# Overview of Fermilab Detector Research and Development

29 Oct. 2014

Erik Ramberg
Fermilab

Fermilab

# Why are we doing this review?

- Mid-course review to make sure we are addressing the correct mix of programs, according to Snowmass and P5, We will try to cover:
  - R&D that has made transition to experiment funding
  - Review of progress during last 2 years
  - New R&D proposed
- Prelude for summer 2015 DOE review
  - How well are we collaborating?
  - Are we using funding sources effectively?
  - Are our facilities adequate and being used appropriately?
- Improve communication/documentation

# Charge to Committee

We request that you assess the quality and impact of Fermilab detector R&D efforts conducted in the last several years and to assess the merit, feasibility and alignment of proposed activities with the Snowmass vision and P5 recommendations for the U.S. detector R&D program. In particular we request that you:

1. Evaluate the impact and promise of the group's research efforts in detector R&D:
   a. The quality and impact of the Detector R&D by the group in the past two years.
   b. The scientific significance, merit, and feasibility of the proposed future program and the competence and promise of the group for carrying it out.
   c. The adequacy of resources for carrying out the proposed research, and cost-effectiveness of the research investment
   d. How well do the group's proposed activities align with the Snowmass vision and P5 recommendations?

2. Assess how effectively the detector R&D effort has exploited and leveraged existing facilities at Fermilab and the importance of these facilities to the future proposed program of work. Evaluate whether additional facilities are needed.

3. Evaluate Fermilab's status and plans for collaborative efforts with universities, other national labs, and industry, in the general areas of detector R&D and technology transfer. Has Fermilab been effective in maintaining and seeking out additional partners for collaborative research?

# Committee members

- The committee members are as follows, with their parallel affiliation:
  - Cosmic frontier detectors: Jeter Hall (PNNL); Dan Akerib (SLAC)
  - Silicon tracking Paul Grannis (Stony Brook); Alex Grillo (UCSC)
  - DAQ& Trigger: Mark Oreglia (U.Chicago); Henrik Van Der Lippe (LBNL)
  - Calorimeter&Photodetector: Jose Repond (ANL); Chris Tully (Princeton)
  - Liquid Argon: Hanguo Wang (UCLA): Bo Yu (BNL)
- Representatives from 5 national labs and 5 universities
- Encourage questions about any part of the program, not just the parallel thrust you've been asked to review.

# indico.fnal.gov/event/DetectorR&DReview

## Fermilab Detector R&D Program Review

chaired by Mark Oreglia (U. Chicago)

Wednesday, 29 October 2014 from **08:00** to **19:00** (US/Central)
at **Fermilab**

Manage

**Description** This internal review of Fermilab's detector research will include 5 parallel sessions, corresponding to the 5 thrusts of Fermilab's program: Silicon Tracking, DAQ/Trigger, Cosmic Frontier, Calorimetry/Photodetection and Liquid Argon.

**Material:** Agenda 2014 | Charge for 2014 Review | Committee 2014 | Committee report 2012 | Documents from 2012 review | Slides

Documents from 2012 review
Account='reviews'
Password='detector_reviews'

Slides from 2012 review

Committee report from 2012

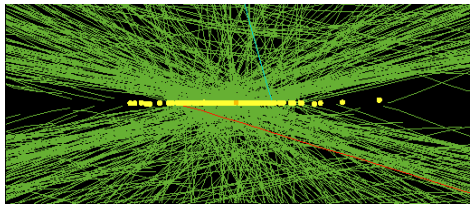
# Agenda

- 8:30 Executive Session (Mark Oreglia)
- 9:00 Introductions (Greg Bock)
- 9:15 Overview (Erik Ramberg)
- 9:50 Coffee
- 10:00 Executive Session (Mark Oreglia)
- 10:30 Parallel Sessions:
  - Cosmic Frontier (Juan Estrada)
  - DAQ/Triggering (Alan Prosser)
  - Collider Silicon (Ron Lipton)
  - Calorimeter / Photodet. (Jim Freeman)
  - Liquid Argon (Stephen Pordes)
- 12:50 Lunch
- 13:30 Executive Session (Mark Oreglia)
- 14:00 Directed R&D & Future (Peter Wilson)
- 14:30 Facilities (Eric James)
- 15:00 Transitions (Erik Ramberg)
- 15:30 Coffee
- 15:40 Executive Session (Mark Oreglia)
- 17:00 Closeout

# Priorities in the Frontiers of Detector R&D

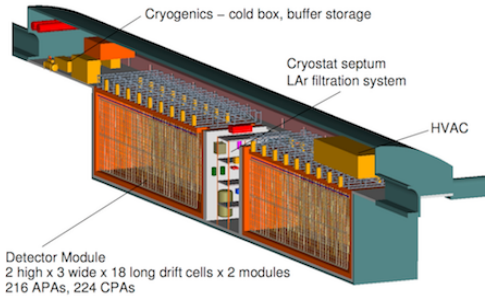
Energy Frontier:

- **Vertex sensors will have to withstand a total fluence of $10^{16}$ particles/cm$^2$**
- **At full luminosity, several hundred overlaid events per 25 nsec crossing will make current triggers untenable**
- **For future lepton colliders, jet resolution of 3% required h**



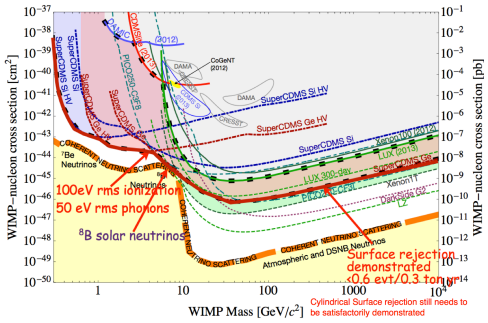
Intensity Frontier:

- **LBNF will require high-performance, low cost multi-kton liquid Argon TPC's**
- **Rare decays and interactions of Giga-Hz beams will require the lowest masses achievable**
- **Ultra-fast timing (~10 psec) photodetectors, trackers and calorimetry will become the norm**




Cosmic Frontier:

- **Dark matter detectors will need background levels of less than 1 nuclear recoil per ton per year**
- **Spectrophotometry of large sky surveys will need new methods to efficiently measure red-shifts in coincidence with position.**
- **Need low noise arrays of $10^5$ microwave sensors for CMB**




Fermilab has a set of portfolios of detector research projects that are designed to meet these priorities

# Comments from Snowmass and P5 on Detector Research and Development

**From the Snowmass Instrumentation Working Group**

**A stably and adequately funded generic instrumentation program with a balanced portfolio of risk, opportunities for young physicists, and a dedicated portion of the HEP budget is essential**. It will ensure that the field invests in its future, and establishes a foundation for a competitive, healthy program for the long term

**From the P5 report**:

**Recommendation 27**: **Focus resources toward directed instrumentation R&D in the near-term for high-priority projects.** As the technical challenges of current high-priority projects are met, restore to the extent possible a balanced mix of short-term and long-term R&D.

**Recommendation 28:** **Strengthen university-national laboratory partnerships in instrumentation R&D through investment in instrumentation at universities.** Encourage graduate programs with a **focus on instrumentation education** at HEP supported universities and laboratories, and fully exploit the unique capabilities and facilities offered at each.

# Fermilab Detector R&D Organization

- The **"Detector Advisory Group"** consists of: (PPD unless otherwise noted)

| | |
|---|---|
| **Technical Point of Contact** | **Erik Ramberg (PPD)** |
| **Silicon tracking representative** | **Ron Lipton (PPD)** |
| **DAQ and Triggering representative** | **Alan Prosser (SCD)** |
| **Calorimetry and photodetection rep.** | **Jim Freeman (PPD)** |
| **Liquid Argon R&D representative** | **Stephen Pordes (ND)** |
| **Astrophysics detectors rep.** | **Juan Estrada (PPD)** |
| **Intensity Frontier representative** | **Bob Tschirhart (SCD)** |
| **Head, Particle Physics Division** | **Patty McBride (ex-officio) (PPD)** |
| **Assoc. head for Engineering** | **Eric James (ex-officio) (PPD)** |
| **Head, New Initiatives R&D** | **Dave Christian (ex-officio)** |
| **Scientific Computing** | **Panagiotis Spentzouris (ex-officio) (SCD)** |
| **External Representative)** | **Ulrich Heintz (Brown University)** |

- The group meets twice a month and monitors and reports on the activities in each of their portfolios.
- Members give advice on the future of the program and participate in reviews of projects in each portfolio
- TPOC informs the Division Heads and Offices of Research and Computing of plans arising out of group discussions and reviews.
- After consultation with DOE, Division Heads and CRO then decide on approval of new directions

# Portfolio's of R&D projects are overseen by the Detector Advisory Group

| PORTFOLIO | DELIVERABLES | DESCRIPTION | THRUST |
|---|---|---|---|
| Silicon Tracking *(R. Lipton)* | Vertex Sensor/3D ASICS | Collaborative development of 3D ASICs | Sensors |
| | Tracking Mechanical | Low mass mechanical support and cooling designs | Core & Infrastructure |
| | Pixel Readout | 65 micron pixel readout development | DAQ/Trigger Electr. |
| Calorimetry & Photodetection *(J. Freeman)* | psec Time-of-Flight | Collaborative LAPPD phototube program at ANL | Sensors |
| | Hadron Calorimetry | Dual readout techniques, QIE10, Phase II CMS endcap | Sensors |
| | SiPM R&D | Testing, fast timing, multi-channel readout | Sensors |
| | Scintillator R&D | Scintillator/WLS co-extrusion, rad hard, thinned extrusions | Core & Infrastructure |
| | Calorimetry CDRD | Multi-institution investigations in calorimetry | Sensors |
| Astrophysics Detectors *(J. Estrada)* | Bubble Chamber | Acoustic rejection of $\alpha$ background / Recoil calibration | Sensors |
| | Silicon Dark Matter | Support of DAMIC technique for dark matter detection | Sensors |
| | CCD R&D | Low noise readout/neutron imaging/CONNIE nu detection | Sensors |
| | MKID | Multiplexed array for spectrophotometry | Sensor |
| | CMB | Infrastructure for high channel count - CMB-4 | Sensor |
| Liquid Argon *(S. Pordes)* | Materials Test Stand | Testing contamination potential of materials for LAr TPC | Cryogenics |
| | Short Baseline Neutrino | Large scale LAr detector planning and development | Cryogenics |
| | Low Background Ar | Low-background Ar for Dark Matter community | Cryogenics |
| | Cold Electronics | Collaborative cold electronics development w/ BNL & MSU | Cryogenics |
| | Test beam for Lar | Develop cryogenics capability at new test beam line | Cryogenics |
| | Light yield at low E | Small chamber to test light yield in LAr | Cryogenics |
| | Solid Xenon | New type of dark matter / axion / $\beta\beta$ detector | Cryogenics |
| | Low Energy Neutrinos | Using Booster Target as a neutrino source | Core & Infrastructure |
| DAQ *(A. Prosser)* | Sensor DAQ | Radiation hardness testing of new sensors | DAQ/Trigger Electr. |
| | $\mu$TCA and ATCA | Evaluation of new data-flow architecture | DAQ/Trigger Electr. |
| | Optical DAQ | Collaborative development of multi-Gbit data links | DAQ/Trigger Electr. |
| | VIPRAM | Triggering for CMS using associative memories | DAQ/Trigger Electr. |
| | CCD R&D | Low noise readout for CCD's | DAQ/Trigger Electr. |
| | DATA LINKS | High speed DAQ | DAQ/Trigger Electr. |
| Facilities & Community Support *(E. Ramberg)* | New efforts / Contingency | New initiatives / management reserve | Core & Infrastructure |
| | Detector Tools | Upgrade of R&D tools | Core & Infrastructure |
| | Test Beam Equipment | Pixel telescope support for test beam | Core & Infrastructure |
| | Workshops / Schools | Conferences, workshops and schools for HEP community | Core & Infrastructure |

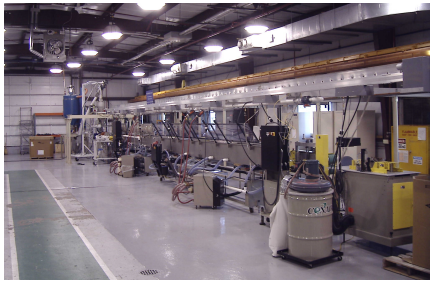
# Fermilab scientists involved in detector R&D

- Bradford Benson
- Flavio Cavanna
- Aaron Chou
- David Christian
- Carlos Escobar
- Juan Estrada
- Jim Freeman
- Ashutosh Kotwal
- Hugh Lippincott
- Ronald Lipton
- Ted Liu
- Anna Mazzacane
- Ornella Palamara
- Adam Para
- Stephen Pordes
- Erik Ramberg
- Brian Rebel
- Mitch Soderberg
- Andrew Sonnenschein
- Michelle Stancari
- Chris Stoughton
- Bob Tschirhart
- Peter Wilson
- Jonghee Yoo

# Fermilab Assets for Detector Research

(See Eric James talk)

- Detector R&D program at Fermilab is enabled by our institutional strengths:
  - Presence of research facilities such as:
    - Test beam facility
    - Silicon Detector facility
    - Precision Metrology facility
    - Rapid prototyping and Special Materials
    - Scintillator Detector Development
    - Thin-Film Facility
    - Liquid Argon Test Facility
    - ASIC Development Facility
  - Experienced, well established engineering groups, such as
    - ASIC development
    - Cryogenics
    - Data Acquisition
  - We encourage a high degree of collaboration with the university community and other national labs.

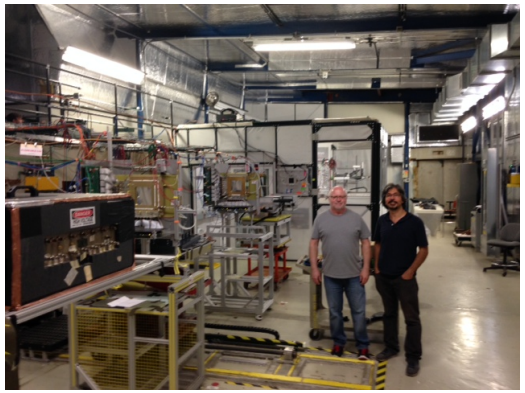


Scintillator extrusion at Lab 5

Clean rooms and metrology at SiDet

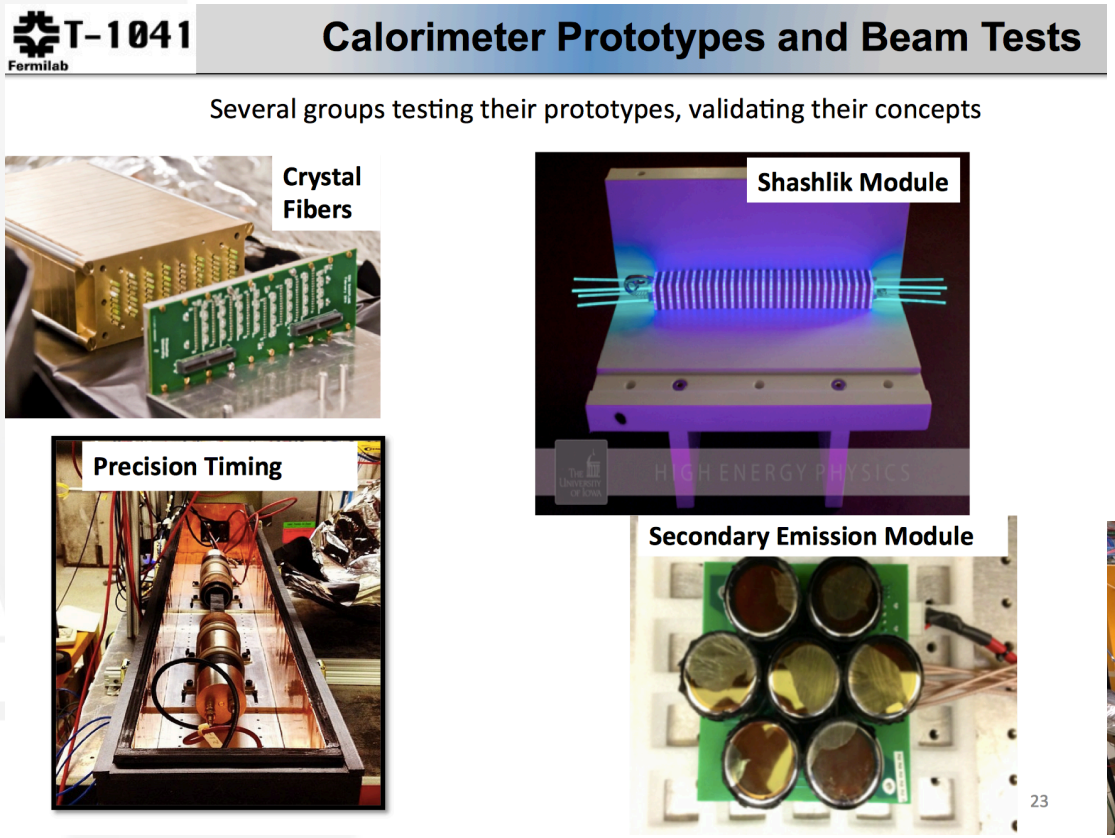
CALICE at the test beam

# A Day at FNAL Test Beam

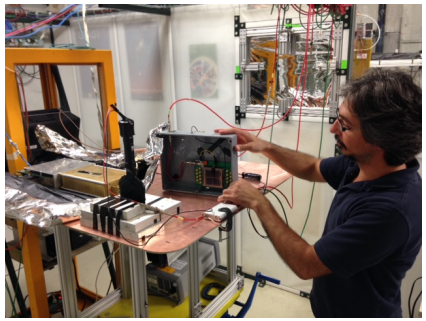


Section 2 of the Fermilab MTest beamline

8/11/2014




Jim Freeman new rad-hard scintillator studies. Behind him is TTU fiber based dual readout



Burak Bilki w/ new ANL MCP. Also studying new scintillators.

# Silicon Tracking

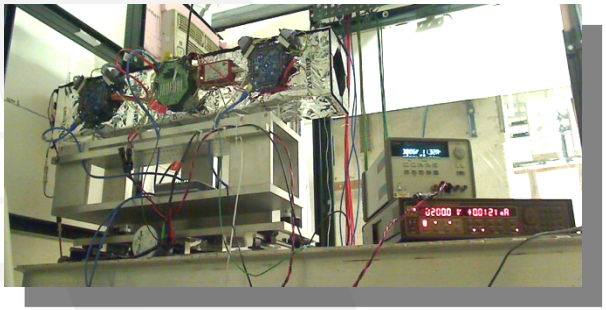
(Managed by Ron Lipton)

# FNAL Provides Comprehensive Approach to Silicon Tracking, Triggering and DAQ R&D for Phase II upgrade of CMS

Creating a tracking and trigger system that can withstand the projected HL-LHC luminosities is arguably the most important detector challenge in the field of High Energy Physics.

There must be a comprehensive approach:

15 US universities
19 foreign institutions
5 laboratories
8 industrial partners



**Sensor**

Testing radiation hardness in new sensors (3D columnar + Diamond).

Sensor thinning and interconnects

**Front End**

Providing new readout for pixel detectors.

Low noise systems using 3D bonding

**L1 Trigger**

Track trigger using 3D techniques

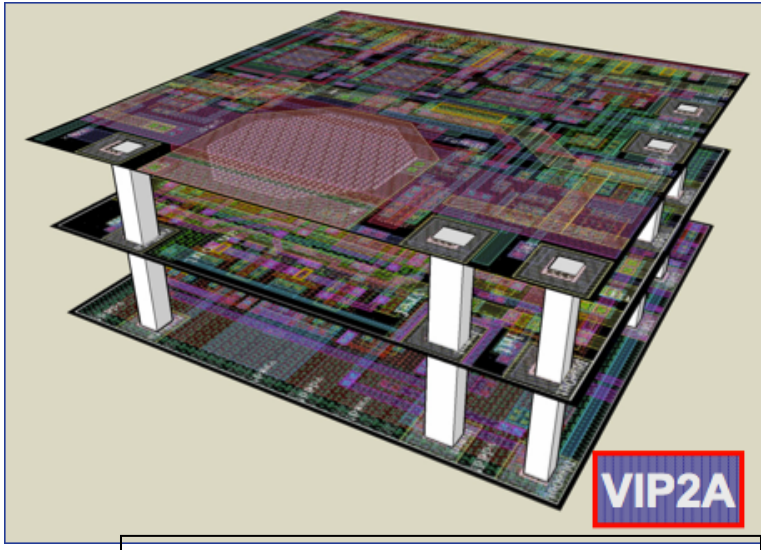
**Data Transmission**

Multi-wavelength optical DAQ

**Track Fitting**

GPU's and Associative Memory

# Transformative Capability of 3D Techniques in Integrated Circuits




3 tier 3D stack for FNAL ILC vertex chip, fabricated by MIT-LL

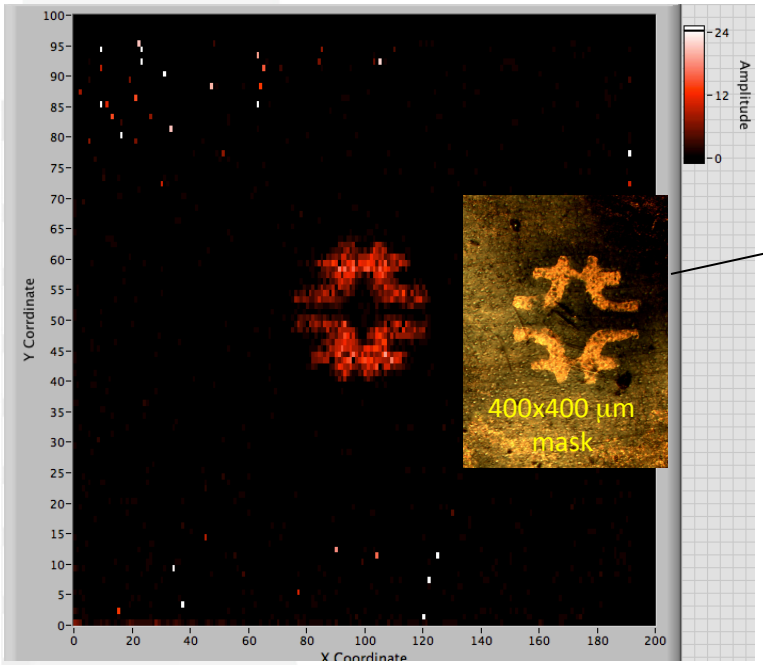
Over the past several years we have demonstrated the ability to:

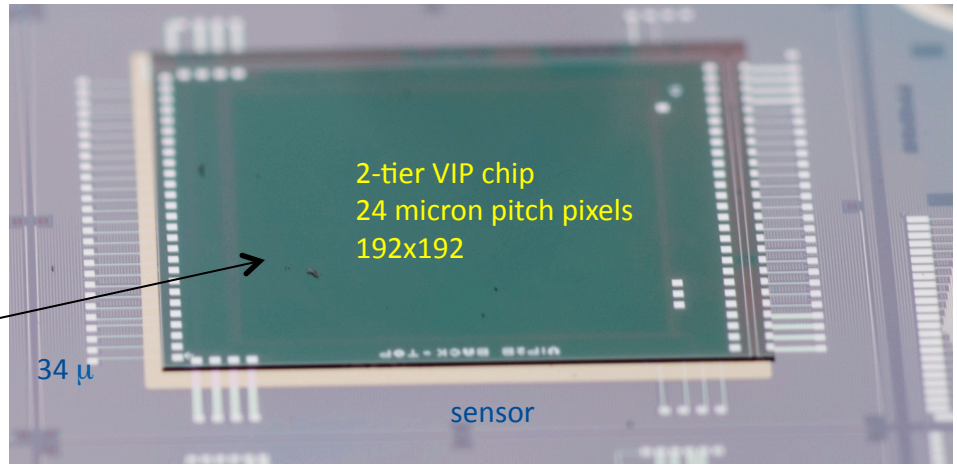
- Collaborate with commercial vendors to build multilayer (3D) integrated circuits with interconnection pitch of 4 microns
- Bond the ICs to sensor and thin the two-layer circuits to 34 μm
- Thin full sensor wafers to 50 microns and process the back contact
- Reduce interconnect noise to ~0, reducing overall noise in fine pitch pixelated sensor by 2x
- Build low mass support and cooling structures

We hope in the future to extend this to

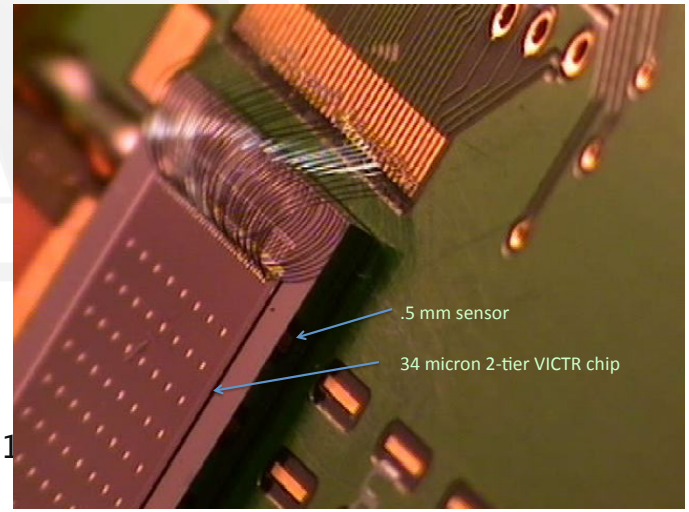
- 8” thinned sensor wafers for CMS HGC and others
- Low cost finely pixelated large area tiled arrays

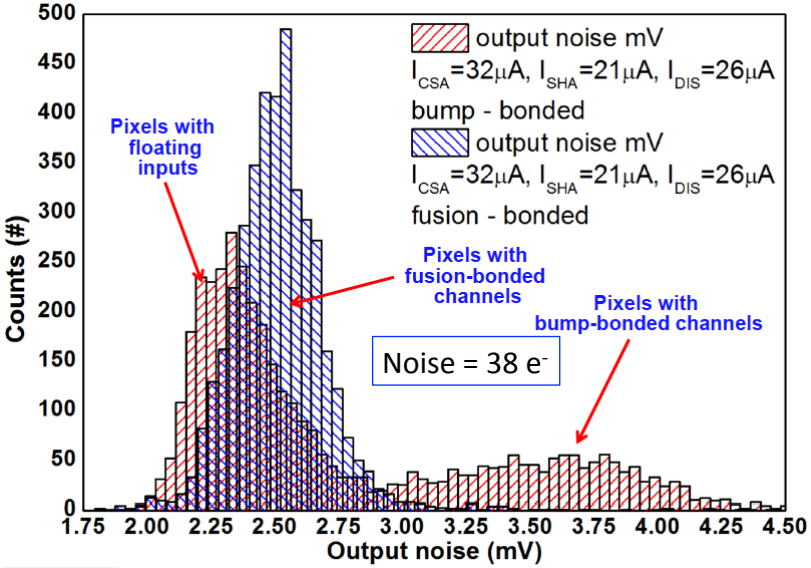
# Some 3D Results




2 Tier VIP ILC vertex chip with $CD^{109}$ source



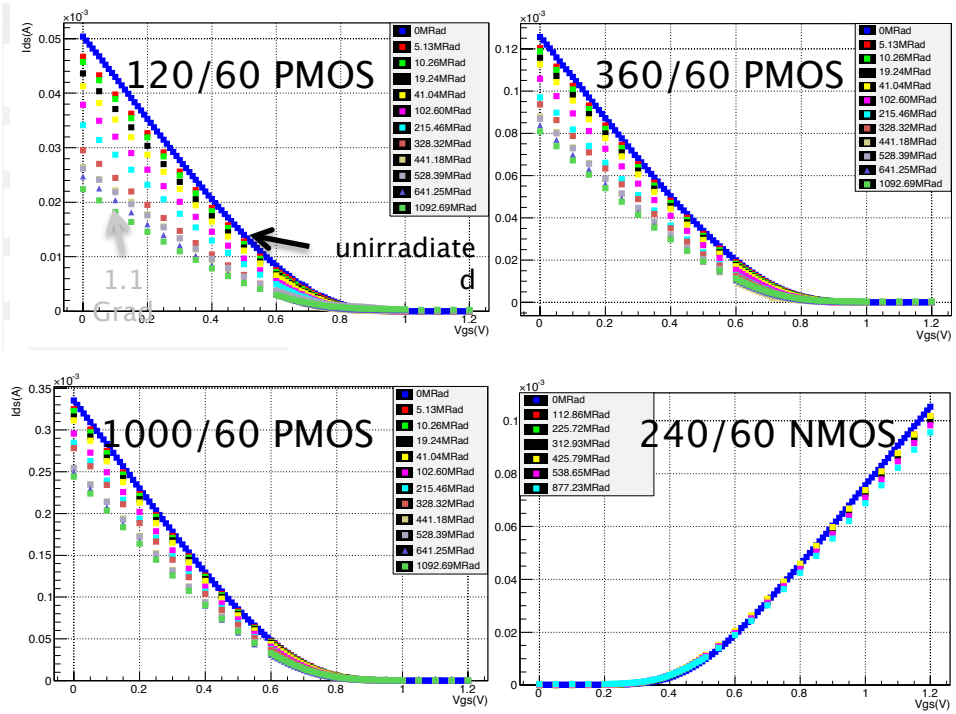



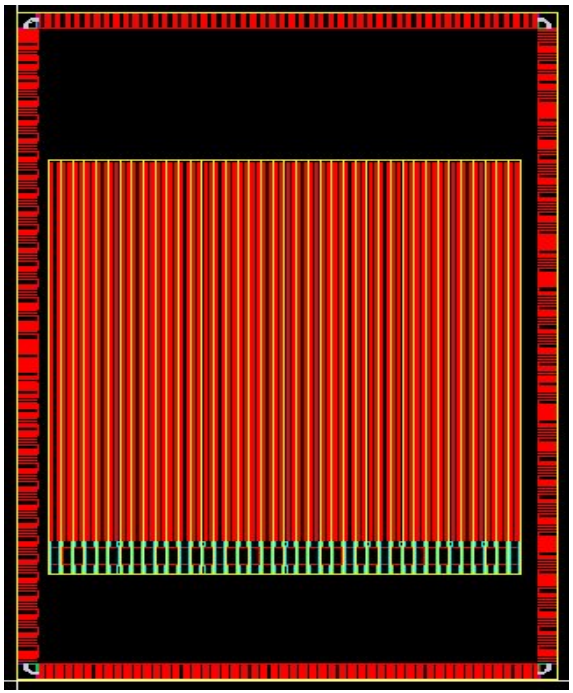

2x reduction in noise over bump bonding



Fermilab

# Silicon Pixel Detector Electronics R&D – RD53 (65nm CMOS)



- 65nm test ASIC designed at FNAL
- γ irradiation at -20C (w/Colorado at Sandia National Laboratory)
- Small PMOS loses current gain.
- ***Less*** damage than at room temp.

- Test ROC designed (130nm CMOS) to demonstrate low threshold operation (<1000 e-) and facilitate sensor R&D.
- 30μ x 100μ pixels, staggered bump bonds, 4.8mm x 4.8 mm active area.
- Chip tests will start in December

Fermilab

# Triggering and Data Acquisition

## (Managed by Alan Prosser)

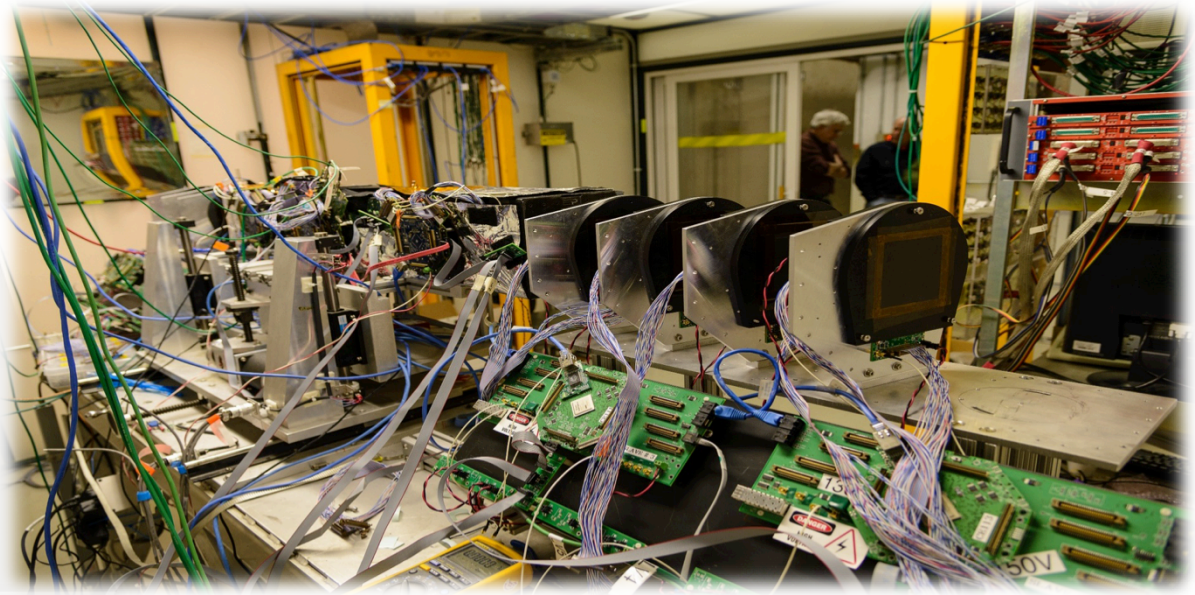
# DAQ

## Fermilab Test Beam Facility DAQ:

- Old pixel telescope DAQ is based on CAPTAN
  - Triggered, 1cm$^2$ coverage, and 8μm track resolution
- New strip telescope completed in FY14 is based on CAPTAN too
  - Dead-timeless, 16cm$^2$ coverage, and 5μm track resolution

## Other DAQ:

- For the last 10 years firmware and software from CAPTAN project supported collaborations within Fermilab, U.S. collaborators at Colorado and Purdue, and Italian collaborators in Milan, Lecce, and Torino.



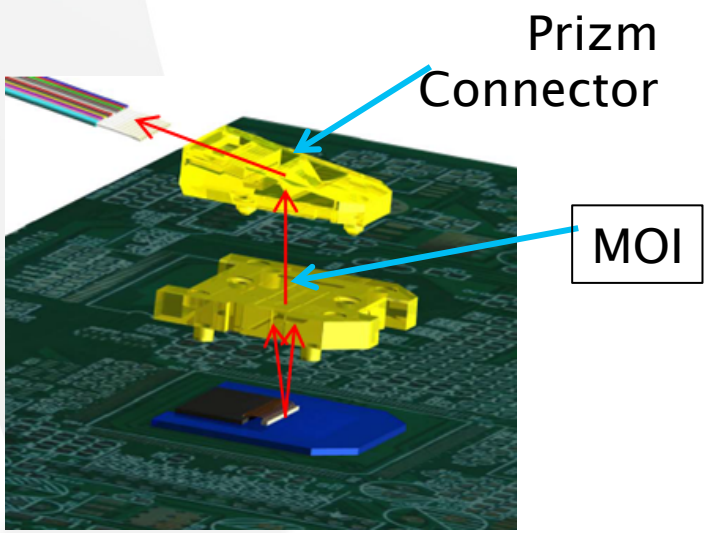
New strip telescope encompassing old pixel telescope at FTBF

# 12-channel Array Optical Transmitter Module (ATx)

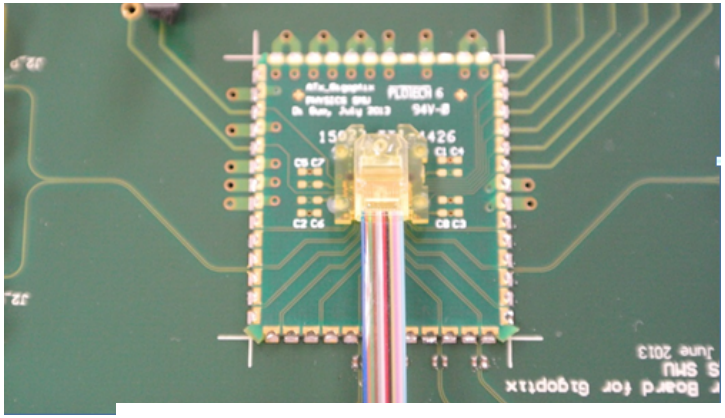
ATx is a compact (1.9 cm x 2.2 cm x 0.44 cm), radiation-tolerant, 12-channel array optical transmitter module towards 120 Gbps optical link, integrating array optical components, a VCSEL array with a driving ASIC in a custom transmitter module.

A custom low-cost and reliable "active-alignment" method was developed to solve the challenging alignment issue in the array optics area.

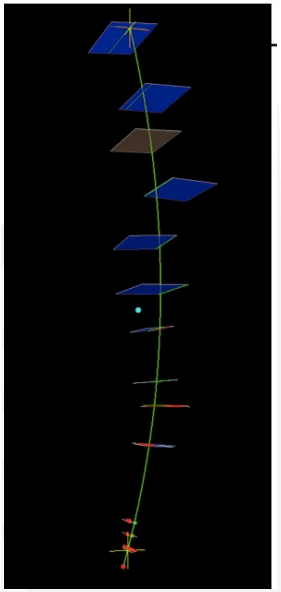
With a commercial VCSEL array driver, the ATx module successfully operated at 10 Gbps/ch and aggregate data rate of 120 Gbps. The optical transmitter eye diagram passed the eye mask, and the transmitted BER less than $10^{-12}$ was achieved at 10 Gbps/ch.

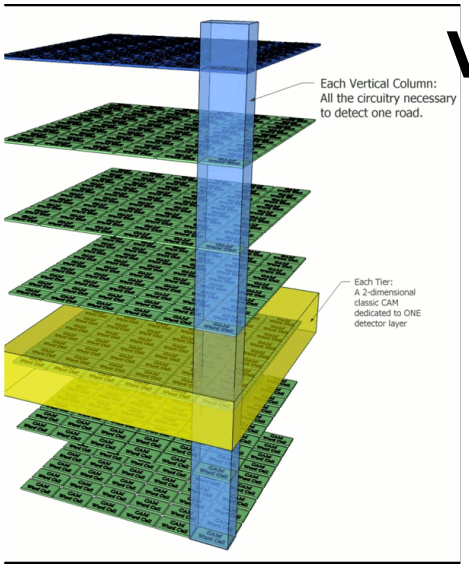



Optical Interface



ATx Module with
ribbon fiber attached






# VIPRAM Project Status Summary

**The past: with steady progress**

Initial Idea: ~2010

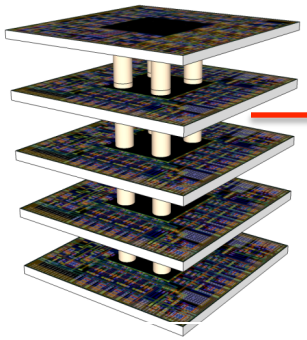
VIPRAM concept paper: 2011

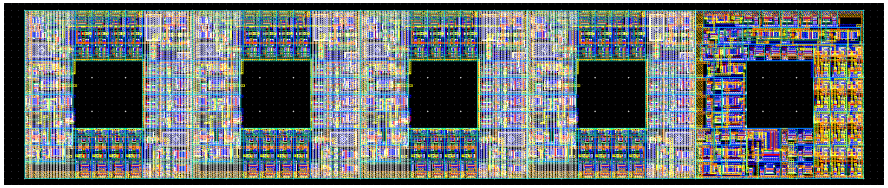
CDRD award: 2012

First 2D Design submission: 2013

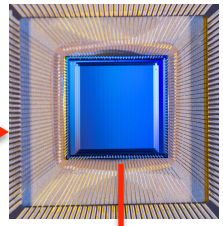
**First ProtoVIPRAM00 chip successfully tested: 2014**

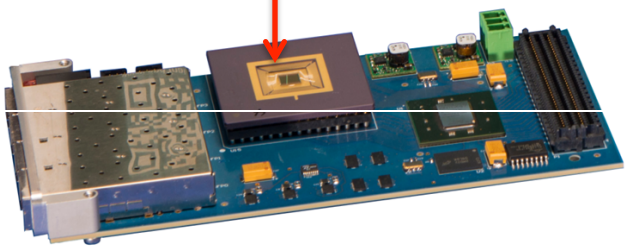
→ **Design building blocks are ready for 3D stacking**





*CAM cell size: 25 um x 25 um, @ 130nm GF CMOS*





**The present and future:**

**The actual 3D design (protoVIPRAM01) ready: 2014**

A 2-tier design for CMS tracking trigger (protoVIPRAM02): 2014-2015

Both Designs ready for submission: 2015

2-tier stacking testing for both designs: 2015-2016

Multi-tier stacking & testing for protoVIPRAM01: 2016-2017

→ **Need continue generic R&D support for work related to 3D**

Fermilab

# Liquid Argon Detectors

(Managed by Stephen Pordes)

# Integrated Approach to Liquid Argon R&D

The development of entire liquid argon systems means that new techniques in materials, electronics, or simulation can be addressed immediately:

Argon — Purification techniques and cryogenics design

↘

TPC — Materials qualification and design

↘

Readout — Low-noise amplifiers in liquid

↘

Full System in Neutrino Beam — ArgoNeuT, LAriaT

↘

Automated Reconstruction — LArSoft Simulation

↘

Synergies — Dark Matter, Proton Decay

Institutions we are collaborating with in hardware R & D:

- Yale – Syracuse (ArgoNeuT)
- Michigan State University (TPC electronics)
- M.I.T and Indiana University (Light readout)
- BNL (TPC electronics and TPC design)
- Princeton (depleted Argon recovery)
- Indiana University (LAPD)

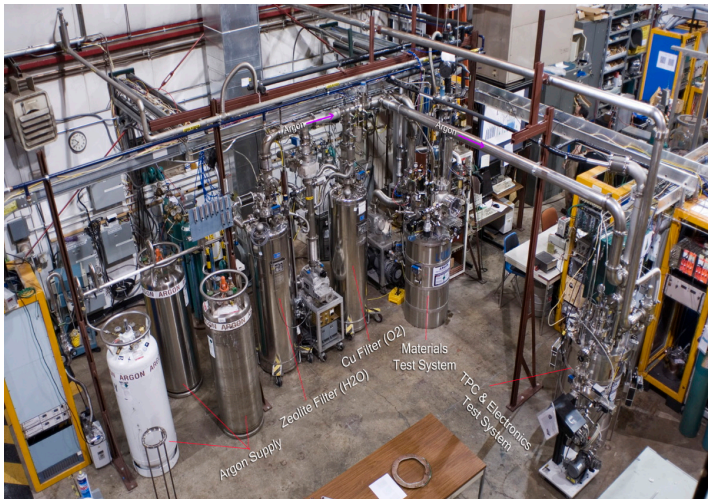
# The Liquid Argon Program

The development of low-cost, low background and highly efficient liquid argon TPC's are a national priority for both neutrino physics and dark matter physics.

Fermilab and collaborators have learned and developed techniques for handling large volumes of liquid Argon and retaining purity enough to drift electrons far distances. We have collaborated widely in the community on these efforts. The R&D is now paving the way for implementing truly large detectors (20-30 kton) with industrial techniques

LAPD 20 ton Liquid Argon Cryostat

Filled without evacuation. 5 meter electron drift distance.




Liquid Argon materials and electronics test stands

# Recent Liquid Argon R & D at Fermilab

**Neutrino Specific**

- TPC performance with electronics and HV
  -> BO TPC and Long BO TPC

- Detailed behavior of particles in liquid Argon
  -> Test beam into LArTPC (LArIAT)

**Dark Matter Specific**

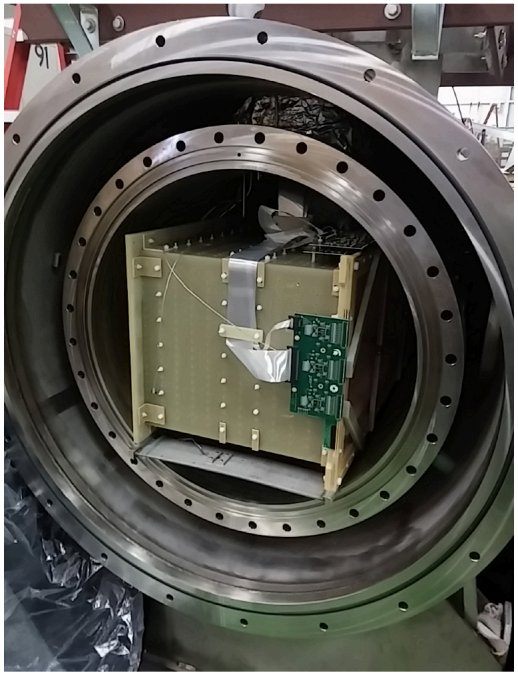
- Light yield from nuclear recoils at low energy (<50 keV)

  -> SCENE (Scint. Efficiency of Noble Elements)

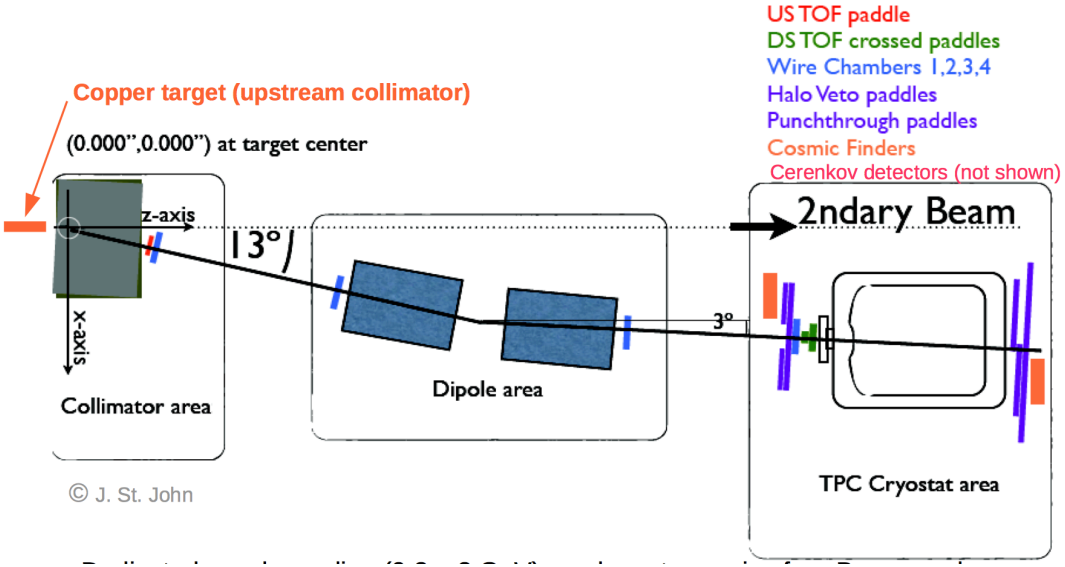
- Argon for low-background experiments
  -> Purification of underground argon

# ‘Liquid Argon in a Testbeam’=LArIAT

- Tertiary beam used by MINERVA moved to new Mcenter Test Beam line
- TOF Particle I.D. for 0.2-0.8 GeV beam



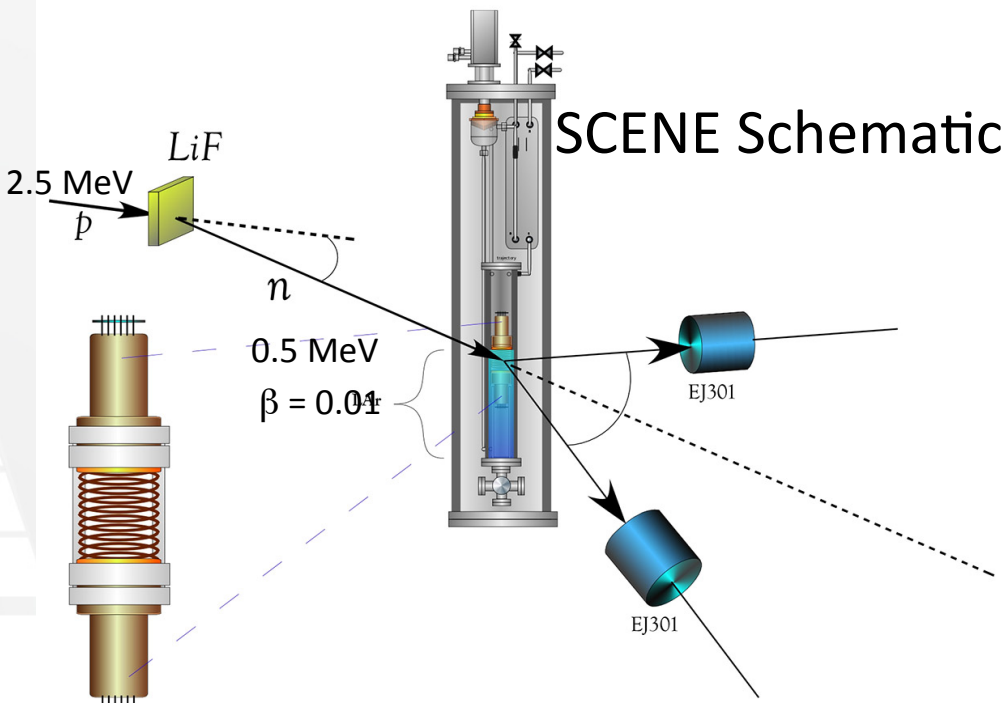
## LArIAT tertiary beamline



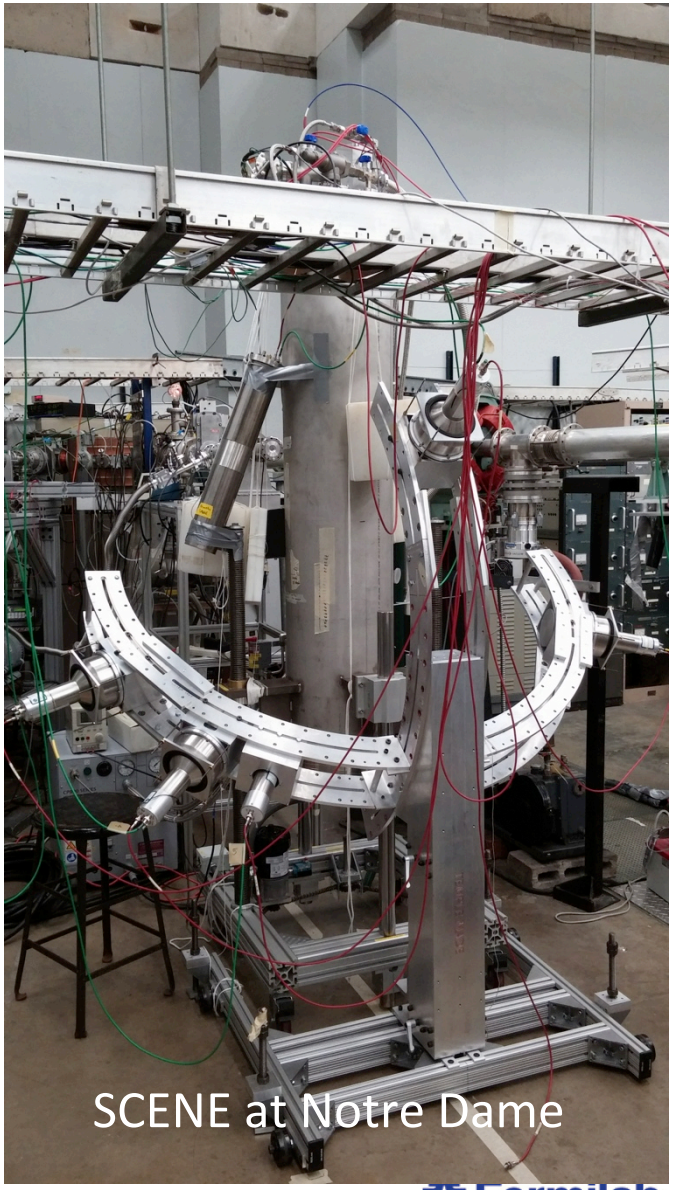
# SCENE – Scintillation Efficiency of Noble Elements

Precision measurement of light output of Argon nuclear recoils in a dual-phase LArTPC using monoenergetic, low energy, pulsed Neutron Beam at Notre Dame

***(Chicago, Fermilab, Princeton, Naples, Notre Dame, Temple, UCLA)***




Scattering kinematics gives energy transfer




Fermilab

# Calorimetry and Photodetection

(Managed by Jim Freeman)

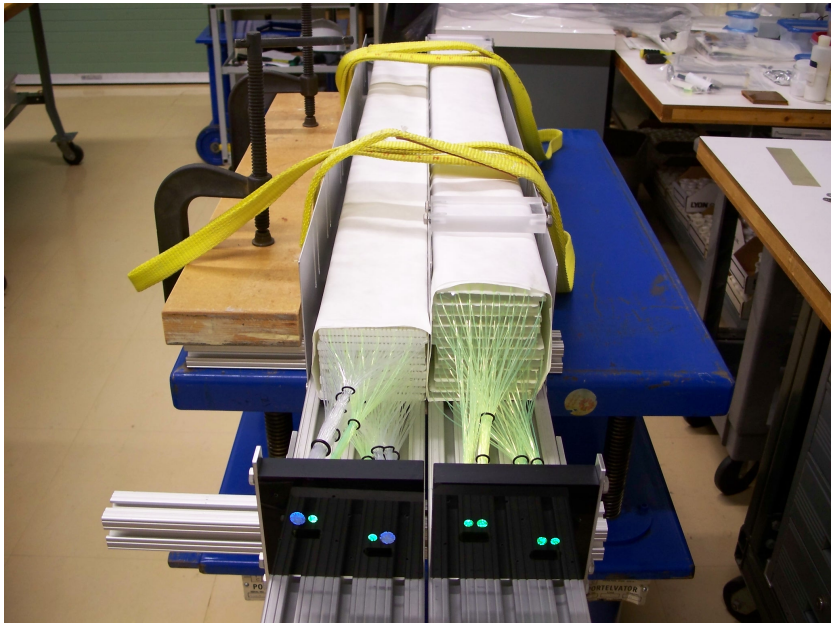
# Broad approach to calorimetry and photodetection:

- Conceptual Studies – simulation of total absorption hadron calorimeter
- Development of new materials – extruded scintillators, new crystals
- Testing and characterization – optical properties, light yields
- Development of new photosensors – LAPPD, SiPM
- Readout Techniques – QIE10, LAPPD, SiPM (TB4 multichannel readout)
- Test Beam Studies – T1004 (crystals), T1015 (heavy glass), GSI heavy ions
- Large Integrated Systems – CALICE, digital HCAL

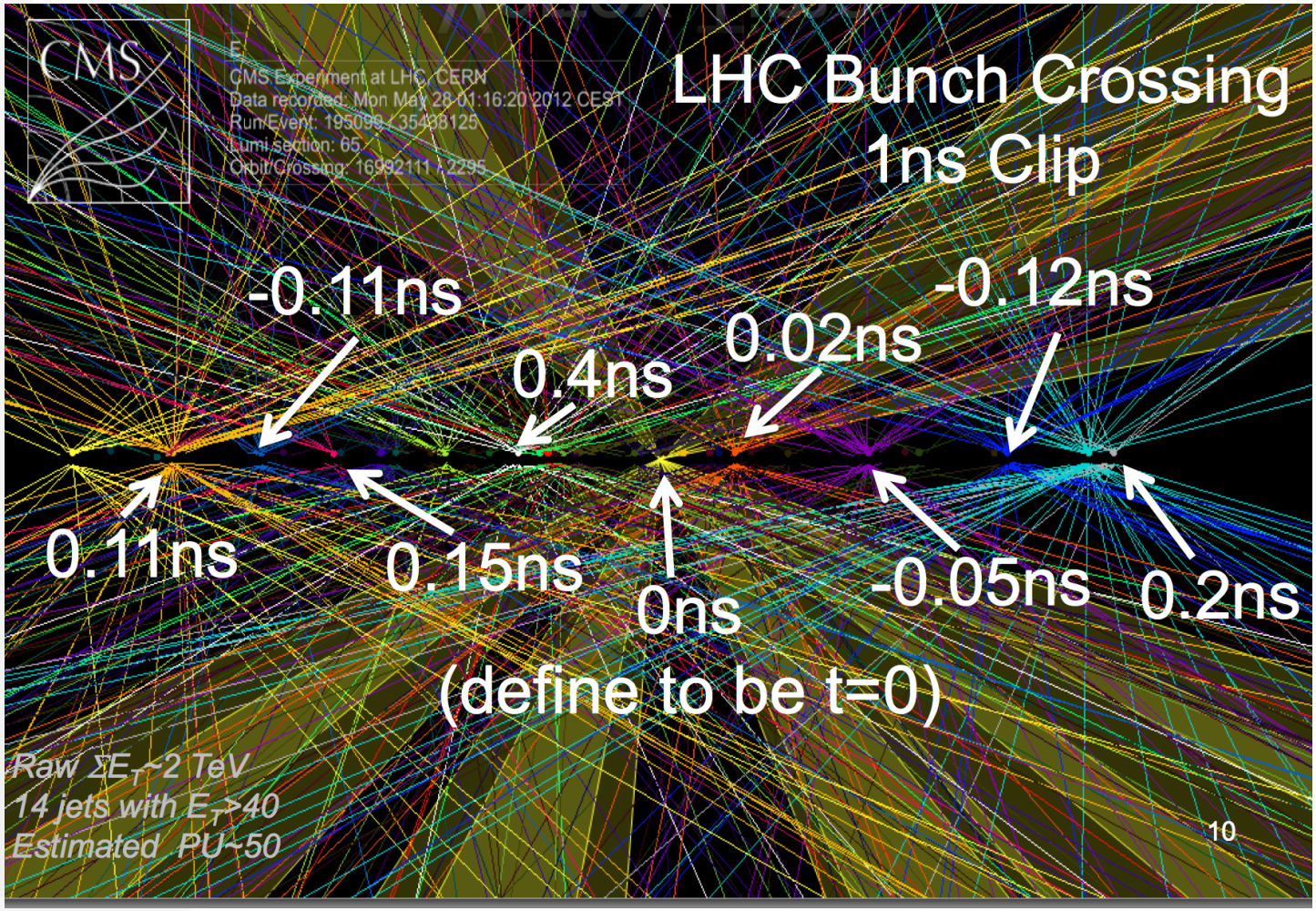
Collaborating institutions:
- ANL (DHCAL, LAPPD)
- Caltech/SICCAS (crystals development)
- LAL Orsay (SiPM characterization)
- University of Iowa (test beam studies)
- University of Udine (scintillating glasses, test beam)
- University of Lecce (test beam)
- University of Cyprus (test beam, materials testing)
- NIU (extruded scintillator)
- U. Cyprus (SiPM charcterization)
- STM; IRST-FBK; Voxtel (SiPM development)
- CERN , Saclay, Milano, GSI (saturation studies)

# Dual Readout Calorimetry at FNAL

- The two ADRIANO 2014 detectors designed for dual readout/ total absorption for high energy experiments are at MTEST receiving beam.
- Their dimensions (10 cm x 10 cm x 105 cm) corresponding to about 3.3 interaction lengths.
- Being a dual-readout and totally active calorimeters (no passive absorber of any sort) they are expected to provide an hadronic energy resolution of the order of 30%/sqrt(E)



# From Chris Tully SSI lecture, 2012



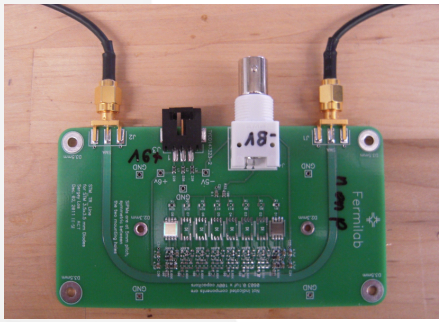

E. Ramberg; "Fast Timing for HGCAL"



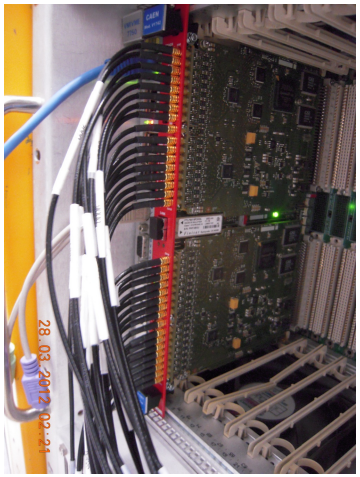
Fermilab

# SiPM's for Time-of-Flight and Calorimetry

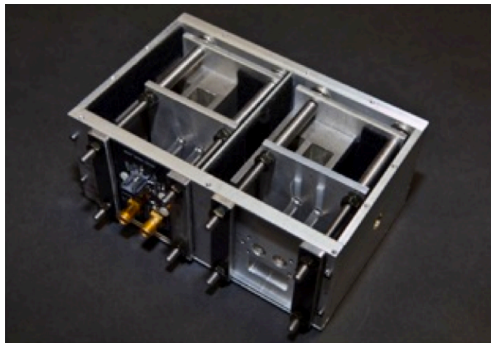
- Silicon PhotoMultipliers are multi-pixel avalanche photodiodes. Pixel sizes on the order of 50 microns and avalanche regions at the micron level.
- Theoretically, they could be one of the fastest particle detectors for HEP (<16 psec shown at FNAL test beam).
- Fermilab has been studying their potential for TOF and calorimetry for several years. Design and testing occurring now for potential use in FP420 forward tracking at CMS.
- DAQ techniques supported by KA25 are being used in Proton Computed Tomography with NIU



Transmission line readout suitable for reading 8 separate SiPM's



CAEN 1742 module digitizes at 5 Gs/s. Good for timing and energy measurement



Example of one geometry of quartz bars and SiPMs for CMS forward region

# Support of LAPPD Project at ANL

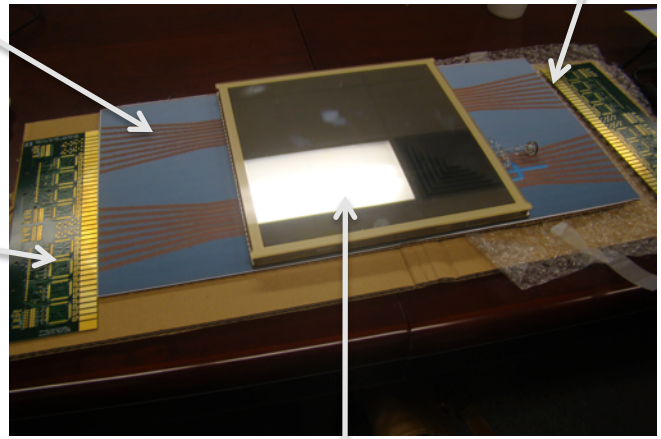
('Large Area Picosecond Photo Detector')

A mockup of the 8" MCP/PMT:

Transmission line readout retains superb timing resolution

Readout on both ends gives 1 mm positional resolution

U.C./Hawaii is developing high speed digitizers (10–20 GHz)



Thin film coating plant for 8" plates

Anatoly Ronzhin holding the 'chalice' for systematic photocathode testing

Caltech, FNAL, U.Chicago have begun a collaboration to study EM shower timing using LAPPD microchannel plates.

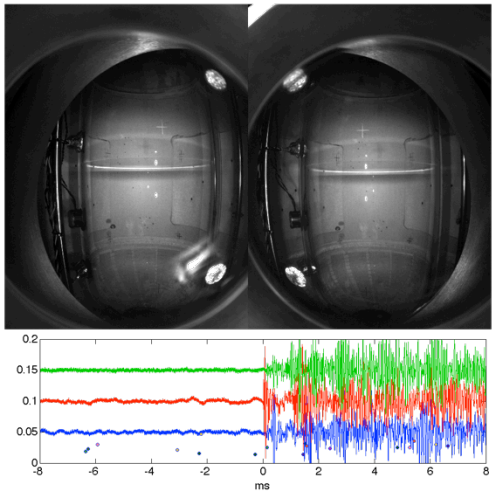
Fermilab

# Astrophysics Detectors for Dark Matter/Dark Energy

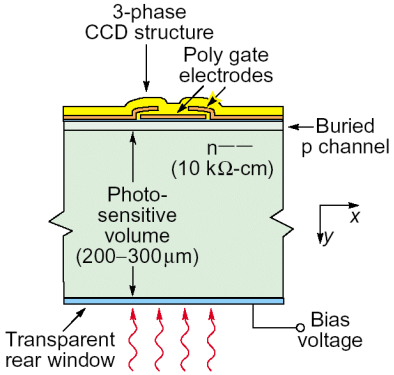
(Managed by Juan Estrada)

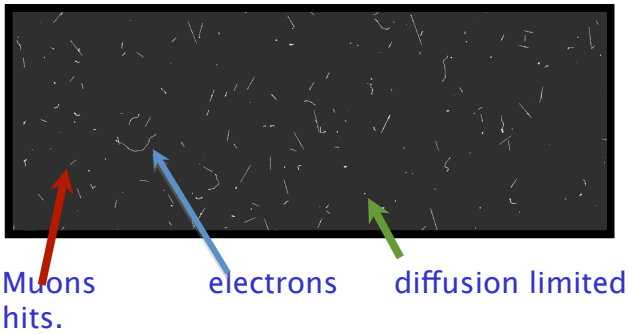
# Alternative Techniques We Have Explored in Dark Matter Detector R&D at Fermilab

Distillation column producing 39Ar depleted Argon for dark matter community.




Supported bubble chamber calibration R&D, such as threshold measurements and acoustic particle i.d. Has been adopted at ANL for stellar nuclear cross section measurements

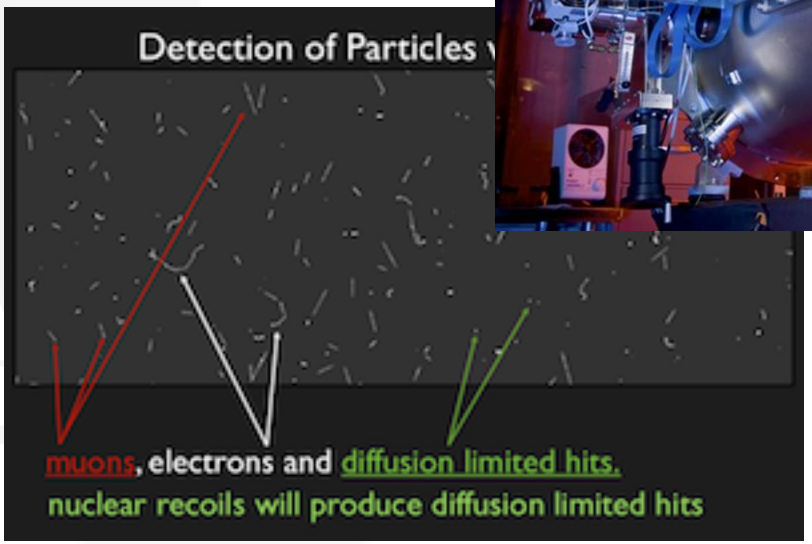


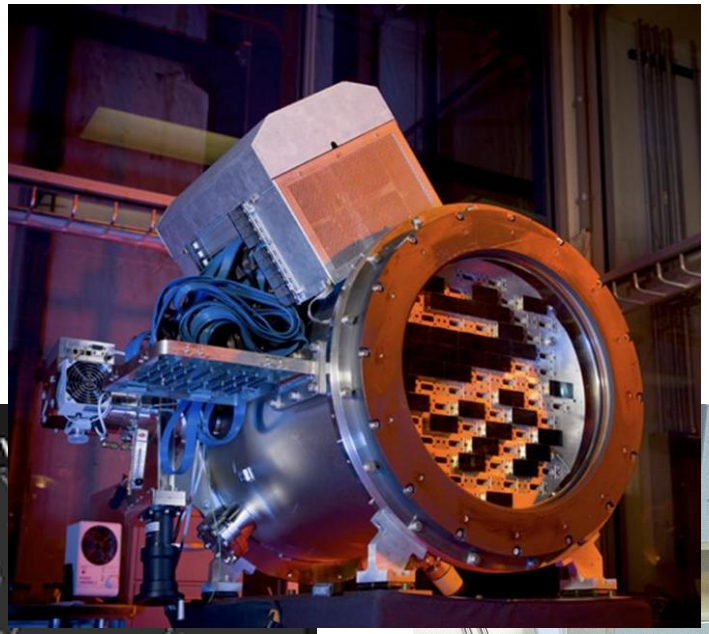



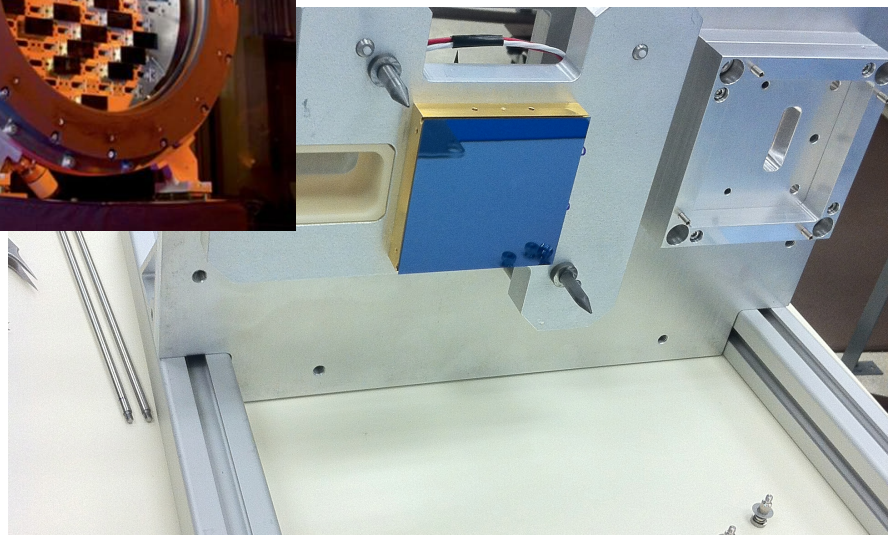

Use DECAM thick CCD sensors for low-mass dark matter search (DAMIC)

**Each avenue has had a strong collaborative framework with significant Fermilab support, leading to operating experiments**

# Expertise we gained from low noise readout and systems integration of DECAM sensors transitioned to detector R&D for DAMIC and is preparing us for DESI

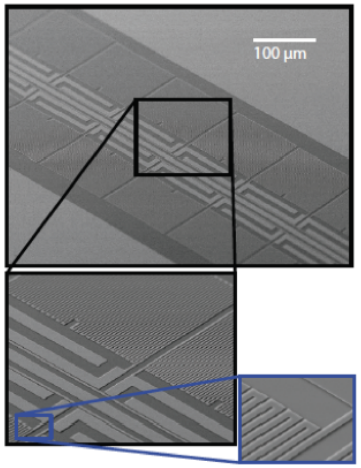


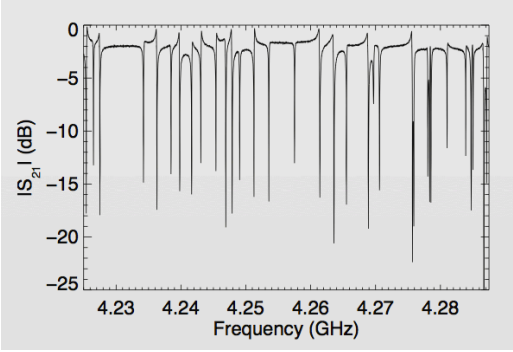





# MKIDs : Have established a new cosmic frontier detector research effort at Fermilab

- MKID = "Microwave Kinetic Induction Detectors"
- Unlike CCD's, MKID arrays can give a photon-by-photon energy and timing measurement, as well as position.
- The capability of these detectors is well matched to our future astrophysics needs, namely spectrophotometry for large area sky surveys
- Fermilab's resources are an excellent match to what is needed for optical MKID research: experience in low level RF, high speed digitization and multiplexing.
- Great deal of collaboration on this direction:



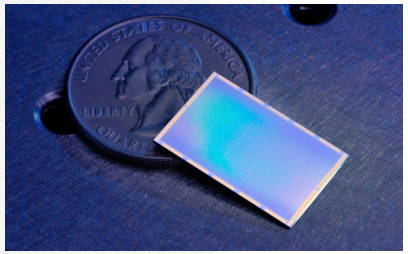




Resonances from each array element

# Using new ADR resource to establish low noise and multiplexing techniques in cryogenic detectors (<100 mK)

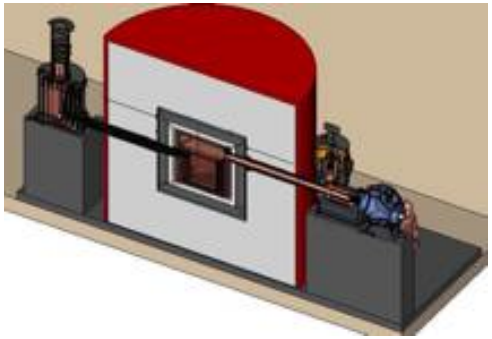
## MKIDs (Dark Energy)

(main driver for the facility)

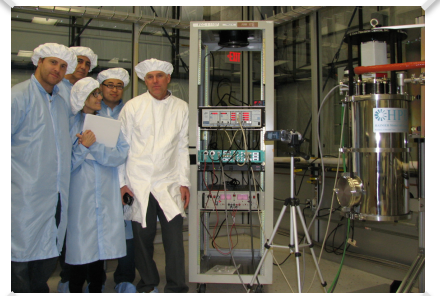


## Super CDMS (Dark Matter)

## Materials properties measurements



Adiabatic Demagnetization Refrigerator @ FNAL.



Operations start 2013.

**30mK at FNAL for the first time!**

## STJ (neutrino decay)

Photon detector development with KEK group

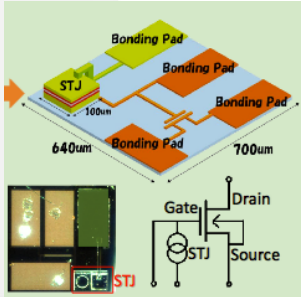



Fig.5 The layout of STJTEG1 chip(left), picture and schematic(right).

## SPT-3G (CMB)

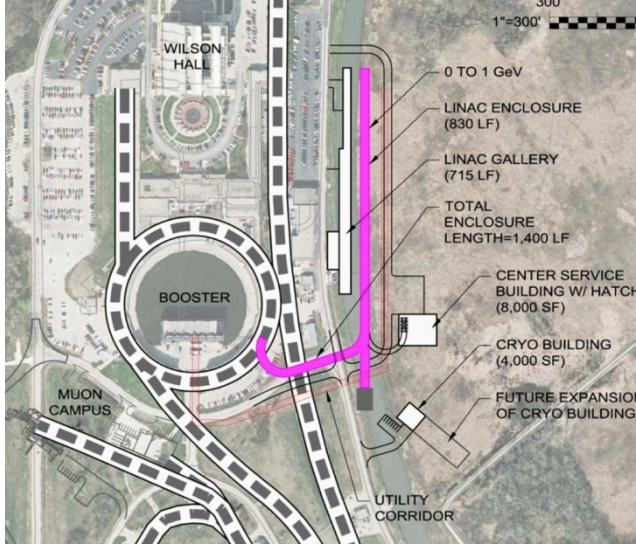
## Resonator tests

…build it and they will come. Used 100% of the time since day 1.

Fermilab

# High Intensity Detector Challenges

# Detectors for High Intensity




**Detector challenges relevant for next generation Mu2e and next generation neutrino experiments, All required by PIP-II intensity beams:**

**High rate Precision Photon Calorimetry**

**Very Low-Mass High-Rate Charged Particle Tracking**

**Time-of-Flight System Performance below 10 psec**

**High Precision Measurements of Neutrino Interactions**

**Large Area Cost Effective (LACE) Detector Technologies**

(Snowmass study: arXiv:1309.6704)

**These map well onto our current and planned program. R&D projects will be supported along these fronts.**

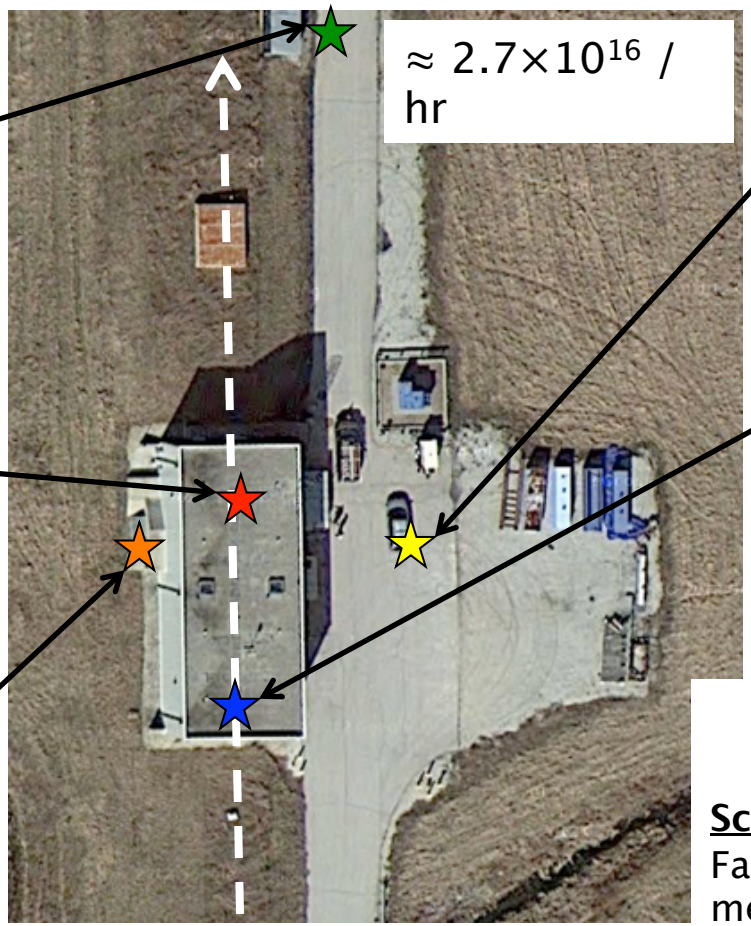
Fermilab

# Neutron Rates in the Booster Target area. This would be background for next generation low energy neutrino experiments in that area: CAPTAIN, CENNS, etc.

**50 m Absorber**
- 6 m from Fe beam stop
- 310 n / $10^{16}$ POT

**Collimator**
- 8 m from Be beam target
- 5608 n / $10^{16}$ POT

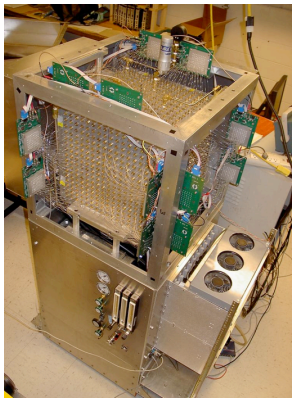
**Stairwell**
- 9 m from Be beam target
- 1384 n / $10^{16}$ POT




**Target 90° FOX**
- 20 m from Be beam target
- 390 n / $10^{16}$ POT

**2012 SciBath Loc**
- 20 m from Be beam target
- 211 n / $10^{16}$ POT

**SciBath**
Fast neutron measurements (10–200 MeV)
U. Indiana



# Communication

Our web site has links to our detector organization and facilities, as well as links to the EDIT school and our detector retreat and reviews:

http://detectors.fnal.gov

Useful Email:

FNAL detector point-of-contact:

ramberg@fnal.gov

Detector Advisory Committee:

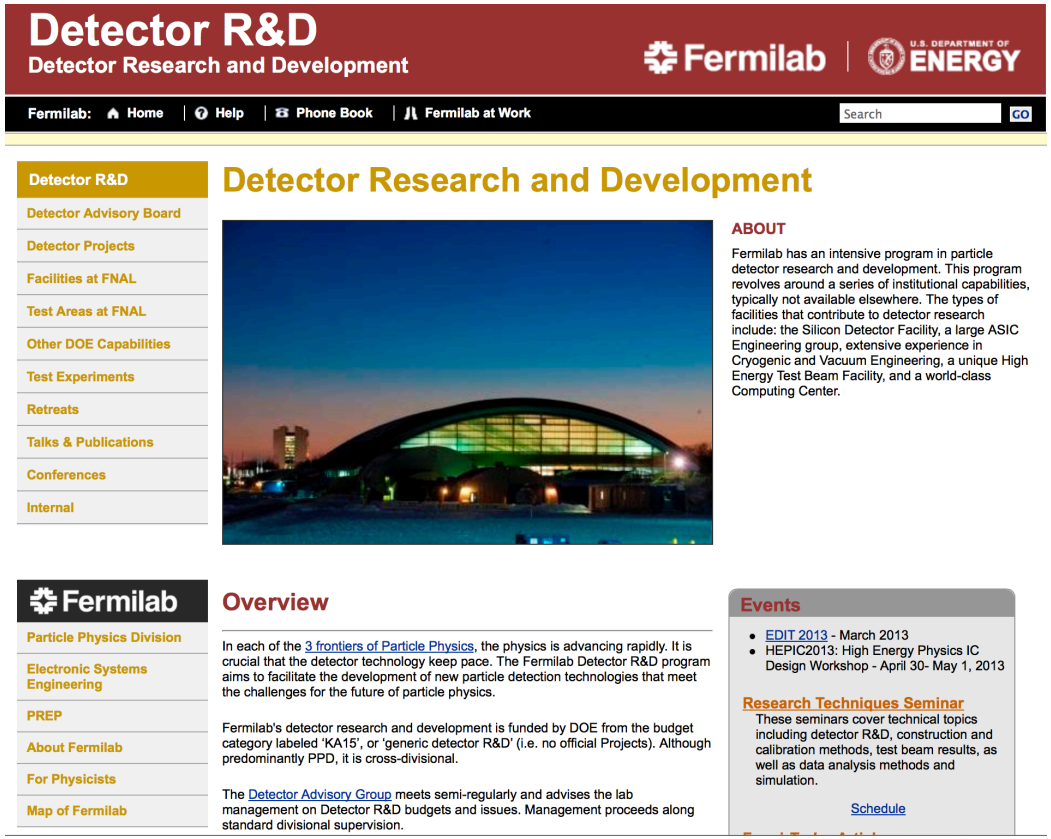
detector-advisory@fnal.gov

Detector R&D mail list (94 members):

detectors@fnal.gov

Test beam users (116 members):

test_beam@fnal.gov



# Research Techniques Seminar

These seminars cover technical topics of interest to experimentalists.
Topics include detector R&D, construction and calibration methods, test beam results, as well as data analysis methods and simulation.
Please send requests and comments to Erik Ramberg (ramberg@fnal.gov).

| Date | Time/Location | Speaker | Topic |
|---|---|---|---|
| | | | |
| Oct 1, 2014 | Curia II, 10:30 | Kevin Hickerson | Precision electroweak tests for new physics using ultracold neutrons |
| Sep 23, 2014 | Curia II, 10:30 | Peter Shirron | Adiabatic Demagnetization Refrigerators for Cooling Low-Temperature Detectors in Space |
| Aug 14, 2014 | Curia II, 10:30 | Daniel Holck | CHOUGH, the Canary Hosted-Upgrade for High-order adaptive optics |
| Aug 5, 2014 | Hornet's Nest, 10:30 | Kim Siang Khaw | Towards next generation fundamental precision measurements with muons |
| May 13, 2014 | Dark Side, 10:30 | Diego Tonelli | A Specialized Processor for Track Reconstruction at the LHC Crossing Rate |
| Apr 29, 2014 | Racetrack, 10:30 | Ben Mazin | Microwave Kinetic Inductance Detectors for UVOIR Astronomy |
| Mar 25, 2014 | Racetrack, 10:30 | Anatoly Ronzhin | Development of a New Fast Shower Maximum Detector Based on Micro Channel Plates as an Active Element |
| Feb 18, 2014 | Curia II, 10:00 | Jonghee Yoo | R&D for a Solid Xenon Detector |
| Feb 4, 2014 | Curia II, 10:30 | Serge Oktyabrsky | Picosecond Photodetectors: What Can We Adopt from the Modern III-V Semiconductor Technologies? |
| Jan 8, 2014 | Hornet's Nest, 11:00 | Gino Bolla | The present CMS tracker and its future prospects. |
| Dec 18, 2013 | West Wing, 10:30 | Pavel Murat | The Mu2e Calorimeter |
| Dec 3, 2013 | Hornet's Nest, 10:30 | Roger Rusack | The Upgrade of the Forward Calorimeter of CMS for the HL-LHC |
| Nov 15, 2013 | Curia II, 9:00 | Agenda | Special 3D ASIC Workshop |
| | | Ray Yarema | 3D ASIC Program at Fermilab: Recent results for 3D Pixels |
| | | Ron Lipton | 3D Circuit Design in High Energy Physics |
| | | Ted Liu | 3D Architectures for Triggering and Pattern Recognition |
| | | Bob Patti | Tezzaron: Evolution of 2.5D and 3D Technologies and Capabilities |
| | | Bob Bradford | Argonne Nat. Lab.: Use of 3D ASIC's in X-Ray Science |
| | | Gregory Deptuch | Discussion – Fermilab's 3D Future |

Always open to interesting topics from international community

http://www-ppd.fnal.gov/eppoffice-w/Research_Techniques_Seminar/

# Summary

- Fermilab has based its detector R&D organization on a "Detector Advisory Group", consisting of representatives of the major detector efforts and lab management
- R&D efforts are centered on several major portfolios, linked to the highest priorities of HEP:
  - Collider tracking and triggering that can support Phase 2 CMS upgrades
  - Liquid argon detector studies for neutrino and dark matter experiments, while guiding production of new SBN near detector. Test beam studies with LAriAT in new MCenter beamline
  - High speed calorimetry and photodetection for pileup mitigation at LHC.
  - Astrophysics dark matter/dark energy/CMB detector development, including new concentration on cryogenic detectors
- Fermilab's resources, facilities and collaborations are crucial in detector research and testing
- Considering the P5 report, detector R&D is beginning a shift into a more project-directed approach

# Agenda

- 8:30 Executive Session (Mark Oreglia)
- 9:00 Introductions (Greg Bock)
- 9:15 Overview (Erik Ramberg)
- 9:50 Coffee
- 10:00 Executive Session (Mark Oreglia)
- 10:30 Parallel Sessions:
  - Cosmic Frontier (Juan Estrada)
  - DAQ/Triggering (Alan Prosser)
  - Collider Silicon (Ron Lipton)
  - Calorimeter / Photodet. (Jim Freeman)
  - Liquid Argon (Stephen Pordes)
- 12:50 Lunch
- 13:30 Executive Session (Mark Oreglia)
- 14:00 Directed R&D & Future (Peter Wilson)
- 14:30 Facilities (Eric James)
- 15:00 Transitions (Erik Ramberg)
- 15:30 Coffee
- 15:40 Executive Session (Mark Oreglia)
- 17:00 Closeout