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What can we do to get better neutron dose equivalent measurements?

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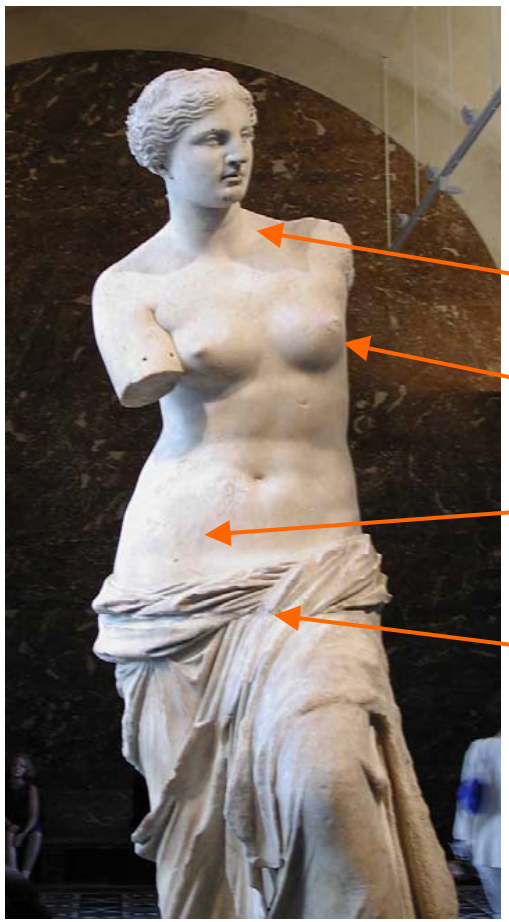
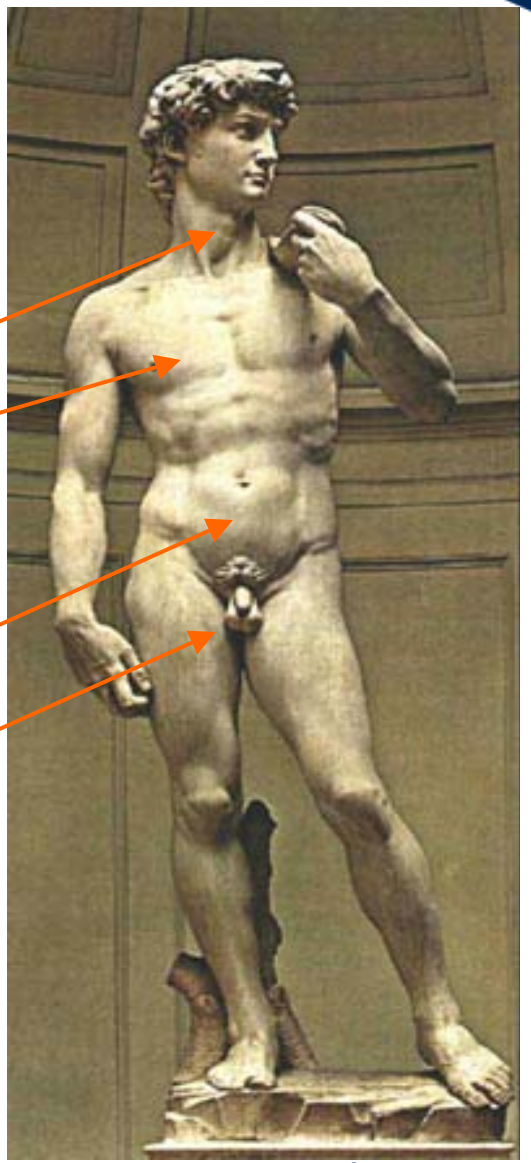
What are we trying to do?
Determine effective dose



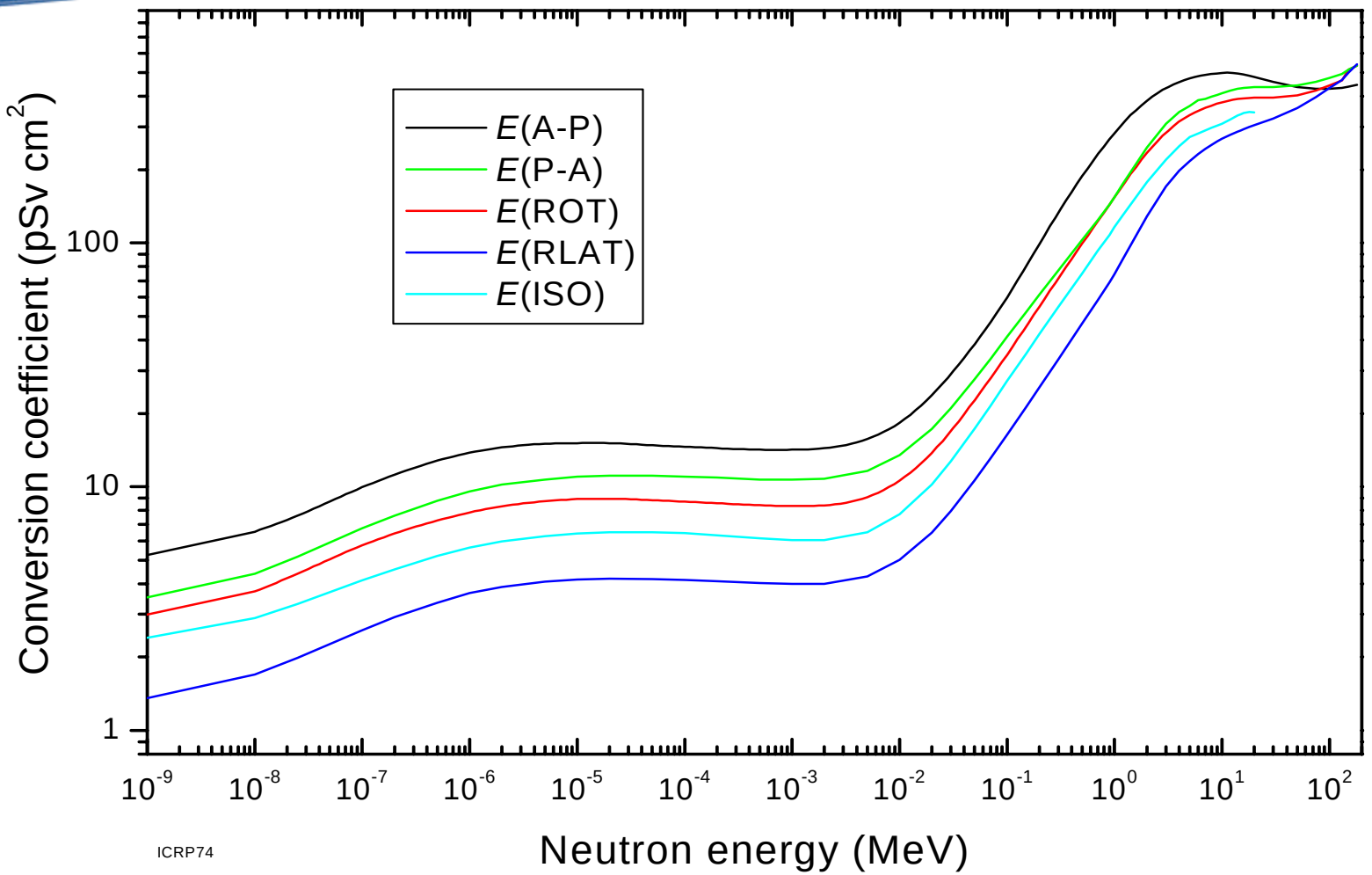
Effective dose, *E*, is the weighted sum of various organ doses, H_T

$$E = \sum_T w_T \cdot H_T$$

Oesophagus	0.05
Thyroid	0.05
Lung	0.12
Breast	0.05
Bone marrow	0.12
Colon	0.12
Liver	0.05
Stomach	0.12
Bladder	0.05
Gonads	0.20
Skin	0.01
Bone surface	0.01
Remainder	0.05



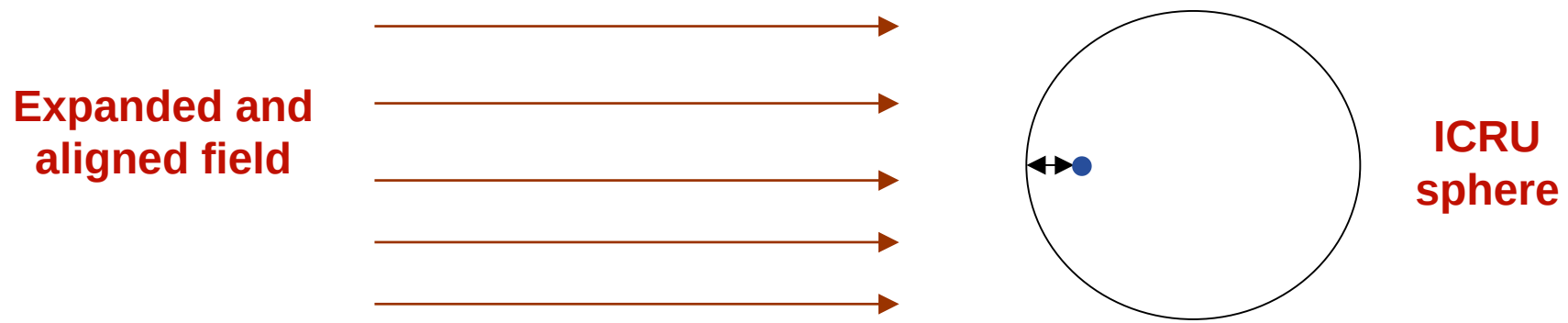
Effective dose conversion coefficients



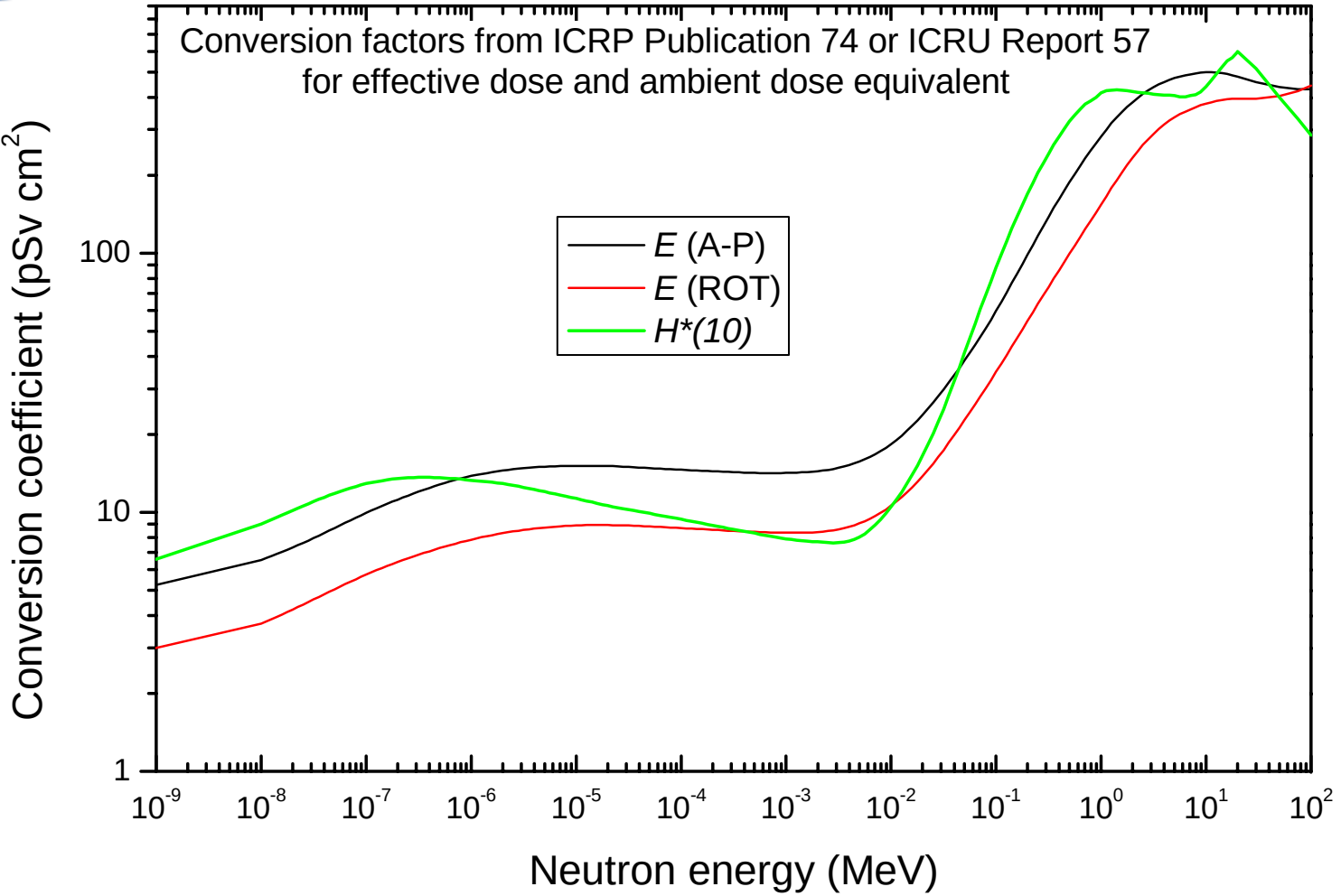
ICRP74

Survey instruments Ambient dose equivalent

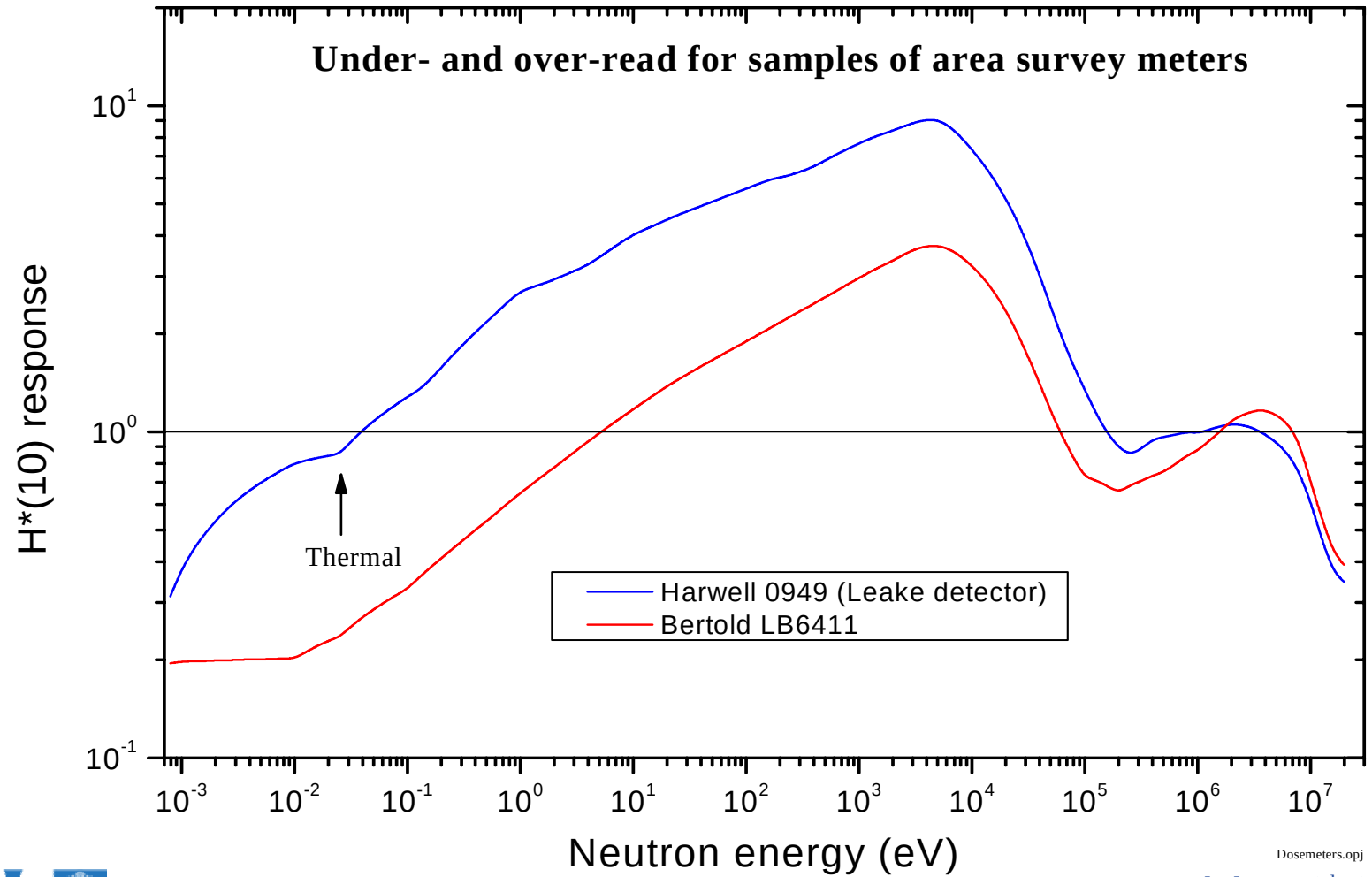
The ambient dose equivalent, *H*(d),* is the dose equivalent that would be produced by the corresponding expanded and aligned field, in the ICRU sphere at a depth of d mm on the radius opposing the direction of the aligned field.



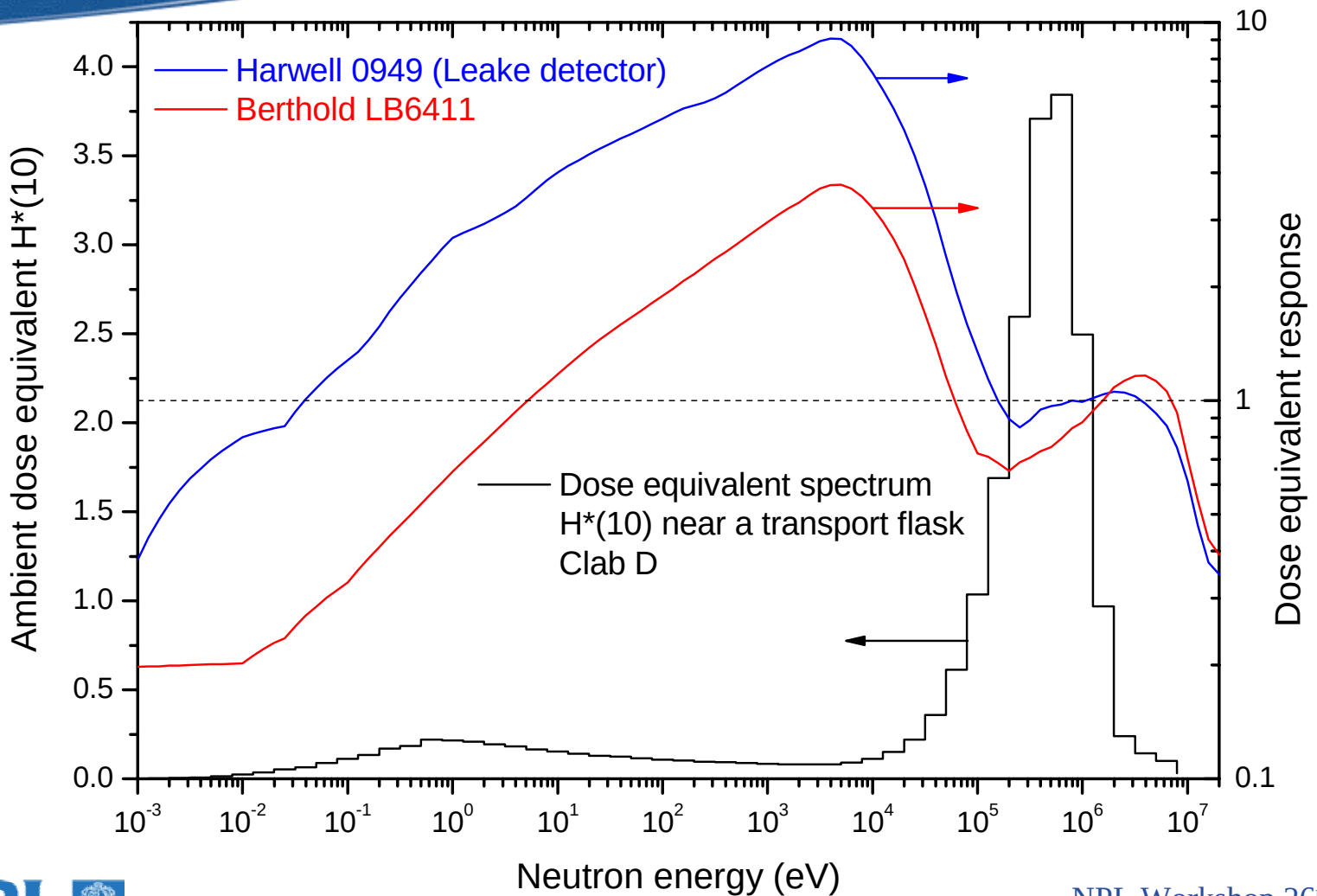
Comparison of *E* and *H**(10)



Typical area survey instrument response functions

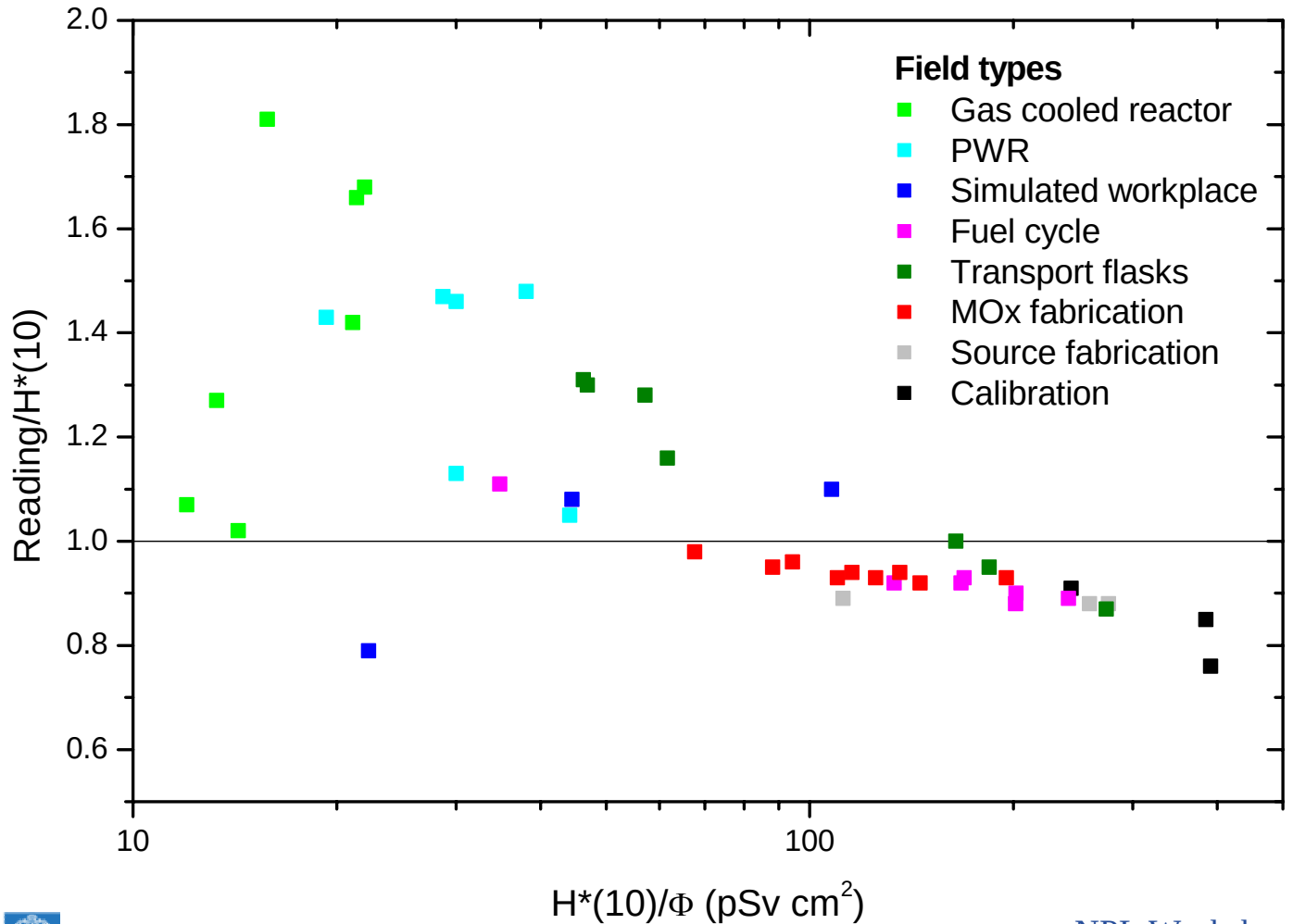


Implications of area survey instrument response functions 1



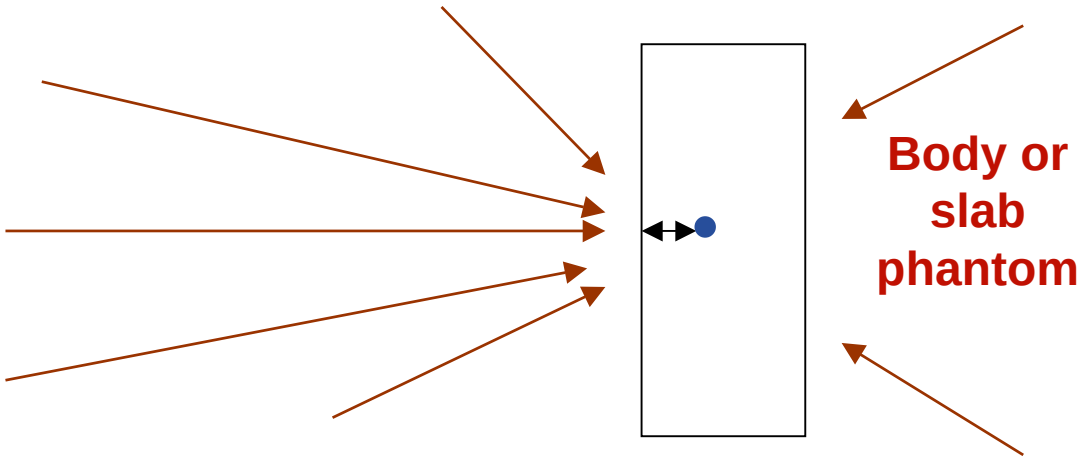
Implications of area survey instrument response functions 2

Leake counter



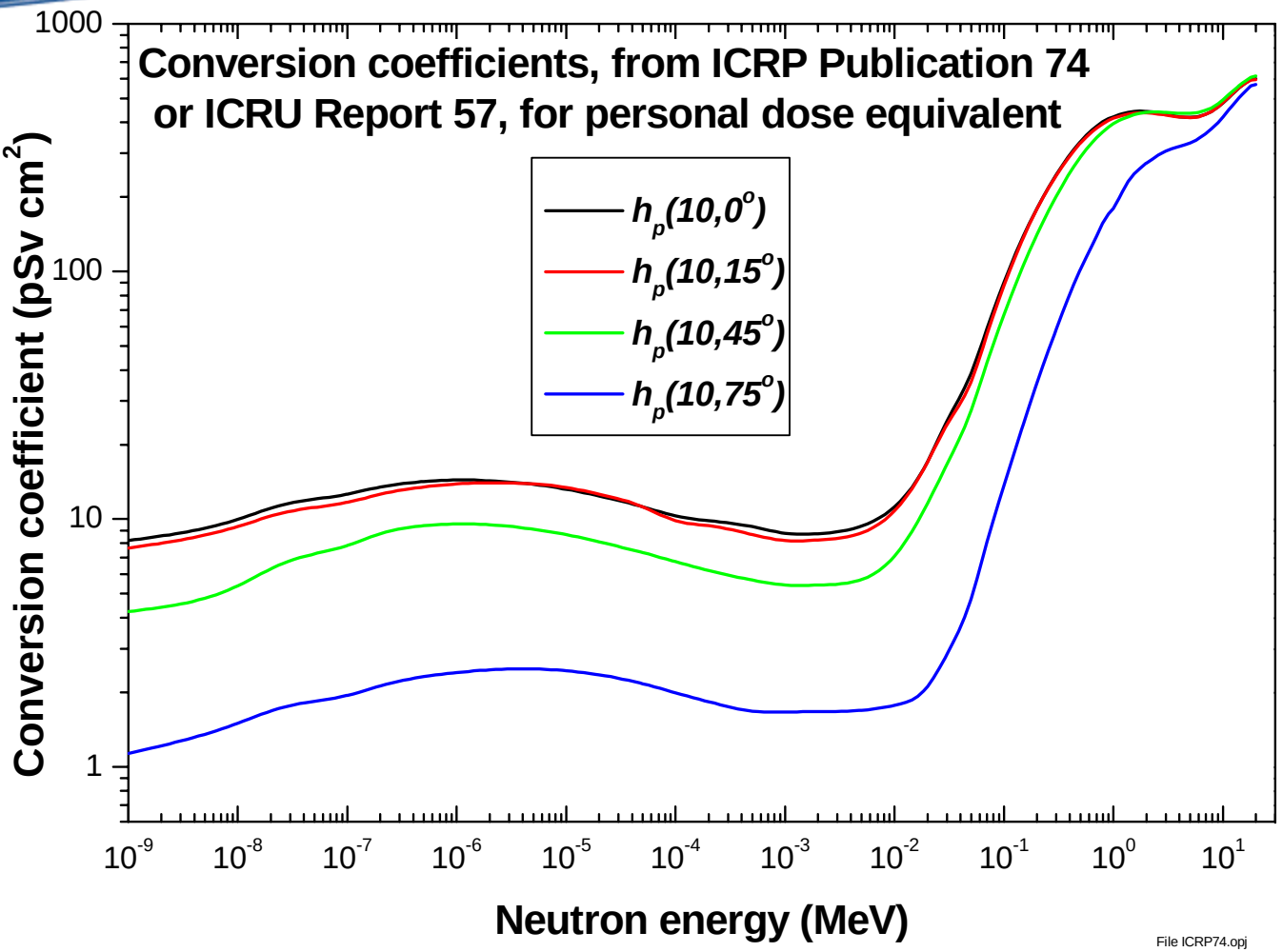
Personal dose equivalent

The personal dose equivalent, $H_p(d)$, is the dose equivalent in soft tissue, at a depth of d mm, below a specified point on the body.

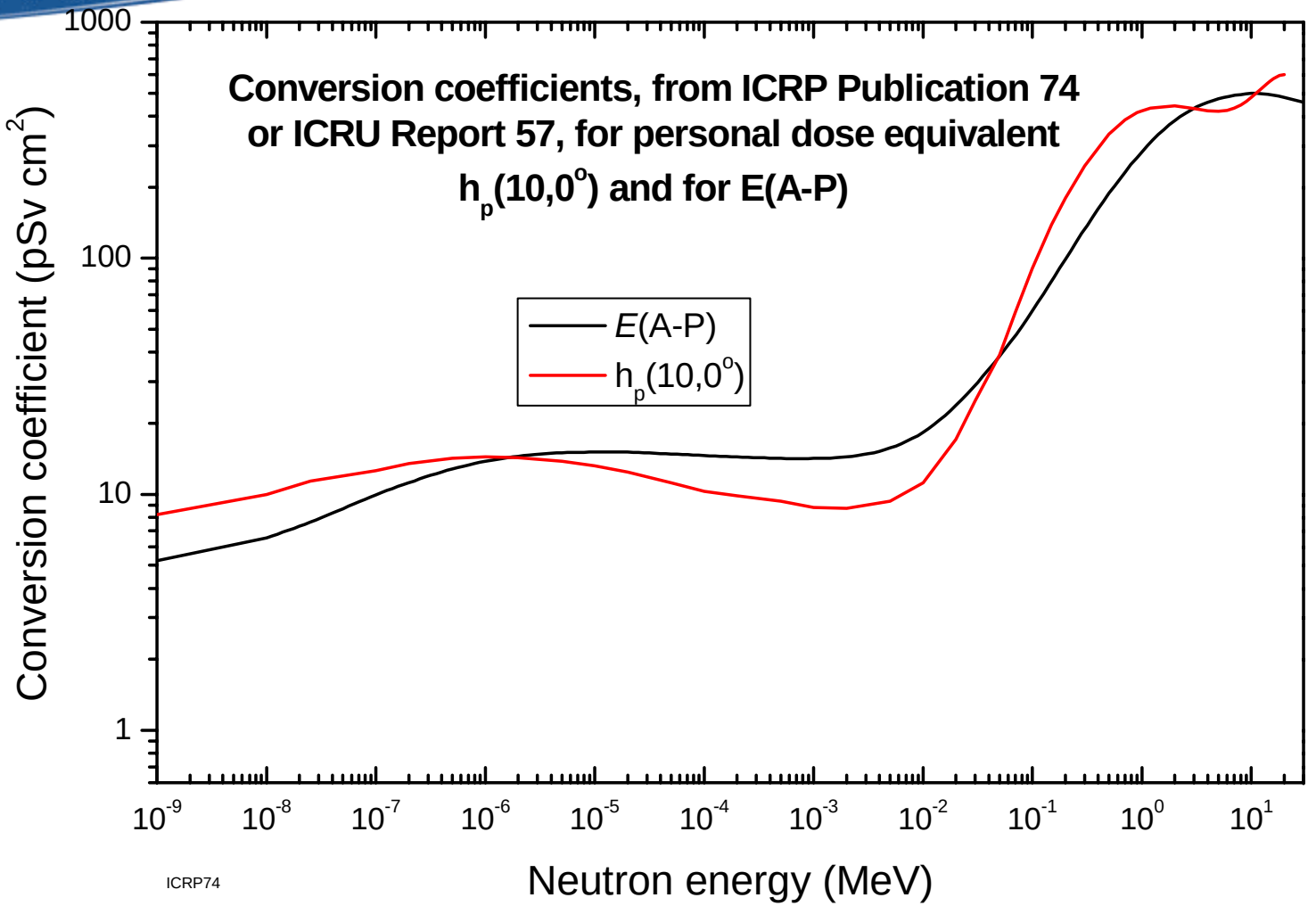


Note : in ICRU Report 47, the ICRU has considered the definition of the personal dose equivalent to include the dose equivalent at a depth, *d*, in a phantom having the composition of ICRU tissue. Then, $H_p(10)$, for the calibration of personal dosemeters, is the dose equivalent at a depth of 10 mm in a phantom composed of ICRU tissue, but of the size and shape of the phantom used for calibration (a 30cm x 30cm x 15cm parallelepiped), and the conversion coefficients, $h_{p,slab}(10)$, are calculated for this configuration.

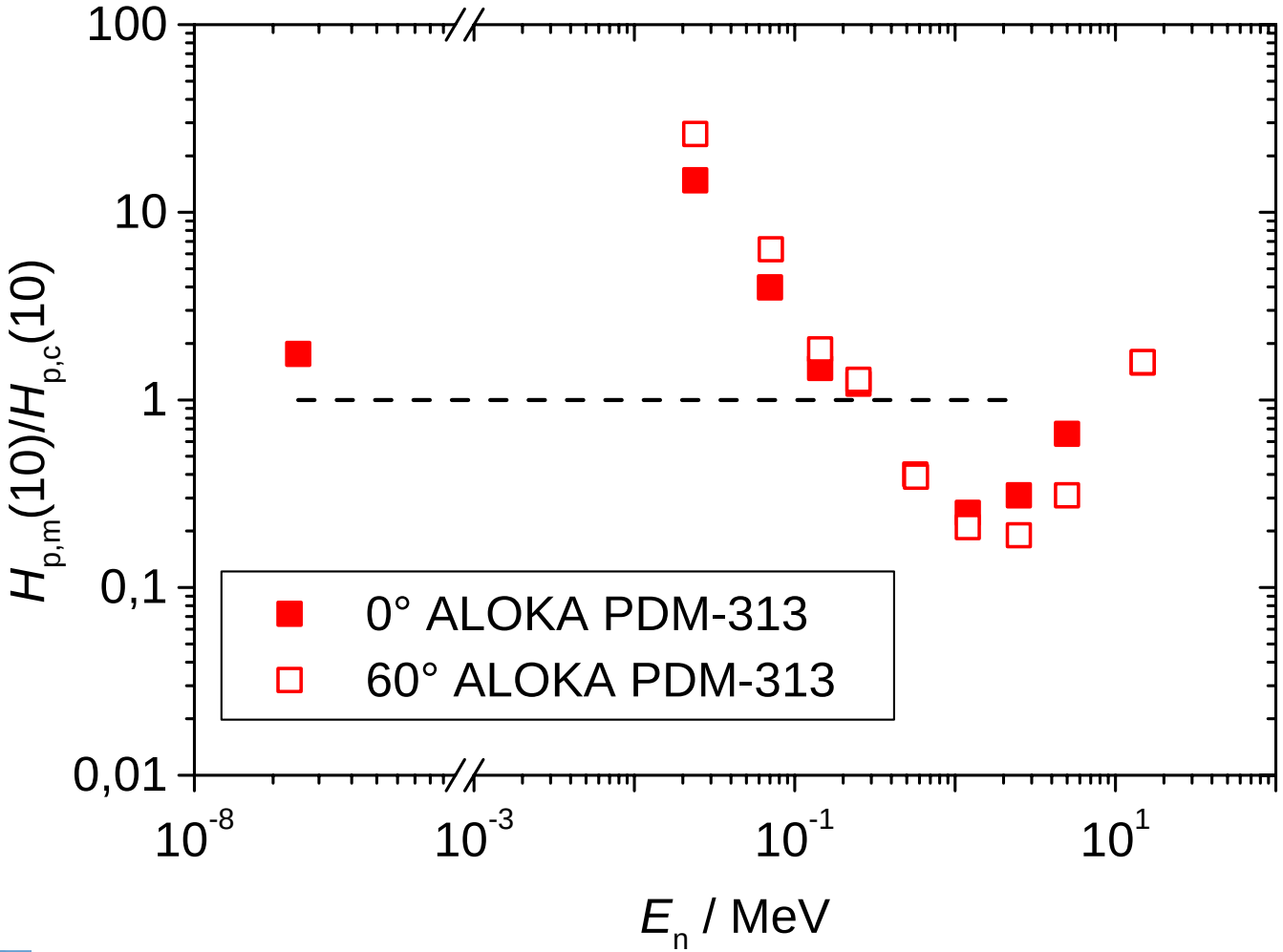
Personal dose equivalent conversion coefficients



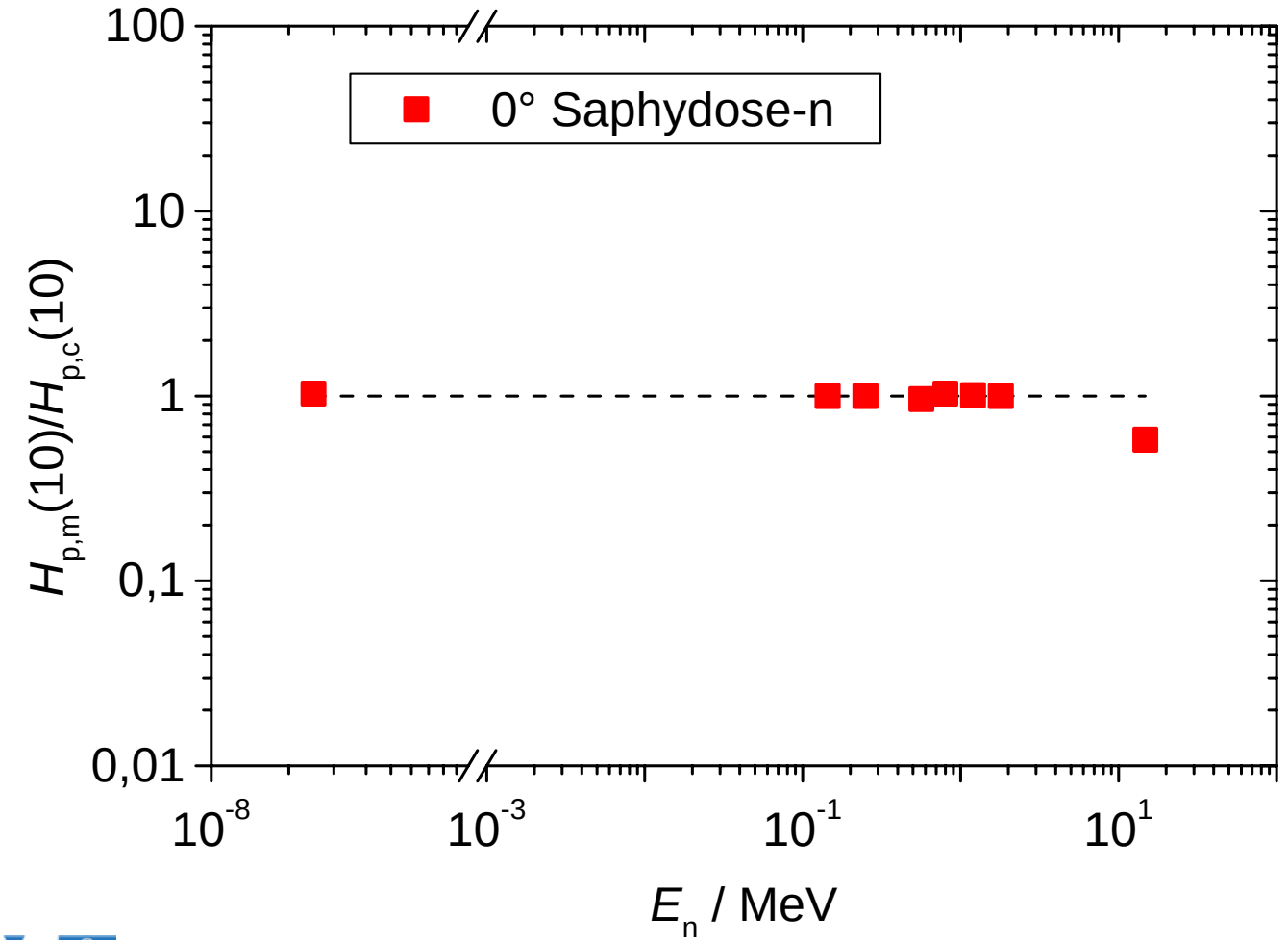
Personal dose equivalent conversion coefficients and *E*



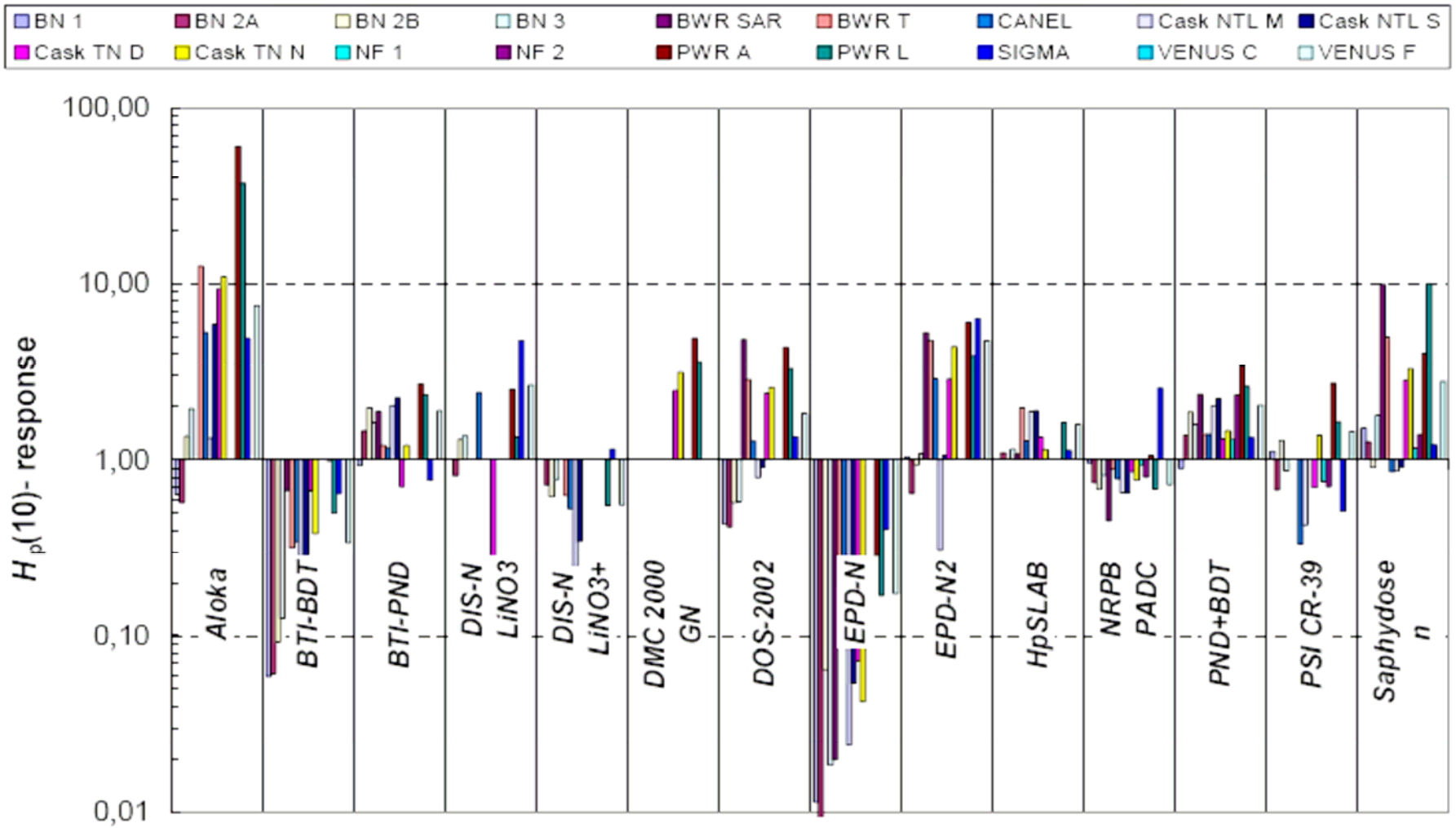
Neutron personal dose equivalent response



Neutron personal dose equivalent response



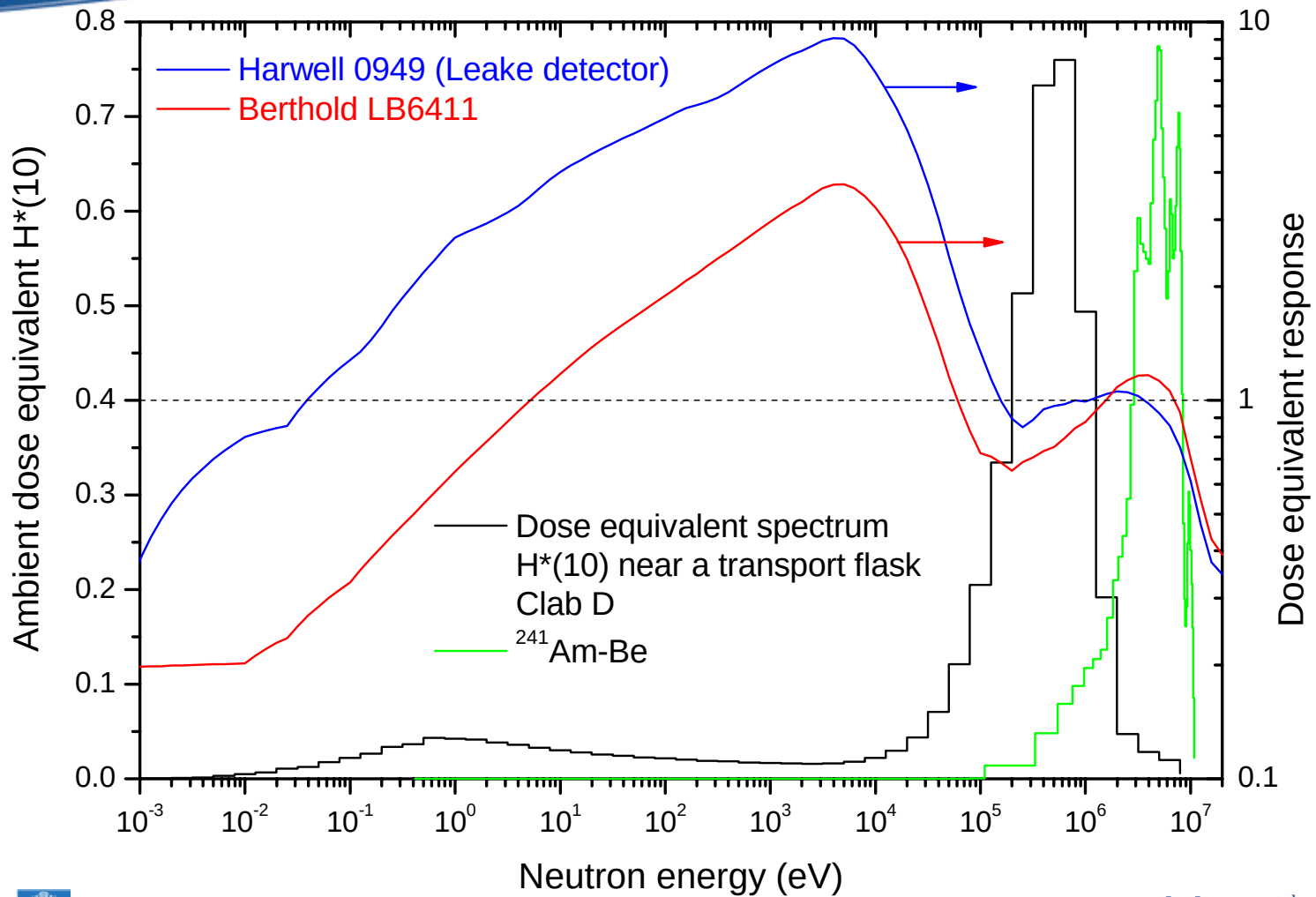
Neutron personal dose equivalent response



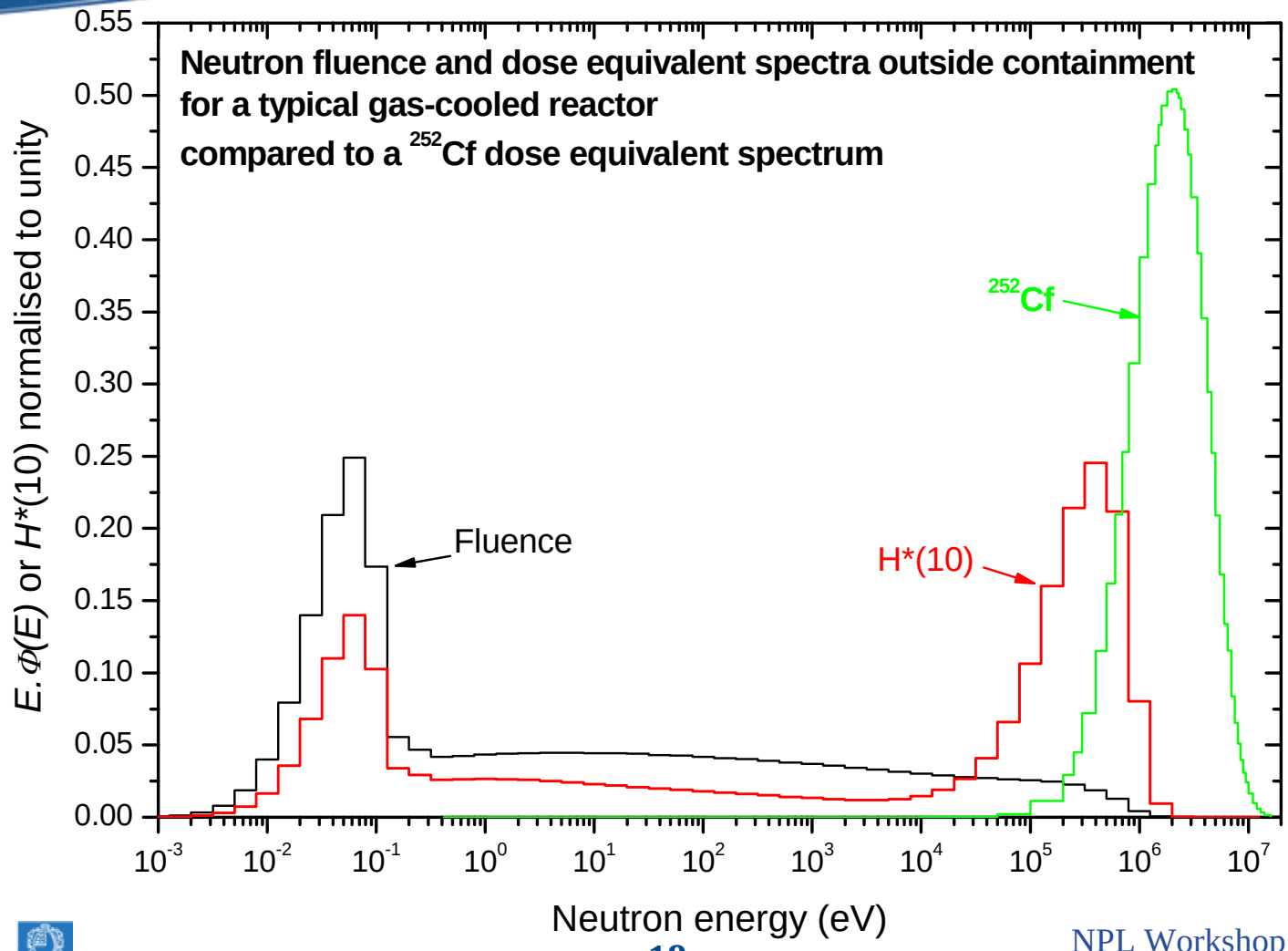
Requirements

- Several approaches to improving neutron dosimetry, e.g.
  - Improved survey instruments and dosemeters
  - Improved knowledge of workplace spectra
  - Improved knowledge of device response functions
  - Education of the practitioners – explaining the problems
- What is the most important?

End


Harwell 0949 (Leake detector)
Berthold LB6411
Dose equivalent spectrum
H*(10) near a transport flask
Clab D
241Am-Be
Ambient dose equivalent H*(10)
Dose equivalent response
Neutron energy (eV)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1
10
10-3
10-2
10-1
100
101
102
103
104
105
106
107

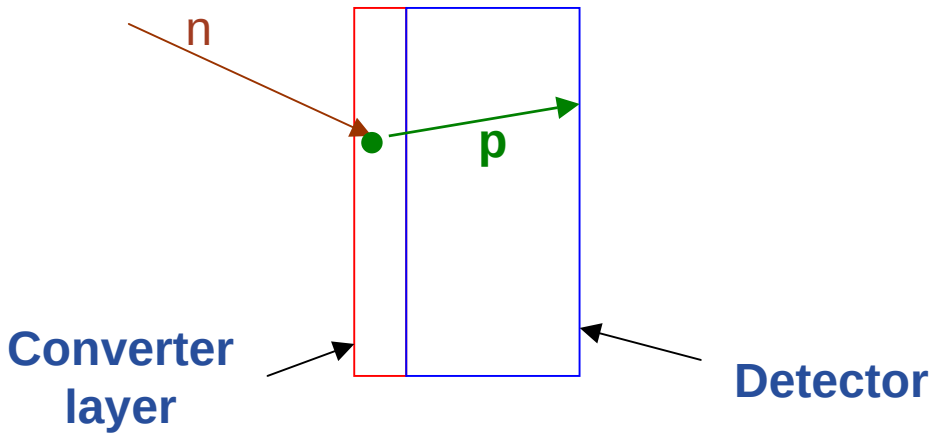
Neutron spectra



Personal dosemeters for neutrons

- **In general there are two mechanisms commonly used to detect neutrons in personal dosemeters – both active and passive:**
  - **Detection of recoil protons from a hydrogenous layer,**
  - **Detection of albedo neutrons from the body (albedo dosemeters).**

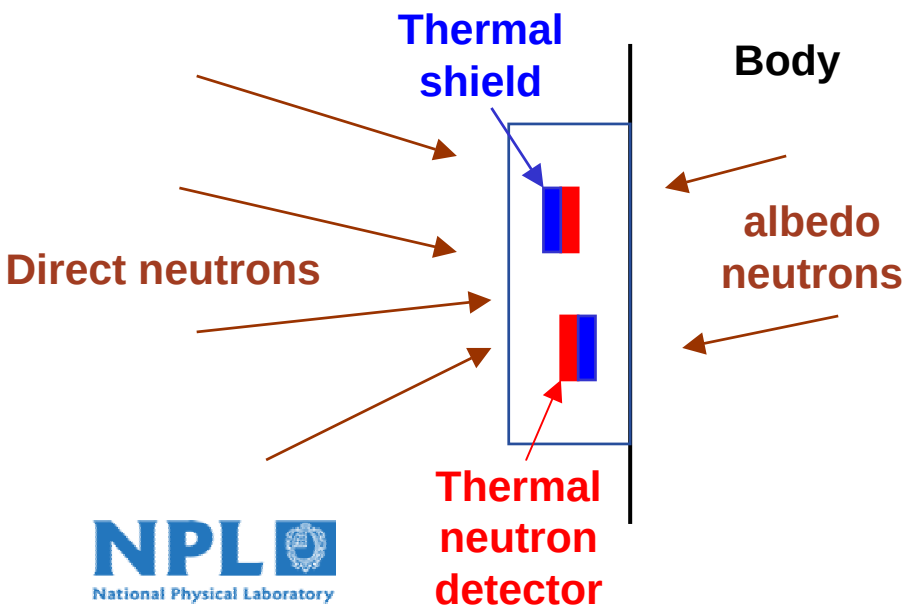
Proton recoil approach - used in etch track dosemeters, electronic dosemeters, etc.

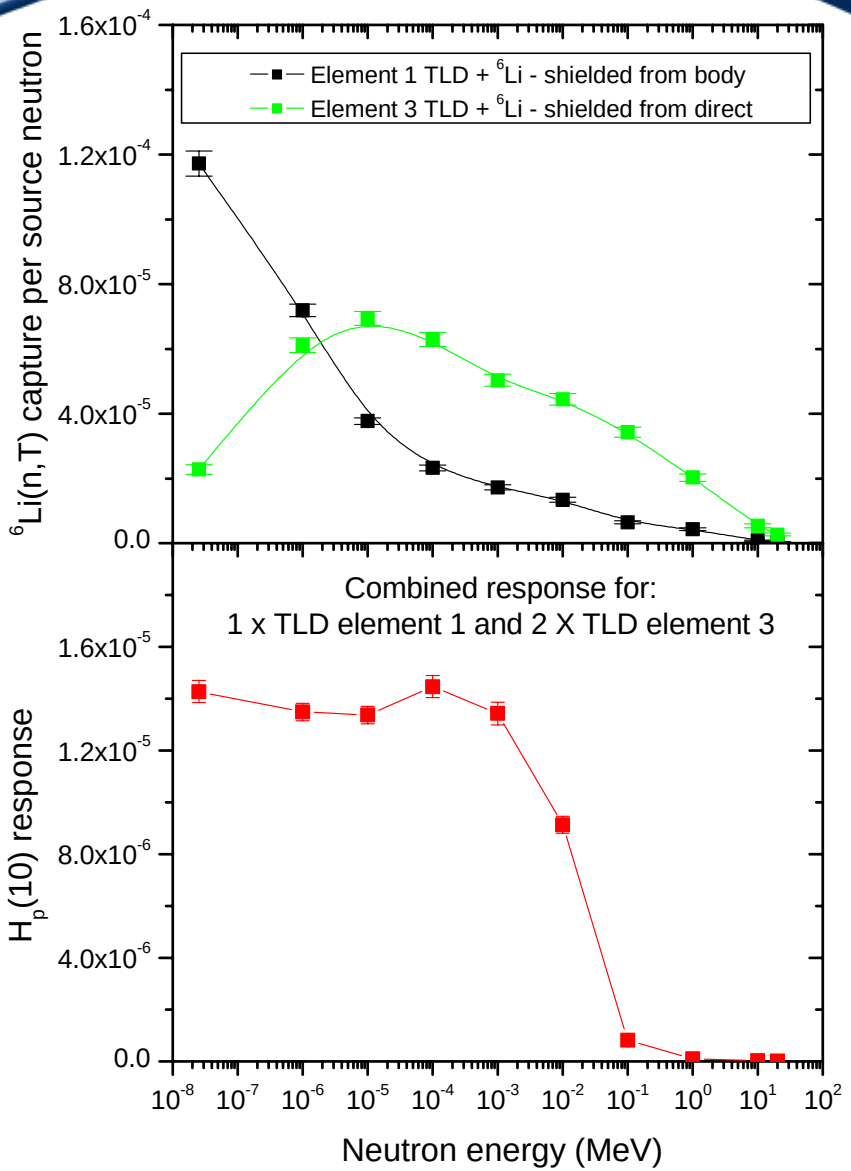


By simply counting the number of recoil protons from a hydrogenous layer get a reasonable estimate of personal dose equivalent for fast (> 50 keV) neutrons

Albedo devices

Albedo devices consist of 2 or more thermal neutron detectors with thermal neutron absorbing material shielding the detectors from the direct neutron field or from the backscattered neutrons.
A careful choice of the combination of the signals from the detectors gives a dose equivalent response up to 1 to 10 keV.





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