

# UV exposure- basics of measuring and data collection



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# Physics of measuring



















- 1 ) physical units ( W, J / m<sup>2</sup> )
- 2 ) evaluate using the erythemal response of human skin to obtain biologically effective UV radiation, expressed as:
  - MED
  - SED
  - UV index

- **MED** – minimal erythemal dose
- **SED** – standard erythemal dose  
(equivalent 100 J/m<sup>2</sup>)
- **UV index** - easily understandable  
measure of biologically active UV  
radiation (0-10 )

The UV radiation dose expressed in SED needed to cause burns in different skin types (Retrieved from: Macgabutlane and Wright, South African Journal of Science, 111: 1-7) (25).

### Fitzpatrick skin type

The UV radiation dose expressed in **SED** needed to cause burns in different

skin types 1 / 2-3 SED	I	 Blue / Green / Grey		Blonde		White / Pale / Freckled Extremely fair skin, always burns, never tans
2 / 2,5-3 SED	II	 Blue		Blonde / Red		White / Pale with beige tint Fair skin, usually burns sometimes tans
3 / 3-5 SED	III	 Brown		Light Brown		White to light brown white olive skin, sometimes burns, tans mostly uniformly
4 / 4,5-6 SED	IV	 Brown		Medium Brown		Light to moderate brown Rarely burns, always tans
5 / 6-20 SED	V	 Brown		Dark Brown		Medium to dark brown Rarely burns, tans more than average
6 / 6-20 SED	VI	 Brown		Black		Dark brown to black Never burns

# Personal UV dosimeter

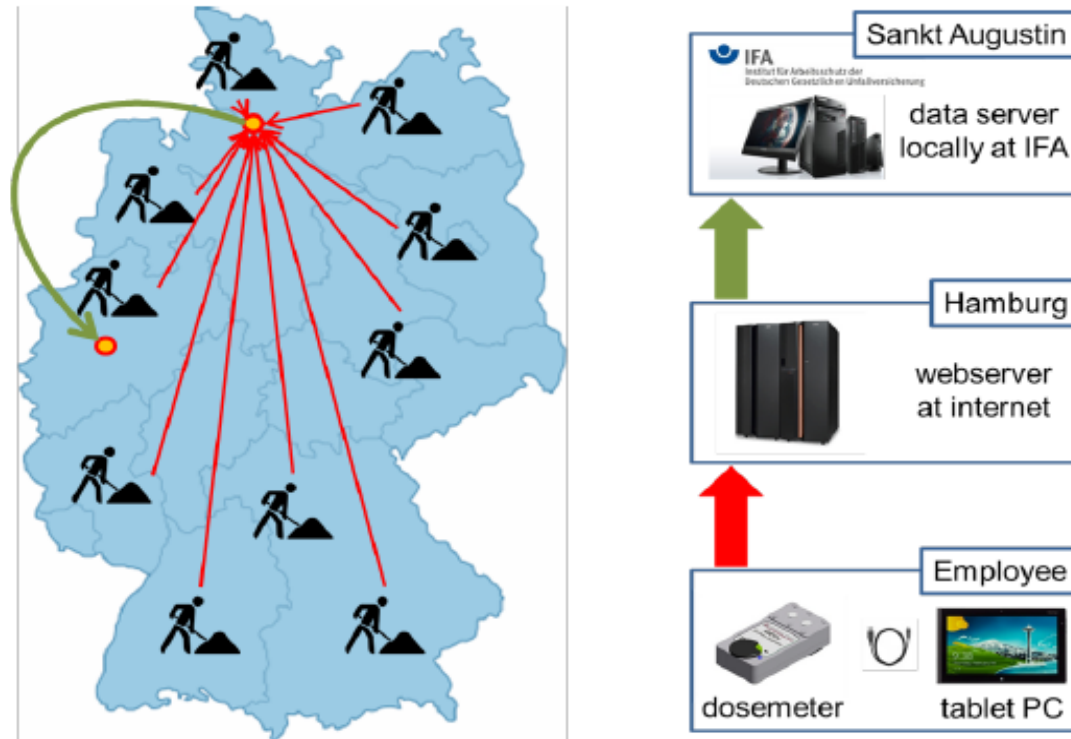
- Personal UV Dosimeters have been developed to support research related to exposure to UV radiation
- Electronic dosimeters are an optimal instrumentality of measuring personal exposure to UV radiation





- **Projects funded by the German Social Accident Insurance (DGUV)**
- Skin tumors induced by natural UV radiation
- Development and evaluation of criteria to distinguish between occupational and non-occupational causation

## How does GENESIS-UV work?

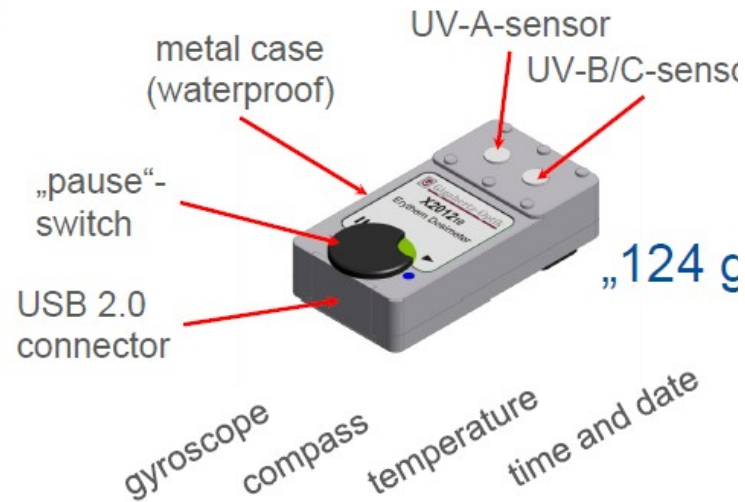


(retrived from : <https://www.dguv.de/ifa/fachinfos/strahlung/genesis-uv/index-2.jsp>)

## Technical aspects

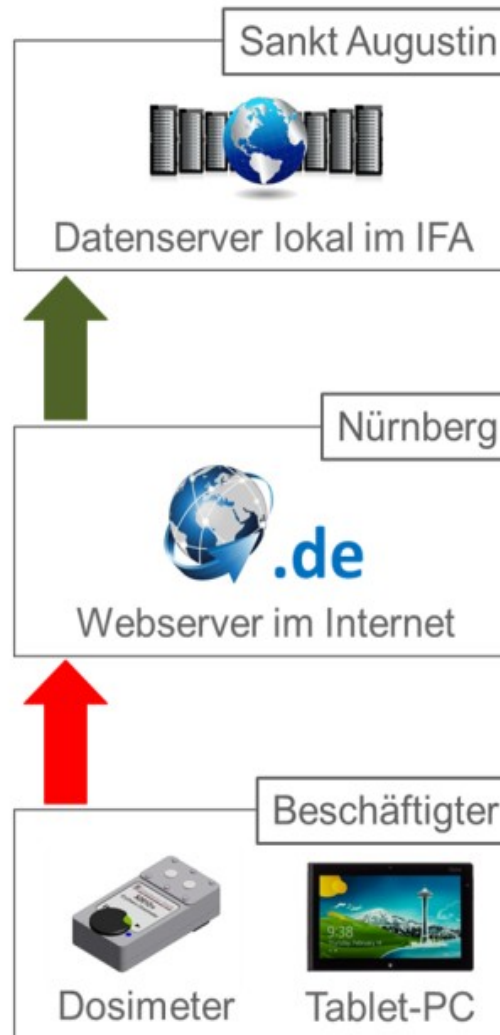


### The „GENESIS-case“



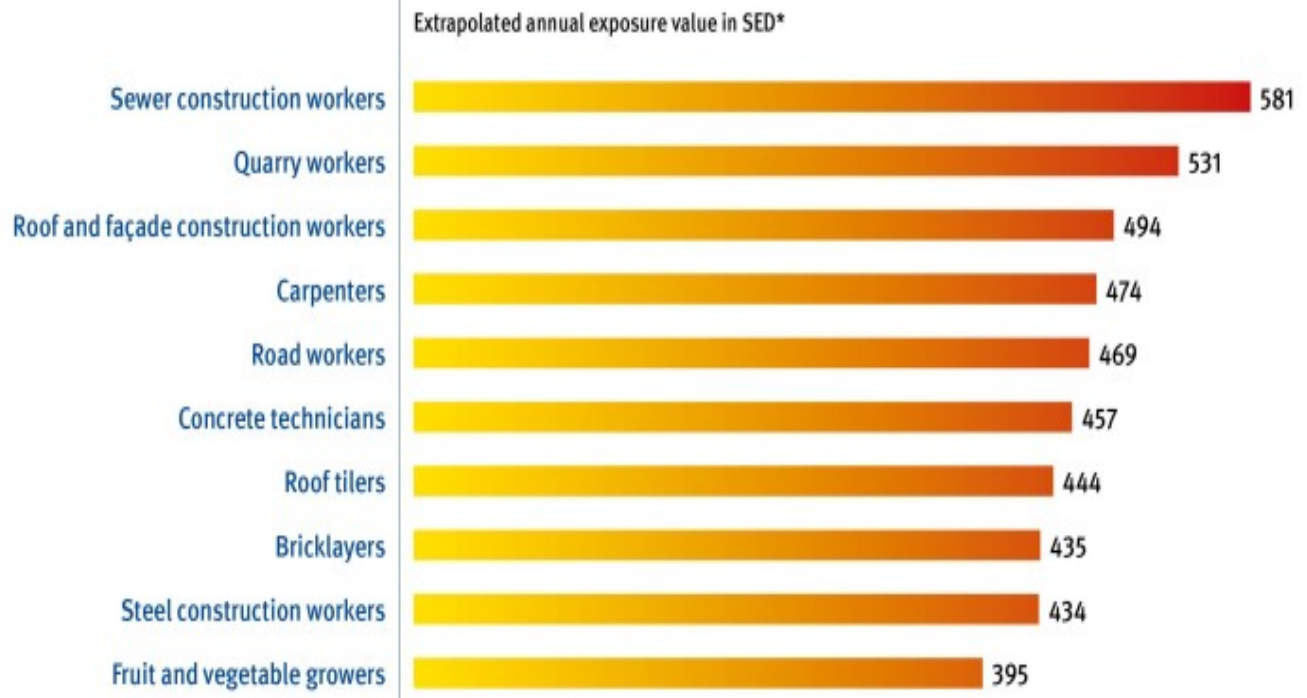
(retrived from : <https://www.dguv.de/ifa/fachinfos/strahlung/genesis-uv/index-2.jsp>)





## Occupations with the highest exposure

## UV radiation exposure



\* Standard erythema dose: 1 SED is sufficient to cause sunburn on skin type 1 (pale skin, reddish hair)

Source: [www.dguv.de](http://www.dguv.de)

**Estimated average annual unprofessional exposure is 130 SED**

**Table 1** Estimated number of years of full outdoor work which are needed to fulfill the criteria of an additional 40 % occupational UV-exposure (Basic assumption: private individual UV-exposure 130 SED/year and additional occupational UV-exposure 170 SED/year).

Age (Years)	50	60	70	80
Cumulative non-occupational lifelong UV exposition (SED)	6 500	7 800	9 100	10 400
Additional occupational exposition of 40 % (SED)	2 600	3 100	3 640	4 160
No. of full years worked outdoors to assume an occupational etiology	15	18	21	24

## **The risk of skin tumors (actinic keratosis, squamous cell carcinoma cell) x 2**

Retrived from : Diepgen TL, Brandenburg S, Aberer W, Bauer A, Drexler H, Fartasch M, John SM, Krohn S, Palfner S, Römer W, Schuhmacher-Stock U, Elsner P. Skin cancer induced by natural UV-radiation as an occupational disease – Requirements for its notification and recognition. JDDG: Journal der Deutschen Dermatologischen Gesellschaft 2014;12:1102–1106

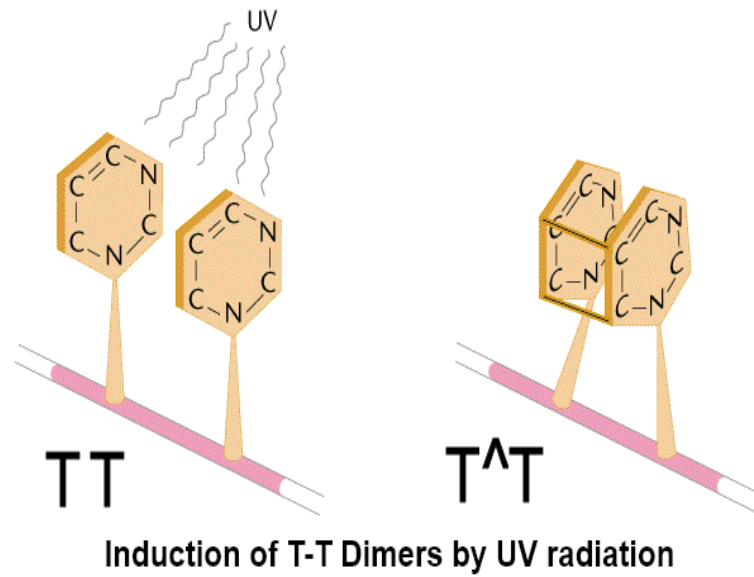
# Biomonitoring of UV exposure

- measurement of the **body burden** of toxic chemical compounds, elements, or their metabolites, in biological substances
- UCA – urocanic acid
- Thymine dimers

### Thymine dimers

Thymine dimers are detectable in urine and may be potentially valuable biomarkers of exposure to UV radiation

picture retrieved from : [https://www.mun.ca/biology/scarr/Thymine-Thymine\\_Dimers.html](https://www.mun.ca/biology/scarr/Thymine-Thymine_Dimers.html)



**Thymidine Dimers** are produced when adjacent thymidine residues are covalently linked by exposure to Ultraviolet radiation. Covalent linkage may result in the dimer being replicated as a single base, which results in a **frameshift mutation**..

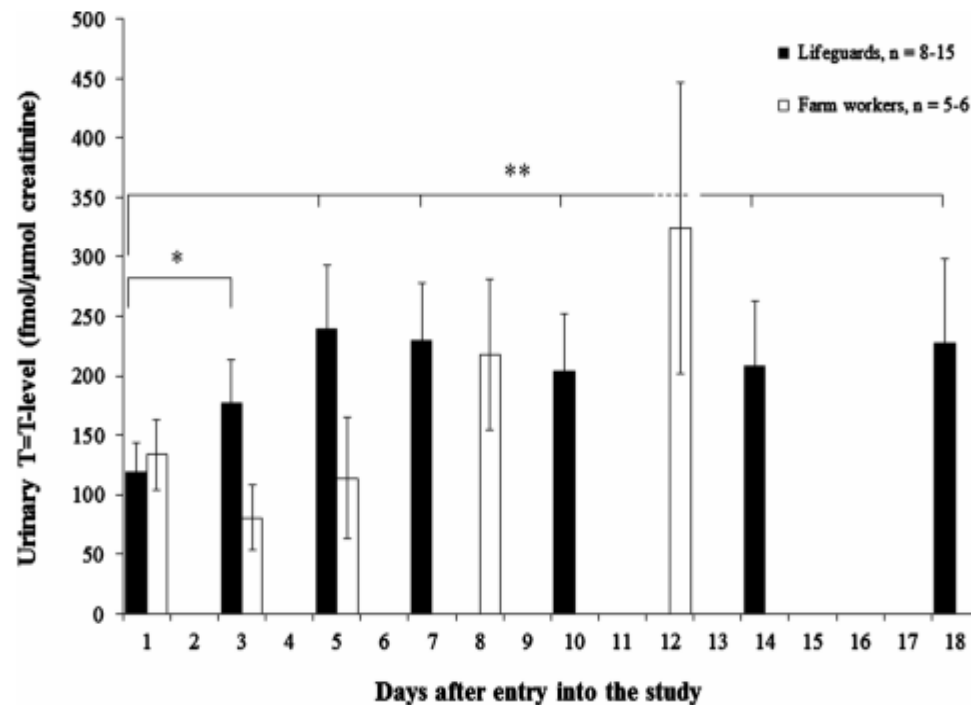
**Study** : relationship between exposure to UV radiation and the level of thymine dimer in the urine of outdoor workers

Personal exposure to UV radiation at 52 rescuers on the beach and agricultural workers.

The average dose of UV radiation was approximately 600 J / m<sup>2</sup>.



The thymine dimer level correlated with the dose of UV radiation, increasing by about 6 fmol / μmol of creatinine for every 100 J / m<sup>2</sup> increase of the UV radiation dose

(retrived from : Liljendahl, Tove Sandberg et al. "Urinary levels of thymine dimer as a biomarker of exposure to ultraviolet radiation in humans during outdoor activities in the summer." *Mutagenesis* 28 3 (2013): 249-56.)



**Fig. 2.** Mean urinary levels of thymine dimer (T=T) at different time points after entry into the study. Day 1 is the day of entry (regardless of date) and each bar represents the mean value for 5–15 subjects (with the standard deviation indicated). For the lifeguards, the level of T=T on all subsequent days was significantly higher than that of day 1 ( $P = 0.012, 0.002, 0.005, 0.002$  and  $0.004$ , respectively; Wilcoxon matched pairs test).

# Urocanic acid

- trans-urocanic acid is formed by the enzymatic deamination of histidine (in filaggrin in skin)
- physiological role is the protection from UV radiation (sunscreen)
- found in epidermis and sweat
- **Trans** (UV absorption)  **Cis** (UV protection)  
 (higher energy, immunoregulatory role in the skin - cis form is known to activate regulatory T cells)
- reduction of trans-urocanic acid levels in epidermis after irradiation of healthy volunteers with erythemal UVB radiation (MED)



**Thank for your attention !**  
**Any further questions please?**