

# LATTICE GAUGE PLANS

Michael Creutz



## Lattice gauge theory is a powerful tool

### Successes

- Confinement                      Quark Confining Dynamics
- Hadronic spectrum
- Verification of chiral symmetry breaking                       $m_\pi^2 \ll m_\rho^2$
- Deconfinement at high temperature  $T_c \sim 150$  Mev
- Matrix elements to test standard model (K decays, etc.)

### Future Potential

Experiments need lattice results for interpretation

- plasma at BNL;                       $g - 2$
- structure functions at JLAB
- weak decays at FNAL, SLAC, BNL, CLEO

Theory errors often dominate

Remove quenched approximation

**TERASCALE COMPUTING ESSENTIAL TO PROGRESS**

## The Lattice SciDAC Project

66 US lattice theorists; 9 member executive committee:

R. Brower, (Boston U.) N. Christ (Columbia U.), M. Creutz (BNL), P. Mackenzie (Fermilab), J. Negele (MIT), C. Rebbi (Boston U.), S. Sharpe (U. Washington), R. Sugar (UCSB) and W. Watson, III (JLab)

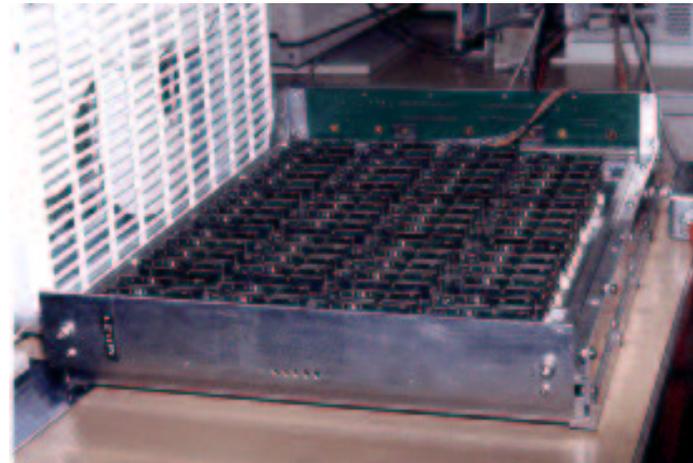
Two prong approach

- QCDOC at BNL
- commodity clusters at Fermi Lab and Jefferson Lab
- $\sim 3 \times 10$  Teraflops distributed computing facility

QCDOC

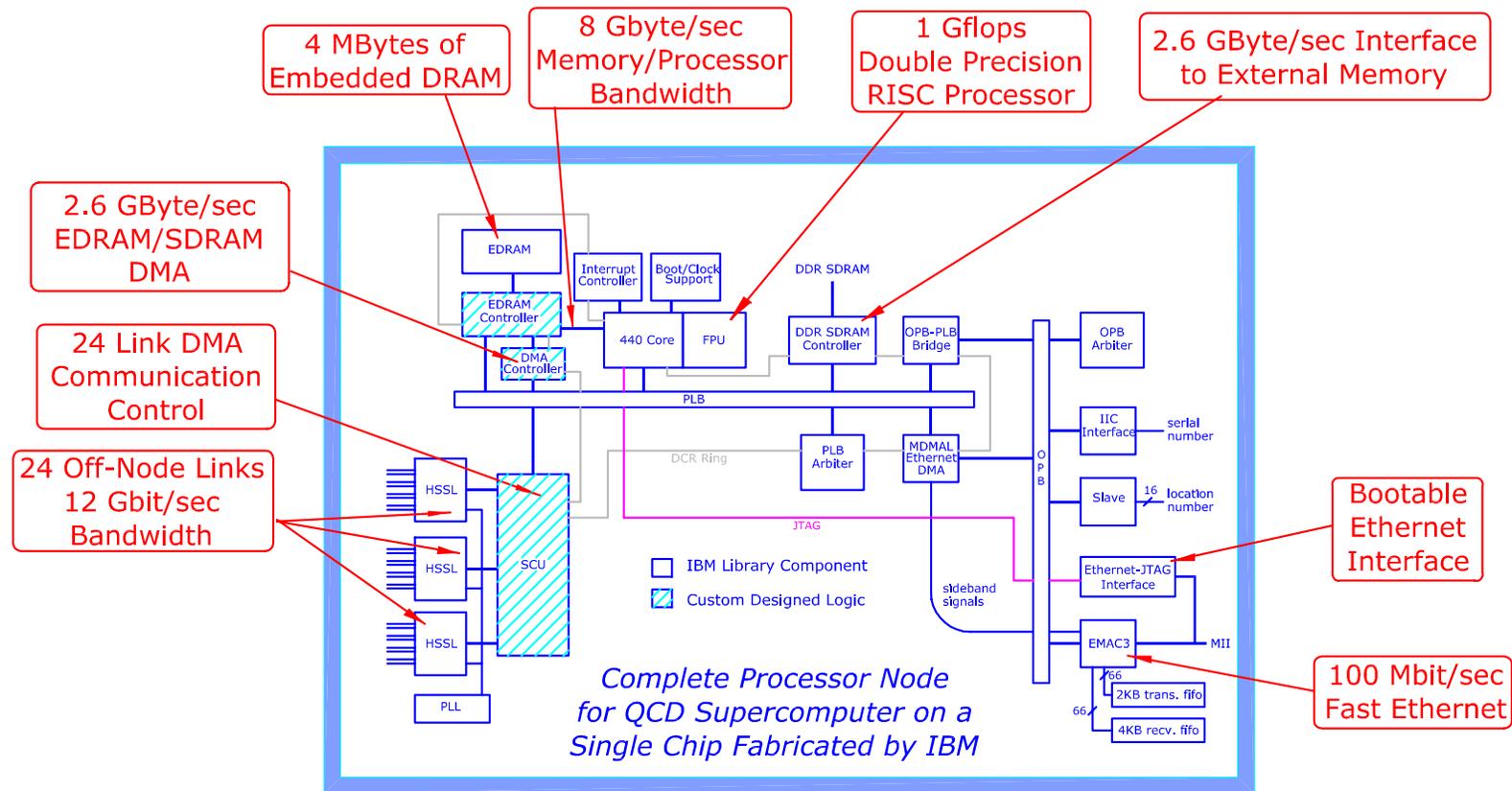
- next generation after QCDSP
- designed by Columbia University with IBM
- on design path to IBM Blue Gene
- Power PC nodes connected in a 6 dimensional torus
- processor/memory/communication on a single chip

# Current RIKEN QCDSP machine



QCDOC places entire node on a single custom chip

## QCDOC ASIC DESIGN



Mission-critical, custom logic (hatched) for high-performance memory access and fast, low-latency off-node communications is combined with standards-based, highly integrated commercial library components.

## Approximate schedule

- chip design: done, released to manufacture
- first chips to be delivered June 7
- 128 node prototype at Columbia: early fall
- 1.5 teraflop development machine, at Columbia: end of year
- 10 teraflop sustained BNL machine: 2004
- 5-8 teraflop clusters at JLAB and FNAL: end of 2005

## DOE panel review, Feb. 2003

Frank Wilczek (MIT) - chair

Roy Briere (CMU)

David Ceperley (NCSA-UIUC)

Candy Culhane (NSA)

Lynn Kissel (LLNL)

Michael Ogilvie (Washington Univ)

Robert Swendsen (CMU)

Peter Varman (NSF)

“In short, we feel the scientific merit of suggested program is very clearly outstanding.”

## BNL: a renowned Center for Lattice Gauge Theory

### Outstanding existing lattice strength

- **BNL High Energy Theory** MC, Soni, Berruto
- **BNL Nuclear Theory** Petrecsky
- **SciDAC** Jung, Petrov
- **RBRC** Aoki, Blum, Dawson, Nemoto, Noaki, Ohta, Orginos, Sugihara, Wettig
- **Columbia** Christ, Mawhinney, postdocs, many students
- **APS** Heller

### RBRC QCDSP

- **600 GFlops peak, dominates current US resources**

### Potential strong interactions with

- **RHIC Computing**
- **Atlas Computing**
- **DOE Grid Computing (PPDG)**
- **Center for Data Intensive Computing**

## Scientific base for the BNL Topical Computing Facility