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TOWARDS HIGHLY ACCURATE ABSORPTION CROSS SECTION AROUND 308 NM FOR REMOTE SENSING OF ATMOSPHERIC OZONE

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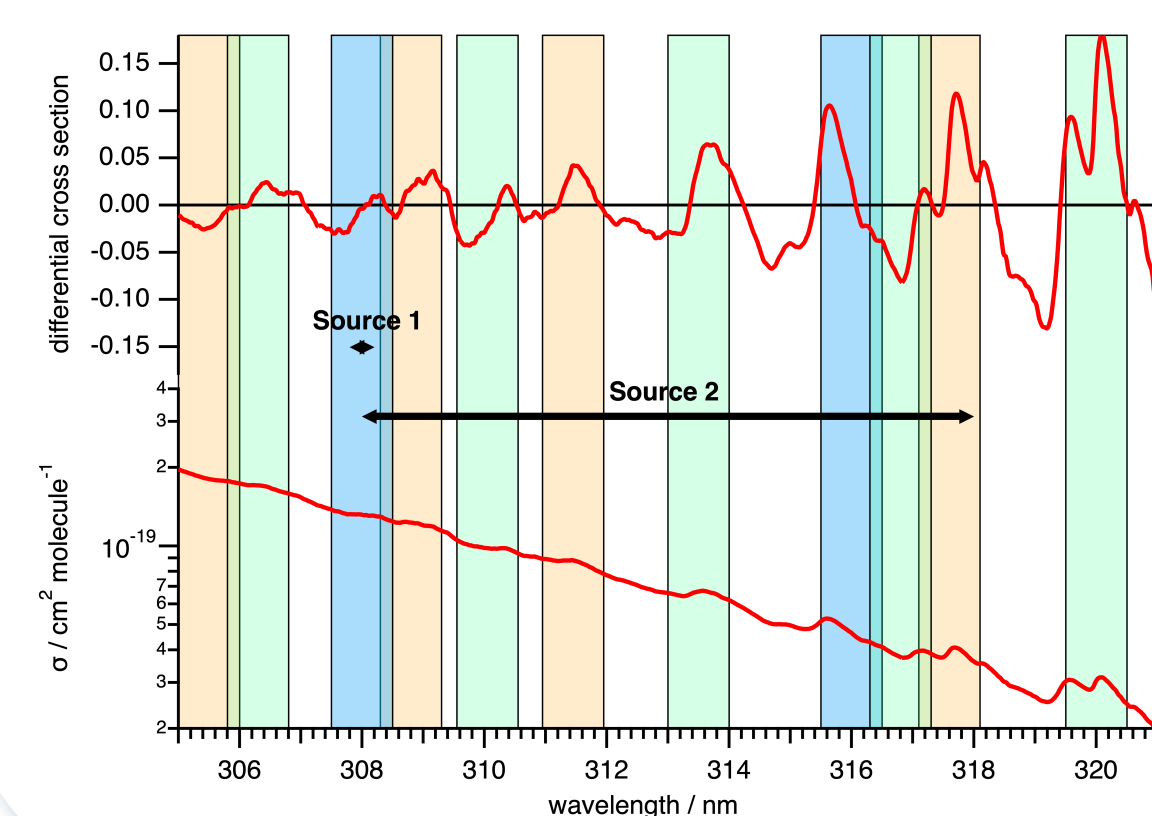
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Motivation

Currently recommended ozone cross sections [1] for remote sensing have been confirmed recently at 253.65 nm through a thorough re-evaluation of literature data that led to the recommendation of a new value with an unprecedented 0.3 % level of accuracy [2]. Still, at other wavelengths larger biases may exist, in particular in the Huggins bands, where more recent studies indicate that deviations might be at the few percent level [3,4].

Overview of Ozone Absorption Cross Section between 305 nm and 320 nm

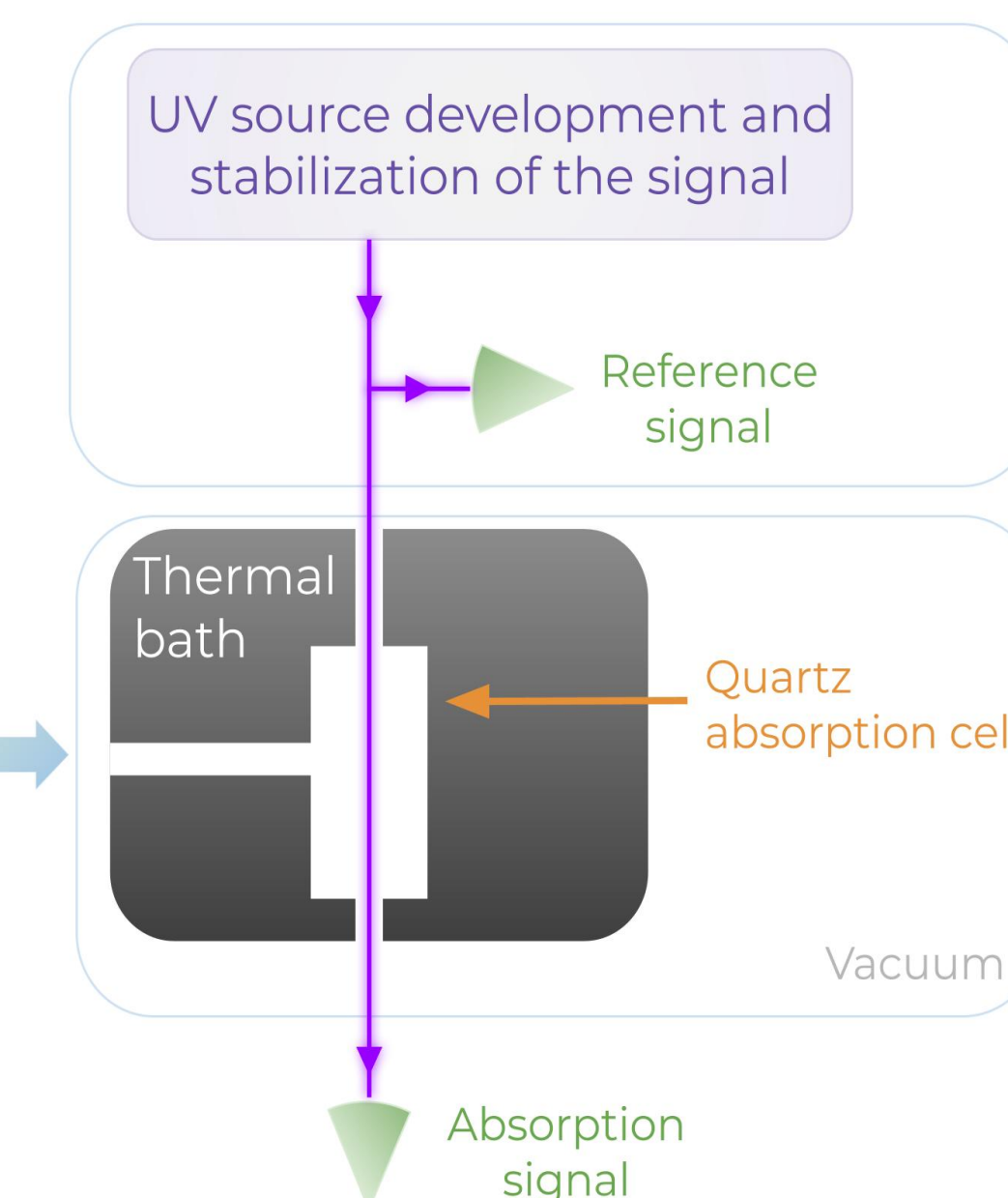
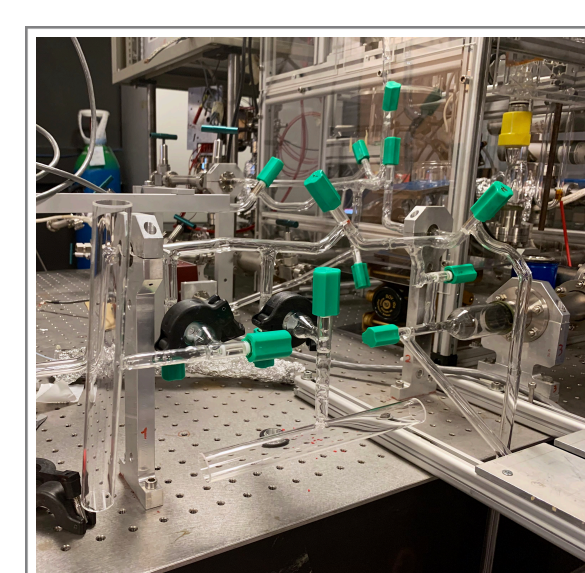


Ozone absorption cross sections and measurement ranges. Absolute values are on the lower trace, differential values on the upper trace. Colored rectangles indicate observation wavelengths for Lidar (blue), Brewer (green), and Dobson (yellow) instruments within a 1 nm spectral window. The horizontal arrows indicate the spectral coverage of two laser sources (source 1: 308 ± 0.2 nm, source 2: 308-318 nm) to be developed

In our ongoing study, we intend to measure the ozone absorption cross section at the 1 % uncertainty level over the 308-318 nm range, used by many observational platforms (stratospheric and tropospheric O₃ lidars, Brewer and Dobson spectrophotometers, nadir UV satellites). These new laboratory data will then be tested in the atmosphere, especially in the UTLS region. Here, we present the project of absorption cross section measurements, the development of two new laser sources and first tests of one of the laser sources.

Basic set up

Our planned cross section measurements rely on new and innovative tunable UV laser sources which will allow for high-resolution and high-accuracy measurements.

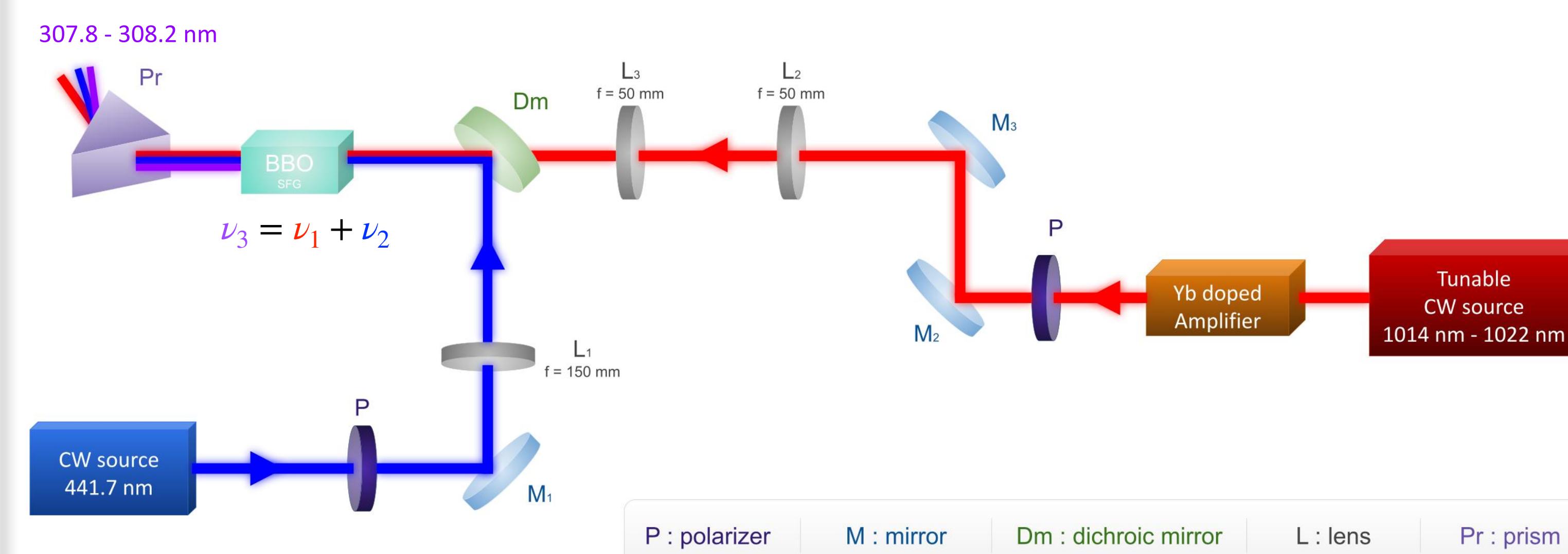


The source signal is directed to a quartz cell containing pure ozone. The absorption cell, whose length has been determined interferometrically [5] measured will be integrated into a thermally stabilized and adjustable housing. The ozone concentration will be determined by UV absorption at 253.65 nm.

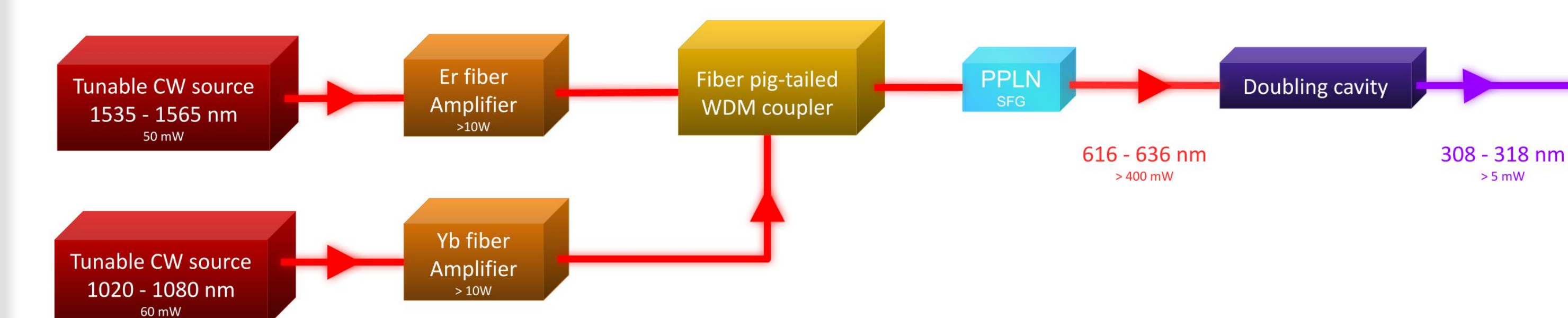
New Tunable UV Sources

To generate UV, we are about developing two tunable sources based on sum frequency generation (SFG) in non-linear optical crystals :

1st source : for stratospheric LIDAR around 308 nm (307.8-308.2 nm)



2nd source : for broader spectroscopic measurements ranging from 308 nm to 318 nm.

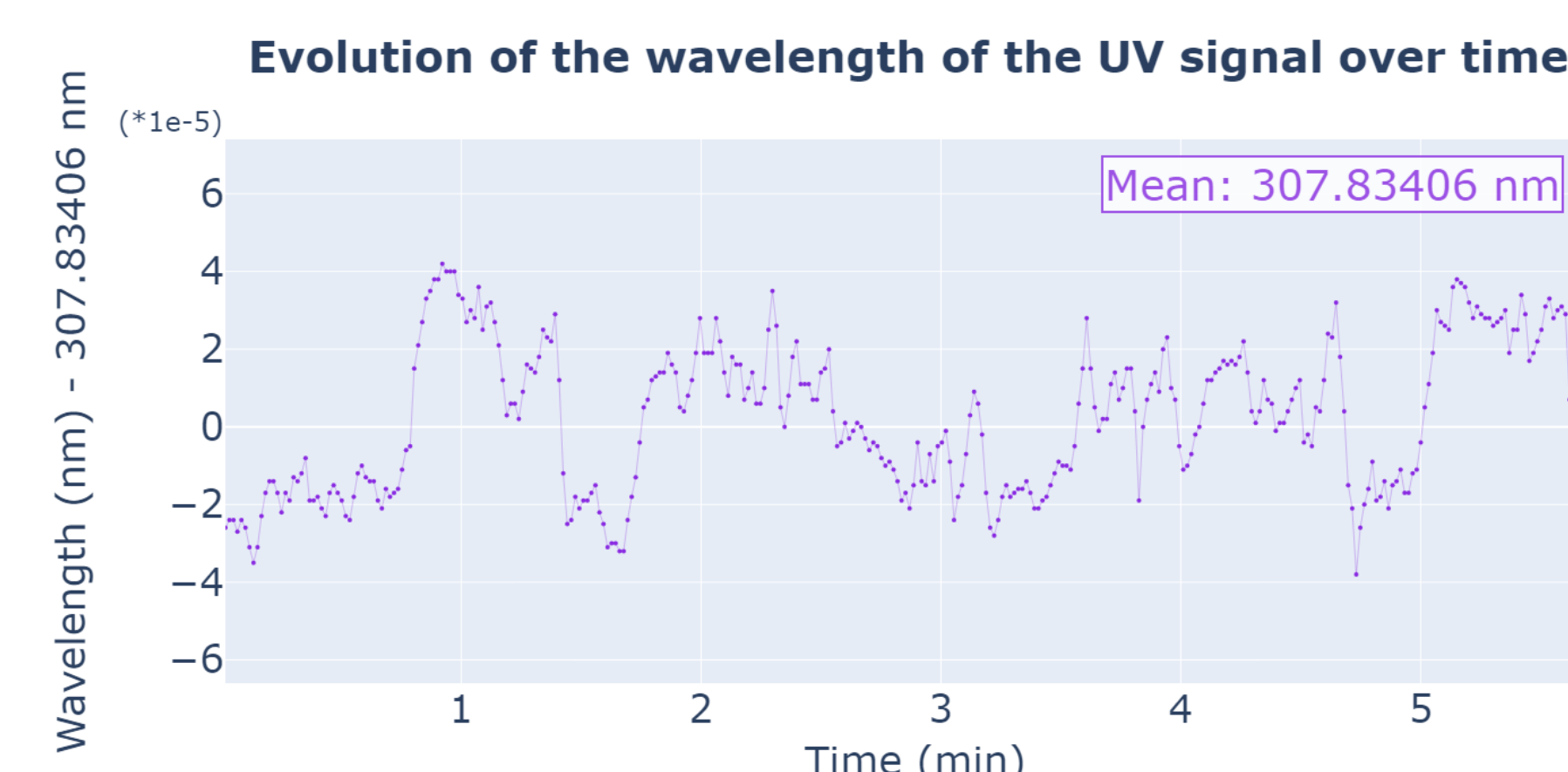


Characterization of the 1st UV source

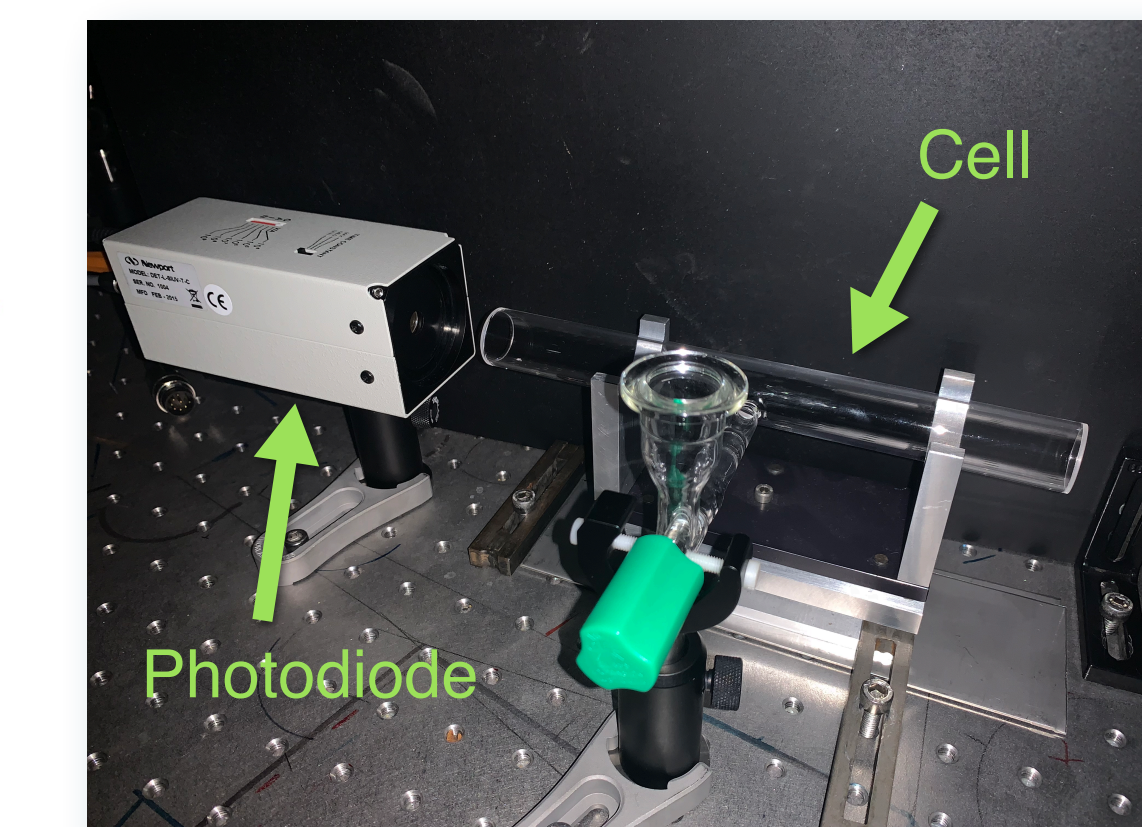
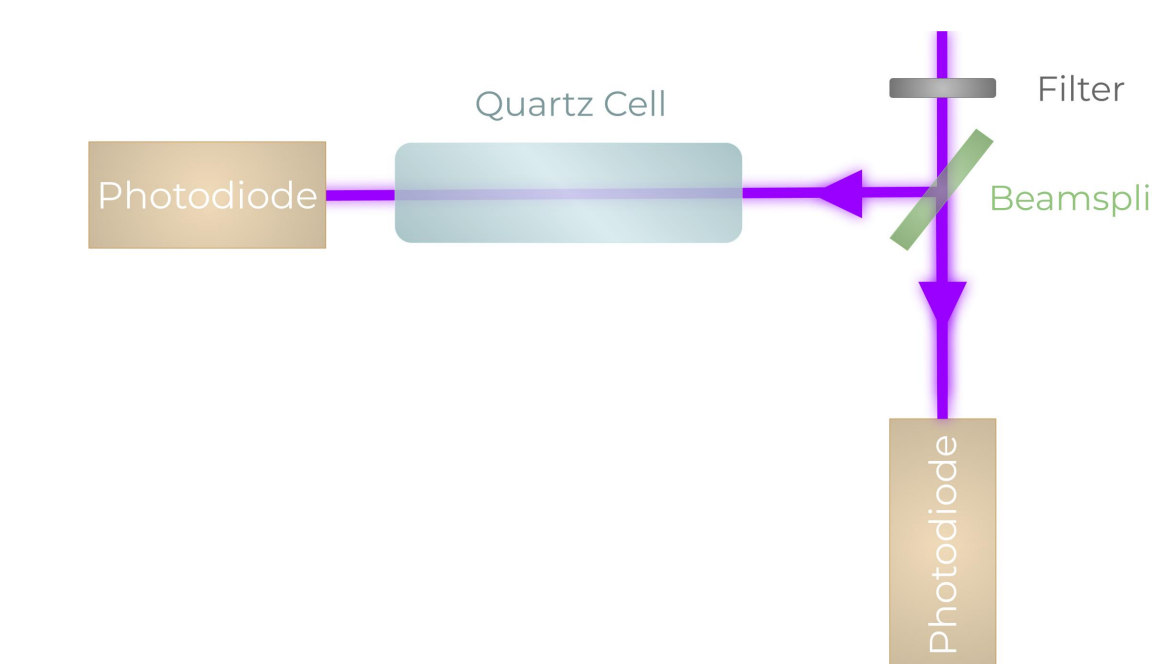
At input powers of 200 mW for the infrared (IR) and 100 mW for the blue (BL) source, we measure a power of 3.5 μW (30 % of the theoretical value). The UV power has been measured using Lock-in detection and a Si-photodiode (Oriel) with calibrated spectral response curve.

We examined the wavelength stability and accuracy within the target tuning range of 307.8 nm to 308.2 nm. The graph shows the stability of the emission wavelength over several minutes. The Table provides a summary of the wavelength measurements obtained using a WS7-60-UV1 wavelength meter (HighFinesse).

Target / nm	λ BL / nm	λ IR / nm	λ UV / nm	Δλ UV / 10 ⁻⁴ nm
307.83406	441.69239	1015.76012	307.83406	0.0
307.90108	441.69251	1016.48969	307.90102	0.6
308.00067	441.69251	1017.57592	308.00058	0.9
308.13737	441.69251	1019.06948	308.13736	0.1
308.20308	441.69251	1019.78861	308.20304	0.4



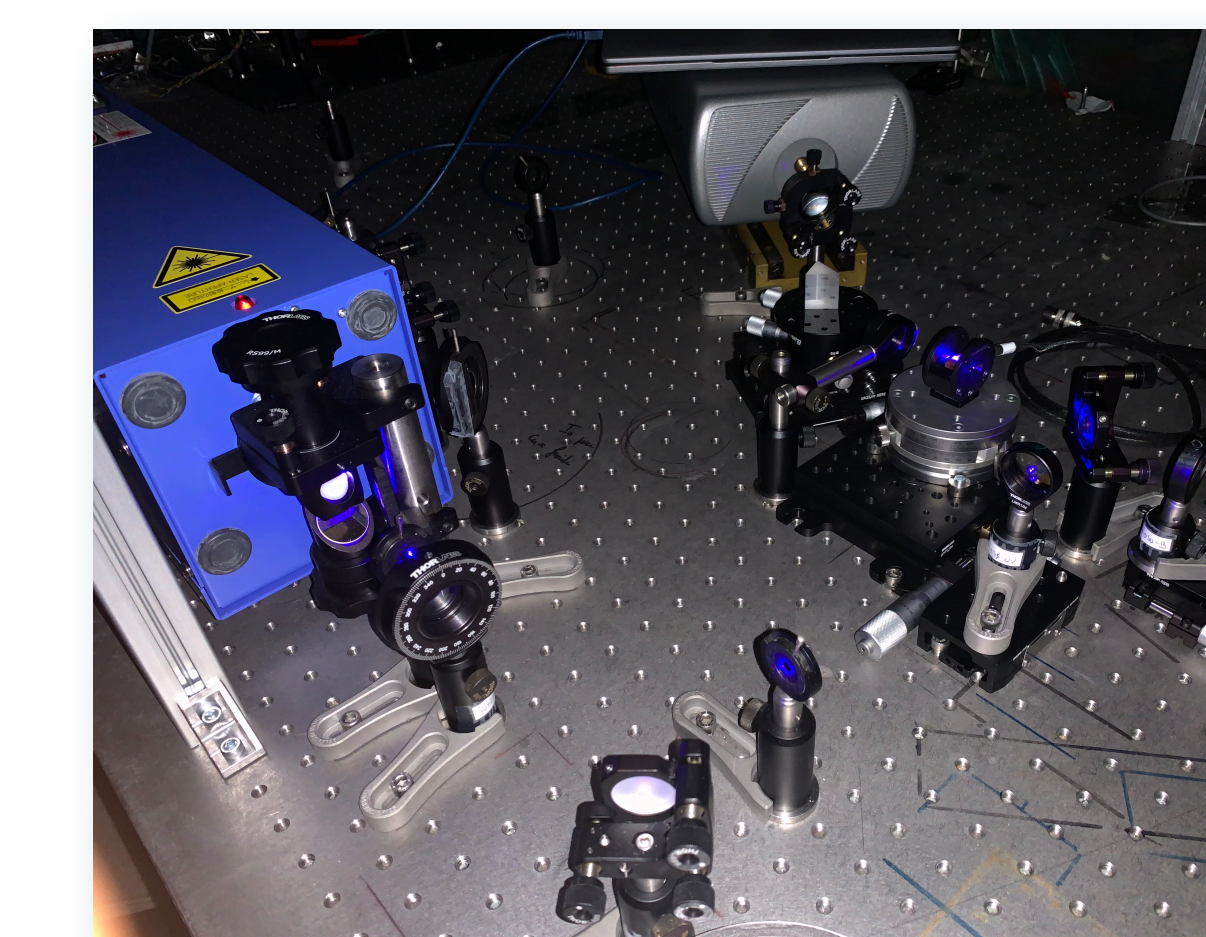
Very first tests at 308 nm



We have made preliminary room temperature absorption tests with and without ozone using the narrow source #1. These have shown that the UV laser power is sufficient to measure the absorption (0.3 % noise at 1s) provided that Lock-In amplification is employed. However, the signal is currently hampered by interference fringes on the order of a few % that need to be reduced before quantitative measurements.

Conclusions and next steps

- First spectrally narrow UV laser source for ozone spectroscopy (1-10 MHz)
- Spectral resolution / laser stability already better than 10⁻⁴ nm
- Set-up intensity stabilisation (AOM) and improve active wavelength control
- Set-up thermally stabilized and adjustable absorption cell
- Conduct ozone absorption measurements directly referenced to UV at 253.65 nm.
- Target absolute uncertainty < 1%.
- Use new data for atmospheric Lidar measurements [6] and compare to radiosondes.
- The same approach will be applied to UV source #2 which provides data for Brewer, Dobson and satellite instruments.



References

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Acknowledgments

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