

## ***Interactive comment on “Instrument concept of the imaging Fourier transform spectrometer GLORIA” by F. Friedl-Vallon et al.***

**F. Friedl-Vallon et al.**

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Dear Jean-Francois,

Thank you for this positive and constructive review. We will address your suggestions (marked by blue writing) point by point.

My main complaint about the paper is that it does not show a spectrum recorded during one of the campaigns. I suggest that a Figure be added showing an overall bandpass spectrum and one band detail, right after Figure 4.

We will include two additional figures in the revised version of the article, one depicting a set of spectra over the full spectral range of the instrument and one showing a zoom

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into a smaller spectral region.

The second complaint is that no mention is made of instrument line shape (ILS) retrieval. This should be added to Section 4.

We will add a paragraph concerning ILS performance. ILS has been studied in detailed instrument simulations with a ray-tracing program and subsequent numerical ILS calculations. The applicability of these calculations to the real instrument has been proven by lab measurements. The modeled ILS will be used in future for the L2 retrieval of CM and DM data. The current preliminary L2 data set has been produced without the use of the ILS model for practical implementation problems.

Page 2304, line 10, should mention the IASI instrument.

We are mentioning space instruments with large focal plane arrays (more than 16 pixel). IASI has 4 detectors, so does not fit in this context.

Page 2305, line 11 and line 21: I would swap the order of these two paragraphs, given that it makes more sense to mention the overall scientific interests before going into the details of the requirement Table. This swap may require some re-wording of the sentences.

We have tried to address this request by a rewording of the first paragraph of section 2 (please see below). We hope also to address the second request of Reviewer 2 with this rewording:

*A brief summary of the scientific aims at the beginning of the section shall outline the background for the discussion of the instrument requirements. A detailed discussion of the scientific aims and references can be found in Riese (2014). The scientific aims comprise of improved understanding of the in-mixing of moist air into the lowermost stratosphere by quasi-horizontal transport, of convective overshooting and of troposphere-stratosphere exchange e.g. by tropopause faults. Furthermore, long-range transport of pollutants, its influence on the ozone budget of the UTLS, and poten-*

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tial pathways from the troposphere into the middle atmosphere shall be investigated. This involves a complex chemistry of many species with life-times of a few weeks. Finally, we are interested in the dynamical forcing for instance by gravity waves and in dynamical structures such as the tropopause inversion layer and its formation. Depending on the focus of an individual science target we are interested in temperatures and a varying number of trace species as well as in cloud properties. In particular for stratosphere-troposphere exchange, pollutants, and for gravity waves it is of advantage to measure as far as possible down into the free troposphere. Filaments in the UTLS...

Page 2310, line 19: "Typical frame rates are in the 3-6 kHz range, depending on the size of the chosen sub frame." The paper must mention the size of these sub frames. With 8 outputs and 10 MHz clock, one can at best output 80 M pixels per second, and probably less if there are dead times at line or frame boundaries. Also, array reset and integration time may happen sequentially with the reading. But even keeping the optimistic 80 M pixels per second, one can read only 13333 pixels at 6 kHz frame rate and that is less than a quarter of the full 256 x 256 array.

See answer to next comment.

Page 2310, line 20: please mention frame integration / reset times and if these happen in parallel or in sequence with frame readout.

The paragraph will be changed to: *Typical frame rates are in the several kHz range, depending on the size of the chosen sub frame. Currently a sub frame with 128 x 48 elements is used resulting in a frame rate of 6.3 kHz. Frame integration time is commandable and is varied between 30  $\mu$ s and 120  $\mu$ s, depending on the scene brightness. The read-out circuit allows integration in parallel to the read-out process.*

Page 2311, line 1: "since full integration time efficiency of the detection system can be reached at the chosen operating temperature". I believe that the effect of a warmer instrument would be to increase the amount of thermal background signal on the detector (some modulated by the interferometer, some not). And so the criterion for the instru-

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ment temperature would be that the thermal background signal is sufficiently lower than the signal from the atmosphere to not contribute too much to the photon noise.

In principle you are right, but the optimal operation temperature according to this criterion is not achievable in practice. It is very low and would lead to a very expensive design of the instrument. The largest contribution to our noise budget are background photons but read noise is not much less. Read noise scales with one over the temporal fill factor, photon noise only with one over square root of the fill factor. So it is advantageous to operate with the largest temporal fill factor that is achievable and this can be reached already at an operating temperature level of 220 K. This is the optimal operation temperature when we look at the cost-performance relation. We considered the full explanation of these rather intricate considerations to be out of scope for this overview article. We're intending to publish an article focusing on the optical and optoelectronic design of GLORIA which will present these issues in more detail.

Page 2310, line 24, I do not understand: "and carbon dioxide snow evolves."

The text has been reformulated to: *Liquid carbon dioxide is sprayed under high pressure through small injection pipes into the cooler tank. The carbon dioxide pressure drops sharply at the exit holes of the pipes, leading to adiabatic cooling and to the generation of carbon dioxide snow.*

Page 2315, line 13, I do not understand: "resolution of T1279"

This is a code for the horizontal resolution of the ECMWF model. We will add a better description and a reference.

All technical comments not mentioned in the reply will be implemented as suggested in the revised version of the article.

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