

## ***Interactive comment on “Assessment of the performance of a compact concentric spectrometer system for Atmospheric Differential Optical Absorption Spectroscopy” by C. Whyte et al.***

**Anonymous Referee #2**

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### General Comments

The paper presents first steps toward the application of a compact concentric imaging spectrometer for DOAS application with a focus on satellite applications. As the general concept of this system was already published (Lobb 2004), the paper presents a first attempt to implement such a concentric spectrometer with its most critical optical elements (convex spherical grating, concave spherical mirror etc.) driven by requirements to use the system for atmospheric Differential Optical Absorption Spectroscopy (DOAS) from Low Earth Orbit. The paper describes the breadboard incl. the key op-

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tical components, as well as first results from spectral and spatial characterisation of the spectrometer. It has to be noted that whereas the spectrometer optics seems to be representative in their dimensioning for an instrument in Low Earth orbit (LEO), the front end optics (telescope) are currently not bread boarded and the used 1 k x 1k CCD detector is not fulfilling the requirements deduced for a sensor in LEO leading to a requirement for a 2 k x 4 k CCD array. The impact of the latter limitation is minimised by translating the used CCD through a 2 x N (number N missing in the manuscript!) array, to map the full focal plane. Main results of the paper are that such a compact system seems to be compliant with the spectral requirements of a DOAS spectrometer and offers good image quality. The paper is well written but did not address important key requirements for a DOAS spectrometer like signal-to-noise (see below). It is therefore recommended that the authors revise the manuscript along the comments given below.

### Specific Comments

SC1) The driving requirements for the spectrometer are not clearly identified. In chapter 1 geostationary as well as LEO and high altitude platform applications are listed, in chapter 2 a sensor in LEO was selected to be the design driver, but no concrete instrument requirements (beside the geometric ones on spatial resolution and swath) were given. It is therefore proposed that the authors make a link to existing mission (or instrument) requirements, for example to the draft Sentinel 4 and 5 MRD (<http://esamultimedia.esa.int/docs/GMES/Sentinel4and5MRDissue1rev0signed.pdf>) as initial reference for a first guess on relevant sensor requirements. The relevant key requirements (see SC2) then needs to be confronted with the estimated performance of the compact concentric spectrometer system, for example in a table. Such a comparison will allow a better judgment in how far the presented system is able to address the relevant key instrument requirements.

SC2) The successful application of a spectrometer for DOAS, especially on weak absorbing species in the UV like HCHO and BrO, puts stringent requirements not only onto the spectral performance of the spectrometer, but also on signal-to-noise and on

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straylight. Whereas straylight is partly addressed as total integrated scatter of the spectrometer, nothing is mentioned about the achievable signal-to-noise for the envisaged LEO application.

It is therefore strongly recommended that a paragraph is added giving information on achievable SNR for LEO applications. In addition, the spectral distribution of straylight needs to be reported and an estimate on the additional straylight contribution from a telescope, to address the question how much the signal in the UV is corrupted by straylight from the visible wavelength.

SC3) As it is obvious that such a compact design could be favourable for satellite applications, the discussion of other design aspects (alignment, robustness, performance etc.) in comparison to existing demonstrated designs used in GOME, SCIAMACHY, OMI or OMPS is missing. It is therefore recommended to add table with pro's and con's of existing designs (for example GOME, SCIA, OMI, OMPS) for space based DOAS spectrometers in comparison to the concentric spectrometer design presented in the manuscript.

SC4) The usage of the references Bovensmann et al 2002 and Bovensmann et al 2004 on page 1904 (row 27) w.r.t. the concentric design is slightly misleading, as both did not give more details on the concentric design. They give the details on one potential application area, namely geostationary sounding of atmospheric pollutants. In that context they trigger the development of the concentric design. It is recommended to clarify this in the text.

SC5) In chapter 2 the "operational" is used too often and the context is not always clear. Please reduce the usage of operational and clarify for the remaining the meaning.

SC6) There seems to be some redundancy in the figures (fig 6 left with fig 9), which needs optimisation.

SC7) The origin of the intensity background in fig. 6, 8, 9, 10 needs to be explained

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(straylight?, electronic offset? etc.).

SC8) The statement at the end of chapter 3 (page 1912, row 19-20) is not fully justified by the material presented in the manuscript, as important performance parameters namely the signal-to-noise ratio and spectral dependence of straylight in the UV are not fully addressed (see SC2). The statement should be revised in light on what could be presented added to the revised manuscript on straylight and SNR.

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