Memmo Federici1, Bruno Martino2, Simone Lotti1

1INAF- IASF Istituto di Astrofisica Spaziale e Fisica Cosmica Roma, 2 CNR – IASI Istituto di Analisi dei Sistemi ed Informatica

email contact: memmo.federici@iasf-roma.inaf.it, bruno.martino@iasi.cnr.it, simone.lotti@iasf-roma.inaf.it

Abstract

For the development of new X-rays detectors as well as for simulation of interactions between particles and matter, very often the scientific community makes his choice on Geant4. This is a very versatile and powerful tool, but some applications can require substantial computing resources. In particular simulations in which is necessary to use a large number of particles can take an extremely long time (sometimes many weeks). To expedite the simulation process we have developed a Cluster: GFORC which currently consists of 4 PCs for a total of 16 GB of RAM 32 cores 6 TB of data storage. The Cluster is easily expandable and thanks to the adopted design criteria achieves an excellent compromise between performance and cost. The management software of Cluster, allows to divide the single instance of the simulation on the available processors, creating a simulation speed similar to that obtained on “parallel systems”. Furthermore the use of Geant4 on GFORC is facilitated by a series of custom graphical user interfaces. The Cluster improves the speed of the simulation used as a test, about a factor of 20 compared to the times obtained by a modern PC.

Software Strategy

GFORC is a calculation tool that is able to split the simulation program in so many programs running simultaneously on the cores of the allocated nodes. Thanks to this mechanism, the result obtained in terms of speed is comparable to the speed of calculation made on parallel platforms.

The great advantage of GFORC is the ability to reuse software written in serial very similar to implementations on parallel platforms.

To efficiently use the features of the calculation in clustering and to facilitate their use have been produced a series of software procedures that implement the following functions:

• Allocation of resources
• Launch of specific tools
• Synchronization instances subjected to the calculation task

Thanks to the strategies adopted in developing the GFORC software, the obtained performance computing, are a factor 20 above the ones obtained with a workstation with single core.

It is important to underline that the cost of the current structure of GFORC is only about 4 times greater than the cost of a single workstation used as a comparison.

The flow chart at right shows one of the main procedures for managing cluster: the login procedure. This is primarily designed to allocate the nodes of the cluster and set the environment variables required for simulations. Also it is known one of the key features of GFORC is the ability to resume, controlled by the users, active sessions still in progress, the user can choose at next login, which of the available parameters.

Graphical User Interface (GUI)

The using of GFORC is facilitated by the implementation of some graphical user interfaces.

Furthermore through these interfaces, users can interact with the simulation programs by changing the input parameters and saving the settings for subsequent reuse.

Below are shown (as an example) some of the graphical interfaces available.

The priorities in GFORC cluster design were chosen by low cost and high performance computing. To achieve this goal it was decided to use only conventional and readily available components. The individual nodes that make up the cluster are of a commercial personal computer, then low-cost hardware with good quality, but conventional.

The diagram shows the current configuration of GFORC. It is at present composed of 4 nodes, each equipped with Intel “I7” Eight-Core processor, 4 GB of DDR3 RAM by 1333 Mhz, and 500 GB of Hard Disk. Overall GFORC develops with its 16 GB of RAM and 32 cores computing power close to 100 Giga Floats (100 x 10^9 Floating point Operations Per Second). The cluster is managed by the resource manager SLURM (Simple Linux Utility for Resource Management). Simulations data results reside on a server with NAS 8000-6 storage capacity of 6 TB. The DATA STORAGE file system is realized by OCFS2 (Oracle Cluster file system). This is a clustered file system which is shared by being simultaneously mounted on each node of Cluster. The OCFS2 is used by nodes in the cluster through the ISCSI transport protocol (Internet Small Computer System Interface) which allows the use of the existing FC/IP infrastructure and produces a great gain in speed communication and data exchange between nodes.

This choice is of paramount importance compared to the use of a file system like ext3 or ext4 by a NFS (Network File System Protocol). Thanks to the choices made the speed of read/write on the disk that containing the users area “home” has increased by an order of magnitude. Access to GFORC is via a secure connection in the “ssh” protocol which allows users to export graphical windows.

The Cluster has an individually controlled power supplies (UPS) controlled via WEB. The power of 10kVA, can guarantee in the absence of mains power, an endurance of several hours for a load of up to 60 nodes.

We present here the results, obtained with GFORC, of a study on the impact of L2 cosmic particles with galactic (CGIR) and solar origin on the X-ray Microcalorimeter Spectrometer (XMS) onboard of the ATHENA mission (ESA). We used a Monte Carlo based simulator to investigate the rejection efficiency of the anticoincidence system and the impact of residual background on the detector performances. Similar GEANT4 simulations have already proven to be able to reproduce the background measured by the XRS microcalorimeter flown on Suzaku (Penruith et al. - Journal of Low Temperature Detectors, accepted paper).

We initially prepared a simple geometrical model sphere model where we assumed a simplified geometry composed by 4 concentric spheres. This is a standard approach, often used in background simulations for space applications (H.Murakami, 2006). Simulations on the sphere model has been used to check the right response of the simulators, requiring low time machine computation, and has been run on a PC with standard performances.

GFORC allowed us to exploits a factor by 20 higher in computational power, so we decided to prepare a second model – detailed model – where the crystal is modeled in great detail, based on the ATHENA specifications.

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