

A Negative Ion Source for the GANDALPH Photodetachment Detector

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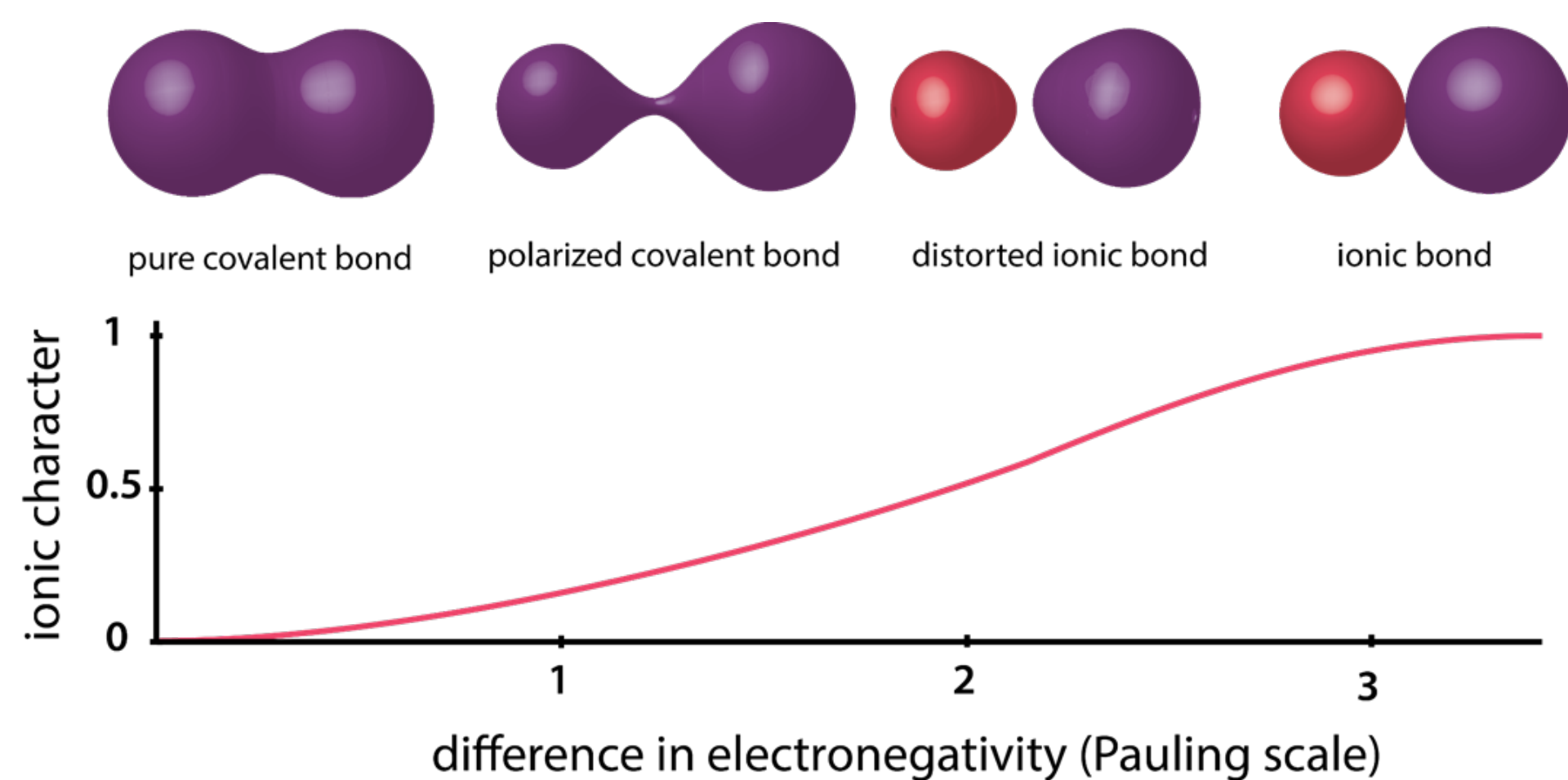


Negative Ions

- Experimental investigations of negative ions can be useful for accurate theoretical approaches beyond the independent particle model.
- Screening of Coulomb force results in polarization as dominating binding potential
- The binding energy of the additional electron is called electron affinity (EA)

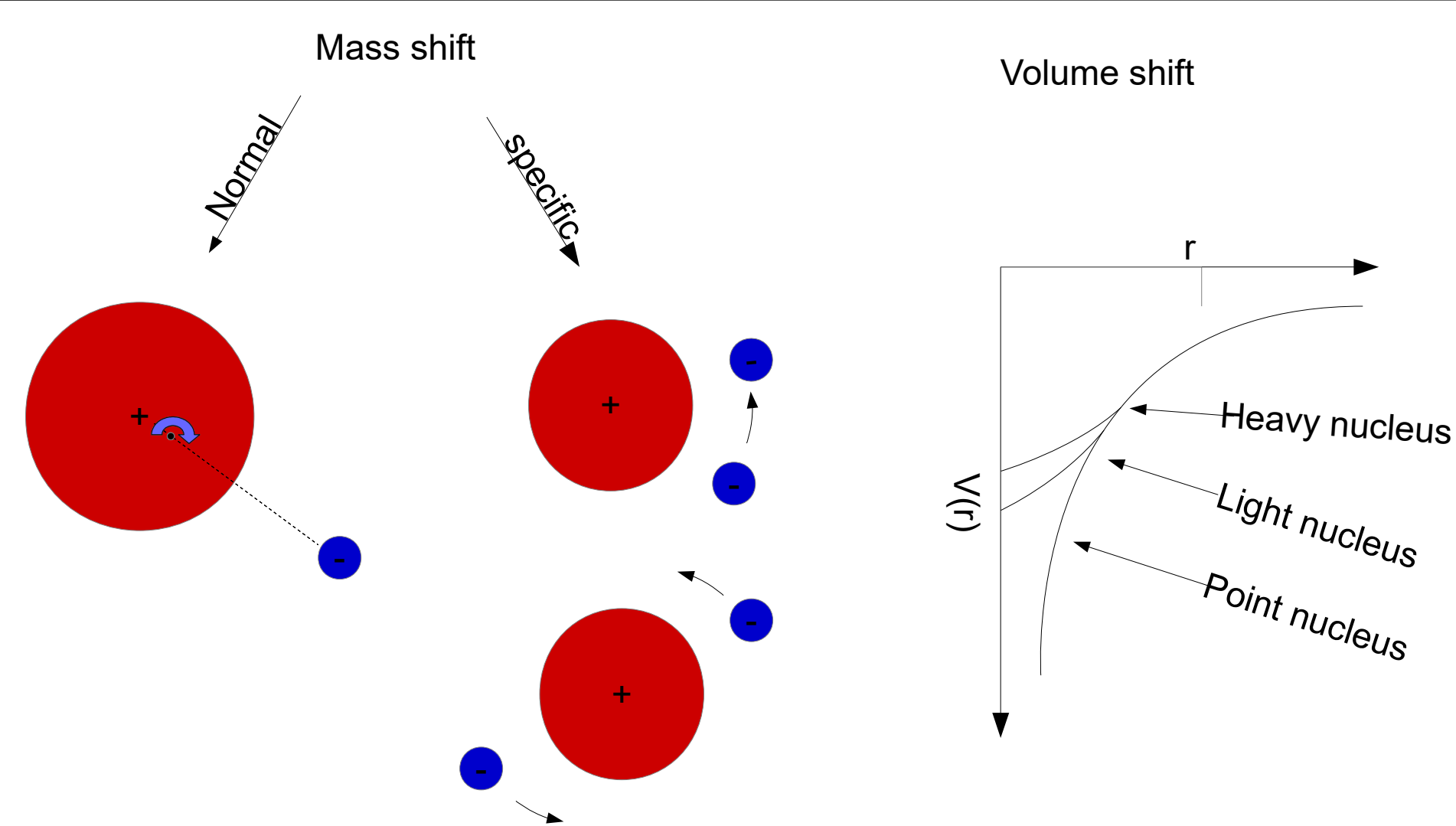
$$EA = E_{ground}(A^-) - E_{ground}(A)$$

Astatine EA



- Astatine is the rarest naturally occurring element on earth's crust.
- The ²¹¹At isotope is a promising candidate for targeted alpha therapy [1].
- Measurement of EA in combination with recently determined IP [2] is needed to obtain the electronegativity.

Isotope shift of chlorine



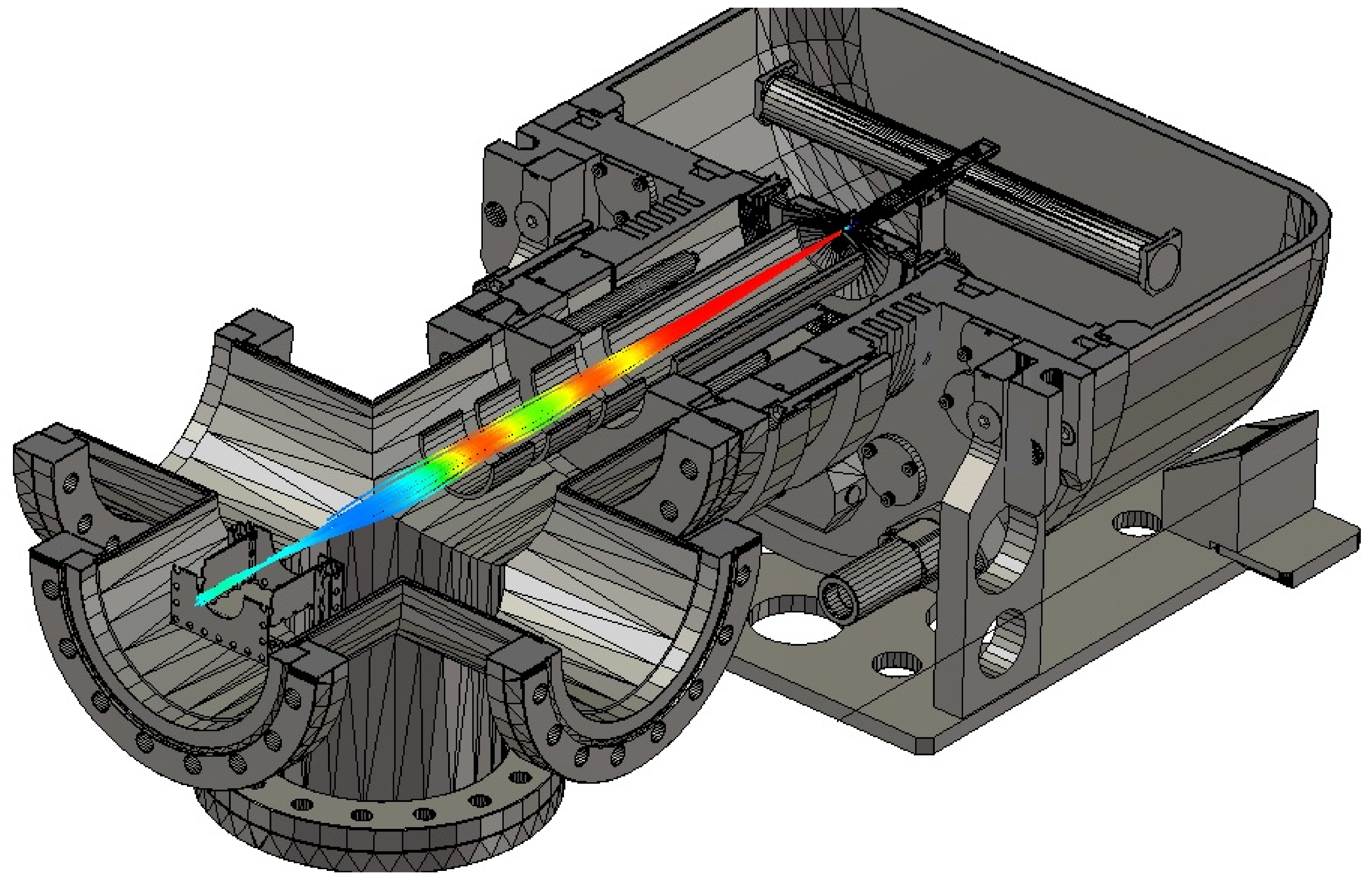
The isotope shift is composed of a volume shift and the normal and specific mass shift. The measurement of the isotope shift of chlorine gives valuable information for a suitable relativistic model [3].

- If the isotope masses are well known the normal mass shift can be accounted for.
- The specific mass shift depends on the electron correlation which makes negative ions ideal systems for investigation.

References

- [1] Vaidyanathan, G. & Zalutsky, M. Astatine Radiopharmaceuticals: Prospects and Problems. *CRP* **1**, 177–196 (2008).
- [2] Rothe, S. *et al.* Measurement of the first ionization potential of astatine by laser ionization spectroscopy. *Nature Communications* **4**, 1835 (2013).
- [3] Verdebout, S. *et al.* A partitioned correlation function interaction approach for describing electron correlation in atoms. *J.Phys.B*.

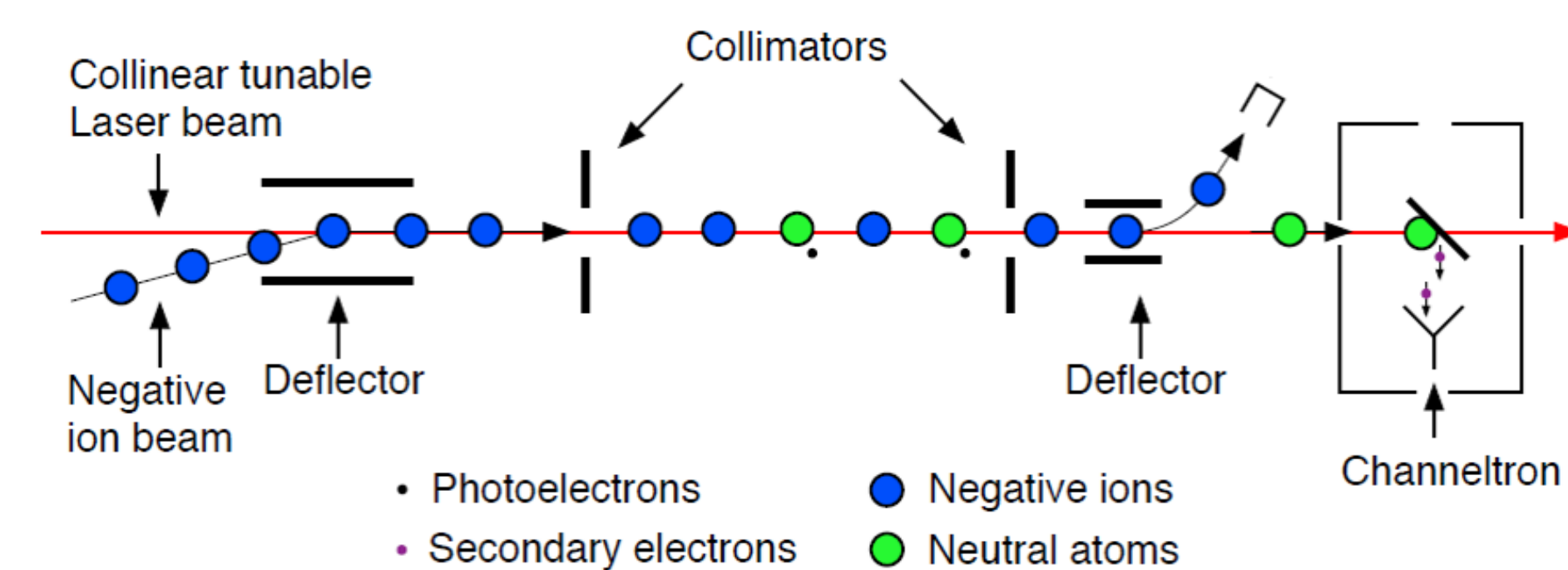
Off-line negative ion source



- The ion source is dedicated for off-line testing and setup of the GANDALPH beamline.
- Standard ISOLDE negative surface source creates synergies with existing infrastructure.

- Einzel lens and steering plates for beam tuning.
- Beam extraction via pulsed or constant high voltage.

Laser photodetachment

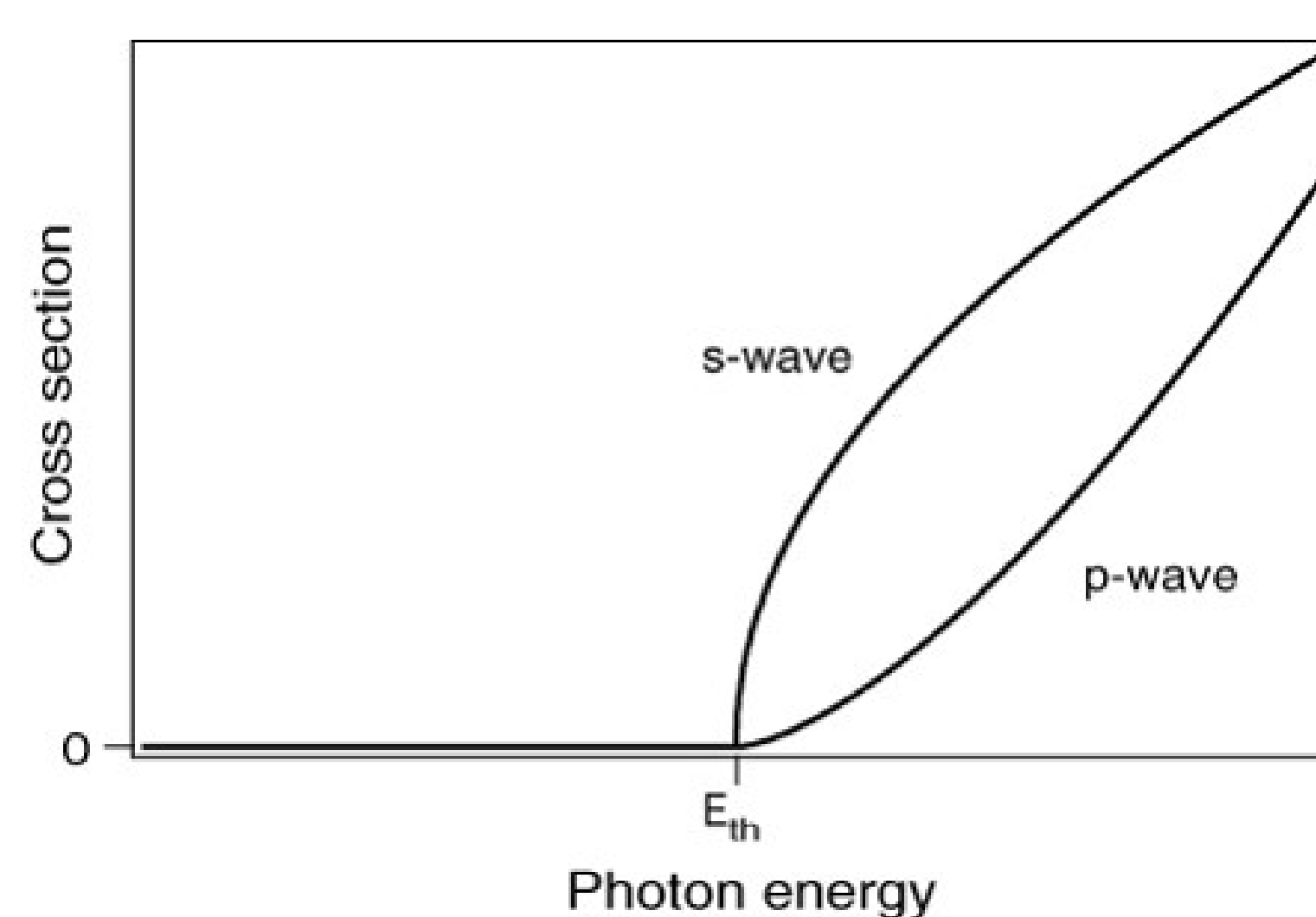


Laser photodetachment threshold spectroscopy is one of the most precise experimental methods to determine the electron affinity.

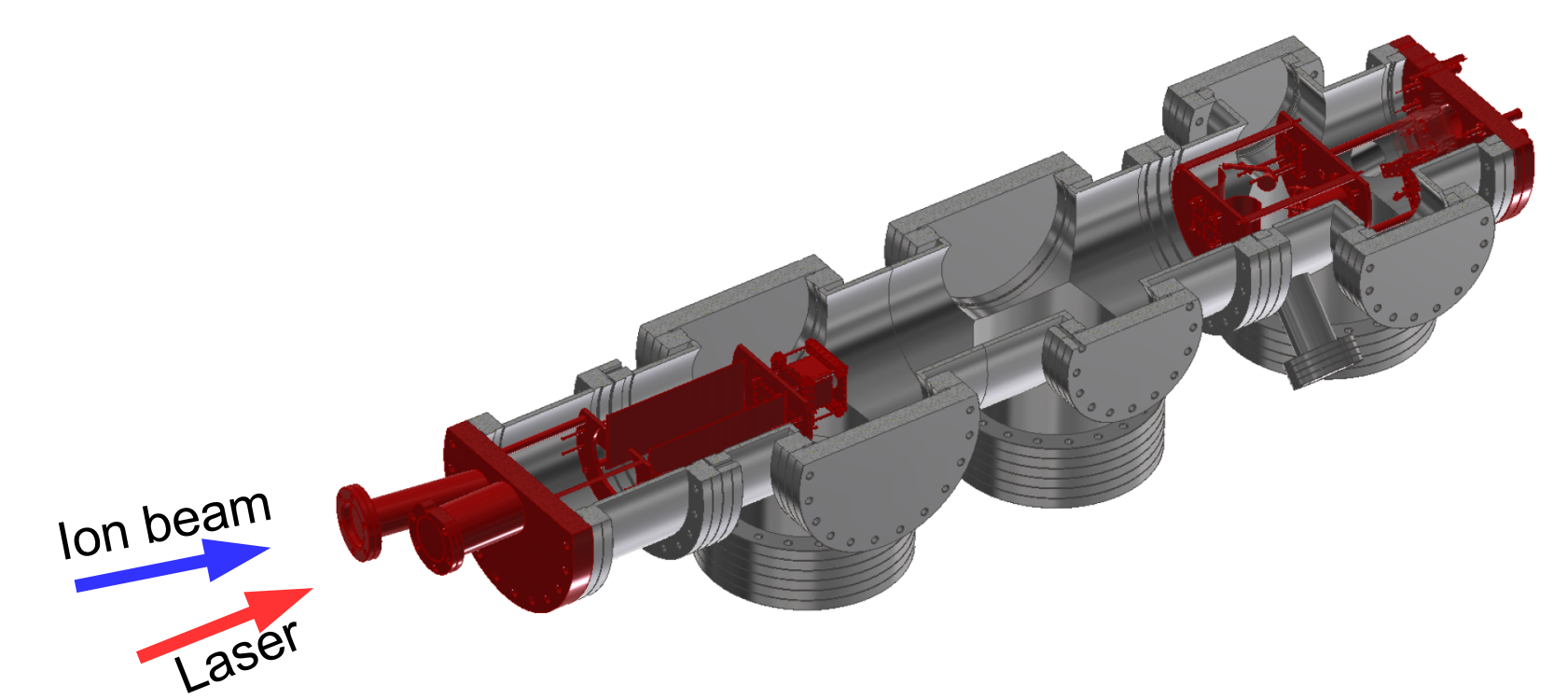
- The ion beam is merged with a tunable laser in the interaction region.
- Cross section of laser and ion beam in the threshold region can be described by the Wigner law:

$$\sigma(E) \propto E_e^{l+\frac{1}{2}}$$

- Neutralized atoms are detected in dependence of the laser energy.



The GANDALPH beamline



The Gothenburg ANion Detector for Affinity measurements by Laser PHotodetachment was built at ISOLDE to determine the electron affinity of radioisotopes by laser photodetachment.

- Neutralized atoms hit an ITO coated glass plate in metal box.
- Secondary electrons are detected via SEM.
- 2nd SEM was added for beam tuning of ion beam currents below 1pA.
- The addition of an alpha detector is planned.

