Description

Name of spokesperson (Collaboration/Lab): A. Algora[1] (IFIC) et al. for the (NA)[2]STARS Collaboration

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Title: Total absorption gamma spectroscopy study of the beta decay of 100Sn

Abstract:

The study of the beta decay of 100Sn can be considered a flagship experiment of fragmentation facilities of new generation. The reasons are clear. The production of this isotope is very challenging, requiring very high primary beam intensities and the related physics is very interesting. On one hand, 100Sn is the last accessible N=Z double magic nucleus that is stable from the perspective of particle emission. On the other hand, its decay is considered of great relevance from the perspective of nuclear structure [Fae13]. Due to the double magic character, shell model calculations are possible, and predict that most of the BGT is concentrated in one 1+ level in 100In, and a very limited population to additional states in 100In is expected. This has important consequences, because this decay is also expected to be the one of the smallest Log ft of all the beta transitions in the nuclide chart, and if the BGT is properly determined experimentally, it can provide means to study the quenching of the gA constant in the nuclear medium (quenching of the Gamow Teller strength, see for example [Gys19] and references therein).

Previous beta decay studies of 100Sn have suffered from limited statistics. The first spectroscopic study employing the RISING Ge array was performed at GSI [Hin12] and the decay level scheme was deduced by placing the identified gamma rays in a pattern similar to a level scheme deduced from theory. The study was revisited at RIKEN (see [Lub19], and even though limited coincidence relations were found, it was not possible to unambiguously place the 1+ state in their work. In the study they keep the same level scheme proposed by Hinke et al. [Hin12]. The problem arises because there are three possible level scheme arrangements depending on which theory is assumed.

If one considers the nearly 100 % efficiency of the TAS technique for detecting gamma cascades, a total absorption spectrometer measurement should be sufficient (if enough statistics is collected) to unambiguously place the 1+ state in 100In. In addition, a high statistics study could also make possible the identification of additional 1+ states populated in the decay, making possible a better estimation of the Gamow-Teller quenching for this relevant decay.

The measurement will be carried out using the upgraded hybrid TAS array, which has been developed within the (NA)[2]STARS project and will be installed at DESIR. The new hybrid TAS will consist of either DTAS [Tai15, Gua18] or Rocinante [Val17], which was refurbished recently [Orr25], together with new $LaBr_3(Ce)$ modules arranged in a star-shaped configuration. Please also note that total absorption measurements also require additional measurements of the daughter activity.

[Fae13] T. Faestermann et al., Prog. in Part. Nucl. Phys. 69, 85 (2013)
[Gua18] V. Guadilla, et al., Nucl. Instr. Meth. A 910, 79 (2018)
[Gys19] P. Gysbers et al., Nature Physics15, 428 (2019)
[Hin12] C. B. Hinke et al., Nature 486, 341 (2012)
[Lub19] D. Lubos et al., Phys. Rev. Lett. 122, 222502 (2019); D. Lubos, PhD thesis, Tech. Univ. Munich (2016)
[Orr25] S.E.A. Orrigo, EPJ Web of Conferences 324, 00024 (2025)
[Tai15] J. L. Tain et al. NIM A 803 (2015) 36
[Val17] E. Valencia, et al., Phys. Rev. C 95, 024320 (2017)

Requested beam availability in…	☒ 1-3 years	☐ 3-5 years	☐ 5-10 years

Beam (ion, energy, intensity, number of UTs – 1UT=8h) :

$^{A}_{Z}X^{1+}$	100Sn	Energy	keV
		Intensity	As high as possible, 1 pps
Bunched beam (yes/no)		Freg / Length	Hz / µs
Purity	As high as possible %	Estimated UT nb	100Sn 21 UT

Production site:

SPIRAL1	S3-LEB
x	x

Instruments to be used (please add instrument name if missing) :

MORA	LUMIERE	TAS	PIPERADE	MLLTRAP	OTHER
		X	X		

Other information (cooled / bunched beam, continuous beam / tape drive system / other request…) :

Tape system required. Depending on existing options it could be produced either via Spiral1 or S3-LEB, choosing the higher production possible. Because of the nature of the measurements the highest possible purity is needed. Separate measurements of the daughter activity are also required. For the estimation we have used 1 pps for 100Sn and 0.4 beta and 0.75 TAS total efficiency. Based on those numbers we propose to measure 7 days. Please note that for a proper analysis 10^5 counts are minimally required in the clean TAS spectrum, but 10^6 guarantees a better result.