Test beam "final results"

- Update on Beam Spread studies
- Energy resolution
- Data – MC comparison

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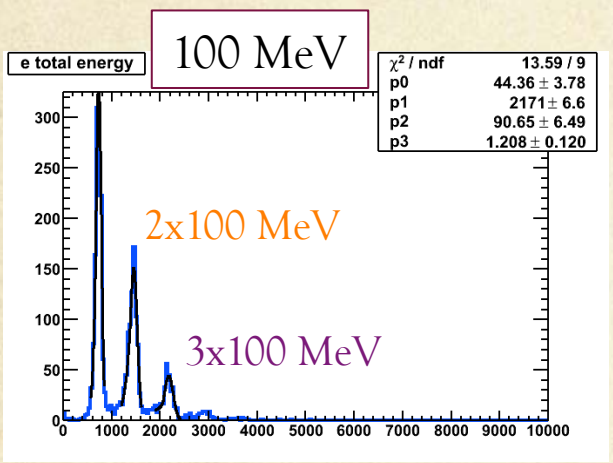
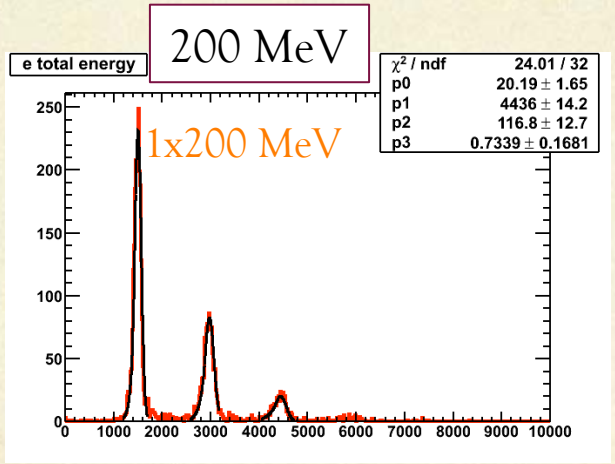
2nd SuperB Collaboration Meeting – LNF
EMC session – December 13th, 2011

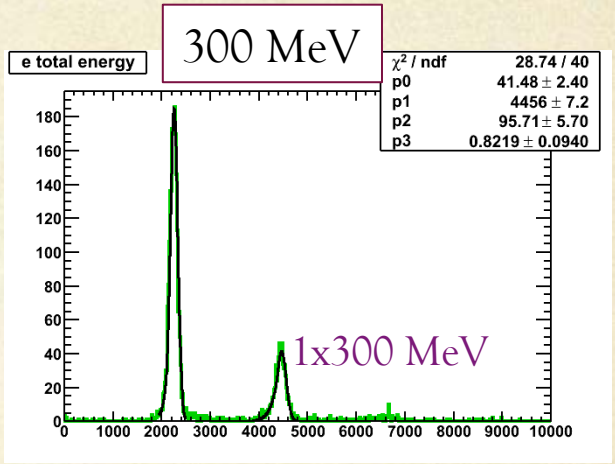
Update on Beam Spread studies

Beam Spread Evaluation from data

- Method presented by Stefano at 11/29 EMC meeting



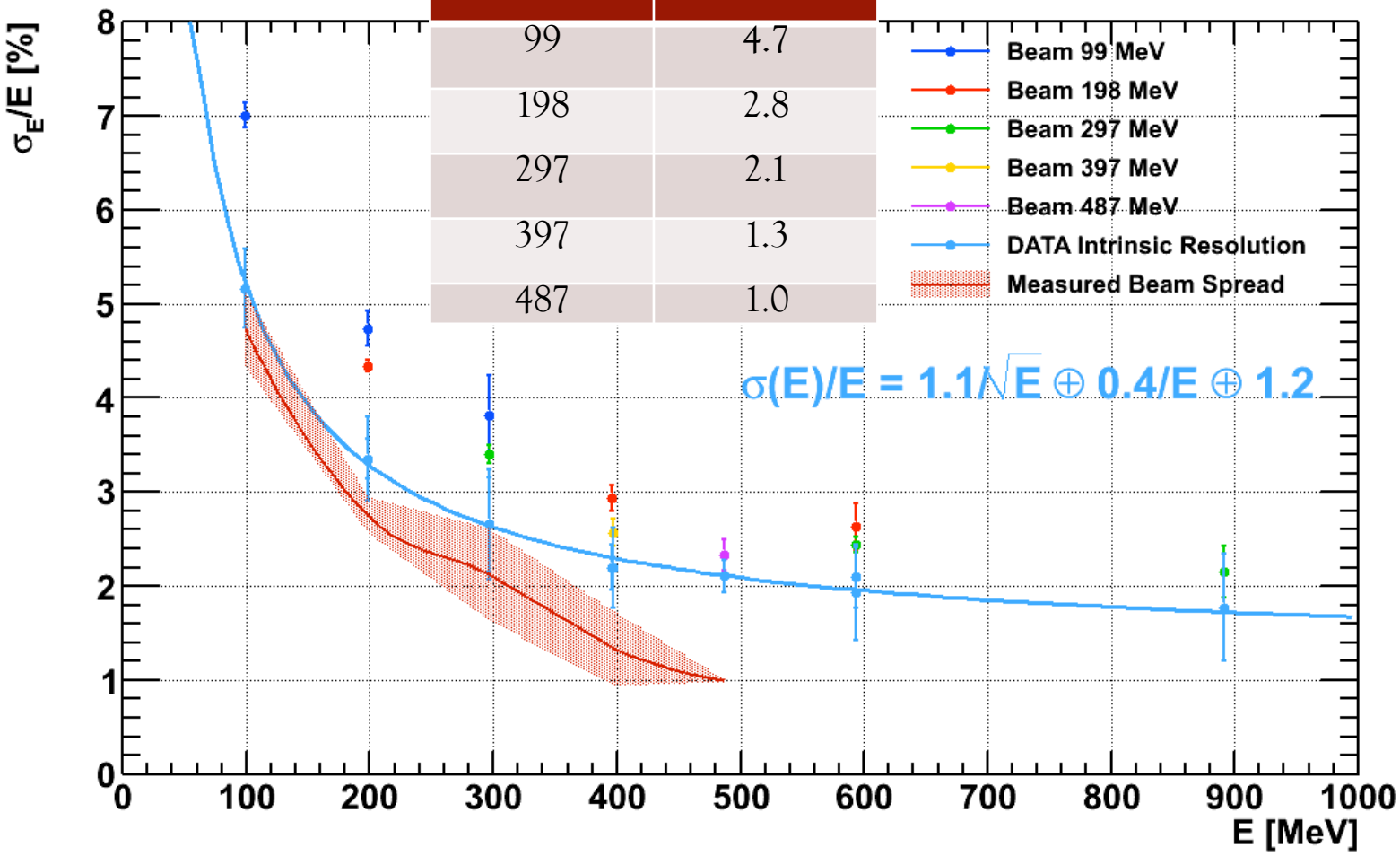




- $\sigma_{TB} = \sigma_{EMC} \oplus \sigma_{BS}$
- σ(100MeV +100MeV) = σ(200MeV) and so one for other energies/multiplicity
- Iterative process to compute σ_{BS} at all energies from data
  - 500 MeV not entering the game, σ_{BS}(500 MeV) = 1% as stated by BTF team

Beam Spread Fit result

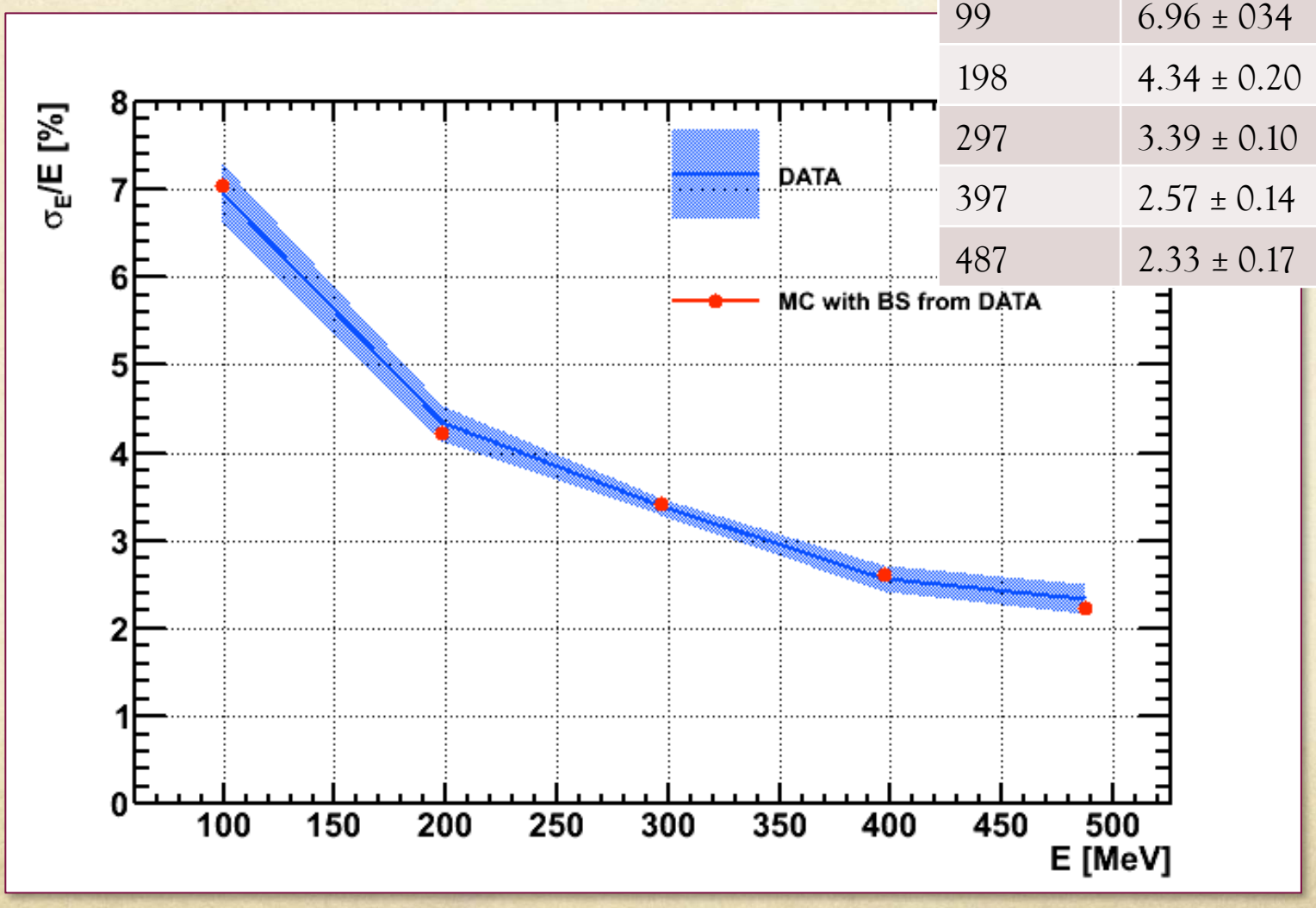
En [MeV]	Spread [%]
99	4.7
198	2.8
297	2.1
397	1.3
487	1.0



Energy resolution

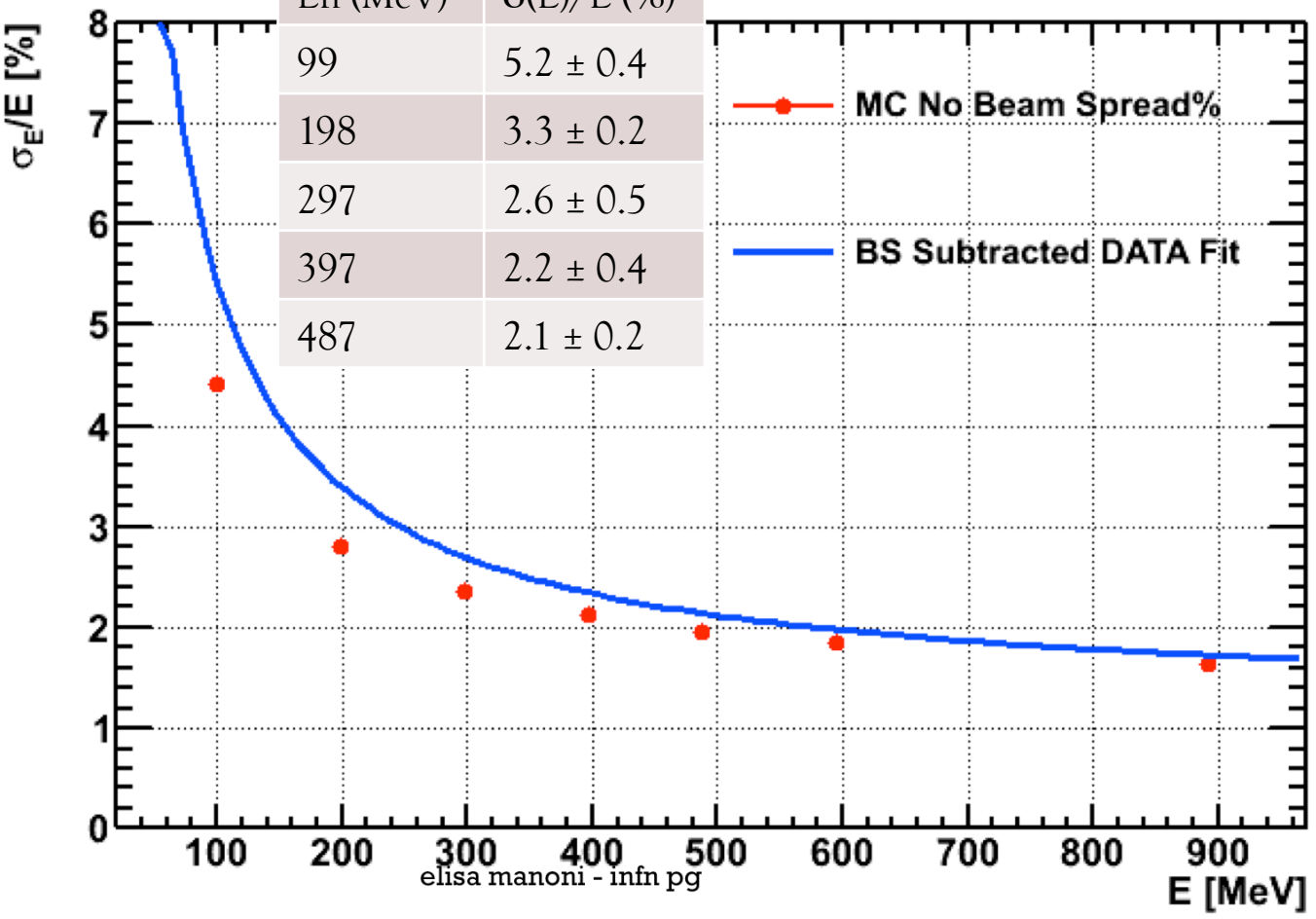
Energy resolution – data Beam spread

En (MeV)	σ(E)/E (%)
99	6.96 ± 034
198	4.34 ± 0.20
297	3.39 ± 0.10
397	2.57 ± 0.14
487	2.33 ± 0.17



Energy resolution – no beam spread

DATA	
En (MeV)	σ(E)/E (%)
99	5.2 ± 0.4
198	3.3 ± 0.2
297	2.6 ± 0.5
397	2.2 ± 0.4
487	2.1 ± 0.2

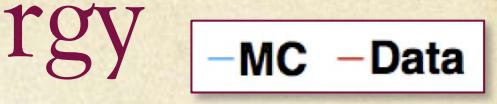


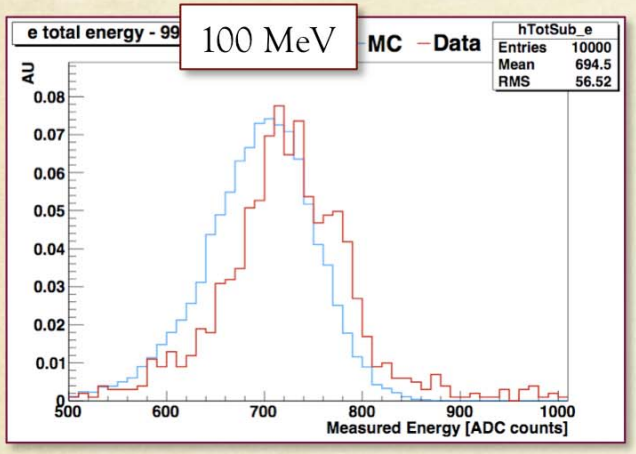
Data – MC comparison

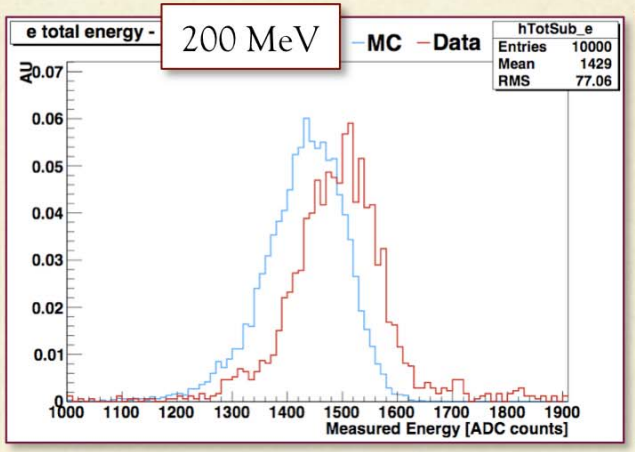
Samples and selection

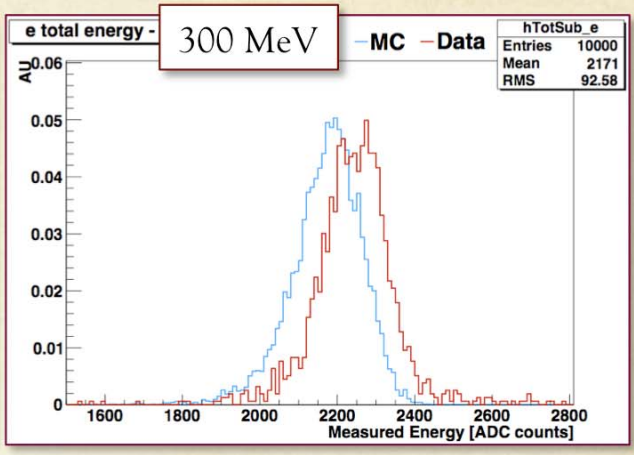
- MC sample:
  - Energy dependent Beam spread
  - Light yield non-uniformity taken from Ren-yuan measurements
  - X-talk and intrinsic LYSO resolution accounted for
  - Electronic noise and signal amplitude as measured from data
  - Realistic geometry and dead material
  - Photo statistics estimated on data
  - 1% intercalibration error
- Selection
  - Data: Si and single particle selections
  - MC: beam spot size similar to box selected in data, shot single particles

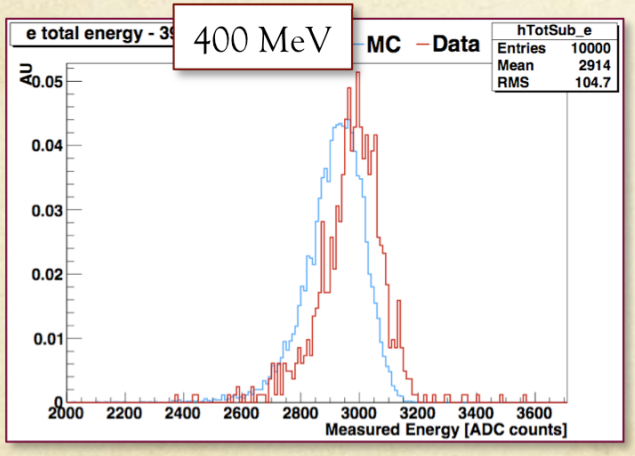
Total Deposited Energy

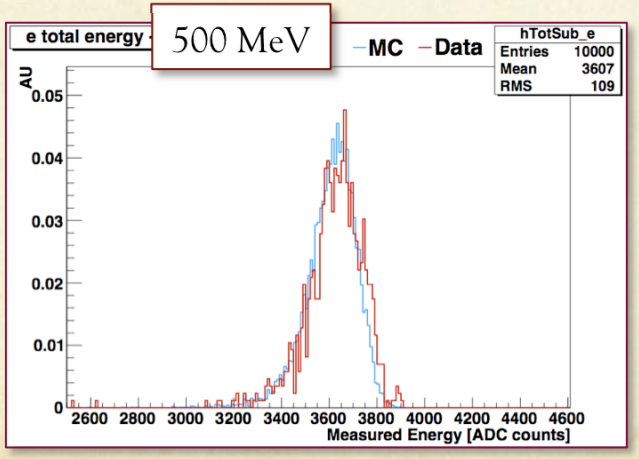






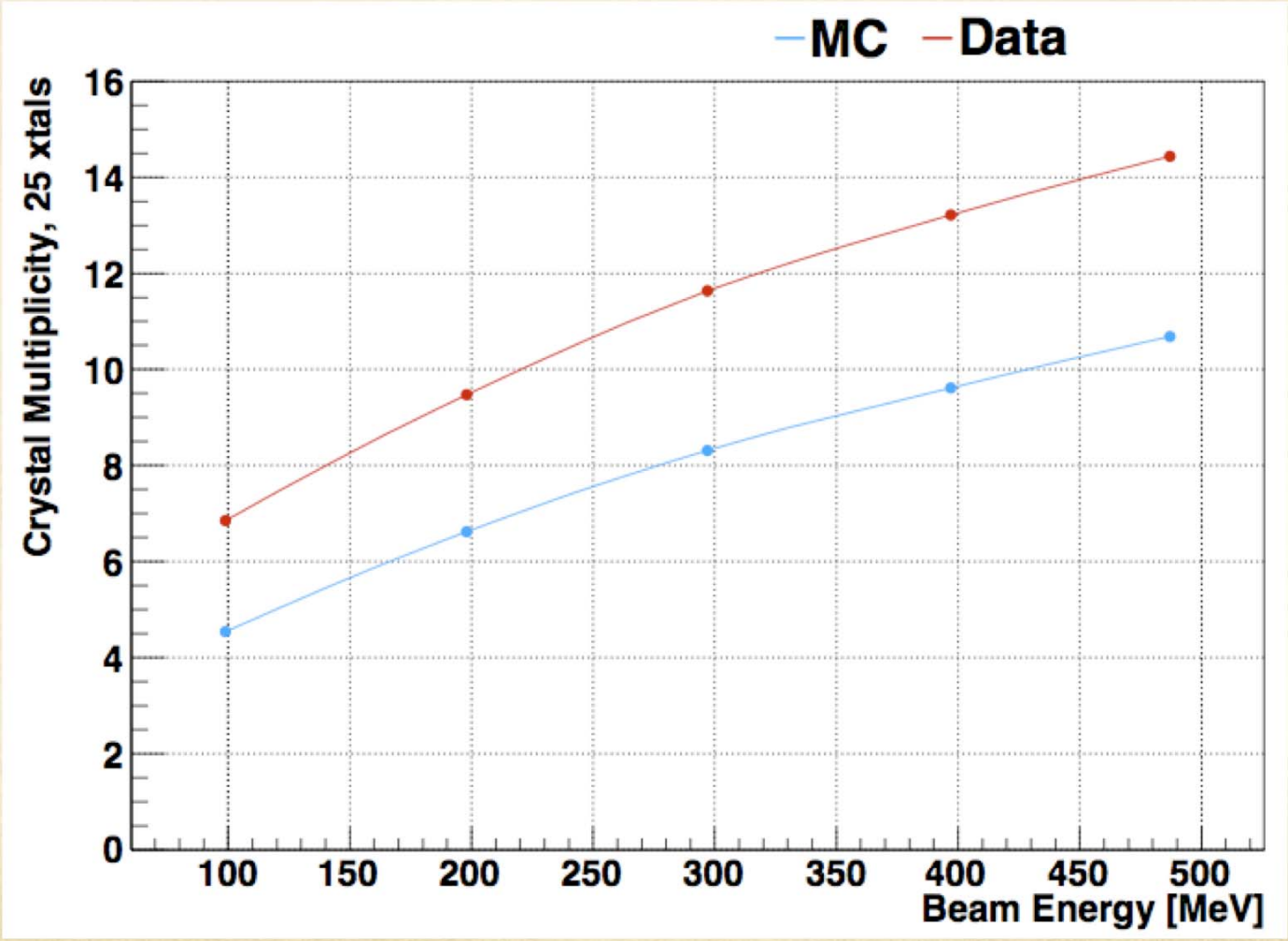




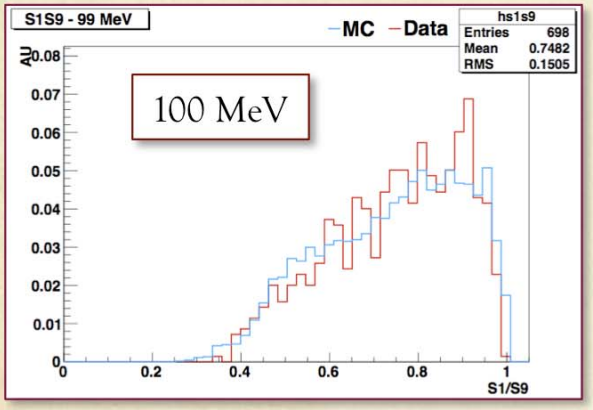


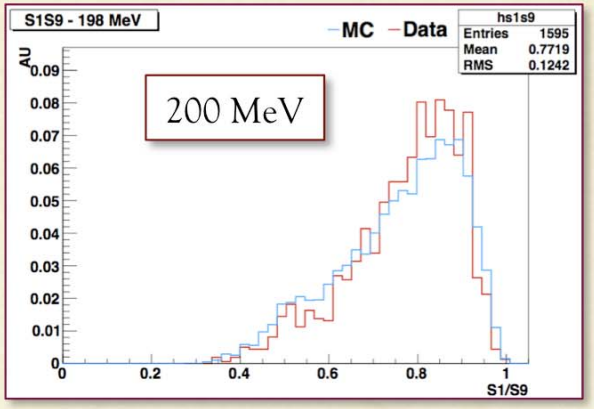
- Data/MC peak positions at 500 MeV aligned by hand
- About 2% shift in peak position at 100-400 MeV
- Distribution widths now in agreement

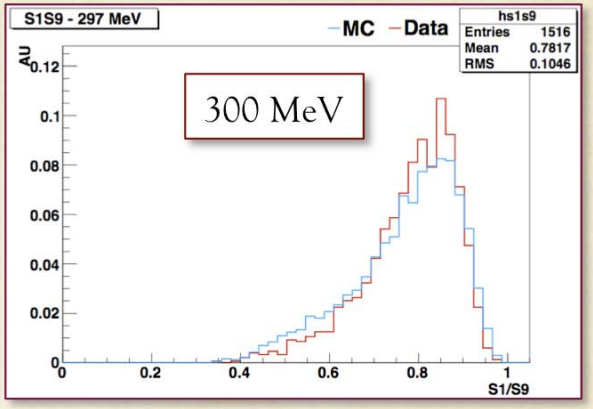
Multiplicty

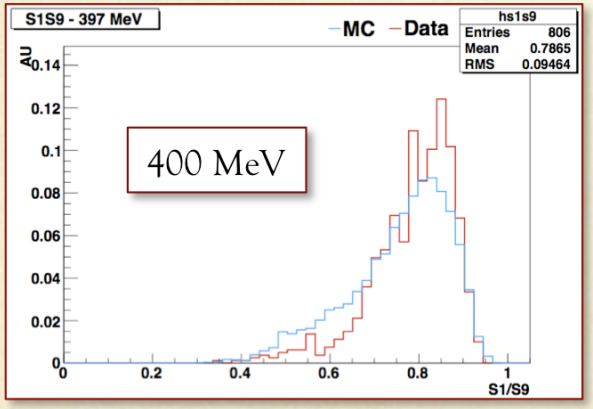


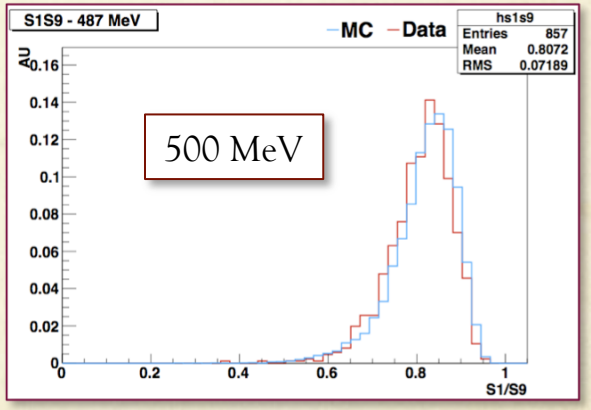
S1/S9


S1S9 - 99 MeV
MC Data
hs1s9
Entries 698
Mean 0.7482
RMS 0.1505
100 MeV
AU
S1/S9


S1S9 - 198 MeV
MC Data
hs1s9
Entries 1595
Mean 0.7719
RMS 0.1242
200 MeV
AU
S1/S9

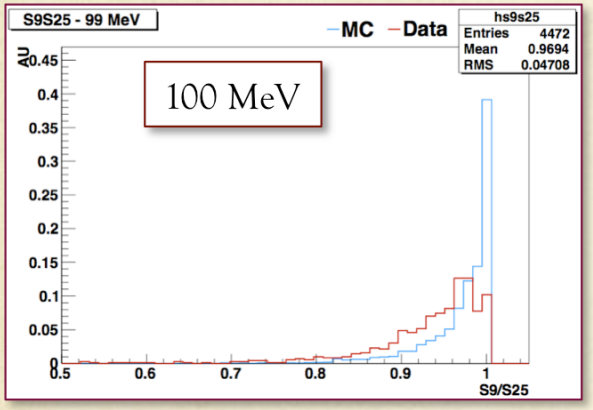

S1S9 - 297 MeV
MC Data
hs1s9
Entries 1516
Mean 0.7817
RMS 0.1046
300 MeV
AU
S1/S9

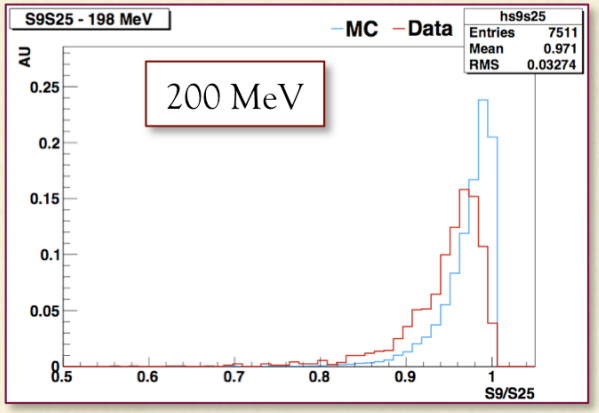

S1S9 - 397 MeV
MC Data
hs1s9
Entries 806
Mean 0.7865
RMS 0.09464
400 MeV
AU
S1/S9

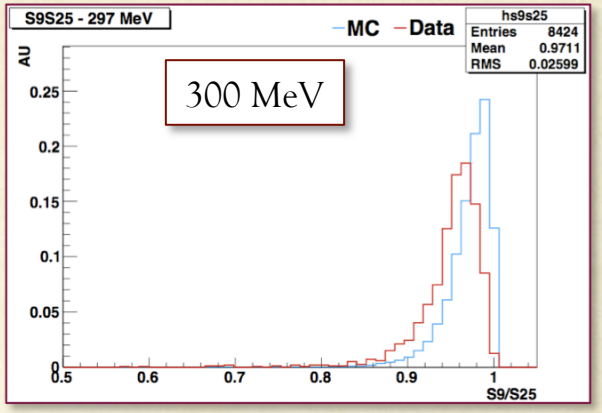

S1S9 - 487 MeV
MC Data
hs1s9
Entries 857
Mean 0.8072
RMS 0.07189
500 MeV
AU
S1/S9

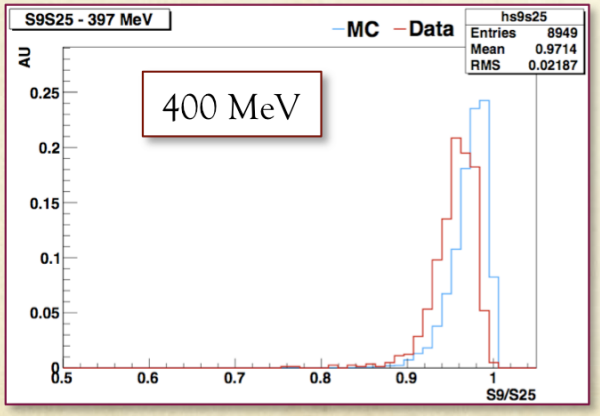
S9/S25

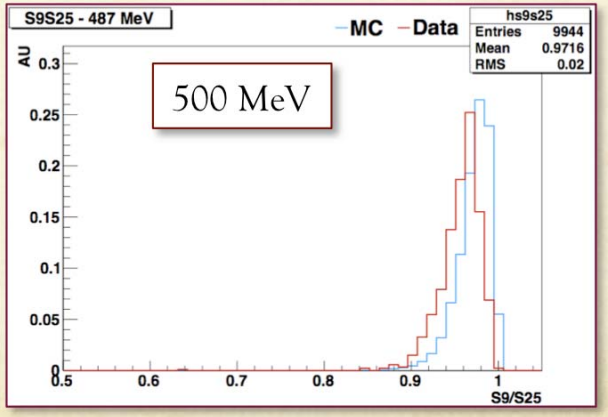

MC
Data


S9S25 - 99 MeV
MC
Data
hs9s25
Entries 4472
Mean 0.9694
RMS 0.04708
100 MeV
AU
S9/S25

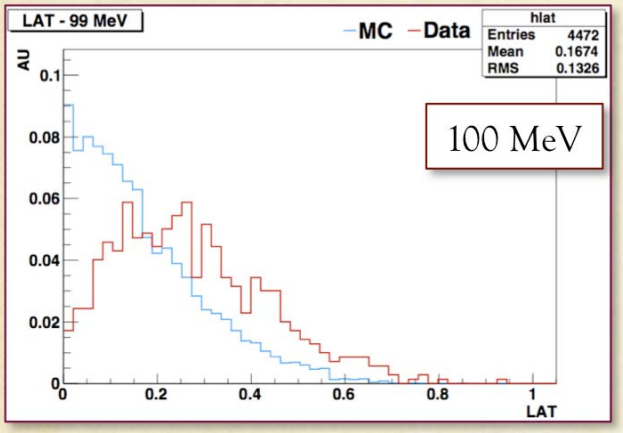

S9S25 - 198 MeV
MC
Data
hs9s25
Entries 7511
Mean 0.971
RMS 0.03274
200 MeV
AU
S9/S25

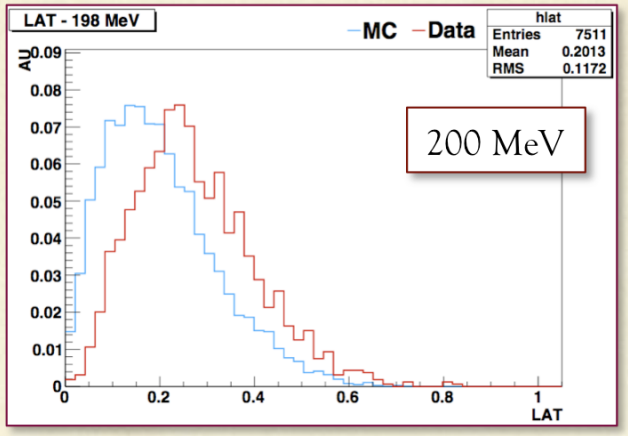

S9S25 - 297 MeV
MC
Data
hs9s25
Entries 8424
Mean 0.9711
RMS 0.02599
300 MeV
AU
S9/S25

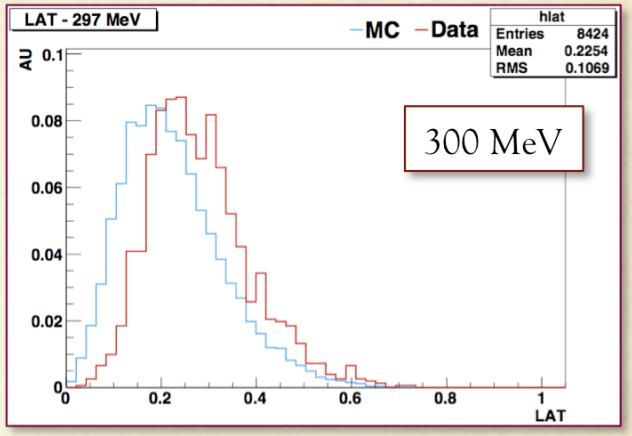

S9S25 - 397 MeV
MC
Data
hs9s25
Entries 8949
Mean 0.9714
RMS 0.02187
400 MeV
AU
S9/S25

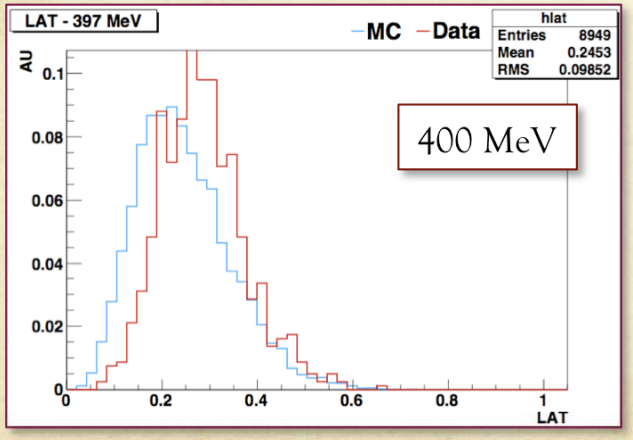

S9S25 - 487 MeV
MC
Data
hs9s25
Entries 9944
Mean 0.9716
RMS 0.02
500 MeV
AU
S9/S25

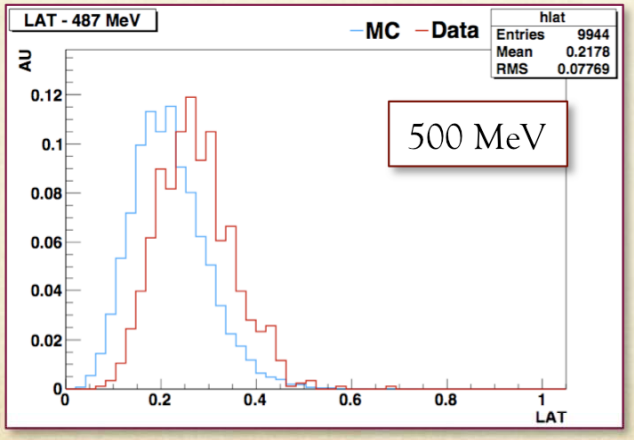
LAT





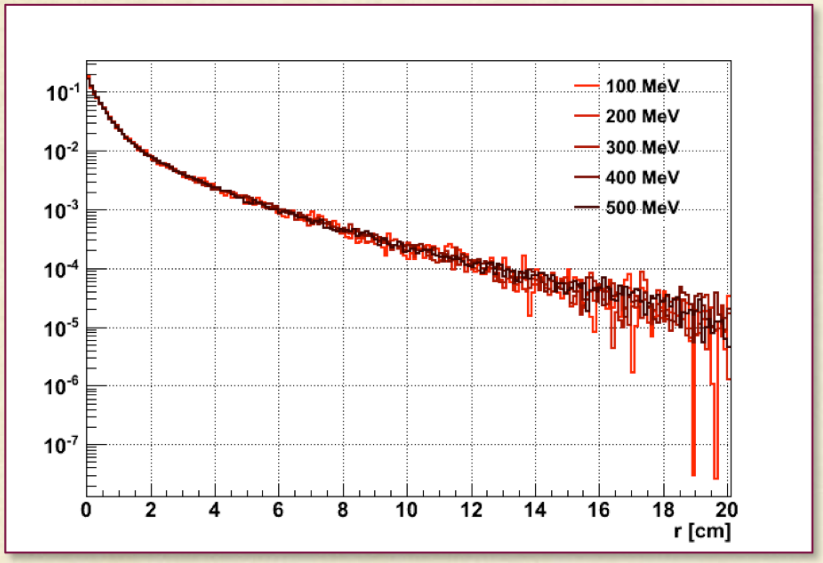


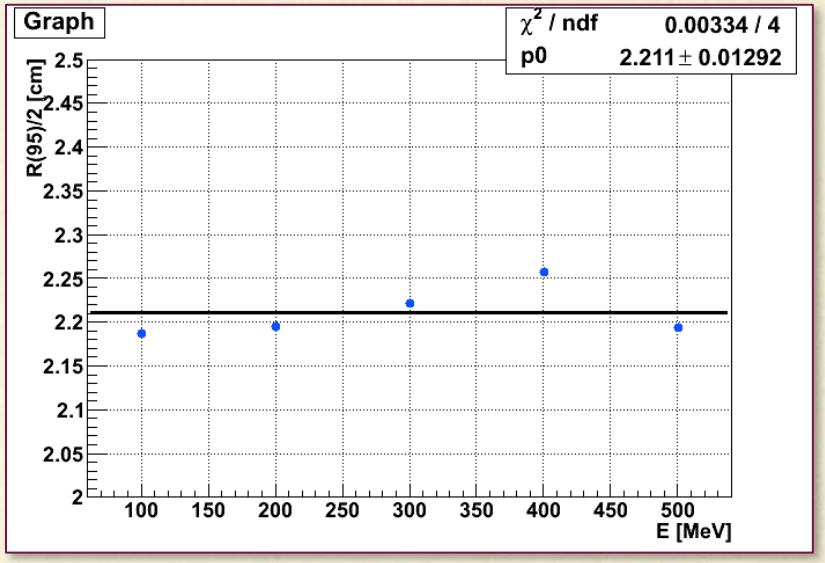




$$LAT = \frac{\sum_{i=3}^{N} E_i r_i^2}{\sum_{i=3}^{N} E_i r_i^2 + E_1 r_0^2 + E_2 r_0^2}$$

Moliere Radius in MC





From MC, estimate R_M = 2.21 ± 0.02 cm
From Ren-Yuan tables, R_M^{LYSO} = 2.07 cm

Conclusion

- Data-driven method to estimate Beam Spread
- Good agreement between Data and MC resolutions
- "Final" Beam Spread subtracted resolutions:
- Disagreement in shower shape under study

En (MeV)	σ(E)/E (%)
99	5.2 ± 0.4
198	3.3 ± 0.2
297	2.6 ± 0.5
397	2.2 ± 0.4
487	2.1 ± 0.2

Extra Slides

Beam Spread Evaluation Technique

Assumption → $\sigma(100+100) = \sigma(200)$

TB Resolution Componenets →

$$\frac{\sigma^2_{TB}(100)}{100^2} = \frac{\sigma^2(100)}{100^2} + \frac{BS^2_{100}}{100^2}$$

$$\frac{\sigma^2_{TB}(200)}{200^2} = \frac{\sigma^2(200)}{200^2} + \frac{BS^2_{200}}{200^2}$$

Two Particle Beam Spread Component (Absolute) →

$$BS^2_{100+100} = BS^2_{100} + BS^2_{100} = 2BS^2_{100}$$

Two Particle Beam Spread Component (Relative) →

$$\frac{BS^2_{100+100}}{200^2} = \frac{2 \times BS^2_{100}}{200^2} = \frac{1}{2}\frac{BS^2_{100}}{100^2}$$

Two Particles TB Resolution Components →

$$\frac{\sigma^2_{TB}(100+100)}{200^2} = \frac{\sigma^2(200)}{200^2} + \frac{1}{2}\frac{BS^2_{100}}{100^2}$$

Knowing BS_{200} we can measure BS_{100} →

$$\frac{\mathbf{BS^2_{100}}}{\mathbf{100^2}} = \mathbf{2} \times \left(\frac{\sigma^2_{\mathbf{TB}}(\mathbf{100+100})}{\mathbf{200^2}} - \frac{\sigma^2_{\mathbf{TB}}(\mathbf{200})}{\mathbf{200^2}} + \frac{\mathbf{BS^2_{200}}}{\mathbf{200^2}} \right)$$

Knowing BS_{100} we can measure BS_{300} →

$$\frac{\mathbf{BS^2_{300}}}{\mathbf{300^2}} = \frac{\sigma^2_{\mathbf{TB}}(\mathbf{300})}{\mathbf{300^2}} - \frac{\sigma^2_{\mathbf{TB}}(\mathbf{3\times 100})}{\mathbf{300^2}} + \frac{\mathbf{1}}{\mathbf{3}}\frac{\mathbf{BS^2_{100}}}{\mathbf{100^2}}$$

Multi Particles Energies and BS

Beam \ Emeas	99	198	297	397	487	594	891
99	99x1	99x2	99x3				
198		198x1		198x2		198x3	
297			297x1			297x2	297x3
397				397x1			
487					487x1		

All but the 500 MeV beam can be used to have multiple measurements of the same intrinsic energy resolution.