

Recent developments and results of WITCH

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5th of December, ISOLDE user workshop 2011



Outline

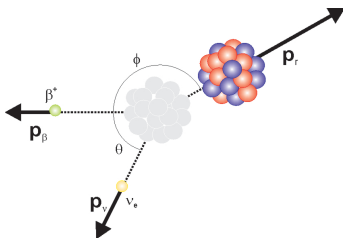
- 1 WITCH setup
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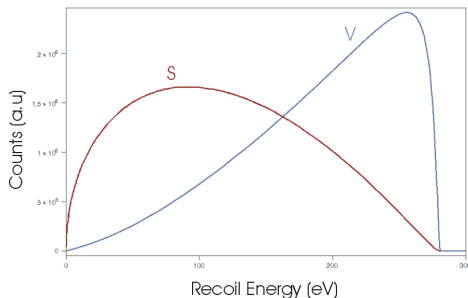
Physics motivation: β - ν angular correlation

$\mathcal{H}_\beta = \mathcal{H}_S + \mathcal{H}_V + \mathcal{H}_T + \mathcal{H}_A + \mathcal{H}_P$ e.g: Fermi β decay ($0^+ \rightarrow 0^+$)

$$W(\theta) \approx 1 + a \frac{v}{c} \cos\theta$$



$$a \approx 1 - \frac{|C_S|^2 + |C'_S|^2}{|C_V|^2}$$

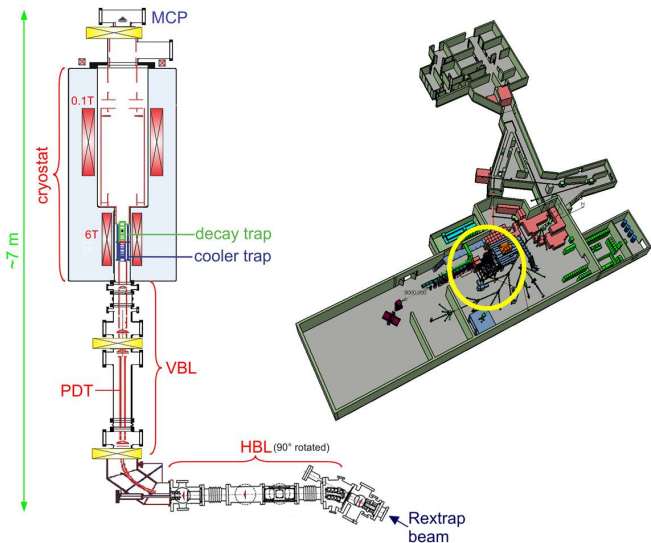


Current experimental limits:
(from nuclear & neutron β decay)

$$\frac{C_S}{C_V} < 7\%, \quad \frac{C_T}{C_A} < 9\%$$

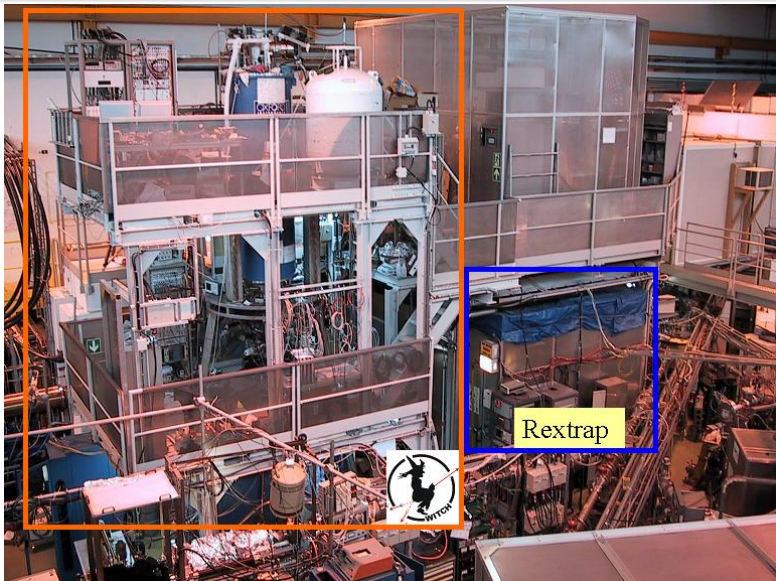


WITCH: Weak Interaction Trap for Charged Particles



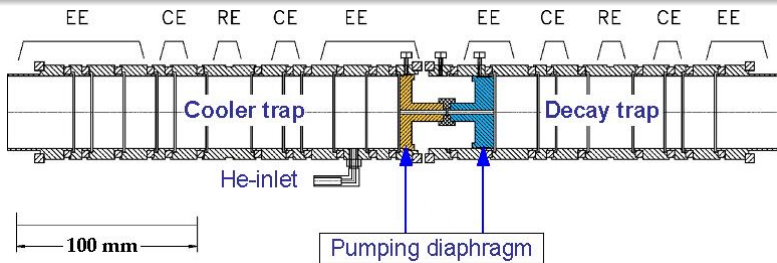


Picture of WITCH in ISOLDE





Ion Cloud Manipulation



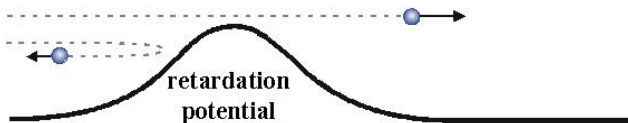
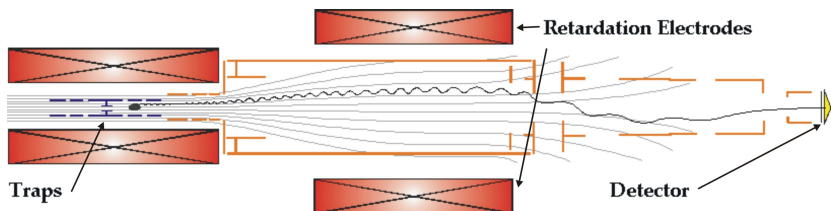
Segmented central electrode (RE)

In cooler trap

- Dipole Excitation (ω_-):
Mass independent removal from trap center
- Quadrupole Excitation (ω_c):
Mass dependent centering
+ buffer gas = cooling of ion cloud



Retardation Spectrometer



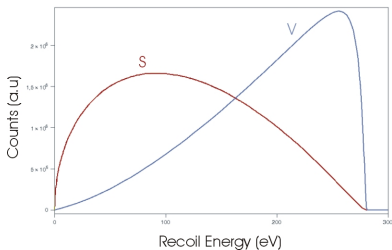
Energy conversion

$$\frac{p_{\perp}^2}{B} = \text{constant} \Rightarrow \frac{E_{\perp, \text{high field}}^{\text{kin}}}{E_{\perp, \text{low field}}^{\text{kin}}} = \frac{B_{\text{high}}}{B_{\text{low}}} = \frac{9\text{T}}{0.1\text{T}} = 98.8\%$$

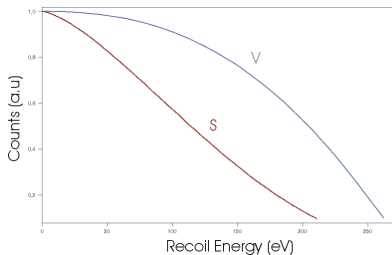


Retardation spectrometer

differential spectrum



integral spectrum



Due to the measurement method integral spectra are measured at WITCH instead of differential spectra.



Where did we stop last year?

Our status end of 2010:

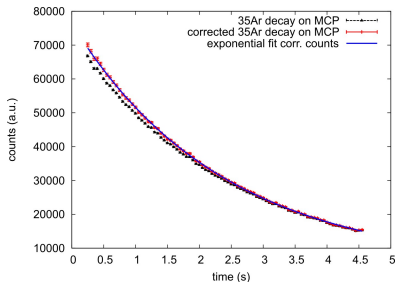
- + installed additional magnet and wire to remove unwanted Penning traps in spectrometer
- + magnetic shielding and offline ion source installed → parallel operation to REX possible
- + simulation programs SIMBUCA and SIMWITCH prepared
- + main detector upgraded to 8cm MCP with delay line anode

- accident while baking → trap electrodes and beam monitoring detectors damaged



Measurements in June 2011

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



First test:

Implantation of ^{35}Ar ions into the detector

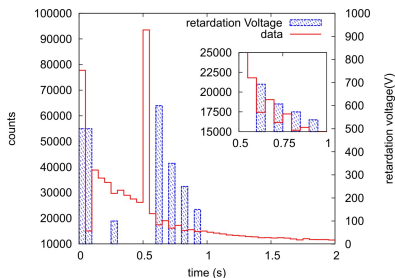
Corrected for dead time of channels and overlapping signals

Extracted value $T_{1/2} = 1.697(12)$ s (Literature $1.775(4)$ s) \rightarrow diffusion processes are important



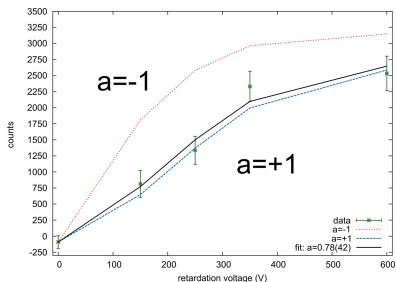
Measurements in June 2011

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



⇒
Analysis

⇒



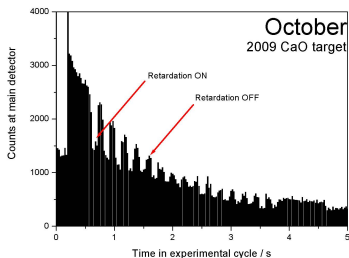
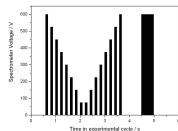
$\beta - \nu$ angular coefficient $a = 0.78(42)$ ($a_{SM} = 0.9$)

from PhD thesis S. van Gorp

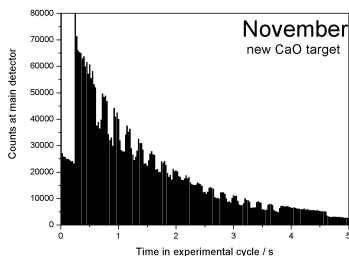


Measurements autumn 2011

Increase of the ^{35}Ar yield delivered from ISOLDE (see J.P. Ramos, Wed. 11:25) and injection efficiency into WITCH magnetic field



⇒
10
days
⇒

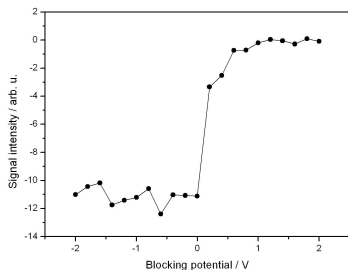


Count rate increase by a factor of 30!!



Measurements autumn 2011

Energy spread of about 0.5 eV
in the traps



\Rightarrow
 \approx
0.5 eV
strag-
gling

adding velocities, but
measuring energies

\Downarrow

energy broadening:

$E_{max} =$

$$E_{recoil} + E_{axial} + 2\sqrt{E_{recoil}E_{axial}}$$

\Downarrow

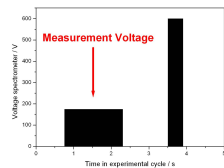
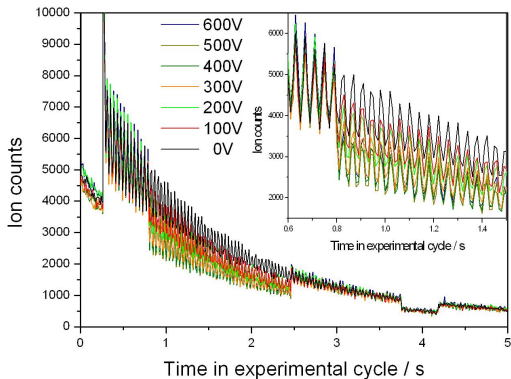
At the endpoint 450 eV for
0.5 eV axial energy strag-
gling:
 ≈ 30 eV energy broadening.

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



Measurements autumn 2011

ON OFF measurement

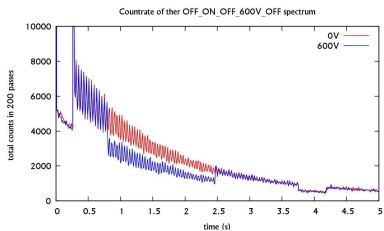


0V and 600V on spectrometer to normalize

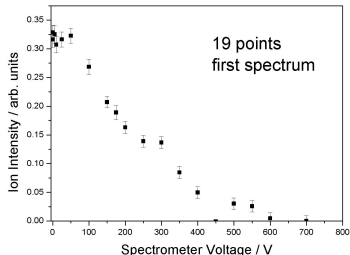


Measurements autumn 2011

ON-OFF measurement for different voltages applied to the spectrometer



19
points
first
analysis



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



Summary & Outlook

Summary 2011

- + discharge and charge exchange problems solved
- + entire system is working together
- + obtained and analyzed the first ^{35}Ar recoil energy spectrum in June
- + acquired statistics for statistical uncertainty of 2-3% in Oct./Nov.

Outlook for 2012

- data analysis → learn from the data
- improvement of the system (eg. correct misalignment)
- studying systematic effects
- gathering more statistics (with better quality) in online runs

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



Acknowledgements

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