



Electronics & RF technology hands-on training done at the JINR University Centre

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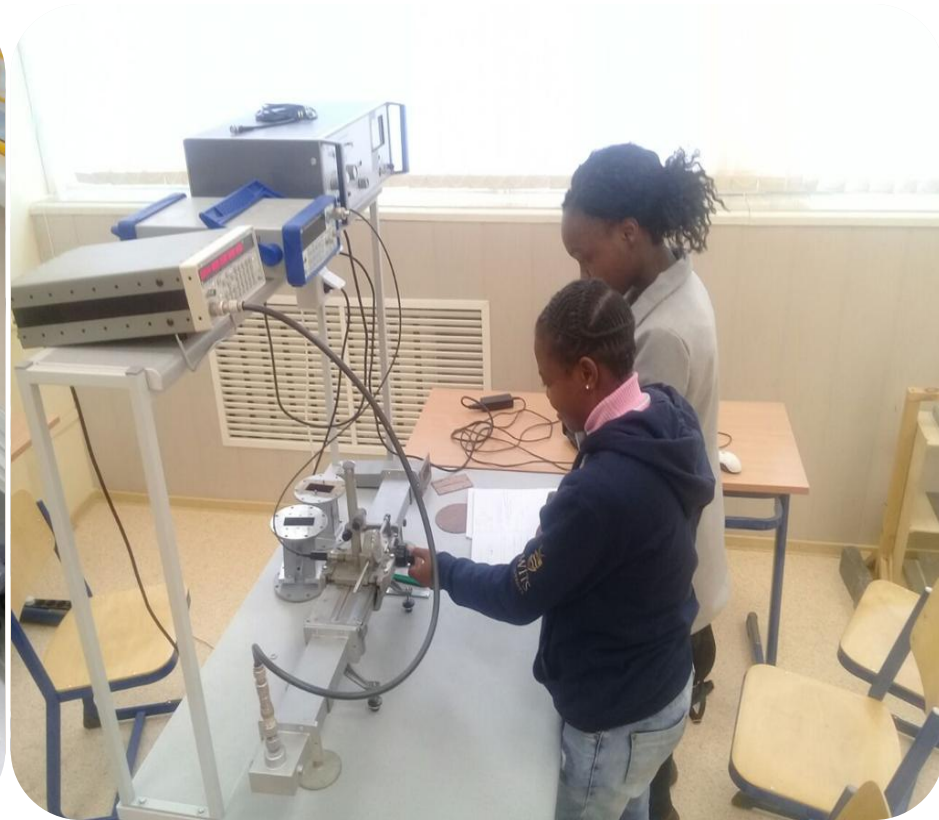
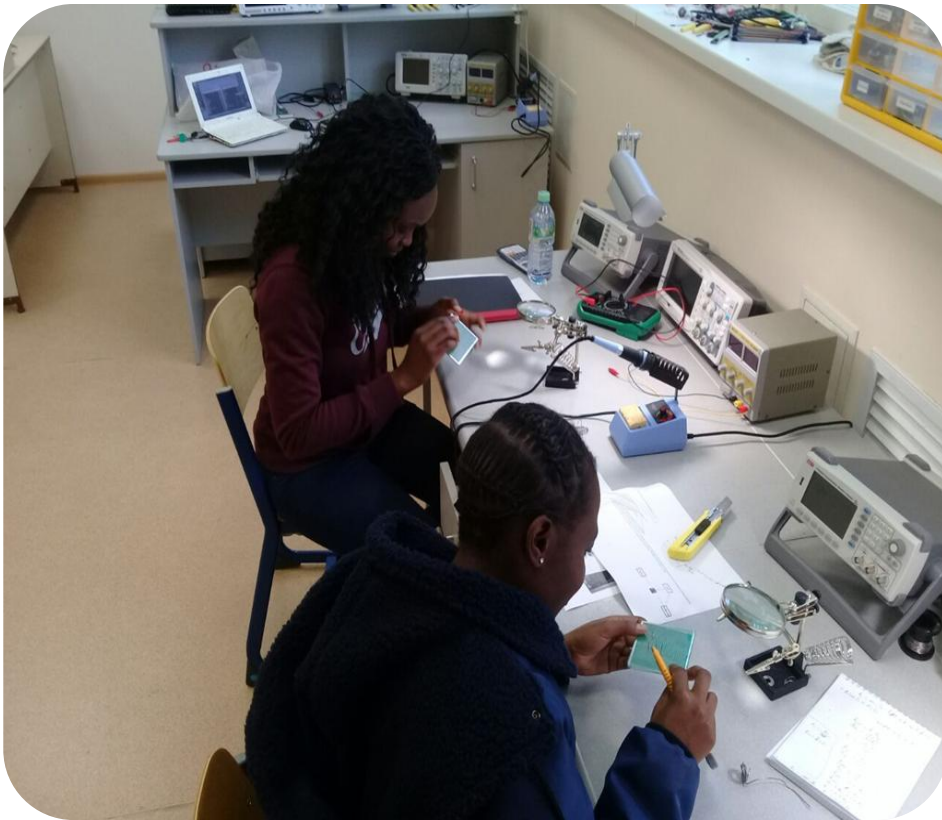
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Aim

- To obtain basic hands skills on electronics and radiofrequency.



Introduction to measuring devices

Multimeter



Generator



Oscilloscope



Power supply



Soldering equipment



Measuring probes

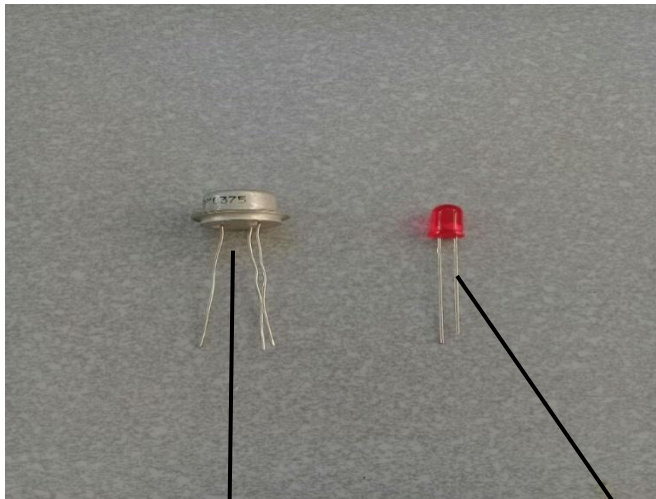


Basic radioelement

Resistors

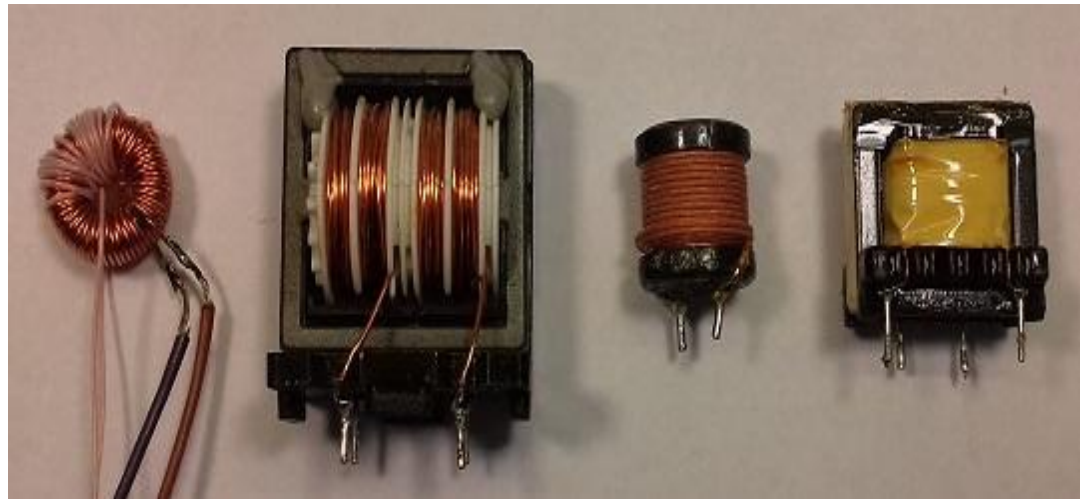


Capacitors



Transistor

Diode



Inductance

High- and low-pass filters

- Electronic filter - instrument for extracting wanted components of the electric signal spectrum
- LPF and HPF are built on basics of the RC circuit, and they are voltage dividers.
- Power supply uses LPF (no HPF), and HPF is used at the output of generator.

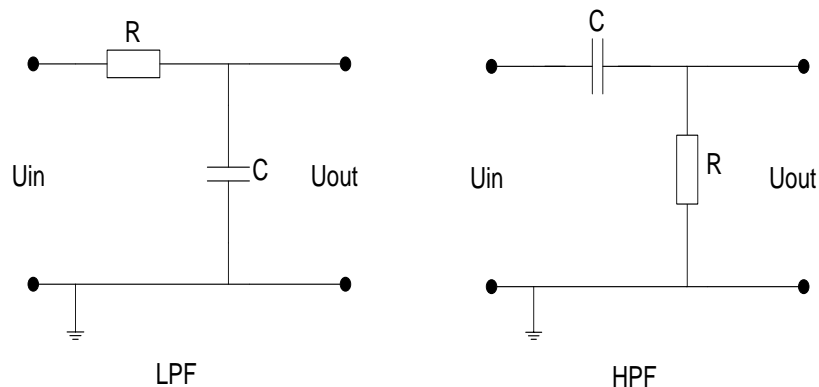
Formulas used to calculate L-shaped LPF

$$X_c = \frac{1}{2\pi f_c C}$$

$$R_{total} = R + X_c$$

$$U_{out} = \frac{U_{in} \cdot X_c}{R_{total}}$$

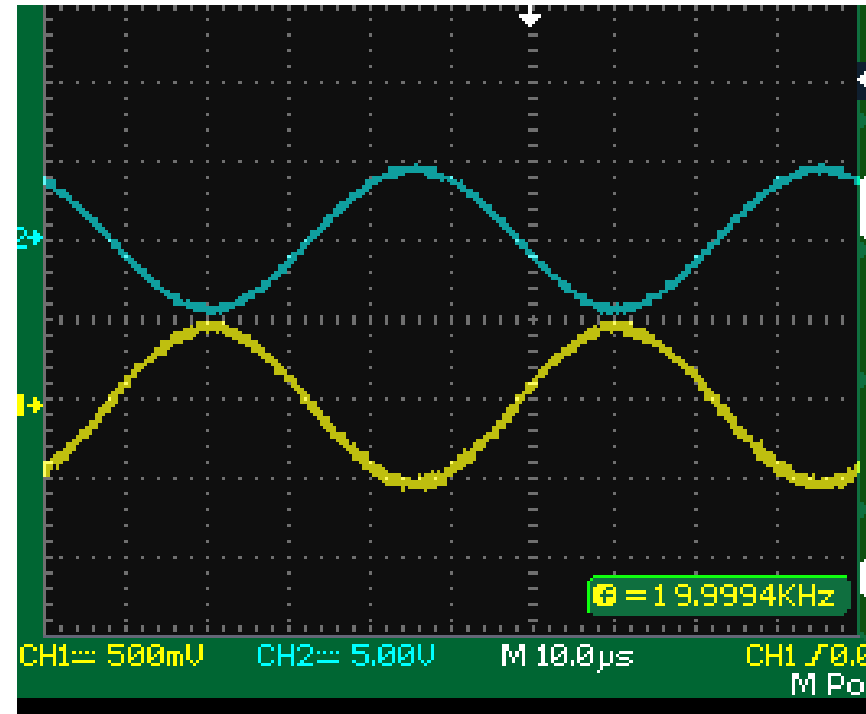
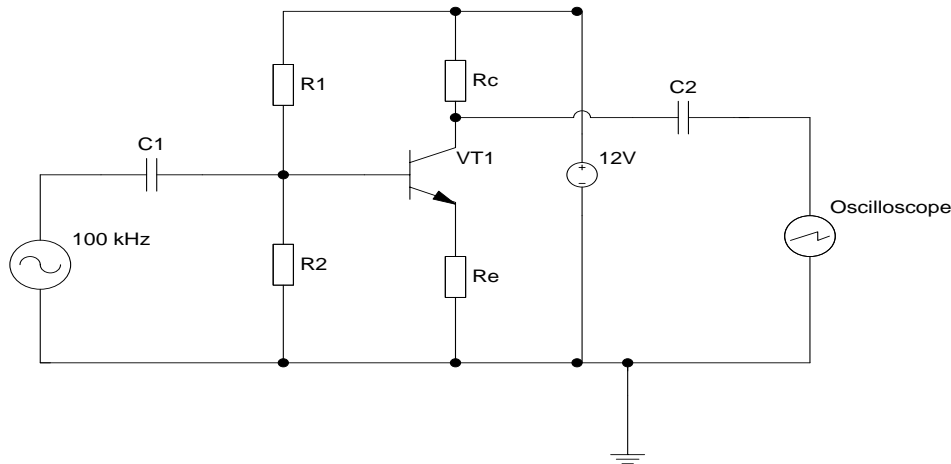
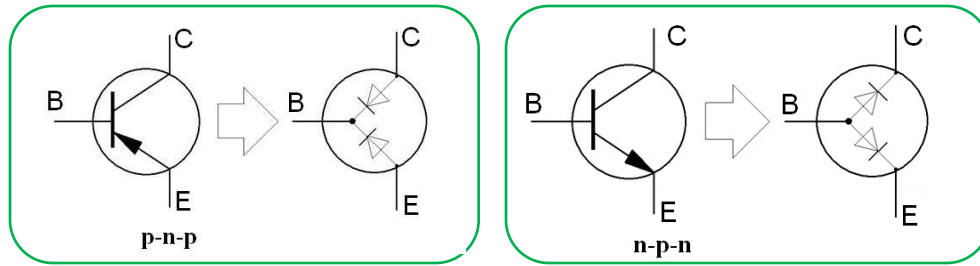
$$\frac{U_{out}}{U_{in}} = 0.7$$



Transistor amplifier cascades

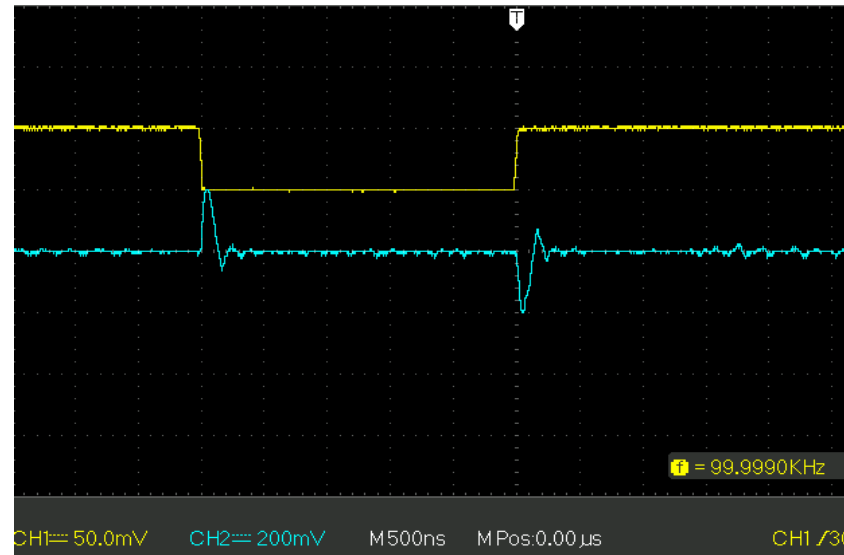
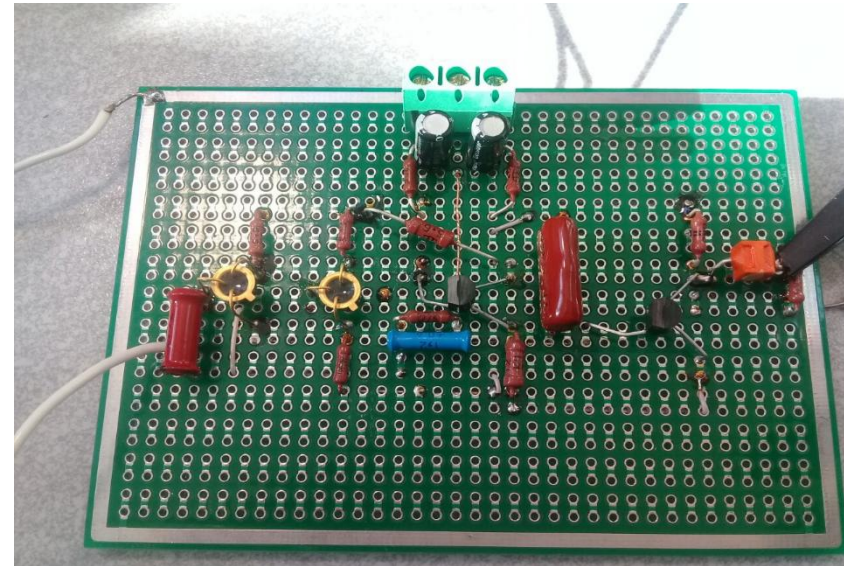
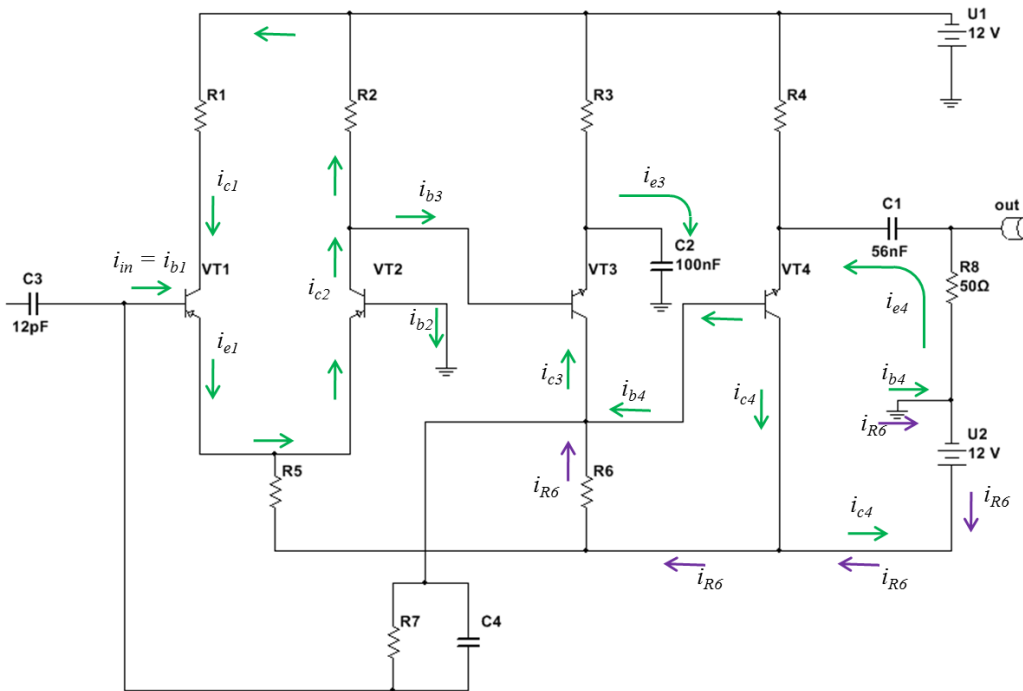
Transistor - electronic component able to amplify input signal power using external power supply.

Bipolar transistor symbols



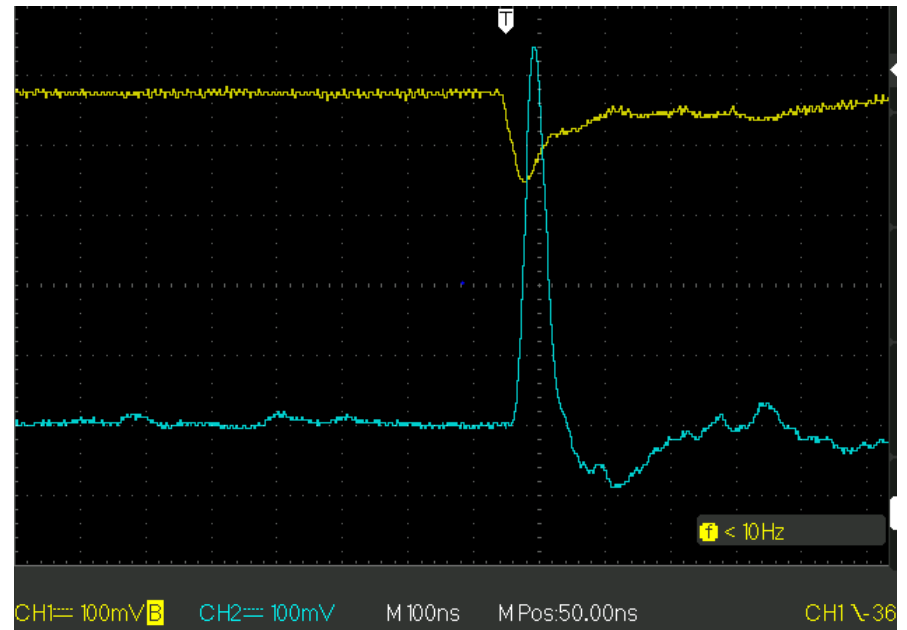
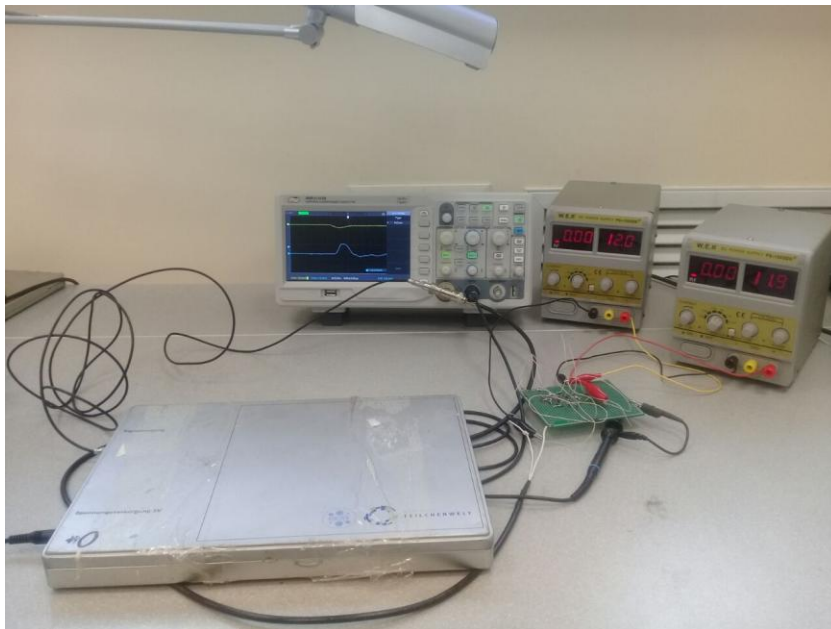
Charge-sensitive preamplifier on bipolar transistors

- Preamplifier - preliminary amplifier that receives a signal (for example, from a detector), increases its power and transfers it to the main amplifier.



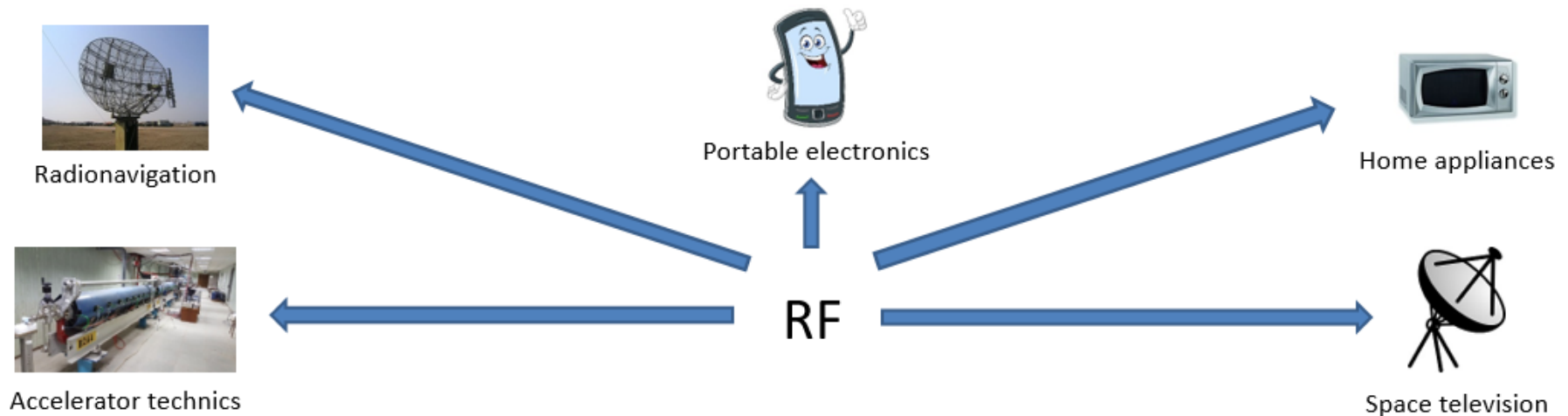
Applications

- Preamplifiers are used in detectors (scintillation detectors, semiconductor detectors, gas-discharge drift detectors, proportional chambers, etc.)
- Amplifier is used in Sound, light, electric motors, etc.



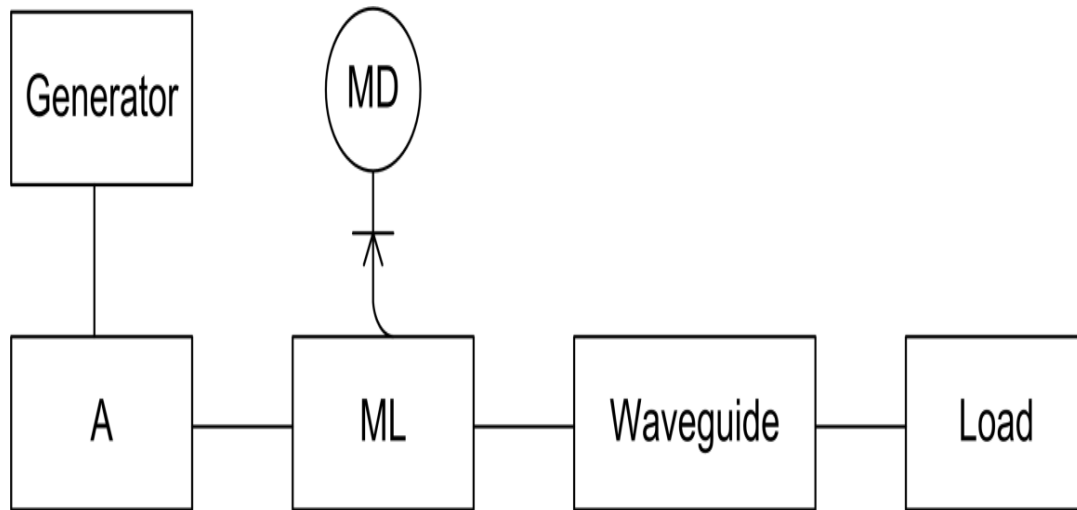
Introduction to microwave technique

- There are many branches where this technique is used. For example, communication, navigation etc.
- In JINR many applications used for accelerators (For heating content in the iron source, and other use it to accelerate iron).



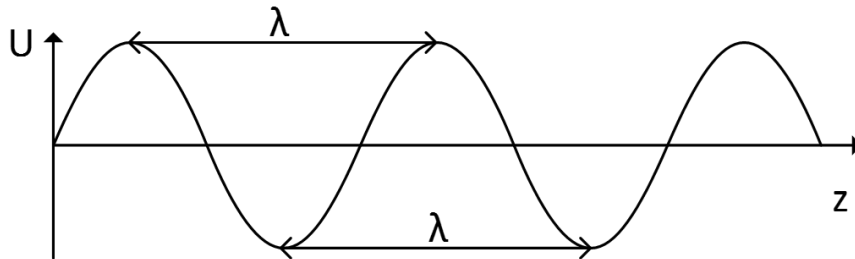
Microwave wavelength

- The wavelength is small, we can measure it and be able to see the real signal using probe with detector.



Work Sequence 1

- Measured and calculated full wavelength in real waveguide.
- Compared the calculated results with the measured one and we had the same results.



$$\lambda_0 = \frac{c}{f}$$

Free space wavelength

$$\lambda_{cr} = \frac{2}{\sqrt{\frac{m^2}{a^2} + \frac{n^2}{b^2}}}$$

Critical wavelength

$$\lambda_W = \frac{\lambda_0}{\sqrt{1 - \frac{\lambda_0^2}{\lambda_{cr}^2 \epsilon \mu} \sqrt{\epsilon \mu}}}$$

Transmission line

Work sequence 2

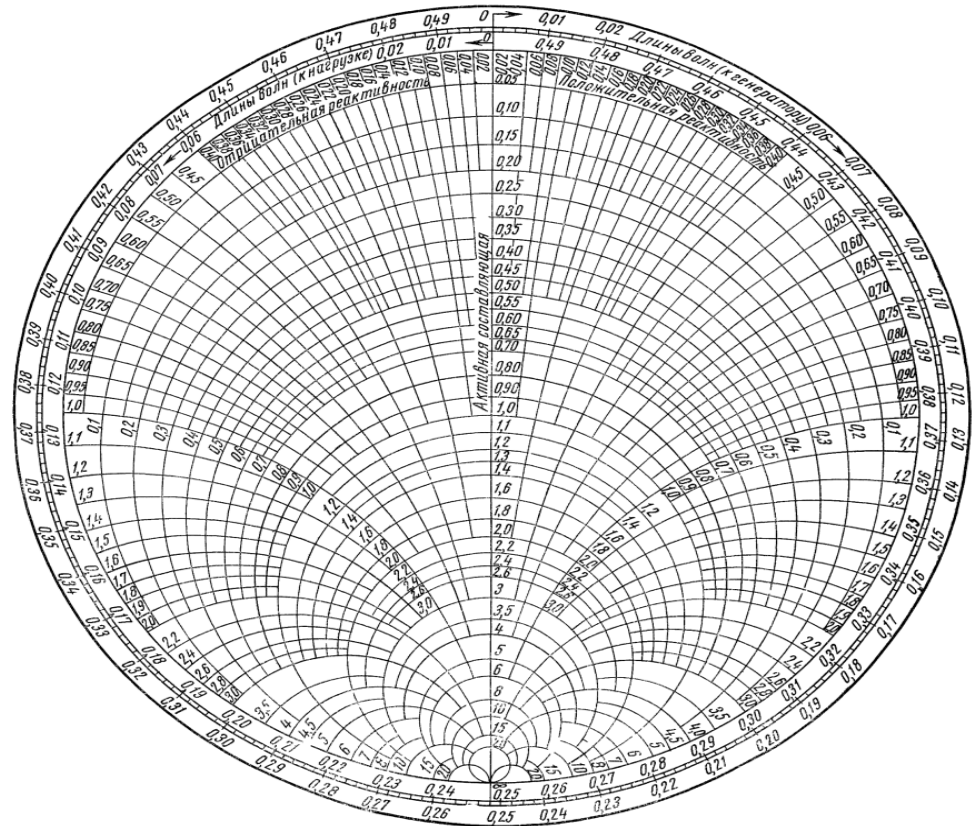
- It is very important to always have good matching between generator, transmission line and load.
- For matching we calculated standing wave ratio coefficient.
- For calculating the standing wave ratio we measured current and calculated electric field strength which is proportional to voltage.

$$\text{SWR} = \frac{E_{max}}{E_{min}} = \frac{H_{max}}{H_{min}}$$

SWR for matched load is approximately 1 since all power from generator goes to the load

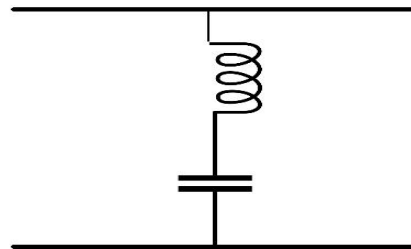
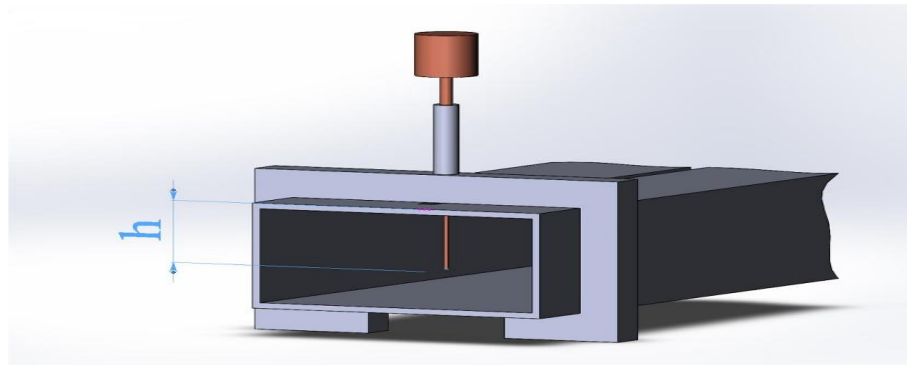
Work sequence 3

- In this work we only calculated active and reactive part of impedance.
- We used smith chart to find different parameters of microwave signal.



Work sequence 4

- Reactive dowel is a metal rod with the r radius inserted to the waveguide through the wide wall.
- In RF techniques the reactive dowel is used for the narrow band matching.



Conclusion

- We obtained various skills in electronics and RF (microwave) which includes working with measuring devices, electronic components, and soldering.
- We learned how to assemble circuit scheme by using soldering iron, solders and electronic components on a pc board.
- We learned how to connect circuit(especially amplified circuit).
- For radiofrequency we only focused on microwave ranging between 300MHz to 300GHz.
- We understood matching between generator transmission line and load.
- We observed and measured wave behavior in the waveguide using different loads.

THANK YOU



Спасибо