Combining extrapolation measurements

- Summary of Inputs
- Combination Strategy
- Results

Guy Wilkinson
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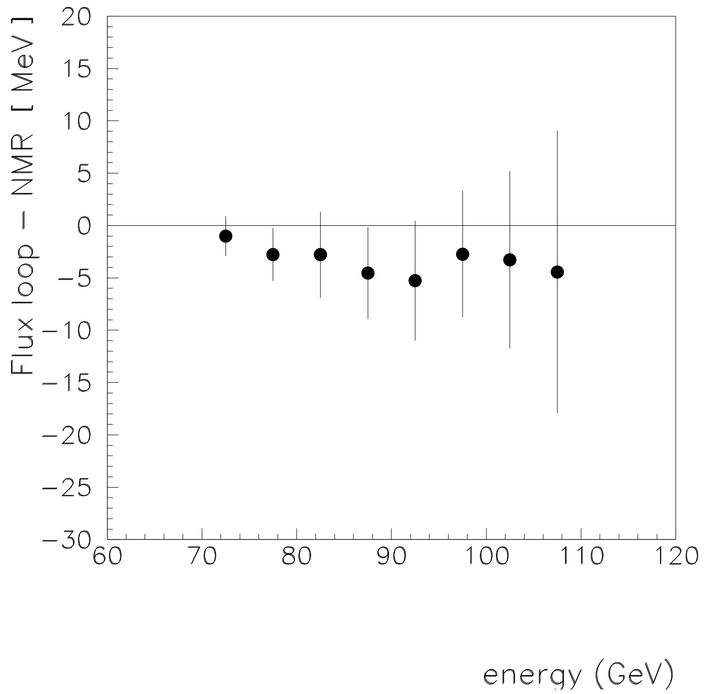
Flux Loop

Error has 2 components which scale linearly

- Error on linearity of flux loop, evaluated from comparison of fit to Epol-NMR and FL-NMR residuals, extrapolated to high energy.
  This is 15 MeV at $E_b = 100$ GeV.
- Error on fringe field outside FL: $\sim 10^{-4}$.
  Take to be 5 MeV at $E_b = 100$ GeV.

Fully correlated between energy points.

No evidence of any energy evolution:



Take central value of -3 MeV, evaluated at 100 GeV, for whole region of 73-108 GeV.

Summary of Measurements

All numbers given as 'Measurement – NMR model'

Spectrometer:

- -4.9 ± 17.9 MeV at $E_b = 92.3$ GeV
- -0.6 ± 9.7 MeV at $E_b = 70$ GeV
- Correlation $=$ 0.75

Q_s:

- 6 measurements – 5 at 80 GeV, 1 at 90 GeV

  $\rightarrow -2.8 \pm 15.6$ MeV at $E_b = 85.2$ GeV

Flux Loop:

- -3 MeV for $E_b = 73 \rightarrow 108$ GeV
- Scaling error: 16.4 MeV at $E_b =$ 100 GeV

Take 3 methods to be independent

Fitting the Measurements

Simplest assumption (taken from flux loop behaviour) is that there is no energy dependence in offset. Discard 70 GeV spectrometer measurement as being 'low energy' and average remaining 3:

$$\text{Offset} = -3.5 \pm 9.6 \text{ MeV}$$

Better approach is to fit offset and slope through all measurements using full covariance matrix. (Here one may also use the Q_s measurements separately – a small gain.)

(Fit mechanism cross-checked by Pete – OK)

A minor detail – year to year variation

Measurements took place in different years:

- Flux loop – $\sim$ equal weights 97–00
- Q_s – 98,99,00 (00 has negligible weight)
- Spectrometer – 00

But model's offset from true energy may change with time, as probes are replaced, and magnets age.

Some indication (upper limit?) provided by evaluating E_b after swapping calibration coefficients

	Dataset				
Fit	'96	'97	'98	'99	'00
'96	0	32.0	34.7	36.9	39.0
'97	-27.5	0	4.1	1.5	0.9
'98	-29.1	-3.6	0	-2.5	-0.3
'99	-27.5	-1.8	1.9	0	2.1
'00	-28.9	-3.6	-0.1	-1.7	0
'97-'00	-27.7	-2.0	1.8	-0.6	1.8

(Large difference for '96 because precision probe mounts not developed until following year)

A minor detail – year to year variation

Adopt following philosophy for fit:

- Decide we are fitting a mean 97-00 model
- FL tests 97-00; spec tests 00; Q_s tests 98,99,00
- Assume that model for a specific year agrees with mean model with a precision of 2 MeV. Add terms in covariance matrix to reflect this.

Consequences are very small

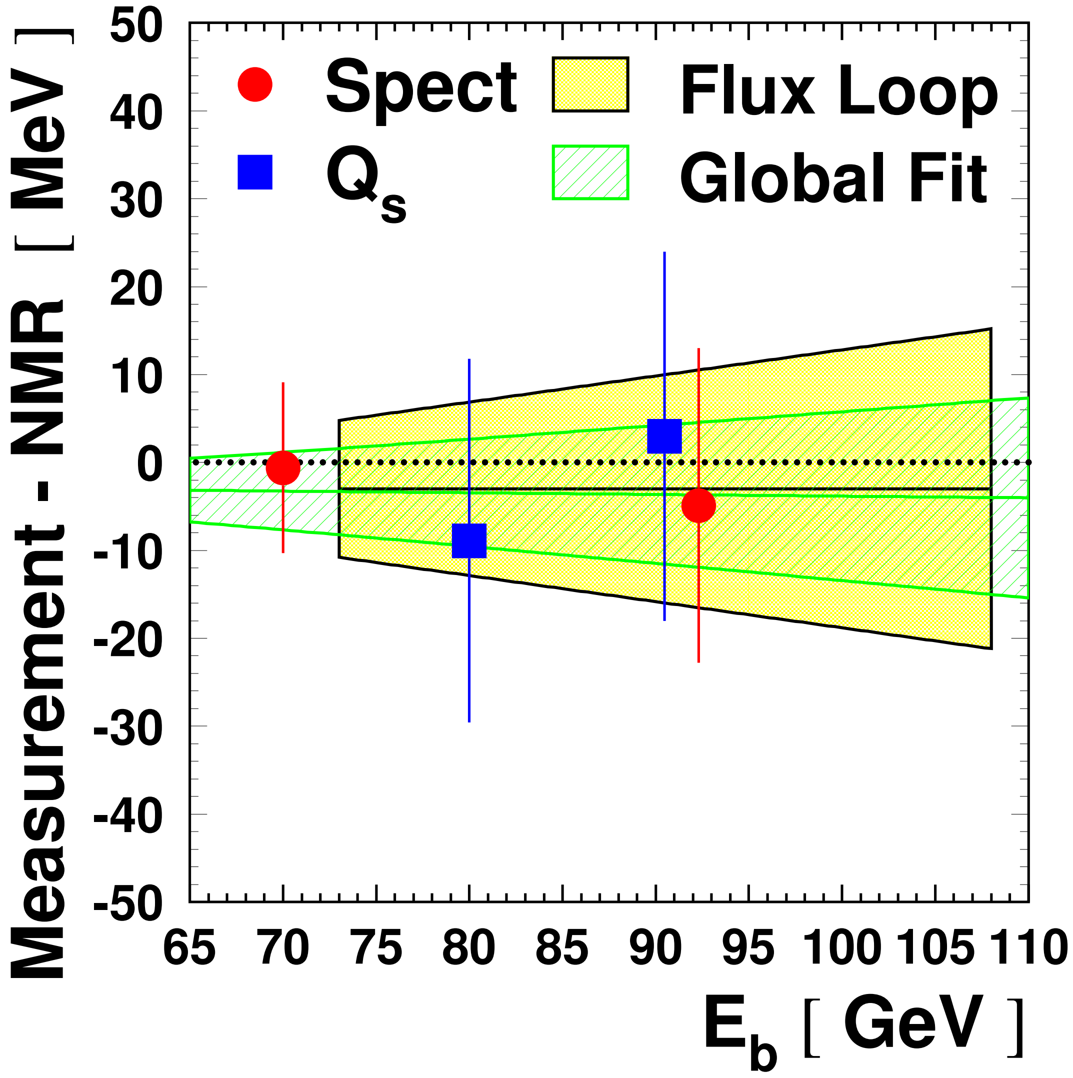
Fit error increases by $< 1\%$

By same argument we should add a year-to-year uncorrelated 2 MeV onto fit error when quoting results for each year. This will have negligible effect.

And '96? Experiments care much less than we do! Adding ~ 30 MeV would surely be too conservative, as we know reason for shift – maybe take half this?

Results of Fit

All data and fit result:



$\chi^2 = 0.27$ for 8 degrees of freedom...

Result propagated to 10 energy points of LEP 2:

	E_b [GeV]									
	80.7	86.0	91.3	94.3	95.8	97.8	99.8	100.8	102.4	103.3
Offset	-3.3	-3.4	-3.4	-3.5	-3.5	-3.5	-3.5	-3.5	-3.5	-3.6
Error	6.1	7.1	8.0	8.6	8.8	9.2	9.5	9.7	10.0	10.2

Fit Variations

Repeat fit with various changes in input:

Variant	Error [MeV] at E_b of: 80.7 GeV	99.8 GeV	103.3 GeV	χ^2/pdf
Everything	6.1	9.5	10.2	0.034
No spec	6.9	10.8	11.5	0.036
No Q_s	7.9	11.9	13.2	0.127
No FL	11.0	14.3	14.9	0.022
FL only	10.1	15.8	16.8	/

- All measurements compatible (too compatible!)
- Spec & Q_s combined more precise than FL