GEO600

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Abstract

The **GEO600** detector is contributing to the **Laser Interferometer Gravitational Wave Observatory**, an international effort to directly measure the effects of gravitational waves.

The analysis of detector data is split into small computational tasks that can be executed on commodity hardware. Based on the BOINC frame-work **Einstein@Home** is managing the execution of these tasks, which all together can outperform even supercomputers.

Gravitational wave data analysis was found to be easily applicable to grid environments and was chosen to drive the integration of resources into **AstroGrid-D**. Until today GEO600 delivers 120.000 cpu hours per month to the scientific community using grid technology.

Gravitational Waves

Gravitational waves have been predicted by the linearized form of the field equations. The nonlinear form of the field equations can be used to predict signal patters in physically realistic situations, which help to reduce the search space within the detector data.

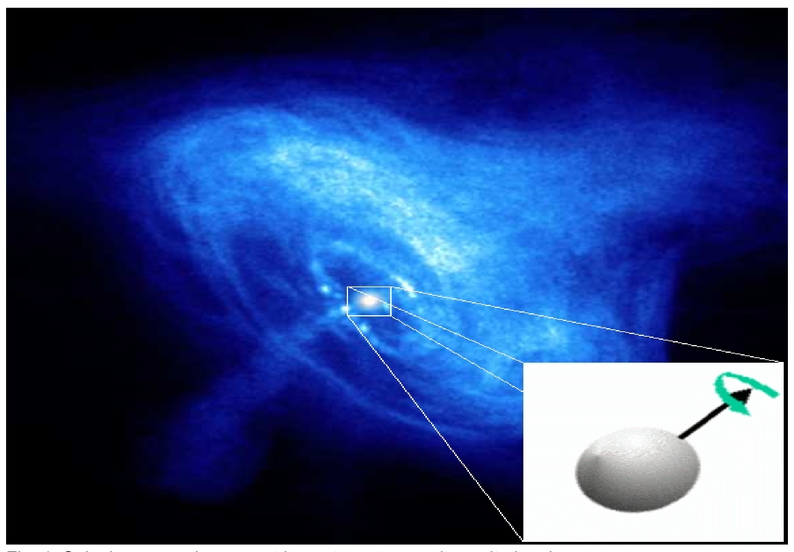

Fig. 1: Spinning non-axis symmetric neutron stars emit gravitational waves

Gravitational Wave Detectors

All gravitational wave detectors in *LIGO* operate as Michelson-Morley interferometers. The most sensitive of them are location in Hanford and Livingston (US) with an interferometer arm length of 2km and 4km. The GEO600 detector operated by the Max-Planck-Institute for Gravitational Physics near Hanover has an arm length of 600m and uses advanced optical instruments to compensate for the smaller size.

Fig. 2: GEO600 detector Hanover, Germany

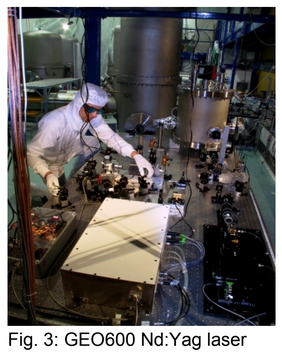

Fig. 3: GEO600 Nd:Yag laser

Einstein@Home

Einstein@Home uses the **Berkley Open Infrastructure for Distributed Computing** - *BOINC*. The data analysis consists of a heuristic search within the detector data for known gravitational wave signal patterns. Powered by the support of its members, who donate the idle time of home and office computers to the search for gravitational waves, the project reaches a peak performance of 72TFlop/s.

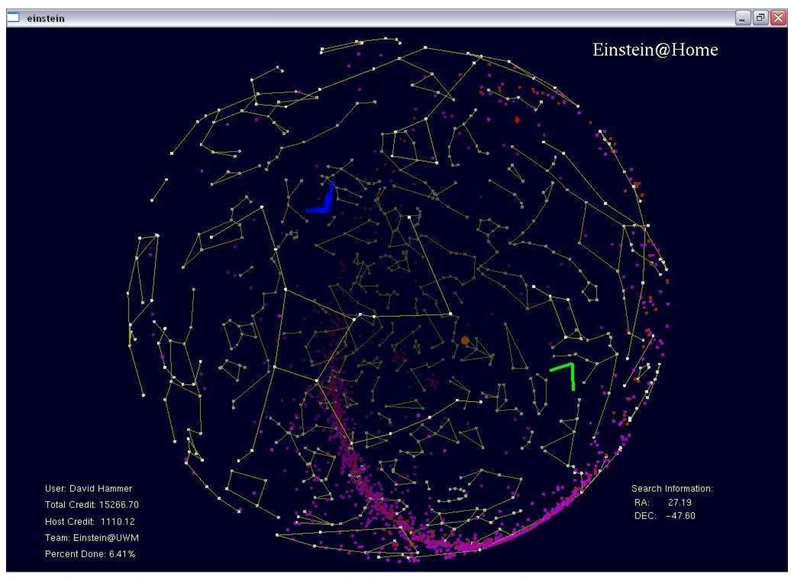

Fig. 4: Einstein@Home developed by the MPI for Gravitational Physics

GEO600 Grid Application

Einstein@Home was identified as an ideal candidate for a grid application:

- multi-platform support
- well tested software base
- simple resource requirements
- build-in checkpoint and recovery methods
- fine grained adjustable runtime
- linear scaling with node number

These advantages make sure, that the data analysis scales with the capabilities of the developing AstroGrid-D. Starting at the very beginning of the project the application was used to farm already available grid resources for the scientific community and to drive the integration of resources into D-Grid.

GEO600 Grid Components

Deployment: The GEO600 application integrates the deployment process into the first submission of a job to a grid resource, which frees the user from any manual deployment procedure.

Resource Discovery: Grid resources are automatically discovered by using information provided by MDS and are ready to use due to the user friendly grid account management system VOMRS.

Job Submission: based on MDS and VOMRS we use an automatic job submission procedure to resources that provide GT4 web services.

Task Management: the metadata associated with job submissions is collected in a MySQL Database at the AEI, which is soon to be replaced by the Stellaris Information Service which supports grid authentication and RDF metadata schemes developed for this purpose.

Data Managment: all data associated with a task is archived at the 120TB sized Astrogrid-D storage resource located at the AIP. Data is pre-staged and post-staged automatically using GridFTP.

Grid Statistics: our database keeps a record of all job submissions to grid resources. It is used to collect usage statistics about individual grid resources and grid users.

GEO600 Production Level Service

In August 2007 we were utilizing 12 large clusters and 20 workstations at a daily base for job submissions.

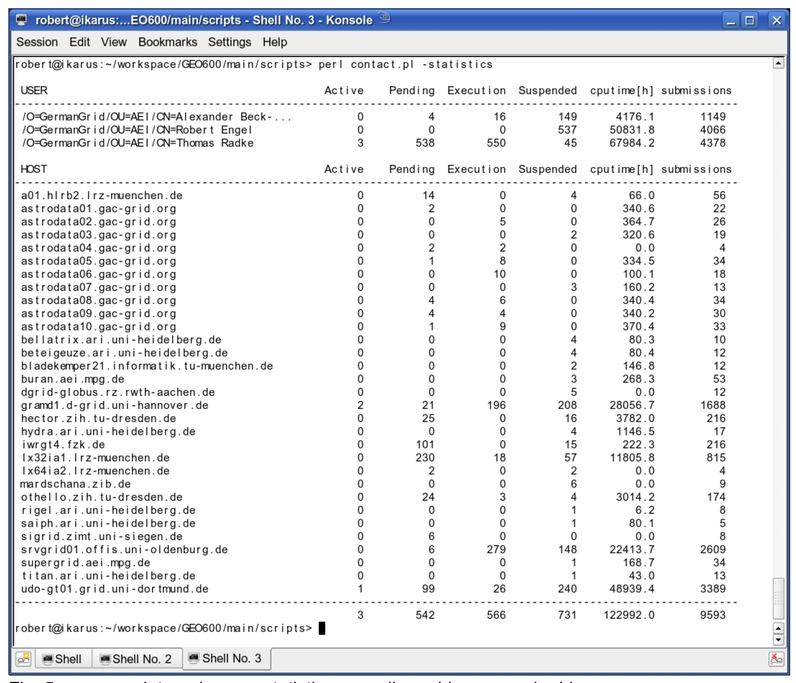

Fig. 5: use case internal usage statistics regarding grid users and grid resources

Together these resources provide 100.000 cpu hours per month to the scientific community. Below the external statistics of Einstein@Home, where GEO600 currently ranks at position 9 in the world wide rankings.

Fig. 6: Daily credits collected by GEO600.

Fig. 7: Total credits collected by GEO600.

References

contact: eScience@aei.mpg.de

http://www.gac-grid.org

http://geo600.aei.mpg.de

http://www.ligo.caltech.edu

http://einstein.phys.uwm.edu

svn://svn.gac-grid.org/software/GEO600

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GEFÖRDERT VOM

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