# Technical parameters

**The Contracting authority requires supplying the equipment which complies with the following minimum parameters:**

**Delivery specifications:**

The delivery will include cloud profiler (hereinafter the **"radar"**) located at the IAP observatory IAP Milešovka. Radar must be operated in a fully unattended and remotely controlled regime from the IAP workplace in Prague.

As part of the radar the uninterruptible power supply (UPS) is required, allowing in case of the electricity failure to maintain operation of the radar and the necessary related technologies (eg. transmission line) for at least 30 minutes.

The protection against lightning must be part of the delivery either in passive or active implementation.

The delivery will include computer server to run Contractor applications installed at observatory Milešovka; a set of recommended spare parts for radar; further supply of appropriate computer hardware and software for radar - to monitor and control the various components of the radar, radar data generation and software for signal processing and evaluation of radar measurements; installation and testing work (installation of the radar station, acceptance tests, software configuration, supply of the appropriate documentation for radar; appropriate training of radar operators).

Further specifications of the public tender are specified lower in technical parameters and in a Contract draft, which is annexed to this tender documentation.

**The following technical conditions of the equipment are considered as minimum requirements that must be fulfilled by the equipment. In the event that the bidder will offer equipment that does not conform to the technical conditions below or does not contain all the components described below, the bidder will be excluded from the tender on the basis of failure to comply with the terms and conditions specified by Contracting authority tender.**

**The Contracting Authority requires that the equipment was brand new, fully functional and complete.**

**Technical parameters:**

**A) The radar system - general characteristics:**

* Delivered must be fully doppler radar system operating in the Ka-band (24-40 GHz) or W-band (75-110 GHz) operated in pulse mode or FMCW;
* Radar must allow simultaneous polarimetric measurements (STAR ​​- Simultaneous Transmission And Reception) or LDR (Linear Depolarization Ratio - the signal is transmitted in only one polarization, accepted both polarizations) mode;
* Radar must perform digital signal processing starting from the intermediate frequency;
* Contract authority requires a digital receiver and signal processing systems from the same manufacturer;
* Data output and consumer products must be in digital form;
* The technical parameters of radar must provide the detection of clouds and vertical profile of hydrometeors above the radar and the evaluation of fall velocity of hydrometeors to a height of at least 15 km.
* The supplied equipment will meet the EMC and its operation will not disturb experimental devices, digital data collection and microwave links located at the observatory Milešovka.

**B) Construction of the radar system:**

* All components of the device must be brand new and their age should not exceed 12 months at the date of the completion of acceptance test SAT. Contract authority expressly notes that prototypes and remanufactured components of the older equipment are not permitted;
* Maximum input power of all equipment ensuring 24-hour operation of the radar cannot exceed 3 kW;
* Equipment must be adapted to the supply network, which comply with DIN EN 50160. The supply voltage is 230 V 50 Hz, single phase connection;
* All electrical equipment must meet the following legislation or regulations;
	+ Act no. 205/2002 Coll., (on technical requirements for products, as amended), and Government Regulation no. 616/2006 Coll., (on technical requirements for products relating to their electromagnetic compatibility);
	+ EN 62305 (for lightning protection);
	+ Government Regulation no. 106/2010 Coll. (On Non-Ionizing Radiation Protection);
* Total size of all radar boxes may not exceed 2000 mm in height, 2000 mm in width and 2000 mm in depth;
* Radar cabinets and installed technology must meet the operating temperature range of -10°C to + 35°C and humidity of 10% - 90%;
* Radar must be constructed as a modular system so that it will allow future upgrade of the parts, at least the antenna, transmitter, receiver, signal processing and PC for processing;
* The connectors must be differentiated according to the key so that they cannot be connected by mistake;
* The connectors must be capable of withstanding repeated engagement and disengagement (in the framework of service requirements) without damage and degradation;
* All connectors and measuring points must have granted access, which must be described in the technical documentation;
* All components of radar including connectors, cables, circuit boards, etc. must be clearly identified and described. Client requires that the labels of all components are in English;
* After an interruption of the power supply system shall allow automatic sequential switching (soft start) and start of operational measurement;
* Safety precautions - all the equipment which could be damaged by inappropriate handling or which endanger the health of operators, must include security protection (safety interlock);
* Noise level of radar cabinets should not exceed 70 dBA when measured one meter in front of cabinets. Contractor at SAT performs the necessary measurements and prepares a report of the measurement;
* Radar must be designed for continuous 24-hour operation;
* Manufacturer's recommended maintenance shutdowns must not cause outages of radar measurements exceeding 1% of the total operational time of measurement, i.e. maximum of 7 hours per month;
* The contractor must guarantee availability of spare parts for at least 5 years from the signing of the agreement;
* The contract authority requires to deliver a service tools that are required to access all measuring points and forced replacement of any components;
* Radar must contain a "network power switch" which enables remote switching on and off of critical blocks of the radar via commands transmitted over a network.

C) Transmitter:

* The transmitter must be of type magnetron with solid state modulator, or semiconductor;
* RF magnetron must have a minimum life time of 50,000 hours;
* transmitting frequency must be in the Ka-band, adjustable in the range 35 to 37 GHz, or in the W band in the range of 93 to 97 GHz;
* The pulse transmit power must be at least 25 kW, the stability of the transmitted power must be 0.2 dB in the normal operating conditions and the time interval of one month, in case of FMCW solution the transmitter power must be at least 0.5 W;
* The length of the pulse transmitter pulse mode must be within the range of 150 to 300 ns;
* Repetition rate (pulse repetition frequency, PRF) for pulse mode must be user-adjustable from a minimum of 3-10 kHz, switching frequency must be possible by software settings within the measurement scenarios without hardware intervention;

D) Antenna:

* The antenna must be parabolic with a gain of at least 40 dBi;
* beam width should be within 1 °;
* Cross-polarization of the antenna must be greater than 35 dB;
* The Contractor shall define a safe distance for work and the incidence of people from all devices that emit radiation exposure;
* The Contractor shall provide the diagram of supplied antenna radiation characteristic parameters measured by a certified company;

E) Receiver:

* Radar delivery must contain a digital receiver (full digitization to an intermediate frequency, at least 14 bit A / D converter);
* The receiver must allow polarimetric measurements;
* Dynamic range shall not be less than 99 dB and linearity better than 0.2 dB;
* The receiver must be low noise, the noise figure maximum 2.5 dB;
* Time stability calibration of the receiver should not exceed 0.2 dB at normal operating conditions and the time interval of one month;
* Overall phase stability of radar system (including a transmitter, receiver and digitalization) must be better than 0.6 ° rms.

F) Signal Processor:

* Signal processor must ensure evaluating at least the following quantities:
	+ uncorrected reflectivity of both polarizations
	+ radial Doppler velocity V;
	+ the width of the Doppler spectrum speed W;
	+ a signal quality index SQI;
	+ linear depolarization ratio LDR;
* Radial resolution of data must be at least 50 m;
* Number of averaged samples (pulses) for evaluating the radar parameters in the radar beam to be adjustable at least in the range 20-512;
* Data resolution of output data must be at least 8bit (256 levels), reflectance data in increments of at least 0.5 DBZ, radial velocity data should linearly cover Nyquist range of velocity.

G) PC SW and HW:

* PC SW and HW must be delivered at least in the following configuration:
	+ a computing server with installed software for manual (interactive) control and monitoring radar and software for administration and management of regular measurement and processing / sending of measured data;
* SW licenses for remote manual (interactive) control and monitoring of radar
* The part of delivery must be the installation media and instructions for installing the software.
* SW and HW must be able to operate in current configuration of Contract authority data networks.

H) Software for both local and remote manual (interactive) control and monitoring of radar:

* SW for manual control and monitoring of radar must allow at least the following functions:
	+ switching off and on of individual parts of the radar;
	+ setting of measurement parameters and signal processing;
	+ display of actual measured data;
* Logging of all errors must be made in text files. Description of the format of these log files must be available.

I) Software for the creation of advanced products:

* Software for creating advanced products must allow at least the following functions:
	+ processing of data from the radar;
	+ the possibility of generating products from all evaluated radar measurements;
	+ creation of at least the following products: reflectance versus time graph, doppler velocity of the cloud particles in dependence on time;
	+ LDR versus time graph;

J) Backup Power Supply UPS:

* The UPS must be of on-line type;
* The UPS must be able to provide 30 minutes of running radar and all the equipment necessary for processing and distribution of radar data;
* Information on the status of the UPS must be available on a data interface via SNMP protocol;

K) Requirements for spare parts for radar:

* set of spare parts for radar must be a part of delivery in the total cost of at least 1.5% of the total contract price;
* The contractor is obliged to specify a set of spare parts in the Appendix. 1;
* The supplier is obligated to assemble a set of spare parts with regard to the MTBF of individual parts.

L) Documentation Requirements:

* Contracting authority declares that all documentation for the device must be in English and delivered in printed and electronic form (including schematics). It must contain at least the following elements:
	+ Operator manual - contains instructions and operations necessary for complete control of radar;
		- instructions for basic system settings and data processing and given specific values ​​of important parameters;
		- operation workflow for control of the system and the accuracy of measurements;
	+ Technical manual - containing a detailed description of the individual facilities and their maintenance;
		- description and principle of operation of each functional block;
		- detailed and clear description of electrical circuits, including diagrams, control-measuring points, values ​​and their histories;
		- description of the implementation of the functional blocks including detailed wiring diagrams, in case of black boxes description of the internal functions and definitions of input and output values ​​and variables;
		- description of the installation, setup, operation, operational instructions, periodic maintenance and periodic diagnosis;
		- description of the solution of typical problems;
	+ Software Guide - contains a description of the programs and data algorithms for signal processing, data collection, product formation and control radar;
		- complete description of the features, structures, control environment, flow and organization of data;
		- detailed description of algorithms for data processing;
		- detailed description of the file formats for crude, product, control and auxiliary data so that it can be handled by own software;
		- interface description of individual software modules;
		- in case of modification of the software the documentation must be updated;
* A draft copy of all documentation in both printed and electronic form will be delivered to the Client at least one month before the SAT. The final version of the document in three hard copies and electronic form must be received prior to installing the radar;
* Approval of the documentation will be part of the approval process;
* Contracting authority reserves the right to reproduce the entire technical documentation or part thereof in electronic and paper form for internal use;
* Contracting authority will be entitled to require the update of documentation that occurs:
	+ about the same time as any change in hardware or software;
	+ in the case of its evident inaccuracy or incompleteness, to which the Contracting authority notifies the applicant;

M) Requirements for acceptance tests:

* The Contractor shall ensure the successful completion of acceptance test SAT (Site acceptance Test):
	+ contractor performs all measurements of transceiver and receiver (eg. transmitted power, frequency stability, intermediate frequency stability, stability of local oscillators, dynamic receiver, LNA gain, signal-to-noise ratio, MDS, etc.).
	+ contractor will check the antenna (gain measurement, beam width);
	+ contractor will check the functionality of all software components;
* Part of the SAT acceptance will be a 48-hour trouble-free operation of the radar, simulating normal operating conditions and expected external infrastructure problems (e.g. Power interruption or failure data networks);
* The contractor is obliged to provide a list and description of all basic operations and measurement performed during the SAT in Appendix no. 1.

N) Requirements for Installation:

* The contractor must ensure the assembly and installation of the radar at the observatory Milešovka. The survey of the physical space available for radar installation for the smooth transport and installation of individual components is the responsibility of the contractor. Contracting Authority warns that for the transport of the equipment to Observatory Milešovka only cargo lift with a load capacity of 250 kg can be used and access by persons performing installation is only possible by hike to the observatory.