



# Hannover NDACC Spectral UV intercomparison 2014

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## Blind intercomparison campaign of UV spectroradiometers

conducted in Hannover, Germany, in July 2014

**Aim:** to assess the ability of the participating research groups to perform long term spectral solar ultraviolet irradiance measurements.

4 groups:

- **German group** from the Leibniz Universität, Hannover (**DEH**) operating the mobile NDACC reference UV instrument
- **Austrian group** from the University of Natural Resources and Life Sciences, Vienna (**AUW**)
- **French group** from the Lille University of Sciences and Technologies (**FRL**)
- **Chilean group** from the Universidad de Santiago de Chile (**CHS**)

Austrian and French instruments are already affiliated to NDACC

Instrument characteristics: all double-monochromators, all Bentham

Instrument name	Type	Focal length mm	FWHM nm	Diffuser	Misalignment correction
DEH reference	DTM 300	300	0.54	Non-flat	ShicRIVM software
AUW	DM 150	150	0.68	Non-flat	ShicRIVM
FRL	DTM 300	300	0.49	Flat	Home-made software
CHS	DM 150	150	0.70	Non-flat	Home-made

All instruments are thermally regulated (not the diffusers)

3 measurement days: 5-6-7 July

Time synchronized spectral scans from 3 to 20 UTC (step 30 min)

Wavelength range: 280-400 nm – Step = 0.25 nm

Calibration: every day between 8 and 9 UTC, with each team field calibrator  
(CHS used the DEH field calibrator)

For the comparisons the **spectral data have been convoluted** with a triangular slit function of 1 nm FWHM

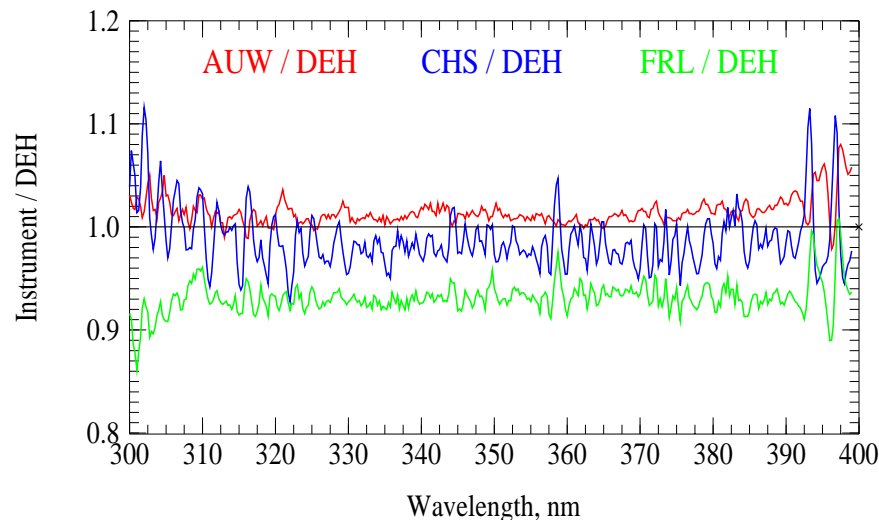
- via ShicRIVM for DEH and AUW data
- via a simple convolution tool for FRL and CHS

Data were submitted to the referee one day after measurement, before 12 UTC

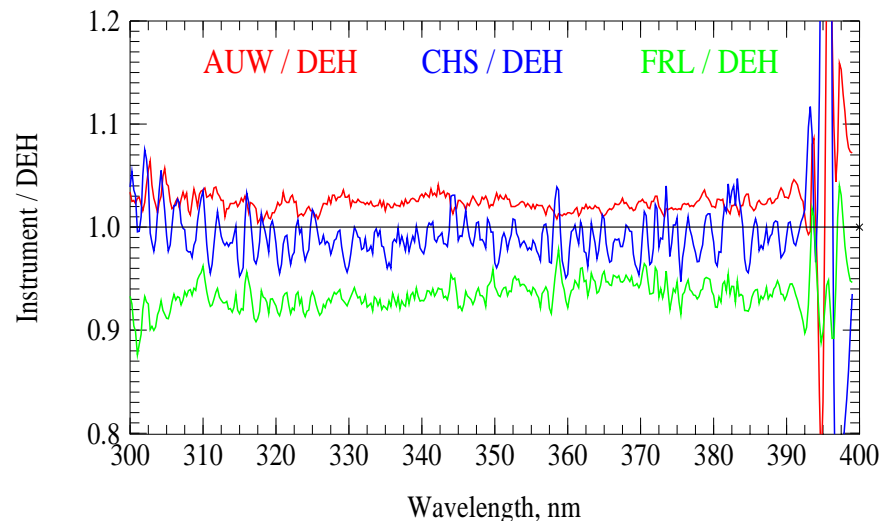
Unfortunately, no clear-sky conditions during the 3 days

# Comparisons of **spectral measurements of global irradiance** (low cloud cover and direct irradiance not blocked by clouds)

05.07 - 08:00 UTC (SZA = 48.84°)



06.07 - 12:00 UTC (SZA = 30.41°)

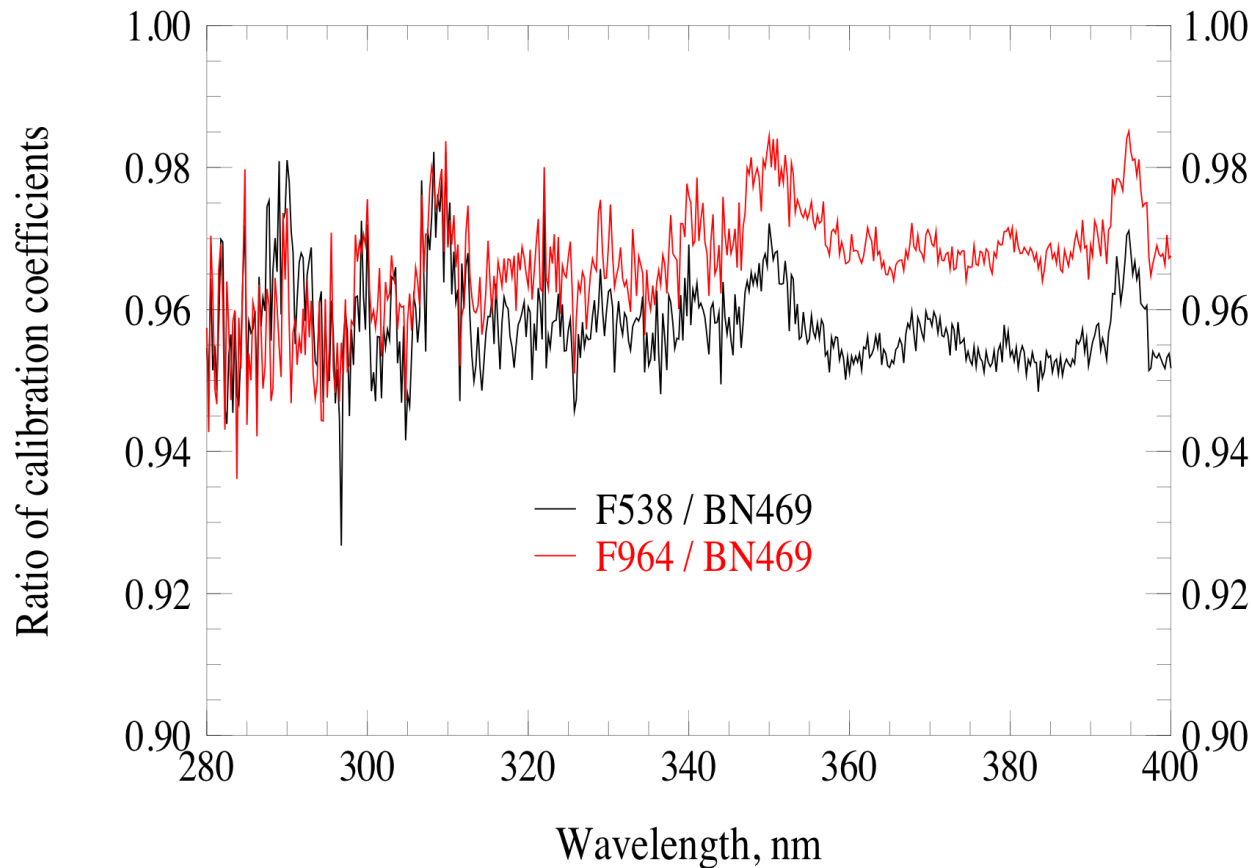


**Smooth ratios** for AUW and FRL, less smooth for CHS (maybe linked to an unperfect shift-correction and/or to the slit function difference, and/or to the 1-nm bandwidth normalization...)

In the 305-390 nm range:

- weak spectral dependance
- ratios close to 1 for AUW and CHS
- far from 1 for FRL (about 0.92 minimum) → pb with FRL data ?

Before the beginning of the blind intercomparison FRL has carried out calibrations with its FRL lamps and also with the DEH lamp



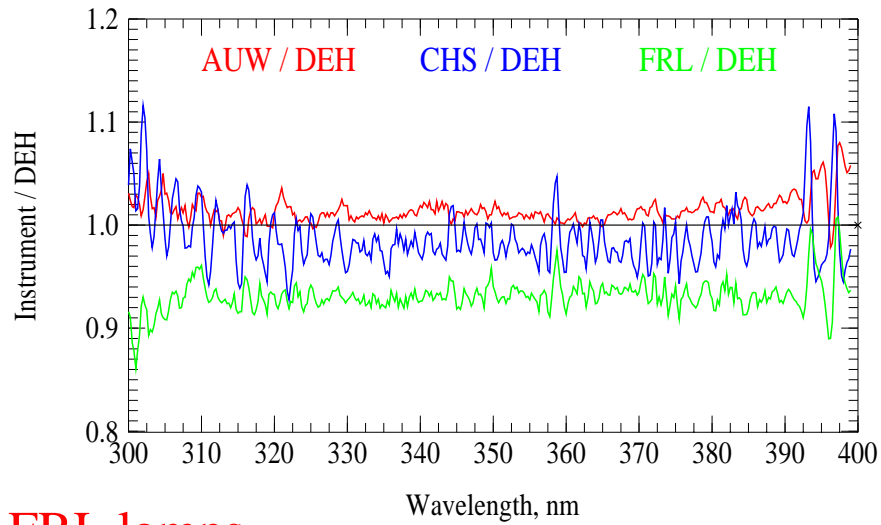
→ 3-4 %  
difference

**FRL:**  
F538 & F964  
traceable to NIST

**DEH:**  
BN469 traceable to  
PTB

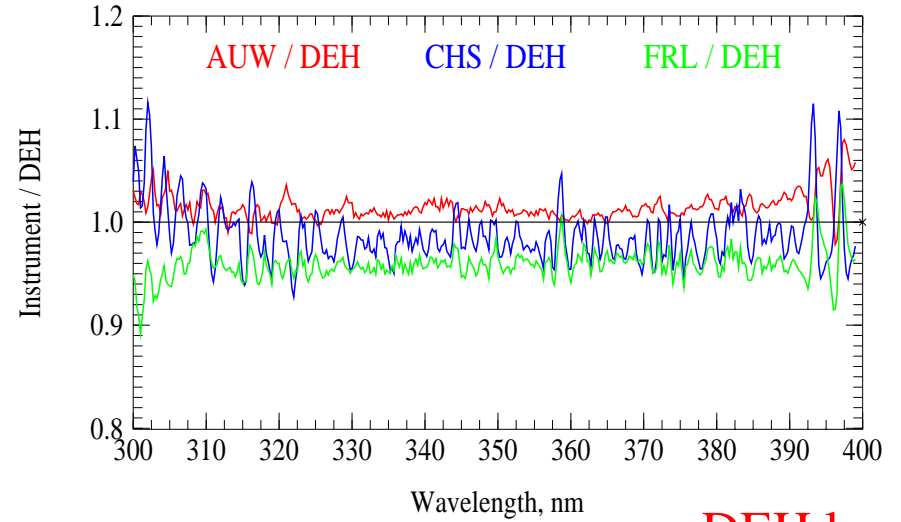
→ This **lamp difference** could partly explain the low ratio FRL/DEH of solar measurements

05.07 - 08:00 UTC (SZA = 48.84°)



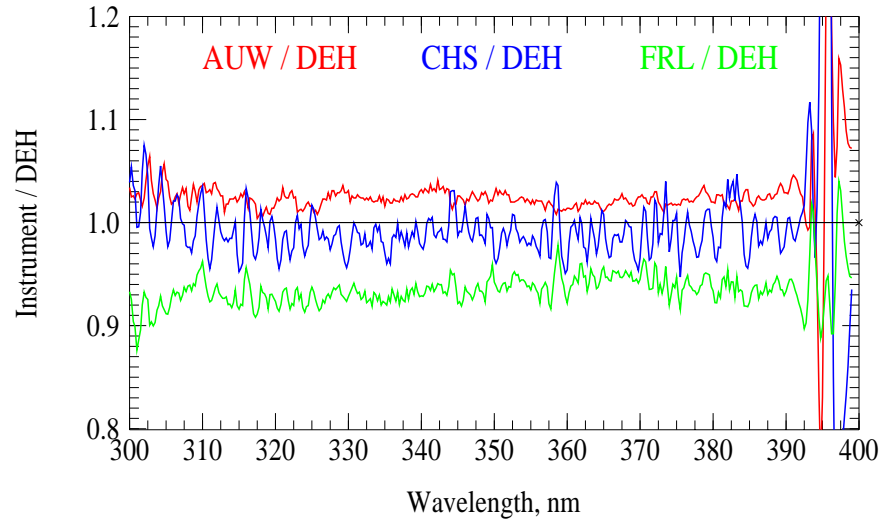
FRL lamps

05.07 - 08:00 UTC (SZA = 48.84°)

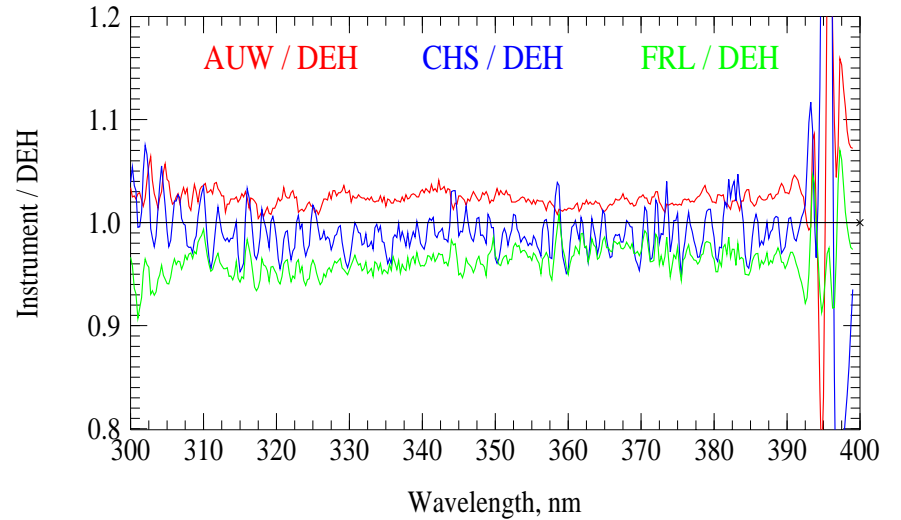


DEH lamp

06.07 - 12:00 UTC (SZA = 30.41°)



06.07 - 12:00 UTC (SZA = 30.41°)



→ Ratios FRL/DEH closer to 1

→ With this **calibration change** all measurements are within  $\approx 4\%$  from the reference in the 305-390 nm range

Satisfying when considering uncertainties on irradiance for a powerful instrument of at least 5.4% at 310nm and 4.2% at 400 nm (2 sigma level, Bernhard et al., 2004)

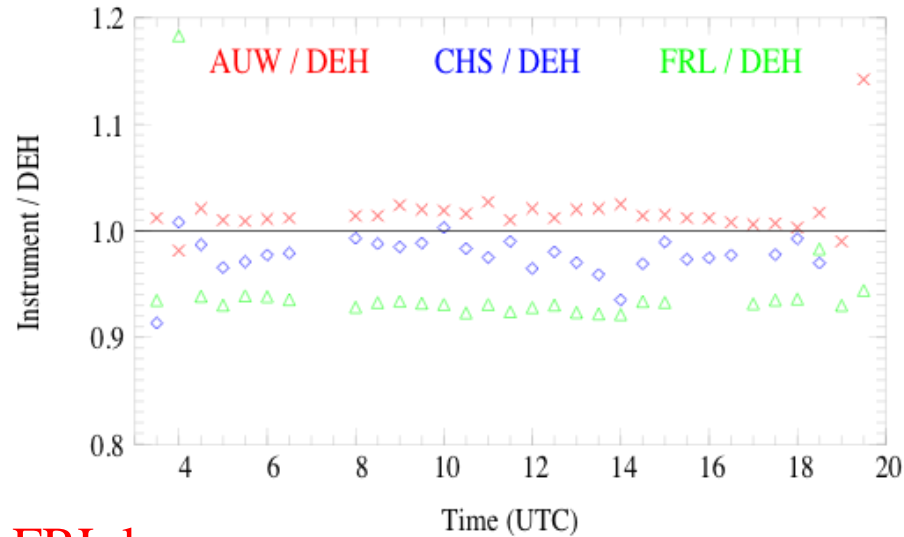
Some problems close to the Fraunhofer lines: linked to the residual wavelength shifts

For wavelengths below 305 nm the deviations increase for all instruments, due to the wavelength shifts of about  $\pm 0.05$  nm, still within the specification range set by NDACC

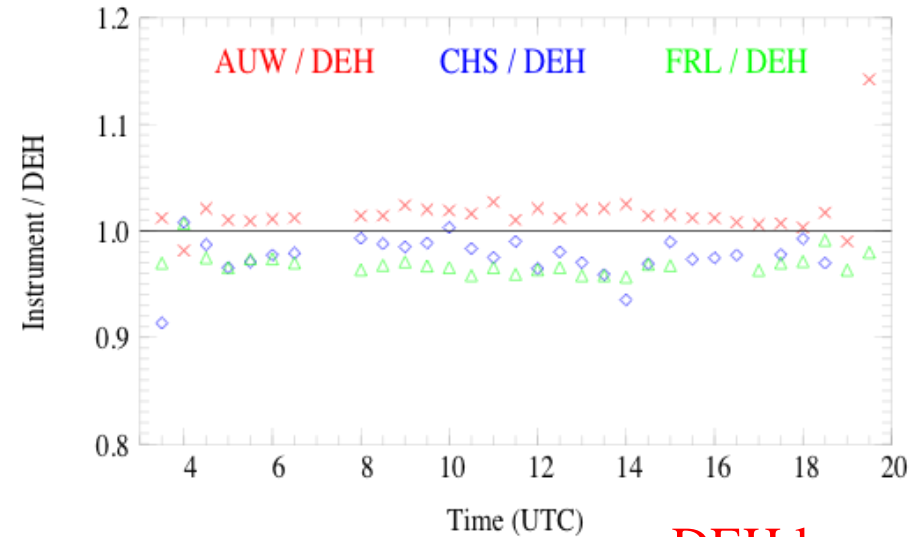


# Comparison of **integrated global irradiance** for the 3 days: diurnal variations

05.07 - UVI (Diffey-CIE)



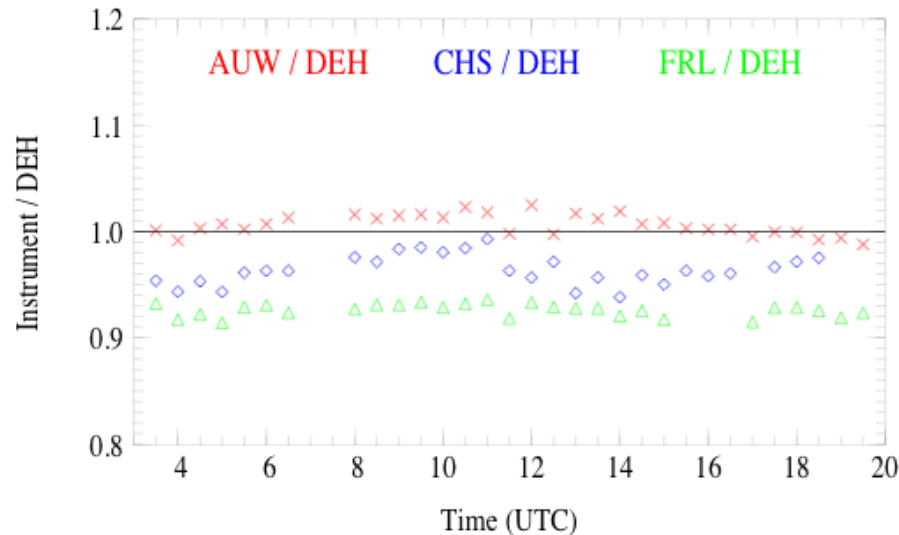
05.07 - UVI (Diffey-CIE)



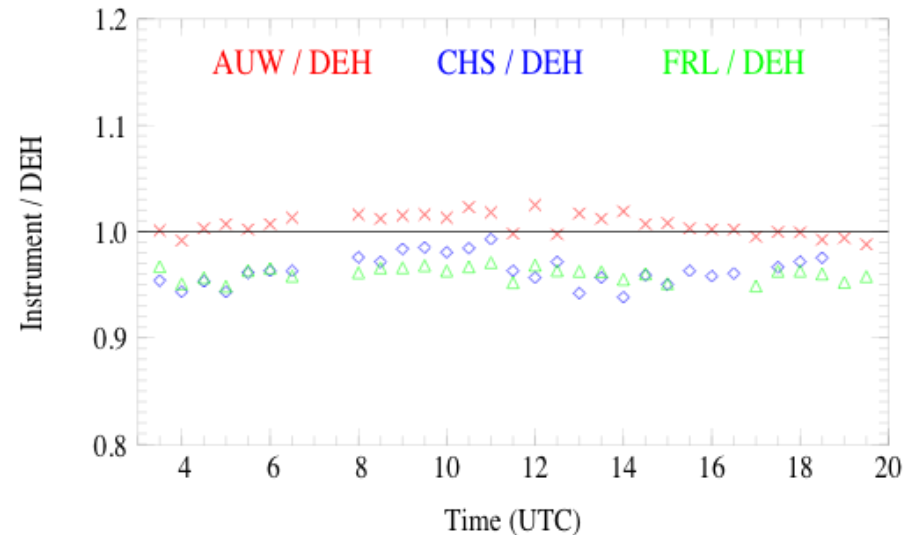
**FRL lamps**

**DEH lamp**

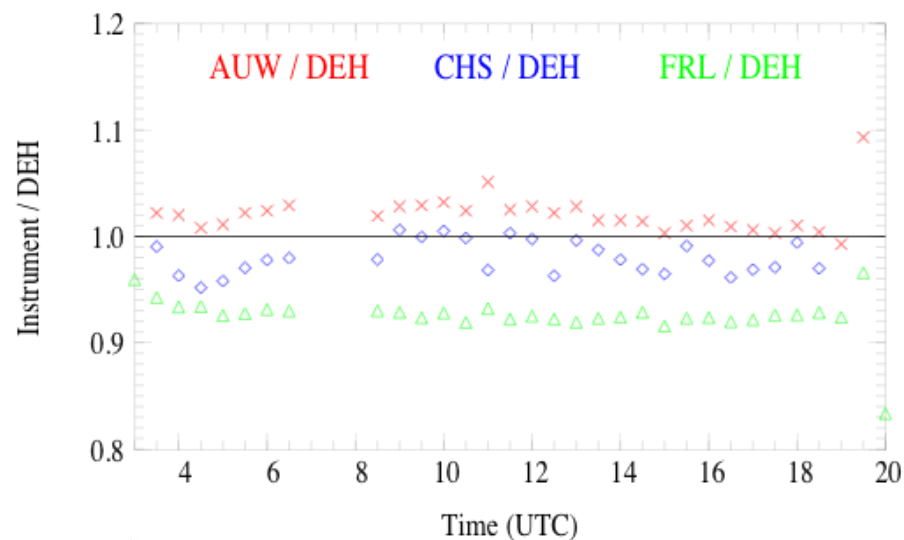
05.07 - UVA (315 - 400 nm)



05.07 - UVA (315 - 400 nm)

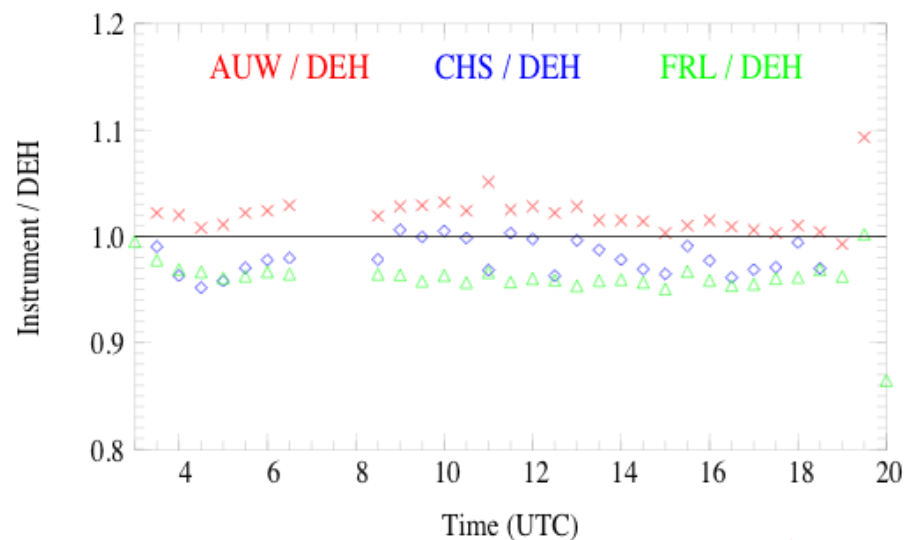


06.07 - UVI (Diffey-CIE)



UVI

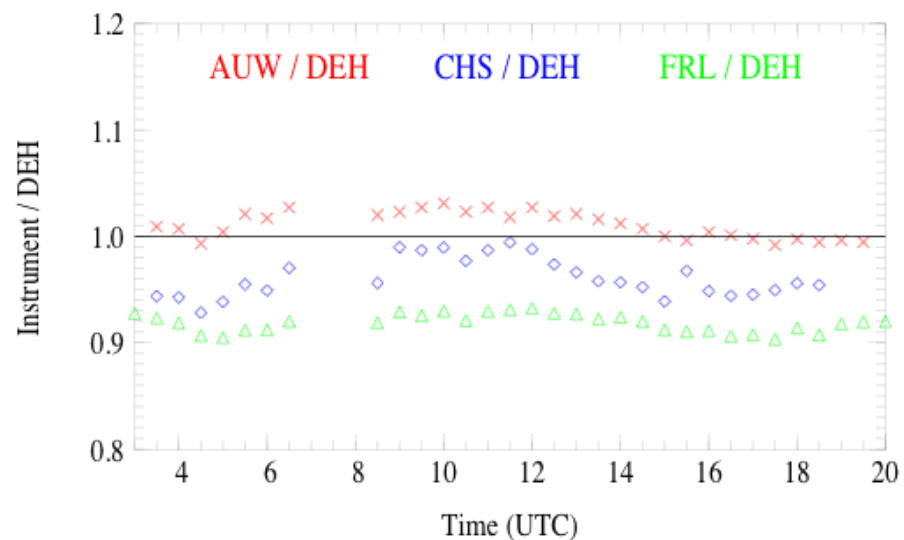
06.07 - UVI (Diffey-CIE)



FRL lamps

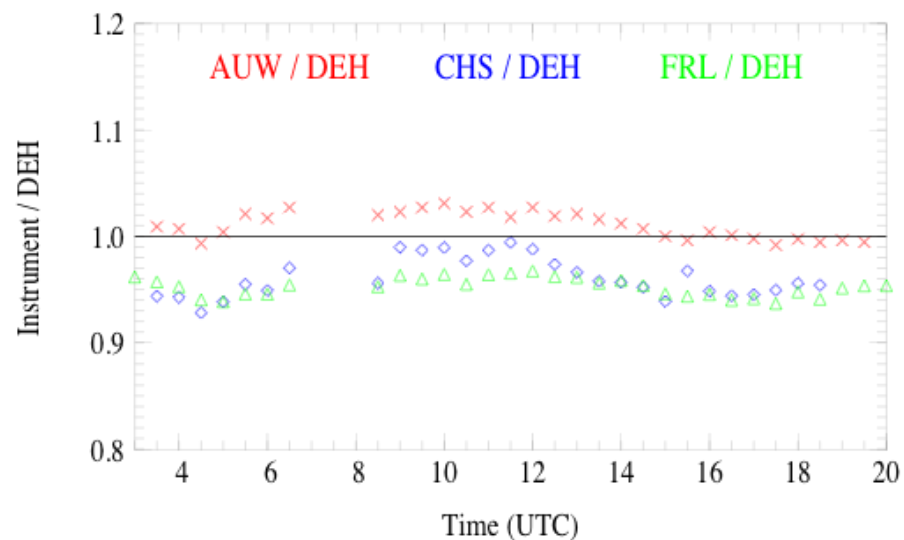
DEH lamp

06.07 - UVA (315 - 400 nm)

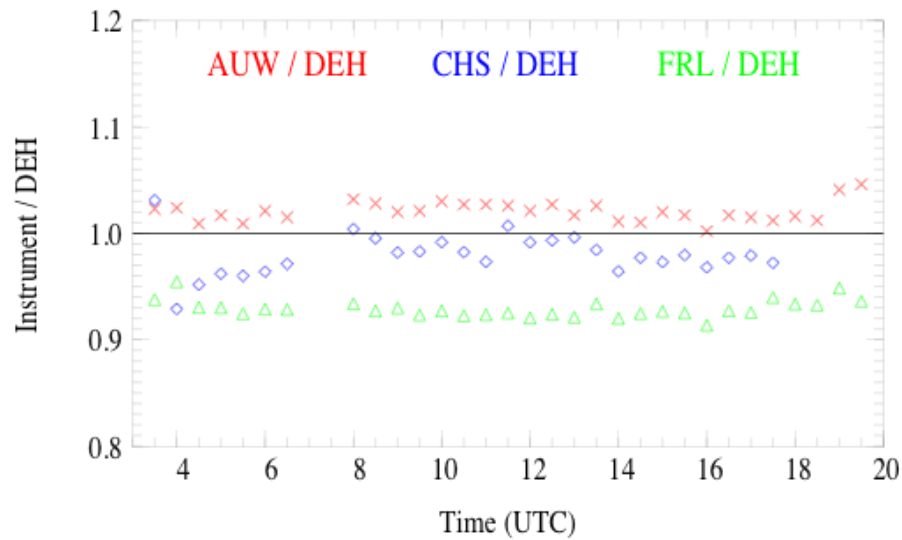


UVA

06.07 - UVA (315 - 400 nm)

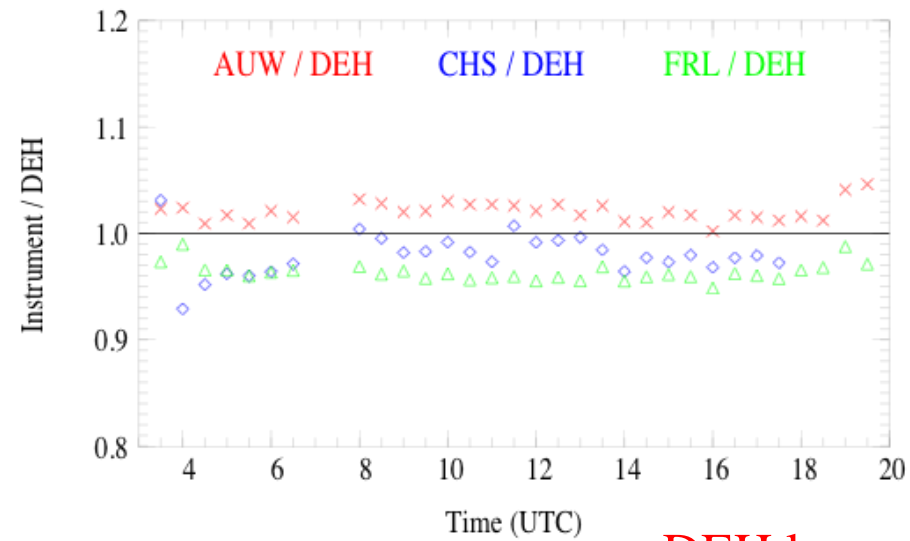


07.07 - UVI (Diffey-CIE)



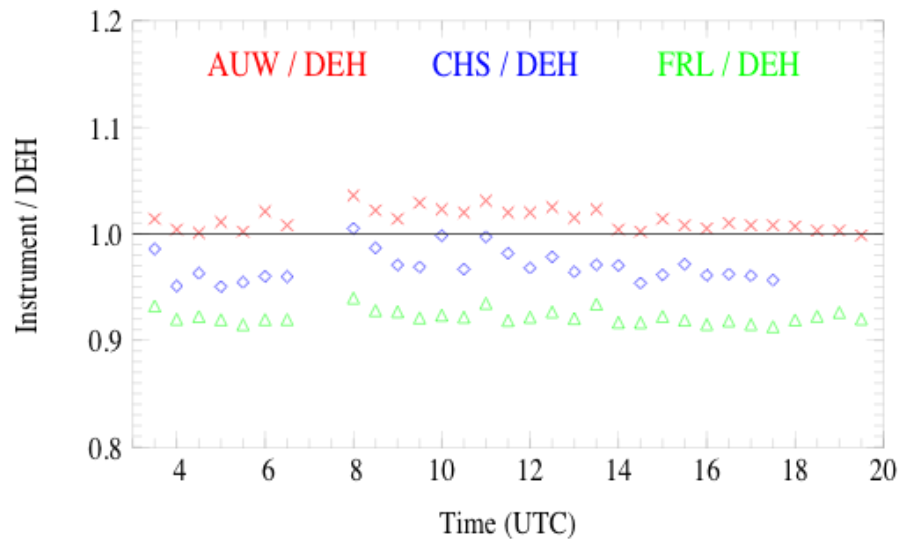
UVI

07.07 - UVI (Diffey-CIE)



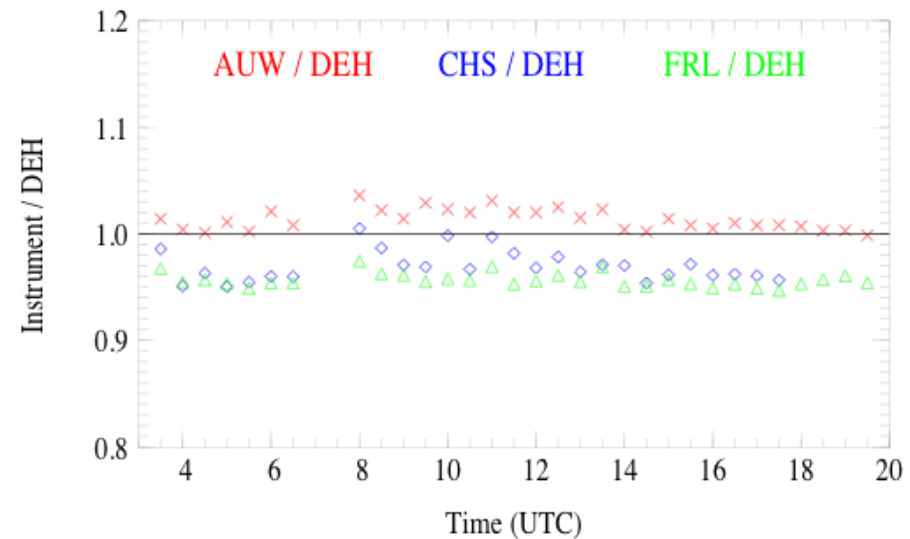
FRL lamps

07.07 - UVA (315 - 400 nm)



UVA

07.07 - UVA (315 - 400 nm)



DEH lamp

→ Same behaviour whatever the spectral range – weak diurnal effect

# Conclusion

- \* A UW and DEH measurements agree very well (on average 2-3% difference)
- \* CHS and DEH data show reasonable agreement. However an independent calibration still needs to be assessed.
- \* Differences of up to 8% between FRL and DEH data may be partly linked to the calibration lamps and/or to the calibration procedure

*DEH-BN469 scale confirmed by comparison with 3 fresh lamps from Gigahertz-Optik (carried out in October by IMUK, Leibniz University, Hannover)*

Though, before deciding changing the FRL standard: other comparisons of standards are necessary

- \* The difference that would remain after changing the FRL standard ( $\approx 4\%$ ) is under study
- \* Nevertheless, the intercomparison of solar measurements revealed a satisfactory behavior of NDACC spectral UV instruments in terms of wavelength shift and stability (over a short 3-day period)