Welcome to the 1st Fermilab Detector Retreat

- Goals of this retreat:
  - Outline the nature of the Fermilab detector R&D program
  - Hear about the status of the various projects and their future direction
  - Discuss how these plans fit into the national program and how they should be supported by Fermilab
  - Hear about new efforts and discuss whether they can fit into the detector R&D program
  - Have a relaxing day, good lunch and beer/absinthe afterwards

Agenda

9:00	Welcome and Introduction	
9:10	Overview of Fermilab Detector Program	E. Ramberg
9:30	ASIC and Sensor R&D	R. Lipton
10:00	Calorimetry and Scintillators	A. Para
10:30	Break	
10:50	Cryogenic Noble Gases	S. Pordes
11:20	Data Acquisition Systems	R. Rivera
11:50	Discussion	
12:20	Lunch	
13:00	CCD R&D	J. Estrada
13:30	Laser Interferometry	A. Chou
13:50	Bubble Chambers	M. Crisler
14:10	Advanced Photodetectors	M. Demarteau
14:30	Discussion	
14:50	Break	
15:10	Beam Diagnostics	M. Wendt
15:30	Beam Facilities	A. Soha
15:50	MilliKelvin facility	J. Yoo
16:10	Discussion	
17:00	Beer	

The Detector Research and Development Program at Fermilab

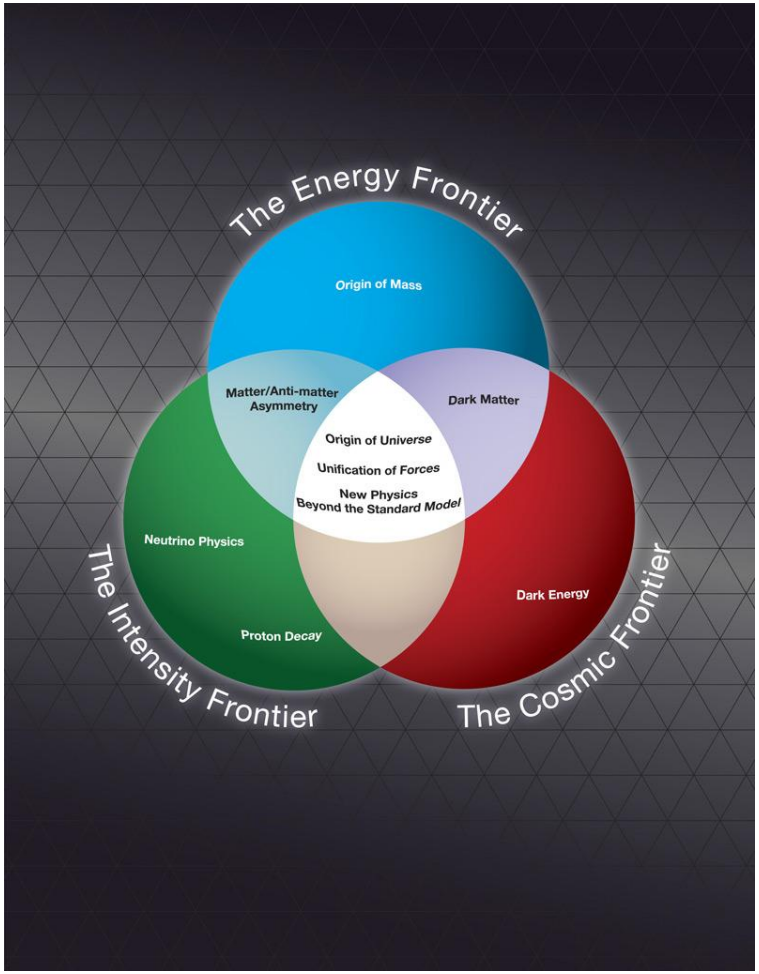
Erik Ramberg

Detector Retreat

5 May, 2011

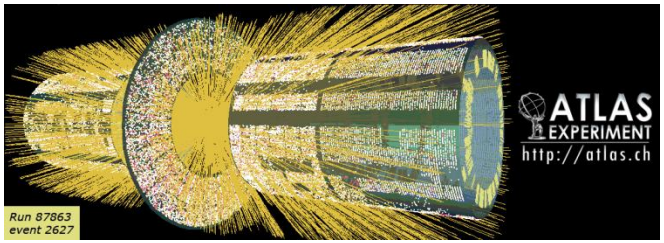
What are the major challenges in the Frontiers of High Energy Physics?

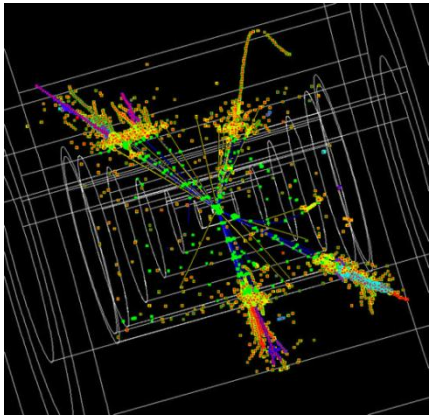
- The '3 frontiers' from DOE outline the major thrusts of high energy physics
- In each area, the physics is advancing rapidly. It is crucial that the detector technology keep pace.



Examples at the Energy Frontier

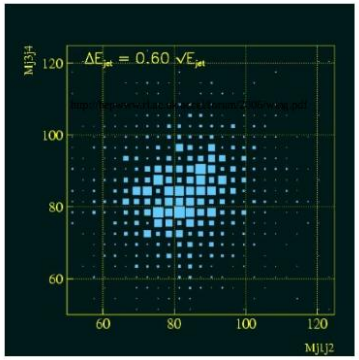
In an upgrade to the LHC detectors, vertex sensors will need to withstand a fluence of 10^{16} particles/cm^2

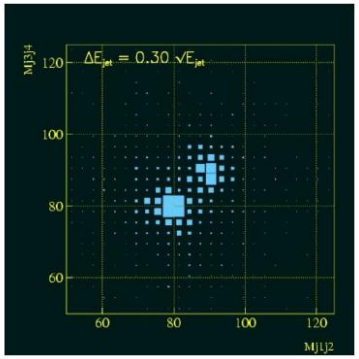




In a lepton collider, support mass needs to be low enough so that the vertex detectors can deliver 4 micron point precision

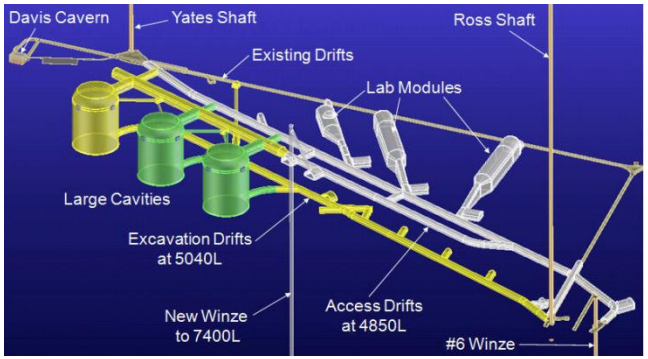
Hadronic jet energy resolutions at a lepton collider need resolution of 30%/sqrt(E) to resolve boson jets.

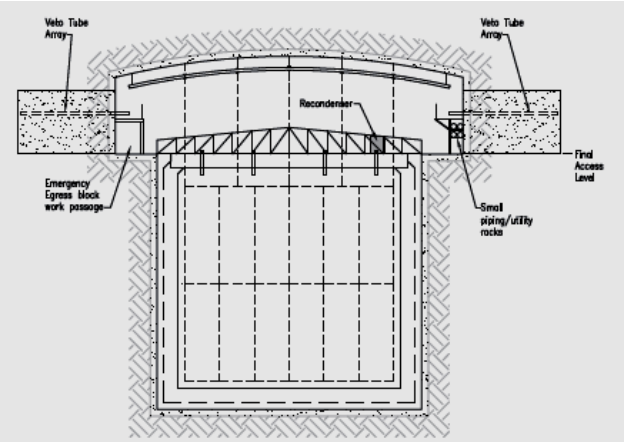




Examples at the Intensity Frontier

It is crucial to find a low-cost, efficient photodetector that can tile a water tank of 300 kton (150,000 PMT's !)

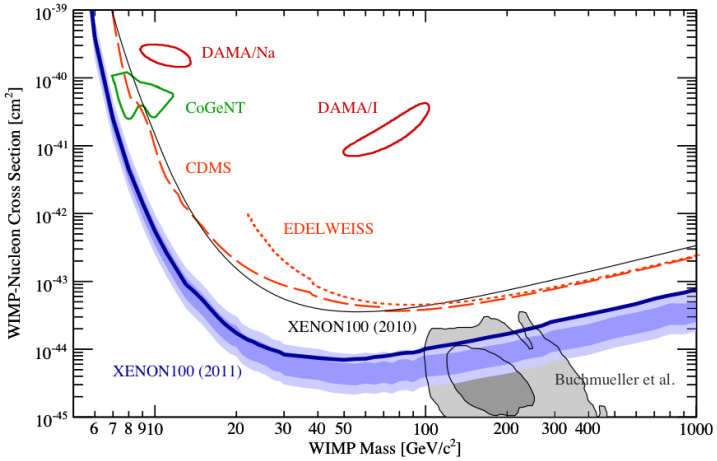




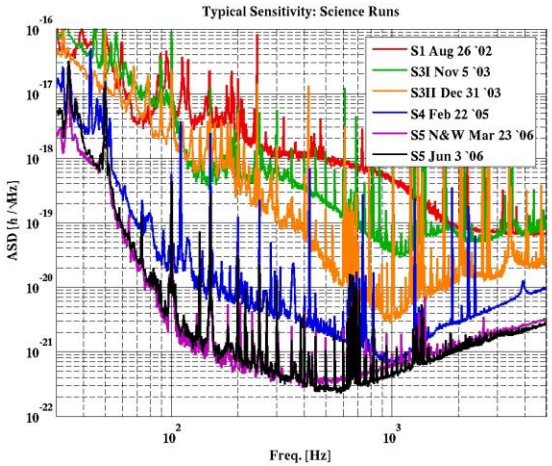
As an alternative to water Cerenkov neutrino detectors, we need to develop a 20 kton liquid Argon TPC detector that can be filled easily, with simple electronic readout

Examples at the Cosmic Frontier

Need to reduce background rates in dark matter detectors down to a level of 1 nuclear recoil per ton per year



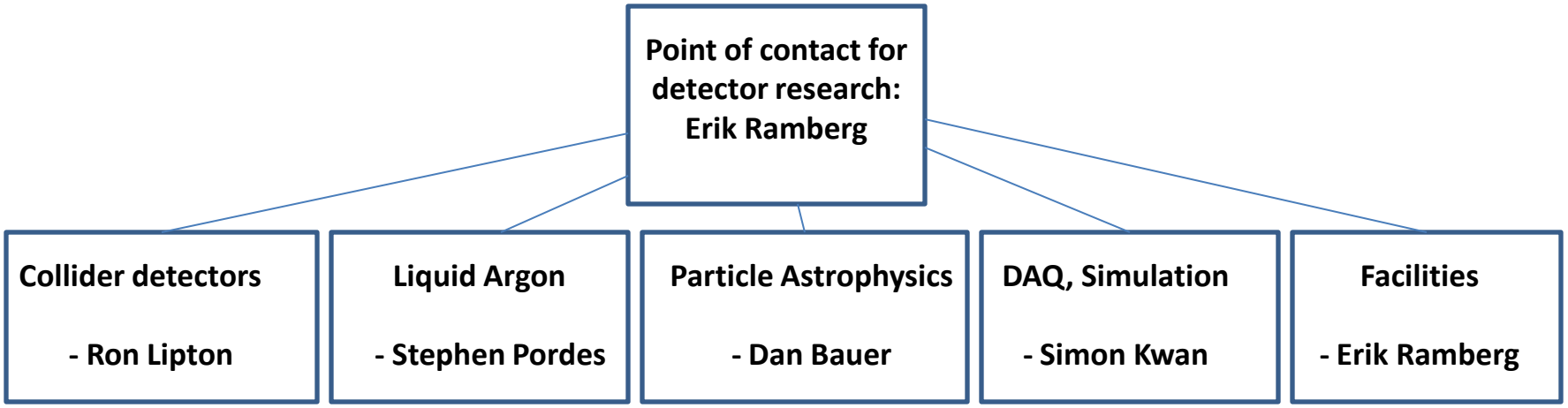
XENON100 results: Aprile, et.al.
arXiv:1104.2549v1 [astro-ph.CO]



GEO600 results: Seifert, et.al.
Opt. Lett. 31, No. 13 (2006) pp2000-2002

Is it possible to probe the Planck scale of space-time with laser interferometry?

Fermilab Detector R&D Organization



The research is funded by DOE from the budget category labeled 'KA15', or 'generic detector R&D' (i.e. no official Projects). Although predominantly PPD, it is cross-divisional.

This 'detector advisory group' meets semi-regularly and advises the lab management on detector R&D budgets and issues. Management proceeds along standard divisional supervision.

One question to discuss: should we change the official detector management at the lab to reflect this kind of structure?

Fermilab Detector Research Description

Project	Project Leader	Task	Task Leader	Comments
Collider detecto	**Ron Lipton**	Tracking ASIC R&D	Ron Lipton	3D ASICS
		Tracking Mechanical	Bill Cooper	ILC solenoid & tracker support
		Calorimetry	Erik Ramberg	QIE Development + SiPM readout
		Psec Time-of-flight	Erik Ramberg	Fast timing/large area photodetector
		Scintillators	Anna Pla-Dalmau	Scintillator Extrusion and Testing
Liquid Argon	**Stephen Pordes**	20 ton demonstrator	Brian Rebel	Purity achievement demonstrator for Lar
		Liquid Argon Dark Matter	Stephen Pordes	Production low background Argon
		Materials Test Stand	Stephen Pordes	A Lar sample test facility
		Cold electronics	Ray Yarema	Digital cold electronics w/BNL
		Solid Xenon	Jonghee Yoo	Solid Xenon +
		ArgoNeut	Bonnie Fleming	
Astrophysics	**Dan Bauer**	CCD R&D	Juan Estrada	Low noise readout for astro + DM
		QUIET	Hogan Nguyen	Low temp noise calibrators+HEMT design
		Bubble Chamber	Andrew Sonnenschein	Acoustic identification of background
		Laser Interferometry	Aaron Chou	High power laser laboratory
DAQ	**Simon Kwan**	Sensor DAQ	Simon Kwan	Rad hardness in new sensor technology
		Optical DAQ	Alan Prosser	Multi-gigabit/s optical DAQ
		xTCA	Simon Kwan	Newest DAQ thrust
Facilities	**Erik Ramberg**	Tools	Peter Wilson	To upgrade R&D tools as needed
		General Initiatives	Erik Ramberg	To support new projects
		ASIC Support	Ray Yarema	Software licenses for ASIC development
		Test Beam Equip&Oper	Erik Ramberg	Pixel telescope for Mtest
		New Mcenter Test Beam	Erik Ramberg	Will have two beamlines for detector R&D

The Detector R&D budget (KA15) supports about 35-40 FTE

Our new web site: http://detectors.fnal.gov

Connecting with the Community

- Workshop on National Coordination of HEP Detector R&D
  - At Fermilab on October 7-9, 2010
  - Goal was to understand interplay between national labs and universities in detector R&D
- Participation in new EDIT Detector School
  - "Excellence in Detectors and Instrumentation Technologies"
  - Goal is to train young researchers in detector techniques
  - At CERN, 31 January - 10 February 2011
  - At Fermilab in February, 2012
- Hosting 2nd TIPP Workshop:
  - Technology and Instrumentation in Particle Physics, 9-14, June, 2011
  - A follow-on to the very successful workshop in Japan in 2009
- Significant sponsoring of focused workshops on individual technologies (e.g. 3-D ASICS, homogenous hadron calorimetry, optical DAQ, etc.)

EDIT-2012 at Fermilab

EDIT detector school at CERN was a smashing success. 88 students had 9 day intensive lab/lecture experience.

Very positive reviews from attendees.

Pier and Young-Kee have committed to having the next one in February, 2012

Local Organizing Committee:

- Dave Christian
- Dmitri Denisov
- Patty McBride
- Elaine Phillips
- Erik Ramberg
- Luciano Ristori
- Aria Soha
- Andrew Sonnenschein

Your participation is certainly encouraged !

DPF Task Force on Instrumentation

- Ian Shipsey (Purdue) and Marcel Demarteau (ANL) have formed a DPF Task Force on Instrumentation. Greg Bock and Patty McBride are members. The goal is to answer the following questions:
  - "Is there need of a national body to evaluate and/or promote the national instrumentation R&D program."
  - "Might targeted resources be established at each of the five national laboratories in order to specifically support particular instrumentation R&D needs of individual researchers at the universities and the laboratories?"
  - "Please comment on the suggestion that a national instrumentation fellowship program be created by the NSF and DOE and Industry for Ph.D. students and postdoctoral scholars to encourage and support research in instrumentation."
  - "What are the thoughts of the committee members on establishing an EDIT style instrumentation school at the US labs (possibly rotating between them), possibly with academic credits?"
  - "Please comment on the relative importance of developing strategic links to, for example, nuclear physics, materials science, condensed matter physics, and electrical and computer engineering …"
  - "What are the committee's thoughts on the establishment of a named prize for instrumentation in experimental high energy physics? "

Where are we going?

- **In the Energy frontier:**
  - Advance silicon devices into a new 3D realm.
  - Continue work on understanding how to build a dual readout calorimeter
  - Establish a comprehensive center for SiPM characterization
  - Investigate optical data transmission for vertex detectors

- **In the Intensity frontier:**
  - Finalize construction and begin testing of a 20 ton Liquid Argon prototype detector
  - Operate new distillation apparatus to create radiopure liquid Argon for dark matter detectors
  - Develop ASIC readout for SiPM's in a time-of-flight system that can potentially be used for medical applications.

- **In the Cosmic frontier:**
  - Calibrate acoustic response to various backgrounds in a bubble chamber, for dark matter detection
  - Look for scintillation and ionization signals in solid Xenon crystals for axion and rare neutrino interactions.
  - Probe Planck scale physics in a high finesse, high power holographic interferometer

- **Improve our facilities:**
  - New MCenter test beam facility
  - New Muon-cooling Test Accelerator (400 MeV protons)
  - New laser lab
  - New probe stations for SiDet
  - Support CCD lab

Is this program the right one for Fermilab ?
If so, we need to defend it.
If not, we need to change it.