GadgetACC (last day)

GadgetACC

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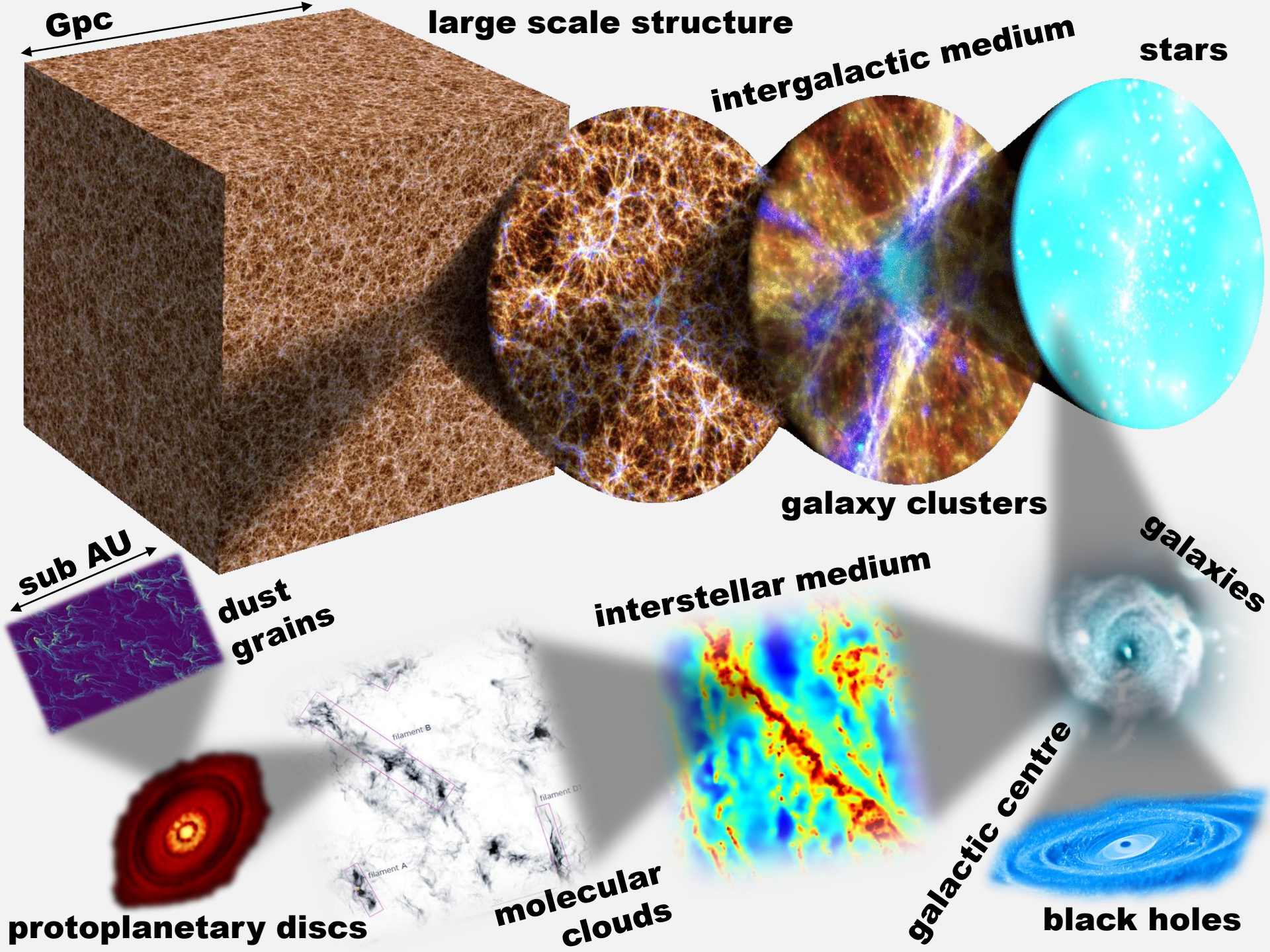
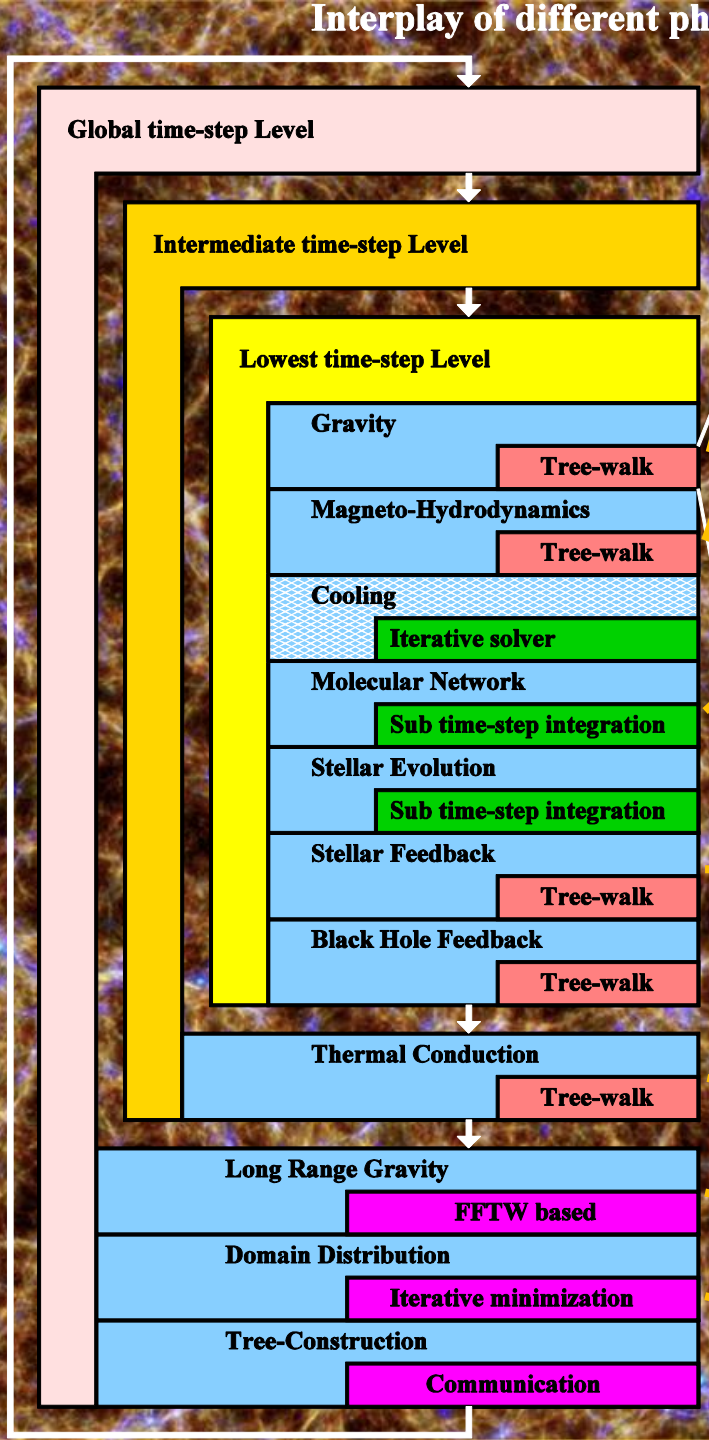
Menthors:
Mathias Wagner & Vasileios Karakas


Gpc
large scale structure
intergalactic medium
stars
galaxy clusters
sub AU
dust grains
interstellar medium
galaxies
filament B
filament D
filament A
protoplanetary discs
molecular clouds
galactic centre
black holes



Our app

Gravity

Smoothed particle hydrodynamics

Radiative losses
+
Chemical network
+
Stellar evolution

Stellar feedback

Black hole treatment

Transport

PM gravity

Work load balancing

Tree

local

Con. gradient

FFTW

Performance (test run on CPU):

Setup: 1 Node, 1 MPI rank, 12 OpenMP tasks

```
Step 2147, Time: 1, CPUs: 1
total                1992.45   100.0%
treegrav              804.20    40.4%
   treebuild          393.27    19.7%
   treeupdate          25.45     1.3%
   treewalk           373.41    18.7%
pmgrav                351.83    17.7%
domain                204.51    10.3%
predict                 8.89     0.4%
kicks                   6.81     0.3%
i/o                     5.82     0.3%
peano                 215.40    10.8%
fof/subfind           343.67    17.2%
  subfind             314.48    15.8%
    density           194.99     9.8%
misc                   51.29     2.6%
```

New bottlelecks ahead !

→ **vague idea**

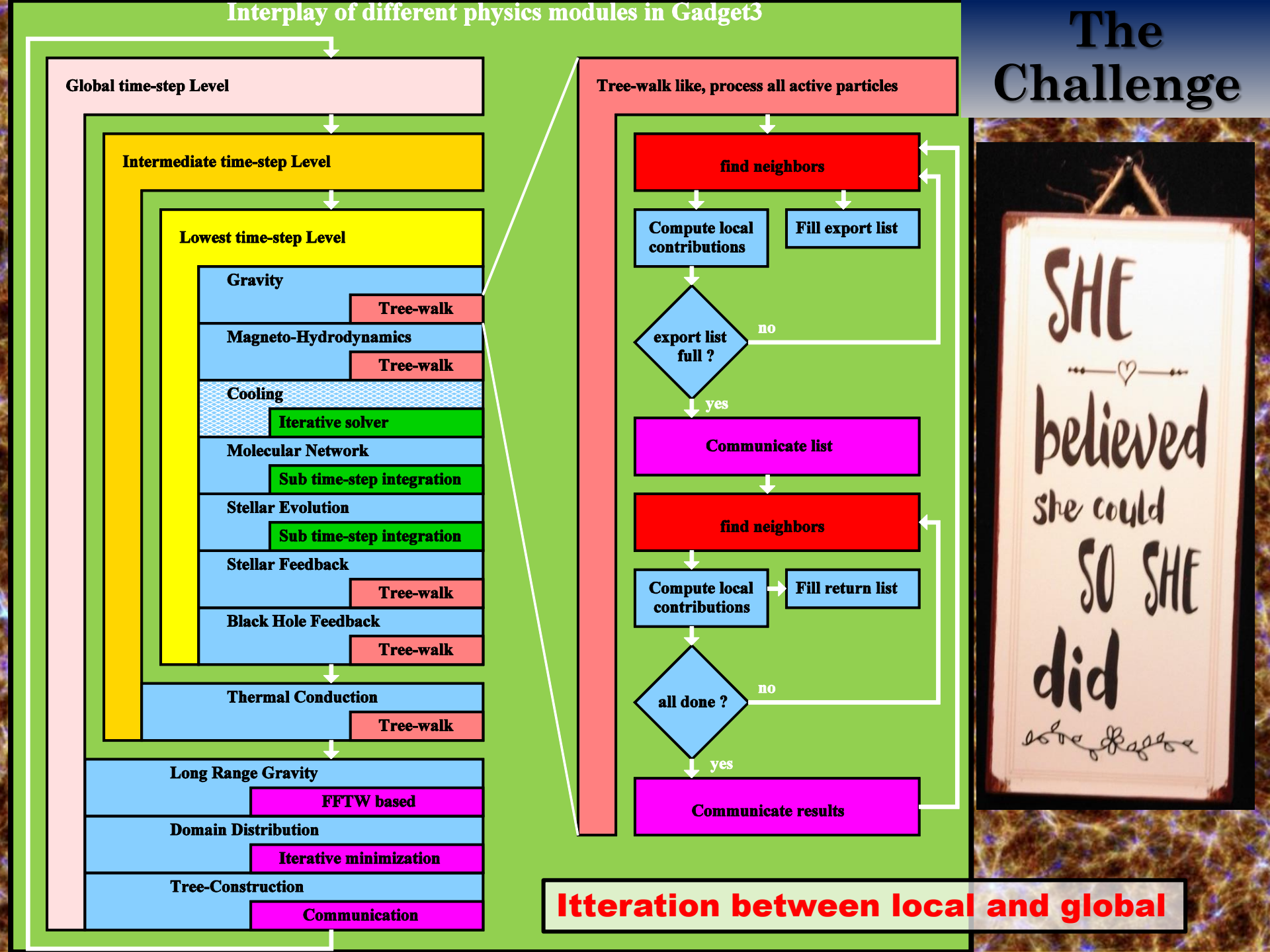
→ **GPU**

→ **solved! (32.44)**

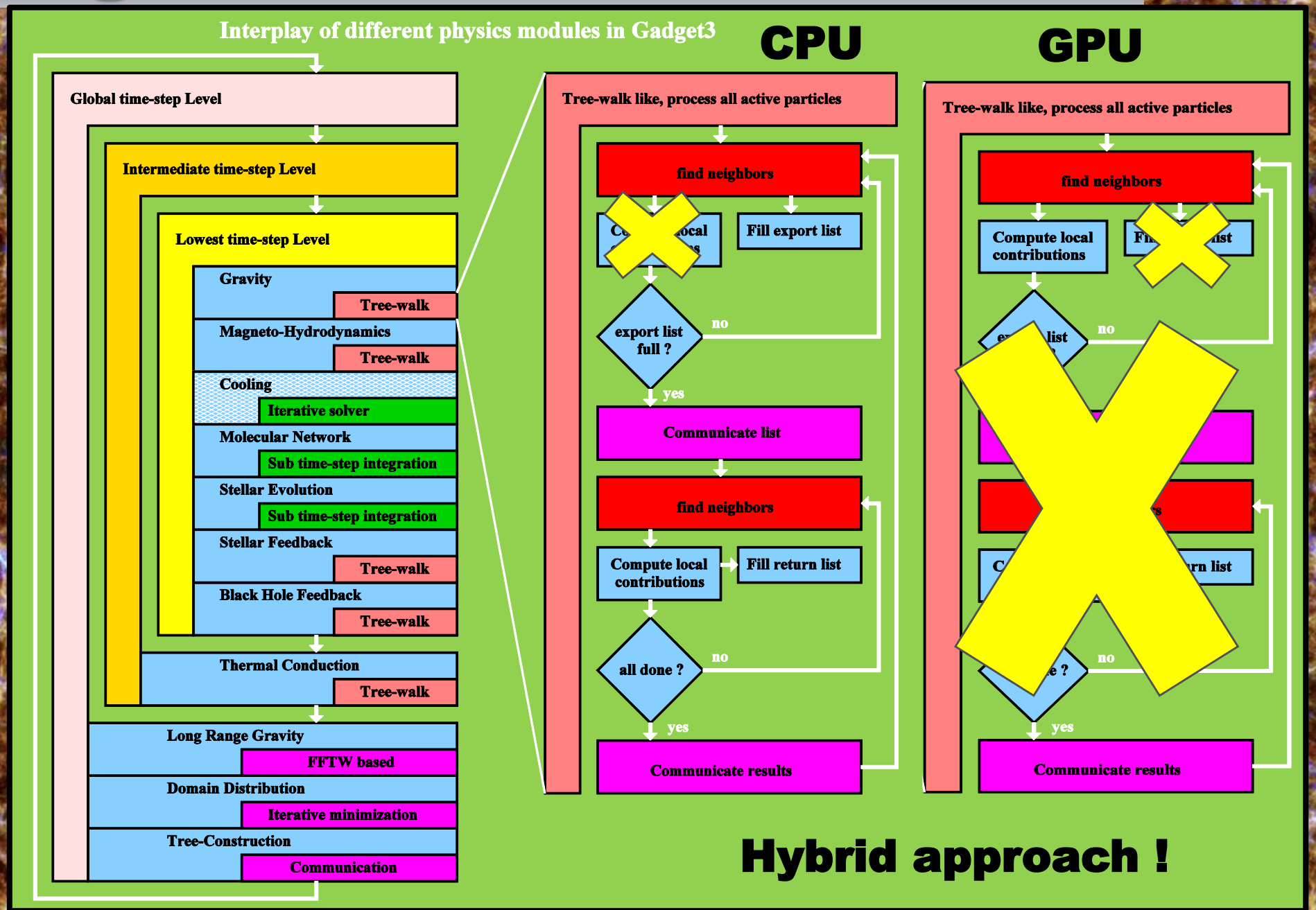
→ **detailed idea**

→ **solved! (120.46)**

→ **GPU**

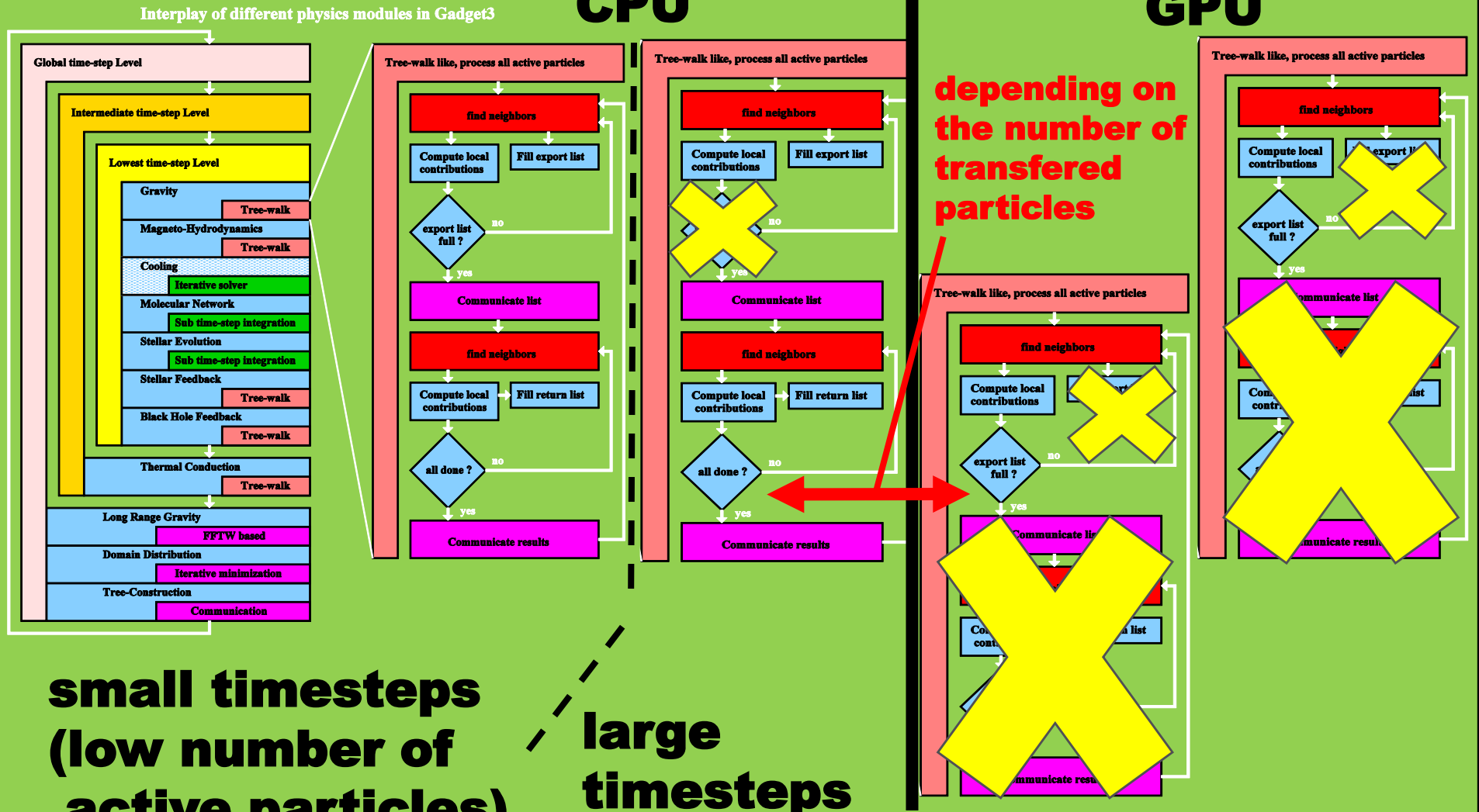

Interplay of different physics modules in Gadget3
Global time-step Level
Intermediate time-step Level
Lowest time-step Level
Gravity
Tree-walk
Magneto-Hydrodynamics
Tree-walk
Cooling
Iterative solver
Molecular Network
Sub time-step integration
Stellar Evolution
Sub time-step integration
Stellar Feedback
Tree-walk
Black Hole Feedback
Tree-walk
Thermal Conduction
Tree-walk
Long Range Gravity
FFTW based
Domain Distribution
Iterative minimization
Tree-Construction
Communication
Tree-walk like, process all active particles
find neighbors
Compute local contributions
Fill export list
export list full ?
no
yes
Communicate list
find neighbors
Compute local contributions
Fill return list
all done ?
no
yes
Communicate results
Itteration between local and global
The Challenge
SHE
believed
she could
SO SHE
did

Algorithmic motif on arival:



Algorithmic motif on departure:

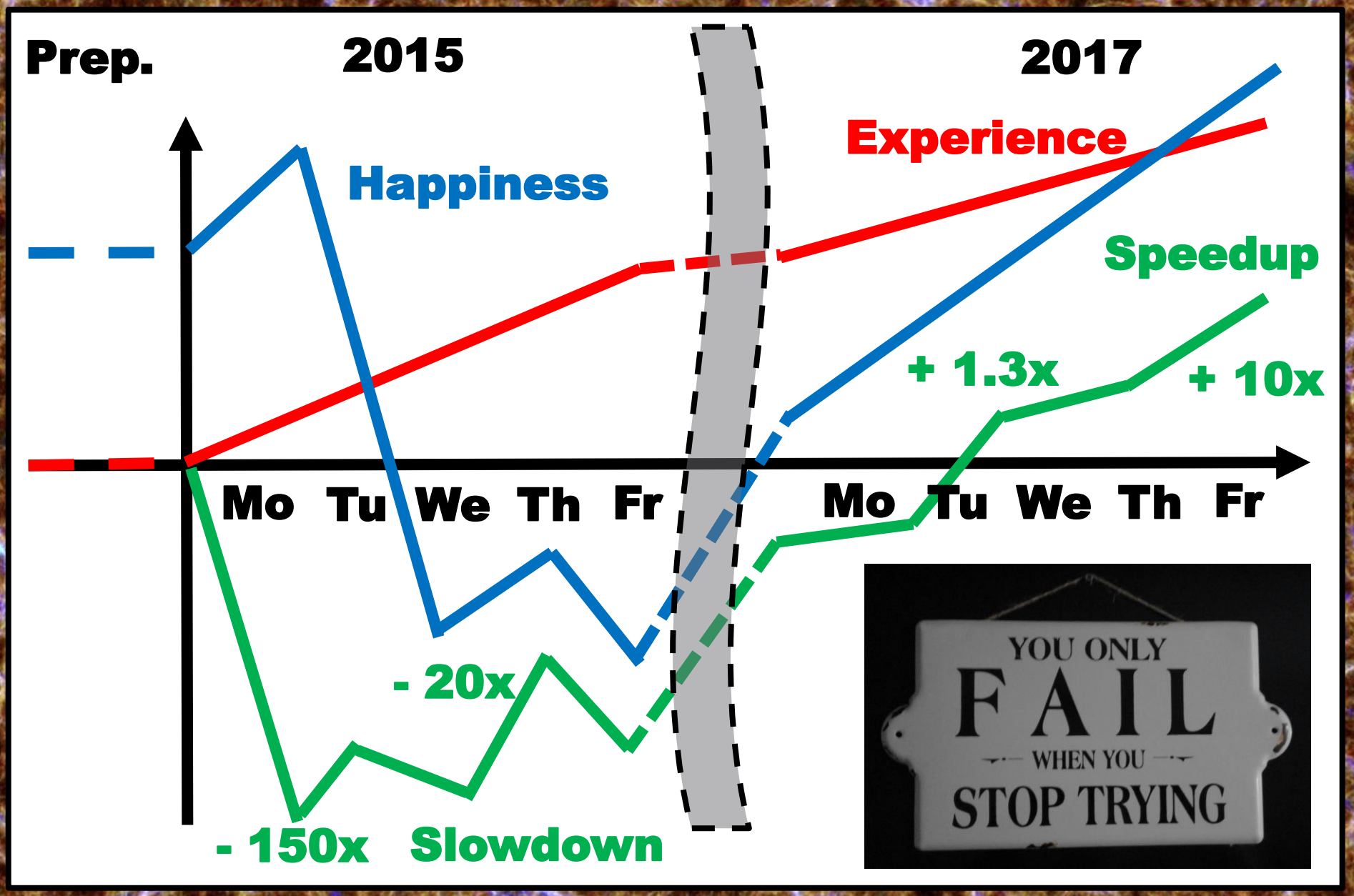
Double hybrid approach !



small timesteps (low number of active particles)

large timesteps (high number of active particles)

from HACK 2015 to HACK 2017



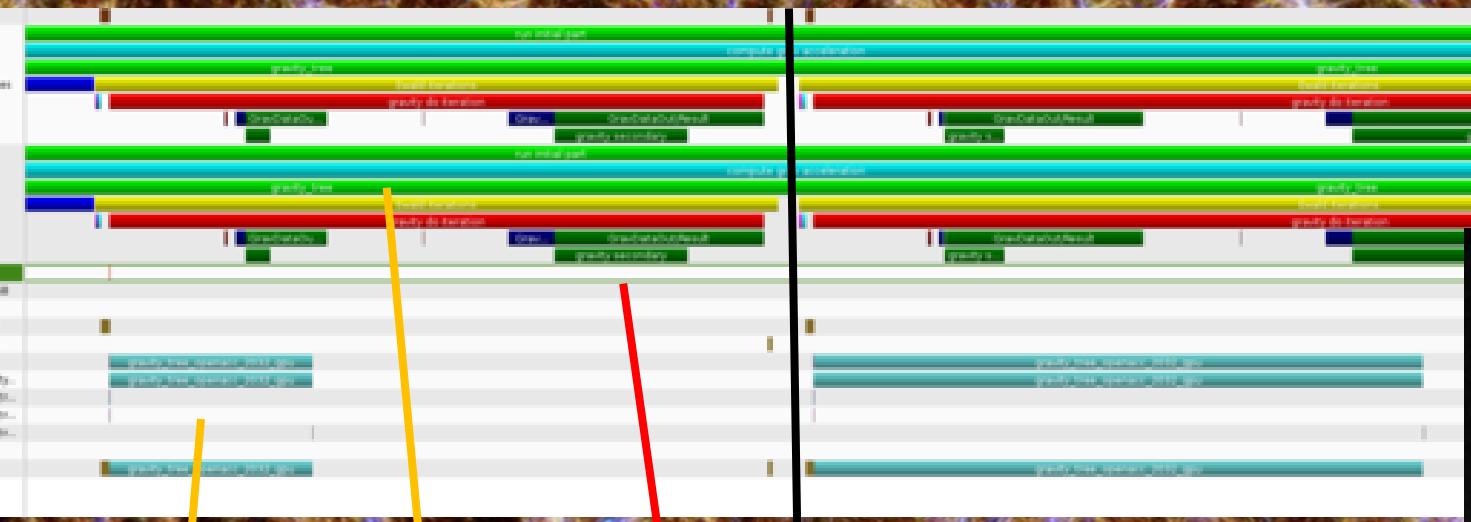
GPU Performance (production):

256 Nodes with GPUs, 48 Million part/node

Step 0, Time: 0.0163934, CPUs: 256	CPU only	GPU hybrid
total	356.60	153.48
treegrav	112.32	44.08
treebuild	17.64	28.08
treewalk	86.22	8.90
pmgrav	52.42	16.92
peano	12.32	4.94

But: 16.9 produced crashes with –O2 (17.7 was fine)

Timings of critical cases:

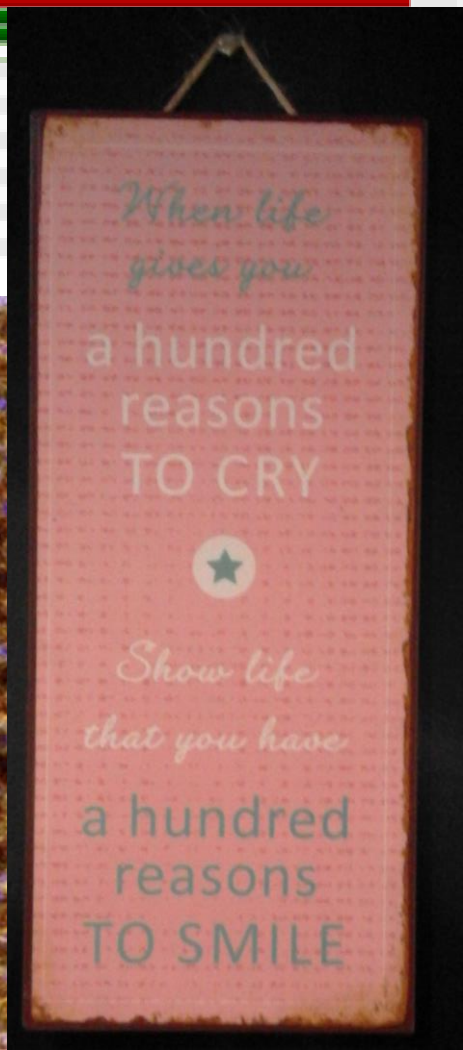


Next timestep

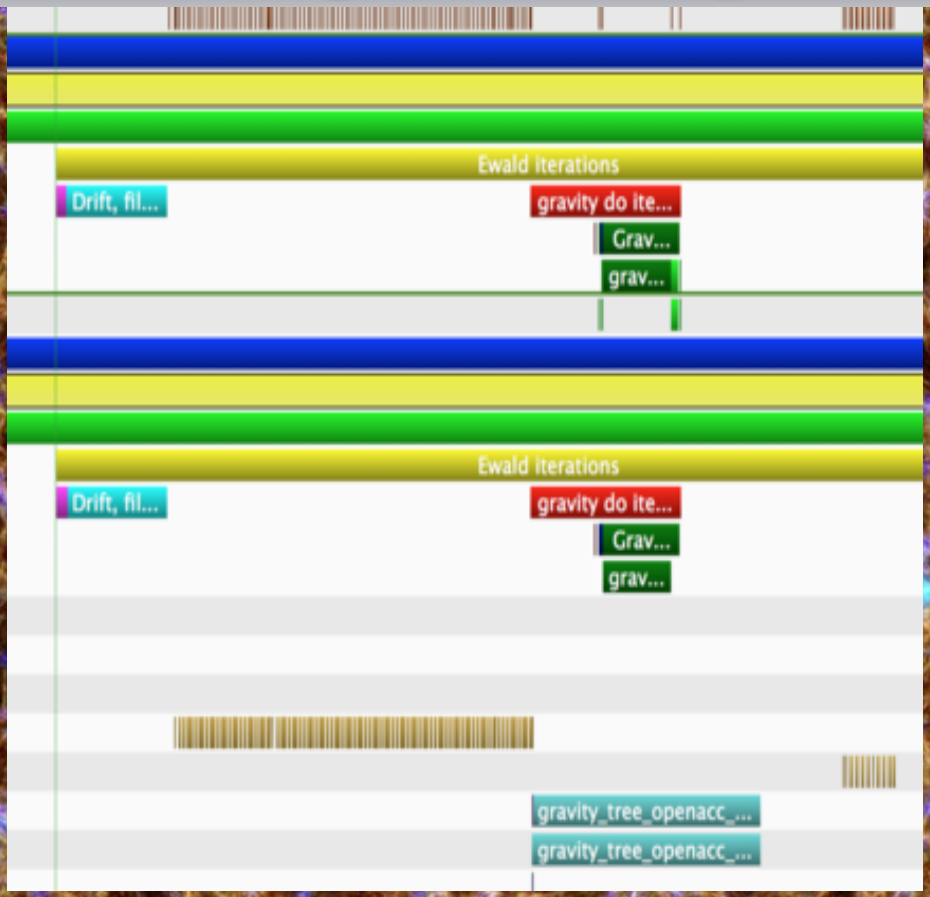
can be placed on the GPU

CPU serving other nodes

GPU kernel for local particlse



Timings of super critical cases:

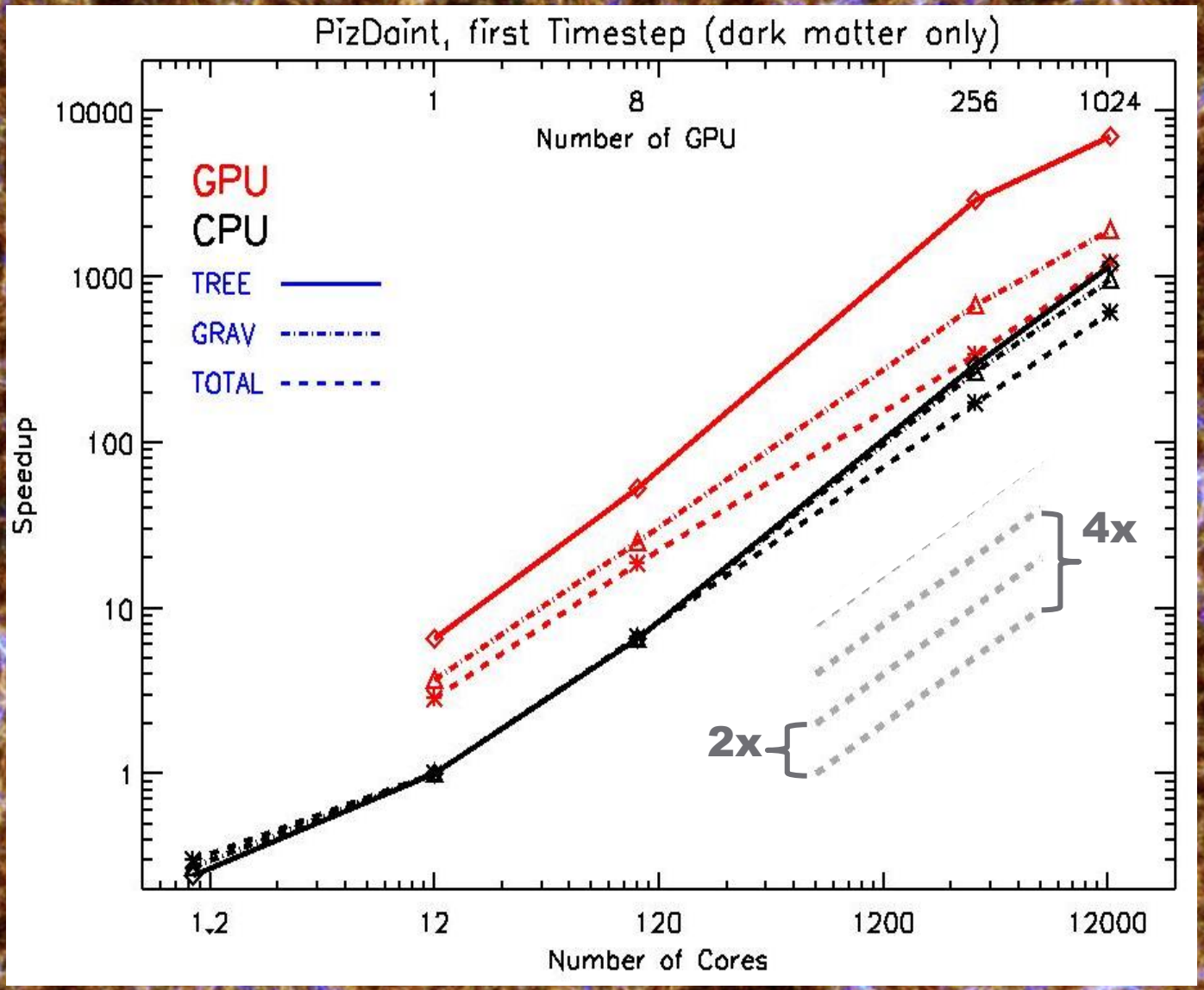


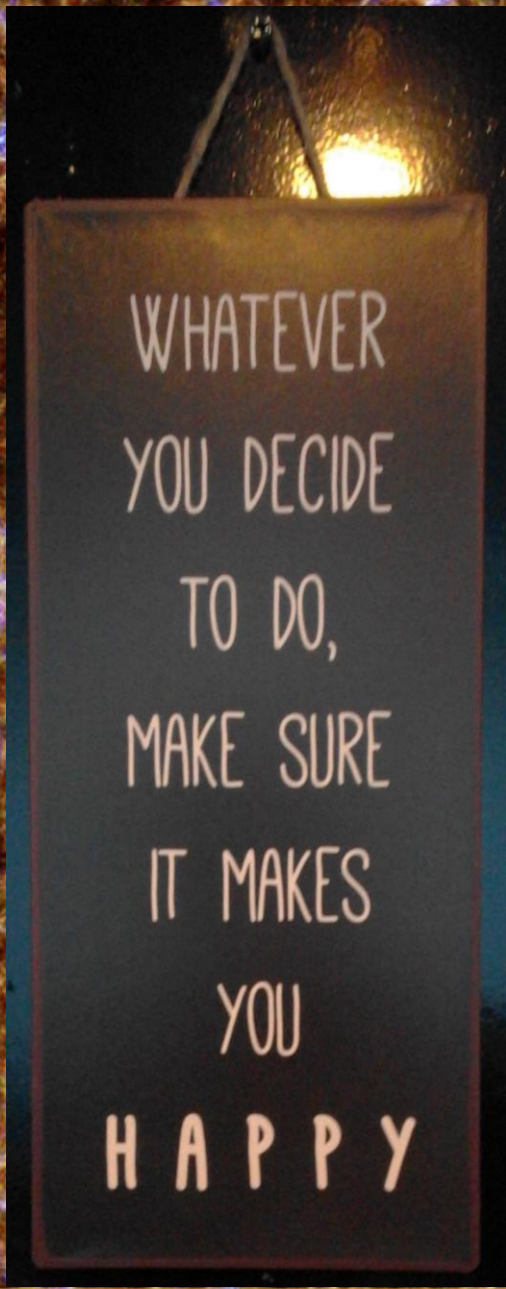
Asyc transfere (using pinned)

But:

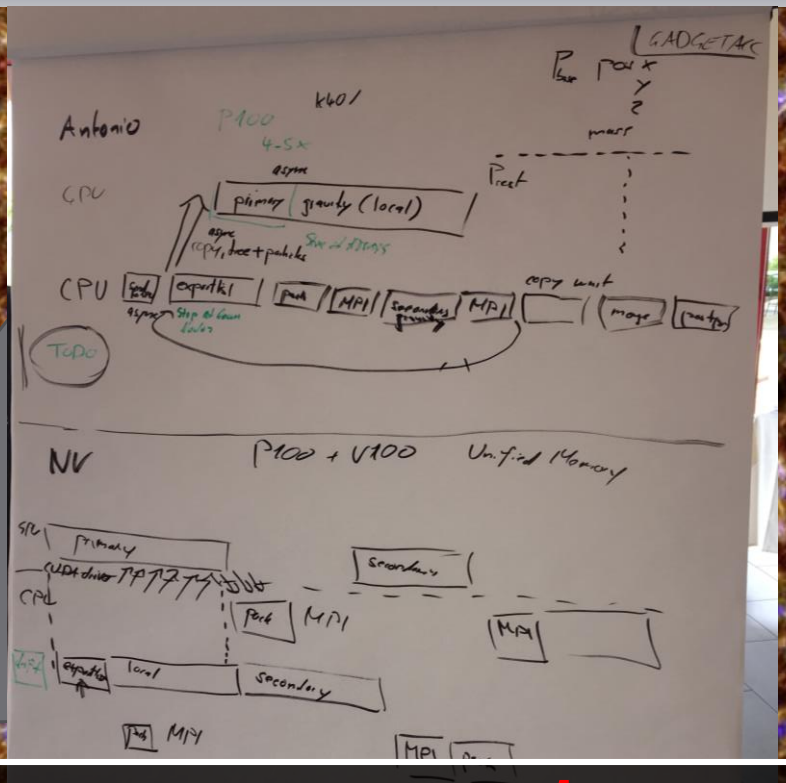
- **Pinning slows down the CPU part !**
- **Causes crashes (pool manager)**

Scaling to large number of GPUs:





Achievements at hackathon 2017:



- Keep Speedup + Happyness positive √
- Profiling / optimize the new approach √
- Test Scaling up to very large number of GPUs √
- Port approach to other physical modules (√)
- Obtain a first production version for GPUs ! (√)
- Additional CPU performance gained !