Operational Experience of DC Photoemission Gun at the compact ERL

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Outline

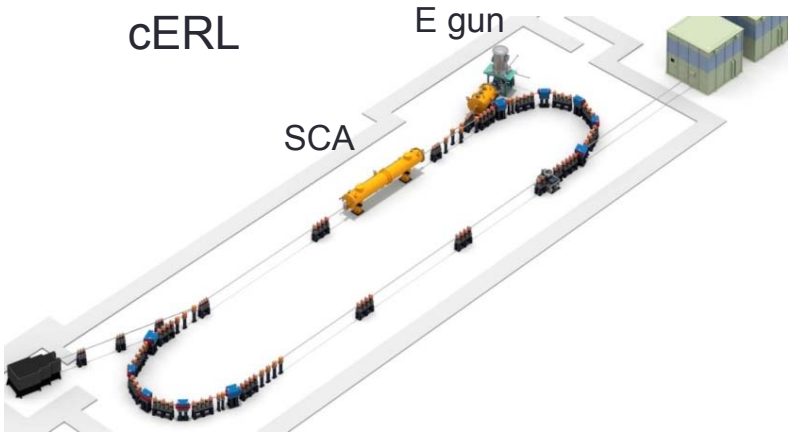
- Introduction
- Development of a 500kV DC gun at JAEA
- Operational status at the compact ERL
- Future plan
- Summary

The next generation ERL light sources

3GeV ERL X-ray source
800MeV ERL-FEL

- 10kW EUV light sources

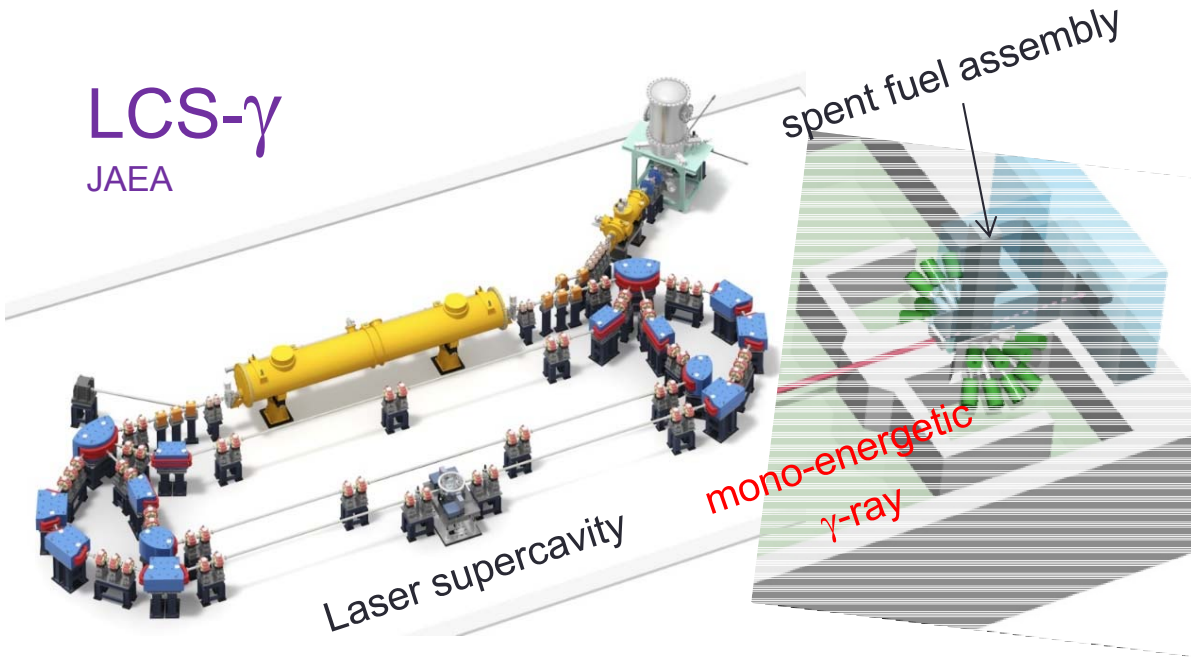
$\frac{E}{150}$ (20MeV)



350MeV ERL LCS γ-ray source

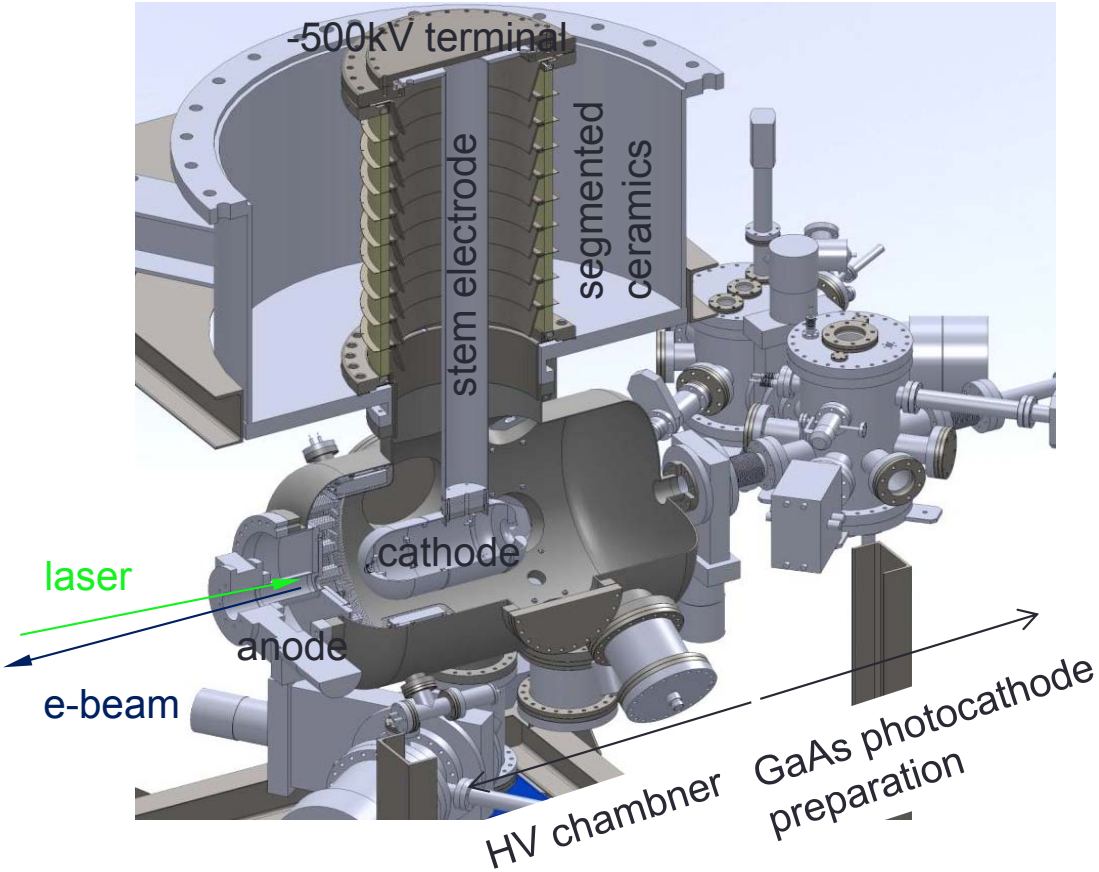
LCS: laser Compton scattering

- flux of > 10^6 of conventional sources



Nondestructive assay (NDA) of spent nuclear fuels

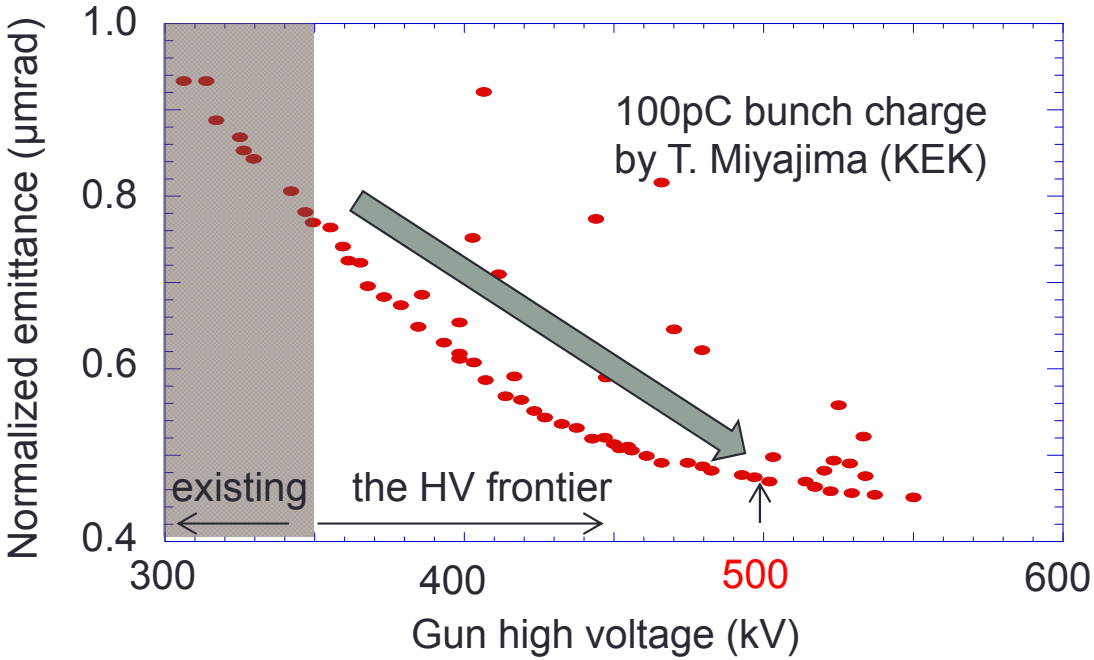
Development of a 500kV photocathode gun at JAEA



γ-ray brightness ∝ I/ε^2

NDA in 1hour ⇨ 1mA/(0.5μm・rad)^2

T. Hayakawa, et al., NIMA 621, 695 (2010)



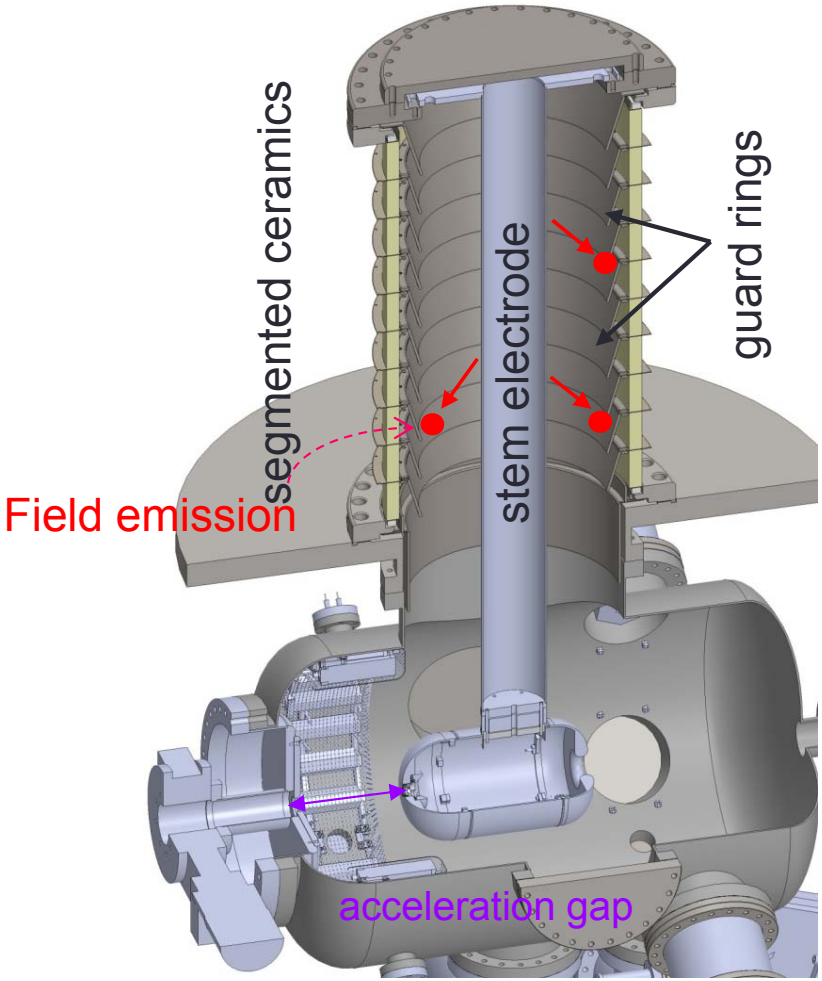
	Requirements
HV	500kV
Photocathode Field	>5MV/m
Current	>1mA

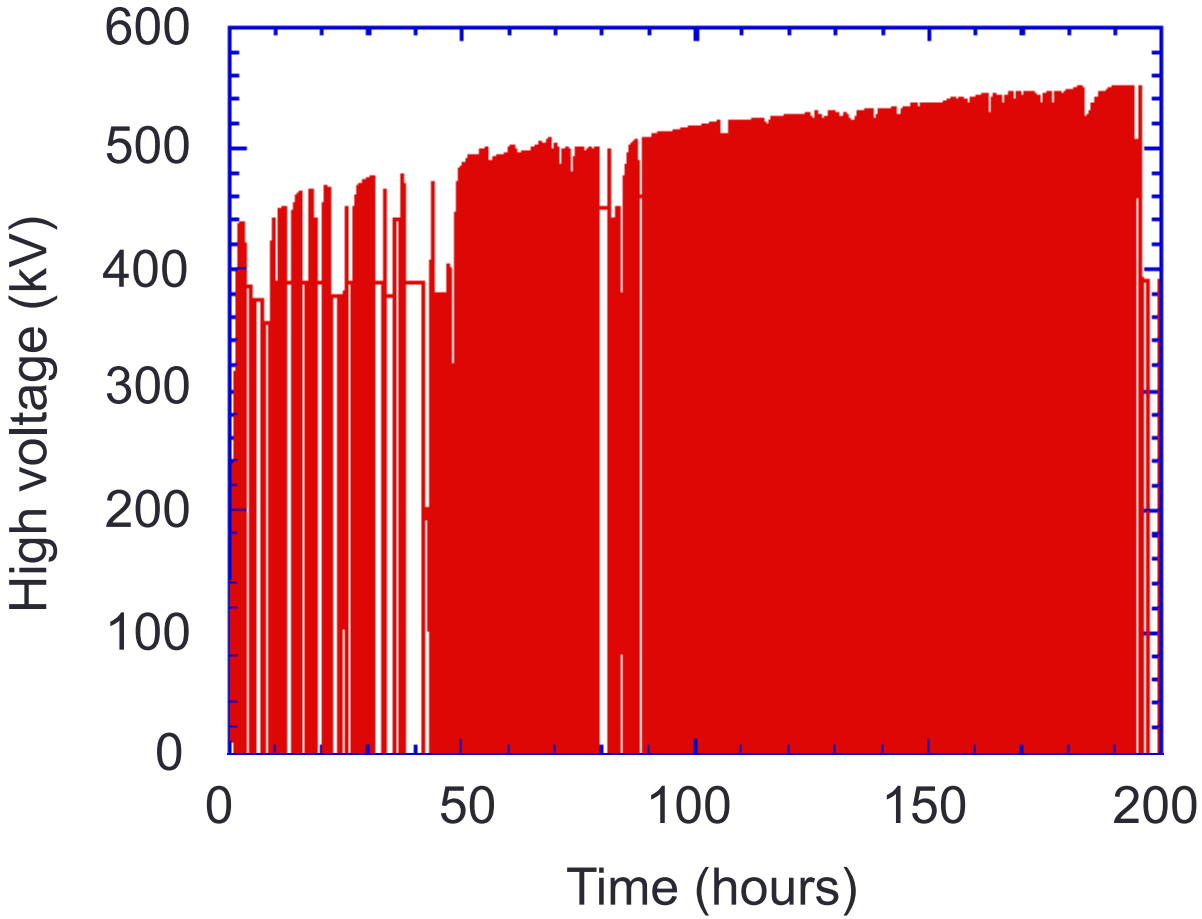
} ⇨ Normalized emittance <0.5μm・rad

HV conditioning of a segmented ceramics insulator

R. Nagai et al., RSI 81, 033304 (2010).
N. Nishimori et al., PRSTAB 17, 053401 (2014).

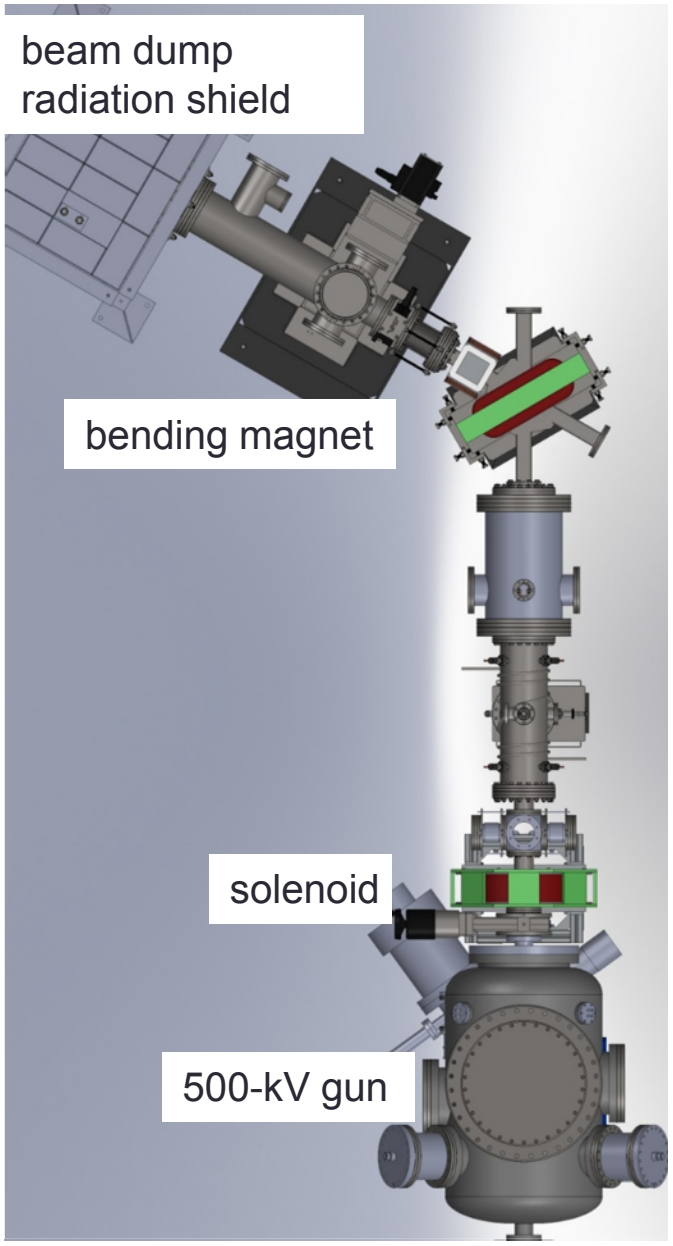
A segmented ceramics help avoid discharge caused by field emission from a central stem electrode. Acceleration gap length was optimized for 500 kV operation.

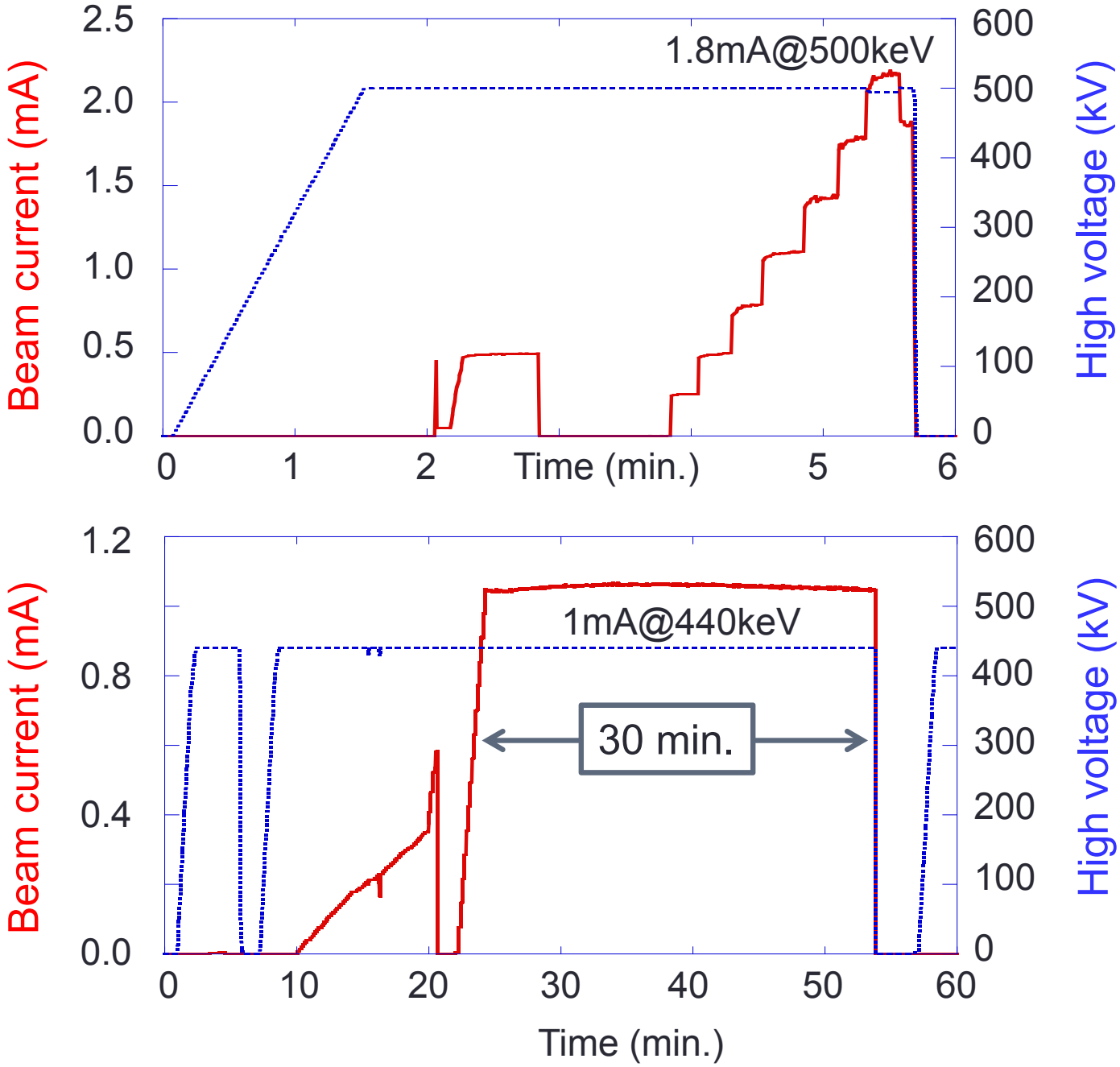




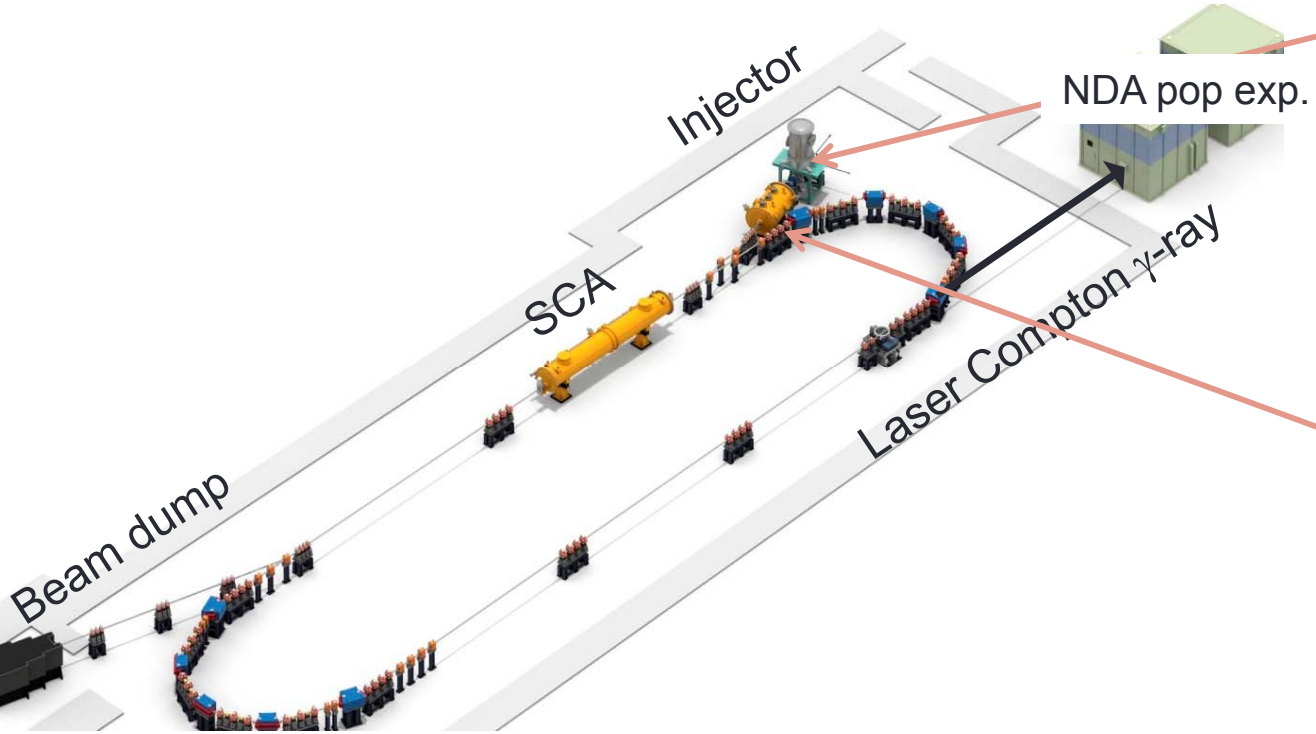
500keV beam generation

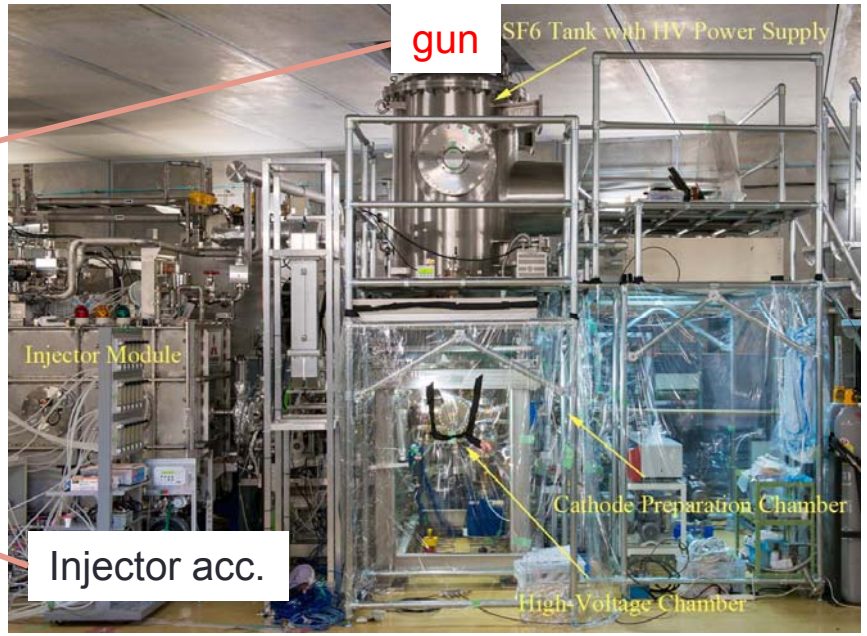
N. Nishimori et al., APL 102, 234103 (2013)



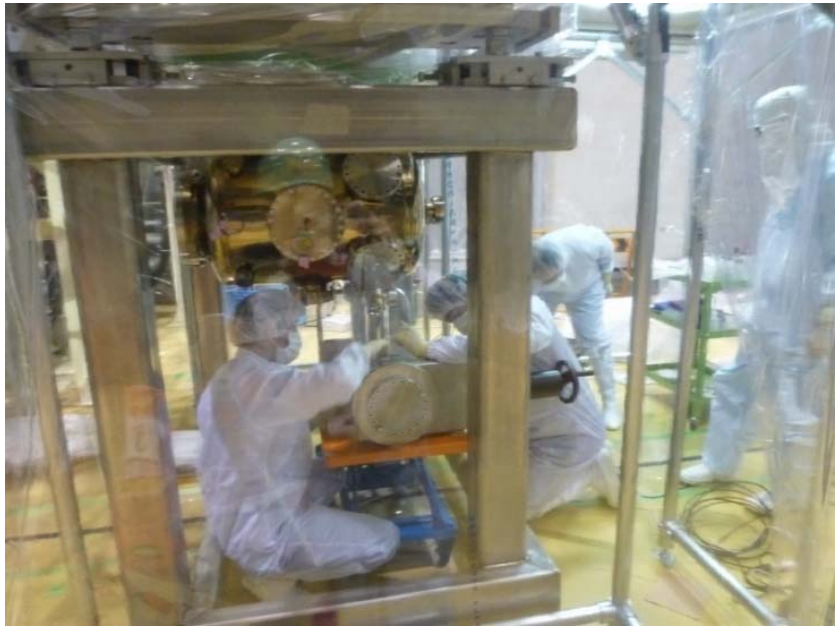


cERL (prototype of the PEARL)





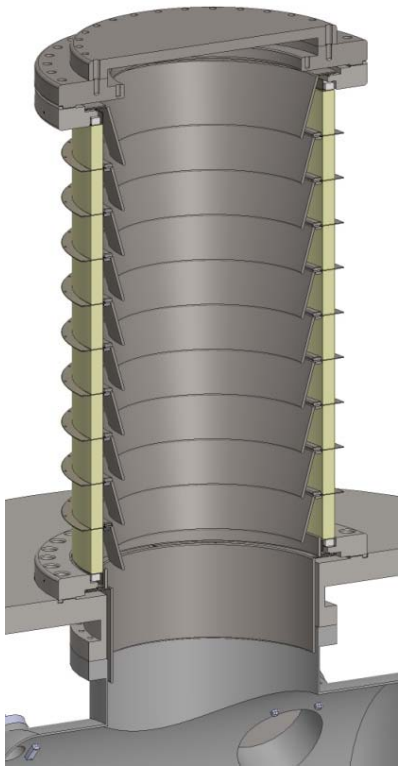
Gun assembly at cERL

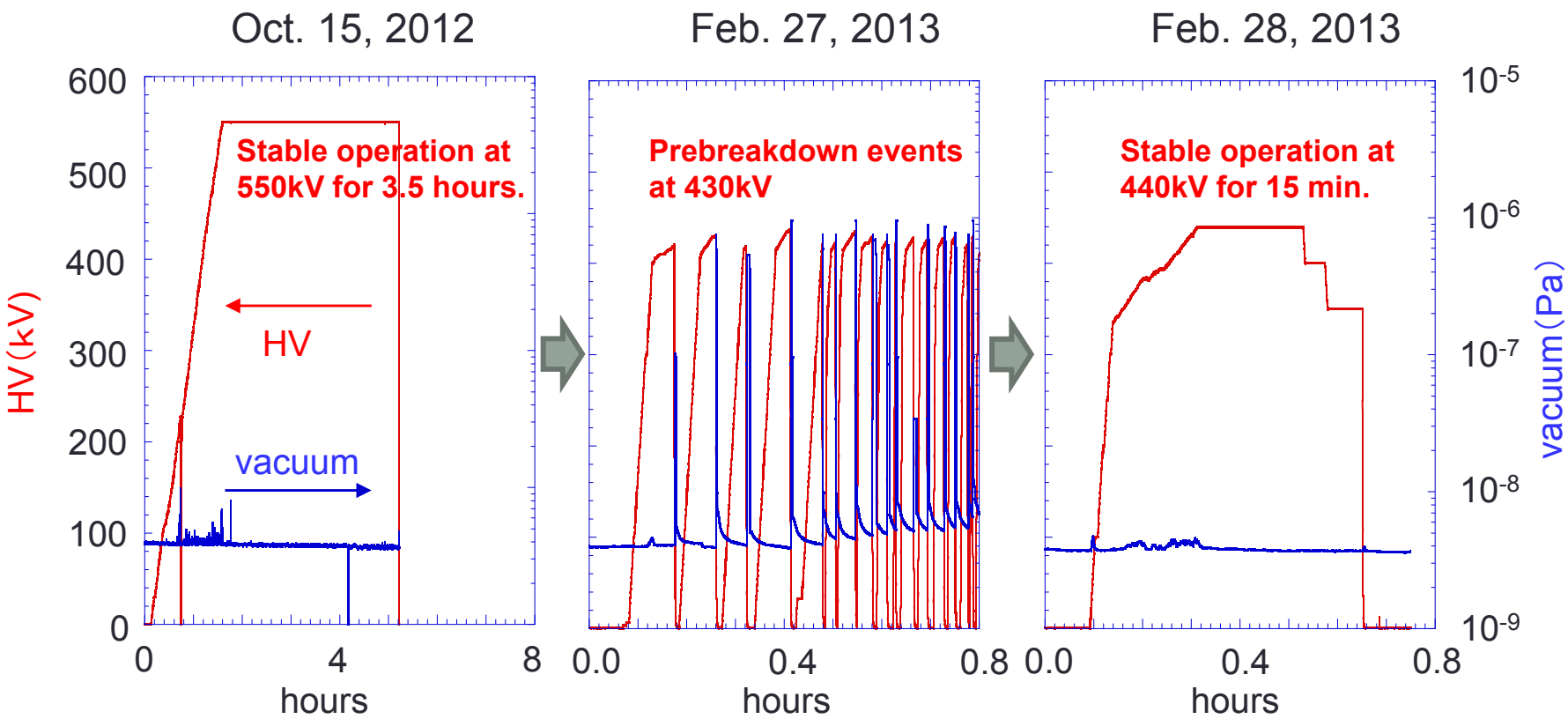


- ✓ Oct. 2012 Transport of gun from JAEA to cERL at KEK
- ✓ Jun. 2013 Injector commissioning 5MeV-0.3μA
- ✓ Mar. 2014 ERL loop commissioning 20MeV-4.5μA
- ✓ Mar. 2015 Laser Compton Scattering (LCS) 20MeV-80μA

Gun voltage is limited to 390kV at cERL.

Why 390kV operation ? (Exp. with insulator only)



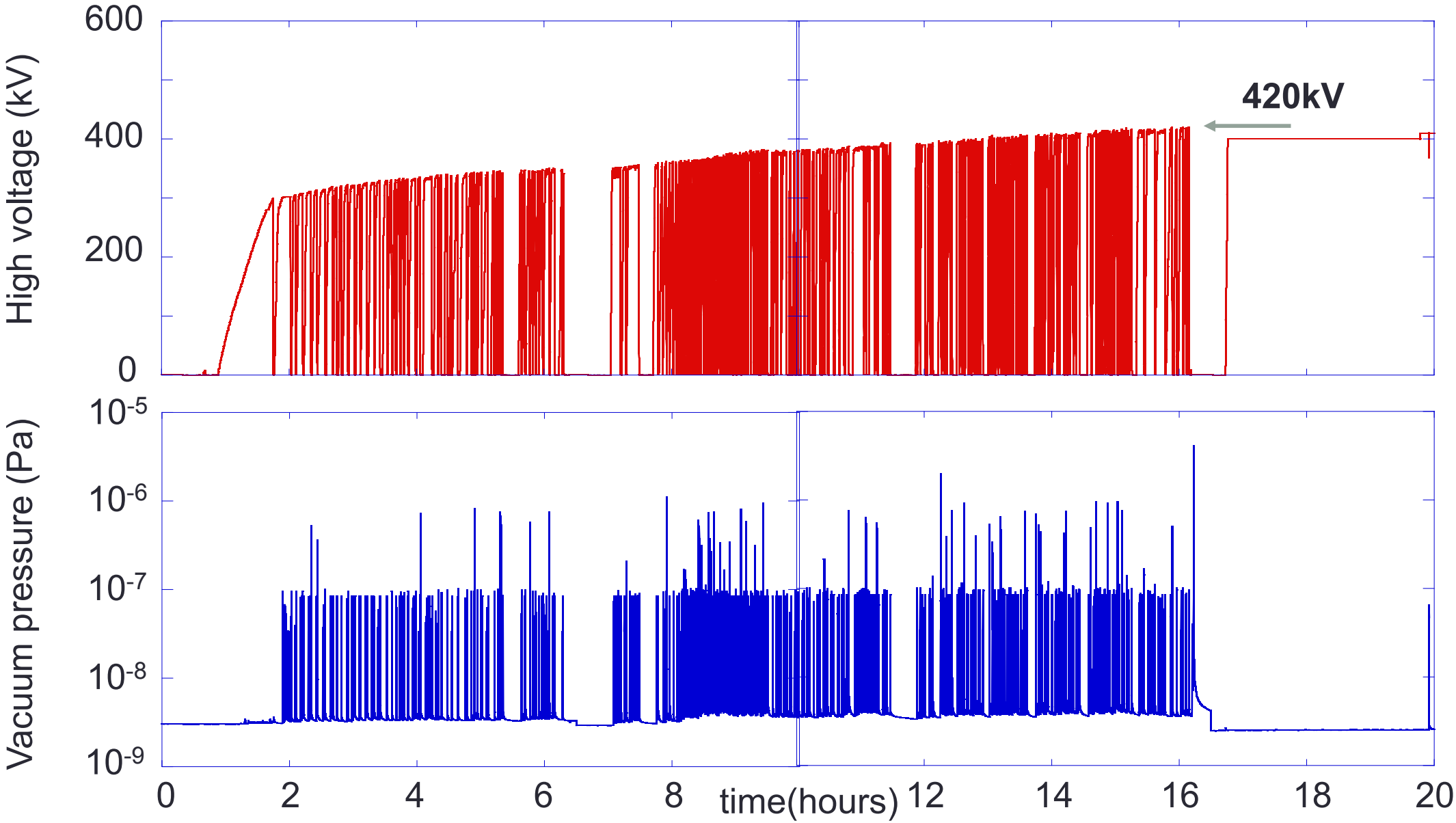


at JAEA
No problem

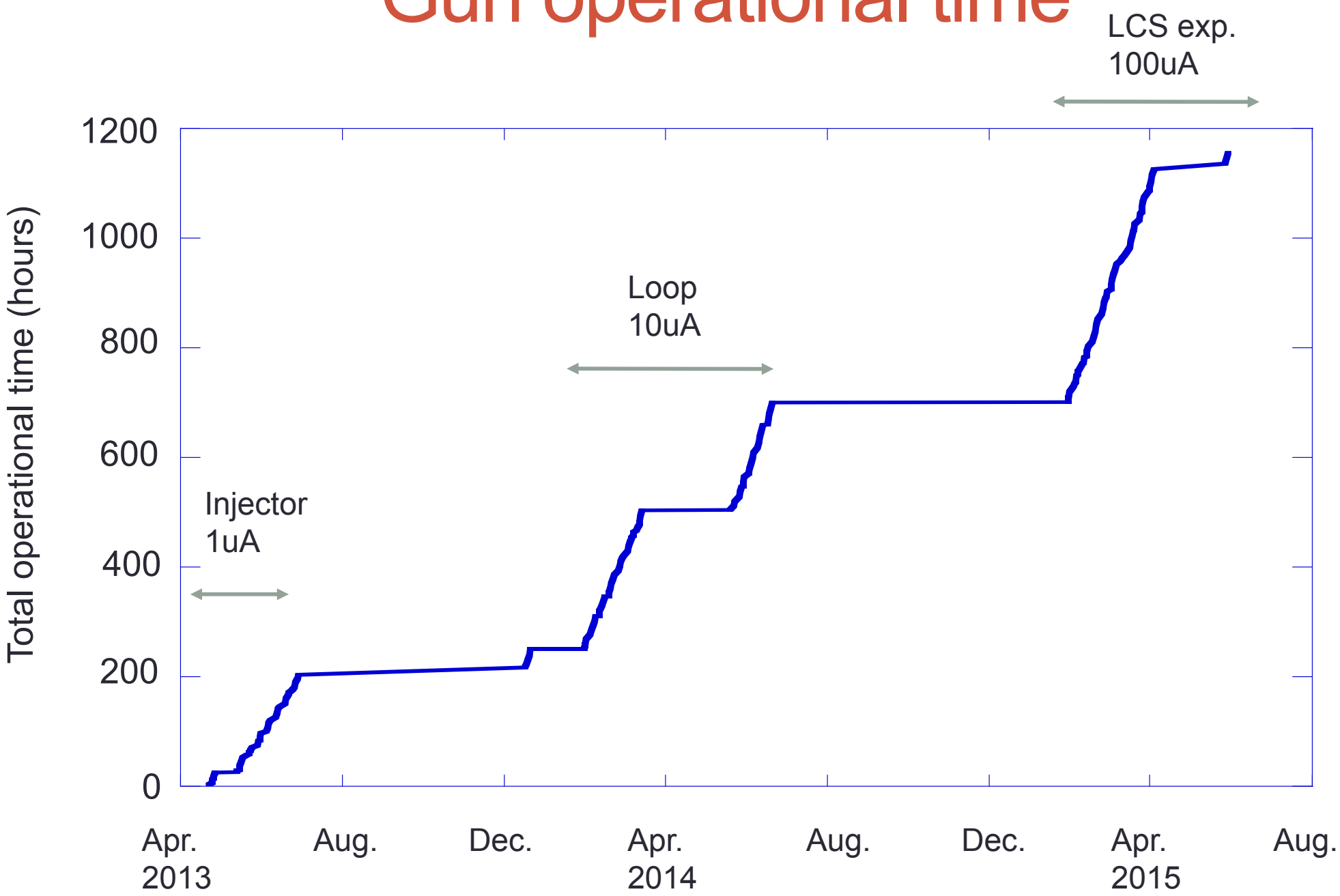
at KEK
A problem happened.

at KEK
Top and bottom ceramics are short-circuited.
8 segments operation

High voltage conditioning with cathode electrode



Gun operational time

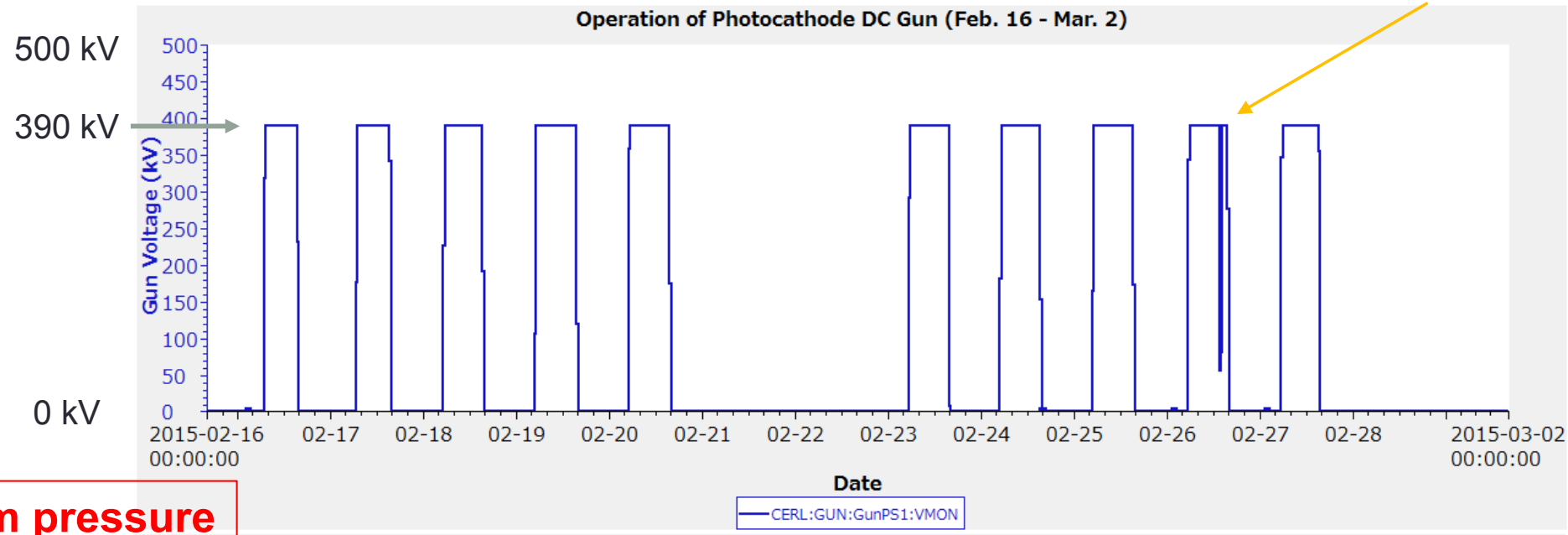


Gun operational status for two weeks

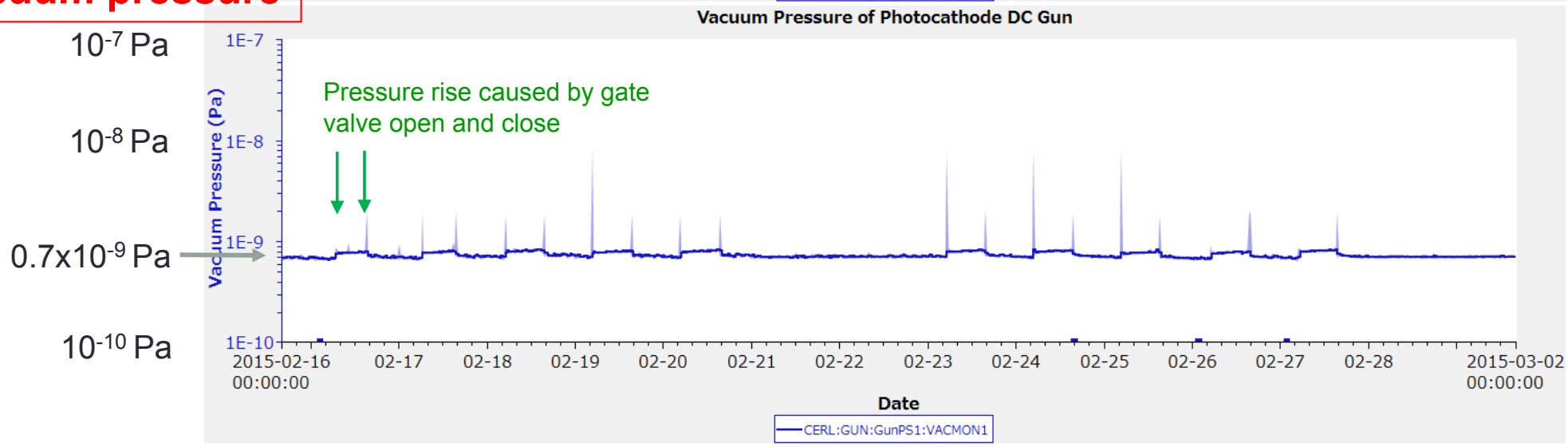
Cathode voltage

Stable operation

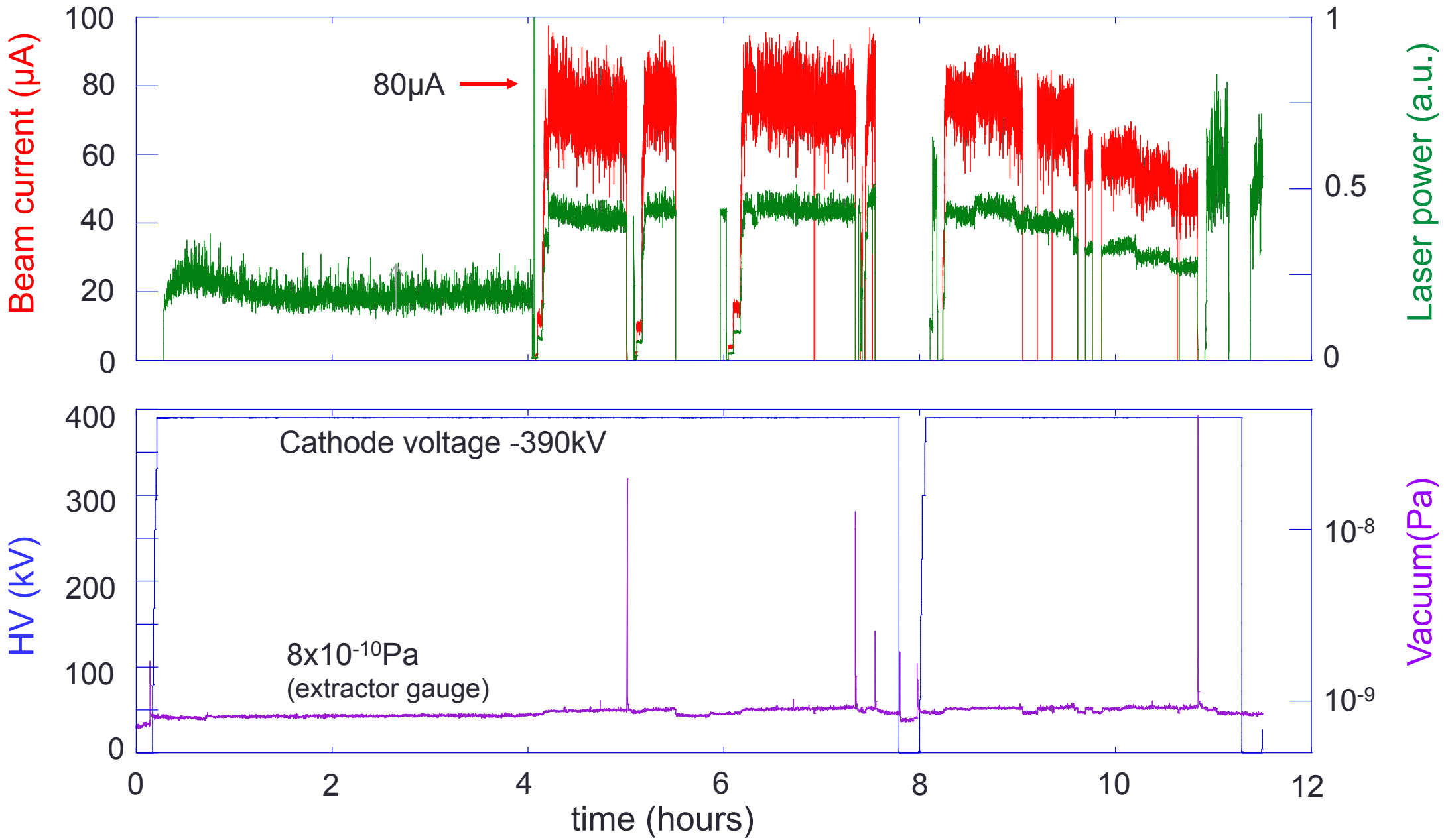
Interruption to enter the acceleration hall



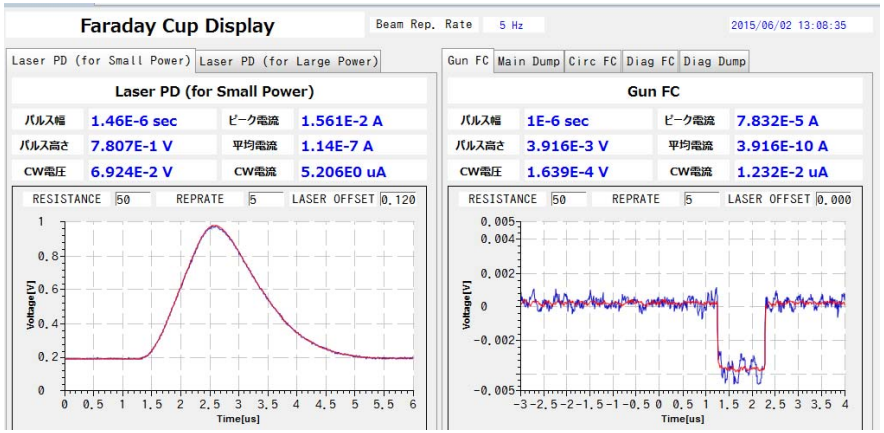
Vacuum pressure

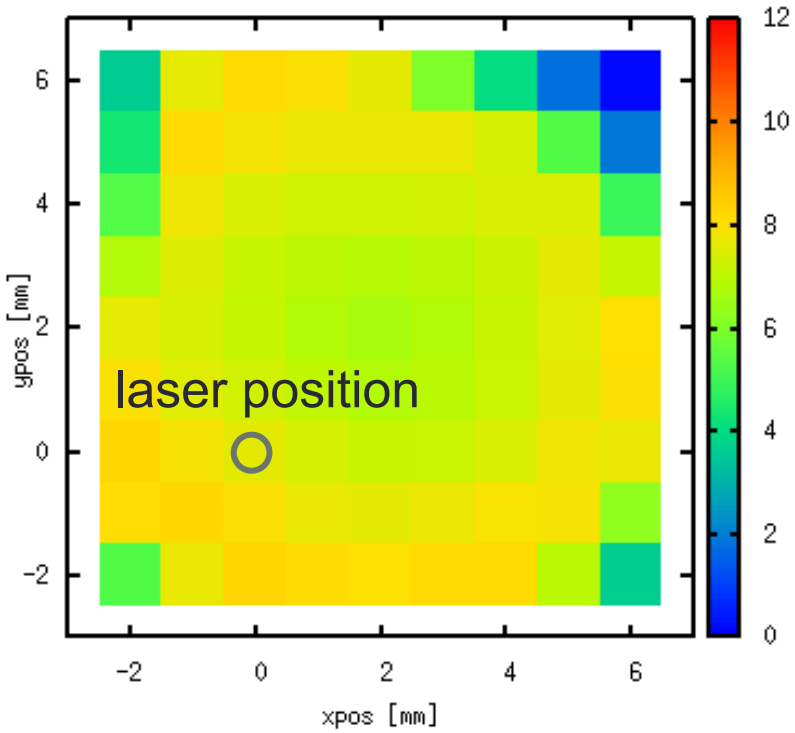


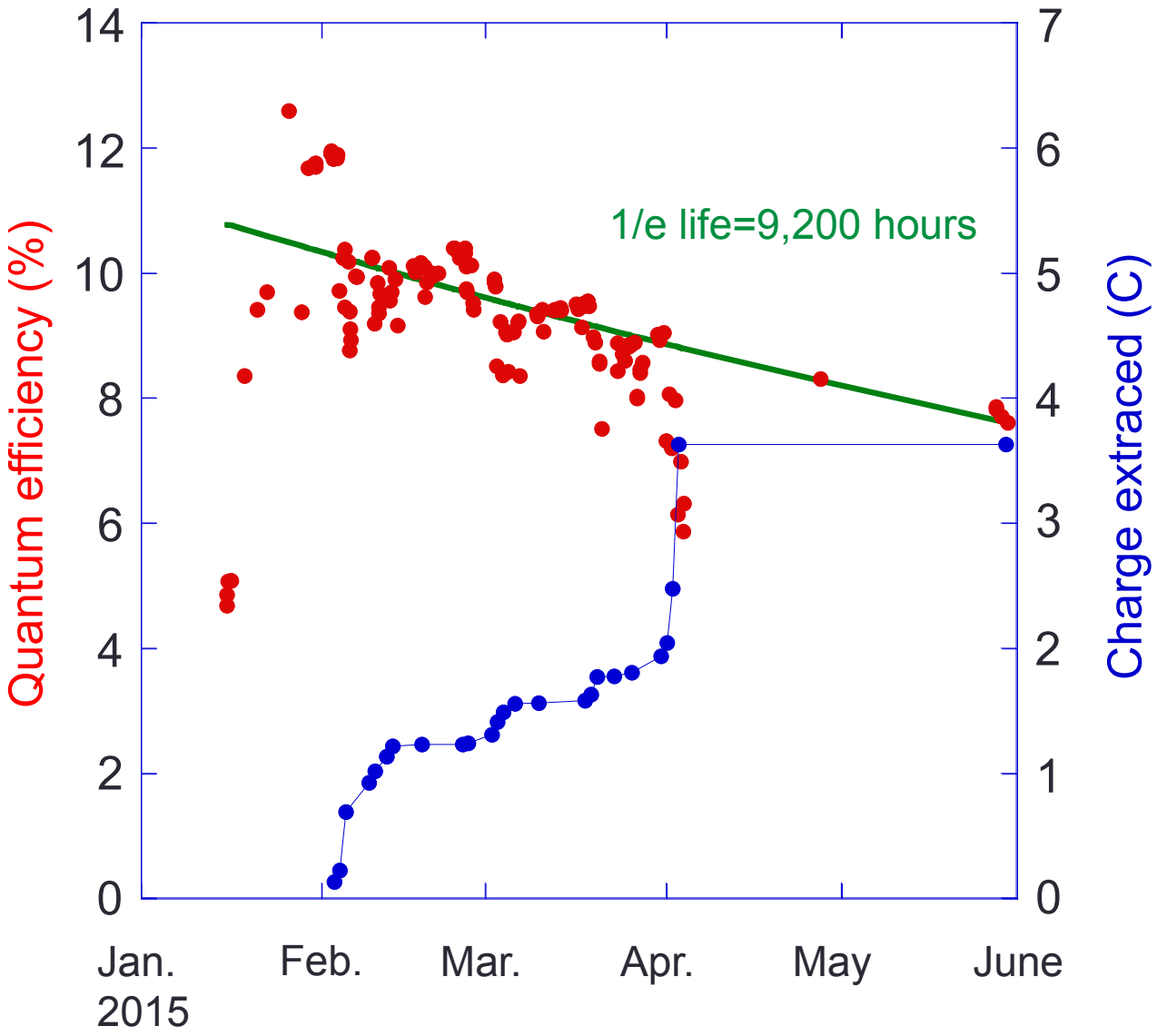
Gun operational status during LCS experiment



QE during LCS experiment



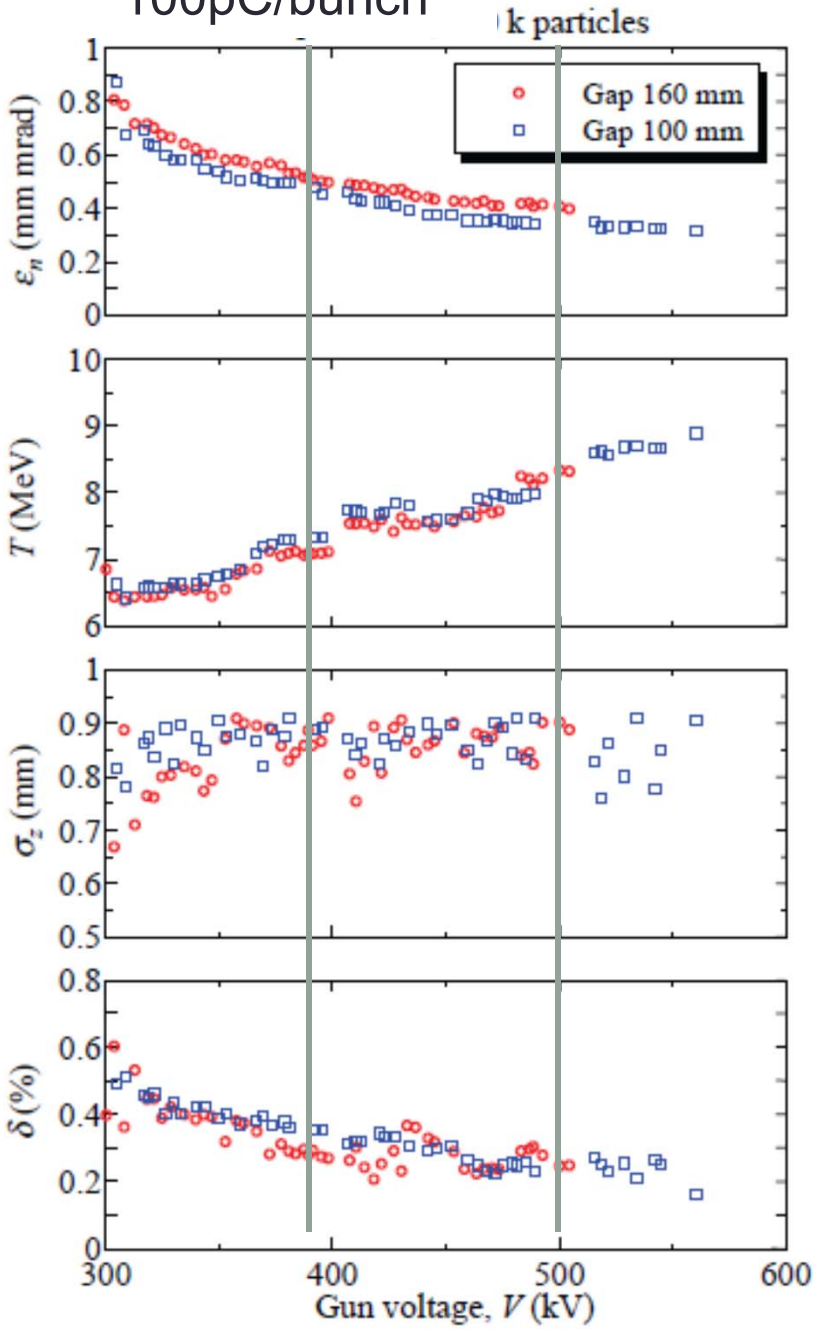




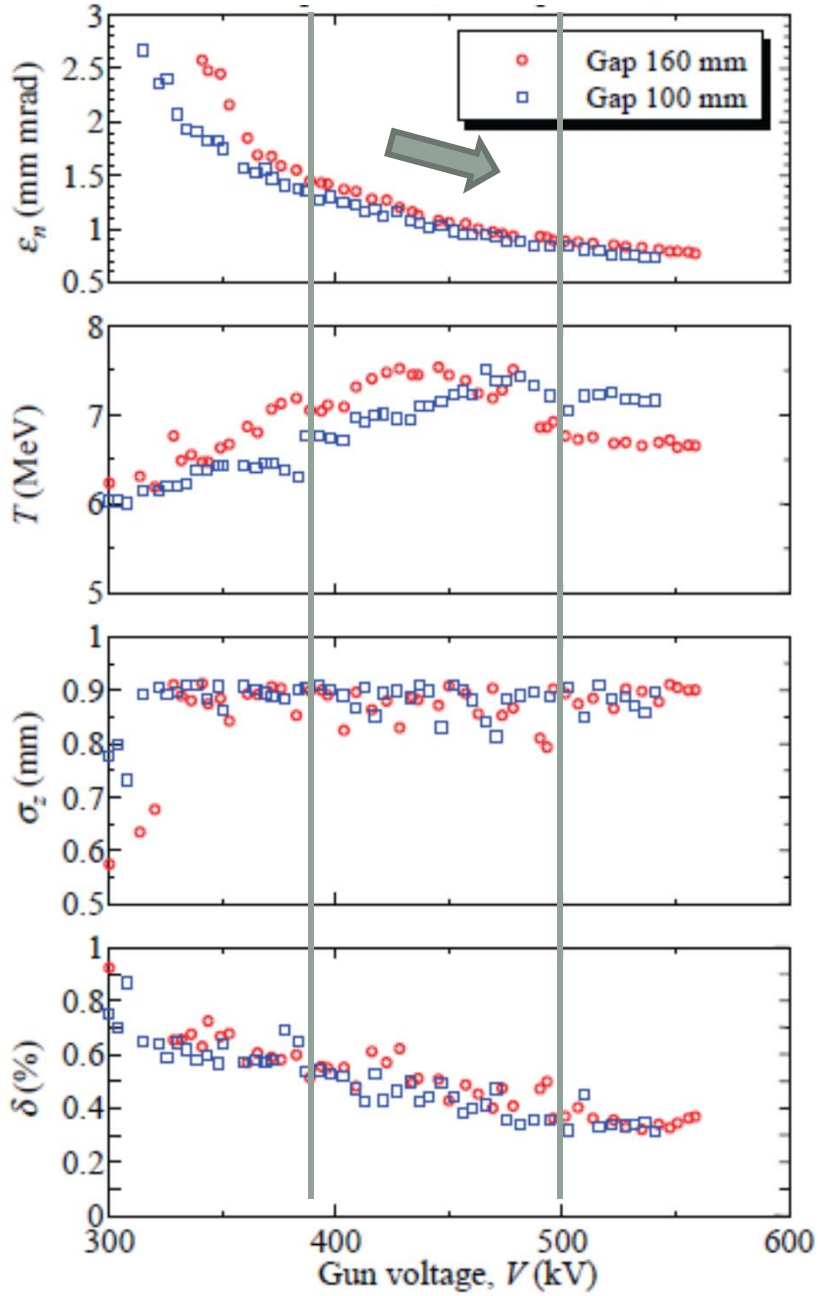
FEL application

T. Miyajima et al., Proc. of FEL2014

100pC/bunch

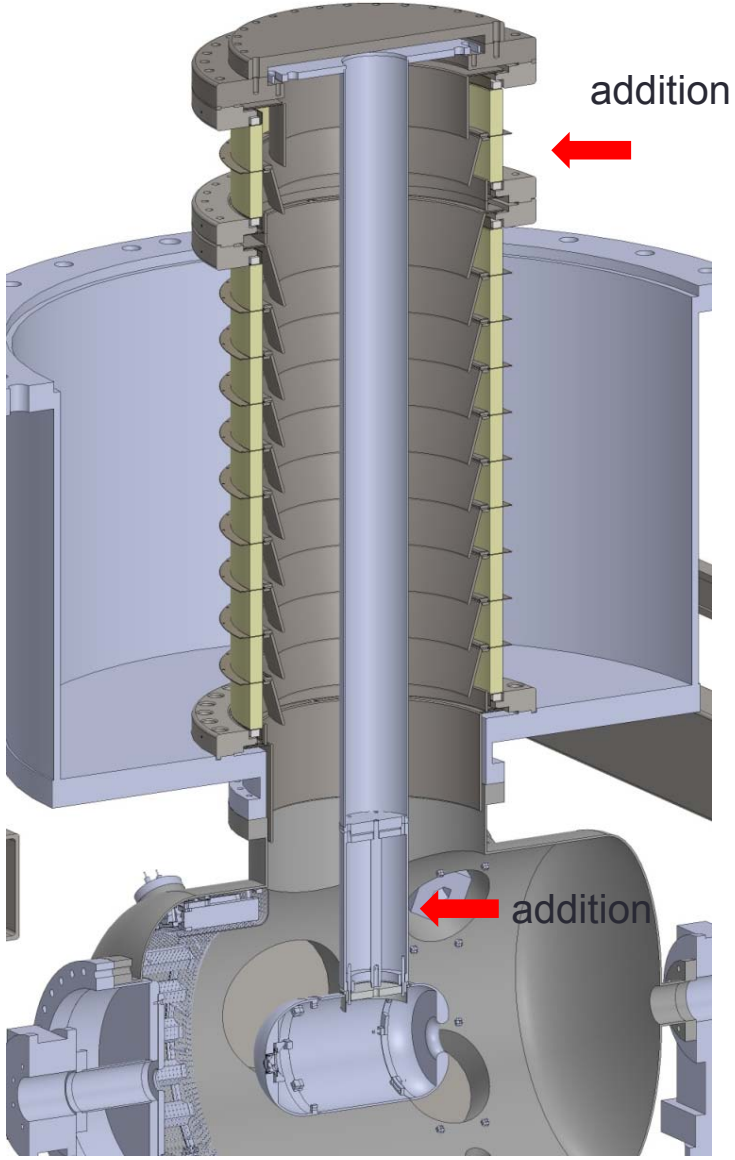


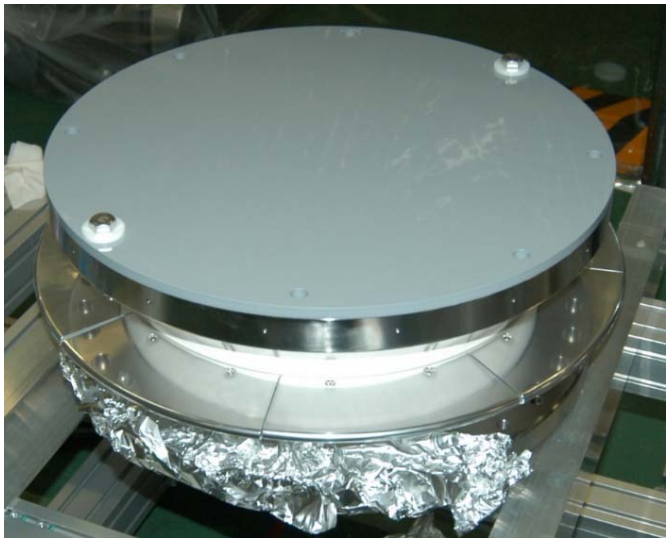
300pC/bunch

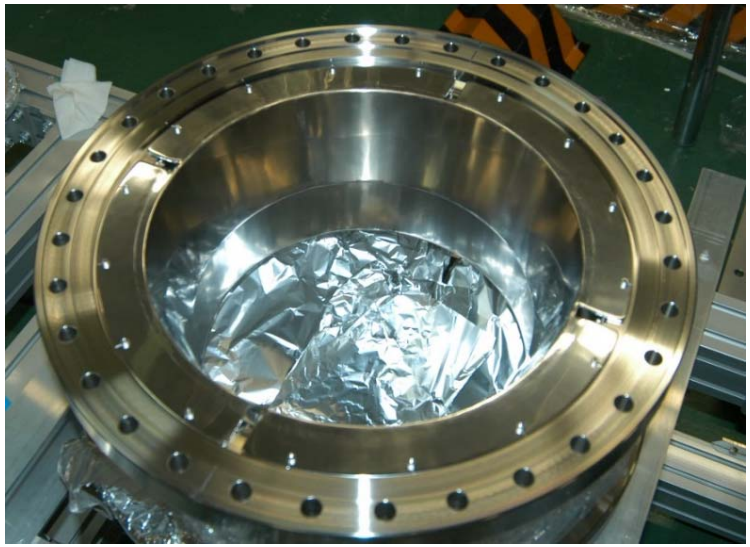


Higher gun voltage is required

A Plan to 500kV operation







- Prepared an additional ceramics
- Install the ceramics in July 2015
- Perform HV test without cathode electrode
- Install an additional stem rod in Sep. 2015
- Perform HV test with cathode electrode
- Perform beam generation in Nov. 2015

Summary

Results at JAEA

✓Generated 500keV electron beam from a photo-gun with current up to 1.8mA

Results at cERL

✓ Provided 390keV beam stably for 1200 hours

✓ 1/e life of GaAs cathode is 9200 hours long enough for commissioning

Future work

- ☐ Install additional ceramic insulator for 500 kV operation at the cERL
- ☐ Develop a photocathode appropriate for high current operation