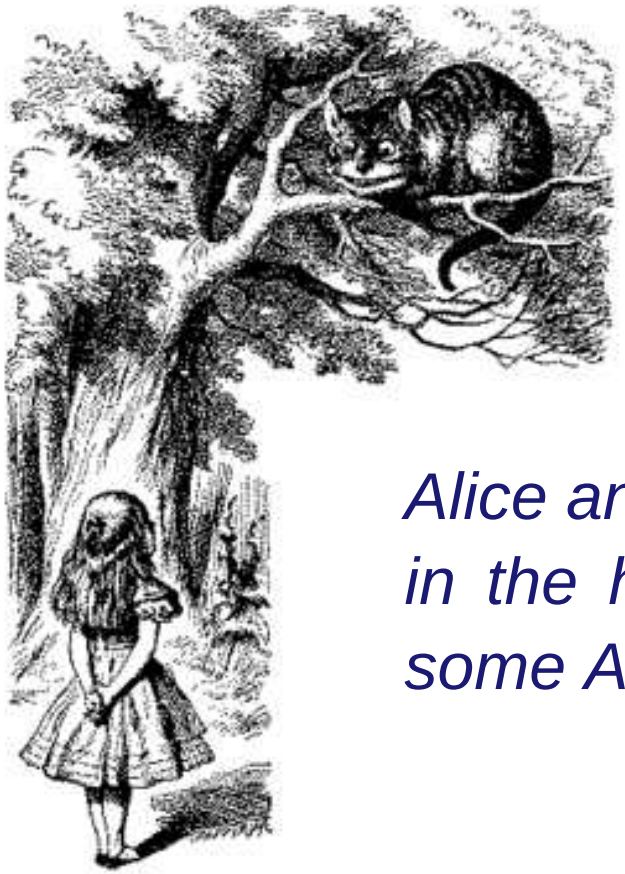


Roma, 5 Maggio 2008
Seminario Tecnologico

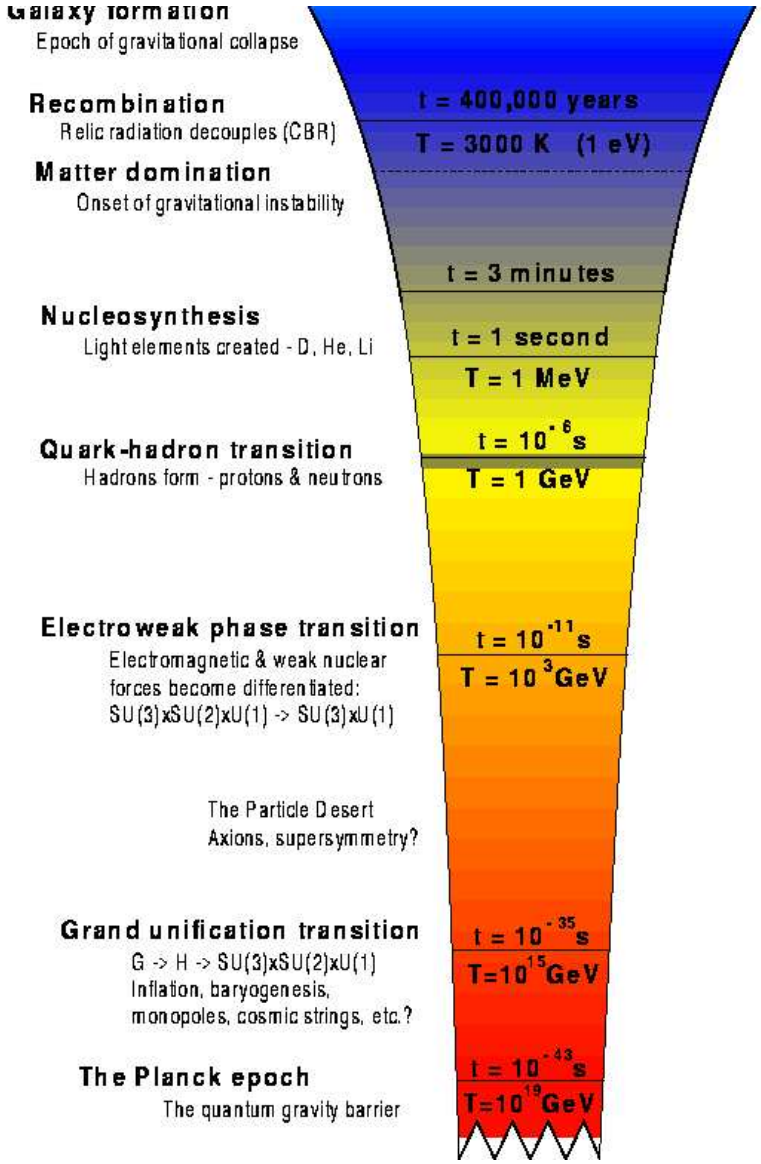
Alice and the Cat, a special moment in the history of the Universe, and some Apes, too

Roma, 5 Maggio 2008
Seminario Tecnologico

ALICE *and the* CAT*, a special moment in the history of the Universe, and some* APES*, too*

CAT - COMPUTER AIDED THEORY
ALICE - A LARGE ION COLLIDER EXPERIMENT AT CERN LHC
APE - THE ARRAY PROCESSOR EXPERIMENT

The History of the Universe



← Standard Cosmology

← Particle Cosmology

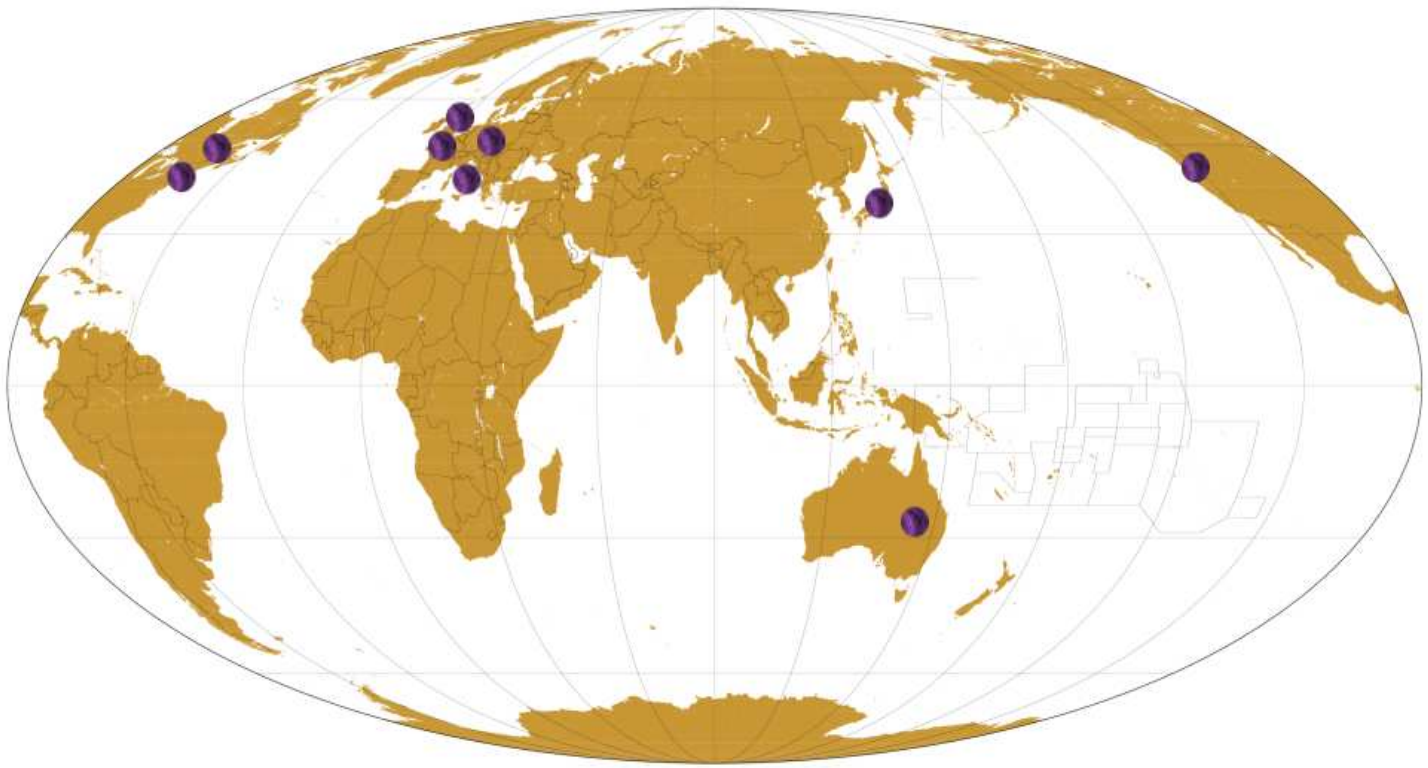
1. GeV $\simeq 10^{13}$ K

← Quantum Cosmology

PLAN

- The International Scenario
- Phases of QCD
- HowTo
- Lattice Data Grid
- Some Results

THE INTERNATIONAL SCENARIO



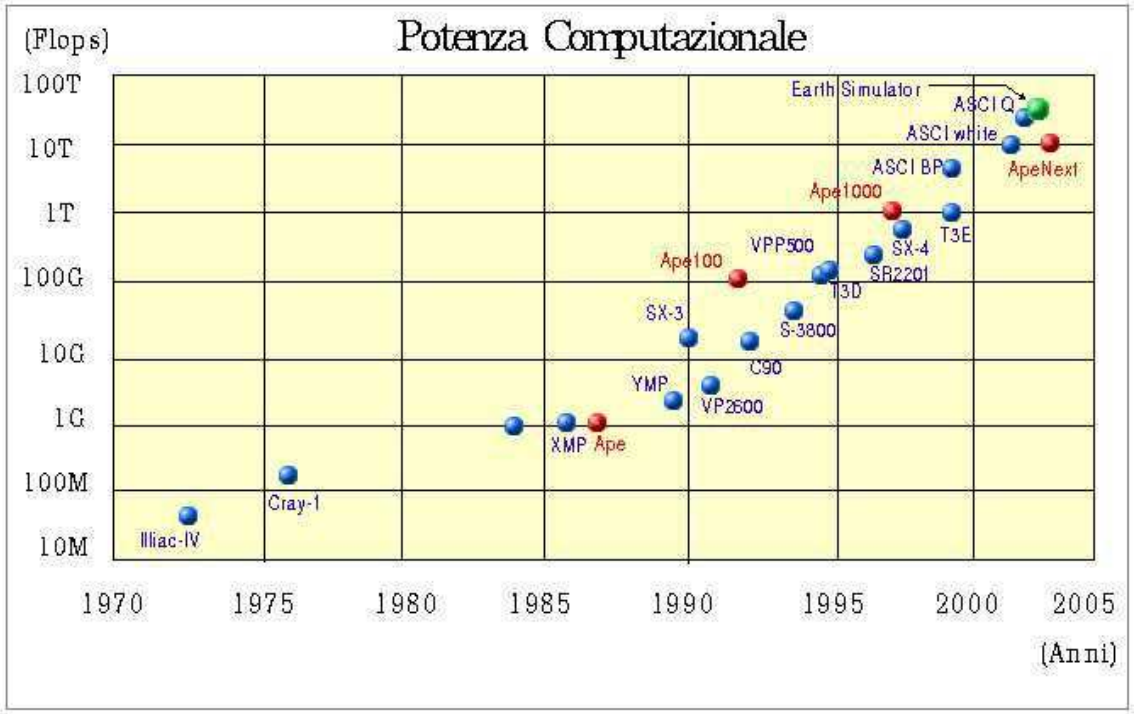
ITALIA

APE

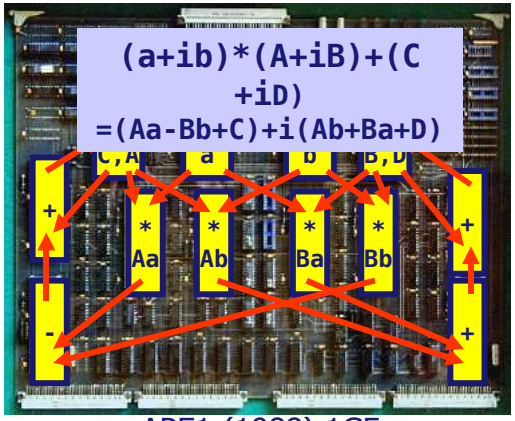
- 3-d Mesh
- First Neighbour Communications : limited but effective
- Chip Architectures optimized for complex a*b + c

SIMILAR PHILOSOPHY : QCDOC, BLUE GENE...

I Progetti APE nel contesto mondiale

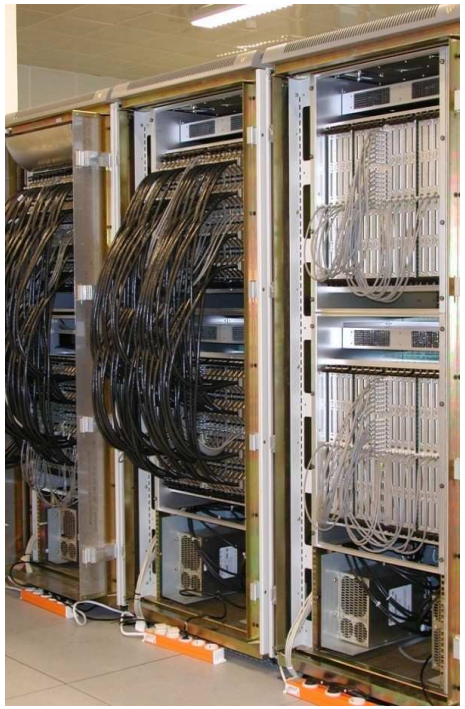


	APE (1988)	APE100 (1993)	APEmille (1999)	apeNEXT (2004)
	Italian research team	Italian research team	European research team + Industry(QSW, Eurotech)	European research team + Industry(Eurotech)
Architecture	SIMD	SIMD	SIMD	SPMD
comp. nodes	16	2048	2048	4096
Interc. Topology	flexible 1D	rigid 3D	flexible 3D	flexible 3D
Memory size	256 MB	8 GB	64 GB	1 TB
registers(w.size)	64 (x32)	128 (x32)	512 (x32)	512 (x64)
Clock speed	8 MHz	25 MHz	66 MHz	200 MHz
Perf./node	64 Mflops	50 Mflops	528 Mflops	1600 Mflops
Agg. Peak perf.	1 Gflops	100 GFlops	1 TFlops	7 TFlops

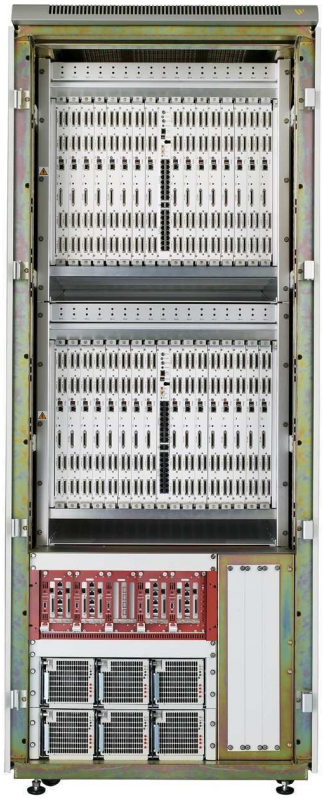


APE1 (1988) 1GF

APE1000 (1992) 25GF, SP, REAL



APEmille (1999) 128GF, SP, Complex



apeNEXT (2004) 800GF, DP, Complex

Francesco Di Renzo **Grid computing e fisica teorica**

Un'occhiata a *theophys* entro la lista delle VO di INFN Grid

VO	Home page	LDAP/VOMS Server	Base DN/VOMS	Register (*)
alice	LHC Alice experiment	lcg-voms.cern.ch	VOMS	Click here!
atlas	LHC Atlas experiment	lcg-voms.cern.ch	VOMS	Click here!
argo	INFN ARGO-YBJ experiment	voms.cnaf.infn.it	VOMS	Click here!
babar	Babar experiment	voms.gridpp.ac.uk	VOMS	Click here!
bio	Grid.it Biology group	voms.cnaf.infn.it	VOMS	Click here!
biomed	BIOMED	cclcgvomsli01.in2p3.fr	VOMS	Click here!
cms	LHC CMS experiment	lcg-voms.cern.ch	VOMS	Click here!
cdf	CDF experiment	voms.cnaf.infn.it	VOMS	Click here!
compassit	NEW VO	voms2.cnaf.infn.it	VOMS	Click here!
compchem	Dipartimento di Chimica-Universita' di Perugia	voms.cnaf.infn.it	VOMS	Click here!
dteam	LCG Deployment	lcg-voms.cern.ch	VOMS	Click here!
egrid	EGRID experiment	voms.cnaf.infn.it	VOMS	Click here!
enea	ENEA	voms.cnaf.infn.it	VOMS	Click here!
enmr.eu	ENMR.EU NEW VO	voms2.cnaf.infn.it	VOMS	Click here!
esr	ESR Home	mu4.matrix.sara.nl	VOMS	Click here!
gridit	General Grid.it Project VO	voms.cnaf.infn.it	VOMS	Click here!
inaf	INAF	voms.cnaf.infn.it	VOMS	Click here!
infngrid	INFN-GRID project	voms.cnaf.infn.it	VOMS	Click here!
ingv	INGV Bologna	voms.cnaf.infn.it	VOMS	Click here!
lhcb	LHC .HCb experiment	lcg-voms.cern.ch	VOMS	Click here!
libi	LIBI	voms.cnaf.infn.it	VOMS	Click here!
lights.infn.it	LIGHTS.INFN.IT NEW VO	voms2.cnaf.infn.it	VOMS	Click here!
magic	MAGIC and grid	mu4.matrix.sara.nl	VOMS	Click here!
pamela	NEW VO	voms.cnaf.infn.it	VOMS	Click here!
planck	Planck Experiment	voms.cnaf.infn.it	VOMS	Click here!
theophys	INFN theorical physics group	voms.cnaf.infn.it	VOMS	Click here!
virgo	INFN Virgo experiment	voms.cnaf.infn.it	VOMS	Click here!
zeus	ZEUS experiment	grid-voms.desy.de	VOMS	Click here!

Certamente una VO piccola se confrontata a quelle dei grandi esperimenti ...

IFAE 2008 **Bologna, 26 Marzo 2008**

US-UK

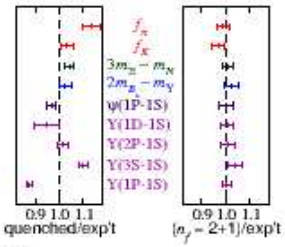
image credit UKQCD Collaboration

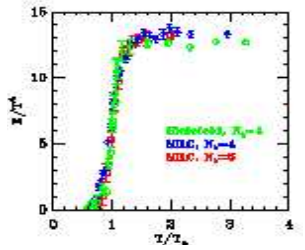
The QCDOC chip integrates 50 million transistors and consumes approximately 5 Watts at a clock speed of 400 MHz.

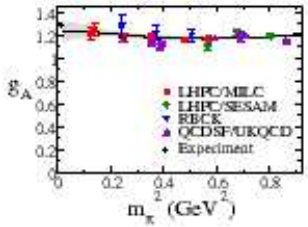
USQCD

US Lattice Quantum Chromodynamics

Particle and Nuclear Physics







USQCD is a collaboration of US scientists developing and using large-scale computers for calculations in lattice quantum chromodynamics.

Lattice QCD calculations allow us to understand the results of particle and nuclear physics experiments in terms of QCD, the theory of quarks and gluons.

USQCD All Hands Meeting, April 4-5, 2008, JLab

Call for proposals for USQCD resources, due Feb. 29, 2008

Lattice QCD Meets Experiment Workshop 2007. Dec. 10-11, Fermilab

SciDAC 2007 Lattice QCD Software Workshop

2007 White papers

Lattice QCD summer school, Aug. 8-28, 2007, Seattle

USQCD in the news...

CERN Courier: Tackling the Challenge of Lattice QCD
Symmetry: Computing the Quarks
Nature: Weighty Questions
CERN Courier: QCDOC Computers Study Quarks
CERN Courier: Lattice QCD and CLEO-c
CERN Courier: Joining Up the Dots with the Strong Force
Nature: Lattice Window on Strong Force

Computing

Call for Proposals

```
Date: February 6, 2008 14:00:01 PM CST
To:   USQCD Collaboration Members
From: USQCD Scientific Program Committee


Dear Colleagues,

This message is a Call for Proposals [NB: Edited and shortened ]

At BNL:

QCDOC supercomputer 12,288 processors running at 400 MHz.


At FNAL:

120 node cluster ("QCD")
    120 single-processor 2.8 GHz P4 nodes
    1 GB memory/node
    Myrinet network

520 node cluster ("Pion")
    518 single-processor 3.2 GHz P4 nodes
    1 GB memory/node
    Infiniband network

600 node cluster ("Kaon")
    600 dual-core, dual-processor 2.0 GHz Opteron nodes
    (2400 total cpu cores available)
    4 GB memory/node
    Infiniband network

Projected ~1000 node cluster ("J/psi")
   1000 quad-core, dual-socket xx GHz Xeon or Opteron nodes
  (~8000 total cpu cores available)
   8 GB memory/node
   Infiniband network

These clusters will share 80 TBytes of associated disk storage


At JLAB:

256 node Infiniband cluster ("6n")
  256 dual-core 3.0 GHz Pentium-
  1 GB memory/node
  Infiniband 4x fabric

396 node Infiniband cluster ("7n")
  396 quad-core, dual-processor 1.9 GHz Opteron (Barcelona)
  8 GB memory/node
  Infiniband 4x fabric
  50 GB local scratch disk/node
```

GERMANY

JÜLICH SUPERCOMPUTING CENTRE (JSC)

JÜLICH FORSCHUNGSZENTRUM

JSC-Startseite
Allgemeines
Höchstleistungsrechner
Computational Science
Grid-Computing
Zentrale DV-Infrastruktur
JSC online
Kooperationen
Publikationen
Lernen & Tagungen
Neues & Termine

> Höchstleistungsrechner



Das Nationale Höchstleistungrechenzentrum "John von Neumann-Institut für Computing (NIC)" stellt Wissenschaftlern am Forschungszentrum Jülich, an Universitäten und Forschungseinrichtungen in Deutschland (und z.T. in Europa) sowie der Industrie Rechenkapazität der höchsten Leistungsklasse zur Verfügung. Dies umfasst die Bereitstellung, den Betrieb und insbesondere die Weiterentwicklung der Supercomputer und der technischen Infrastruktur, u.a. der Datenspeicher, Visualisierungssysteme und Netzwerke sowie der Software. Weitere wesentliche Aufgaben des NIC sind Benutzerunterstützung und Ausbildung.

John von Neumann-Institut für Computing (NIC)
Supercomputer IBM p690-Cluster JUMP
Supercomputer IBM Blue Gene/L JUBL
Supercomputer IBM Blue Gene/P JUGENE
Benutzerunterstützung
Aus-und Weiterbildung

letzte Änderung 03.04.2008 | Sabine Höfler-Thierfeldt | Ausdrucken

	Blue Gene/L	Blue Gene/P
Node Properties		
Processor	PowerPC 440	PowerPC 450
Processors per node (chip)	2	4
Processor clock speed	700 MHz	850 MHz
Coherency	Software managed	SMP
L1 cache (private)	32 KB per core	32 KB per core
L2 cache (private)	7 stream prefetching	7 stream prefetching
	2 line buffers/stream	2 line buffers/stream
L3 cache (shared)	4 MB	8 MB
Physical memory per node	512 MB	2 GB
Main memory bandwidth	5.6 GB/s	13.6 GB/s
Peak performance	5.6 GFlop/s	13.6 GFlop/s
Torus network		
Bandwidth	2.1 GB/s	5.1 GB/s
Hardware latency (nearest neighbour)	200 ns (32B packet)	160 ns (32B packet)
	1.6 μs (256 B packet)	1.3 μs (256 B packet)
Global collective network		
Bandwidth	700 MB/s	1700 MB/s
Hardware latency (round trip worst case)	5.0 μs	3.0 μs

Table 1. Blue Gene /P vs. Blue Gene /L.

JSC Homepage
General
Supercomputers
Computational Science
Grid Computing
Central IT Infrastructure
Configuration
IT security
Software Offerings
Software sale
Software Licence Server
JSC online
Cooperations
Publications
Study & Conferences
News & Events

> Central IT Infrastructure > Configuration > IBM Blue Gene/P JUGENE

IBM Blue Gene/P

JUGENE - Juelicher Blue Gene/P

- 16 Racks with 32 nodecards x 32 compute nodes (total 16384)
  - Compute node: 4-way SMP processor
  - Processortype: 32-bit PowerPC 450 core 850 MHz
  - Processors: 65536
  - Overall peak performance: 223 Teraflops
  - Linpack: 167 Teraflops
  - Main memory: 2 Gbytes per node (aggregate 32 TB)
  - I/O Nodes: 152
  - Networks:
    - Three-dimensonal torus (compute nodes)
    - Global tree / Collective network (compute nodes, I/O nodes)
    - 10 Gigabit ethernet / Functional network (I/O Nodes)
  - Power Consumption: max.40 kW per rack
- 2 Service nodes IBM p55A:
  - Total number of processors: 8
  - Processortype: Power5 1.6 GHz
  - Total amount of memory: 32 GB
  - Operating System: SuSE Linux Enterprise (SLES 10)
- 2 Login nodes IBM p55A:
  - Total number of processors: 8
  - Processortype: Power5 1.6 GHz
  - Total amount of memory: 32 GB
  - Operating System: SuSE Linux Enterprise (SLES 10)
  - Internet address: jugene.zam.kfa-juelich.de

High Messages for the users

Availability of Systems

The IBM Blue Gene/P is available for selected projects which run massively parallel application codes scaling up to several thousands of processors.

Projects/applications that may be selected must meet the demands described in Allocation of Computing Resources on BG/P .

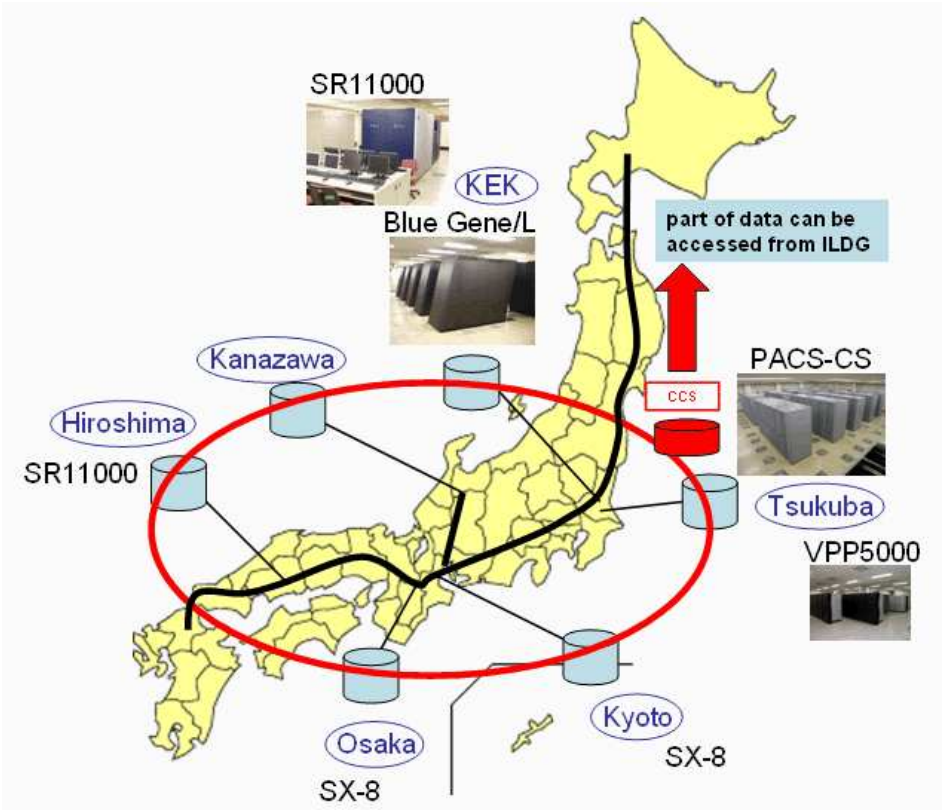
Users on the Blue Gene/P system must have a valid account on the IBM Regatta p690+ cluster (Jump). Generel information about allocation of computing resources is available as well as online forms for resource allocation.

For more information refer to publications and ZAM documentation about

IBM Blue Gene/P JuGene .

last change 20.11.2007 | Ulrike Schmidt | Print

JAPAN


SR11000
KEK
Blue Gene/L
part of data can be accessed from ILDG
Kanazawa
PACS-CS
CCS
Hiroshima
SR11000
Tsukuba
VPP5000
Kyoto
Osaka
SX-8
SX-8

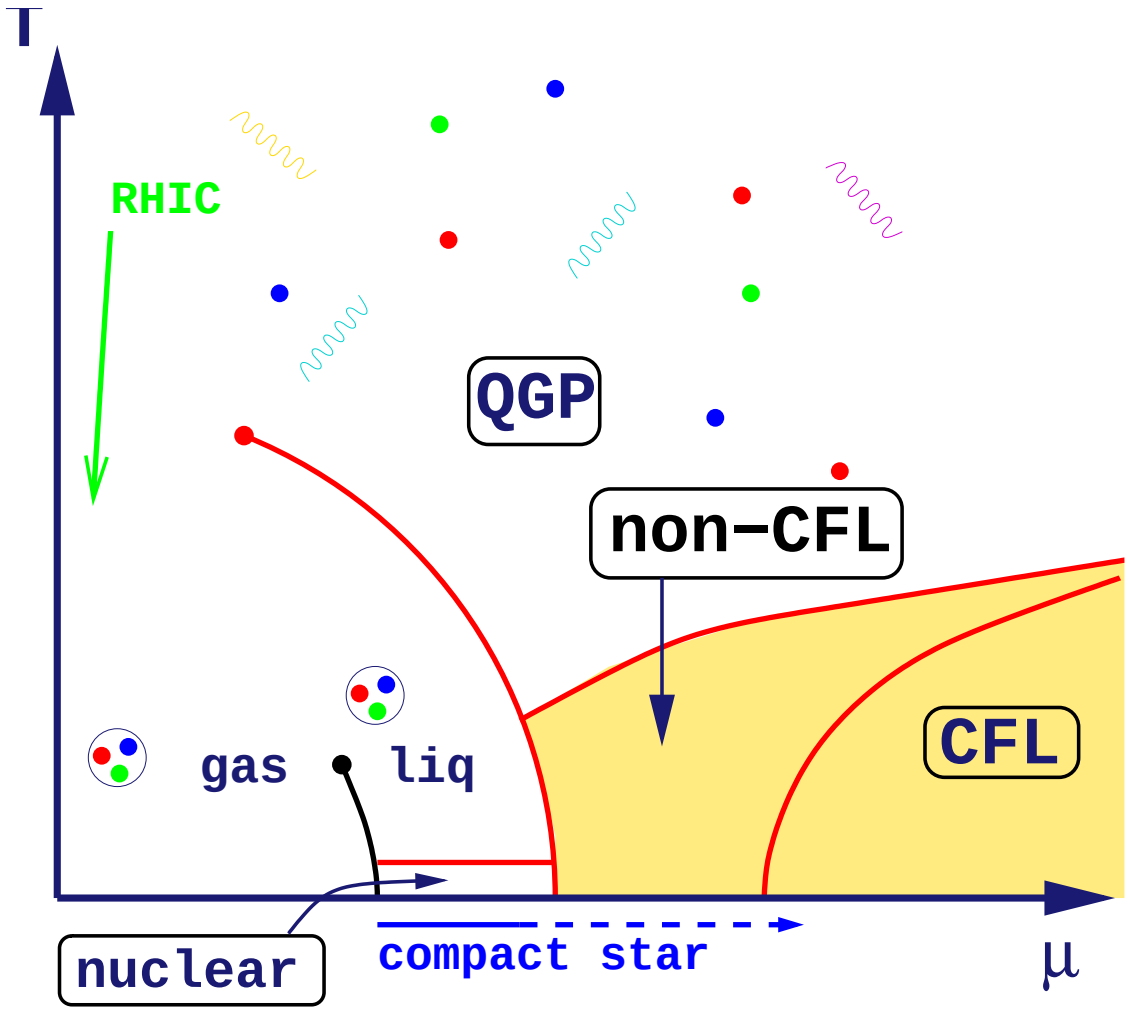
Facilities

Computer Systems

The computational facilities of the center mainly consist of a massively parallel cluster system PACS-CS and its front-end computer system, and the new generation of astrophysics simulator FIRST.
The front-end computer system consists of the system controlling servers to manage the PACS-CS cluster and the small-sized mini-PACS-CS for program development, Magellan (Hitachi SR11000J) for post-processing and analysis on generated data by PACS-CS, 120 TByte of large capacity file server to hold all data of these facilities. There are additional medium to small size clusters for data analysis and general networking services. All machines are connected by Gigabit Ethernet LAN to support high-speed data exchange. Two of high-speed Ethernet switch connect all facilities in the computer building and research building with 10 Gbps Ethernet. All these facilities support various style of computation such as traditional vector-type scientific computation but also the cluster computing to support our computational science.
The operation of PACS-CS is permanently monitored on job execution status and detailed system temperature such as CPU, chassis and network interfaces on each computational node. The status of the machine and air conditioners are remotely monitored to detect any failure.

The PACS-CS system is a PC cluster system which consists of 2560 nodes, connected by 20480 Gigabit Ethernet cables. The system achieved 10.35Tflops in the Linpack Benchmark, ranking 34th on the June 2006 Top 500 List.

PHASES OF QCD



M. Alford

Three issues:
thermodynamics, symmetry, confinement

I. Thermodynamics

$\mathcal{Z}(\mathcal{V}, \mathcal{T}, \mu)$ **grand canonical partition function gives**

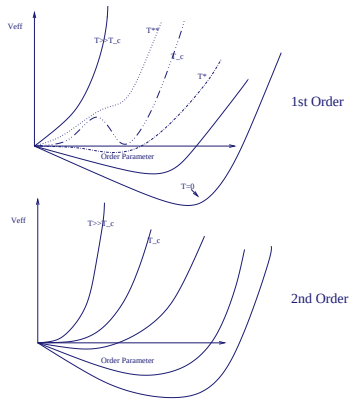
- **Thermodynamics**

$$N = T\frac{\partial ln\mathcal{Z}}{\partial \mu}$$

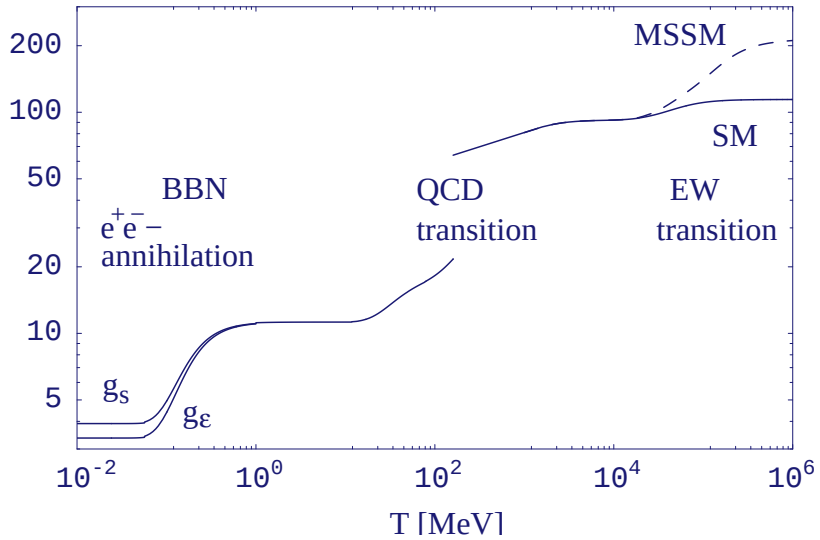
$$S = \frac{\partial T ln\mathcal{Z}}{\partial T}$$

- **Effective potential**

$$V(\phi, T, \mu) = -T ln\mathcal{Z}(\phi) - J\phi$$



I- Thermodynamics: Gradi di Liberta' e Transizioni di Fase



Schwarz, 2003

II. Symmetry Breaking Patterns for N_f light quarks, m=0

Pisarski, Wilczek; original discussion
Basile, Pelissetto, Vicari 2005; RG analysis

	$U(1)_A$ anomaly	suppressed anomaly at T_c
QCD	$\mathrm{SU}(N_f)_L \otimes \mathrm{SU}(N_f)_R \to \mathrm{SU}(N_f)_V$	$\mathrm{U}(N_f)_L \otimes \mathrm{U}(N_f)_R \to \mathrm{U}(N_f)_V$
$N_f = 2$	O(4) or first order	$U(2)_L \otimes U(2)_R / U(2)_V$ or first order
$N_f \geq 3$	first order	first order

$$[SU(3)_{\mathrm{color}}] \times \underbrace{SU(3)_L \times SU(3)_R}_{\supset [U(1)_Q]} \times U(1)_B \to \underbrace{SU(3)_{C+L+R}}_{\supset [U(1)_{\tilde{Q}}]} \times Z_2 \qquad (1)$$

III. Confinement

“..parvemi tre giri,
di tre colori e
d’una contenenza”

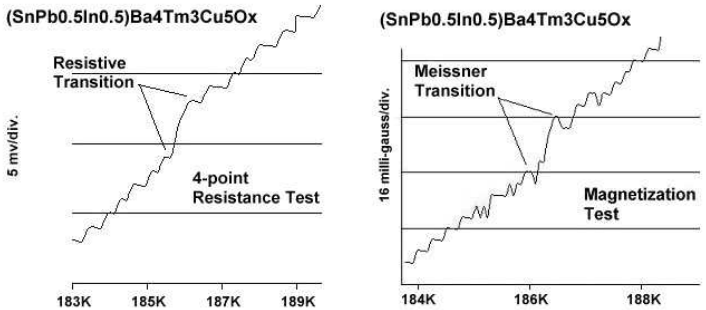
III. Confinement–Deconfinement - more poetry!

”..svaniscono i corpi
in un fluire di tinte”

III. Confinement : A mundane view!

Confinement is one of the
Million Dollars Problems..

HOWTO
study a phase transition?



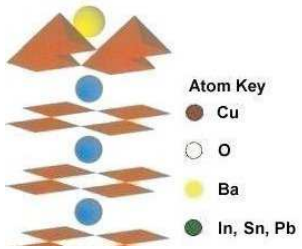
The First Ambient Temperature Superconductor

- Antarctica is Cold Enough -

14 March 2008
Superconductors.ORG

On 21 July, 1983, the Vostok Research Station in Antarctica logged the coldest temperature ever measured on earth at -89.2 C. This is equivalent to 183.95 Kelvin. On March 6, 2008, Superconductors.ORG measured signs of superconductivity just over 185 Kelvin in an optimized 1223/1212 intergrowth, marking the first observation of superconductivity at earth ambient temperatures.

Like the 181K superconductor reported in January of 2008, the 185K superconductor appeared as a minority phase in a 1223/1212 host that was doped with extra Tm and Cu (see structure types at page bottom). Through trial-and-error Tc was found to peak with slightly more lead (Pb) and slightly less indium (In) than the 181K formulation. Eight separate tests of the compound produced an average Tc of 185.6K. Interestingly, the 3-to-1 ratio of 4A to 3A metals in the insulating layer is also the ratio that produces the highest transition temperatures among binary alloy superconductors.



The structure type responsible for this record high Tc is believed to be a 1245/1212 intergrowth (shown at left) with formula $(Sn_{1.0}Pb_{0.5}In_{0.5})Ba_4Tm_5Cu_7O_{20+}$. This structure does not form stoichiometrically. It results as a byproduct only. So, commercial prospects of this discovery will hinge on manufacturers developing a method of mass producing and refining it into a pure form.

The graphs at page top show a resistive transition just above 185K and a Meissner transition just above 186K*. The volume fraction of the 1245/1212 phase is less than 1% of the bulk, which would normally require multiple plots to be summed together to improve the signal-to-noise ratio.

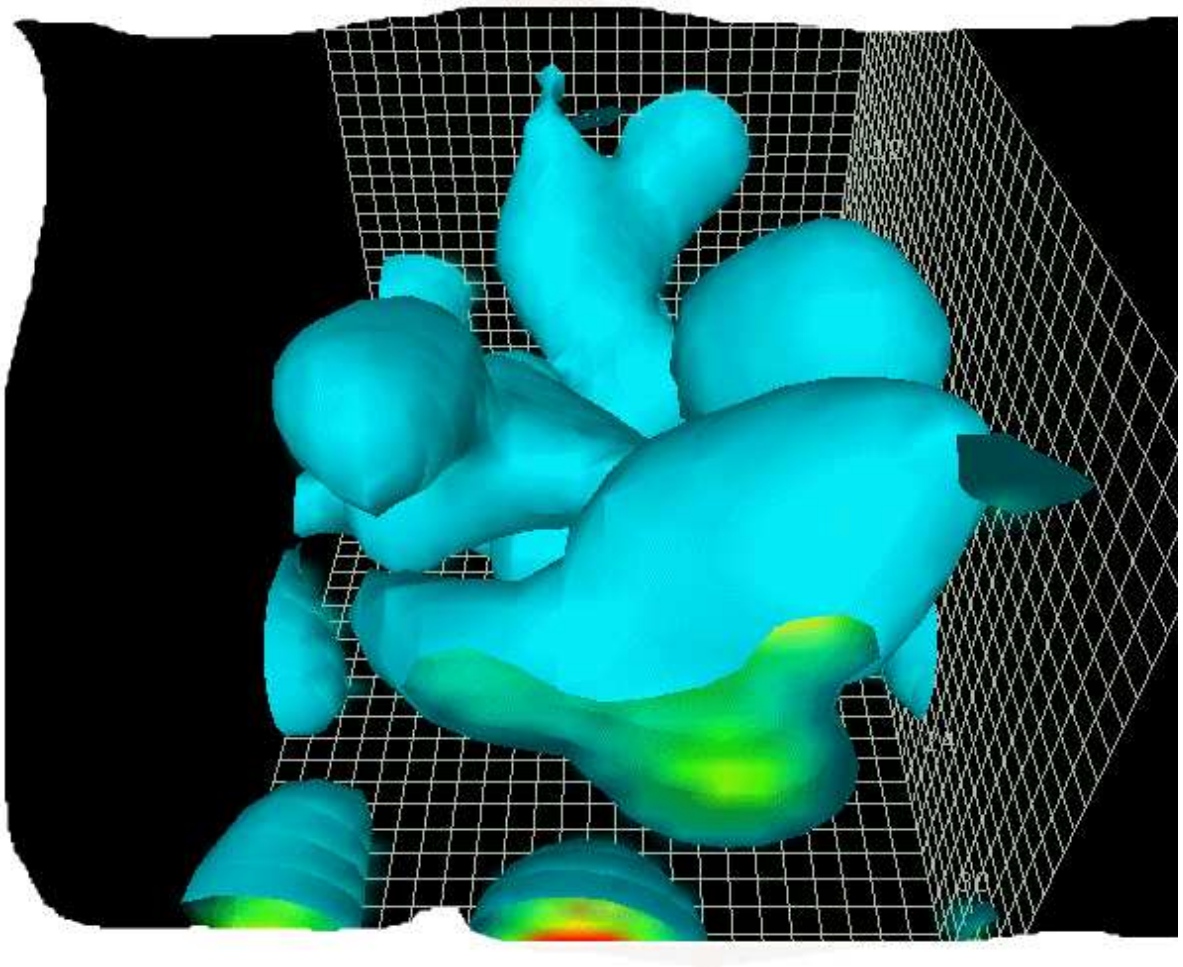
A Dictionary

Specimen $\longleftrightarrow$ Configuration (collection of gauge fields)

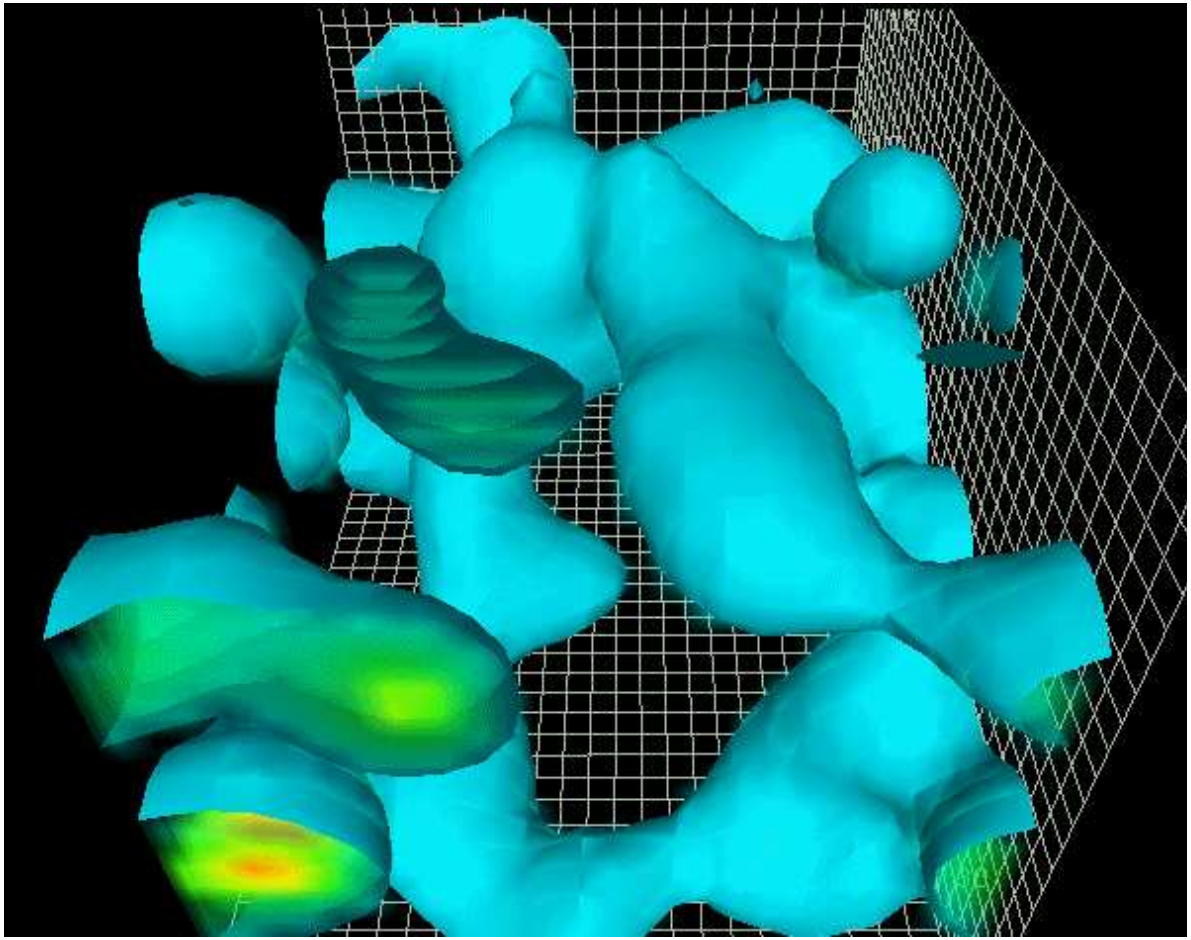
Repeat Measures $\longleftrightarrow$ Use Independent Configs

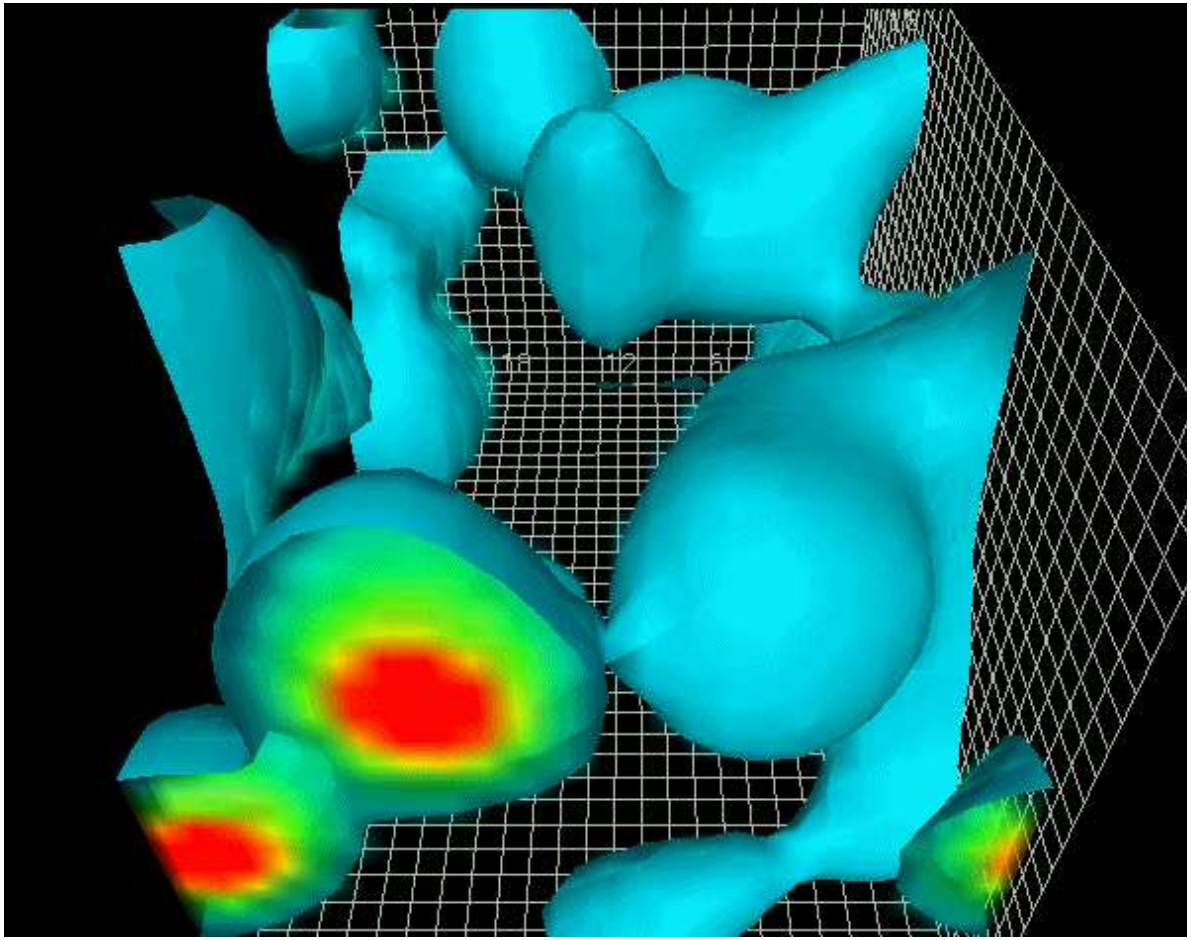
External Fields $\longleftrightarrow$ Bare Quark Masses

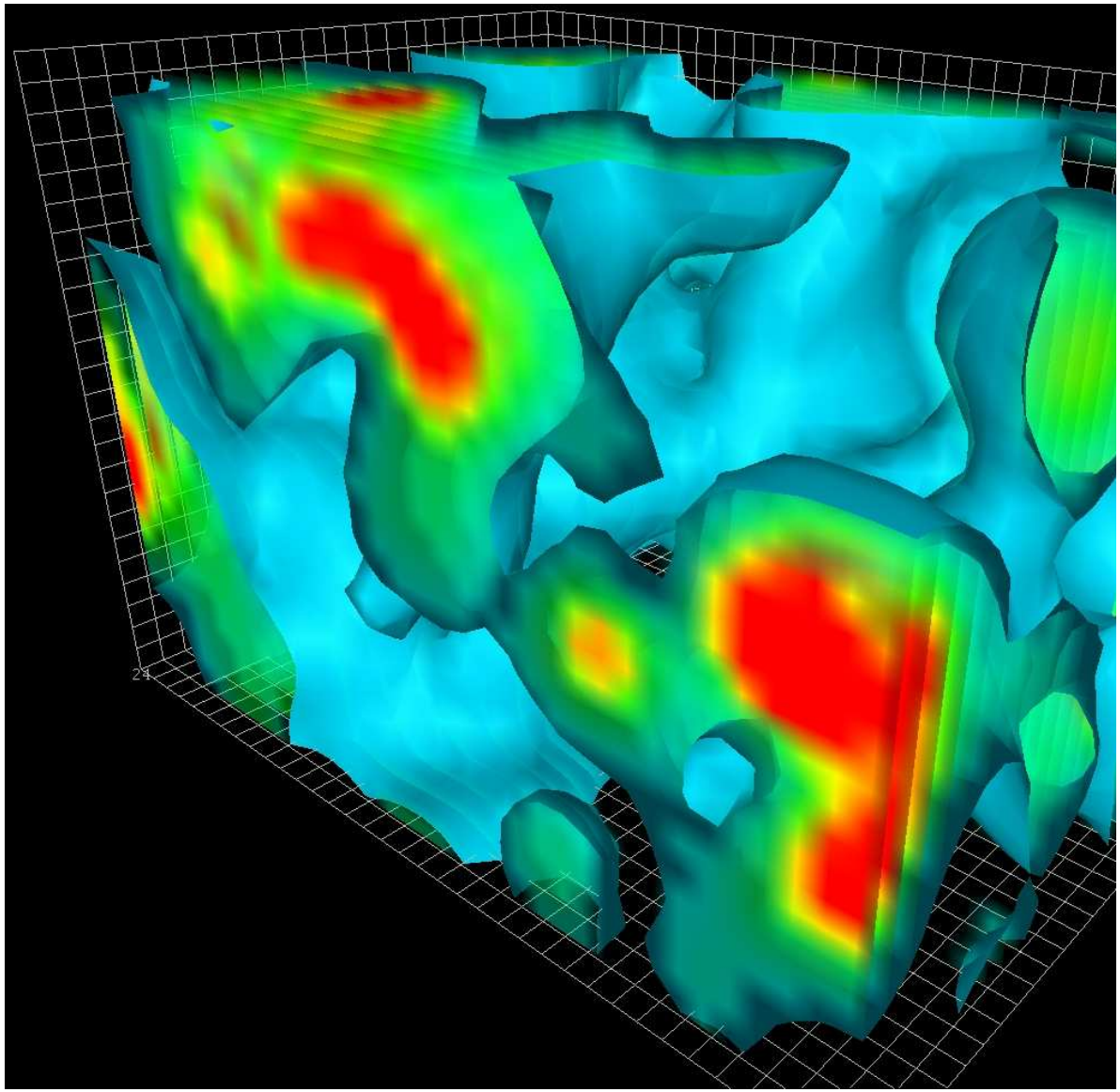
Observables : experimental choice.

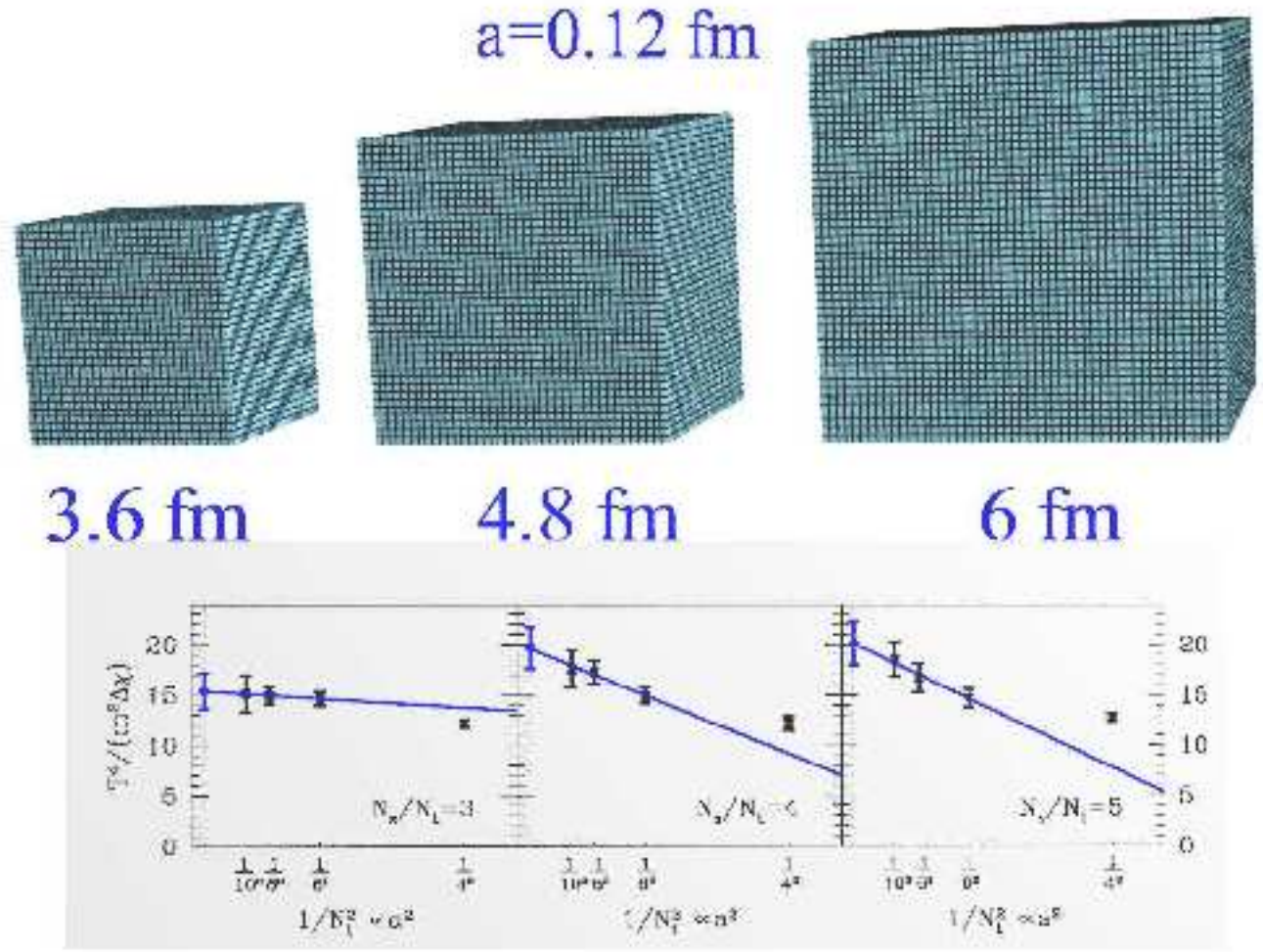


Adelaide SSC









Wuppertal

Figure 3. The upper pictures show three different physical V-s with our finest discretization. The lower plots show the dimensionless quantity $T^4/(m^2\Delta\chi)$ as a function of a^2 and their continuum extrapolated values. No V dependence is observed.

THE STORAGE ISSUE : GRID

International Lattice Data Grid (ILDG)

Web portal for the ILDG Lattice QCD Data Archive

Home

This is a web portal for searching distributed archives of lattice QCD gauge configuration data from par
International Lattice Data Grid(ILDG).

The interface can search for data at the following sites:

- USQCD - United States Lattice Gauge Theory Computational Program
- UKQCD Collaboration
- CSSM - Centre for the Subatomic Structure of Matter (Australia)
- JLDG - Japan Lattice Data Grid
- LDG - Lattice Data Group (Germany, France, Italy)

Currently the interface only supports searching of data sets based on metadata attributes.

In future the capability of downloading lattice configuration data will be added.

List Ensembles

LDG Home
List Ensembles

- mc://USQCD/LHPC/aniso/wilson/NF2/wl_16_64_5p5_x2p38_um0p4086 [usqcd]
- mc://USQCD/LHPC/aniso/wilson/NF2/wl_16_64_5p5_x2p38_um0p4125 [usqcd]
- mc://USQCD/LHPC/aniso/wilson/NF2/wl_24_64_5p5_x2p38_um0p4086 [usqcd]
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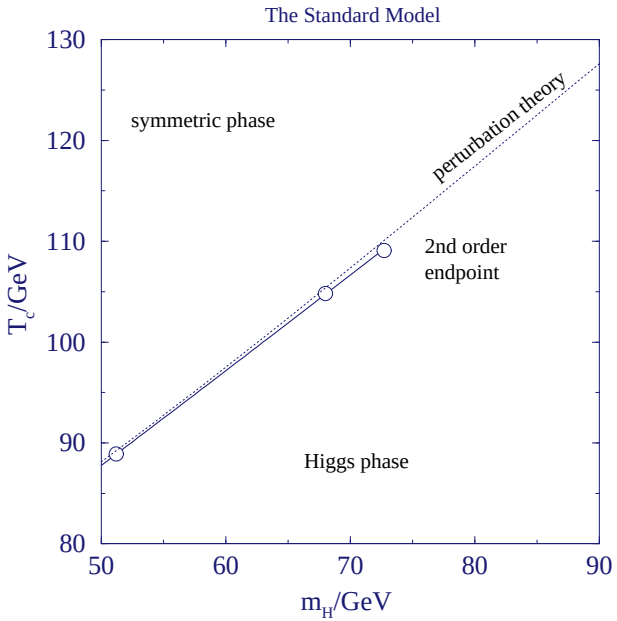
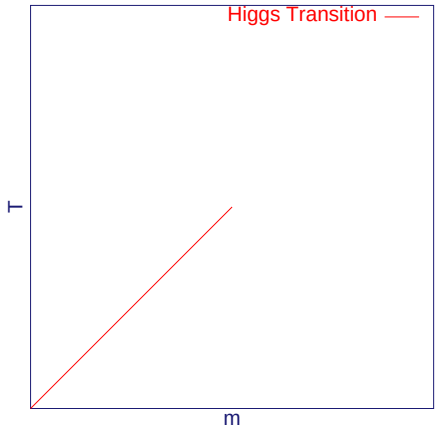
SOME RESULTS

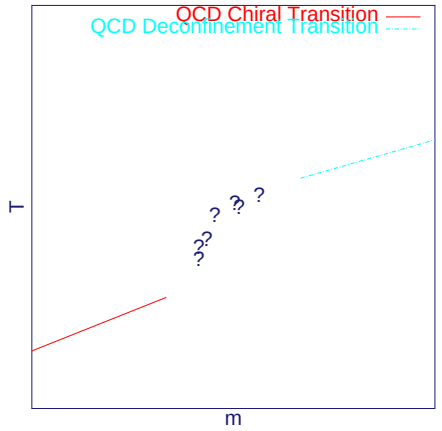
EW Phase Diagram, and Higgs Mass



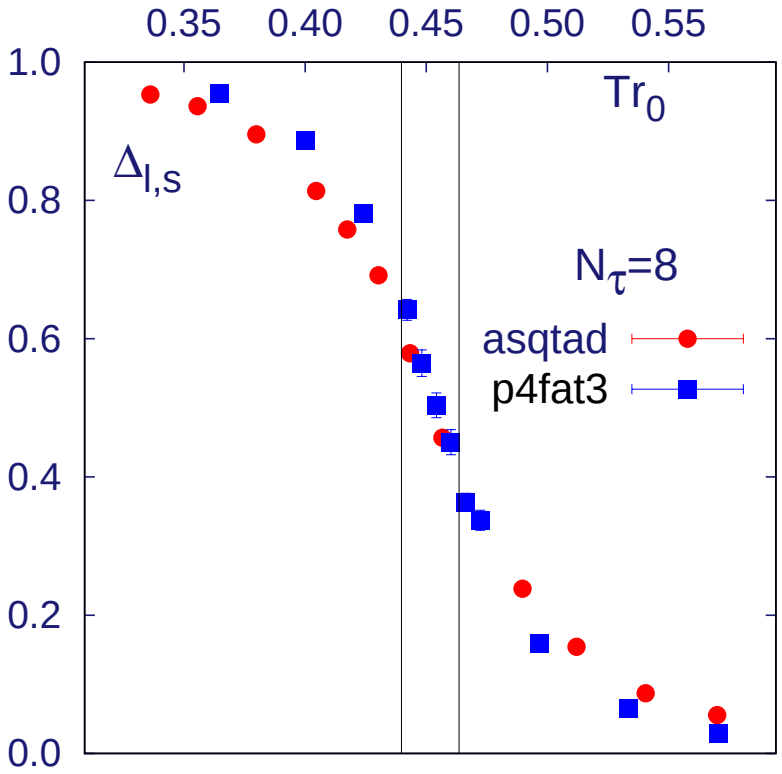
Rummukkainen, Laine, 2001

EW vs QCD

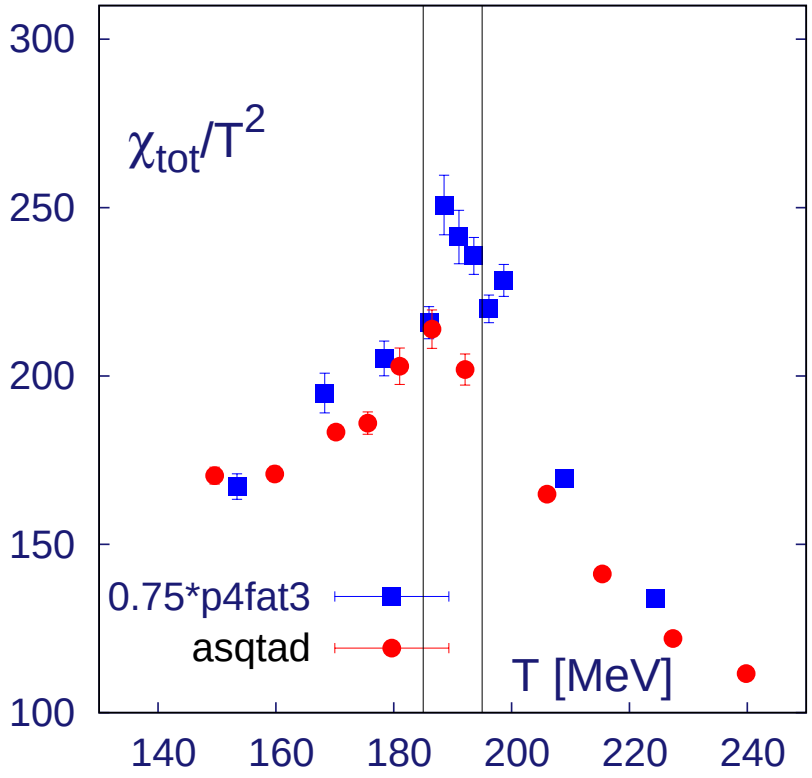

Higgs Transition
T
m


QCD Chiral Transition
QCD Deconfinement Transition
T
m
?
?
?
?
?

QCD RBC


0.35
0.40
0.45
0.50
0.55
1.0
0.8
0.6
0.4
0.2
0.0
$\Delta_{l,s}$
Tr_0
N_τ=8
asqtad
p4fat3

RBC


300
250
200
150
100
χ_{tot}/T^2
0.75*p4fat3
asqtad
T [MeV]
140
160
180
200
220
240

WUPPERTAL-JUELICH

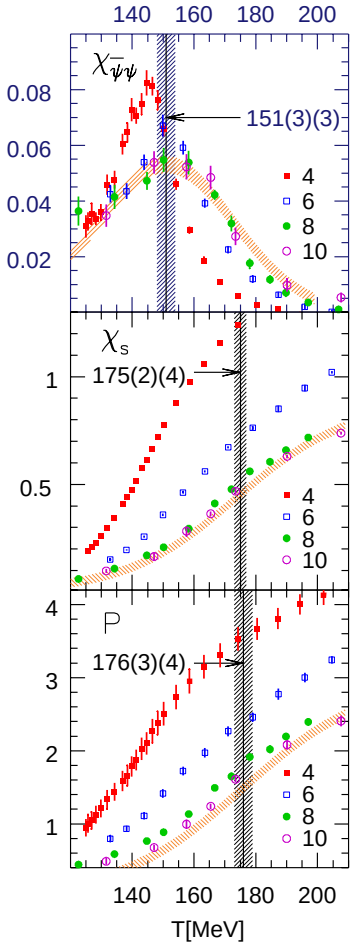


Figure 7: Temperature dependence of the renormalized chiral susceptibility ($m^2\Delta\chi_{\bar{\psi}\psi}/T^4$), the strange quark number susceptibility (χ_s/T^2) and the renormalized Polyakov-loop (P_R) in the transition region. The different symbols show the results for $N_t = 4, 6, 8$ and 10 lattice spacings (filled and empty boxes for $N_t = 4$ and 6, filled and open circles for $N_t = 8$ and 10). The vertical bands indicate the corresponding transition temperatures and their uncertainties coming from the T$\neq$0 analyses. This error is given by the number in the first parenthesis, whereas the error of the overall scale determination is indicated by the number in the second parenthesis. The orange bands show our continuum limit estimates for the three renormalized quantities as a function of the temperature with their uncertainties.

Open problems at $\mu = 0$

Tc - chiral and deconfinement

Universality Class of 2 light quarks

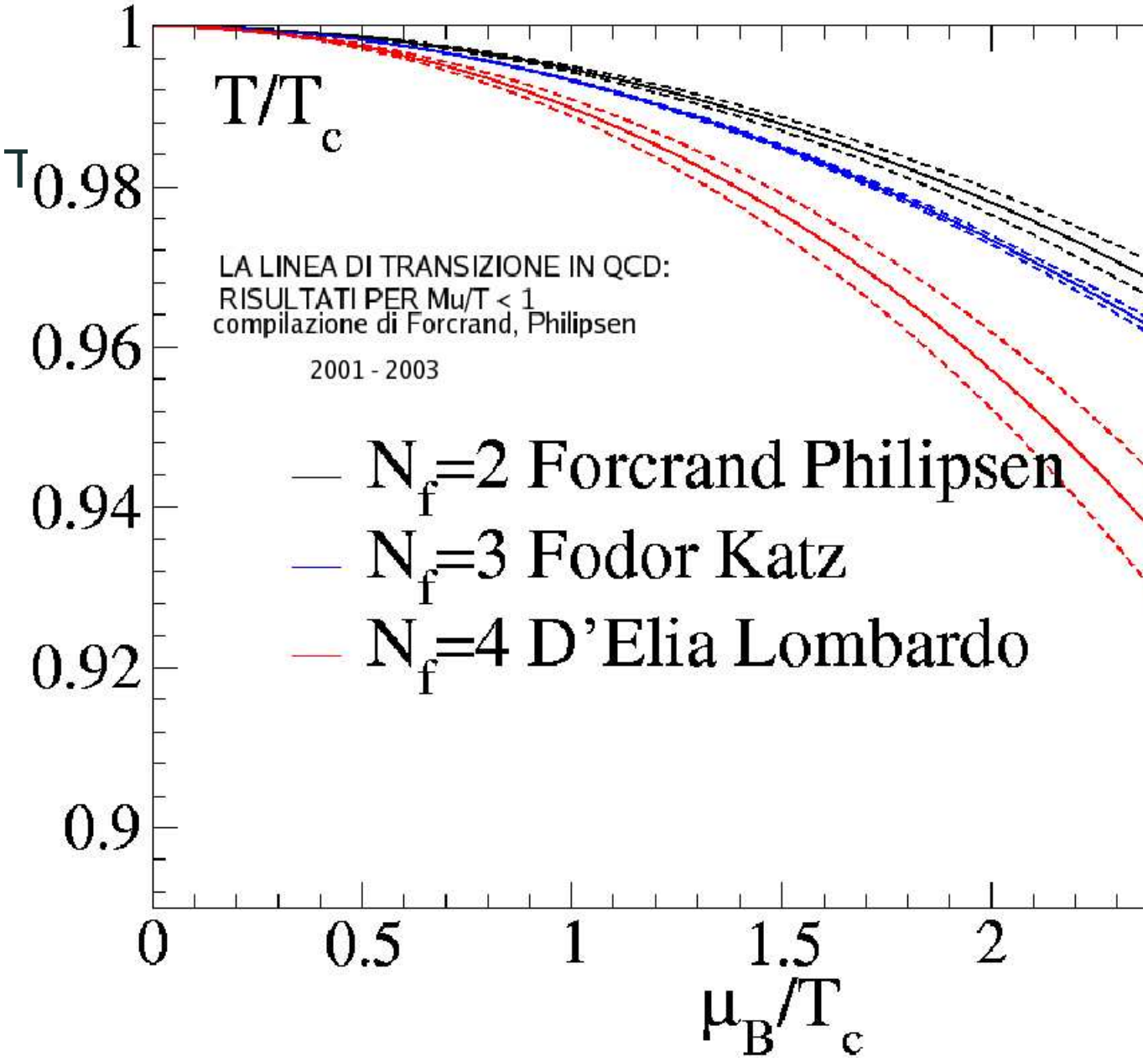
Staggered Fermions:

- *O(2) or O(4) with Nt=8 but scaling window very narrow - other behaviour cannot be ruled out (Kogut Sinclair 2004)*

- *O(2) at strong couplint very high precision low masses Chandrasekharan Strouthos, 2004*
- *First order (O(2) / O(4) ruled out) Nt=4 Pisa Group, 2005*
- *O(2) Nt=8 Kogut, Sinclair 2006*

Wilson fermions:

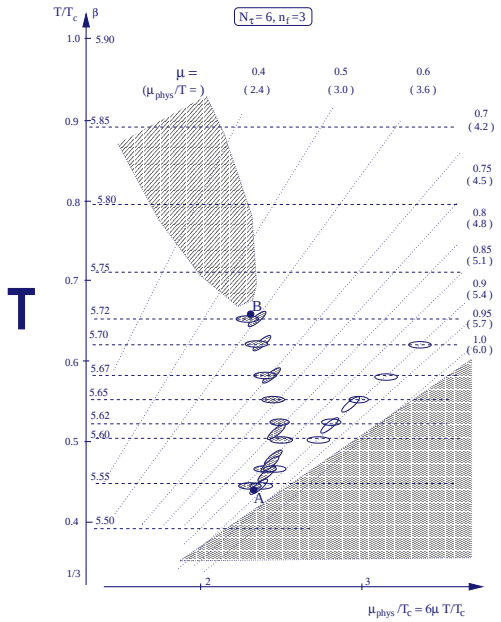
- *Apparently compatible with O(4) scaling Nt=4- CP-Pacs 2001*
- *In progress su apeNEXT - INFN-DESY-HUMBOLDT*


T/T_c
T
1
0.98
0.96
0.94
0.92
0.9
LA LINEA DI TRANSIZIONE IN QCD:
RISULTATI PER Mu/T < 1
compilazione di Forcrand, Philipsen
2001 - 2003
N_f=2 Forcrand Philipsen
N_f=3 Fodor Katz
N_f=4 D'Elia Lombardo
0
0.5
1
1.5
2
μ_B/T_c

HEAVY QUARK EFFECTIVE MODEL

Double limit: $M \to \infty,\ \mu \to \infty,\ \zeta \equiv \exp(\mu - \ln M)$: **Fixed**

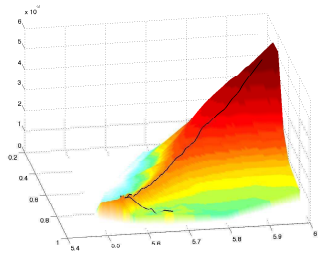
Evolved 'quenched approximation' in the presence of charged matter



T

μ_B

Polyakov Loop



Results for $N_f = 3$:

- **Identified phase transition**
- **Indentified Ridge in the T, μ plane**
- **Studies of diquark in progress**

Di Pietro, Feo, Seiler, Stamatescu 2008

DENSITY OF STATES

Luo, Azcoiti et al,, Ambjorn et al., Anagnostopoulos and J. Nishimura,

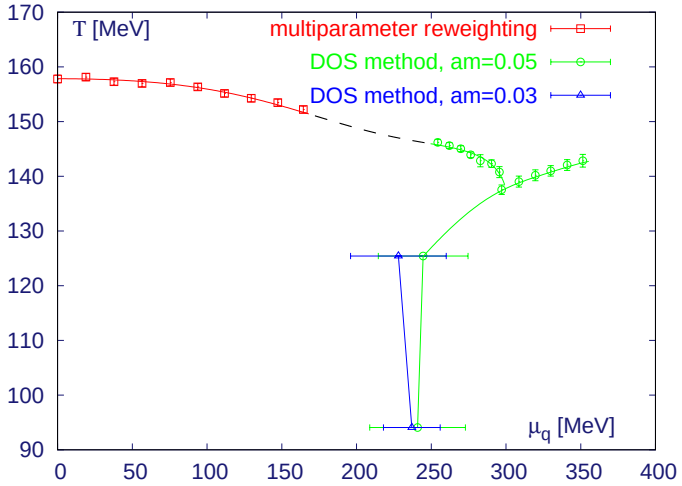
$$< O >= \int d\phi \ \langle O f(U) \rangle_\phi \, \rho(\phi) \Big/ \int d\phi \ \langle f(U) \rangle_\phi \, \rho(\phi) \ , \phi \text{ fixed}$$

Density of states – ρ –
constrained partition function:
$\rho(x) = \int \mathcal{D}U \; g(U) \, \delta(\phi - x).$

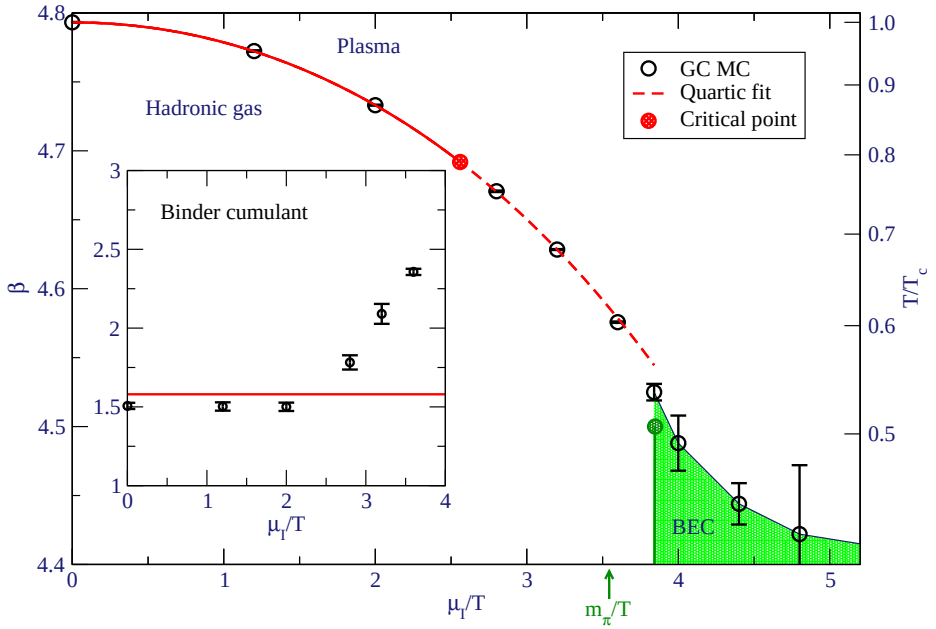
Results for $N_f = 4$

- **Signal of two phase transition lines**
- **Indication for a triple point**

Fodor, Katz, Schmidt 2007

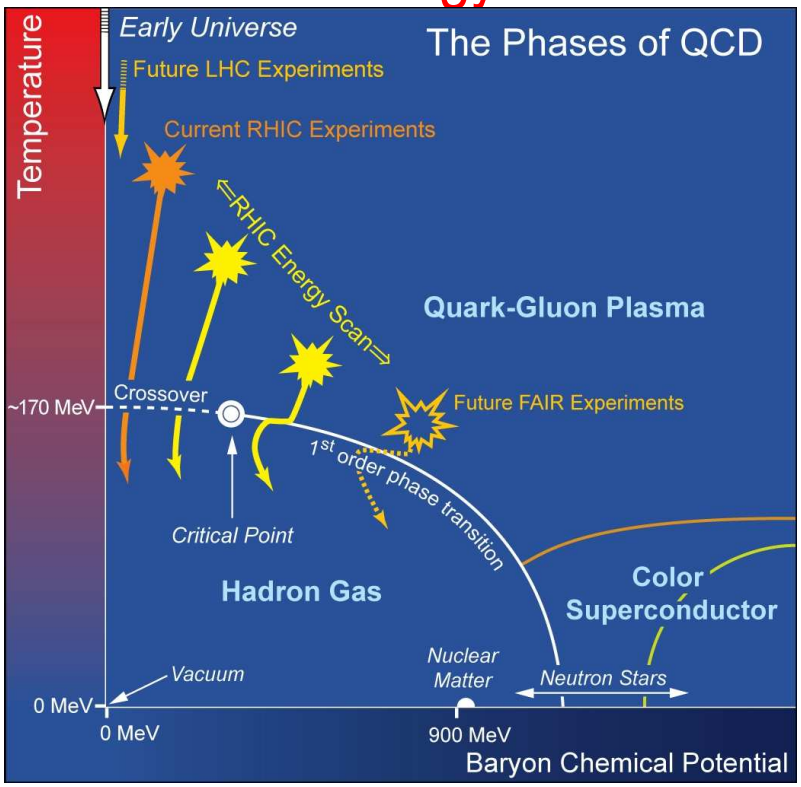


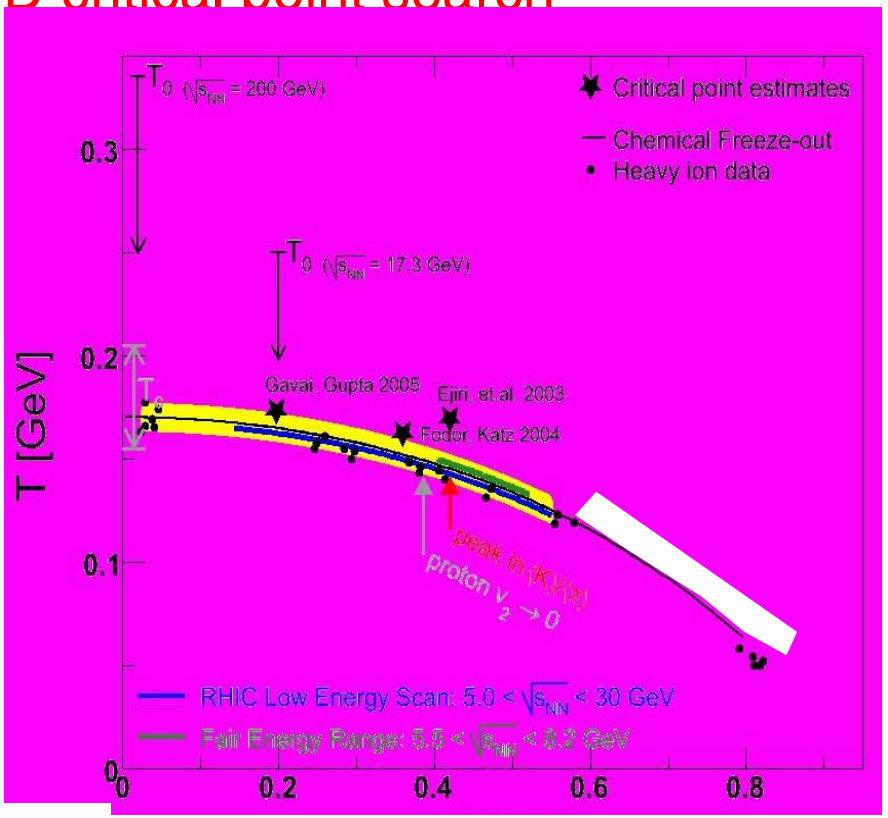
THE PHASE DIAGRAM FOR A FINITE ISOSPIN DENSITY



Forcrand, Stephanov, Wenger, 2007

Ultimately the focus of such studies in the future: Beam Energy Scan & QCD critical point search





STAR Collaboration is planning for initial beam energy scan in Run 10 (fall 2009)
(See G. Odyniec, Session XXIV)

Primary tool: search for anomalously large particle identified fluctuations with comprehensive particle identification for charged particles provided by TPC + TOF

STAR@QM2008

FUTURE

LHC

THEORETICAL DEVELOPMENTS

NEW COMPUTERS