Computing Requirements for Ansys Fluent Thermal Analysis of the Neutral Particle Spectrometer

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This note describes the required computer environment for computational fluid dynamic thermal simulations in Ansys Fluent for the Neutral Particle Spectrometer (NPS).

The NPS model's complexity—due to its large number of crystals (1080), thin carbon fiber dividers and mu-metal heat conductors (0.5 mm), and small separation between crystals (0.5 mm)—requires for its thermal simulation [1] advanced software features that demand high performance computing (HPC).

Ansys Fluent solver has a default set of four cores for parallel processing of meshing and solver computing. Scaling the simulation's computational level is possible with HPC licensing options—individual (anshpc), bundle of licenses (anshpc_pack), or work groups—based on the size of the user environment and Ansys capabilities.

Each anshpc license comes with a core. Jefferson Lab has six anshpc licenses. Therefore, if all six licenses are used, along with the four cores that come with Fluent solver, a maximum of ten cores can be used simultaneously.

The total number of cores available with the anshpc_pack is given by the formula

Total cores = anshpc_pack cores + 4 Fluent solver cores

where anshpc_pack cores are given by

anshpc_pack cores = 2×4^{n}; the number of anshpc_packs $n \in [0, 8]$.

For example, four anshpc_packs would provide 512 cores.

Additionally, where the Ansys Fluent software packages are installed and running—local, server, or cloud—is critical because the number of cores and RAM play a key role in parallel computing.

For optimum mesh generation for the model, 2 GB of RAM is required per million cells. The required memory can vary based on the selected method to mesh the model [2]. Estimated memory for the number of cells and solver precision are given in Table I.

One hundred million mesh cells were generated in the first attempt. Since the RAM on the computer was only 64 GB, it was increased to 512 GB. Though the model with 100 million mesh cells was able to be opened on the computer with the 512 GB of RAM and 10 cores, computing was slow. Therefore, an acceptable meshing of 17 million cells was generated, facilitating reduced simulation time and faster computing. [3].

Figure 1, a screenshot of the computer performance during the execution of the thermal simulation, shows that for the model with 17 million cells, the CPU usage is ~6% and the memory usage is ~14.5 GB for each of the eight cores.

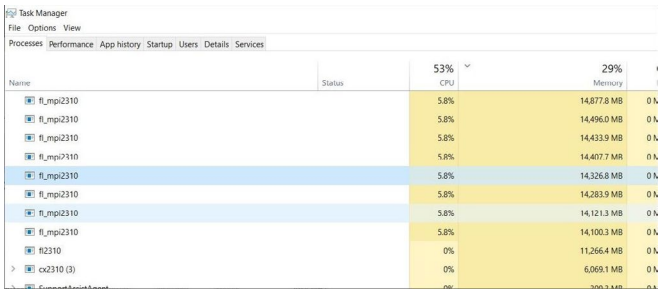

FIG. 1. Screenshot of computer performance while executing the thermal simulation for the model with 17 million cells. CPU usage is ~6% and memory usage of each one of the eight cores is ~14.5 GB.

In conclusion, core, memory, and mesh cell size requirements were researched, calculated, and resolved to execute Ansys Fluent thermal analysis.

[1] E. Rindel, NPS Cooling System, Unite Mixte de Recherche, Universite of Paris-Sud 11, January 2021.
[2] Ansys, *Ansys Meshing User's Guide*, Release 2021R2, July 2021.
[3] P. Campero, et all. *Modeling and Meshing the Neutral Particle Spectrometer for Ansys Fluent Simulation*, DSG-Note 2023-44, 2023.

Mesh cells [M]	Solver precision	Used cores from four anshpc packs	Default Fluent solver cores	Total cores used	Fluent Solver used memory [GB]	Memory used per core [GB]	Total memory used [GB]	Estimated memory [GB]
100	double	4	4	8	9.3	~29	241.3	200
100	single	4	4	8	8.9	~15.2	130.5	200
17	double	4	4	8	6.1	~14	118.1	34

TABLE I. Monitored parameters for different numbers of mesh cells and solver precision (columns 1 and 2), using four cores from four anshpc licenses (one core/anshpc license).