Pencil Code User Meeting 2007*
(Stockholm, 14-17 August)

Organizers: Axel Brandenburg, Boris Dintrans, Wolfgang Dobler, Anders Johansen, & Petri Käpylä

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1 Summary

This was the third meeting of this kind which brought together some 19 Pencil Code users from around the world including Calgary, Cambridge, Freiburg, Halifax, Heidelberg, Helsinki, London, Potsdam, Stanford, Stockholm, Toulouse, and Uppsala. The program of the 4 day meeting included 19 talks of about 30+15 minutes with science results and 9 discussion sessions where a number of emerging issues were considered. Some of the scientific highlights include presentations about the co-evolution of dust and gas in magnetized self-gravitating shearing sheets, the introduction of curvilinear coordinates, hydrodynamic and hydromagnetic simulations of Taylor-Couette flows in cylindrical coordinates, the implementation of an implicit solver of the heat equation and of a multigrid solver for the Poisson equation. The discussion topics included in particular the anticipated migration from CVS to the subversion repository, the change to version 3 of the GPL license agreement, improvements of the suite of automatic nightly tests of the code, improvements of the manual, a multi-author paper discussing methods and tests, as well as discussions about curvilinear coordinate systems and the option of using upwinding derivatives in cartesian and non-cartesian coordinate systems. All talks are recorded and now publicly available as streaming videos; see `http://agenda.albanova.se/conferenceDisplay.py?confId=185`.

2 Description of the scientific content and discussion at the event

The purpose of the meeting was to bring the core developers together and to allow others to interact with them and learn more about the Pencil Code

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(http://www.nordita.dk/software/pencil-code/). The code is a multipurpose code for massively parallel computing (especially on the cheaper Linux cluster). It includes optionally hydrodynamics, magnetic fields, radiation, ionization, multi-species dust dynamics with coagulation, dust and tracer particles, self-gravity, and certain reaction-diffusion equations. It is developed and maintained under the Concurrent Versioning System (CVS; see http://www.nongnu.org/cvs/) by around 25 people with check-in permission and has been downloaded by over 450 registered users (without check-in permission).

During the meeting it became clear that the PENCIL CODE has expanded significantly in the number of lines of code and the number of subroutines (Fig. 1). The increase in the functionality of the code is documented by the rise in the number of sample problems (Fig. 2). In order to keep the development of the code going, it it important that the users are able to understand and modify (program!) the code.

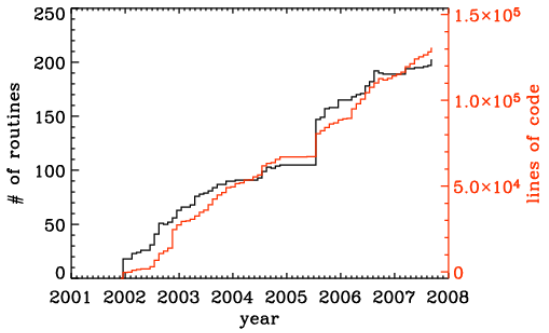


Figure 1: Number of lines of code and the number of subroutines since the end of 2001. The jump in the Summer of 2005 was the moment when the developments on the side branch (eos branch) were merged with the main trunk of the code. Note the approximately linear scaling with time.

3 Assessment of the results and impact of the event on the future direction of the field

The meeting had been important for a number of reasons. Given that there was a large number of new users, this meeting helped introducing these new users to each other and to the rest of the core developers. Some of the new users emphasized the usefulness of the manual, but they identified also a number of shortcomings having to do with learning the interior of the code and being able to modify it. As a consequence, a number of modifications have already been made in the manual.

Another important development is the imminent migration of the CVS repos-

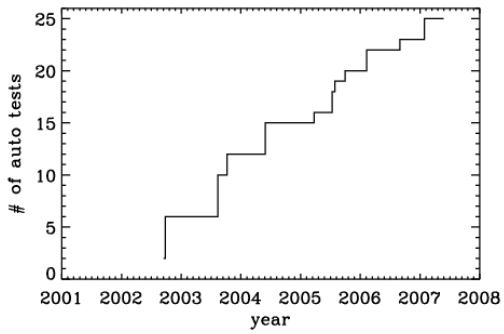


Figure 2: Number of tests in the sample directory that are used in the nightly auto tests. Note again the approximately linear scaling with time.

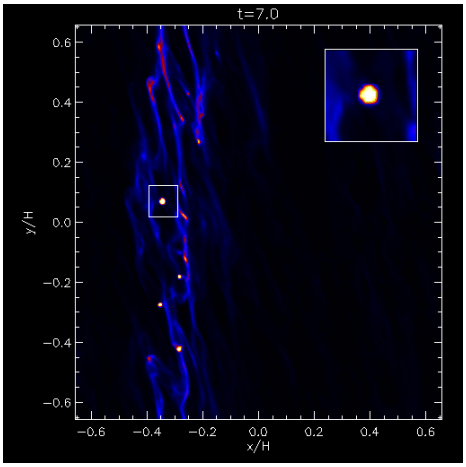
itory to subversion (SVN). During the meeting this process was tested and the code is now available on a preliminary SVN server. The final migration will be done in a few weeks when all other users had a chance to test the new system and to identify problems. By and large, the problems (e.g. with firewalls) are minor in comparison with the advantages (moving files, preserving links, and the atomic version numbers that help tracing the order of changes in various routines).

As part of the new SVN repository, there is now also a new bug tracking system (Trac). Until now we have been using bugzilla instead, but now the entire bugzilla database has been moved to Trac. Bugs are now referred to as tickets, emphasizing that much of it is rather a request for improvement. A new additional tickets have been filed and several additional clean-ups in the code have already been done.

On the technical side, a major addition to the code has been the implementation of curvilinear coordinates. In the Pencil Code this became a relatively simple modification, because this change is simply represented by going from partial derivatives to covariant derivatives. This implies the addition of terms involving Christoffel symbols and emerges as a relatively neat modification. During the meeting it was emphasized that some of the recent additions done for spherical coordinates may still be missing for cylindrical coordinates (e.g. timestep control and some diagnostic variables). The implementation of high-order upwinding was regarded as a useful option that seemed to require a lot of work. This is because high-order upwinding corresponds to the addition of a hyperviscosity term with an amplitude proportional to the magnitude of the velocity, and hyperviscosity would be cumbersome to implement in spherical or cylindrical coordinates. However, it was then realized that such a change might be relatively simple because the change to curvilinear coordinates corresponds also here for first order derivatives just to the addition of relatively few additional terms involving Christoffel symbols.

4 Highlights of results obtained with Pencil Code during the last year

4.1 Planetesimal formation by self-gravity



A self-gravity solver was implemented for the Pencil Code by Anders Johansen and Jeff Oishi as part of an exchange programme between Max Planck Institute for Astronomy in Heidelberg and American Museum of Natural History in New York. This solver was subsequently used for modelling the gravitational instability of solids (boulders) in a protoplanetary disc. The figure shows the column density of solids. Boulders have concentrated in the magnetised turbulence into a thin sheet with a so high density that gravitationally bound objects have condensed out of the turbulent flow.

5 Final program of the meeting

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Tuesday, 9-10:30, 11-12:30
9:00 Axel Brandenburg   Introduction
9:15 Anders Johansen    Dust in self gravitating shearing sheets
Cristina Green          Traveling waves in sheared convection
Discussion

Tuesday, 14-15:30, 16-17:30
Wolfgang Dobler         CVS, Mercurial or Subversion -- do we need a
Sven Bingert            Field aligned heat conduction in the corona
Marcus Gellert          Hydrodynamic simulations in cylindrical coordinates
Discussion

Wednesday, 9-10:30, 11-12:30
Miikka Visl          Formation of elephant trunks
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Tobias Heinemann Migrating to subversion
Discussion

Wednesday, 9-10:30, 11-12:30
Steve Berukoff Plans to implement protostellar disc chemistry
Chao-Chin Yang Fueling the circum-nuclear region of a barred galaxy
Discussion

Wednesday, 14-15:30, 16-17:30
Petri Kpyl Hi-res MHD on the Finnish Louhi machine
Anne Liljestrm Reynolds stresses in shearing boxes
Discussion

Thursday, 9-10:30, 11-12:30

Dhrubaditya Mitra Simulations in spherical coordinates
Nathalie Toque Turbulent diffusion
Boris Dintrans I. Global convection; II. Implicit method
Discussion

Thursday, 14-15:30, 16-17:30

Wladimir Lyra Global disc simulations
Lars Mattsson Disc Simulations: Evolving Late-type Galaxies
Mikaela Sundberg Code comparison projects - A sociological view
Discussion

Friday, 9-10:30, 11-12:30

Wolfgang Dobler Multigrid solvers for the Pencil Code
Discussion

Friday, 14-15:30

Axel Brandenburg Parallelization in the x-direction
Discussion

6 Budget

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