# New limits for T-violation in neutron beta decay – Status of Trine

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The investigation of free neutron beta decay scrutinises the Standard Model and provides limits for new physics beyond standard theories. Whether or not time reversal invariance is hold in neutron decay can be linked to the triple product of electron and antineutrino momenta $\vec{p}_{\mathrm{e}}$ and $\vec{p}_{\bar{\nu}}$ with respect to the neutron spin direction $\vec{\sigma}_{\mathrm{n}}$, for example. A violation of this fundamental symmetry may show up in the differential decay propability $\mathrm{d}W$ as a non-vanishing coefficient $D$ describing the strength of this correlation [1]:

$$\mathrm{d}W \propto 1 + D\vec{\sigma}_{\mathrm{n}}\frac{\vec{p}_{\mathrm{e}} \times \vec{p}_{\bar{\nu}}}{E_{\mathrm{e}}E_{\bar{\nu}}} + \dots \tag{1}$$

The contribution to $D$ arising from the CKM-mechanism of T-violation is on the level of $10^{-9}$ but within the framework of new models (e.g. supersymmetry, leptoquarks etc.) values for $D$ up to the $10^{-3}$ range may emerge.
Our collaboration measured the coefficient $D$ with the detector Trine (TU München). The experiment was carried out in 2000 at the Institut Laue Langevin (ILL) in Grenoble. Trine uses multiwire proportional chambers (MWPC) in coincidence with plastic scintillators for electron detection and low noise high efficient PiN diodes for proton detection. The spatial information of the MWPC together with the segmention of the PiN arrays was exploited in the data analysis for systematic tests [2]. The excellent $\gamma$ suppression of the MWPC provided a signal-to-background ratio of 23. The preliminary result is $D = (-3.1 \pm 9.1) \times 10^{-4}$ [3].
At present we are preparing a new beam time starting in November 2002. With a more homogenous beam compared to the last measurement the main systematic limitation will be reduced. A larger beam dimension and the higher neutron flux from the new cold beam facility at ILL will increase the statisctics. Together with a new detector arrangement we expect to measure $D$ with an accuracy of $2 \times 10^{-4}$. The former measurement and the current status of Trine will be presented.

## References

[1] J.D. Jackson et al., Phys.Rev. **106** (1957) 517-521.
[2] Test der Zeitumkehrinvarianz am D-Koeffizienten des freien Neutronenzerfalls mit TRINE, T. Soldner, Dissertation, Technische Universität München, 2001.
[3] T. Soldner et al., Proceedings of the ISINN9 Conference, Dubna, May 2001.