

GRID-enabling BEAMnrc & *1st CLASS* PARTICLE TRANSPORT

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Velindre Cancer Centre
Canolfan Ganser Felindre

In collaboration with

Welsh e-Science Centre
Canolfan e-Wyddoniaeth Cymru





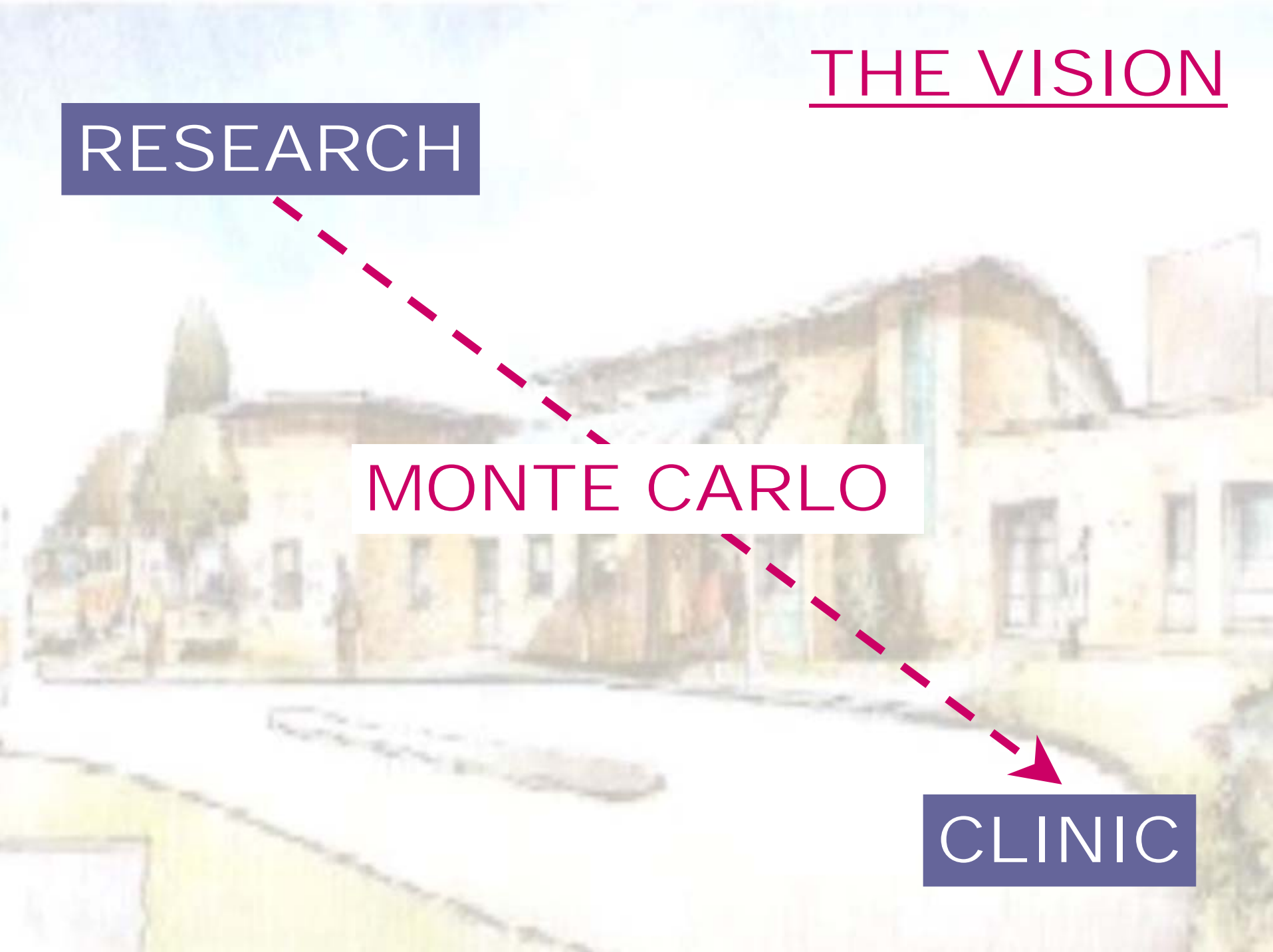
Velindre Cancer Centre
Canolfan Ganser Felindre

THE VISION

RESEARCH

MONTE CARLO

CLINIC



THE VISION

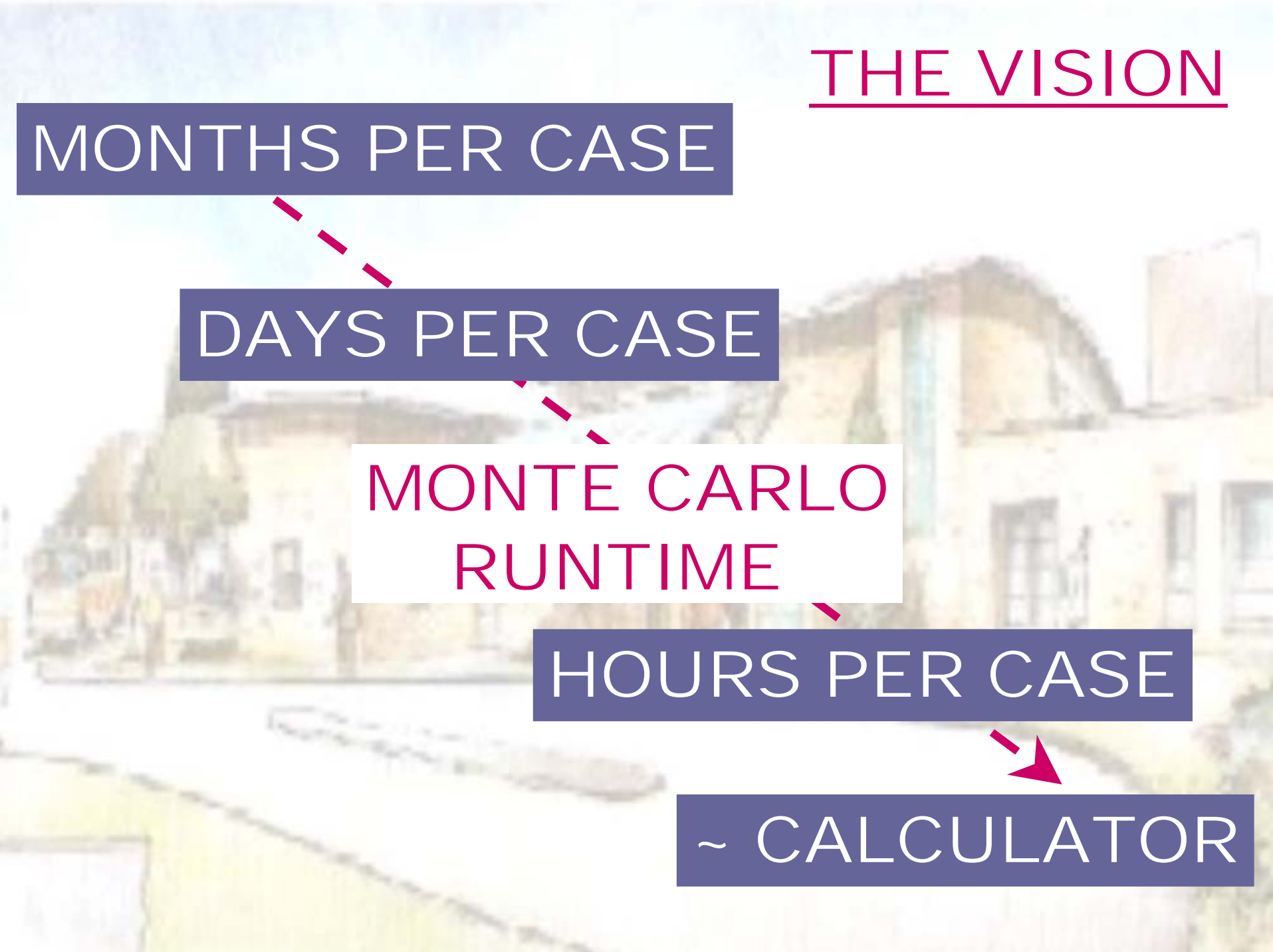
MONTHS PER CASE

DAYS PER CASE

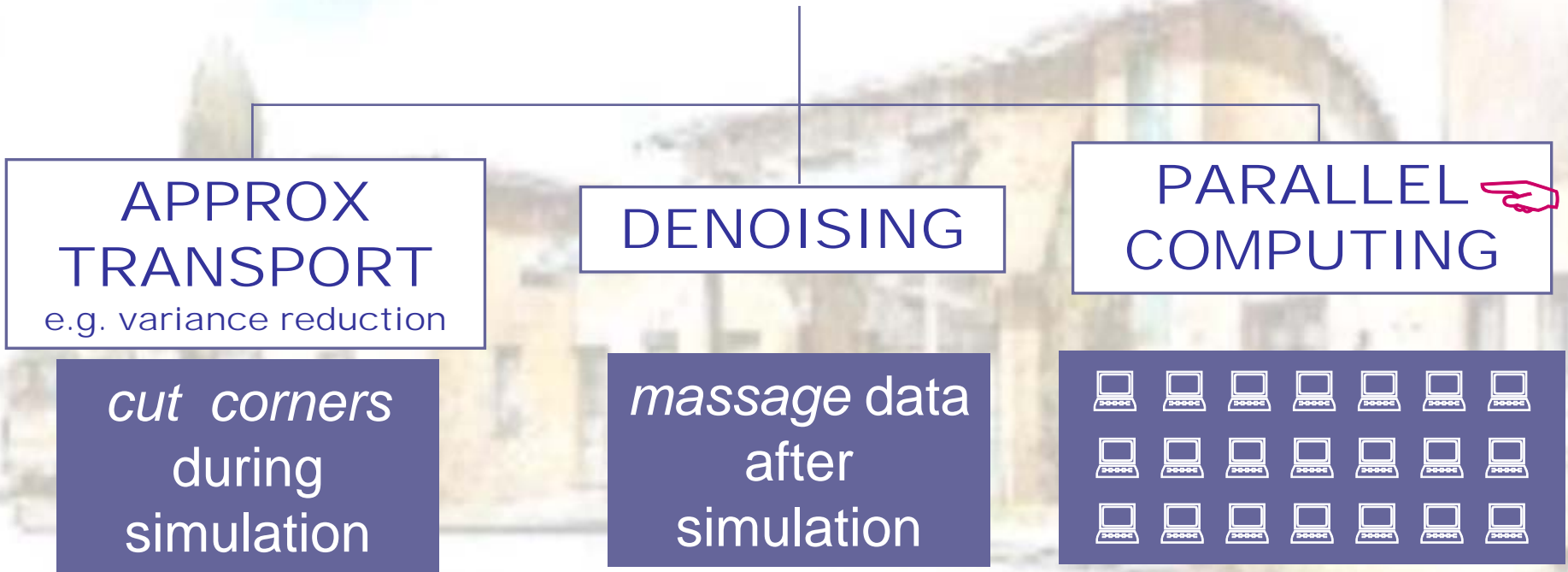
MONTE CARLO
RUNTIME

HOURS PER CASE

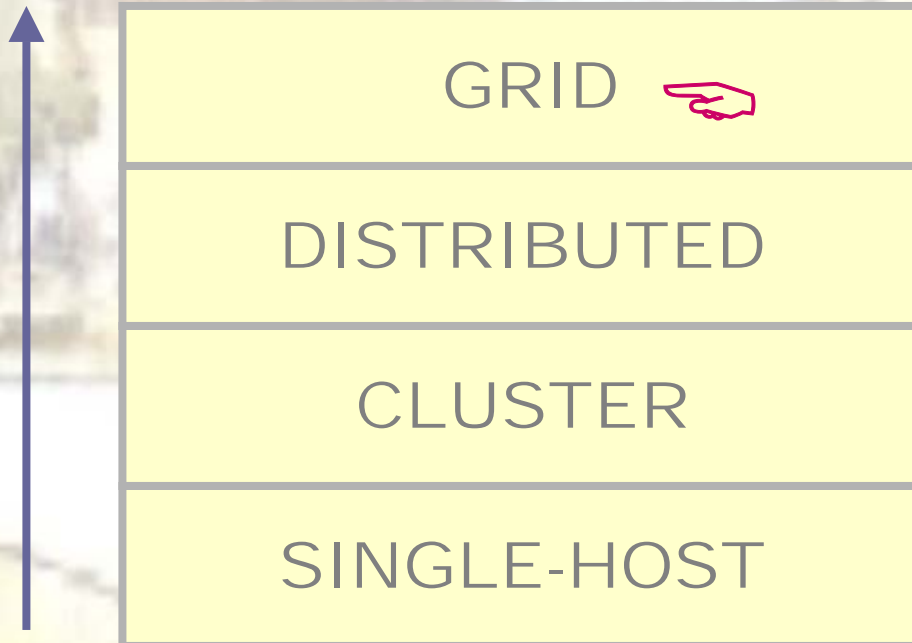
~ CALCULATOR



WAYS OF MAKING IT FAST!



- LESS CONTROL
- MORE RESOURCES
- HETEROGENEOUS
- DECENTRALISED
- LESS SECURE



PARALLEL
COMPUTING

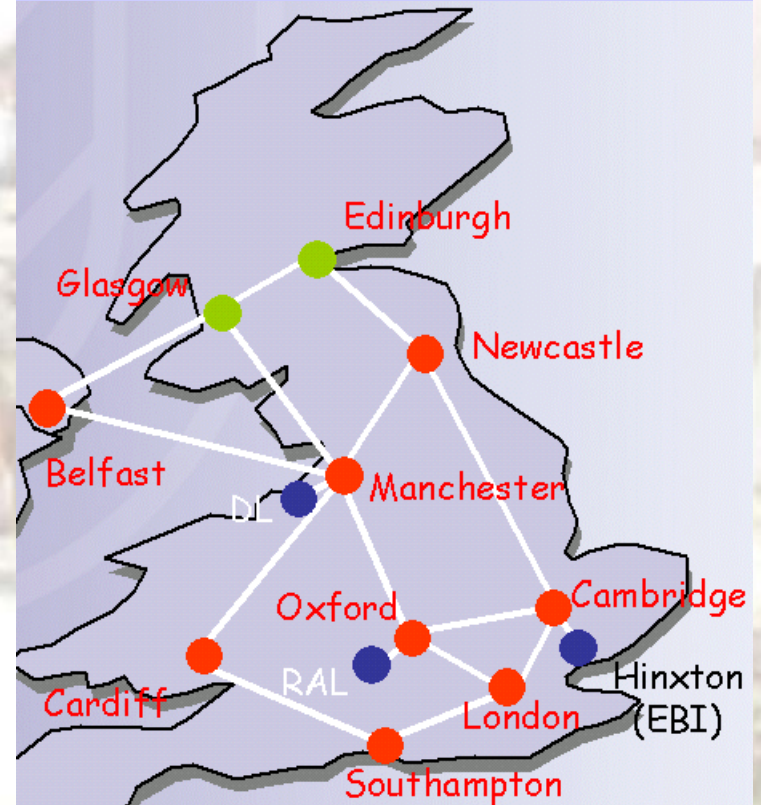
THE GRID

IDEALLY
*LIKE POWER GRIDS,
GENERATION & SUPPLY
SHOULD BE HIDDEN
FROM THE USER*

single
command



UK e-Science GRID



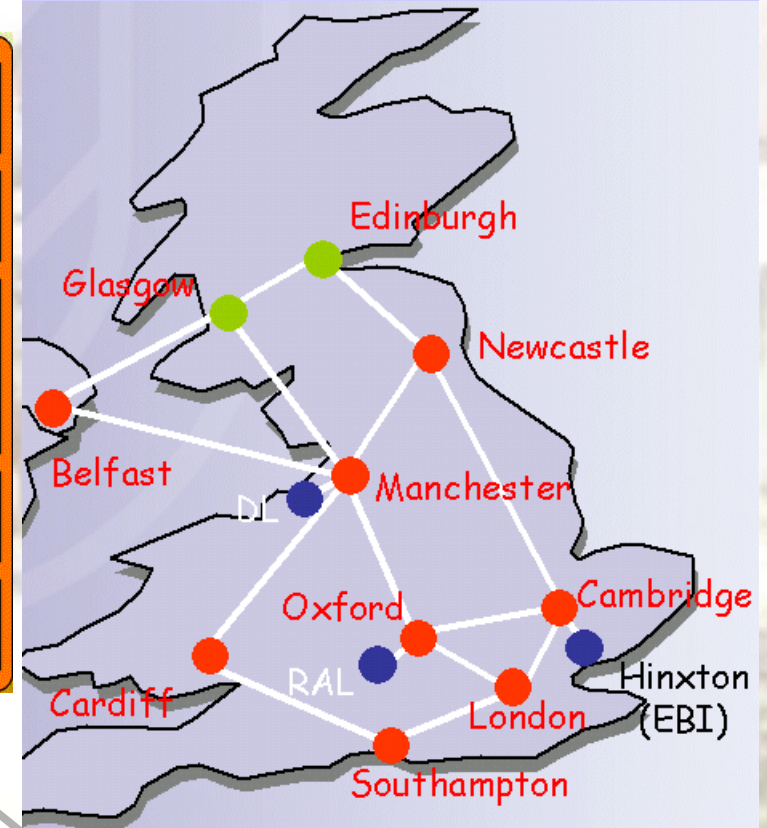
THE GRID

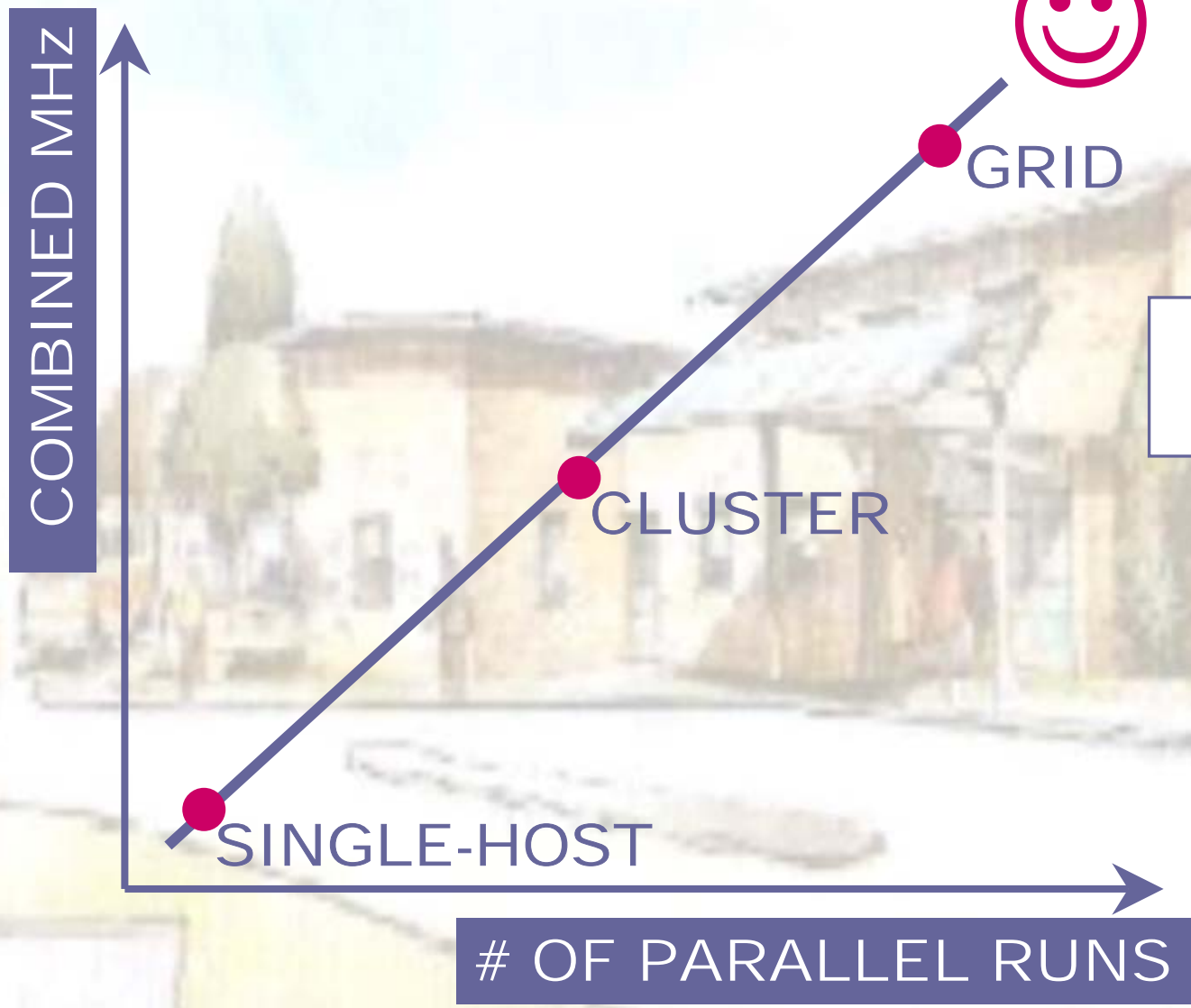
HOWEVER
INTERFACING IS
COMPLEX &
APPLICATION-
DEPENDENT

single
command



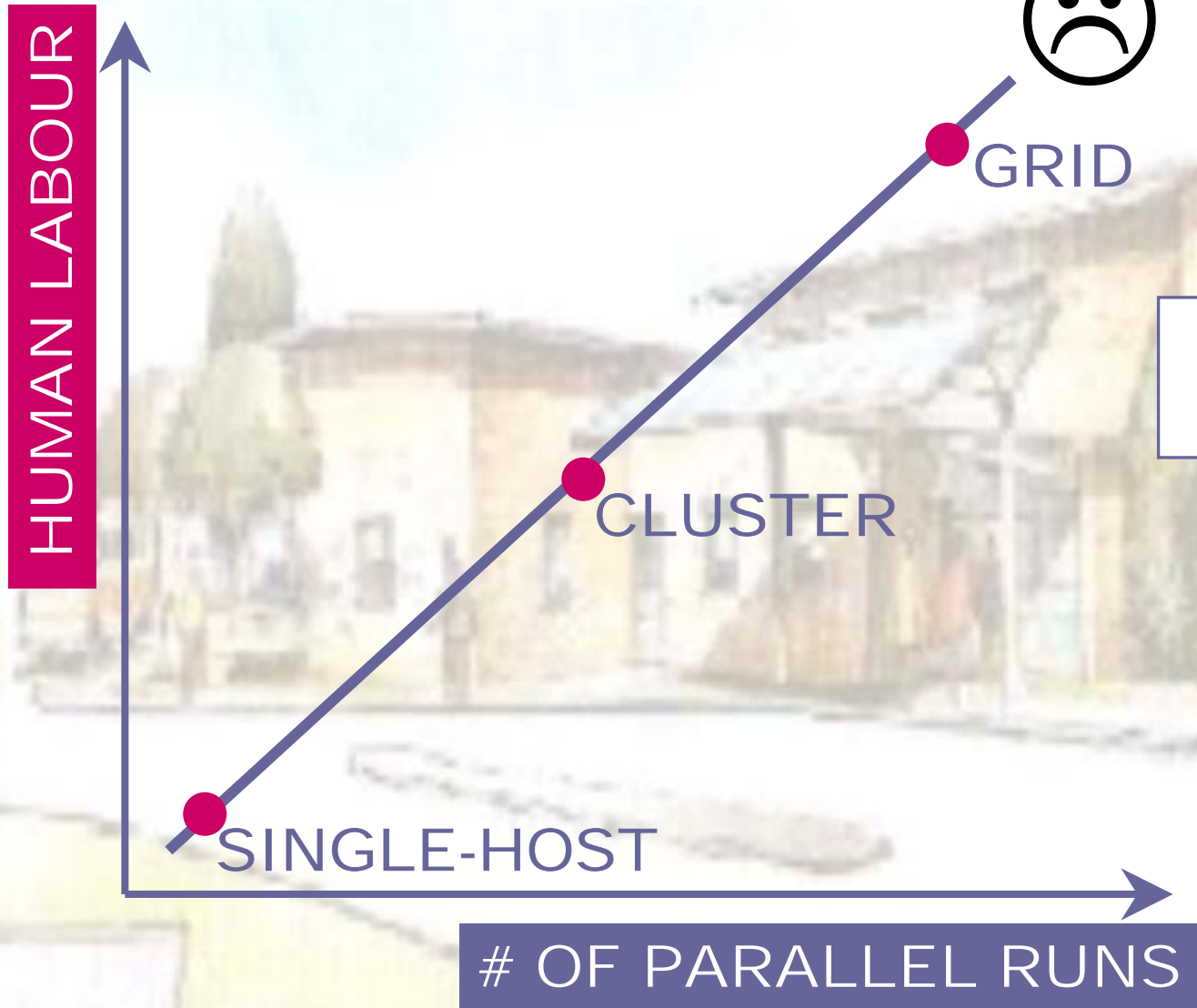
UK e-Science GRID





PARALLEL COMPUTING

HOWEVER...



PARALLEL COMPUTING

SOME

**SINGLE
COMMAND-LINE
FROM THE USER.
NO FURTHER
INTERACTION
NEEDED.**

eg. 200 PARALLEL RUNS

LOGIN TO
EACH S
10 SITES
10 US
& 10

SEND
200
DIF
SITES: C
GLASG

x

SOME
N,
TALL

SOLUTION

LOGIN TO
GLOBUS
10 SITES, THEN
10 USERNAMES
& 10 PASSWDS!

SOME
JOBS
CONDOR
GET
STUCK

GET 100 ×
NO. OF
OUTPUT
FILES

SEND JOBS TO
200 HOSTS OF
DIFFERENT
SITES: CARDIFF,
GLASGOW,

**PERL UTILITY
TOOLS**

OF WHICH SOME
WOULD BE
BIG-ENDIAN,
OTHERS *SMALL*

SOURCES

GLOBUS

authentication,
authorisation, data transfer

www.globus.org

CONDOR

queuing, scheduling,
priority scheme,
resource classification

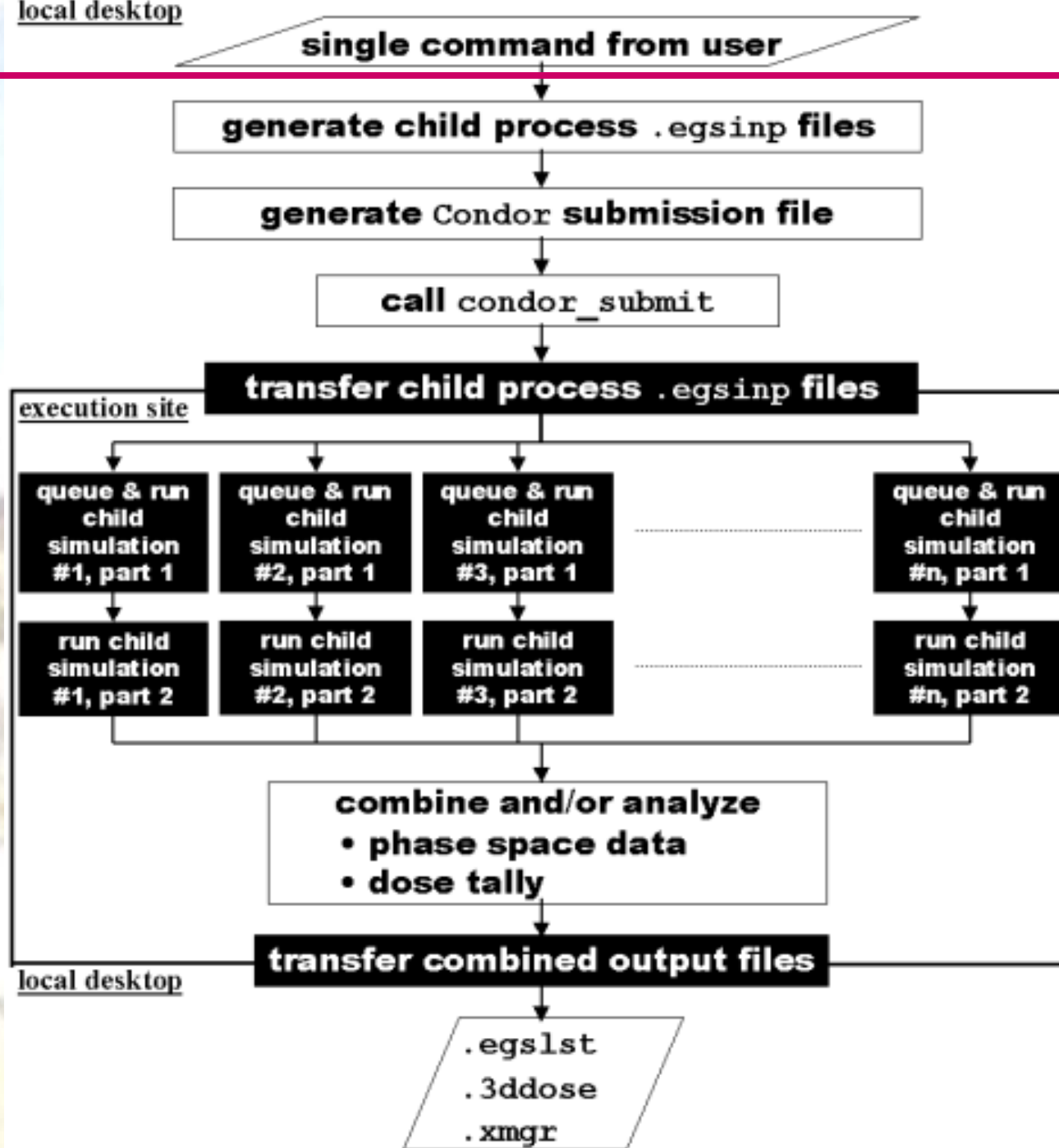
www.cs.wisc.edu/condor/

PERL UTILITY TOOLS

streamlining BEAMnrc
simulations

Chin PW, Lewis DG and Giddy J
"Implementation of BEAMnrc Monte
Carlo simulations on the GRID"
*14th Int. Conf. on the Use of Computers
in Radiation Therapy 2004*


AUTOMATED



"ANALOG
SIMULATION"

RADIATION TRANSPORT
CALCULATION

IDEAL BUT
NOT PRACTICAL

e.g. in gold,  electrons undergo
7000 elastic
scatterings from
500 to 250keV

DETERMINISTIC
EQUATIONS

ANALOG
SIMULATION

RADIATION TRANSPORT
CALCULATION

MORE ACCURATE
BUT SLOWER



GENERAL-PURPOSE
MONTE CARLO CODES



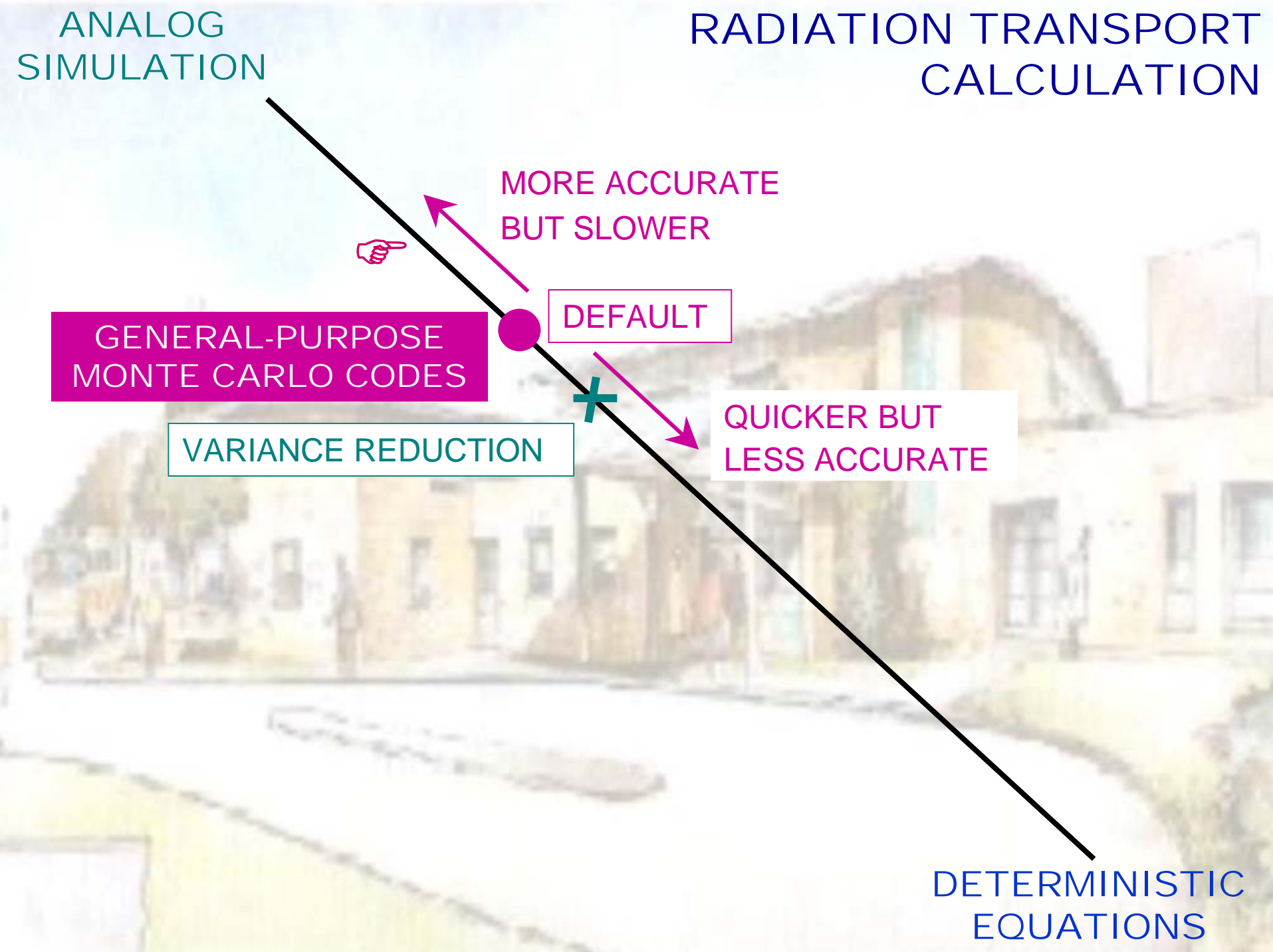
DEFAULT

VARIANCE REDUCTION



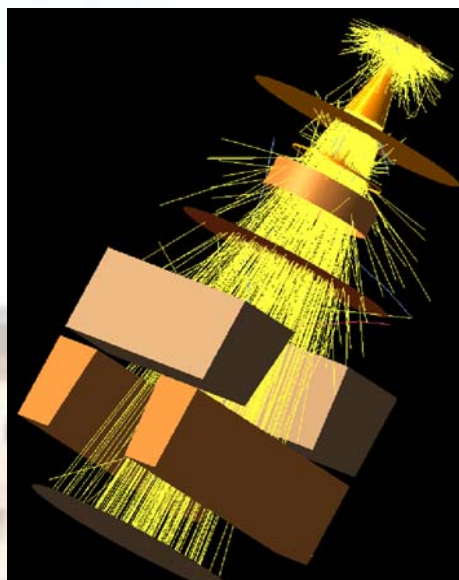
QUICKER BUT
LESS ACCURATE

DETERMINISTIC
EQUATIONS



an example

1ST CLASS TRANSPORT USING BEAMnrc



2000
HISTORIES

NEED 2×10^9
HISTORIES

REQUIRES
~ 6 MONTHS
OF RUNTIME
ON A 2.8GHz
Pentium 4!

SCORES
1 PARTICLE

WANTED:
 10^6 PARTICLES

~ 1 to 2 WEEKS ON THE WELSH e-SCIENCE GRID
(20~60 SGIs) depending on availability of resources

1ST CLASS

DEFAULT

#####

:Start MC Transport Parameter:

Global ECUT= 0

Global PCUT= 0.01

Global SMAX= 0

ESTEPE= 0.25

XIMAX= 0.5

Boundary crossing algorithm= EXACT

Skin depth for BCA= 0

Electron-step algorithm= PRESTA-II

Spin effects= On

Brens angular sampling= KM

Brens cross sections= BH

Bound Compton scattering= On

Pair angular sampling= KM

Photoelectron angular sampling= On

Rayleigh scattering= Off

Atomic relaxations= On

:Stop MC Transport Parameter:

#####

:Start MC Transport Parameter:

Global ECUT= 0

Global PCUT= 0.01

Global SMAX= 5

ESTEPE= 0.25

XIMAX= 0.5

Boundary crossing algorithm= PRESTA-I

Skin depth for BCA= 0

Electron-step algorithm= PRESTA-II

Spin effects= On

Brens angular sampling= Simple

Brens cross sections= BH

Bound Compton scattering= Off

Pair angular sampling= Simple

Photoelectron angular sampling= Off

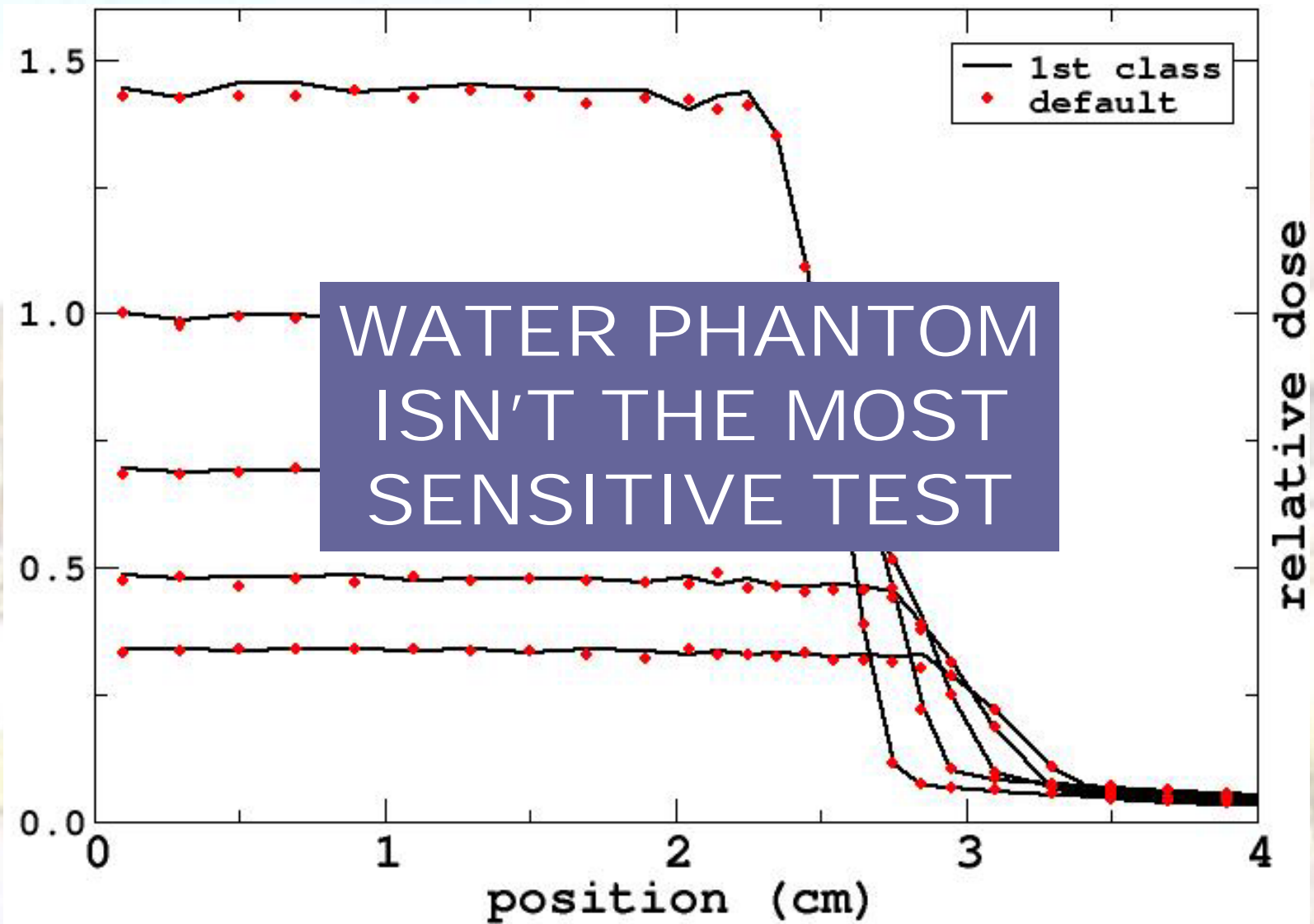
Rayleigh scattering= Off

Atomic relaxations= Off

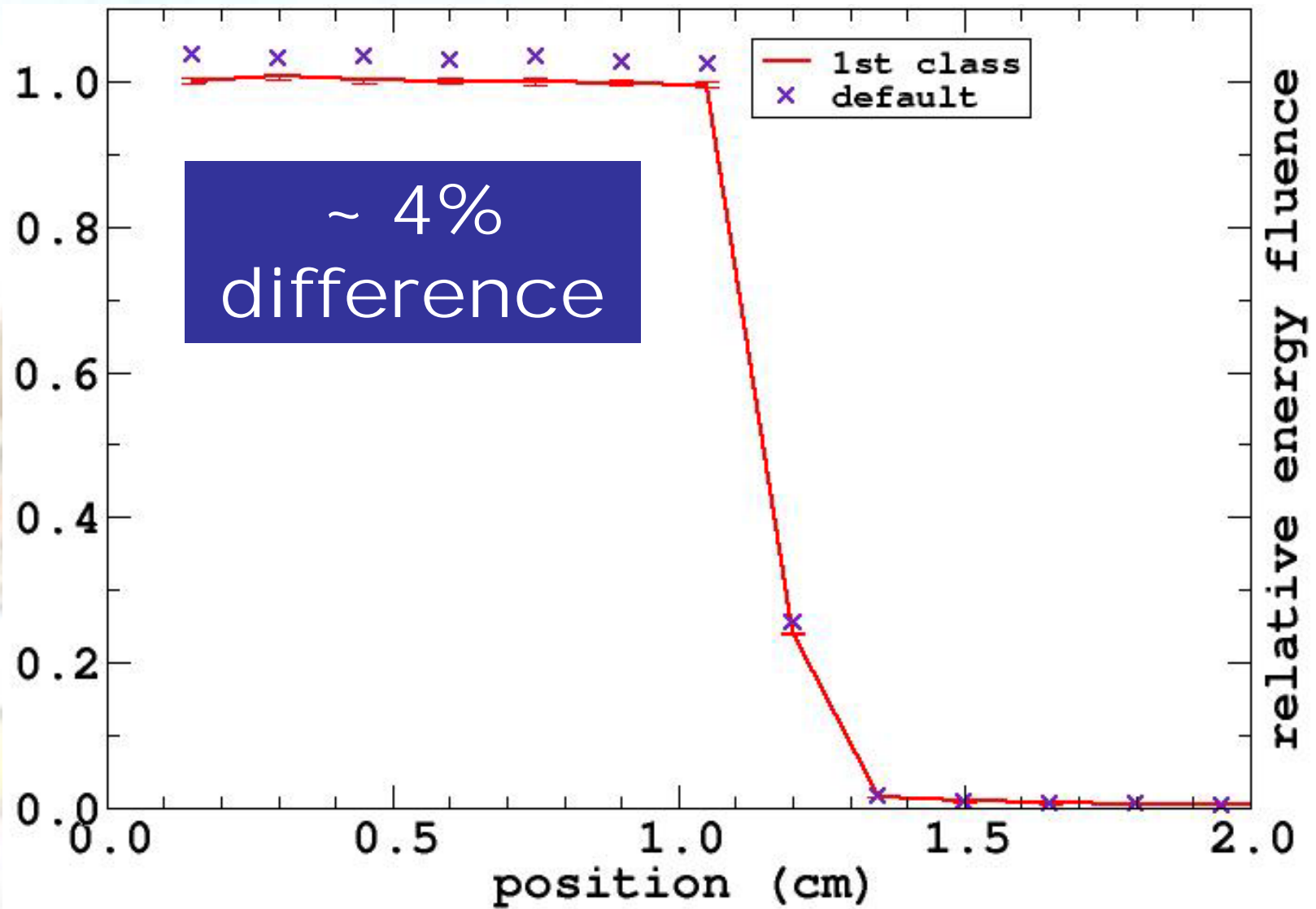
:Stop MC Transport Parameter:

IN-PHANTOM

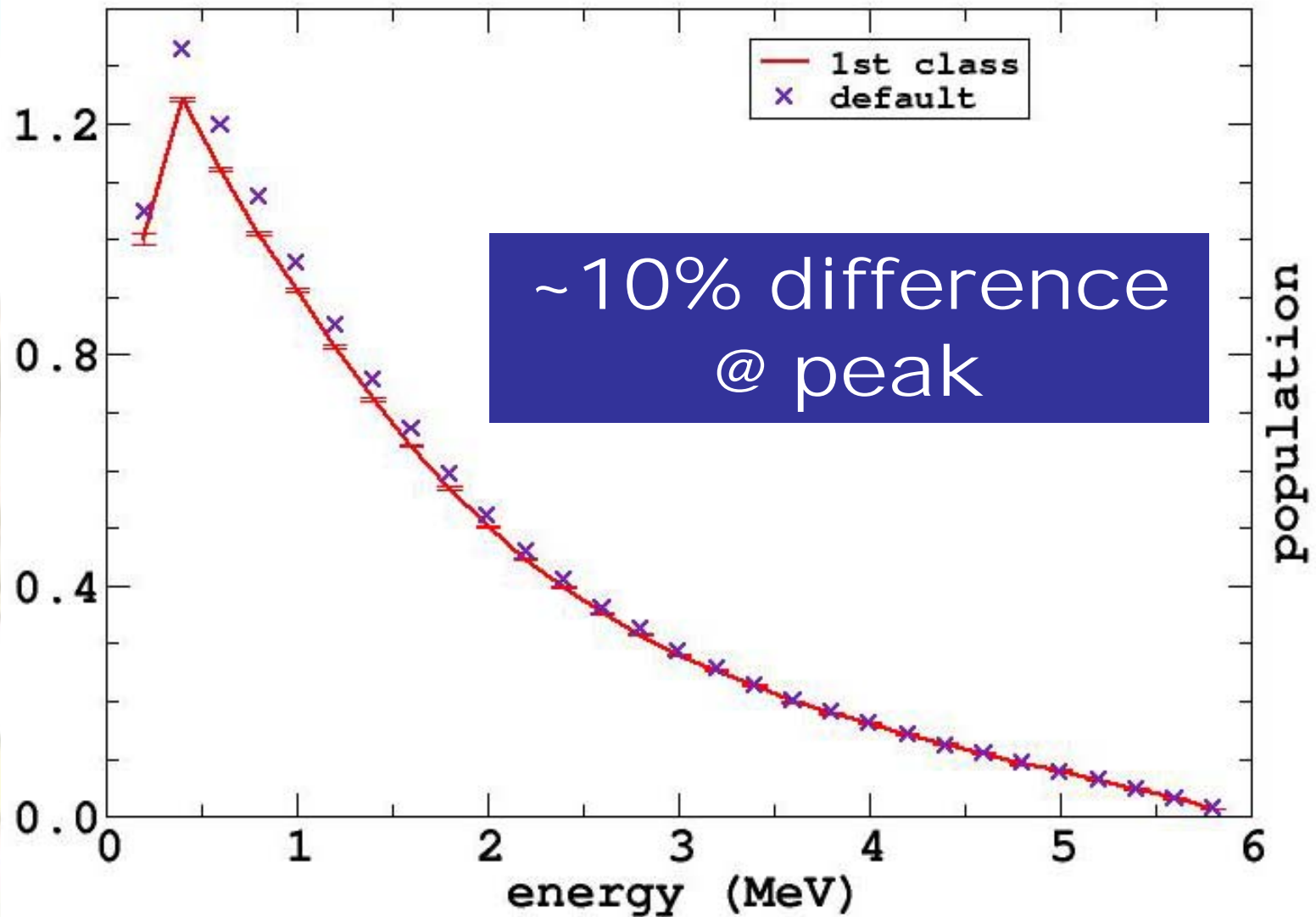
no noticeable
difference, but...



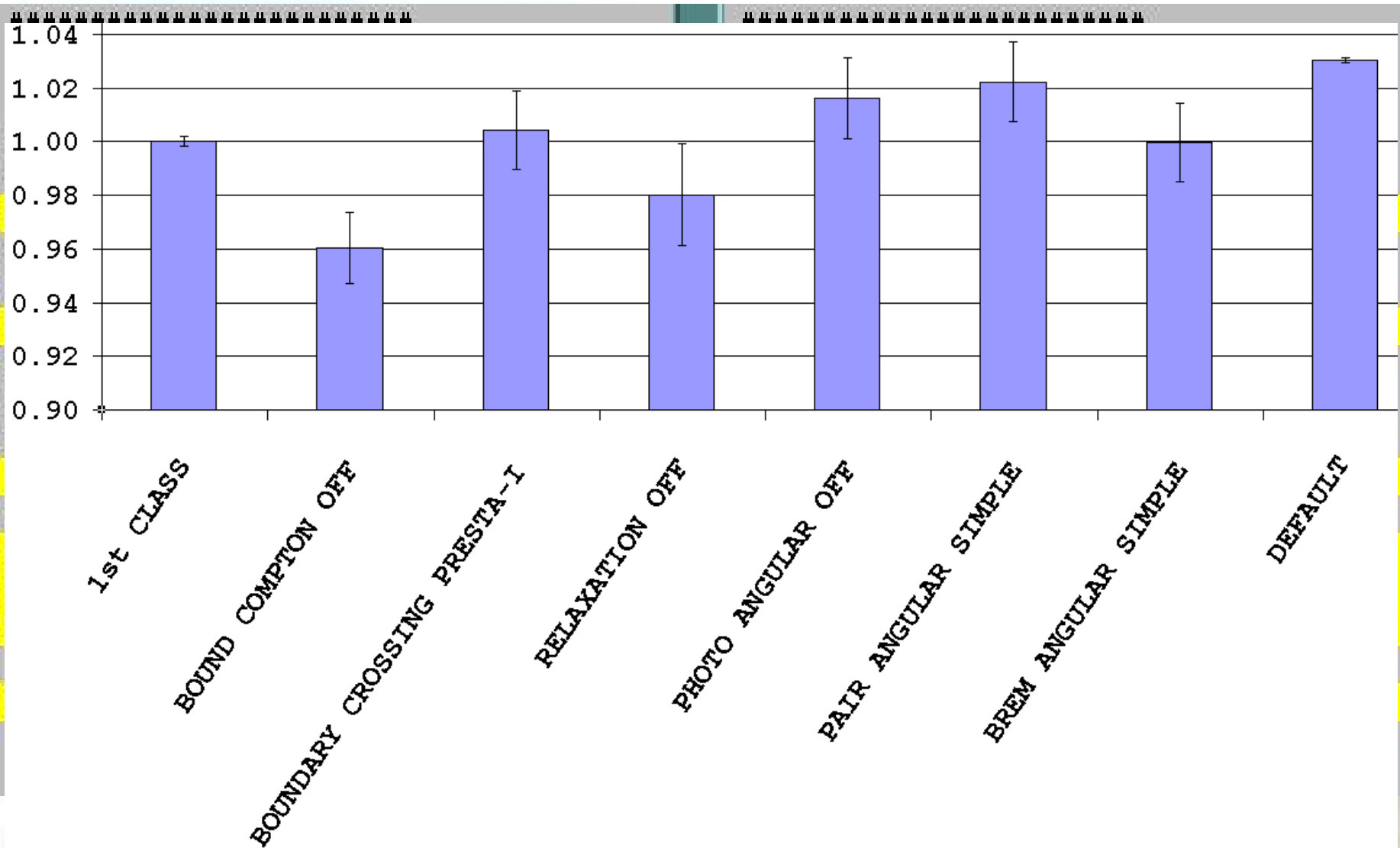
PHASE-SPACE ANALYSIS: ENERGY FLUENCE



PHASE-SPACE ANALYSIS: ENERGY SPECTRUM



INVESTIGATION IN PROGRESS: WHO'S THE CULPRIT?



Summary

- GRID-enabled BEAMnrc & DOSXYZnrc
- developed Perl utilities suite for single-command automation
- demonstrated significant difference between *1st class* and *default* transport parameters

Further work

Grid of grids! (Presently Welsh e-Science GRID only)

Acknowledgement

Thanking Cancer Research Wales & Yr Ysgol Uwchradd Tregaron for PhD support.