Results –3 (Specific activity)

2. Nippon Ginko Sample

- Recovery

  $\eta_{Ni} = 38.1 \pm 2.9$ %

- Efficiency

  $\varepsilon_{Ni} = 0.00717 \pm 0.00043$ cps/Bq

- Radioactivity

  $A(^{63}Ni) = 0.0259 \pm 0.0090$ Bq

- Specific activity (at the bomb explosion)

  $S(^{63}Ni) = 0.00247 \pm 0.00088$ Bq/gCu

- Calculation

  $S(^{63}Ni) = 0.00182$ Bq/gCu

Conclusion

1. ^{63}Ni can be measured by present Si–NaI anticoincidence beta–ray spectrometer.

2. Preliminary result of Nippon Ginko sample is determined to be 0.00247±0.00088 Bq/gCu, which is 30 % high than the calculation.

3. Further improvements are necessary
   - ✧ Ni recovery through chemical process
   - ✧ Beta–ray detection efficiency

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on Reassessment of A-Bomb Dosimetry

Cross section measurements of the $^{63}Cu(n,p)^{63}Ni$ reaction

(KURRI) Koichi Takamiya

Joint Meeting of Japan-U.S. Working Groups
on Reassessment of A-Bomb Dosimetry
March 21-23, 2001 Hiroshima, Japan

Introduction

- Motivation

  Estimate neutron fluence emitted from Hiroshima A-bomb by measuring ^{63}Ni produced in Cu samples.

- Problem

  Scarce experimental data of excitation function for $^{63}Cu(n,p)^{63}Ni$.

- In this work

  The excitation function was measured in the neutron energy region of $E_n = 1.75 \sim 6.58$ MeV.

In This Presentation

- Experimental
- Our Previous Result
- Our Present Result
- Discussion
- In the future

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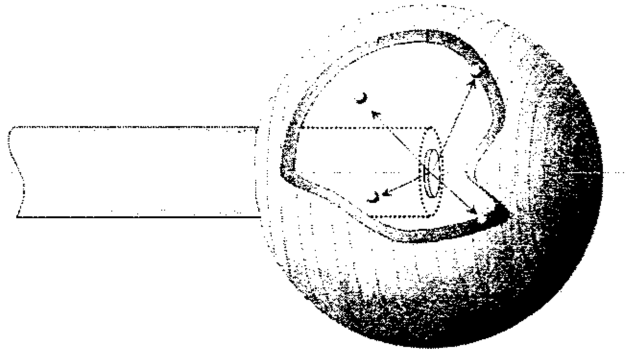
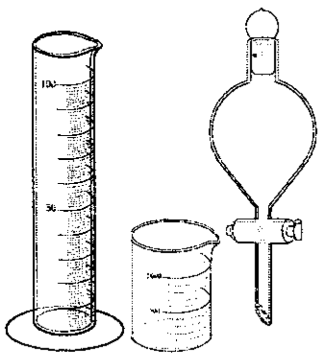
Experimental

- Fast neutron irradiation
  [at Fast Neutron Laboratory (Tohoku Univ.)]



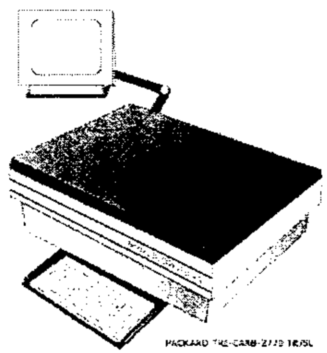
$^{63}Cu(n,p)^{63}Ni$



- Chemical separation of Ni from irradiated Cu samples
  [at Research Reactor Institute of Kyoto University]

^{63}Ni in Cu samples ⟶ Ni component

- Determination of ^{63}Ni produced in Cu samples by low-background liquid scintillation counter
  [at RI centre (Univ. of Tokyo)]



Measuring β -rays from ^{63}Ni

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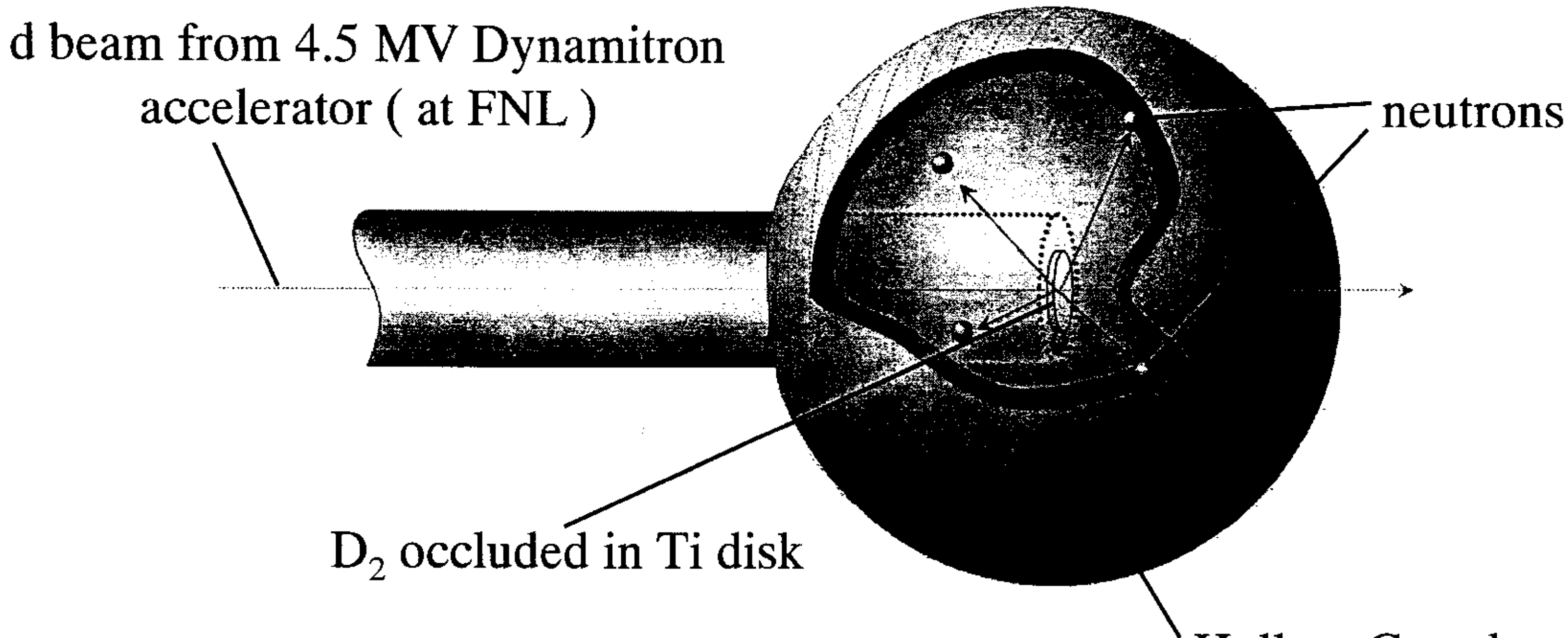
Experimental (Fast Neutron Irradiation)



- Irradiated neutron energy
  $E_n = 1.75 \sim 6.58$ MeV

D(d,n) → $^{63}Cu(n,p)^{63}Ni$

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Experimental (Chemical Separation)

- Simple scheme of chemical separation

Electrolysis (12～30 hours)

    Remove almost the whole Cu

↓

Anion exchange (DOWEX 1X8)

    Separate Ni, Co and Cu components

↓

Extraction

    Refinement of Ni component

- Chemical yield in this work (ICP-AES)

30 ～ 100 %

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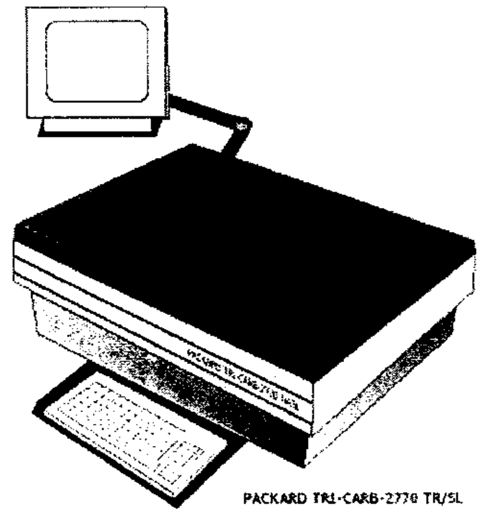
Experimental (Determination of ^{63}Ni)

- Separated ^{63}Ni samples
  (+water 1 mL+ clearsol 5 mL)
- Standard ^{63}Ni samples
  (+ clearsol 5 mL)



β ray measurement (RI centre, Univ. of Tokyo) PACKARD:TRI-CARB-2770 TR/SL	
60min ×7	10min ×6

Quenching correction data
(counting efficiency)

Chemical yield

Determination of ^{63}Ni

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Previous Results

$E_n = 5.23 \sim 6.58$ MeV

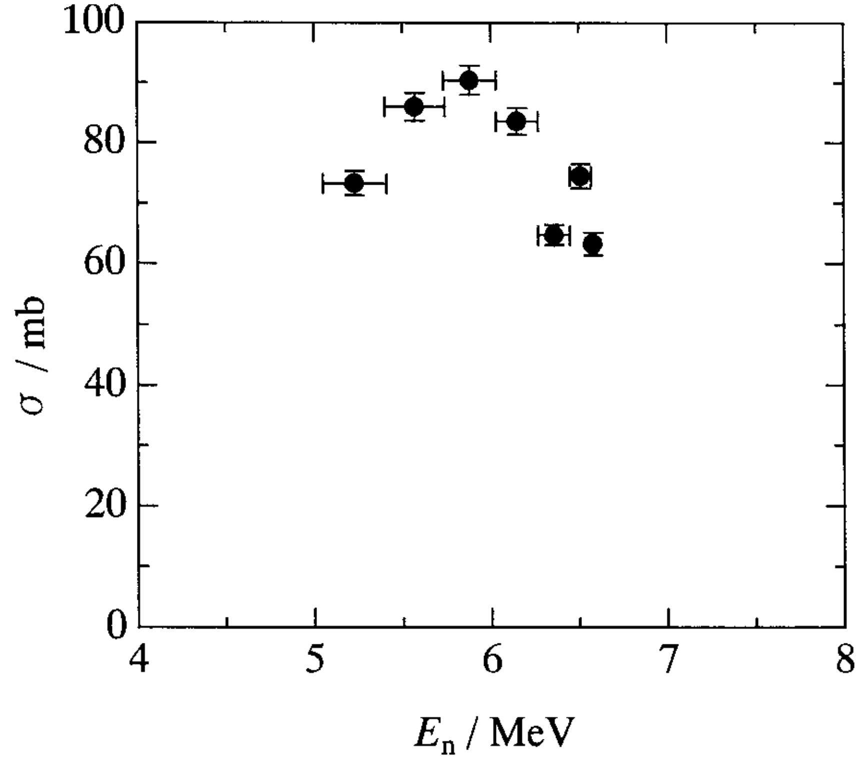

Fig. Excitation function of $^{63}Cu(n,p)^{63}Ni$ shown in the previous meeting.

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Present Results

$E_n = 1.75 \sim 6.58$ MeV

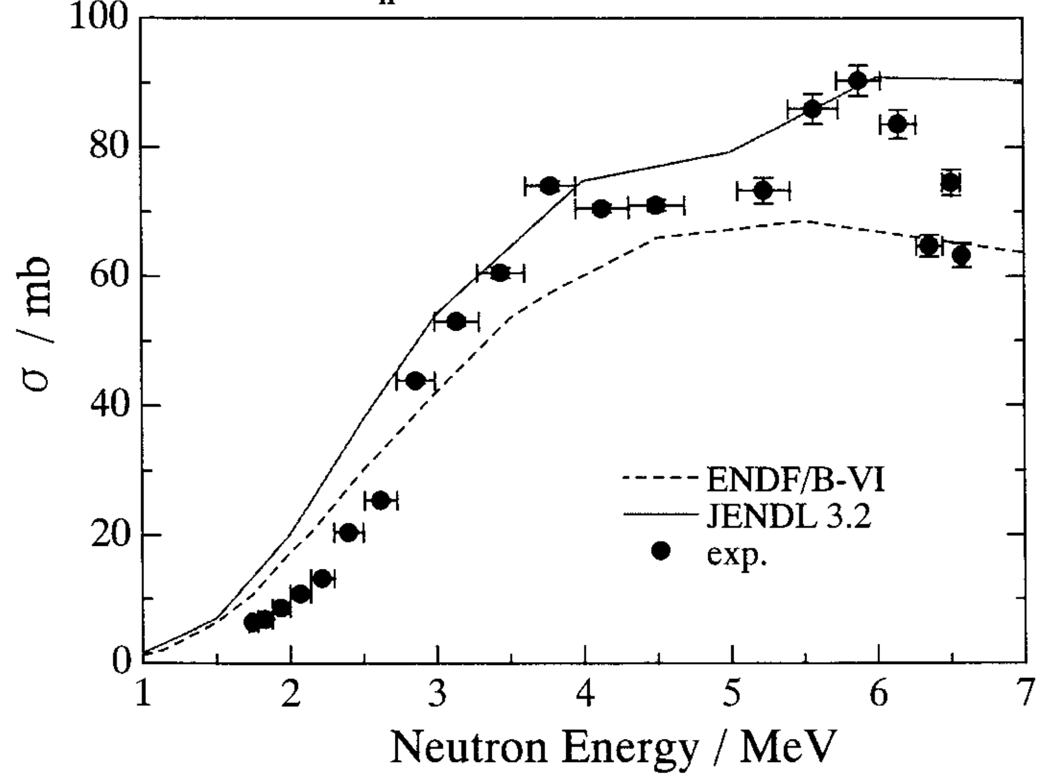

Fig. Excitation function of $^{63}Cu(n,p)^{63}Ni$.

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Present Results: Comparison with Our Previous Work

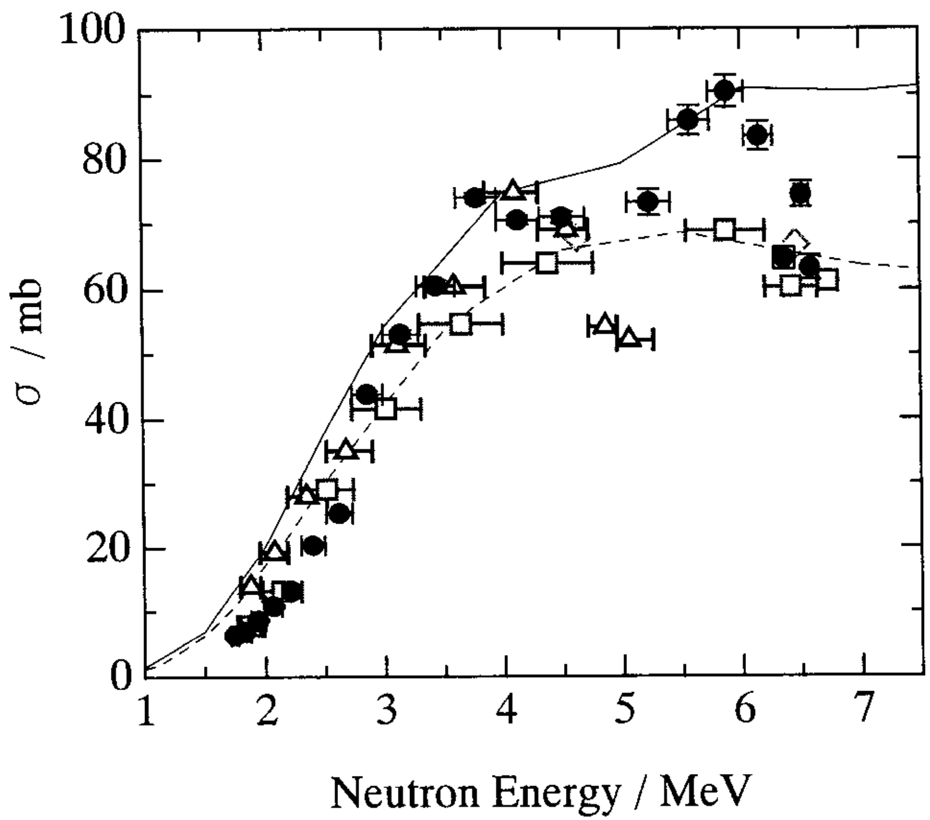

Fig. Excitation function of ^{63}Cu(n,p)^{63}Ni.

Our results are nearly consistent in *E*n < 4.5 MeV.
Discrepancy is found in high energy region (*E*n > 4.5 MeV).

Similar tendency (data at high energy have lower cross section) was found.

▼

Is this tendency caused by <u>our experimental condition</u>?

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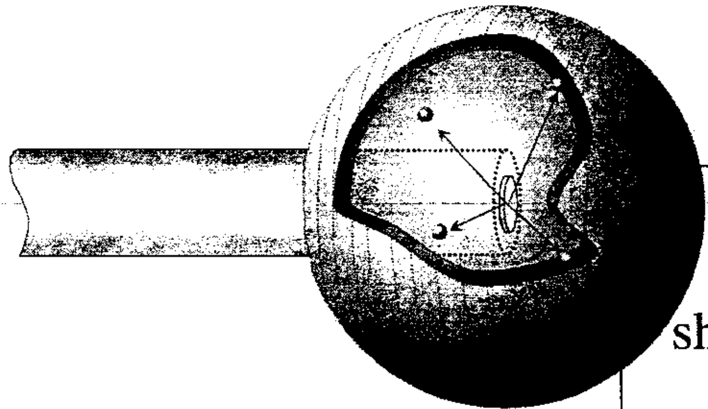
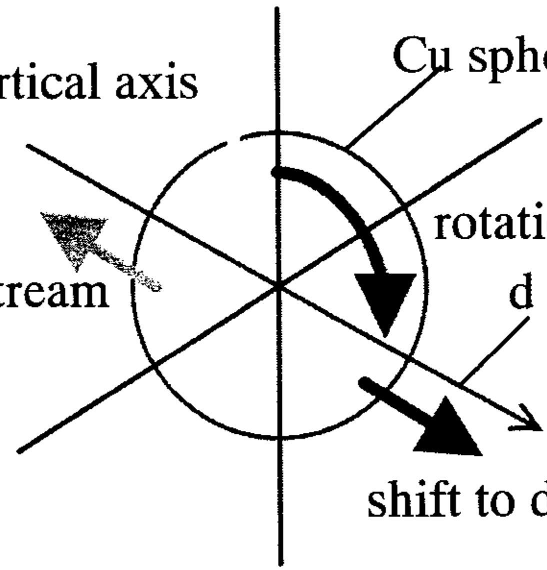
Discussion: Effect of Geometric Shift of Cu Sphere

- In these experiment・・・

<u>The Cu sphere may have shifted ...</u>

Estimation of neutron energy and fluence for each separated Cu sample might be different from real values.





To estimate the effect of geometric shift, a simulation was carried out.

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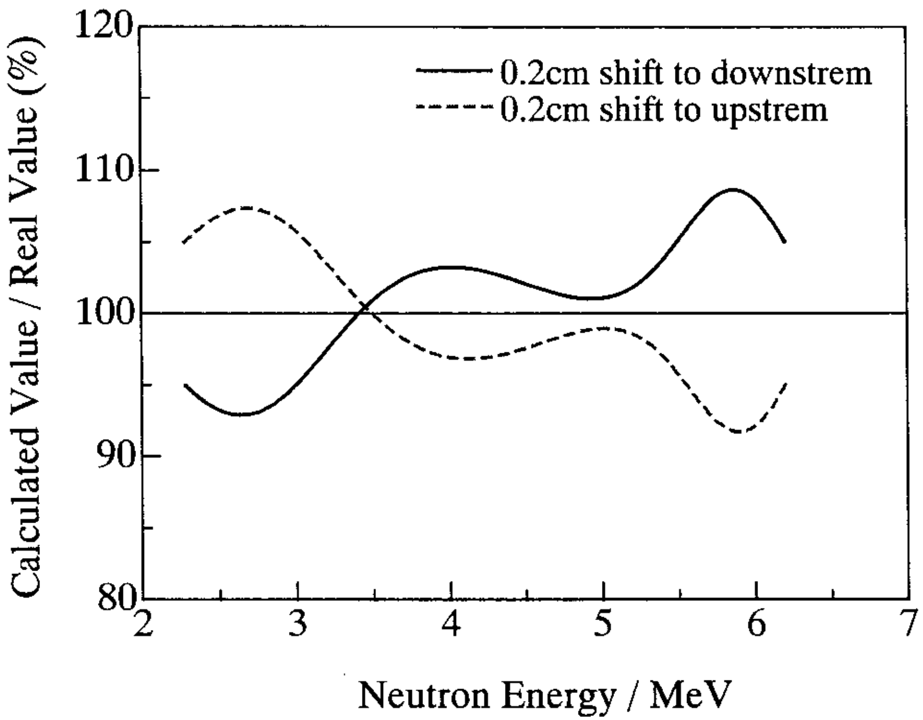
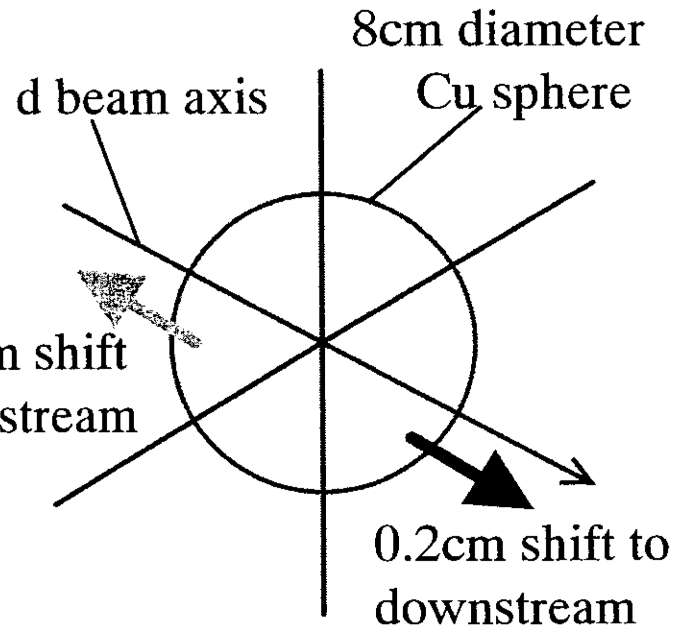
Discussion: Effect of Geometric Shift of Cu Sphere

Example of simulated results





About 10%$_{(MAX)}$ of discrepancy was found.

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Conclusion and Future Plan

- Small shift of Cu sphere gives discrepancy to cross section.
  - The small discrepancy at low energy region are within the limit of the geometric effect.
  - But the discrepancy among our results at high energy region are beyond the limit of the geometric effect.

- An irradiation experiment is planned in May (or June) 2001.
  - A setup of an irradiation system will be reconsidered to reduce the geometric effect.

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Calculation of Ni-63 yield by using the crack model

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Research Institute for Radiation Biology and Medicine

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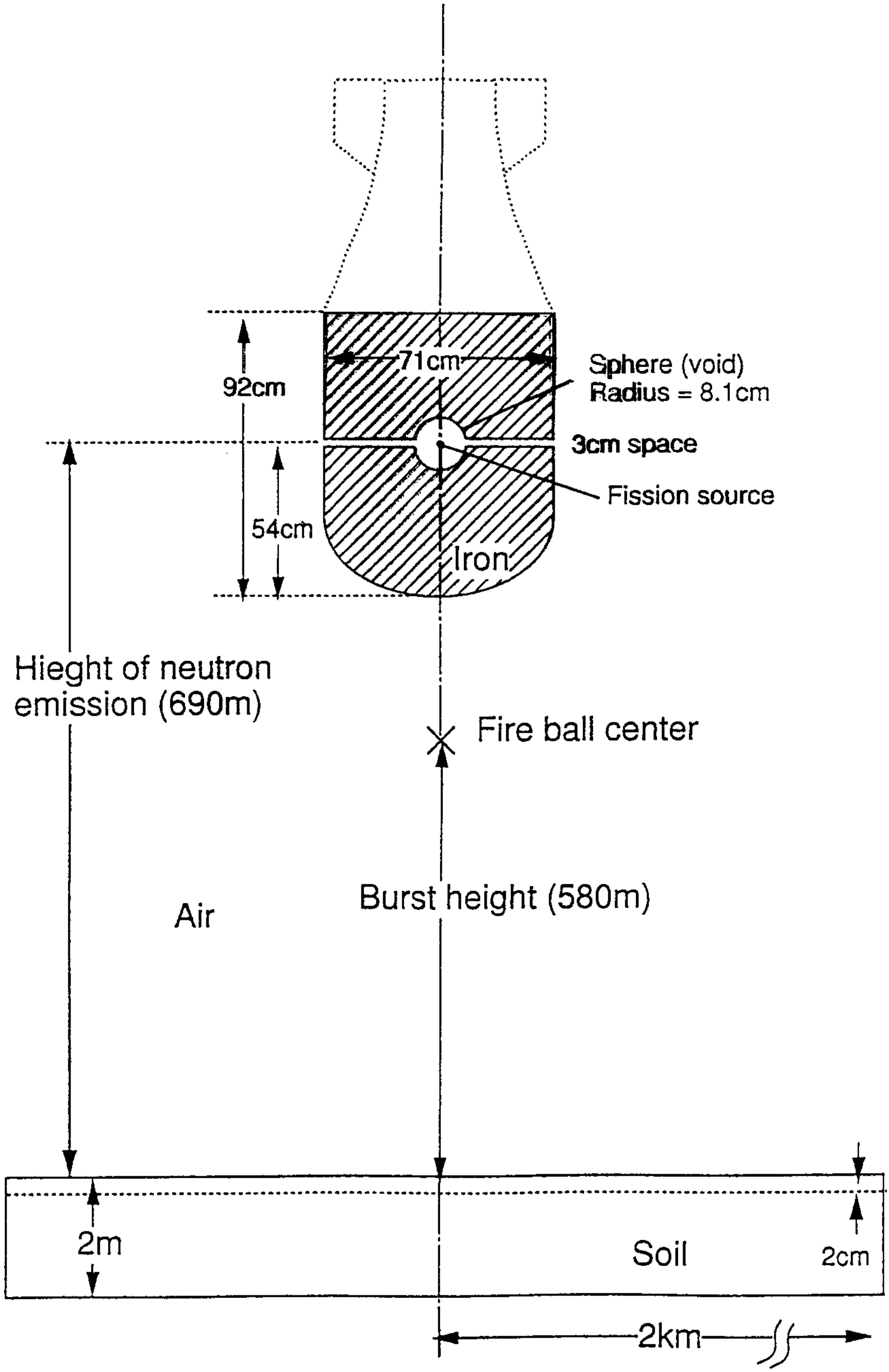
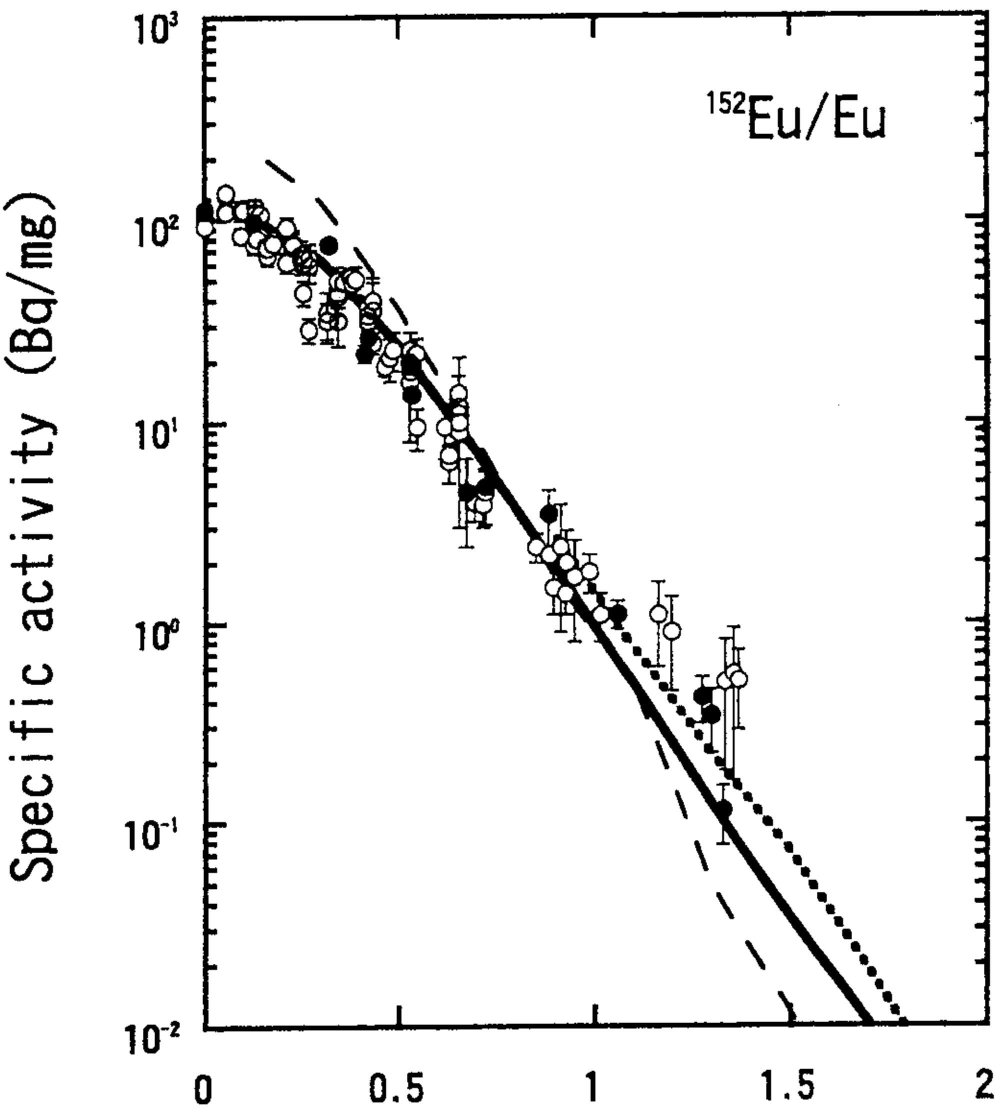
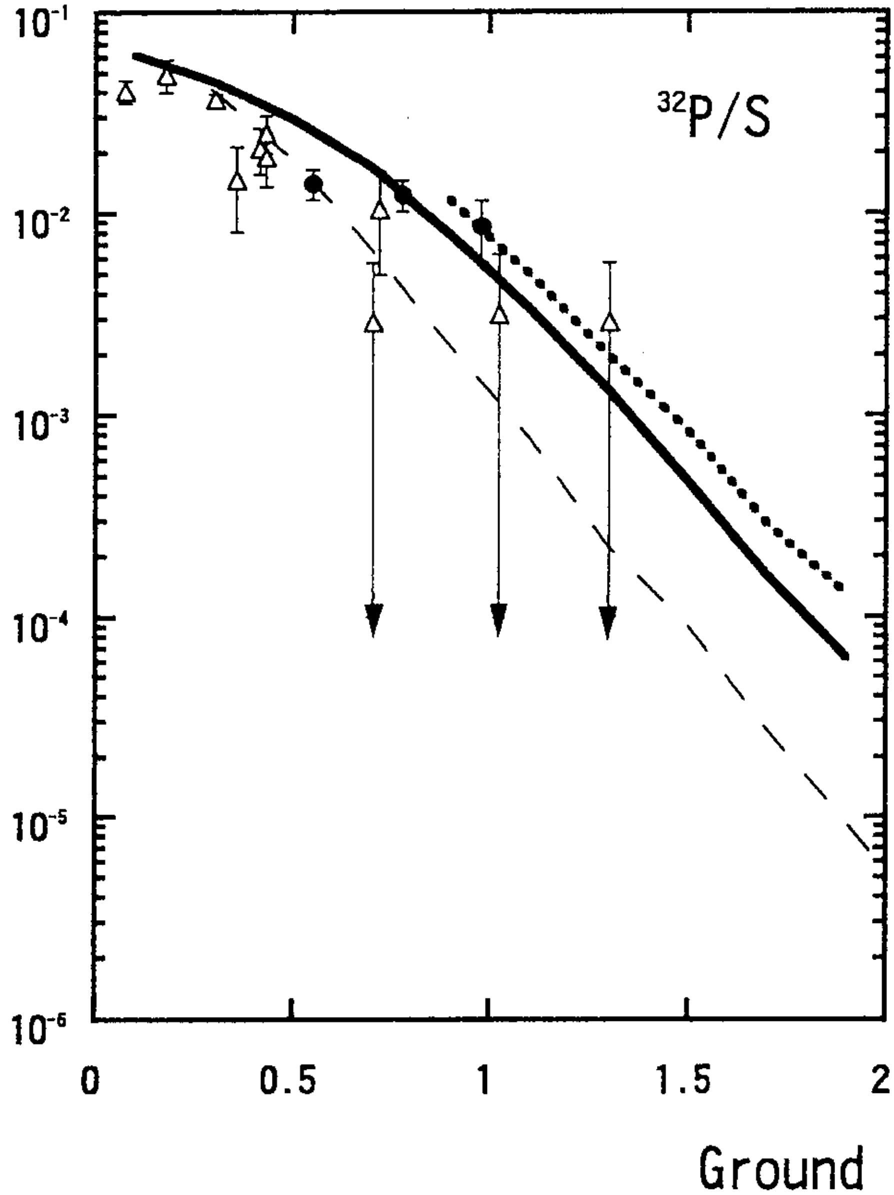
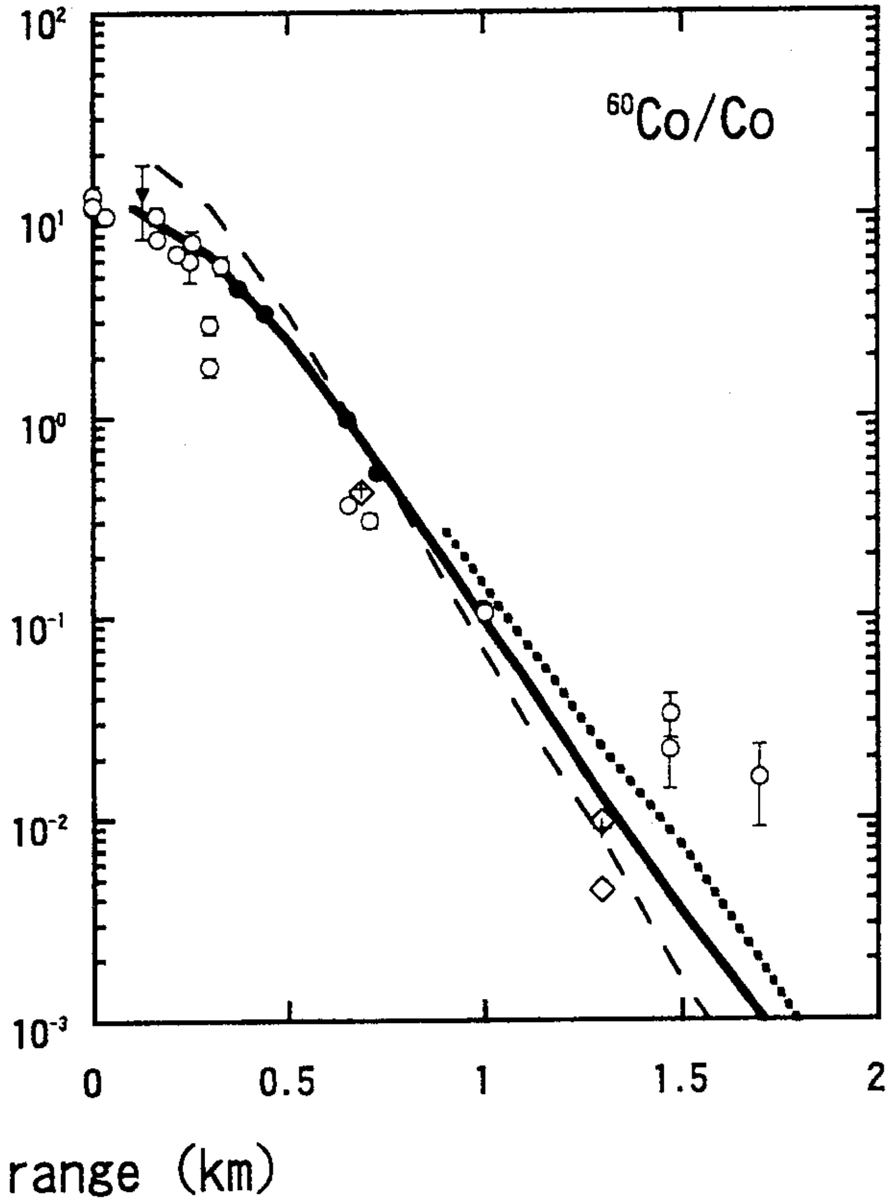


71cm
92cm
Sphere (void)
Radius = 8.1cm
3cm space
Fission source
54cm
Iron
Hieght of neutron
emission (690m)
Fire ball center
Burst height (580m)
Air
2m
Soil
2cm
2km



10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
Specific activity (Bq/mg)
$^{152}Eu/Eu$
0
0.5
1
1.5
2


10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
10⁻⁶
32P/S
0
0.5
1
1.5
2
Ground


^{60}Co/Co
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
0
0.5
1
1.5
2
range (km)