

Radiative processes studied in collisions of U^{92+} with a H_2 target

Günter Weber^{1,2}

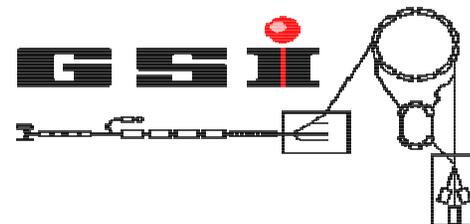
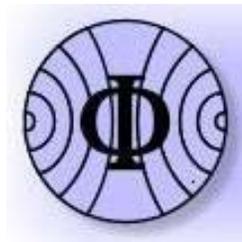
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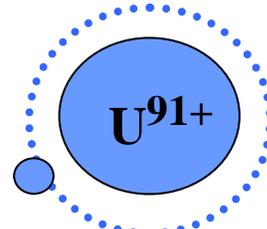


Radiative Electron Recombination (REC)

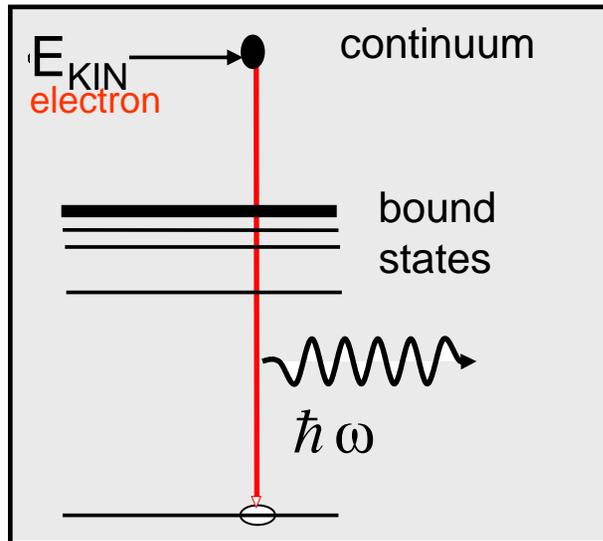
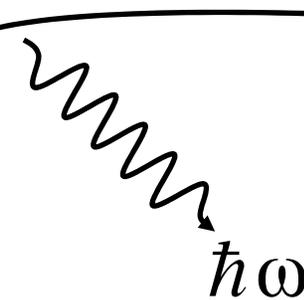
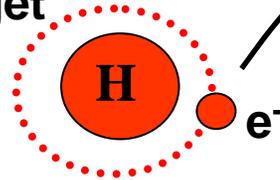
Projectile



v



Target

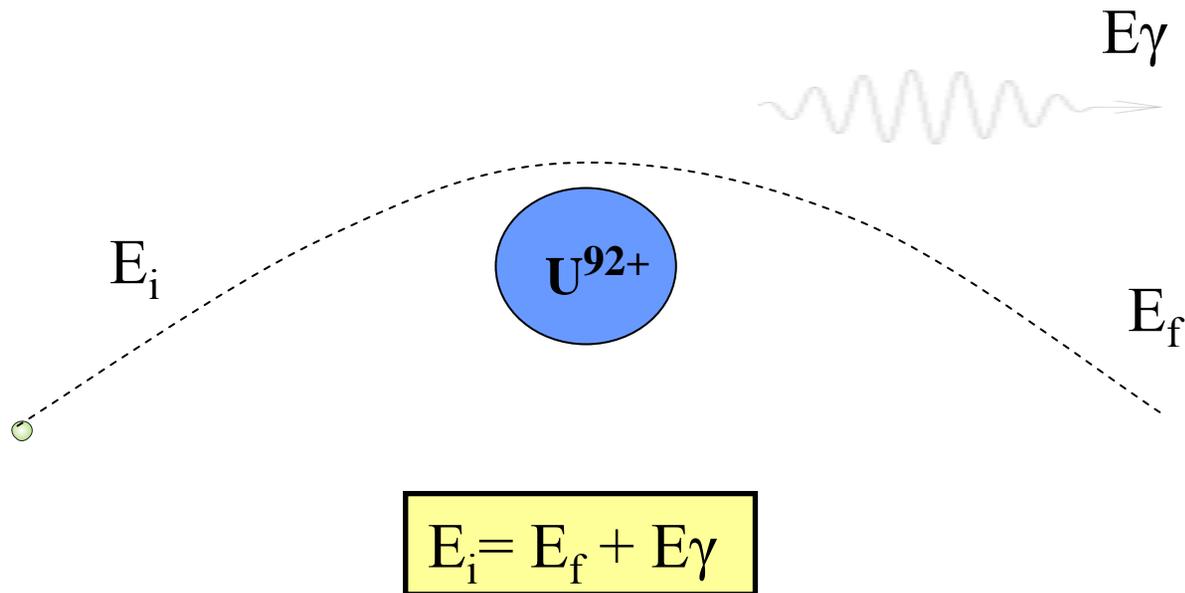


X - ray energy

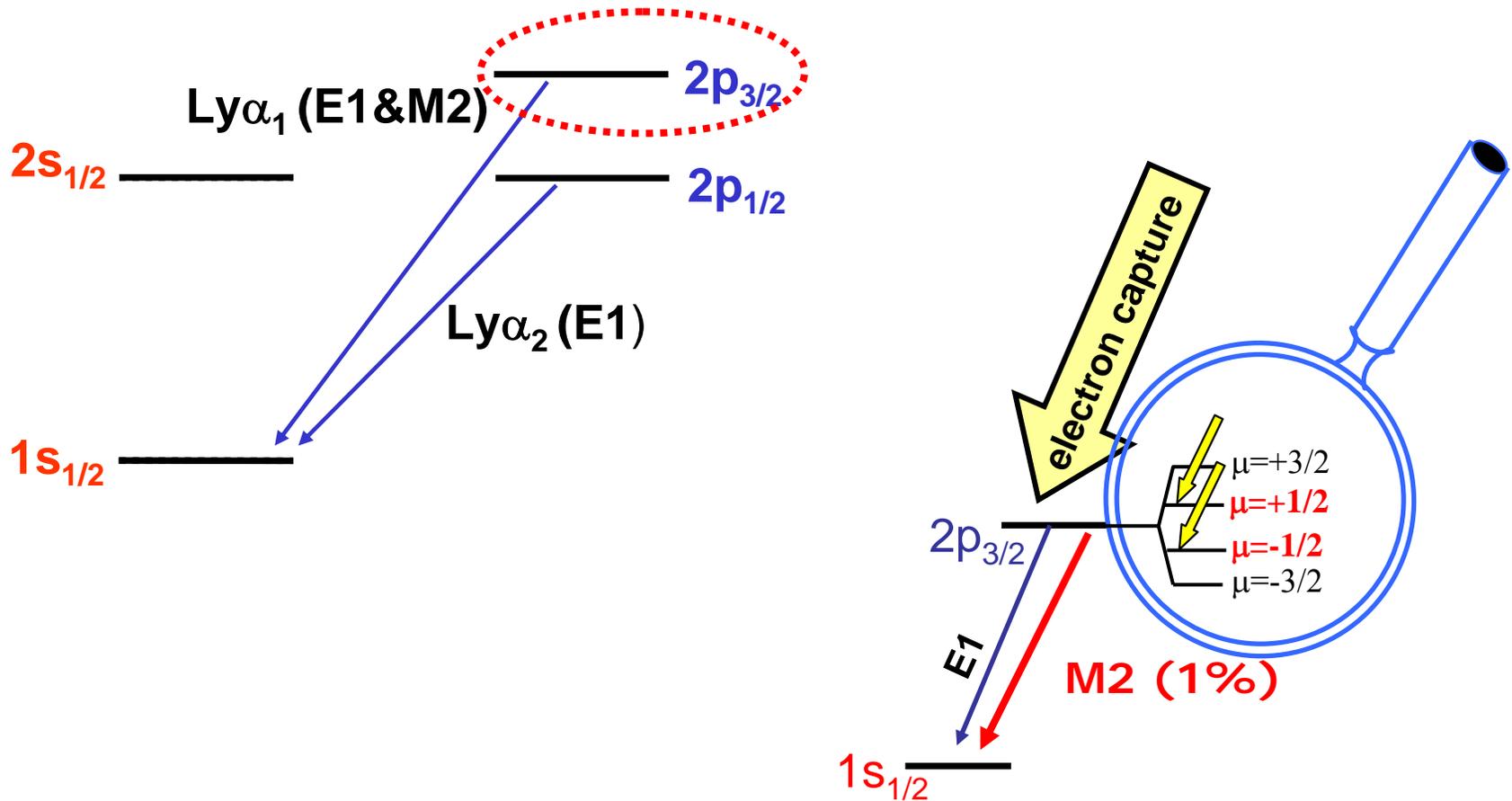
$$\hbar\omega = E_B + E_{KIN}$$

Electron Bremsstrahlung

Projectile System:

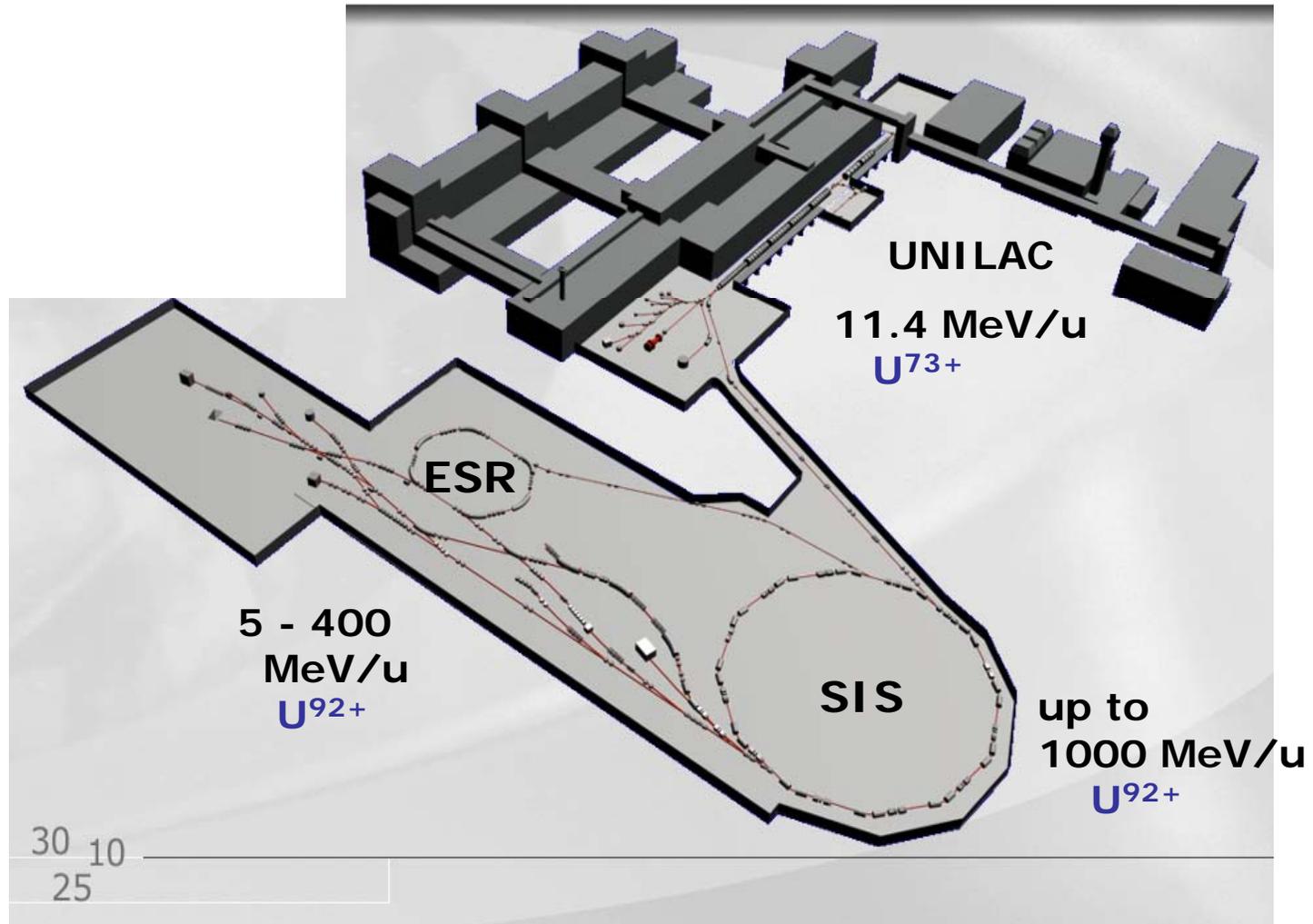


Lyman- α radiation



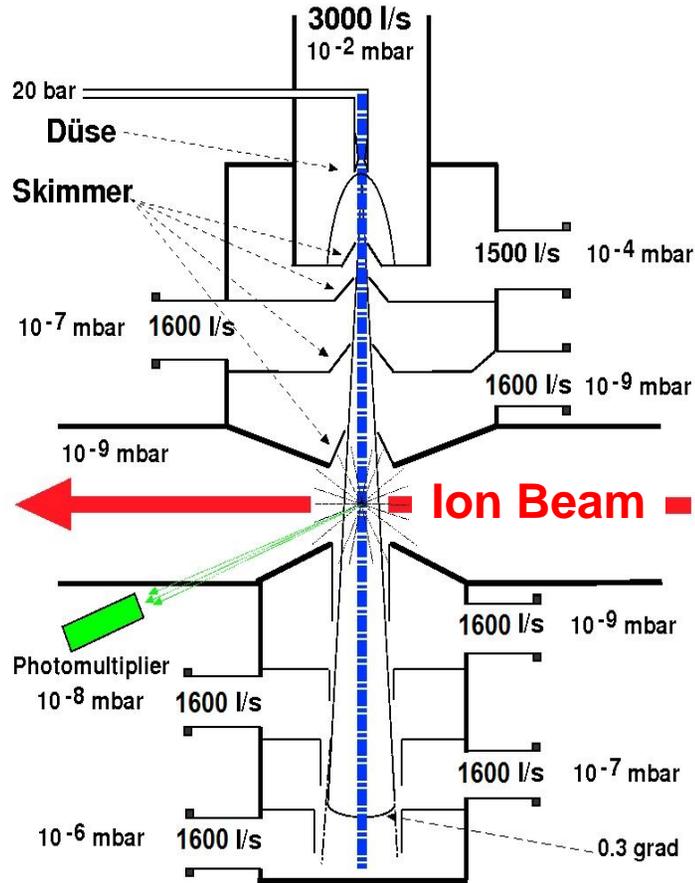
REC leads to a non statistical population of the magnetic sub-levels

The GSI Facility



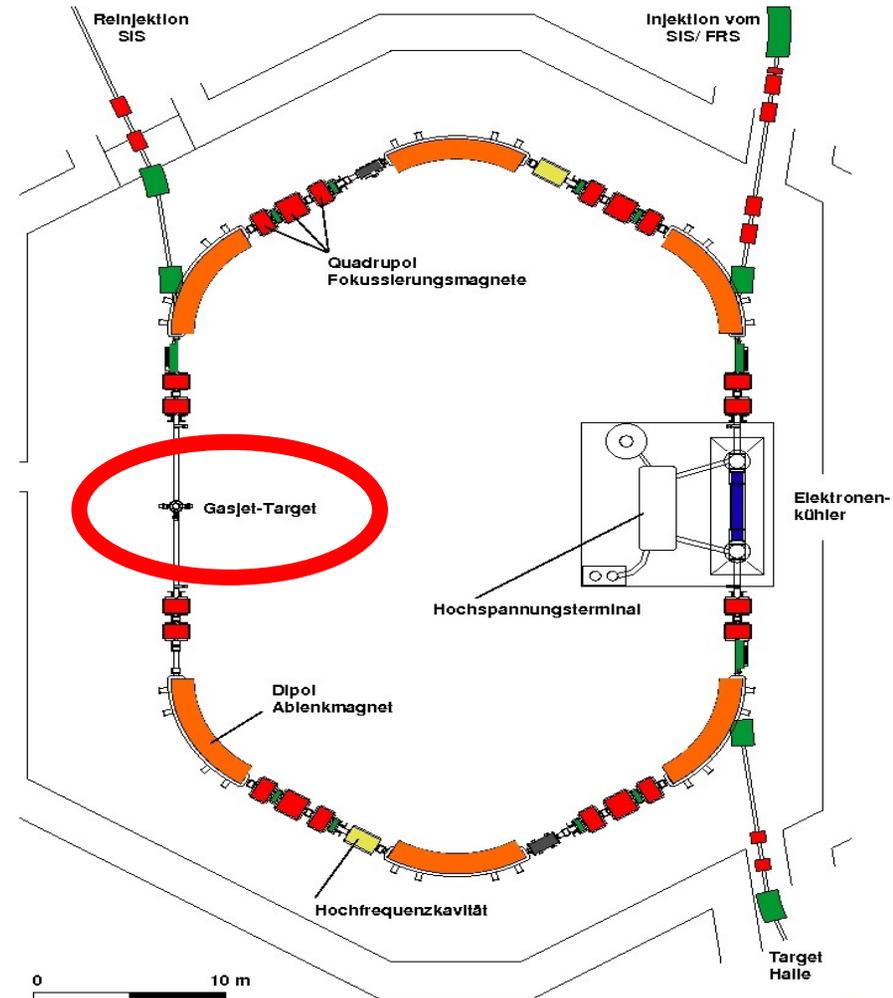
ESR & internal gas target

Internal Gasjet-Target



available Targets: H₂, N₂, Ar, Kr, Xe
typical density: 10¹² particles/cm³

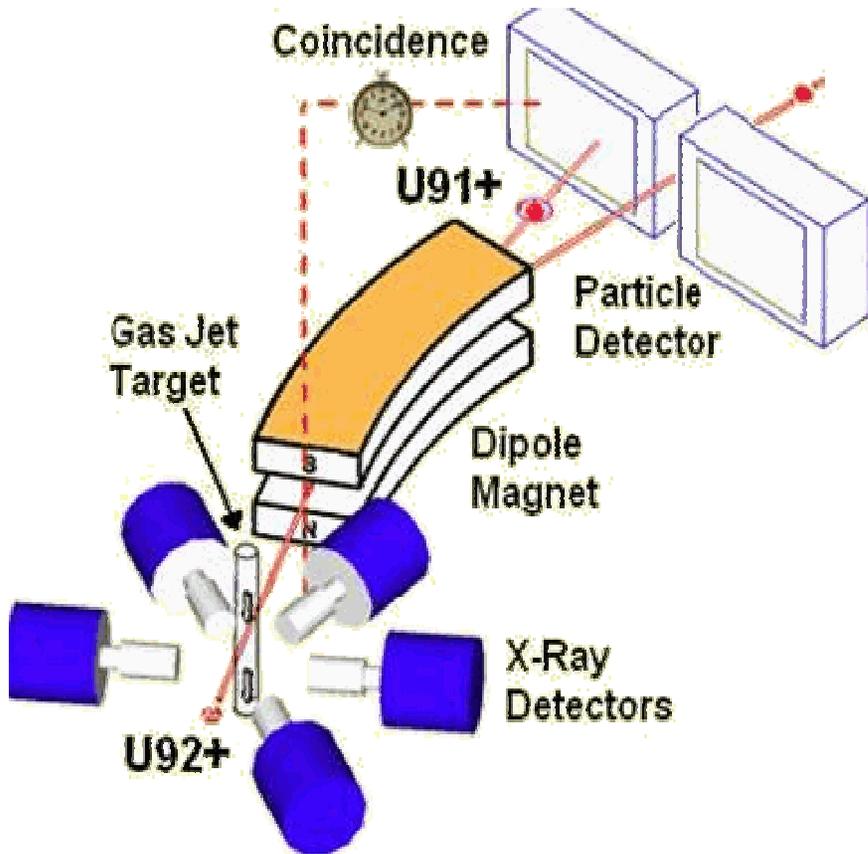
Experimental Storage Ring (ESR)



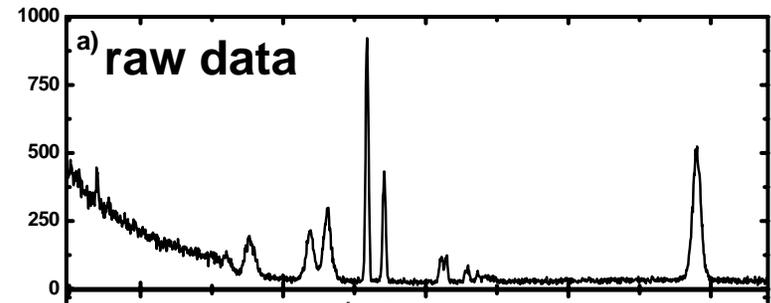
The Experiment

$U^{92+} \rightarrow H_2$ @ 96.6 MeV/u

Experimental Set-up

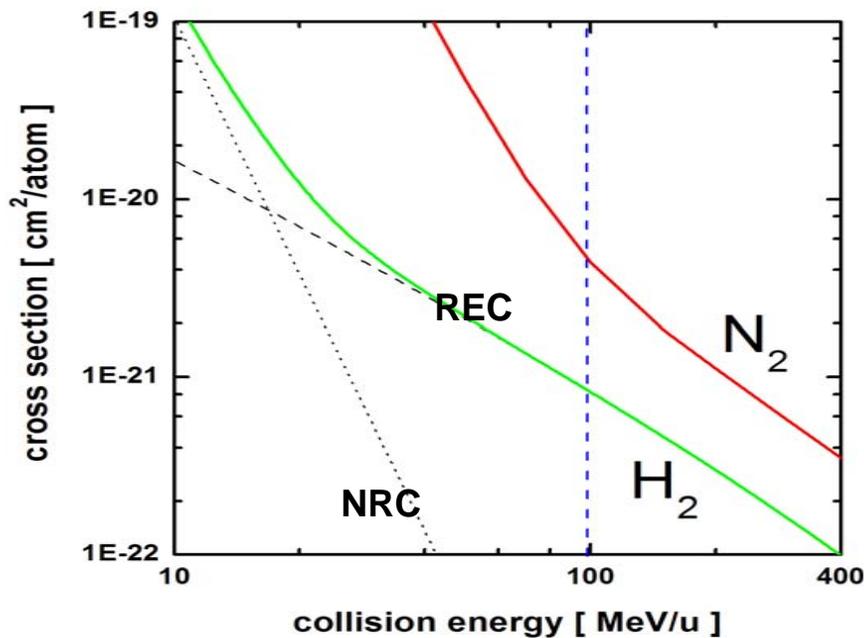


X-ray Spectra at 150°

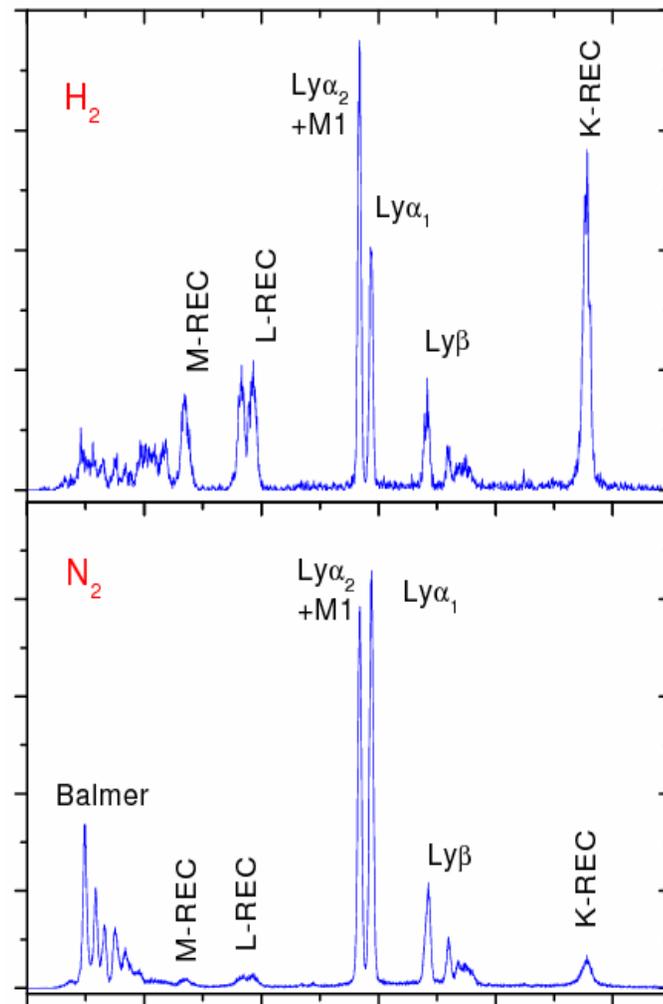


Advantages of the Hydrogen target

- ✓ narrow Compton profile
- ✓ electron capture dominated by REC



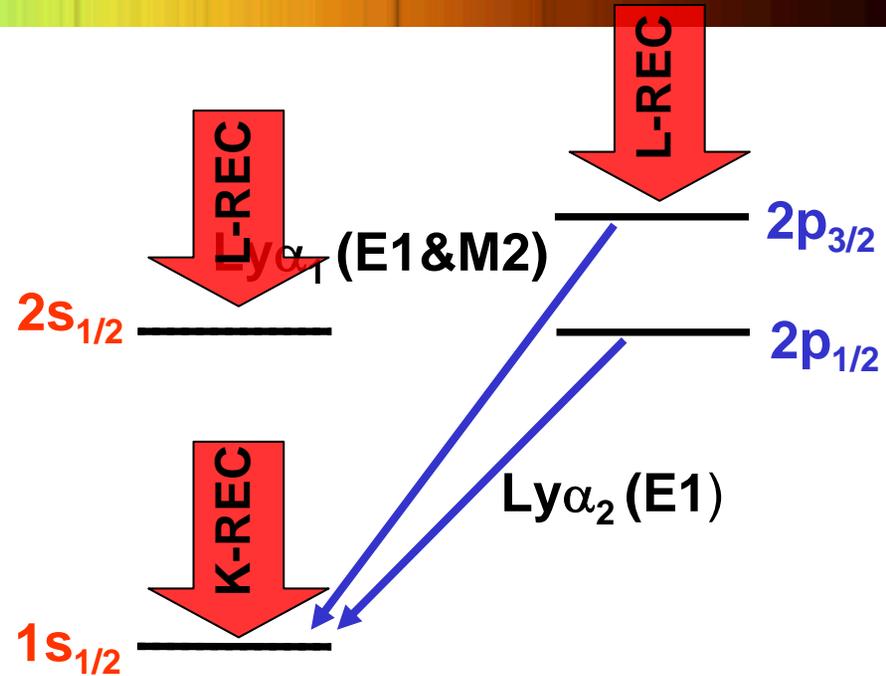
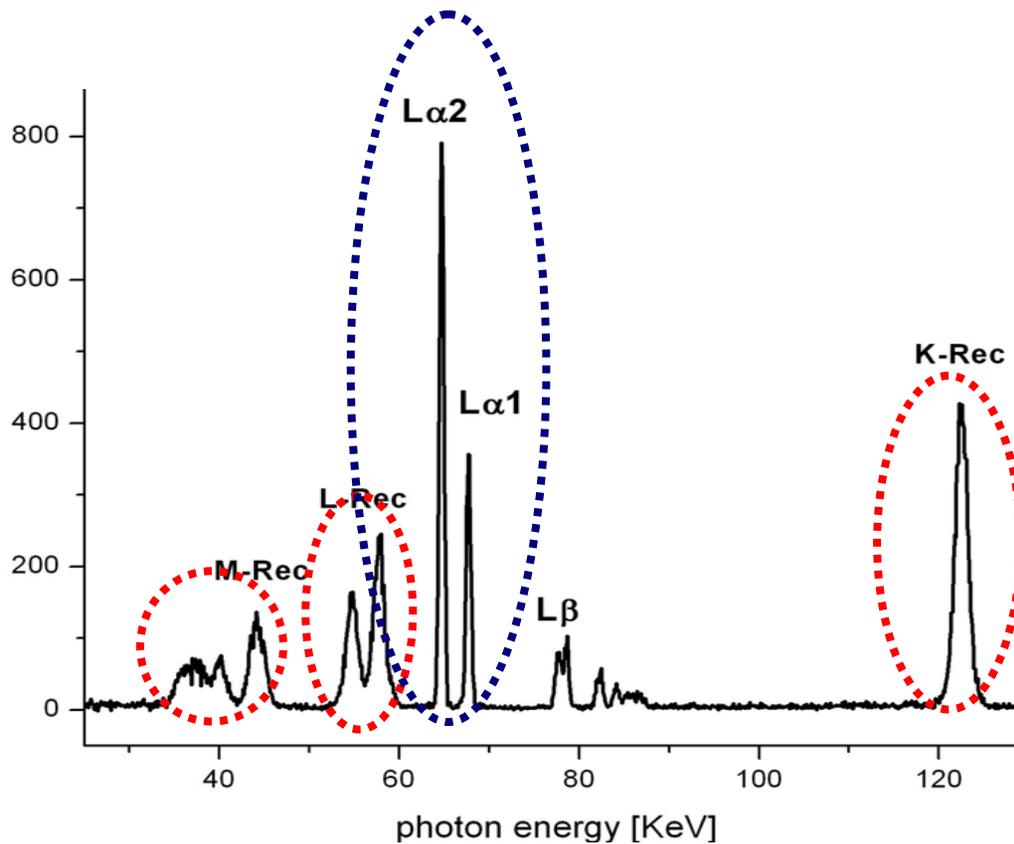
[Th. Stöhlker et al.]



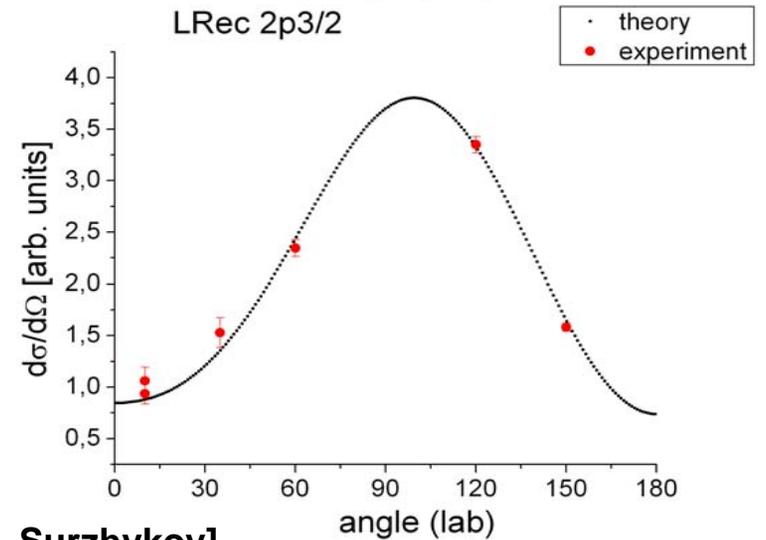
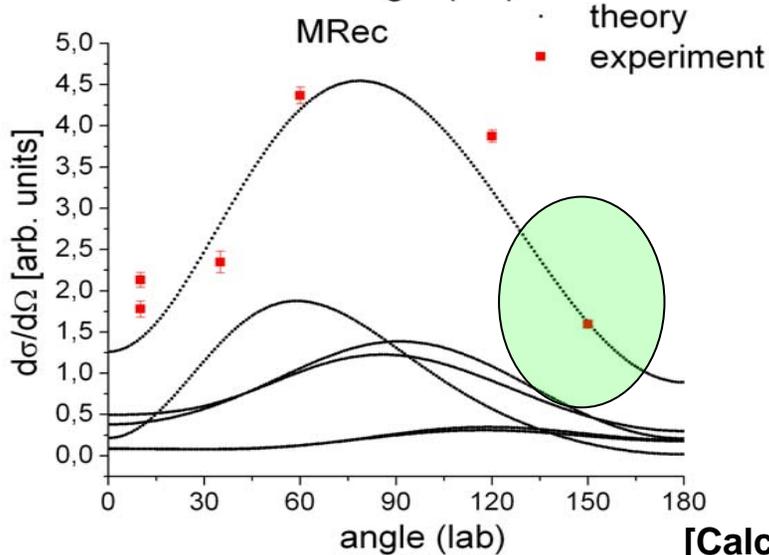
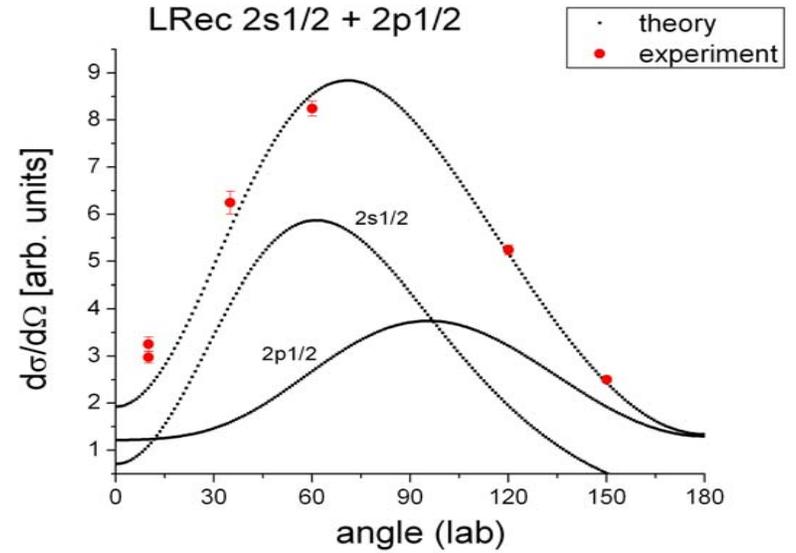
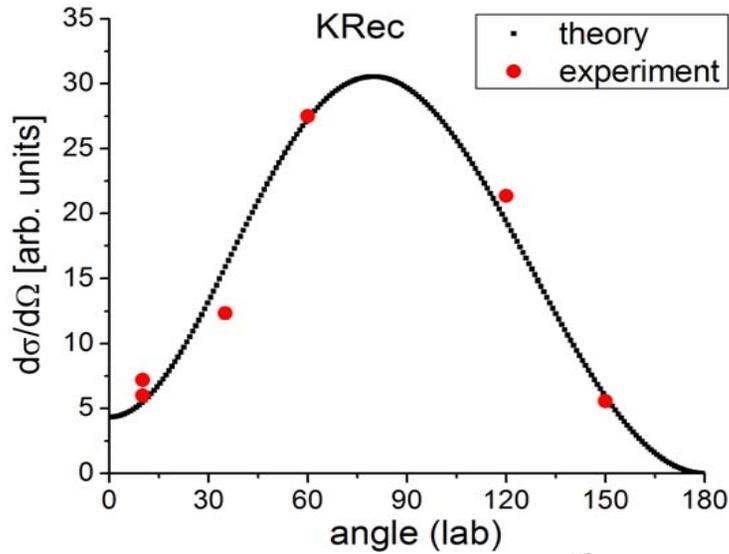
[A. Krämer et al.]

REC radiation

X-ray Spectra at 150°

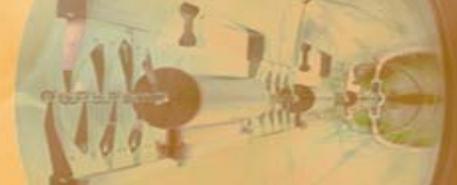


REC angular distribution: Theory vs. Experiment

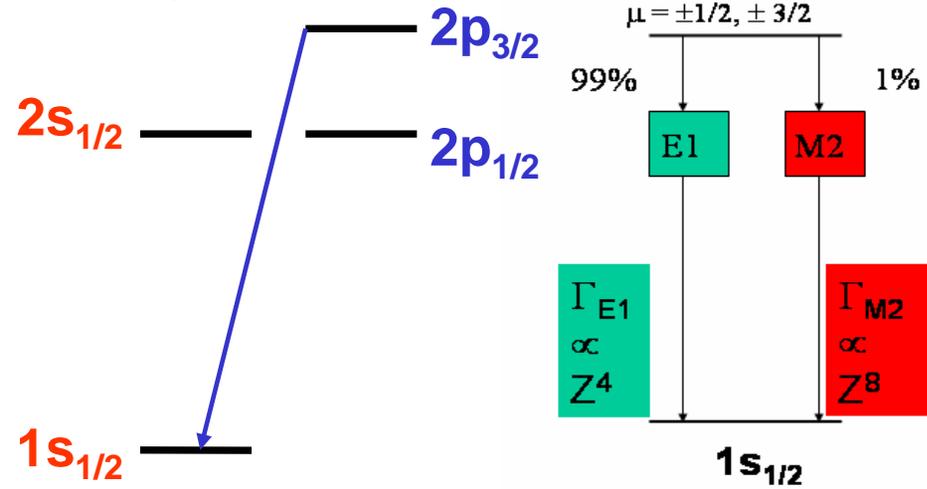


[Calculations: A. Surzhykov]

Results: Lyman- α_1 anisotropy



Ly α_1 (E1&M2)

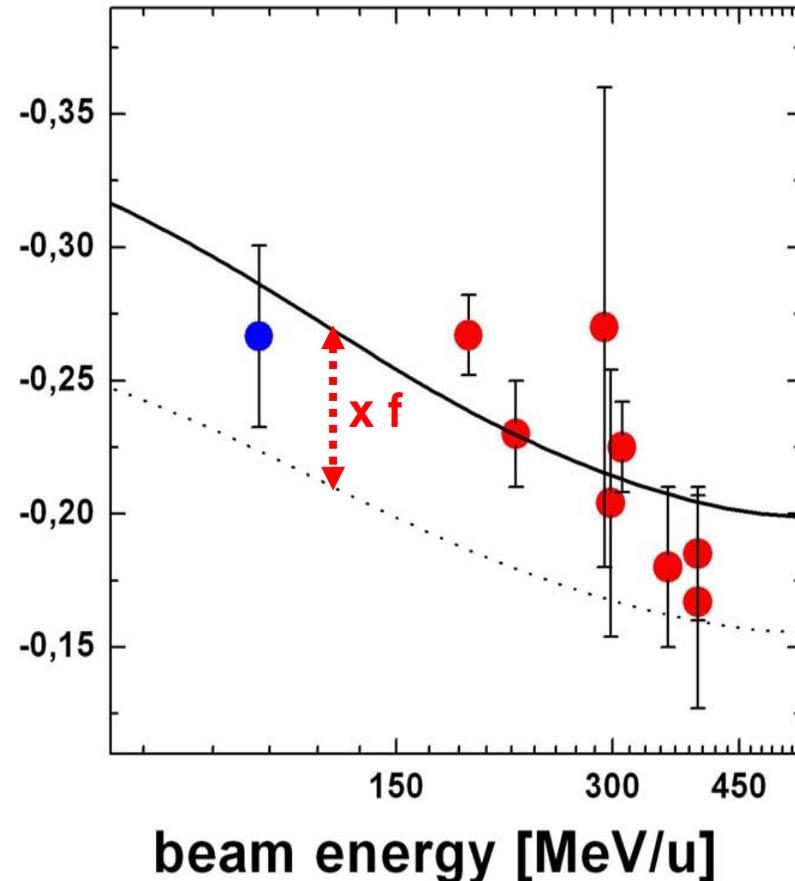


Theory for Z=92: $f = 1.28$

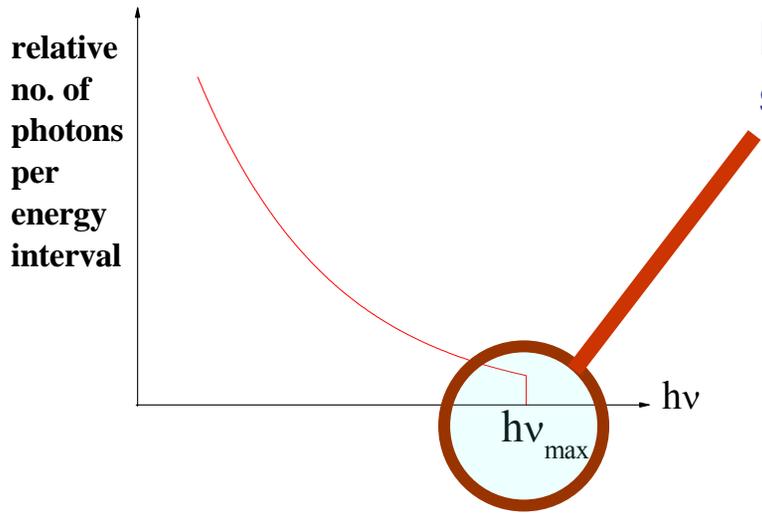
$$W(\theta) \propto 1 + f \left(\frac{a_{M2}}{a_{E1}} \right) \beta_A \left[1 - \frac{3}{2} \sin^2 \theta \right]$$

$$f \left(\frac{a_{M2}}{a_{E1}} \right) \propto \left[1 + 2 \sqrt{3} \frac{\langle \|M2\| \rangle}{\langle \|E1\| \rangle} \right]$$

alignment parameter β_A

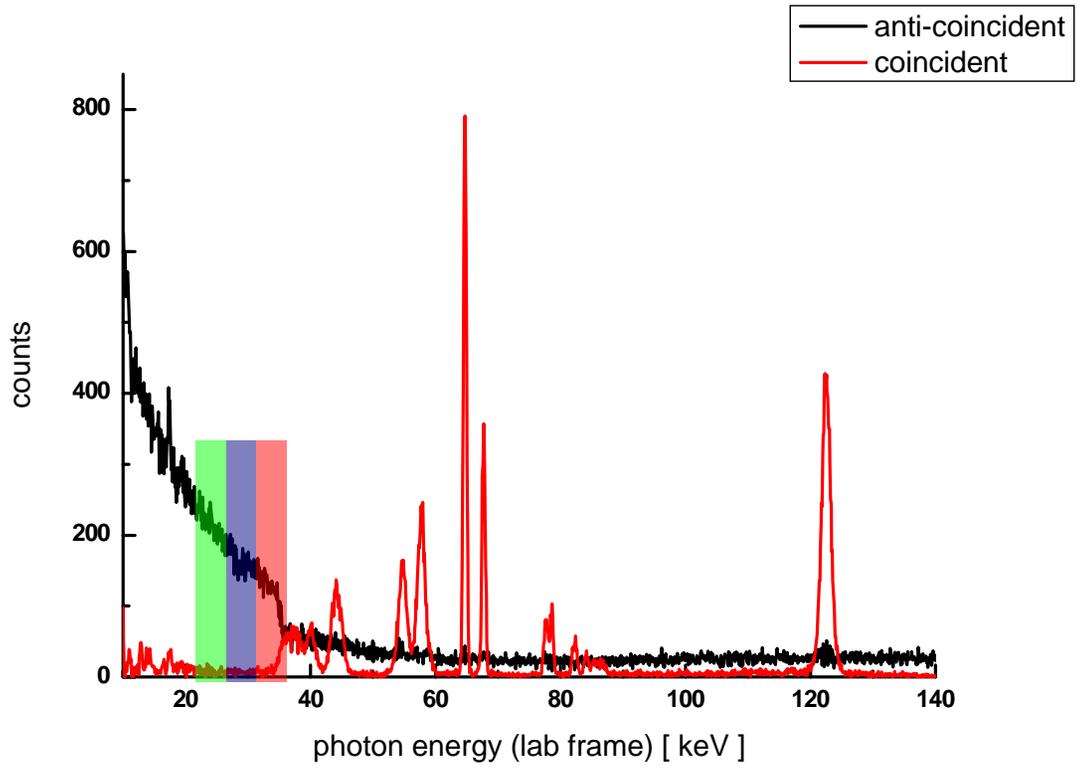


Short wavelength limit of e^- Bremsstrahlung

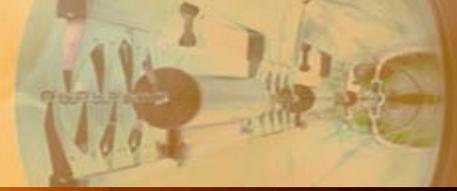


Relativistic QM calculation: Finite cross section at the high frequency limit

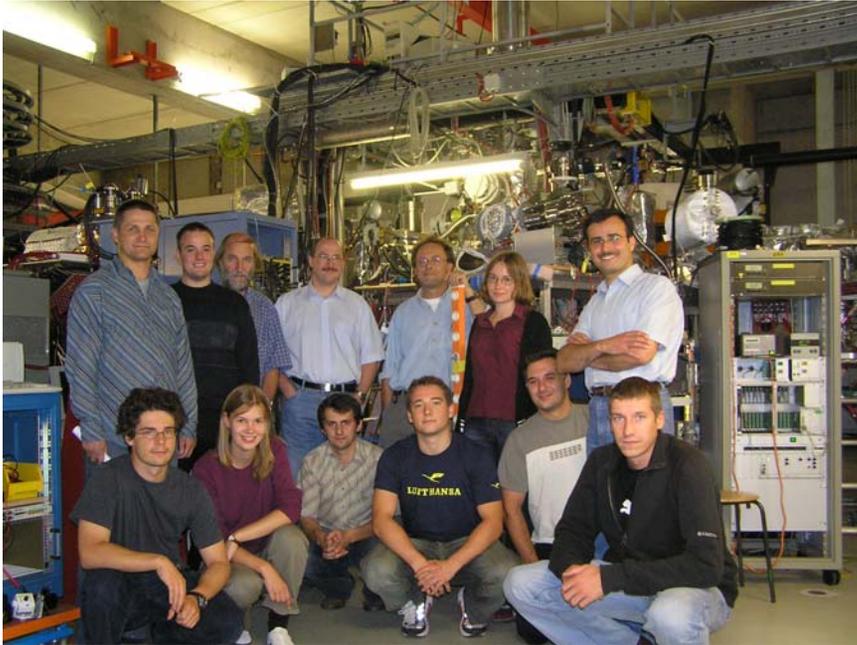
The short wavelength limit...
...shows the smooth transition from REC to capture into continuum states
...reflects details of the ions Coulomb potential



Thank you for your attention



... and many thanks to the working group!



Literature:

- REC angular distribution

J. Eichler, Th. Stöhlker 'Radiative Electron Capture in Relativistic Ion-Atom Collisions and the Photoelectric Effect in Hydrogen-like High-Z Systems' Phys Rep 439 (2007)

- Ly- α alignment

A. Surzhykov et al. 'Lyman- α Decay in Hydrogenlike Ions: Interference between the $E1$ and $M2$ Transition Amplitudes' Phys Rev A 88 (2002)

- Bremsstrahlung

T. Ludziejewski et al. 'Study of electron bremsstrahlung in strong Coulomb fields at the ESR storage ring' Hyperfine Interactions 144 (1998)