

How Accurately Do We Know The Formation of Solar ^8B

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1. **Nuclear Physics Inputs: Standard Solar Model**
2. **The $^7\text{Be}(p,\gamma)^8\text{B}$ Reaction**
 - (a) **Direct Capture (DC)**
Seattle, Weizmann Experiments
 - (b) **Coulomb Dissociation (CD)**
RIKEN2, GSI1, GSI2 Experiments
3. **Some Strong Statement Appeared in Publications**
 - (a) **on Exaggerated Accuracy**
 - (b) **on Disagreement Between DC and CD**

Notre Dame, CGS12, September 8, 2005

The Laboratory for Nuclear Science At Avery Point



 Laboratory for
Astrophysics
1084 Shennecossett



SNO Salt Phase Result:

$$\Phi_\nu = 4.94 \pm 0.21 \text{ (stat)} \quad {}_{-0.34}^{+0.38} \text{ (syst)} \times 10^6 \text{ cm}^{-2} \text{ sec}^{-1} \quad [1]$$

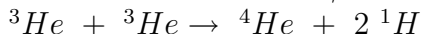
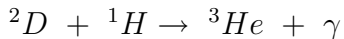
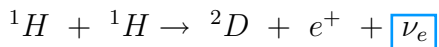
$$\frac{\Phi_{SSM}}{\Phi_\nu} = 1.17$$

[2]

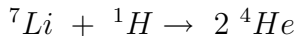
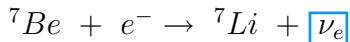
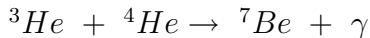
[1] B. Aharmin *et al.*; nucl-ex/0502021.

[2] J.N. Bahcall and M.H. Pinsonneault; Phys. Rev. Lett. **92**(2004)121301.

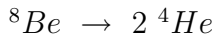
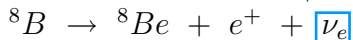
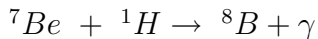
SOLAR FUSION



PPI - 86%



PPII - 14%

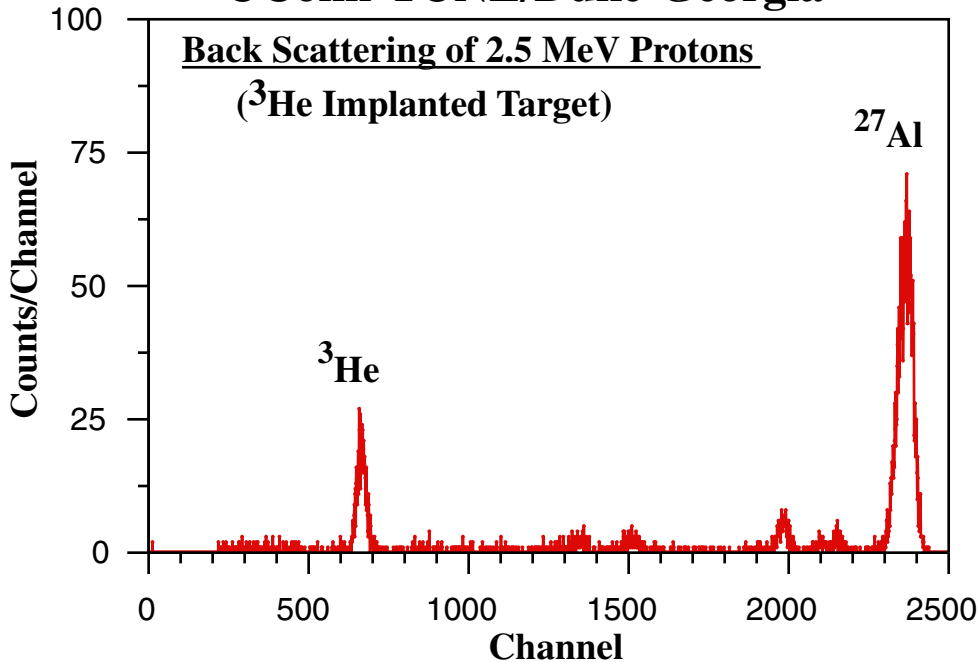


PPIII - 0.01%

BS05 Fractional Uncertainties

Source	^8B	^7Be
p-p	0.01	0.004
$^3\text{He} + ^3\text{He}$	0.02	0.02
$^3\text{He} + ^4\text{He}$	0.08	0.08
$\text{p} + ^7\text{Be}$	0.04	0.00
Composition	0.12	0.05
Opacity	0.05	0.03
Diffusion	0.04	0.02
Luminosity	0.03	0.01

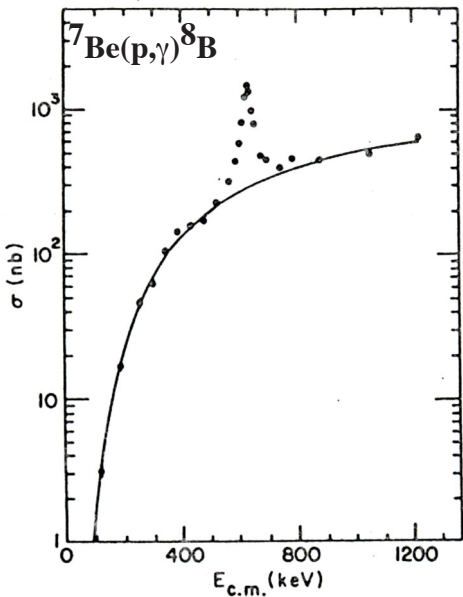
UConn-TUNL/Duke-Georgia



$$\sigma_{17} = S_{17}/E \times e^{-2\pi\eta}$$

$$(\eta = Z_1 Z_2 \alpha / \beta) \quad E_{\text{cm}} = 18 \text{ keV}$$

Fillipone(1983)



Seattle Result on ${}^7\text{Be} + \text{p} \rightarrow {}^8\text{B} + \gamma$:

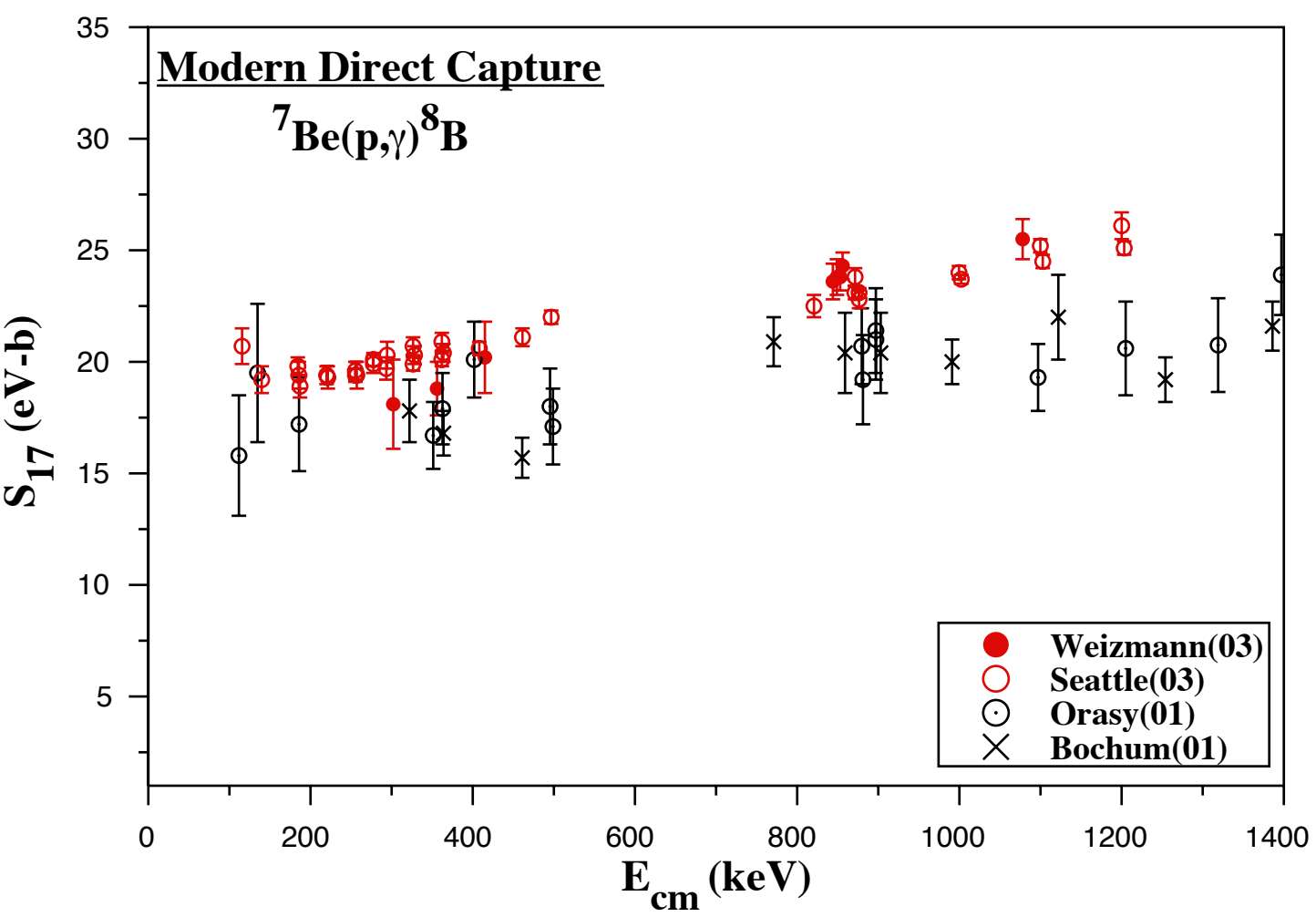
$$S_{17}(0) = 21.4 \pm 0.5 \text{ (expt)} \pm 0.6 \text{ (theory)} \text{ eV-b} \quad [1]$$

Previous Compilation:

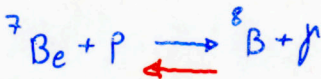
$$S_{17}(0) = 19 \pm 4 \pm 2 \text{ eV-b} \quad [2]$$

[1] A.R. Junghans *et al.*; Phys. Rev. **C68**(2003)065803.

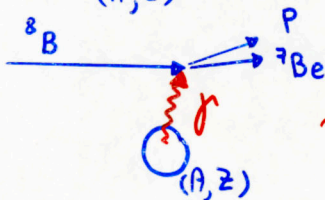
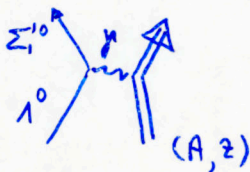
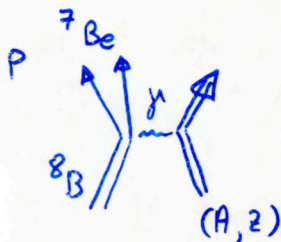
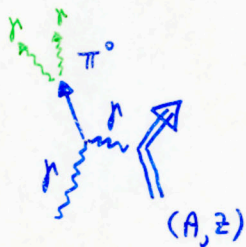
[2] E.G. Adelberger *et al.*; rev. Mod. Phys. **70**(1998)1265.



CAPTURE REACTION:



PRIMA KOFF (1951):



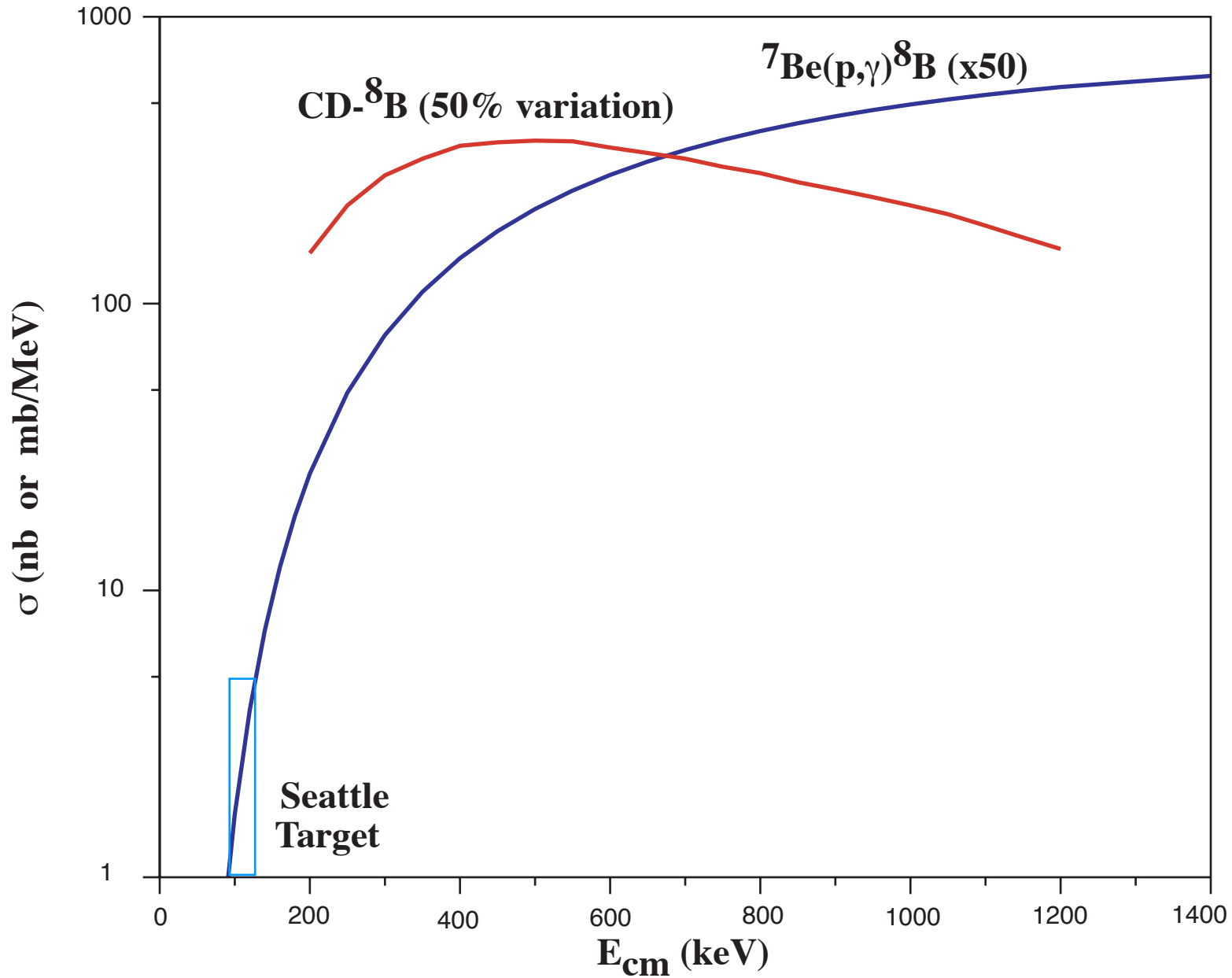
$\sim 40 \text{ fm} !!$

ENHANCEMENT:

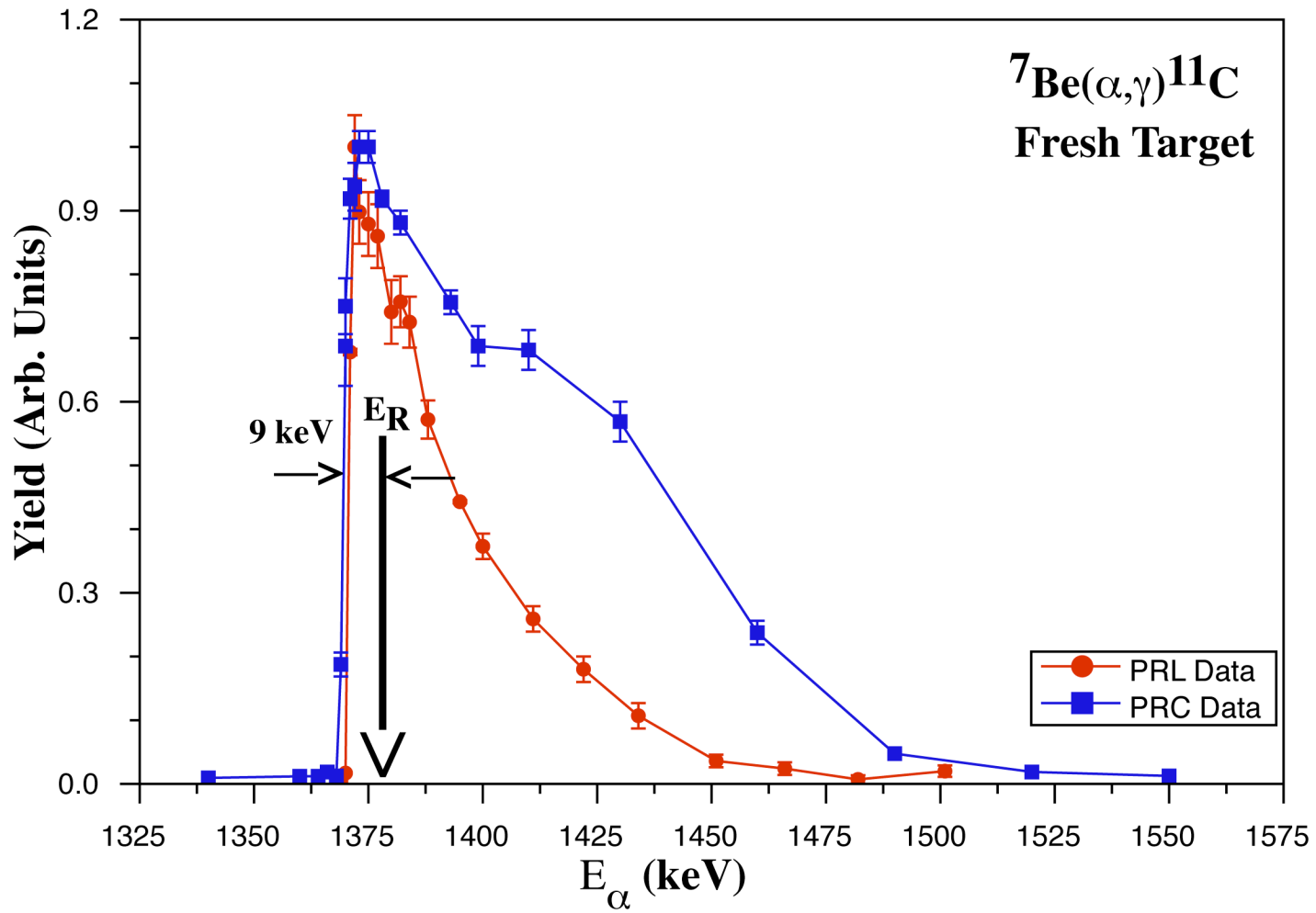
(I) $\pi/k^2 \approx 1,000$

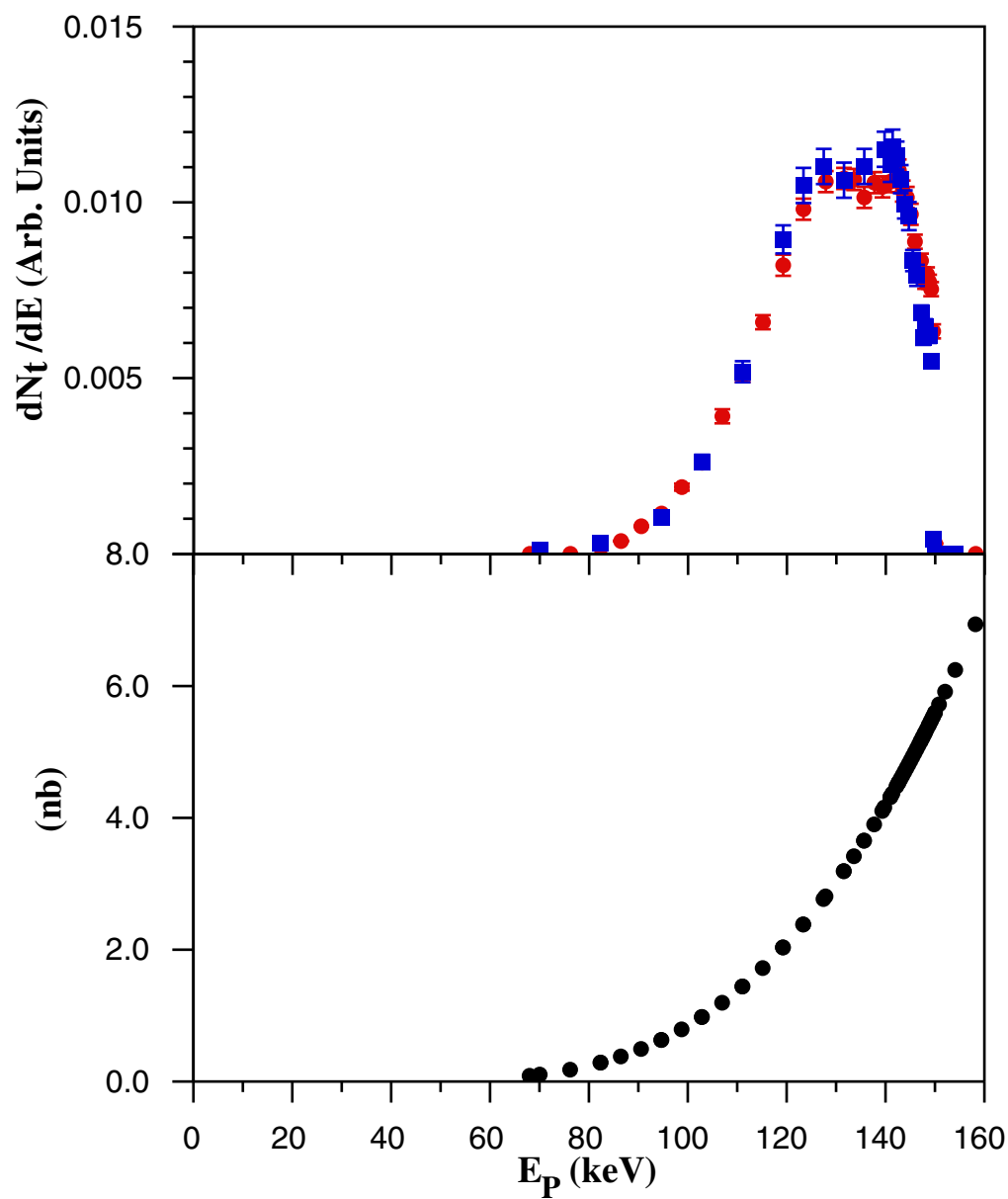
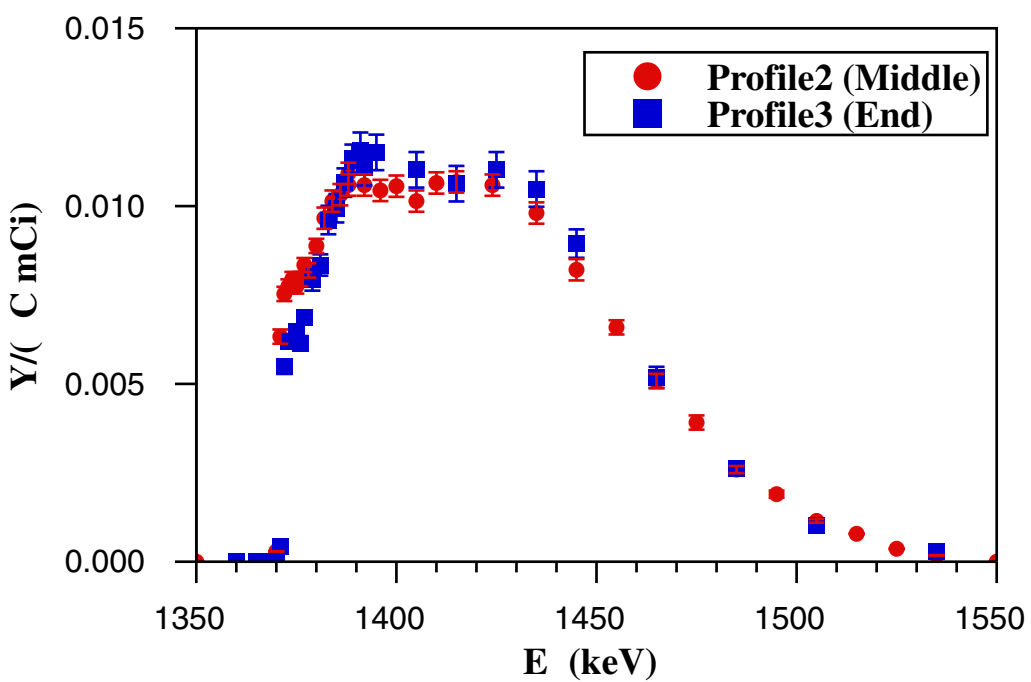
(II) $m_\gamma(E_1) \approx 1000$

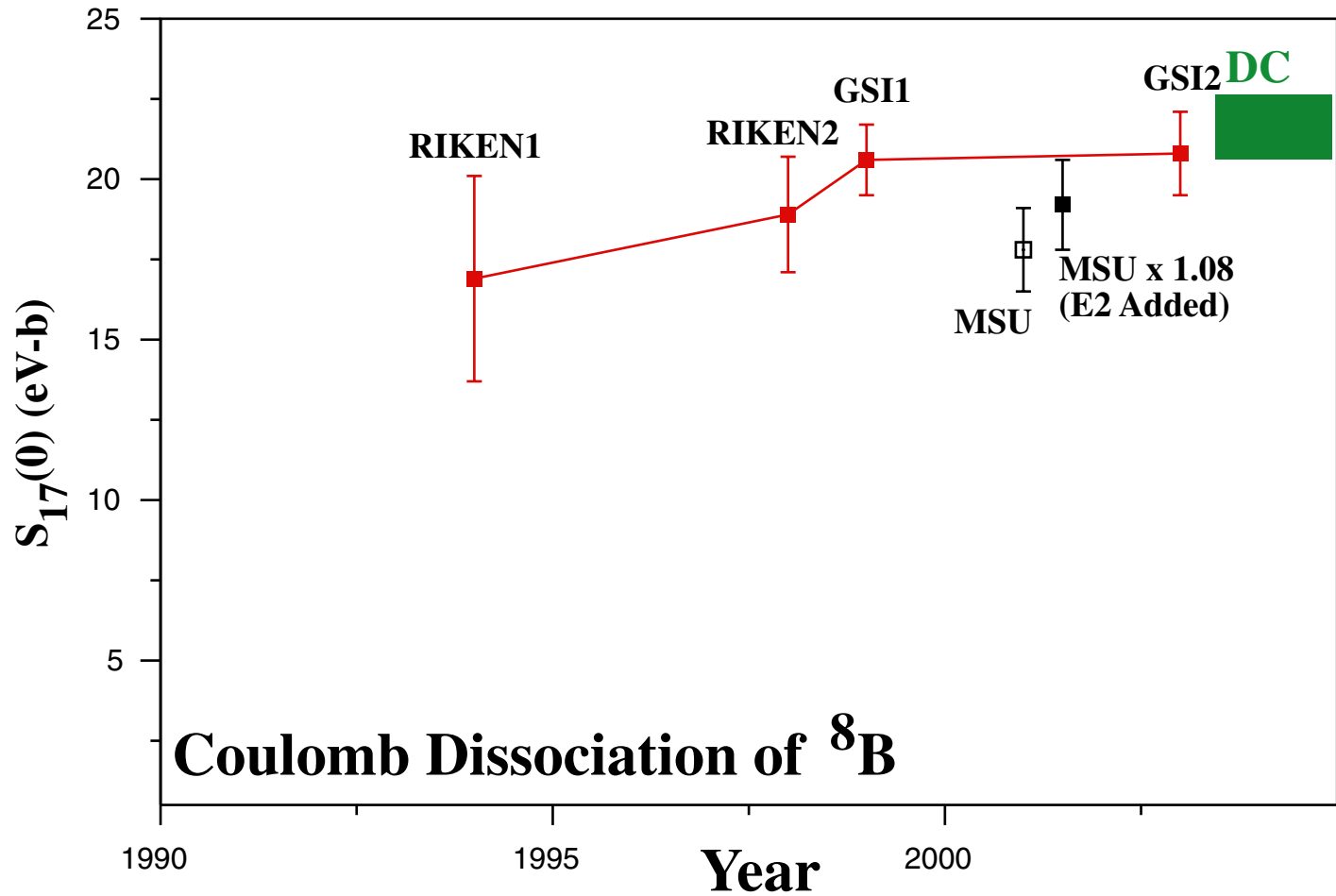
BAUR, BERTULANI, REBEL - 1986



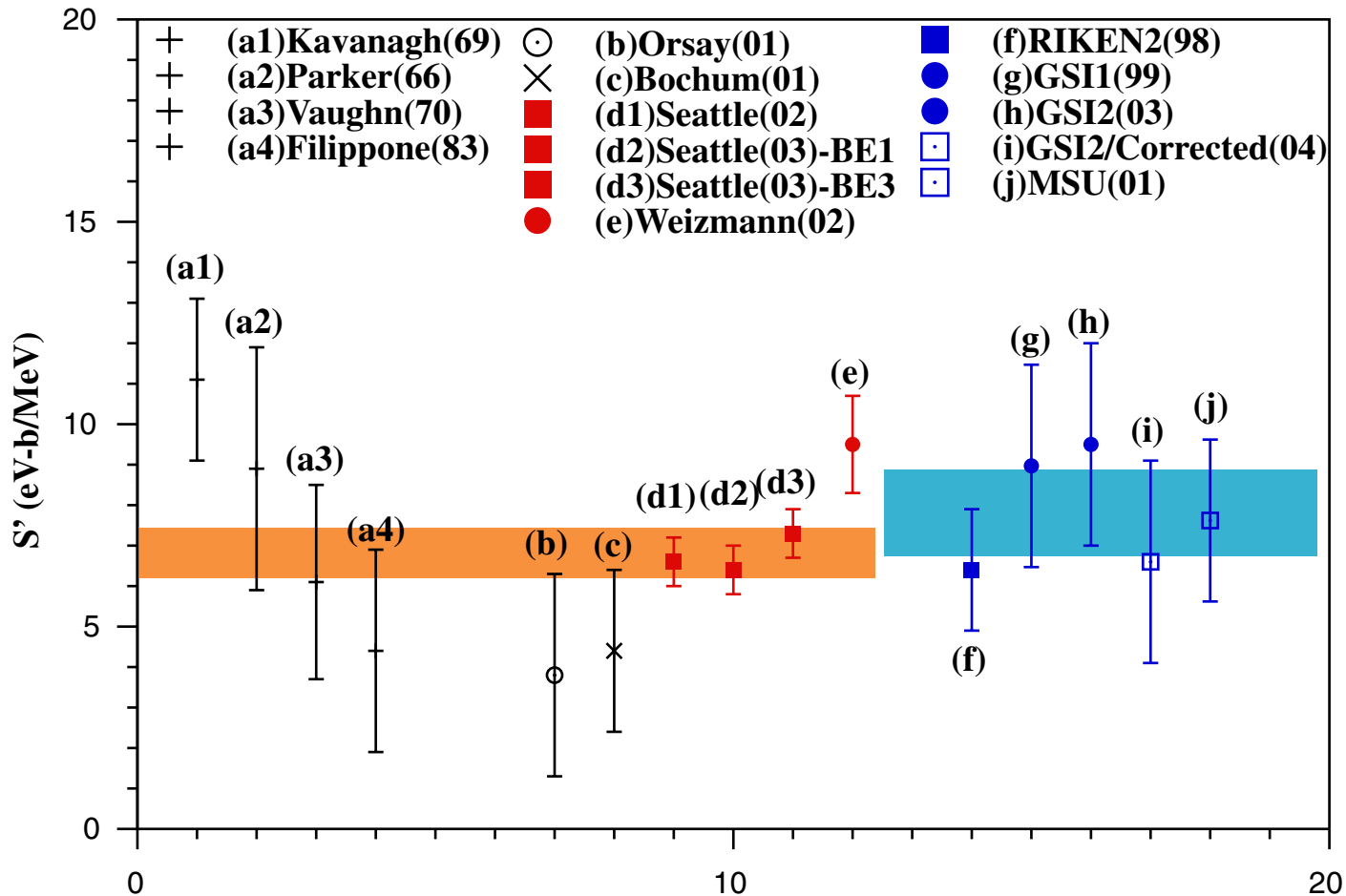
${}^7\text{Be}(\alpha,\gamma){}^{11}\text{C}$
Fresh Target

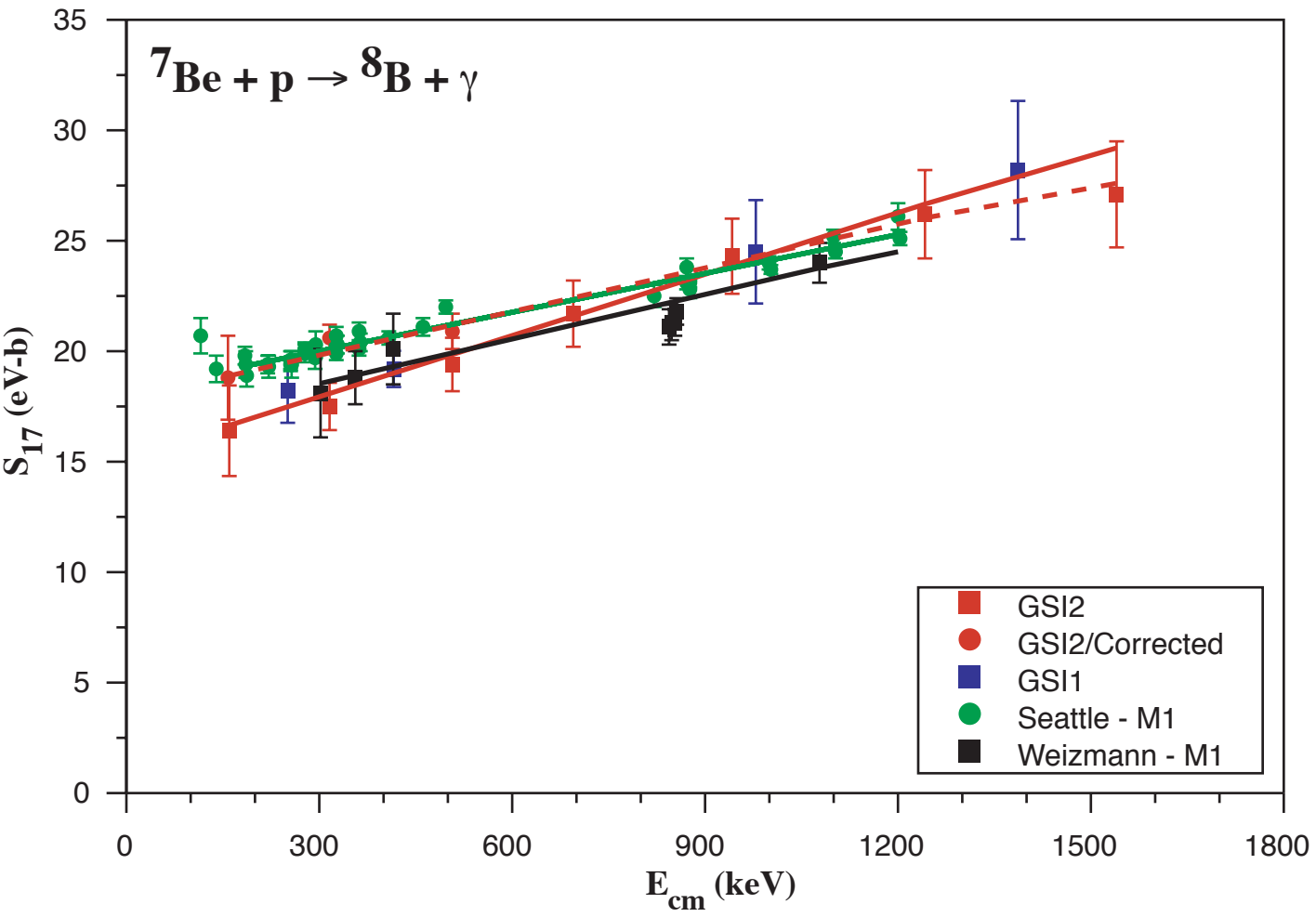




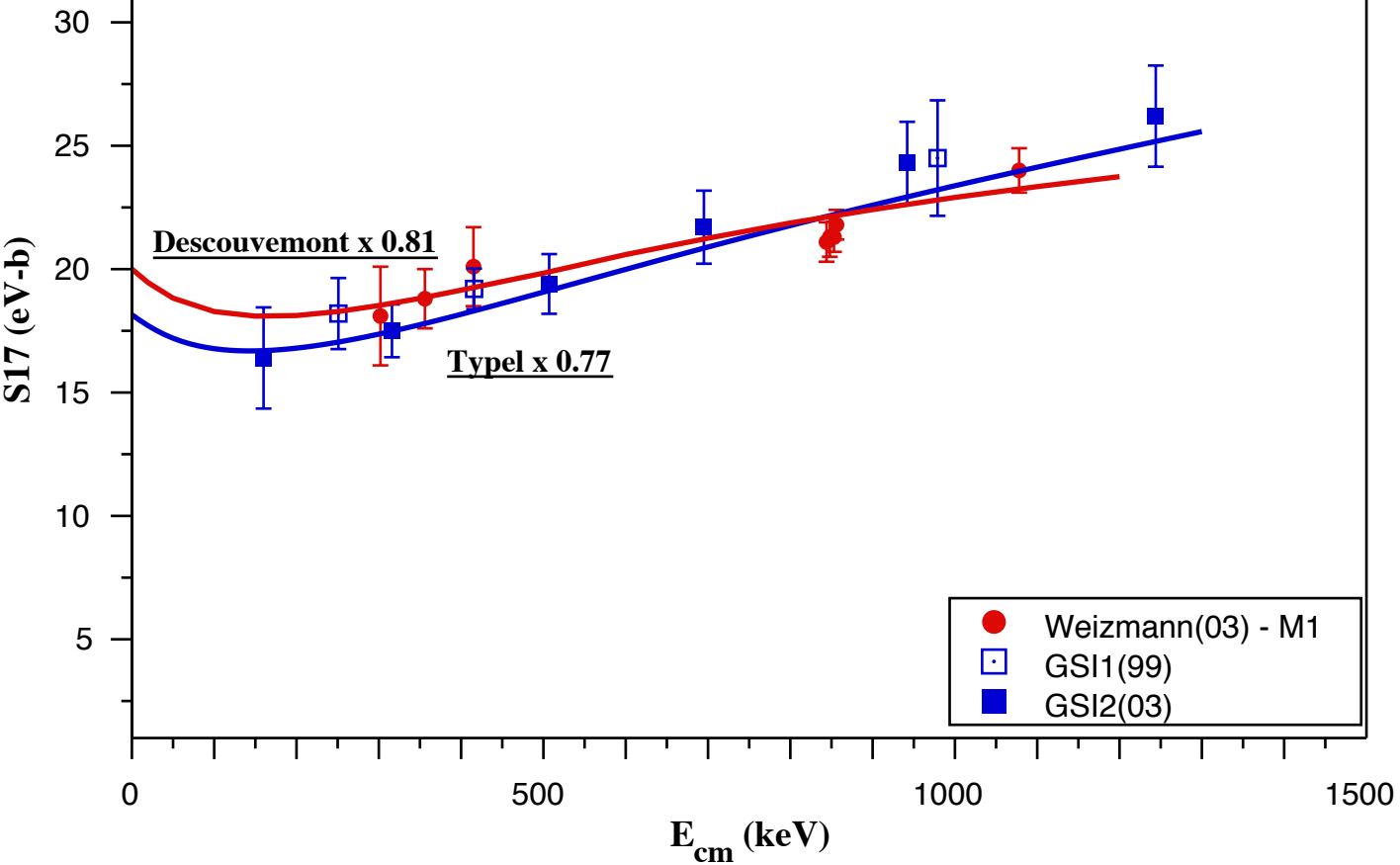


Slope of data $S' = dS/dE$





${}^7\text{Be}(p,\gamma){}^8\text{B}$



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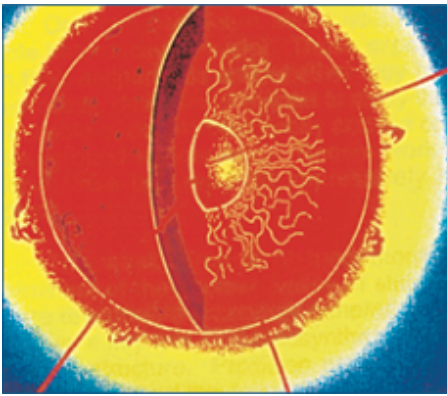
Reasonable Conservative Estimate:

$$S_{17}(0) = 21.4 \pm 0.8 \text{ (expt)} \boxed{^{+0.0}_{-3.0}} \text{ (extrap)} \text{ eV-b} \quad [3]$$

[1] A.R. Junghans *et al.*; Phys. Rev. **C68**(2003)065803.

[2] E.G. Adelberger *et al.*; rev. Mod. Phys. **70**(1998)1265.

[3] M. Gai; nucl-ex/0312003.



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^8B Solar Neutrino Flux:

S_{34} soon will be known (<5%)

S_{17} Seattle result must be checked

Extrapolation must be checked

Claim of Exaggerated Accuracy (NO)

Claim of Discrepancy Between CD and DC (NO)

Is $\text{SSM}/\text{Flux} = 1.17$ significant?