The Zürich-Locarno Method

Marco Cagnotti, Specola Solare Ticinese

Brussels, 22.5.2012

The Wolf/Wolfer's formula

1848: Wolf

$R = 10.g + f$

1893: Wolfer

$R = k.(10.g + f)$

Since 1893 until 1981, the k of the observers in Zürich has been 0.6 by definition (Wolfer, Brunner, Waldmeier). But…

…which observer?

Sometime a person did the drawing of the day and another did the counting.

- k is a parameter that expresses the peculiarities of the observer (telescope, sight, seeing, propensity for more counting or not)
- **The k for Wolf was 1**
- Wolf and Wolfer observed in parallel for 16 years
- **The k for Wolfer was 0.6** (he counted the smallest spots that Wolf didn't count and weighted the spots too)
- Unfortunately, as far as we know, **the "true" method has never been exactly described in written form until 1948** and later in 1968 by Waldmeier
- We think that the counting method was transmitted orally by a director of the Observatory to his assistants and particularly to his successor.

The Specola Solare Ticinese (SST)

1957-1981: Max Waldmeier established the SST

- The station on the south of the Alps of the Zürich Observatory
- Aim: replace the northern Observatory in case of nasty weather

The Specola Solare Ticinese (SST)

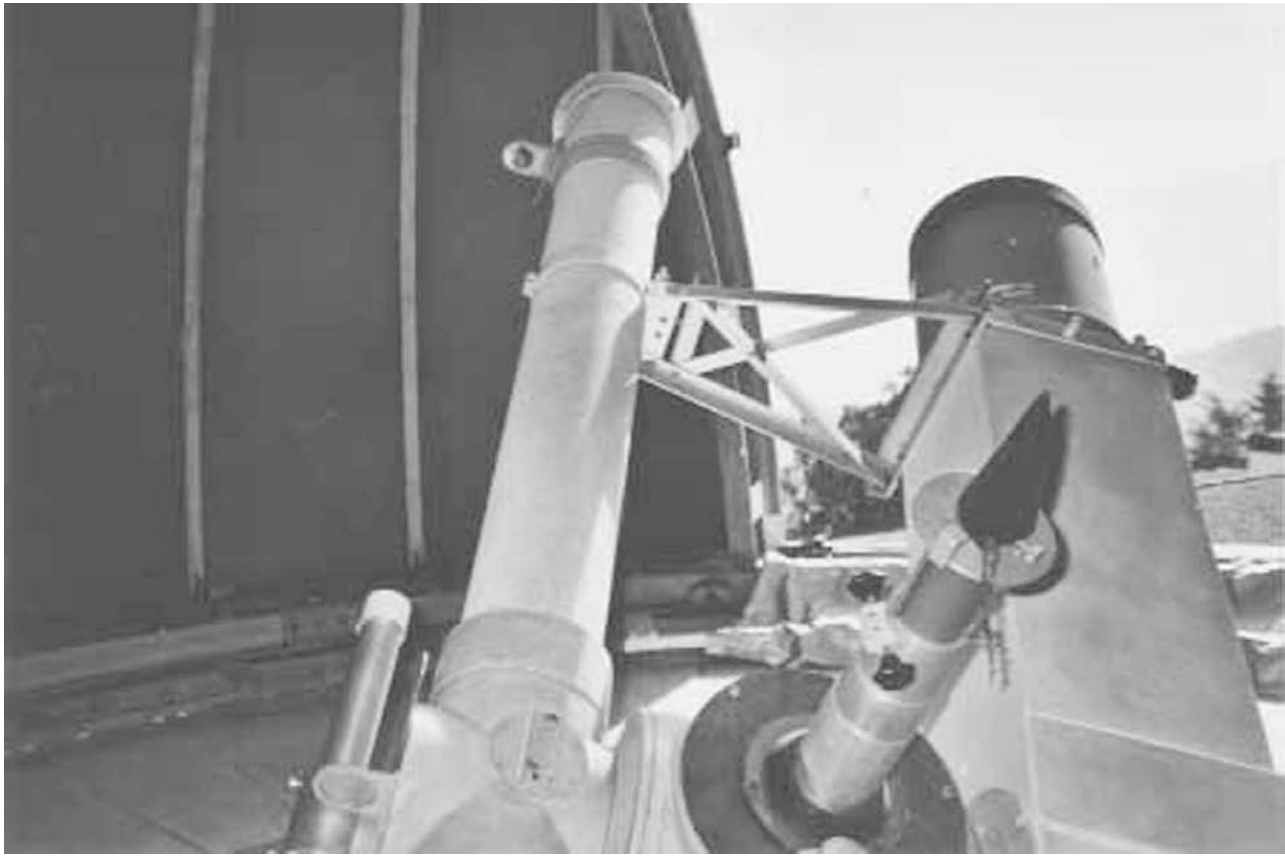
1957-1981: Max Waldmeier established the SST

- **Sergio Cortesi** and Araldo Pittini were instructed by Waldmeier in the drawing and the counting of the sunspots
- **Sergio Cortesi has ever had the same k as Waldmeier: 0.6**

The Specola Solare Ticinese (SST)

1957-1981: Max Waldmeier established the SST

• The telescope at the Specola is a Zeiss of 15 cm stopped down at 8 cm, in respect of the original instrument of Wolf, Wolfer etc.



The Specola Solare Ticinese (SST)

1957-1981: Max Waldmeier established the SST

- We observe the Sun with the projection technique
- The Sun has been observed and drawed almost daily **during more than 50 years**

Yesterday…

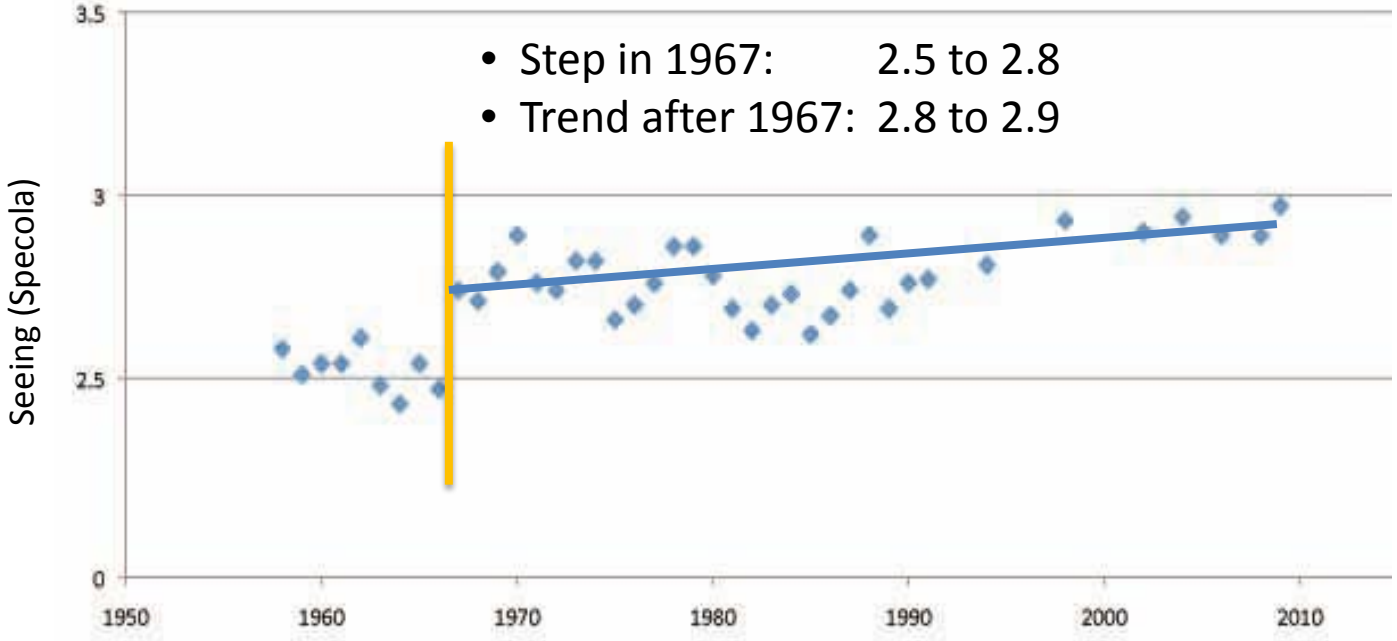
…and today

The Specola Solare Ticinese (SST)

1957-1981: Max Waldmeier established the SST

• During the years, **the quality of the seeing has slightly changed**
• In the 60s a house has been built near the Specola, with a metal root that provoked convective currents and turbulence of the air and damaged the seeing

Seeing's scale:
Specola: 1, best – 5, worst
SIDC: 5, best – 1, worst



The Specola Solare Ticinese (SST)

1957-1981: Max Waldmeier established the SST

- All the drawings and the countings of the Specola since 1957 until 1981 are now archived at ETH in Zürich
- The remaining are in our archives and available in our Website (specola.ch)

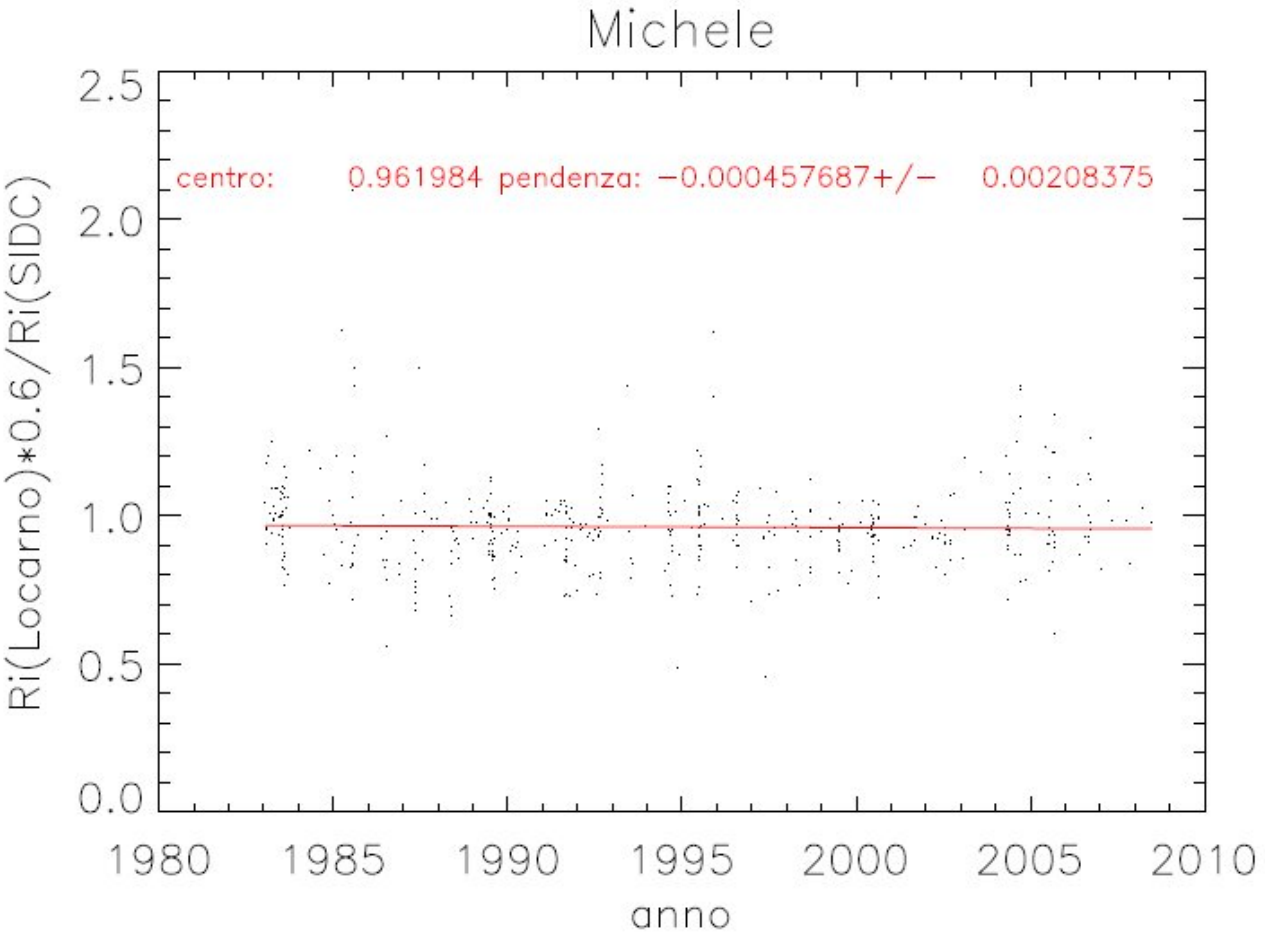
The Specola Solare Ticinese (SST)

1981-now: the SIDC era

• In 1981 the Zürich Observatory relocated this line of research to the SIDC in Brussels with the agreement of the IAU
• **The Specola Solare Ticinese was considered as the pilot station of the SIDC network**
• Since 1981 to 2010 Cortesi has been the Specola's director. His k parameter has been considered equal to 0.6.
• The staff now: Michele Bianda (IRSOL), Marco Cagnotti (present director and principal observer), Sergio Cortesi (former director and second observer), Andrea Manna, Renzo Ramelli (IRSOL)
• Their k, compared with the k of Sergio, has ever been very stable and close to 0.6.
•**Relative K coefficients of alternate observers vs Cortesi close to 1:**
0.961 to 1.037 (i.e. +/- 4 %)
•**No significant trend (< 0.2% / year)**

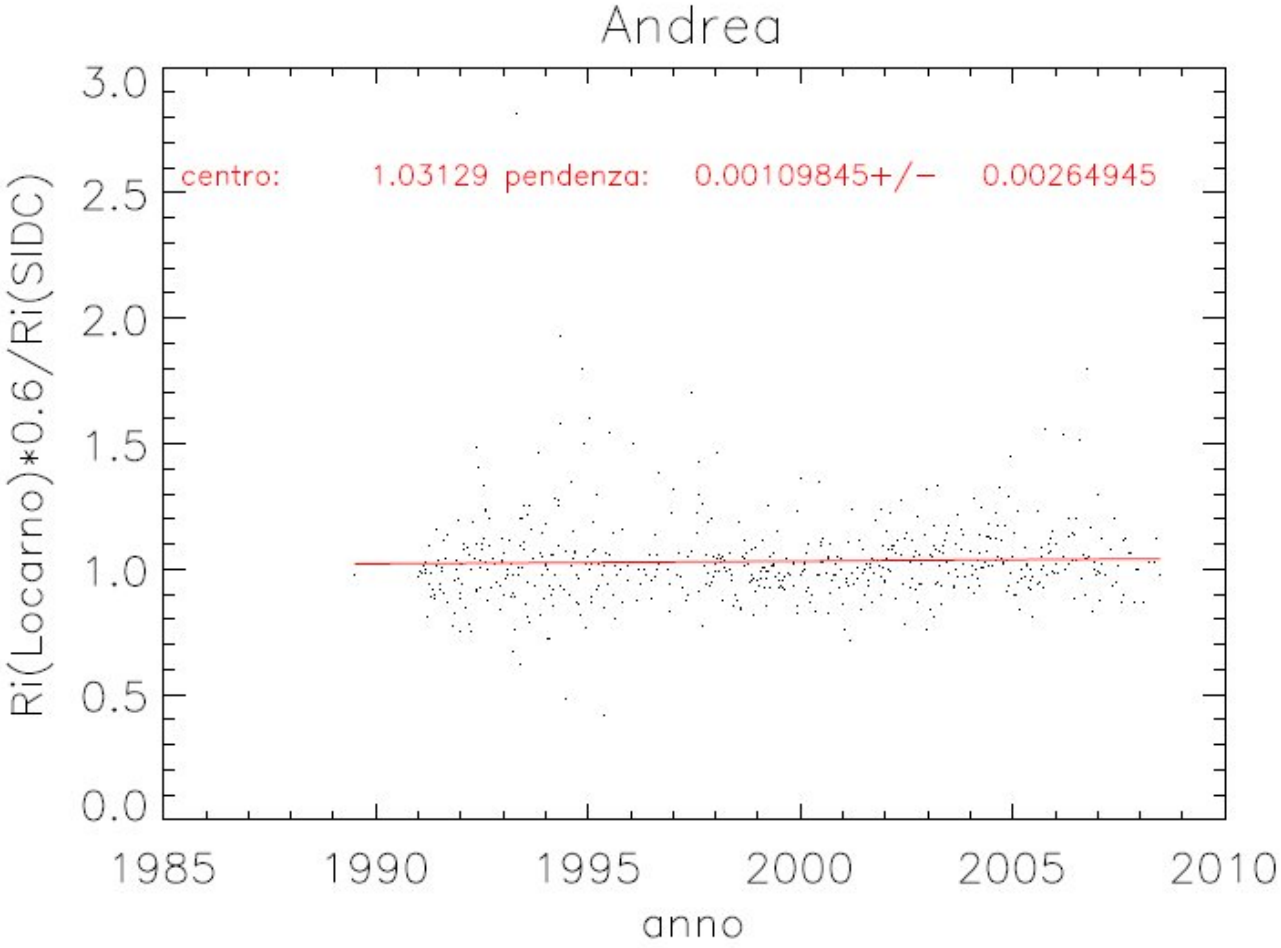
S.Cortesi versus other observers

- Michele Bianda
- 25 years
- K= 0.961
- Trend= 0.000 +/- 0.002



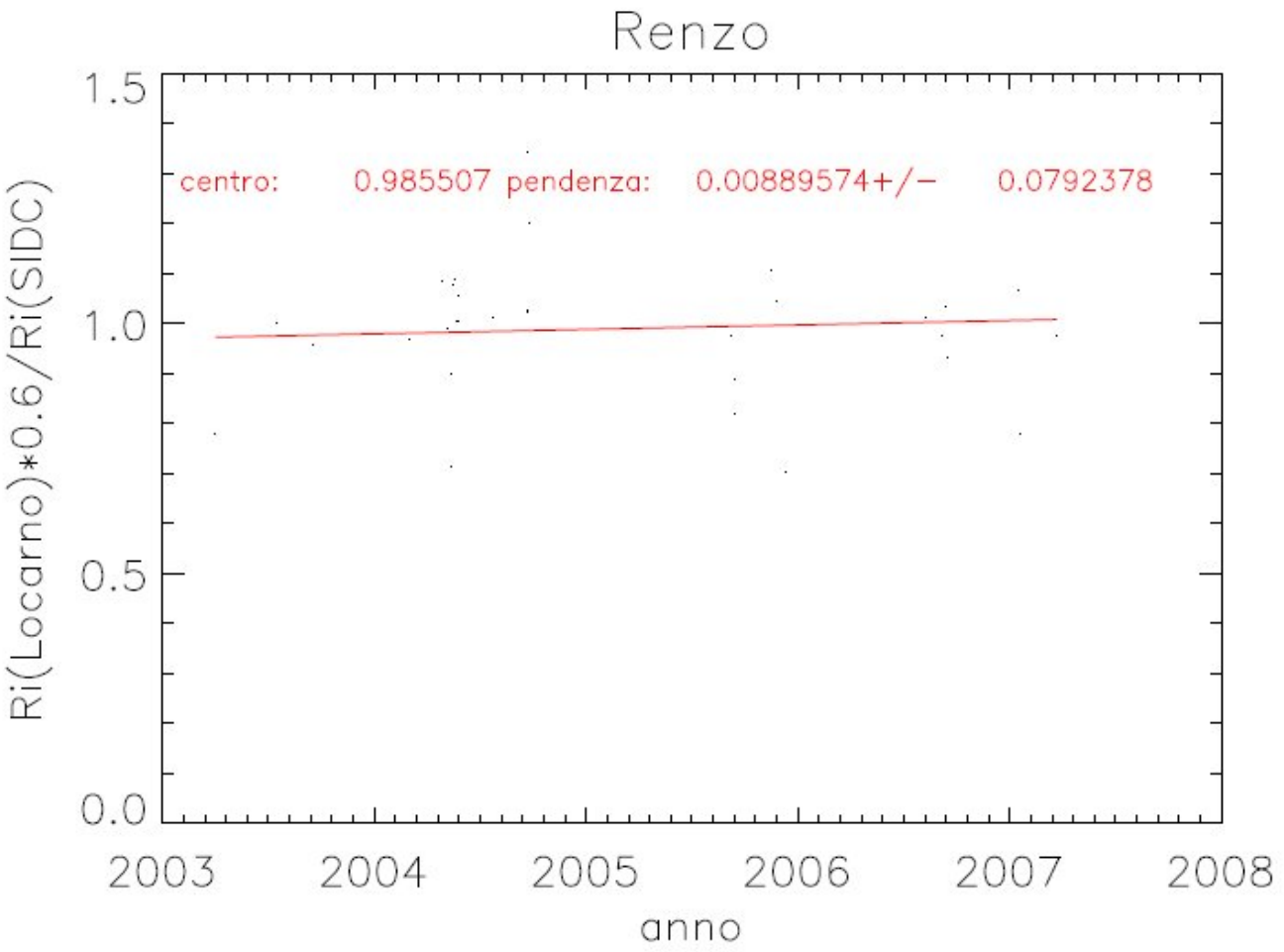
S.Cortesi versus other observers

- Andrea Manna
- 18 years
- K= 1.031
- Trend= 0.001 +/- 0.002



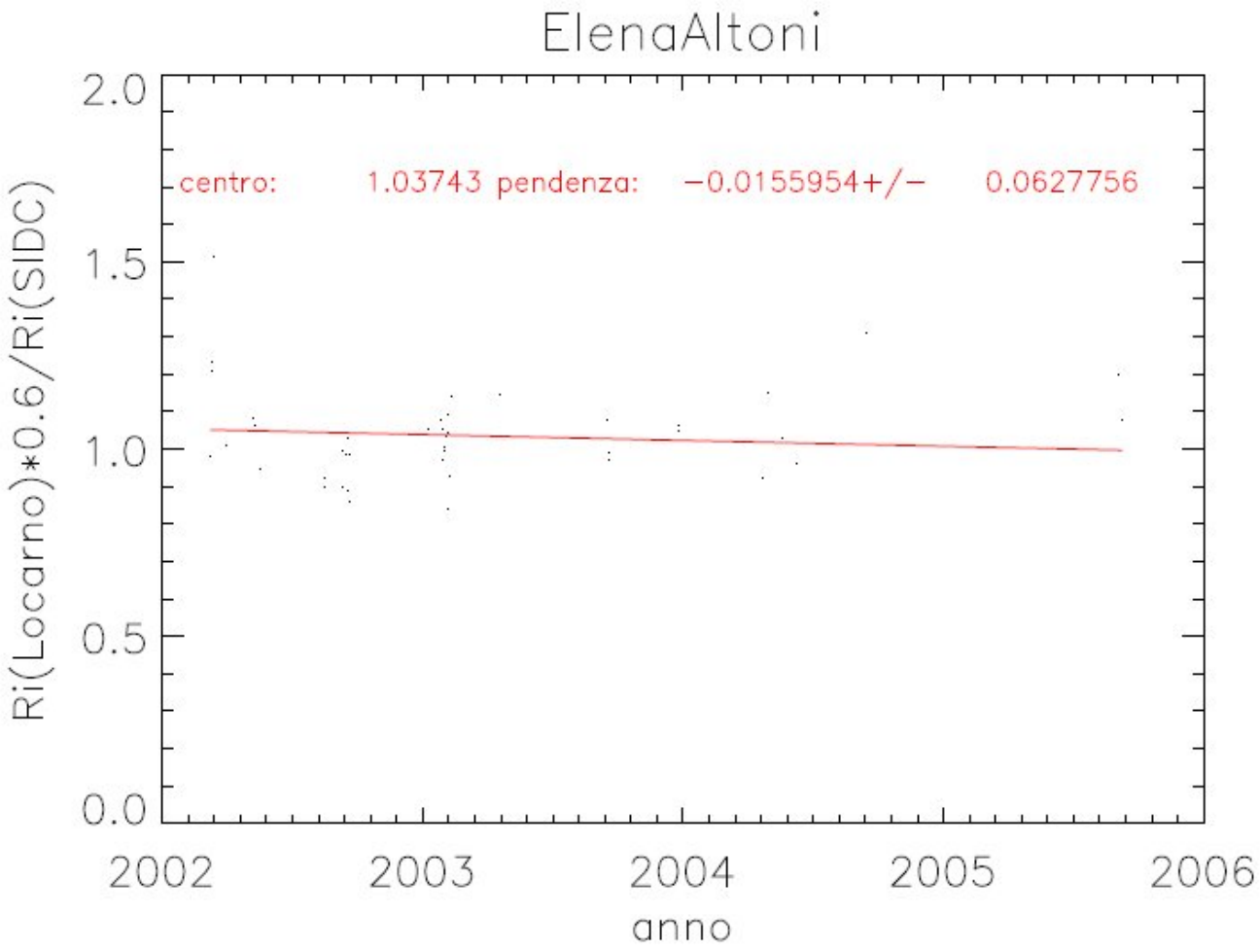
S.Cortesi versus other observers

- Renzo Ramelli
- 4 years
- K= 0.986
- Trend= 0.01 +/- 0.08



S.Cortesi versus other observers

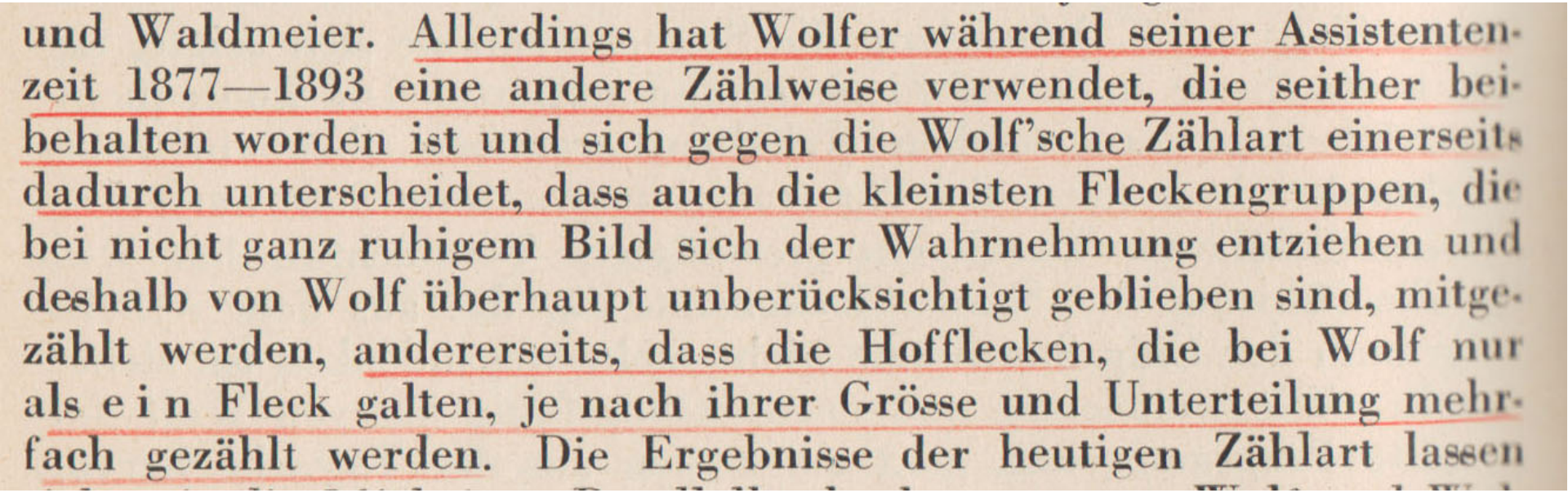
- Elena Altoni
- 4 years
- K= 1.037
- Trend: 0.02 +/- 0.06



The counting method

The tradition

• Unfortunately, as far as we know, the "true" method has never been exactly described in written form until 1948 and 1968 by Waldmeier



und Waldmeier. Allerdings hat Wolfer während seiner Assistentenzeit 1877—1893 eine andere Zählweise verwendet, die seither beibehalten worden ist und sich gegen die Wolf'sche Zählart einerseits dadurch unterscheidet, dass auch die kleinsten Fleckengruppen, die bei nicht ganz ruhigem Bild sich der Wahrnehmung entziehen und deshalb von Wolf überhaupt unberücksichtigt geblieben sind, mitgezählt werden, andererseits, dass die Hofflecken, die bei Wolf nur als ein Fleck galten, je nach ihrer Grösse und Unterteilung mehrfach gezählt werden. Die Ergebnisse der heutigen Zählart lassen

The counting method

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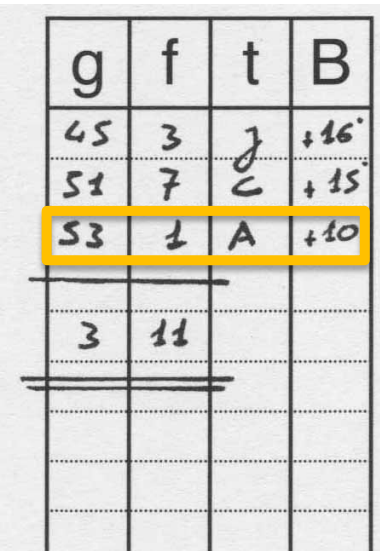
Berücksichtigung der Größe der Flecken. Bei Wolf war f' die Anzahl der Flecken, gleichgültig ob es sich um punktförmige Objekte oder um große Hofflecken handelte. Später wurden den Flecken entsprechend ihrer Größe Gewichte erteilt: Ein punktförmiger Fleck wird einfach gezählt, ein größerer, jedoch nicht mit Penumbra versehener Fleck erhält das statistische Gewicht 2, ein kleiner Hoffleck 3, ein größerer 5. Die Gruppen- und

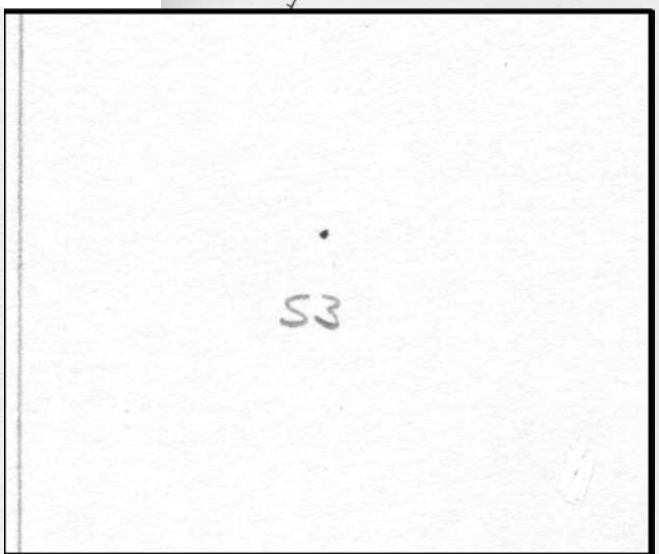
The counting method

The procedure

A small spot without penumbra is counted 1.



g	f	t	B
45	3	J	+16
51	7	C	+15
53	1	A	+10
3	11		

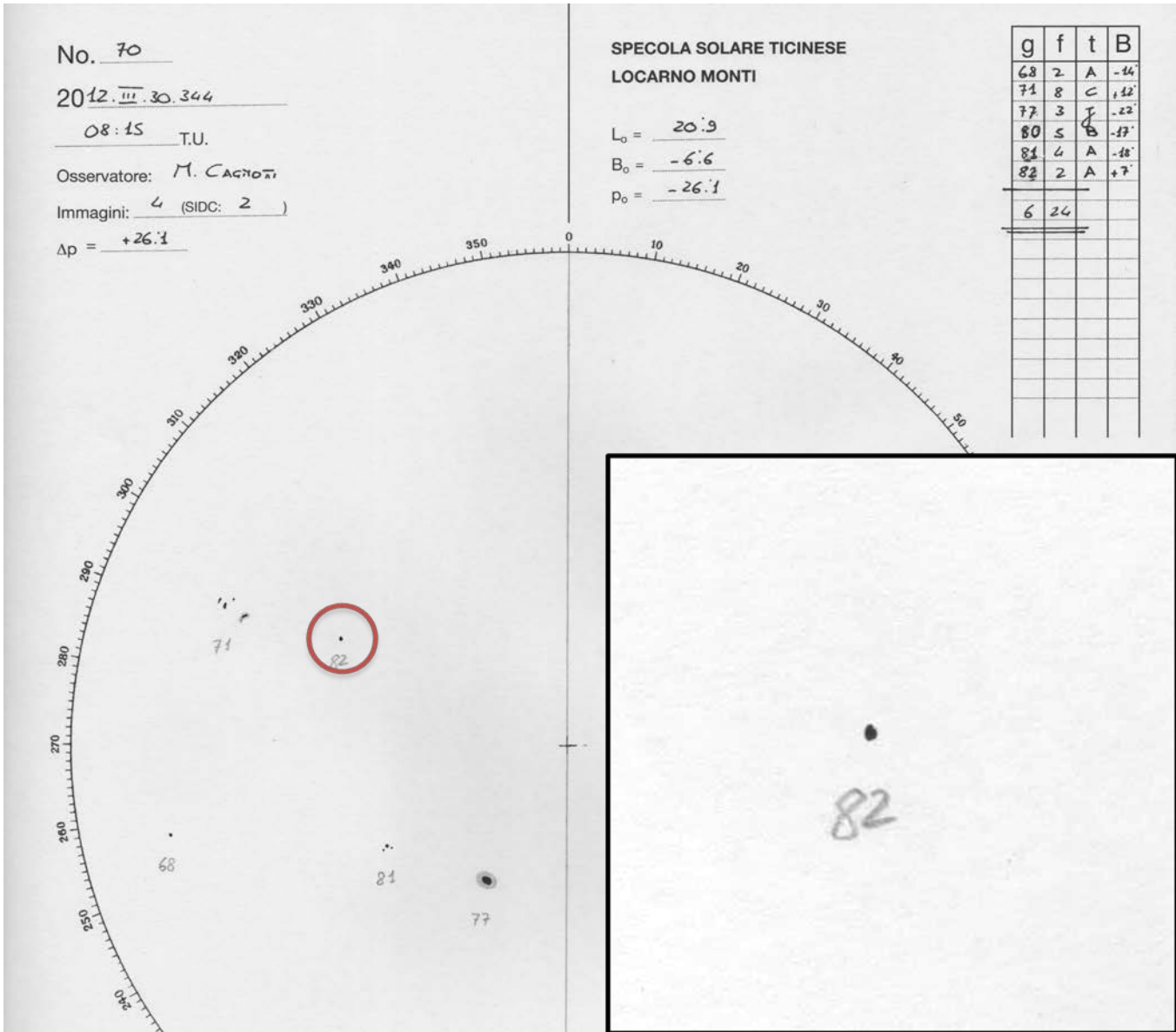


The counting method

The procedure

A big spot without penumbra is counted 2.

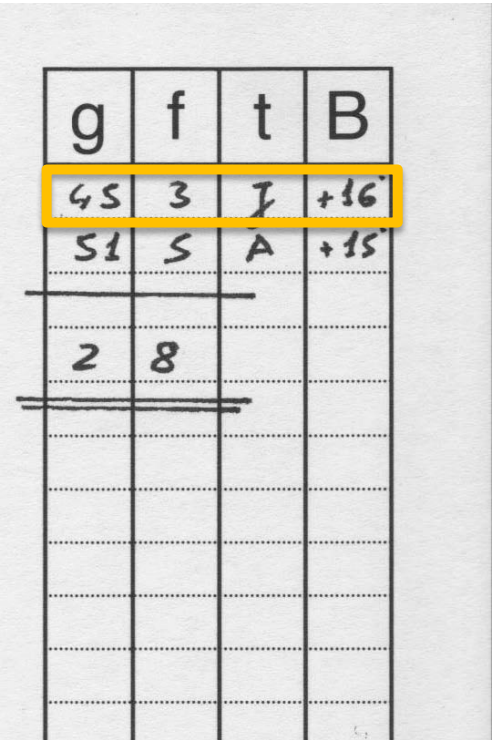
g	f	t	B
68	2	A	-14
71	8	C	+12
77	3	J	-22
80	5	B	-17
81	4	A	-18
82	2	A	+7
6	24		

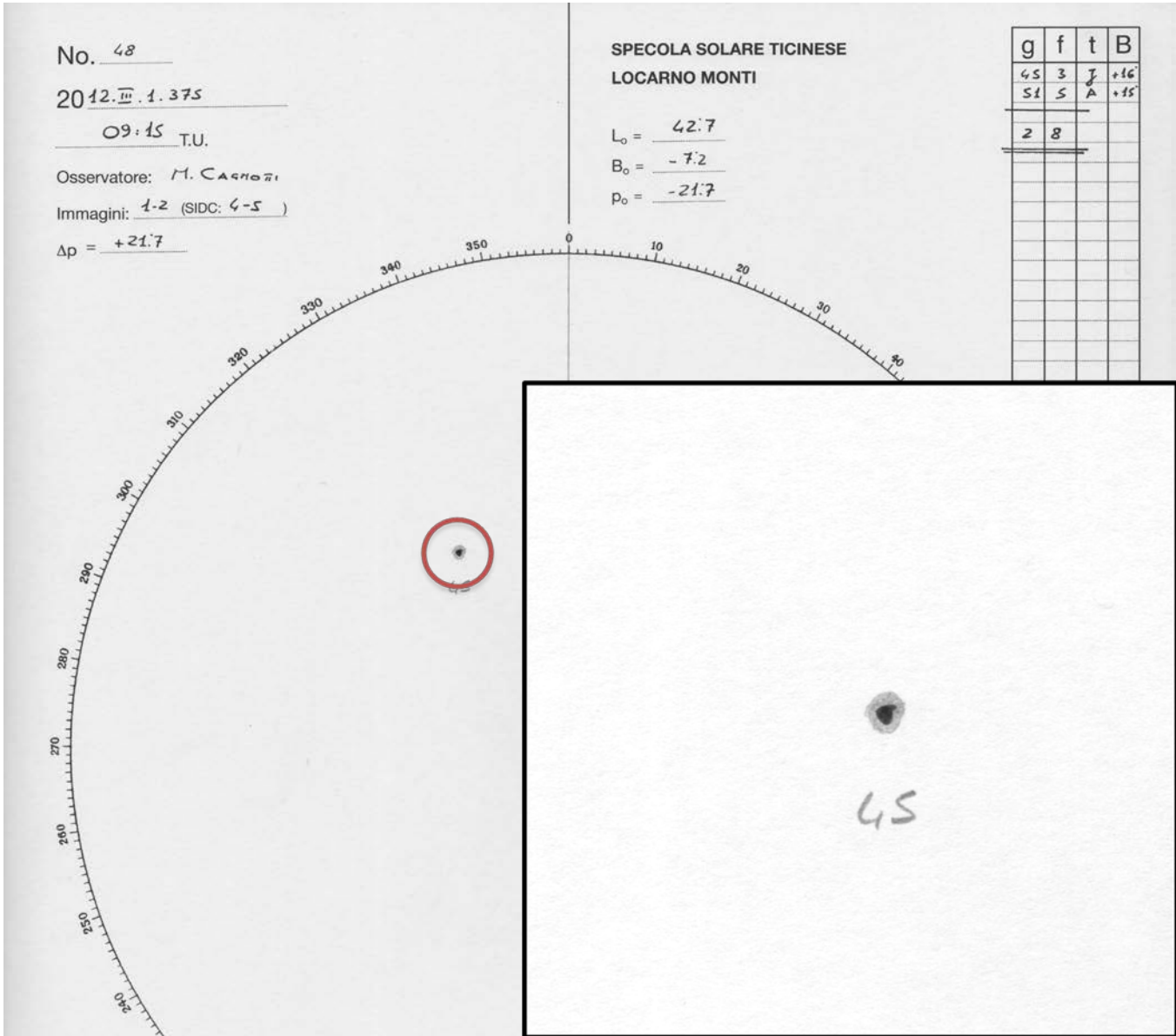


The counting method

The procedure

A spot with penumbra is counted 3.



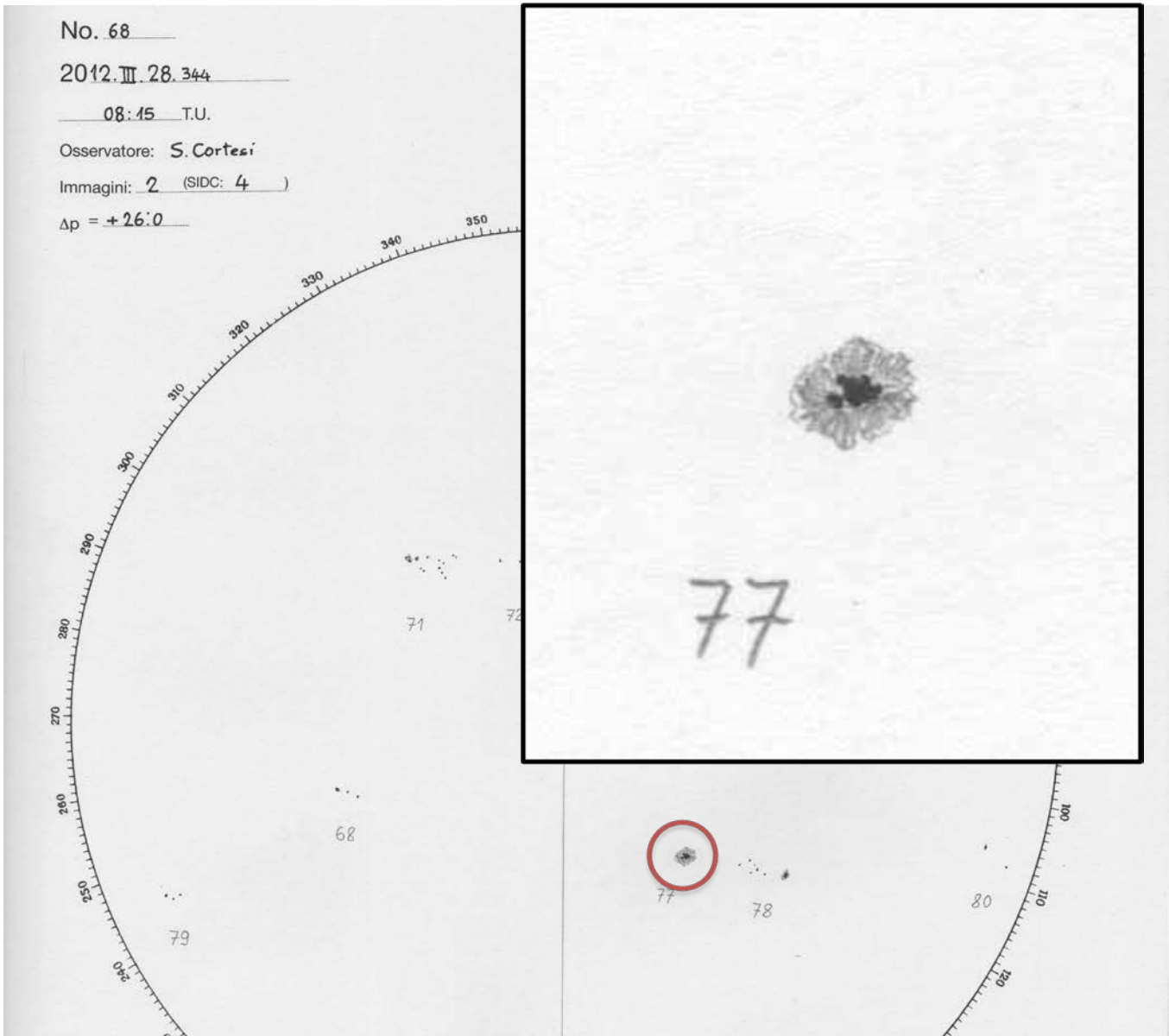


The counting method

The procedure

A big spot with penumbra is counted 4.

g	f	t	B
68	4	B	-14°
71	16	C	+12°
72	2	B	+12°
77	4	J	-22°
78	7	C	-24°
79	3	B	-24°
80	4	C	-18°
7	40		

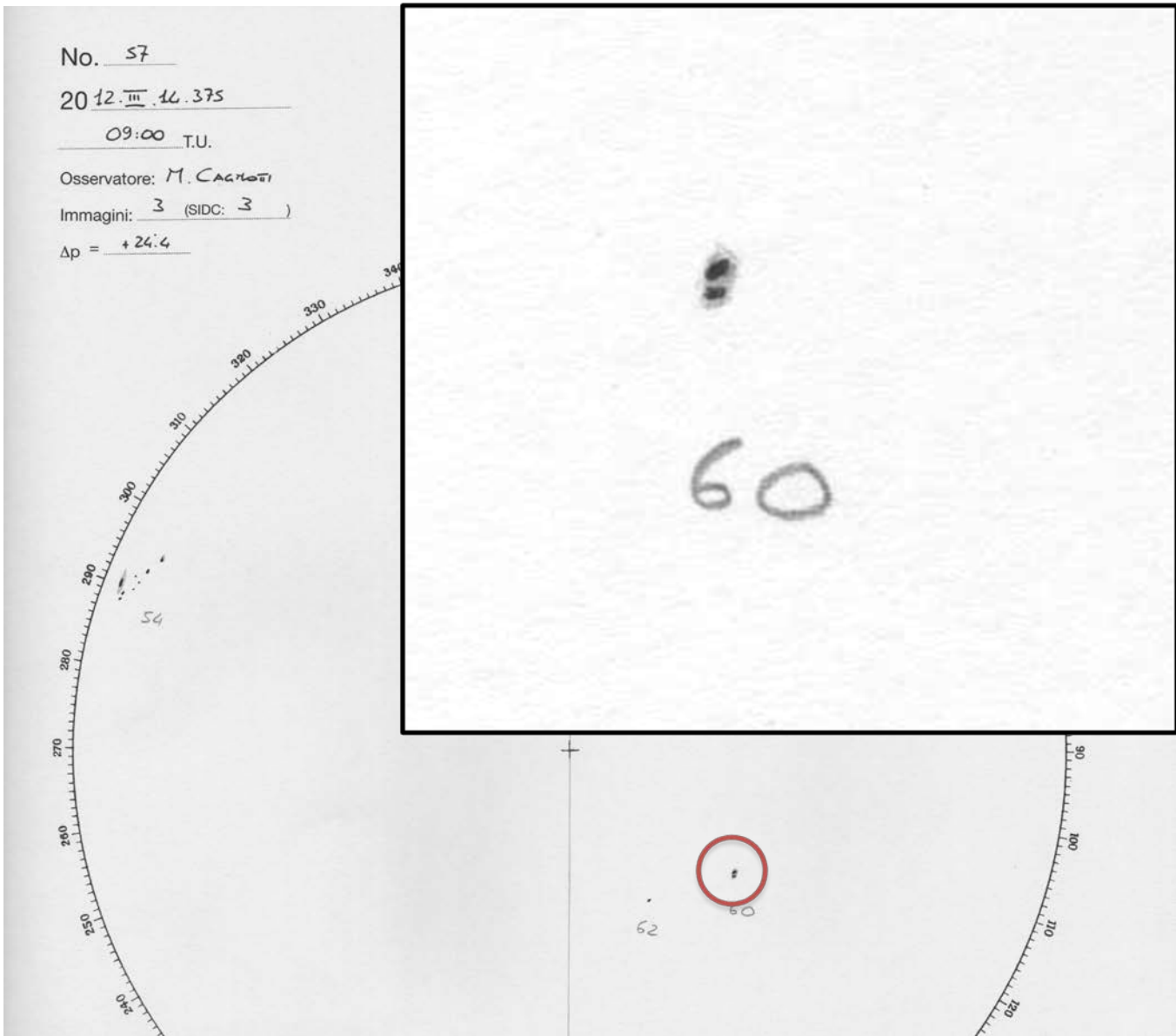


The counting method

The procedure

A spot with penumbra and two umbrae is counted 5.

g	f	t	B
54	13	E	+18°
58	15	C	+13°
60	5	I	-21°
61	13	D	+12°
62	1	A	-25°
5	47		

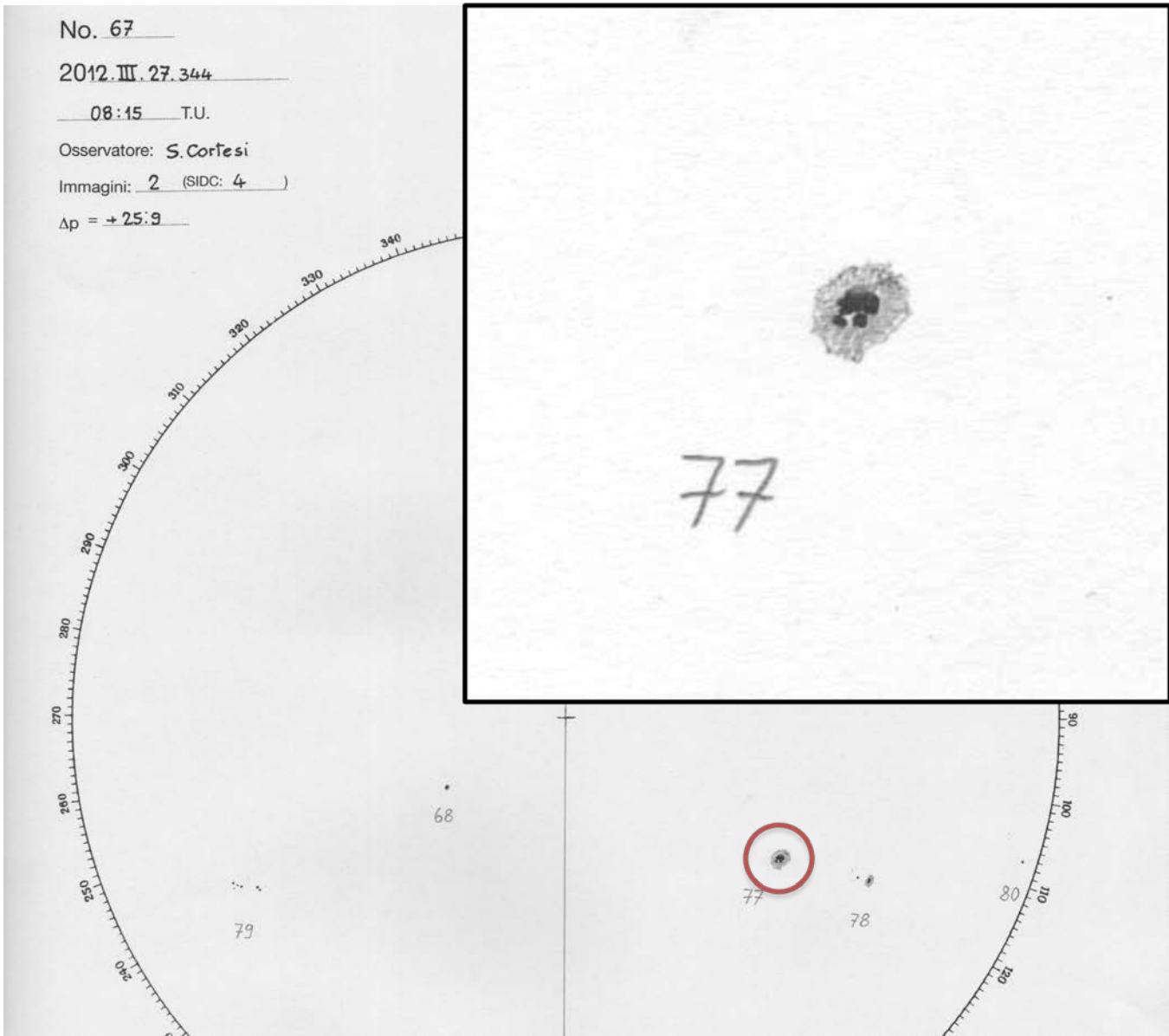


The counting method

The procedure

We could count even 6 or more when there are more umbrae and the structure Of the spot is complex.

g	f	t	B
68	3	J	-15°
71	18	D	+12°
72	4	B	+12°
77	6	J	-23°
78	5	J	-24°
80	2	A	-18°
79	7	B	-25°
7	45		

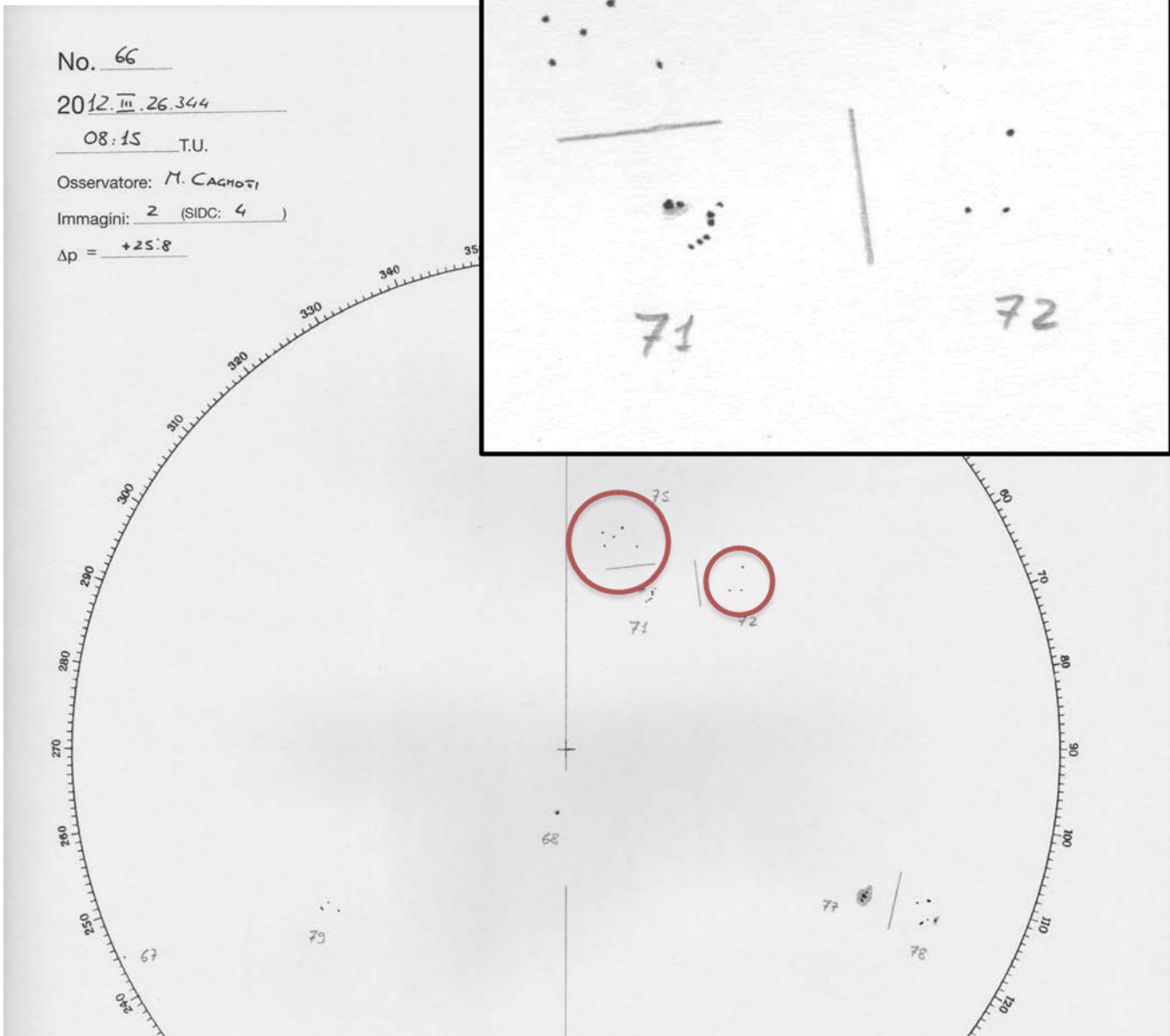


The counting method

The procedure

We could not even count a spot if it is very small or faint. Two or three or even four small spots could be counted 1.

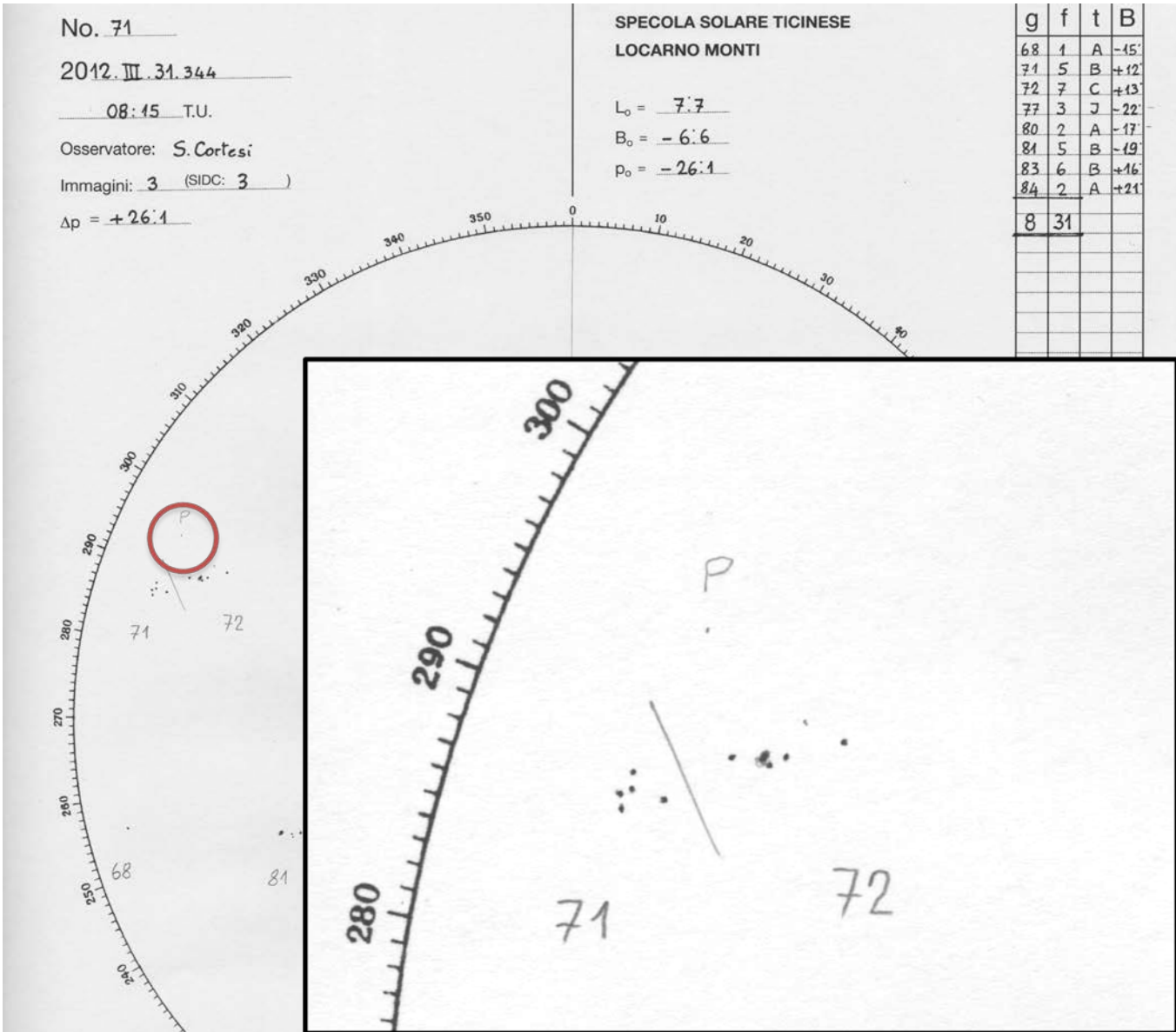
g	f	t	B
67	1	A	-26°
68	3	I	-16°
71	6	J	+12°
72	2	A	+13°
75	4	B	+19°
77	6	J	-22°
78	9	C	-24°
79	3	B	-24°
8	34		



The counting method

The procedure

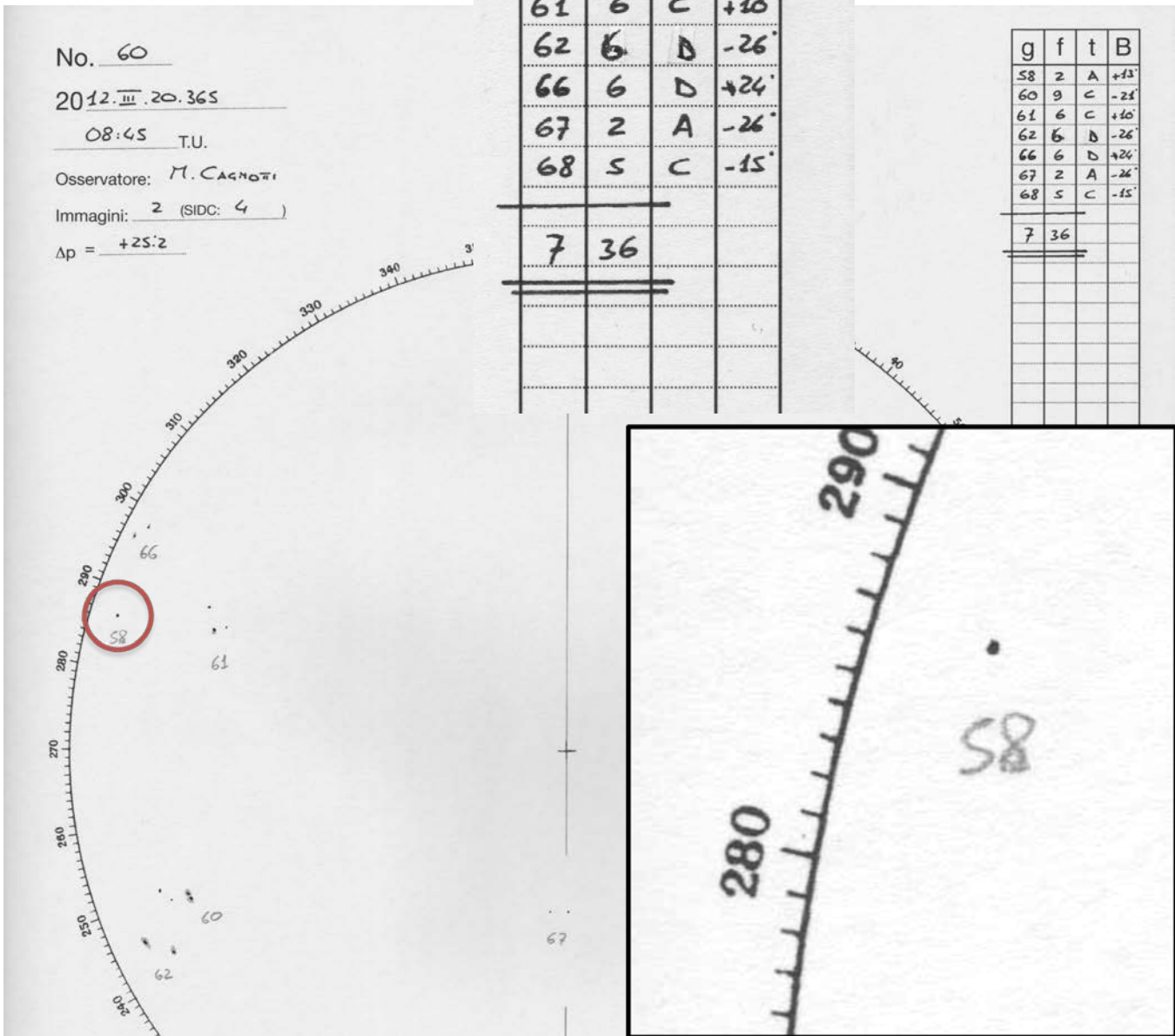
The pores are not counted. A pore is a very faint spot that doesn't survive for more than 1 hour.



The counting method

The procedure

We give more weight to the spots near the edge of the Sun.
A spot that would be counted 1 on the center could be counted 2 if it is near the limb. And so a spot with umbra that would be counted 3 could be counted 4 and even 5 if it is very close to the limb



The counting method

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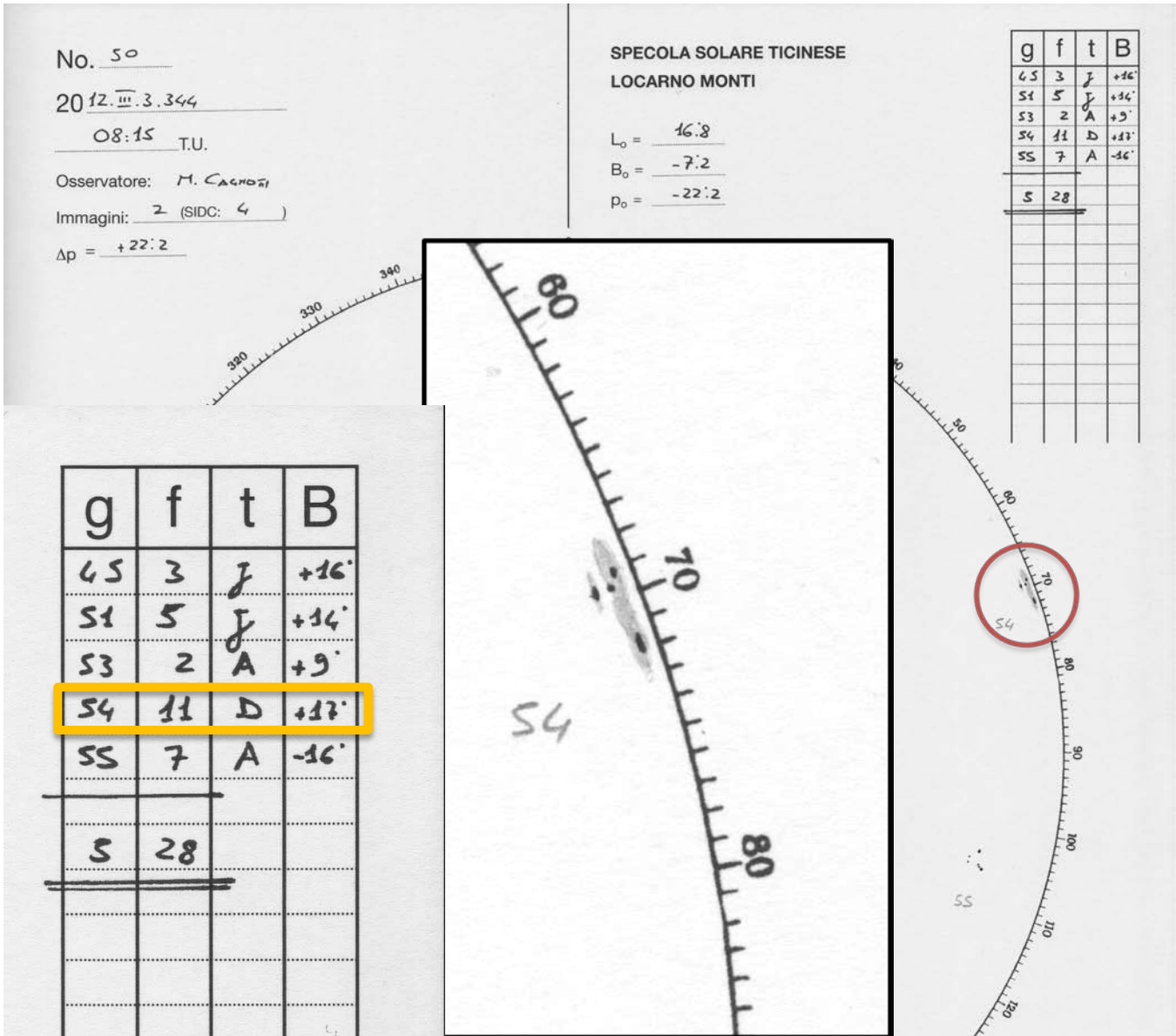


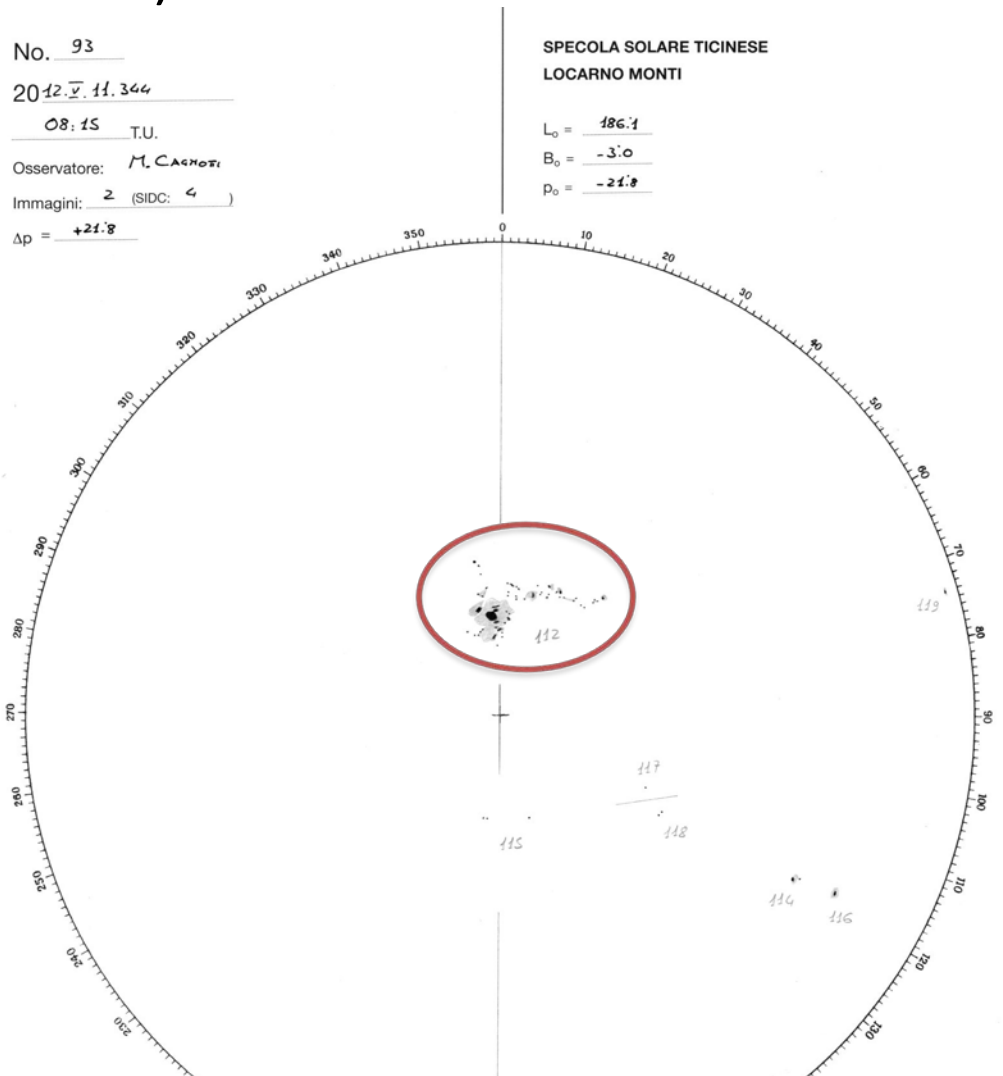
The counting method

The procedure

There is a component of subjectivity in the counting: often two observers don't count in the same manner, although they use the same rules. However, their k are long-term consistent.

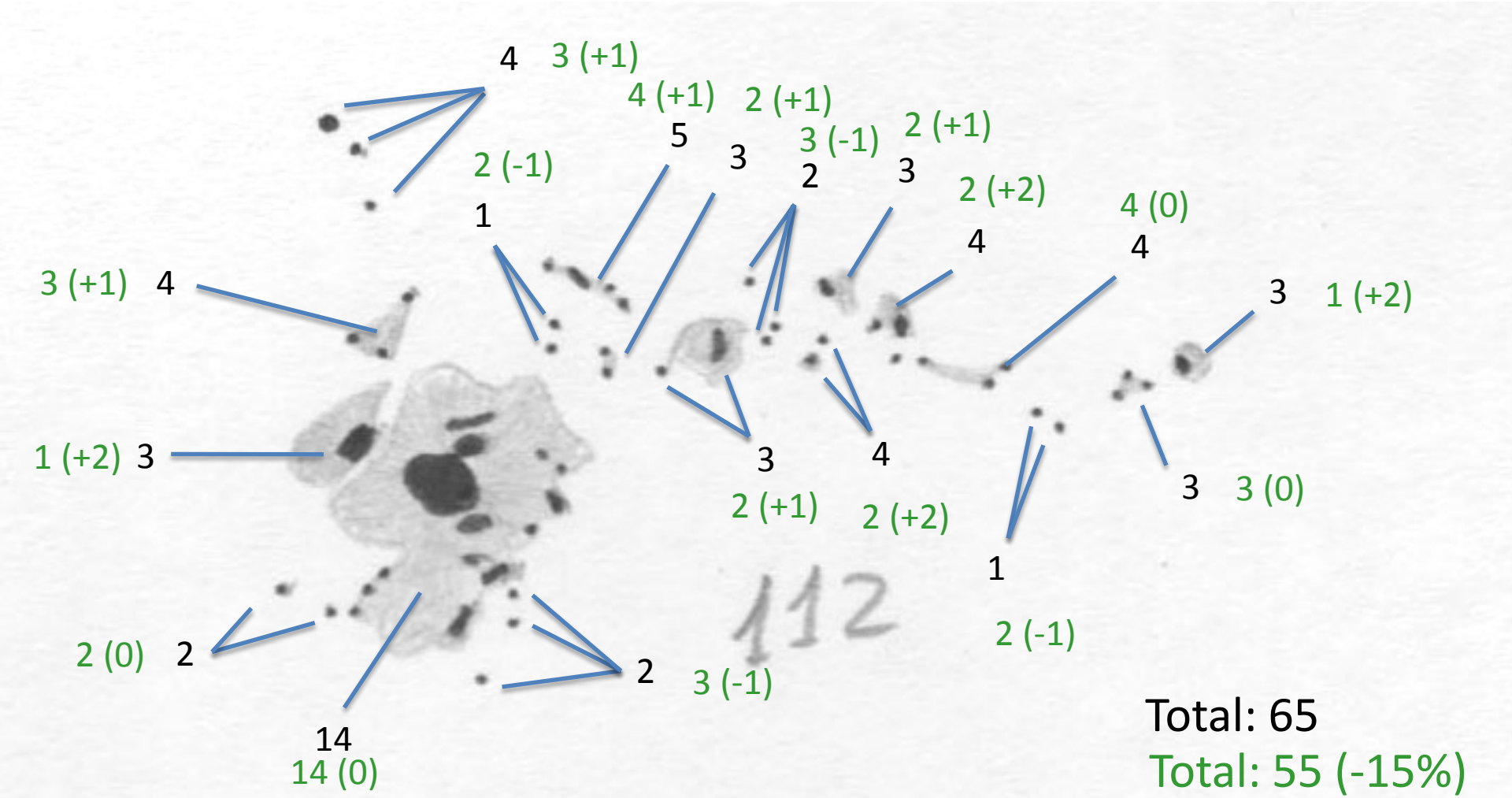
The counting method

An example with a big group (AR1476)



The counting method

An example with a big group (AR1476)



Total: 65

Total: 55 (-15%)

The weighting problem

Did Waldmeier implement the weighing of the sunspots depending on their size?

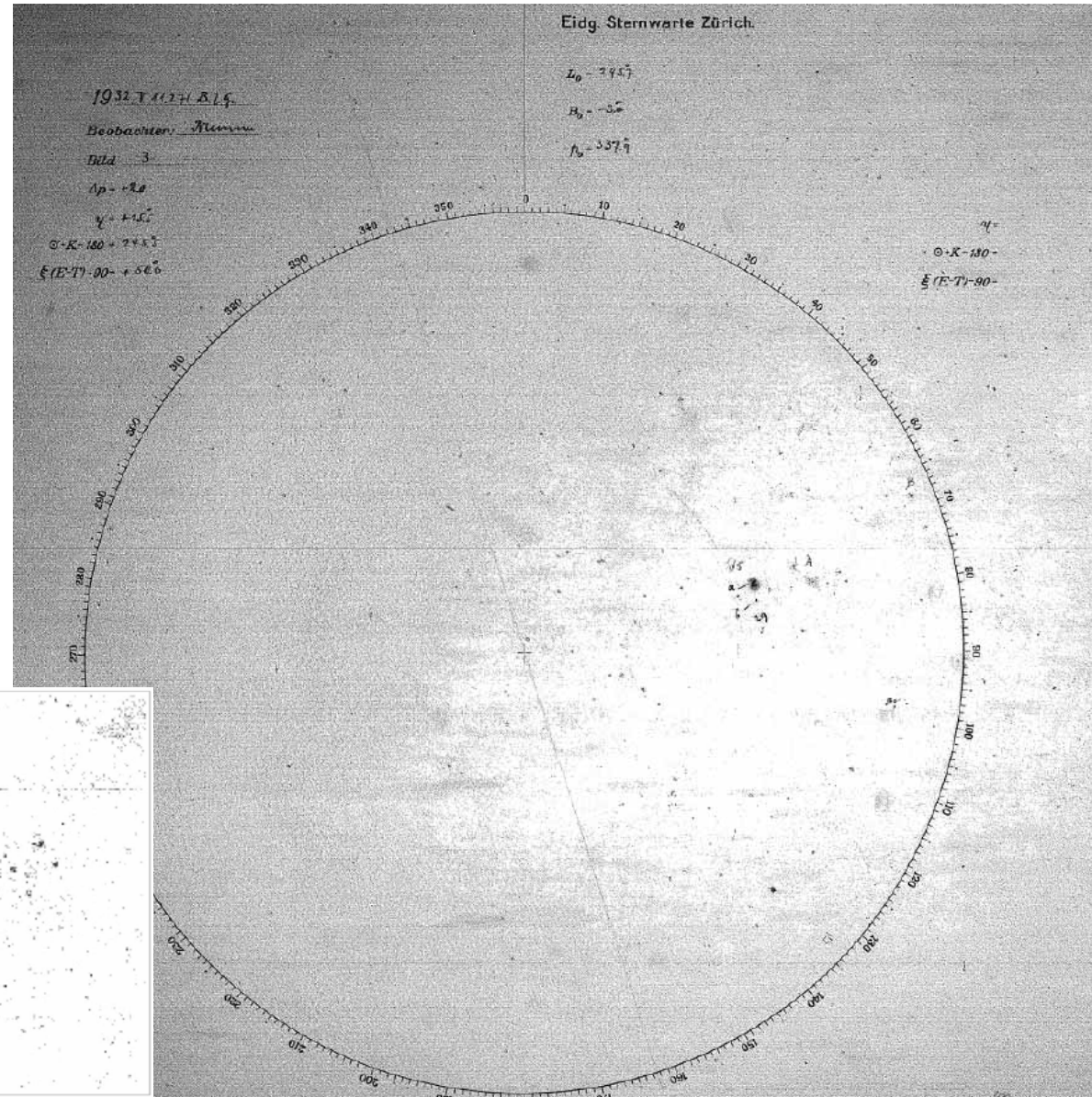
We collaborated with a high school student of Lugano, Michael Eggemann, in his high school work on solar physics and sunspots.
From ETHZ he got the digital files, extracted from the microfilms, of 26 drawings and 13 tables of the times of Wolfer and Brunner, in the years 1912 and 1932, during the minimums of the Sun's cycle.
The aim was **to find some examples of J spots and to see how much they were counted**.
On the drawings the counting was not written, so Michael extracted the counting from R reported in the SIDC's database.

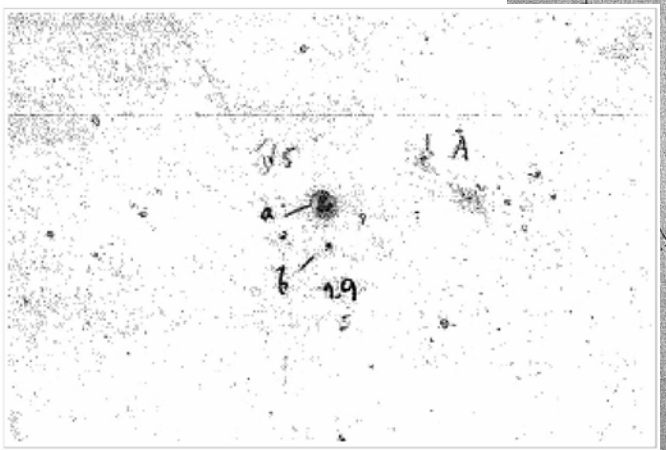
The weighting problem

11th May 1932

(director: Brunner)

Group 29, with two spots (a, b)
one with penumbra
From the SIDC's database: R = 9





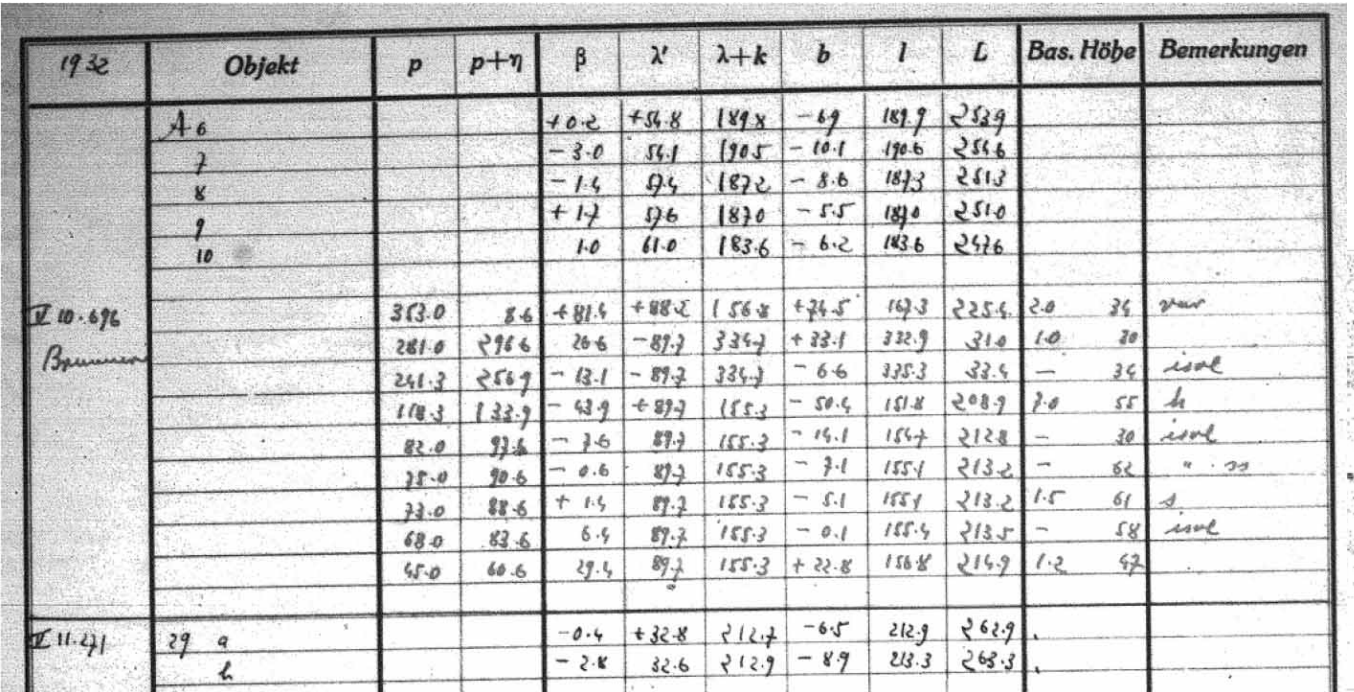
The weighting problem

11th May 1932

(director: Brunner)

Group 29, with two spots (a, b)
one with penumbra
From the SIDC's database: R = 9

If the spots were been counted 1, R would have been 7:
R = 0.6 . (10 + 2) = 7.2
We can conclude that f = 5:
9 = 0.6 (10 + f) => f = 5



1932	Objekt	p	p+η	β	λ'	λ+k	b	l	L	Bas.	Höhe	Bemerkungen
	A 6			+0.2	+54.8	189 x	−6.9	181.9	253.9			
	7			−3.0	54.1	190.5	−10.1	190.6	254.6			
	8			−1.4	52.4	187.2	−8.6	187.3	251.3			
	9			+1.7	57.6	187.0	−5.5	187.0	251.0			
	10			1.0	61.0	183.6	−6.2	183.6	247.6			
X 10.6		353.0	8.6	+81.4	+88.2	156.8	+24.5	162.3	225.4	2.0	34	var
Brunner		281.0	296.6	26.6	−87.2	334.7	+33.1	332.9	31.0	1.0	20	
		241.3	256.9	−13.1	−89.2	336.7	−6.6	335.3	33.4	—	34	isol
		118.3	133.9	−43.9	+89.2	155.3	−50.4	151.8	208.9	3.0	55	h
		82.0	97.6	−3.6	89.2	155.3	−14.1	154.7	212.8	—	30	isol
		75.0	90.6	−0.6	87.2	155.3	−7.1	155.1	213.2	—	62	" "
		73.0	88.6	+1.4	89.2	155.3	−5.1	155.1	213.2	1.5	61	s
		68.0	83.6	6.4	89.2	155.3	−0.1	155.4	213.5	—	58	isol
		45.0	60.6	29.4	89.2	155.3	+22.8	156.8	214.9	1.2	47	
X 11.4	29 a			−0.4	+32.8	212.7	−6.5	212.9	262.9			
	b			−2.8	32.6	212.9	−8.9	213.3	263.3			

The weighting problem

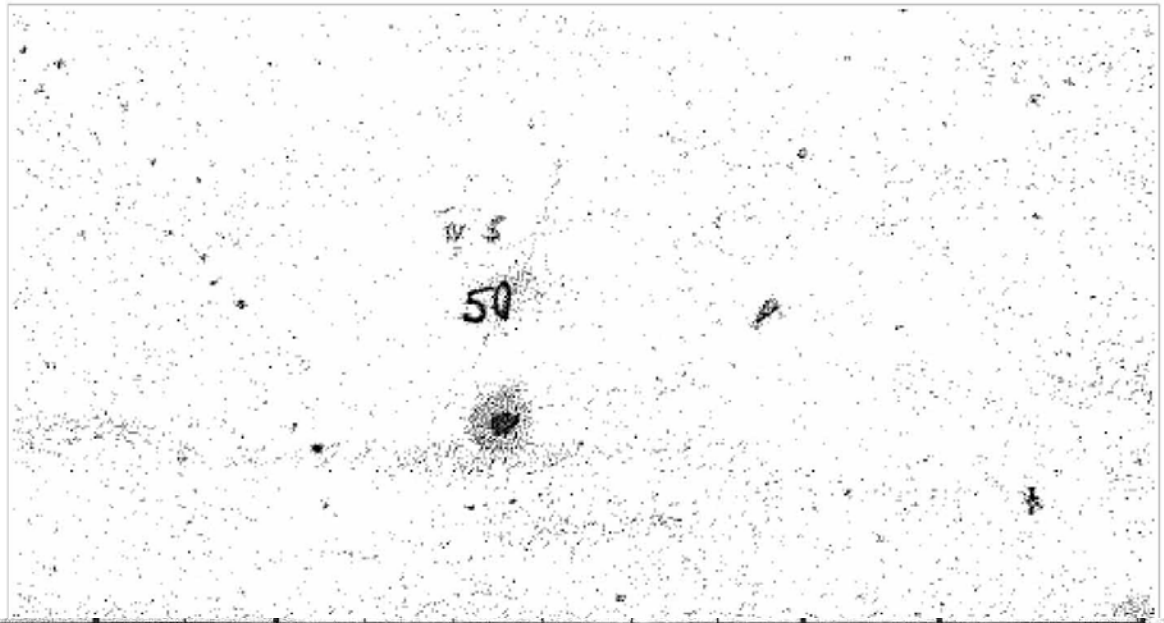
31st July 1932

(director: Brunner)

Group 50, type J

From the SIDC's database: R = 9

If the spot had been counted 1,
R would have been 7:
R = 0.6 . (10 + 1) = 6.6
But, if the observer had counted 5:
R = 0.6 . (10 + 5) = 9



VII 31.250	50			−10.9	+30.8	292.2	−8.1	293.3	274.7		
				Maximum Fortuleu							
		335.0	320.1	+50.1	−89.6	52.6	+54.1	60.3	41.6	− 26	cool
VII 31.251		254.0	239.1	− 30.9	− 89.7	52.7	− 26.4	49.7	31.0	3.9	84
Brunner											
VII 31.253		333.0	318.1	+48.1	−89.6	52.6	+ 52.2	49.8	30.5	2.4	28
Brunner		257.0	242.1	− 33.9	− 89.7	52.4	− 23.4	48.7	29.4	6.7	87
		150.0	135.1	− 45.1	+89.5	233.5	− 49.1	240.2	220.9	1.5	35
		142.0	127.1	− 33.1	89.7	233.3	−41.2	238.3	219.0	4.3	28
		113.0	98.1	− 8.1	89.7	233.3	− 12.4	234.3	215.0	0.8	46
		93.0	78.1	+ 11.9	89.7	233.3	+ 7.5	232.3	213.0	9.0	83

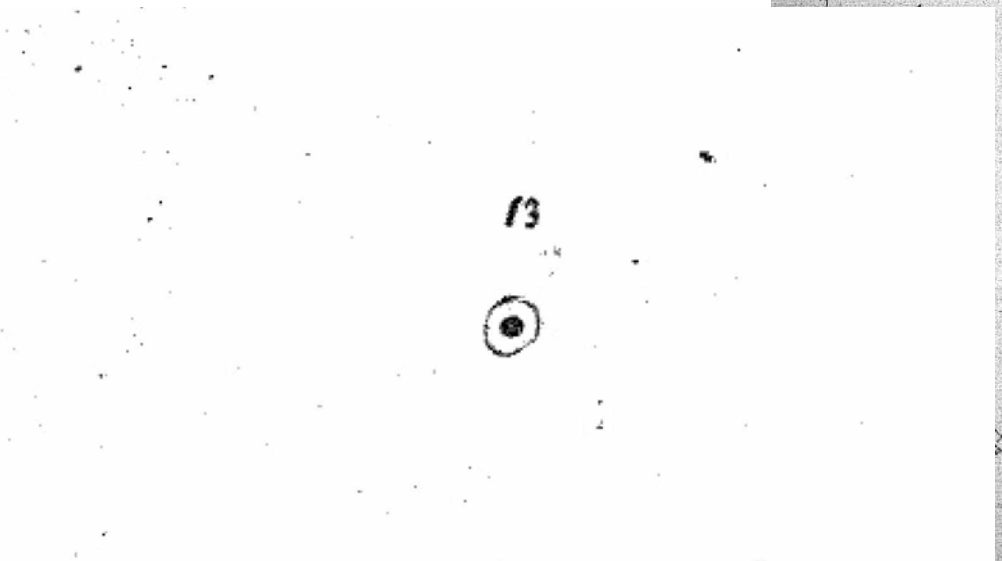
The weighting problem

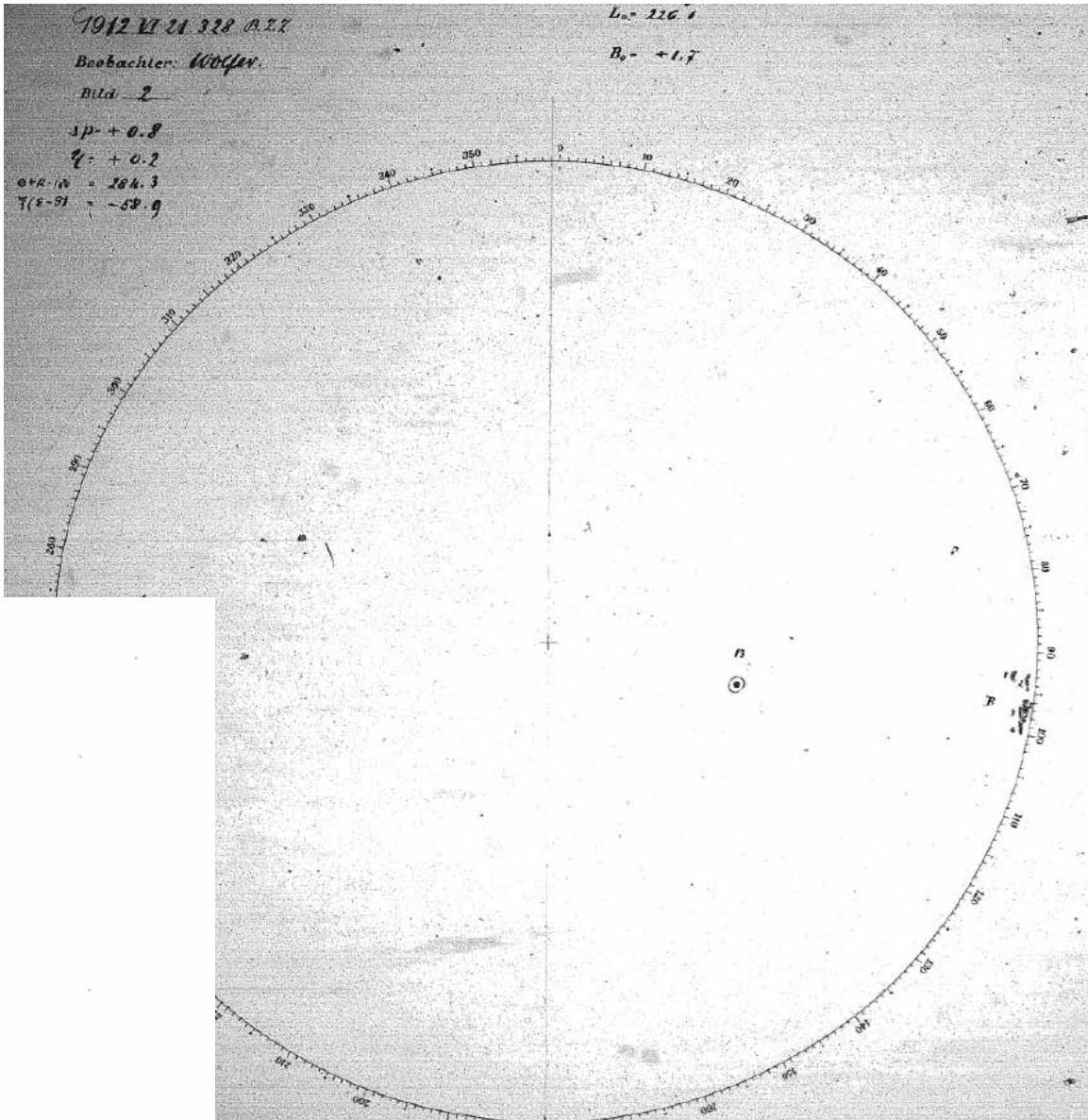
20th-23th June 1912

(director: Wolfer)

Group 13, type J

From the SIDC's database: R = 7





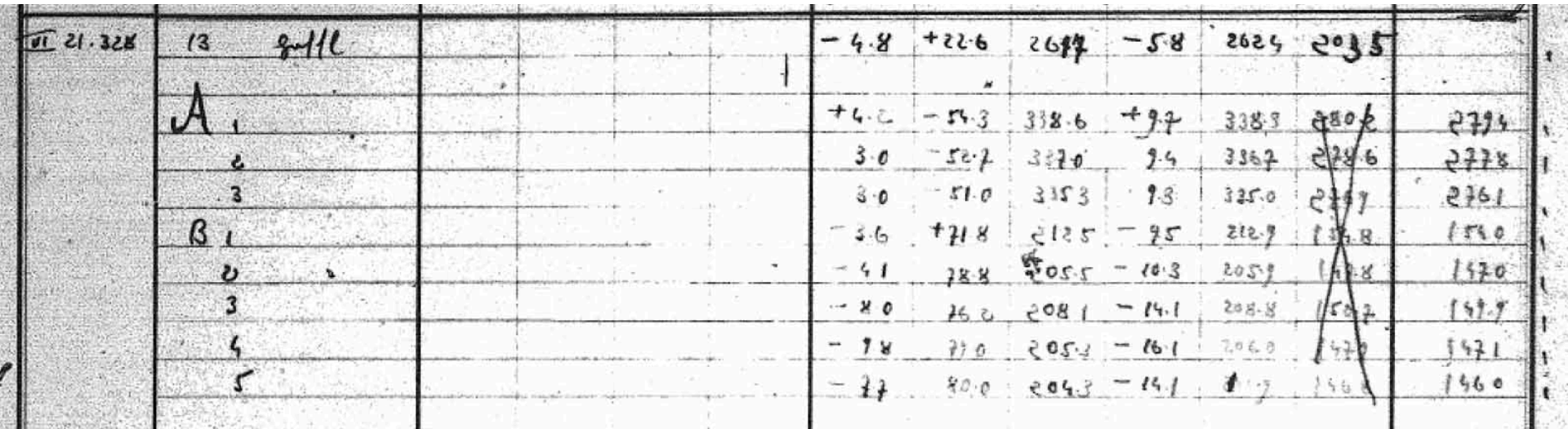
The weighting problem

20th-23th June 1912

(director: Wolfer)

Group 13, type J
From the SIDC's database: R = 7

We could deduce that this group has ever been counted 1 or 2:
R = 0.6 . (10 + 1) = 6.6
R = 0.6 . (10 + 2) = 7.2



The weighting problem

From Michael's study we could conclude: the weighing of the spots with penumbra has been implemented not by Waldmeier but by Brunner.