**Press release**
**For release: under embargo**

# The power of PRACE: Looking beyond the Standard Model

*PRACE awarded millions of core hours on three of Europe's most powerful supercomputers (17.5 million on JUQUEEN (JSC@GCS); 7.5 million on FERMI (CINECA); 5 million on SuperMUC, (LRZ@GCS)) to a project in fundamental physics entitled "Next generation of lattice QCD simulations of the first two quark generations at the physical point". The project was implemented by a multi-national team of physicists, who shed light on the tension between theory and experiment when looking at the anomalous magnetic moment of the muon. For this pioneering work the team received the "Ken Wilson lattice award."*

The standard model (SM) of high energy physics describes the fundamental interaction between elementary particles – bits of energy and mass so tiny that it sometimes (like in the case of the Higgs boson) needs enormous machines such as the Large Hadron Collider (LHC) at CERN to actually find hints of them or detect them. The standard model is often referred to as "*a theory of almost everything*", but despite its success, we know that it cannot be the theory of particle interaction down to arbitrary small distances or equivalently arbitrary large energies. It is predicted that at some very small, so far unknown distance a new kind of physics will appear, replacing our present picture of particle interaction with something completely new.

It is for this quest beyond the laws of presently known physics that Dr. Karl Jansen of NIC, DESY in Zeuthen, Germany, applied for access to Europe's most powerful high performance computers via the PRACE 5$^{th}$ Regular Call for Proposals. A consortium of more than 50 physicists spanning 8 European countries, led by Dr. Jansen and anchored in the European Twisted Mass Collaboration, was awarded a multi-year access project, with allocations of core hours on three systems: 17.5 million core hours on JUQUEEN installed at Jülich Supercomputing Center (JSC@GCS), Germany; 7.5 million core hours on FERMI installed at CINECA, Italy and 5 million core hours on SuperMUC, installed at Leibniz Supercomputing Centre (LRZ@GCS), Germany.

With this extensive support from PRACE, Dr. Jansen and his team applied lattice field theory methods to quantum chromodynamics (QCD) simulations to unravel the secrets of the strong force between quarks and gluons, a force that has great impact on nuclear and high energy physics. Besides the award winning work on the anomalous magnetic moment of the muon, they also computed the hadron spectrum and decay constants as well as hadron matrix elements relevant for e.g. dark matter detection and understanding non-perturbative phenomena. The novelty of their project lay in the first-time inclusion of the complete first two quark generations in the simulations: essentially the development of a new method in which the lattice data come close to nature.

Projects in fundamental physics such as this are in dire need of high performance computing resources, as the computational costs increase rapidly for smaller and smaller hadron masses, which means that researchers are often limited to values of e.g. pion masses that are approximately a factor two larger than those observed in nature.

PRACE is proud to help further this fundamental research and the results it yields for both the physics community in terms of improvements to the standard model, as well as for computational science as

the applications, used for lattice QCD involve enormously complicated calculations, test the supercomputers very aggressively and thus help develop and debug the architectures. It is also noteworthy that more than 25 Ph.D. students and young postdocs are collaborators in Dr. Jansen's project, giving significant push to the careers of the next generation scientists.

**About PRACE**
The Partnership for Advanced Computing in Europe (PRACE) is an international non-profit association with its seat in Brussels. The PRACE Research Infrastructure (RI) provides a persistent world-class High Performance Computing (HPC) service for scientists and researchers from academia and industry. The PRACE computer systems and their operations are funded by the governments of the representative organizations hosting the systems. The Implementation Phase of PRACE receives funding from the EU's Seventh Framework Programme (FP7/2007-2013) under grant agreements n° RI-261557 and n° RI-283493.

**About the European Twisted Mass Collaboration**
The European Twisted Mass Collaboration comprises all three universities of Rome, the universities of Bonn, Liverpool, Glasgow, Barcelona, Seville, Valencia, Orsay, Saclay, Frankfurt, Groningen, Cyprus, Grenoble, Berlin, M□unster, Poznan, Bern and the research centers DESY in Hamburg and Zeuthen, ECT* in Trento and LPSC in Grenoble. http://www-zeuthen.desy.de/~kjansen/etmc/

**About CINECA**
www.hpc.cineca.it
CINECA is a non-profit Interuniversity Consortium of 54 Italian Universities, The National Institute of Oceanography and Experimental Geophysics - OGS, the National Research Council - CNR, and the Ministry of Education, University and Research - MIUR.

**About GCS**
The Gauss Centre for Supercomputing (GCS) consolidates the three national supercomputing centres HLRS (High Performance Computing Center Stuttgart - http://www.hlrs.de/), JSC (Jülich Supercomputing Centre - www2.fz-juelich.de), and LRZ (Leibniz Supercomputing Centre, Garching - www.lrz.de) into Germany's Tier-0 Supercomputing institution. Concertedly, the three centres provide one of the largest and most powerful supercomputer infrastructures in Europe to serve a wide range of industrial and research activities in various disciplines. They also provide top-class training and education for the national as well as the European High Performance Computing (HPC) community. GCS has its headquarters in Berlin/Germany.

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