Towards surface experiments at HITRAP

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FOM GSI

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ITS LEIF

Introduction

- HITRAP - GSI
  - Facility for slow highly charged ions

    (kinetic energy ~keV, potential energy up to 1MeV!)
  - Electron dynamics
  - Metallic vs. insulating surfaces

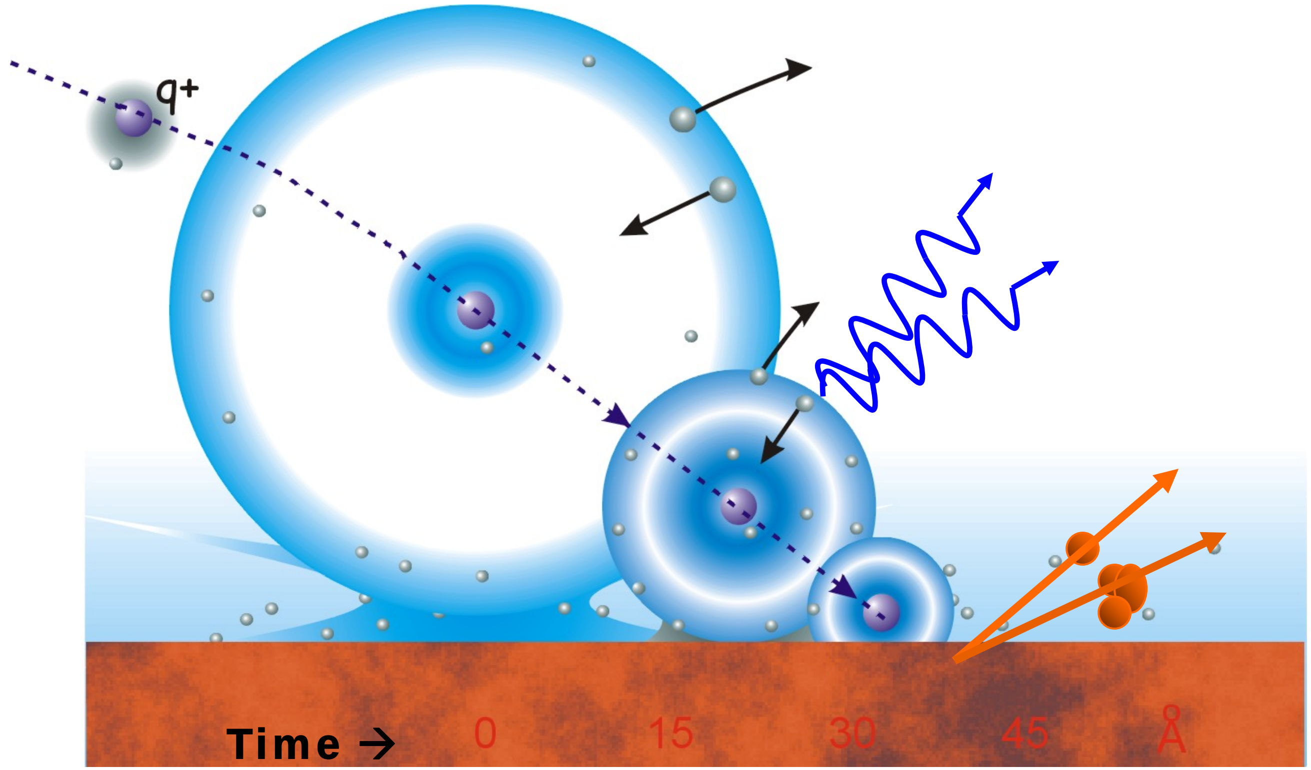
- Electron capture according to the classical over the barrier model

- New IISIS set up

- First results on C_{60}/Au system

Artistic impression

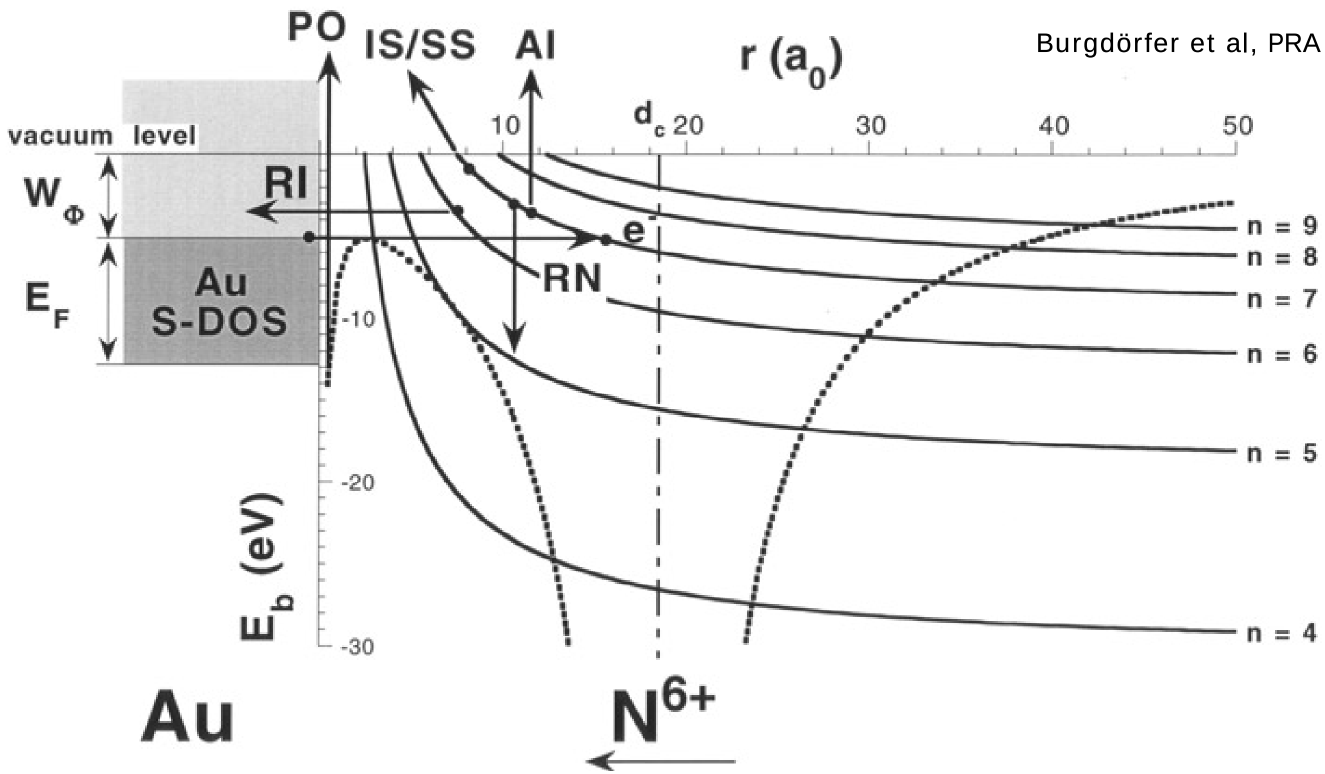
Hollow atom formation



All processes happen on a femtosecond scale

Some electronic processes

according to the classical over the barrier model



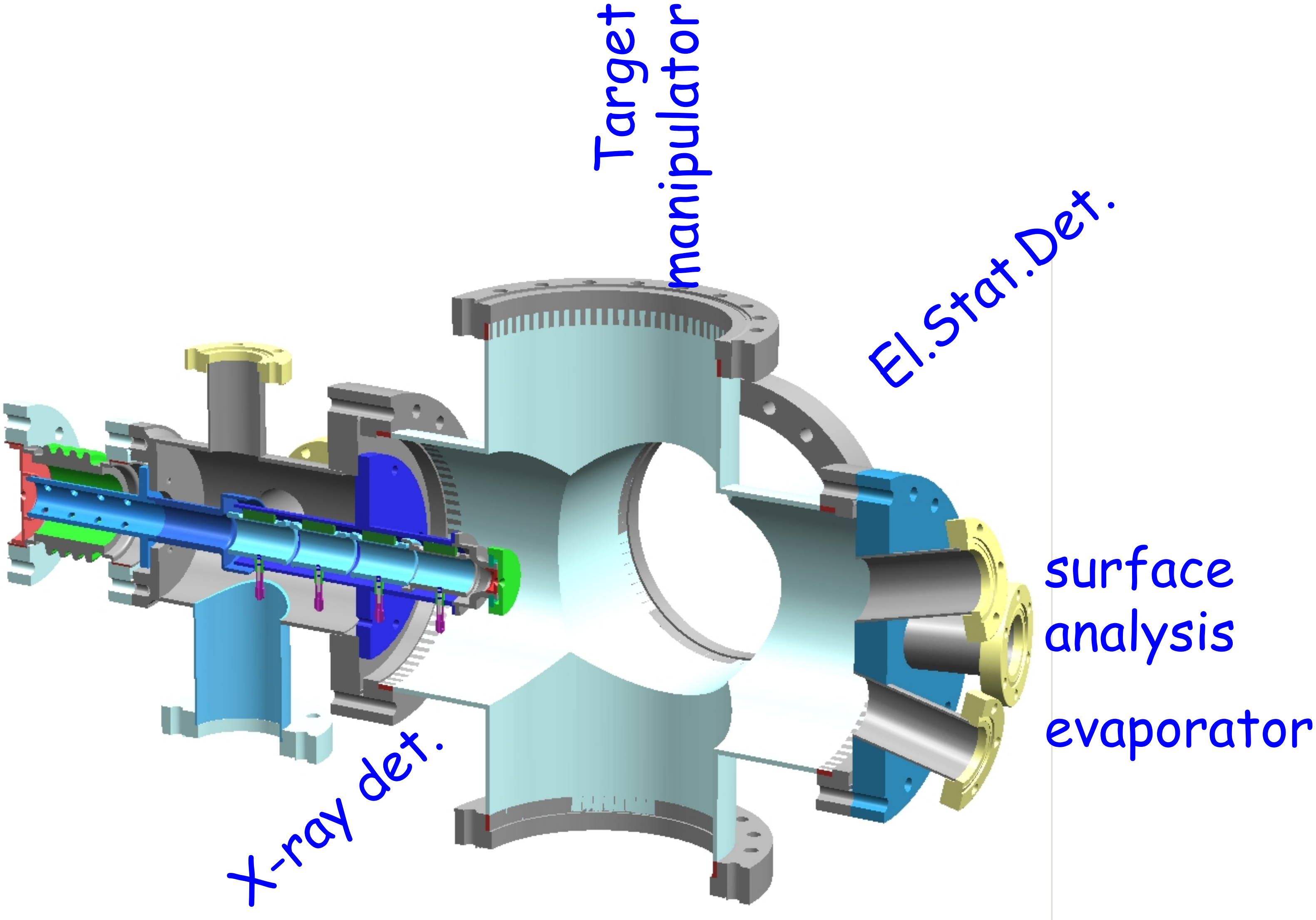
Burgdörfer et al, PRA **44** (1991) 5647

distance of first electron capture: $D=(2q)^{1/2}/W_\phi$
into the shell $n \approx q$

High q – (very) large distance when first capture occurs

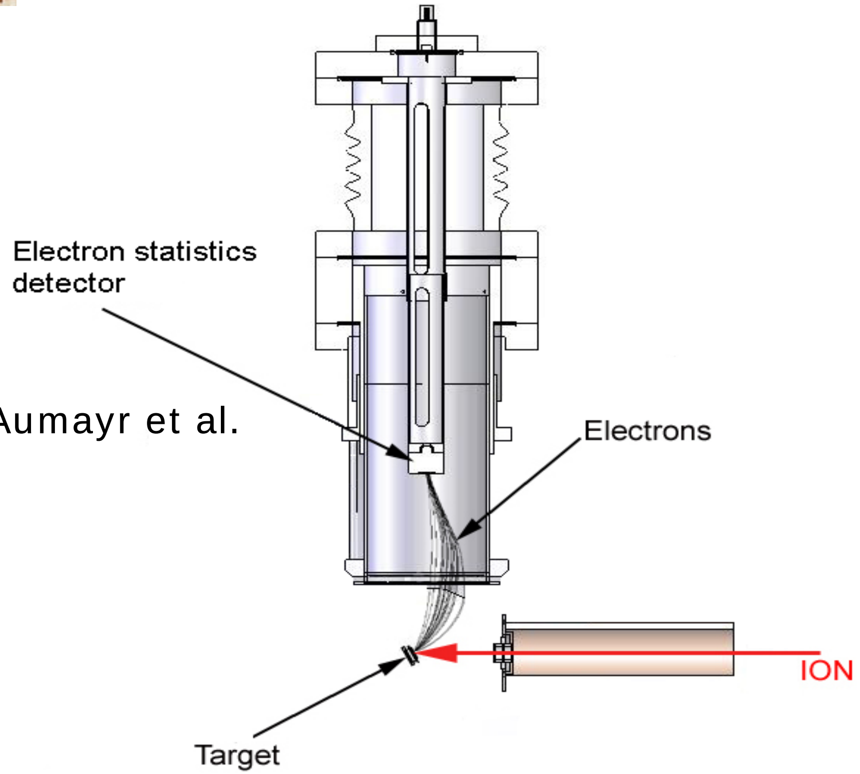
IISIS: multi-user station for HITRAP

Inelastic Ion Surface Interactions Set-up

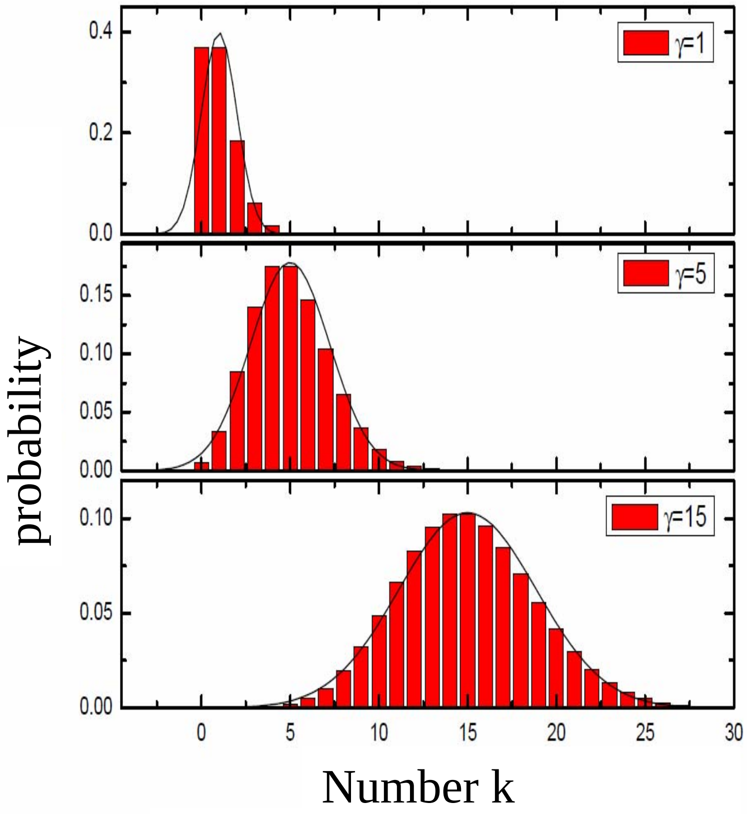


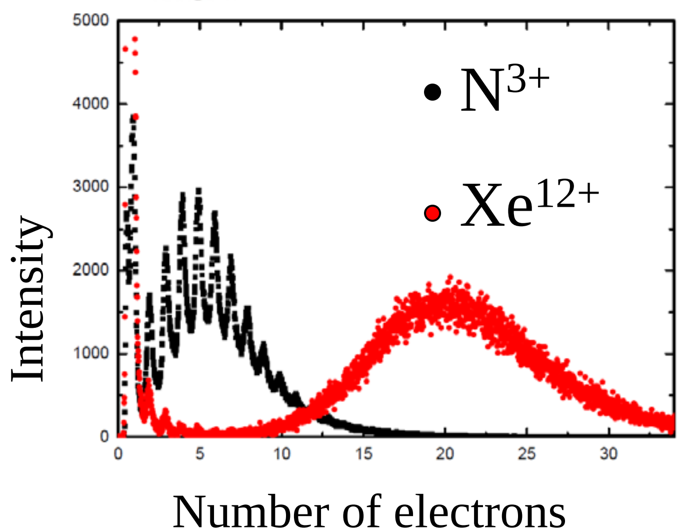
IISIS: electron statistics detection

Aumayr et al.



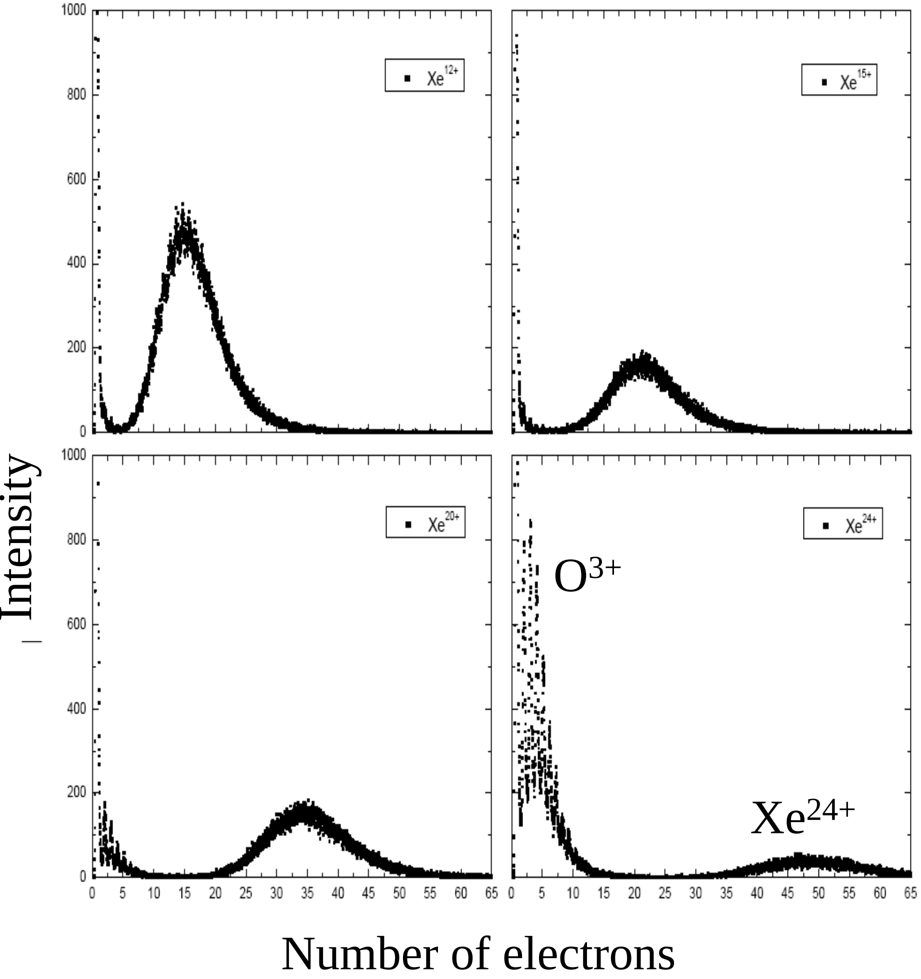
$$P(k;\gamma) = \frac{\gamma^k e^{-\gamma}}{k!}$$



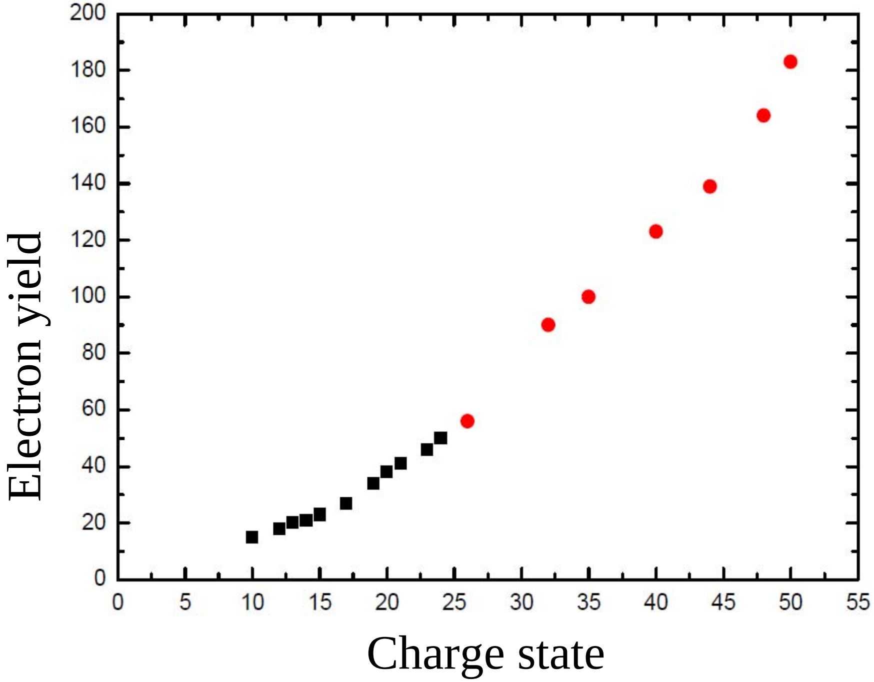


$$G(k;\gamma) = \frac{1}{\sqrt{2\pi\gamma}} e^{-\frac{(\gamma-k)^2}{2\gamma}}$$

IISIS: first electron yield data



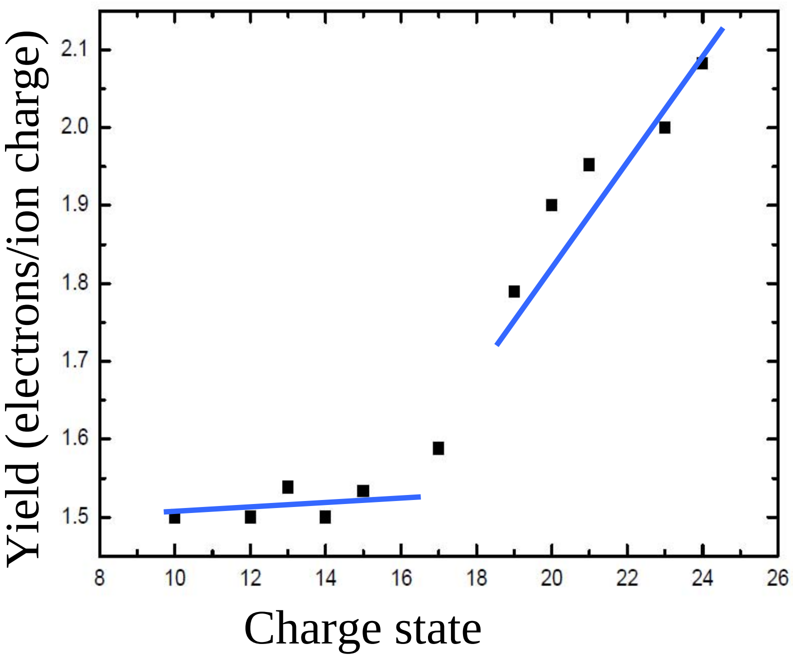
Xe^{q+} - Au



Meissl *et al*, J. Surf. Sci. Nanotech **6** (2008) 54

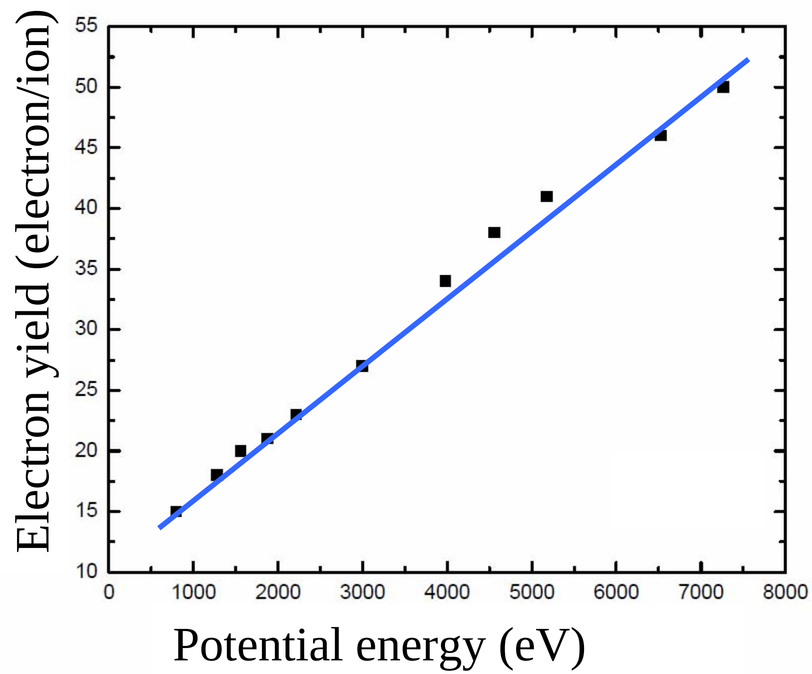
12xq keV Xe^{q+} - Au

γ/q vs q



4d shell | 4p shell

γ vs E_{pot}



slope 140

~70 eV/emitted electron

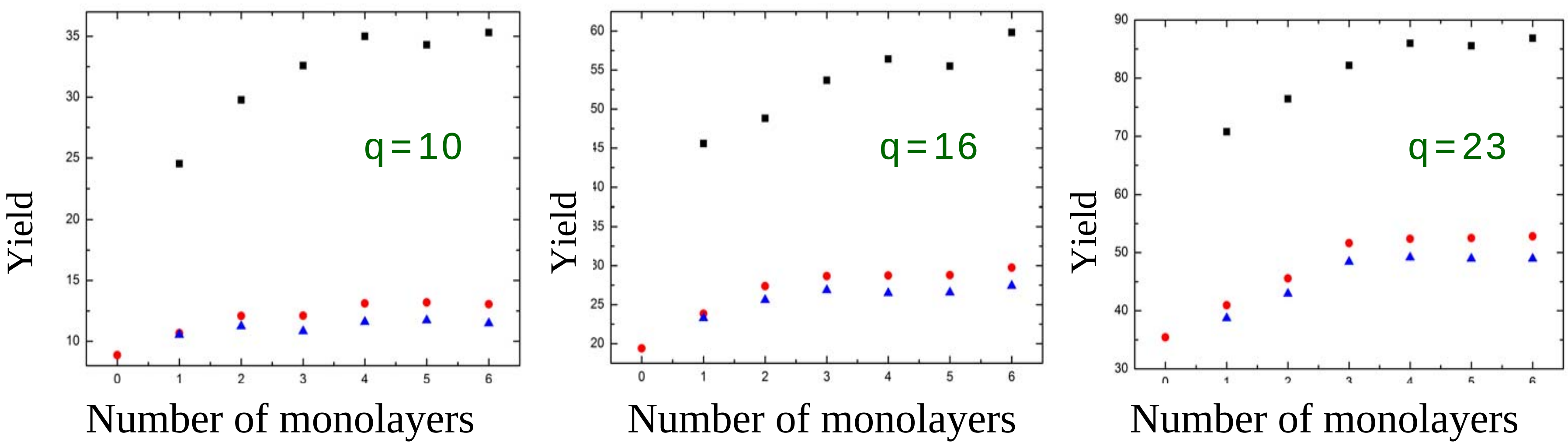
First data on C_{60} films on Au
Changing the electronic structure

Film production (Omicron evaporator)

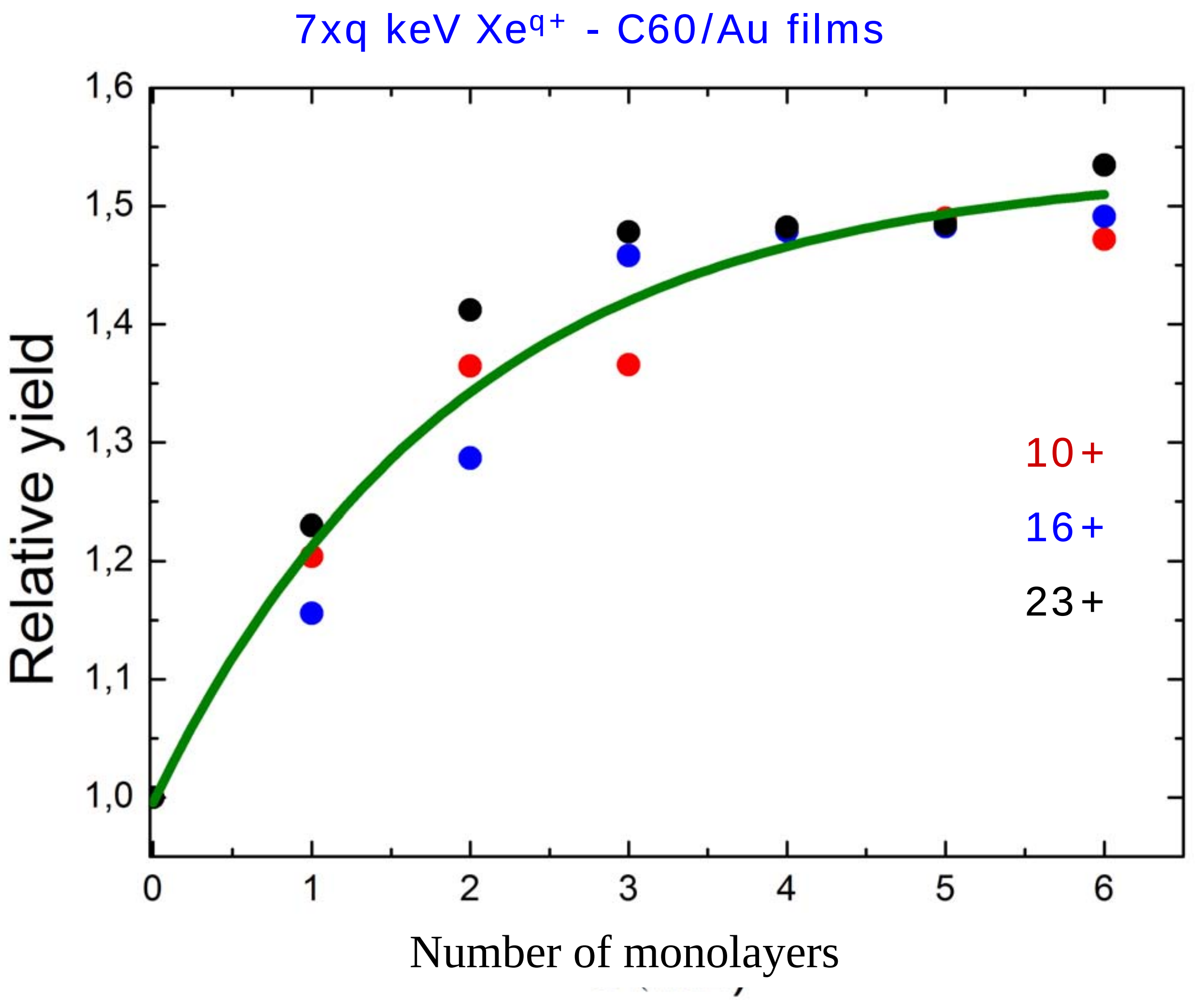
in situ calibration evaporation on quartz microbalance

comparison to 1ML C60 produced via “heating recipe”

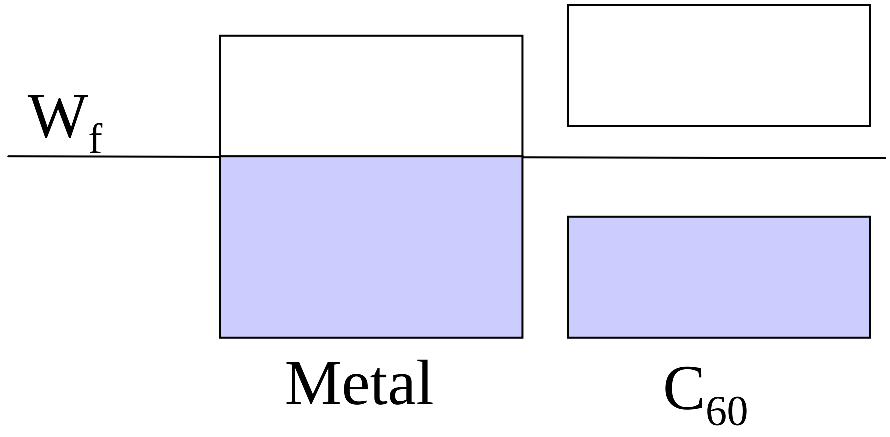
7xq keV Xe^{q+} - C60/Au at different angles of incidence: 10°, 45° and 60°

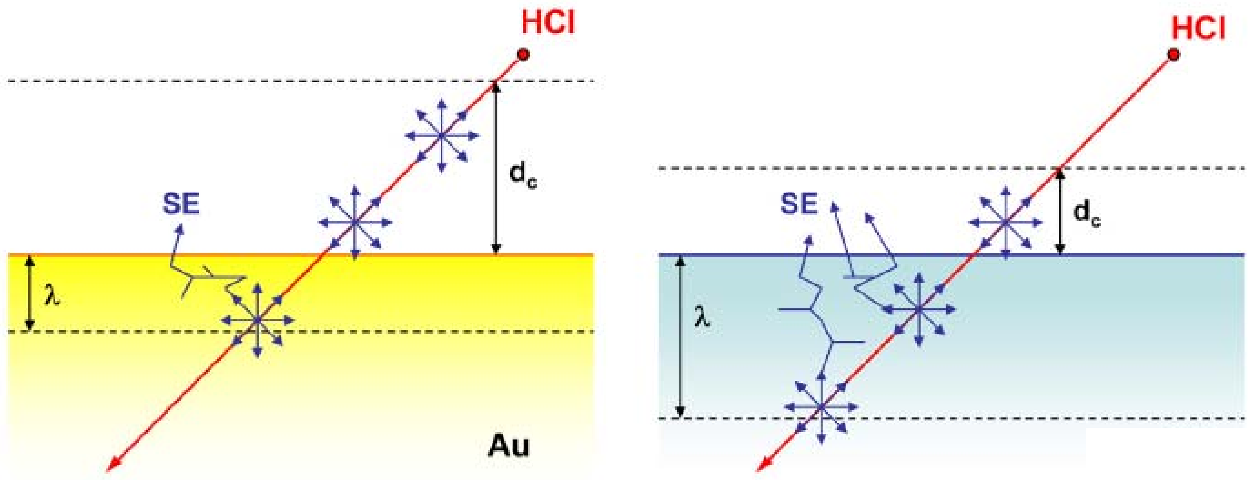


Relative electron yield versus C60 coverage



Insulator versus metal





capture distance – states/time

resonant ionization

secondary electrons

escape depth

conclusions

IISIS

Inelastic Ion Surface Interactions Set-up

electron statistics detection at low energy

first tests on C60/Au succesfull

remaining issues:

Further characterization of the film/surfaces

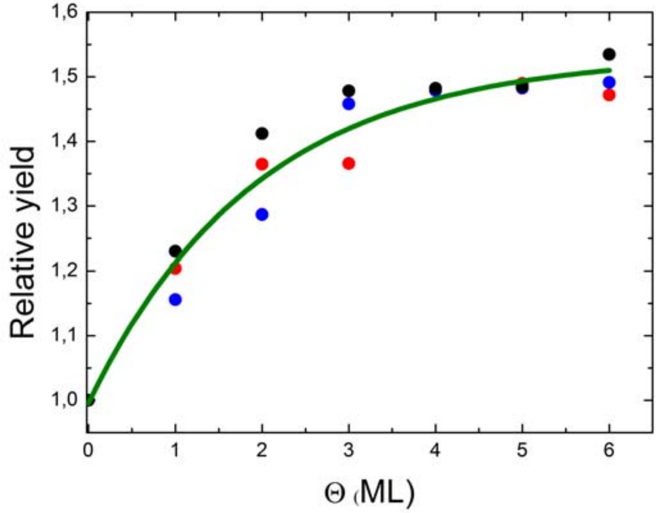
full scale simulations at low energy

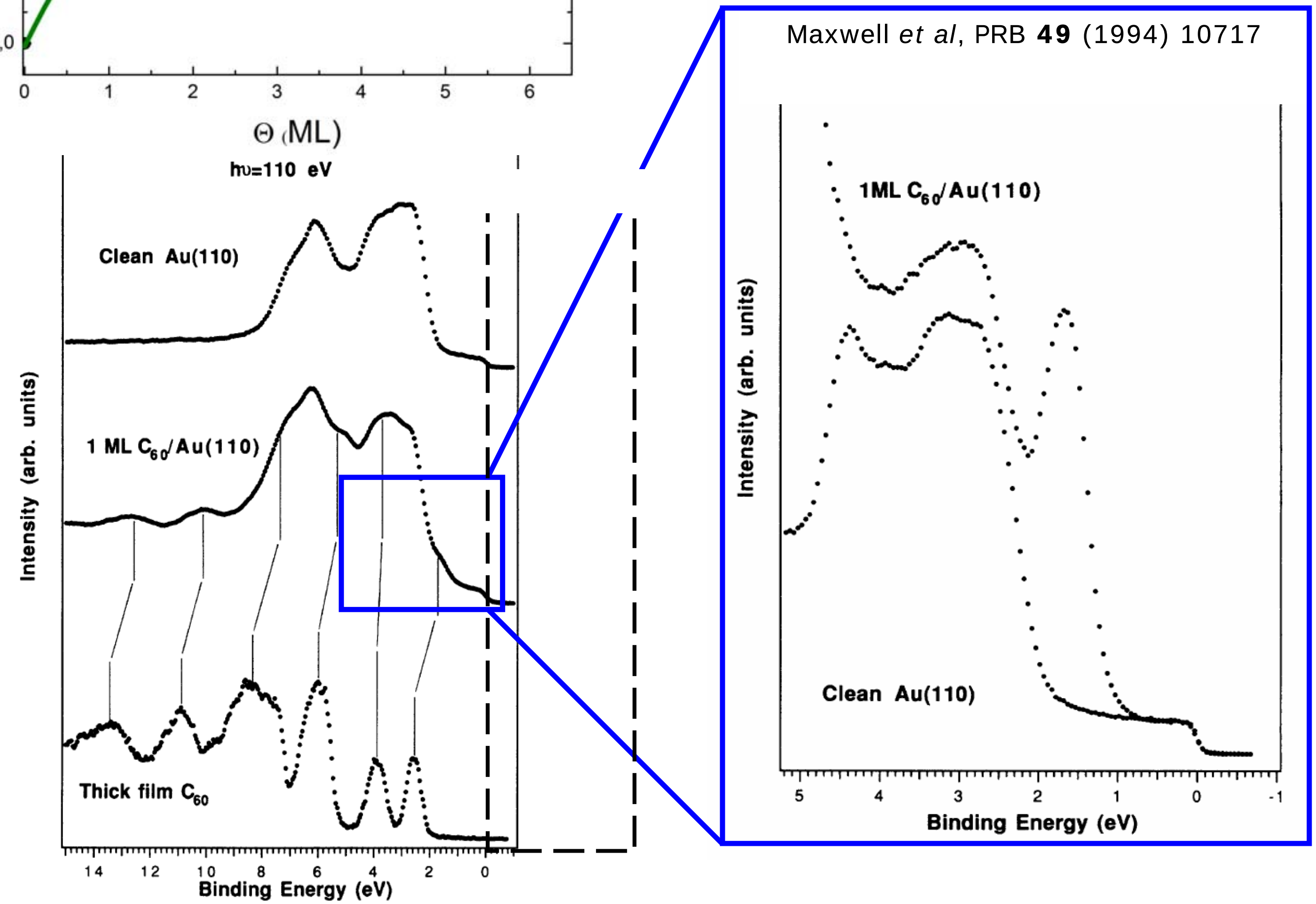
(inc. angle, position of beam,...)

incorporation of X-ray detection

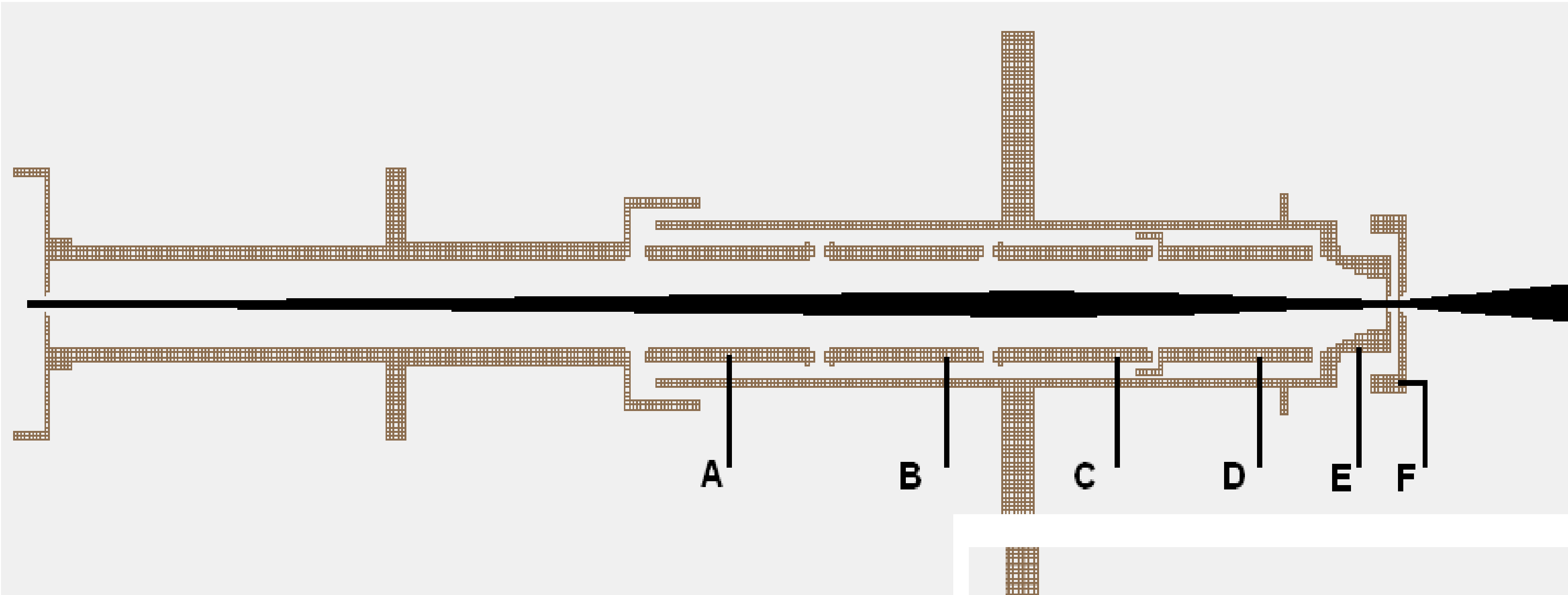
Thank you for you attention!

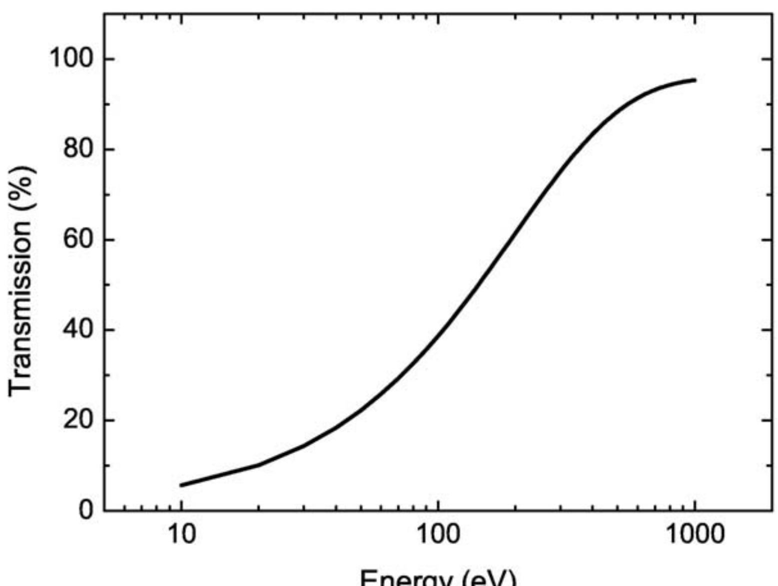
densities of states

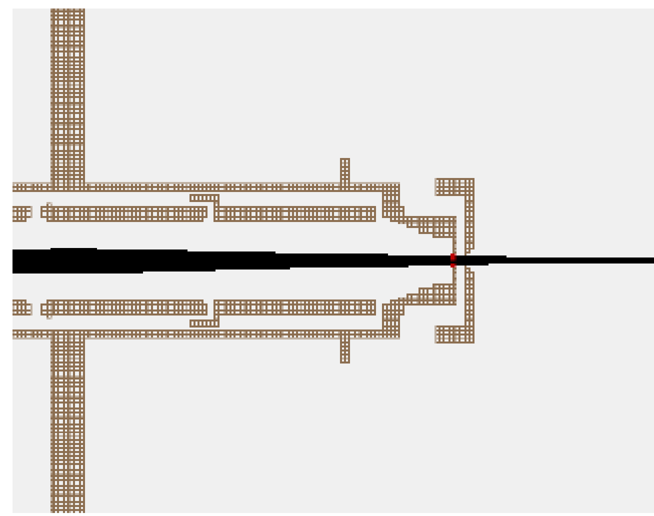




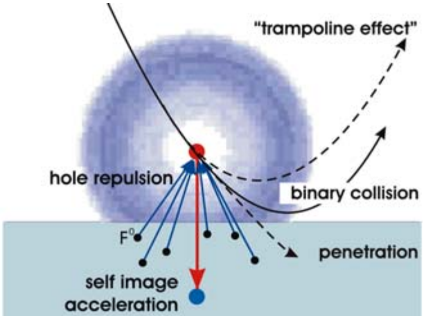
IISIS: deceleration and transport





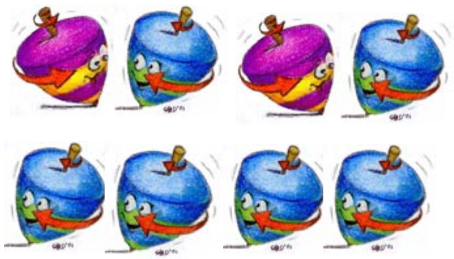


Experiments at HITRAP



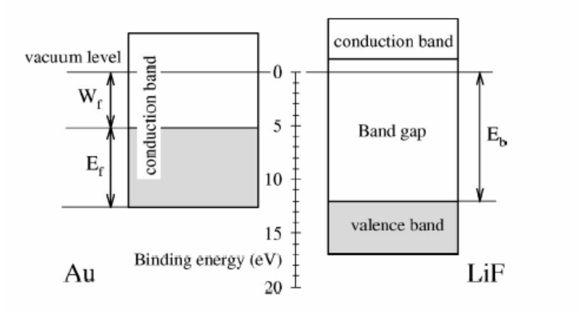
TRAMPOLINE effect

on insulators

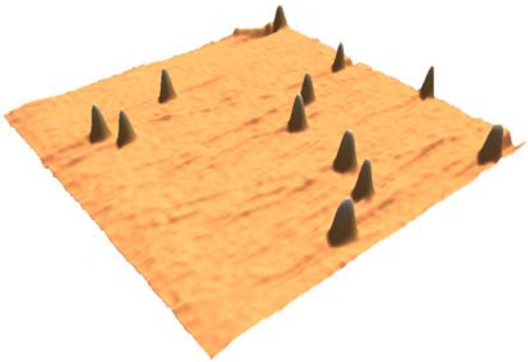


Exotic, spin-polarized hollow atoms

Magnetized surfaces



metals vs. insulators
Thin films



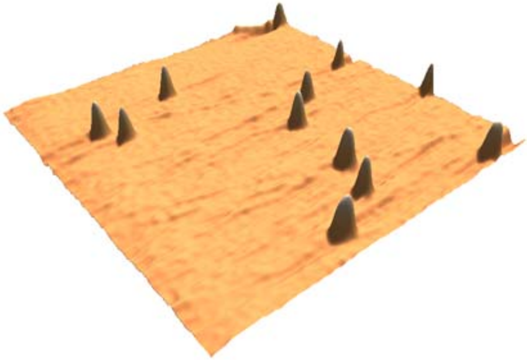
Surface lithography

first generation of experiments

Not yet optimal HITRAP beams

No hard constraints on beam energies

THIN FILMS: bridges between metals and insulators



Surface lithography

electron statistics microscopy

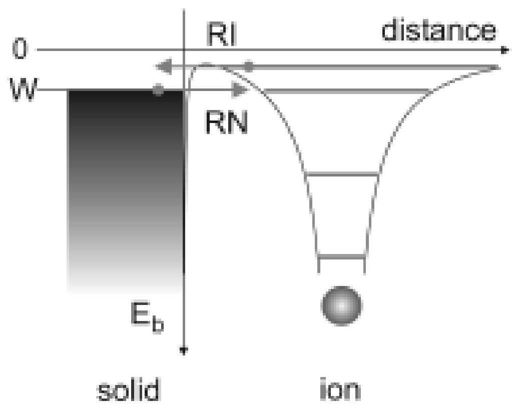
(in collaboration with Aumayr et al (Vienna))

simultaneously look for X ray spectra

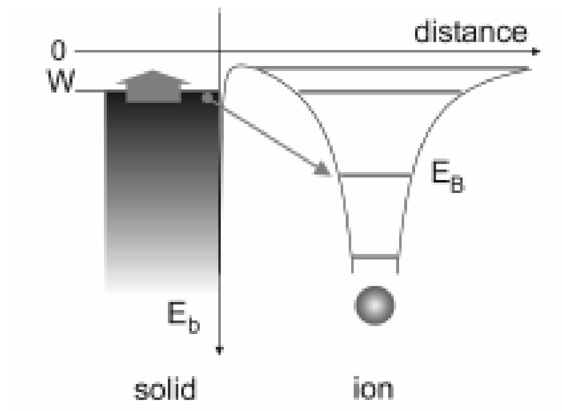
(in collaboration with Stöhlker et al (GSI))

Some electron capture processes

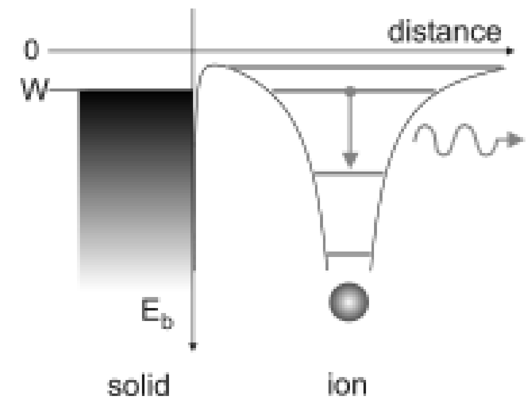
according to the classical over the barrier model



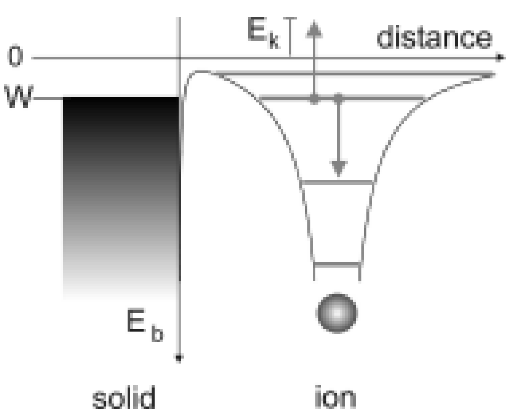
electron resonant ionization/neutralization



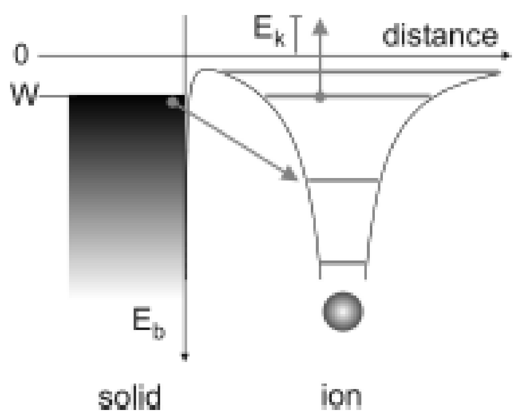
Auger neutralization



Radiative transition



Auto ionization

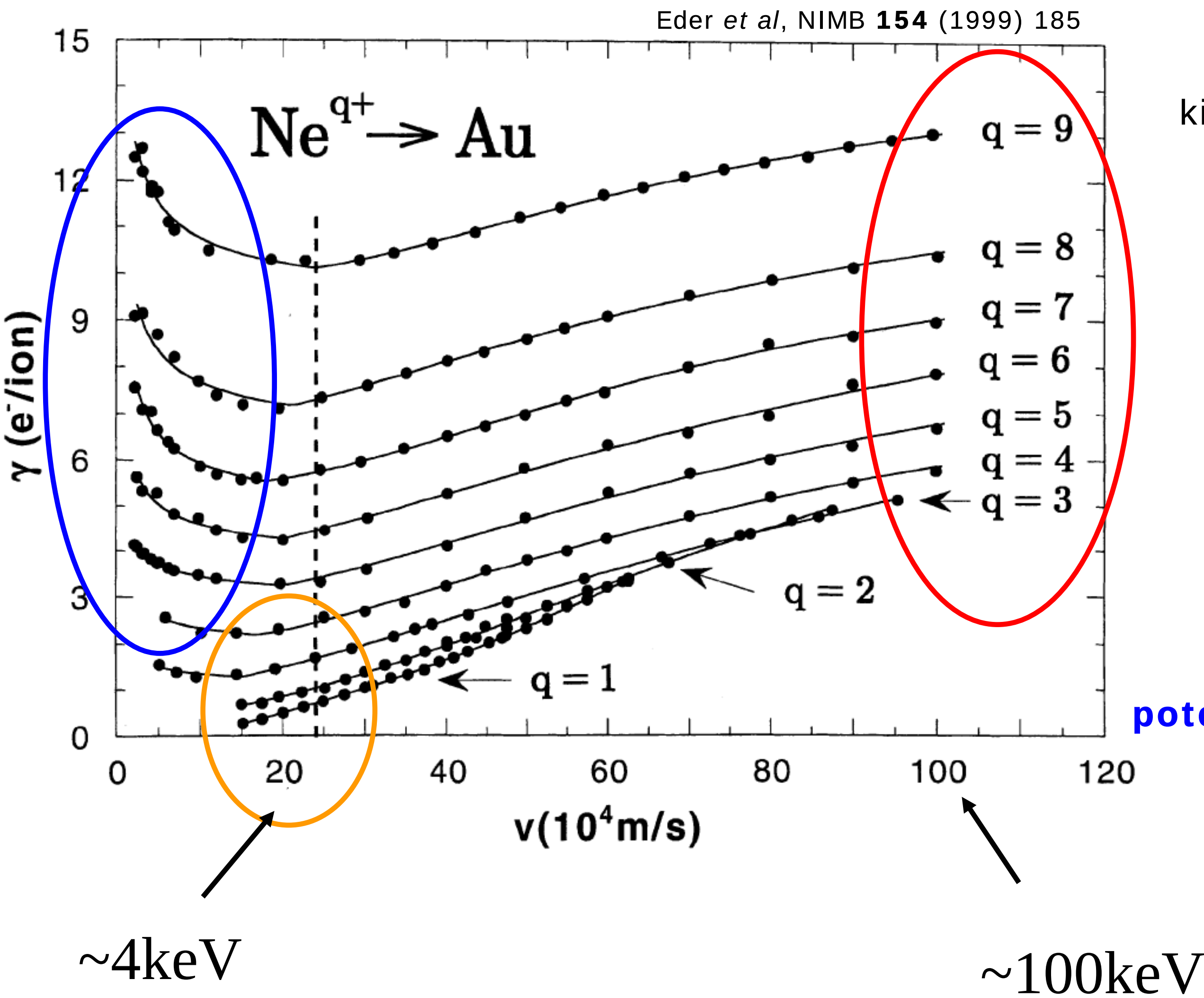


Auger deexcitation

distance of first electron capture:

$D = (2q)^{1/2} / W_\phi$

into $n \approx q$



kinetic emission threshold

$$v_{\mathrm{th}} = \frac{1}{2} v_{\mathrm{F}} \left(\sqrt{1 + \frac{W_{\Phi}}{E_{\mathrm{F}}}} - 1 \right)$$

~ 0.3 keV/amu

electronic KE

eKE

collisional KE

cKE

potential energy emission

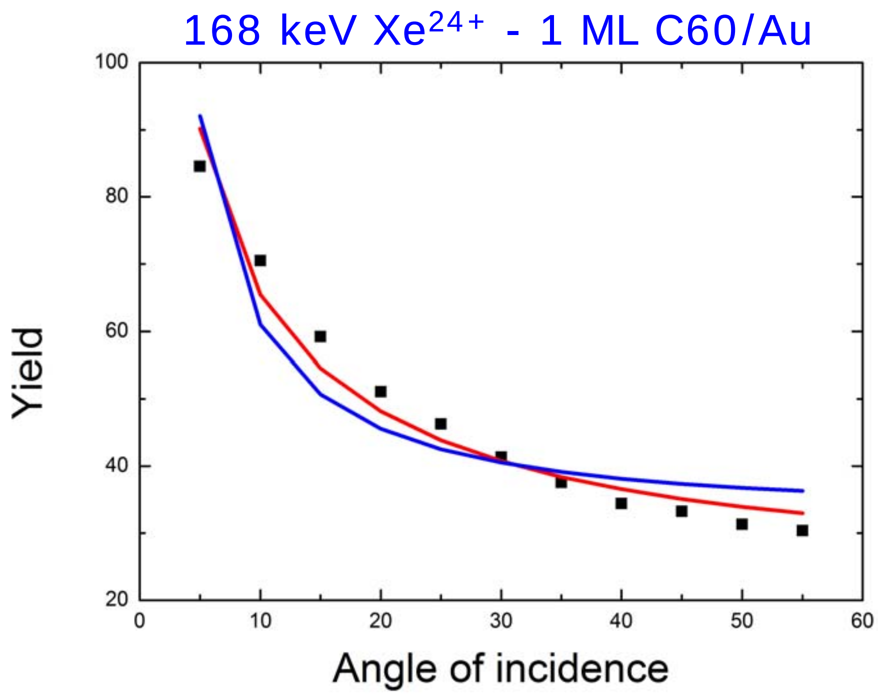
PE

First data on C60 films on Au

Film production (Omicron evaporator)

in situ calibration evaporation on quartz microbalance

comparison to 1ML C60 produced via “heating recipe”



kinetic electron emission:

$\gamma = \gamma_0 + \gamma_\theta \cos^{-1}\theta$

potential electron emission:

$\gamma = \gamma_0 + \gamma_\theta \cos^{-0.5}\theta$