

AWB Scope Calculations Help

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1 Introduction

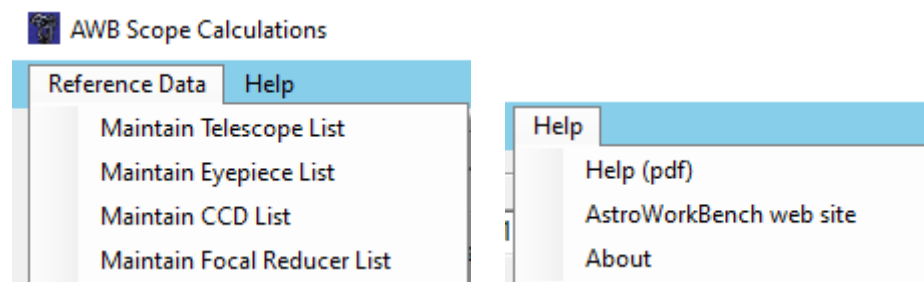
AWB Scope Calculations is one of a set of applications under my AstroWorkBench (AWB) collection that I use during my observational sessions. I wrote this application with the purpose of allowing some frequently used calculations to be tailored to any setup and therefore quickly calculated.

2 Startup

Upon starting the AWB Scope Calculations application the following screen will be presented

The screenshot shows the main interface of the 'AWB Scope Calculations' application. It features a menu bar at the top with 'Reference Data' and 'Help' options. The main area is divided into several sections for inputting telescope and eyepiece data. The 'Telescope' section includes fields for Focal Length (mm), Dawes Limit (arc-secs), Limiting Visual Mag (approx), OR Aperture (mm), and Focal Ratio (fr), with 'Calculate' and 'Clear' buttons. The 'Focal Reducer (FR) or Barlow' section has fields for FR, OR FR's Focal Length (mm), FR distance to CCD (mm), Barlow, Acting Focal Ratio (fr), and Acting Focal Length, also with 'Calculate' and 'Clear' buttons. The 'CCD' section includes fields for Select CCD, Bin, Pixel Size X by Y (microns), Chip Size X by Y (pixels), Arc Secs per pixel, and Field of View (X by Y) in arc mins, with 'Calculate' and 'Clear' buttons. The 'Minimum Filter Size' section has fields for Select CCD, CCD diagonal size (mm), CCD to filter distance (mm), and Minimum filter size (mm), with 'Calculate' and 'Clear' buttons. The 'Eyepiece Projection' section includes fields for Select Eyepiece, OR Focal Length (mm), Eyepiece distance to CCD (mm), New Scope Focal Length (mm), and New Scope Focal Ratio (fr), with 'Calculate' and 'Clear' buttons. The 'Eyepiece' section includes fields for Select Eyepiece, Focal Length (mm), Apparent Field (deg), Magnification, Real Field Of View, and Exit Pupil (mm), with 'Calculate' and 'Clear' buttons.

The menu bar, shown below in exploded view, allows access to additional screens to maintain the reference data, access the Help file (this document) and my website www.astroworkbench.co.uk.



NOTE: It is recommended that before you use the main screen, you add / modify the lists of reference data (telescopes, Focal Reducers, Eyepieces and CCDs) to include your own setup. This will make the subsequent use of the main screen easier as all entries that are maintained by the reference data screens appear in the drop-down lists on the main screen.


3 Reference Data Screens

The reference data screens allow information to be entered to describe your setup as follows: -

- Maintain Telescope List;
- Maintain Eyepiece List;
- Maintain CCD List;
- Maintain Focal reducer List and distance.

3.1 Maintain Telescope List

Enter your telescope(s) details including the Aperture in mm and the Focal ratio.

 MaintainTelescopes — □ ×

	Make	Model	Aperture (mm)	F-ratio
▶	Celestron	C11	279	10
	Meade	LX200	250	10
*				

Delete Current Row

Save All Changes

Enter the manufacturer of the scope

3.2 Maintain Eyepiece List

Enter your eyepieces details including their Focal Length in mm and Field of View in degrees.

Maintain Eyepieces

	Make	Model	Focal Length (mm)	Field Of View (degrees)
▶	Meade	Series 4000 Plössl	6.4	52
	Meade	Series 4000 Plössl	9.7	52
	Meade	Series 4000 Plössl	12.4	52
	Meade	Series 4000 Plössl	15	52
	Meade	Series 4000 Plössl	20	52
	Meade	Series 4000 Plössl	26	52
	Meade	Series 4000 Plössl	32	52
	Meade	Series 4000 Plössl	40	44
	Meade	Series 4000 Plössl	56	52
	Meade	Series 4000 Super Wide	13.8	67
	Meade	Series 4000 Super Wide	18	67

Delete Current Row

Save All Changes

Enter the manufacturer of the eyepiece

3.3 Maintain CCD List

Enter your CCD(s) details including the X and Y pixel sizes in microns, the chip X and Y sizes in pixels and the chip diagonal size in mm. These should be specified in your CCD manual.

Maintain CCDs

	Make	Model	Pixel Seize X (nm)	Pixel Seize Y (nm)	Chip Size X (pixels)	Chip Size Y (pixels)	Diagonal Size (mm)
	Atik	314L+	6.45	6.45	1392	1040	11
▶	Atik	383L+	5.4	5.4	3362	2504	22.5
	Canon	EOS6D	6.54	6.54	5472	3648	43.3
	ZWO	ASI120MM	3.75	3.75	1280	960	6.1
	ZWO	ASI178MC	2.4	2.4	3096	2080	8.9
	ZWO	ASI1600MM P...	3.8	3.8	4656	3520	21.9
*							

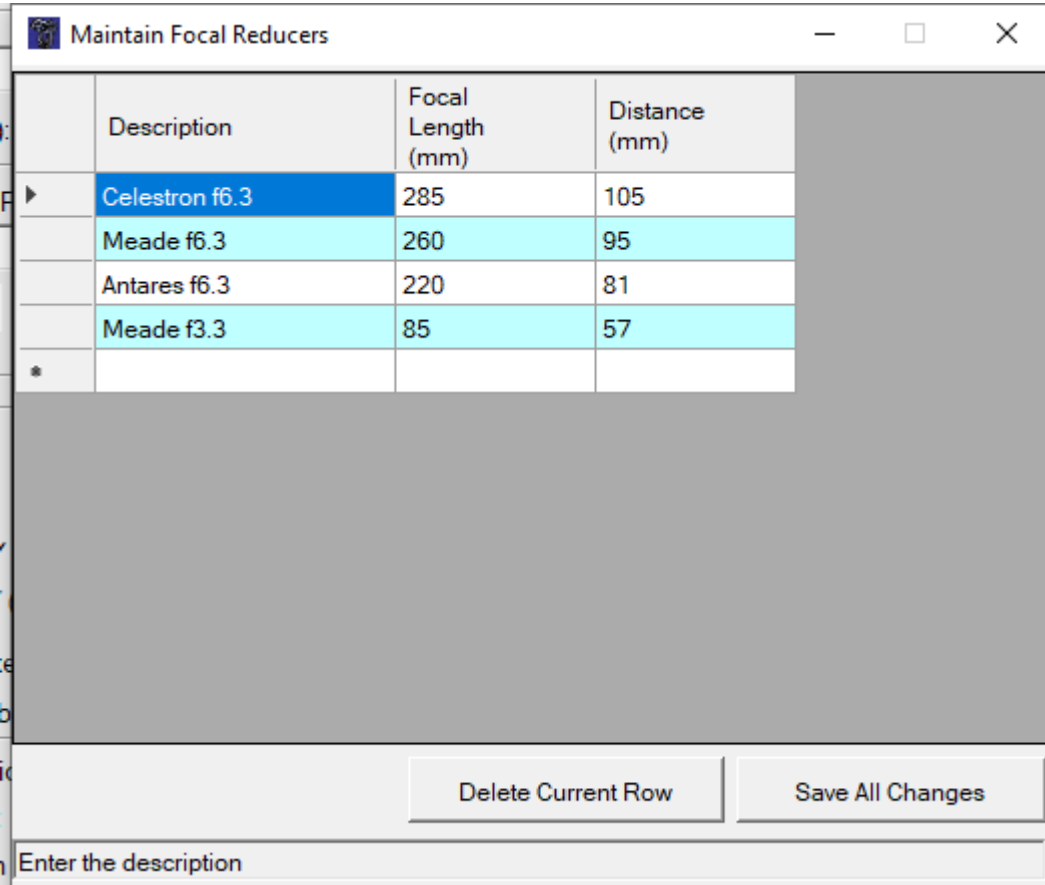
Delete Current Row

Save All Changes

Enter the manufacturer of the CCD

3.4 Maintain Focal reducer List

Enter your focal reducer(s) details including its focal length in mm. Also ensure that the FR distance to the CCD is set correctly for your setup – see section 4.2 for details.



The screenshot shows a window titled "Maintain Focal Reducers" with a table containing the following data:

	Description	Focal Length (mm)	Distance (mm)
▶	Celestron f6.3	285	105
	Meade f6.3	260	95
	Antares f6.3	220	81
	Meade f3.3	85	57
*			

Below the table are two buttons: "Delete Current Row" and "Save All Changes". At the bottom is a text input field labeled "Enter the description".

4 Main Screen

The main screen is split into the following five sections:

- Telescope;
- Focal Reducer;
- CCD;
- Minimum Filter Size;
- Eyepiece Projection;
- Eyepiece.

These sections are explained below:

4.1 Telescope

This section must be completed before using any of the other sections.

To use this section:

- 1) Use the drop list to select your scope **OR** enter the aperture and focal ratio of your scope.
- 2) Press the *Calculate* button.
- 3) The Focal length, Dawes Limit and Limiting Visual Magnitude will be calculated and displayed.
- 4) You may clear all fields via the *Clear* button.

The screen shots below show (i) the results for a Celestron C11 being selected via the drop-list and (ii) the same Aperture and Focal ratio being entered manually.

The image displays two screenshots of the 'Telescope' section of a software interface. Both screenshots show the same calculated results: Focal Length (mm) is 2790, Dawes Limit (arc-secs) is 0.42, and Limiting Visual Mag (approx) is 14.7. The top screenshot shows the 'Celestron C11, Aperture=279mm, fr=10' selected in a dropdown menu, with 'OR Aperture (mm)' and 'Focal Ratio (fr)' fields empty. The bottom screenshot shows the 'OR Aperture (mm)' field filled with '279' and the 'Focal Ratio (fr)' field filled with '10', while the dropdown menu is empty. Both screenshots have 'Calculate' and 'Clear' buttons.

4.2 Focal Reducer

If you use a focal reducer on your scope then enter its details in this section.

To use this section:

- 1) Use the drop list to select your focal reducer **OR** enter the focal length of the focal reducer and the distance to the CCD – **this measurement is critical**, see below for details.
- 2) Press the *Calculate* button.
- 3) Effective focal ratio of your setup will be displayed.
- 4) You may clear all fields via the *Clear* button.

The screen shots below show the results of:

- 1) A Celestron f6.3 reducer that has a focal length of 285mm being placed with 105mm between the focal reducer and CCD. Note that at this distance the acting telescopes focal ratio is the 'advertised' f6.3.
- 2) The same reducer being placed with 120mm between the focal reducer and CCD. Note that at this distance the acting telescopes focal ratio is actually f5.8 and not the 'advertised' f6.3.

Focal Reducer (FR) or Barlow			
FR:	<input type="text" value="Celestron f6.3, FL=285"/>	OR FR's Focal Length (mm):	<input type="text"/>
Barlow:	<input type="text"/>	FR distance to CCD (mm):	<input type="text" value="105"/>
		Acting Focal Ratio (fr):	<input type="text" value="6.3"/>
		Acting Focal Length:	<input type="text" value="1762"/>
			<input type="button" value="Calculate"/>
			<input type="button" value="Clear"/>

Focal Reducer (FR) or Barlow			
FR:	<input type="text" value="Celestron f6.3, FL=285"/>	OR FR's Focal Length (mm):	<input type="text"/>
Barlow:	<input type="text"/>	FR distance to CCD (mm):	<input type="text" value="120"/>
		Acting Focal Ratio (fr):	<input type="text" value="5.8"/>
		Acting Focal Length:	<input type="text" value="1615"/>
			<input type="button" value="Calculate"/>
			<input type="button" value="Clear"/>

It is therefore critical that to achieve the optimal f6.3 usage for this particular focal reducer the distance needs to be 105mm.

To show what is meant by the '*FR distance to CCD*', and how you can measure it, click the "?" button which presents the following diagrammatic example set up. The FR distance to the CCD is from the edge of the focal reducers glass element to the plane of the CCD, and for the example shown below, a Celestron focal reducer with a focal length of 285, it is 105mm for the focal reducer to work at f6.3.



4.3 CCD

To use this section:

- 1) Use the drop list to select your CCD **OR** enter the pixel and chip sizes of your CCD.
- 2) Press the *Calculate* button.
- 3) The arc seconds per pixel and FOV will be displayed.
- 4) You may clear all fields via the *Clear* button.

Note that the heading text of the section changes when you calculate a scope and/or a focal reducer to show the acting focal length and f-ratio which are being used for the CCD calculations.

The screen shots below show:

- 1) An Atik 314L+ being used on a scope (or a scope with a focal reducer) working at a focal length of 1762mm with a f-ratio of f6.3 (this is my C11 with a f6.3 focal reducer setup).
- 2) The same as (1) but with the CCD binning at 2x2.
- 3) The same CCD but on a 2790mm and f10 setup (this is my C11 without the focal reducer).

Note how the arc secs per pixel and FOV differ. The arc seconds per pixel is a useful indicator which indicates if you are in danger of over or under sampling your image. Click the question mark help button next to the field for a further explanation of this value.

CCD (scope fl 1762mm at f6.3)

Select CCD:	Atik 314L+	Bin:	1x1
OR			
Pixel Size X by Y (microns):	<input type="text"/>	<input type="text"/>	Calculate
Chip Size X by Y (pixels):	<input type="text"/>	<input type="text"/>	
Arc Secs per pixel:	0.75	?	Clear
Field of View (X by Y):	17.52	13.09 arc mins	

CCD (scope fl 1762mm at f6.3)

Select CCD:	Atik 314L+	Bin:	2x2
OR			
Pixel Size X by Y (microns):	<input type="text"/>	<input type="text"/>	Calculate
Chip Size X by Y (pixels):	<input type="text"/>	<input type="text"/>	
Arc Secs per pixel:	1.51	?	Clear
Field of View (X by Y):	17.52	13.09 arc mins	

CCD (scope fl 2790mm at f10)

Select CCD:	Atik 314L+	Bin:	1x1
OR			
Pixel Size X by Y (microns):	<input type="text"/>	<input type="text"/>	Calculate
Chip Size X by Y (pixels):	<input type="text"/>	<input type="text"/>	
Arc Secs per pixel:	0.48	?	Clear
Field of View (X by Y):	11.06	8.27 arc mins	

4.4 Minimum Filter Size

To use this section:

- 1) Use the drop list to select your CCD **OR** enter the chip diagonal size in mm of your CCD.
- 2) Enter the distance from your filter to the CCD chip in mm.
- 3) Press the *Calculate* button.
- 4) The minimum size of filter to cover the size of the chip is then displayed.
- 5) You may clear all fields via the *Clear* button.

Note that the heading text of the section changes when you calculate a scope and/or a focal reducer to show the acting focal length and f-ratio which are being used for the calculation.

The screen shot below shows:

- The scope's acting focal length is 1762mm with an f-ratio of f6.3 (this is for my Celestron C11 with a f6.3 focal reducer).
- An Atik 383L+ CCD camera has been selected that has previously been set up in the CCD reference data screen (with a diagonal size of 22.5mm).
- The distance from the CCD chip to the filter has been entered as 20mm.
- The calculated minimum filter size is 25.4 which means a standard 1 ¼" filter will be fine for this set up.

Minimum Filter Size (scope fl 1762mm at f6.3)

Select CCD:

OR

CCD diagonal size (mm):

CCD to filter distance (mm):

Minimum filter size (mm):

The second screen screen shot below shows:

- The scope's acting focal length is 1762mm with an f-ratio of f6.3.
- A camera is being used whose chip diagonal size has been entered as 12.84mm.
- The distance from the CCD chip to the filter has been entered as 30mm.

The calculated minimum filter size is 17.4mm which means a standard 1 ¼" filter will be fine for this set up.

Minimum Filter Size (scope fl 1762mm at f6.3)

Select CCD:

OR

CCD diagonal size (mm):

CCD to filter distance (mm):

Minimum filter size (mm):

4.5 Eyepiece

To use this section:

- 1) Use the drop list to select your eyepiece **OR** enter the focal length and FOV of your eyepiece.
- 2) Press the *Calculate* button.
- 3) The Magnification, the real field of view and exit pupil size will be calculated and displayed.
- 4) You may clear all fields via the *Clear* button.

Note that the heading text of the section changes when you calculate a scope and/or a focal reducer to show the acting focal length and f-ratio which are being used for the eyepiece calculations.

The screen shot below shows the results for an eyepiece with a 26mm focal length with 52 degrees FOV for a scope with an acting focal length of 2790mm and an f-ratio of 10. In this example it shows that the moon (which has an approximate size of 0.5 degrees) will fill the view provided by this eyepiece.

Eyepiece (scope fl 2790mm at f10)

Select Eyepiece: Meade 26mm 52 degs, Series 4000 Plössl

OR

Focal Length (mm):

Apparent Field (degs):

Magnification: 107

Real Field Of View: 0.48 degrees

Exit Pupil (mm): 2.6

Calculate

Clear

The maximum night adapted pupil size for a person is normally around 5 to 8mm (typically decreases as you get older). The exit pupil calculation gives you the size of the image coming from the eyepiece. In the above example (2.6mm) your eye should therefore have no problem accommodating this setup.

4.6 Eyepiece Projection

Eyepiece projection is commonly used for imaging planets as it provides a larger image for small objects.

To use this section:

- 1) Use the drop list to select your Eyepiece **OR** enter the focal length of an eyepiece.
- 2) Enter the distance from your eyepiece to the CCD.
- 3) Press the *Calculate* button.
- 4) Effective focal length and focal ratio of your setup will be displayed.
- 5) You may clear all fields via the *Clear* button.

Note that the heading text of the section changes when you calculate a scope and/or a focal reducer to show the acting focal length and f-ratio which are being used for the eyepiece projection calculations.

The screen shot below shows the results for an eyepiece with a 20mm focal length with 52 degrees FOV for a scope with an acting focal length of 2790mm and an f-ratio of 10. In this example it shows that the resulting acting image equates to a focal length of 12,555mm and a f-ratio of 45.

Eyepiece Projection (scope fl 2790mm at f10)

Select Eyepiece:

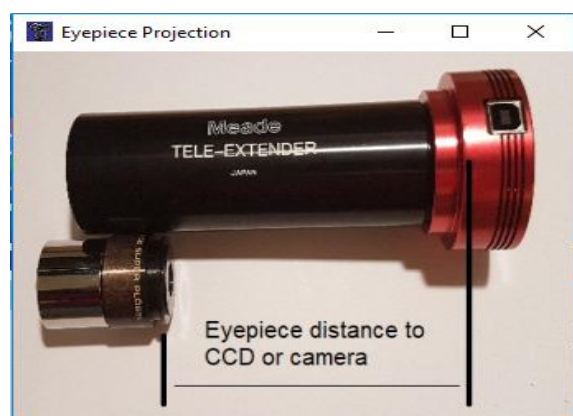
OR Focal Length (mm):

Eyepiece distance to CCD (mm): ?

New Scope Focal Length (mm):

New Scope Focal Ratio (fr):

To show what is meant by the 'the distance from your eyepiece to the CCD', and how you can measure it, click on the "?" button which presents the following diagrammatic explanation. It is the distance from the edge of the eyepiece glass element to the plane of the CCD (the image shows the eyepiece outside the tele-extender but during operation the eyepiece is inside the tele-extender which is then attached to the back of the scope).



5 Further Information

Please visit my website www.astroworkbench.co.uk for further applications, documents and articles.

Thanks.

Keith.