

GPUs
and
Physics & Astronomy

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Welcome

And thank you to all and specially to,

Horst Simon

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Stanford/KIPAC staff (Martha Siegel)

UC/LBL staff

Goals of the workshop

International collaboration

Confluence of industry and academia

Common roadblocks and challenges

Future roadmaps

The journey...

From

“What’s a GPU?”

To

“How many GPU can this cluster hold? That’s not acceptable! We need more.”

NASA ADS - GPU keyword search yields 78 hits

2009 41 papers

2008 11 papers

Why GPUs

Performance (10x to 400x enhancements)

Volume and Rate

Energy efficiency

Green computing, green science

Price and Portability

Remote computing

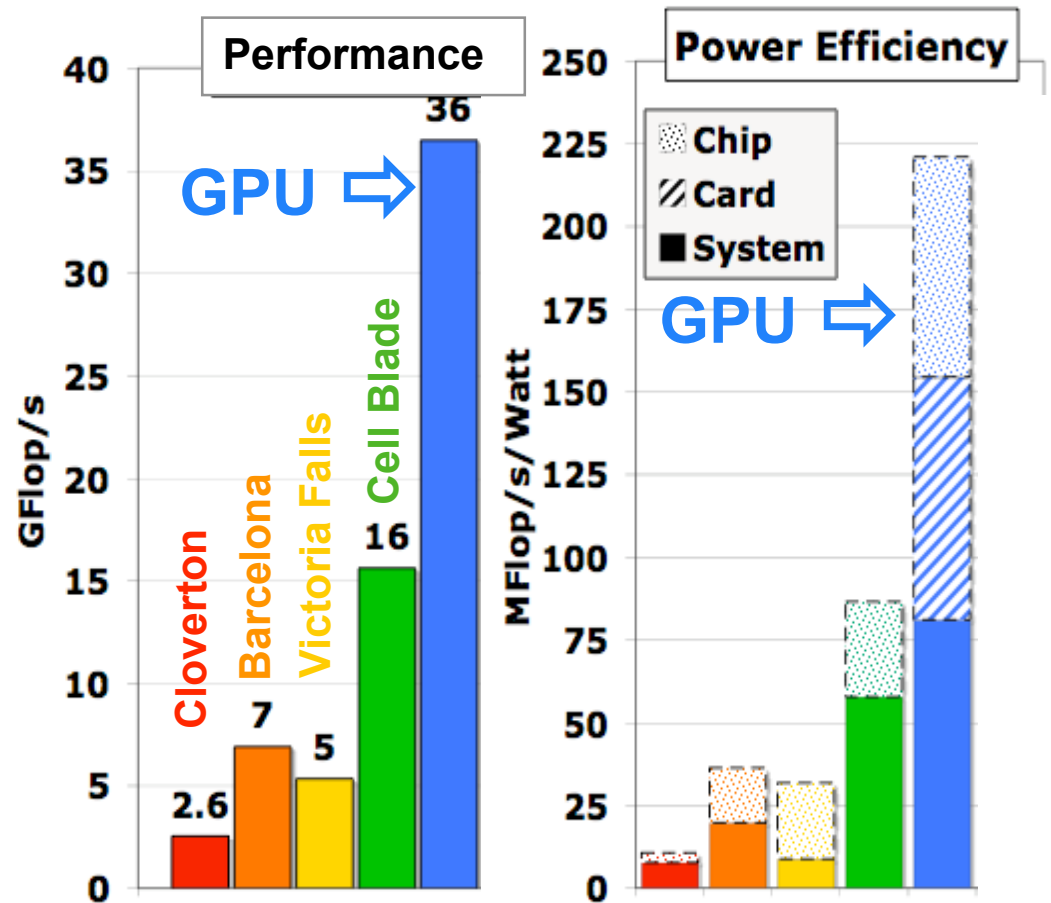
Benchmarks

CRD/NERSC GPU-based Systems

NVIDIA 8800GTX, 128 core, 8 sockets (345 Single Precision (SP) Megaflops/GPU)

NVIDIA GTX280, 240 core, 1 socket (78 Double Precision (DP) Megaflops)

NVIDIA QuadroPlex 2200 S4, 1024 cores, 1 socket (1 Teraflop SP and 345 Gigaflops DP)



Power efficiency comparison on various CRD/NERSC systems delivered for a PDE solver (Heat Equation) on a 128^3 block-structured grid. Superior GPU (GTX280) performances and power efficiency are quite evident. (K. Datta, et al.)

Data Volume

Next-generation Physics & Astronomy experiments

Palomar Transient Factory	2 GB/night
Dark Energy Survey	300 GB/night (2PB total)
LSST	0.5 PB/month
ATLAS	1 PB/year
LHC	15 PB/year

Challenges for Physics & Astronomy community

No generic turnkey solutions available

Cross-discipline expertise needed

Our approach...

Classification of applications

Simulations

(Cosmology, Adaptive optics, Fourier optics)

Instrumentation

(Software Correlator, Real-time imaging, SDR)

Data Processing

(Pipelines, Signal processing)

Our approach... (cont'd)

Common algorithms

Fast Fourier Transforms

Convolutions (with FFT)

N-body

N-point correlation functions

...

Solutions

Tools

API / Middleware

Software Framework

Hardware test beds

Complete hardware / software turnkey solutions

Education / Collaboration

Real Cases

LSST, ATA, JDEM, Dome A, DES...

Low Frequency pipeline, Transient Search, Real-time imaging, Software correlator, Wavefront Phase Retrieval, Adaptive Optics, PSF modeling, Spectrograph simulation, N-point correlation, N-body simulations, Ray tracing...

Issues...

Avoid porting of code

Explore languages CUDA, OpenCL...

Hardware bottlenecks

Extend solutions to other science domains
(medical imaging, climate modeling...)