Astrolarius · Learn

Collimating a Ritchey-Chrétien

From “I always have one bad corner” to a round field: what to adjust, in what order, and how to know you’re done.

An Astrolarius guide, based on the Deep Sky Instruments method

The Ritchey-Chrétien (RC) has a reputation for being impossible to collimate, and the forums back that up: **“I always have one bad corner”** has been the most common RC thread for a decade. It isn’t bad luck. Both mirrors on an RC are adjustable, so you can get a perfect center with a scope that is still out of collimation.

The good news: there’s a method that works, and it converges in two or three rounds. **Primary first, for the center; then secondary, for the corners.** Here it is step by step, with what each tool is actually good for, and an assistant that reads your frames and tells you which screw to turn.

What you need

- ☐ Your RC: a closed-tube 6″, 8″ or 10″ (GSO and its rebrands: Astro-Tech, TS-Optics, Omegon, Apertura, StellaLyra…) or a truss or carbon one.
- ☐ The keys or drivers for both mirrors’ screws, and a bit of tape to label them.
- ☐ Your usual imaging camera, with no reducer or flattener.
- ☐ For the daytime part, whatever you have: a Cheshire, a well-collimated laser or a collimation scope. You don’t need to buy anything expensive.
- ☐ For the night part: a rich star field about 70° up, good tracking and an hour or two.

The 6 steps

1. **Before you touch anything: is it collimation?.** Odd stars in the corners aren’t always the mirrors: it can be a tilted sensor, the RC’s own field curvature, guiding or a sagging focuser.

2. **Why an RC is different.** Two hyperbolic mirrors, both adjustable: you can get a perfect center with the scope still out of collimation. That's why the order matters.
3. **Mechanics first.** No collimation holds with a sagging focuser, pinching screws or an imaging train that wobbles. Ten minutes of checks save whole nights.
4. **By day: get it close.** With a Cheshire, a well-collimated laser or a collimation scope you can get an RC close in half an hour. To finish, you need stars.
5. **At night: primary for the center, secondary for the corners.** With defocused stars and your imaging camera: the primary removes the coma in the center, the secondary balances the corners, and you repeat two or three times.
6. **How to know you're done (and keep it that way).** In focus, the four corners should look the same as each other. If they match but aren't perfect, that's the design: a flattener, not more screws.

And at the end, a log sheet to write down every screw you turn. The web version, always up to date: astrolarius.com/en/learn/collimating-a-ritchey-chretien

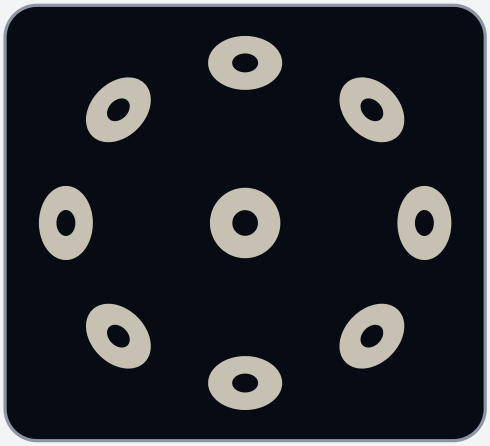
Step 1 of 6

Before you touch anything: is it collimation?

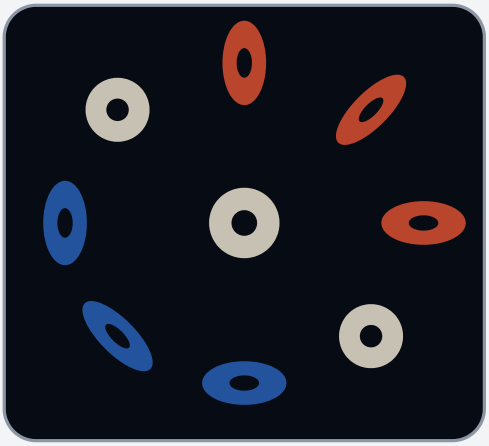
Odd stars in the corners aren't always the mirrors: it can be a tilted sensor, the RC's own field curvature, guiding or a sagging focuser.

A bad corner has many parents

A lot of "my RC is out of collimation" threads turn out to be something else. Before you turn a screw, look at **how** the stars look and **where**:



Balanced
all alike from the center



Unbalanced
pointed at top, flat at bottom

Out of focus. Balanced doesn't mean "round": it's fine if they're all a little flat, as here. What gives away bad collimation is that they change from one side to the other.

From symptom to cause

What you see	Most likely cause	What to adjust
All four corners equally bad, elongated toward the center or sideways	The RC's own field curvature and astigmatism: it's the design	Nothing in the collimation: a flattener or a smaller sensor
One corner or one side worse than the rest, and it goes out of focus first	A tilted sensor or focuser	The focuser, the imaging train or a tilt adapter

What you see	Most likely cause	What to adjust
One corner “pointed” and the opposite one “flat”, with a good center	Misaligned mirrors	The secondary (step 5)
The center donut brighter on one side	Coma from misaligned mirrors	The primary (step 5)
Every star elongated the same way, center included	Guiding, tracking or wind	The mount, not the mirrors
Triangular stars or odd spikes	A pinched mirror: screws too tight	Back the retaining screws off a little

What tells collimation and tilt apart: collimation changes the shape of the stars; tilt mostly changes where they come to focus.

Sensor size matters

An RC without a flattener doesn’t have a flat field. With a 4/3 camera you’ll barely notice; with APS-C the 8″ RC is right at the limit (TS-Optics quotes its corrected field at about 30 mm), and with full frame the corners will always be worse. If all four corners fail **equally**, it isn’t collimation: no amount of turning will fix it.

> ⚠ **Heads-up**
>
> Always test without a reducer or flattener. Otherwise you mix their backfocus with the collimation and there’s no way to tell which is which.

> **Our advice**
>
> Fix sensor tilt before you collimate. The method in this guide balances the whole field, and if the camera is tilted the mirrors will end up compensating for it: the scope will be truly out of collimation.

☐ **Step 1 done**

Step 2 of 6

Why an RC is different

Two hyperbolic mirrors, both adjustable: you can get a perfect center with the scope still out of collimation. That's why the order matters.

Two mirrors, two jobs

On a Newtonian it's enough for the primary to point the right way. On an RC **both mirrors are hyperbolic and both are adjustable**: their axes have to be parallel and also coincide. And there's a trap: there's a position where the secondary leaves the center **free of coma even though the axes don't coincide**. What's left is unbalanced astigmatism, and it shows up in one corner. That's the infamous "perfect center, bad corner".

That gives you the division of labor, the same in every technical source: the **primary** mostly moves the coma in the center; the **secondary**, the balance of the corners (and a little of the center). Doing it the other way round, using the secondary to clean up the center, is the most common mistake, and it never converges.

The center marks lie a little

The ring painted on the secondary marks its **mechanical center**, not the optical one, and the two can be anywhere from a few thousandths of an inch to a tenth of an inch (about 2.5 mm) apart. The baffles aren't necessarily perfectly centered either. That's why an RC can "look" collimated in a collimation scope and still perform badly, and vice versa. Daytime tools get you close; **the stars have the final say**.

Closed tube or truss

On the closed-tube GSO 6″ and 8″, **the focuser bolts to the primary mirror cell**: every time you move the primary, the focuser tilts with it, and the weight of the camera adds leverage. That's the source of the forums' "endless loop" and of the "never touch the primary" advice. It's not that you can't: it's that

you have to check the focuser every time. On 10″ and larger, and on truss or carbon scopes, the focuser and the primary are separate.

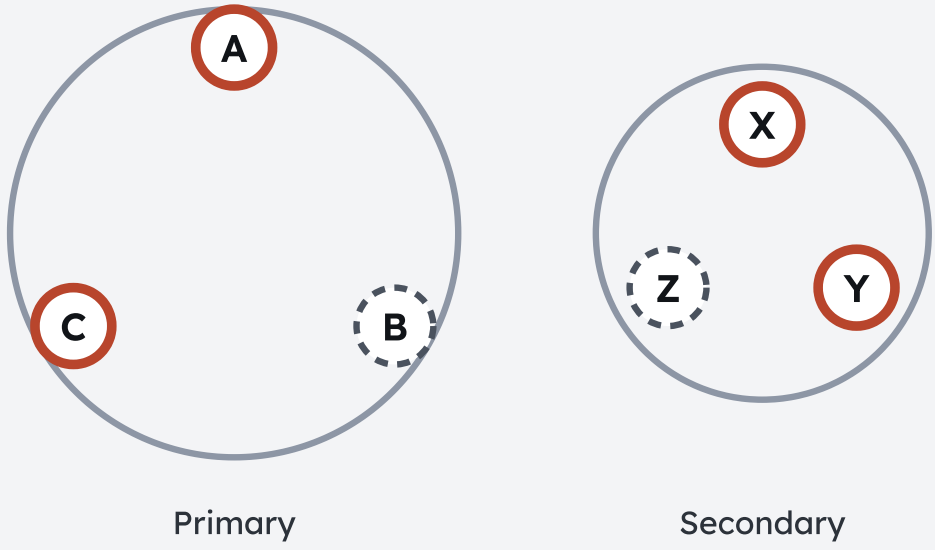
The bigger the scope, the finer the work

Collimating a 6″ or 8″ is a lot more forgiving than a 12″ or 14″. At the same focal ratio, the same angular error does more damage the bigger the mirror. Big mirrors also weigh more, shift more as the tube tilts, and take much longer to reach ambient temperature: until they do, the donut “boils” and any measurement will fool you.

If your RC is 12″ or larger: set it out **an hour or two early**, collimate at the altitude you’ll be imaging at, and expect **more rounds** than with an 8″. That’s normal.

Give the screws names

Looking at the scope **from the back**, starting at the top and going clockwise: **A, B and C** on the primary; **X, Y and Z** on the secondary. Label them with tape. **Never touch B and Z**: two screws per mirror are enough to move it in any direction, and this way it doesn’t creep over time.



Seen from the back, starting at the top and going clockwise. B and Z (dashed) are never touched.

> ⚠ **Heads-up**
>
> On the GSOs, the secondary's center screw sets the mirror spacing at the factory: don't touch it to collimate.

> **Our advice**
>
> Always write down what you turn: "A, tightened 1/8". If something goes wrong, you'll know how to go back. It's the difference between a test night and a wasted night.

☐ **Step 2 done**

Step 3 of 6

Mechanics first

No collimation holds with a sagging focuser, pinching screws or an imaging train that wobbles. Ten minutes of checks save whole nights.

What to check

- **The focuser**: no play when you push on it with the camera attached. The stock ones sometimes flex; a good adjustment or a better focuser fixes it.
- **The imaging train**: threaded connections rather than compression rings, and nothing hanging loose.
- **The mirror screws**: snug, not forced. Overtightened screws pinch the mirror and give you triangular stars.
- **Sensor tilt**: check it with a tilt analyzer before you collimate.
- **Where to collimate**: about 70° up, the part of the sky you'll image. Check first that the collimation holds when you point to different parts of the sky.
- **With your working train**: the same camera, the same spacers and the focuser roughly where it usually sits at focus. A different train weighs differently and levers differently.
- **With a cooled-down tube**: if two frames in a row, without touching anything, don't look alike, the air in the tube is still moving. Wait.

A focuser tilt adapter

On closed tubes, a **tilt adapter between the tube and the focuser** (TS-Optics and others sell them for these RCs) lets you aim the focuser at the secondary without touching the primary. It doesn't replace collimation, but it breaks the "I move the primary and my focuser goes crooked" loop. Heads-up: depending on how it's fitted, it can cover the primary's screws.

> **Tip**
>
> A camera tilt plate (ZWO, Gerd Neumann and similar) corrects the sensor, not the mirrors: it's for tilt, not for collimation.

- [ ] **Step 3 done**

Step 4 of 6

By day: get it close

With a Cheshire, a well-collimated laser or a collimation scope you can get an RC close in half an hour. To finish, you need stars.

What each tool measures

Daytime tools for an RC		
Tool	What it does	What it doesn't
Cheshire eyepiece	Centers the focuser on the secondary and gets the mirrors close	Fine-tune the primary or the secondary
Plain laser	Same as the Cheshire, if the laser itself is collimated and seated well	It fools you if it's loose in the focuser or out of collimation
Holographic (DOE) laser	Lets you check by eye that everything is "more or less" right	Both mirrors can be off at the same time and the pattern still look fine
Collimation scope (Takahashi-style)	Centers the secondary's mark and the baffle rings	Tell you whether the mark is the optical center
Electronic collimator (Ocal and similar)	The same as the collimation scope, on a screen	The final touch: you still need the star
Cassegrain laser (Hotech)	Collimates the mirrors without stars, on the bench	Repeat the same result every time: opinions are split

No daytime tool finishes the job: they all get the scope "close", and the star decides.

The order on the bench

1. Center the focuser (or the tilt adapter) so it points at the center of the secondary.
2. Adjust the secondary until its mark is centered in the collimation scope, Cheshire or laser.
3. Adjust the primary until the baffle rings look concentric.
4. Repeat 2 and 3 two or three times: each one moves the other a little.
5. On the closed-tube 6″ and 8″, check the focuser after every touch of the primary.

> **Tip**
> If you don’t have any of these, no problem: the night method works just as well starting from a scope that’s roughly right. It just takes a little longer.

☐ **Step 4 done**

Step 5 of 6

At night: primary for the center, secondary for the corners

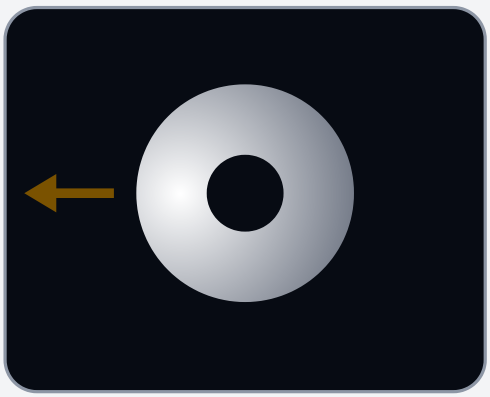
With defocused stars and your imaging camera: the primary removes the coma in the center, the secondary balances the corners, and you repeat two or three times.

The frame

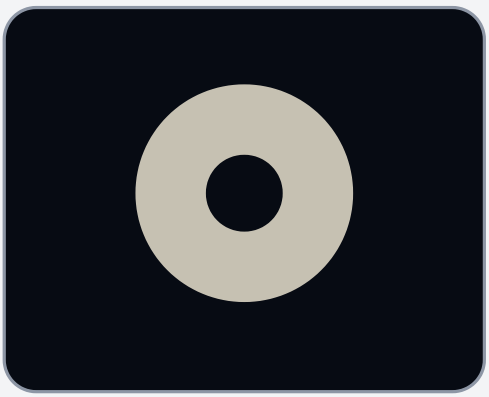
Point at a **rich star field** about 70° up (the Milky Way is ideal). Focus, then **rack the focuser out** (moving the camera away) until you see donuts about 30 or 40 pixels across: note how far, and always do it the same way. Take a **5 to 30 second** frame (10 or 15 work well), with good tracking.

Step 1: the primary removes the coma in the center

Look at the donut in the center. If it's **brighter on one side**, there's coma. The Deep Sky Instruments rule: **tighten the primary's pull screw on the bright side** (or loosen the opposite one). Small turns: 1/4 to 1/16 of a turn, smaller each time. One frame after every turn.



Coma: bright on the left
tighten the pull screw there



No coma
the ring, evenly bright

Only the center donut. "That side" means on the scope, not on the screen: the assistant works out which it is with a test turn.

Step 2: the secondary balances the corners

Now look at the stars near the edge, all at the same distance from the center. In a collimated RC they **look the same as seen from the center**: all round, all "flat" (short axis toward the center) or all "pointed" (long axis toward the center). What matters is that they match, not that they're round.

If they come out pointed on one side and flat right across from it, the mirrors are misaligned. The rule: **tighten the secondary's pull screw on the side of the flat stars.**

And back to the primary

Touching the secondary puts a little coma back in the center: remove it with an equal and opposite touch of the primary. Repeat both steps until the center is clean and the corners match. **Two or three rounds are usually enough**; with practice, 10 to 15 minutes.

> ⚠ **Heads-up**
>
> Don't use the secondary to clean up the center: it's the most common mistake. It leaves the center free of coma and the corners badly unbalanced.

How to turn a pull screw

Each adjustment point has a screw that **pulls** the mirror and one (or two) that **push**. To tighten the pull screw: back the push screw off a little, turn the pull screw as needed, then snug the push screw back with similar force. To loosen, the other way round. That way the mirror goes exactly where you send it and isn't left loose or pinched.

Knowing which screw is which

The rules say "the one on the bright side", but in the image you can't tell which screw is on that side: it depends on how the camera is rotated. Deep Sky Instruments covers one quadrant of the aperture and sees which part of the donut disappears. The Astrolarius assistant does it differently: it asks you to

tighten one screw 1/8 of a turn, measures how much and in which direction the image changes, and works out how far to turn each one.

> **Tip**
>
> Tightening the pull screw on one side is the same as loosening the one on the opposite side. If a screw is already very tight, use the opposite one.

> **Our advice**
>
> When you're close, stop judging the screen by eye: small differences fool you. That's why we built the assistant: it measures the coma and the balance with numbers in every frame.

☐ **Step 5 done**

Step 6 of 6

How to know you're done (and keep it that way)

In focus, the four corners should look the same as each other. If they match but aren't perfect, that's the design: a flattener, not more screws.

The in-focus check

Focus carefully and take a 30 to 60 second frame. The stars in the **four corners should look the same as each other** (even if they aren't as tight as the ones in the center). If one corner is still worse than the rest, there's room to improve; if all of them are equally elongated, that's the RC's own field curvature.

Mirror spacing

If the focal length from plate solving is well off the nominal one, the mirror spacing isn't the design spacing: on amateur RCs, every millimeter changes the focal length by about 11 to 20 mm. It's a delicate adjustment that you almost never need: **leave it for last, and only if the difference is clear**.

Keeping it

- A well-collimated, well-secured RC holds for months.
- Check it after transporting the scope, after a knock, and if you change cameras.
- Write down where the screws ended up: if something moves, you'll know how to go back.
- If nothing works, the mirror may have been mounted badly at the factory: there are optical shops that collimate RCs.

> **Our advice**
>
> The goal isn't perfect collimation, it's a balanced image: the same small flaw in every corner shows much less than one bad corner.

☐ **Step 6 done**

Your collimation log

One line per change: which screw, which way and how much, and what the stars did. If a change makes things worse, undo it exactly and you're back where you were.

Date	
Telescope and camera	
Reducer or flattener (if any)	
Temperature, and how long the scope cooled	
Star used (and how high it was)	
How far out of focus (donut size in pixels)	

#	Screw	Direction and amount	Center donut	Corners
e.g.	*A*	*tightened 1/8 turn*	*less bright on the left*	*no change*
1				
2				
3				
4				
5				
6				
7				
8				
9				

Am I done?

- [ ] Out of focus, the center donut is evenly bright all the way around.
- [ ] Out of focus, the stars near the four corners look alike, seen from the center.
- [ ] In focus, the four corners are about as sharp as each other.
- [ ] I checked it again on another night, with the scope cooled down.

Notes:

Collimate your RC with the assistant: it measures the coma and the balance in your own frames (for now, in Spanish): astrolarius.com/es/herramientas/asistente-de-colimacion-rc