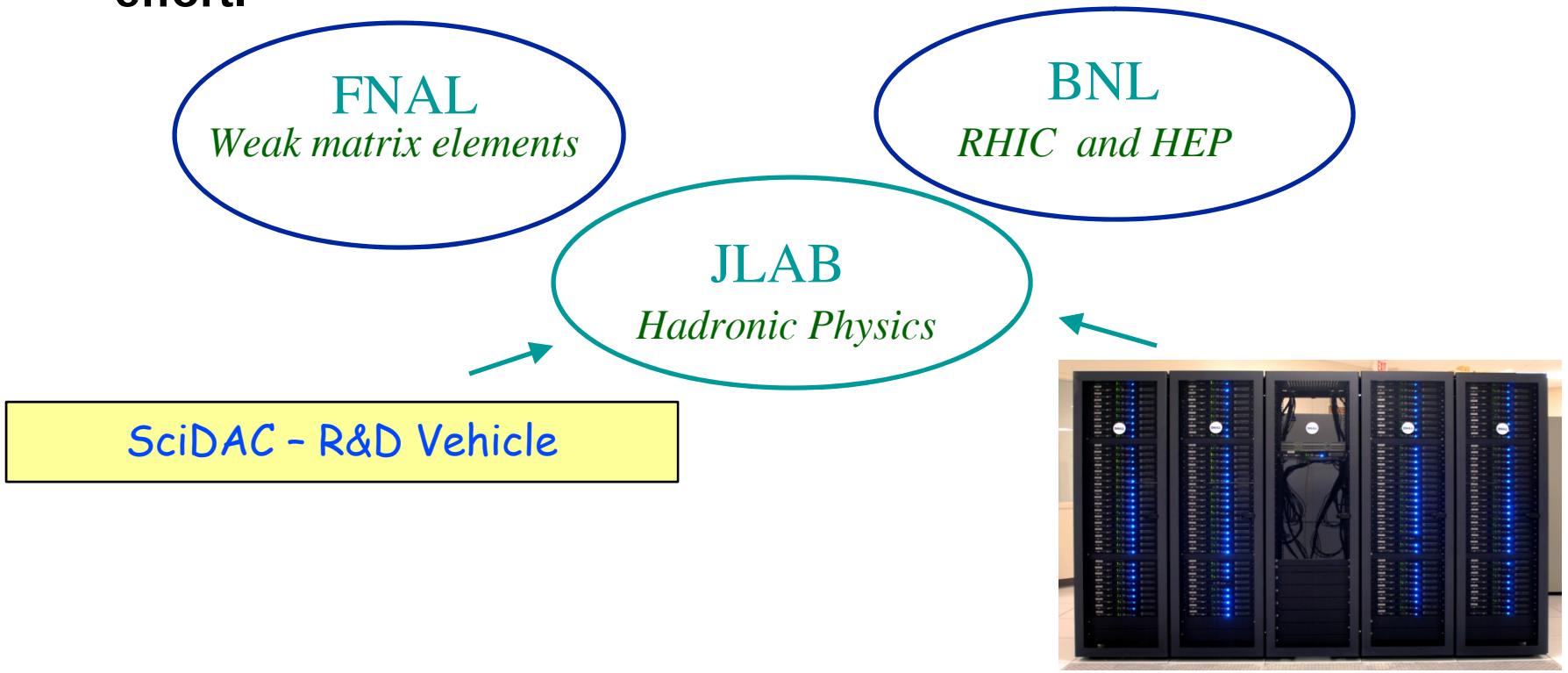
Lecture 1: QCD on the Lattice

- Pure Gauge QCD on the lattice
- Adiabatic potential and Confinement
- Adding quarks
- "Benchmarking QCD" – low-lying hadron spectrum

USQCD National Effort

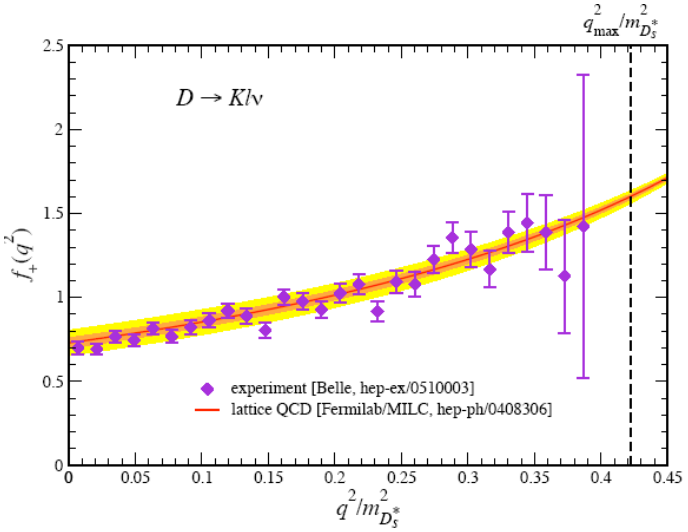
- **Co-equal partnership of BNL, FNAL and JLab in lattice QCD effort.**



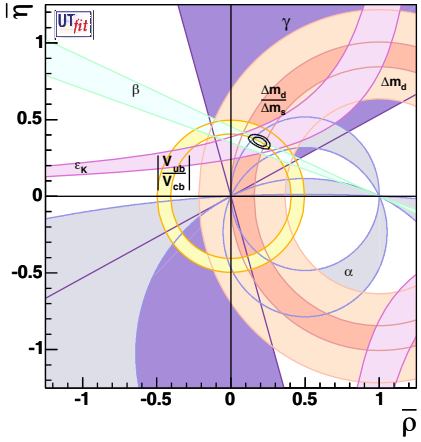
Hadronic and Few-body Physics

High-energy Physics

D → K semileptonic form factor



HEP: *Parameters of Standard Model*

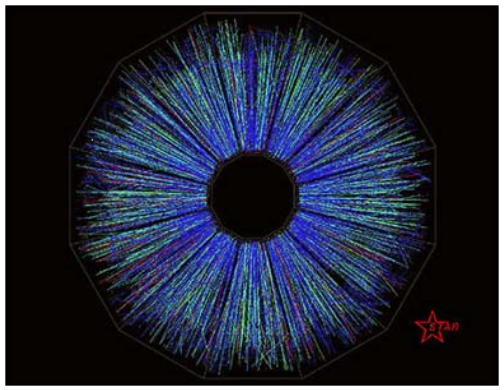


Similar calculations for B mesons will be vital for tests of the Standard Model of Particle Physics.

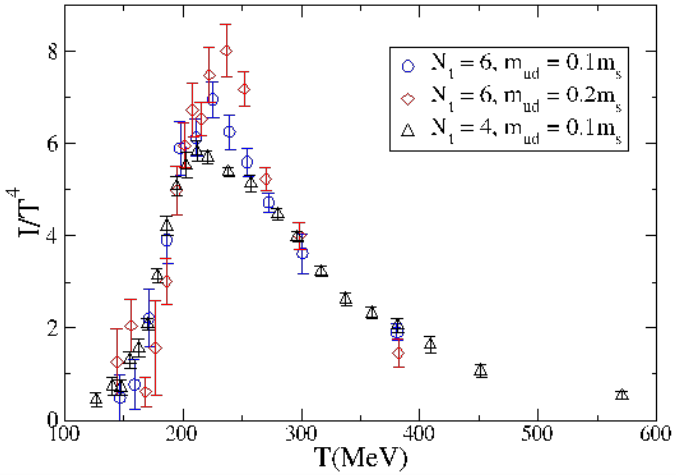
Thermodynamics of Hot and Dense Matter

Such matter is studied at the RHIC accelerator at BNL by colliding beams of relativistic heavy ions.

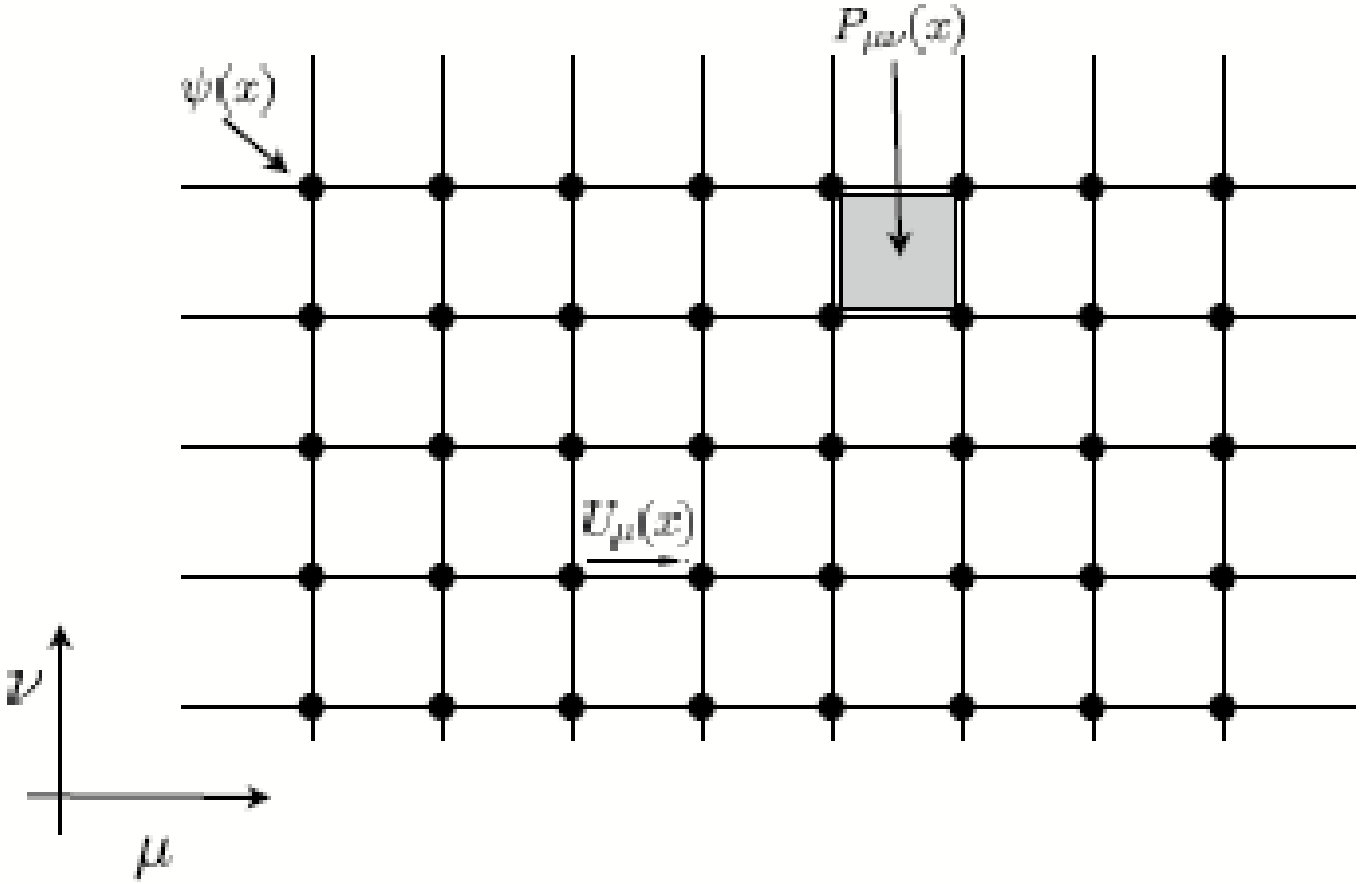
Dense matter created at RHIC quickly equilibrates and behaves like a perfect fluid. This accords with lattice QCD results



Lattice QCD calculation of $(E-3P)/T^4$. Would vanish for ideal gas; interpreted as strong attractive forces in quark-gluon plasma

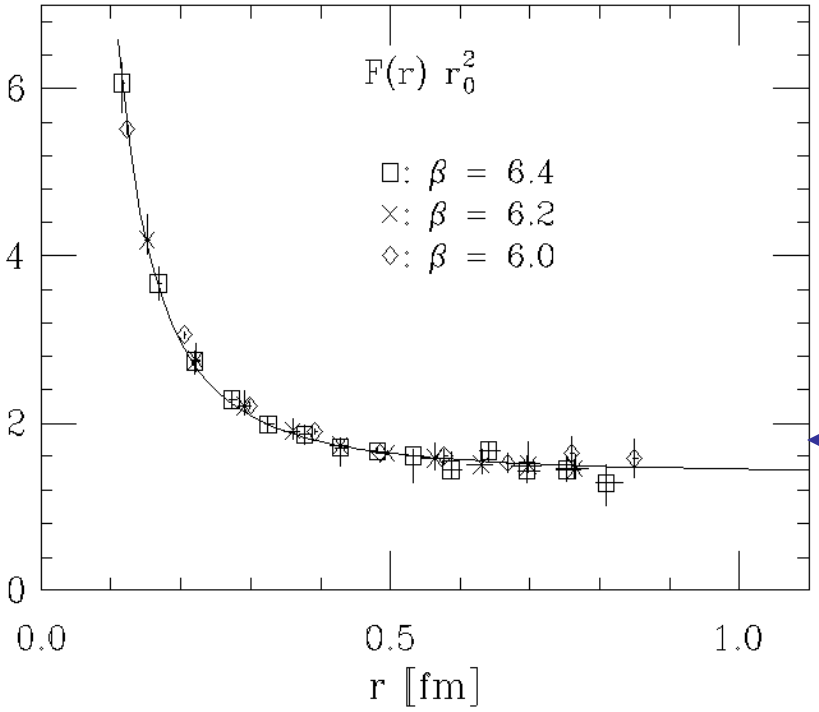


A Two-Dimensional Lattice



Adiabatic Potential - I

Why do we never see a free quark? One of the early successes of lattice QCD was the demonstration of *confinement* – *the constant force between color-non-singlet objects at large distances.*

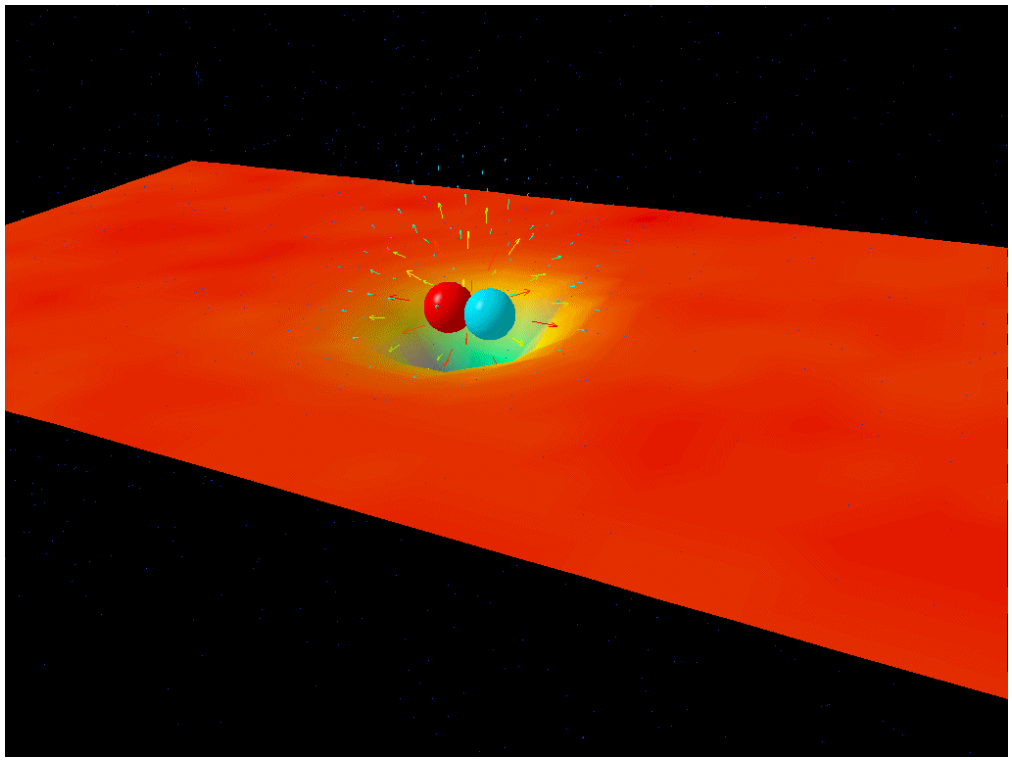


Force between heavy quark-antiquark pair constant
UKQCD (1994)

10 Tonnes

Adiabatic Potential - II

- **Visualisations of confinement between a quark and an antiquark by *Derek Leinweber***



95% of nucleon mass is due to binding of QCD

http://www.physics.adelaide.edu.au/theory/staff/leinweber/VisualQCD/Nobel/index.html

String Breaking

Bali et al, PRD71, 114513 (2005)