Software for analysis of waveforms acquired by digital Doppler broadening spectrometer

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- Data analysis can be repeated several times to optimize its parameters and to filter out pulses damaged by pile-up or by ballistic deficit.
- Tedious adjustment of the analogue NIM devices is not necessary anymore.
- Improved data quality: lower background, better energy resolution (pure-digital setup)

Waveform analysis: • Determine number of pulses and initial values of their amplitudes and positions. • Fit waveform by model function:



References [1] Čížek J, Vlček M and Procházka I 2010 Nucl. Instrum. Meth. A 623 982-994 [2] Čížek J, Vlček M and Procházka I 2012 New Journal of Physics 14 035005

Source code and pre-compiled binaries available at http://physics.mff.cuni.cz/kfnt/us/groups/pas/software.html

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Advantages of digital spectrometers

• All detector signals are recorded and accessible for later analysis.

DCDB Software package

The DCDB Software package includes following programs:

- **DCDB Gen** : Generates synthetic data for testing purposes.
- DCDB MPI: Analyzes raw pulses from detectors by fitting them with model function. Fitted parameters are stored in intermediate binary files readable by DCDB Hist program.
- **DCDB Hist**: Calibrates energy and generates 1D and 2D spectra from intermediate binary files created by DCDB MPI program.

$$f(t) = f_{main}(t) + f_{pile-up}(t) + f_{prec}(t) + bcg$$

$$_{main}(t) = \left[\frac{1}{\beta_3\sqrt{2\pi}}\exp\left(-\frac{t^2}{2\beta_3^2}\right)\right] \star \left[\beta_0 H_s(t-\beta_2)\exp(-\beta_1(t-\beta_2))\right]$$

$$_{ile-up}(t) = \left[\frac{1}{\beta_3\sqrt{2\pi}}\exp\left(-\frac{t^2}{2\beta_3^2}\right)\right] \star \left[\beta_4 H_s(t-\beta_5)\exp(-\beta_1(t-\beta_5))\right]$$

$$f_{prec}(t) = \beta_6 \exp(-\beta_1 t)$$

• Energy is directly proportional to the amplitude of the main pulse β_0 . • Waveforms damaged by pile-up or by ballistic deficit are discarded by χ^2 filter.

χ^2 filter

Conclusion

- Software for off-line analysis of pulse signals from HPGe detectors has been developed. Two configurations were considered:
- (i) semi-digital setup where pulses shaped in SA are sampled;
- (ii) pure digital setup where pulses from detector pre-amplifiers are digitized directly.
- The algorithms employed in software analysis are described. Software developed in this work is freely available in the form of source code and pre-compiled binaries.



