H. Montgomery, P. Grannis

DØ Experiment/Collaboration

The road to discovery

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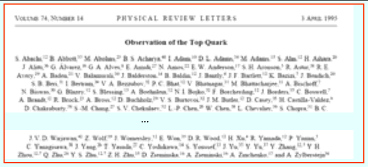
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Observation of the Top Quark

403 authors signed the paper

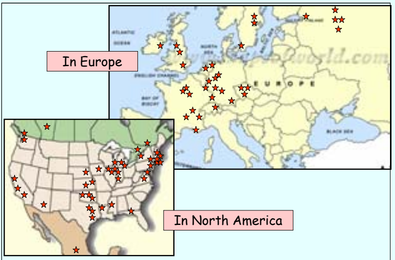
42 institutions

8 countries (Brazil, Colombia, France, India, Korea, Mexico, Russia, US)

2

Now about 720 participants; 86 institutions in 20 countries, spanning the globe

3



4

International contributions

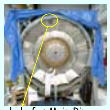
France: Transition Radiation Detector used for electron identification

Russia: End calorimeter module components and Forward Muon System

India: Cosmic ray scintillation shield

Brazil: Components of trigger system

Columbia, Korea, Mexico: Software development



hole for Main Ring

5

Graduate student training

About 230 students have received PhD's on DØ. They made many original contributions to the top discovery. These students are perhaps our most important product.

Shown are some of the students in 1995; they are now professors, lab physicists, and in industry and government.

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Building the experiment

Developing the concept	1983
Approval (for up to L < 3 10^{30} !)	1984
Design and construction	1984 – 1991
Installation	1991 – 1992
Roll-in	♥-day, 1992
First collisions	April 14, 1992
Physics data	> August 1992
Top discovery paper	March 1995

Most members of the collaboration took part in all phases – building the experiment and using it for physics.

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Coming for dessert but eating the main course

By the time of Run I, several groups and many individuals (and a spokesperson) had joined the experiment to work on the upgraded detector.

They were assimilated, and brought into the hunt for the top. Several of the students who came in this wave played important roles in the top quark analysis.

There was enough work that no one who offered was turned away.

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How does the work get done?

The work of the collaboration – building, testing, software development, physics analysis – takes place in groups of a only a few people. Each person works in 2 or 3 of these small groups, within the matrix of higher level groups.

Everyone works on Editorial Boards that intensively scrutinize each physics analysis prior to public presentation.

In this way, high energy physics is similar to small scale science. The added feature is that each person must communicate his/her results effectively in the larger groups.

And the scale of the questions asked can be larger.

The search for the top group stretched many components of the detector and analysis to their limits

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Calorimeter vacuum cleaner

The calorimeter modules have dozens uranium plates. Uranium 'rusts' and the oxides make dust that can short the high voltage signal.

Extensive poking and swabbing was done on clean room shifts.

Finally, each module was connected to a huge vacuum tank; the gate valve was opened and the remaining dust whooshed out of the module, leaving the module squeaky clean.

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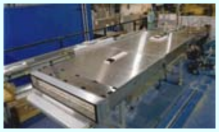
Zapping the muon chambers

The muon chambers are huge so must be cheap to build. The usual G10 material used for cathodes is expensive and cheaper 'glass steel' was used. Alas, the glass steel over time caused deposits of 'gunk' on the wires, decreasing efficiency.



An in situ method of 'zapping', pulsing the wires with high voltage to explode the gunk off the wires like a snake shedding its skin.

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Data to paper

The full DØ data set is huge. Software improvements occur continuously, so in early 1995 when the top quark was emerging, DØ needed to reconstruct the whole top data set with a consistent package.

A small group undertook this rapid reconstruction and finished in about a month. To do this, all the other physics group data streams were interrupted. Data taken in January was in the sample used for top discovery in February.

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Multivariate analyses

The traditional method of selecting interesting events is to make a series of specific cuts – electron p_T, missing E_T, pseudorapidity, angles between jets etc. The analysis presented in the discovery paper was done this way.

An alternative was being developed that treated the relevant variables globally, using neural networks, probability density estimators, random grid searches to allow complex cuts in multi-dimensional space, thus improving signal efficiency.

These methods continued to mature and gained acceptance in DØ. Subsequent searches and analyses have made extensive use of them.

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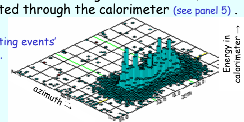
Main ring beam pipe

DØ started 4 years after CDF, and it was a scramble to fund it. One of the cost-reductions was the decision not to make a large bypass of the Main Ring as done at CDF, so the Main Ring was directed through the calorimeter (see panel 5).



A scheme for blanking data collection when the main ring bunches were present was found, causing a 5 - 10% loss of live time. (The top triggers were restrictive enough that the main ring blank was relaxed.)

Run 2 removed the main ring altogether!

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So who discovered the top?

Question: Which DØ members deserve the credit for the top quark discovery?

Answer: all of them, even some who did not sign the paper.

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So hats off to the hundreds of men and women who felt the urge to chase the elusive top quark …

and finally satisfied the itch

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