Results from FCAL Beamtest (part 2)

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GlueX Calorimetry Meeting
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Outline

This talk is a follow-up on the talk I gave at the previous calorimetry meeting on Dec 18, 2012. The talk is available at
https://halldweb1.jlab.org/wiki/images/d/d5/2012-12-18FCALbeamtest_KeiMoriya.pdf

Details will be in the revised analysis note, document 2118 on the docDB.
http://argus.phys.uregina.ca/cgi-bin/private/DocDB/ShowDocument?docid=2118

- Further analysis of energy resolution
- Gaussian method for timing

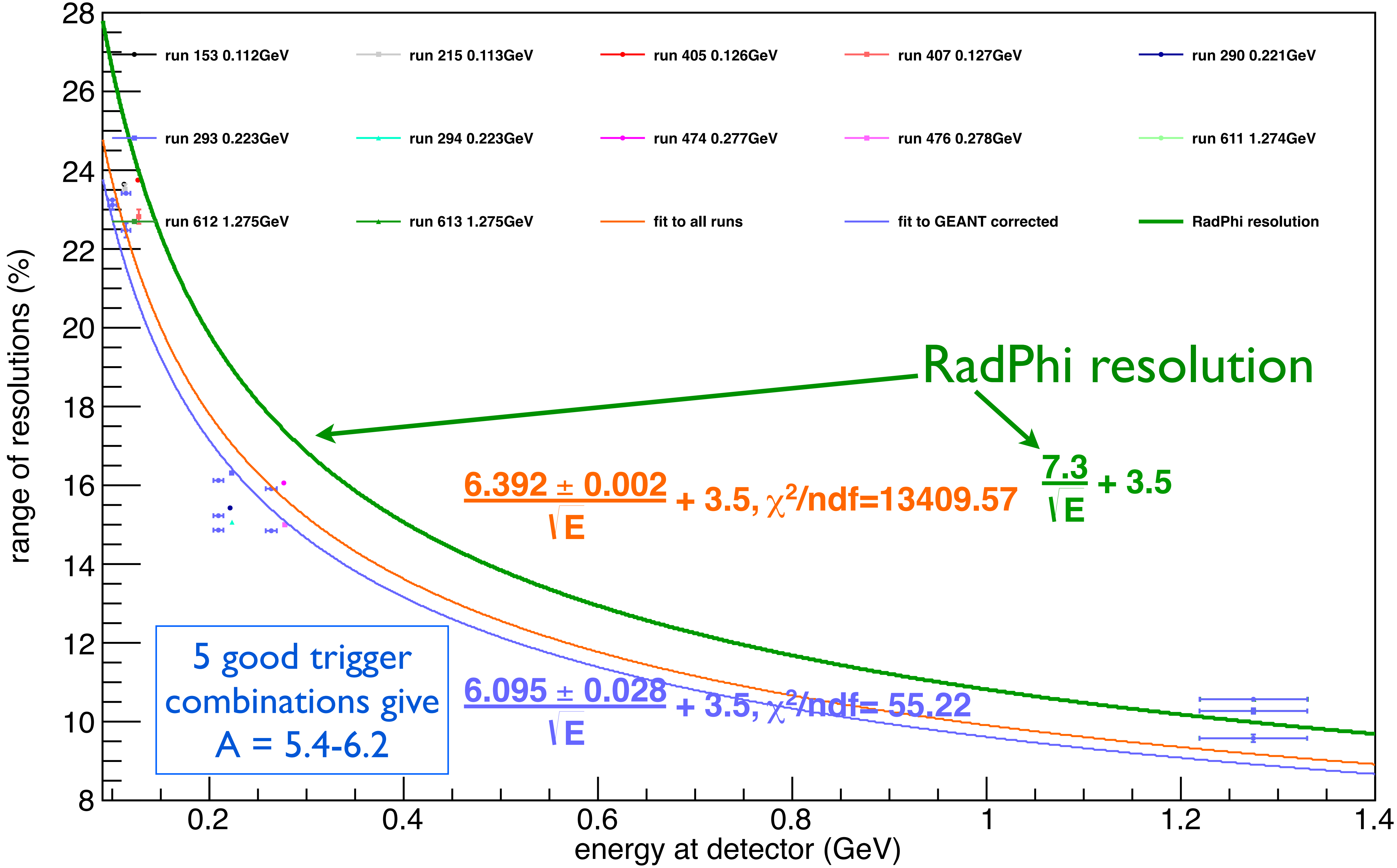
Energy Resolution

During the last meeting, it was pointed out that:

1. We should check the signal shape and make sure it is Gaussian
2. We should only use runs that had the individual HV values gain balanced in our final fit to extract the resolution as a function of energy
3. We should try fits with the terms added in quadrature, i.e., $a/\sqrt{S_P} \oplus b$

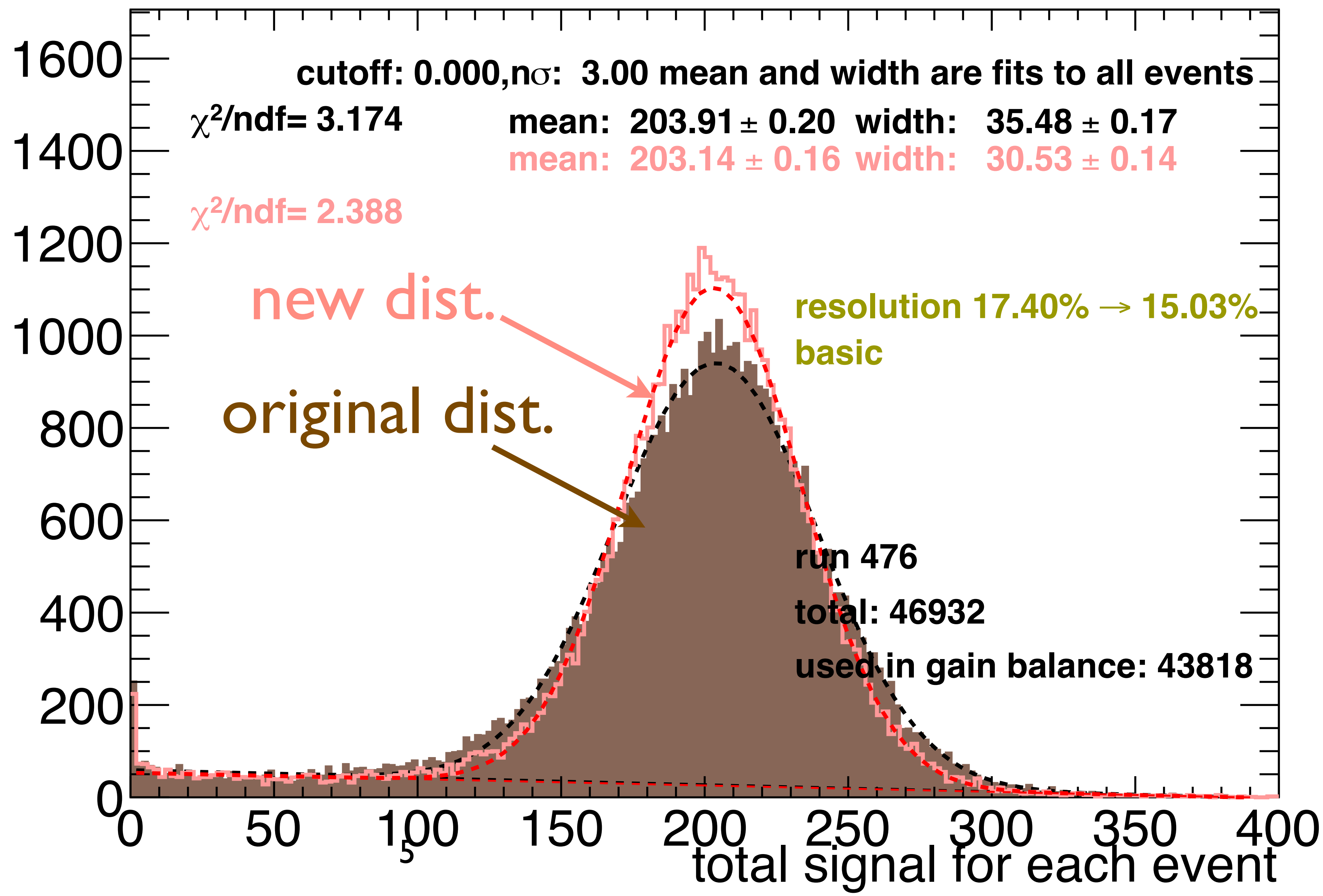
(RECAP) Energy Resolution

- Orange number is without GEANT correction
- Blue number is with GEANT correction



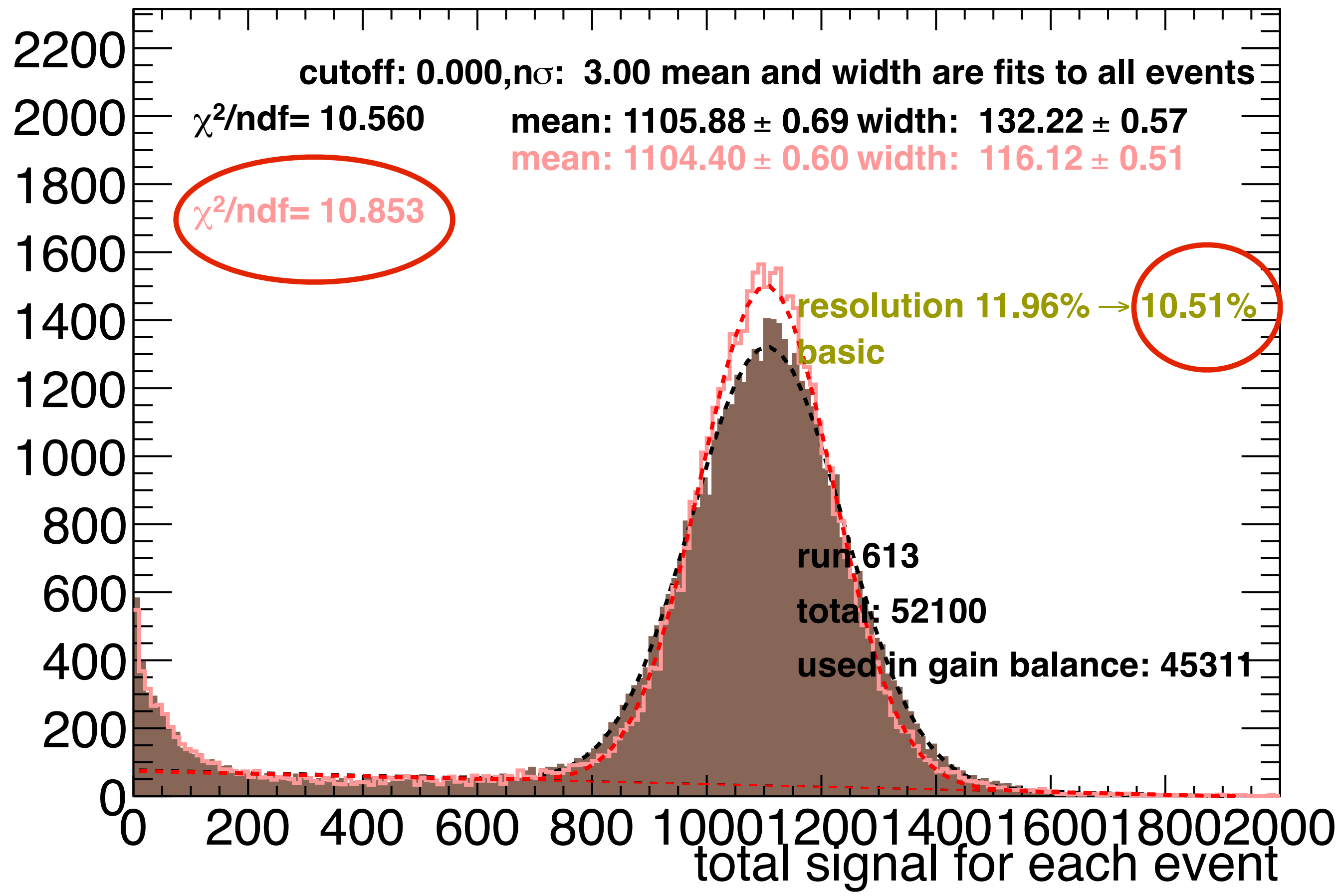
1. Signal shape

- Signal shape is sum of all detectors for each individual event
- After fitting the original distribution to Gaussian + linear bg., we apply gain balancing procedure to minimize the width
- The final distribution is fit again with a Gaussian + linear bg., and our resolution is given as σ = width/center

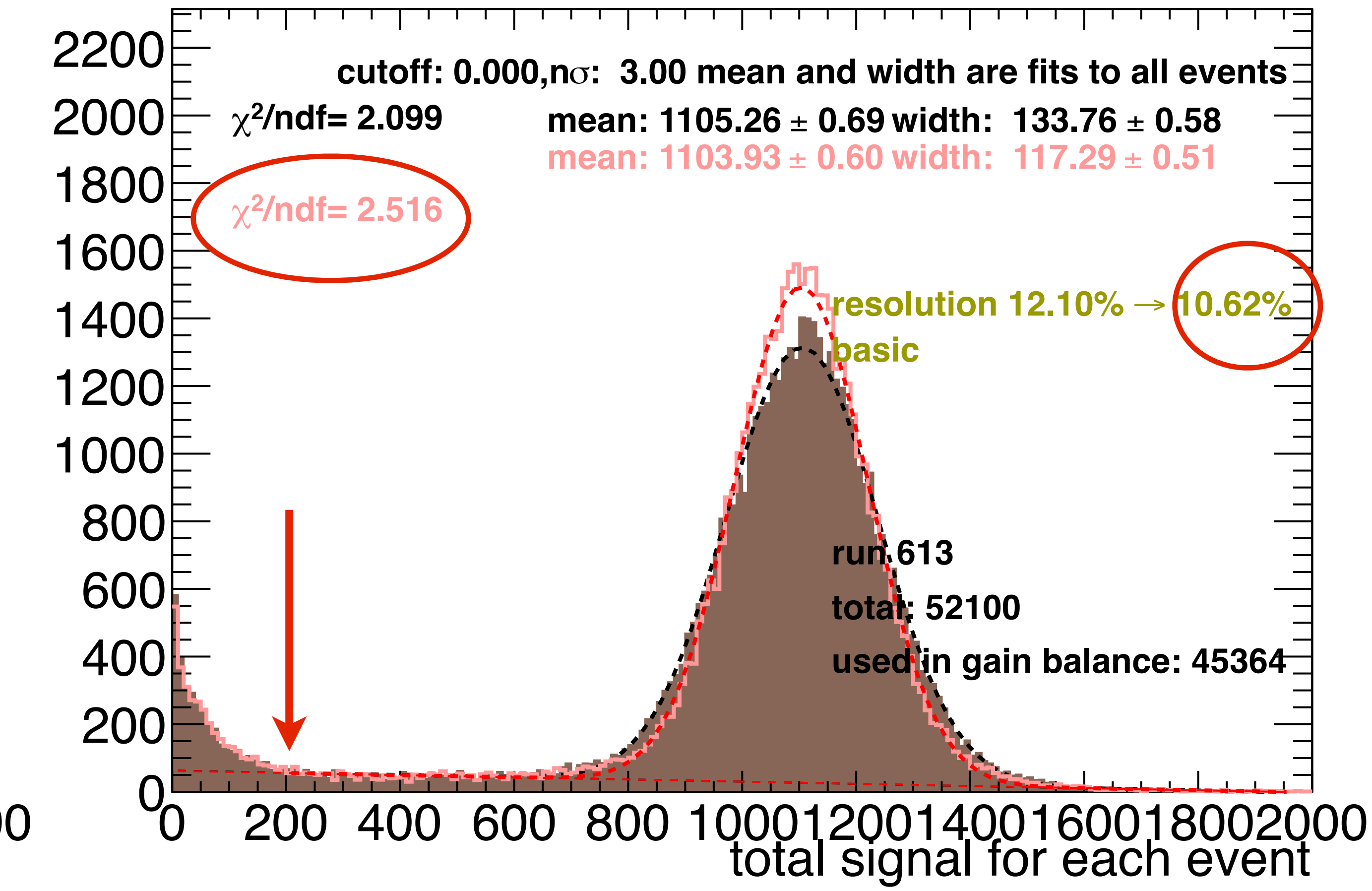


1. Signal shape

- In some cases there is a background on the low end
- We can make the χ^2 better by truncating the fit range
- The resolution does not change drastically with this change



fit entire range



fit down to 200

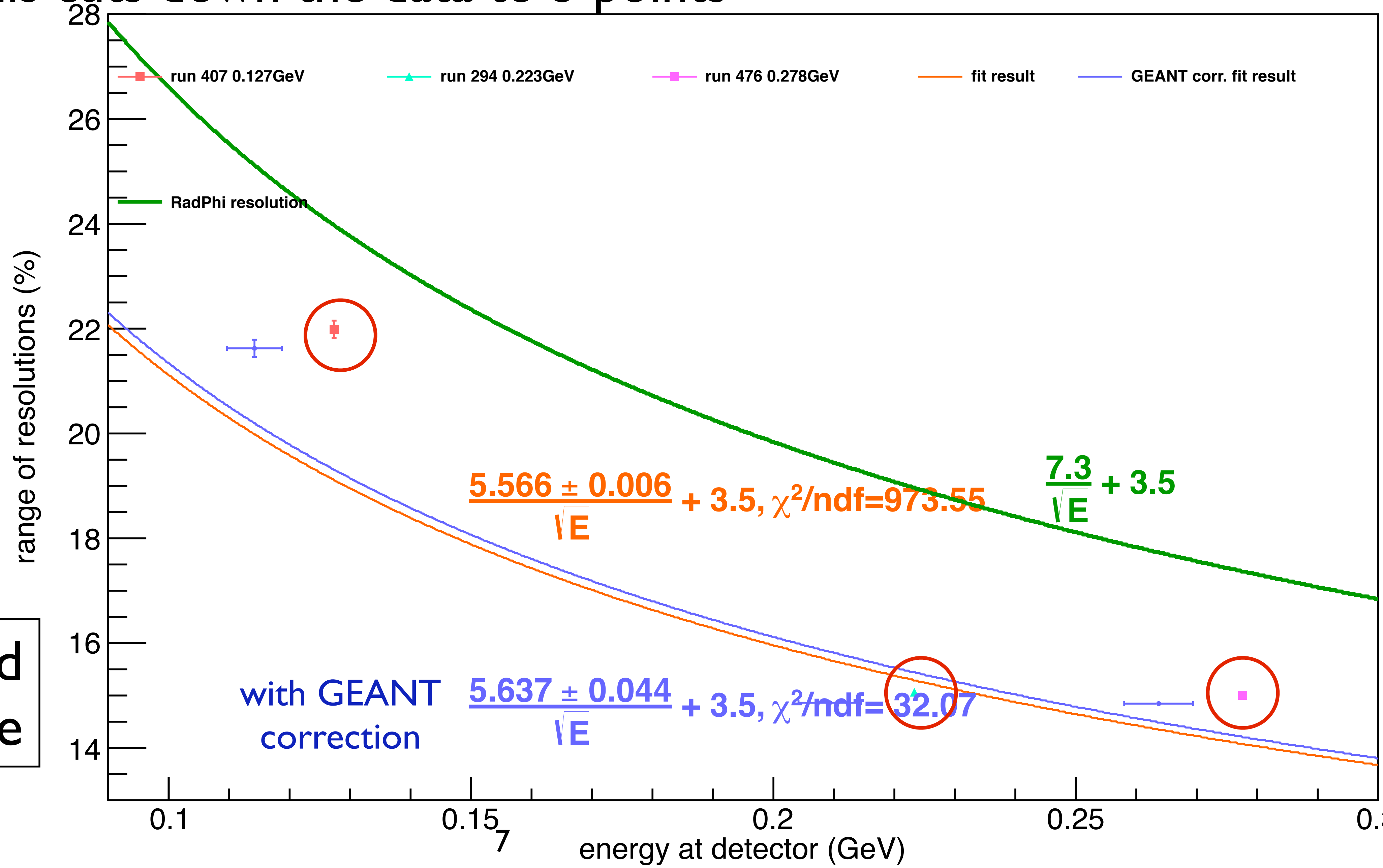
In general, χ^2/NDF ~ 2-4 for all fits. There tends to be a background on the low side, but this does not affect the resolution.

2. Runs to use in Final Results

- Previously we used all possible runs to determine energy dependence of resolution
- Since the resolutions are much better for runs that had the HV on the PMTs balanced to give similar gains, we should use only these
- Problem is this cuts down the data to 3 points

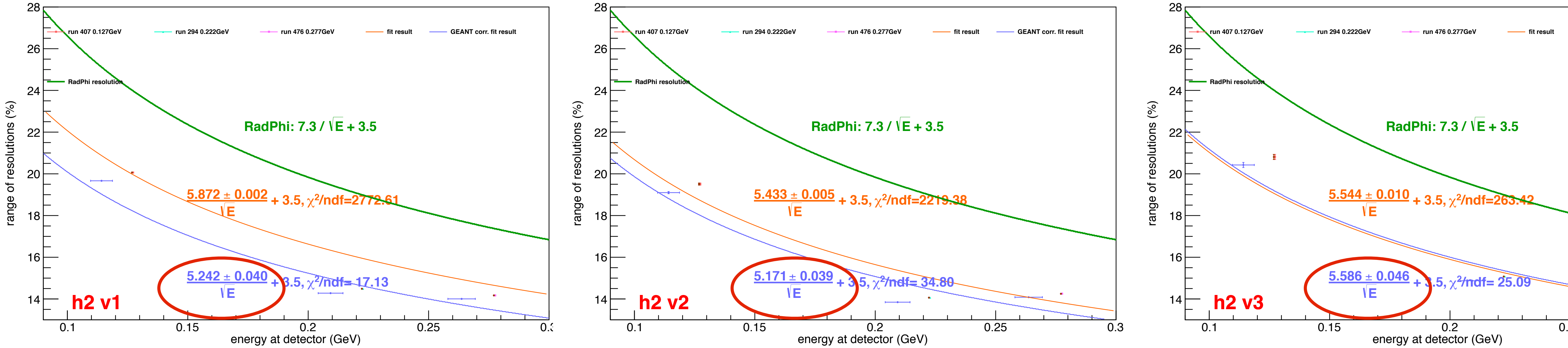
overall fit

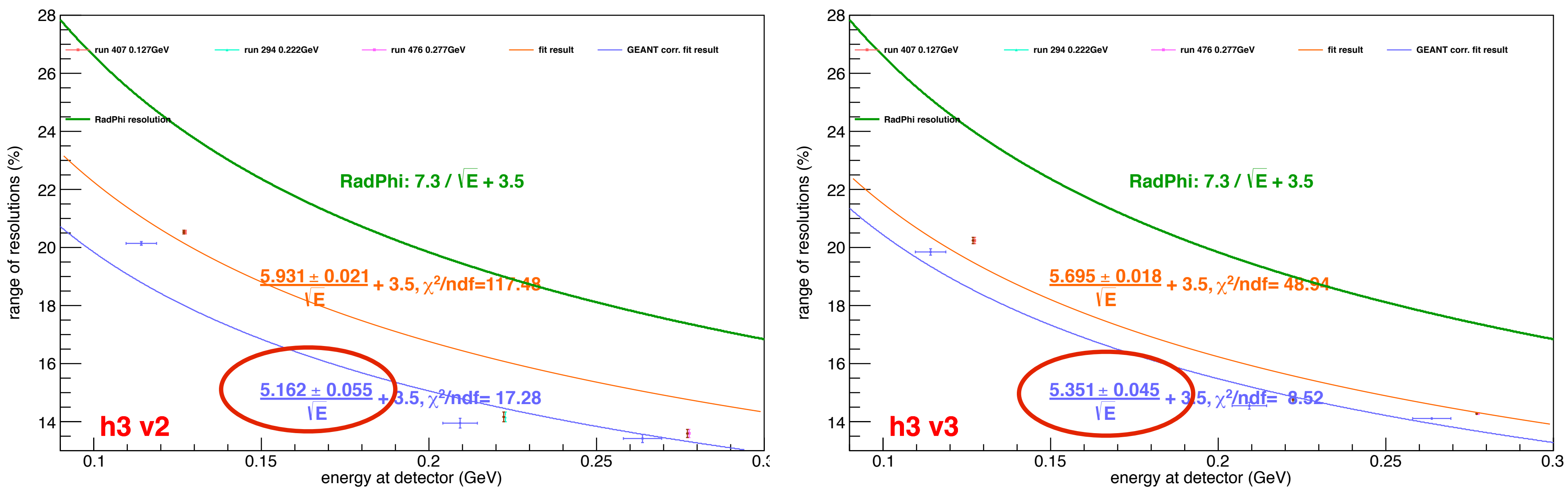
base term fixed to RadPhi value



Previous Results

Look at all 5 good trigger combinations



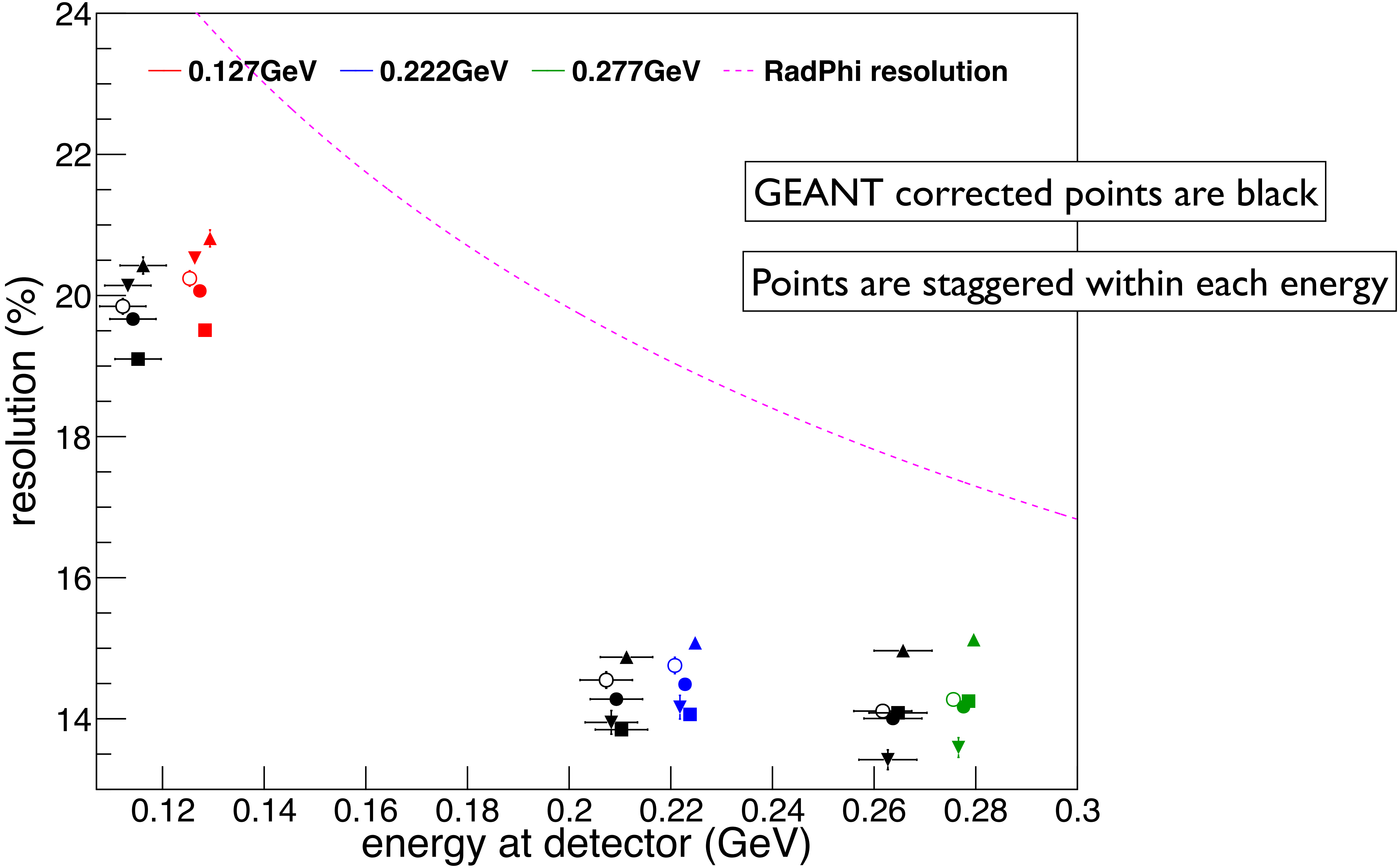


strong correlations among fit params

two higher points are almost equal

With base term fixed, we get 5.2-5.6 for statistical term.
For our final result, we will simply show the raw resolution values, and not quote a fit result.

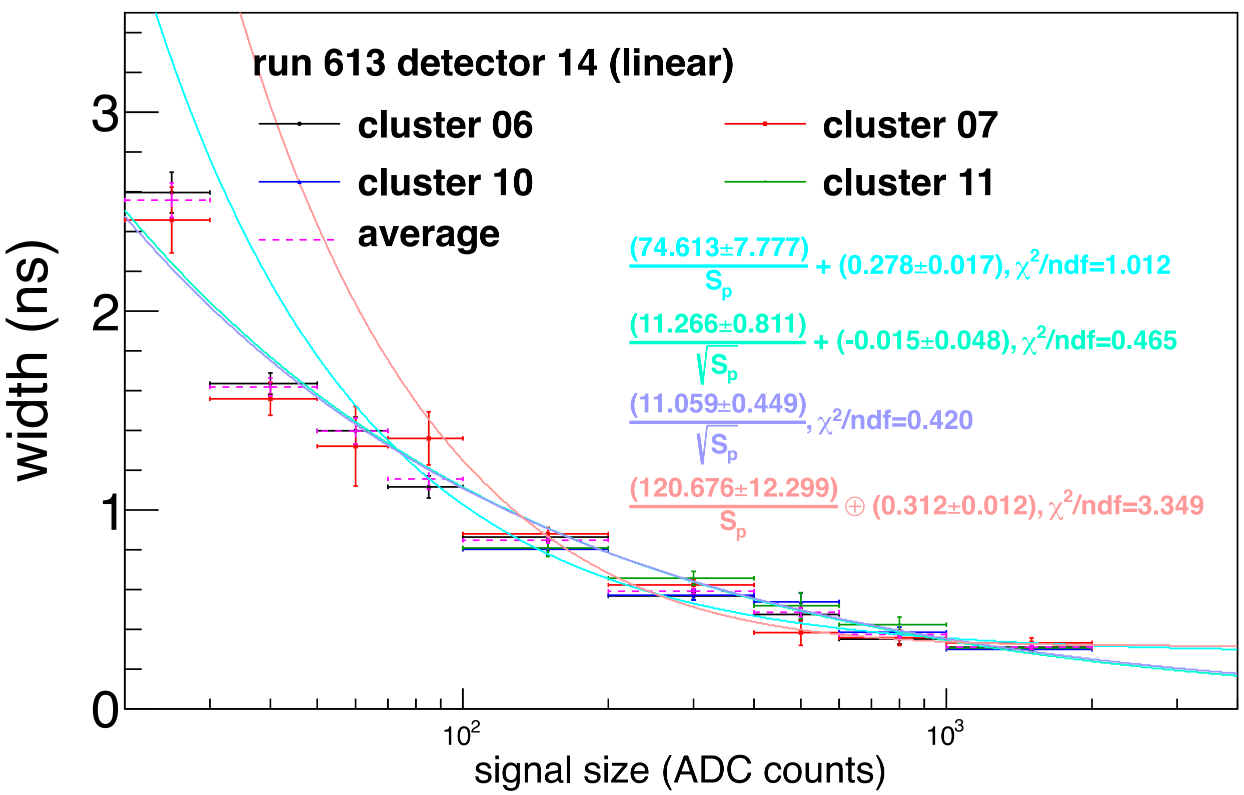
Final Results

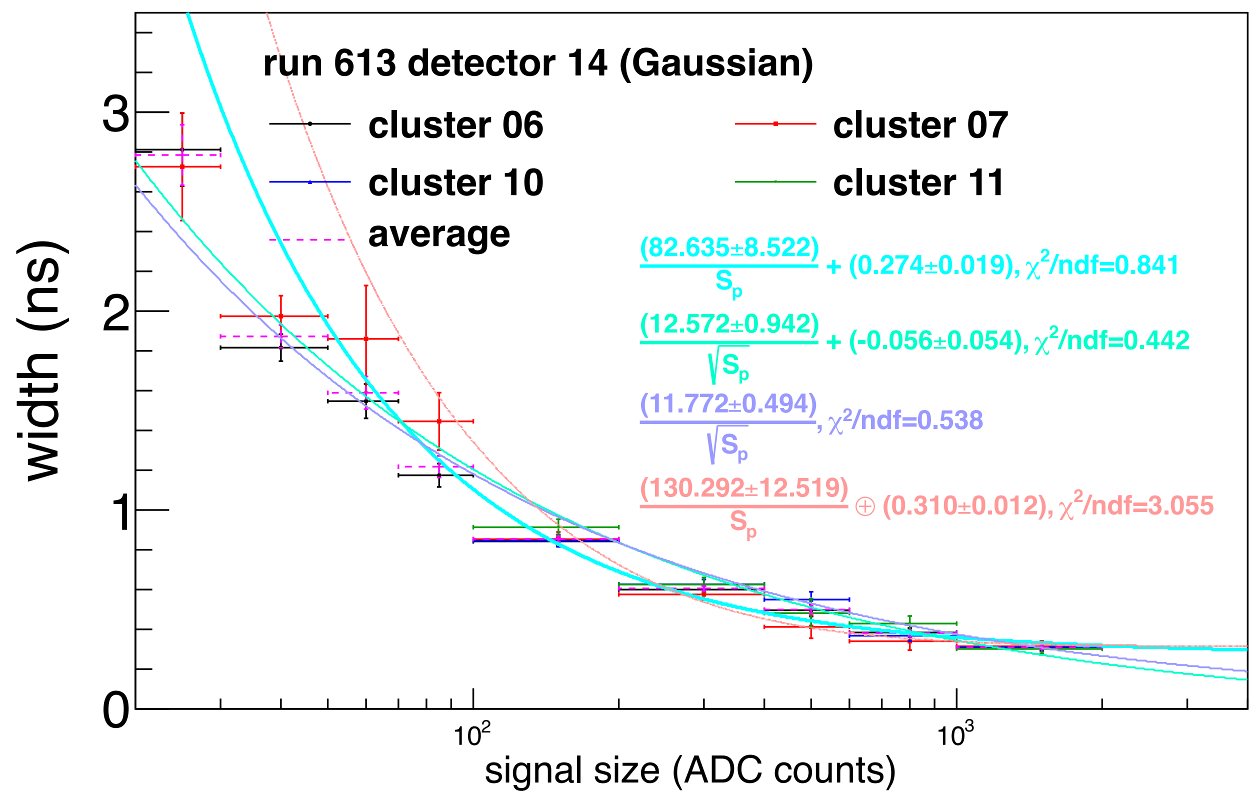


Timing Resolution

- It was pointed out at the last meeting that we could check that the Gaussian method gives very similar results to the linear method that was used.
- The Gaussian method assumes a Gaussian form for the timing of the rising edge of the signal, and converts the two samples directly before the peak sample (height S_P)into a linear form. The timing is then given by interpolating the transformed points to where it crosses $S_P/2$.

Comparison of Methods





linear method

Gaussian method

fit functions:

a/S_p+b

overshoots low region

$a/\sqrt{S_p}+b$

base term tends to go negative

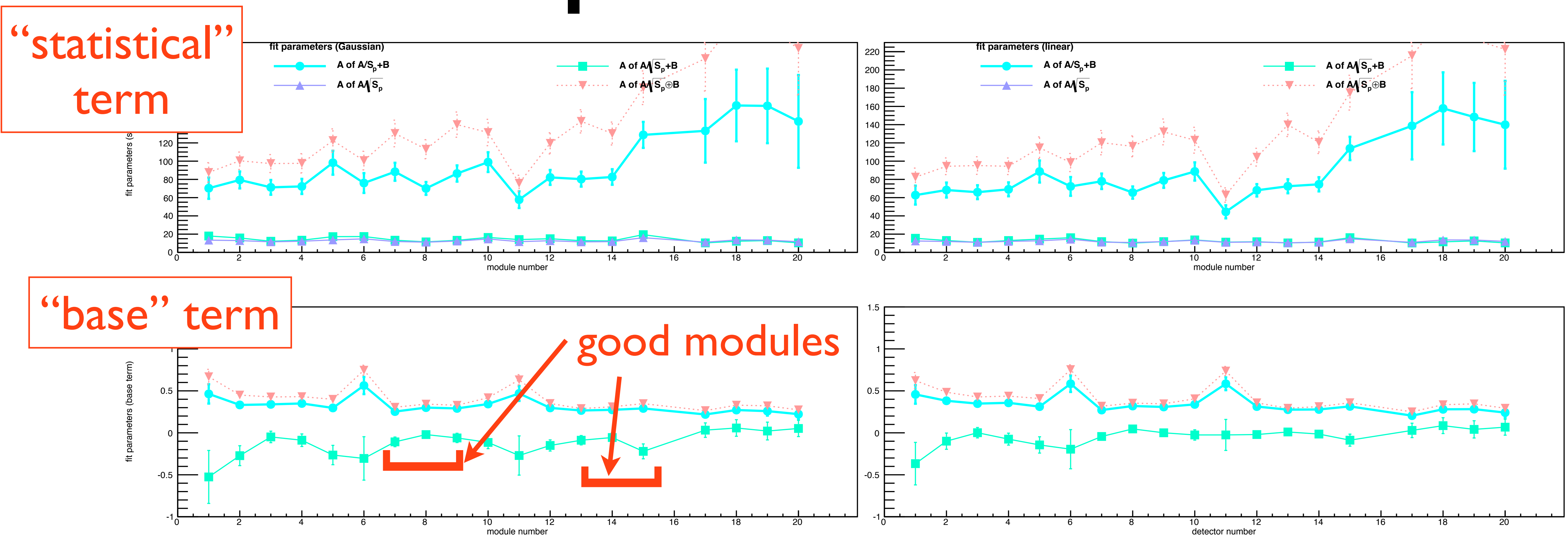
$a/S_p \oplus b$

quadrature sum

$a/\sqrt{S_p}$

no base term

Comparison of Fits



linear method

Gaussian method

fit functions:

Nearly identical results

$a/\ S_p+b$

$a/S_p\oplus b$

$a/\sqrt{S_p}+b$

$a/\sqrt{S_p}$

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Statistical Analysis

- We can combine the results of each module that gave us a fit to obtain a final resolution number.
- We take the weighted average of all 6 good modules, and take the standard deviation as the error

inside module, bottom 2 rows

	a (linear)		b (linear)		a (gaussian)		b (gaussian)	
	best average	standard dev.	best average	standard dev.	best average	standard dev.	best average	standard dev.
a/S_p+b	72.9	5.3	0.29	0.02	81.7	6.4	0.28	0.02
$a/\sqrt{S_p}+b$	11.2	0.7	-0.00	0.03	13.1	1.1	-0.08	0.05
$a/\sqrt{S_p}$	11.1	0.4	---	---	11.9	0.6	---	---
$a/S_p \oplus b$	122.2	12.4	0.33	0.03	129.5	11.7	0.32	0.02

Previous IU NIM paper gives
a = 114 ± 46, b = 0.155 ± 0.077 (linear)
a = 117 ± 34, b = 0.203 ± 0.079 (Gaussian)
for fits with $a/S_p + b$

With the same fit function, we get
a = 72.9 ± 5.3, b = 0.29 ± 0.02 (linear)
a = 81.7 ± 6.4, b = 0.28 ± 0.02 (Gaussian)
For pulse height of 500 mV -> ~0.30 ns
For pulse height of 100 mV -> ~0.38 ns

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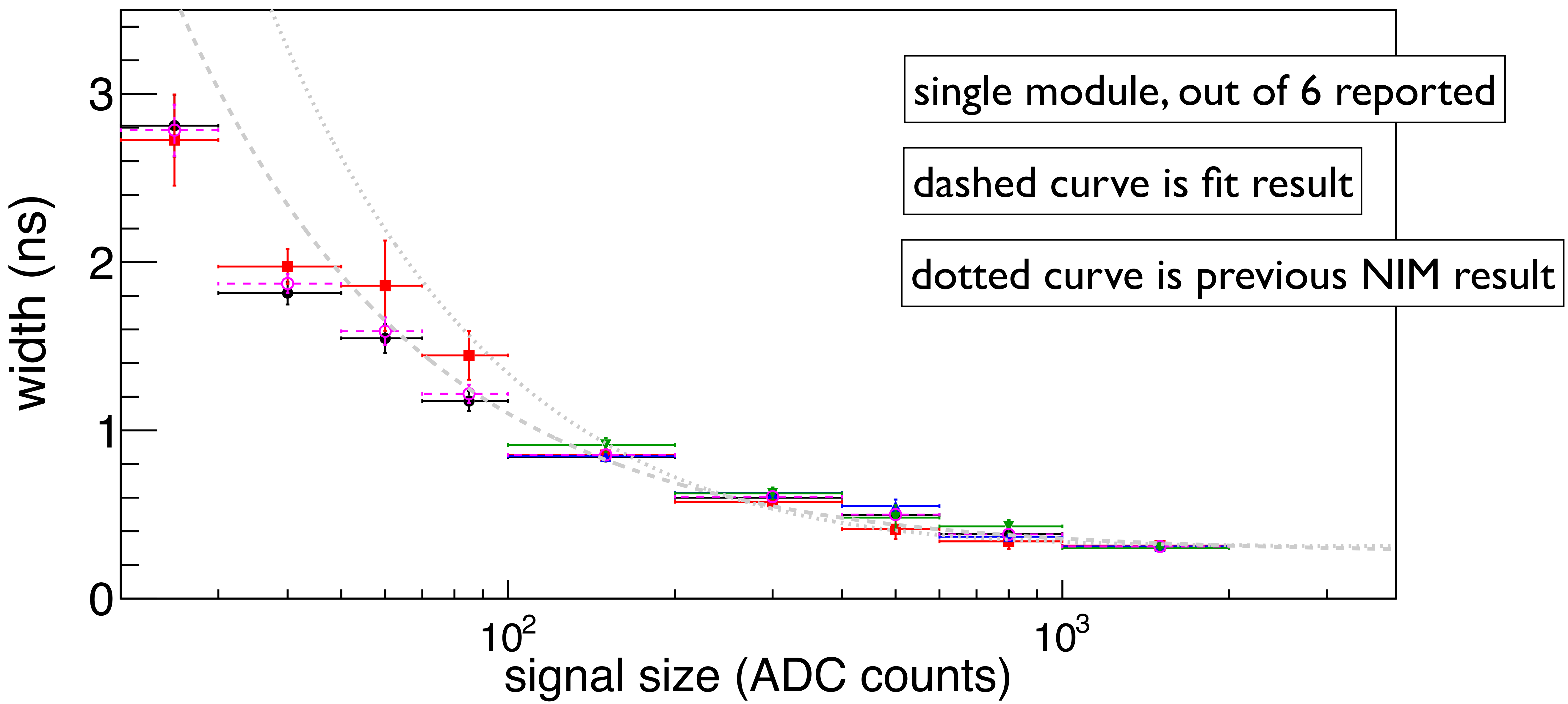
Final Results



Summary of Results

- Results are currently being worked into NIM paper (should be ready to circulate within a week)
- Please check paper, and author list for omissions
- Our results show that the energy resolution is qualitatively better than that of RadPhi
- Timing resolution under real beam conditions is as good as, or even better than previous NIM results suggest

Many thanks to everybody who helped in the beam test