UV NEWS

The official newsletter of the Thematic Network for Ultraviolet Measurements

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Contents

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UVNEWS is the official newsletter of the Thematic Network for Ultraviolet Measurements. The Network was earlier funded by the Standards, Measurements and Testing programme of the Commission of the European Communities, as project number SMT4-CT97-7510. *UVNEWS* is published at irregular intervals. It is aimed to exchange knowledge between the participants of the Network and to disseminate information on the forthcoming and past activities of the Network. The newsletter also contains scientific and technical articles on UV measurements and a news-section about activities in the field of UV measurements. The newsletter welcomes all announcements and articles that might be of importance for the readers. Material to be published in *UVNEWS* should be sent to:

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In case of longer articles or announcements, use of E-mail is preferred. The date of the next possible issue is not known. It will most likely be published with the 7th workshop around 2007 – 2008.

Photographs: Cover: Participants of the 6th Workshop, Page 3: Poster session (Picture taken by L. Ylianttila, STUK), Scenery of Davos, (Picture taken by François Christiaens, L´Oréal).

The Sixth Workshop in Davos, Switzerland
October 20 - 21, 2005

Petri Kärhä
Helsinki University of Technology, Finland

The sixth workshop of the Thematic Network for Ultraviolet Measurements was arranged in Davos, Switzerland, on October 20 - 21, 2006. The meeting was hosted by the Physicalisch-Meteorologisches Observatorium Davos (PMOD/WRC). The number of participants in the workshop was approximately 110, which is an all-time record. This was mainly because the workshop was arranged in combination with a bigger event, NEWRAD 2005. Due to the high attendance, it should be considered that the workshop could also in future be arranged in connection with some other event.

The workshop contained 5 oral sessions:

- Uncertainty and intercomparison issues (3 talks)
- UV measurements techniques: Spectroradiometers (2 talks)
- UV measuremements techniques: Detectors and sources (4 talks)
- UV measurements related with Healthcare and Health & safety (4 talks)
- UV material effects, testing and sterilisation (4 talks)

In addition, 18 posters were presented. The authors were given a chance to submit extended abstracts on their presentations, which can be found in the following section. Davos is one of the first places where solar UV was measured. During the excursion we had a chance to see some of the earliest equipment used. These early measurements are reviewed in an extra article kindly provided by Ulf Wester starting on page 4.

Between the scientific presentations, also the continuation of the Network was discussed. Continuation of the meetings was considered important, so the next workshop, already seventh in series, should be organised around 2008. The place is still unclear, but should be in Europe. Places suggested and favoured by participants included e.g. Norway, Scotland, Poland and Czech. Nevertheless, arrangement needs a volunteer local organiser. We should also bear in mind, that arrangement in combination with some other event, might bring broader attendance. This event might be on solar UV measurements, radiometry in general, photonics, medicine, health care, pharmacology, biotechnology, weathering and climate, because the spread of interests and research areas of participants is rather wide. The steering group of the network welcomes all useful ideas and volunteers.

Davos was a wonderful venue for the workshop, not only because of the nice scenery and climate, but mainly because of the efficient arrangements. Everything worked as a Swiss clock. On behalf of us participants, I would like to take this opportunity and thank again all organisers, especially Julian Gröbner and Werner Schmutz of PMOD/WRC. Those willing to visit Davos again might note that PMOD/VRC is celebrating its 100 years of solar observations by arranging a conference dedicated to solar UV measurements on Sepember 18 – 20, 2007.

Solar UV-research on great grandpa´s time

U. Wester
Swedish Radiation Protection Authority (SSI)

> "*Ultraviolet radiation has of late attracted a great deal of attention not only by reason of the photochemical processes, so important from a physiological point of view, which these rays are able to produce, but also on account of the prospects of closer investigations into the amount of the ozone of the atmosphere, which the study of ultra-violet radiation opens out.*"

The quoted statement above stems from a report of UV-measurements 1926-27 (Aurén 1929), but is still valid in 2005. Observations of ultraviolet irradiance in the sunlight and with the object of investigating the amount of ozone in the atmosphere, had been made at a number of sites particularly at high altitude health resorts in Switzerland. It was known how the intensity of radiation increased with altitude, that it varied at places of equal altitude due to differences in atmospheric transmission, that diffuse radiation from the sky at lower solar altitudes (< 45º) is stronger than the direct UV-radiation which increases with solar altitude. It was also known that an overclouded sky may be of great intensity (Dorno, Götz, and others).

Appropriate instruments were available commercially. Photoelectric cells with a cadmium or a potassium cathode were charged to a reference voltage. The discharge current and time was measured with an electrometer as the cell was exposed to solar UV-radiation through, a for the cell and spectral range chosen, optical filter.

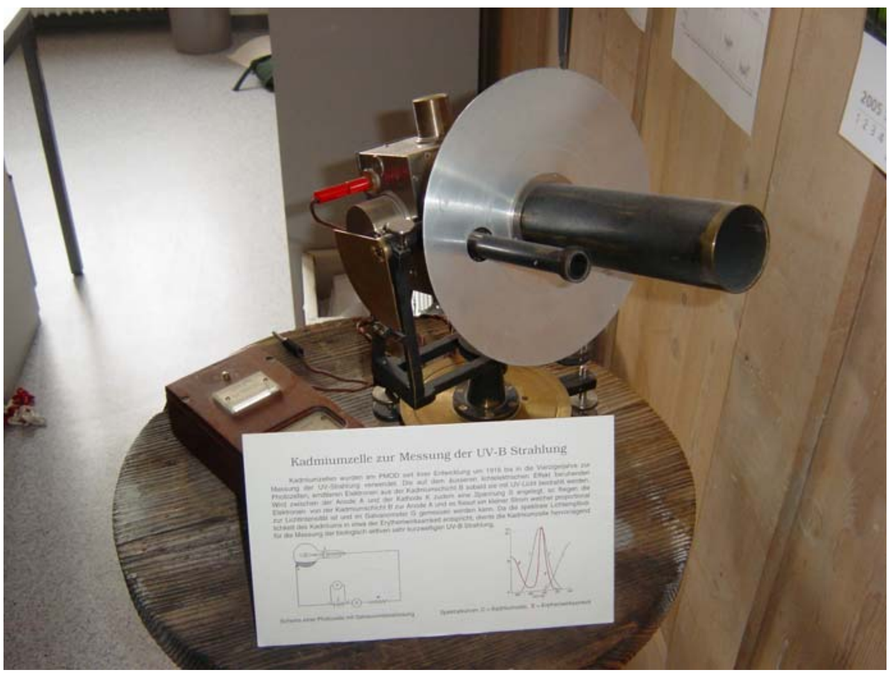

Figure 1. This UVB-measuring sun photometer, presently a museum object in PMOD/WRC at Davos, may be the normal cell used in the 1920´ies at the solar research center of Davos for intercomparisons with other similar UV-measuring instruments and for normalising their results into units of the "Davos-scale." (Photo: Lasse Yliantilla, STUK).

Solar UV-measurements were made at a number of places also outside Switzerland, even at Aswan in Egypt and at Bandung in Indonesia. In Sweden T.E. Aurén, a scientist funded by the Swedish Anthropological and Geographical Society, made measurements of both direct and diffuse solar UV-radiation with Cd-cells at five places, Abisko being the northernmost, during the summers of 1926 and 1927 "to ascertain in how far radiation depends on the geographical position of the place under observation". In Finland extensive measurements were made which also were well documented (Lunelund 1944; Lunelund et al 1929). On one occasion the UV-variation was studied during a solar eclipse.

Auréns solar UV-measurements in the 1920´s were made with electrometers and two filtered cadmium cell photometers (Manuf. Gunther & Tegetmeyer) with a spectral sensitivity ranging from approximately 244 to 366 nm, and a maximum around 313 nm. Aurén noted that in sunlight there is "hardly any radiation of a shorter wavelength than 291 nm" and that due to the comparatively small longwave UV-sensitivity of Cd-cells "the radiation observed with the cell generally corresponds to the province that is interesting from a biological point of view, which extends from 320 nm to the (short-) end of the spectrum".

During the 1920´s cadmium cells employed in research into ultraviolet radiation were compared with a so called normal cell kept at the solar research centre at Davos in Switzerland. A Cd-cell photometer still exists as a museum object in the building of the World Radiation Center (PMOD/WRC) at Davos (Figure 1).

Table 1. Solar UV-irradiance mean values July-August in Davos-units (from Aurén).

Site	Latitude	Altitude	Year	Solar elevation		
	°N	(m. a.s.l)		25°	35°	45°
Muottas-Muraigl	46.5	2456	1923	102	216	341
Davos	46.8	1560	1916-18	66	136	223
Agra	46	565	1923	45	96	151
Stockholm	59.4	55	1926-27	30	85	141
Abisko	68.4	375	1926-27	39	93	169

After an intercomparison in 1927, repeated in 1929 to confirm an unchanged sensitivity of his cells, Aurén was able to compare his solar UV-measurement results with others expressed in units of the "Davos-scale" (Table 1).

During the 1990´s an increasing skin cancer incidence has been in the focus for preventive measures and of considerable media- and some public attention and has been attributed to depletion of the ozone layer, charter holidays at southern latitudes, longer vacations, more time spent outdoor, misguided beauty concepts promoting extensive habits of tanning and widespread use of sunbeds. This has resulted in UV-measurements with modern instruments. An internationally agreed UV-index has worldwide become a means to estimate erythemally harmful solar UV effects on the skin. Unfortunately it is presently not possible to compare data from old UV-measurements in the Davos-scale made early in the 20th century with modern measurements of the UV-index made in the beginning of the 21st century.

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Realization of a new commercial radiometer for measurement of the total UV effective irradiance of sunbeds

M.G. Pelizzo[1,2], P. Ceccherini[3], D. Garoli[1,2], P. Nicolosi[1,2], P. Masut[3], and D. Grove[4]

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4. LUXEL Corp., WA 98250 USA

Long exposition to sun radiation causes burns, skin aging, erythema and even melanoma cancer [1]. In the European regulation EN60335-2-27 [2] the toxicity of UV radiation emitting machines for domestic use is discussed and upper-limit exposition effective dose are established. As well as other artificial sources, sun tanning units should be monitored and certified according with the law. There is the necessity to develop a clear measurement procedure to verify sunbed irradiance in metrological laboratories, and to develop portable instrumentation for the irradiance verification in situ. In order to measure the total effective irradiance of sunbeds and sun lamps a new radiometer with a spectral response curve equivalent to the CIE Erythemal Action Curve (EAC) [3] (Fig.1) has been designed and realized. An action spectrum describes the relative effectiveness of UV radiation at a particular wavelength in producing a particular biological response; the EAC was defined by McKinlay and Diffey (1987) and has been accepted by the Commission Internationale de l'Eclairage (CIE) as the standard representation of the average skin response to UVB and UVA. The radiometer developed measures the total effective irradiance (Weff/m2) by integrating the irradiance weighted by the EAC over the whole UVA-UVB range. The sensor is hand portable, user friendly and competitive on the market. A request for an Italian patent has been deposited by Istituto Nazionale per la Fisica della Materia (INFM), Italy [4].

The system consists of a transmission diffuser, an interferential filter and a photodiode detector (Fig.2).

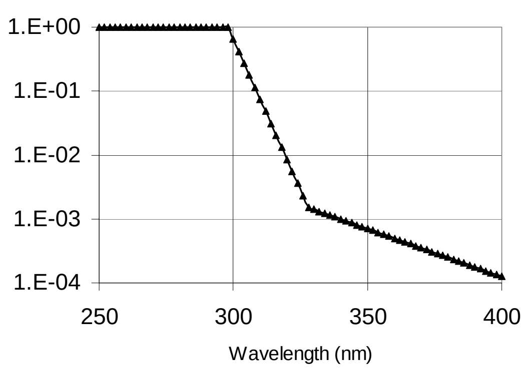

Figure 1. The CIE Erythemal Action Curve (EAC).

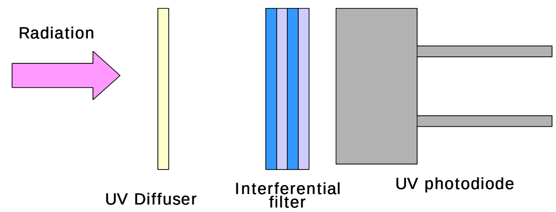

Figure 2. Radiometer optical scheme.

The diffuser can be either a teflon film or a quartz glass, being the first more indicated for its diffusion properties. In order to select the most appropriate detector, many different commercial photodiodes have been considered [1]. They are all blind in the visibile and IR. The one that have been purchased are:

- SiC photiodiodes, nominal area 0.22 mm^2 (6)
- p-i-n GaN photiodiodes, nominal area 0.5 mm^2 (2)
- Different AlGaN Schottky phodiodes, nominal area 0.5 mm^2:
- Peak response at 250 nm (2)
- Peak response at 300 nm (2)
- Peak response at 300 nm + Visible filter (2)

Both relative and absolute response (Fig.3) have been measured.

The following are some outcomes of the measurements:

- AlGaN and GaN seems to have a low sensibility with respect to SiC, therefore to measure the same irradiance value larger active areas are necessary, fact that implies an increase of the costs.
- GaN seems to be not so sensitive above 360 nm, so they are suitable to cover the whole 250-400 nm range.
- AlGaN with 300 nm cutoff are usually sold for the matching between their spectral response and the erythemal action curve. From our measurements it appears that there is still a difference between EAC and AlGaN spectral response.
- All 6 SiC photodiode have a very similar absolute spectral responses over the whole spectral range of interest

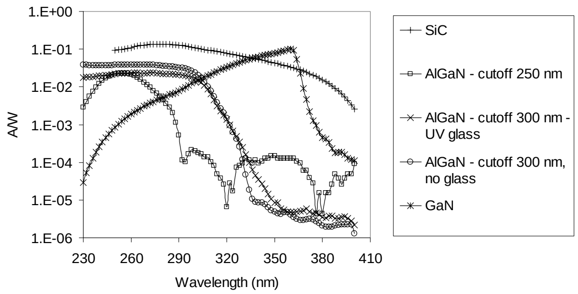

Figure 3. Absolute spectral response curve of different photodiodes.

SiC have been selected also for the higher efficiency, high shunt resistance and stability over time. In order to match the CIE EAC curve an innovative interferential filter has been designed. The filter transmission curve is optimized in such a way that its product with the photodiode spectral response curve and the diffuser transmission curve matches the EAC according with the following:

$$\frac{\text{CIE Curve}(\lambda)}{R_{ph}(\lambda) * R_{diff}(\lambda)} = R_{filter}(\lambda) \quad (1)$$

where the CIE Curve (λ) is the Erythemal Action Curve of Fig.1, $R_{ph}(\lambda)$ is the photodiode spectral response as recovered by our measurements, $R_{diff}(\lambda)$ is the diffuser transmission, $R_{filter}(\lambda)$ is the filter transmission. The theoretical response of the whole system has been evaluated and compared to EAC (Fig.4), showing a almost perfect match.

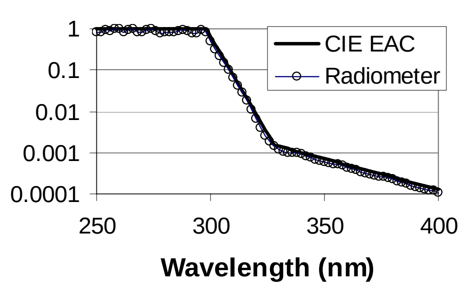

Figure 4. Radiometer theoretical spectral response (normalized) compared to the CIE Erythemal Action Curve.

Filter has been deposited by LUXEL Corp. and its optical properties have been verified as stable after thermal cycling. A first prototype of the radiometer has then been assembled (Fig.5). Spectral response of the prototype has been measured (Fig.6) showing very interesting results. Further improvement is expected after optimization of the filter deposition process. The new instrument concept can be used to develop an outdoor radiometer for ambient UV monitoring.

Figure 5. Radiometer prototype.

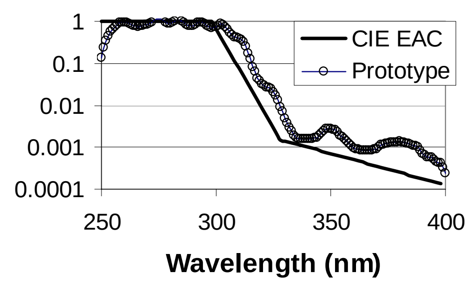

Figure 6. Radiometer measured spectral response (normalized) compared to the CIE Erythemal Action Curve.

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