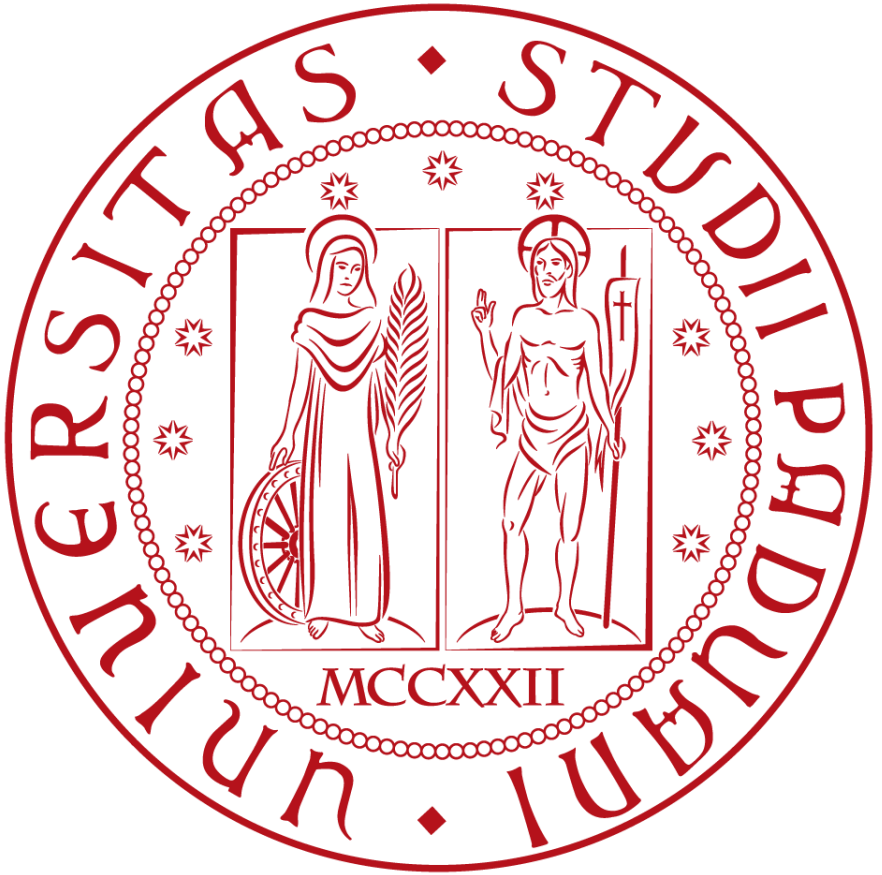
STUDIO DELLE PRESTAZIONI DEL QUANTUM ANNEALER D-WAVE

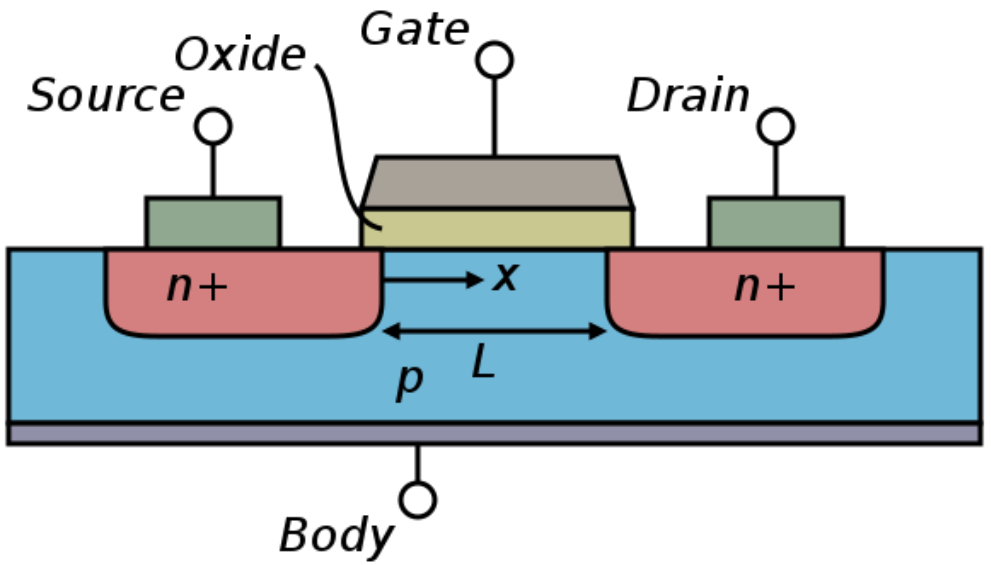


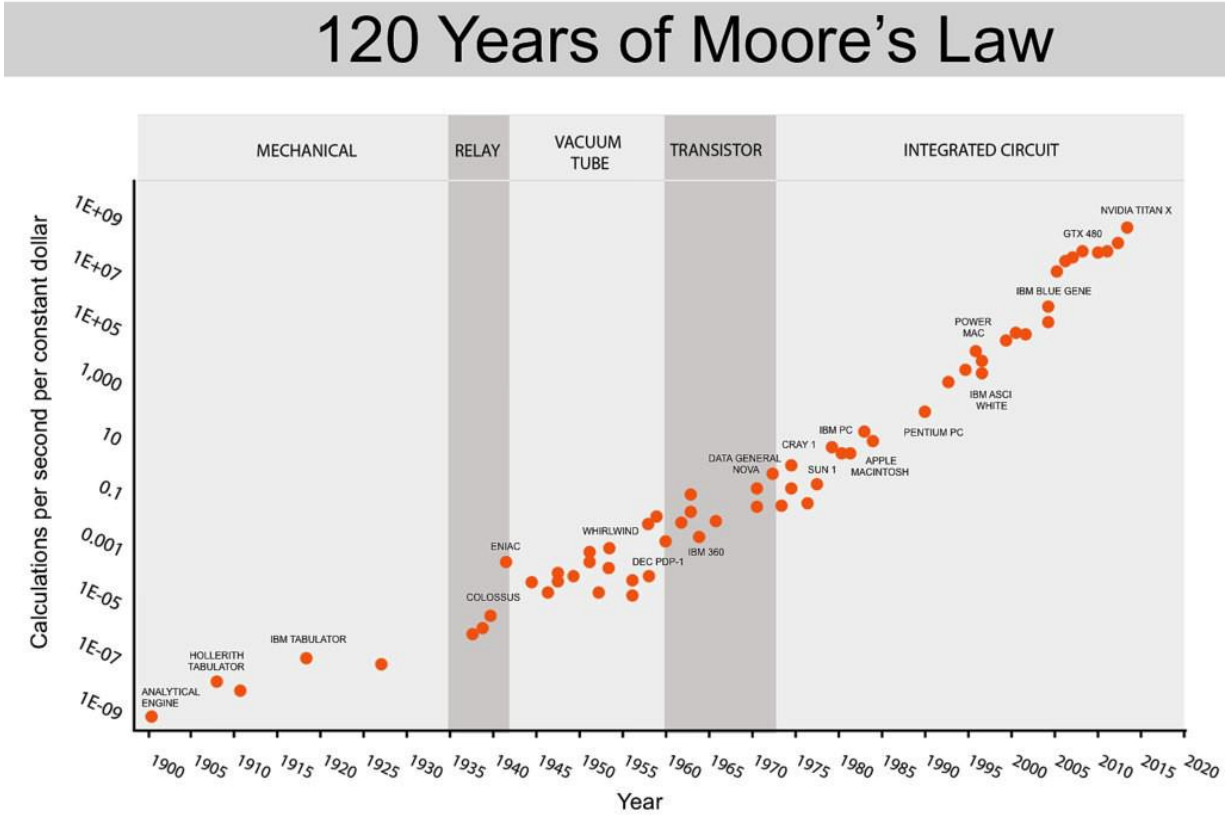
28 Settembre 2018

Prof. Giuseppe Vallone

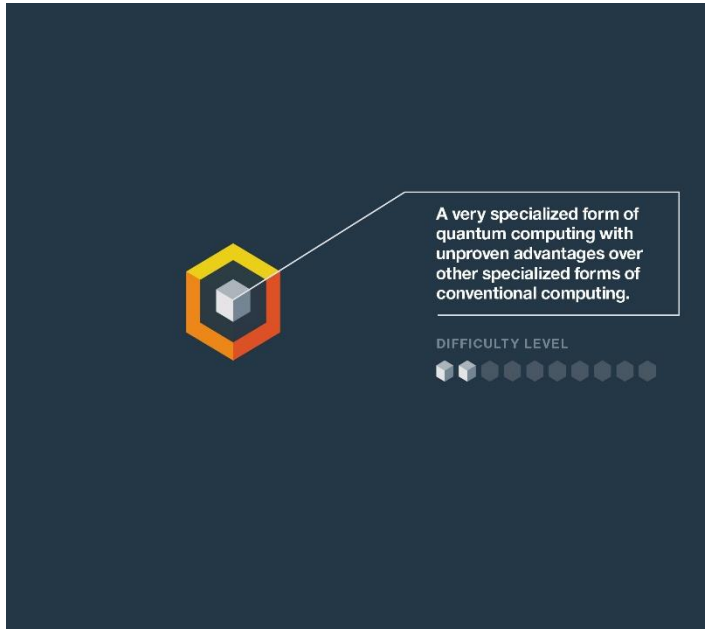
Federico Berra

Indice:


Oxide
Gate
Source
Drain
n+
x
n+
p
L
Body

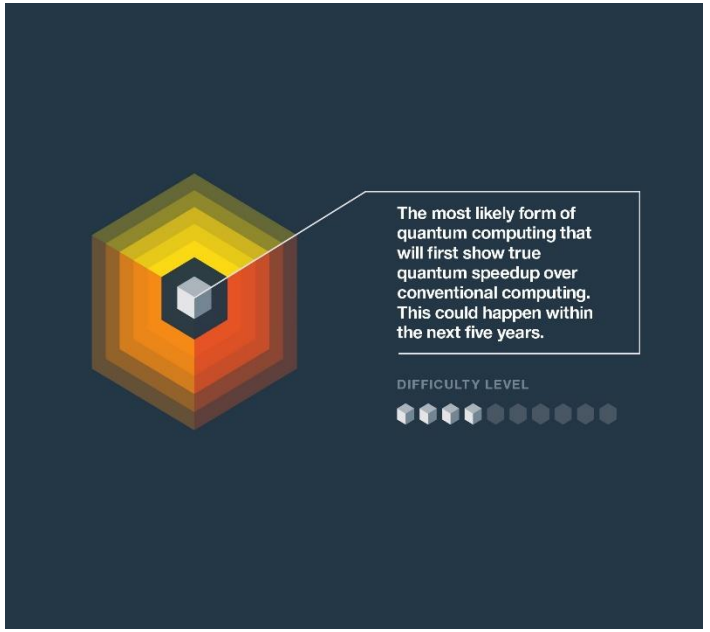

120 Years of Moore's Law
MECHANICAL
RELAY
VACUUM TUBE
TRANSISTOR
INTEGRATED CIRCUIT
Calculations per second per constant dollar
1E+09
1E+07
1E+05
1,000
10
0.1
0.001
1E-05
1E-07
1E-09
NVIDIA TITAN X
GTX 480
IBM BLUE GENE
POWER MAC
IBM ASCI WHITE
PENTIUM PC
IBM PC
CRAY 1
APPLE MACINTOSH
DATA GENERAL NOVA
SUN 1
WHIRLWIND
ENIAC
IBM 360
DEC PDP-1
COLOSSUS
IBM TABULATOR
HOLLERITH TABULATOR
ANALYTICAL ENGINE
1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Year

Quantum Annealer

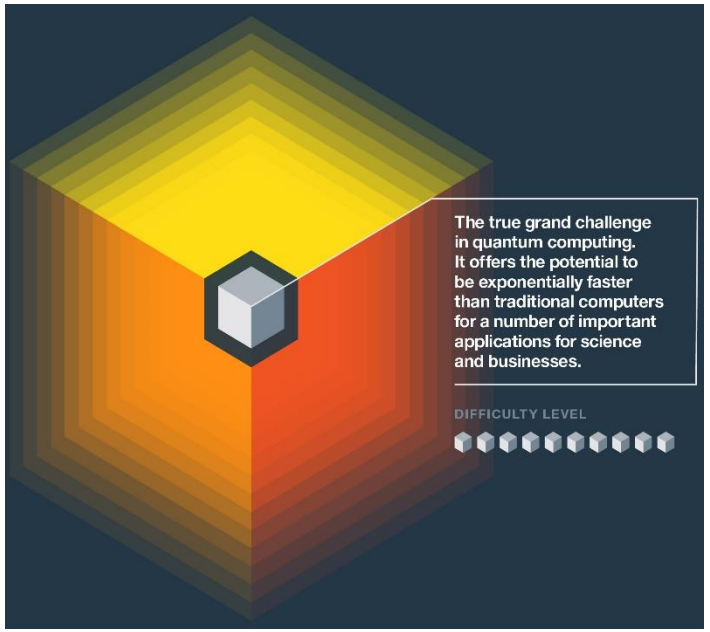


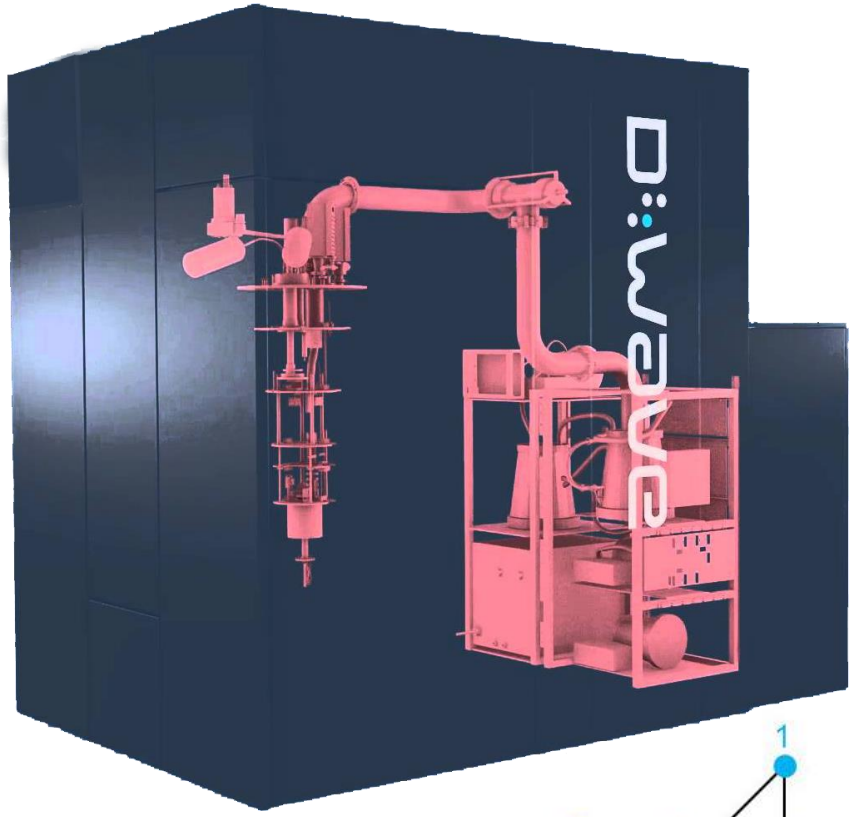
D-Wave One
D-Wave Two

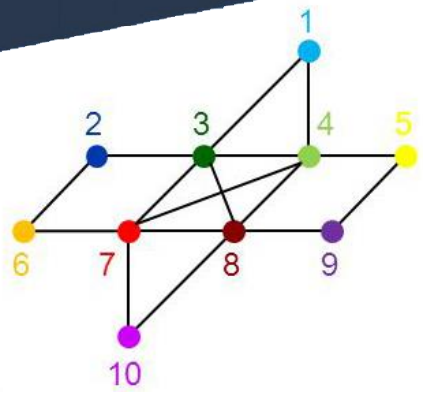
Analog Quantum

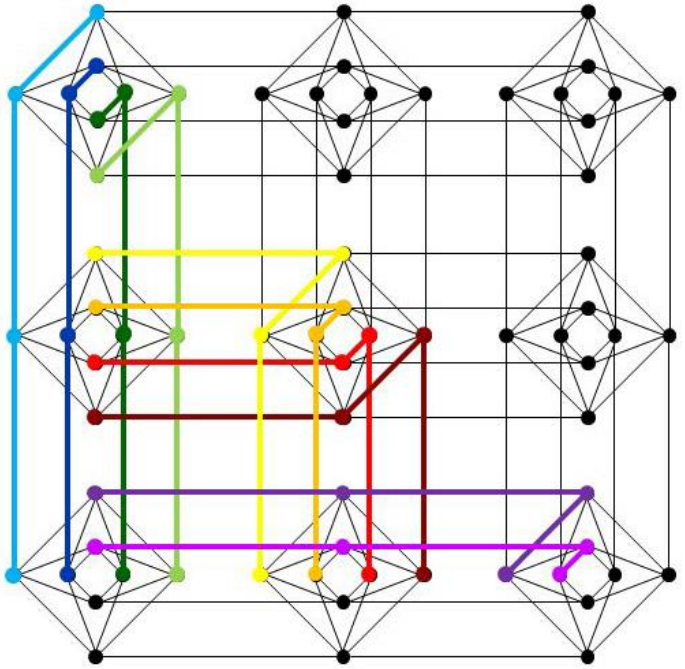


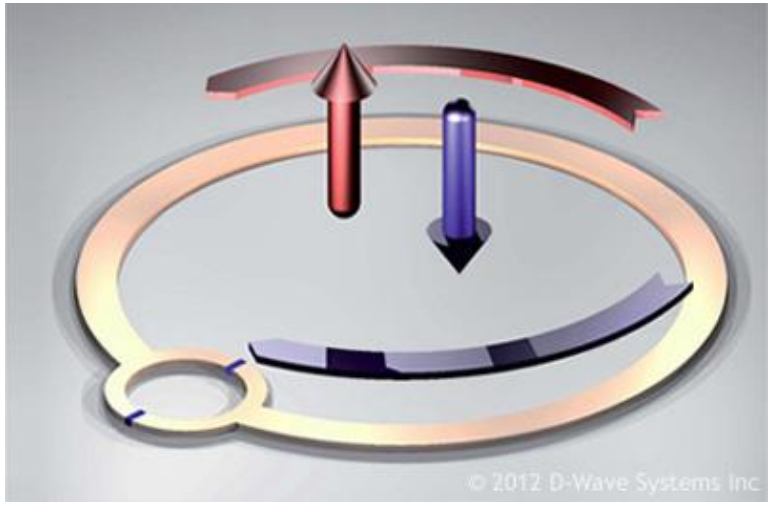
Universal Quantum




D-Wave


1
2
3
4
5
6
7
8
9
10

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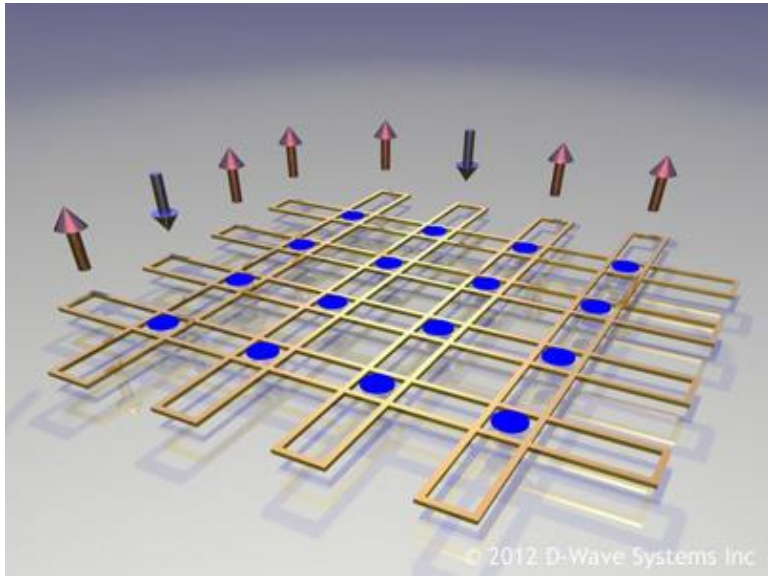
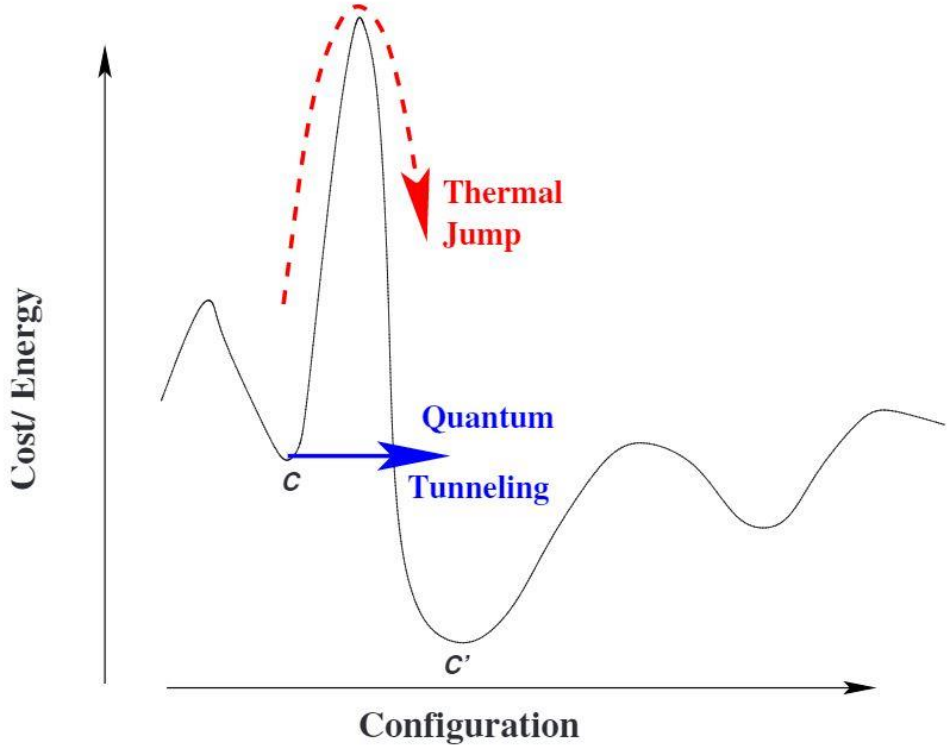
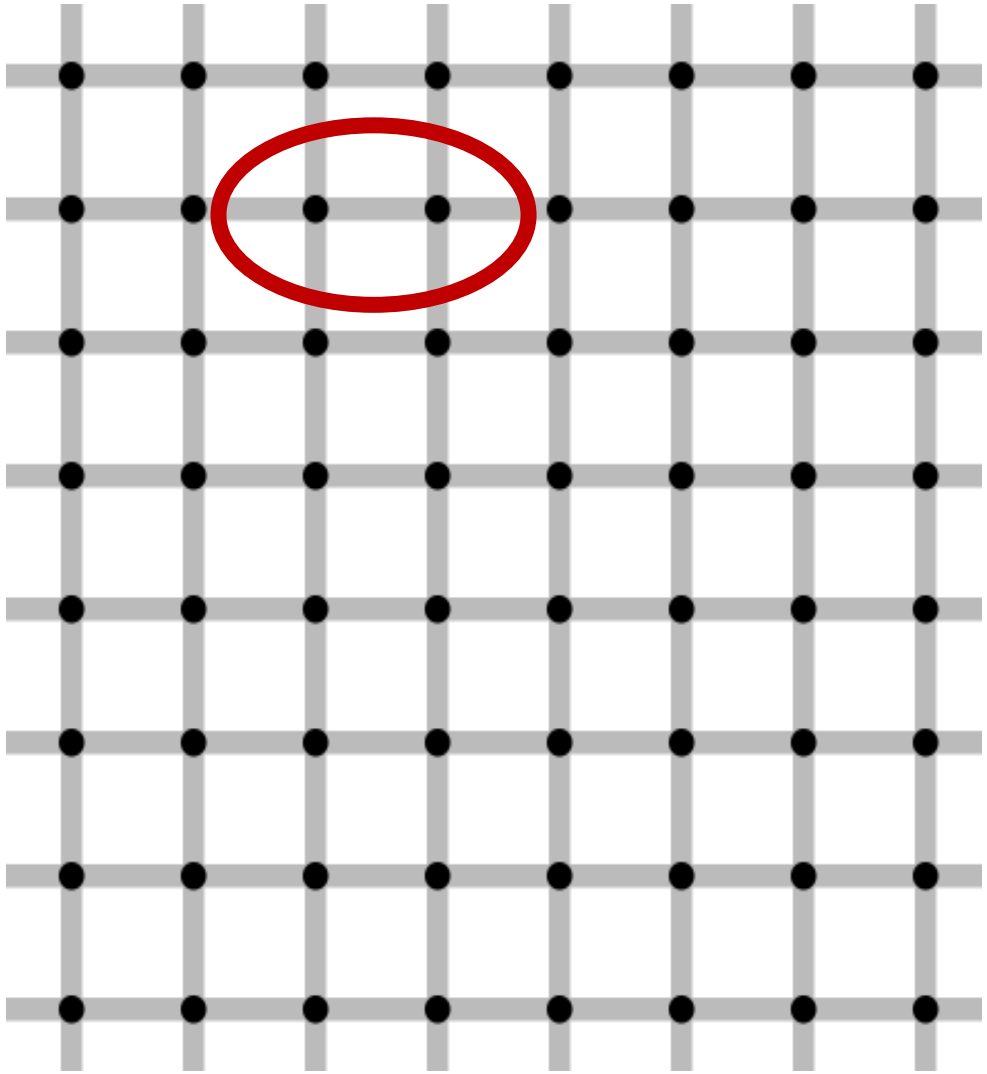

© 2012 D-Wave Systems Inc

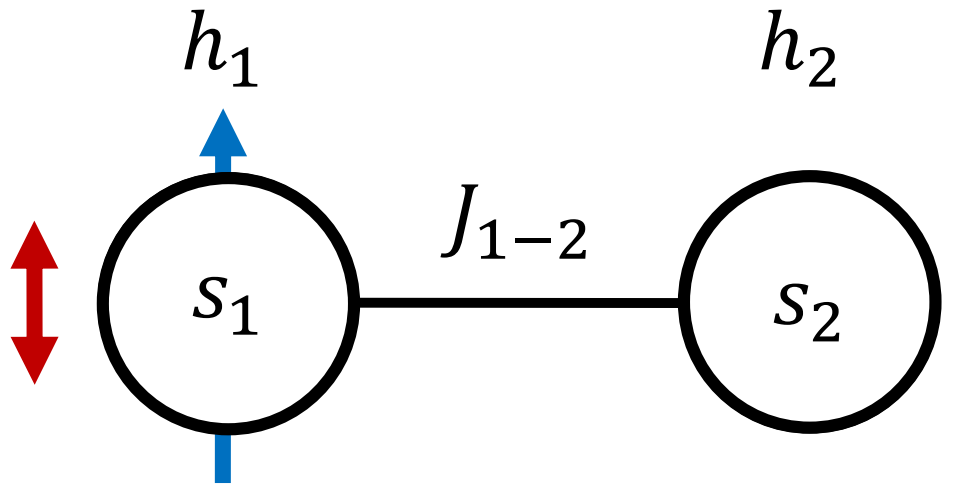


H_1 *Semplice*

H_2 *Difficile*

$$H(t) = t \cdot H_1 + (1 - t) \cdot H_2$$



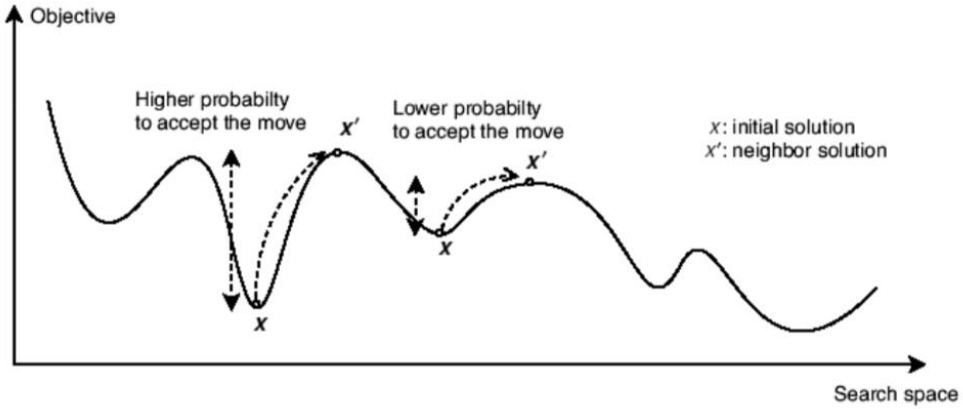


$$H_p = \sum_{i=1}^{N} h_i \sigma_i^z + \sum_{i,j=1}^{N} J_{ij} \sigma_i^z \sigma_j^z$$

$$H(t) = \Gamma(t) \sum_{i=1}^{N} \Delta_i \sigma_i^x + \Lambda(t) H_p$$

- se $\Delta E \leq 0$ viene tenuta
- altrimenti viene tenuta con probabilità

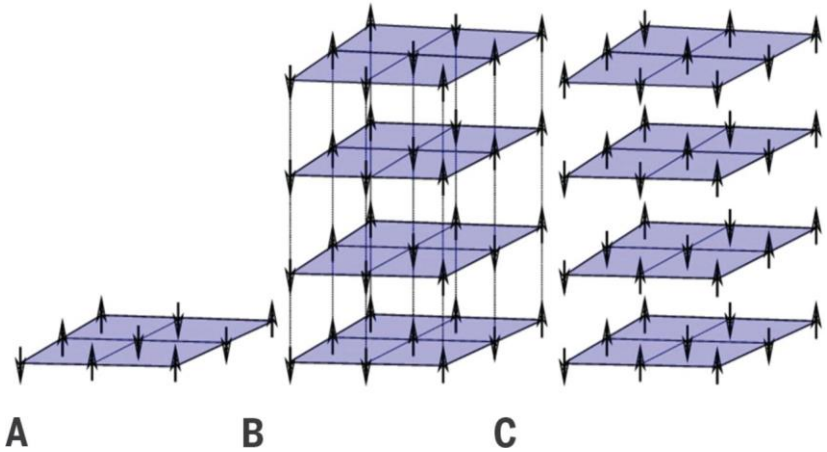
$$P(\Delta E) = exp\left(-\frac{\Delta E}{k_B \cdot T} \right)$$

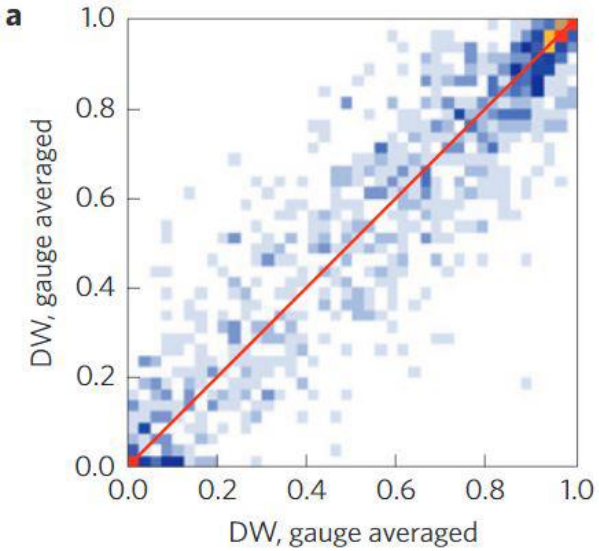


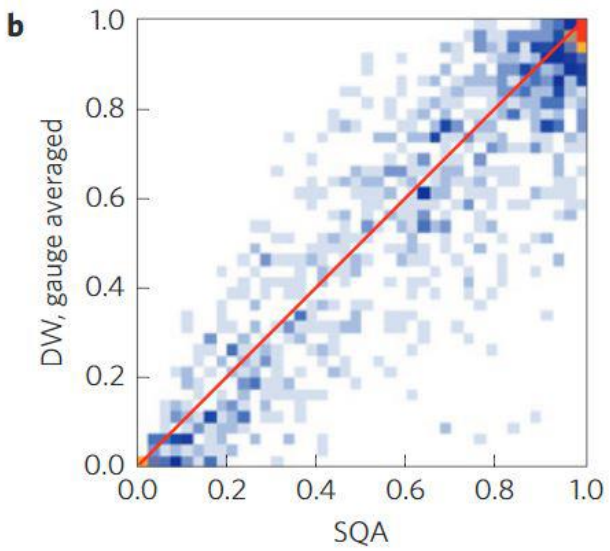
<PIMC>

<CT-SQA>

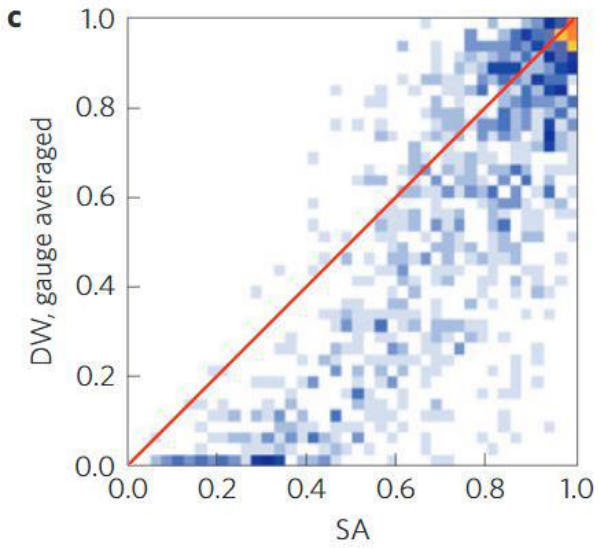
<DT-SQA>

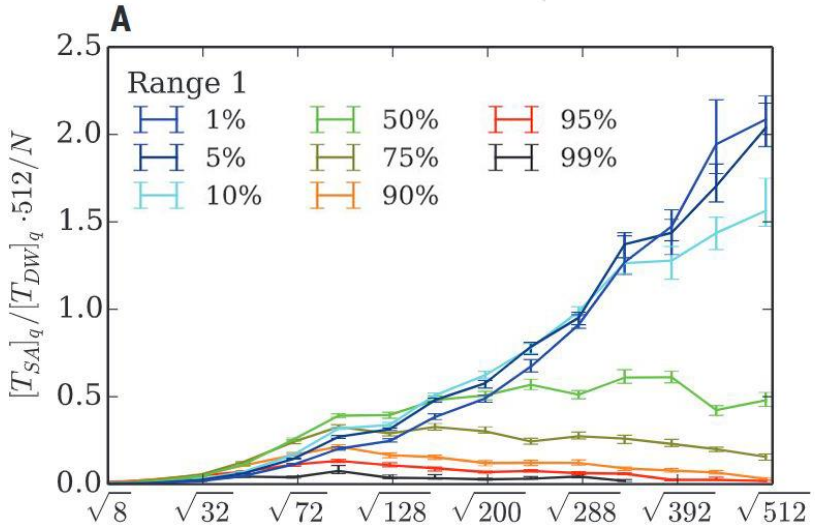


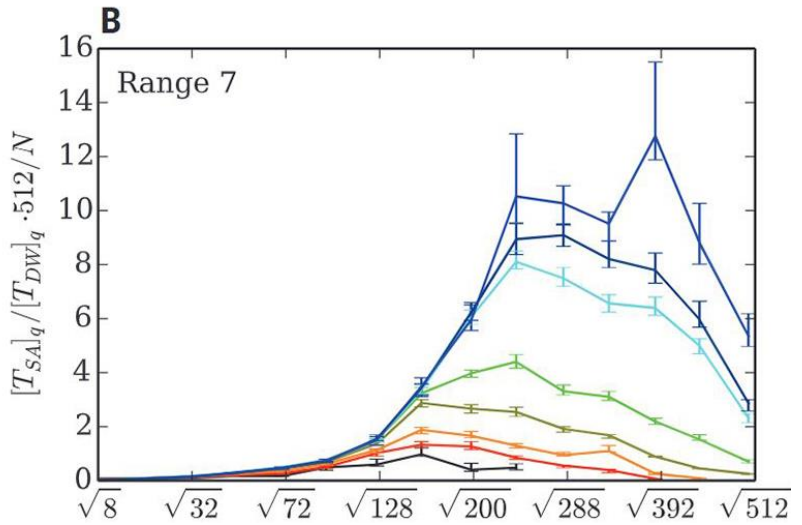


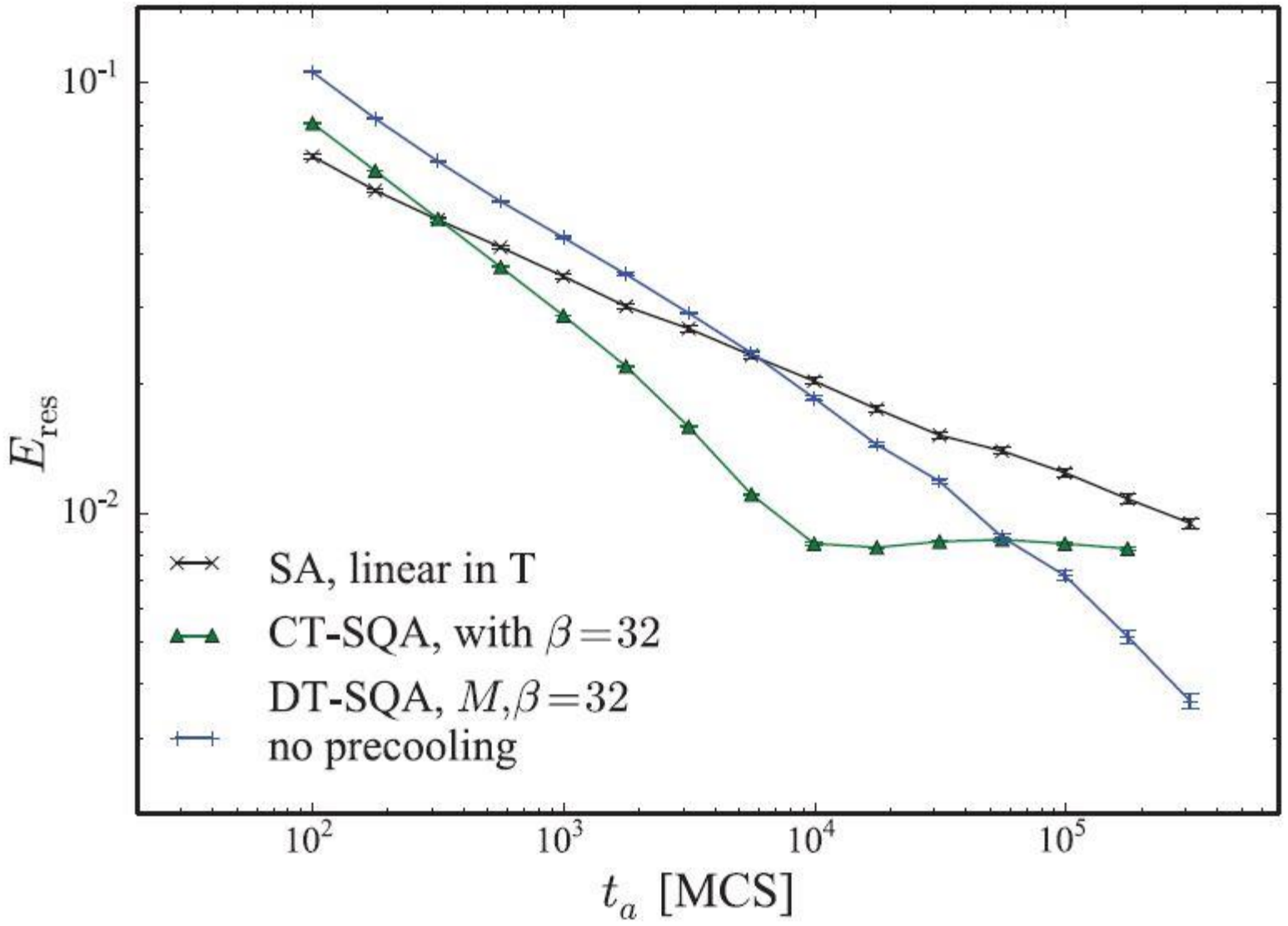


$$S_{DW} = \lim_{N \to \infty} \frac{T_{SA-SQA}(N)}{N \cdot T_{DW}(N)}$$

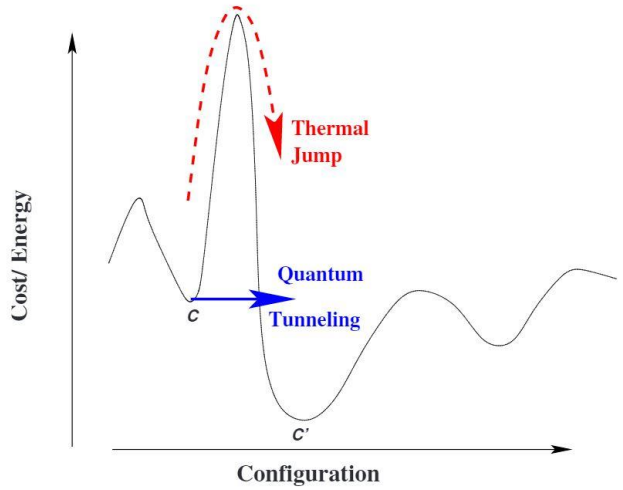


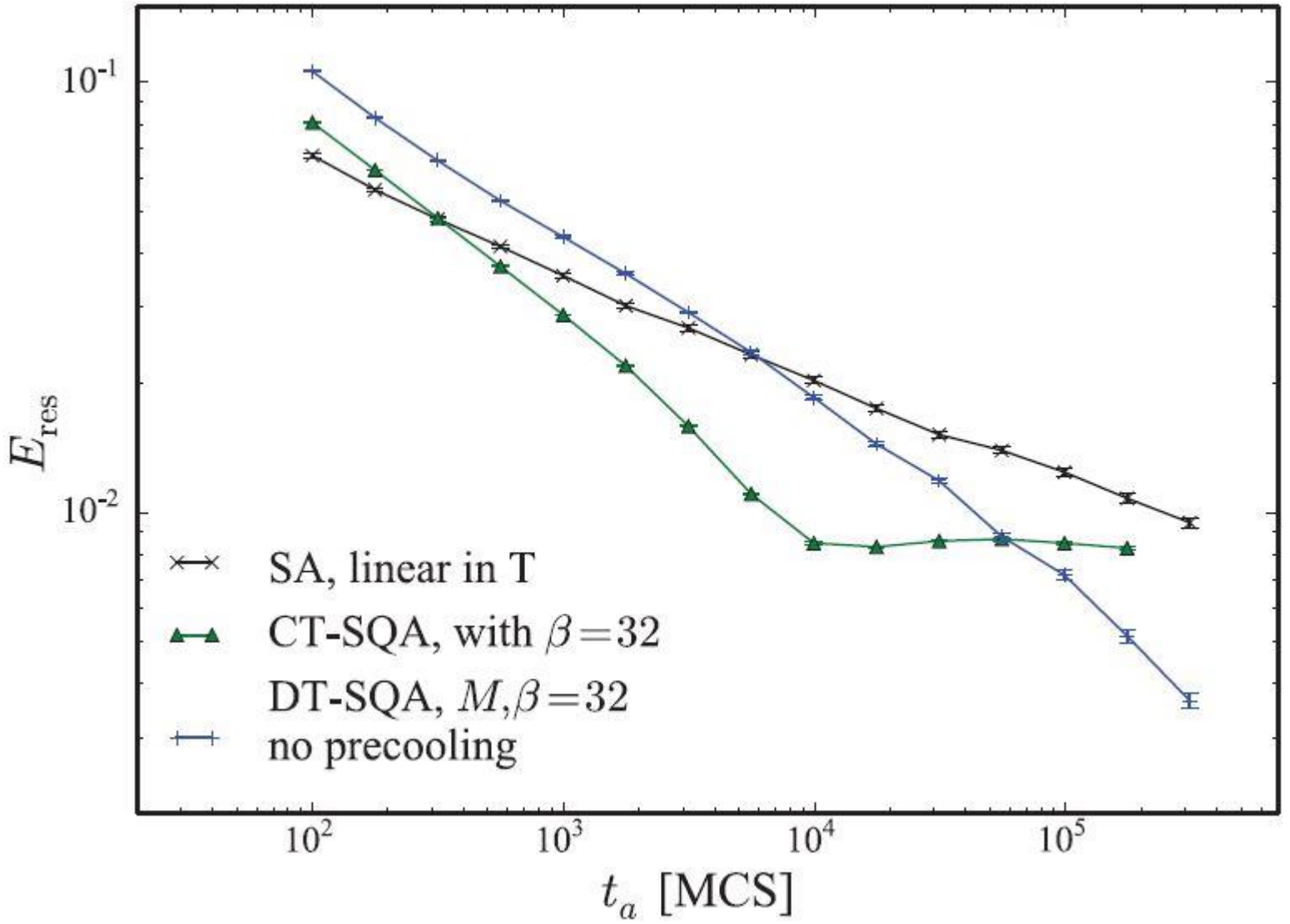





10^{-1}
10^{-2}
E_{res}
SA, linear in T
CT-SQA, with $\beta=32$
DT-SQA, $M,\beta=32$
no precooling
10^2
10^3
10^4
10^5
t_a [MCS]

- Tunneling accorcia le distanze
- Meglio del CT
- Non testato sopra il 2d





Fine
Q & A