Calibration of the SolACES Spectrometer Observation

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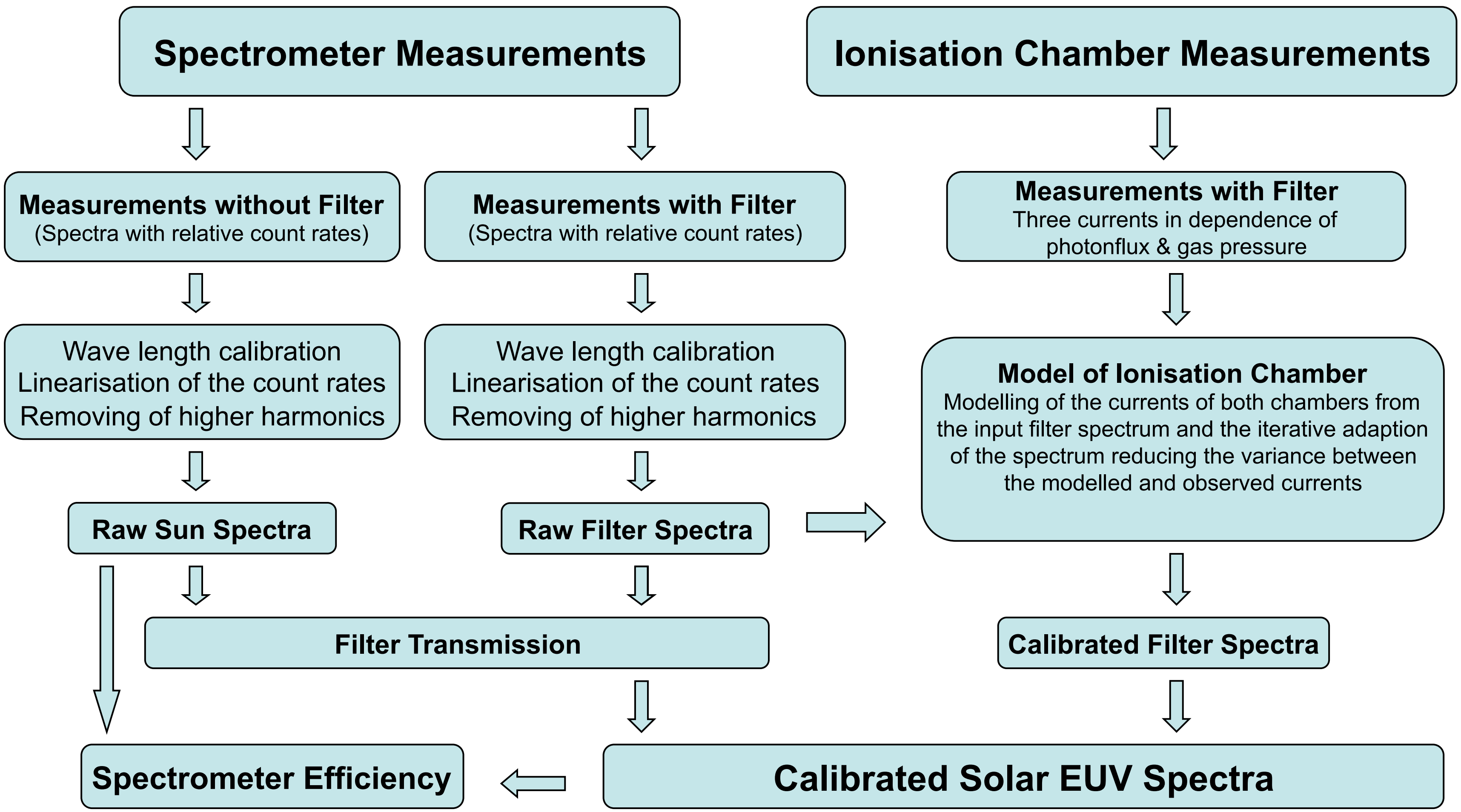
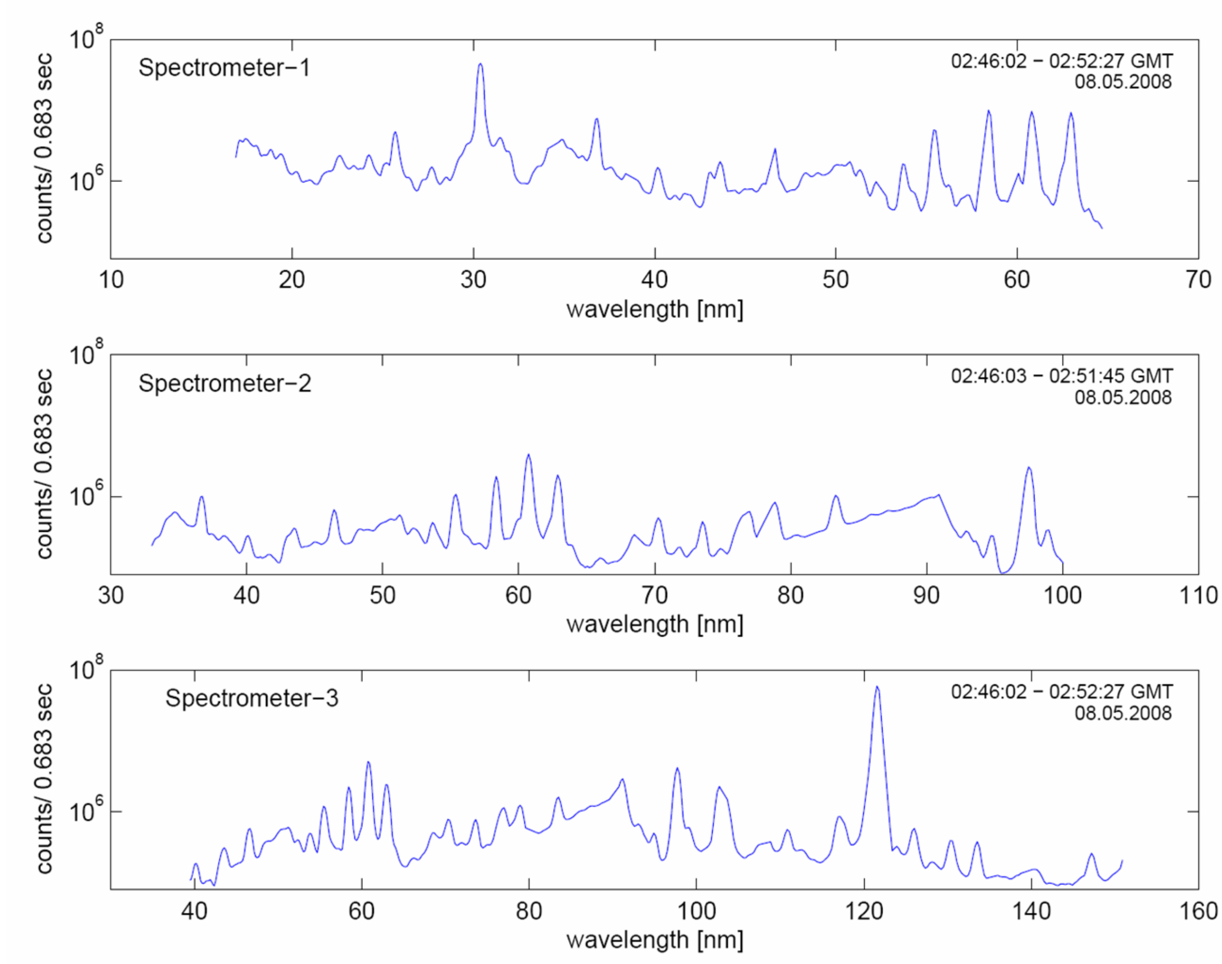
SolACES Calibration Measurements



Spectrometer Measurements

EUV Solar flux measurements in the spectral range 16-150 nm

(raw data spectra,
not calibrated,
harmonics are included)

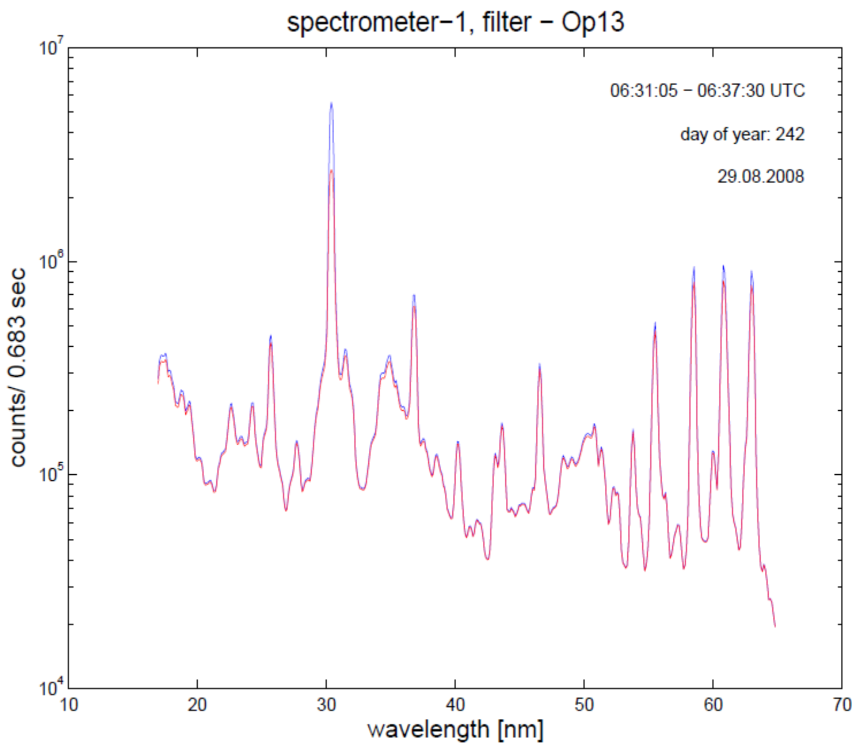


Linearisation/Correction of high count rates

Dead Time Correction

The time interval which is necessary to process one pulse is called ***dead time,*** referring to the fact that the system is „dead“ to process another pulses during this time interval. With increasing count rate not all signals can be counted. For a retriggerable system like the channeltron the relation between real and observed count rate is

$$\phi_{obs} = \phi_0 \cdot e^{-\phi_0 \bullet \tau}$$



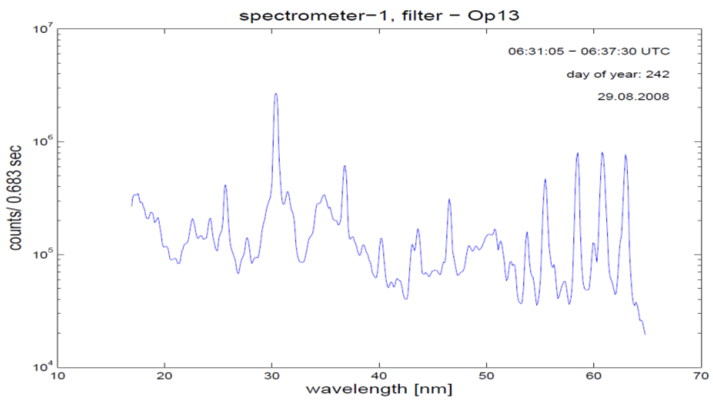
Two methods to determine the dead time are used:

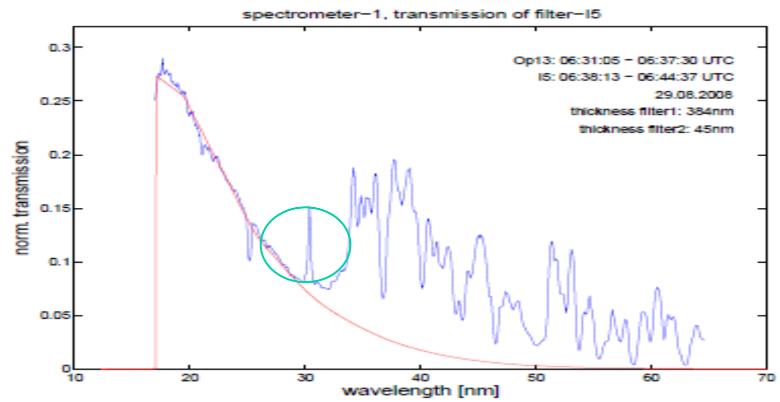
1. Adaption of the filter transmission of strong lines
2. Adaption of the spectral resolution of a strong line to that of a filter observation of the same line

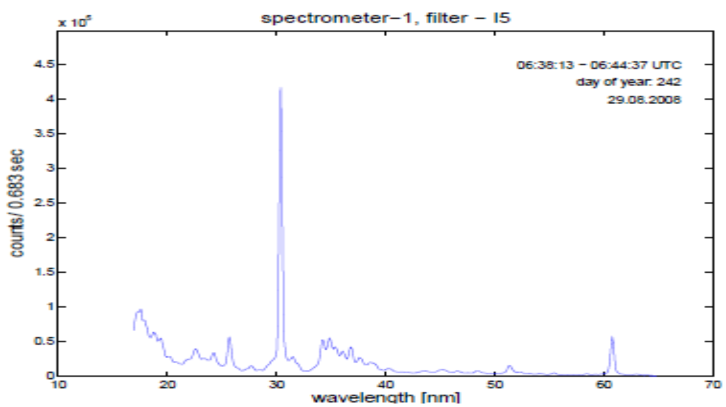
$$\tau = 1.99 * 10^{-7} s$$

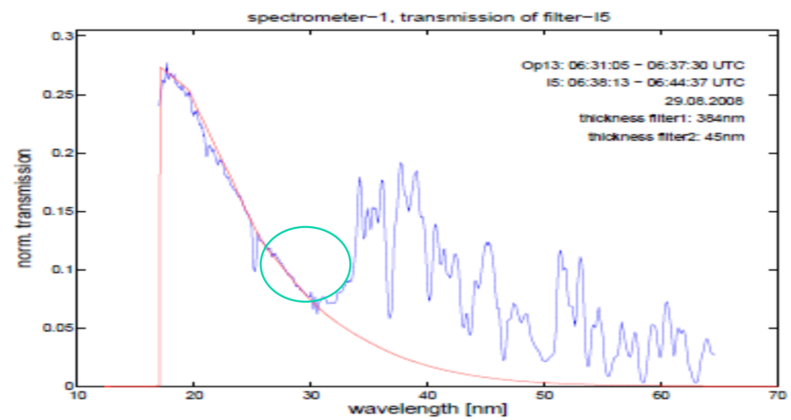
Linearisation/Correction of high count rates

1. Adaption of the filter transmission of strong lines





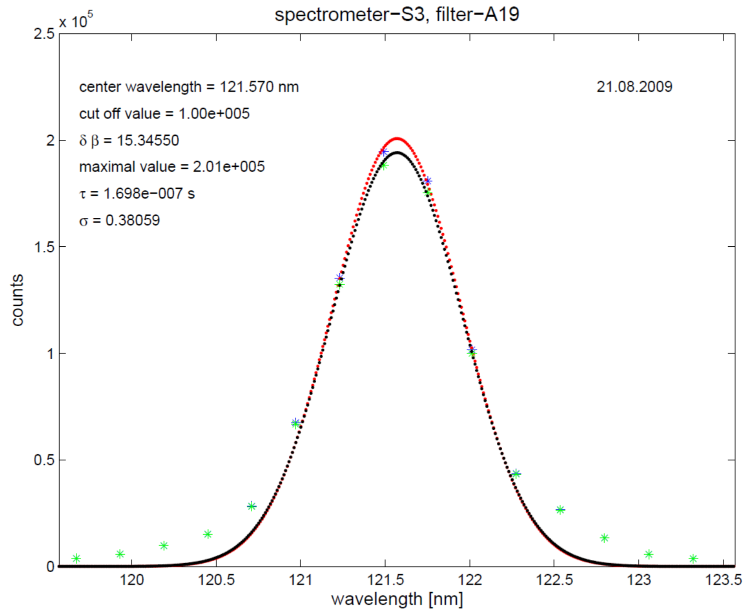


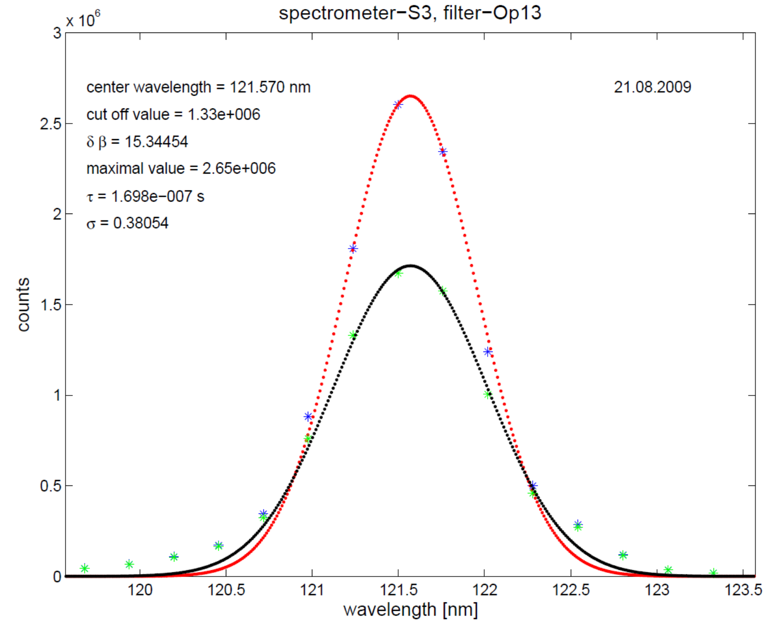


$$\tau = 1.99 * 10^{-7} s$$

Linearisation/Correction of high count rates

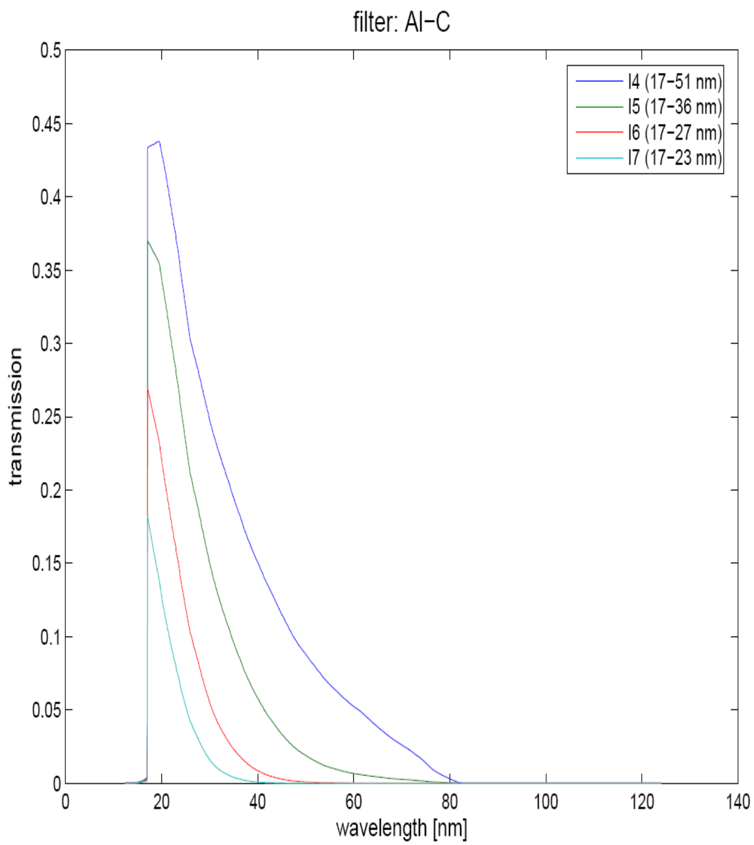
2. Adaption of the spectral resolution of a strong line to that of a filter observation of the same line

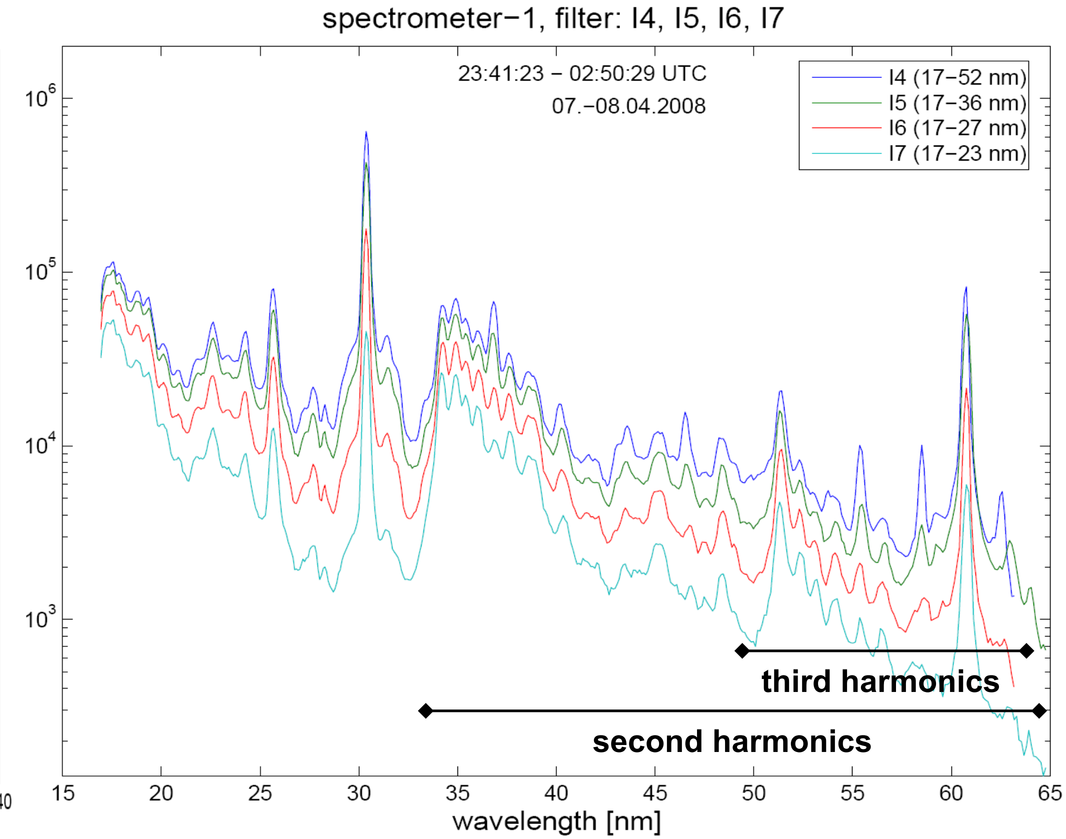




$$\longrightarrow \quad \tau = 1.698 * 10^{-7} s$$

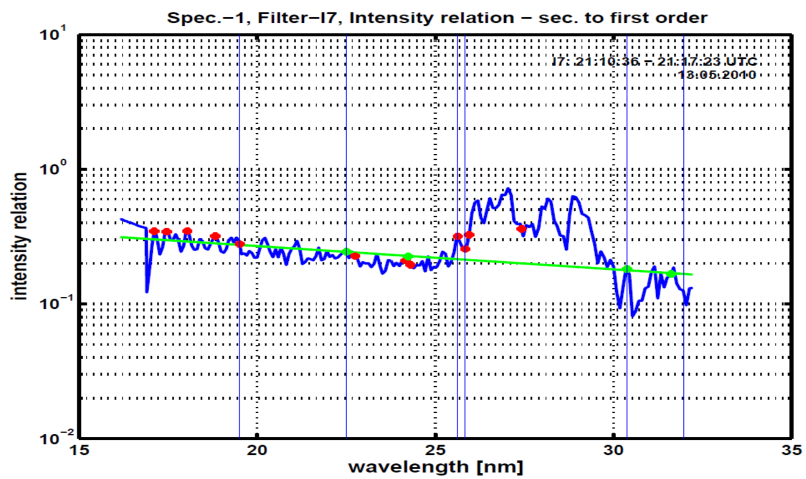
Data Evaluation with Filters

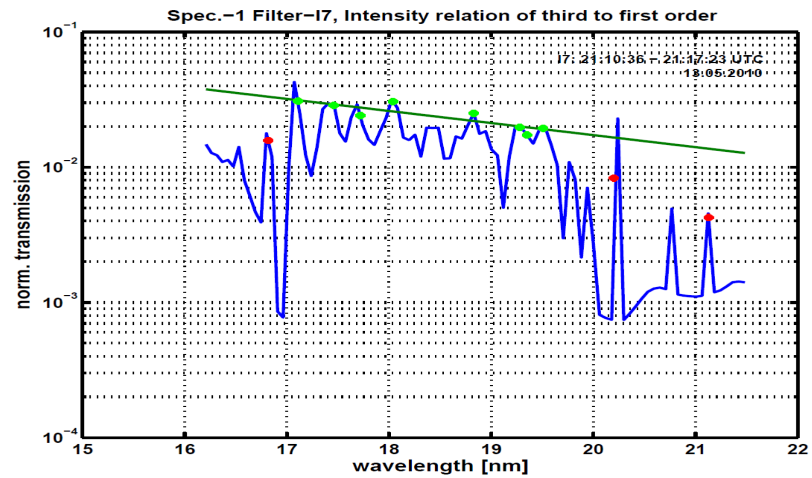


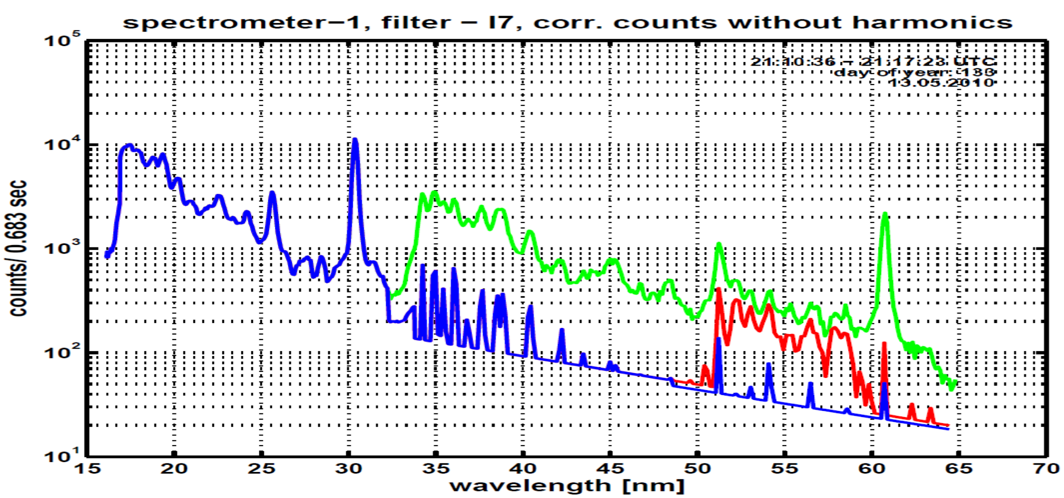


- Filters allow to extract different spectral ranges, but also to identify higher harmonics contributions.
- Filters are the link between the spectrometer observations and the calibrations by the ionisation chambers.

Correction of second and third diffraction orders



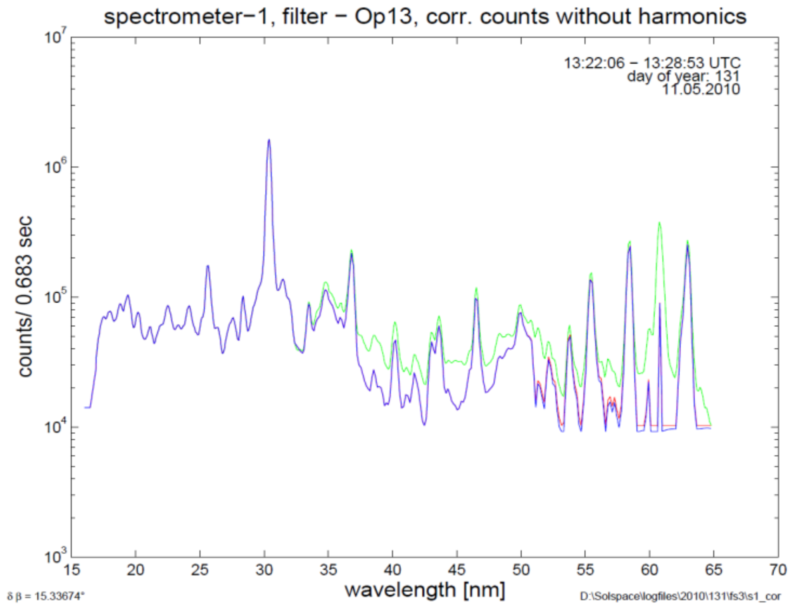




Correction of second and third diffraction orders

Conclusions

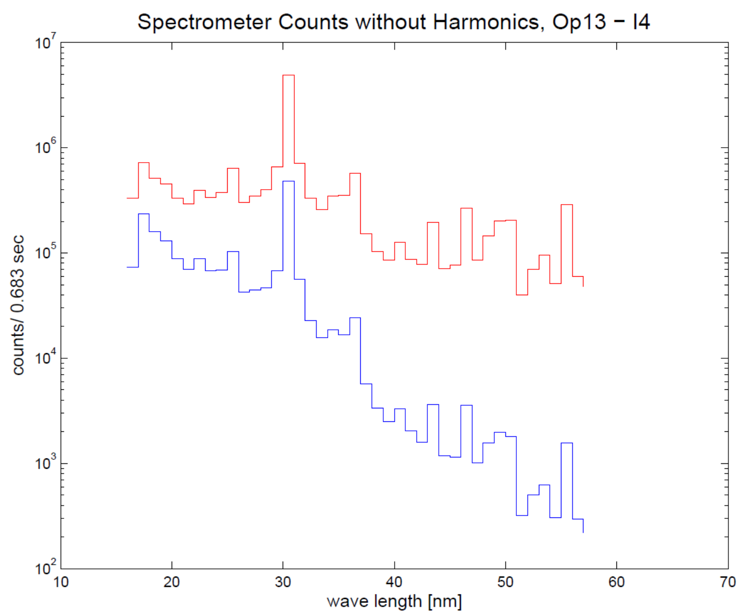
- The approximating logarithmical linear curves giving the relation between the emissions of the second to the first and of the third to the first reflection orders are stable for all spectrometers over the time.
- We have determined these curves at the beginning of the SolACES observations when the channeltrons were most stable.



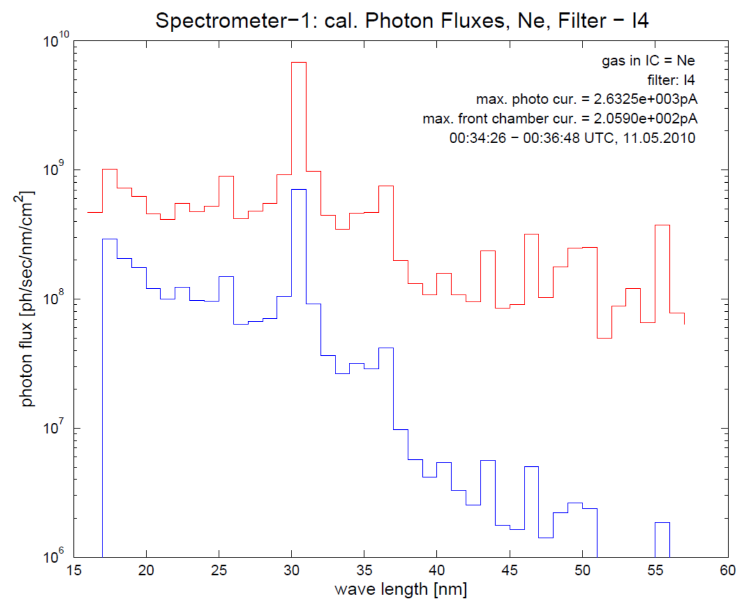
To calibration

Photon Flux Calibration

First raw calibration factor - 1400 ph/nm/cm^2



1nm binning



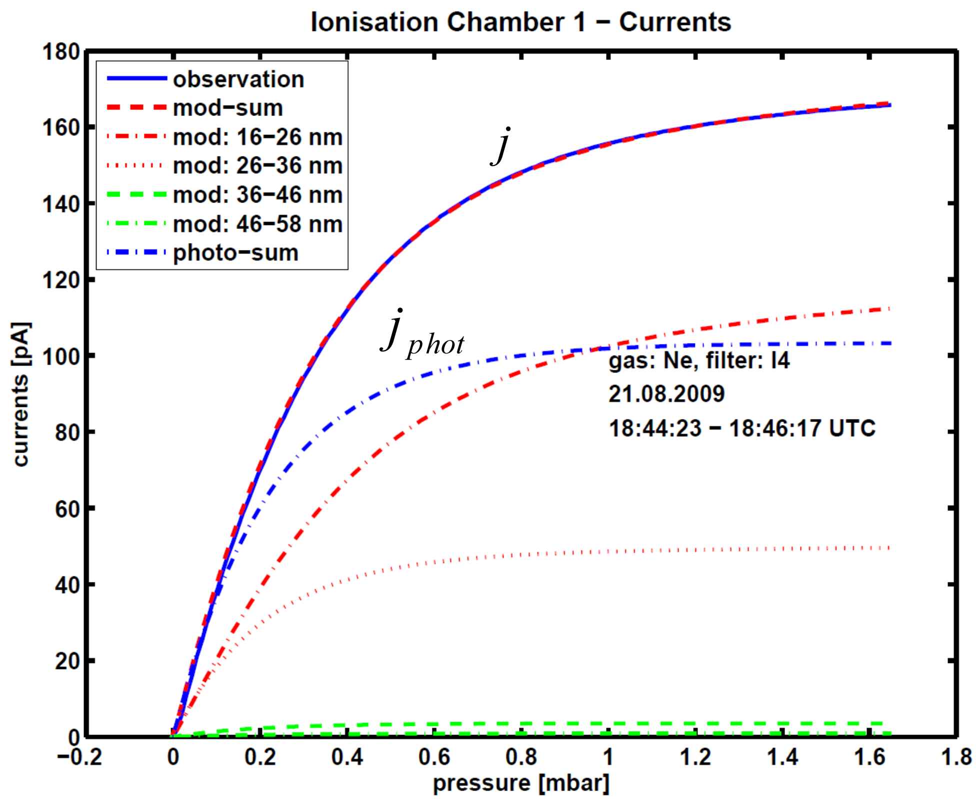
Start photon distribution

Photon Flux Calibration (Modelling)

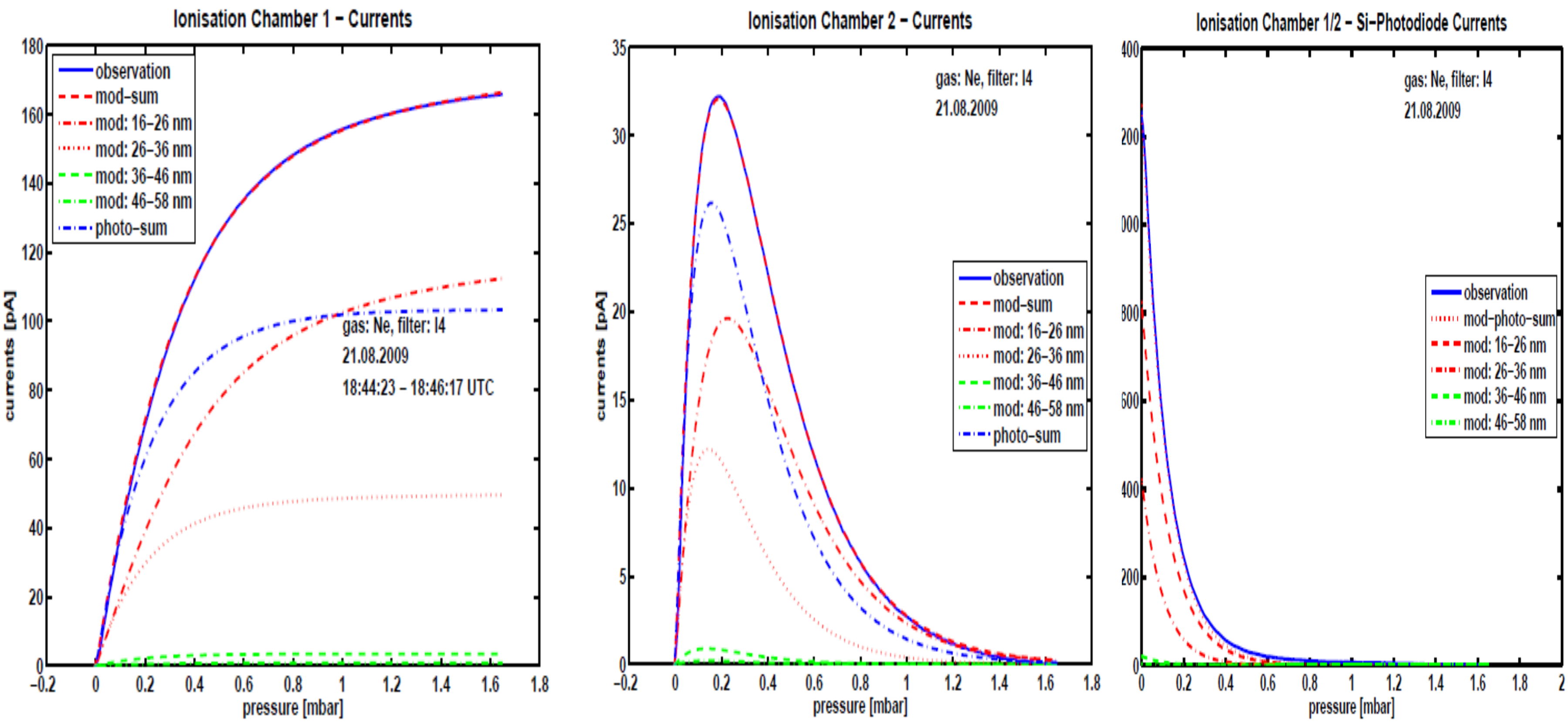
$$j_{phot,i} = y_i \times \phi_F \times (1 - \exp(-n \times \sigma_i \times l)) \qquad (Beer - Lambert\ law)$$
$$j_{\sec_1,i} = j_{phot,i} \times (1 - \exp(-n \times \sigma_{el,i} \times l_{e_1,i}))$$
$$j_{\sec_2,i} = j_{\sec_1,i} \times (1 - \exp(-n \times \sigma_{el,i} \times l_{e_2,i}))$$
$$j_{\sec_3,i} = j_{\sec_2,i} \times (1 - \exp(-n \times \sigma_{el,i} \times l_{e_3,i}))$$

$j_{phot,i}$ - photon current
$j_{\sec_{1,2,3},i}$ - secondary currents by electrons
ϕ_F - photon flux at chamber input (filter)
y_i - yield, electrons per photon
σ_i - ionisation coefficient - photons
$\sigma_{el,i}$ - ionisation coefficient - electrons
l - chamber length
$l_{e_{1,2,3},i}$ - maximal length of electron orbit

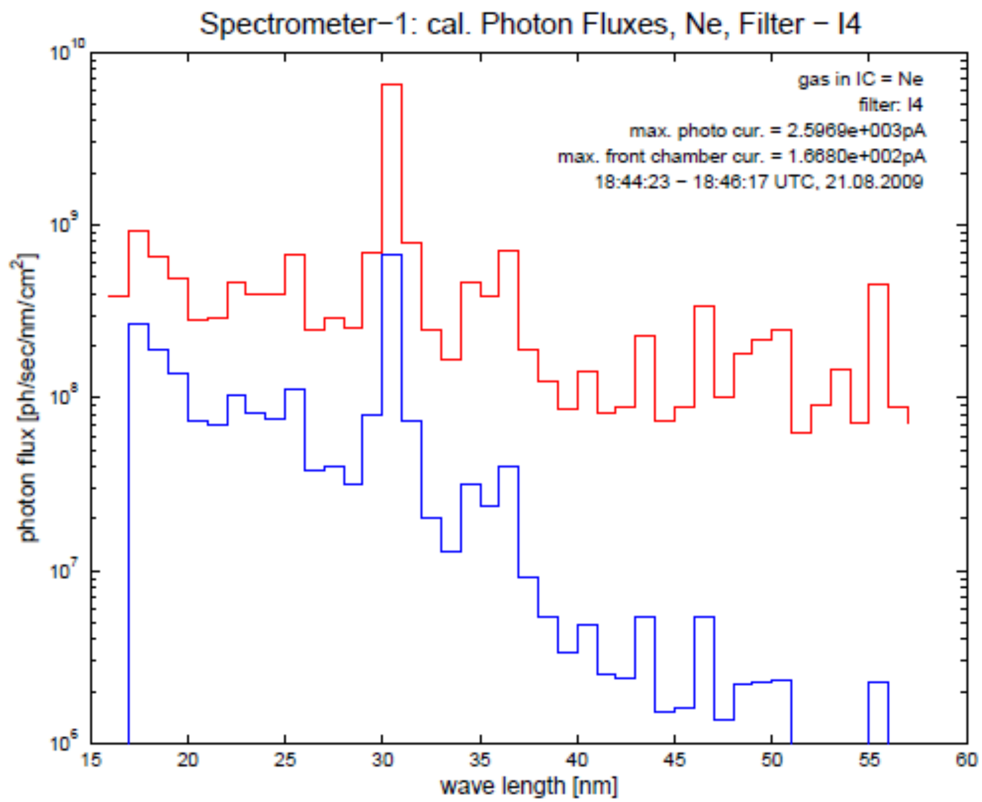
$$j_{phot} = \sum_{nb} j_{phot,i}$$
$$j_{\sec_1} = \sum_{nb} j_{\sec_1,i}$$
$$j_{\sec_2} = \sum_{nb} j_{\sec_2,i}$$
$$j_{\sec_3} = \sum_{nb} j_{\sec_3,i}$$
$$j = j_{phot} + j_{\sec_1} + j_{\sec_2} + j_{\sec_3}$$
nb – number of bins



Photon Flux Calibration

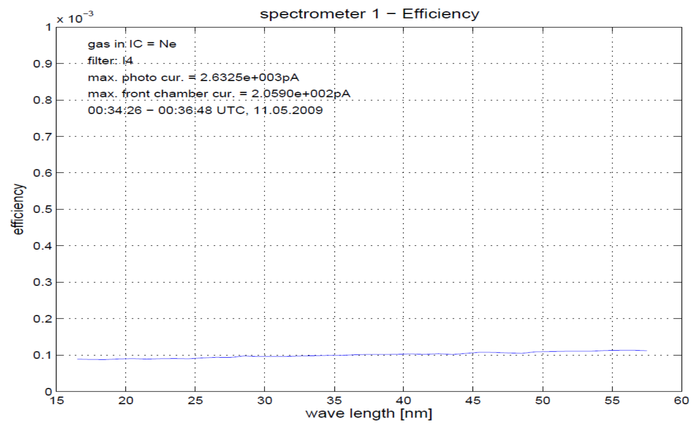


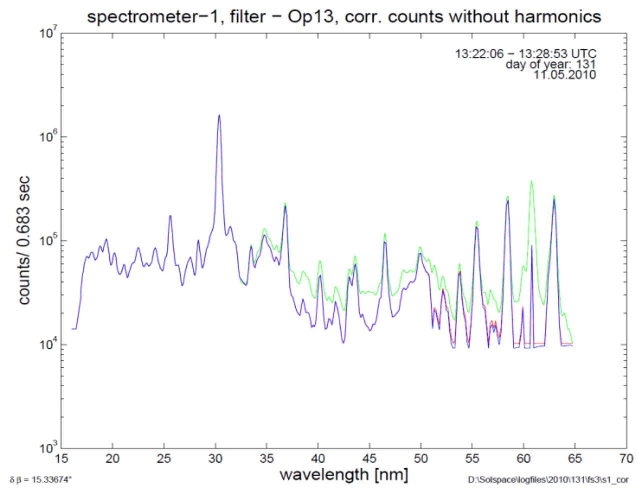
Calibrated Spectrum

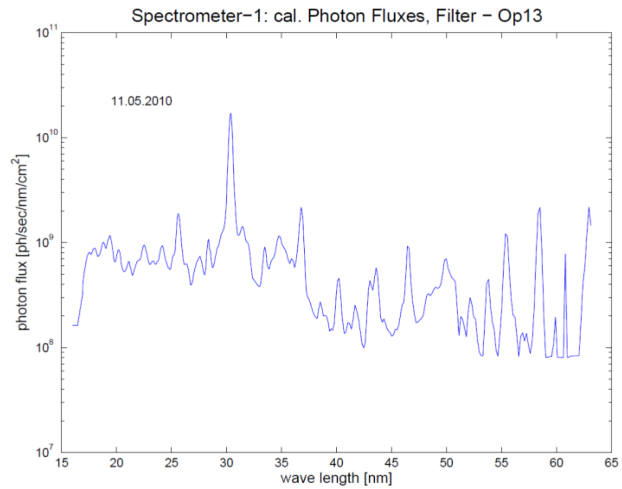


Standard Spectrometer Measurement Calibration

spectrometer efficiency from calibration observations







Sun spectra from standard spectrometer observation

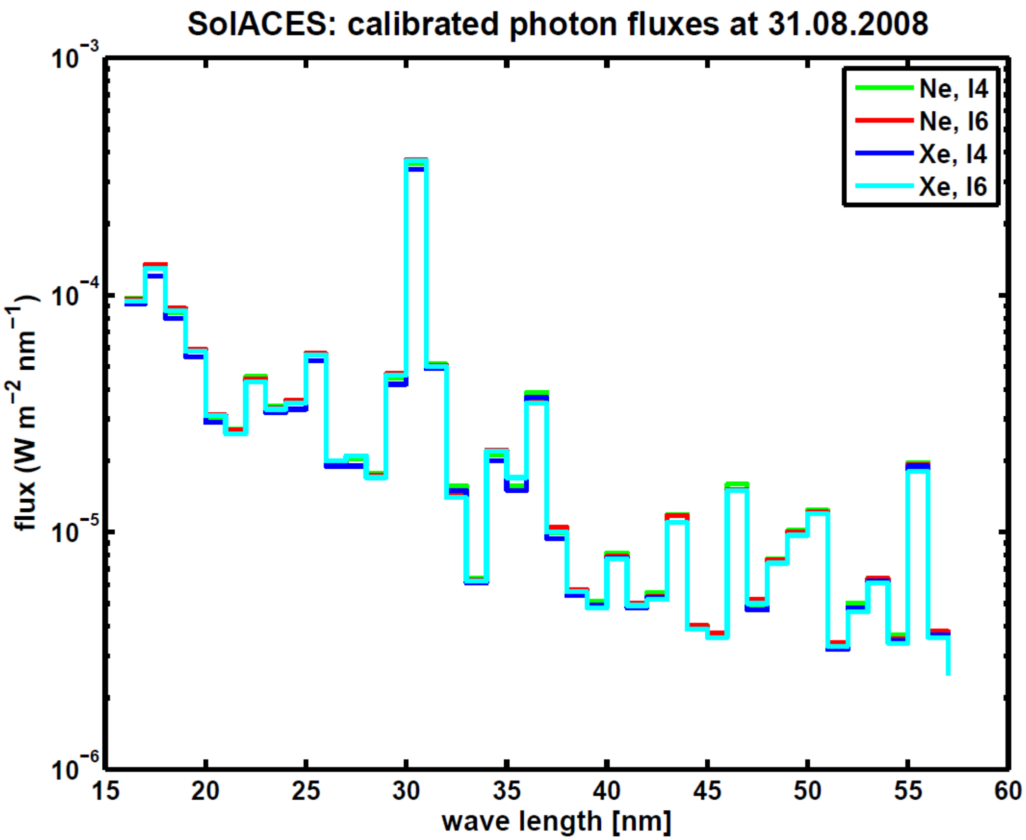
calibrated solar EUV spectra

Internal Intercomparison

Neon: Ionisation energy = 21.56 eV
Xenon: Ionisation energy = 12.13 eV

Different photon absorbtion cross-sections

Transmission of I4: 17-55 nm
Transmission of I6: 17-35 nm

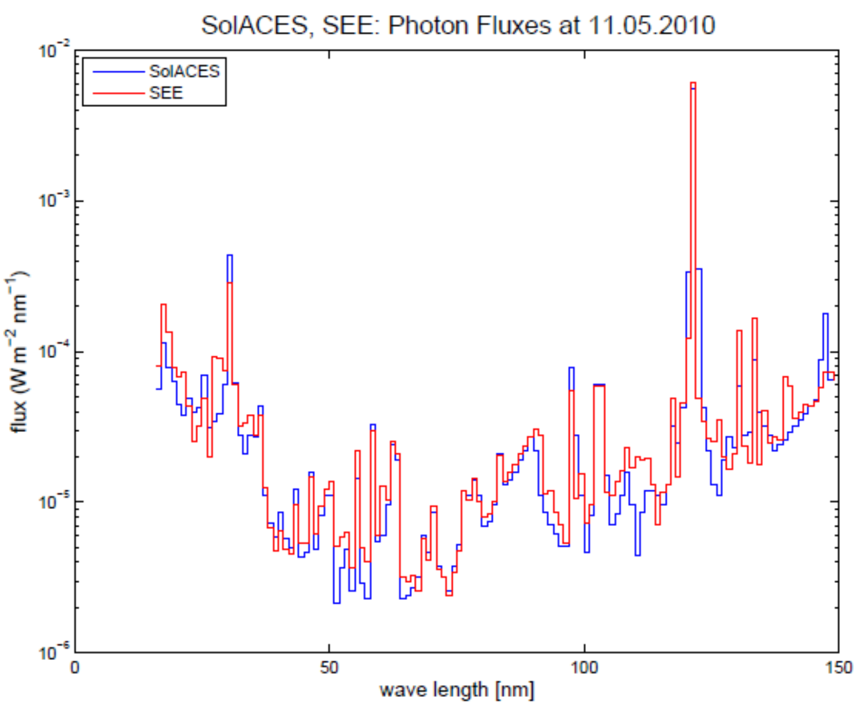


→ **Successfull cross-checks**

Photon Flux Calibration - Comparison

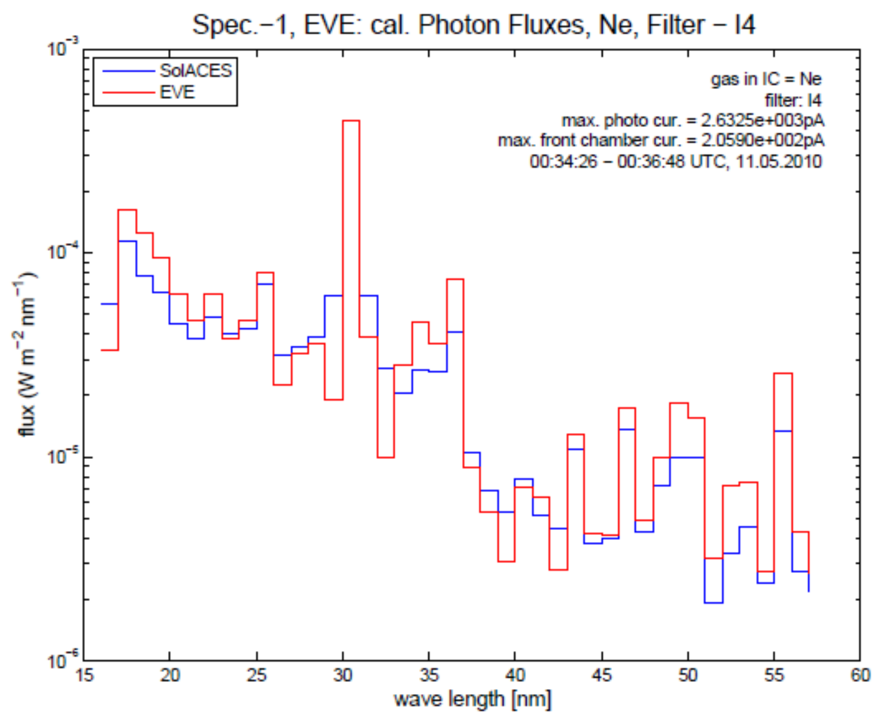
SolACES

Comparison with TIMED/SEE observations



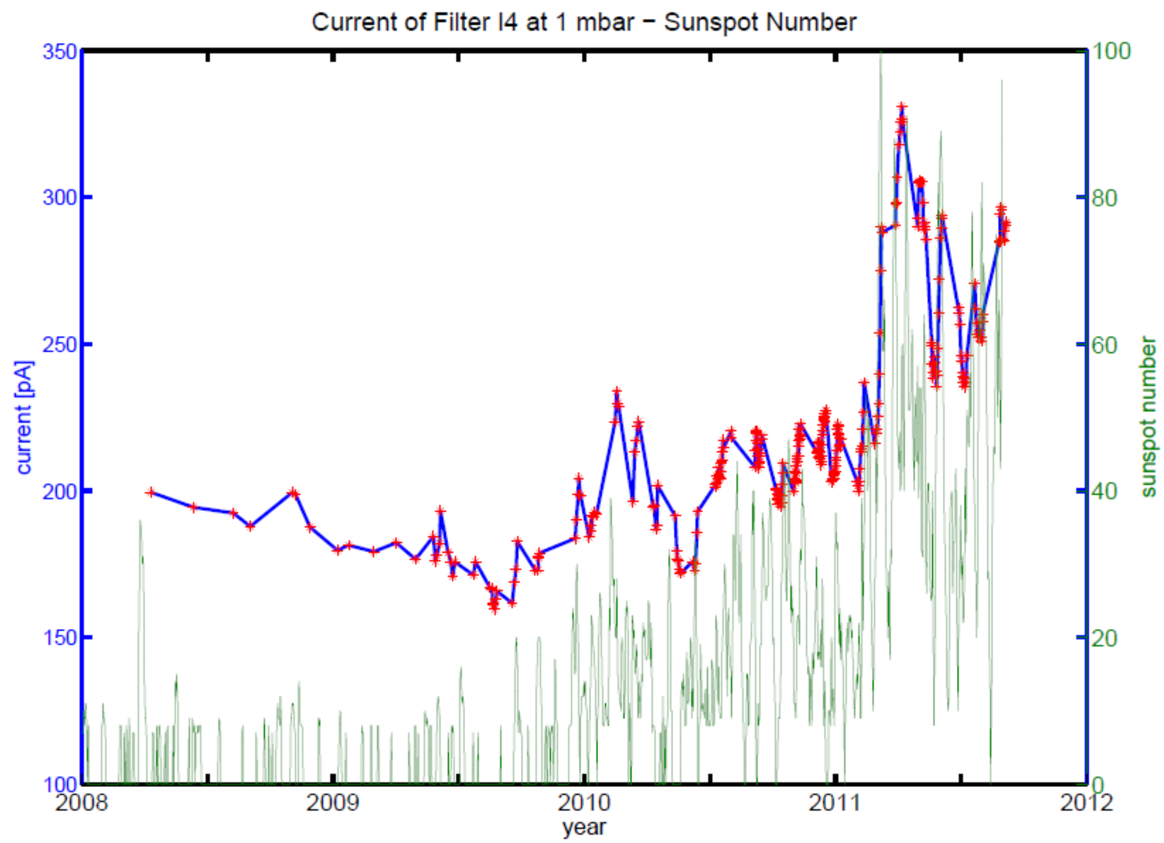
Thanks to the SEE team.

Comparison with calibration rocket EVE



SDO EVE calibration rocket was launched at May 3rd 2010.
Thanks to T. Woods.

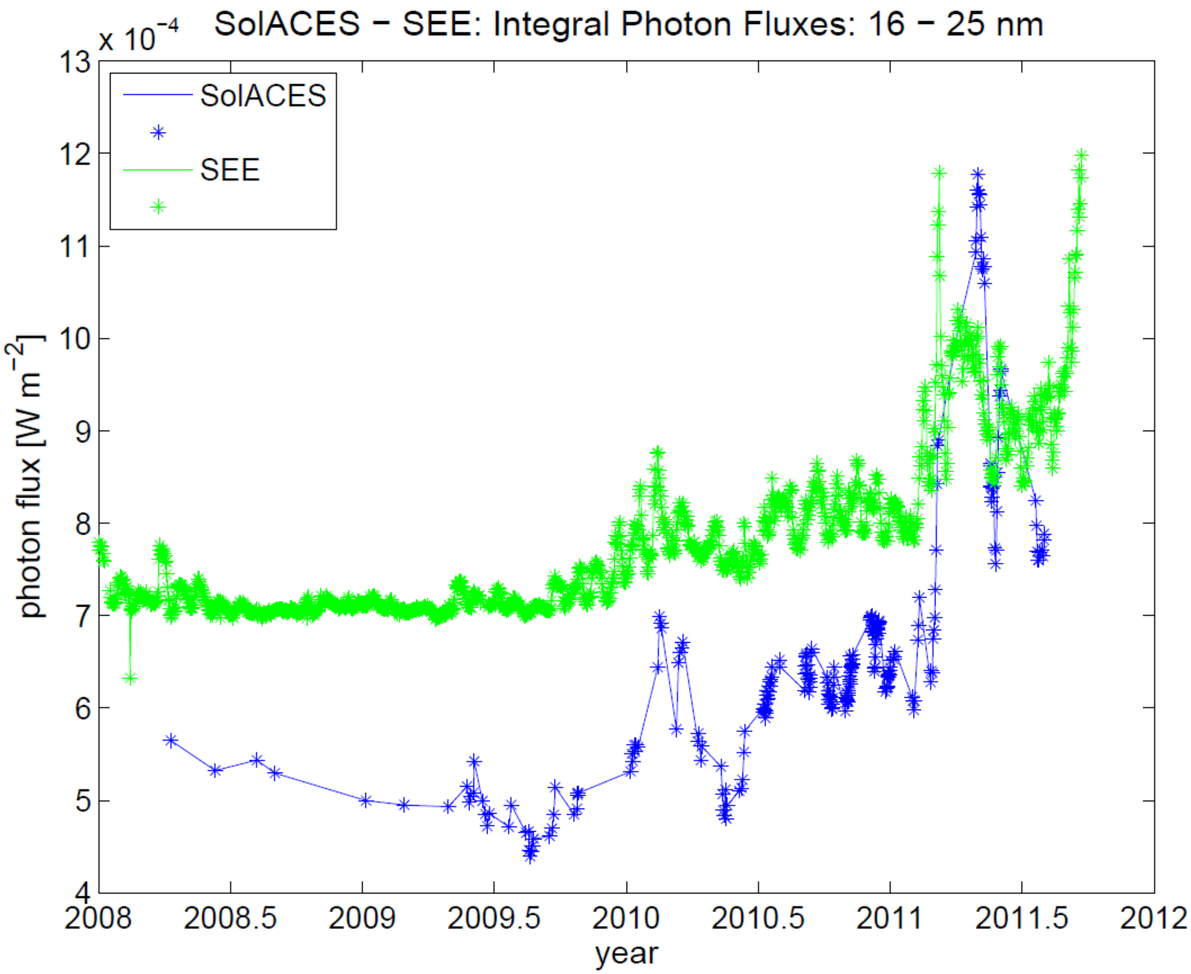
Low Solar Activity Observed by the Ionisation Chamber SolACES



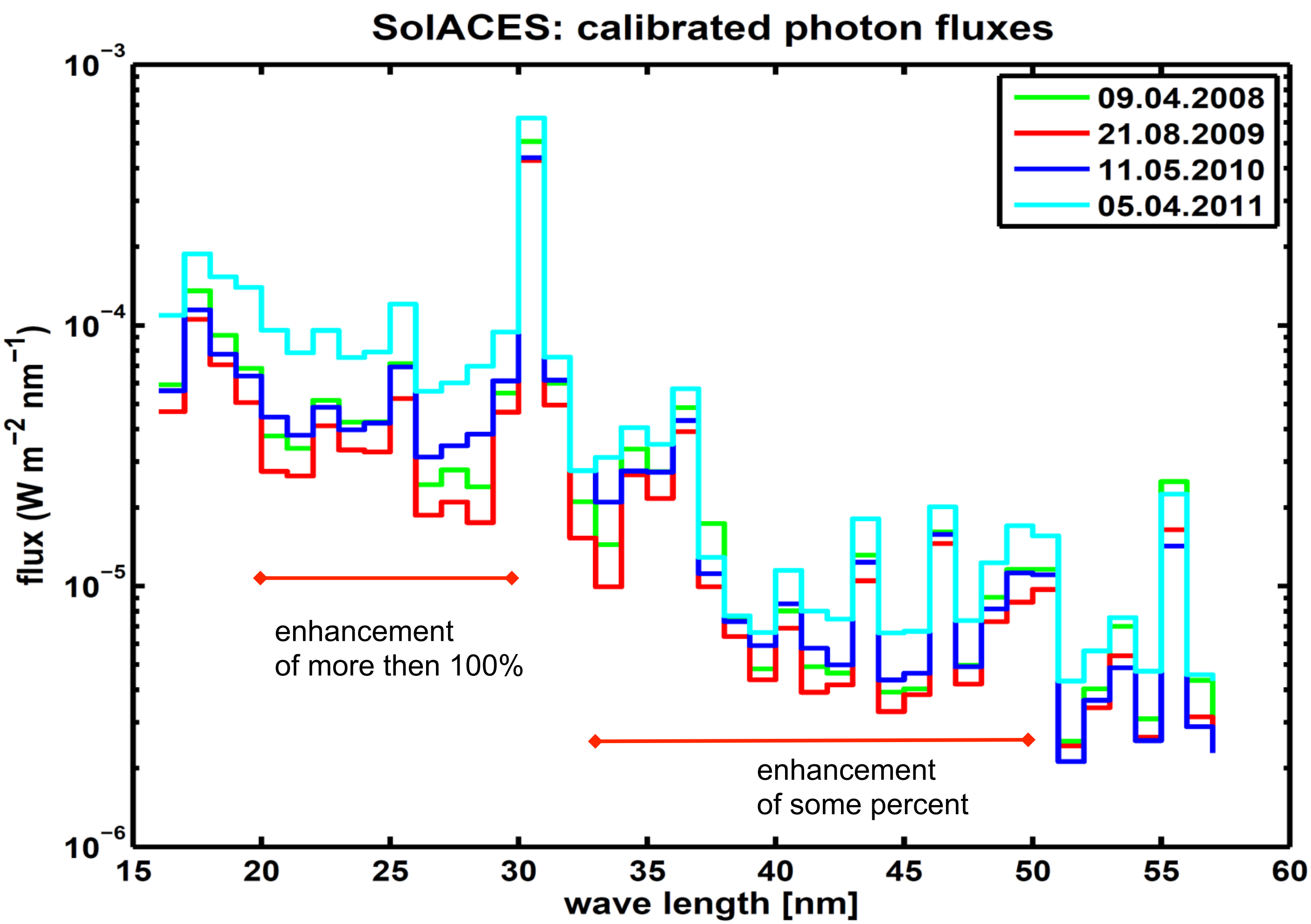
The first ionisation current of the Al/C filter I4 as an absolute measure of the 16-40 nm EUV iradiance.

Low Solar Activity in the spectral range 16 – 25 nm

SolACES



Variability of the 16-50 nm EUV



SUMMARY

- We are on a good way to produce calibrated spectra.

- Methods to extract the higher harmonics have been optimized.

- We think to have good calibration up to 50 nm and around the Ly- alpha line.

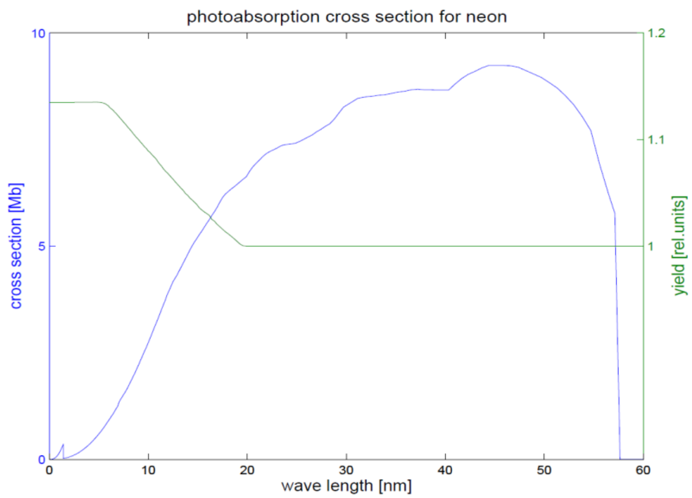
- For the range 50-110 nm we will check with the SEE data to take into account the current contribution from the x-ray irradiance below 16 nm that is not recorded by SolACES. For the range >130 nm our data statistics shall be improved by using SEE data.

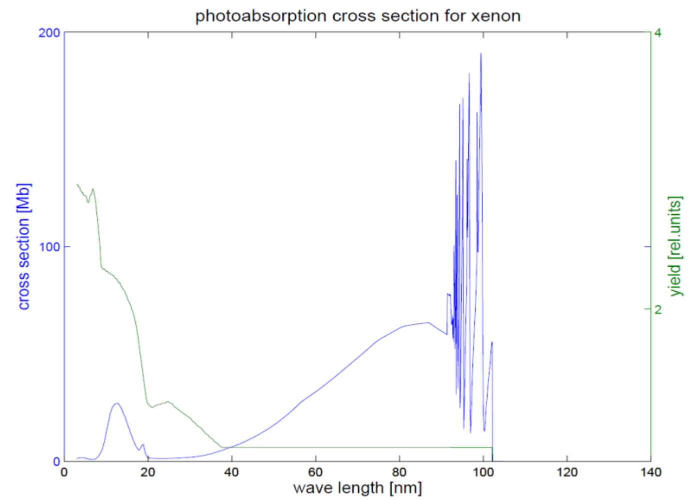
- We have shown results spectra, which can be calibrated directly (spectra and ionisation chamber observations are nearby). After comparing with your observations at this workshop, we will fastly produce the calibration of the other spectra.

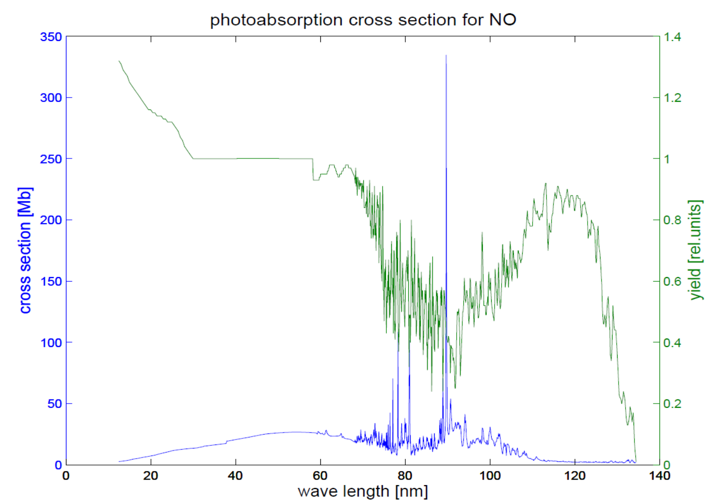
- The calibrated spectra will be provided to investigate the impact of the solar irradiance variability on the Earth's climate changes as well as on the thermospheric/ ionospheric interactions that are part of the TIGER program and to anyone interested in using solar EUV irradiance.

Photon Flux Calibration – Cross Section

SolACES







Neon: Ionisation energy = 21.56 eV
Xenon: Ionisation energy = 12.13 eV
NO: Ionisation energy = 9.2 eV

Source

Neon, Xenon:

•B.L. Henke, E.M. Gullikson, and J.C. Davis, Atomic Data and Nuclear Data Tables 54 no.2, 181-342 (July 1993).
•Samson, J.A.R., G.N. Haddad, Phys. Rew. Lett., 875, 1974.
•Samsom. J.A.R., W.C. Stolte,J. of Electron Spectroscopy and Related Phenomena, 123, (265-276, 2002.

NO

• Watanabe et al. , Appl. Optics, 391, 1967.