# Ultra-Low-Power HPC
## Green Computing

TOKYO TECH Pursuing Excellence

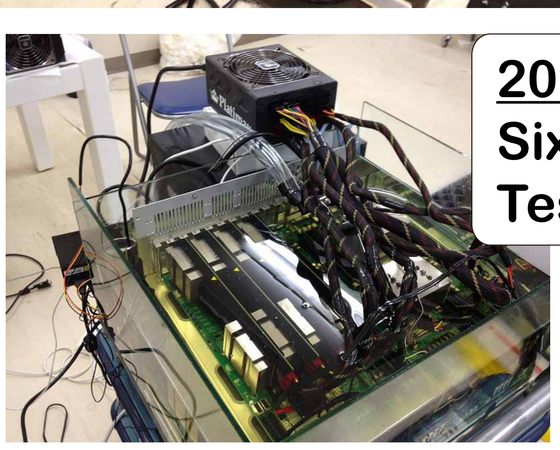
## ULP-HPC Project

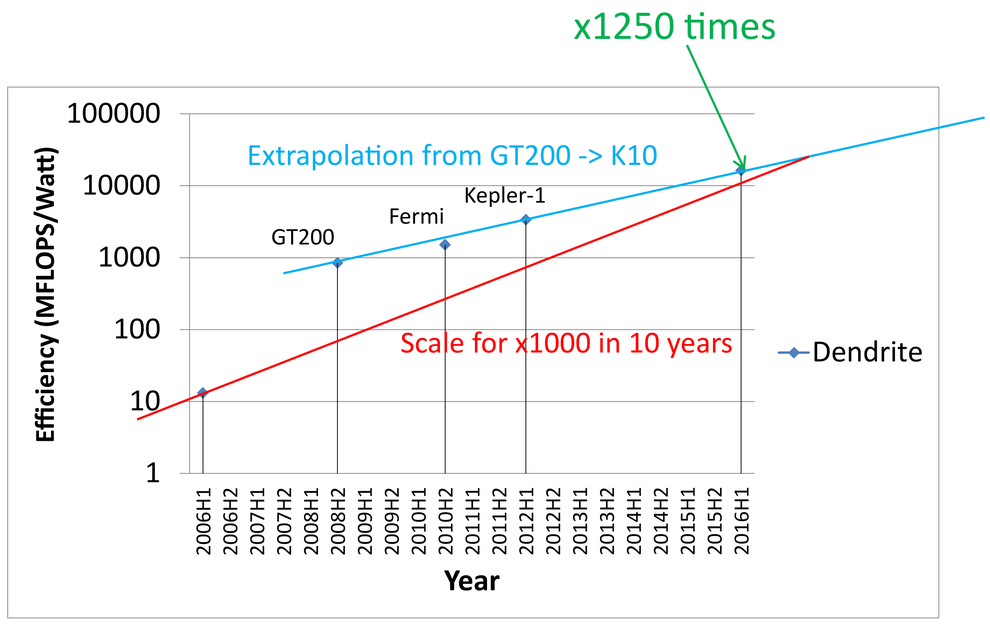
ULPHPC project is funded by JST CREST from 2007 Oct. to 2013 Mar. The main goal of the project is improvement in power efficiencies. We are working on

1,000x power efficiency within 10 years

from 2006H1 (TSUBAME 1.0) to 2016H1.



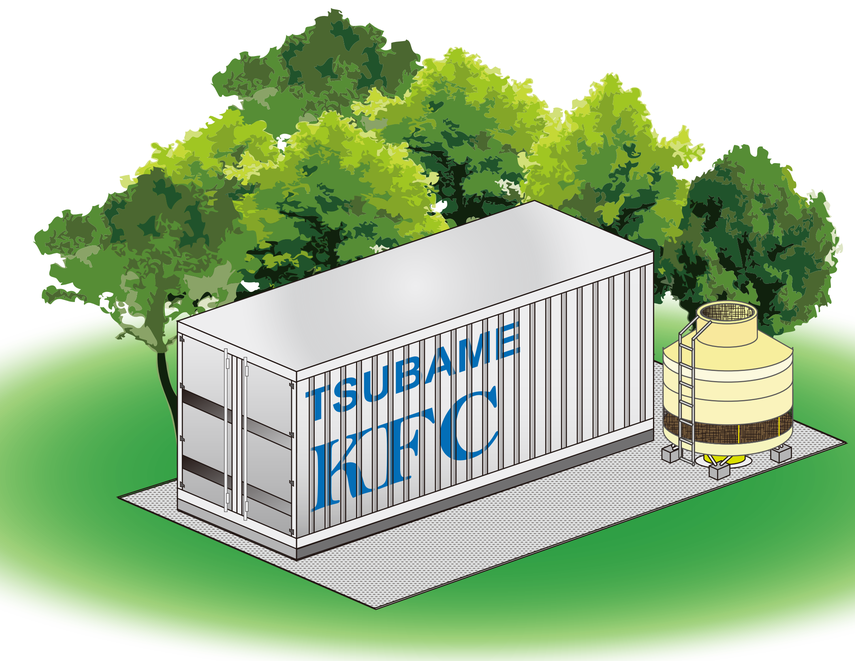

This graph shows the power efficiency in dendrite solidification simulation code (See Gordon Bell panel for detail). 2006H1 machine has only CPUs. In 2008H2, the system with GT200 GPU achieves 60x improvement. After that, GPU changes to Fermi and Kepler, which provide us higher power efficiency without any code change. Using extrapolation, we will achieve 1,250x power efficiency in 2016H1.

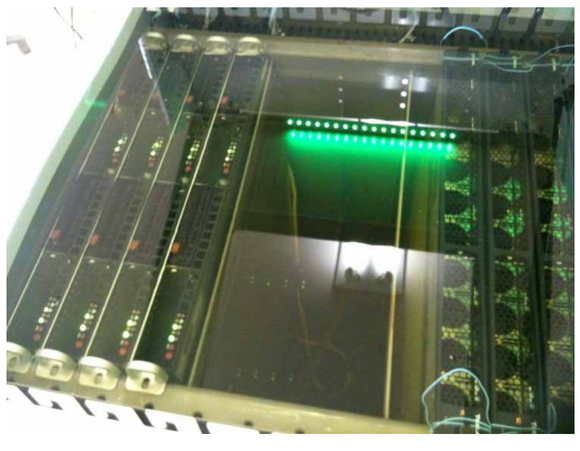
## GPGPU

We are also contributing to the GPGPU community. We developed many high performance software for GPU such as heterogeneous LINPACK, sparse solvers, FFT and so on. We extended auto-tuning system ABCLib, and now it supports GPU and auto-tuning not only for performance but also for energy.

## Cooling Technology

Supercomputers require much energy not only for the computer systems but also for cooling facilities. In term of PUE (Power Usage Effectiveness), TSUBAME 2.0 has very good PUE of 1.28. We aim further better PUE using many new technologies. GPUs have high thermal density, therefore we need aggressive cooling technology such as oil-submersion cooling.



This is the design of a container based supercomputer system we are planning. Everything is optimized for minimum energy for cooling as well as for the highest compute density.

http://www.gsic.titech.ac.jp/sc12