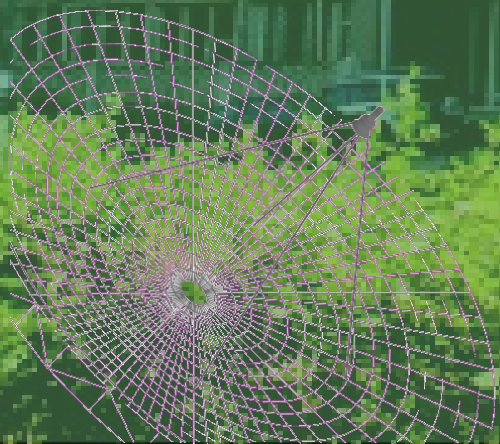




DIGITAL SIGNAL PROCESSING IN MILLIMETER BAND FMCW-RADAR

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A.S. Vasilev, I.V. Popov



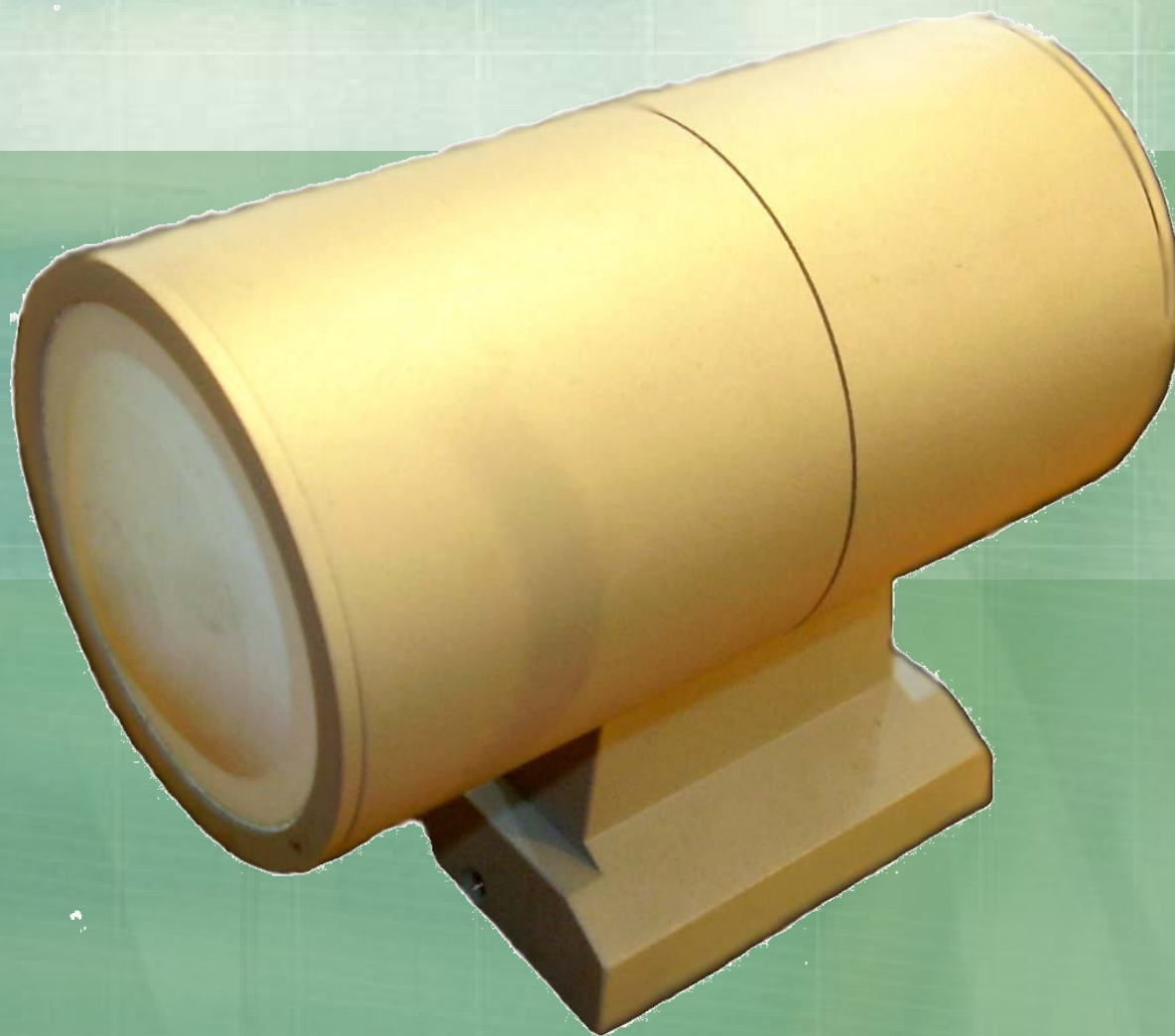
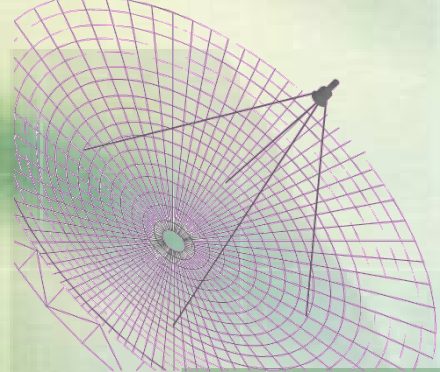


Fig. 1 - Physical configuration of the millimeter band FMCW-radar

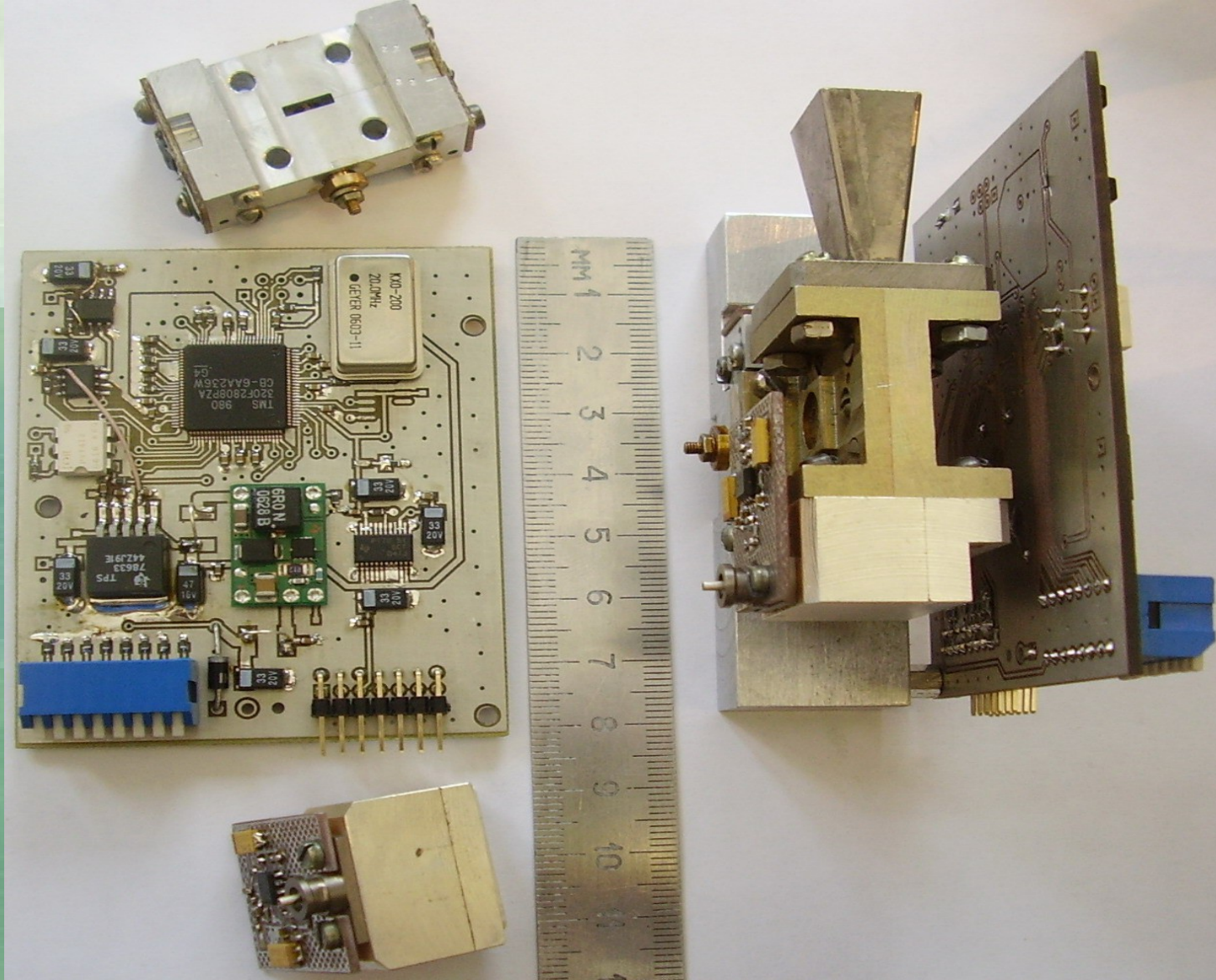
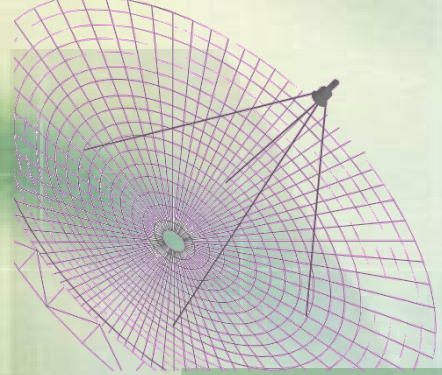


Fig. 2 - Physical configuration of the millimeter band FMCW-radar



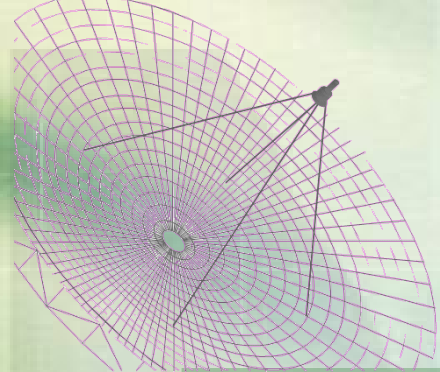
VCO – voltage-control oscillator
DAC – digital-to-analog converter
ADC – analog-to-digital converter
SPI – serial peripheral interface
SCI – scalable coherent interface
DSP – digital signal processor
1 – horn-lens antenna
3 – mixer

**Fig. 3 - Block diagram of the frequency-modulated
continuous wave radar**



ADC – analog-to-digital converter
RAM – random access memory
ROM – read-only memory
VCO – voltage-controlled oscillator
SPI – serial peripheral interface
FFT – fast Fourier transform
DSP – digital signal processor
DAC – digital-to-analog converter

Fig. 4 - The DSP core block diagram fragment 5



F_d – output mixer difference
frequency

T_m – modulation period

F_{d1} – distance-insensitive
frequency



**Fig. 5 – Operating principle of the frequency-modulated
continuous wave radar**

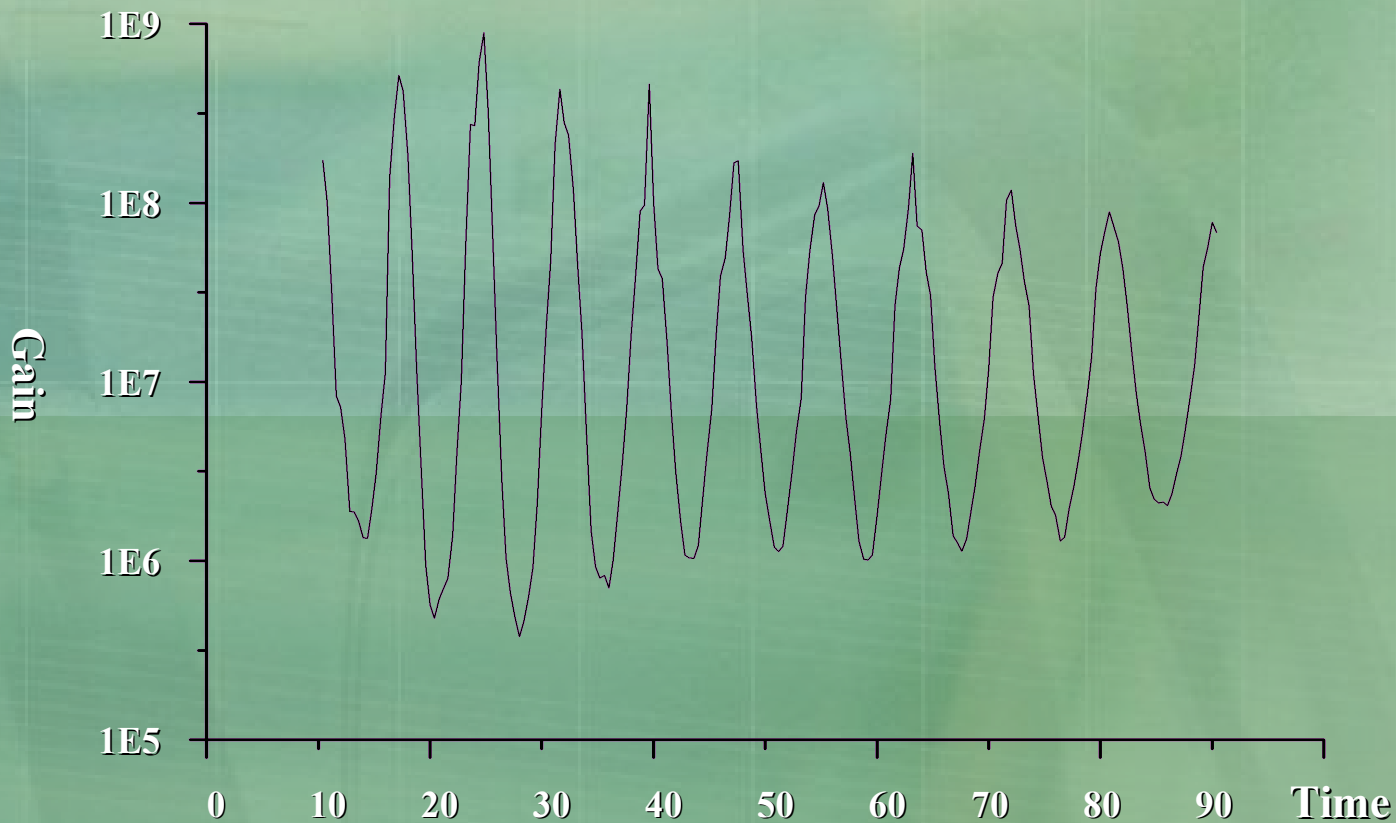
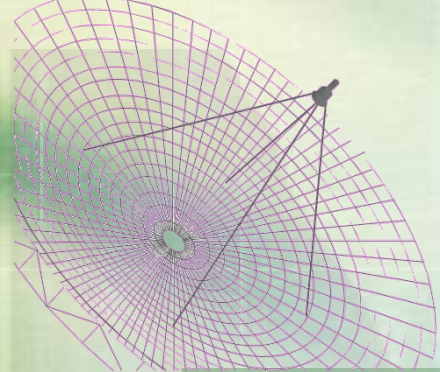


Fig. 6 – The difference frequency F_d signal

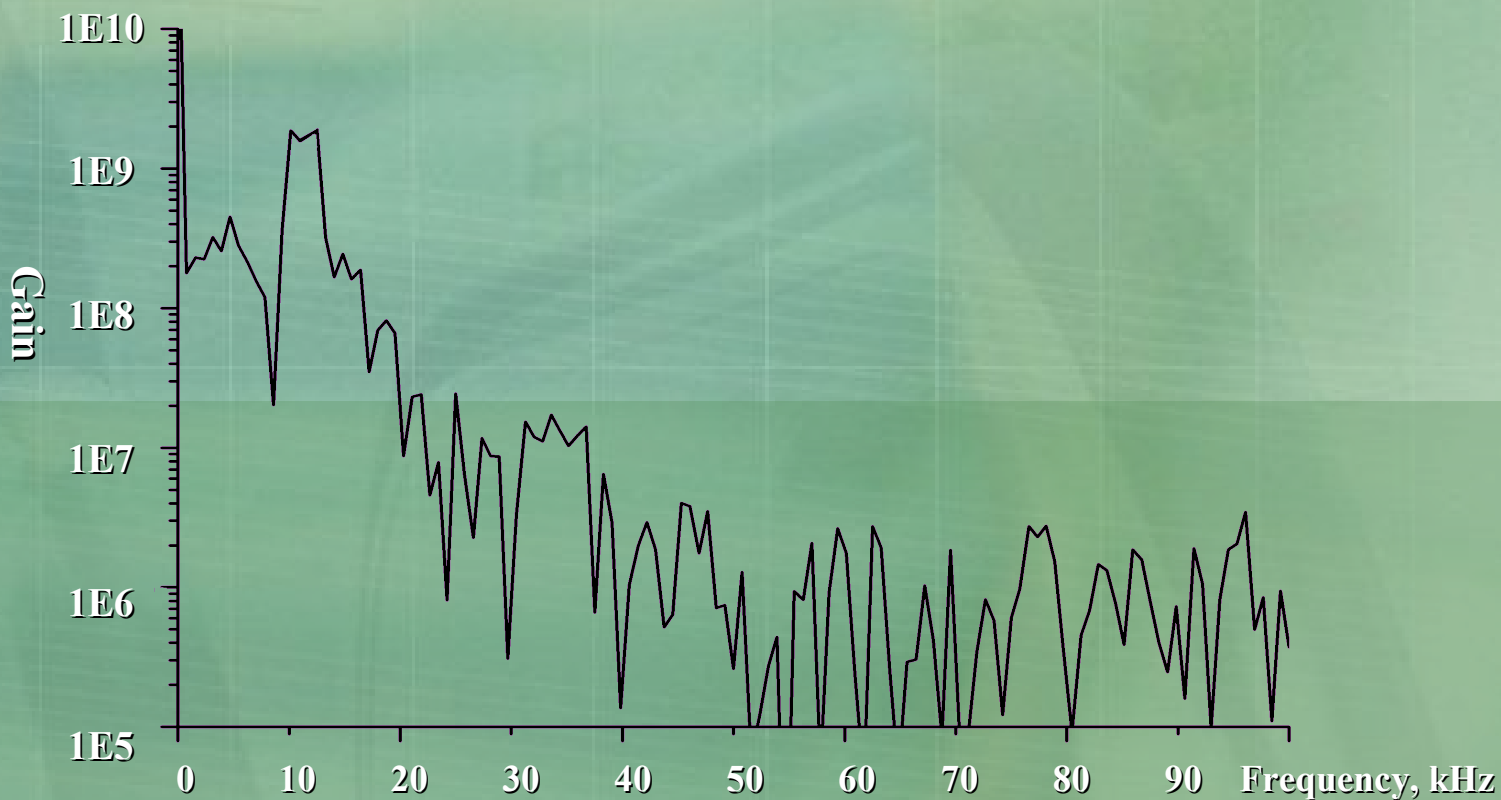
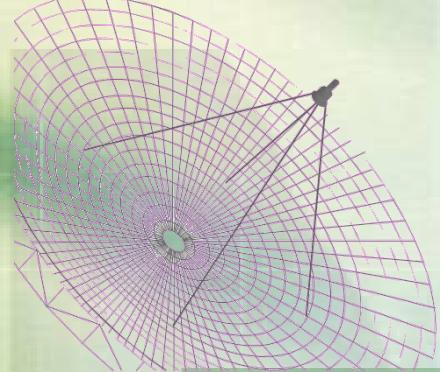


Fig. 7 – Digital processing free spectrum of the difference frequency

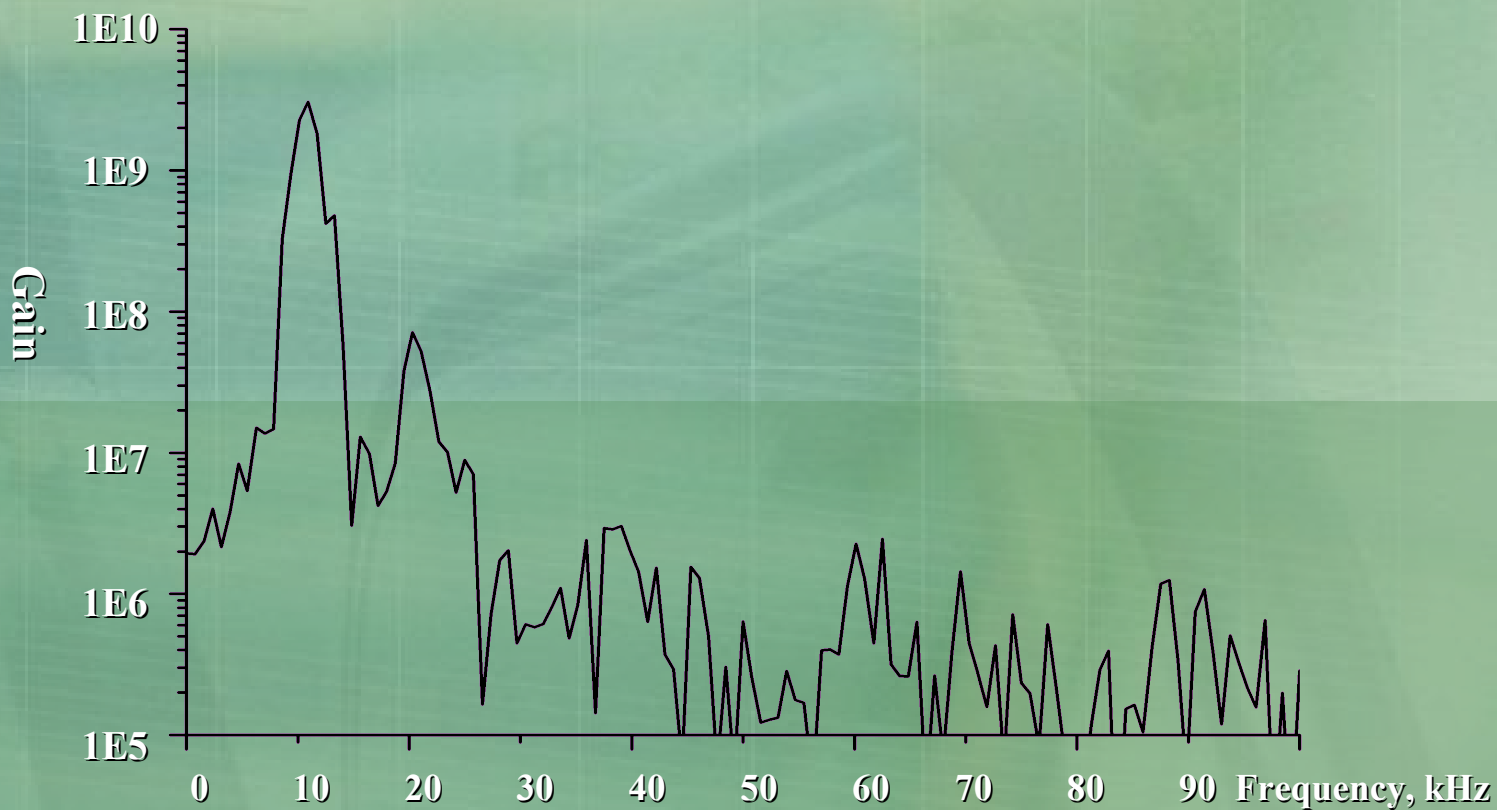
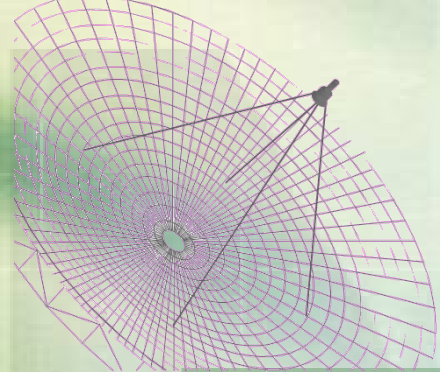


Fig. 8 – Digitally processed spectrum of the difference frequency

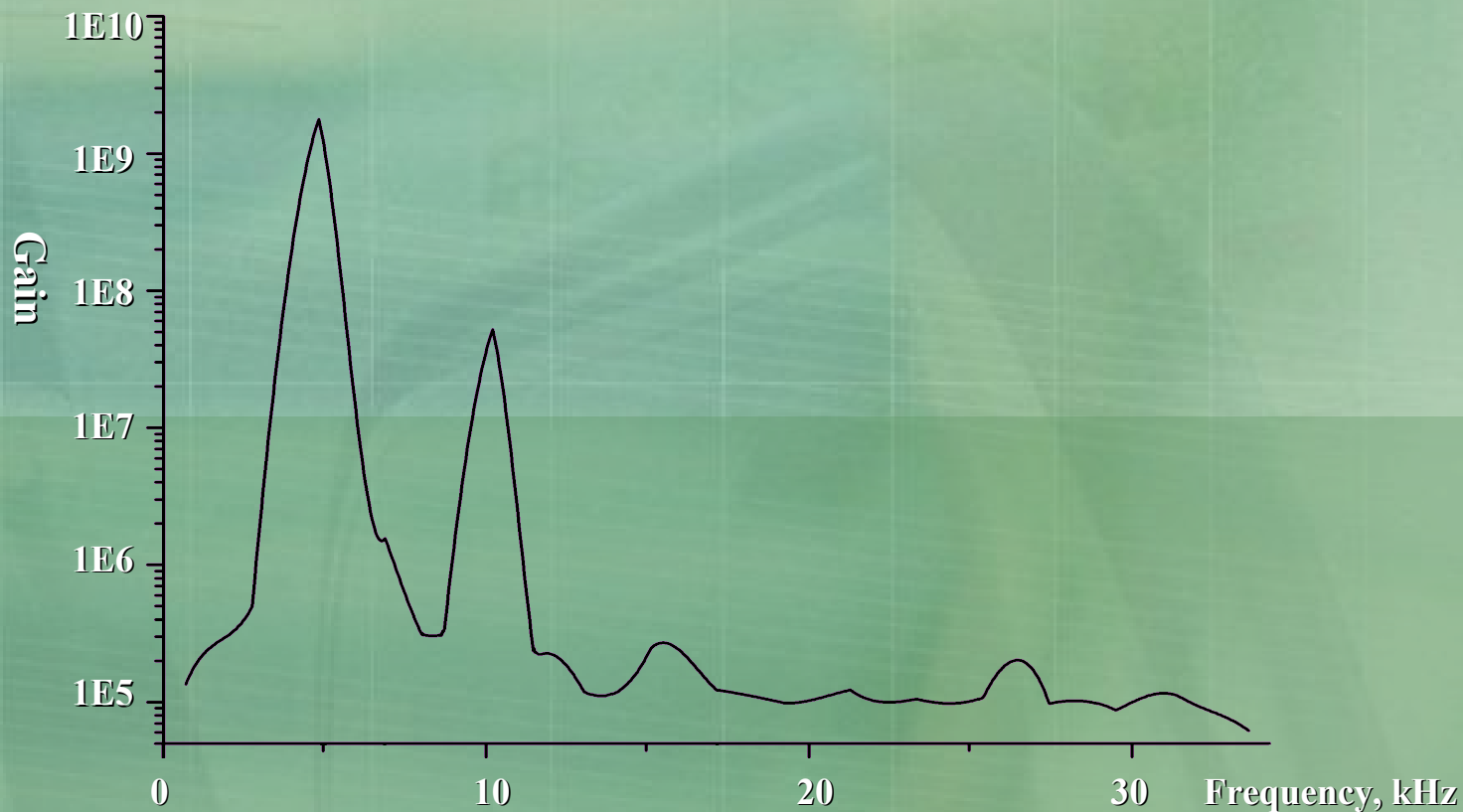
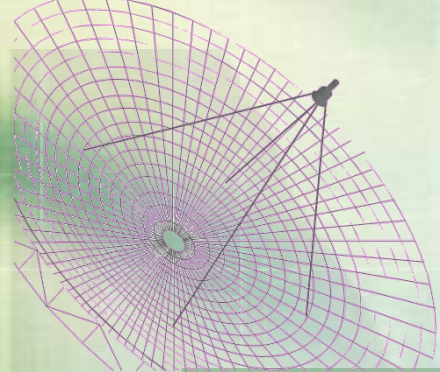


Fig. 9 – Digitally processed and multiply integrated spectrum of the difference frequency



- Initialization – peripheral installation-specific settings
- New “saw” setting – the next digital code delivery
- ADC sampling – input signal digitization and data array forming into the DSP memory
- High-pass filtering – signal responses improving digitally processing
- DFFT – discrete fast Fourier transform
- Analysis of results – analysis and decision making
- Results displaying – Fourier spectrum displaying onto the indicating device

Fig. 10 – Operating algorithm



Resume

The digital signal processor appliance to shape and process signals in the FMCW-radar lets one:

- improve the spectral responses by the optimal form shaping of the oscillator frequency modulation signal to the calculated ones;
- compensate the oscillator and transceiving path amplitude-frequency characteristic ripples;
- realize the digital filtering and fast Fourier transform for the sensed signals;
- implement the in-sync mode of the returned signals receiving;
- increase the resolvability over the distance owing to output signal spectrum processing.