Experimental and Numerical Study of the ALBA LINAC Cooling System

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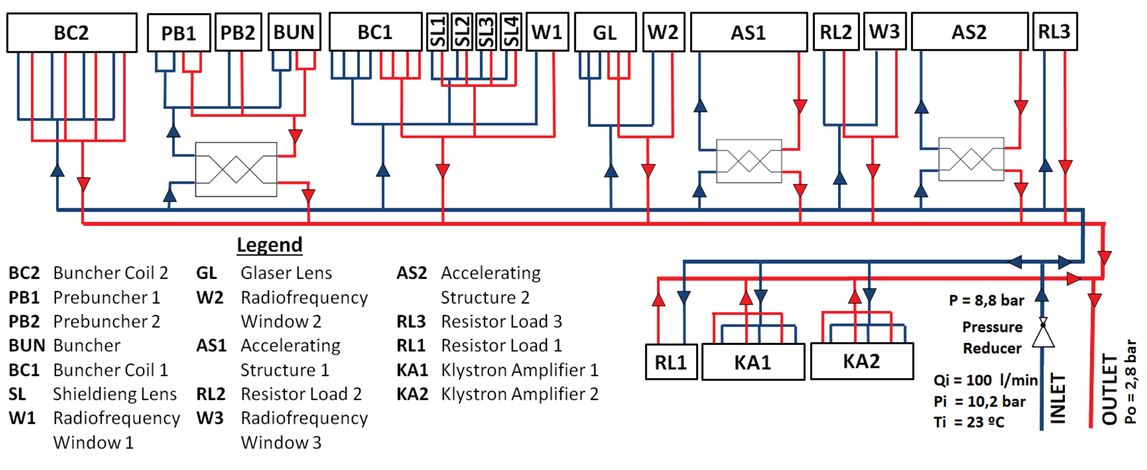
Abstract

This work investigates experimentally and numerically the performance of the ALBA LINAC cooling system. The main objective is to enhance the hydraulic system in order to significantly improve its thermal and water flow stability. In normal operation some problems have been identified that affect the performance of the LINAC: flowrate below the nominal values and water flow decreasing in time. The cooling subsystems have been experimentally characterized in terms of the pressure drop and flowrate. The measurements were taken using a portable hydraulic unit made at ALBA as well as a set of ultrasonic flowmeters. For the numerical studies the cooling network has been simulated using the software Pipe Flow Expert. The experimental results have shown that a number of components are too restrictive. In some cases the possibility to increase the flowrate is limited. The numerical results show that the velocity magnitude is inadequate in some places, producing air bubble entrapment, high pressure drop at pipes and insufficient flow. Based on this study several modifications are presented in order to raise the nominal flow and to adequate the water flow velocities between 0.5 and 3 m/s.

LINAC Cooling Water System

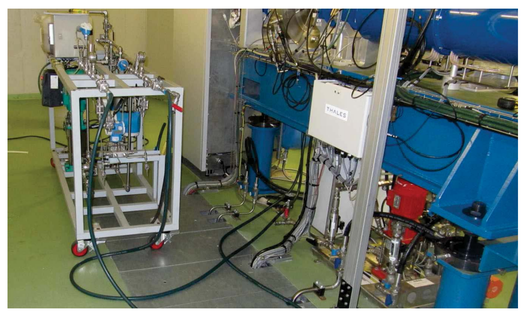


Legend

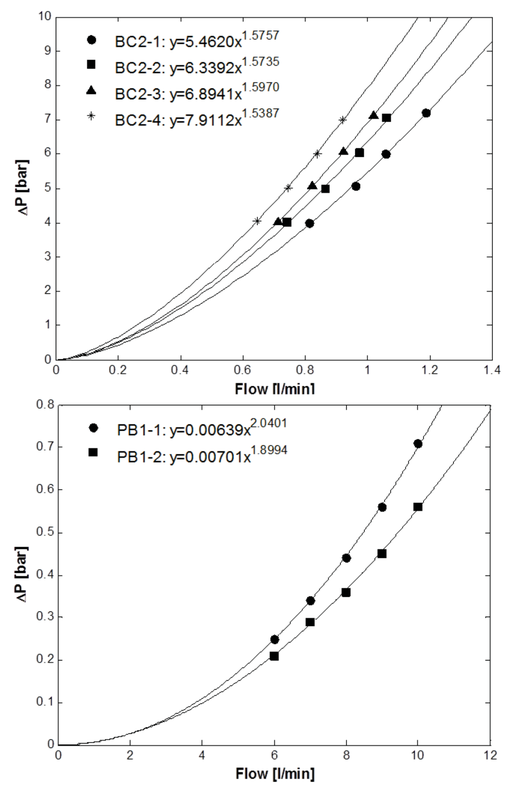
BC2	Buncher Coil 2	**GL**	Glaser Lens	**AS2**	Accelerating Structure 2
PB1	Prebuncher 1	**W2**	Radiofrequency Window 2	**RL3**	Resistor Load 3
PB2	Prebuncher 2	**AS1**	Accelerating Structure 1	**RL1**	Resistor Load 1
BUN	Buncher	**RL2**	Resistor Load 2	**KA1**	Klystron Amplifier 1
BC1	Buncher Coil 1	**W3**	Radiofrequency Window 3	**KA2**	Klystron Amplifier 2
SL	Shieldieng Lens				
W1	Radiofrequency Window 1				

The LINAC cooling water system has two different functions. From one side it cools the elements with strong dissipation of power: klystrons, RF cavities, RF loads, RF ceramic windows and magnets. And from the other side the system regulates the water temperature of the RF cavities in order to tune them for working at the nominal RF frequency.

Experimental Measurements

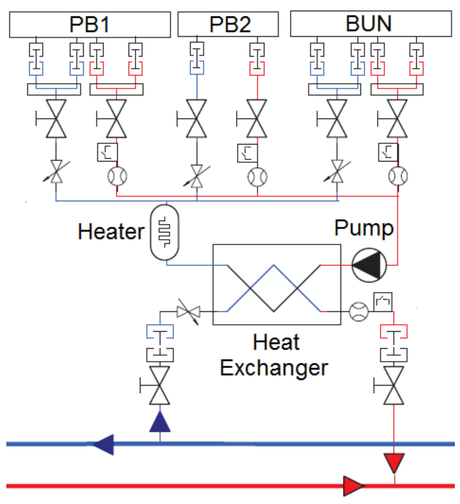


All the LINAC sub components have been characterized in terms of the pressure drop versus flowrate. The measurements were taken using a portable hydraulic unit as well as a set of ultrasonic flowmeters.

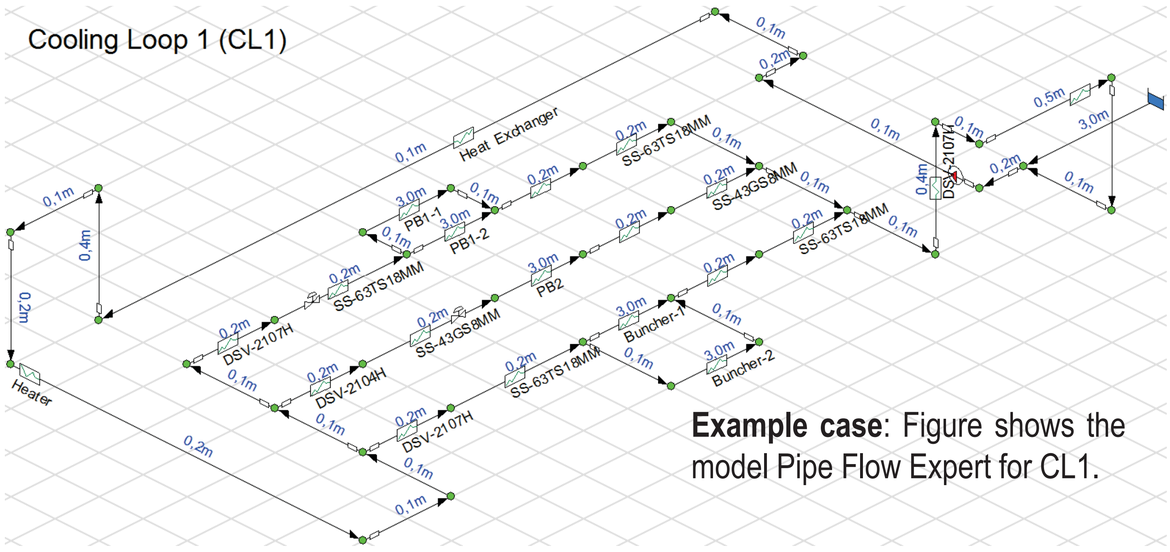


Example case: Pressure drop versus flowrate experimental correlations for BC2 and PB1.

1D Numerical Simulations

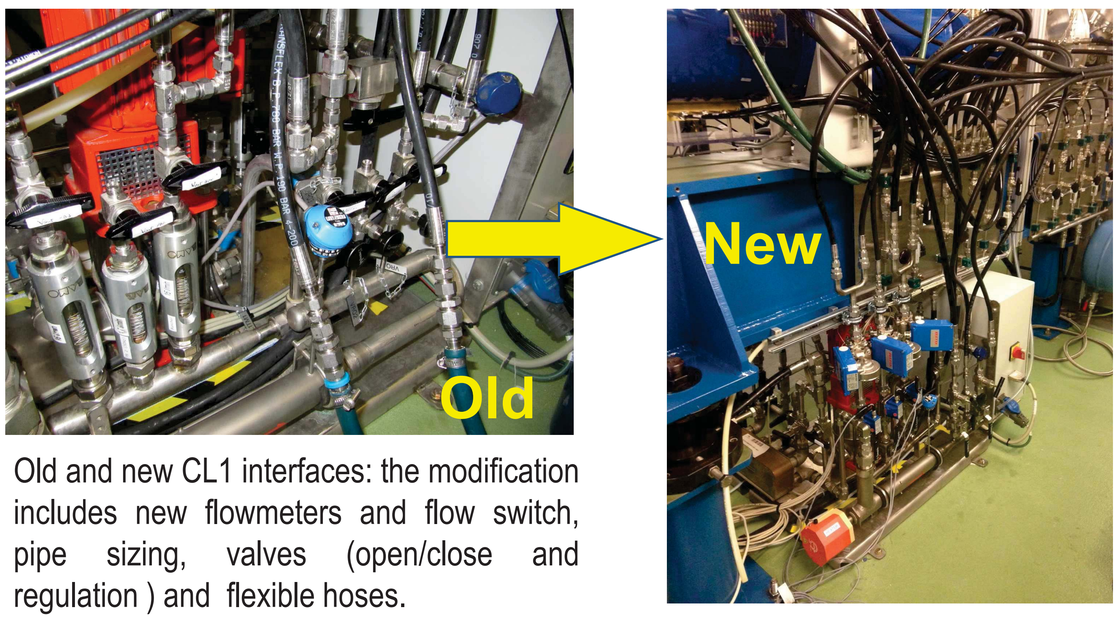


An accurate 1D model of the LINAC cooling system has been built. The model includes all the net pipes, bends, pipe entrance, changes of section, branding of current, valves (open/close type, regulators), pressure reducer, flowmeters, pumps and local components. A total of 199 pipes and 57 components have been used for the simulation model. The numerical predictions have been compared with experimental data. A good agreement has been found with deviations of the main variables below 11%.



Example case: Figure shows the model Pipe Flow Expert for CL1.

Improvement of Cooling Interfaces



Old and new CL1 interfaces: the modification includes new flowmeters and flow switch, pipe sizing, valves (open/close and regulation) and flexible hoses.

Conclusions

The hydraulic characteristics of the LINAC sub components were investigated both experimentally and numerically. By applying mathematical correlations of pressure drop versus flow rate, it has been found that a number of sub components are too restrictive. On the other hand, a detailed description of the velocity magnitude at the interfaces has been obtained. Based on these results, modifications have been implemented in the LINAC cooling system with the aim to improve its performance

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