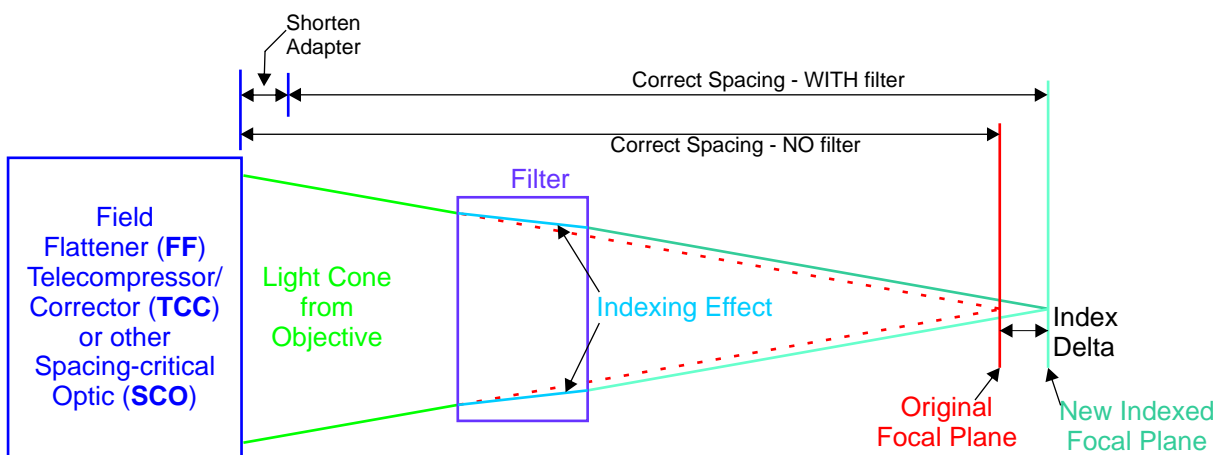# Filter Indexing Calculations
for Optics with Critical Spacing Requirements
Astro-Physics Field Flatteners (FF) and Telecompressor/Correctors (TCC)

How to Calculate Backfocus - Two points of view:
1. Delta = New - Original   Positive value
2. Delta = Original - New   Negative value
Same absolute value - only the sign changes - THIS IS CONFUSING!!!

BOTTOM LINE - Filters, slips and chamber-windows **increase** the length of the light path. Therefore, **if a fixed spacing is required**, you must **decrease** the length of any adapters in the light path **that are inside this fixed space** by the **TOTAL** amount of the indexing for **ALL** filters, chamber-windows, cover-slips, etc. Everything from the FF or TCC to the Camera becomes a single fixed unit that moves together during focusing. Adapters on the objective side of the FF or TCC might then need to be **lengthened** by 2X the index amount all other things being equal to move the focus back to the new focal plane with respect to the objective. This lengthening, however, is normally achieved by simply racking the focuser, but it occurs in front of the space-critical optic.

To avoid problems for a space-critical optic like an AP FF or TCC, always sum up all of your fixed (unchangeable) components including the positive index value(s). Then subtract from the required spacing to arrive at the adapter length(s) for adapters between the SCO and the CCD.

EXAMPLE: AP 175 Field Flattener to Finger Lakes ProLine CCD with Monster MOAG
    ProLine 16070 with CFW2-7 (42.85mm)
    Monster MOAG (31.75 mm)
    CCD Sensor-chamber Window / Cover Glass index (1.18 mm)   (varies - get from CCD Camera Manufacturer)
    Filter index for 3 mm thick filter (1.0 mm) (normally ~ 1/3 the filter thickness)
    Required Spacing from AP Field Flattener to Chip: (114.9 mm)
    42.85 + 31.75 + 1.18 + 1.0 = 76.78
    114.9 - 76.78 = **38.12 mm**   This is the total available for ALL connecting
        adapters.

>   Note that without the indexing: 114.9 - (42.85 + 31.75) = 40.3 mm
>   With negative index values: 114.9 - (42.85 + (-1.18) + (-1.0) + 31.75) = 42.48 mm

FOOTNOTE: There are two different considerations when calculating filter indexes.

1-When considering what adapter length is required for an optic that does NOT have a fixed spacing distance (one which can be moved and focused), then one only needs to understand that you will need to add approximately 1/3 of the total thickness of the filters, chamber window and sensor coverslip to the adapter length so that you can reach focus.

2-However, it is a completely different consideration when you are using an optic that requires a set spacing distance to the sensor as part of the optical path (examples: AP Field Flatteners and Telecompressor Correctors). These optics must retain the exact spacing distance of their specifications from their rear flange to the sensor. They move as a fixed unit with the sensor as focus is done.

When filters, chamber window and sensor coverslip are placed between these optics and the sensor, then the increase in light path must be removed by shortening the intermediate adapter length(s). This is the adapter which goes between the FF or TCC and the sensor, not the adapter which might be on the telescope side of the FF or TCC.

In either case, the "bottom line" expressed above does not change. A filter or other flat piece of glass in the light path increases the length of the light path. The rest is simple arithmetic.