



Center for the Advancement of Natural
Discoveries using Light Emission

Cooling System of AREAL

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Cooling Laboratory of CANDLE Research Institute

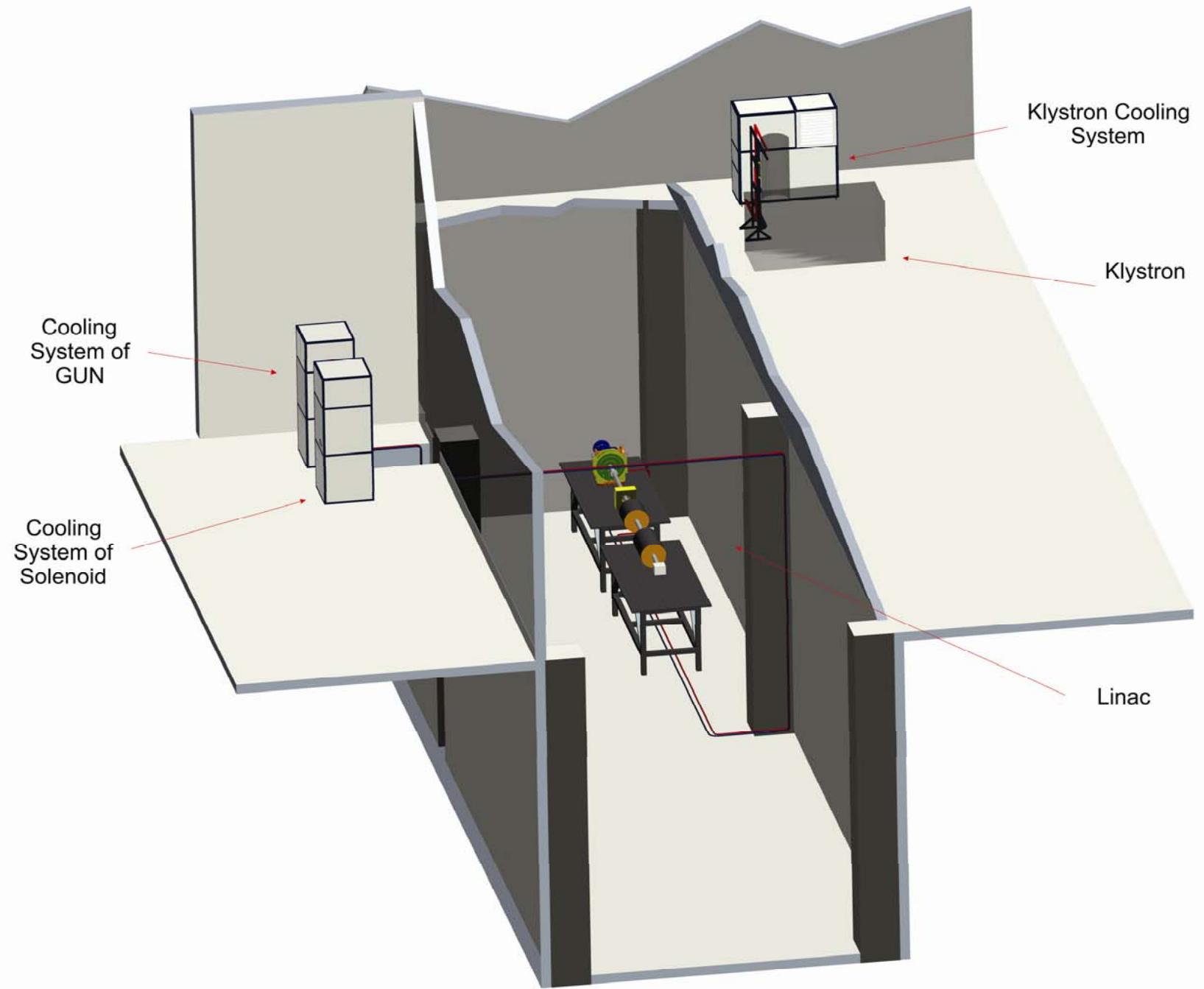
Yerevan 15.07.2013

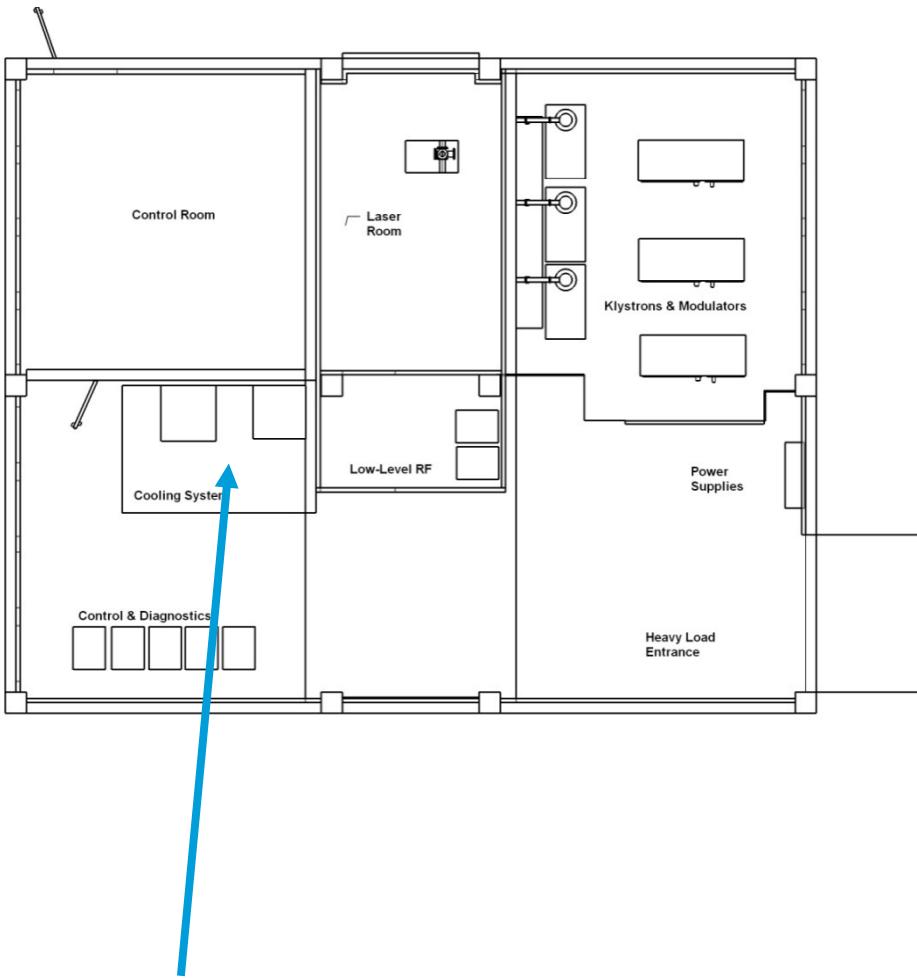
Requirements on Cooling Systems of AREAL

- | Satisfy necessary individual cooling parameters that devices and systems of accelerator possess;
- | Must be a safe, stable and reliable system;
- | High productivity;
- | High automatization;
- | Sustainability;
- | Easy maintenance;
- | Economic efficiency.

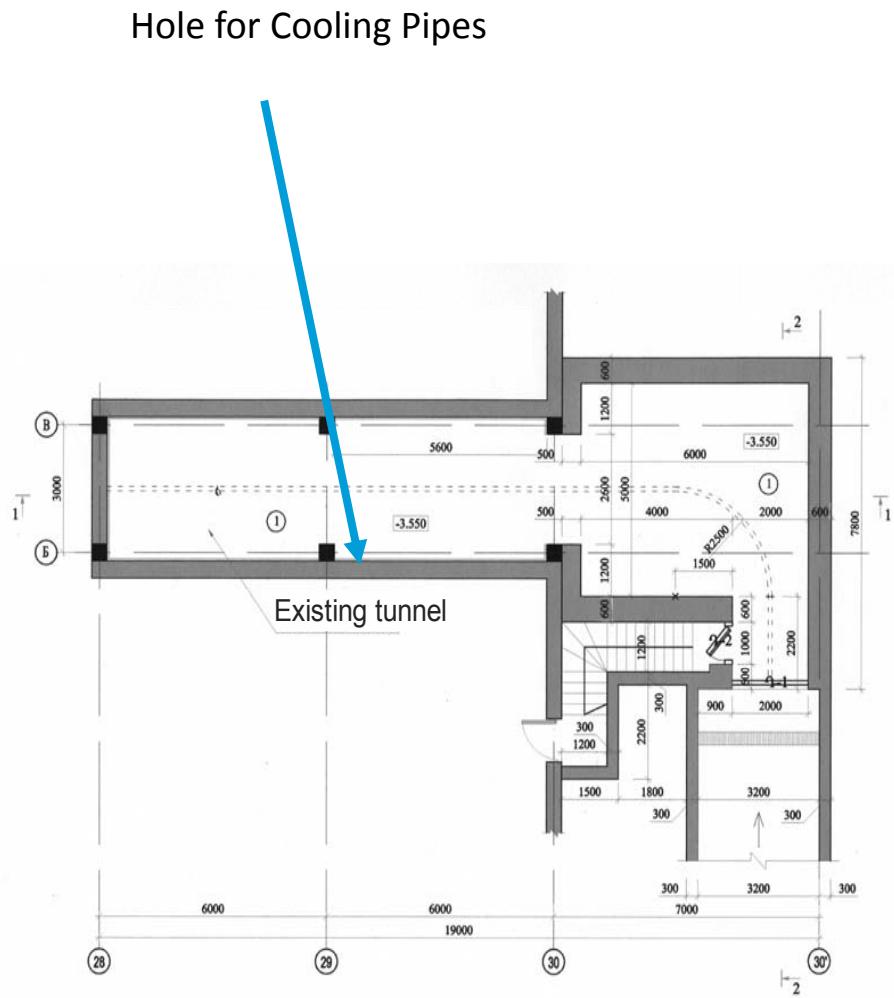
Operation Temperature Accuracy of Devices and systems of AREAL

	Rf Gun	Klystron		Beam Dumps, Magnets
		Resonator	Magnets	
Cooling Capacity (W)	- 500	500 – 1'500		500 – 2'000
Temperature (°C)	30 - 55	30-55		
Temperature stability (°C)	+/-0.1	+/-0.5	+/-1	+/-1
Water Flow rate (l/min)	11	3.64	20.5	2-10
Pressure	Not exceed 4.2kg/cm ²	Not exceed 4.2kg/cm ²		1.5-3 kg/cm ²
Coolant	De-ionized water	Distilled water		Demineralised water
De-ionization level	5.6 MΩ cm	50 kΩ cm		50 kΩ cm

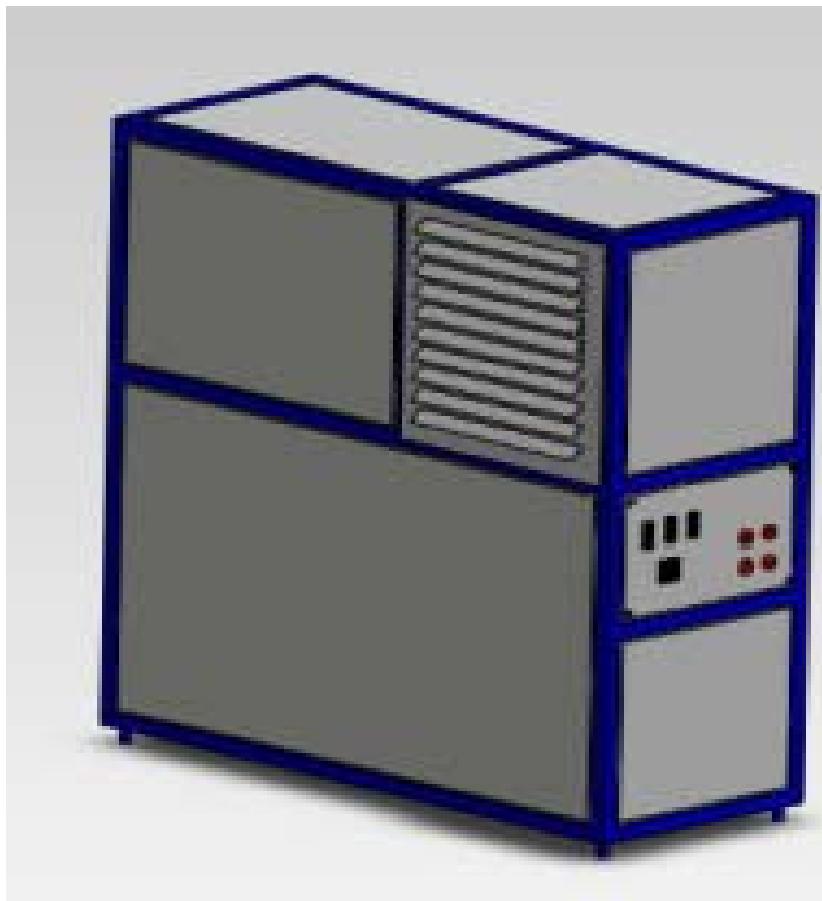




Cooling System Location



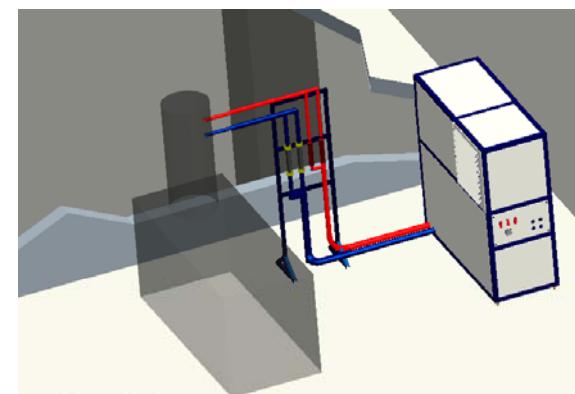
Cooling System of AREAL Klystron



3D Model of Klystron Cooling System

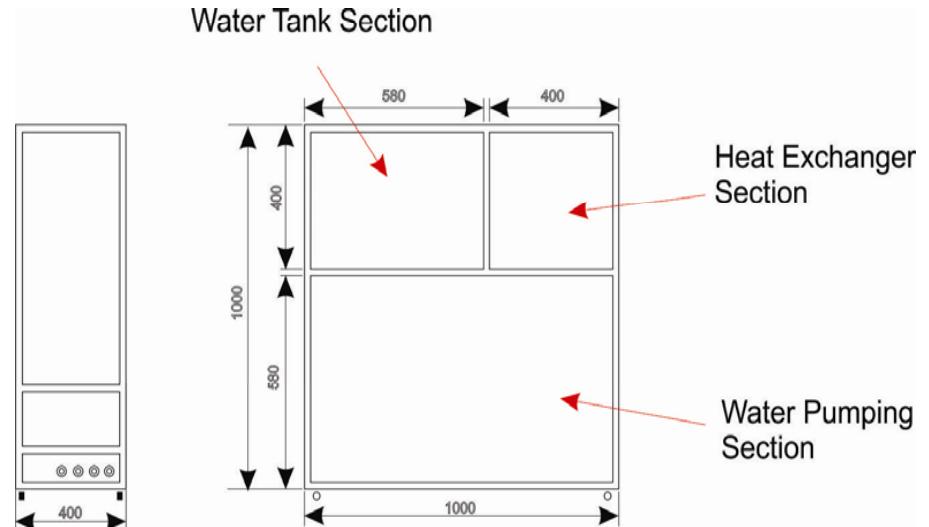
Main Requirements on Klystron Cooling System

Supplied water temperature stability	resonator	+/-0.5°C
	magnet	+/-1°C
Working temperature		30 – 55 °C
Water flow to body		3.64l/min
Water flow to collector		20.5 l/min
Resistance of cooling water		50kOhm cm min
Pressure drop not exceed		4.2 bar



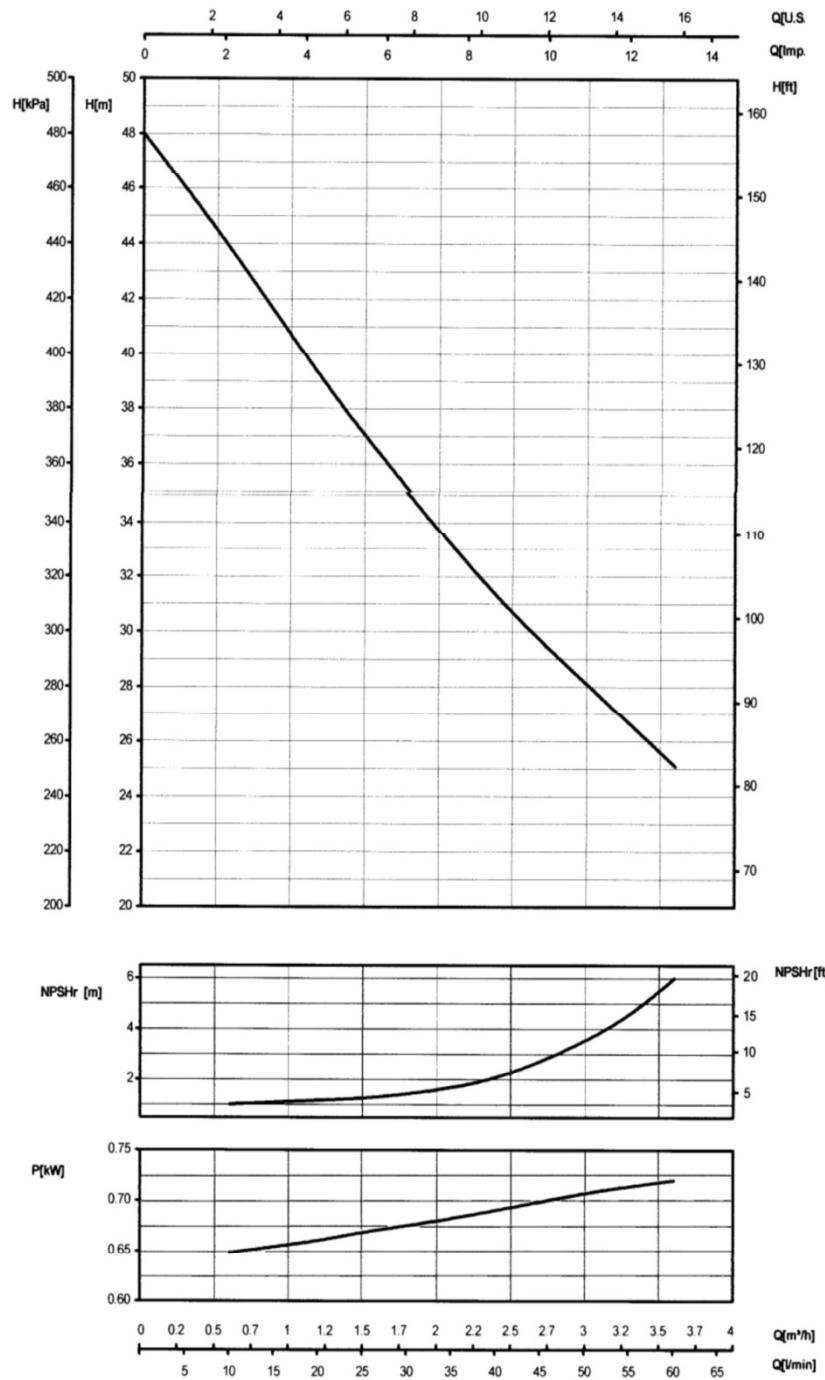


Real Cooling System of Klystron



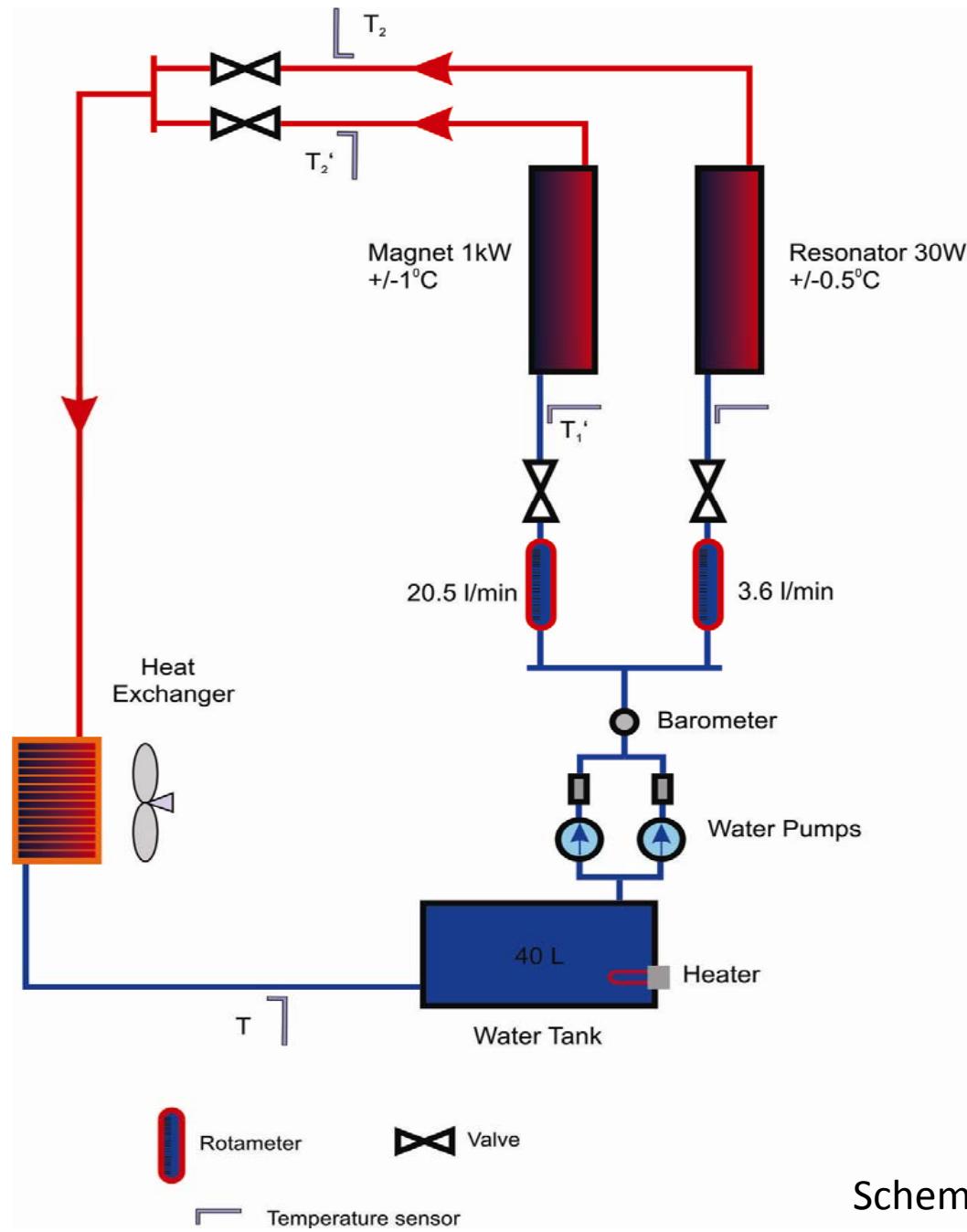
Parameters of Klystron Cooling System

Characteristics	Value
Temperature range	30- 55 °C
Temperature stability	+/- 0.5 °C
Temperature sensors type	Pt100
Coolant	De-ionized water
Water de-ionization range	50,000 to 18,000,000 ohms-cm
Max pressure	3.3 bar
Max ambient temperature	30 °C



Pump Characteristics

Maximum Temperature of pumped liquid	-15 to 50
Maximum Ambient Temperature	40
Maximum working Pressure	6 bar
Capacities up to	3.6 m ³ hr
Heads up to	48 m
Liquid quality required	Clear free from solids abrasive substances and non aggressive
Standart voltage	230V-50Hz single phase
Pump Body	AISI 304 Stainless steel



Schematic scheme of the Klystron cooling system

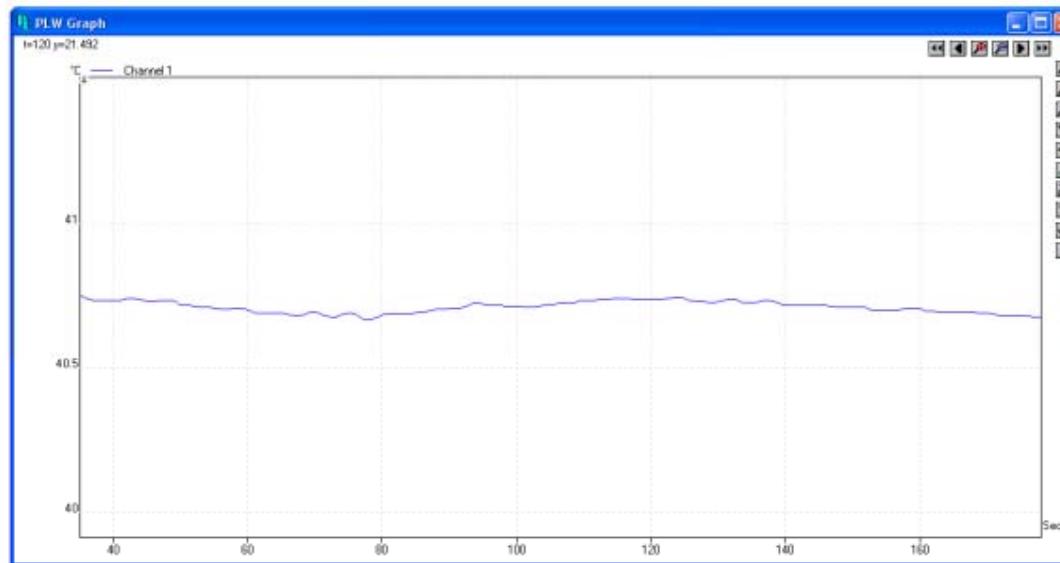
Precise Measurements of the Temperature



Pt-104



Pt-100



Results of precise temperature measurement

Main parameters of Pt-104			
Type	Temperature	Resistance	Voltage
Sensor	PT100, PT1000	n/a	n/a
Range	-200 to +800 °C	0 to 375 Ω 0 to 10 kΩ	0 to 115 mV 0 to 2.5 V
Accuracy (at 23 ±2 °C)	0.015 °C + 0.01% of reading	20 ppm at 100 Ω	0.4%
Temperature coefficient	5 ppm/°C	5 ppm/°C	100 ppm/°C
RMS noise with filter	0.01 °C	10 ppm	10 ppm
Resolution	0.001 °C	1 μΩ	0.156 μV
Overload protection	±30 V		
Number of inputs	4		
Converter resolution	24 bits		
Conversion time	720 ms per channel		
Input connectors	4-pin mini-DIN		
Input impedance	>1 MΩ		
Output connectors	USB and Ethernet		
Probe type	SE012		
Temperature range	-50 to +250 °C		
Accuracy	±0.03 °C @ 0 °C		
Dimensions			
Length	150 mm		
Diameter	4 mm		
Cable	2 m		
Material	Stainless steel probe, PTFE cable		
Handle	No		

Main Parameters of SE-012 Sensors

Probe type	SE012
Temperature range	-50 to +250 °C
Accuracy	±0.03 °C @ 0 °C
Dimensions	
Length	150 mm
Diameter	4 mm
Cable	2 m
Material	Stainless steel probe, PTFE cable
Handle	No

Schematic diagram of the water treatment scheme



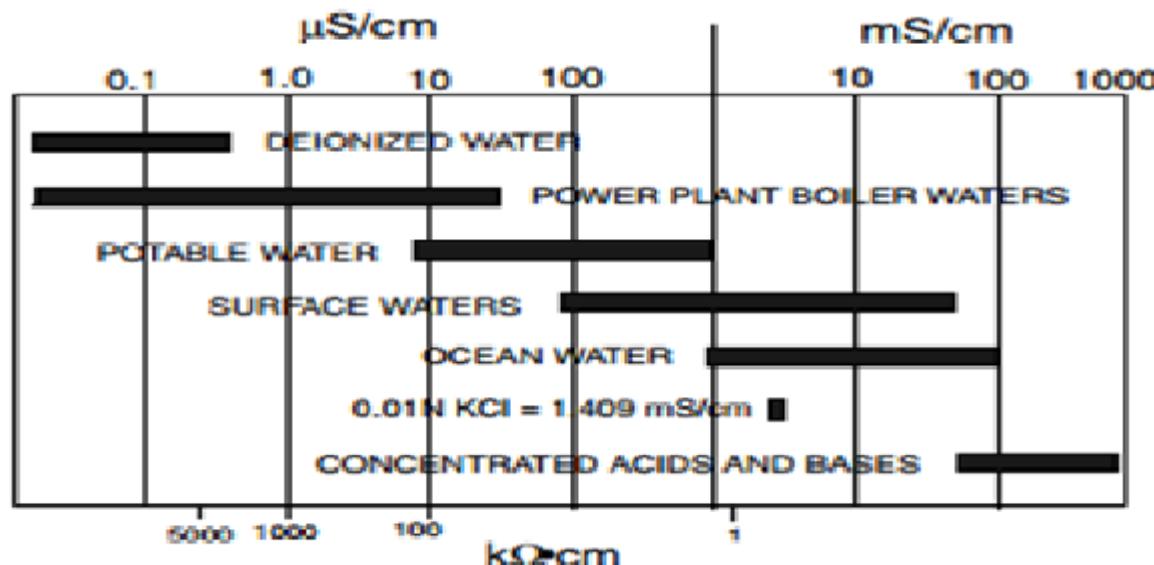
Technical Specification of Bantam Deionizer

Model	D0805
Flow rate	Up to 38 L/hr
L x W x H	22 x 15 x 72 cm
Feed water pressure	0.35 to 4.9 kg/cm
Resistivity	Reads 25'000 to 18MΩ cm
Electrical Requirements	240V, 50/60Hz

Technical Specifications of DE-5 distiller

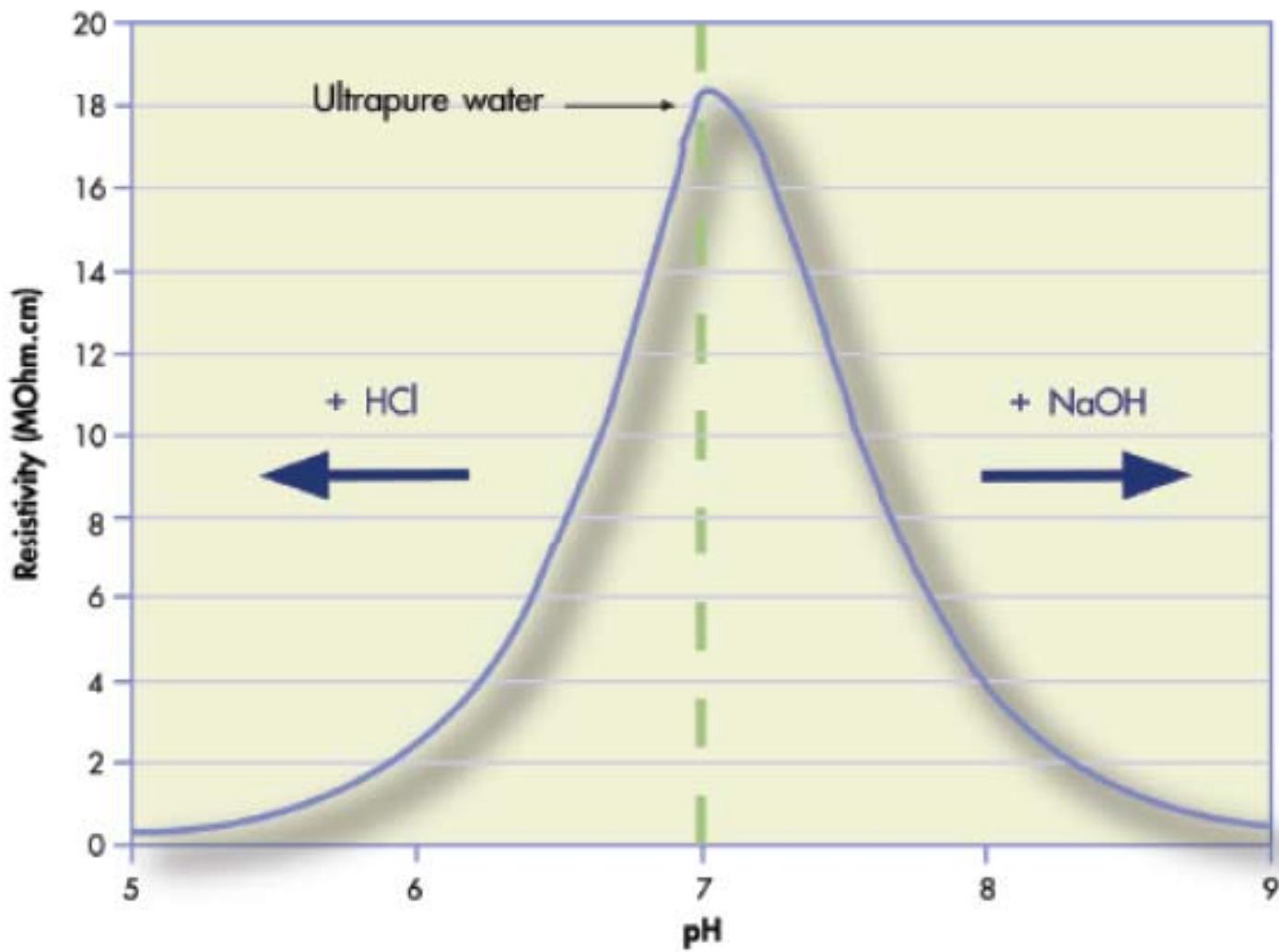
Model	DE-5
Electrical Resistance Level	294 117 Ω-cm
Flow rate	5 L/hour

Water Electrical Resistance Measurement Process.

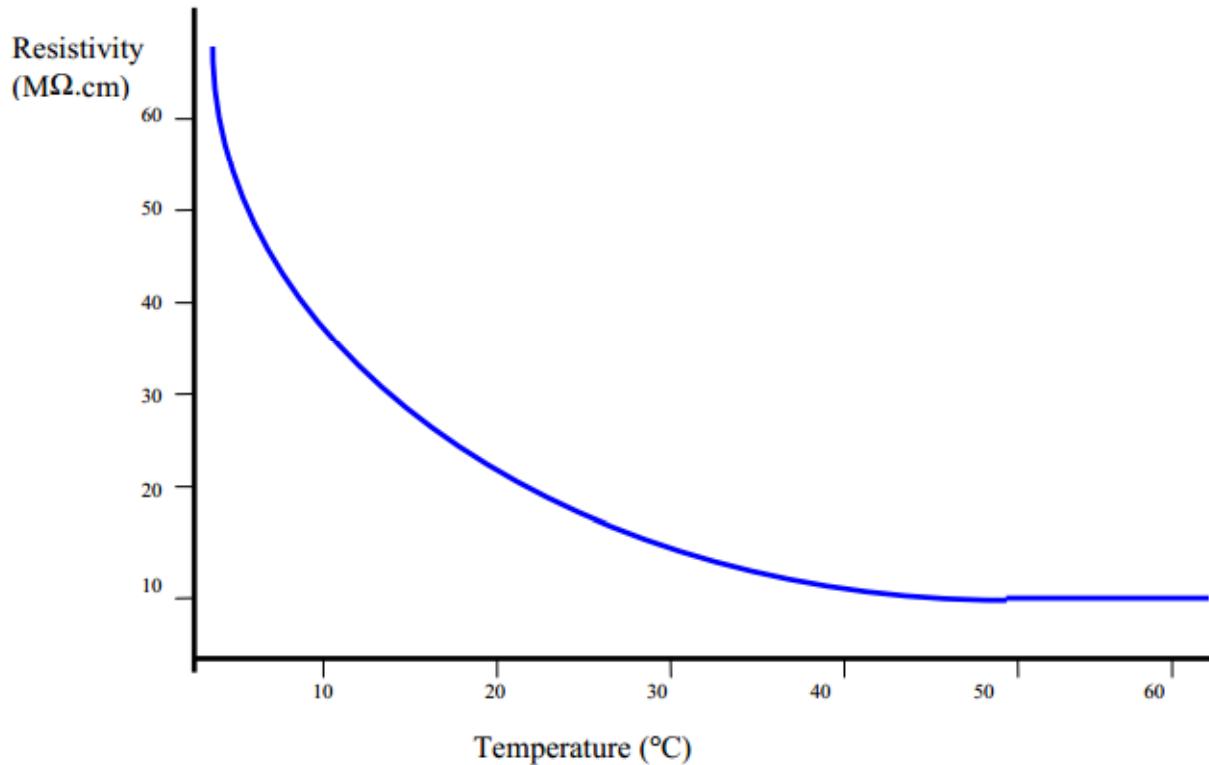


Technical characteristics of SX-650 conductometer

Conductivity	Range Accuracy ATC Auto. Calibration	Cond.:0~50.0µS/cm 50~500µS/cm 0.50~5.00mS/cm 5.0~50.0mS/cm TDS: 0 ~ 35.0g/L Sal.: 0 ~ 25ppt Res.:0 ~ 20.0MΩ·cm +/-1.0% FS 0 ~ 50°C(Auto.), Compensation Factor:2.0% /°C 1 point(1413µS/cm)
Temperature	Range Resolution Accuracy	0 ~ 50°C 0.1°C +/-0.5°C
Other Specifications	Power Dimension & Weight Quality & Safe Certificate	CR2032 lithium batteries×2, continuous use for over 100 hours Meter:148×29×14mm / 43g Case:168×96×28mm / 180g ISO9001:2008, CE and CMC
Working Conditions	IP Rating	IP57 Dustproof & Waterproof



Electrical Resistivity Versus pH of Deionized water



Relationship between the resistivity of ultra-pure water and temperature

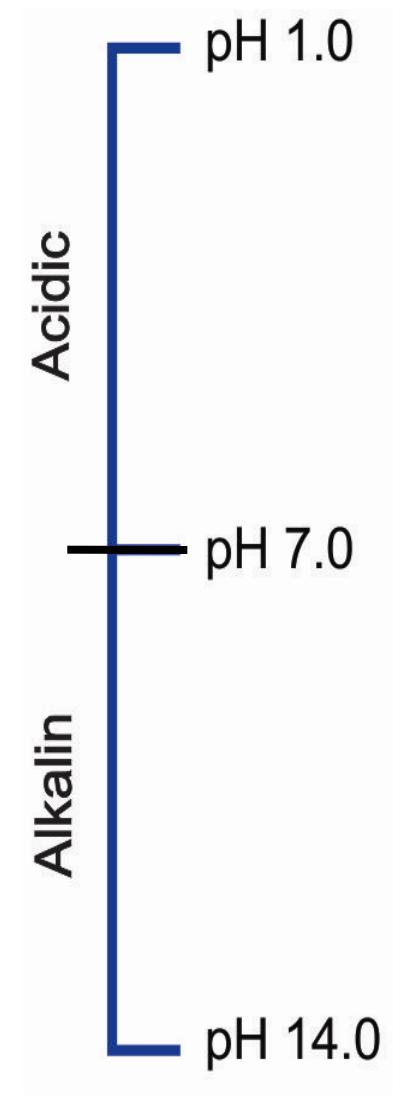


Photo-injector Gun Cooling System Specification.

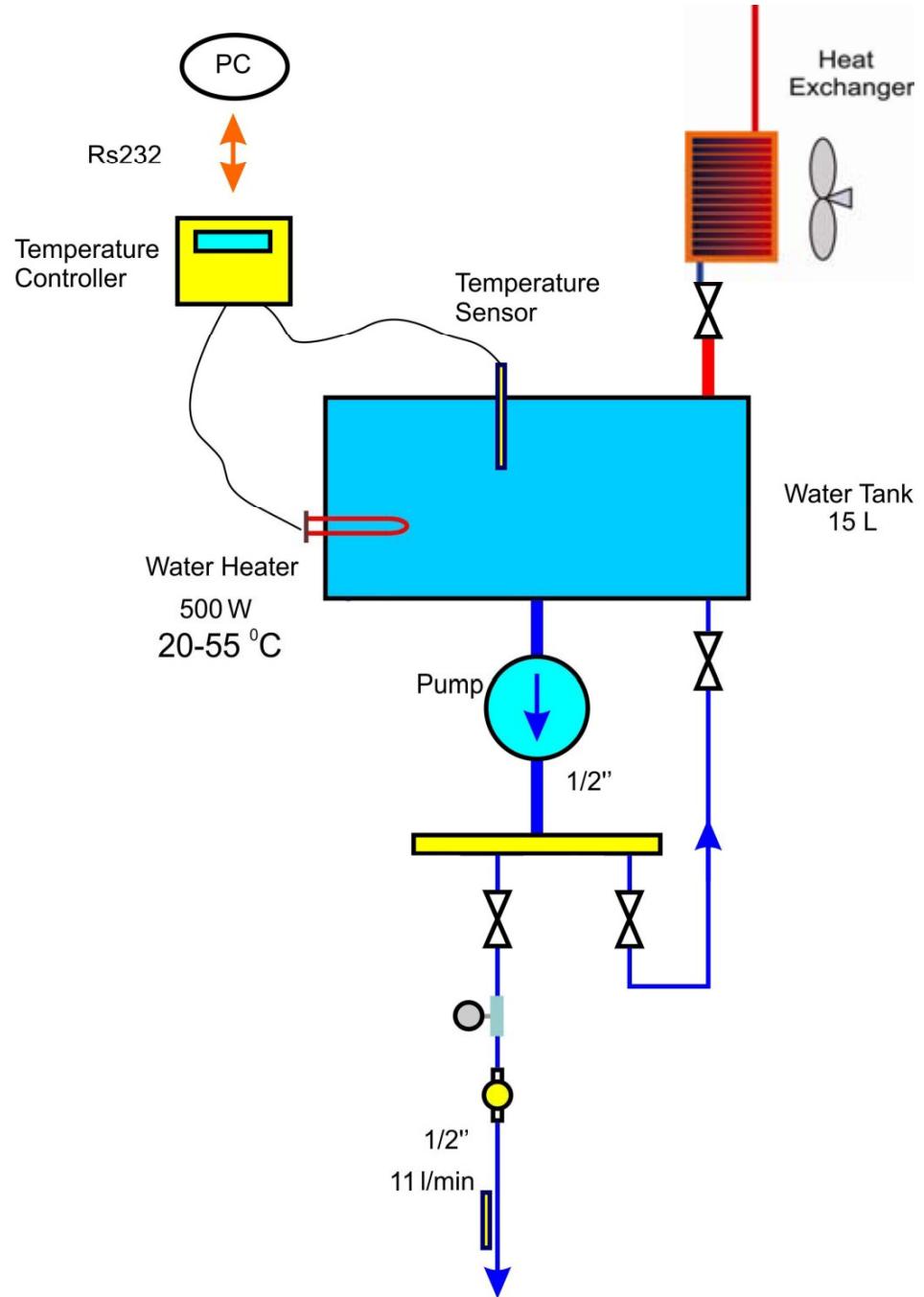
Photo-injector Gun Cooling Parameters			
Cooling Capacity (W)	Temperature Stability (+/-)	Water Pressure	Temperature Range
300	0.1	1 – 3 bar	20-55

Conditions.

- Precise temperature sensors;
- High automatization level;
- Inert and hermetic materials;
- Avoid different metallurgy;
- Appropriate hydraulic system;
- Reliable components;

Conditions for maintain UltraPure Water in the Cooling System

- Appropriate electrical resistance level of inlet water;
- Vacuum deaeration from cooling system;
 - Appropriate inert and corrosion-resistance materials;
- possibility of monitoring the O₂ , CO₂ and conductivity level.



Software



Thank You for Attention