Der Schiefspiegler

De ontwerpen van Anton Kutter

2016, Arjan te Marvelde

Overzicht

Bulletin A, 1958, Sky Publishing Corp.

- Gleanings for ATM's -

SKY AND TELESCOPE Bulletin A

Gleanings for ATM's

THE SCHIEFSPIEGLER (OBLIQUE TELESCOPE)

by

ANTON KUTTER

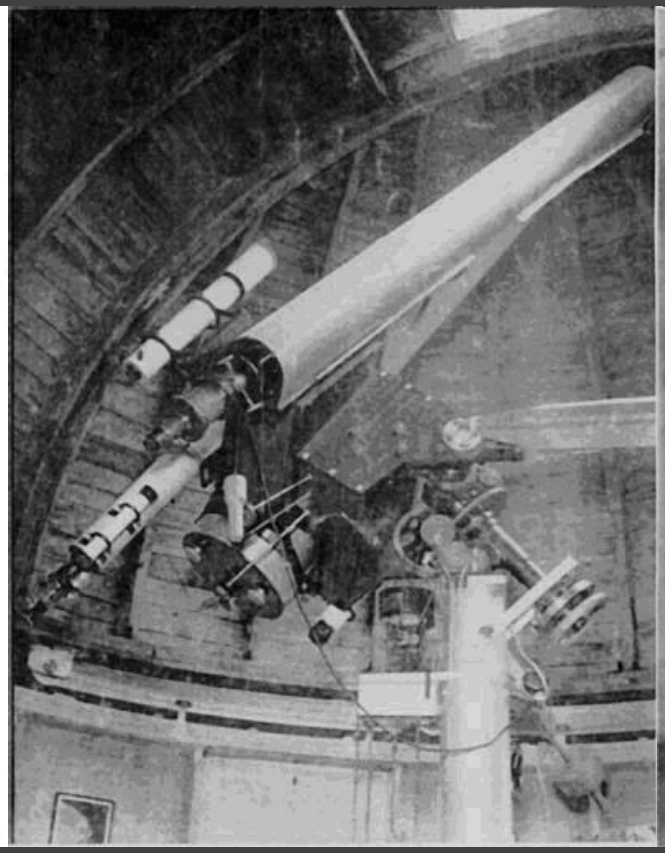
Waldseer Strasse 3

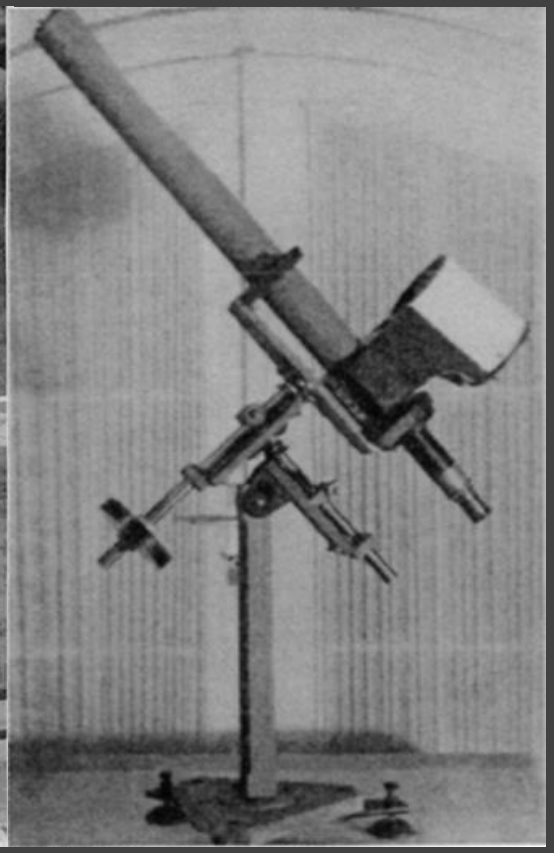
Biberach an der Riss

West Germany

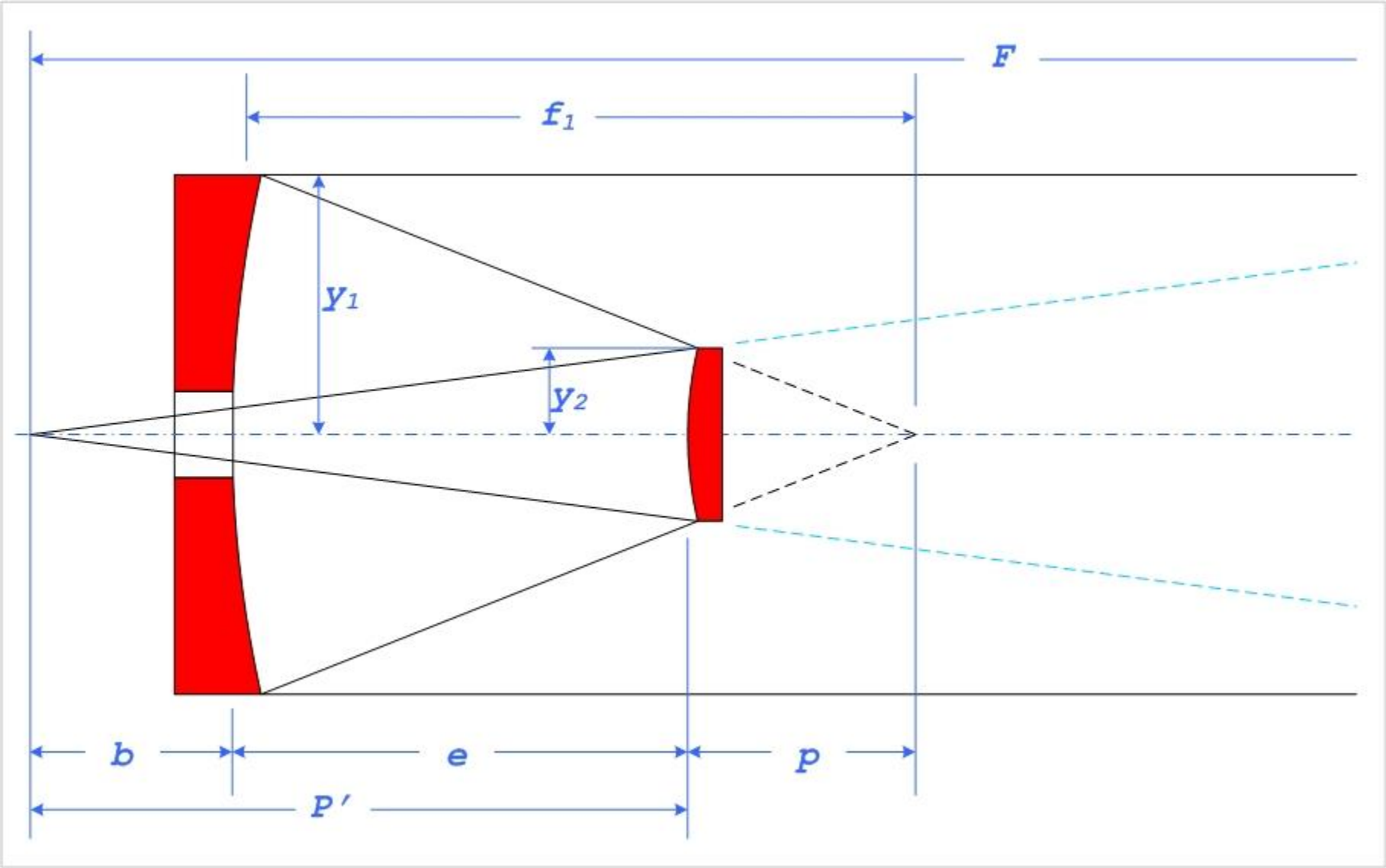
NOTE: Mr. Kutter's figure 3 appears on page 66 of the December, 1958, issue of SKY AND TELESCOPE; his figure 7 is the front-cover picture of the same issue; and some of his moon photographs are reproduced with the article in that issue, "Moon Photographs with an Off-Axis Reflector," beginning on page 65.

SKY PUBLISHING CORPORATION
Harvard Observatory
Cambridge 38, Mass.





Cassegrain als basis



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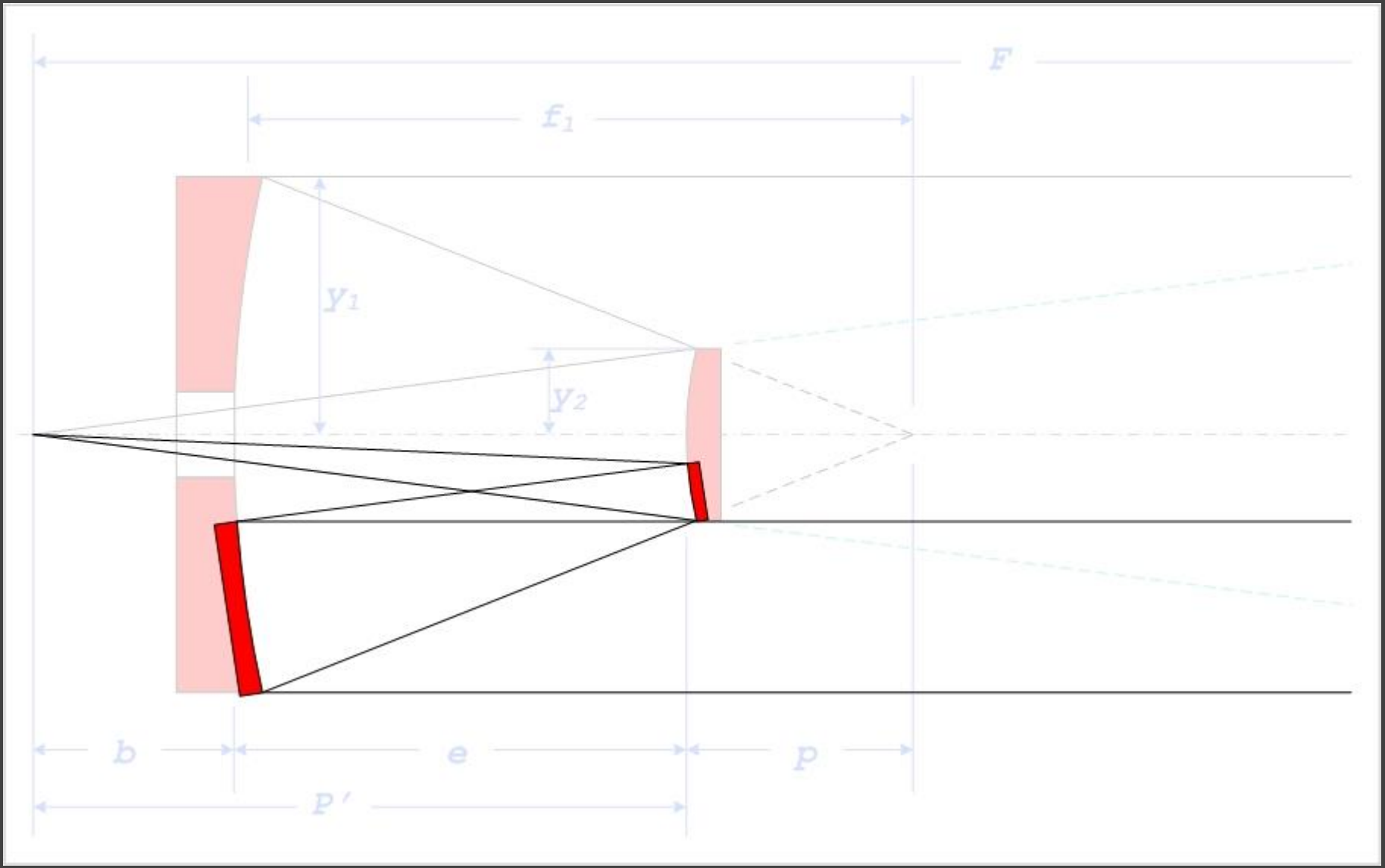
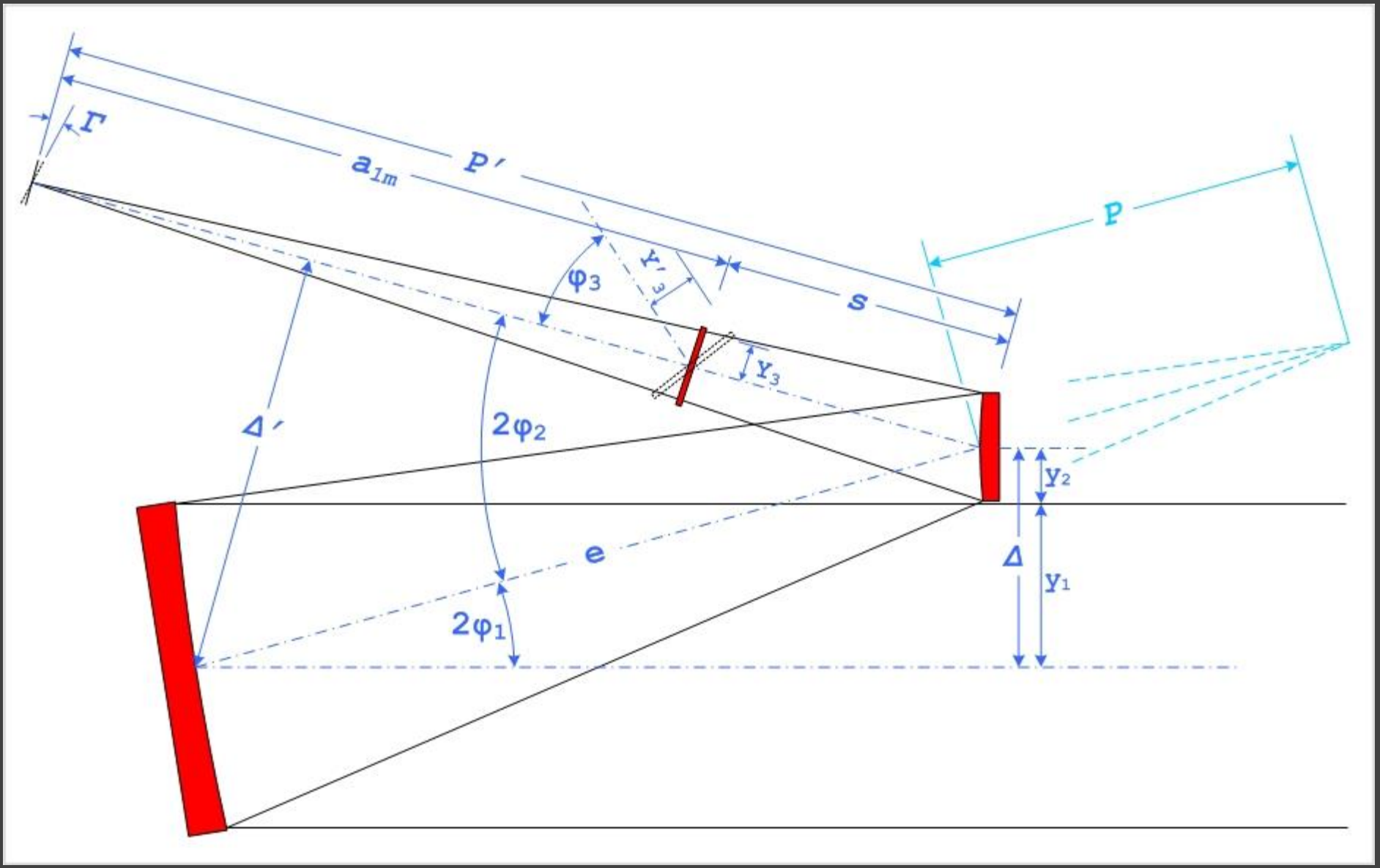


Kutter's ontwerp



De analyse…

1) condition of focal lengths

$$a_{1m} = \frac{k \cdot F_m}{\ell}$$

Gives the location where meridional and sagittal beam diameters are equal, measured frm the meridional focus. This is also the location of the corrector lens.

2) condition of coma

$$\beta = 3 \cdot y_1^2 \left[\left\{ \sin(\varphi_1) \cdot \left(\frac{1}{r_1} \right)^2 \right\} + \left\{ \left(\frac{y_2}{y_1} \right)^3 \cdot \sin(\varphi_2) \cdot \left(\frac{1}{p} - \frac{1}{r_2} \right) \cdot \frac{1}{r_2} \right\} + \left\{ \left(\frac{y_3}{y_1 \cdot \cos(\varphi_3)} \right)^3 \cdot \sin(\varphi_3) \cdot \frac{1}{2 f_3} \left[\left(\frac{1}{a_{1m}} - \frac{1}{2 f_3} \right) \cdot \left(\frac{1}{n} + 2 \right) + \frac{1}{2 r_3} \cdot \left(\frac{1}{n} + 1 \right) \right] \right\} \right]$$

Where the three terms represent coma contributions of primary mirror, secondary mirror and corrector lens.

3) condition of astigmatism

$$\xi = \sin^2(\varphi_1) \cdot \frac{y_1}{f_1} + \frac{y_2}{y_1} \cdot \sin^2(\varphi_2) \cdot \frac{y_2}{f_2} + \frac{y_3}{y_1 \cdot \cos(\varphi_3)} \cdot \sin^2(\varphi_3) \cdot \frac{y_3}{f_3 \cdot \cos(\varphi_3)}$$

Again, the three terms represent the contributions of the optimal elements.

Primaire spiegel

Secundaire spiegel

Corrector

Schief-kit

Design estimation

Parameters			
System focal length (F)	Feff	3600	mm
Primary focal length (f1)	Fpri	2260	mm
Primary diameter	Dpri	150	mm
Secondary focal length (f2)	Fsec	2260	mm
Secondary diameter	Dsec	72	mm
Additional room secondary	Psec	10	mm
Back Focal Length (b)	b	0	mm
Mirror separation (e)	e	1388	mm
Primary cone radius (y1)	Ypri	75	mm
Secondary cone radius (y2)	Ysec	28.9	mm
Magnification (A)	Af	1.593	
Primary ROC (r1)	Rpri	4520	mm
Secondary ROC (r2)	Rsec	4520	mm
Effective cone length (p')	Ceff	1388	mm
Residual cone length (p)	p	872	mm
Cone radius ratio (y1/y2)	Yratio	2.593	
Degrees per radian	dpr	57.296	°/rad
Arcsec per radian	spr	206265	"/rad

Solution estimation

Anastigmatic device			
Mirror offset (Δ)	delta1	127	mm
Primary inclination (φ1)	phi1	2.628	°
Secondary inclination (φ2)	phi2	6.827	°
Primary offset (Δ')	delta2	328	mm
Coma-free device			
Mirror offset (Δ)	delta1	127	mm
Primary inclination (φ1)	phi1	2.628	°
Secondary inclination (φ2)	phi2	11.007	°
Primary offset (Δ')	delta2	520	mm
Catadioptic device			
Mirror offset (Δ)	delta1	127	mm
Primary inclination (φ1)	phi1	2.628	°
Secondary inclination (φ2)	phi2	10.171	°
Primary offset (Δ')	delta2	483	mm
Corrector position (s)	cs	542	mm
Corrector inclination (φ2)	phi3	28	°
Sagittal primary focus (f1s)	f1s	2265	mm
Astigmatic cutting length diff (k)	k	7.595	mm
Astigmatic focal length diff (l)	dl	31.877	mm
Meridional syst focal length (Fm)	Fm	3679	mm
Meridional final cone length (p'm)	pm	1419	mm

Design optimization

Parameters			
Primary inclination (φ1)	phi1	2.630	°
Secondary inclination (φ2)	phi2	6.830	°
Corrector focal length (f3)	Fcor	25000	mm
Corrector inclination (φ3)	phi3	0	°
Corrector refractive index	Nc	1	
Secondary to corrector (s)	s	850	mm
Cone radius at corrector (y3)	Ycor	11.6	mm
Cor/Pri diam ratio (y'3/y1)	Ycp	0.155	
Dimensions			
Final cone length (p'm)		1419	mm
Mirror offset (Δ)	delta1	127	mm
Primary offset (Δ')	delta2	328	mm
Residual coma (β)	beta	3.0	"
Residual astigmatism (ξ)	xi	0.0	"
System parameters			
1/2 FOV with 1.25" eyepiece		0.255	°
Image plane tilt	Gamma	5.01	°
Airy disk diameter		1.8	"

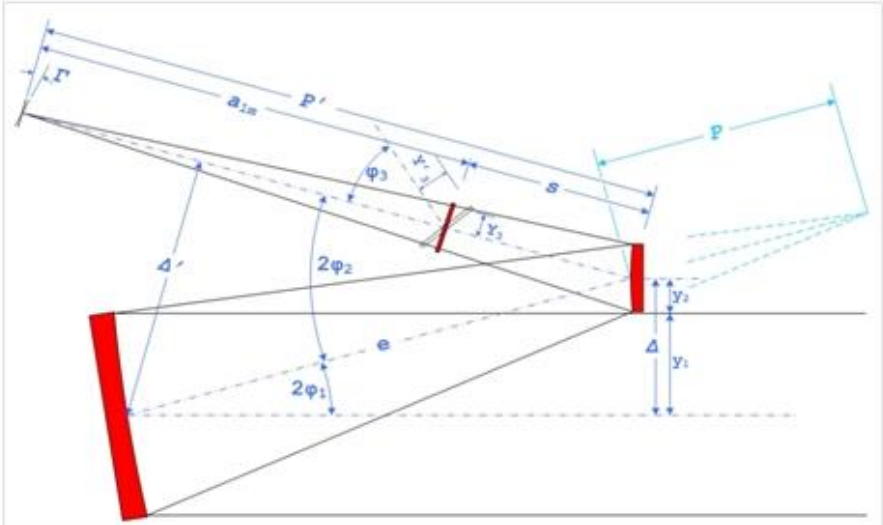
Fill in *Design estimation* parameters in the yellow boxes.

Solution estimation gives three initial solutions.

Use these as starting points for *Design optimization*.

Optimize to desired performance, by changing the numbers in the yellow boxes.
When no corrector lens is used, just set **Nc** to 1.
Check residual abberations against airy disk.
Return to *Design estimation* when desired performance can not be achieved.

The calculated dimensional design parameters are in the grey boxes.

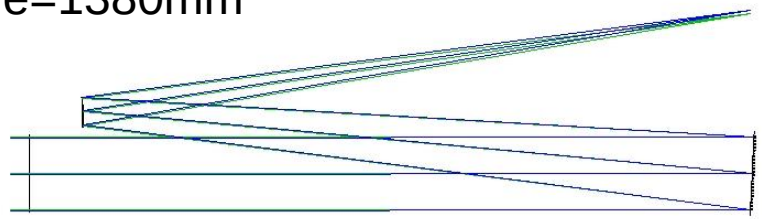


Anastigmaat / Coma-vrij

150mm - F/24

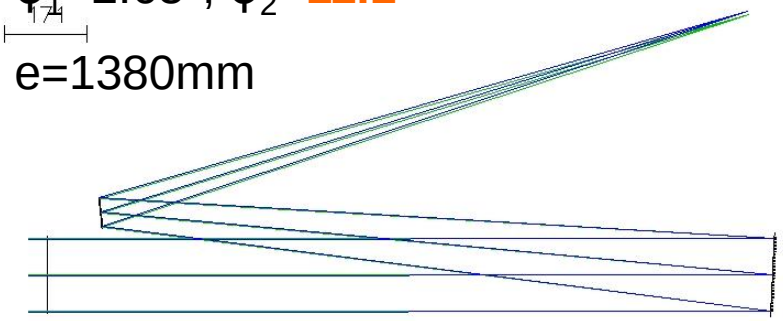
φ_1=2.65º, φ_2=**6.9º**

e=1380mm



φ_1=2.65º, φ_2=**11.1º**

e=1380mm

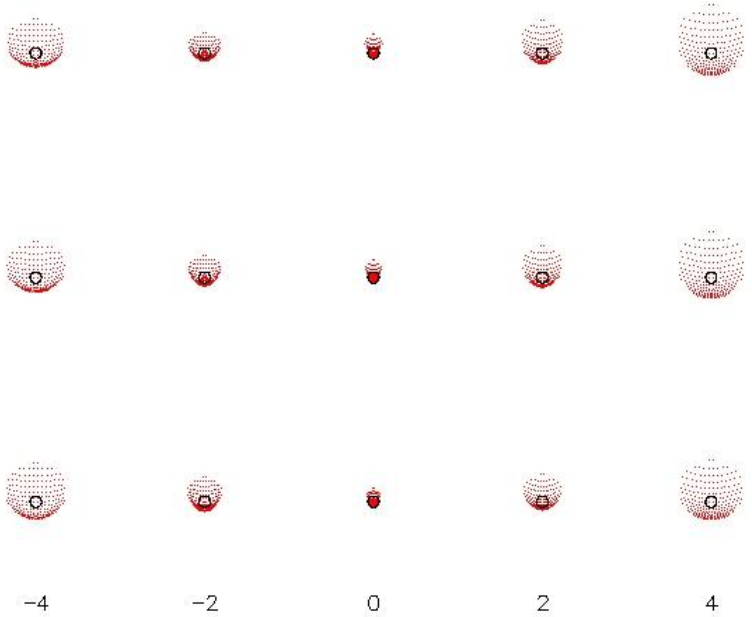


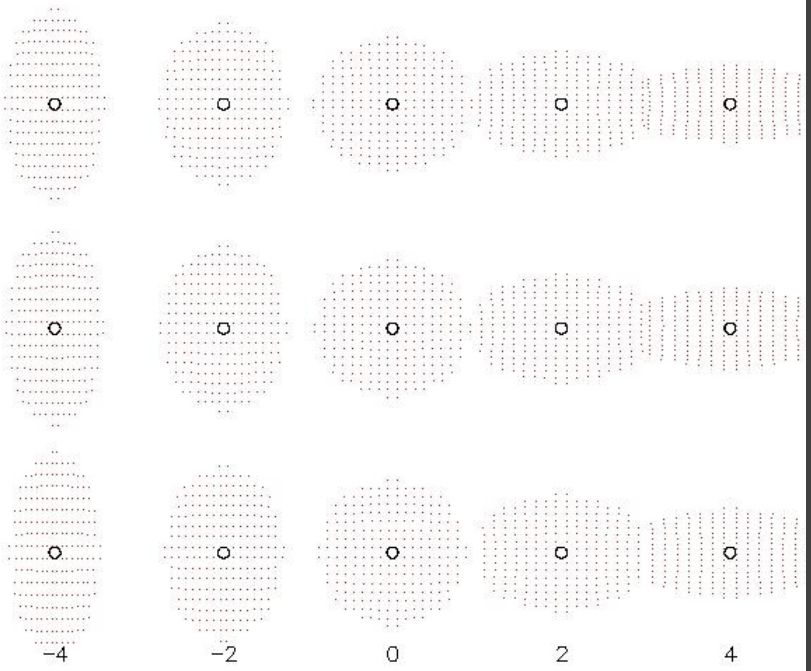
FULL FIELD
0.1deg

0.7 FIELD
0.07deg

ON-AXIS
0deg

0.4



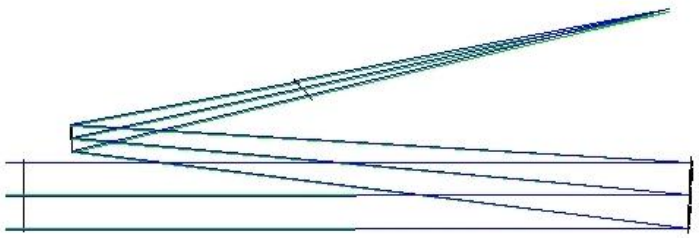


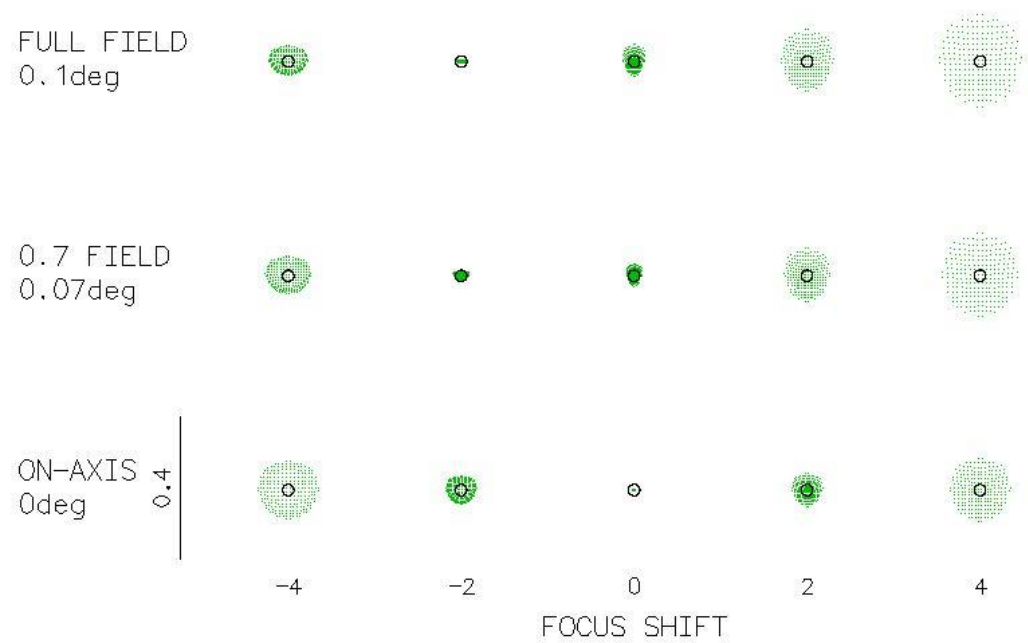
Catadioptrisch

- PCX lens, f_3=40 meter
- Afstand tot secundaire: s=55cm
- Inclinatie φ_3=30.2º

φ_1=2.65º, φ_2=**8.5**º

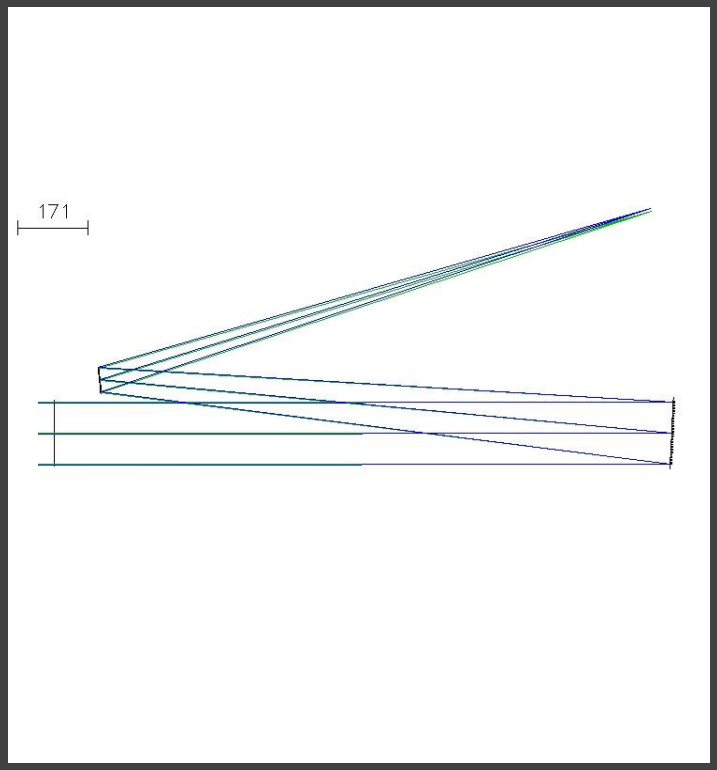
e=1380mm

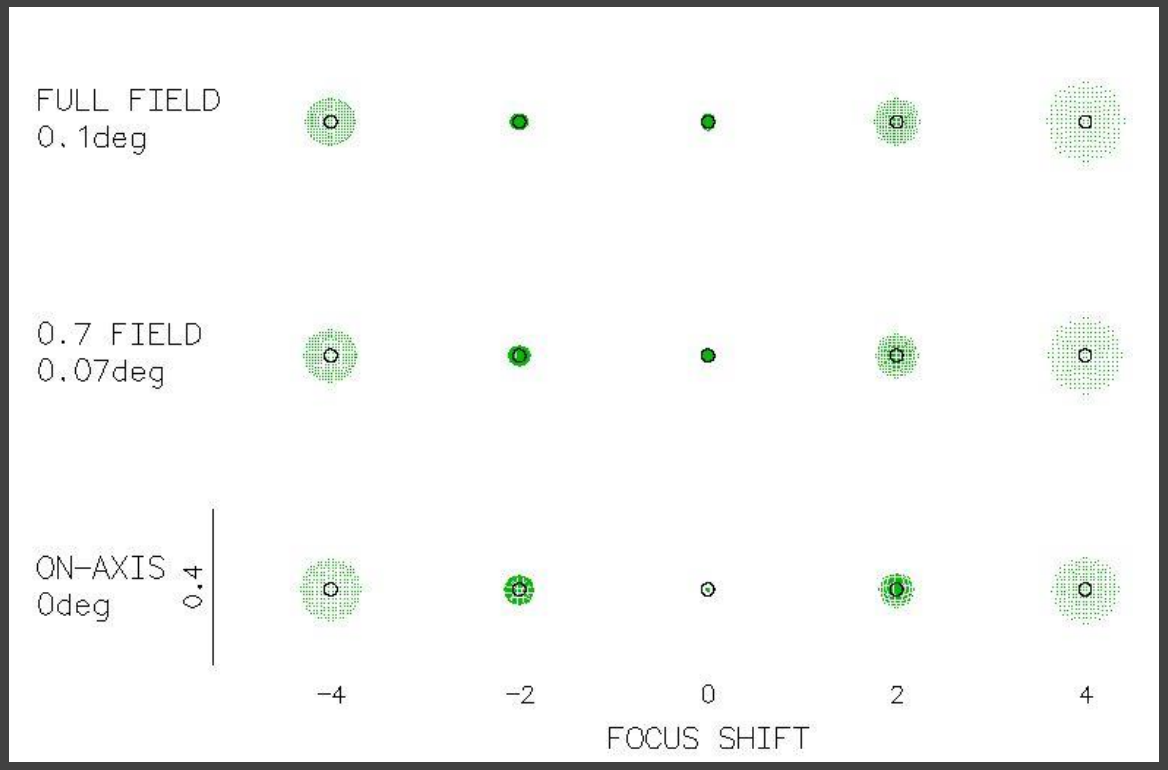




Toroïde secundaire

- Uitgangspunt: Coma-vrij systeem
- Toroïde compenseert astigmatisme
  → 6 fringes; ΔRoC=10cm





Stapsgewijs

1. Bepaal de basis afmetingen:
   - *o.b.v.* F-primair, F-seuncair, F-systeem, Back-focus, Buisdiameter
   - *m.b.v.* de Cassegrain vergelijkingen
2. Bepaal de inclinaties:
   - *o.b.v.* Gewenste systeemtype, Minimalisatie abberaties
   - *m.b.v.* de Kutter vergelijkingen
3. Optimaliseer in raytracer (e.g. OSLO)

Downloads

- Gleanings Bulletin A:
  http://atm.udjat.nl/articles/The Schiefspiegler.pdf

- Schief toolkit:
  http://atm.udjat.nl/resource/schief_kit.xlsx

- OSLO LT:
  http://www.sinopt.com/software1/downloads1/dloads_lt.htm

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