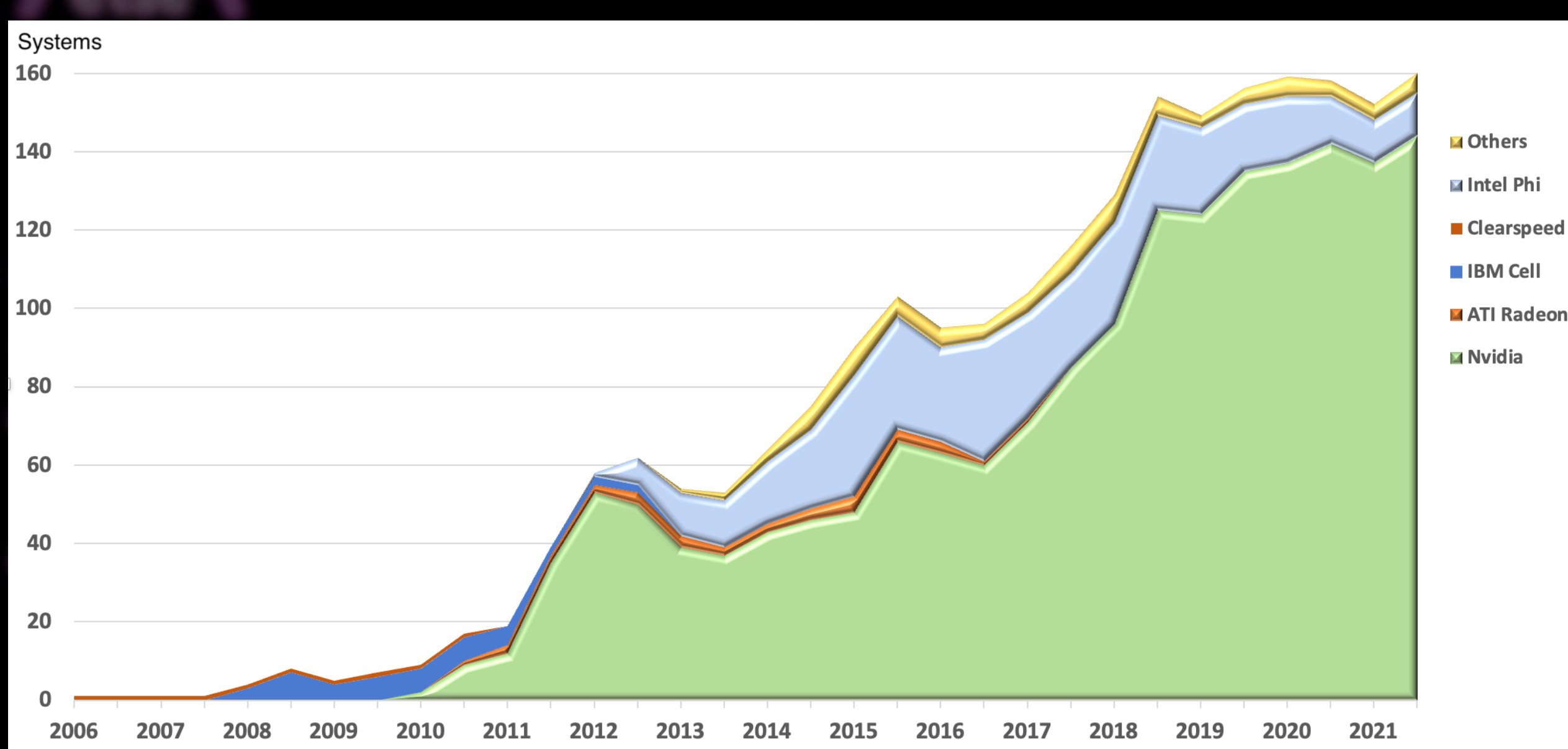# IDEFIX

## An exascale-ready code for (magneto-) hydrodynamics

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Idefix is a Kokkos[1]-based code solving the (M)HD equations in arbitrary geometry written in C++17. Idefix can run both on the latest accelerated supercomputer using GPUs and on your laptop, with no hassle.

### The facts

The number of accelerated clusters is rising



# systems using GPU accelerators in the TOP500[2]

### The magic

- Replace C arrays by `IdefixArray`
- Replace for loops by `idefix_for`

That's it* !

```
1   // User-defined gravitational potential. This function is enrolled in the
2   // integration algorithm by the constructor of the Setup class (see below)
3   void Potential(DataBlock& data,
4                  const real t,
5                  IdefixArray1D<real>& x1,
6                  IdefixArray1D<real>& x2,
7                  IdefixArray1D<real>& x3,
8                  IdefixArray3D<real>& phi) {
9
10      idefix_for("Potential",
11                 0, data.np_tot[KDIR],
12                 0, data.np_tot[JDIR],
13                 0, data.np_tot[IDIR],
14          KOKKOS_LAMBDA (int k, int j, int i) {
15              phi(k,j,i) = -1.0/x1(i);
16      });
17  }
```

* In a few cases, extra steps are required such as when performing reduction operations
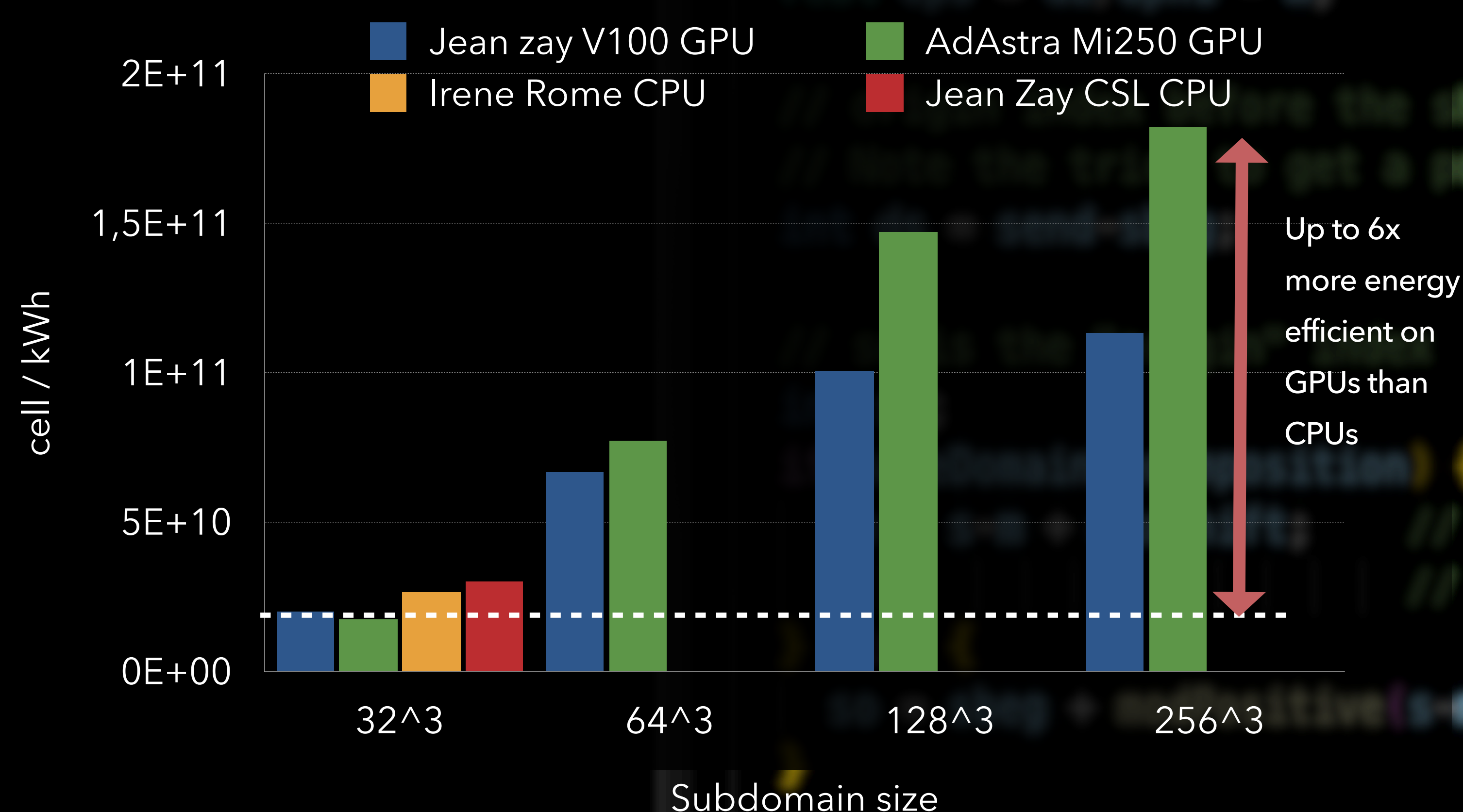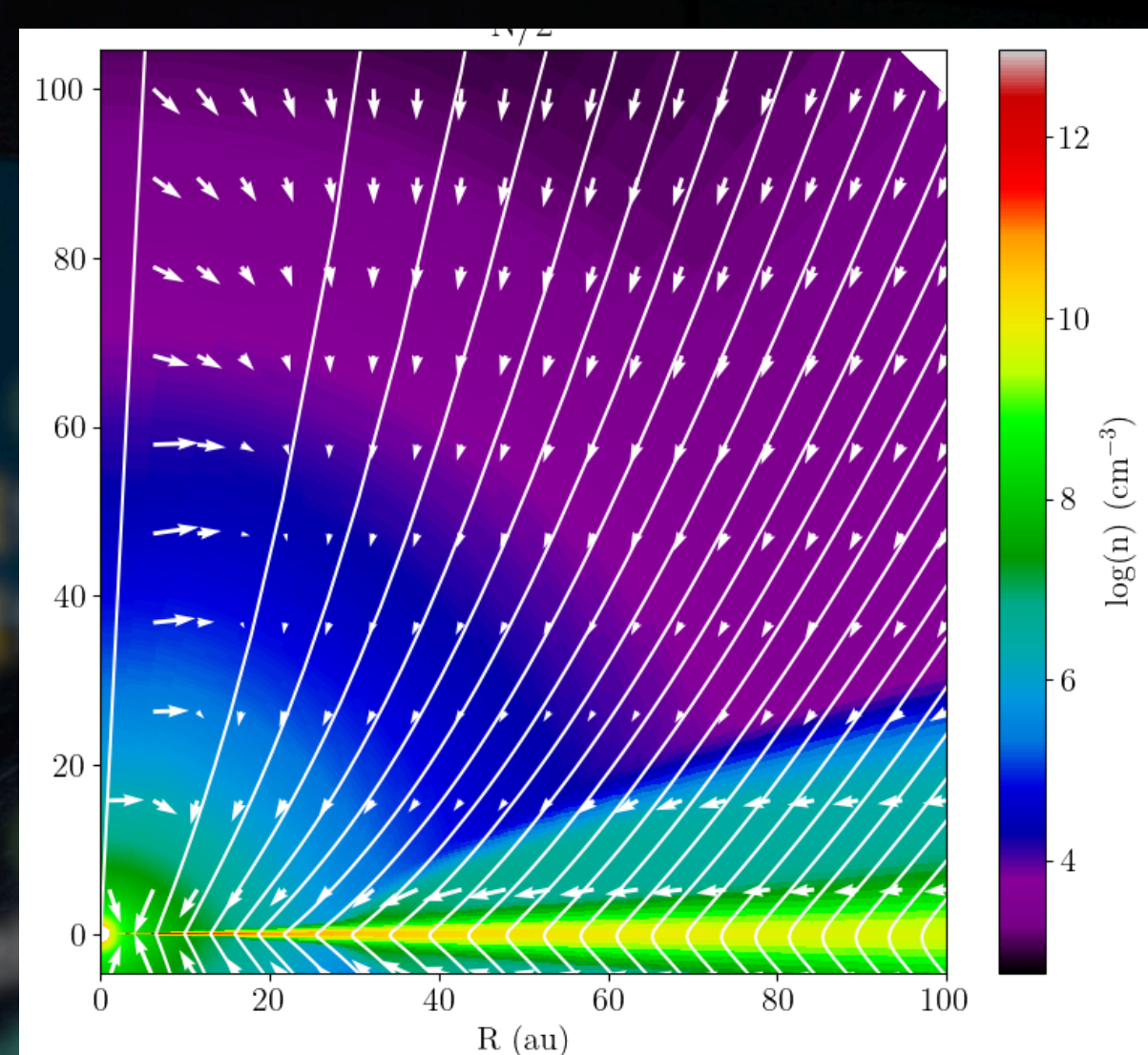
### Performance & energy efficiency
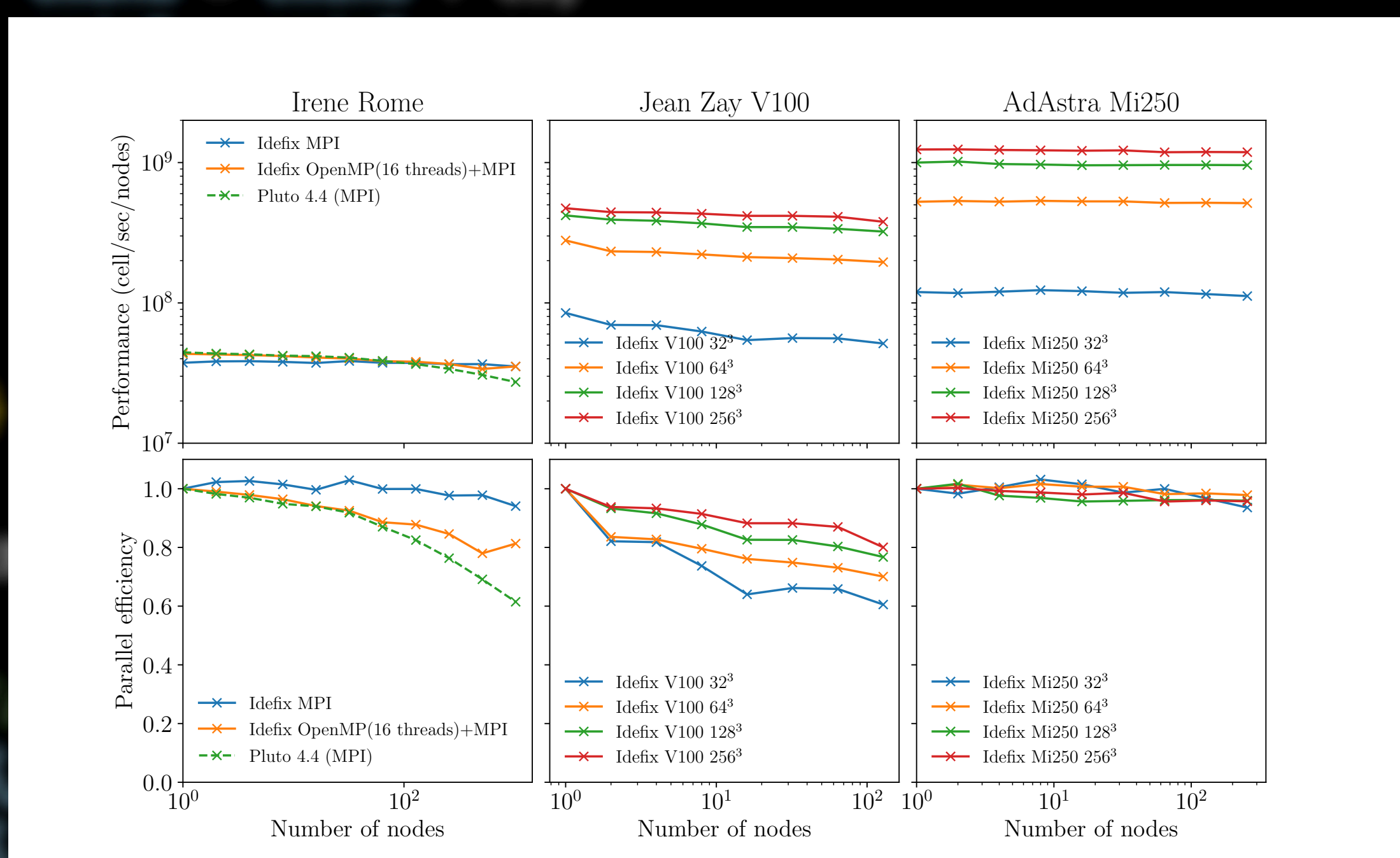


>80% parallel efficiency on up to 131 000 CPU cores and up to 2048 AMD Mi250 GPUs.
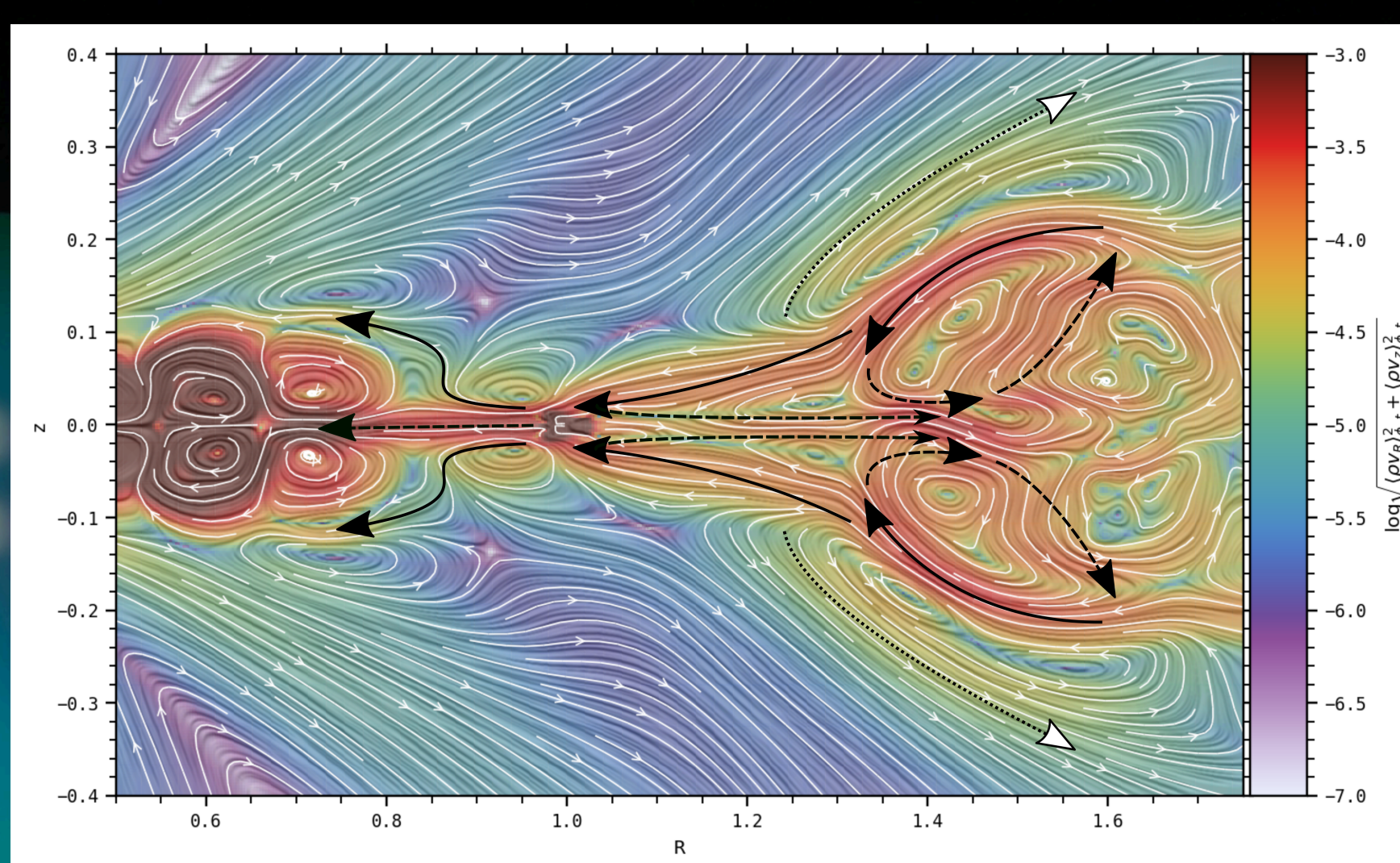Speedup: a single Nvidia V100~120 Intel CSL cores.
Performances comparable to Pluto 4.3[3] on CPUs



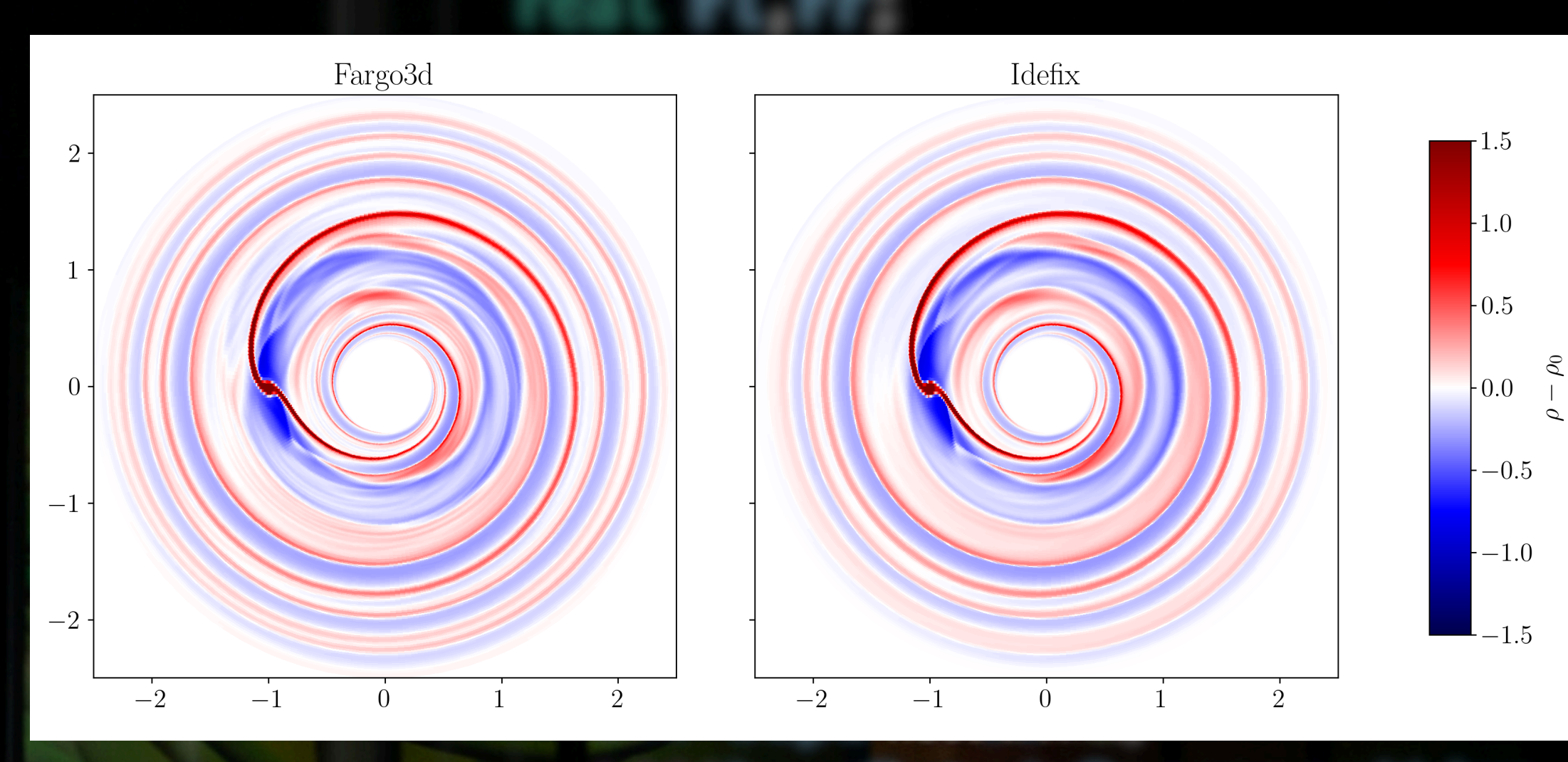Up to 6x more energy efficient on GPUs than CPUs

### Tests & Applications



NiMHD core collapse simations
[J. Mauxion]



Planet-disk-MHD wind interaction
[G. Wafflard-Fernandez]



Orbital advection with embedded planets
(comparison with Fargo3D[4])

Try it!

References
1- Trott, C. R., Lebrun-Grandié, D., Arndt, D., et al. 2022, IEEE. Transactions on Parallel and Distributed Systems, 33, 805
2- Reed D., Gannon D., Dongarra J., 2022, arXiv, arXiv:2203.02544.
3- Mignone, A., Bodo, G., Massaglia, S., et al. 2007, ApJS, 170, 228
4- Benítez-Llambay, P. & Masset, F. S. 2016, ApJS, 223, 11

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MHDiscs
Revealing the dynamics of planet-forming discs

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