HEPAP Meeting

High Energy Physics Program
Argonne National Laboratory

March 7, 2003

Lawrence E. Price, Division Director

Selected Topics

HEP at ANL

1. The next steps in understanding neutrinos
2. Measurement of α_s at ZEUS
3. Preparing for physics at CDF
4. Putting LARGE pieces of ATLAS together
5. Dielectric-loaded waveguides at high power
6. Calorimetry for the Linear Collider
7. Higgs production at LHC with soft gluon resummation

8. Budget shocks

1. The next steps in understanding neutrinos

What we'll know

MINOS/UNO
Borexino/Lens
JPARC/reactor
Off-axis
OPERA
Mini-BooNE
KATRIN
ββ
ν-Factory
ν-Telescopes

- ✓ See dip in atmospheric ν L/E distribution
- ✓ Measure the Energy Spectrum of Solar ν's.
- ✓ Determine U_{e3} (θ_{13})
- ✓ Are CP violation effects Large?
  - ✓ If so, what is the CP phase δ?
- ✓ Can we see τ's in $\nu_\mu \rightarrow \nu_\tau$?
- ✓ Can we settle the LSND question?
- ✓ Measure the absolute ν masses?
- ✓ Is the neutrino Majorana or Dirac?
- ✓ Is the mass hierarchy normal or inverse?
- ✓ Are there astrophysical sources of >TeV ν's?

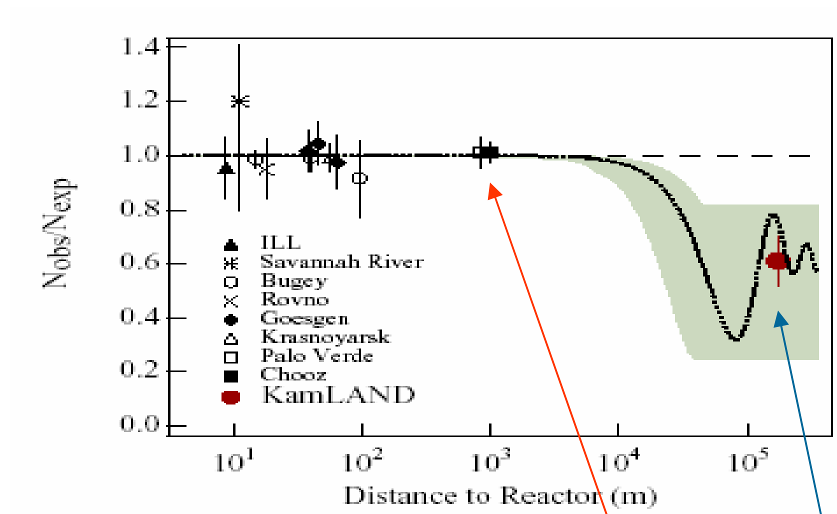
March 13, 2003
Neutrino Telescopes, Venice

Maury Goodman, Argonne

42

Possible Reactor search for θ_{13}

- Previous experiments limited by 3% uncertainty in reactor power.
- All measure the same energy spectrum.
- Further detectors need more overburden to reduce backgrounds
- Need 10-100 tons (not kilotons)
- Potentially cheap and fast
- Use 2 or 3 similar detectors
- **Need careful control of systematics!!!**



KamLAND sees a 40% deficit/shape at 200km

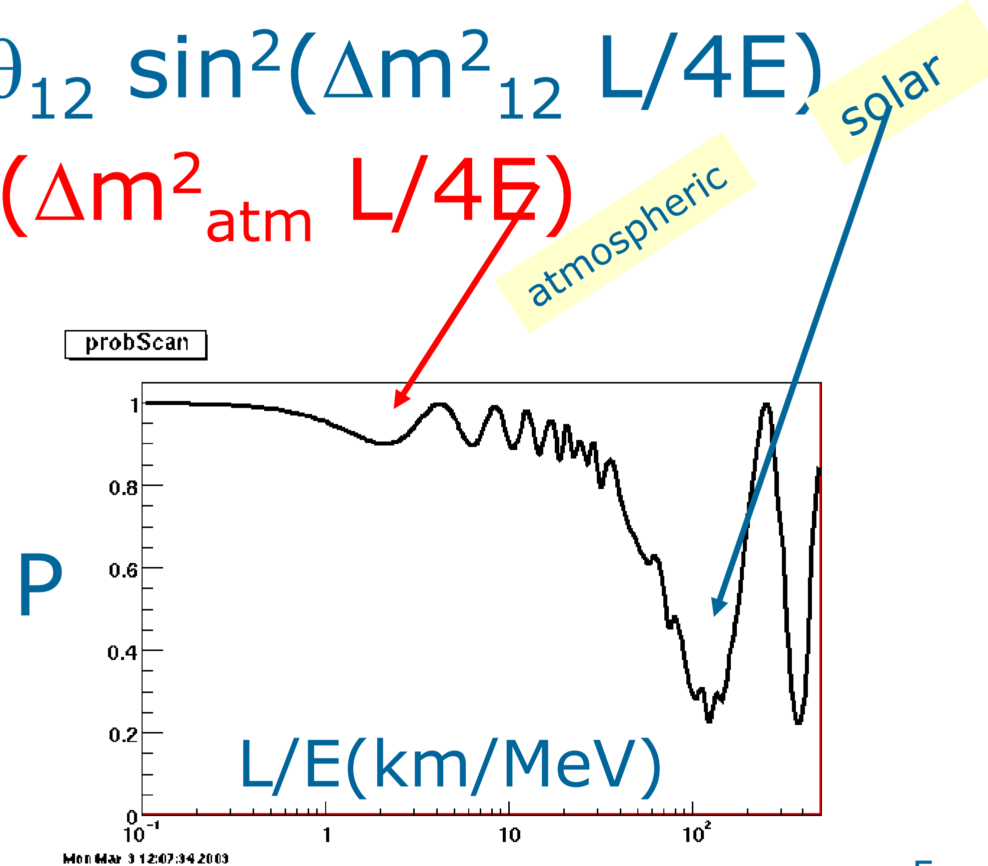
related to Δm^2_{12}

Search for a 1-5% deficit/shape at ~1 km

related to Δm^2_{23}

Θ_{13} from reactors

- $P(\nu_e \rightarrow \nu_e) = 1$
- $- \cos^4\theta_{13} \sin^2 2\theta_{12} \sin^2(\Delta m^2_{12} L/4E)$
- $- \sin^2 2\theta_{13} \sin2 (\Delta m^2_{atm} L/4E)$
- (Ignores CP)
- (Ignores matter)



Possible Sites

Previous Reactor Experiments and new sites under consideration

Chooz	France	1100 m	8.5 Gw	300 MWE	5 ton
Bugey	France	40/95 m	5.6 Gw	16 MWE	1/0.5 ton
Palo Verde	US	890 m	11.6 Gw	32 MWE	11.3 ton
KamLAND	Japan	180 km	200 GW(26)	2700 MWE	1000 ton
Krasnoyarsk	Russia	115/1000 m	~1 GW	600 MWE	46t
Chooz-2	France	450/1100 m	8.5 GW	?/300 MWE	
Diablo Canon	US (Cal)	(~1 km?)	6.1	600 MWE	
Wolf Creek	US (KS)	(~1 km?)	3.2 GW		
Boulby	UK	25 km	3.1 GW	2860 MWE	
Heilbronn	Germany	19.5 km	6.4 GW	480 MWE	
Kashiwasaki	Japan	1.7 km	24.3 GW		20 ton
Texono	Taiwan	(~2 km?)	4.1 GW(NP4)		
IMB/Perry	US(Ohio)	10 km	1.2 GW	1570 MWE	
Reactor	Location	Detector L	Power	Overburden	Detector M

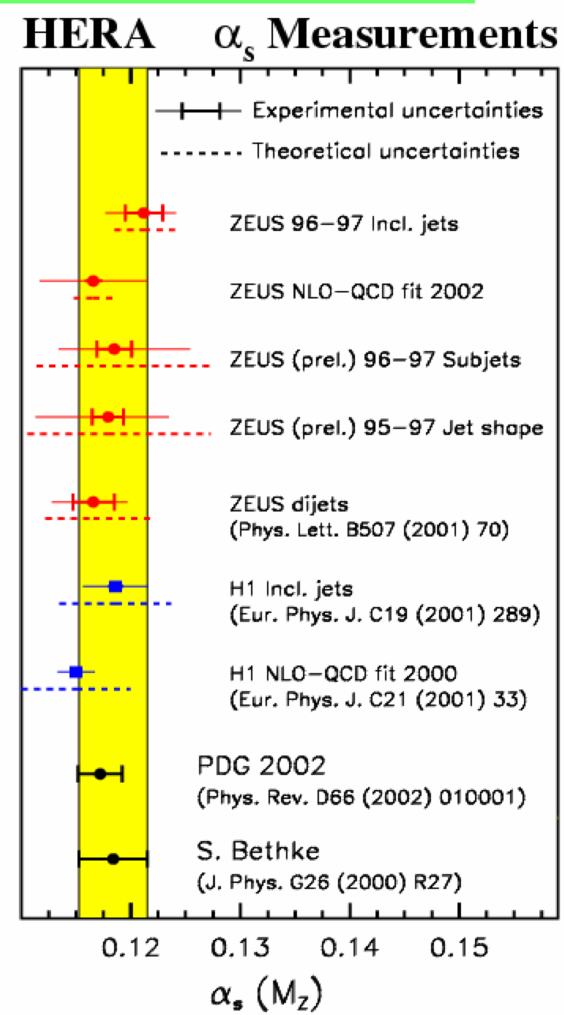
Meanwhile the MINOS detector is coming together

Measurements of α_s at ZEUS

Inclusive Jet Cross Sections in the Breit Frame, Physics Letters B 547 (November 2002) 164-180

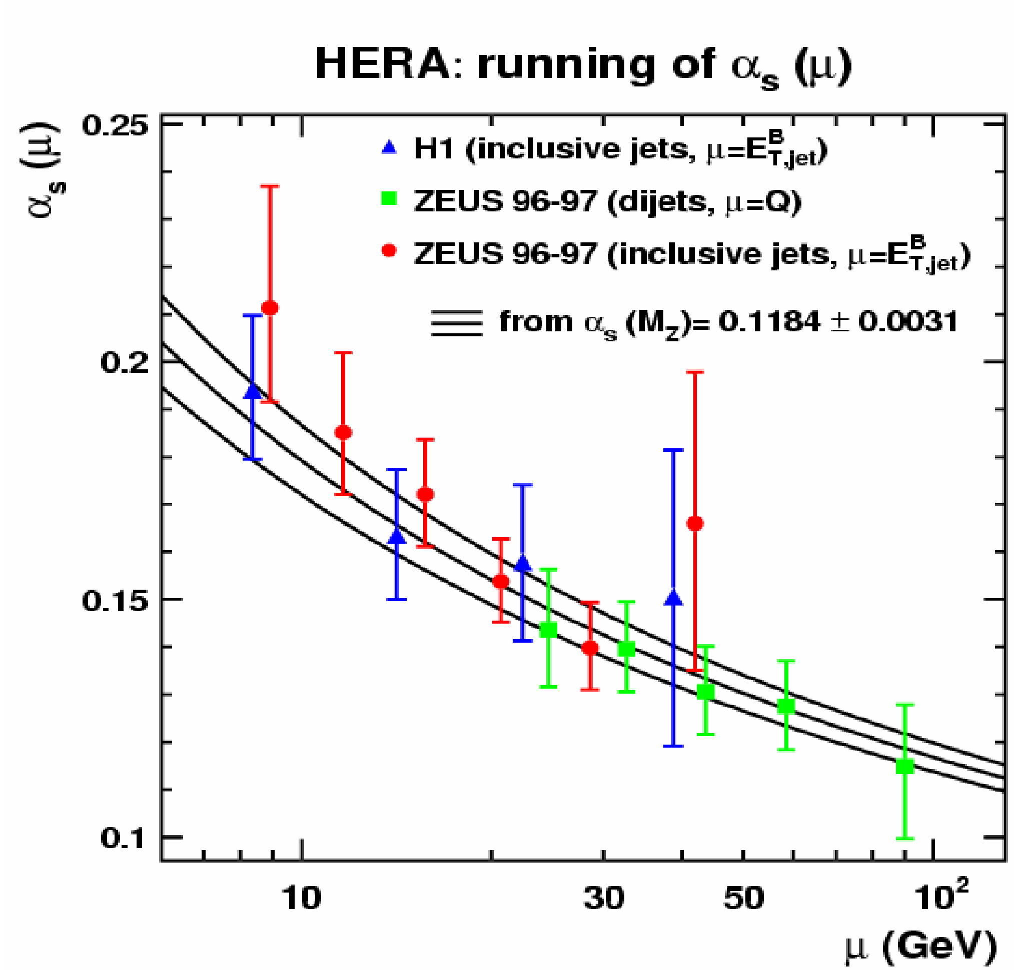
Best published measurement of α_s is from inclusive jets

- **Experimental and theoretical errors are roughly equal**
- **Decade long program with significant Argonne leadership**
  - ***Studies of jet algorithms, leading to choice of k_T algorithm***
    - minimize the uncertainty of hadron to parton corrections
    - infra-red safe
  - ***Close collaboration with NLO code generators: D. Graudenz, E. Mirkes, D. Zeppenfeld, M. Seymour, S. Catani, B. Poetter, M. Klasen, M. Kramer, S. Frixione . . .***



Measurements of α_s at ZEUS

- ***Precision measurement of alphas in widest range of scales in one experiment***
- ***Enormous effort to understand calorimeter energy scale for hadronic jets, comparing different methods***
  - ANL pioneered the most precise determination, based on a comparison of the transverse momenta of the scattered electron and the balancing jet in DIS NC events



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Preparing for physics at CDF

Focus on B physics

- Masa Tanaka, Bob Wagner, Karen Byrum, Barry Wicklund, Tom LeCompte
- Extensive work on b triggers, which are working well
  - *5 x as many J/psi per pb-1 as Run I*
  - *modified the Run II trigger to collect J/psi events all the way down to Pt=0, cf Pt>5 in run I.*
    - looking at 100% of the J/psi cross section, versus 7% in run I
- Calibration of away-side flavor tags

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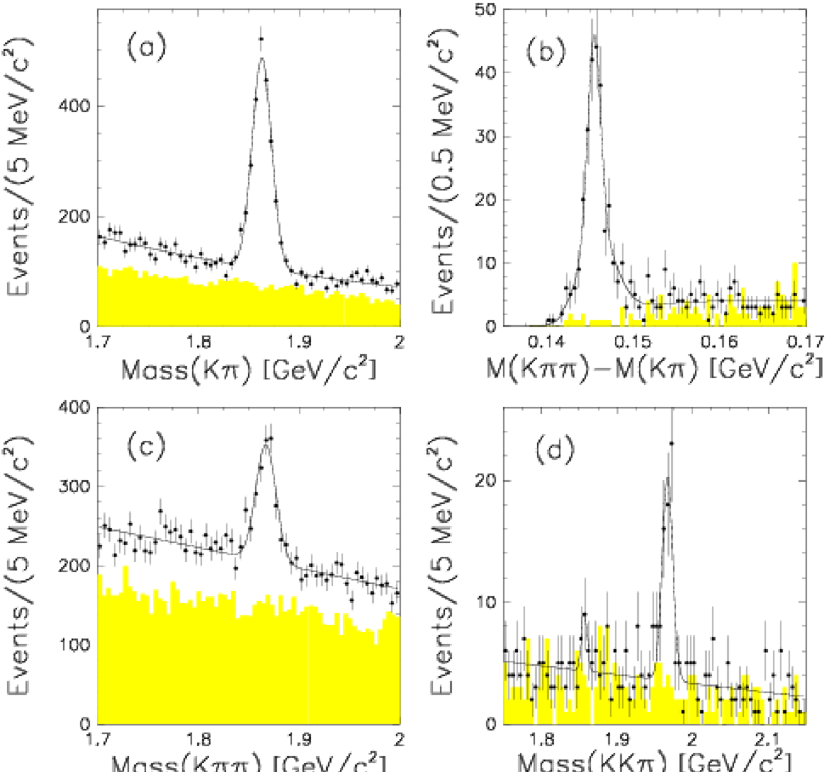
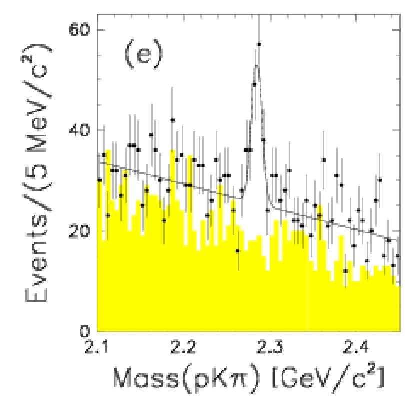
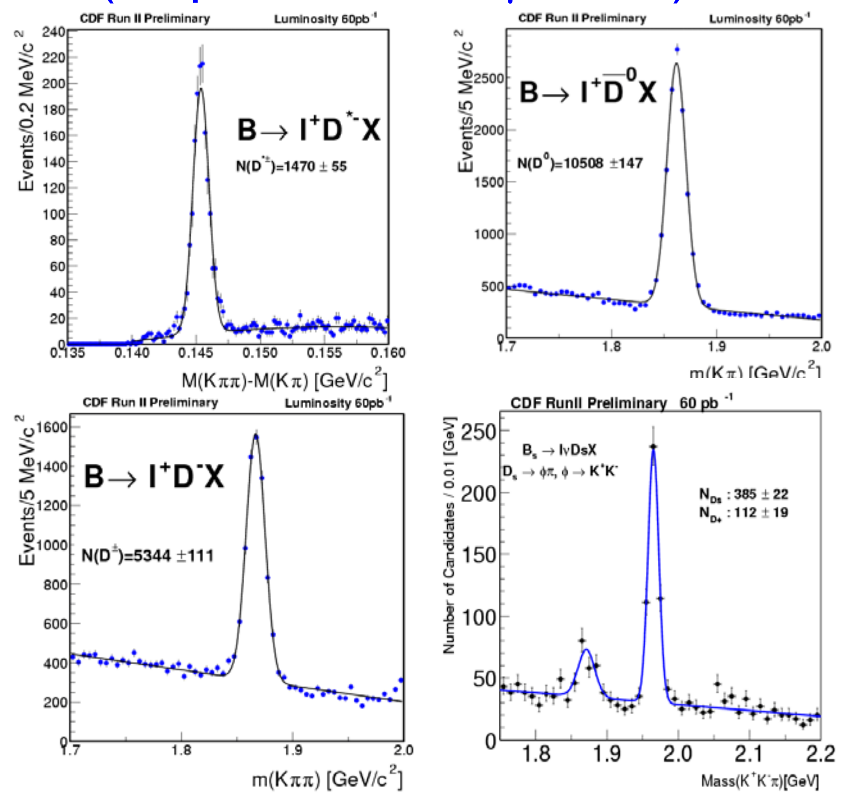
- Run I (100 pb^{-1}, 8 GeV e)

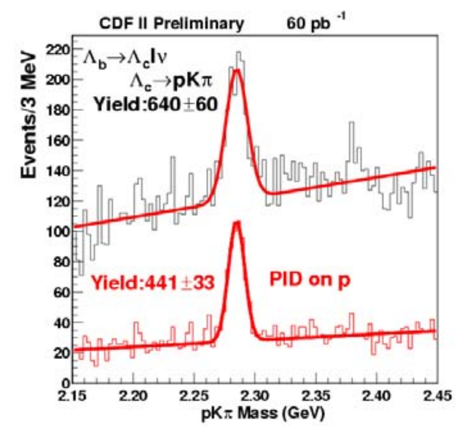




- Run II(60 pb^{-1},4 GeV e/μ+SVT)



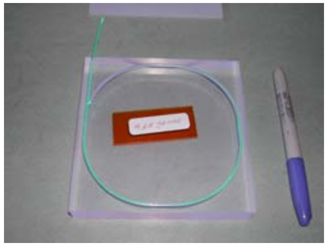
	D^0	D*	D^+	Ds	Λ_c
Run I (/100 pb^{-1})	1800	230	730	60	60
Run II (/60 pb^{-1})	5000	800	2700	400	450
(Run II / Run I)	4.5	5.8	6.2	11.	7.0



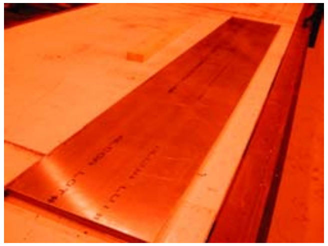
CDF Preshower Run IIb Upgrade

Steve Kuhlmann, Level-2 Manager
Joey Huston, Level-3 Manager Preshower
Dave Toback, Level-3 Manager EM Timing

- 2 cm Dubna scintillator for Preshower



- Aluminum shells, full-scale mechanical prototype built at ANL



- Prototypes being assembled and tested at ANL

Putting LARGE pieces of ATLAS together

HEP at ANL

Preassembly of the Scintillating Tile Hadronic Calorimeter began at CERN in November

- Module production (10 and 20 ton pieces) is complete
- Now assembling 650 and 1300 ton barrels
- Structural design and analysis done at ANL
- All calorimeters and cryostats are supported by the tile calorimeter

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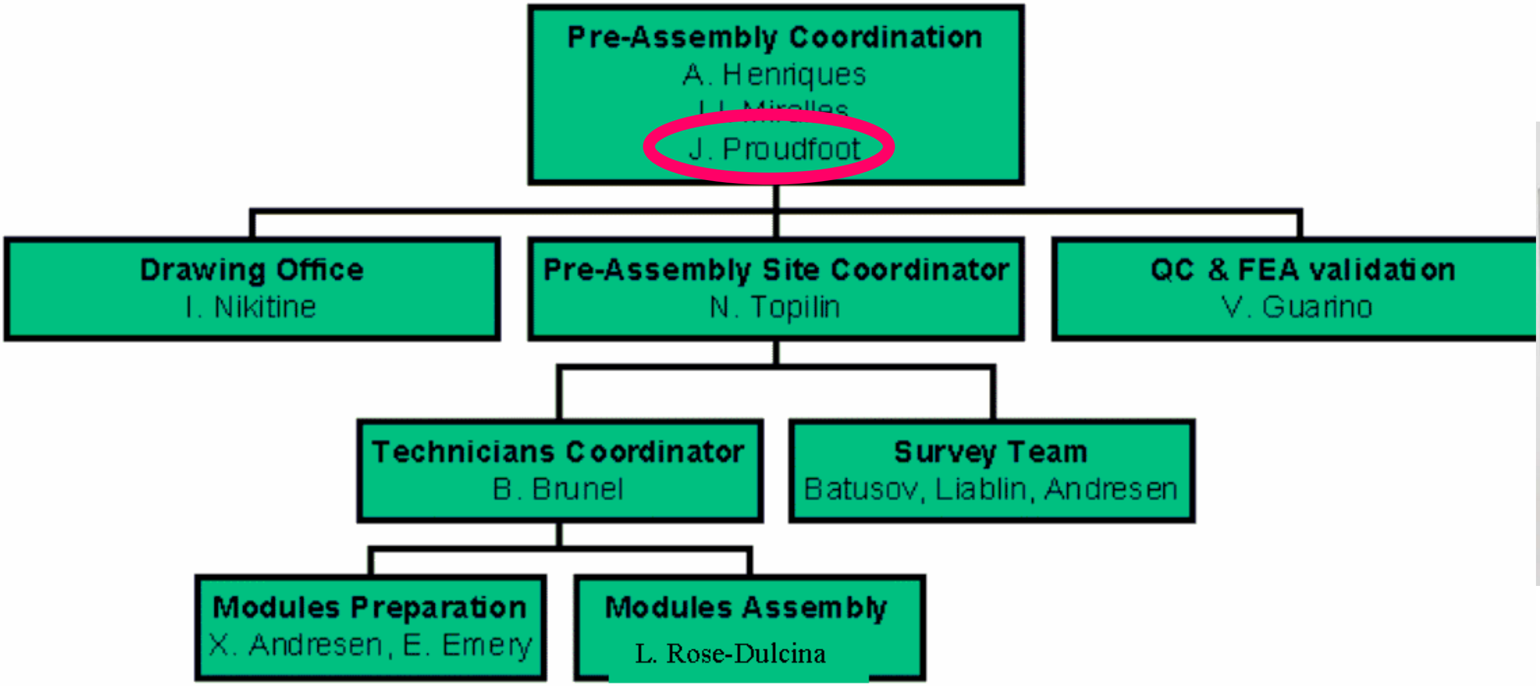
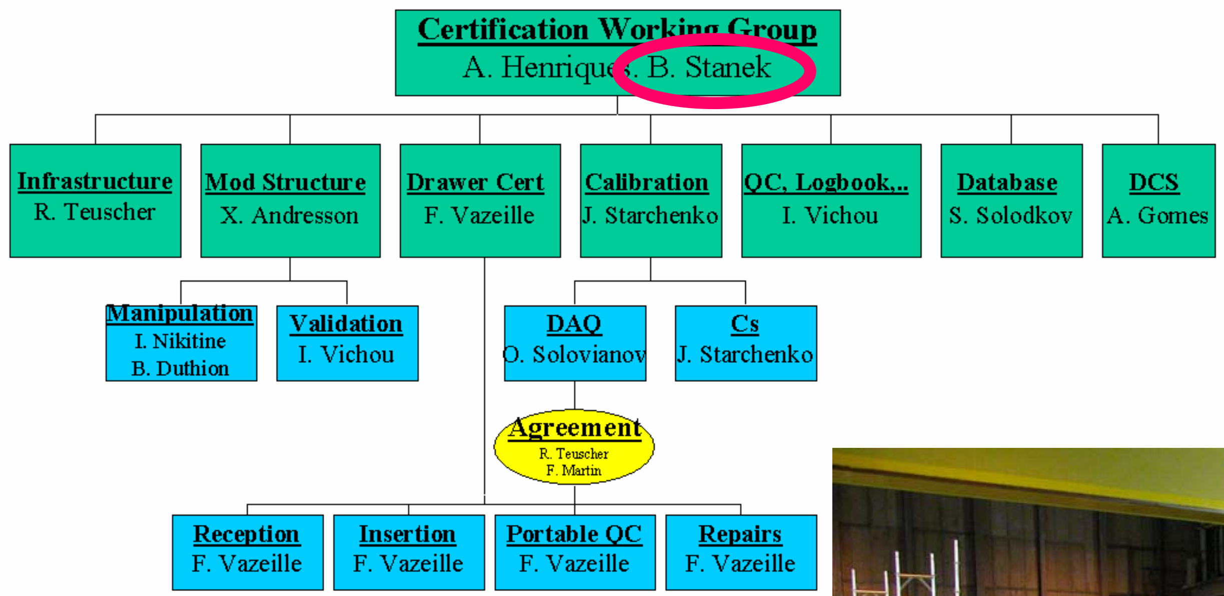

Pre-Assembly Coordination
A. Henriques
J. Proudfoot
Drawing Office
I. Nikitine
Pre-Assembly Site Coordinator
N. Topilin
QC & FEA validation
V. Guarino
Technicians Coordinator
B. Brunel
Survey Team
Batusov, Liablin, Andresen
Modules Preparation
X. Andresen, E. Emery
Modules Assembly
L. Rose-Dulcina


ATLAS


Module Certification Process

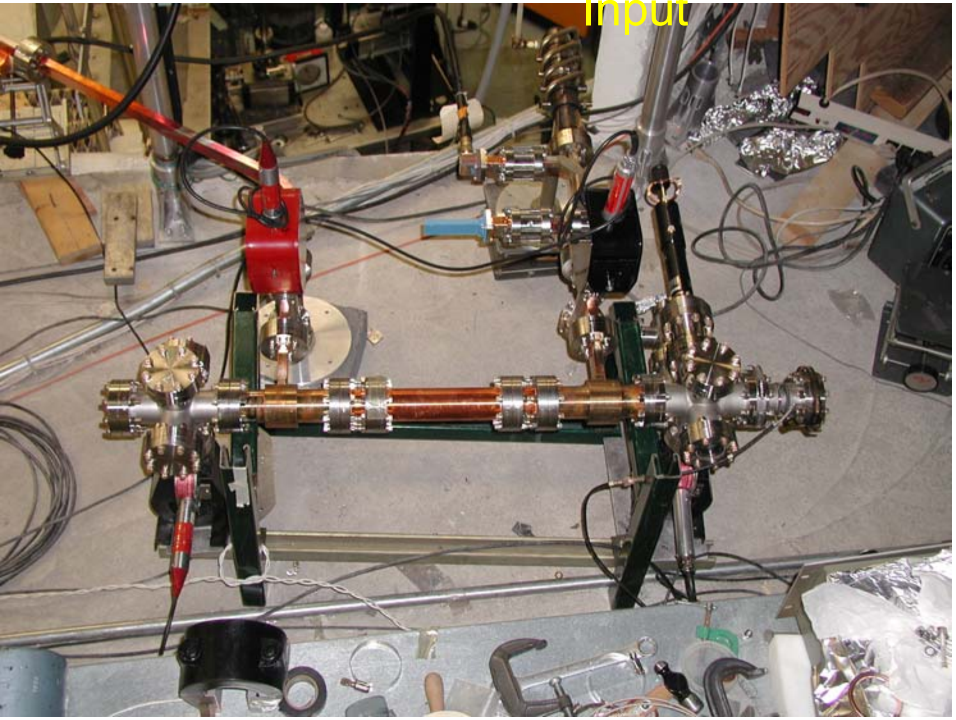


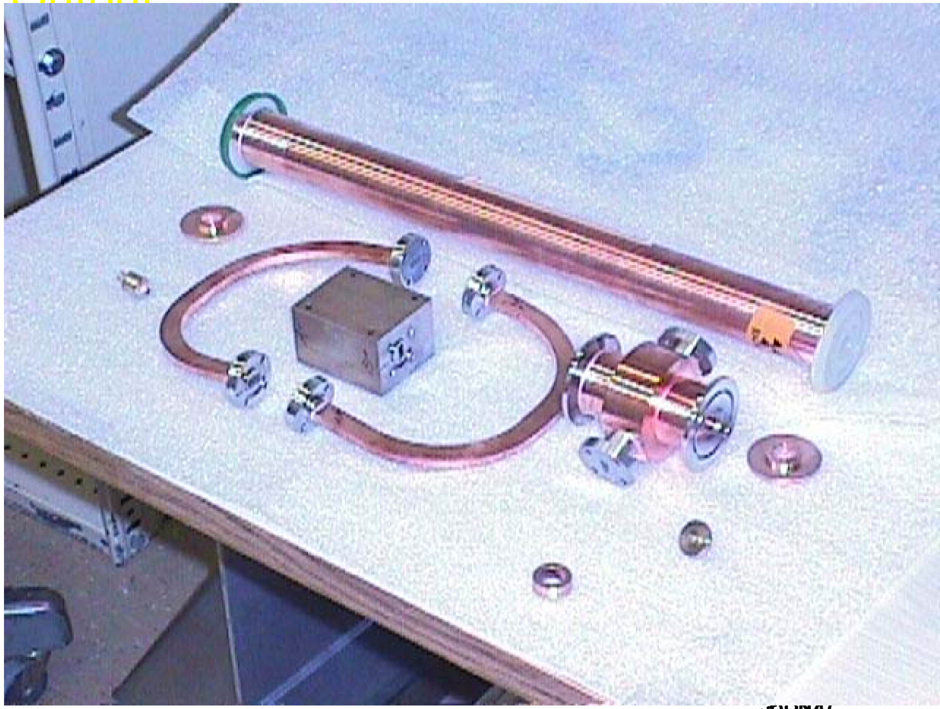
- Checkout with 3 Tile calibration systems
  - CS137 source in tubes
  - Laser flasher to test PMTs
  - Charge injection to preamplifiers
- Set PMT gains
- Verify Envelope and Mechanical Integrity

5. Dielectric-loaded waveguides at high power

NRL Test Set-up

CERN Test Parts



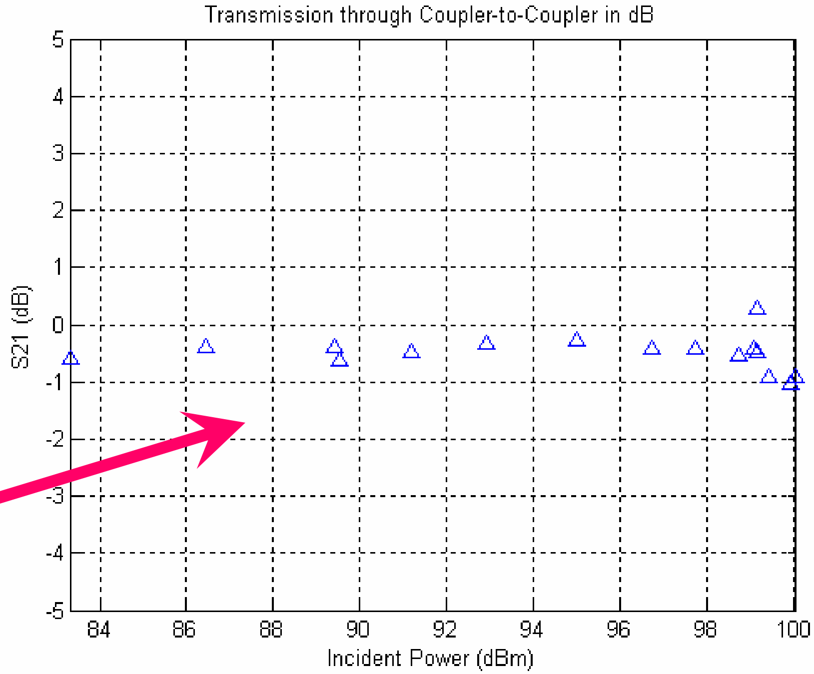


Experiment Summary

HEP at ANL

First tests of Dielectric Loaded Accelerator structures at high power to determine breakdown limits

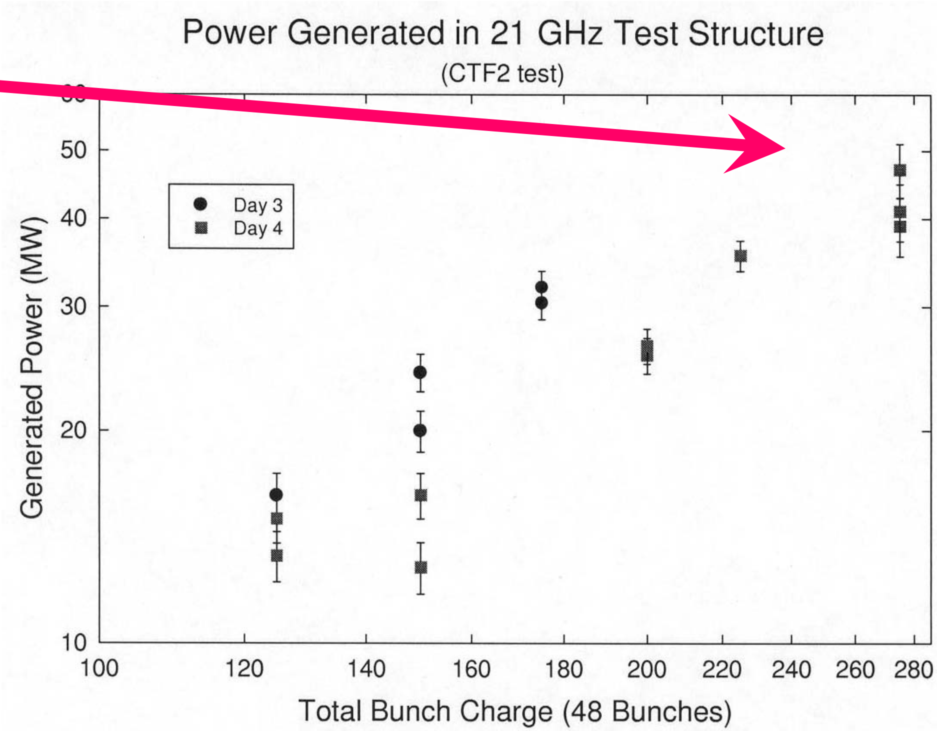
– **1. Alumina structure at Naval Research Laboratory**
  - *Redesigned rf coupling eliminate arcing problem of first model*
  - *No dielectric breakdown was observed for 150 – 200 ns pulse up to 5 MW; A few breakdown signatures were observed at 1.5 micro-seconds*
  - *Excellent coupling of the rf power*
  - *Observed absorbtion of RF power and light emission at high power (new phenomenon).*
  - *No dark current observed at the Faraday cup*



Experiment Summary

HEP at ANL

- 2. Corderite structure at CERN
  - *No dielectric breakdown observed up to 40 MW*
  - *Nonlinear power absorption not observed, although power was higher*
- Interpret power absorption and light production as secondary electron emission in Alumina, which has a low emission coefficient.
- MgCaTi materials with very low emission coefficients will be on hand shortly and will be tested for the observed effect.
- If this interpretation is correct, coating alumina or other dielectrics with TiN or simple Ti should suppress the emission. This will be tried shortly.



e 1: Power generated in the 21 GHz Power Extractor for various total beam charg

6. Calorimetry for the Linear Collider:

Collaboration

Argonne National Laboratory

I Ambats, G Drake, V Guarino, J Repond, D Underwood, B Wicklund, L Xia

Boston University

J Butler, M Narain

Fermilab

(M Albrow), C Nelson, R Yarema, (A Para, V Makeeva)

University of Chicago

K Anderson, E Blucher, J Pilcher, M Oreglia, H Sanders, F Tang

Development of a Digital HCAL with RPCs

- Goal is calorimeter with 30%/sqrt{E} (needed for disentangling WW and ZZ Higgs decay channels) –
- This ambitious goal requires new approach: Energy Flow Algorithm
- Argonne working on simulation and development of RPCs as active medium of the HCAL to realize this goal
  - Simple, cheap, reliable, able to be finely segmented (as needed for Digital HCAL)
  - Excellent results in our test chambers with single pads (high eff, low noise) - starting measurements with multi-pads –
  - Big challenge: development of readout for such large number of channels: - 1m^3 prototype will have 400,000 channels –
    - will require custom front-end ASIC

IV. Design work on the electronic readout

System overview

I RPC ASIC

located on the chambers

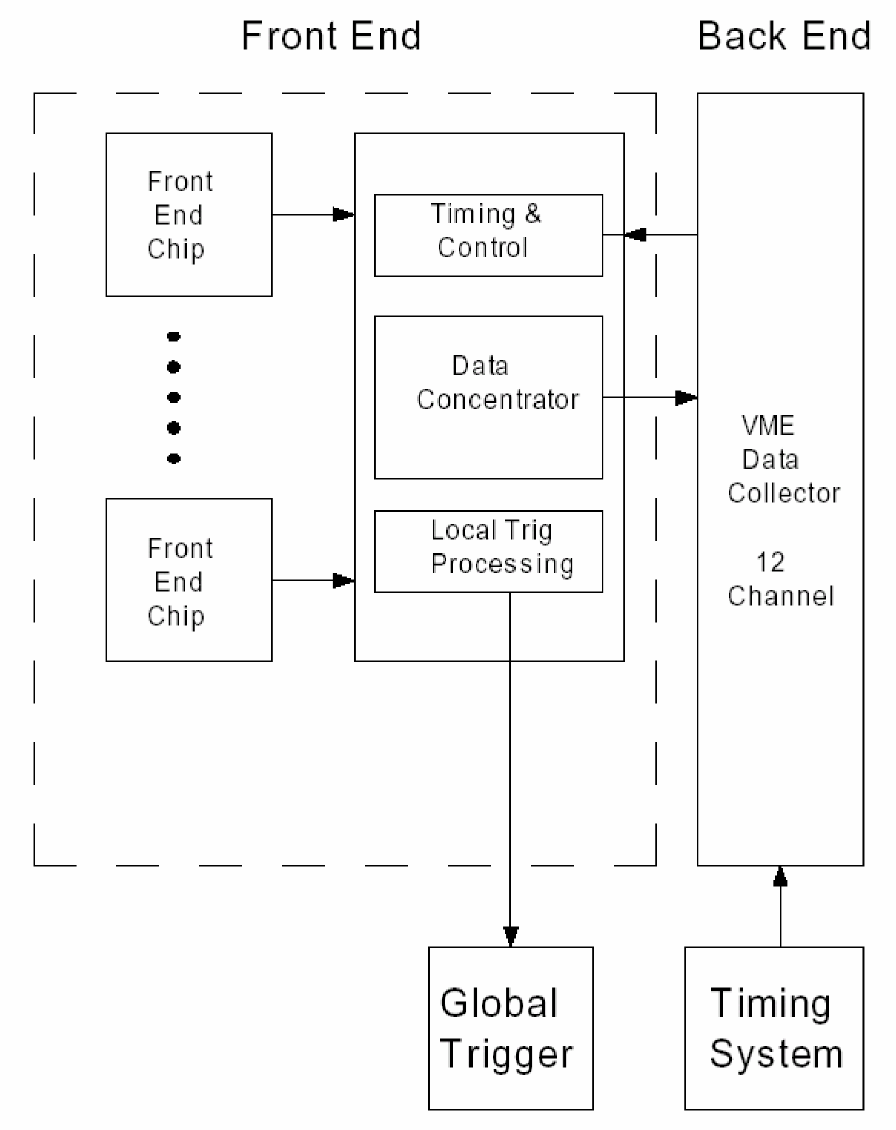
II Data concentrators

funnels data from several FE chips

III VME data collector

funnels data from several data concentrators

IV External timing and trigger system



VI. Plans for the next 15 months

Finalize chamber design by 6/03

Complete tests with prototype readout systems by 6/03

Specify characteristics of FE ASIC by 7/03

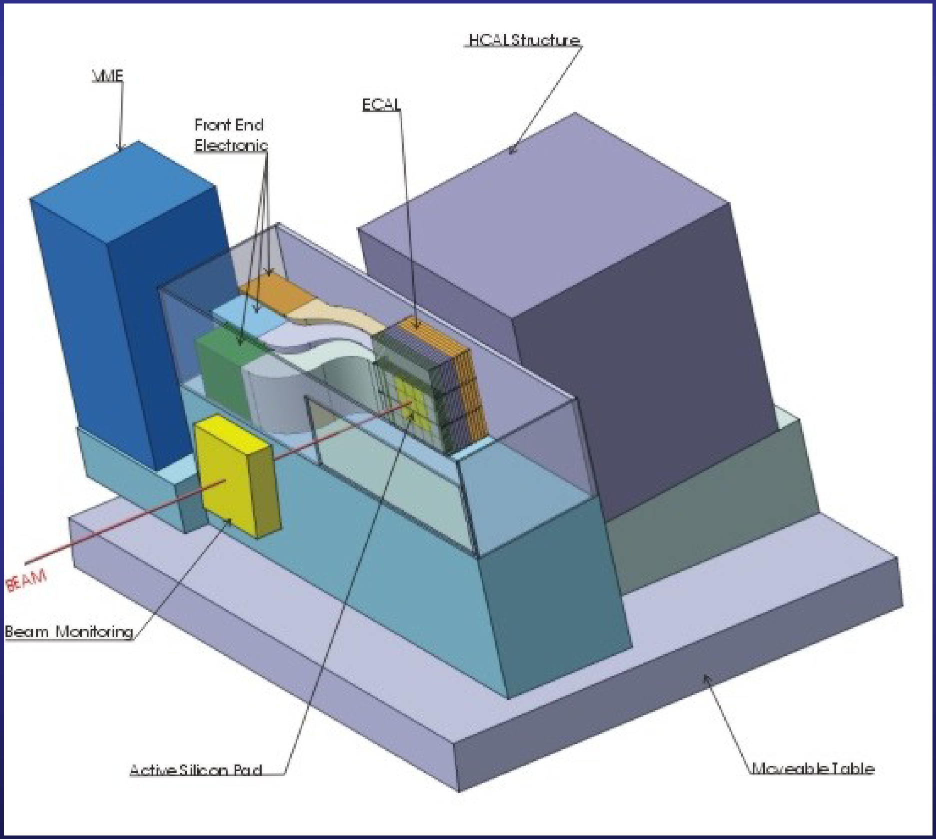
Initiate production of chambers by 10/03

Evaluate pre-production of readout boards and ASIC by 3/04

Initiate production of readout boards by 4/04

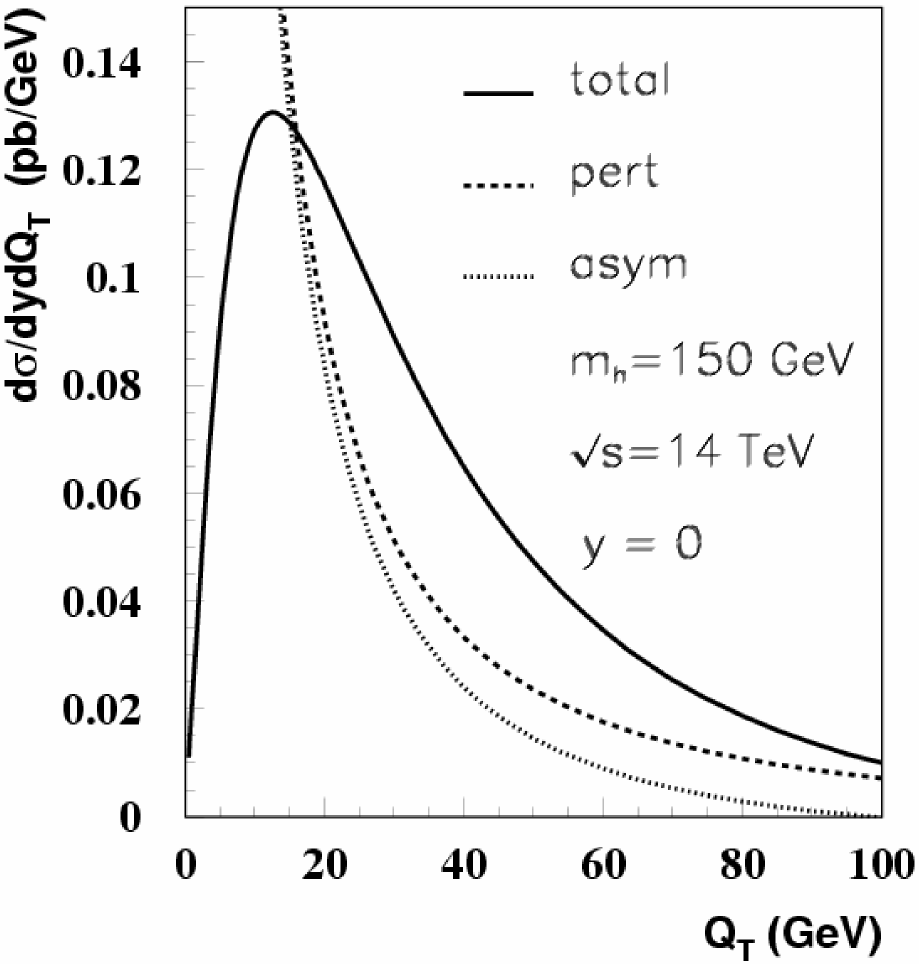
Initiate production of data collections systems by 4/04

Goal: Ready for test beams in Summer 2004



7. Higgs production at LHC with soft gluon resummation

- E. Berger and J. Qiu, hep-ph/0212306.
- Gluon fusion most important Higgs production channel at hadron colliders.
- Fixed order perturbation theory gives divergent result at low transverse momentum. To master the divergence we must sum the effects of gluon radiation to all orders in the strong coupling.
- Result suggests that signal to background ratios can be improved by selecting Higgs bosons with "large' Q_T



ANL and National HEP Priorities

HEP at ANL

From President's Budget Justification (Purple **= work at ANL)**

- The major activities under the Proton Accelerator subprogram are the broad research programs using the **CDF** and **D-Zero** detectors at the Tevatron at Fermilab; the neutrino research program using the **NuMI/MINOS** and **MiniBooNE** facilities at Fermilab and at the **Soudan Mine site** in Minnesota; the **LHC program**, and **maintenance and operation** of these facilities. The **Tevatron collider** programs will determine whether the Standard Model accurately predicts the mechanism that breaks the symmetry between natural forces and generates mass for all fundamental particles or whether an alternate theory is required. The **NuMI/MINOS** and **MiniBooNE** programs will perform decisive controlled measurements of fundamental neutrino properties, including neutrino oscillations, which will provide important clues and constraints to the theory of matter and energy beyond the Standard Model. The **LHC program** will insure that the U.S. high energy physics research program will be one of the key players at the next energy frontier. There are much smaller specialized efforts involving the **HERA accelerator** machine at DESY in Germany, and the **KEK proton accelerator** in Japan.

8. Budget shocks

HEP at ANL

We are doing key parts of the projects that have high priority and are at the center of the HEP program, especially in Proton Accelerator Research, Theory, and Accelerator R&D.

For the FY 2004 President's budget, the DOE HEP budget went up (marginally), Proton Accelerator Research nationally went up (marginally), but Argonne's budget in this area went down by a larger amount.

There was an increase in the (smaller) Accelerator R&D task and that will permit faster progress in understanding dielectric structures and doing practical acceleration with them.

Total ANL HEP base budgets

	Then-year K$	2004$ Inflation Corrected	2004$ Scientific Inflation Corrected
FY 1998	8305	9353	10508
FY 1999	8480	9363	10317
FY 2000	8465	9163	9903
FY 2001	8409	8924	9459
FY 2002	8013	8337	8667
FY 2003	8165	8328	8492
FY 2004 (Pres.)	7995	7995	7995

2004 ANL Program Goals

CDF: Operate and maintain EMCal, prerad, sh max (new ANL front end electronics), e/γ and B triggers and electron software; Prototype Run IIb preshower system; manage CDF detector ops and Run IIb Calorimeter upgrades; physics results in B-production and flavor tagging (J/psi and semileptonic subgroup management), W/Z, photon production/calibration; jet res. for Higgs (+LC overlap)

ZEUS: Operate and maintain U-Scint Cal, Cal trigger proc., SRTD L1 trigger, barrel presamp, Straw Tracker FE electronics; ZEUS spokesman; coordinate 2 analysis groups; extract physics results in structure functions, jets and α_s, precision EW studies

MINOS: Install/commission near detector & electronics; Install NuMI neutrino beam; Develop software to measure neutrino cross sections; Continue physics analysis of cosmic muon charge ratio

ATLAS: Complete tile preassembly and begin installation in pit (ATLAS critical path); Write High Lev Trig TDR, test prototype SRB; DB Core software and data challenge 2/3

2004 ANL Program Goals

HEP at ANL

Theory: Publish in QCD, Beyond SM, Collider pheno, Lattice calcs, alternative quantization, and others; workshop on 3rd gen fermions

Advanced Accelerator R&D: Acceleration studies high current single and multiple drive pulses generation and characterization; high gradient wakefield generations using the high current electron beam and its applications for 2 beam transformer system; high power rf studies on X-band dielectric wave guides

R&D/Study projects: Build and beam test 1 m^3 lin coll calorimeter, LC simulation of physics results vs. hadronic resolution; Provide mechanical design, cost estimate, schedule and detector prototype for NuMI off-axis expt; Build and test 500 channel prototype of Veritas upgrade camera; Write proposal for Reactor θ_{13} experiment

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We are losing people because of budgets

FY 2002

- -5 technicians (of 15)

FY 2003

- -2 physicists (of 43 E+T, including postdocs)
- -1 technician

FY 2004

- -2 physicists
- -2 technicians
- +1 Accelerator physicist (4 prev)

Experimental Impacts on 2004 Goals

HEP at ANL

Lost in 2004 Pres. Bud.

CDF: (no change)

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