Design and fabrication of a Controlled water based cooling system for the CBM Muon Chamber

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Motivation

A triple GEM based Muon Chamber (MUCH) will be used in the CBM Experiment at FAIR [1,2],GSI for Muon Detection

□ The Readout Electronics of the MUCH will continuously dissipate heat which is estimated to be 90 W per Sector.

□ To keep the temperature within the desired working range this heat must be taken out continuously.

□ Since wire bonding technique is used, air cooling is not an option, water cooling [3] is preferred.

□ An automated intelligent flow controller has been devised for this purpose.







30.6

30.4 0



Water Flows through 6mm Copper pipes, soldered on copper plate

□ Flow is controlled by the <u>automated cooling controller</u>

The PID loop

A closed loop negative feedback PID system is used for the flow control mechanism [4].
 The Algorithm is based on the formula

OUTPUT = $k_p^* e(t) + k_i \int e(t) dt + k_d^* de(t)/dt$, where $k_p^*, k_d^*, k_i^* = constants$ e(t) = (Desired temperature-Actual temperature)

Output from controller is 8 bit PWM [5] signal
 Motor is controlled via Power Transistor



□ The controller effectively cools down the system within reasonable time

- □ Accuracy was noted to be around 1°C
- □ Sink Temperature was noted using a normal laboratory thermometer
- □ The Result was found to be more accurate when Sink temp was low



FIG. 2: Temperature and water flow rate as a function of time for different set points

Summary and future plans

Preliminary tests indicate that the system is working as expected, fluctuation of temperature is within allowable range.

- □ Tuning the PID parameters more finely will reduce the fluctuation further.
- □ The Copper channels will be replaced with Aluminium Channels of real size.
- □ Radiation hard microcontroller will be deployed.

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[1] http://www.fair-center.eu/ [2] S. Biswas et al., NIM A 824 (2016) 504. [3] Vikas Jain et al., DAE-BRNS Symp. On Nucl. Phys. 60 (2015). [4] http://innovativecontrols.com/blog/basics-tuning-pid-loops [5] http://www.electronicstutorials.ws/blog/pulse-width-modulation.html

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