MEASUREMENT OF MUON CAPTURE RATE BY ^3He NUCLEI

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In 1993 at PSI meson factory we have started the experiment [1] on precision measurement of muon capture by ^3He nuclei, by the efforts of collaboration of PNPI (Russia), PSI (Switzerland), LBL (USA), TUM (Germany), IMEP (Austria), UCL (Belgium). This team has recently successfully performed measurement of muon sticking probability in muon catalyzed dt fusion [2]. We plan to reach $< 1\%$ precision in evaluation of muon capture rate, this will enable comparison with the latest calculations [3] and determination of meson exchange currents contribution and the value of pseudoscalar constant G_p near 10% accuracy. The studies of muon capture by ^3He nucleus, $\mu^3He \to t + \nu_\mu$, look more promising compared to muon capture reactions on protons and deuterons, $\mu p \to n + \nu_\mu$ and $\mu d \to 2n + \nu_\mu$ because, first, charged reaction products — tritons — are more suitable for observation, and, second, due to absence of complicating mesomolecular phenomena with changing spin states [4]. Moreover, the influence of nuclear structure on the capture is under scrupulous control, due to progress in theory of few-nucleon systems and development of realistic $N - N$ potentials [5].

The experimental method is based on a high pressure ionization chamber (IC), developed at PNPI, which combines properties of sensitive target and of a detector of charged reaction products. The multi-anode version of the IC was used (Fig.1) that provided information on muon stop position and on energies, durations and shapes of signals, scanned by fast Flash-ADC's. The IC had a sensitive volume of 15 cm^3, it was filled at 110 atm pressure, and the rate of muon stops was up to 2000/s at proton currents of 200–400 μA. The rate of registered muon capture events was $3 \div 5/s$. Along with tritons, products of two other channels of muon capture have been registered, $d + n + \nu_\mu$ and $p + 2n + \nu_\mu$, in coincidence with 19 plastic scintillation counters surrounding the IC.

The special system for gas purification and filling the IC was constructed, it provided cleaning up to 10^{-6} impurities level, and compressed ^3He by turning it into liquid phase by pumping off gaseous ^4He. The admixture of ^4He in operating ^3He gas was less than 0.1%. During the experiment (5 weeks) more than 10^6 events of muon capture was acquired, more than all previous world statistics. Fig.2 shows the energy spectra of muon capture tritons and of events with protons and deuterons, registered by the IC. In the region of triton peak

and of events with protons and deuterons, registered by the IC. In the region of triton peak the background is low and energy resolution is good, $\Delta E/E_t \sim 5\%$. The data evaluation is in progress.

This experiment will be a good complement to the experiments on muon capture by polarized ^3He nuclei, soon planned to be performed at LAMPF (USA) and TRIUMF (Canada).

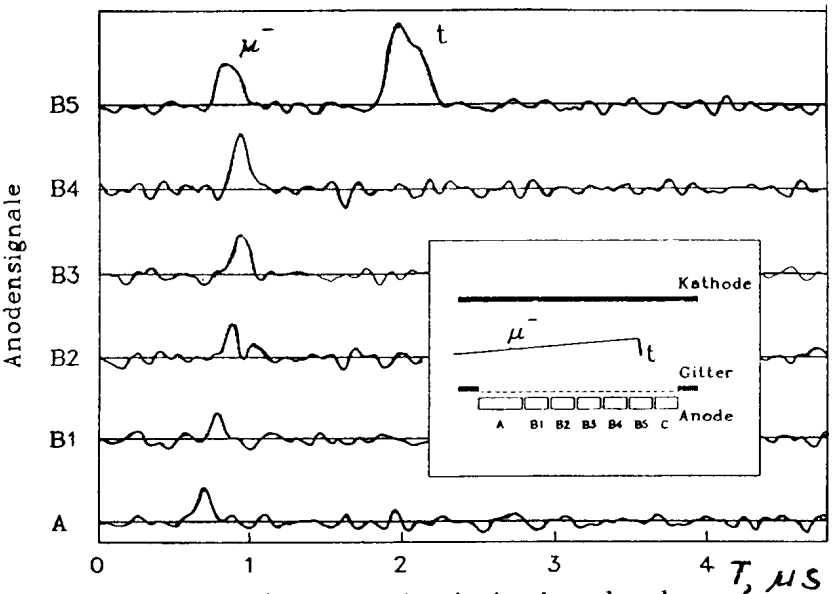

Fig.1. Flash-ADC signals, demonstrating ionization chamber response to incoming muon and to reaction $\mu^3He \to t + \nu_\mu$ that follows muon stop

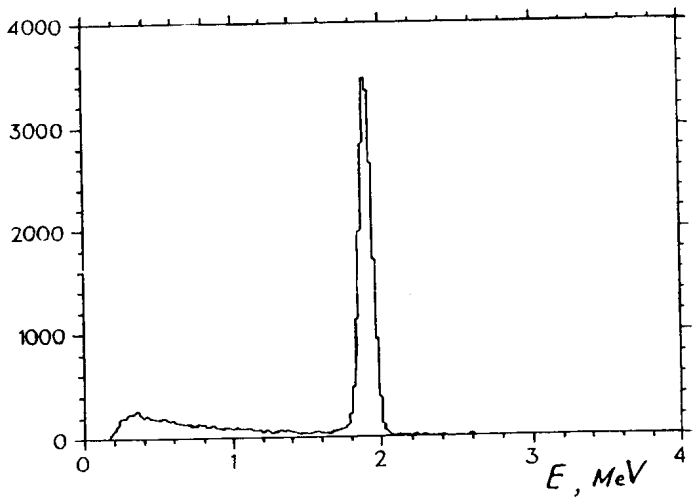

Fig.2. Energy spectrum of muon capture products, measured in ionization chamber, $\Delta E/E_t \sim 5\%$

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