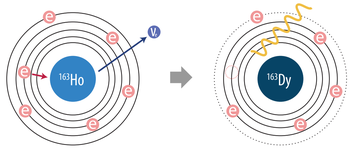
Data Reduction Algorithms for the ECHo Experiment

A. Barth[1] and R. Hammann[1]
for the ECHo Collaboration

[1]Kirchhoff Institute for Physics, Heidelberg University

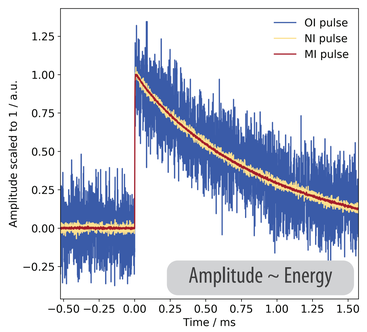
^{163}Ho and the Neutrino Mass



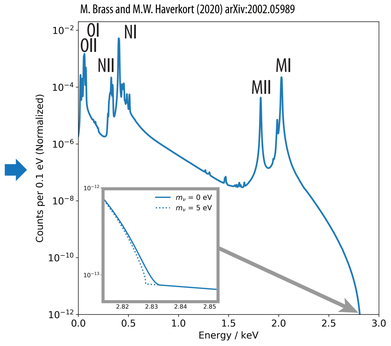
$$^{163}_{67}\mathrm{Ho} \rightarrow {}^{163}_{66}\mathrm{Dy}^{*} + \nu_e$$

$$^{163}_{66}\mathrm{Dy}^{*} \rightarrow {}^{163}_{66}\mathrm{Dy} + E_C$$

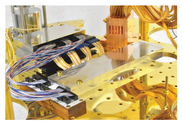
L. Gastaldo et al., EPJ ST 226, 8 (2017); A. De Rujula and M. Lusignoli, Phys. Lett (1982)



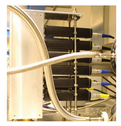
M. Brass and M.W. Haverkort (2020) arXiv:2002.05989



Data Acquisition



ECHo module with two-stage SQUID readout



SQUID readout electronics

SQUID connector box and ADC

- ΔT: Time difference to previous trace in any channel
- ΔT_{Ch}: Time difference to previous trace in one channel

^{163}Ho Event	• Energy independent pulse shape • Statistically distributed ΔT_{Ch}
Pileup on Tail	Inside time window ($\Delta T_{Ch} < 2$ ms) Outside time window ($\Delta T_{Ch} > 2$ ms)
Muon Event	Muon-induced shower → Coincident signal in multiple channels
Phone Signal	GSM mobile communication standard with well-defined pulse frequencies
Triggered Noise	Miscellaneous temporary electronic disturbances

Offline Data Reduction

First Level: Time Information Filter

Holdoff Filter
Discard traces with $\Delta T_{Ch} < T_{Holdoff}$

Burst Filter
Discard time intervals with abnormally high rate

Coincidence Filter
Discard traces with $\Delta T < 8$ µs

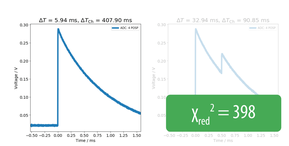
GSM Filter
Discard traces with ΔT associated to GSM pulse frequencies

Second Level:

Template Fit
- Create mean pulse from traces by cross-fitting traces in batches
- Fit traces to template to recover amplitude and χ^2_{red}

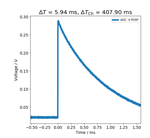
Pulse Shape Filter
Discard traces with high deviation from template

Application of Filters

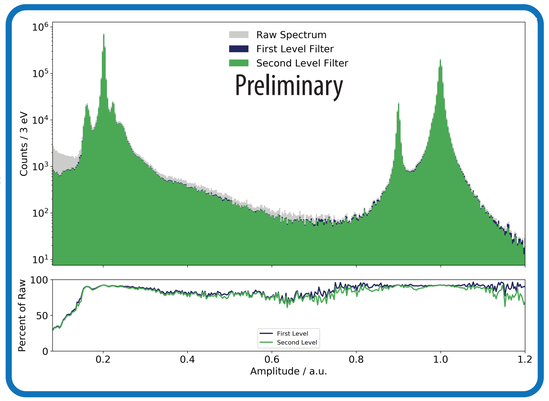


Further Steps to Final Spectrum:

- ☐ Temperature correction
- ☐ Energy calibration



Spectrum after **Data Reduction**



Conclusions

- Energy-independent data reduction
- Data reduction allows for reliably selecting thermal pulses corresponding to signal events in the calorimeter
- Algorithms suitable to be implemented online
- GSM signals can be screened in future experiments
  → disable GSM Filter
  → avoid discarding good pulses
- Algorithms can be adapted for ECHo-100k

The ECHo Experiment

Funded by DFG