# HEP Computing Coordination Australia

Geoffrey Taylor
The University of Melbourne

# Outline

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- Research Funding in Australia
- High Energy Physics in Australia
- Computing Infrastructure
- HEP Computing and Infrastructure Activities
- Some Words about HEP Grid Experience
- Future HEP Computing in Australia.

# Research Funding in Australia

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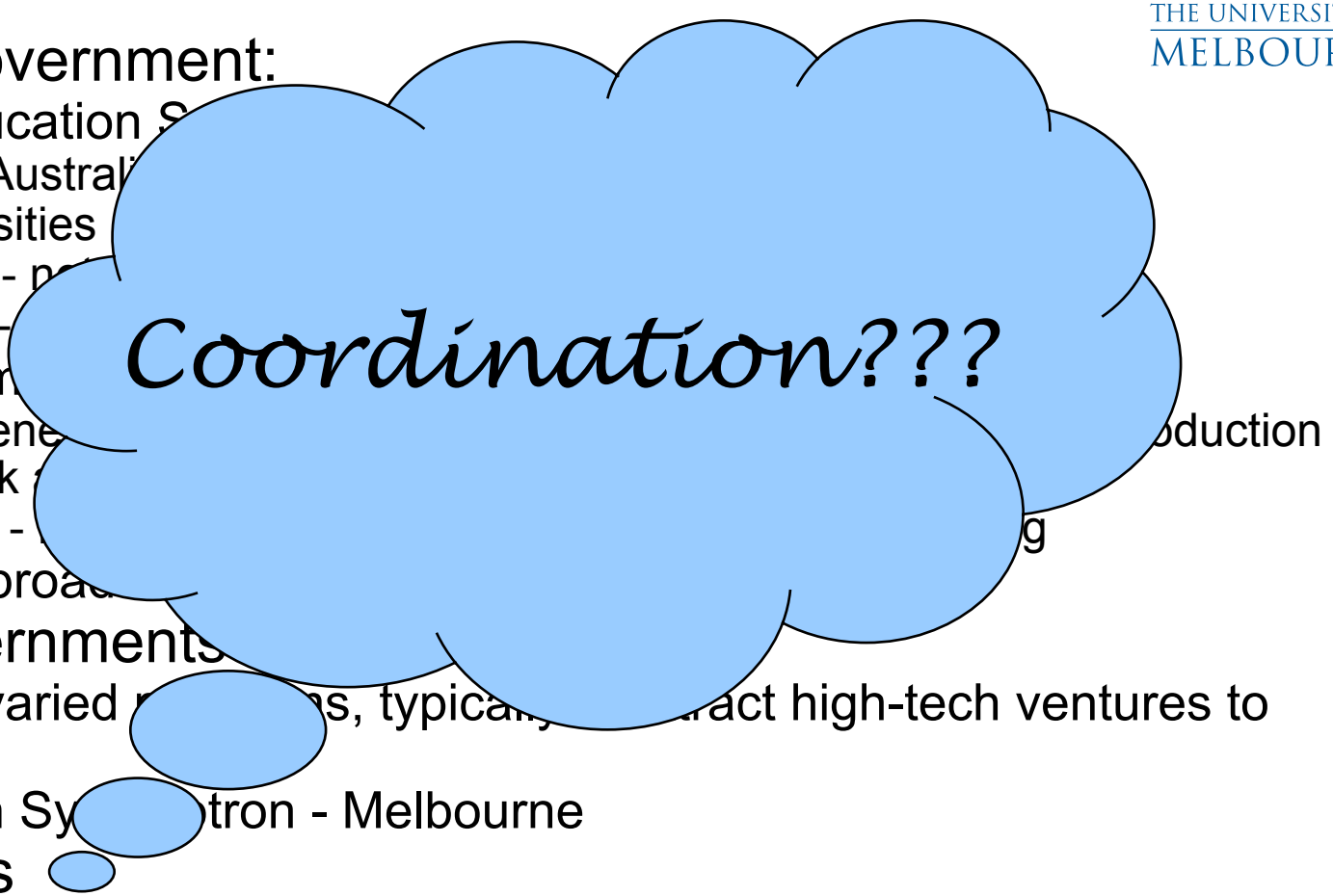
- Federal Government:
  - Dept. Education S
    - ARC (Australi
    - Universities
    - aarnet - n
    - APAC -
  - Dept. Com
    - Grangene
      network
    - NICTA -
  - CSIRO - broa
- State Governments
  - Smaller, varied r s, typica tract high-tech ventures to the state.
  - Australian Sy tron - Melbourne
- Universities
  - 38 Australia-wide, but
  - “Group of Eight” dominate research scene

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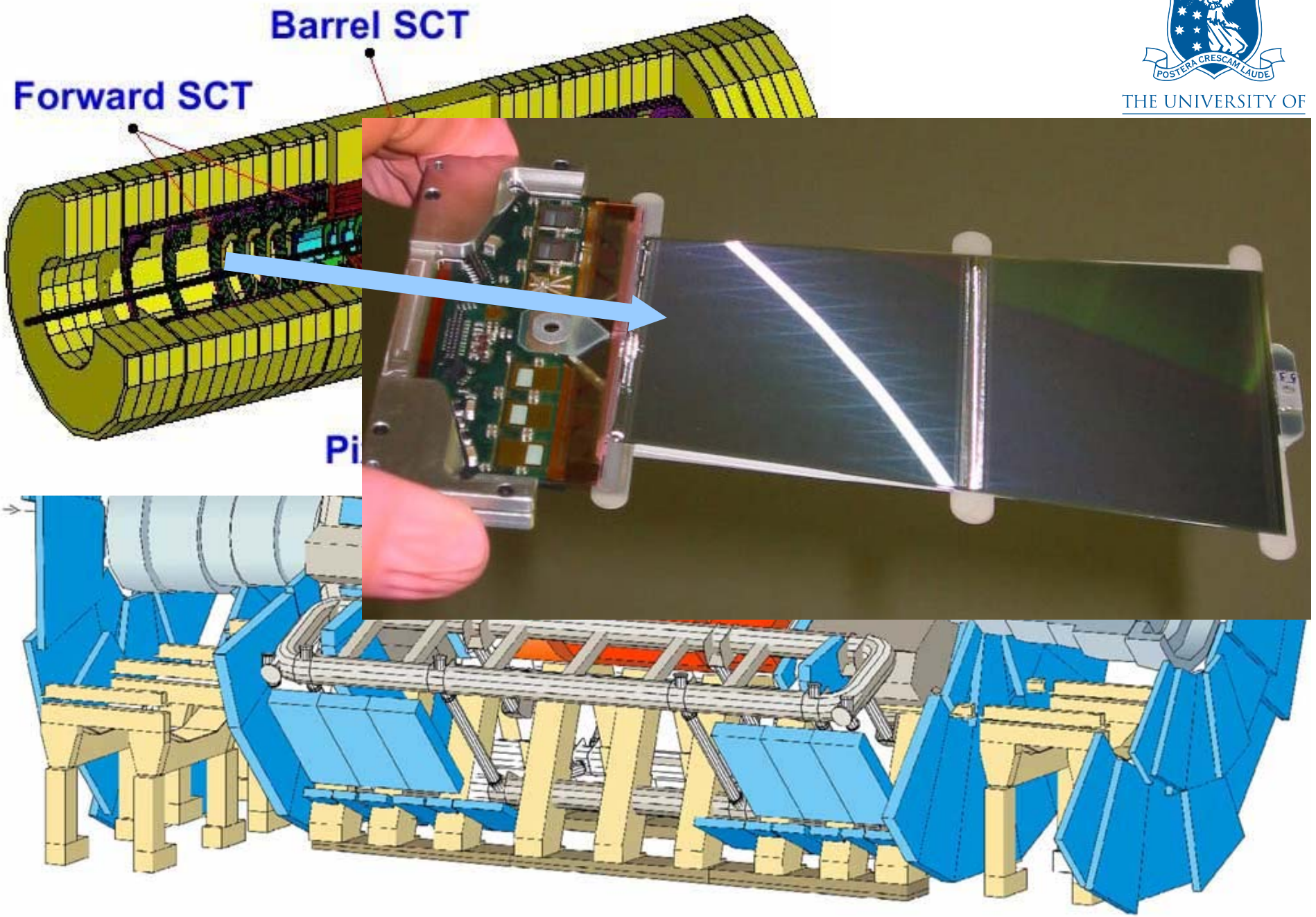
# High Energy Physics in Australia

- Experimental Work
  - Universities of Melbourne, Sydney, Wollongong
  - Belle: SVD Construction; Software; Analysis; GRID Based MC
  - ATLAS: SCT Construction; ID Software; Tier-2?

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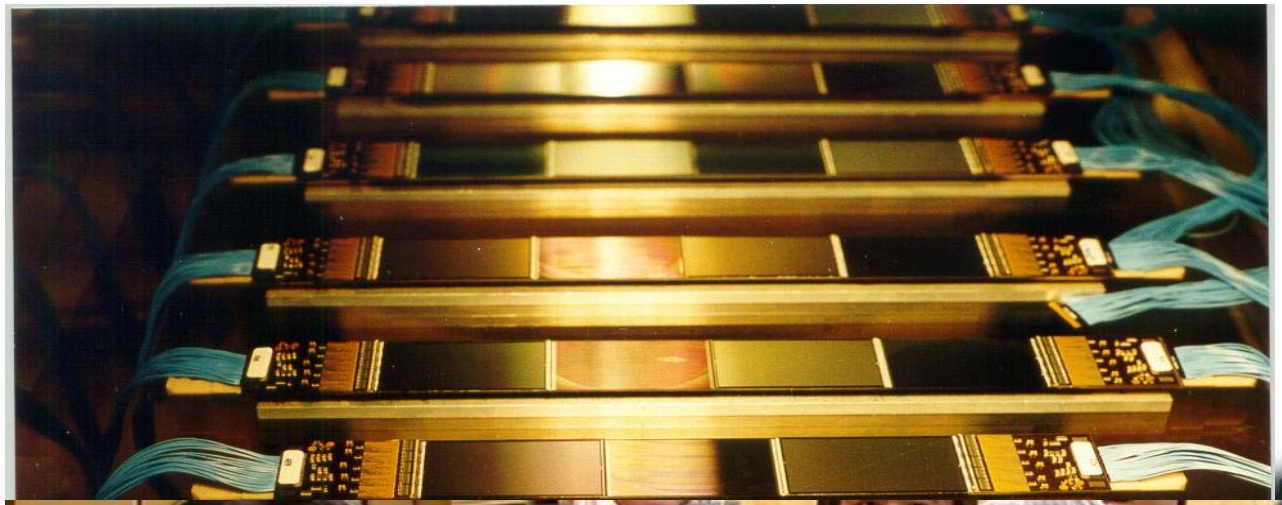

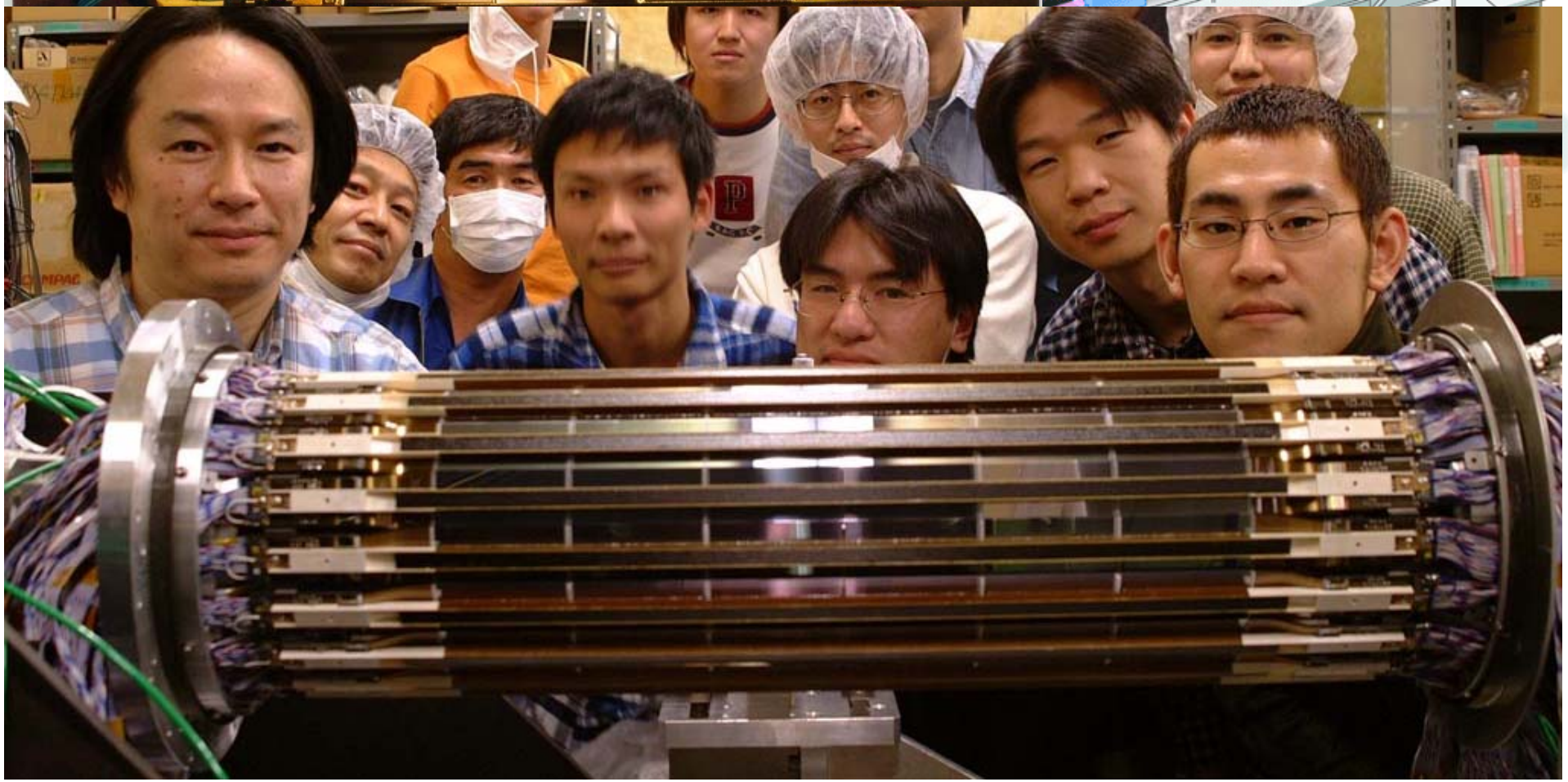

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  - Universities of Melbourne, Sydney, Wollongong
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- Theoretical Work
  - Universities of Melbourne, Adelaide
  - Adelaide: large scale QCD calculations

# Quantum Chromodynamics (QCD)

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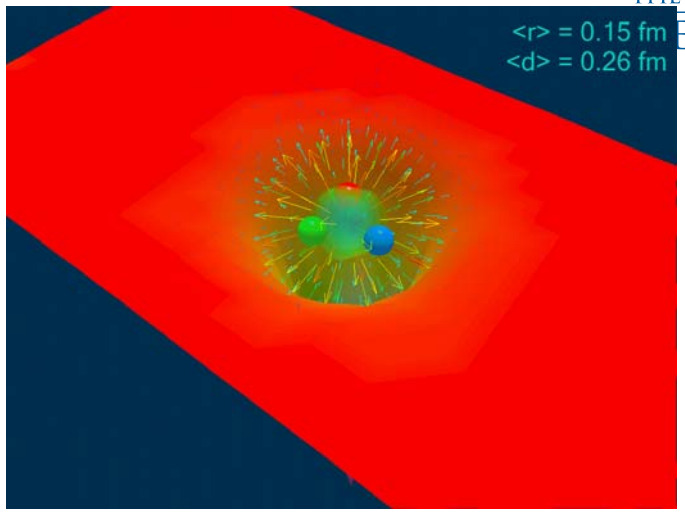
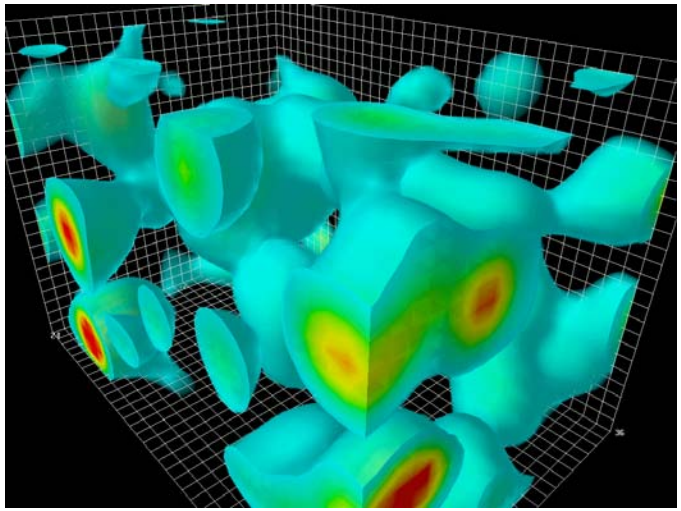
- the fundamental quantum field theory of the Standard Model
  - Centre for the Subatomic Structure of Matter (CSSM), The University of Adelaide.
  - describes the interactions between quarks and gluons
    - eg. found in nuclei (protons, neutrons)
    - “flux tube” binds quarks in nuclei
- simulations on a space-time lattice – only first-principles approach to study
  - Ideal – large physical volume; fine lattice spacing
  - typically 20 cubed or slightly larger
  - eg. QCD “Lava Lamp” (vacuum action density)
  - can take months–years on Tera-flop scale computers
- International Lattice Data Grid (ILDG)
  - sharing generated data sets
  - sharing initial lattice state data
  - can help save computation time



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  - Adelaide: large scale QCD calculations

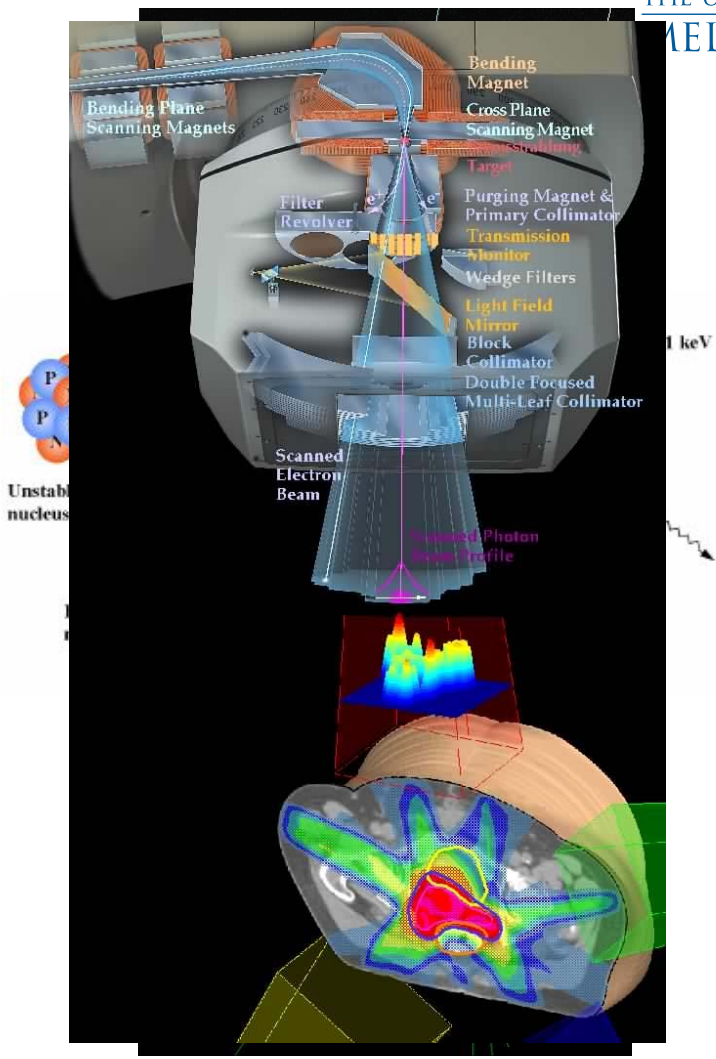
➔ Relatively Small Community

➔Need to share facilities with other areas

➔"Tyranny of Distance": e-Research good for Australia

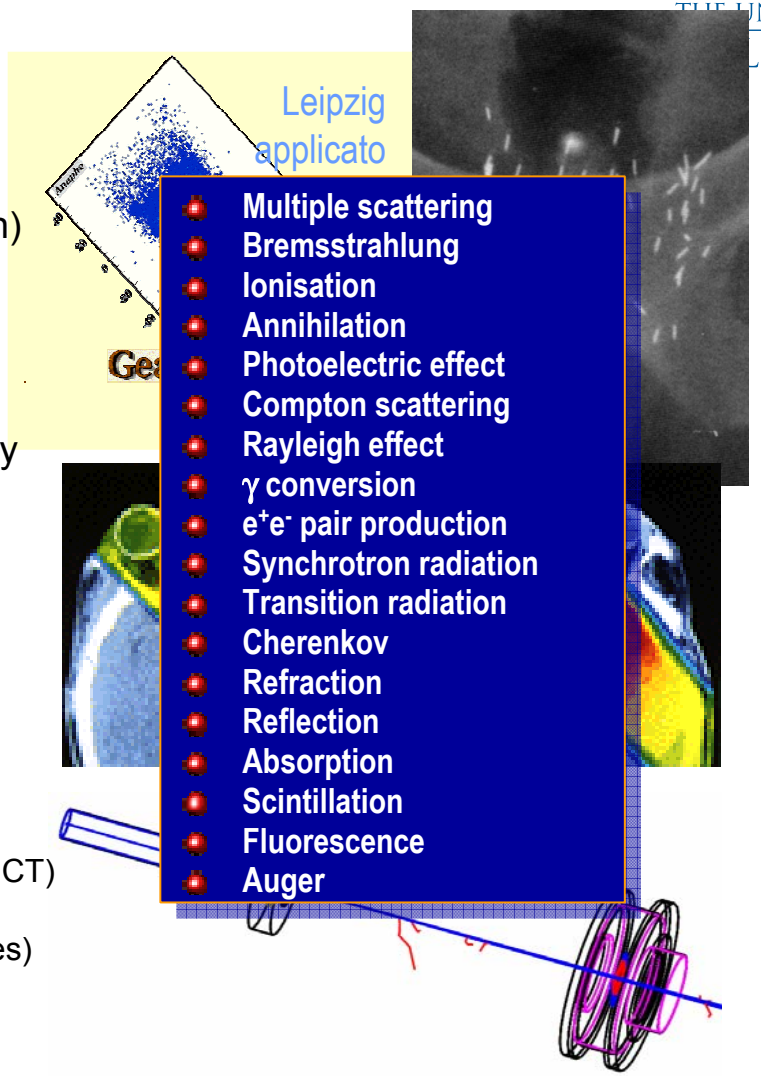
# Medical Physics

- Simulation from experiments like ATLAS have lead to technology transfers…
  - Astrophysics (cosmic rays, design telescopes)
  - Radiation Protection (effect on astronauts, equipment)
- major transfers in Medical
  - Emission Tomography (eg. PET)
  - Radiation Therapy (eg. brachy-therapy, electron therapy, proton therapy)
  - Radiation Therapy equipment design (low energy particle accelerators)



# Medical Physics

- Efforts within Australia…
  - University of Melbourne, University of Wollongong, Peter Mac.
  - PET
  - Radiation Therapy (prostate cancer, proton)
  - Nanodosimetry (DNA level, cell death)
- HEP collaboration “GEANT”
  - GEANT4 toolkit for simulating passage of particles through matter
  - incorporates effects needed for high energy (LHC) and low energy
  - able model complex geometries
  - accurately predict dose calculation
- GEANT4
  - used to help design medical equipment
    - inexpensive high resolution PET using advanced silicon technology
    - Nanodosimetry detectors
  - real-time patient planning
    - reproduce real geometry and tissues (from CT)
    - predict optimal plan
    - real-time, before patient moves (few minutes)
    - Investigating cluster and Grid computing

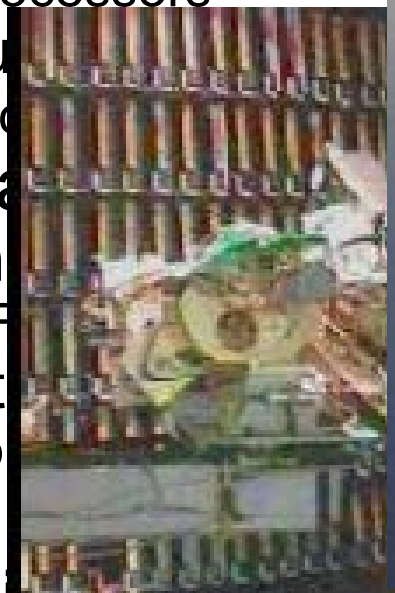


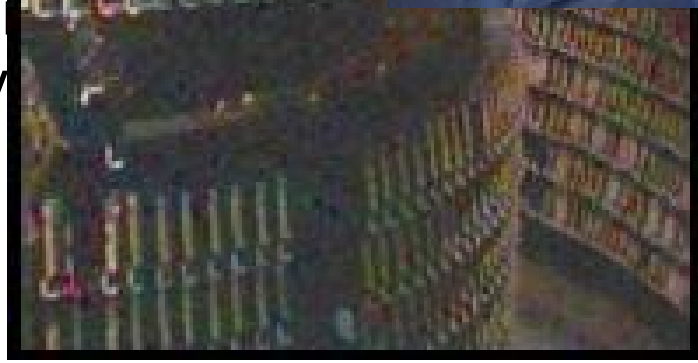
# Computing Infrastructure in Australia

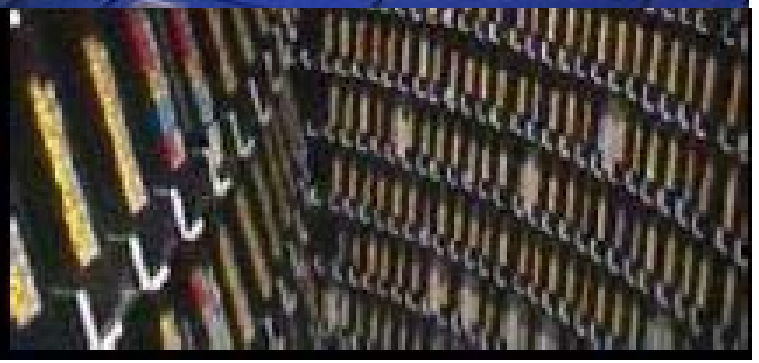
- Compute and Storage
  - Advanced Computing Partnerships
    - APAC (Key National Computing Facility)
    - State Based Facilities: VPAC, ac3, SAPAC,
  - Universities
- Networks
  - Grangenet (DCITA)
  - Aarnet (Universities)

# APAC National Facility

- Computing Systems
  - SGI Altix 3700 Bx2 sy
    - 1680 processors
  - HP AlphaServer SC E
    - 508 processors
  - Dell Linu
    - 150 pr
- Mass Data
  - Hierarch
    - SAM-F
  - Storaget
    - Capab
- Usage
  - mainly bi
  - currently

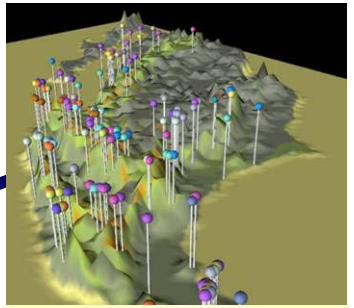






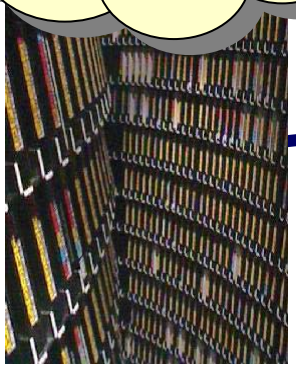
# APAC Grid Interfaces

Research Teams



Sensor Networks

Data Centres



QPSF

IVEC

AC3

APAC NATIONAL FACILITY

SAPAC

ANU

CSIRO

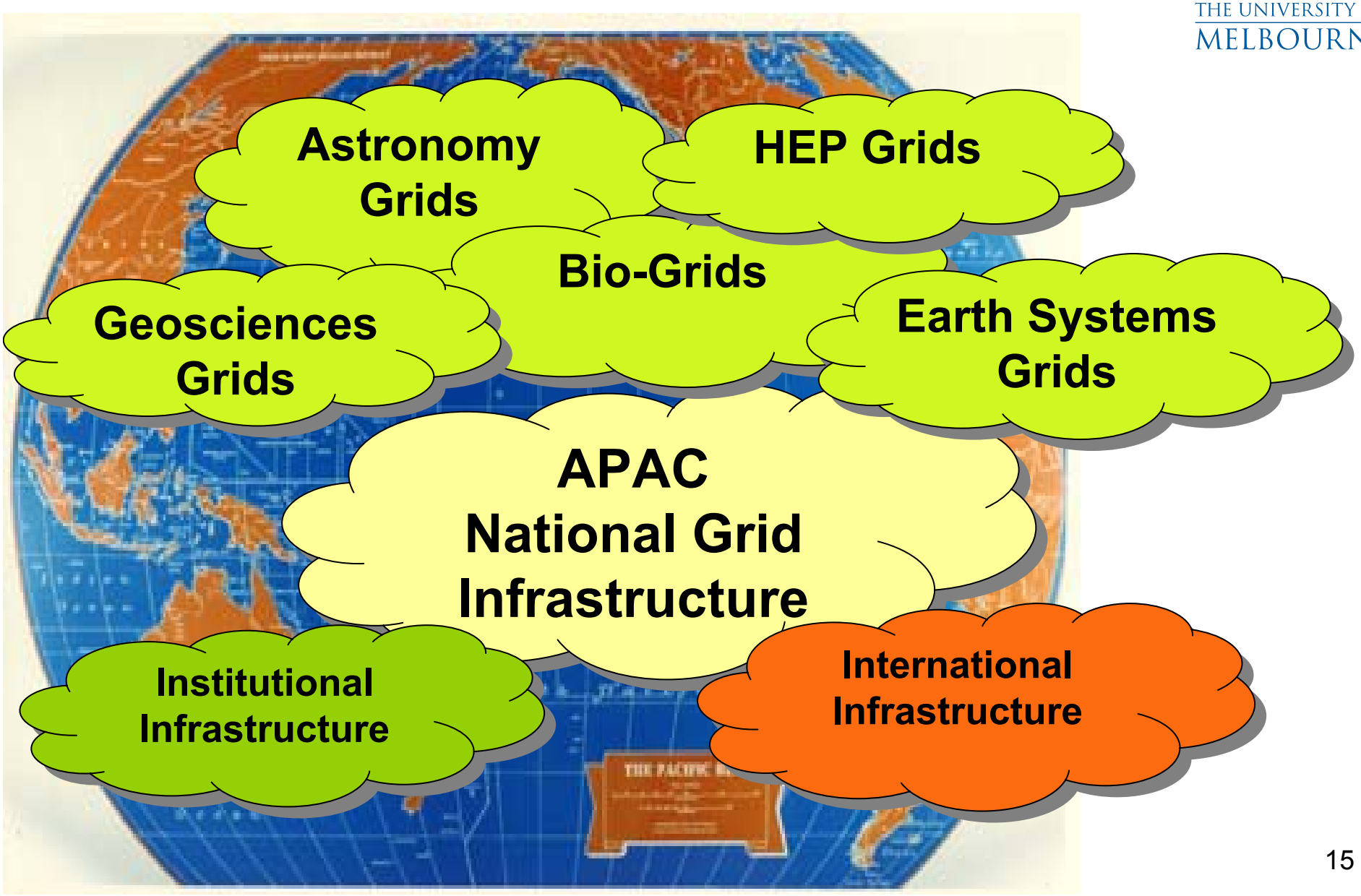
TPAC

VPAC

Instruments

Other Grids:
Institutional
National
International

# Context of APAC Grid



# APAC Grid Infrastructure

- Computing Infrastructure
  - APAC certificate authority
  - VDT middleware (Globus)
  - meta-scheduling (PBS-based)
  - system monitoring and management
  - job distribution for parameter searches (NIMROD/G)
- Information Infrastructure
  - storage resource broker (SRB)
  - metadata management support (XML-based)
  - resource discovery
- User Interfaces and Visualisation Infrastructure
  - Gridsphere-based portals
  - workflow engines
  - collaborative visualisation tools (RVS,…)

# APAC Grid Application Projects

- High-Energy Physics
- Astronomy
- Earth Systems Science
- Computational Chemistry
- Bio-informatics
- Geosciences

# The (previous) Australian Problem

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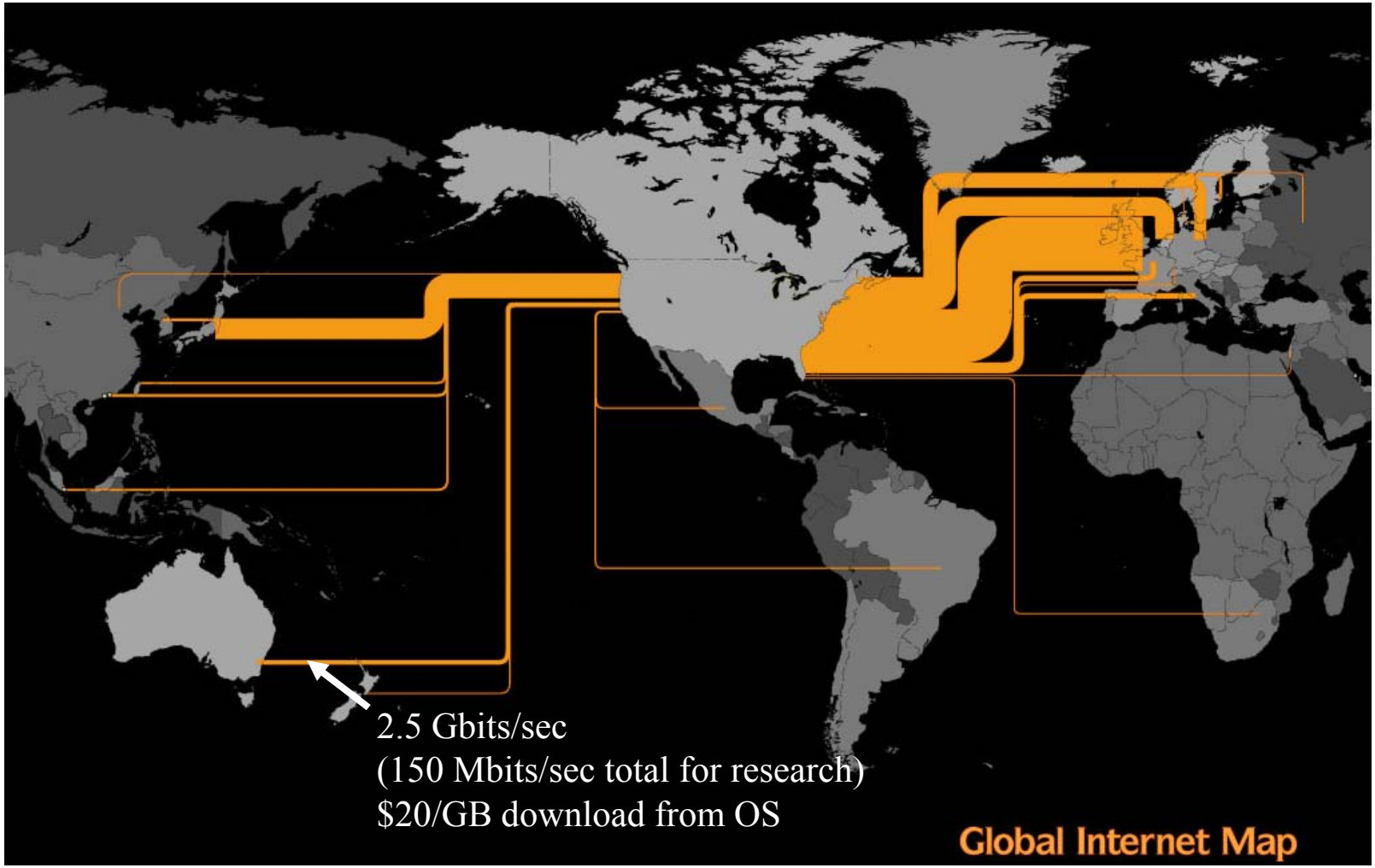
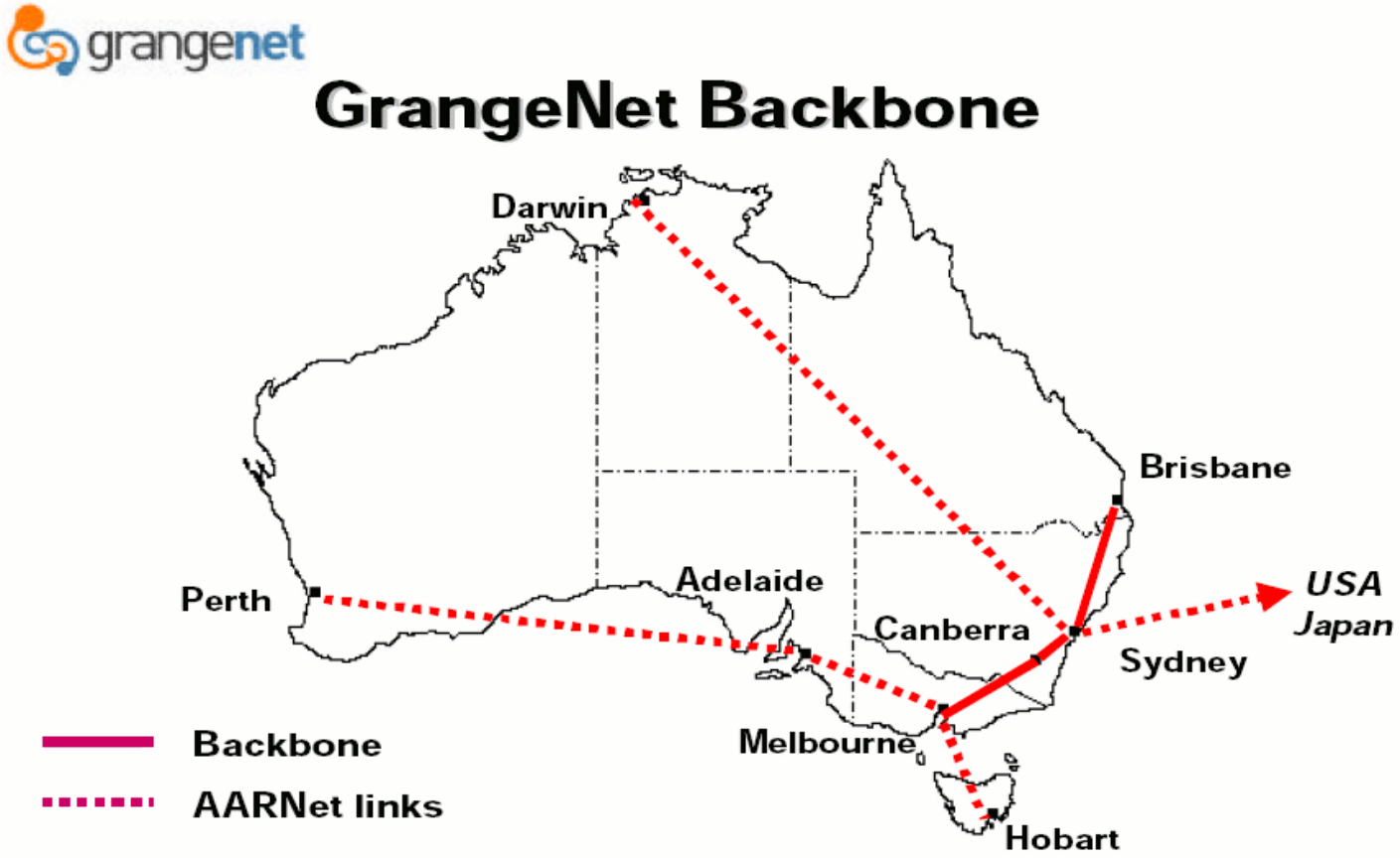
- bandwidth to the rest of the world! (before 2004)



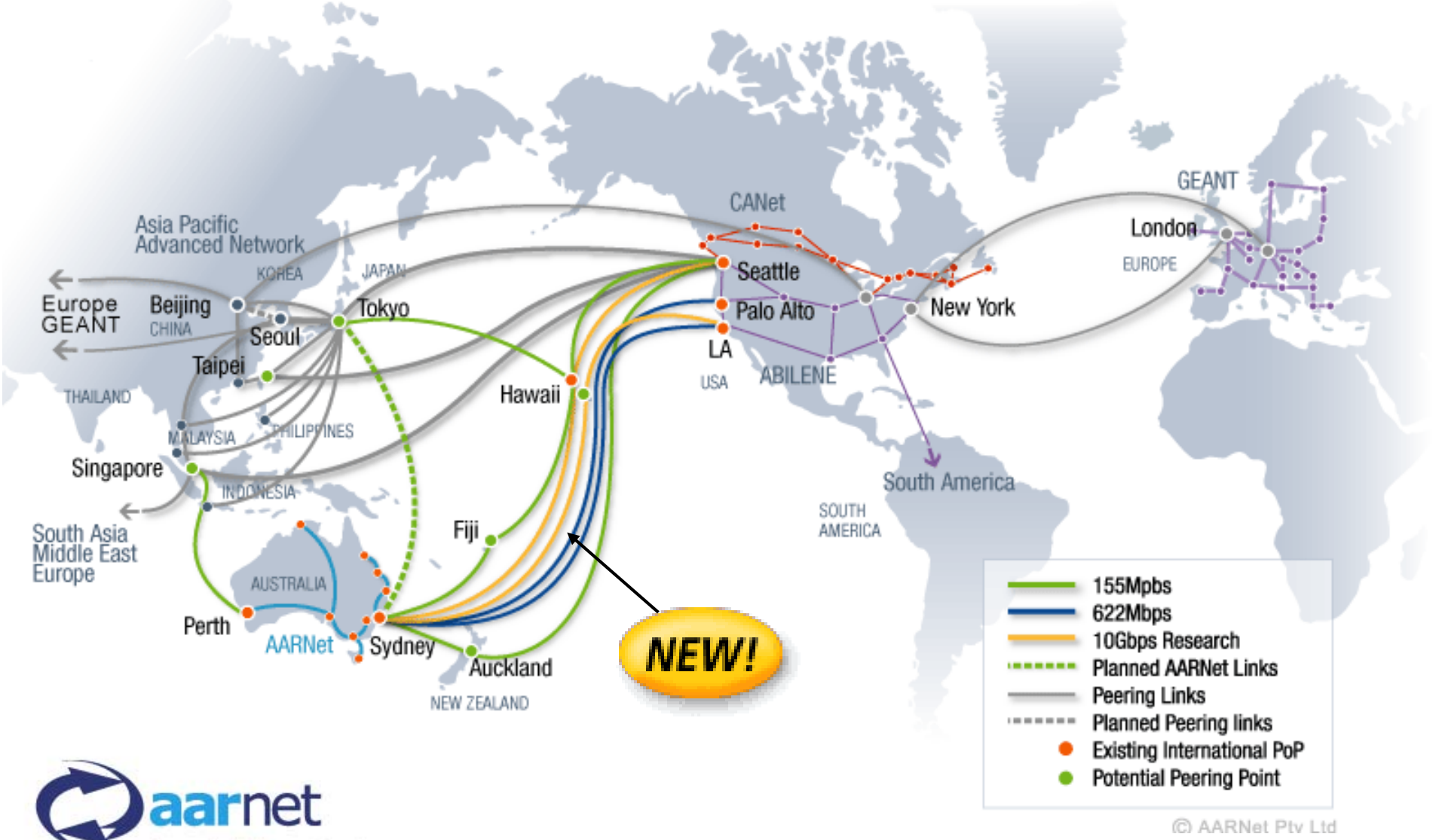
# Recent Bandwidth Upgrades: National

- GrangeNet - Australian Research Network
  - 10 Gbit/s research network through eastern Universities



# Recent Bandwidth Upgrades - International

… *Australia is now well-connected*




aarnet
Australia's Research and Education Network - AREN

# Some Computation Develops in Australian HEP

- Funding Overview
- Developments in Belle
- Developments towards ATLAS (LCG)

# EPP Grid project

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- The general idea…
  - Data Grid tools and techniques will be used at the LHC and ATLAS
  - We will need experience with Grid to get the most out of ATLAS
  - Australia is a long way from CERN (Geneva)!
    - So we have a lot to benefit by better utilising remote/distributed data
  - Network costs are expensive
    - $20 AUD per GB download cost
    - New research network infrastructure is coming soon.
    - Need tools for intelligent network usage (caching, replication etc.)
  - Belle is an ideal test case for Grid on a smaller scale
    - ~400 people
    - ~50 institutes
    - 100's TB of real data, exponentially increasing data set
    - This has stretched our processing and storage needs.
    - $4 \times 10^9$ simulated events required in 2004 just to keep up.
  - Australia can make a major contribution
    - Providing CPU resources for processing and simulation
  - Help Australian researchers and computing facilites gain experience in a computation tool necessary for the future of "BIG" science (collaborative science)
  - Try to do as much as possible with the existing low level Grid tools!

# Funding Overview

- 2002 VPAC Expertise Program Grant (G.M. , M.S)
  - 1 post-doc for expertise with Grid/HPC ; collab. with many groups
- 2003 VPAC Expertise Program Grant
  - Physics – Belle and Grid computing
  - Rajkumar Buyya (CS) – Data Grid Scheduling
  - Dirk van der Knijff (ARC) – ATLAS data challenges
  - Collaboration with University of Adelaide and IBM Asia-Pacific
- 2004 – 2006 ARC Discovery Project Grant
  - $0.5 million AUD over 3 years at University of Melbourne jointly between Particle Physics and Computer Science
  - Working within the LHC and global Grid infrastructure
  - Advanced data cataloguing and access
  - Investigate, develop, utilise Australian eScience infrastructure
- 2004 – 2006 APAC National Grid Program
  - one of several partners ; working towards Grid infrastructure
  - “Experimental and Theoretical High Energy Physics” applications project ; approx $0.4 million AUD over 3 years
  - Belle production will be the first application deployed on APAC National Grid!

APAC Grid

# Experimental High-Energy Physics

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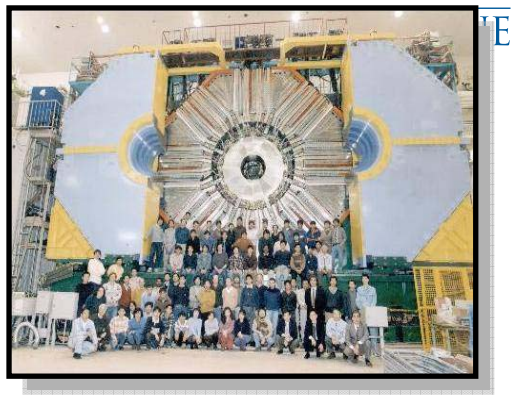
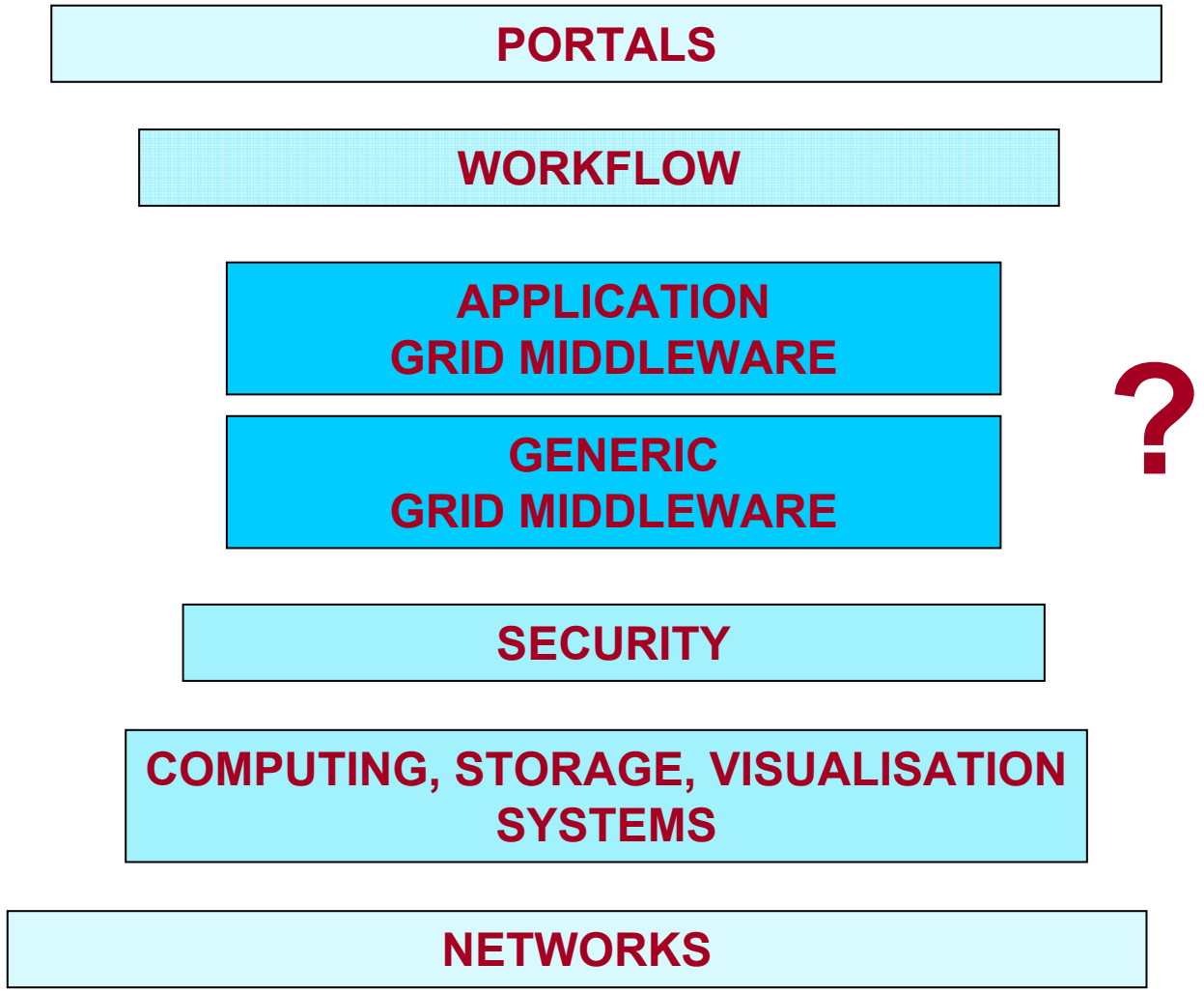


- Belle Experiment
  - K.E.K. B-factory
  - Australian grid for Belle data
    - exploiting Globus 2.x, SRB
    - data grid based at APAC Nati Facility
    - move to APAC Grid infrastructure
- Atlas Experiment
  - Large Hadron Collider (LHC) at CERN
  - Deployed LCG toolkit, will follow EGEE
  - Plan for Tier 2 facility in Australia

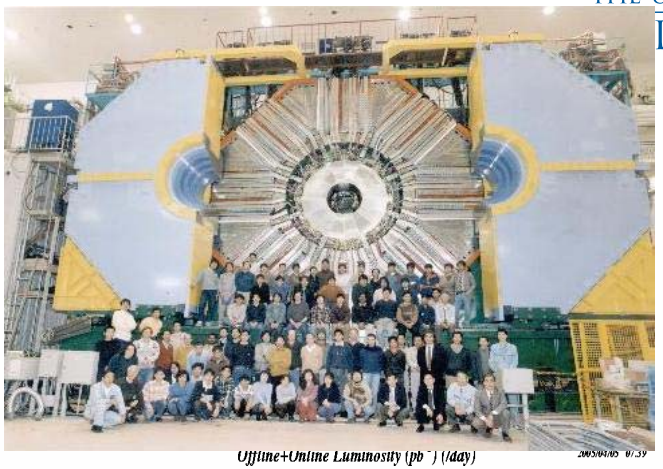
ATLAS

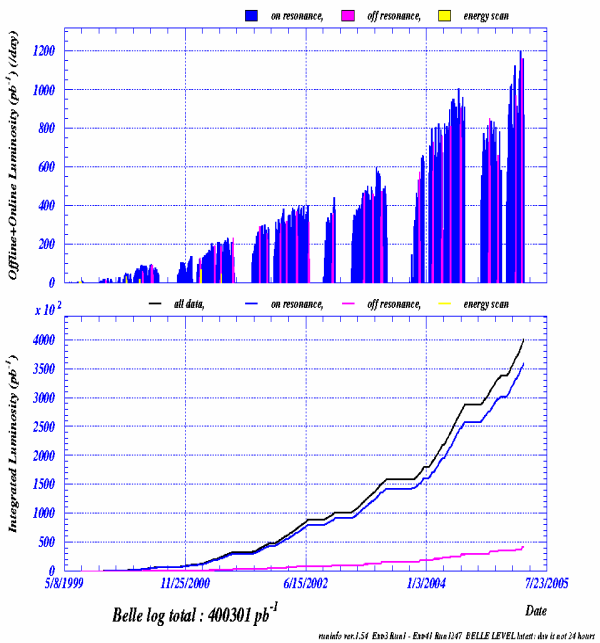
# APAC Grid Architecture



# Belle Experiment

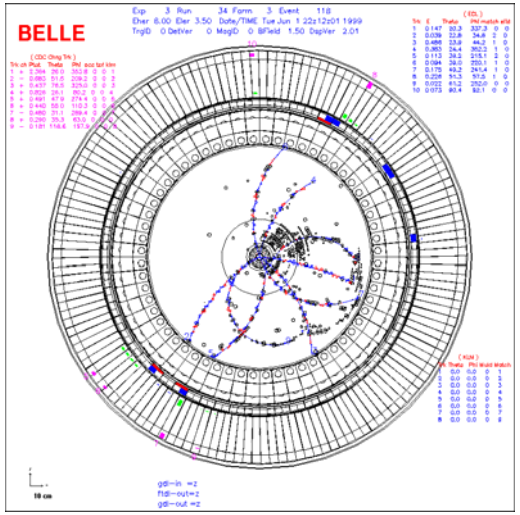
- Belle on KEKB Accelerator, Japan
  - Australia member since 1997
  - collides e- e+ to generate B mesons
  - Investigating fundamental violation of CP symmetry
    - Related  the universe matter – antimatter imbalance
  - Luminosity increasing rapidly
  - Great!
    - increase in collisions
    - increase in data
    - greater statistics, probe deeply
  - Means more simulated data need
    - maintain 3:1 ratio (Sim:Real data)

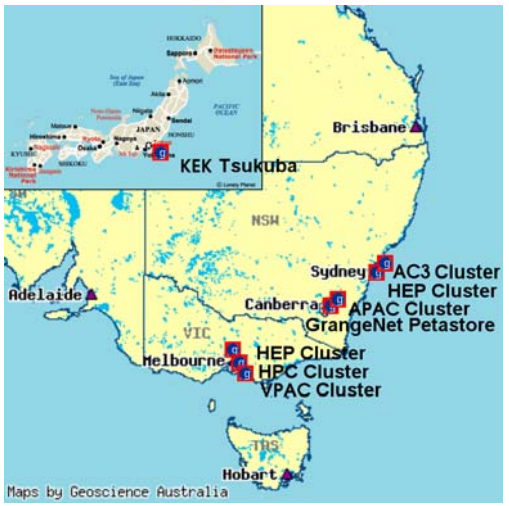




# Belle Experiment

- Created a computing challenge
  - 4 billion events simulated in 2004
  - 3 seconds of CPU per event
  - Saturated KEK computing facilities!
- Belle Monte Carlo Production
  - Facilities around the world contributed CPU
  - Australian major contributor, using our computing facilities
    - Access ~200 CPU over 5 facilities
    - APAC, ANUSF, VPAC, SC3, Melbourne Uni's ARC
    - data replicated between Australia and Japan via SRB (storage resource broker)
  - Effort ongoing in 2005



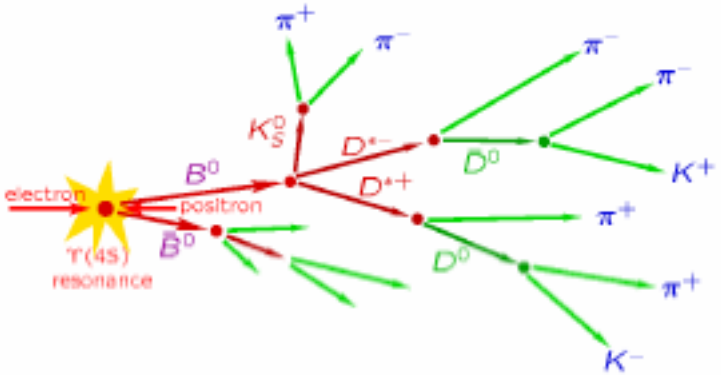
# The Belle Analysis Data Grid *Testbed*

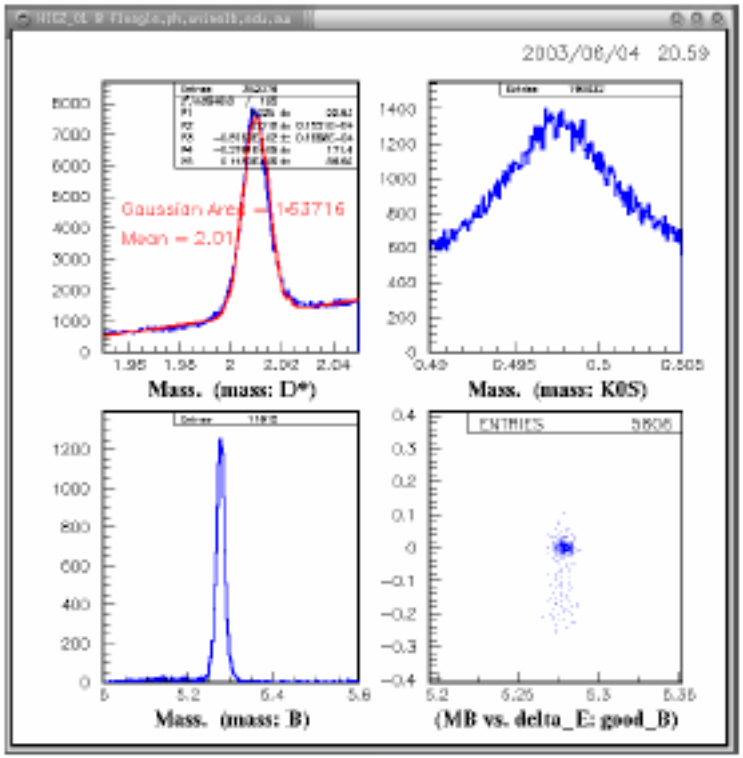
IBM Asia–Pacific provided 5 machines for a distributed testbed:

- Quad CPU 2.6GHz; 70 GB disk
- Deployed at:
  - University of Melbourne (Physics)
  - University of Melbourne (CS)
  - University of Sydney
  - University of Adelaide
  - Australian National University (Canberra)

# Demonstrations at PRAGMA4 and SC2003

- 1,000,000 events analysed using Grid-enabled BASF
- Decomposed into 100 Grid jobs
- Optimised job assignment to minimise:
  - data transmission time *and*
  - computation time.



# The Belle SRB Federation

Recent collaboration between:

- KEK Computing Research Centre
- Australian National University Supercomputing Facility (ANUSF)
- University of Melbourne
- Belle computing group

Aims to provide a distributed data management solution for Belle:

- Use Storage Resource Broker (SRB) for Belle data management
- Federation between SRB servers at KEK, ANUSF and Melbourne.
  - *KNU Korea, AS Taiwan, INP Krakow, IHEP Beijing have joined the federation*

Australian Belle Monte Carlo production uses SRB@ANUSF

- Distribution of input and output data
  - Utilising computing resources from VPAC, AC3, UoM, ANUSF.

# Belle MC production with SRB:

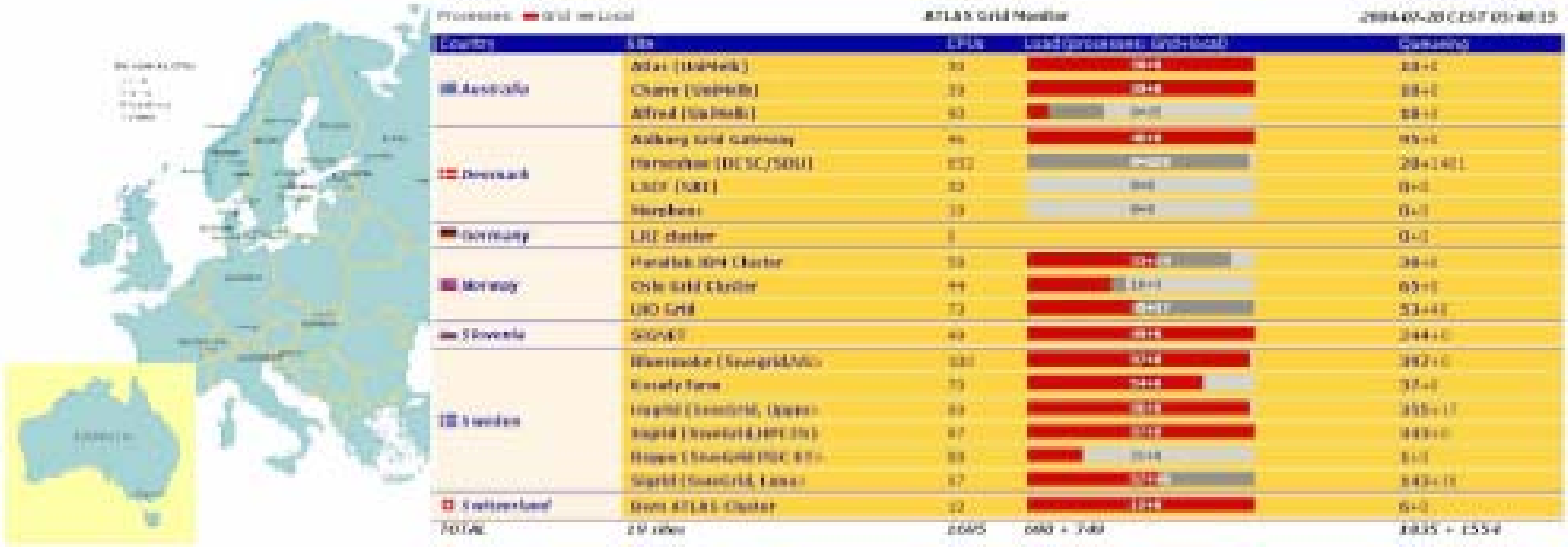
- Current status of Belle MC production in Australia
  - We have produced 150 million simulated events:
    - Approximately 5000 CPU days
    - 4.5 Terabytes of output data
- SRB support for Belle Analysis Data grid
  - We have now added SRB support to our Belle Grid toolkit
    - SRB-aware grid scheduler
    - Queries SRB for data locality
    - Dispatches jobs according to static network map
  - We are testing grid deployment now
- Will change all Belle MC production to grid based job dispatch.

# APAC Partner Computing Resources for HEP

- We have access to linux cluster facilities at:
  - Australian Partnership for Advanced Computing Canberra
    - 150 × 2.66 GHz Pentium 4
  - Victorian Partnership for Advanced Computing Melbourne
    - 97 × dual 2.8 GHz Xeon
  - ac3 Sydney
    - 155 × dual 3.0 GHz Xeon
  - University of Melbourne Melbourne
    - 48 × dual 2.4 GHz Xeon

# LCG Activities in Australia

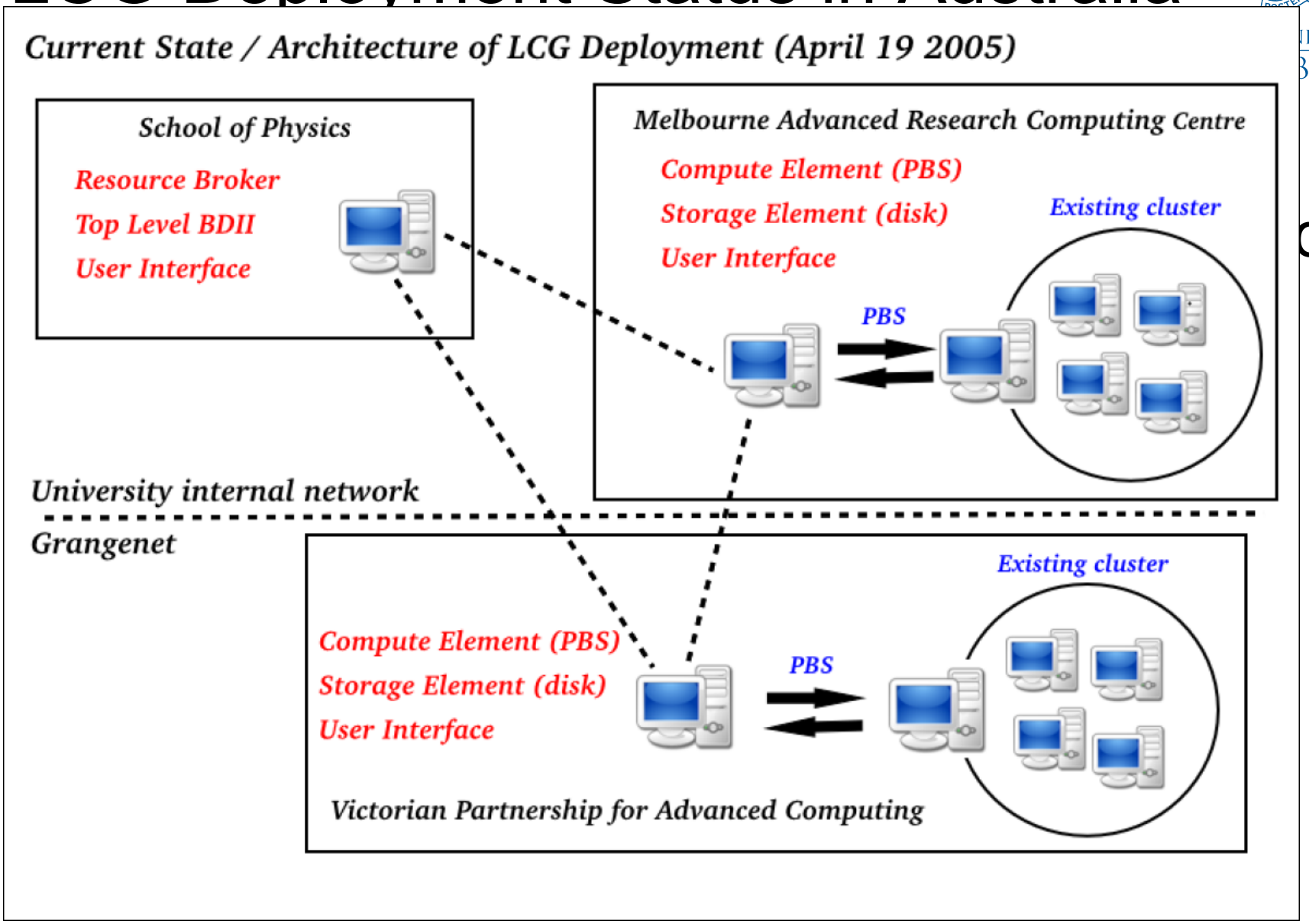
- We have been participated in ATLAS Data Challenges 1 and 2
- As a member of Nordugrid!!
- Data challenges being run by Advanced Research Computing group at University of Melbourne:



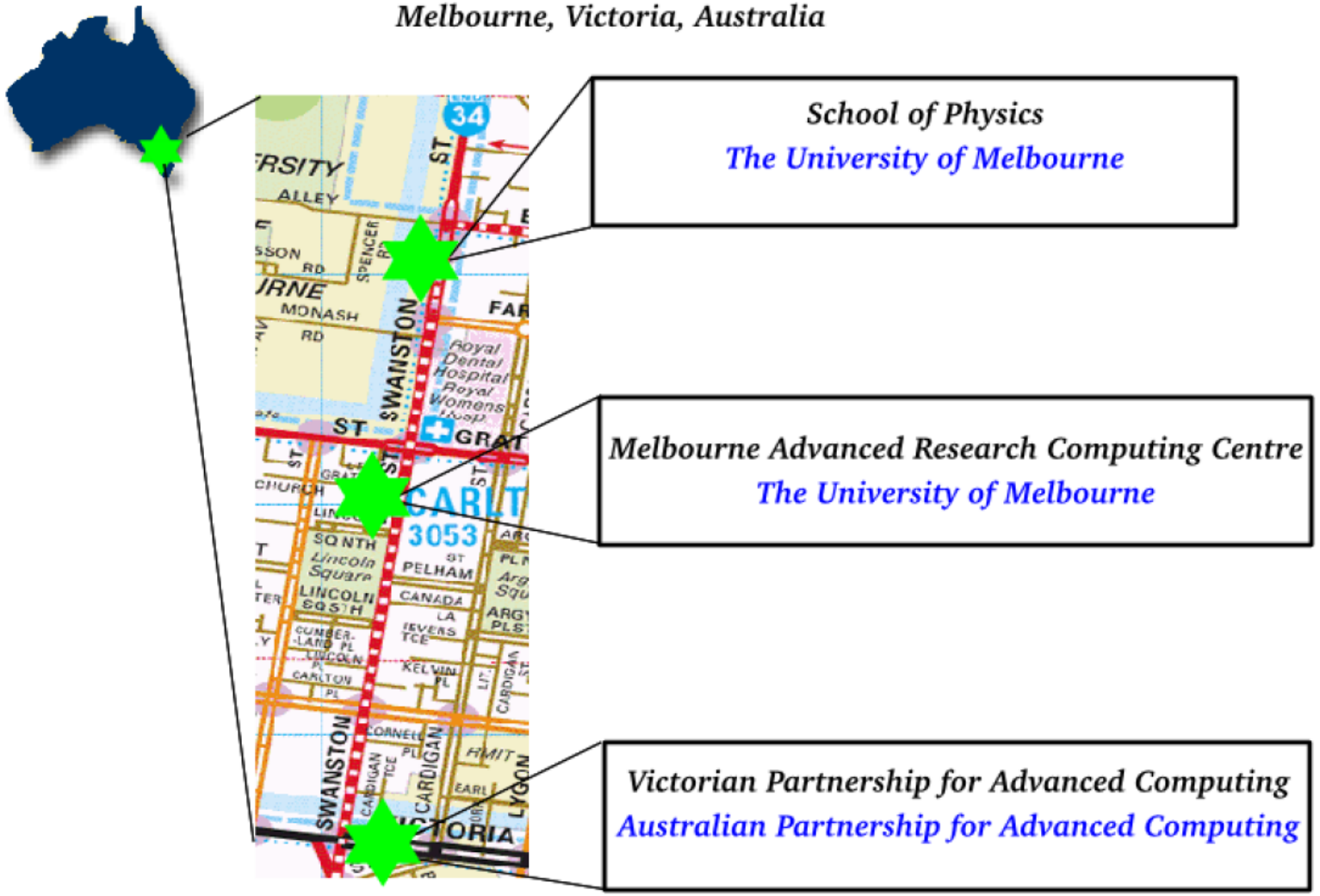
# A few details on LCG deployment

- Resource broker/information system in Melbourne Physics.
- Sees two 'LCG gateways' interfaced to:
  - VPAC
  - Melbourne University PBS clusters.
- Resource broker has user Grid interface tools providing:
  - access to compute elements
  - providing grid tools to access/manage storage.
- If the job passes all authentication/authorisation, passed to PBS for scheduling/running:
  - BEFORE PBS server: looks like an LCG grid
  - AFTER PBS server: looks like a cluster resource
- Allows system policy to remain in control of host inst. whilst becoming a part of the LHC grid.
  - Simplifies rollout:
    - one node per site as opposed to re-installation/configuration of all the nodes at that site.

# LCG Deployment Status in Australia



# LCG toolkit deployment in Australia



# Plans for LCG Rollout

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- In near term (LCG on APAC Grid) :

  Integrate LCG nodes at VPAC and MU

  - Make BASF(LCG) available at VPAC and MU, ac3 and SAPAC(using VDT1.2 tools)
  - Lyle Winton GRID scheduler to submit jobs, in parallel, to all participating sites (mixture of VDT and LCG)
  - Build/configure/integrate LCG gateways into ac3 and SAPAC
  - Move Belle MC completely onto LCG GRID
  - First application on the APAC trial grid.
    - Demonstrate inter-operation between grid infrastructures
  - Prepare for Tier-2 centre in Australia.

# Summary

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- HEP is small part of Australian Science
- Research Funding for Research Computing Dispersed
  - Excellent support from APAC, aarnet, ARC, Universities
- Must work with other fields
  - Must continue to argue the benefits to other fields of supporting HEP computing as a driver, and conduit to international developments.
  - Must continue to bring benefits from HEP to broader community.
- LCG Grid Deployment underway.
- Plans for LHC Tier-2 underway.
  - Albeit in shared/distributed facilities.

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- Thanks to:
  - Glenn Moloney
  - Lyle Winton
  - Marco La Rosa

  For contributions to this presentation