Photocathode and Gun of Highly Polarized Electron Source developed for GLC

Nagoya University

Masahiro Yamamoto

PES Collaborators

Nagoya University

T.Nakanishi, S.Okumi, F.Furuta, K.Wada
M.Yamamoto, M. Miyamoto, M.Qwahara,
N.Yamamoto, K.Naniwa
O.Watanabe, H.Kobayakawa, M.Takeda

Osaka Prefecture University

H. Horinaka, T. Matsuyama

KEK

H.Mastumoto, M.Kuriki, M.Yoshioka, J.Urakawa
T. Omori, Y. Kurihara

JAERI

T.Nishitani

Spring-8

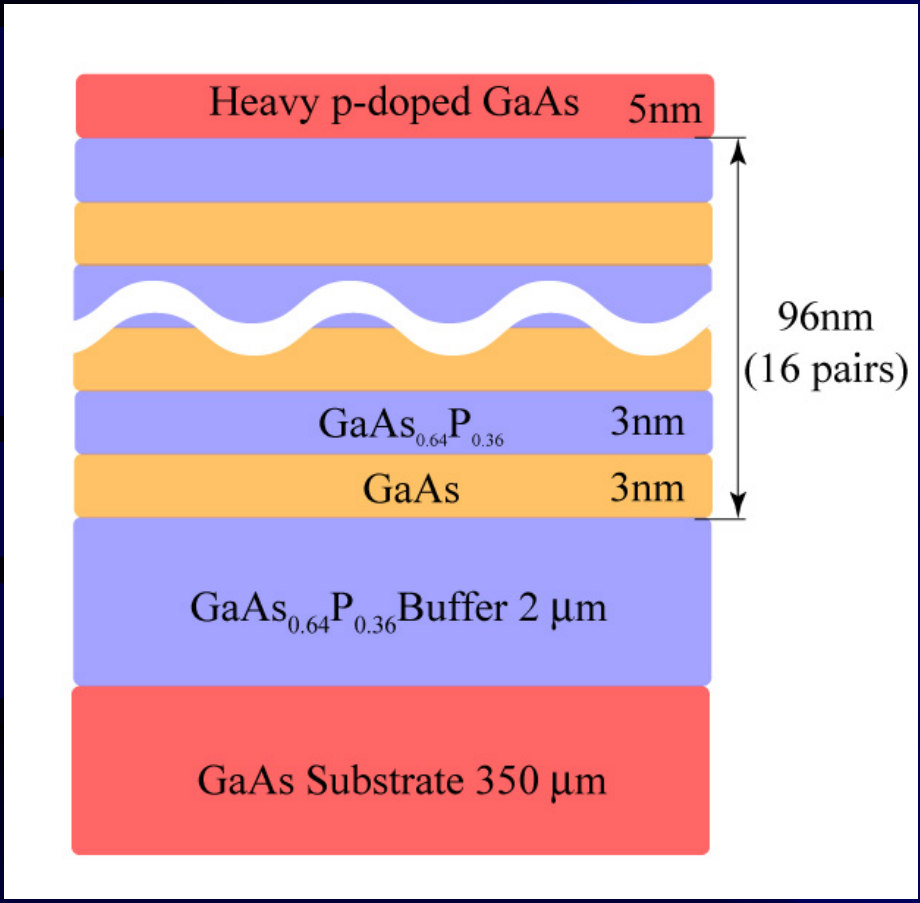
K.Togawa

Outline

- Photocathode
  - GaAs-GaAsP strained superlattice
- 200kV Gun
  - Features
  - Improvement of a vacuum system
- Next high field gradient Gun
  - Research of reduction of dark current from metal surface
- Summary

1. Photocathode

GaAs-GaAsP strained superlattice



Samples were grown by MOCVD

The fraction of P

As:P 0.64 : 0.36

Thickness

GaAs well 3nm

GaAsP barrier 3nm

16pairs total 96nm

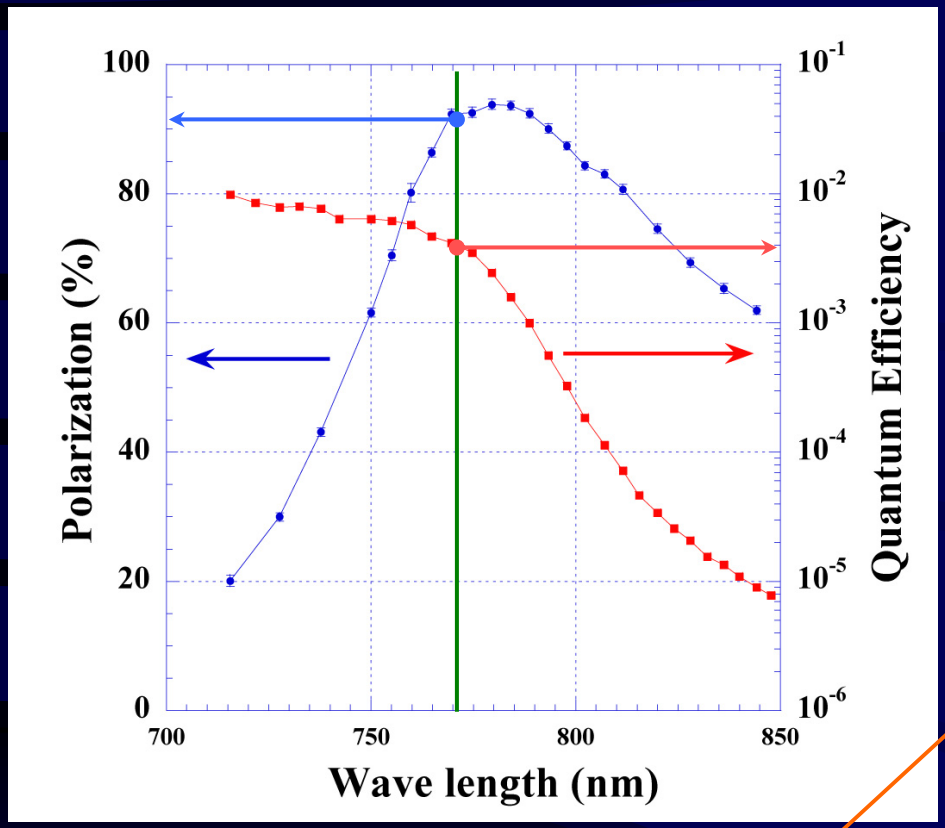
Doping density (Zn^+)

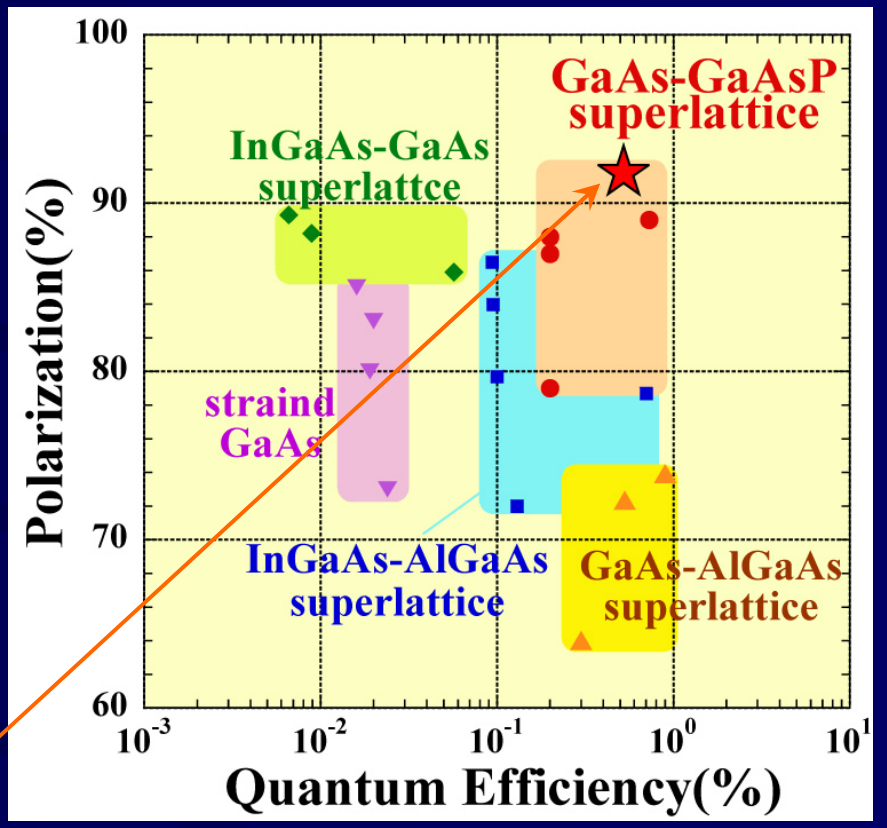
Surface $6.0 \times 10^{19}/cm^3$

Interior(superlattice,buffer)

$1.5 \times 10^{18}/cm^3$

Performance of GaAs-GaAsP superlattice





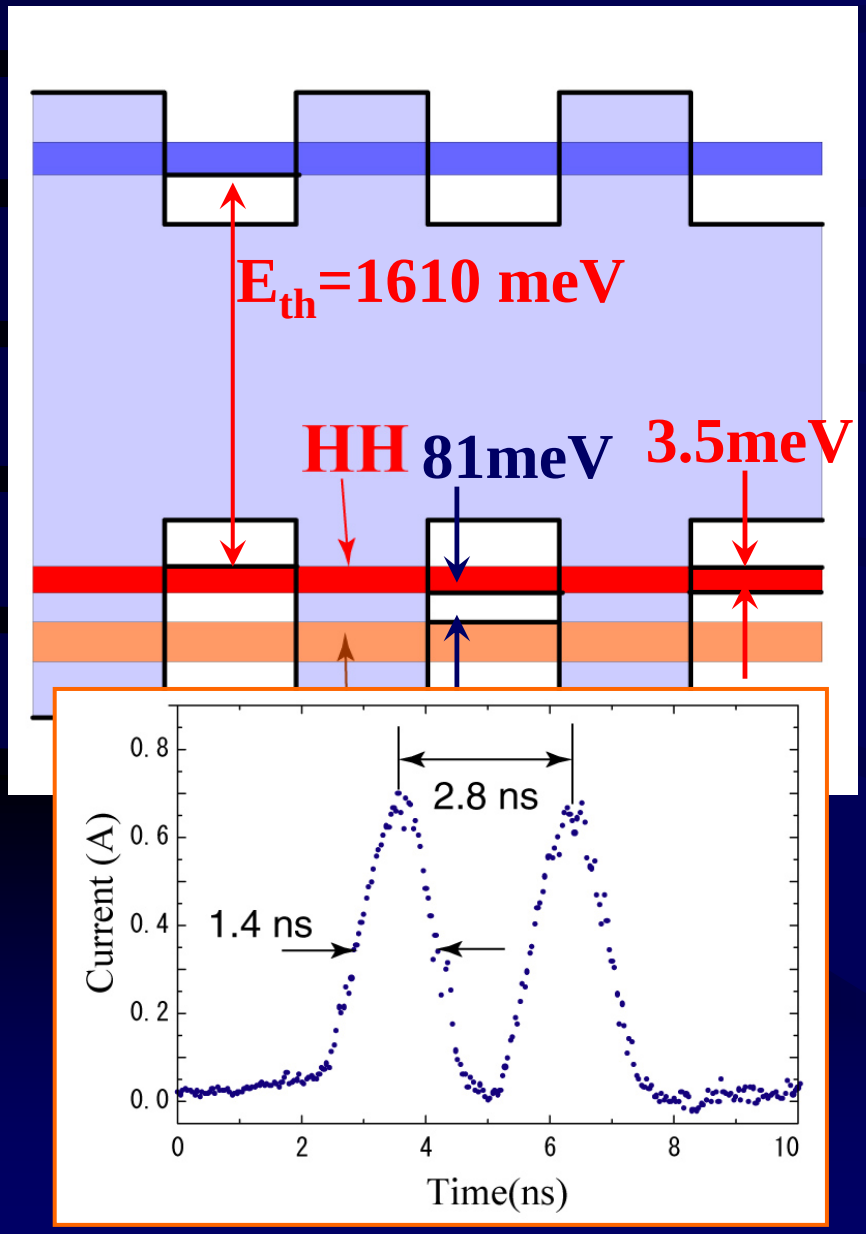
@778nm

Polarization 92%

Q.E. 0.5%

GaAs-GaAsP superlattice has the best performance !

Advantages of GaAs-GaAsP superlattice

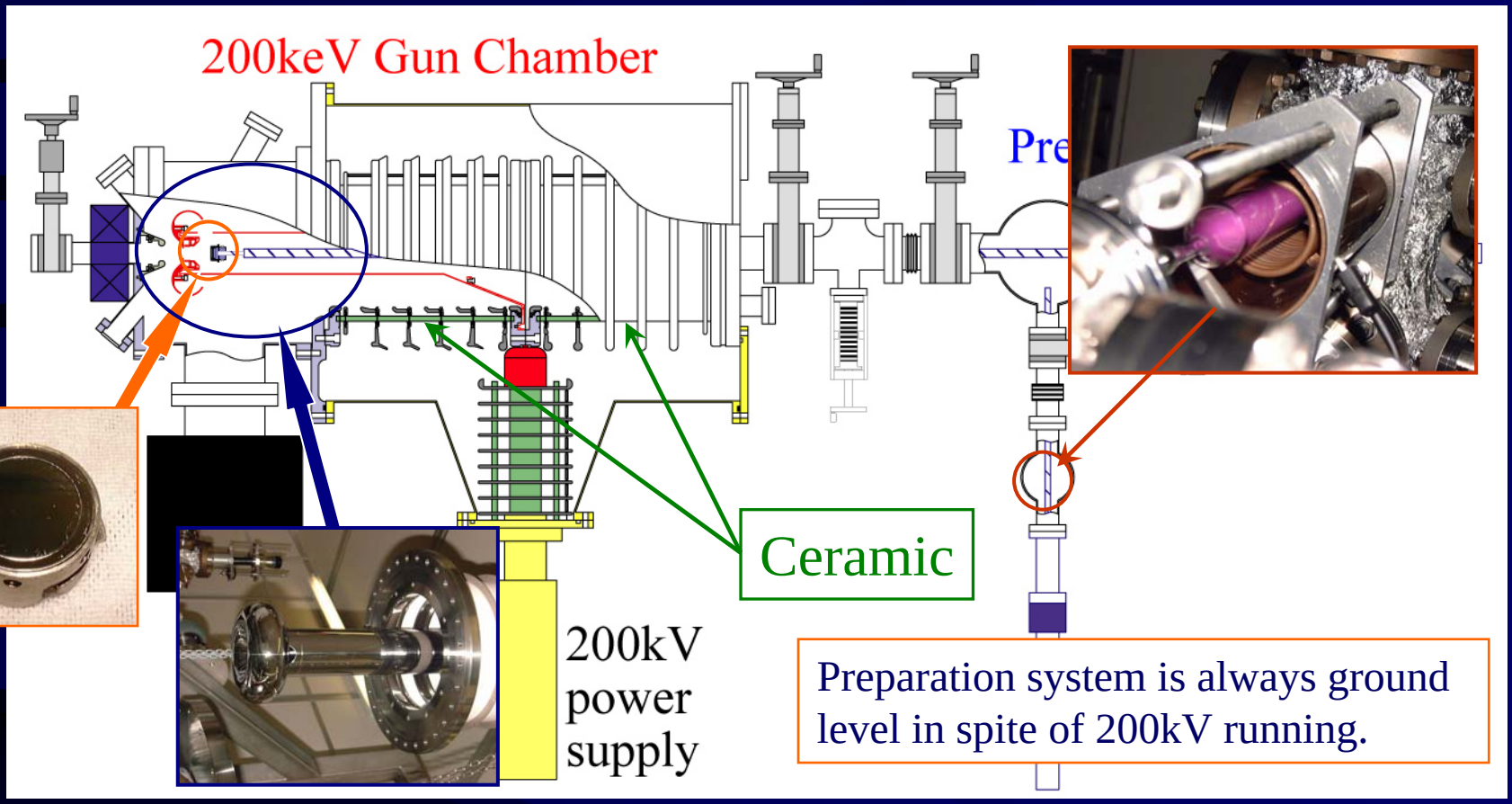


- Wide band gap.
  → Q.E. ↗
- Large split between HH and LH band.
  → Polarization ↗
- Narrow band-width of heavy hole state.
  → polarization ↗

- Nanosecond bunch beam production is possible.

2. The 200kV Gun

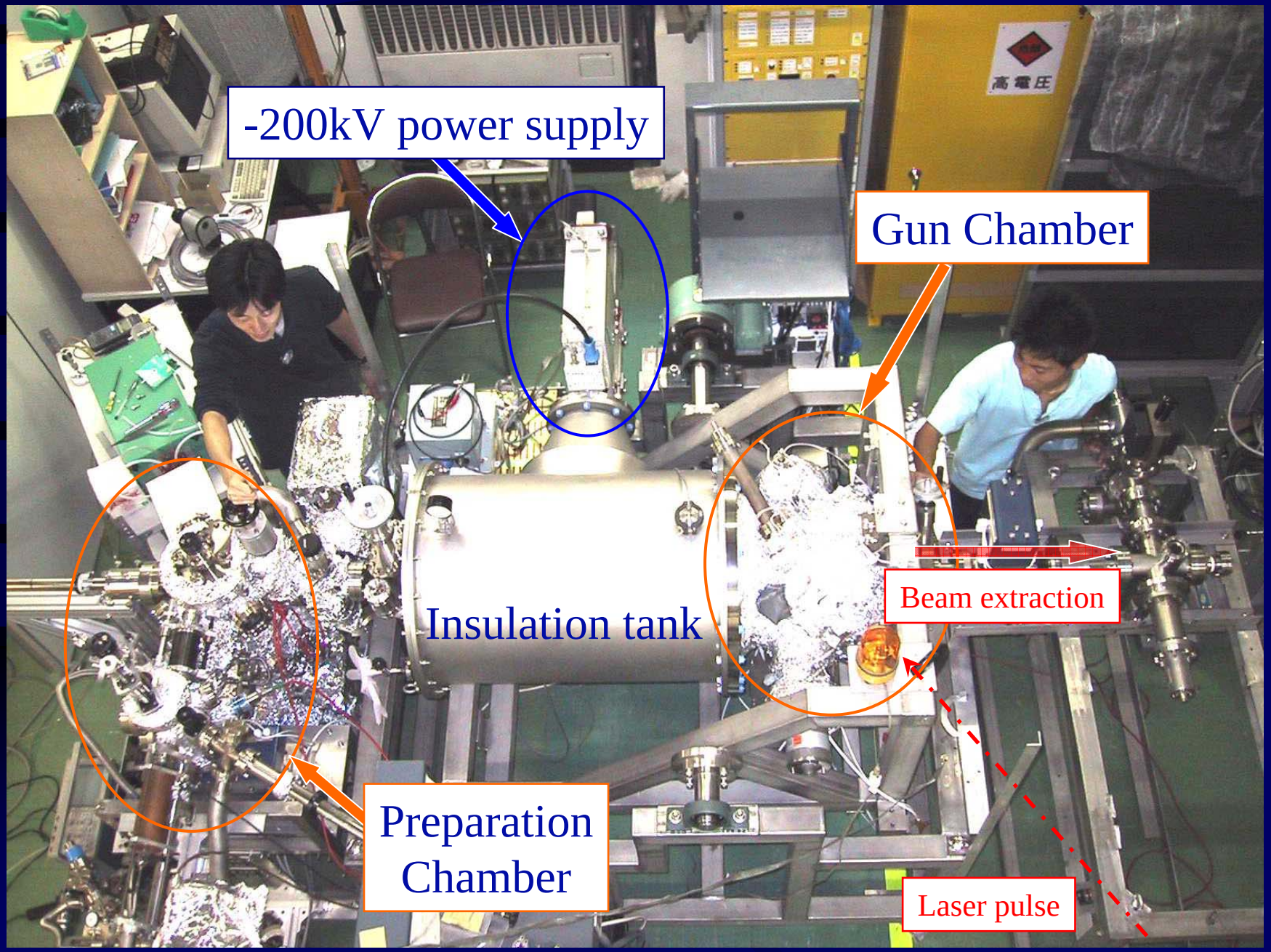
Features of the 200kV Gun



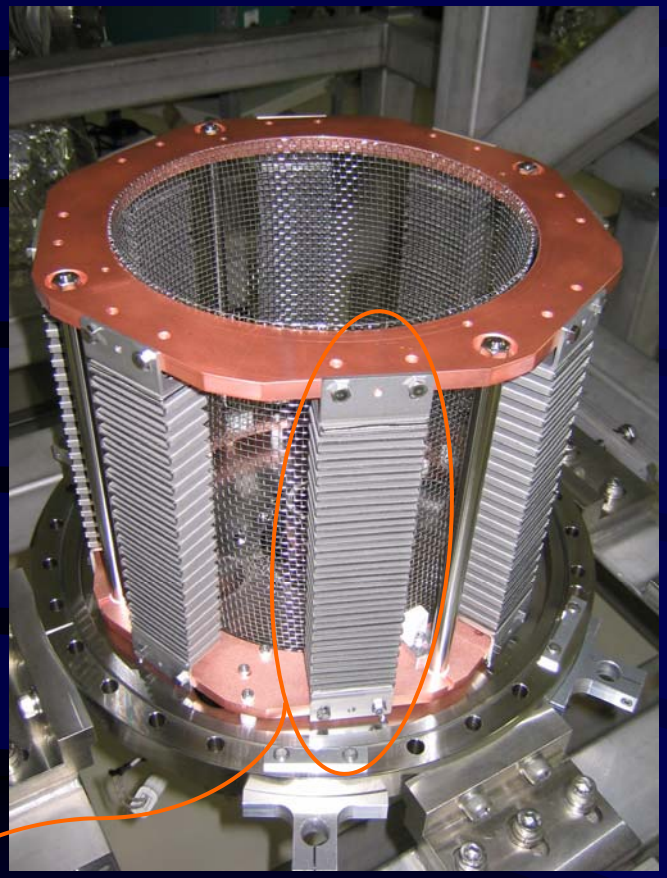
- Load lock system
- Clean-Z (super-clean SUS316L)
- Electro-buff polishing (R<0.12 μ m)

→ 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

Improvement of a vacuum system



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

	Pumping Speed (NEG only)	Total Pressure
Before	850 l/s	3.2e-9 Pa
After	**4290 l/s**	**5.7e-10 Pa**

Residual Gas Analysis (Partial Pressure)

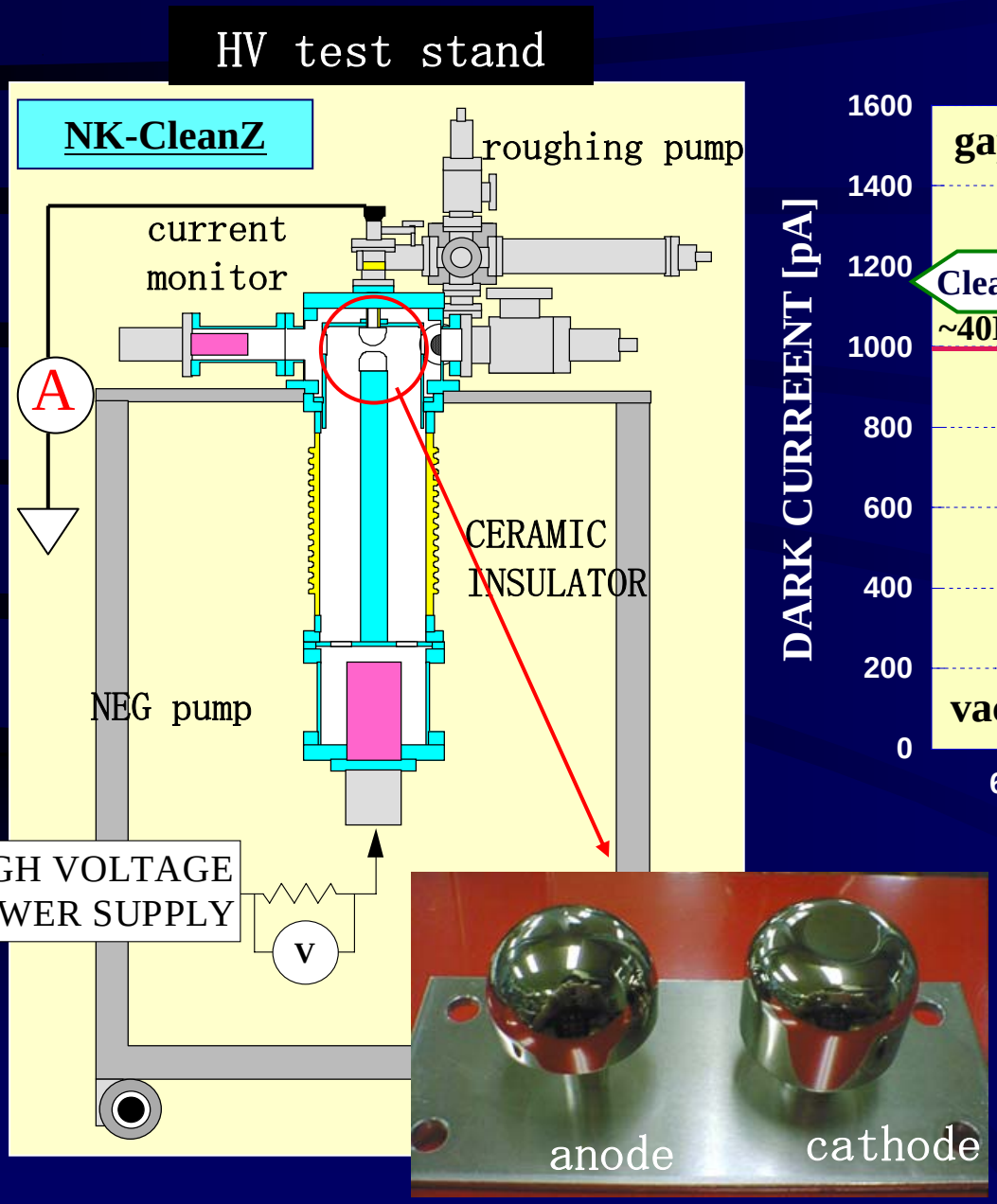
	H_2O	CO_2
Before	1.1e-10 Pa	2.3e-10 Pa
After	**2.6e-11 Pa**	**5.1e-11 Pa**

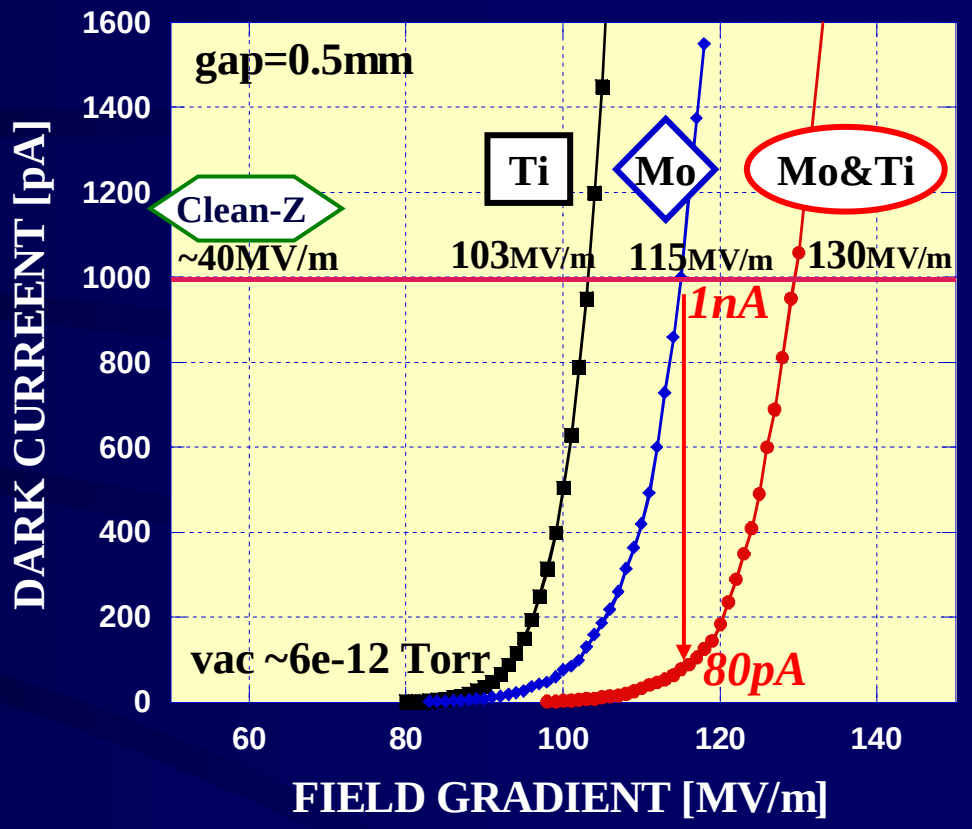
τ_{dark} ~ 40 hours (before,measured)
~ 200 hours ?? (after,estimation)

Lifetime will be measured soon....

3. The Next high field gradient Gun

Reduction of the dark current from metal surface





The pair of Mo cathode and Ti anode showed the best performance.

The paper will be published soon.

Summary

- GaAs-GaAsP strained superlattice
  - It is one of the best photocathode
    - Polarization 92(±6)% Q.E. 0.5% @778nm
    - Nanosecond multi-bunch beam production is possible
- 200kV Gun
  - 200keV PES has already been constructed
  - Improvement of a vacuum by additional NEG modules
    - UHV 5e-10Pa , the dark lifetime is estimated ~ 200 hours
- Next high field gradient DC-gun
  - Ti anode & Mo cathode is the most effective combination for a reduction of the dark current

→ E > 10MV/m on the photocathode