Nimrod/EnFuzion

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Today’s time table

- 9:30 – 11:00 Introduction to Cluster Computing
  - eScience
  - History of Nimrod/EnFuzion
  - Clusters
  - Parameter sweeps
  - EnFuzion Demonstration of EnFuzion running under Windows

- 11:30 – 1:00 Grid Computing

- 2:00 – 3:00 Distributed Optimization

- 3:30 – 4:30 eScience Projects

The Nimrod team

- http://www.csse.monash.edu.au/nimrod

Project head	David Abramson
Nimrod/G core technology	Slavisa Garic
Scheduler & APST Interface	Shahaan Ayyub
Portal and Web Services	Colin Enticott
Active Sheets	Paul Roe, Gavin Cheuk & Slavisa Garic
Applications	Colin Enticott and Tom Peachey
Nimrod/O core technology	Tom Peachey & Andrew Lewis

eScience

- What is eScience?

- Categories
  - – Data storage, informational services, metadata etc.
  - – Real time data
  - – Data transformations
    - Visualisation
  - – Computational experiments
    - modelling

Modelling

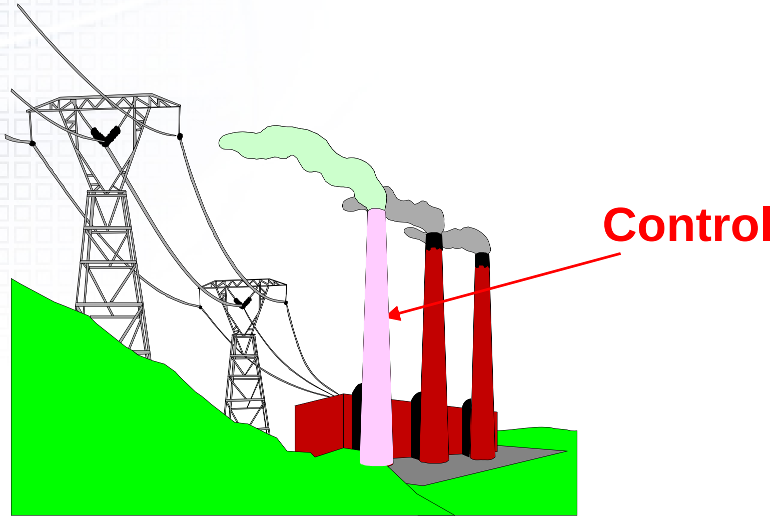
- Computational experiment
  - Needs CPU power

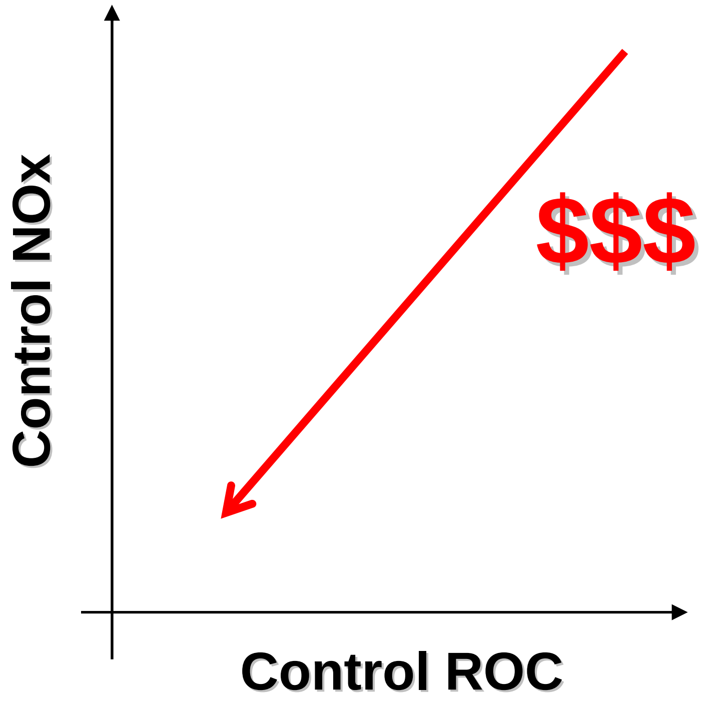
- Can simulate real world experiments

This is how it all began

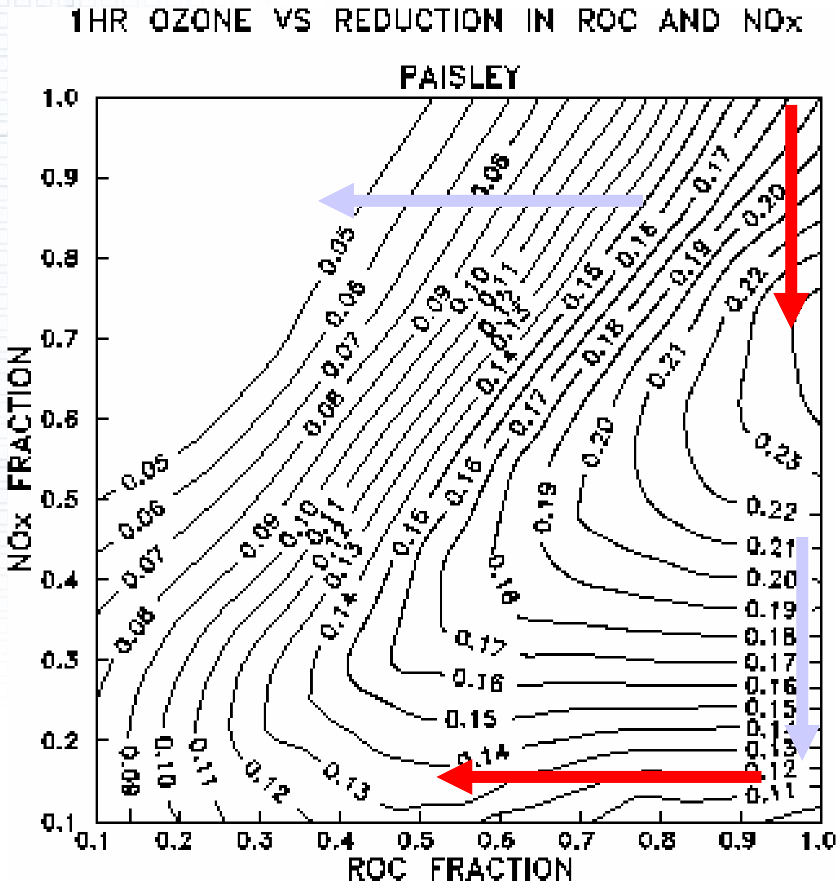
Air pollution modelling circa 1990

- Want to control Ozone
  - What happens if we reduce NOx?
  - What happens if we reduce ROC?





But, Ozone chemistry is non-linear



Decreasing NOx increases Ozone

Decreasing ROC decreases Ozone

Decreasing NOx decreases Ozone

Decreasing ROC increases Ozone

Parametric Execution

- Study the behaviour of some of the output variables against a range of different input scenarios.
  - For example, what is the expected Ozone output given the NOx and ROC levels?
- Computations are uncoupled (file transfer)
  - The result of one parameter set does do affect the results of another parameter set
- More realistic simulations
  - Increasing the number of values of NOx and ROC to explore will produce a higher resolution result

Multiple Runs

- to validate the model
  - Comparison with real world data
- to explore the “parameter space”
  - What is the expected behaviour given new parameters?
- for non-deterministic models to average over an ensemble
- to find parameters that optimize some result
  - After lunch

Cross product

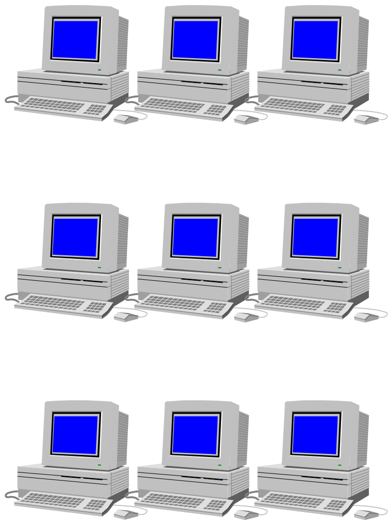
- For each value of NOx
  - For each value of ROC
    - What is the Ozone output level?

	0.1	0.2	0.3	0.4	0.5	…
0.1	Job	Job	Job	Job	Job	
0.2	Job	Job	Job	Job	Job	
0.3	Job	Job	Job	Job	Job	
0.4	Job	Job	Job	Job	Job	
0.5	Job	Job	Job	Job	Job	
…						

Cluster computing

- Where can we run these jobs?

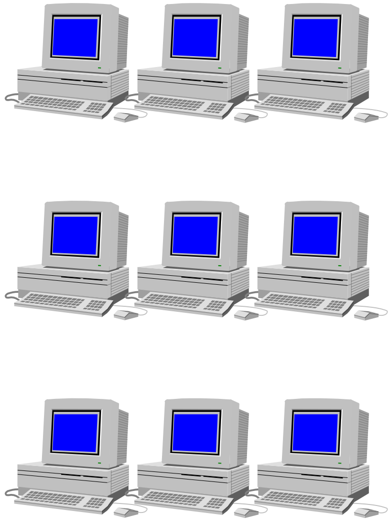
- Idle workstations
  - Lab computers
  - Using EnFuzion
  - EnFuzion will wait until the computer is idle before it starts a job



- Dedicated computational resources
  - Resources that allow only remote access to the computers
  - These resources have been set up for the sole purpose of running computational heavy experiments.

Cluster computing - queuing

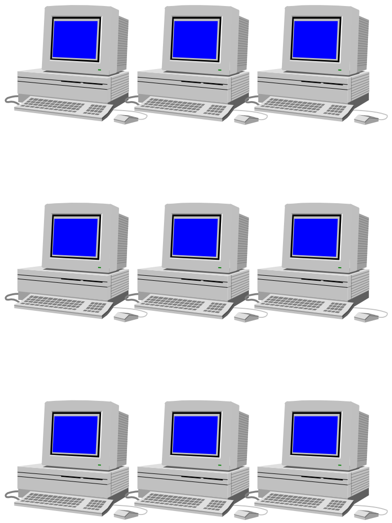
- What happens if the demands increase?
- Idle workstations
  - EnFuzion will run one job per node.
  - First in first served
- Dedicated computational resources
  - Have quotas and fair sharing policies



Cluster computing – more power

- What happens if I need more computers?

- Use Nimrod/G
  - After morning tea



Nimrod & EnFuzion

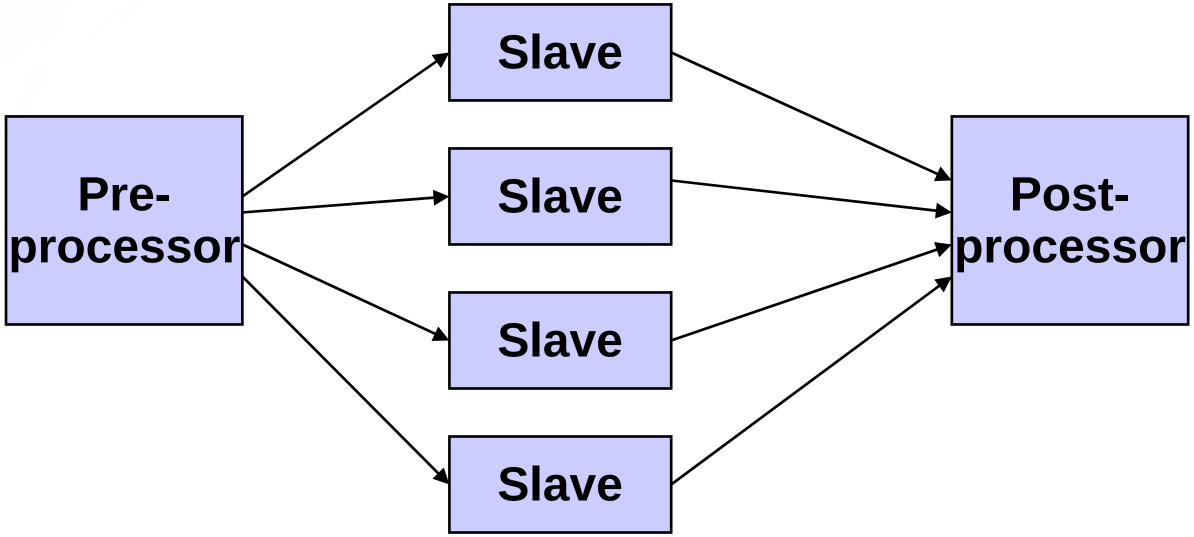
Nimrod History

- Project History

– Initial Cluster version	1994
– Nimrod/G	1997
– EnFuzion (Axceleon)	1997
– Nimrod/O	1999

Nimrod Goals

- Goals
  - Supports parametric execution
  - Execute programs
  - Varying parameters
  - Simple scatter/gather
  - Make parallel computing easy for parametric problems



Pre-processor

Slave

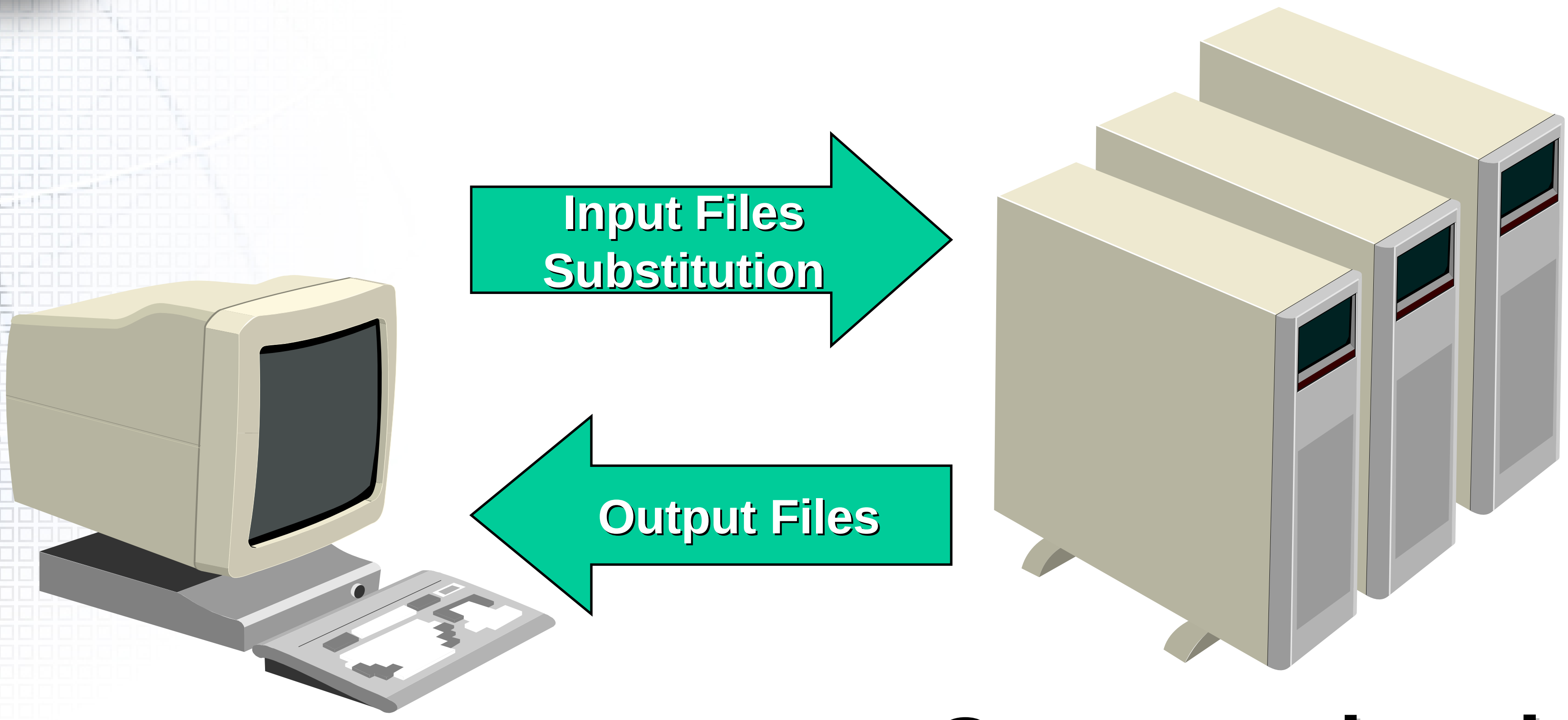
Slave

Slave

Slave

Post-processor

Nimrod Execution Architecture



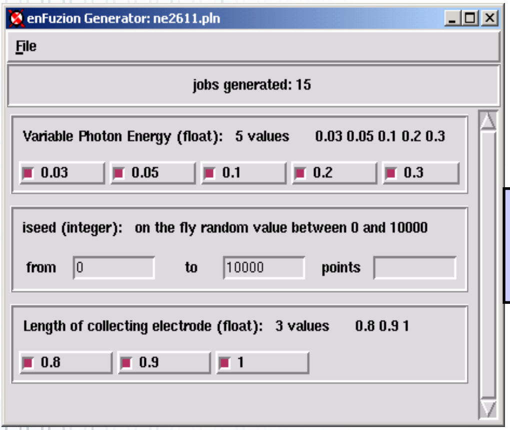
Input Files Substitution

Output Files

Root Machine

Computational Nodes

How does a user develop an application using EnFuzion?



enFuzion Generator: ne2611.pln

File

jobs generated: 15

Variable Photon Energy (float): 5 values 0.03 0.05 0.1 0.2 0.3

0.03 | 0.05 | 0.1 | 0.2 | 0.3

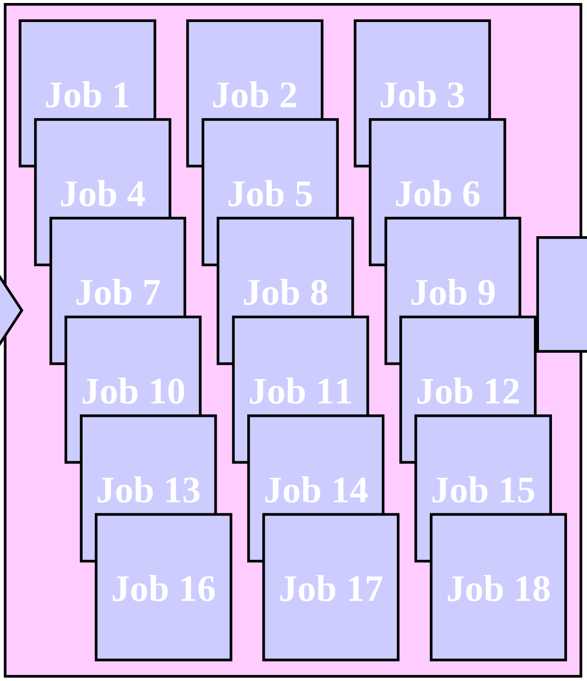
iseed (integer): on the fly random value between 0 and 10000

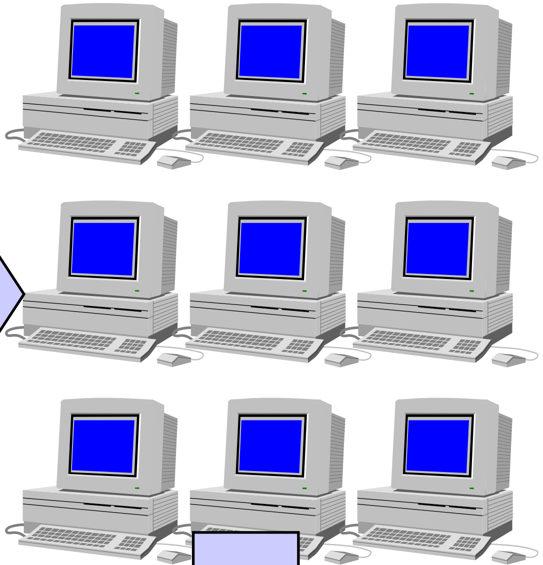
from 0 to 10000 points

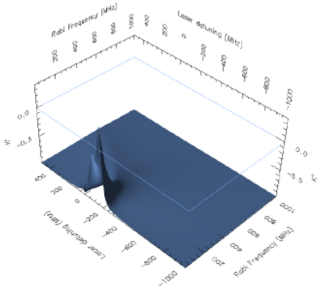
Length of collecting electrode (float): 3 values 0.8 0.9 1

0.8 | 0.9 | 1

Description of Parameters PLAN FILE







K' (Rabi Frequency, Laser Detuning)

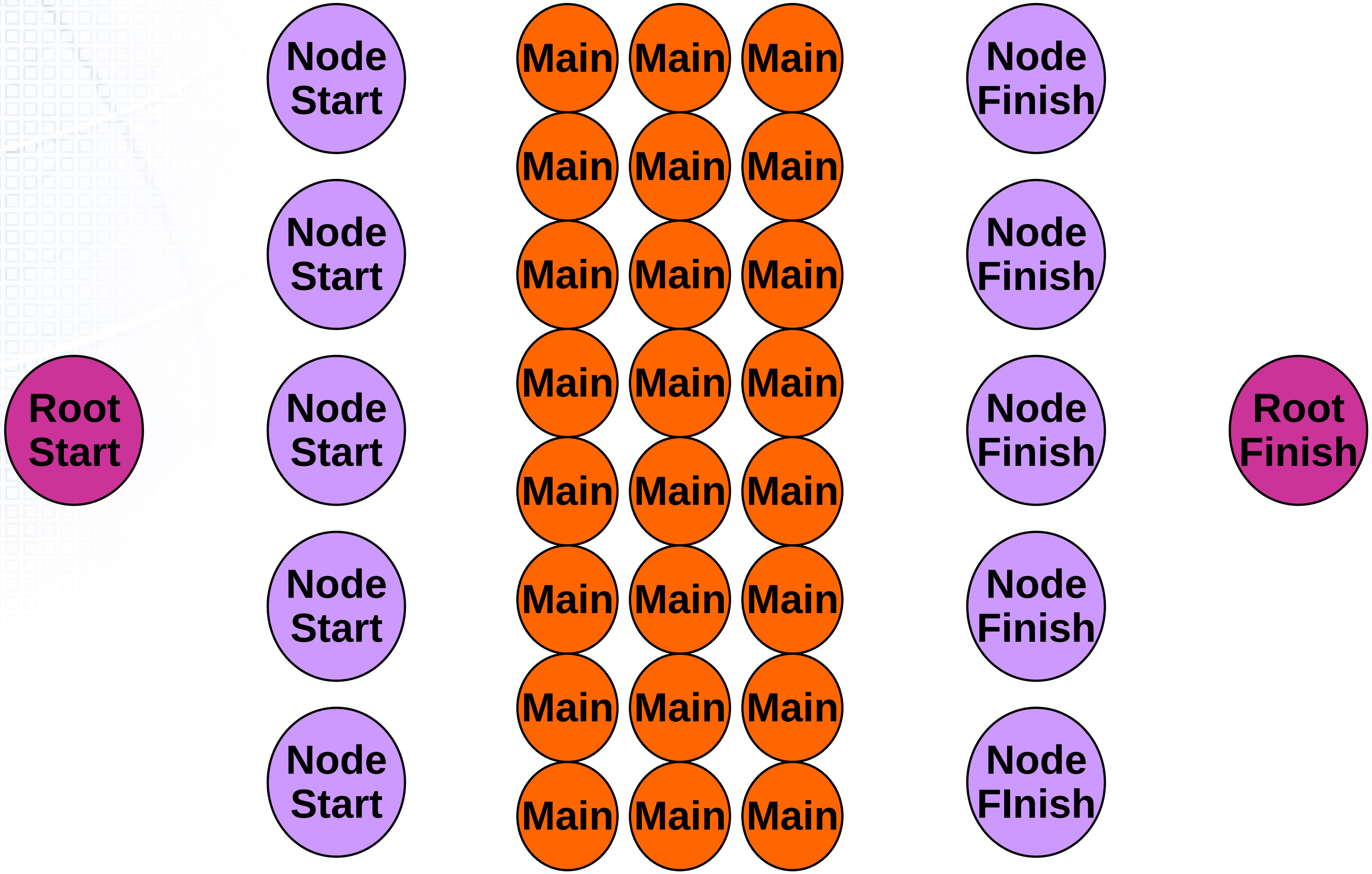
Rubidium I=5/2 isotope : Zero Doppler width

Plan file for HLmeteorite

```
parameter input_seed integer random from 1 to 1000000 points 2000;

task main
    copy p.x node:p.x
    copy projectile.input.sub node:projectile.input.sub
    copy projectile.x node:projectile.x
    substitute projectile.input.sub projectile.input
    node:execute ./p.x
    copy node:distance.out distance.out.$input_seed
    copy node:temperature.out temperature.out.$input_seed
    copy node:error.out error.out.$input_seed
    copy node:disk.out disk.out.$input_seed
    copy node:density.out density.out.$input_seed
    copy node:initial_particle.out initial_particle.out.$input_seed
    copy node:ejected_particle.out ejected_particle.out.$input_seed
    copy node:stopped_particle.out stopped_particle.out.$input_seed
endtask
```

How is the experiment coordinated?



Root Start

Node Start

Node Start

Node Start

Node Start

Node Start

Main Main Main

Main Main Main

Main Main Main

Main Main Main

Main Main Main

Main Main Main

Main Main Main

Main Main Main

Node Finish

Node Finish

Node Finish

Node Finish

Node FInish

Root Finish

EnFuzion demonstration