Measurement of ²¹⁴Bi beta spectrum with the XENONnT dark matter experiment

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XENONnT

- Main goal: detect dark matter by directly measuring the small energy from the scattering with a xenon nucleus.
- Main ingredients:
 - > Big sensitive detector
 - Quiet underground lab
 - > Patience





Radon chain



Radon chain



Luin

Allowed _____1st Unique _____1st Non Unique

To test shape from theory models.
 Requires taking into account nuclear structure!

$$N(p) \propto \underbrace{p^2 \left(Q - T_{\rm e}\right)^2}_{
m statistical} F\left(Z', p
ight) |M_{
m fi}|^2 S(p,q)}_{
m Fermi}$$

$$\begin{array}{c} 0.0006 \\ 0.0005 \\ 0.0004 \\ 0.0003 \\ 0.0002 \\ 0.0001 \\ 0.0000 \\ 0 \end{array} \begin{array}{c} 214 \text{Bi to g.s. } 214 \text{Po }\beta^{-} \text{decay spectrum} \\ 0.0004 \\ 0.0002 \\ 0.0001 \\ 0 \end{array} \begin{array}{c} 0.0001 \\ 0 \end{array} \begin{array}{c} 0.0001 \\ 0 \end{array} \begin{array}{c} 0 \\ 0 \end{array} \end{array} \begin{array}{c} 0 \\ 0 \end{array} \end{array} \begin{array}{c} 0 \\ 0 \end{array} \begin{array}{c} 0 \\ 0 \end{array} \end{array} \begin{array}{c} 0 \\ 0 \end{array} \begin{array}{c} 0 \\ 0 \end{array} \end{array}$$

How do we measure it?

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Signals in XENONnT





²¹⁴Bi β-decay to ²¹⁴Po

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Decay scheme



01²¹⁴P0 163.45 µs 4

Results



Summary

- Measured spectrum of 214-Bi from background data
- Tool to test nuclear structure models using spectrum shape
- Currently used as internal beta calibration in XENONnT
- Soon more data and one extra radon isotope

