The Tokyo EBIT

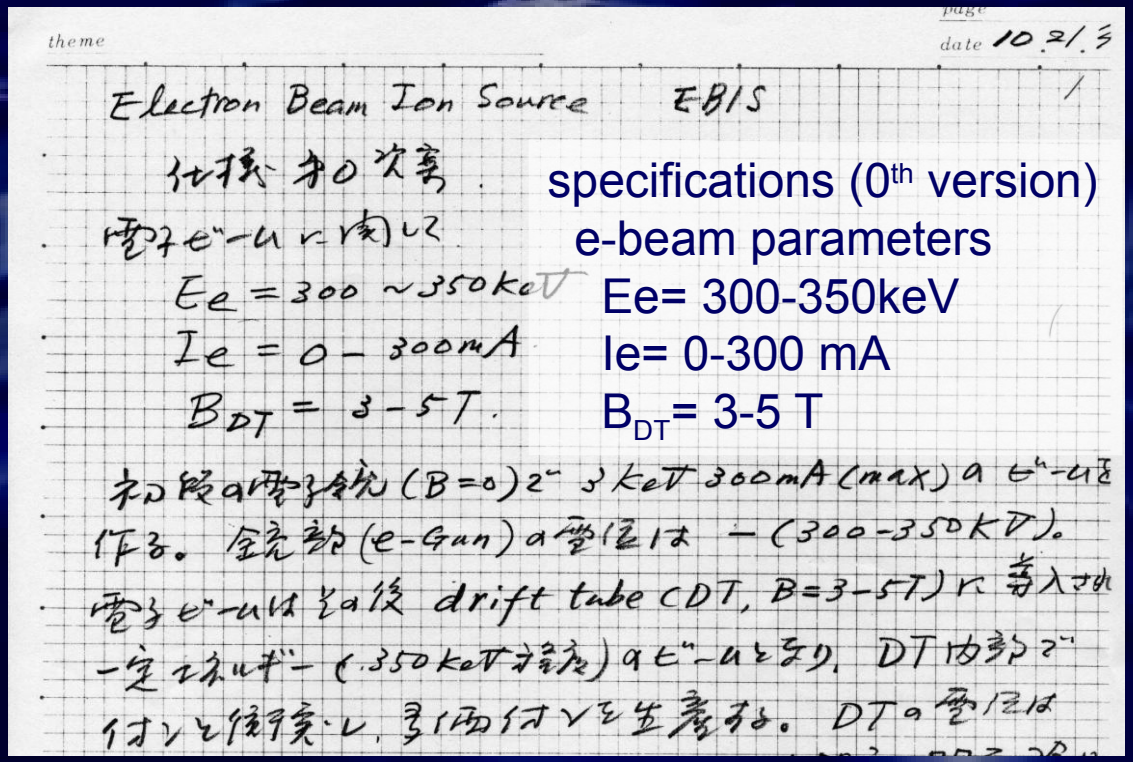
NAKAMURA, Nobuyuki
Inst. for Laser Science, The Univ. of Electro-Communications

HIE-EBIS
CERN
October 16, 2012

Brief history

YEBISU project since 1992

- **Grant-in-aid for scientific research on priority areas "Atomic physics of highly charged ions" (S.Ohtani) 1992-**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date 10.21.93

Electron Beam Ion Source EBIS

仕様書0次案

電子ビームに関して

E_e = 300 ~ 350 keV

I_e = 0 - 300 mA

B_{DT} = 3 - 5 T.

初段の電子銃 (B=0) で 3 keV 300 mA (max) のビームを作る。銃数 (e-Gun) の電圧は −(300-350 kV)。電子ビームはこの後 drift tube (DT, B=3-5T) に導入され一定エネルギー (350 keV 付近) のビームとなり、DT 内部でイオンと衝突し、多価イオンを生成する。DT の電圧は

specifications (0th version)
e-beam parameters
Ee= 300-350keV
Ie= 0-300 mA
B_{DT}= 3-5 T

memo by
S. Ohtani
(21 Oct. 1992)

The following equipment items are offered for sale by P & T for various research purposes. Please contact D. Schneider for prize and delivery informations.

1) 45 degree electrostatic parallel plate electron analyzers as single and tandem devices for UHV conditions optional

2) Position sensitive proportional counters for x-ray spectroscopy

3) Position sensitive multi-channel plate detectors (UHV)

4) Metal Vapor Vacuum Arc Ion Source

5) Non-cryogenic "Electron Beam Ion-Trap-Source"

6) Cryogenic "Electron Beam Ion-Trap-Source"

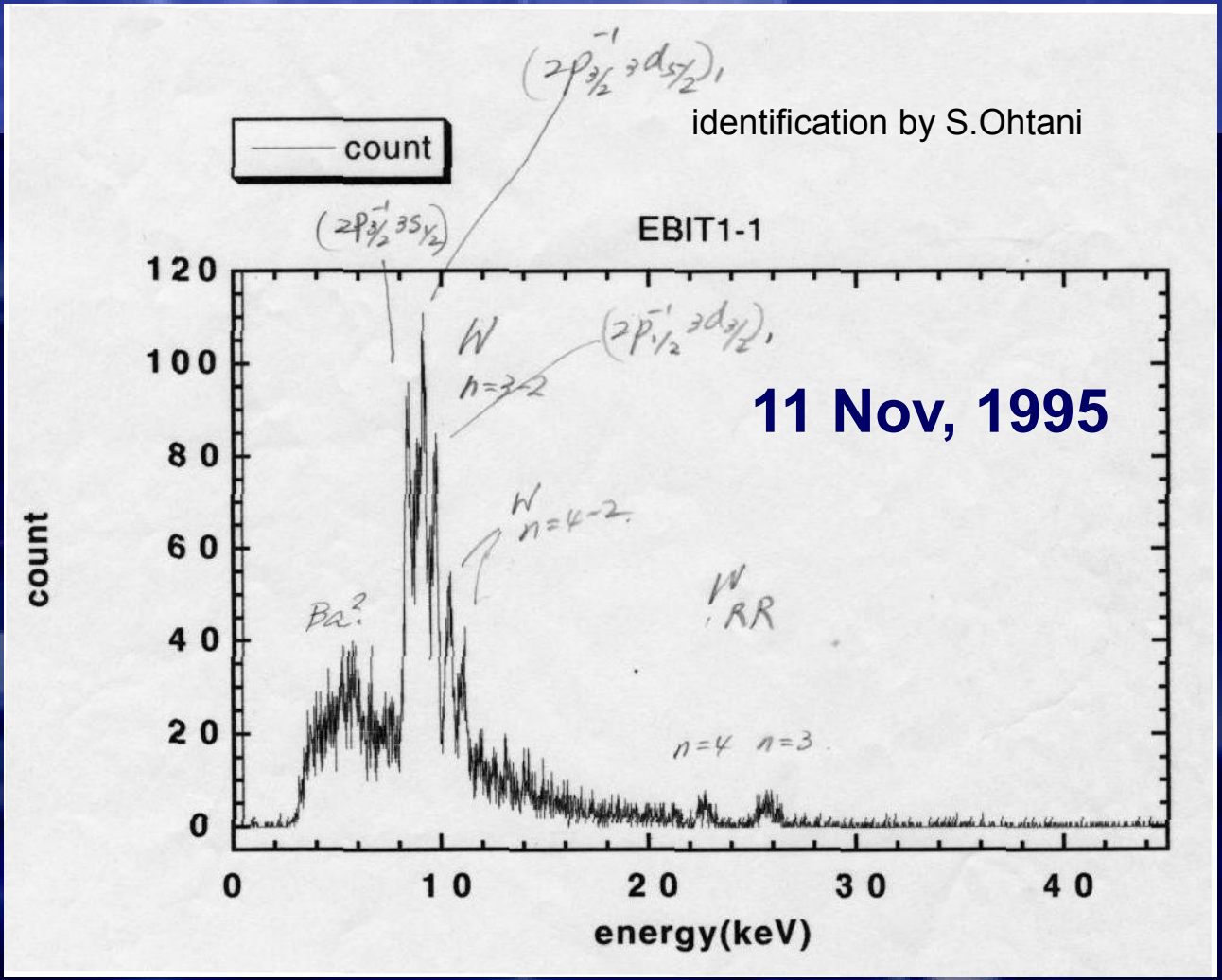
7) Data aquisition program and system

Contact: Dieter H. G. Schneider Tel. + FAX 510 449 0624

Fax from D.Schneider which suggested us to buy the EBIT developed at LLNL.

Tokyo-EBIT in construction

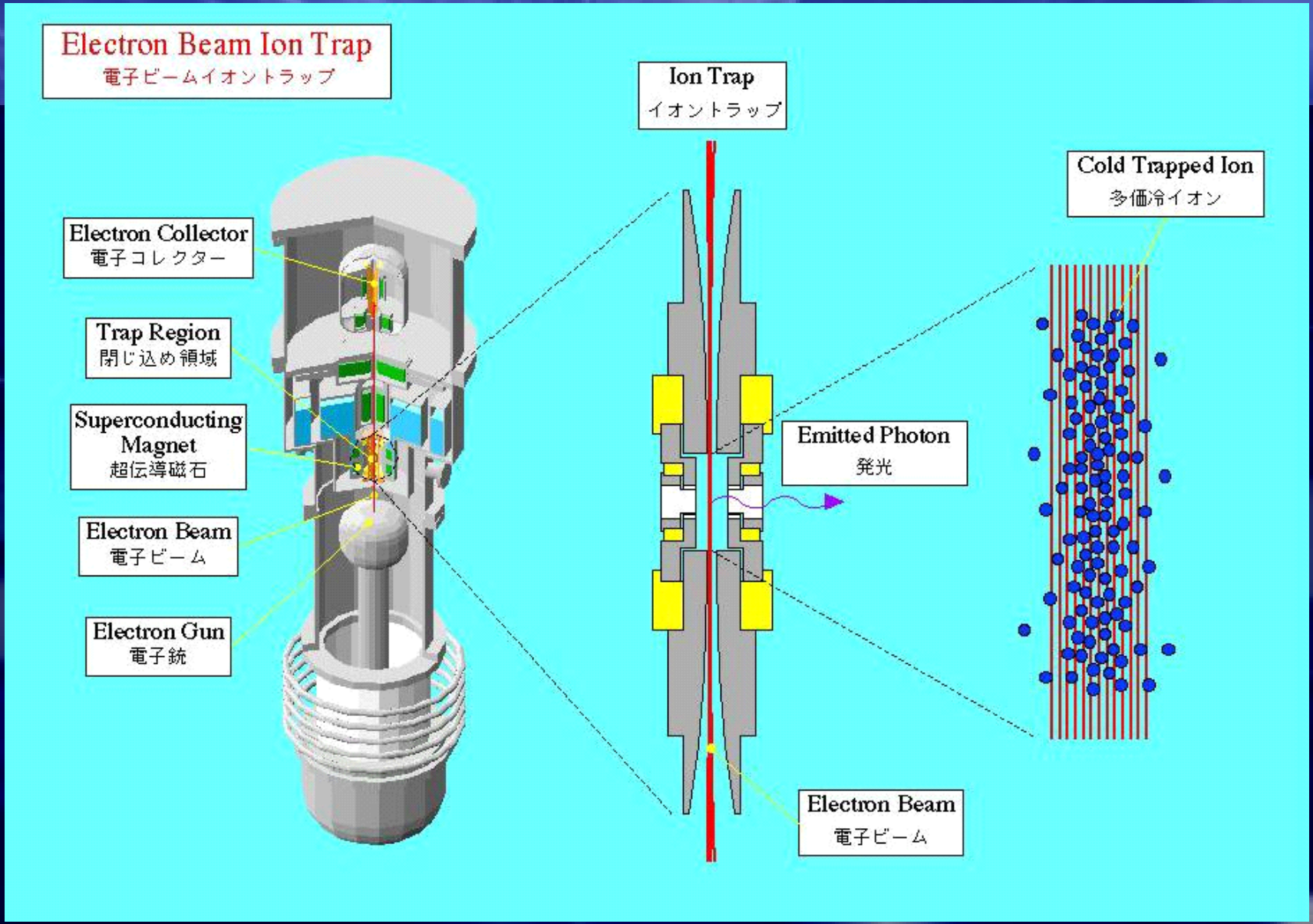
First spectrum of the Tokyo-EBIT



~9 years after the first spectrum at LLNL
~3 years after the memo by S.Ohtani

Structure of the Tokyo EBIT

The Tokyo EBIT

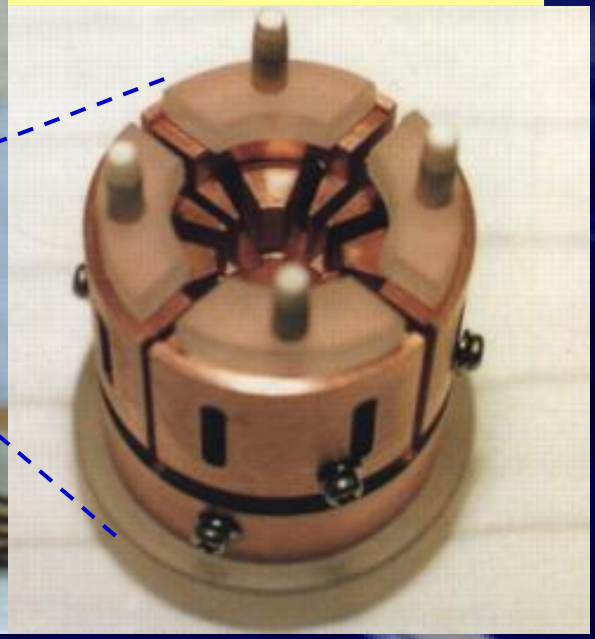


S. Ohtani

Tokyo-EBIT

Ion trap

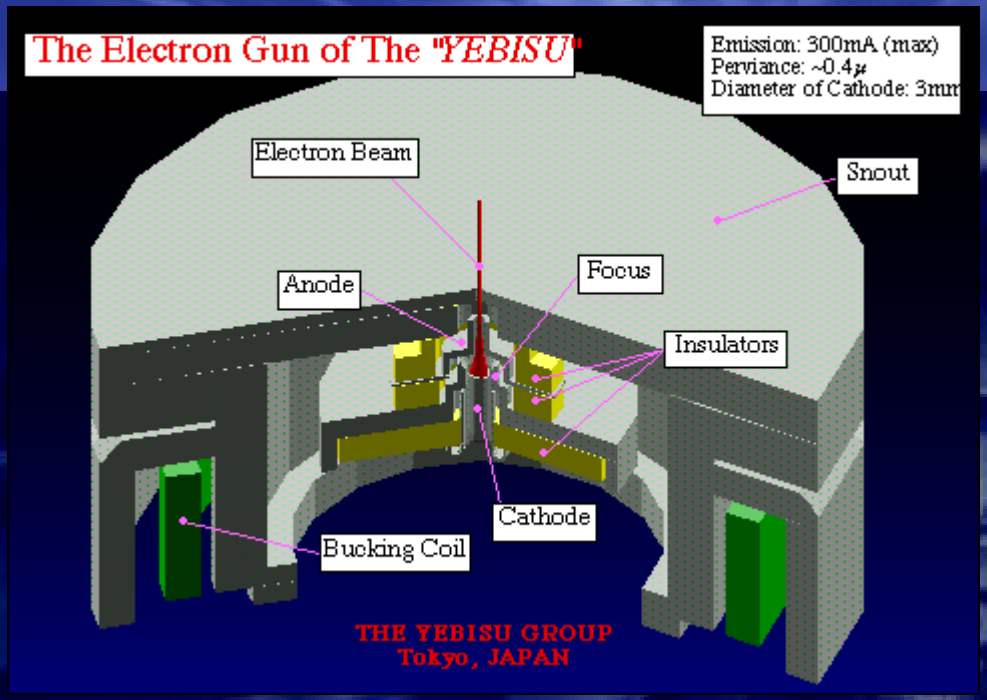
Middle of the trap

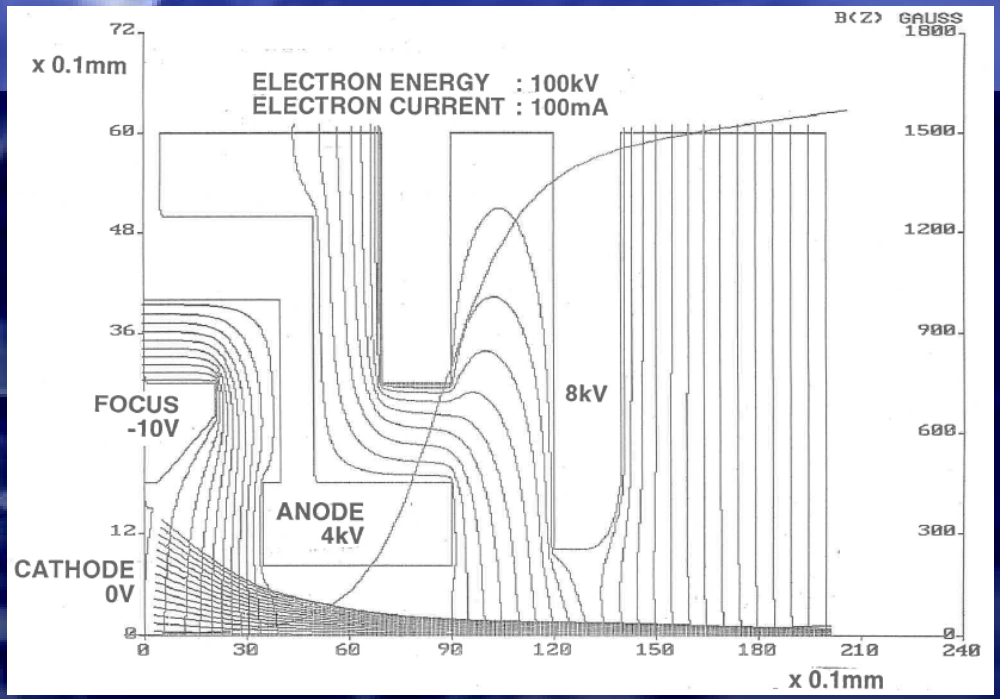


Important parameters of the Tokyo-EBIT

	achieved	designed
Max. electron energy (keV)	180	340
Max. electron current (mA)	330	300
Max. magnetic field (T)	4.5 (typically 4.0)	4.5
Cryostat temp. (K)	2.4 (typically 4.2)	2.4

Electron gun of the Tokyo-EBIT





- Spherical concave shaped cathode
- Diameter of the cathode: 3 mm
- Porous tungsten matrix infiltrated BaO, CaO and Al_2O_3
- Brillouin focusing condition (B=0 at cathode)
- Perviance: 0.44 μ $A/V^{3/2}$
- Tokyo cathode laboratory Co. Ltd.

TCL Tokyo Cathode Laboratory

Thomson scattering system for diagnosing e-beam density

H. Kuramoto et al., RSI 2002

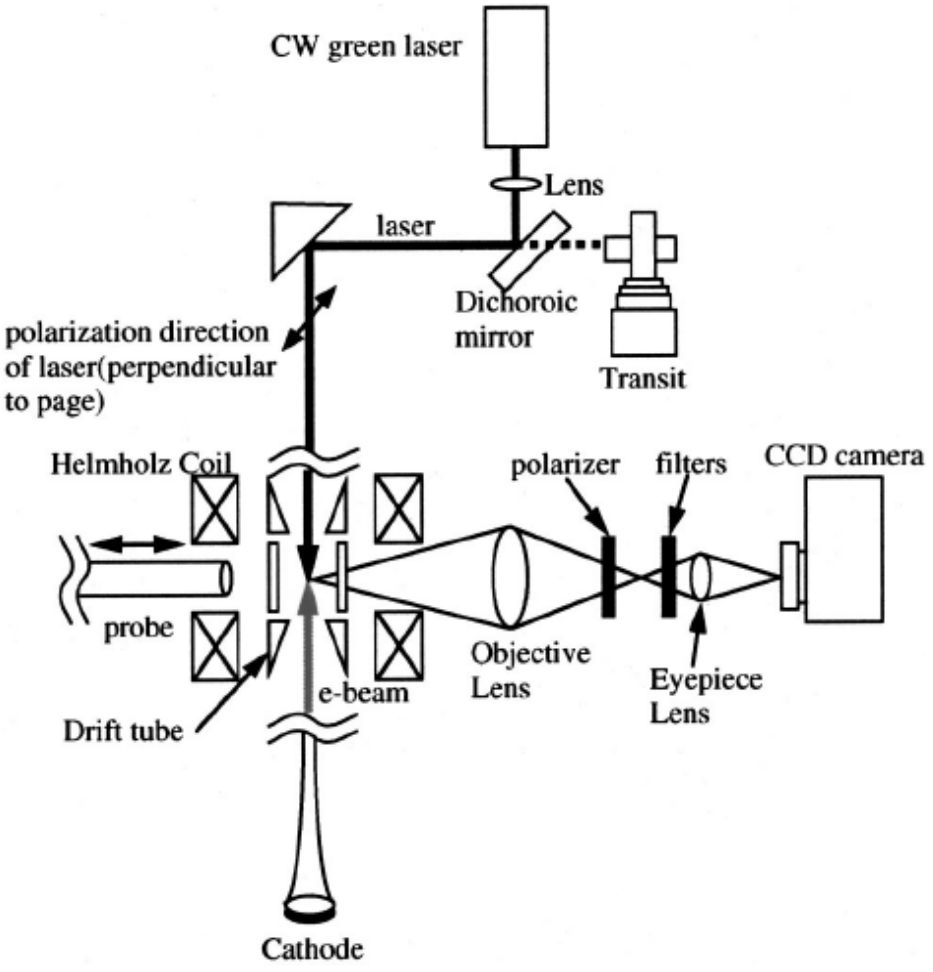
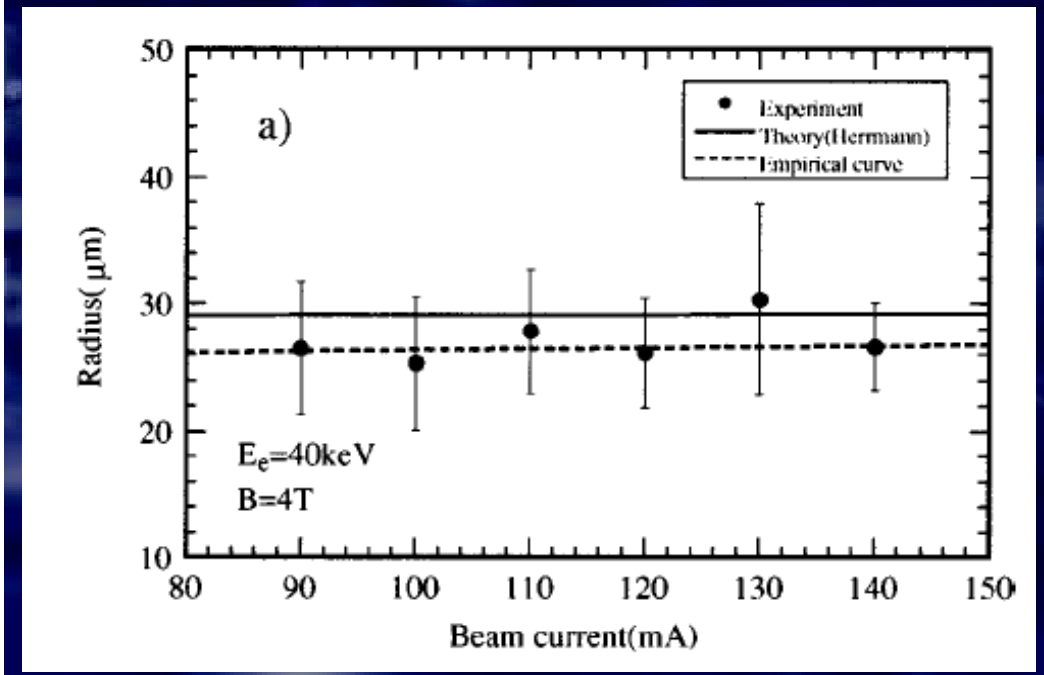
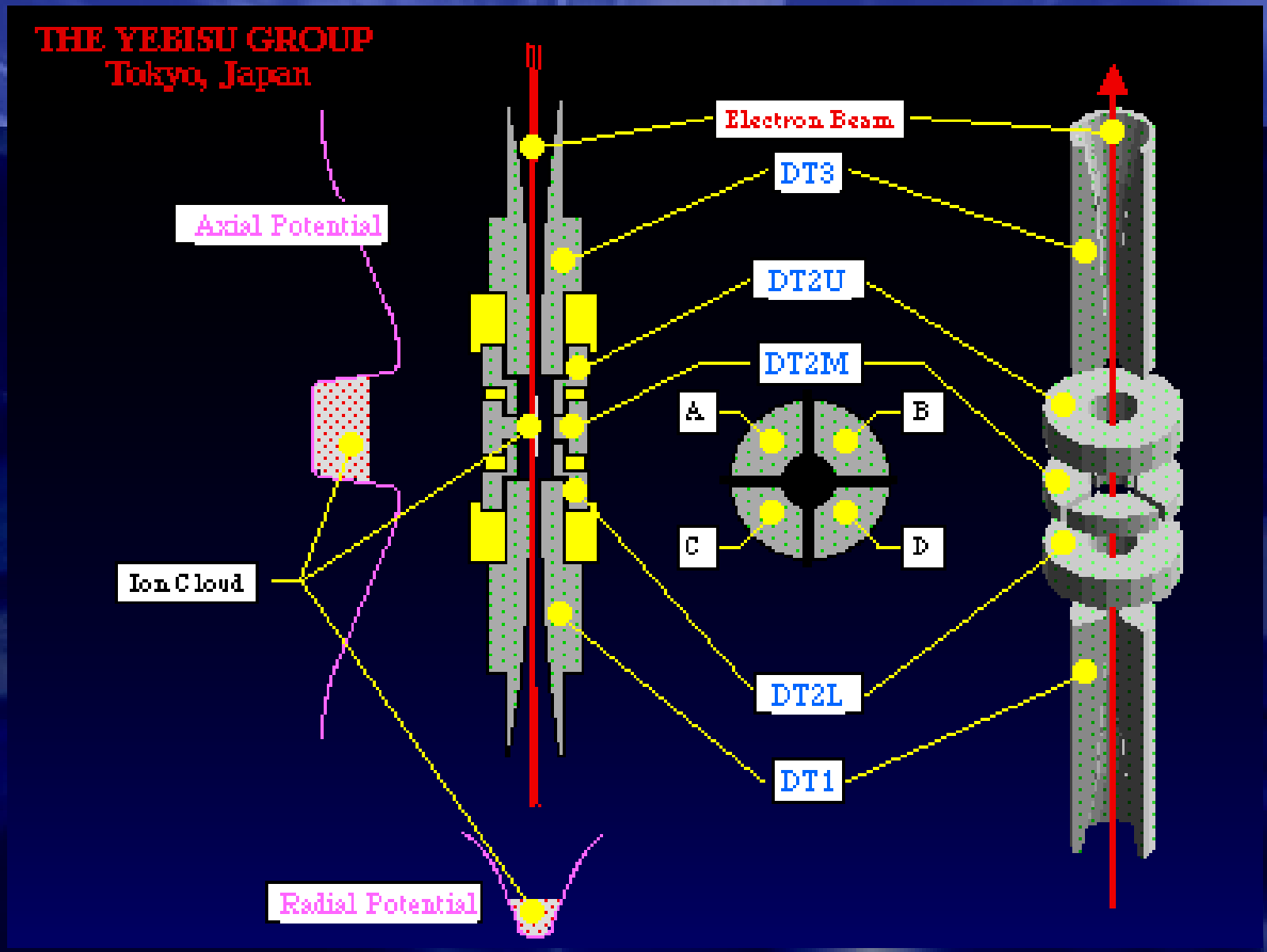


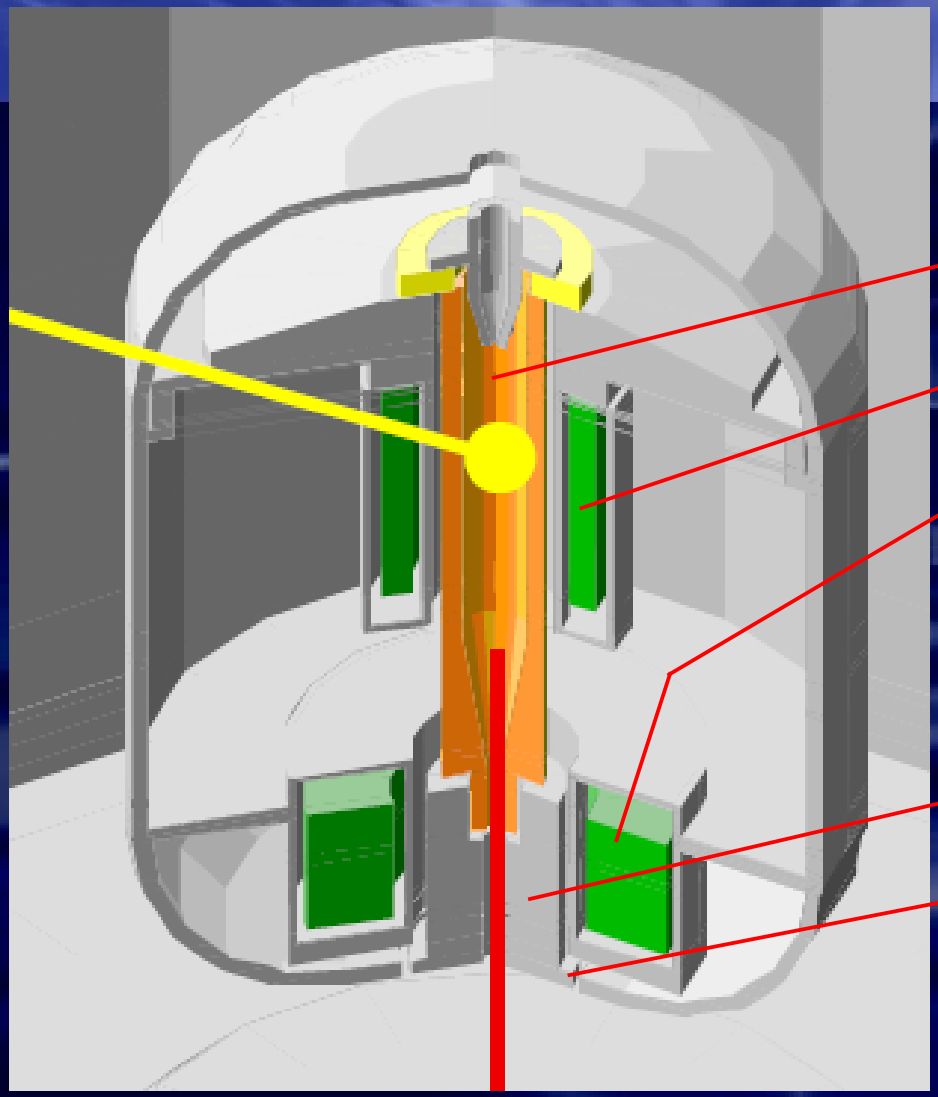
FIG. 1. Schematical view of the experimental setup for Thomson scattering measurement.



Trap structure of the Tokyo-EBIT

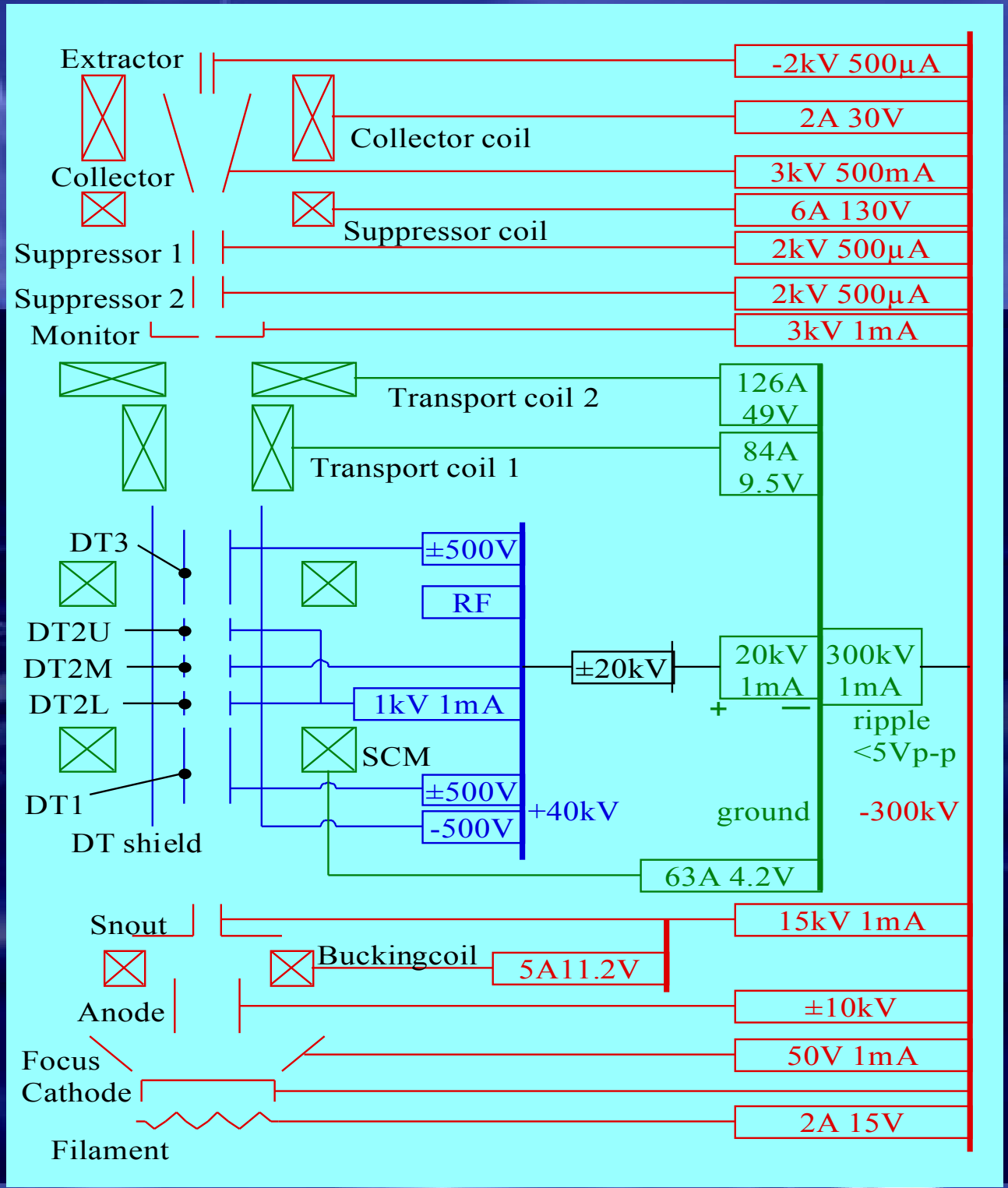


Collector of the Tokyo-EBIT

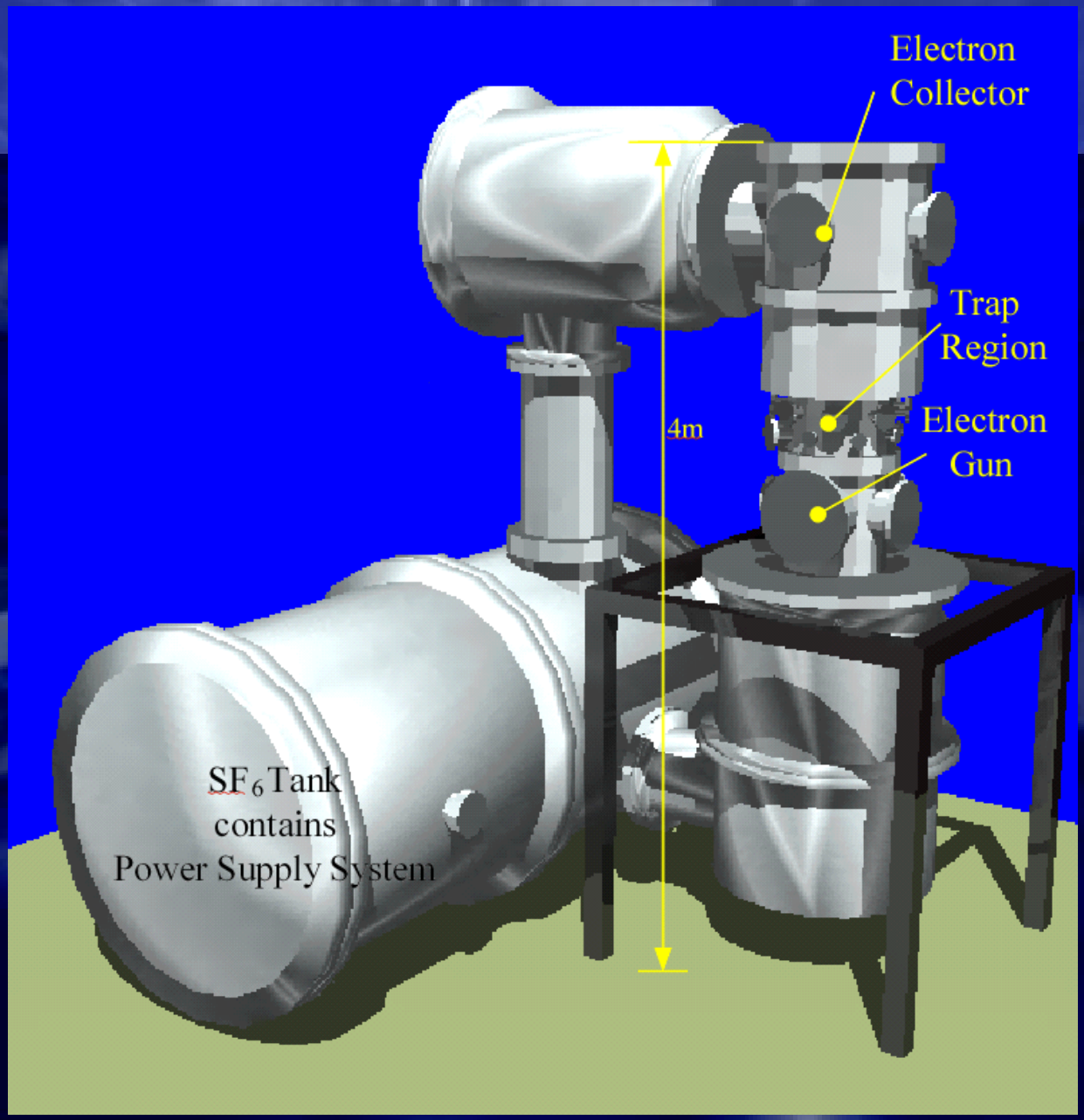


Power supply system

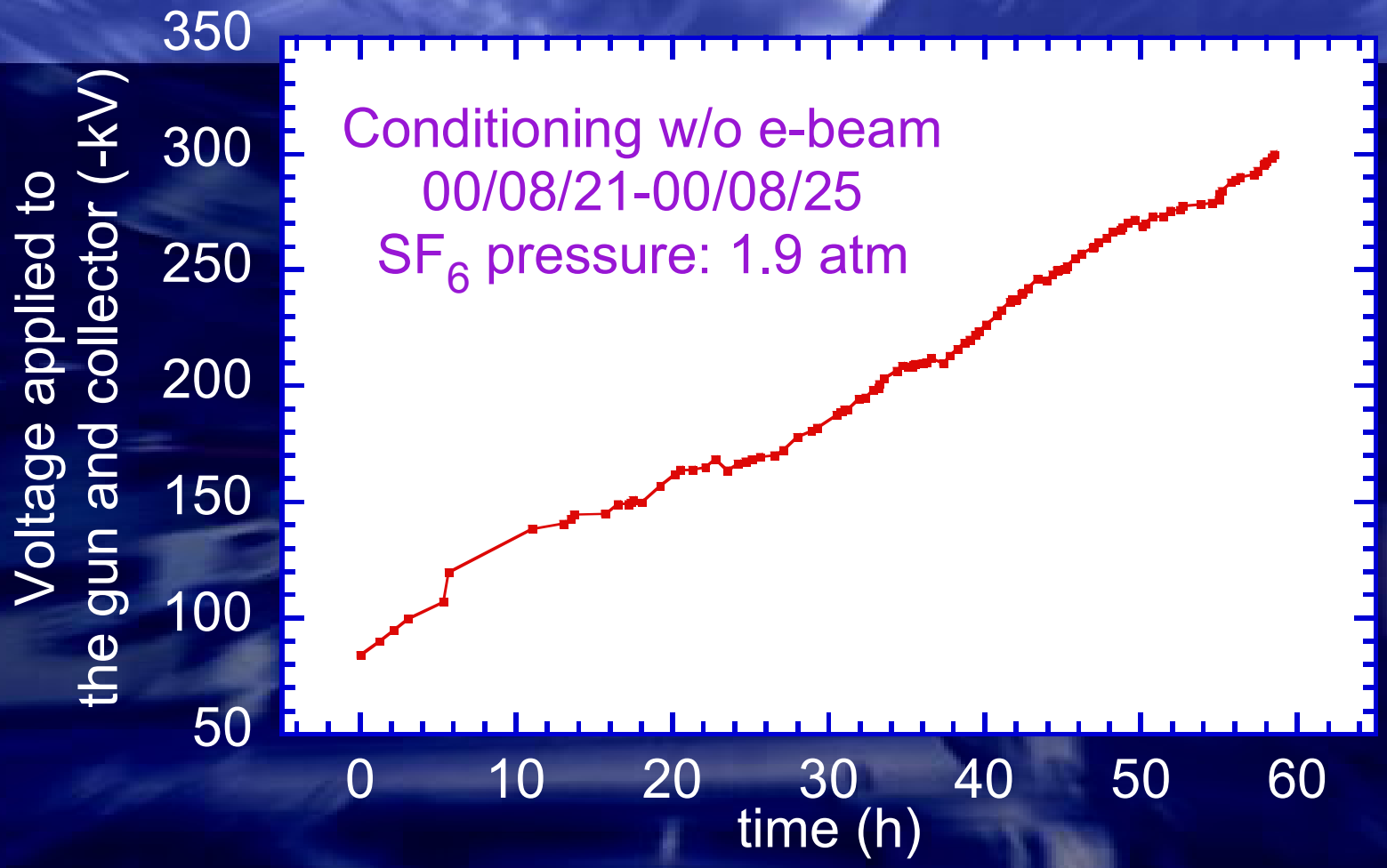
Power supplies



SF6 tank for power supplies

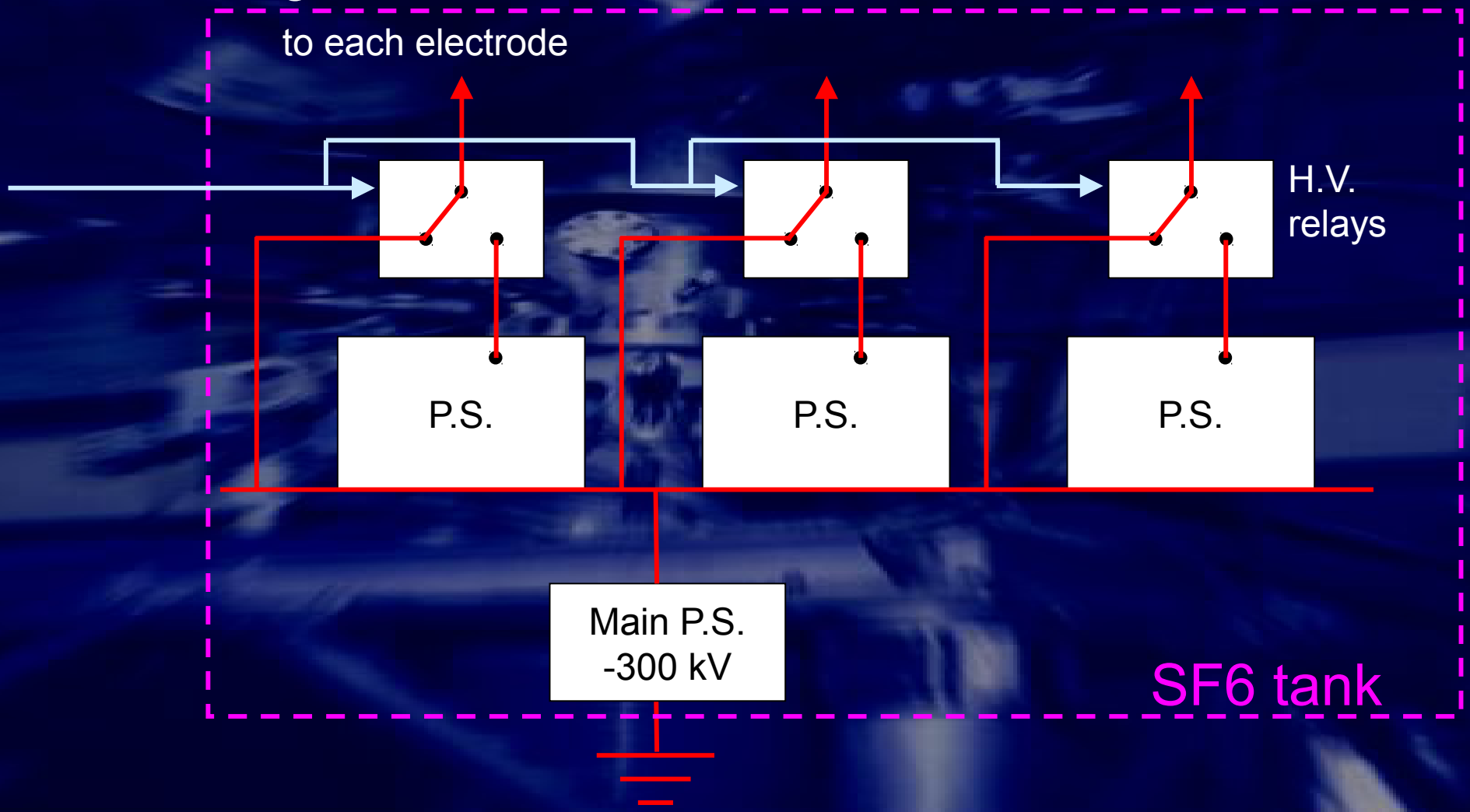


High voltage conditioning



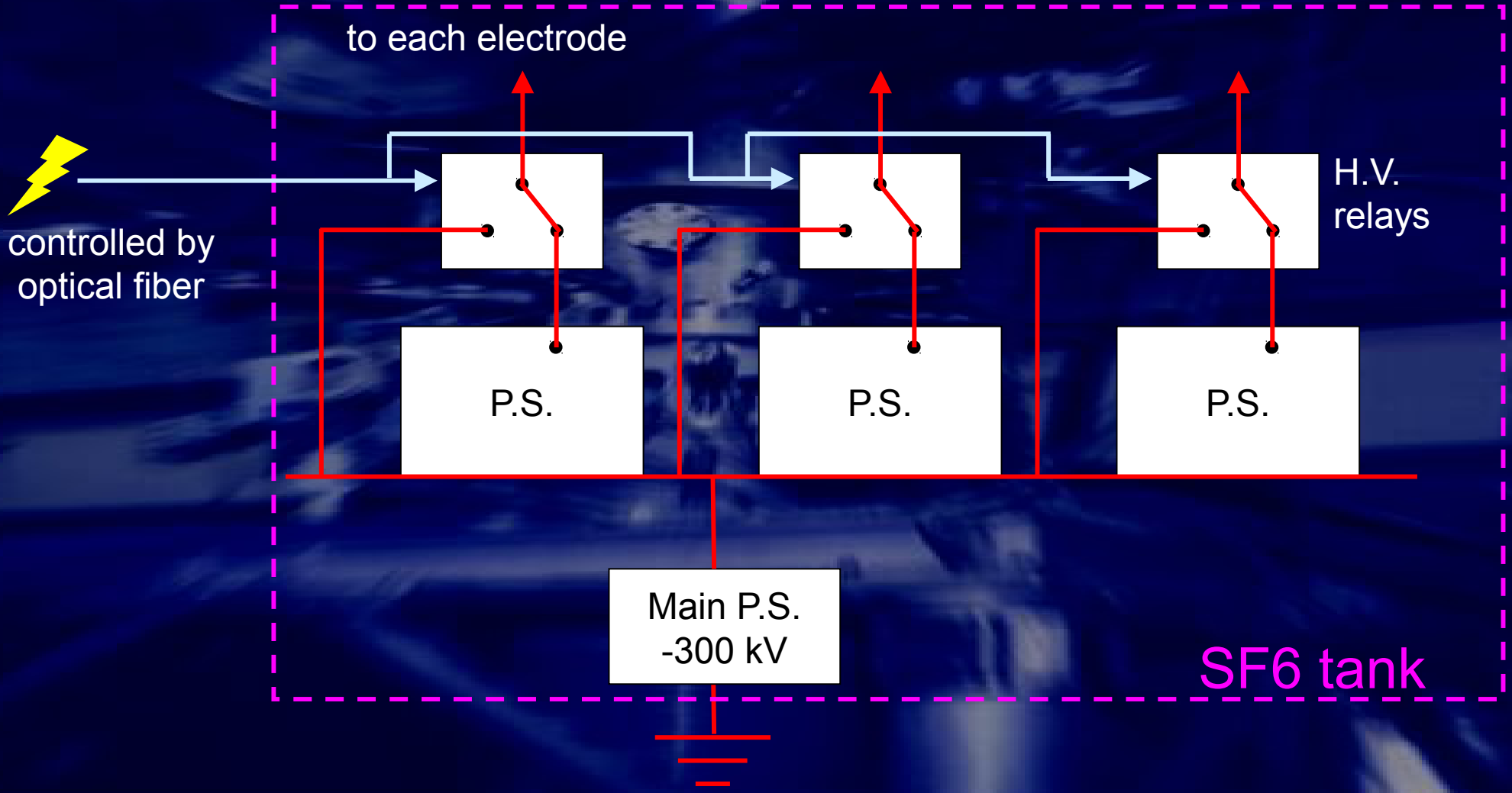
Relay system for protecting power supplies

in conditioning



Relay system for protecting power supplies

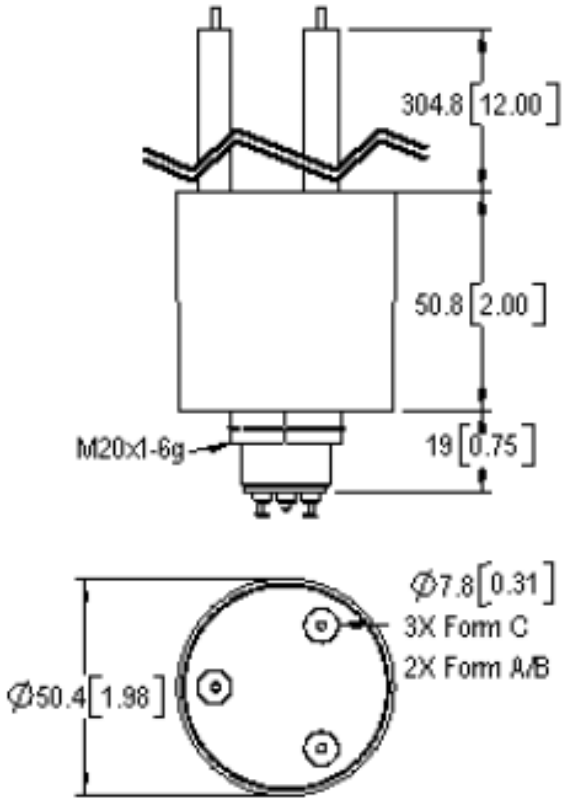
in operation



High voltage relays

G62A - G62B - G62C 25 kV

RoHS Compliant



FEATURES

G62A & G62B & G62C

- Compact design saves precious space while isolating 25kV
- Flying leads provide versatile high voltage connections

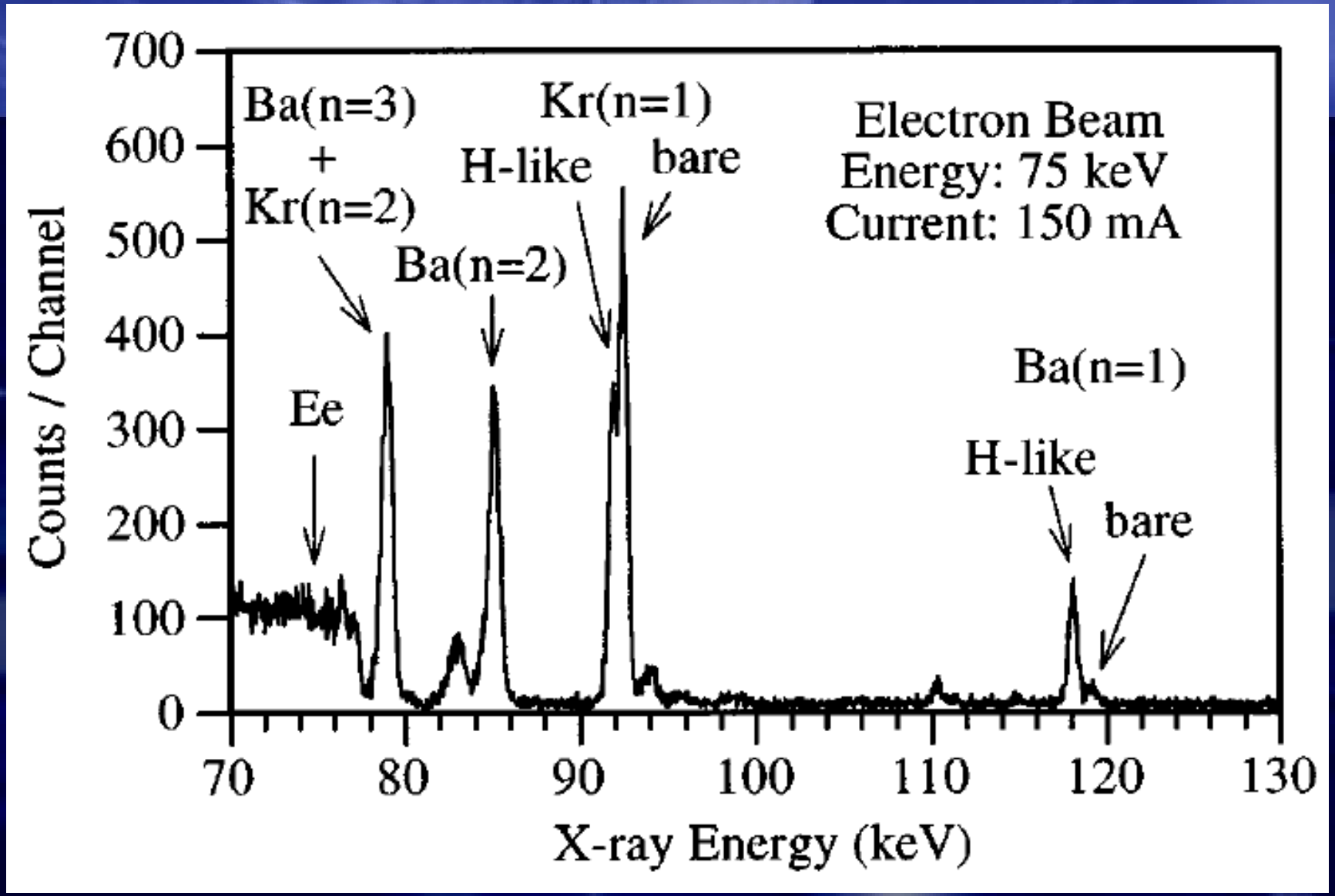
GIGAVAC®

Experience in applying H.V.

- Early days
  - Although there were discharges and Bremsstrahlung during conditioning, there were few discharge and Bremsstrahlung if the voltage was decreased from an experienced voltage.
- Recently
  - We have serious Bremsstrahlung at 150 kV or higher even after conditioning at 200 kV.

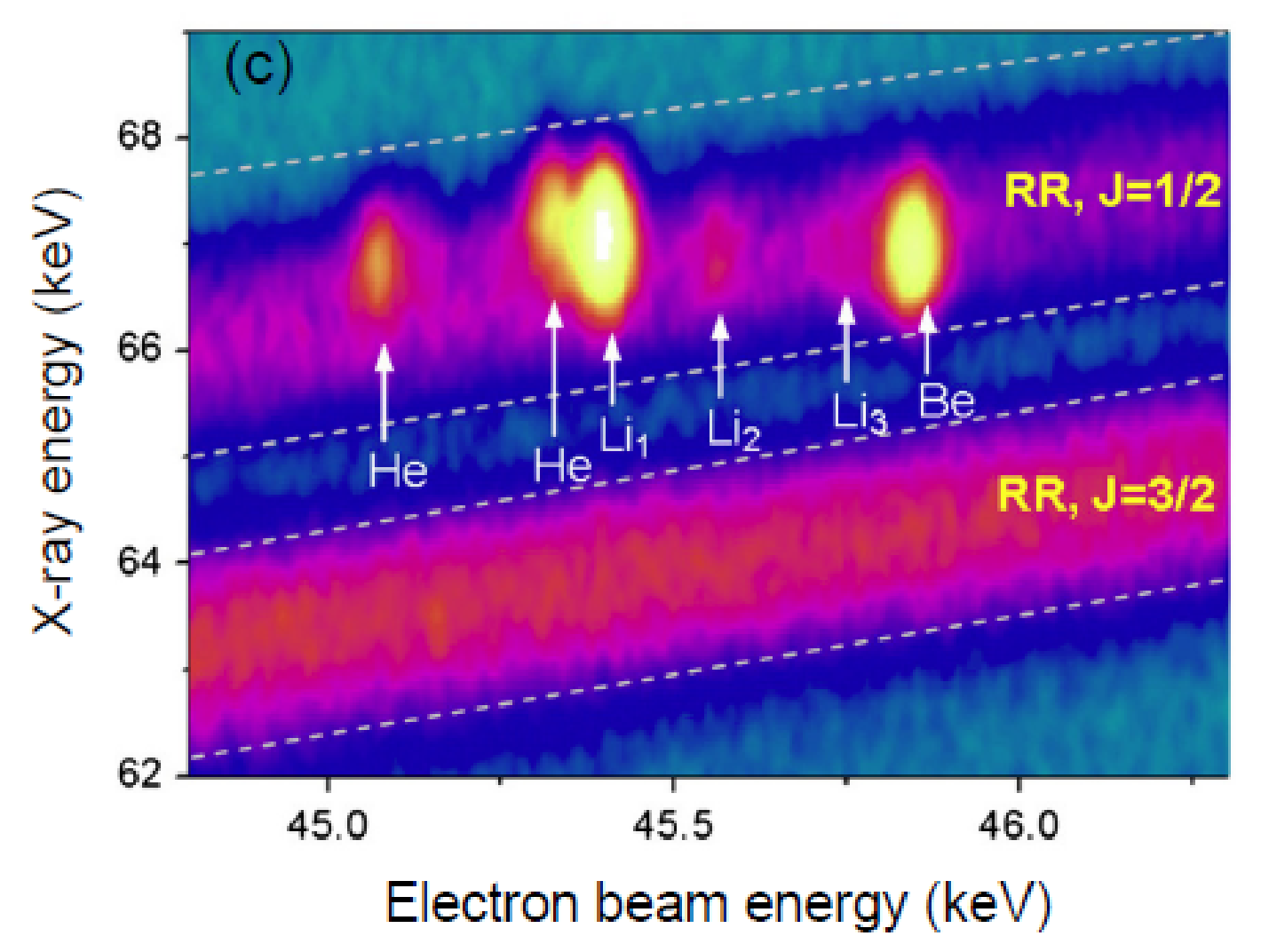
Performance of the Tokyo EBIT

Typical x-ray spectra



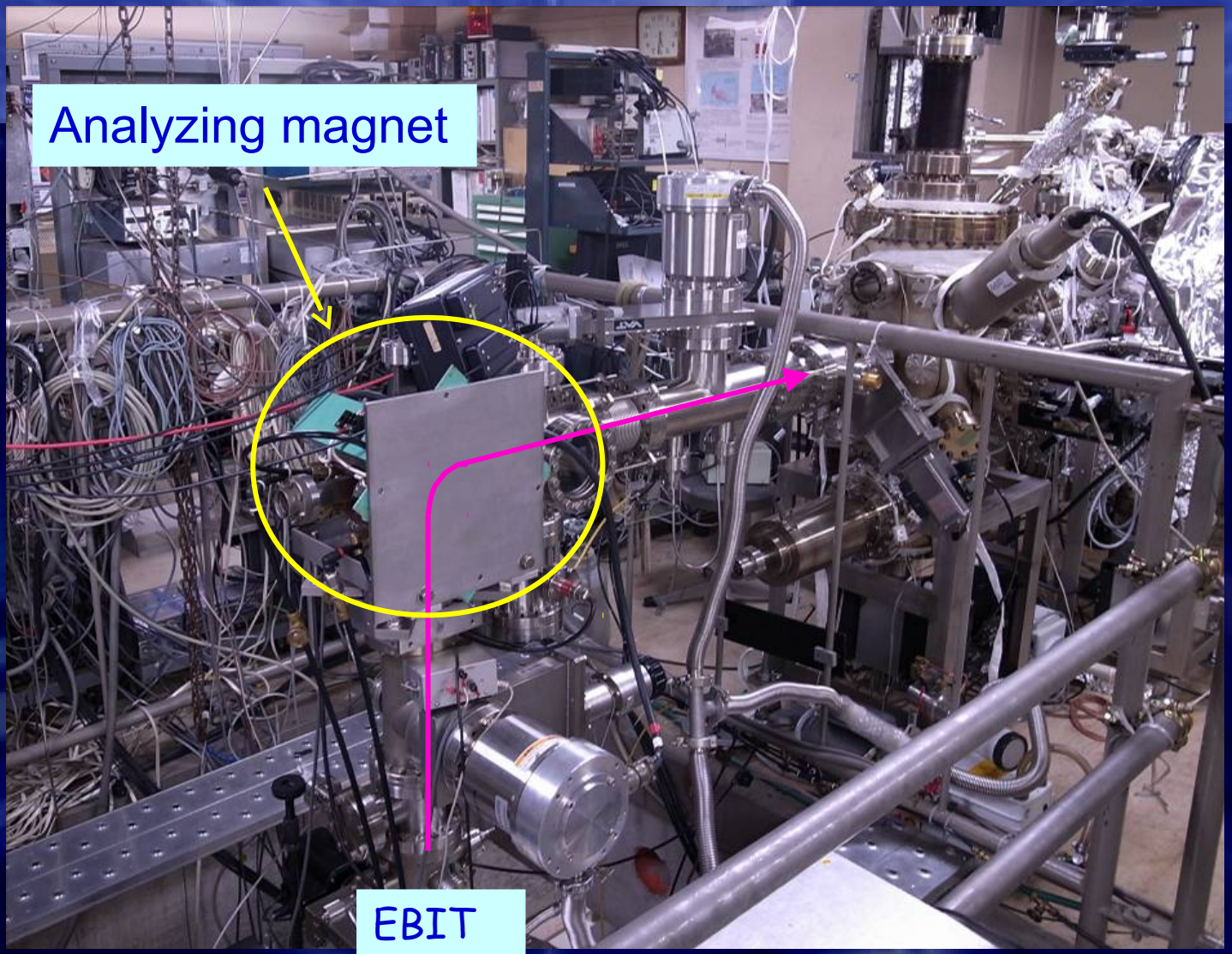
N. Nakamura et al., RSI 1998

Typical x-ray spectra

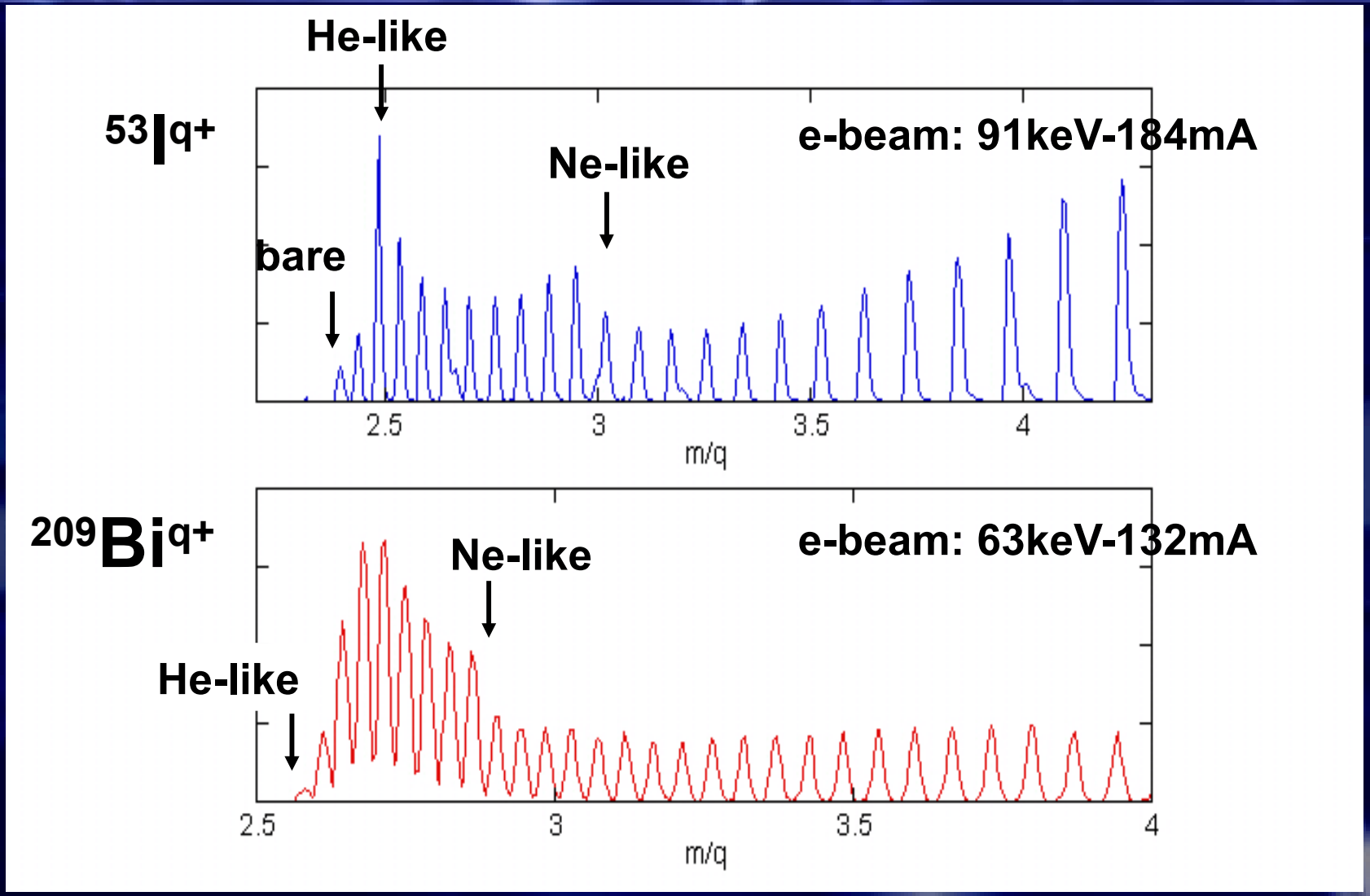


X-ray spectrum obtained for investigating dielectronic recombination of highly charged Au ions (Hu et al. PRL 2012).

Beam line for extracted ions

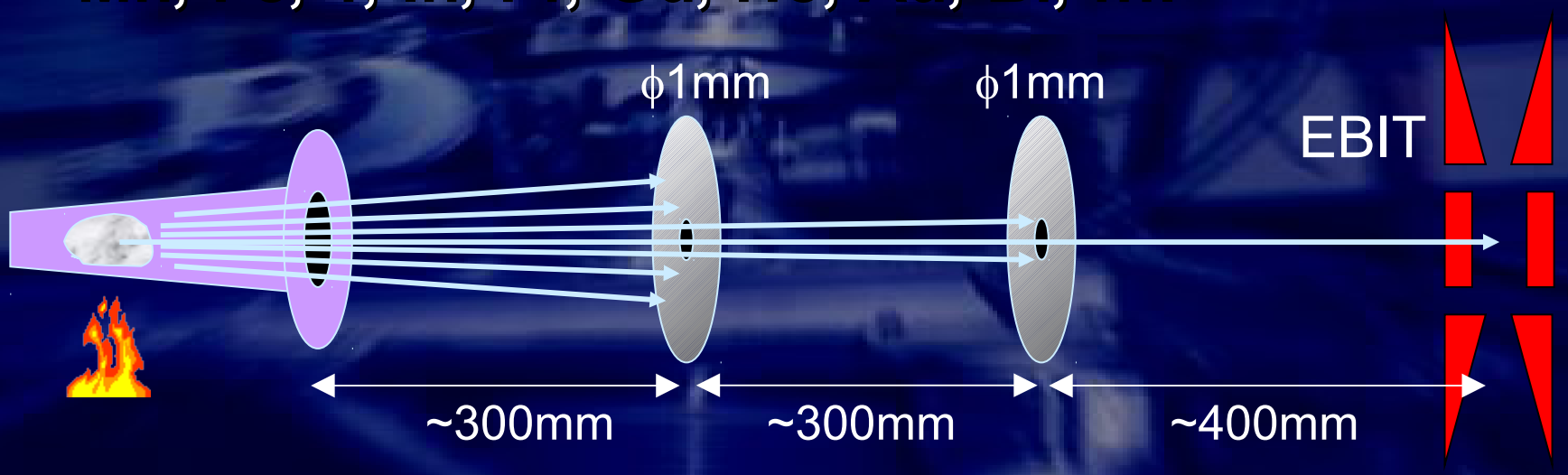


Typical charge spectra of extracted ions



Injection of various elements

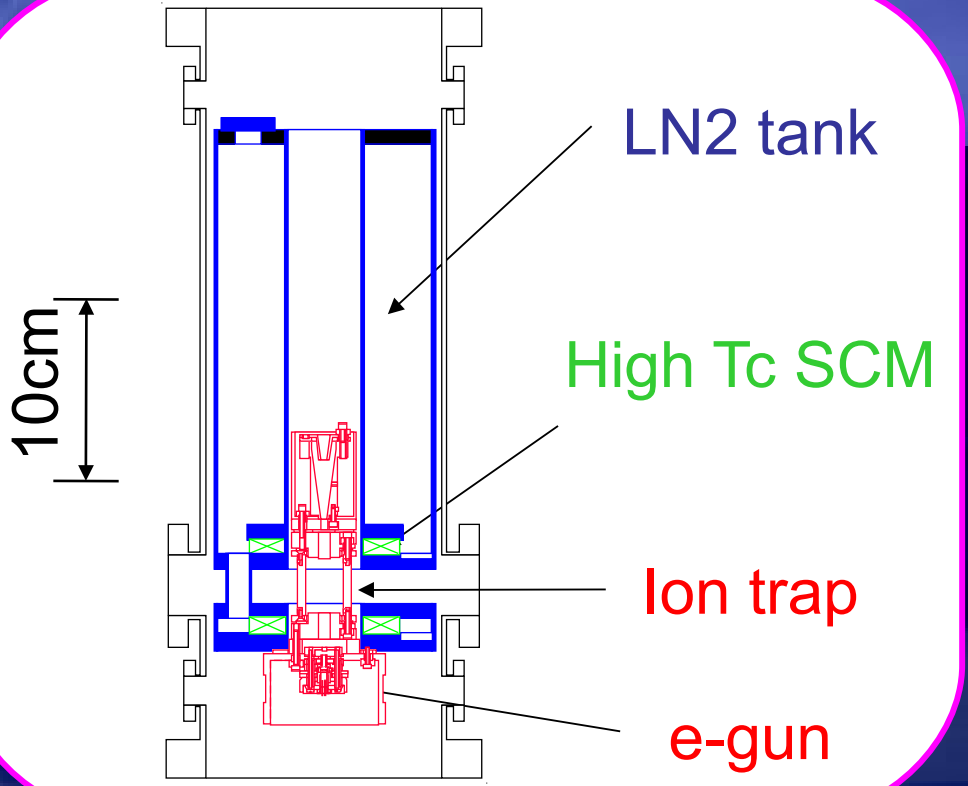
- Ordinary gas injector
  - Rare gases
  - CH_3I for I, $W(CO)_6$ for W, $Fe(C_2H_5)_2$ for Fe
- Effusion cell (Knudsen cell, K-cell)
  - Mn, Fe, Y, In, Pr, Gd, Ho, Au, Bi, ….



Yamada et al., RSI 77 (2006) 066110

CoBIT (Compact, Corona, … EBIT)

N.Nakamura et al., RSI 79 (2008) 063104

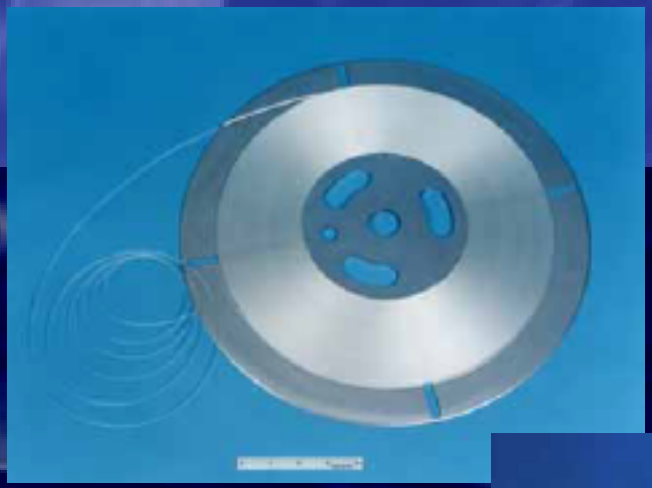


Specifications

e-beam energy	100 – 2500 eV
e-beam current	20 mA (max)
Magnetic field	0.2 T (max)
Temperature	77 K (High-Tc SCM)

高温超電導
High Temperature Superconductor (HTS)

Sumitomo DI-BSCCO®



With over 40 years R&D experience, Large-scale mass production facilities for HTS products are available.

Not for experiment! HTS systems are commercially available today!

高温超電導線

高温超電導ｹｰﾌﾞﾙ

高温超電導ﾏｸﾞﾈｯﾄ

SUMITOMO ELECTRIC

UEC members

- Present
  - Staff: Nobuyuki Nakamura
  - PD: Hayato Ohashi, Susanta Das
  - M students (x 6) + B students (x 3)
- Former
  - Staff: Shunsuke Ohtani, Chikashi Yamada, Nobuo Yoshiyasu, Frederick J. Currell
  - PD: D. Kato, T. Kinugawa, H. Kuramoto, H. Shimizu, M. Tona, X.M. Tong, H. Watanabe
  - Many students