13 July 2024

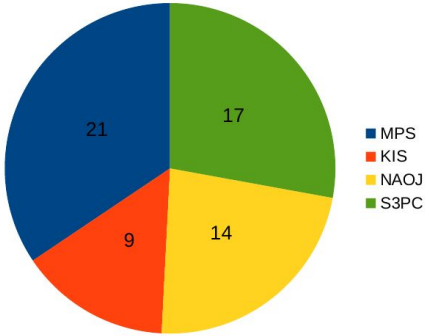
Observing plan for Sunrise III

Outline

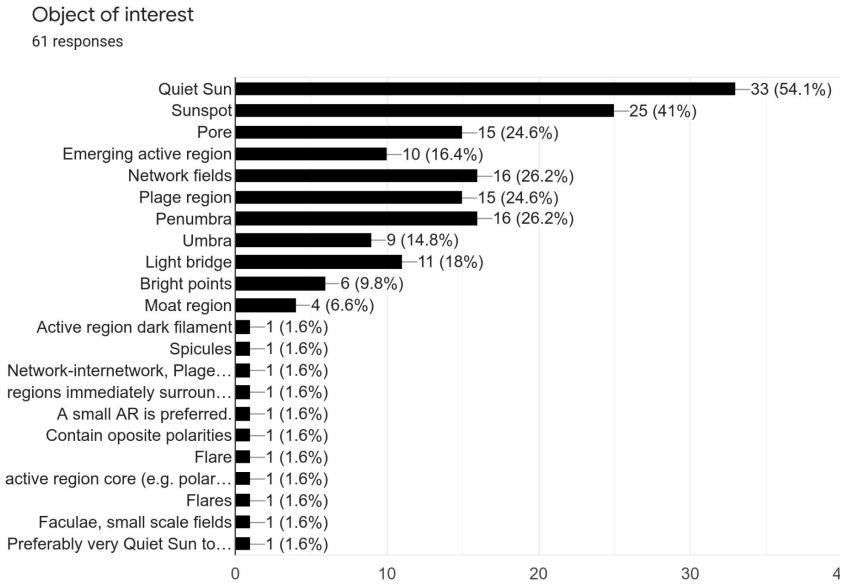
List of all the observing ideas

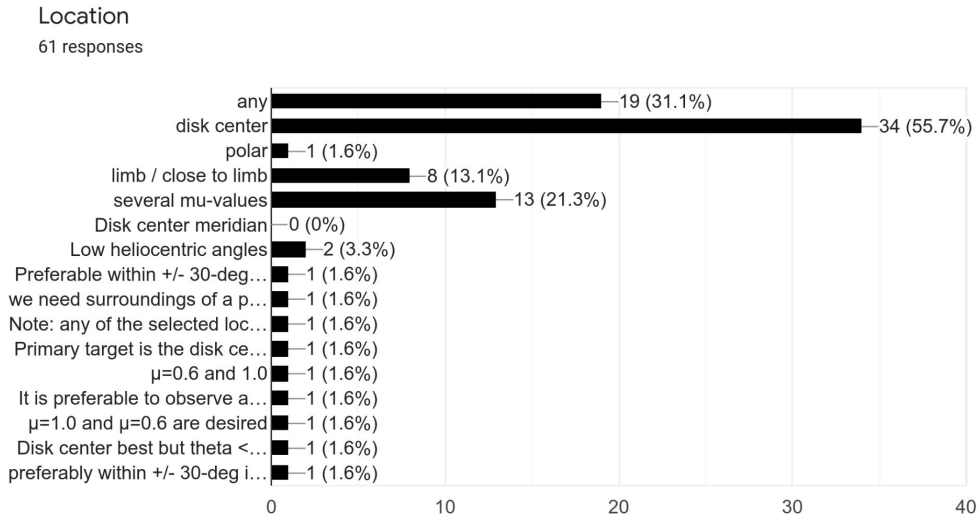
- Title and scientific justification of all the observing ideas
- Observing ideas requiring SUSI
- Observing ideas requiring SCIP
- Observing ideas requiring TuMag

Overview of all the observing ideas



- We received 61 observing ideas from the Sunrise consortium + 9 proposals through the SOLARNET program
- The observing ideas have requested for multiple instruments
- 51/61 ideas involve SCIP
- 53/61 ideas involve SUSI
- 53/61 ideas involve TuMag
- 76% (49 ideas + 4 proposals) have requested for quiet Sun + Network fields
- 52% (34 ideas + 2 proposals) have requested for disc center observations





Steps to build the observing plan

- All the observing ideas were grouped based on their instrument requirements
- Three lists, one for each instrument, SCIP, SUSI and TuMag, were created
- For TuMag, the observing modes are already well defined. Only two free parameters: observing mode and duration of the scan
- For SUSI and SCIP, we have many free parameters: FOV, scan speeds or integration times, intensity only or full Stokes, Spectral window for SUSI, duration of the scan
- The first step was to bin the observing ideas with similar demands and to design observing modes for these bins
- Initially, we aimed at keeping the observing plan as simple as possible with only 5 modes (SUSI and SCIP) common to all the targets. Simple plan is easier to program and to test.
- But such a plan will limit the capabilities of the instruments
- We decided to divide the total observing time into ‘flexible’ and ‘fixed’ times observations
- Total observing time ~ 75% flexible time + 25% fixed time

Steps to build the observing plan

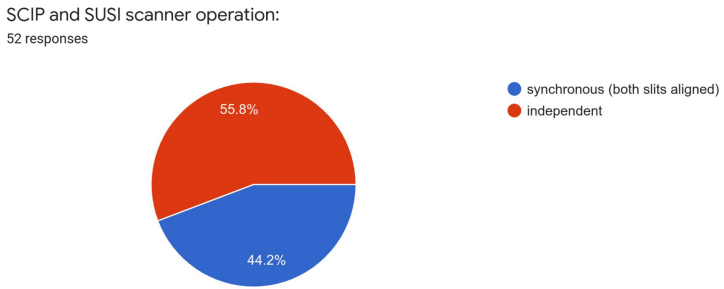
- During flexible time, the instrument teams can run their own observing plan
- During fixed time observations, the three instruments will work in a complementary way. SUSI and SCIP will work in sync modes, that is the scan time of SUSI is same as SCIP
- The total observing time requested in the observing ideas (Sunrise consortium + SOLARNET proposals) is between 116 hours and 135 hours depending on the instrument.
- The first day is dedicated to commissioning the instruments. Sunrise I and II flights lasted for five days. We assume the same for Sunrise III.
- SUSI has limited storage space. From Tino: "*the data storage system allows 86 hours (3.6 days) of uninterrupted observations of SUSI+SCIP+TUMAG. After the 86 hours, the disks are filled up to 85% only, because the write transfer speed is then getting lower and lower, but is still high enough for SCIP+TUMAG, so that these two instruments can continue their observations after the 86 hours*"
- Update: after 86 hours SUSI can continue to observe but in Stokes I mode
- We assume that for SUSI, 50% of the total observing time would be required for flat-fielding and calibration measurements
- We have ~43 hours for science observations with SUSI
- Due to limited storage space, it is very important to prioritise the observations.

Challenges observing in the UV

- Photon budget in UV is low and the photon levels go further down as we move away from the disk center
- In darker features such as umbra, we have even fewer photons
- To get good S/N ratio, SUSI must do slow spatial scans
- Often the SUSI spatial scan speeds requested in the observing ideas are not sufficient to get a good S/N ratio
- Slow spatial scans ⇒ longer time per scan
- Low cadence time-series observations are not ideal
- However, a few time-series have been designed but mostly for smaller FOV
- For CLV and limb/pole scans SUSI operates at slowest scan speed
- In addition spectral, temporal and/or spatial binning can be done to further improve the S/N ratio

Sync modes between SUSI and SCIP

- Many observing ideas have requested for sync mode between SUSI and SCIP
- Photon budget in the infrared is different compared to the UV
- Designing sync modes between SUSI and SCIP is challenging
- They could be accommodated for QSDC, CLV and limb/pole scans
- In active regions, SCIP does faster scans to capture the dynamics in the chromosphere. If SUSI does faster scans then we do not get good S/N ratio
- Hence we only have a couple of sync modes for the active regions



SCIP observing modes

	Integration time [ms]	Duration [min]	FOV [arcsec]	Data Rate [Mbps]	Data Volume [Gb]
N1D	10240	107.1	58.0	143.4	921.5
N1.5D	10240	55.3	30.0	143.4	475.6
N1F	1024	11.9	58.0	512.0	365.7
N2D	10240	37.0	20.0	143.4	318.1
N2F	1024	4.1	20.0	512.0	126.2
N3D	10240	9.3	5.1	143.4	80.3
N3F	1024	1.0	5.1	512.0	31.9
N4D	10240	1.9	1.0	143.4	16.3
N4F	1024	0.21	1.0	512.0	6.5
N5	5120	0.26	0.28	184.3	2.9
N6	1024	0.02	0.09	512.0	0.59
R1	10	0.66	58.0	601.1	23.9
R2	10	0.17	15.0	601.1	6.2
R3	10	0.012	1.0	601.1	0.42

11

(*) data rate and data volume are approximated values because of the uncertainty of image compression

D: deep mode; F: fast mode; N: normal mode with I,Q,U,V; R: rapid mode, I only

SCIP team designed 14 observing modes based on the requests in the observing ideas

An additional mode: modified N1F was later added to accommodate fixed scans in sunspots

TuMag + SCIP combination modes proposed by TuMag team

No.	Cadence	TuMag + SCIP modes	OIs covered	Target
1	87.8s	Obs 0-p + Obs 2 + N3F	4, 55	QSDC, sunspot
2		Obs 0-p + Obs 2 + N3D	10, 23	QSDC, sunspot, CLV, limb
3		Obs 0-p + Obs 2 + N2D	21 (flares)	flares
4		Obs 0-p + Obs 2 + N6	41 (flares)	flares
5		Obs 0-p + Obs 2 + R1	42 (flares)	flares
6	46.6s	Obs 0-s + Obs 2 + R1	1, 5	QSDC, sunspot, CLV, limb
7		Obs 0-s + Obs 2 + R2	46, 43, 49, 20, 31	QSDC, CLV, limb, sunspot
8	31.5s	Obs 0-s + Obs 3 + N5	19, 27	QSDC, sunspot, limb, CLV
9		(Obs 0-s + Obs 3 + N2D) Obs-1 + Obs-2 + N2D	17, 34, 44	ARcore, AR filament, AR plage
10	70.4s	Obs 1 + Obs 2 + N1F	26	QSDC, CLV
11		Obs 1 + Obs 2 + N3F	18, 57, 11, 50	QSDC
12		Obs 1 + Obs 2 + N4D	53 (polar regions)	Polar, QSDC
13		Obs 1 + Obs 2 + N2D	3	QSDC, sunspot
14		Obs 1 + Obs 2+ N1F	22, 38, 54, 24, 2	Penumbra, sunspot
15		Obs 1 + Obs 2 + N2F	30, 39, 37	Penumbra
16		Obs 1 + Obs 2 + N3F	14, 45, 7, 56	Sunspot, penumbra
17		Obs 1 + Obs 2 + N4F	52	QSDC, CLV
18		Obs 1 + Obs 2 + N6	36	QSDC, sunspot
19	26.8s	Obs 2 + N3F	28, 60, 40	QSDC, sunspot
20		Obs 2 + N5	12	QSDC
21		Obs 2 + N2D	32	sunspot
22	57.9s	Obs 4 + N3D	13, 16	Spicules/limb
23	123.5	Obs 4 + Obs 5 + N1D	6, 15, 25, 48	QSDC, CLV, limb, sunspot
24	57.7s	Obs 5 + N6	47	QSDC

QSDC: 15 modes [7 unique TuMag combinations]
CLV: 7 modes [5 unique TuMag combinations]
Limb/pole: 6 modes [6 unique TuMag combinations]
Sunspot: 12 modes [6 unique TuMag combinations]
AR core, AR filament, AR plage: 1 each

Spectral lines: **Fe I 525.02 nm + Fe I 525.06 nm + Mg I b2 517.3 nm**

Observing Modes:	N wavelengths	N pol States	N acc**	Total obs time***	Target S/N	Size (MB/s)
Obs 0-s:	15	1	2	**11,88**	500	11,22
Obs 0-p:	15	4	19	**53,1**	1000	10,04
Obs 1:	10	4	19	**35,67**	1000	9,97
Obs 2:	8	4	19	**26,74**	1000	10,63
Obs 3:	5	2	25	**11,65**	1000	7,63
Obs 4:	3	4	114	**57,83**	2500	1,84
Obs 5:	3	4	114	**57,67**	2500	1,84
PD (100 frames):	1	4	1	**10,67**	1000	66,64

Obs 0-s: **spectrocopic** mode. 15 wl sampes across the line from -70 to 70 pm with 10 pm step size for Mg I b2
Obs 0-p: **extended** mode. 15 wl sampes across the line from -70 to 70 pm with 10 pm step size with polarization for Mg I b2
Obs 1: **normal** mode. 9 wl points in the line + continuum [-30 , -20 , -10 , -5 , 0 , 5 , 10 , 20 , 30 , 70] pm for Mg I b2
Obs 2: **normal** mode. 7 wl points in the line + continuum [-12 , -8 , -4 , 0 , 4 , 8 , 12 , 22] pm for Fe I 525 lines
Obs 3: **fast** mode. 4 wl points in the line + 1 continuum [-8, -4 , 4 , 8 , 22] pm for Fe I 525 lines. Stokes I and V only.
Obs 4: **deep** mode. 3 wl points in the line [-10 , 0 , -10] pm for Mg I b2 line
Obs 5: **deep** mode. 3 wl points in the line [-8 , 0 , -8] pm for Fe I 525 lines

TuMag combination modes	Data rate [MB/s]
Obs 0-p + Obs 2	20.67
Obs 0-s + Obs 3	18.75
Obs 1 + Obs 2	20.60
Obs 4 + Obs 5	3.68
Obs 0-s + Obs 2	21.85

SUSI slit scan speeds for sync modes

7/15 SCIP modes are used for fixed observations in sync with SUSI. They are highlighted in the table.

The slit scan speed for SUSI for these sync modes are calculated below

For SCIP:
Nstep=FOV/0.0936”
Integration time= 0.512 * Npmu * Nslit
Normal mode scan time = (integration time + 0.128) * Nstep
Rapid mode scan time = 0.064 * Nstep

For SUSI:
Scan speed= FOV/(SCIP scan time)

For a given SCIP integration time, SUSI slit scan speed decreases with FOV

Sound speed
Photosphere: 7 km/s
Chrom: 10 km/s (Ca II H & K formation heights)
Upper-chrom: 15 km/s (Mg II h & k, Ly-alpha)

Corresponding scan speeds:
Photosphere: 0.0096”/s
Chrom: 0.0138”/s
Upper-chrom: 0.0206”/s

No.	Mode	FOV	Integration time	SCIP Nstep	Duration	Scan speed (arcsec/sec)
1	N1D	58” (58.032”)	10.240	620	107.1 min	0.00902
2	N1.5D	30”(30.046”)	10.240	321	55.4 min	0.00901
3	N1F	58”(58.032”)	1.024	620	11.9 min	0.0812
4	N2D	20”(20.03”)	10.240	214	36.9 min	0.00901
5	N2F	20”(20.03”)	1.024	214	4.1 min	0.0811
6	N3D	5.1”(5.05”)	10.240	54	9.5 min	0.00894
7	N3F	5.1”(5.05”)	1.024	54	1.056 min	0.0805
8	N4D	1.0”(1.03)	10.240	11	1.9 min	0.00877
9	N4F	1.0”(1.03)	1.024	11	12.6 s / 0.21 min	0.0789
10	N5	0.28”	5.120	3	15.7 s / 0.26 min	0.0178
11	N6	0.09” (s & s)	1.024	1	1.15 s / 0.02 min	-
12	R1	58”(58.032)	0.01	620	39.7 s / 0.66 min	-
13	R2	15”(15.07)	0.01	161	10.3 s / 0.17 min	-
14	R3	1.0”(1.03”)	0.01	11	0.72 s / 0.012 min	-
15	Modified N1F	58”(58.032”)	2.048	620	1349 s / 22.49 min	0.0434

Data volumes

Target	SCIP (hr) No cal	SCIP (hr) With cal	SUSI (hr) No cal	SUSI (hr) With cal	TuMag (hr) No cal	TuMag (hr) With cal	SCIP (GB)		SUSI (GB)		TuMag (GB)	TuMag (GB) With cal
Quiet Sun disc center	15.24	21.67	11.85 + 60 min	19.27	15.24	21.67	2785.8		29862.0		1041.36	
Pole	4.11	7.77	4.05	7.77	4.11	7.77	845.54		10206.0		235.824	
CLV towards pole, mu=0.7	4.6	9.5	4.25	9.5	4.6	9.5	701.85		10710.0		346.093	
CLV towards pole, mu=0.5	4.6	9.5	4.25	9.5	4.6	9.5	701.85		10710.0		346.093	
East/West limb	2.0	4.5	1.85	4.5	2.0	4.5	128.155		4649.0		148.32	
Sunspots	12.01	17.25	5.86 + 40 min	11.57	12.01	17.25	2569.1		16438.8		859.858	
Other AR targets	10.312	18.22	7.9	15.25	10.312	18.22	2754.66		20155.8		779.392	
SUSI full spectral scan (QS+ plage)	11.2	10.35 + 10.35	11.2	10.35 + 10.35	11.2	10.35 + 10.35	860.35		28224.0		833.414	
Flare observations	12	14.1	2	3.15	12	14.1	162000		5040.0		52320.9	
Low latitude coronal hole	2.33	4.72	2.33	4.72	2.33	4.72	233.51		5880.0		113.54	
Total	**66.402 + 12 = 78.402 hr**	**127.93 hr 5.33 days**	**55.04 + 2 = 57.54 hr**	**105.93 hr 4.41 days**	**66.402 + 12 = 78.402 hr**	**127.93 hr 5.33 days**	**169.521 TB**		**141.4 TB**		**55.68 TB**	

Priority blocks

- We have designed priority blocks for different targets
- These blocks contain up to four observing modes
- They can be considered as the smallest unit of observations
- The blocks make it easier to hop between targets
- The flat fielding and calibration blocks would have to be placed around these blocks and if necessary, in between them
- SUSI scans in the blue can only be done around noon
- Hence we have created Elevation-dependent (**orange**), Elevation-independent (**green**) blocks, and blocks without SUSI (**violet**)
- Elevation-independent blocks can be run any time of the day, for example, right after commissioning
- The high priority blocks are designed to be Elevation-independent

Priority blocks

- SUSI scans in the blue (λ < 350 nm) are grouped in Elevation-dependent blocks
- For QSDC, Elevation-dependent blocks can be done within a 12 hour window between 6AM - 6PM (local time). Measured flux at 300 nm, 313 nm, 388 nm & 397 nm as a function of time can be found here
- For pole and CLV observations, Elevation-dependent blocks must be done close to noon
- Some of the SUSI observations are shorter than that of SCIP and TuMag which makes the length of the priority blocks different for SUSI and SCIP or TuMag
- To get the maximum science out, we must first run the blocks which last the same duration for all three instruments. This way SUSI does not need to be turned off early in the mission. The high priority blocks are designed to be of equal length
- The blocks can be interrupted in case there is a flare. This must be agreed upon by the three instrument teams.
- If an observation in one instrument fails, then the other instruments continue. The failed instrument will either automatically join when mode changes or with manual interference
- If we are left with disk space, then the blocks can be repeated on different targets

Fixed modes
Flexi modes
Minimum success

Quiet Sun disc center

		SCIP				SUSI					TuMag				OIs covered		
No	Priority	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed (“/s)	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration	Slit position	SUSI	SCIP	TuMag
QS1	1	0.09”	1.0 s (N6)	1.0s	30	0.15”	0.01	Ca II K	15s	30	Obs 1 + Obs 2	70.4s	6.06 hrs	SUSI does small scans around SCIP	8, 27, 36, 52	12, 27, 36, 47	
QS2	2	58”	10s (N1D)	107 min	107	58”	0.00901	Ca II K	107 min	107				Sync	1, 6, 25, 4,48, 5	1, 6, 15, 25, 26, 48, 51, 60	26, 18, 57, 1, 50, 51, 3, 36, 52
QS4a	3	1”	1.0s (N4F)	12.6 s	60	1”	0.0789	Ca II H	12.6 s	60				Sync	40, 51, 52, 50, 31	11, 52	
QS4b	3	1”	1.0s (N4F)	12.6 s	60	1”	0.0789	410.5 - 407.5	12.6 s	60							
QS8	4	58”	10s (N1D)	107 min	107	58”	0.00901	410.5 - 407.5	107 min	107				Sync	1, 6, 25	1, 6, 15, 25, 26, 48, 51, 60	
QS6	5	58”	10 ms (R1)	39.6s	60	3”	0.025	410.5 - 407.5	2 min	60	Obs 0-s + Obs 2	46.6s	60 min	Independent	50, 12, 55	5	
QS3	6	58”	10s (N1D)	107 min	107	58”	0.00901	359.8 - 357.8	107 min	107	Obs 4 + Obs 5	123.5s	107 min	Sync	25, 33, 29, 20	1, 6, 15, 25, 26, 48, 51, 60	6,15,25,48
QS5a	7	5”	1s (N3F)	63 s	120	5”	0.0805	327 - 329	63 sec	120	Obs 1 + Obs 2	70.4s	120 min	Sync	25, 26, 19, 47, 11, 43	11, 52, 18, 57	28, 60, 40, 12
QS5b		0.09”	1.0 s (N6)	1.0s	60	REF SCAN	REF SCAN	407.3 nm	REF SCAN	60	Obs 1 + Obs 2	70.4s	60 min				
QS7a		58”	1s (N1F)	11.9min	11.9											4, 10	
QS7b	8	1”	10 ms (R3)	0.72s	180	1”	0.32	Ca II K	3.12s	60	Obs 0-s + Obs 2	46.6s	180 min + 23.8 min	Independent	60	20, 31, 43, 49	5, 1, 46, 43, 49, 20, 31
QS7c		58”	1s (N1F)	11.9min	11.9											4, 10	
Total (hr)					**15.24**					**12.85**			**15.24**				

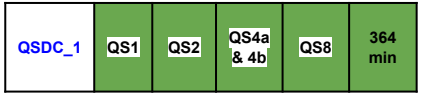
For underlined OIs more than one instrument specification requests are met at the same time

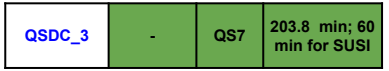
Overview slide

Fixed modes
Flexi modes

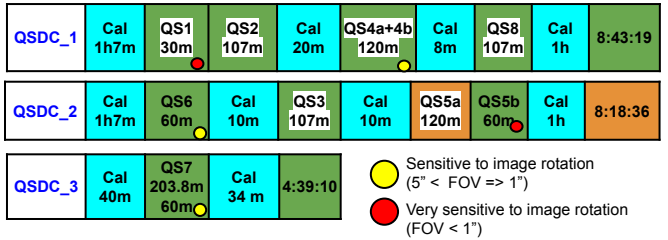
Quiet Sun disc center priority blocks

		SCIP				SUSI					TuMag		
	No	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed (“/s)	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration
QSDC_1	QS1	0.09”	1.0 s (N6)	1.0s	30	0.15”	0.01	Ca II K	15s	30	Obs 1 + Obs 2	70.4s	6.06 hrs
	QS2	58”	10s (N1D)	107 min	107	58”	0.00901	Ca II K	107 min	107			
	QS4a	1”	1.0s (N4F)	12.6 s	60	1”	0.0789	Ca II H	12.6 s	60			
	QS4b	1”	1.0s (N4F)	12.6 s	60	1”	0.0789	410.5 - 407.5	12.6 s	60			
	QS8	58”	10s (N1D)	107 min	107	58”	0.00901	410.5 - 407.5	107 min	107			
QSDC_2	QS6	58”	10 ms (R1)	39.6s	60	3”	0.025	410.5 - 407.5	2 min	60	Obs 0-s + Obs 2	46.6s	60 min
	QS3	58”	10s (N1D)	107 min	107	58”	0.00901	359.8 - 357.8	107 min	107	Obs 4 + Obs 5	123.5s	107 min
	QS5a	5”	1s (N3F)	63 s	120	5”	0.0805	327 - 329	63 sec	120	Obs 1 + Obs 2	70.4s	120 min
	QS5b	0.09”	1.0 s (N6)	1.0s	60	REF SCAN	REF SCAN	407.3 nm	REF SCAN	60	Obs 1 + Obs 2	70.4s	60 min
QSDC_3	QS7a	58”	1s (N1F)	11.9min	11.9	1”	0.32	Ca II K	3.12s	60	Obs 0-s + Obs 2	46.6s	180 min + 23.8 min
	QS7b	1”	10 ms (R3)	0.72s	180								
	QS7c	58”	1s (N1F)	11.9min	11.9								
	Total (hr)				**15.24**					**12.85**			**15.24**





With cal blocks



Spectral window	407.5 nm - 410.5 nm	Ca II K	Ca II H	327.0 nm - 329.0 nm	357.8 nm - 359.8 nm	385.9 nm - 387.9 nm	406.0 nm - 408.6 nm
Central wavelength	409.0 nm	393.8 nm	396.8 nm	328 nm	358.8 nm	386.9 nm	407.3 nm

In the above blocks, the fixed modes are highlighted in white

- We created three priority blocks. The number indicates the priority.
- Blocks 1 & 3 are Elevation-independent. They can be run anytime of the day, for example, right after commissioning.
- Only if we can run Block 1 for 6 hours continuously without interrupting for calibration/flat fielding then QS8 is part of Block 1. Otherwise, QS8 is in Block 2.

Overview slide

Fixed modes
Flexi modes
Minimum success

Quiet Sun disc center

Data rates and volume

		SCIP						SUSI (Data rate: 700 MB/s)						TuMag				
No	Priority	FOV	Exposure	Scan time	Duration (min)	Data rate [MB/s]	Data volume [GB]	FOV	Scan speed (“/s)	Sp. window	Scan time	Duration (min)	Data volume [GB]	Mode	Cadence	Duration	Data rate [MB/s]	Data volume [GB]
QS1	1	0.09”	1.0 s (N6)	1.0s	30	64.0	115.2	0.15”	0.01	Ca II K	15s	30	1260.0	Obs 1 + Obs 2	70.4s	6.06 hrs	20.6	449.41
QS2	2	58”	10s (N1D)	107 min	107	17.925	115.078	58”	0.00901	Ca II K	107 min	107	4494.0					
QS4a & 4b	3	1”	1.0s (N4F)	12.6s	120	64.0	460.8	1”	0.0789	Ca II H+ 410-407	12.6s	60 + 60	5040.0					
QS8	4	58”	10s (N1D)	107 min	107	17.925	115.078	58”	0.00901	410.5 - 407.5	107 min	107	4494.0					
QS6	5	58”	10 ms (R1)	39.6s	60	75.1375	270.495	3”	0.025	410.5 - 407.5	2 min	60	2520.0	Obs 0-s + Obs 2	46.6s	60 min	21.85	78.66
QS3	6	58”	10s (N1D)	107 min	107	17.925	115.078	58”	0.00901	359.8 - 357.8	107 min	107	4494.0	Obs 4 + Obs 5	123.5s	107 min	3.68	23.63
QS5a	7	5”	1s (N3F)	63 s	120	64.0	460.8	5”	0.0805	327 - 329	63 sec	120	5040.0	Obs 1 + Obs 2	70.4s	180 min	20.6	222.48
QS5b		0.09”	1.0 s (N6)	1.0s	60	64.0	230.4	REF SCAN	REF SCAN	407.3 nm	REF SCAN	60	2520.0					
QS7a		58”	1s (N1F)	11.9min	11.9	64.0	45.696											
QS7b	8	1”	10 ms (R3)	0.72s	180	75.1375	811.485	1”	0.32	Ca II K	3.12s	60	2520.0	Obs 0-s + Obs 2	46.6s	203.8 min	21.85	267.18
QS7c		58”	1s (N1F)	11.9min	11.9	64.0	45.696											
					15.24 hr		**2785.8 GB**					**12.85 hr**	**29862.0 + 2520.0 GB**			**15.24 hr**		**1041.36 GB**

Overview slide

Quiet Sun disc center high cadence

	SCIP				SUSI					TuMag			
Name	FOV	cadence	No. of steps	Duration (min)	FOV	Scan speed (“/s)	Sp. window	Scan time	Duration (min)	Line	Wavelength sampling	Cadence	Duration (min)
QSHC1	3”	2.0 s (rapid mode)	32	30	1”	0.33	407.3	3.03s	10	5250.2A	5 points	4.8s	10
QSHC2					1”	0.16	407.3	6.25s	10	5250.2 + 80mA	1 point	1s	10
QSHC3					1”	0.083	407.3	12.05s	10	5250.2A	5 points	4.8s	10
Total (minutes)				**30.0**					**30.0**				**30.0**

Spectral window	406.0 nm - 408.6 nm
Central wavelength	407.3 nm

QSDC_HC	Cal 41 m	QSHC1 10 m	QSHC2 10 m	QSHC3 10 m	1:14:58

- New timeline requested by the TuMag team
- High cadence quiet Sun observations are used for “Ultra-local Helioseismology”. Essentially, it involves detecting the propagation of transient acoustic waves in the quiet Sun with Sunrise. These waves have been observed naturally in MuRAM simulations in the mid-low photosphere and propagate vertically and spatially along the surface.

Overview slide

SUSI full spectral scan

Fixed modes
Flexi modes

		SCIP				SUSI					TuMag			OIs covered			
No.	Target	FOV	Exposure	Scan time	Duration	FOV	Scan speed	Sp. window	Scan time	Duration	Mode	Cadence	Duration	SUSI & SCIP slit positions	SUSI	SCIP	TuMag
FS1	QS	15”	6.144s	16.7 min	5.6 hr	5”	0.01”/s	Entire range	8.3 min	40 x 8.3 = 5.6 hrs	Obs 2	26.74s	5.6hr	independent	58, 59	-	-
FS2	Plage	15”	6.144s	16.7 min	5.6 hr	5”	0.01”/s	Entire range	8.3 min	40 x 8.3 = 5.6 hrs	Obs 2	26.74s	5.6hr	independent	58, 59	-	-
					11.2 hr					11.2 hr			11.2 hr				

- For SUSI, full spectral scan is high priority
- We would like to do this right after QSDC scans
- We would like to have one scan in QS and one in an active region

Overview slide

SUSI full spectral scan priority blocks

Fixed modes
Flexi modes

		SCIP				SUSI					TuMag		
	No.	Target	FOV	Exposure	Scan time	Duration	FOV	Scan speed	Sp. window	Scan time	Duration	Mode	Cadence	Duration
FS_1	FS1	QS	7.5”	6.144s	8.3 min	5.6 hr	5”	0.01”/s	Entire range	8.3 min	40 x 8.3 = 5.6 hrs	Obs 2	26.74s	5.6hr
FS_1	FS2	Plage	7.5”	6.144s	8.3 min	5.6 hr	5”	0.01”/s	Entire range	8.3 min	40 x 8.3 = 5.6 hrs	Obs 2	26.74s	5.6hr
						11.2 hr					11.2 hr			11.2 hr

FS_1	FS1	336 min
FS_1	FS2	336 min

With cal blocks

FS_1	Cal 2h12 m	FS1 6h	Cal 2h 20m	10:21 :40

[UV flux measurement from Tino]

No.	Spectral window (nm)	Central wav. (nm)
1	309.0 - 310.9	309.95
2	310.9 - 312.8	311.85
3	312.8 - 314.7	313.75
4	314.7 - 316.6	315.65
5	316.6 - 318.5	317.55
6	318.5 - 320.4	319.45
7	320.4 - 322.3	321.35
8	322.3 - 324.2	323.25
9	324.2- 326.1	325.15
10	326.1 - 328.0	327.05

No.	Spectral window (nm)	Central wav. (nm)
11	328.0 - 329.9	328.95
12	329.9 - 332.1	331.0
13	332.1 - 334.3	333.2
14	334.3 - 336.5	335.4
15	336.5 - 338.7	337.6
16	338.7 - 340.9	339.8
17	345.3 - 347.5	346.4
18	347.5 - 349.7	348.6
19	349.7 - 351.9	350.8
20	351.9 - 354.1	353.0

No.	Spectral window (nm)	Central wav. (nm)
21	354.1 - 356.3	355.2
22	356.3 - 358.5	357.4
23	358.5 - 360.7	359.6
24	360.7 - 362.9	361.8
25	362.9 - 365.1	364.0
26	365.1 - 367.3	366.2
27	367.3 - 369.5	368.4
28	385.8 - 388.0	386.9
29	388.0 - 390.2	389.1
30	390.2 - 392.4	391.3

No.	Spectral window (nm)	Central wav. (nm)
31	392.4 - 394.6	393.5
32	394.6 - 396.8	395.7
33	396.8 - 399.0	397.9
34	399.0 - 401.2	400.1
35	401.2 - 403.4	402.3
36	403.4 - 405.6	404.5
37	405.6 - 408.6	407.1
38	408.6 - 411.6	410.1
39	411.6 - 414.6	413.1
40	414.6 - 417.6	416.1

More details on the chosen spectral windows can be found here

Overview slide

SUSI full spectral scan priority blocks

Execution sequence

309.95f (Free spectral scan, n=6, odd)
313.75f (Pos. 6.3)
317.55f (Pos. 6.5)
321.35f (Pos. 6.7)
325.15f (Pos. 6.9)
328.95f (Pos. 6.11)
400.10f (Pos. 5.23)
395.70f (Pos. 5.21)
391.30f (Pos. 5.19)
386.90f (Pos. 5.17)
366.20f (Pos. 5.15)
361.80f (Pos. 5.13)
357.40f (Pos. 5.11)
353.00f (Pos. 5.9)
348.60f (Pos. 5.7)
339.80f (Pos. 5.5)
335.40f (Pos. 5.3)
331.00f (Pos. 5.1)
——————————————
404.50f (Pos. 4.1)
410.10f (Pos. 4.3)
416.10f (Pos. 4.5)

311.85f (Free spectral scan, n=6, even)
315.65f (Pos. 6.4)
319.45f (Pos. 6.6)
323.25f (Pos. 6.8)
327.05f (Pos. 6.10)
402.30f (Pos. 5.24)
397.90f (Pos. 5.22)
393.50f (Pos. 5.20)
389.10f (Pos. 5.18)
368.40f (Pos. 5.16)
364.00f (Pos. 5.14)
359.60f (Pos. 5.12)
355.20f (Pos. 5.10)
350.80f (Pos. 5.8)
346.40f (Pos. 5.6)
337.60f (Pos. 5.4)
333.20f (Pos. 5.2)
407.10f (Pos. 4.2)
413.10f (Pos. 4.4)

UV flux measurement from Tino

More details on the chosen spectral windows can be found here

SUSI full spectral scan

Data rates and volume

Fixed modes
Flexi modes

		SCIP						SUSI (Data rate: 700 MB/s)						TuMag				
No.	Target	FOV	Exposure	Scan time	Duration	Data rate [MB/s]	Data volume [GB]	FOV	Scan speed	Sp. window	Scan time	Duration (min)	Data volume [GB]	Mode	Cadence	Duration	Data rate [MB/s]	Data volume [GB]
FS1	QS	15”	6.144s	16.7 min	5.6 hr	21.338	430.174	5”	0.01”/s	Entire range	8.3 min	40 x 8.3 = 5.6 hrs	14112.0	Obs 2	26.74s	5.6hr	10.63	214.3
FS2	Plage	15”	6.144s	16.7 min	5.6 hr	21.338	430.174	5”	0.01”/s	Entire range	8.3 min	40 x 8.3 = 5.6 hrs	14112.0	Obs 2	26.74s	5.6hr	10.63	214.3
					11.2 hr		**860.35 GB**					**11.2 hr**	**28224.0 GB**			**11.2 hr**		**428.6 GB**

Overview slide

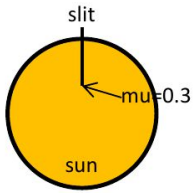
Pole modes

Fixed modes
Flexi modes

		SCIP				SUSI					TuMag			OIs covered			
No.	Priority	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration (min)	Slit position	SUSI	SCIP	TuMag
PL1	1	30”	10.0 s (N1.5D)	55 min	55	30”	0.00901 ”/s	Ca II K	55 min	55	Obs 4	57.9s	55	Sync	13, 16	1, 13, 48	2
PL4	TBD	1”	1s (N4F)	12.6s	60	0.15”	0.01”/s	Ca II K	15s	60	Obs 1 + Obs 2	70.4s	120	Independent		16, 52, 53	26, 53, 52
PL5	TBD	S&S	1s (N6)	0.02m	60	1”	0.01”/s	Ca II H	100s	60				Independent	13, 16 ,53	13, 16, 53	
PL2	TBD	58”	10ms (R1)	~40s	62	20”	0.009”/s	410.5 - 407.5	37 min	37	Obs 0-s + Obs 3	31.5s	74	Independent	16	46, 49	19
PL3	TBD	58”	1s (N1F)	12 min	12	20”	0.009”/s	359.8 -357.8	37 min	37				Independent	19, 33, 35	5, 10	
					4.15 hr					**4.15 hr**			**4.15 hr**				

For underlined OIs more than one instrument specification requests are met at the same time

Slit position



In the pole mode, we cover upto mu=0.3 then we go for mu=0.5 and mu=0.7 in the CLV mode

→ If 20” is off limb + 40” is on-disk then the bottom of slit is at mu~0.28
→ If 12” is off limb + 48” is on-disk then the bottom of slit is at mu~0.31
We can go for 15” off limb + 45” on-disk.

Pole priority blocks

Fixed modes
Flexi modes

	No.	Priority	SCIP FOV	SCIP Exposure	SCIP Scan time	SCIP Duration (min)	SUSI FOV	SUSI Scan speed	SUSI Sp. window	SUSI Scan time	SUSI Duration (min)	TuMag Mode	TuMag Cadence	TuMag Duration (min)
PL_1	PL1	1	30”	10.0 s (N1.5D)	55 min	55	30”	0.00901 ”/s	Ca II K	55 min	55	Obs 4	57.9s	55
PL_1	PL4	TBD	1”	1s (N4F)	12.6s	60	0.15”	0.01”/s	Ca II K	15s	60	Obs 1 + Obs 2	70.4s	120
PL_1	PL5	TBD	S&S	1s (N6)	0.02m	60	1”	0.01”/s	Ca II H	100s	60			
PL_2	PL2	TBD	58”	10ms (R1)	~40s	62	20”	0.00901 ”/s	410.5 - 407.5	37 min	37	Obs 0-s + Obs 3	31.5s	74
PL_2	PL3	TBD	58”	1s (N1F)	12 min	12	20”	0.00901 ”/s	359.8 -357.8	37 min	37			

4.15 hr | 4.15 hr | 4.15 hr

Spectral window	407.5 nm - 410.5 nm	Ca II K	Ca II H	327.0 nm - 329.0 nm	357.8 nm - 359.8 nm	385.9 nm - 387.9 nm
Central wavelength	409.0 nm	393.8 nm	396.8 nm	328 nm	358.8 nm	386.9 nm

PL_1	PL1	PL4	PL5	175 min	
PL_2	PL2	PL3	74 min		

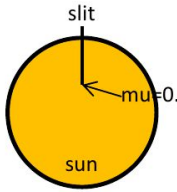
With cal blocks

PL_1	Cal 1h7m	PL1 55m	PL4 60m	Cal 10m	PL5 60m	Cal 1h	5:14:48
PL_2	Cal 41m	PL2 62m 37m	PL3 12m 37m	Cal 33m	2:30:40		

Sensitive to image rotation (5” < = FOV => 1”)

Very sensitive to image rotation (FOV < 1”)

Slit position



In the pole mode, we cover upto mu=0.3 then we go for mu=0.5 and mu=07 in the CLV mode

→ If 20” is off limb + 40” is on-disk then the bottom of slit is at mu~0.28
→ If 12” is off limb + 48” is on-disk then the bottom of slit is at mu~0.31
We can go for 15” off limb + 45” on-disk.

In the above blocks, the fixed modes are highlighted in white

Pole modes

Data rates and volume

Flexi modes
Fixed modes

		SCIP						SUSI (700 MB/s)						TuMag				
No.	**Priority**	**FOV**	**Exposure**	**Scan time**	**Duration (min)**	**Data rate [MB/s]**	**Data volume [GB]**	**FOV**	**Scan speed**	**Sp. window**	**Scan time**	**Duration (min)**	**Data volume [GB]**	**Mode**	**Cadence**	**Duration (min)**	**Data rate [MB/s]**	**Data volume [GB]**
PL1	1	30”	10.0 s (N1.5D)	55 min	55	17.925	59.152	30”	0.00901”/s	Ca II K	55 min	55	2310.0	Obs 4	57.9s	55	1.84	6.072
PL4	TBD	1”	1s (N4F)	12.6s	60	64.0	230.4	0.15”	0.01”/s	Ca II K	15s	60	2520.0	Obs 1 + Obs 2	70.4s	120	20.6	148.320
PL5	TBD	S&S	1s (N6)	0.02m	60	64.0	230.4	1”	0.01”/s	Ca II H	100s	60	2520.0					
PL2	TBD	58”	10ms (R1)	~40s	62	75.138	279.513	20”	0.009”/s	410.5 - 407.5	37 min	37	1554.0	Obs 0-s + Obs 3	31.5s	74	18.85	81.432
PL3	TBD	58”	1s (N1F)	12 min	12	64.0	46.08	20”	0.009”/s	359.8 -357.8	37 min	37	1554.0					
					4.15 (hr)		**845. 545 GB**					**4.15 (hr)**	**10206 GB**			**4.15 (hr)**		**235.824 GB**

Overview slide

E-W limb modes

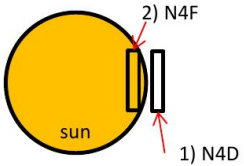
Fixed modes
Flexi modes

	SCIP				SUSI					TuMag			OIs covered			
No.	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration	SUSI & SCIP slit positions	SUSI	SCIP	TuMag
EW1	1”	10s (N4D)	1.9min	60	20”	0.009”/s	410.5 - 407.5	37 min	37	Obs 1 + Obs 2	70.4s	137 min	Independent		13	26, 53, 52
EW2	10”	1s	2 min	16.7	10”	0.01”/s	385.9-387.9	16.7 min	16.7				Independent	61	-	
EW3	S&S cycle	10s	33 sec per sparse raster	60	0.15”	0.01”/s	Ca II K	15s	60				SCIP slit at 3”, 5”, 7” off limb and repeat.	13, 53	SOLARNET proposal	
				2.3 hr					**1.89 hr**			**2.3 hr**				

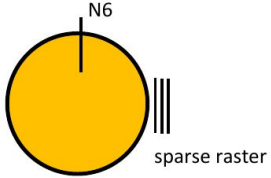
- E-W limb scan is low priority
- To be discussed: SUSI cannot do the sparse raster with SCIP for EW3.
- EW3: SUSI can do 0.15” scans at one off-limb position for 60 minutes

Slit positions

No 4 of EW limb mode



No5 of polar & EW limb mode



Overview slide

E-W limb priority blocks

	SCIP				SUSI					TuMag		
	No.	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration
EW_1	EW1	○ 1”	10s (N4D)	1.9min	60	20”	0.009”/s	410.5 - 407.5	37 min	37	Obs 1 + Obs 2	70.4s	137 min
	EW2	10”	1s	2min	16.7	10”	0.01”/s	385.9 - 387.9	16.7 min	16.7			
	EW3	● S&S cycle	10s	33 sec per sparse raster	60	● 0.15”	0.01”/s	Ca II K	15s	60			
					2.3h					1.89 hr			2.3 hr

EW_1	EW1	EW2	EW3	120 min; 111 min for SUSI

With calib block

EW_1	Cal 1h7m	EW1 60m 37m ○	EW2 16.7m	EW3 60m ●	Cal 1h	4:28:20

Spectral window	407.5 nm - 410.5 nm	Ca II K	Ca II H	327.0 nm - 329.0 nm	357.8 nm - 359.8 nm	385.9 nm - 387.9 nm
Central wavelength	409.0 nm	393.8 nm	396.8 nm	328 nm	358.8 nm	386.9 nm

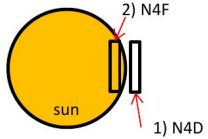
- E-W limb scan is low priority
- To be discussed: SUSI cannot do the sparse raster with SCIP for EW3.
- EW3: SUSI can do 0.15” scans at one off-limb position for 60 minutes

○ Sensitive to image rotation (5” < = FOV => 1”)

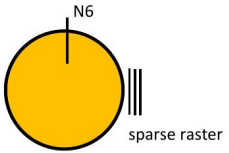
● Very sensitive to image rotation (FOV < 1”)

Slit positions

No 4 of EW limb mode



No5 of polar & EW limb mode



Overview slide

E-W limb modes

Data rates and volume

Flexi modes

	SCIP						SUSI (data rate: 700 MB/s)						TuMag				
No.	**FOV**	**Exposure**	**Scan time**	**Duration (min)**	**Data rate [MB/s]**	**Data volume [GB]**	**FOV**	**Scan speed**	**Sp. window**	**Scan time**	**Duration (min)**	**Data volume [GB]**	**Mode**	**Cadence**	**Duration**	**Data rate [MB/s]**	**Data volume [GB]**
EW1	1”	10s (N4D)	1.9min	60	17.925	64.53	20”	0.009”/s	410.5 - 407.5	37 min	37	1554.0					
EW2	10”	1s	2min	16.3	-	-	10”	0.01”/s	385.9 - 387.9	16.7 min	16.7	701.4	Obs 1 + Obs 2	70.4s	120 min	20.60	148.32
EW3	S&S cycle	10s	33s per spare raster	60	17.675	63.625	1”	0.01”/s	Ca II K	100s	60	2520.0					
				2 hr		**128.155 GB**					**1.89 hr**	**4775.4 GB**			**2 hr**		**148.32 GB**

Overview slide

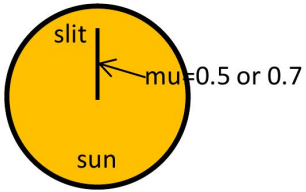
CLV towards pole

Flexi modes
Fixed modes

		SCIP				SUSI					TuMag			OIs covered			
No.	Priority	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration (min)	Slit position	SUSI	SCIP	TuMag
CLV1	TBD	58”	10.0 s (N1D)	107 min	107	58”	0.00901”/s	Ca II K	107 min	107	Obs 1 + Obs 2	70.4s	107	Sync. To be reduced to 30” if necessary	26, 48	1, 13, 26, 48	48
CLV4	TBD	1”	1s (N4F)	12.6s	60	0.15”	0.01”/s	Ca II K	15s	60	Obs 0-p + Obs 2	87.8s	60	Independent	52, 8	52	26,52
CLV5	TBD	20”	10s (N2D)	37 min	37	30”	0.025”/s	Ca II H	20 min	20	Obs 0-p + Obs 2	87.8s	37	Independent	48, 26	1, 13, 26, 48	10
CLV2	TBD	58”	10ms (R1)	39.6s	60	20”	0.009”/s	410.5 - 407.5	37 min	37	Obs 0-s + Obs 2	46.6s	60	Independent	26	5	5, 1, 46
CLV3	TBD	58”	1s (N1F)	12 min	12	20”	0.009”/s	359.8 - 357.8	37 min	37	Obs 0-p + Obs 2	87.8s	12	Independent	19, 33, 46, 48, 59	10	10
					4.6 hr/mu					**4.35 hr/mu**			**4.6 hr/mu**				

For underlined OIs more than one instrument specification requests are met at the same time

Slit positions



- Repeat at two mu values, mu=0.5 and mu=0.7
- Slits to be adjusted such that the center of the slit is at mu=0.5 or mu=0.7

Overview slide

CLV towards pole priority blocks

Flexi modes
Fixed modes

		SCIP				SUSI					TuMag		
	No.	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration (min)
CLV_1	CLV1	58”	10.0 s (N1D)	107 min	107	58”	0.00901”/s	Ca II K	107 min	107	Obs 1 + Obs 2	70.4s	107
	CLV4	1”	1s (N4F)	12.6s	60	0.15”	0.01”/s	Ca II K	15s	60	Obs 0-p + Obs 2	87.8s	60
CLV_2	CLV5	20”	10s (N2D)	37 min	37	30”	0.025”/s	Ca II H	20 min	20	Obs 0-p + Obs 2	87.8s	37
	CLV2	58”	10ms (R1)	39.6s	60	20”	0.009”/s	410.5 - 407.5	37 min	37	Obs 0-s + Obs 2	46.6s	60
	CLV3	58”	1s (N1F)	12 min	12	20”	0.009”/s	359.8 - 357.8	37 min	37	Obs 0-p + Obs 2	87.8s	12
					4.6 hr/mu					**4.35 hr/mu**			**4.6 hr/mu**

CLV_1	CLV1	CLV4	167 min	
CLV_2	CLV5	CLV3	CLV2	109 min or 94 min for SUSI

With calib blocks

CLV_1	Cal 1h7m	CLV1 107m	Cal 9m	CLV4 60m	Cal 1h	5:03:33
CLV_2	Cal 1h7m	CLV5 37m 20m	CLV3 12m 37m	CLV2 60m 37m	Cal 1h	4:26:30

Sensitive to image rotation (5” < = FOV => 1”)
Very sensitive to image rotation (FOV < 1”)

In the above blocks, the fixed modes are highlighted in white

CLV1 and CLV4 are grouped in Block 1 so that the length of the high priority block is the same for all three instruments

Spectral window	407.5 nm - 410.5 nm	Ca II K	Ca II H	327.0 nm - 329.0 nm	357.8 nm - 359.8 nm	385.9 nm - 387.9 nm
Central wavelength	409.0 nm	393.8 nm	396.8 nm	328 nm	358.8 nm	386.9 nm

Overview slide

CLV towards pole

Data rates and volume

Fixed modes
Flexi modes

	SCIP						SUSI (Data rate: 700 MB/s)						TuMag				
No.	FOV	Exposure	Scan time	Duration (min)	Data rate [MB/s]	Data volume [GB]	FOV	Scan speed	Sp. window	Scan time	Duration (min)	Data volume [GB]	Mode	Cadence	Duration (min)	Data rate [MB/s]	Data volume [GB]
CLV1	58”	10.0 s (N1D)	107 min	107	17.925	115.079	58”	0.00901”/s	Ca II K	107 min	107	4494.0	Obs 1 + Obs 2	70.4s	107	20.60	132.252
CLV4	1”	1s (N4F)	12.6s	60	64.0	230.4	0.15”	0.01”/s	Ca II K	15s	60	2520.0	Obs 0-p + Obs 2	87.8s	60	20.67	74.412
CLV5	20”	10s (N2D)	37 min	37	17.925	39.794	30”	0.025”/s	Ca II H	20 min	20	840.0	Obs 0-p + Obs 2	87.8s	37	20.67	45.887
CLV2	58”	10ms (R1)	39.6s	60	75.138	270.497	20”	0.00901”/s	410.5 - 407.5	37 min	37	1554.0	Obs 0-s + Obs 2	46.6s	60	21.85	78,660
CLV3	58”	1s (N1F)	12 min	12	64.0	46.08	20”	0.00901”/s	359.8 - 357.8	37 min	37	1554.0	Obs 0-p + Obs 2	87.8s	12	20.67	14.882
				4.6 hr/mu		**701.85 GB**					**4.35 hr/mu**	**10962.0 GB**			**4.6 hr/mu**		**346.093 GB**

Overview slide

Sunspot modes

Fixed modes
Flexi modes
Minimum success

			SCIP				SUSI					TuMag			OIs covered			
No.	Priority	Target	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed (“/s)	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration (min)	Slit position	SUSI	SCIP	TuMag
SP1	TBD	Sunspot	58”	2.048 s (mod. N1F)	22.5 min	22.5	58”	0.043	Ca II H	22.5 min	22.5	Obs 1 + Obs 2	70.4s	129.5	Aligned	2, 22	2, 10, 22, 37, 38, 39, 54	3, 22, 38, 54, 24, 2, 30
SP2	TBD	Sunspot	58”	10 ms (R1)	~40s	107	58”	0.00901	Ca II K	107 min	107				independent	37	5, 42	39, 37, 14, 45, 7, 56, 36
SP4a	TBD	Sunspot	0.09”	1s (N6)	1s	60	0.15”	0.01	Ca II H	15 s	60	Obs 0-s + Obs 3	31.5s	120	Center of sunspot for SL9	27, 36, 8, SL9	27, 36, 41, SL9	27, SL9
SP4b	TBD	Sunspot	0.09”	1s (N6)	1s	60	0.15”	0.01	410.5 - 407.5	15 s	60				Center of sunspot?	27, 36	27, 36, 41	
SP3	TBD	Sunspot	58”	1.0s (N1F)	11.9 min	11.9	58”	0.0812	410.5-407.5	11.9 min	11.9				Aligned	54	2, 10, 22, 37, 38, 39, 54	3, 22, 38, 54,
SP8	TBD	Sunspot penumbra	1”	1s (N4F)	12.6s	180	3”	0.08	327-329	37.5s	60	Obs 1 + Obs 2	70.4s	191.9	Independent	30, 39, 14	14, 30, 45, 52, 56	24, 2, 30, 39, 37, 14, 45, 7, 56, 36
SP6	TBD	Sunspot	58”	1s (N1F)	11.9 min	11.9 m/day = 47.6 m	-	-	-	-	-	Obs 1 + Obs 2	70.4s	11..9 min/day			2, 10, 22, 37, 38, 39, 54	
SP7a	TBD	Sunspot	1”	10ms (R3)	0.72s	60	-	-	-	-	-	Obs 0-s + Obs 3	31.5s	237 min			31	27
SP7b	TBD	Sunspot	58”	1s (N1D)	107 min	107	-	-	-	-	-						2, 10, 22, 37, 38, 39, 54	
SP9	TBD	Sunspot	5.1”	N3F	1.056 min	70	5.1” + REF SCAN	0.0805	Ca II H + 399.6 nm	63.3 s	30 + 40 (REF SCAN)							
						12.01 hr					**5.86 hr**			**12.01 hr**				

For the highlighted SUSI spectral window, Ca II K was changed to Ca II H

For underlined OIs more than one instrument specification requests are met at the same time

Overview slide

Sunspot priority blocks

Fixed modes
Flexi modes

	No.	Target	SCIP FOV	SCIP Exposure	SCIP Scan time	SCIP Duration (min)	SUSI FOV	SUSI Scan speed ("/s)	SUSI Sp. window	SUSI Scan time	SUSI Duration (min)	TuMag Mode	TuMag Cadence	TuMag Duration (min)
SP_1	SP1	Sunspot	58"	2.048 s (mod. N1F)	22.5 min	22.5	58"	0.0430	Ca II H	22.5 min	22.5	Obs 1 + Obs 2	70.4s	129.5
	SP2	Sunspot	58"	10 ms (R1)	~40s	107	58"	0.00901	Ca II K	107 min	107			
	SP4a	Sunspot	0.09"	1s (N6)	1s	60	0.15"	0.01	Ca II H	15 s	60	Obs 0-s + Obs 3	31.5s	190
	SP4b	Sunspot	0.09"	1s (N6)	1s	60	0.15"	0.01	410.5 - 407.5	15 s	60			
	SP9	Sunspot	5.1"	1s (N3F)	1.056 min	70	5.1" + REF SCAN	0.0805	Ca II H + 407.3 nm	63.3 s	30 + 40 (REF SCAN)			
SP_2	SP3	Sunspot	58"	1.0s (N1F)	11.9 min	11.9	58"	0.0812	410.5-407.5	11.9 min	11.9			
	SP8	Sunspot penumbra	1"	1s (N4F)	12.6s	180	3"	0.08	327-329	37.5s	60	Obs 1 + Obs 2	70.4s	191.9
SP_3	SP7a	Sunspot	1"	10ms (R3)	0.72s	60	-	-	-	-	-			
	SP7b	Sunspot	58"	1s (N1D)	107 min	107	-	-	-	-	-	Obs 0-s + Obs 3	31.5s	167 min
SP_4	SP6	Sunspot	58"	1s (N1F)	11.9 min	11.9 m/day = 47.6 m	-	-	-	-	-	Obs 1 + Obs 2	70.4s	11.9 min/day
						12.1hr					6.52 hr			12.1 hr

SP_1	SP1	SP2	SP4a &4b	SP9	320 min		
SP_2	SP3	SP8	-	192 min or 72 min for SUSI			
SP_3 No SUSI	SP7a	SP7b	167 min				
SP_4 No SUSI	SP6	11.9 min					

SP_4 block to be done on same sunspot everyday for 4 days. Does not involve SUSI.

With cal blocks

SP_1	Cal 1h7m	SP1 22.5m	SP2 107m	Cal 10m	SP4a + 4b 120m	Cal 20m	SP9 70m	Cal 1h	8:13:22	
SP_2	Cal 1h7m	SP3 11.9m	SP8 180m 60m	Cal 1h	5:21:30					
SP_3 No SUSI	SP7a 60m	SP7b 107m	Cal 33m	3:27:18						
SP_4 No SUSI	SP6 11.9m	0:14:41								

Sensitive to image rotation (5" < FOV => 1")

Very sensitive to image rotation (FOV < 1")

In the above blocks, the fixed modes are highlighted in white

→ SP6 is to be repeated on the same sunspot everyday for 4 days by SCIP and TuMag.

Spectral window	407.5 nm - 410.5 nm	Ca II K	Ca II H	327.0 nm - 329.0 nm	357.8 nm - 359.8 nm	385.9 nm - 387.9 nm	406.0 nm - 408.6 nm
Central wavelength	409.0 nm	393.8 nm	396.8 nm	328 nm	358.8 nm	386.9 nm	407.3 nm

Overview slide

Sunspot modes

Data rates and volume

Fixed modes
Flexi modes
Minimum success

		SCIP						SUSI						TuMag				
No.	Target	FOV	Exposure	Scan time	Duration (min)	Data rate [MB/s]	Data volume [GB]	FOV	Scan speed (“/s)	Sp. window	Scan time	Duration (min)	Data volume [GB]	Mode	Cadence	Duration (min)	Data rate [MB/s]	Data volume [GB]
SP1	Sunspot	58”	2.048 s (mod. N1F)	22.5 min	22.5	38.4	51.84	58”	0.043	Ca II H	22.5 min	22.5	945.0	Obs 1 + Obs 2	70.4 s	129.5	20.6	160.062
SP2	Sunspot	58”	10 ms (R1)	~40s	107	75.138	482.38	58”	0.00901	Ca II K	107 min	107	4494.0					
SP4a	Sunspot	0.09”	1s (N6)	1s	60	64.0	230.4	0.15”	0.01	Ca II H	15 s	60	2520.0	Obs 0-s + Obs 3	31.5 s	120	18.85	135.72
SP4b	Sunspot	0.09”	1s (N6)	1s	60	64.0	230.4	0.15”	0.01	410.5 - 407.5	15 s	60	2520.0					
SP3	Sunspot	58”	1.0s (N1F)	11.9 min	11.9	64.0	45.696	58”	0.0812	410.5-407.5	11.9 min	11.9	499.8					
SP8	Sunspot penumbra	1”	1s (N4F)	12.6s	180	64.0	691.20	3”	0.08	327-329	37.5s	60	2520.0	Obs 1 + Obs 2	70.4 s	191.9	20.6	237.189
SP6	Sunspot	58”	1s (N1F)	11.9 min	11.9 m/day 47.6 m	64.0	45.696 x 4	-	-	-	-	-		Obs 1 + Obs 2	70.4 s	11..9 min/day	20.6	14.71/day
SP7a	Sunspot	1”	10ms (R3)	0.72s	60	75.138	270.495	-	-	-	-	-						
SP7b	Sunspot	58”	1s (N1D)	107 min	107	17.925	115.079	-	-	-	-	-		Obs 0-s + Obs 3	31.5 s	237.0	18.85	268.047
SP9	Sunspot	5.1”	1s (N3F)	1.056 min	70	64.0	268.8	5.1” + REF SCAN	0.0805	Ca II H + 399.6	63.3 s	30 + (40)	2940.0					
					12.01		**2569.1 GB**					**6.52 hr**	**16438.8 GB**			**12.01 hr**		**859.858 GB**

For the highlighted SUSI spectral window, Ca II K was changed to Ca II H

Overview slide

Other active region modes

Fixed modes
Flexi modes

			SCIP				SUSI					TuMag				OIs covered		
No.	Priority	Target	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed (“/s)	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration (min)	Slit position	SUSI	SCIP	TuMag
AR1	1	EB/Moat/MMF	20”	10s (N2D)	37 min	110.9	20”	0.00901	Ca II K	37 min	110.9				Aligned		3, 17, 32, 34, 44	22
AR2		EB/Moat/MMF	20”	1s (N2F)	4.1 min	120	20”	0.00901	410.5 - 407.5	37 min	111	Obs 1 + Obs 2	70.4s	267.9	Independent	55, 3, 24	24, 57	
AR3		Plage	20”	10s (N2D)	37 min	37	-	-	-	-	-						21, 32, 34,44, 60	44, 57,52
AR4a		Plage	58”	1s (N1F)	11.9 min	11.9	-	-	-	-	-						9	
AR4b	3	Plage	58”	10ms (R1)	10 ms	86	30”	0.00901	Ca II K	55m	55m	Obs 0-s + Obs 2	46.6s	110	independent	23, 29, 9, 21	5	5, 1, 31
AR4c		Plage	58”	1s (N1F)	11.9 min	11.9	30”	0.00901	410.5 - 407.5	55m	55m				independent	23, 29, 9, 21	9	
AR5a	2	plage	1”	1s (N4F)	12.6s	60	1”	0.0789	Ca II H	12.6s	60	Obs 1 + Obs 2	70.4s	120	Slit aligned	27, 31, 44, 52, 55, 60	52	44,57,52
AR5b	2	plage	1”	1s (N4F)	12.6s	60	1”	0.0789	410.5 - 407.5	12.6s	60				Slit aligned	27, 31, 44, 52, 55, 60	52	
AR6a		plage	58”	1s (N1F)	11.9min	11.9	-	-	-	-	-						9	
AR6b		plage	1”	10ms (R3)	0.72s or 0.012m	60	-	-	-	-	-	Obs 0-s + Obs 2	46.6s	83.8			31	5,1,31
AR6c		plage	58”	1s (N1F)	11.9min	11.9	-	-	-	-	-						9	
AR7		QS or AR Filament	20”	10s (N2D)	37 min	37	20”	0.00901	Ca II K	37 min	37 min	Obs 0-p + Obs 2	87.8s	37		34	34	
						10.312 hr					7.9 hr			10.312 hr				

Overview slide

Other active region priority blocks

Fixed modes
Flexi modes

			SCIP				SUSI					TuMag		
	No.	Target	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed (“/s)	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration (min)
AR_1	AR1	EB/Moat/MMF	20”	10s (N2D)	37 min	110.9	20”	0.0090	Ca II K	37 min	110.9	Obs 1 + Obs 2	70.4s	230.9
	AR2	EB/Moat/MMF	20”	1s (N2F)	4.1 min	120	20”	0.00902	410.5 - 407.5	37 min	111			
AR_2	AR5a	plage	1”	1s (N4F)	12.6s	60	1”	0.0789	Ca II H	12.6s	60	Obs 1 + Obs 2	70.4s	157
	AR5b	plage	1”	1s (N4F)	12.6s	60	1”	0.0789	410.5 - 407.5	12.6s	60			
	AR3	Plage	20”	10s (N2D)	37 min	37	-	-	-	-	-			
AR_3	AR4c	Plage	58”	1s (N1F)	11.9 min	11.9	30”	0.00901	410.5 - 407.5	55m	55m	Obs 0-s + Obs 2	46.6s	110
	AR4b	Plage	58”	10ms (R1)	10 ms	86	30”	0.00901	Ca II K	55m	55m			
	AR4a	Plage	58”	1s (N1F)	11.9 min	11.9	-	-	-	-	-			
AR_4	AR6a	plage	58”	1s (N1F)	11.9min	11.9	-	-	-	-	-	Obs 0-s + Obs 2	46.6s	83.8
	AR6b	plage	1”	10ms (R3)	0.72s or 0.012m	60	-	-	-	-	-			
	AR6c	plage	58”	1s (N1F)	11.9min	11.9	-	-	-	-	-			
AR_5	AR7	QS or AR Filament	20”	10s (N2D)	37 min	37	20”	0.00901	Ca II K	37 min	37 min	Obs 0-p + Obs 2	87.8s	37
						10.3h					7.9 hr			10.3 hr

Spectral window	407.5 nm - 410.5 nm	Ca II K	Ca II H	327.0 nm - 329.0 nm	357.8 nm - 359.8 nm	385.9 nm - 387.9 nm
Central wavelength	409.0 nm	393.8 nm	396.8 nm	328 nm	358.8 nm	386.9 nm

AR_1 (Moat)	AR1	AR2	231 min; 222 min for SUSI	
AR_2 (Plage)	AR5a	AR5b	AR3	157 min; 120 min for SUSI
AR_3 (Plage)	AR4c	AR4b	AR4a	110 min
AR_4 (plage)	AR6a	AR6b	AR6c	84 min
AR_5 (Filament)	AR7	37 min		

With calib blocks

AR_1 (Moat/EB/MMF)	Cal 1h7m	AR1 110.9m	Cal 10m	AR2 120m 111m	Cal 1h	6:09:28
AR_2 (Plage)	Cal 1h 7m	AR5a 60m	AR5b 60m	AR3 37m	Cal 1h	4:46:45
AR_3 (Plage)	Cal 40m	AR4c 11.9m 55m	AR4b 86m 55m	AR4a 11.9m	Cal 35m	3:20:23
AR_4 (Plage)	AR6a 11.9m	AR6b 60m	AR6c 11.9m	Cal 34m	2:13:23	
AR_5 (Filament)	Cal 1h7m	AR7 37m	1:45:23			

Sensitive to image rotation (5” < FOV => 1”)

Very sensitive to image rotation (FOV < 1”)

In the above blocks, the fixed modes are highlighted in white

Overview slide

Other active region modes

Data rates and data volume

Fixed modes
Flexi modes

			SCIP						SUSI						TuMag				
No.	Priority	Target	FOV	Exposure	Scan time	Duration (min)	Data rate [MB/s]	Data volume [GB]	FOV	Scan speed (“/s)	Sp. window	Scan time	Duration (min)	Data volume [GB]	Mode	Cadence	Duration (min)	Data rate [MB/s]	Data volume [GB]
AR1	1	EB/Moat/MMF	20”	10s (N2D)	37 min	111.0	17.925	119.273	20”	0.00901	Ca II K	37 min	111.0	4657.8	Obs 1 + Obs 2	70.4s	267.9	20.6	331.112
AR2		EB/Moat/MMF	20”	1s (N2F)	4.1 min	120	64.0	460.8	20”	0.00901	410.5 - 407.5	37 min	111.0	4657.8					
AR3		Plage	20”	10s (N2D)	37 min	37	17.925	39.794	-	-	-	-	-						
AR4a		Plage	58”	1s (N1F)	11.9 min	11.9	64.0	45.696	-	-	-	-	-		Obs 0-s + Obs 2	46.6s	110	21.85	144.210
AR4b	3	Plage	58”	10ms (R1)	10 ms	86	75.138	387.712	30”	0.00901	Ca II K	55m	55m	2310.0					
AR4c		Plage	58”	1s (N1F)	11.9 min	11.9	64.0	45.696	30”	0.00901	410.5 - 407.5	55m	55m	2310.0					
AR5a	2	plage	1”	1s (N4F)	12.6s	60	64.0	230.4	1”	0.0789	Ca II H	12.6s	60	2520.0	Obs-1 + Obs 2	70.4s	120	20.6	148.32
AR5b	2	plage	1”	1s (N4F)	12.6s	60	64.0	230.4	1”	0.0789	410.5 - 407.5	12.6s	60	2520.0					
AR6a		plage	58”	1s (N1F)	11.9min	11.9	64.0	45.696	-	-	-	-	-		Obs 0-s + Obs 2	46.6s	83.8	21.85	109.86
AR6b		plage	1”	10ms (R3)	0.72s or 0.012m	60	75.138	270.497	-	-	-	-	-						
AR6c		plage	58”	1s (N1F)	11.9min	11.9	64.0	45.696	-	-	-	-	-						
AR7		QS or AR Filament	20”	10s (N2D)	37 min	37	17.925	39.794	20”	0.00901	Ca II K	37 min	37 min	1554.0	Obs 0-p + Obs 2	87.8s	37	20.67	45.89
						10.312 hr		**2754.66 GB**					**7.9 hr**	**20529.0 GB**			**10.312 hr**		**779.392 GB**

Overview slide

Emerging flux region priority block

Fixed modes
Flexi modes

EMF_1

		SCIP				SUSI					TuMag		
No.	Target	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed (“/s)	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration (min)
AR1	EMR	20”	10s (N2D)	37 min	110.9	20”	0.0090	Ca II K	37 min	110.9	Obs 1 + Obs 2	70.4s	230.9
AR2	EMR	20”	1s (N2F)	4.1 min	120	20”	0.0811	410.5 - 407.5	4.1 min	120			

Spectral window	407.5 nm - 410.5 nm	Ca II K	Ca II H	327.0 nm - 329.0 nm	357.8 nm - 359.8 nm	385.9 nm - 387.9 nm
Central wavelength	409.0 nm	393.8 nm	396.8 nm	328 nm	358.8 nm	386.9 nm

EMF_1	AR1	AR2	231 min

With calib blocks

EMF_1	Cal 1h7m	AR1 110.9m	Cal 10m	AR2 120m	Cal 1h	6:09:28

In the above blocks, the fixed modes are highlighted in white

Overview slide

Flare observations

	SCIP				SUSI					TuMag			OIs covered		
	No.	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed	Sp. window	Scan time	Duration (min)	Mode	Cadence	Duration (min)	Slit position	SUSI	SCIP	TuMag
FL_1	Flare 1	-18.7" 0" +18.7"	Sparse raster Rapid mode	5.6s 5.6s 5.6s	120	58"	1"/s	Ca II K or 327 - 329	1 min	1 to 2 hours max	Obs 0-p + Obs 2	87.8s	120		OI41	-	-
FL_2	Flare 2	58"	1s (N1F)	11.9 min	720	58"	1"/s	Ca II K or 327 - 329	1 min	1 to 2 hours max	Obs 0-p + Obs 2	87.8s	720		OI41		

Data rates and volume

	SCIP						SUSI (Data rate: 700 MB/s)						TuMag				
No.	FOV	Exposure	Scan time	Duration (min)	Data rate [MB/s]	Data volume [GB]	FOV	Scan speed	Sp. window	Scan time	Duration (min)	Data volume [GB]	Mode	Cadence	Duration	Data rate [MB/s]	Data volume [GB]
Flare 1	tbd	tbd	tbd	tbd	tbd	tbd	58"	1"/s	Ca II K or 328 nm	1 min	2 hour	5040.0	Obs 0-p + Obs 2	87.8s	120	20.67	8720.2
Flare 2	58"	1s (N1F)	11.9 min	720	64.0	162000	58"	1"/s	Ca II K or 328 nm	1 min	2 hour	5040.0	Obs 0-p + Obs 2	87.8s	720	20.67	52320.9
				12 hr							2 hr				12 hr		

- SUSI's spectral window for flare observations will depend on the time of the day when flare occurs and its position on the Sun's disc.
- Flare observations in the blue will be unique and interesting
- Ca II K core emission can be 25 times I_c for highly energetic flares (Fang et al. 1992, PASJ)
- **Only one flare program, either flare 1 or flare 2 will be used**

FL_1	Flare 1	2 hours
FL_2	Flare 2	2 hr max for SUSI; up to 12 hrs for SCIP &TuMag

Condition for flare monitoring (from SCIP team)

- The flare monitoring program will be performed when the 2 conditions below are satisfied.
  1. The observations for QSDC/Sunspot/Other AR (priority 1,2,3) has been finished
  2. Major flare watch is issued from Max Millennium News

More information

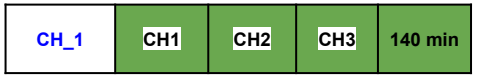
Overview slide

Fixed modes
Flexi modes

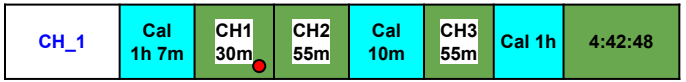
Low latitude coronal hole

		SCIP				SUSI					TuMag			
	No.	FOV	Exposure	Scan time	Duration (min)	FOV	Scan speed	Spec. window	Scan time	Duration (min)	Mode	Cadence	Duration (min)	Slit position
CH_1	CH1	0.09”	1.0 s (N6)	1.0s	30	0.15”	0.01”/s	Ca II H	15s	30	Obs 0-s + Obs 3	31.5s	30	SCIP in sit & stare, SUSI does small scans
	CH2	30”	10s (N1.5D)	55 min	55	30”	0.00901”/s	Ca II K	55 min	55	Obs 1 +Obs 2	70.4s	55	Slits aligned
	CH3	30”	10s (N1.5D)	55 min	55	30”	0.00901”/s	410.5 - 407.5	55 min	55	Obs 4 + Obs 5	123.5	55	Slits aligned
					140 min					140 min			140 min	

- Not high priority
- For SUSI we would like to have one scan in Ca II K line to capture the chromosphere. Since coronal hole magnetic fields are weak, we want another scan at 410 nm because this region has lines with largest polarization signals
- All above modes can be run as a single Elevation-independent block



In the blocks, the fixed modes are highlighted in white



Spectral window	407.5 nm - 410.5 nm	Ca II K	Ca II H	327.0 nm - 329.0 nm	357.8 nm - 359.8 nm	385.9 nm - 387.9 nm
Central wavelength	409.0 nm	393.8 nm	396.8 nm	328 nm	358.8 nm	386.9 nm

Overview slide

Low latitude coronal hole (may be)

Data rates and data volume

Fixed modes

	SCIP						SUSI (Data rate: 700 MB/s)						TuMag				
No.	**FOV**	**Exposure**	**Scan time**	**Duration (min)**	**Data rate [MB/s]**	**Data volume [GB]**	**FOV**	**Scan speed**	**Spec. window**	**Scan time**	**Duration (min)**	**Data volume [GB]**	**Mode**	**Cadence**	**Duration (min)**	**Data rates [MB/s]**	**Data volume [GB]**
CH1	0.09”	1.0 s (N6)	1.0s	30	64.0	115.2	0.15”	0.01”/s	Ca II H	15s	30	1260.0	Obs 0-s + Obs 3	31.5s	30	18.75	33.75
CH2	30”	10s (N1.5D)	55 min	55	17.925	59.153	30”	0.00901 ”/s	Ca II K	55 min	55	2310.0	Obs 1 + Obs 2	70.4s	55	20.60	67.98
CH3	30”	10s (N1.5D)	55 min	55	17.925	59.153	30”	0.00901 ”/s	410.5 - 407.5	55 min	55	2310.0	Obs 4 + Obs 5	123.5	55	3.58	11.814
				140 min		**233.51 GB**				**140 min**		**5880.0 GB**			**140 min**		**113.54 4 GB**

For the highlighted SUSI spectral window, Ca II K was changed to Ca II H

Overview slide

Priority blocks without calibration

QSDC

Block 1 Elevation- indep	QS1	QS2	QS4a & 4b	QS8	364 min
Block 2 Elevation- dep	QS6	QS3	QS5a	QS5b*	347 min
Block 3 Elevation- indep	QS7	204 min; 60 min for SUSI			

CLV

Block 1 Elevation - indep	CLV1	CLV4	167 min	
Block 2 Elevation - indep	CLV5	CLV3	CLV2	109 min; 88 min for SUSI

Pole

Block 1 Elevation - indep	PL1	PL4	PL5	175 min
Block 2 Elevation - indep	PL2	PL3	74 min	

Full spectral scan

Block 1 Elevation- dep	FS1	336 min
Block 2 Elevation- dep	FS2	336 min

Sunspots

Block 1 Elevation - indep	SP1*	SP2*	SP4a &4b*	SP9*	320 min
Block 2 Elevation - dep	SP3*	SP8*	192 min; 72 min for SUSI		
Block 3 No SUSI	SP7a	SP7b	167 min		
Spl Block No SUSI	SP6	11.9 min			

EW limb

EW Elevation - ind	EW1*	EW2	EW3	120 min; 111 min for SUSI

Coronal hole

CH Elevation - ind	CH1	CH2	CH3	140 min

Flare

Flare Elevation-ind or dep	Flare 1 (SUSI in CA II K)	2 hr max for SUSI; up to 12 hrs for SCIP and TuMag
Flare Elevation-ind or dep	Flare 2 (SUSI at 328 nm)	2 hr max for SUSI; up to 12 hrs for SCIP and TuMag

Only one flare program, either flare 1 or flare 2 will be used

Other active regions

Moat Elevation - indep	AR1	AR2	231 min or 213 min for SUSI	
Plage 1 Elevation- indep	AR5a	AR5b	AR3	157 min; 120 min for SUSI
Plage 2* Elevation- indep	AR4c	AR4b	AR4a	110 min
Plage 3 No SUSI	AR6a	AR6b	AR6c	84 min
Filament Elevation - indep	AR7	37 min		

Green: Elevation - independent
Orange: Elevation - dependent
Violet: No SUSI blocks

The fixed modes in priority blocks are highlighted in white

Underlined modes cover SOLARNET proposals.
*SP2 has SST co-obs request.
* have special requests. See this slide

Priority and calibration blocks

QSDC

QSDC_1	Cal 1h7m	QS1 30m	QS2 107m	Cal 20m	QS4a+4b 120m	Cal 8m	QS8 107m	Cal 1h	8:43:19
QSDC_2	Cal 1h7m	QS6 60m	Cal 10m	QS3 107m	Cal 10m	QS5a 120m	QS5b* 60m	Cal 1h	8:18:36
QSDC_3	Cal 40m	QS7 203.8m 60m	Cal 34m	4:39:10					

Sensitive to image rotation (5" < FOV => 1")

Very sensitive to image rotation (FOV <1")

QSDC_HC	Cal 41 m	QSHC1 10 m	QSHC2 10 m	QSHC3 10 m	1:14:58

CLV

CLV_1	Cal 1h7m	CLV1 107m	Cal 9m	CLV4 60m	Cal 1h	5:03:33
CLV_2	Cal 1h7m	CLV5 37m 20m	CLV3 12m 37m	CLV2 60m 37m	Cal 1h	4:26:30

Pole

PL_1	Cal 1h7m	PL1 55m	PL4 60m	Cal 10m	PL5 60m	Cal 1h	5:14:48
PL_2	Cal 41m	PL2 62m	PL3 12m	Cal 41m	2:30:40		

Sunspots

SP_1	Cal 1h7m	SP1* 22.5m	SP2* 107m	Cal 10m	SP4* 120m	Cal 20m	SP9* 70m	Cal 1h	8:13:22
SP_2	Cal 1h7m	SP3* 11.9m	SP8* 180m 60m	Cal 1h	5:21:30				
SP_3 No SUSI	SP7a 60m	SP7b 107m	Cal 33m	3:27:18					
SP_4 No SUSI	SP6 11.9m	0:14:41							

Other active regions

AR_1 (Moat,EB, MMF)	Cal 1h7m	AR1 110.9m	Cal 10m	AR2 120m 111m	Cal 1h	6:09:28
AR_2 (Plage)	Cal 1h 7m	AR5a 60m	AR5b 60m	AR3 37m	Cal 1h	4:46:45
AR_3 (Plage)	Cal 40m	AR4c 11.9m 55m	AR4b 86m 55m	AR4a 11.9m	Cal 35m	3:20:23
AR_4 (Plage)	AR6a 11.9m	AR6b 60m	AR6c 11.9m	Cal 34m	2:13:23	
AR_5 (Filament)	Cal 1h7m	AR7 37m	1:45:23			

Emergence flux region

EMF_1	Cal 1h7m	AR1 110.9m	Cal 10m	AR2 120m	Cal 1h	6:09:28

Coronal hole

CH_1	Cal 1h7m	CH1 30m	CH2 55m	Cal 10m	CH3 55m	Cal 1h	4:42:48

EW limb

EW_1	Cal 1h7m	EW1* 37m 60m	EW2 16.7m	EW3 60m	Cal 1h	4:28:20

Full spectral scan

FS_1	Cal 2h12m	FS1 6h	Cal 2h20m	10:21:40

Flare

FL_1	Flare 1	03:09:23
FL_2	Flare 2	2hr for SUSI 14:06:50

Only one flare program, either flare 1 or flare 2 will be used

Green: Elevation - independent
Orange: Elevation - dependent
Violet: No SUSI blocks

The fixed modes in priority blocks are highlighted in white

Underlined modes cover SOLARNET proposals.
*SP2 has SST co-obs request.
* have special requests. See this slide

Target	SCIP	SUSI	TuMag	Avg.	Overall
Quiet Sun disc center	2	1	1	1.3	1
AR emergence	1	3	2	2	2
Pole	8	7	9	8	7
CLV towards pole, mu=0.7	11	9	7	9	9
CLV towards pole, mu=0.5	9	5	7	7	5
East/West limb	10	11	6	9	10
Sunspots	3	6	3	4	3
Other AR targets *Moat/EB/MMF* *Plage* *AR/QS filament*	5 - - -	4	5 - - -	4.7	4
SUSI full spectral scan	6	2	4	4	3
Flare	4	8	8	6.7	6
Low latitude coronal hole	7	10	10	9	11

Launch on 03.06.2024

Science blocks	Suitable start times (UTC)
QSDC_1	02.06 12:30 to 02.06 14:00 03:06 01:00 to 02.06 02:00
QSDC_2	02:06 07:00 to 02.06 11:30 03.06 00:00 03.06 07:30 to 03.06 12:00
SP_1	02.06 10:00 to 02.06 14:00 02.06 22:00 to 03.06: 02:00
SP_2	02.06 11:00 to 02.06 13:30 03.06 02:00 to 03.06 04:30

Science blocks	Suitable start times (UTC)
FS_1	03:06 02:00 to 03.06 08:30
CLV_1	02.06 10:30 to 02.06 15:30 02.06 23:00 to 03.06 04:00
AR_2	02.06 13:00 to 02.06 16:30 03.06 00:30 to 03.06 05:00
QSDC_HC	02.06 13:00 to 02.06 18:00 03.06 02:00 to 03.06 06:30
PL_1	02.06 11:30 to 02.06 15:30 02.06 23:30 to 03.06 03:30

AR_1, EMF_1, CLV_2, PL_2, AR_3, AR_5, SP_4 can be started anytime

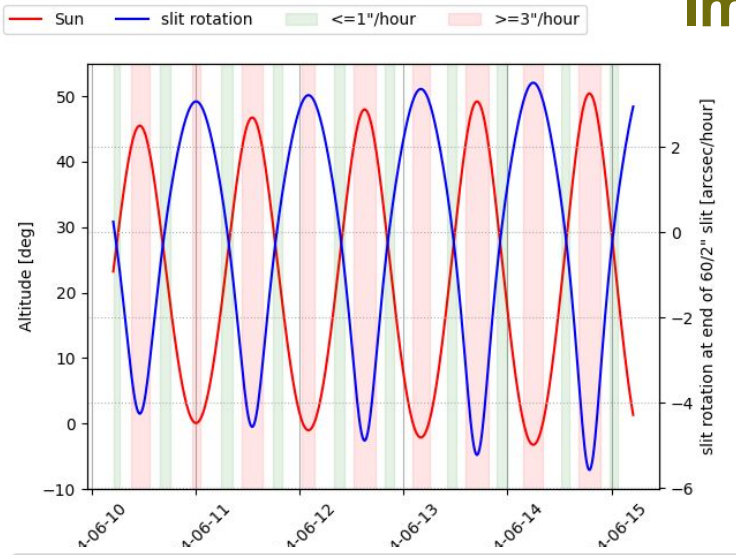
Observing ideas covered by priority blocks & spl requests

Priority block	No. of OIs covered
QSDC block 1	24
QSDC block 2	23
QSDC block 3	10
Sunspot block 1	19
Sunspot block 2	13
Sunspot block 3	19
Sunspot spl block	
Active region block 1 (Moat)	9
Active region block 2 (Plage 1)	10
Active region block 3 (Plage 2)	7
Active region block 4 (Plage 3)	4
Filament block	1

Priority block	No. of OIs covered
CLV block 1	6
CLV block 2	10
Pole block 1	7
Pole block 2	8
EW block	6
Coronal hole block	-
Flare block	1
Full spectral scan quiet Sun	2
Full spectral scan Plage	2

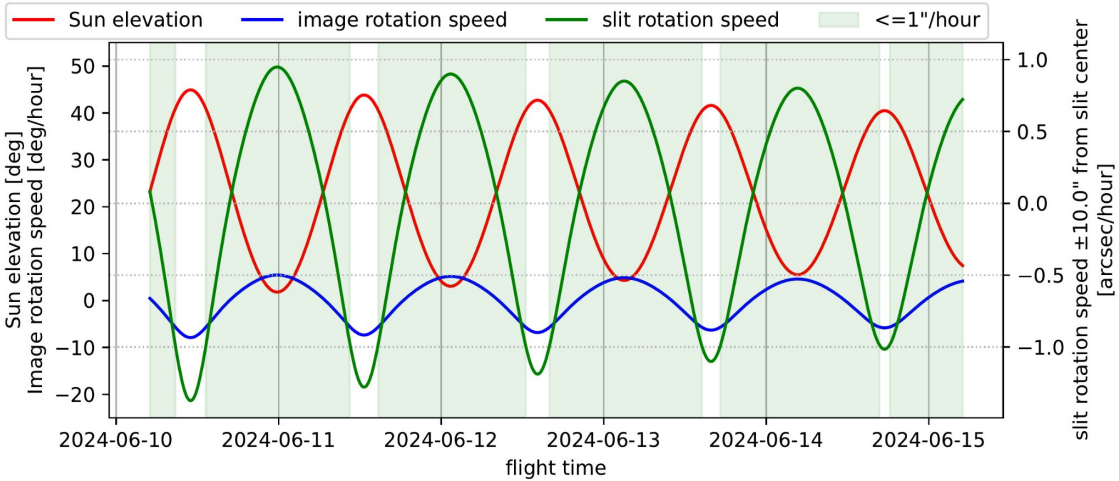
1. SP8: slit aligned to penumbral filament
2. SP4a and SP4b: Center of sunspot for SCIP.
3. QS5b and SP9: SUSI reference scans.
4. Plage 2 block: Plage + QS in the vicinity of plage to study Ca II K formation in circumfacular regions. Request to run Plage 2 block after one of the QSDC blocks.
5. EW1: Spicules over plage
6. SP1, SP2, SP3: three full fov sunspot scans. Requests for center at umbra, center at limb-side penumbra, center at center-side penumbra.

Image rotation



- Image rotation due to Alt-Azimuth mount of the telescope
- Rotation is maximum when the Sun is at highest or lowest elevation
- Small spatial scans are most affected
- Max rotation altitudes:
  - ~42 deg - 45 deg
- For 15th June, 2024:

Time	Azimut	Altitude
10:45	143.56°	42.13°
11:00	148.11°	42.92°
11:15	152.74°	43.62°
11:30	157.44°	44.21°
11:45	162.22°	44.70°
12:00	167.05°	45.08°
12:15	171.92°	45.33°
12:30	176.82°	45.47°
12:45	181.73°	45.49°
13:00	186.63°	45.39°
13:15	191.51°	45.17°
13:30	196.36°	44.83°
13:45	201.15°	44.37°
14:00	205.88°	43.81°
14:15	210.53°	43.14°
14:30	215.10°	42.38°



Sunrise III Daily Science Planning

Sunrise III status overview (system, pointing, instruments) (≤5')
The Sun Today (Sebas, Ishikawa san) (5')
Observing program discussion:

1. SWG: decide on first priority target (QS, spot, limb, plage, …)
2. SWG: select region (which spot? Which limb? Where QS?), and feature (penumbral filament, plage with ½ spot, PIL, …)
3. SO: propose matching observing blocks
4. SWG: decide on observing block
5. Repeat (1) to (4) until we have 36 hours filled in
6. SO: schedule blocks wrt. elevation / image rotation ("shuffle")
7. All: finalize observing program

SWG = Science Working Group Leaders (PI + SWG instrument leaders)

SO = Science Operations (Smitha, Andi, Sebas)

Flare observations

- Flare observations higher priority than pole
- Get frequent updates from GOES
- In the 12 hr block, after a flare occurs then we break off and do calibration
- SUSI will be observing the whole time but the data storage starts when things are starting to get more active
- To be discussed: Flare block entry points:
  - At what points in a science block can we interrupt the observations to go to flare site?
  - Flare observations on day 2 or day 3?

Requests for pole, limb observations

- **Request for polar scan: 1**

1. “Small scale field evolution in both polar areas”

- **Request for limb/close to limb observations: 9**

1. “Measurement of spicular magnetic field”: slit along spicules
2. “Temporal evolution of solar spicules at high resolution”: slit perpendicular to limb
3. “Identification of wave drive mechanism in the magneto convection”
4. “Scattering polarization at the limb and on the disk”
5. “Across the limb in the UV”
6. “Hanle imaging of turbulent magnetic fields at the solar limb”
7. “Mg I b2 for studying linear and scattering polarization signals”
8. “Inspecting oscillations and wave signatures in photospheric small-scale swirls and their chromospheric counterpart”
9. “Magnetic fields, Alfvénic waves and dynamic instabilities in spicules” : two sets requested, one with slit perpendicular to pole, other parallel to limb.

Observing ideas not covered by SUSI

- Ideas requesting for faster large FOV scans in the QS disc center. They have mostly requested for Stokes I only: OI18, OI46
- Long time series faster scans of small FOV (> 1”) in active regions (I or IQUV): OI17, OI38, OI45
- Enhancement of Balmer jump during solar flares at 364 nm: OI42
- Dedicated mode for circumfacular region (OI9)

SOLARNET proposals

No	Title	Name of PI	Affil.	target	SUSI requirements	SCIP requirements	TuMag requirements	Duration	Comments
1	**Light Bridges: a Three-Dimensional View from the Photosphere to the Chromosphere**	A. B. Griñón Marín,	Oslo, Stockholm	Light bridges, or Umbral dots	FOV: 5”; Ca II H line (no atomic polarization); slit scan speed: 0.08125”/s; polarimetric sensitivity: 0.5%	Exposure: 1.024 s; 30 repetitions	Obs 0-p, Mg line polarimetry	32 min	SP9
2	**Thermodynamic and magnetic properties of solar filaments**	Carlos J. Díaz Baso	Stockholm	Quiet Sun filaments or AR filaments	Full-Stokes, FOV:20”, 0.01”/s, Ca II H line, sync with SCIP	Exposure: 9.2s; IQUV, one full scan	Obs0-p+ Obs-2	33 min	Done but in Ca II K, AR7
3	**Heating through ubiquitous small-scale bipoles in the quiet-Sun chromosphere**	Jaime de la Cruz Rodríguez	Stockholm	Supergranule, covering part of network	Full-Stokes, FOV:18.72”, 0.01492”/s, Ca II H line, sync with SCIP scan speed: sigma_Q,U = 2.3x10-3; sigma_V = 1.6x10-3	Exposure: 6.272s; Noise: 5.6x10-4	Obs-1	21 min	Partly covered but in Ca II K line; QS2
4	**Observations of small-scale magnetic reconnection events in the hydrogen Balmer lines (Hδ, Hε, and Hζ)**	Luc Rouppe van der Voort	Oslo	Quiet Sun, internetwork + network region mu=0.6-0.7	Spectroscopic mode, FOV:30”, 0.5% noise in I, Spatial samping: 0”.06, Scan speed: 0.17”/s, H-delta, H-epsilon, H-zeta lines + full-stokes, FOV:2”, 0.01”/s, 401 nm	IQUV, exposure:1s; 2”	Obs-3	30 min	The requested scan speeds, sampling and noise levels are not consistent. Cannot observe at H-zeta due to molecular bands. H-epsilon & H-delta lines at mu=0.7 are covered in CLV scans.
5	**Understanding the nature of the magnetic oscillations associated with the FIP effect**	Mariarita Murabito	INAF, Italy	Sunspot	Full-Stokes, FOV:1.5”, 0.06”/s, Ca II K line	25"- 30", Rapid mode	Obs-3 + Obs-1	1 hr - 2 hr	SP2

SOLARNET proposals

No	Title	Name	Affil.	target	SUSI requirements	SCIP requirements	TuMag requirements	Duration	Comments
6	**Magnetic fields, Alfvénic waves and dynamic instabilities in spicules**	Ramon Oliver	University of the Balearic Islands (Spain)	2”-8” above limb, slit parallel to limb	Spectroscopic, FOV: 6,” 1.06”/s; Ca II H line, Ca II K , H-delta line + Spectroscopic, S&S, 3”, 5”, 7” above limb, Ca II H line, Ca II K , H-delta line + Spectroscopic, S&S, Slit perpendicular to pole	Normal mode, 3”, 5”, 7” off limb; 10s integration at each limb position; + Rapid mode, slit perpendicular to limb	-	1.5 hr +1 hr + 1hr	EW3, Partly covered in pole observations. 20% of slit will be above limb.
7	**Mapping the geometry of the small-scale magnetic field in the quiet Sun using multi-line Zeeman and Hanle diagnostics.**	R. J. Campbell	Belfast	Quiet Sun disc center	IQUV, full FOV, 0.01”/s, Sr 407.8 nm	Full FOV, 10s exposure,	Obs-4 + Obs-5	1.83 hr	QS3 or QS8
8	**Quiet Sun magnetic field: properties and energy input**	Sanja Danilovic	Stockholm	Quiet Sun disc center	Full-Stokes, FOV:30”, 0.01492”/s, 408nm, sync with SCIP	Nstep=320, Npmu=12, Nslit=1; Exposure: 6.144s	Obs-1	34 min	Done in QS8 for 107 minutes
9	**High-frequency waves as energy reservoir of the resonant umbral chromosphere**	T. Felipe	IAC, Spain	Sunspot or a pore near disk center(mu > 0.7)	Sit & Stare, slit crossing the center of the umbra/pore, Ca II H or K	Exposure: 2s, sit & stare	Obs-0s	75 min	SP4a for 60 minutes

Co-observations planning

Document maintained by Sebas

Co-obs webpage: http://www2.mps.mpg.de/services/sunrise/sot/index.html

Requests for co-observations with SST

Observing mode	SST requests
QS2	SST/CRISP
PL3	No details given
AR4	No details given
AR7	SST/H-alpha filtergram images
SP2 (SOLARNET)	CRISP: DEEP POLARIMETRY FE I 6173 + CA II 8542 • Ca 8542: 26 line positions, full Stokes, 8 exposures per state, wavelengths=[-1680, -1040, -880, -720, -640, -560, -480, -400, -320, -240, -160, -80, 0, 80, 160, 240, 320, 400, 480, 560, 640, 720, 880, 1040, 1680] • Fe 6173: 21 line positions, full Stokes, 6 exposures per state, from 6173.14 to 6173.54 with a step of 0.2 mÅ • Cadence: best possible (target: 30-40 s) CHROMIS: Stokes-I fast cadence spectral scans, cadence: best possible (target: 30-40 s) • Hβ Stokes-I, 60 spectral points

Planned instrument setup for co-obs

GREGOR Instruments

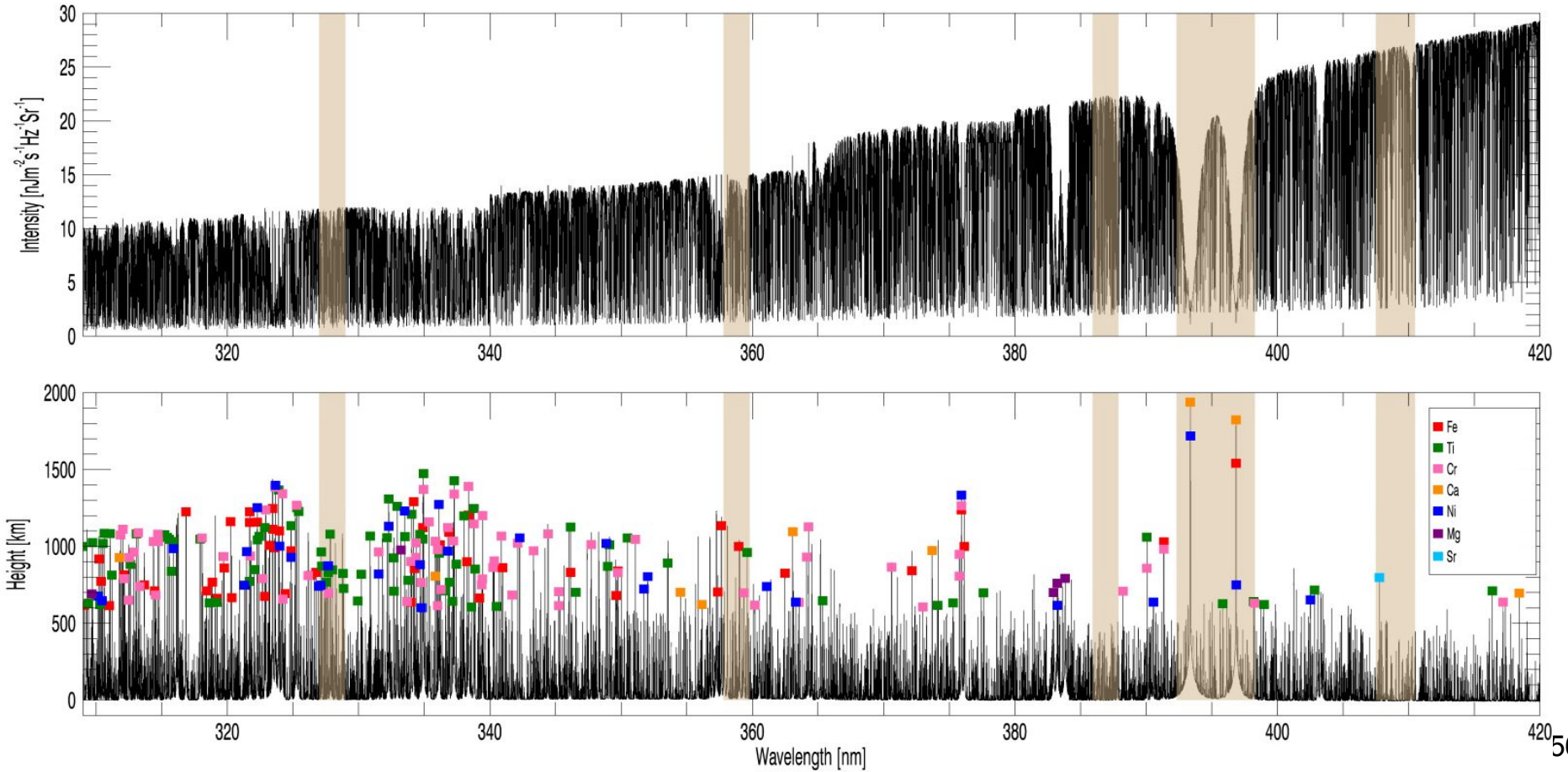
- GRIS polarimetric mode (Slit) 10830 region. Int. time 100 ms. 10 accumulations, 400 steps. This is a FOV of ~64”x54. 450 steps FOV of ~64”x60”. Slit North-South.
- HiFI+: 3 Channels. No. 1 G-band and Blue-continuum, No. 2 Narrow-band and Broad-band Hα, and No. 3 Ca II H and TiO. Freq. As fast as possible when the **seeing is very good**.
- BBI: 3 Channels. TiO, Hα, Ca II K (Not ready)
- Beam Splitter 900nm. Slit Jaw Continuum.

SST

Jorrit Leenaarts: “We will likely use one (or at most two) SST observing sequences fr Sunrise support. Our current plan is CHROMIS: Ca K relatively standard program+ 400 nm continuum. How far into the wing should be decided. Cadence ~10 s
CRISP: 8542 with polarimetry, 6173 with polarimetry, Halpha without polarimetry. Cadence ~30 s.”

SUSI spectral windows chosen for different observations

SUSI observing window and height of formation of lines



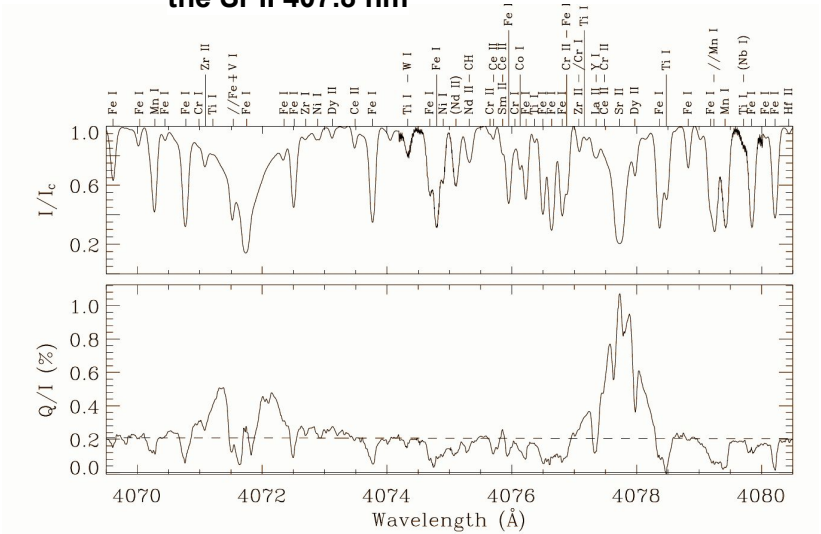
Region 1

407.5 nm - 410.5 nm, the red region: (spectral coverage ~ 3 nm)

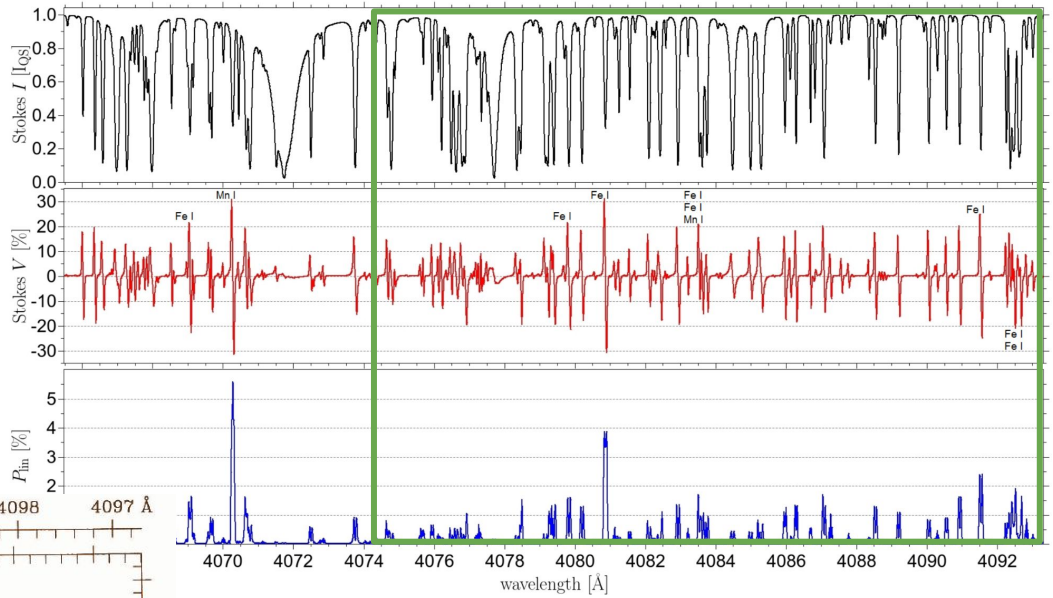
- Covers more than 60% of Tino's region with large V/I signals (Riethmueller & Solanki 2019). Covers 5/7 spectral lines with V/I > 20%
- Strong scattering polarization line Sr II 407.8 nm
- H-delta line at 410.2 nm. Useful for detecting Ellerman bombs.
- Has fewer molecular blends.
- Contains mostly photospheric lines.
- Higher photon flux.
- Estimated flux and noise levels for this region can be found here

The red region: 410.5 nm - 407.5 nm

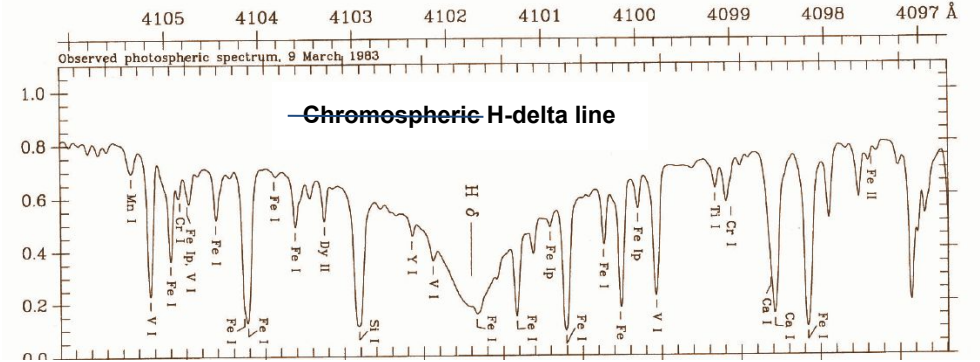
Strong scattering polarization in the Sr II 407.8 nm



Strong stokes V profiles



Riethmueller & Solanki (2019)

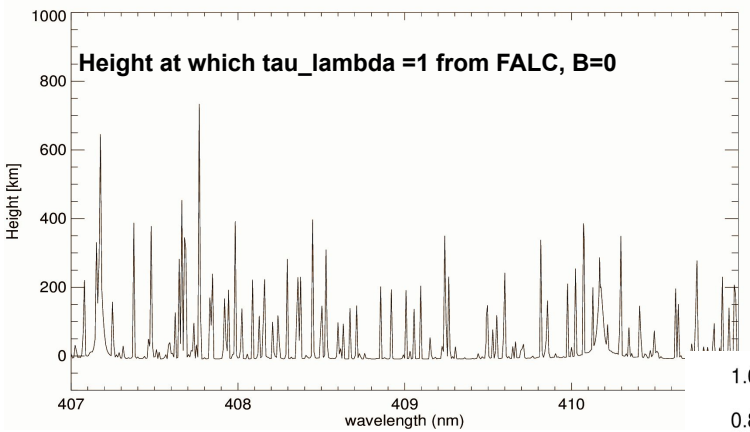


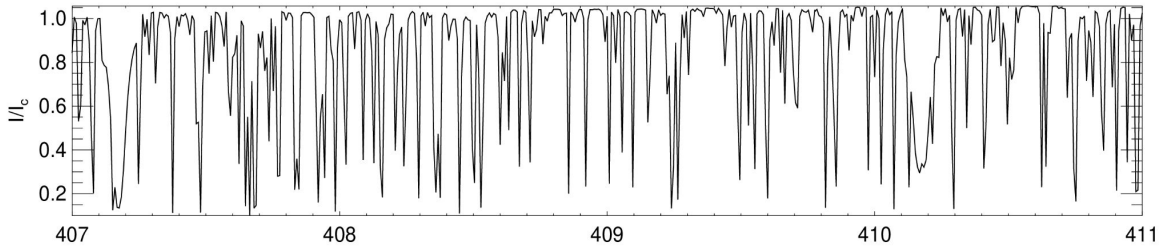
~~Chromospheric~~ H-delta line

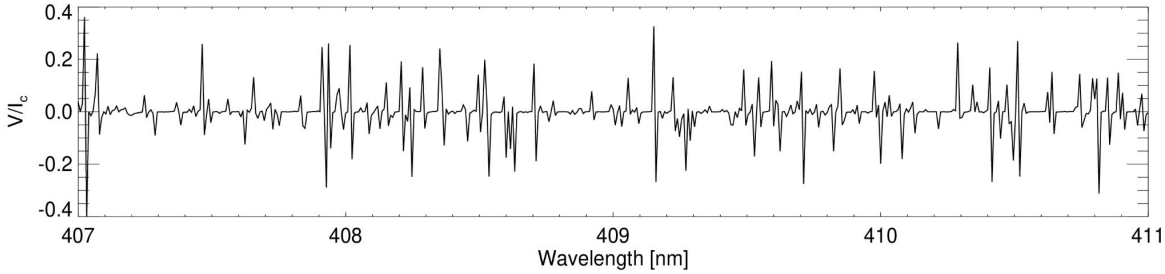
4069.0650 Å	Fe I	g = 2.2500
4070.2790 Å	Mn I	g = 3.3333
4079.8384 Å	Fe I	g = 2.0000
4080.8749 Å	Fe I	g = 3.0000
4083.5421 Å	Fe I	g = 1.5000;
4091.5527 Å	Fe I	g = 2.0000
4092.4562 Å	Fe I	g = 1.7500;

Lines with V/I >20%

Stokes V profiles and height of formation





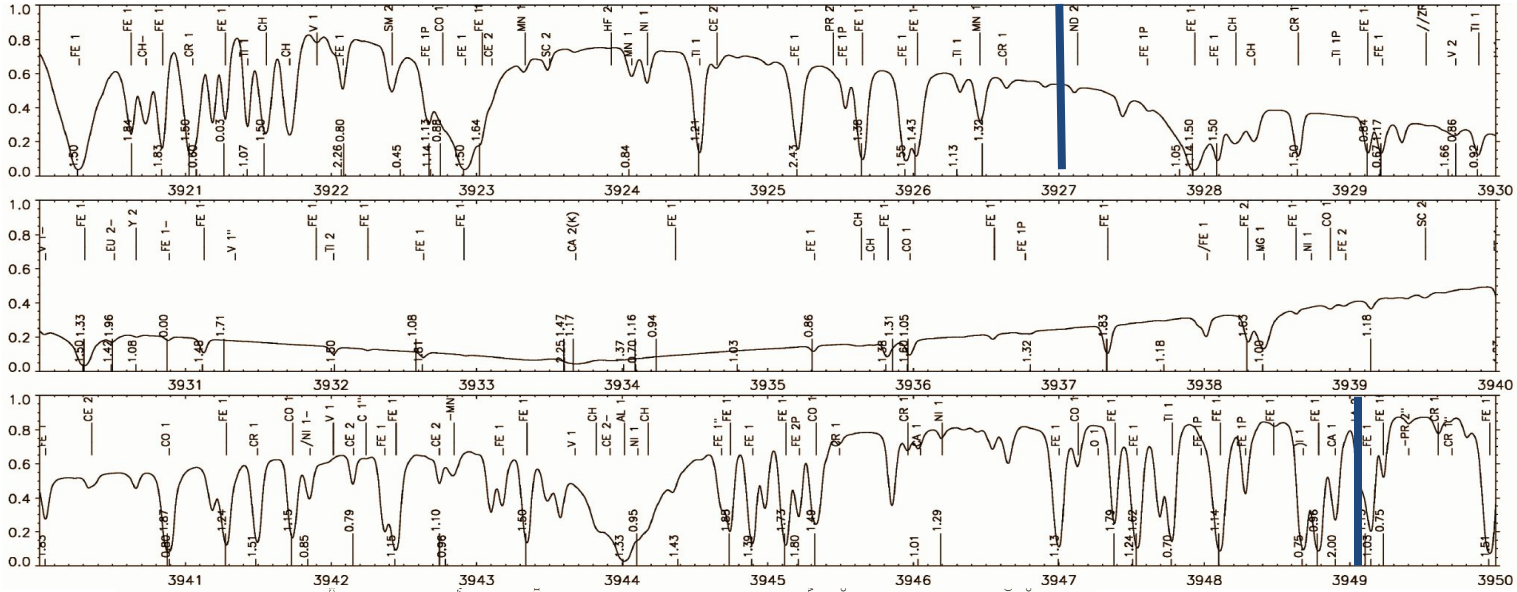


Region 2

Ca II H or K line, the chromospheric region: (spectral coverage ~ 2.2 nm)

- Formed higher than the Ca II 8542 A line of SCIP
- 50% of observing ideas have requested for this line
- Diffraction limited spatial resolution of SST at 393 nm is same as Sunrise.
- Advantage over CHROMIS: seeing free long time series, wider spectral coverage, higher spectral resolution
- Can focus mainly on spectroscopic signals to get faster scans and capture chromospheric dynamics
- Single scans at SUSI's slowest scan speeds can record full-stokes
- Scattering polarization in Ca II K is mainly for academic interest. Cannot be inverted.
- Ca II H & K lines have a strong coupling with the Ca II 8542 A line
- The estimated flux and noise levels in this window can be found here

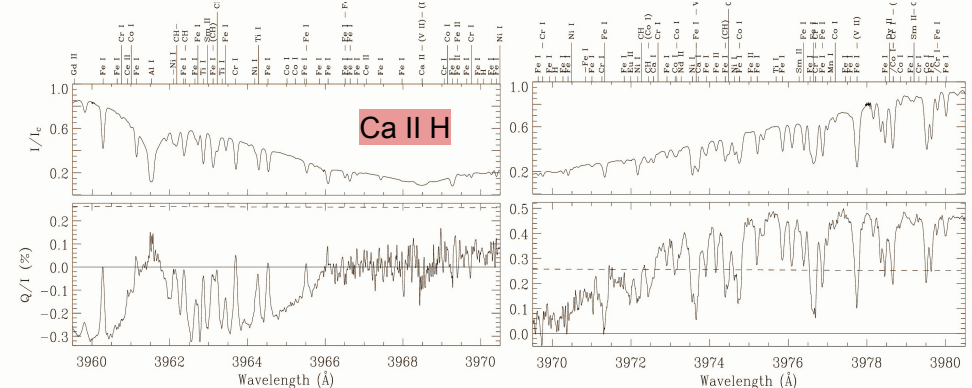
Ca II K line spectral window

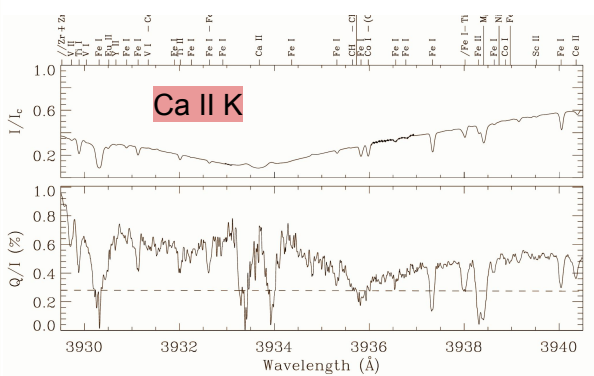


Ca II K (½ ->3/2 -> ½) has scattering polarization signal

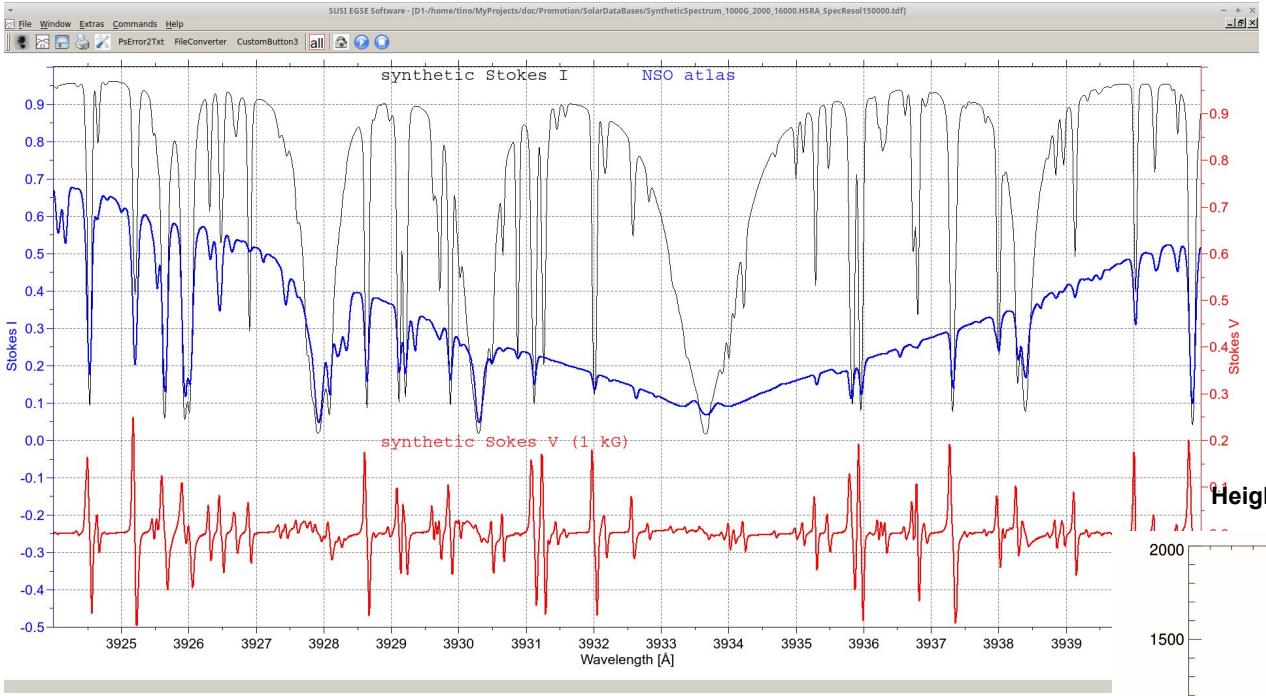
Ca II H (½ -> ½ -> ½) no scattering polarization

Ca II K line, Lande factor: 1.167
Ca II H line, Lande factor: 1.334



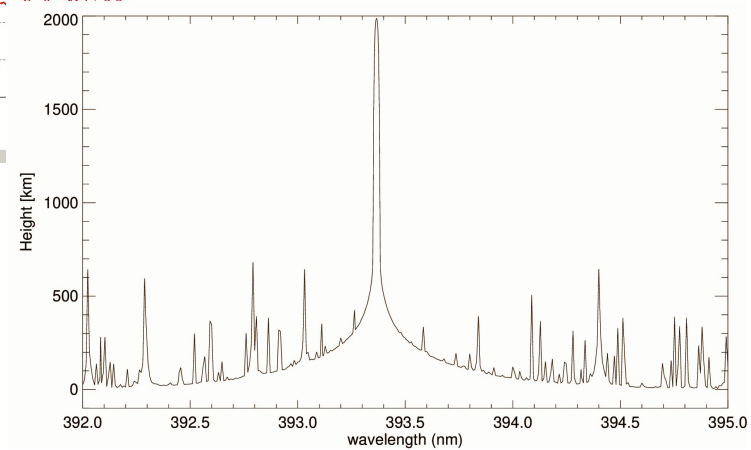


Ca II K line spectral window

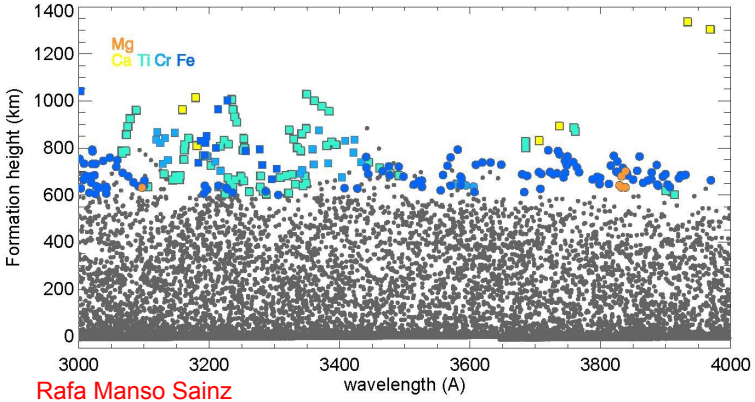


courtesy Tino Riethmueller

Height at which tau_lambda =1 from FALC, B=0

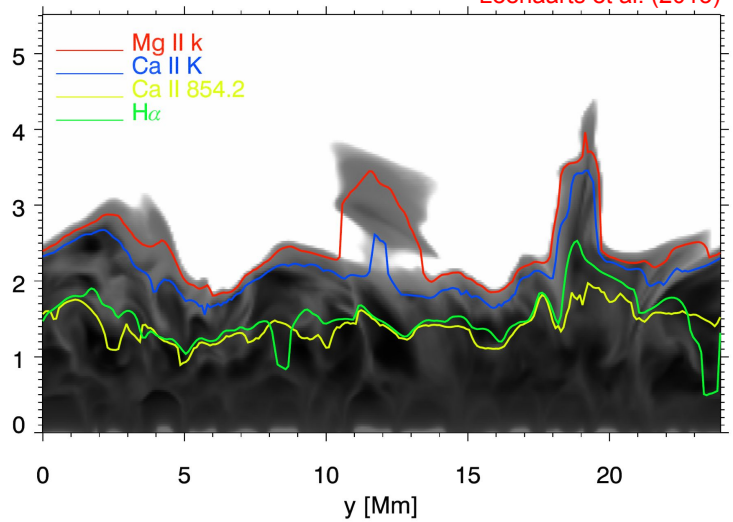


Height of formation of chromospheric lines



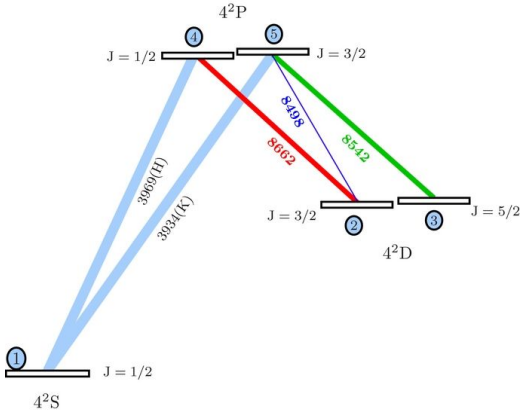
Rafa Manso Sainz

Leenaarts et al. (2013)

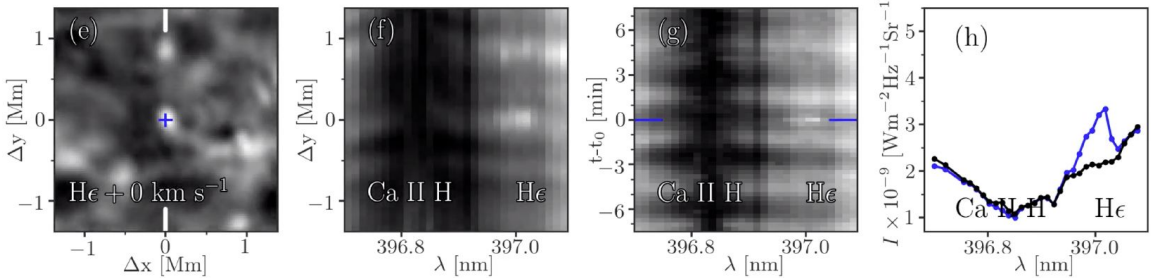


- Ca II H and K formed higher than the Ca II 8542 line
- Ca II 8542 formed at similar heights as the H-alpha line
- Ca II H is blended by the H-epsilon line
- H-epsilon line shows enhancement in quiet Sun Ellerman bombs

Quintessential Ca model atom



Carlin et al. (2012)



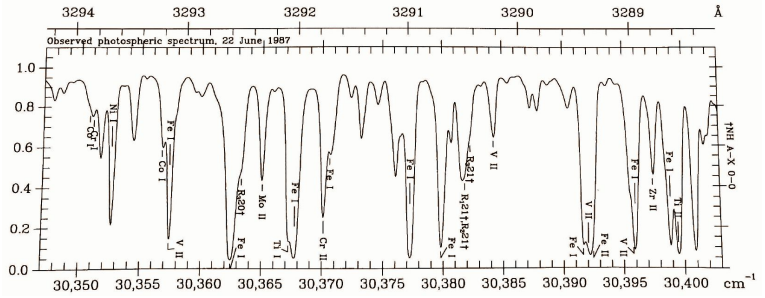
Joshi et al. SOLARNET proposal

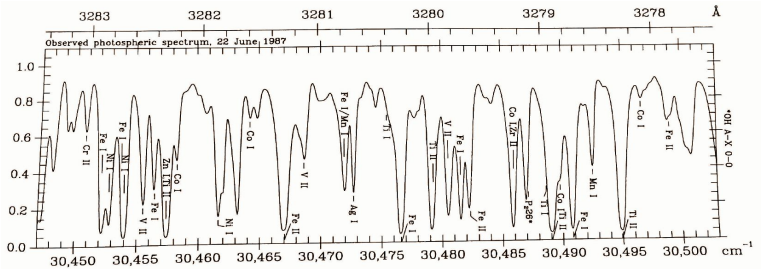
Region 3

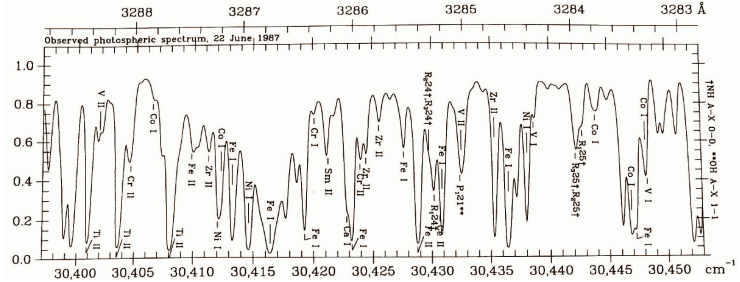
327.0 nm - 329.0 nm, the blue region: (spectral coverage ~ 2 nm?)

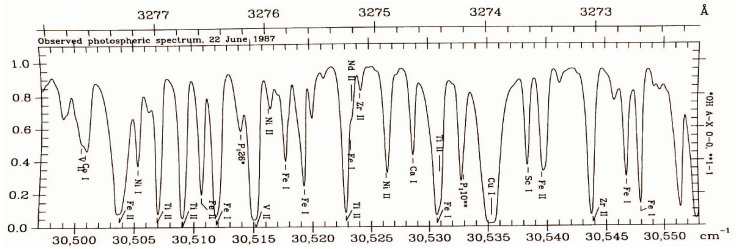
- Region in the blue for higher spatial resolution.
- Alternate to the 315 nm studied in Riethmueller & Solanki 2019. Region around 315 nm has molecular band head.
- This region has fewer molecular blends.
- No strong scattering polarization (mostly below continuum polarization).
- SUSI polcal measurements available
- Many lines formed above 400 km
- Expected flux and noise levels in this region can be found here

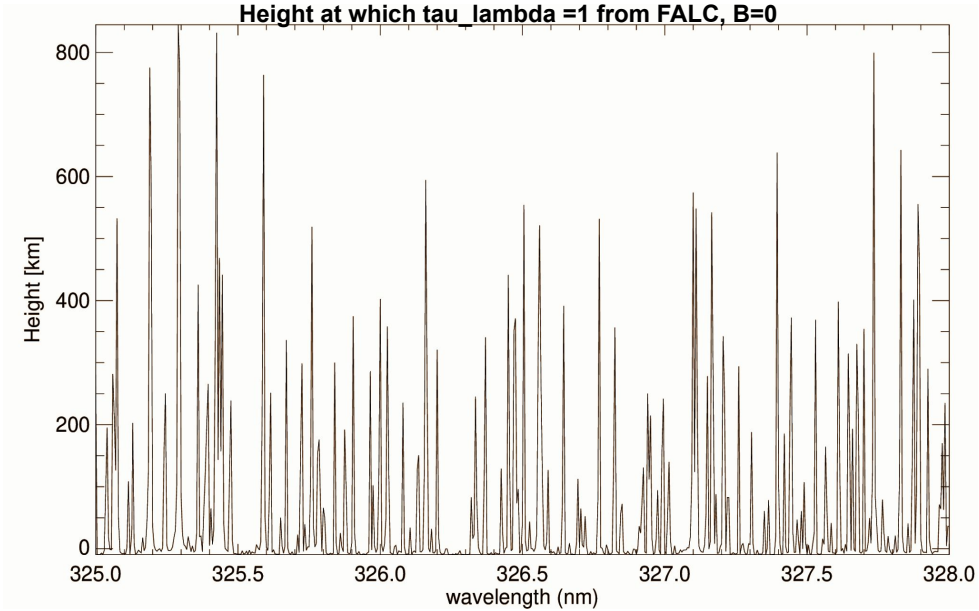
The blue region: 329.0 - 327.0 nm







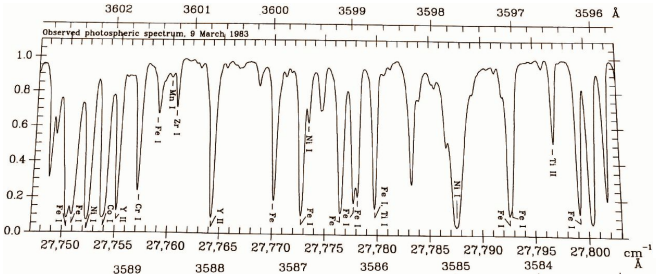


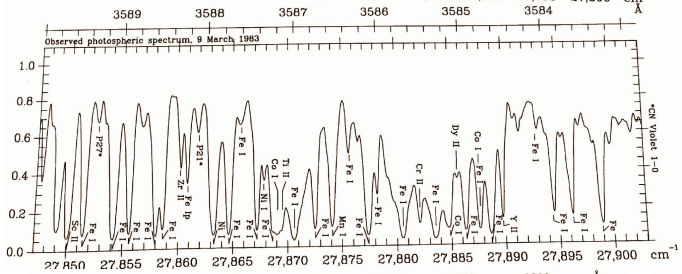


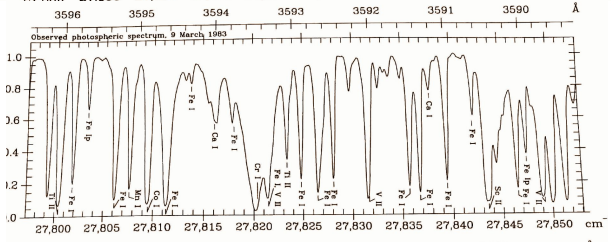
Special interest windows

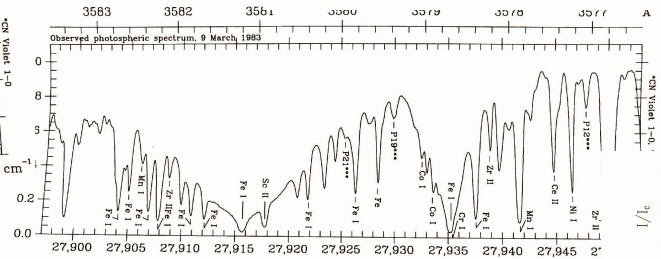
Region 4

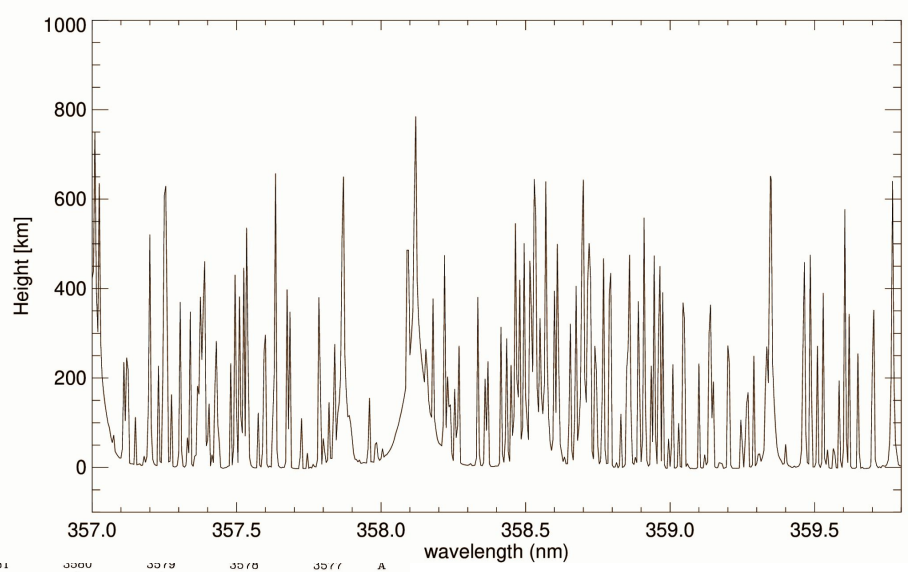
1. **359.8 nm - 357.8 nm: (spectral coverage ~ 2 nm)**
   a. Covers the Cr I 359.35 nm line with strong scattering polarization
   b. Interesting region for limb/pole observations
   c. Has very few molecular lines in FTS atlas

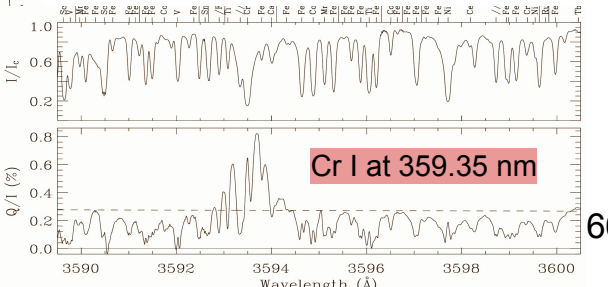




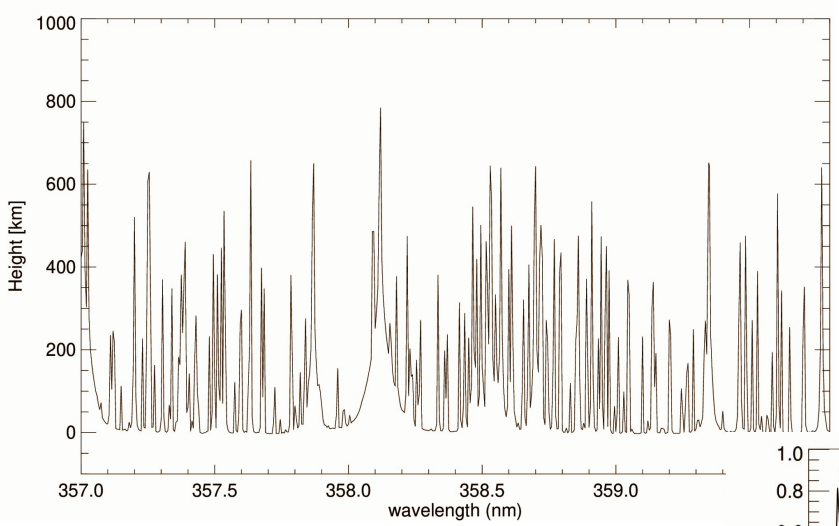




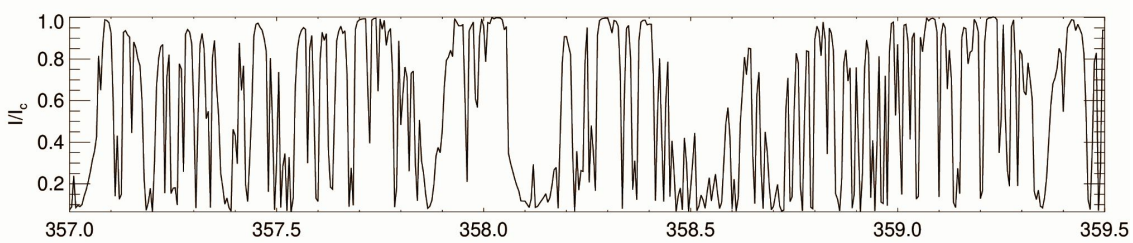


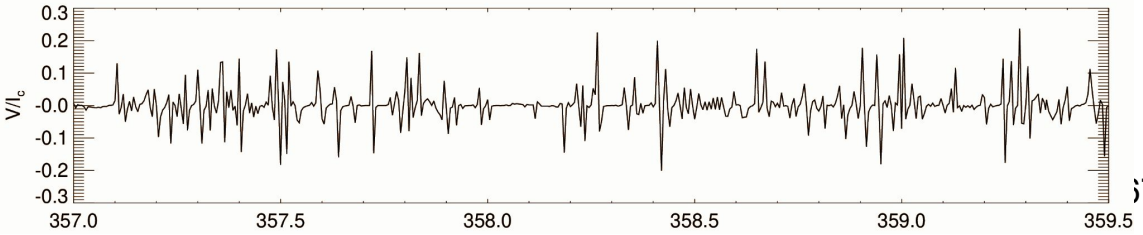


Stokes V profiles and height of formation



359.8 nm - 357.8 nm

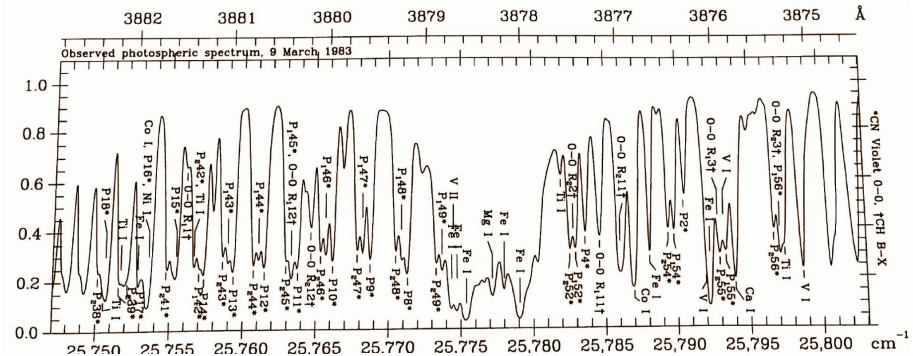


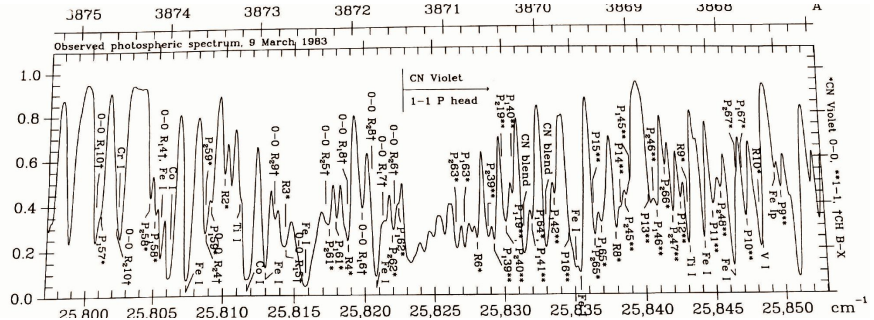


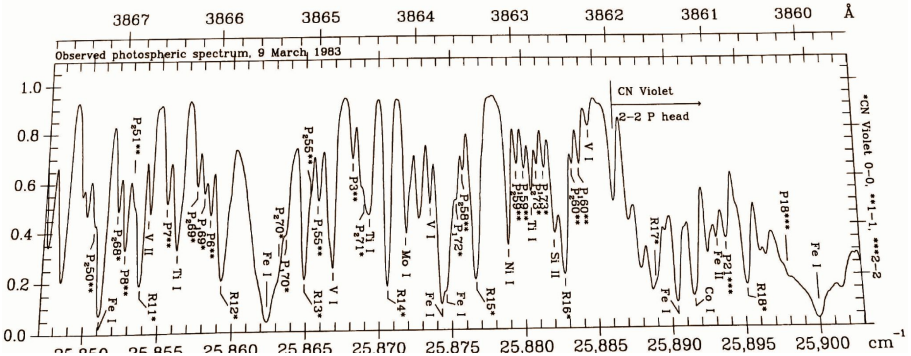
Region 5

Special interest windows

2. **388.0 nm - 386.0nm: (spectral coverage ~ 2 nm)**
   a. Covers the CN molecular band head
   b. Interesting region for limb/pole observations







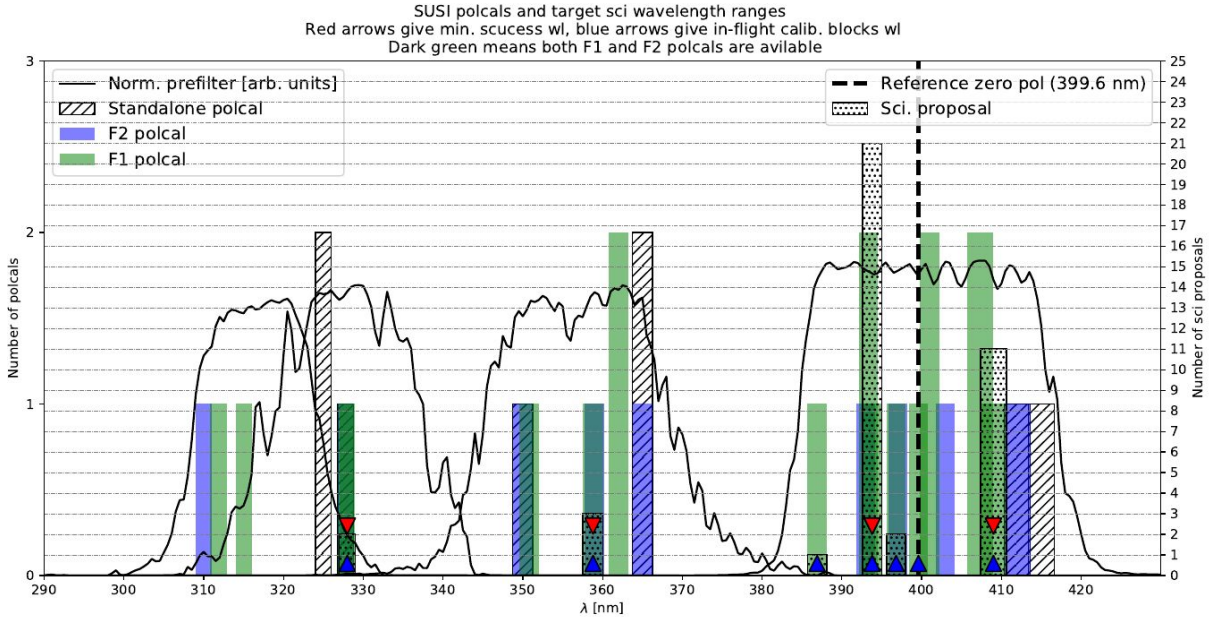
SUSI full spectral region

Special interest windows

3. **Full spectral range of SUSI:**
    a. One or two scans in QS+ plage region.
    b. Polcal measurements available over: 13 spectral windows
    c. Total coverage: 31.4 nm
    d. If we cover, on average, 2.5 nm per scan, we need ~13 scans
    e. Flatfielding: 13 times

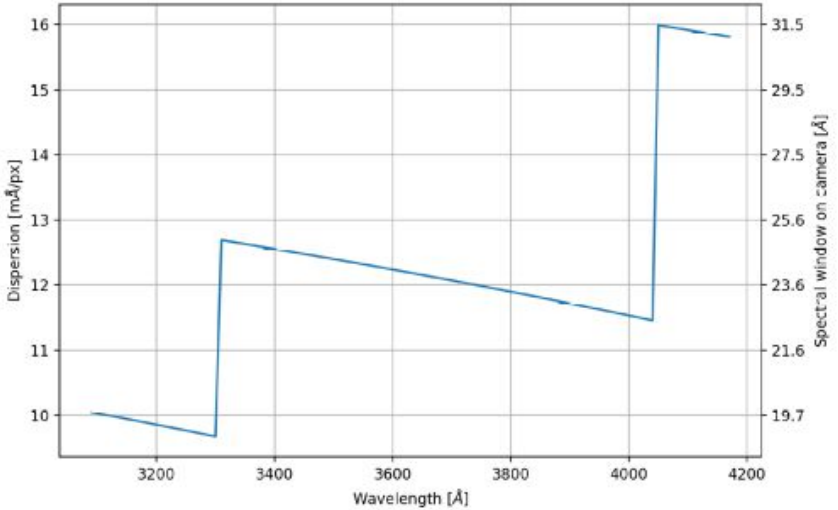
Polcal in F1
405.8 – 408.9
399.9 – 402.1
360.9 – 363.1
314.0 – 316.0

Polcal in F2
410.37 - 413.63
401.83 - 404.18
395.81 - 398.19
391.81 - 394.19
363.76 - 366.25
357.75 - 360.25
348.73 - 351.27
326.81 - 328.80
309.0 – 311.0



SUSI full spectral region

Spectral sampling and spectral window on the SP cameras



SP order-sorting filters

Filter no.	Prioritized wavelengths [nm]	CWL [nm]	FWHM [nm]	Usable wavelength range [nm]
1	314	317	15.9	308.9 - 324.6
2	323	327	24.3	316.4 - 340.7
3	359	358	23.1	346.2 - 369.3
4	393.3, 396.8, 408	401	31.6	385.8 - 417.4

Spectral window size:

Up to 330.0 nm : 1.9 nm
330.0 nm - 405.0 nm : 2.2 nm
405.0 nm – 417.0 nm : 3.0 nm

Filters 1 and 2: 309 nm – 340 nm

309 nm – 330 nm with 1.9 nm window size: 11 windows
330 nm – 341 nm with 2.2 nm window size: 5 windows

Filter 3: 346.2 nm – 369.3 nm

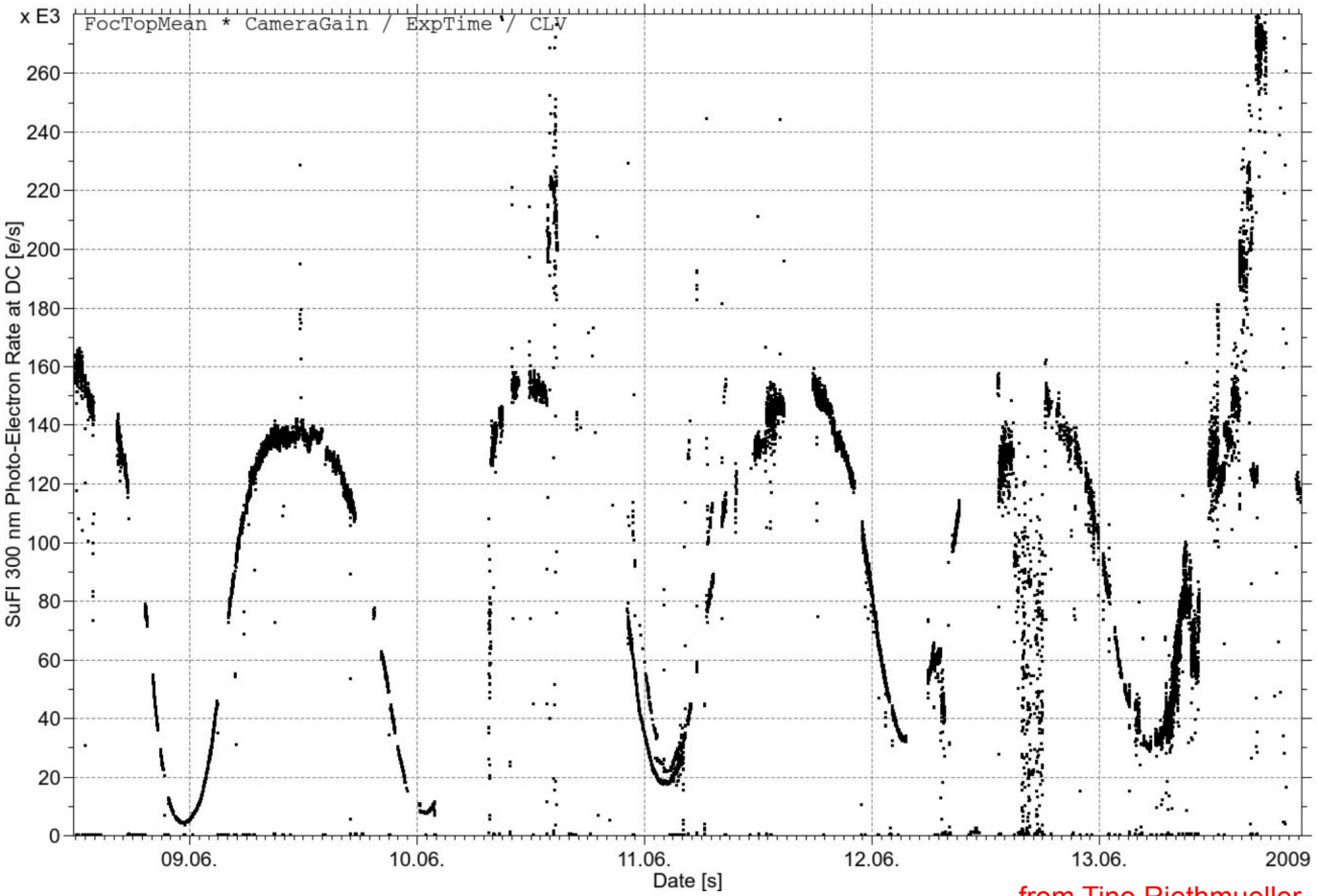
346.2 nm – 369.3 nm with 2.2 nm window size: 11 windows

Filter 4: 385.8 nm – 417.4 nm

385.8 nm – 405.0 nm with 2.2 nm window size: 9 windows
405.0 nm – 417.4 nm with 3.0 nm window size: 4 windows

Total number of windows: 40

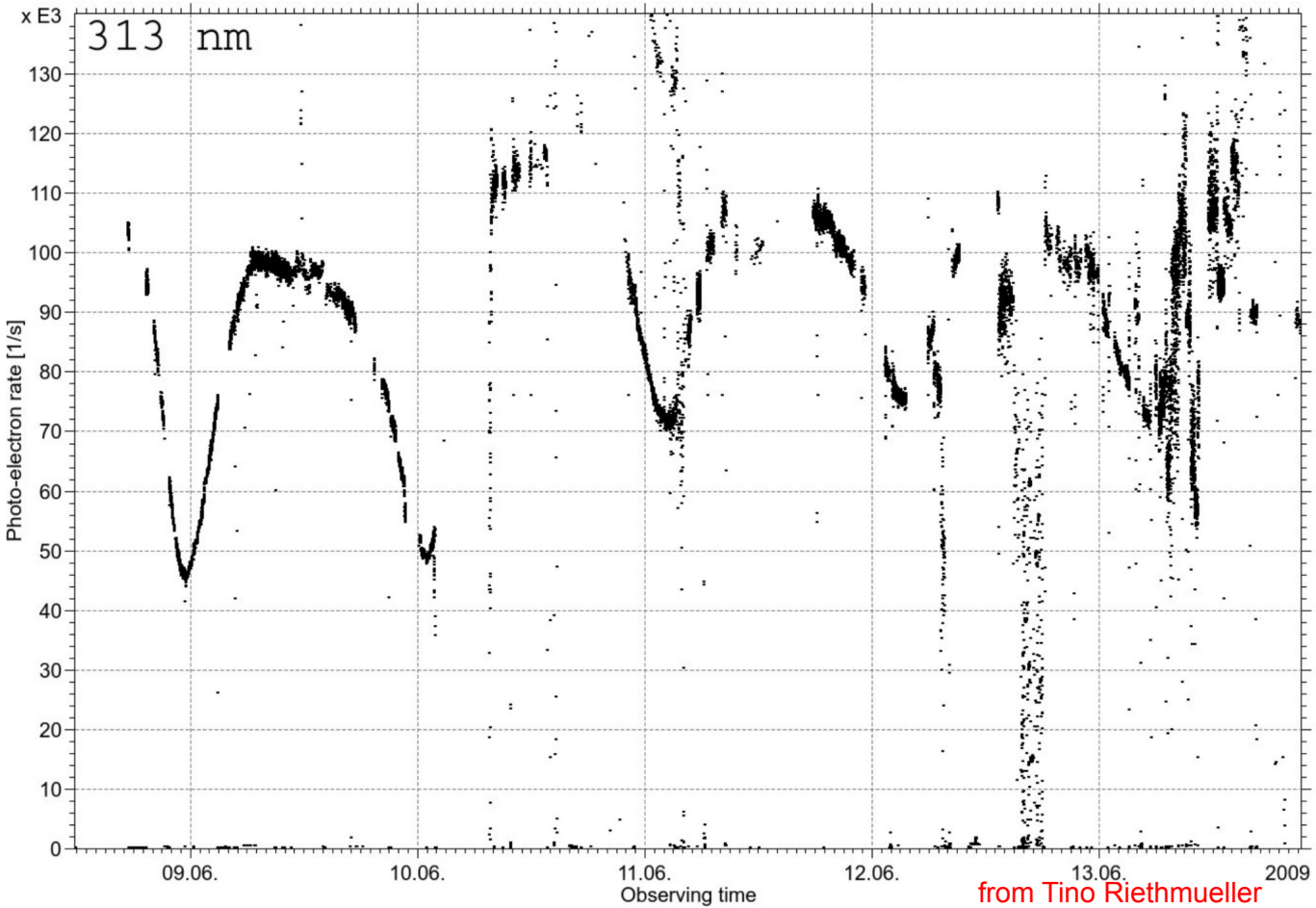
Measured flux at 300 nm as a function time



from Tino Riethmueller

back

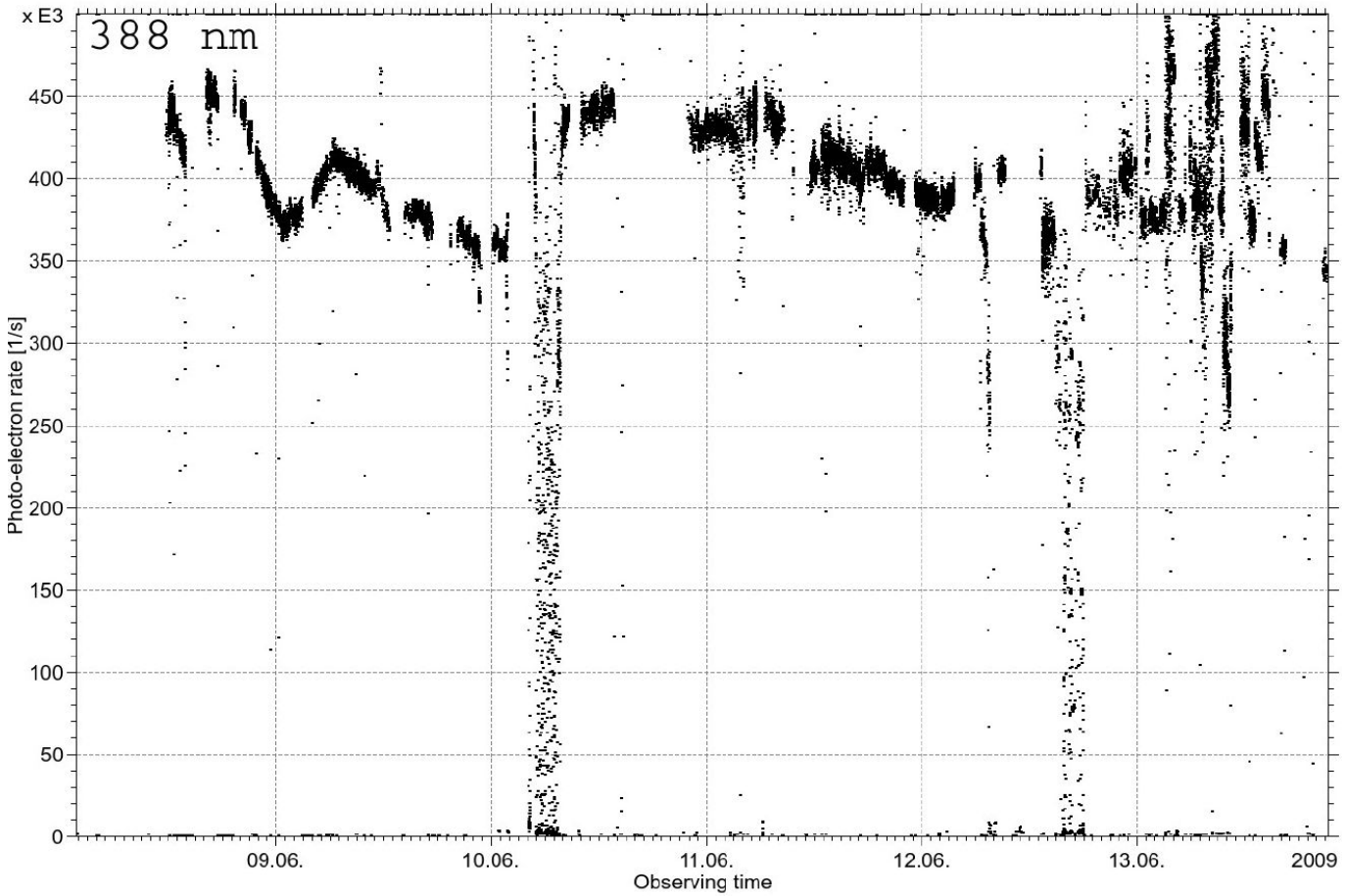
Measured flux at 313 nm as a function time



from Tino Riethmueller

back

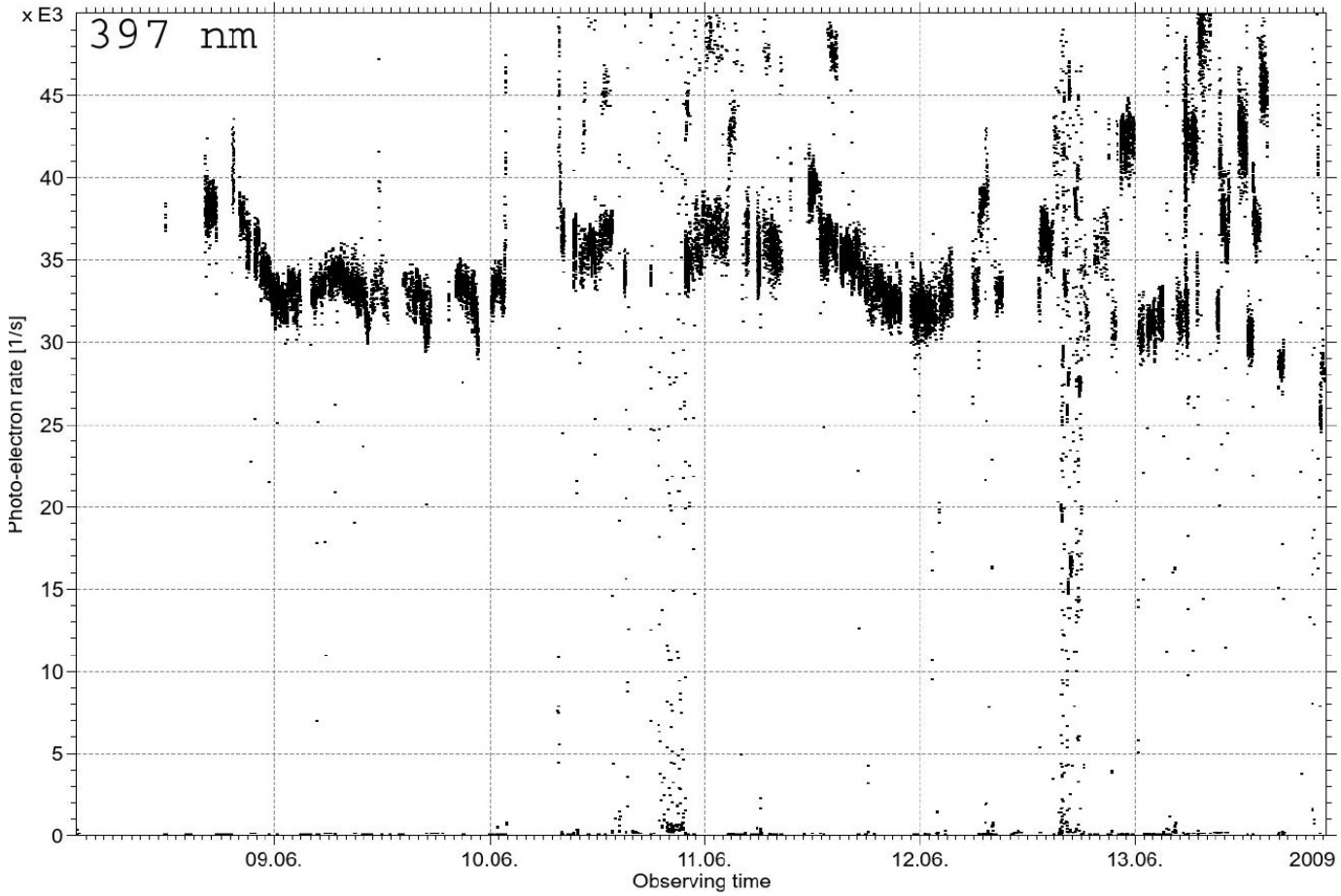
Measured flux at 388 nm as a function time



from Tino Riethmueller

back

Measured flux at 397 nm as a function time



from Tino Riethmueller

back

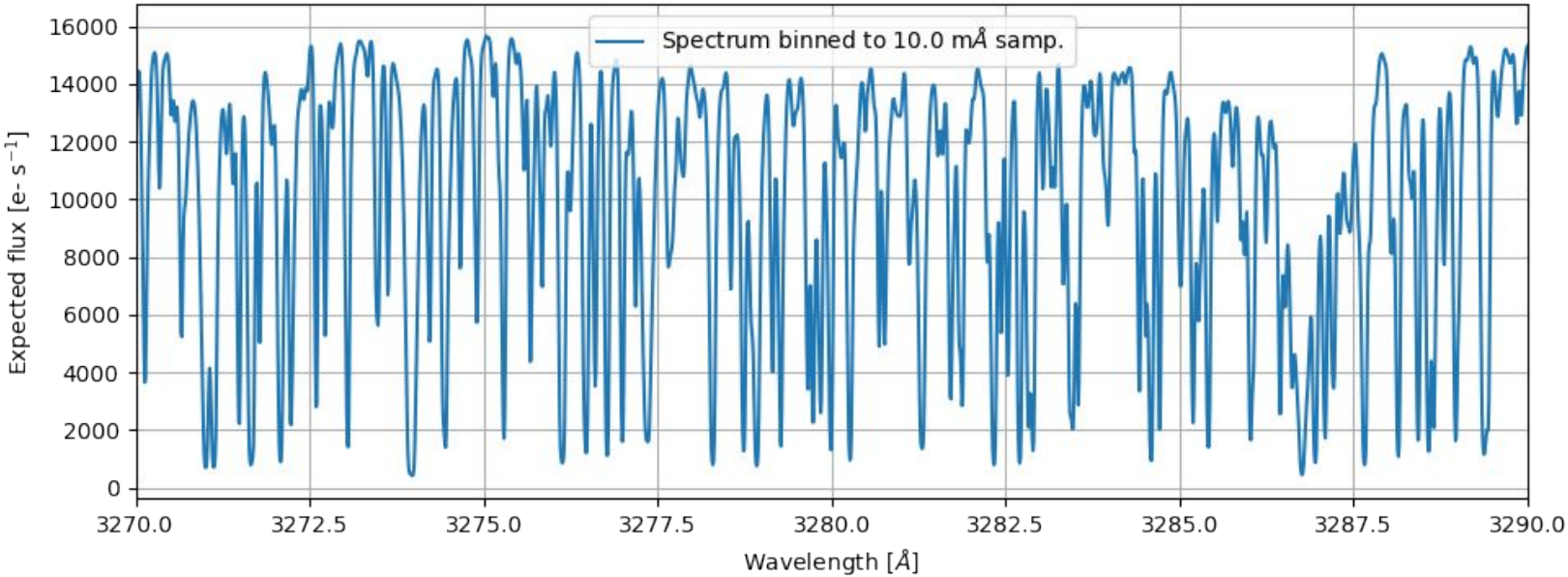
Expected flux and noise in different SUSI spectral windows

by Alex Feller

Spectral region: 328 nm

328 nm region

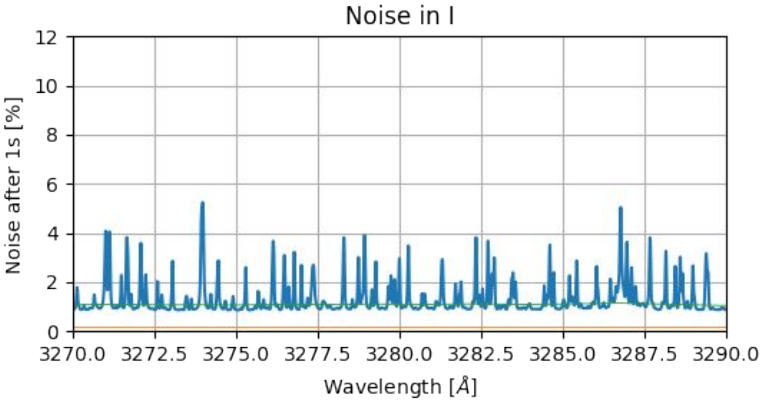
Expected flux

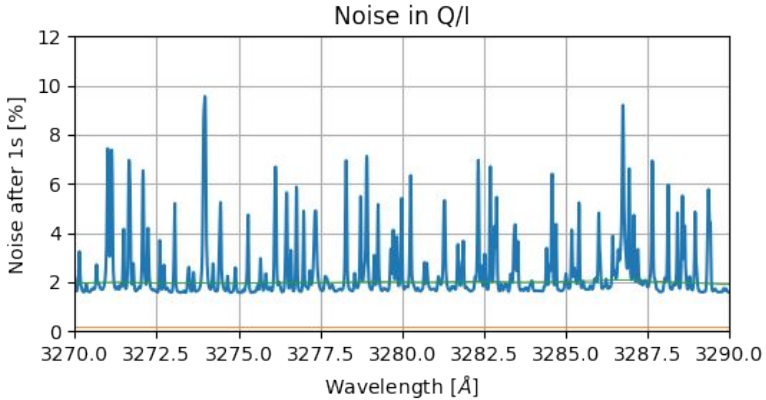


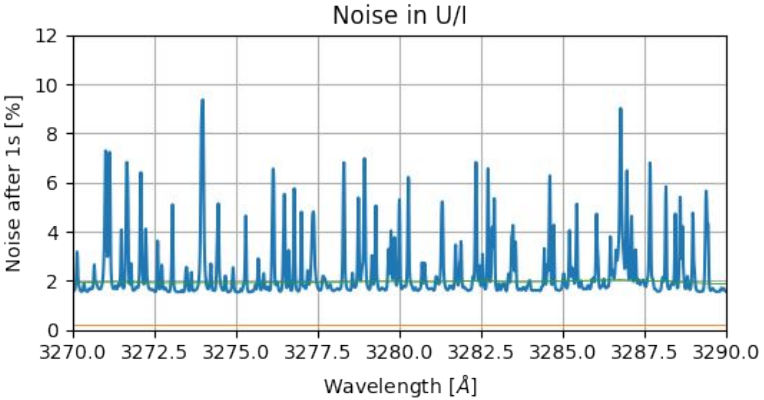
328 nm region

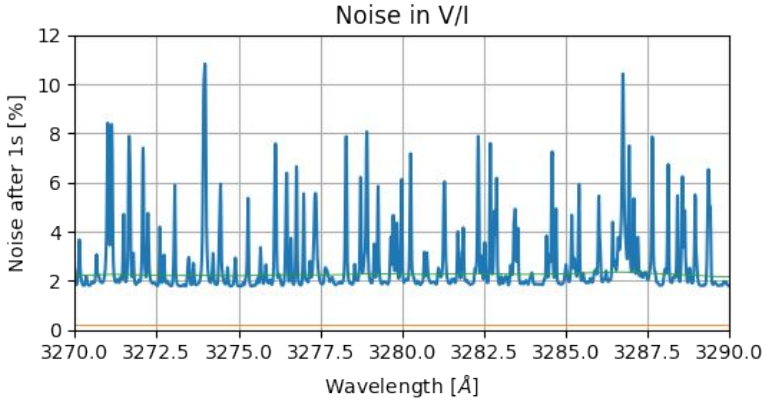
Reference plots:

Noise after 1s, at intrinsic SUSI sampling (10 mÅ, 0.03”, slit width 0.06”)





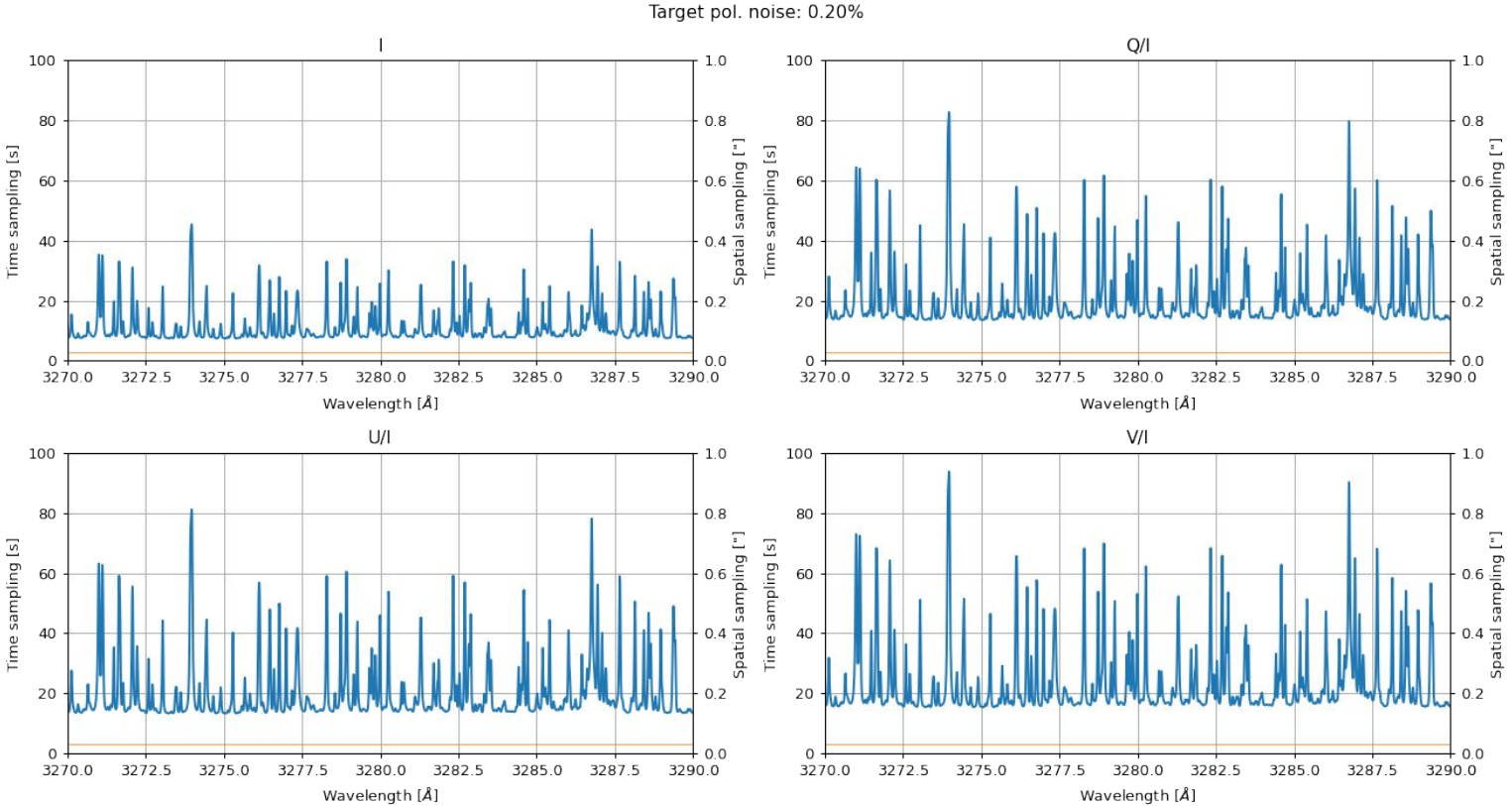




328 nm region

Reference plots:

Target noise level 0.2%, scan speed 0.01”/s, spectral sampling 10 mÅ



328 nm region

Optimum spatio-temporal sampling
Wings of 2 strongest lines (Cu I 3274 Å, Fe I 3286.7 Å)

Scan speed ["/s]	Stokes I Target noise = 1%		Stokes Q, U (V) Target noise = 0.2%	
	Δt [s]	Δx = Δy ["]	Δt [s]	Δx = Δy ["]
0.01	5.4	0.05	50	0.50
0.025	3.4	0.09	31.6	0.79
0.08	1.9	0.15	17.7	1.41

328 nm region

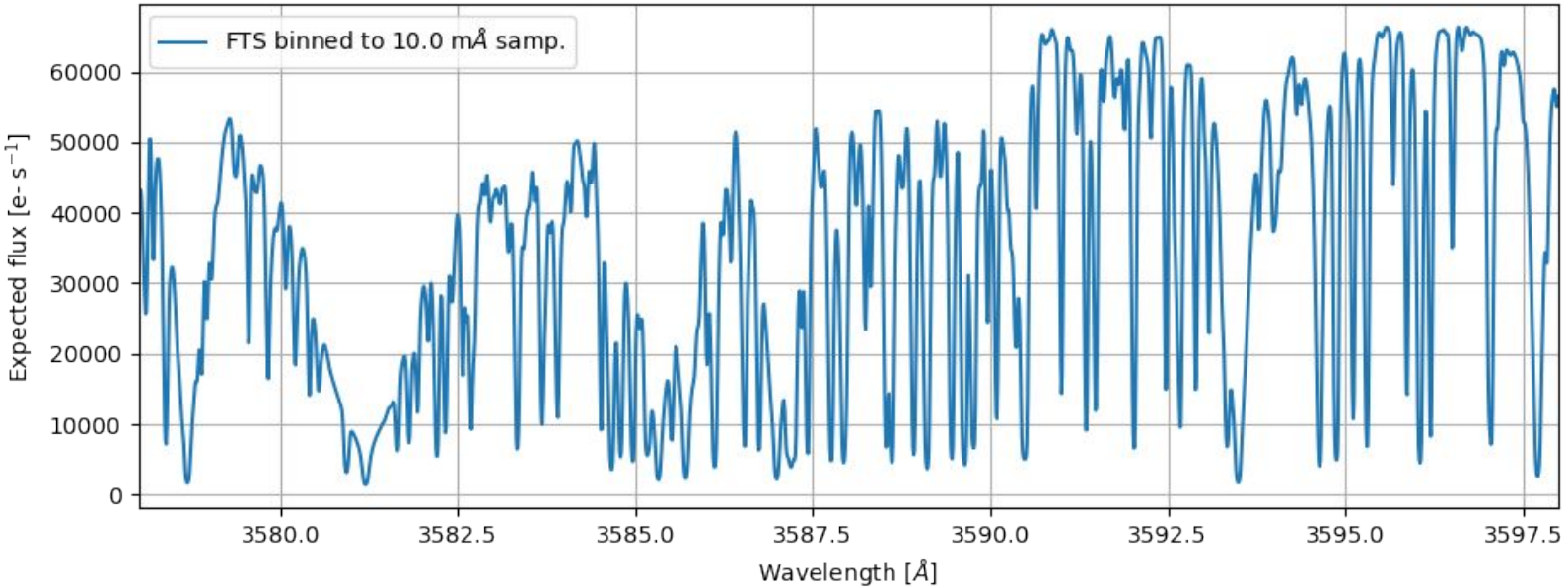
Optimum spatio-temporal sampling
Wings of most other lines

Scan speed ["/s]	Stokes I Target noise = 1%		Stokes Q, U (V) Target noise = 0.2%	
	Δt [s]	Δx = Δy ["]	Δt [s]	Δx = Δy ["]
0.01	4.0	0.04	40	0.40
0.025	2.5	0.06	25.3	0.63
0.08	1.4	0.11	14.1	1.13

Spectral region: 359 nm

359 nm region

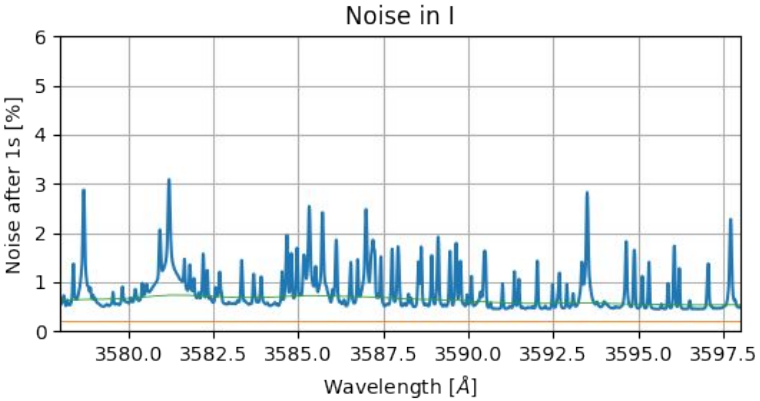
Expected flux

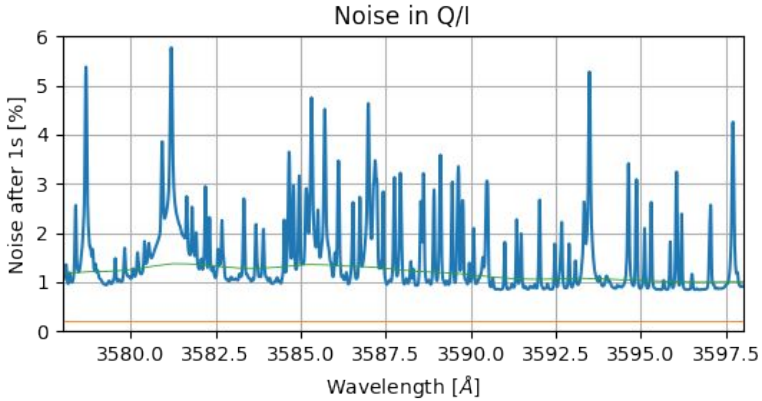


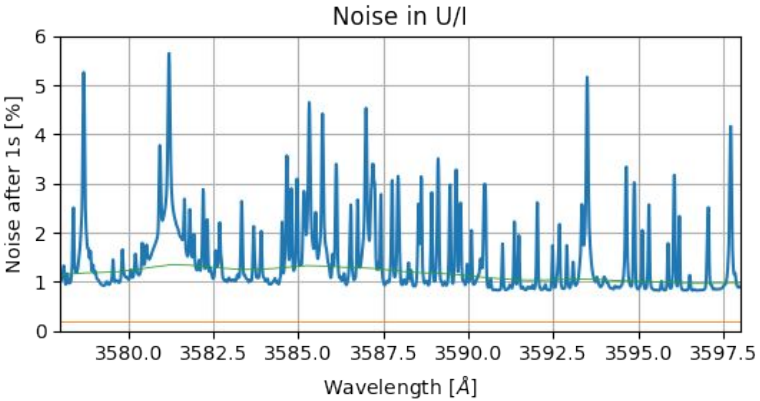
359 nm region

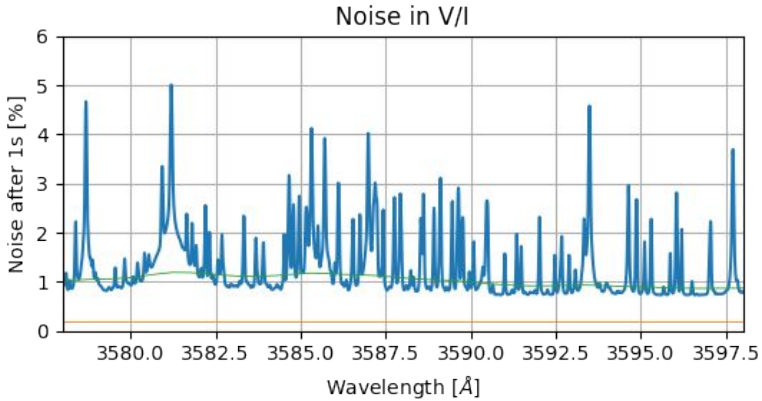
Reference plots:

Noise after 1s, at intrinsic SUSI sampling (10 mÅ, 0.03”, slit width 0.06”)





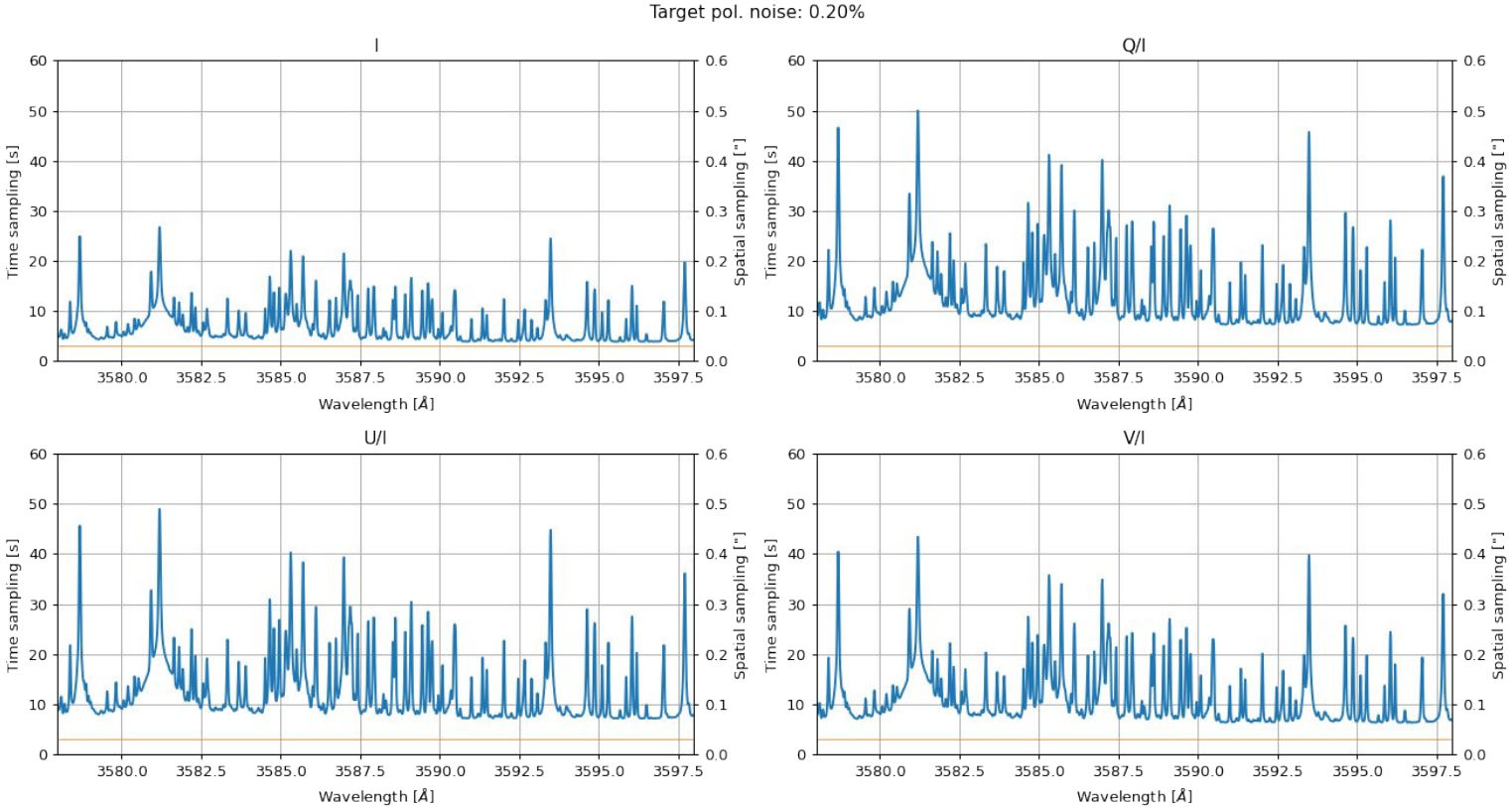




359 nm region

Reference plots:

Target noise level 0.2%, scan speed 0.01”/s, spectral sampling 10 mÅ



359 nm region

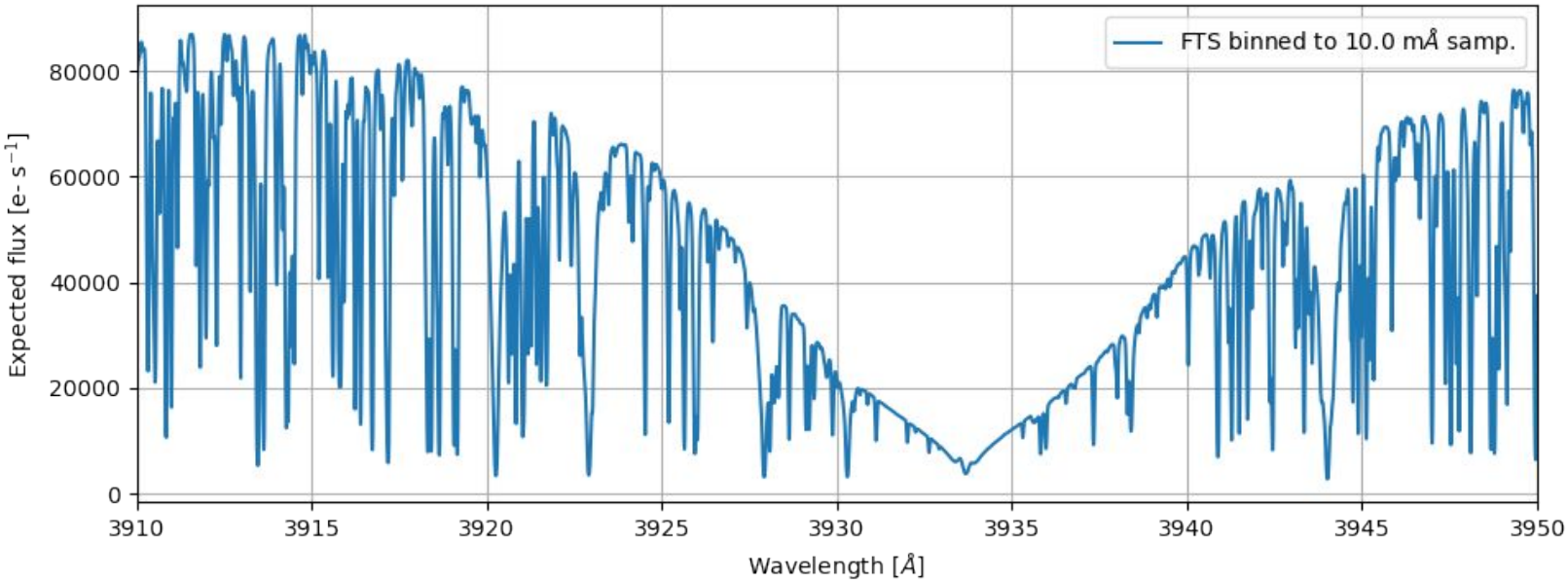
Optimum spatio-temporal sampling, Fe I 3581.2 Å line core

Scan speed ["/s]	Stokes I Target noise = 1%		Stokes Q, U (V) Target noise = 0.2%	
	Δt [s]	Δx = Δy ["]	Δt [s]	Δx = Δy ["]
0.01	5.4	0.05	50	0.50
0.025	3.4	0.09	31.6	0.79
0.08	1.9	0.15	17.7	1.41

Spectral region: Ca II K

Ca II K

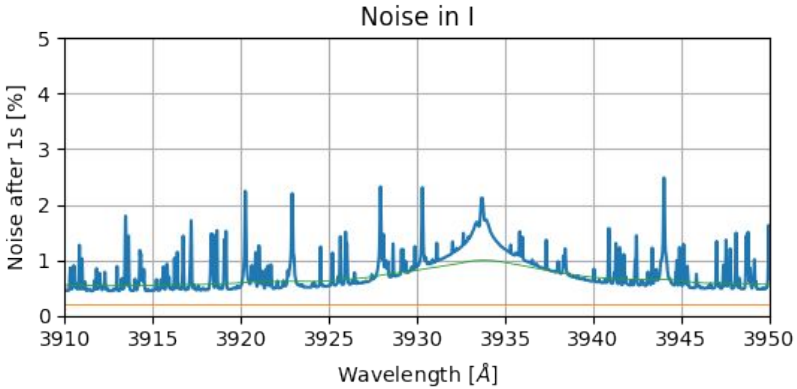
Expected flux

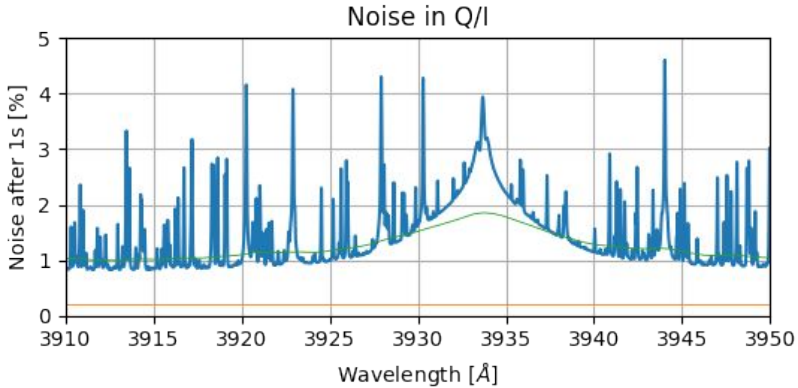


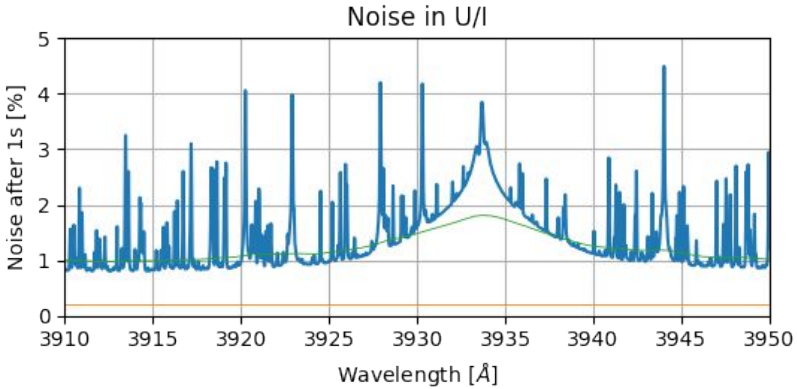
Hang test observations (2021-11-12T11:47Z) have shown that we have reached about 65% of the expected flux, from the ground, despite high humidity and low Sun elevation angles (~20.5°).

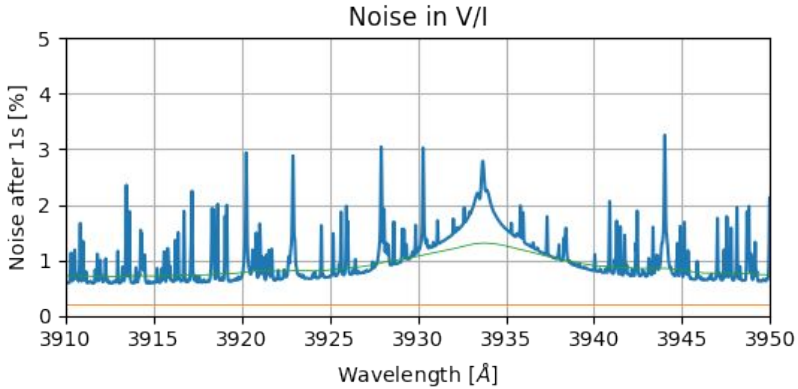
Ca II K

Reference plots:
Noise after 1s, at intrinsic SUSI sampling (10 mÅ, 0.03”, slit width 0.06”)



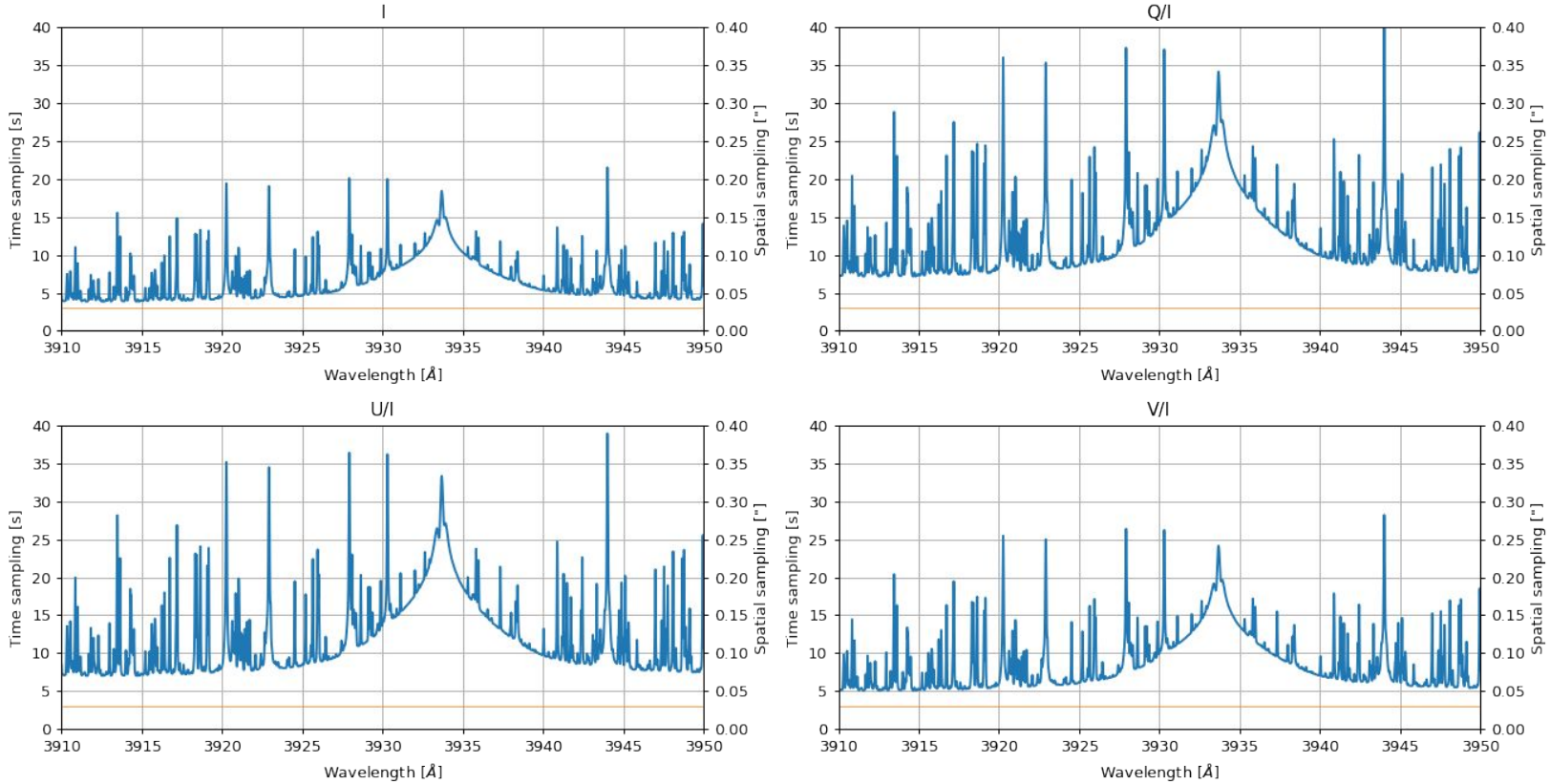






Ca II K

Reference plots:
Target noise level 0.2%, scan speed 0.01”/s, spectral sampling 10 mÅ



Ca II K

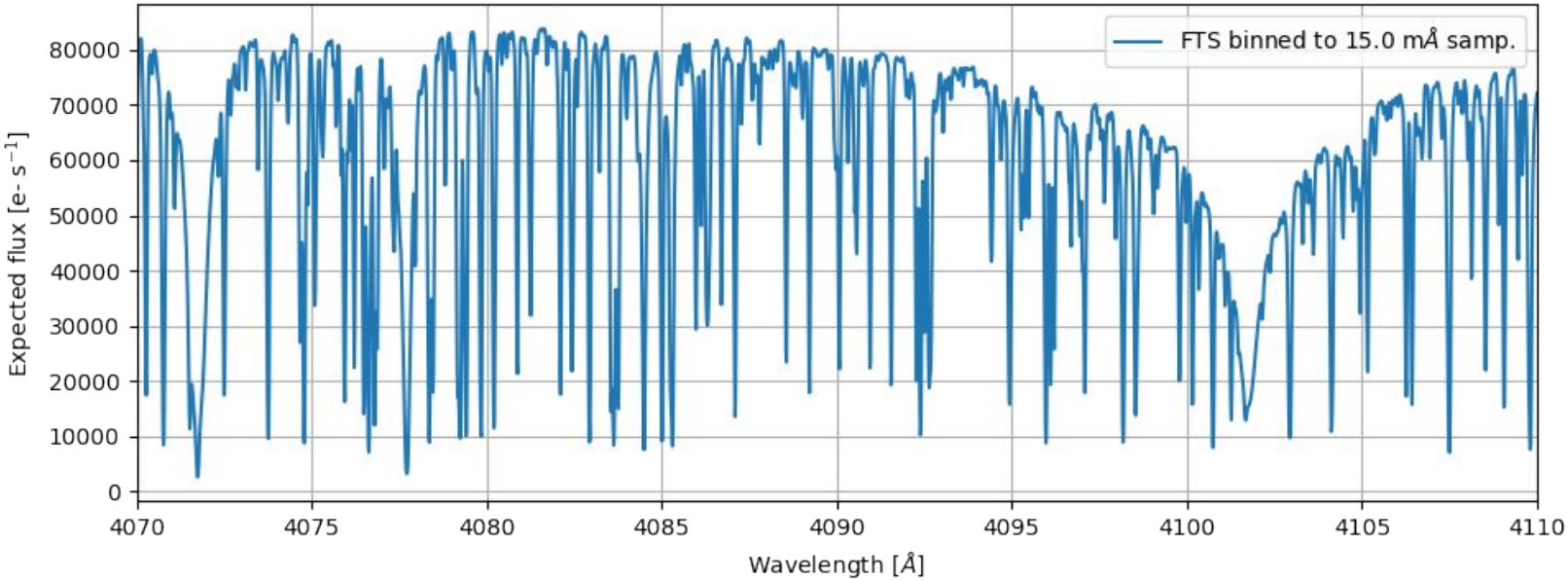
Optimum spatio-temporal sampling, Ca II K line core

Scan speed ["/s]	Stokes I Target noise = 1%		Stokes Q, U, V Target noise = 0.2%	
	Δt [s]	Δx = Δy ["]	Δt [s]	Δx = Δy ["]
0.01	3.6	0.04	34.0	0.34
0.025	2.3	0.06	21.5	0.54
0.08	1.3	0.10	12.0	0.96

Spectral region: 408 nm

408 nm region

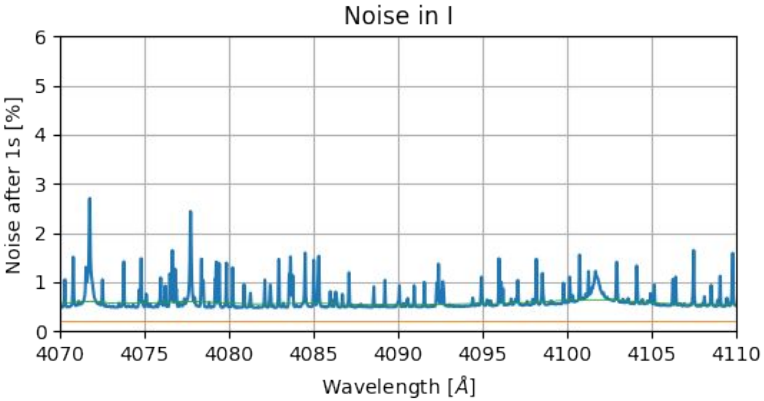
Expected flux

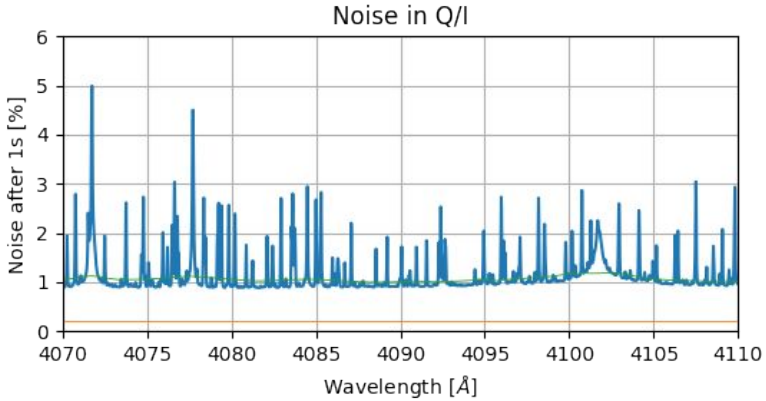


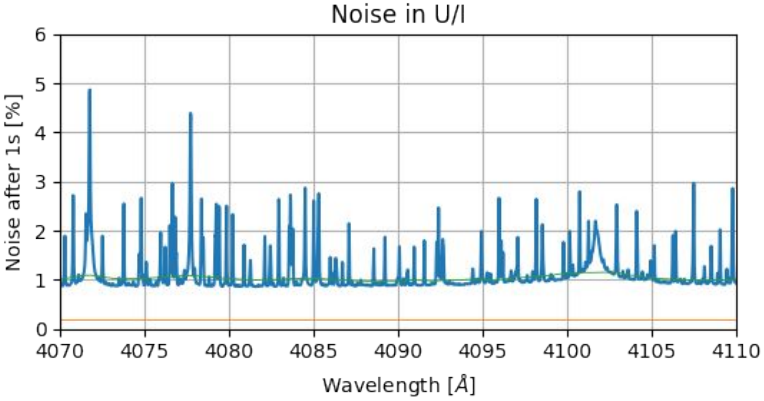
408 nm region

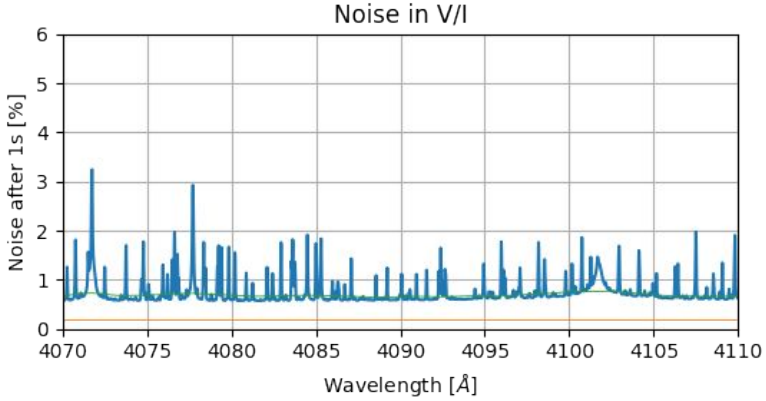
Reference plots:

Noise after 1s, at intrinsic SUSI sampling (10 mÅ, 0.03”, slit width 0.06”)





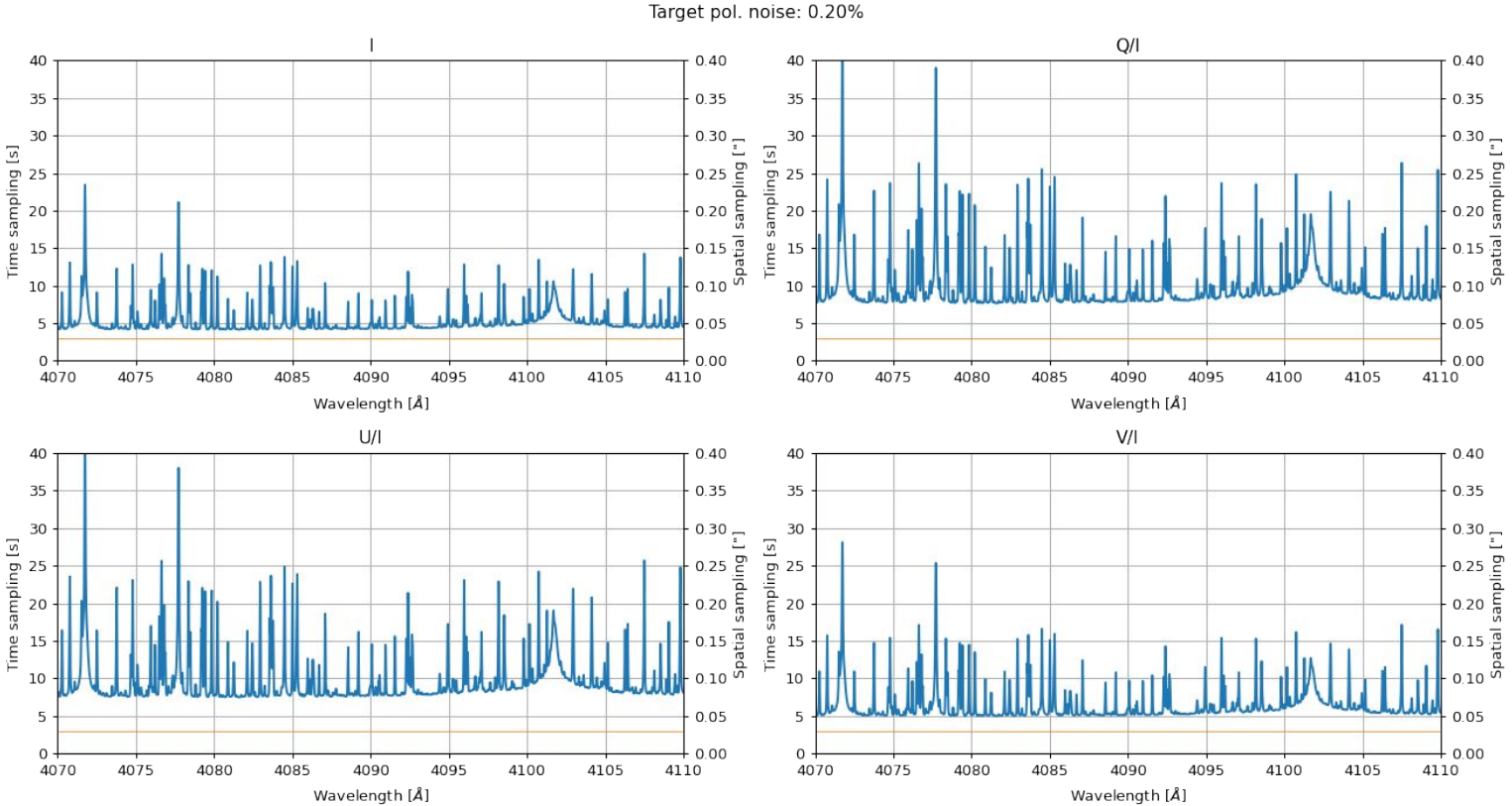




408 nm region

Reference plots:

Target noise level 0.2%, scan speed 0.01”/s, spectral sampling 10 mÅ



408 nm region

Optimum spatio-temporal sampling, Hδ line core

Scan speed ["/s]	Stokes I Target noise = 1%		Stokes Q, U (V) Target noise = 0.2%	
	Δt [s]	Δx = Δy ["]	Δt [s]	Δx = Δy ["]
0.01	2.2	0.02*	20 (13)	0.2 (0.13)
0.025	1.4	0.03	12.6 (8.2)	0.32 (0.21)
0.08	0.8	0.06	7.1 (4.6)	0.57 (0.37)

*) Noise level is already reached after a scan range which is smaller than the intrinsic spatial sampling

Alex: extra slides

Further noise reduction by spatio-temporal binning

$$F = \sigma^{-2} = \phi \, \Delta t \, \Delta y \tag{1}$$

F: accumulated signal in both SUSI SP cameras (e-)
σ: photometric noise = polarimetric noise x pol. efficiency
ϕ: flux [e- $''^{-1}$ s^{-1}], along slit (integrated over fixed spectral sampling and slit width)
s: slit width ["]
Δy: spatial sampling along slit["]
Δt: time sampling [s]

Coupling of spatial and time dimension due to scanning (or solar evolution) with speed v:

$$\Delta x = v \, \Delta t \tag{2}$$

We have 4 free parameters: noise, scan speed, time sampling and spatial sampling. In the following we always assume equal sampling in both spatial dimensions, i.e. $\Delta x = \Delta y$. This is based on the assumption that characteristic signal speeds of solar evolution, and spatial scales of solar structures under study, are typically direction independent.

In the following we describe 3 use cases, where different observing parameters are specified. The best solution, in terms of post-facto binning of the data, can be different in each case.

Note that the general amount of available flux ϕ can be adjusted by spectral binning. If the solution in terms of spatio-temporal sampling is unsatisfactory, another iteration can be attempted, based on a larger spectral binning (spectral resolution tradeoff), if possible.

Case 1

This case is relevant when a characteristic signal speed of solar evolution needs to be properly captured by the instrument, e.g. to study dynamic phenomena (solar structures changing their shape or moving around with time).

Assumption: scan speed v and noise σ is specified.

From this, and from the general assumption $\Delta x = \Delta y$, we can derive the optimum combination of sampling in time and space from eqs. 1 and 2:

$$\Delta t = \frac{1}{\sqrt{\phi \, \sigma^2 \, v}}$$

$$\Delta x = \Delta y = \sqrt{\frac{v}{\phi \, \sigma^2}}$$

Note that a higher scan speed biases the solution towards higher time resolution and a coarser spatial resolution.

Case 2

This case applies if the focus is on a given characteristic spatial scale of solar structures to be resolved, and if dynamics are less important.

Assumption: Spatial sampling $\Delta x (= \Delta y)$ and noise σ are specified.

In this case the optimum time sampling follows directly from eq. 1:

$$\Delta t = \frac{1}{\sigma^2 \, \phi \, \Delta y}$$

and can also be expressed in form of a simple scaling law, which can be conveniently applied e.g. on the above noise plots:

$$\frac{\Delta t}{\Delta t_0} = \left(\frac{\sigma_0}{\sigma} \right)^2 \cdot \frac{\Delta y_0}{\Delta y},$$

σ_0 refers to the noise shown in the noise plots, and $\Delta t_0, \Delta x_0$ to the instrinsic sampling of 1s and 0.03" respectively, which the noise plots are based on.

The scan speed is then fixed by eq. 2: $v = \Delta x / \Delta t$.

Case 3

This case applies if the focus is on temporal resolution, and if spatial scales to be resolved are less important. This case will probably be of most interest for fixed slit or quasi-fixed slit observations, i.e. very short repetitive scans.

Assumption: Time sampling Δt and noise σ are specified.

In the case of short repetitive scans, the optimum scan speed follows from eqs. 1 and 2:

$$v = \frac{1}{\sigma^2 \, \phi \, \Delta t^2}$$

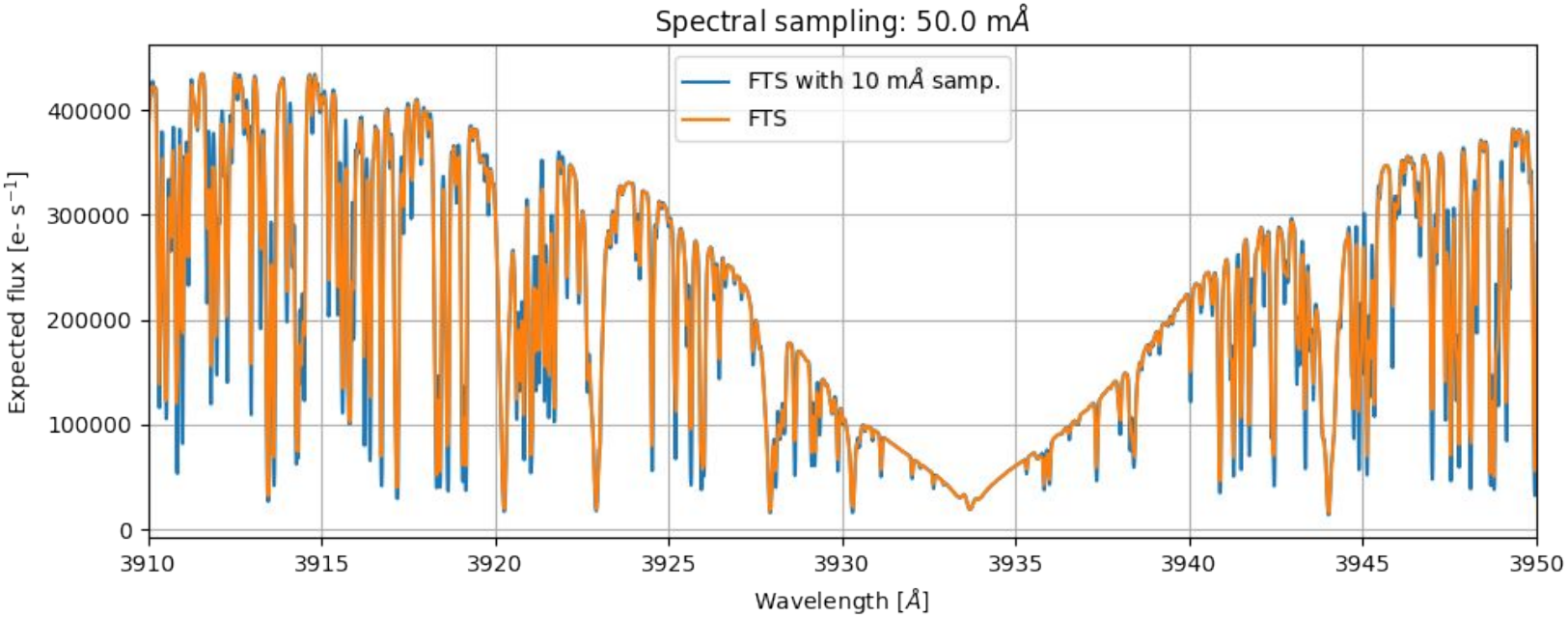
and the spatial sampling is then given by eq. 2: $\Delta x = v \, \Delta t$

In the case of true fixed slit observations ($v = 0$), binning in the scan direction does not apply and the noise can be only be reduced by spatial binning along the slit. The required spatial sampling is then given directly by eq. 1:

$$\Delta y = \frac{1}{\sigma^2 \, \phi \, \Delta t}$$

Ca II K

Expected flux



Hang test observations (2021-11-12T11:47Z) have shown that we have reached about 65% of the expected flux, from the ground, despite high humidity and low Sun elevation angles (~20.5°).

Ca II K

Example: SOLARNET proposal ‘Ellerman bombs’

Requirements given in the proposal:

- Spatial sampling: 0.06”
- Scan speed: 0.17 “/s
- Noise level in Stokes I: 0.5%

This combination of requirements is not possible.

In the following we provide 2 possible solutions, assuming

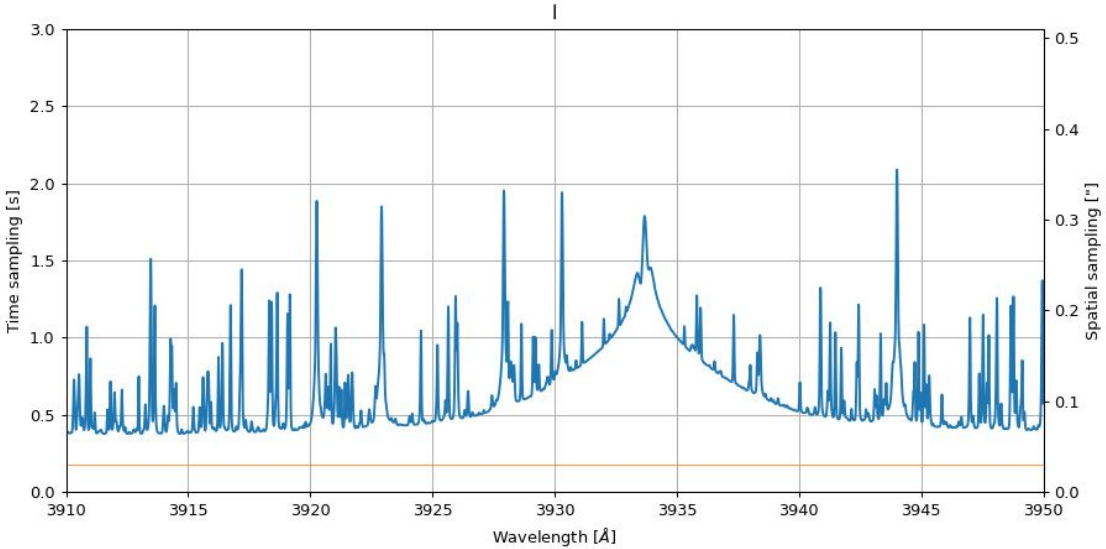
1. scan speed is most important (case 1)
2. Spatial sampling is most important (case 2)

Ca II K

Example: SOLARNET proposal ‘Ellerman bombs’

Case 1: Required scan speed is most important

After 1s integration, and at intrinsic SUSI sampling, the noise in the line core of Ca II K is about 2.1% (slide #31). This noise shall be reduced to 0.5% by spatio-temporal binning, based on the equations of case 2 (slide #34). The solution is shown below.



Required sampling in the line core is 1.8s and 0.3” respectively.

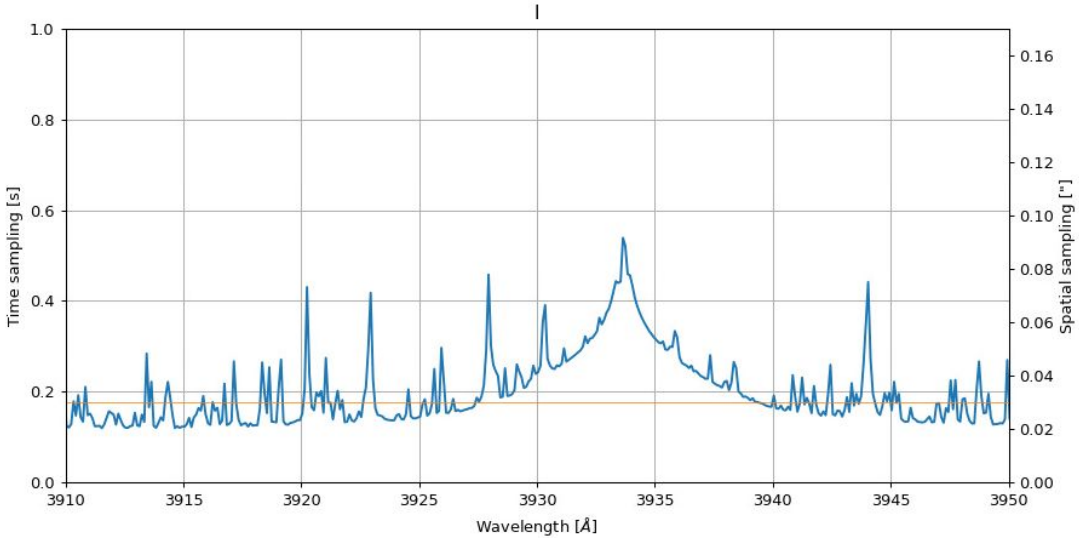
As can be seen, the spatial sampling is strongly incompatible with the required 0.06”!

Ca II K

Example: SOLARNET proposal ‘Ellerman bombs’

Case 1: Required scan speed is most important, tradeoff in spectral sampling

After 1s integration, and at intrinsic SUSI sampling, the noise in the line core of Ca II K is about 2.1% (slide #31). This noise shall be reduced to 0.5% by spatio-temporal binning, based on the equations of case 2 (slide #34). In addition a **tradeoff in spectral sampling** is accepted by applying (for the sake of this example) a strong spectral binning by a factor 10 (100 mÅ sampling). The solution is shown below.



Required sampling in the line core is now reduced by a factor 3 (sqrt of flux increase by spectral binning, cf. slide #33) to about 0.6s and 0.09” respectively.

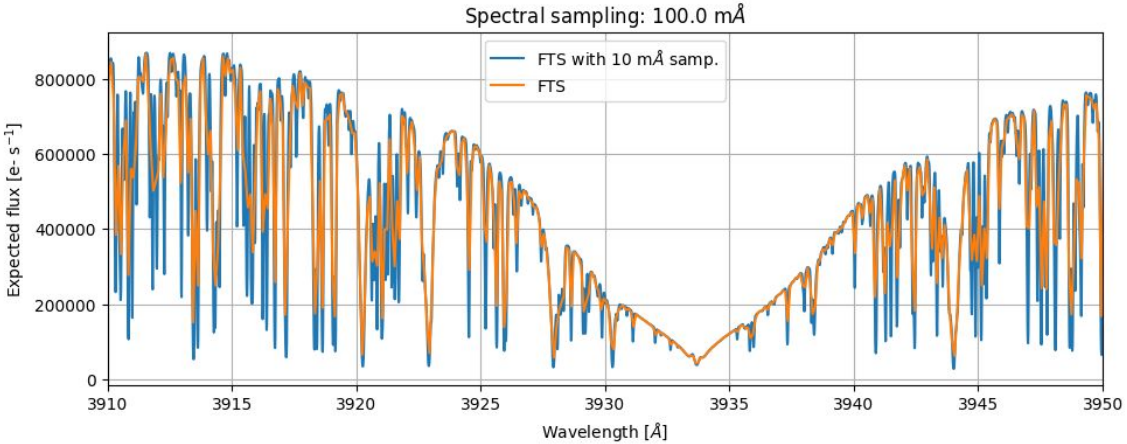
The spatial sampling is still incompatible with the requirement of 0.06”.

Ca II K

Example: SOLARNET proposal ‘Ellerman bombs’

Case 1: Required scan speed is most important, tradeoff in spectral sampling

After 1s integration, and at intrinsic SUSI sampling, the noise in the line core of Ca II K is about 2.1% (slide #31). This noise shall be reduced to 0.5% by spatio-temporal binning, based on the equations of case 2 (slide #34). In addition a **tradeoff in spectral sampling** is accepted by applying (for the sake of this example) a strong spectral binning by a factor 10 (100 mÅ sampling). The solution is shown below.



Such a strong spectral binning has of course an obvious effect on the observed spectrum, although the effect on the broad line core still seems to be ok.

Ca II K

Example: SOLARNET proposal ‘Ellerman bombs’

Case 2: Required spatial sampling is most important

After 1s integration, and at intrinsic SUSI sampling, the noise in the line core of Ca II K is about 2.1% (slide #31). This noise shall be reduced to 0.5% by spatio-temporal binning, based on the equations of case 2 (slide #33). In this case, a simple scaling law can be applied to the noise plot of slide #31:

$\Delta t = (2.1\% / 0.5\%)^{**}2 \times (0.03 / 0.06) \times 1s = 8.8$ s

The scan speed is then given by: v = 0.06 “ / 8.8s = 0.007 “/s. This is incompatible with the instrument specifications (scan speed > 0.01”/s).

To meet the noise and spatial resolution requirements, a **tradeoff in spectral sampling** has therefore to be accepted. Let us assume a spectral binning by a factor 2 (20 mÅ sampling), which increases the flux by a factor 2. Time sampling and scan speed scale with the same factor:

$\Delta t = 8.8 / 2 = 4.4$s
v = 0.007 x 2 = 0.014”/s

Now the scan speed is within the specified instrumental range. The scan speed can be further increased (and time sampling reduced accordingly), depending on the acceptable limitations in spectral resolution.