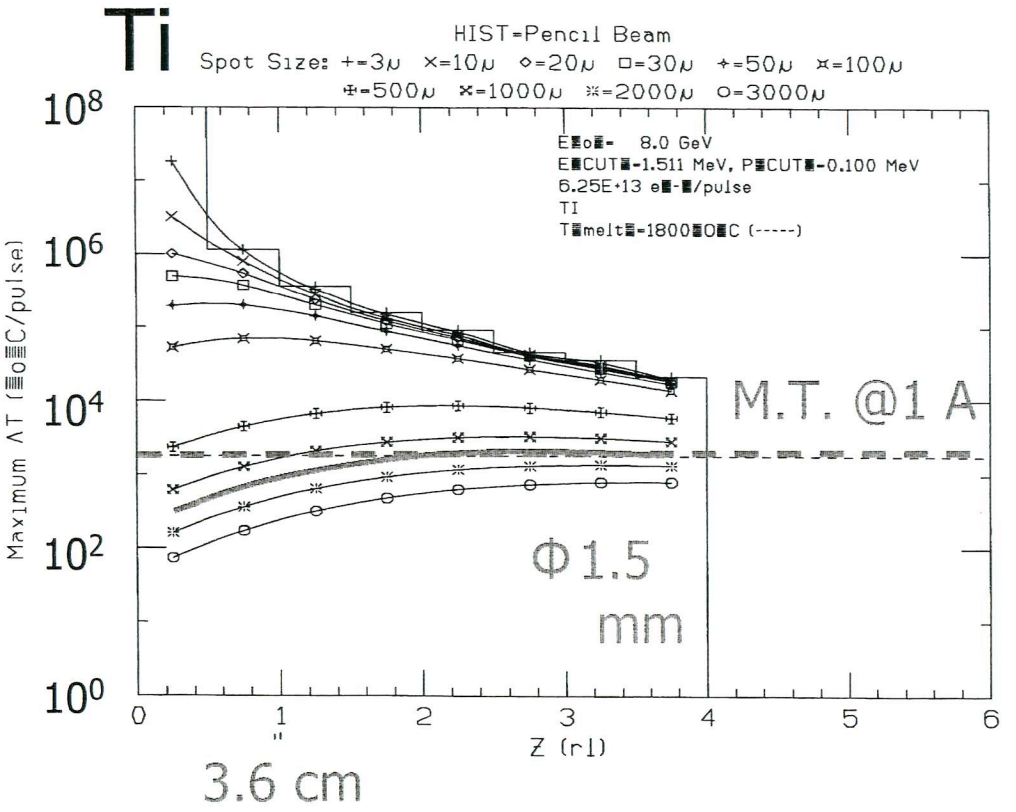
- Study on finding necessary radiation length
  - Ver.4.5 with a special mask head was installed (HER).



- Different R.L. (1.1 ~ 2.4) was tested by changing beam orbit at mask.
- For the case R.L.=1.8 and 2.4 , mask reduce the BELLE background but grooves were generated in Cu region.
- R.L. = 1.1 seems enough to reduce BELLE background but occasionally high radiation dose were observed.
- For such a short R.L., many masks should be installed to avoid unexpected heavy radiation damage to BELLE.

1. Groove on Mask Head_5

- Possible material
  - Calculation of temperature using EGS4 for several materials

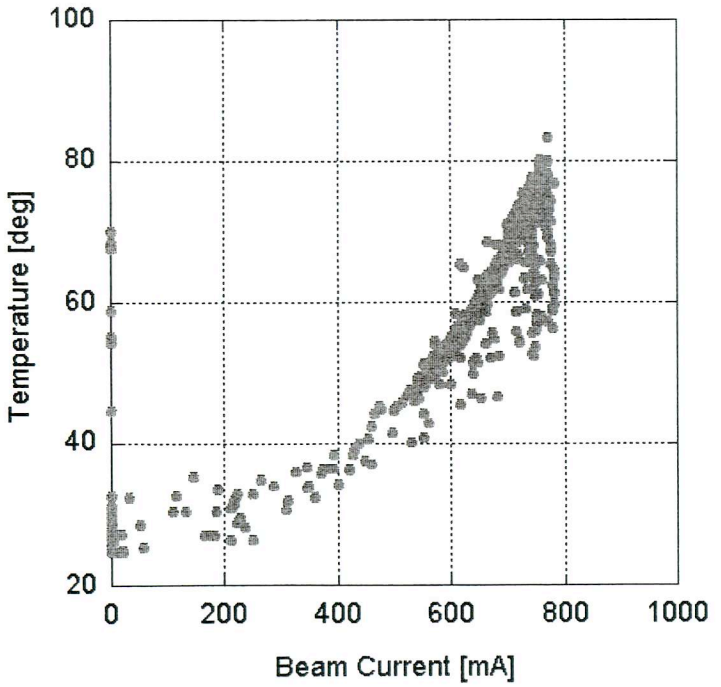


- For HER (1.1 A), Ti mask with R.L. of about 2 can be used.
- Four horizontal Ti mask with 2.2 R.L (80 mm) was installed in last January and any defect has not been observed yet.
- Other Cu masks will be changed to Ti masks this year.
- For LER (2.6 A), Ti mask with 1 R.L. may be possible, but the plan is not fixed yet. It depends on the results of HER.

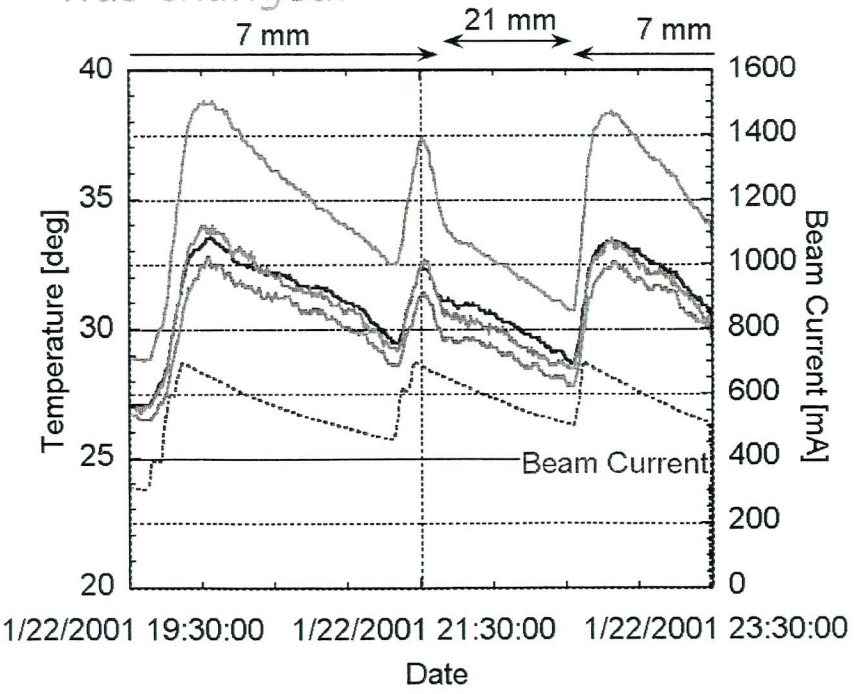
2. Heating of Bellows_1

- Bellows near masks Ver.4 was heated.
  - Proportional to square of beam current
  - Depends on fill pattern
  - Shows resonant behavior

Behavior of bellows temperature against beam current

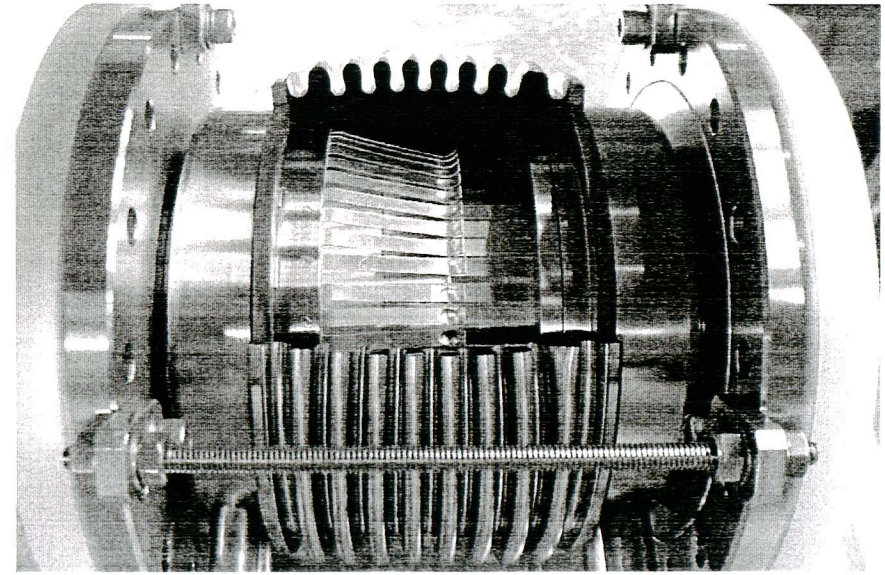


Resonant behavior of temperature. Position of mask (= bellows length) was changed.



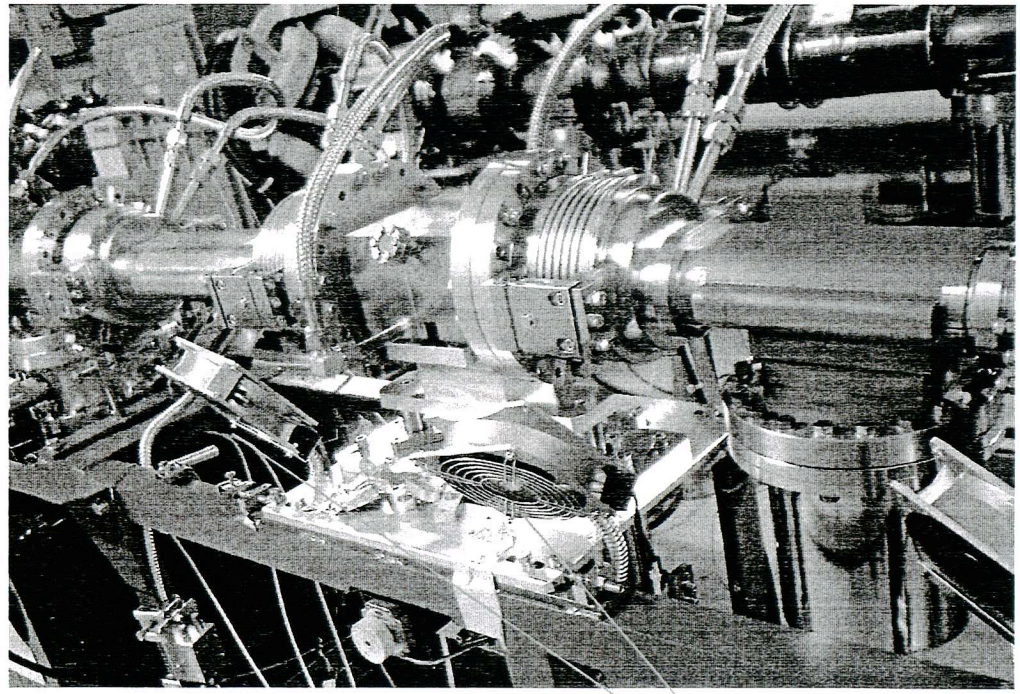
2. Heating of Bellows_2

- Cause : MAFIA calculation indicates that the mask excite TE mode HOM at mask head and the HOM goes inside of bellows through slots between fingers.
  - The calculation also said there was many resonant frequency inside of bellows, that is just like a coaxial cavity.
  - Estimated input power is about 100~200 W (@40~60°C) at off resonance.
    - Estimated from the temperature of bellows assuming forced cooling by air in turbulent flow.
- Effect : Heating limited filling pattern.



2. Heating of Bellows_3

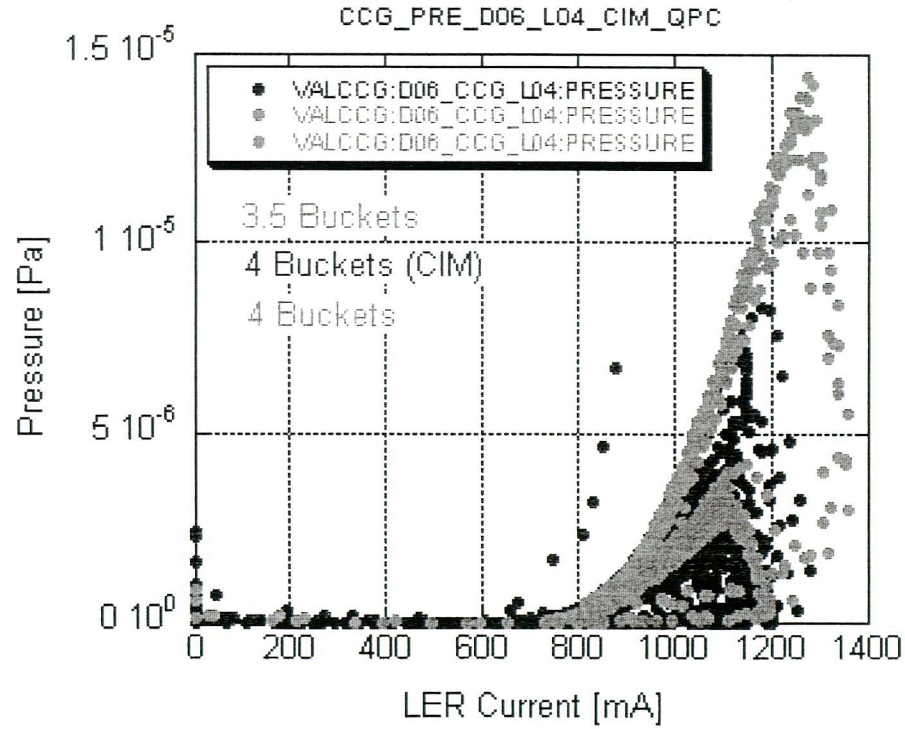
- Countermeasure 1: Cooling each bellows by small fan
- Countermeasure 2: Adjust of bellows length (1~2 mm)
  - Some improvement may be necessary in future.



Cooling Fan

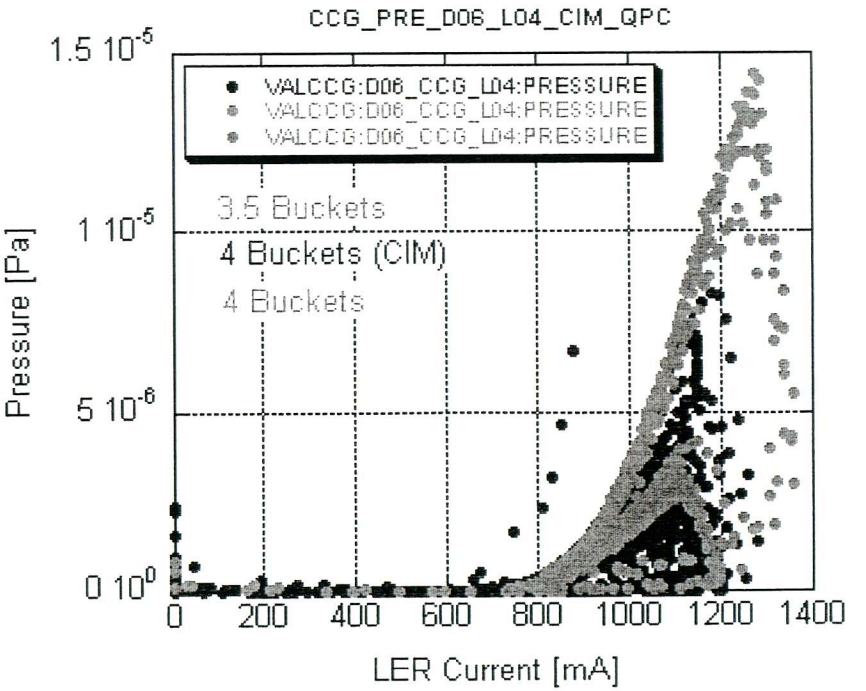
3. High Pressure at Mask Region_1

- During last autumn rum, the rapid pressure rise near LER mask region was observed at the beam current higher than ~800 mA.
- The pressure contributes over a half of total pressure at about 1300 mA.
- The pressure began to affect the background of BELLE.



3. High Pressure at Mask Region_2

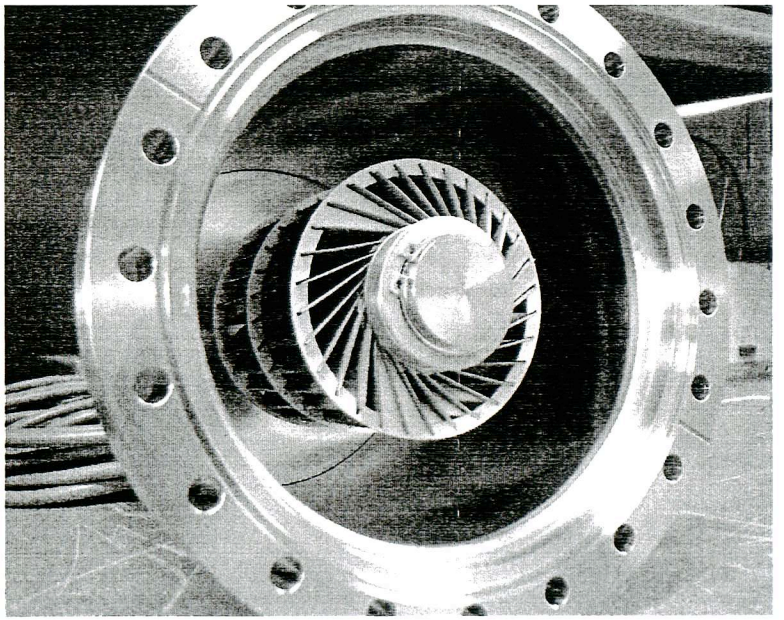
- Characteristics of the pressure rise
  - The pressure rises rapidly against the current.
    - Not gas desorption by synchrotron radiation
  - The peak does not correspond to the Max. current.
    - Heating
    - Not multipactoring
  - The heating is depend of total current.
    - Not resonance
  - The aging proceed slowly.



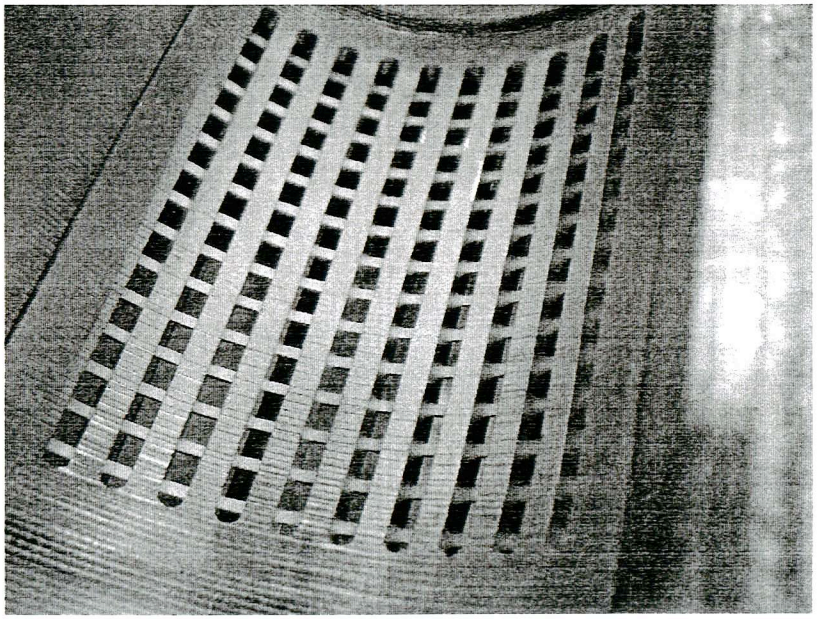
3. High Pressure at Mask Region_3

- A suspect
  - NEG is heated by HOM generated at mask (same as bellows heating)
  - Heated NEG desorbs H_2 gas.
  - HOM intrude the NEG chamber through the RF shield at the pumping port.
  - The existing RF shield seems week against TE mode HOM.
    - Cross bar has a thickness of only 0.5 mm. -> ~3 mm is necessary.

NEG inside chamber



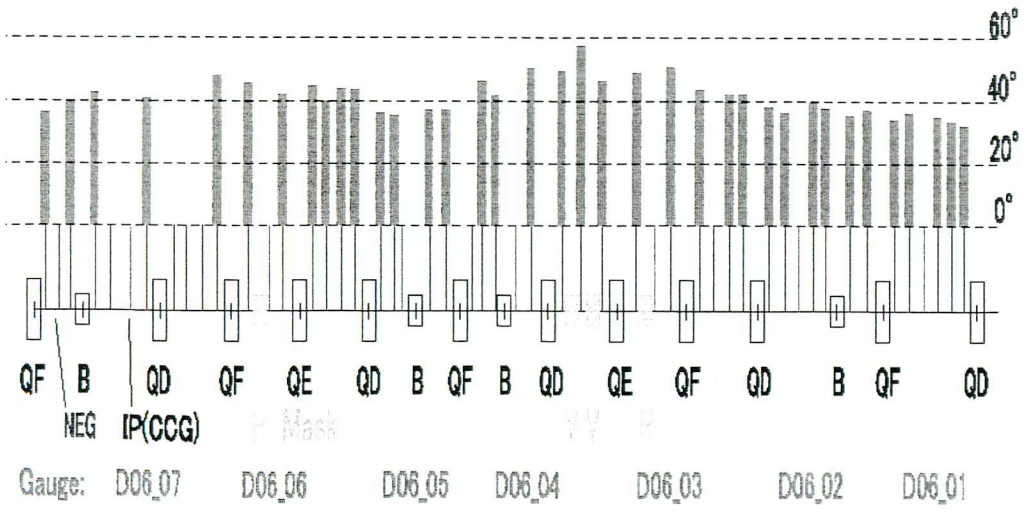
RF shield of chamber



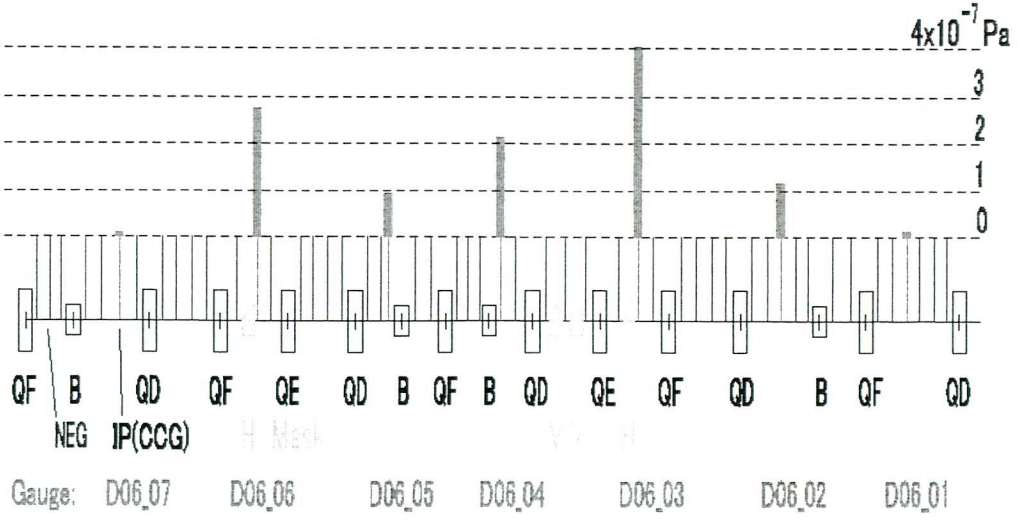
3. High Pressure at Mask Region_4

- Reason_1
  - Temperature of NEG chamber near mask is higher than other ones.
  - The estimated input power is about 60W and the temperature is above 150 °C from comparison with the temperature during activation.
  - Pressure distribution is almost same as the temperature's.

Temperature Distribution of NEG Chambers near Masks
After 30 min. from Beam Abort

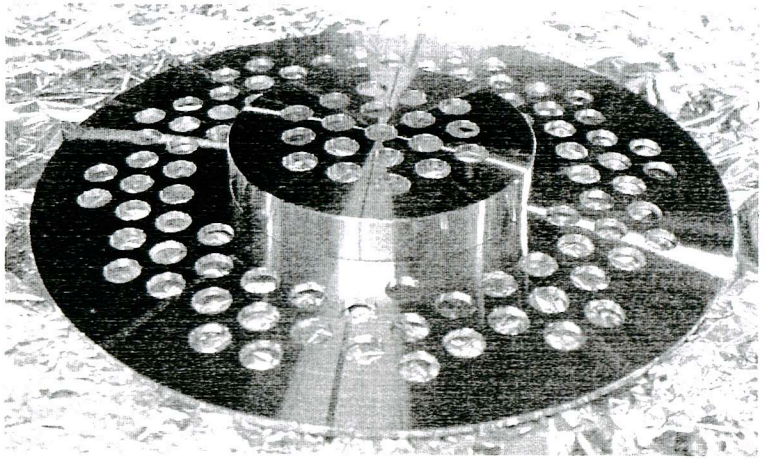


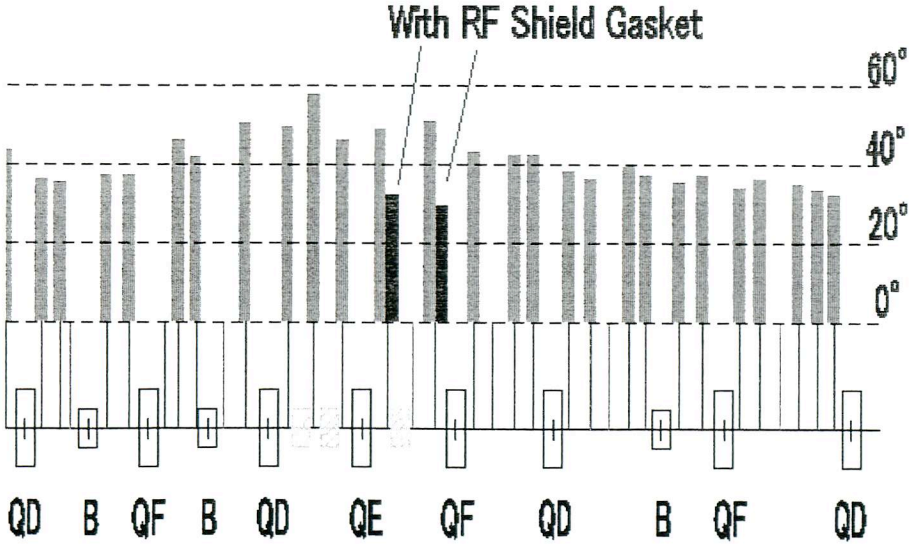
Pressure Distribution near Masks
at 1000 mA

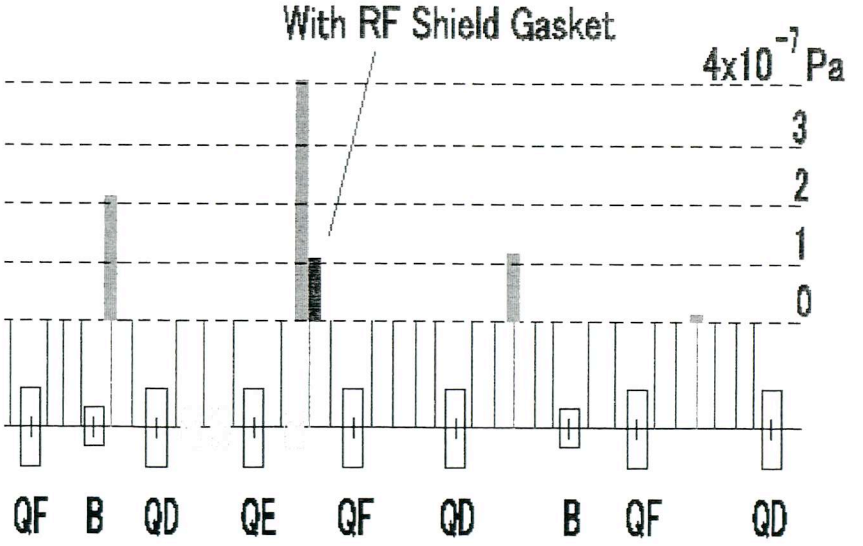


3. High Pressure at Mask Region_5

- Reason 2
  - Two RF shield gaskets with many holes of ϕ8 mm is installed between beam duct and NEG chamber near a gauge.
  - The effect is apparent.



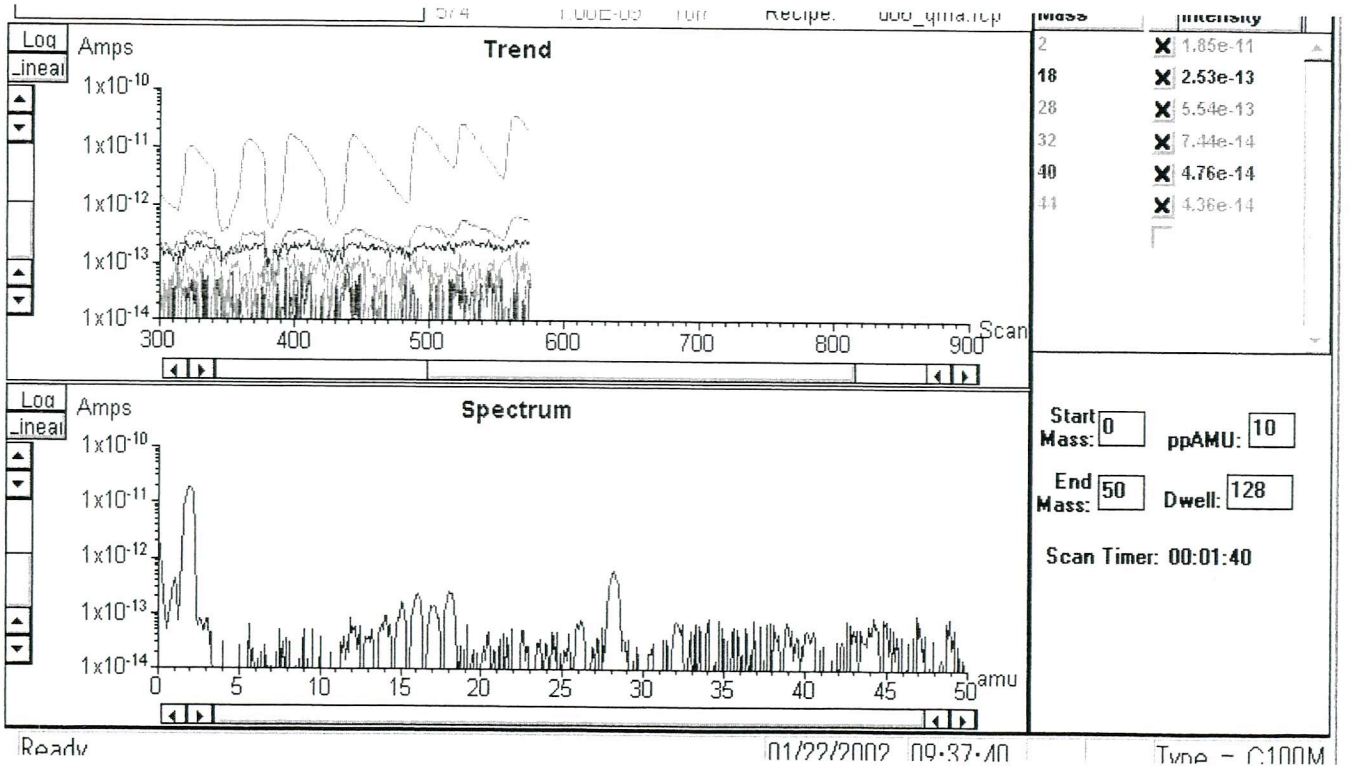




3. High Pressure at Mask Region_6

- Reason 3
  - Residual gas component
  - Main gas is H_2

Gas from NEG



- Countermeasure : Install RF shield gaskets for about 100 NEG ports near masks.

Future Plans

- On Pressure Rise : Install RF shield gaskets for NEG ports near masks.
  - Next month !!
- On Groove : Replace mask head material from Cu to Ti
  - HER mask will be replaced until this summer.
  - Countermeasure for LER masks is not fixed yet (depend on the results of HER).
  - It can serve as a test for KEKB upgrade plan.
- On Bellows Heating : Improve bellows structure to avoid HOM heating.
  - It serves also as a test for KEKB upgrade plan.

Summary

- New masks (Ver.4.x and Ver.5) are now working well.
  - Old mask (Ver.3.2) will be replaced to the new one.
- Heating of bellows near masks has been observed.
  - The heating is coped with cooling fan now.
  - Some improvements will be necessary for future.
- Groove on the mask head is still a main problem.
  - Ti mask head is now tested and seems well for HER.
  - For LER the further study is necessary.
- Pressure rise at mask region was observed recently.
  - RF shield gaskets will be installed.
- Development of movable masks for higher current is an important subject for the next machine.