

Solar Observations with a Low Frequency Radio Telescope

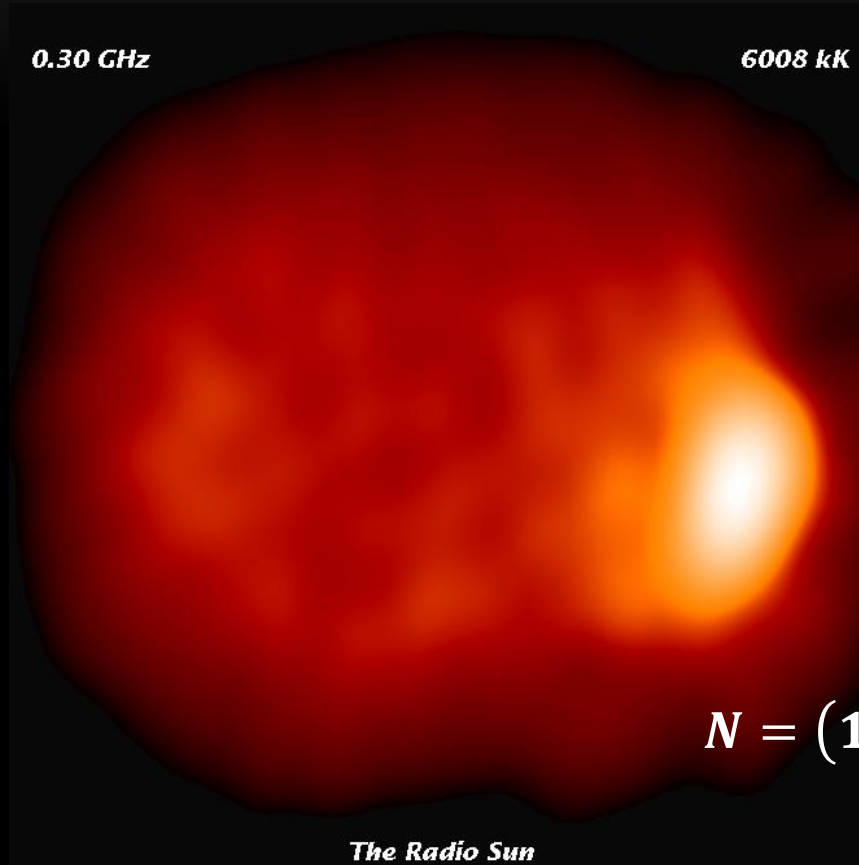
I. Myserlis¹, J.H. Seiradakis¹ and M. Dogramatzidis²

¹Aristotle University, Department of Physics,
Section of Astrophysics, Astronomy and Mechanics, Thessaloniki, Greece

²Lyceum Nikiforou Dramas, Greece



The Radio Sun

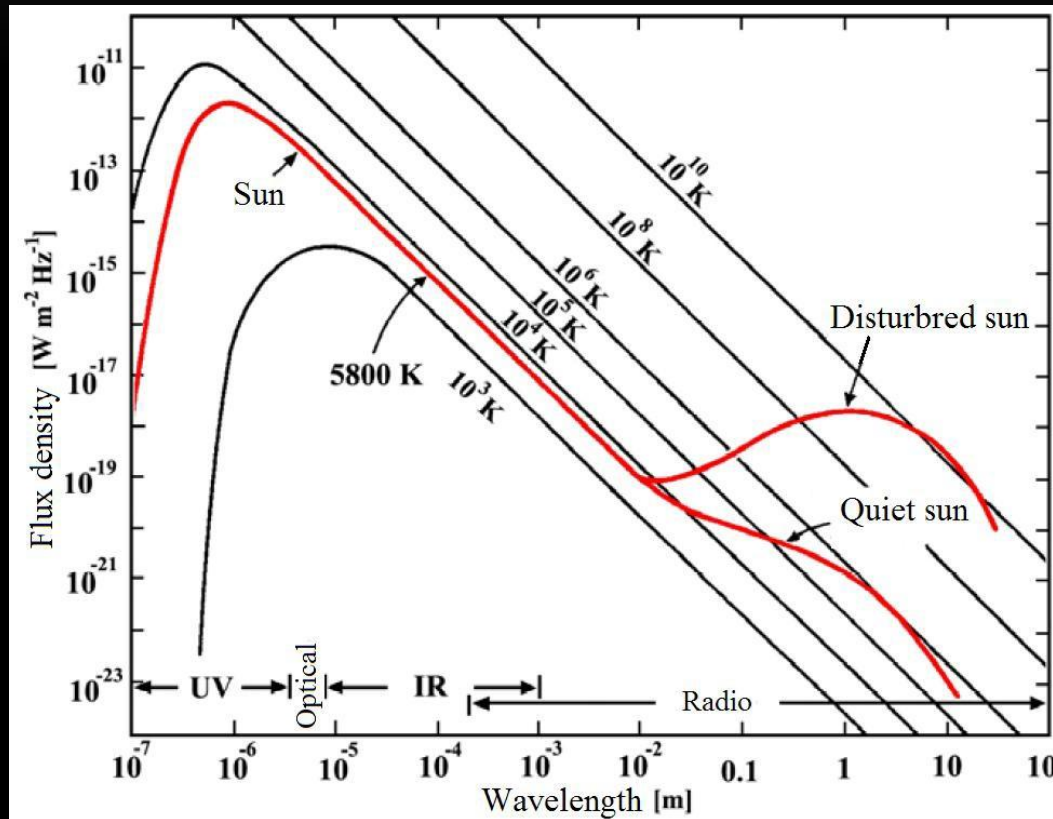


$$\nu = \frac{e}{2\pi} \sqrt{\frac{N}{\epsilon_0 m}} \quad [\text{Hz}]$$

$$N = (1.55 \cdot r^{-6} + 2.99 \cdot r^{-16}) \cdot 10^{14} \quad [m^{-3}]$$

The Radio Sun

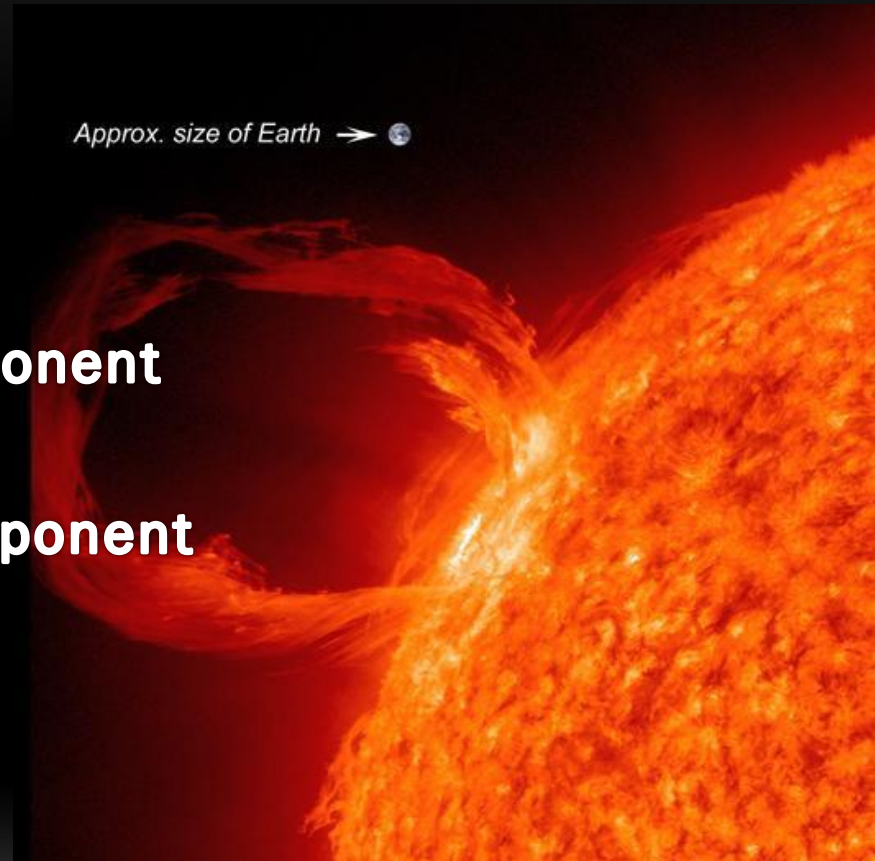
Simplified solar spectrum



The Radio Sun

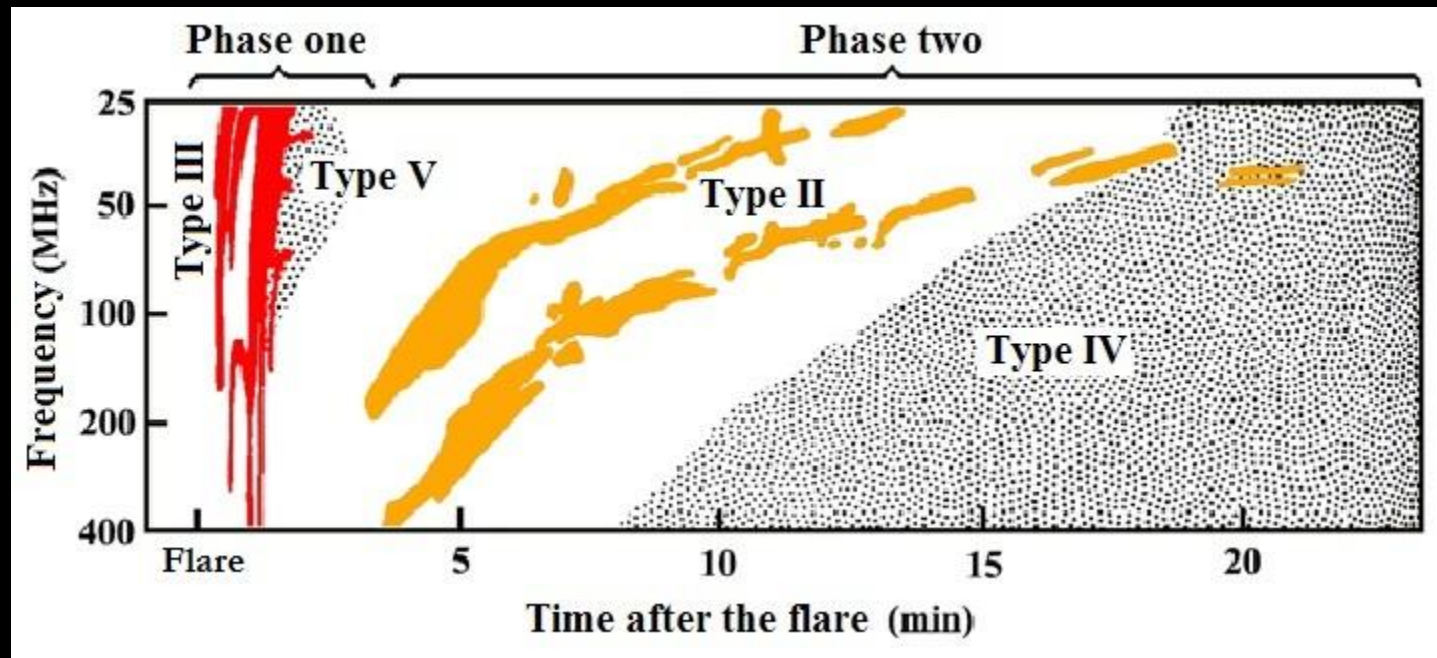
❖ Disturbed sun:

- Slowly varying component
- Rapidly varying component



The Radio Sun

❖ Rapidly varying component



Technical Aspects

❖ Low frequency radio monitoring station:

- Dual dipole phased array antenna
- Low frequency radio receiver
- Dedicated computer

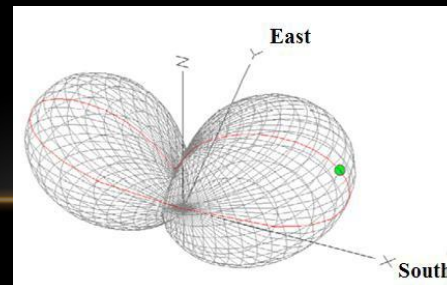
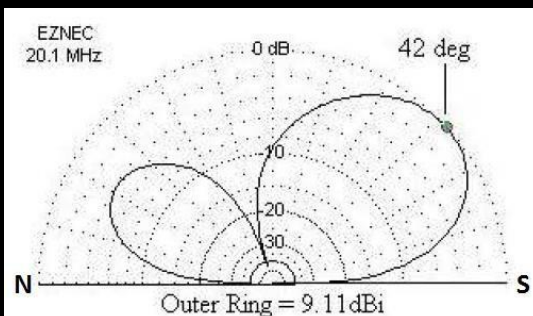
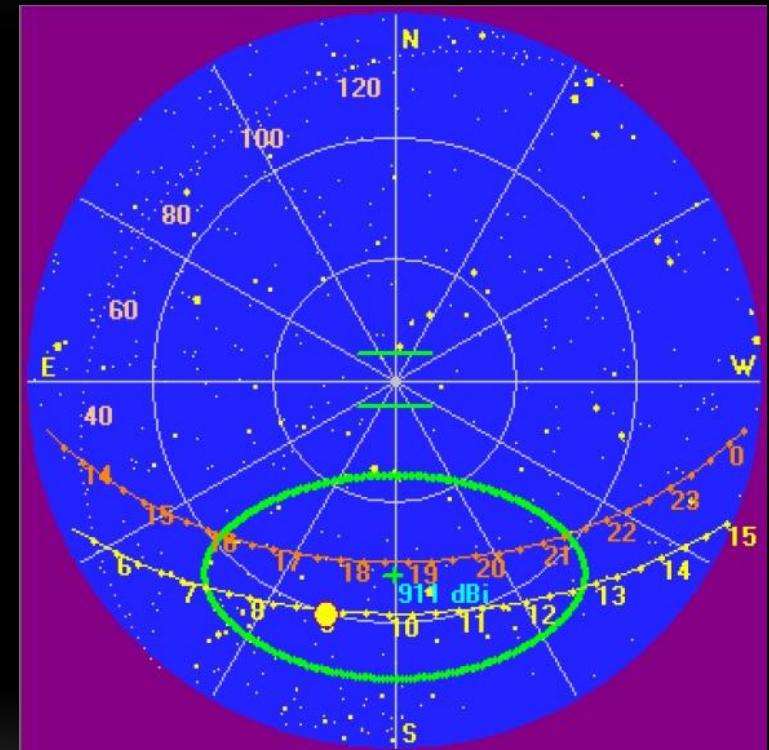
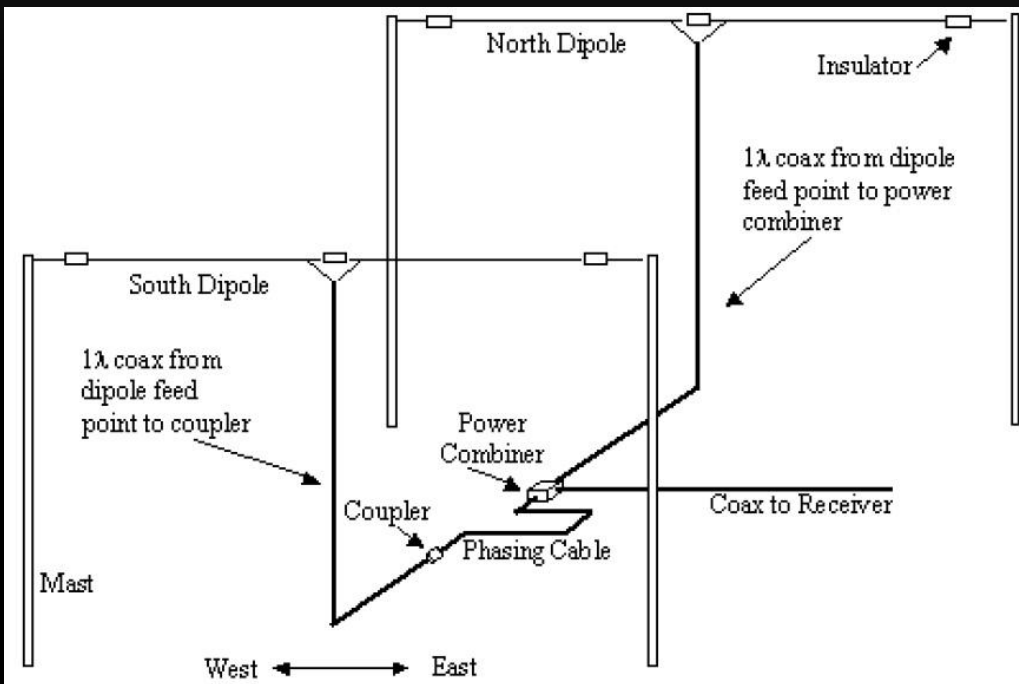
❖ Based on NASA's Radio JOVE project

- <http://radiojove.gsfc.nasa.gov/>



Technical Aspects

❖ Antenna configuration and pattern



Technical Aspects

❖ Antenna coordinates:

- $40^{\circ}37'50''.06$ North
- $22^{\circ}57'33''.3$ East



Technical Aspects

❖ Antenna coordinates:

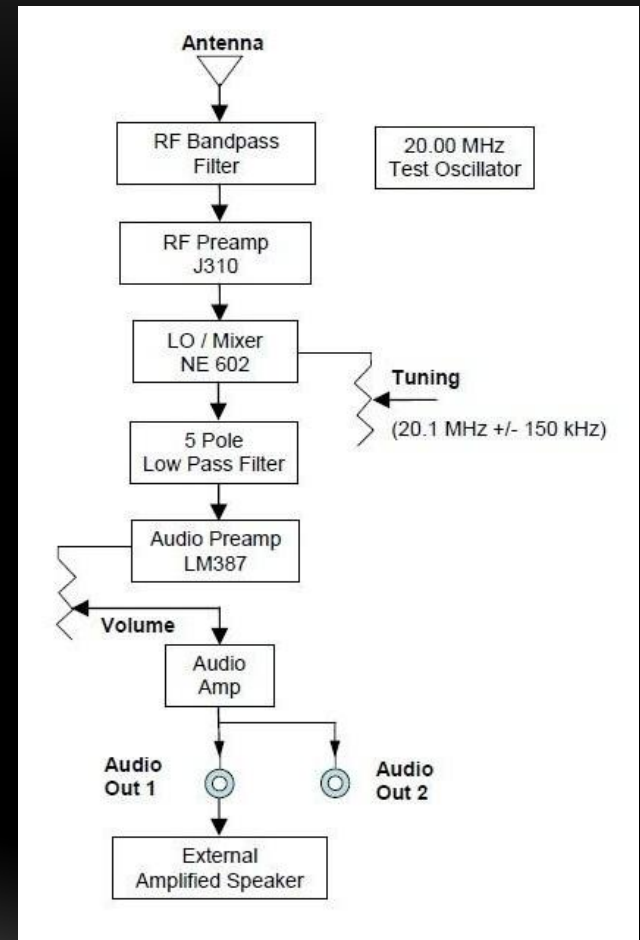
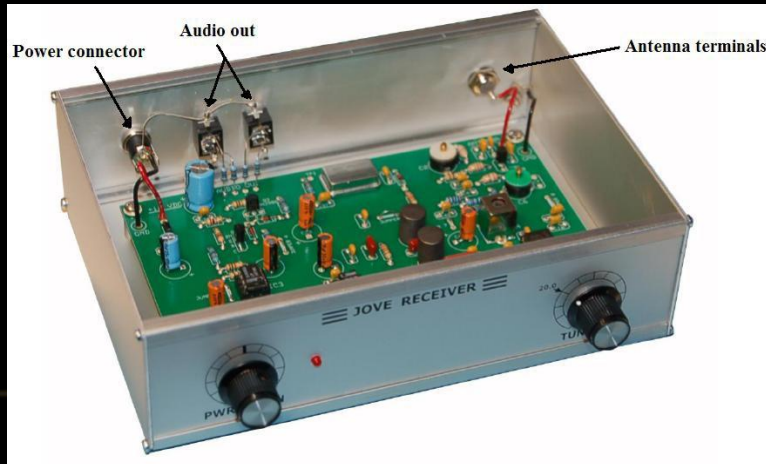
- $40^{\circ}37'50''.06$ North
- $22^{\circ}57'33''.3$ East



Technical Aspects

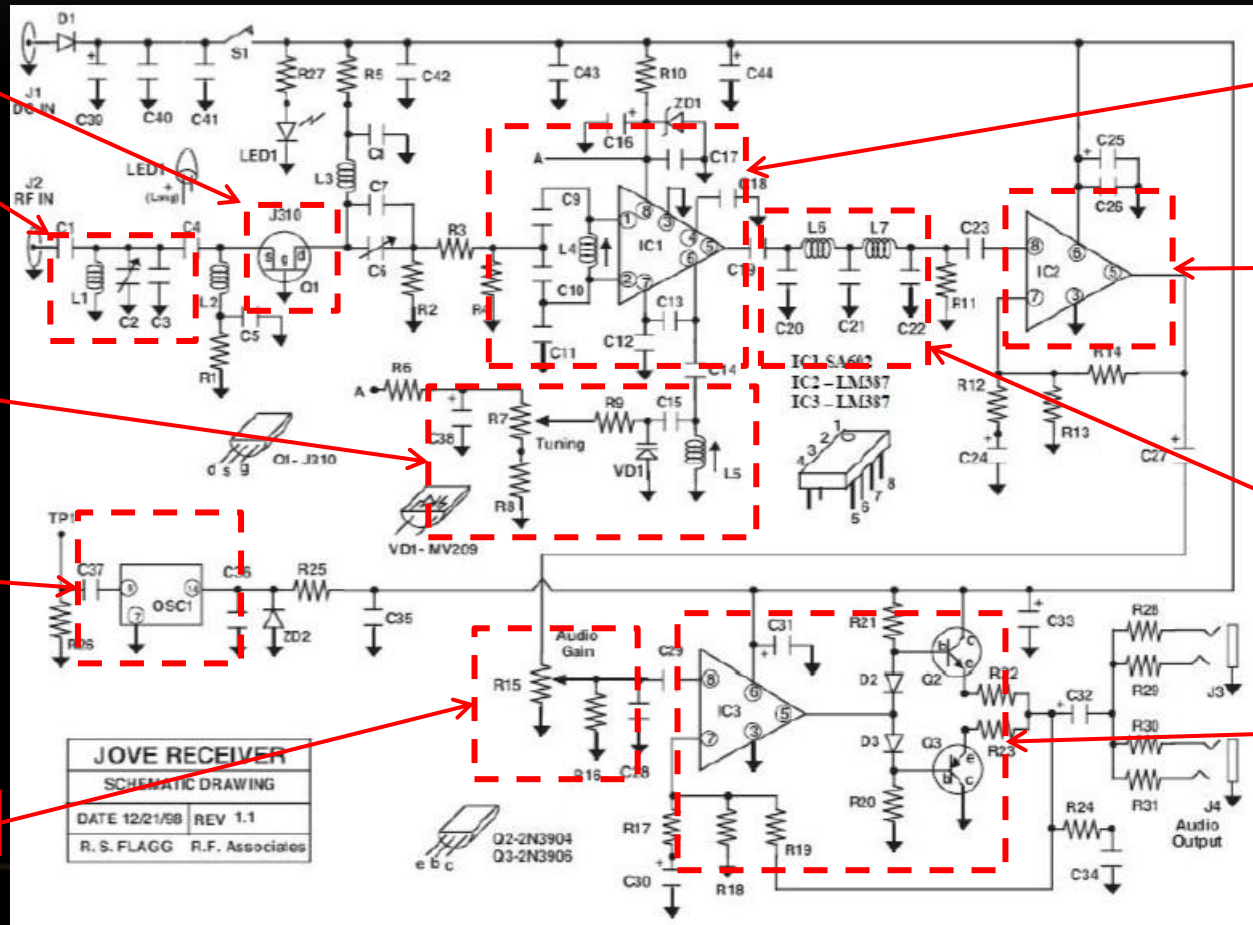
❖ Low frequency radio receiver

- Superheterodyne principle
- Middle frequency: 20.1 MHz
- Tuning range: 19.9 – 20.2 MHz
- Bandwidth: 5 kHz



Technical Aspects

❖ Low frequency radio receiver



Amplifier

Bandpass filter

Tuning control

Test oscillator

Volume control

Local oscillator
& Mixer

Amplifier

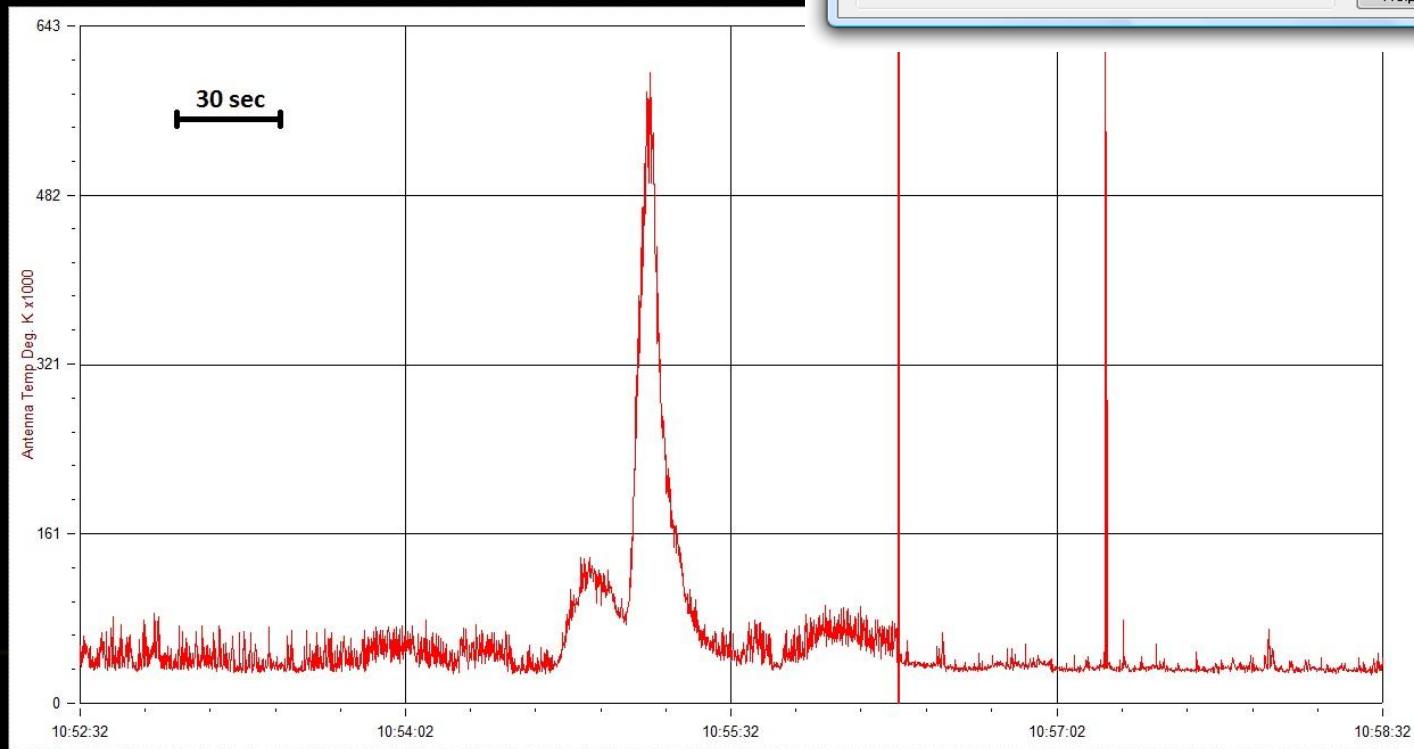
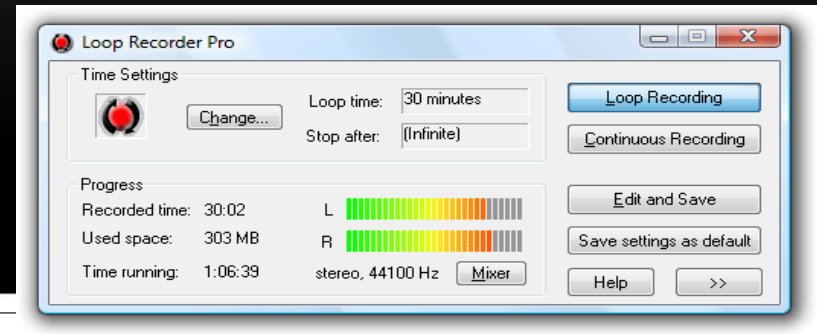
Low pass filter

Amplifiers

Technical Aspects

❖ Software

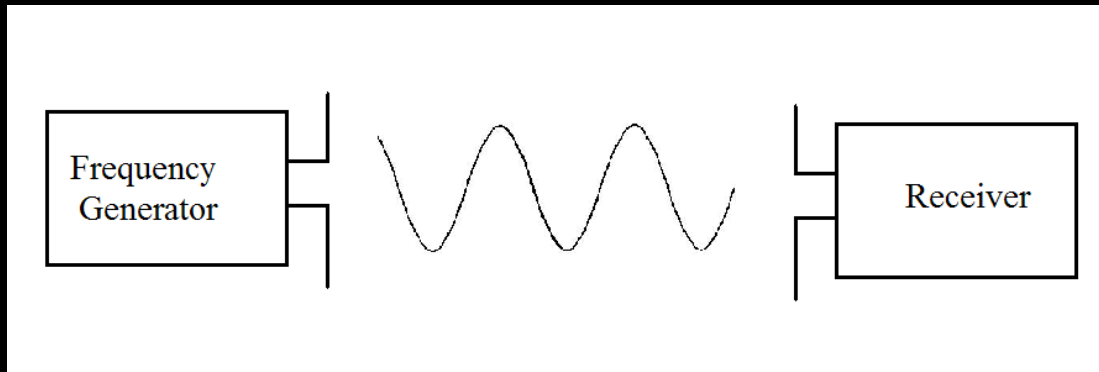
- Radio SkyPipe II
- Loop Recorder Pro 2.06



Technical Aspects

❖ System calibration

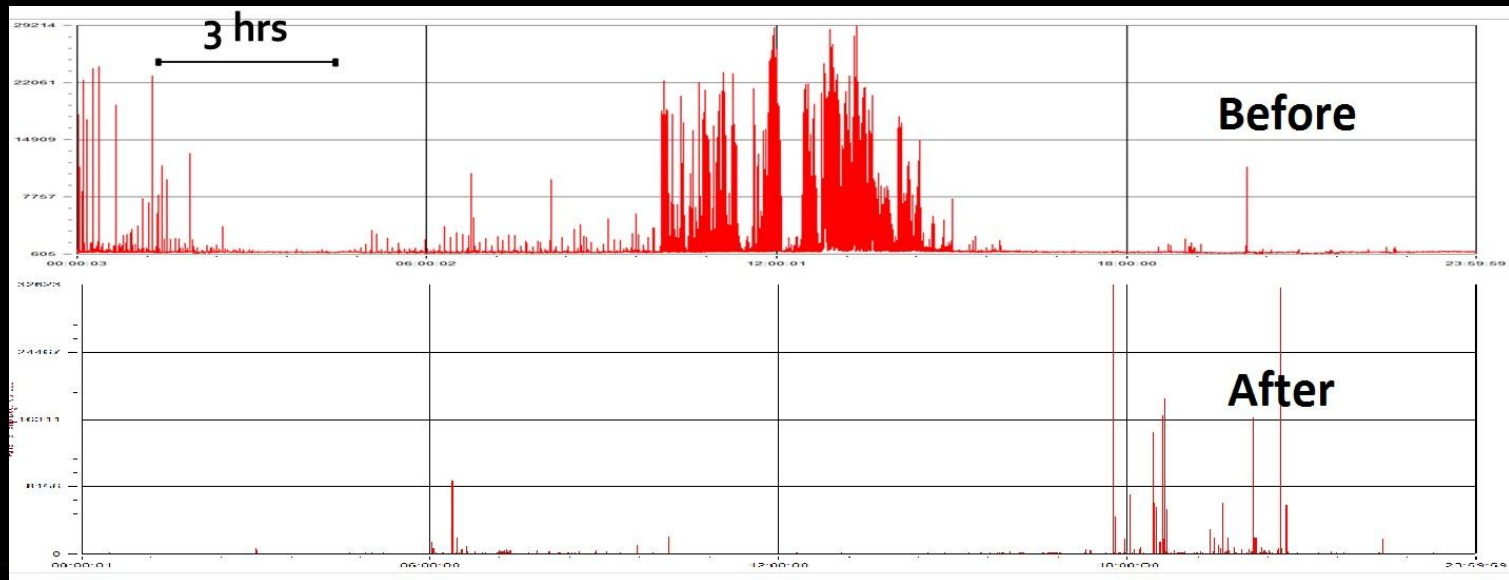
- Frequency calibration
- Antenna temperature calibration
 - Calibrated noise source RF2080 C/F



Observations

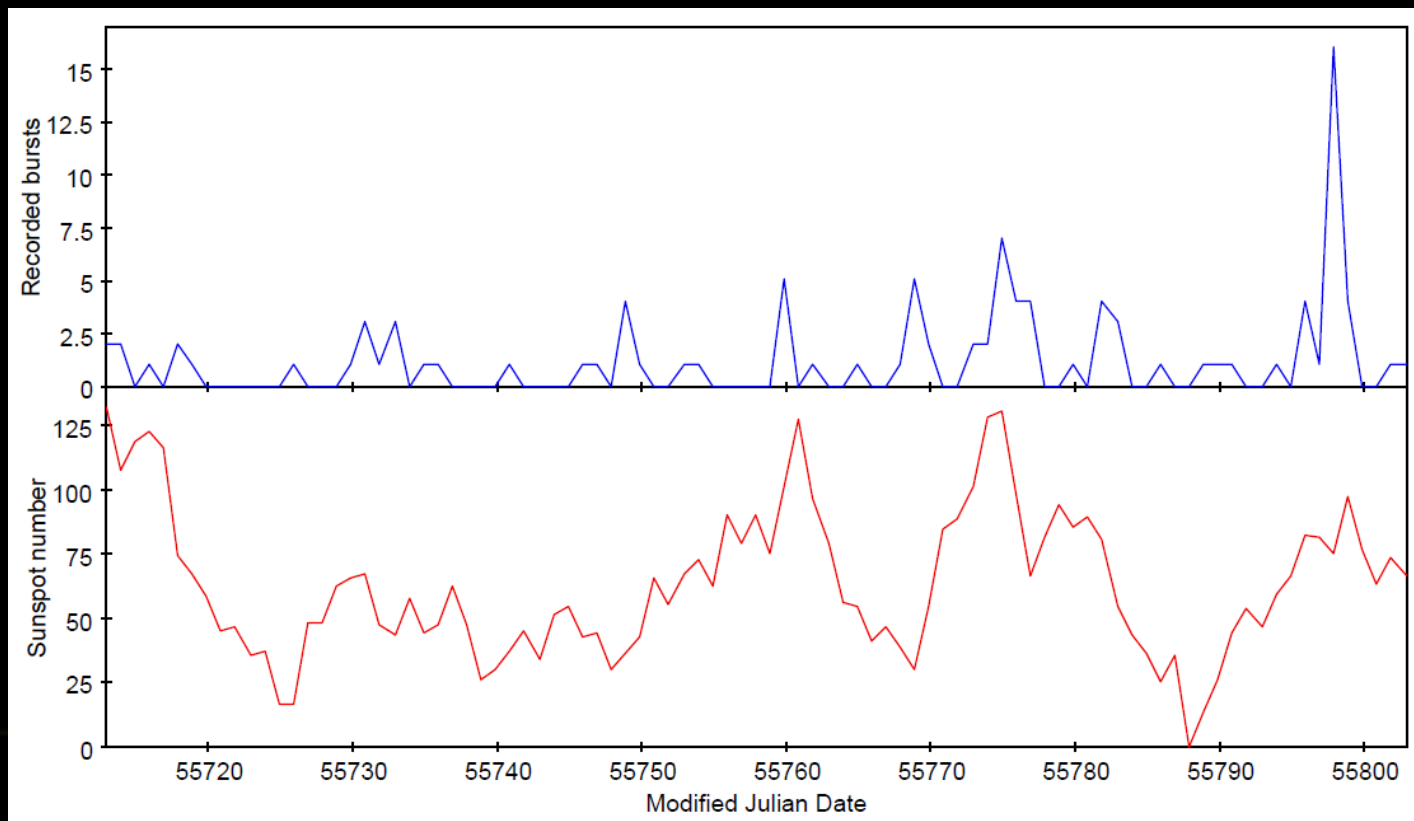
❖ Sources of interference

- **Natural**
 - **I.e. Thunderstorms**
- **Manmade**
 - **I.e. strong international broadcasting radio stations**



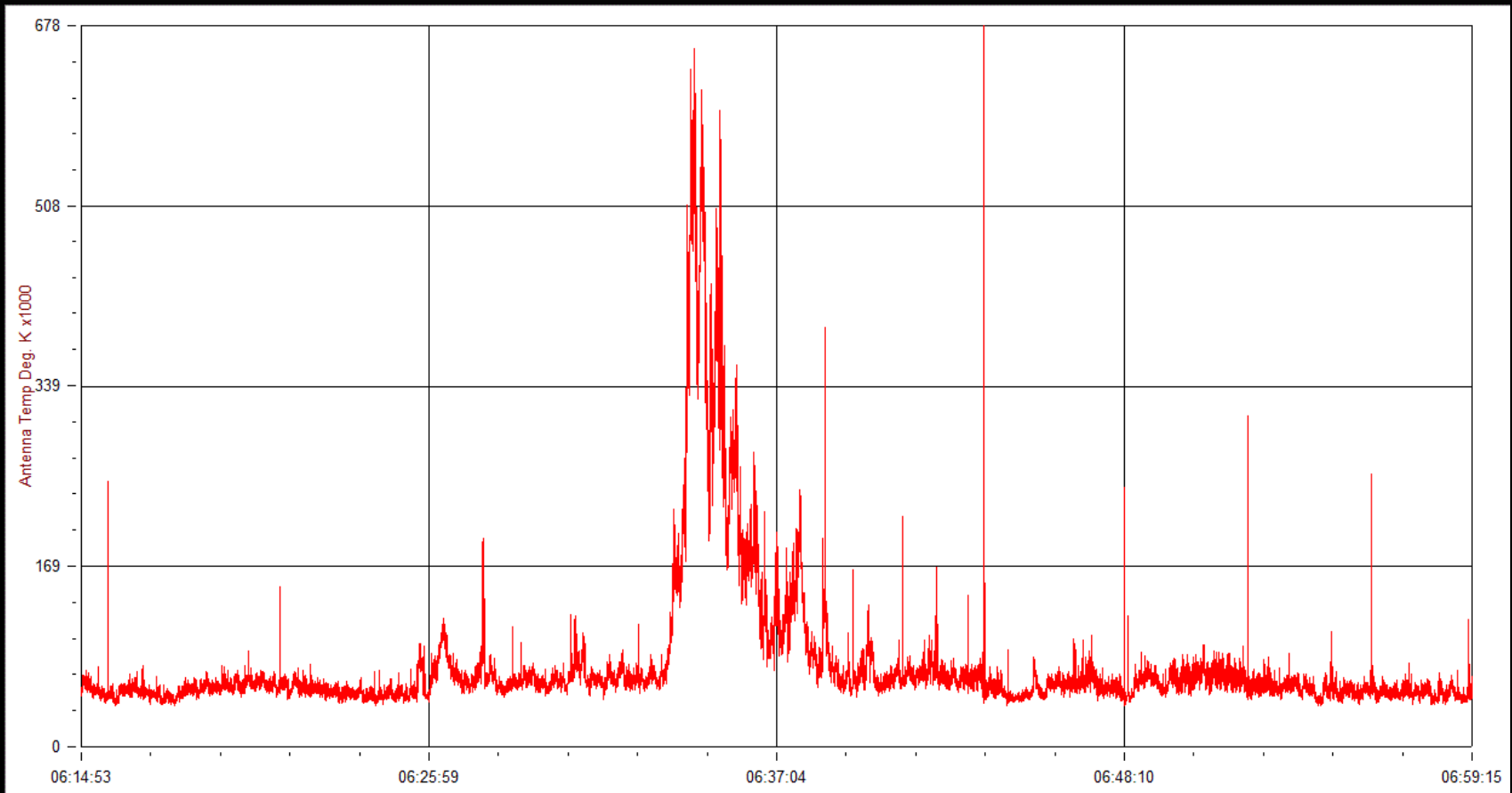
Observations

- ❖ Over 100 solar radio bursts recorded since July 2010
- ❖ Correlated with solar flares and X-ray events



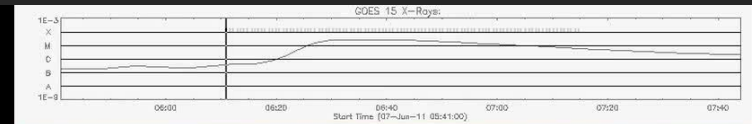
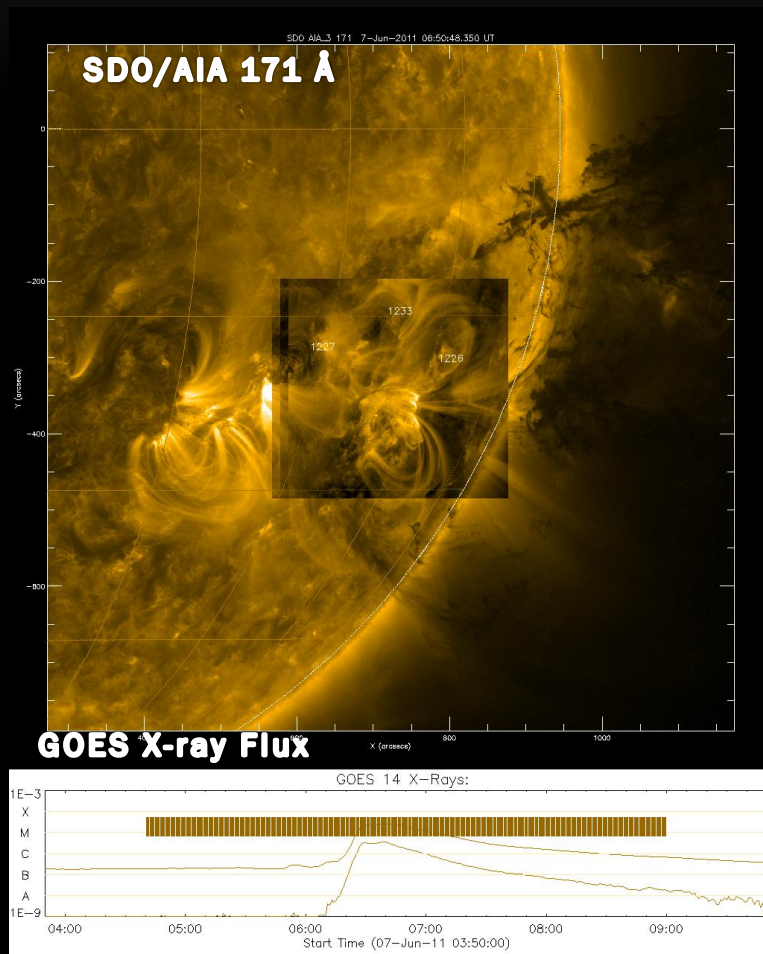
Observations

❖ Solar radio burst on 07/06/2011



Observations

❖ Solar radio burst on 07/06/2011



SDO/AIA 211/193/171 Å

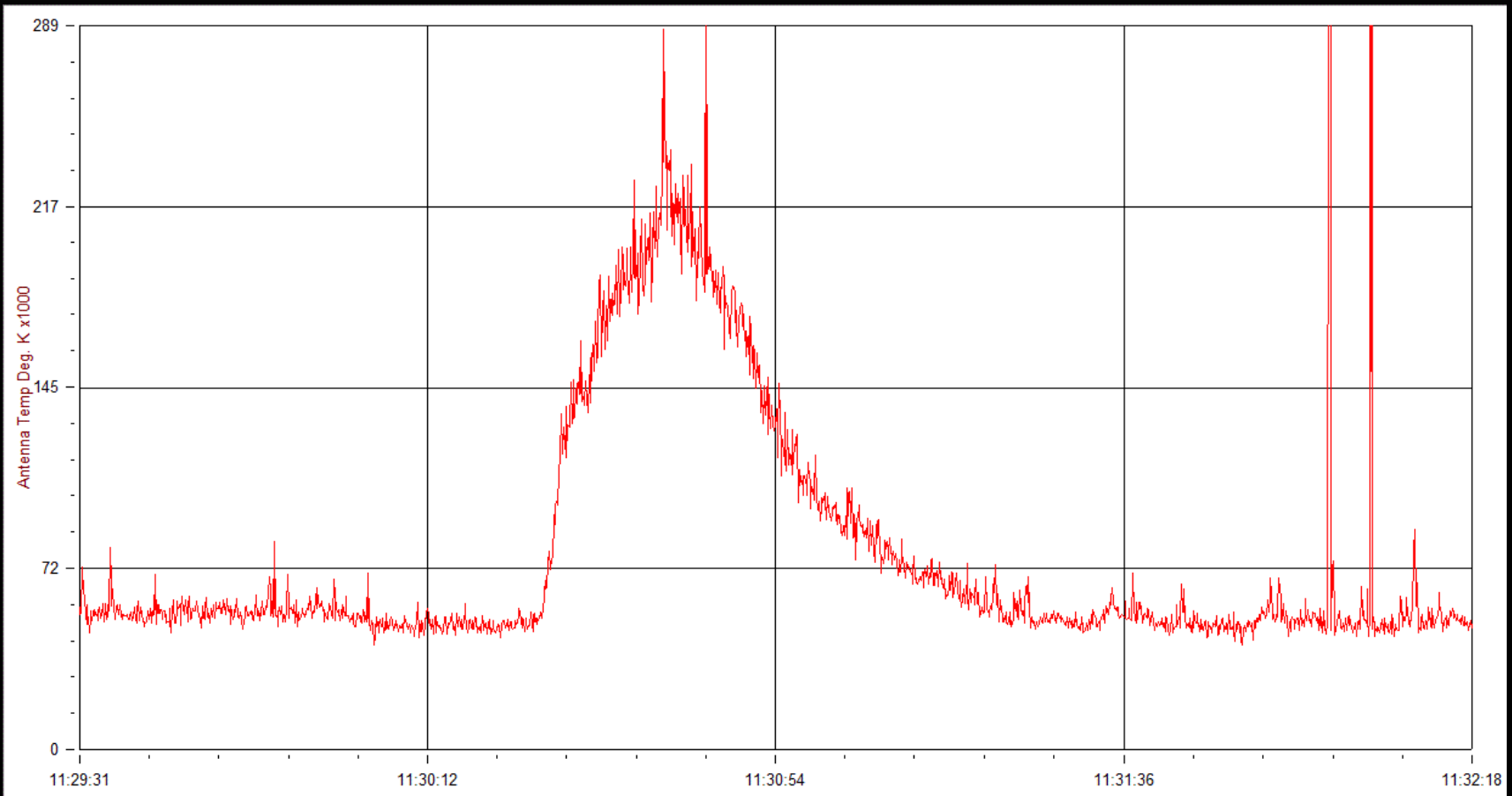


NOAA report

| Event | Begin | Max | End | Obs | Q | Type | Loc/Frq | Particulars | Reg# |
|--------|-------|------|------|-----|---|------|---------|--------------|------|
| 3710 | 0616 | 0641 | 0659 | G15 | 5 | XRA | 1-8A | M2.5 4.4E-02 | 1226 |
| 3710 | 0619 | 0629 | 0809 | LEA | 3 | FLA | S21W54 | 2N PRB | 1226 |
| 3710 + | 0623 | 0638 | 0645 | LEA | G | RBR | 2695 | 710 | 1226 |
| 3710 + | 0623 | 0625 | 0645 | LEA | G | RBR | 4995 | 910 | 1226 |
| 3710 + | 0624 | 0637 | 0645 | LEA | G | RBR | 1415 | 300 | 1226 |
| 3710 + | 0624 | 0625 | 0643 | LEA | G | RBR | 8800 | 870 | 1226 |
| 3710 + | 0624 | 0625 | 0625 | LEA | G | RBR | 410 | 170 | 1226 |
| 3710 | 0625 | //// | 0650 | LEA | C | RSP | 25-120 | II/2 | 1226 |
| 3710 + | 0625 | 0625 | 0642 | LEA | G | RBR | 15400 | 390 | 1226 |
| 3710 | 0625 | 0633 | 0644 | LEA | G | RBR | 245 | 6400 | 1226 |
| 3710 | 0626 | //// | 0658 | LEA | C | RSP | 25-180 | IV/2 | 1226 |
| 3710 + | 0629 | 0634 | 0639 | LEA | G | RBR | 610 | 260 | 1226 |

Observations

❖ Solar radio burst on 26/07/2011

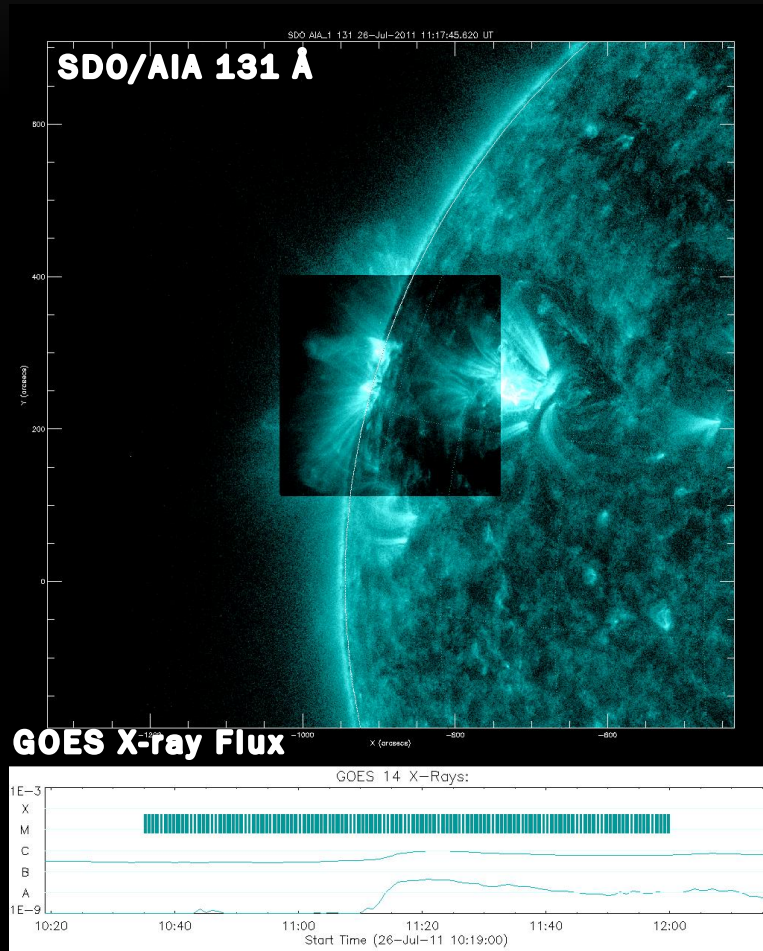


Observations

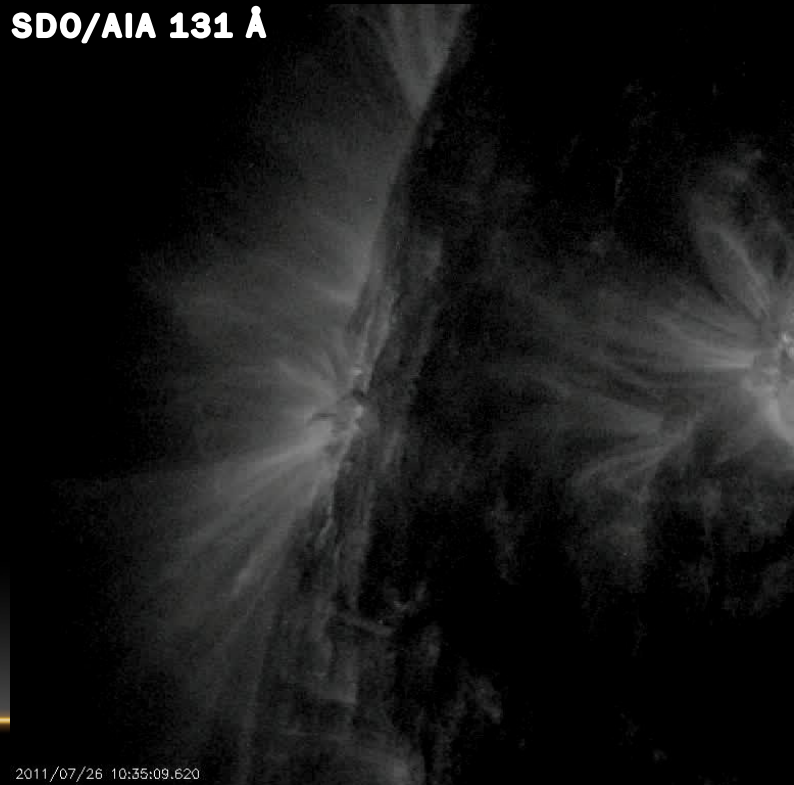
❖ Solar radio burst on 26/07/2011

NOAA report

| Event | Begin | Max | End | Obs | Q | Type | Loc/Frq | Particulars | Reg# |
|-------|-------|------|------|-----|---|------|---------|--------------|------|
| 9530 | 1112 | 1122 | 1139 | G15 | 5 | XRA | 1-8A | B9.4 1.2E-03 | 1261 |
| 9530+ | 1115 | //// | 1156 | SVI | C | RSP | 025-180 | VI/2 | |



SDO/AIA 131 Å



Summary - Conclusions

- ◆ **We set up a dual dipole phased array antenna for solar observations**
- ◆ **We constructed a radio receiver working at 20.1 MHz**
- ◆ **We set up a monitoring station at the Observatory of the Aristotle University**
- ◆ **Frequency and Antenna temperature calibration**
- ◆ **Over 100 verified solar radio bursts since July 2010**
- ◆ **Correlated with solar flares and X-ray events**
- ◆ **A second monitoring station, working at 36 MHz, is under construction at Nikiforos, Drama**
- ◆ **We plan to construct a third one, in Thessaloniki, working at the free of interference frequency of 58 MHz**

Thank you