FERMILAB-SLIDES-08-009-PPD

Current and Near-Term Physics Research Program

Jeffrey A. Appel

Physics Advisory Committee
June 17 - 21, 2008
Naperville, Illinois

Outline

- Focus will be on Fermilab accelerator-based exp'ts

  Collider: CDF and DZero
  Neutrinos: SciBooNE, MiniBooNE,
  MINOS, MINERνA, NOνA
  Others: E906/Drell-Yan, MIPP,
  FOCUS, KTeV, HyperCP, NuTeV, SELEX,
  Meson Lab Test Beam

- See talk by Andrew Sonneschein on particle astrophysics experiments
- Talks by Daniela Bortoletto and Jeff Berryhill on CMS

First, the Year's PhD's

3	Accelerator Physics
25	Auger Observatory
48	CDF
1	CDMS
30	DZero
4	KTeV
1	LPC/CMS
4	MiniBooNE
8	MINOS
1	MIPP
1	SciBooNE
13	SDSS
1	Theoretical Astrophysics

Total of 150 fresh PhD's !

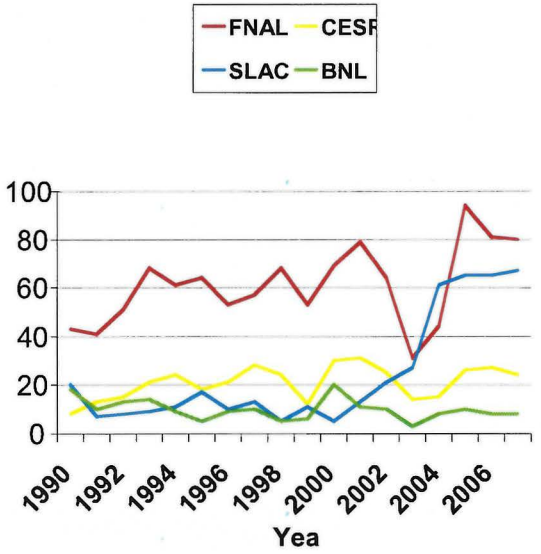
from the list at the 41st Annual Users' Meeting, June 4-5, 2008

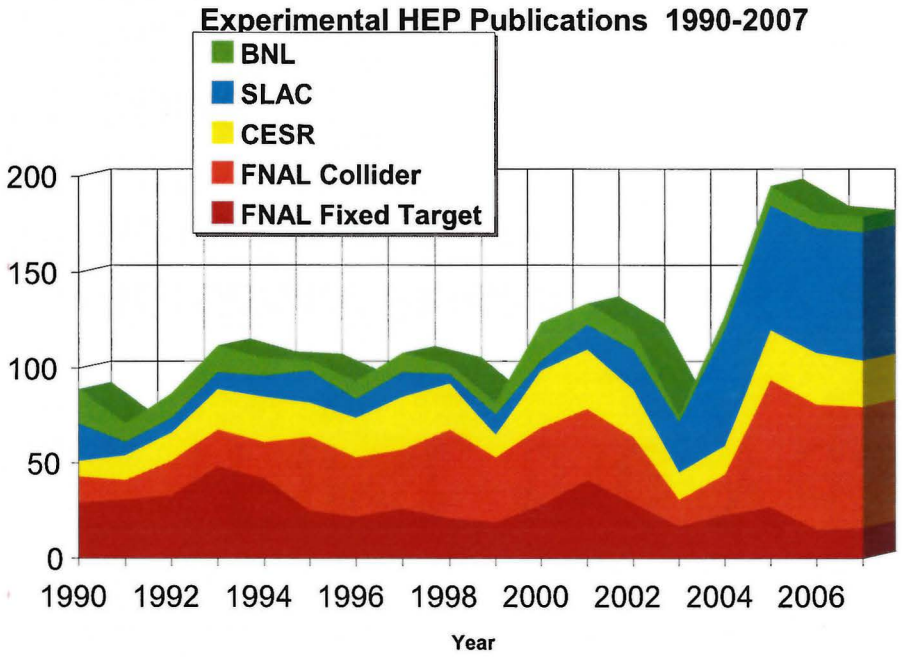
Cal. Year Accelerator-Based HEP Publications

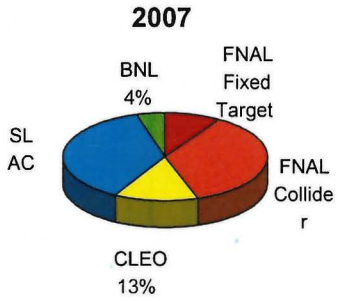
Experimental HEP Publications 1990-2007

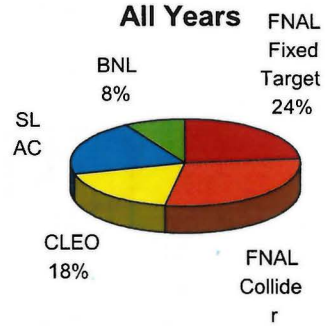
FNAL	Fixed Target	Collider	CESR	SLAC	Fixed Target	e+e-	BNL	HEP	Heavy Ions	Total
43	29	14	8	20	0	20	18	13	5	89
41	31	10	13	7	1	6	10	9	1	71
51	33	18	15	8	2	6	13	6	7	87
68	48	20	21	9	4	5	14	8	6	112
61	42	19	24	11	7	4	9	4	5	105
64	25	39	18	17	7	10	5	1	4	104
53	22	31	21	10	5	5	9	7	2	93
57	26	31	28	13	5	8	10	7	3	108
68	21	47	24	5	3	2	5	4	1	102
53	19	34	12	11	4	7	6	4	2	82
69	28	41	30	5	1	4	20	14	6	124
79	41	38	31	13	0	13	11	7	4	134
64	29	35	25	21	0	21	10	9	1	120
31	17	14	14	27	1	26	3	2	1	75
44	23	21	15	61	1	60	8	5	3	128
94	27	67	26	65	1	64	10	5	5	195
81	15	66	27	65	1	64	8	3	5	181
80	16	64	24	67	1	66	8	1	7	179
1101	492	609	376	435	44	391	177	109	68	2089
61.2	**27.3**	**33.8**	20.9	24.2	**2.4**	**21.7**	9.8	**6.1**	**3.8**	**116.1**
16.3	**9.2**	**18.0**	6.8	22.9	**2.3**	**23.9**	4.3	**3.7**	**2.1**	**36.4**

Phys. Lett. B, Phys. Rev Lett., Phys. Rev. D, Euro Phys J Jan 7, 2008









Tevatron Collider Program

CDF

and

DZero

The CDF Collaboration

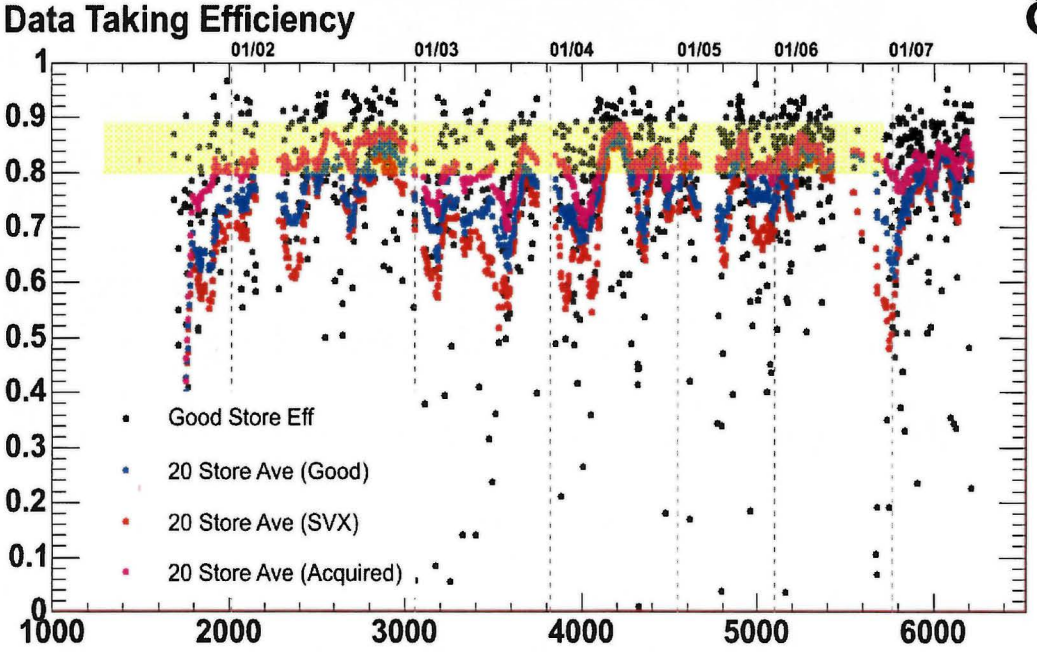
CDF Operations and Performance

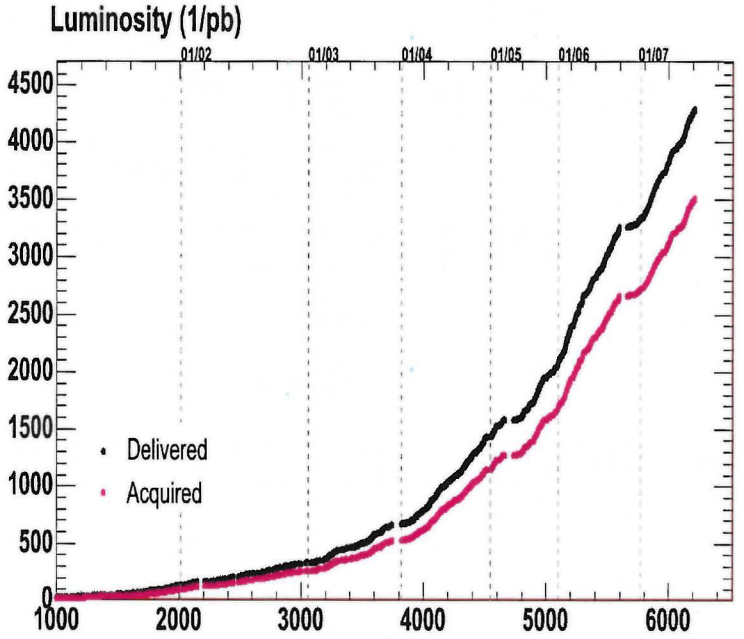
Total luminosity:

~4.2 fb^{-1} delivered, ~3.5 fb^{-1} to tape

3.3 fb^{-1} to tape with silicon operational

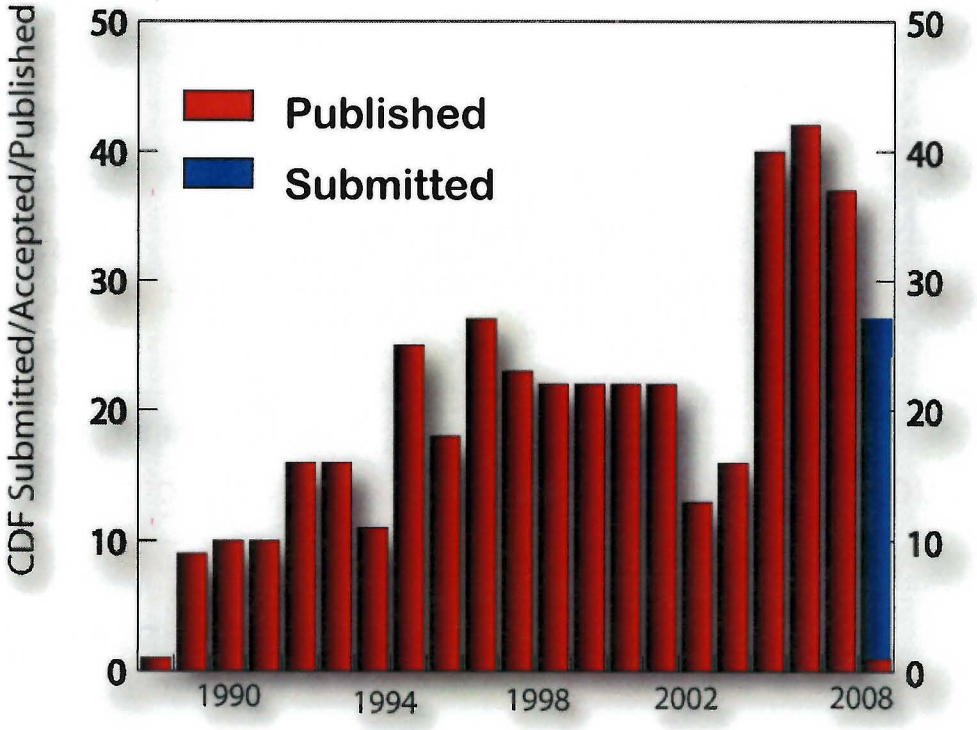
- Stable collection of data: taking efficiency 85% (2003-present)





Accelerator continues to set records!

CDF Publications & Ph.D's



- CDF: 415 publications total
  - 145 in Run 2
  - 38 last year
- CDF has 28 submitted so far in 2008
  - another 50+ in internal review
- Conference Results
  - 53 new results presented at winter ski conf.
  - 73 abstracts submitted to ICHEP08
- # of Ph.D's completed
  - 27 in 2006
  - 40 in 2007

Physics Highlights from 1-2 fb^{-1}

Most are world's best results.

Observation of B_s-mixing
- Δm_s = 17.77 ± 0.10 (stat) ± 0.07(sys)

Observation of new baryon states
- **Σ_b and Ξ_b**

WZ discovery (6-sigma)
- Measured cross section 5.0 ± 1.7 pb

ZZ observation
- 4.4-sigma

Single top evidence (3-sigma) with 1.5 fb^{-1}
- cross section = 2.9 pb
- $|V_{tb}|$= 1.02 ± 0.18 (exp.) ± 0.07 (th.)

Measurement of Sin(2β_s)

Wine & Cheese seminars on all these topics and more

Precision W mass measurement
- Mw_cdf = 80.413 ± 0.048 GeV

Precision Top mass measurement
- Mtop_cdf = 172.7 ± 2.1 GeV

W-width measurement
- 2.032 ± 0.071 GeV

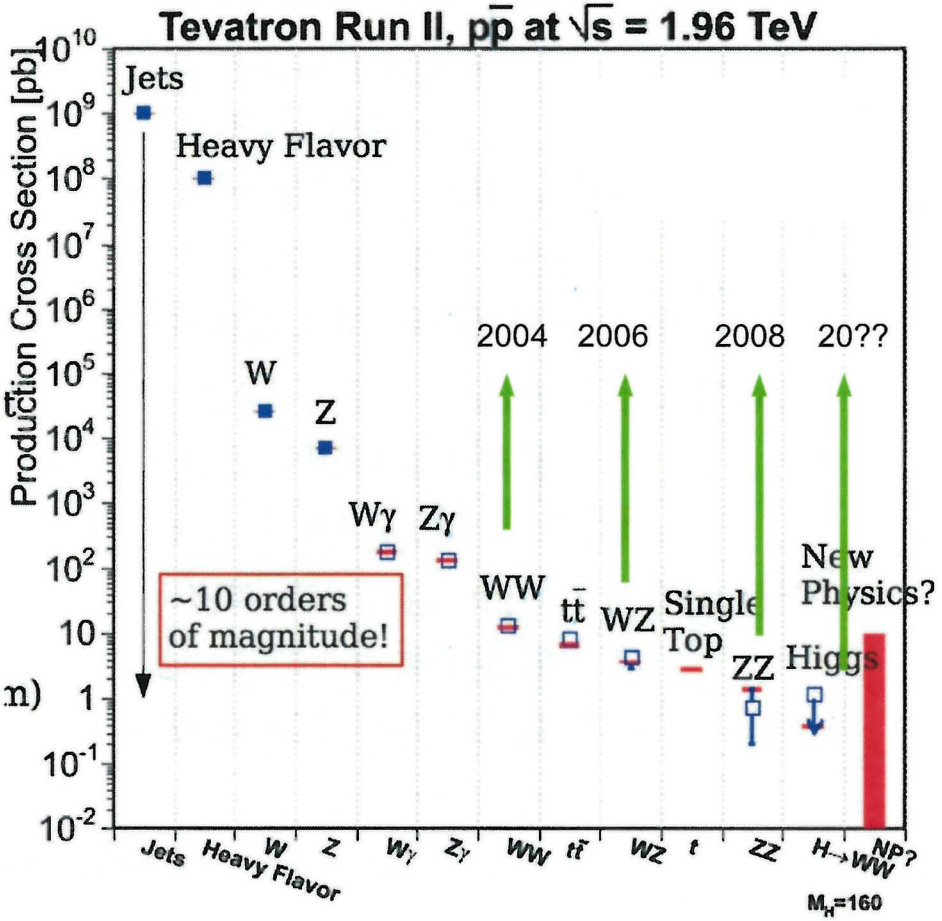
Observation of new charmless B->hh states

Observation of D^o-D^obar mixing

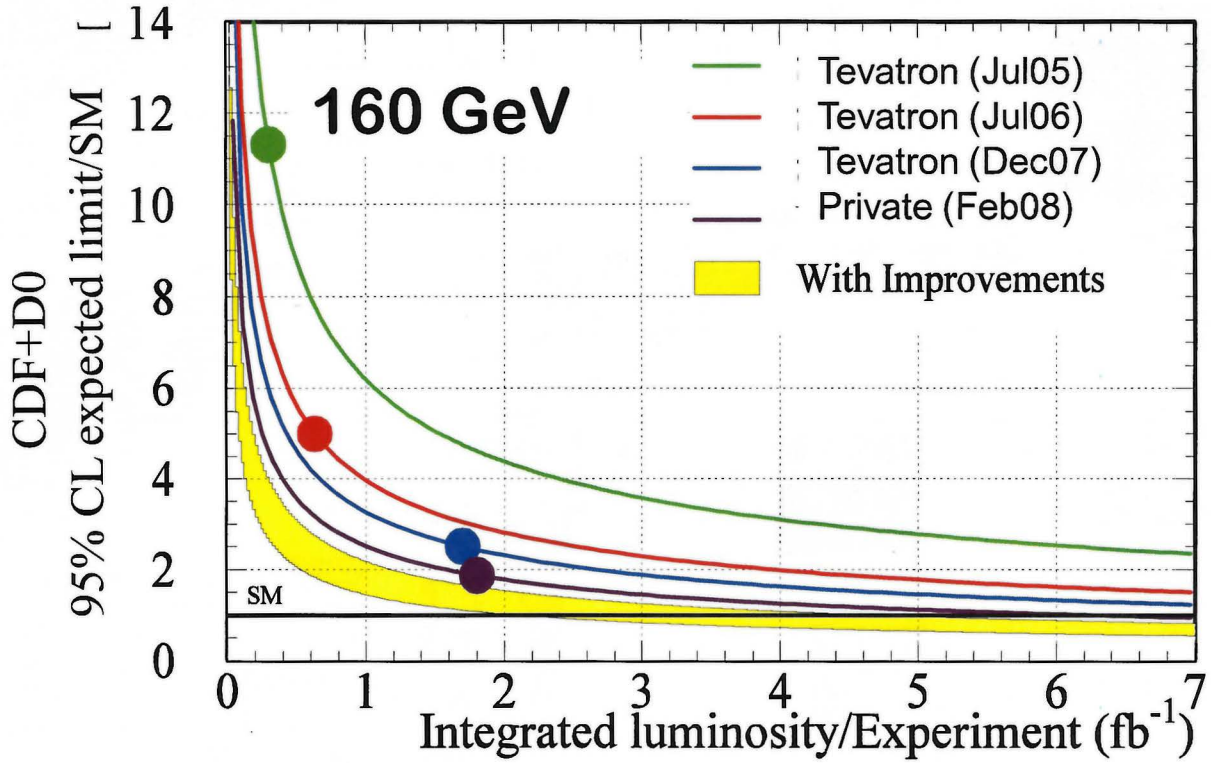
Constant improvement in Higgs Sensitivity

Program Evolution

- Luminosity & Time
  - Physics benefits from both:
    - more events
    - new channels
    - new techniques
    - better background control
    - more properties studied
    - more discovery possibilities

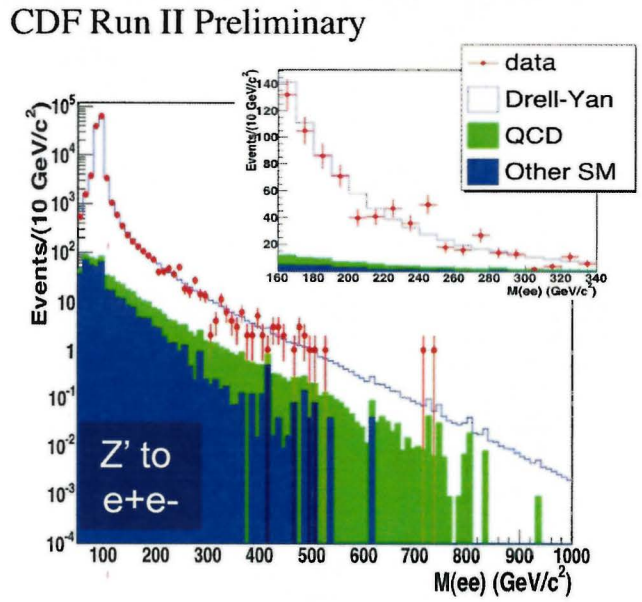


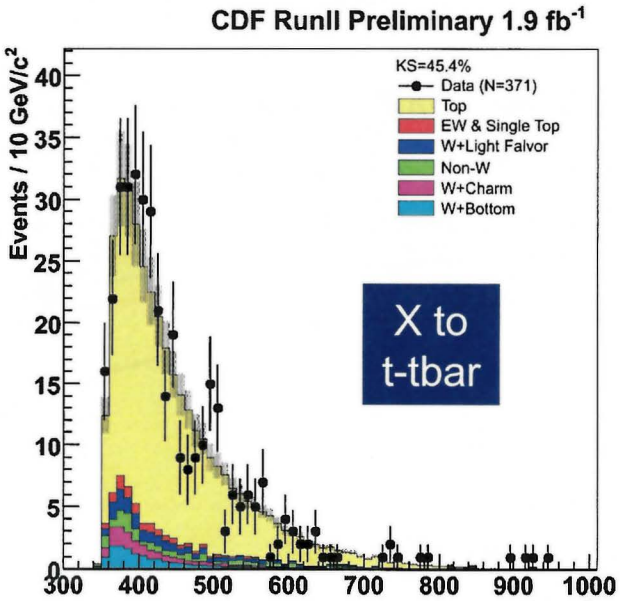
CDF Physics: SM Higgs



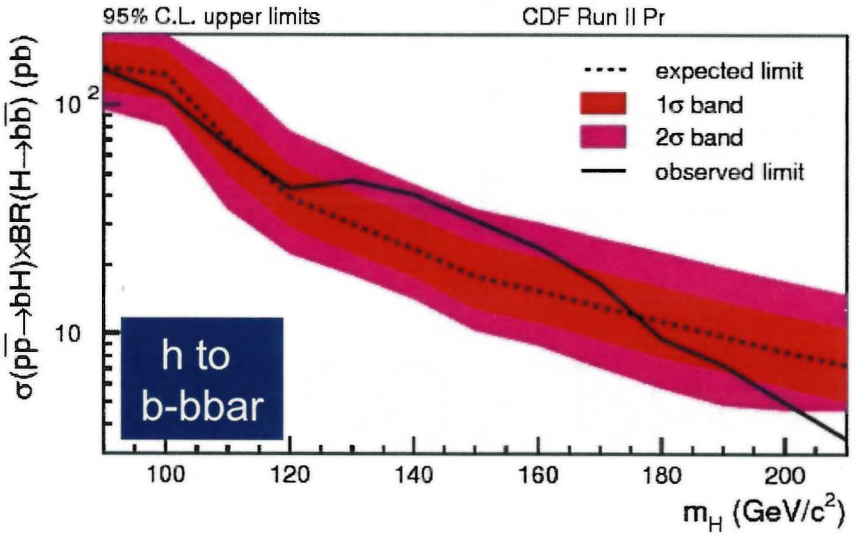
- CDF sensitivity is improving faster than 1/sqrt(L)
  - Lots of ideas… and implementing them!
  - Also pursuing many factors of 5-10 %

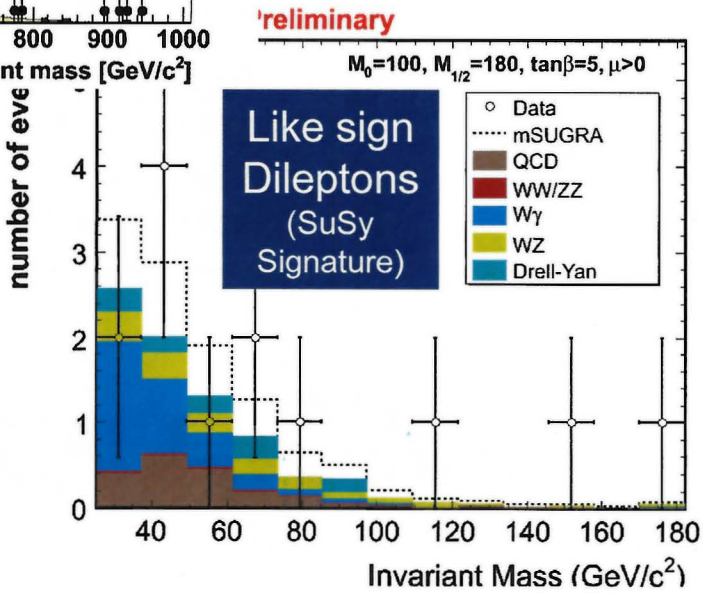
CDF Physics: Other Exotica





All these show 2-3σ excess !





The DZero Collaboration

DØ today is international Collaboration of 561 physicists from 18 nations

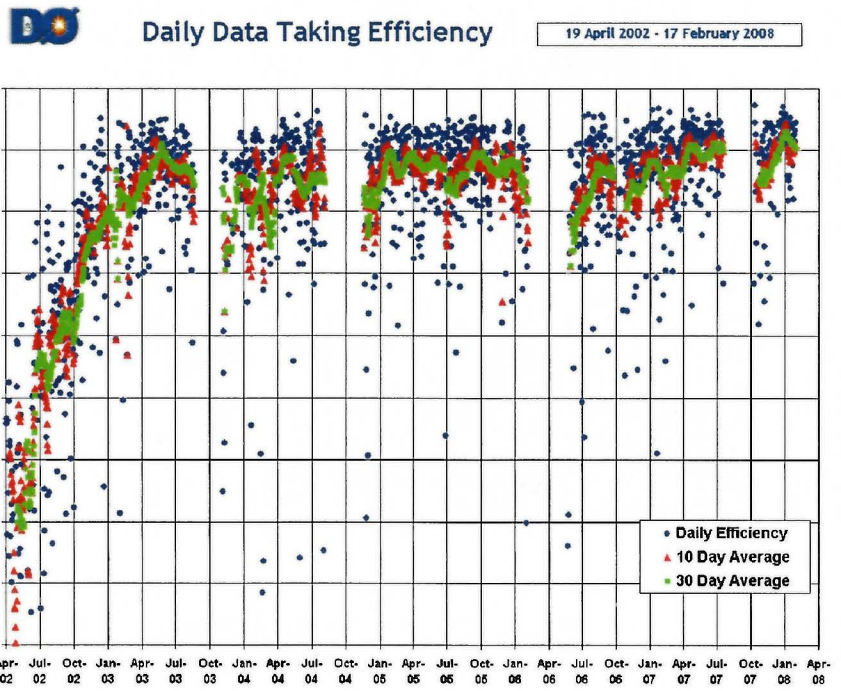
September 2007

Institutions: 82 total, 38 US, 44 non-US

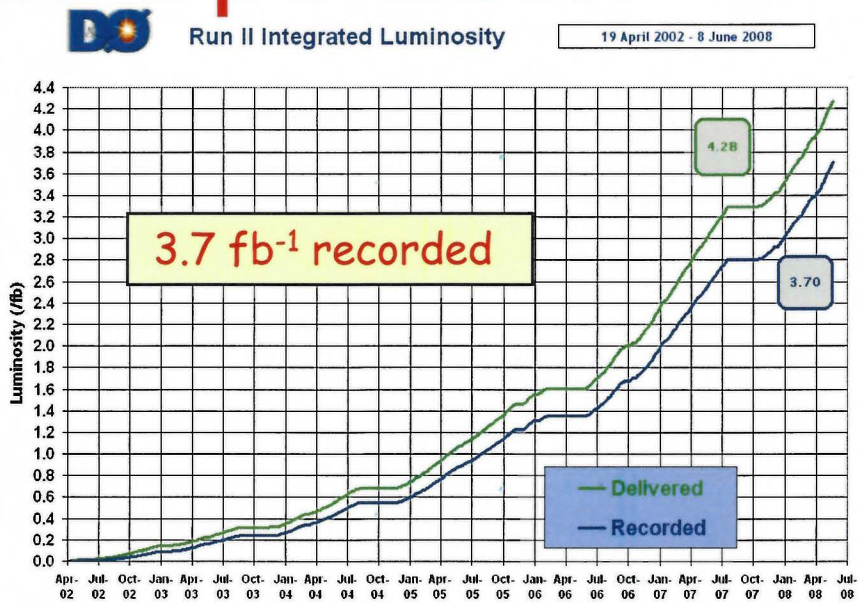
Collaborators:
~ 50% from non-US institutions
~ 100 postdocs, ~140 graduate students

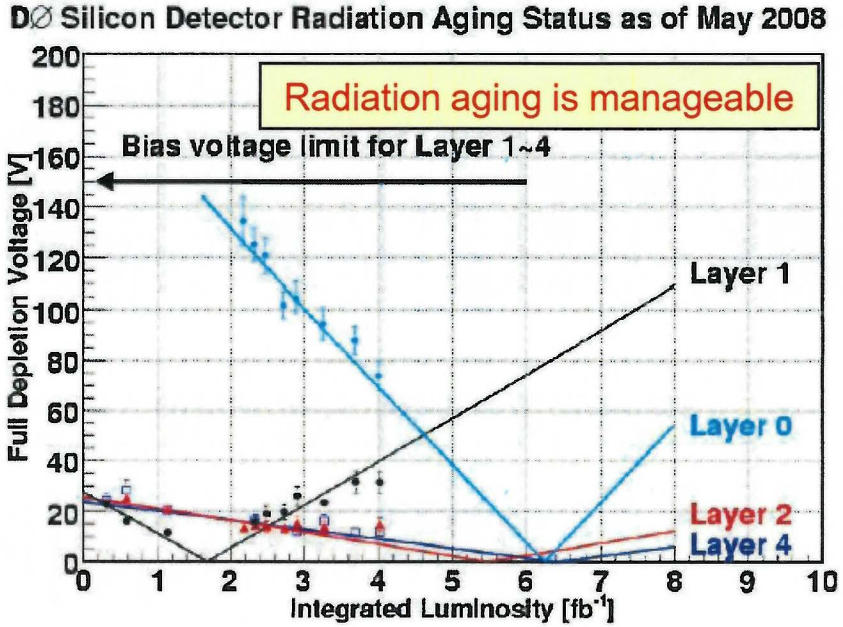
DZero Detector Operation

- Excellent data taking over past year
  - 90+%-to-tape efficiency over past 3 months
  - Even during high luminosity running!



Indication of the experiment maturity and well above competitor's numbers





DZero Collaboration Physicist FTE Analysis

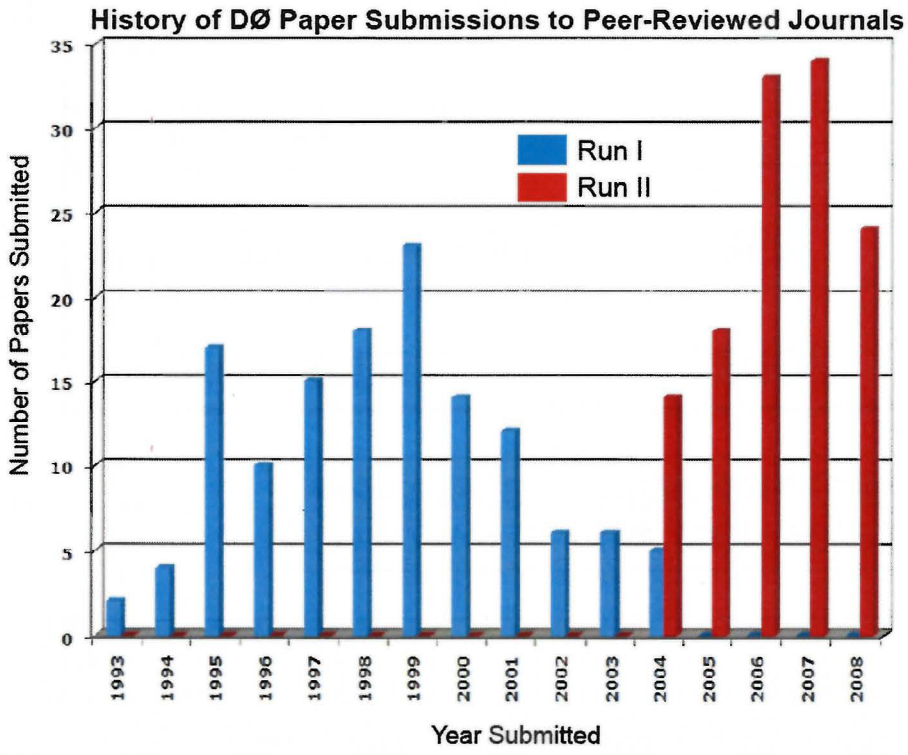
Estimates of available full-time-equivalent physicists (FTE's) are obtained from an analysis of the Memoranda of Understanding (MoU's) submitted by each institution on DØ

The corresponding 2007-2009 MOU data (collected in 2006-2007) and 2009-2011 MOU data (collected in 2008) are provided below

Physicist FTE's	2007	2008	2009	2010	2011
2007-2009 MoU data	357	272	184		
2009-2011 MoU data			240	185	119

- 30% increase in 2009 FTE with respect to previous set of MoU's demonstrates the strengthened commitment of the Collaboration to continuing Tevatron program
- Estimate for 2010 manpower needs (excluding analysis) are ~100 FTE's
  - Expect sufficient but lean manpower for 2010 run including data taking, processing and physics analysis

DZero Physics Highlights



publications with up to 2.8 fb^{-1} of data

124 DØ Run II publications (PRL/PLB/PRD)

44 publications submitted since 6/2007

>150 conference presentations since 6/2007

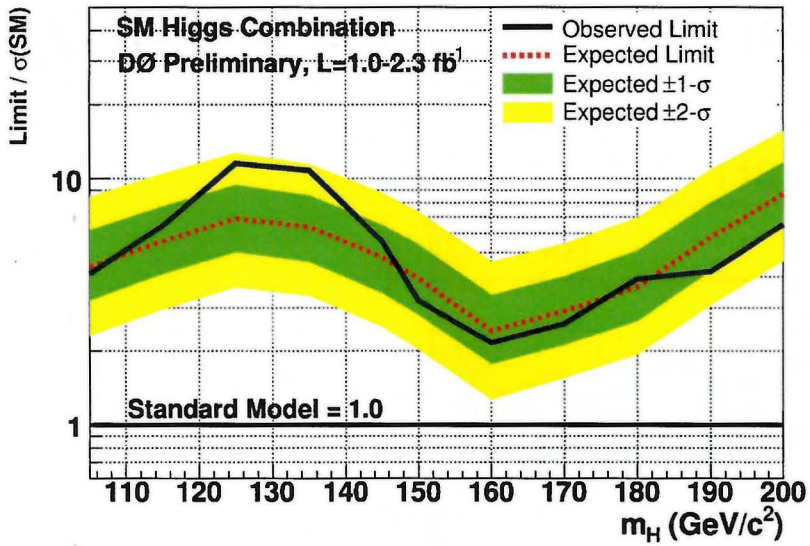
~ 35 PhDs per year

covering

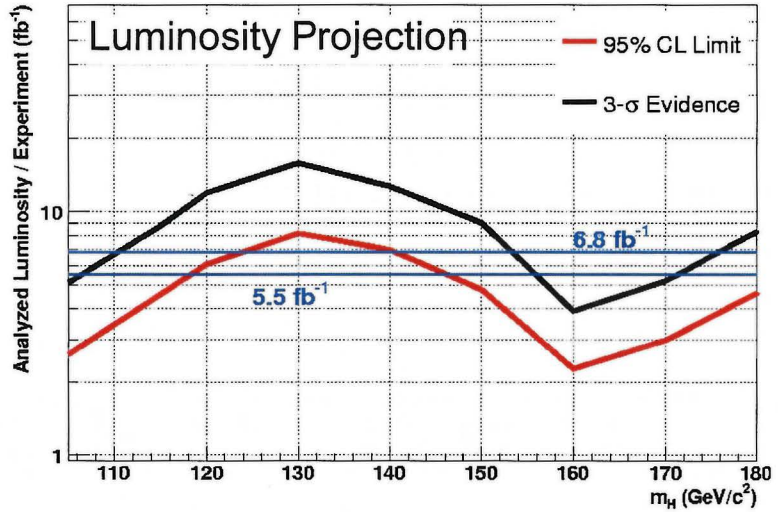
- QCD and jets
- B physics
- Top quarks
- Electroweak physics
- Searches for new phenomena
- Searches for Higgs bosons

Search for SM Higgs Bosons

arXiv:/0712.0598 [hep-ex] + update



2010
2009



Combination of large number of channels:

- low mass: WH, ZH
- high mass: H → WW

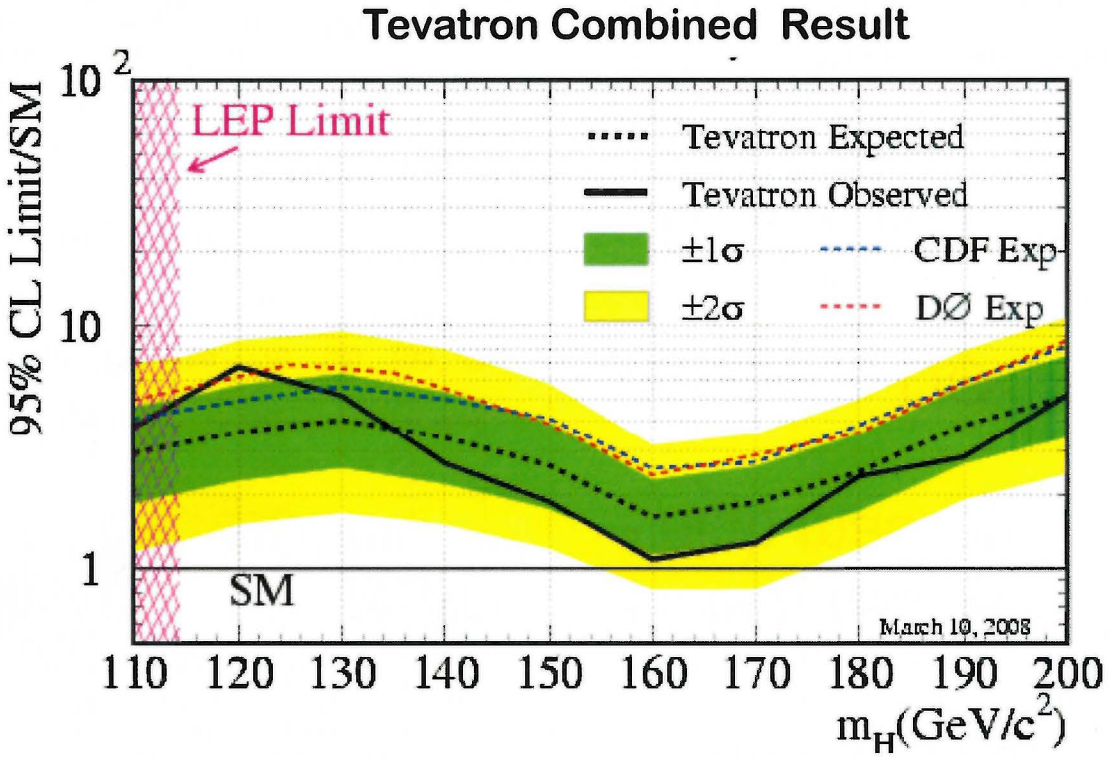
unique to DØ:

- H →γγ, HW → WWW

95% exclusion expected over a wide mass range

3 sigma evidence possible

CDF & DZero Combined SM Higgs



- Tevatron combination limit/SM:
  - 6.8 at M_H=120 GeV/c^2
  - 1.1 at M_H=160 GeV/c^2 ==> expect exclusion soon !

Neutrino Program

SciBooNE

MiniBooNE

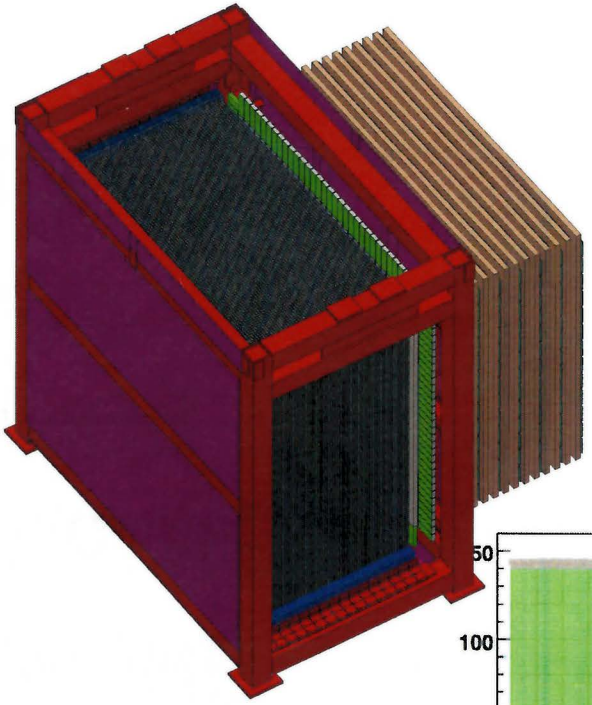
MINOS

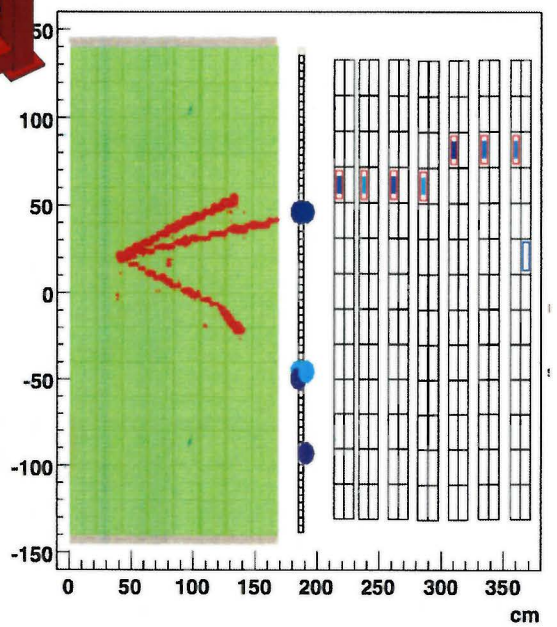
MINERνA

NOνA

SciBooNE (E-954)

- SciBar vertex detector
  - 14,336 channels
  - 99.85% hit efficiency for MIP
  - Owned by Kyoto/KEK
  - MAPMTS, electronics must be returned to Japan
- Electron catcher (EC)
  - 11 radiation lengths
  - 14%/sqrt(E) resolution
  - 256 channels
  - PMTs and electronics must be returned to Italy
- Muon Range Detector (MRD)
  - 99% muon hit efficiency
  - 362 channels
  - ~100 PMTs must be returned to US owners





SciBooNE Institutions

- Italy
  - INFN and University of Rome "La Sapienza"
- Japan
  - KEK
  - ICRR
  - Kyoto University
  - Tokyo Institute of Technology
- Spain
  - University of Barcelona
  - University of Valencia
- UK
  - Imperial College London
- USA
  - University of Cincinnati
  - University of Colorado
  - Columbia University
  - Fermilab
  - Indiana University
  - Los Alamos National Lab
  - Louisiana State University
  - Purdue University Calumet
  - Saint Mary's University of Minnesota

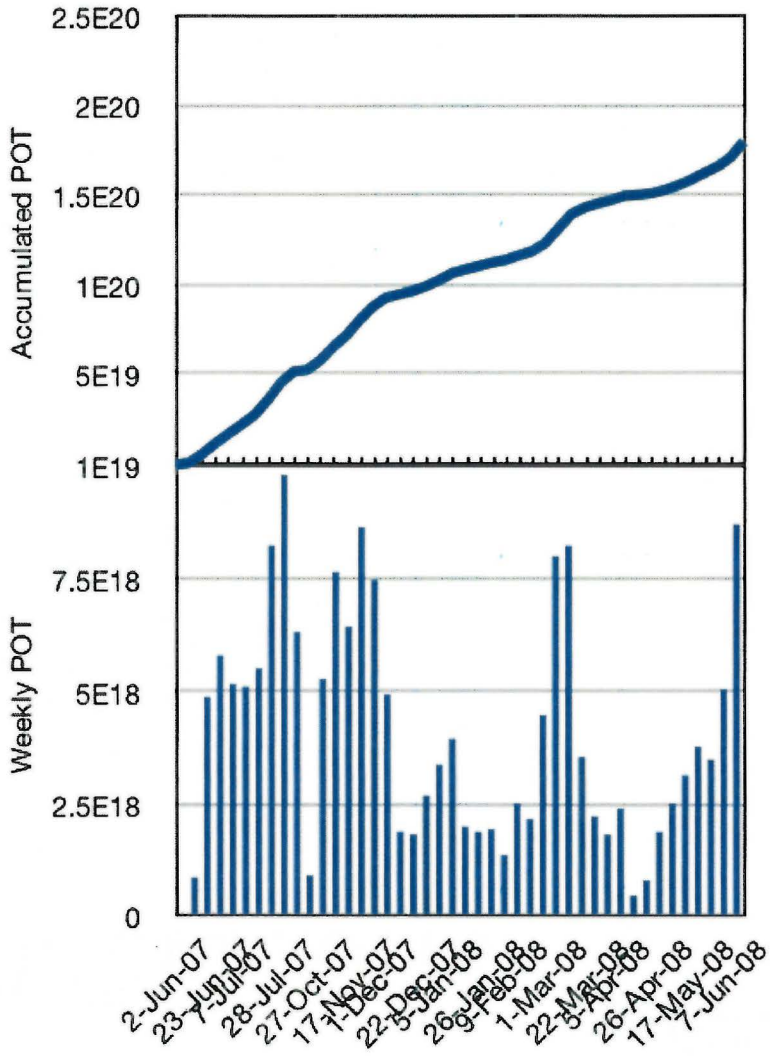
SciBooNE Data Progress

- Collected 1.05 E20 POT in neutrino mode
  - 0.99 E20 POT passing data quality cuts
- Collected 0.85 E20 POT in antineutrino mode
  - 0.80 E20 POT passing data quality cuts
- Average detector efficiency 94%

- Goal is to reach 1 E20 also in antineutrino mode

News Flash:

At Monday's AEM, SciBooNE announced receiving just over 2 10^{20} POT, the MOU goal.

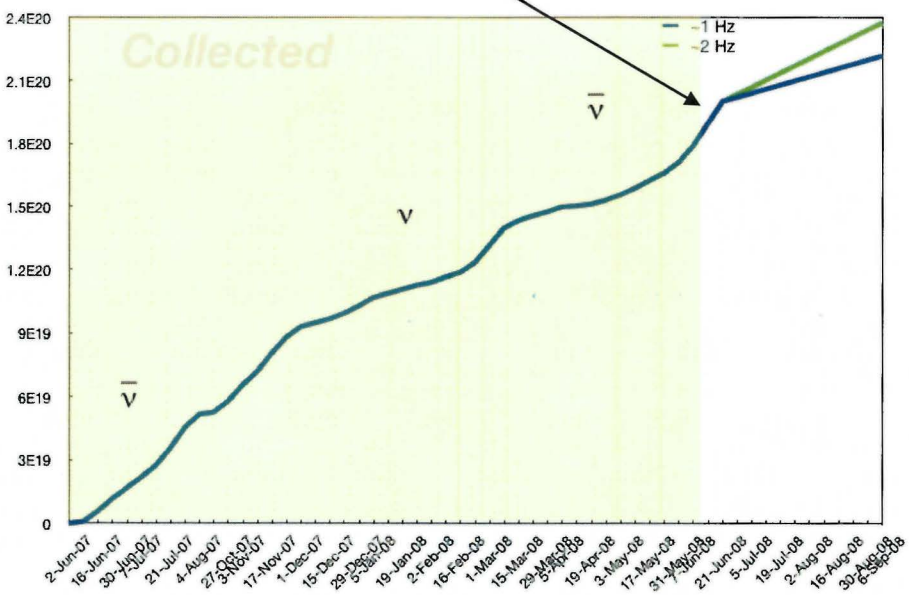


End of SciBooNE Beam Run

- Will decommission detector beginning August 18
- PMTs, electronics, etc. returned to owners
  - SciBar - Japan
  - EC - Italy
  - MRD - US universities and Fermilab
- Barring disasters, should easily achieve POT goals before end of run
- PhD students will remain at FNAL until analyses are finished

POT PROJECTION

Assuming 2.5 weeks of NuMI shutdown



MiniBooNE (E944)

Collaboration

A. A. Aguilar-Arevalo,[5] C. E. Anderson,[16] A. O. Bazarko,[13] S. J. Brice,[7] B. C. Brown,[7] L. Bugel,[5] J. Cao,[12,*] L. Coney,[5,†] J. M. Conrad,[5] D. C. Cox,[9] A. Curioni,[16] Z. Djurcic,[5] D. A. Finley,[7] B. T. Fleming,[7,16] R. Ford,[7] F. G. Garcia,[7] G. T. Garvey,[10] C. Green,[10,7] J. A. Green,[9,10] T. L. Hart,[4,‡] E. Hawker,[10,3,§] R. Imlay,[11] R. A. Johnson,[3] G. Karagiorgi,[5] P. Kasper,[7] T. Katori,[9] T. Kobilarcik,[7] I. Kourbanis,[7] S. Koutsoliotas,[2] E. M. Laird,[13] S. K. Linden,[16] J. M. Link,[5,15] Y. Liu,[12] Y. Liu,[1] W. C. Louis,[10] K. B. M. Mahn,[5] W. Marsh,[7] P. S. Martin,[7] G. McGregor,[10] W. Metcalf,[11] P. D. Meyers,[13] F. Mills,[7] G. B. Mills,[10] J. Monroe,[5,¶] C. D. Moore,[7] R. H. Nelson,[4] V. T. Nguyen,[5] P. Nienaber,[14] J. A. Nowak,[11] S. Ouedraogo,[11] R. B. Patterson,[13,**] D. Perevalov,[1] C. C. Polly,[9] E. Prebys,[7] J. L. Raaf,[3,††] H. Ray,[10,8] B. P. Roe,[12] A. D. Russell,[7] V. Sandberg,[10] R. Schirato,[10] D. Schmitz,[5] M. H. Shaevitz,[5] F. C. Shoemaker,[13] D. Smith,[6] M. Soderberg,[16] M. Sorel,[5,‡‡] P. Spentzouris,[7] I. Stancu,[1] R. J. Stefanski,[7] M. Sung,[11] H. A. Tanaka,[13,§§] R. Tayloe,[9] M. Tzanov,[4] R. Van de Water,[10] M. O. Wascko,[11,¶¶] D. H. White,[10] M. J. Wilking,[4] H. J. Yang,[12] G. P. Zeller,[5,10] and E. D. Zimmerman[4]

2 National Laboratories, 14 Universities, 80 Researchers

- University of Alabama
- Bucknell University
- University of Cincinnati
- University of Colorado
- Columbia University
- Embry-Riddle Aeronautical University
- Fermi National Accerator Laboratory
- University of Florida
- Indiana University
- Los Alamos National Laboratory
- Louisiana State University
- University of Michigan
- Princeton University
- Saint Mary's University of Minnesota
- Virginia Polytechnic Institute
- Yale University

Broad Range of Analyses

 = PhD Student (7 already graduated)

- **No organizational separation between neutrino and anti-neutrino mode**
- **11 PhD Students + 7 graduated**

- Oscillation
  - Refined Nue appearance
  - Nuebar appearance
  - Numu and numubar disappearance
  - 1 PRL, ~3 further papers expected
- Low Energy Excess
  - Big effort
  - 2+ papers expected
- Alternative Oscillations
  - Phenomenology
  - CP violation, Lorentz violation, ...
  - 3+ papers expected
- NuMI Events
  - Large event rate from NuMI beam
  - Check on osc. and Low E
  - 1 paper being written
- CCQE
  - 1 PRL, 2 further papers expected
- CC π^+
  - 2 papers expected
- CC π^0
  - Reconstruction challenges overcome
  - 1 paper expected
- NC π^0
  - 1 paper submitted PLB
  - Coherent/resonant in nu and anti-nu modes
  - Flux averaged cross-section measurement
  - 2 further papers expected
- NC Elastic
  - Flux averaged cross-section measurement
  - 1 paper expected
- ν_μ-e Elastic
  - Nu mag. Mom
  - 1 paper expected.

MiniBooNE Present and Future

- Taken ~6.6 x 10^{20} POT in neutrino mode
  - Making suite of cross-section measurements
  - Searching for various neutrino oscillations
  - Publications coming out
- Taken ~2.5 x 10^{20} POT in anti-neutrino mode
  - Making suite of cross-section measurements
  - Searching for anti-neutrino disappearance
- In Nov 2007 request granted for extra running for an anti-nue appearance search
  - LSND result was an indication of anti-nue appearance
  - Extra ~2.5 x 10^{20} POT (making grand total of ~5 x 10^{20} POT)
  - Should take FY2008 and FY2009 running

MiniBooNE Oscillation Summary

- Electron Neutrino Appearance
  - Combining Analyses
    - Sets a tighter limit
  - Compatibility of High Δm^2 Measurements
    - High Δm^2 experiments compatible with 2v osc. at only 3.94% level
  - Low Energy Electron Candidate Excess
    - Full update coming this summer
  - Data from NuMI Beam
    - Sample complementary to MB flux, only small significance LE excess seen with current uncertainties
- Muon Neutrino Disappearance
  - Result this summer
- Anti-Electron Neutrino Appearance
  - Doubling current POT for result

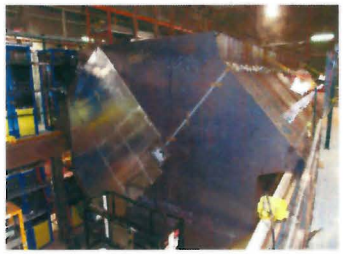
Publication Update Since Nov 2007

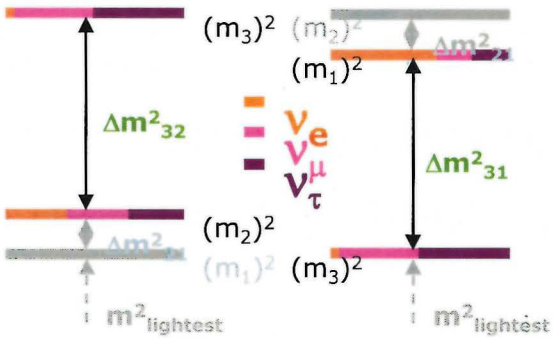
- CCQE paper accepted by PRL (Phys. Rev. Lett. 100, 032301 (2008))
- π^0 paper accepted by PLB (Phys. Lett. B 664/1-2 pp 41-46 (2008))
- LSND, MiniBooNE, KARMEN, & Bugey compatibility paper accepted by Phys. Rev. D. (arXiv:0805.1764 [hep-ex])
- Paper on ν_e background from muon internal Bremsstrahlung submitted to the archive (arXiv:0706.3897 [hep-ex])
- 4 students graduated
  - D.W. Schmitz,
    "A Measurement of Hadron Production Cross-Sections for the Simulation of Accelerator Neutrino Beams and a Search for νμ → νe Oscillations in the Δm2 ≈ 1 eV2 Region",
    PhD Thesis, Columbia University, 2008
  - D.C. Cox,
    "A Measurement of the Neutral Current Neutrino-Nucleon Elastic Cross Section at MiniBooNE",
    PhD Thesis, Indiana University, 2008
  - A.A. Aguilar-Arevalo,
    "An Improved Neutrino Oscillations Analysis of the MiniBooNE Data",
    PhD Thesis, Columbia University, 2008
  - R.B. Patterson,
    "A Search for Muon Neutrino to Electron Neutrino Oscillations At Δm2 > 0.1 eV2",
    PhD Thesis, Princeton University, 2007

MINOS (E875)

$$\begin{pmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{pmatrix} = \begin{pmatrix} c_{12} & s_{12} & 0 \\ -s_{12} & c_{12} & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 \\ 0 & c_{23} & s_{23} \\ 0 & -s_{23} & c_{23} \end{pmatrix} \begin{pmatrix} c_{13} & 0 & s_{13}e^{i\delta} \\ 0 & 1 & 0 \\ -s_{13}e^{-i\delta} & 0 & c_{13} \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 \\ 0 & e^{i\alpha/2} & 0 \\ 0 & 0 & e^{i\alpha/2+i\beta} \end{pmatrix} \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix}$$

$$P\left(\nu_\mu \rightarrow \nu_\mu\right) = 1 - \sin^2 2\theta \sin^2\left(\frac{\Delta m^2 L}{E}\right)$$

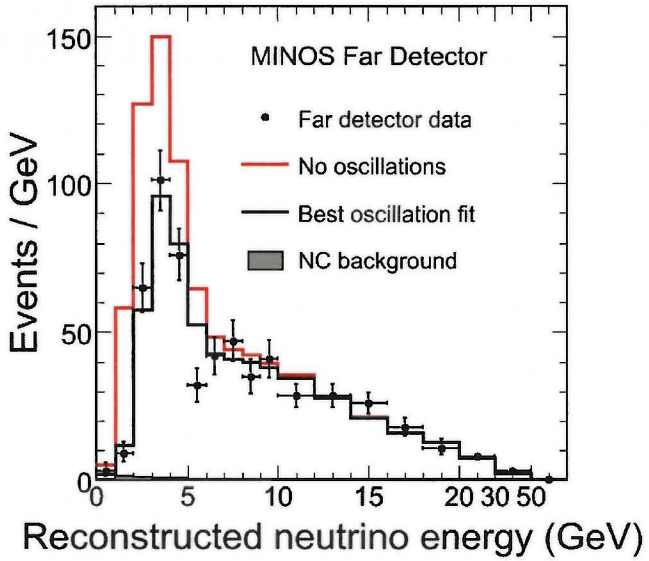




MINOS Recent Results

ν_μ -> ν_x new analysis using 3.25 e^{20} p.o.t.

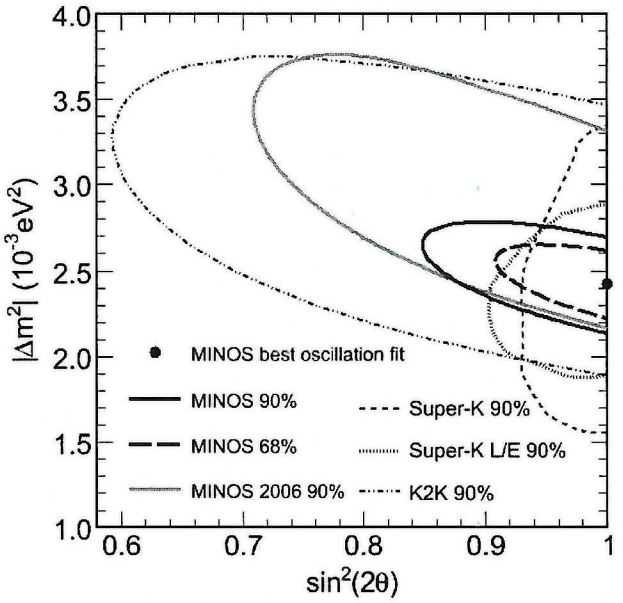
Improved NC background



World best measurement of

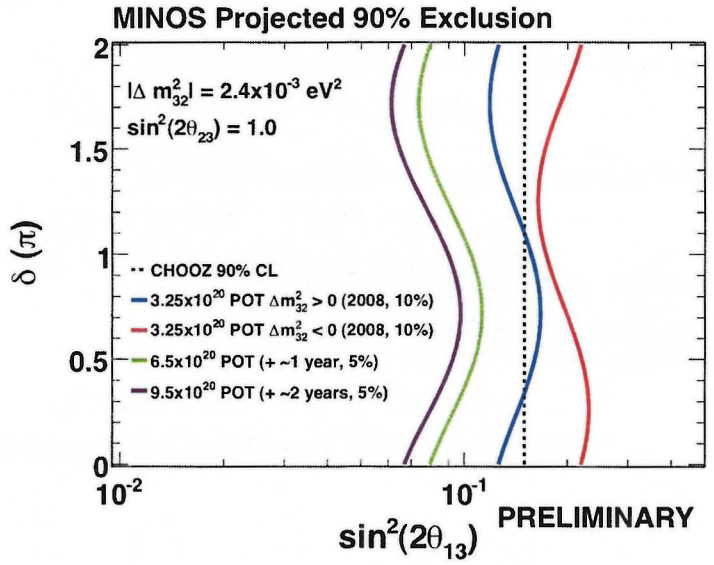
Δm^2 : $2.43 \times 10^{-3} \pm 0.13$ eV^2

$\sin^2 2\theta > 0.95$

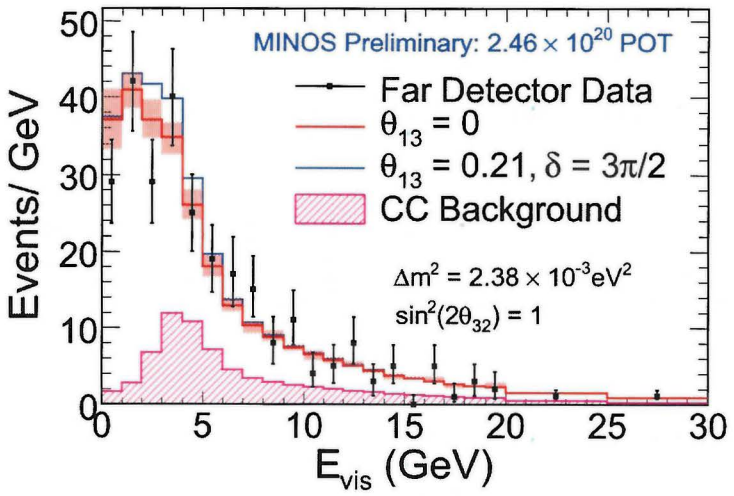


MINOS Recent Results

ν_e sensitivity using data driven background estimate



Search for oscillations to sterile neutrinos via comparison of NC like events in Near and Far Detectors



MINOS Publications

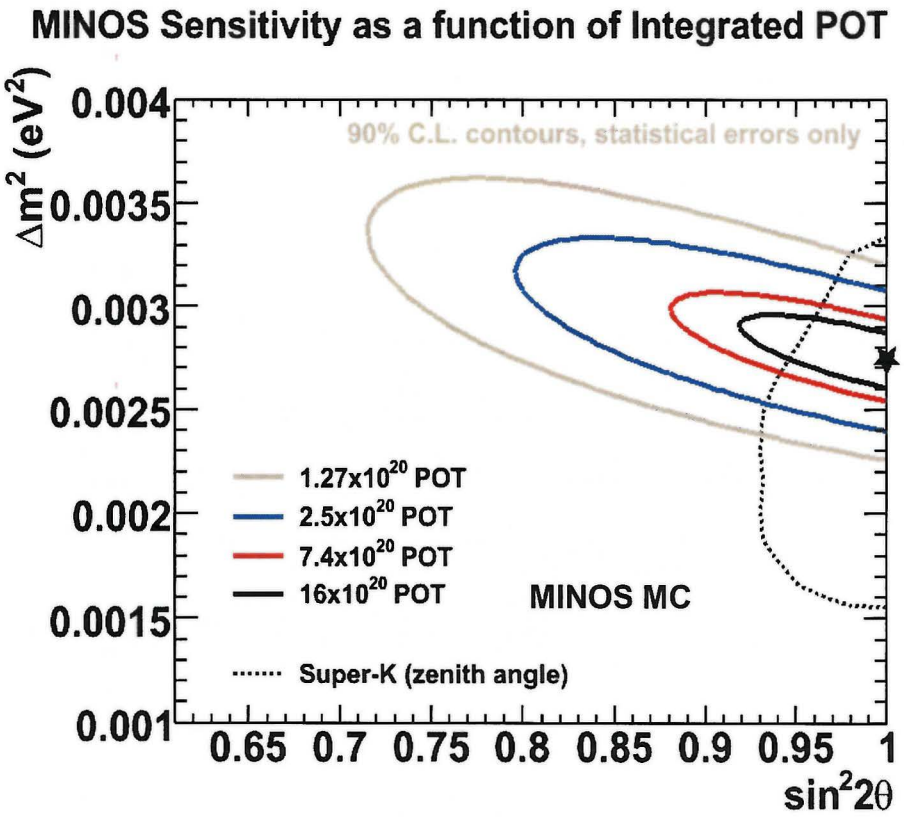
- **Oscillation related publications**
  - CC analysis : 1.27×10^{20} POT
    - D.G. Michael et al. (273 authors), "**Observation of muon neutrino disappearance with the MINOS detectors in the NuMI neutrino beam**", Phys. Rev. Lett. 97, 191801 (2006).
    - "**Study of muon neutrino disappearance using the Fermilab Main Injector neutrino beam**", Phys.Rev.D77:072002 (2008)
  - CC analysis : 3.25×10^{20} POT
    - "**Measurement of Neutrino Oscillations with the MINOS Detectors in the NuMI beam**" (submitted 6/12/08)
  - NC analysis : 2.4×10^{20} POT
    - "**Measurement of the total flux of active neutrinos in the MINOS long baseline experiment**" (to be submitted in 2 weeks)
- **Other publications**
  - P. Adamson et al. (203 authors), "Measurement of neutrino velocity with the MINOS detectors and NuMI neutrino beam" , Phys.Rev.D76:072005 (2007)
  - P. Adamson et al. (200 authors), "Measurement of the atmospheric muon charge ratio at TeV energies with the MINOS detector", Phys.Rev.D76:052003 (2007)
  - P. Adamson et al. (199 authors), "Charge-separated atmospheric neutrino-induced muons in the MINOS far detector", Phys.Rev.D75:092003 (2007)
  - "The magnetized steel and scintillator calorimeters of the MINOS experiment" arxiv:0805.3170 (to be submitted next week)
  - Testing Lorenz Invariance and CPT conservation with MINOS Near Detector neutrinos (to be submitted 6/15/08)
  - "Sudden Stratospheric Warmings seen in the MINOS deep underground muon data", submitted to Nature Physics

MINOS Status & Plans

- Present Membership : 140
  (40 non-USA)(2008)
- Post 2009, new experiments will bleed academic effort
- Magnitude of this effect not yet known

	2008	2009
students	30	30
Postdocs	17	17
Total FTEs	75	72

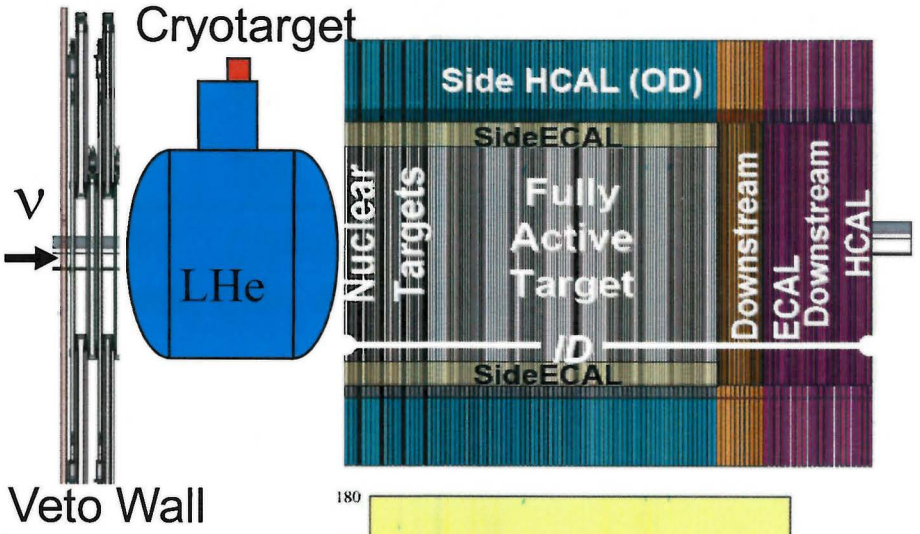
MINOS Outlook

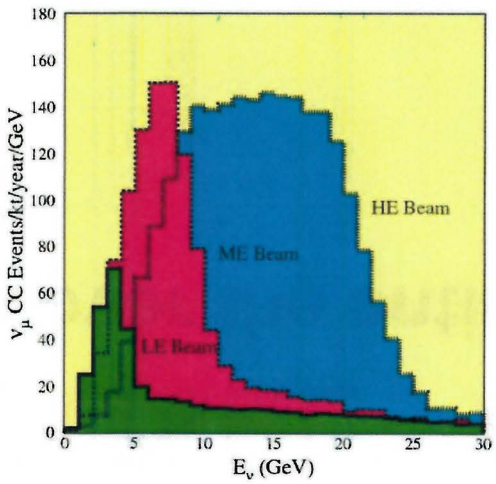


- Muon neutrino disappearance
  - 7x10^{20} p.o.t by summer 2009
- Electron neutrino appearance
  - first result on 3.25x10^{20} p.o.t. by end 2008
  - 7x10^{20}p.o.t summer 09
- Search for exotics
  - Sterile neutrino update 7x10^{20} p.o.t. summer 09
  - Neutrino decay/de-coherence
- Anti-neutrino oscillations
  - anti-ν running > 09?

MINERνA (E938)

- **MINERvA is designed to study neutrino-nucleus interactions in unprecedented detail**
- ***The goals (DOE CD-0)***
  - To make measurements needed for current and future oscillation experiments
  - A broad program of measurements of weak interactions on a strongly bound system
- ***Why MINERvA at NuMI?*** *(DOE CD-1)*
  - NuMI provides
    - **High intensity for precision measurements in a fully active detector**
    - **A wide range of available energies**
  - The MINERvA design includes
    - **A low risk, demonstrated technology**
    - **Reconstruction of a broad range of final states**
    - **Multiple nuclear targets to study the effect of the nucleus on neutrino interactions**

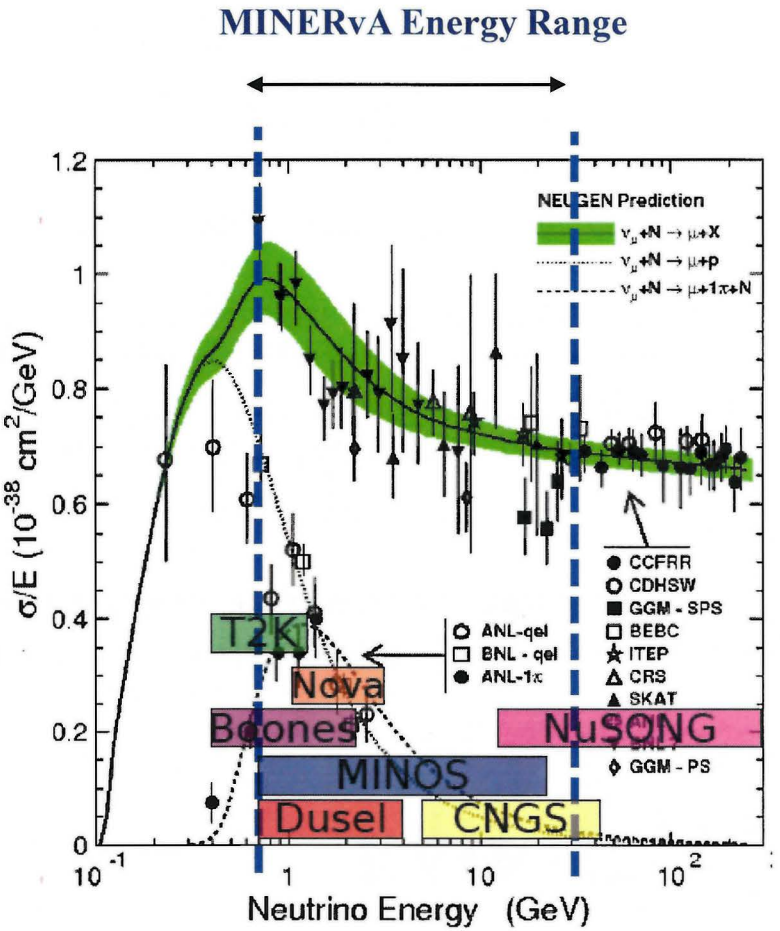




NuMI Beam Spectra

MINERνA Energy Range Crucial to MINOS, NOνA and DUSEL

(The only scattering experiment to cover the entire DUSEL energy range)

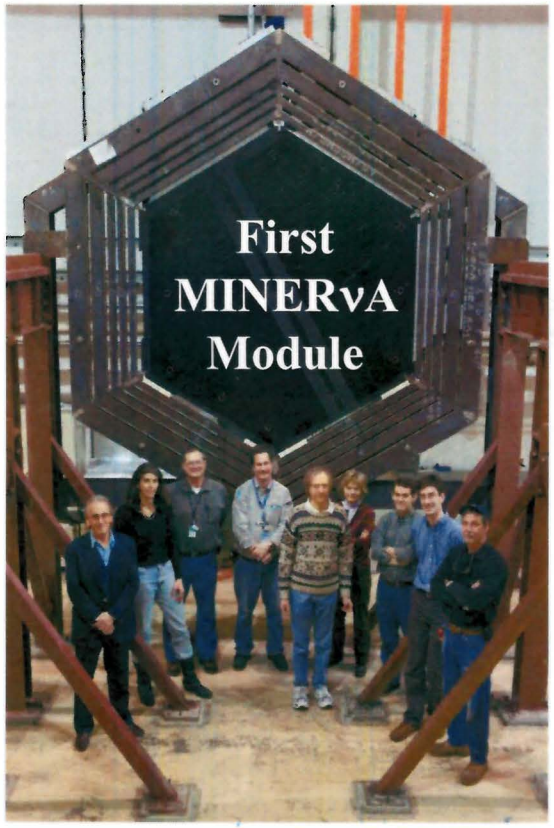


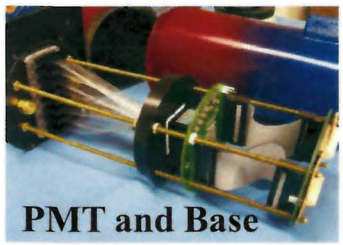
Estimated Cross section uncertainties

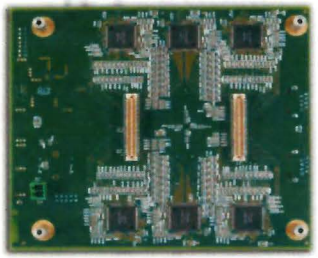
Process	Current	After MINERνA
QE	20%	5%
Res	40%	5/10%(CC/NC)
DIS	20%	5%
Coh	100%	20%

MINERνA Schedule

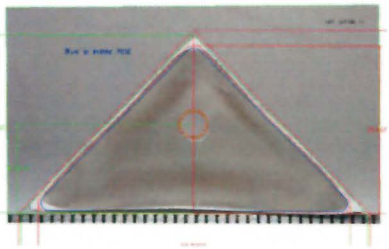
- Obtained CD-3b Approval: November 2007
- Completing "tracking prototype" detector
  - 20 full modules
  - Commission with cosmic rays mid 2008
- Test Beam Program has begun in MTEST
  - Low momentum tertiary beam design begun
  - Test Beam Detector under construction
- Construction (mostly in FY08-09) has begun!
  - Parts fabrication and testing in FY08
  - Module assembly and source testing in FY09
  - Forecast completion in early 2010







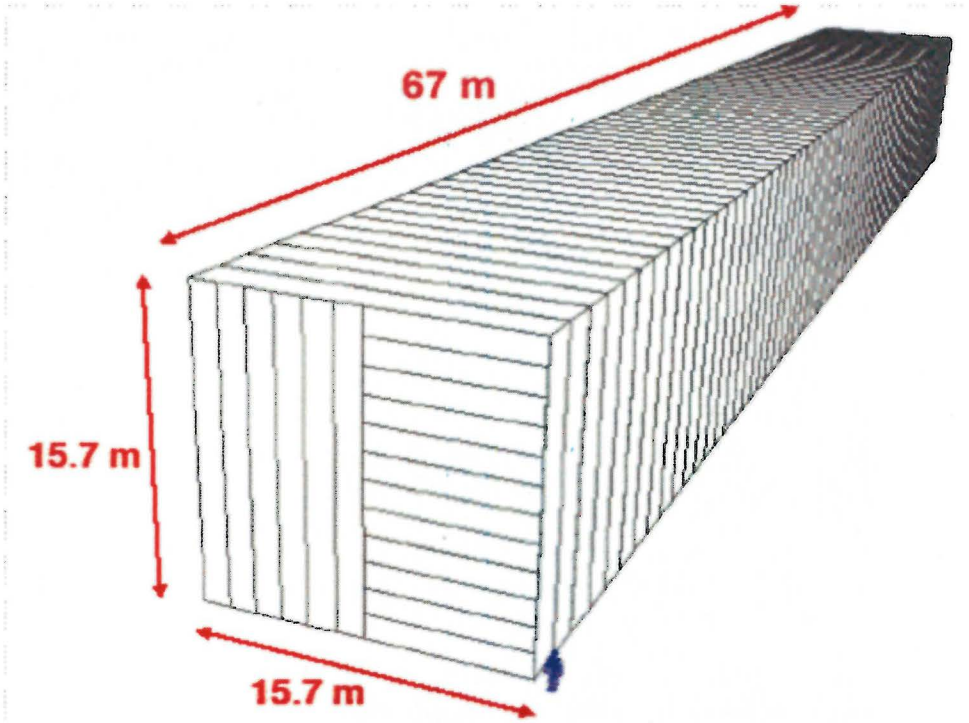
Scintillator Extrusion

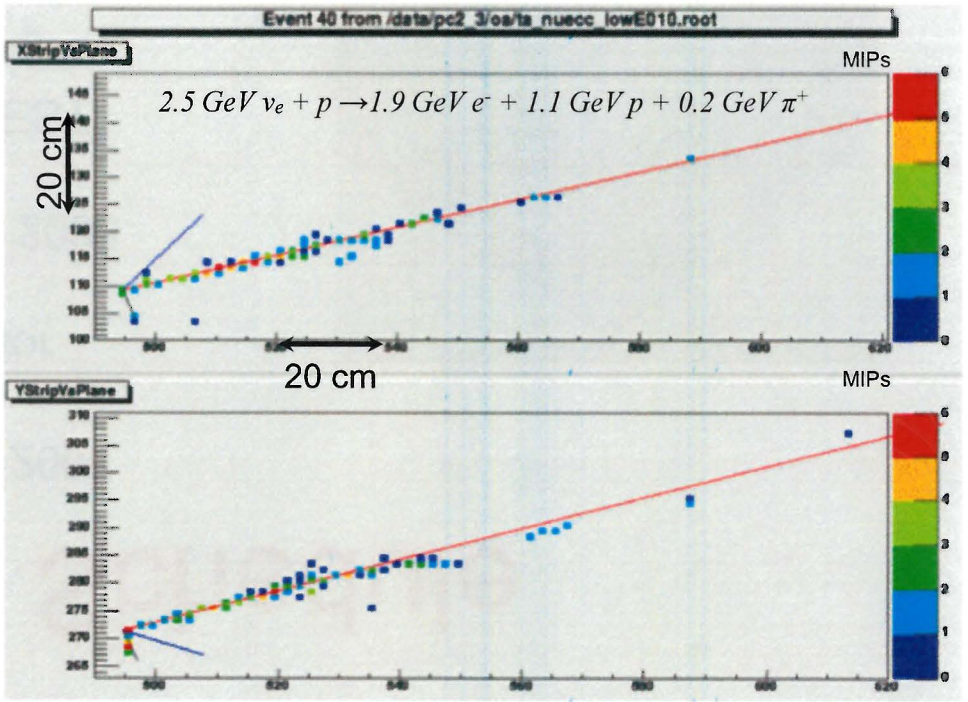


NOνA (E929)

- NOνA is a second generation experiment on the NuMI beamline which is optimized for the detection of muon neutrino to electron neutrino oscillations, and for antineutrinos too. $\nu_\mu \rightarrow \nu_e$ $\bar{\nu}_\mu \rightarrow \bar{\nu}_e$
- NOνA is:
  - An upgrade of the NuMI beam intensity from 400 kW to 700 kW
  - A 15 kt "totally active" tracking liquid scintillator calorimeter sited 14 mrad off the NuMI beam axis at a distance of 810 km
  - A 215 ton near detector identical to the far detector sited 14 mrad off the NuMI beam axis at a distance of 1 km

159 scientists and engineers from 28 institutions (5 countries: US, France, Germany, Greece, Russia)





NOνA Schedule

- Major progress last year
  - NOνA passed DOE Office of Science CD2/3a in Oct. 2007.
  - Passed External Independent Review (EIR) in Nov. 2007
- FY08 omnibus stopped most work on NOνA. Some progress is being made using FY07 carryover and universities
  - FY08 Omnibus required repeats. Passed DOE Office of Science CD2 review again in April 2008. EIR scheduled for June 19. Project TPC increased to $278M to cover escalation and 36% contingency.
  - Environmental Assessment and "Finding of No Significant Impact" have been approved by DOE. This clears NOνA through the DOE NEPA process.
  - Expect CD3a in Feb. 2009, CD3b in Sept. 2009
  - Were it not for the omnibus, construction would have started 3 months ago
- Cost & schedule adjusted to include FY08 omnibus and anticipated 4 month continuing resolution in FY09
  - Start of construction April 2009
  - First 2.5 kt taking data August 2012
  - Detector complete January 2014
- P5 recommended NOνA in all funding scenarios except for lowest (FY08-flat) where they recommended canceling NOνA detector in order to fund "higher priorities", e.g. ANU.

Other Fixed-Target Experiments

E906

MIPP

FOCUS

KTeV

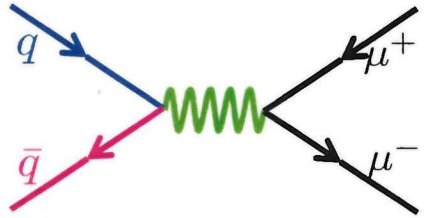
HyperCP

NuTeV

SELEX

Meson Lab Test Beam Program

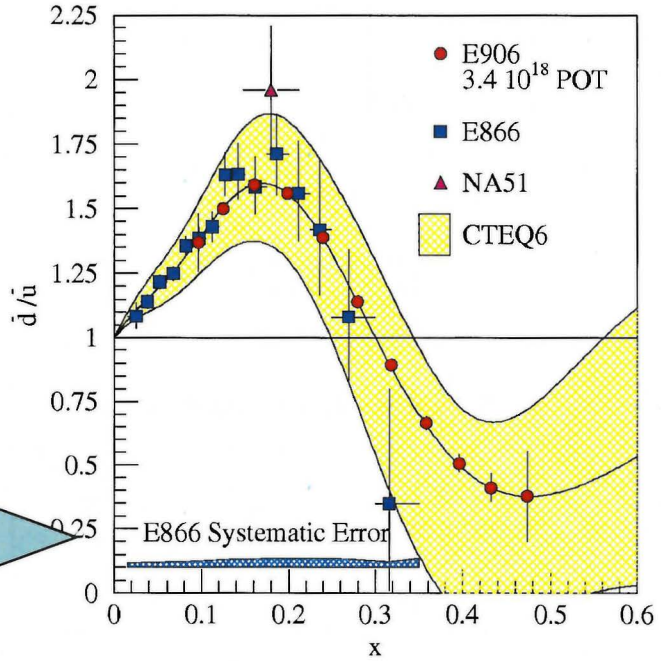
E906 Measurements and Origins of the Sea Quarks: d-bar/u-bar

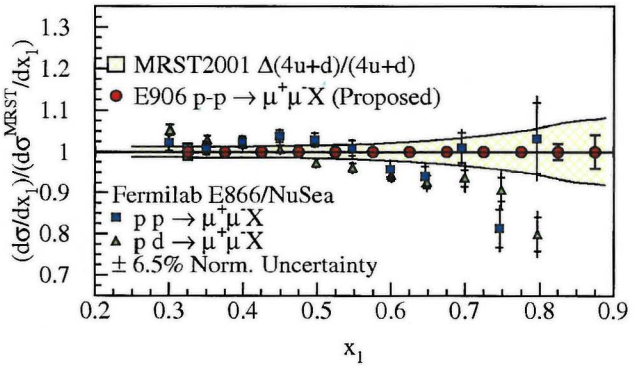


- **Drell-Yan allows for selective study sea quarks.**
  - In a fixed target experiment, kinematics, acceptance and parton distributions combine to select interactions dominated by annihilations of antiquarks in the target.
- **What is the structure of the nucleon?**
  - **What is d-bar/u-bar?** First large-x measurement of sea quarks.

    Ratio of pd to pp cross sections give it.

  - What are the origins of the sea quarks?
  - **What is the high-x structure of the proton?** Drell-Yan measures beam valence parton distributions at very high-x with **no nuclear corrections**
- **CTEQ and MRST want these data!!**





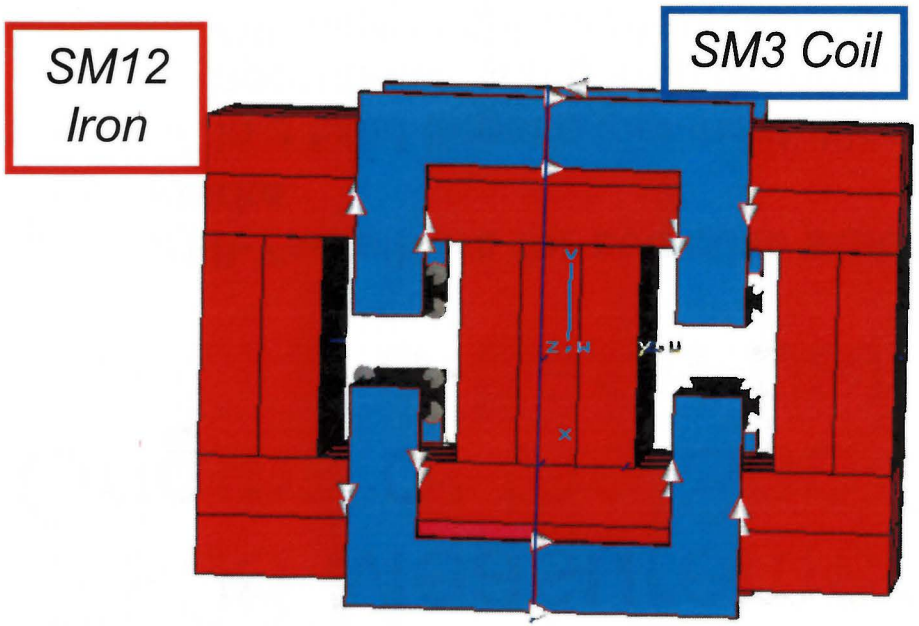
E906 Redesign

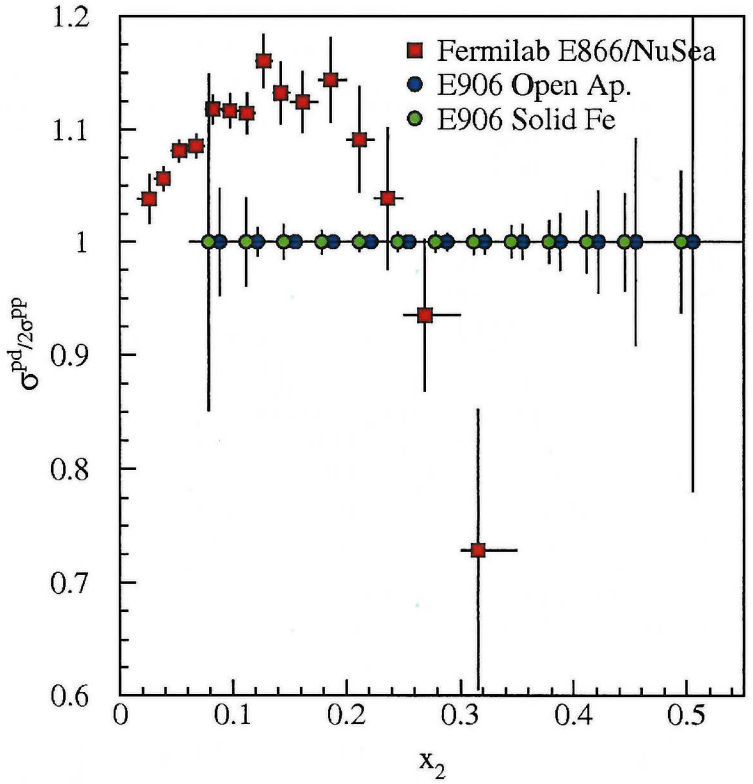
Redesign of Spectrometer

Solid iron magnet replaces open aperture magnet. Existing coils, iron.

Additional, largest tracking chamber.

Increased acceptance for high x_F, higher x_2 sensitivity.





E906 Collaboration and Funding

Additional collaborating institutions (since 2006 proposal):

- KEK, Kyoto, RIKEN, Tokyo Tech—Station 3 Tracking; substantial funding of "common" equipment (*e.g.* beam line and magnets)
- Academia Sinica, Ling-Tung Univ.—modern readout electronics via FPGA.
- Maryland, Michigan—cryogenic targets

These groups have agreed to take on key tasks for the E906/Drell-Yan experiment and **demonstrate continued interest in this experiment**

Funding

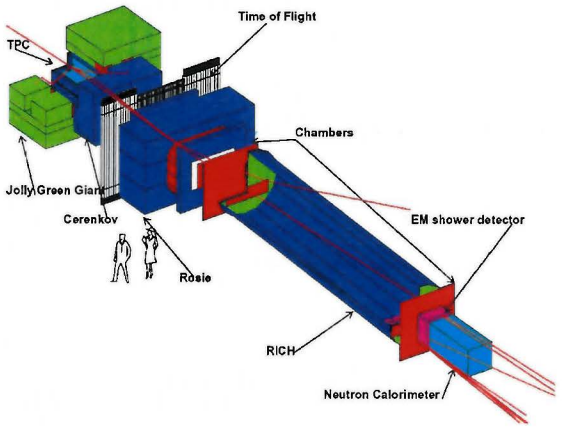
- DOE/**Nuclear Physics** has agreed to fund the spectrometer upgrade
  - Initial funds received in FY07.
  - With new design, funds can now be "reprogrammed" to Fermilab for infrastructure (*e.g.* beam line, etc.) needed for experiment.
- **Japanese collaborators** have indicated they expect to contribute significantly toward Fermilab infrastructure as well.
- E906 believes that they have found sufficient resources to cover Fermilab's M&S costs for E906.

In order to proceed, an MOU detailing Fermilab's and collaboration's responsibilities is needed.

- Fermilab task force is currently helping in preparation for this MOU.

MIPP (E907)

- Experiment consists of:
  - instrumented secondary beam line with PID, TPC, 9 drift chambers, PID with TPC dE/dx, ToF, multi-cell Cherenkov, RICH, and Calorimeter
- Currently in the final stage of analysis of data taken in 2005/2006
  - several unexpected issues delayed the analysis during the last year. All of these were resolved with minor impact on final data quality.
  - expect first publications this summer:
    - NIM article with detector performance
    - cross sections of 120 GeV/c protons on NuMI target
  - many more publications to follow soon after this



Upgrade to MIPP is proposed

Key features:

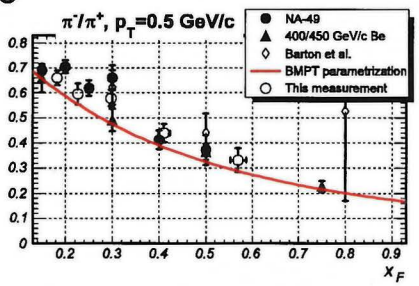
- increase DAQ rate x 100
- Rebuild JGG with more uniform field
- add recoil detector
- improve beam to get beam momenta down to 1 GeV/c
- improve interaction trigger

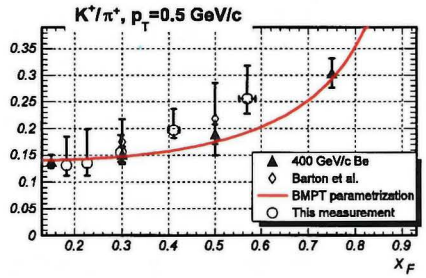
MIPP Results

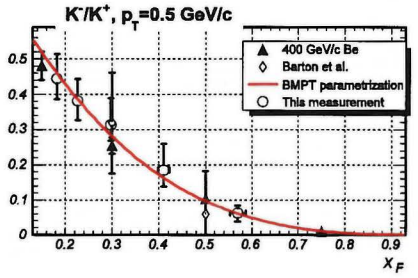
- Two PhD theses finished
  - Ratio of Pion Kaon Production in Proton Carbon Interactions (Andre Lebedev)
  - Measurement of Pi-K Ratios from the NuMI Target (S. Seun)

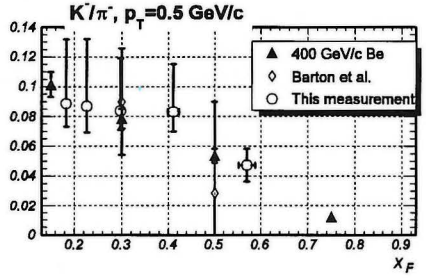
- Expect three PhDs this or next year
  - Kaon mass (N. Graf, Indiana)
  - Cross sections at 58 and 120 GeV/c (G. Aydin and Y. Gunaydin)

Data Summary 27 February 2006			Acquired Data by Target and Beam Energy Number of events, x 10^6								
Target			E								Total
Z	Element	Trigger Mix	5	20	35	40	55	60	65	85	120	
0	Empty[1]	Normal		*0.10*	*0.14*			*0.52*			*0.25*	*1.01*
	K Mass[2]	No Int.				*5.48*	*0.50*	*7.39*	*0.96*			*14.33*
	Empty LH[1]	Normal		*0.30*				*0.61*		*0.31*		
1	LH	Normal	0.21	1.94				1.98		1.73		7.08
4	Be	*p* only									1.08	
		Normal			0.10			0.56				1.75
6	C	Mixed						0.21				
	C 2%	Mixed		0.39				0.26			0.47	1.33
	NuMI	*p* only									1.78	1.78
13	Al	Normal			*0.10*							*0.10*
83	Bi	*p* only									1.05	
		Normal			0.52			1.26				2.83
92	U	Normal						1.18				1.18
Total			0.21	2.73	0.86	5.48	0.50	13.97	0.96	2.04	4.63	31.38









FOCUS (E831)

Recent Publications

- **Study of Cabibbo Suppressed Decays of the D+(s) Charmed-Strange Meson involving a K0(S).**
  By FOCUS Collaboration (J.M. Link *et al.*). FERMILAB-PUB-07-410, Aug 2007.
  Published in **Phys.Lett.B660:147-153,2008**.

- **Search for a pentaquark decaying to Cascade- pi-.**
  By FOCUS Collaboration (J.M. Link *et al.*). FERMILAB-PUB-07-409, Aug 2007.
  Published in **Phys.Lett.B661:14-21,2008**.

- **Dalitz plot analysis of the D+ ---> K- pi+ pi+ decay in the FOCUS experiment.**
  By FOCUS Collaboration (J.M. Link *et al.*). FERMILAB-PUB-07-127-E, May 2007. Published in **Phys.Lett.B653:1-11,2007**.

- **Study of the D0 ---> pi- pi+ pi- pi+ decay.**
  By FOCUS Collaboration (J.M. Link *et al.*). FERMILAB-PUB-06-491-E, Jan 2007. 38pp.
  Published in **Phys.Rev.D75:052003,2007**.

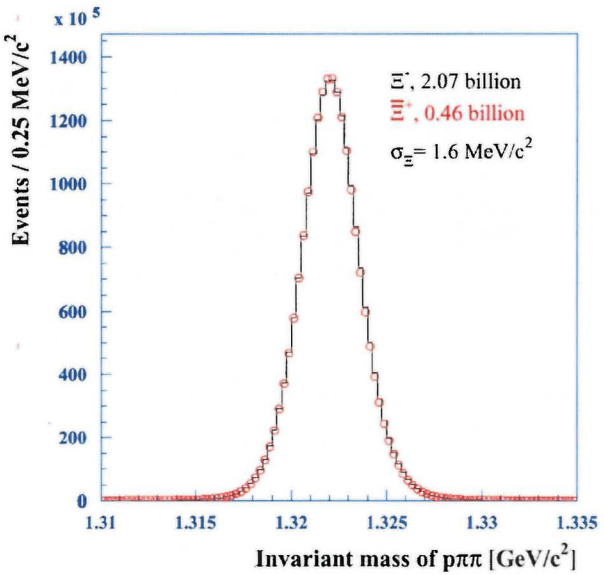
E871 - HyperCP

- Collaboration:

Academia Sinica, Taiwan
Fermilab
Universidad de Guanajuato, Mexico
Illinois Institute of Technology
University of Lausanne, Switzerland
Lawrence Berkeley National Laboratory
University of California, Berkeley
University of Michigan, Ann Arbor
University of South Alabama, Mobile
University of Virginia, Charlottesville

- Primary scientific goal:

To search for direct CP-violation in the sequential decays $\Xi^- \to \Lambda\pi^- \to p\pi^-\pi^-$ and $\bar{\Xi}^+ \to \bar{\Lambda}\pi^+ \to \bar{p}\pi^+\pi^+$ with a sensitivity of ~1 × 10^{-4}.



Based on 8.6 ×10^8 Ξ^- and 2.3 × 10^8 $\bar{\Xi}^+$, preliminary results on CP-asymmetry:

$$A_{\Xi\Lambda} = [-6.0 \pm 2.1(\text{stat}) \pm 2.1(\text{syst})] \times 10^{-4}$$

Also:

$$BR(\Omega^- \to \Xi^{*0}_{1530}\pi^-) < 7.61\times10^{-5}$$

$$BR(\Omega^+ \to \overline{\Xi^{*0}_{1530}}\pi^+) < 5.61\times10^{-5}$$

$$BR(\Omega^- \to \Xi^-\pi^+\pi^-) = [4.32 \pm 0.56(stat) \pm 0.28(syst)]\times10^{-4}$$

$$BR(\Omega^+ \to \Xi^+\pi^-\pi^+) = [3.13 \pm 0.71(stat) \pm 0.20(syst)]\times10^{-4}$$

KTeV (E799 and E832)

- 45 publications now, will end at 50 publications.
  (http://kpasa.fnal.gov:8080/public/ktev_pubs.html)

- 32 PhD theses.

  (http://kpasa.fnal.gov:8080/public/ktev_theses.html)

KTeV announced final result on ε/ε' at Fermilab W&C Seminar

February 25, 2008.

KTeV Recent Publications

- **Final Results from the KTeV Experiment on the Decay K(L) ---> pi0 gamma gamma.**
  By KTeV Collaboration (E. Abouzaid *et al.*) FERMILAB-PUB-08-140-E, May 2008.

- **Determination of the Parity of the Neutral Pion via the Four-Electron Decay.**
  By KTeV Collaboration (E. Abouzaid *et al.*). FERMILAB-PUB-08-032, Feb 2008. Published in **Phys.Rev.Lett.100:182001,2008**.

- **Search for lepton flavor violating decays of the neutral kaon.**
  By KTeV Collaboration (E. Abouzaid *et al.*). FERMILAB-PUB-07-646-E, Nov 2007. Published in **Phys.Rev.Lett.100:131803,2008**.

- **Search for the Rare Decay K(L) ---> pi0 pi0 gamma.**
  By KTeV Collaboration (E. Abouzaid *et al.*). FERMILAB-PUB-07-427-E, Aug 2007. Submitted to Phys.Rev.Lett.

- **Measurement of the Decay K(L) ---> pi0 e+ e- gamma.**
  By KTeV Collaboration (E. Abouzaid *et al.*). Jun 2007. Published in **Phys.Rev.D76:052001,2007**.

- **First observation of K(L) ---> pi+- e-+ nu e+ e-.**
  By KTeV Collaboration (E. Abouzaid *et al.*). FERMILAB-PUB-07-162-E, May 2007. Published in **Phys.Rev.Lett.99:081803,2007**.

- **Measurements of the Decay K(L) ---> e+ e- gamma.**
  By KTeV Collaboration (E. Abouzaid *et al.*). FERMILAB-PUB-07-690-E, Feb 2007. Published in **Phys.Rev.Lett.99:051804,2007**.

NuTeV (E-815)

The NuTeV Collaboration

T. Adams (4), A. Alton (4), S. Avvakumov (8), L. deBarbaro (5),
P. deBarbaro (8), R. H. Bernstein (3), A. Bodek (8), T. Bolton (4), J. Brau (6), D. Buchholz (5), H. Budd (8),
L. Bugel (3), J. Conrad (2), R. B. Drucker (6), B. T. Fleming (2), R. Frey (6), J.A. Formaggio (2), J. Goldman (4),
M. Goncharov (4), D. A. Harris (8), R. A. Johnson (1), J. H. Kim (2), S. Koutsoliotas (2), M. J. Lamm (3),
W. Marsh (3), D. Mason (6), J. McDonald (7), K. S. McFarland (8), ,C. McNulty (2), D. Naples (7), P. Nienaber (3),
A. Romosan (2), W. K. Sakumoto (8), H. Schellman (5), M. H. Shaevitz (2), P. Spentzouris (2),
E. G. Stern (2), N. Suwonjandee (1), M. Tzanov (7), M. Vakili (1), A. Vaitaitis (2), U. K. Yang (8),
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(6) University of Oregon, Eugene, OR 97403
(7) University of Pittsburgh, Pittsburgh, PA 15260
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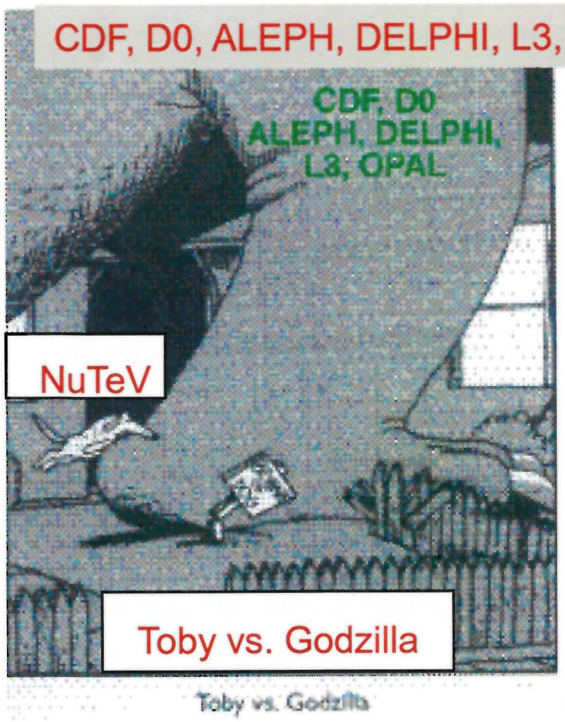
Scientific Spokespersons: Robert Bernstein, Michael Shaevitz

This Year's Publications

1) Measurement of the Nucleon Strange-Antistrange Asymmetry at Next-to-Leading Order in QCD from NuTeV Dimuon Data.
FERMILAB-PUB-07-734, Nov 2007. 4pp. Published in Phys.Rev.Lett.99:192001,2007.

2) The strange-antistrange asymmetry, the NuTeV measurement & a peek at future prospects.
By NuTeV Collaboration 2007. 5pp.
Published in AIP Conf.Proc.967:264-268,2007

And presentation at DIS on NuTeV anomaly, K. McFarland



NuTeV is Still Hot

1)Precise determination of electroweak parameters in neutrino nucleon scattering.
By NuTeV Collaboration (G.P. Zeller et al.). ** Press Release **.
Published in Phys.Rev.Lett.88:091802,2002, Erratum-ibid.90:239902,2003.
e-Print: hep-ex/0110059

TOPCITE = 250+

Weak Mixing Angle: 365 cites, 25 this year:

2) Precise measurement of dimuon production cross-sections in muon neutrino Fe and muon anti-neutrino Fe deep inelastic scattering at the Tevatron.
By NuTeV Collaboration (M. Goncharov et al.). Published in Phys.Rev.D64:112006,2001.
e-Print: hep-ex/0102049

TOPCITE = 100+

Ongoing Work:

New radiative corrections; new strange sea, and more

3) On the effect of asymmetric strange seas and isospin violating parton distribution functions on sin**2 theta(W) measured in the NuTeV experiment.
By NuTeV Collaboration (G.P. Zeller et al.). 4pp.
Published in Phys.Rev.D65:111103,2002, Erratum-ibid.D67:119902,2003.
e-Print: hep-ex/0203004

TOPCITE = 50+

SELEX (E-781)

Charmed Baryon Production and Decay

New Papers to be in Print

1) First Observation of the Cabibbo-suppressed Decays $\Xi_c^+ \to \Sigma^+ \pi^- \pi^+$ and $\Xi_c^+ \to \Sigma^- \pi^+ \pi^+$ and Measurement of their Branching Ratios.
(E. Vazquez-Jauregui et al.).
Submitted to Phys.Lett.B

2) Polarization of Λ^0 and anti-Λ^0 inclusively produced by 610-GeV/c Sigma- and 525-GeV/c proton beams. (J.L. Sanchez-Lopez et al.).
Submitted to Phys.Rev.D

3) Measurement of the Ω_c^0 lifetime.
(M. Iori et al.).
Submitted to Phys.Lett.B

U. Akgun,[16] G. Alkhazov,[11] J. Amaro-Reyes,[13] A.G. Atamantchouk,[11,a] A.S. Ayan,[16] M.Y. Balatz,[8,a] A. Blanco-Covarrubias,[13] N.F. Bondar,[11] P.S. Cooper,[5] L.J. Dauwe,[17] G.V. Davidenko,[8] U. Dersch,[9,b] A.G. Dolgolenko,[8] G.B. Dzyubenko,[8] R. Edelstein,[3] L. Emediato,[19] A.M.F. Endler,[4] J. Engelfried,[13] I. Eschrich,[9,c] C.O. Escobar,[19,d] N. Estrada,[13] A.V. Evdokimov,[8] I.S. Filimonov,[10,a] A. Flores-Castillo,[13] F.G. Garcia,[19,5] M. Gaspero,[18] I. Giller,[12] V.L. Golovtsov,[11] P. Gouffon,[19] E. Gülmez,[2] He Kangling,[7] M. Iori,[18] S.Y. Jun,[3] M. Kaya,[16,e] J. Kilmer,[5] V.T. Kim,[11] L.M. Kochenda,[11] I. Konorov,[9,f] A.P. Kozhevnikov,[6] A.G. Krivshich,[11] H. Krüger,[9,g] M.A. Kubantsev,[8] V.P. Kubarovsky,[6] A.I. Kulyavtsev,[3,5] N.P. Kuropatkin,[11,5] V.F. Kurshetsov,[6] A. Kushnirenko,[3,6] S. Kwan,[5] J. Lach,[5] A. Lamberto,[20] L.G. Landsberg,[6,a] I. Larin,[8] E.M. Leikin,[10] Li Yunshan,[7] G. López-Hinojosa,[13] M. Luksys,[14] T. Lungov,[19] V.P. Maleev,[11] D. Mao,[3,h] Mao Chensheng,[7] Mao Zhenlin,[7] P. Mathew,[3,i] M. Mattson,[3] V. Matveev,[8] E. McCliment,[16] M.A. Moinester,[12] V.V. Molchanov,[6] A. Morelos,[13] K.D. Nelson,[16,j] A.V. Nemitkin,[10] P.V. Neoustroev,[11] C. Newsom,[16] A.P. Nilov,[8,a] S.B. Nurushev,[6] A. Ocherashvili,[12,k] Y. Onel,[16] E. Ozel,[16] S. Ozkorucuklu,[16,l] A. Penzo,[20] S.V. Petrenko,[6] P. Pogodin,[16,m] M. Procario,[3,n] V.A. Prutskoi,[8] E. Ramberg,[5] G.F. Rappazzo,[20] B.V. Razmyslovich,[11,o] V.I. Rud,[10] J. Russ,[3] J.L. Sánchez-López,[13] P. Schiavon,[20] J. Simon,[9,p] A.I. Sitnikov,[8] D. Skow,[5] V.J. Smith,[15] M. Srivastava,[19] V. Steiner,[12] V. Stepanov,[11,o] L. Stutte,[5] M. Svoiski,[11,o] N.K. Terentyev,[11,3] G.P. Thomas,[1] I. Torres,[13] L.N. Uvarov,[11] A.N. Vasiliev,[6] D.V. Vavilov,[6] E. Vázquez-Jáuregui,[13] V.S. Verebryusov,[8] V.A. Victorov,[6] V.E. Vishnyakov,[8] A.A. Vorobyov,[11] K. Vorwalter,[9,q] J. You,[3,5] Zhao Wenheng,[7] Zheng Shuchen,[7] and R. Zukanovich-Funchal[19]

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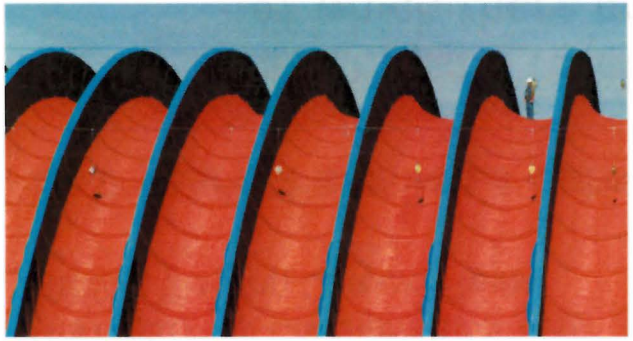
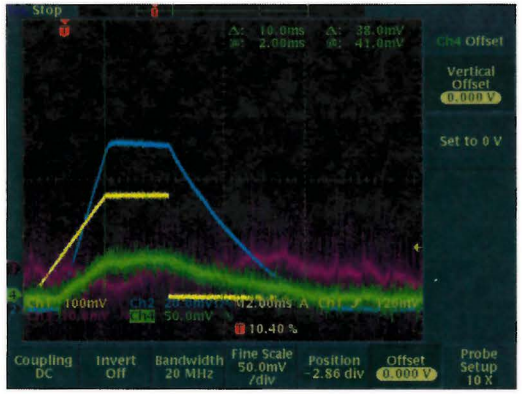
[20] *University of Trieste and INFN, Trieste, Italy*

Meson Test Beam Facility





- **Accelerator Division created a new beamline for MTest:**
  - 13 magnets moved, 11 new elements, new target
- **Significant upgrade to user facility:**
  - -New roof, new floor, diff. Cerenkov, pixel telescope
- **AD now investigating how to pulse beam at the msec level**

Pulsing the QXR supply with ~3 msec / 45 Volts

Beam Energy (GeV)	Rate at Entrance (per spill)	Rate at Exit of (per spill)	%Pions, Muons	% Electrons
16	132,000	95,000	87%	13%
8	89,000	65,000	55%	45%
4	56,000	31,000	31%	67%
2	68,000	28,000	<10%	>90%
1	69,000	21,000	<10%	>90%

CALICE's studies at Fermilab will benefit from the increased low energy flux

List of Test Beam Memoranda of Understanding (MOU):

T979: Ultra-fast timing
T978: CALICE Experiment
T977: MINERVA Experiment
T976: CsI Timing Experiment
T971: LHCb Silicon Detector Upgrade
T970: DHCAL Detector Research
T967: Muon g-2 Calorimeter Test
T966: Monolithic pixel detector for ILC
T965: PSiP Photosensors
T964: ILC GEM Chamber Characteristics
T963: STAR Muon Telescope Detector
T959: Microparticle Shielding Assessment
T958: FP420 Fast Timing Test
T957: NIU Tail Catcher/Muon Test
T956: ILC Muon Detector Tests
T955: RPC Detector Tests
T953: U. Iowa Cerenkov Light Tests
T951: ALICE EMCAL Prototype Test
T950: Vacuum Straw Tracker
T943: U. Hawaii Monolithic Active Pixel Detector
T941: UIowa PPAC Test
T936: US/CMS Forward Pixel
T935: BTeV RICH
T933: BTeV ECAL
T932: Diamond Detector
T931: BTeV Muon
T930: BTeV Straw
T927: BTeV Pixel
T926: RICE

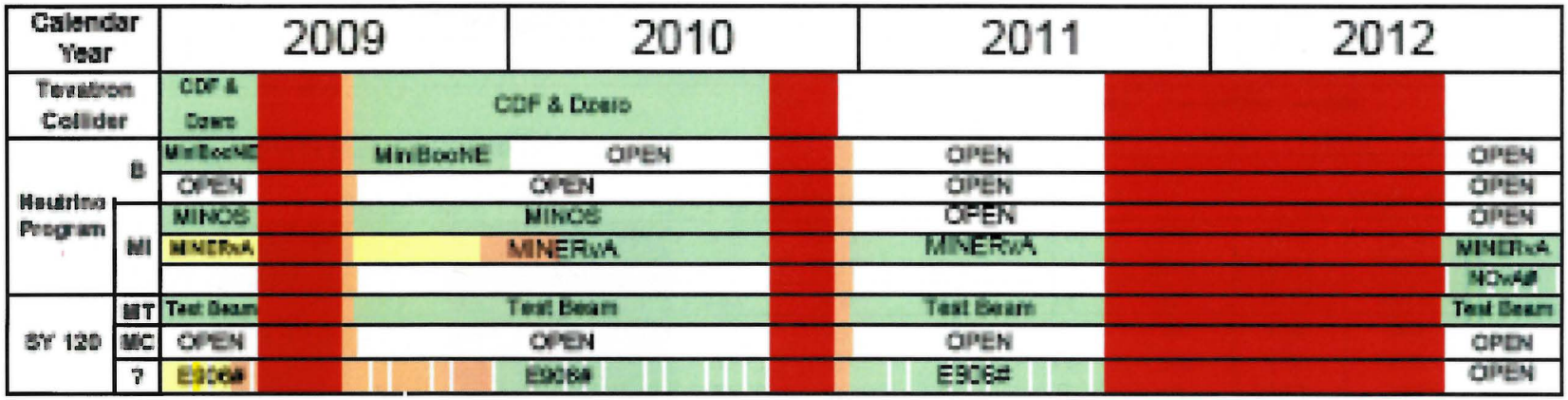
In 5 years, Fermilab's detector test beam facility has supported:

- 29 experiments
- which had a total of 87 institutions
- of which there are 45 U.S. institutions
- including 6 national laboratories

Draft Long Range Schedule

Draft 2009-12 Fermilab Accelerator Experiments Schedule

This version is tentative, and only for discussion; not yet a plan.



This draft schedule is meant to show the general outline of the Fermilab accelerator experiments schedule, including unscheduled periods.

Major components of the schedule include shutdowns:

In Calendar 2009, the Shutdown starts in the first full week of April, and lasts for about 10 weeks for civil construction.

An 8-9 week shutdown is shown for FY2010.

A 50 week shutdown is shown to upgrade the proton source and change the NuMI beam to the Middle Energy configuration.

Further action is required to establish scheduling of NOvA and Drell-Yan/E906.

- RUN or DATA
- STARTUP/COMMISSIONING
- INSTALLATION
- M&D (SHUTDOWN)

19-Mar-09

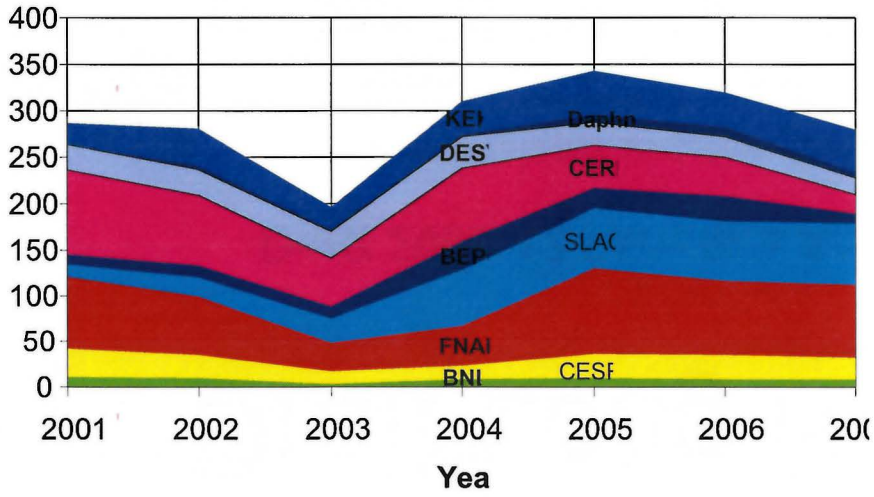
Basking in the Glow of Running Accelerators in the US

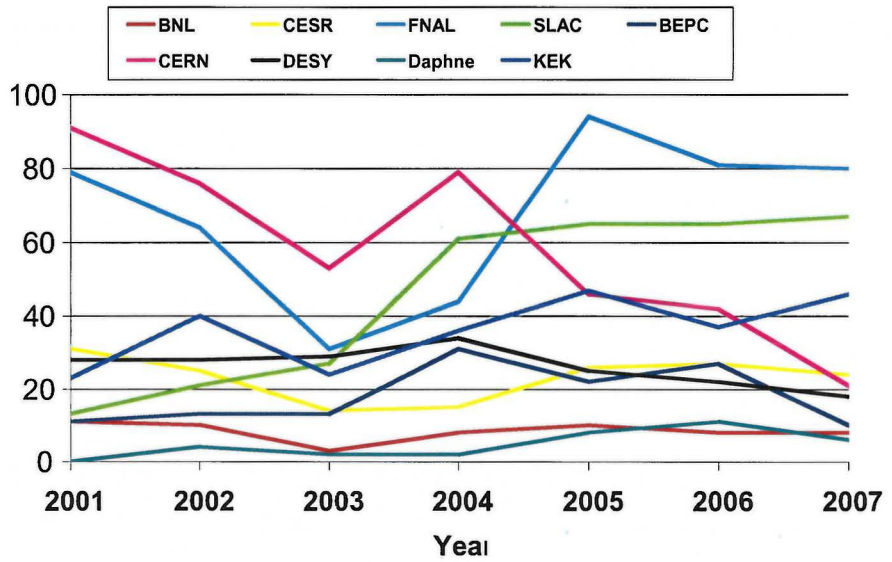
Experimental HEP Publications 2001-2007

Year	BNL	CESR	FNAL	SLAC	BEPC	CERN	DESY	Daphne	KEK	USA	WORLD
2001	11	31	79	13	11	91	28	0	23	134	287
2002	10	25	64	21	13	76	28	4	40	120	281
2003	3	14	31	27	13	53	29	2	24	75	196
2004	8	15	44	61	31	79	34	2	36	128	310
2005	10	26	94	65	22	46	25	8	47	195	343
2006	8	27	81	65	27	42	22	11	37	181	320
2007	8	24	80	67	10	21	18	6	46	179	280
Total	58	162	473	319	127	408	184	33	253	1012	2017
<mean>	8.3	23.1	67.6	45.6	18.1	58.3	26.3	4.7	36.1	144.6	288.1
Sigma	2.6	6.3	22.6	24.0	8.5	24.7	5.2	3.9	9.6	42.6	46.7

JHEP, Phys. Lett. B, Phys. Rev Lett., Phys. Rev. D, Euro.Phys J 8-Jan-12

Experimental HEP Publications 20





Conclusion

The current Fermilab experimental program is healthy, and producing world-leading HEP results, with the possibility for major discovery still available in the near term.