Intercalibration by optimizing resolution

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Fitting calibration constants

Goal: check if we can improve the resolution by fitting the intercalibration constants.

- Fit simultaneously all intercalibration constants to get the “best” energy resolution.
- Energy resolution taken as the core resolution of a binned fit to the data with a crystal Ball function (a fit is performed for each set of parameters).
- Include temperature corrections determined during TB*

Data used for this fit:

- Run 350 & 351 : beam on crystal 12,1 GeV, High gain
- Cherenkov signal compatible with electron hypothesis
- Temperature correction: -0.002/degree
- Check effect on subsequent runs

Note: The parameters are very correlated and the minimum region is quite flat, so the uncertainties are quite large. **Take these results with caution.**

* http://blog.hep.caltech.edu/wiki/index.php/Temperature_corrected_inter_calibration_Oct28_update

Fitting method

Idea: we perform a fit in the fit.

- Fit the 24 intercalibration constants (constant of central crystal (12) is fixed to 1) to minimize the energy resolution. The latter is defined as the core resolution (σ) of the Crystal Ball function used to fit the energy spectrum.

- The core resolution is obtained by another fit (secondary fit) for a given set of calibration constants. The energy distribution is recalculated using this set of constants, including all corrections, and fitted with a Crystal Ball function.

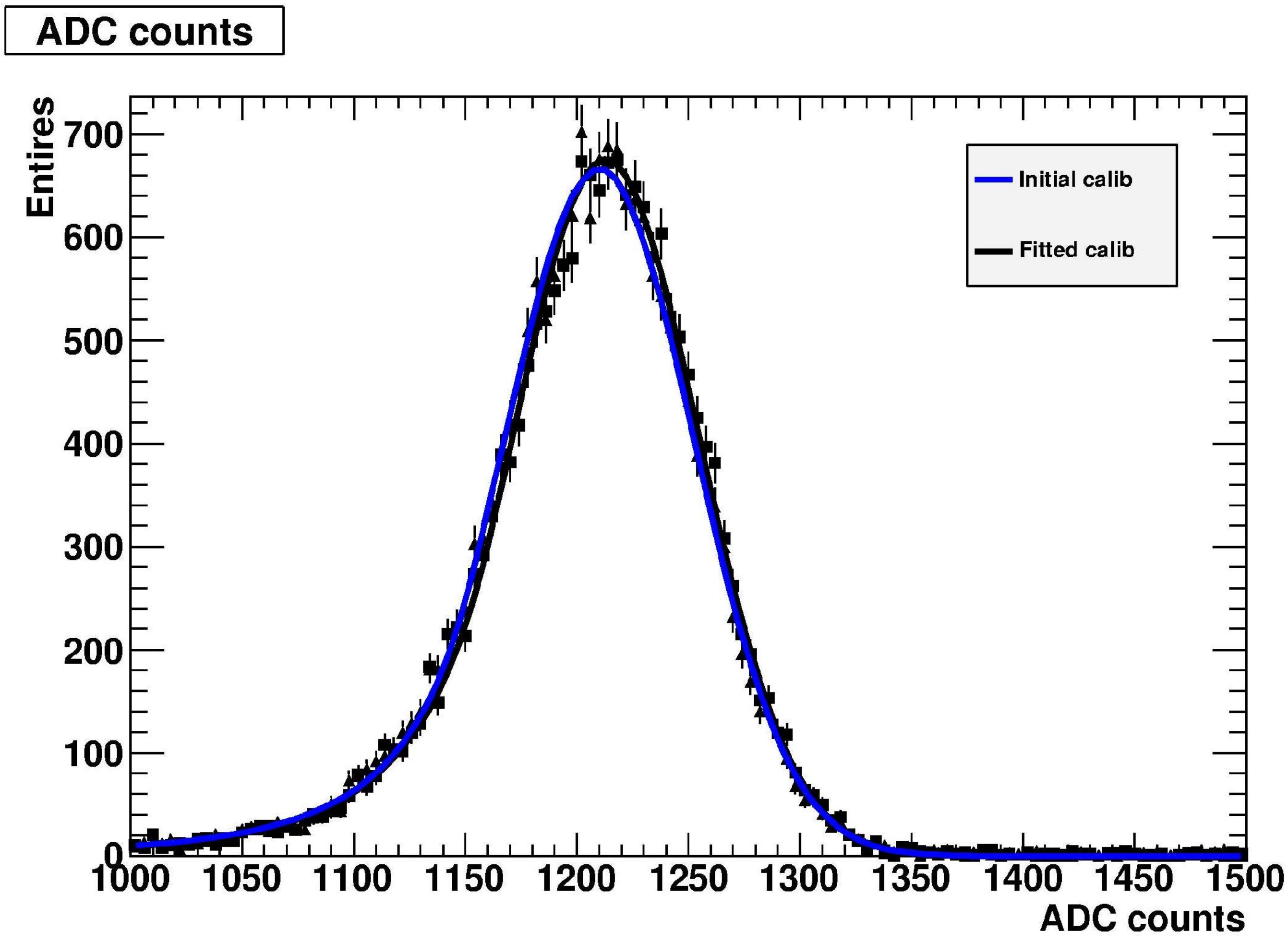
- At each step, we make sure the secondary fit converges properly (even a single failed fit can alter the convergence of the primary fit).

- Use the calibration constants measured by fitting the m.i.p for each crystal separately as starting values (Test beam result).

- All parameters are heavily correlated, and the results of the fit depends on the amount of data used and fitting range.

This works, but this needs more data to produce really “stable” results

Results (Run 350 & 351)



Initial Resolution

σ_E/E = 3.51 ± 0.03 %

HWHM/E = 4.1 %

Fitted resolution

σ_E/E = 3.42 ± 0.03 %

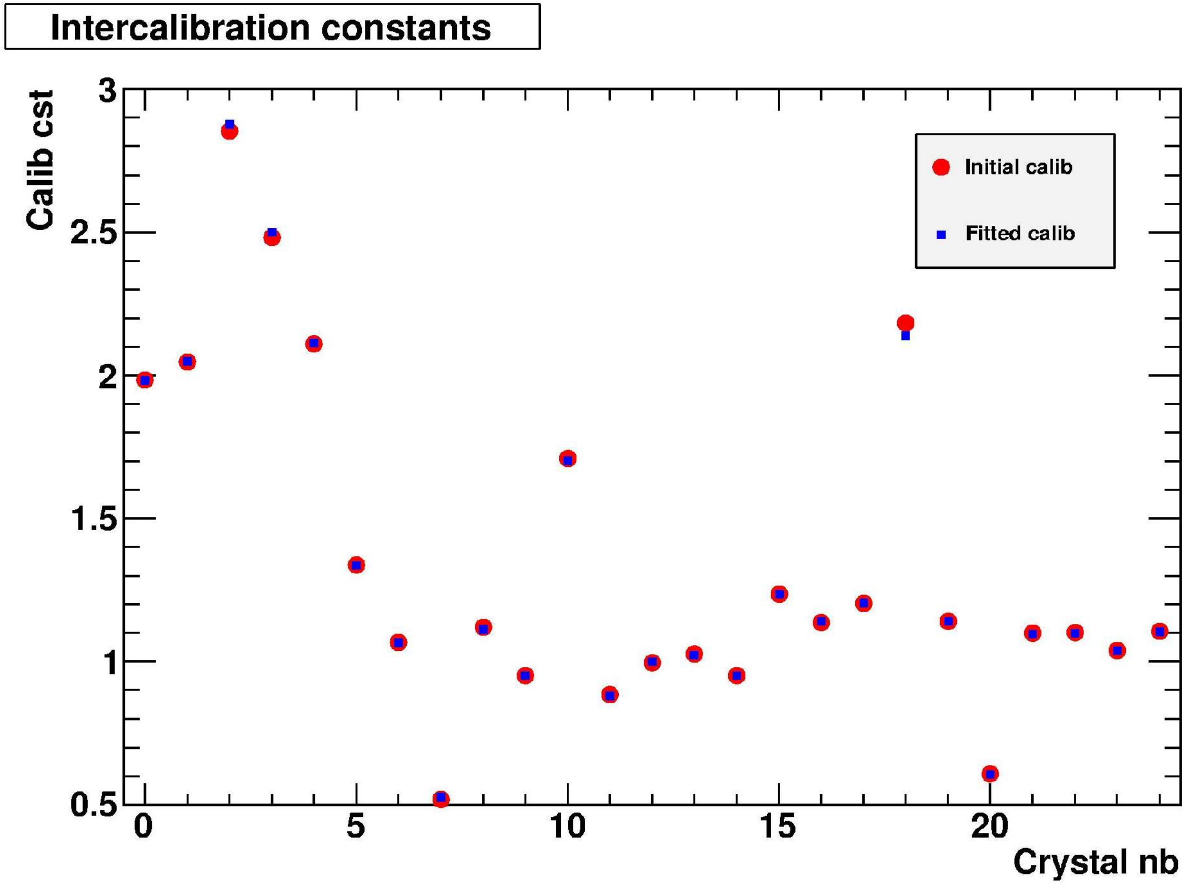
HWHM/E = 4.0 %

Uncertainty on σ_E = 0.8%

Small improvement, fit converges to values similar to initial values

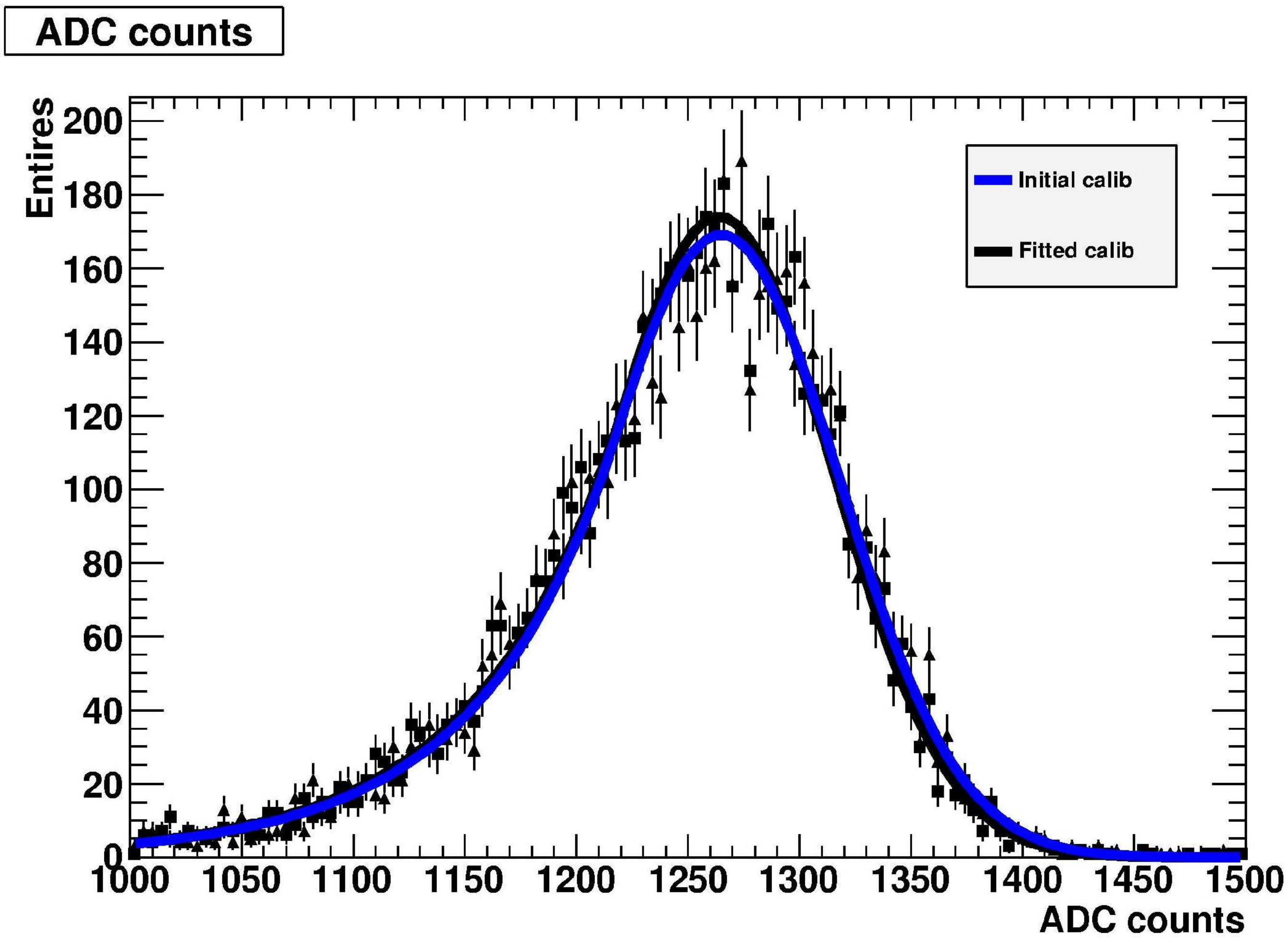
Fitted intercalibration constants

Crystal	Fitted Ci	(Initial Ci)
0	1.98439 +- 0.5751	(1.982)
1	2.04664 +- 0.6154	(2.049)
2	2.85352 +- 0.8273	(2.877)
3	2.48211 +- 0.7348	(2.499)
4	2.10942 +- 0.5152	(2.114)
5	1.33844 +- 0.0981	(1.336)
6	1.06659 +- 0.0483	(1.065)
7	0.51931 +- 0.0526	(0.527)
8	1.11930 +- 0.0903	(1.113)
9	0.95104 +- 0.2569	(0.951)
10	1.71011 +- 0.5132	(1.702)
11	0.88447 +- 0.0091	(0.88)
12	1 (1)	
13	1.02575 +- 0.0433	(1.022)
14	0.95213 +- 0.2846	(0.951)
15	1.23601 +- 0.3639	(1.237)
16	1.13607 +- 0.0404	(1.14)
17	1.20291 +- 0.0465	(1.206)
18	2.18197 +- 0.6573	(2.139)
19	1.13969 +- 0.2649	(1.14)
20	0.60775 +- 0.1797	(0.606)
21	1.10037 +- 0.3281	(1.095)
22	1.10278 +- 0.3200	(1.099)
23	1.03874 +- 0.3002	(1.039)
24	1.10562 +- 0.3250	(1.103)



Large uncertainties for outer crystals, need more data to reduce them

No fit, apply simply new intercalibration constants



Initial Resolution

σ_E/E = 4.2 ± 0.1 %

HWHM/E = 5.1 %

Fitted resolution

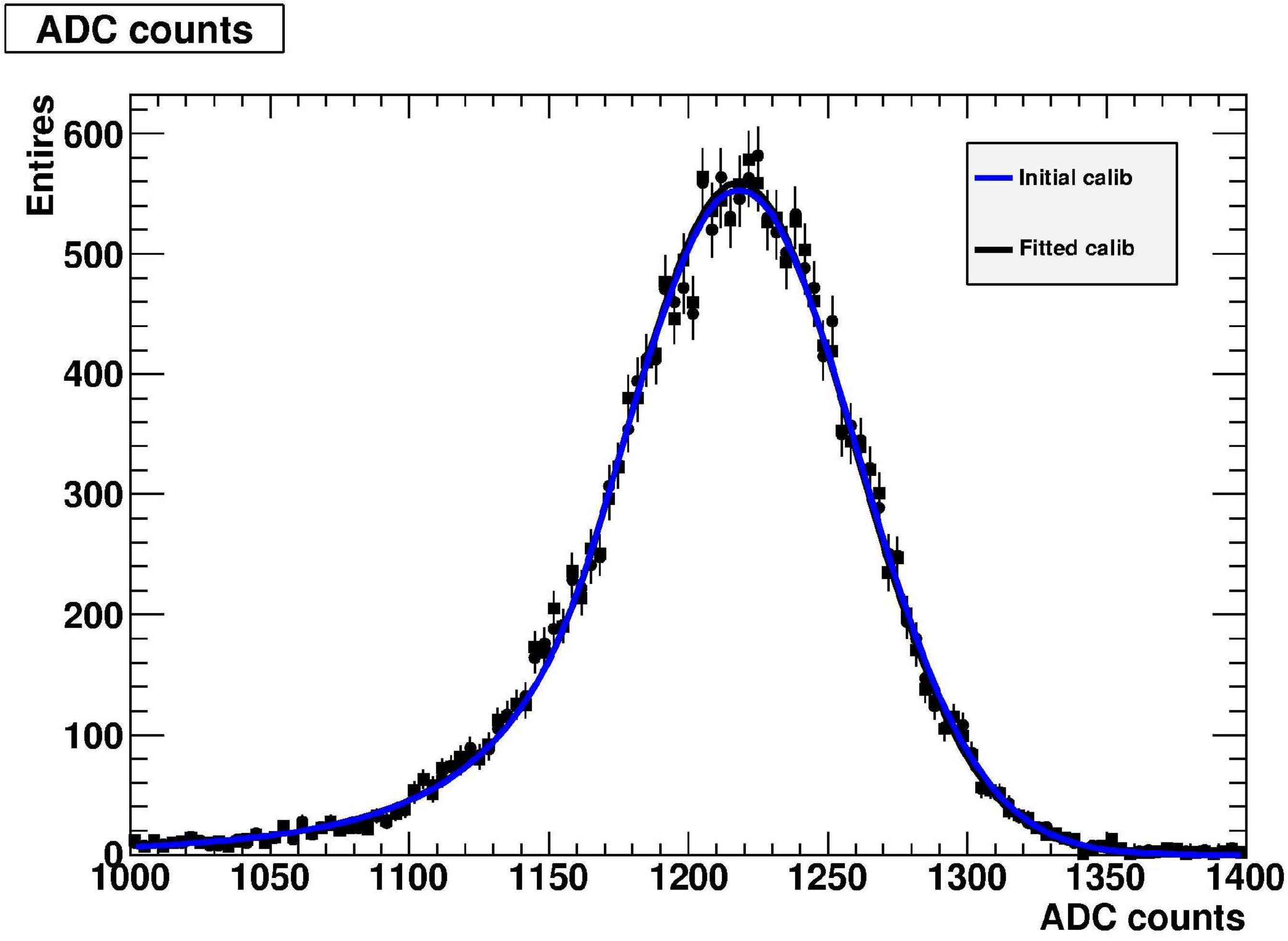
σ_E/E = 4.0 ± 0.1 %

HWHM/E = 4.9 %

Uncertainty on σ_E = 1.7%

Note that difference in quadrature of σ_E/E ~ 1-1.5%

Fitting all crystal with new constants from Elisa



Initial Resolution

σ_E/E = 3.48 ± 0.03 %

HWHM/E = 4.1 %

Fitted resolution

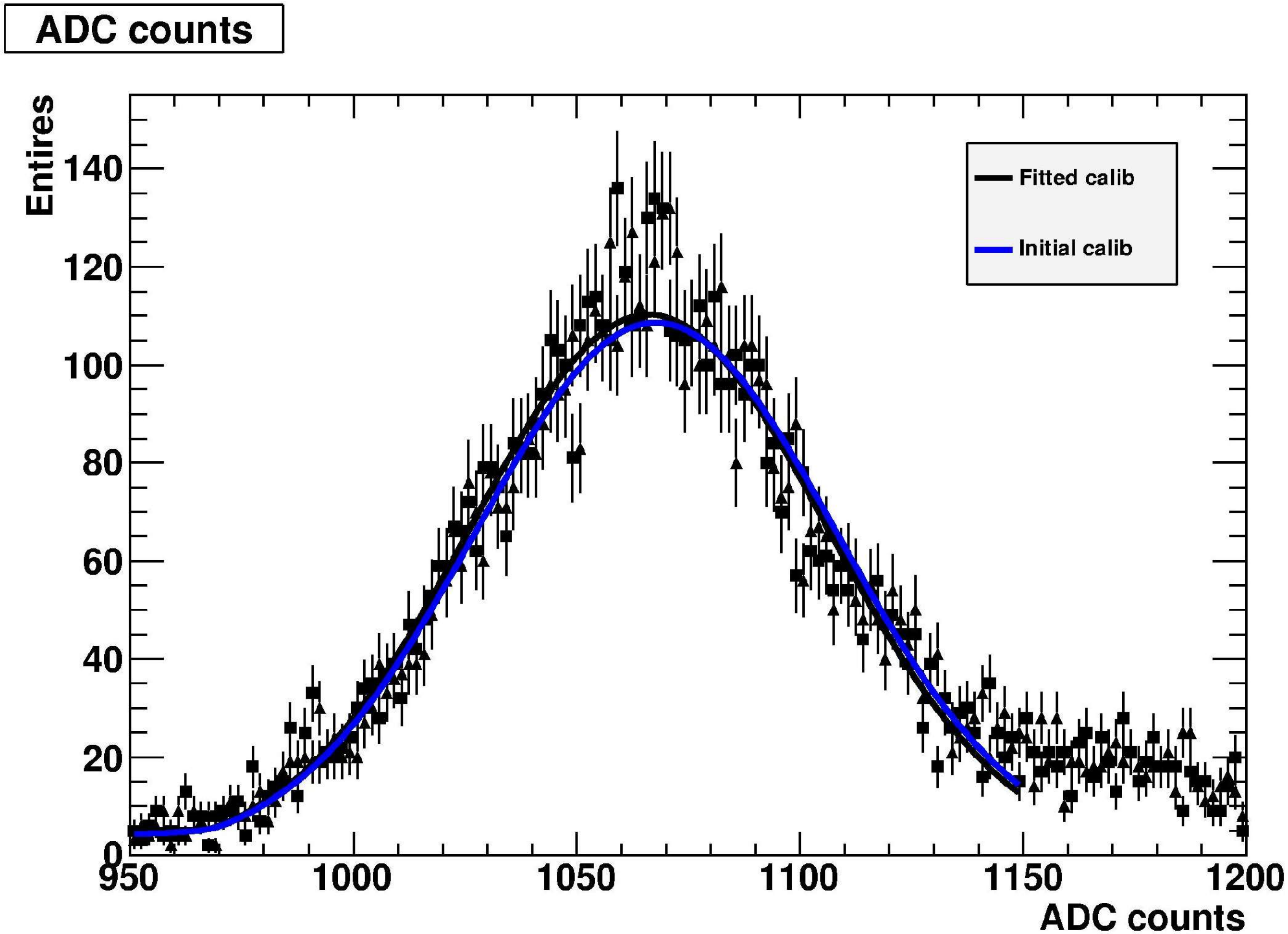
σ_E/E = 3.43 ± 0.03 %

HWHM/E = 4.0 %

Uncertainty on σ_E = 0.8 %

Similar results

Could only refit the inner crystal constants



Initial Resolution

σ_E/E = 3.8 ± 0.1 %

HWHM/E = 4.4 %

Fitted resolution

σ_E/E = 3.7 ± 0.1 %

HWHM/E = 4.3 %

Large variations with respect to fit range

Large tail, the fit is quite unstable, I really had to tweak the procedure to make it work !

Conclusion

Proof of principle: the method seems to work, but require more statistics to produce stable results.

Small improvement in σ_E/E (a few percent) for 1 GeV Runs, similar conclusion if the new calibration constants provided by Elisa are used.

Difference in resolution seems to suggest that the intercalibration uncertainty is around 1-1.5%. This number looks reasonable.

Not enough data for high energy runs (low APD gain) to get proper convergence of the fit. We can try next time...