

# Our LBL Visit: Accomplishments and Future Work

Mauro Calderara <sup>1</sup>   Jonathan Coles <sup>2</sup>   François Gaignat <sup>1</sup>

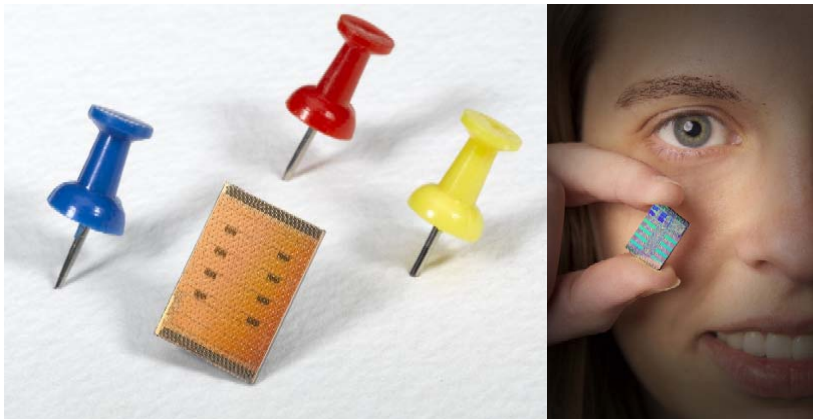
<sup>1</sup>ETH Zürich

<sup>2</sup>Institut für Theoretische Physik, Universität Zürich

August 5, 2007

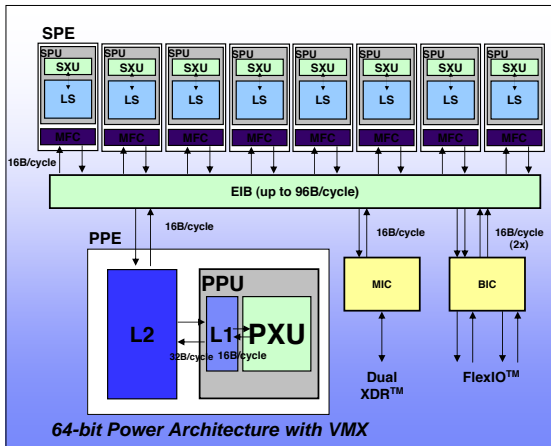


# Introduction to the Cell Processor



Dr. Michael Perrone, IBM. MIT Lecture Slides

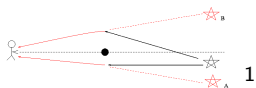
# Introduction to the Cell Processor



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# What can we do with the Cell?

- Gravitational Lens Modeling



- Solar System Integration



- 3D FFTs



- MHD

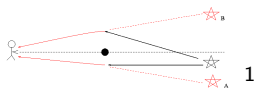
The future of these fields require higher precision calculations than current hardware provides.

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<sup>1</sup>Michael Richmond. <http://spiff.rit.edu/classes/phys240/>

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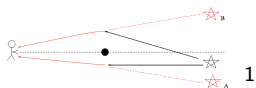
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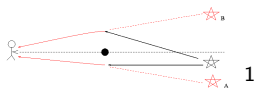
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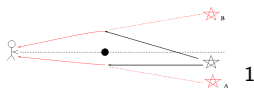
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# High-Precision Library

Many high precision or arbitrary precision libraries already exist:

- qd/dd
- arprec

These are yet tailored to take advantage of the vector capabilities of the Cell processor.

Our High-precision Floating-point Numbers (HFNs):

- Use 11-bit exponents and 117-bit mantissa (with hidden bit)
- Fit completely into a single SPU register
- Can be easily adjusted to support IEEE quad-precision format.

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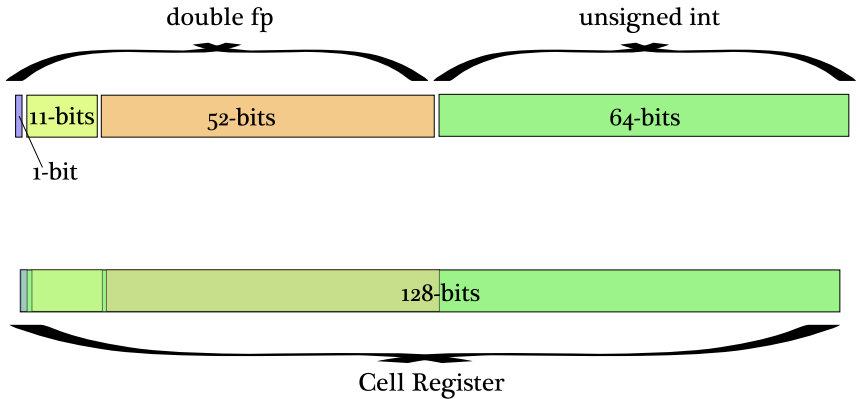
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# HFN Layout



# Multiplication

Basic idea:

- split the mantissa
- multiply the parts of the mantissa
- add the products
- (compute the exponent and the sign)

Many possible implementations:

- floating-point + integer vs integers only
- size of the parts of the mantissa

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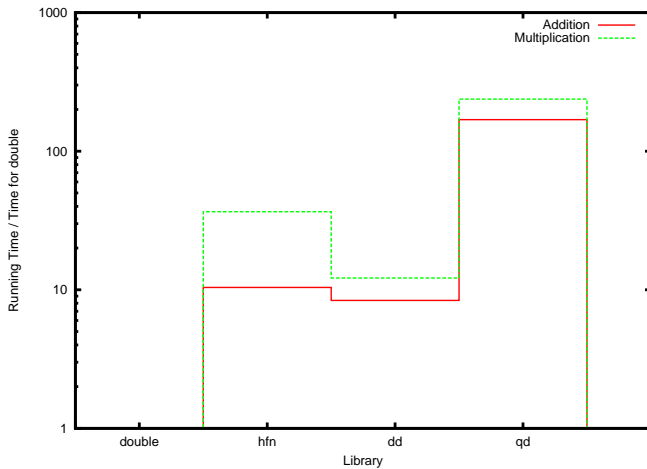
√

exp log

$\sin^{(-1)}$   $\cos^{(-1)}$   $\tan^{(-1)}$

GammaFunction  
Quadrature

# Performance



# MPI: Single Transfer BM

**PingPong** Classical pattern, measures startup and throughput of single messages between two processes.

**PingPing** Similar to PingPong, message passing is obstructed by oncoming messages (crucial). Processes wait for each other and send simultaneously.

# MPI: Parallel Transfer BM

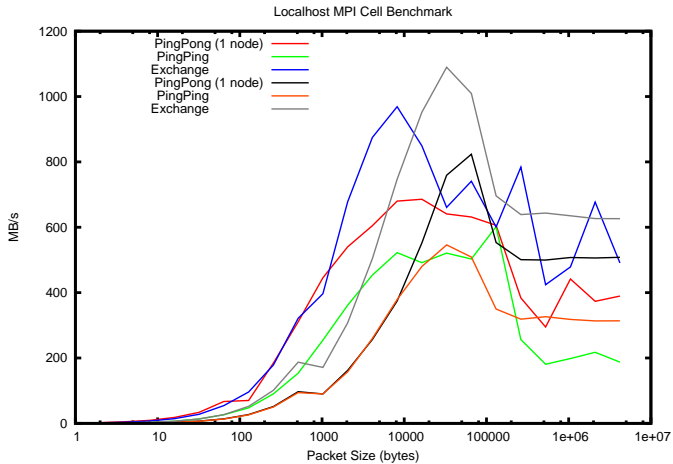
**Sendrecv** Processes form a periodic communication chain, sending to the "righthand" and receiving from the "lefthand" neighbour.

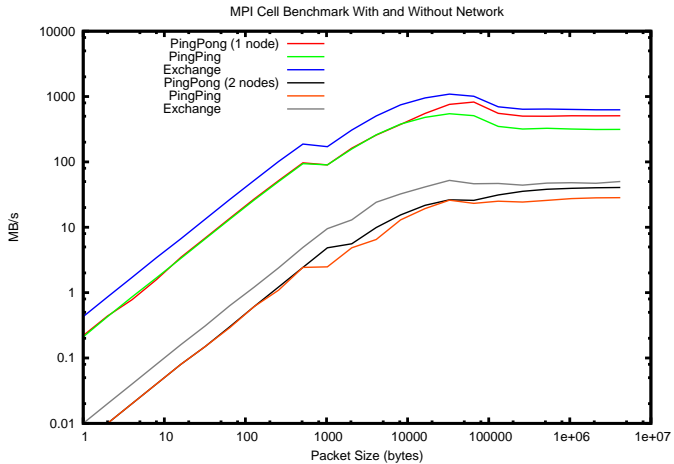
**Exchange** A pattern often seen in grid splitting algorithms (Cactus?), forming a 1D communication chain similar to Sendrecv but sending and receiving towards both sides.

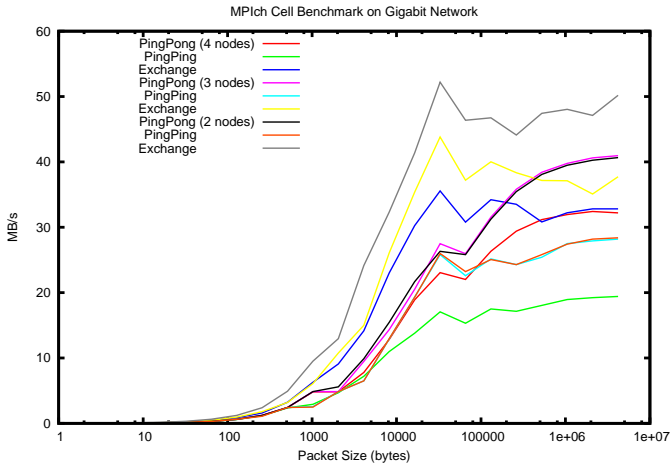
# MPI: Collective BM (i.e. other benchmarks)

- Reduce
- Reduce\_scatter
- Allreduce
- Allgather
- Allgatherv
- Alltoall
- Alltoallv
- Bcast
- Barrier

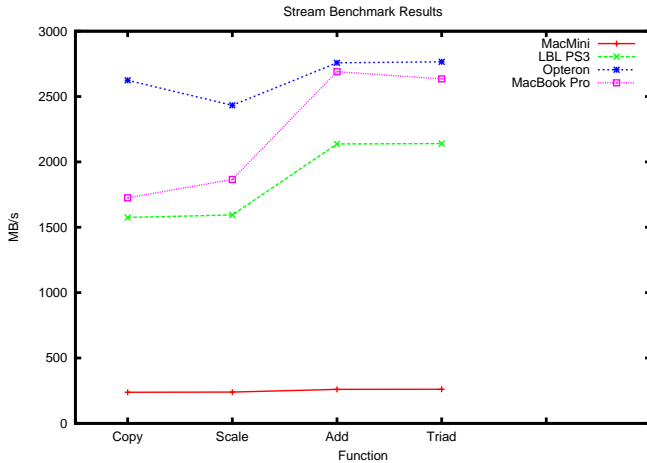
Source: Intel MPI Benchmark Handbook (v3.0)







# Stream Benchmark



# Future Work

- MPI (Lenny and John)
- FastBit (Kurt Stockinger)
- Cactus Kernels (John)
- Supernovae Simulations (Peter Nugent)

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# Who, What, Where Next?

- Us
- Future students: Master's and undergrad projects
- Great potential for further collaboration

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# Thank You

Thank you very much for your generosity, hospitality, and help!