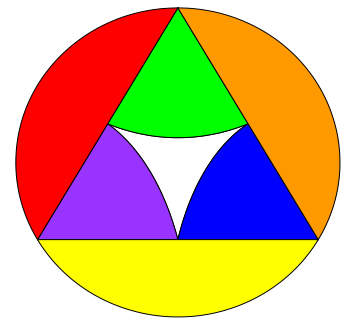
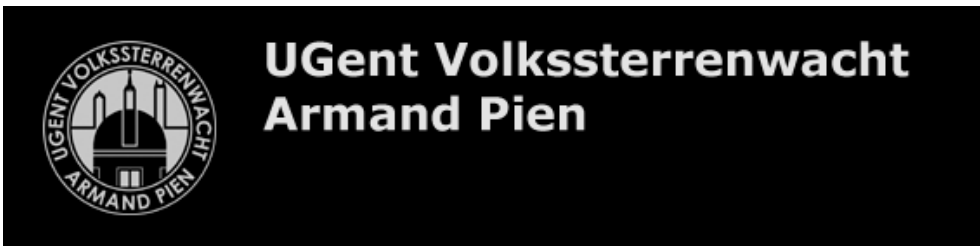


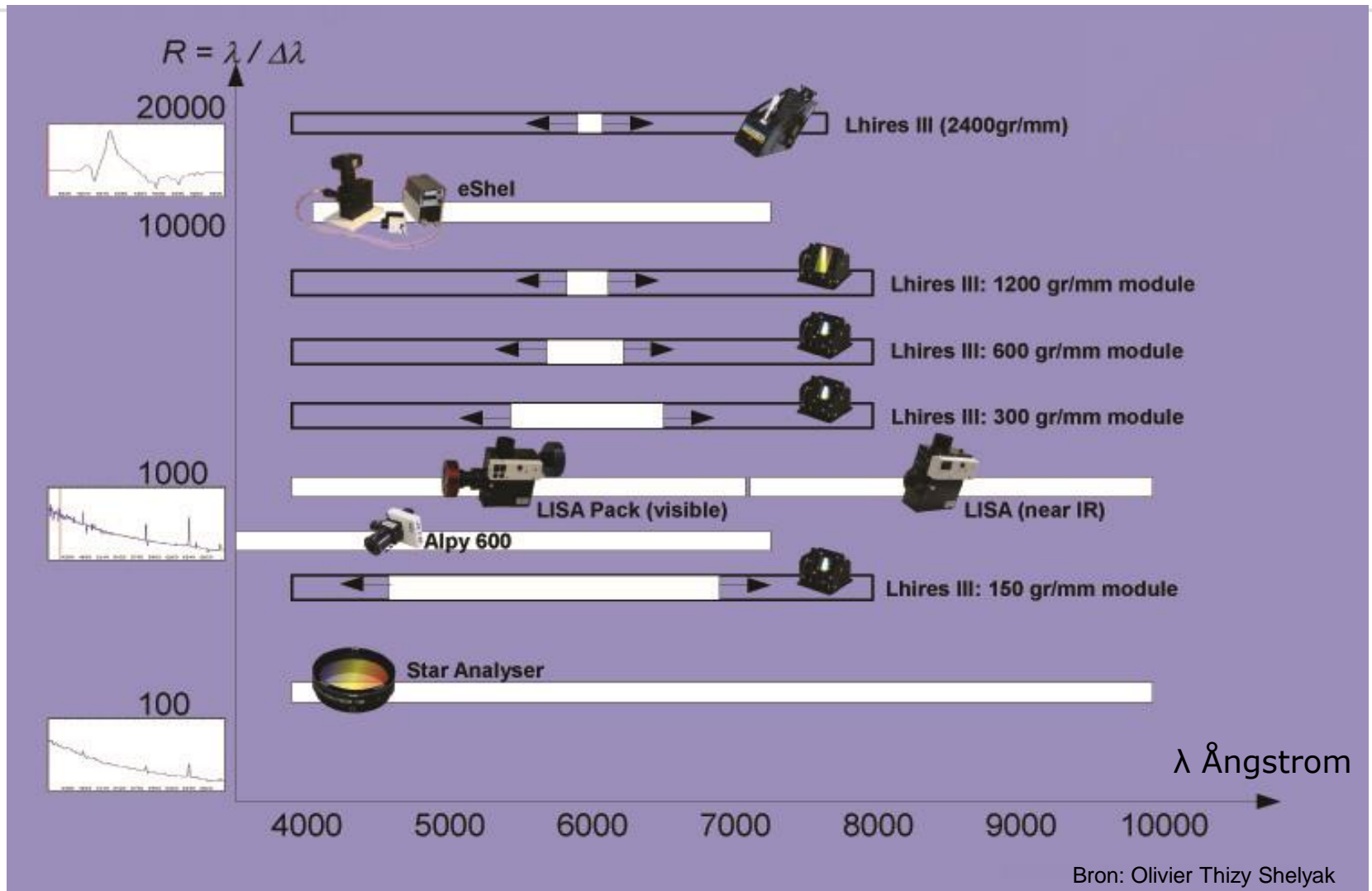


► Spectroscopie in de Sterrenkunde

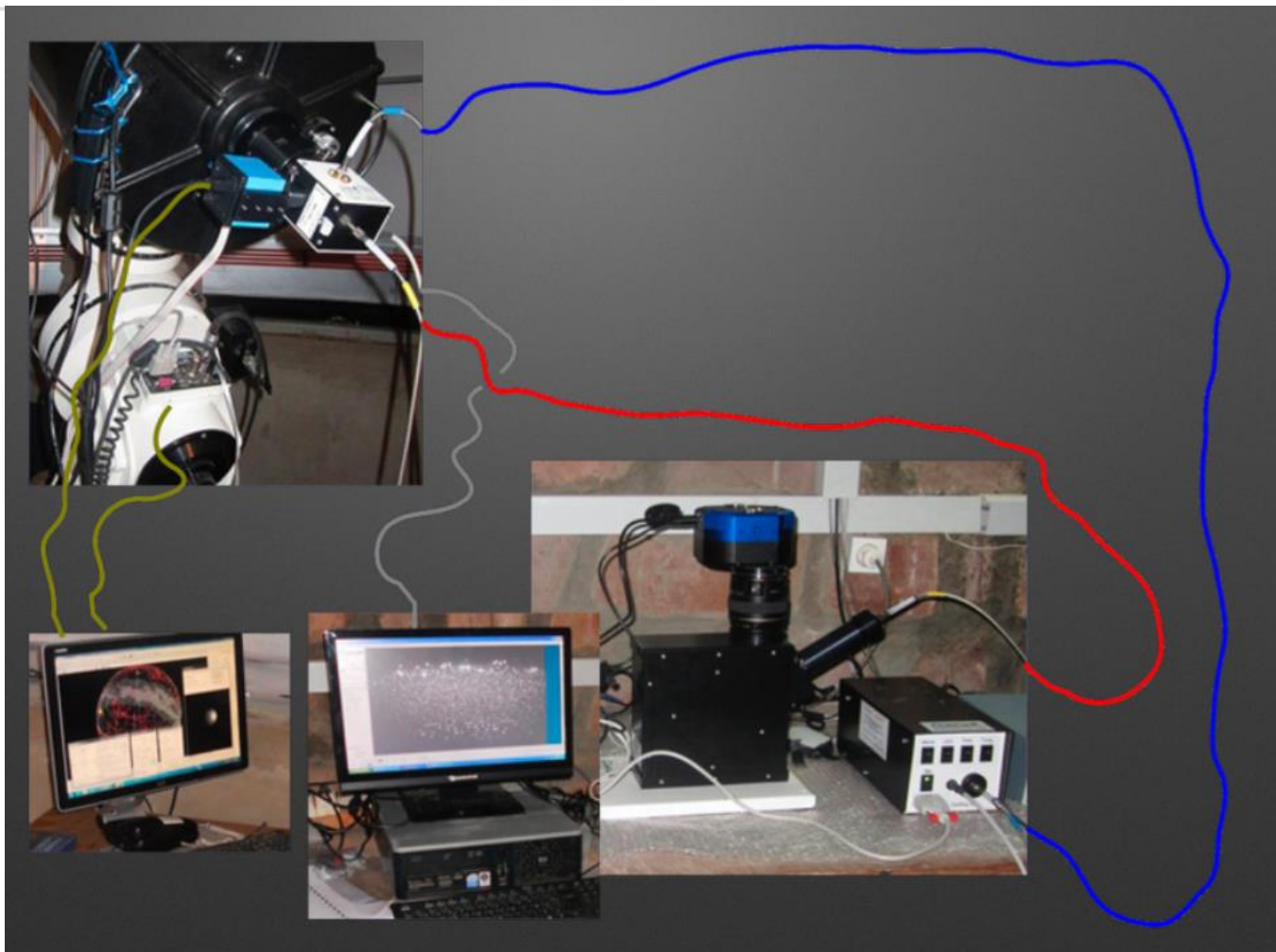
Het ontwerp, de bouw en het testen van een echelle spectrograaf.



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



eShel firma Shelyak 16 500 € (excl. Camera's)

www.shelyak.com

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

Eine neue Dimension für wissenschaftliche Spektroskopie mit kleinen Teleskopen

baader planetarium

BACHES Echelle-Spectrograf | # 2458600

SBIG und SKYRIS Kameras nicht im Lieferumfang enthalten

BACHES mittleres spektrales Auflösungsvermögen

RCU-Rückseite mit LAN- und RS-232-Anschluss

RCU - Remote Calibration Unit (optional erhältlich | # 2458605)

BACHES - BASIC eCHELLE Spectrograph firma Baader Planetarium
7 995 € + RCU 4 200 € (excl. Camera's)

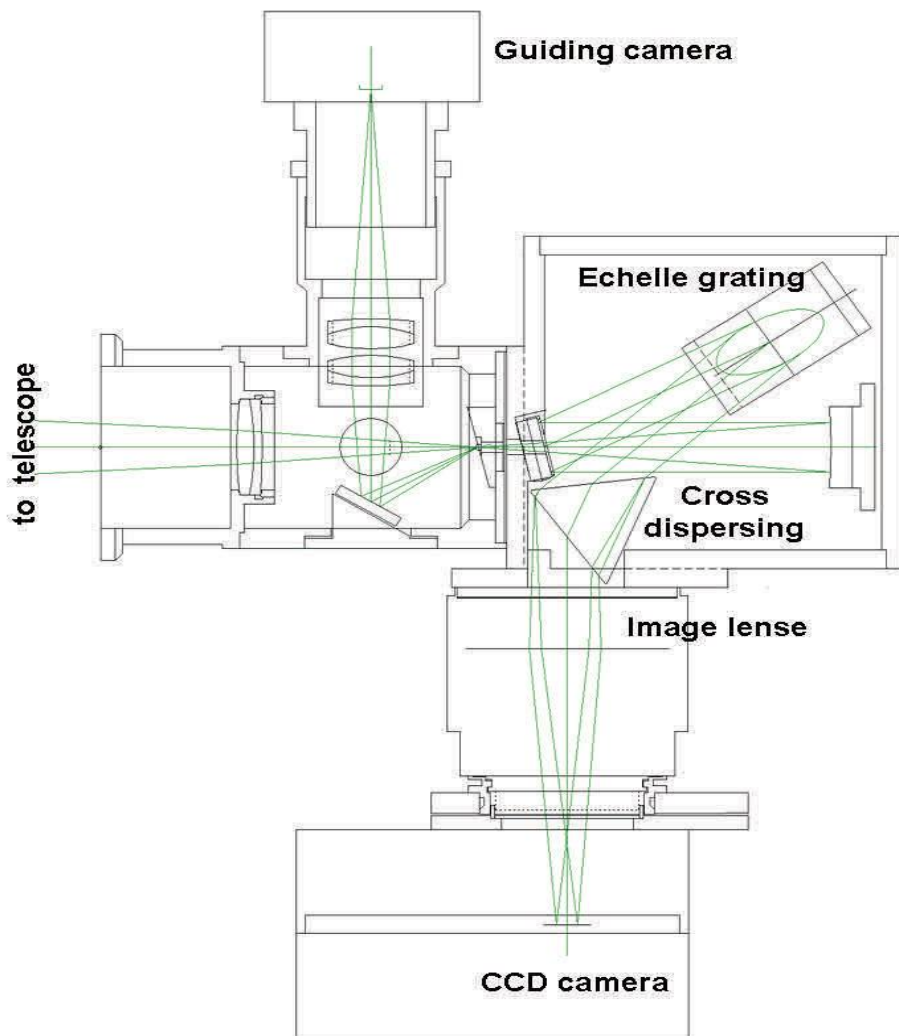
www.baader-planetarium.com

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



**Sques firma Eagle Owl Optics 5 970 € (6190 SFr 24/4/2015)
(Op bestelling?) Incl. calibration unit. www.eagleowloptics.com**

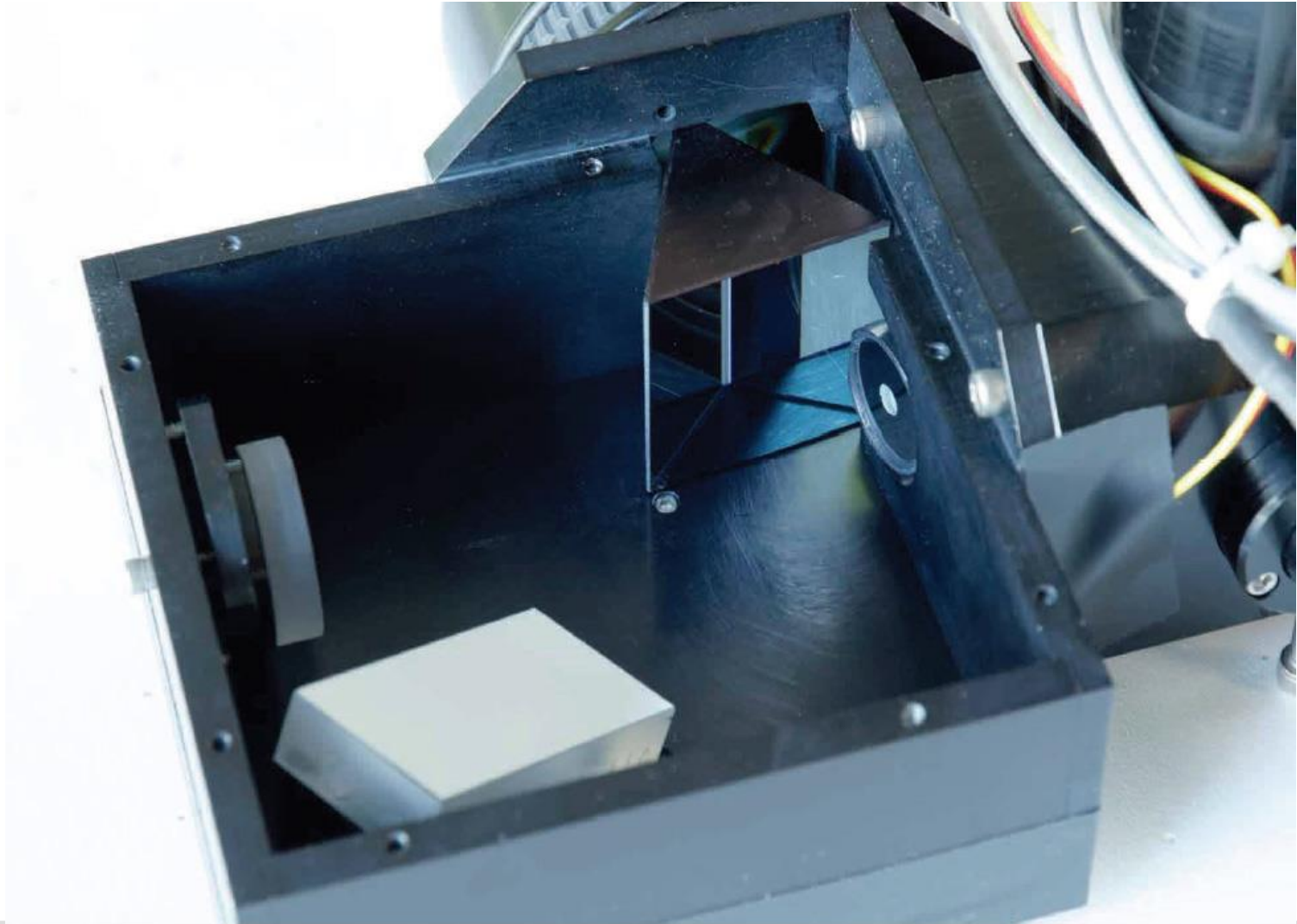
Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



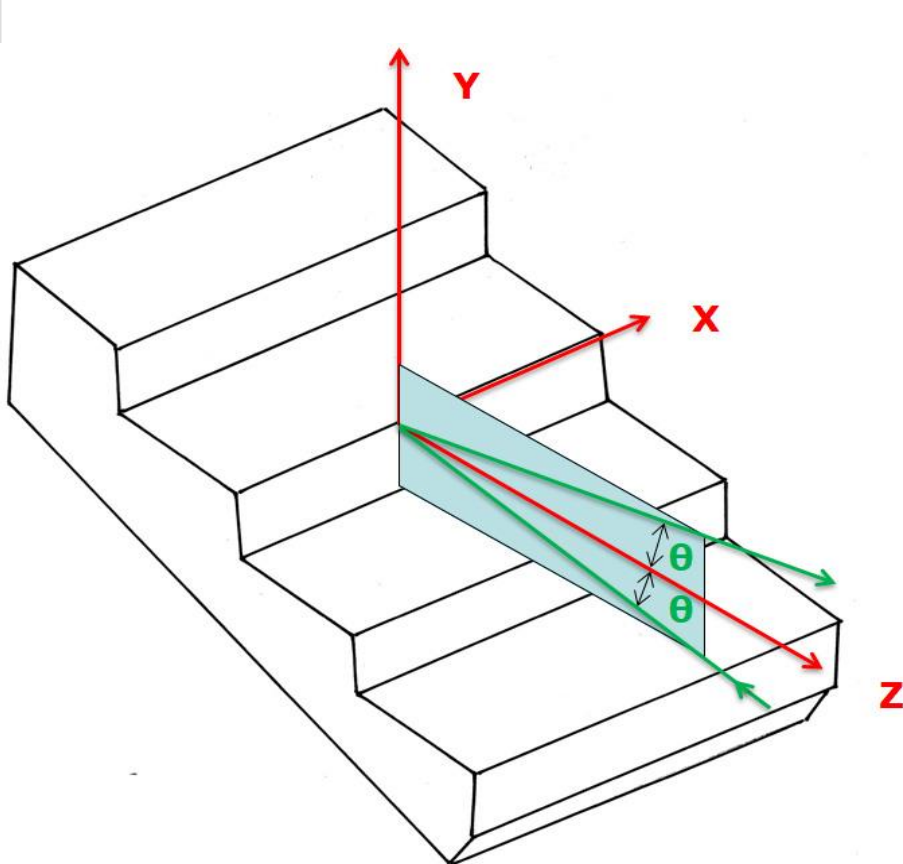
**BAV Magazine N° 2
12/2017 P.17 by Tim
Lester**

https://www.bav-astro.eu/images/Up_MagazinSpec/BAV-Magazin_2.pdf

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

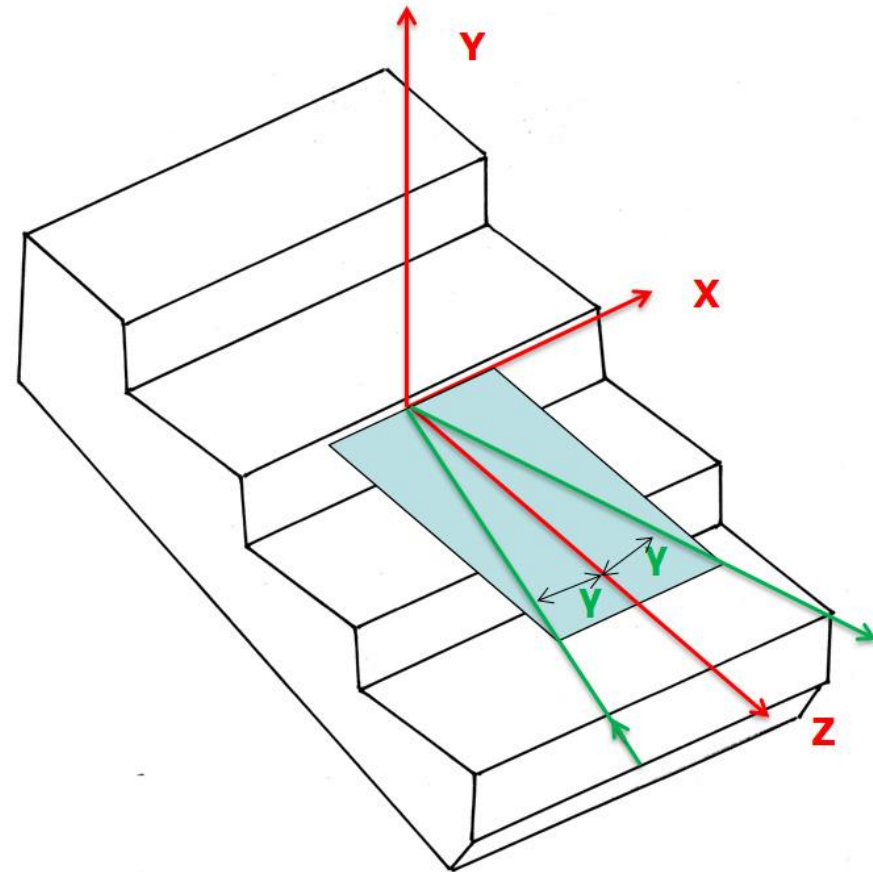


Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



$\theta > 0$ $\gamma = 0$

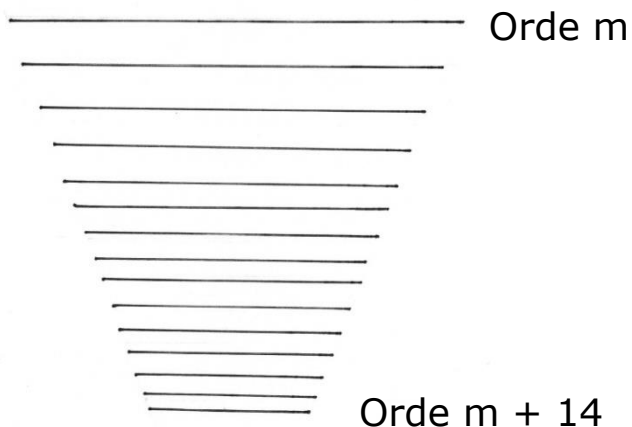
Echelle Rooster



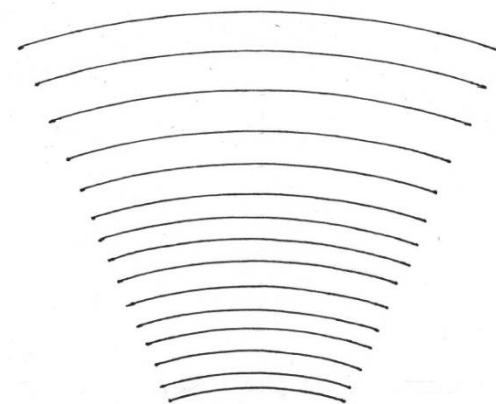
$\theta = 0$ $\gamma > 0$

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

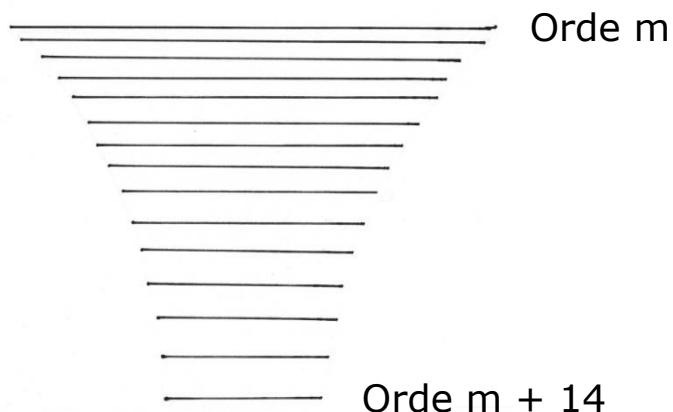
Echellogram (Schematische voorstelling)



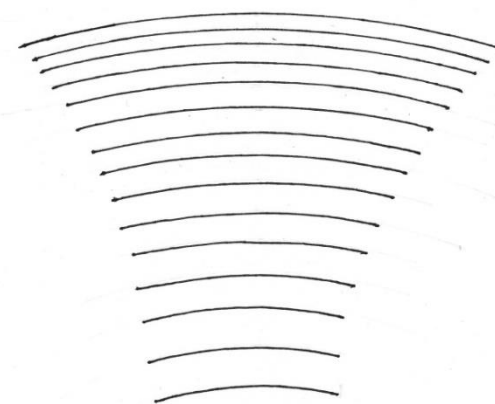
Cross Disp. ROOSTER $\theta > 0$ $\gamma = 0$



Cross Disp. ROOSTER $\theta = 0$ $\gamma > 0$



Cross Disp. PRISMA $\theta > 0$ $\gamma = 0$



Cross Disp. PRISMA $\theta = 0$ $\gamma > 0$

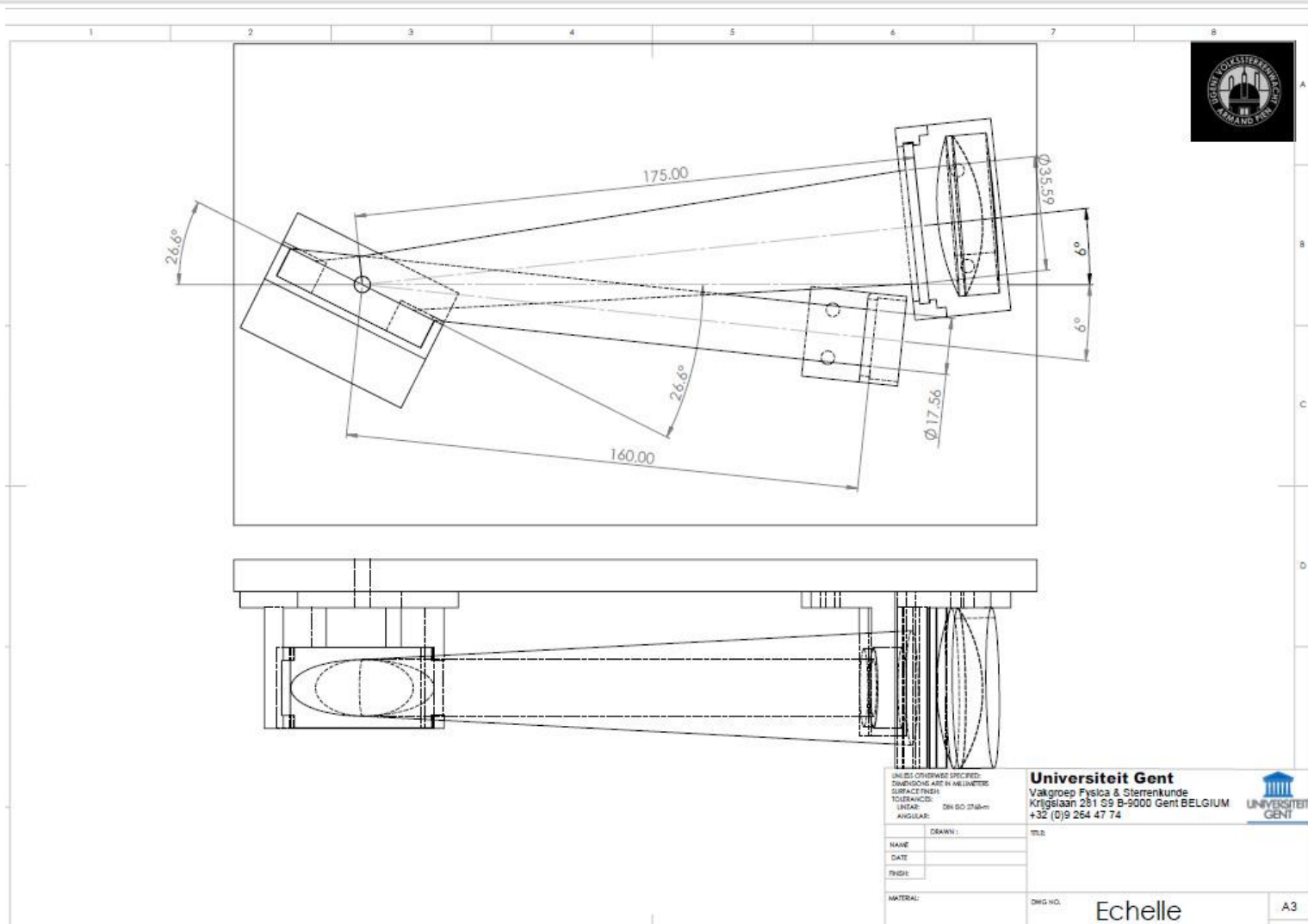
Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
	Ordnung	Zentralwellenlänge λ_c	Ordnungsabstand in Angström	Ordnungsabstand in Pixeln	Lambda (Min)	Lambda (Max)	Ordnungslänge in Angström	Dispersion [Å/Pixel]	freie Ordnungslänge in mm	Ausreichende Überlappung ?	Überlappung in Angström	R	Spektrale Auflösung ($\Delta\lambda$)	Abtastfaktor	Eingabeparameter			CCD-Abmessungen	Eingabe: kleinste Ordnung	Eingabe: größte Ordnung		
1	Ordnung														Pixelabmessung CCD (p):	4.54	12.48	9.98	33	58		
2	33	6824			6708	6940	232	0.17		ja	28	9.545	0.71	2.12	Pixelanzahl CCD (Nx):	2749						
3	34	6623	201	75	6511	6736	225	0.16	10.93	ja	33	10.375	0.64	1.95	Pixelanzahl CCD (Ny):	2199	9.98					
4	35	6434	189	71	6325	6544	219	0.16	10.61	ja	37	11.321	0.57	1.78	Objektiv-Durchmesser (D):	279						
5	36	6255	179	67	6149	6362	213	0.15	10.30	ja	41	12.391	0.50	1.63	Teleskop-Brennweite (F):	2790						
6	37	6086	169	63	5983	6190	207	0.15	10.02	ja	44	13.584	0.45	1.49	Spaltbreite in μm :	40.0						
7	38	5926	160	60	5825	6027	202	0.15	9.75	ja	47	14.548	0.41	1.39	Binning in Dispersionsrichtung (fi):	2						
8	39	5774	152	57	5676	5872	196	0.14	9.49	ja	50	16.477	0.35	1.23	Kollimator-Brennweite (f1):	175						
9	40	5630	144	54	5534	5726	192	0.14	9.25	ja	54	17.354	0.32	1.16	Kamera-Brennweite (f2):	111						
10	41	5493	137	51	5399	5586	187	0.14	9.02	ja	58	18.315	0.30	1.10	Seeing in Bogensekunden (s):	4						
11	42	5362	131	49	5271	5453	182	0.13	8.80	ja	61	18.363	0.29	1.10	Linienichte Echelle in Linien/mm:	79						
12	43	5237	125	47	5148	5326	178	0.13	8.59	ja	65	18.288	0.29	1.10	Theta:	6						
13	44	5118	119	44	5031	5205	174	0.13	8.39	ja	69	17.732	0.29	1.14	Blazewinkel:	63.4349						
14	45	5004	114	42	4919	5090	170	0.12	8.19	ja	73	16.949	0.30	1.19	Linien/mm Cross Disperser:	300						
15	46	4896	109	41	4812	4979	167	0.12	8.02	ja	77	17.535	0.28	1.15	Abstand Echelle bis Cross Disperser:	180						
16	47	4791	104	39	4710	4873	163	0.12	7.84	ja	81	17.812	0.27	1.13	Abstand Cross Disperser bis Kameralinse:	20						
17	48	4692	100	37	4612	4771	160	0.12	7.67	ja	85	18.066	0.26	1.12	Baulänge des Kameraobjektives:	18						
18	49	4596	96	36	4518	4674	156	0.11	7.51	ja	89	18.291	0.25	1.10	Totaler Winkel Cross Disperser (Gitter):	28						
19	50	4504	92	34	4427	4581	153	0.11	7.36	ja	93	18.314	0.25	1.10								
20	51	4416	88	33	4341	4491	150	0.11	7.21	ja	97	18.687	0.24	1.08								
21	52	4331	85	32	4257	4404	147	0.11	7.07	ja	101	17.919	0.24	1.13								
22	53	4249	82	31	4177	4321	145	0.11	6.94	ja	105	16.135	0.26	1.25	Ausgabeparameter							
23	54	4170	79	29	4099	4241	142	0.10	6.80	ja	109	14.131	0.30	1.43	Beugungswinkel (Blazewinkel - Theta):	57.4						
24	55	4094	76	28	4025	4164	139	0.10	6.68	ja	113	12.296	0.33	1.64	Minimaler Abtast-Faktor:	1.08						
25	56	4021	73	27	3953	4090	137	0.10	6.56	ja	117	12.201	0.33	1.64	Maximaler Abtast-Faktor:	2.12						
26	57	3951	71	26	3884	4018	134	0.10	6.44	ja	121	10.988	0.36	1.84	F/D (F-Zahl) des Teleskops:	10.0						
27	58	3883	68	25	3817	3949	132	0.10	6.33	ja	125	9.871	0.39	2.05	Seeingscheibchen:	54.1						
28															Mindest-Durchmesser Kollimator in mm:	17.5						
29															Maximale Bildtiefe Kollimator in μm :	800.0						
30															Maximale Bildtiefe Kamera in μm :	36.4						
31															notwendige CCD-Länge in mm:	10.93						
32															notw. CCD-Breite in mm:	3.98						
33															Mindest-Gitterbreite in mm:	17.5						
34															Mindest-Gitterlänge in mm:	49.8						
35															Notw. Durchm. Cross Disperser in mm:	49.2						
36															Notwendige F-Zahl des Kameraobjektivs:	2.00						
37															Parameter in kritischen Bereichen werden rot dargestellt !							

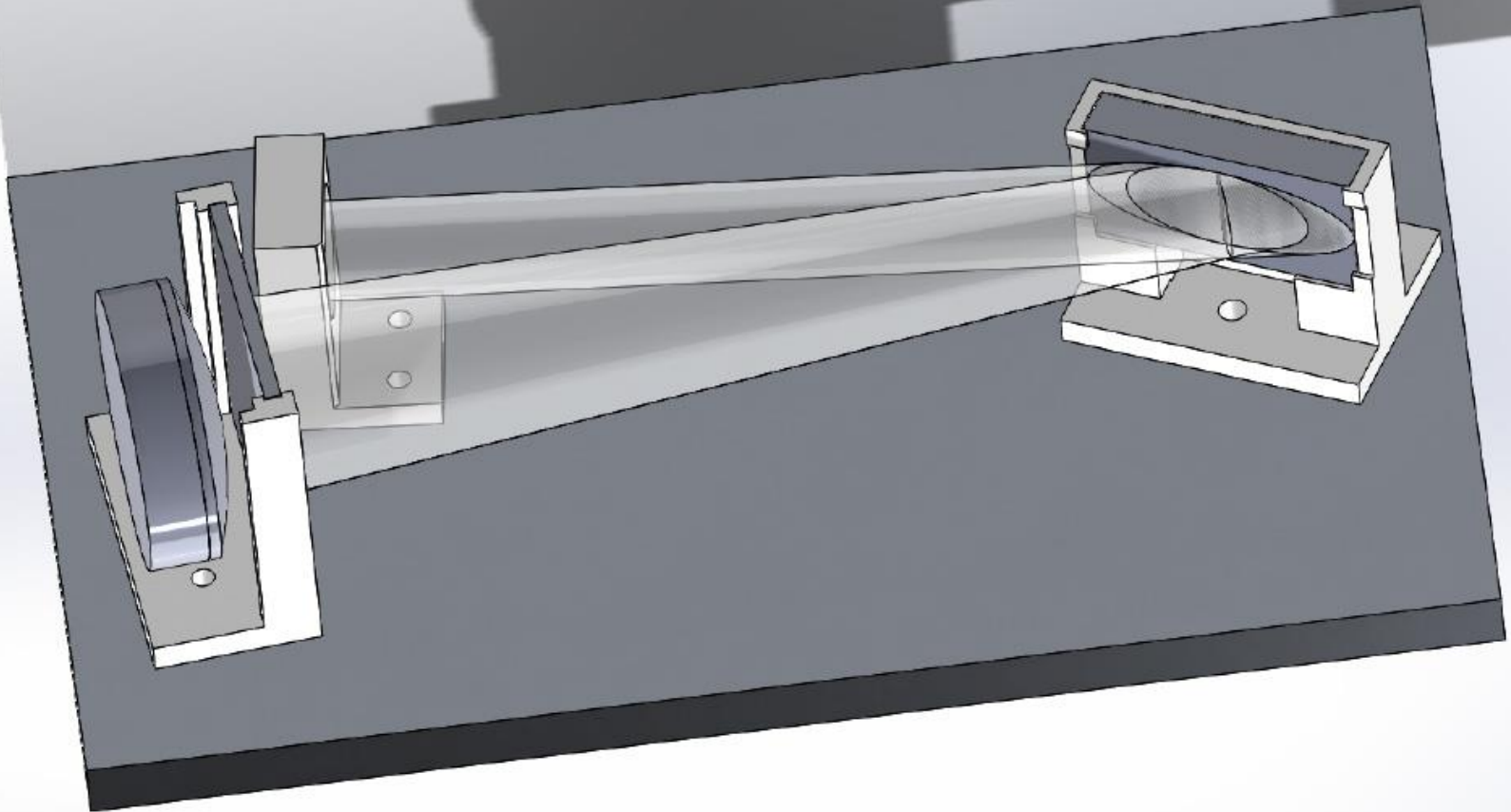
SimEchelle.xls van Klaus Vollmann

https://www.stsci.de/wp-content/uploads/2018/02/simechelle_e.xls

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



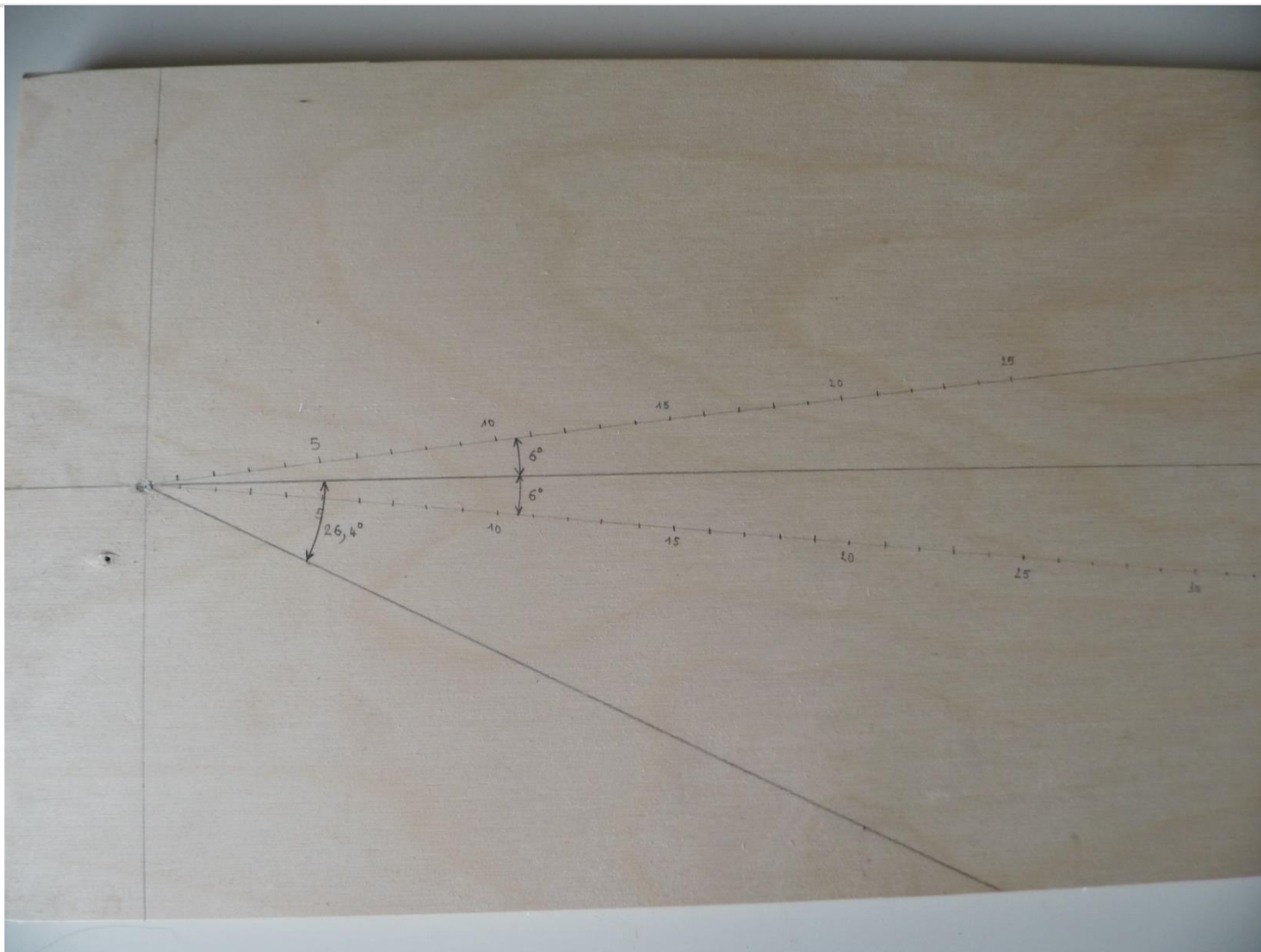
Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

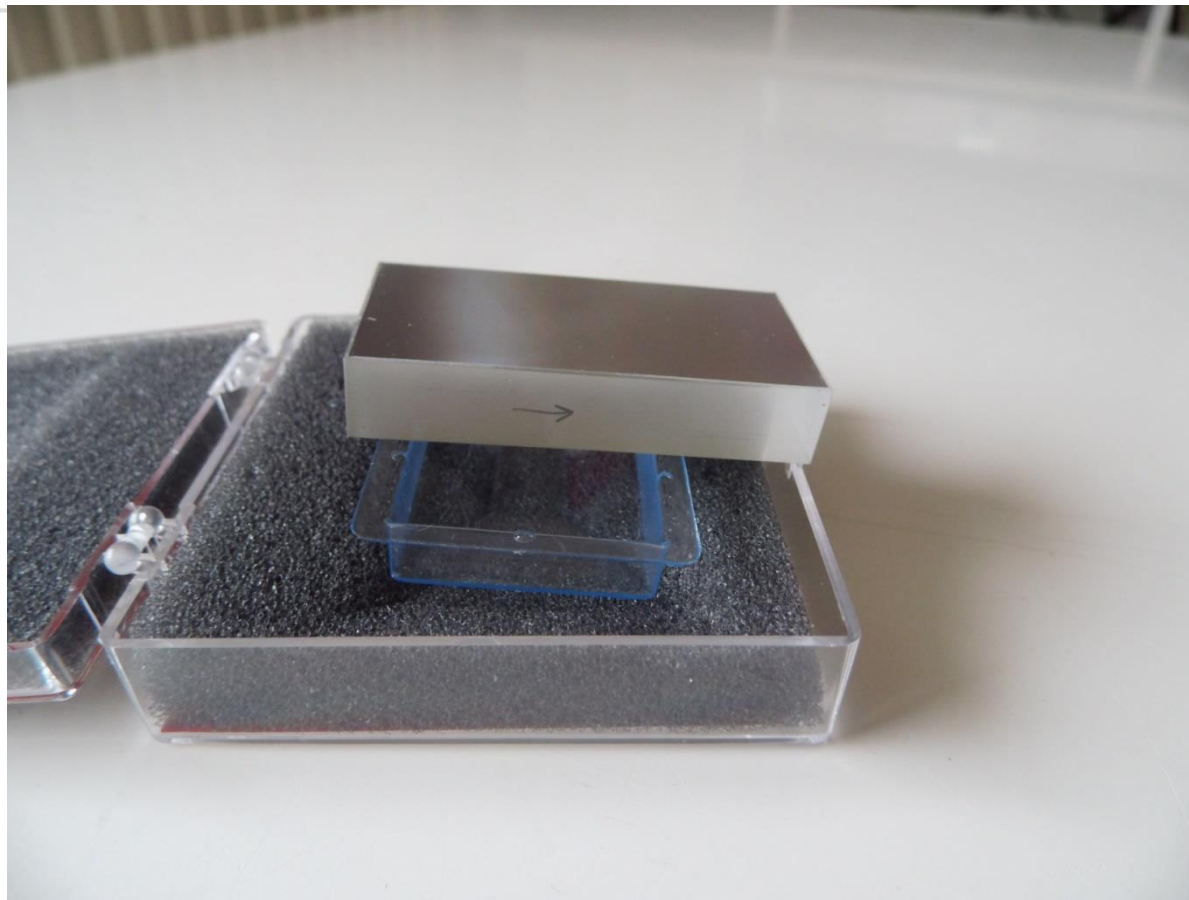


Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

Deze en volgende optische onderdelen werden gesponsord door de volkssterrenwacht Armand Pien in Gent !!!



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

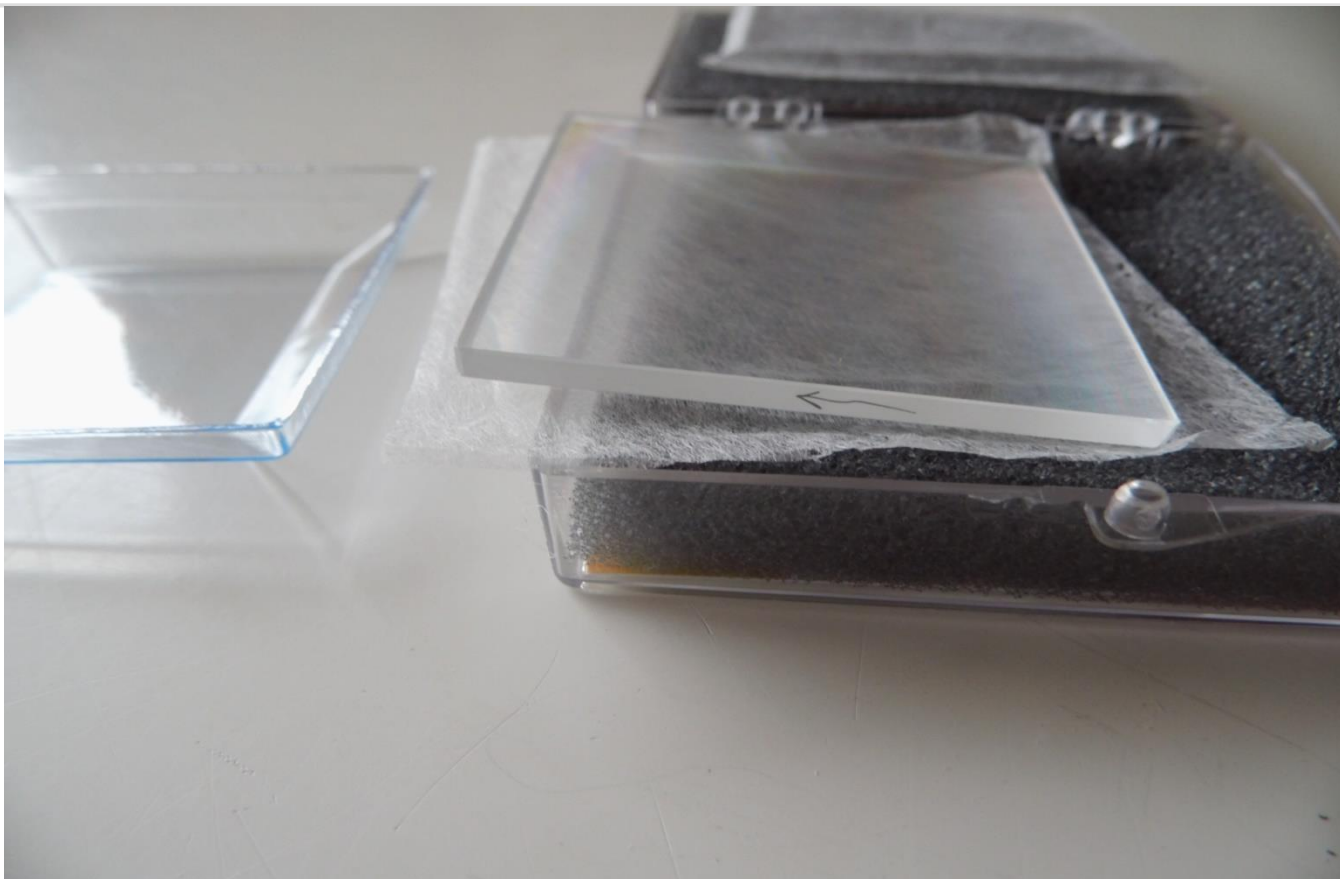


Echelle rooster: Thorlabs

GE2550-0863 - Echelle Grating, 79.0 Grooves/mm, 63° Blaze, 25 mm x 50 mm x 9.5 mm 209,14 EURO

<https://www.thorlabs.com/thorproduct.cfm?partnumber=GE2550-0863>

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



**Cross disperser: Thorlabs
GT50-03 - Visible Transmission Grating, 300 Grooves/mm, 17.5° Groove
Angle, 50 mm x 50 mm 190,04 EURO**
<https://www.thorlabs.com/thorproduct.cfm?partnumber=GT50-03>

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Collimator lens: Edmund Optics. Te benaderen diameter 17,5635 mm f/10 (focal length =175 mm) Achromaat, 380 tot710 nm. Beschikbare lenzen zijn allen 1 inch diameter!!! 25,4 mm !!!! #32-884 25mm Dia. x 175mm FL, MgF₂ Coated, Achromatic Doublet Lens 87,50 EURO

<https://www.edmundoptics.com/p/25mm-dia-x-175mm-fl-mgfsb2sub-coated-achromatic-doublet-lens/2670/>

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Camera lens: Edmund Optics

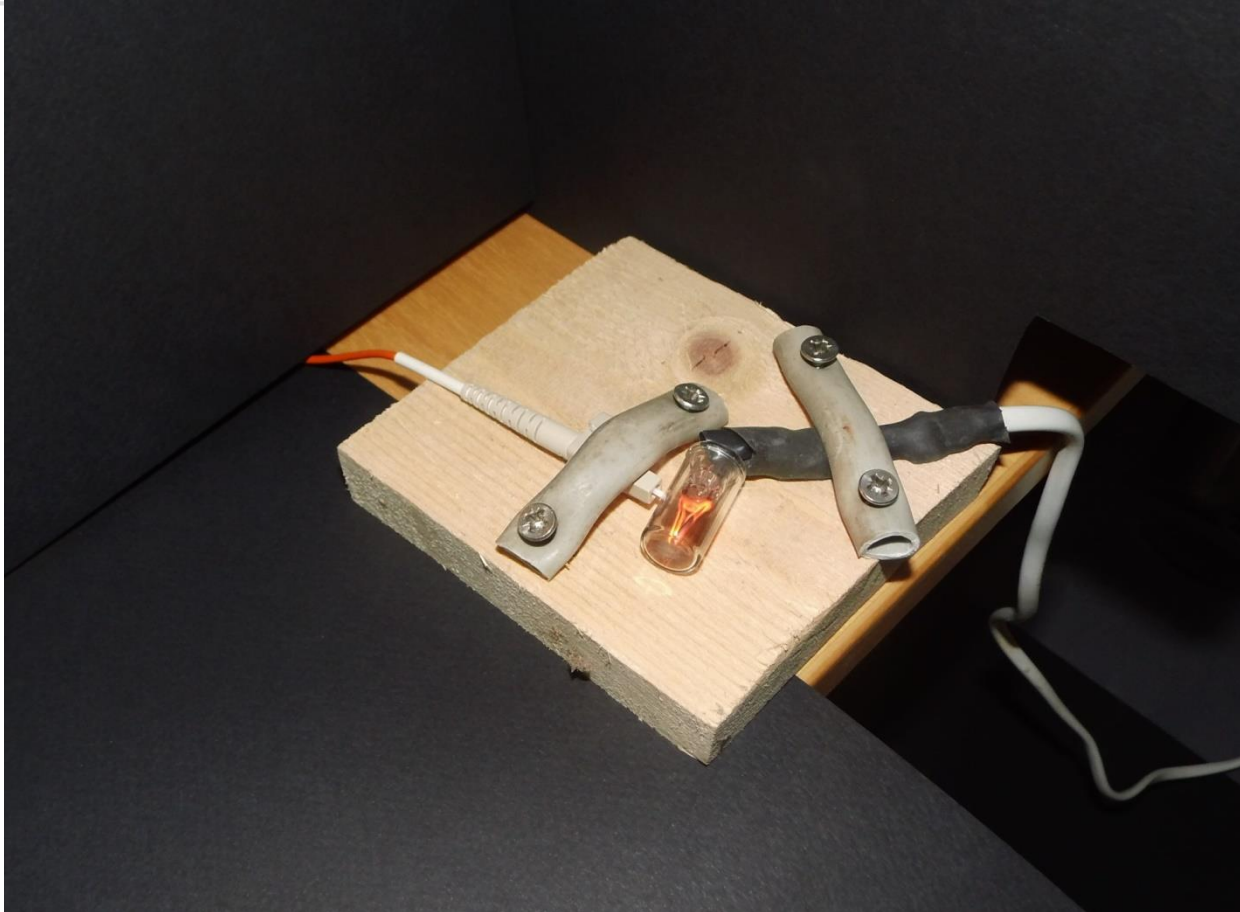
#45-353 50mm Dia. x 100mm FL, MgF₂ Coated, Achromatic Doublet Lens

<https://www.edmundoptics.com/p/50mm-dia-x-100mm-fl-mgfs2sub-coated-achromatic-doublet-lens/5823/>

Te benaderen diameter 49,6 mm f/2.01

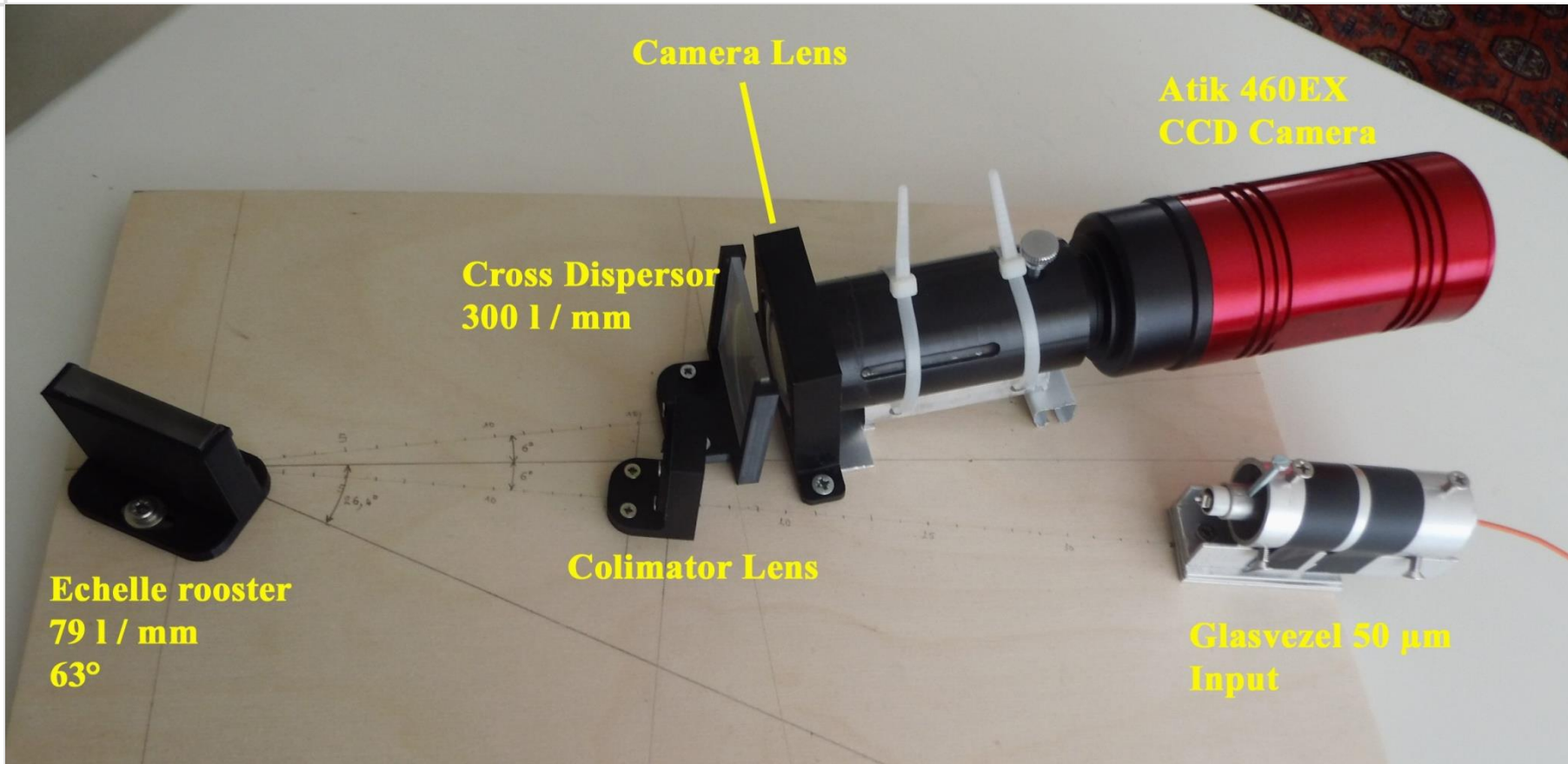
135,00 EURO

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



**Lichtbron (kalibratielamp) Neon - Xenon
(Philips ST10 TL lamp starter) via multimode fiber 50 μ m**

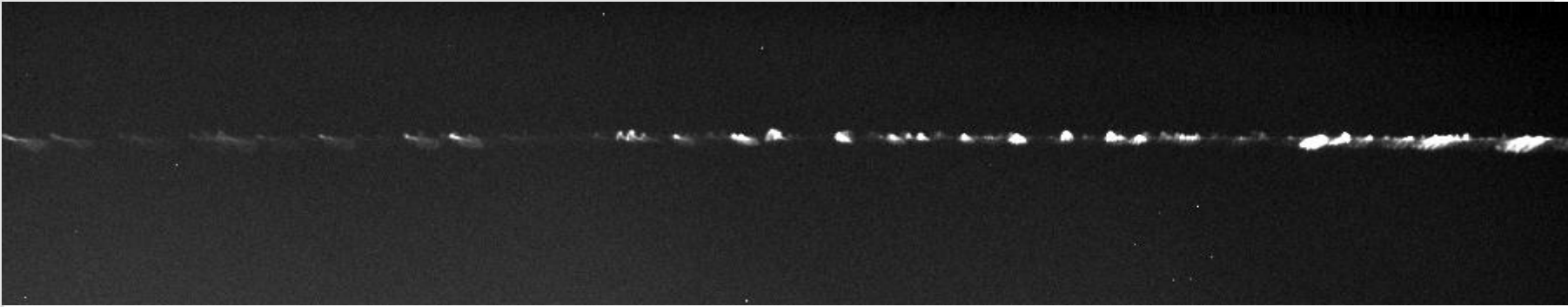
Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



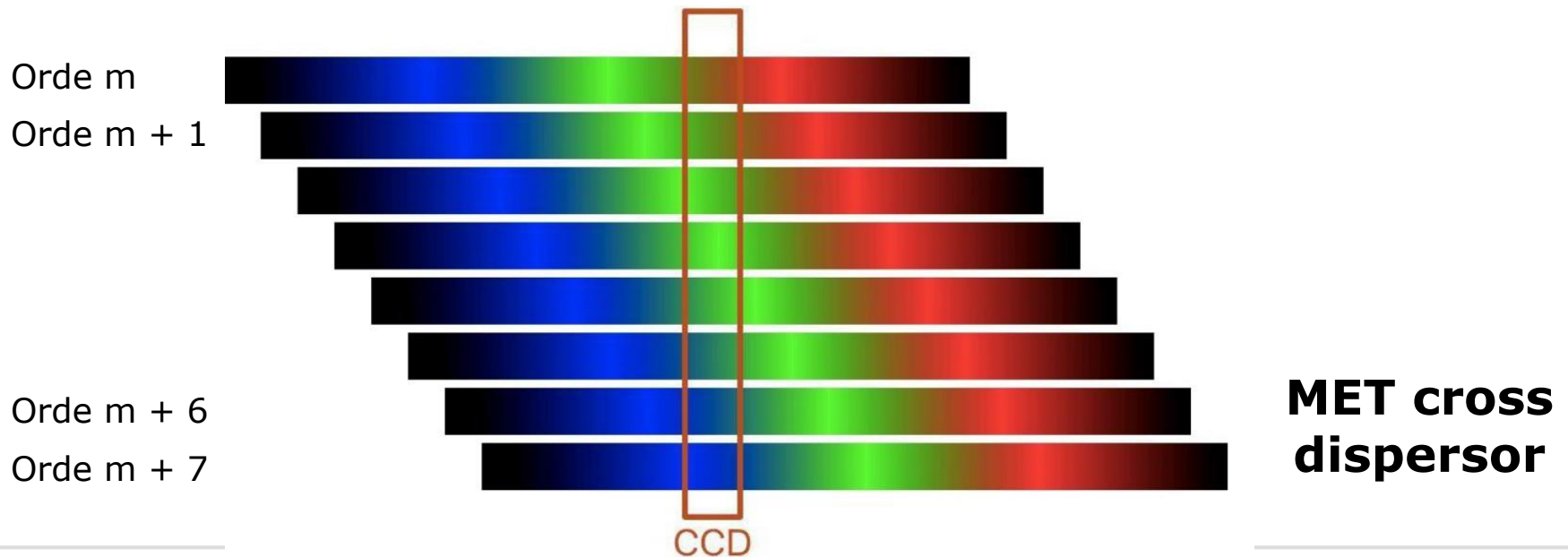
Eerste opstelling



Zelfbouw Echelle spectrograaf - Tivoli Oudenburg

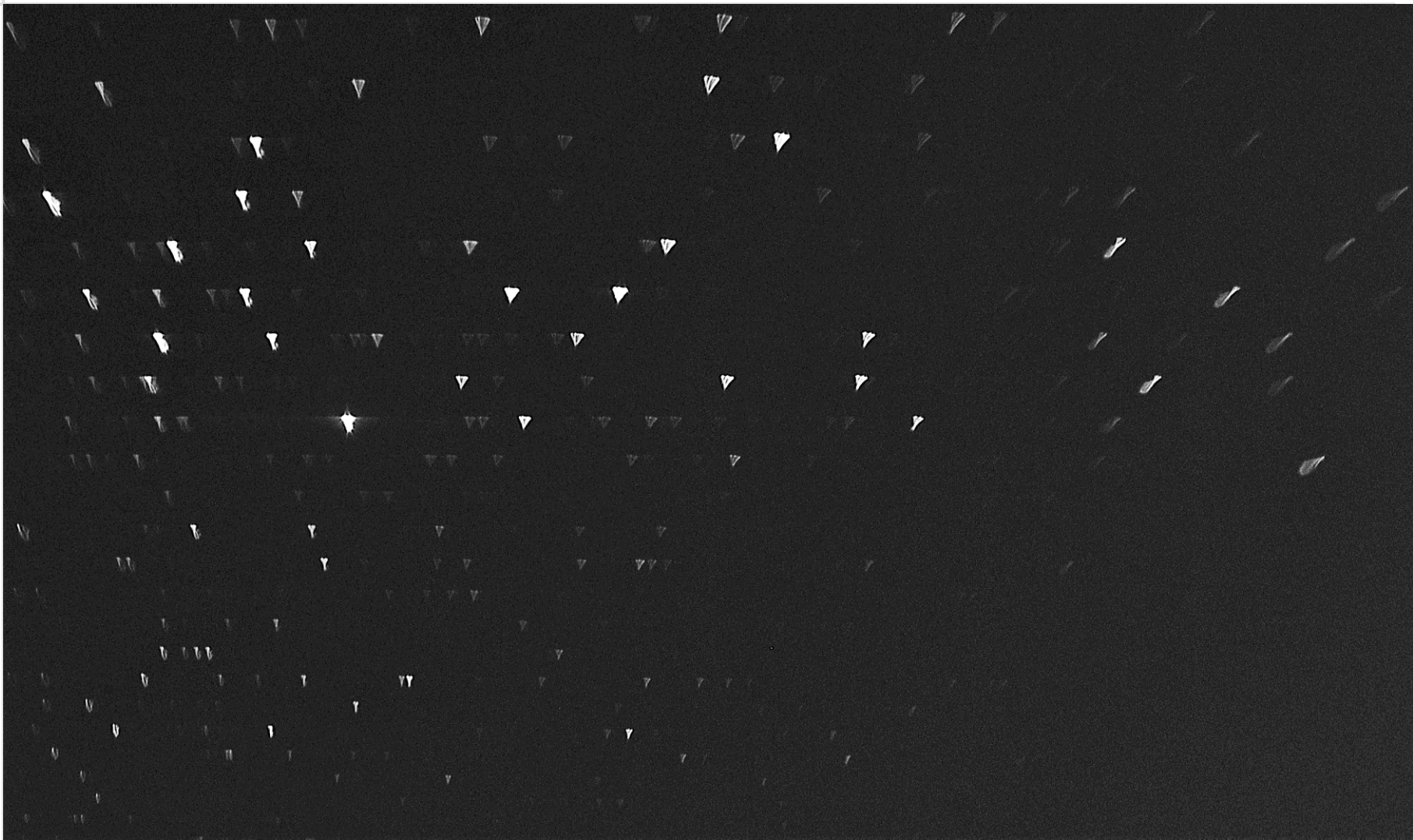


Echelle foto ZONDER cross dispersor. Alle ordes op één lijn.



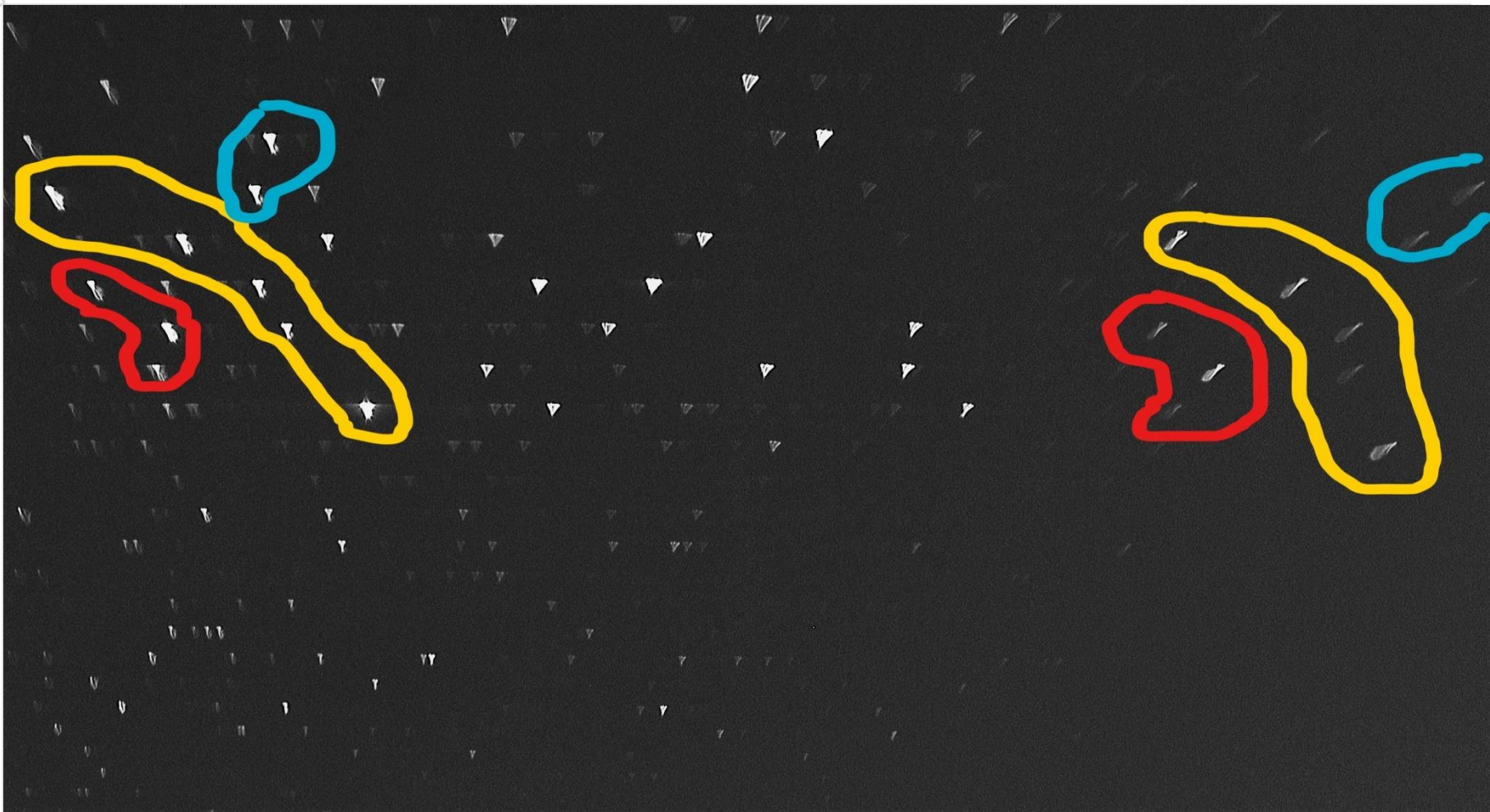


Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch





Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Overlap tussen de ordes

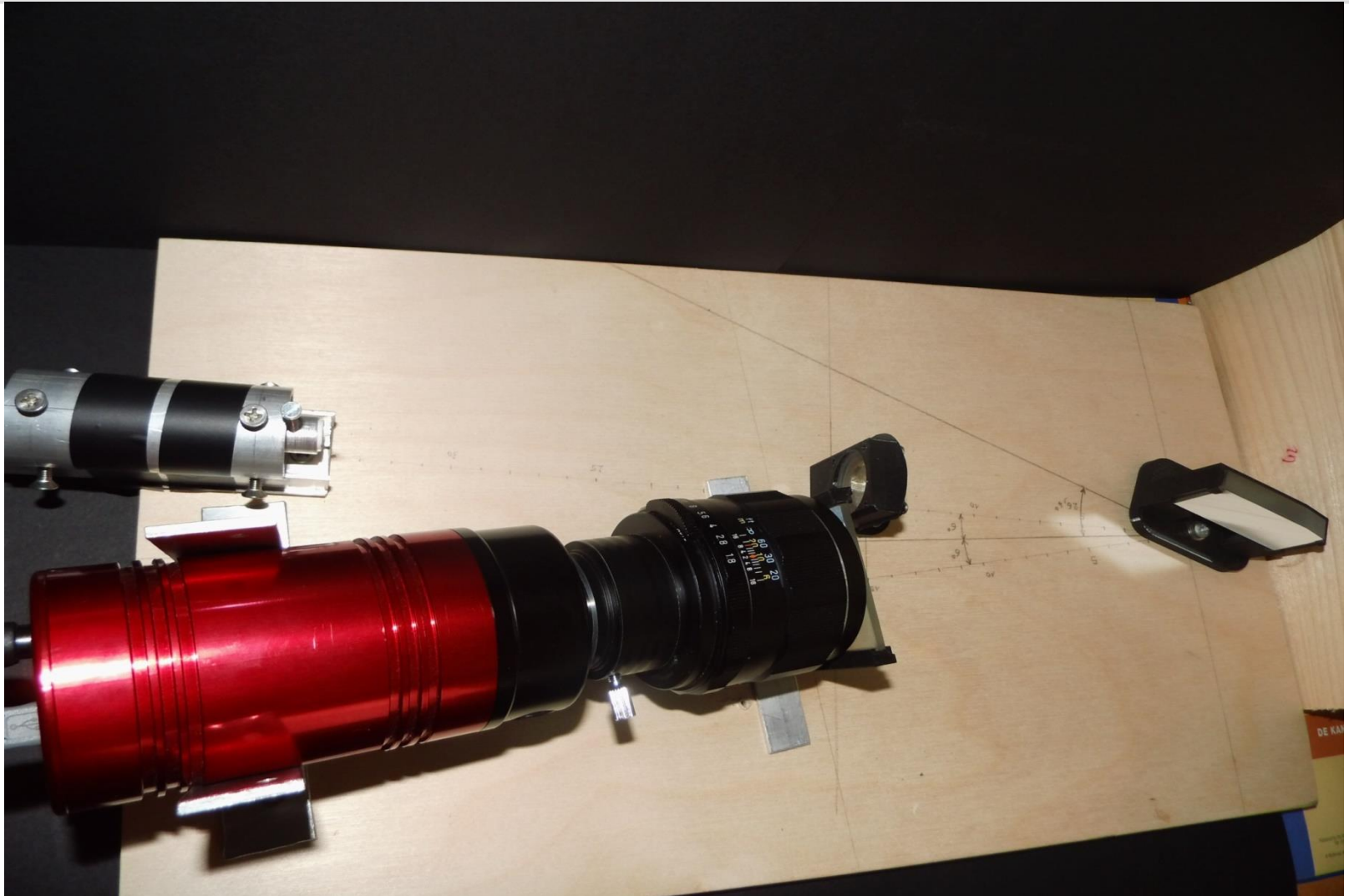
Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Nieuwe camera lens: Asahi Pentax 1:1.8 / 85

Minder sferische aberratie? Geschonken door Optiek De Pauw Waasmunster

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



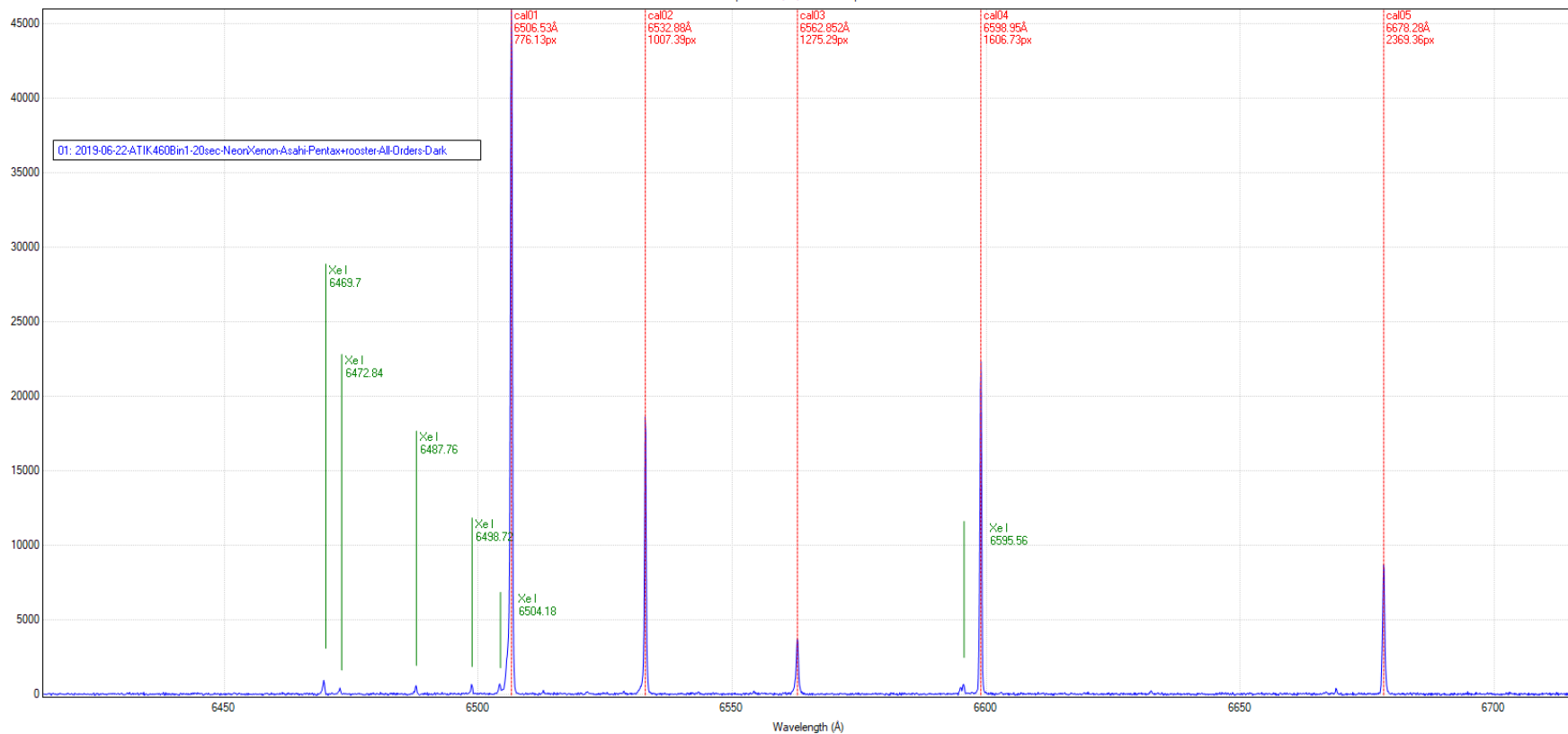


Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

Neon Xenon 20 sec -Dark Atik 460 EX Bin 1x1 FWHM: 0.46631Å (R = 13953 @6506.5Å) 4.049px FWHM: 0.39795Å (R = 16582 @6599Å) 3.7036px Orde 34 van het spectrum (Rond H-alpha)
Dispersion = 0.10961298 Å / px



BASS Project 1.9.6 Beta 20M

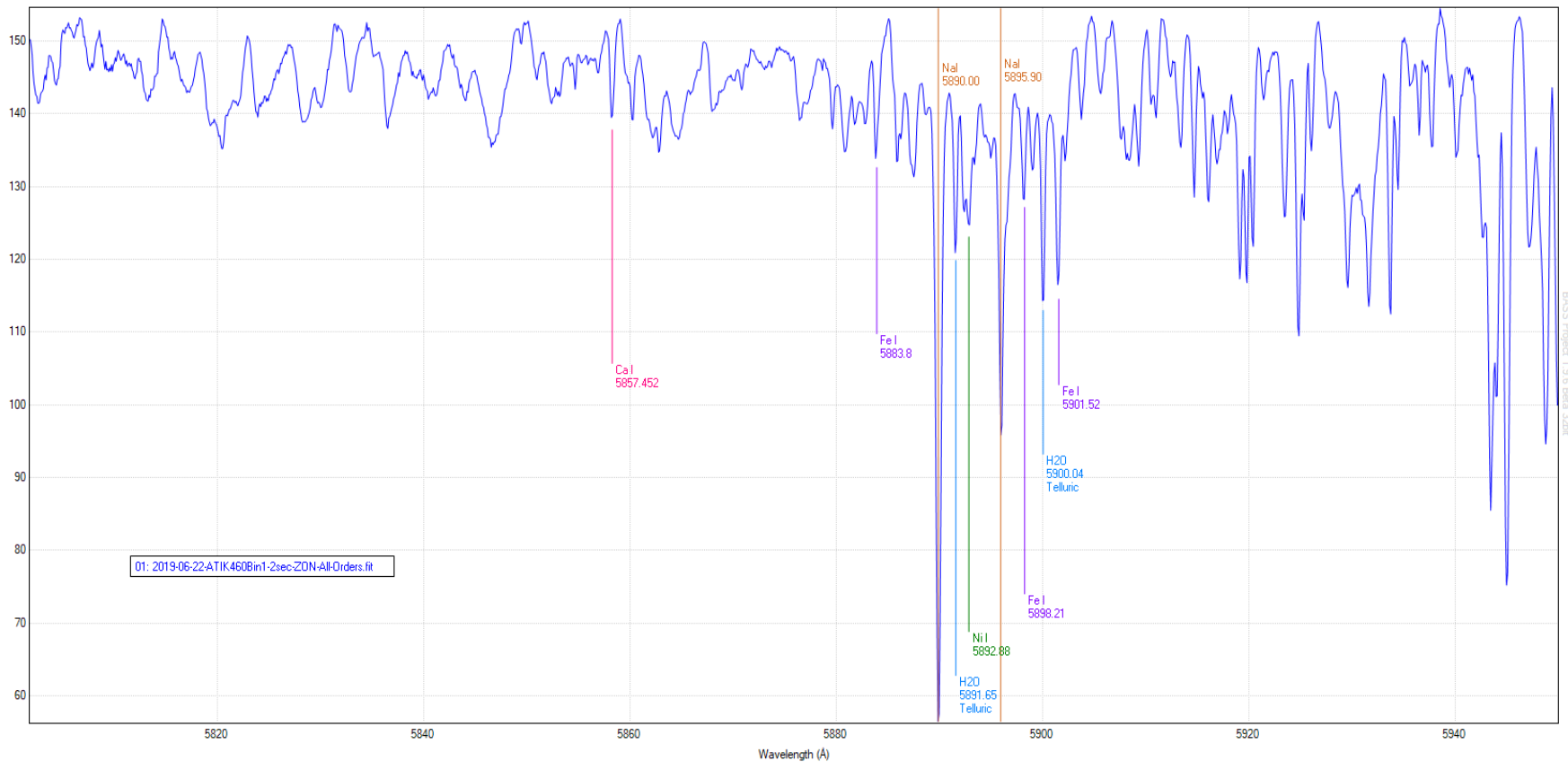


Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

Zon 2 sec ATIK460EX Echelle Asahi-Pentax 85 f1.8 Order 38 FWHM: 0.56824Å (R = 10365 @5889.9Å) 5.8057px
Dispersion 0.09677268 Å / px

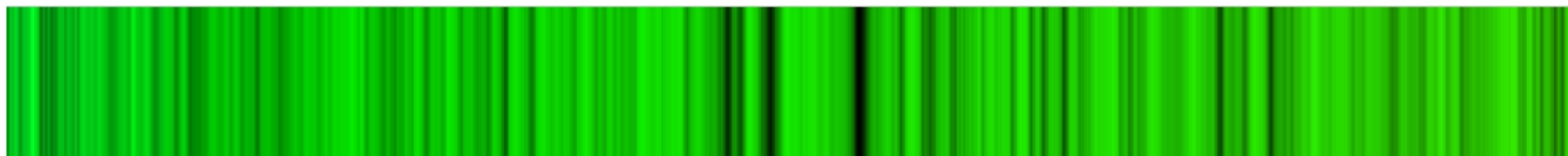
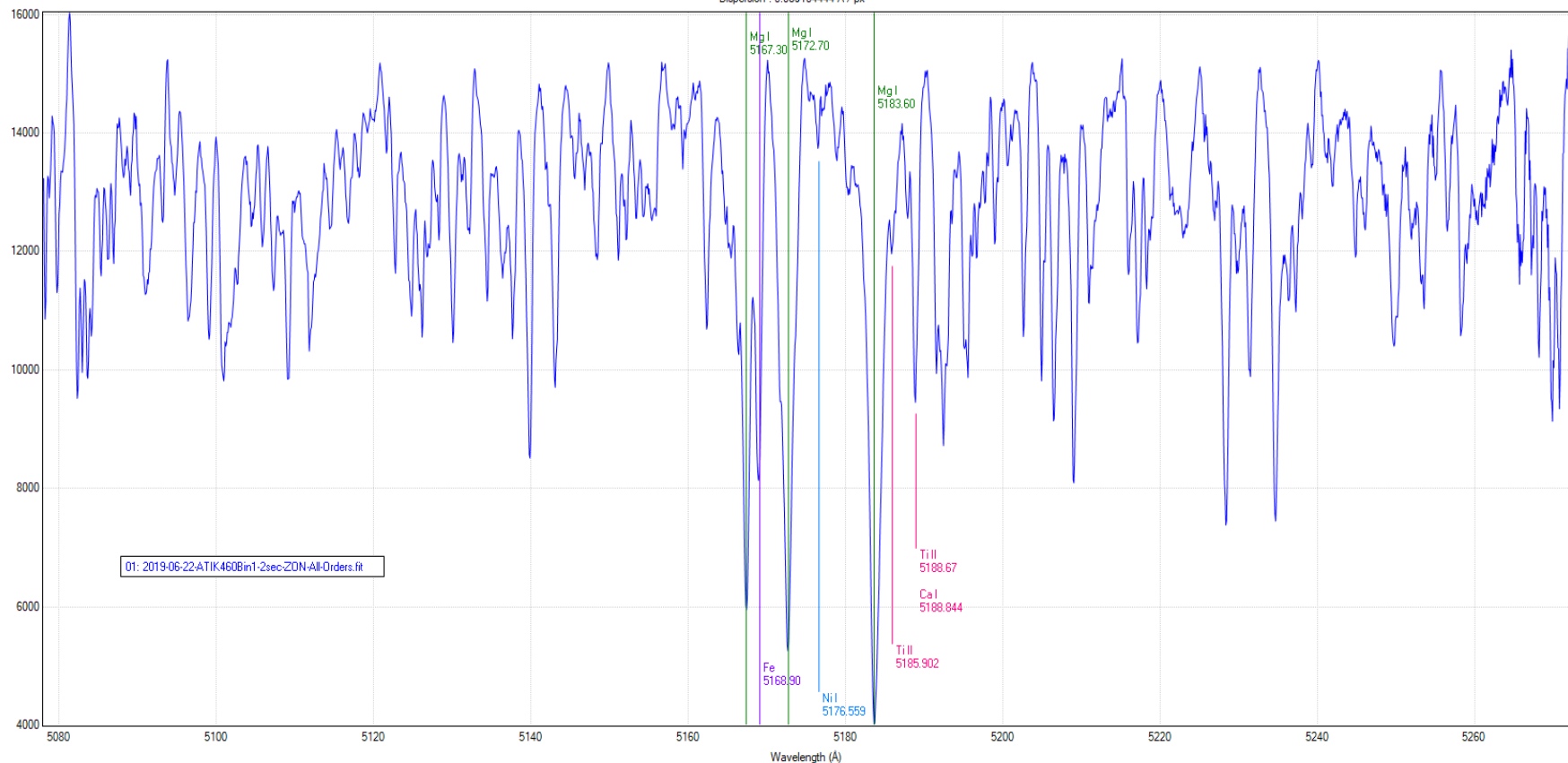


BASS Project 1.9.6 beta 32d

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

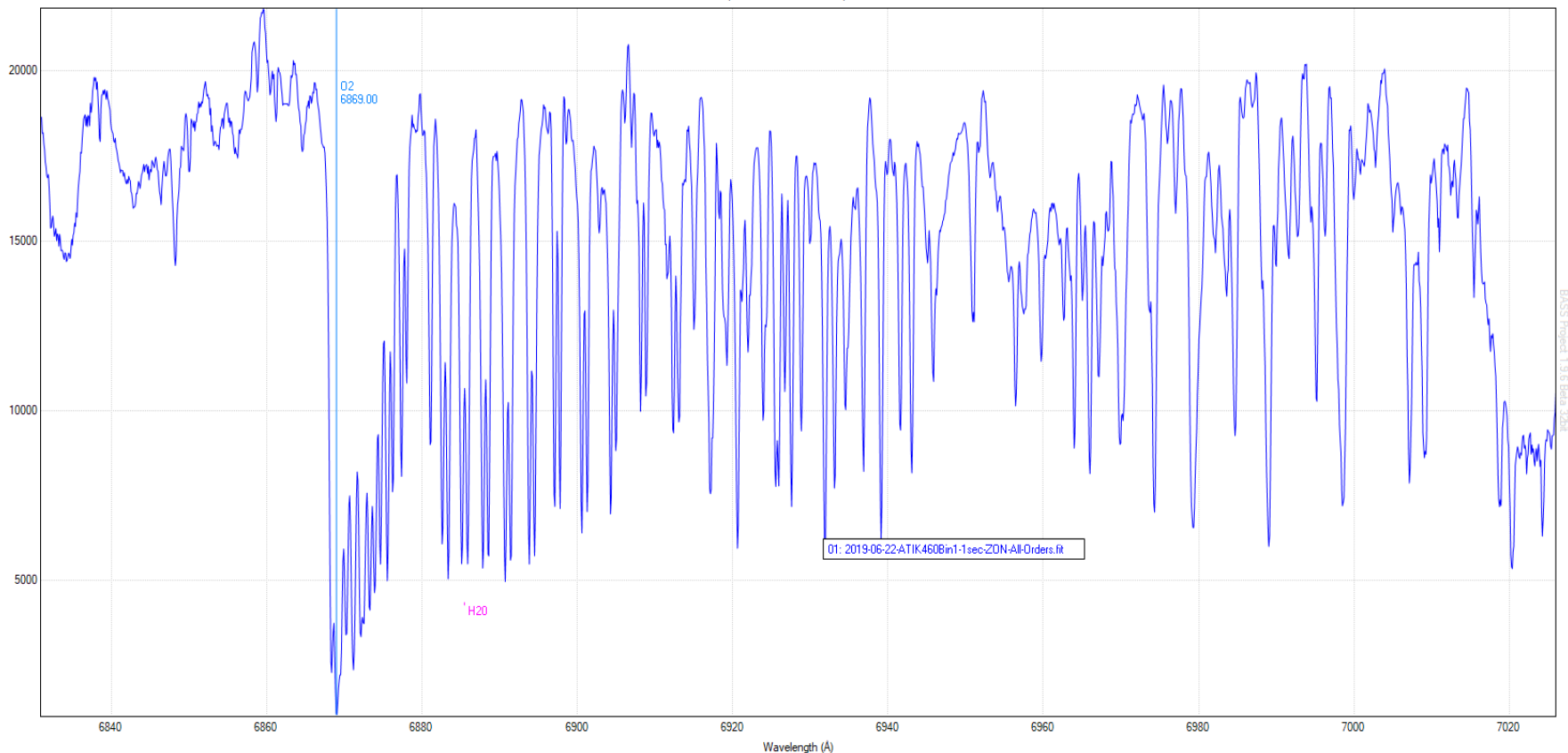
Zon 2 sec ATIK460EX Echelle Asahi-Pentax 85 f1.8 Order 43 (Continuum Removed)

Dispersion : 0.089104444 Å / px



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

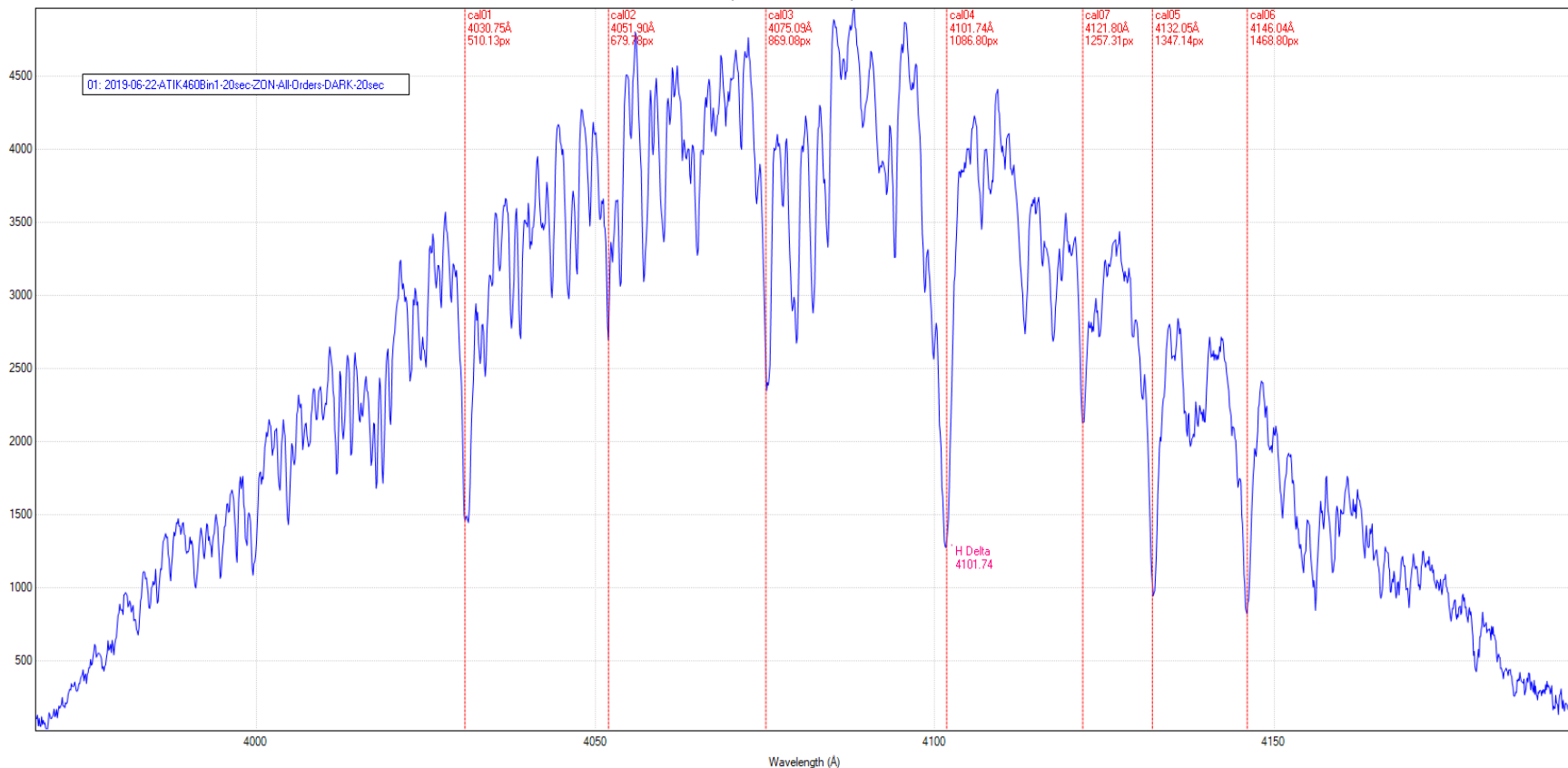
Zon 1 sec ATIK460EX Echelle Asahi-Pentax 85 f1.8 Order 32 H2O (Telluric Double absorption lines (Continuum removed))
Dispersion 0.096777268 Å / px



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

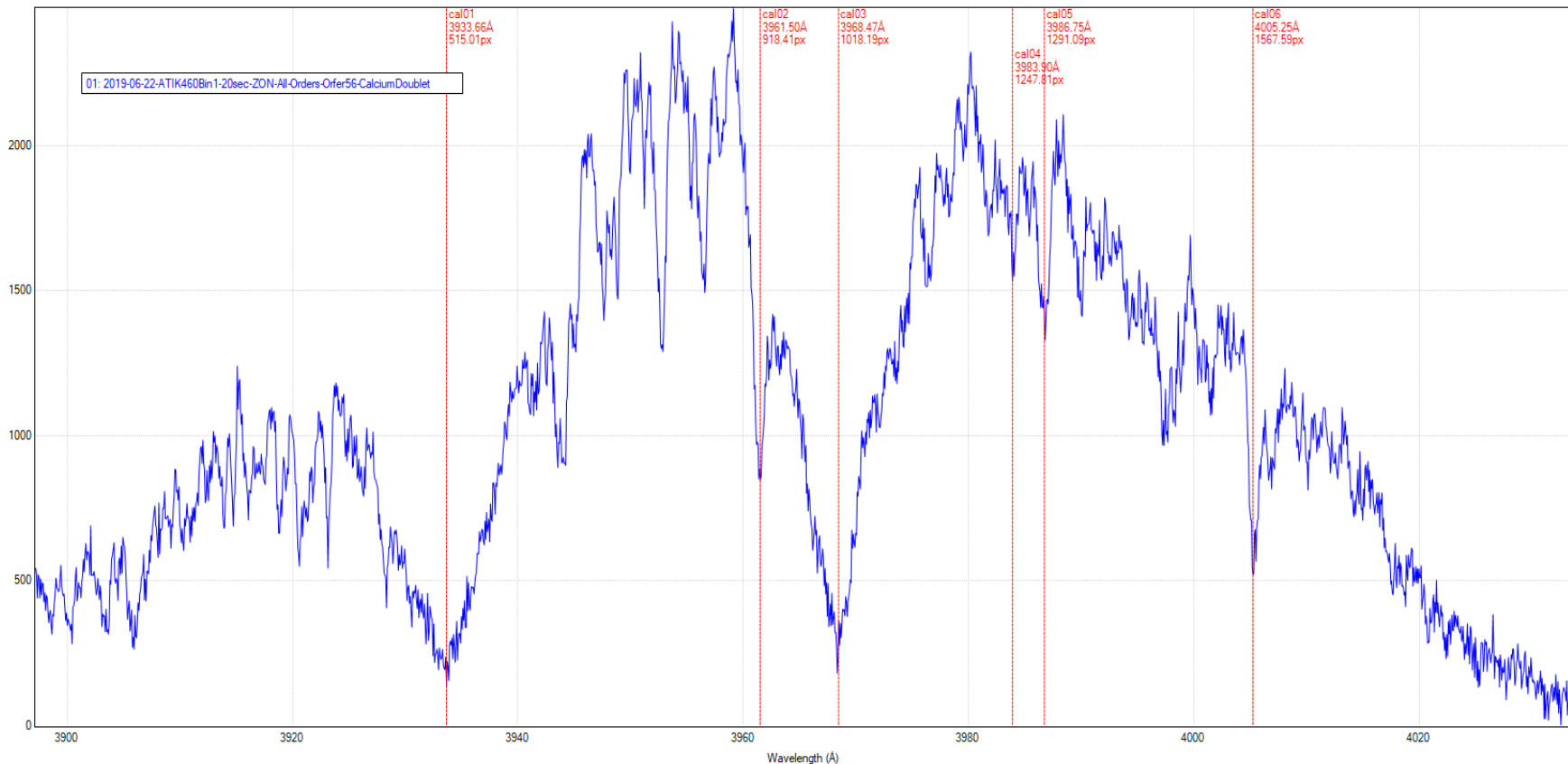
Zon 20 sec ATIK460EX Echelle Asahi-Pentax 85 f1.8 Order 55 (Omgeving H-Delta 4101.74 Å)

Dispersion = 0.10634237 Å / px



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

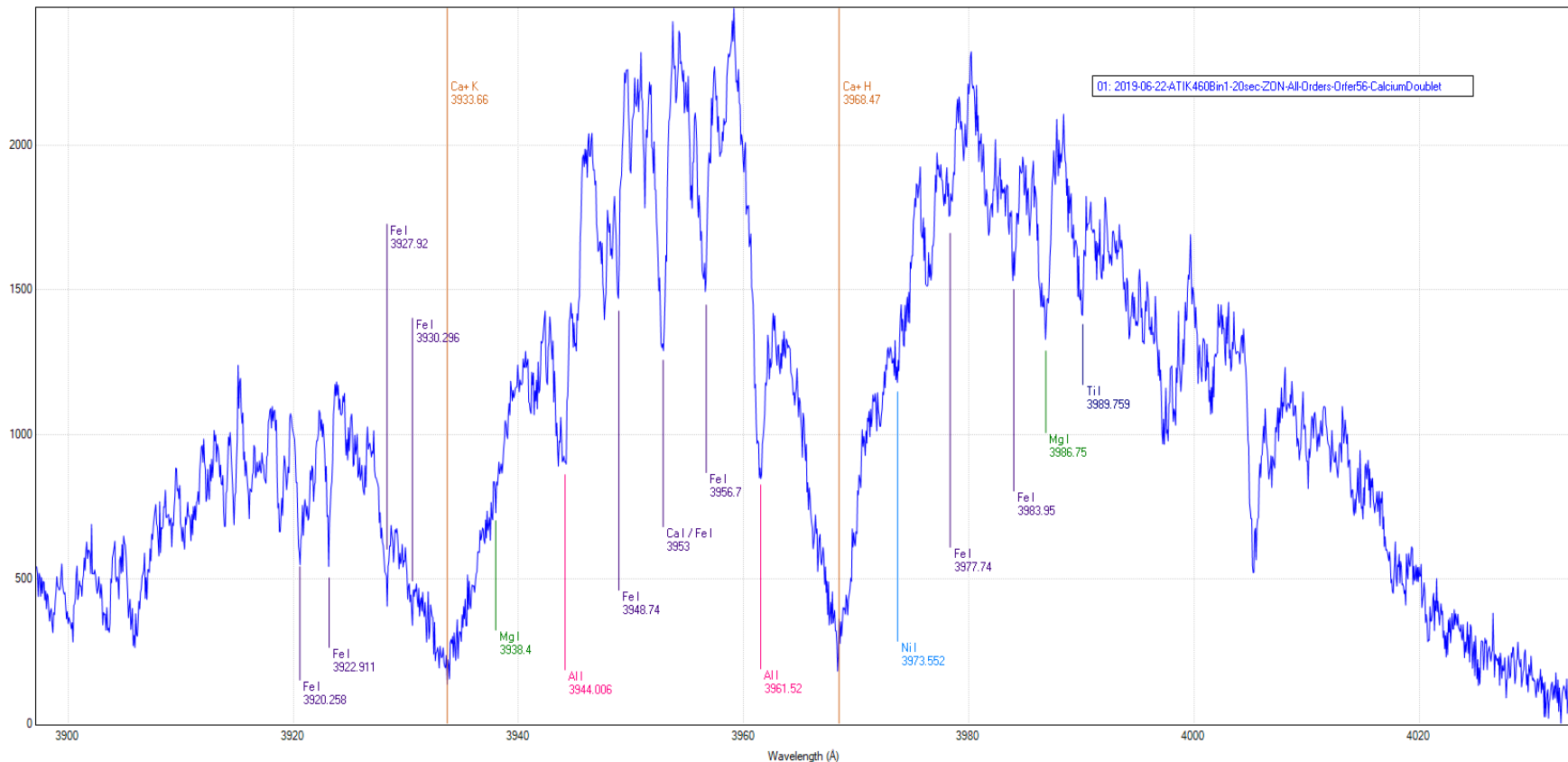
Zon 20 sec ATIK460EX Echelle Asahi-Pentax 85 f1.8 Order 56 (Omgeving Calcium Doublet 3933.66 Å_3968.47 Å)



BASS Project 1.95 Beta 324x

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

Zon 20 sec ATIK460EX Echelle Asahi-Pentax 85 f1.8 Order 56 (Omgeving Calcium Doublet 3933.66 Å, 3968.47 Å)



BASS Project 1.9.6 Peter 2004

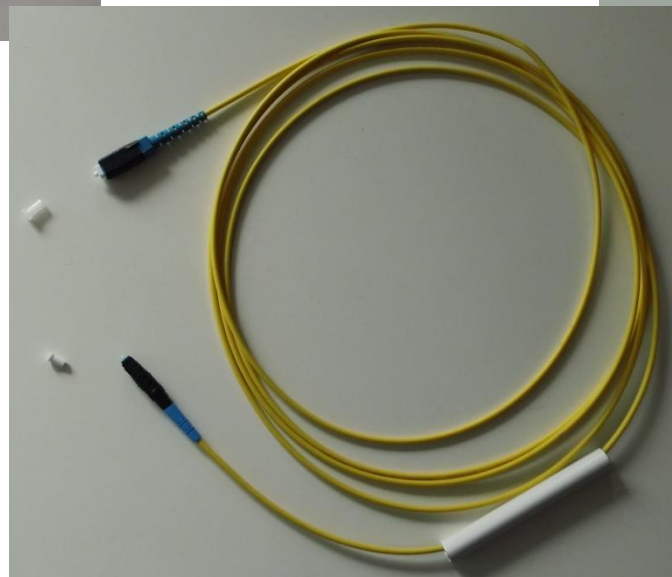
Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



**Glasvezel 50 μm
Oude versie van
Shelyak eShel**

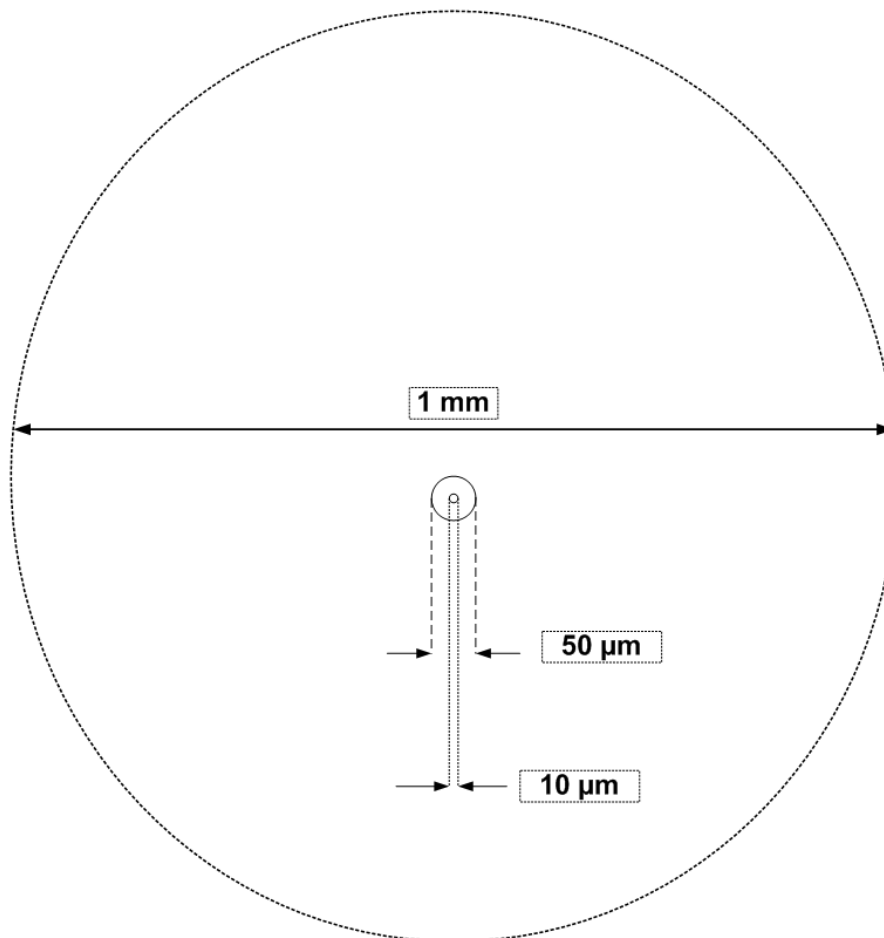


**Glasvezel 50 μm
Multi Mode
Patch kabel met
micro lenzen**



**Glasvezel 10 μm
Single Mode
Patch kabel met
micro lenzen**

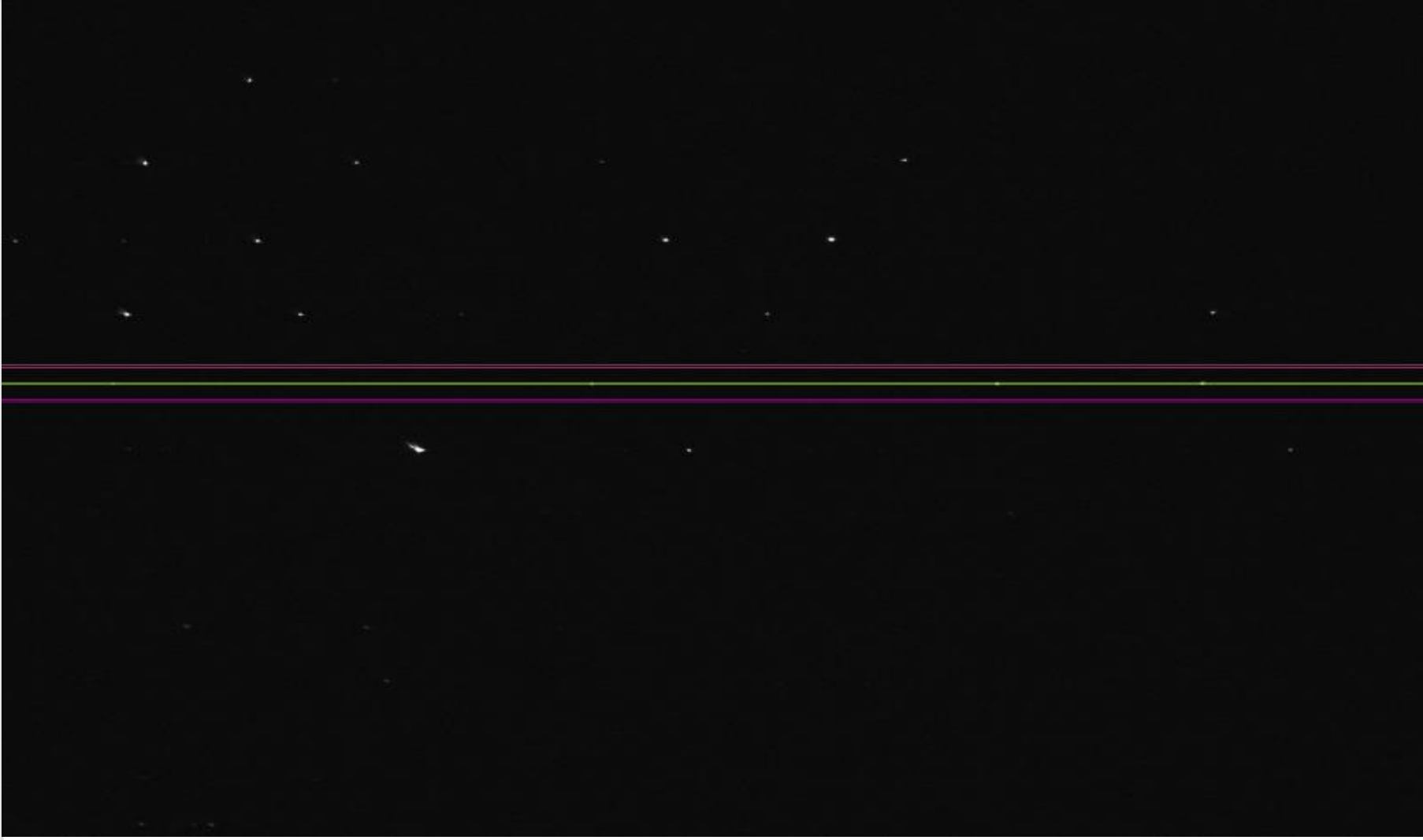
Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



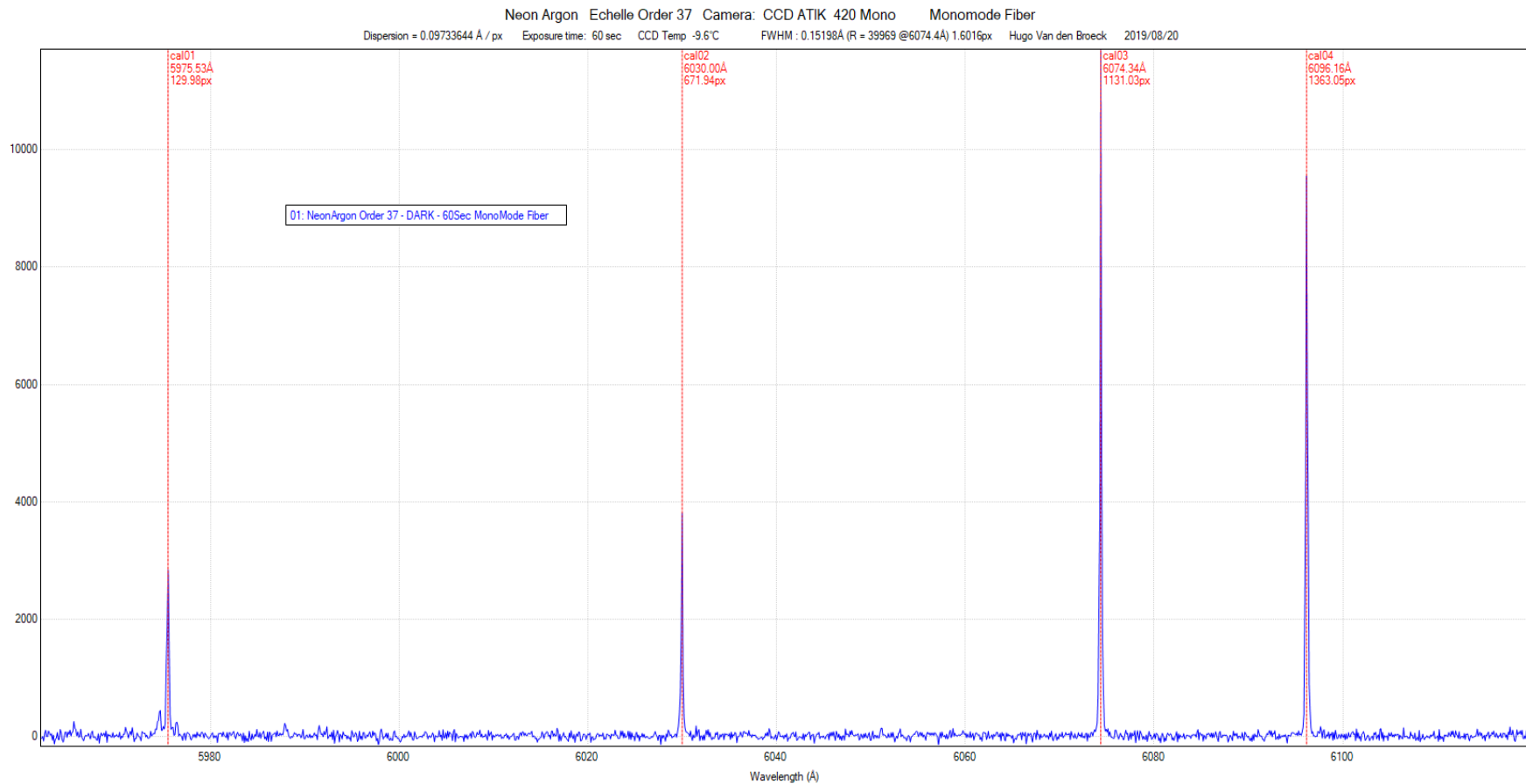
Single Mode Fiber. Diameter glasvezel = 8 a 10 μm
Nuttig oppervlak 25 x minder dan een 50 μm Multimode fiber!



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

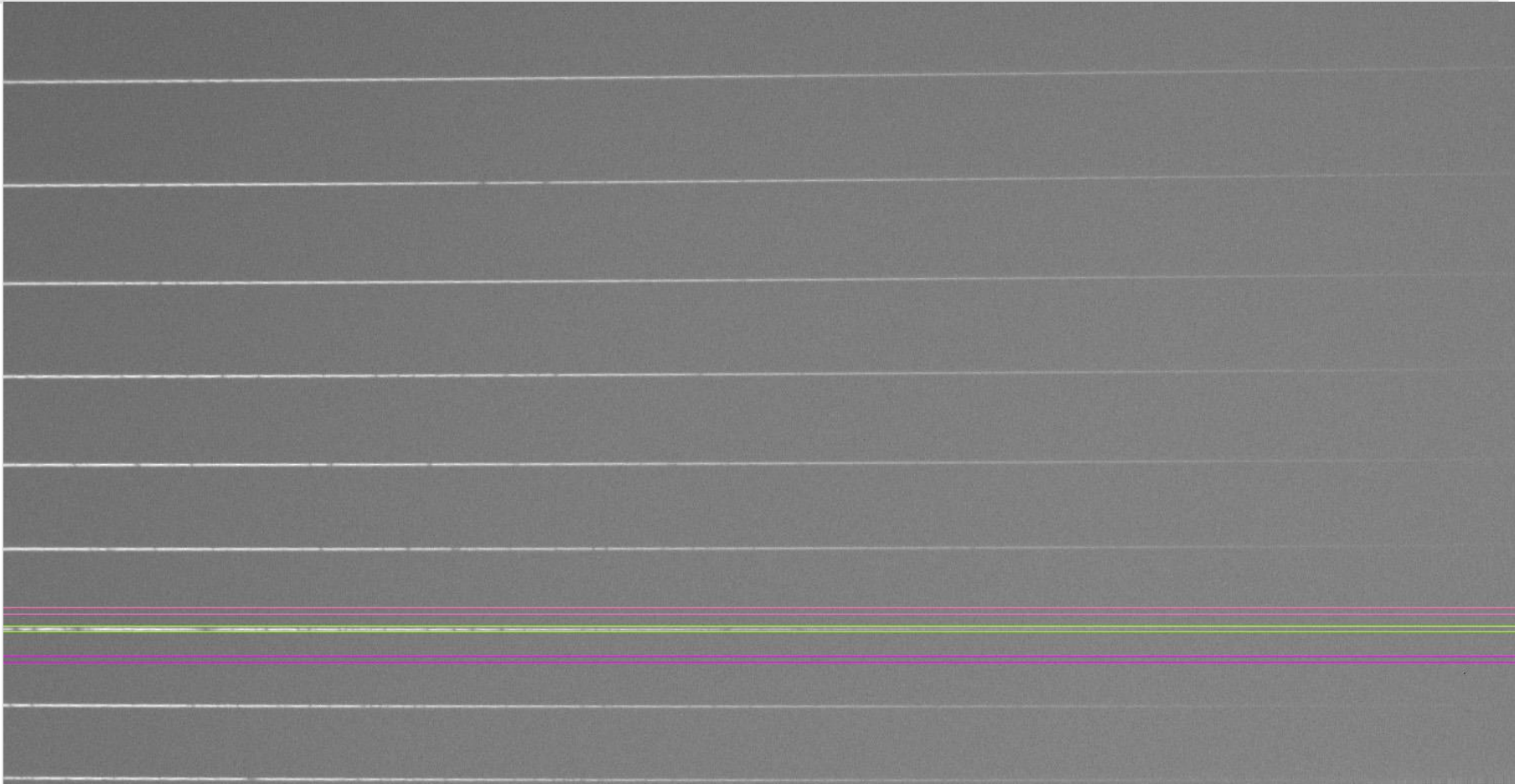


Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



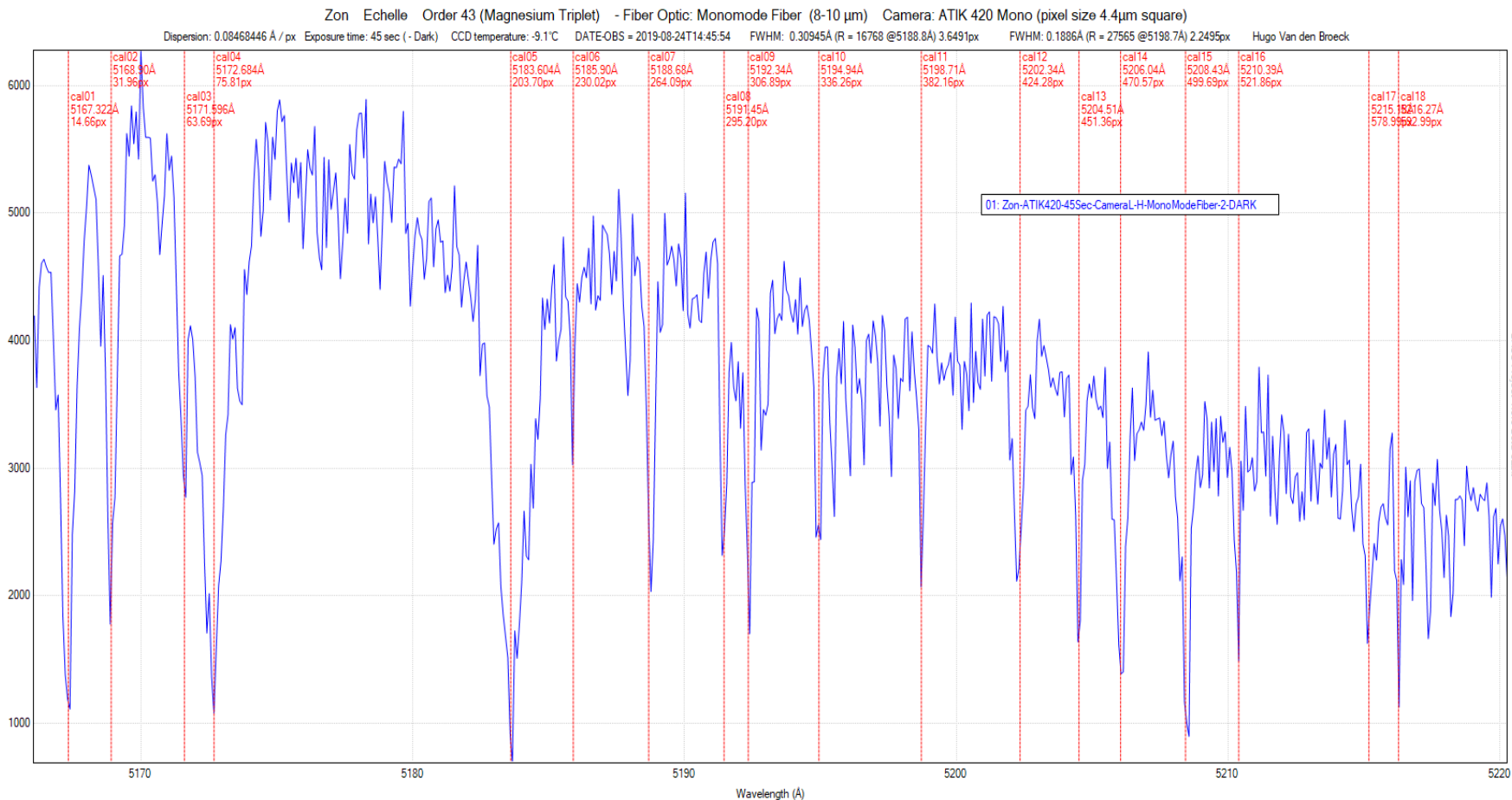


Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



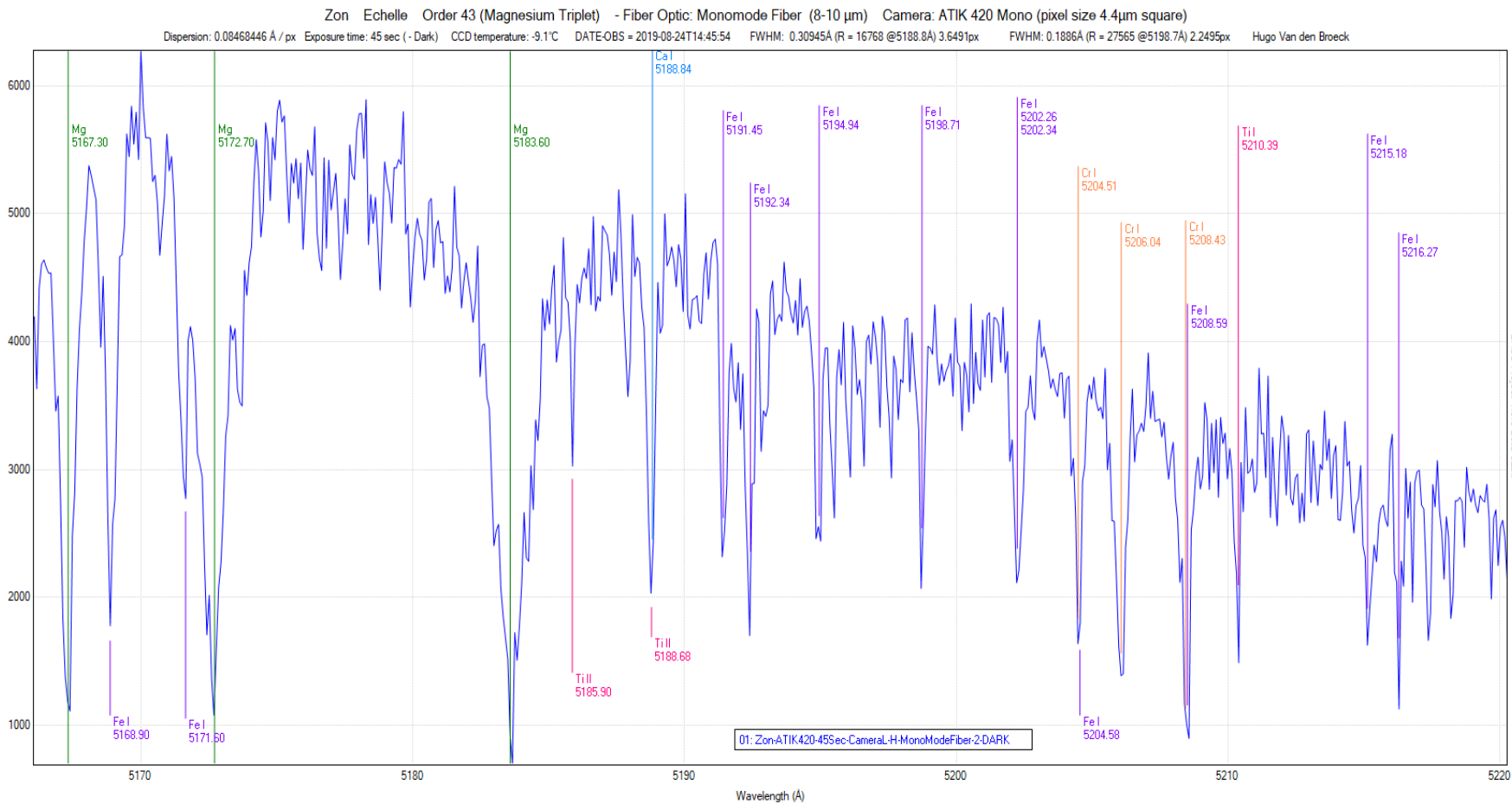
Zon: Spectrale Orde 43 (Magnesium triplet)

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

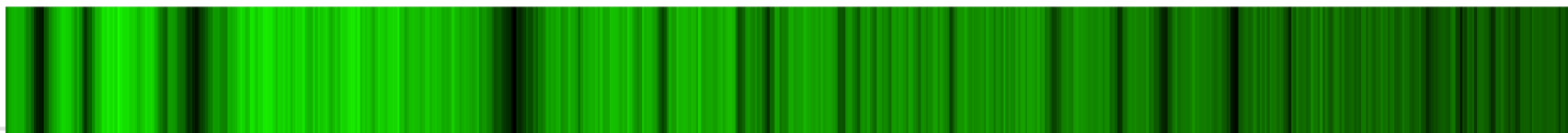


BASS Project 1.9.6 beta 32d

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

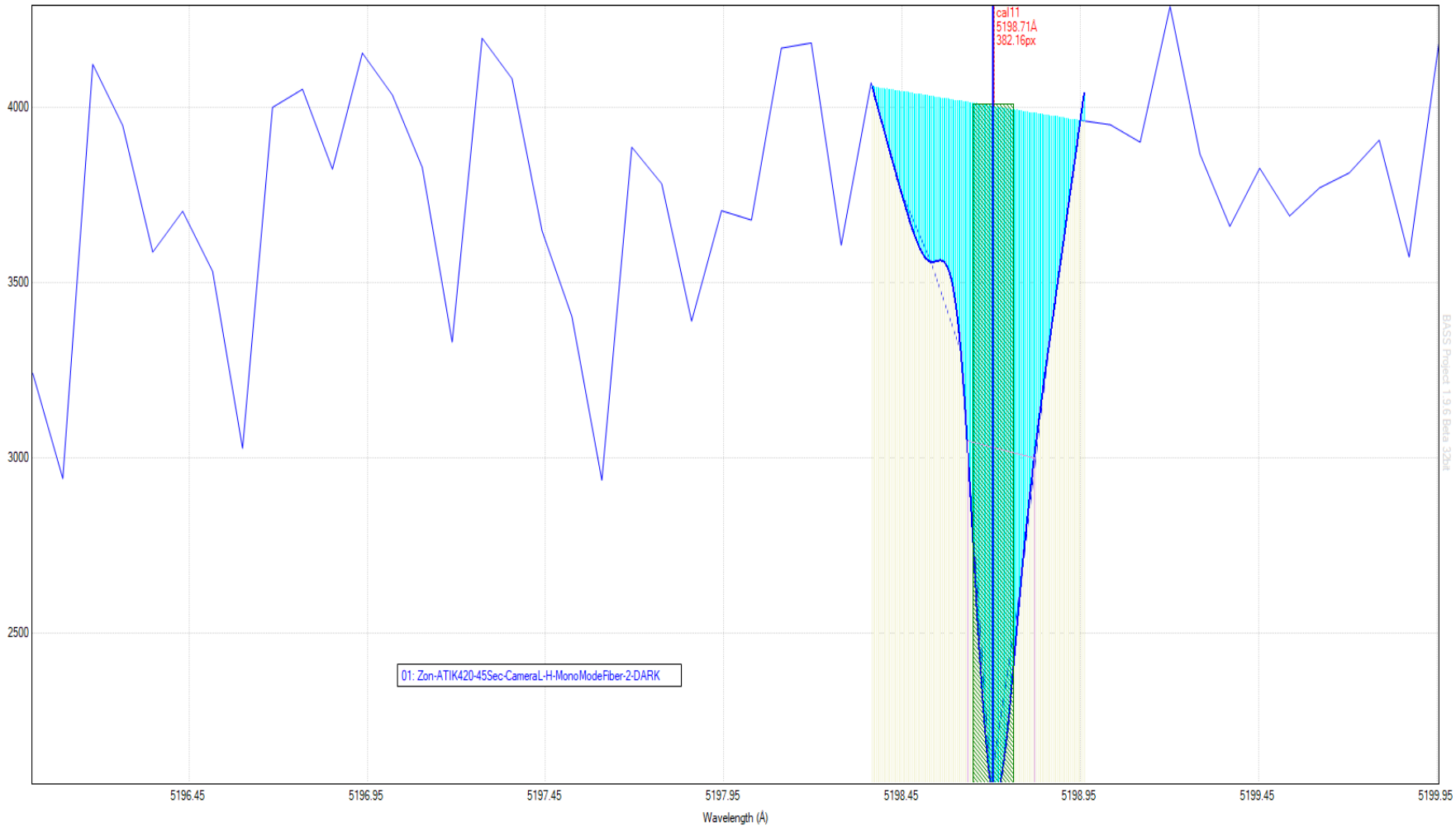


BASS Project 1.9.6 Beta 3.04

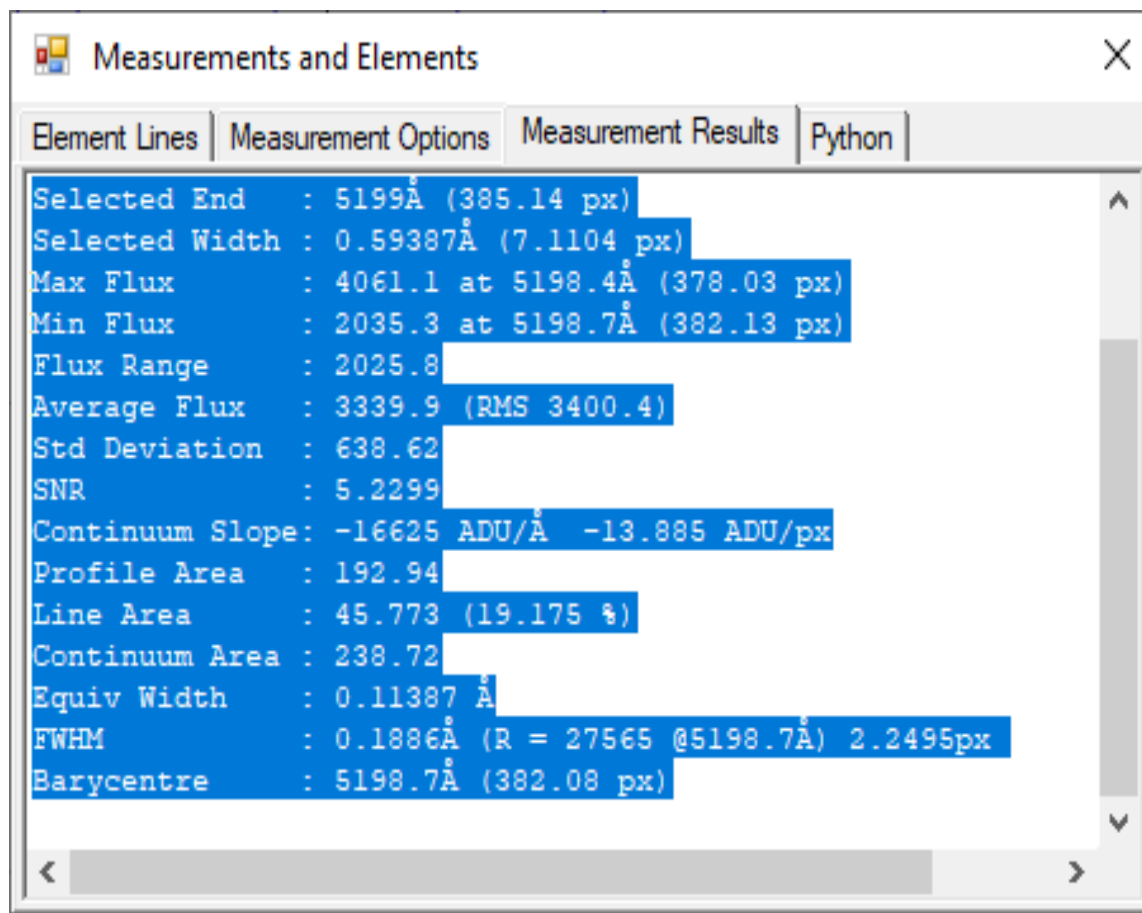


Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

Zon Echelle Order 43 (Magnesium Triplet) - Fiber Optic: Monomode Fiber (8-10 μm) Camera: ATIK 420 Mono (pixel size 4.4 μm square)
Dispersion: 0.08468446 $\text{\AA}/\text{px}$ Exposure time: 45 sec (- Dark) CCD temperature: -9.1 $^{\circ}\text{C}$ DATE-OBS = 2019-08-24T14:45:54 FWHM: 0.30945 \AA (R = 16768 @5188.8 \AA) 3.6491px FWHM: 0.1886 \AA (R = 27565 @5198.7 \AA) 2.2495px Hugo Van den Broeck

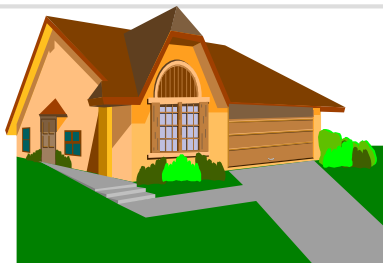


Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Naar een volwaardige spectrograaf

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Behuizing



Regelmechanismen:
Collimator lens focus
Echelle rooster push pull
Uitlijning mechanisme in X,
Y en Z voor cameralens

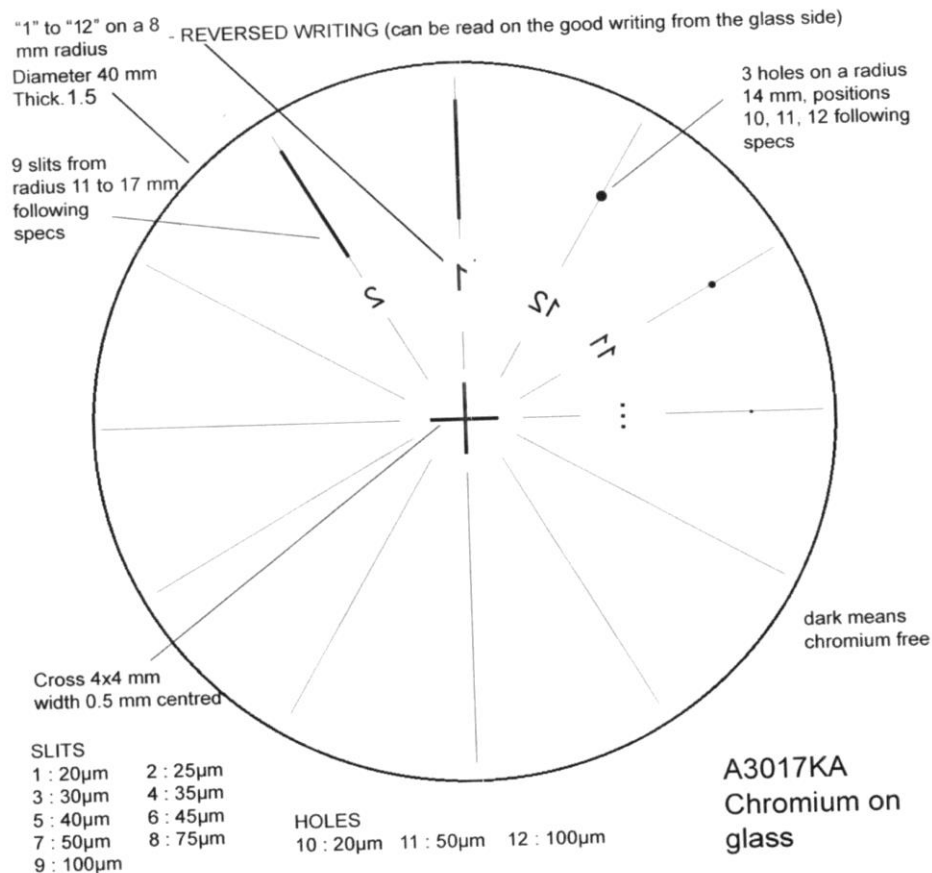


Vattingen voor telescoop,
science & guiding camera



Guiding unit

Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch



Gezocht: Pinhole / Slit plaatje (spiegelend)



Zelfbouw Echelle spectrograaf - Tivoli Oudenbosch

Ter informatie:

De volkssterrenwacht Armand Pien organiseert naar jaarlijkse gewoonte een cursus “spectroscopie”.

Deze cursus gaat door in Gent in het najaar van 2019 op 5 maandag avonden
(van 18 november tot 16 december)

Omvat: 3 avonden theorie over astronomische spectroscopie
1 avond spectroscopen
1 avond praktijk: reductie van een sterspectrum

Meer info: <http://www.armandpien.be/page/cursussen>

Einde

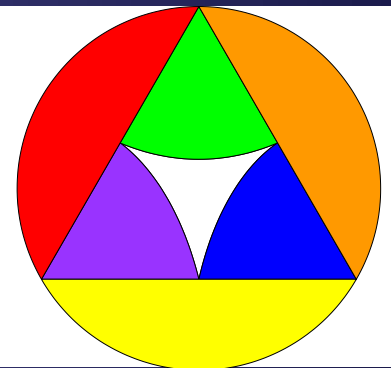


**UGent Volkssterrenwacht
Armand Pien**

Spectroscopie in de sterrenkunde
Zelfbouw Echelle Spectroscoop
Bijeenkomst Tivoli Oudenbosch



**UNIVERSITEIT
GENT**



16 november 2019