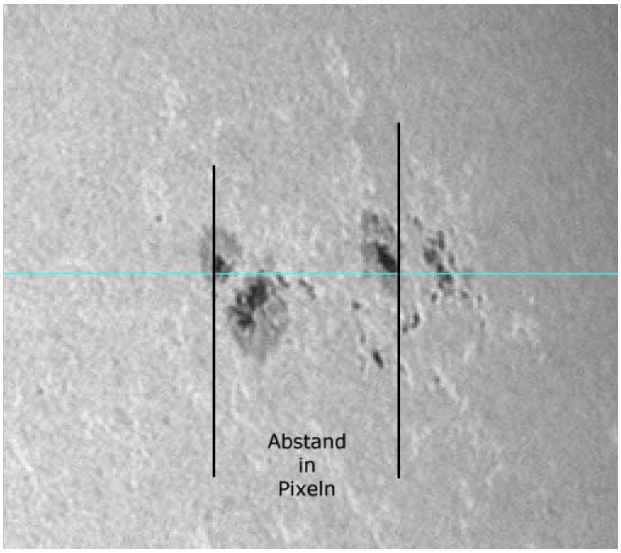
# The Baader Telecentric System TZ-2
# How important is the Working Distance?

For successful solar observation with narrowband line filters (half-widths (HWB) below 1 Angstrom) made by *Solar Spectrum* and *Day Star,* a telescope with a focal ratio of at least f/30 and a parallel beam of light is a prerequisite. This focal ratio can be achieved either by stopping down the objective aperture - or preferably by extending the focal length with a "telecentric system" (in short: telecentric or TZ).

Telecentric systems are not to be equated with Barlow lenses! Only a TZ creates a parallel beam of light and only in this way is an even representation of the chromospheric structures across the entire field of view of the telescope possible. Even in a telescope stopped down to f/30, the light rays converge slightly and thus hit the etalon at different angles. In the etalon - which is only ~2/10 mm thick - they are reflected back and forth up to 1000 times in order to filter out the H-alpha line by interference. Beams hitting the edge of the image at an angle will travel a longer path through the etalon, and the filter effect changes towards the edge.




*Focal length = 1,085mm, EDF in main focus, stopped down to 100mm, Baader Herschel wedge and D-ERF filter.*

To determine the corresponding focal length and thus the extension factor of the telecentric system, a sunspot group with an exactly known focal length was taken as a reference. The distance between two sunspots was determined in Photoshop and then images were taken through the H-alpha filter adapted to the TC and compared with the target focal length.

The sunspot group AR 2335 on 2 May 2015 served as reference. The images were created as avifiles with a Celestron Skyris Video Module 445M. Due to the many individual images, seeing effects are averaged in the final image, so that the focal length determination turns out to be quite accurate. Before the measurement, the different images are rotationally symmetrically aligned to each other in Photoshop.

In my case, the TZ-2 is built into the Baader M68 Tele-Compendium for better stability (see the image to right, where the TZ-2 can be seen in the partly removed Tele-Compendium).

The nominal distance for the TZ-2 (2x focal length extension) should be 200 mm from the end of the sleeve of the lens group to the image plane and then provide the extension factor of 2.0.

The nominal distance of the TZ-2 was varied to 160 mm, 200 mm (nominal value) and 230 mm during the test exposures. The results were as follows:

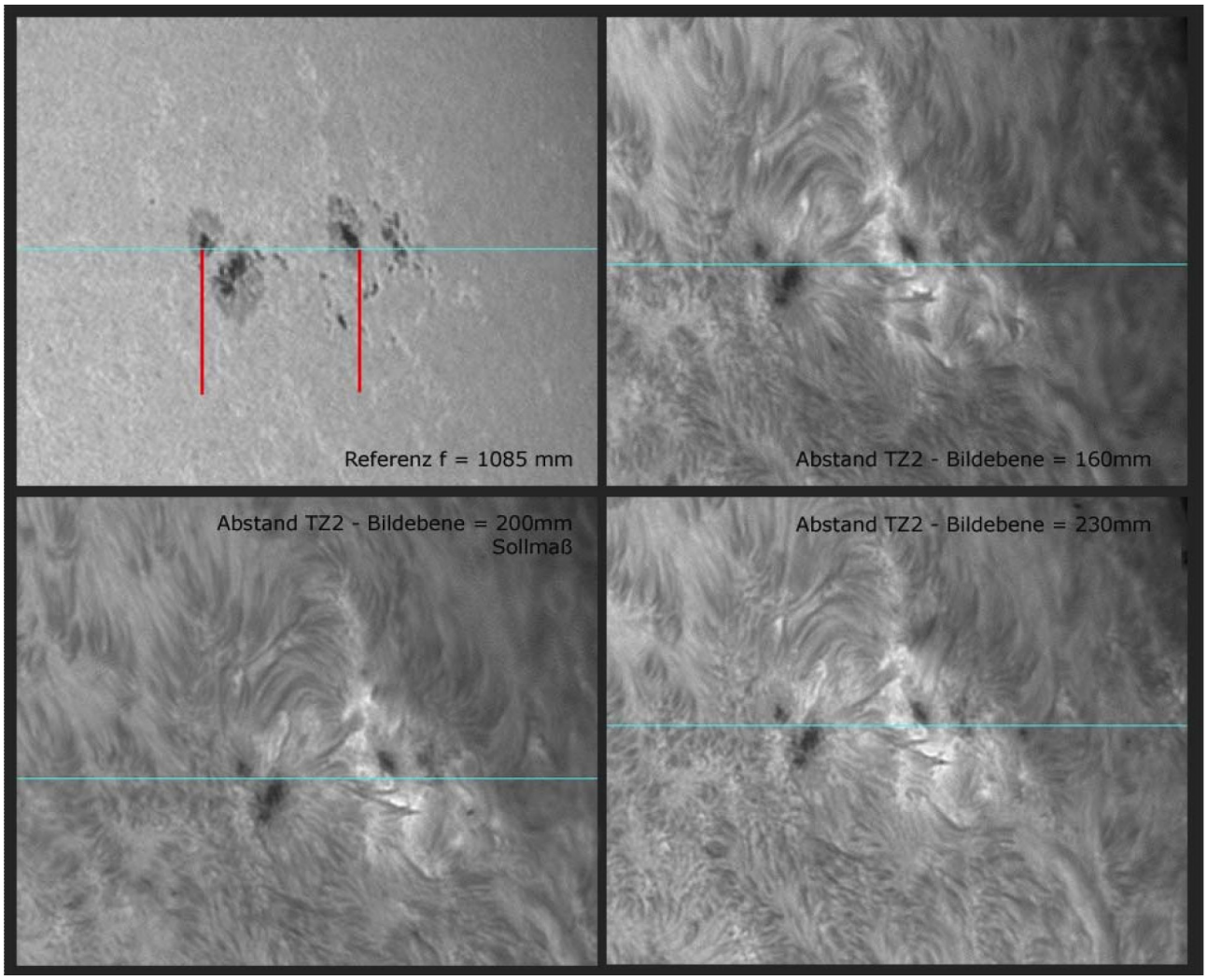
A distance of

160 mm results in a focal lengthening factor of 2.07,
200 mm results in a focal lengthening factor of 1.98 and at
230 mm results in a focal lengthening factor of 1.96.

The results show that the distance between the lens element of the TZ-2 and the image plane is quite uncritical. The focus shifts inwards, i.e. towards the lens, with increasing distance between lens element and image plane. I did not notice any deterioration of the image quality at 160 mm and 230 mm distance – however, the seeing conditions were quite miserable.

This results in the following focal lengths and aperture numbers on my EDF (related to 75 mm aperture):

160 mm = 2,246 mm, f/30
200 mm = 2.148 mm, f/28.7 and at
230 mm = 2,127 mm, f/28.4




*Composition of the comparison images: Top left, the reference focal length, then images at the three different distances between the lens element and the image plane.*

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