

The background of the slide is decorated with various colored geometric shapes and error bars. These include blue triangles pointing up and down, red circles, yellow crosses, pink plus signs, and grey asterisks. Several vertical error bars in colors like red, pink, and green are also present, some with horizontal caps. The shapes and error bars are scattered across the slide, with a higher concentration on the left and right sides.

Welcome and Proposal to the Community

Jason Detwiler, UW

Community Meeting on Recommended Values for $0\nu\beta\beta$ NME

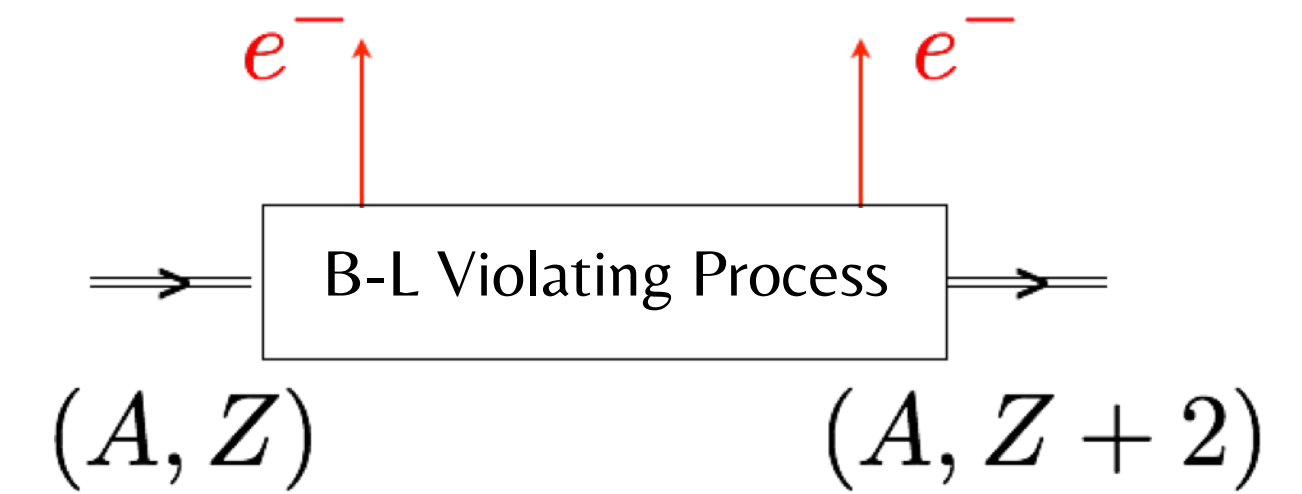
September 10, 2026

Disclaimer: I'm co-spokesperson of LEGEND and participated in the MAJORANA DEMONSTRATOR and KamLAND-Zen experiments

Neutrinoless Double-Beta Decay

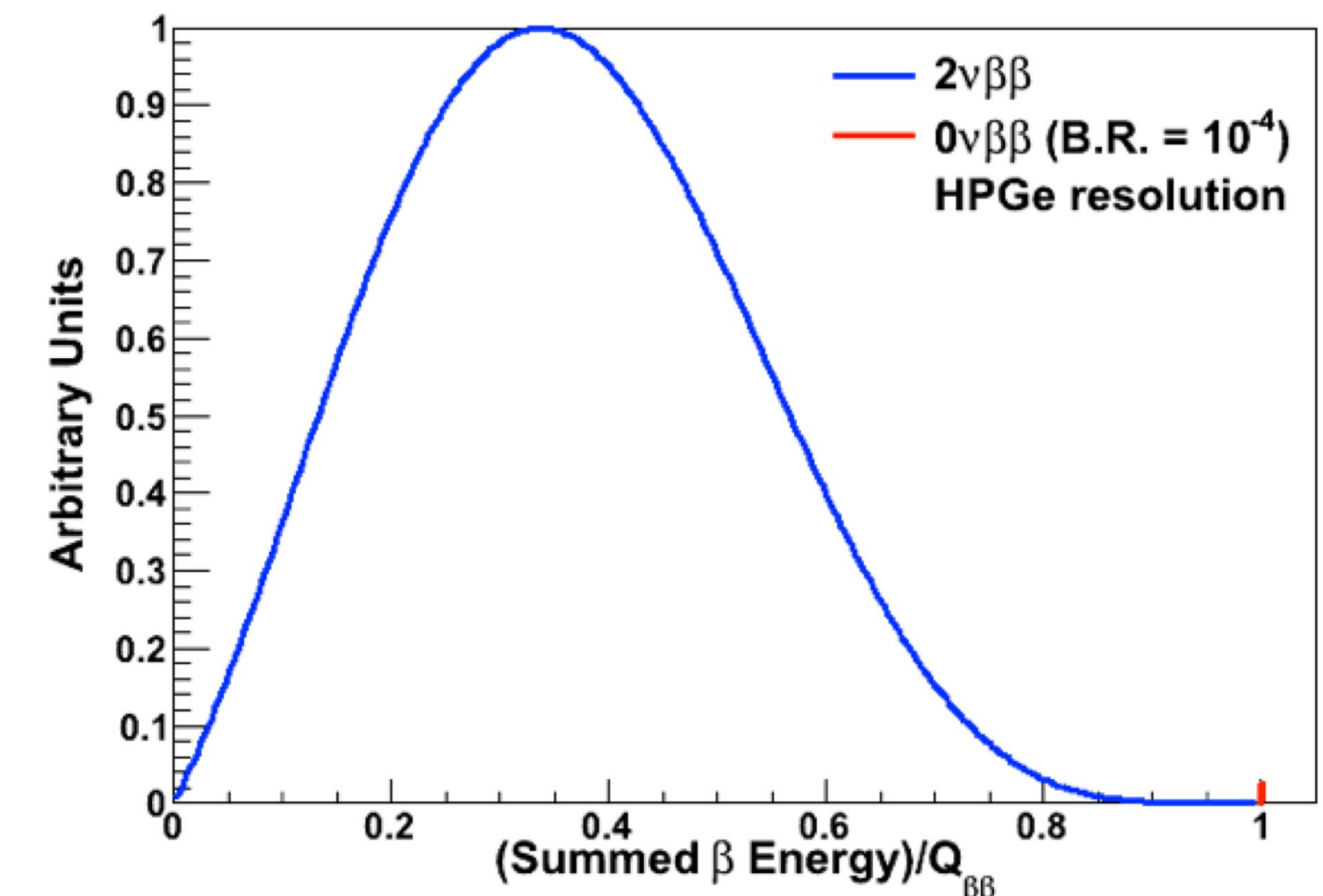
Creates two new particles of matter but no antimatter

- Compelling, well-motivated physics: generically predicted by leading theories describing the
- An observation of this process would be important regardless of theoretical motivations

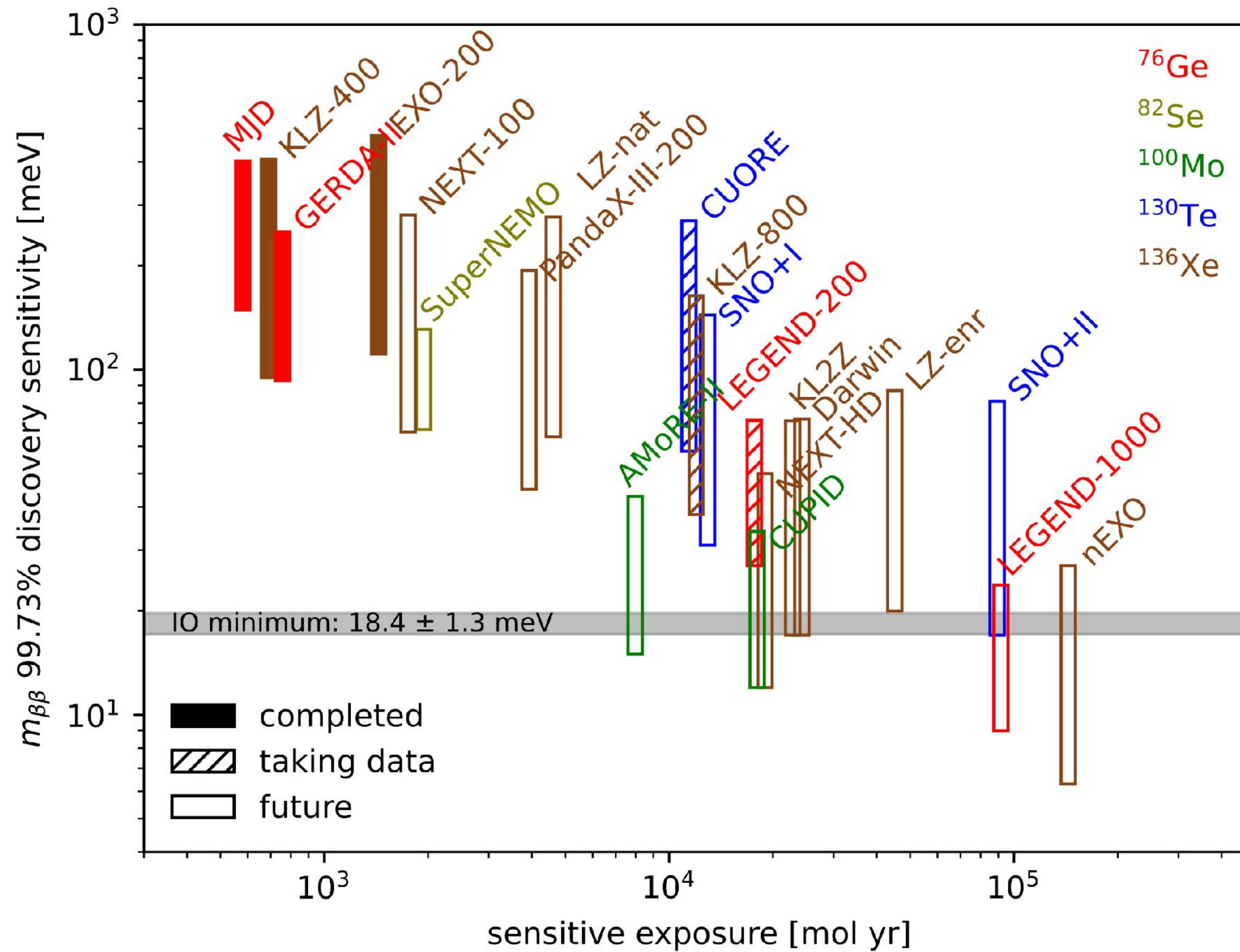


Primary Experimental Observable: Decay Rate

- δ peak at $Q_{\beta\beta}$: $\Gamma_{1/2}^{0\nu} = G |M_{\nu} m_{\beta\beta} + \epsilon M_{SR} + \dots|^2$
- Some experiments can also measure individual beta energies and the opening angle between them



Current and Future Sensitivities

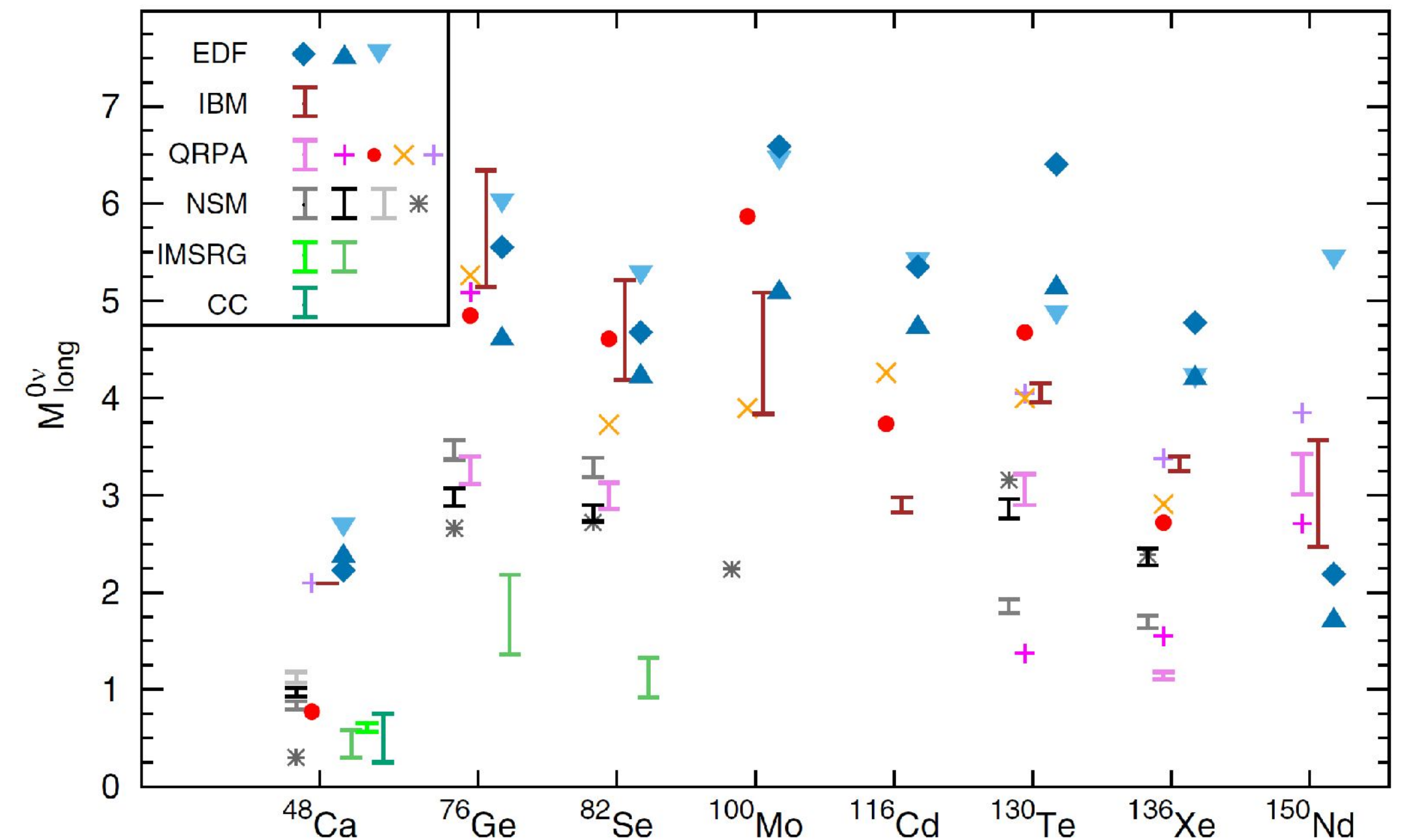


Nuclear Matrix Elements

- NME are the bridge between the experimental measurements and the physical parameters of interest:

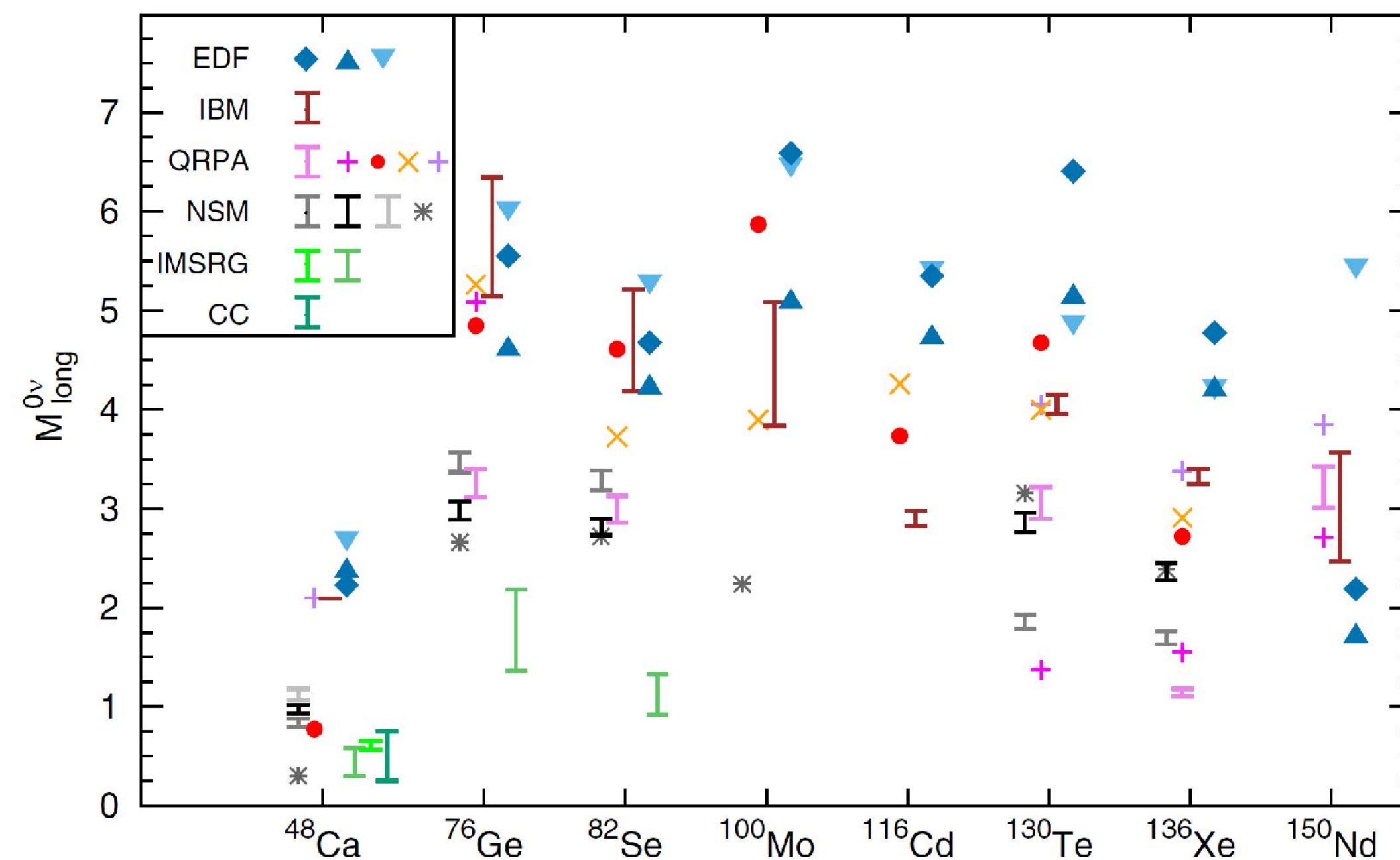
$$\Gamma_{1/2}^{0\nu} = G |M_\nu m_{\beta\beta} + \epsilon M_{SR} + \dots|^2$$

- If we discover $0\nu\beta\beta$ decay, we will need the NME to extract those parameters
- We also use NME to make plans and funding decisions for future experiments
- It's important to have trustworthy values, especially for the isotopes being pursued



Nuclear Matrix Elements

- But the NME are notoriously difficult to compute:
 - Values have historically varied by factors of 2-3 or more
 - And have been missing physics responsible for the “quenching” of single-beta decay rates
 - And have also been missing M_{SR}
 - And have had uncertainties quantified only for parts of the calculations



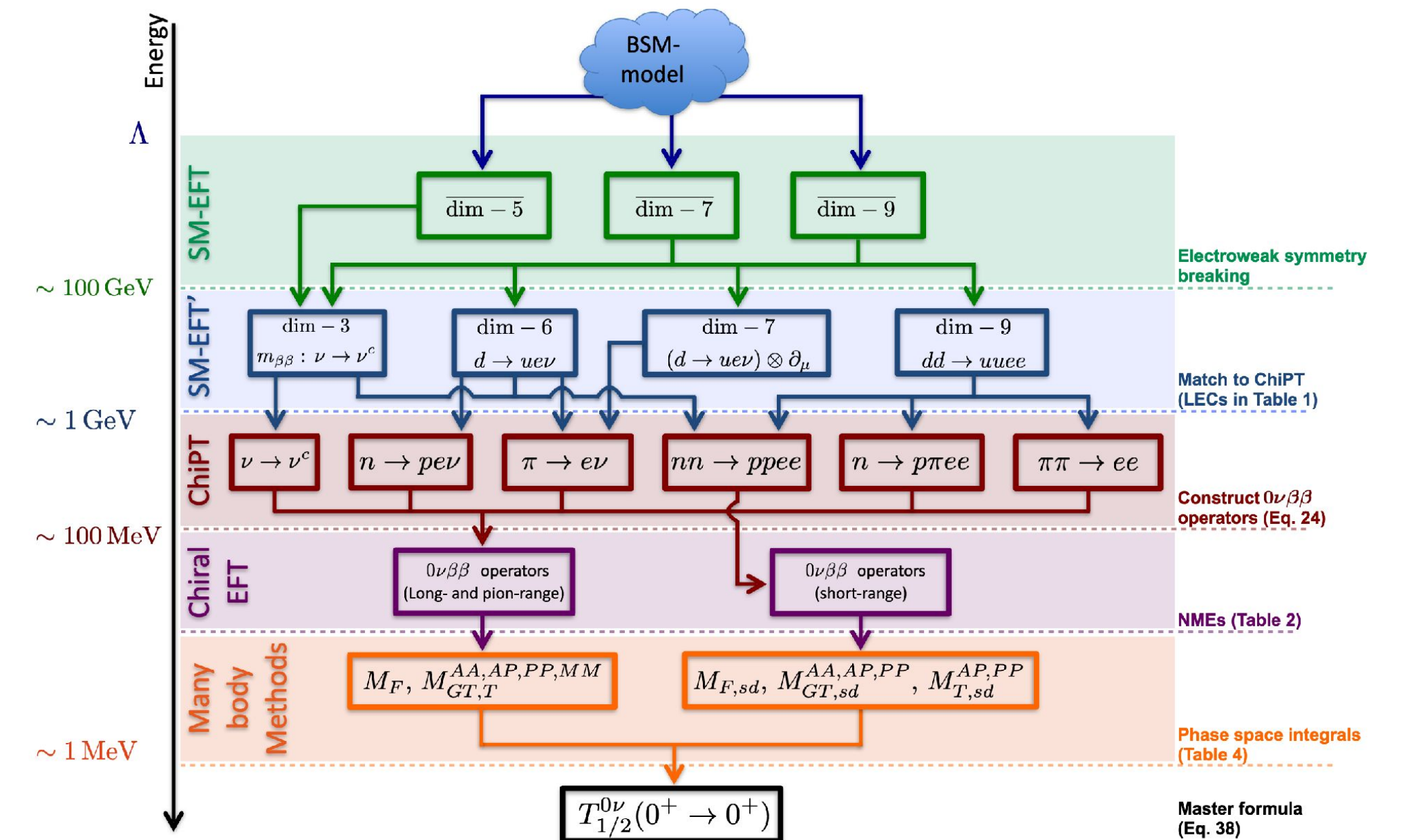
A New Era for NME

- More sophisticated and higher-fidelity and calculations are now possible



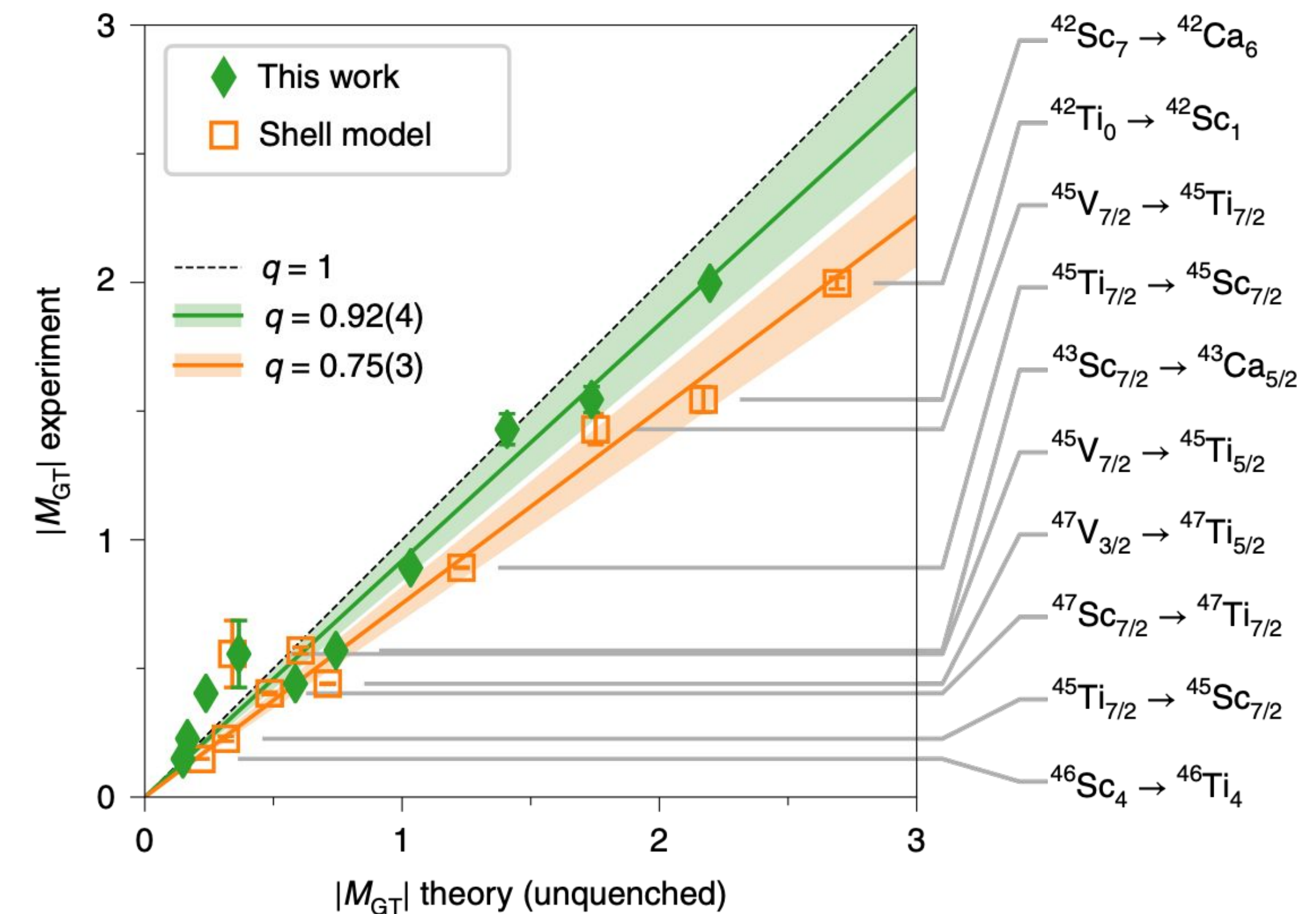
A New Era for NME

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- χ EFT has provided a systematic approach to NME and identification of the contact term



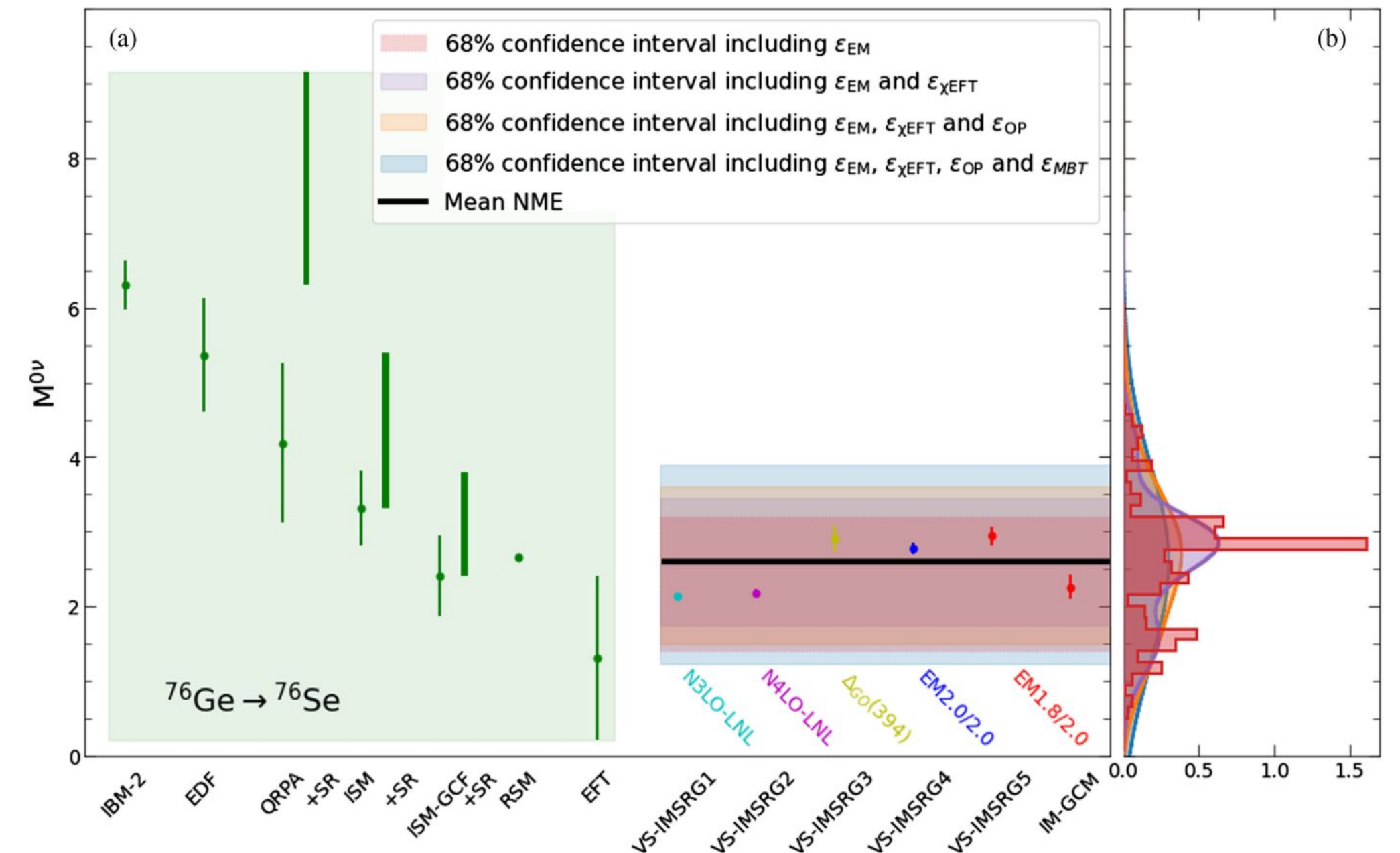
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- Ab-initio methods appear to resolve the quenching problem in ordinary beta decay



A New Era for NME

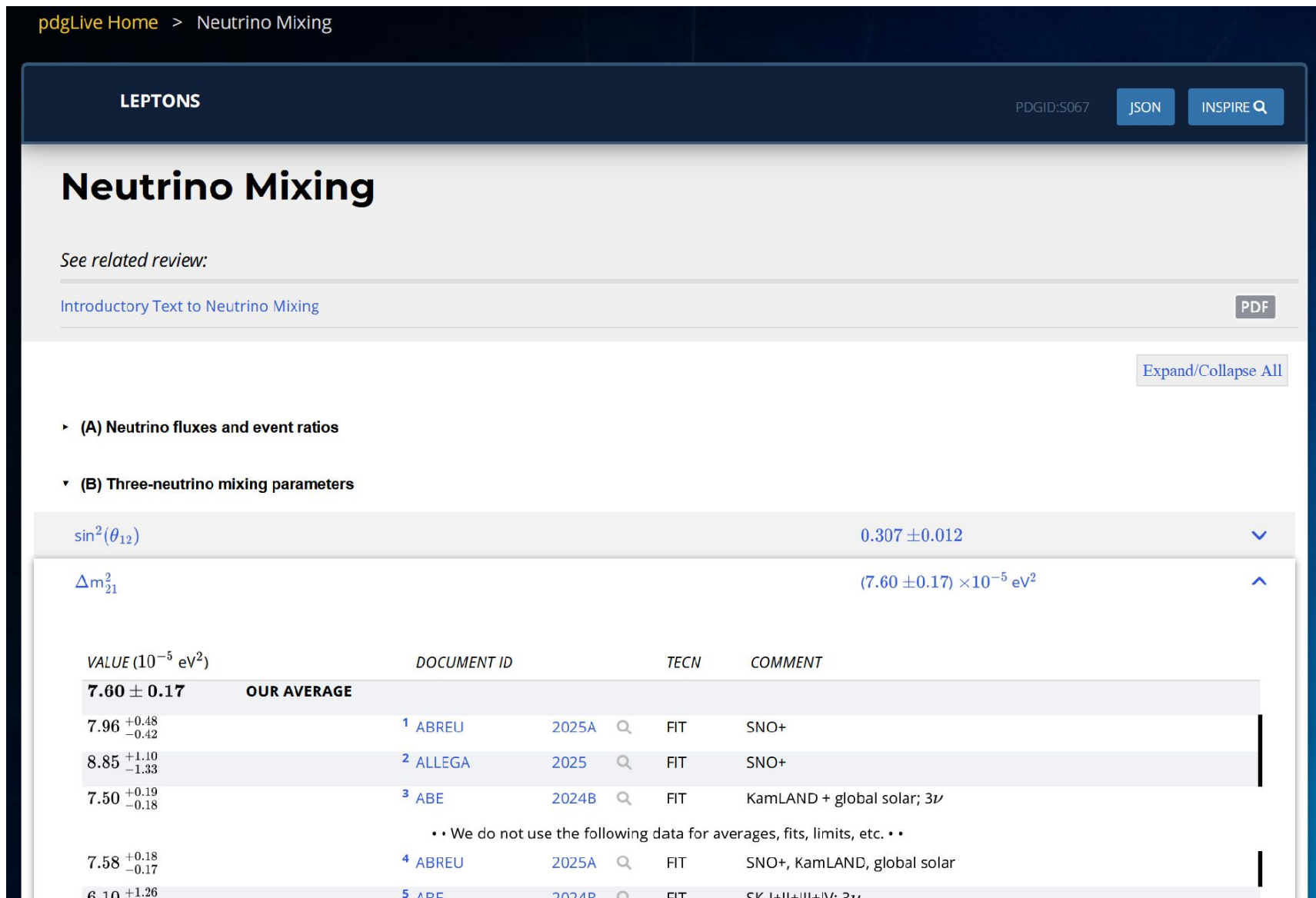
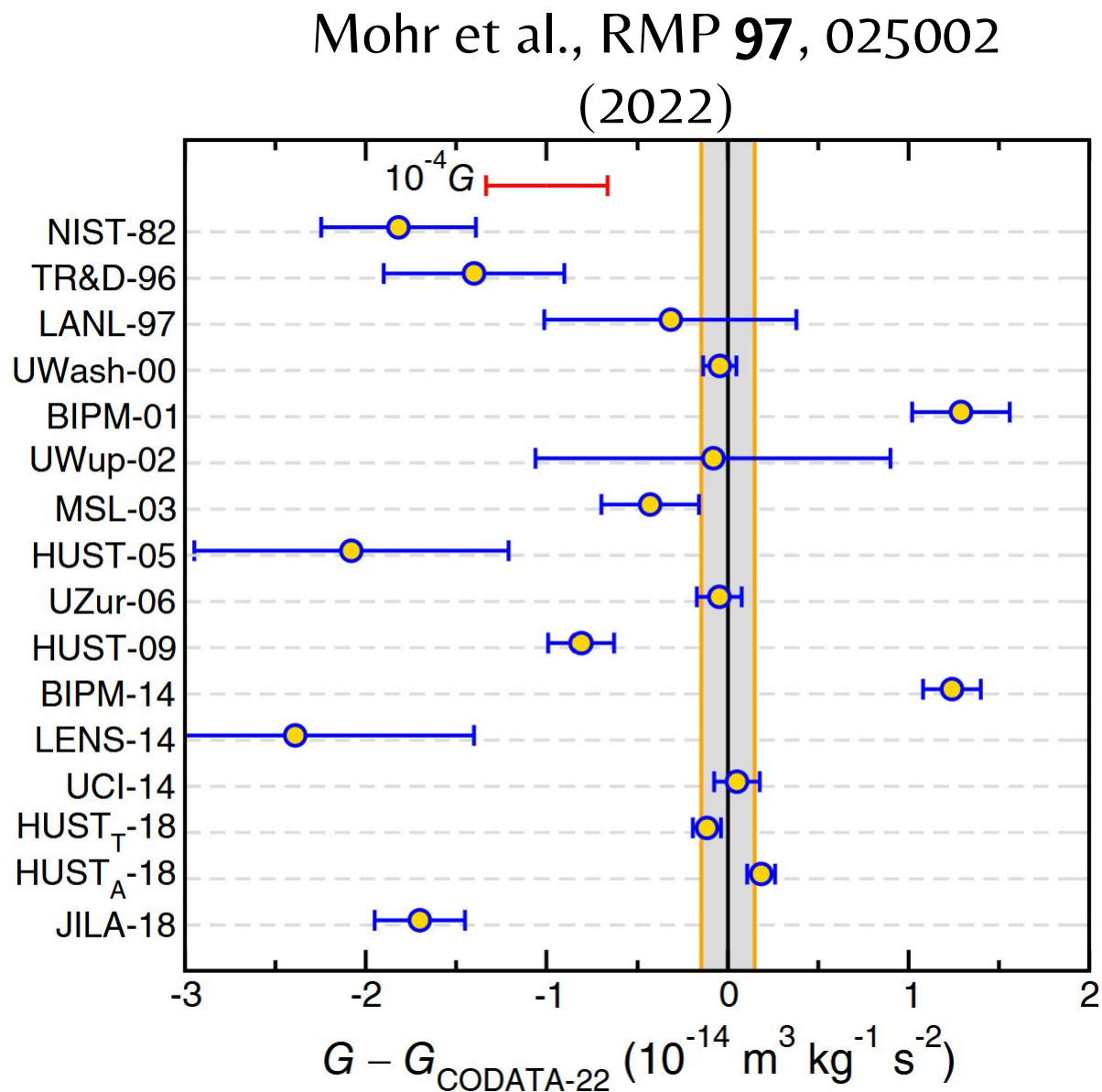
- More sophisticated and higher-fidelity and calculations are now possible
- χ EFT has provided a systematic approach to NME and identification of the contact term
- Ab-initio methods appear to resolve the quenching problem in ordinary beta decay
- “Full” uncertainty quantification is underway



An Experimentalist's Perspective

- It's hard to figure out what NME we are supposed to use
 - Usually: start with the last big review and then ask theorist friends if any new ones should be added
- We of course wish they were large, but it's more important that they be correct
 - We want to use NME that incorporate all known physics, including quenching and the contact term
- We also want to know the full uncertainty
 - Once NME are available with uncertainties, we will start moving away from NME without uncertainties
- We want to make apples-to-apples comparisons across isotopes
 - We don't want to unfairly advantage or disadvantage ourselves or our colleagues
- We propose to perform formal NME *evaluations*

Examples from other Subfields



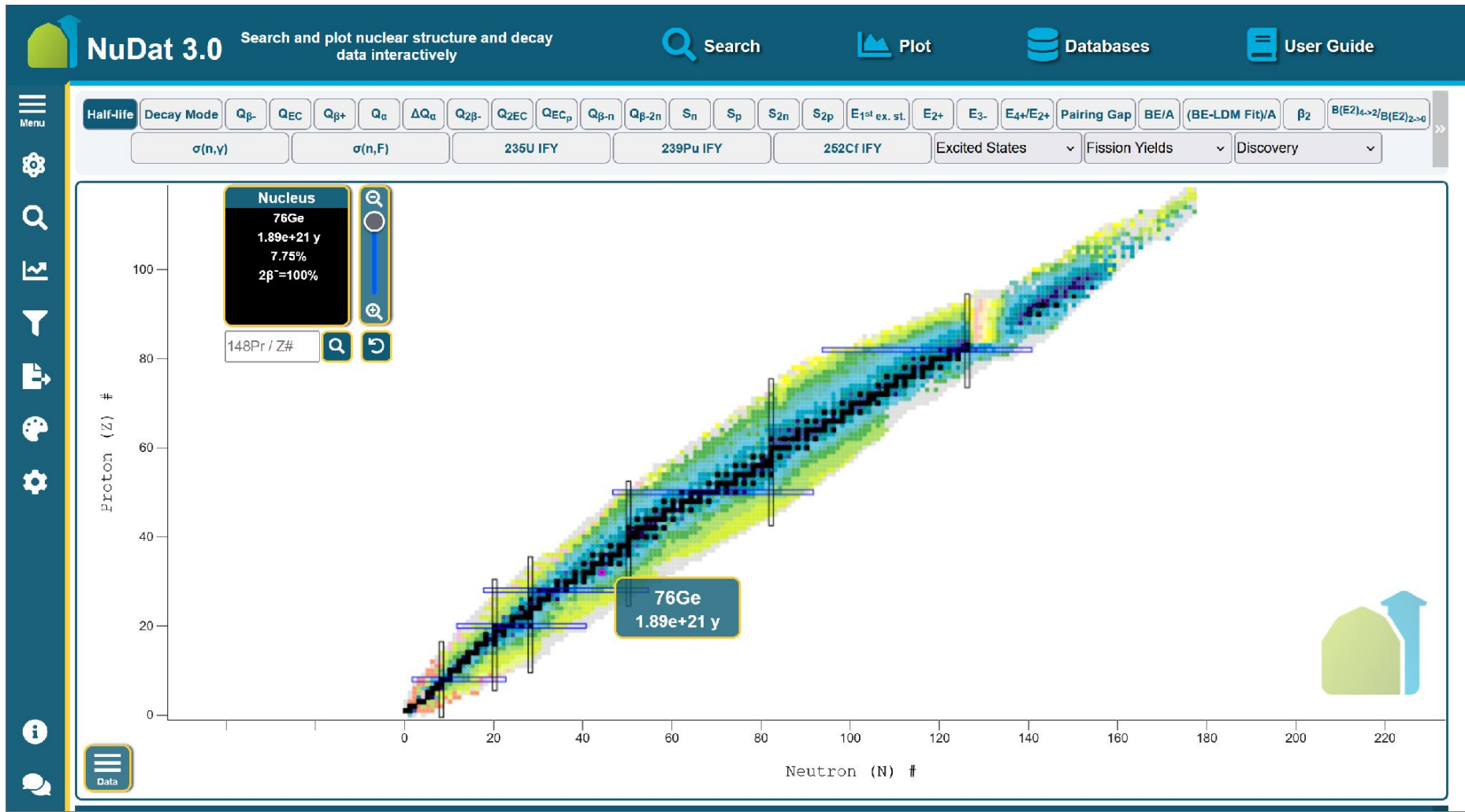
Physics Reports 1143 (2025) 1–158



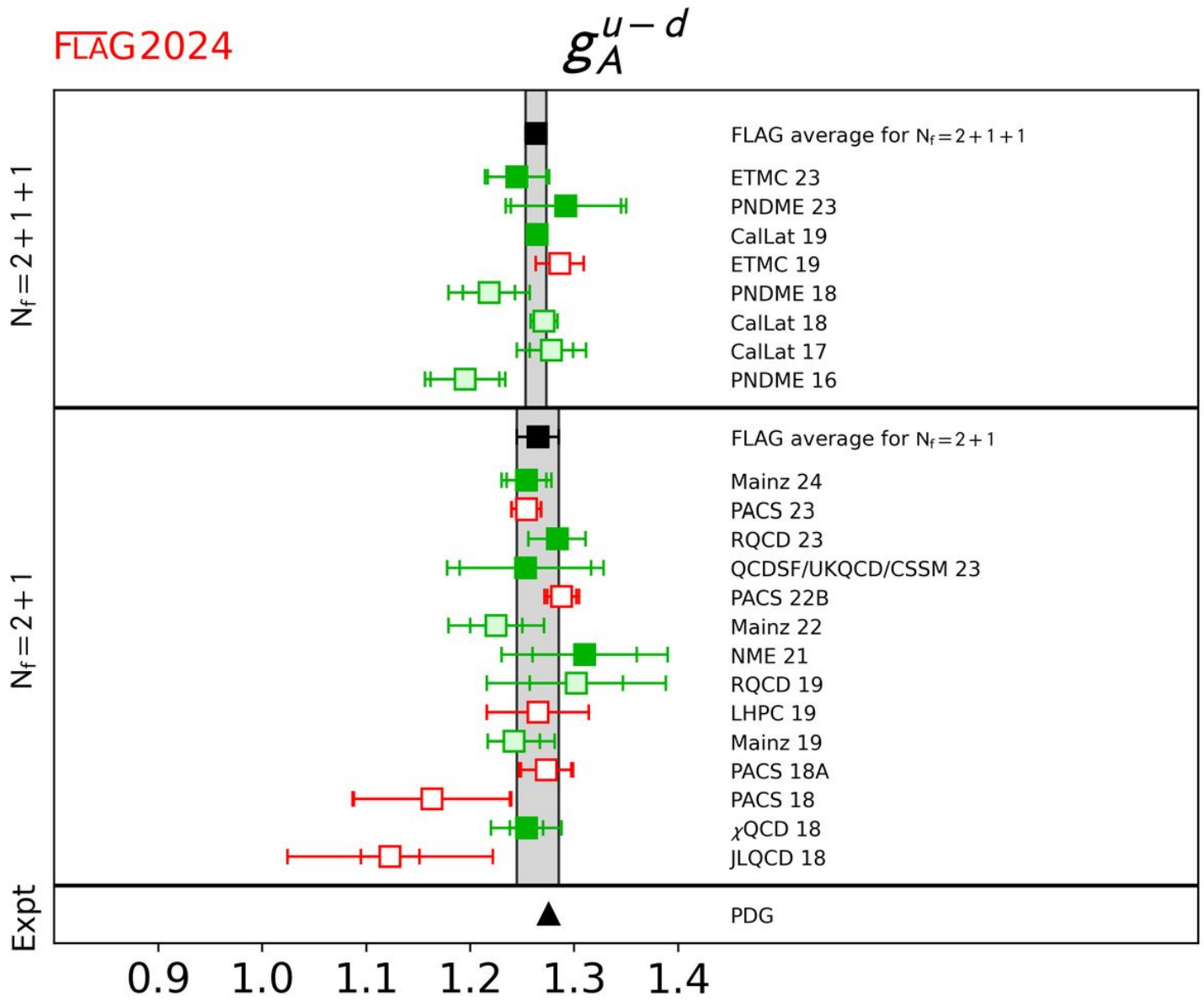
Review article

The anomalous magnetic moment of the muon in the Standard Model: an update

R. Aliberti ^{1,2}, T. Aoyama ³, E. Balzani ^{4,5}, A. Bashir ^{6,7}, G. Benton ^{8,9}, J. Bijnens ¹⁰,
V. Blobushtskii ^{1,2}, T. Blum ^{11,12}, D. Boito ¹³, M. Brune ^{14,15}, E. Budassi ^{16,17}



FLAG2024



Recommended Values for Neutrinoless Double-Beta Decay Nuclear Matrix Elements

June 29, 2026 - July 24, 2026

ORGANIZERS

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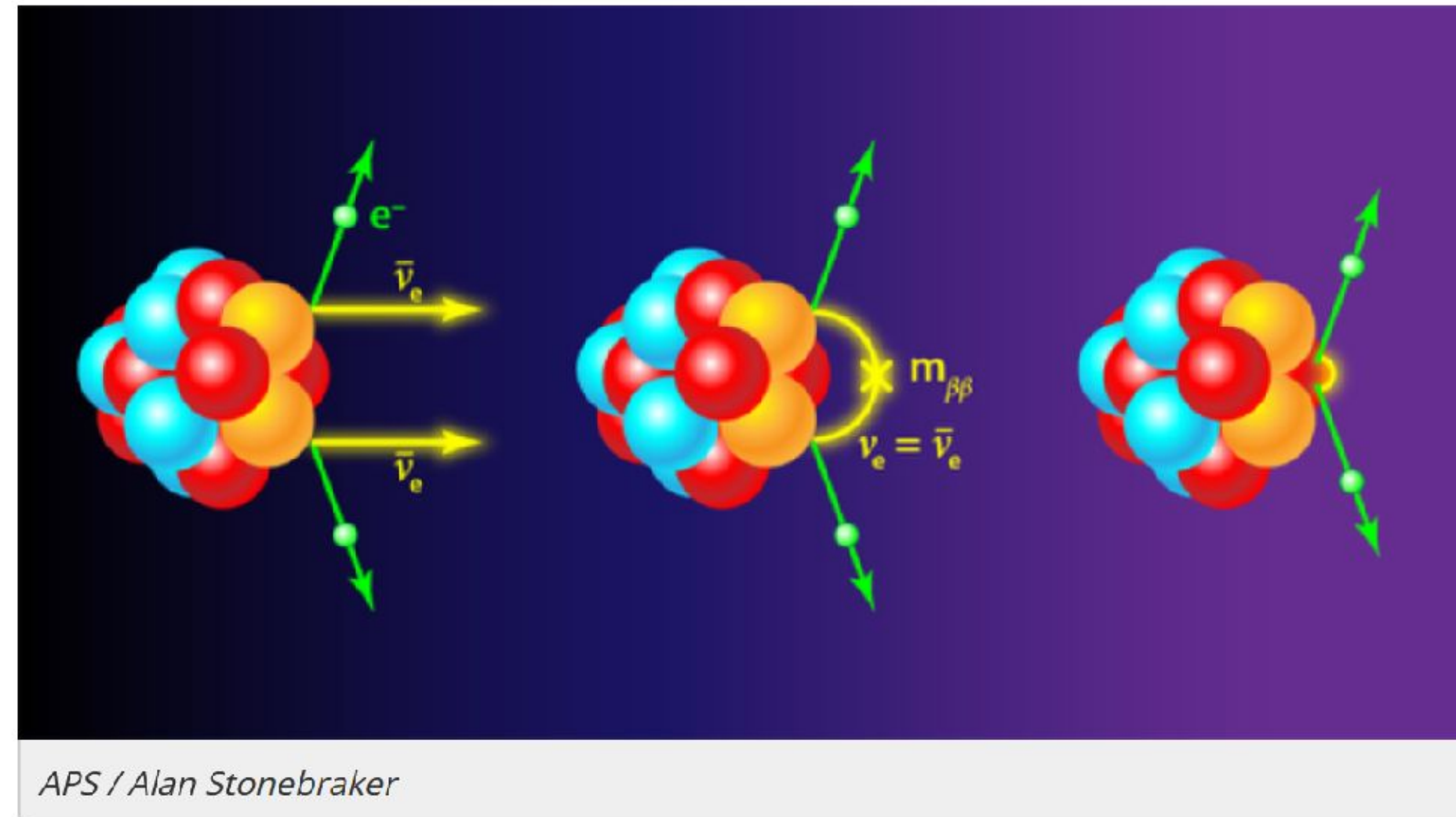
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[VIEW SCHEDULE](#)

[PARTICIPANT LIST](#)

The priority application deadline for this program has passed

Week 1: Many-Body Methods – *Ab Initio* and Phenomenological. Discussion of the nuclear structure physics relevant for understanding $0\nu\beta\beta$ decay.

Week 2: Double Beta Decay Operators and the Contact Term. Discussion of the physics connecting the nuclear decay to lepton-number-violating physics.

Week 3: Uncertainty Quantification. Discussion of sources of uncertainty and error propagation.

Week 4: Workshop and Recommendation Development – “Toward Recommended Values for Neutrinoless Double Beta Decay Nuclear Matrix Elements”. Workshop to engage the larger community, including experimentalists, in the process of producing reliable and community-vetted NME values. Will include the drafting of a whitepaper summarizing results from the program to disseminate the first community-vetted NME values, and development of a plan for their stewardship into the future.

Proposal to the Community

Write a whitepaper together on “Recommended ranges for α NME”, with three key components:

- Agree on a shared long-term vision for NME evaluations
- Establish a first "inclusive" range of NME values representing the present state-of-the-art, without imposing strong restrictions
- Agree upon a set of criteria to be applied for the next re-evaluation (~3 years from now)

On the following slides, I present starting points for the each of these, workshopped at the INT.

Future Vision for NME Evaluations

- NME evaluations with full uncertainties and correlations (across NME and across isotopes) at a level meeting the experimental requirements (currently ~30%)
- For the ≤ 15 scheme-independent NME combinations motivated by chiral EFT as well as for the combination for light neutrino exchange, and all coupling constants needed to connect BSM physics to $0\nu\beta\beta$ decay.
- At least for ^{48}Ca , ^{76}Ge , ^{82}Se , ^{100}Mo , ^{130}Te , and ^{136}Xe , and ...
- With methods that satisfy some benchmark criteria, for example ability to reproduce other relevant measured observables

Proposed criteria for recommended values for *this* iteration:

- The authors stand behind their calculations and argue that they should be included in the “recommended range” at present, distinguishing between “state-of-the-art” and “benchmark” calculations.
- The calculations should include many body correlations e.g. to account for deformation for deformed nuclei.
- Each method should discuss how / whether quenching physics and the contact term appear / are treated, and should summarize existing validations.
- The calculations should identify whether they are available at the same level of effort at least for ^{76}Ge , ^{100}Mo , ^{130}Te , and ^{136}Xe . Although not required, we emphasize that ^{48}Ca and ^{82}Se are also of considerable interest. Each method should include discussion of any isotope-specific difficulties.

Proposed goals for the next iteration

(I) Basic Criteria

- Inclusion of collective/static correlations, for example deformation, pairing, etc.; as well as dynamic correlations
- Proper treatment of higher-order terms in the current operator
- Avoiding or explaining “ g_A quenching” by properly treating the correlations and current operator as mentioned above
- Consistent inclusion of high-momentum neutrino exchange (e.g. the contact term and short-range correlations)
- Assessment of the systematic and parametric theoretical uncertainties at least for light neutrino exchange. The evaluation should list the specific contributions assessed. When possible, the correlations between isotopes and uncertainty components should be provided.
- Available at the same level of effort at least for ^{48}Ca , ^{76}Ge , ^{82}Se , ^{100}Mo , ^{130}Te , and ^{136}Xe , plus any new experimental targets on this time frame

Proposed goals for the next iteration

(II) Benchmark against a subset of:

- Integrated and differential $2\nu\beta\beta$ decay rates, to ground and excited states
- β +/- strengths and decay spectra
- Partial and total muon capture rates
- Neutrino cross sections
- Single and double-charge exchange cross sections
- Two-nucleon transfer reactions
- Nuclear levels (energy spectra)
- Electromagnetic transitions, including M1, 2γ , E2, . . .
- Heavy-ion collision observables
- Isobaric multiplet mass equations
- Performance on analytically solvable models or fictitious decays in light nuclei with precise results in other methods

Proposed goals for the next iteration

(III) Probe NMEs with a subset of:

- For cross-comparison:
 - Decomposition into short- and long-distance windows
 - Radial transition density
 - Multipole decomposition
 - Decomposition by multiphonon states in the intermediate nucleus (if applicable)
- Tests of robustness
 - The restoration of isospin and spin-isospin symmetry
 - The effect of deformations
 - ...

Whitepaper Draft

- INT program participants have begun drafting a whitepaper as a proposal to the community:

<https://www.overleaf.com/read/rffxvkktvtwv#4be722>

[whitepaper walkthrough]

- **DISCLAIMER:** the text is rough, unbalanced, contains some controversial statements, and is very much a work-in-progress
 - We ask you not to focus on details at this point, and just view it as a generic proposal for a future whitepaper
 - We drafted in in the hope that it can serve as a useful starting point, assuming the community supports this effort.

Aspirational Timeline

- First-draft editing through the Fall
- Set a deadline of December 31 for publication of results to be included in the whitepaper.
- Finish incorporating new results in the Winter.
- Polishing and circulation to collect endorsements in the Spring.
 - Alongside the authors we can list endorsers: individuals / collaborations who didn't provide text but support the content
- Prepare a special session / workshop at MEDEX 2027 to try to finalize the document for submission.
- Target journal: propose Physics Reports (or similar, style to be updated)

Coordination and Drafting Plan

- Hold editing meetings ~weekly
 - Cycle between at least two different times, chosen to maximize participation: typical individuals would join ~every other week
Meeting poll (answer for times that work in general for you for the near future): <https://www.when2meet.com/?38468303-VrWwH>
 - Directly contact individuals in existing editing teams if you would like to join
 - Communicate via bb-nme-evals-editors@u.washington.edu mailing list
- Hold community meetings every 1-2 months
 - Update the community on the draft status and discuss controversial topics
 - Communicate via bb-nme-evals@u.washington.edu mailing list
- Post meeting agendas and minutes to <https://indico.global/category/1652>
- Webpage, style guide (TBD), and other materials in a repository at <https://github.com/bb-nme-evals>