Latest results with the Warsaw Optical Time Projection Chamber

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Workshop on ACTive TARgets and Time Projection Chambers for High-intensity and Heavy-ion beams in Nuclear Physics, Santiago de Compostela, January 2018

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Rare decay modes at the proton drip-line $_{2p}$ radioactivity & β -delayed multiparticle emission





Two proton emission:

- rare events
- convincing evidence from a single event
- providing angular correlations
- providing energy distribution and decay mechanism

β -delayed particle emission

- ▶ background from β electrons
- detect particles at low energy (needed by astrophysics)
- ▶ β 3p β d, β t, β α ...
- convincing evidence from a single event

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Time Projection Chamber with optical readout



▶ atmospheric pressure

- different gas mixtures
- GEM foils provide charge amplification

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Data acquisition system



- standart TOF-dE identification
- ▶ trigger starts data recording by CCD camera and PMT
- ► 100µs after the trigger the sensivity of the detector is switched to high level

3D track and energy reconstruction



$^{27}\mathrm{S}$ and $^{26}\mathrm{P}$ @ ACCULINNA



Low energy protons seen for the first time!



⁶He @ REX - ISOLDE

 $^6\mathrm{He} \rightarrow \mathrm{d} + \alpha$ with very small BR $\sim 10^{-4}$

 \rightarrow bunched mode



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data recording

$^6\mathrm{He}$ @ REX - ISOLDE







M. Pfützner et al., Phys. Rev. C 92, 014316 (2015)



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$^{11}\mathrm{Be}$ @ HIE - ISOLDE



[1] - D. Millener et al., Phys. Rev. C26 (1982) 1167-1185
[2] - K. Riisager et al., Phys. Lett. B 732, 305 (2014).

- ▶ 1n halo nucleus
- $T_{1/2} = 13.76(7) s$
- decay modes:
 - β^- , BR = 100%
 - $\beta^{-}\alpha$, BR = 3.1(4)% [1]
 - $\beta^- p$, BR:
 - $^*\,$ theoretical predictions $\sim 10^{-8}\,$
 - * experimental indirect measurement $\sim 10^{-6}$ [2]
 - * NO DIRECT observation so far

$^{11}\mathrm{Be}$ @ HIE - ISOLDE

- ▶ BR ~ 10^{-6}
- Q-value $\sim 280 \mathrm{keV}$
- \rightarrow bunched & movie mode



Ongoing developments

▶ tests of different gas mixtures:

- amount of light for different wavelengths
- ions neutralization
- optimal working point
- ▶ using of two PMT to improve signal/noise ratio
- comparison of light and charge readout

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Beta decay of 22.23 Si studied at MARS with the Optical Time Projection Chamber

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PHYSICAL REVIEW C 92, 014316 (2015)

β decay of ⁶He into the $\alpha + d$ continuum

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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Proposal to the ISOLDE and Neutron Time-of-Flight Committee

Beta decay of ¹¹Be

October 4, 2016

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PHYSICAL REVIEW C 95, 034315 (2017)

β-delayed proton emission from ²⁶P and ²⁷S

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