Determination of the experimental upper limit of the rare βp-branch of ^{8}B

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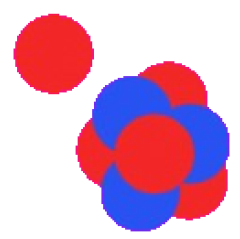
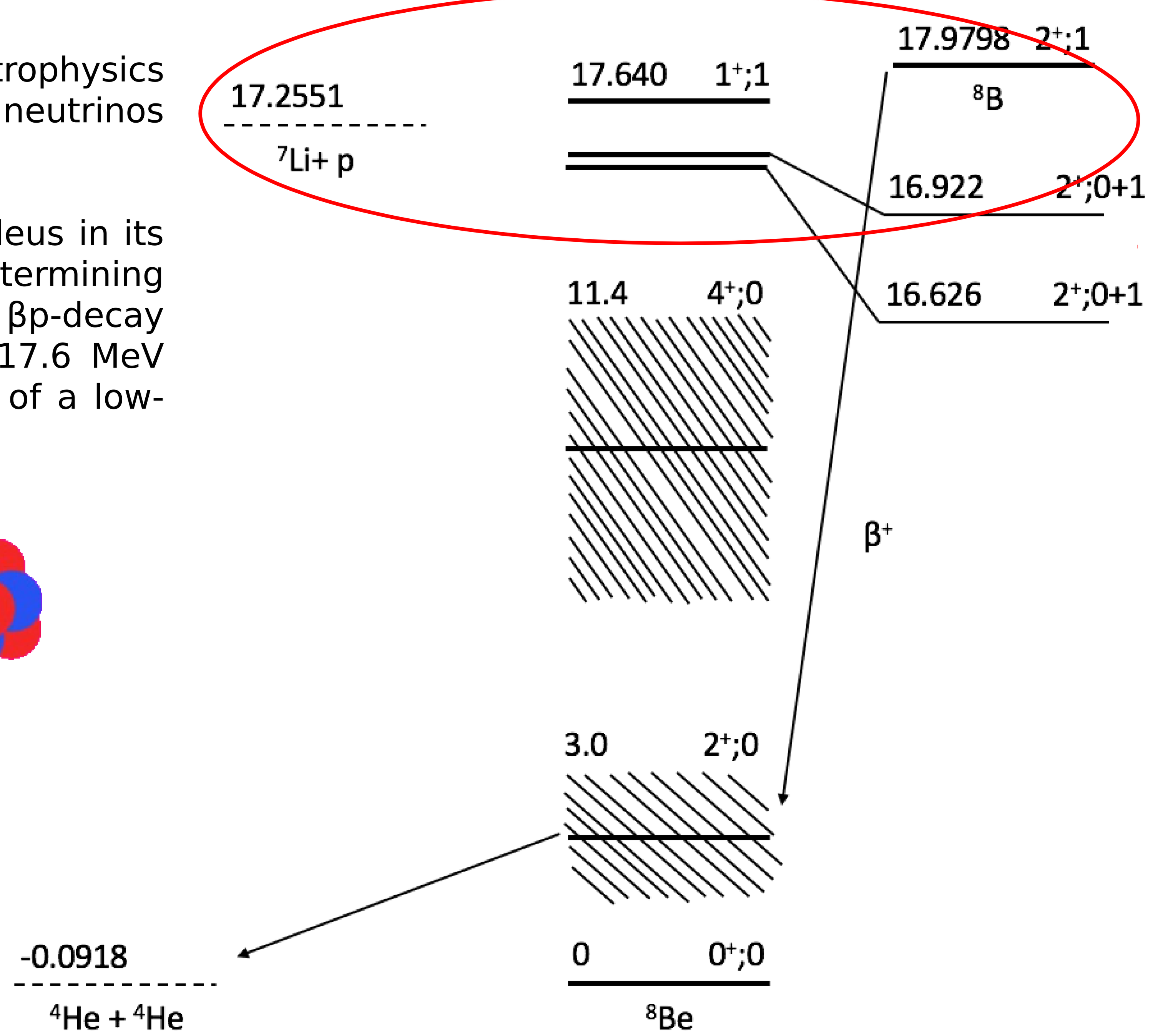
Introduction

The decay of ^{8}B is of high relevance in astrophysics since it is the mainly source of solar neutrinos above 2 MeV.

^{8}B is the only confirmed proton halo nucleus in its ground state [1]. We are interested in determining the rare and previously non-observed βp-decay branching ratio. This EC-decay via the 17.6 MeV state of ^{8}Be is followed by the emission of a low-energy proton of 337 keV [2].





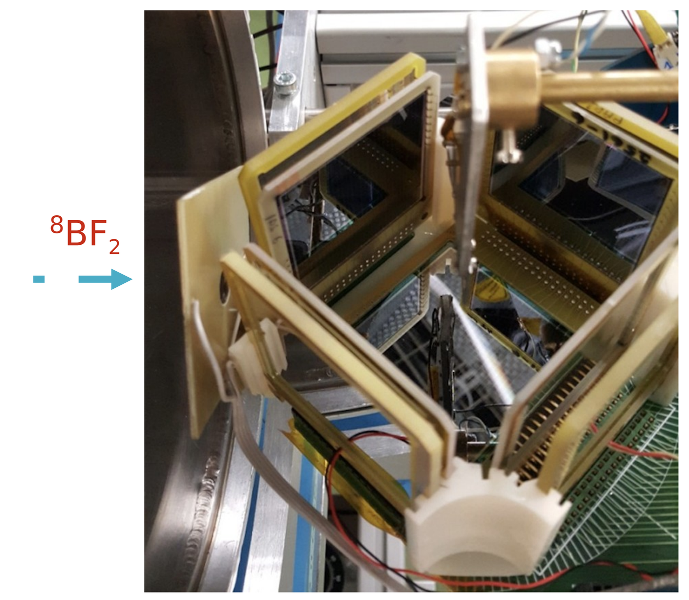
Assuming ^{8}B as a proton-halo configuration (^{7}Be core + proton), the EC would occur on the ^{7}Be-core and an upper limit of the branching ratio has been set theoretically to $2.3 \cdot 10^{-8}$ [3].

The Experiment

We used a set of 4 particle-telescopes each formed by 1 Double Sided Silicon strip Detector (DSSD) plus 1 thicker Si-PAD detector. Further, a thicker DSSD placed bellow the implantation foil to maximize the β detection.

At the center of this setup is the carbon foil catcher of 31μg/cm² where the ^{8}B beam is implanted.

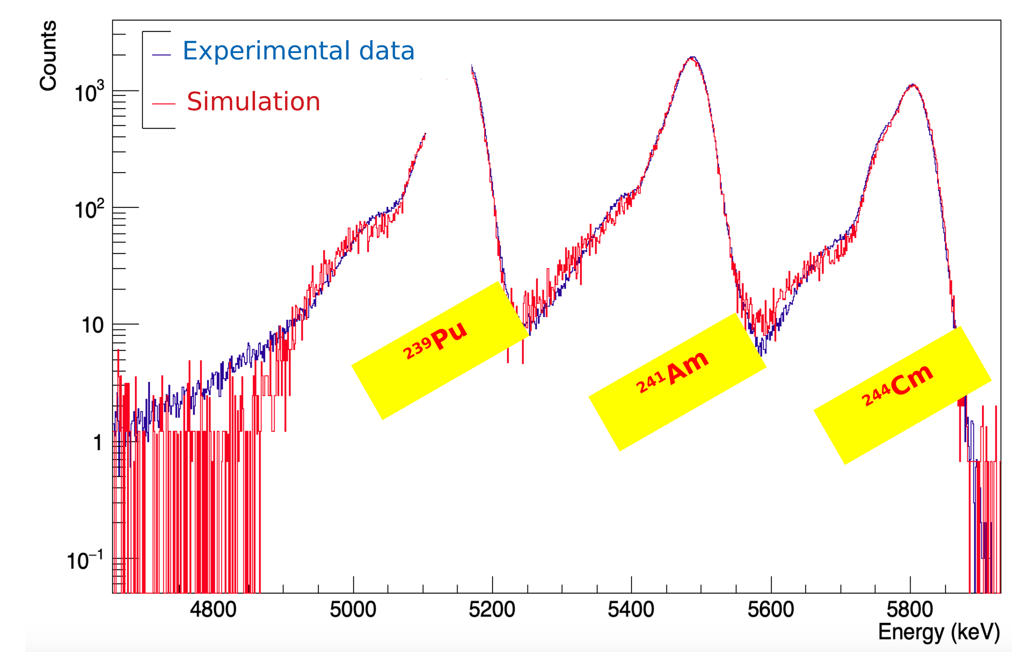
The thicknesses of the detectors were chosen thick enough (60μm) to stop all the α-particles of the ^{8}Be fragmentation and thin (40μm) to minimize the β-response at low energies.



Geant4 Simulations

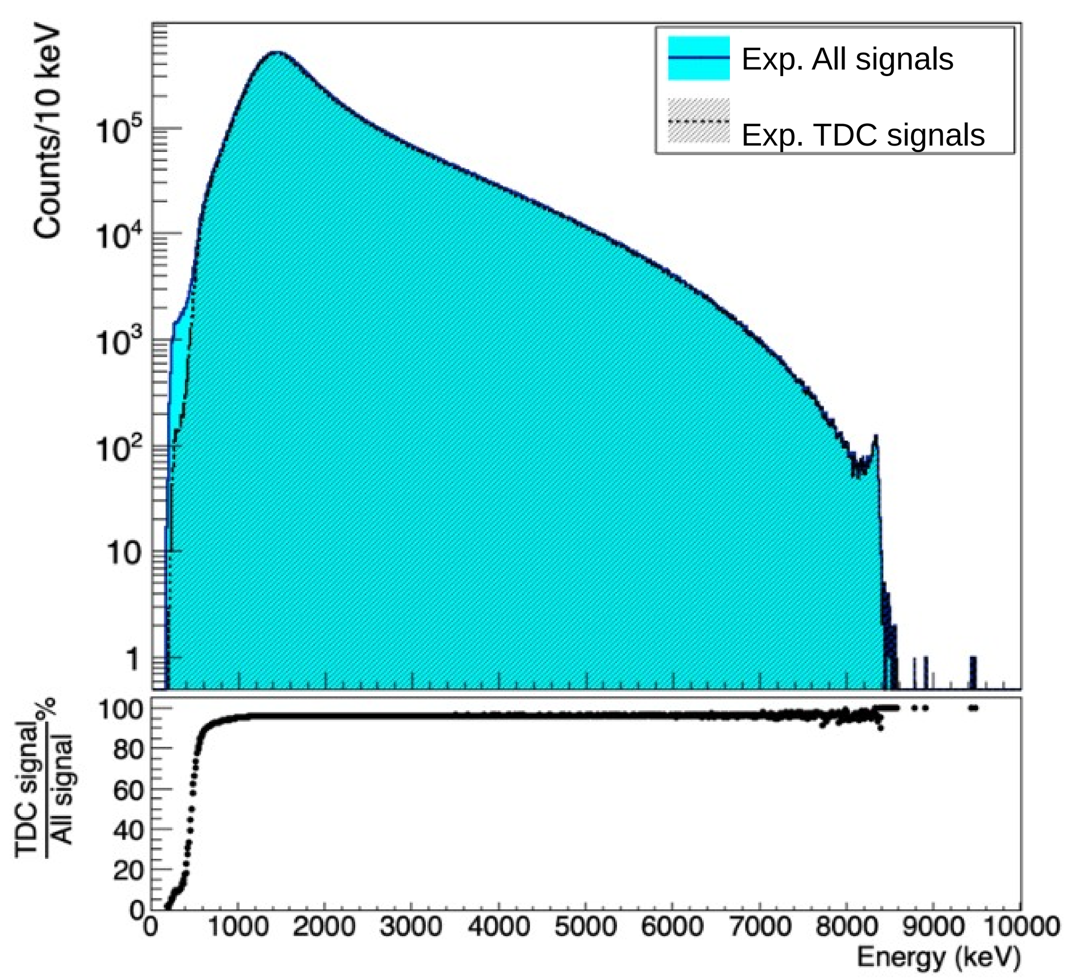
The geometrical set-up was defined and fine tuned using a Geant4 simulation, fitting fully the experimental response to the mono-energetic α-source ^{148}Gd and determining the response funtion of the full set-up.

The obtained response function fully reproduces the experimental spectrum of the standard triple α-source, as shown on the figure.

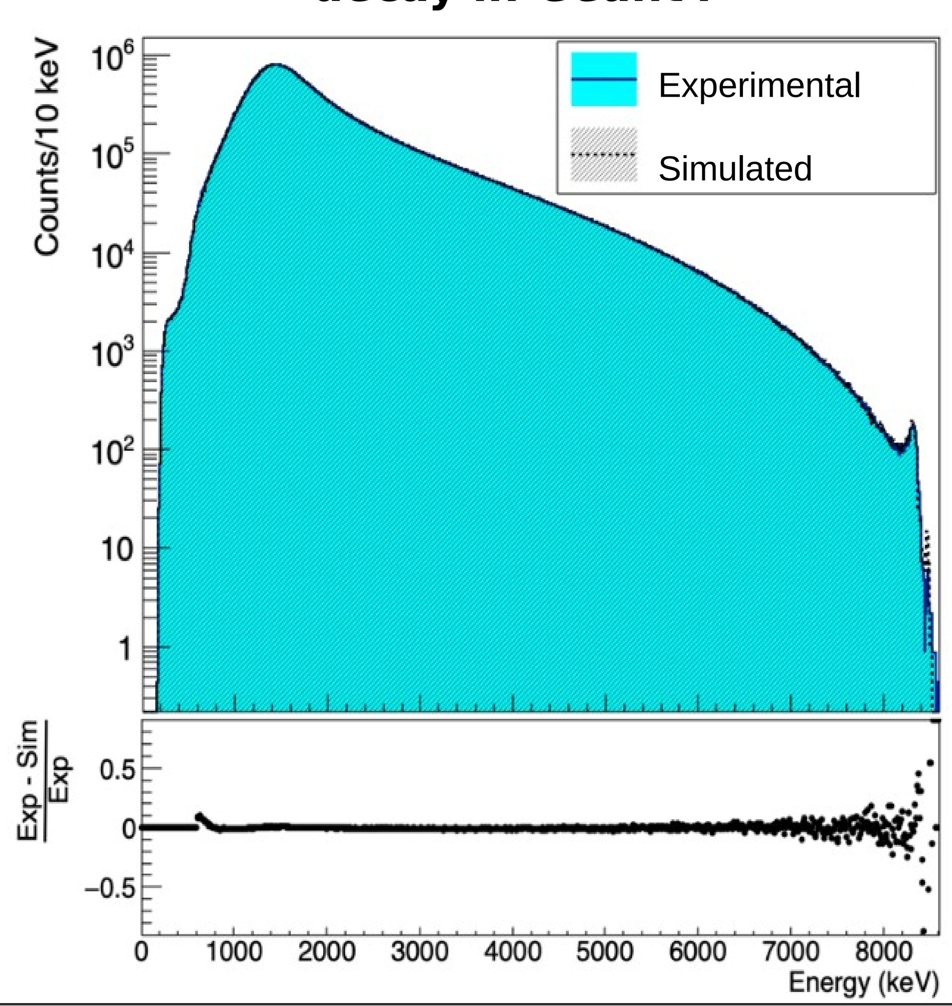


Methodology

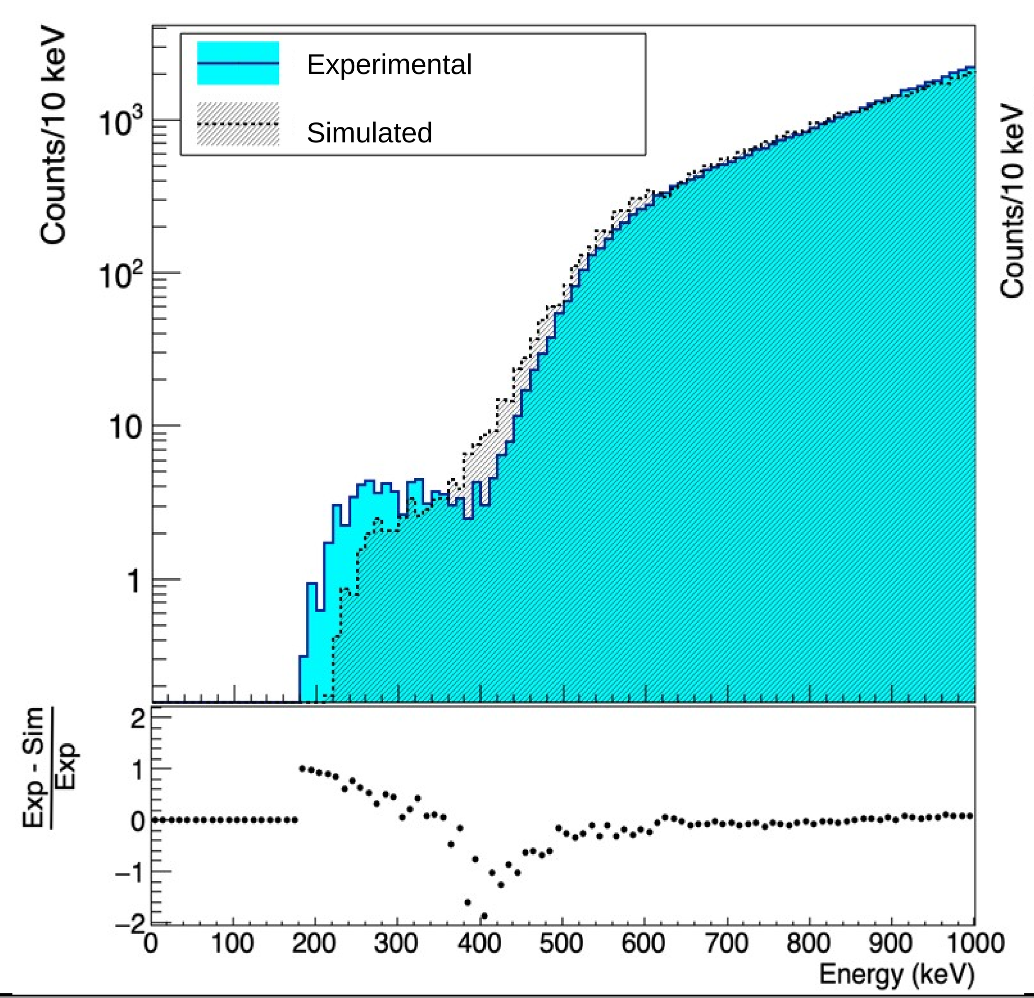
Correction of trigger and thresholds efficiency



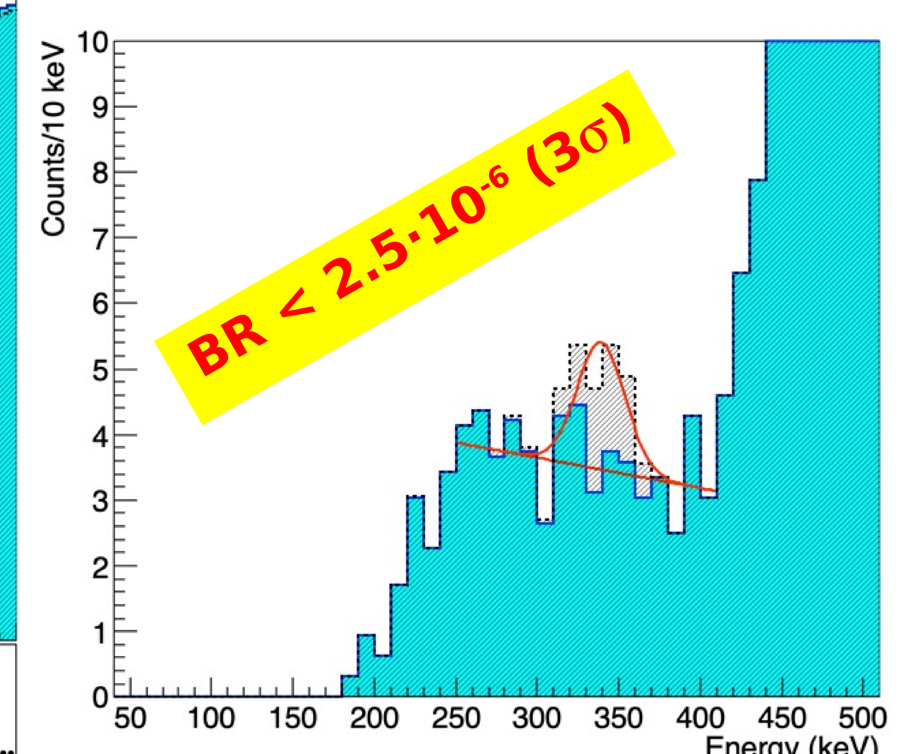
Simulation of the ^{8}B resonance decay in *Geant4*



Validation with the anticoindence (mul=1) spectra



Proton peak simulation over the experimental data



Results and Conclusions

- We have **characterise the DSSDs** used in the experiment reproducing the α-source
- We have **implemented the ^{8}B resonance** decay in *Geant4* (not defined in the libraries).
- We have **determined the experimental upper limit** of the rare βp-branch at $2.5 \cdot 10^{-6}$ at a 99.9% confidence level (3σ)

References

[1] J.A. Wheeler et al., Phys. Rev. **59**(1):27 (1941)
[2] T. Nilsson et al., Hyp. Inter **129** (2000) 67-81
[3] M.J.G. Borge et al., Jour. Phys. G: Nucl. and Part. Phys. **40** (2013) 035109

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