# MATRIX ALGEBRA FOR GPU AND MULTICORE ARCHITECTURES

# MAGMA

The Matrix Algebra for GPU and Multicore Architectures (MAGMA) project aims to create a new generation of linear algebra libraries that achieve the fastest possible time to an accurate solution on heterogeneous/hybrid systems, using all available processing power. The main focus is the development of a dense linear algebra library for hybrid systems of homogeneous x86-based multicores accelerated with GPUs. MAGMA is designed to be similar to LAPACK in functionality, data storage, and interface, in order to allow scientists to effortlessly port any of their LAPACK-relying software components to take advantage of the new architectures.

#### **HYBRID ALGORITHMS**

MAGMA uses a hybridization methodology where algorithms of interest are split into tasks of varying granularity and their execution scheduled over the available hardware components.

Small non-parallelizable tasks, often on the critical path, are scheduled on the CPU, and larger more parallelizable ones, often Level 3 BLAS, are scheduled on the GPU.

# **MAGMA BLAS**

MAGMA BLAS targets a subset of BLAS routines for NVIDIA GPUs that are specific to MAGMA and can improve on CUBLAS. It includes routines for Fermi and for the older generation of Tesla GPUs. MAGMA BLAS supports streaming. Its new GEMM for Fermi GPUs is now used in CUBLAS 3.2.

# MAGMA 1.0

- Linear Systems Solvers
- Least Squares Solvers
- Mixed-Precision Iterative Refinement for Linear Systems and Least Squares
- Eigenvalue/singular value Solvers
- MAGMA BLAS
- CPU and GPU Interfaces
- Multiple Precision Support
- Multicore and one NVIDIA GPU Support
- Linux, Mac OS

#### **CURRENT RESEARCH**

• Integrating MAGMA with tools and libraries like:

**PLASMA**, to more efficiently use multicore hosts

**StarPU**, to support heterogeneous nodes featuring multiGPUs and multicore

**DAGUE**, to support distributed systems of manycore CPUs and multi-GPUs

- Autotuning framework and OpenCL port
- Extended functionality, including sparse linear algebra

#### PERFORMANCE



#### MAGMA LU-based solvers on Fermi (C2050)



C2050: 448 Cores @ 1.15 GHz SP/DP peak is 1030/515 Gflop/s



