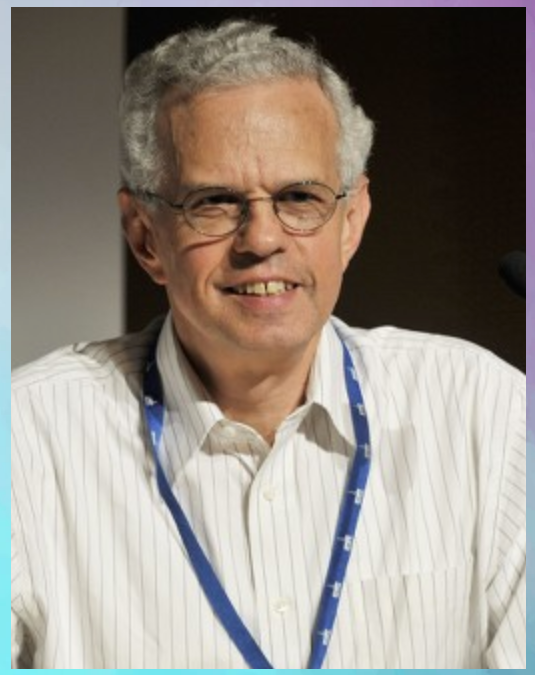
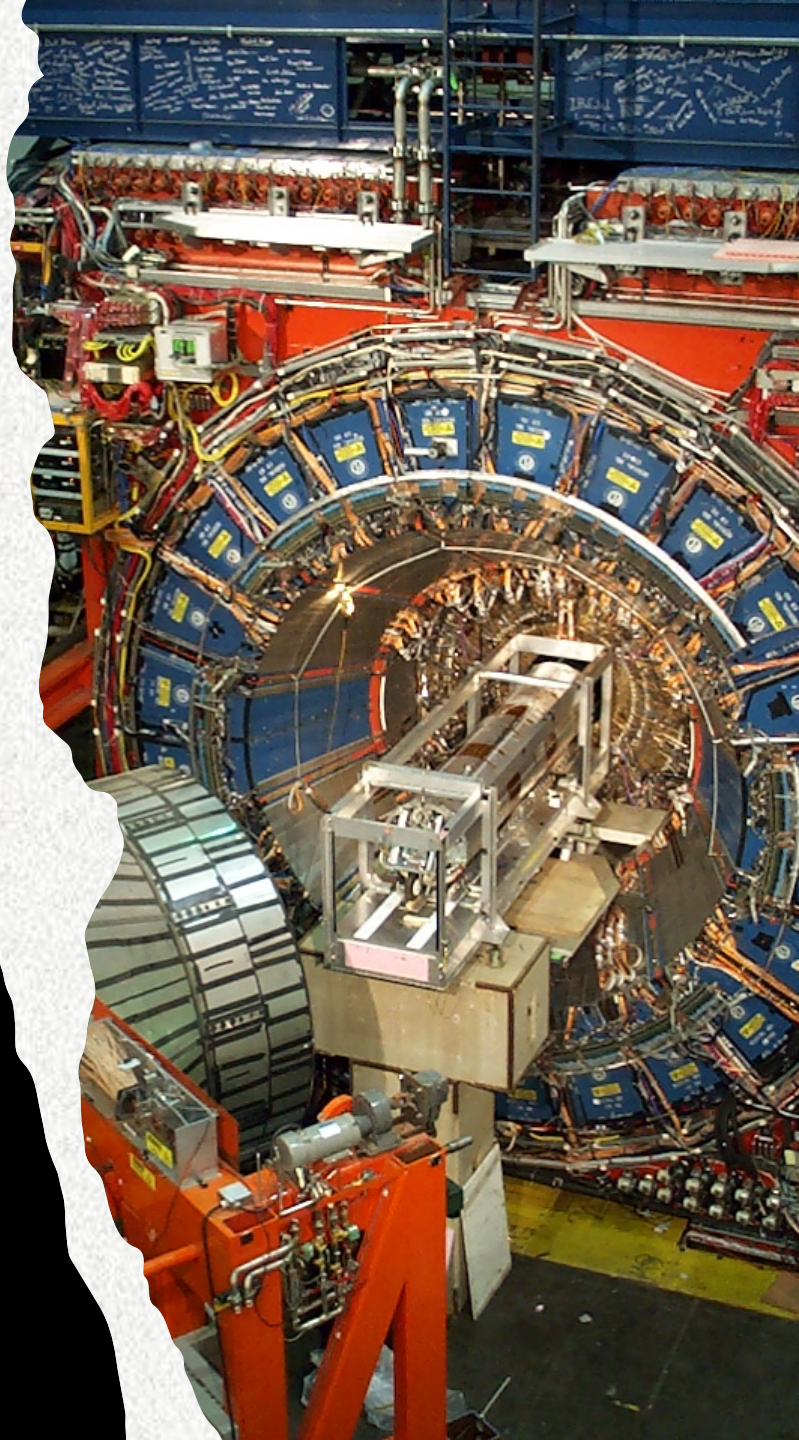


Mel and CDF

MelFest Symposium

May 20, 2023



Why am I giving this talk?

- It is my great pleasure to speak at this symposium about Mel's career. When asked by Young-Kee I was honored but also concerned since I did not overlap with Mel during much of the time the he was playing leadership roles at CDF. In fact, I joined only in late 1993, and was working below the CDF control room testing LeCroy TDC when all the excitement about top was going on with Mel and others "upstairs".
- So my plan for this talk has been to contact CDF colleagues familiar with these days and collect talks and photos from this era. This will form the bulk of what I am about to show. Thanks to those who helped. Some of you here today are more familiar with these early days, so feel free to add and correct what I say!

The plan ..

First review the "big picture" of events leading to the creation of Fermilab and the CDF experiment. This sets the time frame into which Mel entered after graduating with a PhD in 1972

Review Mel's role the planning and construction of CDF

Then his leadership during the operation of CDF, in physics and as Co-spokesperson

A few concluding remarks

How it all started

In the late 1965 there was a call for proposals from the Atomic Energy Commission and the National Academy of Sciences to build a 200 GeV proton accelerator in the US. They received 126 proposals !

The NAS narrowed the list of sites down to seven in March 1966: Sierra Nevada, California; Denver, Colorado; South Barrington, Illinois; Weston, Illinois; Ann Arbor, Michigan; Brookhaven, New York; and Madison, Wisconsin.

The Weston site had some challenges

- Local opposition: Residents feared that the influx of physicists would bring traffic and "disturb the moral fiber of the community."
- Legal problems: the site selection was hampered due to the lack of fair-housing laws in Illinois
- It was a green-field site (compared to Berkeley, BNL, Argonne ..,)

But the Weston site chosen!

- The Weston site had many strengths: including accessibility to users from all areas of the country given its Midwestern location and proximity to O'Hare airport. Also some political connections in Congress!

- The AEC issued a press release announcing the selection of the Weston Illinois site on December 16, 1966.

WEATHER
Cloudy Saturday and warmer, with high in lower 40s. See Page 54.

CHICAGO SUN-TIMES

FINAL TURF EDITION

Vol. 19, No. 274 Phone 321-3000 SATURDAY, DECEMBER 17, 1966 80 Pages, 2 Sections—10 Cent

How Weston Won A-Site

SPECIAL SECTION IN CENTER FOLD

By Tom Littlewood
Sun-Times Bureau

WASHINGTON—The Atomic Energy Commission chose Weston in the Chicago metropolitan area Friday as the location of the world's largest scientific instrument, a circular atom smasher three miles around.

The Illinois entry in DuPage County won a national competition for the site of the AEC's new high-energy physics laboratory.

At the heart of the laboratory is planned a 200-billion electron volt accelerator that will take eight years to build at a cost of possibly $375,000,000. The instrument will be designed to hurl tiny particles of matter at high speeds so that physicists can study the fundamental structure of the atom, the building blocks of the universe.

When completed, the laboratory will employ 2,300 scientists, technicians and others. It will cost an estimated $60,000,000 a year to run and is expected to stimulate the economy of the entire west suburban region.

All but four of the 50 states submitted more than 200 proposed sites. The AEC reduced the field drastically in September, 1965, and asked the National Academy of Sciences for further advice. Last March the academy screened out all but six finalists.

Glenn T. Seaborg, the AEC

Turn to Page 5

Other stories and pictures on Pages 3, 4, 6 and 7.

Weston, selected as nation's atom-smasher capital, is easily accessible to O'Hare Airport, tollways, Argonne National Laboratory and major universities. (Sun-Times Map)

Holding a press conference in Weston, picked as site for the world's largest atom smasher, are (l. to r.) Matthew Molitor and Eugene Jones, village trustees; Arthur Therfault, village president, and State Rep. Lewis V. Morgan, chairman of Illinois Commission on Atomic Energy. (Sun-Times Photo)

THE WESTON FACTS

Here, at a glance, are the salient facts concerning Weston's 200-billion electron volt proton accelerator:

WHERE—Western Du Page County, near developing Du Page and Kane County communities.

COST—Up to $375,000,000, probably in more than one stage.

COMPLETION TIME—About a decade, with up to two years of planning and preliminary work and eight years of construction.

JOBS—The construction phase is expected to employ some 1,200 persons year around. The accelerator, when completed, is to have a staff of more than 2,000, with an affiliated visiting staff of up to 1,000. An unknown number of jobs would be created through spin-off industry that results from the presence of research installations.

IMPACT ON ECONOMY—Unlimited, but the accelerator is to have an annual operating budget of $60,000,000 and one official says 3,000 new workers means $17,000,000 more in bank deposits annually, $9,000,000 more in retail sales and 90 more retail establishments.

IMPACT ON COMMUNITIES—The same official estimates that 3,000 new workers means 9,000 more people, and 2,700 more schoolchildren.

Victory On The Lakefront

See Editorial On Page 25; McCormick Place Story On Page 2

The National Accelerator Lab

- The driving force behind the construction of the new laboratory in Weston Illinois was Robert Wilson, who was appointed the Director in February 1967.
- The lab was called the National Accelerator Lab (renamed as Fermlab in 1974).
- Remarkably the NAL's Main Ring accelerator quickly achieved its design energy of 200 GeV in March 1972. And then rapidly surpassed this going to 500 GeV by May 1976

Bob Wilson: "The main application of the work here is spiritual, if you will. It's because, in a philosophical sense, in the tradition of Democritus, we feel we have to understand in simplest terms, what matter is, in order to understand who we are."

Moving on to super-conducting magnets and the Tevatron

Installation of final magnet in Energy-saver-doubler in March 1983

- 1972-1983 Tevatron design and construction
- 1983: first beams at 512 GeV proton beams
- 1984: then 800 GeV proton beams
- 1981-1985 Anti-proton source design and construction
- Oct.16 1985 pbar – p first collisions at 1.6 TeV

Accelerator Control room when first 512 GeV proton beam July 1983

Mel's entry into HEP using his own words from an interview in 1995

Mel : " I became involved in high-energy physics entirely by accident. I was an undergraduate at Penn (graduated 1966) and I was looking around for a summer job and lo and behold, in one of the high-energy groups they needed someone for a summer job and that's how I started. Worked on some electronics for an experiment at Brookhaven, spent a summer at Brookhaven working from eight in the morning until two in the morning seven days a week and fell in love with it. Shows how nuts I am that I did and that was it. "

"I stayed in high-energy physics [and graduated with PhD from Princeton 1972]"

Planning for colliding beam experiments 1976-1977

- Mel: "… when Bob Wilson first decided to have an initiative looking at the possibility of having colliding beams at Fermi Lab, he set up a Colliding Beam Department with Jim Cronin as the head and that was in December of 1976, and the initial group was about, must have been about, 10 or 15 people meeting informally discussing both accelerator and detector issues and I was a member of that initial group."

Fermilab

Fermi National Accelerator Laboratory
P.O. Box 500 • Batavia, Illinois • 60510

Directors Office

December 13, 1976

Dear Colleagues:

On November 17 a meeting was held to discuss various possibilities for the organization of work on colliding beam experiments. After considering the ideas set forth in that meeting, I am proceeding to set up a Colliding Beam Experiments Department within the Research Division.

Robert Wilson

Colliding Beams Meeting

May 6, 1977

Present: J. Cronin, J. Walker, H. Frisch, A. Tollestrup, R. Loveless, I. Gaines, R. Diebold, D. Cline, C. Rubbia, C. Ankenbrandt, D. Johnson, A. Ruggiero, M. Shochet

Planning for colliding-beam detectors in 1977

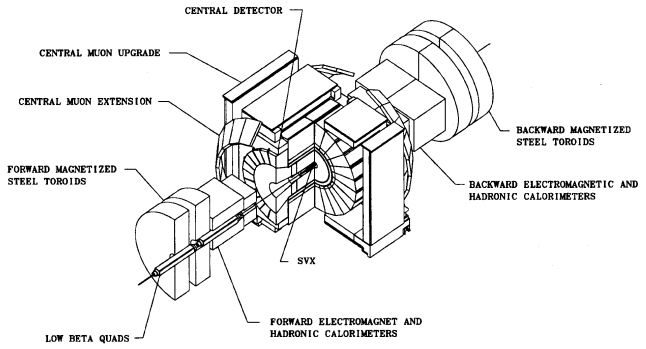
Mel: "It began in a summer study that we had in Aspen in the summer of 1977, and there we broke up into groups that were to focus on designing either a non-magnetic detector or a magnetic detector, which we did. In the end, after a number of months of arguing the pros and con, it was generally agreed upon that the magnetic detector would be most powerful and that what we were really looking at was a solonoid design. After that then the technical details which were, took a long time to settle on what was the best way to design each individual piece and that was a lot of hard work. But at least our direction was pretty clear once we set the general framework. "

Aspen 1977 workshop

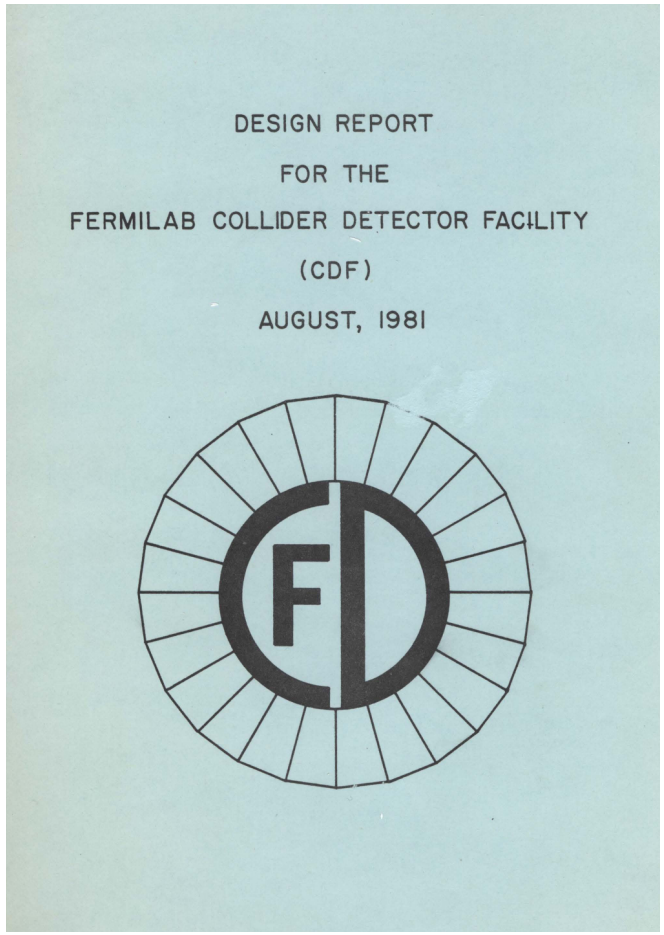
Detector Group planning: Atac, Breidenbach, Brenner, Frisch, Hitlin, Johnson, Lach, Olsen, Pilcher, Pless, Sadulet, Sens, Shochet, Slaughter, Walker, Weitsch

Formation of the CDF collaboration

- At Fermilab in 1977 the Director Bob Wilson created the Colliding Detector Facilities Department with Alvin Tollestrup as Chair.
- This resulted in the formation of the CDF Collaboration in 1980 with Co-spokespersons Alvin and Roy Schwitters.
- The CDF Conceptual Design Report was completed in 1981



CDF was born as a USA-Japan-Italy Collaboration of 13 institutions and 87 physicists



For the Fermilab Collider Detector Facility (CDF)

Argonne National Laboratory - D. Ayres, R. Diebold, E. May, B. Musgrave, L. Nodulman, J. Sauer, R. Wagner, A.B. Wicklund

University of Chicago - H. Frisch, C. Grosso-Pilcher, M. Shochet

Fermi National Accelerator Laboratory - M. Atac, F. Bedeschi, A. Brenner, T. Collins, T. Droege, J. Elias, J. Freeman, I. Gaines, J. Grimson, D. Gross, D. Hanssen, H. Jensen, R. Kadel, H. Kautzky, R. Kephart, M. Ono, R. Thatcher, D. Theriot, A. Tollestrup, R. Yamada, J. Yoh

Laboratori Nazionali dell' INFN - Frascati - S. Bertolucci, M. Cordelli, P. Giromini, P. Sermoneta

Harvard University - G. Brandenburg, R. Schwitters

University of Illinois - G. Ascoli, B. Eisenstein, L. Holloway, U. Kruse

KEK - S. Inaba, M. Mishina, K. Ogawa, F. Takasaki, Y. Watase

Lawrence Berkeley Laboratory - W. Carithers, W. Chinowsky, R. Kelly, K. Shinsky

University of Pisa - G. Bellettini, R. Bertani, L. Bosisio, C. Bradaschia, R. DelFabbro, E. Focardi, M.A. Giorgi, A. Menzione, L. Ristori, A. Scribano, G. Tonelli

Purdue University - V. Barnes, R.S. Christian, C. Davis, A.F. Garfinkel, A. Laasanen

Texas A & M - P. McIntyre, T. Meyer, R. Webb

Tsukuba University - Y. Asano, S. Kim, K. Kondo, S. Miyashita, H. Miyata, S. Mori, I. Nakano, Y. Takaiwa, K. Takikawa, Y. Yasu

University of Wisconsin - D. Cline, R. Loveless, R. Morse, L. Pondrom, D. Reeder, J. Rhoades, M. Sheaff

Construction of CDF detector starts in B0 collision hall in July 1982

Fermilab

MINUTES OF THE COLLIDER DETECTOR MEE

May 25, 1984

1. CDF has run out of money.

MINUTES OF THE COLLIDER DETECTOR MEETING

November 9, 1984

1. There will be a workshop to discuss upgrades to the CDF detector in early January.

MINUTES OF THE COLLIDER DETECTOR MEETING

December 7, 1984

1. While in B0 people should watch out for falling objects. More formal safety procedures are under consideration.

- Lab dedicated completion of CDF1 detector in October 1985

Mel's choice of involvement with the CDF detector

Mel: "Well it's something that Henry and I discuss early on. What we wanted to do was find a piece of the detector which we found intellectually challenging and appropriate to a university. And we decided that one of the most intellectually challenging issues was the one of triggering. "

"We latched on to it so early that there wasn't even a debate about who was going to do the trigger because nobody even had time to think about it, we said we were going to do it. And that's what we worked on. First the general structure of how it was going to work and then the detailed designs of all of the individual components of the system."

The Silicon Vertex Trigger (SVT) hardware

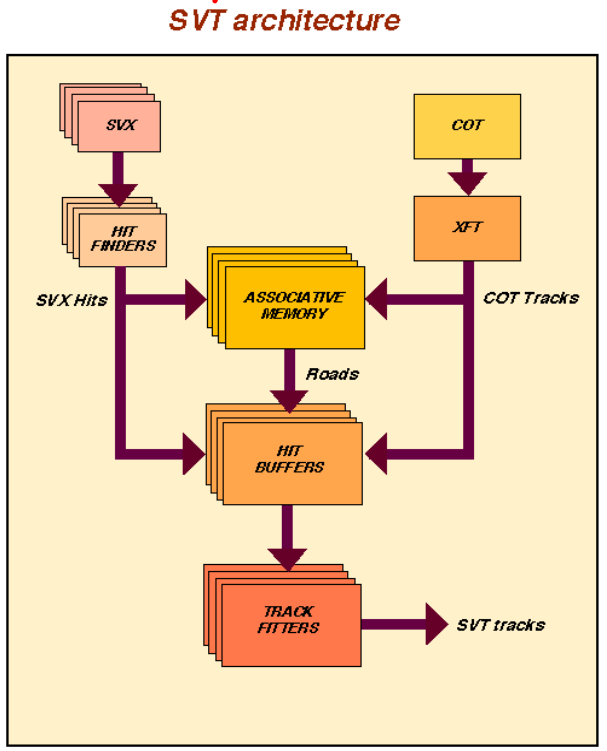
- **A new concept in an event trigger**
- **Triggering on displaced vertices** at Level 2:
  a Chicago-Pisa-Trieste project
- Leaders
  Mel Shochet and Luciano Ristori
- **First on-line B physics trigger at a hadron collider**
- **Installed in March 2001 for CDF Run 2**

Mel's involvement with the SVT

Luciano: "The joining of the University of Chicago to the SVT project was very important to convince the INFN to fund it. … Of course Mel's personal judgement on the solidity and value of the SVT concept was crucial in the process as was Henry's. If Mel had not believed in the feasibility of SVT and in its potential for physics, SVT would probably have never existed."

"Mel followed closely all the development and construction of SVT in all the details, engaging his students and giving fundamental contributions in some specific crucial components (like the "Hit Finder" and the "Track Fitter"). "

SVT: System architecture



Hit finder: computes and outputs the centroid of each SVX cluster

Associative memory: pattern recognition

Hit buffer: retrieves the original full resolution silicon hit coordinates and XFT track associated with each road

Track fitter: fits XFT track and SVX hits

Mel and physics at CDF

- Mel was early on interested in heavy flavor physics at CDF, serving as Co-convener of this working group when it was first organized.

Mel " Brig Williams and I were the conveners of that group when it first was organized. In the early days of the detector we were organized around what we call the algorithm groups, which focused on how you were going to reconstruct the primary objects that all physics analyses were going to use."

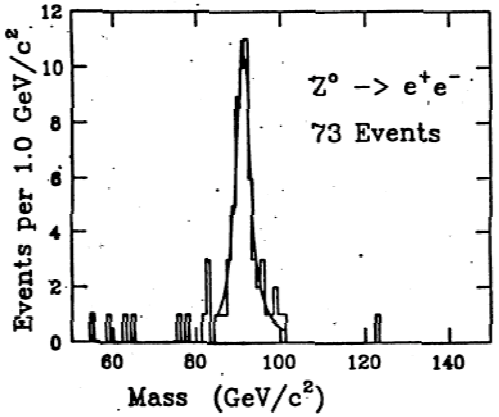
- ..and then searching for the top quark ...

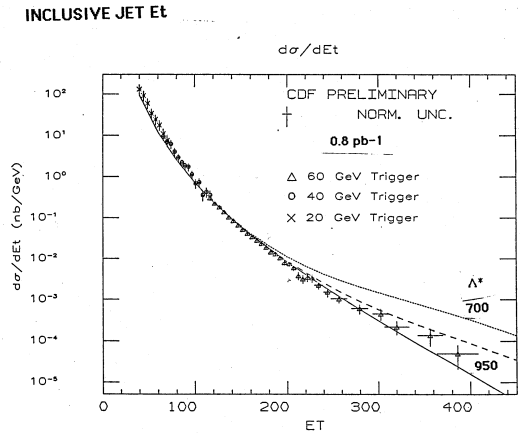
Mel: What happened was, that the primary focus of the heavy flavor group was top although there were presentations on B production. But after a while it became clear that in fact CDF was going to be doing more and more B physics.

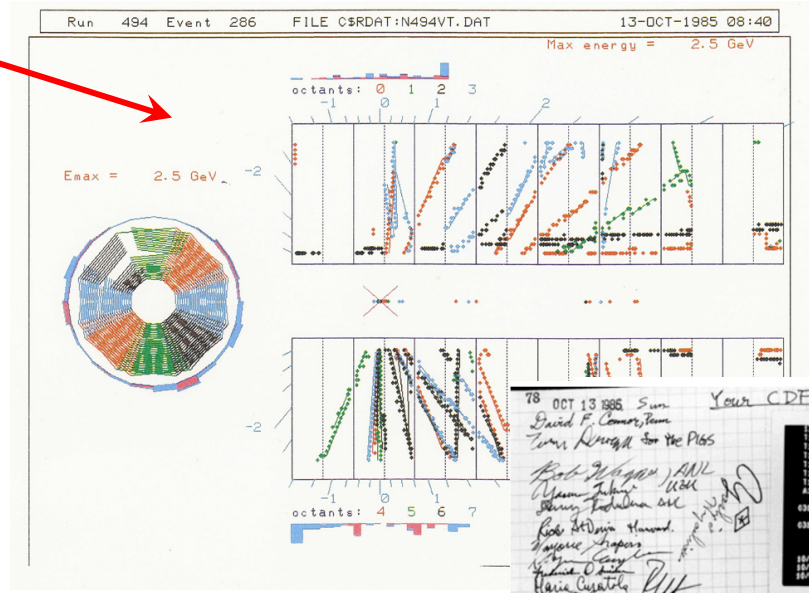
First data taking with the CDF detector

- Oct 13 , 1985 first pbar-p collisions observed
- 1988-1989: ~ 4 pb^{-1} on tape at √s = 1.8 TeV.

First look at jets, Z mass …







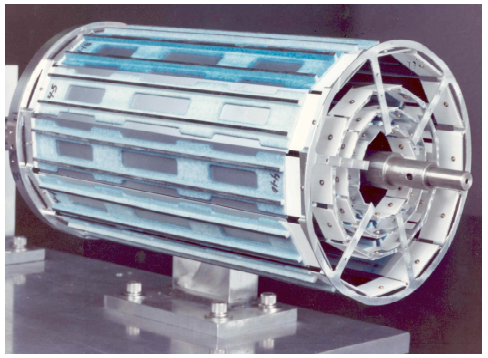
Best Z mass for 3 weeks before MARK II turned on

Mel elected CDF Co-spokesperson in 1989 with Alvin

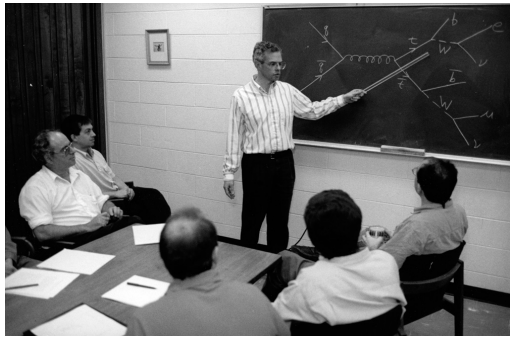
Run 1 of CDF and search for the top quark

- Data taking for Run 1 of CDF started with Run 1A (1992) and continued with Run 1 B (1994 - 96). Total of 110 pb^{-1}

During this run a silicon vertex tracker was installed in CDF (SVX, SVX')



- Mel served as CDF Co-spokesperson over this time, first with Alvin (1989-1992) and then with Bill Carithers (1992-1995)



Conversation between Bill and Mel : “the top mass limits are not getting better …”

Bill Carithers: “We were very fixated on developing better top mass limits. Mel had gone to recent conference to announce our mass limit of 60 Gev, the world’s best. Afterward, we began to notice that our mass limits were not improving with additional data. There were all these pesky “background” events that looked a lot like top. I remember one day when we were sitting in our offices on the third floor of the Assembly building when we looked at each other and wondered whether we were really starting to see a signal. Mel said something like “I wonder what the significance is now”. It turned out that I had recently bought a copy of the Mathematica software that made it easy to do Gaussian integrals. The significance was about 2.8 sigma if I remember correctly. Mel thought that we should appoint a committee to advise us on next steps for analysis and eventual publication. We did this (Alvin was the chair) and the rest was history. “

Run 1 of CDF and the discovery of the top quark

- Giorgio Chiarelli: What I remember much better is the role Mel had in the top working group. He was a driving force and was able to keep most (if not everybody) people on board. There was a competition inside CDF (different groups), and tensions were high. In 1994 the difficulty was to have the Collaboration united behind the evidence …

- After 68 pb^{-1} of data, observation of the top quark was published in April 1995
- See next talk by Tony Liss for all the details!

Sending the top observation paper to PRL April 1995

… and telling the world about it

Concluding remarks

- I hope in this short talk I was able to show the broad contributions Mel has made to the CDF experiment:
  - participation in early design of the detector
  - innovations in triggering through the SVT
  - Physics analysis and convenorships
  - Collaboration leadership as Co-spokesperson

- Much more to come in this Symposium

  Next: Top and EWK physics at CDF

- And now I invite your remarks ☺.

Acknowledgments

Communications with Bill Carithers, Giorgio Charelli, Luciano Ristori and Franco Bedeschi

Talks given by Giorgio Bellettini, Mark Lancaster, Donatella Lucchesi and Larry Nodulman

Photos provided by the Valerie Higgins (Fermilab archivist) and Mary Heintz (U. of Chicago)