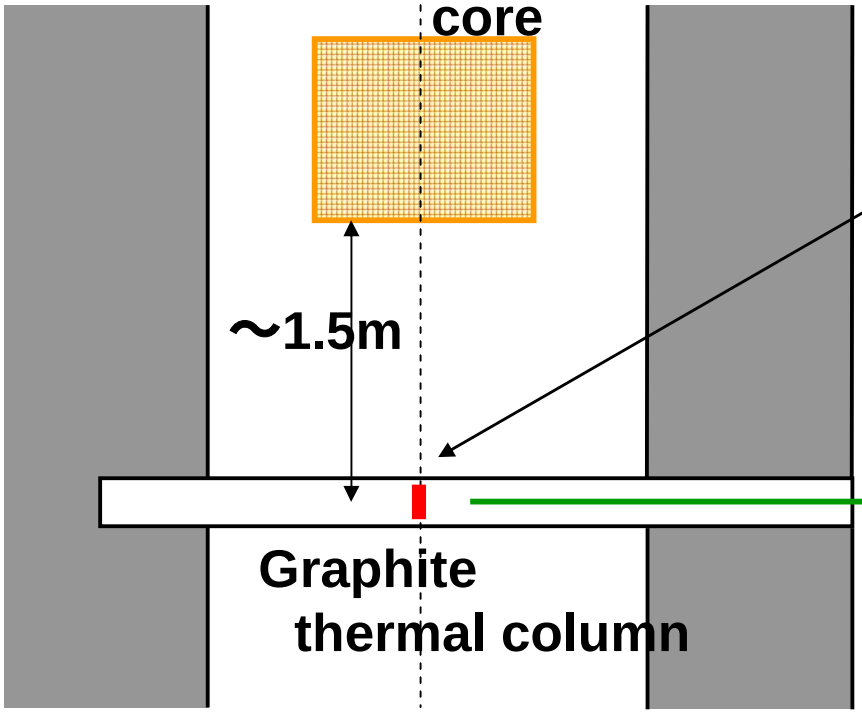
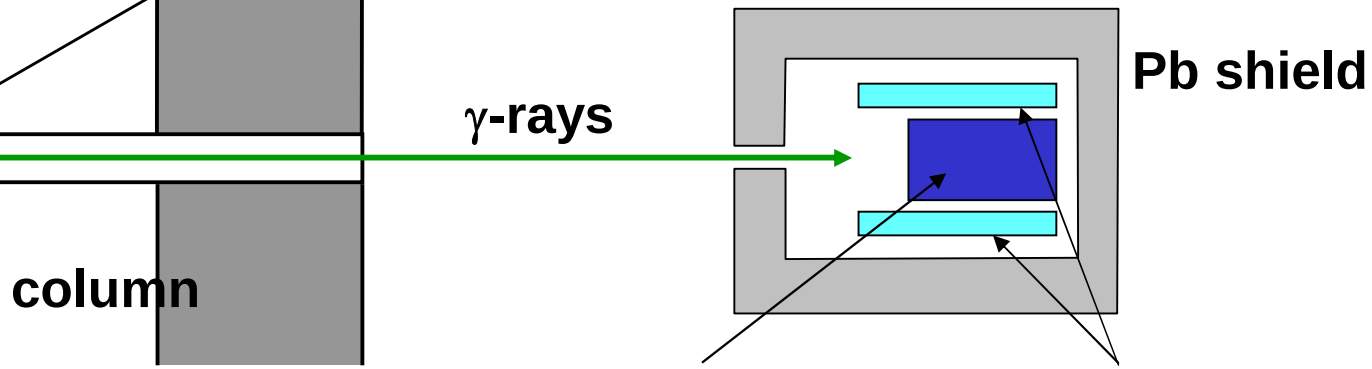
News Flash for LLFP Cross-Section Measurements

Experimental Conditions

8MW Los Alamos
Omega West Reactor



Irrad. Sample
^{93}Zr enriched 114.0-mg
^{107}Pd // 201.4-mg
$(CH_2)_n$ 100.0-mg



Ge(Li) detector **NaI(Tl) detector**

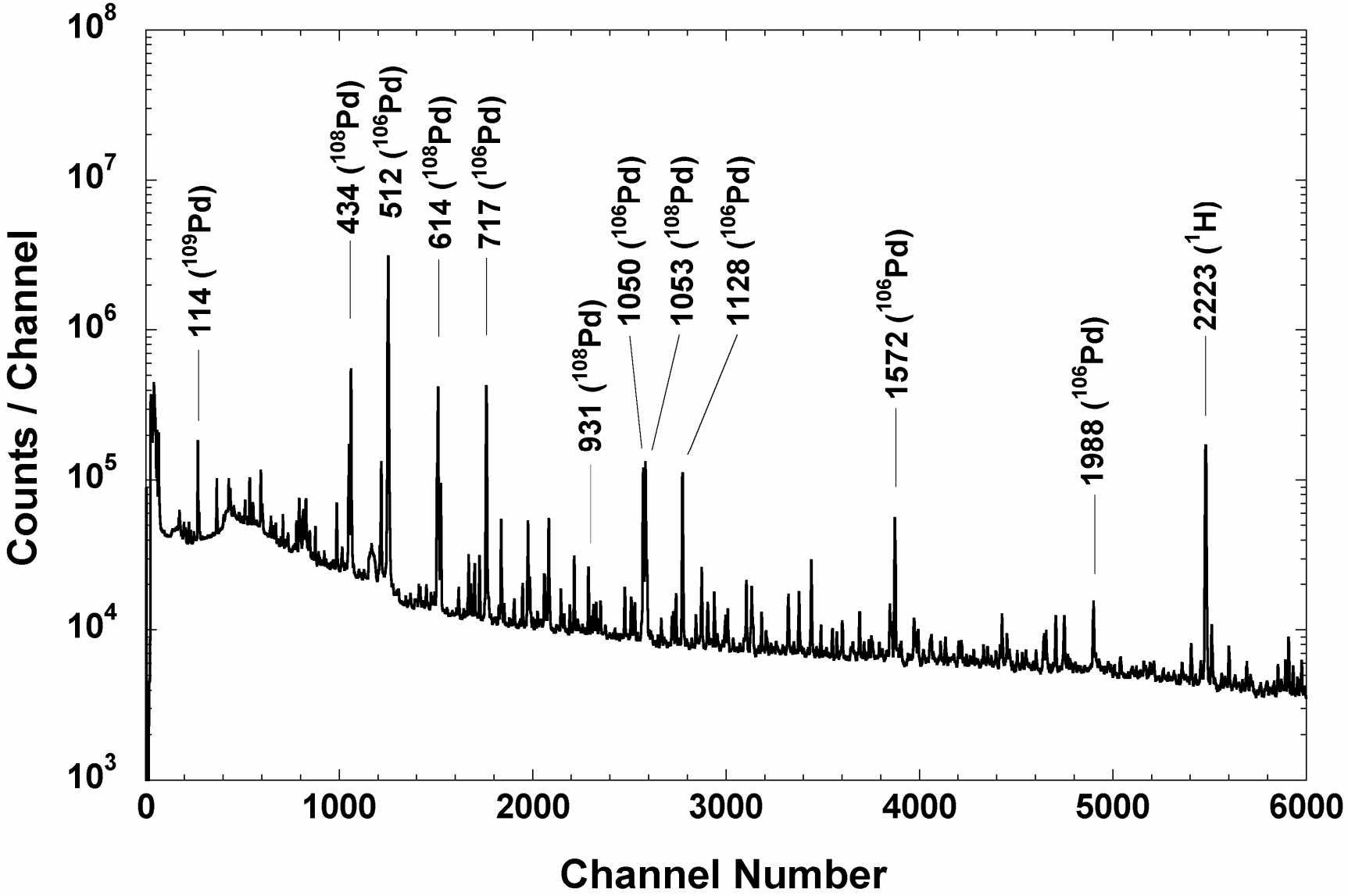
Anti-Compton mode
Pair-spectrometer mode

Flux ~6×10^{11} n/cm^{2}s
Cd(In) ratio ~ 2000
Maxwell distribution

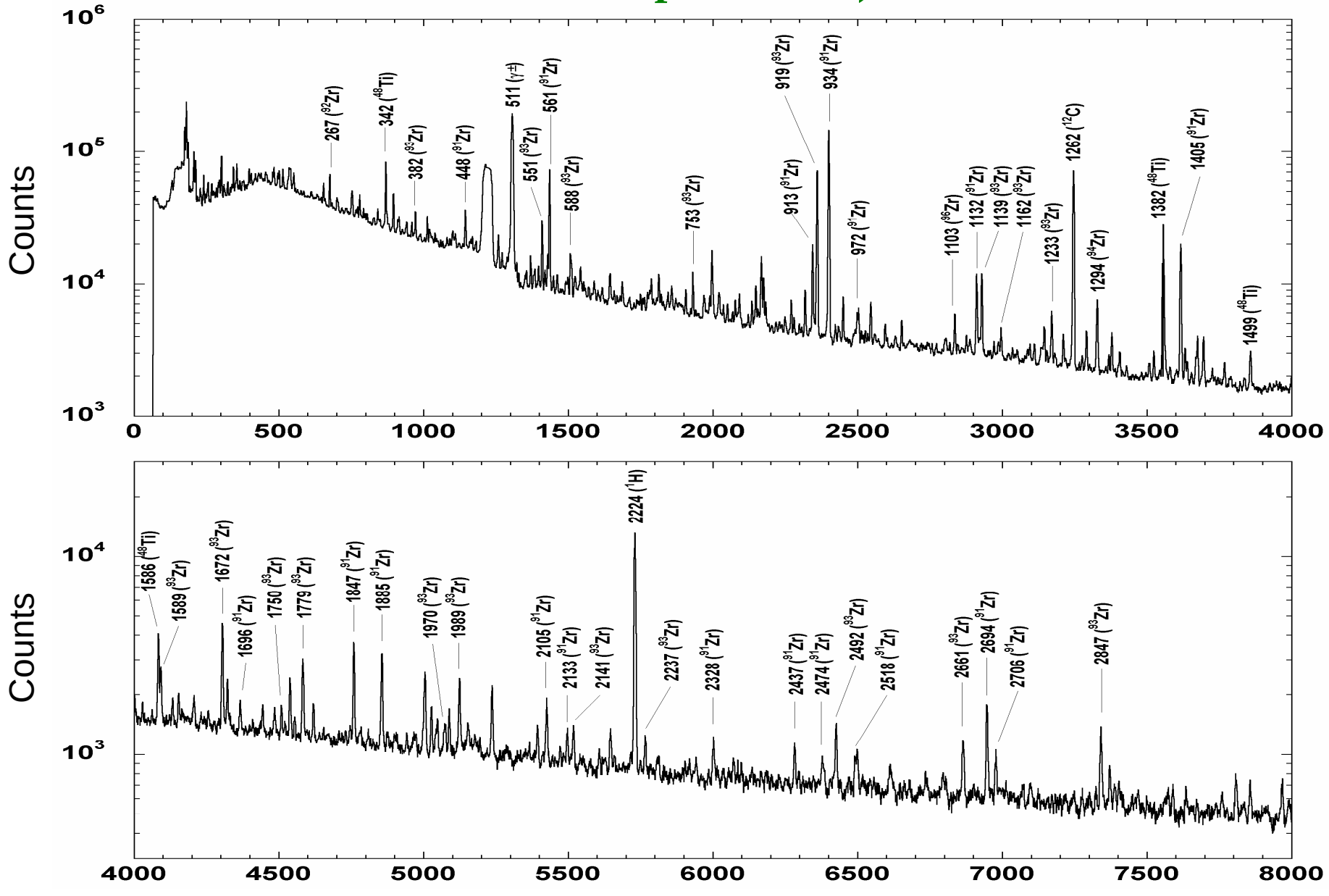
Isotopic Compositions of Samples

Zirconium Mass	Atom(%)	Palladium Mass	Atom(%)
90	**2.29** *5*	**104**	**1.61** *2*
91	**18.61** *10*	**105**	**48.50** *5*
92	**18.95** *10*	**106**	**22.90** *5*
93	**19.98** *10*	**107**	**15.54** *5*
94	**20.50** *10*	**108**	**8.77** *2*
96	**19.67** *10*	**110**	**2.68** *2*

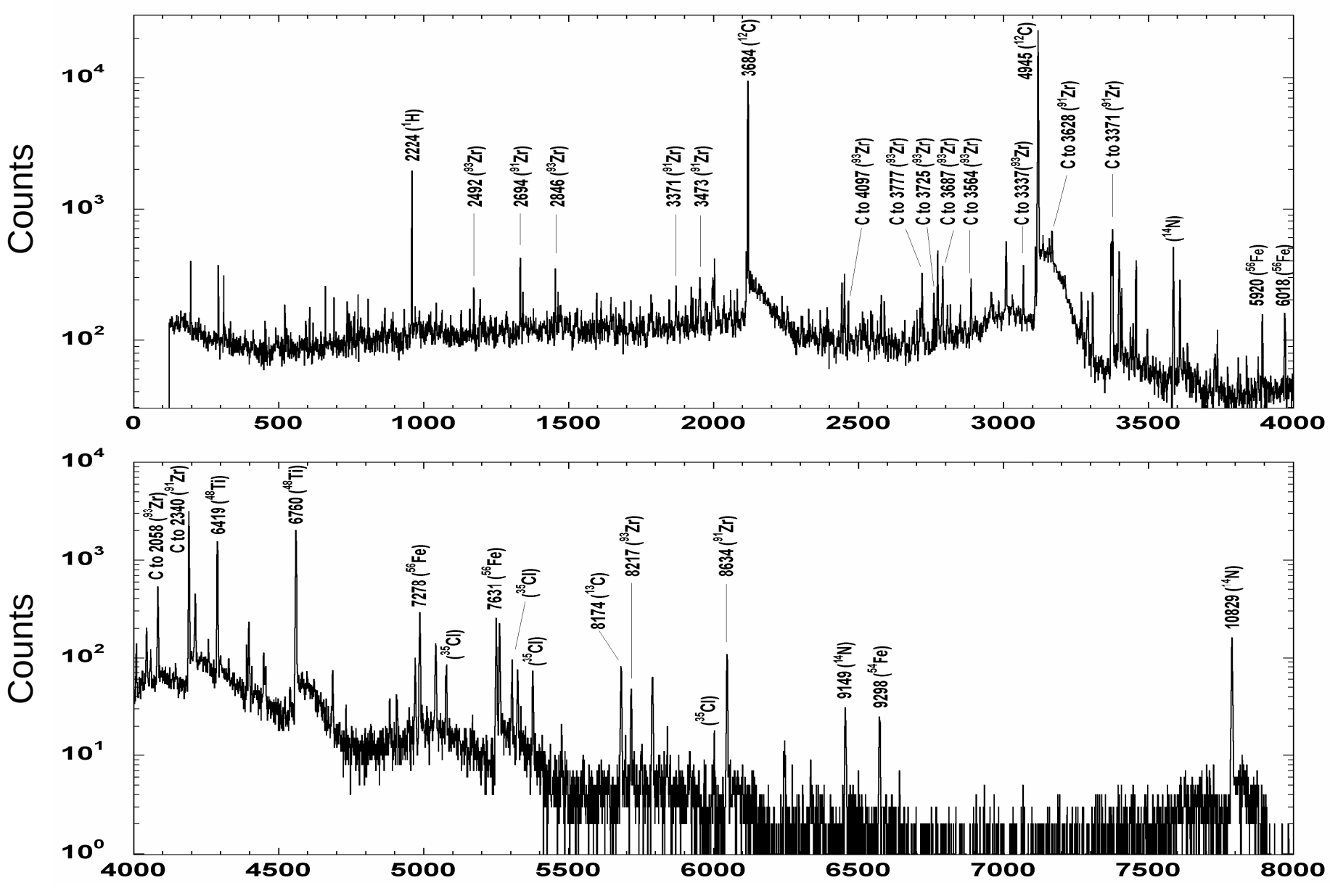
Prompt γ-ray Spectrum of Pd sample



Prompt γ-ray Spectrum of Zr sample (Anti-Compton mode)



Prompt γ-ray Spectrum of Zr sample (Pair-Spectrometer mode)



Emission Intensity: I_γ

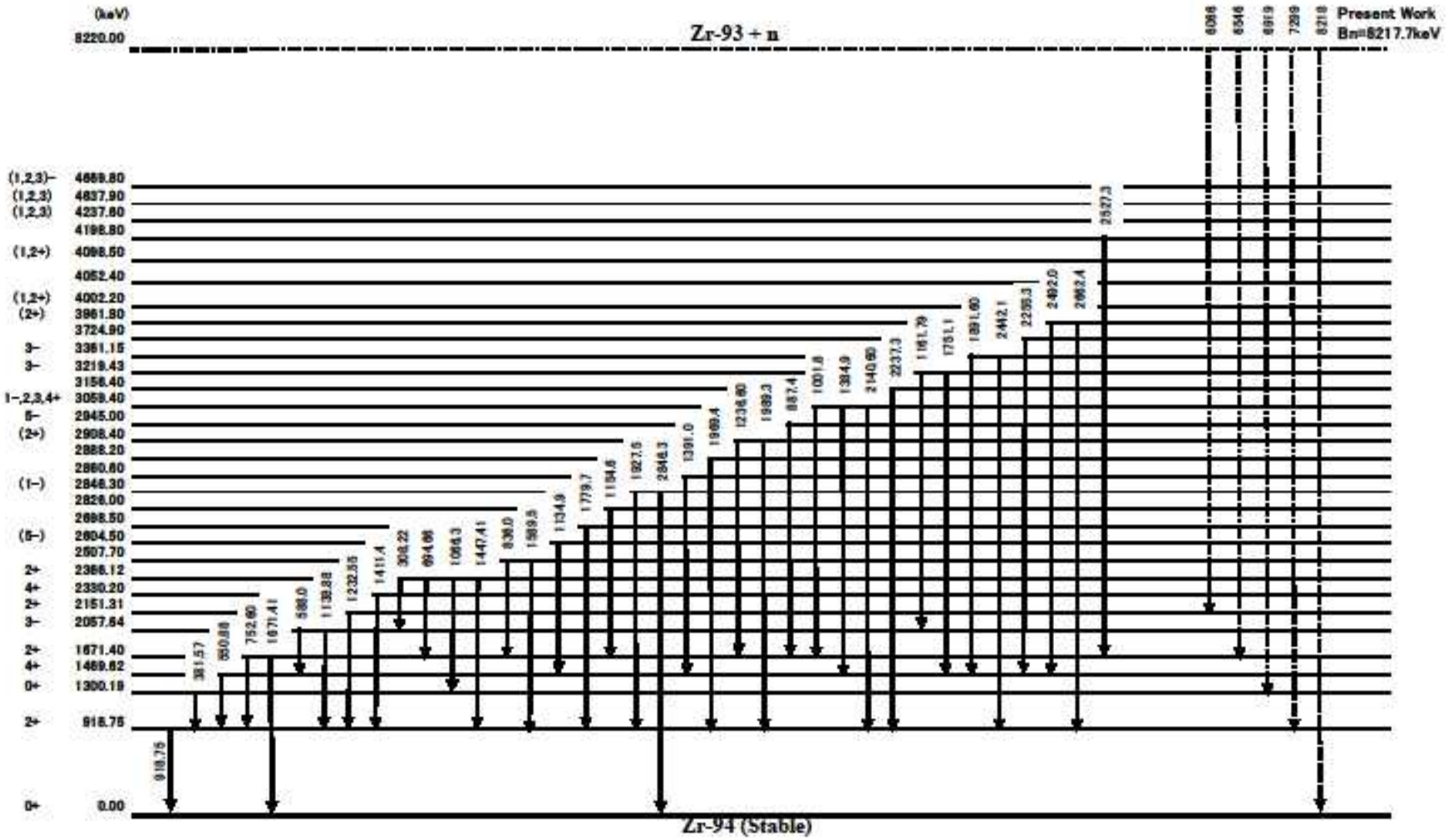
Intensity I_g is given by :

$$I_\gamma = \frac{\varepsilon_H n_H \sigma_H}{n_x Y_H} \cdot \frac{Y_x}{\varepsilon_x}$$

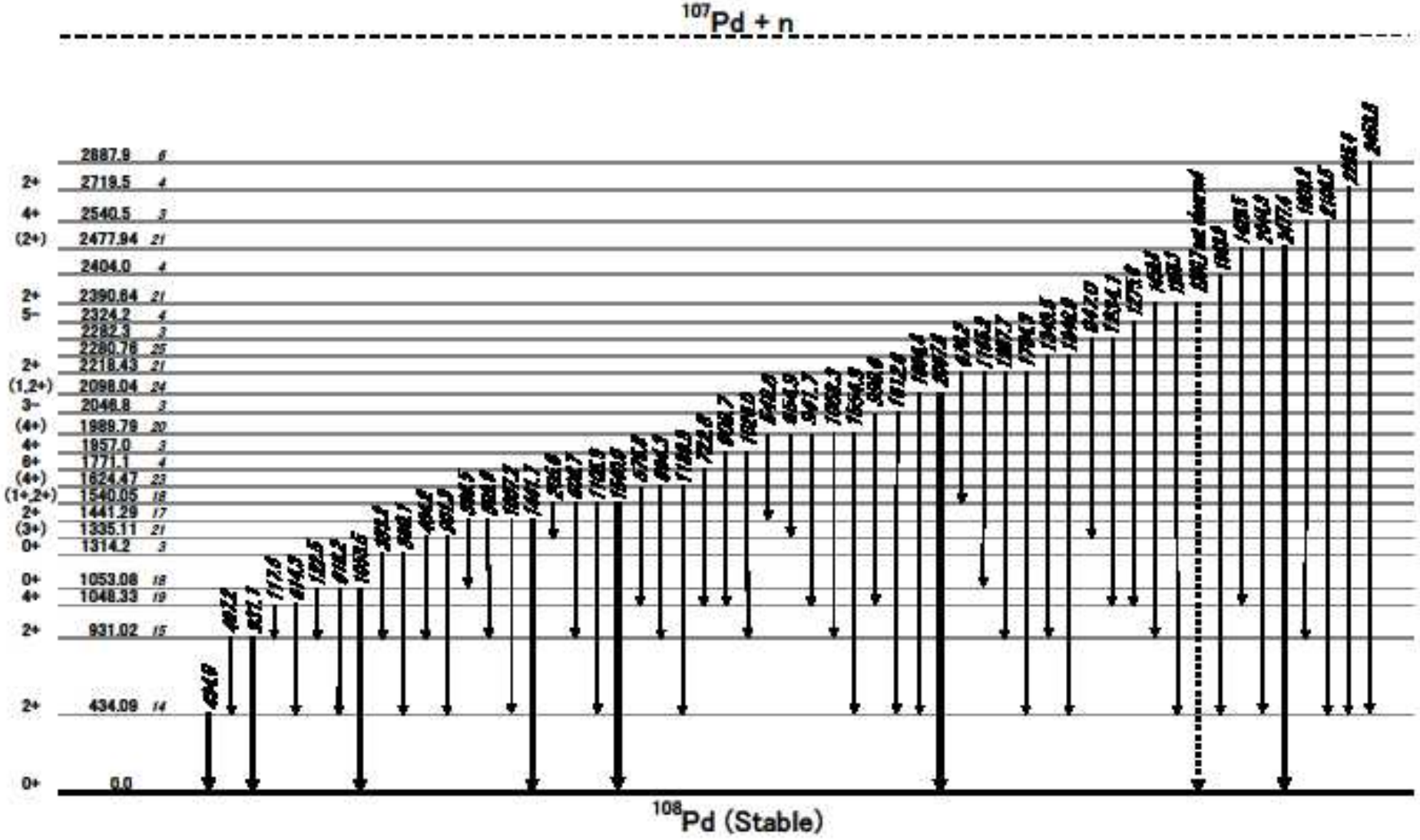
where

- **n_H, n_x : Ammounts of H and Samples (Zr or Pd)**
- **ε_H : Efficiency for 2.2-MeV γ ray**
- **ε_x : Efficiencies for γ rays from samples**
- **σ_H : Cross-section of ^{1}H 332.6±0.7(mb)**
- **Y_H : Yield of 2.2-MeV γ ray**
- **Y_x : Yields of γ rays from Samples**

Level Scheme for ^{94}Zr mainly based on the well-known information



Level Scheme for ^{108}Pd mainly based on the well-known information



Intensities $I_{\gamma\ g.s.}$ for the γ rays feeding the g.s. of ^{94}Zr

Observed Eγ (keV)	Intensity $I_{\gamma\ g.s.}$ (mb)
918.8	544±18
1671.5	53±2
2846.5	27±1
4225.2	5±1
8217.4	5±1

$$\sum_{g.s.} I_\gamma = 0.63 \pm 0.02 \ \ (b)$$

(Lower Limit)

Results
Present results for ^{91}Zr and ^{93}Zr cross sections together with reported data

References		σ_0 for ^{91}Zr (b)	σ_0 for ^{93}Zr (b)
H.Pomerance[a)]	1952	1.52 ± 0.12	1.3 < σ_0 < 4
Garrison *et al.*[b)]	1962	1.2 ± 0.3	1.1 ± 0.4
Clayton[c)]	1972	1.579	1.996
Mughabghab *et al*.	1981	1.24 ± 0.25	1.3 < σ_0 < 4
T.O.I 8ed.	1998	1.24 ± 0.25	2.7 ± 1.4
JENDL-3.3	2002	1.247	2.239
Present Result (lower limit)		1.30 ± 0.04	0.63 ± 0.02
Present Result (estimation)		1.5 ± 0.2	0.76 ± 0.13

a) Measurements with ORNL pile oscillator
b) Statistical Model estimates
c) Calculation by the resonance parameters from BNL-325

Intensities $I_{\gamma\ g.s.}$ for the γ rays feeding the g.s. of ^{108}Pd

Observed Eγ (keV)	Intensity $I_{\gamma\ g.s.}$ (mb)
434.0	7588±255
931.1	606±19
1053.5	488±73
1441.7	214±8
1540.0	104±6
2097.6	83±6
2477.4	72±7

$$\sum_{g.s.} I_{\gamma} = 9.16 \pm 0.27 \ \ (b)$$

(Lower Limit)

Gamma-ray intensity balance for the 434 keV level

	E_γ [a]	Intensity I_γ [b]	E_γ [a]	Intensity I_γ [b]
IN	497.2 *3*	1940 *63*	1664.4 *3*	34 *4*
	614.3 *3*	2168 *81*	1784.3 *3*	117 *7*
	618.2 *3*	454 *30*	1846.9 *3*	133 *6*
	880.1 *3*	93 *4*	1956.3 *3*	45 *5*
	901.3 *3*	713 *23*	1969.9 *3*	33 *4*
	1007.2 *3*	399 *13*	2044.3 *3*	133 *8*
	1105.9 *3*	169 *9*	2106.5 *3*	103 *7*
	1189.9 *3*	39 *5*	2285.4 *3*	82 *8*
	1554.9 *4*	42 *8*	2453.8 *6*	27 *6*
	1612.6 *3*	374 *18*		
OUT	434.0 *3*	7588 *255*		
ΣI_γ(in) =7.10±0.11 (b)			ΣI_γ(out) = 7.59±0.26 (b)	

a) In our notation,497.2 *3* is 497.2 ± 0.3 keV, etc.

b) γ–ray cross section in mb. In our notation, 1929 *44* is 1929 ± 44, etc.

Experimental and evaluated data for ^{107}Pd & ^{105}Pd cross-sections

References for ^{107}Pd		σ_0 (b)	I_0 (b)
Singh *et al*.	1978	—	87
Mughabghab *et al*.	1981	1.8 ± 0.2	86.6
Macklin	1985	—	108.1 ± 4.3
T.O.I. 8ed.	1998	1.8 ± 0.2	—
JENDL-3.3	2002	2.0071	112.2
Present Result		9.16 ± 0.27	—

References for ^{105}Pd		σ_0 (b)
T.O.I. 8ed.	1998	20.0 ± 3.0
JENDL-3.3	2002	20.25
Mughabghab	2003	21.0 ± 1.5
Firestone *et al.*	2005	21.1 ± 1.5 *
Present result		19.1± 0.5 *