Production of ^{83}Rb for calibration sources for dark matter and neutrino mass experiments

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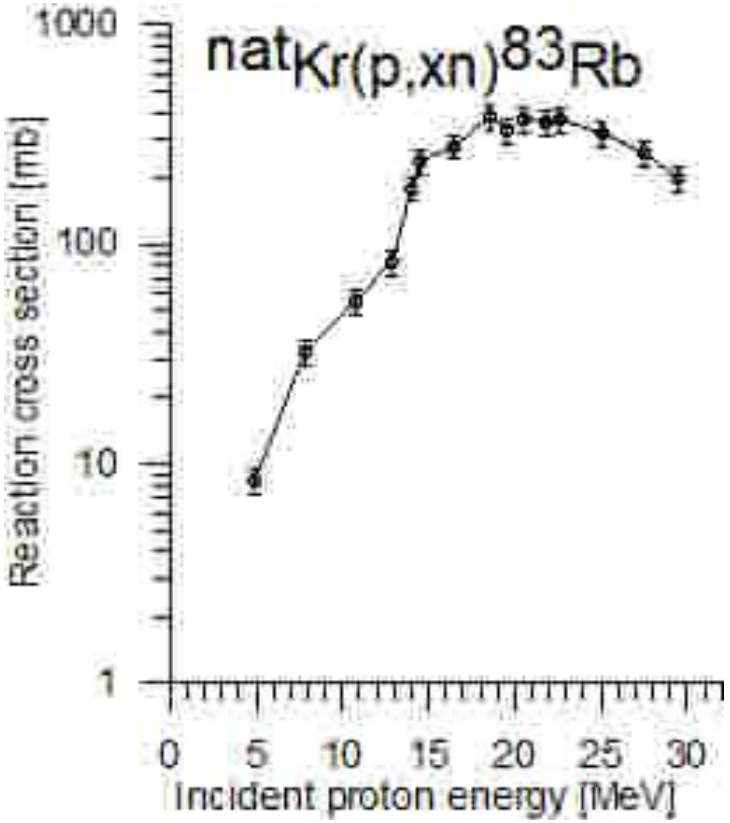
Motivation

- Decays:
  - ^{83}Rb ($T_{1/2}$ = 86.2 d) -> ^{83m}Kr
  - ^{83m}Kr ($T_{1/2}$ = 1.8 h) -> ^{83}Kr
- **Monoenergetic electrons** of internal conversion of **^{83m}Kr** have a well known low energy.
- They are suitable for **the test, calibration and systematic measurements** of detector systems.
- Examples of use:
  - At KATRIN:
    - To investigate the properties of **the windowless gaseous tritium source** and high-energy-resolution **electrostatic electron spectrometers**.
    - To calibrate the measurements of the **high voltage** and monitor its stability.
  - At XENON, for calibration of the energy scale of **the xenon liquid detector**.
  - At ALICE (CERN), for calibration of **the Transition Radiation Detector**.

^{83}Rb production

- Isotope ^{83}Rb is produced in the **reaction of protons on the natural krypton gas**.
- The main contributing reaction is **^{84}Kr(p,2n)^{83}Rb**.
- Smaller amounts of radioactive isotopes **^{84}Rb** ($T_{1/2}$ = 33 d) and **^{86}Rb** ($T_{1/2}$ = 19 d) are **also produced** in the reaction.
- They **do not disturb the ^{83m}Kr in its applications** because the intensity of their low energy electrons is weak.
- For the irradiation of natural krypton with protons at the NPI cyclotrons a **pressurised gas target is used**.



Production method development

- For the **cyclotron U-120M** (E_p=26.5 MeV, I_p=15 μA) and the new **cyclotron TR-24** (E_p=24 MeV, I_{pmax}=45 μA), gradually four types of the targets (from T1 to T4) from the aluminium alloy were developed and used.
- Up to now the most efficient **target T4** is irradiated with a proton current 45 μA, with initial krypton pressure of 10 bar. The **^{83}Rb production rate is 150 MBq/hour**.
- Further steps for production **optimization**:
  - **Target length** - to reduce ^{84}Rb and ^{86}Rb production.
  - Alloy with **less Fe and Ni** - to **decrease the contamination** with radioactive Co isotopes.
  - Try to **irradiate at 25 MeV** at TR-24 (needs a special cyclotron regime) - to reduce ^{84}Rb and ^{86}Rb production.
  - **Larger defocusing** of the proton beam at the target input windows **to reduce their local thermal load**.