



Space Radio for Ukraine

Assembly Manual for the Educational Radio Telescope

Workshop for Teachers and Educators in Radio Astronomy

Manual author: Valentyna Babur, DESY

With support from: Martin Schwinzerl (DZA) and Pavlo Plotko (DZA)

Contact: Pavlo Plotko (DZA) · pavlo.plotko@dzastro.de

Contents

1	Introduction	2
2	Assembling the Conical Horn Antenna	2
2.1	Materials and Tools	2
2.2	Part Templates	3
2.3	Step-by-Step Instructions	3
3	Electronic Unit: Component List	11
4	Exercise 1. Wideband Analysis with the Log-Periodic Antenna	14
4.1	Required Components	14
4.2	Connection Diagram	14
5	Exercise 2. Detecting the 21-cm Line of Neutral Hydrogen	15
5.1	Required Components	15
5.2	Connection Diagram	15
5.3	Assembly Procedure	15
6	Calibration and Basic Checks	18

1. Introduction

This manual has been prepared for participants of the **Space Radio for Ukraine** workshop. Its aim is to guide you step by step through assembling an educational radio telescope, correctly connecting the electronic unit, and completing two introductory radio astronomy exercises.

2. Assembling the Conical Horn Antenna

2.1. Materials and Tools

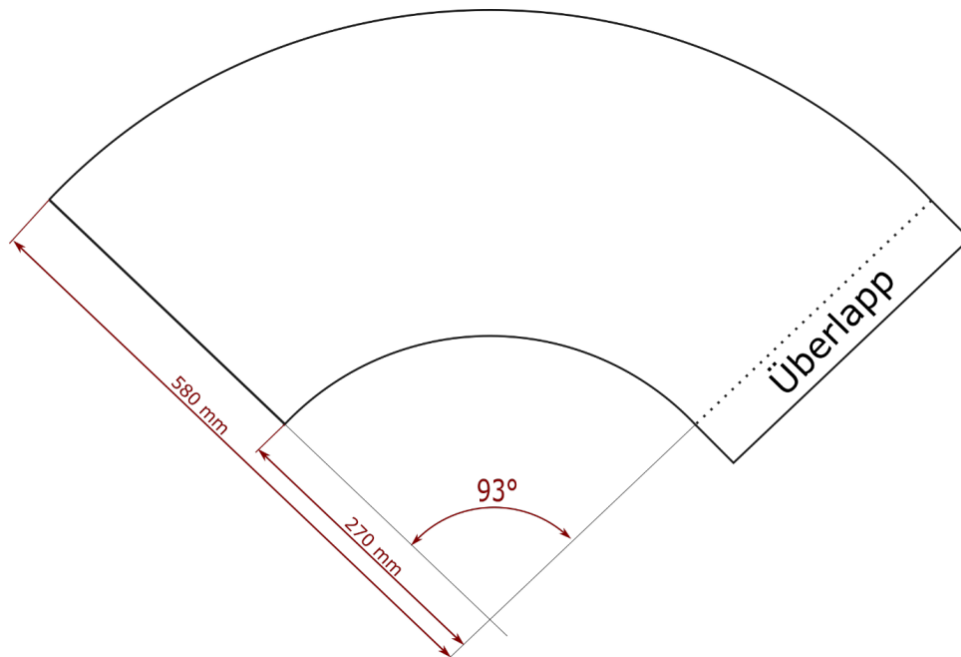
Main materials

- 2 sheets of DIN A1 cardboard;
- 1 roll of conductive adhesive tape;
- 1 roll of aluminium foil;
- 1 empty tin can, 2.5 l (140 × 180 mm);
- 1 antenna element;
- 1 tripod;
- 1 antenna mount.

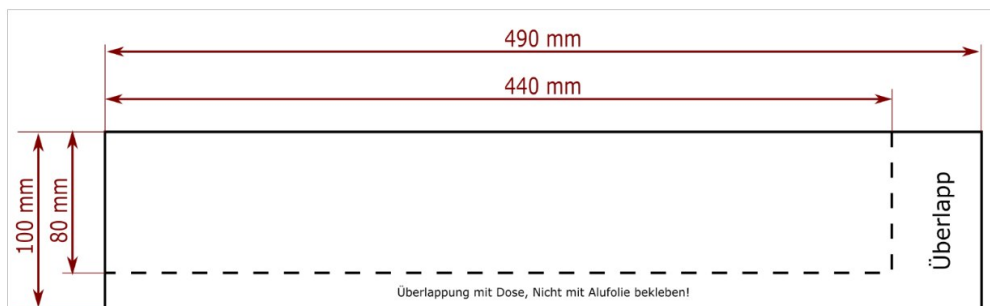
Auxiliary materials and tools

- pencil;
- scissors;
- thread;
- protractor;
- ruler;
- glue.

2.2. Part Templates



(a) Conical funnel template



(b) Collar template

Figure 1. Templates for the horn antenna components

2.3. Step-by-Step Instructions

Step 1. Glue the two sheets of cardboard together with an overlap of approximately 7 cm, as shown in Fig. 2.



Figure 2. Gluing the two cardboard sheets together

Step 2. Using the templates in Fig. 1, draw the conical antenna components: the **funnel** and the **collar**. To draw the funnel arc, use a thread attached to a pencil, as shown in Fig. 3.

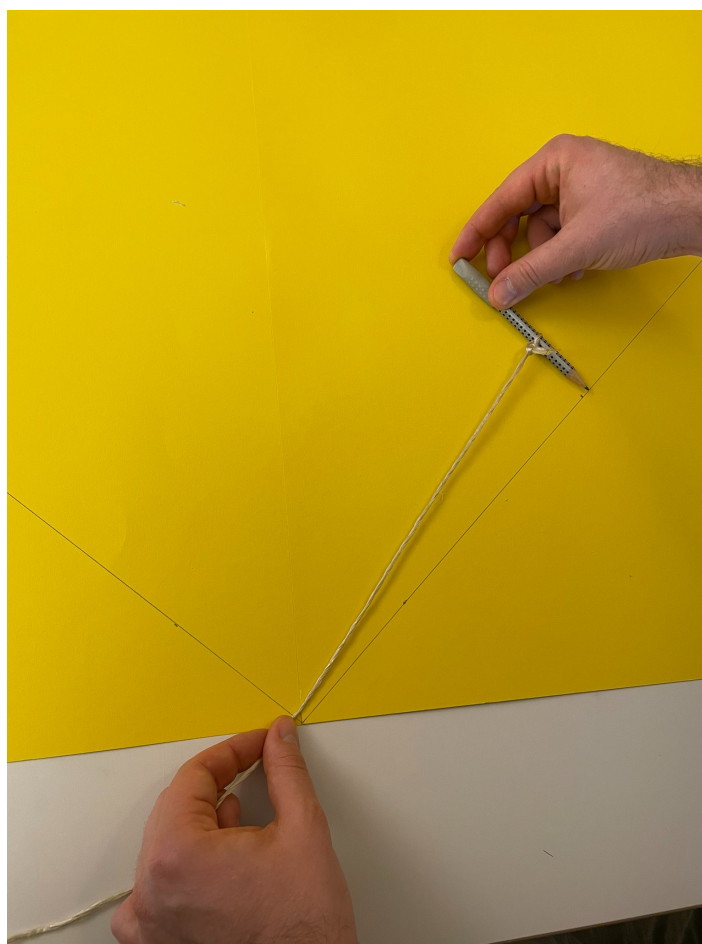


Figure 3. Drawing the arc using a thread and pencil

Step 3. Cut out the drawn elements. Fig. 4 shows the blanks after marking.



Figure 4. Marked elements before cutting

Step 4. Cover one side of the funnel and collar with aluminium foil. Leave a strip of approximately 7 cm without foil along the funnel edge for subsequent gluing. It is recommended to additionally cover the small arc of the funnel and the long edge of the collar with conductive adhesive tape.

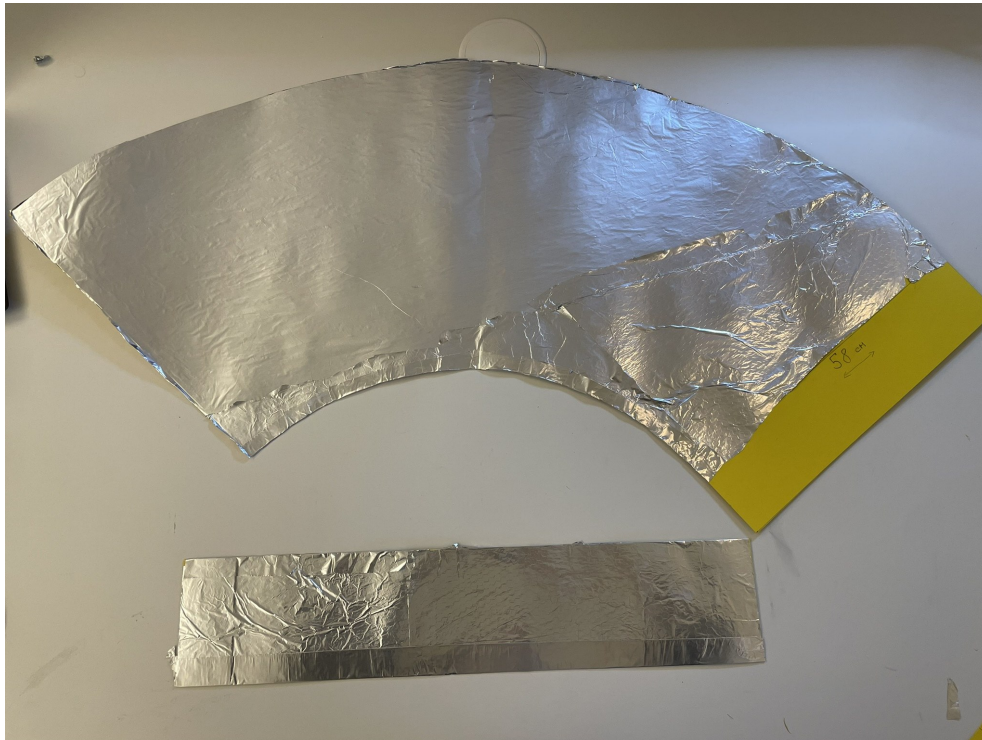


Figure 5. Cut elements covered with foil

Step 5. Form and glue the funnel, as shown in Fig. 6.



Figure 6. Completed conical funnel

Step 6. Prepare the antenna element and insert it into the pre-drilled hole in the tin can. Secure it firmly with a nut.



Figure 7. Installing the antenna element into the can

Step 7. Firmly attach the collar to the can using conductive adhesive tape.



Figure 8. Attached collar.

Step 8. Attach the funnel to the collar and make sure all conductive parts are in firm contact with each other. Use additional conductive adhesive tape if needed.

Step 9. Check the electrical conductivity of the entire assembly using a multimeter, as shown in Fig. 9.



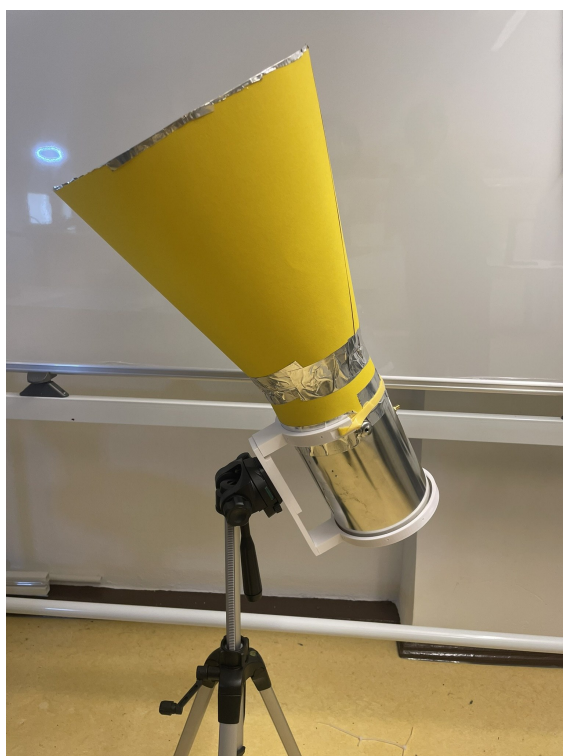
Figure 9. Conductivity check.

Step 10. Assemble the tripod mount as shown in Fig. 10.



Figure 10. Completed mount.

Step 11. Attach the mount with the antenna to the tripod.



The conical horn antenna is ready!

The antenna is ready to be connected to the electronic unit and to begin the first observations.

3. Electronic Unit: Component List

The components are numbered in the photos below. The same numbering is used in the table for convenience.



Figure 11. Electronic unit components

No.	Component	Qty
1	Low-Noise Amplifier (LNA), 0.1 MHz – 6 GHz	1
2	Amplifiers SPF5189Z or TQP3M9009	2
3	Bias Tee	1
4	Bandpass Filter 1420 MHz (BPF)	1
5	SDR module (Software Defined Radio)	1
6	Red-black power cable, 250 cm	1
7	Portable power bank	1
8	SMA adapters “female–female”	2
9	SMA cables 30 cm “female–female”	2
10	SMA cables 15 cm “female–female”	2
11	SMA cable 100 cm “female–female”	1
12	$\lambda/4$ antenna element	1
13	Wideband log-periodic antenna	1
14	Filter	1
15	Spectrum analyser TinySA	1

4. Exercise 1. Wideband Analysis with the Log-Periodic Antenna

4.1. Required Components

- log-periodic antenna (13);
- amplifier (1) — if needed;
- filter (14);
- spectrum analyser TinySA (15).

4.2. Connection Diagram

In the simplest configuration, the following sequence is used:

log-periodic antenna (13) → filter (14) → spectrum analyser TinySA (15)

An amplifier (1) can be added to the chain if needed:

log-periodic antenna (13) → amplifier (1) → filter (14) → spectrum analyser TinySA (15)

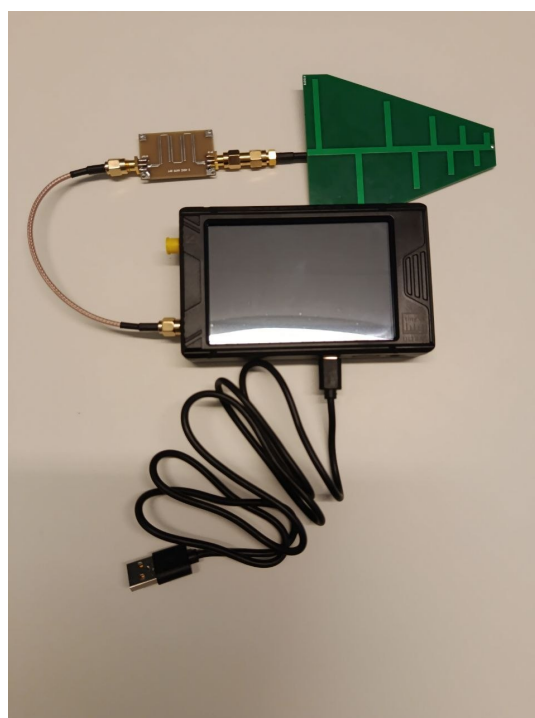


Figure 12. Connecting the log-periodic antenna to the spectrum analyser

5. Exercise 2. Detecting the 21-cm Line of Neutral Hydrogen

5.1. Required Components

- antenna (12), already mounted in the horn antenna structure;
- amplifier (1);
- Bias Tee (3);
- 1420 MHz bandpass filter (4);
- two amplifiers (2);
- SDR module (5);
- power cable (6);
- portable power bank (7);
- SMA adapters (8);
- SMA cables 30 cm (9);
- SMA cables 15 cm (10).

5.2. Connection Diagram

Recommended sequence:

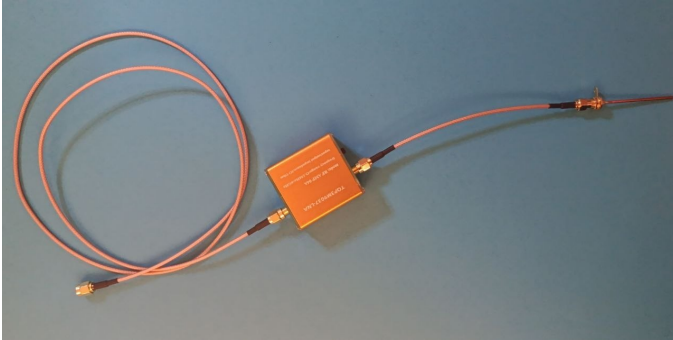
antenna (12) → amplifier (1) → cable 30 cm (9) → Bias Tee (3) → adapter (8) → filter 1420 MHz (4) → cable 15 cm (10) → amplifier (2) → adapter (8) → amplifier (2) → cable 30 cm (9) → SDR module (5)

Important: The 1420 MHz bandpass filter must **always** be placed **after** the Bias Tee. An incorrect sequence may damage the filter.

5.3. Assembly Procedure

1. Connect the antenna (12), mounted in the horn structure, to amplifier (1).
2. Connect amplifier (1) to the Bias Tee (3) using a 30 cm cable (9).
3. Connect the Bias Tee (3) to the 1420 MHz filter (4) using adapter (8).
4. After the filter, connect the first amplifier (2) using a 15 cm cable (10).

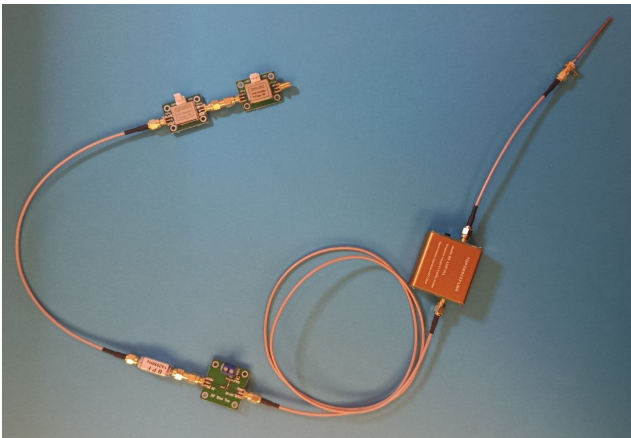
5. Connect the two amplifiers (2) to each other using adapter (8).
6. Connect the SDR module (5) to the output of the second amplifier using a 30 cm cable (9).
7. Connect the power supply to the relevant components using the power cable (6) and the portable power bank (7). Use a screwdriver to connect the Bias Tee.



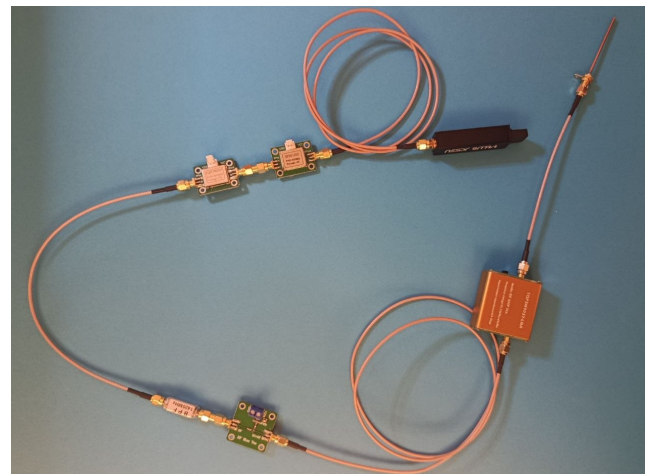
(a) Antenna, amplifier and Bias Tee



(b) Filter and amplifiers



(c) Intermediate assembly stage



(d) Connecting the SDR module

Figure 13. Step-by-step assembly of the receiving chain for 21-cm line observations

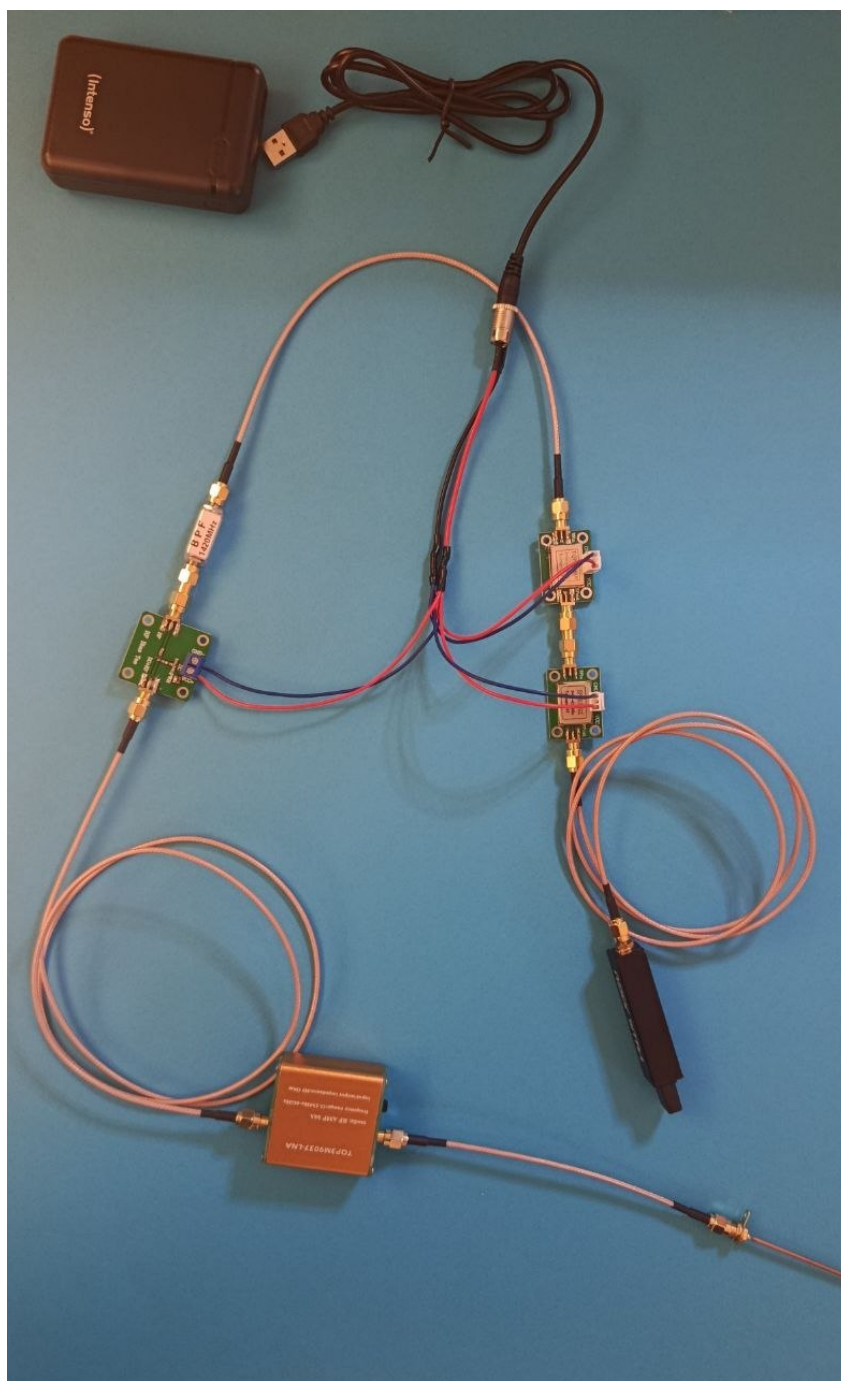


Figure 14. Fully assembled receiving chain for detecting the 21-cm line

6. Calibration and Basic Checks

Before starting any observations, carry out the following checks:

1. **Antenna conductivity check.** Using a multimeter, verify that all conductive parts of the horn antenna are in electrical contact.
2. **Mechanical stability check.** Make sure the antenna is securely fastened to the mount and tripod.
3. **SMA connection check.** All connectors must be tightly screwed on, but without excessive force.
4. **Component sequence check.** Carefully verify the placement of the Bias Tee, filter and amplifiers.
5. **Power supply check.** Make sure all active components that require power are connected correctly.

Tip: If the signal is weak or absent, point the antenna towards open sky, away from buildings and metallic structures that may reflect or absorb the signal.