Xenon TPC $0\nu\beta\beta$ community statement

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Understanding why the universe is made of matter—and hence why we exist at all—is one of the most fundamental questions in science. A leading idea is that a rare nuclear process, neutrinoless double beta decay ($0\nu\beta\beta$), could reveal how the early universe came to favor matter over antimatter. Detecting this decay would be a landmark discovery, providing crucial experimental evidence to support theories that aim to explain the origin of matter. Although experiments have not yet observed it, they have reached extraordinary sensitivity, probing half-lives ($T_{1/2}$) longer than 10^{26} years. Moving forward requires a new generation of large, coordinated international experiments.

On November 12–14, 2025, experts in rare-event searches using xenon met at McGill University to discuss the potential for a unified global effort to pursue the search for $0\nu\beta\beta$ decay in ^{136}Xe in the next decade. The workshop was highly constructive, with broad agreement on the need for a next-generation flagship experiment using xenon capable of substantially improving current sensitivity. A follow-up meeting is being scheduled in Manchester in Fall 2026 to continue progress.

One outcome of the McGill meeting was an agreement to draft this community statement and gather signatures to demonstrate broad international interest, not only in the scientific goals of neutrinoless double beta decay, but also in the promise of a next-generation xenon experiment and the importance of a coordinated community effort. The participants reached consensus on several key points:

Scale and scientific reach: The future program will require significant investment because of its size and the large quantity of xenon involved. The long-term goal of the community is to discover or rule out Majorana neutrinos, regardless of the mass ordering or absolute mass value. The next step that appears achievable with several existing technologies is to reach the ambitious milestone of $T_{1/2} = 10^{28}$ y, with a program that may need to be staged according to resource availability.

Timeliness: Given the realization and advancement of cryogenic crystal programs in this field, the concretization of the next-generation xenon-based experiment able to reach the competitive sensitivity of 10^{28} years is perfectly timely.

Need for a unified approach: Given the scale and investment required, securing support for the next-generation program will be most successful through the presentation of a single, unified, and coherent proposal backed by the full scientific community. There was a strong consensus at the workshop that the community is interested in working together to achieve the scientific goals.

Roadmap development: A clear roadmap outlining how the community will converge on a unified vision is essential for developing a viable and fundable concept. This roadmap development will be initiated ahead of the next meeting in Manchester.

The McGill workshop established strong international alignment on the scientific goals, scale, and collaborative work needed for a next-generation xenon TPC experiment. The community, defined by those signed below, will now work toward a unified roadmap to present a compelling, coordinated case for future investment.