The high energy response of the electronic neutron/photon PTB dosemeter DOS-2002

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- DOS-2002, Principles
- DOS-2002, Response for intermed. energy neutrons
- DOS-2002, Response for high energy neutrons
- DOS-2002, Technical information
- DMC2000 GN, Commercialization
- Outlook

PTB DOS-2002

Principle

1 silicon detector with pulse height thresholds
^{6}LiF and polyethylene converter
heavy boron shielding

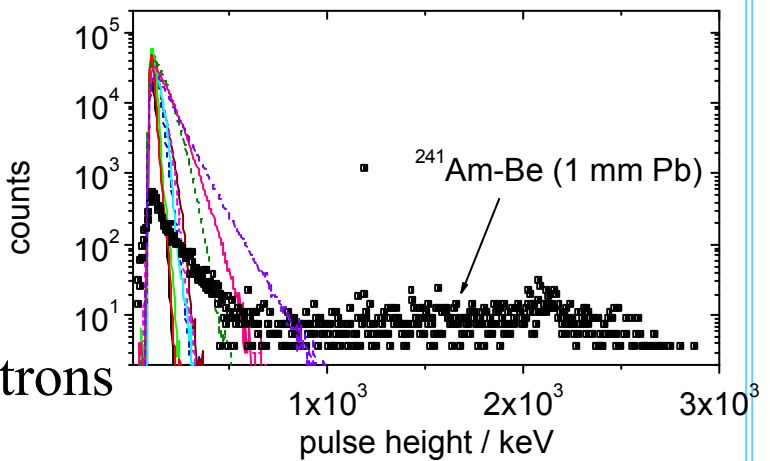
1 silicon detector

Advantages

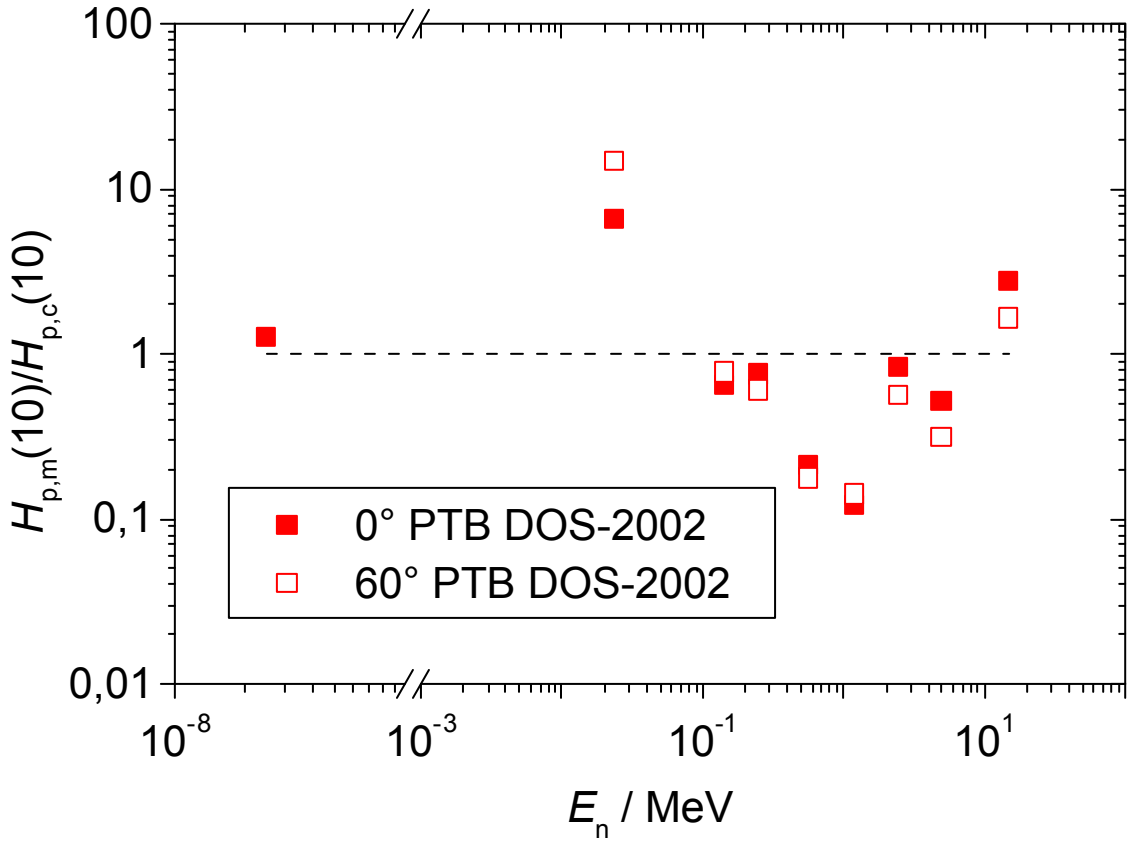
simple design
neutron and photon dosemeter
good response in reactor fields?

Drawbacks

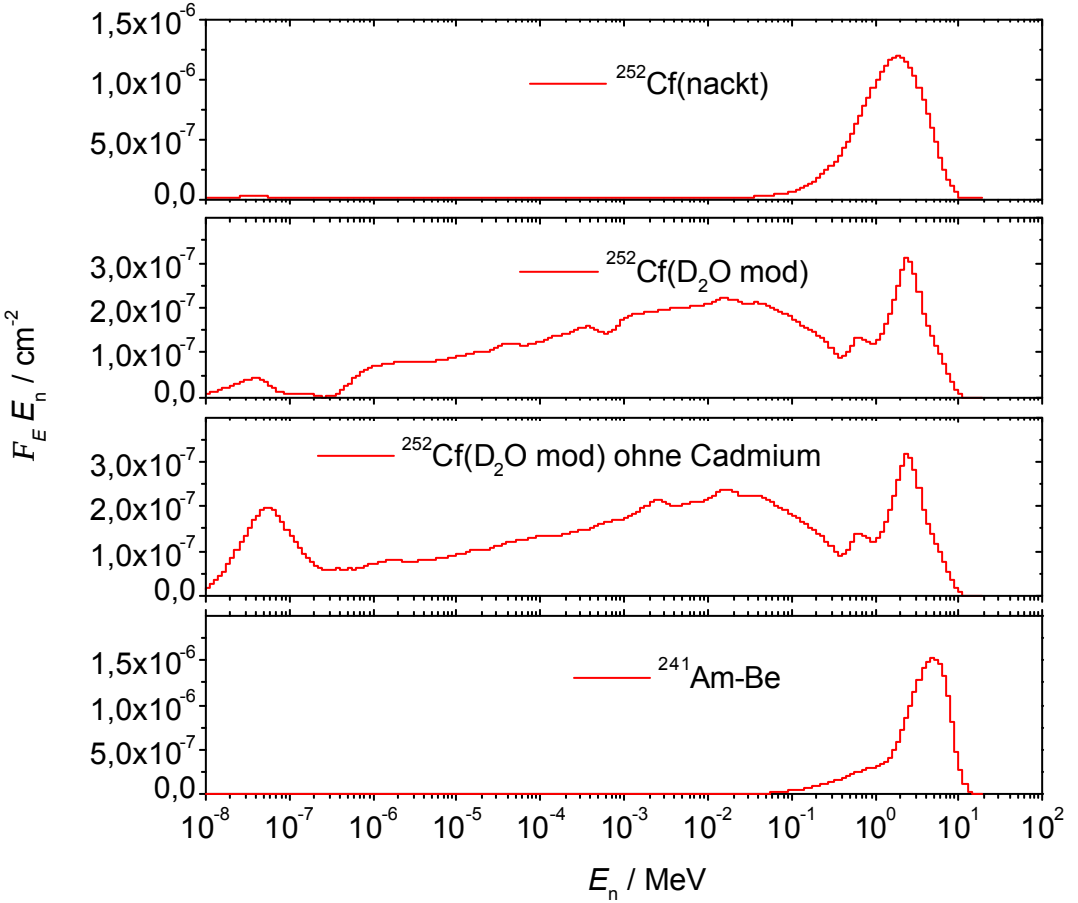
underresponse for fast neutrons
overresponse for intermediate neutrons
shock sensitive



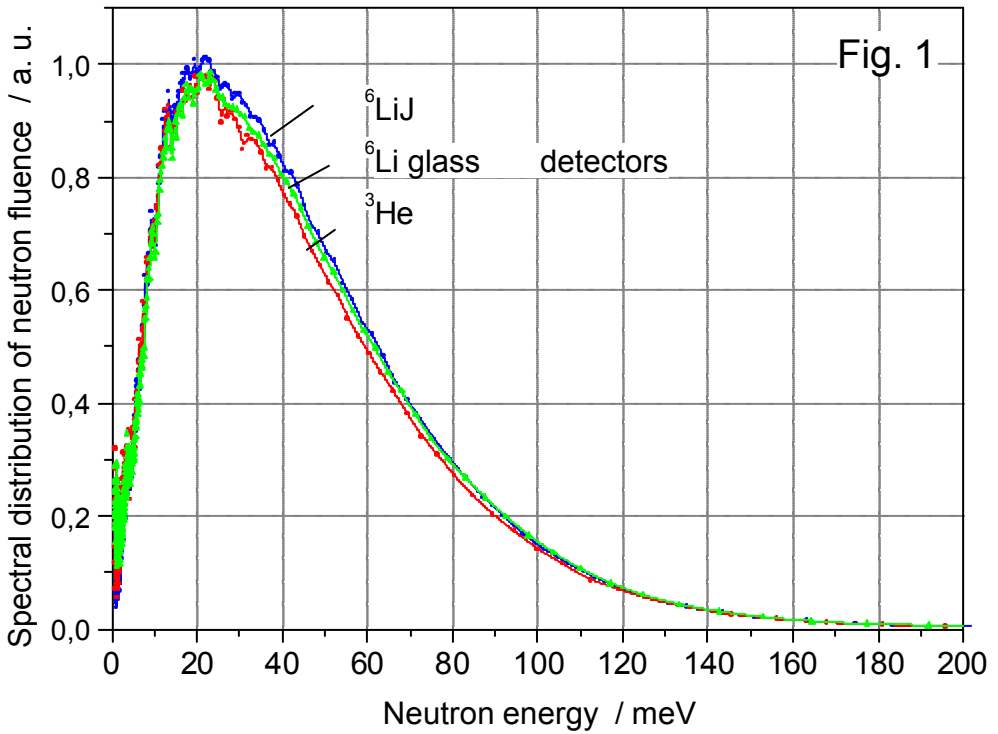
Neutron personal dose equivalent response



Spectral distributions of sources



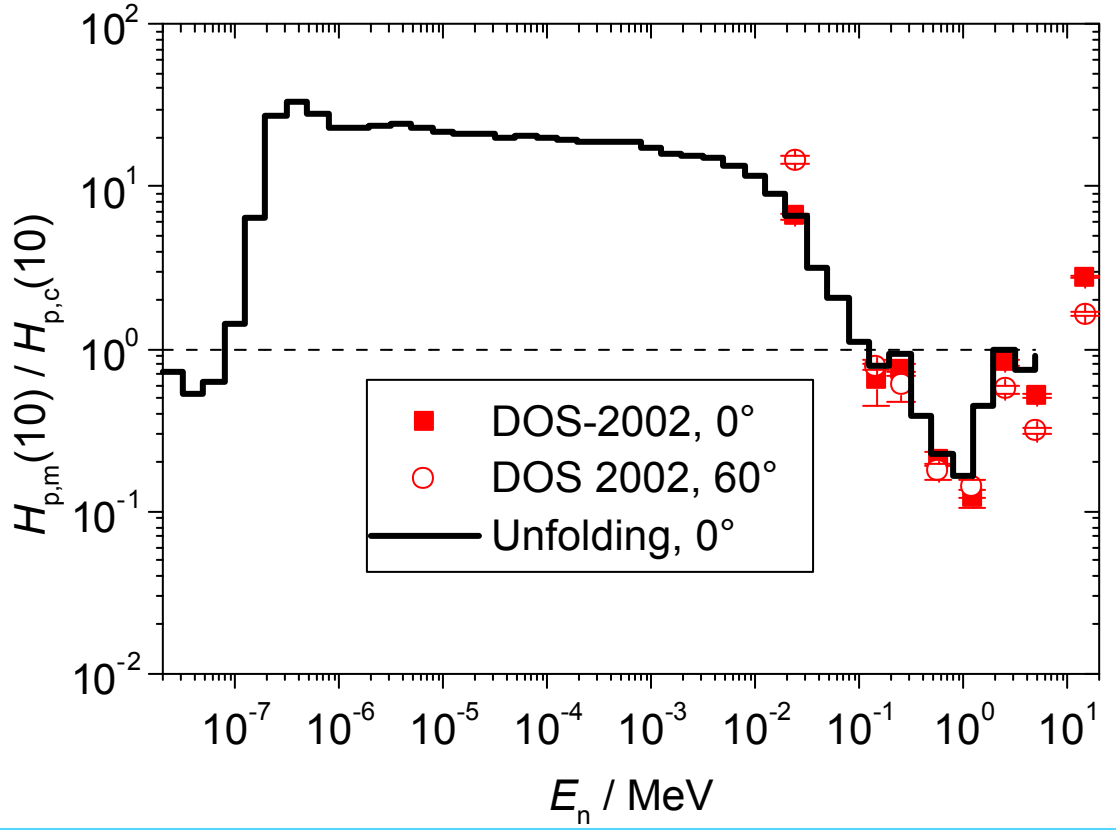
Thermal field (GKSS)



Response for intermediate neutrons by unfolding

- $H_{p,m}(10) = \int dE \cdot R_H(E) \cdot ?_E(E) \cdot h_{p?}(10;E)$
- Hepro unfolding (Mieke) without preinformation
- Input matrix: Spectra of sources (^{252}Cf(bare), ^{252}Cf(mod) – with and without cadmium shielding – , ^{241}Am-Be), quasi-monoenergetic neutrons produced at the PTB accelerator and thermal neutron beam (GKSS)
- Input measurement data: Measured readings in all fields

DOS-2002, Response for intermediate neutrons

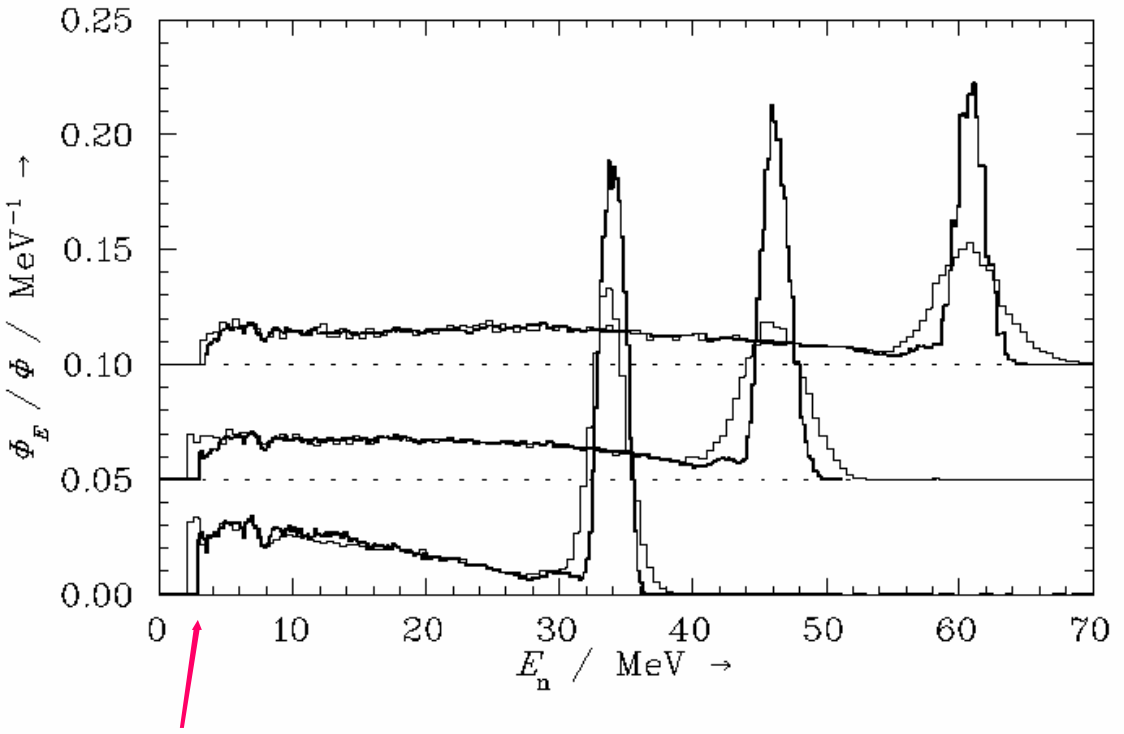


High energy neutrons, Availability

- UCL (Louvain-la Neuve, Belgium): 33 MeV, 45 MeV, 60 MeV, 80 MeV?
- TSL (Uppsala, Sweden) : up to 150 MeV
- NAC (Cape Town, South Africa): up to 200 MeV
- JAERI (Japan): up to about 90 MeV
- Tohoku University (Sendai, Japan): up to 200 MeV
- RIKEN (Wako, Japan): up to 200 MeV
- CERN (Geneva, Switzerland): CERF with 2 peaks (1 MeV and 100 MeV)
- LAWRENCE BERKELEY NATIONAL LABORATORY: up to 800 MeV

- PTB performs characterization at UCL and NAC
- Beamtime not easily available (project request, costs)

High energy neutrons, Spectral distributions (UCL)



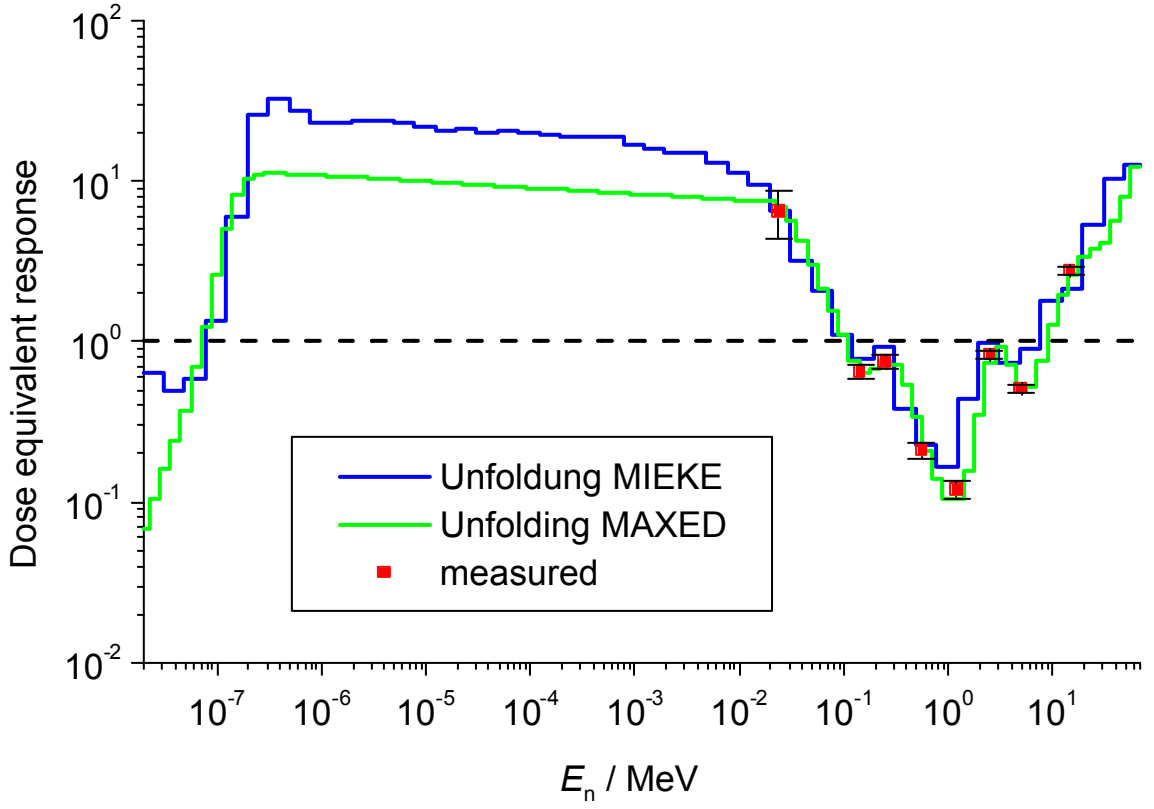
Flat extrapolation below 3 MeV

DOS-2002, Measured response

Neutron field	$H_{p,m}(10)/H_{p,c}(10)$ 0°	$H_{p,m}(10)/H_{p,c}(10)$ 60°
24 keV	6.50 ± 0.45	14.5 ± 1.04
144 keV	0.64 ± 0.21	0.77 ± 0.05
250 keV	0.75 ± 0.07	0.60 ± 0.13
565 keV	0.21 ± 0.02	0.18 ± 0.02
1.2 MeV	0.12 ± 0.02	0.14 ± 0.02
2.5 MeV	0.83 ± 0.06	0.56 ± 0.04
5.0 MeV	0.51 ± 0.03	0.31 ± 0.03
14.8 MeV	2.76 ± 0.15	1.64 ± 0.10
thermal	1.27 ± 0.14	-
^{252}Cf(bare)	0.54 ± 0.03	
^{252}Cf(D_2Omod) with 1 mm Cd	1.40 ± 0.09	
^{252}Cf(D_2Omod) without Cd	1.43 ± 0.11	
^{241}Am-Be	0.77 ± 0.08	
33 MeV	3.62 ± 0.72*	
60 MeV	7.33 ± 1.46*	

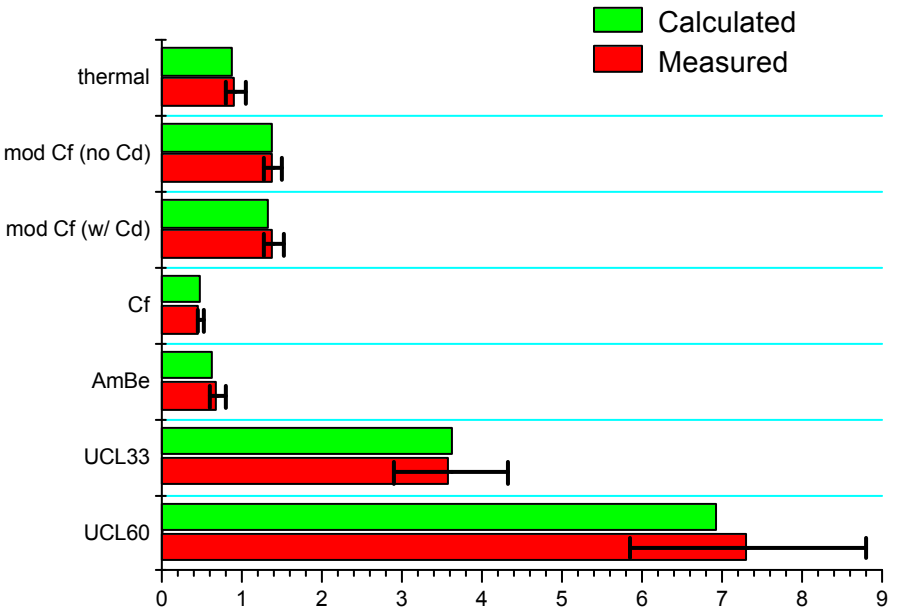
$H_{p,m}(10)$: measured personal dose equivalent
$H_{p,c}(10)$: conventional true value
* response with respect to H*(10)

DOS-2002, High energy neutron response



Comparison of calculated and measured response using unfolding results (Maxed)

MAXED: Maximum Entropie unfolding
with Bayesian parameter estimation (WinBUGS)



DOS-2002 Major characteristics

Dosemeter	PTB DOS-2002
Type of detector	1 silicon detector
Dimensions/ weight	67 mm x 90 mm x 26 mm, 150 g
Power supply, autonomy	1.2 V nickel metal hydride accumulator, >60 hours
Temperature	-20°C to + 50°C
Sensitivity	~330 cts/µSv for photons*, ~0.5 cts/µSv for neutrons*
Energy and angular response	± 40% from 70 keV to 7 MeV for photons, ± 55% for broad neutron fields, both for angles within ± 60 deg.
Dose range	0.016 µSv to 10 Sv for photons, 10 µSv to 10 Sv for neutrons
Digital display	Dose 0.01 to 2999 mSv, dose rate 0.1 to 2999 mSv/h
Optical alarms	Red LED
Alarm thresholds	Any value between 1 to 2999 mSv and 0.1 to 2999 mSv/h
Data storage	Personal dose equivalent for neutrons and photons, protocol of last 50 operations

* Individual calibration factors for each dosemeter

Commercialization: DMC2000GN

- Smaller, lighter (75 g)
- Higher automonie (1/2 year)
- Improved response around 1 MeV

Conclusion and Outlook

- High overresponse (factor 10) for 60 MeV neutrons
- Overresponse (factor 5 to 10) in fields with spectra similar to flight altitudes expected
- Calibration in CERF field necessary
- Calibrations at higher neutron energies (up to 200 MeV) necessary
- Unfolding is a powerful tool in mixed fields
- Influence of primary charged particles needs to be estimated for use in space