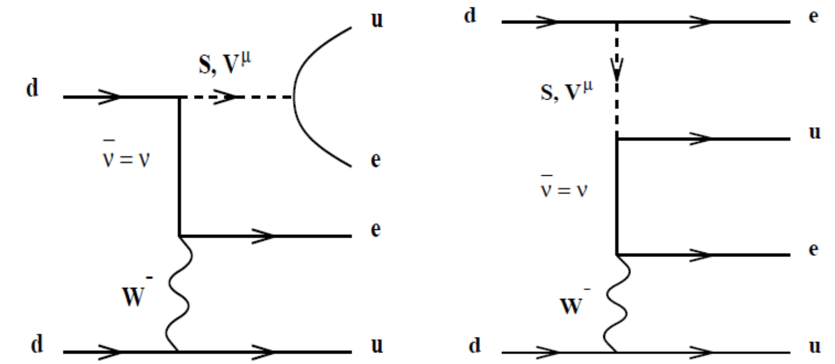

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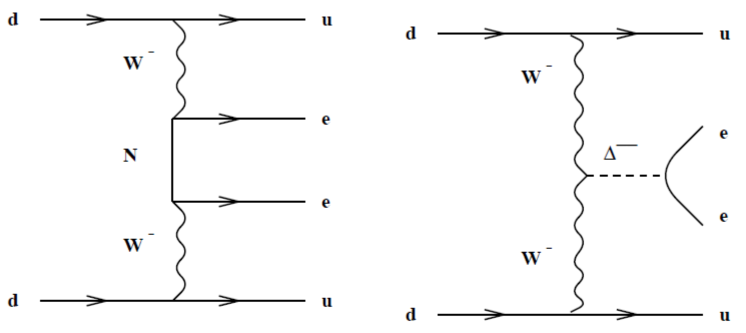

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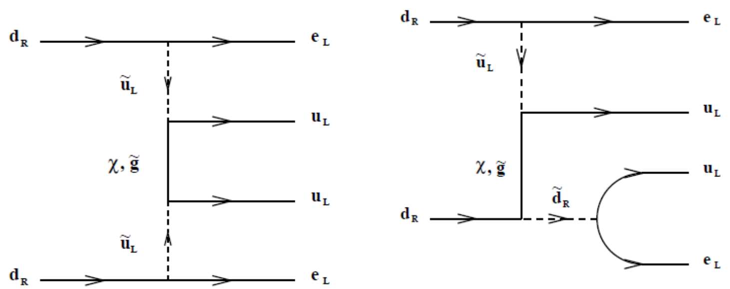
Der Doppelbetazerfall kann alles
(Dr. M.Hirsch)

Neutrinoless Doube Beta Decay can do anything



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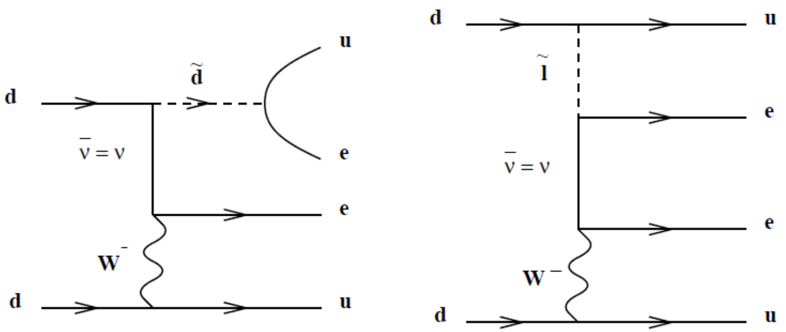

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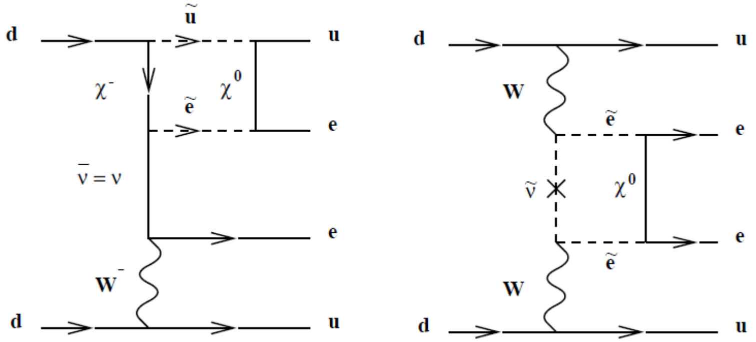
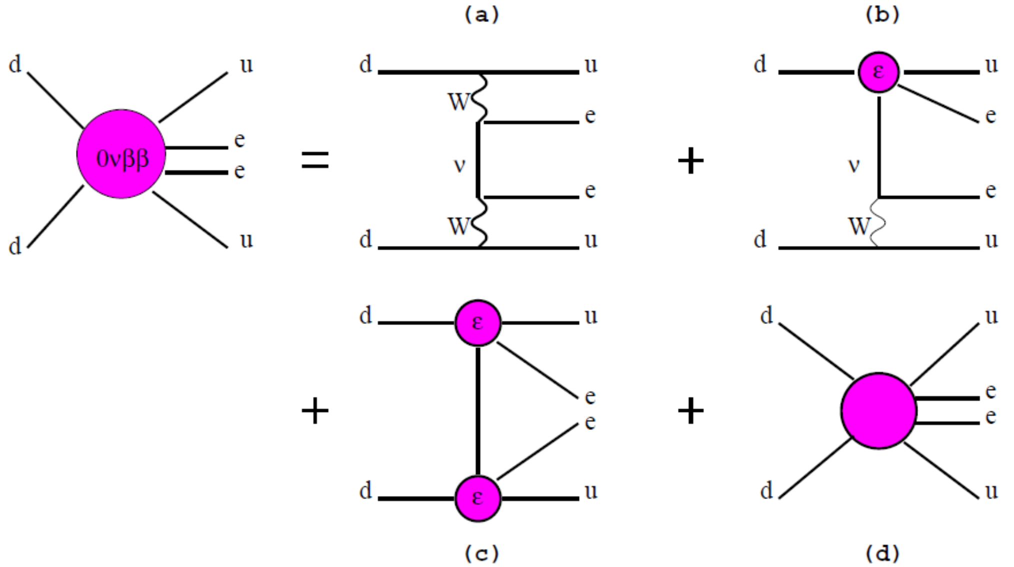


Figure 13. Examples of R_P conserving SUSY contributions to $0\nu\beta\beta$ decay (from [Hir9

Der Doppelbetazerfall kann alles
(Dr. M.Hirsch)



6 May 1999

PHYSICS LETTERS B

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Physics Letters B 453 (1999) 194–198

Towards a superformula for neutrinoless double beta decay

H. Päs [1], M. Hirsch [2], H.V. Klapdor-Kleingrothaus [3], S.G. Kovalenko [4]

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18 January 2001

PHYSICS LETTERS B

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Physics Letters B 498 (2001) 35–39

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A superformula for neutrinoless double beta decay II: the short range part

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Editor: P.V. Landshoff

Journal of Physics G: Nuclear and Particle Physics

TOPICAL REVIEW

Future perspectives of double beta decay and dark matter search - GENIUS

H V Klapdor-Kleingrothaus[1], J Hellmig[1] and M Hirsch[1]

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Journal of Physics G: Nuclear and Particle Physics, Volume 24, Number 3
Citation H V Klapdor-Kleingrothaus *et al* 1998 *J. Phys. G: Nucl. Part. Phys.* **24** 483
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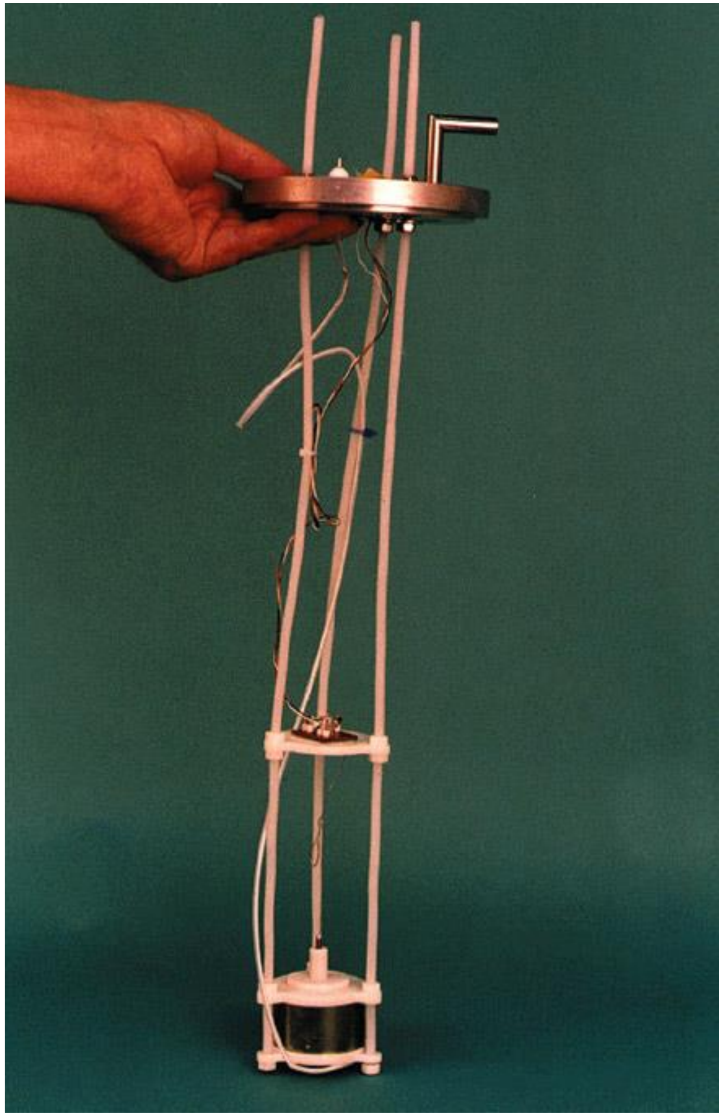

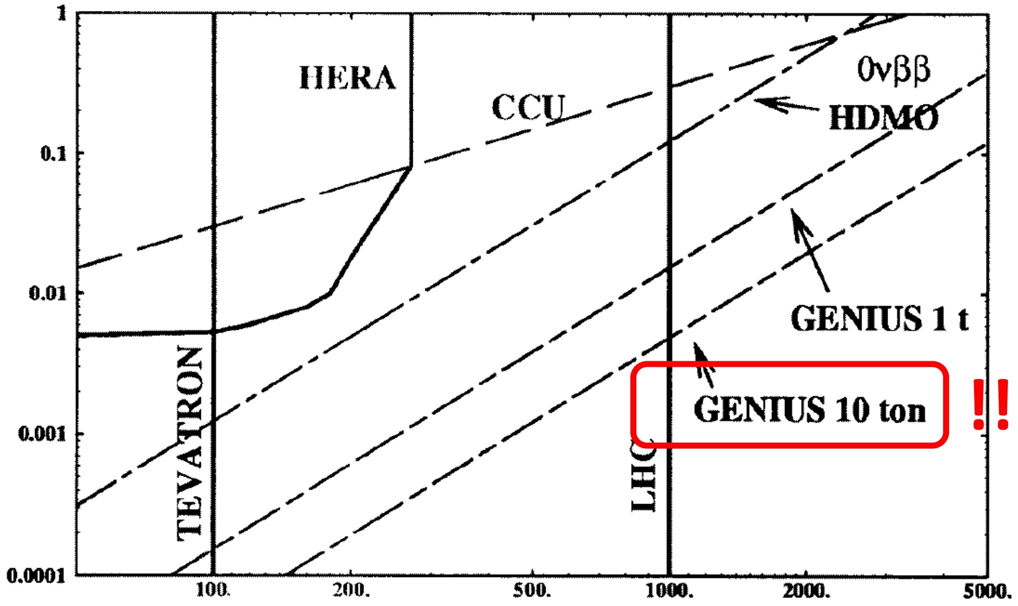

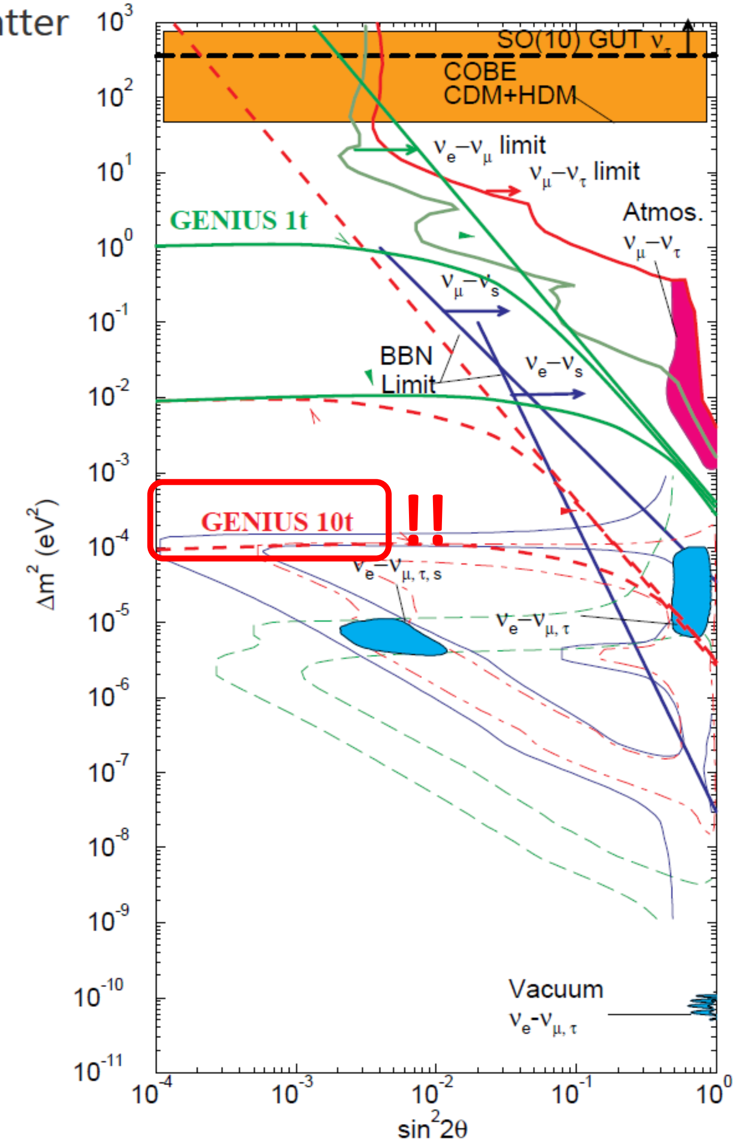

Actually the only publication with Martin and me as co-authors

Purely experimental!

Physics Reports
Volume 307, Issues 1–4, 1 December 1998, Pages 301-308

Double beta decay went missing?

GENIUS: a new dark matter project

L. Baudis, J. Hellmig, M. Hirsch, G. Heusser, H.V. Klapdor–Kleingrothaus[1 1], B. Majorovits, Y. Ramachers, H. Strecker

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https://doi.org/10.1016/S0370-1573(98)00065-9

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Abstract

GErmanium in liquid NItrogen Underground Setup (GENIUS) is a proposal for a high mass germanium experiment with a much larger sensitivity for direct WIMP detection relative to existing experiments. It would operate 1 ton of "naked" Ge-detectors in a liquid nitrogen shielding of very low level radioactivity. Already in a first 100 kg of natural Ge version, GENIUS would be able to reach a sensitivity of the order 0.01 counts/d kg and additionally to look for the annual modulation WIMP-signature. Operating 1 t of enriched ^{76}Ge-detectors, GENIUS could search for the neutrinoless double beta decay, probing neutrino masses down to 0.02 eV.

GENIUS

a Supersensitive Germanium Detector System for Rare Events

H.V. Klapdor–Kleingrothaus, L. Baudis, G. Heusser, B. Majorovits, H. Päs
Max–Planck–Institut für Kernphysik, Heidelberg, Germany

Martin went missing!

August 1999

The GENIUS collaboration includes groups from:
MPIK Heidelberg, Germany; Inst. of Nucl. Research, Kiev, Ukraine; Physik. Techn. Bundesanstalt, Braunschweig, Germany; Internat. Center for Theoret. Physics, Trieste, Italy; JINR Dubna, Russia; Inst. of Radiophys. Research, Nish-nij Novgorod, Russia; Dep. of Physics, Northeastern Univ. Boston, USA; Dep. of Physics, Univ. of Maryland, USA; Los Alamos Nat. Lab., USA; Dep. de Fisica Teorica, Univ. of Valencia, Spain; Dep. of Physics, Texas A&M Univ., USA

Spokesman of the Collaboration: H. V. Klapdor–Kleingrothaus

MPI-Report MPI-H-V26-1999

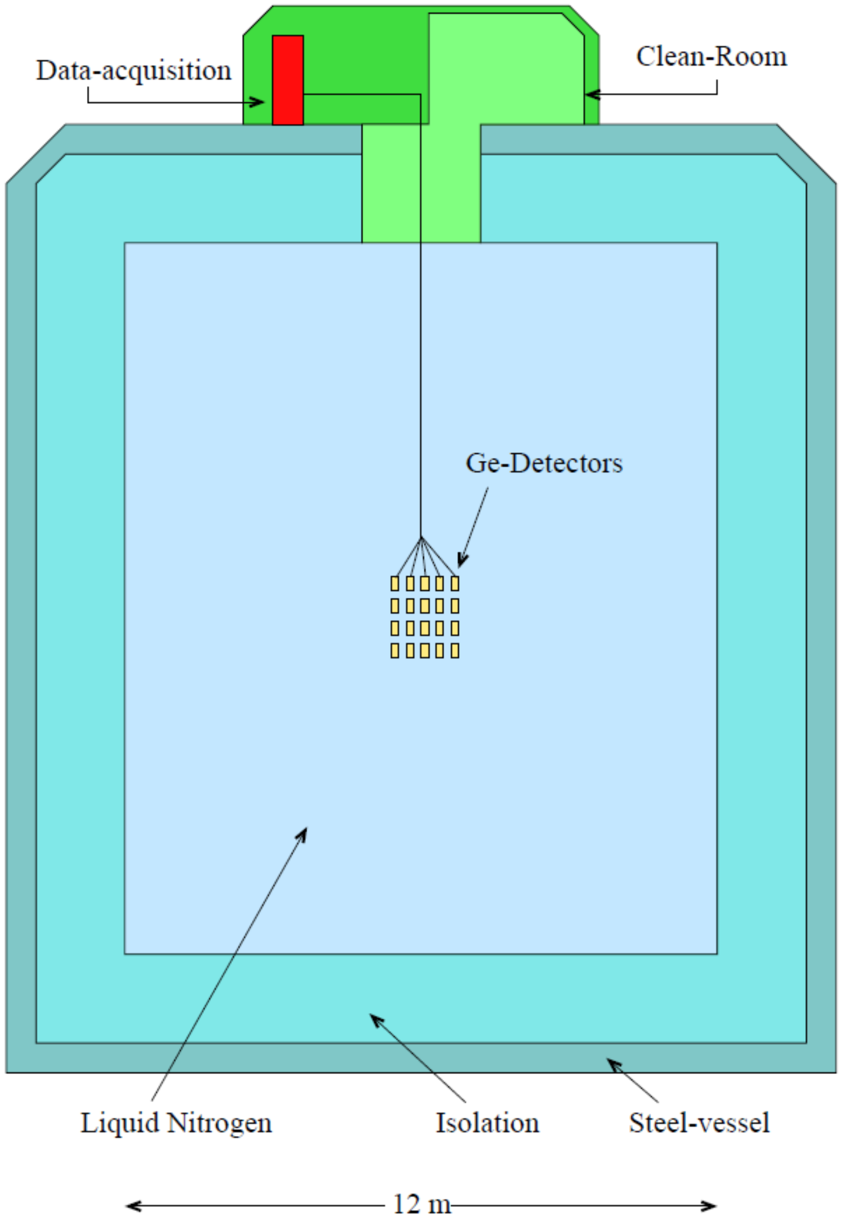

Figure 6. Schematic view of the GENIUS experiment.

GENIUS

a Supersensitive Germanium Detector

System for Rare Events

H.V. Klapdor–Kleingrothaus, L. Baudis, G. Heusser, B. Majorovits,

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The GENIUS Collaboration

Status September 1999

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Valencia appeared!

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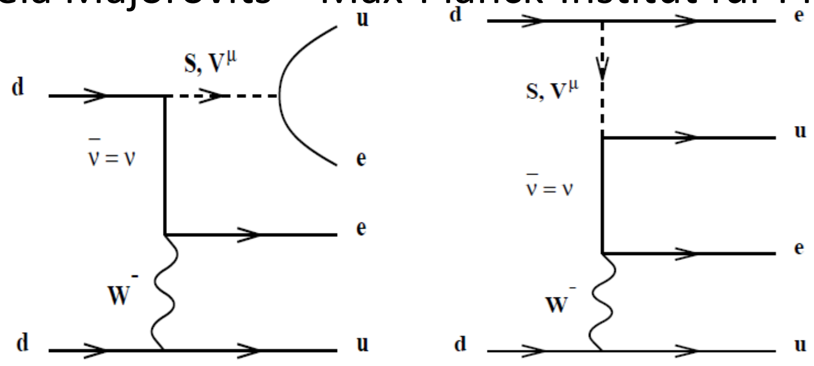
Departamento de Fisica Teorica, University of Valencia, Spain

R. Arnowitt
Department of Physics, Texas A&M University, USA

* Spokesman of the Collaboration



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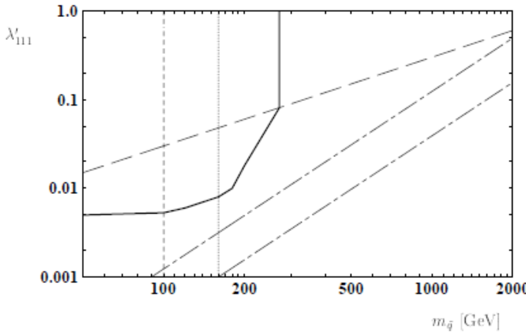


Figure 23. Comparison of limits on the R–parity violating MSSM parameters from different experiments in the λ'_{111}–$m_{\tilde{q}}$ plane. The ashed line is the limit from charged current universality according to [Bar89]. The vertical line is the limit from the data of Tevatron [Roy92]. The thick full line is the region which might be explored by HERA [But93a]. The two dash–dotted lines to the right are the limits obtained from the half–life limit for $0\nu\beta\beta$ decay of ^{76}Ge, for gluino masses of (from left to right) $m_{\tilde{g}}$ =1TeV and 100 GeV, respectively. The regions to the upper left of the lines are forbidden. (from [Hir95])

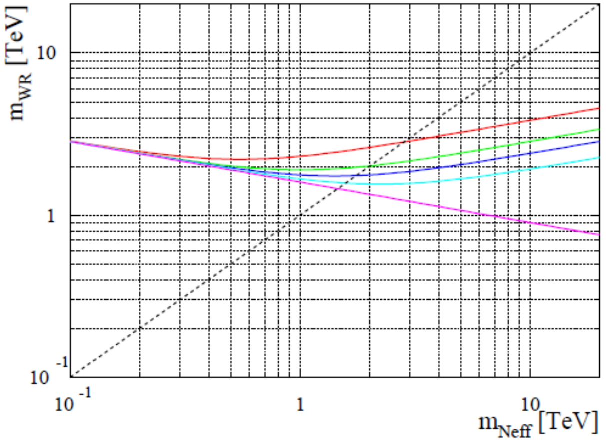
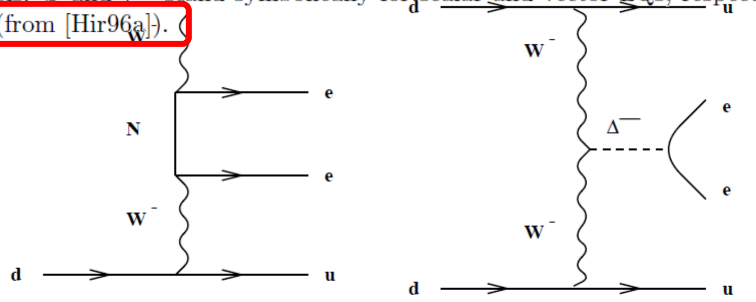


Figure 22. Limits on the mass of the right-handed W-boson from neutrinoless double beta decay (full lines) and vacuum stability (dashed line). The five full lines correspond to the following masses of the doubly charged higgs, $m_{\Delta^{--}}$: 0.3, 1.0, 2.0, 5.0 and ∞ [TeV] downward (from [Hir96e]).



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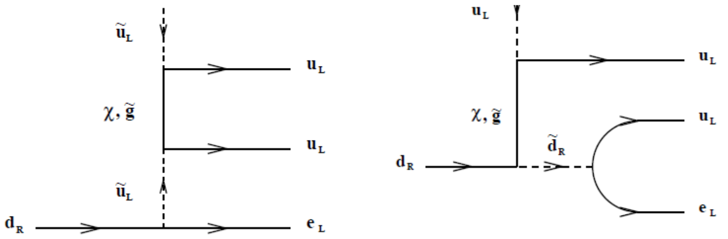

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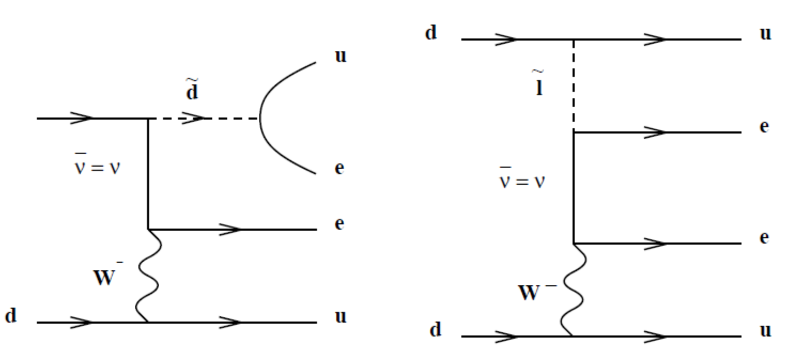

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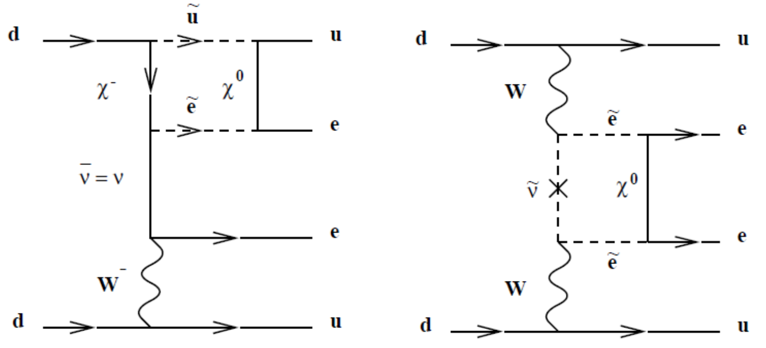

Figure 13. Examples of R_P conserving SUSY contributions to $0\nu\beta\beta$ decay (from [Hir97

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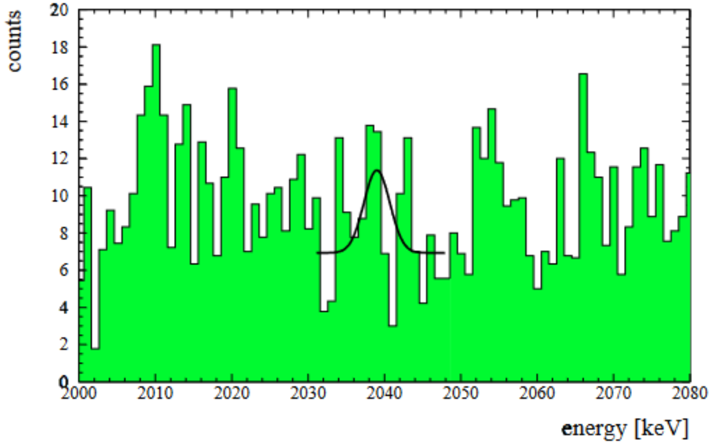
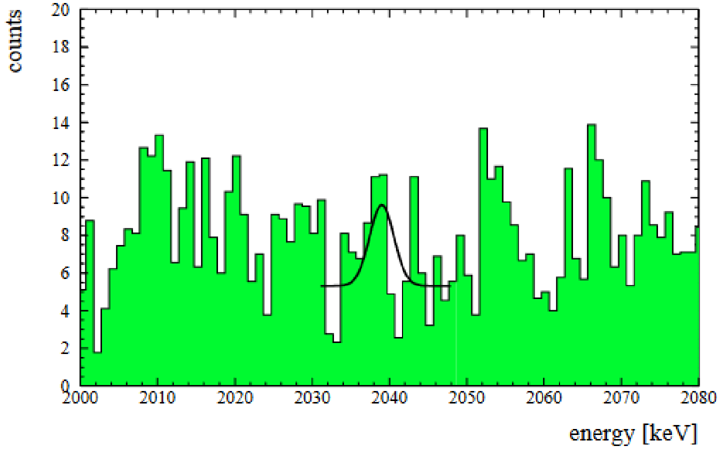
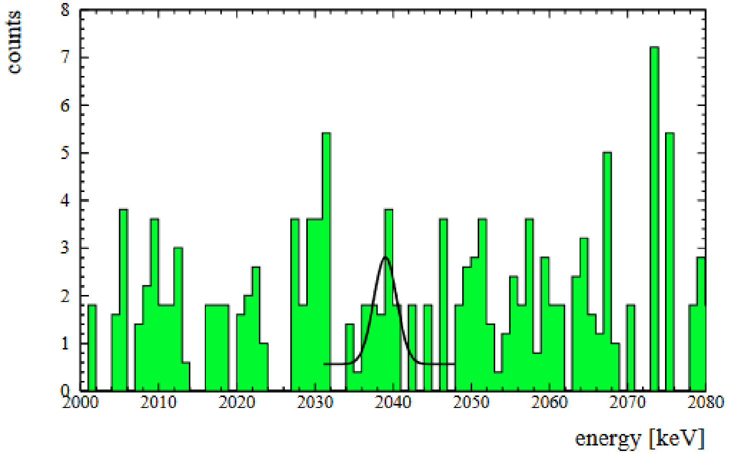
A lot of Martin in the references

Der Doppelbetazerfall kann alles
(Dr. M.Hirsch)







Modern Physics Letters A | Vol. 16, No. 37, pp. 2409-2420 (2001) | Research Papers

EVIDENCE FOR NEUTRINOLESS DOUBLE BETA DECAY ?

A question mark went missing?

H. V. KLAPDOR-KLEINGROTHAUS*, A. DIETZ, H. L. HARNEY and I. V. KRIVOSHEINA†

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Received 5 December 2001

Table 2. Half-life for the neutrinoless decay mode and deduced effective neutrino mass from the Heidelberg–Moscow experiment.

Significance (kg y)	Detectors	$T^{0\nu}_{1/2}$ (y)	$\langle m \rangle$ (eV)	Conf. level
54.9813	1, 2, 3, 4, 5	$(0.80–35.07) \times 10^{25}$	(0.08–0.54)	95% c.l.
54.9813	1, 2, 3, 4, 5	$(1.04–3.46) \times 10^{25}$	(0.26–0.47)	68% c.l.
54.9813	1, 2, 3, 4, 5	1.61×10^{25}	0.38	Best value
46.502	1, 2, 3, 5	$(0.75–18.33) \times 10^{25}$	(0.11–0.56)	95% c.l.
46.502	1, 2, 3, 5	$(0.98–3.05) \times 10^{25}$	(0.28–0.49)	68% c.l.
46.502	1, 2, 3, 5	1.50×10^{25}	0.39	Best value
28.053	2, 3, 5 SSE	$(0.88–22.38) \times 10^{25}$	(0.10–0.51)	90% c.l.
28.053	2, 3, 5 SSE	$(1.07–3.69) \times 10^{25}$	(0.25–0.47)	68% c.l.
28.053	2, 3, 5 SSE	1.61×10^{25}	0.38	Best value

The GERmanium Detector Array
for the search of neutrinoless double beta decay in Ge-76
at the Laboratori Nazionali del Gran Sasso (LNGS)

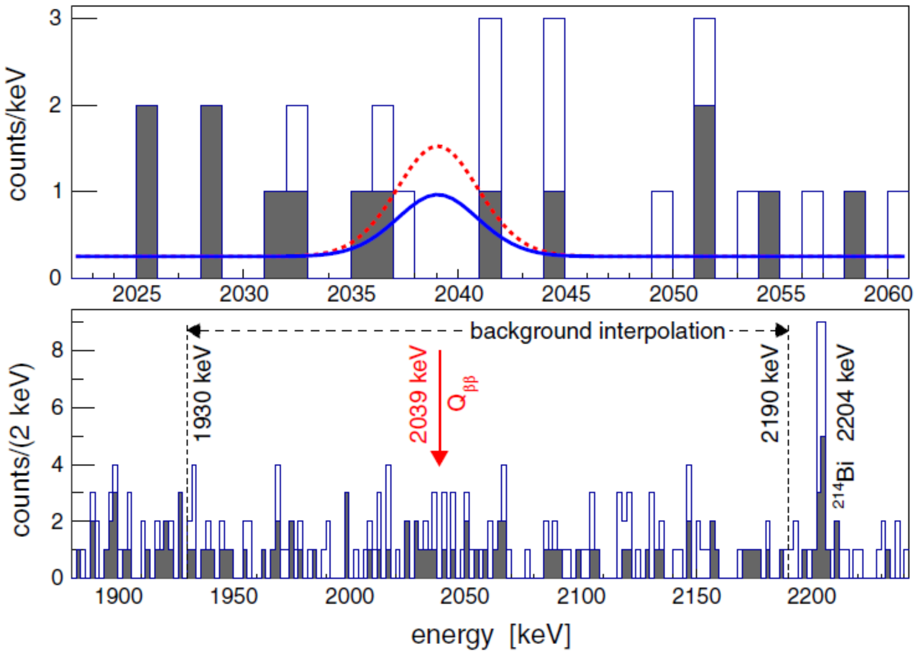
- *Founded in 2004*
- *Started data taking in 2010*

The GERmanium Detector Array

for the search of neutrinoless double beta decay in Ge-76
at the Laboratori Nazionali del Gran Sasso (LNGS)

The peak went missing?

- *Founded in 2004*
- *Started data taking in 2010*
- *2013 Klapdor claim strongly disfavored*



PRL 111, 122503 (2013)

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PHYSICS OF ELEMENTARY PARTICLES AND ATOMIC NUCLEI. EXPERIMENT

Why is the Conclusion of the Gerda Experiment Not Justified[1]

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Heidelberg, Germany

*e-mail: *prof.klapdor-kleingrothaus@hotmail.de; **irinakv57@mail.ru*

Abstract—The first results of the GERDA double beta experiment in Gran Sasso were recently presented. They are fully consistent with the HEIDELBERG–MOSCOW experiment, but *because of its low statistics cannot proof anything at this moment.* It is no surprise that the statistics is still far from being able to test the signal claimed by the HEIDELBERG–MOSCOW experiment. The energy resolution of the coaxial detectors is a factor of 1.5 worse than in the HEIDELBERG–MOSCOW experiment. The *original goal* of background reduction to 10^{-2} counts/kg y keV, or by an order of magnitude compared to the HEIDELBERG–MOSCOW experiment, *has not been reached.* The background is **only** a factor 2.3 lower if we refer it to the experimental line width, i.e. in units counts/kg y energy resolution. *With* pulse shape analysis (*PSA*) the background in the HEIDELBERG–MOSCOW experiment around $Q_{\beta\beta}$ is 4×10^{-3} counts/kg y keV [1], which is *a factor of 4 (5 referring to the line width) lower* than that of GERDA with pulse shape analysis. The amount of enriched material used in the GERDA measurement is 14.6 kg, only a factor of 1.34 larger than that used in the HEIDELBERG–MOSCOW experiment. The background model is oversimplified and not yet adequate. It is not shown that the lines of their background can be identified. GERDA has to continue the measurement further ~5 years, until they can responsibly present an understood background. The present half life limit presented by GERDA of $T^{0\nu}_{1/2} > 2.1 \times 10^{25}$ y (90% confidence level, i.e. 1.6σ) is still lower than the half-life of $T^{0\nu}_{1/2} = 2.23^{+0.44}_{-0.31} \times 10^{25}$ y [1] determined in the HEIDELBERG–MOSCOW experiment.

2. GENERAL DEFICIENCIES OF THE EXPERIMENT AND THE ANALYSIS

2.1. Half Life and Double Line

The conclusion that the result of the HEIDELBERG–MOSCOW experiment (a signal at a 6.4 σ c.l. [1]) is refuted, is *wrong.*

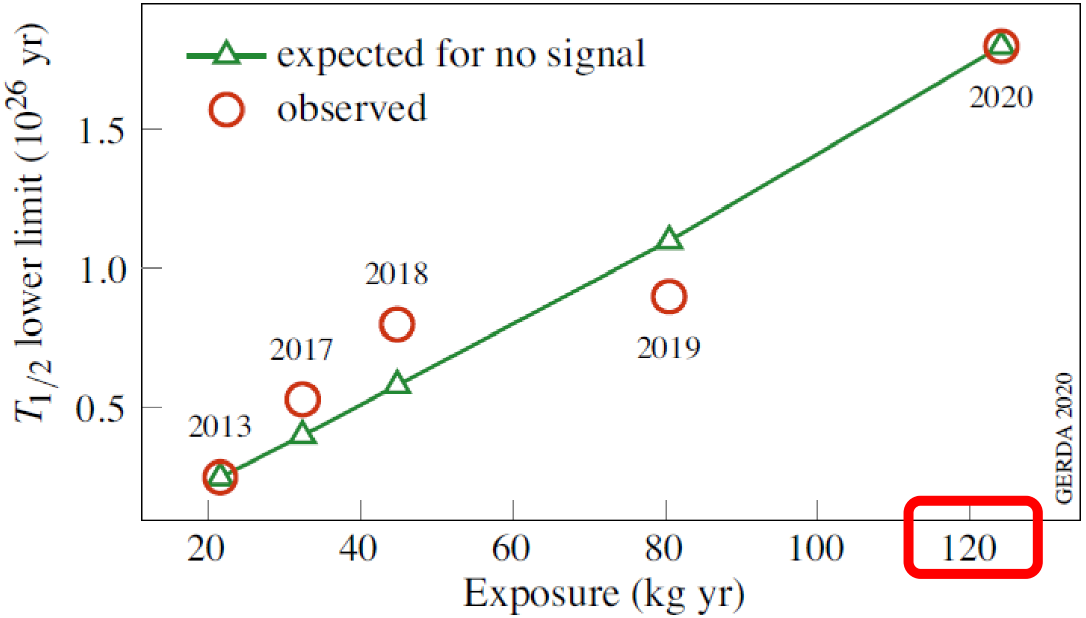
The reason is very simple. The authors of [6, 7], compare their result to the line at (2038.1–2038.5) ± 0.5(stat.) ± 1.2(syst.) keV in the *full* (not PSA—treated)

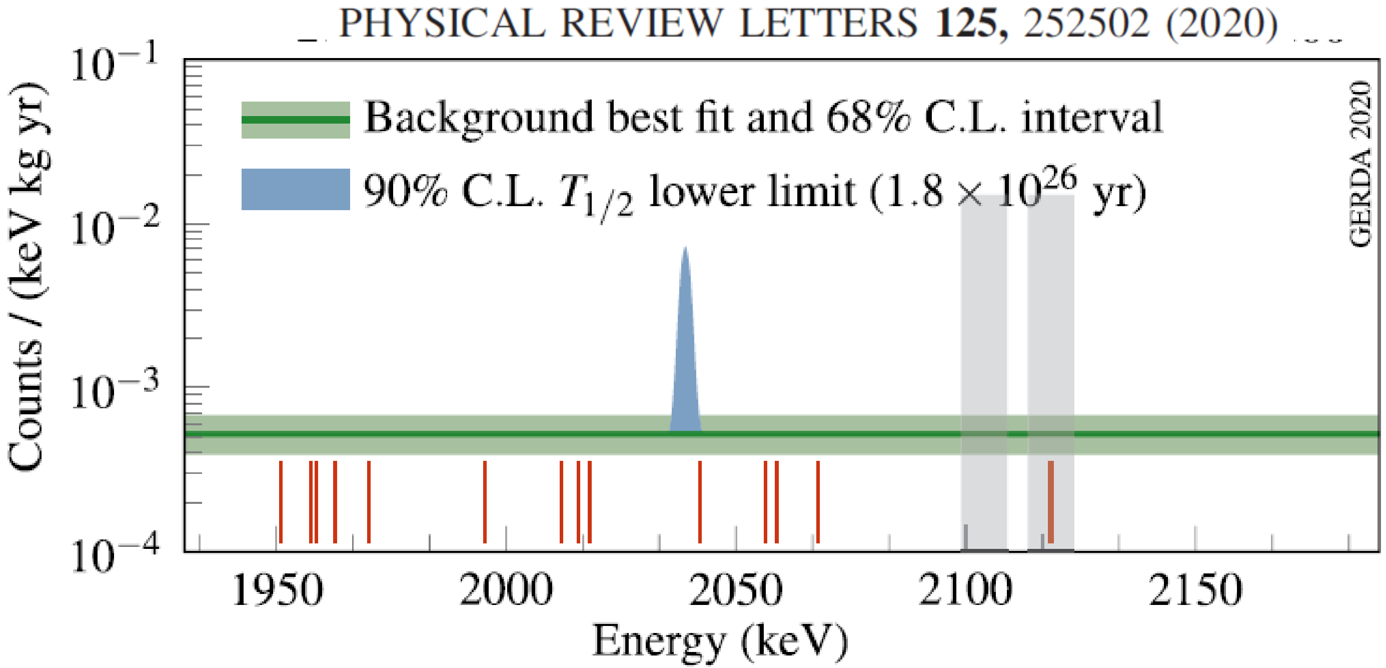
KK went missing since?

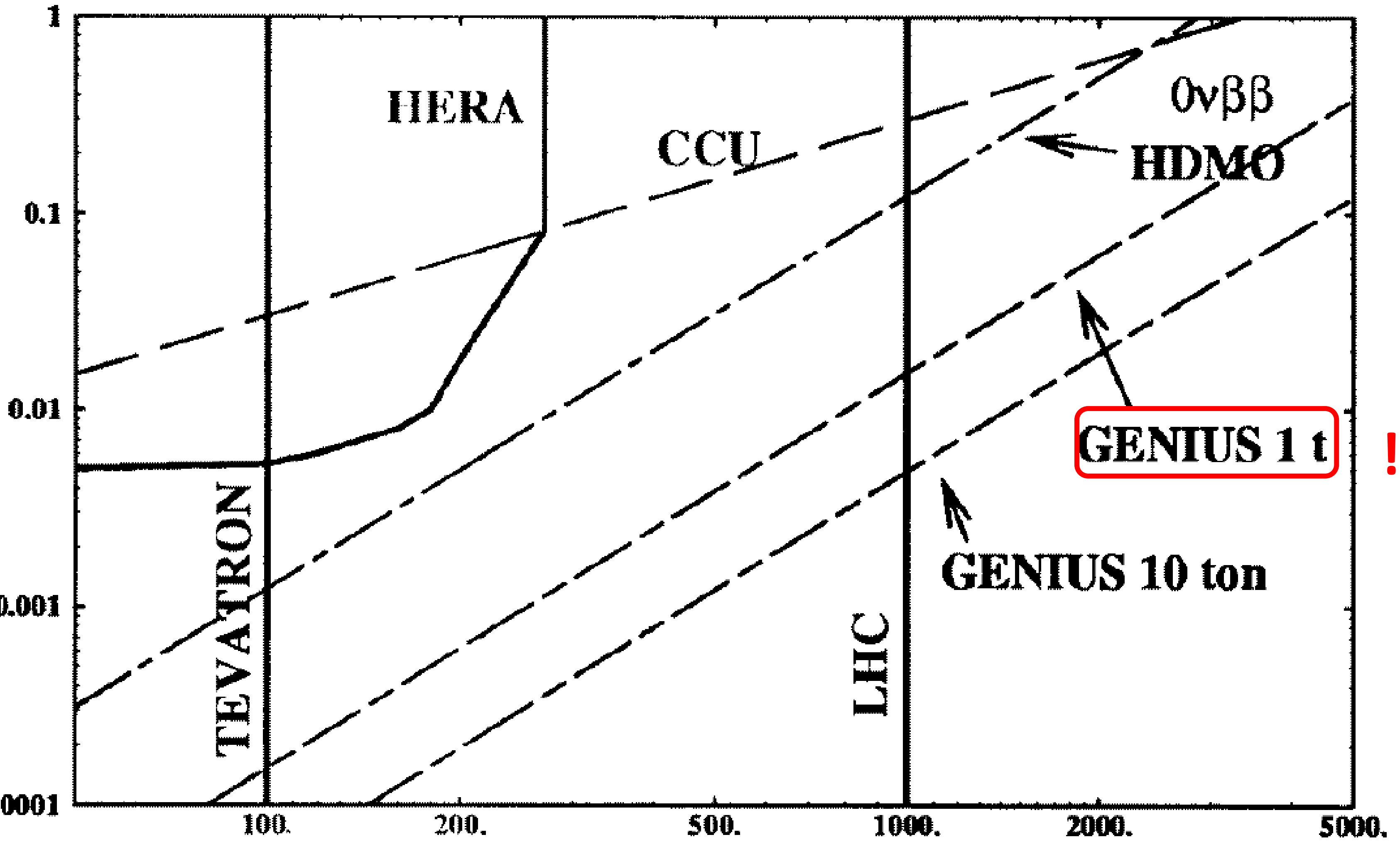
The GERmanium Detector Array

for the search of neutrinoless double beta decay in Ge-76 at the Laboratori Nazionali del Gran Sasso (LNGS)

- *Upgrade in 2015*
- *„Background free“ measurement until 2019:*
  120 kg yr exposure







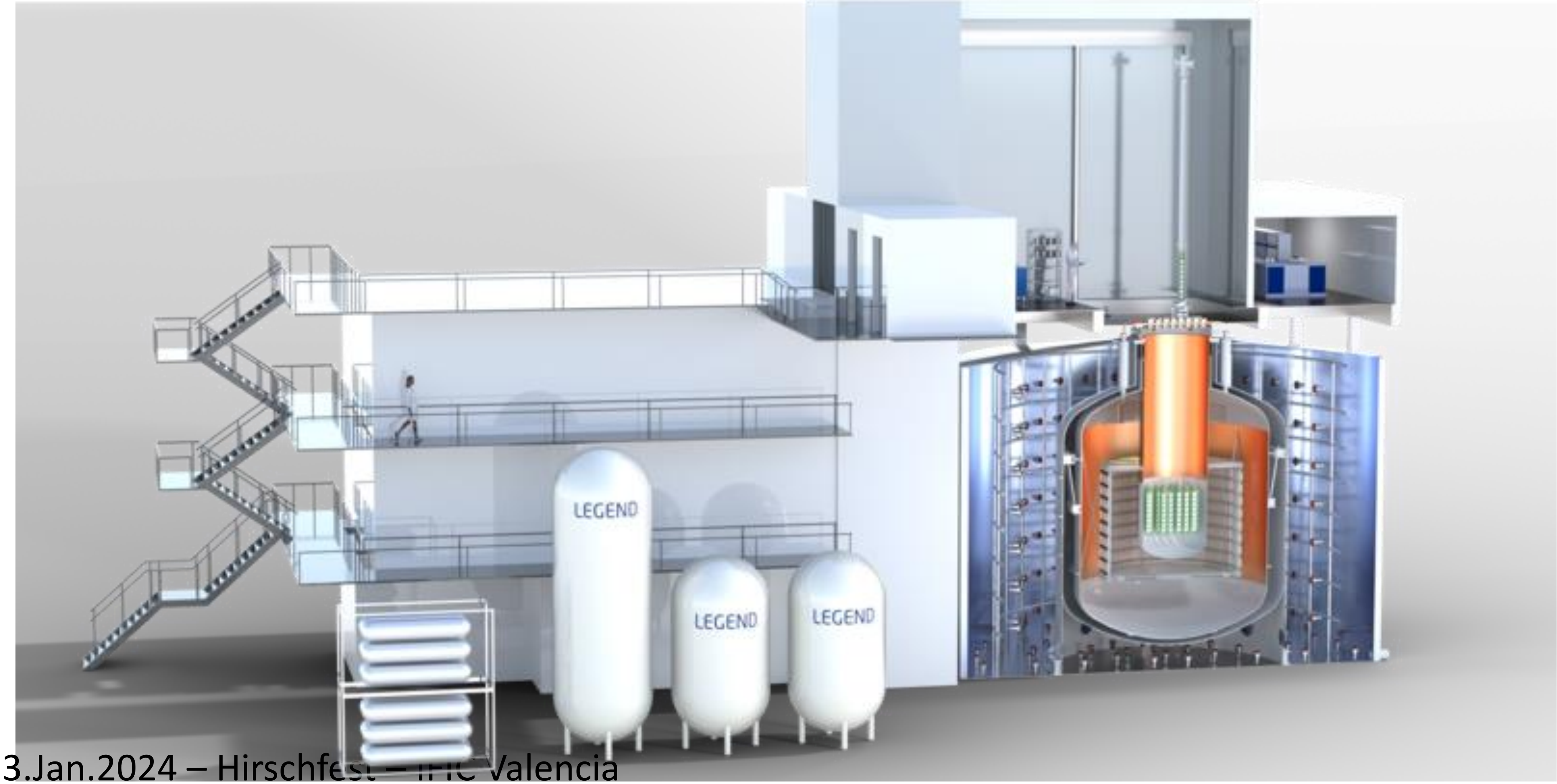
!!
We are missing the ton scale?

Béla Majorovits – Max-Planck-Institut für Physik

LEGEND

Large Enriched Germanium Experiment for Neutrinoless ββ Decay

Reaching the proposed GENIUS ton scale
Presently ~ 100 kg installed in old GERDA tank
Presently preaparing for US DOE CD1



Performance Parameters	
0νββ Isotope	^{76}Ge
Enrichment fraction	92%
Isotopic mass	910 kg
$Q_{\beta\beta}$	2039 keV
Energy resolution at $Q_{\beta\beta}$	2.5 keV FWHM
Overall analysis efficiency	0.70
Run time	10 yr
Background goal	< 0.03 cts/(FWHM·t·yr)
	< 10^{-5} cts/(keV·kg·yr)
$T_{½}^{0\nu}$	$1.4 \cdot 10^{28}$ yr (90% C.L. Sensitivity)
	$1.2 \cdot 10^{28}$ yr (3-σ Discovery)
$m_{\beta\beta}$	10 – 20 meV (3-σ Discovery)
	9 – 19 meV (90% C.L. Sensitivity)

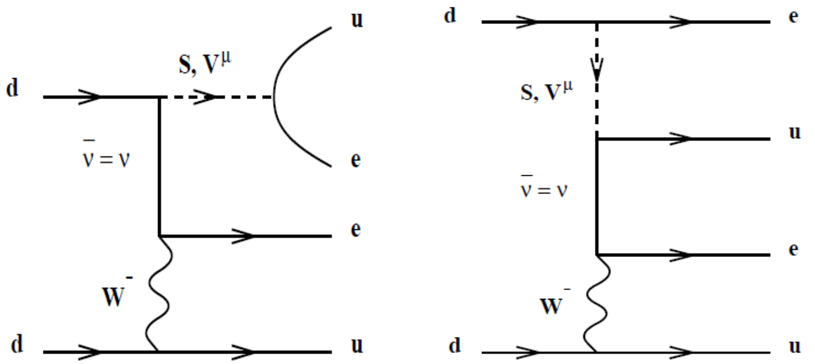


Figure 19. Examples of Feynman graphs for $0\nu\beta\beta$ decay within LQ models. S and V^{μ} stand symbolically for scalar and vector LQs, respectively (from [Hir96a]).

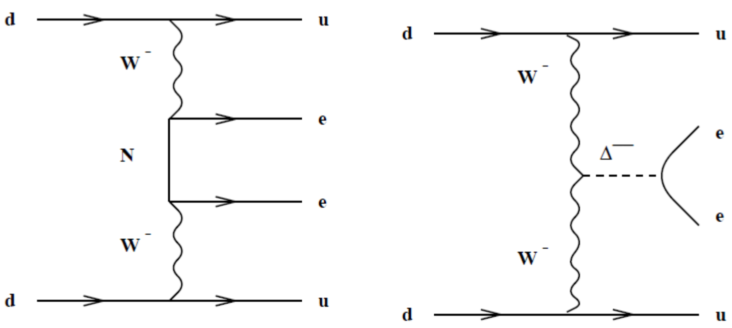
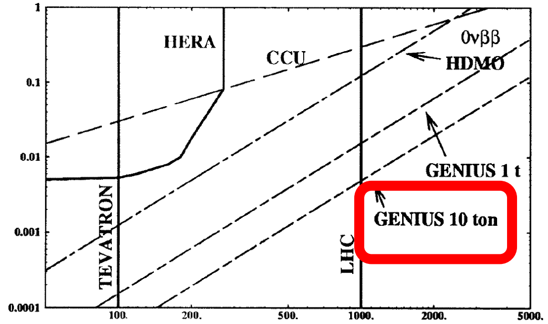


Figure 15. Left: Heavy neutrino exchange contribution to neutrinoless double beta decay in left-right symmetric models, and Right: Feynman graph for the virtual exchange of a double-charged Higgs boson (from [Hir96d]).

Der Doppelbetazerfall kann alles (Dr. M.Hirsch)



The show must go on!

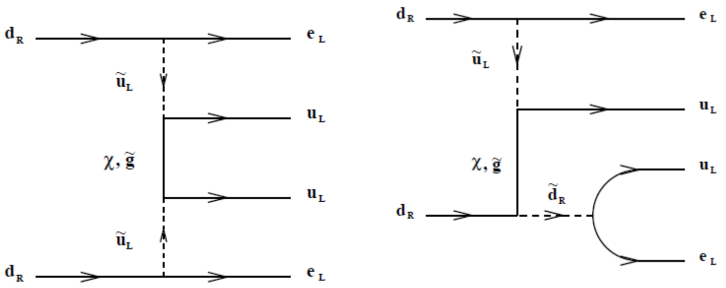


Figure 11. Examples of Feynman graphs for $0\nu\beta\beta$ decay within R–parity violating supersymmetric models (from [Hir95a]).

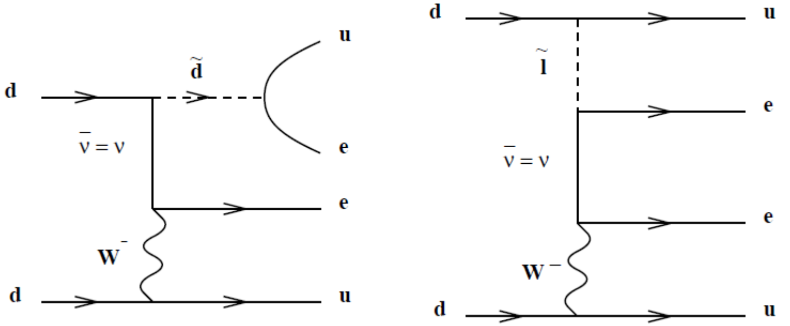


Figure 12. (left) Feynman graph for the mixed SUSY-neutrino exchange mechanism of $0\nu\beta\beta$ decay. R-parity violation occurs through scalar quark exchange. (right) As left figure, but for scalar lepton exchange (from [Hir96]).

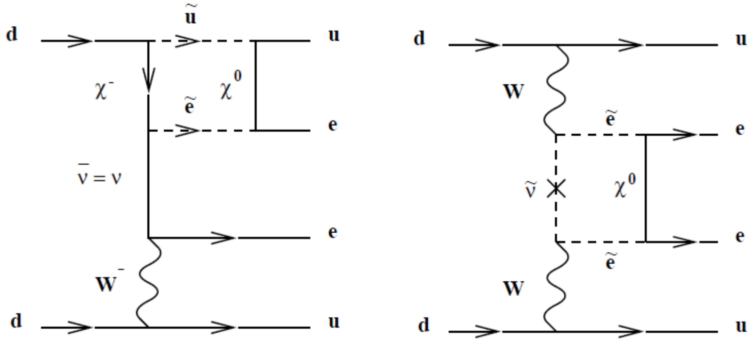


Figure 13. Examples of R_P conserving SUSY contributions to $0\nu\beta\beta$ decay (from [Hir9

Evidence for neutrinoless double beta decay

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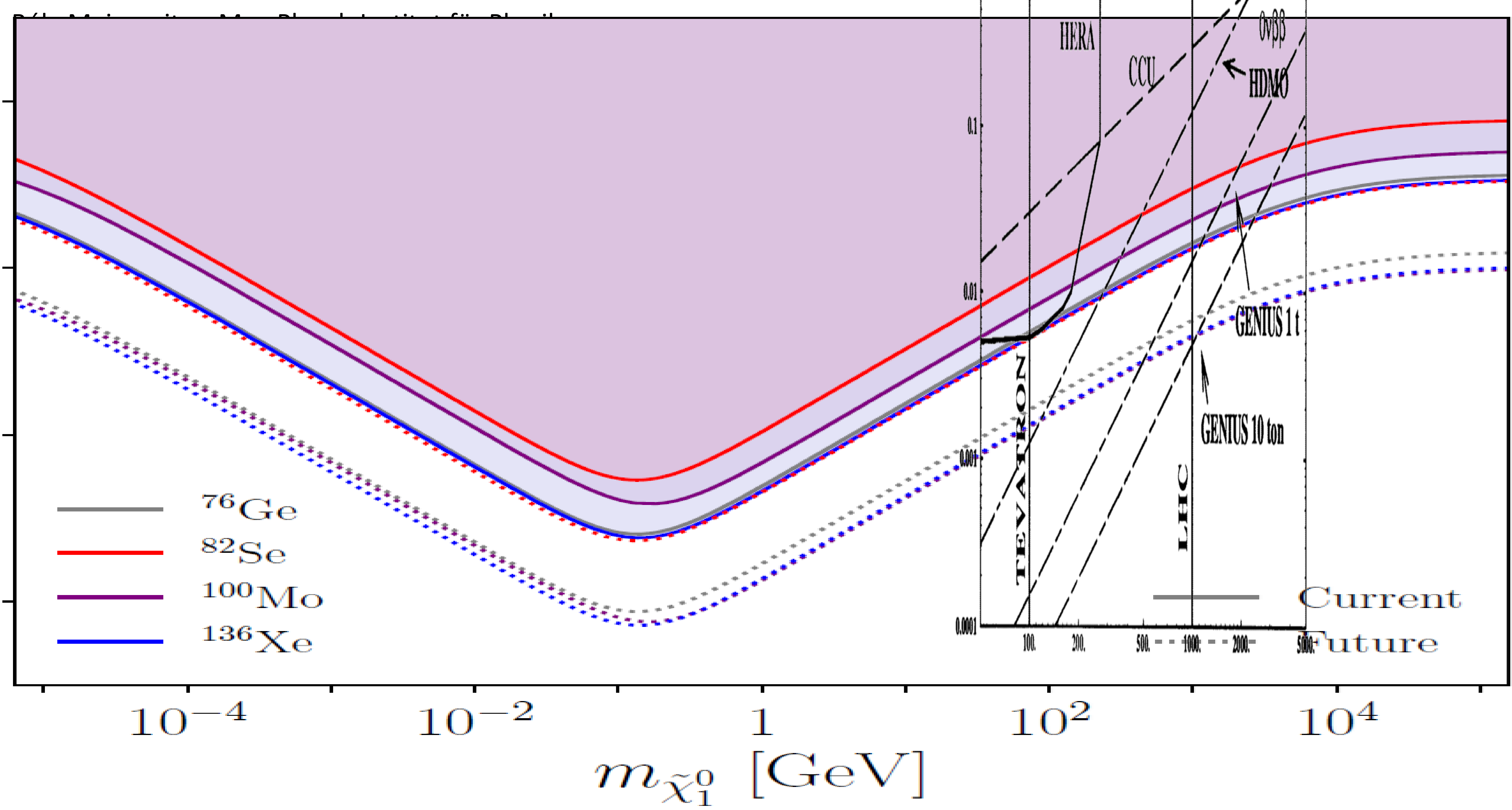

^{76}Ge
^{82}Se
^{100}Mo
^{136}Xe
Current
Future
10^{-4}
10^{-2}
1
10^{2}
10^{4}
$m_{\tilde{\chi}_1^0}$ [GeV]
HERA
CCU
$0\nu\beta\beta$
HDMO
GENIUS 1 t
GENIUS 10 ton
TEVATRON
LHC
0.1
0.01
0.001
0.0001
100.
200.
500.
1000.
2000.
5000.