

# Experiments and Simulations with Charged Particle Beams

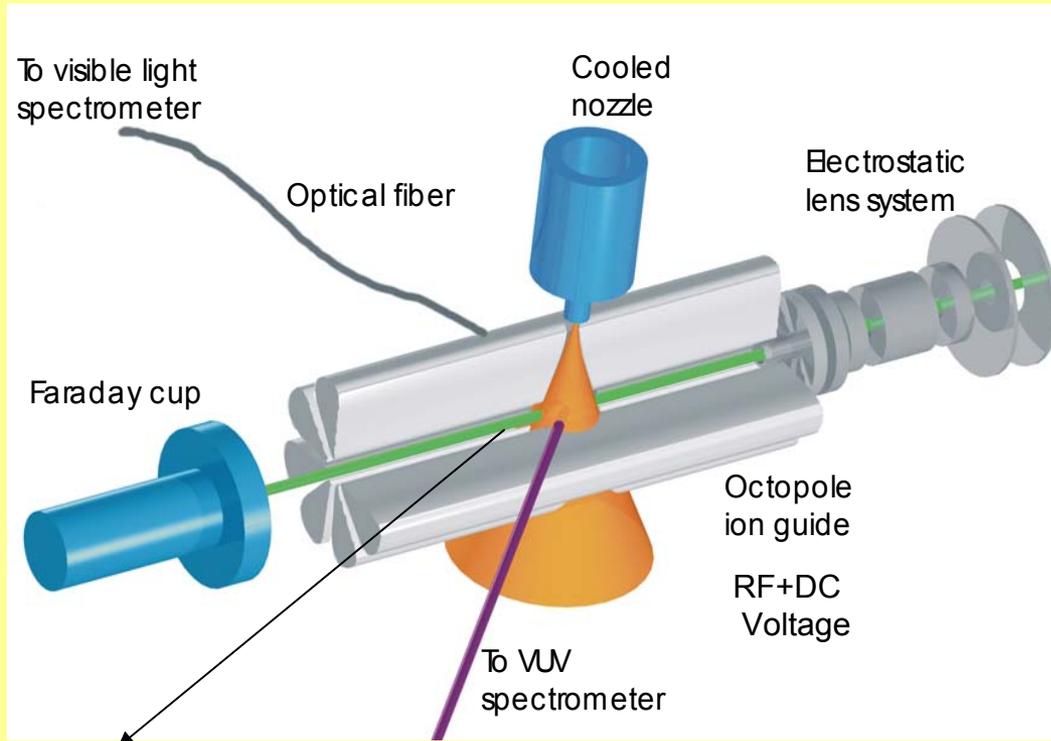
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# Overview of scientific activities

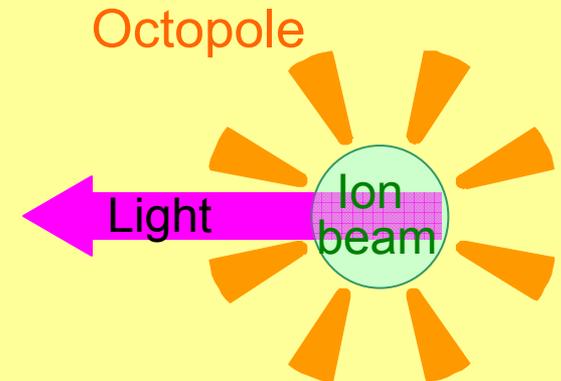
- Diploma work: University of Szeged (1999), Harmonic generation in KrF (248 nm) laser - plasma interaction
- PhD at KVI Groningen (1999-2004), Charge exchange processes in slow ion - molecule collisions (*Space charge effects in RF octopole ion guide*)
- Present: Post doc at ATOMKI Debrecen, (2005-2008), *Ion guiding through nanocapillaries* and Fragmentation of biologically relevant molecules
- Future: Possible in-kind contribution to XFEL Bunch compression and Start-to-end Simulation

# Charge exchange experiments at KVI



Decelerated beam down to 20 eV

The visible range of the beam is limited



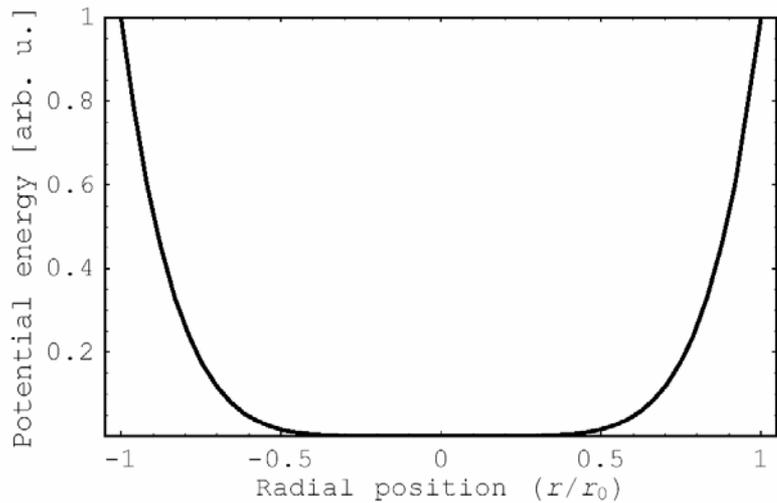
A very narrow beam is needed for full visibility

# Space charge effect on ion distribution

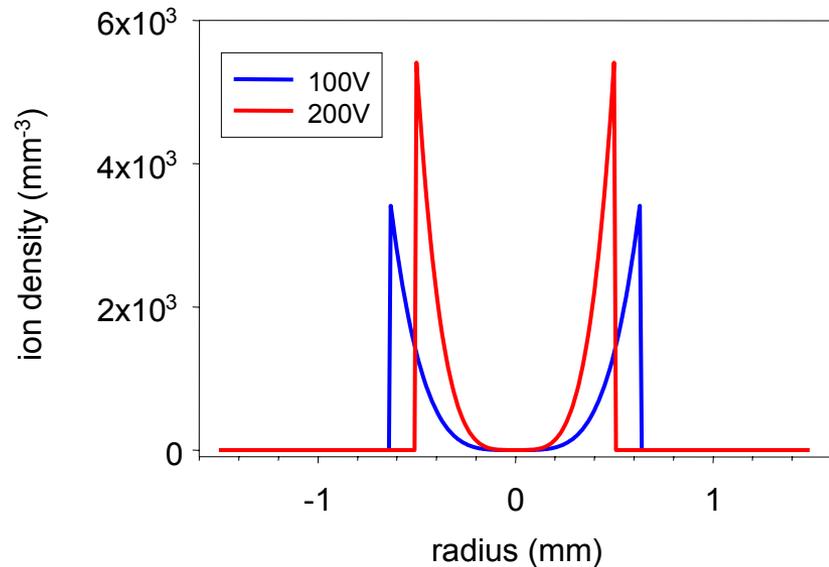
Ions try to spread due to space charge

The effective potential of the octopole confine the beam

Effective potential  $\sim r^6$



Ion density  $\sim r^4$

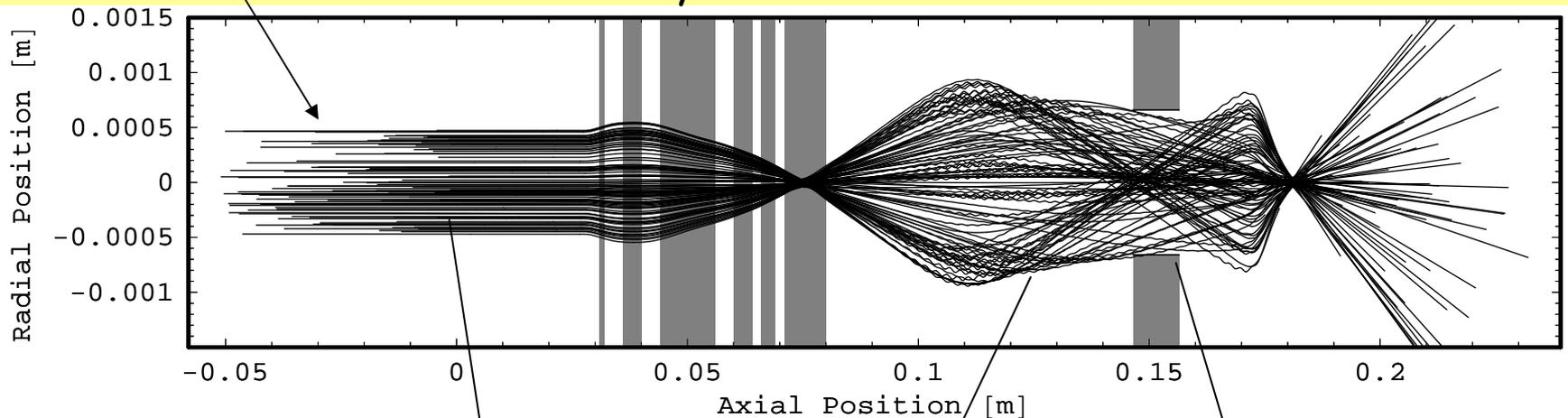


# Simulation of ion trajectories

Ion beam:  
long bunch of ions  
( $N=100$ ) randomly  
distributed

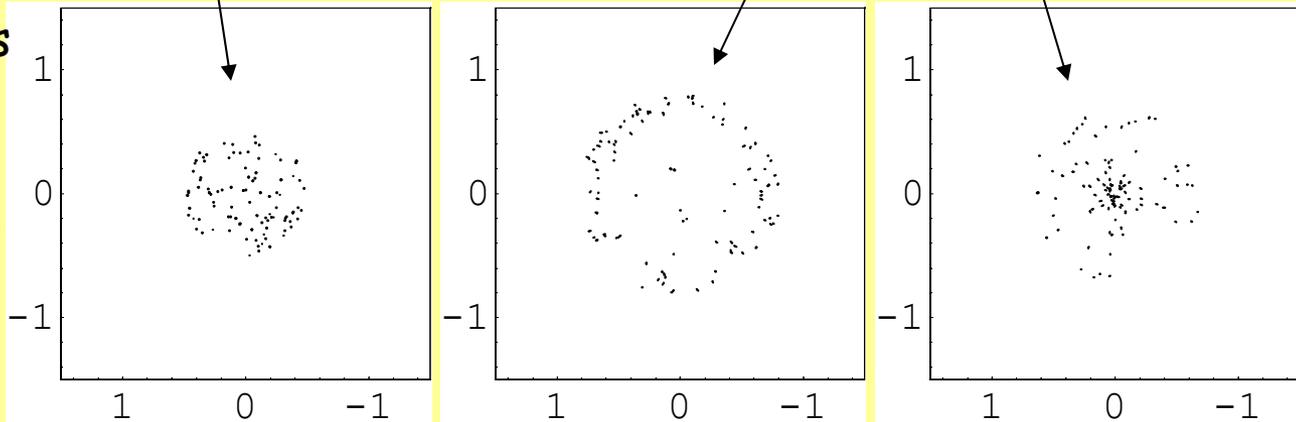
The electric field of  
the lens system and  
the RF octopole  
is numerically calculated

Interaction between the ions  
(space charge) is calculated by  
weighted charge method

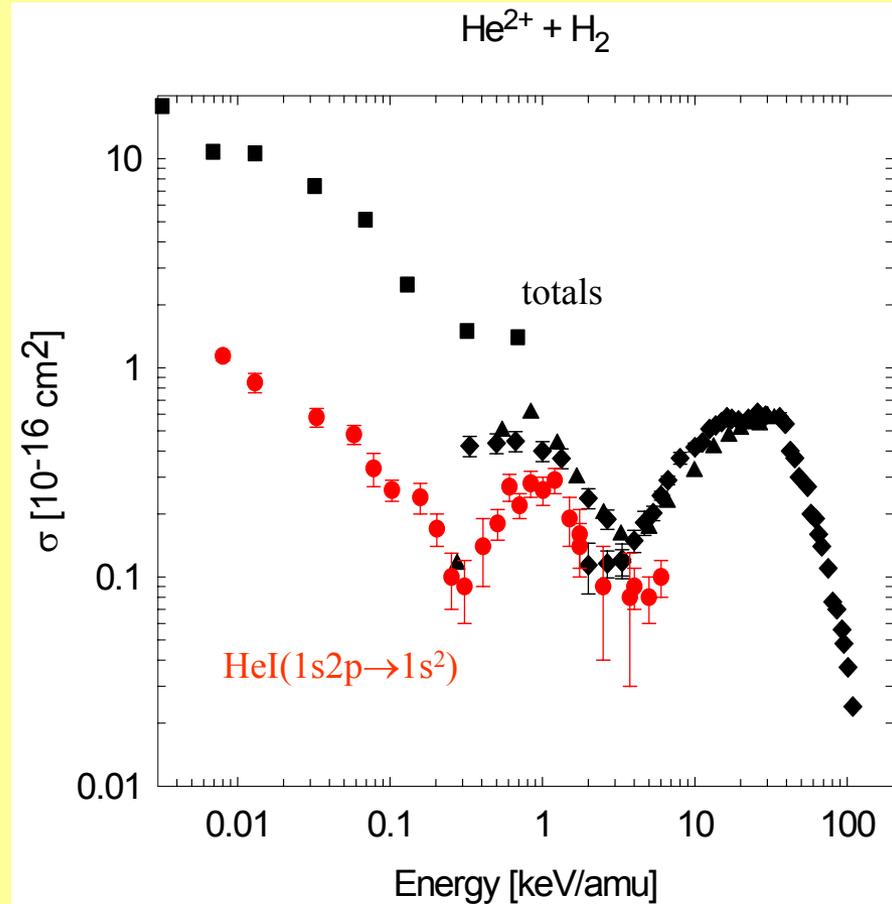
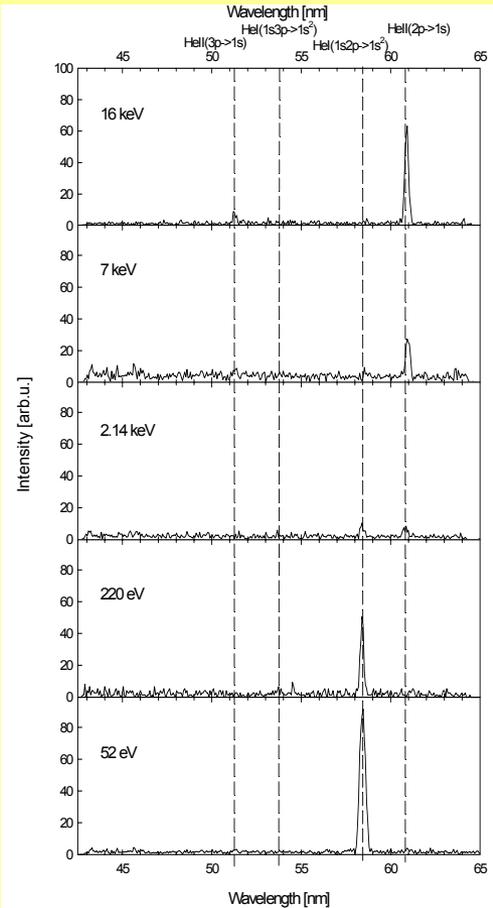


Cross sections  
of the beam:

Oscillation between  
hollow and filled  
structures



# Experimental Results

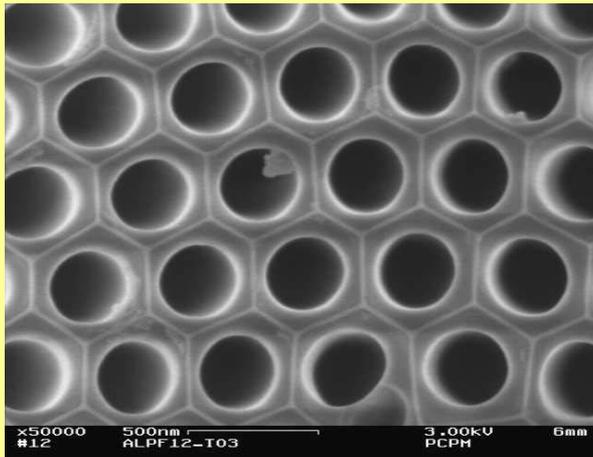


Absolute line emission cross sections!

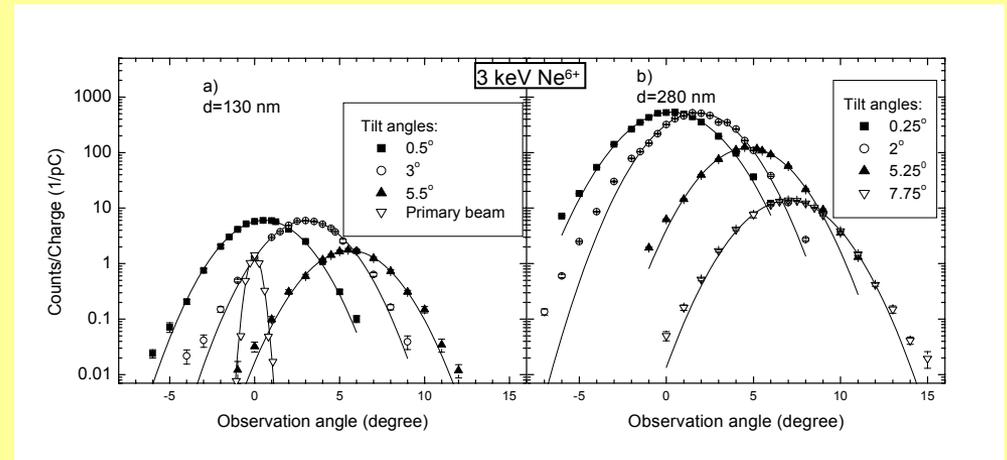
# Ion guiding through nanocapillaries at ATOMKI

Slow ions pass through strongly tilted capillaries in thin insulating membranes

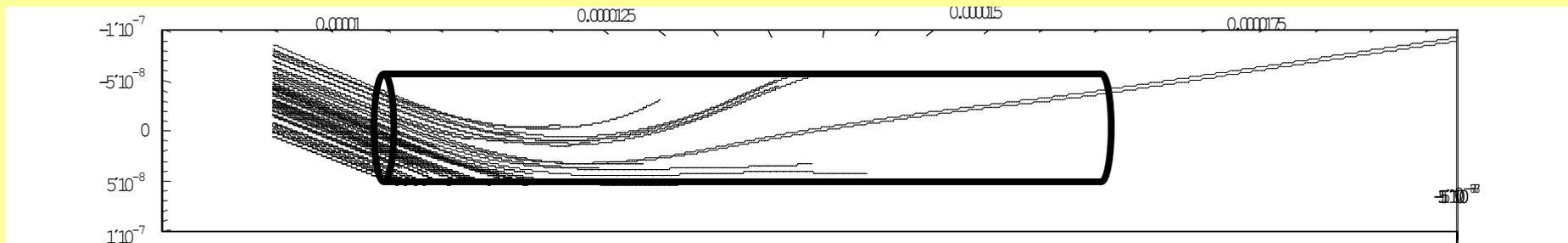
SEM image of  $\text{Al}_2\text{O}_3$  capillaries



Angular distribution of the transmitted ions



Simulation



# Interest in XFEL

- Simulation of space charge effects in bunch compression - trajectory calculations
- Bunch shape diagnostic