# Using the WestGrid Glacier cluster to untangle TWIST

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# The TWIST experiment

- TRIUMF Weak Interaction Symmetry Test
- Performed using a Muon beam from the TRIUMF cyclotron to measure the decay distributions of polarized muons to high precision
- Determine parameters characterizing the muon decay to a precision 3 to 10 times higher than previously achieved
- To better understand the left-right asymmetry presently incorporated in the Standard Model

# The TWIST experiment (2)

The experimental group is a collaboration of approximately 30 researchers and 5 graduate students from

- Canada: TRIUMF (Canada's National Laboratory for Particle and Nuclear Physics) , University of Alberta, University of British Columbia, University of Montreal, University of Regina
- USA: Texas A&M and Valparaiso University
- Russia: RRC "Kurchatov Institute"

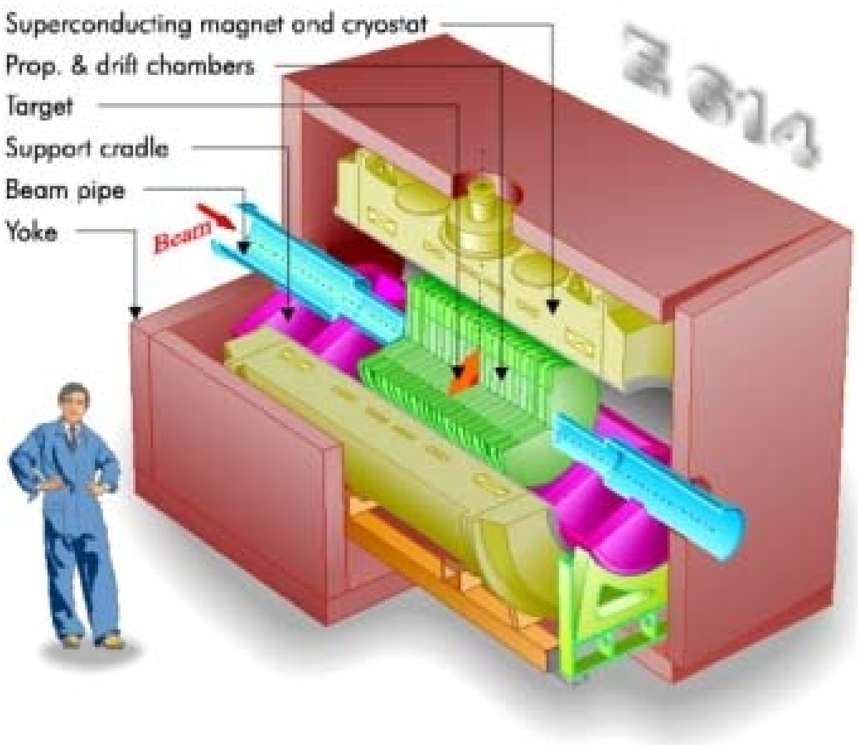
# The TWIST detector

Stack of 56 low mass planar drift chambers, 80 active wires per tracking chamber

Highly uniform 2 Tesla magnetic field

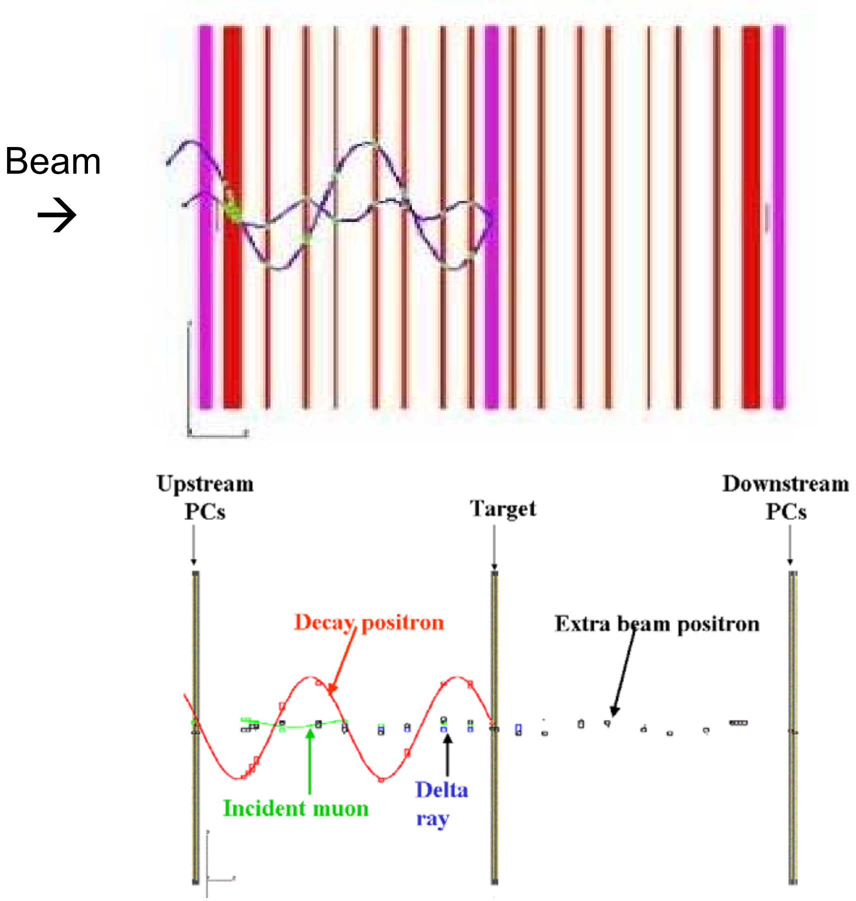
Thin target at the center of the stack

Hundreds of channels monitoring the ambient conditions: gas pressures and temperatures in chambers, beam magnet settings, CCD cameras monitoring the position of chambers, etc.



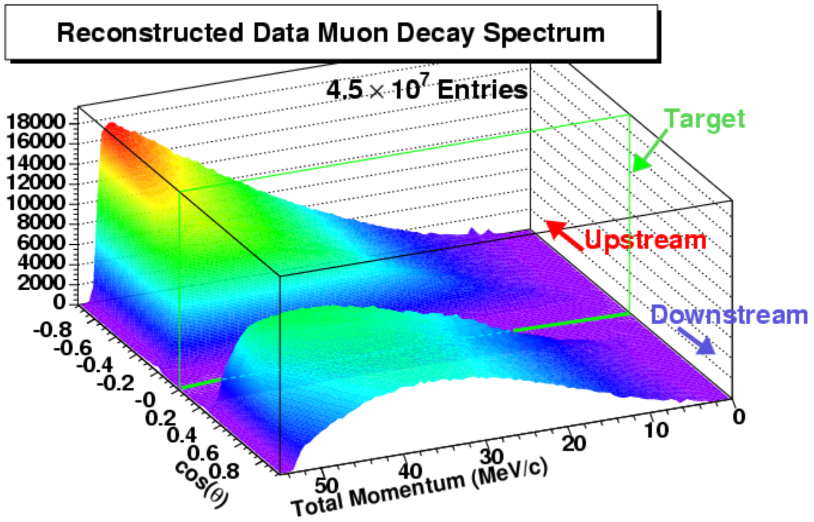
# TWIST events

- Data consist of “events”: a muon entering the detector, stopping in the target and decaying into a positron.
- Times at which wires are hit relative to the time when a muon crosses a trigger counter are recorded.
- Average size: 2 Kbytes per event



# The TWIST Analysis Process

- Reconstruct the helicoidal path of the decay positrons to create distributions in momentum *p* and decay direction *cos(θ)*




- The shape of the spectra is sensitive to the Muon decay parameters (Michel parameters: ρ, η, δ and $P_\mu \xi$) which enter in the formulation of the Standard Model

# Analysis Process (cont)

- Simulate the experiment using *GEANT3*, to produce data files in the exact same format as the real detector
- Analyze the simulation data files with the same reconstruction program as the real data files.
- Analyze the real data files.
- Fit the real data spectra to simulated data spectra to extract Michel parameters.

# Analysis Process (cont)

- To improve by an order of magnitude on the published values of the Michel parameters, a given data set needs ~ $3 \times 10^9$ events.
- The systematic effects must also be controlled at the same level of precision.
- Several data sets (and corresponding simulations) must be taken to study the systematic effects:

  magnetic field effects, chamber alignments, chamber response, beam tune, polarization, muon stopping distribution, software reconstructions biases, etc.

# TWIST computing resources challenge

- Assuming one CPU = a 3GHz Xeon
- Processing a $10^9$ events data set takes:
  - 70 ms/event simulated → 810 CPU days
  - 30 ms/event analyzed → 347 CPU days
  - Simul + anal of simul + anal of data →1504 CPU days
- TWIST cluster at TRIUMF = 30 CPUs
- Beta user on Glacier: the WestGrid UBC/TRIUMF cluster consisting of 1008 Xeons.

# TWIST Phase 1

- Goal: analyze the data taken in 2002 to obtain a factor of 3 improvement on ρ and η; understand the systematic effects to improve the detector. Only $3 \times 10^8$ events data sets needed. Real data sets total 10 TBytes.
- Production simulation and analysis has been taking place since November on Glacier and fitting of spectra on the TWIST cluster.
- Need fast connections between systems; using a dedicated 1 GBit Ethernet link between TRIUMF and Glacier

# Challenges

- TWIST computing is serial by nature. It does not need shared memory or shared communications between processors. It does constant IO reading and writing: ~ 100 KB/s in and same out. The GLACIER cluster is suited to this kind of application.
- But, while using all available processors for simulations, it was found that the output should be sent to disks on the local nodes to keep the processor > 99% busy. Using the global file system suffered from bottlenecks on the file servers.
- From Nov 2003 to Feb 2004, TWIST has gathered 22 TB of data on Glacier. Most of it is on the Tivoli tape system which has experienced a lot of teething problems
- Transfer of data between the TRIUMF TWIST cluster and Glacier is done using BBFTP to maximize the efficiency of the dedicated 1Gbit link. BBFTP encrypts only usernames and passwords. It is optimized for large files and uses multi-stream transfer. *http://doc.in2p3.fr/bbftp*

# Can TWIST use a true GRID?

- TWIST uses a static linked image for production because it needs to guarantee that all CPUs involved would give the same answer. In a Grid, the CPUs can be completely different and need different images. TWIST needs to validate on all different CPUs
- TWIST has a need for significant IO throughput continuously. If the file system is distributed, what speed is needed on the network links between sites for example to keep 1000 simultaneous TWIST jobs working properly? Do we need to use something like the GASS (Global Access to Secondary Storage) Globus tool?