Astro-Physics

Optimizing Your Field Flattener or Telecompressor Corrector (TCC)

There are a number of variables that come into play when using refractors with CCD and CMOS cameras. The large chips and small pixel size in today's cameras make precise optical alignment more important than ever. This document explains how Astro-Physics field flatteners and Telecompressor Correctors (TCCs) work, how to determine whether your imaging train needs a spacing adjustment, and how to use the SRSET-27 and SRSET-327 spacer ring sets to dial in a flat field.

How Field Flatteners and TCCs Work

Field flatteners are designed to exactly counter the inherent inward curvature of a refractor's focal plane and to bring star size down by a factor of about 50 — down to roughly 5–6 microns — with perfectly round images across the field. By and large, that is what Astro-Physics field flatteners are designed to do, but this exact cancellation depends on two things: the precise focal length of the telescope, and the precise distance from the flattener optics to the sensor.

A small difference in the scope's focal length from ideal can require a different chip-to-flattener distance. If that distance is too short or too long, the correction is imperfect: stars become slightly larger, and you may see oval astigmatism and/or coma, especially toward the edges of the frame. To get the best star shape across large sensors, the chip-to-flattener distance often needs to be modified by a few millimeters — inward or outward — from the nominal value. In most imaging setups no adjustment will be needed, but some sensor and camera combinations benefit noticeably from fine-tuning.

Diagnosing the Direction of Correction

Before changing any spacing, you need to know whether your field is under-corrected (still curving inward) or over-corrected (curving outward). Simply inspecting an image with defocused corner stars cannot tell you this — and image-inspection programs such as CCD Inspector cannot tell you the direction either. They can show that the field is not flat, but not which way it curves.

The reliable method is to compare the exact best-focus position of stars at the center of the frame against the exact best-focus position of stars near a corner. The direction the focuser has to travel between those two best-focus points tells you which way the correction is off.

Procedure

1. **Focus on the center.** Carefully focus on a star near the center of the frame. Note the exact focuser position.
2. **Focus on a corner.** Choose a star near a corner of the frame and focus precisely on it. Note the exact focuser position.
3. **Compare the two positions.** The direction and magnitude of the difference tells you both which way the field is curving and roughly how much spacing change is needed.

A note on sensor tilt: if your camera has any tilt, the field flattener will not correct all four corners the same way. With simple field curvature alone, every corner star will reach best focus at the same focuser position; if different corners give different best-focus points, you are seeing tilt as well as curvature, and tilt should be addressed before chasing spacing.

Interpreting the Results

There are two cases, and they call for opposite adjustments:

Case 1: Field is under-corrected (curving inward)

If, to focus on the corner star, you have to move the focuser inward — toward the objective lens, away from the camera — then the field is still curving inward. The flattener is under-correcting, and the sensor needs to sit a little farther from the flattener.

Adjustment: increase the distance between the flattener and the sensor (move the chip back a few millimeters).

Case 2: Field is over-corrected (curving outward)

If, to focus on the corner star, you have to move the focuser outward — away from the scope, toward the camera — then the flattener is over-compensating. The focal plane needs to move inward, closer to the flattener.

Adjustment: decrease the distance between the flattener and the sensor.

In either case, work in steps of 1–2 mm at a time, re-imaging and re-measuring between changes until corner stars and center stars come to focus at the same position. This iterative approach is the only way to achieve a precise flat field.

Making the Adjustment: Spacer Rings

Astro-Physics offers spacer ring sets that make this fine-tuning straightforward. Each set contains three beautifully machined, black-anodized 1 mm thick rings:

- **SRSET-27** — for use with 2.7” field flatteners and TCCs
- **SRSET-327** — for use with 3.27” field flatteners and TCCs

In most imaging setups these rings will not be needed. However, when diagnosis shows that the spacing should be changed, there are two ways to use them:

To increase the spacing

Add one, two, or three 1 mm rings to the rear threads of the field flattener or TCC. This is the simplest case — each ring moves the sensor 1 mm farther from the flattener.

To decrease the spacing

Switch to a shorter back-focus spacer. Astro-Physics offers back-focus spacers in several lengths — typically 22.1 mm, 18.3 mm, 17 mm, and 16 mm — so you can step down to the next shorter spacer and then, if needed, add one or more 1 mm rings to fine-tune the exact distance. For example, the difference between the 22.1 mm and 18.3 mm spacers is 3.8 mm, so adding rings to the 18.3 mm spacer lets you fill in any intermediate value between those two standard lengths.

Working in 1 mm increments this way, you can experiment until the corner and center focus positions match.

Special Note: QUADTCC with Large Sensors

The QUADTCC was designed for the 35 mm format, but it can also be used with larger sensors such as the 16803 KAF, provided the spacing is reduced slightly. The reduction needed is typically in the range of 1–3 mm and is best determined using the diagnostic procedure above.