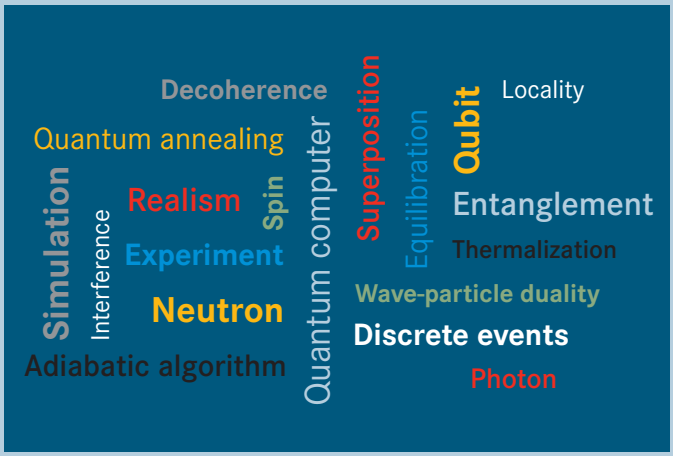
JÜLICH
FORSCHUNGSZENTRUM

JSC Research Group
Quantum Information Processing

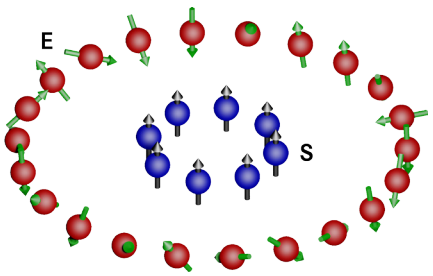


Massively parallel quantum spin dynamics simulator simulates 43-qubit quantum computer on JUQUEEN (262,144 CPUs)

- Nearly perfect scaling with increasing problem size and number of CPUs
- Beats exponential scaling
- Obeys Gustafson's law

Simulation of quantum spin systems

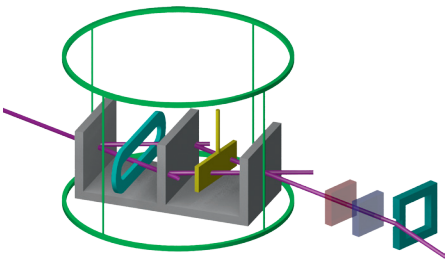
- Solve the time-dependent Schrödinger equation (TDSE) for systems with up to 36 qubits
- Investigate decoherence, equilibration and thermalization of a system S coupled to an environment E



- No need to postulate the canonical ensemble; it may be a natural consequence of the dynamical evolution of (small) quantum systems

Event-based simulation of quantum phenomena

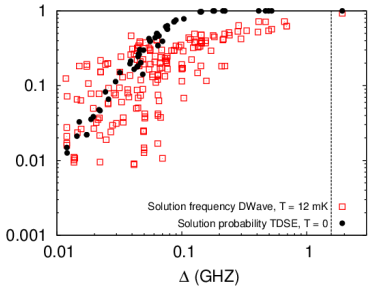
- Experiments with single photons and neutrons
  - Record individual detector clicks (= events)
  - Demonstrate interference and entanglement



- Discrete event (particle-like) simulations provide a realistic cause-and-effect description of experimental observations

Adiabatic quantum computing / Simulation on a D-Wave 2 System

- Solution to a hard 2-SAT optimization problem with 18 Boolean variables, designed to hide a unique ground state from a large number of first excited states, is encoded in the ground state of H_p. To find the solution:
  - Initialize system in "easy to reach" ground state of H_i
  - Slowly modify the Hamiltonian of the system from H_i to H_p using $H = \lambda H_p + (1-\lambda)H_i$. The energy spectrum as a function of λ exhibits a minimum gap Δ.



Contact: k.michielsen@fz-juelich.de | **Website:** www.fz-juelich.de/ias/jsc/qip