# Discrepancy of <σ> measurements in the U-235 neutron field at high neutron energies

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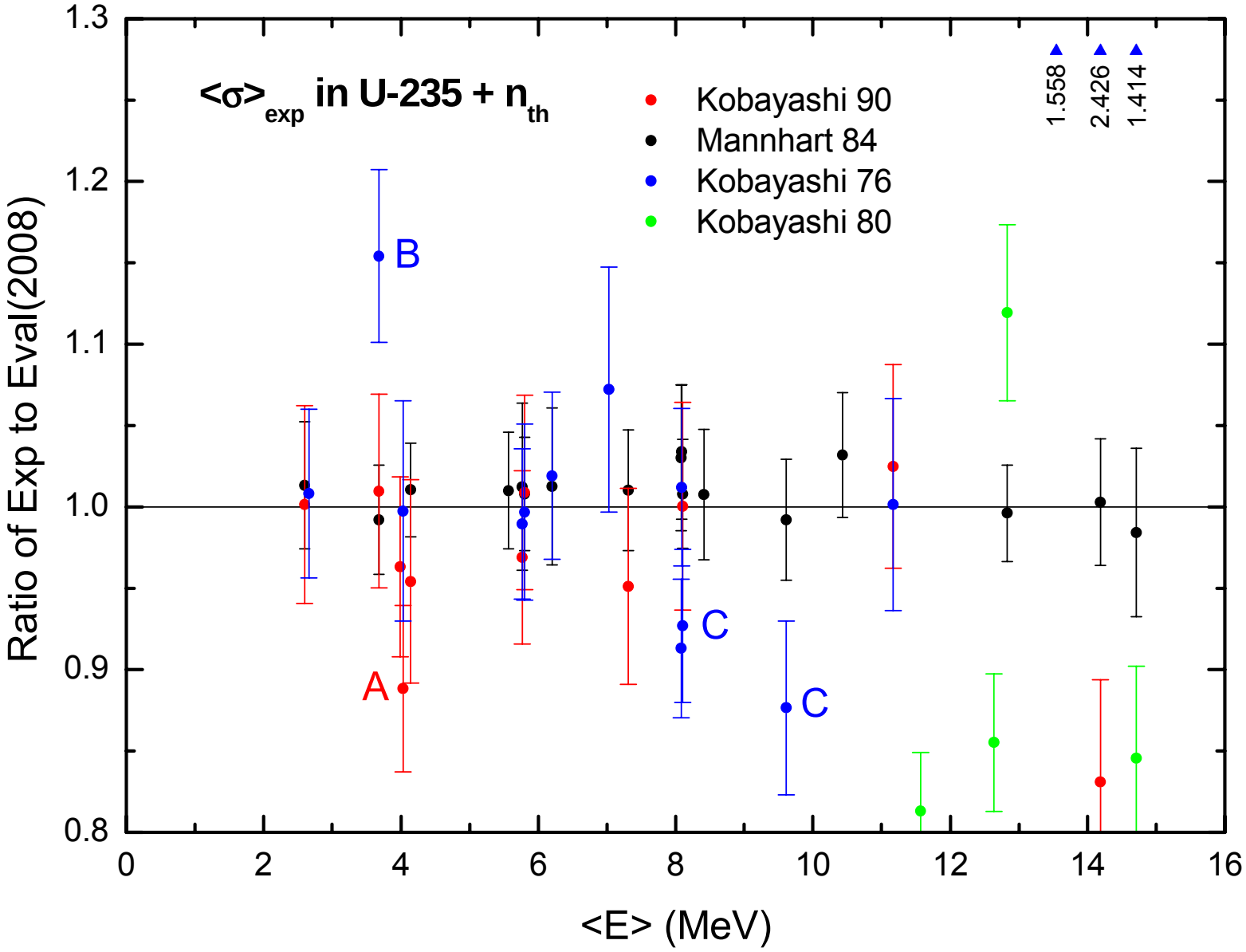
<σ>exp in U-235 + nth
Kobayashi 90
Mannhart 84
Kobayashi 76
Kobayashi 80
1.558
2.426
1.414
B
A
C
C
Ratio of Exp to Eval(2008)
<E> (MeV)
1.3
1.2
1.1
1.0
0.9
0.8
0
2
4
6
8
10
12
14
16

## Experimental data sets

| | Reference | Facility | Scattering correction | Monitor used | Reaction decay data |
|---|---|---|---|---|---|
| ● | **Kobayashi 90**<br>X4 = 22216<br>Progress Report<br>NEANDC(J)-155 (1990) p.52 | KUR (5 MW),<br>thermal column,<br>fission plate (11 mm) | MCNP calc.<br><br>effect is negligible for $E_n$ > 1 MeV | Al-27(n,α)Na-24 | **???** |
| ● | **Mannhart 84**<br>X4 = 22020<br>Geesthacht 84, Vol.2 (1984) p.813 | BR1,<br>cavity in<br>thermal column,<br>cylindrical fission converter (0.18 mm) | Neutron transport calculation,<br><br>corrections from 4.3% to 9.3% | Ni-58(n,p)Co-58<br>In-115(n,n')In-115m | given |
| ● | **Kobayashi 76**<br>X4 = 20693<br>NST 13 (1976) p.531 | YAYOI core | **none**<br><br>spectrum > 2 MeV is equal to fission spectrum | In-115(n,n')In-115m<br>Ni-58(n,p)Co-58<br>Al-27(n,α)Na-24 | given |
| ● | **Kobayashi 80**<br>X4 = 21693<br>Progress Report<br>NEANDC(J)-067 (1980) p. 42 | YAYOI core<br>+ fission plate | **???** | **???** | **???** |

**Remarks**

| | |
|---|---|
| **A** | **Reaction: Zn-64(n,p)Cu-64**<br>Instead of the strong annihilation radiation (β+) of Cu-64 a very weak gamma line was measured. If the decay data used in the measurement are identical to that of **Kobayashi 76** then the given ratio value must be increased by 5%. |
| **B** | **Reaction: Ti-47(n,p)Sc-47**<br>The calibration of a Ge detector at the 160 keV gamma line of the Sc-47 decay is difficult. This could be an explanation of the relatively high value given. |
| **C** | **Reactions Ti-48(n,p)Sc-48 and V-51(n,α)Sc-48**<br>The reaction product of both reactions is Sc-48. The decay of Sc-48 consists of a 3-fold gamma cascade. The summing losses in the activity measurement are therefore relatively large. The similar low values of both reactions suggest an imperfect summing correction. |
| | **In addition valid for the experiment of Kobayashi 76:**<br>The corrected values (monitor cross section and decay data) of Cu-63(n,2n), Zr-90(n,2n) and Ni-58(n,2n) are outside of the range of the figure given.<br>The missing numerical values are:<br><E> = 13.55 MeV Cu-63(n,2n)Cu-62 new value = 1.558 (original value = 0.979) *<br><E> = 14.19 MeV Zr-90(n,2n)Zr-89 new value = 2.426 (original value = 2.230)<br><E> = 14.71 MeV Ni-58(n,2n)Co-58 new value = 1.414 (original value = 1.254)<br><br>* The corrected value of Cu-63(n,2n)Cu-62 comprises a factor of 1.462 exclusively from the decay data correction. Even the decay of Cu-62 is mainly β+. Similar as in the case of Cu-64 (see remark A) only a weak gamma line was measured. The intensity value used deviates strongly from the present knowledge. |

## The situation of the high energy data is contradictory

**There are two possible scenarios to improve the situation:**

- A neglect of the scattering correction in the experiment **Mannhart 84** would reduce the given data between 4.3% (at 2 MeV) and 9.3% (at 14 MeV)

- The high energy data of **Kobayashi 80** would be increased by a factor of 1.096, if the unknown value of the monitor cross section is identical to that used in the experiment **Kobayashi 76.**

## Summary

- **Up to 10 MeV neutron energy**, the various <σ> data, measured under quite different experimental conditions, are relatively consistent if one considers the errors of the data and accepts some spread in the measurements.

- **A possible solution of the conflicting high-energy data** could be given if one considers the history of the Al-27(n,α)Na-24 monitor cross section used in the experiments of Kobayashi.
  In the experiment **Kobayashi 90** a numerical value of (0.706 ± 0.028) mb has been used which is exactly the value measured in the experiment **Mannhart 84**.
  In the earlier experiment **Kobayashi 76** the numerical value used is 0.644 mb.This value is 10% lower than the more recent one.
  With some probability one can assume that in the experiment **Kobayashi 80** the lower of the both values of the monitor cross section has been used. Under such circumstances an increase of the high-energy data of **Kobayashi 80** in the order of 10% would be necessary.

- **However, due to missing details in the documentation of the experiment Kobayashi 80, the mentioned assumptions cannot be substantiated by facts.**