The intercalibration of neutron monitors

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Outline

Neutron monitors and calibration – why?

Challenges:

1. Energy response
2. Temperature sensitivity
3. Environmental (surface) effects

Deriving spectra from neutron monitor count rates

Relationhip between intensity $j(P)$ and counting rate N is

$$j(P) = -dN/dP \,/\, S(P,x)$$

where S = the atmospheric yield function.

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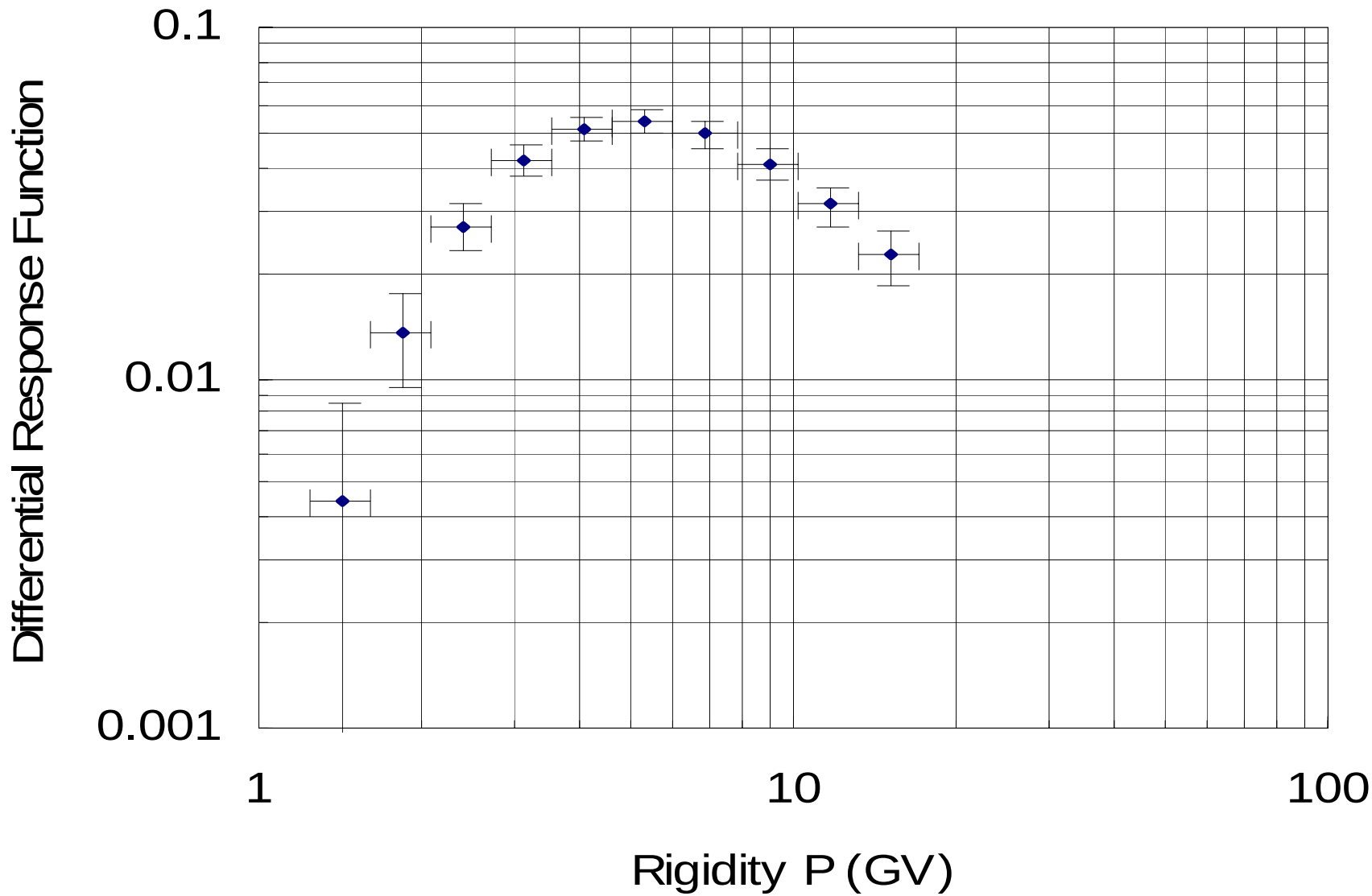
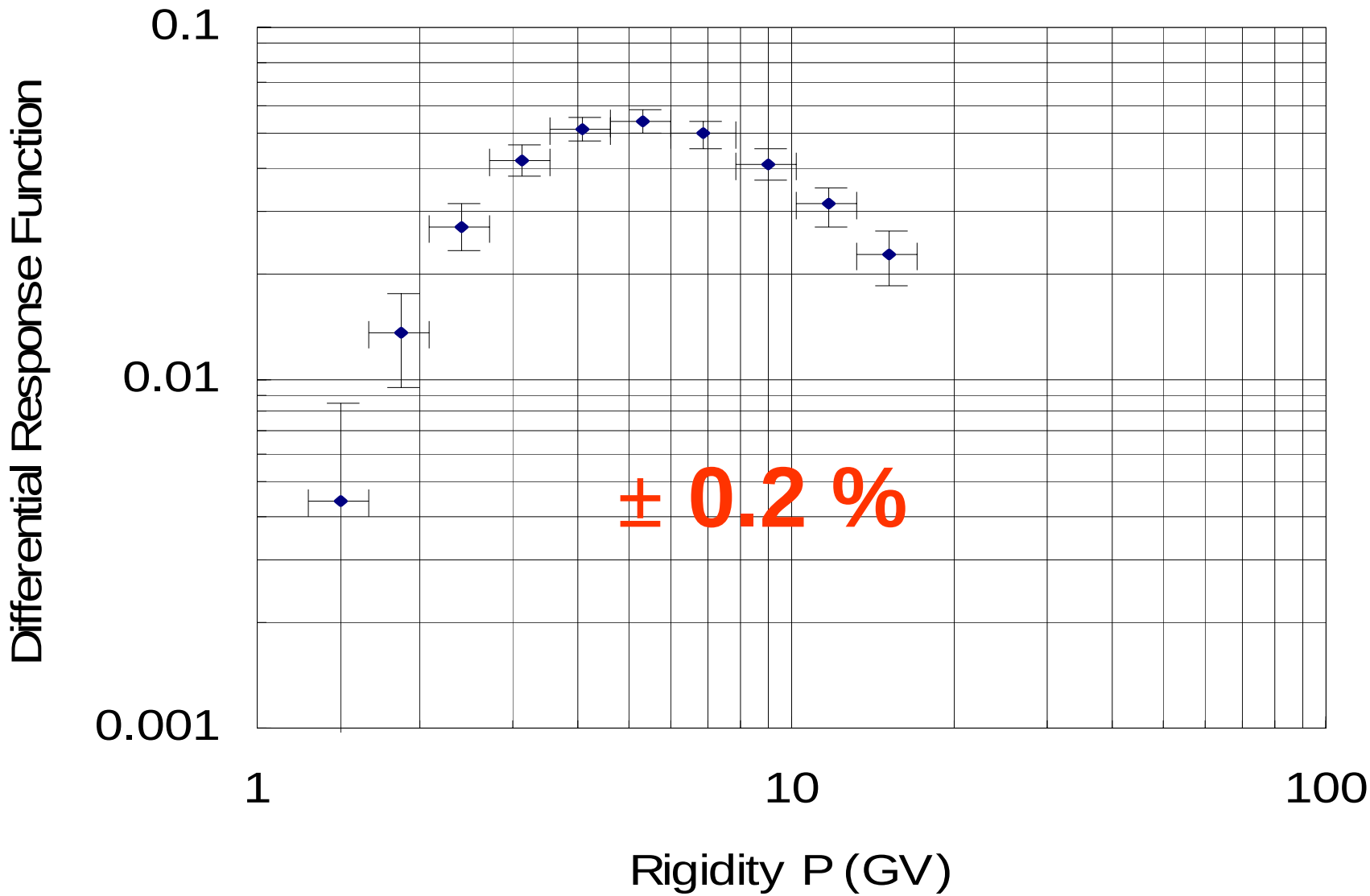
In practice: neutron monitors have different efficiencies and suffer from drifts – hence latitude surveys

Example

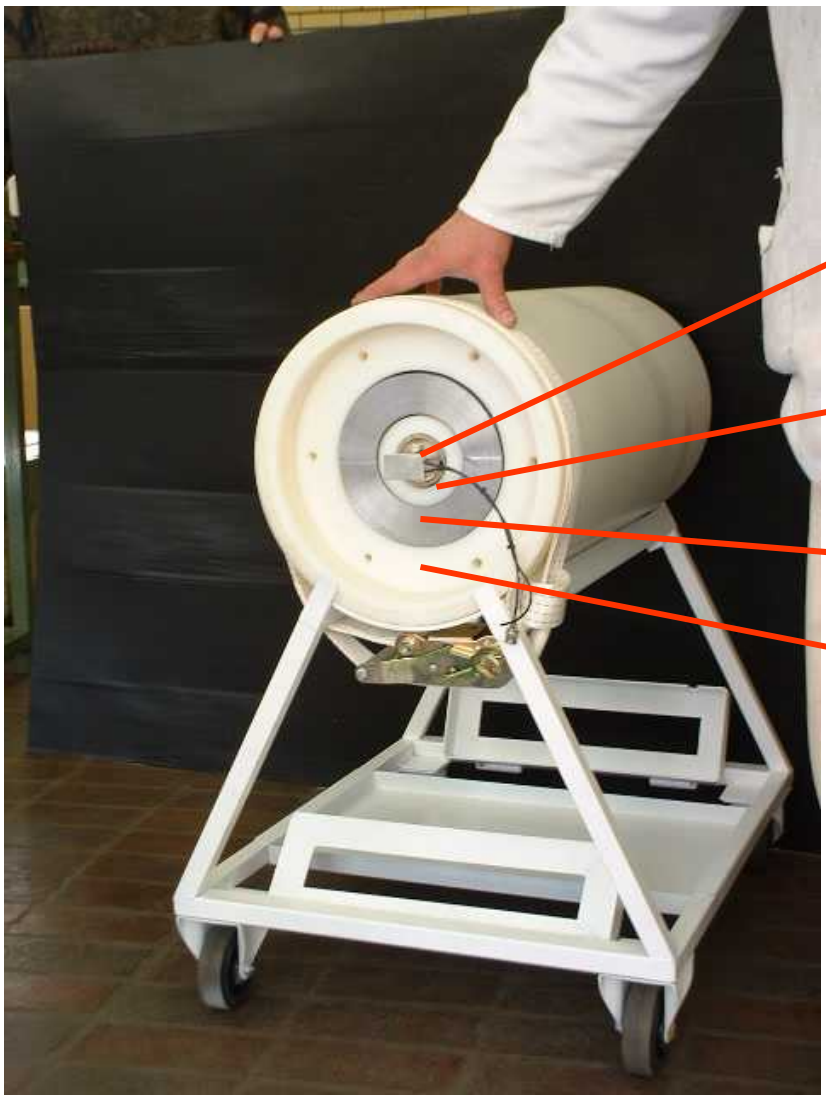

0.1
0.01
0.001
Differential Response Function
1
10
100
Rigidity P (GV)

Example


0.1
0.01
0.001
1
10
100
Differential Response Function
Rigidity P (GV)
± 0.2 %


MOBILE HDD
CALIBRATION
NEUTRON MONITOR
GPS ANTENNA
PRESSURE
INPUT
ETHERNET
MONITOR
POWER
KEYBOARD
UNIT FOR SPACE PHYSICS
POTCHEFSTROOM UNIVERSITY
SOUTH AFRICA
STRAP
STORAGE SPACE FOR

Configuration of calibrator



Pre-amplifier on the ^{3}He counter

Inner moderator of polyethylene

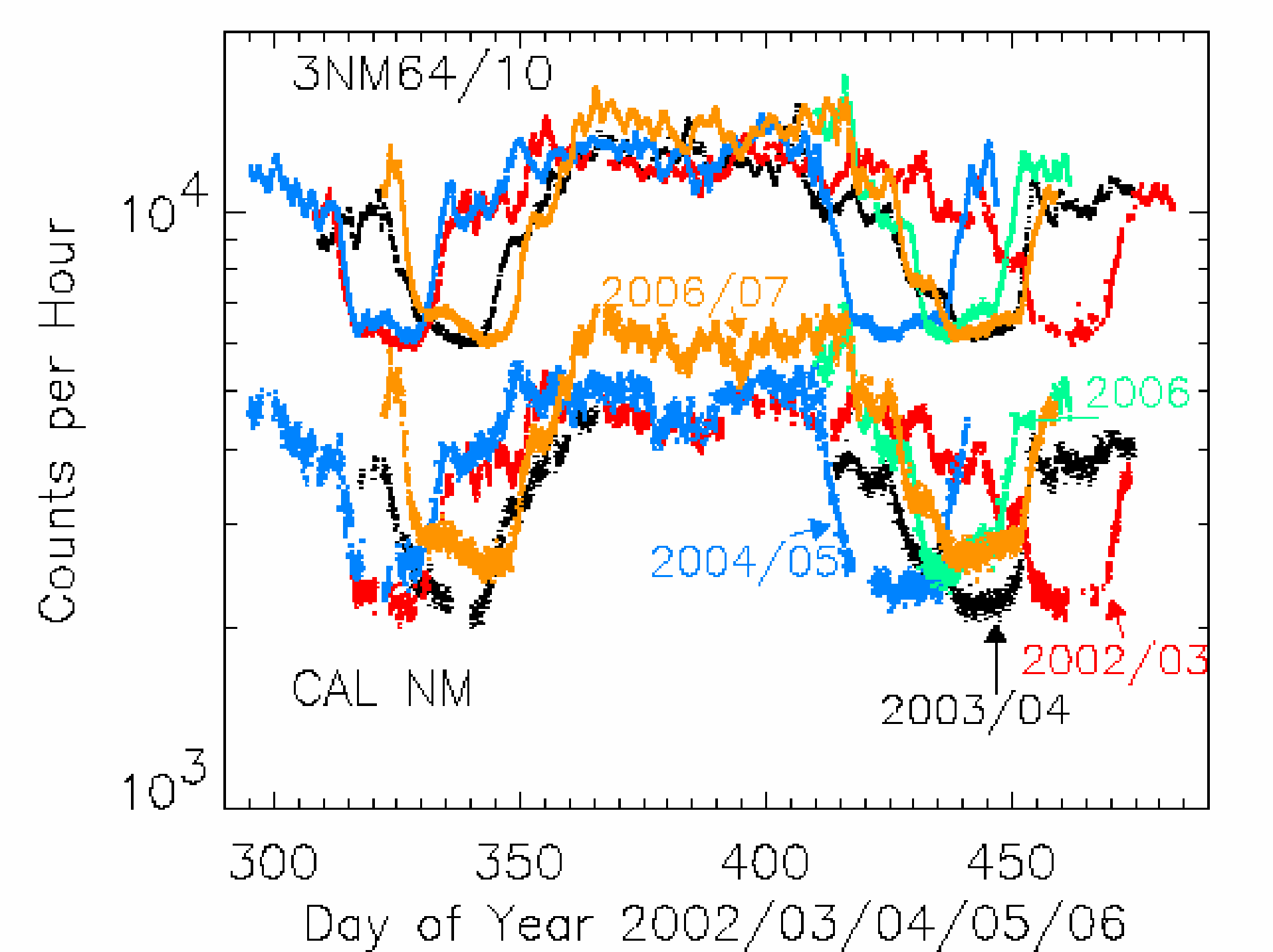
Lead producer

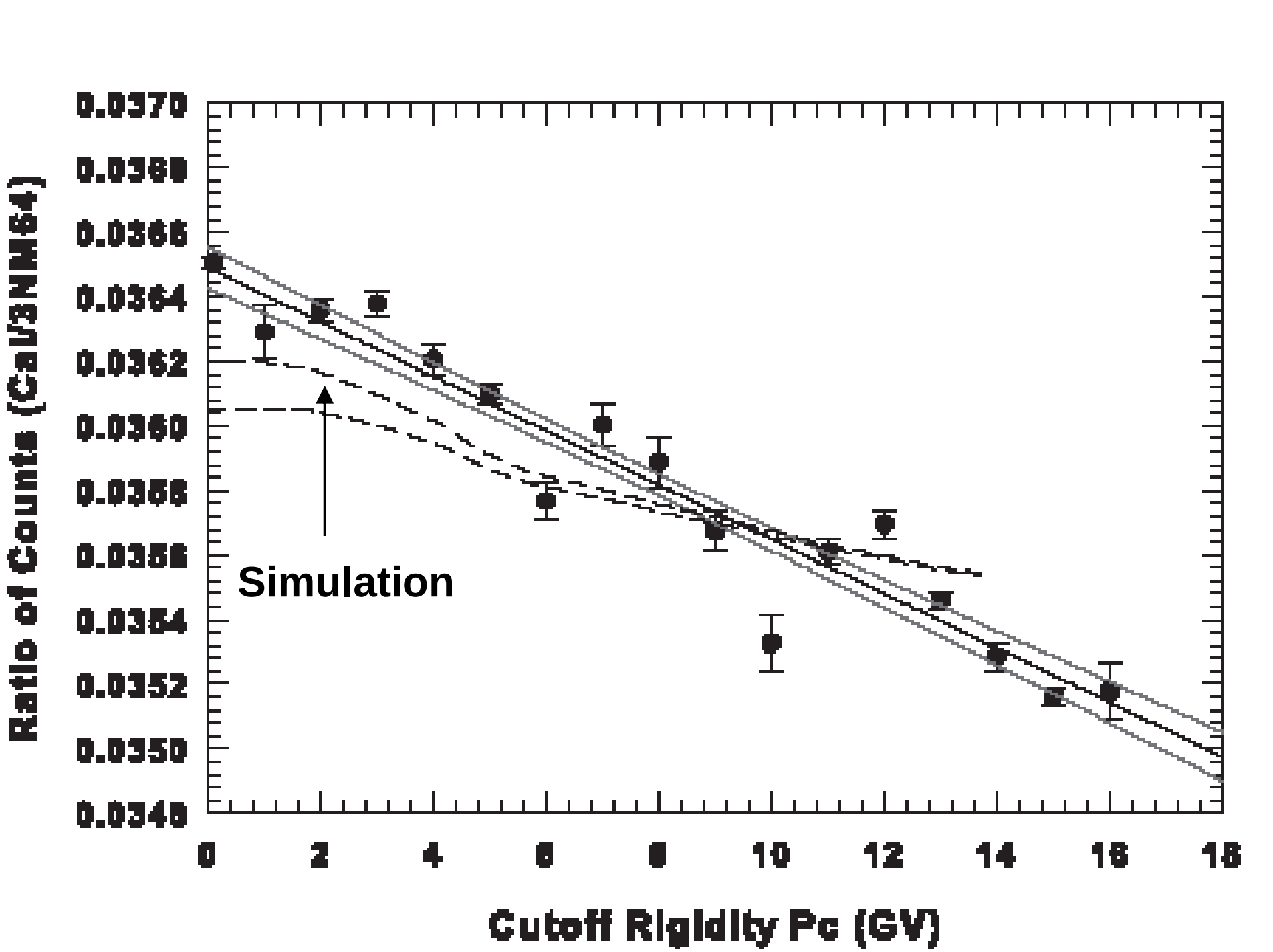
Outer reflector of polyethylene

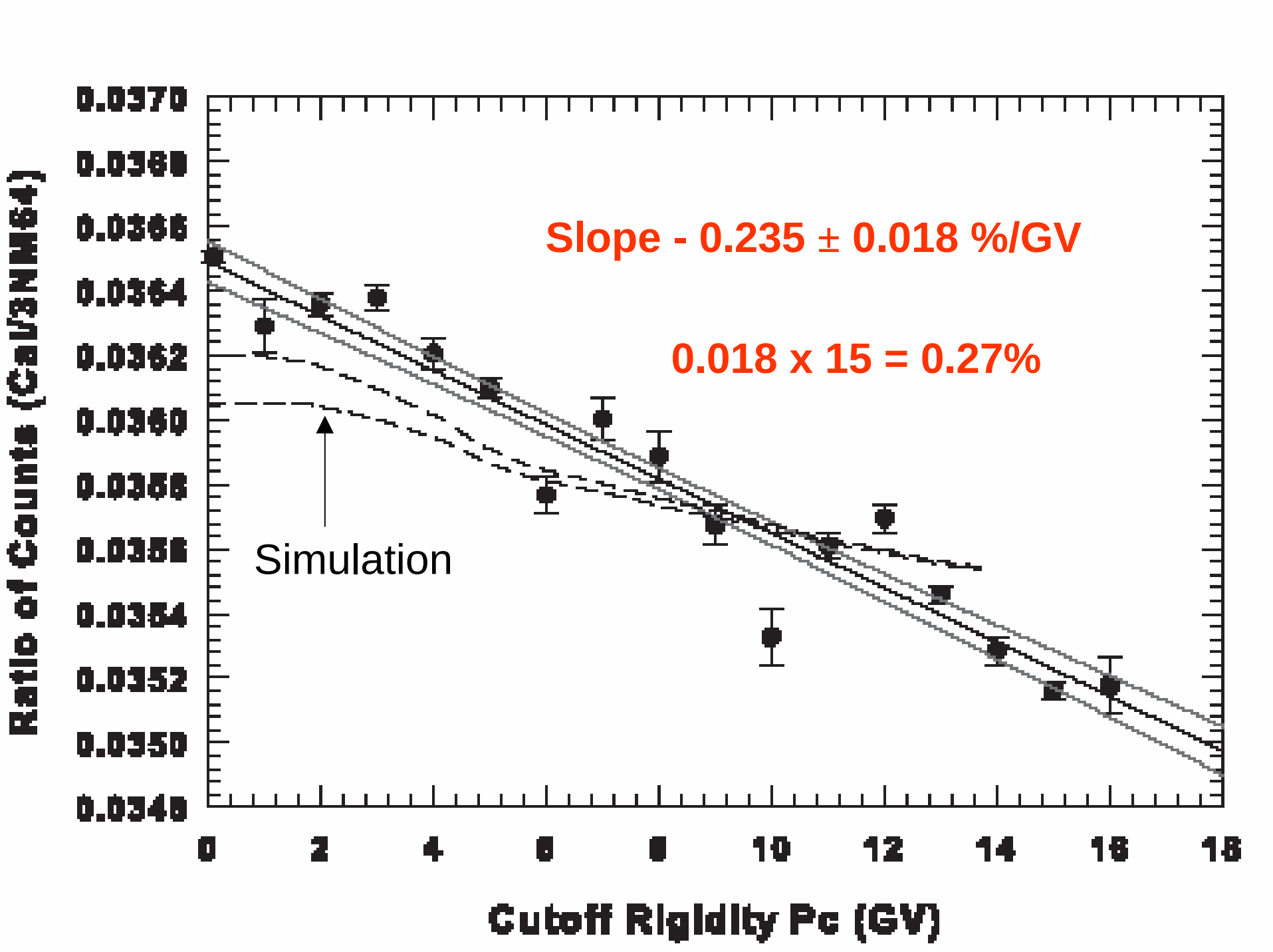
260 kg

1. Energy response

Latitude Surveys in 2002/03, 2003/04, 2004/05, 2005/06, 2006/07


3NM64/10
2006/07
2006
2004/05
2002/03
2003/04
CAL NM
Counts per Hour
10^4
10^3
300
350
400
450
Day of Year 2002/03/04/05/06


Ratio of Counts (Ca/3NM64)
0.0370
0.0368
0.0366
0.0364
0.0362
0.0360
0.0358
0.0356
0.0354
0.0352
0.0350
0.0348
0
2
4
6
8
10
12
14
16
18
Simulation
Cutoff Rigidity Pc (GV)


Slope - 0.235 ± 0.018 %/GV
0.018 x 15 = 0.27%
Simulation
Ratio of Counts (Ca1/3NM64)
Cutoff Rigidity Pc (GV)
0.0370
0.0368
0.0366
0.0364
0.0362
0.0360
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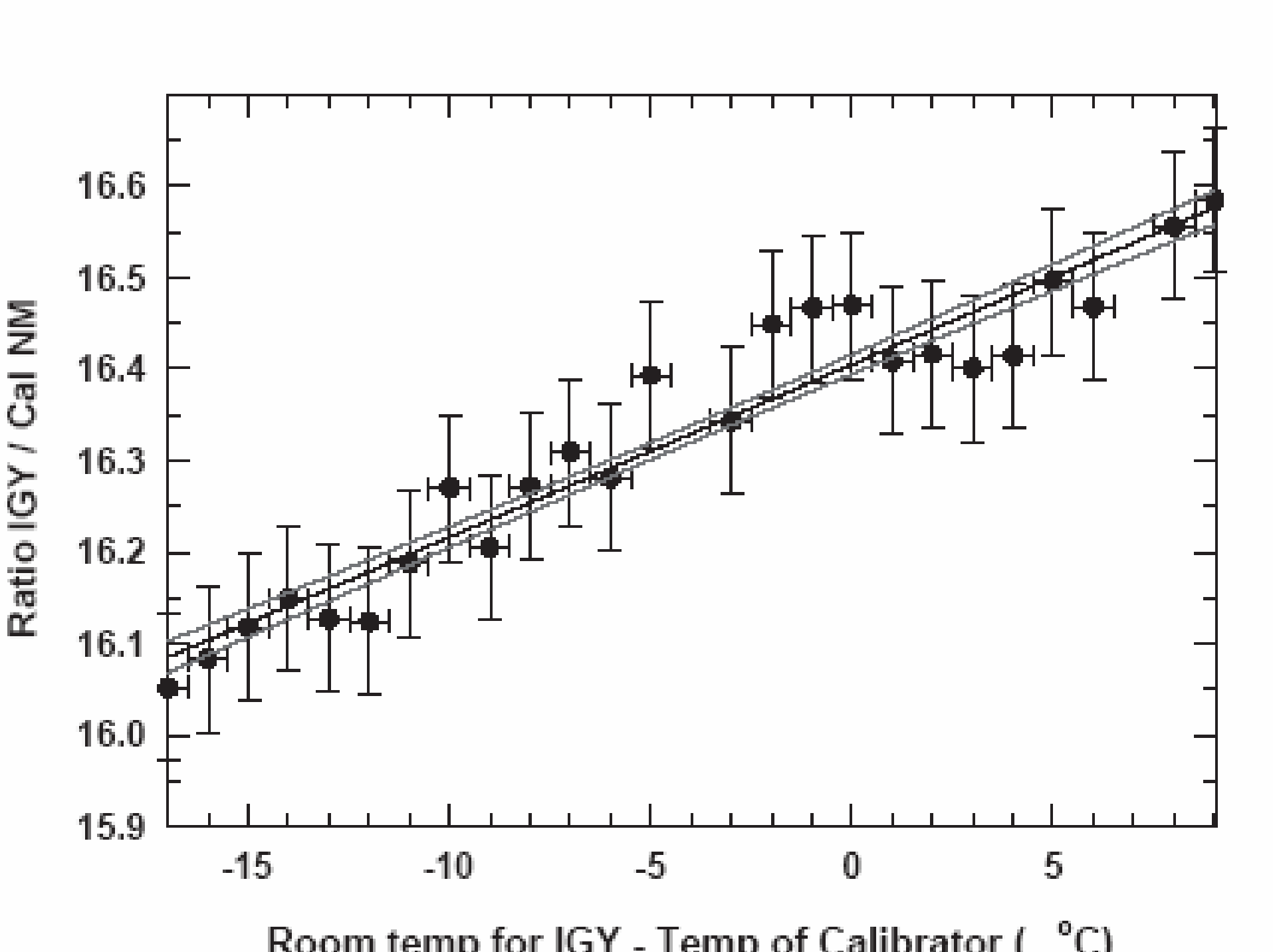
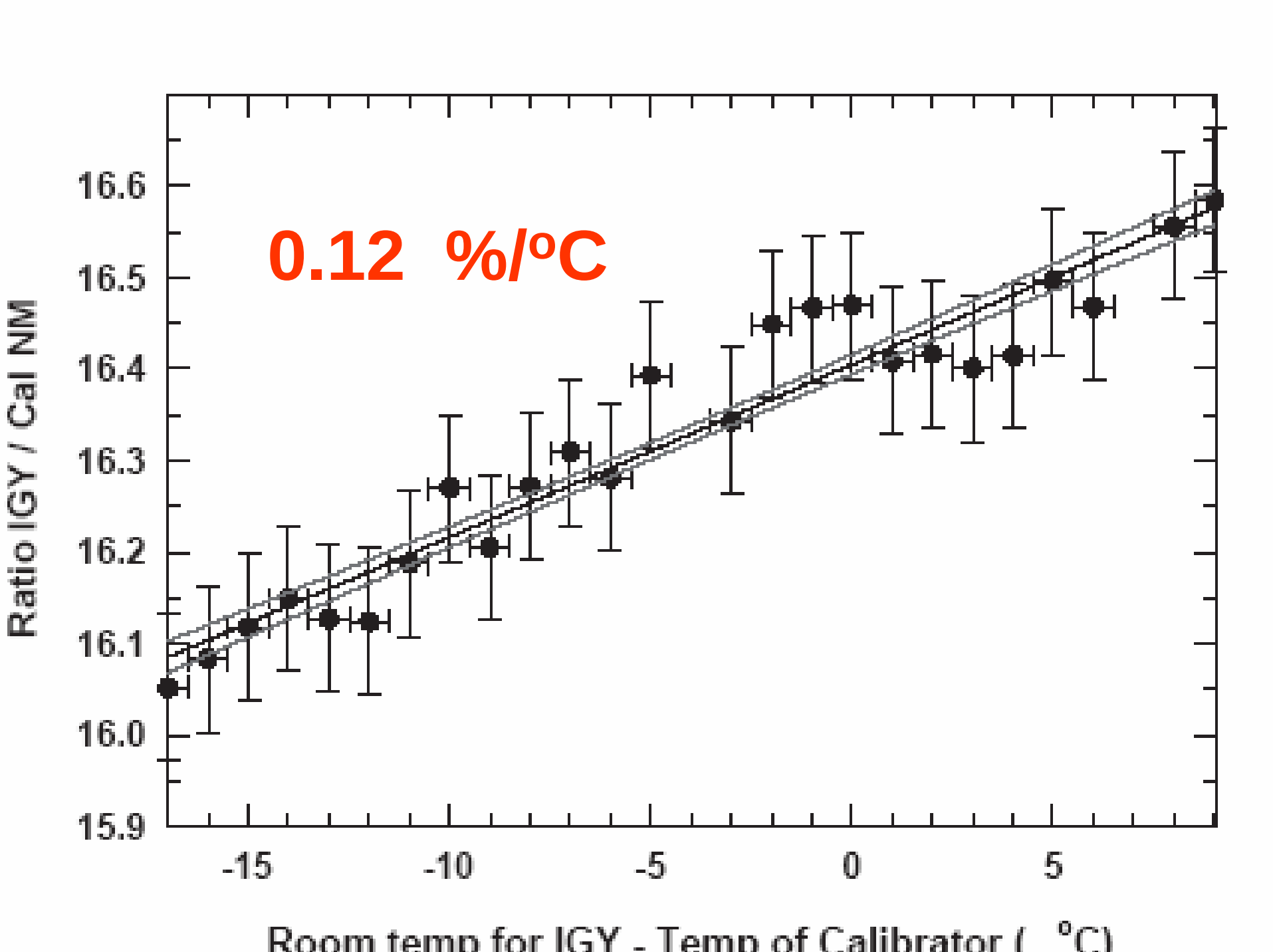
0.0350
0.0348
0
2
4
6
8
10
12
14
16
18

2. Temperature sensitivity

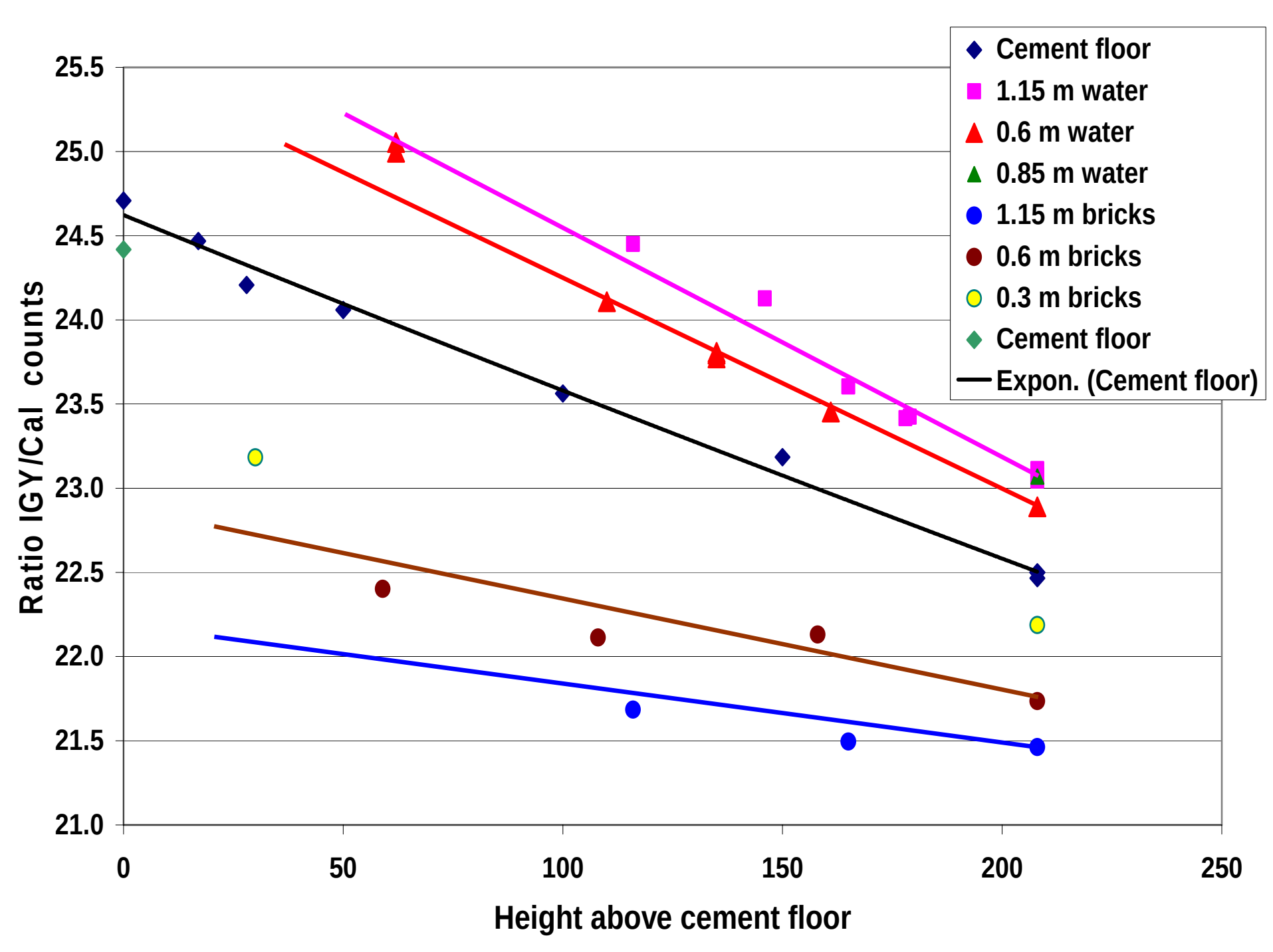

16.6
16.5
16.4
16.3
16.2
16.1
16.0
15.9
Ratio IGY / Cal NM
-15
-10
-5
0
5
Room temp for IGY - Temp of Calibrator (°C)

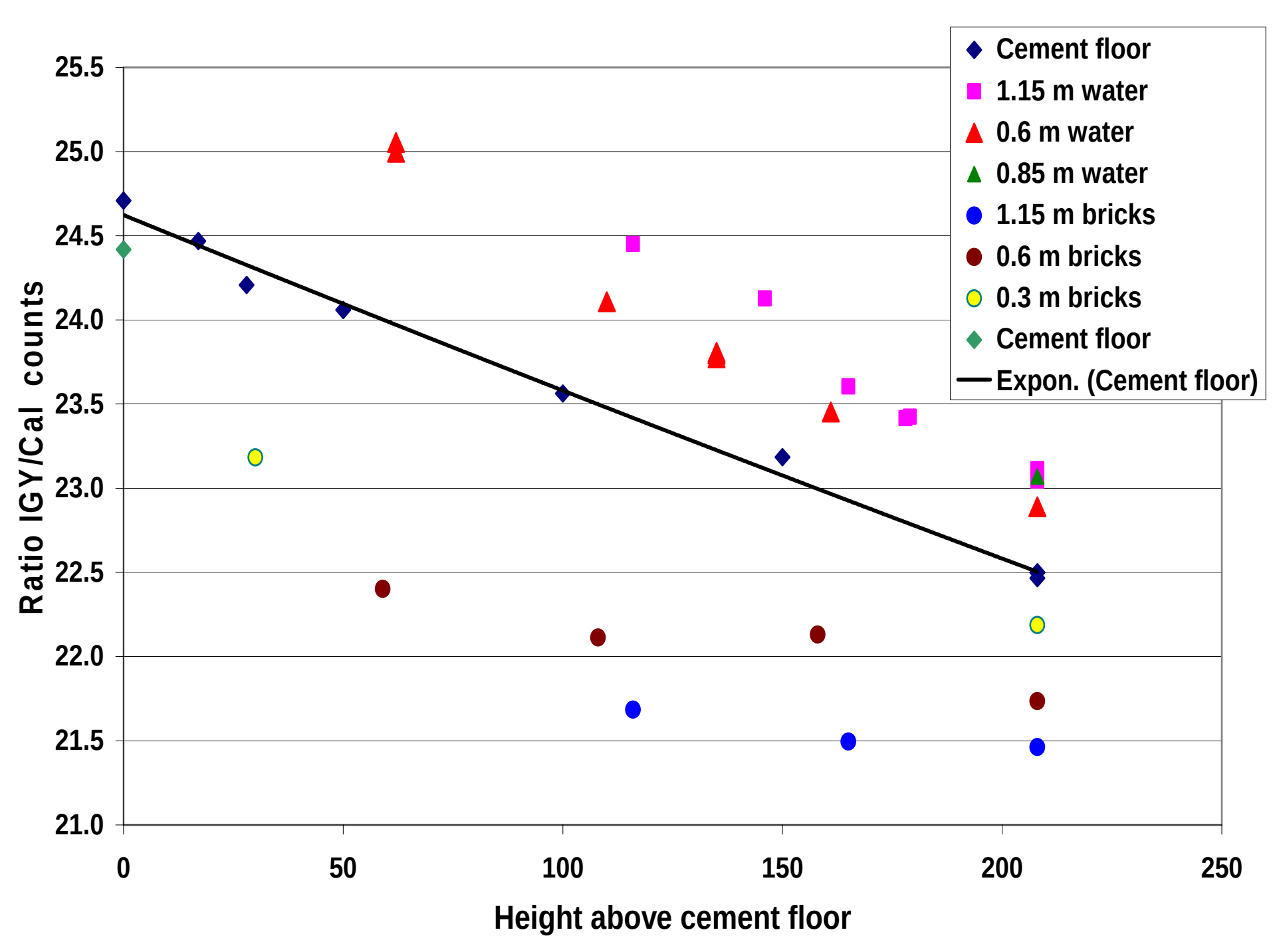

0.12 %/°C
Ratio IGY / Cal NM
16.6
16.5
16.4
16.3
16.2
16.1
16.0
15.9
-15
-10
-5
0
5
Room temp for IGY - Temp of Calibrator (°C)

Temperature coefficients

^{3}He Calibrator	0.12 %/ºC
^{3}He NM64 (Thule/Nain)	0.09 %/ºC
^{3}He NM64 simulation	0.07 %/ºC
$^{10}BF_3$ IGY (Potchefstroom)	0.06 %/ºC
$^{10}BF_3$ NM64 (Thule)	0.04 %/ºC
$^{10}BF_3$ NM64 simulation	0.02 %/ºC

3. Environmental sensitivity


Cement floor
1.15 m water
0.6 m water
0.85 m water
1.15 m bricks
0.6 m bricks
0.3 m bricks
Cement floor
Expon. (Cement floor)
Ratio IGY/Cal counts
25.5
25.0
24.5
24.0
23.5
23.0
22.5
22.0
21.5
21.0
0
50
100
150
200
250
Height above cement floor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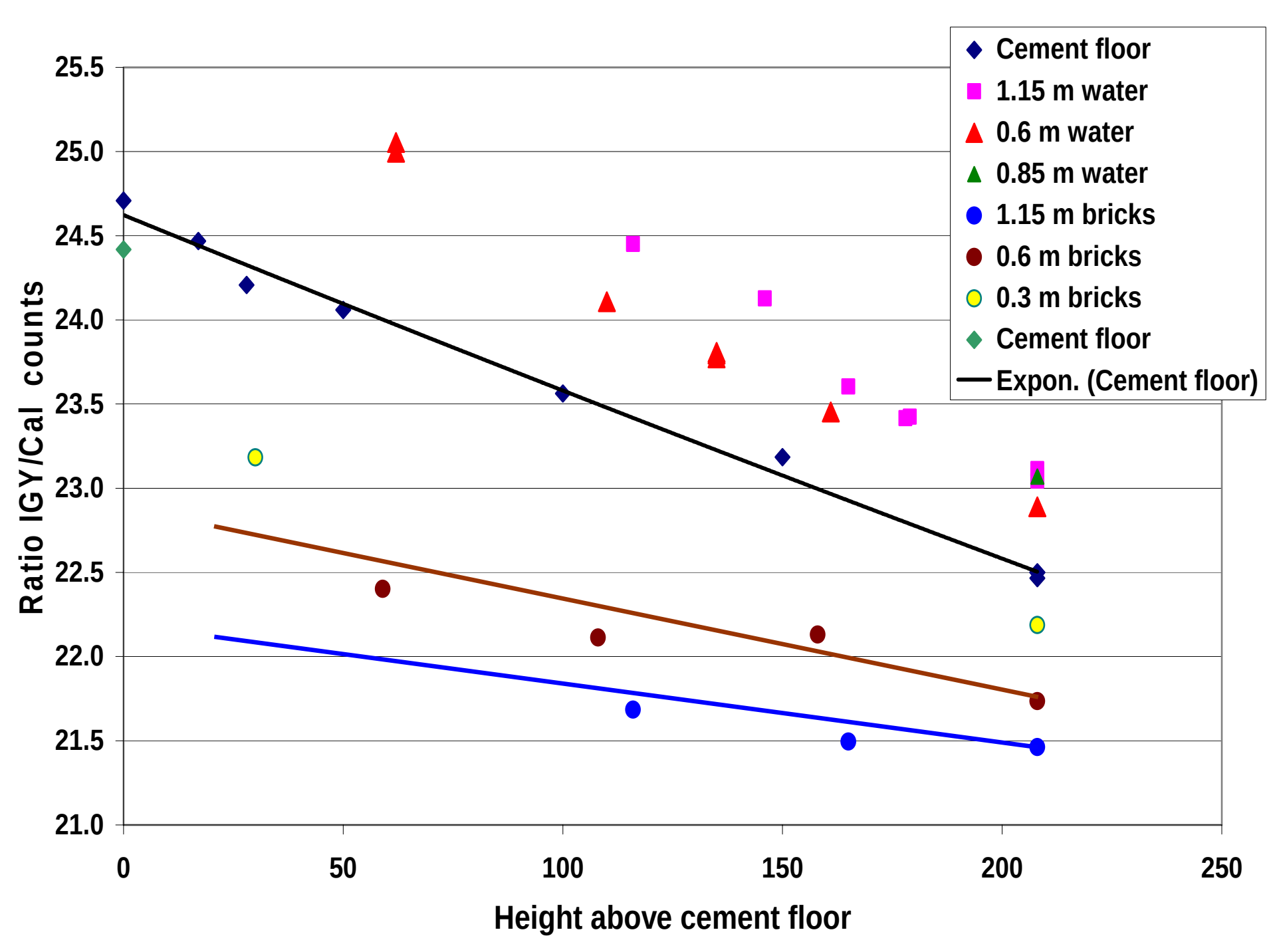
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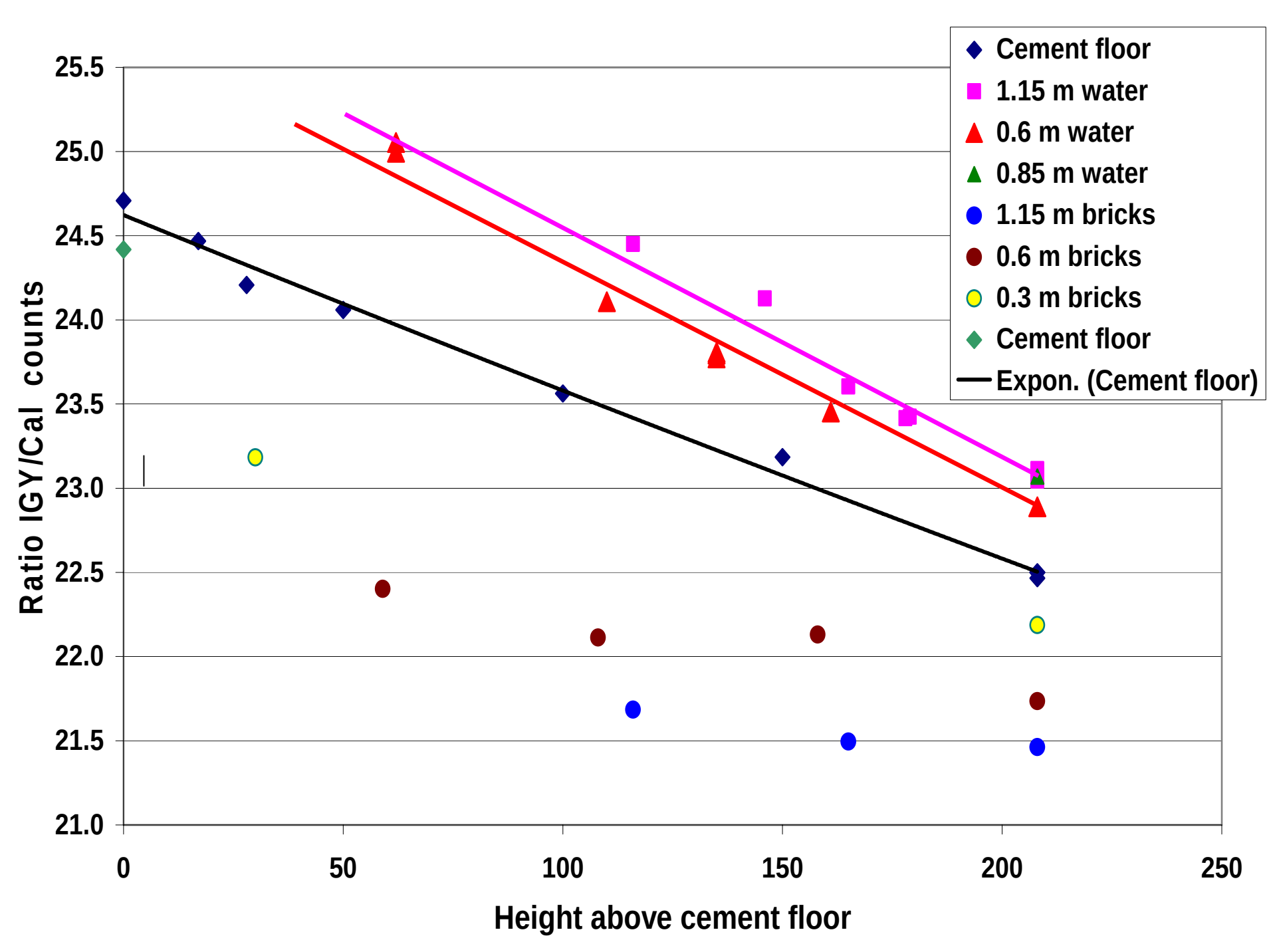
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Height above cement floor

Conclusion
(±0.2%)

- Energy dependence: OK
- Temperature sensitivity: OK
- Environmental effects: challenge