Numerical Thermo-Fluid Dynamics Modeling of a Processing Unit of the Fast Track Trigger for ATLAS

N. Delmonte[1,2], P. Cova[1,2], A. Lanza[2], P. Giannetti[3], A. Annovi[3], S. Daniele[1]

1. University of Parma, Dept. of Information Engineering, Parma, Italy
2. Istituto Nazionale di Fisica Nucleare - INFN Section in Pavia, Italy
3. Istituto Nazionale di Fisica Nucleare - INFN Section in Pisa, Italy

Introduction: We describe the thermal modeling of a crate hosting boards with Associative Memories (AM) designed for the Fast Tracker Trigger (FTK) system of the ATLAS detector at the CERN Large Hadron Collider [1]. FTK is a highly paralleled hardware system designed to provide global tracks reconstructed in the inner detector. The hardware system is based on AM for pattern recognition and fast FPGAs for track reconstruction.

The estimated power consumption of the PU (Process Unit) crate for the final system is more than 5 kW, which makes challenging the design of the rack cooling system.

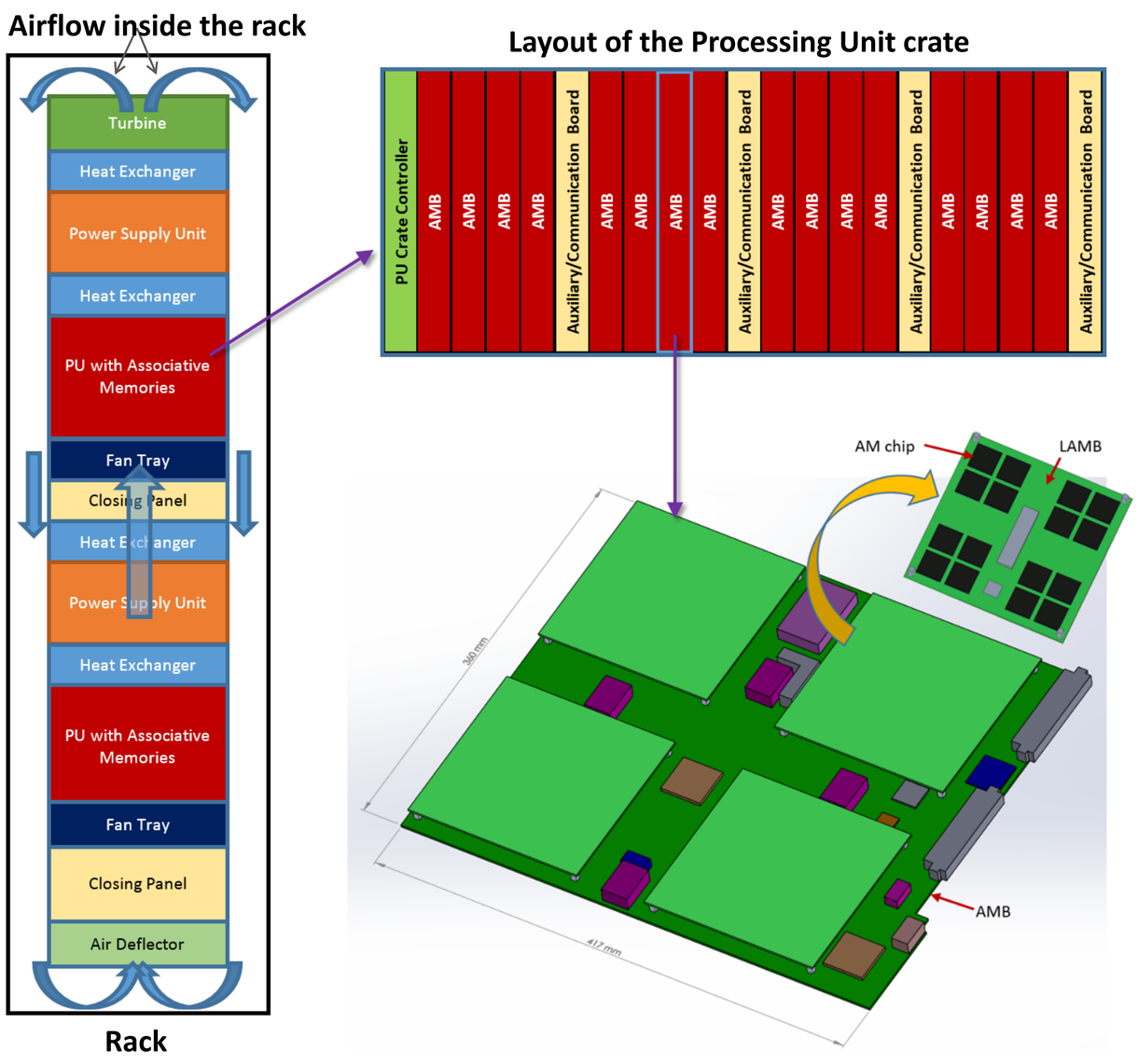

Figure 1. System setup: (left) schematic section of the rack containing crates of power supplies and PU with AMs, fan trays and heat exchangers; (up-right) schematic front view of a PU with AMs; (down-right) simplified 3D geometries of AM Board (AMB) and Local AMB (LAMB).

Modeling: We set a COMSOL model to solve a conjugate heat transfer problem (HT in Solids, for the PCBs and the crate aluminum structure, coupled to the CFD model of the turbulent air flown).

To simplify the analysis, we have drawn 1/3 of the whole PU crate, because the fans at the bottom inlets are placed as a 2 rows x 3 columns matrix, and preliminary isothermal CFD simulations showed an almost repetitive air flow with respect to the 3 columns. Instead of the layout of Fig. 1, has been considered the worst thermal case of the crate filled only by AMBs.

The fans have been modeled as boundary conditions giving the static pressure curve data taken by the 6400 rpm fan datasheet.

Results: The results obtained by stationary simulation with a dissipated power of 2.5 W per AM chip, and a temperature of the air at the fans of 20 ºC, are shown in Figs. 2 and 3.

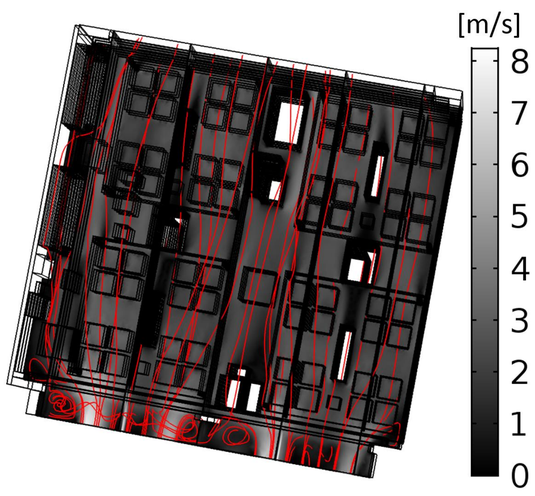

Figure 2. Air speed in a slice between the two AMB in the middle of the 1/3 simulated crate.

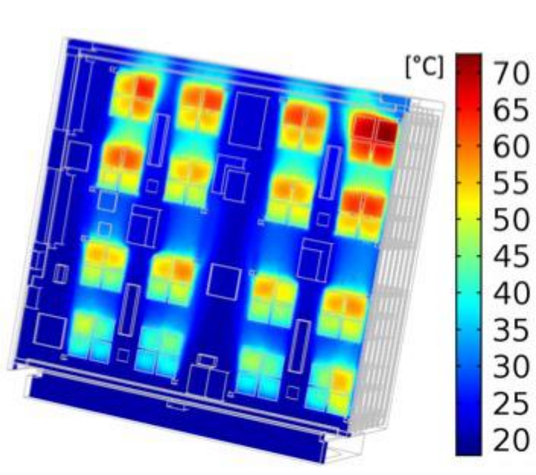

Figure 3. Thermal map of a slice passing through AM chips of the AMB close to the crate wall (hottest board).

Conclusions: The simulated thermal map matches quite good the preliminary measurement tests, thus this COMSOL model will be helpful for sizing the cooling system of future revisions of the presented system.

References:

1. J. Anderson et al., FTK: a Fast Track Trigger for ATLAS, Journal of Instrumentation, Vol. 7, pp. 1-8 (2012).