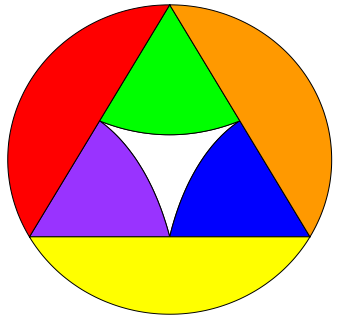
Spectroscopie in de Sterrenkunde

Een poging tot het bouwen van een spectroscoop

HUGOS

Hoge-resolutie **U**niversele **G**lasvezel-**O**ptische **S**pectroscoop

UGent Volkssterrenwacht
Armand Pien

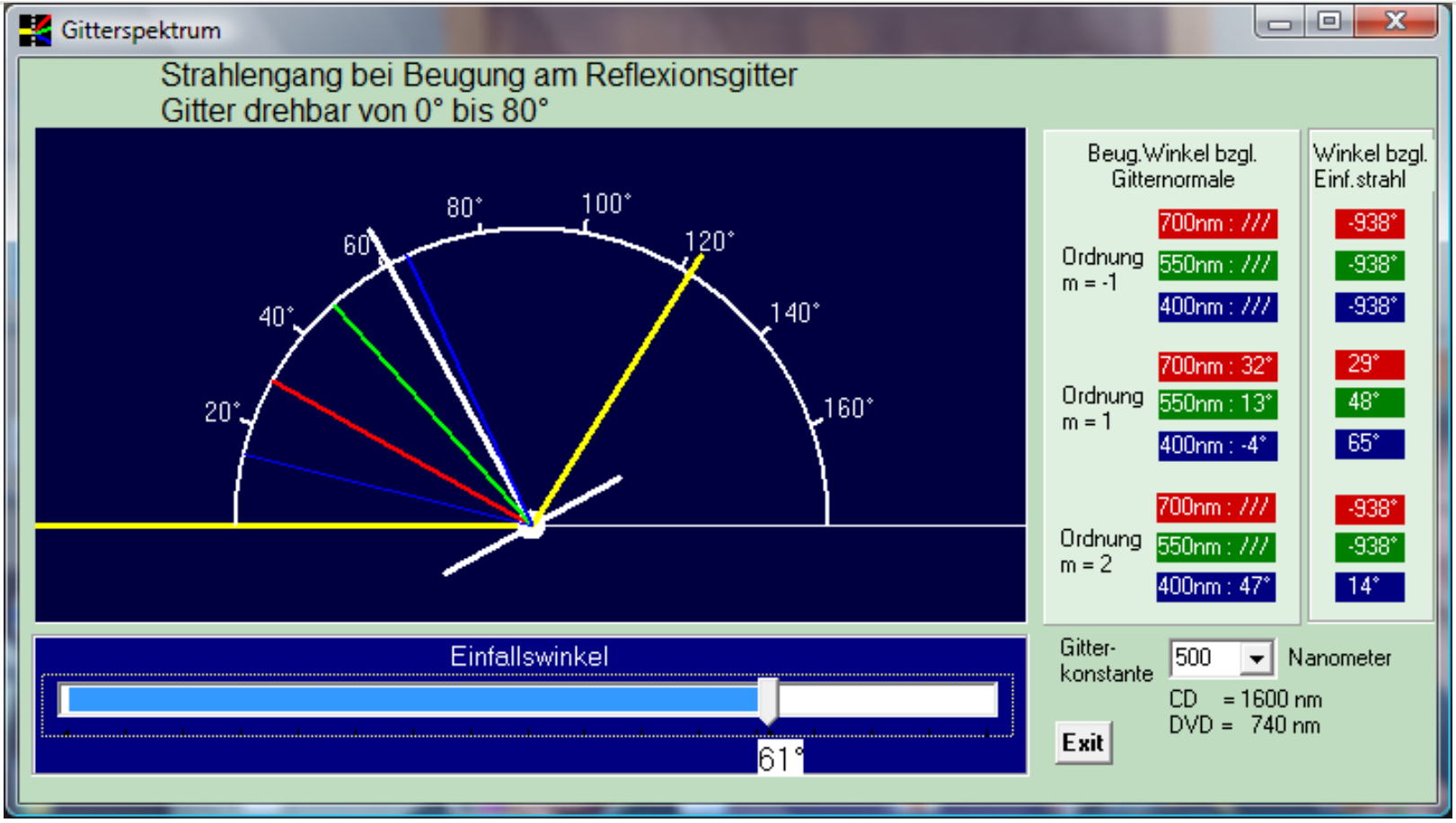


Hugo Van den Broeck

26 november 2016

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



ReflexionsSpektrum van Dr. Bernd Loibl

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

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

- Multi Mode Fiber. Diameter glasvezel = 50µm

- 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 spectroscoop 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 (ε) :	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/Δλ)	**563**	

Other Results

Angle of incidence (α) :	62.96	°
Angle of diffraction (β) :	24.96	°
Anamorphic factor (r) :	0.50	
diffraction limit grating, FWHMd :	2.07	microns
Slit/ image width on CCD, FWHMt :	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-FWHMo :	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-FWHMc :	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 (ρ) :	**0.12**	Å/ pixel
Resolving power (R) :	**10177**	
Spectral resolution (Δλ) :	**0.64**	Å
Dispersion (r) :	28.33	Å/ mm

Wavelength Range

Reference wavelength (λ0) :	**6563**	Å
Lambda min. (λ1) :	6462	Å
Lambda max. (λ2) :	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(Tf):	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: thoughput does not take into account undersized

Camera

Camera (Select from list)	**Atik420**	
pixel sizel (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 (fλ) :	**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/Δλ) :	**563**

Limiting Mag

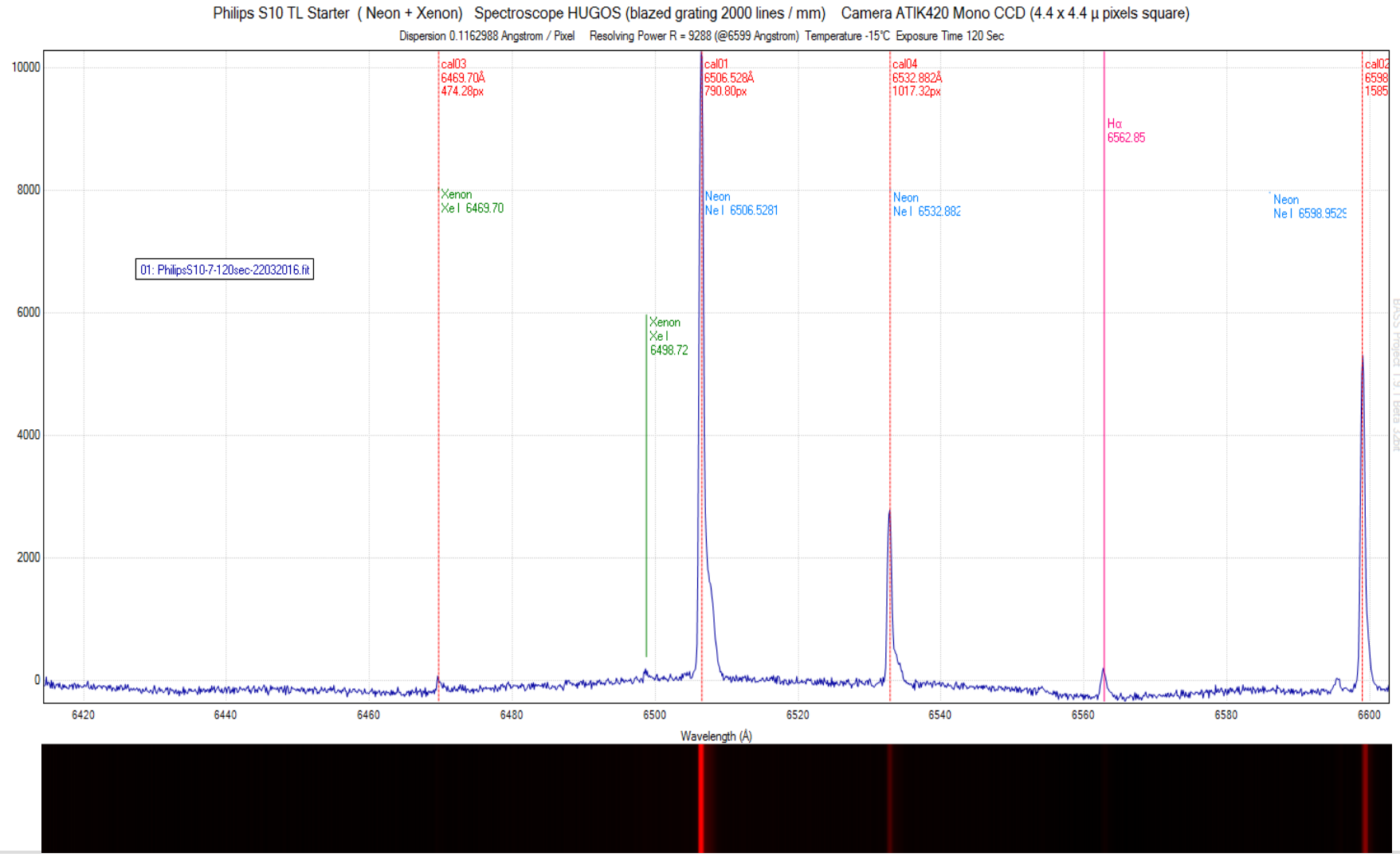
Limiting Mag.(Bowen-mod):	12.36

SNR Calculations

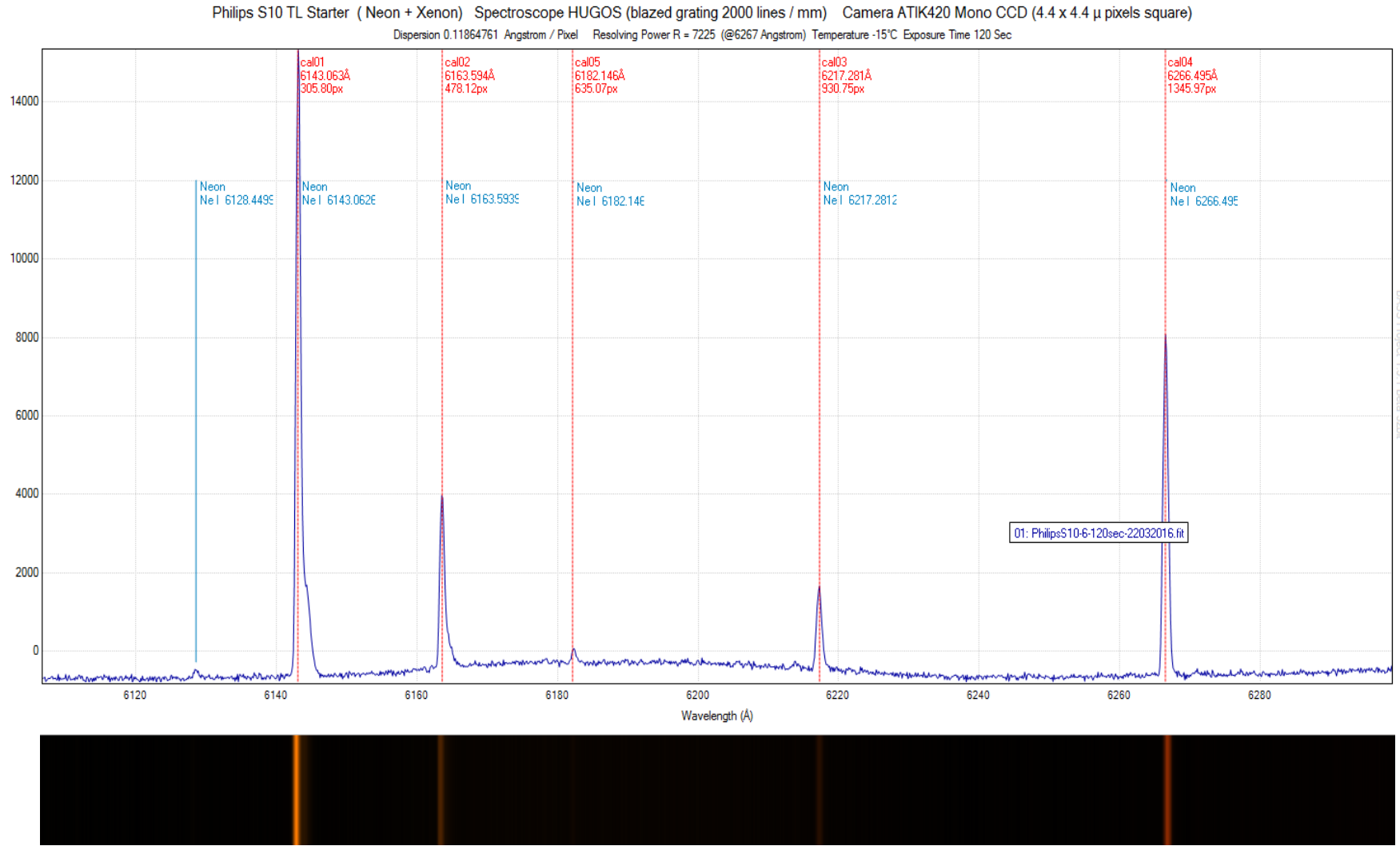
Number of photons (E) :	20.82	photons/cm2/s/Å
Sky background(Ed) :	0.000131	photons/cm2/s/Å/ arc sec
Final Efficiency (R) :	12.93	%
Useful signal (Nm) :	61698	e-/pixel
Background noise (Ns) :	2736	e-/pixel
Noise(σ) :	249	*e-/pixel*
Signal/Noise by interval Δλ :	563	*e-/pixel*
Noise from Signal :	*254*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

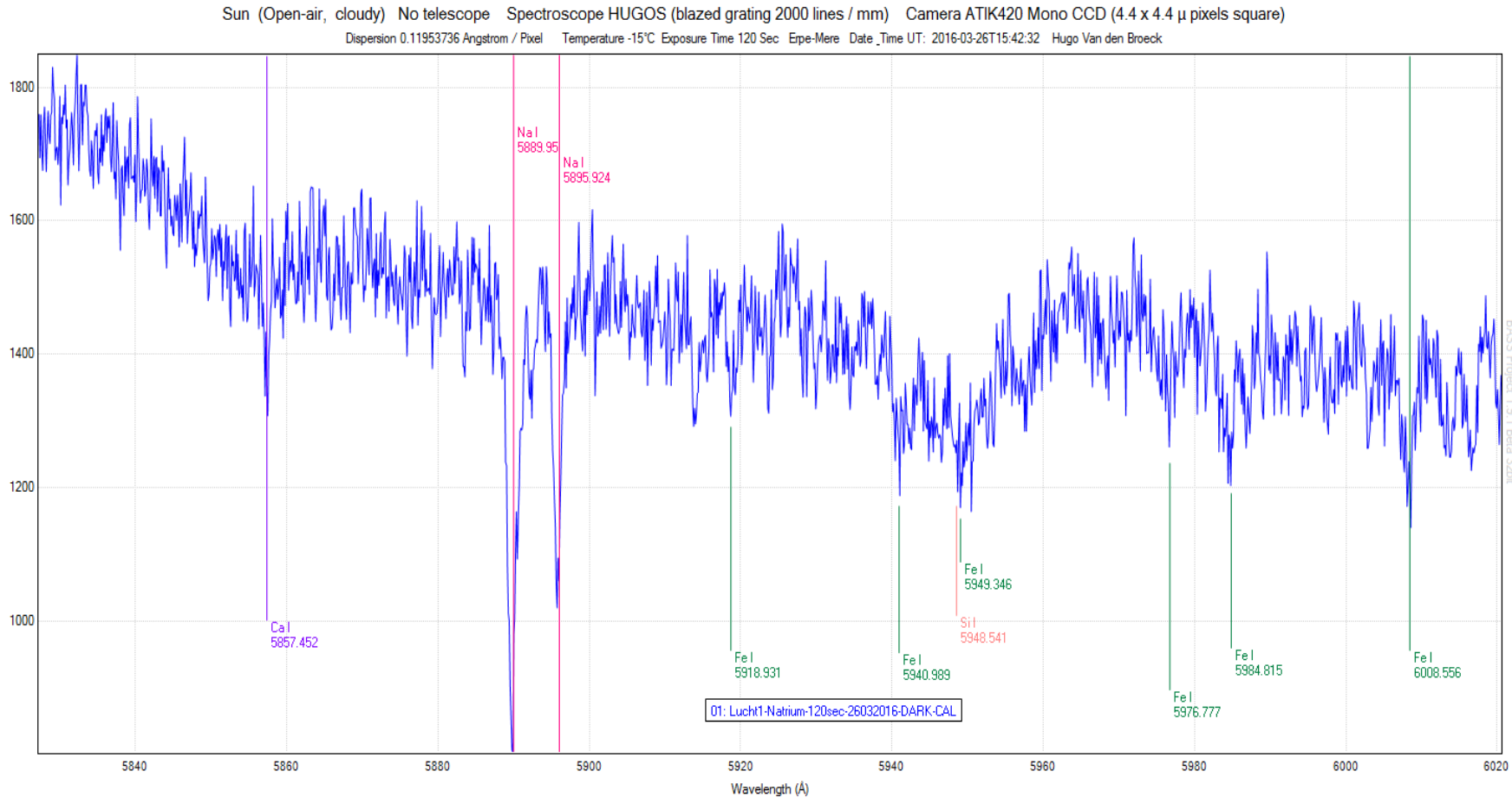
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



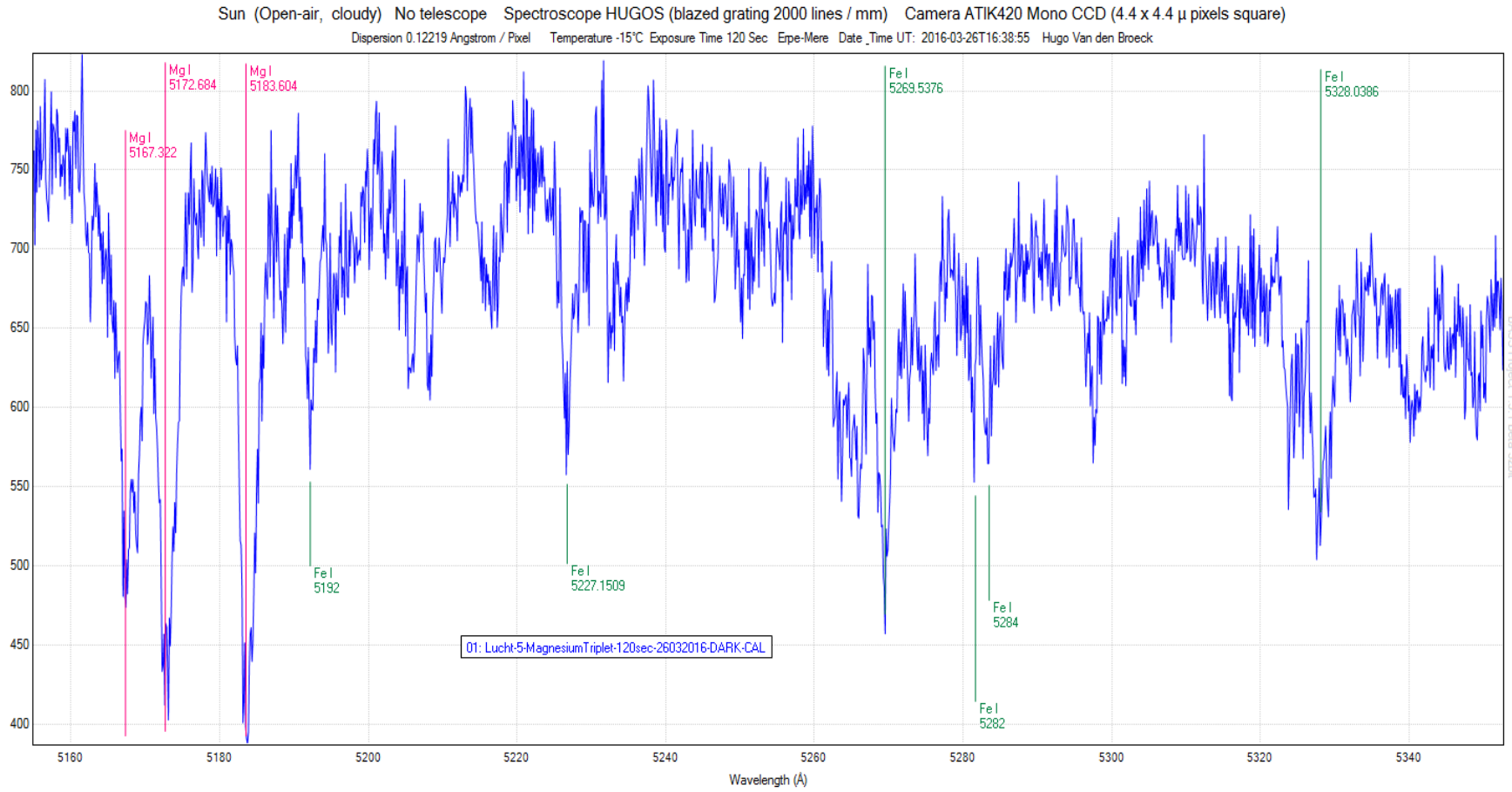
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



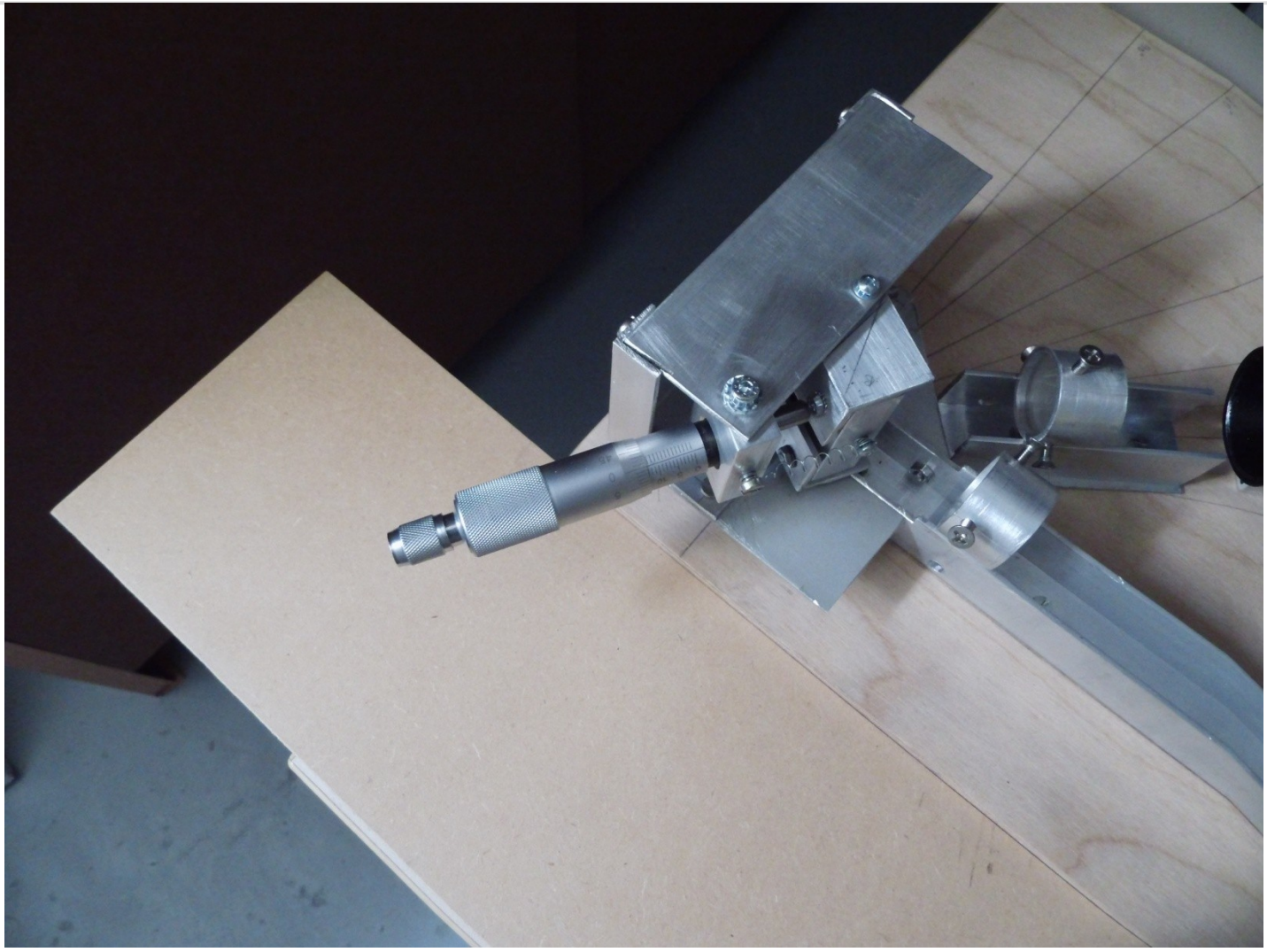
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscoop 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

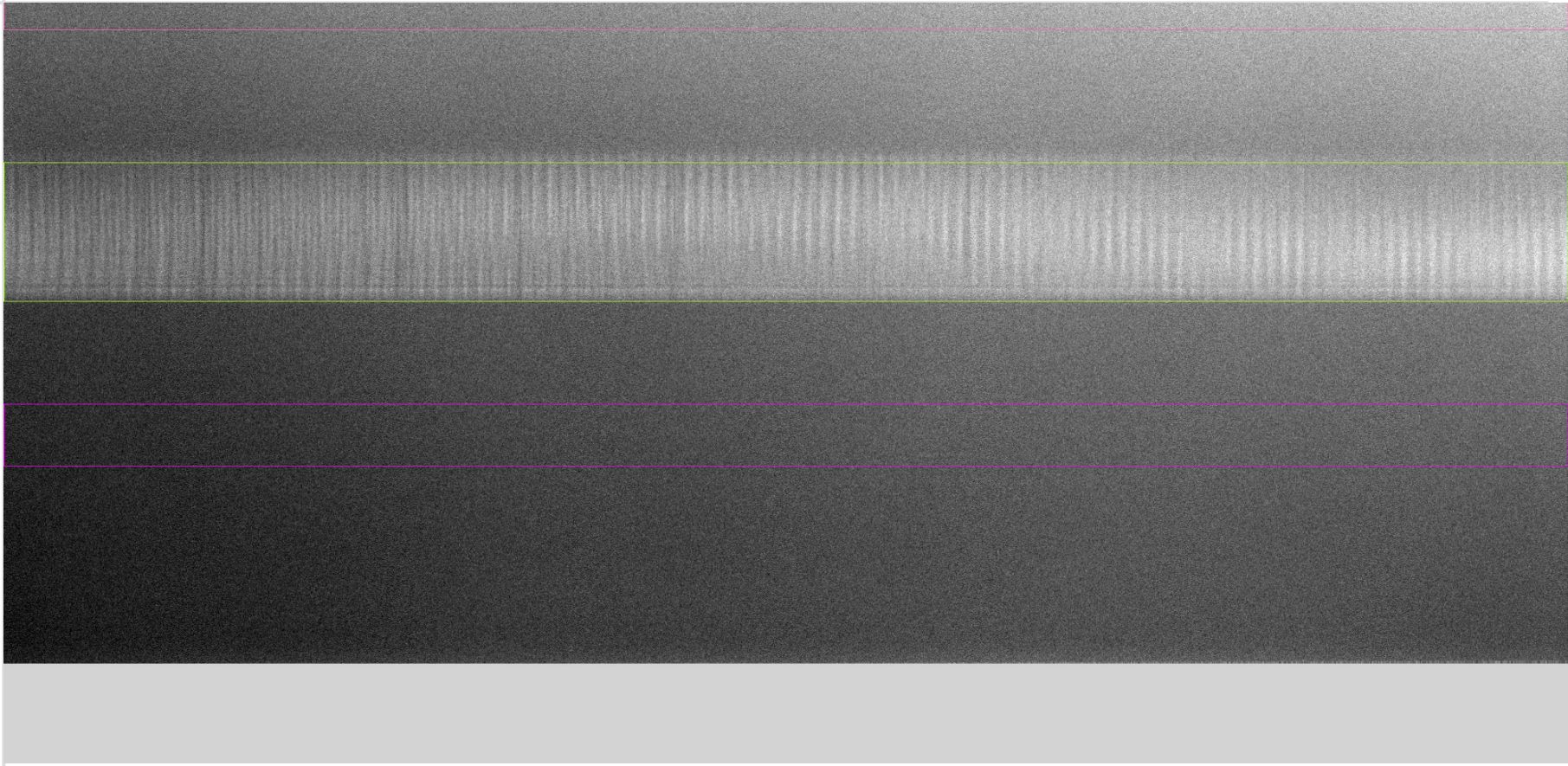
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

Single Mode Fiber. Diameter glasvezel = 8 a 10 µm

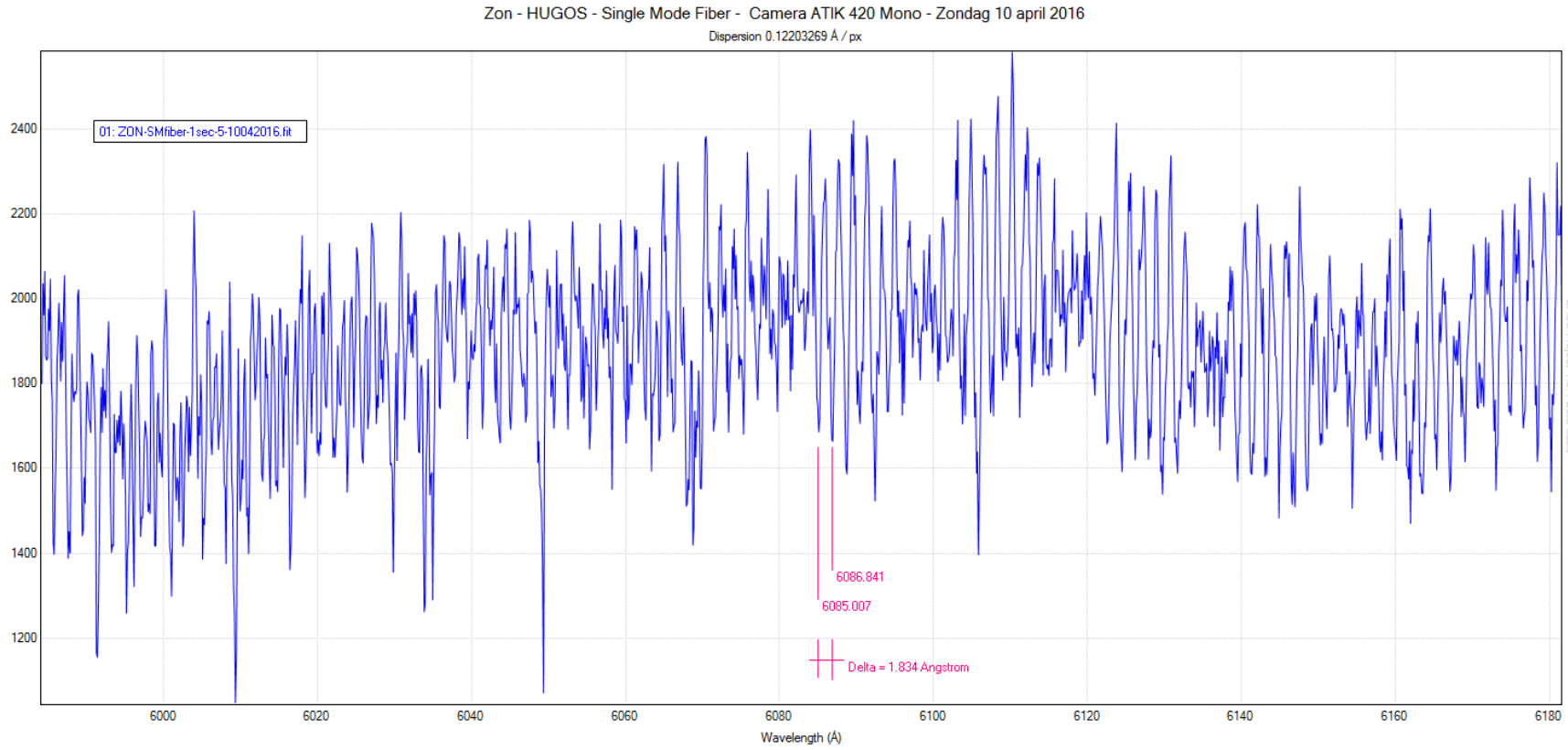
Nuttig oppervlak 25 x minder dan een 50 µm Multimode fiber!

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

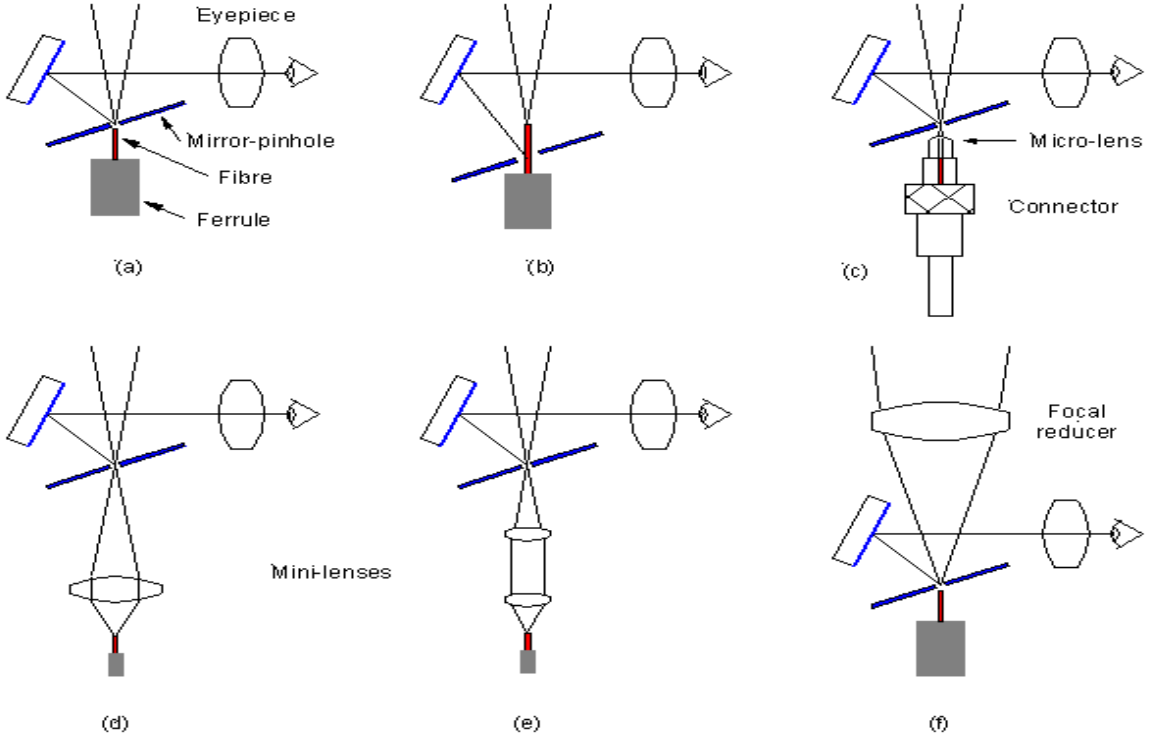


Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

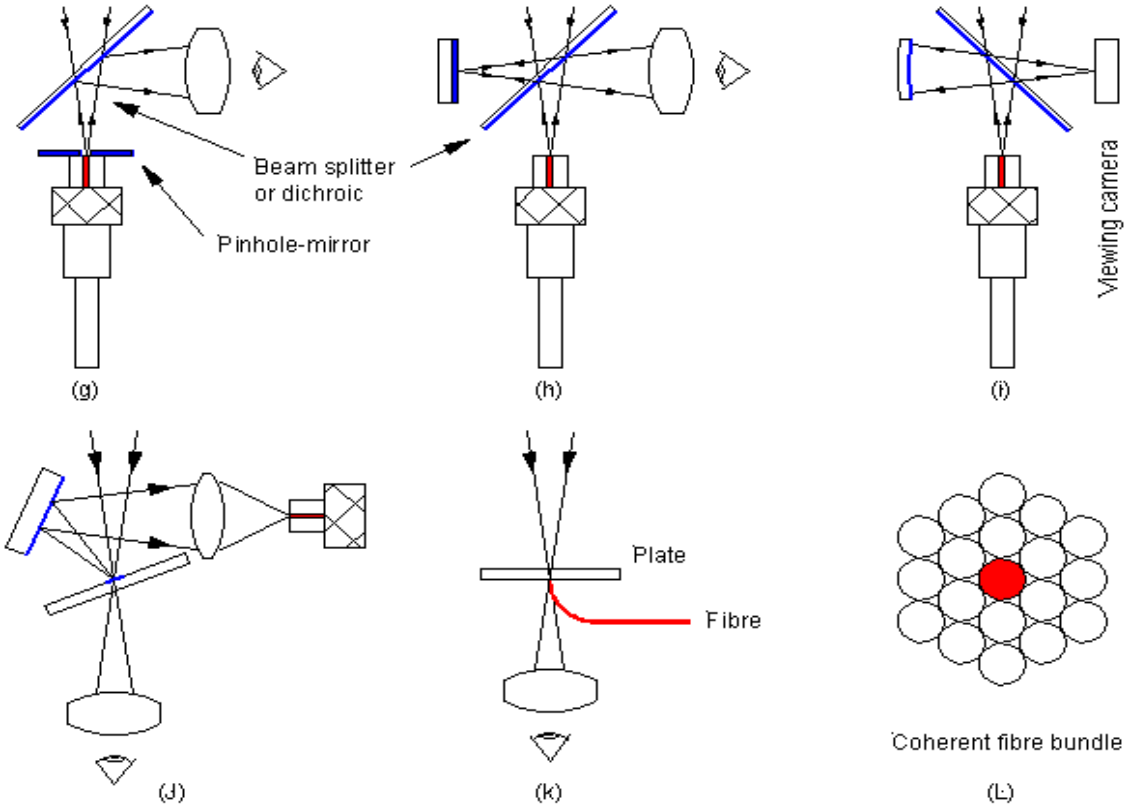
Guidehead: De Achilespees van een zelfbouw glasvezel spectroscoop.

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

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

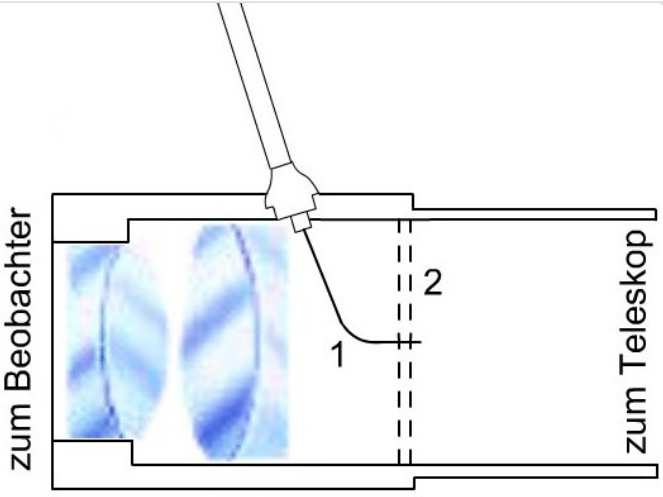


Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



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/

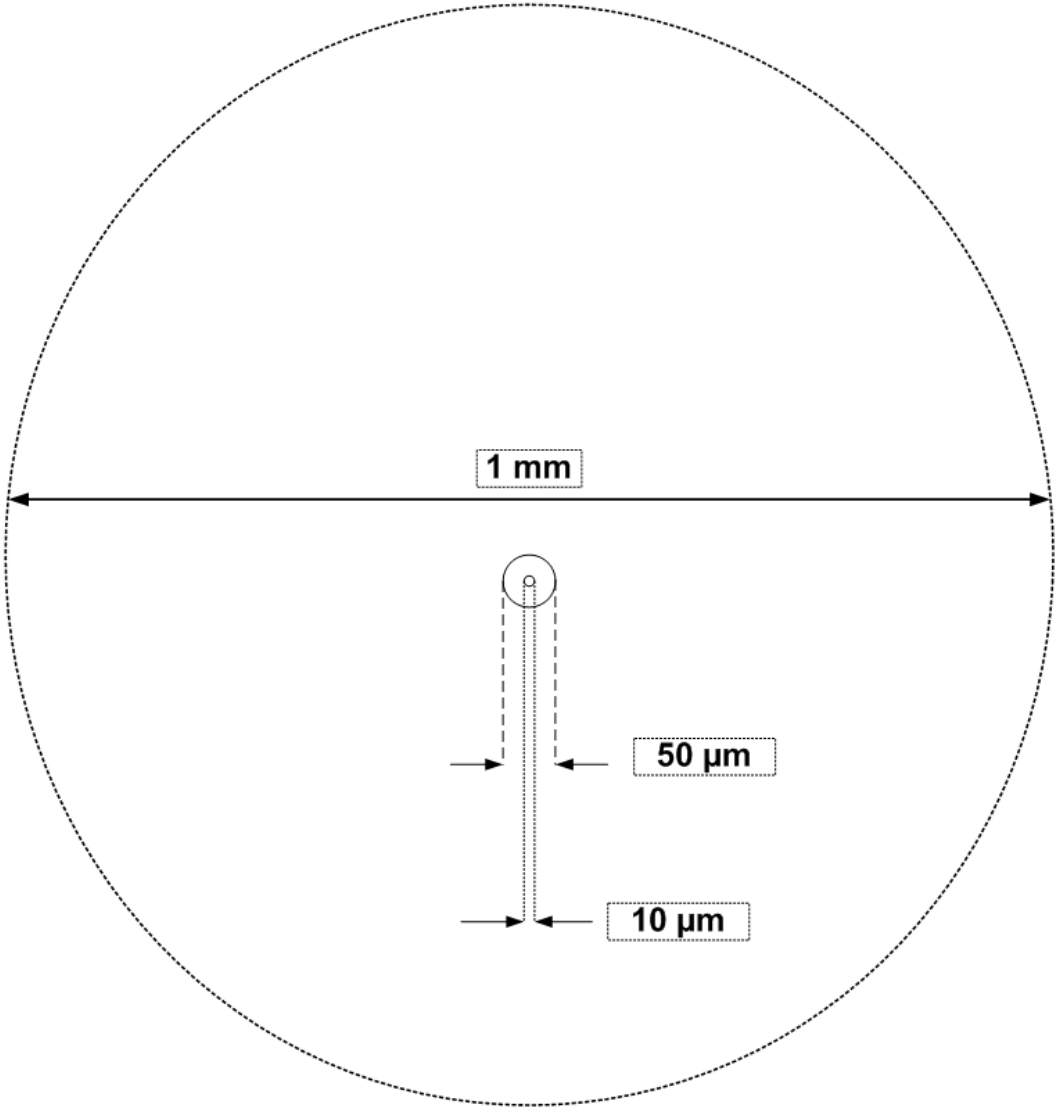
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



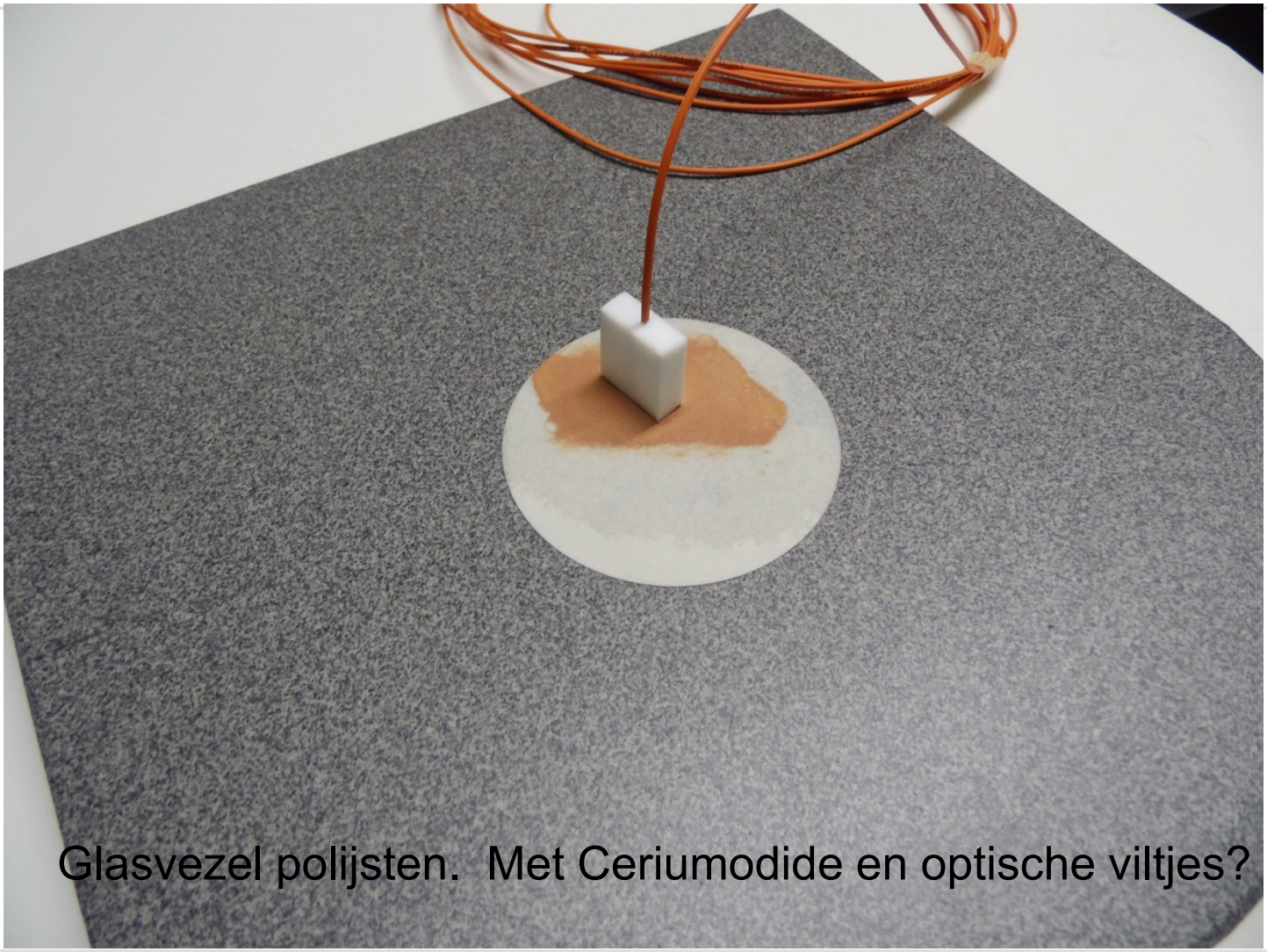
Schoolproject

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

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



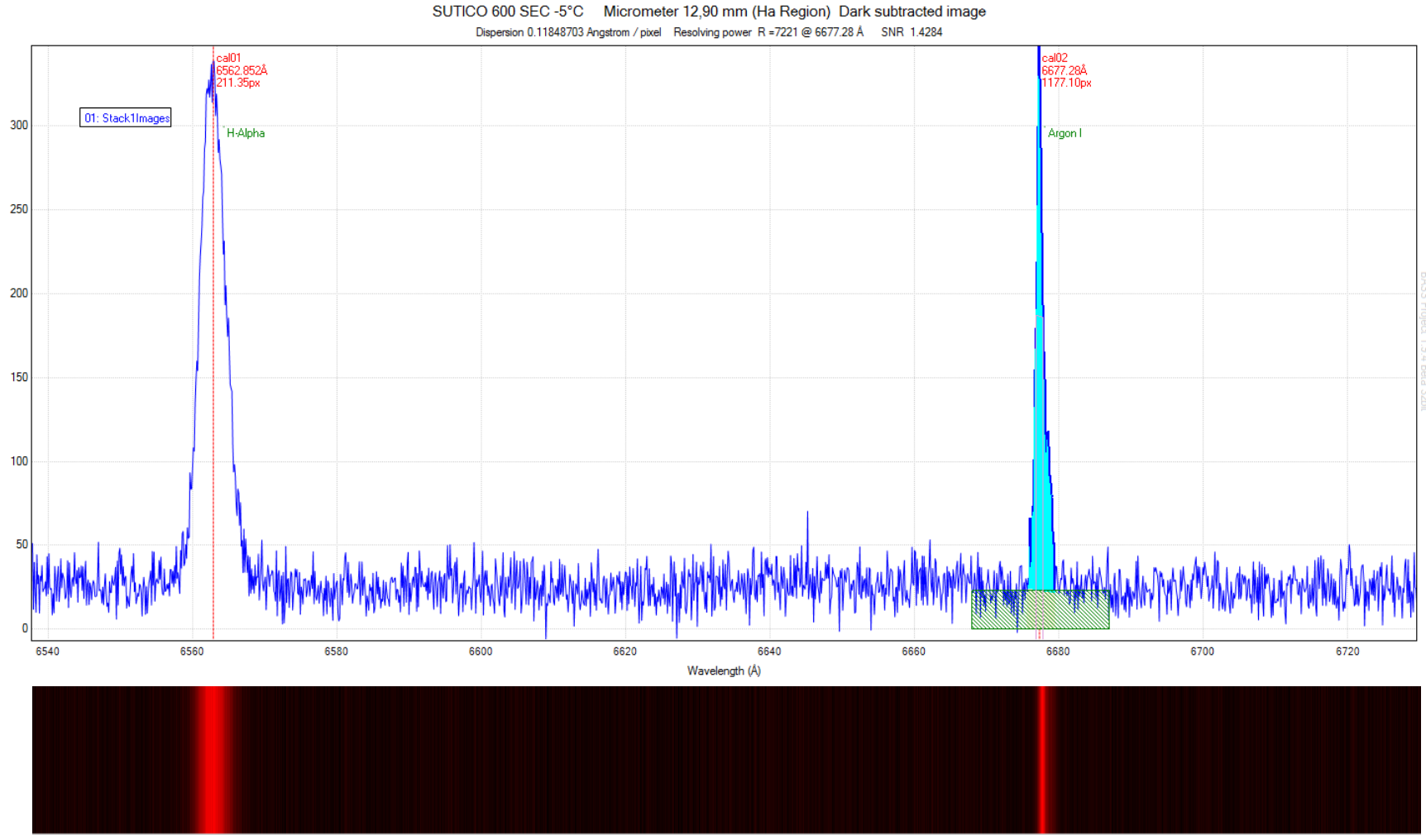
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Glasvezel polijsten. Met Ceriumodide en optische viltjes?

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



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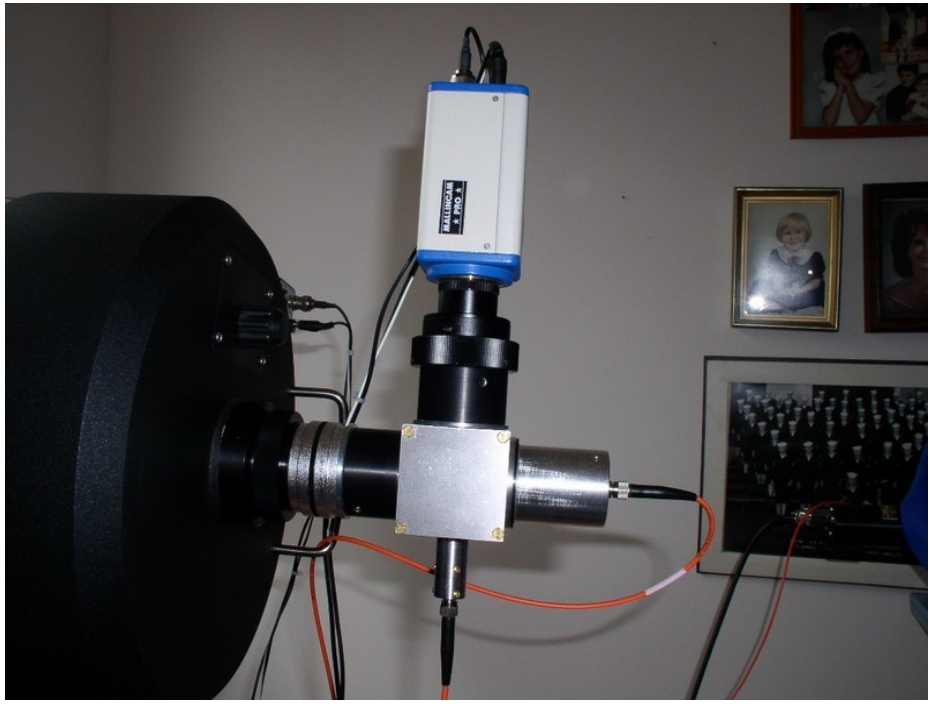
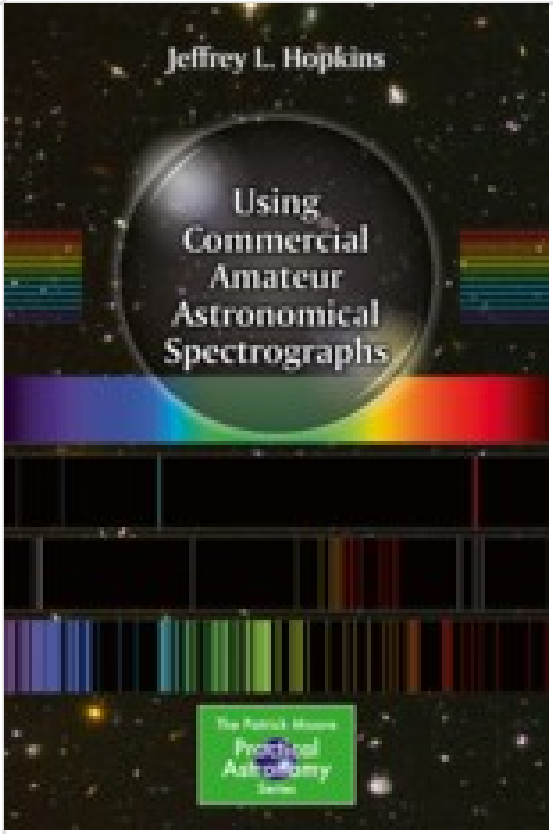


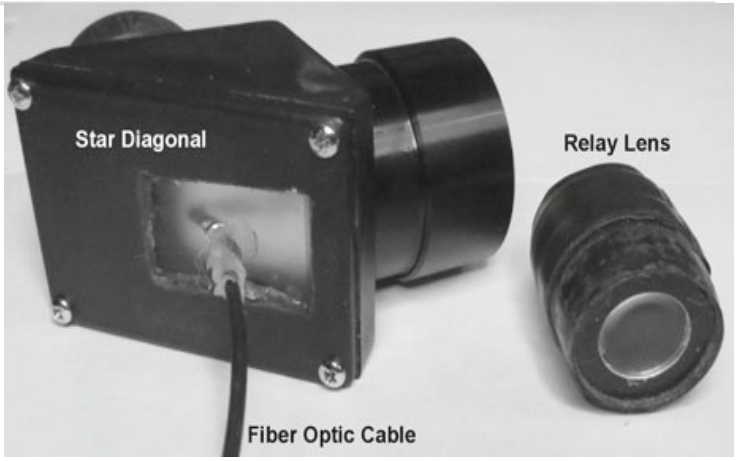
CM1-BP108 30mm cube pellicle beamsplitter 92/8 transmission.

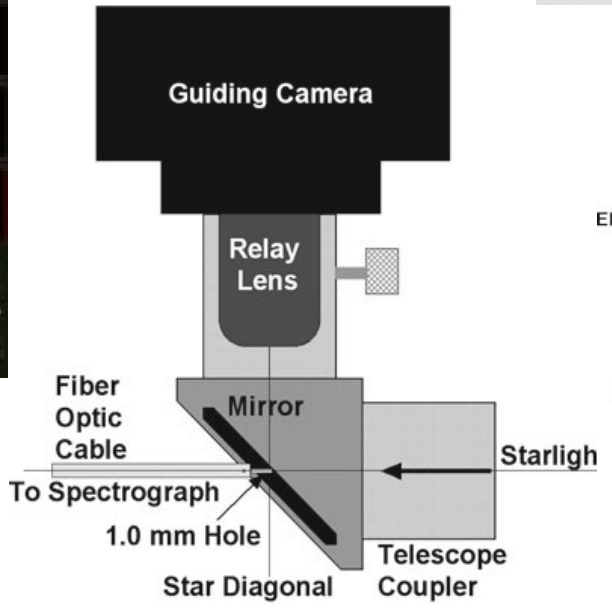
Ontworpen door Richard ssb73q@rochester.rr.com in RSpec forum.

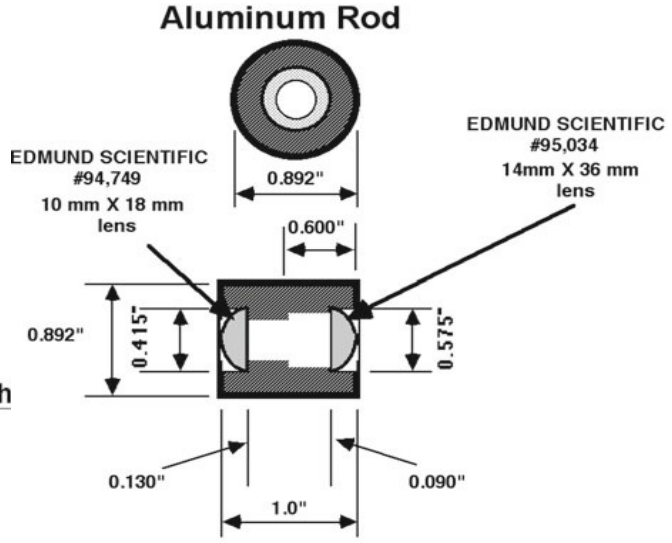
Met standaard onderdelen, aangekocht bij Thorlabs

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch









Iets over Zelfbouw Kalibratielampen

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

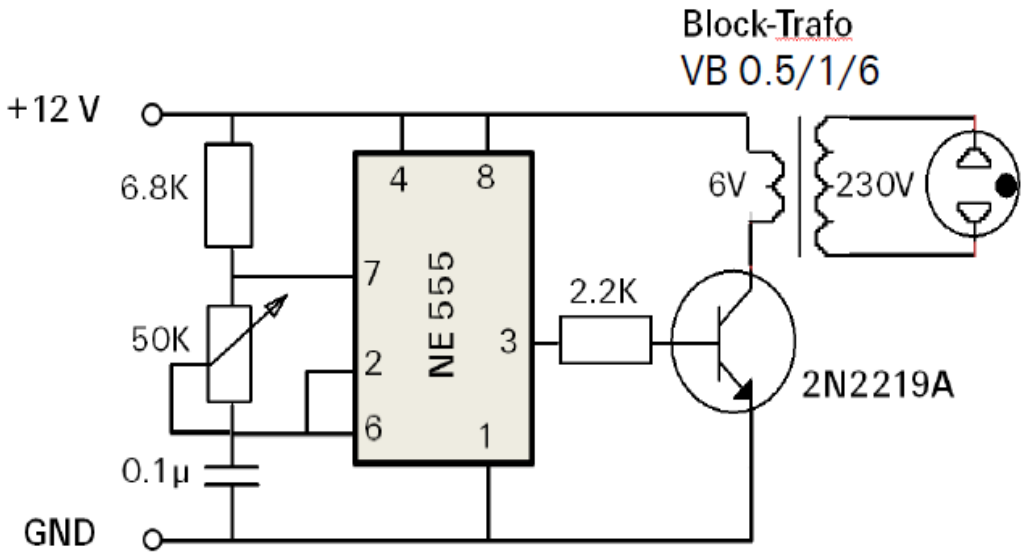
Thorium – Argon calibratielamp van de eShel spectroscoop:
ZEER DUUR! (Bij Shelyak; alleen lamp 799,00 EURO)

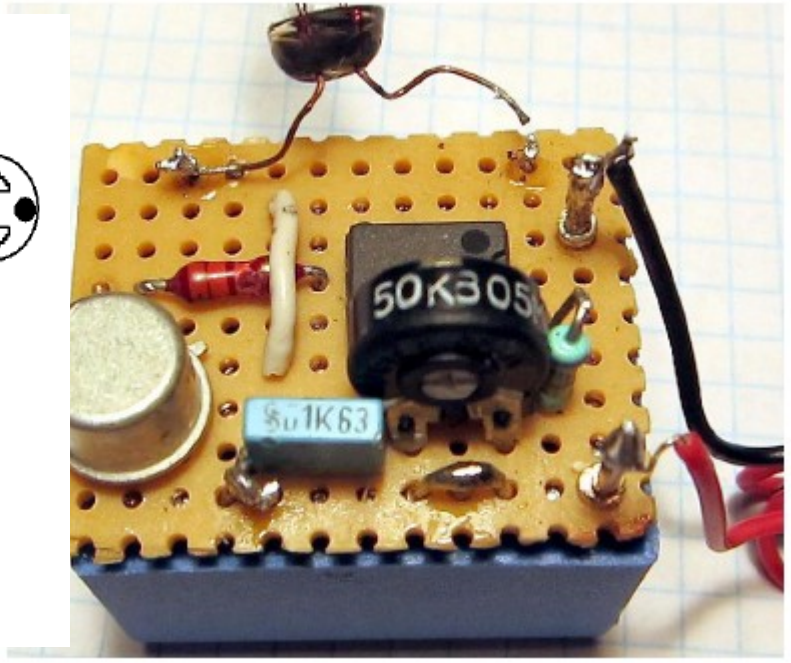
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

Goedkoper met TL Starter lampjes. Rechtstreeks op 220Volt

(Vergeet de voorschakelweerstand niet! (Ongeveer 25 K-Ohm in serie))

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

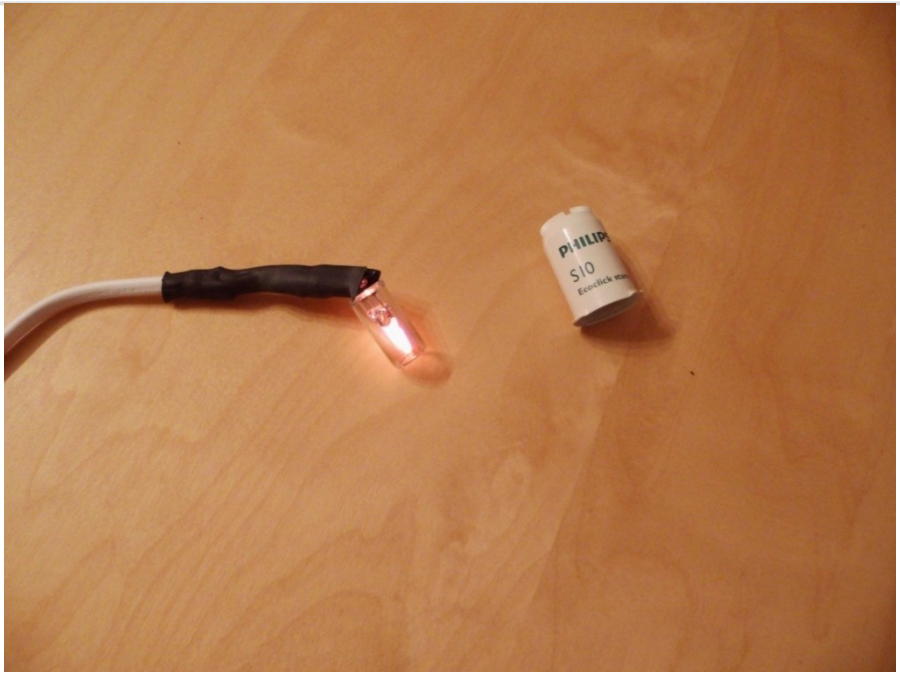




http://www.ursusmajor.ch/downloads/inverter-12v-dc-_-230v-ac-2.0.pdf

Of via de veiliger methode van Richard Walker op 12 volt

Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



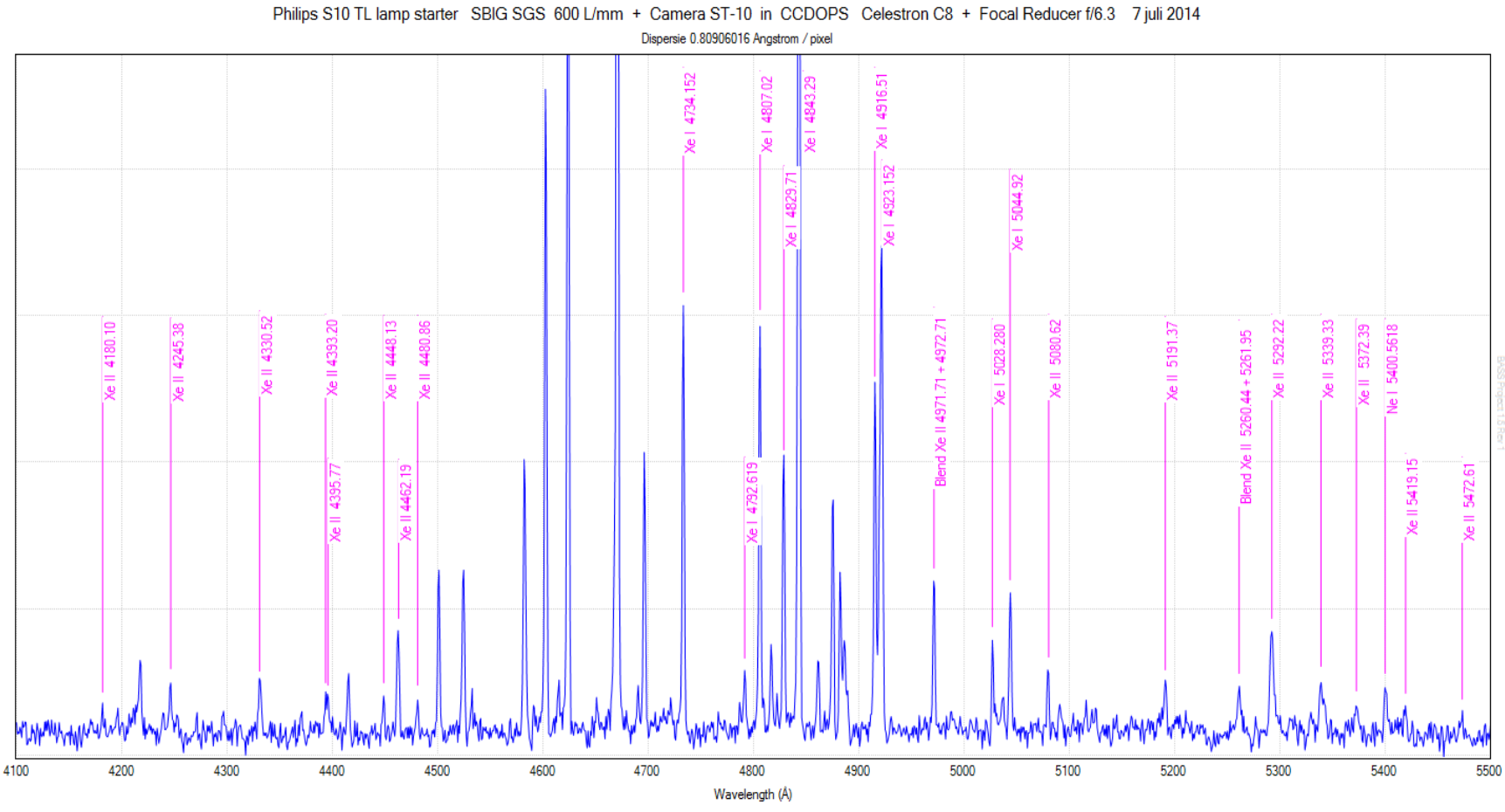
Spectrum van Philips S10 TL lamp starter

Met Neon en Xenon gas

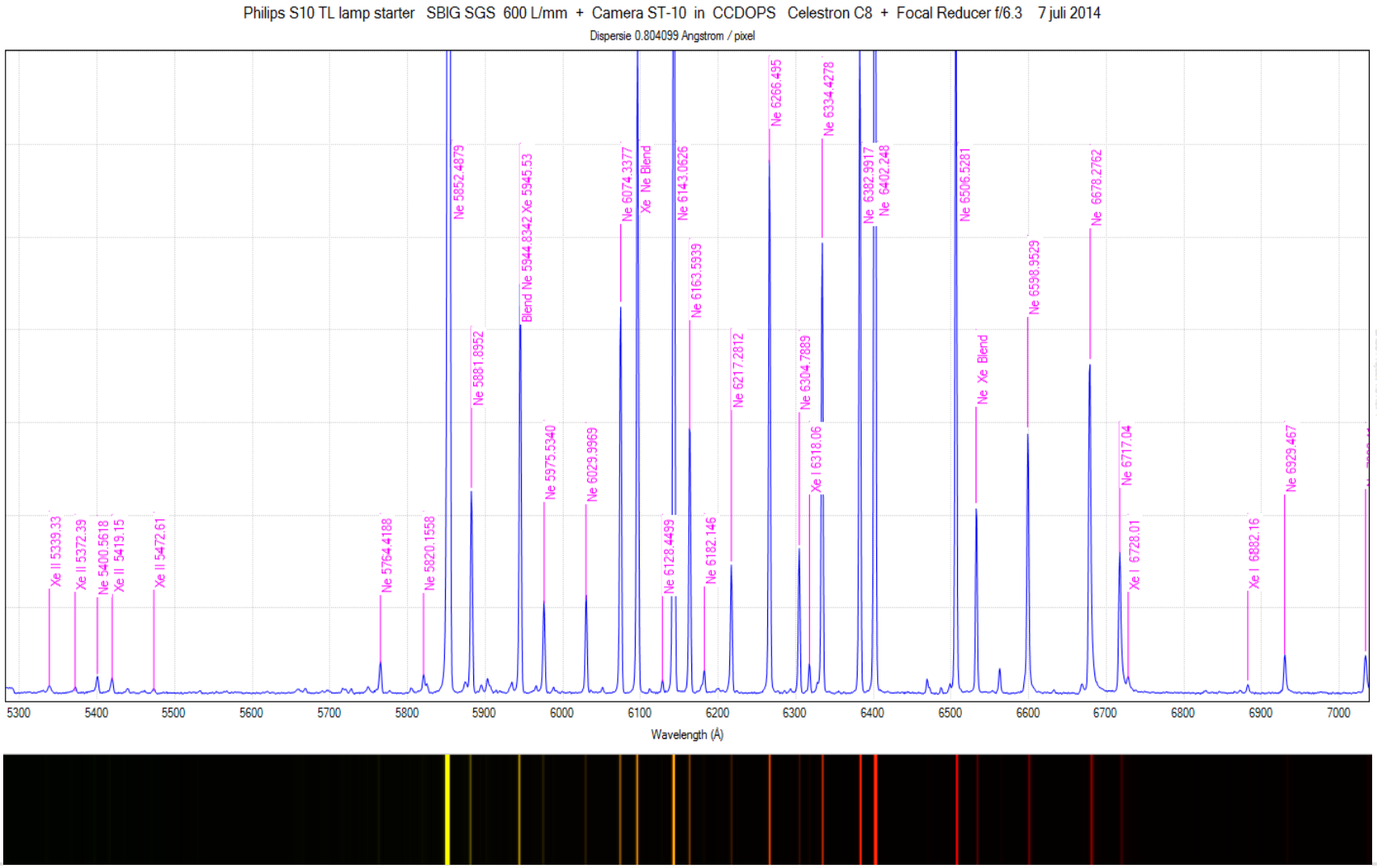
Spectrum opgenomen met SBIG SGS spectroscoop, 600 L/mm

SBIG ST-10 camera, Celestron C8 telescoop en focal reducer f/6.3

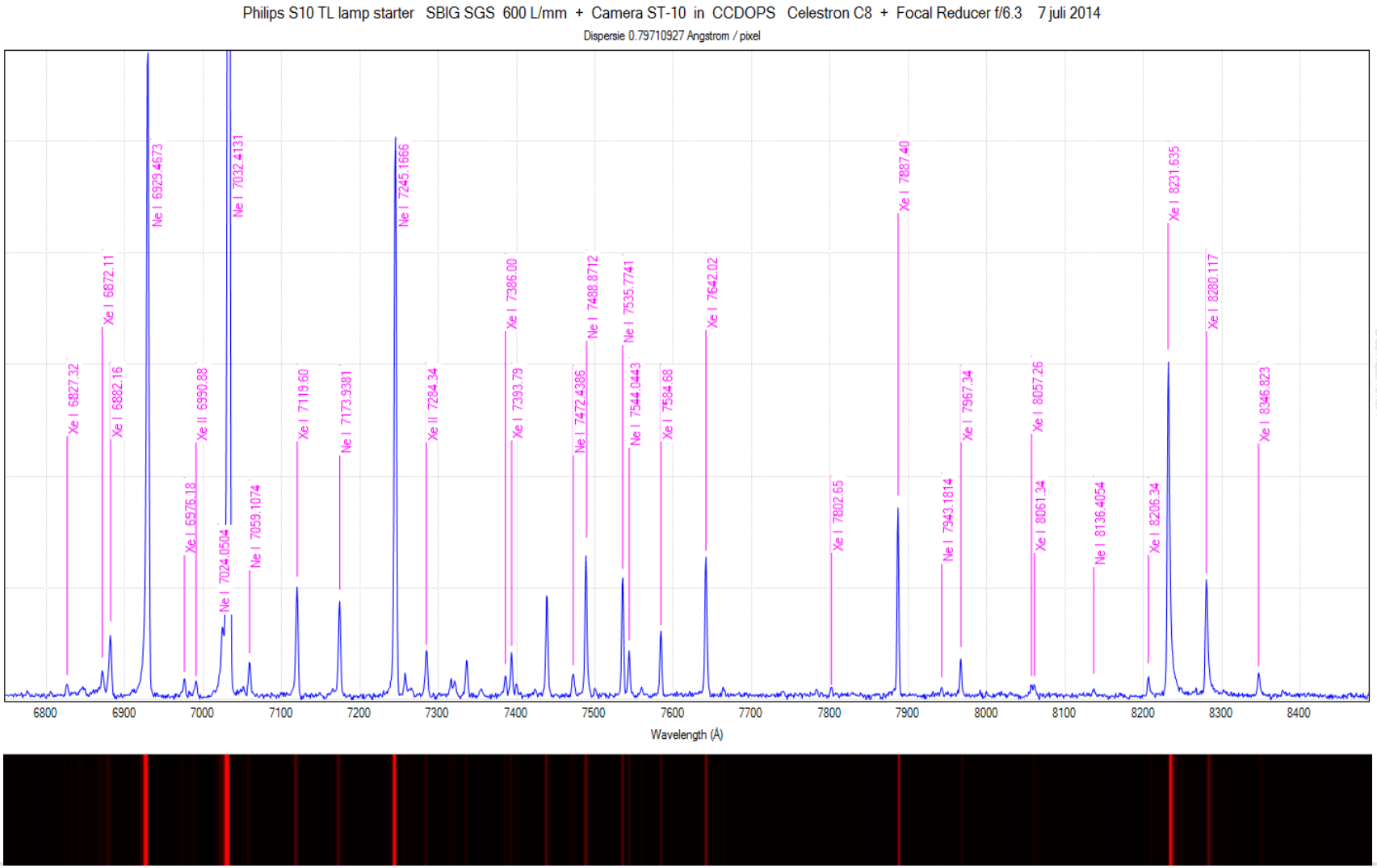
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



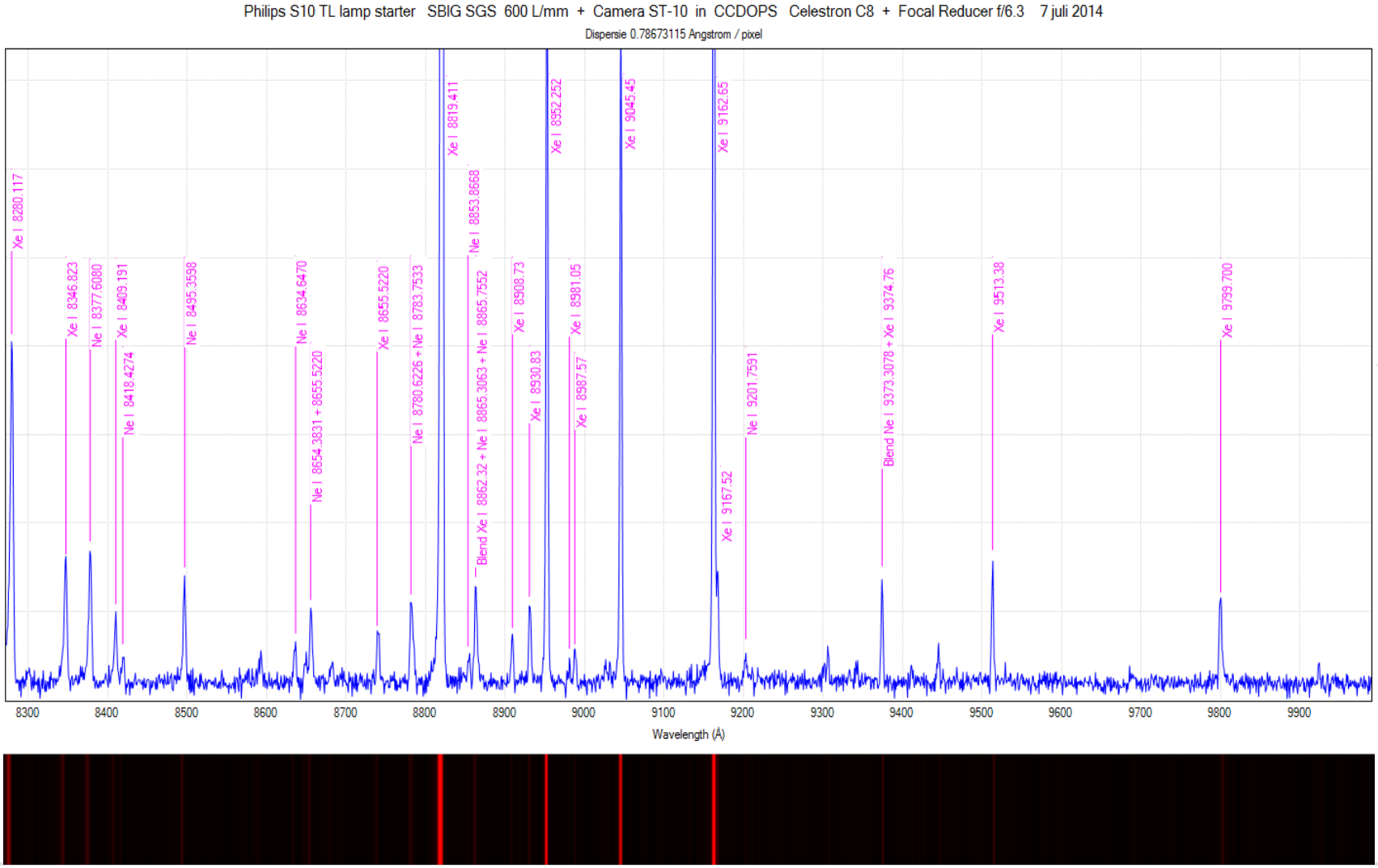
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



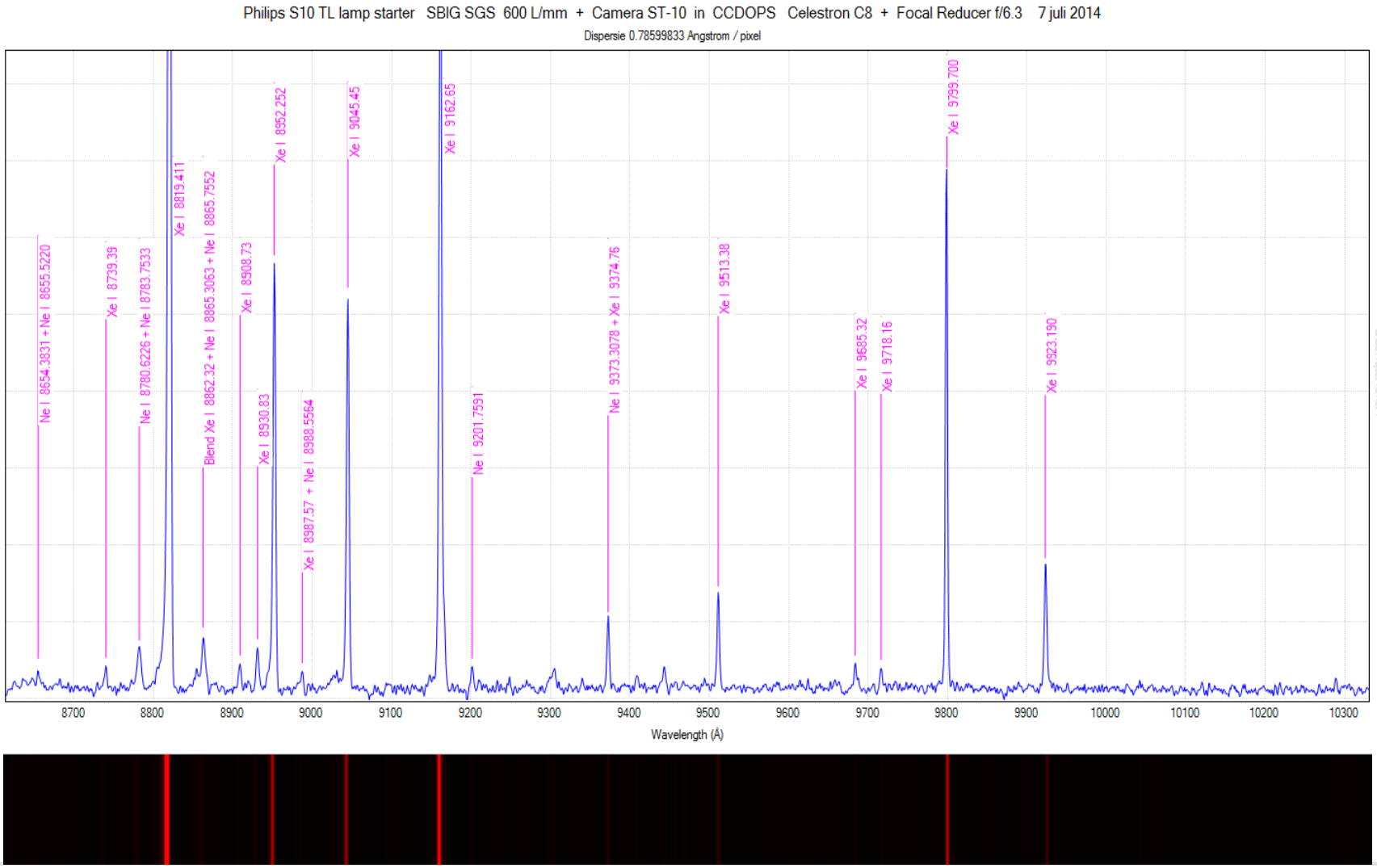
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



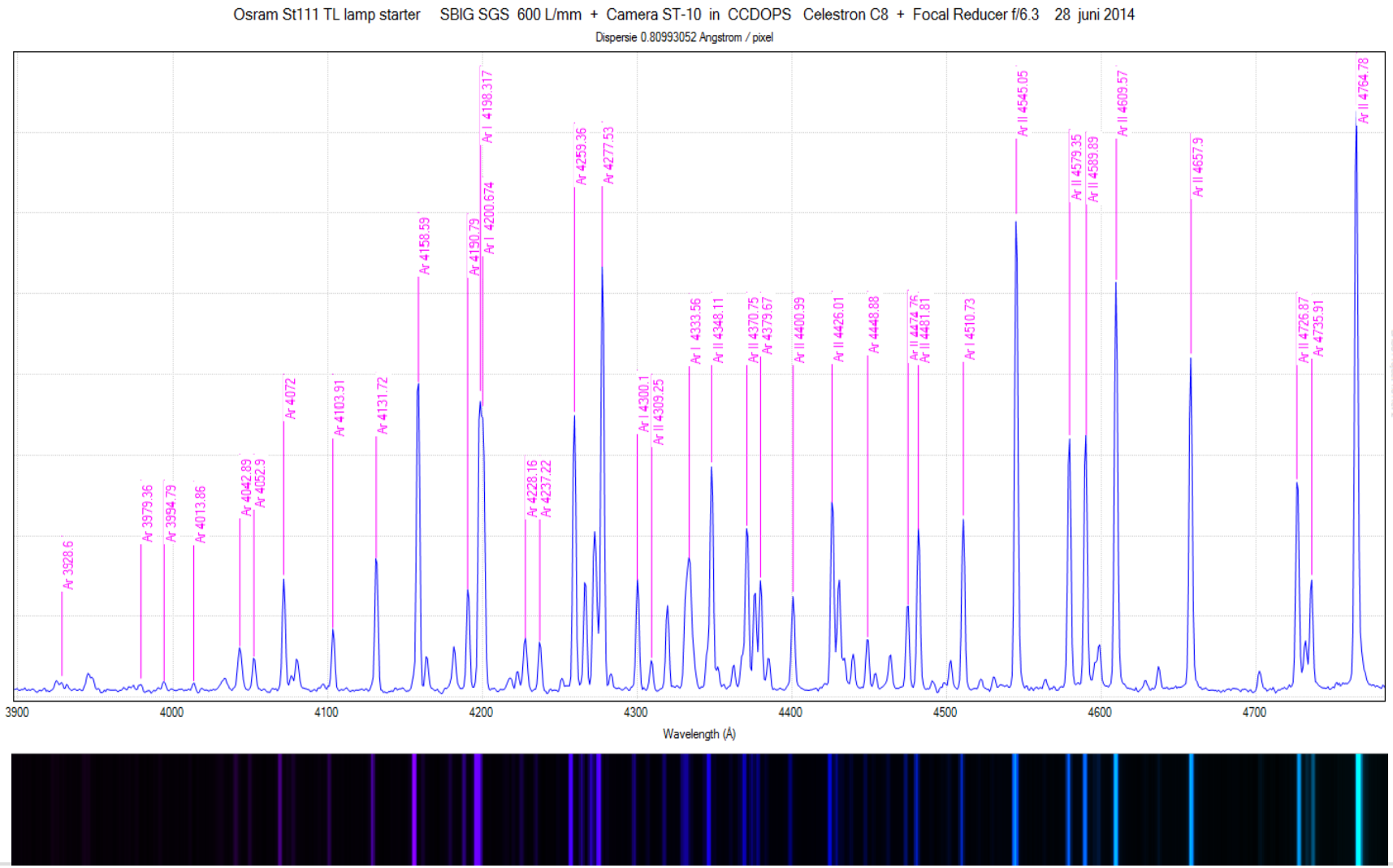
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

Spectrum van Osram St 111 TL lamp starter

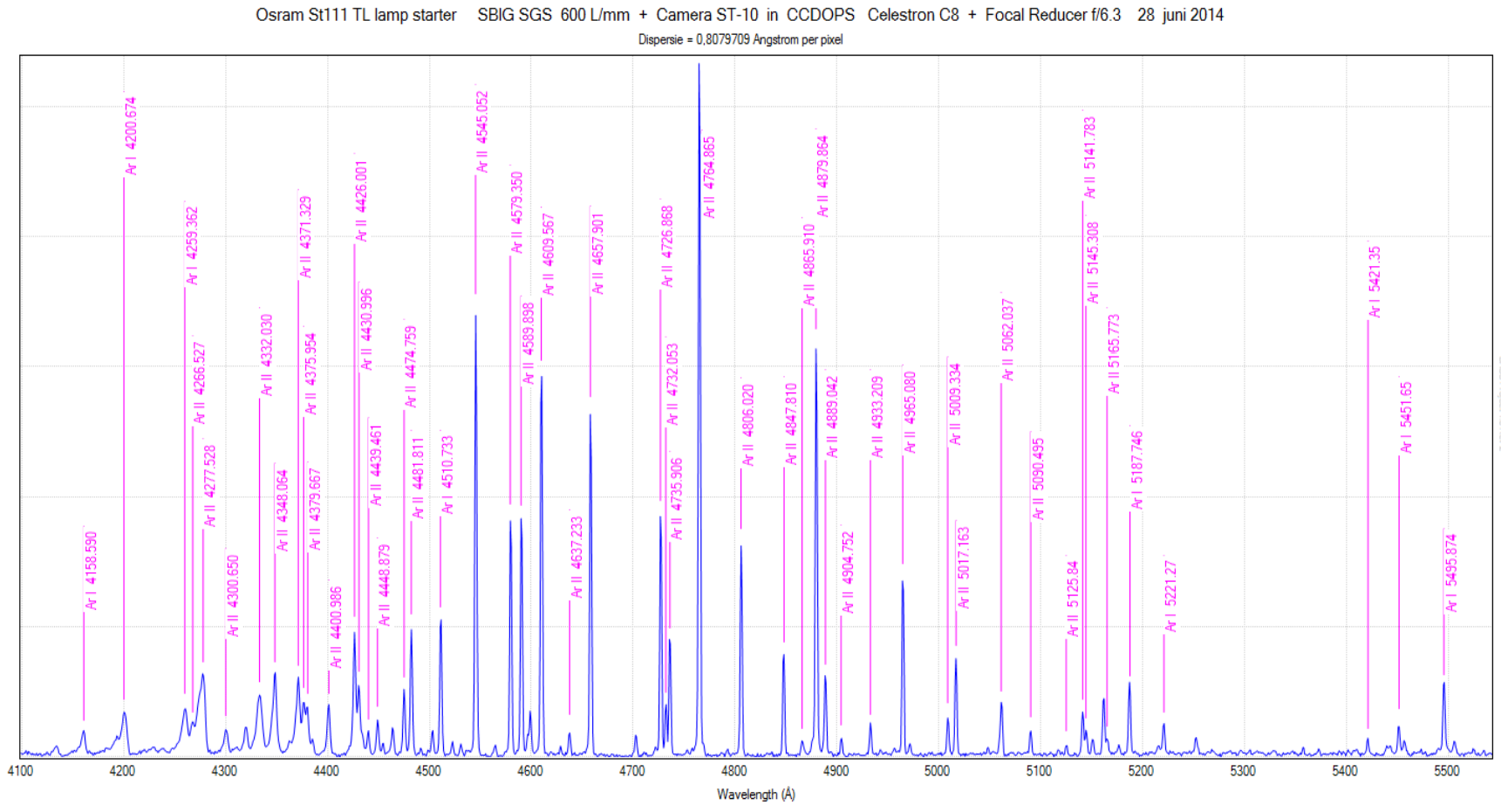
Met Argon en Krypton gas

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

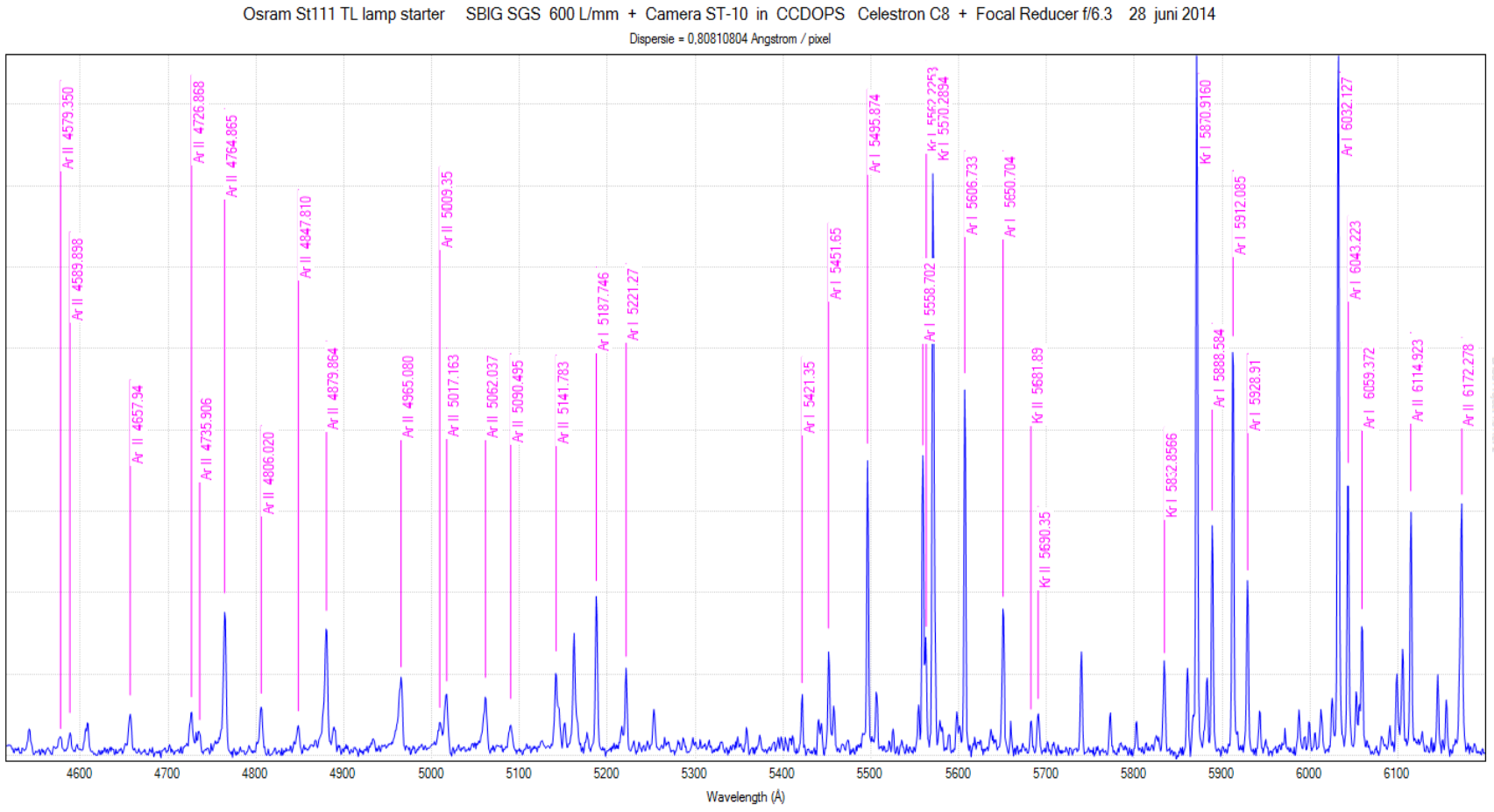
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



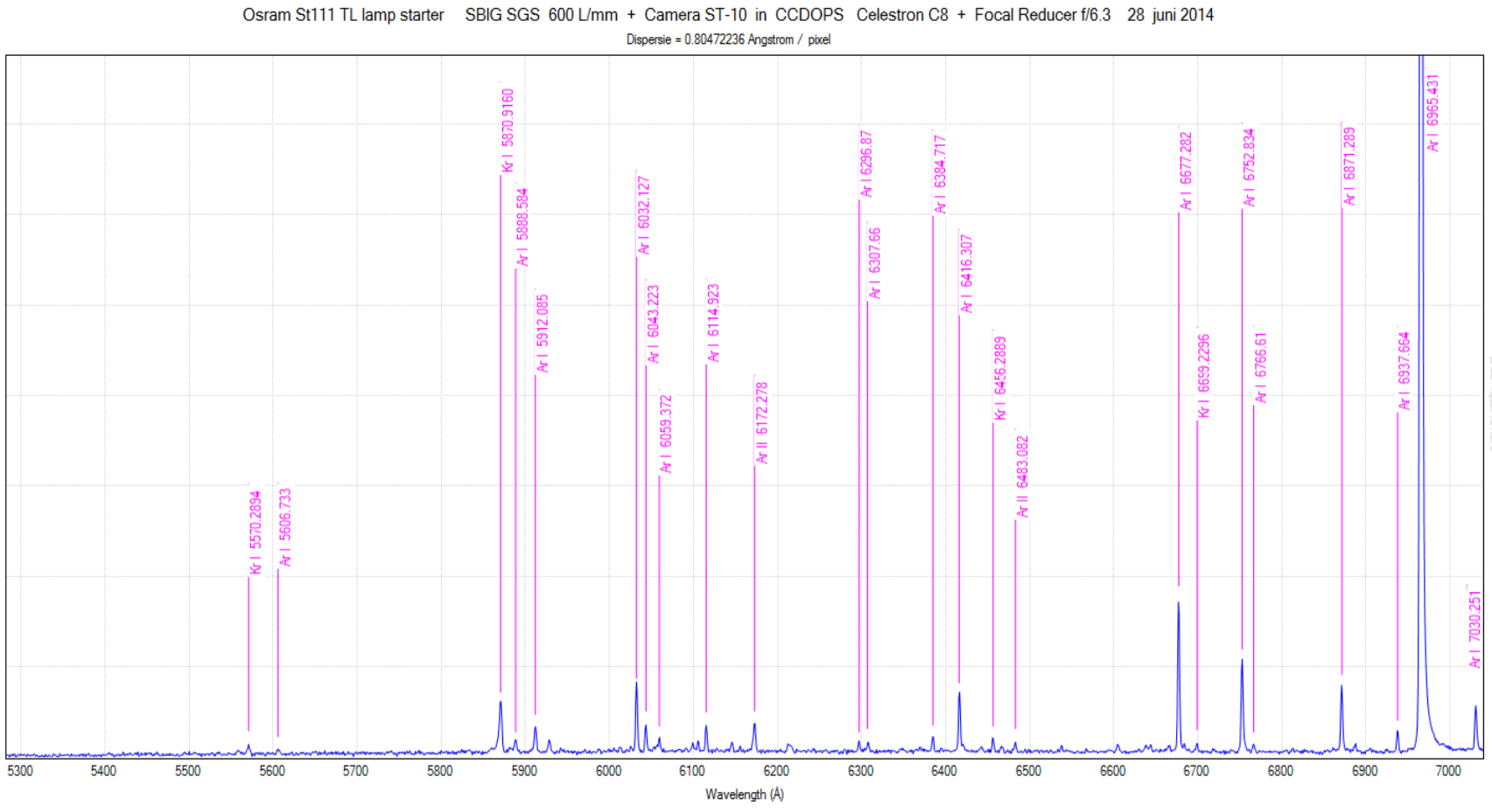
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



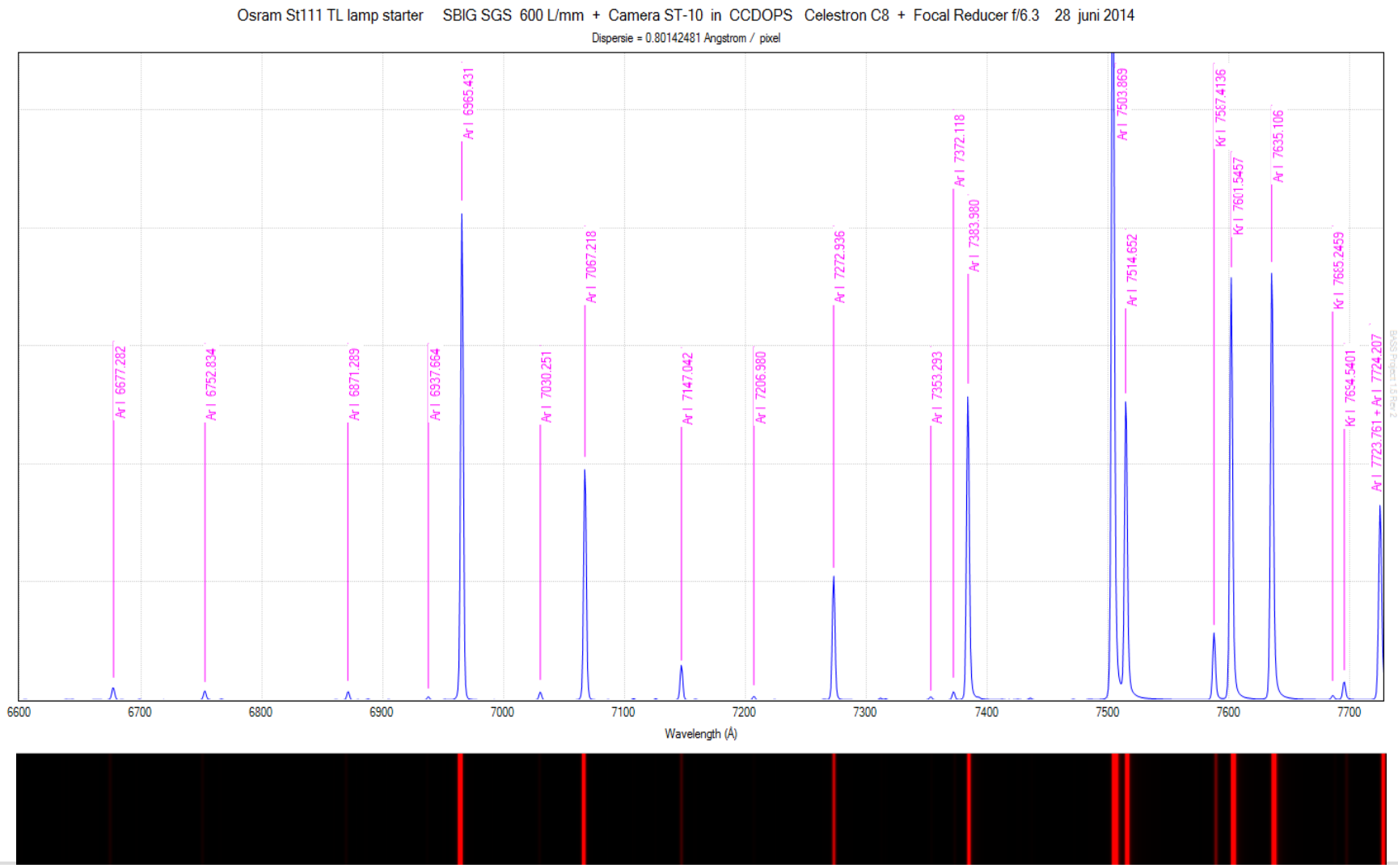
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



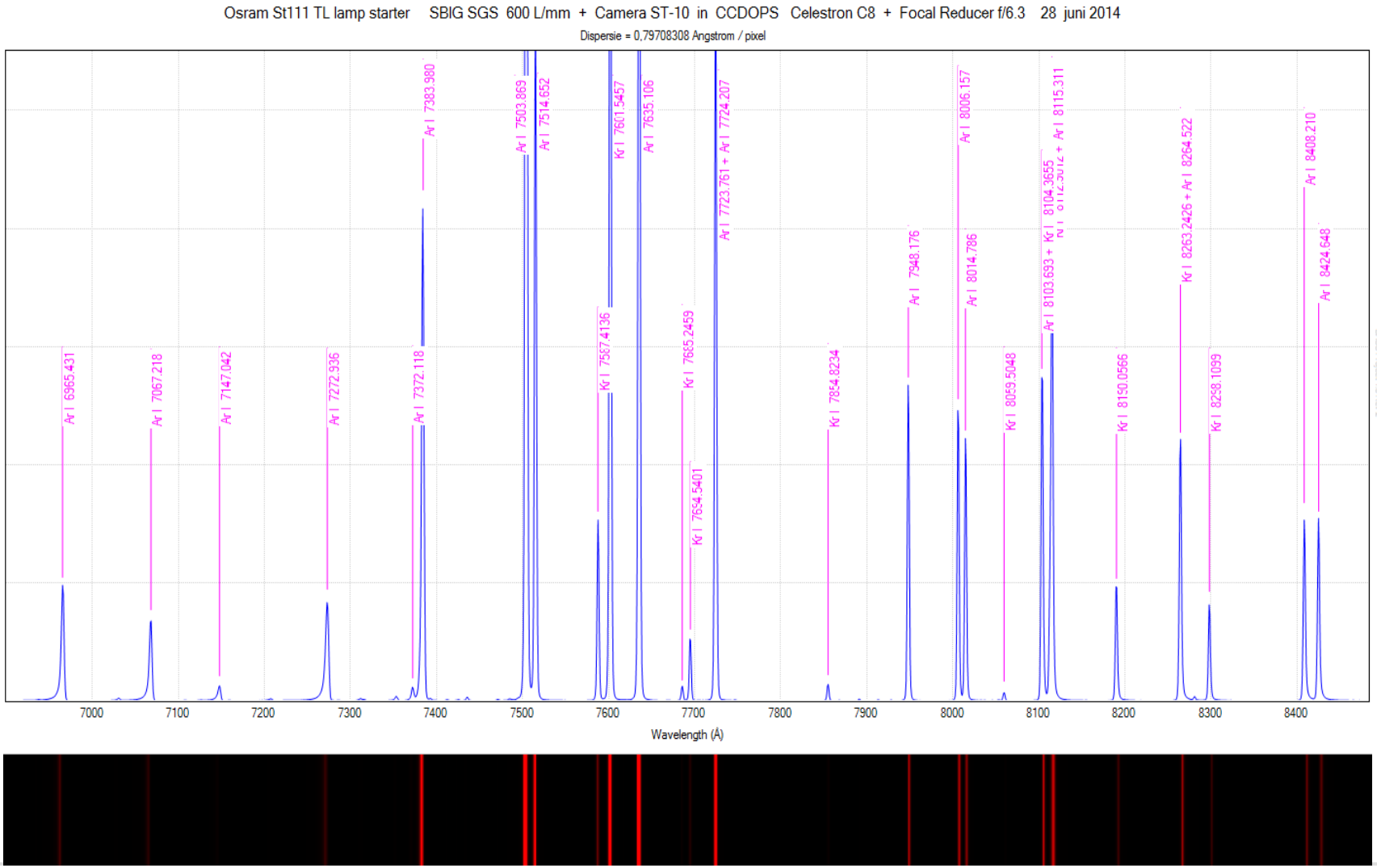
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



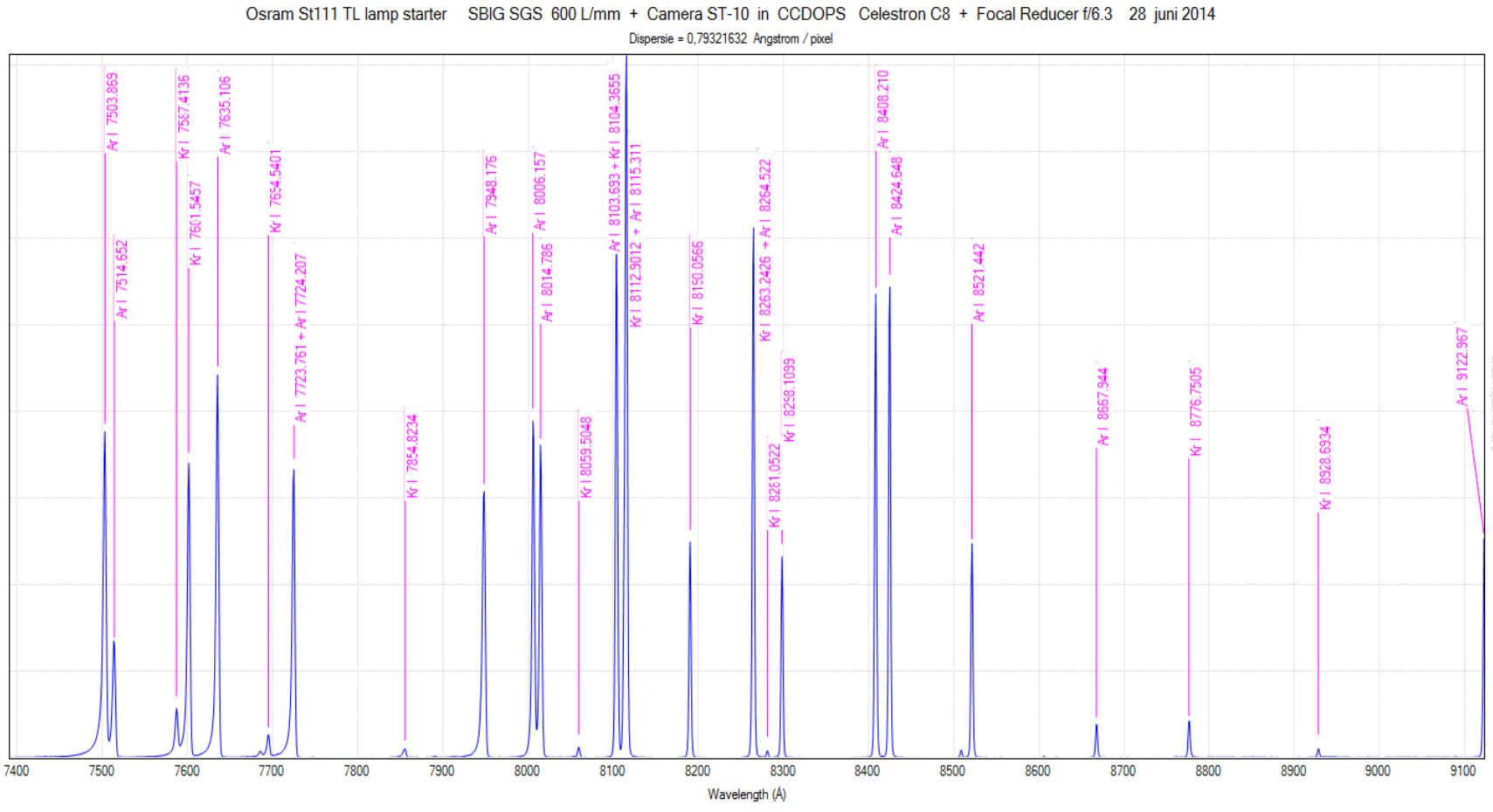
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



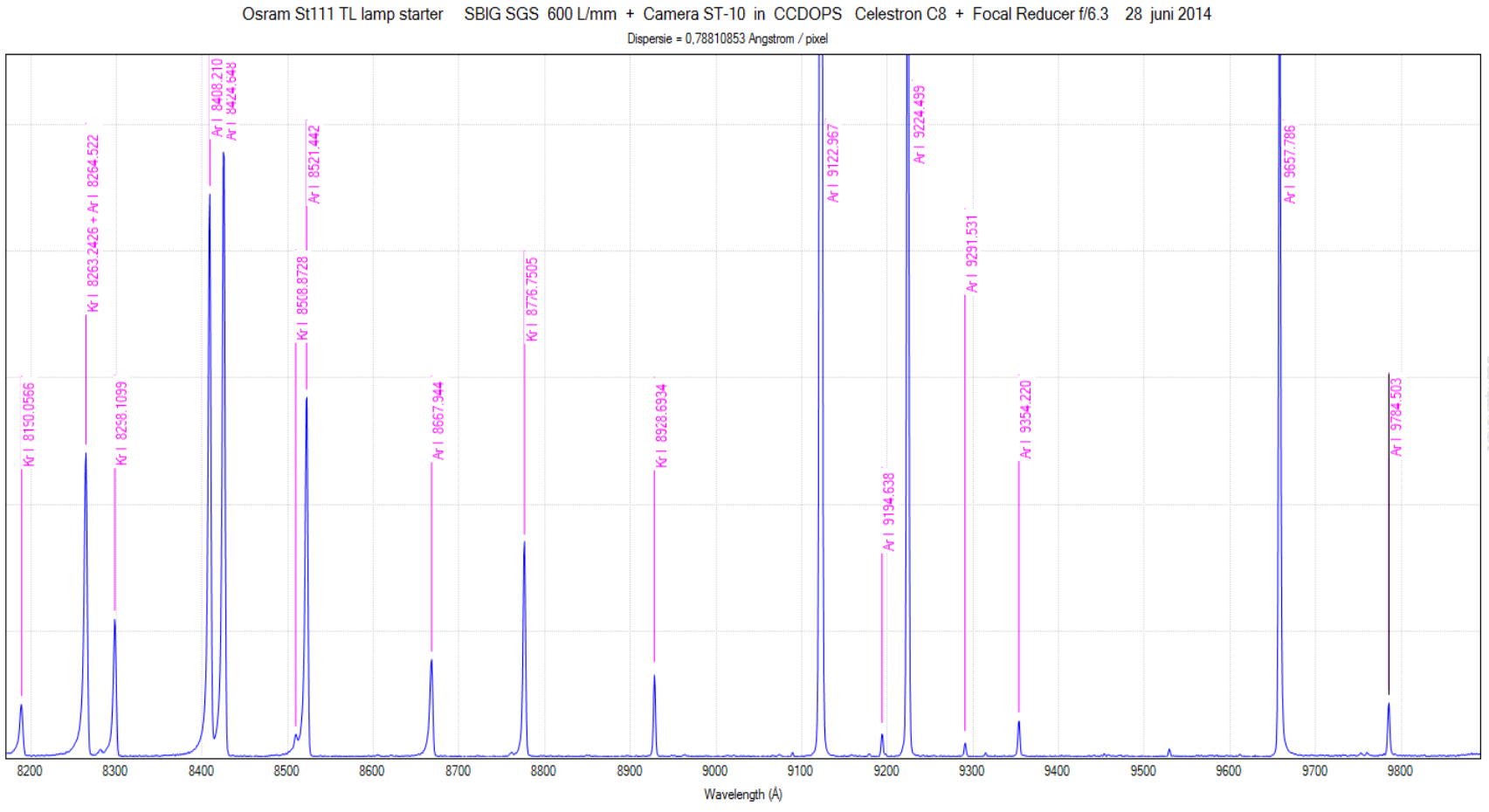
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



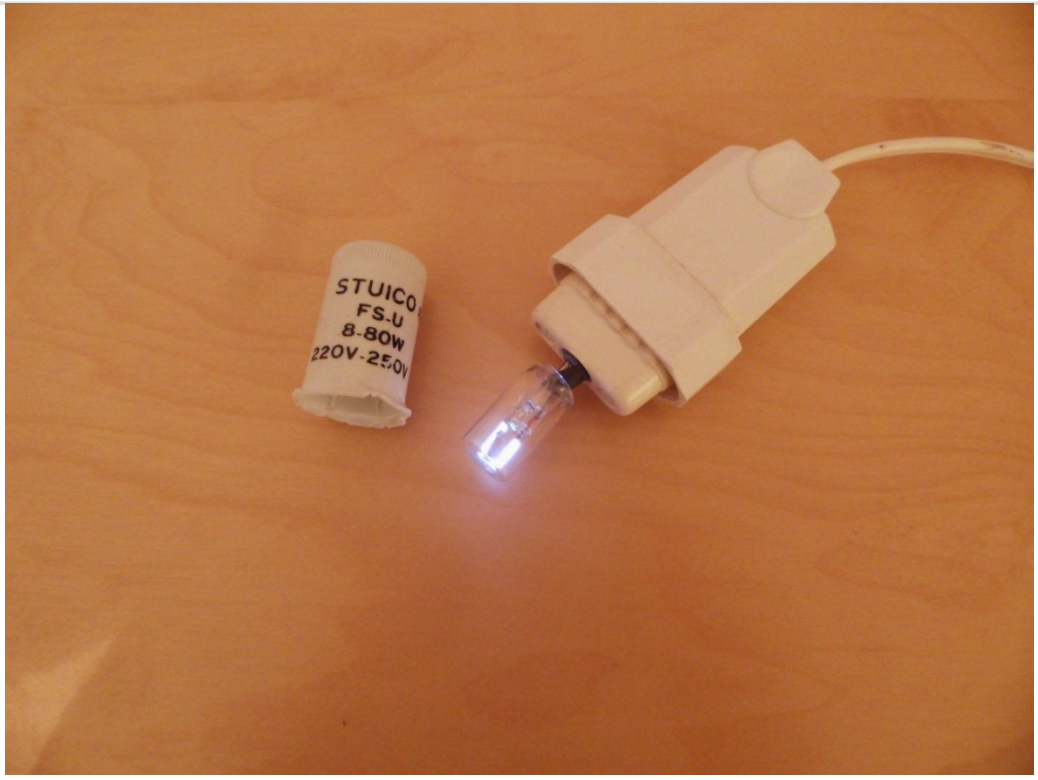
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch

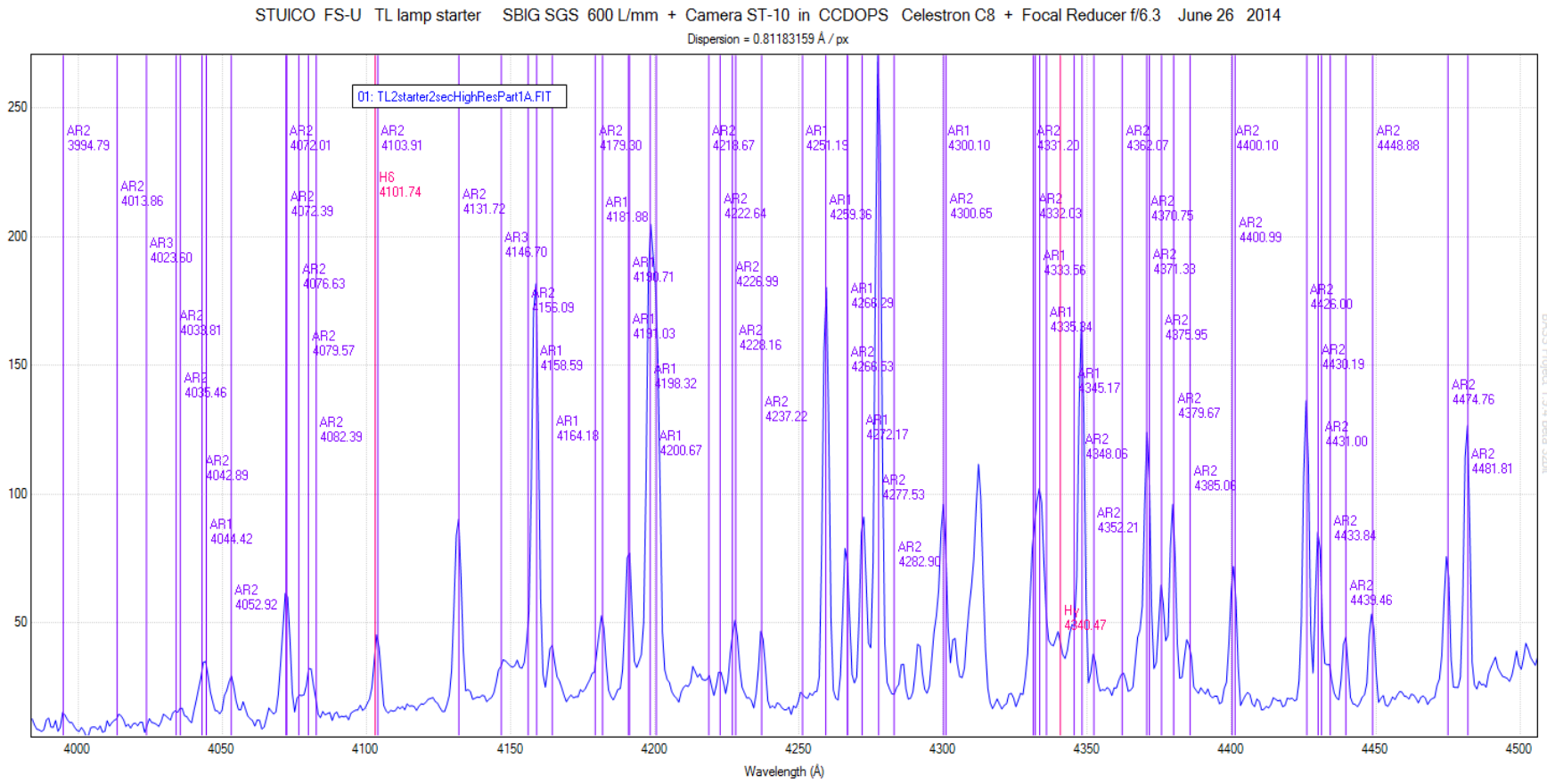


Spectrum van Stuico (Sutico) FS-U TL lamp starter

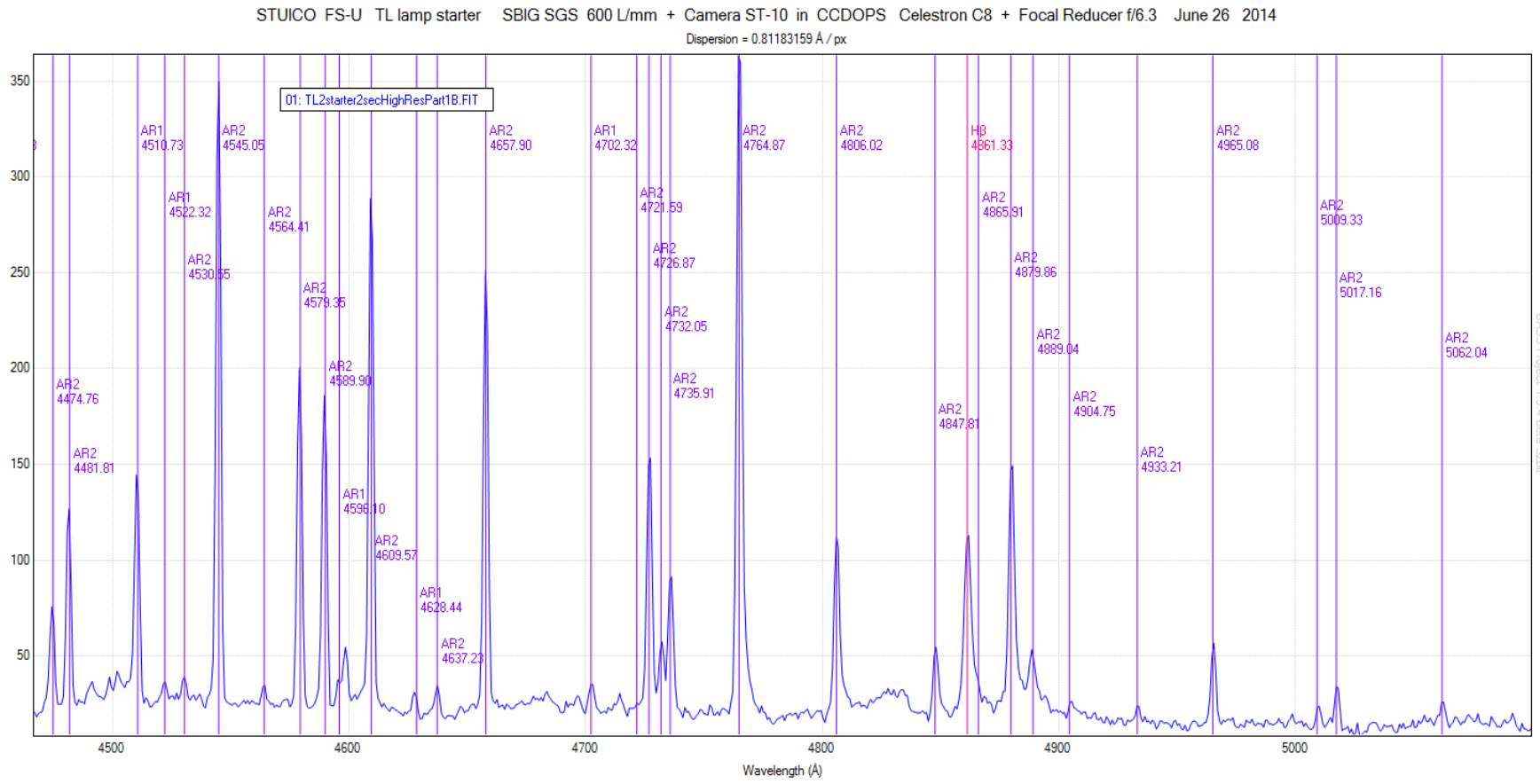
Met Argon en Waterstof

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

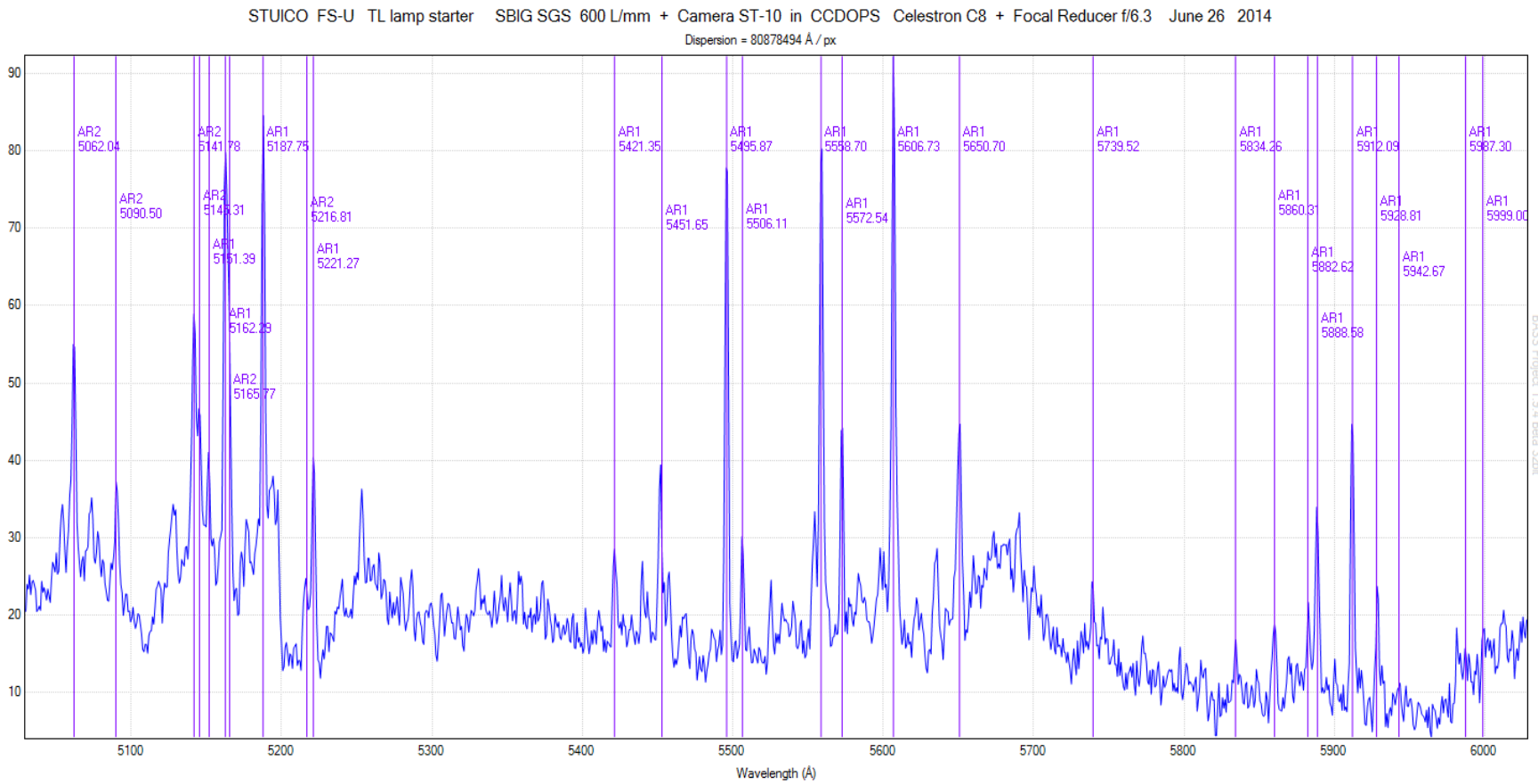
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



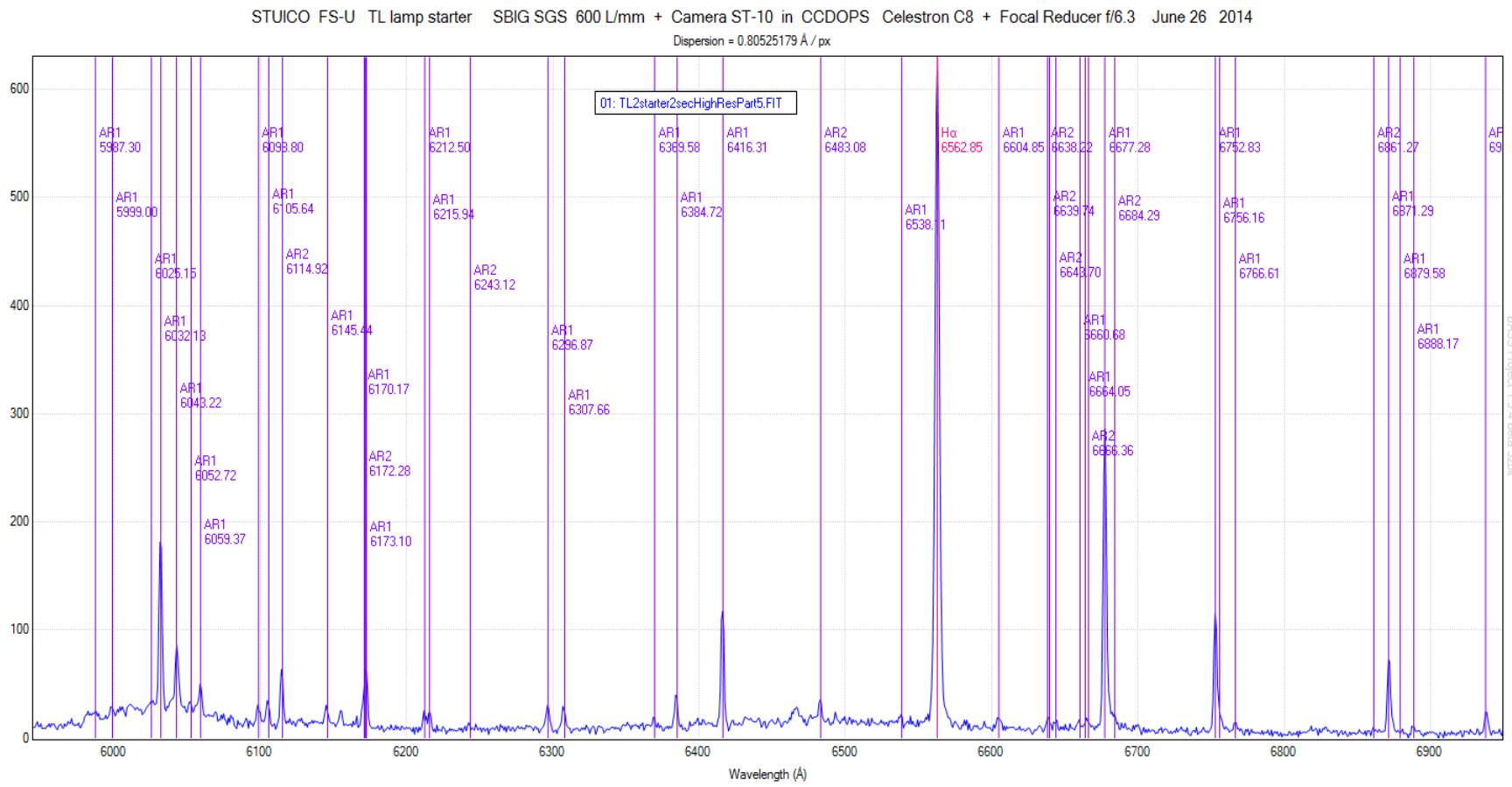
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



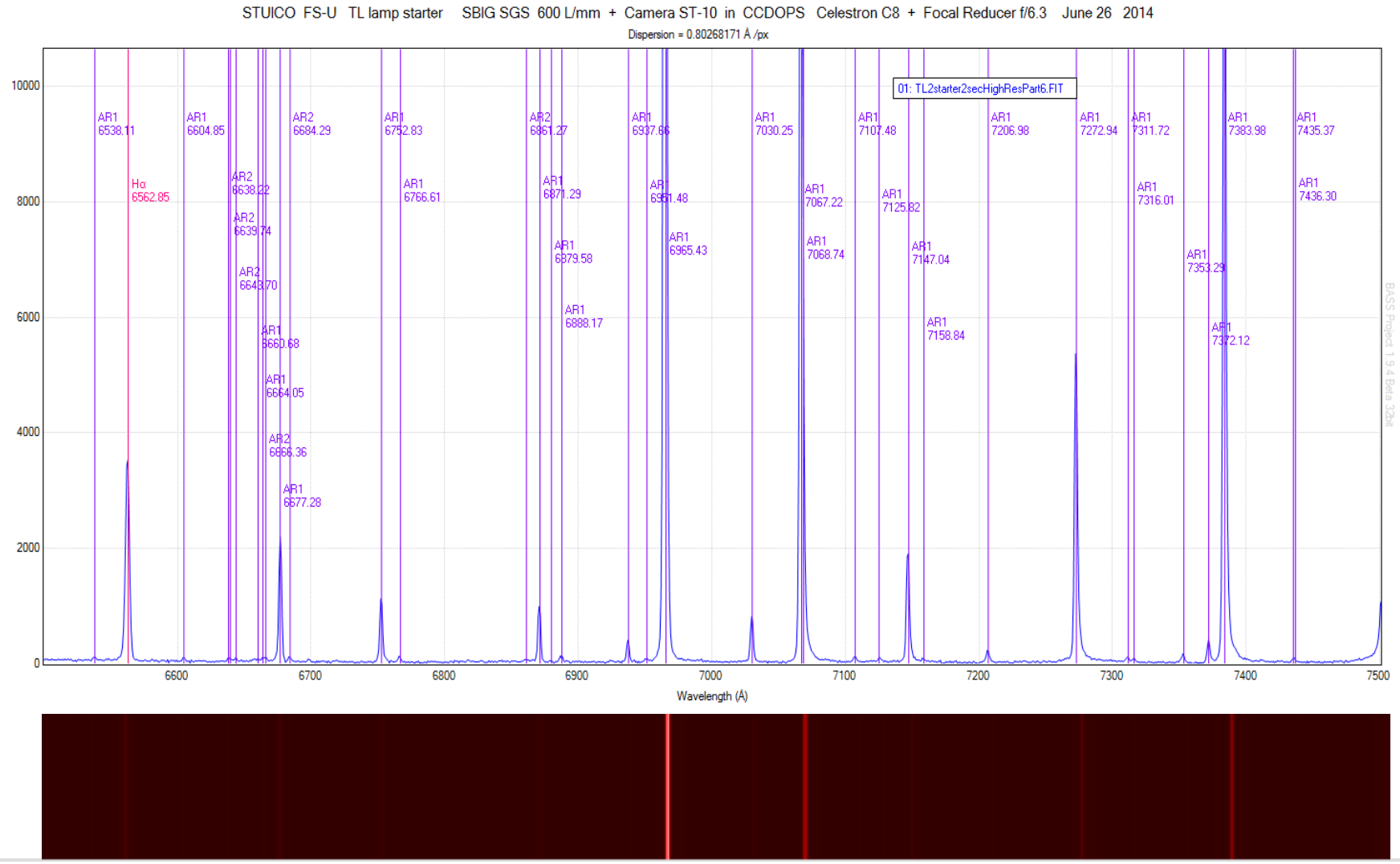
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



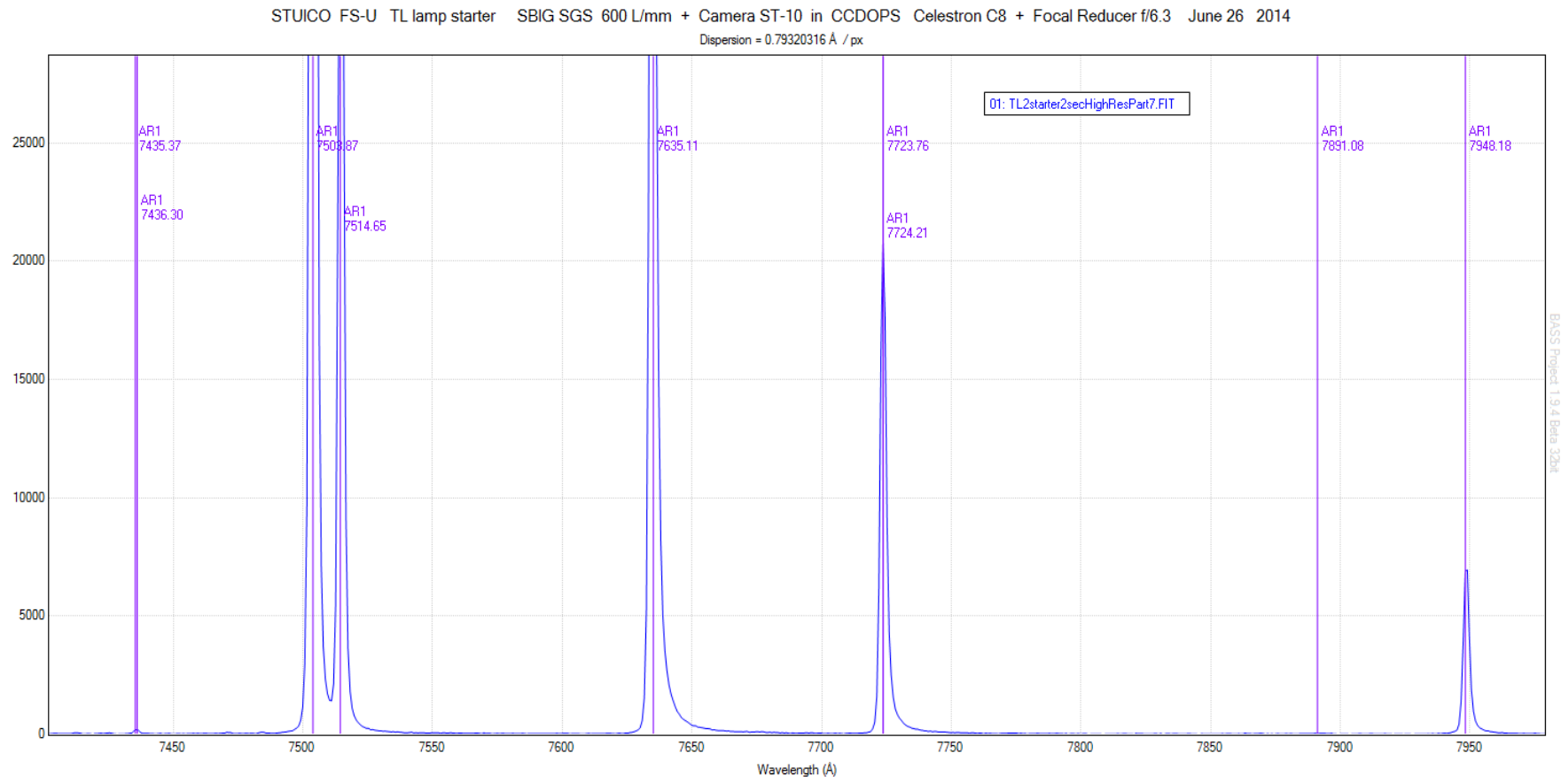
Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscoop bijeenkomst Tivoli Oudenbosch



Zelfbouw spectroscoop 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