Prospects and Limitations of Grid Computing in Particle Phyiscs

Plymouth, January 31, 2007

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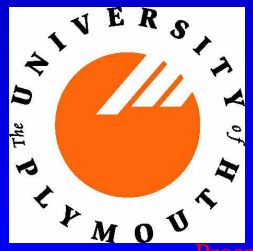
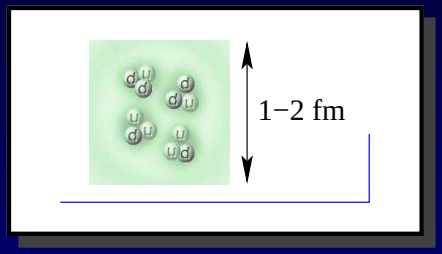


Glimpse of Particle Physics:

- Particle Physics $\leftrightarrow$ Quantum Field Theory

Electromagnetism	(QED)
Strong interactions	(QCD)
“Weak” interactions	(WS-theory)
Gravity	(?)



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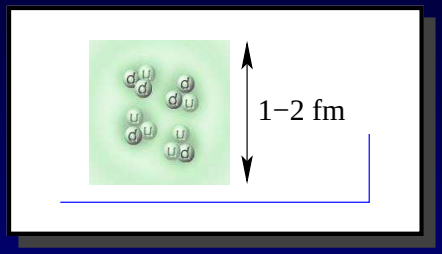
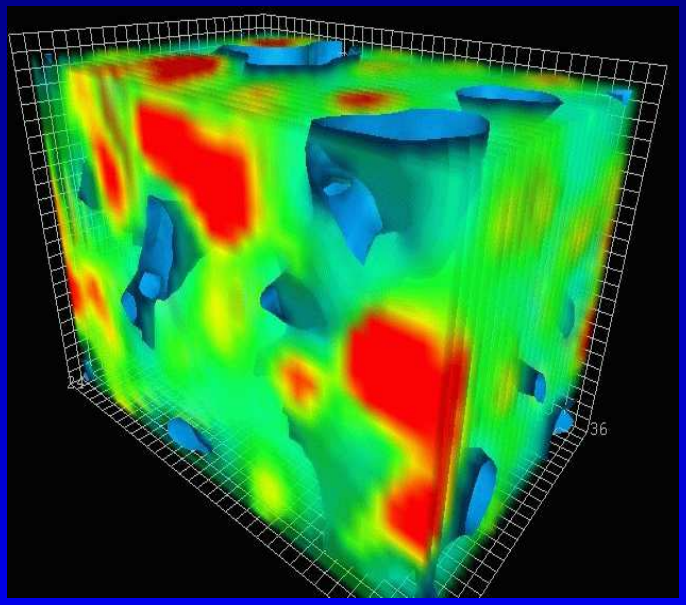


- Quantum Field Theory $\leftrightarrow$ Fluctuating fields

  Size of fluctuations $\leftrightarrow$
  h (Planck's constant)



(CSSM, Adelaide)

Glimpse of Particle Physics:

- Particle Properties $\leftrightarrow$ Fluctuations

  Ball moving through air $\rightarrow$mass
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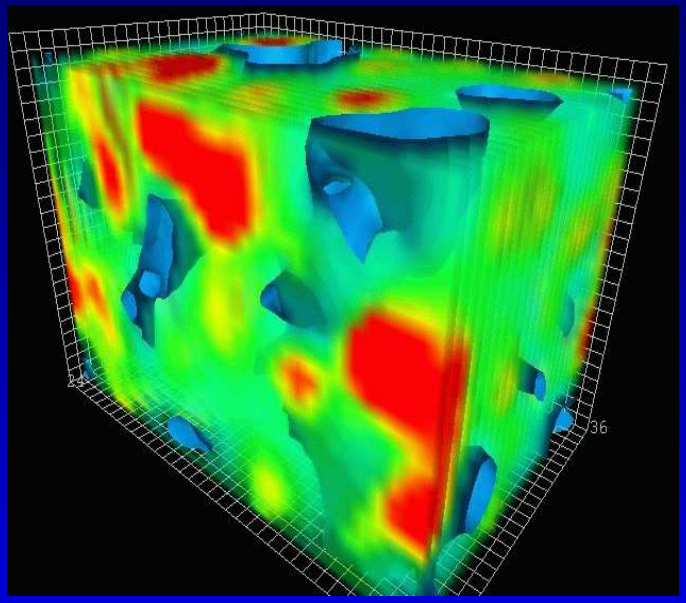
- Theory $\Rightarrow$ Probability for a "field configuration"

  Task $\rightarrow$ Average over field configurations



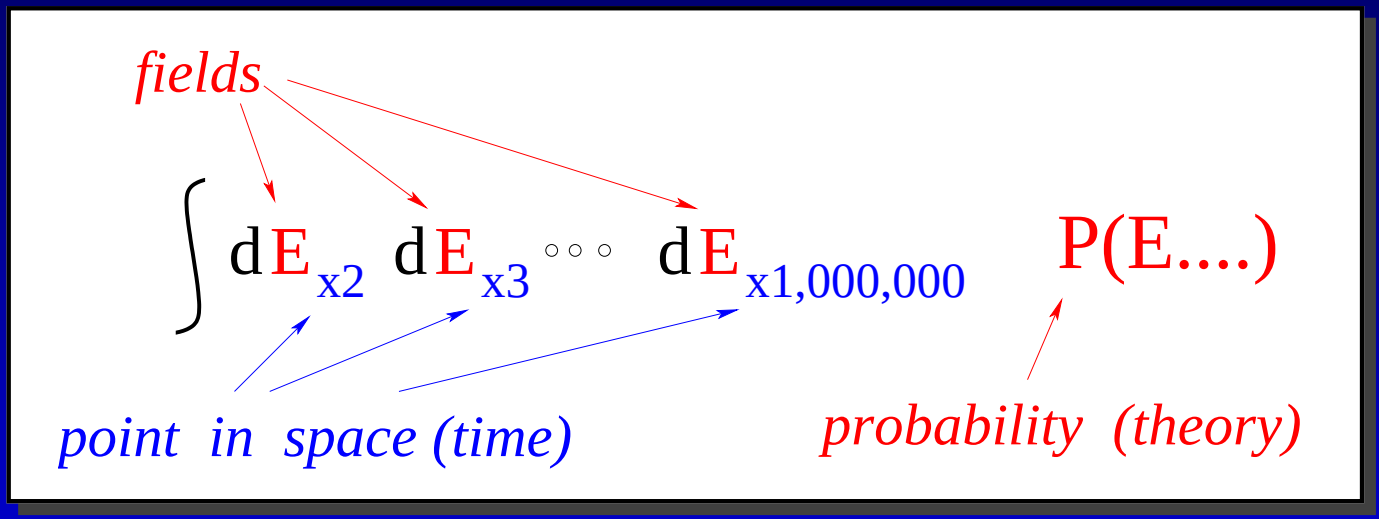
A Computational Challenge:

- Average over configurations

1-dim integration $\int dx\ P(x)$

2-dim integration $\int dx\ dy\ P(x,y)$

here: high-dim integration:



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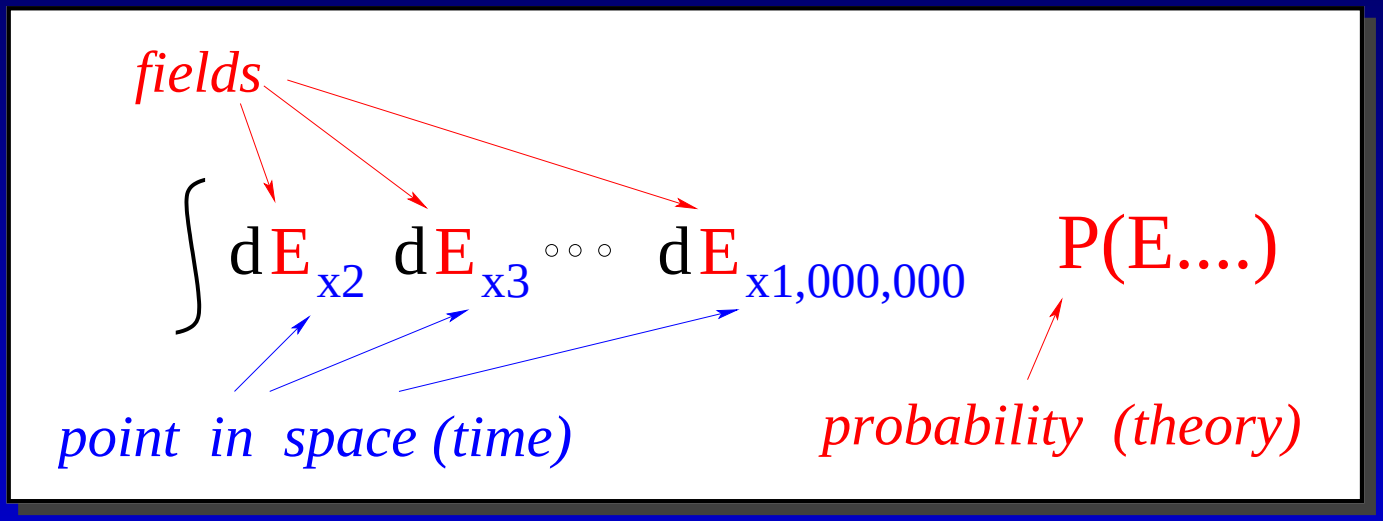

- Can we do it “brute force”?

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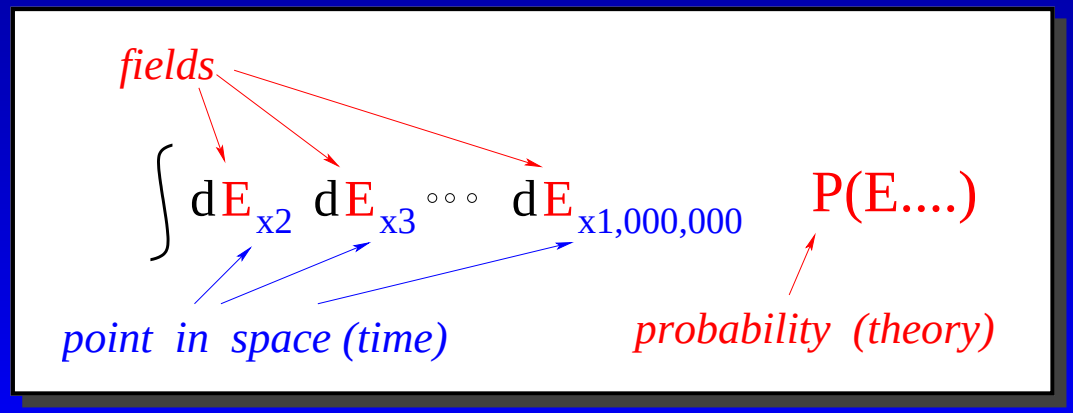
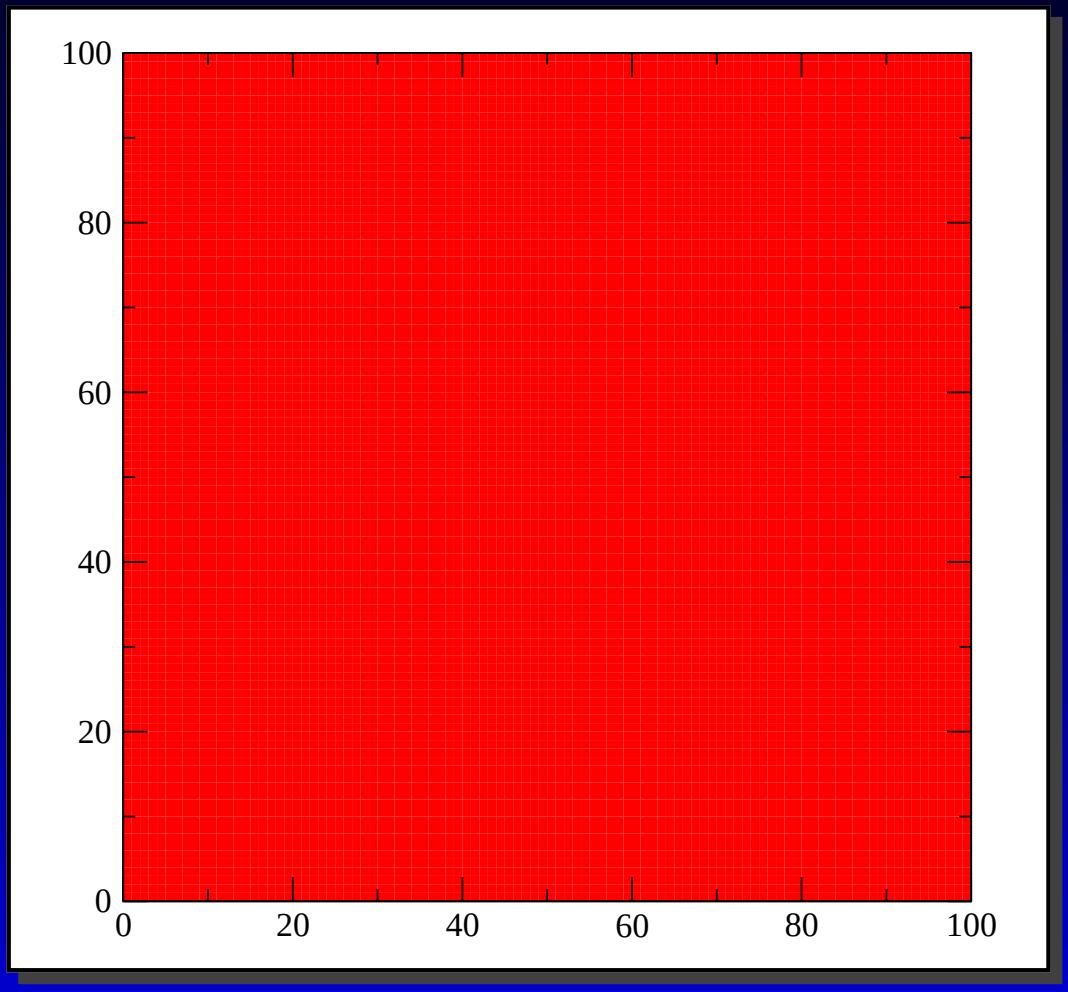
- Solution: Importance Sampling
  use only configurations which are "probable"



A case study: the Magnet



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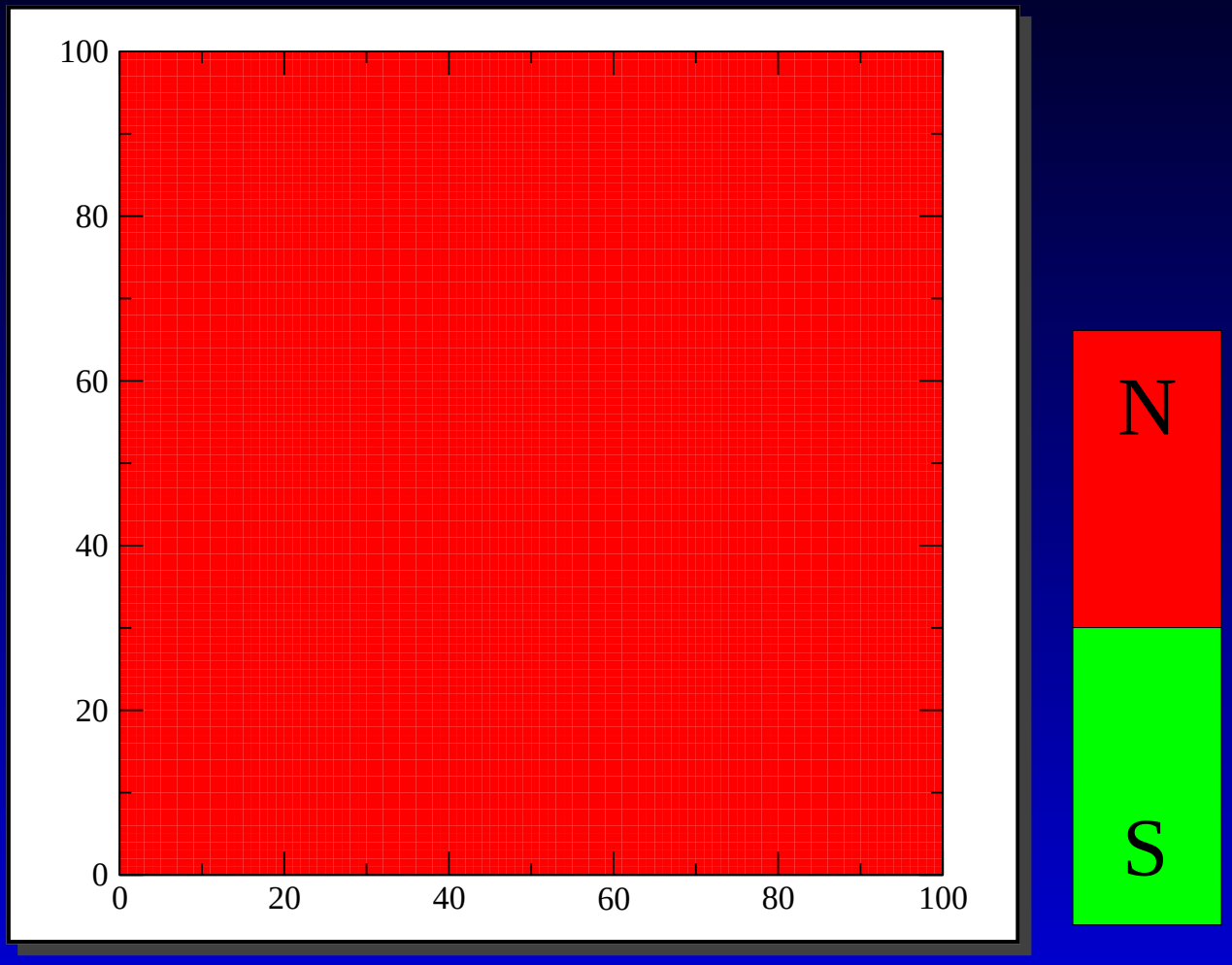

Ferromagnet at room temperature

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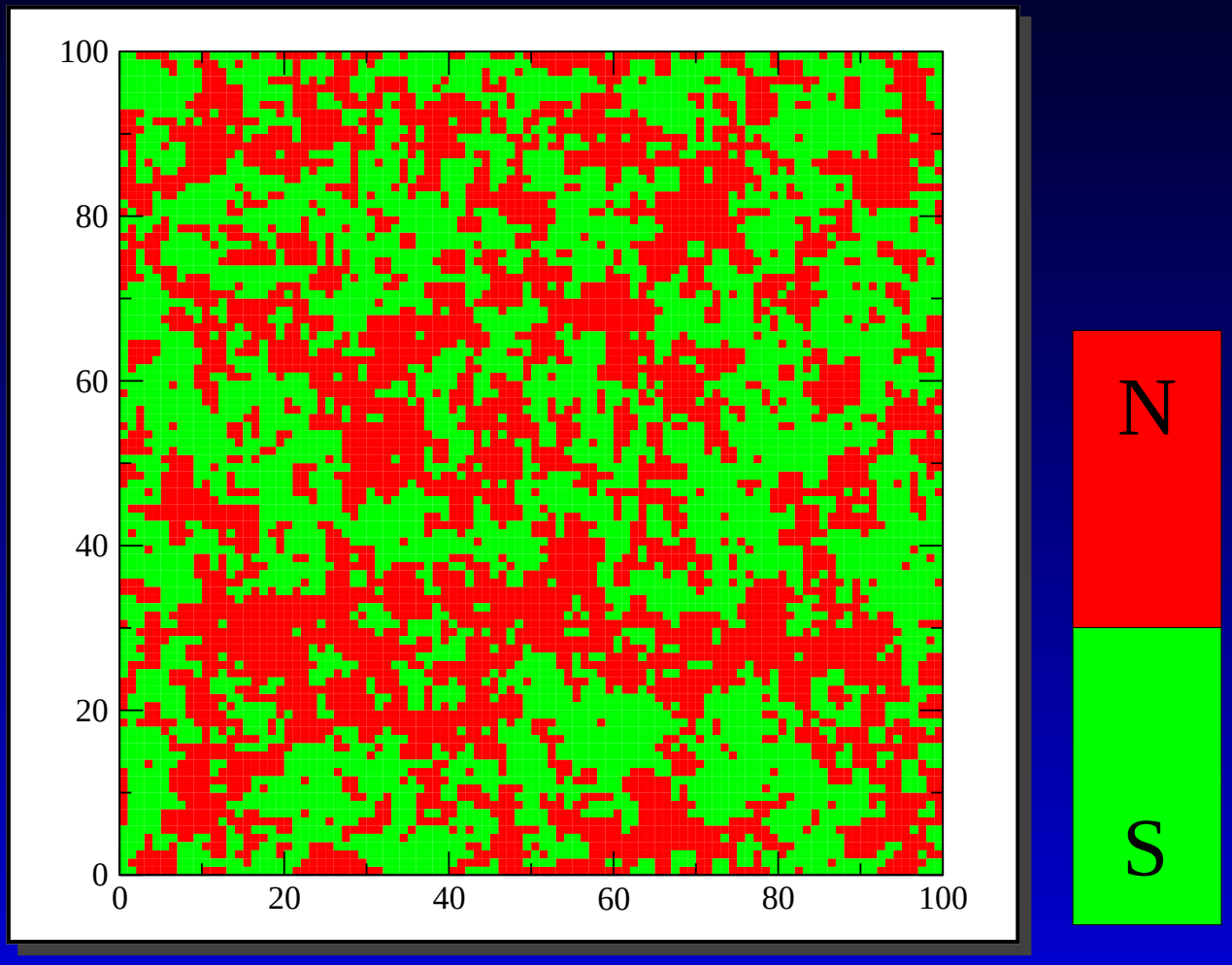
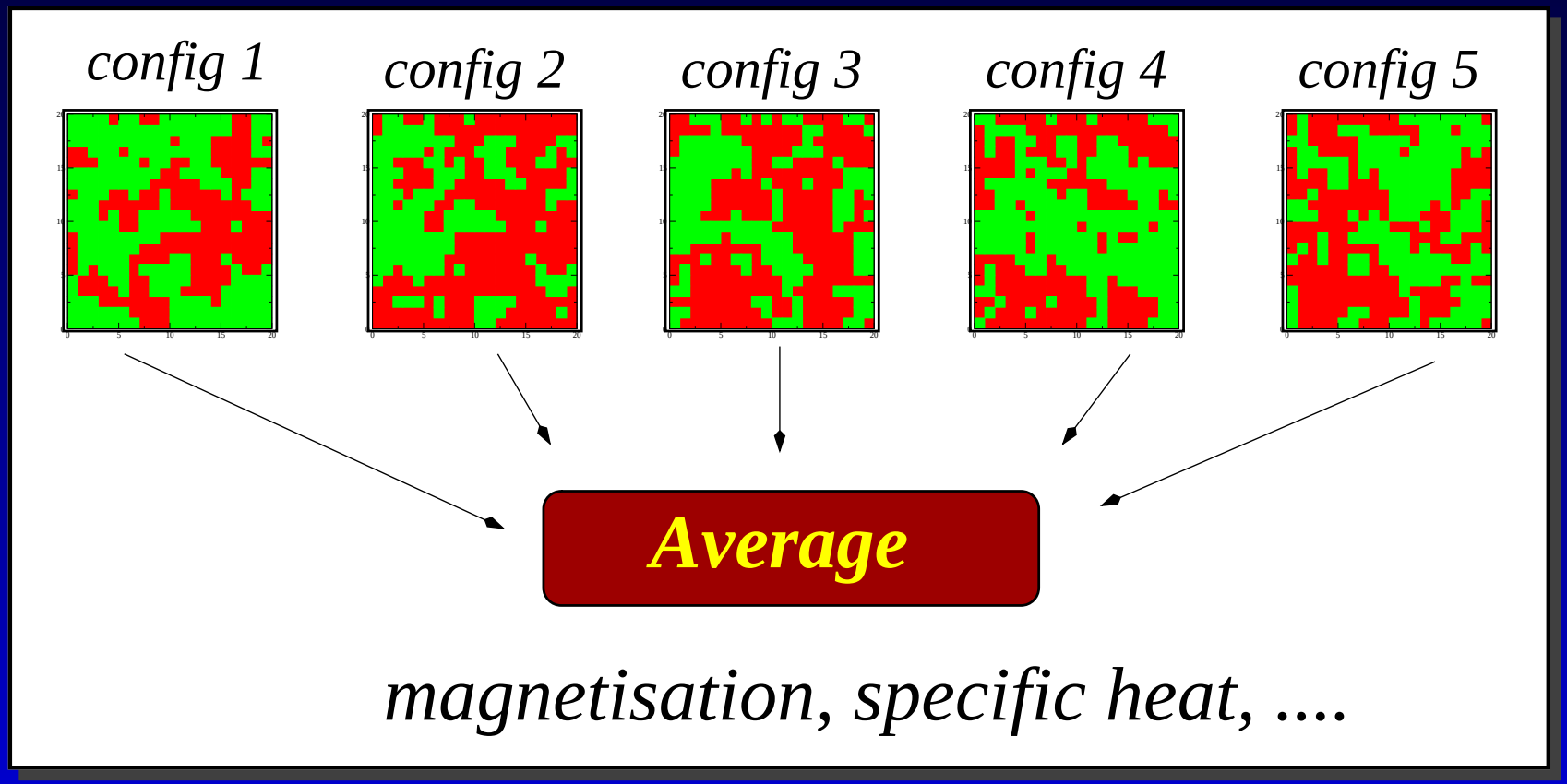
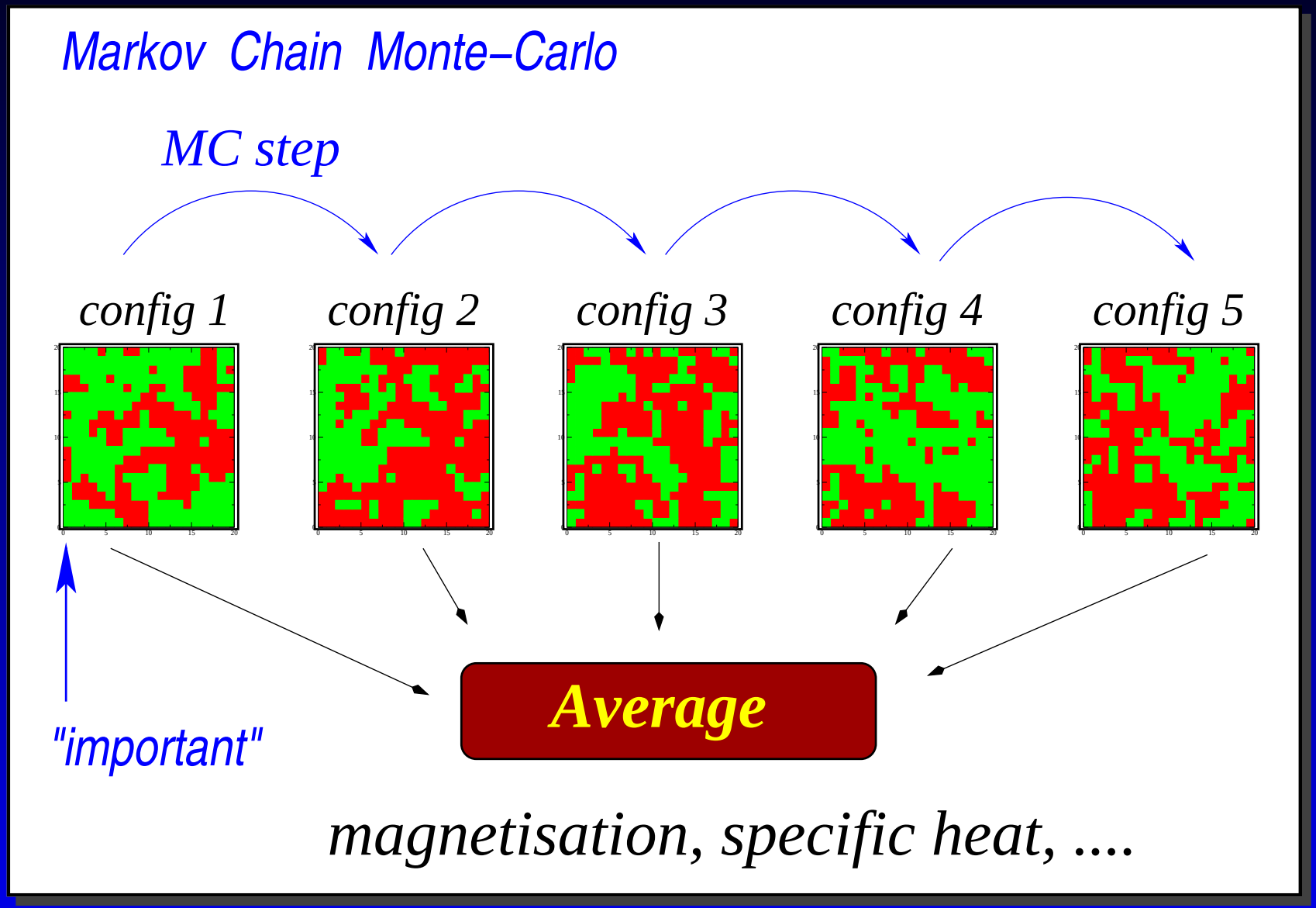


Ferromagnet at high temperature ($\longrightarrow$ paramagnet)

In Practice:


config 1
config 2
config 3
config 4
config 5
Average
magnetisation, specific heat, ...

In Practice:


Markov Chain Monte–Carlo
MC step
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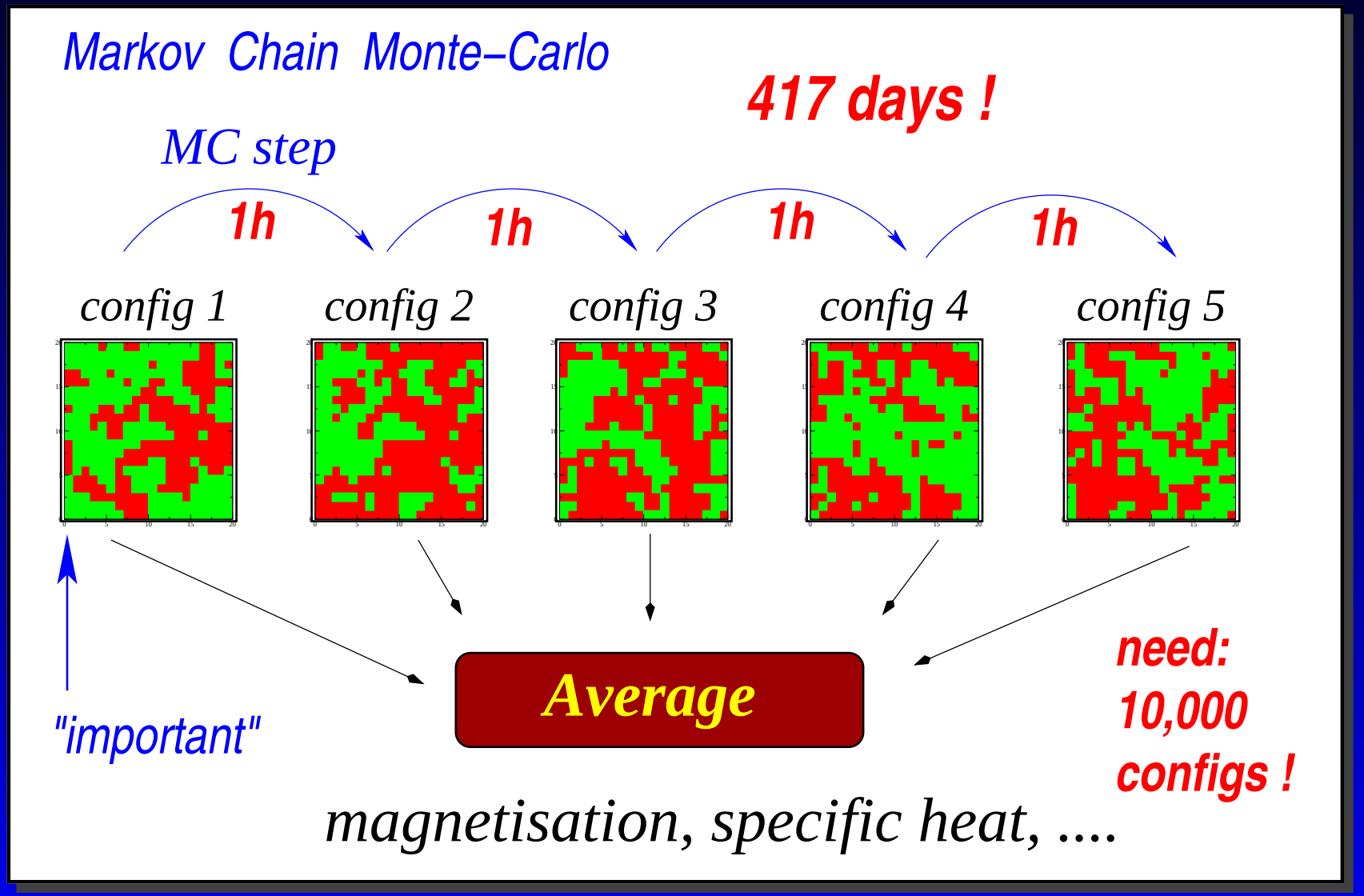
Markov Chain Monte–Carlo
417 days !
MC step
1h
1h
1h
1h
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config 5
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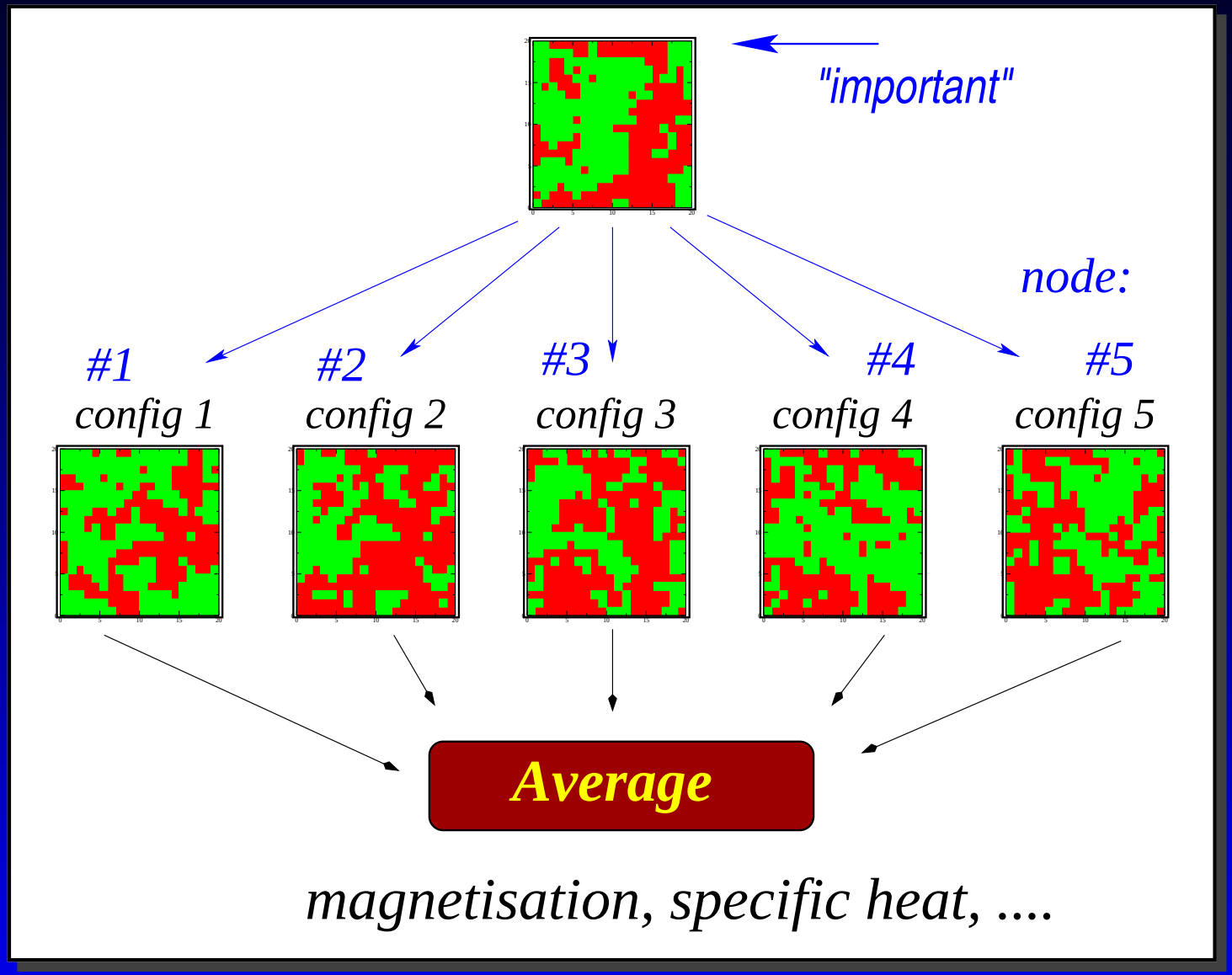
Average
need:
10,000
configs !
magnetisation, specific heat, ...

Prospects of GridComputing:



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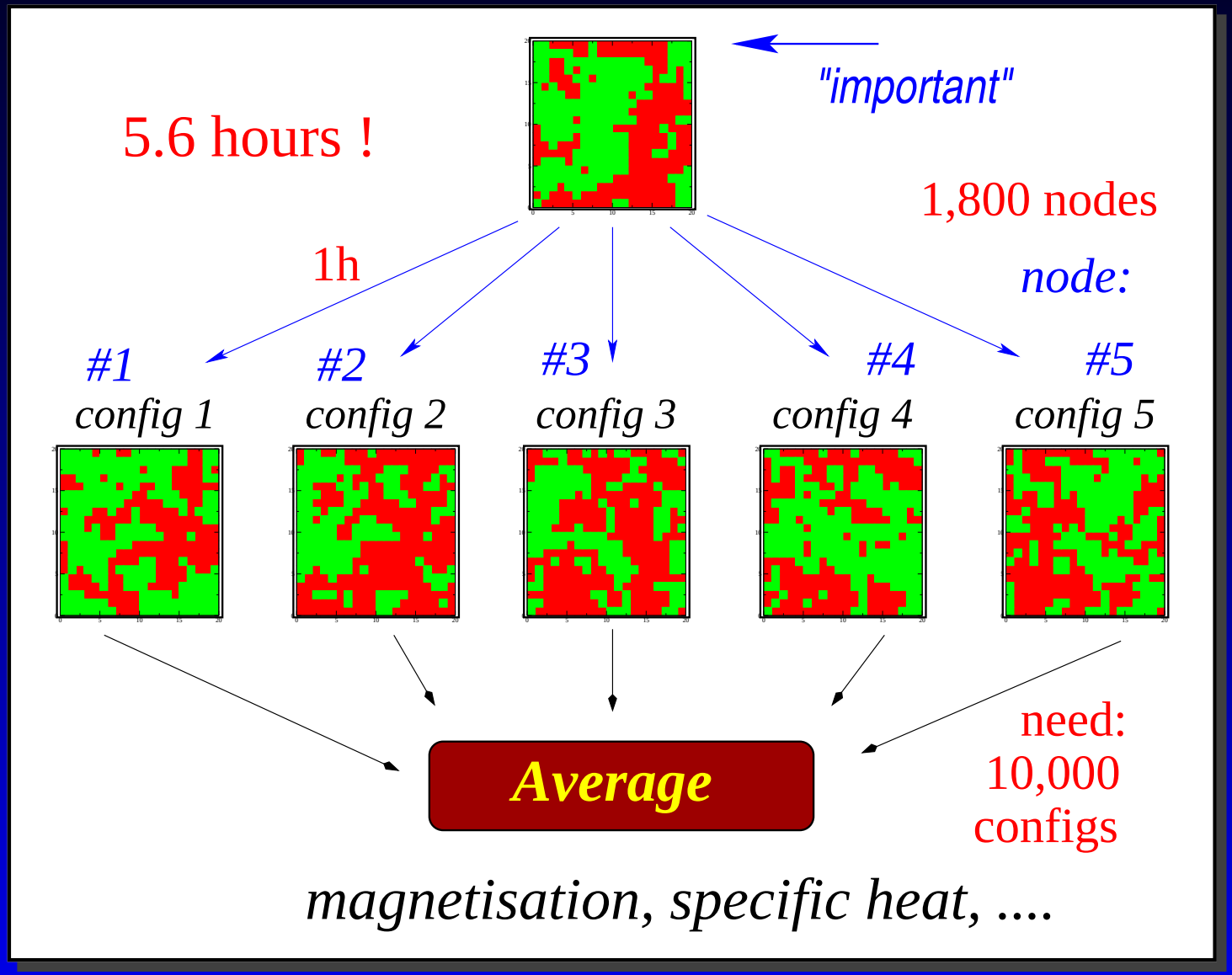

Limitations of GridComputing:

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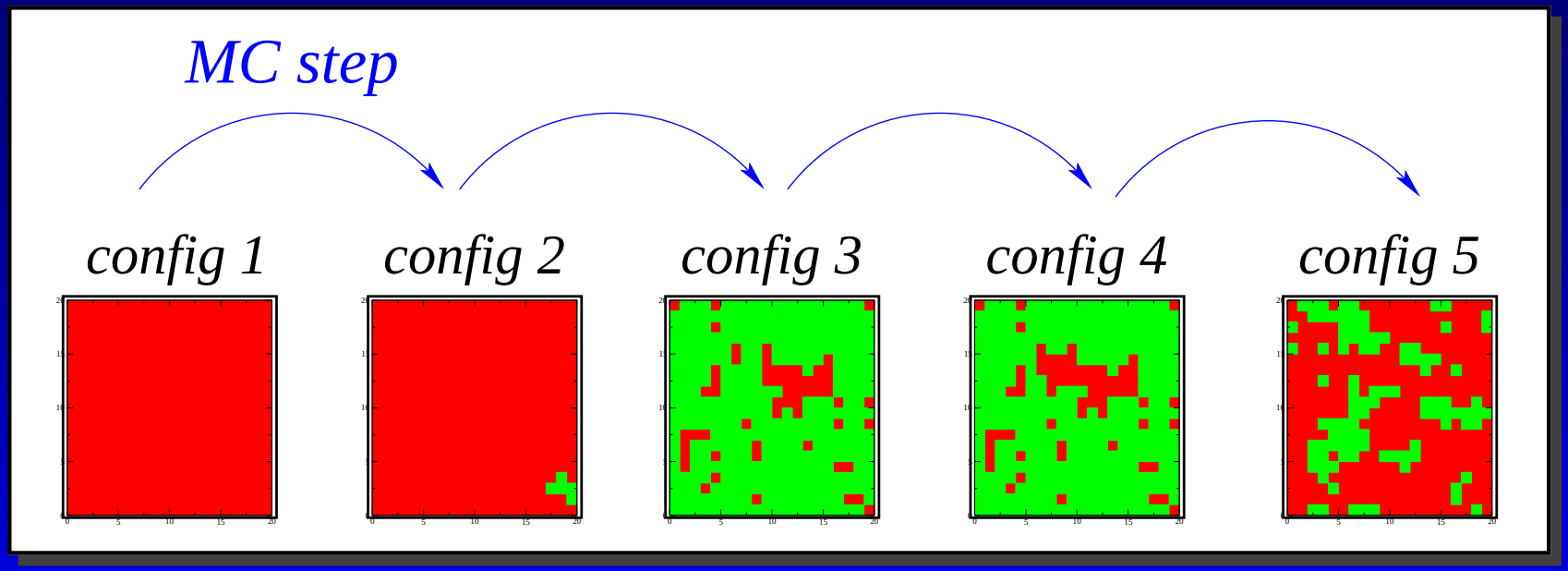

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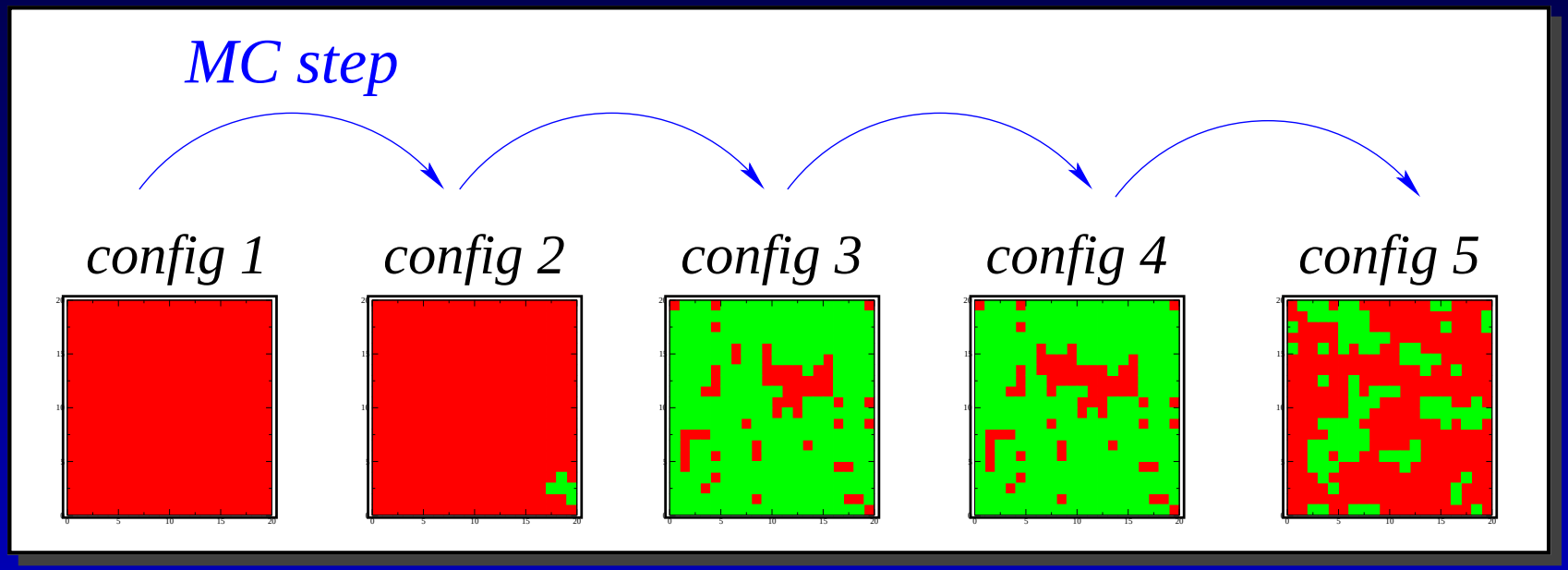
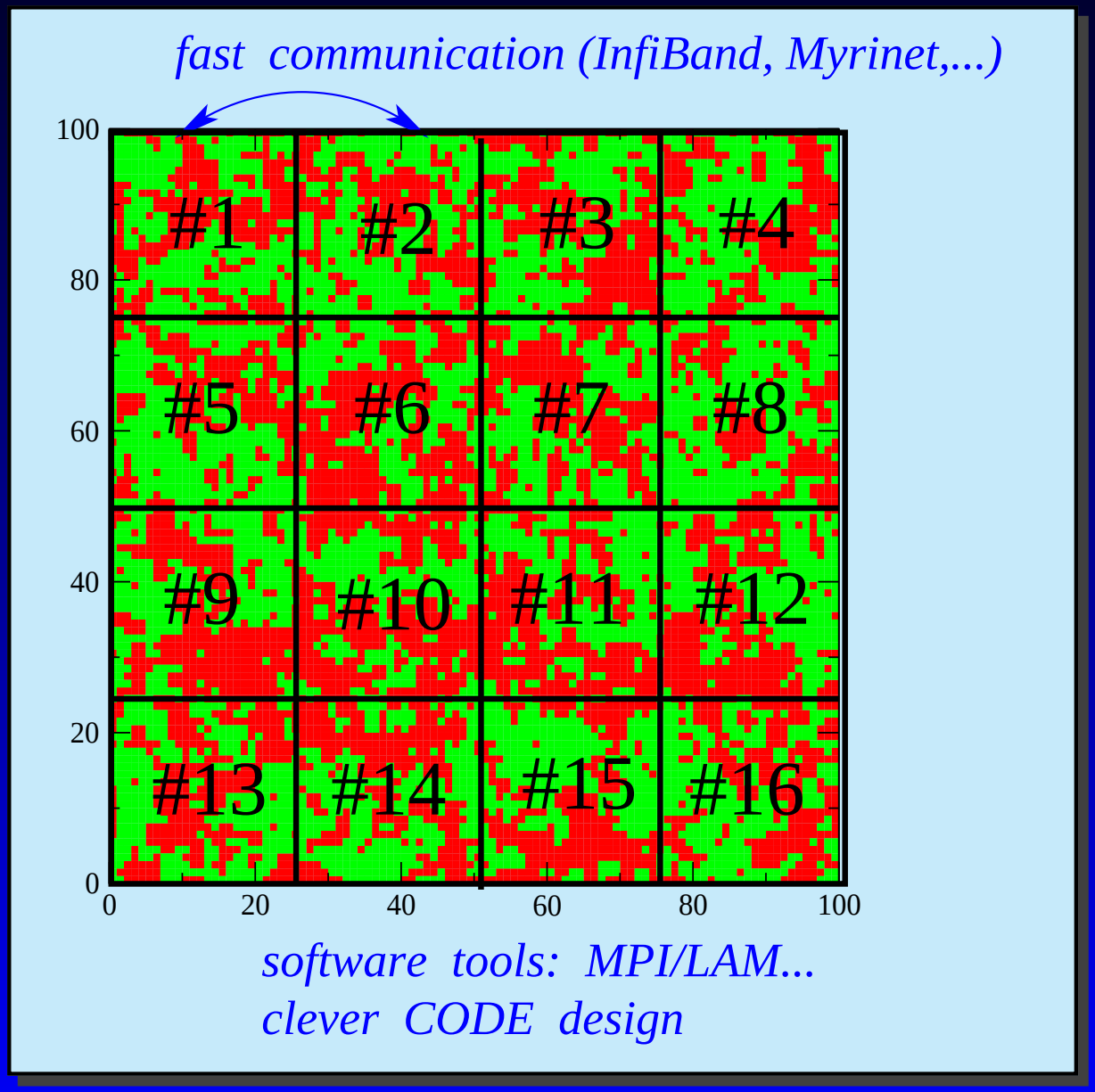


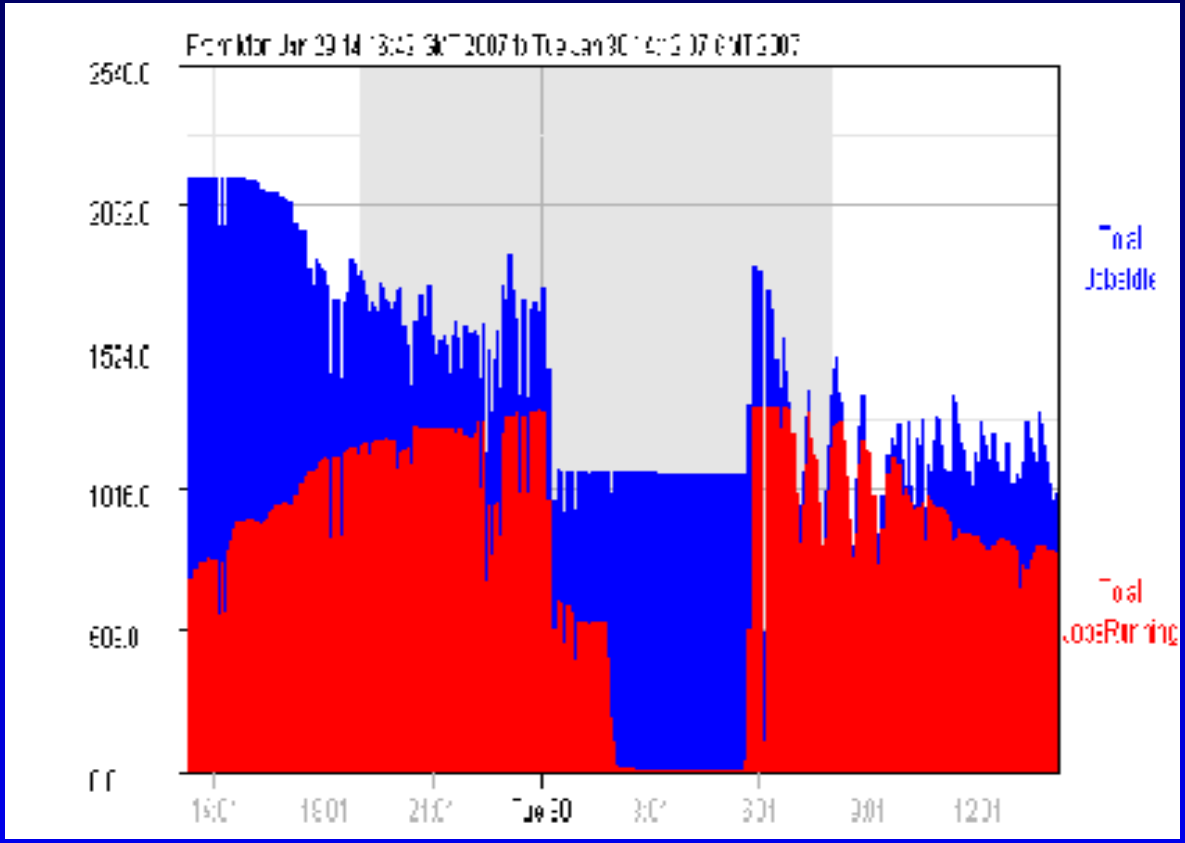
- 200 configs needed $\longrightarrow$ 8 days!
- grid facilities of little help!
- Solution: Make each step faster: cluster computing

ClusterComputing:



Particle Physics Project:

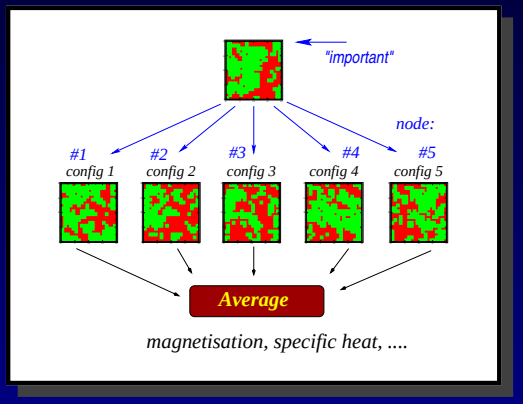
- `ClusterComputing:` 11 $\times$ 8 hours
  Linux cluster at the University of Tübingen
- `GridComputing:` 1780 nodes, 24 hours using PlymGrid



Conclusions:

- `GridComputing:` valuable tool for simulations in Particle Physics

  417 day $\longrightarrow$ 5.5 hours



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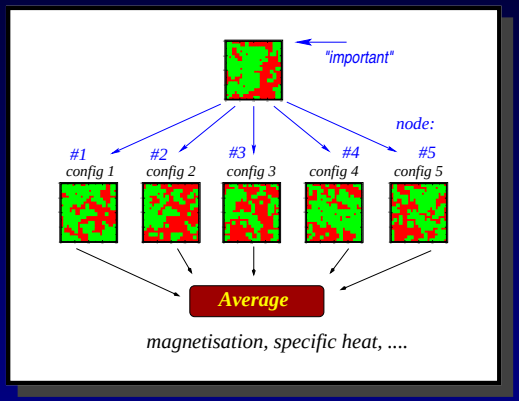

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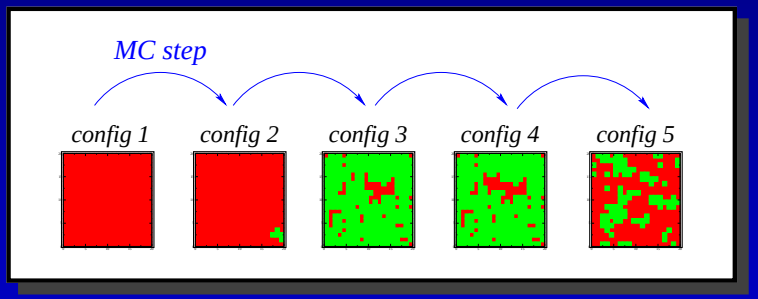

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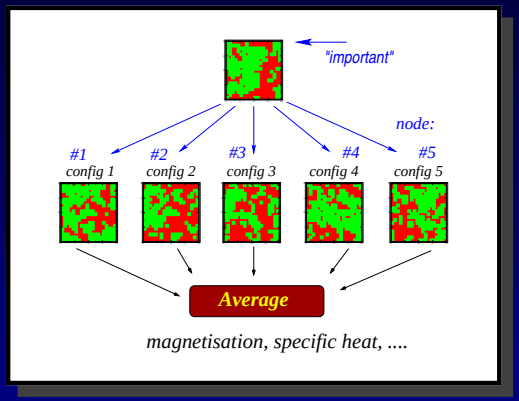

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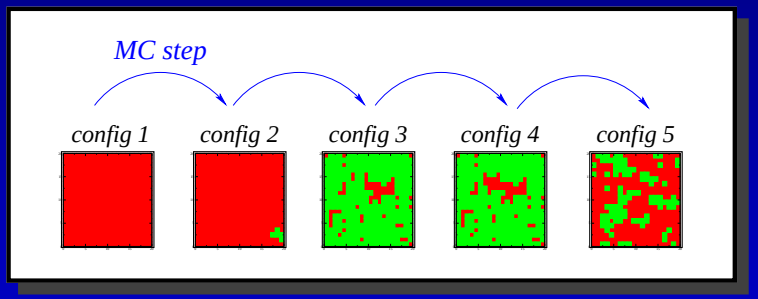

- Ideal setting:

  Hybrid: cluster + grid facilities