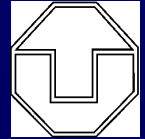


Technische Universität Dresden



Medizinische Fakultät Carl Gustav Carus

Reformfakultät des Stifterverbandes für die Deutsche Wissenschaft
Harvard Medical International Association Institution

Department of Dermatology



“Baseline-Reference of Solar UV-Exposures” to assess individual UV exposure levels in the population

Peter Knuschke

UV Conference „One Century of UV Radiation Research“
Davos, 18.-20. September 2007

Epidemiological studies proofed a correlation

UV radiation – Skin tumours



(EU-Directive: UVR a Carcinogen)

Problem UV radiation I:

- ***Carcinogen UV radiation***

permanent present

in the ambient solar UV radiation

in every day live

Problem UV radiation II:

Increasing skin cancer incidences
influenced by:

- Increasing life expectancy –
increasing cumulative UV live-time dose



Changed leisure-time behaviour

- Changed ideal of beauty
 - „brown is beautiful“, sunbeds -
- Mobility
 - e.g. tourism to sunny regions



- also in winter -

Problem UV radiation III

Minimization of additional UV exposures in work time by artificial UV sources

- Health prevention in UV exposed workplaces: 200.000 workplace with **artificial** UV sources (Germany)
- Measurement and assessment:
EN 14255-1
- Base of assessment:
8h-threshold values: EU-Directive (2006/25/EG)



EUROPEAN UNION

THE EUROPEAN PARLIAMENT

THE COUNCIL

Brussels, 27 January 2006
(OR. en)

1992/0449 B (COD)
C6-0001/2006

PE-CONS 3668/05

SOC 479
CODEC 1111

LEGISLATIVE ACTS AND OTHER INSTRUMENTS

Subject: Directive of the European Parliament and of the Council on the minimum health and safety requirements regarding the exposure of workers to risks arising from physical agents (artificial optical radiation) (19th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)

Joint text approved by the Conciliation Committee provided for in Article 251(4) of the EC Treaty.

PE-CONS 3668/05

DG G II

MS/cb

EN

Problem UV radiation IV

Minimization of solar UV exposures in work time

- Health prevention in **solar UV** exposed workplaces
2...3 Mio workplaces (Germany)

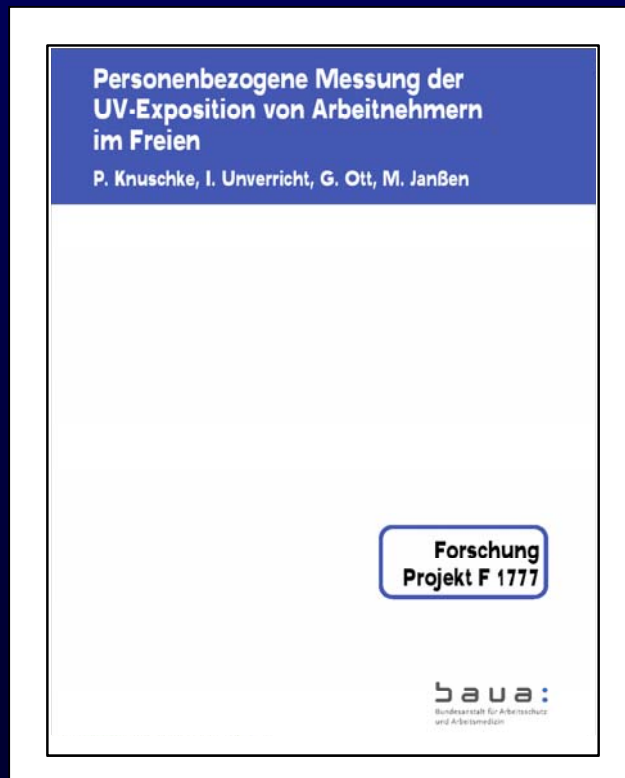


- Measurement and assessment:
prEN 14255-3 (final vote: 2007)
- Base of assessment:
**! No assessment criteria for the magnitude
of the biological effective UV exposure levels !**

Base to assess the magnitude of solar UV exposure

- EU-Directive: Only artificial UV radiation
- **! No assessment criteria for the magnitude of the biological UV exposure levels !**
- neither for workplaces nor for the public -

In:



New concept:

**Baseline-Reference of
solar UV exposure**

Background

Existing limit values to artificial UV exposures

➔ not applicable to solar exposed workplaces.

To draw up health care regulations for outdoor workplaces -
scientific based reference is necessary

Health care in solar UV exposed workplaces

FAQs:

- Magnitude of increased cumulative solar UV exposure compared to the „normal population“
- How could be defined a „*normal population*“- what is the amount of the UV exposure level of such a „normal population“?
- Relationships between occupational UV exposures and non-occupational UV exposures (*leisure time; holidays*)
- [Magnitude of natural UV skin protection: Useable as a protection component?]

Proposed Baseline-Reference

based on results of research projects:

German Federal Ministry of Education and Research:

- „Personal-UV-Dosimetry - using polysulphone films as UV-Sensor“
Support-N°: 07UVB54B (1996-1999)
- „Mean individual UV-exposures in the population“
Support-N°: 07UVB54C/3 (1999-2003)

Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (Federal Institute of Occupational Safety and Health):

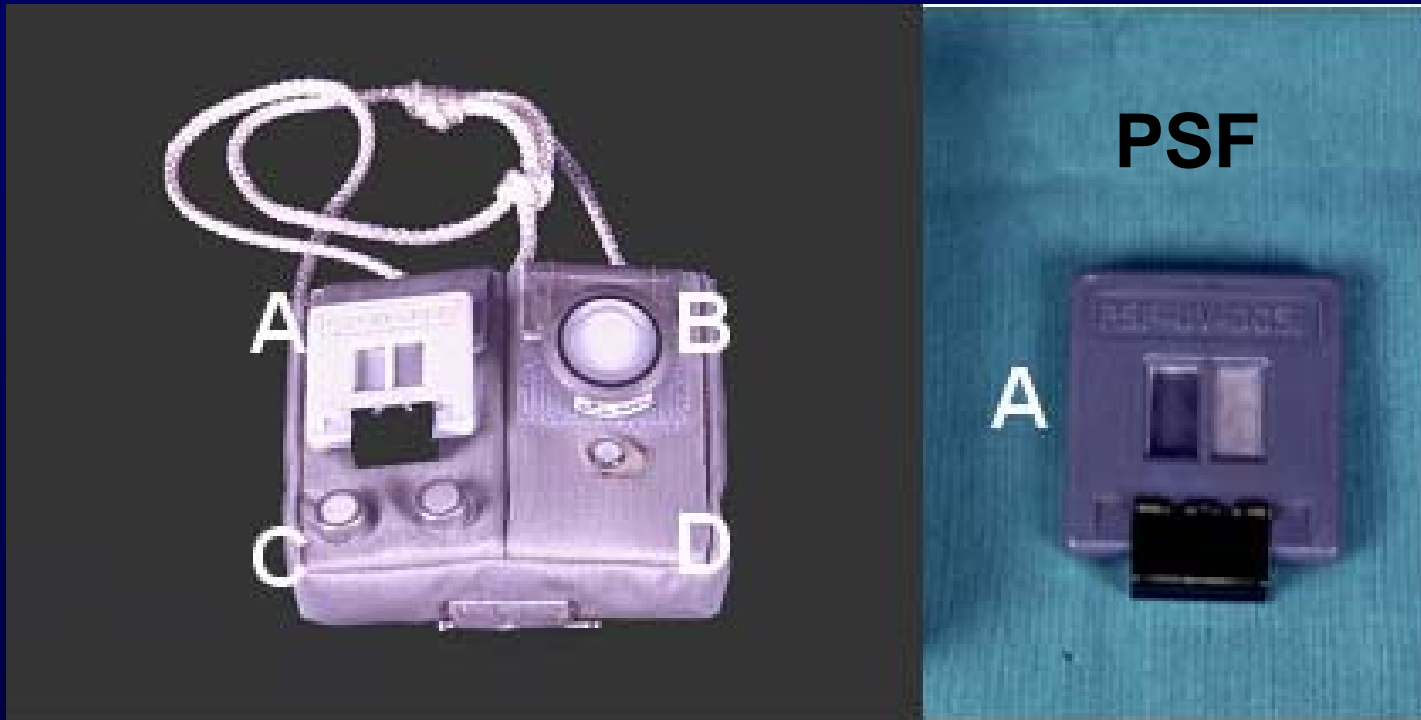
- „Personal UV monitoring in outdoor workers“
Support-N°: F1777 (2003-2006)

Personal UV monitoring in sections of the population

Person group	Characterization	1)	2)	3)
		'96-'98 n =	'00-'02 n =	'03-'05 n =
Pre-school age	Kindergarten	15	75	-
pupils	Primary school	8	70	-
Students	Grammar school	24	-	-
	Sporting group / rowers	13	-	-
Students	University	15	-	-
Indoor workers	Outdoor active in leisure time	11	140	3
	Less outdoor active (passive) in leisure time	15		
Outdoor worker	Road construction workers	12	120	-
	Gardeners	10		
	Roofer	10		
	Postmen; Traffic warden			15
	Construction workers			15
	Agricultural workers	-	-	15
	Dustmen			15
Working outdoors and indoors	Window cleaners	-	-	15
	Kindergarten teachers	-	7	15
	PE-teachers	-	-	15
Not in employment	Housewives	10	-	-
	Beginning retirement age	10	-	-
	Old people's home	13	-	-

- ¹⁾ Knuschke P, Krins A. (2000) UV-Personendosimetrie mit Verwendung des Polysulfonfilms als Sensor. Schlussbericht BMBF-Projekt 07UVB54B, TIB Hannover F 00 B 1544
- ²⁾ Knuschke P, Kurpiers M, Koch R, Kuhlisch W, Witte K. (2004) Mittlere UV-Expositionen der Bevölkerung. Final Report on BMBF-Projekt 07UVB54C/3, TIB Hannover F05B898
- ³⁾ Knuschke P, Unverricht I, Ott G, Janßen M. Personenbezogene Messung der UV-Exposition von Arbeitnehmern im Freien. Schriftenreihe der Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Forschung, F 1777; Dortmund/Berlin/Dresden 2007; ISBN 978-3-88261-060-4

Actinic personal UV dosimeters available in Germany



- (A) Polysulphone film dosimeter (Dermatology / Technische Universität Dresden)
- (B) VioSpor dosimeter (Fa. Biosense, Bornheim)
- (C) X2000 datalogger-dosimeter (Fa. Gigahertz-Optik, Puchheim)
- (D) UVDAN datalogger-dosimeter (Fa. ESYS, Berlin / AWI Bremerhaven)

Personal UV monitoring

Data capture of

individual biological-effective **UV exposure in everyday life** round the year;
in addition:

- **biological-effective global radiation** simultaneously
- **body distribution** of solar **UV exposure** in everyday life, mean of 3/5 days
- **UV exposure-relevant personal data** (volunteer diaries and other data)

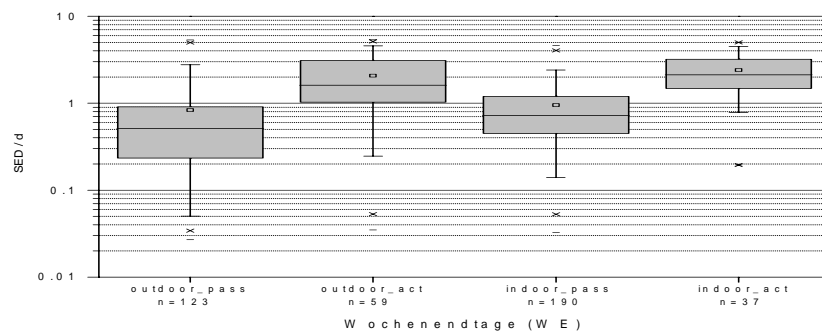
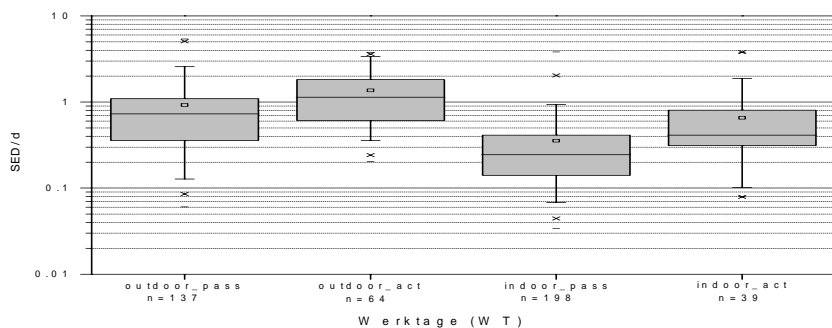


Statistical distribution of individual UV exposure in population groups

Example:

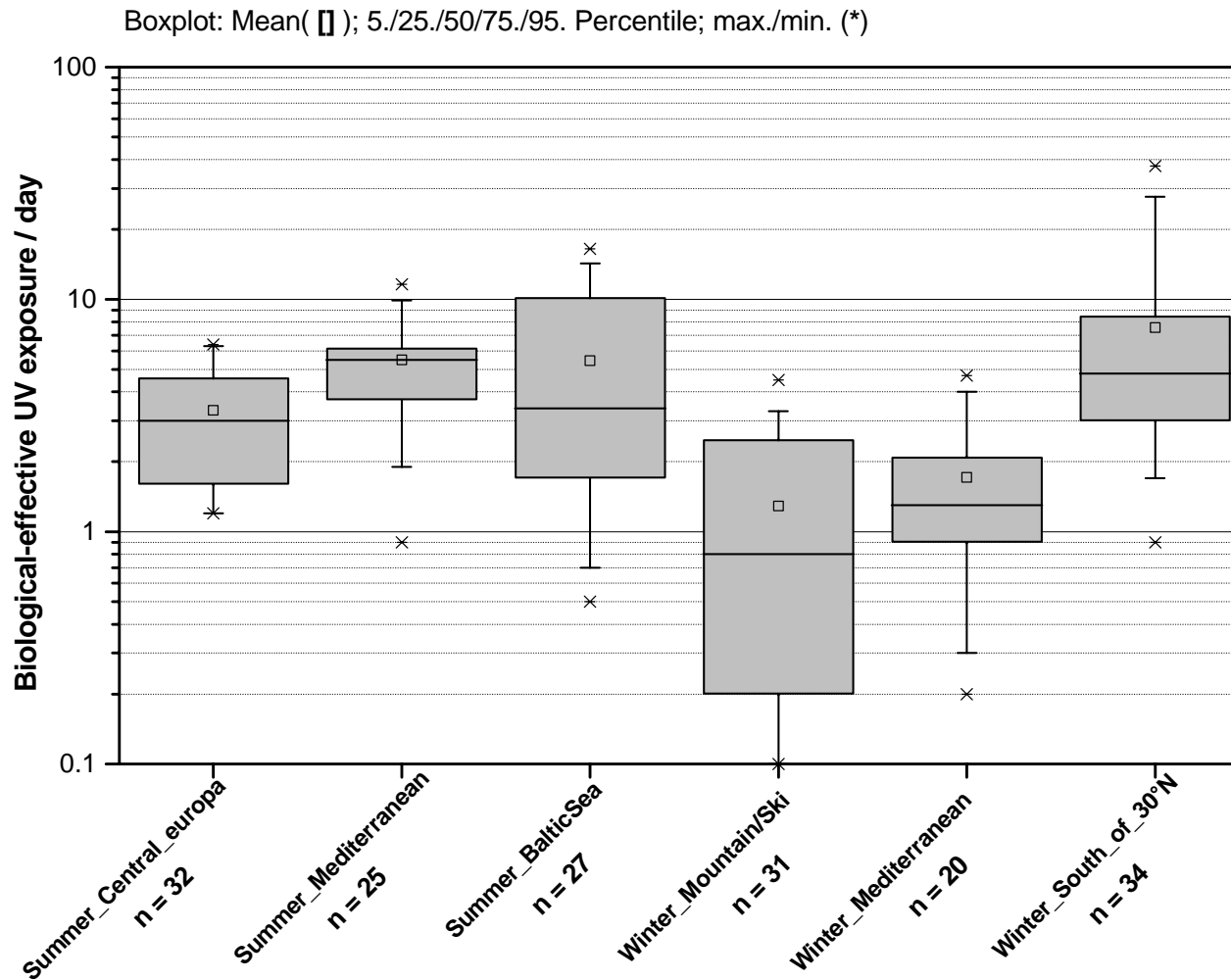
Distribution of $H_{ery} / SED/d$ (chest position)

- indoor **vs.** outdoor worker, active **vs.** passive in leisure time
- working days (WT) **vs.** leisure time/weekend days (WE)
- measurement period: $\gamma_s = 60^\circ$ (solar noon elevation)



Individual UV exposures in holidays

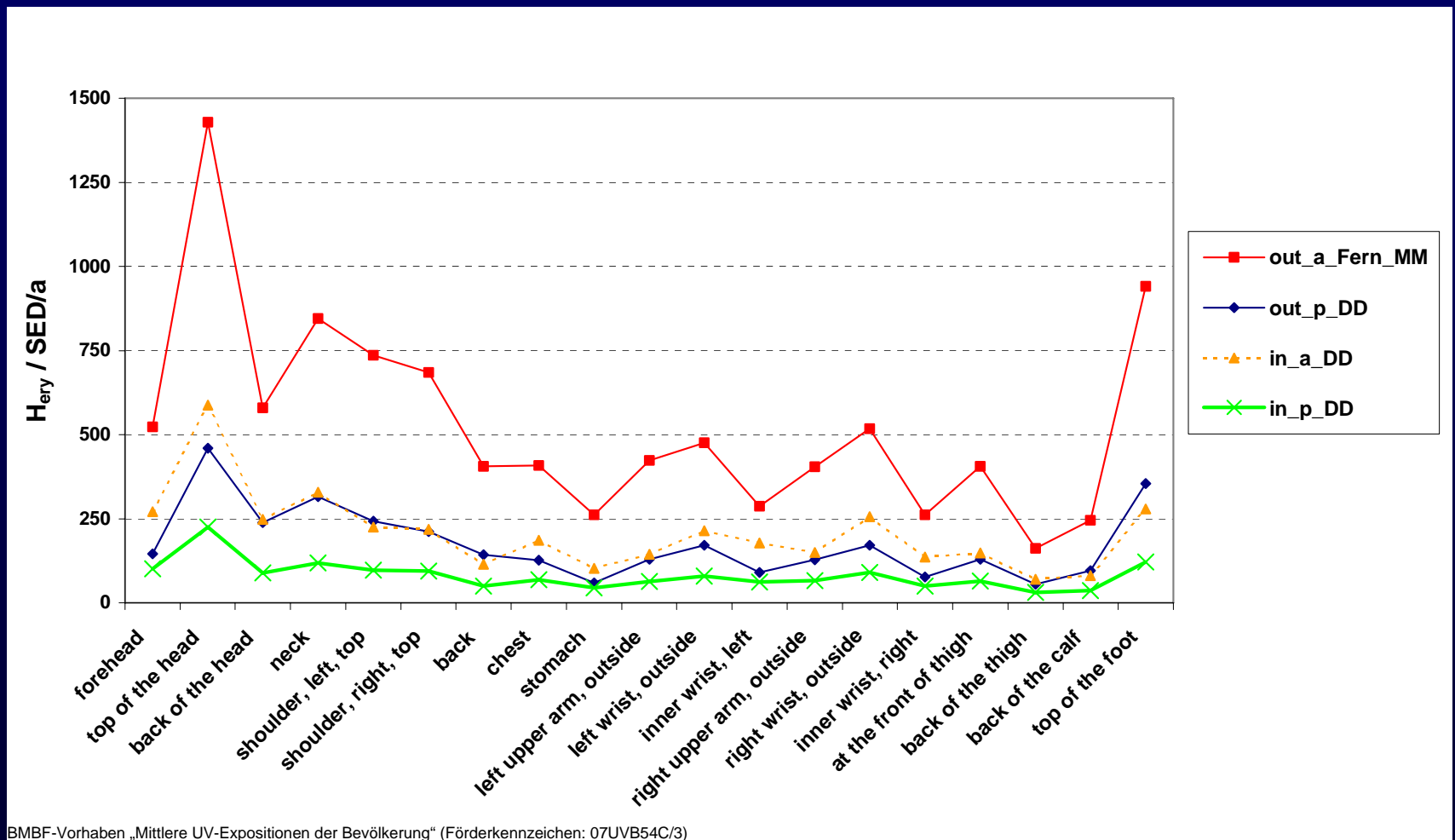
Biological-effective personal UV dose: holidays in different regions and seasons



© Knuschke, Kurpiers 2002

Results from BMBF-project „Mittlere UV-Expositionen der Bevölkerung“ (Support-N°: 07UVB54C/3)

Body distribution of the cumulative annual UV exposure of indoor workers and outdoor workers



BMBF-Vorhaben „Mittlere UV-Expositionen der Bevölkerung“ (Förderkennzeichen: 07UVB54C/3)

in_p_DD = recommended baseline-reference of solar UV exposures

6 Recommended Baseline-Reference to assess individual solar UV-exposure

Die Untersuchungen quantifizierten die erwarteten, gestaffelten UV-Expositionslevel für die gewählten repräsentativen Berufsgruppen im Freien Beschäftigter mit solar-exponierten Arbeitsplätzen.

Zur „Messung und Beurteilung von personenbezogenen Expositionen gegenüber inkohärenter optischer Strahlung“ gibt die Serie der Standards EN 14255 umfassende Verfahrensrichtlinien. Es wird die solare UV-Exposition für Arbeitsplätze und die Bevölkerung (prEN 14255-3) und die UV-Exposition durch künstliche UV-Strahlenquellen an Arbeitsplätzen (EN 14255-1) behandelt.

Die Verfahrensvorgaben zur Bewertung der individuellen UV-Expositionen liegen fest. Die Basis dieser Bewertung ist aber nicht Bestandteil dieser Standards. Für den EU-Bereich sind für die künstliche optische UV-Strahlung an Arbeitsplätzen spektrale Grenzwerte festgelegt (EU-Richtlinie 2006).

Up to now, no baseline-reference exist to assess the magnitude of individual solar UV exposures.

Basing on the analysis of the personal UV monitoring studies on distribution of the individual UV exposures in the different sections of the population (Knuschke et al. 2000; Knuschke et al. 2004; BAuA- research project F 1777, we propose the following baseline-reference to assess the magnitude of individual solar UV exposures:

- Referenzbasislevel für UV-Expositionen ist die mittlere UV-Exposition von ständig im Gebäude Beschäftigten.
Von den Innenbeschäftigten soll nur der Personenkreis in die Auswahl eingeschlossen werden, der bezüglich des Freizeitverhaltens durch geringe Aktivitäten im Freien geprägt ist (= **passive Innenbeschäftigte bzw. in-p**).
Für den Urlaubsanteil an der UV-Jahresexposition sollen mittlere UV-Expositionslevel für Urlaub am Wohnort in Deutschland/Mitteuropa ohne erhöhte Freizeitaktivitäten im Freien zugrunde gelegt werden. In die UV-Jahresexposition geht ein dreiwöchiger Sommerurlaub (Juli/August), ein einwöchiger Urlaub (Februar/kein Wintersport) und ein einwöchiger Weihnachtsurlaub ein.
- Es werden mittlere individuelle UV-Expositionen pro Arbeits- bzw. Werktag im Jahresverlauf für Bewertungen zu einem speziellen Zeitpunkt im Jahr zugrunde gelegt (Tab. 6.1).
- Es werden mittlere individuelle UV-Expositionen pro Freizeit- bzw. Wochenendtag im Jahresverlauf für Bewertungen zu einem speziellen Zeitpunkt im Jahr zugrunde gelegt (Tab. 6.1).
- Es werden mittlere individuelle UV-Expositionen pro Jahr (Werktags-, Freizeit- und Urlaubsanteil) o. g. Personengruppe passiver Innenbeschäftigter zugrunde gelegt, um Bewertungen zu langfristigen UV-Expositionen vernehmen zu können.
- Da die solare UV-Exposition einer Intensitätsverteilung über den Körper unterliegt, wird die Brustposition als Referenzmessposition festgelegt.

Damit können sowohl aktuelle solare UV-Einzelexpositionen, als auch permanente UV-Langzeitexpositionen in ihrem Ausmaß bewertet werden.

Personal UV Monitoring in Outdoor Workers

P. Knuschke, I. Unverricht, G. Ott, M. Janßen

Forschung
Projekt F 1777

baua:
Bundesanstalt für Arbeitsschutz
und Arbeitsmedizin

ISBN 978-3-88261-060-4

http://www.baua.de/nn_8514/de/Publikationen/Fachbeitraege/F1777.html__nnn=true

Knuschke, UV Conference, Davos/CH, 18.-20.09.2007

Baseline-Reference: in_p_DD

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Tab. 6.1 Referenzbasis von Tagesdosen zur Bewertung solarer UV-Expositionen in Deutschland/Mitteleuropa
 Basiswerte der UV-Tagesdosis (erythem-effektive Bestrahlung H_{ery}/d in SED/d) für verschiedene saisonale Sonnenhöhenwinkel γ_s in Brustposition;
 - für Arbeits-/Werktage (WTin-p)
 - für Freizeit-/Wochenendtage (WEin-p)

Mittagssonnenhöhe γ_s	Referenzbasis H_{ery} (WTin-p) für Werktage in SED / d	Referenzbasis H_{ery} (WEin-p) für Wochenendtage in SED / d
60°	0.35	1.0
42°	0.10	0.45
30°	0.05	0.1
15°	0.02	0.025

Tab. 6.2 Referenz - Basiswert für kumulative UV-Jahresdosen

	UV-Jahresdosis H_{ery} (Jahr, in-p) in J/m ² / a
Passive Innenbeschäftigte (gesamt)	70
Passive Innenbeschäftigte (werktäglich)	20

Begründung für die Wahl dieser Referenzbasis:

- . . .

Baseline-reference¹⁾

of annual effective ambient UV exposures $H_{\text{eff/ref}}(\mathbf{a})$

to assess the magnitude of long-term effects of individual exposures by solar and/or additional artificial UV radiation

- (a) = cumulative annual UV exposure of workdays (w) + leisure time days (l) + holidays (h)
- (a_w) = workday share (w) of the annual UV exposure

	Baseline-reference of annual UV-exposure $H_{\text{eff/ref}}$ in J/m ² /a (chest position)		
	$H_{\text{er/ref}}$ (in SED/a)	$H_{\text{ICNIRP/ref}}$	$H_{\text{NMSC/ref}}$
$H_{\text{eff/ref}}(\mathbf{a})$	7.000 (70)	1.800	16.000
$H_{\text{eff/ref}}(\mathbf{a}_w)$	2.000 (20)	500	4.200

¹⁾ applicable for Central Europe and at least the latitude range 45°...55° N

Baseline-reference

Seasonal depending values of daily effective UV exposures $H_{\text{eff/ref}}(\text{d})$ to assess the magnitude of short term individual exposures by solar and/or additional artificial UV radiation.

- for workdays: $H_{\text{eff/ref}}(\text{w}_{60^\circ}) \dots H_{\text{eff/ref}}(\text{w}_{15^\circ})$

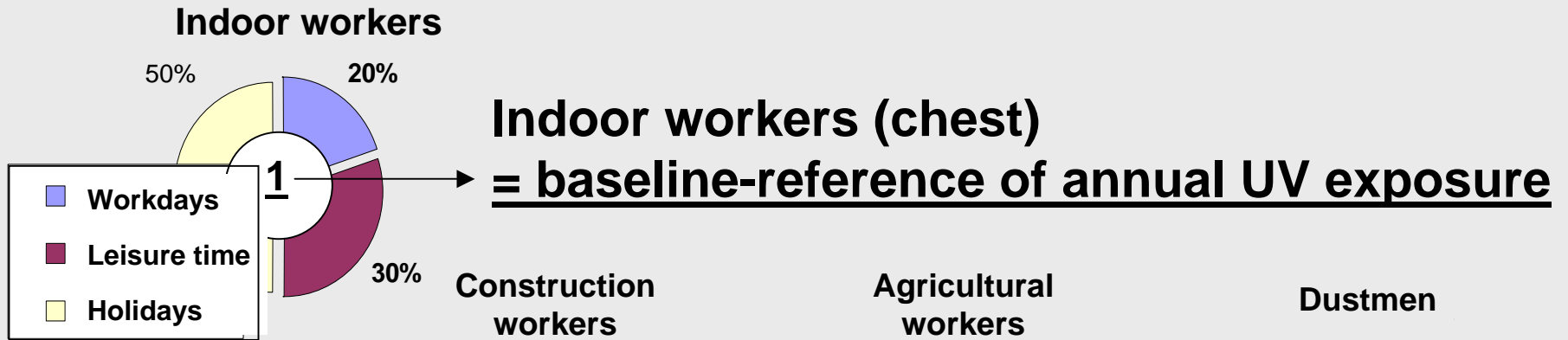
- for leisure time/weekend days: $H_{\text{eff/ref}}(\text{l}_{60^\circ}) \dots H_{\text{eff/ref}}(\text{l}_{15^\circ})$

Noon solar elevation γ_s (= time of the year, in latitude: 45°...55°N)	Baseline-reference of daily UV-exposure $H_{\text{eff/ref}}(\text{d})$ per day in J/m ² /d (chest position)					
	workdays			leisure time/weekend days		
	$H_{\text{er/ref}}$ (in SED/d)	$H_{\text{ICNIRP/ref}}$	$H_{\text{NMSC/ref}}$	$H_{\text{er/ref}}$ (in SED/d)	$H_{\text{ICNIRP/ref}}$	$H_{\text{NMSC/ref}}$
60° (May-Aug)	35 (0.35)	10	75	100 (1.00)	25	225
42° (Apr; Sep)	10 (0.10)	2.5	25	45 (0.45)	10	100
30° (Feb/Mar; Oct)	5 (0.05)	1.0	10	10 (0.10)	2.0	20
15° (Dec...Jan)	2 (0.02)	0.45	3.5	2.5 (0.025)	0.55	4.5

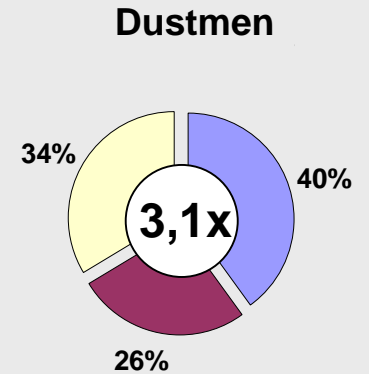
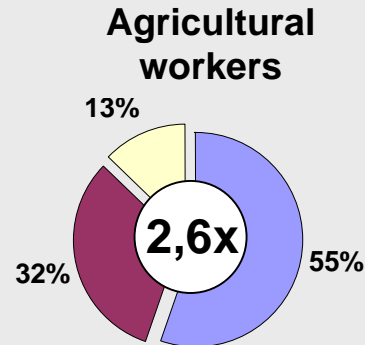
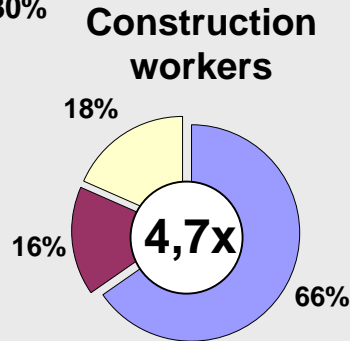
The intention of the *baseline-reference* is to *apply* it for:

- Risk assessment of *solar-exposed work places*.
- Assessment of the *additional fraction* of solar *UV exposure* caused by the individual *leisure time and holiday* behaviour.
- Assessment of the *additional UV exposure* and possible risk by the use of *sunbeds*.
- *Benefit-risk-estimation* in the *dermatological UV phototherapy* of chronic diseases.
- To assess the baseline-reference UV exposure level with respect to the minimal exposure parameters of a sufficient UV-induced Vitamin D synthesis

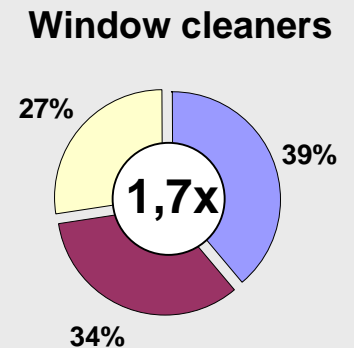
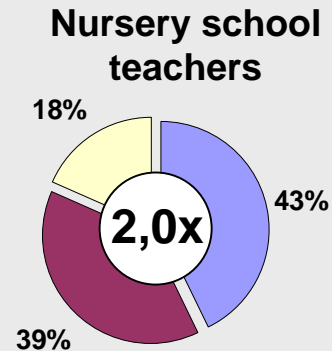
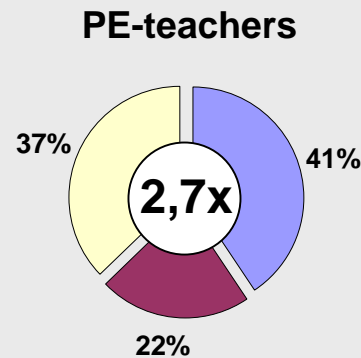
Workday, leisure time and holiday fractions of annual UV exposures



Occupation outdoors:

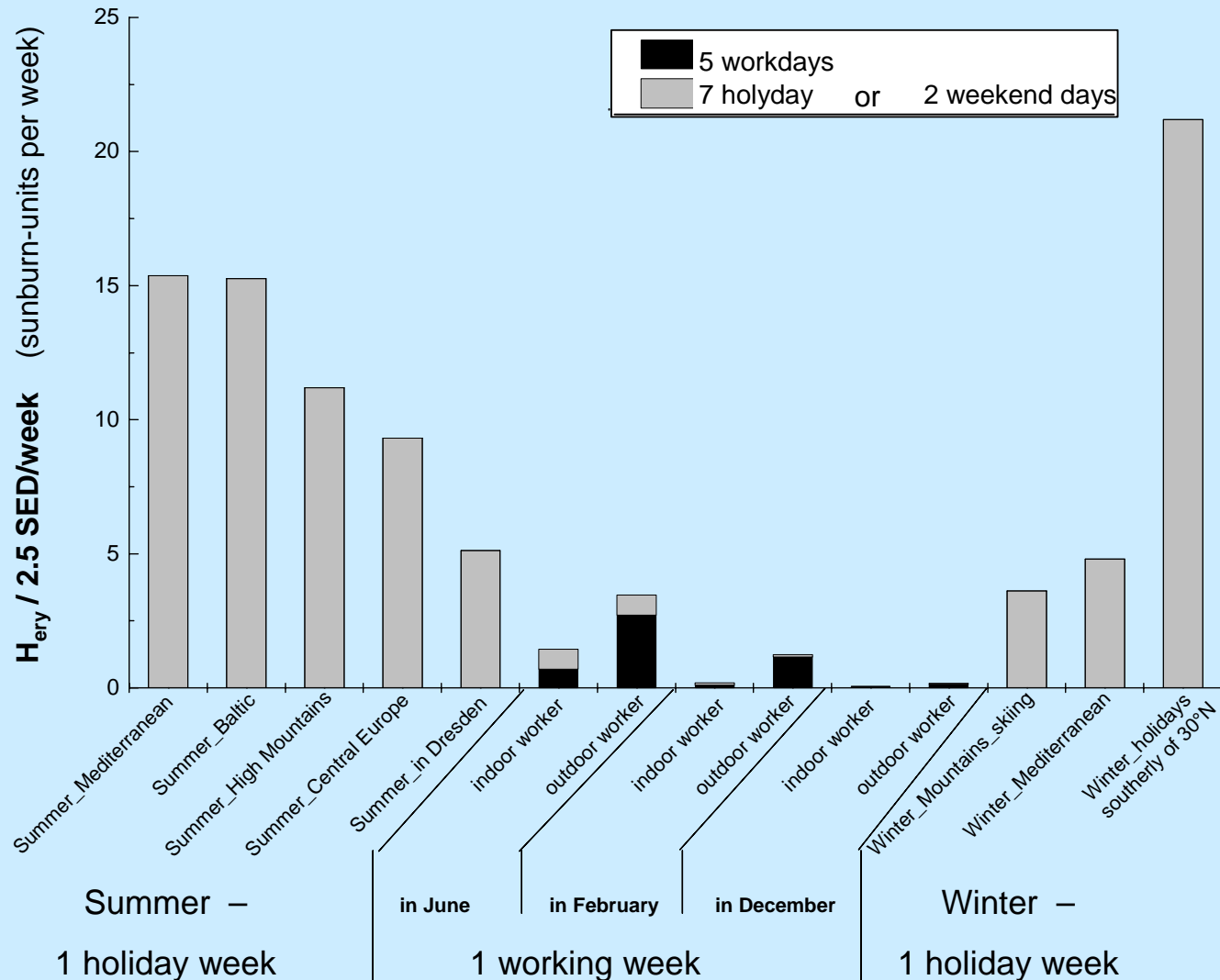


Occupation intermittent outdoors:



Holiday UV exposures and seasonal Baseline-Reference

7 holidays vs. 5 workday + 2 leisure time days (of the baseline-reference)



Knuschke P, Kurpiers M, Koch R, Kuhlisch W, Witte K. (2004) Mean individual UV-exposures in the population. Final Report on BMBF-project 07UVB54C/3, TIB Hannover F05B898

Minimal UV exposure for vitamin D photosynthesis and mean personal UV dose

- Minimal UV exposure (to realize 25OHD₃: >20 ng/ml, age: >80 a)

2x 30% MED (skin type related) per week on face, arms and hands

(Knuschke P et al.: Restoration of normal vitamin D-serum levels in elderly people by a long-term low dosage UV-phototherapy. Photodermatol Photoimmunol Photomed 12 (1996) 251)

- Ratio of mean personal UV doses in the population and minimal UV exposure:

Indoor person	= Baseline-Reference			
Skin type:	I	II	III	IV
Feb/Mar	0.4	0.3	0.2	0.2
May/Jun	3.6	2.9	2.1	1.6
Sep	1.1	0.9	0.6	0.5
Dec	0.1	0.1	0.1	0.1
Outdoor worker	= Baseline-Reference			
Skin type:	I	II	III	IV
Feb/Mar	1.0	0.8	0.6	0.4
May/Jun	5.8	4.7	3.3	2.6
Sep	2.5	2.0	1.5	1.1
Dec	0.3	0.2	0.2	0.1

© Knuschke 2004

(Knuschke P et al. Mean individual UV-exposures in the population.

Final Report on BMBF-project 07UVB54C/3, (2004) TIB Hannover F05B898)

Conclusion:

**Proposed baseline-reference
can serve as scientific base for:**

- Health prevention regulations of outdoor workplaces
- Public health prevention
- Risk estimation of sunbed use
- UV photodiagnosics/ -therapy

On behalf of the co-workers of the research projects

Dept. of Dermatology / TU Dresden:

- *Dipl.-Chem. Ines Unverricht*
- *Dipl.-Phys. Mathias Kurpiers*
- *Dipl.-Chem. Katrin Witte*
- *Dr. rer. nat. Andreas Krins*
- *Dr. rer. nat. Wiltrud Kuhlisch*
- *and many student research assistants*

BAuA Dortmund:

- *Dipl.-Ing. Günter Ott*
- *Dipl.-Ing. Marco Janßen*





*Thank you
for
your attention!*

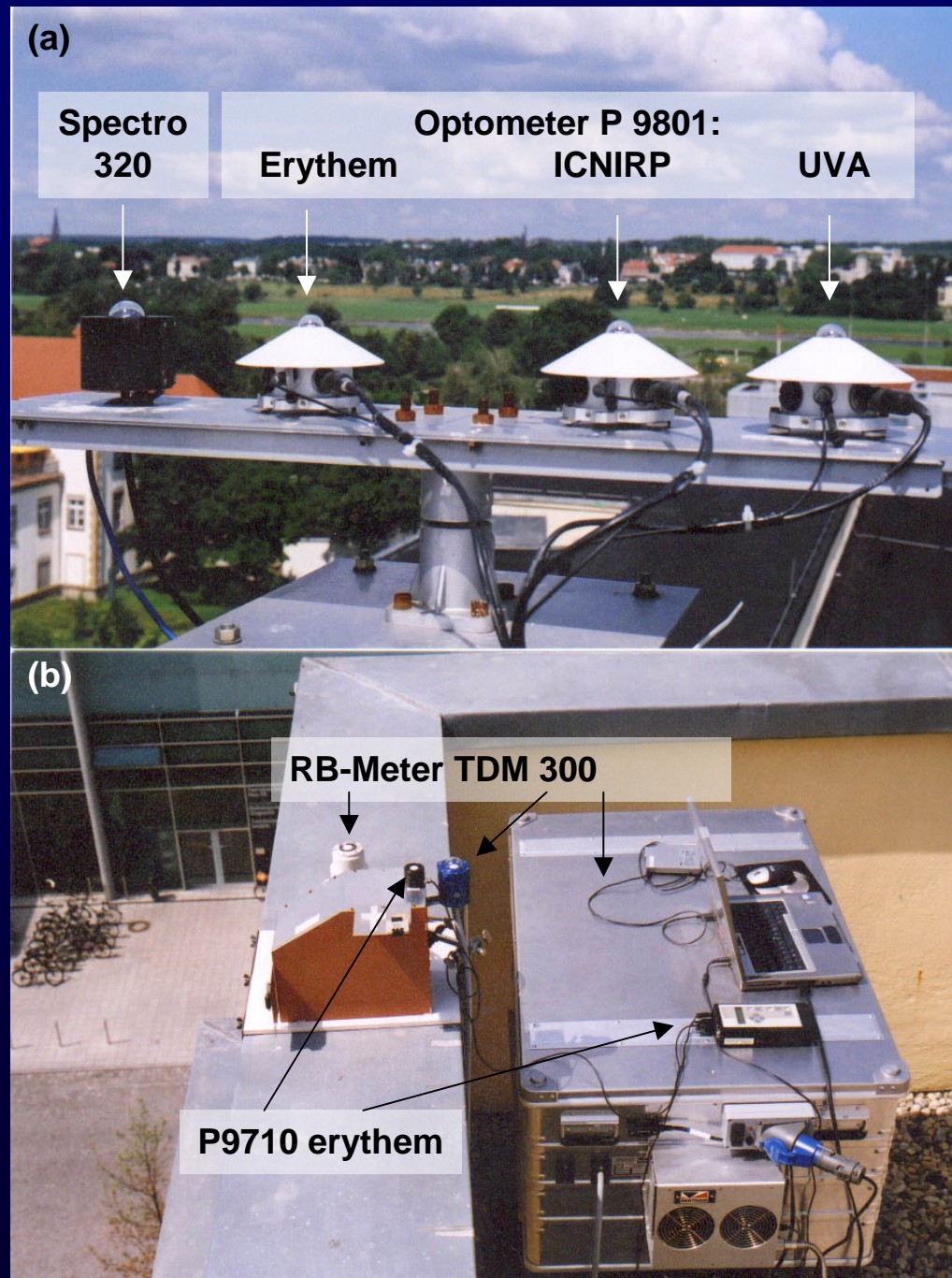
*Dresden
100 % protected
from UV radiation*

Präzisionsmesstechnik zur Interkalibrierung von aktinischen UV-Personendosimetern

- Spektralradiometer
- aktinische Breitbandradiometer

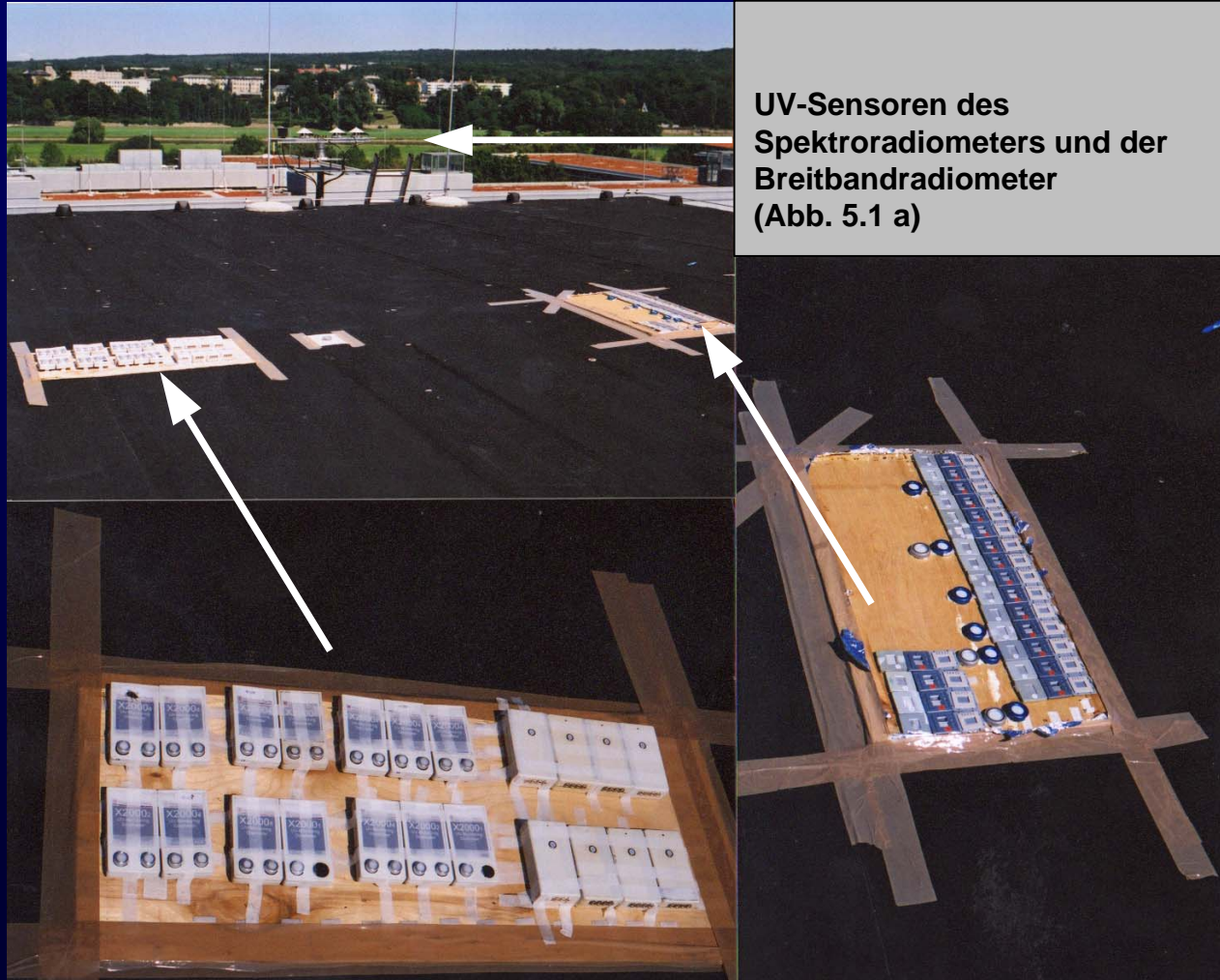
UV-Messstation der Dermatologie / TU Dresden und Messtechnik der BAuA Dortmund

BAuA-Forschungsprojekt F1777 „Personenbezogene Messung der UV-Exposition von Arbeitnehmern im Freien“



Interkalibrierung aktinischer UV-Personendosimeter an Doppelmonochromator-Spektroradiometer und aktinischen Breitbandradiometern

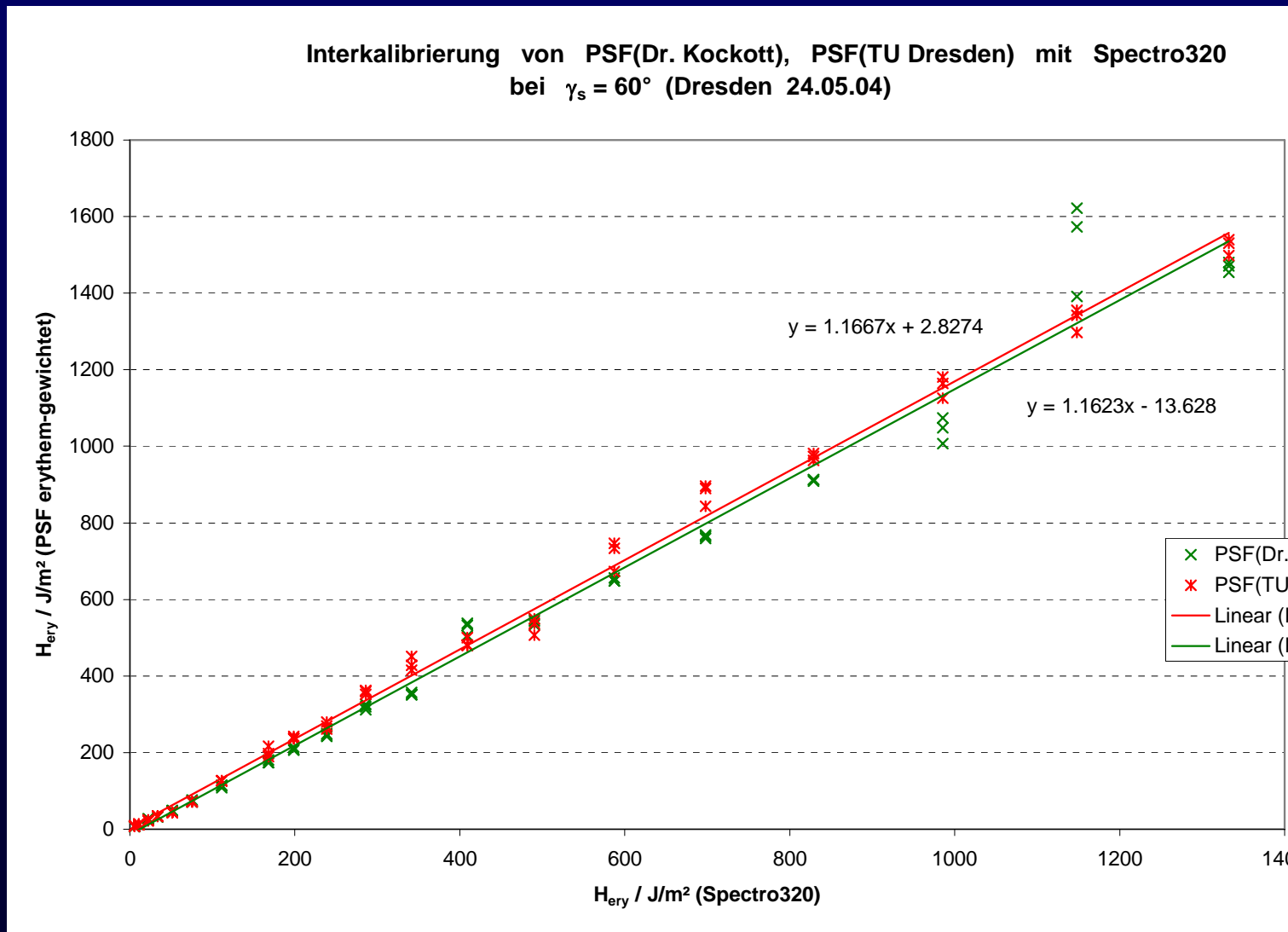
(Interkalibrierungen bei Mittagssonnenhöhen $\gamma_s = 60^\circ, 42^\circ, 30^\circ, 15^\circ$)



BAuA-Forschungsprojekt F1777

PSF – einfacher aber präziser UV-Sensor zur aktinischen Dosimetrie

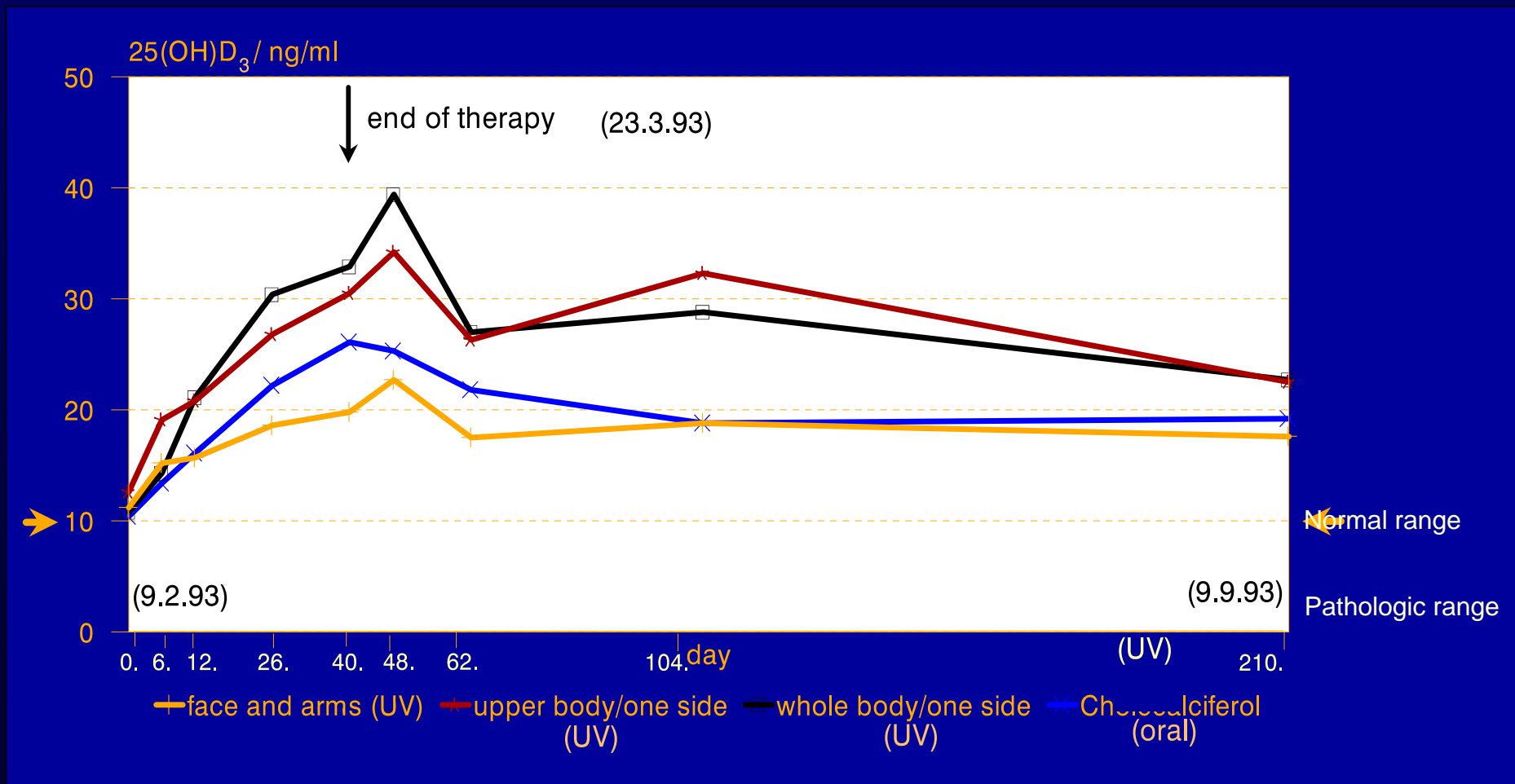
durch Methode zur photobiologisch-gewichteten Auswertung



Personal UV Monitoring

- Measurement periods
 - A: 16 days in each season of the year (γ_s : 30°, 60°, 42°, 15°)
 - B: 52 weeks of the year (daily)
- Personal UV dosimetry:
(separate for)
 - workdays
 - leisure time (weekend days)
 - holiday time
 - body distribution of UV exposure (exemplary)
- Documentation of UV exposure-relevant personal data:
 - UV skin type-relevant data
 - volunteer diaries on outdoor behaviour:
 - time spent outside,
 - status of clothing, SPF when used sunscreen,
 - hobbies, travel to workplace
- Measurement of the **global influences** to the individual UV exposure level*)
 - biological effective global UV radiation (erythemal, ICNIRP, UVA)
 - meteorological data (provided by DWD/German Meteor. Service)

Increase of serum-25(OH)D₃ in residents of a nursing home after UV-therapy (Philips TL01, 0.3 MED) or Cholecalciferol (oral)



Short-term study: Serum 25(OH)D₃ in winter after 4x indoor tanning in 2 weeks vs. untreated control (Group E)

