

タングステンイオンの 電荷変換衝突断面積測定

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Production of absolute cross-sections for fusion-relevant electron capture processes

1988 – 1994

$C^{1,2,3+} +$

$H_2, CO_2, CH_4, C_2H_6, C_3H_8$

Energy = (0.5) 5 - 32 keV

1995 – 1997

$Cr^{1,2+} +$

$He, Ne, Ar, Kr, H_2, CO, CO_2, CH_4, C_2H_6, C_3H_8$

$Be^{1,2+} +$

$He, Ne, Ar, Kr, H_2, CO, CO_2, CH_4, C_2H_6, C_3H_8$

1998 – 2000

$Ni^{1,2+} +$

$He, Ne, Ar, Kr, H_2, CO, CO_2, N_2, CH_4, C_2H_6, C_3H_8$

2001 – 2004

$Fe^{1,2+} +$

$He, Ne, Ar, Kr, H_2, CO, CO_2, N_2, CH_4, C_2H_6, C_3H_8$

$Be^{1,2+} +$

$He, Ne, Ar, Kr, H_2, CO, CO_2$

$B^{1,2+} +$

$He, Ne, Ar, Kr, H_2, CO, CO_2$

2005 – 2008 – present

$W^+, W^{2+} +$

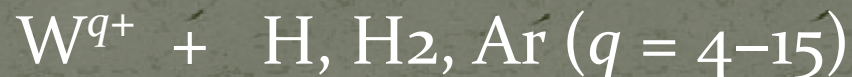
$He, Ne, Ar, Kr, H_2, D_2, N_2, CH_4, C_2H_6, C_3H_8$

IAEA CRP on “Atomic Data for Heavy Element Impurities” (2005 – 2009)
required data for elements with atomic mass ≥ 13 ; (Ar, Kr, Xe), Si, Cl,
Cr, Fe, Ni, Cu, Mo and W and CRP for **W** continues until 2014.

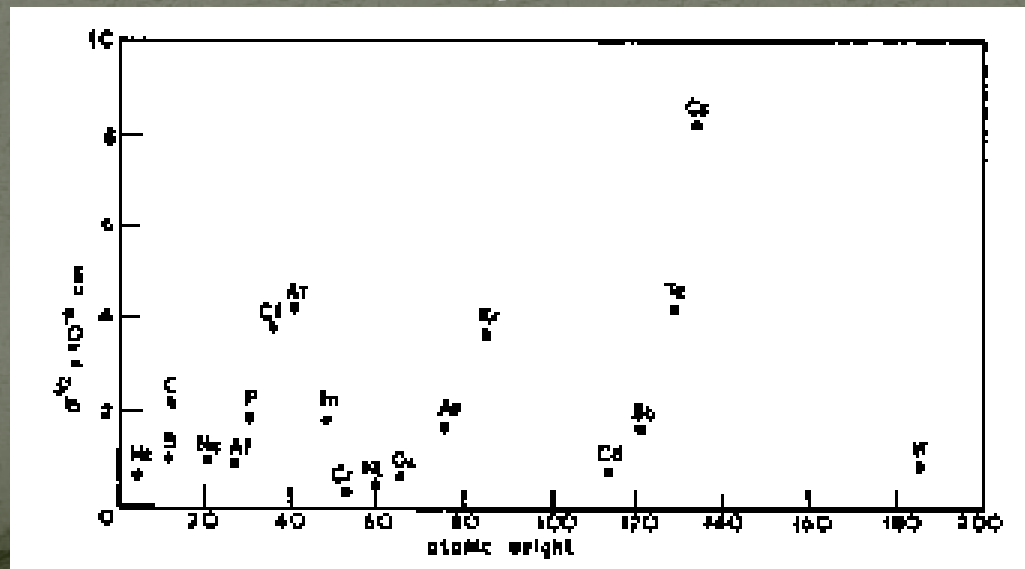
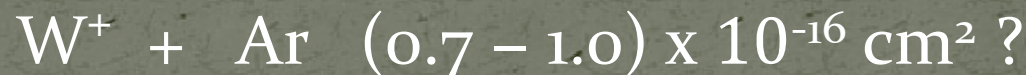
Charge exchange cross-sections for W ions in the literature

Only two Experimental papers available except ours.

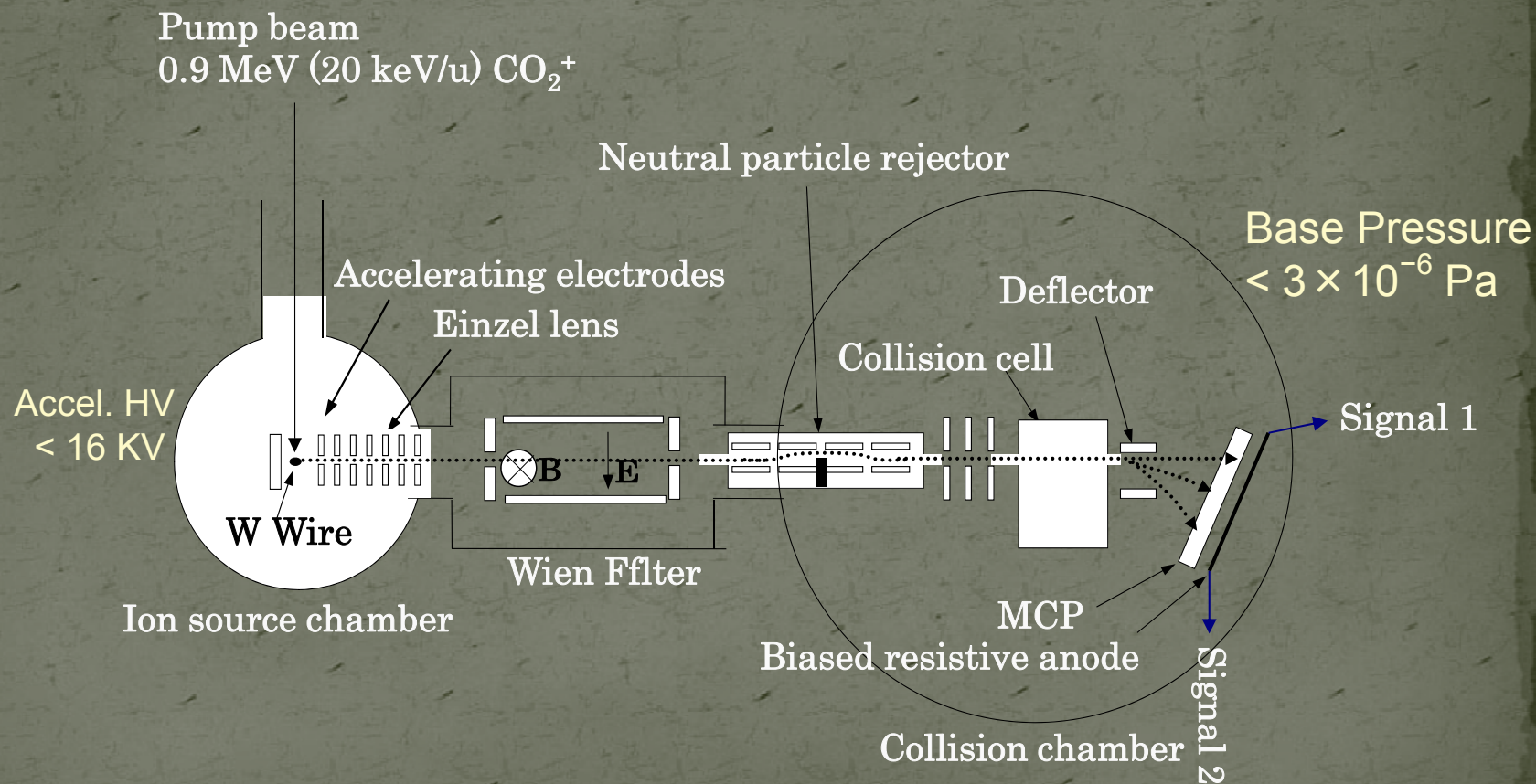
- Meyer *et al.* at 8.5, 11 MeV in PRA 19, 515 (1979).



- Kheyrandish, Armour and Jones at 40 keV in Vacuum 34, 269 (1984).

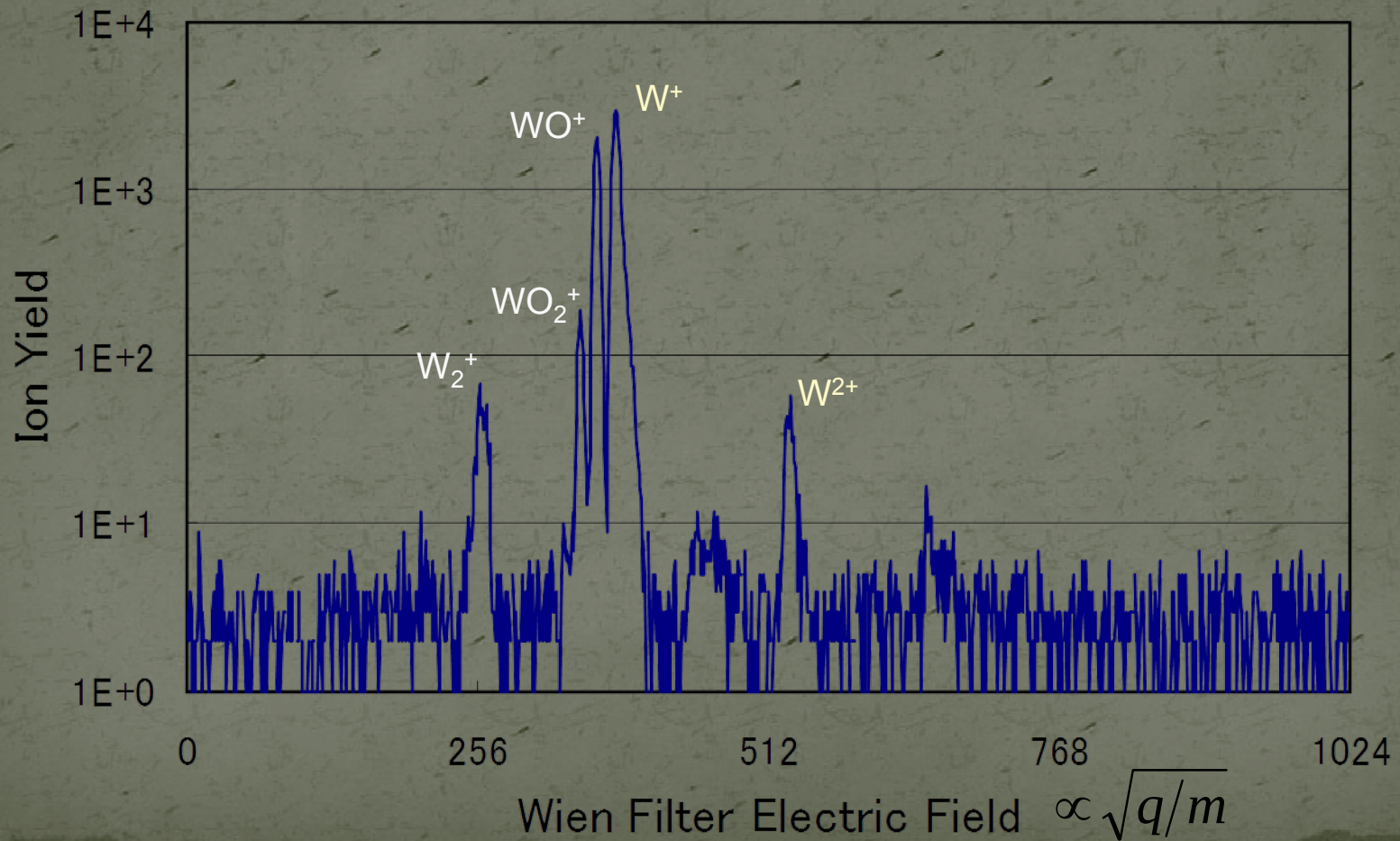


Experimental setup



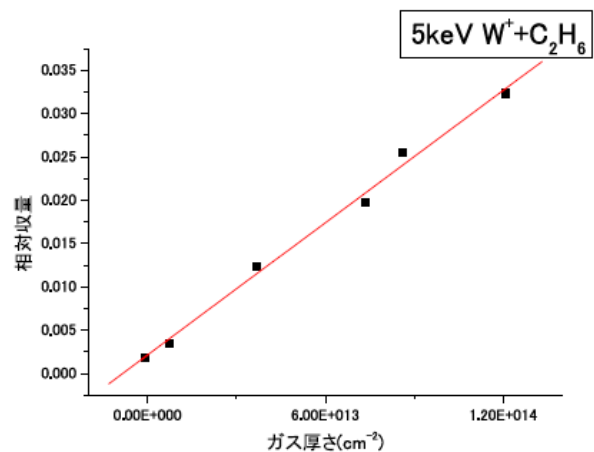
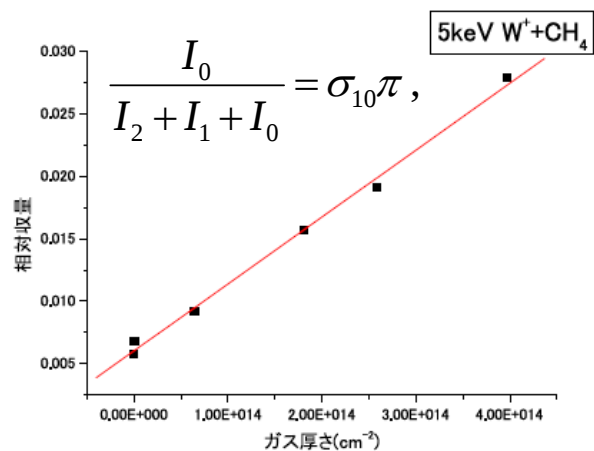
Initial W ion beam preparation

7.5 keV W^+ Extraction

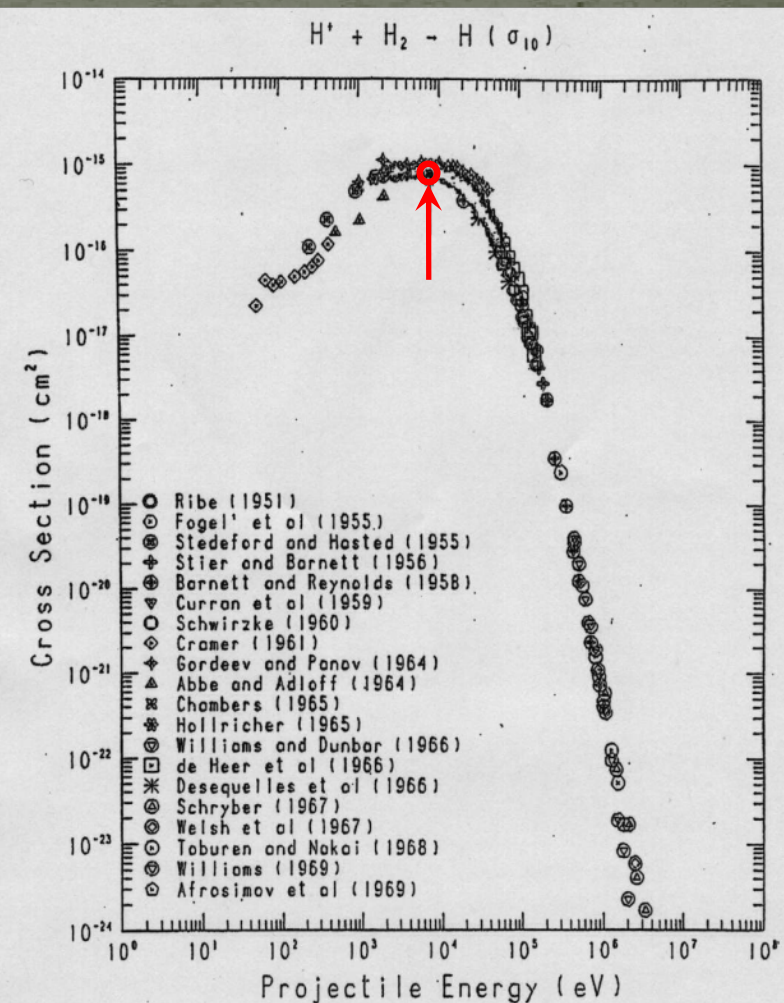


Initial growth method

Growth curve for 5 keV W^+

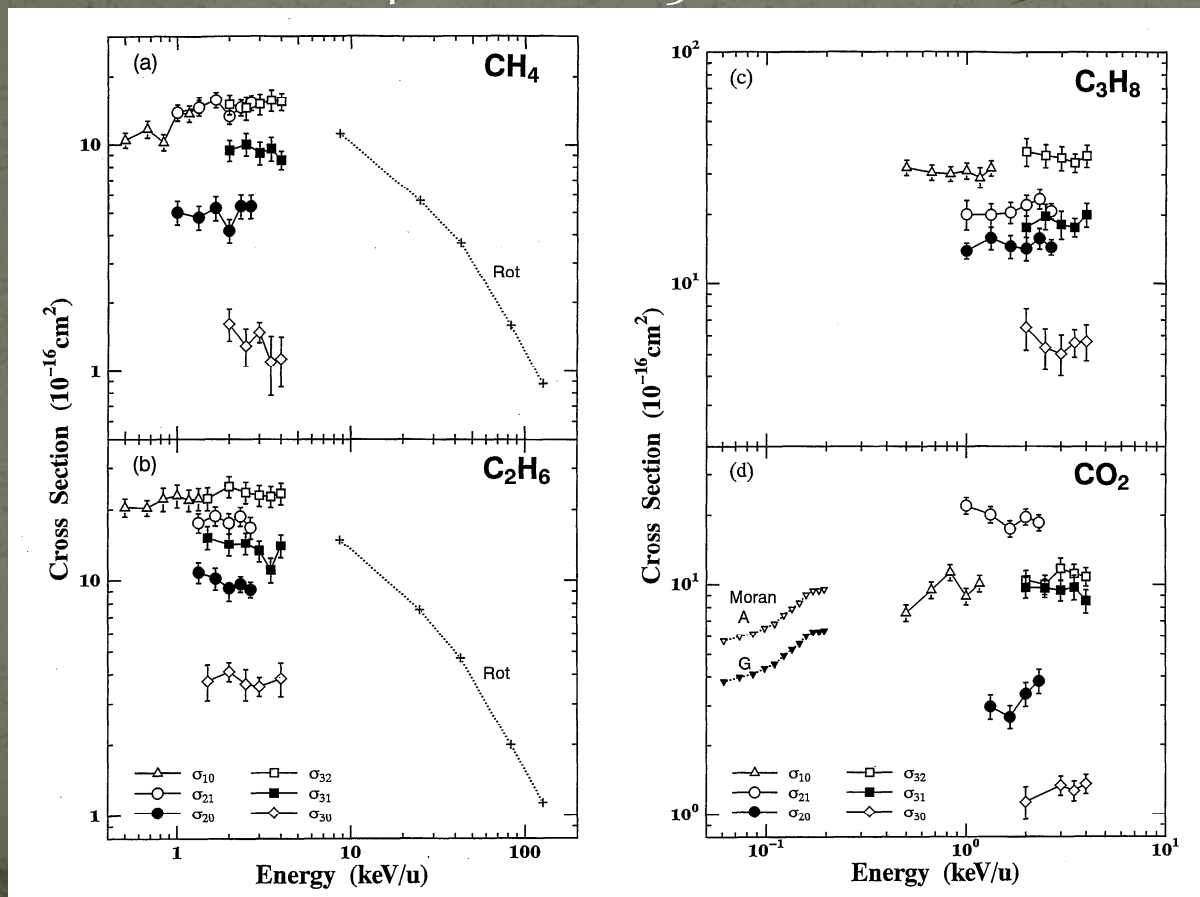


Bench mark for 7.5 keV $H^+ + H_2$ collision

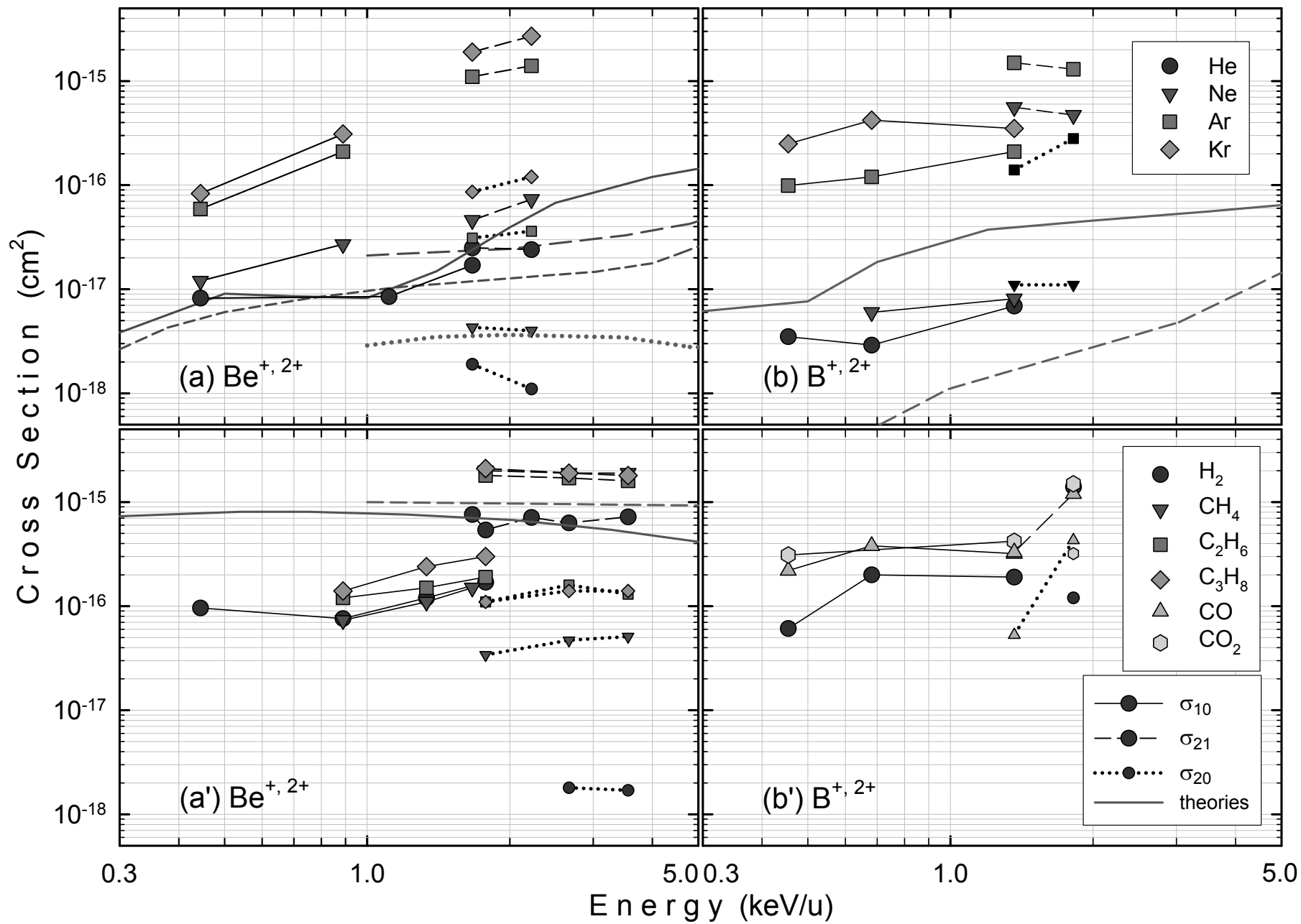


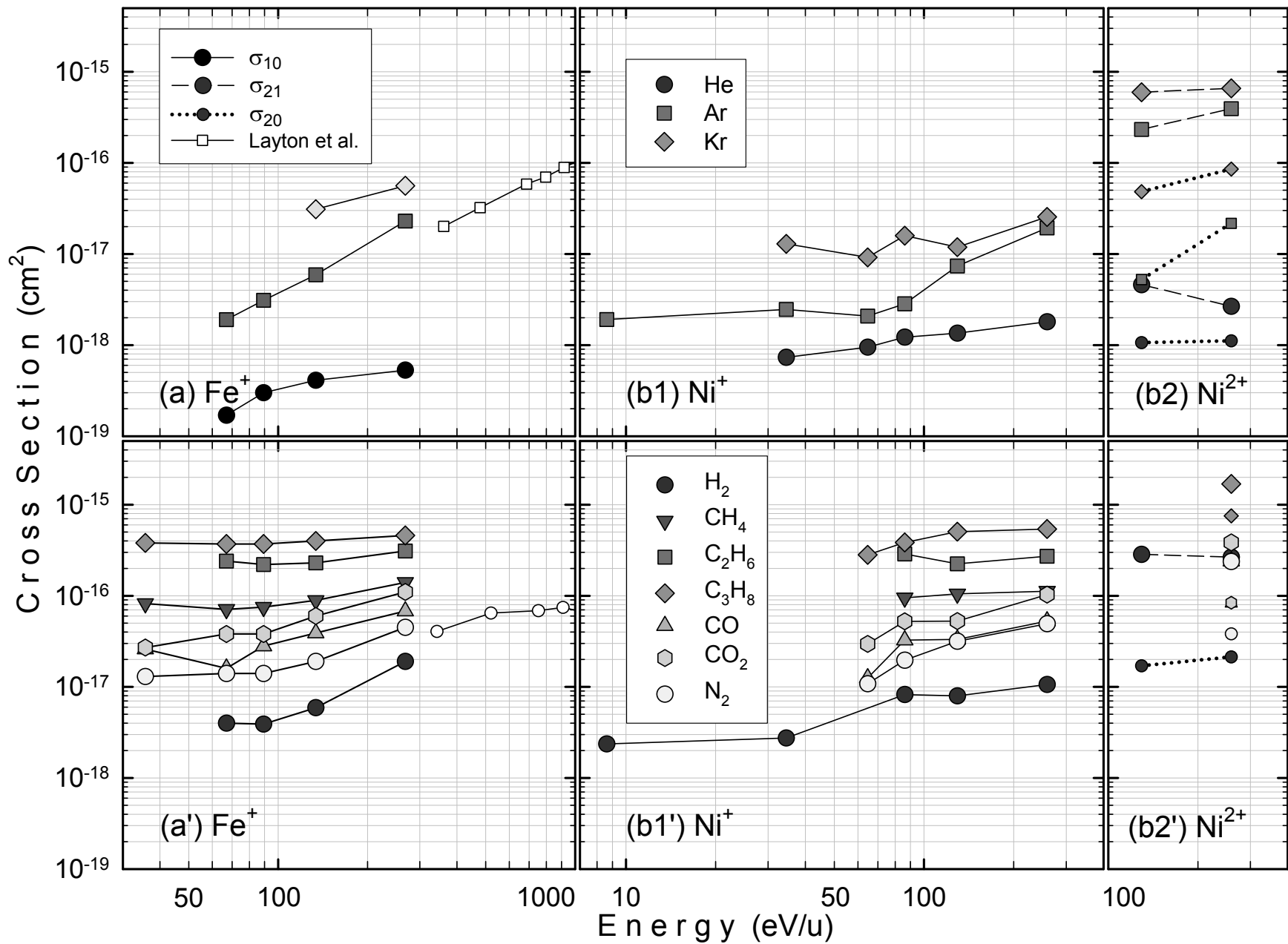
Results

- Electron capture cross sections for C^{q+} ions ($q=1-4$) from H_2 , CH_4 , C_2H_6 , C_3H_8 , and CO_2 targets

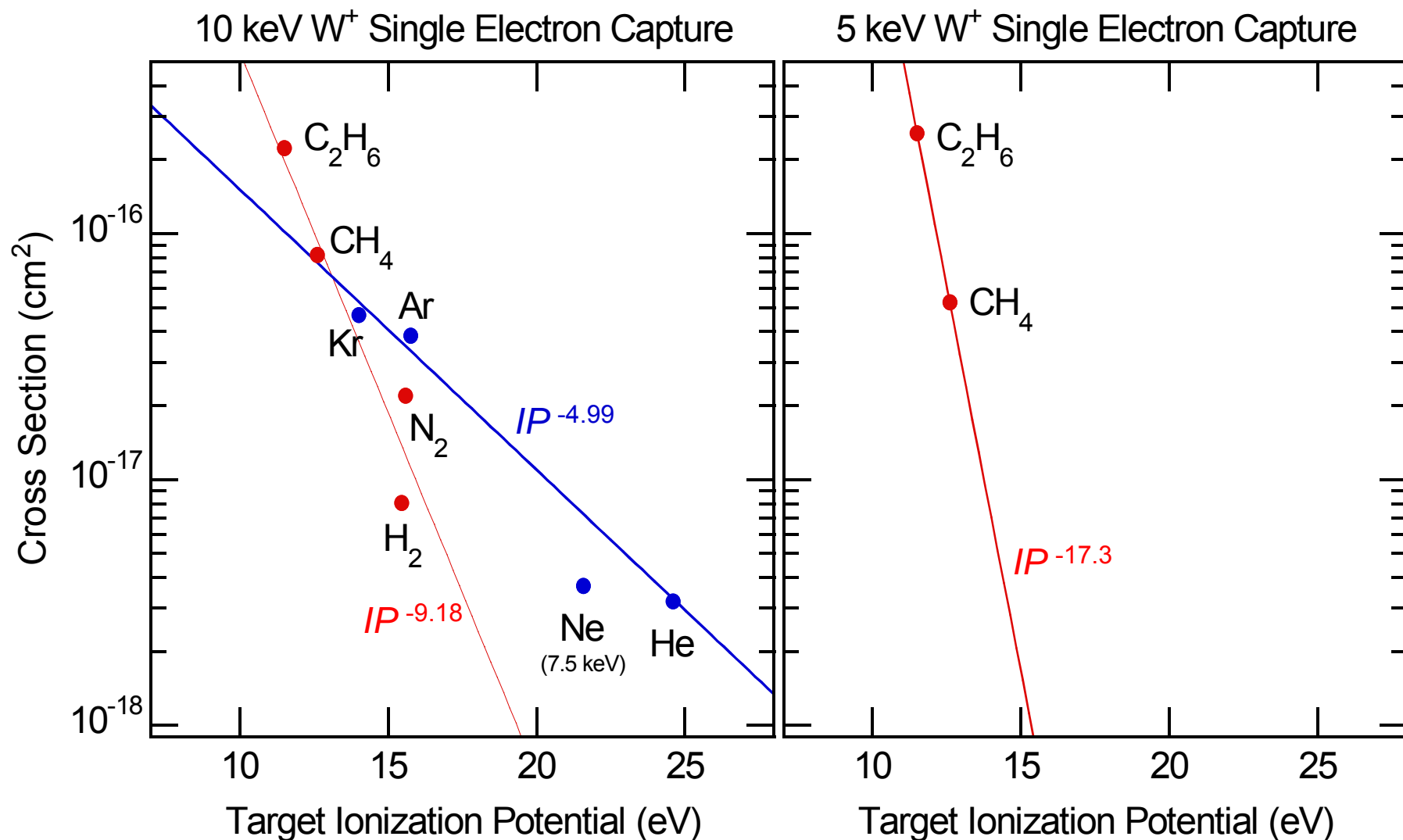


A. Itoh *et al.*,
J. Phys. Soc. Jpn 64,
3255 (1995)

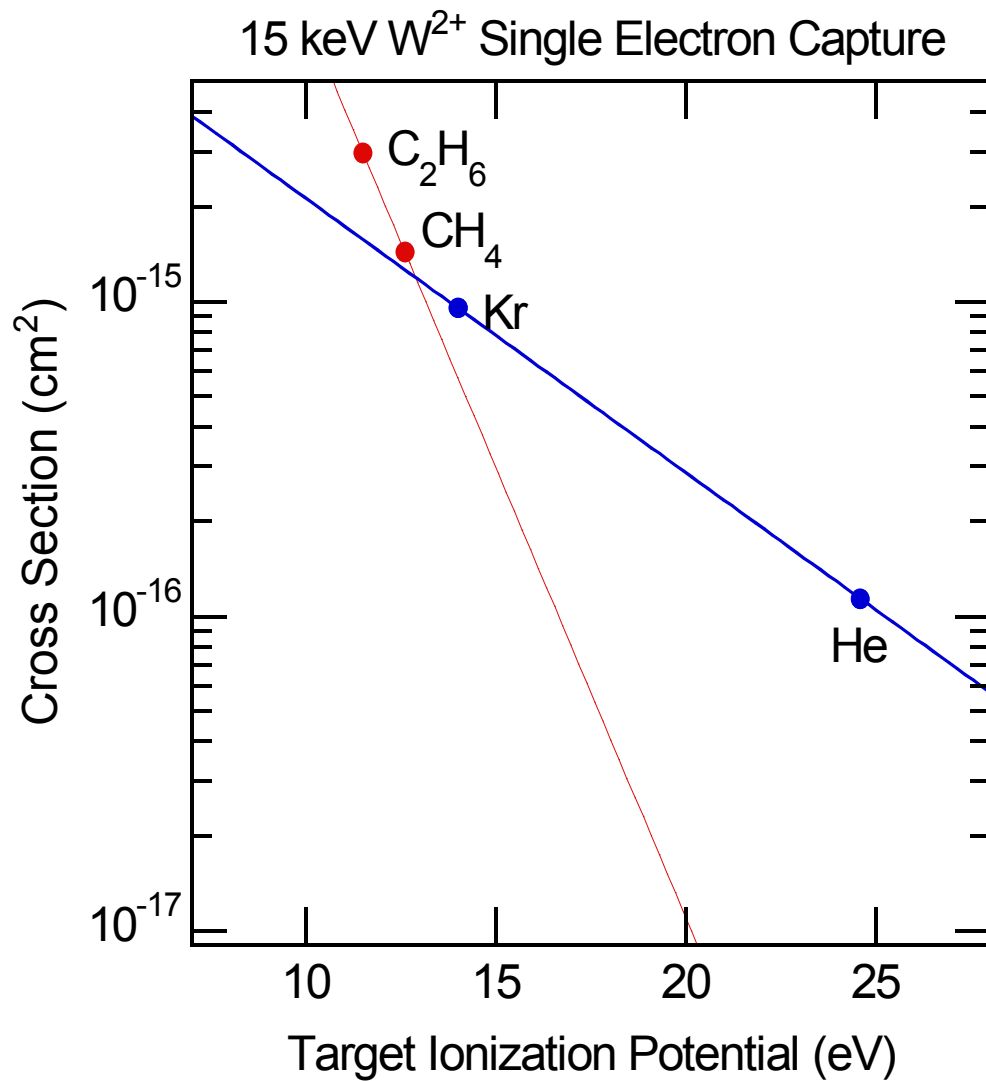




Single electron capture cross-sections for W^+ ions on gas targets at 10 and 5 keV (54 and 27 eV/u)

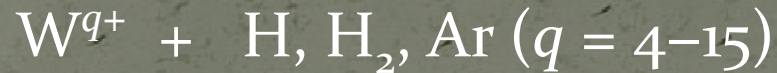


Single electron capture cross-sections for W^{2+} ions on gas targets at 15 keV (82 eV/u)



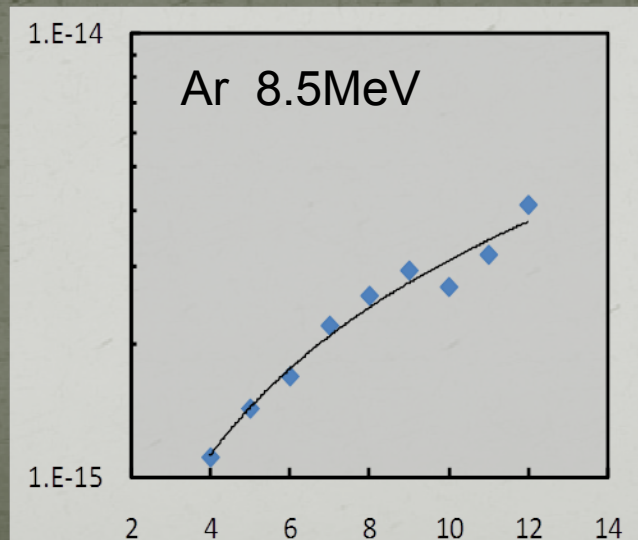
Charge exchange cross-sections for W ions in the literature

Meyer *et al.* at 8.5, 11 MeV (46, 60 keV/u) (1979)



$$\sigma_{\text{H}_2} = 1.6 \times 10^{-16} q^{1.3} \text{ (cm}^2\text{)}$$

$$\sigma_{\text{Ar}} = 2.4 \times 10^{-16} q^{1.1} \text{ (cm}^2\text{)}$$



Charge exchange cross-sections for W ions in the literature

Kheyrandish , Armour and Jones at 40 keV (210 eV/u) (1984)



W900477/volume 34/numbers 1-2/pages 269 to 273/1984
Printed in Great Britain

0042-207X/84\$3.00+.00
Pergamon Press Ltd

The measurement of charge transfer cross-sections for a variety of ions on air and argon

H Kheyrandish and D G Armour, *Department of Electronic and Electrical Engineering, University of Salford, Salford M5 4WT, UK*

and

E J Jones, *Chemistry Division, AERE Harwell, Harwell, Oxfordshire OX11 0RA, UK*

A brief review of the importance of charge exchange collisions and their significance in particle accelerators is presented and an apparatus designed to study such collisions is described. This apparatus has been used to measure the charge exchange cross-sections for a number of projectiles of technological interest in air and argon in the energy range 10–40 keV. $\sigma_{1,0}$ cross-sections for Sb^{+} , As^{+} , In^{+} , P^{+} , N_2^{+} , O_2^{+} , N^{+} , O^{+} , Ge^{+} , Cr^{+} , Fe^{+} are reported. The significance of the cross-section values and their dependence on energy from the point of view of optimum transportation of ion beams and on the accuracy of dose measurements in ion implantation is discussed.

Charge exchange cross-sections for W ions in the literature

Kheyrandish , Armour and Jones at 40 keV (210 eV/u) (1984)

$$W^+ + Ar \quad (0.7 - 1.0) \times 10^{-16} \text{ cm}^2 ?$$

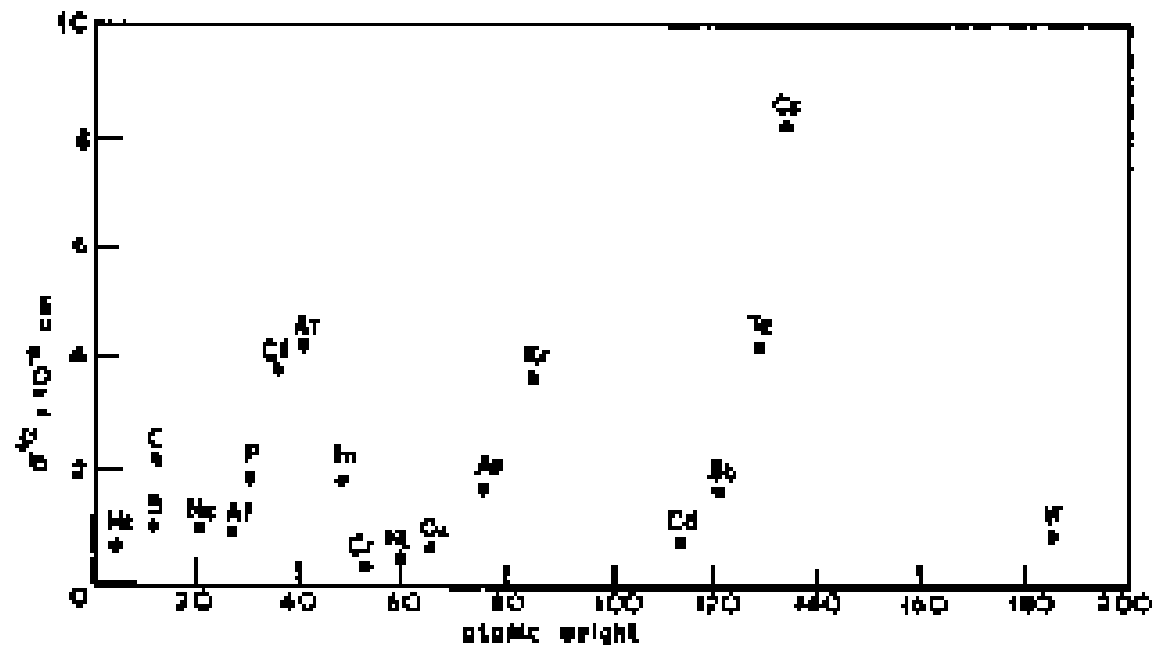
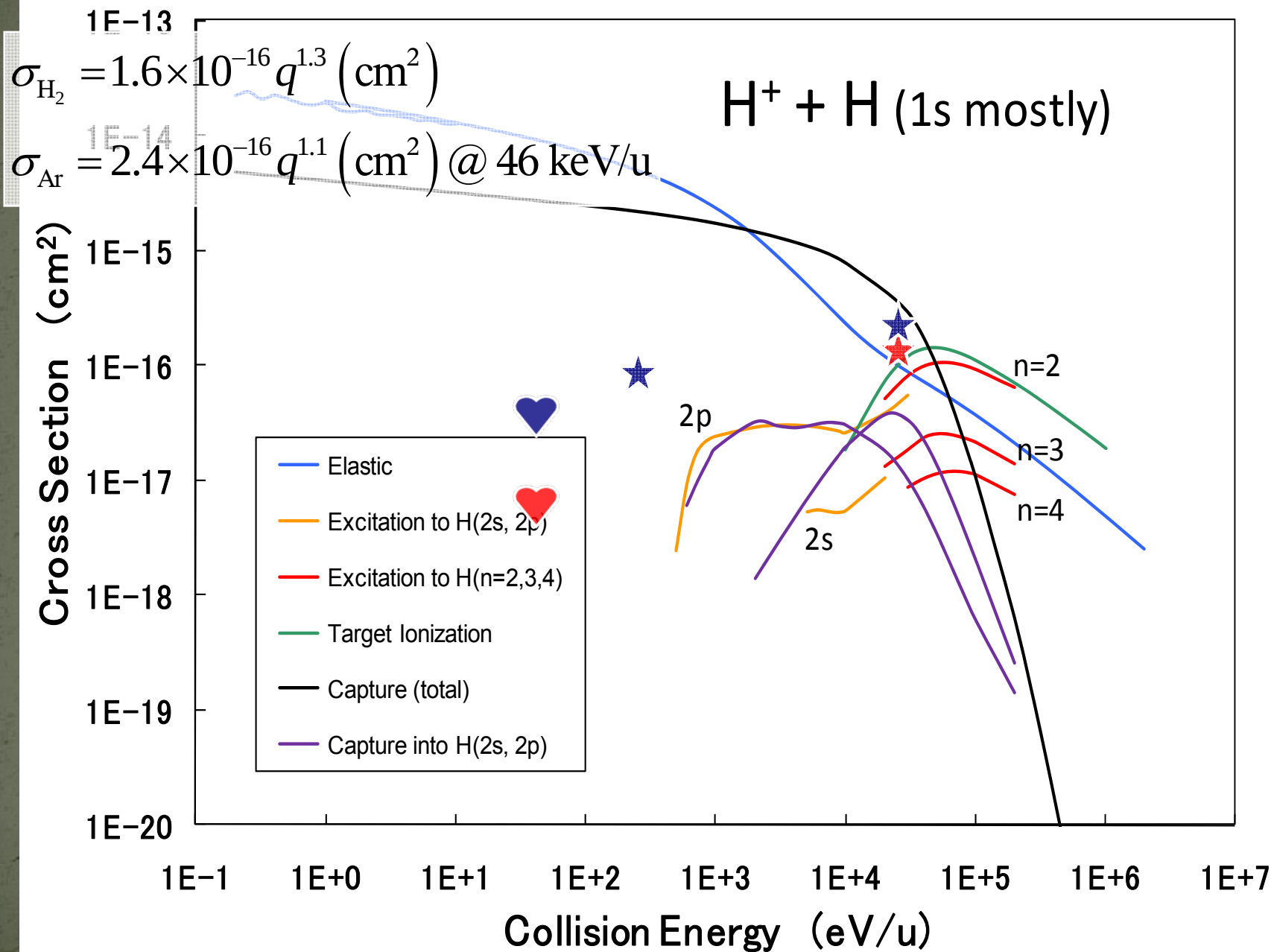
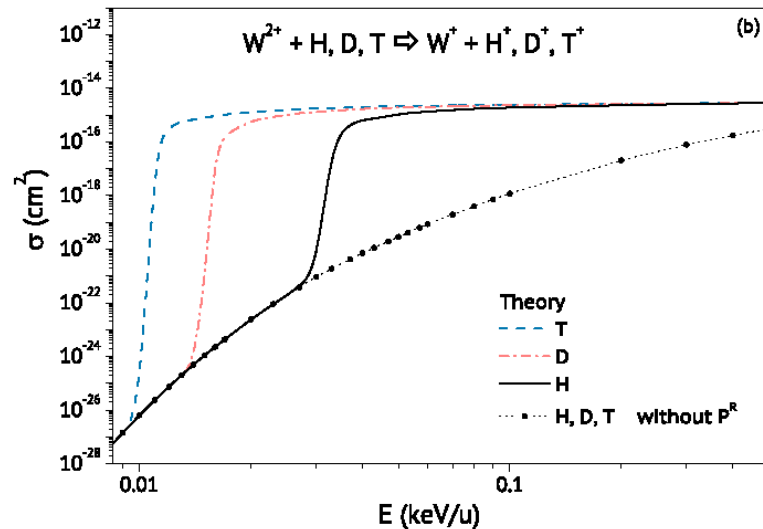
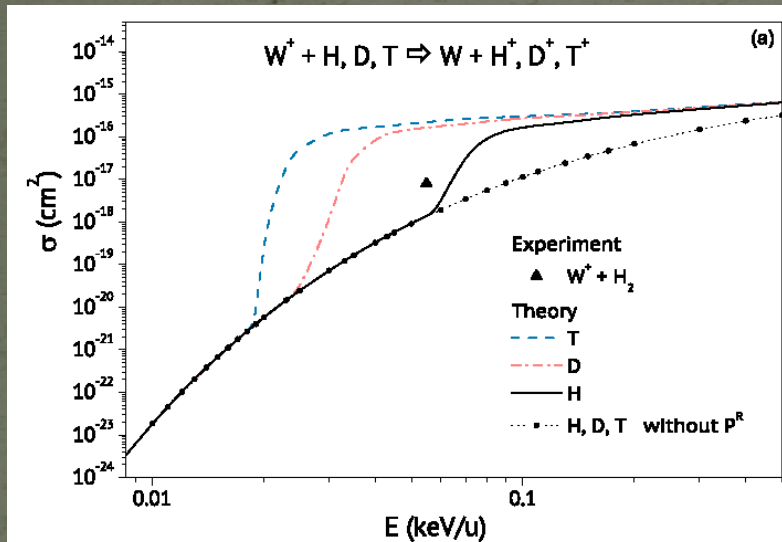


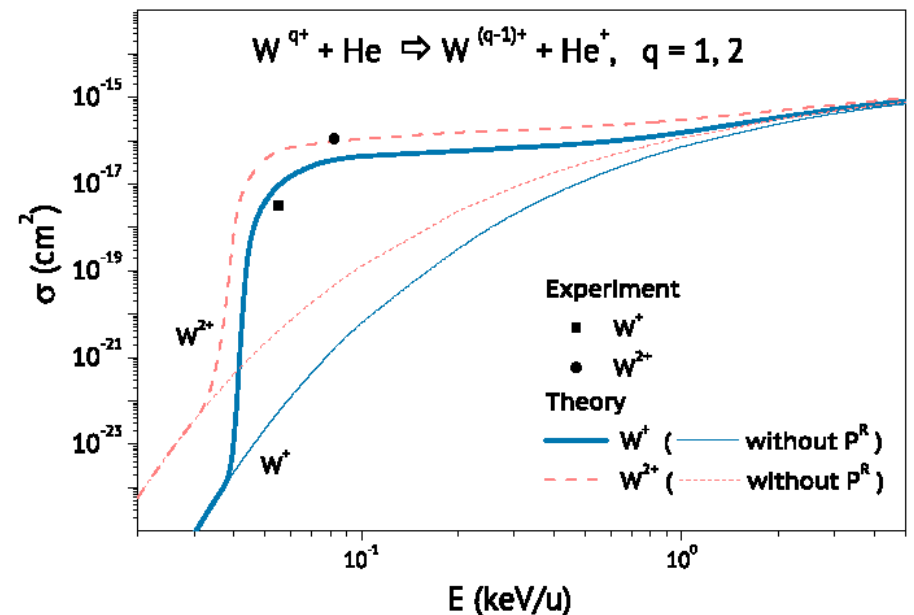
Figure 3. Variation of $\sigma_{ce} \times 10^{-16}$ with atomic weight for an incident velocity of $2 \times 10^7 \text{ cm s}^{-1}$ on argon.



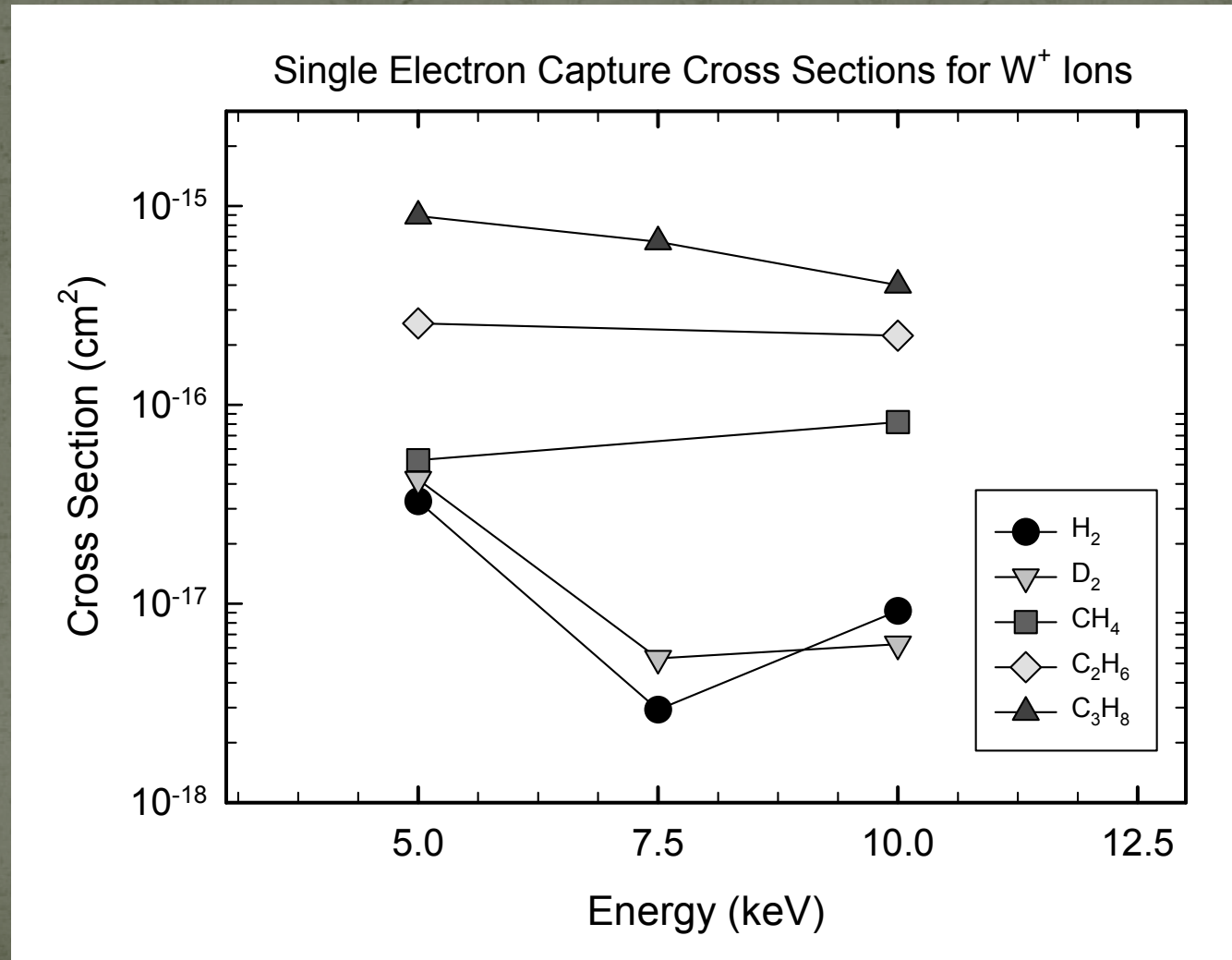
Theoretical cross-sections for W^+ and W^{2+} ions on H, D, T and He targets



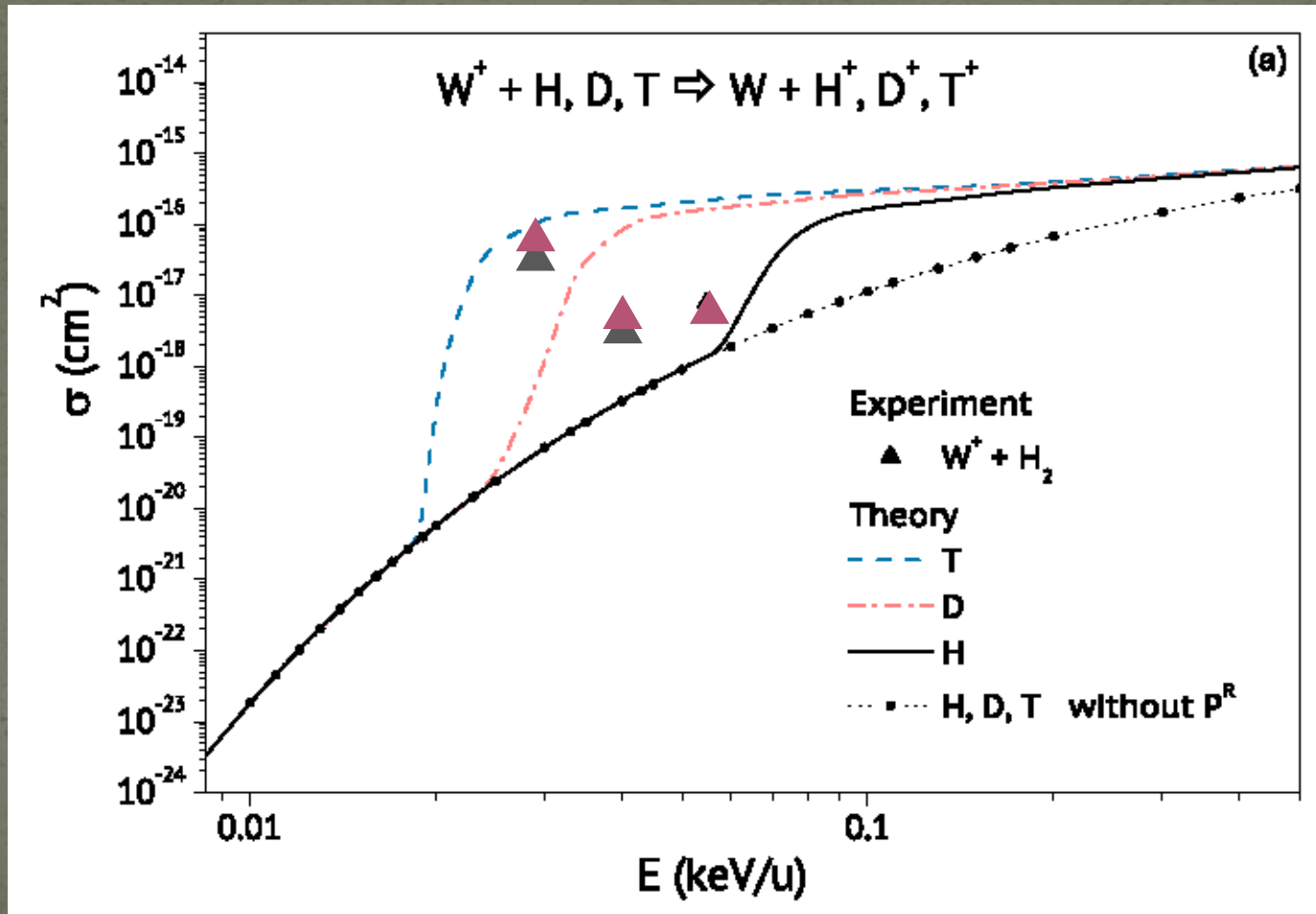
I. Yu Tolstikhina *et al.*, JPB 45 (2012) 145201.



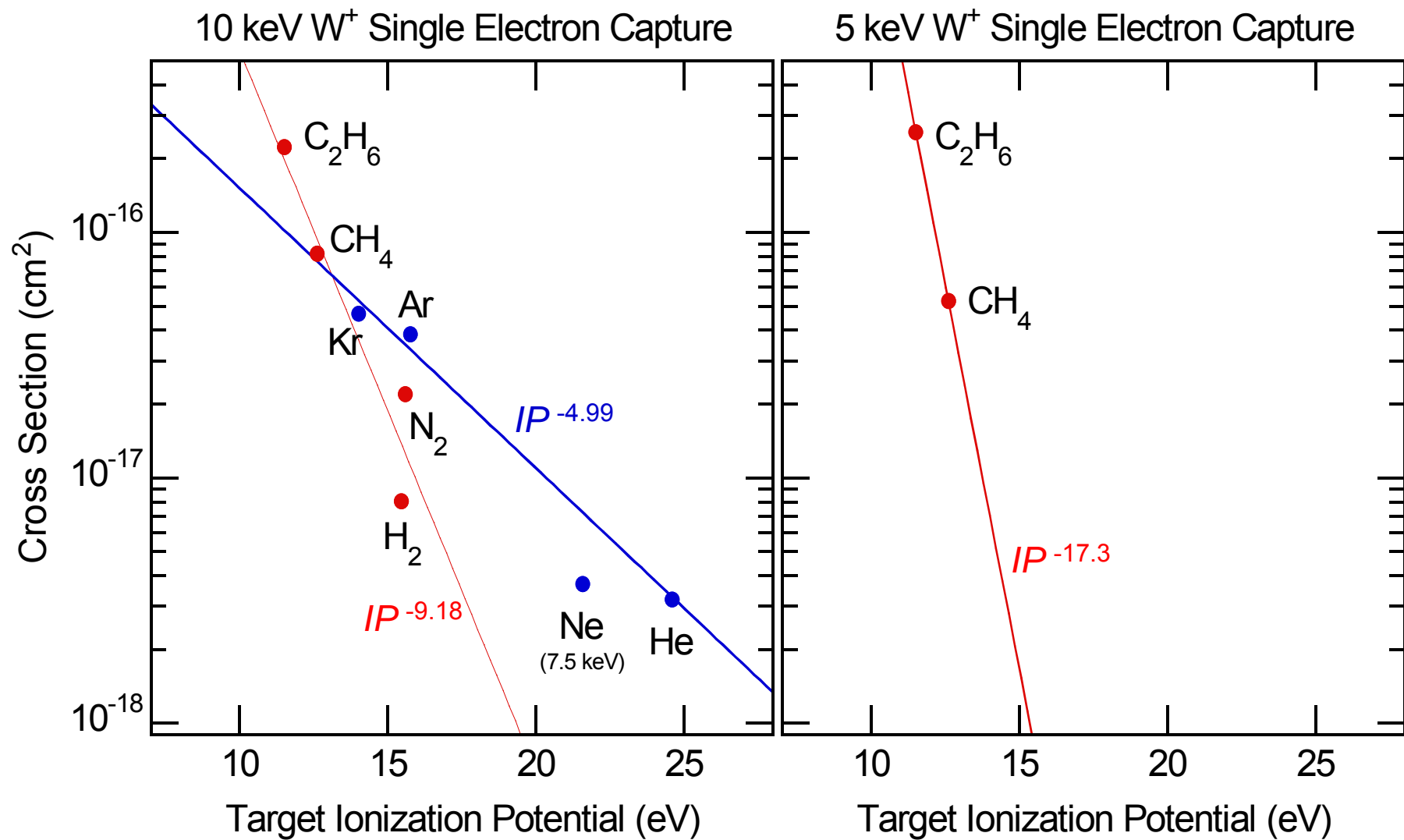
Brand new data for H₂, D₂, and C₃H₈ targets at 5.0, 7.5, and 10 keV



Brand new data for H₂ and D₂ targets at 5.0, 7.5, and 10 keV



Previous data to be updated



New data for H₂, D₂, and C₃H₈ targets

