Instructions how to perform an energy calibration in the MARaBQQU environment

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Abstract

This document describes how to perform an energy calibration by use of MARaBQQU's `MacroBrowser` and the `ROOT` macro `Encal.C`.

1 How to perform an energy calibration

To perform an energy calibration (gamma or particle) call the `MacroBrowser`:

```
MacroBrowser
```

A menu will then pop up showing several `ROOT` macros. Choose `Encal.C` from this list.

You'll get a form (fig. 1) to specify parameters needed to start the calibration:

- `Histogram file (.root)`
  Click on the folder button and choose the `ROOT` file containing your calibration spectra. Then select some histograms from the list below either by **range** (first . . . last) or one by one (**single**). Press `apply` to accept selection, `clear` to reset list.
- `Calibration source`
  Choose `Co60` or `Eu152` for gammas, `TripleAlpha` for particles
- `Calibration energies`
  Enter file containing calibration energies. Default is `$MARABOU/data/encal/energies.dat`. See 2.3 for a format description.
- `Calibration data`
  Where to write calibration data (extension `.cal`).
  Calibration data will be formatted according to `ROOT`'s resource format (ROOT object `TEnv`, 2.1);
- `Calibration results`
  Where to write detailed calibration results (extension `.res`). Same formatting rules as for `.cal` files apply (2.2).
- `Fit results`
  `ROOT` file where to store histograms together with fit data as well as liniear regression data (extension `.root`).
- `Clear output files`
  Click `yes` to remove existing files (`.cal` and `.res`) on start. If `no` is chosen new data will be appended to existing files, existing items will be overwritten with new values.
- `Precalibration file`
  To get an `Eu152` calibration you have to preform a `Co60` calibration step first in order to assign gamma energies to peak centers. The name of the `Co60` calibration file from a previous run has to be given here.
- `Lower/Upper limit`
  Limits of the display/fit region (channels)
- `Threshold for peak finder`
  Relative height of peaks taken into account given by percentage of maximum peak (continued on next page)

- `Sigma`
  `sigma` value for gaussian fit
- `Fit mode`
  Either `gauss` or `gauss+tail`: how to fit lines in the histogram.
- `Fit grouping`
  You may fit `single` peaks or an `ensemble` of peaks (may give better results for `Co60` and `TripleAlpha` calibrations).
- `Background`
  You have the choice between a `const` or `linear` background.
- `Range for peak fit`
  Set lower and upper limits for the peak fit region (single peak or group fitting), given in units of `sigma`.
- `Display results`
  Check button `step` to stop after each fit, check `2dim` to display a two-dim histogram containing re-calibrated histograms line by line.
- `Verbose`
  Choosing button `yes` will output some diagnostics to `stdout`.

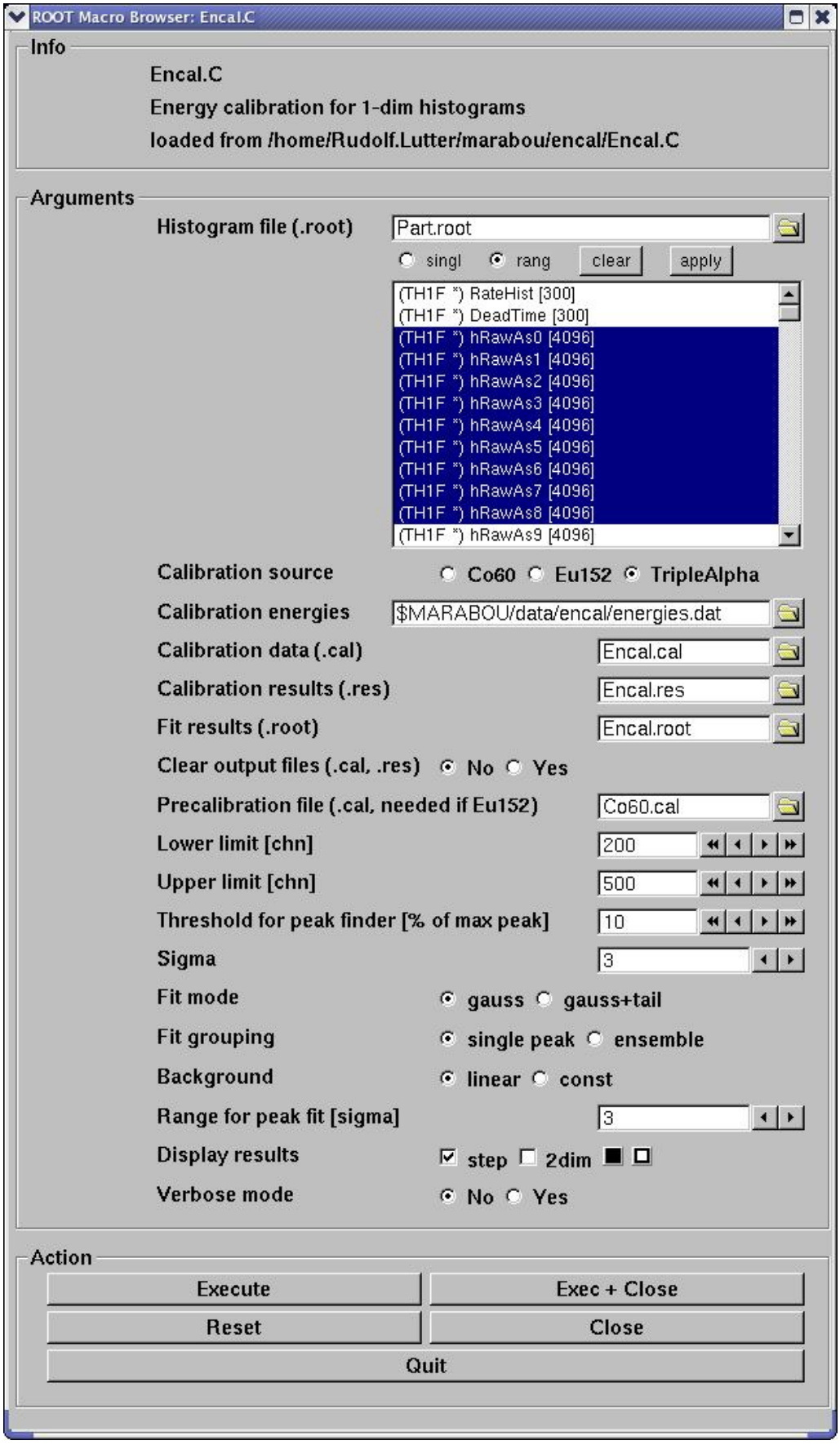

Figure 1: `Encal.C`: how to perform an energy calibration

Press `Execute` to start the calibration.

A new window will pop up showing fit results (fig. 2).

The upper part shows peak centroids (blue markers) as returned by the peak finder together with the gaussian fit (red curve).
The lower part shows the linear regression results when assigning alpha lines 5.157 MeV (^{239}Pu), 5.486 MeV (^{241}Am), and 5.865 MeV (^{244}Cm) to peaks, respectively.
The title bar below the graphs shows the resulting calibration formula `E(x) = a0 + a1 * x`.

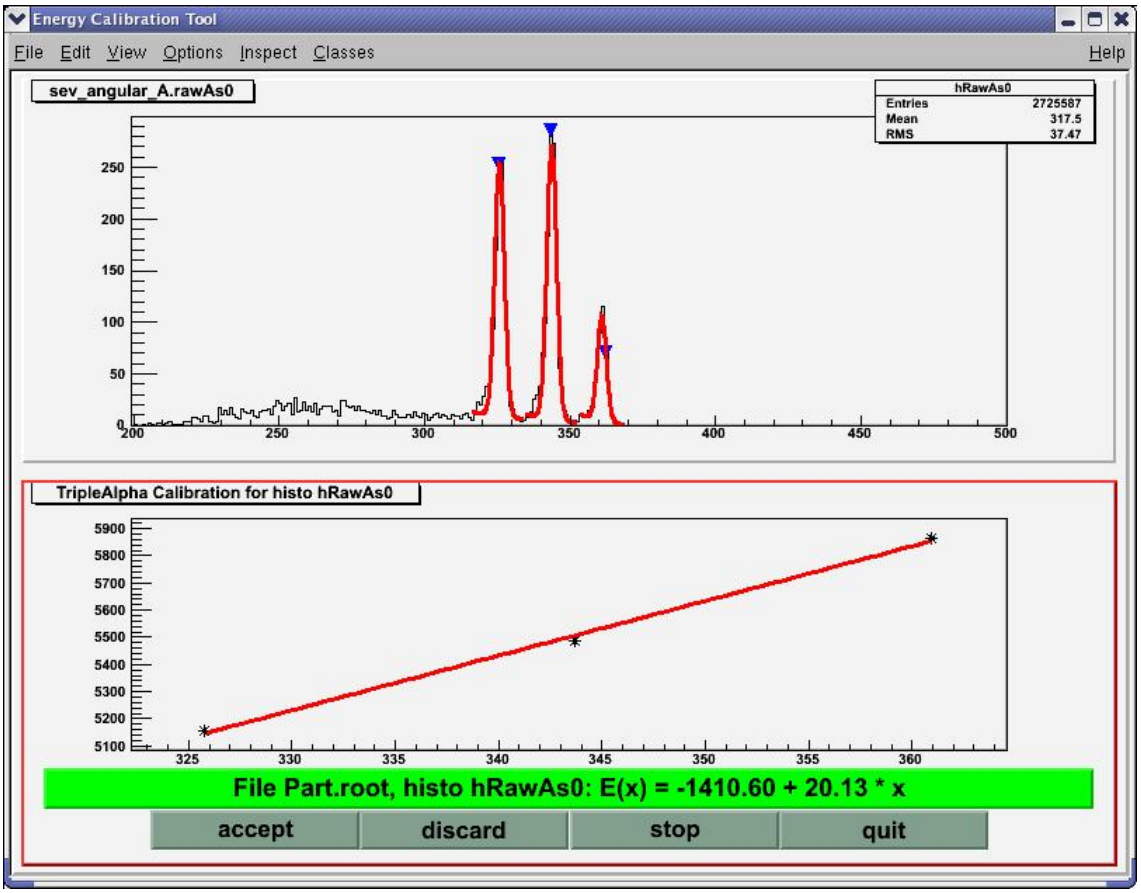

Figure 2: `Encal.C`: fit and calibration results

If you have chosen `step` mode you now have to press one of the buttons at the bottom edge of the display:

- `accept` add calibration data to output file (`.cal`) and continue with next histogram.
- `discard` discard calibration and continue with next histogram.
- `stop` leave calibration loop and return to `MacroBrowser`'s menu (fig. 1).
- `quit` close files and exit from `ROOT`.

If you checked the `2dim` button you will get a two-dimensional histogram showing calibrated histograms line by line (fig. 3).
From this plot you can see immediately that calibration of histogram `hRawAs1` didn't give satisfactory results. Now try the following:

- Go back to `MacroBrowser`'s menu (fig. 1)
- Reset the histogram list by pressing `clear`
- Select histogram `hRawAs1` from the list (button `apply`)
- Change flag `Clear output files` to `no`
- Change the `sigma` value to `2`
- Press `Execute` to start over

The new fit data for histogram `hRawAs1` will then overwrite the existing ones without changing other entries. You then end up with fig. 4.

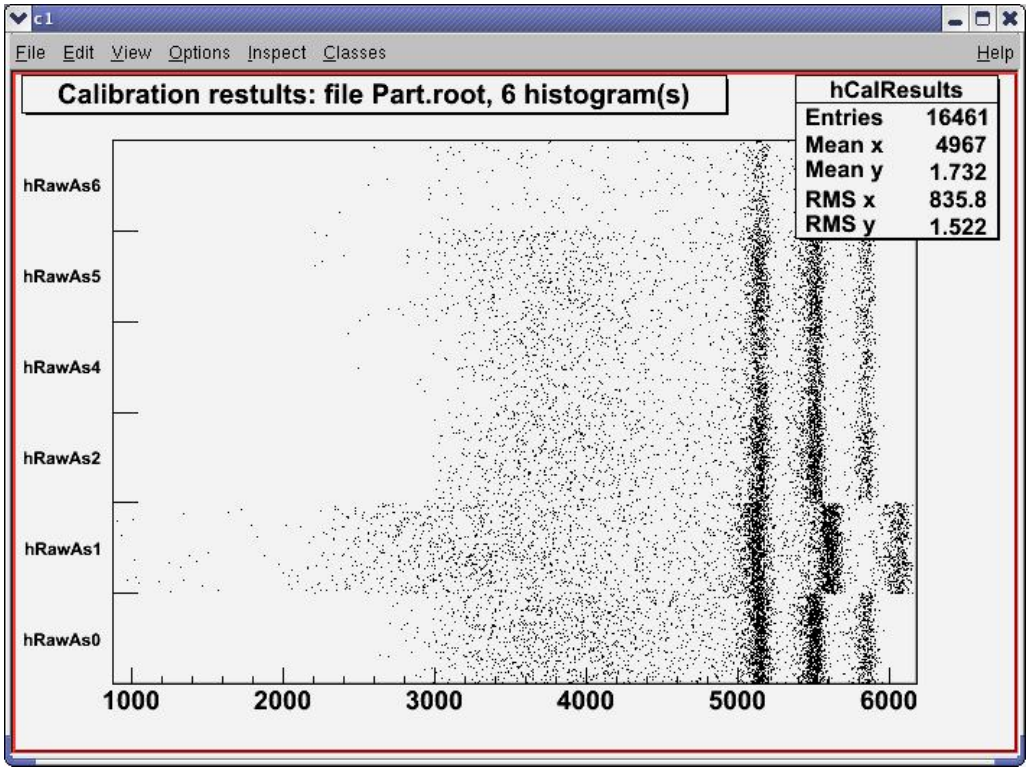

Figure 3: `Encal.C`: 2-dim plot of calibrated histograms, first try

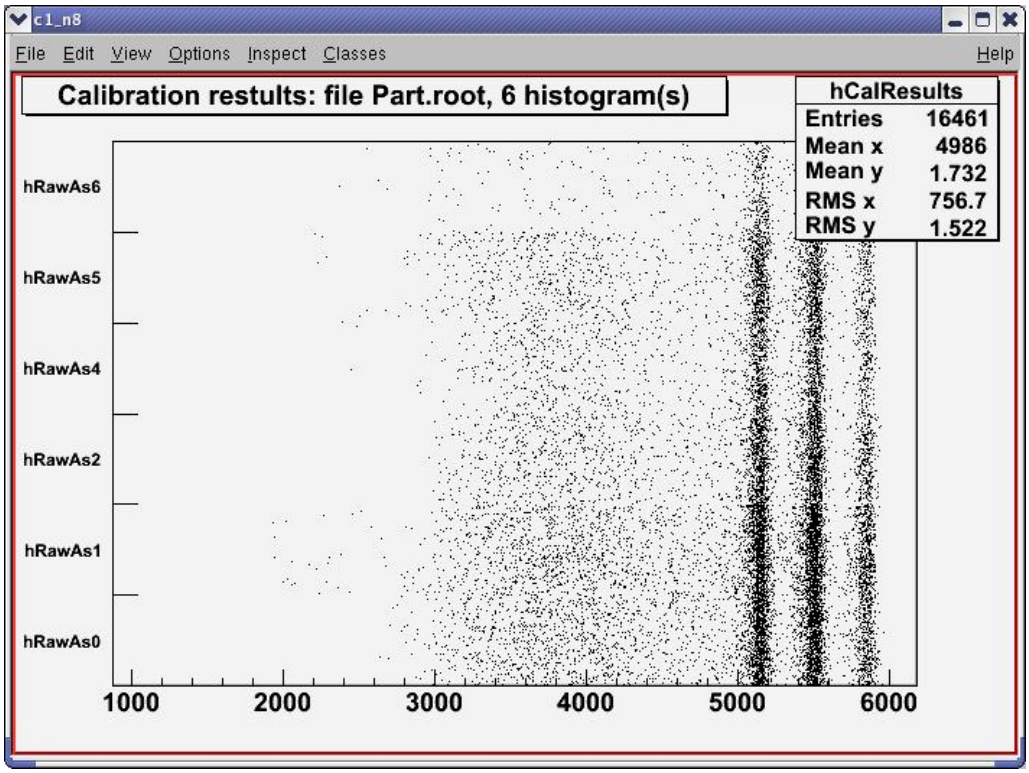

Figure 4: `Encal.C`: 2-dim plot after re-fitting

2 File formats

2.1 Calibration data (extension .cal)

A calibration data file (extension .cal) generated by Encal.C is formatted according to ROOT's resource format (see ROOT documentation, object TEnv). It consists of a header followed by entries for each histogram.

Header	Calib.ROOTFile: <HistoFile>.root Calib.Source: Co60 or Eu152 or TripleAlpha Calib.Energies: <path to file containing calib energies> Calib.NofHistograms: <NH>
Entry (1 per histo)	Calib.<HistoName>.Xmin: <lower limit> Calib.<HistoName>.Xmax: <upper limit> Calib.<HistoName>.Gain: <gain a_1> Calib.<HistoName>.Offset: <offset a_0>

This file may be read in directly to the data acquisition program by use of method TMrbAnalyze::ReadCalibrationFromFile(

2.2 Detailed calibration results (extension .res)

In addition to the calibration data file (2.1) detailed fit results will be written toa file with extension .res. Its format is similar to that of the .cal file but contains much more information.

Header	Calib.ROOTFile: <HistoFile>.root Calib.Source: Co60 or Eu152 or TripleAlpha Calib.Energies: <path to file containing calib energies> Calib.NofHistograms: <NH> Calib.Emin: <minimum energy over all histos> Calib.Emax: <maximum energy> Calib.Xmin: <minimum channel> Calib.Xmax: <maximum channel>
Histo entry (1 per histo)	Calib.<HistoName>.Xmin: <lower limit> Calib.<HistoName>.Xmax: <upper limit> Calib.<HistoName>.NofPeaks: <NP> Calib.<HistoName>.Gain: <gain a_1> Calib.<HistoName>.Offset: <offset a_0> Calib.<HistoName>.FitOk: TRUE, FALSE, or AUTO
Peak entry (1 per peak per histo)	Calib.<HistoName>.Peak.<I>.X: <centroid peak finder> Calib.<HistoName>.Peak.<I>.Xfit: <centroid gaussian fit> Calib.<HistoName>.Peak.<I>.Xerr: <centroid error> Calib.<HistoName>.Peak.<I>.Y: <amplitude peak finder> Calib.<HistoName>.Peak.<I>.Yfit: <amplitude gaussian fit> Calib.<HistoName>.Peak.<I>.Yerr: <amplitude error> Calib.<HistoName>.Peak.<I>.Chi2: <chisquare gaussian fit>

2.3 Calibration energies

Calibration energies have to be provided as ROOT resources (see ROOT documentation, object TEnv).

Header	Calib.NofCalibrations: <NC> Calib.SourceNames: <Source1>:<Source2>:...:<SourceNC>
Entry (1 per line per source)	Calib.<SourceN>.NofLines: <NL> Calib.<SourceN>.Line.<I>.E: <energy> Calib.<SourceN>.Line.<I>.Eerr: <error>