



WITCH - First results with ³⁵Ar

Martin Breitenfeldt^a

T. Porobic^a, M. Tandecki^a, S. Van Gorp^a, P. Friedag^b, V. De Leebeeck^a, G. Soti^a, Ch. Weinheimer^b, A. Herlert^c, F. Glück^d, V. Yu. Kozlov^d, D. Zákoucký^e, M. Beck^f, G. Ban^g, C. Couratin^g, X. Fléchard^g, E. Liénard^g, N.

Severijns^a

^a IKS - Leuven, Belgium
^b IKP - Münster, Germany
^c FAIR - Darmstadt, Germany
^d KIT - Karlsruhe, Germany
^e NPI - Rež , Czech Republic
^f IFP - Mainz, Germany
^g LPC - Caen, France

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Outline



1 Motivation

2 Technical setup

3 Experimental results 2011

- June experiment
- Autumn experiments
- (Systematics)

4 Summary and Outlook

Physics motivation: β - ν angular correlation

 $\mathcal{H}_{\beta} = \mathcal{H}_{S} + \mathcal{H}_{V} + \mathcal{H}_{T} + \mathcal{H}_{A} + \mathcal{H}_{P}$ e.g: Fermi β decay $(0^{+} \rightarrow 0^{+})$



$$\mathsf{a}pprox 1-rac{|\mathcal{C}_{\mathcal{S}}|^2+|\mathcal{C}_{\mathcal{S}}'|^2}{|\mathcal{C}_{\mathcal{V}}|^2}$$



Current experimental limits: (from nuclear & neutron β decay) $\frac{C_s}{C_V} < 7\%, \frac{C_T}{C_A} < 9\%^1$

¹N. Severijns et al., Rev. Mod. Phys. 73 (991) 2006.

First results with ${}^{35}Ar > Motivation$

Picture of WITCH in ISOLDE





Technical upgrades

Experimental Setup:

- + State of the art control system^{a,1}
- + Magnetic shielding and offline ion source installed \rightarrow parallel operation to REX possible²
- + Charge exchange: Vacuum upgrade and stacking at WITCH^a
- Installed additional magnet and wire to remove unwanted Penning traps in spectrometer^{a,b}
- + Main detector upgraded to 8cm MCP with delay line anode b

Analysis tools

+ Simulation programs SIMBUCA^{c,3} and SIMWITCH^{b,d} prepared

^aPhD thesis M. Tandecki ^bPhD thesis P. Friedag ^cPhD thesis S. Van Gorp ^d diploma thesis J. Mader

- ¹M. Tandecki et al., NIMA 629 (2011) 396-405.
- ²E. Traykov et al., NIMA 648 (2011) 1-14.
- ³S. Van Gorp et al., NIMA 638 (2011) 192-200
- ⁴M. Beck et al., NIMA 503 (2003) 567
- ⁵M. Beck et al., EPJA 47 (2011) 45.







Measurements in June 2011



After on-line repair of our system, switch to HRS and change of target unit:



 $\beta - \nu$ angular coefficient a = 1.12(33) $(a_{SM} = 0.9004(16)^1)$

from PhD thesis S. van Gorp, to be published

¹ N. Severijns et al., Phys. Rev. C 78 (055501) 2008.

Measurements autumn 2011

After October run: New try with new target in a freed slot

ON OFF measurement





0 V and 600V on spectrometer to normalize

Measurements in November 2011

ON-OFF measurement for different voltages applied to the spectrometer



Simulations are ongoing.

Statistics in all measurements in autumn allow a determination of $\beta - \nu$ angular correlation coefficient *a* of about 2-3%.



Measurements in November 2011

Status of WITCH after the November data:

- $\checkmark~$ Several 10 000 Ar ions in the trap.
- ✓ Misalignment between electric and magnetic field.
- (✓) The detector/DAQ system need to be finalized.
 - There is still "background ionization".



Raw data for 5 V during measurement time.



Energy straggling



Energy spread of about $0.5 \, \text{eV}$ in the traps



adding velocities, but measuring energies ∜ energy broadening: $E_{max} =$ $E_{recoil} + E_{axial} + 2\sqrt{E_{recoil}E_{axial}}$ ╢ At the endpoint 450 eV for 0.5 eV axial energy straggling: \approx 30 eV energy broadening.

Characterization of the system in combination with simulations is required to study the systematic uncertainties/limits of WITCH.

First results with ${}^{35}\text{Ar}$ > Experimental results 2011 > (Systematics)

Energy distribution as function of ions



An Example:



Note the absolute ion number has not been calibrated.

From PhD thesis S. Van Gorp.

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Summary and Outlook



Status of WITCH

- WITCH is operational
- First online data with ³⁵Ar are analyzed
- Two more sets of data available (under analysis)

Plan for until the long shutdown

- Simulations
- Correction and improvement of the system
- Online experiment end of the year

The aim is to take data for a preliminary result for a before the long shutdown.



Thanks to the technical group of ISOLDE for their tremendous effort to improve the ion of interest to contamination ratio as well as the construction of a new target in just one week time and to the I88 collaboration for stepping back for the November run.

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