

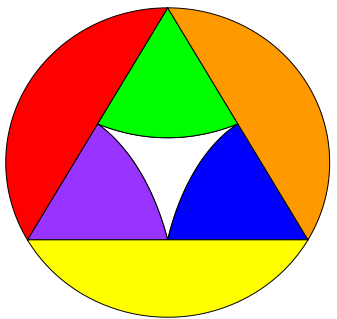
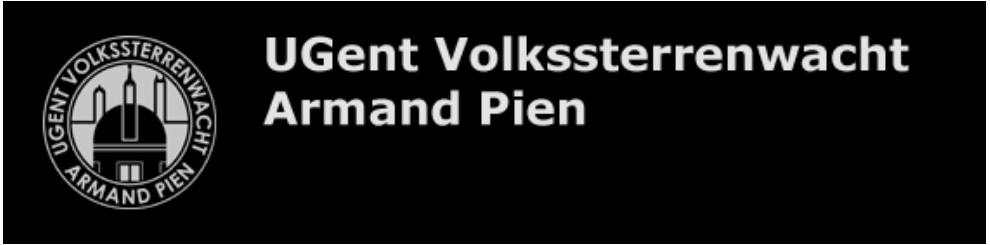


► Spectroscopie in de Sterrenkunde

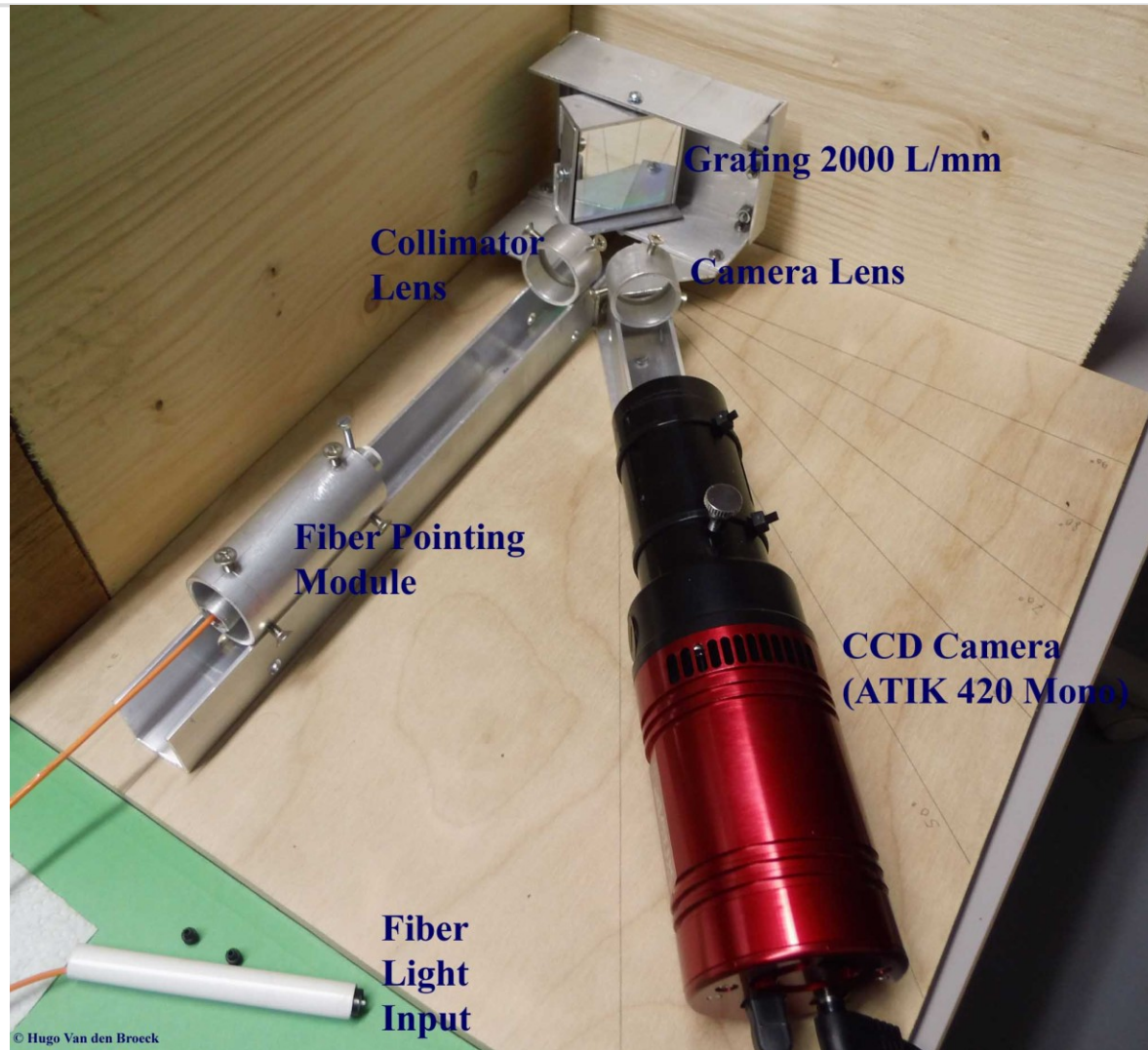
Een poging tot het bouwen van een spectroscop

HUGOS

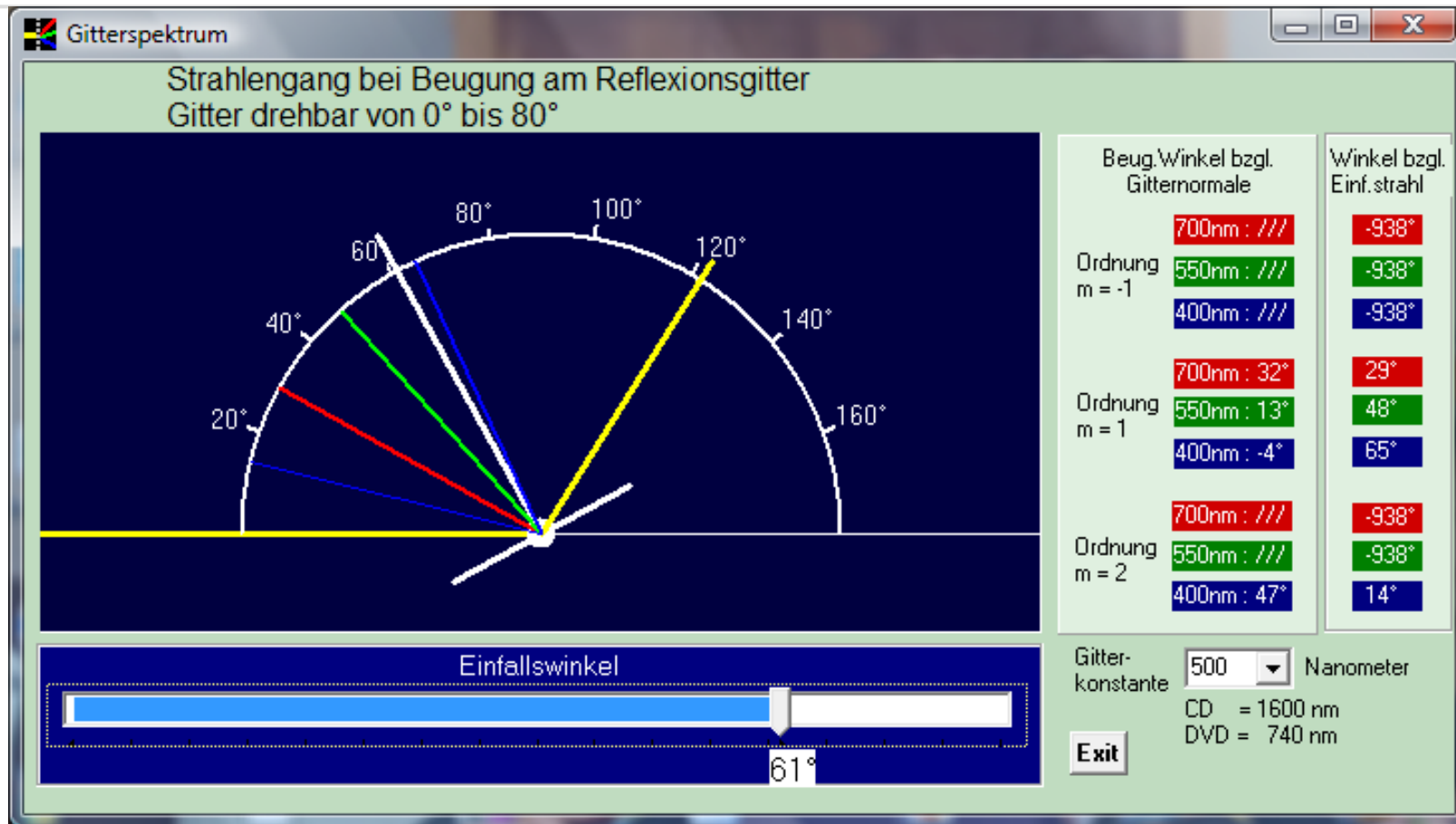
Hoge-resolutie **U**niversele **G**lasvezel-**O**ptische
Spectroscop



Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch



ReflexionsSpektrum van Dr. Bernd Loibl

<http://www.bernd-loibl.de/ReflexionsSpektrum.zip>



Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

- **Multi Mode Fiber. Diameter glasvezel = 50 μ m**
- **Collimator & camera lens 25 mm diameter, f/6,5**
- **De invallende hoek komt van een Celestron C11 (f/10) met f/6,3 focal reducer.**
- **Rooster: 2000 lijnen / mm. 50 x 50 mm.**
- **Enkel onderste helft (h = 25 mm, l = 50 mm) wordt gebruikt.**

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

SIMSPEC V4.2 english version, by Ken Harrison , original version by Christian Buil

Latest Revision: mrt/16

Enter data in highlighted cells

Telescope	
Diameter (D) :	279.4 mm
Focal Ratio, F/D (F#) :	6.3
Focal length (f) :	1760.2 mm
Secondary Diameter	96 mm
Central obstruction (c) :	0.34
Telescope throughput (To) :	0.95
Seeing/ Atmosphere	
Seeing (ϕ) :	4"
Atmospheric transmission (Ta) :	0.8
Sky magnitude (mag/arc sec ²) :	17
Star size at focus (FWHM):	34.1 microns

NOTES:

See www.astrosurf.org/buil/us/spe2/hresol1.htm
www.astrosurf.org/buil/us/stage/calcul/design_us.htm
 (explanatory notes and worked example)

SUMMARY	
Resolving power R	10177
Spectral resolution	0.64 Å
Wavelength range	202 Å
Grating-Lines/ mm	2000
Grating-Diffraction order	1
Slit width	50 microns
Target Mag.	4.0
Signal/Noise (SNR/pixel)	248
Signal/Noise (SNR/ $\Delta\lambda$)	563

Other Results	
Angle of incidence (α) :	62.96°
Angle of diffraction (β) :	24.96°
Anamorphic factor (r) :	0.50
diffraction limit grating, FWHM _d :	2.07 microns
Slit/ image width on CCD, FWHM _t :	22.76 microns

Spectrograph	
Collimator	
Collimator-Focal length (f1) :	160 mm
Collimator-Required Focal ratio (Fc) :	6.3
Collimator-Minimum diameter (d1) :	25.4 mm
Resolution of Collimation lens-FWHM _o :	15 microns
Camera	
Camera-Focal length (f2) :	160 mm
Camera-Distance to grating (T) :	60 mm
Camera-Minimum lens diameter (d'2) :	53.3 mm
Camera-Maximum focal ratio (Fo) :	3.0
Resolution of Camera lens-FWHM _c :	15 microns

Collimator/Camera -Total angle (γ) :	38°
Slit width (w) :	50 microns

Grating	
Grating-Lines/ mm (n) :	2000
Grating-Diffraction order (k) :	1
Grating - Actual width	50 mm
Grating - Actual height	25 mm
Grating - Minimum height (H) :	27.0 mm
Grating - Minimum width (W) :	55.9 mm
Dispersion (p) :	0.12 Å/pixel
Resolving power (R) :	10177
Spectral resolution ($\Delta\lambda$) :	0.64 Å
Dispersion (r) :	28.33 Å/mm

Wavelength Range	
Reference wavelength (λ_0) :	6563 Å
Lambda min. (λ_1) :	6462 Å
Lambda max. (λ_2) :	6664 Å
Wavelength range/ image frame :	202 Å

Throughput efficiency	
Transmission efficiency- guide system:	1
Transmission efficiency-transfer mirror:	0.98
Transmission efficiency-Collimator lens (To) :	0.96
Transmission efficiency-Camera lens (Tc) :	0.96
Transmission efficiency-Grating (Tg) :	0.6
Entrance slit transmission(Tt) :	0.9
% efficiency due to undersized grating -width	0.87
% efficiency due to undersized grating -height	0.87
Total Transmission of Spectrograph (Ts) :	0.365

Note: throughput does not take into account undersized

Camera	
Camera (Select from list)	Atik420
pixel size (p) :	4.4 microns
number of X pixels(Nx) :	1620
quantum efficiency (η) :	52.80 %
Read noise (RON) :	4 e-/pixel
Dark noise (Nd) :	0.001 e-/s/pixel
Binning, X axis (fx) :	1
Binning, Y axis (fy) :	1
Sampling Factor :	5.17

Exposure	
Subs, exposure time (ts) :	300 secs
number of subframes (n) :	1
Total exposure time (t) :	300 secs
Spectrum size/ spread	
Height of Spectrum (n) :	23 pixel

Target Star	
Magnitude (m) :	4
Effective temperature (Te) :	10000 K
Bolometric Correction (BC) :	-0.4
SNR (Theoretical)	
Signal/Noise (SNR/pixel) :	248
Signal/Noise (SNR/ $\Delta\lambda$) :	563
Limiting Mag	
Limiting Mag.(Bowen-mod) :	12.36

SNR Calculations

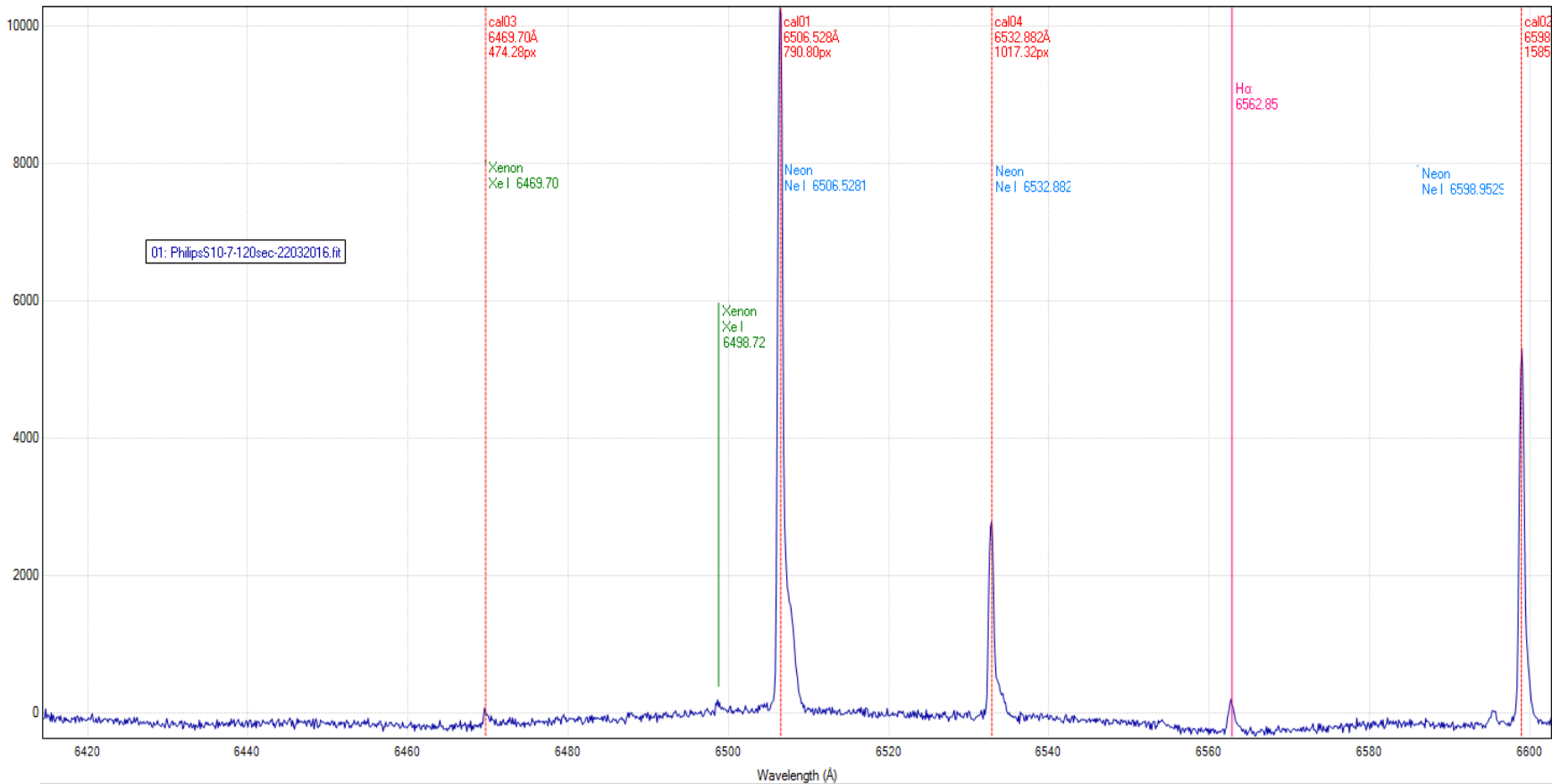
Number of photons (E) :	20.82 photons/cm2/s/Å
Sky background(Ed) :	0.000131 photons/cm2/s/Å arc sec
Final Efficiency (R) :	12.93 %
Useful signal (Nm) :	61698 e-/pixel
Background noise (Ns) :	2736 e-/pixel
Noise(σ) :	249 e-/pixel
Signal/Noise by interval $\Delta\lambda$:	563 e-/pixel
Noise from Signal :	254 e-/pixel
Noise from Electronics :	19 e-/pixel

Note: Actual SNR obtained will be influenced by the guiding (total time the target star is held on the slit gap)
 A good estimate of actual SNR is 50% - 80% the theoretical.

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

Philips S10 TL Starter (Neon + Xenon) Spectroscopie HUGOS (blazed grating 2000 lines / mm) Camera ATIK420 Mono CCD (4.4 x 4.4 μ pixels square)

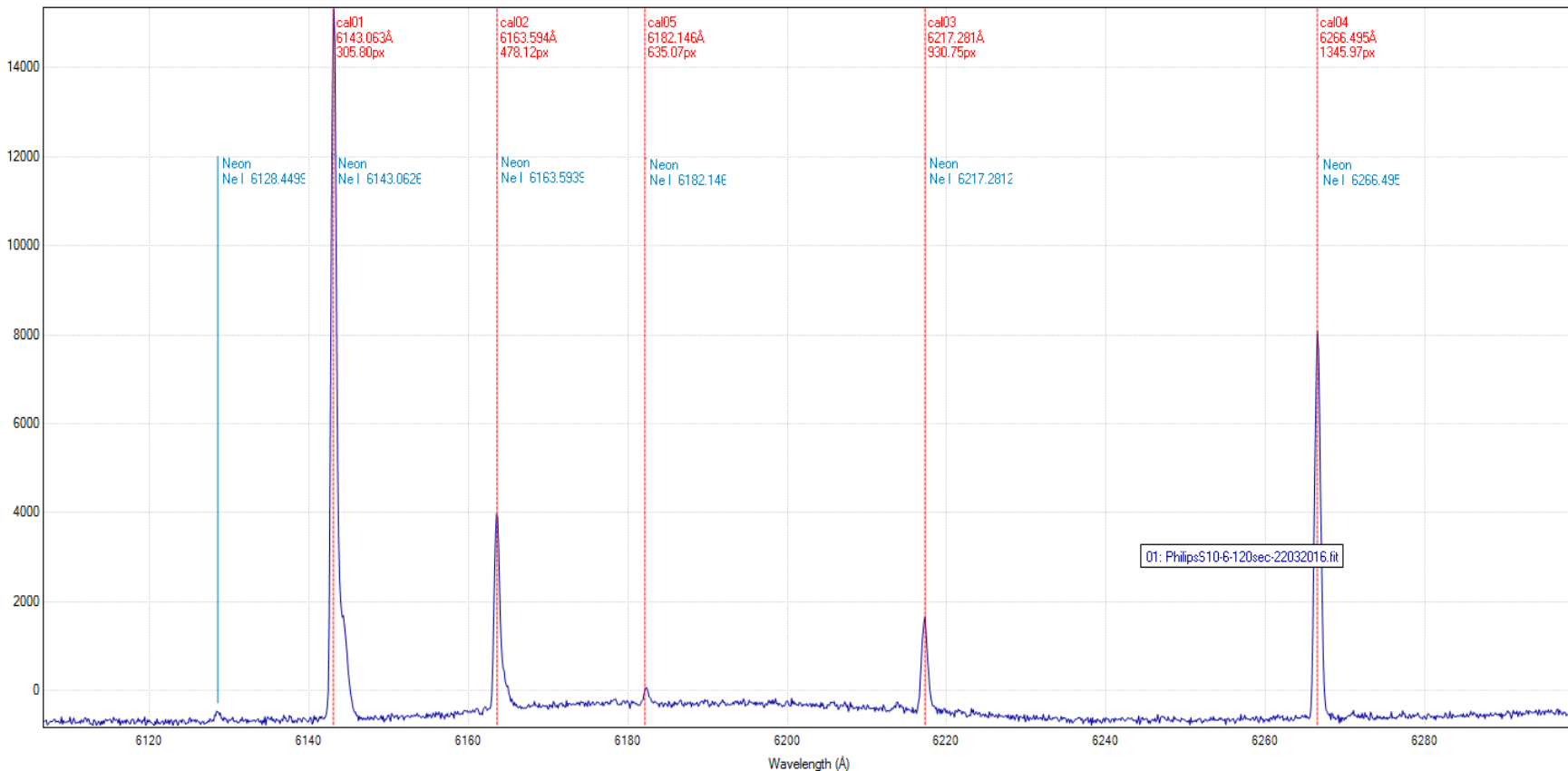
Dispersion 0.1162988 Angstrom / Pixel Resolving Power R = 9288 (@6599 Angstrom) Temperature -15°C Exposure Time 120 Sec



Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

Philips S10 TL Starter (Neon + Xenon) Spectroscopie HUGOS (blazed grating 2000 lines / mm) Camera ATIK420 Mono CCD (4.4 x 4.4 μ pixels square)

Dispersion 0.11864761 Angstrom / Pixel Resolving Power R = 7225 (@6267 Angstrom) Temperature -15°C Exposure Time 120 Sec



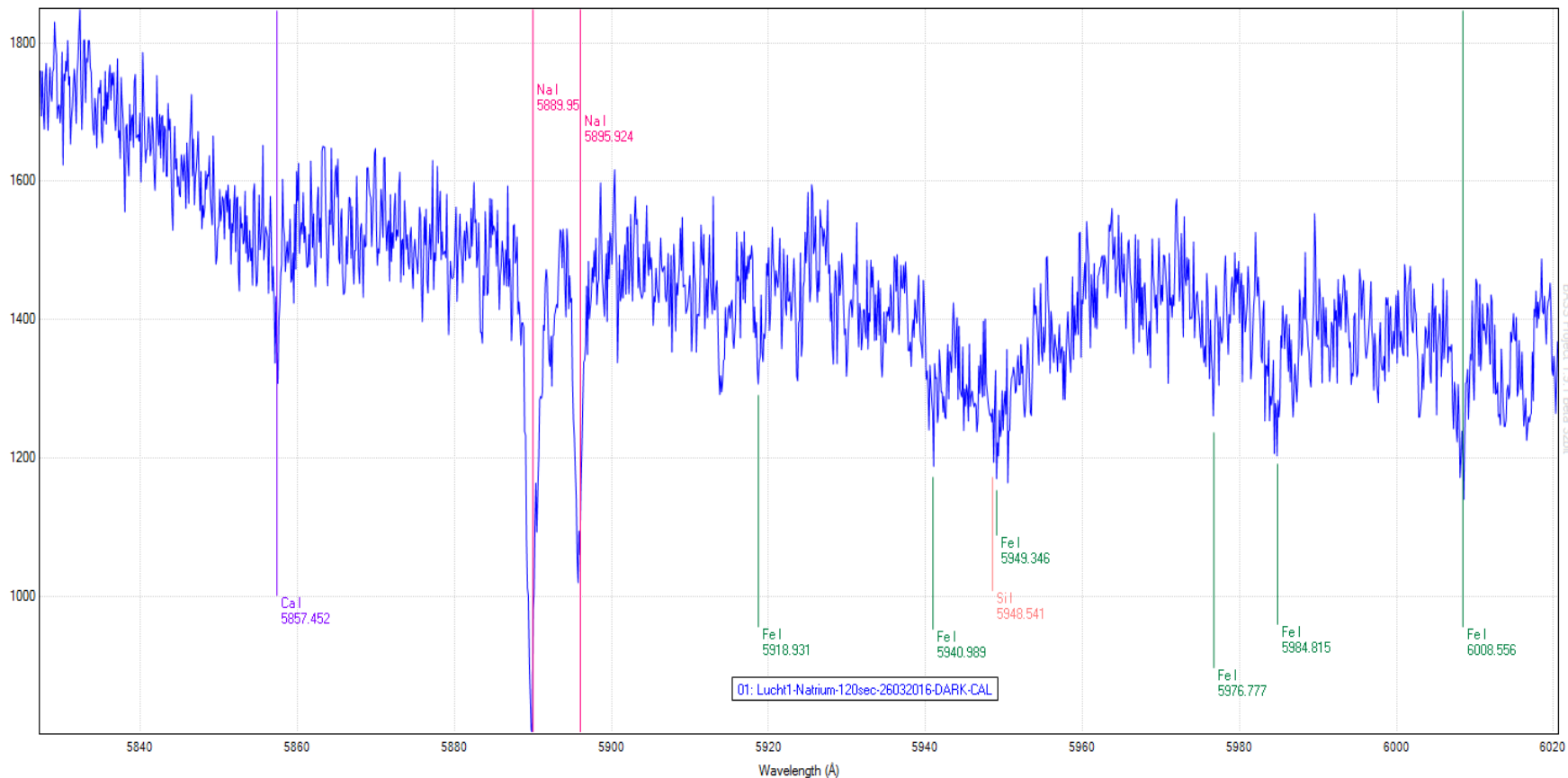
BASS Project 1.9.1 Beta 32x4



Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

Sun (Open-air, cloudy) No telescope Spectroscopie HUGOS (blazed grating 2000 lines / mm) Camera ATIK420 Mono CCD (4.4 x 4.4 μ pixels square)

Dispersion 0.11953736 Angstrom / Pixel Temperature -15°C Exposure Time 120 Sec Erpe-Mere Date_Time UT: 2016-03-26T15:42:32 Hugo Van den Broeck

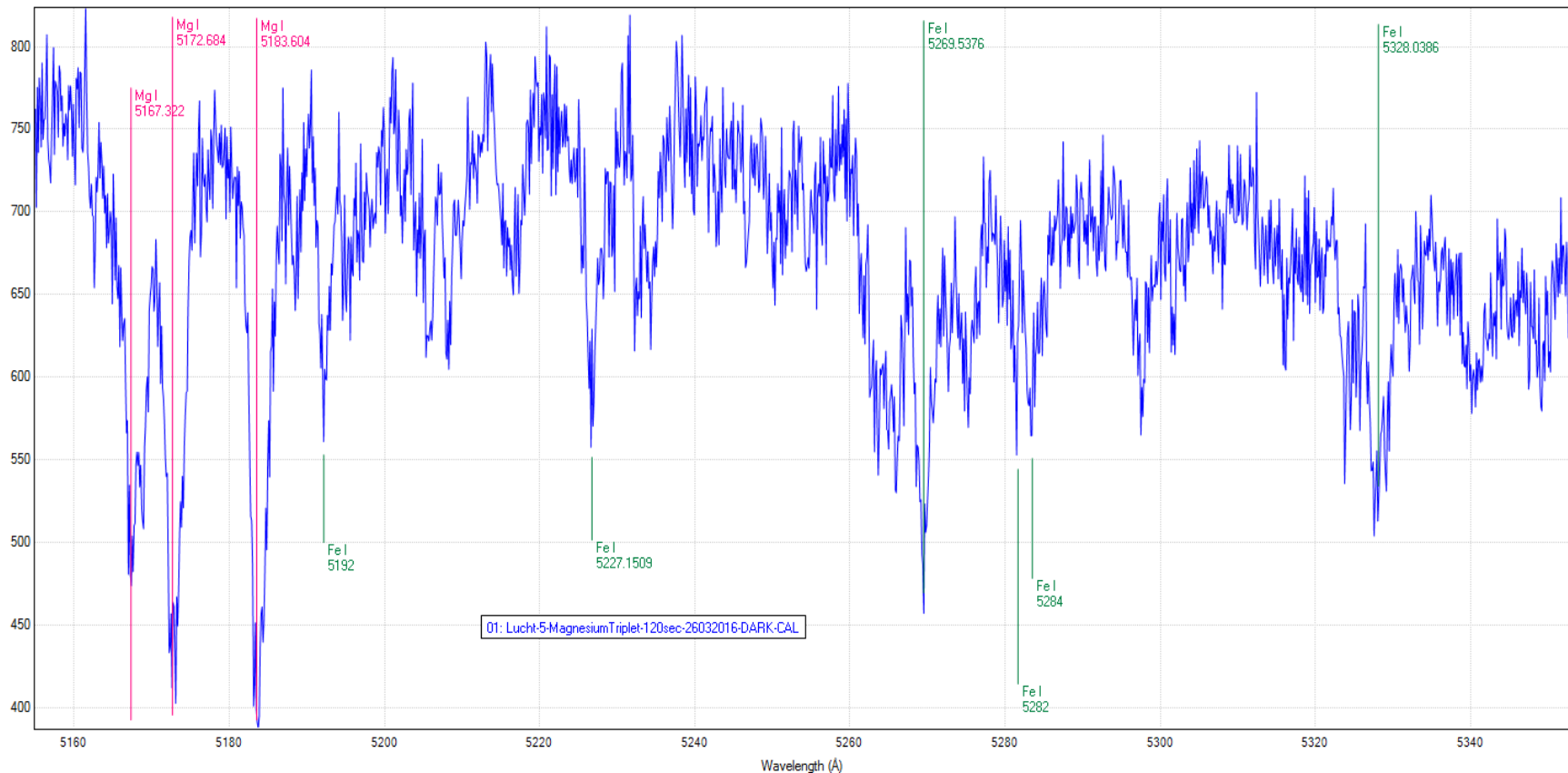


BASS Project 1.9.1 Beta 2004

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

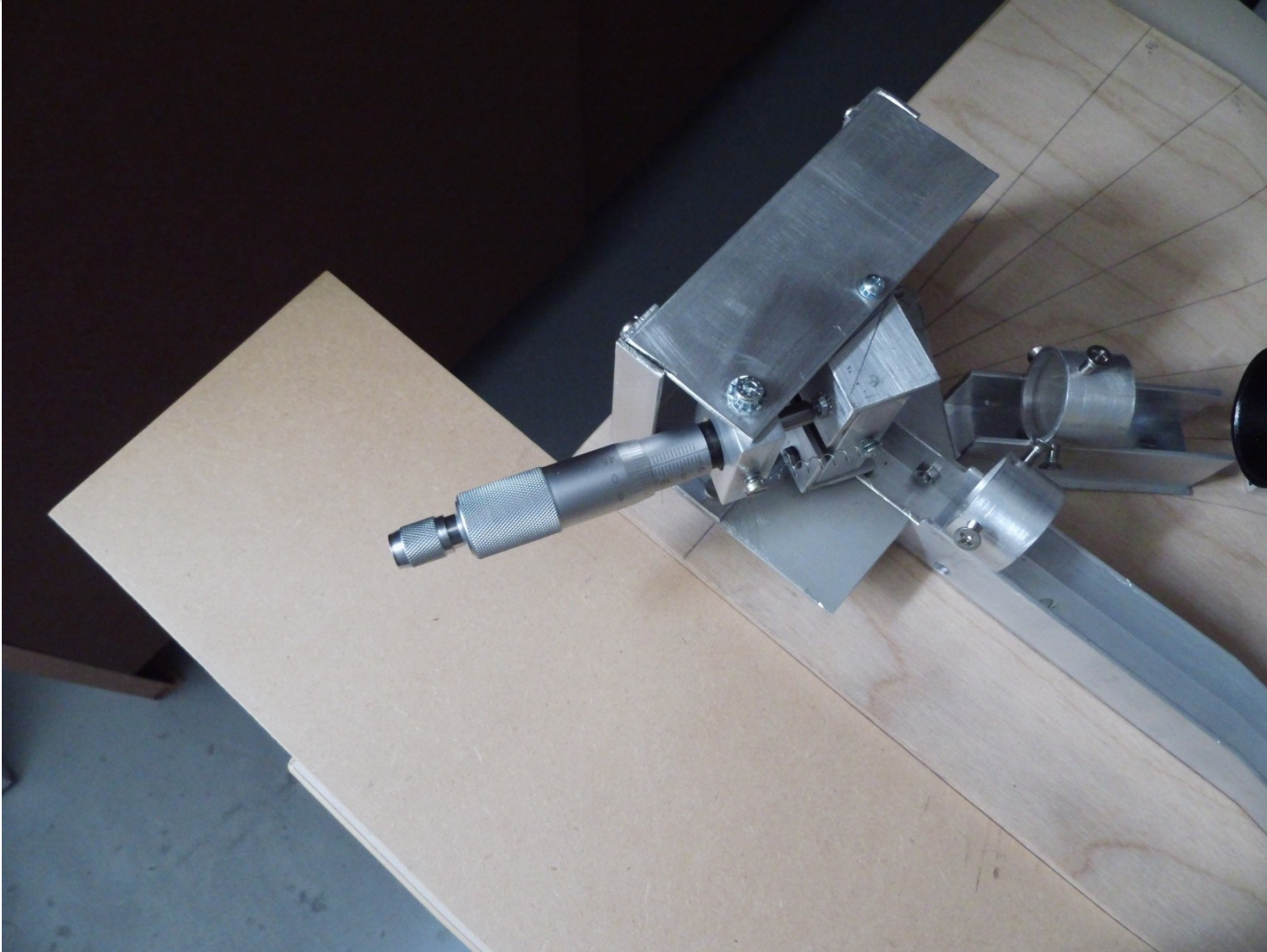
Sun (Open-air, cloudy) No telescope Spectroscopie HUGOS (blazed grating 2000 lines / mm) Camera ATIK420 Mono CCD (4.4 x 4.4 μ pixels square)

Dispersion 0.12219 Angstrom / Pixel Temperature -15°C Exposure Time 120 Sec Erpe-Mere Date_Time UT: 2016-03-26T16:38:55 Hugo Van den Broeck



BASS Project 1.3.1 Beta 324

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

HUGOS SPECTROSCOOP
met 2000 lijnen/mm rooster

Micrometer Instelling	Centrum golflengte in Ångstrom		Bereik in Ångstrom	Breedte in Ångstrom	Dispersie Å / px
20.00	4144.65		4039.4 4249.9	210.5	0.1301879
19.50	4261.8		4156.5 4367.1	210.6	0.13026172
19.00	4427.1		4322 4532.2	210.2	0.13004945
18.50	4595.6		4491 4700.2	209.2	0.12937152
18.00	4767.25		4663.2 4871.3	208.1	0.12867883
17.50	4942.65	H-Beta 4861.33	4838.7 5046.6	207.9	0.12854076
17.00	5122.3		5019.1 5225.5	206.4	0.12764318
16.50	5304.05		5201.8 5406.3	204.5	0.12645339
16.00	5490		5387.9 5592.1	204.2	0.12630851
15.50	5677.4		5576.4 5778.4	202	0.12493413
15.00	5869	Na Doublet (D1 - D2)	5768.8 5969.2	200.4	0.12398302
14.50	6057.85		5958.5 6157.2	198.7	0.12291509
14.00	6252.35		6154 6350.7	196.7	0.12165547
13.50	6440.5		6343.7 6537.3	193.6	0.1198318
13.00	6622.45	H-Alpha (C) 6562.8518	6526.5 6718.4	191.9	0.11874182
12.50	6814.95		6719.3 6910.6	191.3	0.1183261
12.00	6998.65		6904.6 7092.7	188.1	0.11634817



Zelfbouw spectroscopie bijeenkomst Tivoli Oudenburg

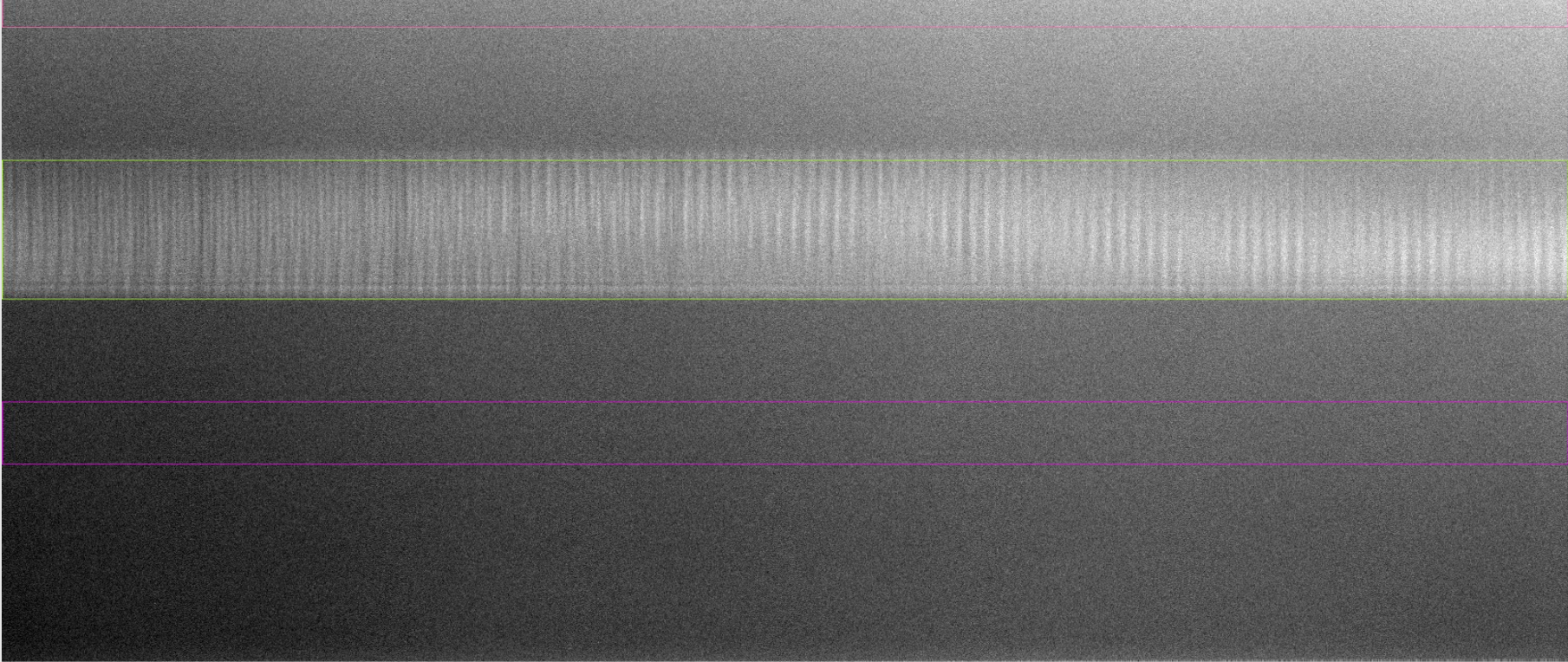
Single Mode Fiber. Diameter glasvezel = 8 a 10 μm
Nuttig oppervlak 25 x minder dan een 50 μm Multimode fiber!

Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch





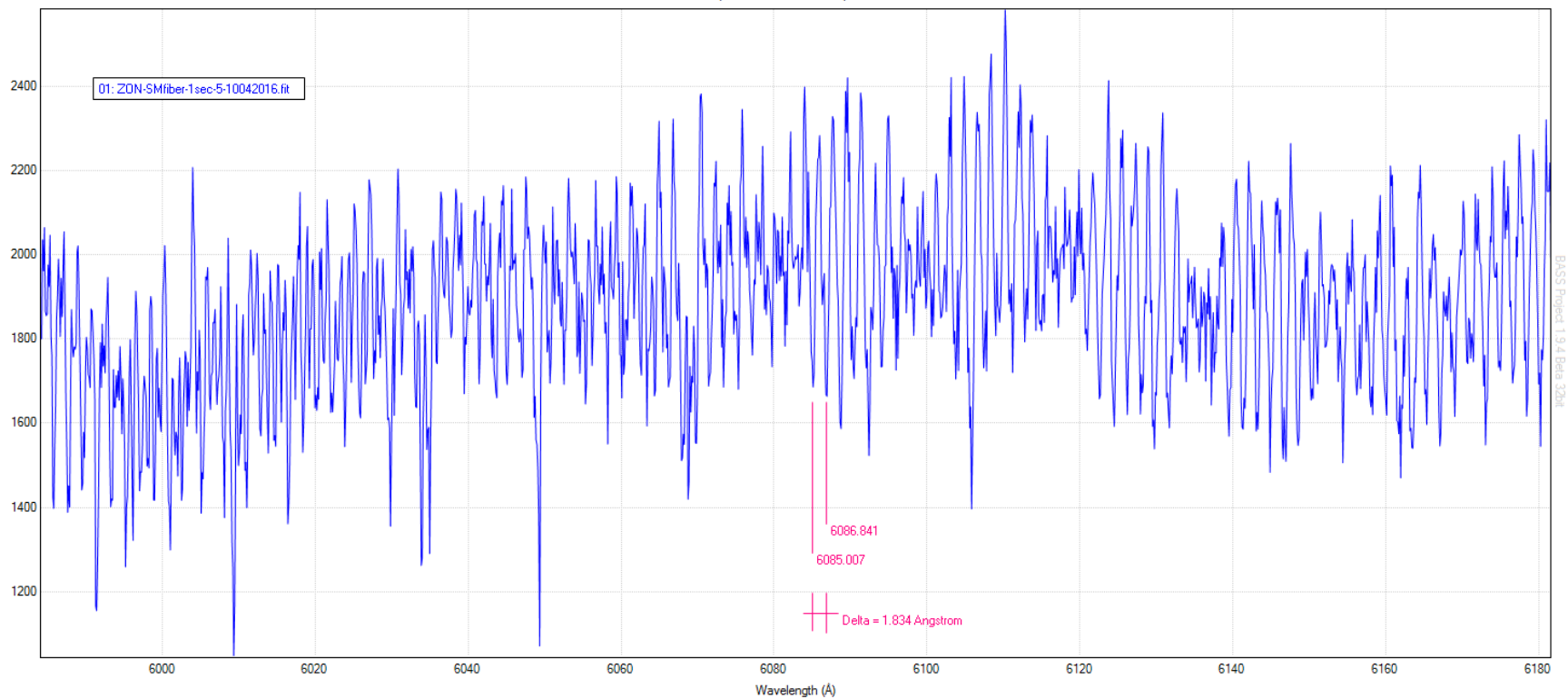
Zelfbouw spectroscopie bijeenkomst Tivoli Oudenburg



Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

Zon - HUGOS - Single Mode Fiber - Camera ATIK 420 Mono - Zondag 10 april 2016

Dispersion 0.12203269 Å / px



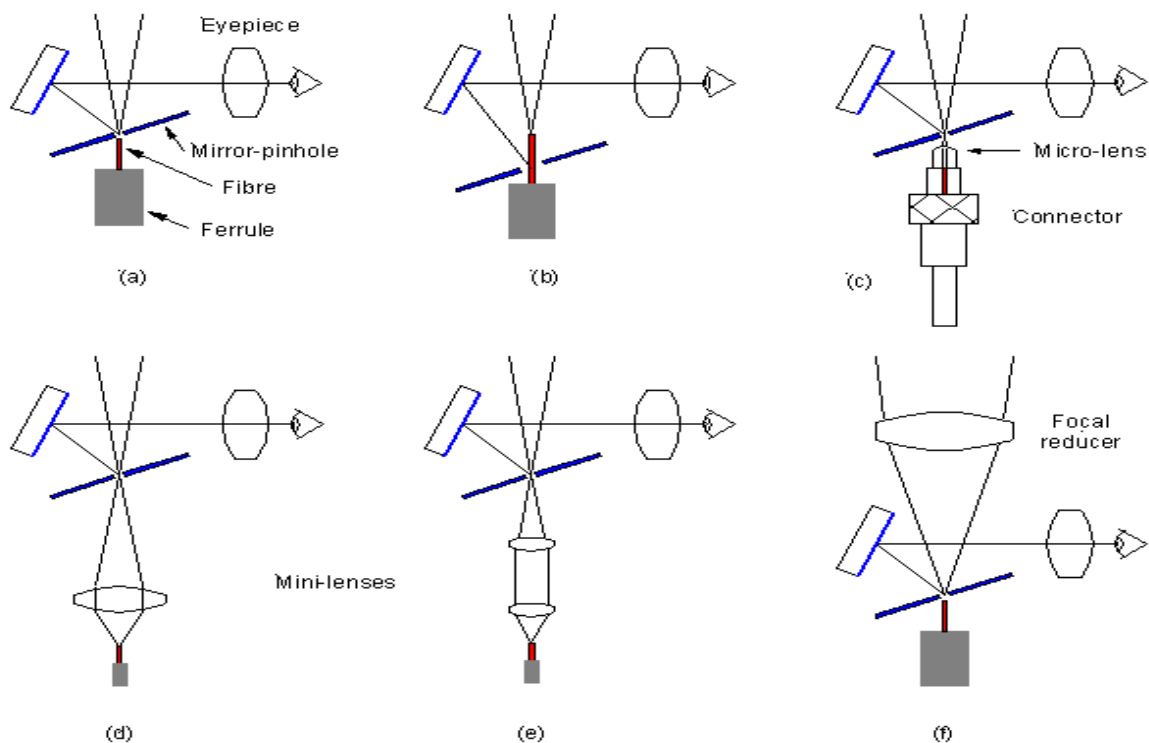
Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

Guidehead: De Achillespees van een zelfbouw glasvezel spectroscopie.

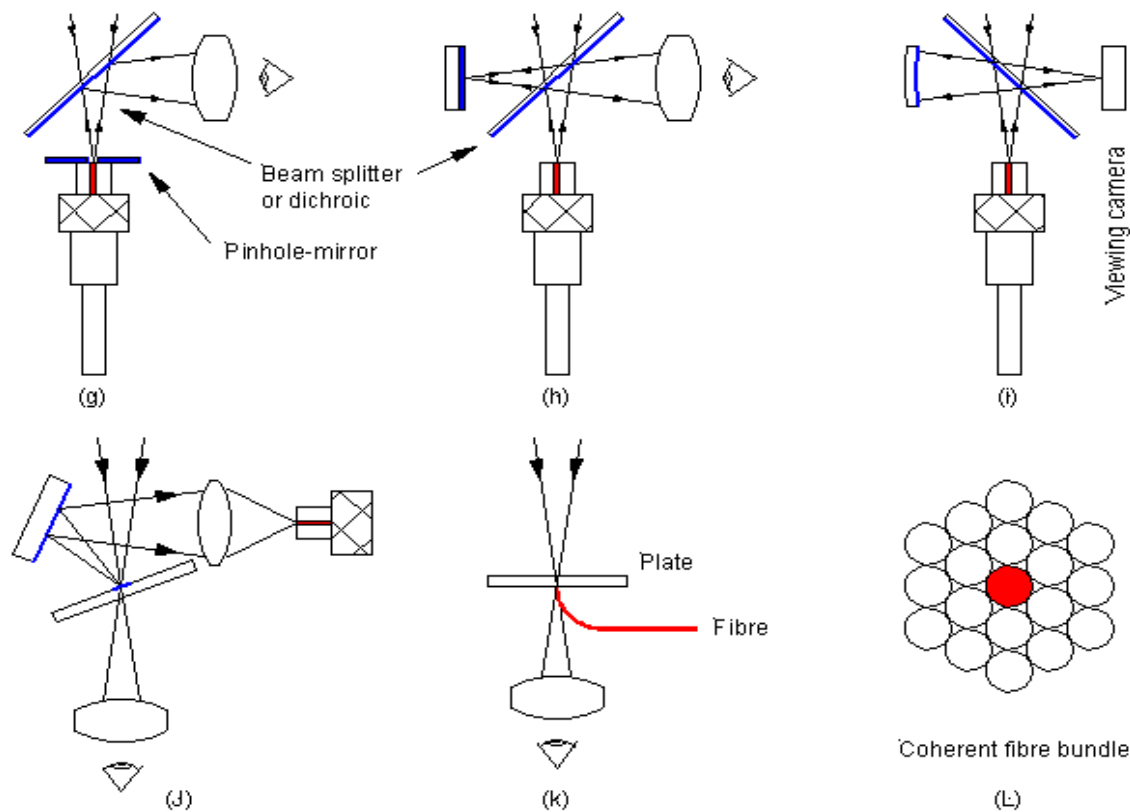


F/6 50 μm Injection unit van Shelyak kost 2490 EURO.
(Zonder glasvezel kabels)

Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

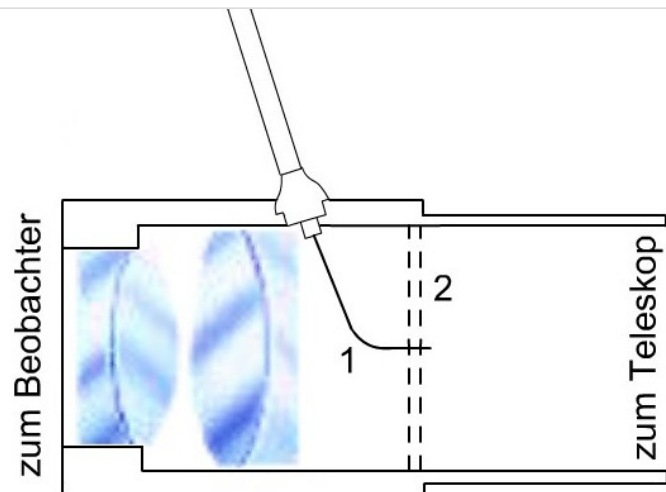


Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch



<https://spectroscopy.wordpress.com/2009/08/01/linking-a-telescope-to-a-spectrograph-through-an-optical-fibre-part-i/>
<https://spectroscopy.wordpress.com/2010/12/30/linking-a-telescope-to-a-spectrograph-through-an-optical-fibre-part-ii/>

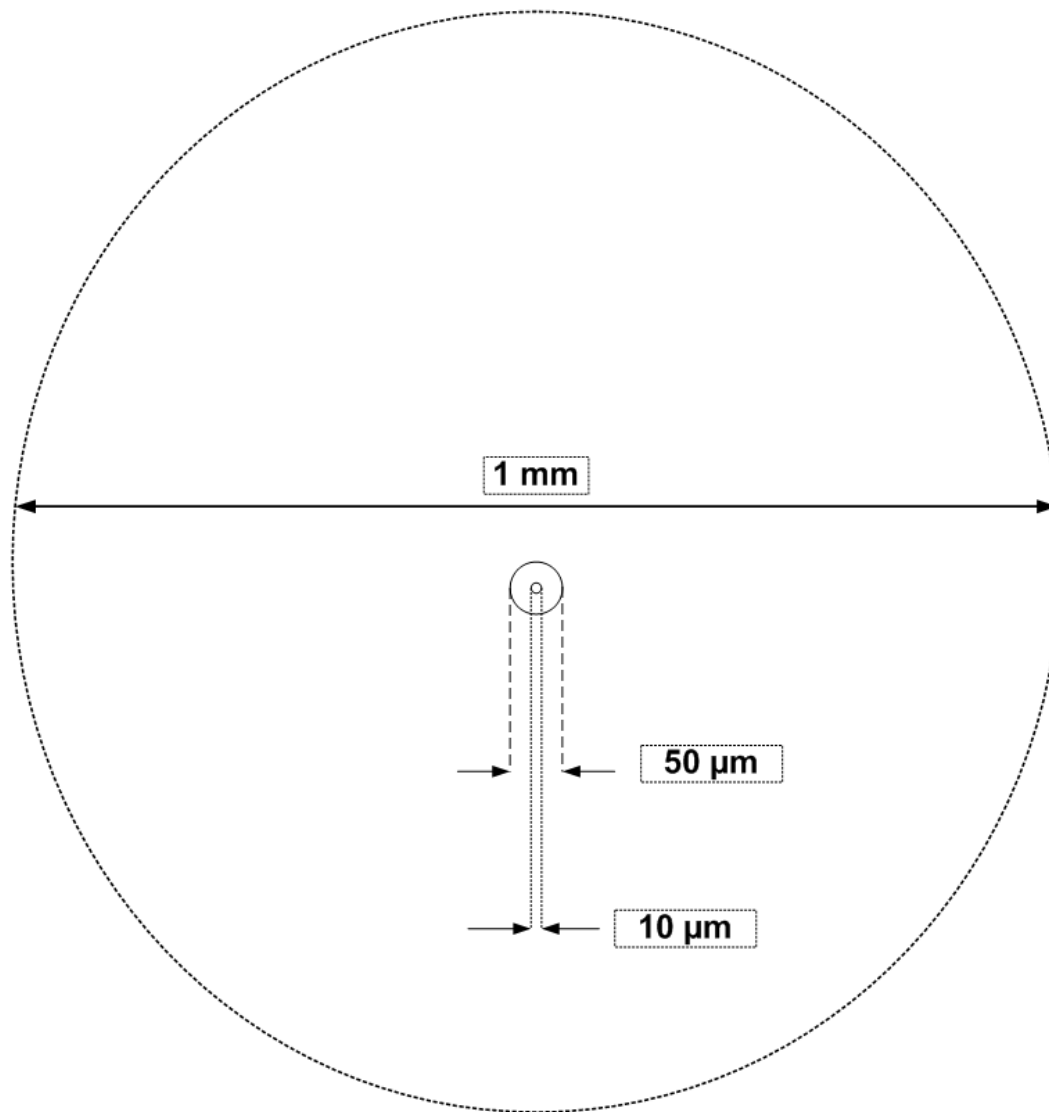
Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch



Schoolproject

<http://spektroskopie.fg-vds.de/pdf/schueler/yannick-suter.pdf>

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenburg



Zelfbouw spectroscopie bijeenkomst Tivoli Oudenburg



Glasvezel polijsten. Met Ceriumdioxide en optische viltjes?

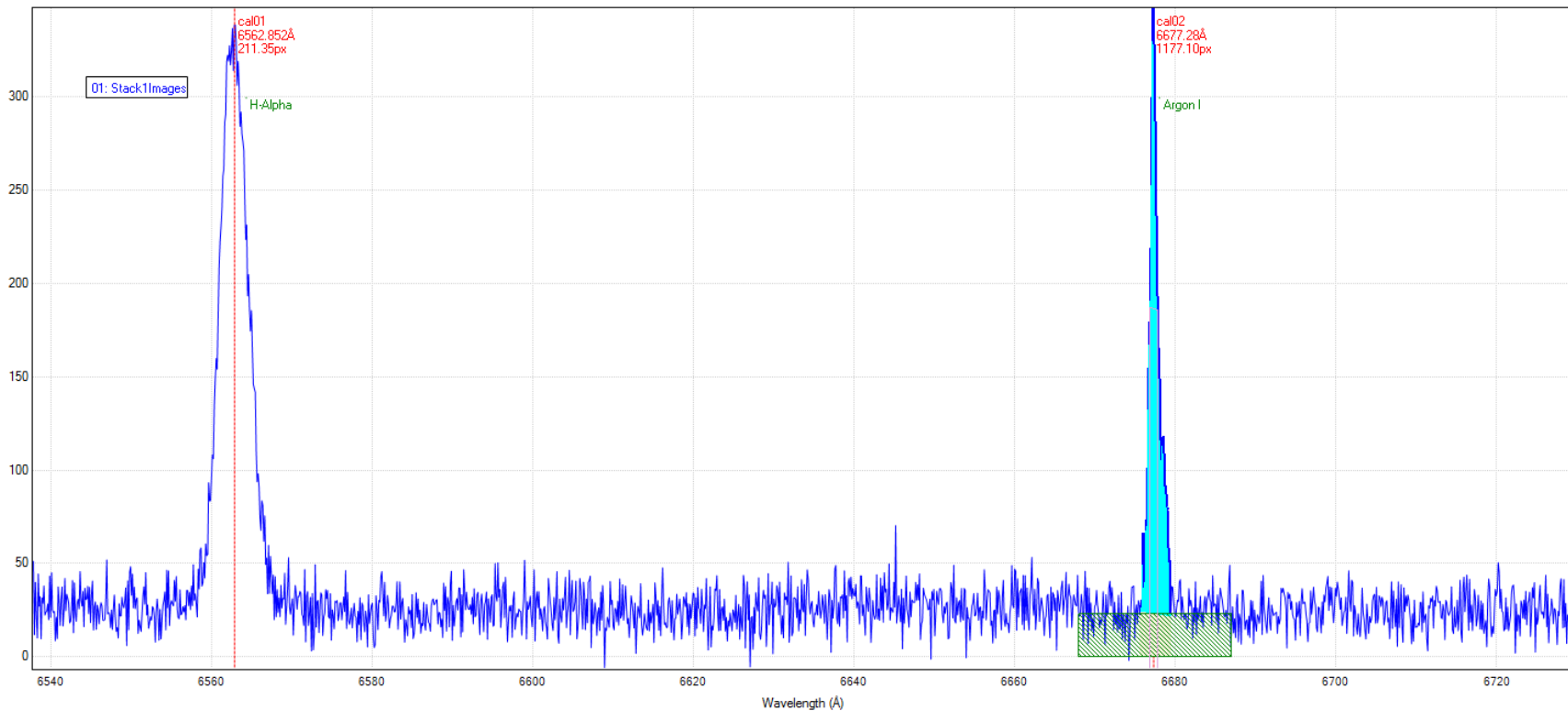
Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

SUTICO 600 SEC -5°C Micrometer 12,90 mm (Ha Region) Dark subtracted image

Dispersion 0.11848703 Angstrom / pixel Resolving power $R = 7221 @ 6677.28 \text{ \AA}$ SNR 1.4284



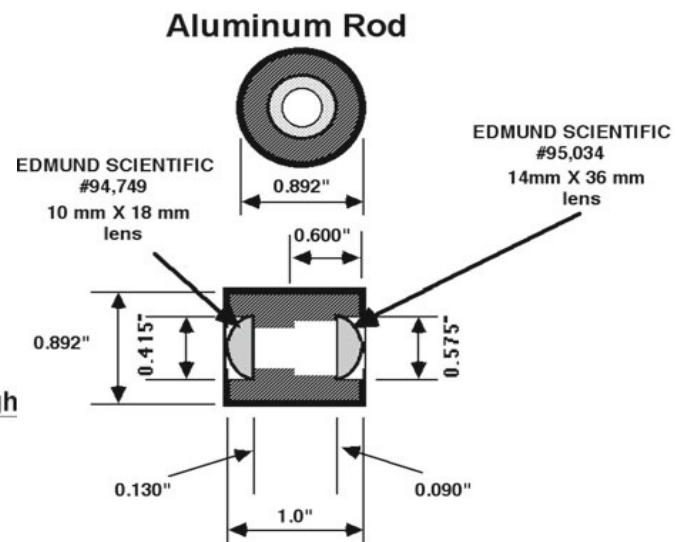
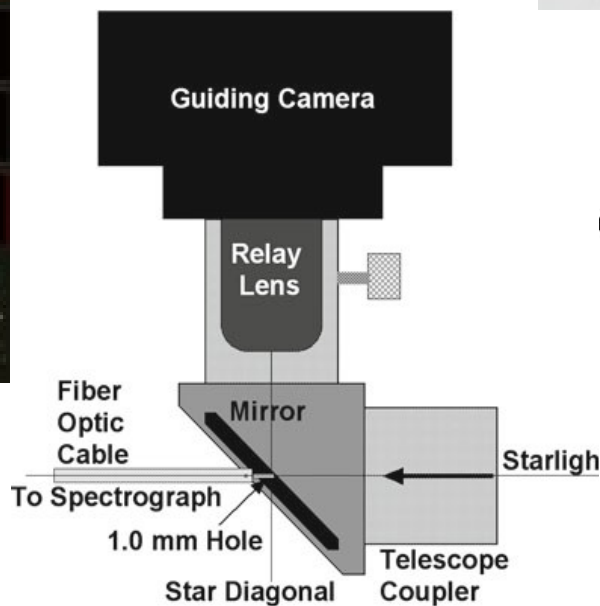
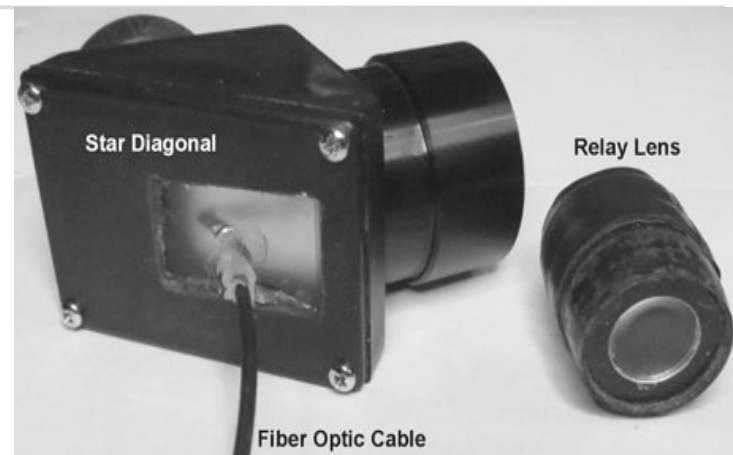
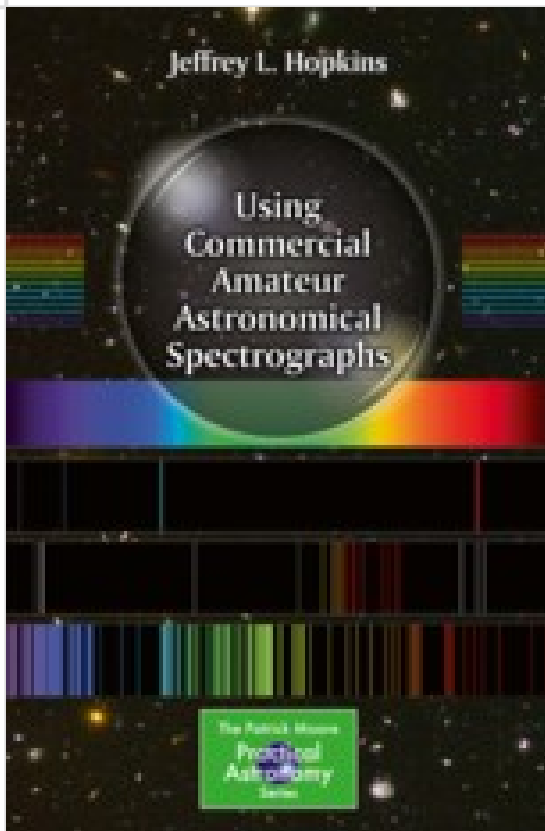
BASS Project 13.4 Bess 33A

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch



CM1-BP108 30mm cube pellicle beamsplitter 92/8 transmission.
Ontworpen door Richard ssb73q@rochester.rr.com in RSpec forum.
Met standaard onderdelen, aangekocht bij Thorlabs

Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch



Iets over Zelfbouw Kalibratielampen

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch



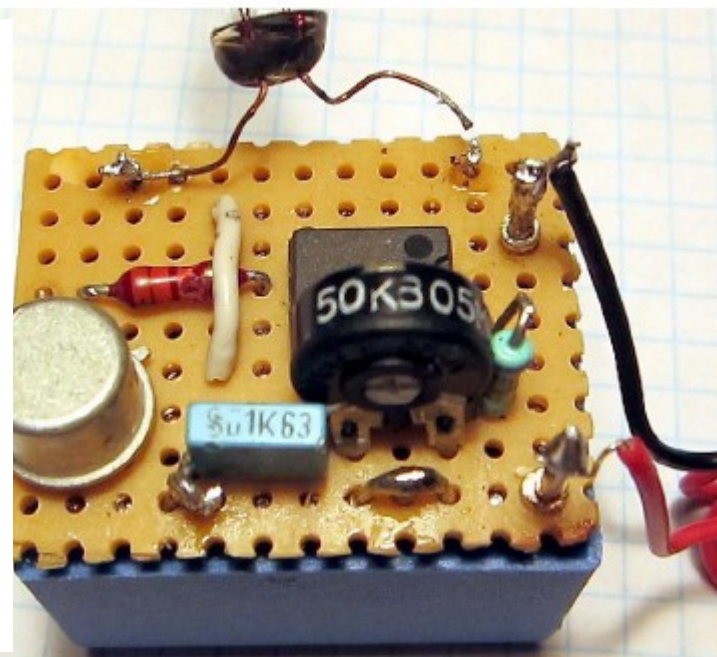
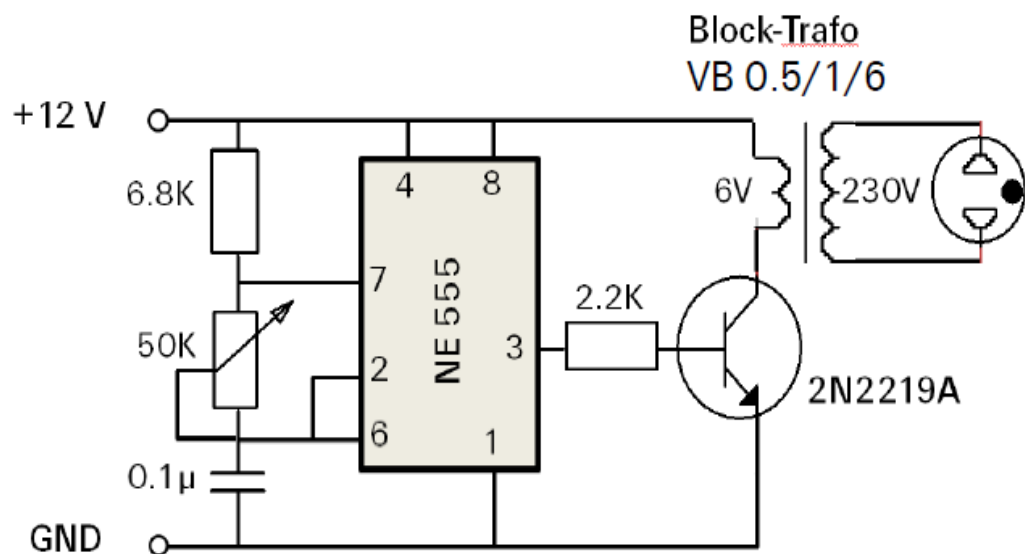
Thorium – Argon calibratielamp van de eShel spectroscopie:
ZEER DUUR! (Bij Shelyak; alleen lamp 799,00 EURO)

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch



Goedkoper met TL Starter lampjes. Rechtstreeks op 220Volt
(Vergeet de voorschakelweerstand niet! (Ongeveer 25 K-Ohm in serie))

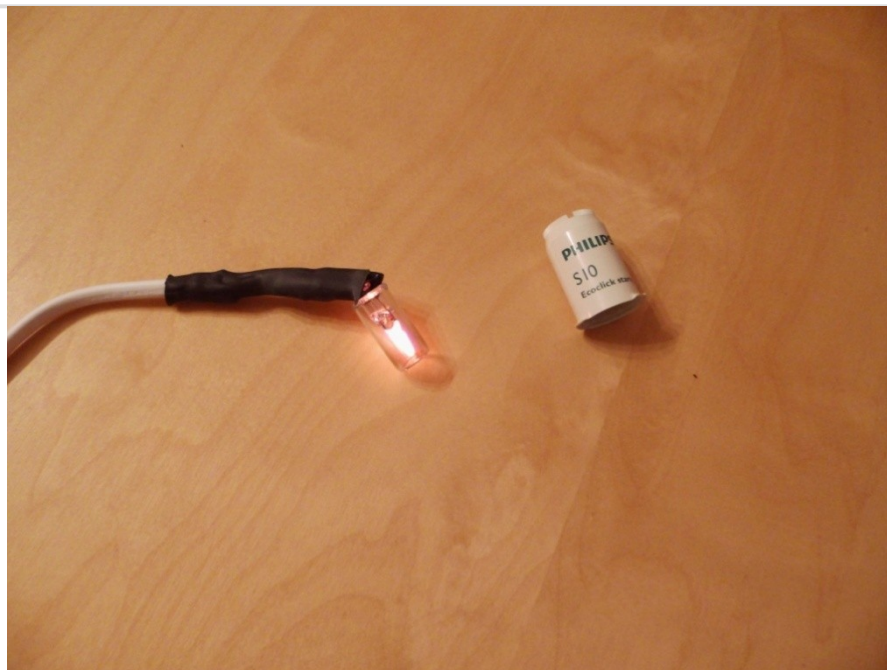
Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch



<http://www.ursusmajor.ch/downloads/inverter-12v-dc--230v-ac-2.0.pdf>

Of via de veiliger methode van Richard Walker op 12 volt

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenburg



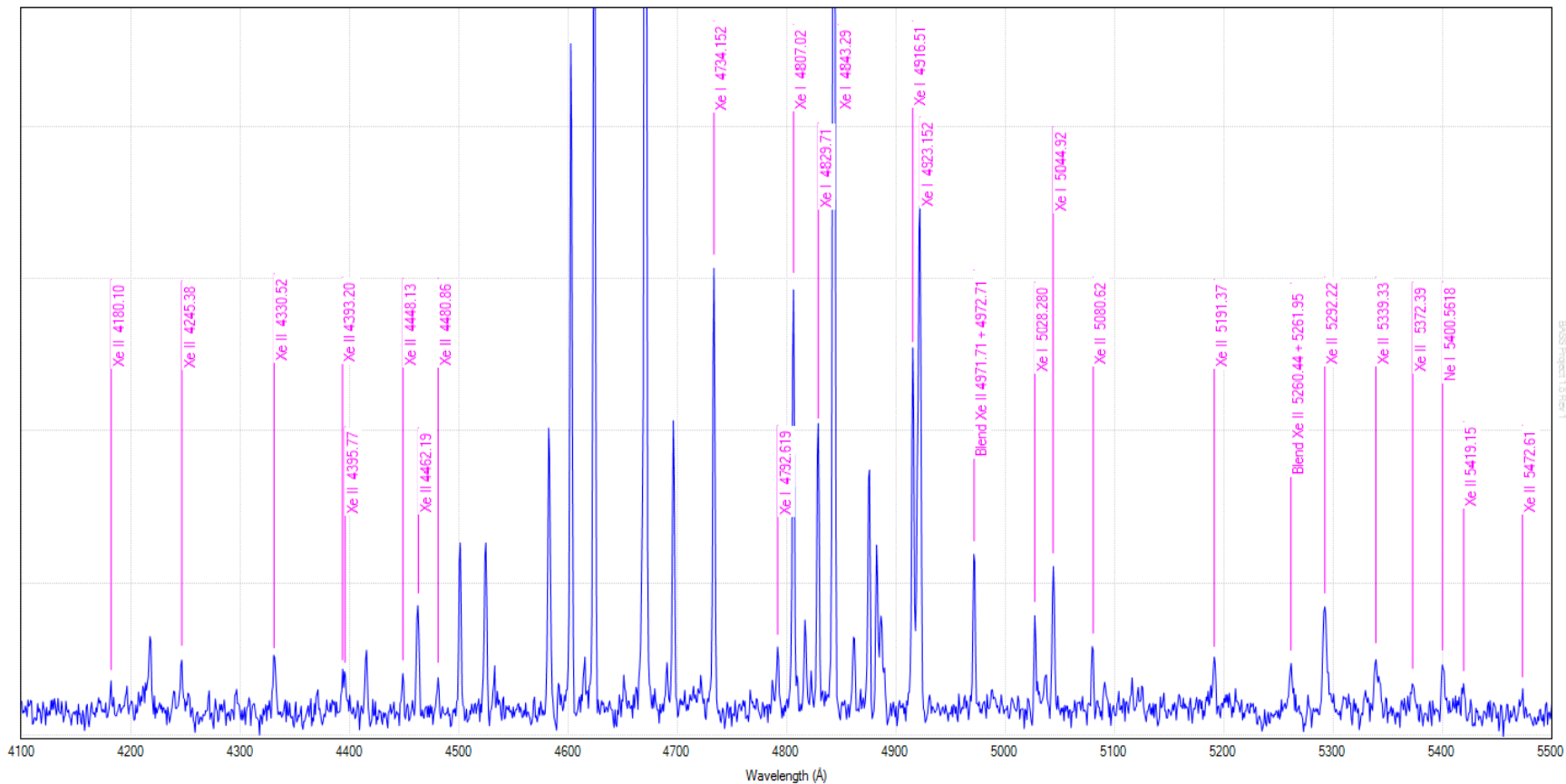
**Spectrum van Philips S10 TL lamp starter
Met Neon en Xenon gas**

**Spectrum opgenomen met SBIG SGS spectroscopie, 600 L/mm
SBIG ST-10 camera, Celestron C8 telescoop en focal reducer f/6.3**

Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

Philips S10 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 7 juli 2014

Dispersie 0.80906016 Angstrom / pixel

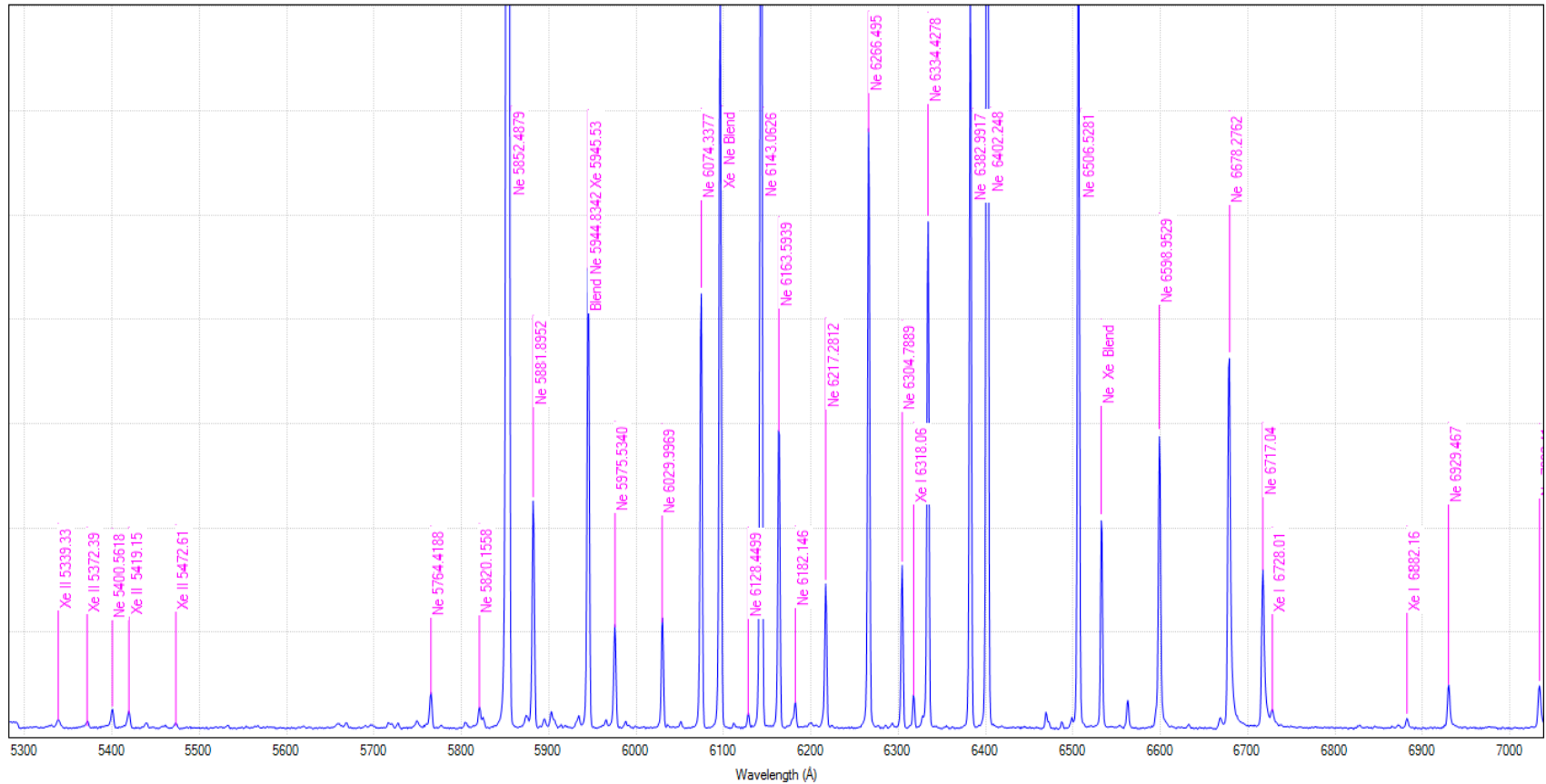


1.489511.tbl@sig.issve

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

Philips S10 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 7 juli 2014

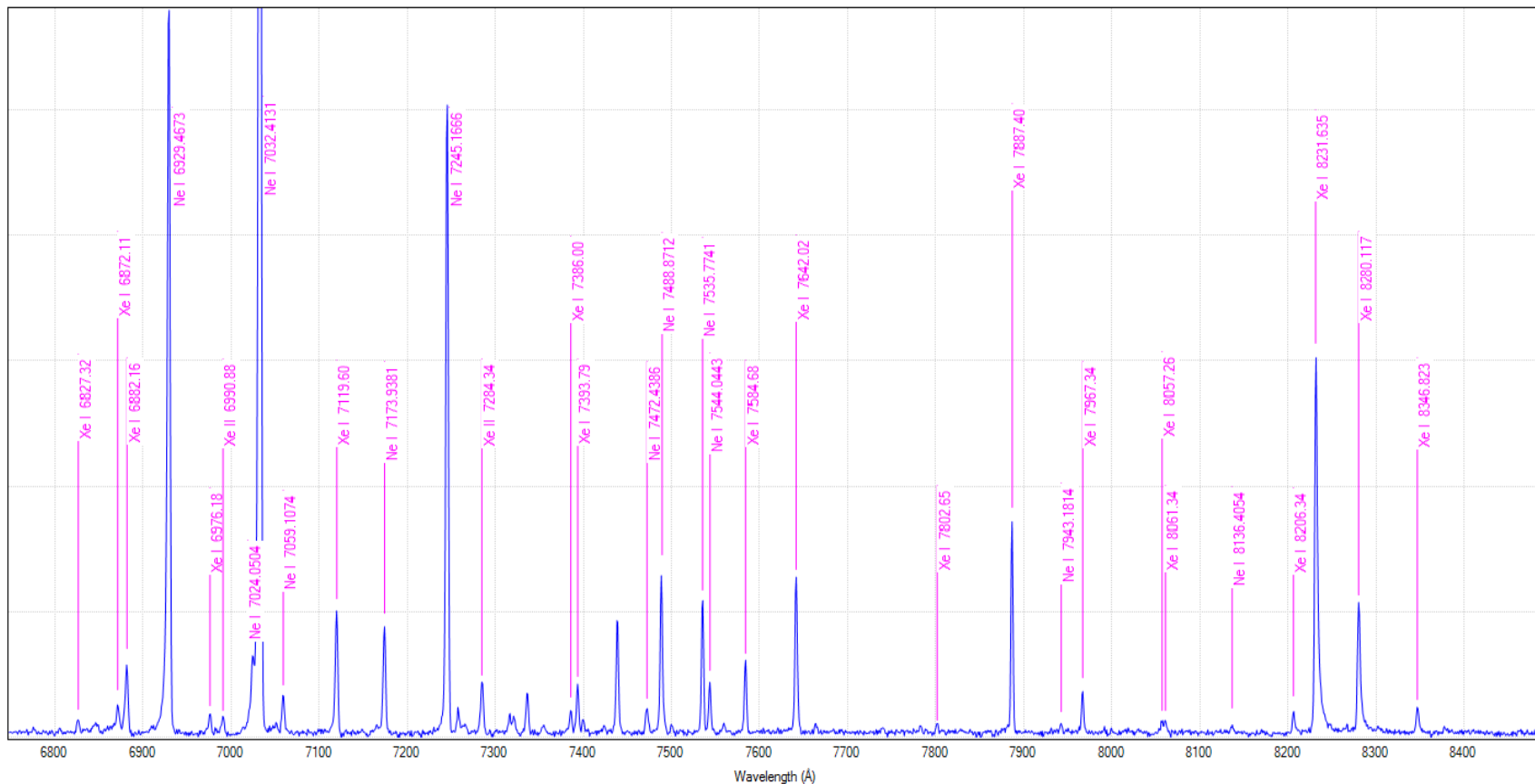
Dispersie 0.804099 Angstrom / pixel



Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

Philips S10 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 7 juli 2014

Dispersie 0.79710927 Angstrom / pixel

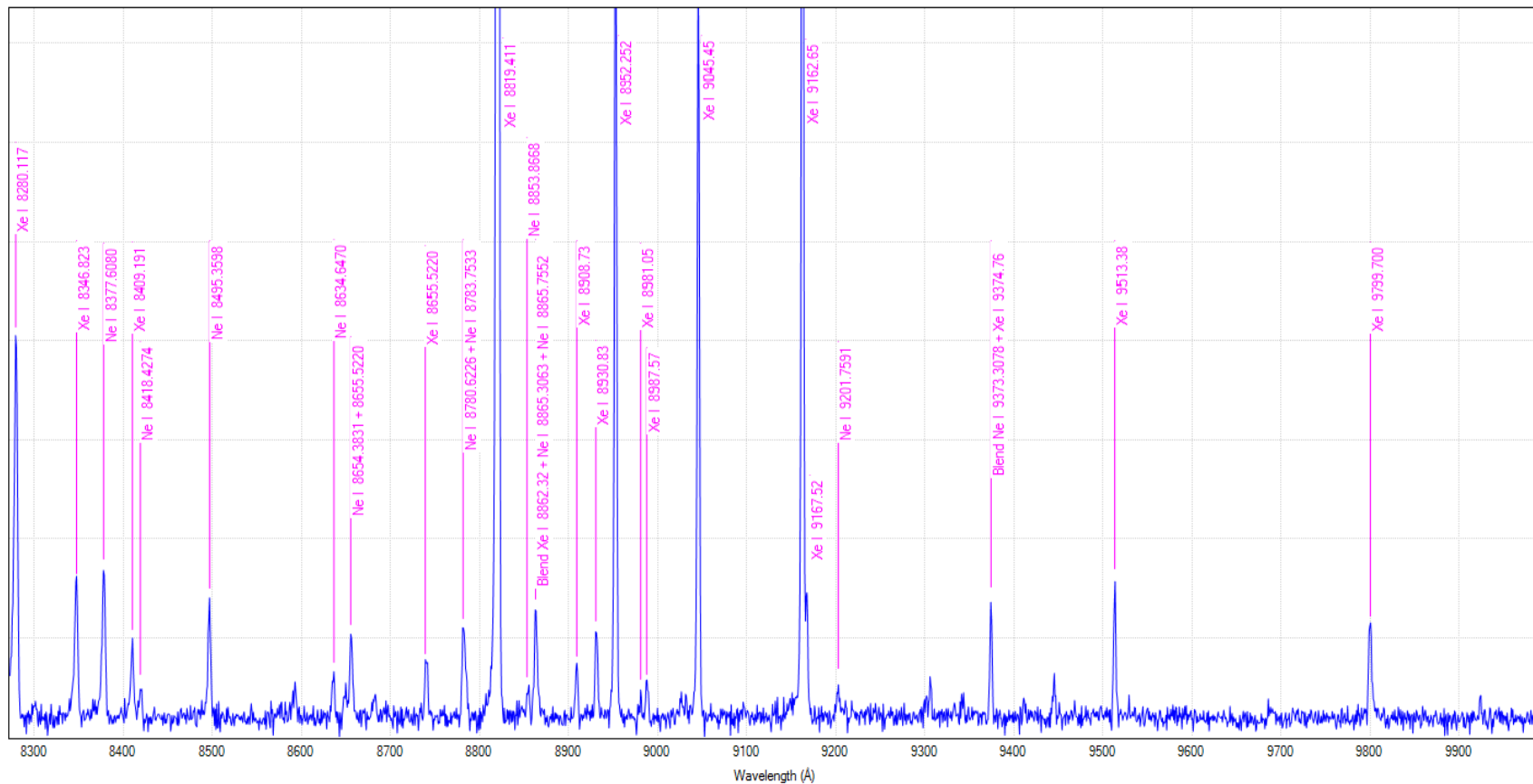


Lamp ST-10

Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

Philips S10 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 7 juli 2014

Dispersie 0.78673115 Angstrom / pixel

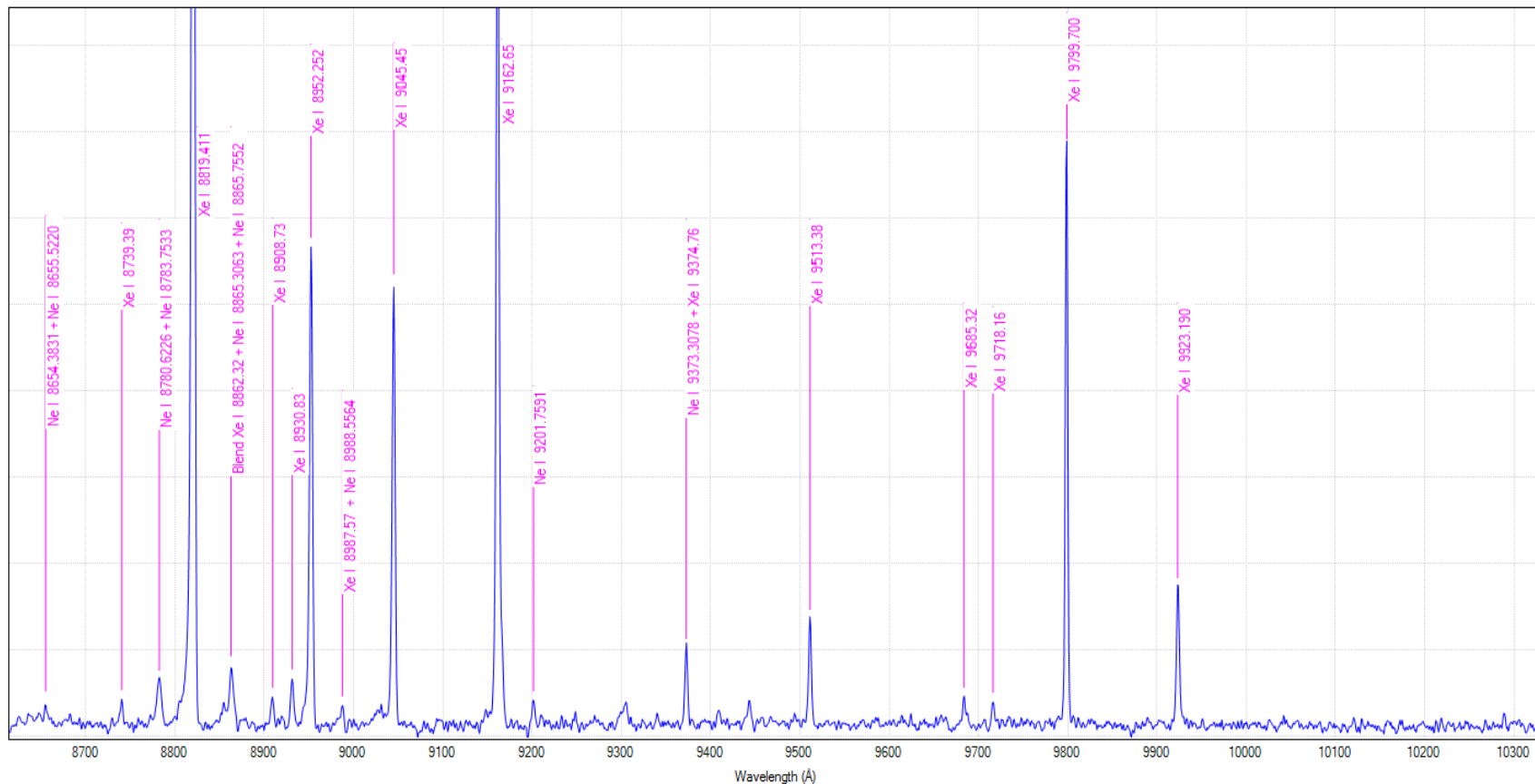


Lamp ST-10, SBIG

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

Philips S10 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 7 juli 2014

Dispersie 0.78599833 Angstrom / pixel



Philips S10 TL lamp starter

Zelfbouw spectroscop bijeenkomst Tivoli Oudenburg



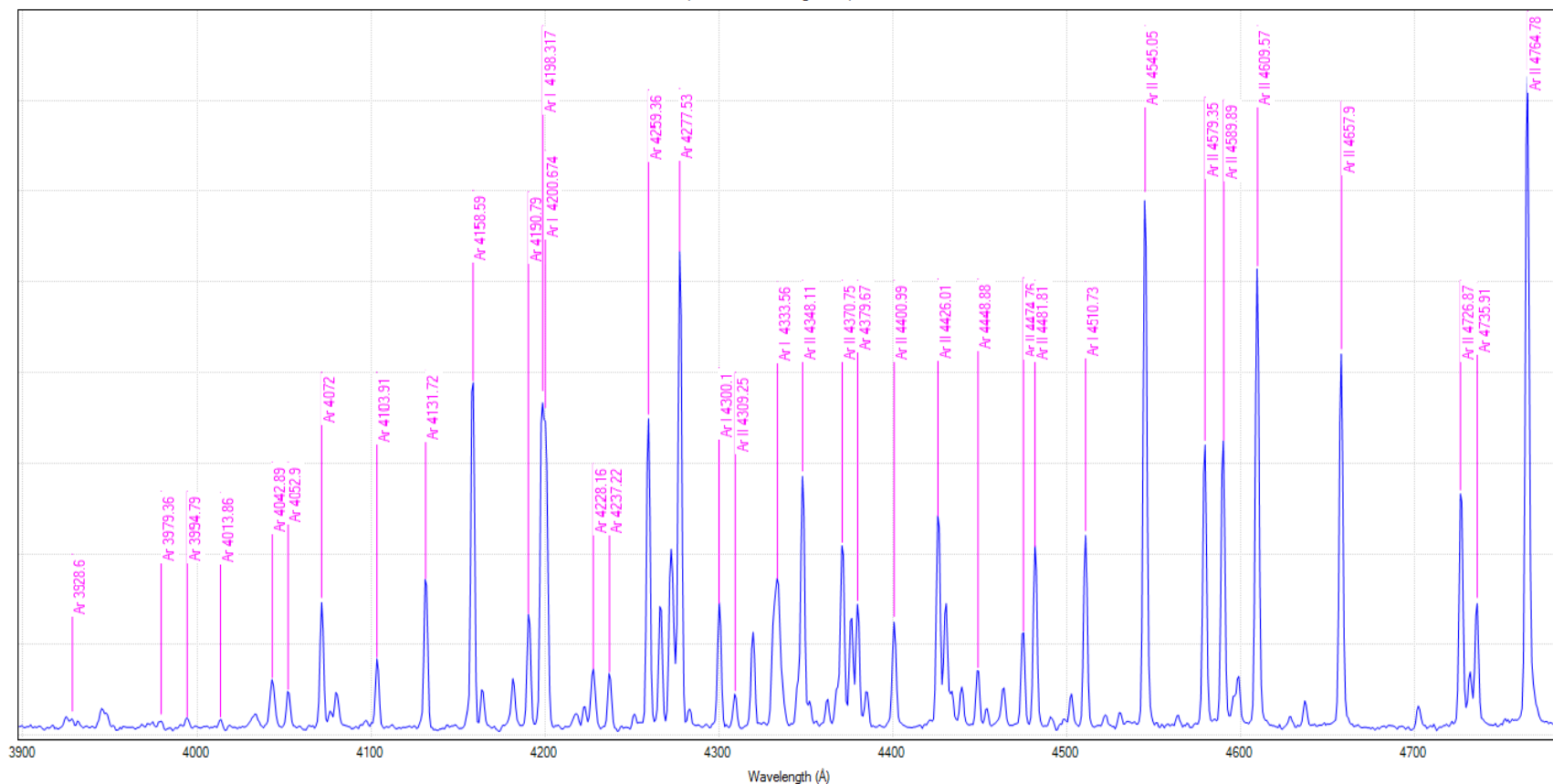
**Spectrum van Osram St 111 TL lamp starter
Met Argon en Krypton gas**

**Spectrum opgenomen met SBIG SGS spectroscop, 600 L/mm SBIG
ST-10 camera, Celestron C8 telescoop en focal reducer f/6.3**

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

Osram St111 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 28 juni 2014

Dispersie 0.80993052 Angstrom / pixel

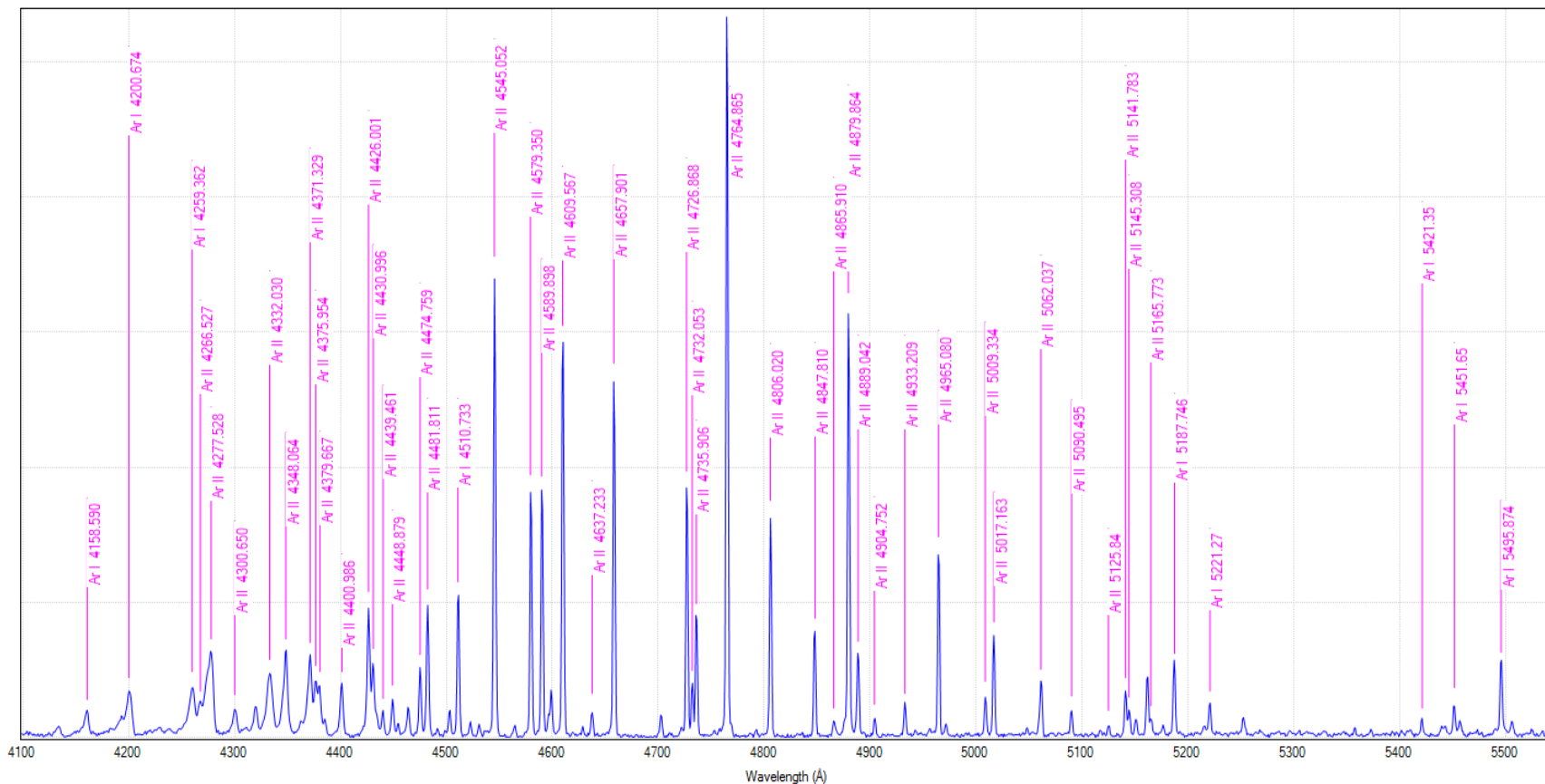


Zelfbouw Spectroscopie

Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

Osram St111 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 28 juni 2014

Dispersie = 0,8079709 Angstrom per pixel

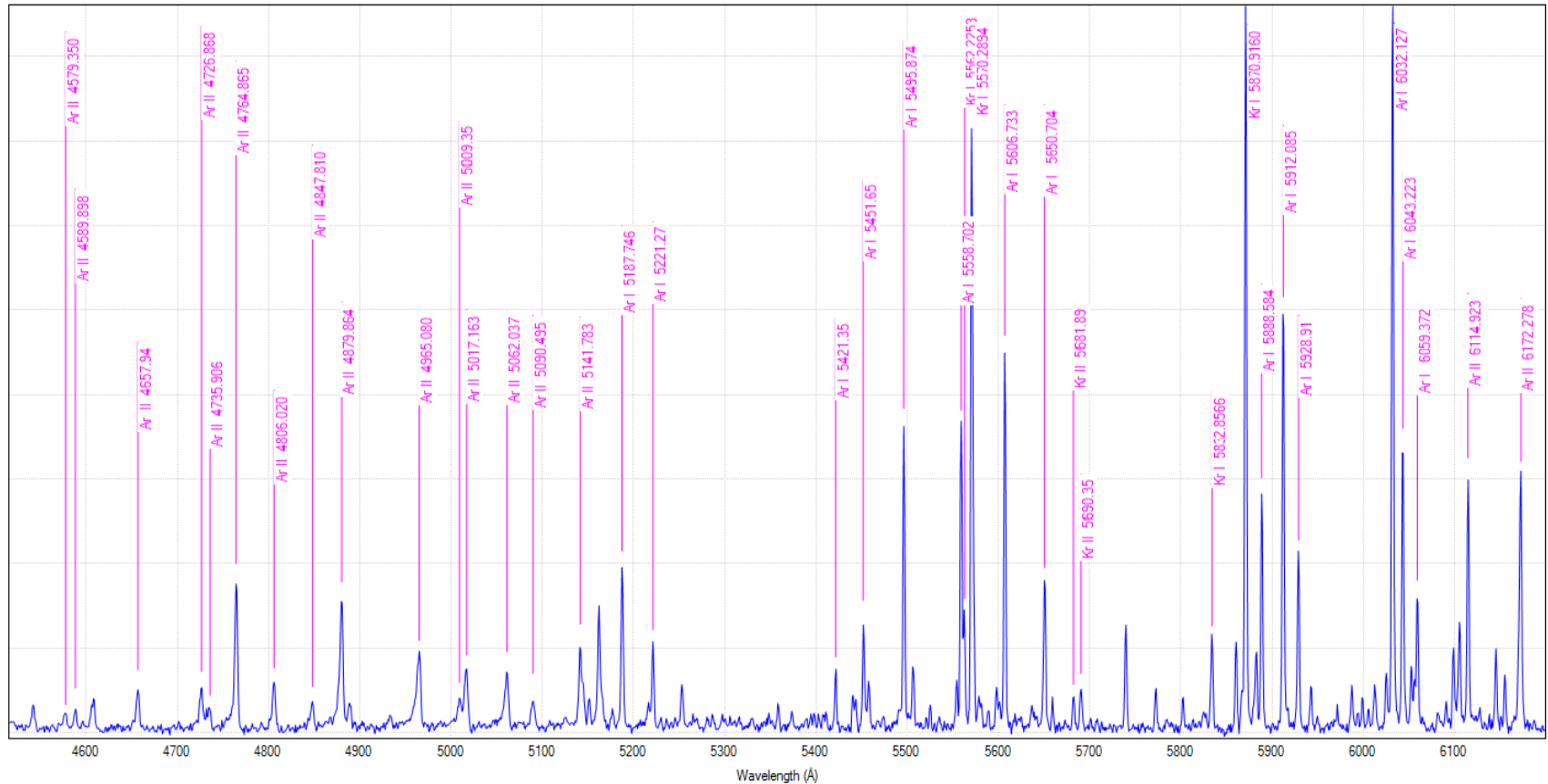


2 Aug 11 10:46:55 AM

Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

Osram St111 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 28 juni 2014

Dispersie = 0,80810804 Angstrom / pixel

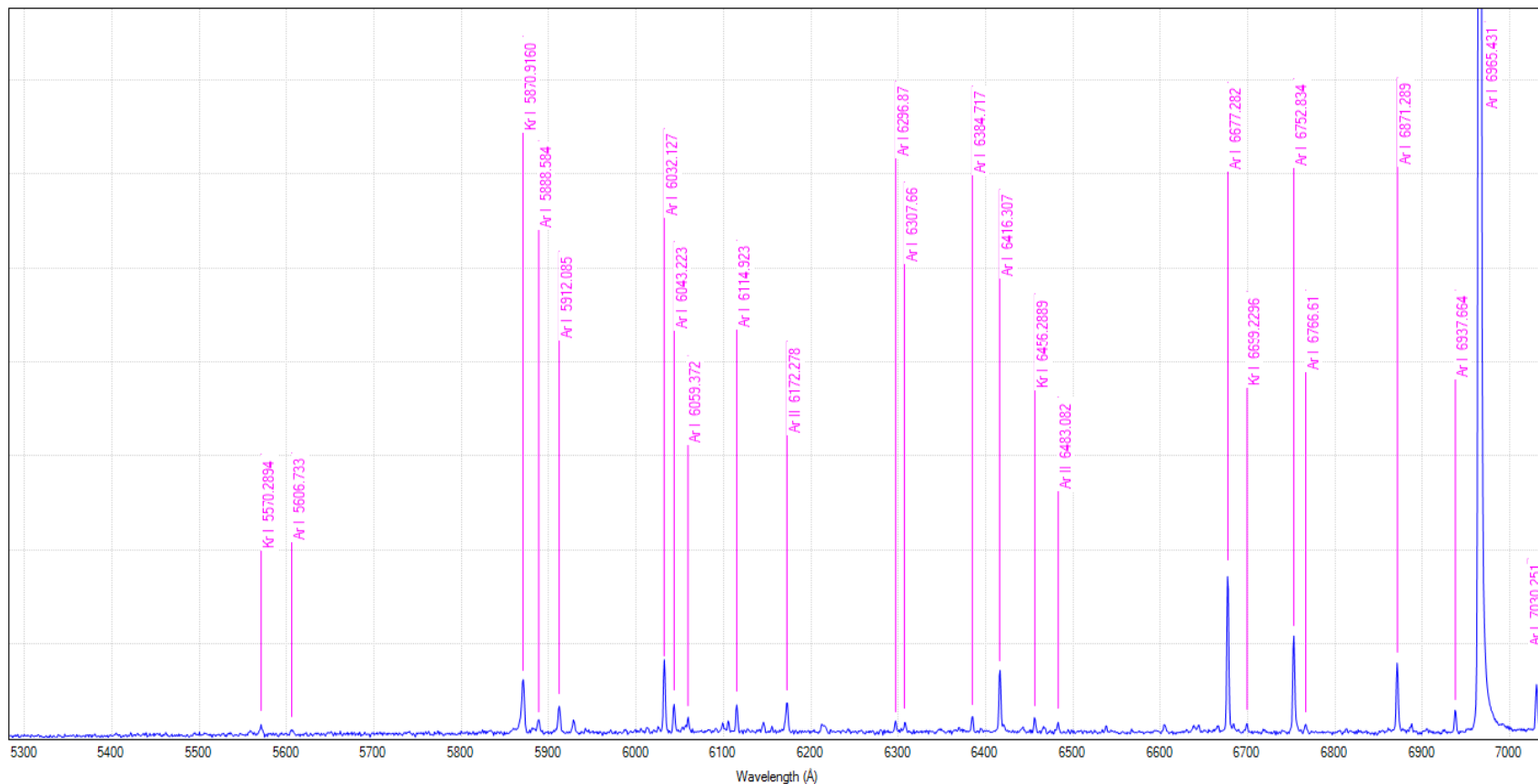


2 149 ST 10digi SSVE

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

Osram St111 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 28 juni 2014

Dispersie = 0.80472236 Angstrom / pixel

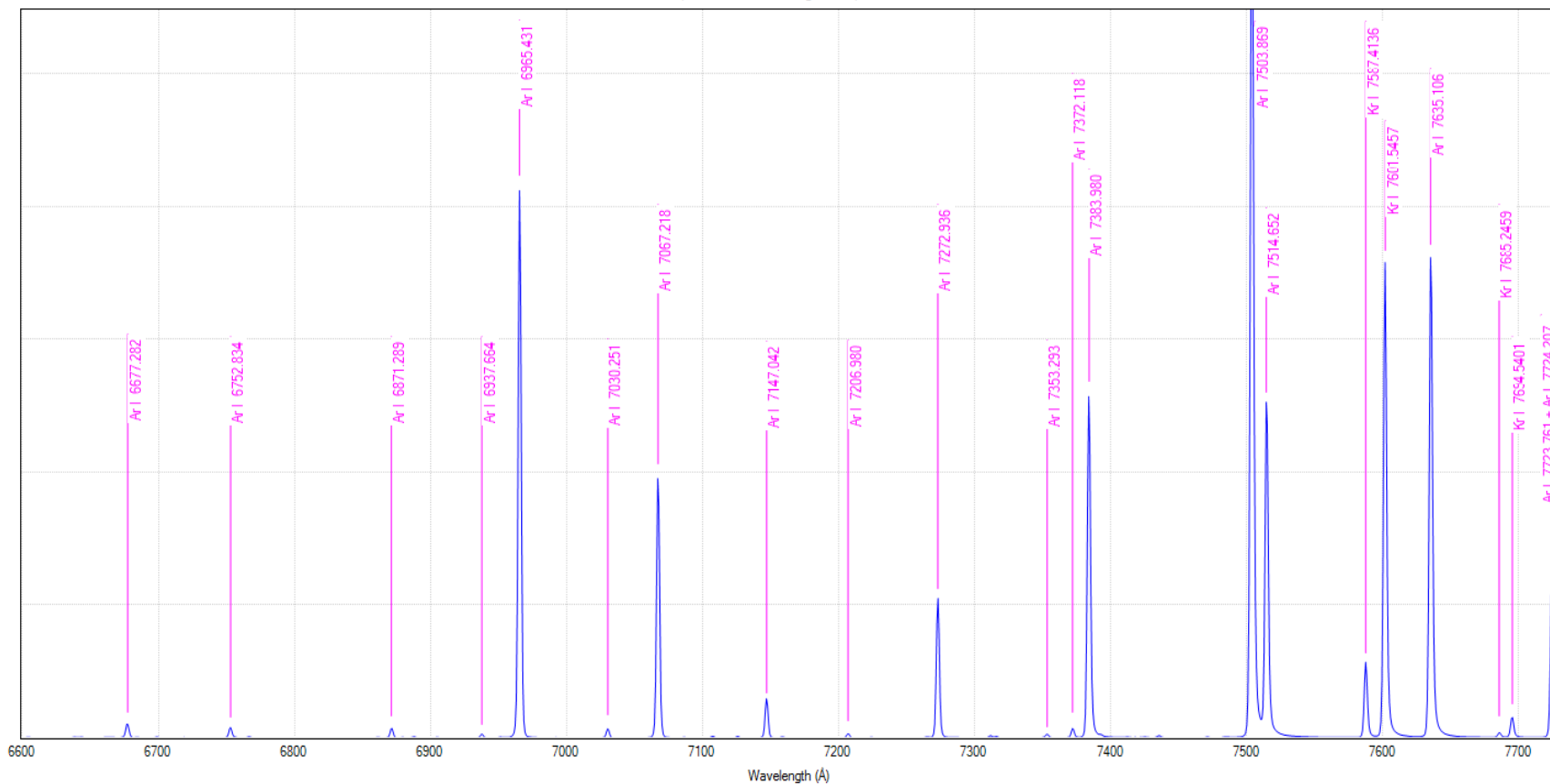


2 Aug 2014 08:55:56

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

Osram St111 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 28 juni 2014

Dispersie = 0.80142481 Angstrom / pixel

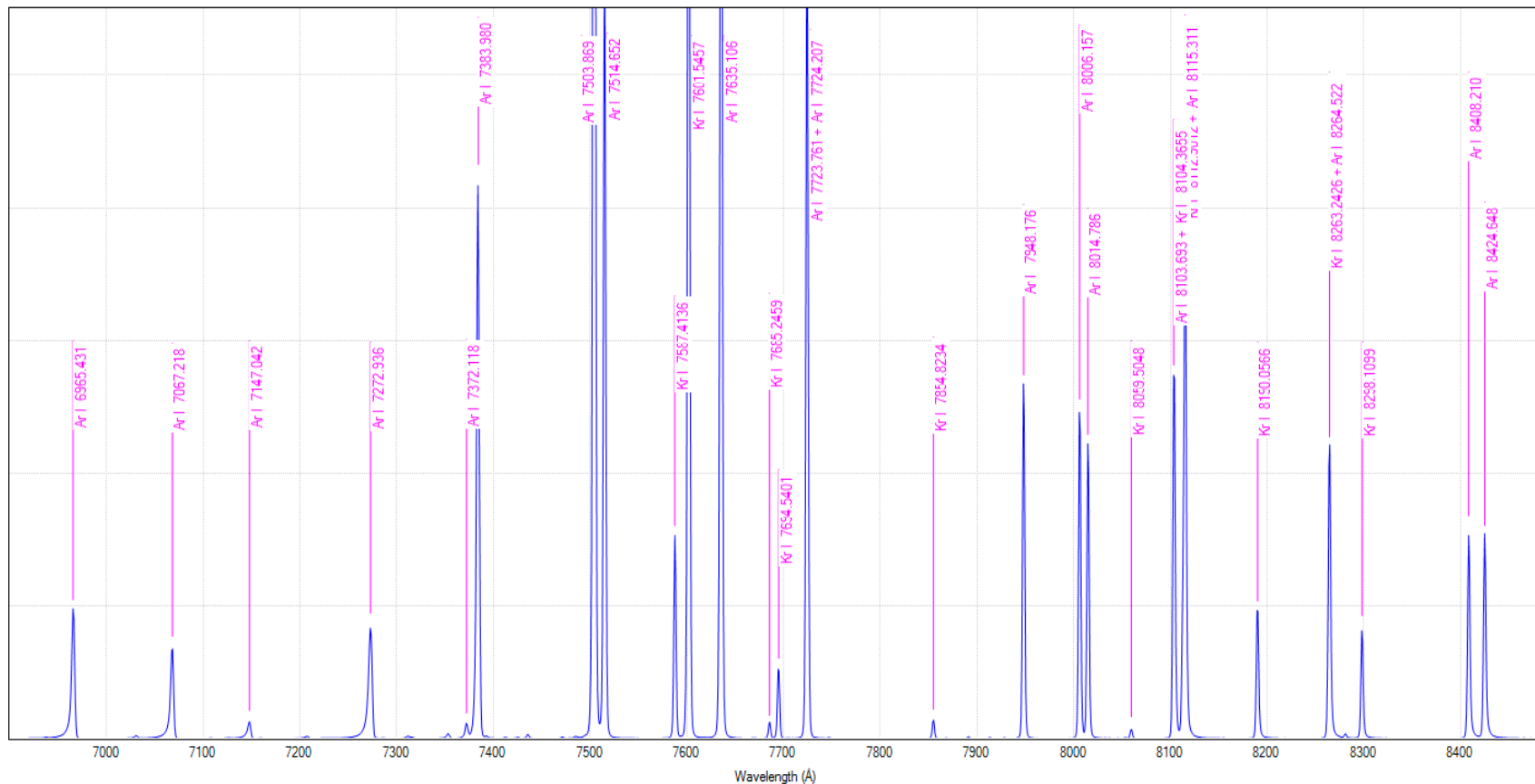


Page 511 Loading ISSVE

Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

Osram St111 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 28 juni 2014

Dispersie = 0,79708308 Angstrom / pixel

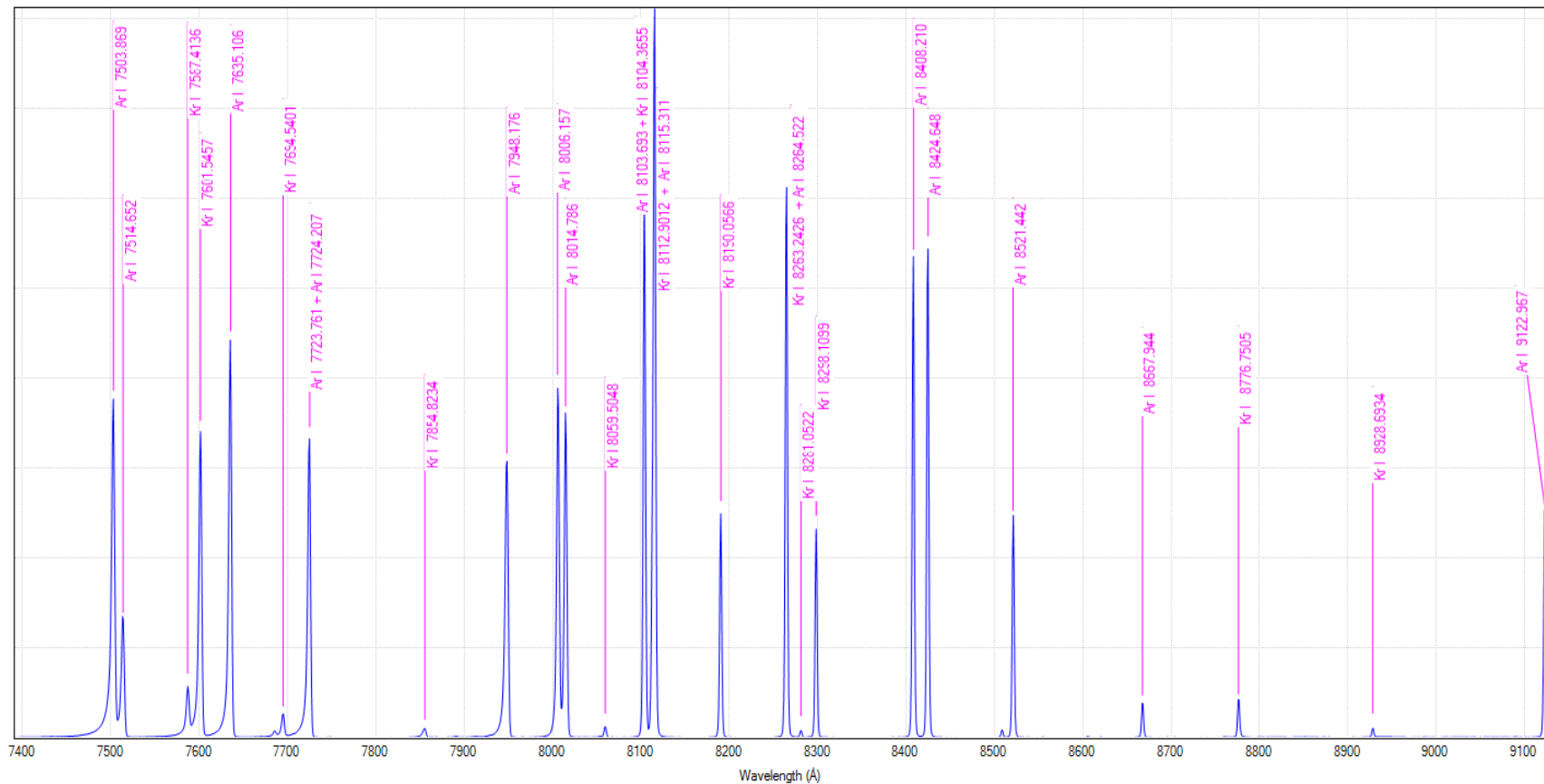


28 Jun 2014 08:55:56

Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

Osram St111 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 28 juni 2014

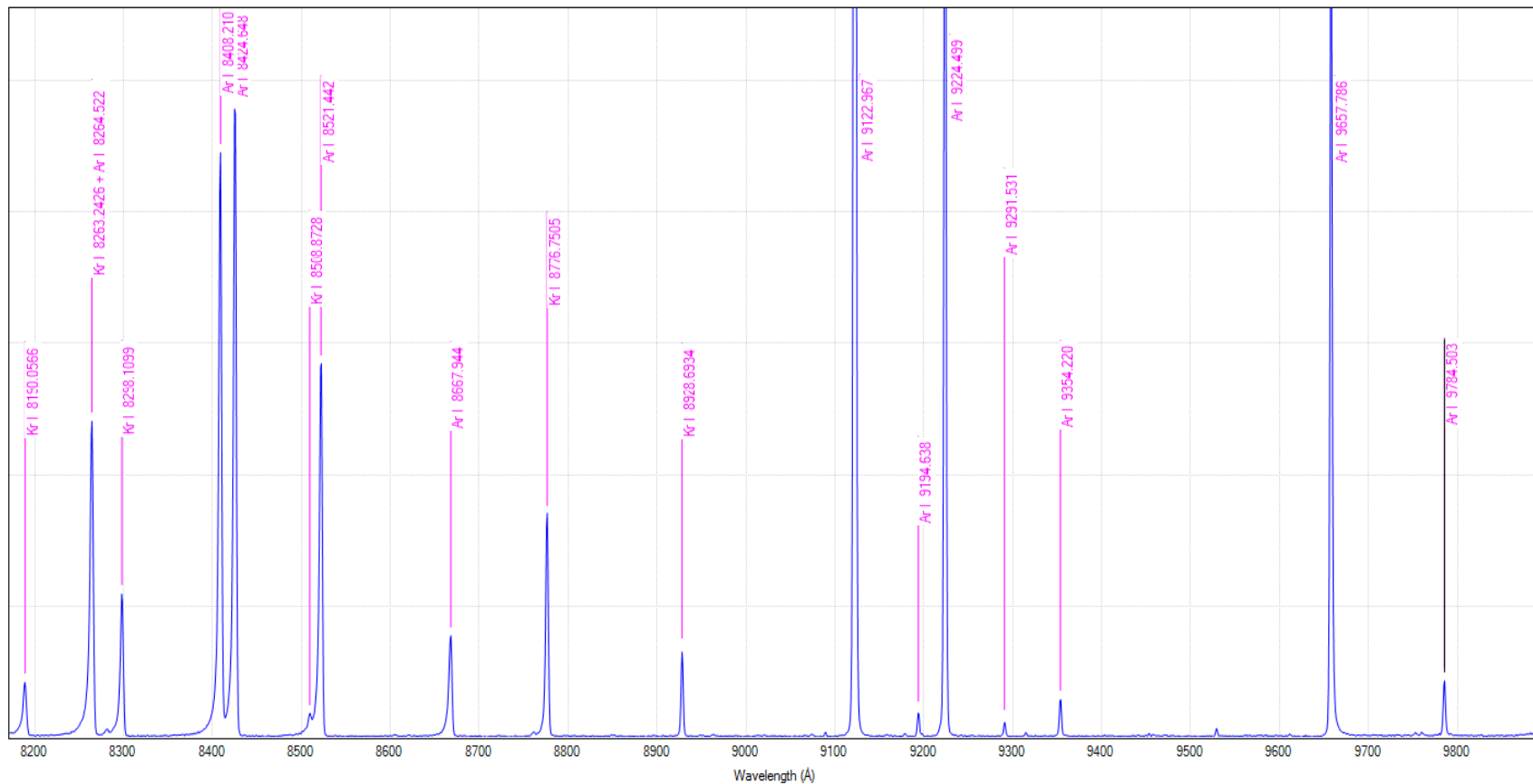
Dispersie = 0,79321632 Angstrom / pixel



Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

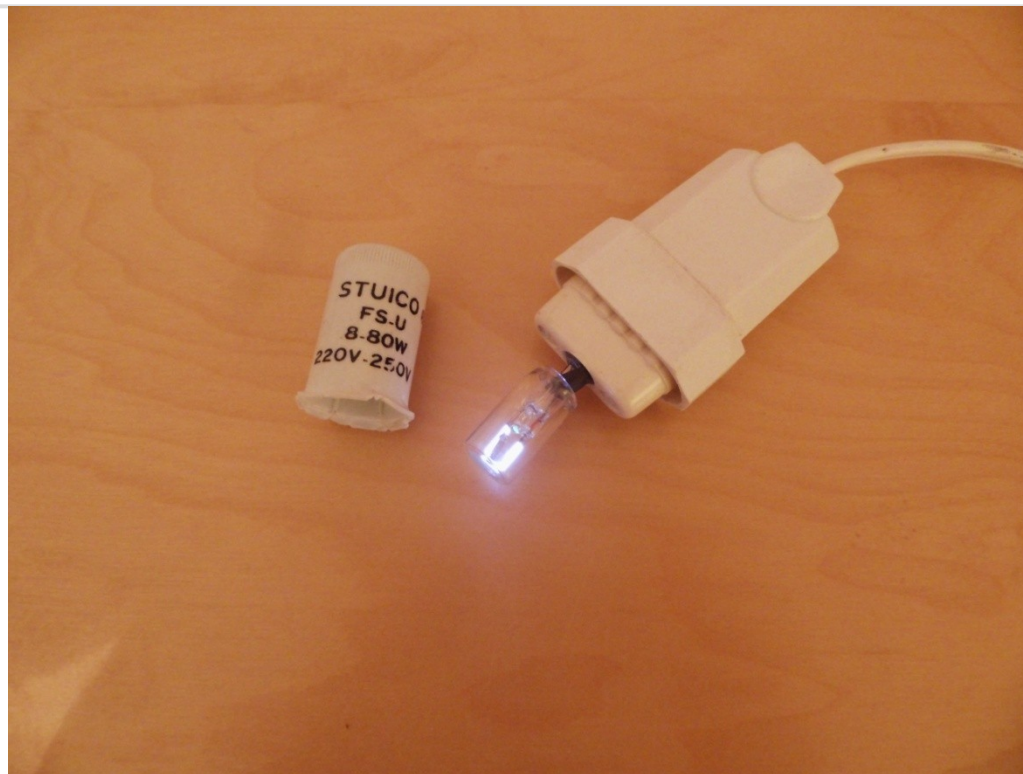
Osram St111 TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 28 juni 2014

Dispersie = 0,78810853 Angstrom / pixel



28 Jun 2014 08:55:56

Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch



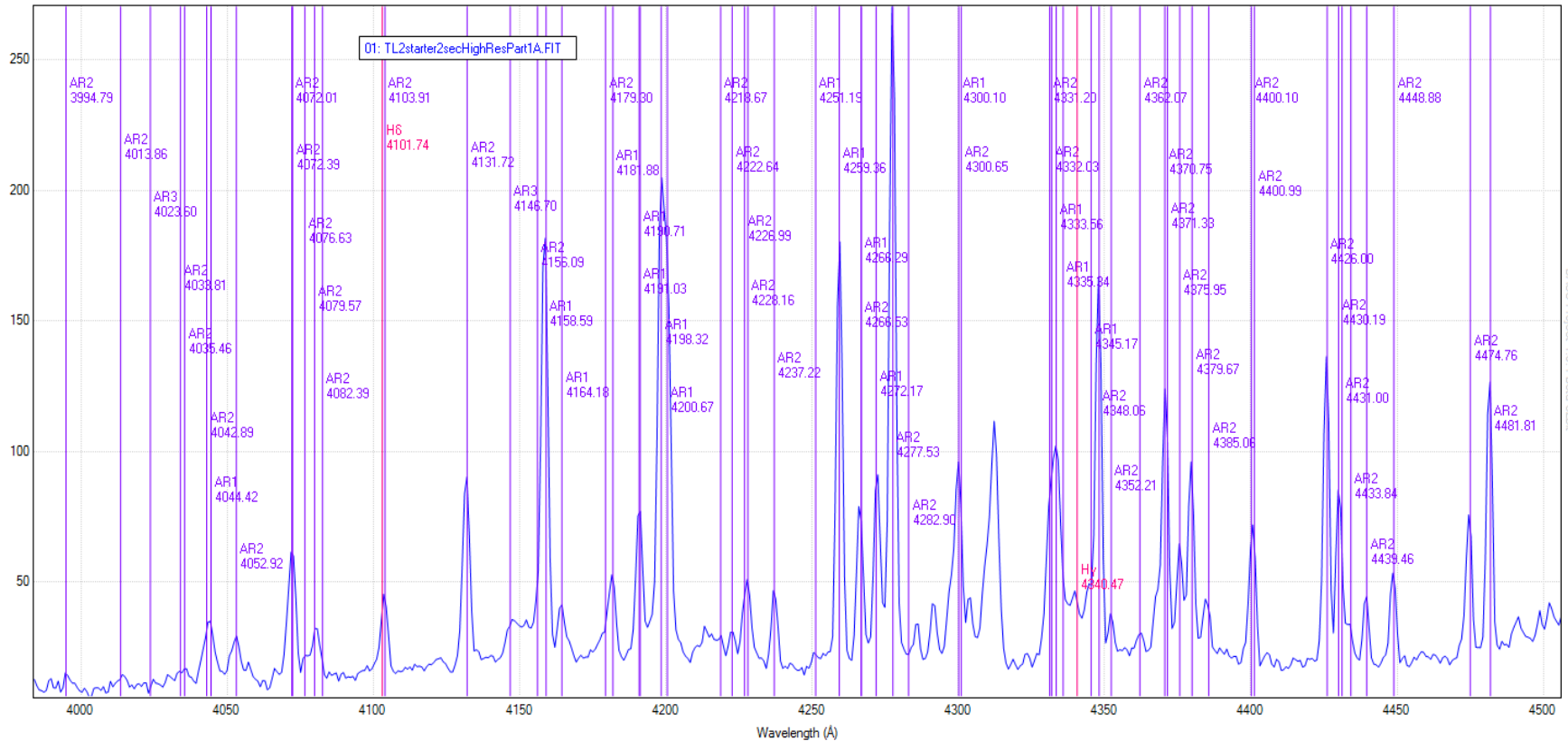
**Spectrum van Stuico (Sutico) FS-U TL lamp starter
Met Argon en Waterstof**

**Spectrum opgenomen met SBIG SGS spectroscop, 600 L/mm SBIG
ST-10 camera, Celestron C8 telescoop en focal reducer f/6.3**

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

STUICO FS-U TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 June 26 2014

Dispersion = 0.81183159 Å/px

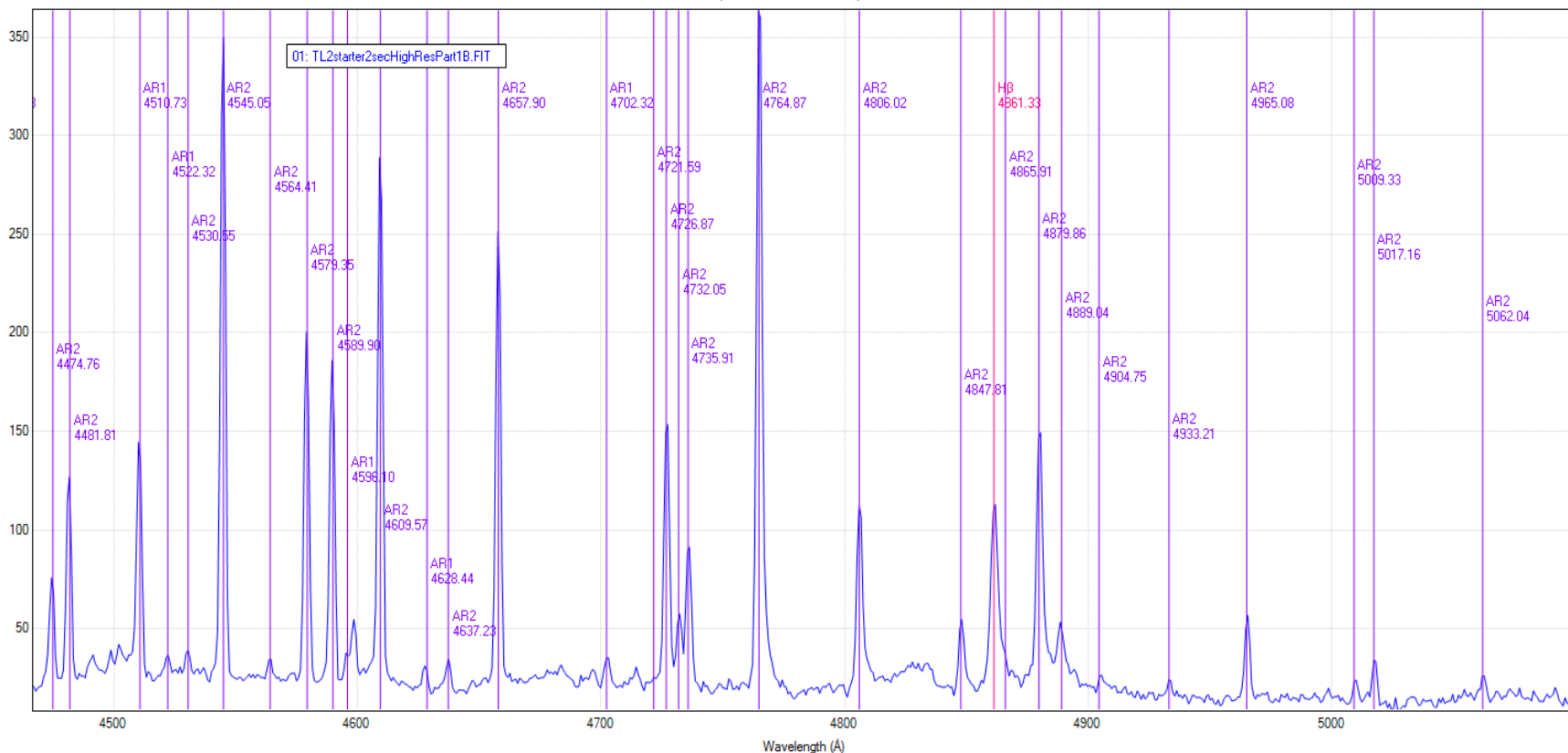


BASS Project 1.9 Beta 32M

Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

STUICO FS-U TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 June 26 2014

Dispersion = 0.81183159 Å / px

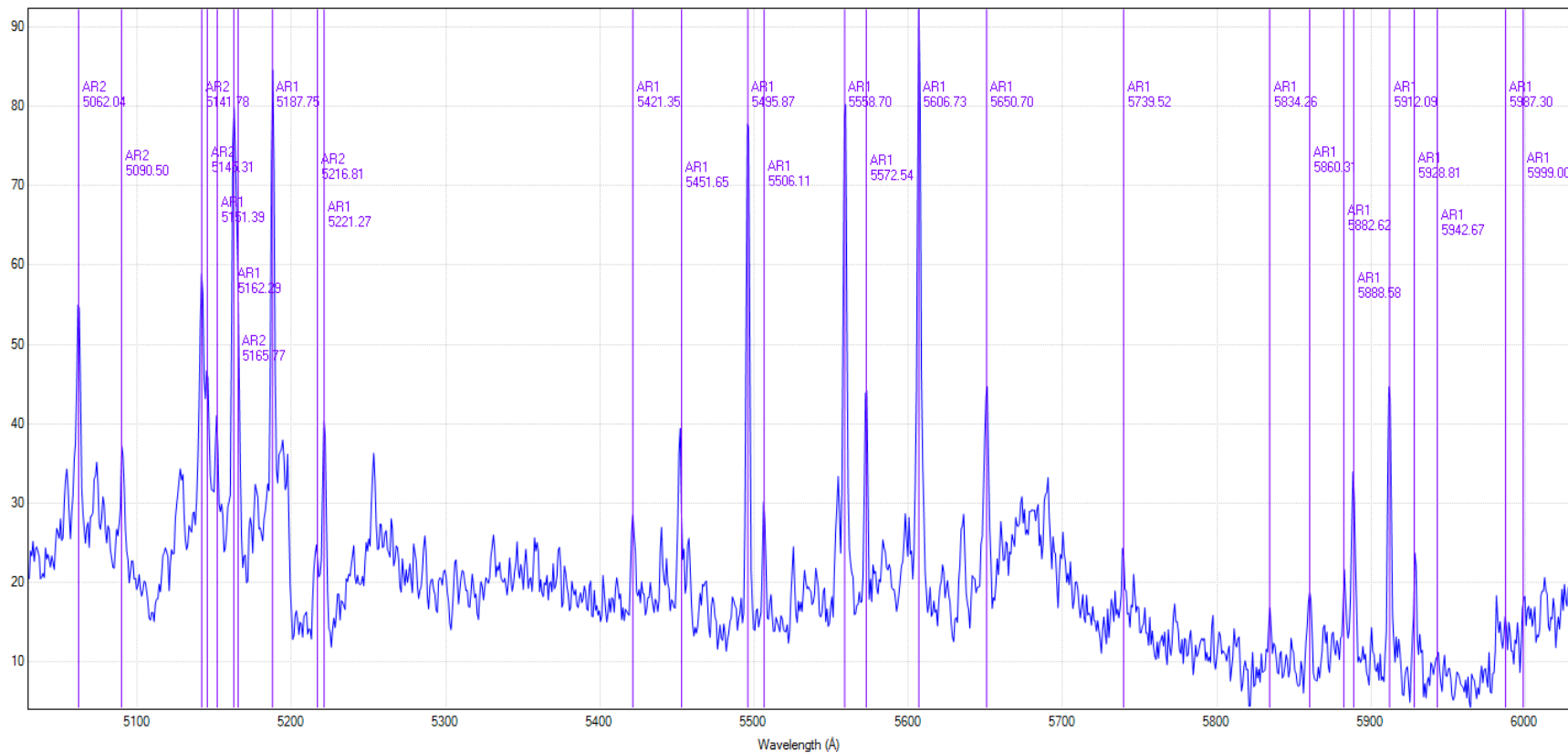


BASS Project 1.9.4 Beta 324

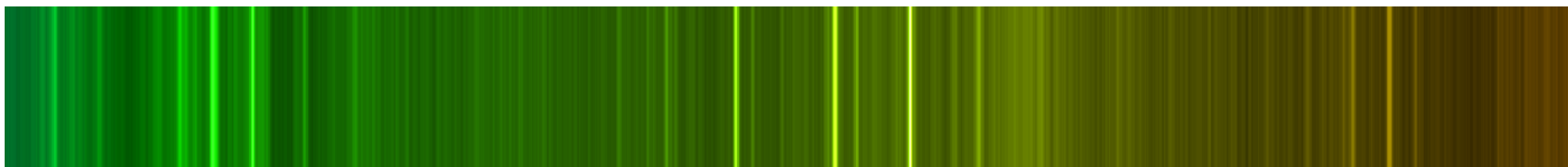
Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

STUICO FS-U TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 June 26 2014

Dispersion = 80878494 Å / px



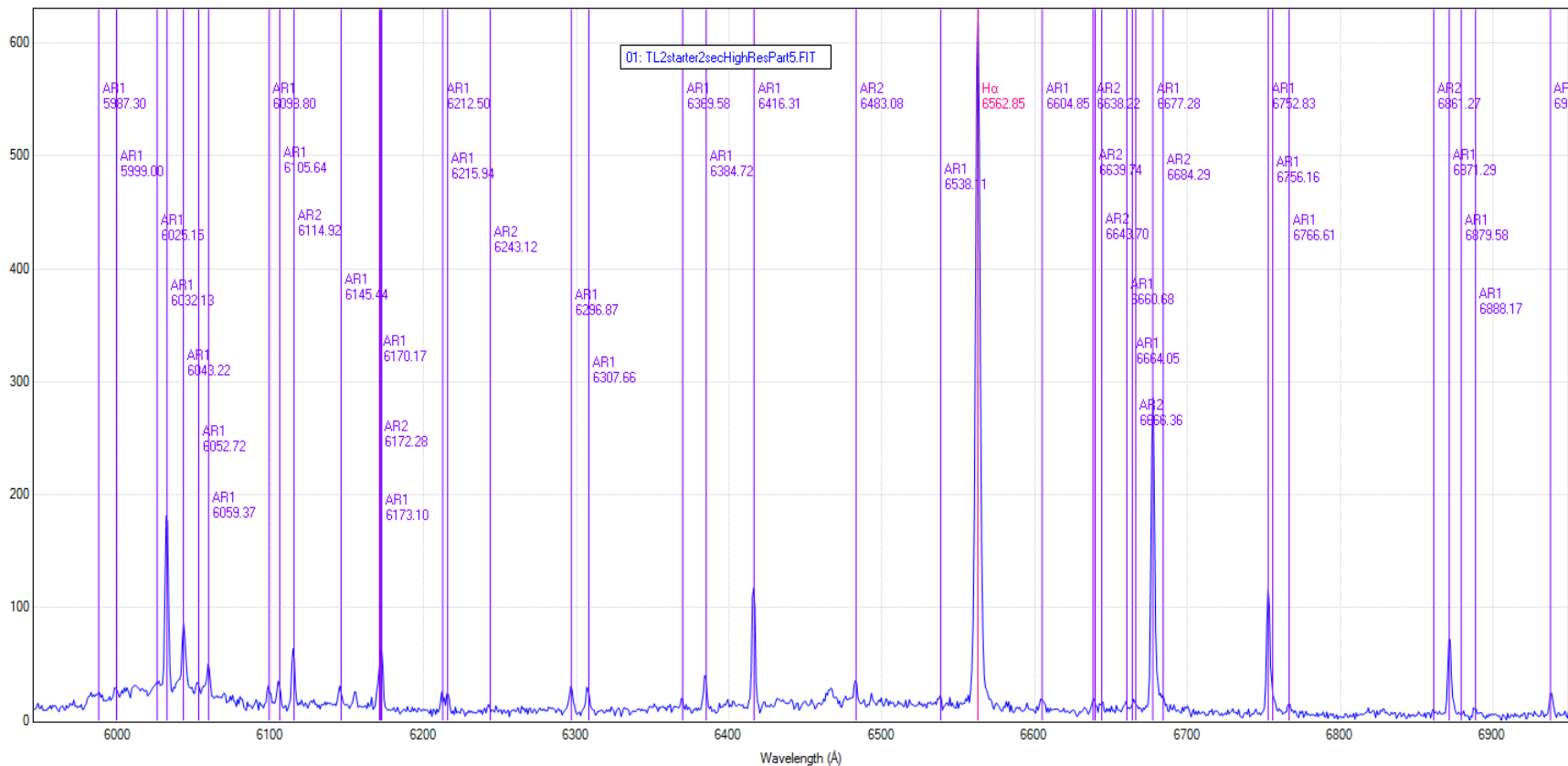
BASS Project 1.9.4 Beta 32M



Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

STUICO FS-U TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 June 26 2014

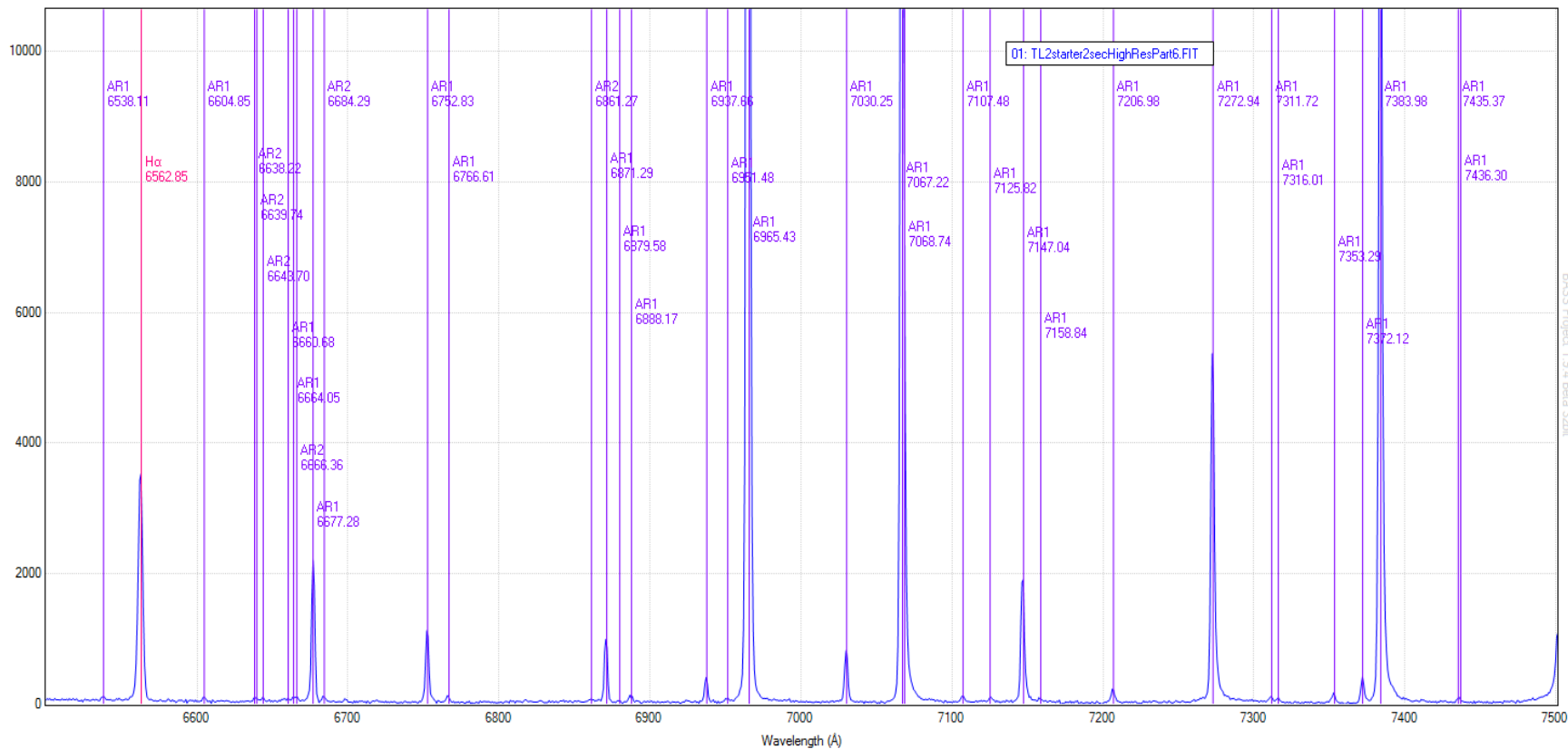
Dispersion = 0.80525179 Å / px



Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

STUICO FS-U TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 June 26 2014

Dispersion = 0.80268171 Å/px

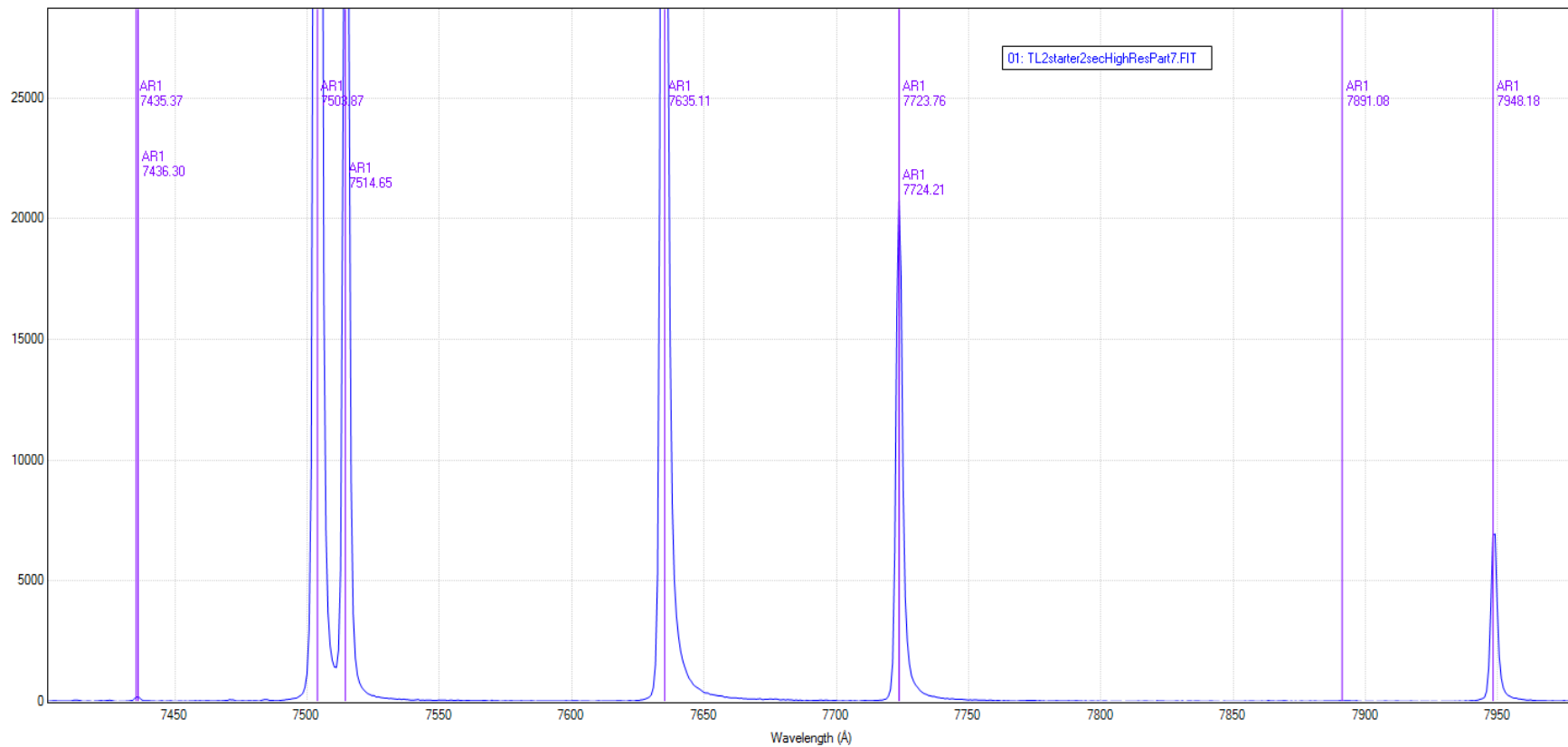


BASS Project 1.6.4 Beta 32b

Zelfbouw spectroscop bijeenkomst Tivoli Oudenbosch

STUICO FS-U TL lamp starter SBIG SGS 600 L/mm + Camera ST-10 in CCDOPS Celestron C8 + Focal Reducer f/6.3 June 26 2014

Dispersion = 0.79320316 Å / px



BASS Project 1.9.4 Beta 32M



Zelfbouw spectroscopie bijeenkomst Tivoli Oudenbosch

Meer Info over het veilig toepassen van “starterlampjes”.

<http://www.ursusmajor.ch/downloads/inverter-12v-dc-230v-ac-2.0.pdf>

<http://www.ursusmajor.ch/downloads/kalibration-mit-glimmstartern-v1.1.pdf>

<http://www.ursusmajor.ch/downloads/sques-relco-sc480-eichlinien-3.0.pdf>

Einde



**UGent Volkssterrenwacht
Armand Pien**

Spectroscopie in de sterrenkunde
Zelfbouw Spectroscoop bijeenkomst Tivoli Oudenbosch
5 november 2016

