Radio emission of the quiet Sun at decameter wavelengths.

Interferometer observations.

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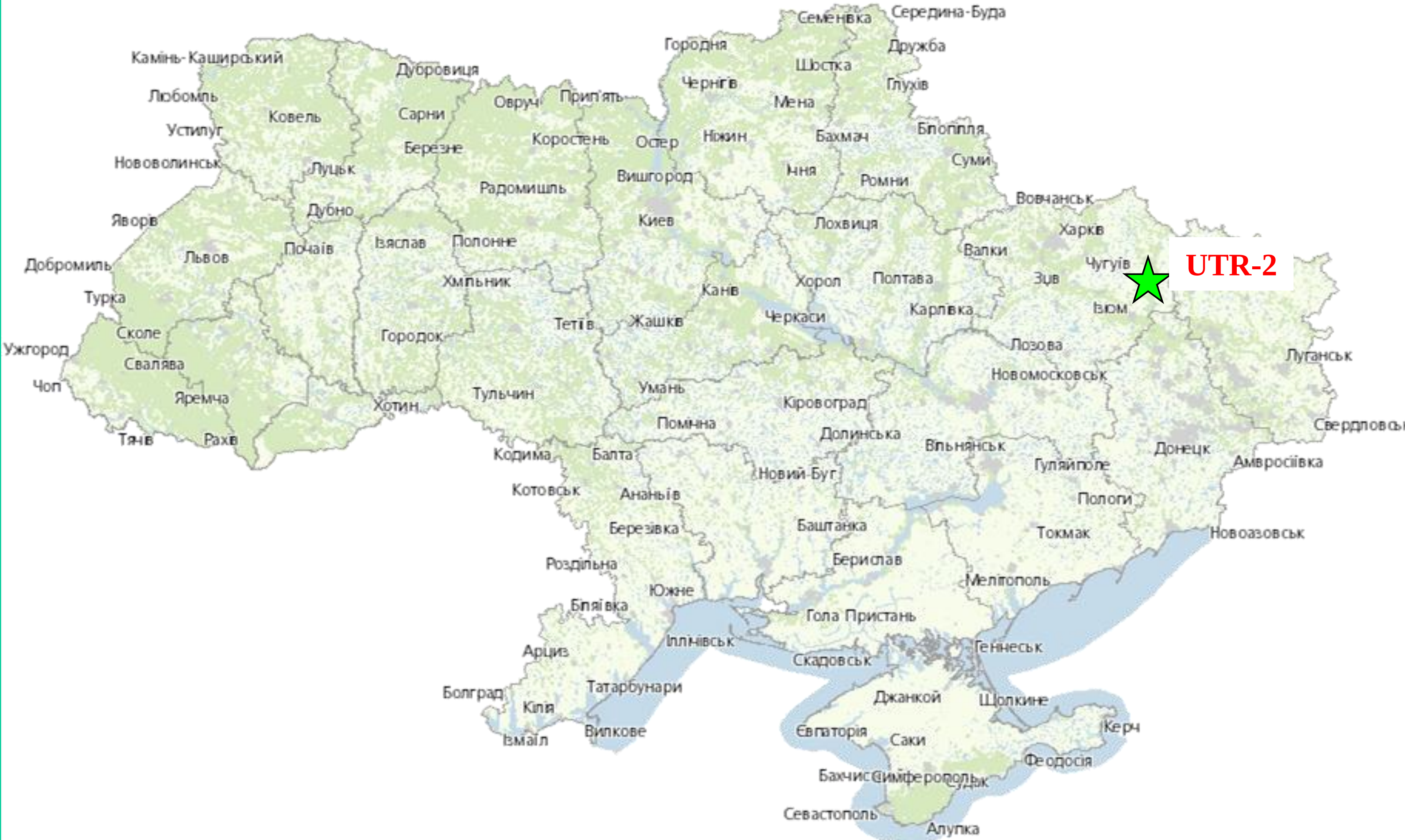
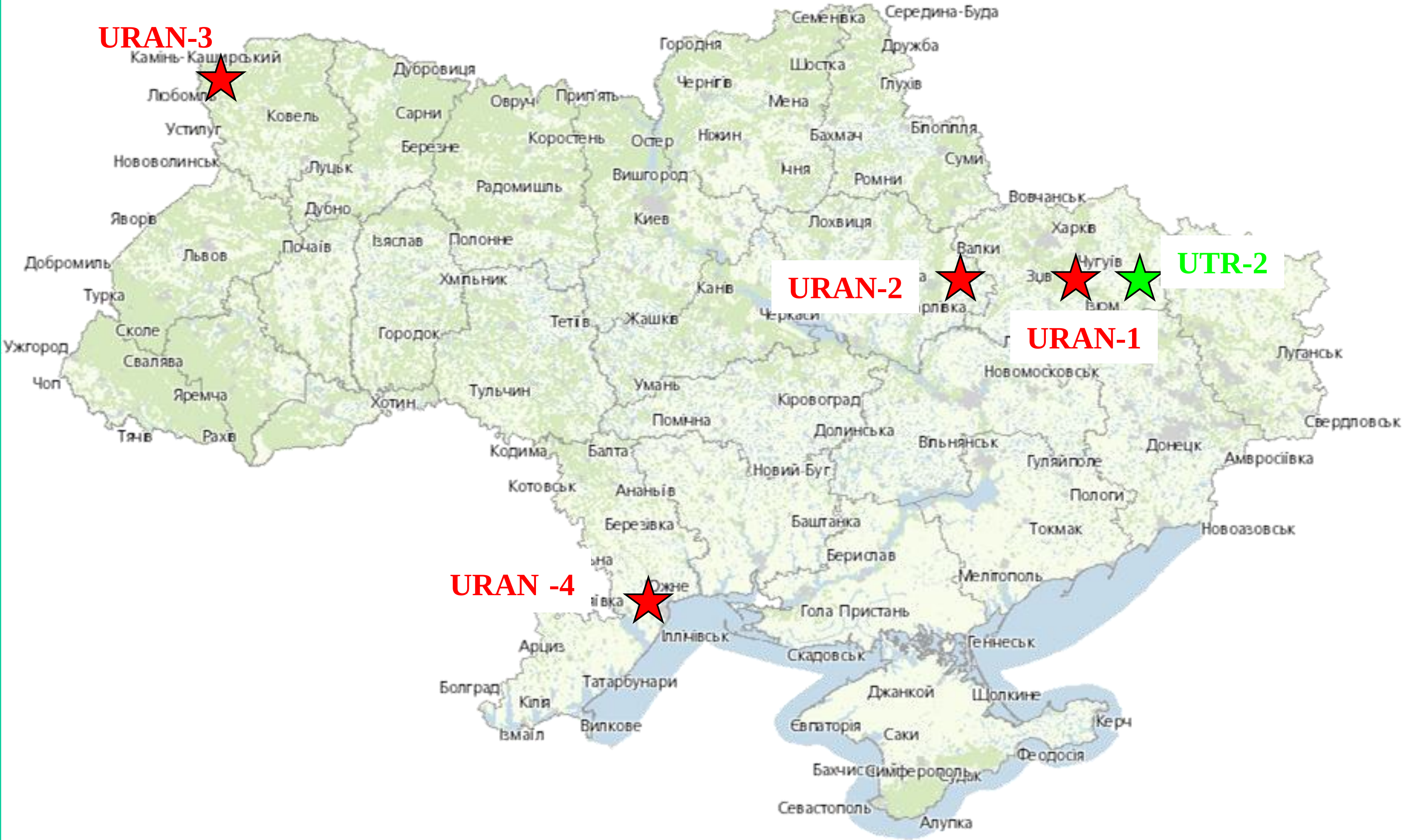
Solar Influences on the Magnetosphere, Ionosphere and Atmosphere
Sunny Beach, Bulgaria, May 30 - June 3, 2016

Ukrainian Radio Astronomy Network




UTR-2

Ukrainian Radio Astronomy Network



URAN-3

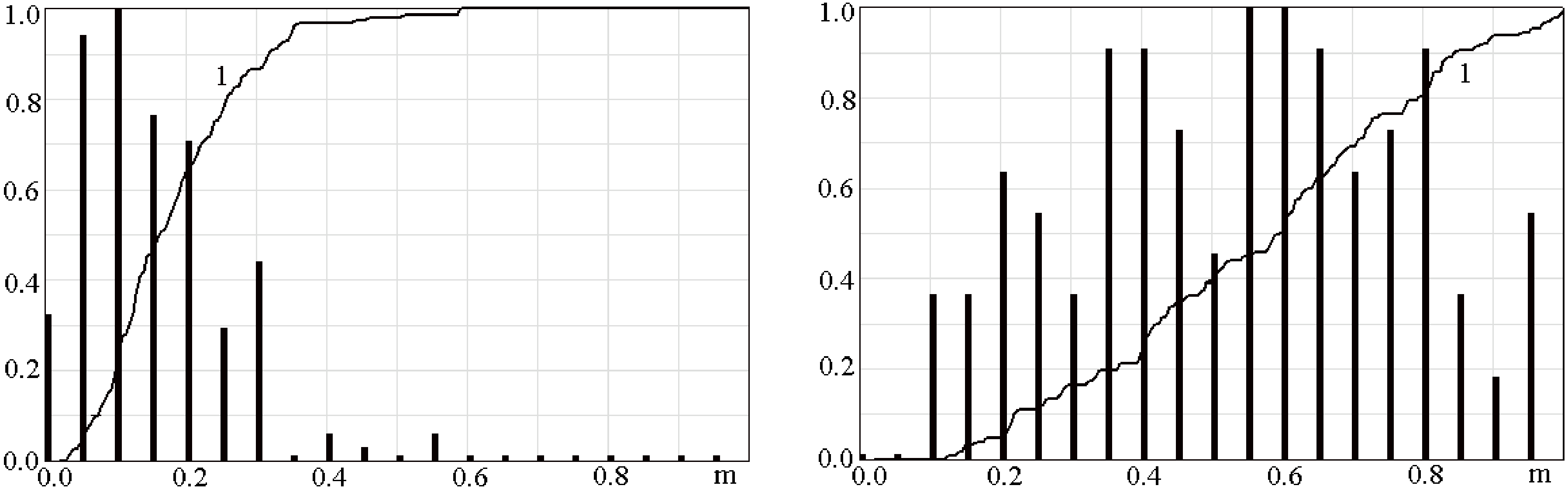
Main parameters of the URAN

Array	UTR-2	URAN-1	URAN -2	URAN -3	URAN -4
Frequency range	8-30 MHz				
Nom. of dipoles	2040	96	512	256	128
Dimensions (m)	53 x 1853 45 x 900	238 x 28	238 x 118	238 x 58	238 x 28
Polarization	linear	two linear (cross dipoles)			
Eff. area m^2	~150000	~5500	~28000	~14000	~7000
Main lobe width	27′ x 27′	3.5° x 30°	3.5° x 7°	3.5° x 15°	3.5° x 30°
Interferometer resolution (25MHz)	27′ x 27′	15″	4″	0,7″	1″

ИССЛЕДОВАНИЕ АСТРОНОМИЧЕСКИМИ МЕТОДАМИ ДЕКАМЕТРОВЫХ ИОНОСФЕРНЫХ МЕРЦАНИЙ НА РАДИОТЕЛЕСКОПЕ УРАН-1

Рашковский С. Л. // Изв. вузов. Радиофизика. – 2004. – Т. 47, № 9. – С. 705–721

- *Amplitude distribution law*
- *The dependence of the scintillation index on the time and date of observation*
- *Temporal characteristics of scintillations*
- *Ionosphere scintillation spectra*
- *Influence of scintillation on the estimation of the average received power*
- *Irregular refraction*
- *The frequency dependence of the scintillation index*

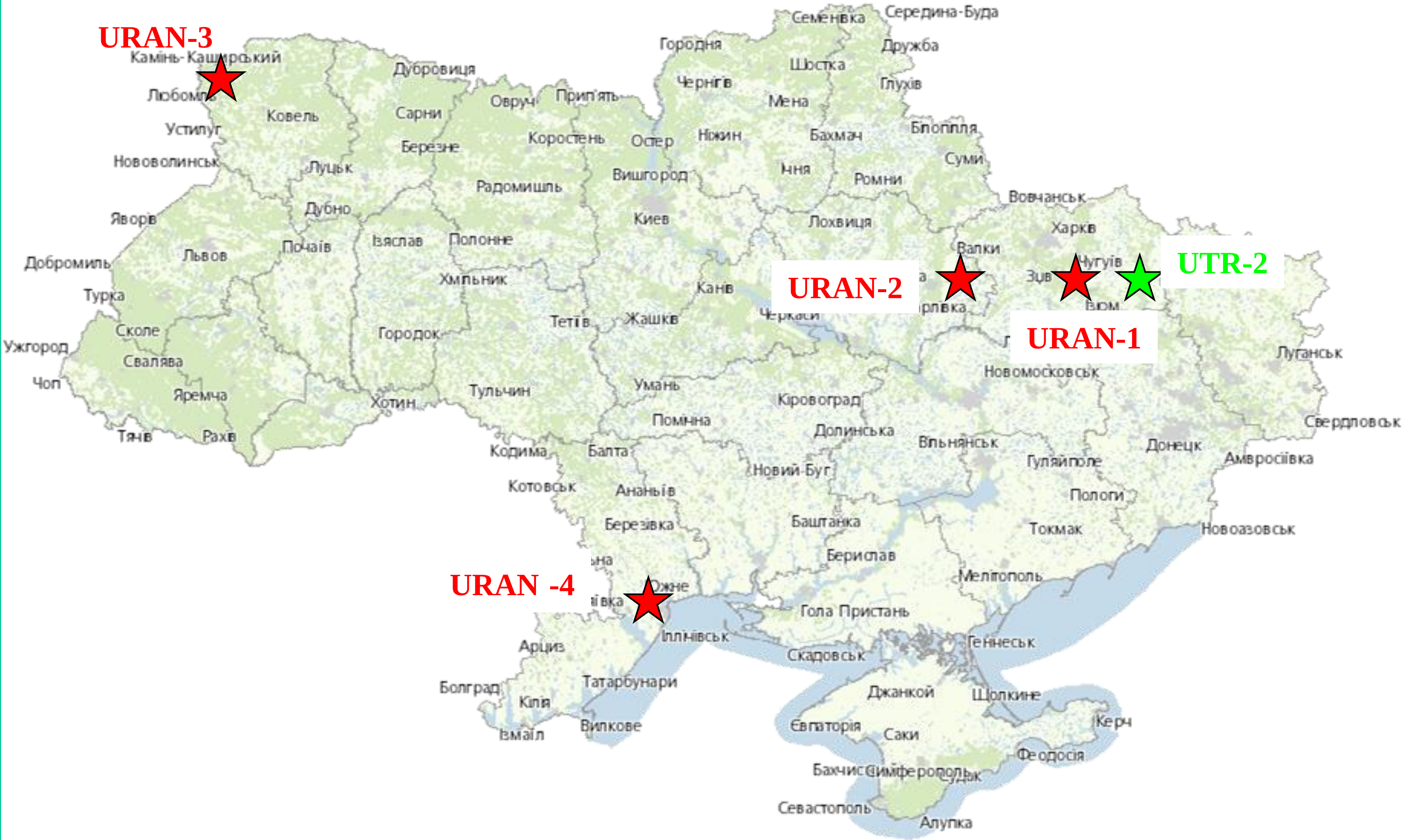


Normalized bar chart of scintillation index in winter (left) and summer (right) time

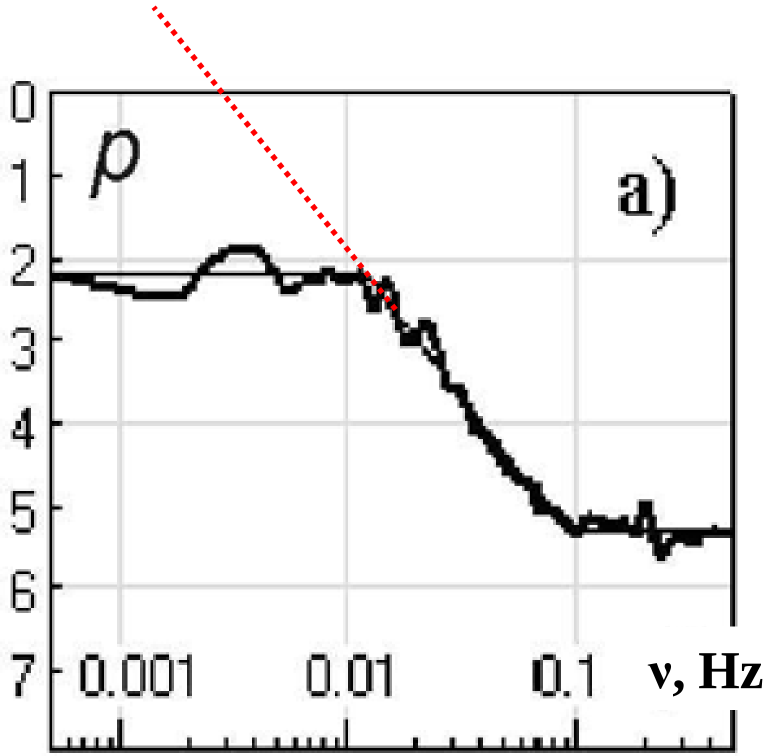
Tasks and telescopes

- The Sun and solar activity – UTR-2, URAN-2
- Interplanetary scintillation – UTR-2, URAN-2, URAN-3
- Ionosphere scintillation – URAN-4, URAN-1

Ukrainian Radio Astronomy Network



$R_f \sim 1$ km *Ionosphere* $D \sim 1000$ km

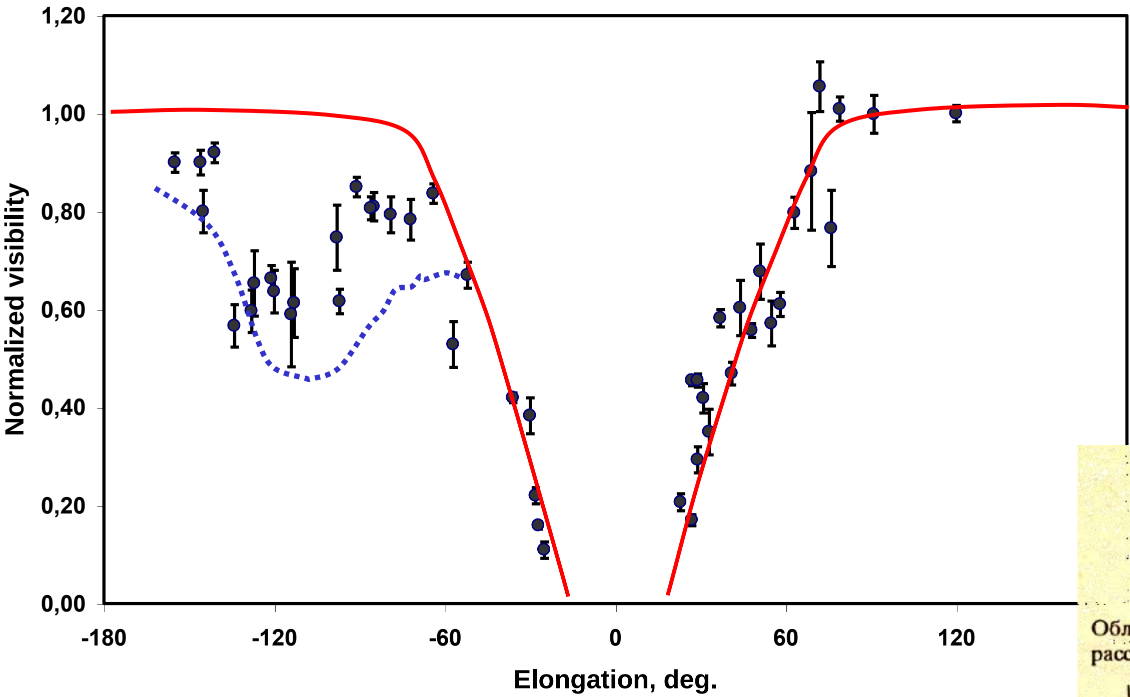


Рашковский С. Л. // Изв. вузов. Радиофизика. – 2004. – Т. 47, № 9.

Interplanetary medium $R_f \approx$ D

Observation of the Crab Nebula with URAN-1 interferometer

С. Я. Брауде, А. В. Мень, С. Л. Рашковский, В. А. Шепелев, и др // Доклады АН УССР. –1989. – № 10



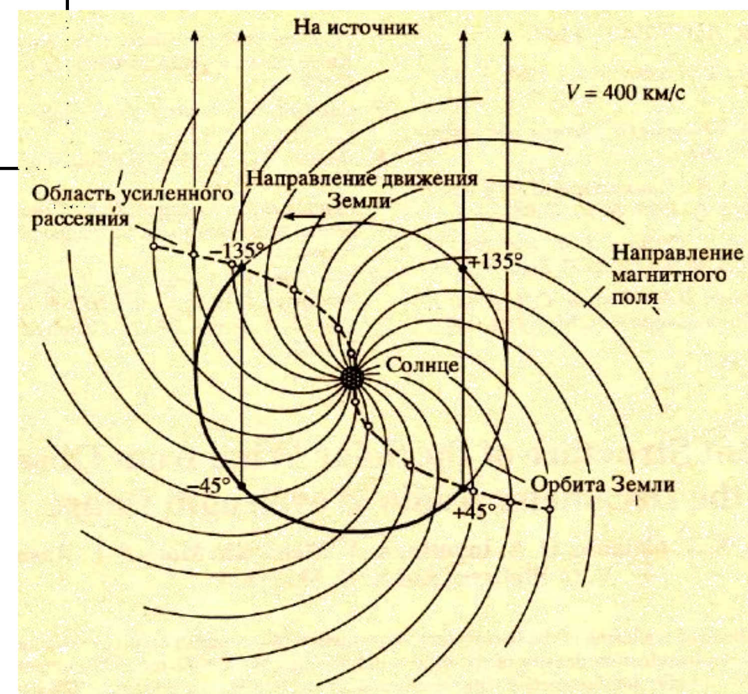
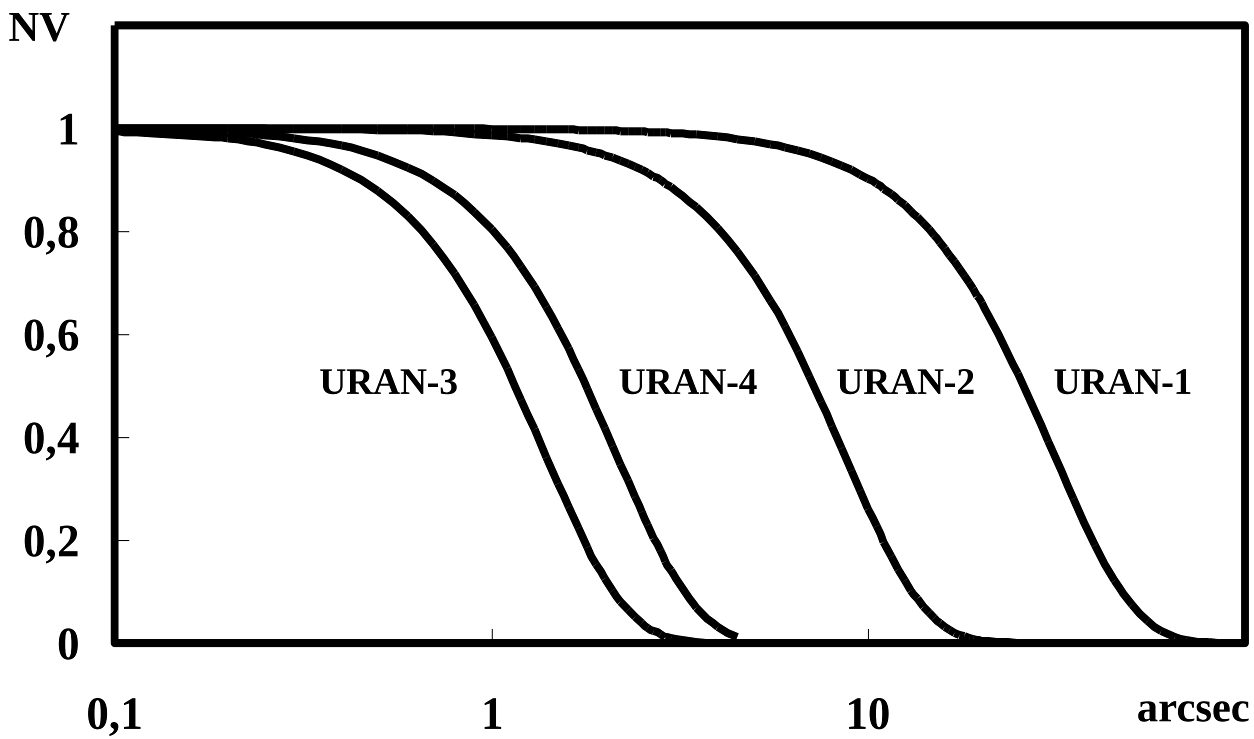


Рис. 4. Структура магнитного поля и положение областей усиленного рассеяния.

Resolving power of the URAN

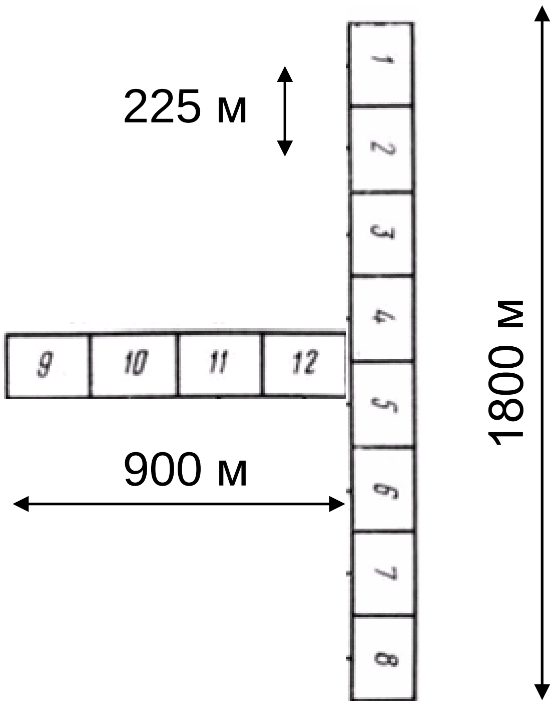


60″ → 0.023

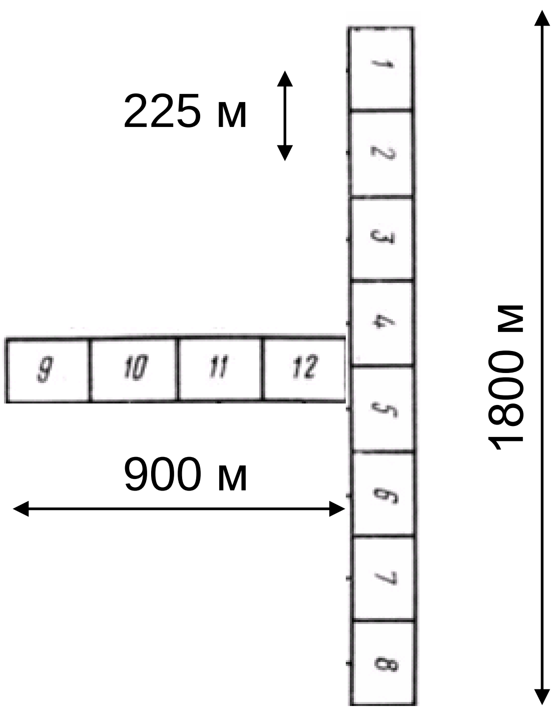
120″ → $3.2 \cdot 10^{-7}$

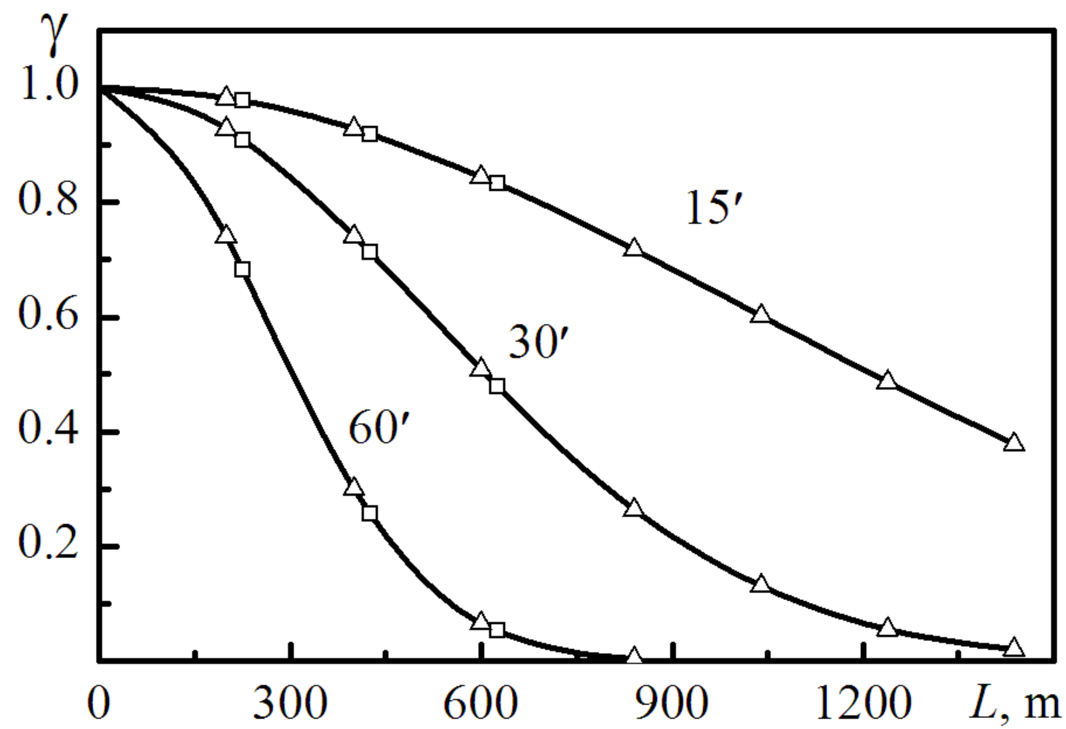
We need an interferometer with shorter baseline

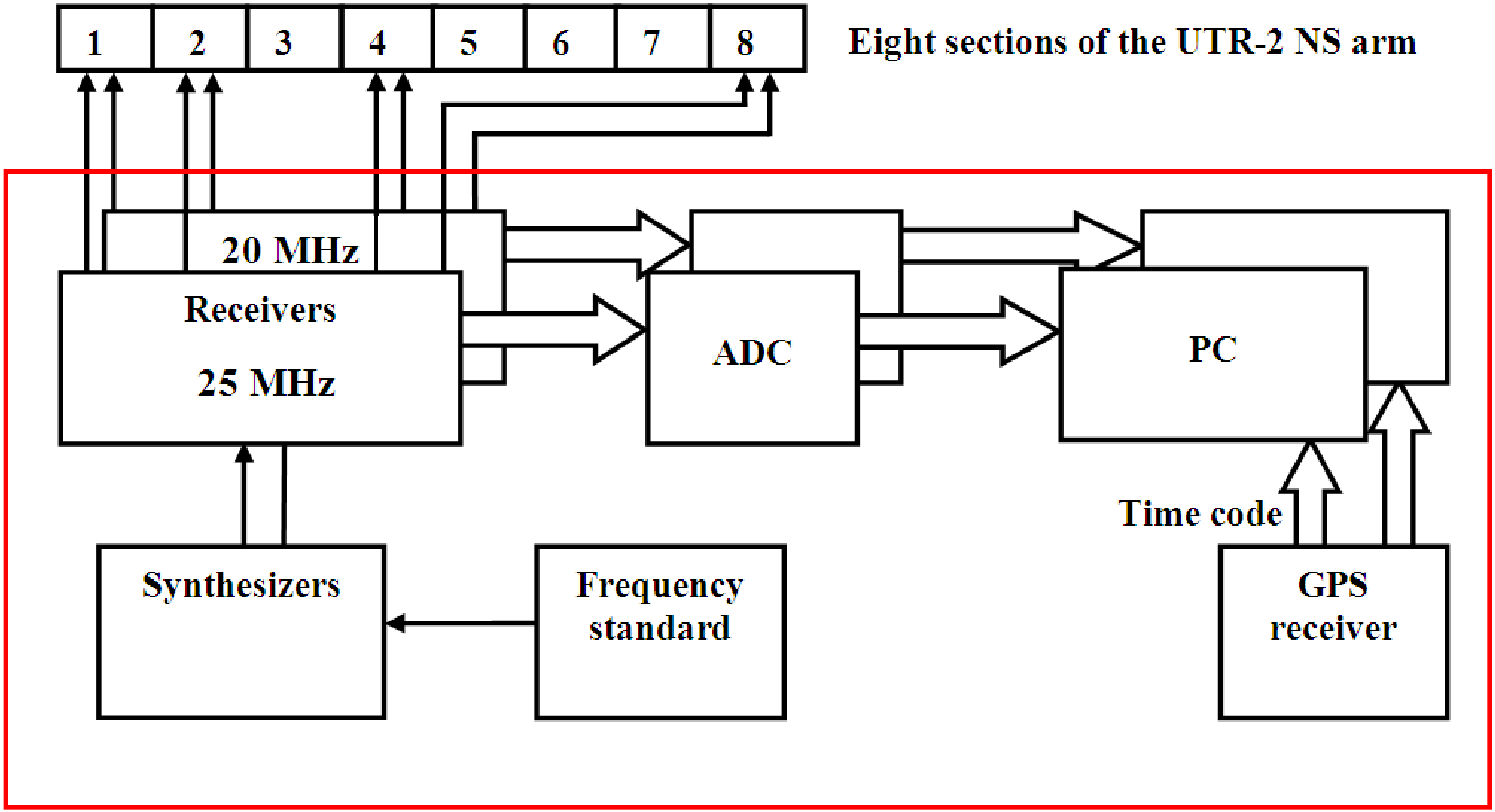
Structure of the UTR-2

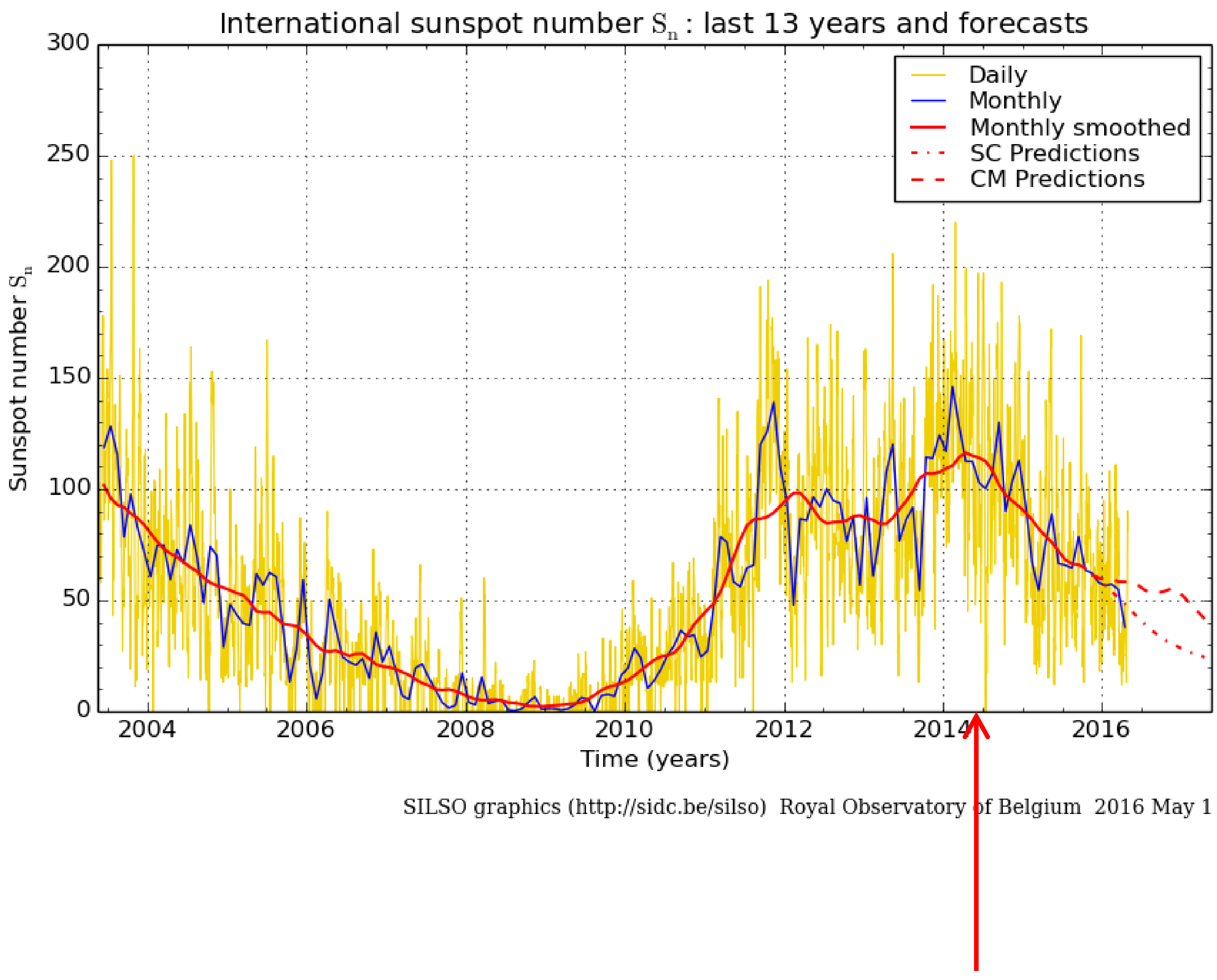


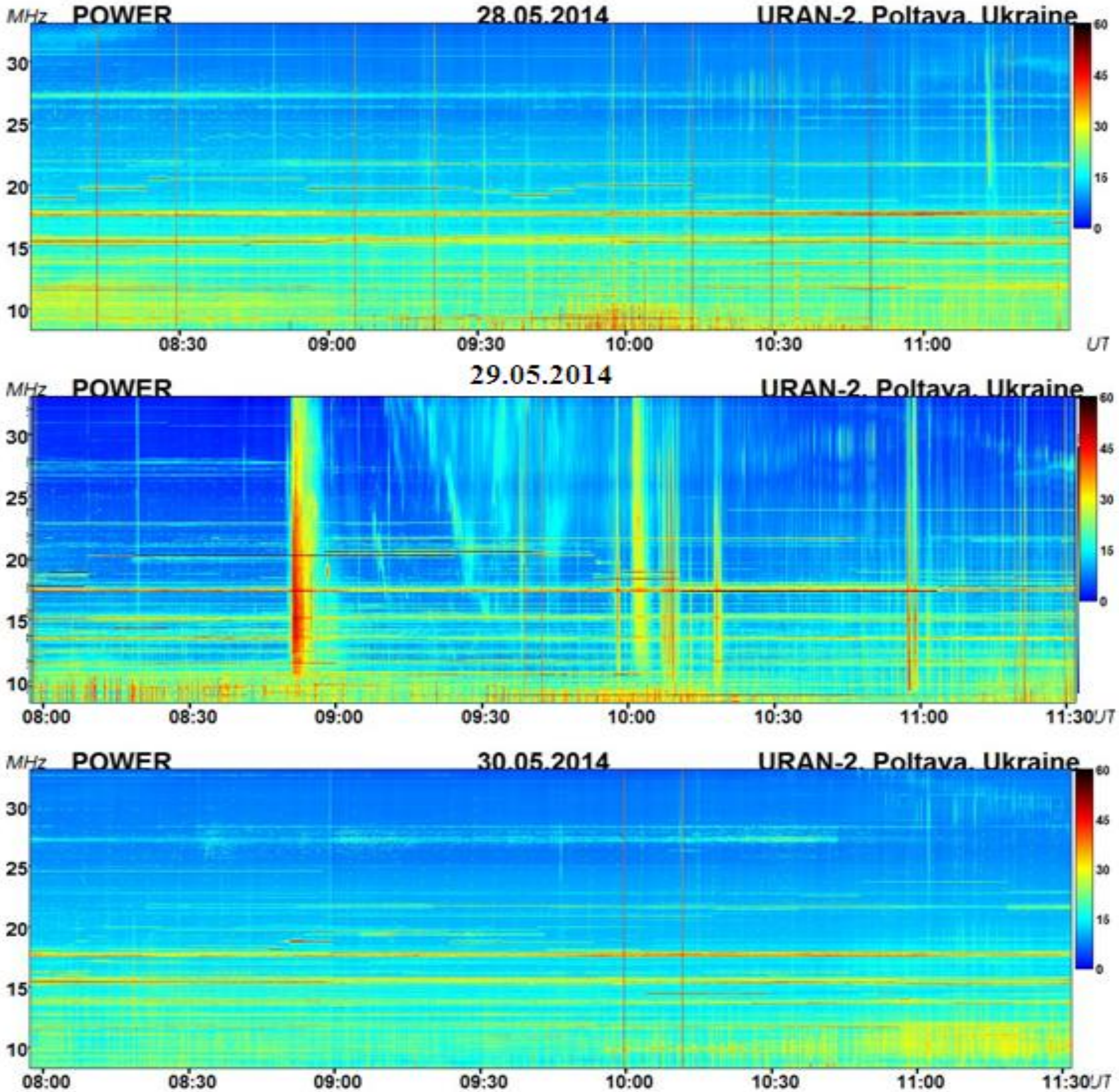
Visibility function of Gaussian sources versus interferometer baseline.

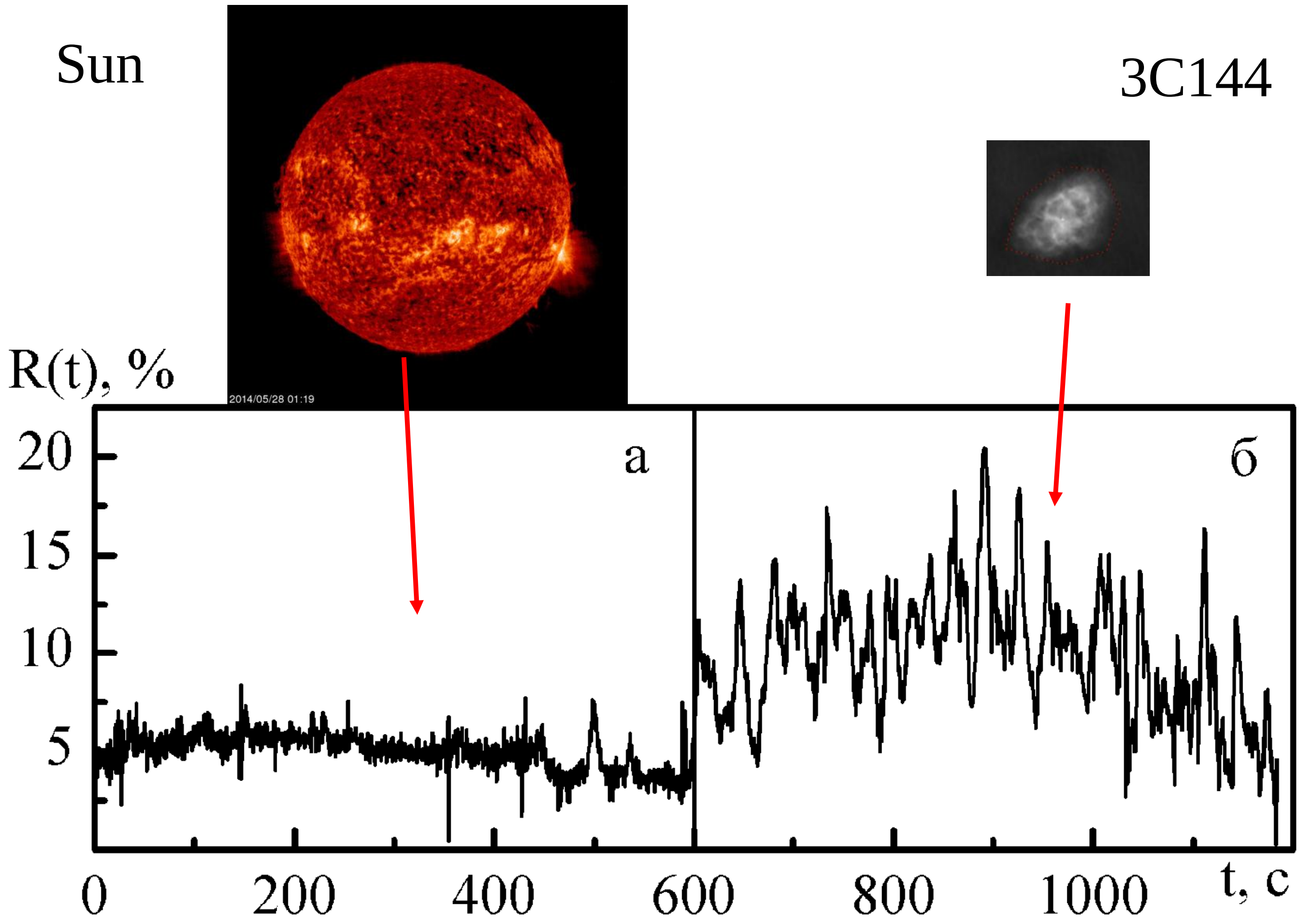




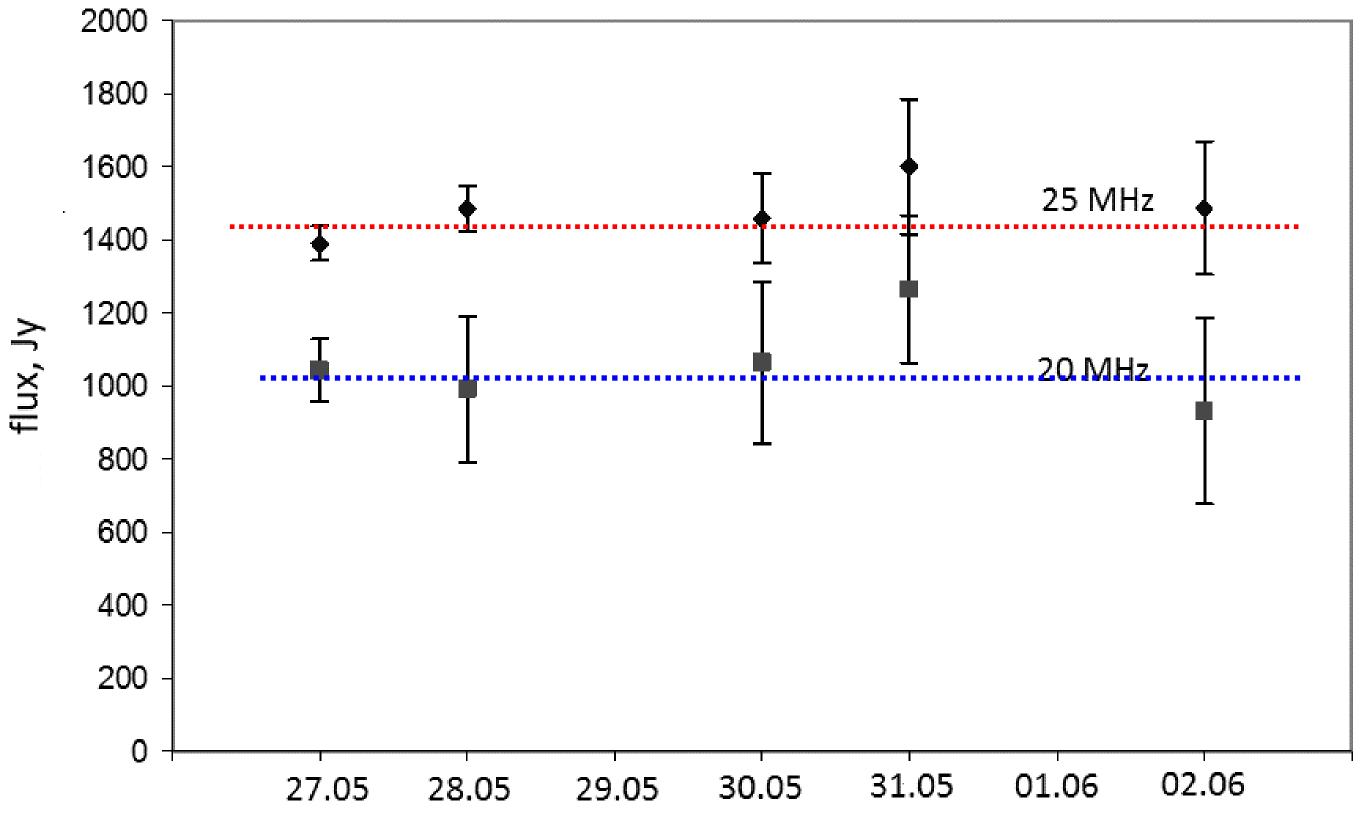

1
2
3
4
5
6
7
8
Eight sections of the UTR-2 NS arm
20 MHz
Receivers
25 MHz
ADC
PC
Time code
Synthesizers
Frequency standard
GPS receiver


International sunspot number S_n : last 13 years and forecasts
Daily
Monthly
Monthly smoothed
SC Predictions
CM Predictions
Sunspot number S_n
Time (years)
300
250
200
150
100
50
0
2004
2006
2008
2010
2012
2014
2016
SILSO graphics (http://sidc.be/silso) Royal Observatory of Belgium 2016 May 1

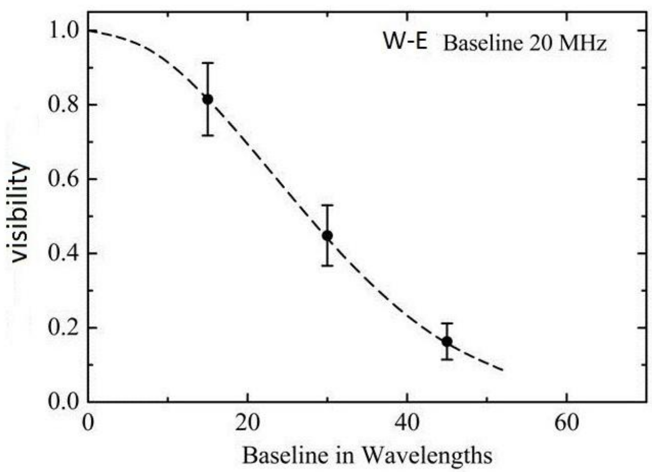

MHz
POWER
28.05.2014
URAN-2, Poltava, Ukraine
30
25
20
15
10
08:30
09:00
09:30
10:00
10:30
11:00
UT
60
45
30
15
0
MHz
POWER
29.05.2014
URAN-2, Poltava, Ukraine
30
25
20
15
10
08:00
08:30
09:00
09:30
10:00
10:30
11:00
11:30
UT
60
45
30
15
0
MHz
POWER
30.05.2014
URAN-2, Poltava, Ukraine
30
25
20
15
10
08:00
08:30
09:00
09:30
10:00
10:30
11:00
11:30
UT
60
45
30
15
0



The Sun and the Crab at 25 MHz



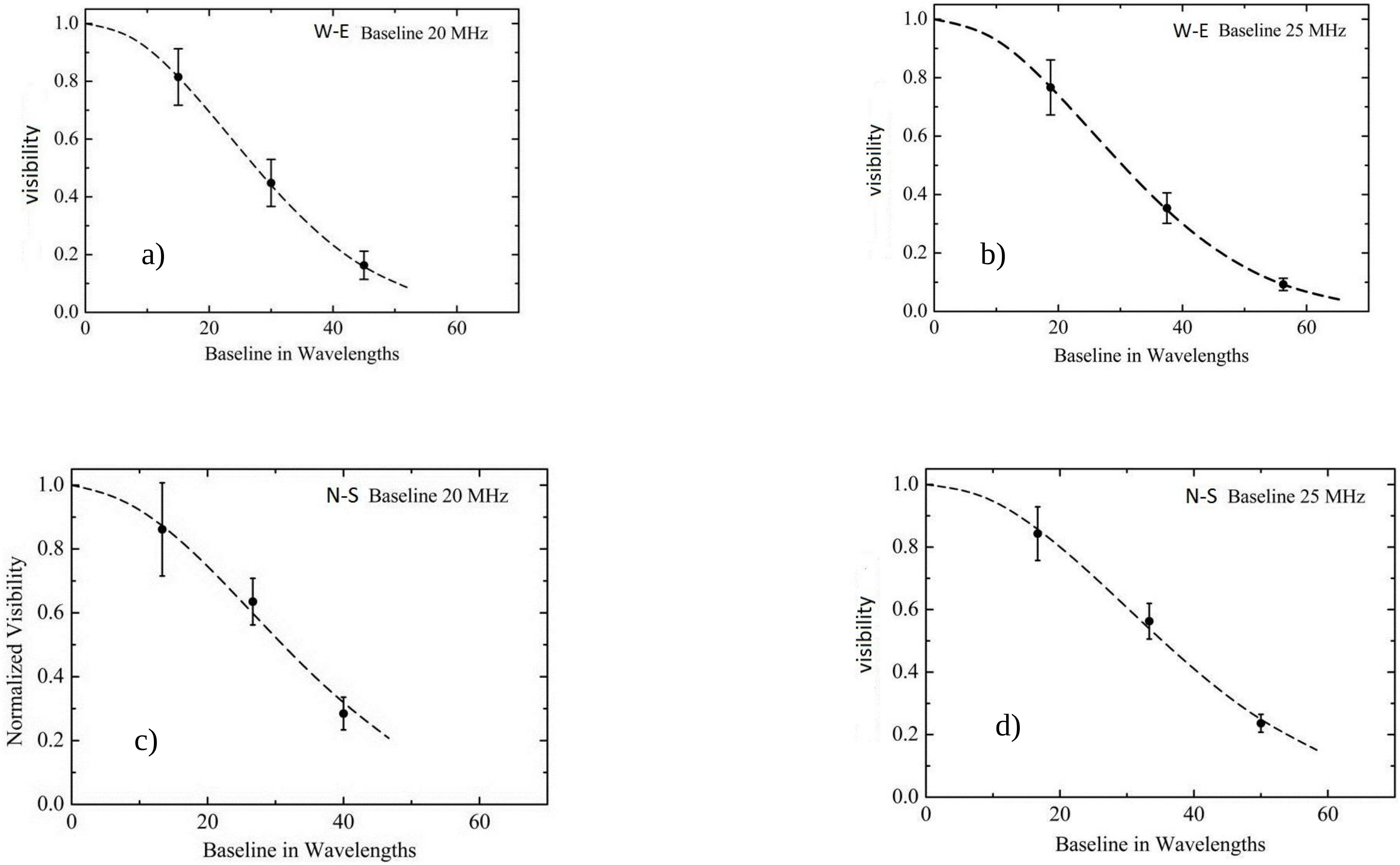
Flux density of the quiet Sun at frequencies 20 MHz and 25 MHz from May 27 to June 2, 2014.



$$\theta = \frac{2\lambda\sqrt{\ln 2}}{\pi L}\sqrt{-\ln \gamma_n}$$

$$\theta = \frac{2\lambda\sqrt{\ln 2}}{\pi}\sqrt{\frac{\ln(\gamma_1/\gamma_2)}{(L_2^2 - L_1^2)}}$$

$$\gamma_n = \exp\left(-\left(\frac{\pi\theta L}{2\sqrt{\ln 2}\,\lambda}\right)^2\right)$$



Visibility functions of the quiet Sun at 20 and 25 MHz in E-W (27, 28 and 30 May) (a,b) and N-S (31 May, 2 June) (c,d) directions.

Angular sizes and flux density of the quiet Sun at 20.0 and 25.0 MHz according to observations on May 27 – June 2, 2014.

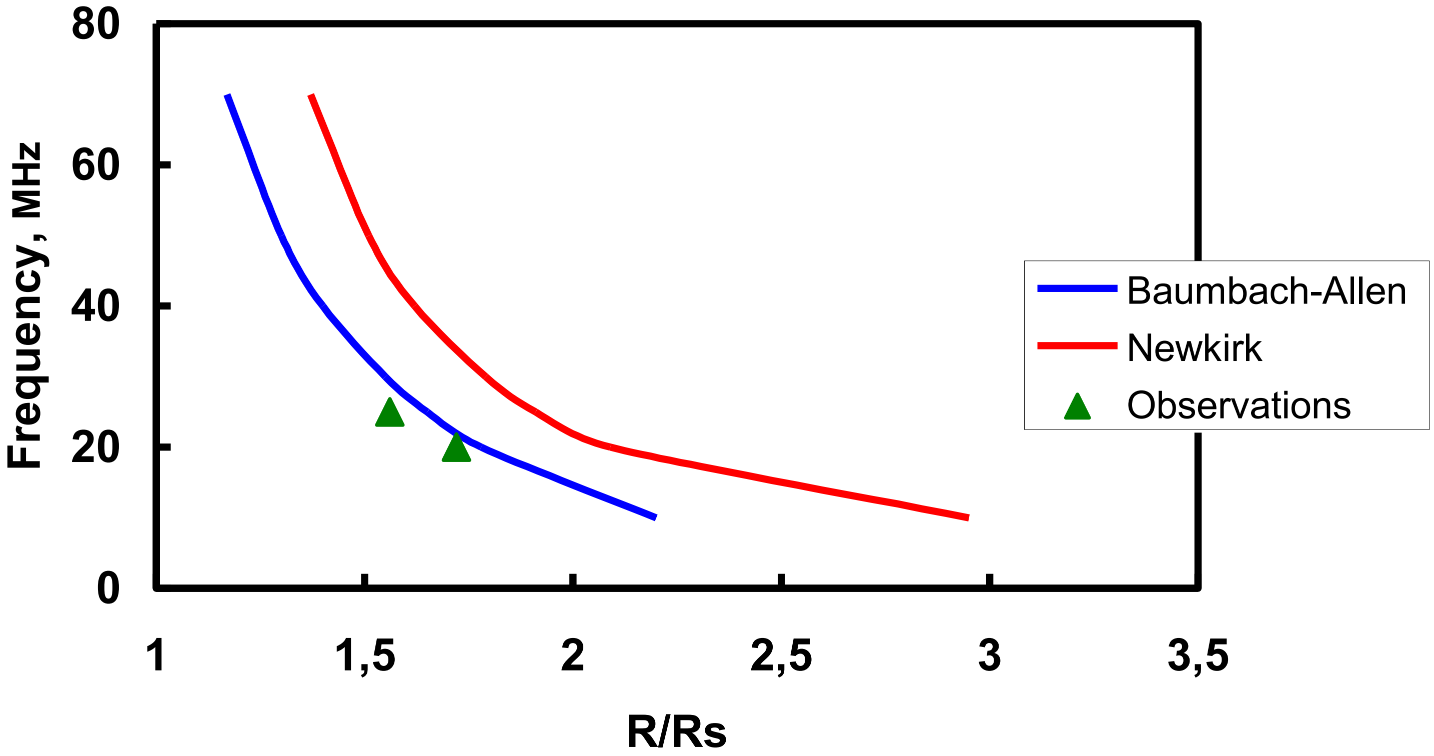
	E-W direction		N-S direction	
Frequency, MHz	**Size, arcmin**	**Flux, Jy**	**Size, arcmin**	**Flux, Jy**
20	**55′±4′**	**1050±150**	**49′ ±3′**	**1100±230**
25	**50′ ±3′**	**1480±130**	**42′± 2′**	**1570±190**

$$T_b = 5.5 \cdot 10^{29} \frac{\lambda^2 S}{\theta_{EW} \theta_{NS}}$$

T_b=5.1×10^5K (20.0 MHz)

T_b=5.7×10^5K (25.0 MHz)

Baumbach-Allen and Newkirk models and radii of the quiet Sun according to the observations

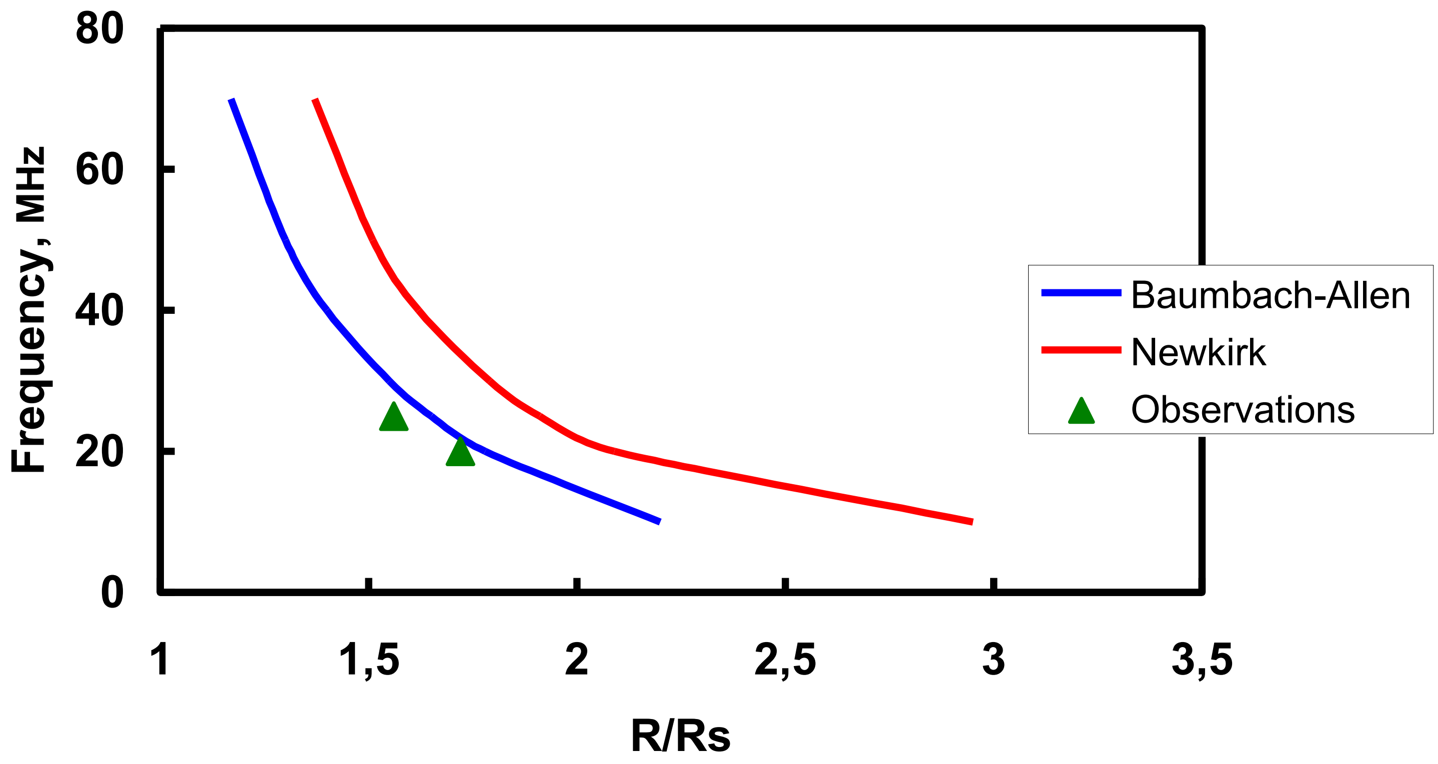


Conclusion

During the first observations in interferometer mode with the UTR-2 radio telescope it was shown that:

- **The interferometer observations can be used for the determination of the quiet Sun parameters such as flux, size and brightness temperature at the heights (0.5–2) $R_\odot$.**
- **Gaussian distribution of the quiet Sun intensity is a good approximation.**
- **On the days before and after CME the fluxes of the quiet Sun are practically the same.**
- **Obtained radii of the quiet Sun at 20.0 and 25.0 MHz are close to distances from the Sun of corresponding local plasma frequencies in the Baumbach-Allen solar corona.**
- **Compression factor of the quiet Sun ellipse is about 0.85-0.9 in the decameter range.**
- **Brightness temperatures of the quiet Sun are T_b=5.1×10^5K and T_b=5.7×10^5K at 20.0 and 25.0 MHz, correspondingly, and they are lower than the temperature of the coronal plasma.**

Baumbach-Allen and Newkirk models and radii of the quiet Sun according to the observations



interferometer investigations

will be

continued