The SkyWatcher Heliostar: a revolution?

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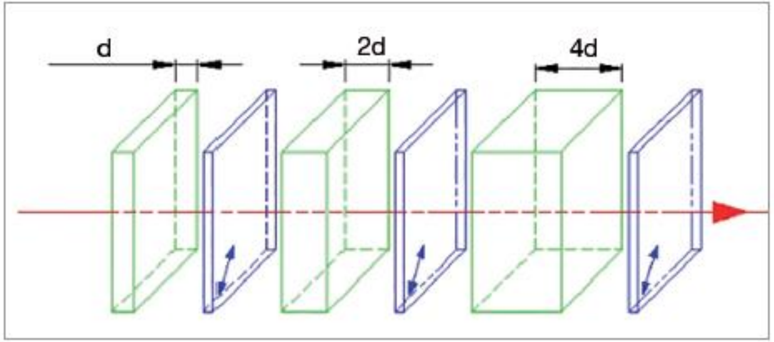
Summary

- Hα technology: a bit of history
- The Heliostar 76 et 100:
  - Operating principle.
  - Some images.
  - Some measurements.
  - How these results are achieved?
  - Sweet spot.
  - Blocking filter.
  - Possible optimization.
- Lunt’s Gen II etalons.

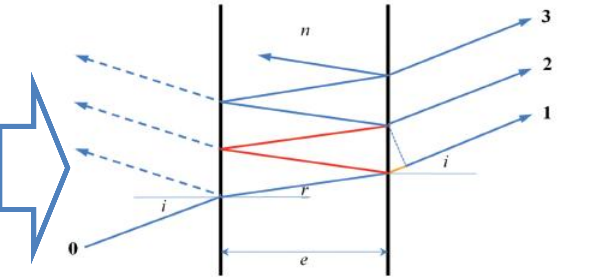
The Lyot-Ohman filter

- Invented independently by B. Lyot (1933) et Y. Ohman (1937).
- Initial goal: observation of prominences outside of eclipses.
- Succession of birefringent and polarizing plates => also called birefringent filter.
- Very difficult to manufacture. Heavy. Temperature regulated to ±0.1 °C.
- OPL (France, 1949-65) : FWHM = 0.75 A.
- B. Halle (RFA, 1950-60) : FWHM = 0.5 A.
- Zeiss (1970) : FWHM = 0.5 A et 0.25 A , “universal” model ajustable from 4200 A to 7500 A.
- 1952 : “amateur” construction par Henry E. Paul (USA). Amateur Telescope Making Book III.

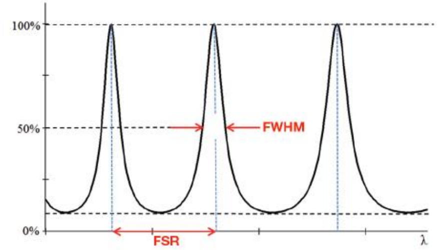


The Fabry-Perot etalon

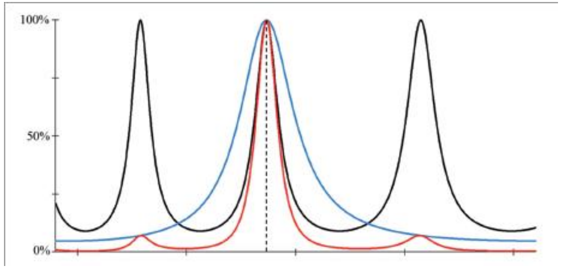
- 1898 : Charles Fabry and Alfred Perot invented the two-mirror, semi-transparent, multiwave
- interferometer. This is the principle behind the Fabry-Perot etalon.



Air gap or mica sheet
e = 0.2 à 0.05 mm



Comb-tooth transmission



The transmission peak on Ha is isolated by the blocking filter

Air-spaced etalon

mica-spaced etalon

Mica-spaced Hα etalons

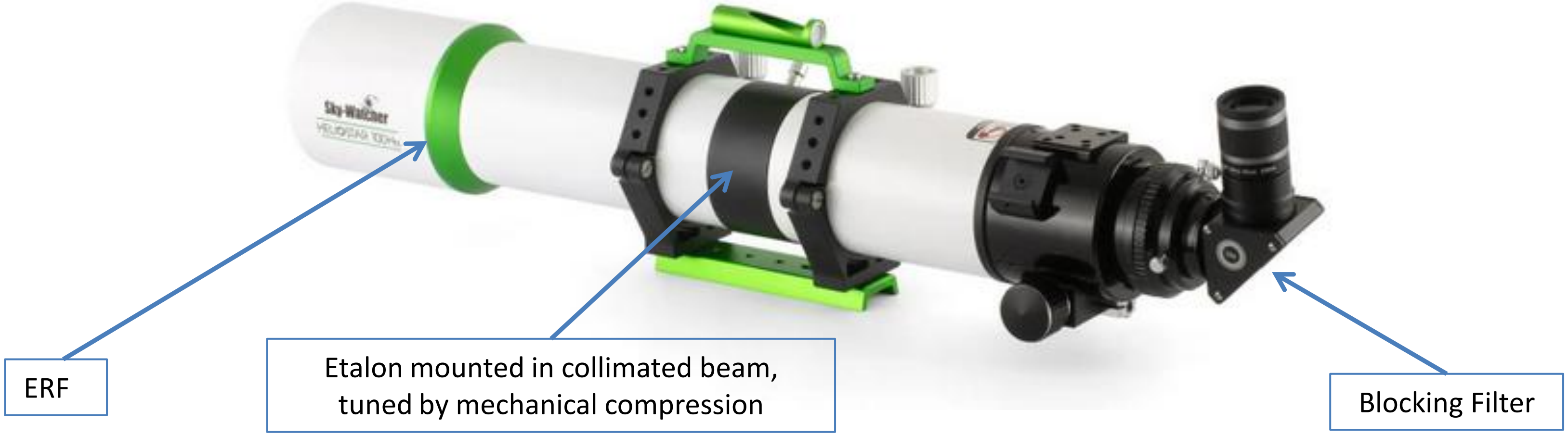
- 1959: J.A. Dobrowolski (Canada) describes the manufacturing principle of a mica-spaced Fabry-Perot etalon and files a patent in 1962.
- *1960 : 5 A multilayer interference Ha filters made by Baird Atomic Inc (Mass, USA), available to amateurs (S&T Aug, 1960)*
- First mica-spaced etalon commercially produced by D. Carson and D. Martin (USA).
- 1966 :first mica-spaced etalon (0.7 A) made in the URSS.
- 1970 : first Hα etalons accessible to (wealthy) amateurs, manufactured par Carson Astronomical Instruments. Skyspear models: FWHM : 0.5 Å to 1.2 Å. The etalon was placed in front of the telescope.
- Early 1970's : Del Wood leaves Carson (which has gone bankrupt) and founds DayStar.
- 2002, Mark Wagner, who had worked at DayStar since 1976, founded Solar Spectum.
- Currently, the advertised FWHM ranges from 0.8 A to 0.3 A FWHM..
- Technology essentially unchanged since the mid-1970s.

(Amateur) air-spaced etalons

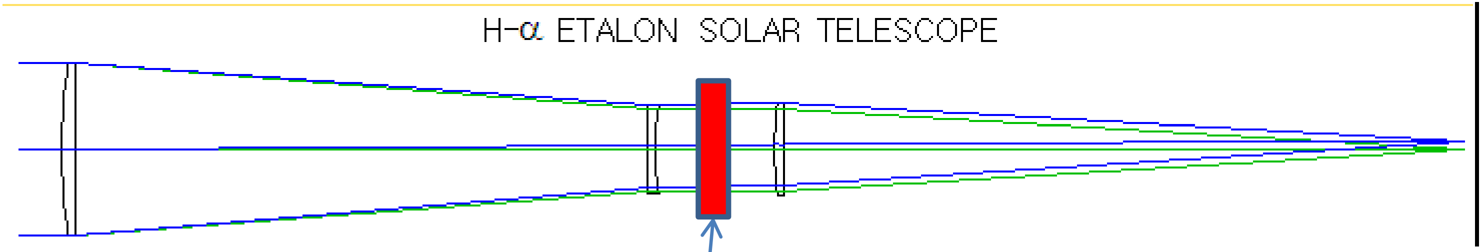
- 1997 : David Lunt founded Coronado after working since 1965 on coating (lasers and very narrow band filters)
  - Inital models:
    - VHn: refractive index =2.4 => not really successfull,
    - SMn : refractive index = 1.52, télécentrique, temperature contril, a few units made
    - AS1 : air-spaced etalon (diameters 40-60-100 mm), to be placed in front of the telescope.
    - Some double-stack made for NASA.
  - Several generations of solar filters and telescopes have succeeded one another.
  - Wavelength adjustment by tilt or mechanical compression(PST in 2003, then SMIII Rich View).
  - 2004 : Coronado sold to Meade for $1.7 million
- 2002 : Ken Huggett founded Solar Scope (Isle of Man).
- 2008 : Andrew Lunt founded Lunt Telescopes and introduced the "pressure tuner" adjustment.
- FWHM specfications < 0.7 A.
- Technology essentially unchanged since the end of 2000s.

The SkyWatcher Heliostar

- Complete telescope, including etalon and BF, dedicated to observing the Sun in Hα.
- Mi-2025 : 76 mm model, f = 630 mm.
- Début 2026 : modèle 100 mm model, f = 760 mm.



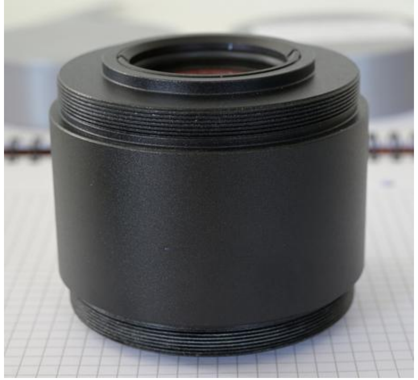
Basic optical diagram

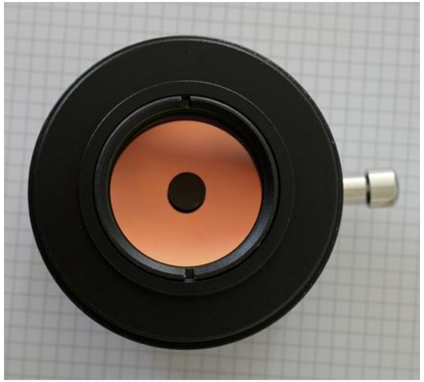


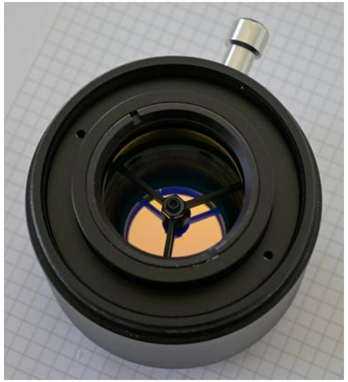
Etalon placed in a collimated beam
(between diverging and converging lenses)

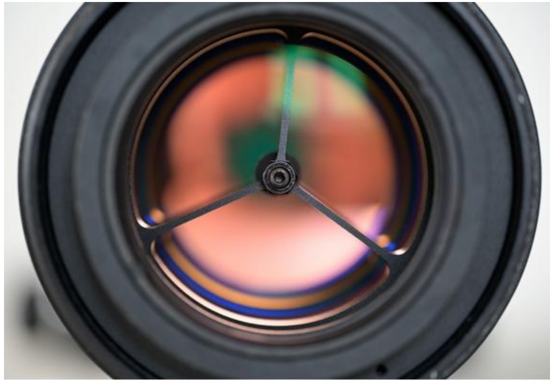
The internal air-spaced etalon

- HS76 : 40 mm etalon, 10 mm central obstruction = 25%.
- HS100 : 60 mm etalon, 10 mm central obstruction = 13%.
- Tuning by mechanical compression: shifts towards blue when the etalon is compressed.
- Tuning amplitude: about 1/8 of a turn = approximately 0.8 A on the HS76.

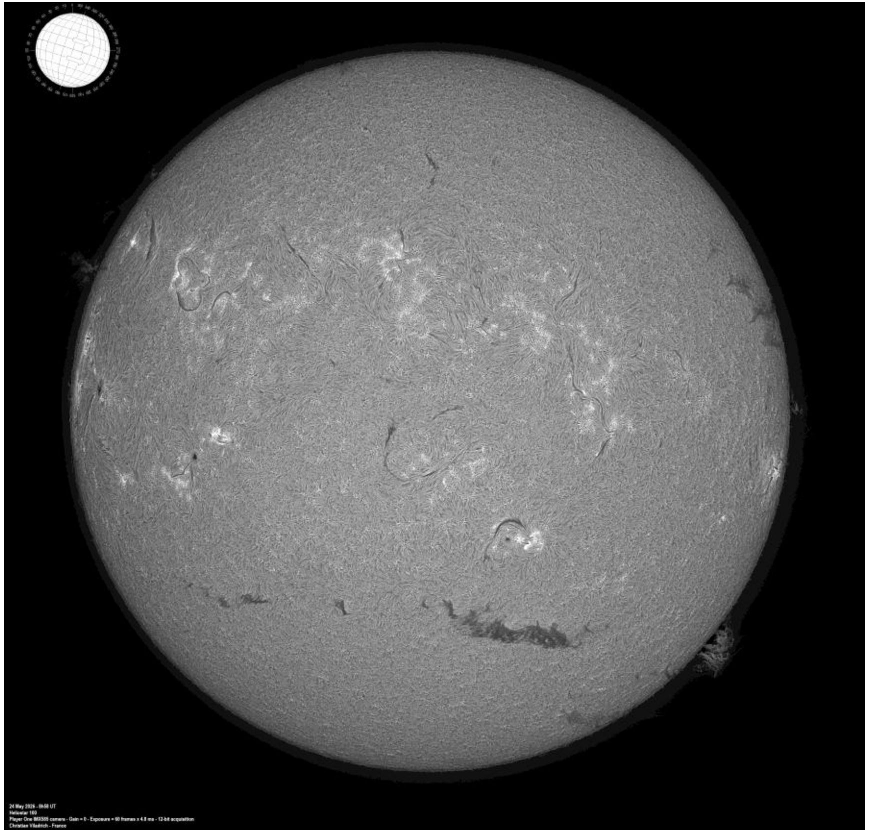








Some images



15 April 2026 - 9h57 UT - AR4419- Heliostar 100 - Astrophysics Barlow lens

Lessons learnt from imaging

- Much higher contrast compared to previous single-stack etalons (Coronado, Lunt).
- Almost comparable to a double-stack: however, a faint double limb is still visible.
- Much easier to adjust than a double-stack configuration.
- Better uniformity than a double-stack configuration.
- After a few weeks, the wavelength tuning seems to remain stable from day to day and little sensitive to temperature.
- However, allow time for temperature adjustment if there is a significant difference (>10 °C) between storage temperature and outside temperature.

Measurements

- The measured FWHM are consistent with the contrast of images.

Heliostar 76					
date	delta CWL not compressed	FWHM not compressed	FWHM on Ha	FSR	Measurement method
June 2025			0.25 A	11.5 A	spectro
Nov 2025	0.6 A	< 0.20 A	< 0.30 A	10.5 A	spectro + H2 lamp
Feb 2026	0.76 A	< 0.30 A	0.32 A	12.2 A	H2 lamp

Heliostar 100					
date	delta CWL not compressed	FWHM not compressed	FWHM on Ha	FSR	Measurement method
Janv 2026	0.27A	0.30 A	0.37 A	10.3 A	spectro + H2 lamp
Janv 2026	0.91 A	0.41 A	0.41 A	16.7 A	spectro + H2 lamp
March 2026	0.65 A	< 0.3 A	< 0.4 A	12.2 A	H2 lamp
March 2026	0.43 A	0.29 A	0.31 A	11.3 A	spectro

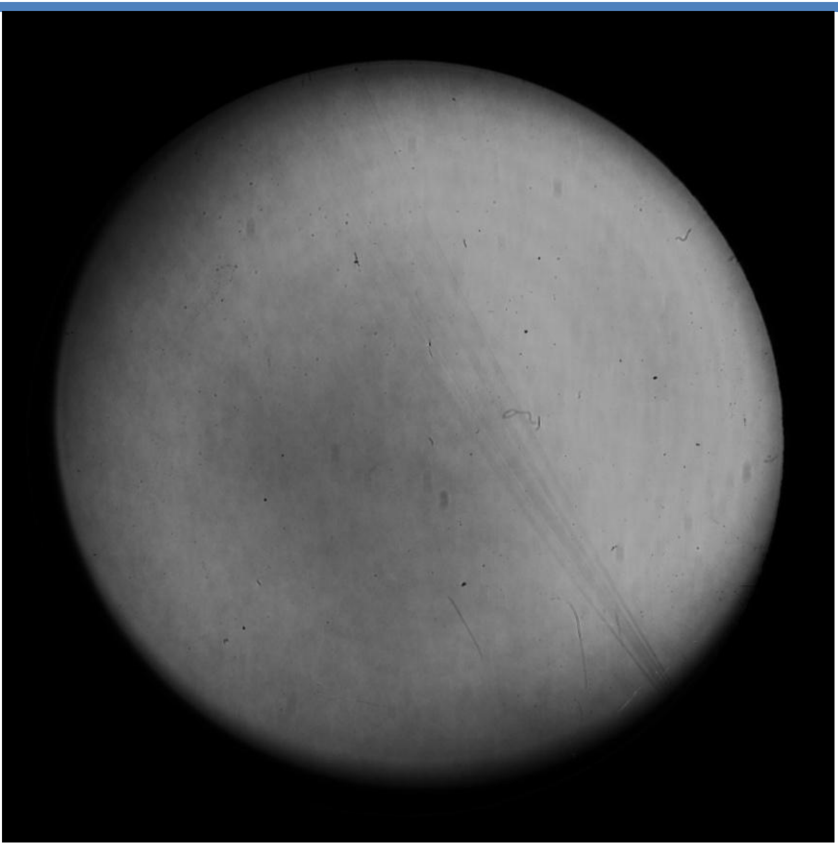
- FWHM improvement by a factor of 2x compared to Lunt and Coronado.

Possible explanations of the etalon performance ?

- Previously, FWHM values of 0.3 A were not accessible to the amateurs.
- Among other factors, the FWHM of an air-spaced etalon depends on:
  - Uniformity of the coating over the surface of the etalon.
  - Flatness of the optical windows (source = manufacturers websites):
    - Lunt Gen I : λ/50 P-V typical,
    - Lunt Gen II : λ/70 P-V typical,
    - Solarscope : λ/100.
  - Roughness of the optical windows:
    - Lunt Gen II : 1.2 nm rms = λ/500 typical.

- Heliostar : the only advertised specification is FWHM < 0.5 A.

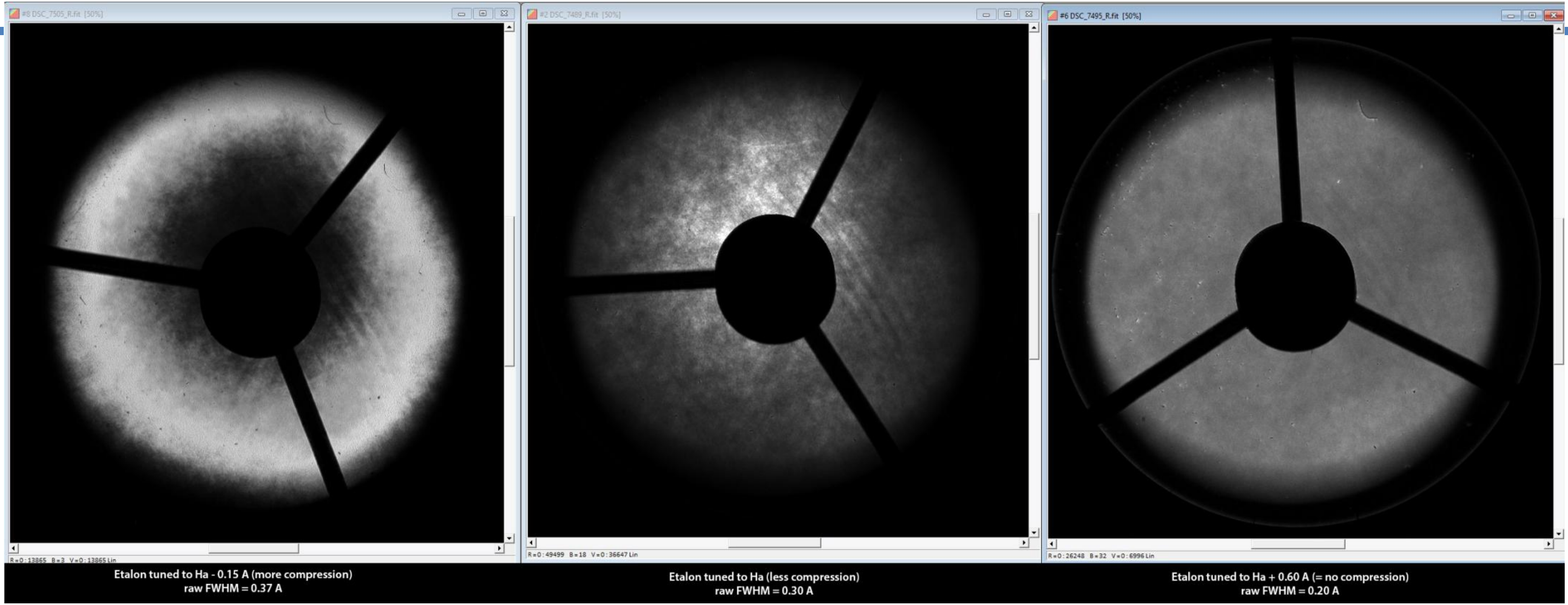
Uniformity of a Lunt 40 Gen I



- Optical setup: nearly point like Hα source, collimated beam illuminating the full aperture of the etalon.

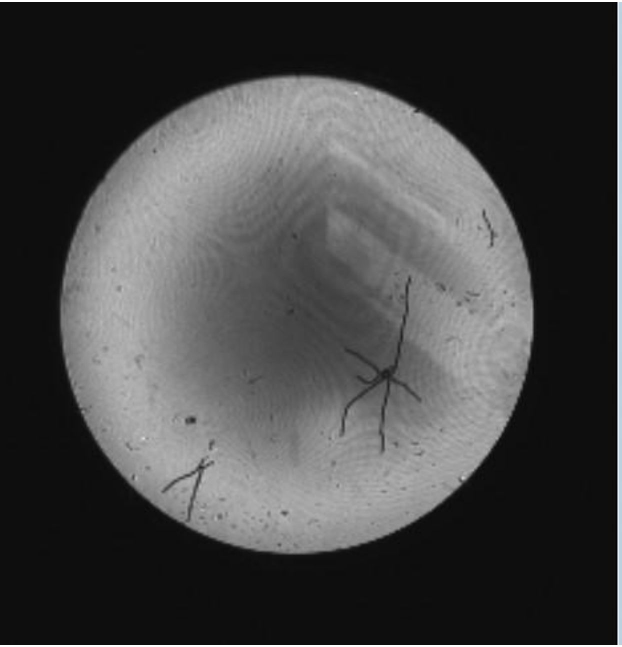
- Qualitative test, still very sensitive.
- Circular polishing marks.
- Some scratches.
- (Slight) non uniformity in transmission.

Uniformity of a Heliostar76 etalon



Very uniform when not compressed (right image)

Uniformity of a Baader Sundancer II



Etalon heating up

Etalon thermally balanced

- Mica non uniformity.
- Propagation of defaults within the etalon due to soot contamination during coating.
- Measured FWHM = 0.9 A

Lunt announcement of Gen II etalons

A Note on Competition and Innovation

Let's address the obvious: SkyWatcher's new Heliostar system, at launch, outperformed the previous-generation Lunt etalon specification. That's simply a fact — and it's no more surprising than a new Android outperforming an older iPhone.

The "old" Lunt products were the gold standard for a very long time. You don't mess with success until you have to. Perhaps it took a kick in the backside from a competitor to accelerate changes that were already in development.

We are raising the bar again.

The new Lunt etalon specification (≤0.35Å single stack, ~0.22Å double stack) represents a significant advancement over both our previous products AND the current competition. Our customers can be assured they are following an innovative company — not a fossil.

Seeing a competitor release a superior product may sting for a moment. But it should also provide confidence: Lunt responds. Lunt innovates. Lunt does not rest on heritage alone.

First measurement of Lunt Gen II

- FWHM specifications < 0.35 A
- Measurement by interferometry on May 11, 2026 (published on May 12): :

FSR (A)	Gap (mm)	raw FWHM (A)	Equivalent tilt(°)	FWHM deconvoluated (A)	Delta CWL formula (6) - (A)	Lunt 40 model
11.1	0.19	0.57	0.31	0.50	0.07	Gen 2
11.0	0.20	0.46	0.47	0.38	0.20	Gen2
11.1	0.19	0.63	0.72	0.57	0.49	Gen1 - 2024+
13.0	0.17	0.70	0.37	0.65	0.09	Gen 1 - 2024+

Lunt information published on the Solar Chat Forum

May 15, 2026
"We have identified a coating specification issue that has affected our new generation DS modules and front-mounted etalon filters. The HR coatings we received from our supplier were not meeting their specified reflectivity at 656nm, which means current production etalons are performing at approximately 0.45Å rather than the advertised 0.35Å. We have identified the root cause and are working with our coating supplier to resolve it. We expect verified 0.35Å etalons to be available in approximately 6-8 weeks"

May 21, 2026:
"The current lead time on the corrected wavelengths is about 90 days."

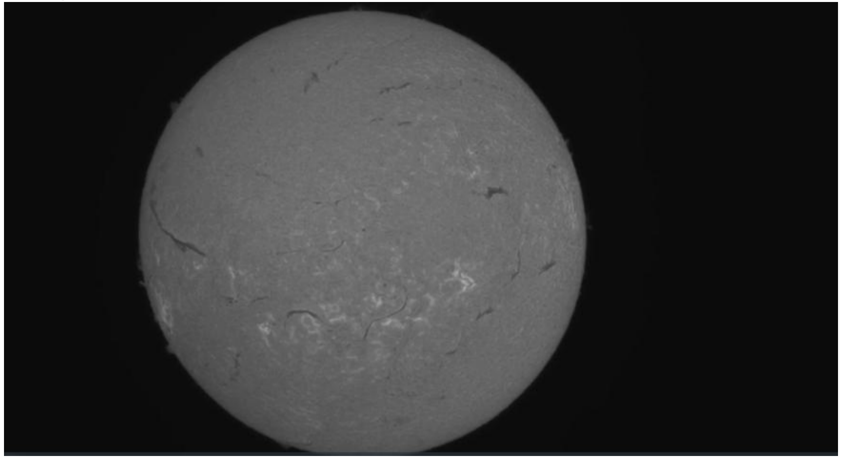
Additional measurements of Lunt 40 Gen II v1

Etalon	Date	FSR (A)	Gap (mm)	raw FWHM (A)	Delta CWL (A) 1srt ring	FWHM deconvoluated (A)	Delta CWL formula (6) (A)	Lunt 40 model	Measuring method
#1	11/05/2026	11.1	0.19	0.63	0.52	0.59	0.49	Gen1 - 2024+	H2 lamp
#2	11/05/2026	13.0	0.17	0.70	0.13	0.67	0.09	Gen 1 - 2024+	H2 lamp
#3	11/05/2026	11.1	0.19	0.57	0.09	0.53	0.07	Gen II v1	H2 lamp
#4	11/05/2026	11.0	0.20	0.46	0.22	0.41	0.20	Gen II v1	H2 lamp
#5	17/06/2026	11.5	0.19	0.51	0.10	0.47	0.05	Gen II v1	H2 lamp
		11.3		0.50	0.09	0.47			spectro
#6	17/06/2026	11.4	0.19	0.55	0.17	0.51	0.12	Gen II v1	H2 lamp
		11.3		0.50	0.18	0.48			spectro
NB : etalons measured over full aperture									

- Note that the CWL Gen II Lunt 40 etalons seem to be very close to Ha. This might be an issue if the expected application is in telecentric beam at f/42 for HR imaging with the IMX432 (delta CWL = -0.22 A at f/42).

What about the sweet spot ?

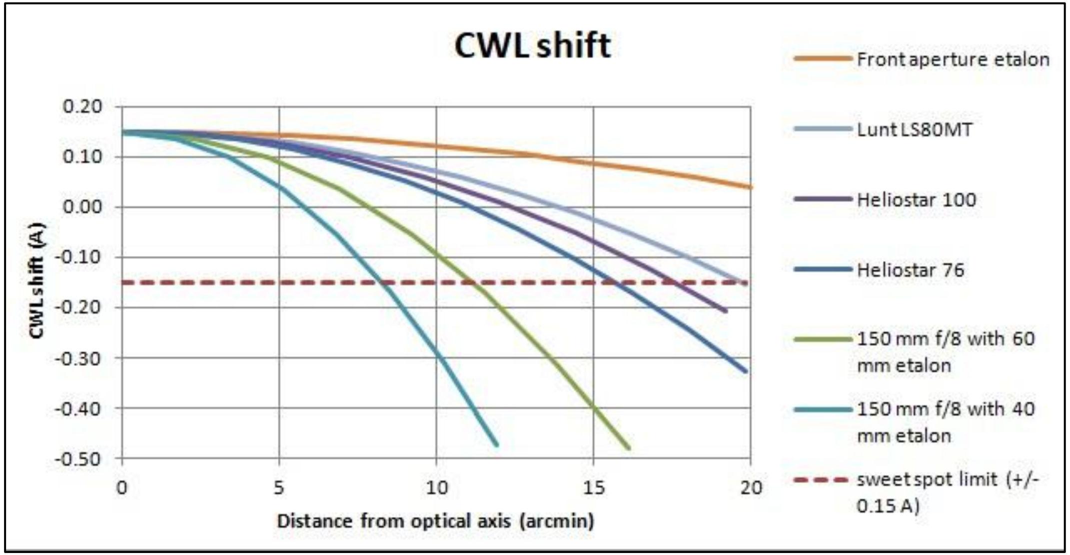
- Sweet spot : the central part of the field is on Hα, but not the outer rim.
- There is nothing wrong about it. It is a matter of optical mounting (collimated mounting), and not about the etalon.
- Rule of thumb : the etalon diameter must be > 50% of the telescope diameter for the sweet spot to cover the solar disk.
- Therefore, the Sun must be correctly centered in the sweet spot.
- Note: the center of the sweet spot is not necessarily in the center of the field (use a sensor larger enough or a XY slider might be helpfull).



https://viladrich.astrosurf.com/astro/soleil/FD/2026/sweet-spot-HS100-2026-06-06-0901.mp4

Sweet spots comparison

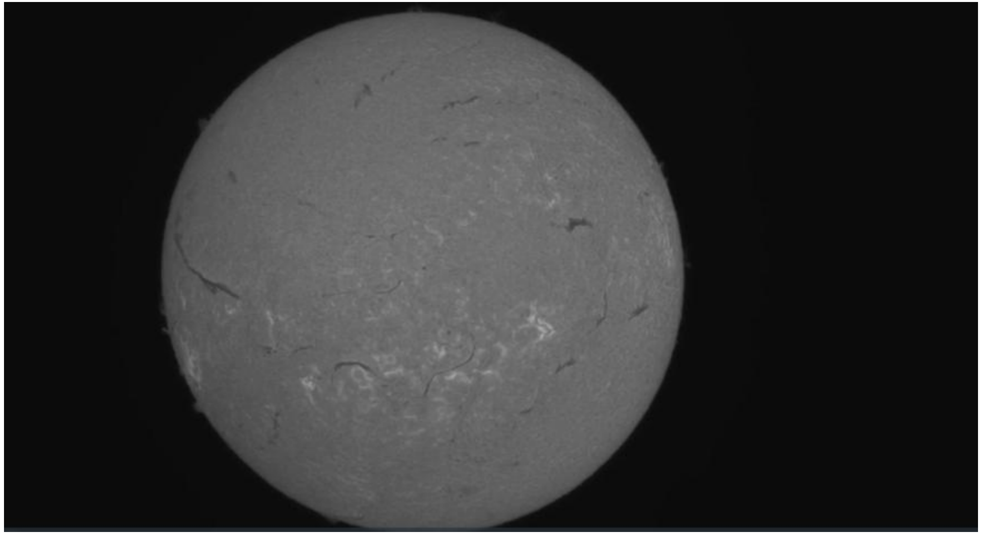
Shift of the central wavelength towards the blue as one moves away from the center of the field.



Configuration	Sweet spot diameter (+/- 0.15 A) (arcmin)
Front aperture etalon	66
Lunt LS80MT	39
Heliostar 100	35
Heliostar 76	31

Wavelength adjustment

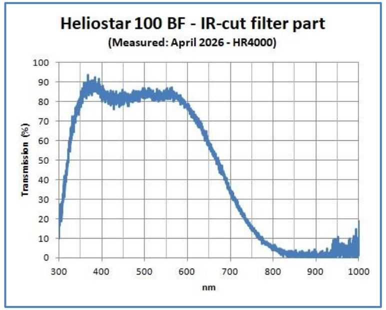
- Criteria for making sure the filter is correctly tuned on the center of the Ha line :
  - Maximize the visibility of the facular plages (=white plages).
  - The brightness of the solar disk should be uniform (= no central bright area, no bright outer rim).

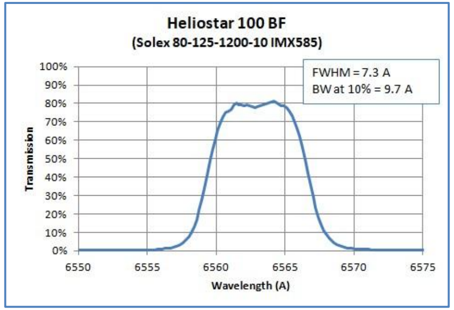


https://viladrich.astrosurf.com/astro/soleil/FD/2026/tune-HS100-2026-06-06-0909%209.mp4

Heliostar 100 blocking filter

- The BF comes in three parts:
  - Ir-cut: similar à KG3, transmission of about 50% on Ha.
  - Mirror of the diagonal: transmission of about 50%.
  - Blocking Filter: RG630 (?) + BF 7 A, transmission of about 80%.

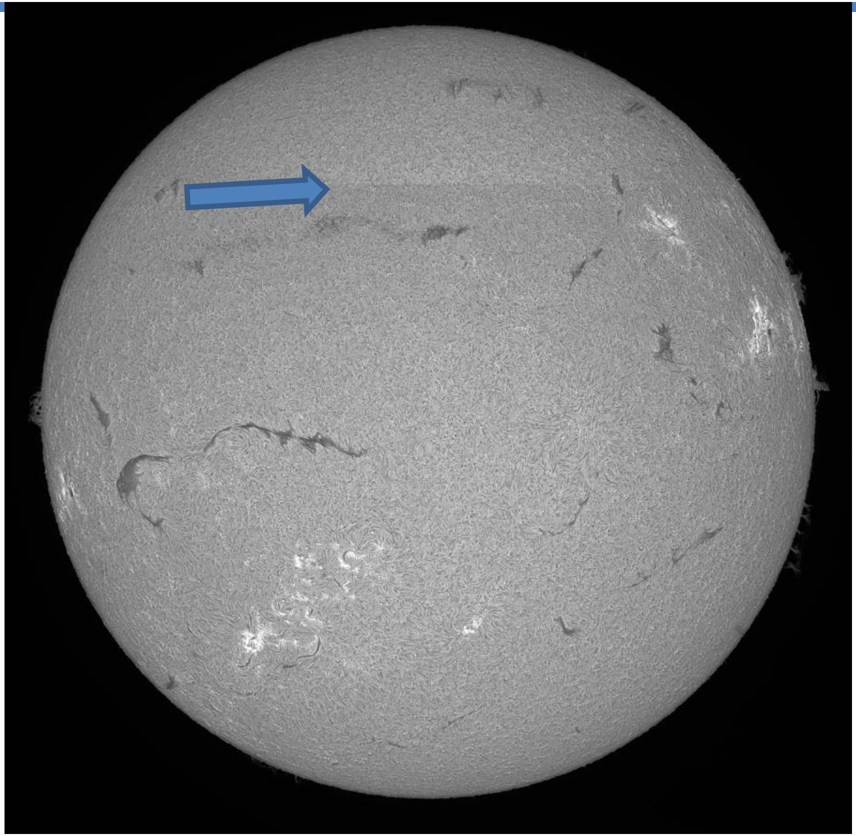


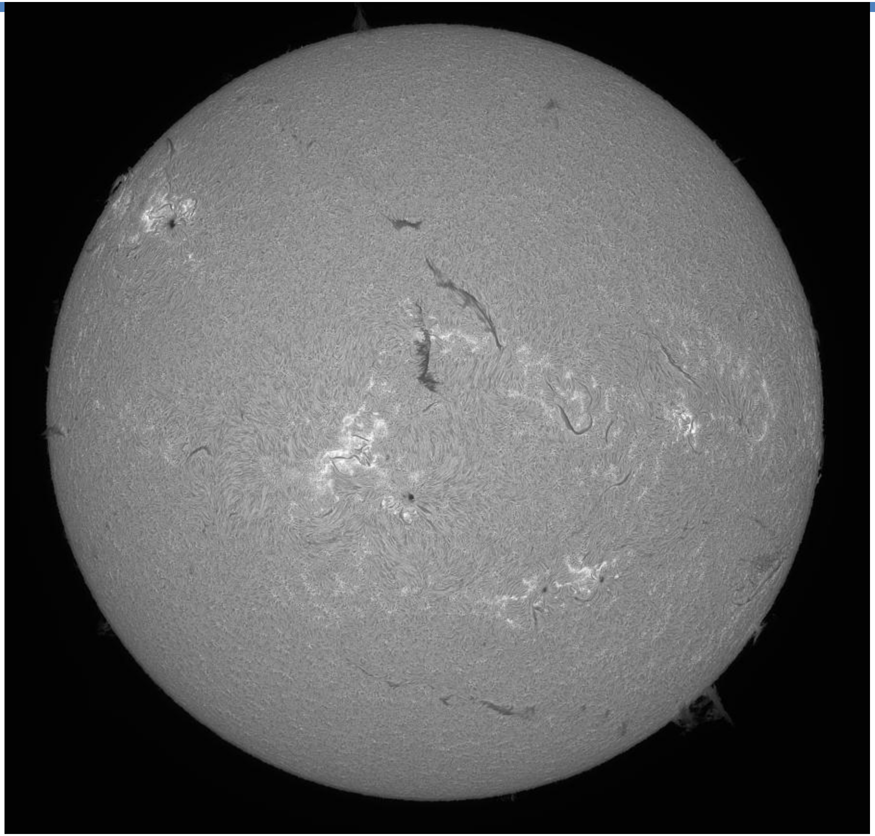


X slide

- Centering the camera (or the eyepiece) on the sweet spot becomes easier.
- Two-tile mosaic with the IMX585 are made easier (the sweet spot does not move with respect to the solar disk).

Two-tile mosaic: without X-slide / with X-slide





IMX585: how to deal with reflections ?

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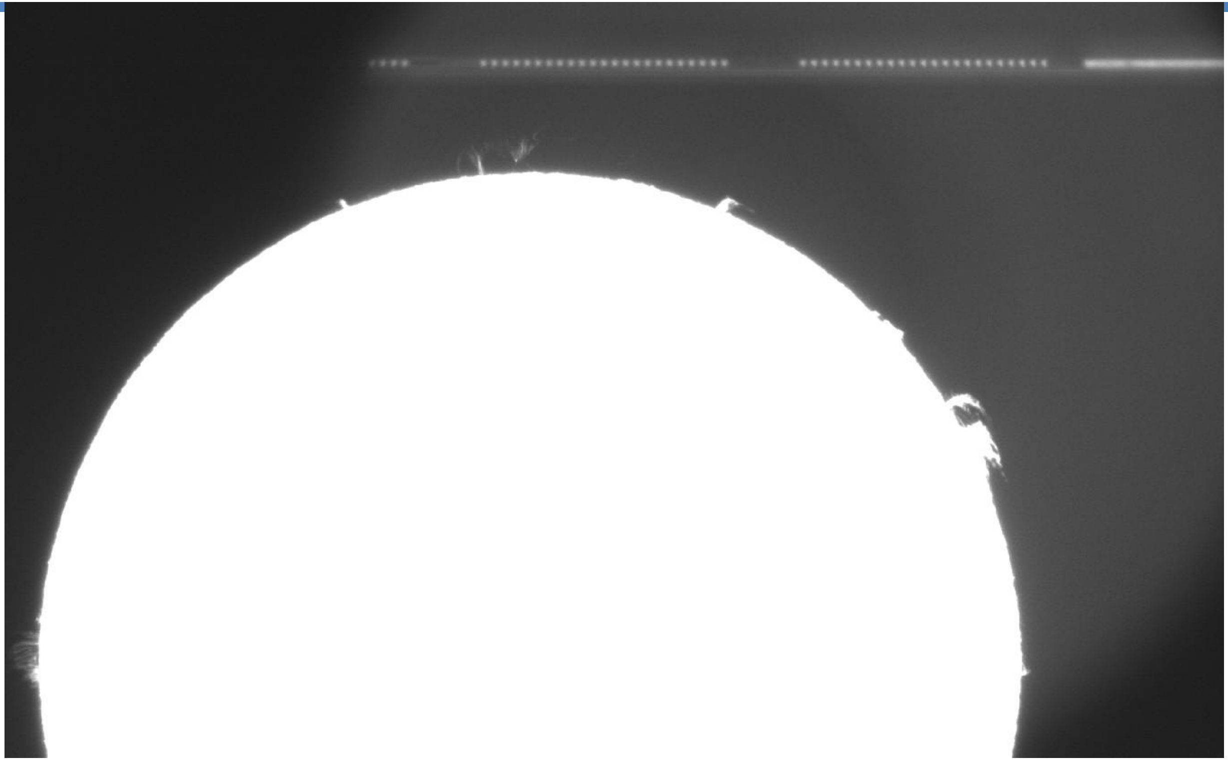

IMX585: how to deal with reflections ?

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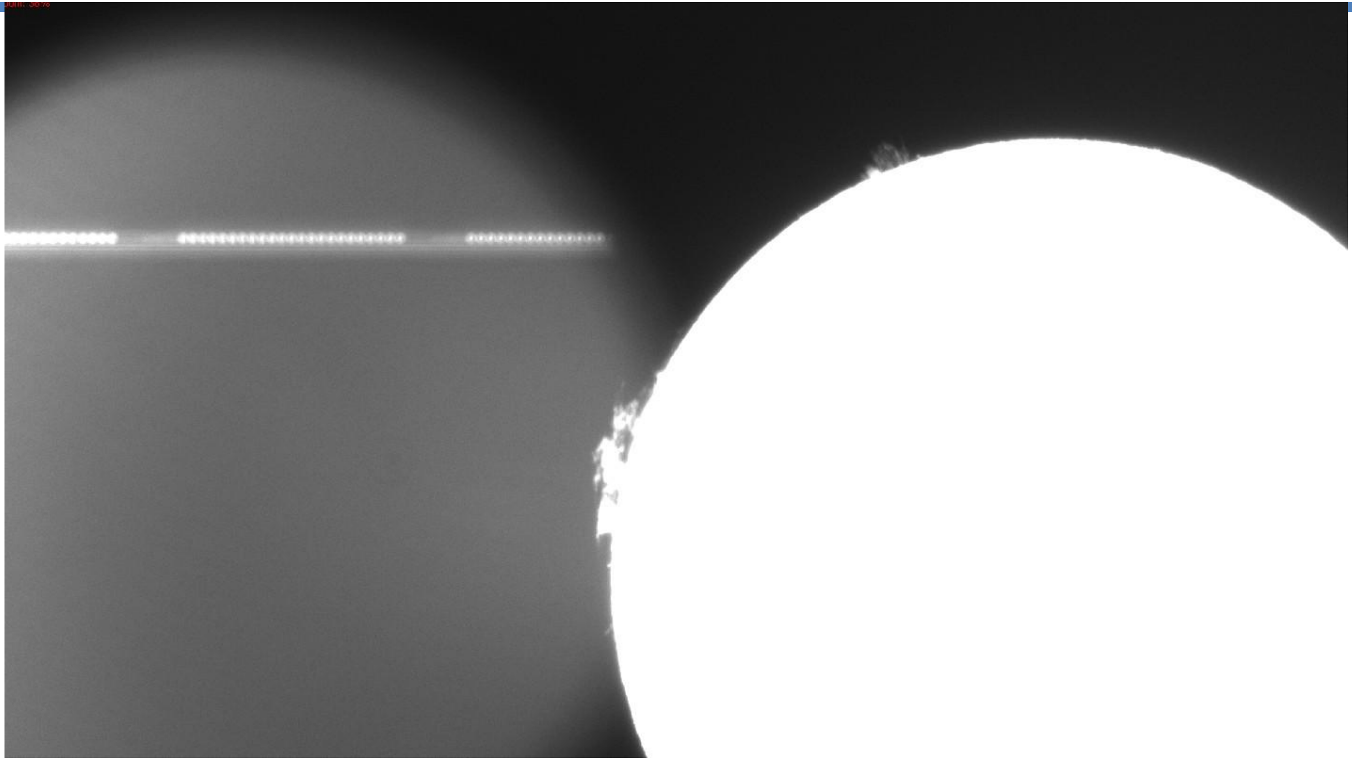

IMX585: how to deal with reflections ?

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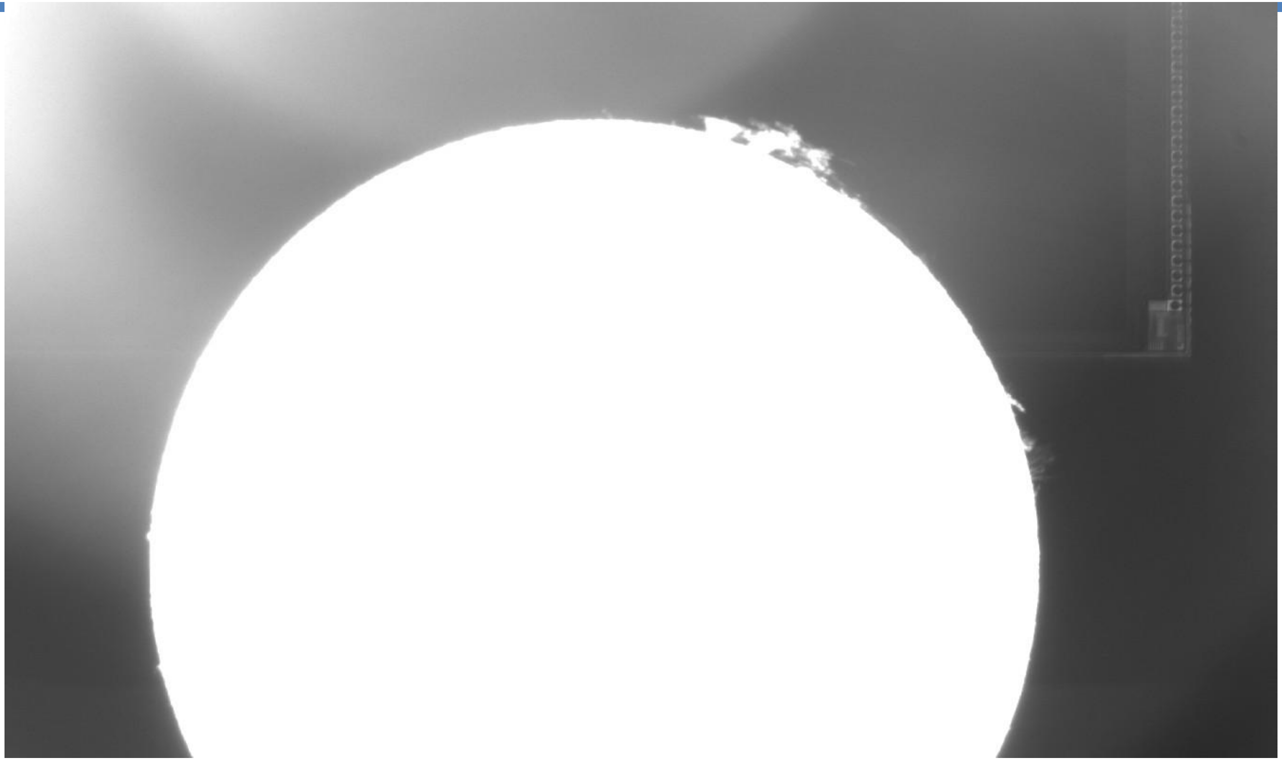
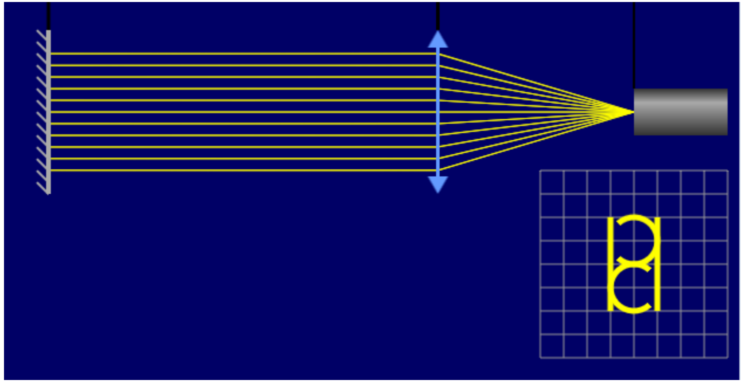


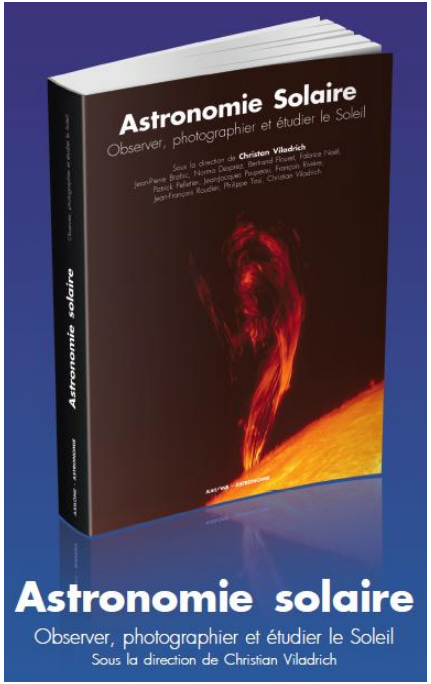
IMX585: how to deal with reflections ?

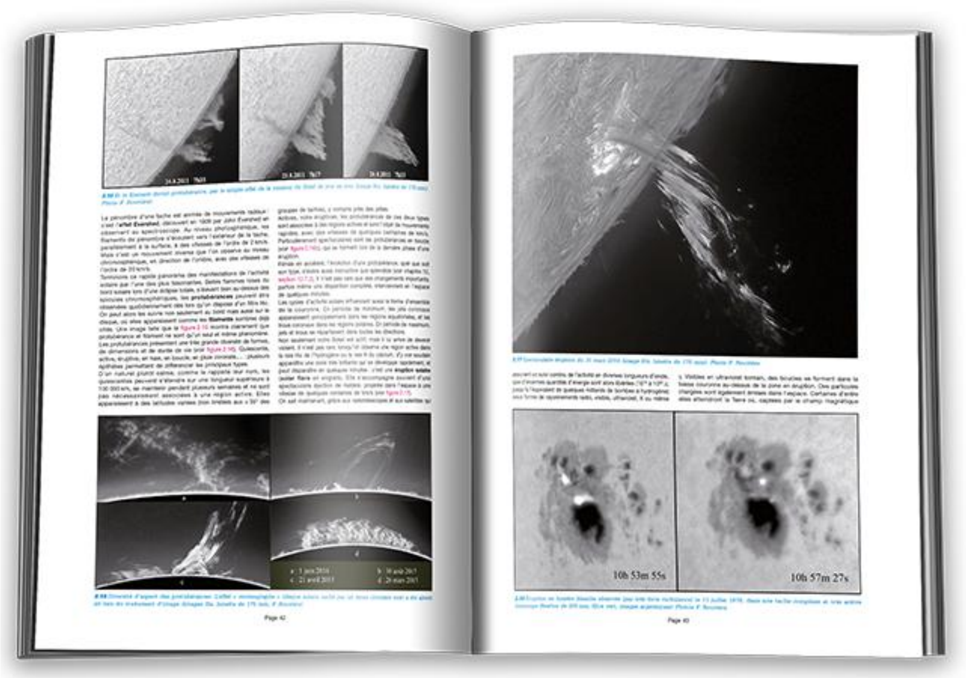
- The etalon + converging lens assembly behaves as an autocollimator: the image of the sensor is reflected by the etalon and its reflection is focused back at the focal point (on the sensor).



- Solution : addition of a circular polarizer between the convergent lens and the sensor.

Thank you for your attention... Questions?





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