Argonne National Laboratory
High Energy Physics Division

Overview of the
HEP Electronics Support Group

Gary Drake

May 24, 2011

Presentation for DOE Review

Electronics Support Group Personnel

Gary Drake	*Group Leader, EE*
John Anderson	*Elec. Eng.*
Patrick De Lurgio	*Elec. Eng.*
Denis Fellman	*Software Professional*
Andrew Kreps	*Elec. Eng*
Jim Schlereth	*Software Prof. (p.t.)*
Bill Haberichter	*Engineering Specialist (p.t.)*
Tim Cundiff	*Engineering Assistant*
Todd Hayden	*PCB Layout*
Jim Bulka	*Instrument Repair/Fabrication*
Mike Anthony	*Instrument Repair/Fabrication*
Joe Pratl	*Instrument Repair (p.t.)*
Carolyn Adams	*Electronics Technician*
John Walendziak	*Electronics Technician*

Total Staff:

- **4 Hardware Engineers**
- **1.5 Software Engineer**
- **1.5 Technical Assistants**
- **1 CAD Layout Person (EA)**
- **2.5 Instrument Repair (EA)**
- **2 Electronics Technicians**

⇨ **14 People Total (12.5 FTEs)**
- **~ 6 FTEs Support HEP**
- **~ 6.5 FTEs Support Other Basic Sciences (PHY, CHEM, Mat. Sci., APS (CAD))**

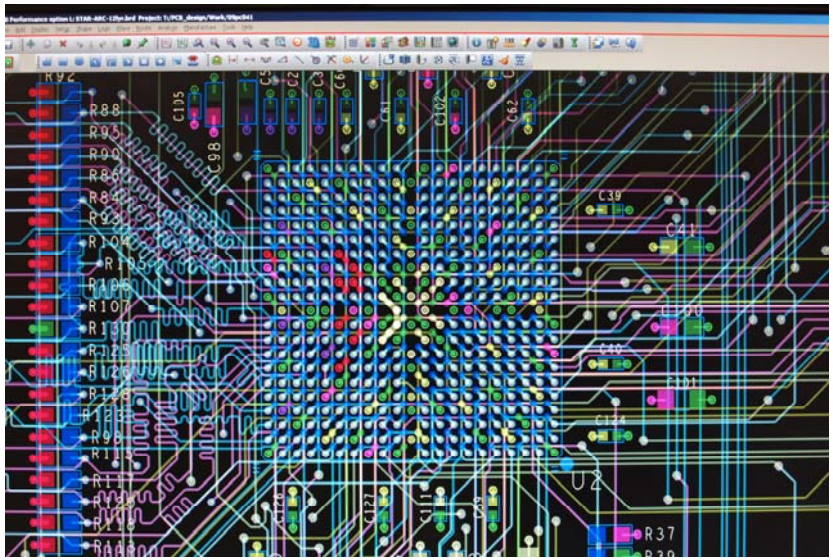
⇨ **Strengthens HEP Program**

⇨ **Provides Crucial Electronics Support for ANL Science & Research**

⇨ ***Well Rounded Group with High Levels of Expertise, Capable of Taking on a Wide Range of Projects***

Group Specialties & Expertise

A. High Speed Digital Design



Types of Projects:

- Data Acquisition
- Trigger Processors
- Computer Interfaces
- High-Speed Communications

Tools & Techniques:

- High-Performance Printed Circuit Board Design (Schematic Capture, PCB Layout, Auto-routing)
- Design with Programmable Logic (FPGAs)
- VHDL
- Timing Simulaiton
- Designs Using Surface Mount Technology
- Designs using Ball Grid Arrays (BGA)

Contributions To:

- **CDF Shower Max**
  - **Readout Board**
- **MINOS Near Detector**
  - **Readout Board**
- **ATLAS TDAQ**
  - **Region of Interest Builder**
- **VERITAS L2 Trigger**
  - **L2 Trigger System**
- **ATLAS FTK**
  - **Readout Driver**

Group Specialties & Expertise

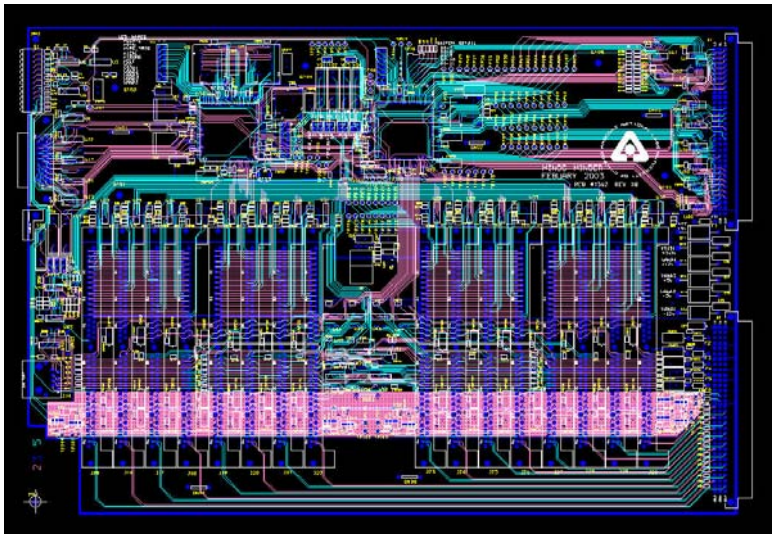
B. Front End Design

Types of Projects:

- Charge Amplifiers
- Preamplifiers
- Digitizers
- Discriminators
- *Implementation of Custom Integrated Circuits (ASICs)*
- Low-Noise Design & Analysis
- HV Power Supply Design
- Switching Power Supply Design

Implementation Techniques:

- Printed Circuit Board Design
- SPICE Simulations
- Surface Mount Technology
- Custom Circuit Design (Collaborate with FNAL)



Contributions To:

- **CDF Shower Max**
  - **ASIC design**
  - **Front-End Board design**
  - **Preamp design**
- **ZEUS Straw Tube Tracker**
  - **Front End Board**
  - **CW PMT base**
- **MINOS Near Detector**
  - **Front-End Board design**
  - **PMT discriminator**
- **Digital HCAL Detector R&D**
  - **Front-End Board design**
- **ATLAS TileCAL**
  - **Low Voltage Power Supply**

Group Specialties & Expertise

C. System Design

Types of Projects:

- Trigger Systems (ATLAS, VERITAS, CDF, ZEUS)
- Front End Data Acquisition Systems (Digital HCAL, MINOS, CDF, ZEUS)

⇨ ***Often Assume Leadership Roles in System Design & Project Engineering***

⇨ ***Form Collaborations & Working Relationships with Other Institutions***

⇨ ***We Provide Support for Our Electronics (and Often Electronics Built for Others) For the Life of the Experiment***

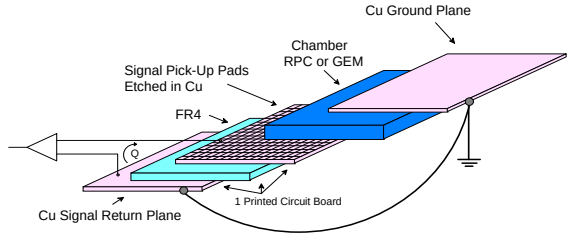
Group Specialties & Expertise

C. System Design (Continued)

⇨ *Close association with division physicists absolutely essential in these projects*

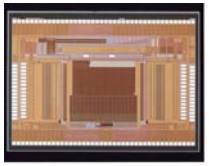
An Example: RPC Digital HCAL Detector R&D

- **We conceived the electronics concept**

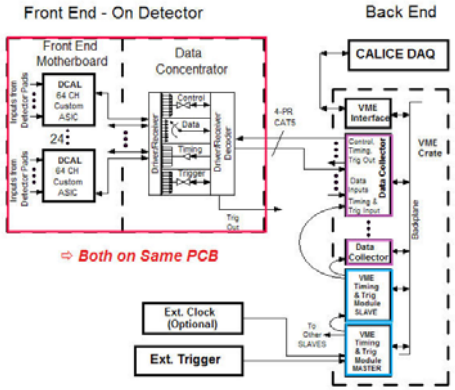


- **We specified & tested the ASIC → FNAL**

DCAL
ASIC



- **We designed the system, & formed a design team**



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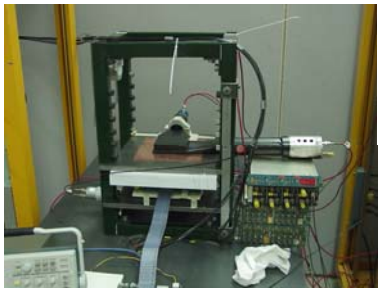
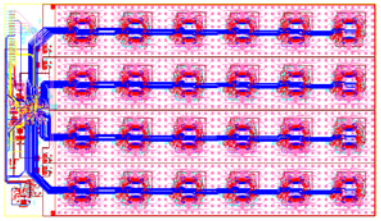
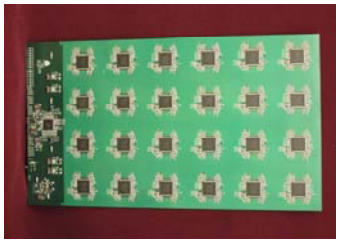
Fermilab

- **We built a Vertical Slice Test**

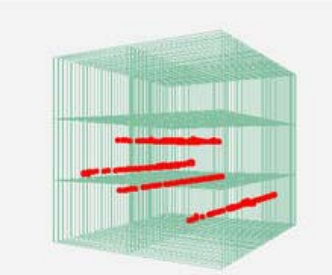


- **We designed the front-end board**

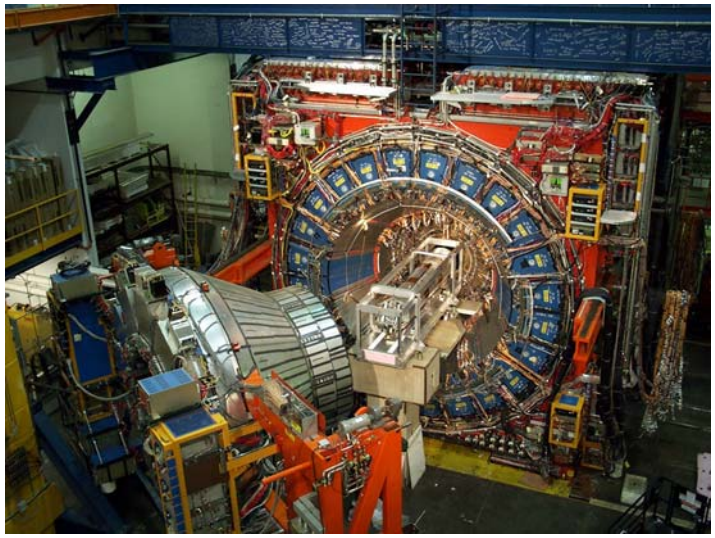




- **We participated in the construction & commissioning → 480,000 ch.**



Recent Projects with Leadership Roles:



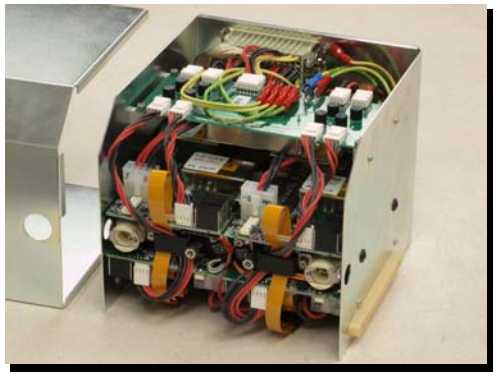
CDF @ FNAL - Shower Max Electronics

ATLAS @ CERN
- L2 Trigger (RoIB) , TileCAL Power Supply, TileCAL Upgrade Elec.

MINOS @ FNAL – Near Det. Electronics

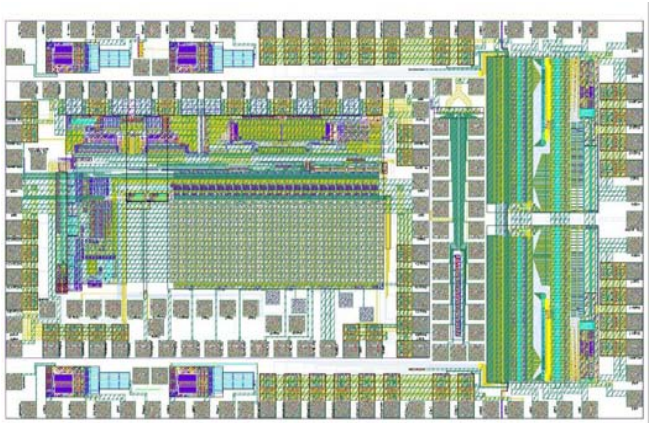
Digital HCAL R&D – Readout System

Current Active HEP Projects:

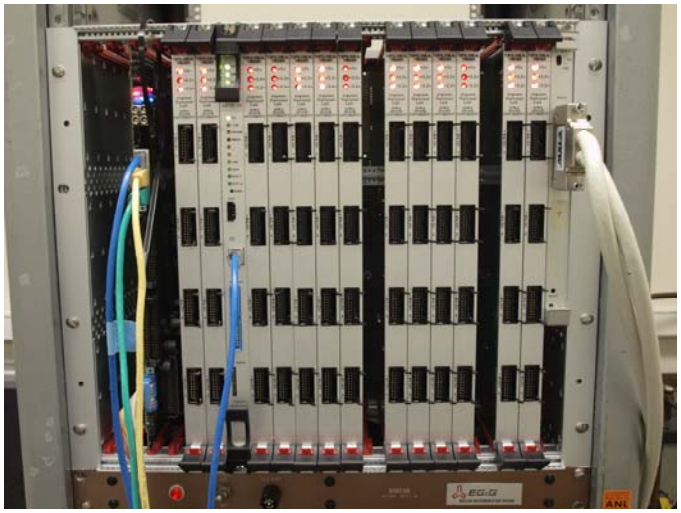


ATLAS TileCAL @ CERN
– 2400 New Power Supplies
See Poster Session

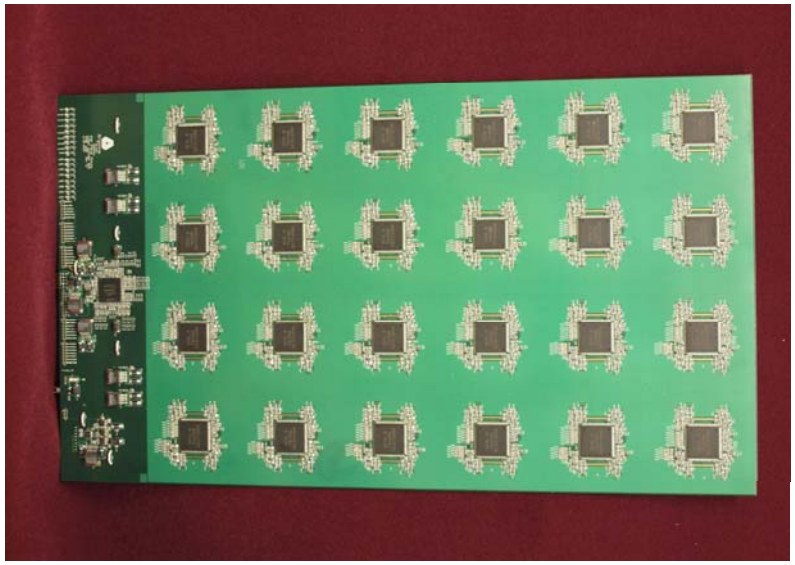
STAR @ BNL
– Forward GEM Tracker DAQ



ATLAS TileCAL @ CERN
– New Front-End ASIC for Phase 2 Upgrade (w/FNAL)



VERITAS @ Arizona (w/ISU)
– New L2 Trigger System
– 4 Crates, 2000 Ch System
See Poster Session



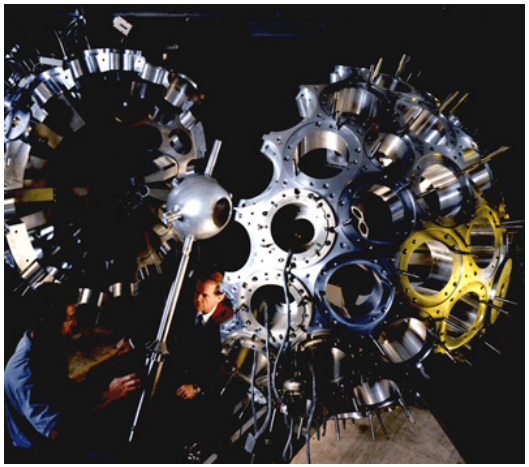
See Poster Session

Digital HCAL R&D @ ANL
– 300 Front-End Boards (Near Completion)

Other Recent Electronics Support Activities:

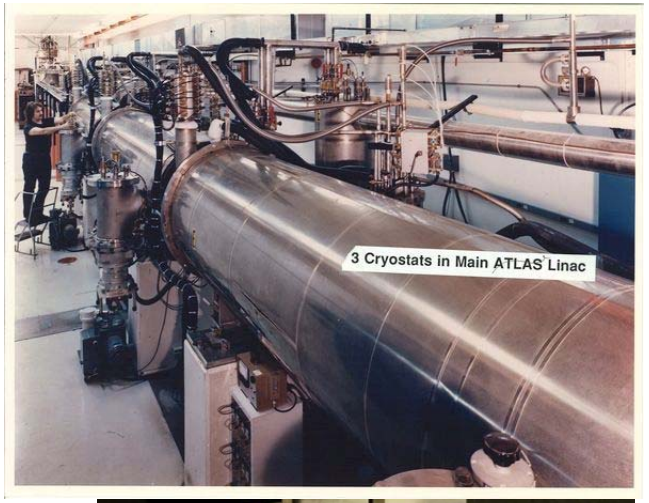
Design, Development, & Support for Other Divisions:

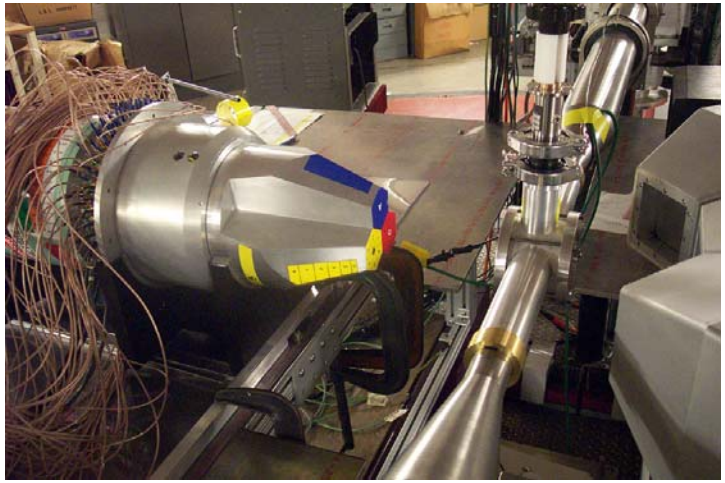
(Provided by HEP Electronics Group…)



Gammasphere
- – Nuclear Physics
- ⇨ *Leading major upgrade of electronics @ ANL*

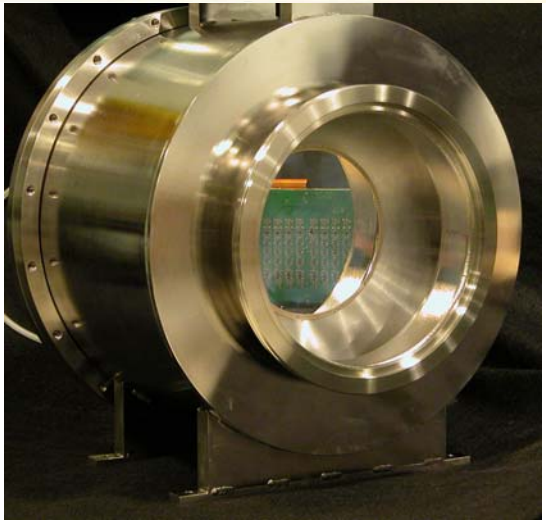
Slit Motor Controller
ATLAS Beam Line
- – Nuclear Physics
- ⇨ *New system*





Gretina (& Greta)
- – Nuclear Physics
- ⇨ *Leading role in trigger*

Time-Resolved Small-Angle Scattering (TRSAX)
- – Chemistry
- ⇨ *Entire system*



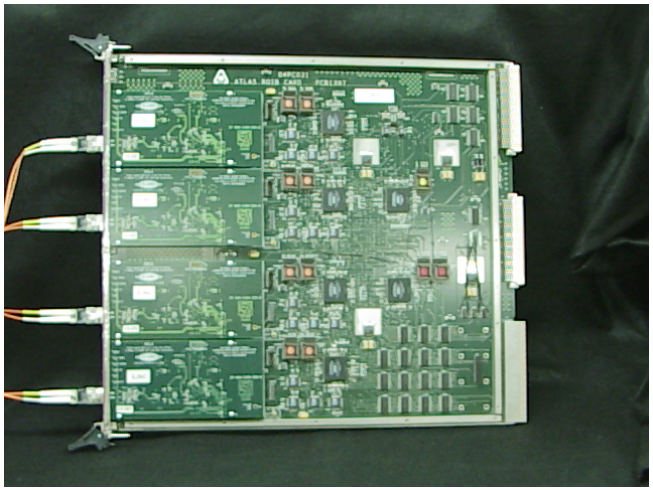
⇨ ***We are the <u>only</u> electronics group at Argonne that provides electronics support for other divisions***

Future Projects - Beginning & Prospects

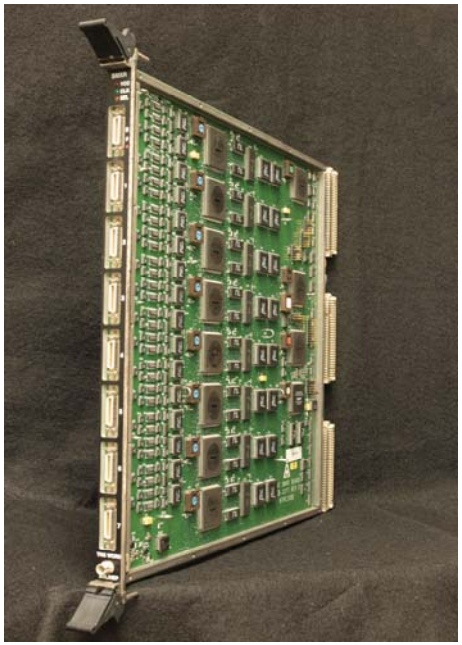
- ATLAS TDAQ – Fast Track Trigger (FTK) Read-out Driver (ROD)
  - ⇨ ***Advanced Telecommunications Computing Architecture (ATCA) Crates***
- ATLAS Phase 2 Upgrades – TileCAL Front-End Elec., Low-Voltage Power Supplies
  - ⇨ ***New ASIC development; Rad-hard regulators; GBT high-speed link***
- Wireless DAQ & Power (Djuric)
  - ⇨ ***Wireless RF techniques; Photovoltaics; Low-power circuits***
- New Level 2 Trigger for Cherenkov Telescope Array (CTA)
  - ⇨ ***Implementation of a topological trigger, next generation of one for VERITAS***
- New Ultra-thin RPC-based Detectors for Calorimetry (Repond)
  - ⇨ ***New DCAL ASIC development; Advanced readout system design***

⇨ ***Variety of Funding Sources, Including:***
LDRD, Project R&D Funding, & HEP Base Funding…

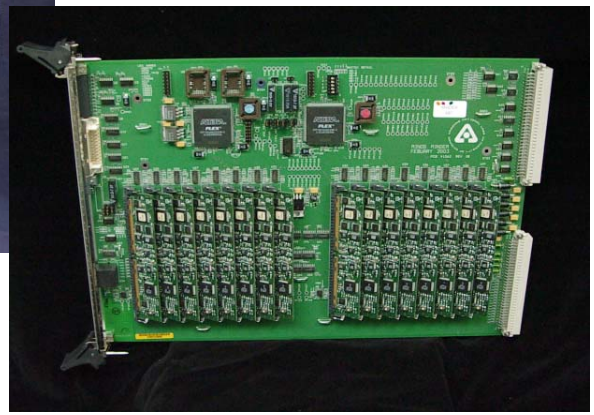
Long-Term Support:



ATLAS TDAQ @ CERN
– RoIB for Level 2 Trigger



CDF @ Fermilab
– Shower Max Electronics
→ Entire system



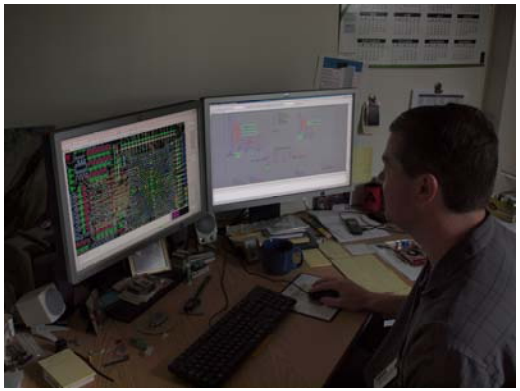
MINOS @ Fermilab
– Near Detector Electronics
→ Entire system
→ Soon to be MINERVA

Also:
NUMI Beamline Instrumentation
@ Fermilab
(No picture available)

Group Specialties & Expertise

D. Printed Circuit Board Design

- 2 skilled CAD layout people
- Support internal HEP projects
- Support other divisions (APS, PHY)



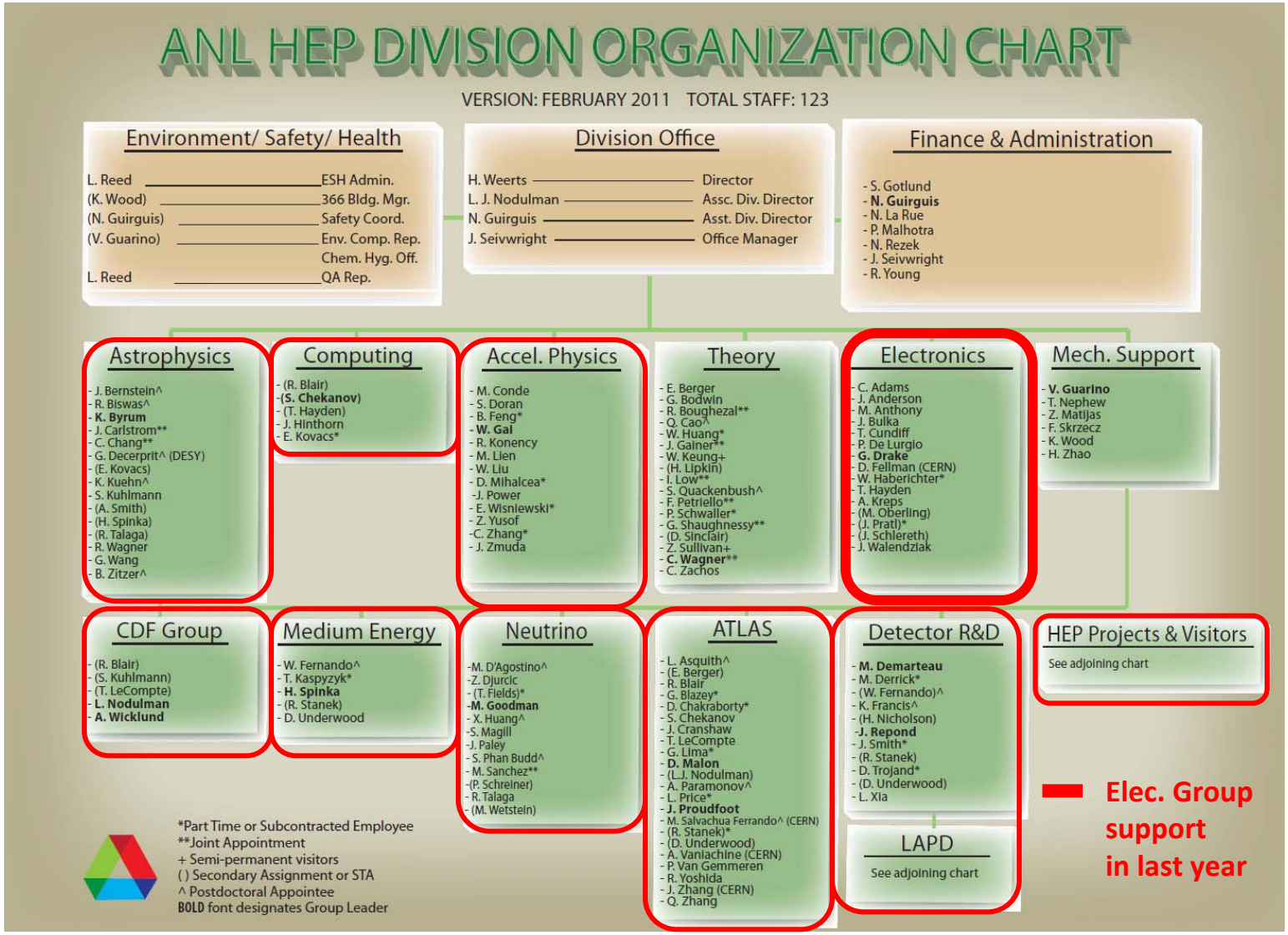
E. Instrument Repair

- 2.5 skilled technical people
- Support internal HEP repair
- Support entire laboratory
- Repair ~250 instruments/yr
- Also do Electrical Safety Inspections

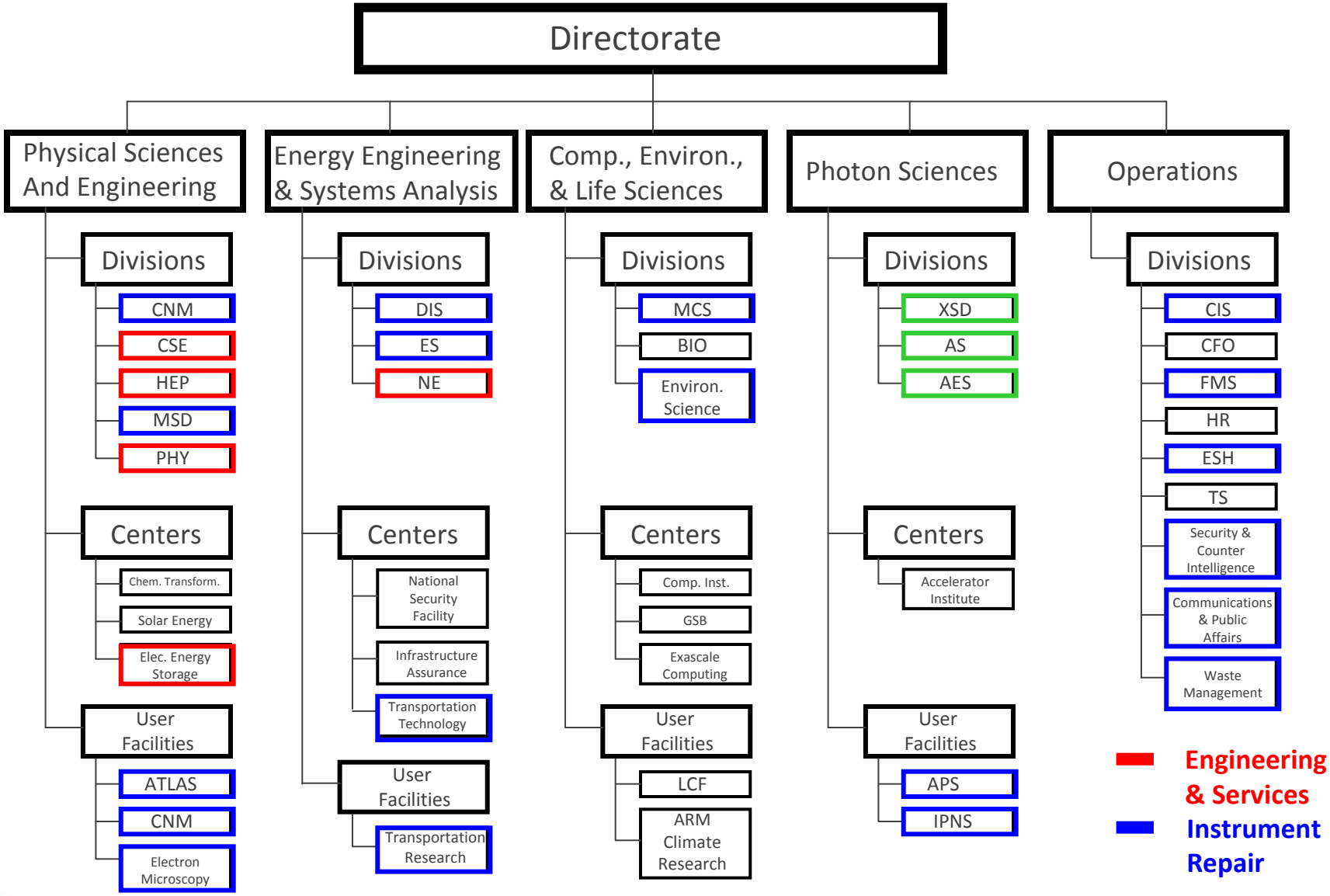
F. Fabrication & Assembly

- 1 EA, 2 Technicians → Skilled craftspeople
- Support internal HEP projects
- Support other divisions (CSE, PHY)

ANL HEP Groups That We Supported This Last Year:



ANL Divisions That We Supported This Last Year:



Summary

- **The ANL HEP Electronics Support Group is a Key Resource for the Division**
  - We have great breadth and depth in our expertise
    - Low-noise, high performance analog design – Front Ends, Low-Noise, Power Supplies, ASICs*
    - High-speed, high performance digital design – Triggers & DAQ
    - System design – Trigger & DAQ
    - ⇨ ***Group size has reached a critical mass to take on any type of project, large or small, any type of design needed***
  - We provide leadership in electronics design in world-class experiments
    - Past successes in ZEUS, CDF, MINOS, ATLAS
    - ⇨ ***Currently leading innovation in DCAL, VERITAS Topological Trigger, & ATLAS***
  - We support nearly all the programmatic groups in the division
    - Relationship of ANL HEP Engineering Group to scientific staff and experiments crucial to success
    - Collaborations with outside institutions strong, particularly with FNAL, UC, & NIU
    - ⇨ ***We are unique in the National Laboratory System, with the Electronics Group embedded within the scientific programmatic groups***
- **The Electronics Group is a Key Resource for Many Divisions at the Laboratory**
  - PHY, CHEM, MSD, APS
  - CAD, Instrument Repair, Electrical Safety

* ASIC Design in Collaboration with FNAL