Commissioning of KEKB Vacuum System

9/Mar/99 KEK Vacuum Group
Y.Suetsugu

Ring

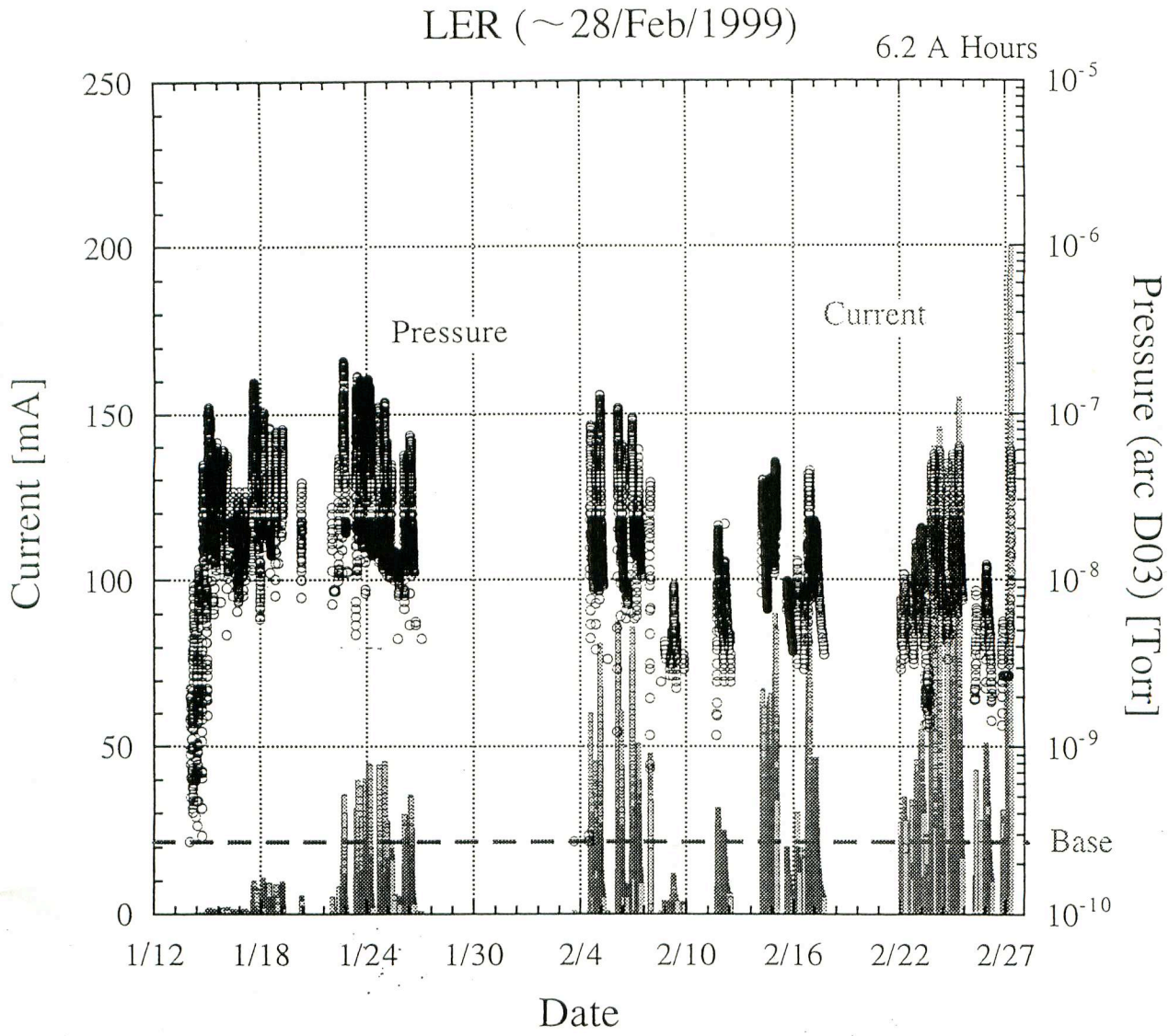
- Pressure vs. Beam Current vs. Life Time
- Decrease of $\Delta P/\Delta I$, Photo-desorption rate
  η [molecules/photon]
- Problems
- Troubles

IR

(to be talked by K.Kanazawa later)

Commissioning

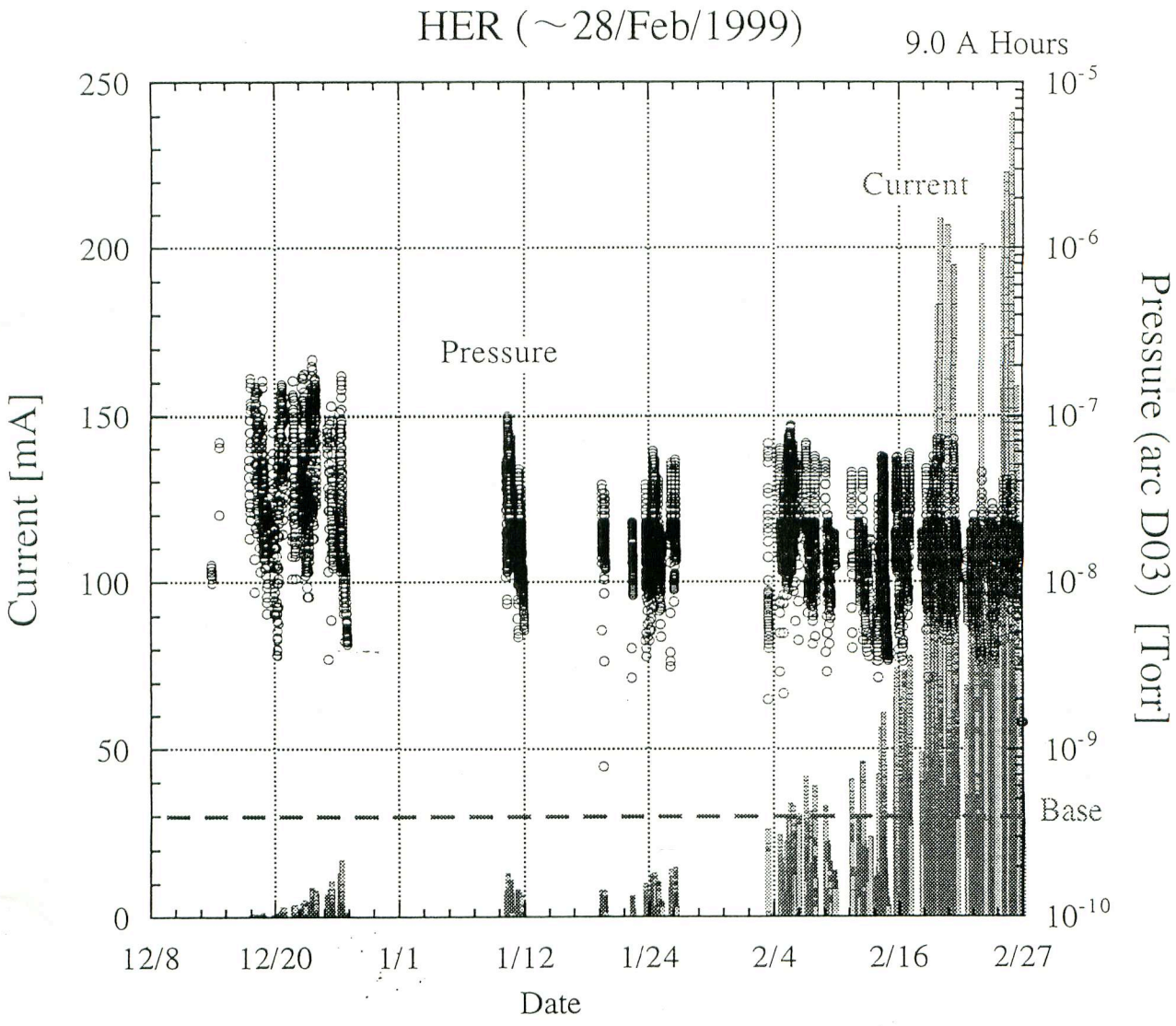
Beam current & Pressure (arc)



Base Pressure ~ 3×10^{-10} Torr

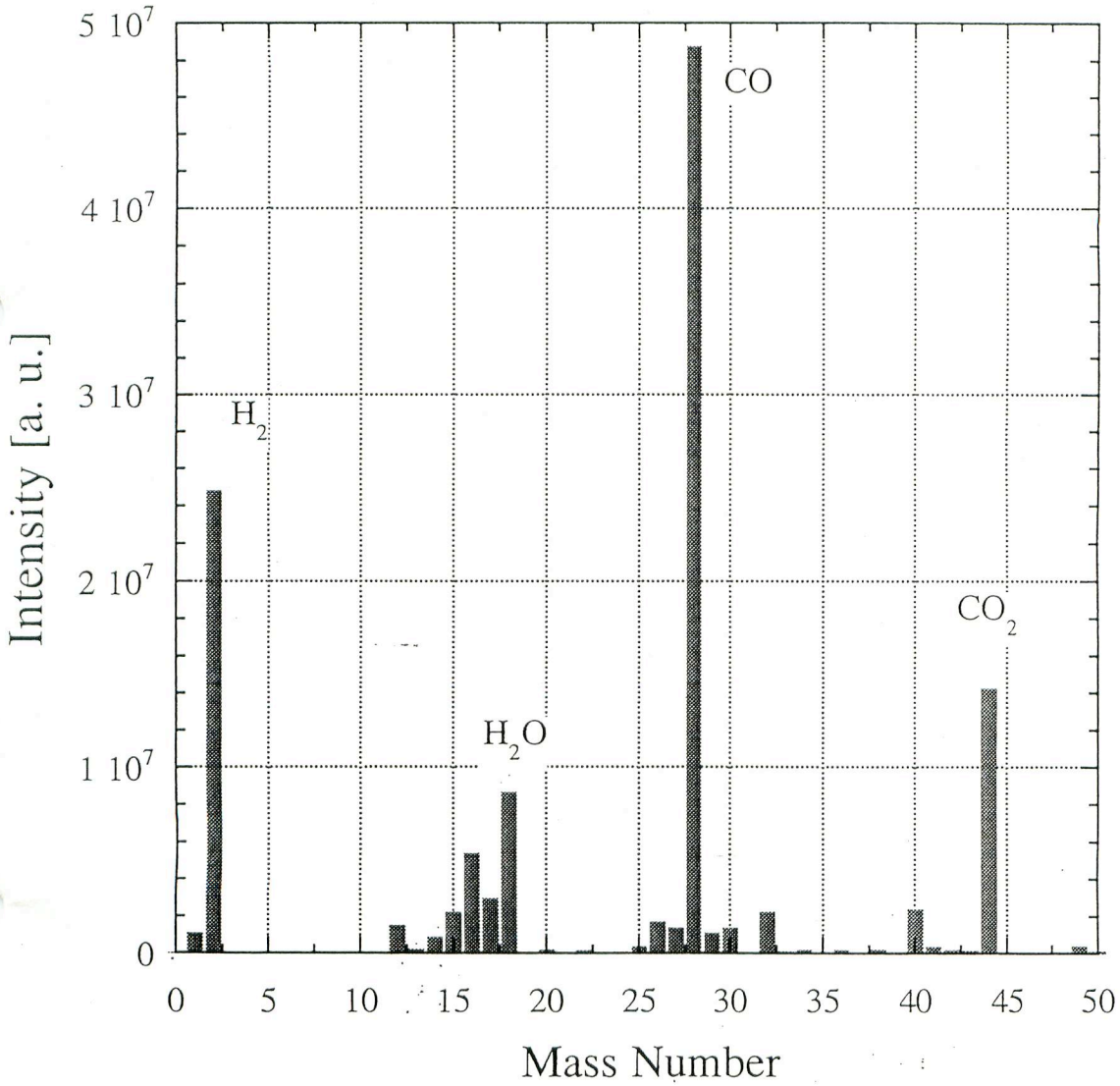
[Pressure (arc D03) <-- Average of 26 CCGs at an arc section]

Beam current & Pressure (arc)



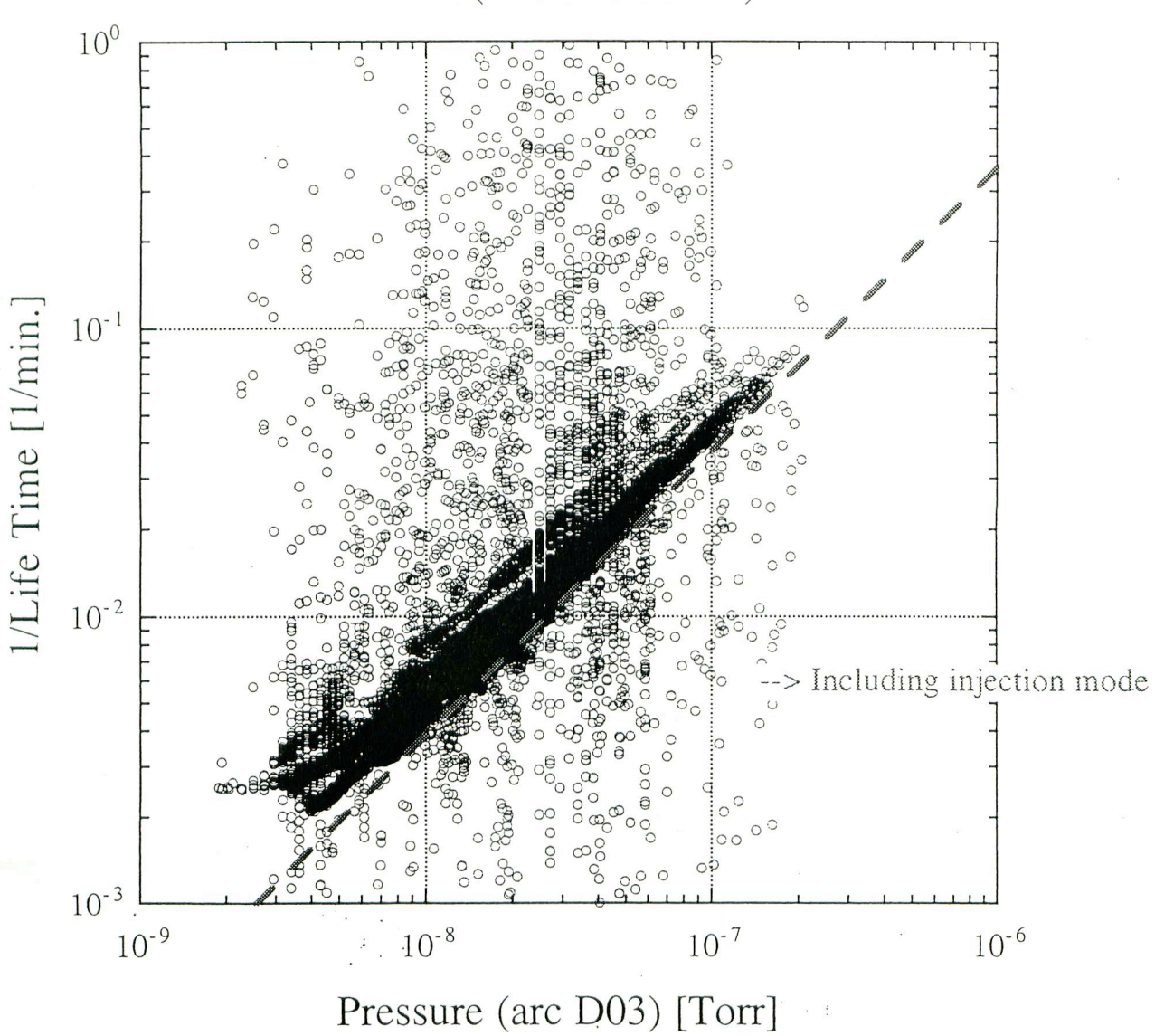
Base Pressure ~ 4×10^{-10} Torr

Residual Gas with Beam (LER, 20 mA)



About 50 % of residual gas is CO during operation.
Without beam, main gas is H_2.

Life time vs. Pressure

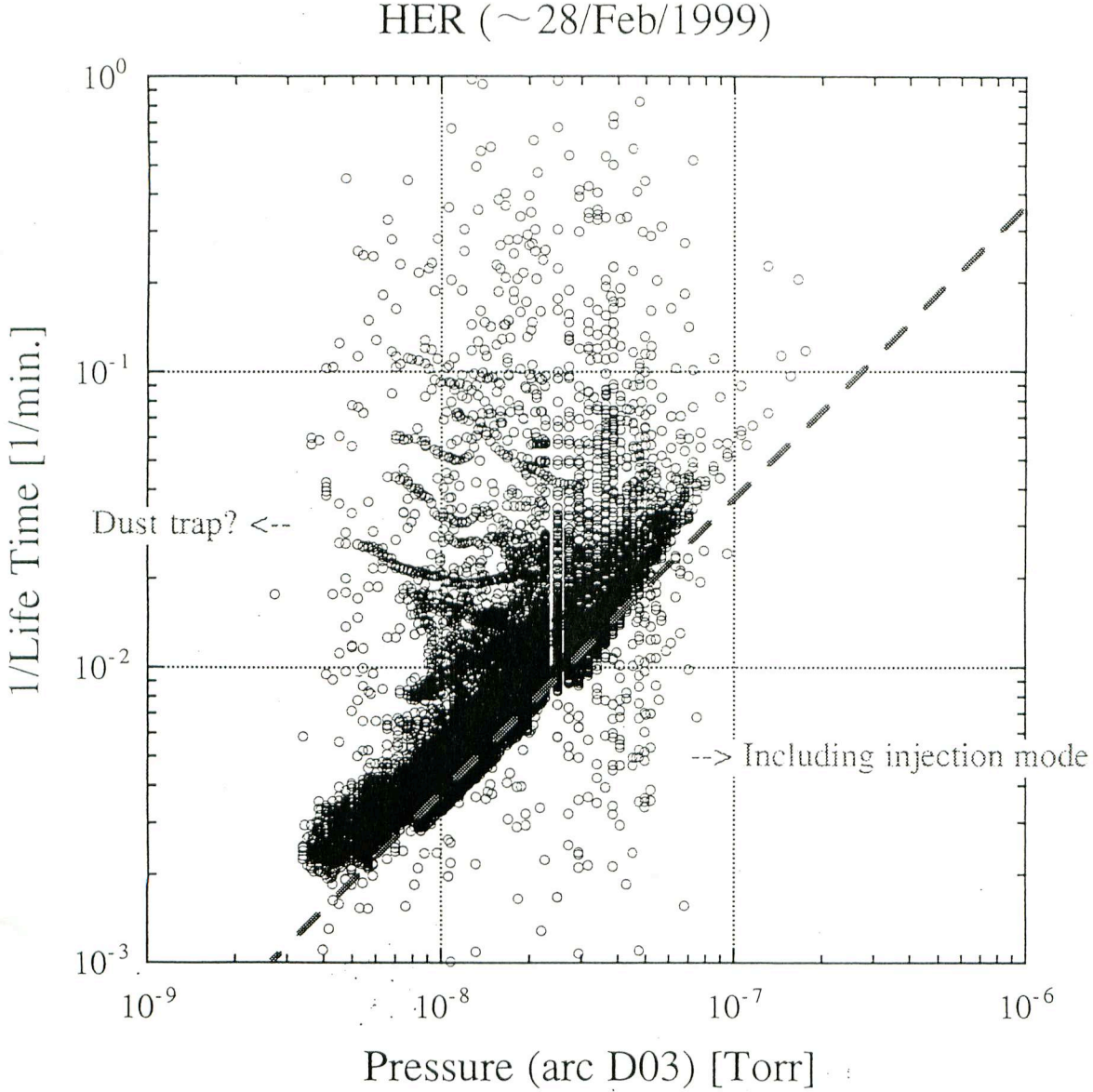


– – – P x Life = 2.7×10^{-6} [Torr min.]

Assuming : Main gas = CO
Bremsstrahlung
$\Delta E/E = 1$ %

Normally the beam life time is determined by pressure.

Life time vs. Pressure



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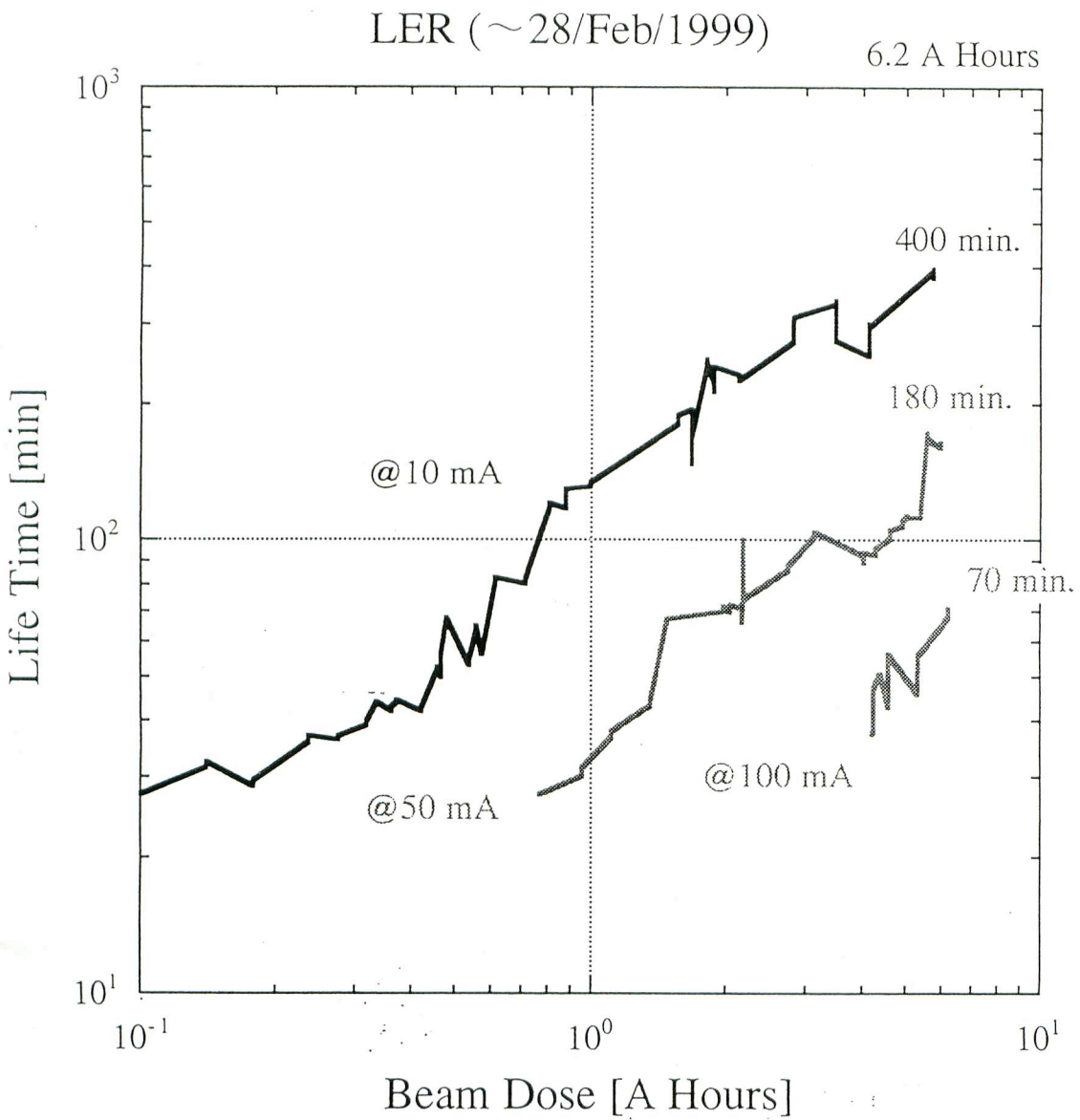
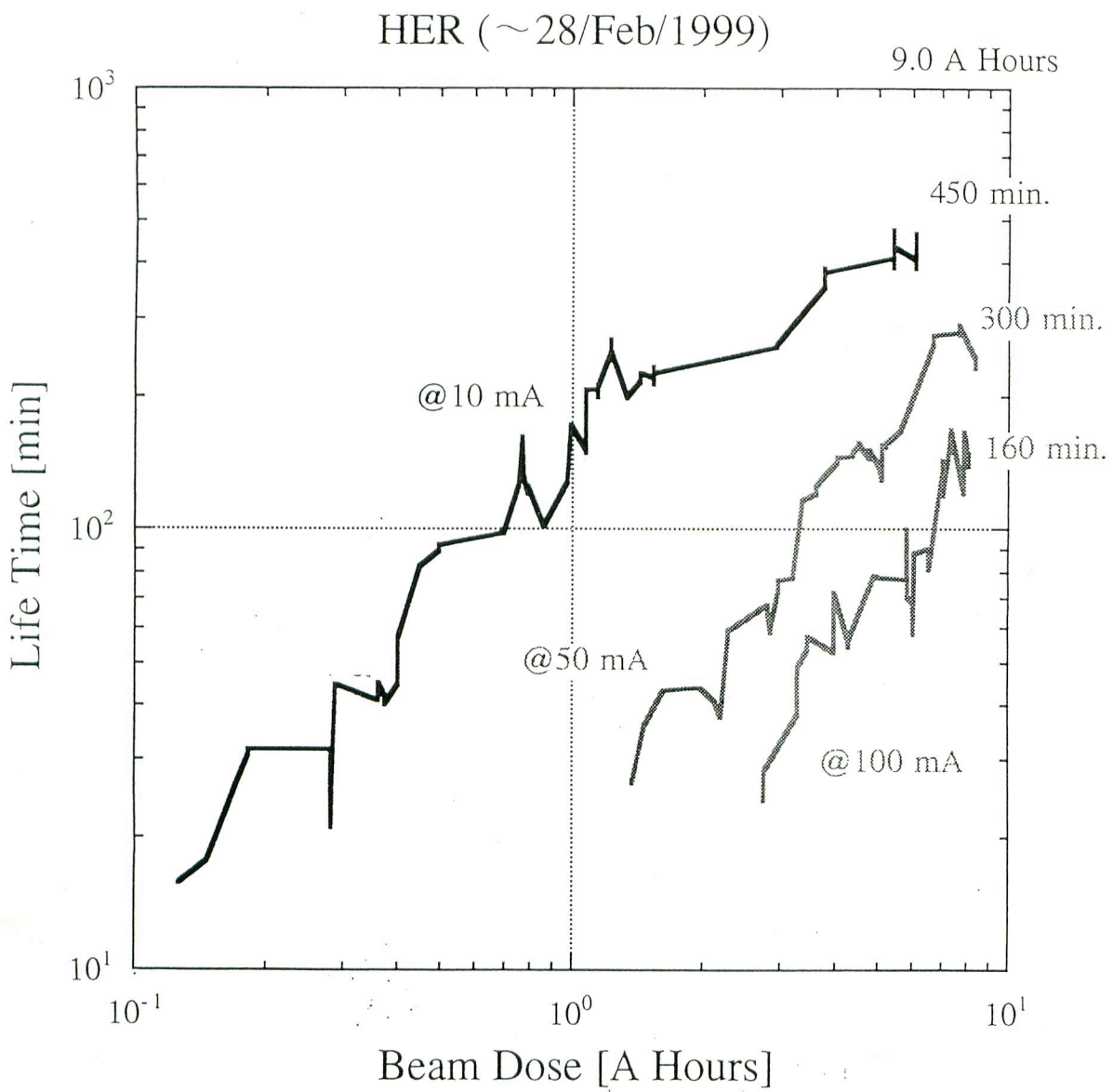
Life Time vs. Beam Dose



At ~6 A Hours,
50 min @150 mA
30 min @ 200 mA

Life Time increases monotonically with beam dose.

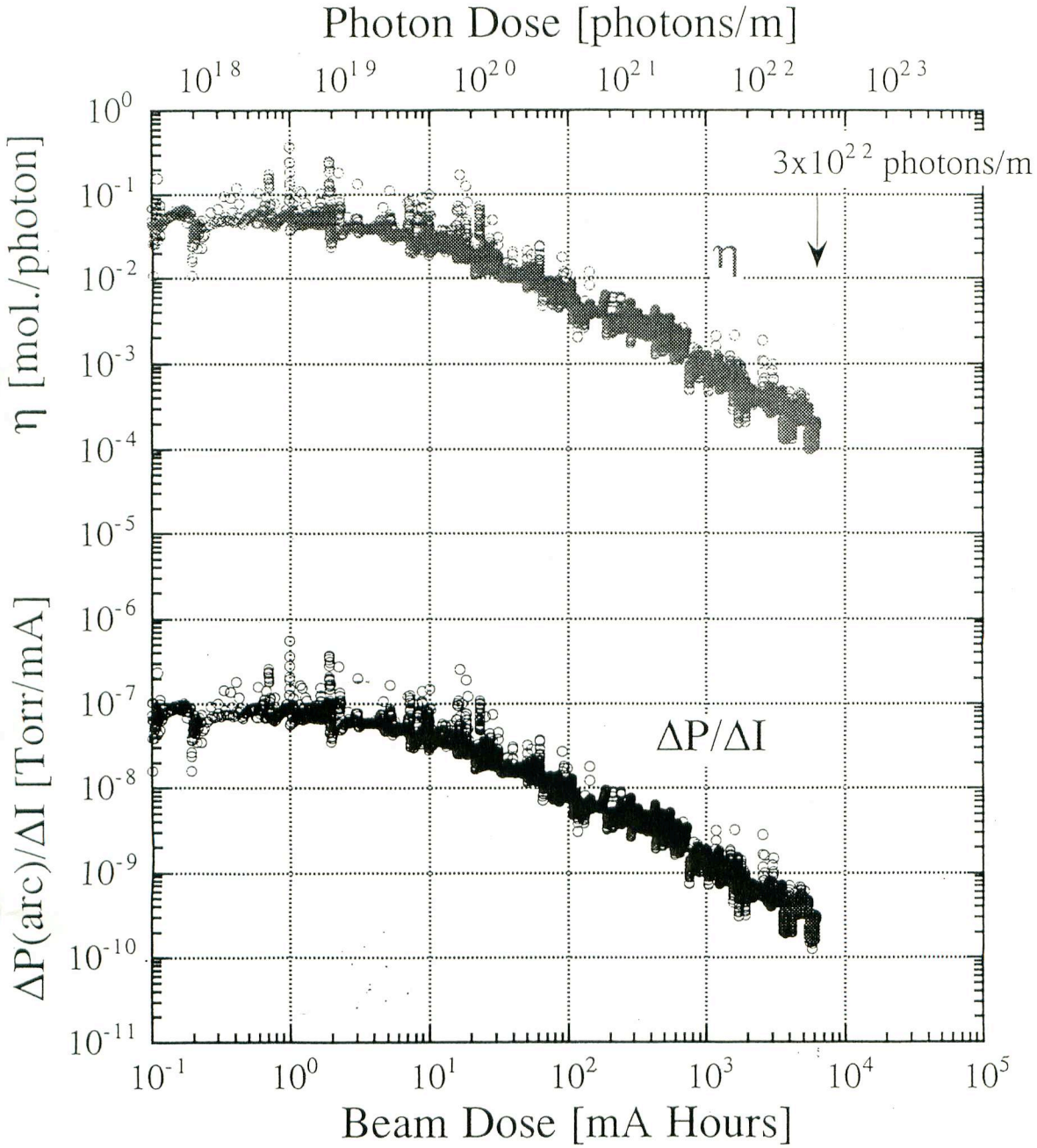
Life time vs. Beam Dose



At ~8 A Hours,
120 min @150 mA
80 min @200 mA

Decrease of photo-desorption rate (η)

LER (～28/Feb/1999)

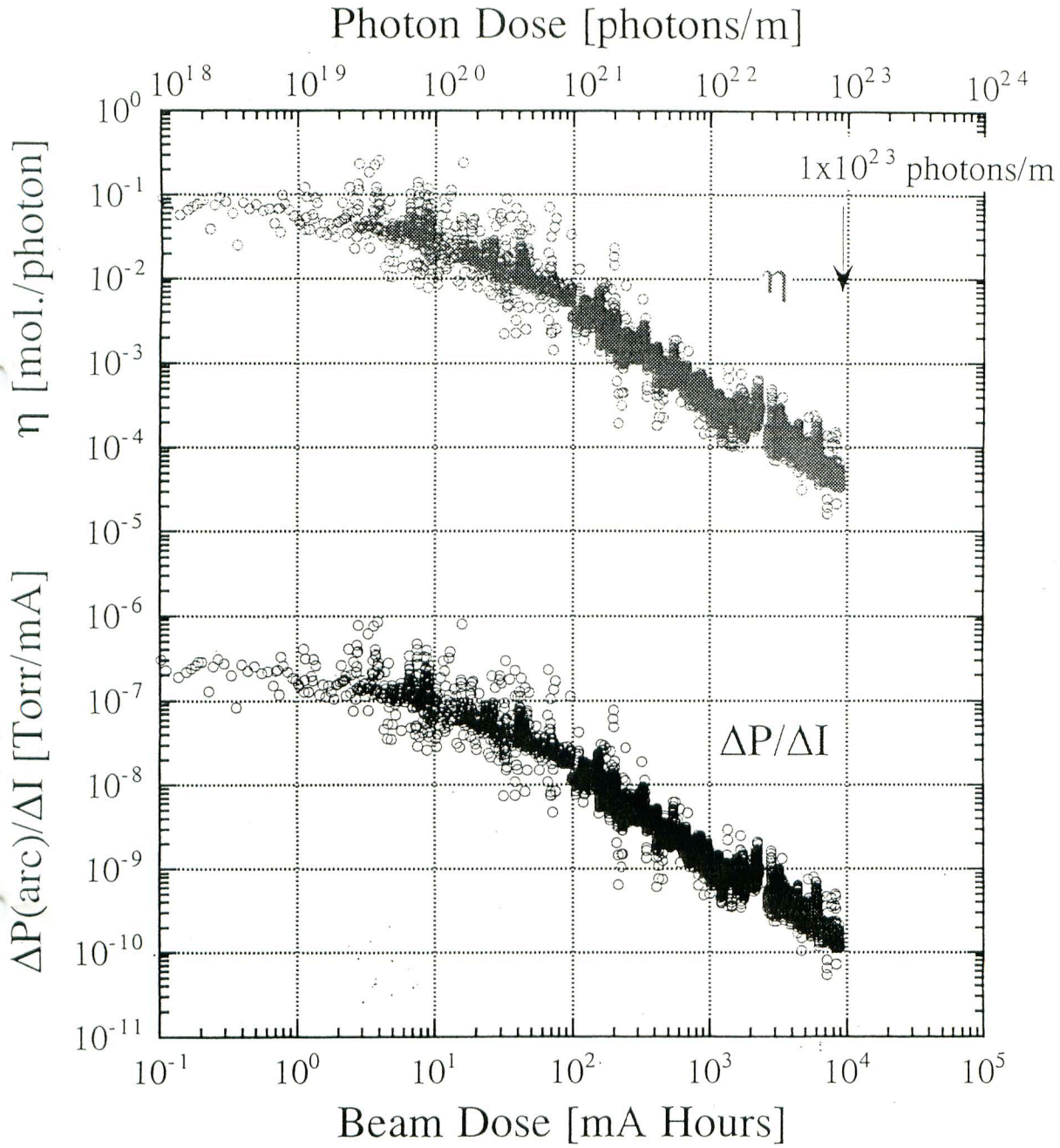


To calculate η,
a constant linear pumping speed (S) = 30 l/s/m was assumed.

For the beam dose > 100 mA Hours,
η decreases with -1～-2/3 power of beam dose.

Decrease of photo-desorption rate (η)

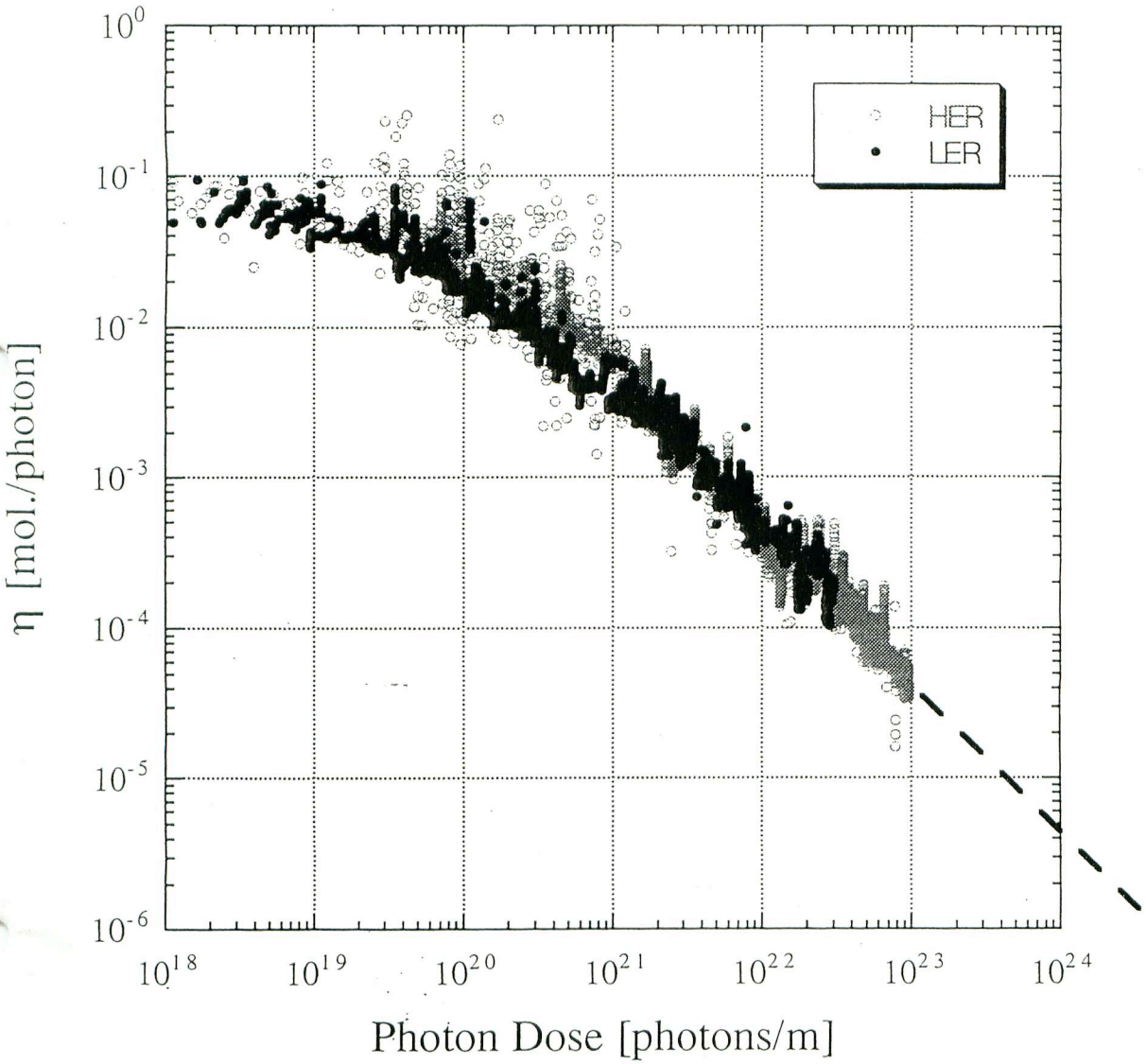
HER (~28/Feb/1999)



To calculate η,
a constant linear pumping speed (S) = 30 l/s/m was assumed.

For the beam dose > 100 mA Hours,
η decreases with ~-1 power of beam dose.

η of LER & HER (~28/Feb/1999)



η decreases in almost same way for LER & HER.

η will reach to 1×10^6 [mol./photon] at several times 10^{24} photons/m.

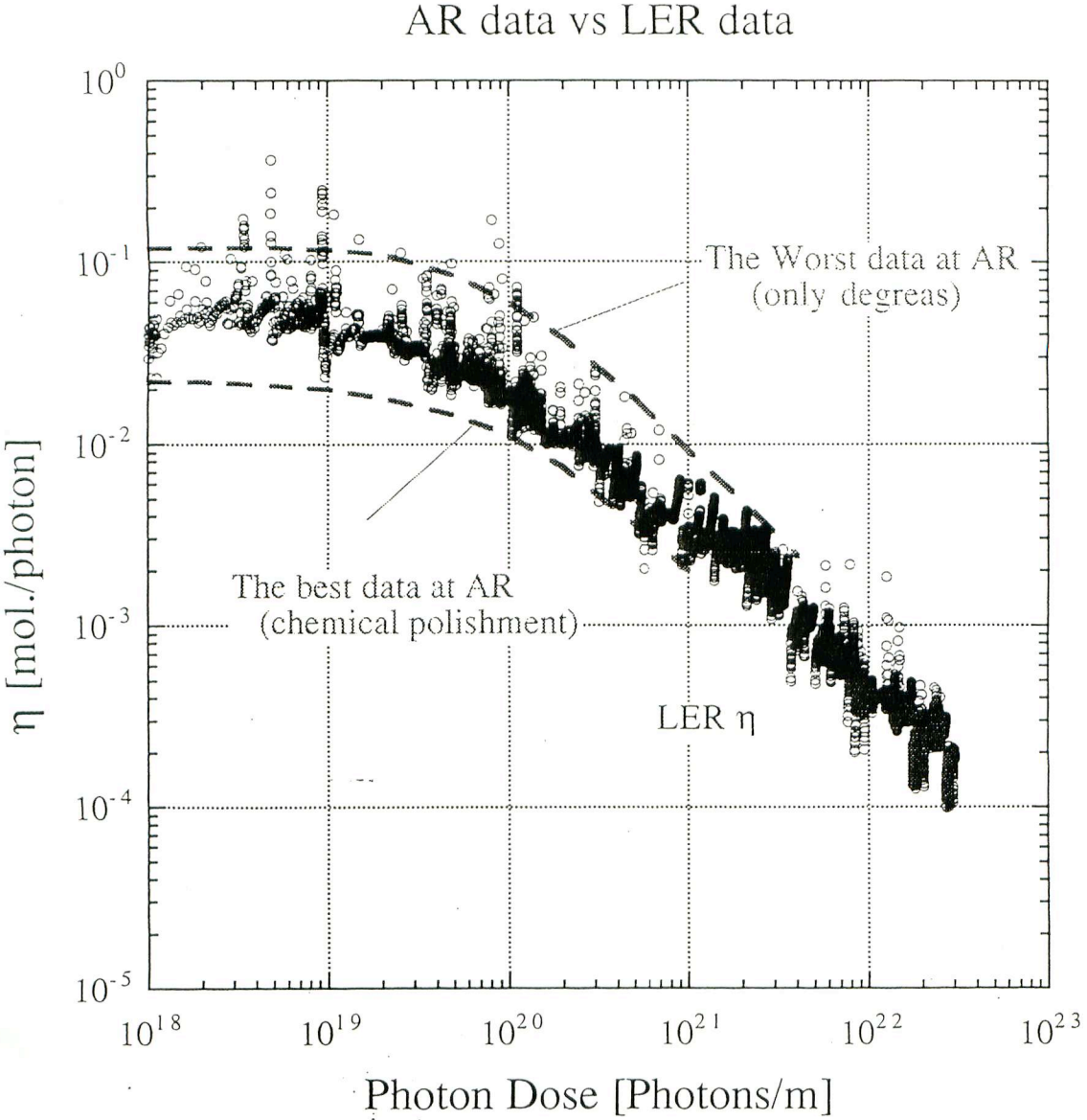
↓

~5×10^5 mA Hours for HER

~1×10^6 mA Hours for LER

Comparision of LER η with R&D data at AR

(TRISTAN Accumulation Ring)



Experiment at AR:

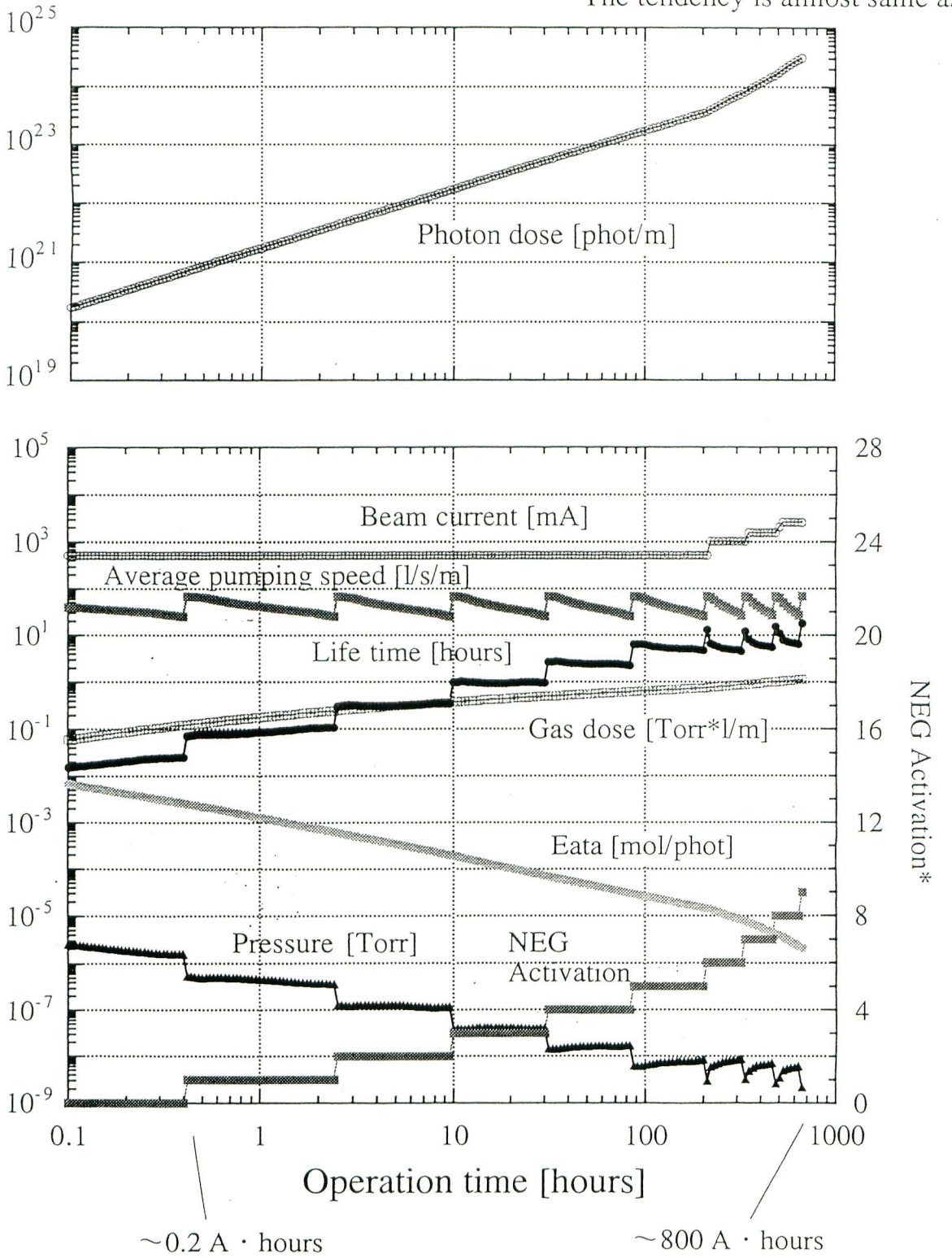
Chamber : Copper (OFC)
Critical Energy of SR : 26.3 keV (6.5 Gev beam)
(LER : 5.9 keV)

η of LER(and HER) is in the reasonable range.

Last year's OHP

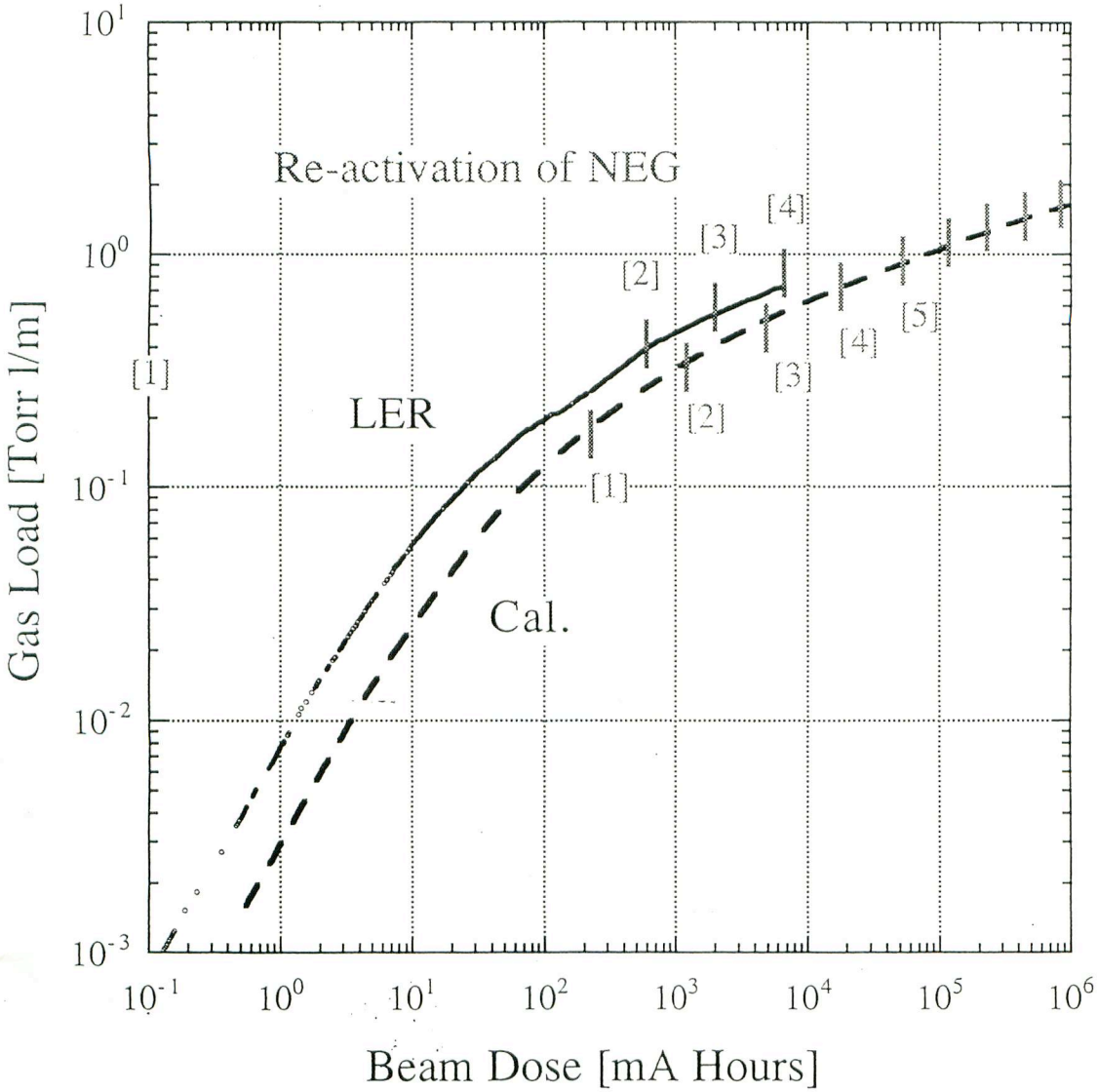
Result of simulation for LER

The tendency is almost same as HER.



*Ion pumps were neglected
Activation was done independent of the life time.

Gas load and re-activation of NEG (LER)
(～28/Feb/1999)



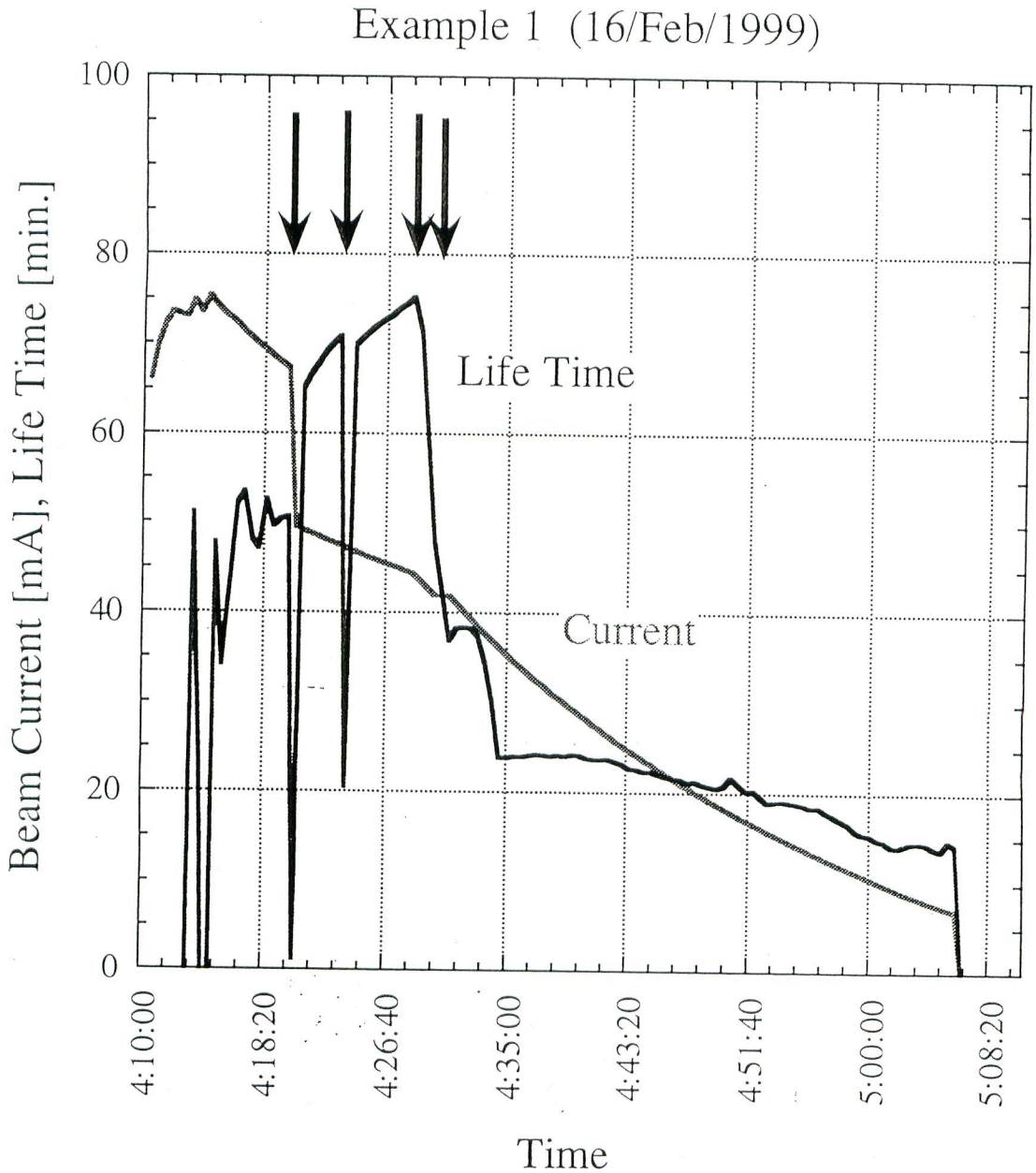
Re-activation of LER is somewhat earler than expectation.

In our layout, total capacity (life time) of NEG is estimated to be more than 30 Torr l/m.

---> No problem

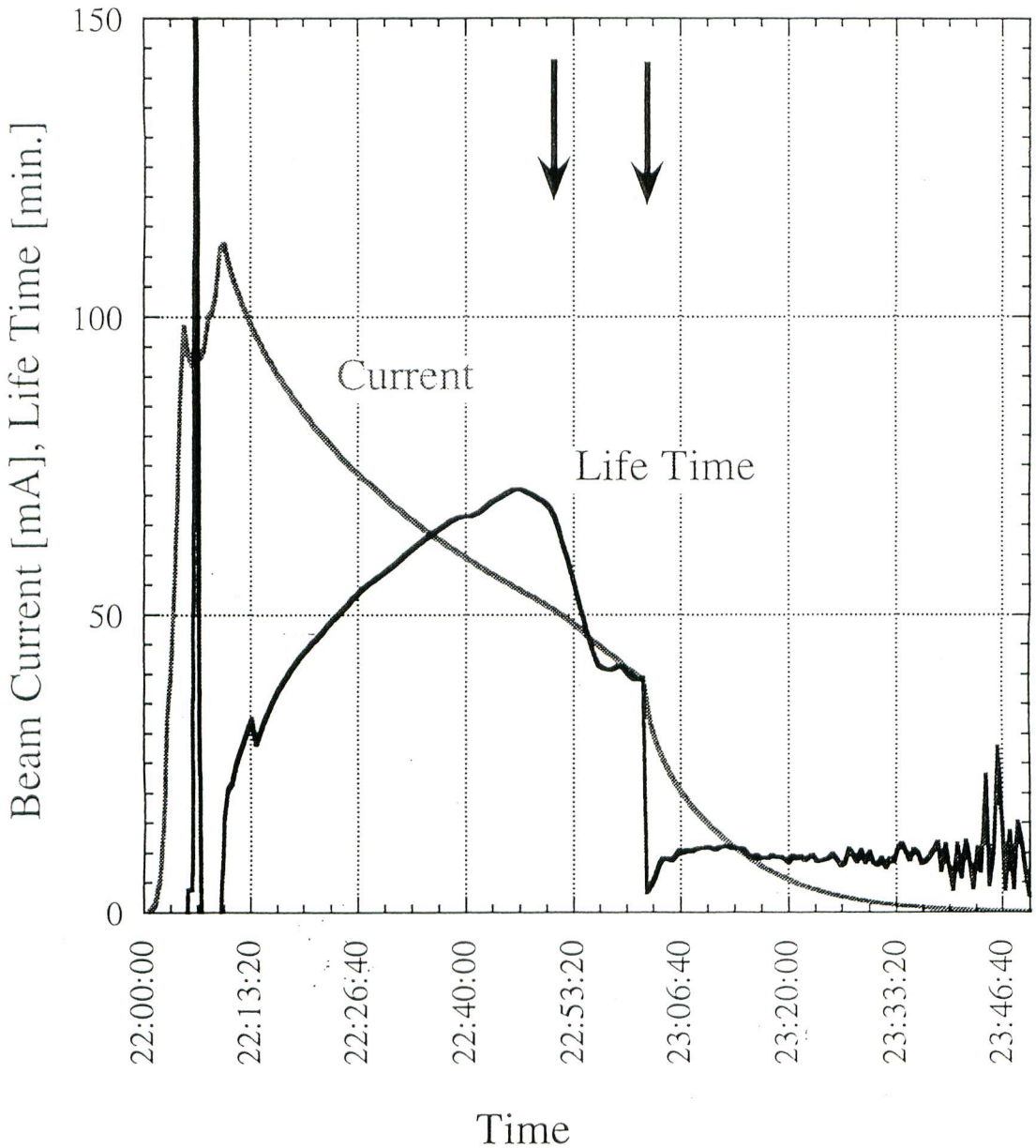
Problems

(1) Dust trapping phenomena at HER



Dust trapping phenomena at HER

Example 2 (18/Feb/1999)



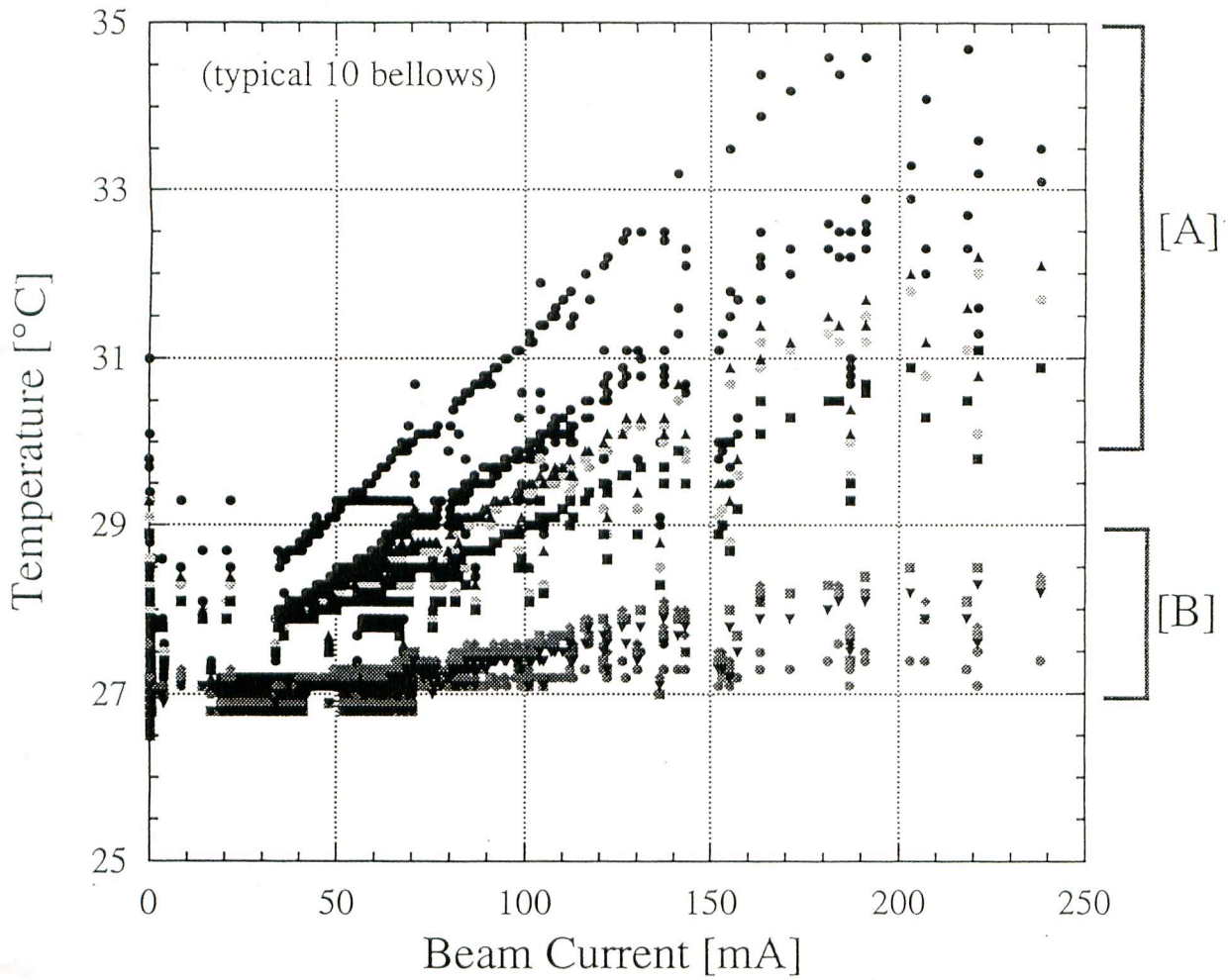
Loss monitor signal is high at only TSUKUBA (IR).
(but it is always high there)

We did not analyze the phenomena yet.
We have to pay more attention after this.

Problems

(2) Heating of chambers and components

[1] Temperature of HER Bellows (20-28/Feb/1999)



Group [A] is located at the most down strem side of water pass including bending magnet.

They will not reflect the temperatures of bellows but that of chambers heated by SR at bending magnet.

8 °C / 200mA (about 6kW/ bending magnet)

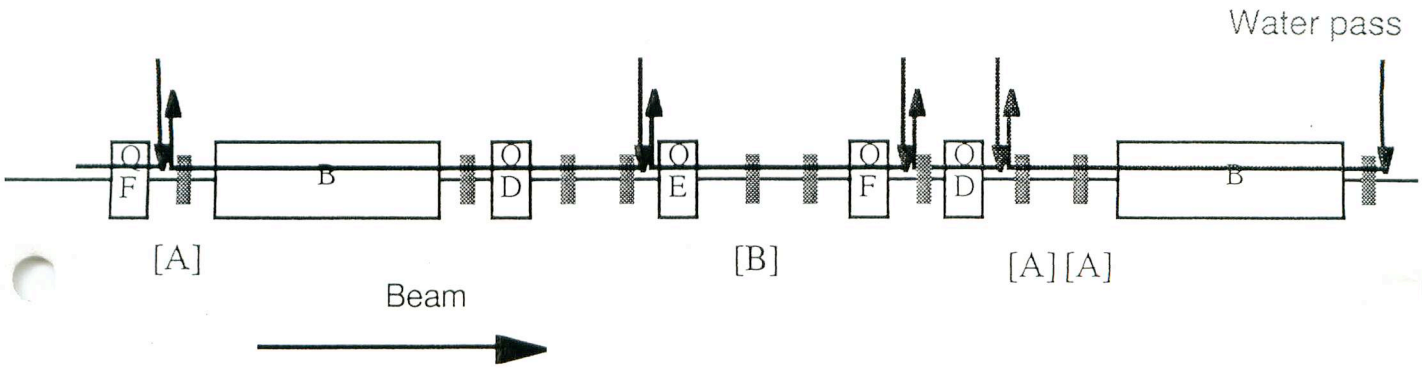
---> Optimization of water pass
Improvement of cooling capacity
(scheduled in this summer)

If [B] shows the temperature of bellows, temperature rise is less than 2°C / 200 mA. ---> No problem

We observed little problem for LER up to now.

Present water pass (typical)

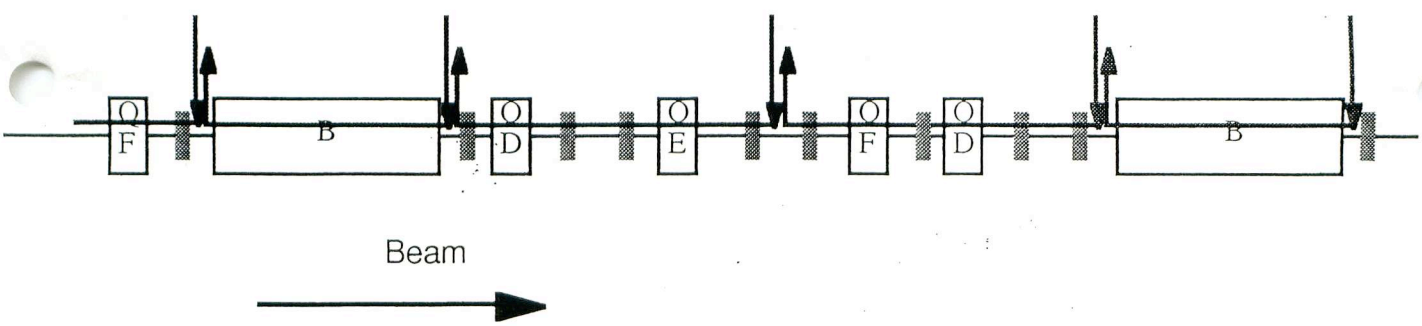
Schematic layout of HER



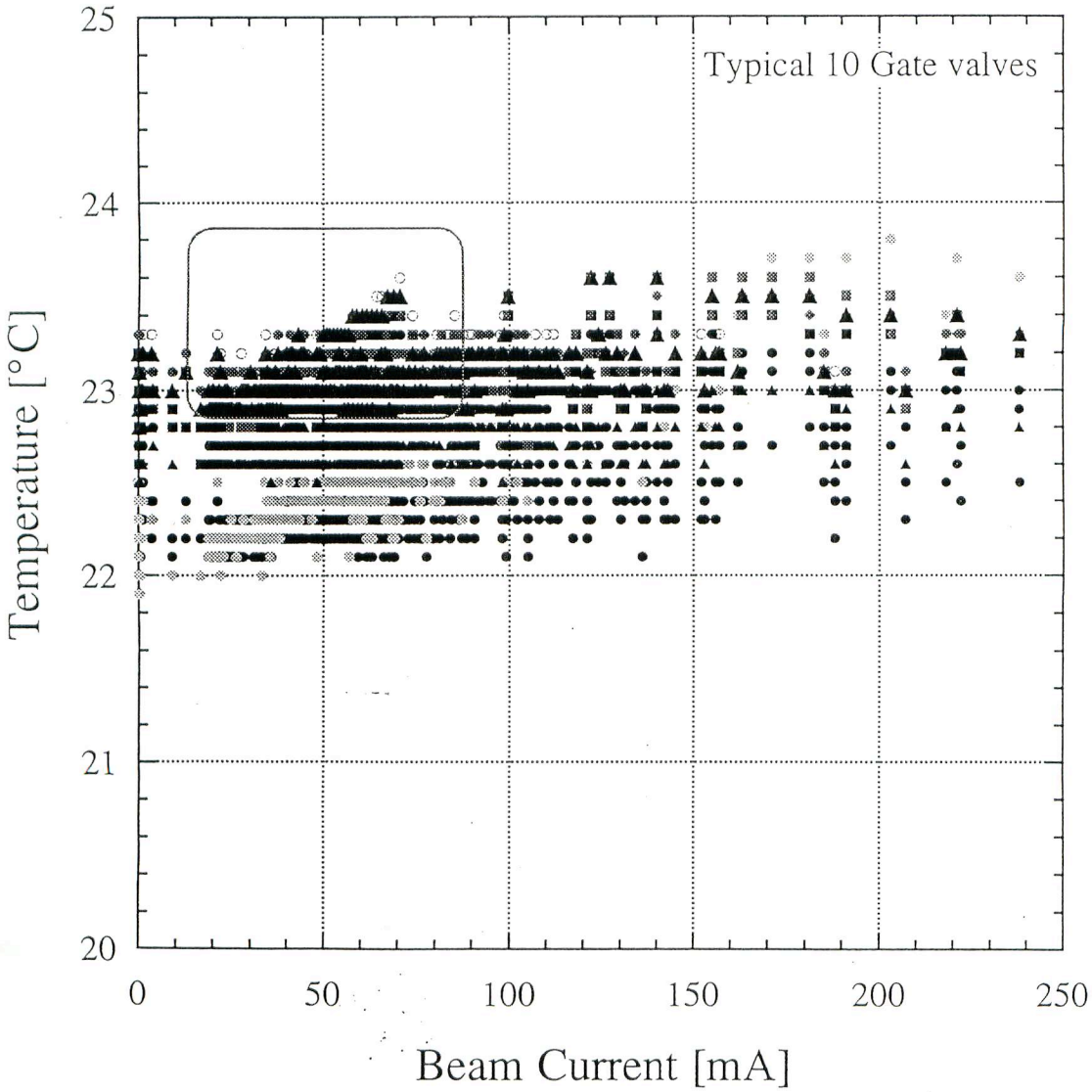
Length of water pass is not regular now.
(It is independent of SR power distribution)

Optimization

For example



[2] Temperature of HER Gate Valves (20-28/Feb/1999)



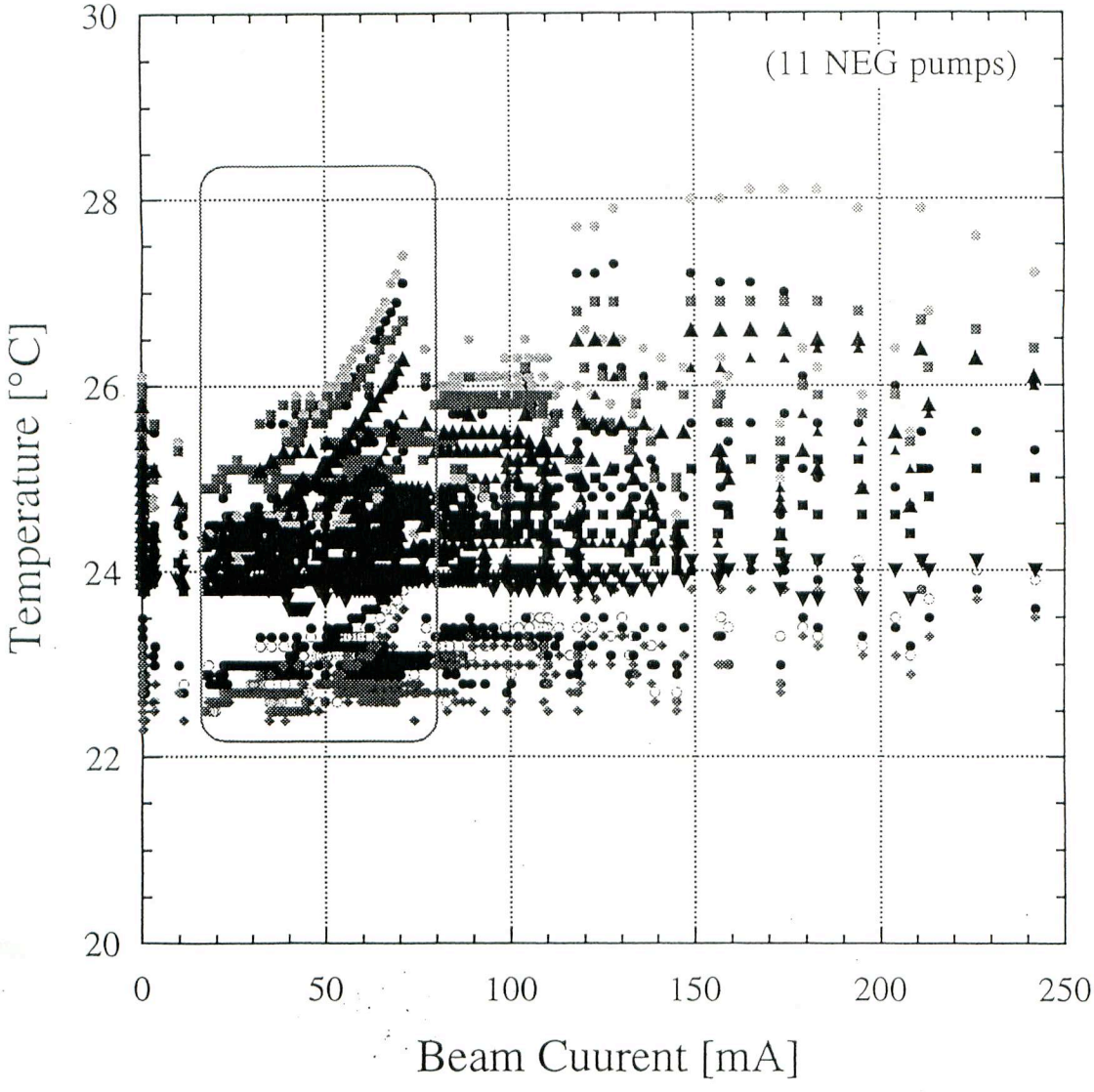
Usually temperature rise is less than 1°C / 200 mA.

But some opetation, it may be larger than 1°C / 100 mA and seems to in proportion to the square of beam current.

---> We have to be careful in future.

No problem for LER Gate valves up to now.

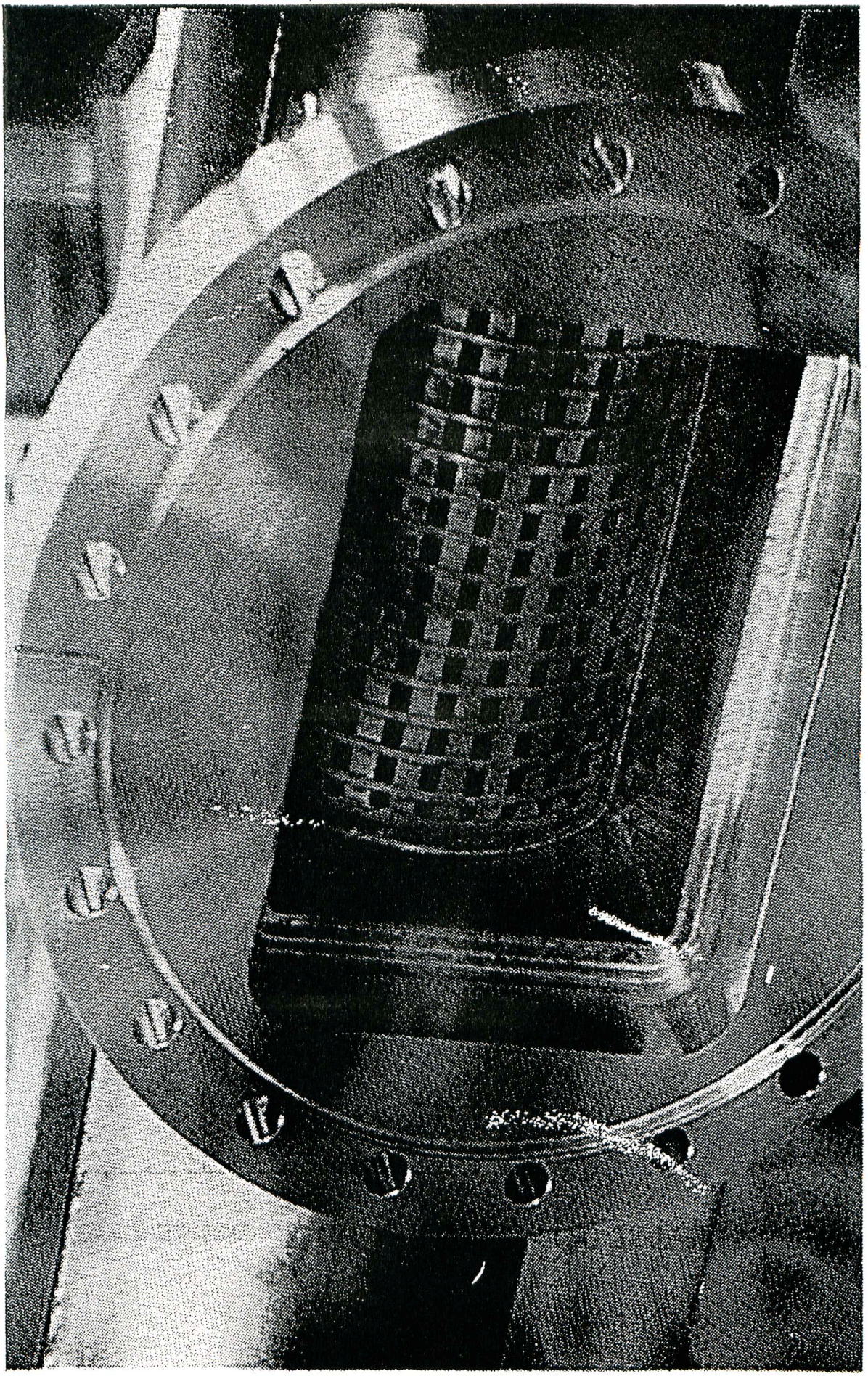
[3] Tempetrature of HER NEG Pump (20-28/Feb/1999)



Usually temperature rise is about 4 °C / 200 mA.
But some operation, it may be larger than 6°C / 100 mA
and also seems to in proportion to the square of beam current.

The same tendency can be seen for some of LER NEG pumps.

We have to keep watching these temperaturs in future.



Troubles (Vacuum break)

[1] Mis-production of Moving Mask near IR
RF-shield does not work. --> in danger of arcing
It gives a little small aperture for injection.
4/Jan/1999 : Removed
27/Jan/1999 : Restored

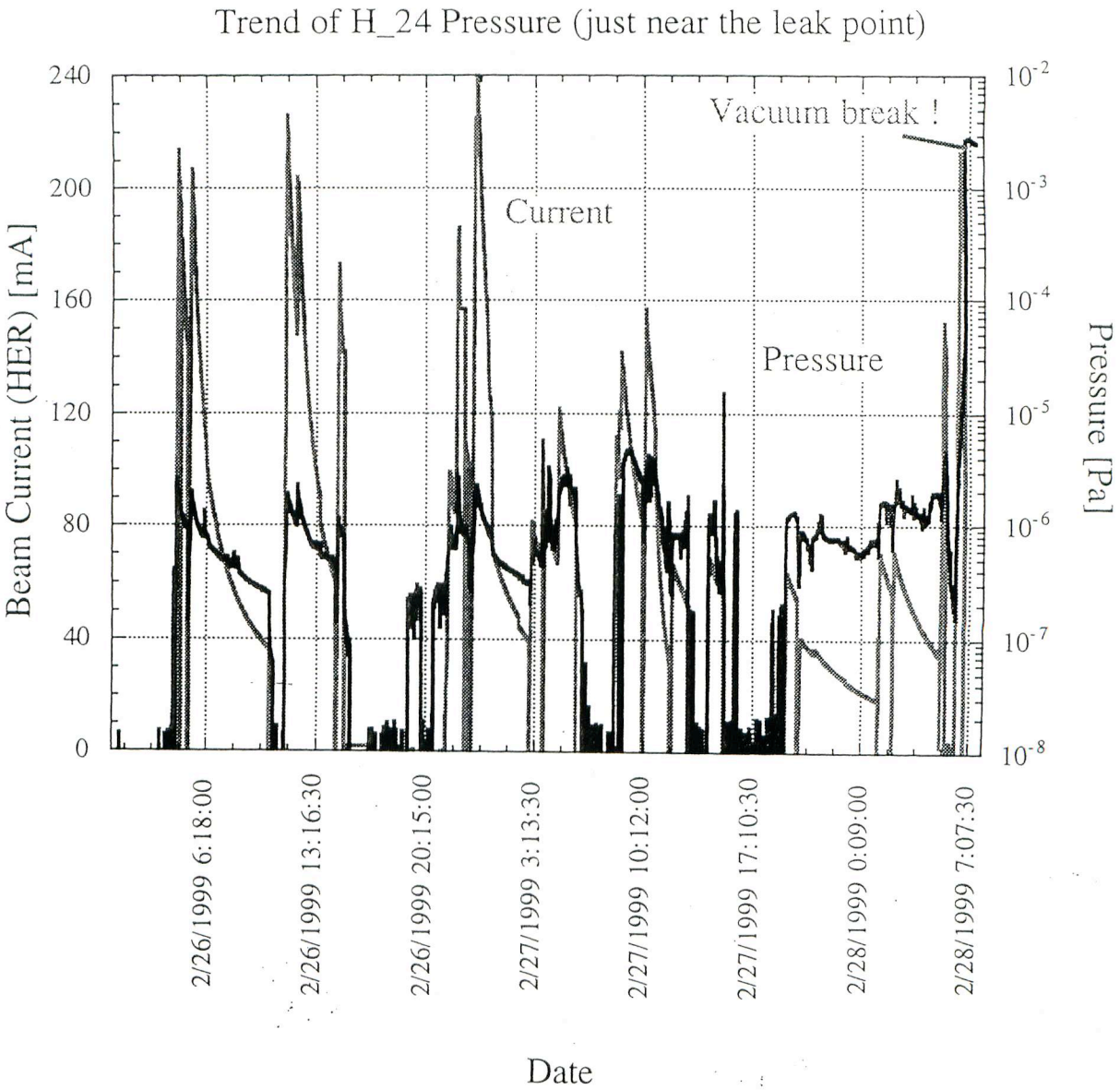
[2] Inspection inside of QC2 chamber at IR (10/Feb/1999)
To check the physical aperture
--> Not guilty!

[3] Vacuum leak at QC2RE chamber at IR (28/Feb/1999)
Over heating of chamber due to SR from QCS (and HOM?).
(to be talked by Kanazawa)

On the view point of the vacuum system,
there were two serious problems:
(1) Gate valve did not closed automatically.
Expand the damage (about a half of each ring)
Threshold was 10 Torr.
(2) Excess temperature of chamber and the abnormal pressure behavior were overlooked.

(1) Inadequate interlock system for high current operation
--> Reexamination of interlock system
Pressure (several CCG gauges) >1×10^{-5} Torr
--> Beam abort signal (less than one second)
--> Close all Gate valves (in 10 seconds)

(2) Poor alarm system
--> Arrangement of more thermo-sensors at anxious parts
--> Reexamination of alarm system
Maximum temperature (> 80 °C),
Pressure (> 1×10^{-6} Torr),
Flow rate of cooling water (< 2 l/min.)


Trend of H_24 Pressure (just near the leak point)
Beam Current (HER) [mA]
240
200
160
120
80
40
0
Pressure [Pa]
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
Vacuum break !
Current
Pressure
2/26/1999 6:18:00
2/26/1999 13:16:30
2/26/1999 20:15:00
2/27/1999 3:13:30
2/27/1999 10:12:00
2/27/1999 17:10:30
2/28/1999 0:09:00
2/28/1999 7:07:30
Date

Summary

[1] •"Vacuum" in the ring is almost satisfactory.
The decrease of photo-desorption rate is near our expectation.
•Vacuum seal by Helicoflex is stable.

[2] •We have to keep watching to dust trapping phenomena and heating of chambers and components.
•The optimization of cooling pass and the improvement of cooling capacity is scheduled at this summer.
•The bellows showed no significant temperature rise up to now.

[3] •There were inadequate interlock system and alarm system against high current operation. Reexamination of these system is an urgent subject and is undergoing.