The LUNA II 400 kV Accelerator

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400 kV electrostatic accelerator (High Voltage Engineering Europe):
• High Voltage is generated by Inline Cockcroft-Walton power supply
• Radio Frequency oscillator excites the gas source (H₂, He)
• The plasma is positioned and confined by an axial magnetic field
• The ions are extracted by an electrode, which is part of the accelerator tube
• Everything imbedded in a tank with a gas mixture of N₂/CO₂ at 20 bar

An adjustable shortening rod permits a dynamical range from 50 to 400 kV, with a maximum current of 500 μA.

Calibration of the beam energy of the accelerator

Non resonant capture reaction with the low Q-value:

\[ ^{12}\text{C}(p,γ)^{13}\text{N} \quad Q = 1943.5\text{keV} \]

\[ E_γ = Q + \frac{M_p}{m_p + M_i} E_p - ΔE_{rec} + ΔE_{Doppler} \]

An accurate calibration of γ-spectra with radioactive sources (the Q-value of the reaction is in the range of γ emitted by sources). The proton energy is determined from the γ-ray energy measured (as the above relation shows)

\[ ^{12}\text{C} \] thick target

High resolution Germanium detector placed at 0° with respect to the beam axis.

Energy range covered: 130 keV ≤ E_p ≤ 400 keV

Characterization of the energy spread of the ion beam and the stability

Narrow resonant capture reaction:

\[ ^{25}\text{Mg}(p,γ)^{26}\text{Al} \quad E_b = 389.24\text{ keV} \quad Γ < 4\text{ eV} \]

Scheme of the experimental set-up

The experimental strategy consists in setting the beam energy at 1 keV above the resonance energy and varying it in steps of 10 eV with a positive voltage applied to the thick target of \(^{25}\text{Mg}\).

Thick target yield curve of \(^{25}\text{Mg}(p,γ)^{26}\text{Al}\)

We obtained an energy spread of:

\[ ΔE_b < 100\text{ eV} \]

The very low energy spread of the proton beam let us see the Lewis effect.

The long term stability of the accelerator is monitored with the yield variation observed at setting the proton beam energy exactly at the resonance value.

Over a period of 73 minutes we observed a shift of ± 2 eV.

The deviation of expected and observed proton energy (Δ) versus the nominal accelerator voltage (V=HV+PV).

The calibration has a statistical uncertainty of 0.06 keV, due to the uncertainty of the reaction Q-value.

We consider a total accuracy of 0.3 keV.