Present status of 200keV polarized electron gun at Nagoya University

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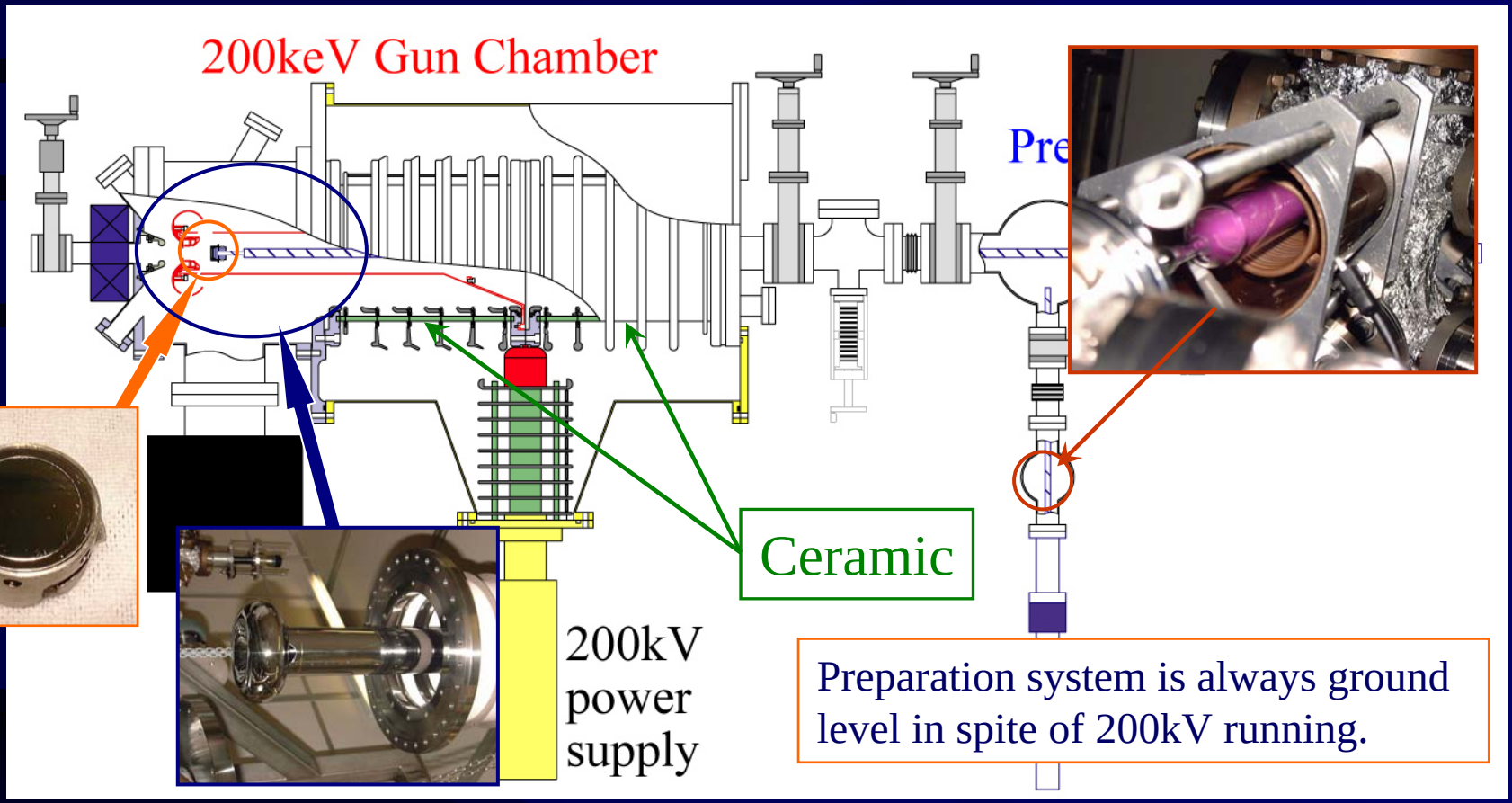
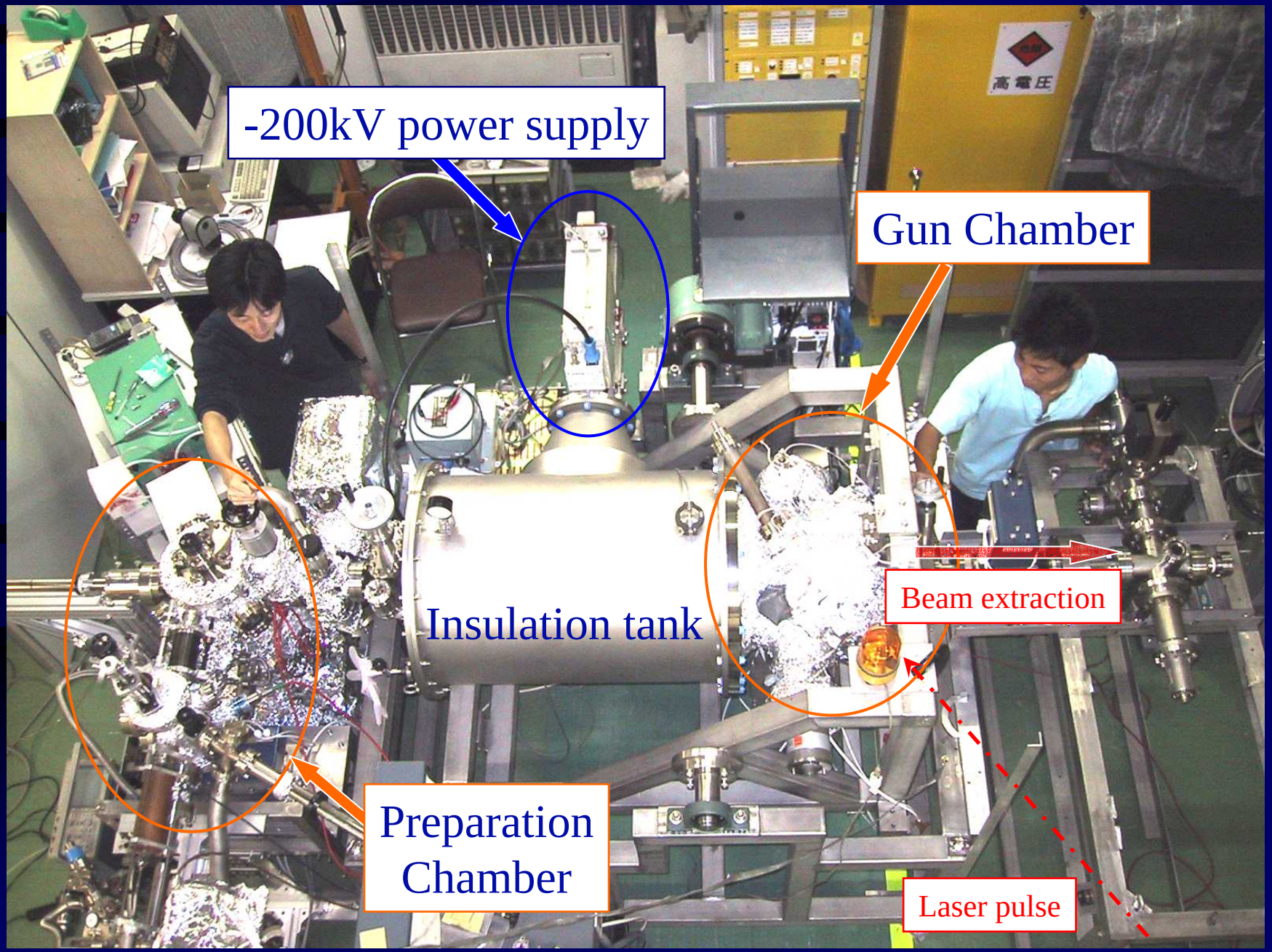
Features of the 200kV Gun



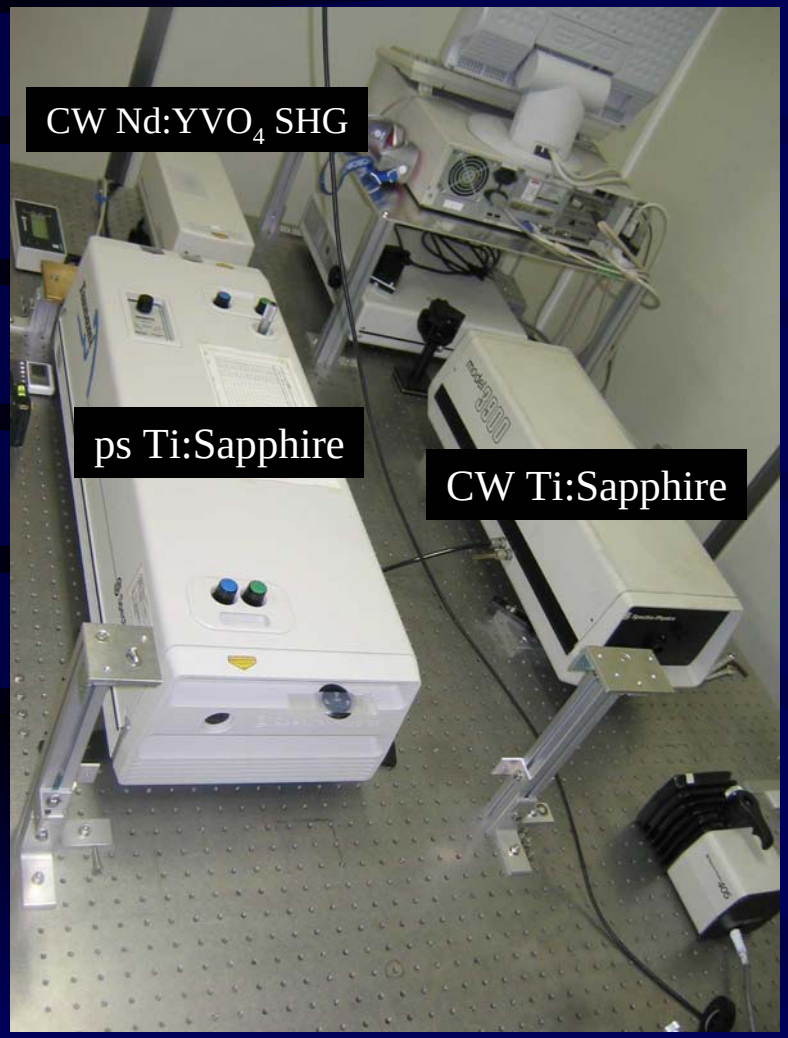
- Load lock system
- Clean-Z (re-melted SUS316L)
- Electro-buff polishing (R<0.12 μ m)

→ Dark current < 1nA (@200kV)

- 3.0MV/m @ photocathode surface
- Double ceramics insulation
- Atomic hydrogen cleaning


-200kV power supply
Gun Chamber
Insulation tank
Beam extraction
Preparation Chamber
Laser pulse

Laser (1)



CW Nd:YVO_4 laser (SHG)
(Millenia VsJ: Spectra Physics)
Power 5W(max), 532nm

Pico-second Ti:Sapphire laser
(Tsunami PS: Spectra Physics)
Pulse width 20 ±1 ps
repetition 81.25 MHz
power 800 mW @780nm

CW Ti:Sapphire laser
(Model 3900: Spectra Physics)
tuning range 750 ~ 950 nm
average power 500 mW

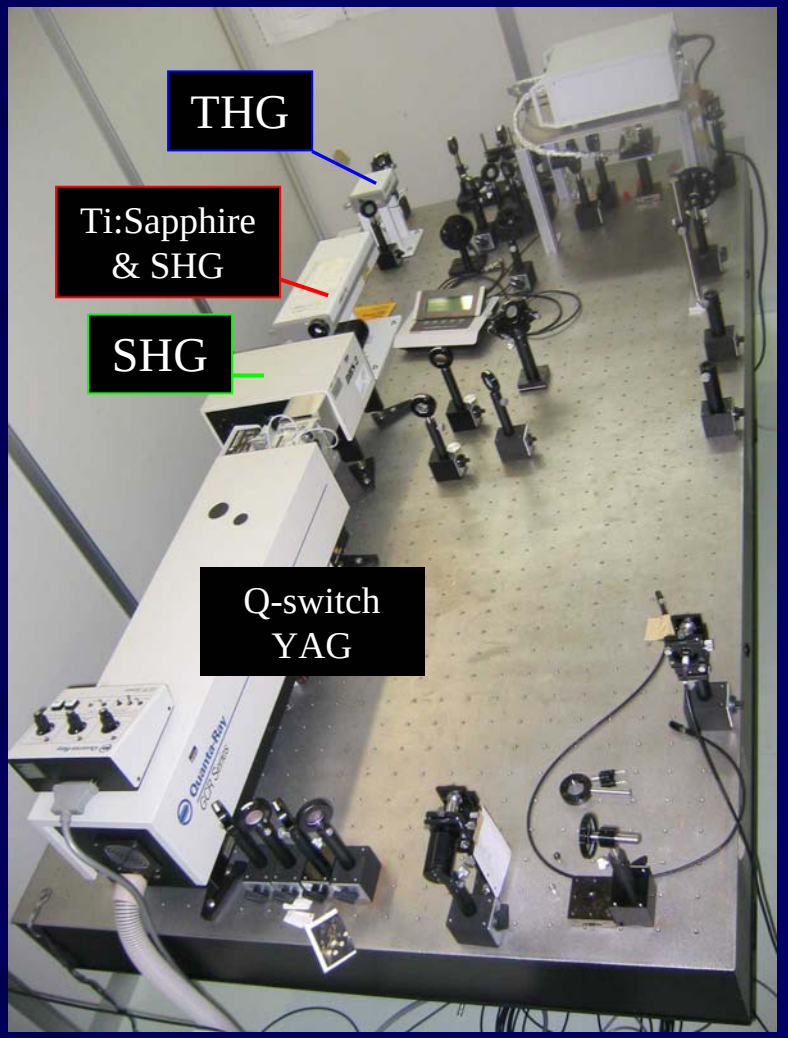
Laser (2)

Q-switch YAG Laser
(GCR-18S: Spectra Physics)
Pulse width ~20 ns
repetition 10 Hz
power 150mJ/pulse @532nm

Ti:Sapphire & SHG
(LT-2211: LOTIS TII)
FF ~ 40 mJ/pulse @780nm
SH ~ 10 mJ/pulse @390nm

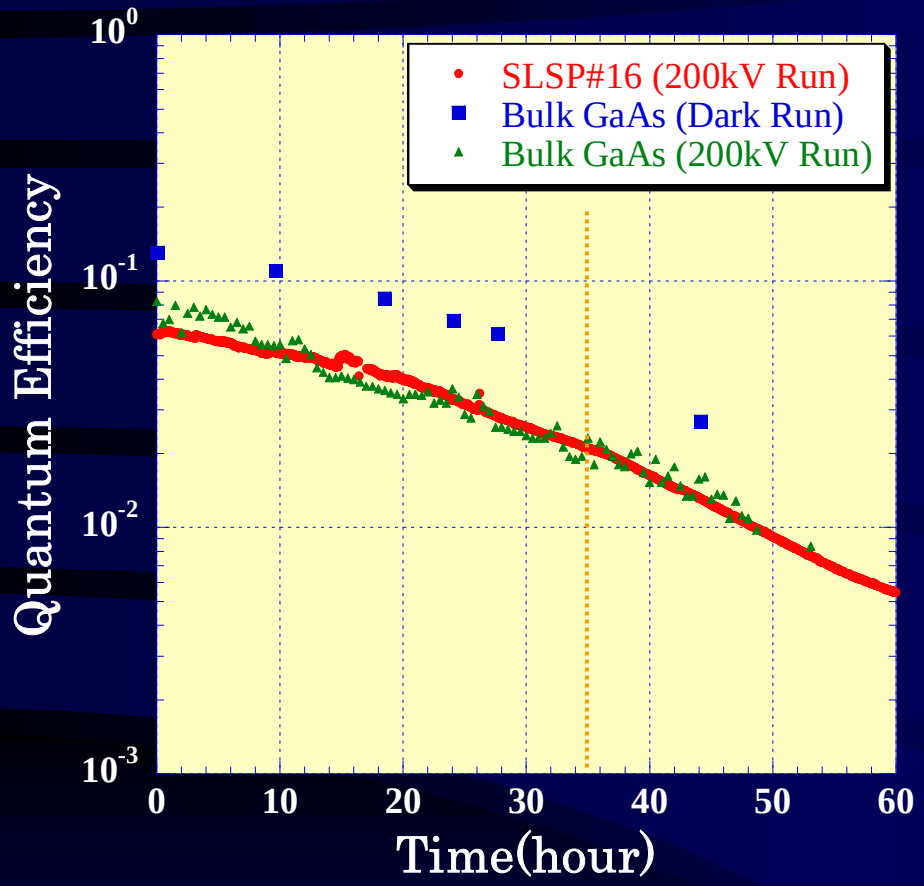
THG (LOTIS TII)
~ 1 mJ/pulse @260nm

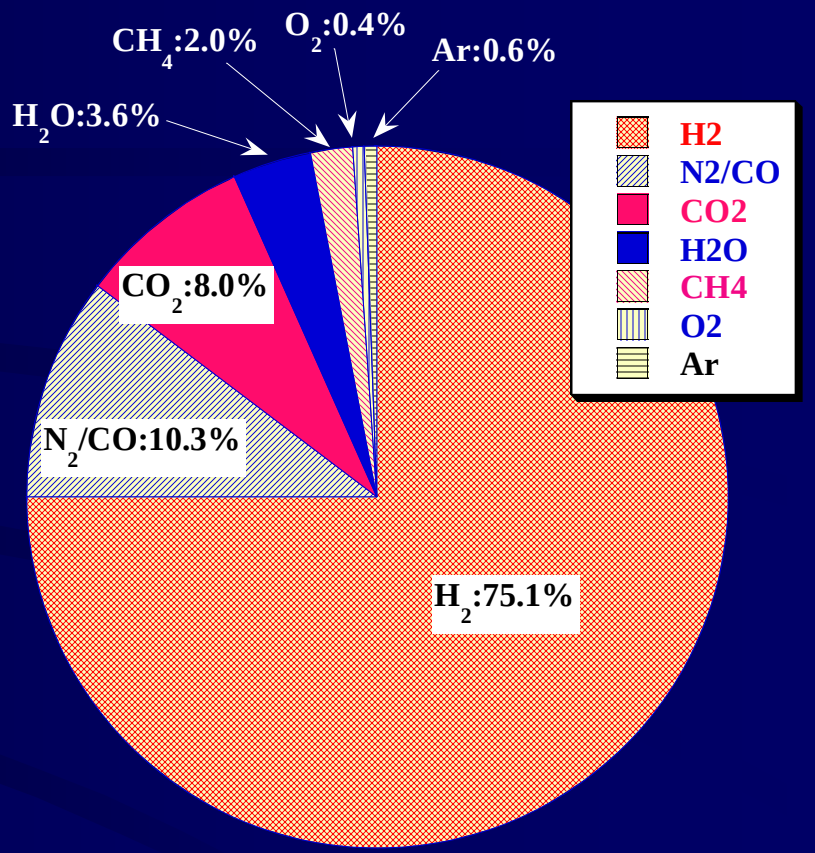
→ Cs_2Te Photocathode experiment



Problem & Improvement

Lifetime problem





Lifetime < 40 hours

Base Pressure : 3.2×10^{-9}Pa

Lifetime was limited by harmful residual gases ?

- H_2O : 1.1×10^{-10}Pa
- CO_2 : 2.3×10^{-10}Pa

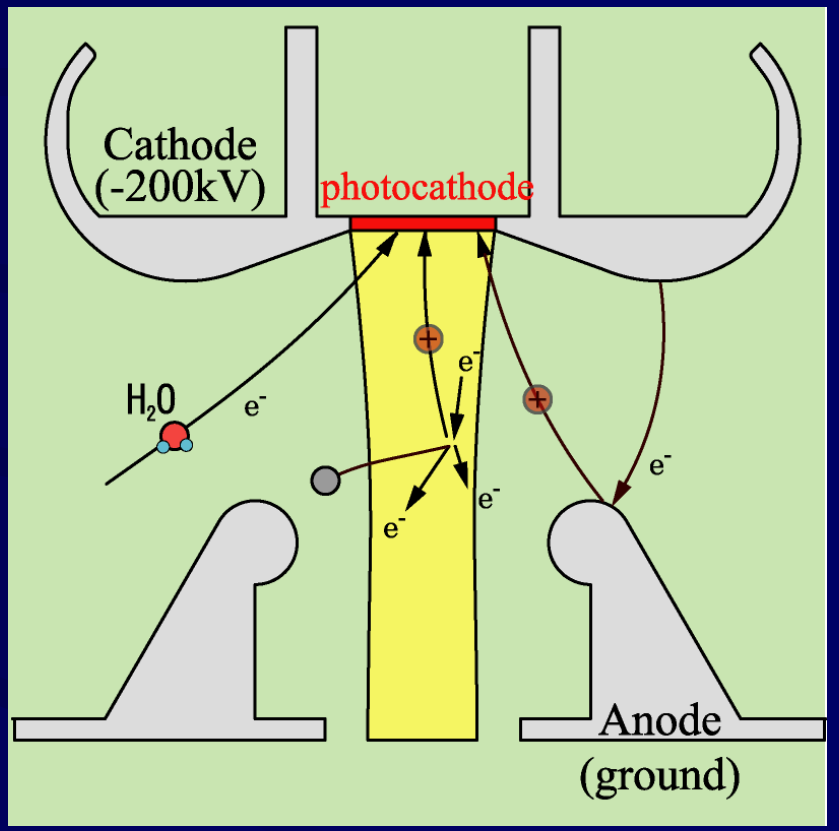
Photocathode Lifetime

$$QE(t) = QE_0 \cdot \exp\left(-\frac{t}{\tau}\right)$$

$$\frac{1}{\tau} = \frac{1}{\tau_{gas}} + \frac{1}{\tau_{DC}} + \frac{1}{\tau_{ion}}$$

τ is determined by ...

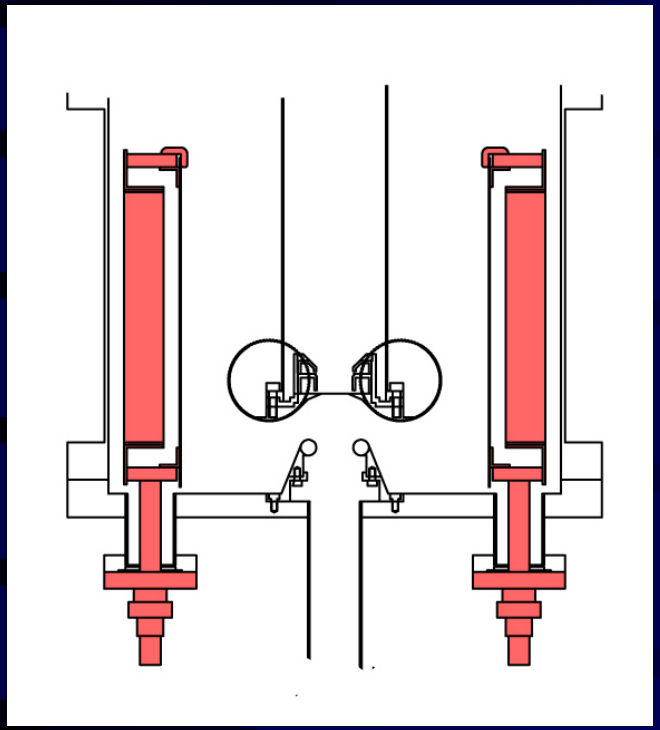
1. Adsorption molecules
2. Field emission
3. Ionization



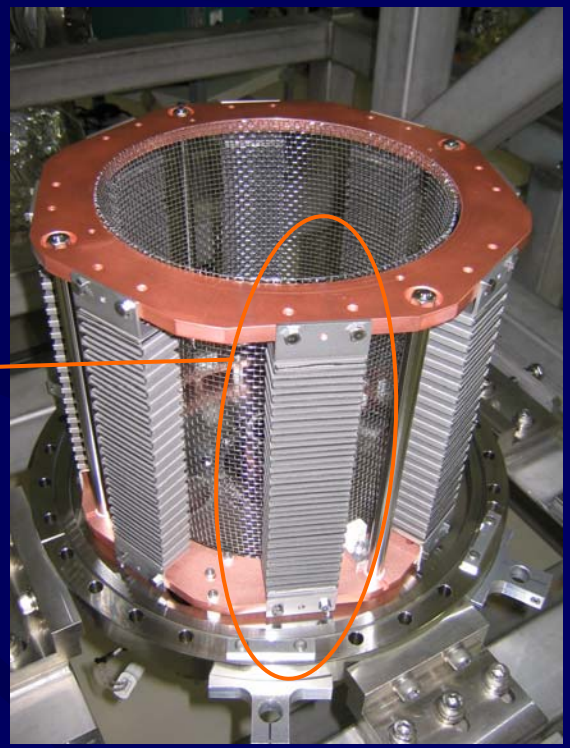
The problem should be conquered first ….

$$\frac{1}{\tau} = \frac{1}{\tau_{gas}} \qquad \tau_{gas} << \tau_{DC}, \tau_{ion}$$

Improvement of a vacuum system

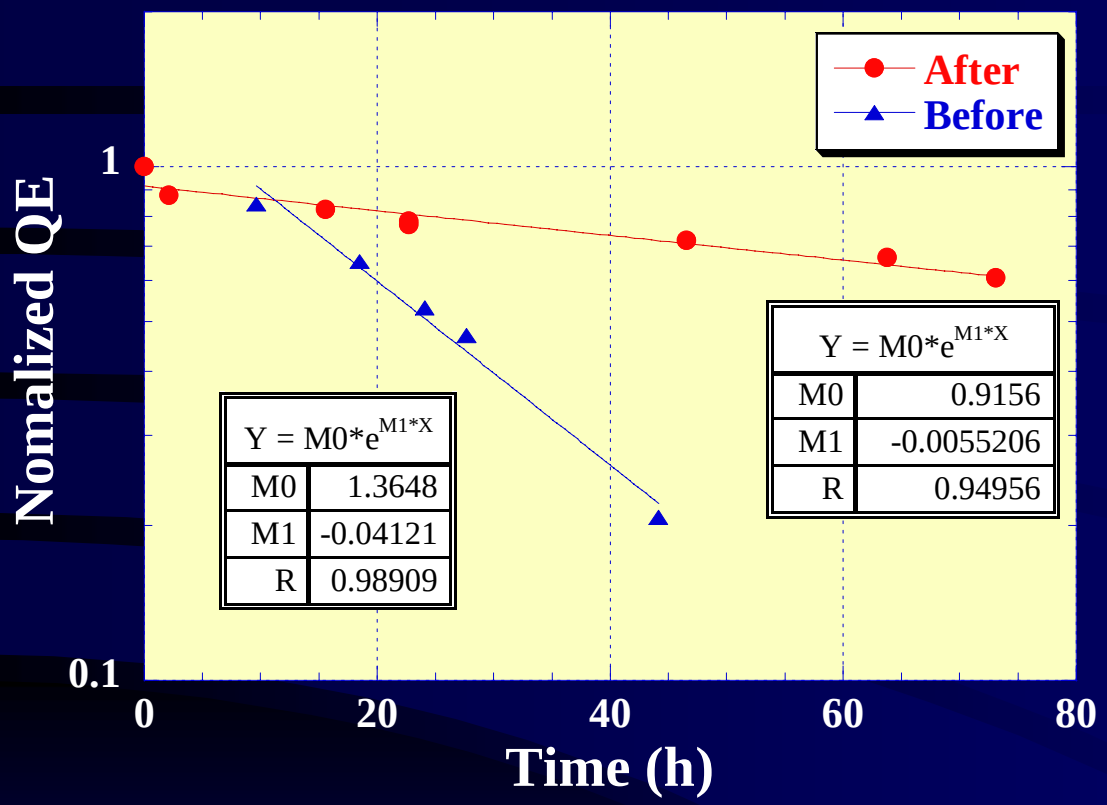


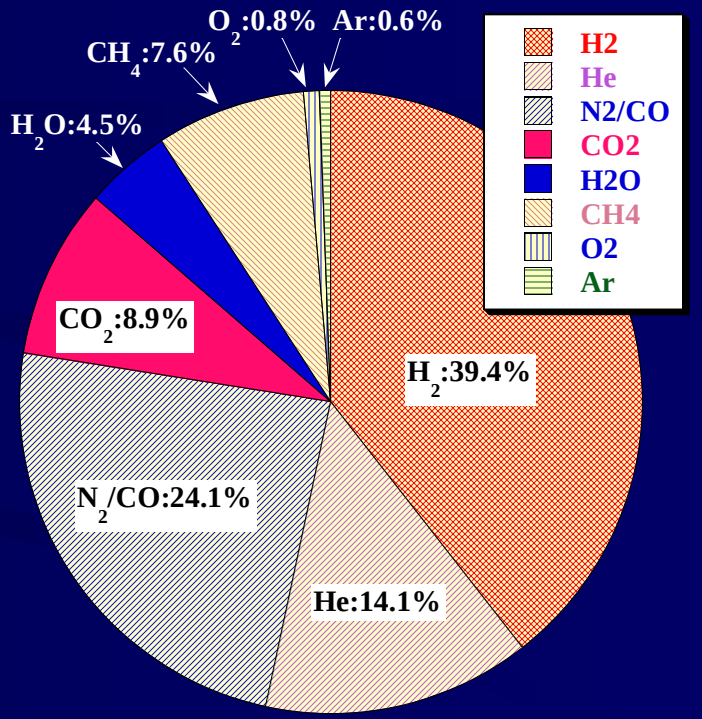
	Pumping Speed	Base Pressure
Before	1200 l/s	3.2e-9 Pa
After	**4640 l/s**	**5.7e-10 Pa**



NEG module
- WP950 （saes getters)
  pumping speed (H_2)　430 l/s×8
  Total　3440 l/s

Improvement of a lifetime





Lifetime was improved ~ 150 hours

Base Pressure : 5.7×10^{-10}Pa

Total harmful gases were reduced to 1/5.

- H_2O : 2.6×10^{-11}Pa
- CO_2 : 5.1×10^{-11}Pa

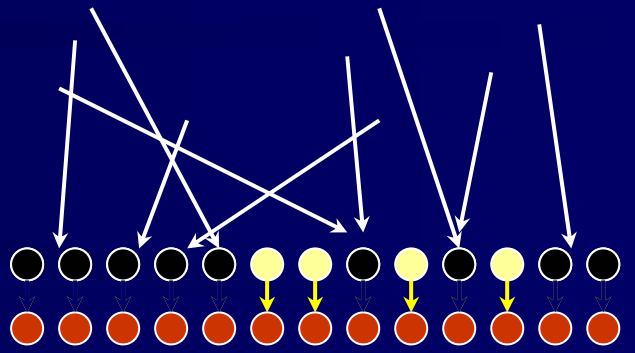
Degradation of NEA Surface

$$-\frac{dN}{dt} = \frac{N(t)}{N_0} \times \alpha \times I_{gas}$$

N_0 : the number of initial dipole site

α : the coefficient of destruction per one molecule.

I_{gas} : the density of harmful molecules flux



$$\tau_{gas} = \frac{N_0}{\alpha \cdot I_{gas}} = \frac{N_0}{\alpha \cdot 9.4 \times 10^8\,[/s/cm^2]} \sim 1.4 \times 10^5\,[s] \quad (\sim 40\ \text{hours})$$

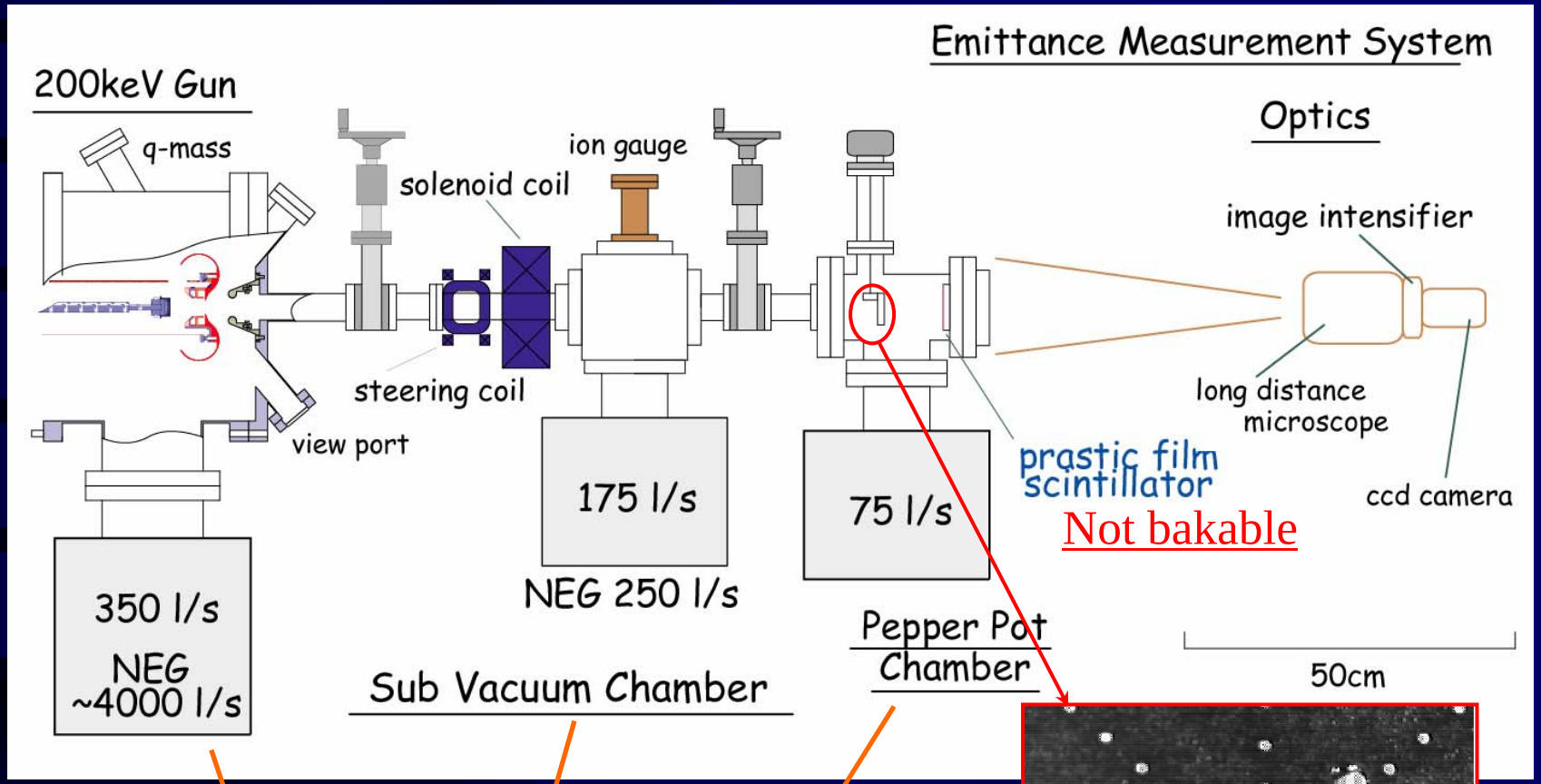
$$= \frac{N_0}{\alpha \cdot 2.2 \times 10^8\,[/s/cm^2]} \sim 5.4 \times 10^5\,[s] \quad (\sim 150\ \text{hours})$$

If $N_0 = 3.3 \times 10^{14}\,[/cm^2]$, $\alpha = 2.5 \sim 2.8$ is estimated.

$I_{gas} \sim 3.5 \times 10^7\,[/s/cm^2]$ is required for achieving 1000 h lifetime

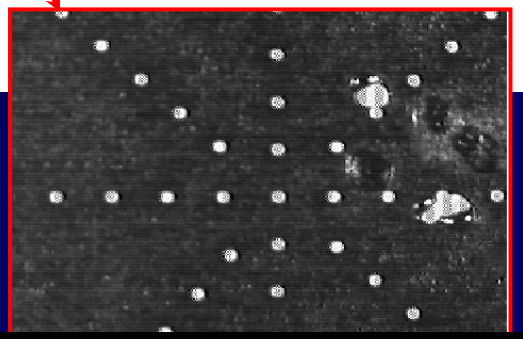
Emittance Measurement System

Emittance Measurement System



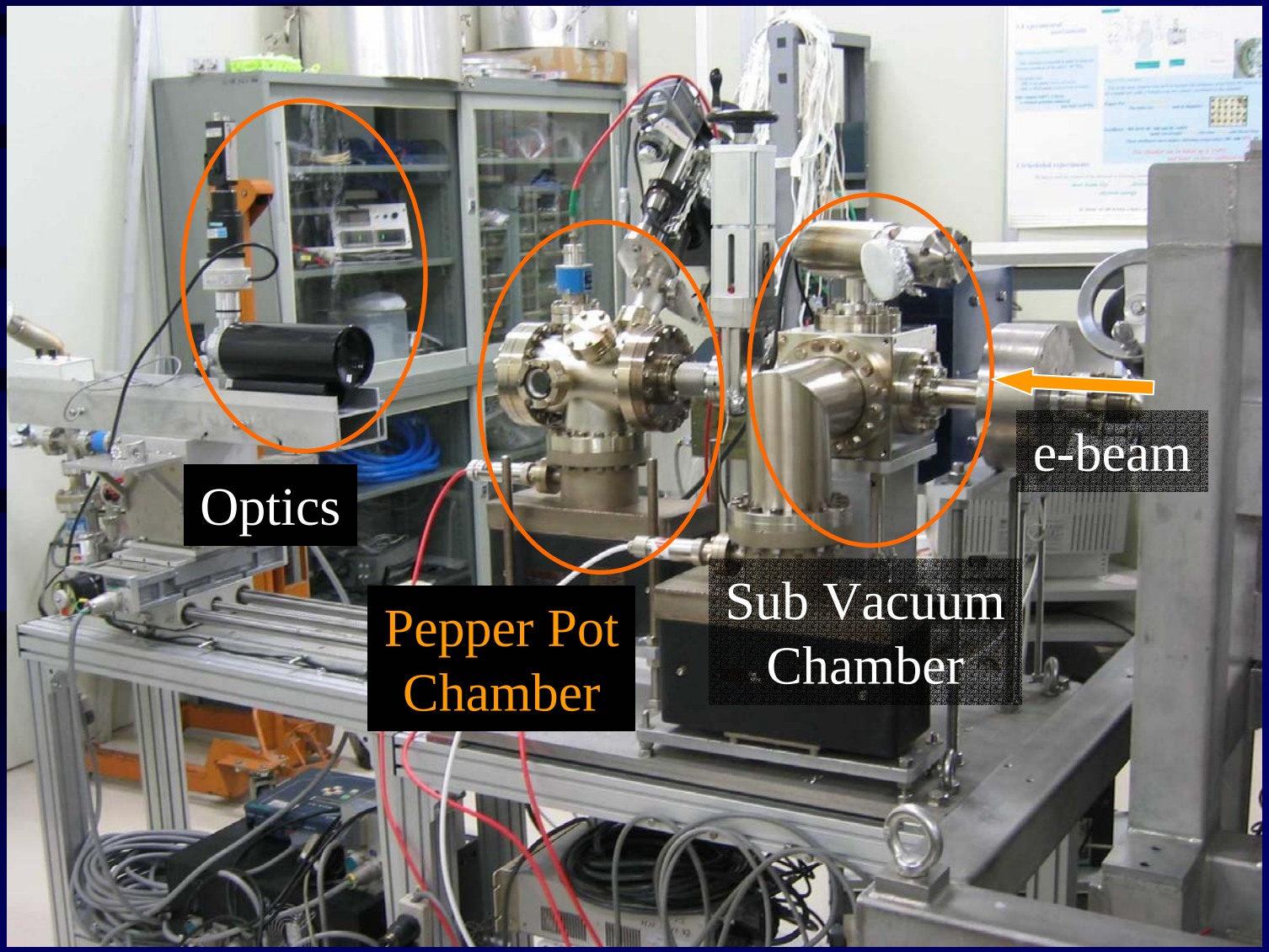
~10^{-10} Pa ~10^{-9} Pa ~10^{-7} Pa

the gun vacuum condition was satisfied.

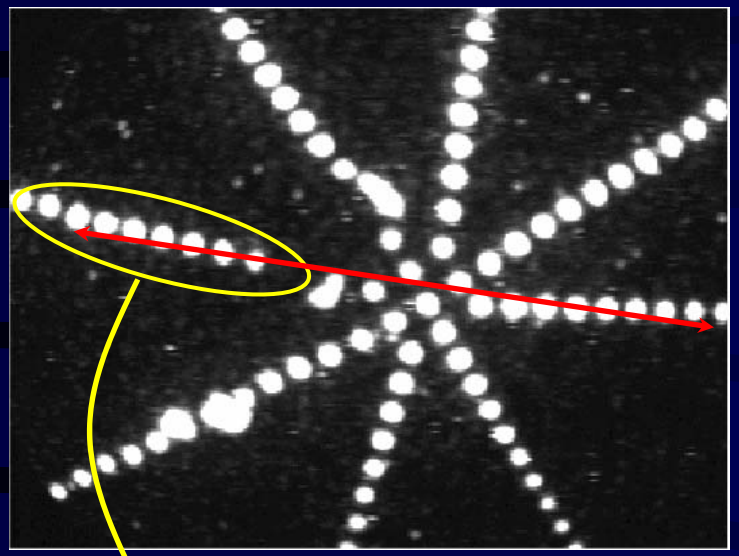


Pepper Pot Mask (10μm holes)

Emittance Measurement System



Preliminary Result

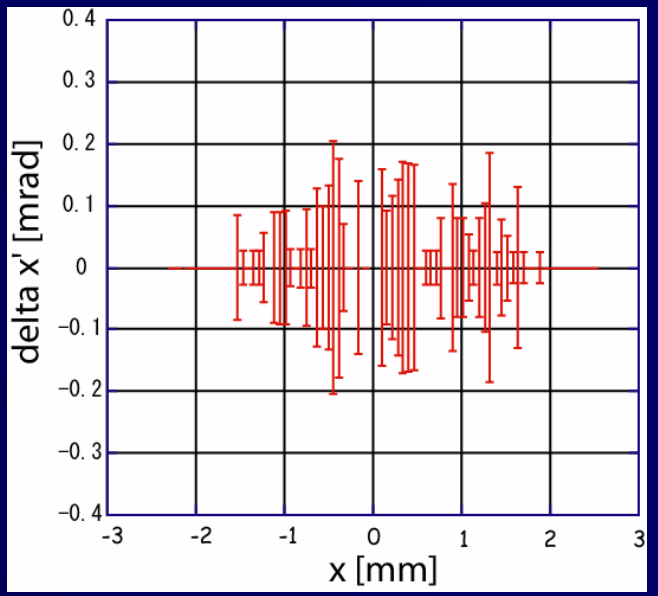


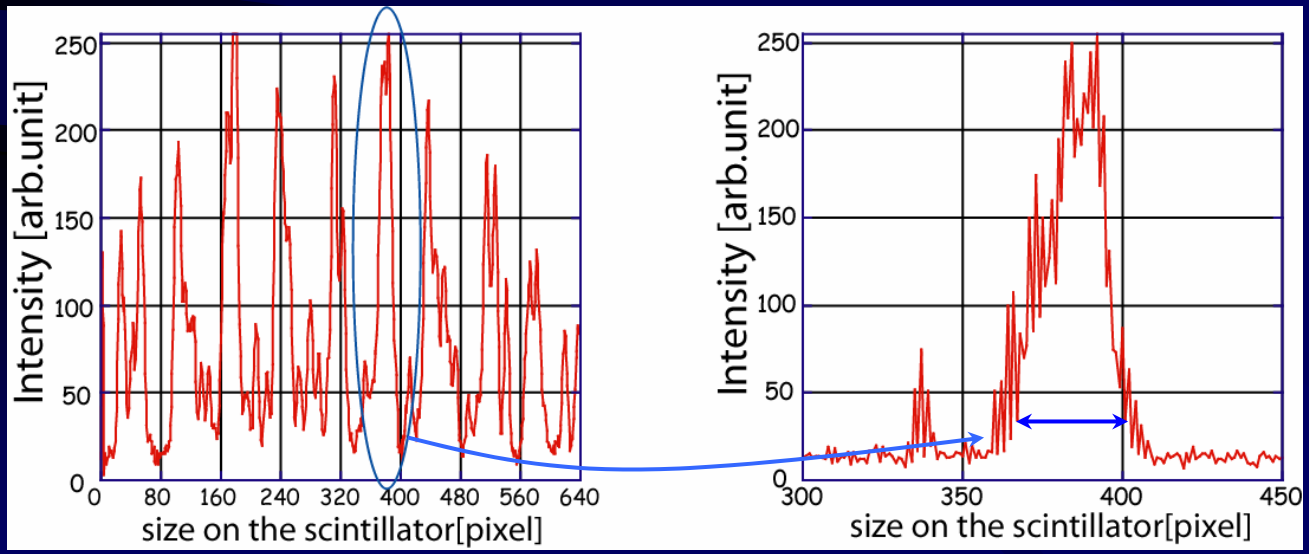
E = 80keV

I_{beam}=100nA

(CW mode)

He-Ne Laser





ε_{rms} ~

1.1 π mm･mrad

Pulse test is preparing now.

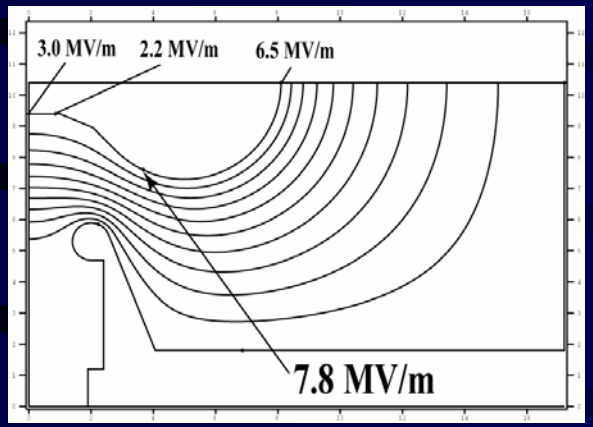
Future Plan

Electrodes for High Field Gradient Gun

Present 200keV Gun

Clean-Z (re-melted SUS316L)

With electro-buff polishing

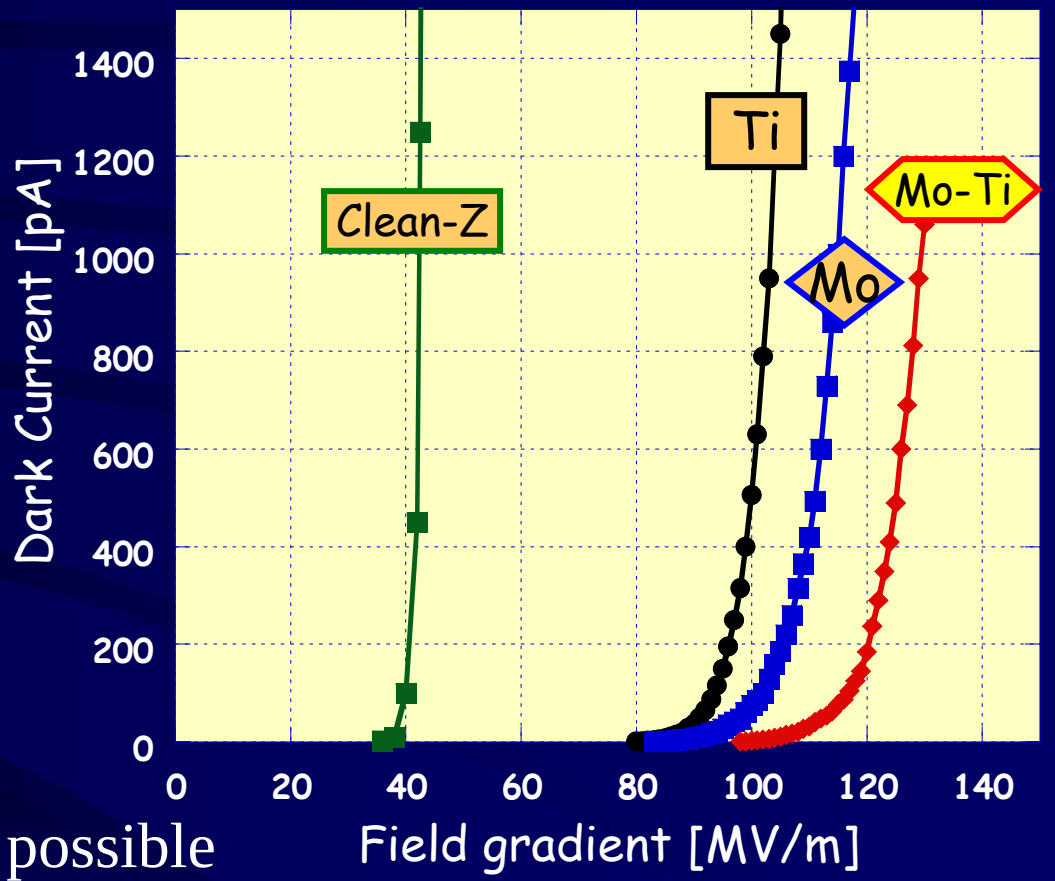


Limited E_{max} ~ 10MV/m

Emax ~ 30MV/m would be possible by using Mo cathode & Ti anode

Achieving 500keV gun would be possible ...

Field emission dependence of electrodes materials



F.Furuta et al.
The result will be published in N.I.M.-A

Summary

(1) Lifetime problem due to residual molecules was improved.

	before	after
Pumping Speed	1200 l/s	~ 4600 l/s
Base Pressure	3.2×10^{-9} Pa	5.7×10^{-10} Pa
Lifetime	< 40 h	~ 150 h

achieving longer lifetime would be possible...

(2) Upgrading new gun chamber and electrodes.

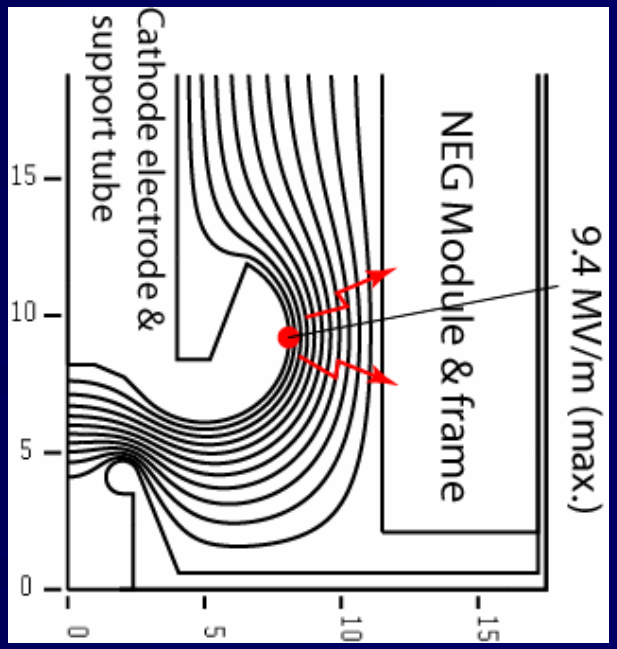
Change to Mo cathode and Ti anode from Clean-Z electrodes.
Avoiding field emission to the gun chamber wall.

(3) Emittance measurement system by pepper pot method has been constructed.

Mistakes...

The electric connection between feed-through and NEG supporter was melted

NEG modules were not activated sufficiently this time.



The NEG supporter detected field emission from cathode more than -100kV bias voltage

Upgrading to new large radius gun chamber is in progress.