NPS Electronics Volume - CFD Thermal Analysis

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EIC Beryllium Pipe Section - CFD Thermal Analysis

I started the thermal analysis of the Neutral Particle (NPS). Inside the detector enclosure, specifically, in the electronic volume heat will be generated as a consequence of the power dissipated by 1080 high and low voltage channels connected to the photo multipliers (PMTs). Based on the current and the voltage required for each high voltage and low voltage channel the power to be dissipated calculated is 352W. The expected operating temperature for the crystals installed in the crystal zone is 18°C.

I developed a simplified model based on the actual dimensions and location of each component provided in the 3D model of the NPS detector. A simplified model is required to avoid meshing issues, unnecessary geometric details from the thermal point of view on the model is avoid since to much details in a complex geometry easily creates errors and delays the simulation process.

The simplified model includes the detector enclosure panels (x6), two heat exchanger plates (located at the bottom and top section of the electronic volume), four heat exchanger fans (two bottom and two at the top section of the electronic volume), air volumes, electronic volume, crystal block, and volume space occupied by the PMTs, bases, and dividers. The geometry and location for the simplified model is shown in Fig.1.

Material properties such as density, specific heat and thermal conductivity are critical for the CFD thermal simulation. Table 1. Shows the material properties implemented for each component of the simplified model.

- **Created simplified model of the NPS detector and implemented in *Ansys Fluid Flow Fluent* software to to find temperature in the crystal blocks**
- **Preliminary results shows the temperature of the crystals blocks of ~20°C**

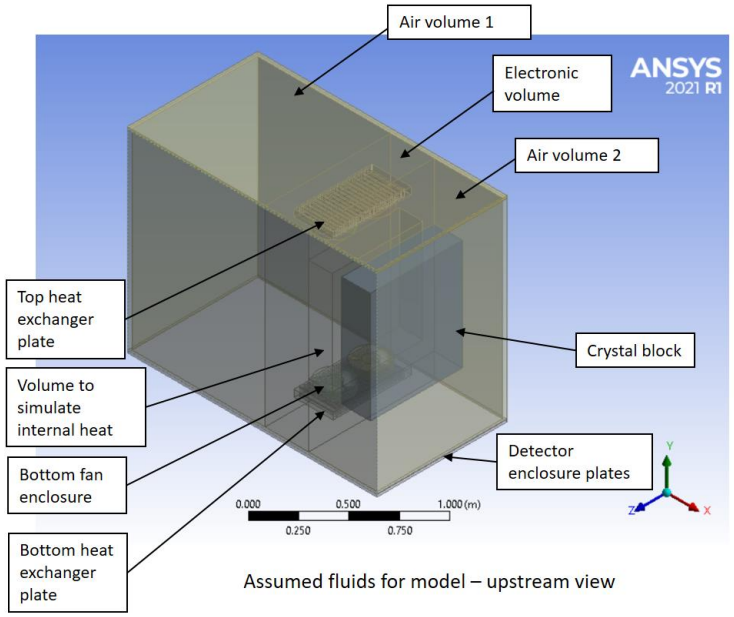

Fig.1. Simplified model, components location

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Component	Material Name	Density [Kg/m3]	Specific Heat [J/KgK]	Thermal Conductivity [W/mK]
Crystals	Lead-Tungstate (PbWO4)	8280	263	2.4
Detector enclosure plates	Plastic(PVC)	1380	1069	0.1753
Electronic volume, air volume 1 and 2	Air	1.225	1006.43	0.0242

Table 1. Utilized material per component in simplified model

I used *Ansys Fluid Flow Fluent* software to perform the setting up of the thermal model analysis, materials, domains for components (fluid or solid), boundary conditions and the simulation conditions. I selected a model named Viscous, k-omega, Shear Stress Transport (SST), which is recommended for turbulent flows. The electronic volume internal heat generation was set to 1000 W/m3, the heat exchanger plates temperature at 10°C, the air temperature at 20°C, and I I had issues to simulate the rotation of the fan blades had to set the air flow fans velocity 3.33 m/s. The thermal heat transfer for the simulation was convection and inlet flow velocity through the fans.

I plan to implement new simplified model, which will include more details such as the cooling plates for the crystals. I will research porous surface options to optimize the heat exchanger simulation Solve rotation direction issues to allow the simulation of the fan blades movement Additional post-processing to visualize data will be critical as well.

I performed computational fluid dynamics simulations with provided parameters and got preliminary result. For the calculated power dissipation of 352 W in the electronics volume, results indicate that the temperature in the electronic volume is ~21°C when the cooling heat exchanger plates are at 10°C and air at ambient temperature (20°C) is blew at a velocity of 3.33 m/s. The temperature for the crystal block was ~ 20°C

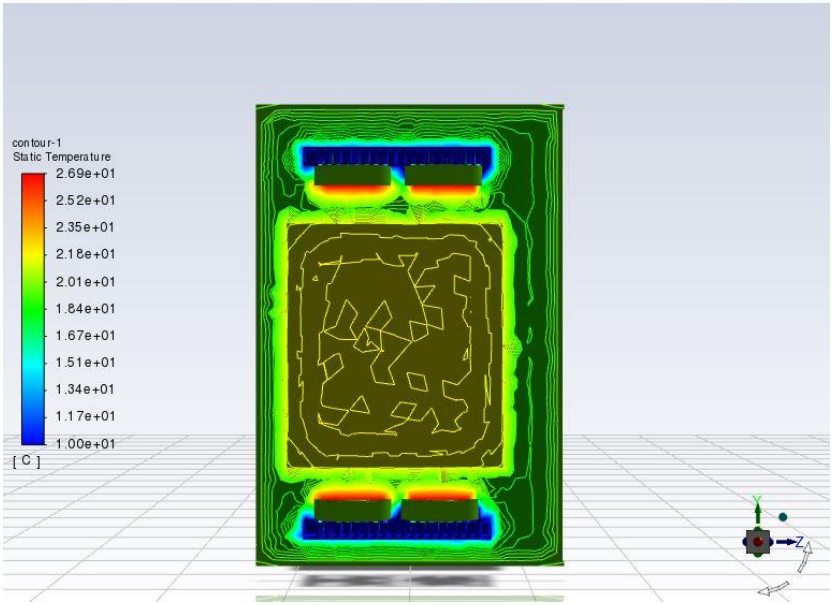

Fig.2. Results - Temperature contour plot