



INTERNATIONAL CONFERENCE ON PHOTONIC  
ELECTRONIC AND ATOMIC COLLISIONS

26 JULY - 1 AUGUST 2017 | CAIRNS CONVENTION CENTRE | QUEENSLAND, AUSTRALIA

# Radiative Double Electron Capture (RDEC) in $F^{9+} + N_2$ , Ne Collisions

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Supported in part by NSF Grant: PHY-1401429



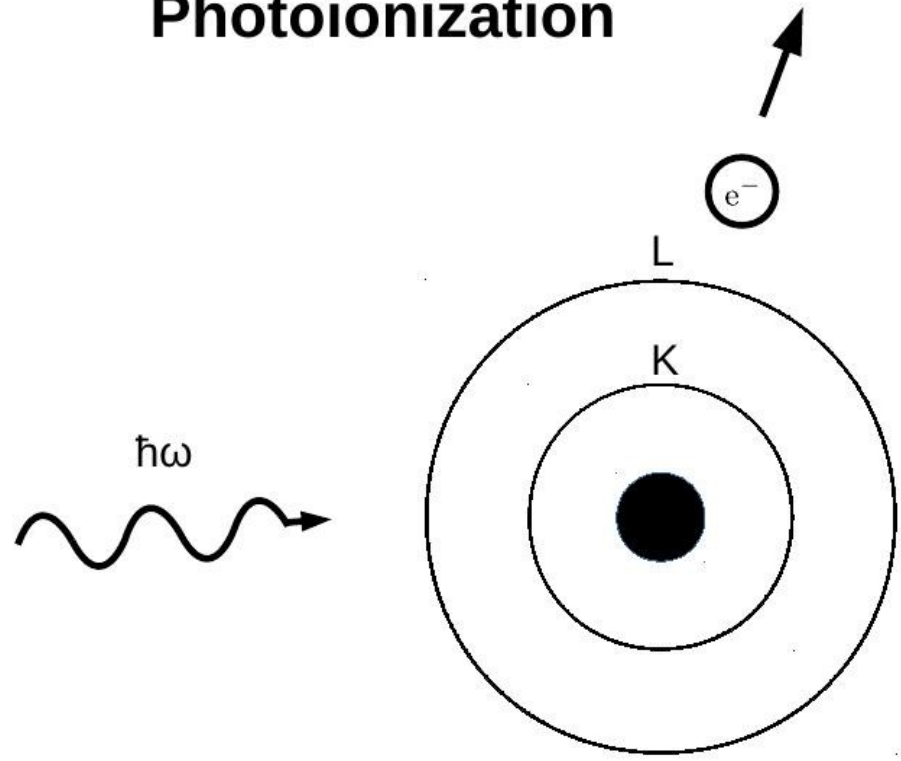


# Outline

- Background
- Previous Experiments
- Experimental Setup
- Results/Discussion
- Conclusion

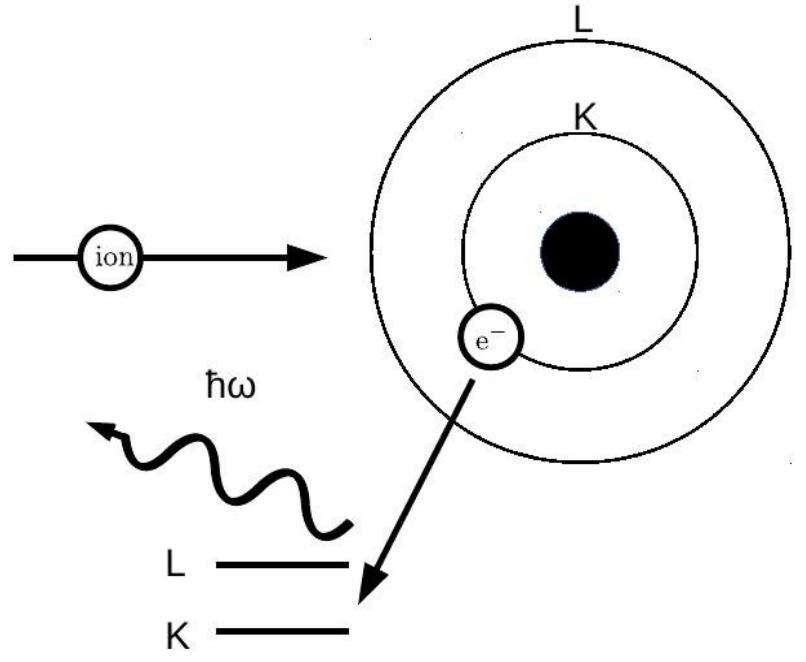
# Background

## Photoionization



$$E_{PI} = K_t + B_t$$

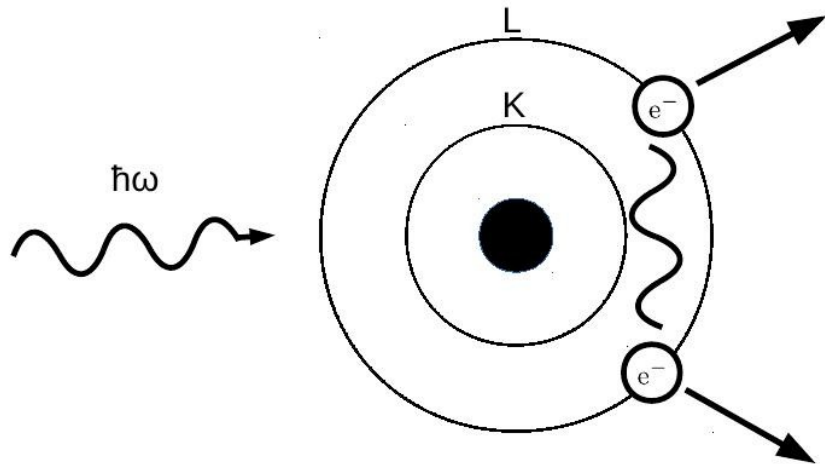
## Radiative Electron Capture



$$E_{REC} = K_t + E_{Bp} - E_{Bt} + \mathbf{v} \cdot \mathbf{p}$$

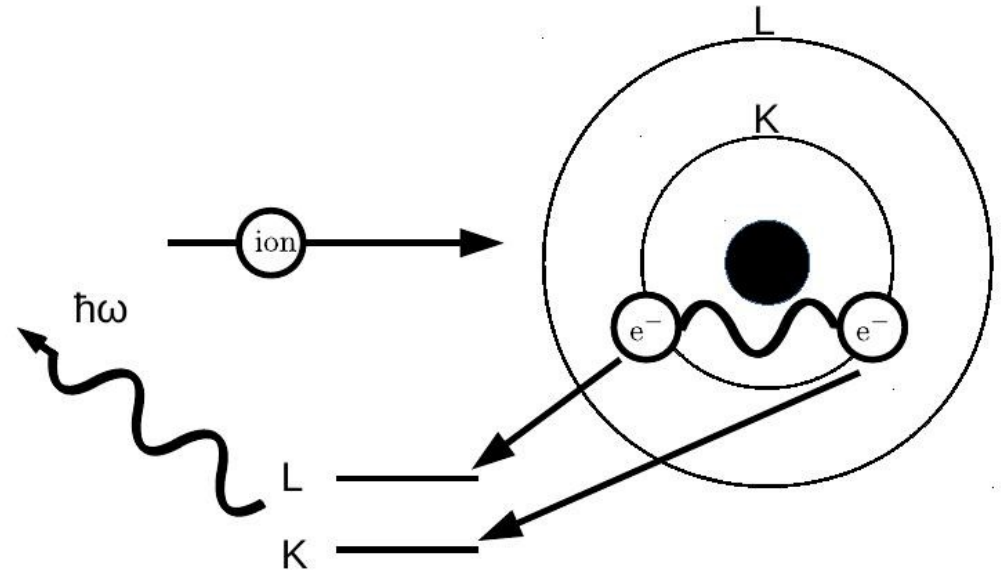
# Background

## Double Photoionization



$$E_{\text{DPI}} = 2K_t + B_t^1 + B_t^2$$

## Radiative Double Electron Capture

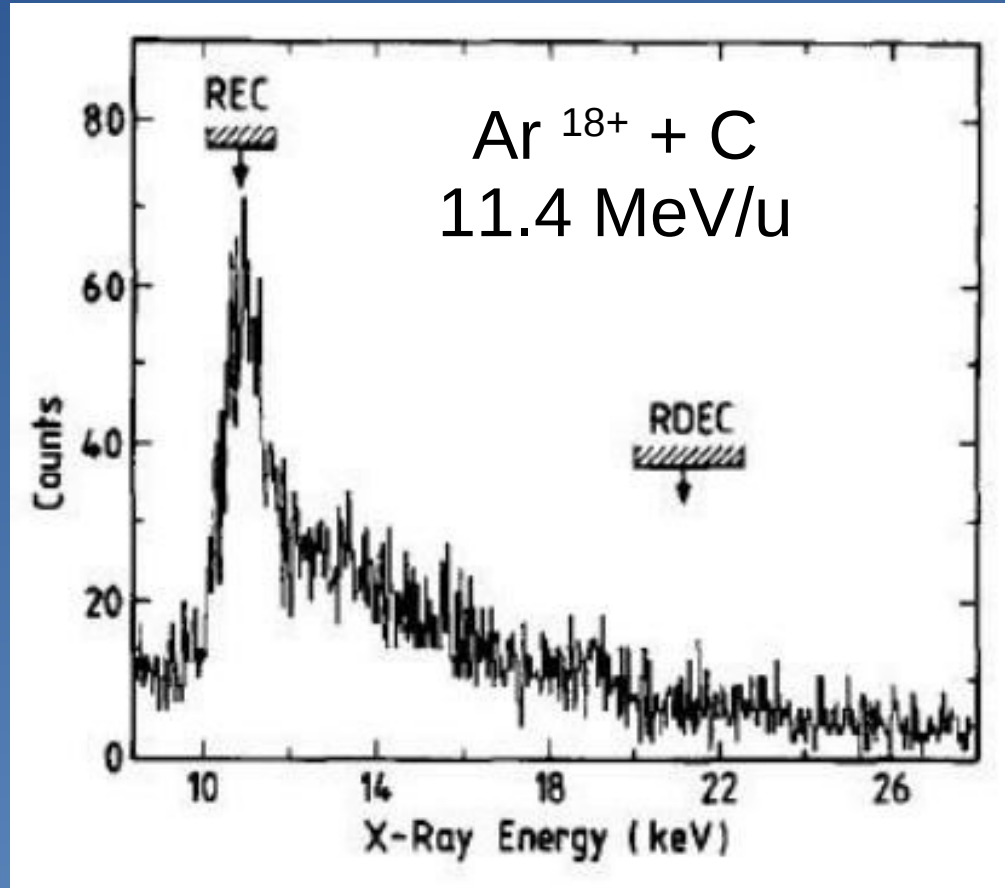


$$E_{\text{RDEC}} = 2K_t + E_{\text{Bp}}^1 + E_{\text{Bp}}^2 - E_{\text{Bt}}^1 - E_{\text{bt}}^2 + \mathbf{v} \cdot \mathbf{p}^1 + \mathbf{v} \cdot \mathbf{p}^2$$

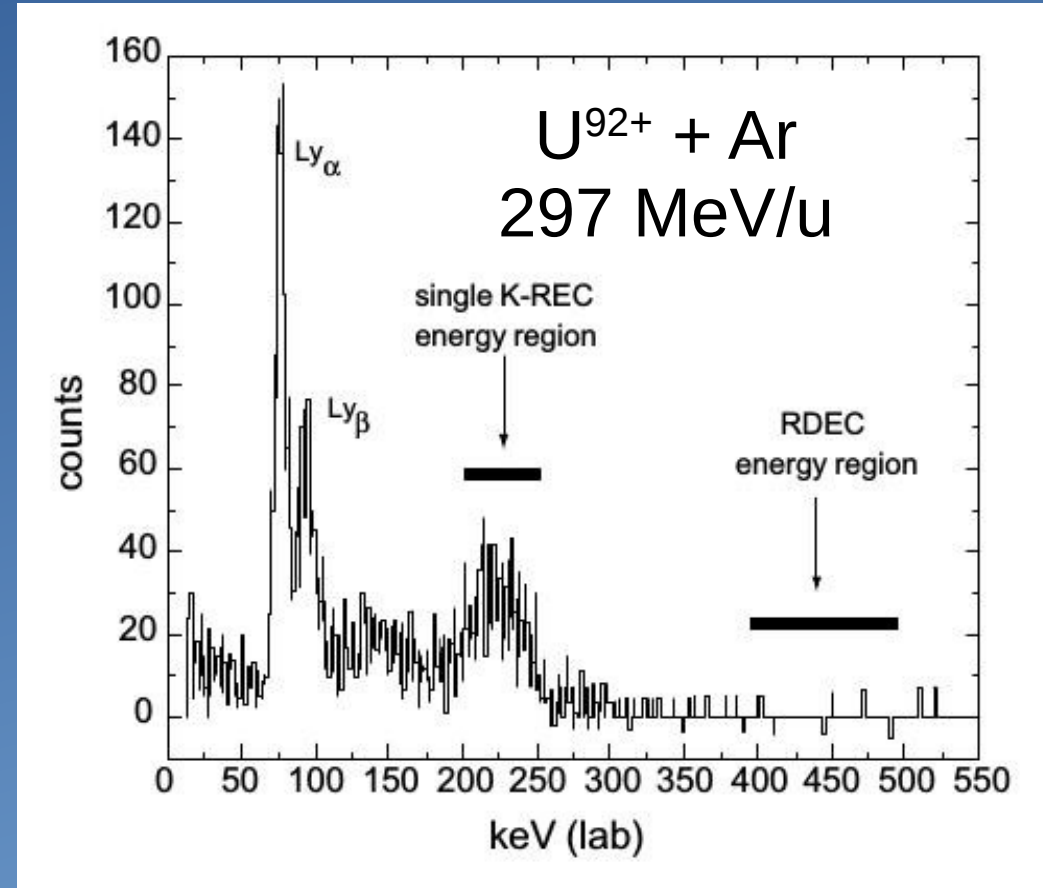
$$E_{\text{RDEC}} \approx 2E_{\text{REC}}$$

# Previous Experiments

- performed by Prof. A. Warczak at GSI, Darmstadt



Warczak *et al.* NIM B, **98** (1995) 303

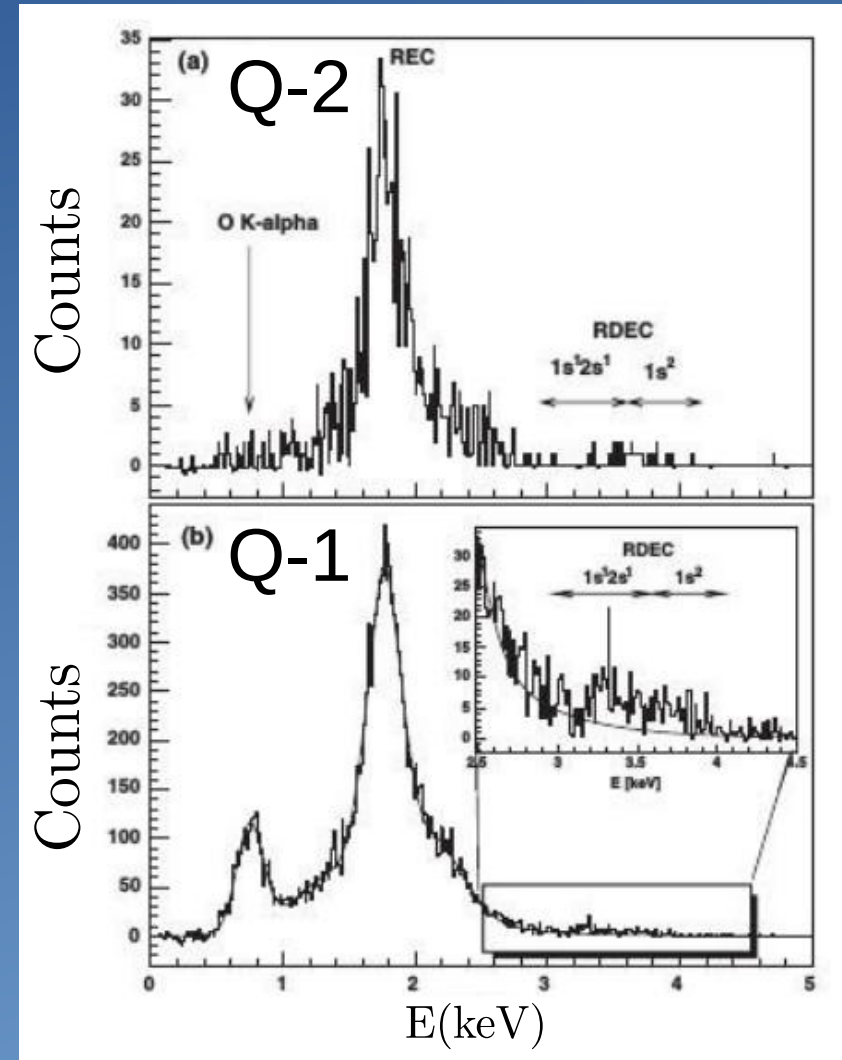


Bednarz *et al.* NIM B, **205** (2003) 573

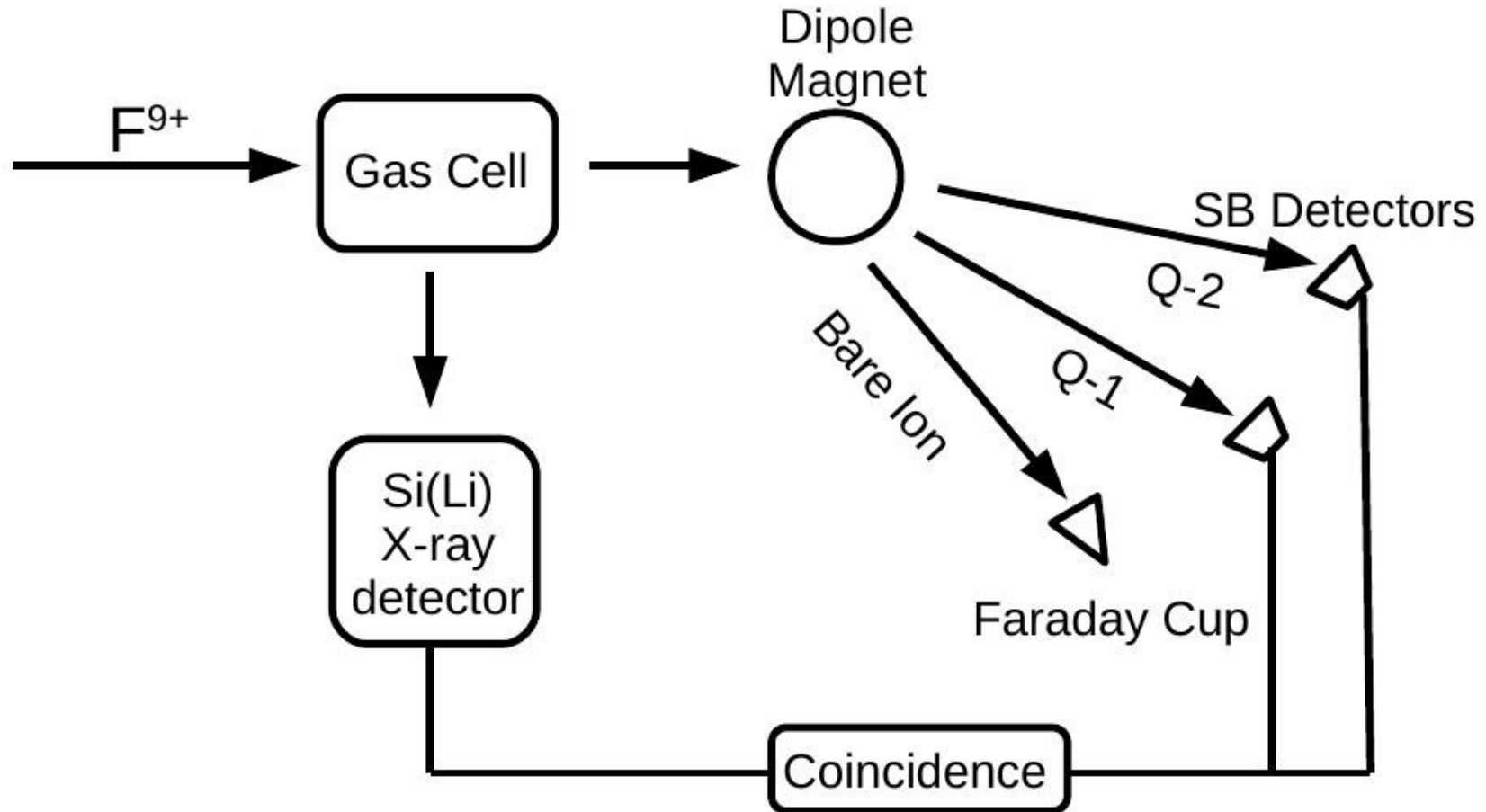


# Previous Experiments

- theory of Nefiodov *et al.* suggests mid-Z, low energy collisions will give larger RDEC cross sections.
- first successful observation by A. Simon *et al.* (2010).
  - 2.38 MeV/u  $O^{8+} + C$
- estimated total RDEC cross section of 5.9 b/atom.



# Experimental Setup



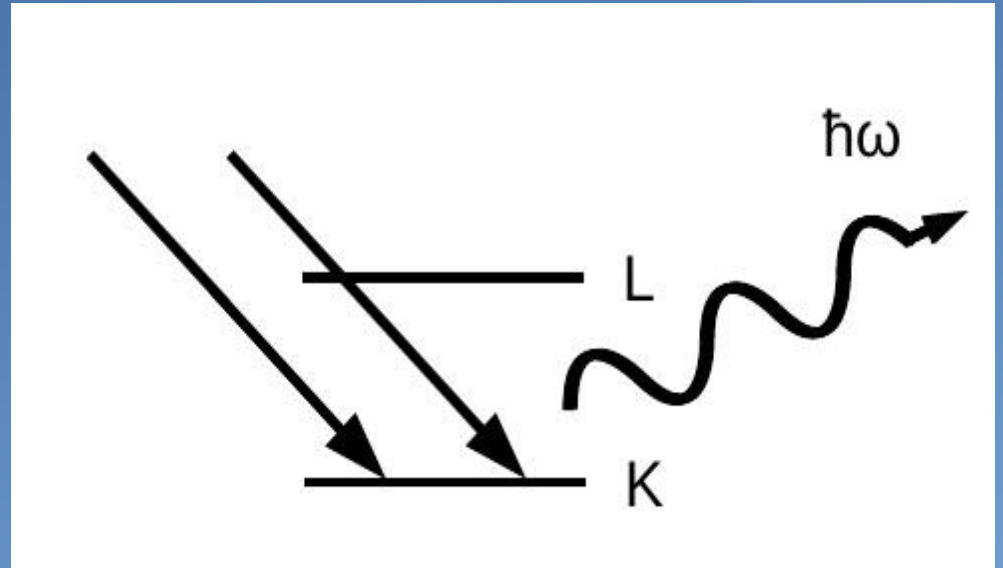
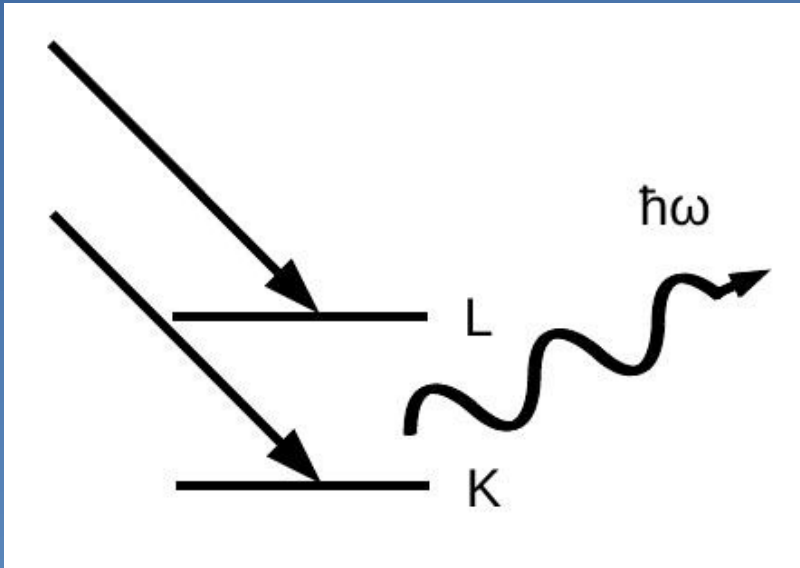


# What We Measured

Projectile: 2.11 MeV/u  $F^{9+}$  (fully-stripped)

Targets:  $N_2$  and Ne (single collision conditions)

- detected coincidences between x rays and singly and doubly charge changed particles



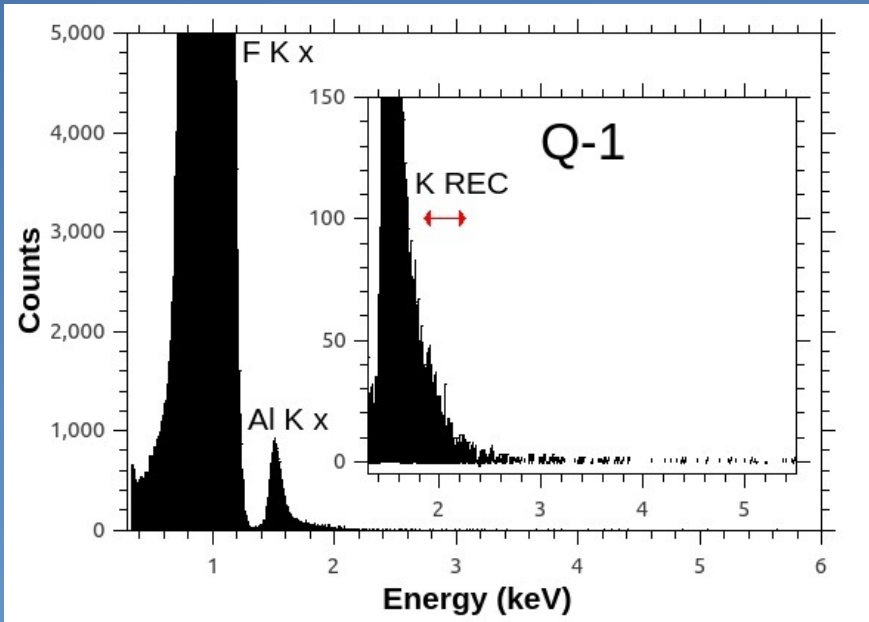
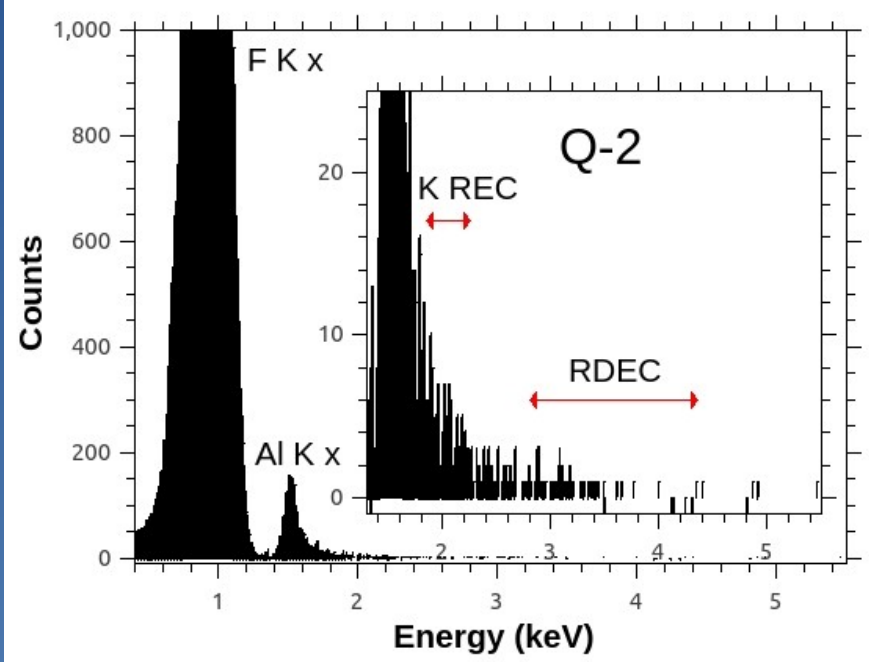




# 2.11 MeV/u $F^{9+}$ + $N_2$

Target Pressure	6 $\mu$
# Incident Particles	$2.53 \times 10^{13}$
# RDEC Counts	$\sim 79$
$d\sigma_{RDEC}/d\Omega$ ( $90^\circ$ )	$\sim 430$ mb

Transition	Energy (keV)
KK $\rightarrow$ KL	2.71
KK $\rightarrow$ KK	3.45
LL $\rightarrow$ KL	3.61
LL $\rightarrow$ KK	4.35

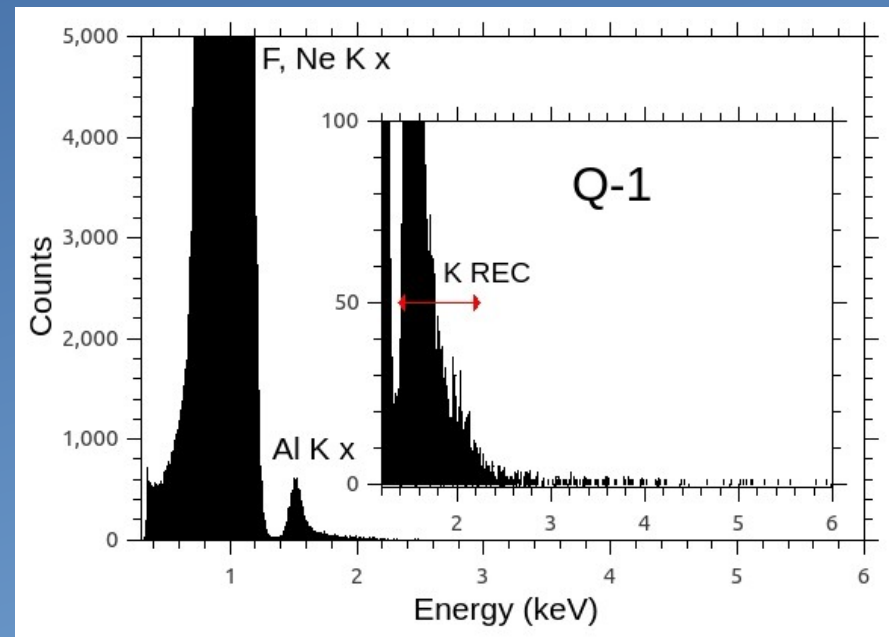
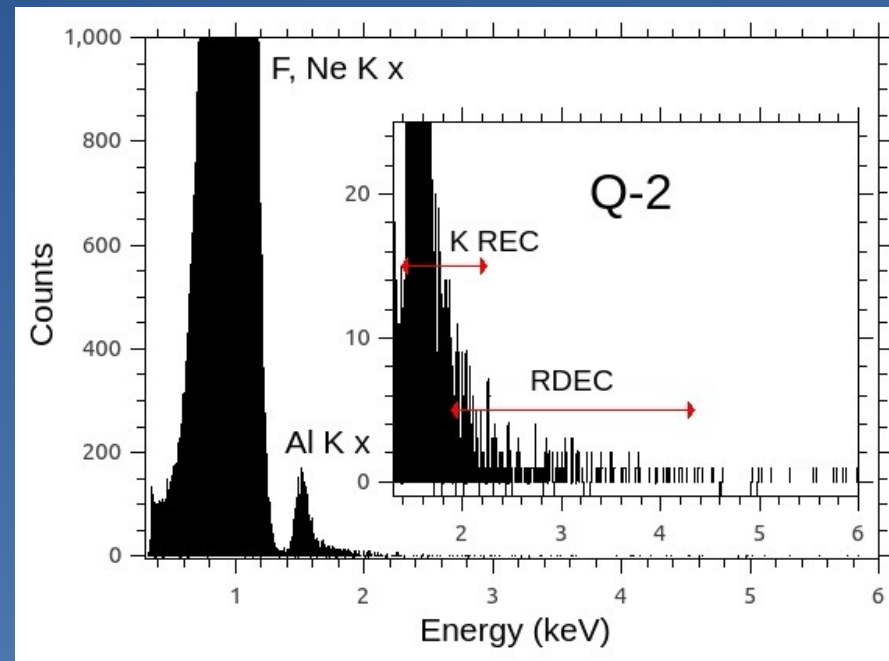




# 2.11 MeV/u $F^{9+}$ + Ne

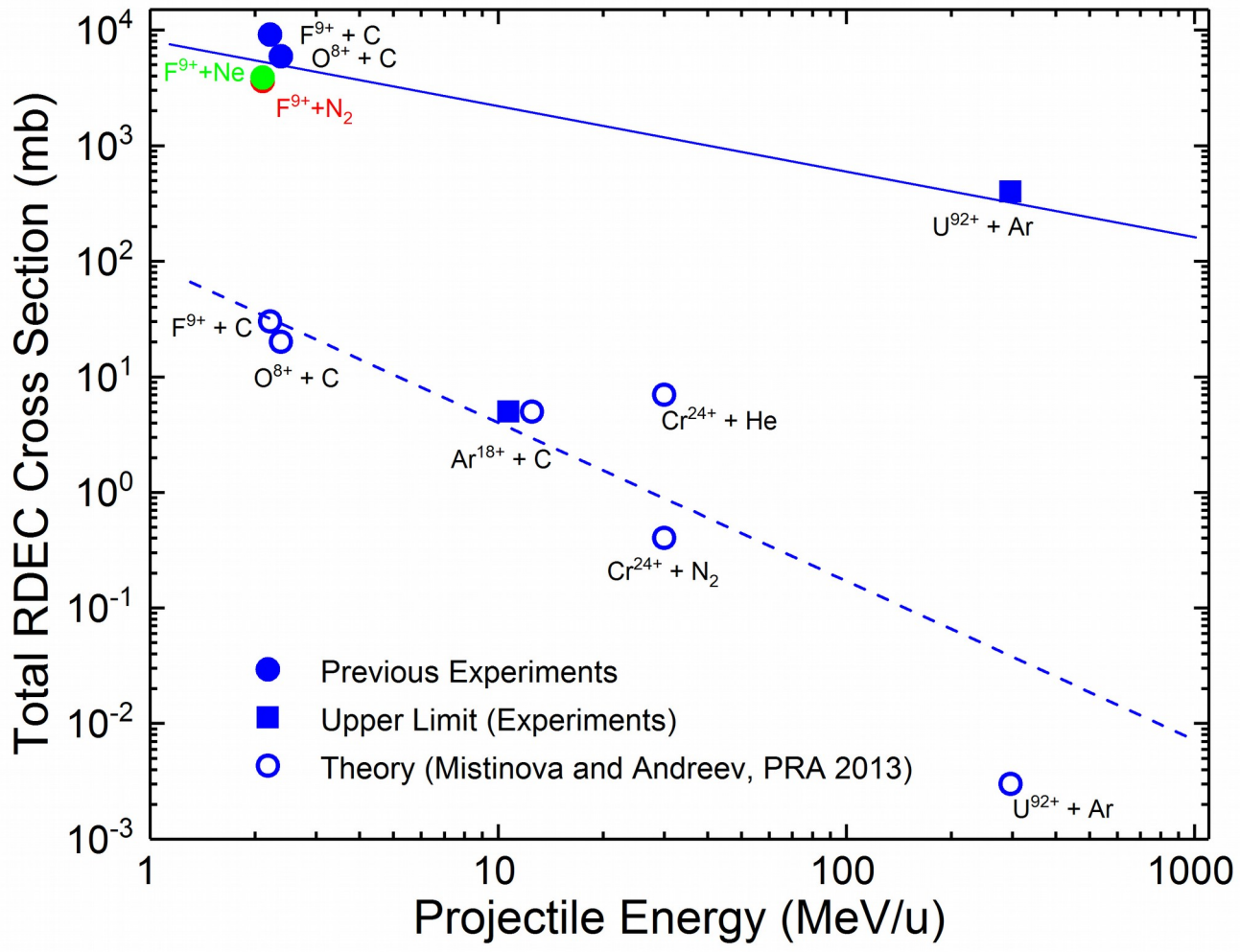
Target Pressure	15 $\mu$
# Incident Particles	$1.35 \times 10^{13}$
# RDEC Counts	$\sim 100$
$d\sigma_{RDEC}/d\Omega$ ( $90^\circ$ )	$\sim 460$ mb

Transition	Energy (keV)
KK $\rightarrow$ KL	1.73
KK $\rightarrow$ KK	2.47
LL $\rightarrow$ KL	3.61
LL $\rightarrow$ KK	4.35





# Comparison





# Future Work

- More counts needed for reliable cross sections
- Completed ~3 weeks of beam time for both  $N_2$ , Ne
- Approximately 2 months of continuous beam time needed for each target
- $F^{8+}$  RDEC cross sections ~4x smaller than  $F^{9+}$
- Plan to investigate RDEC for  $F^{9+}$  + He and C



Please see poster MO-131  
*Radiative Double Electron Capture (RDEC)*  
*in  $F^{9+} + N_2$  Collisions*  
by P. N. S. Kumara

Thank you for your attention!

