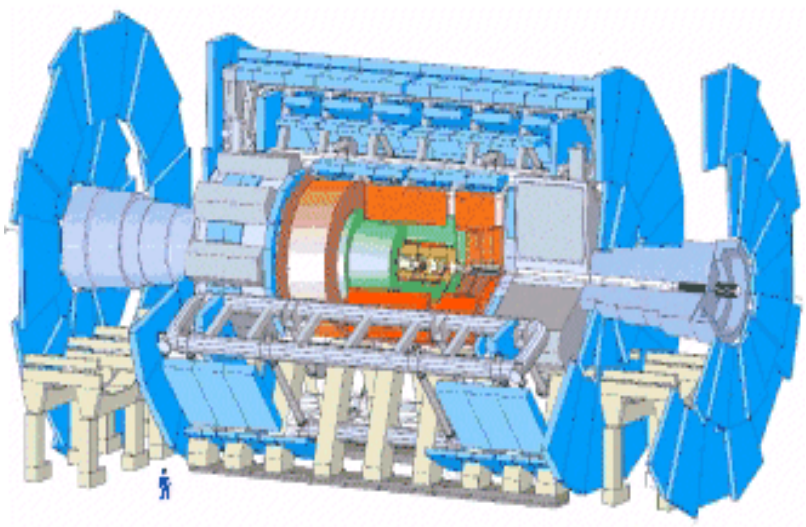
# *LHC Computing Plans*



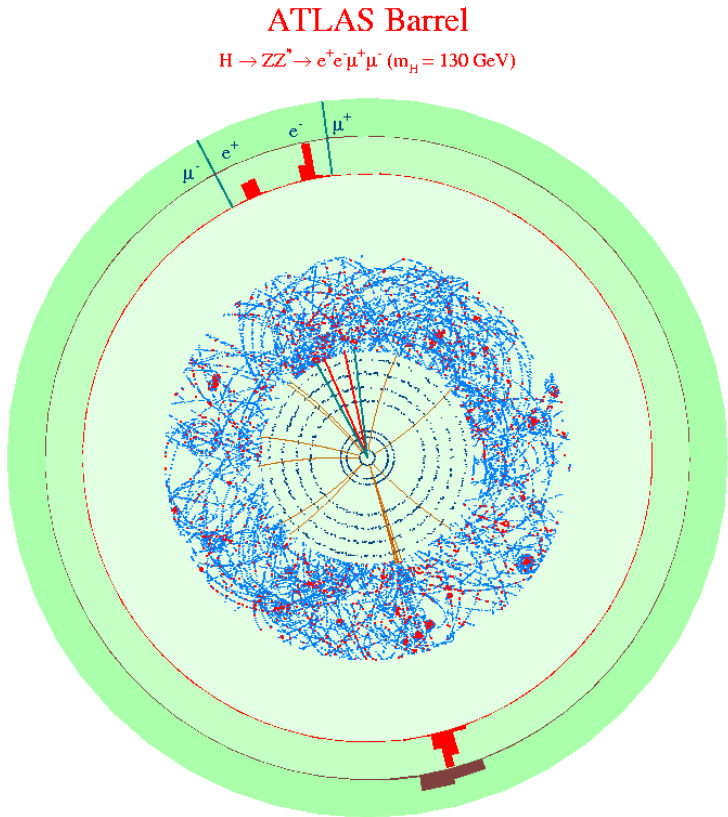
- Scale of the challenge
- Computing model
- Resource estimates
- Financial implications
- Plans in Canada

# *Introduction*

- LHC is a leap forward in beam energy, density and collision frequency
- Analysis of the data will be a computing challenge
  - unprecendented complexity and rates of the data
  - length of the experimental programme
  - large geographically distributed collaborations
- CERN has undergone a review of LHC computing
  - material and human resources at CERN are insufficient
  - shortfall is estimated to be 10-40 MCH/yr and 40-50 FTE/yr

# *Scale of the challenge*

- 30 million events per second
- Online selection:
  - reduces rate to 100 events/s
  - size to 1-2 MB per event
- Data rate:
  - 100 MB/s or 10 TB/day
  - 100 days/year = 1 PB/year




*1 interesting event is buried in a background of 1E13 events*

Typical computing parameters for a single LHC experiment:

- •processing power > 1,000,000 SpecInt95
- •storage accumulation rate > 2 PB/year
- •data throughput > 1 Terabit/s
- •simultaneous users ~ 1000

Length of the program is expected to be > 10 years

- •represents ~10 evolutionary market cycles and one "revolutionary" change in each category (hardware, system architecture and operating system)

Large geographically distributed community

- •~2000 physicists (4 times the LEP experiments)
- •"globalization" of the community who all want transparent access

***Planetary scale, the length of the program, and the large data volumes and rates make up the unique challenge of LHC Computing***

# *LHC Computing Model*

The computing requirements cannot be satisfied at a single site

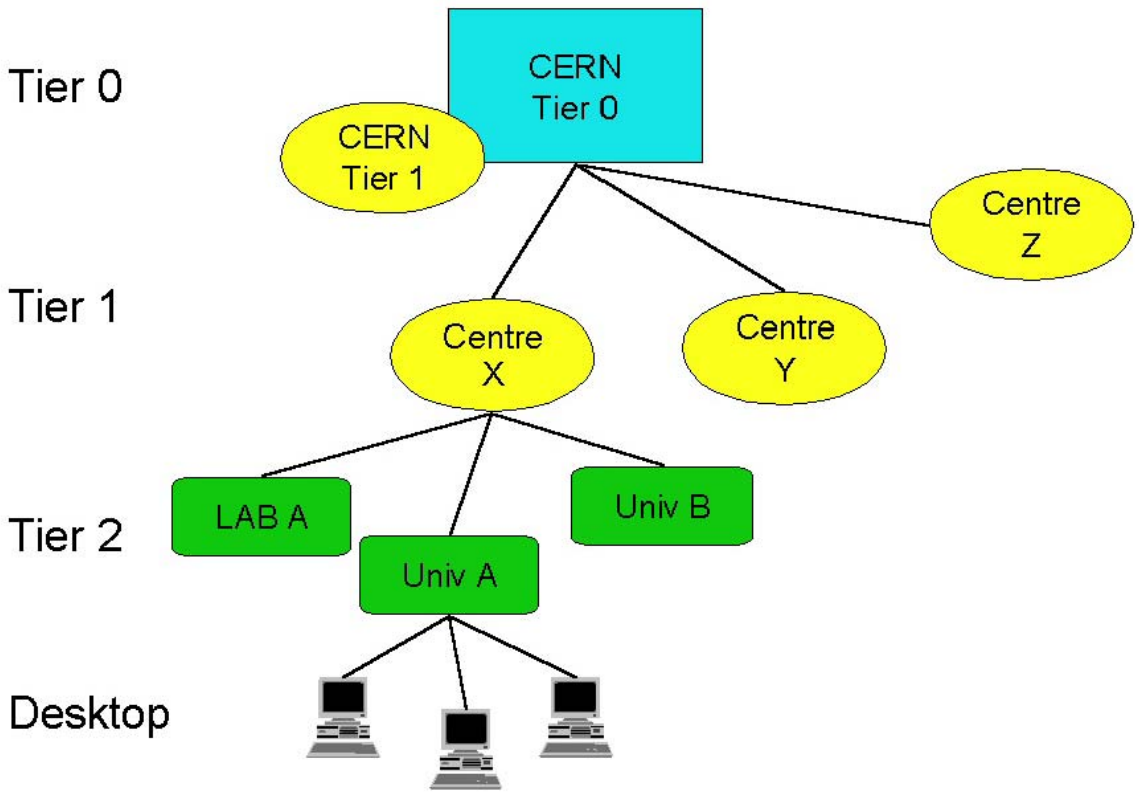
- need to exploit geographically distributed resources
- utilize established computing expertise and infrastructure
- tap into funding sources not usually available to particle physics

LHC Computing Model:

- hierarchical structure with the CERN at the top tier
- Large national or intra-national centres
- National or institutional centres
- Desktop

*Close integration of computing resources at external institutions with those at the accelerator laboratory has not been attempted*

# *LHC Computing Model*




One Tier 0 site at CERN for data taking

ATLAS (Tier 0+1) in 2007:
400 TB disk, 9 PB tape,
700,000 SpecInt95

Multiple Tier 1 sites for reconstruction and simulation

400 TB disk, 2 PB tape
200,000 SpecInt95

Tier 2 sites for user analysis

# *Grid Activities in CERN*

The goal is to make many activities Grid-aware

- data transfers between the regional centres
- production of simulated data
- reconstruction of real/simulated data
- data analysis

Tools (middleware) for the Grid are being developed

- management tools for the jobs, data, computing farms and storage
- monitoring tools for the network and computing facilities
- security and authentication

*CERN is leading the Data-Grid Project which will address these issues for particle physics, genome project and space science*

# *Deployment at CERN*

- Prototype stage: 2001-2004
  - goal is to have a facility with 50% of the scale required by a single LHC experiment
- Pilot stage: 2005
  - services set up for each experiment
- Production: 2006-2007
  - expansion and conversion of pilot service in production mode

# *Human Resources*

Manpower estimates at CERN for all LHC expts

- do not include online or core software which are the responsibility of the experiment

***LHC Review identified Core Software as critically undermanned***

Prototype phase: ~ 75 FTE's per year

Production phase: ~ 60 FTE's per year

*CERN IT can provide 20 FTE's per year.*

*The shortfall must be picked up by the external institutions.*

# *Financial implications*

- Prototype 2002-2004 23 MCH/yr
  - 10 MCH/yr hardware + 13 MCH/yr manpower
- Pilot and Production >2005 45 MCH/yr
  - 35 MCH/yr hardware + 10 MCH/yr manpower
- Missing funding:
  - prototype 2002-2004: 13 MCH/yr
  - production > 2005: 40 MCH/yr

*ATLAS institutions will need to contribute 3 MCH/year in 2002-2004 and 10 MCH/year 2005-2015 for CERN based resources*

# *ATLAS-Canada*

Montreal
Toronto
York
Carleton

Victoria
UBC
TRIUMF
Alberta


30 faculty at 8 institutions
100 Canadians

*NSERC MIG $15 million for detector components that are currently under construction*

*TRIUMF has contributed $30 million to the LHC accelerator through in-kind contributions of items such as magnets*

# *ATLAS-Canada Computing*

We want to be leaders in the analysis of ATLAS data.

To do this we require:

- A large Tier 1-2 type facility in Canada
  - we want all the data during the first few years of ATLAS
- Tier 2-3 sites at each institution or groups of institutions
  - 1 or 2 may have additional resources dedicated to MC production

# *ATLAS Computing in Canada*


**Tier1:**
400 TB disk, 2 PB tape
200,000 SpecInt95

10% in 2004
40% in 2005
100% in 2006

# *Current plans*

Project Outlines to the 2 CFI International Funds due July 3

- *Joint Venture* - $100M for 4 projects in Canada
  - *Canadian-Tier1* facility at University of Toronto with mass storage and processing
  - Monte Carlo production sites (UofA and UdeM)
  - Tier2 sites at other sites (Carleton, TRIUMF,Victoria)
    - ballpart estimate is $20M for hardware and manpower

# *Current plans*

- *Access Venture* - $100M for projects outside Canada
  - Establish a team of 5 HQ Canadians at CERN to contribute to central activities for 2002-2007
    - the team would focus on a single project
    - team members would be resident at CERN for 2-3 years
    - strongly supported by CERN and ATLAS management
    - $4 M for 2002-2007
  - Contribute to ATLAS computing hardware at CERN
    - ATLAS hardware costs are estimated to be $9M (2001-2004) and $25M (2005-2007)
    - ATLAS-Canada is 3% : $250K (2001-4) and $750K (2005-7)

# *Other activities*

In parallel, there are a number of requests submitted to CFI for shared computing resources

- Toronto Linux cluster
  - support CDF and ATLAS-dev
- WestGrid (UA, Calgary, SFU, UBC, TRIUMF)
  - shared-memory machines, Linux cluster and storage
  - support TRIUMF expts and ATLAS-dev
- Victoria (UVic, DAO, PFC, PGC, as well as UBC, TRIUMF)
  - large storage facility and shared-memory machine
  - support BaBar and ATLAS-dev

# *TRIUMF's Role*

Our community needs a centre for Subatomic Computing

- Canada has few physicists with computing expertise
  - particularly evident with new OO software
  - US leads the ATLAS software development
- ATLAS is not the only experiment with large storage requirements
- We should be active in Grid Research and E-Science

TRIUMF is the natural location for such a facility

- TRIUMF cannot apply to CFI
- Possible option for next 5 year plan

# *R and D Activities*

- Commodity Linux farms:
  - Alberta (Thor) for ATLAS 3rd level trigger
  - Victoria for BaBar physics analysis
- Storage management
  - use of Hierarchical Storage Manager (HSM) underway at Victoria
  - plan to connect with 20TB tape library with BaBar Linux farm
- Grid
  - R.Kowalewski and R.S. funded by C3.ca for Grid research
  - established a small testbed between Victoria and TRIUMF
  - collaborating with HPC NRC Group in Ottawa
  - goal is run BaBar MC production over a Grid

# *Summary*

Exciting time in computing for particle physics.

- LHC and ATLAS will push the limits of computing technology.

Canada will need to contribute to central resources and create a RegCentre

- We are applying to the CFI Int Funds
- Other options include existing facilities funded by the CFI Innov Fund
- Also, NSERC and the TRIUMF 5 year plan

Canadians are actively involved in computing issues

- playing a leading role in ATLAS software development
- pursuing initiatives to build up local resources (CFI) as will as development projects (Linux clusters, storage, Grid)