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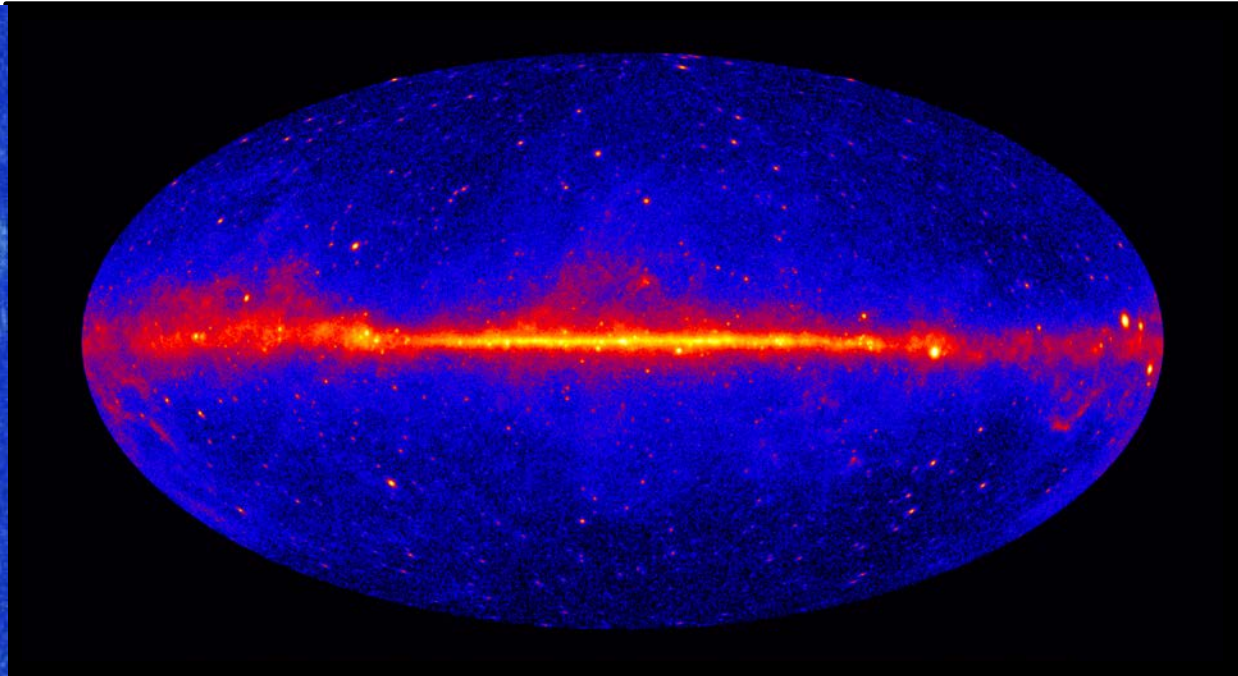
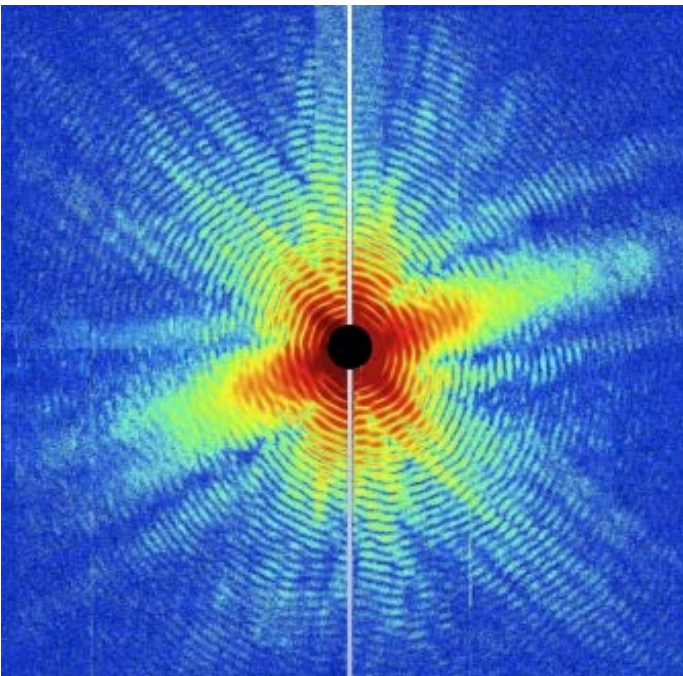
# Particle Physics & Astrophysics at SLAC

David B. MacFarlane  
Associate Laboratory Directory for PPA

# Mission of the New SLAC

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- Grow into the premier Photon Science Laboratory
  - Build and operate world leading facilities
  - Perform world leading science at these facilities
- Maintain our position as the premier accelerator laboratory
- Pursue strategic programs in particle physics, particle astrophysics and cosmology



# SLAC Organization

SLAC National Accelerator  
Laboratory  
Persis Drell, Director  
Mark Reichanadter, Acting COO

Accelerator  
N. Holtkamp

Operations  
M. Reichanadter  
(Acting)

LCLS  
J. Stohr

SSRL  
C.-C. Kao

Photon Science  
C.-C. Kao  
(Acting)

Particle Physics  
& Astrophysics  
D. MacFarlane

LSST Project  
S. Kahn, Director  
N. Kurita, PM

KIPAC Division  
R. Blandford  
A. Roodman, Deputy

Elementary Particle  
Physics Division  
C. Young

Research Electronics  
& Software Division  
G. Haller

Research Mechanical  
Engineering Division  
K. Fouts

Scientific Computing  
Applications Division  
A. Boehnlein  
R. Dubois, Deputy

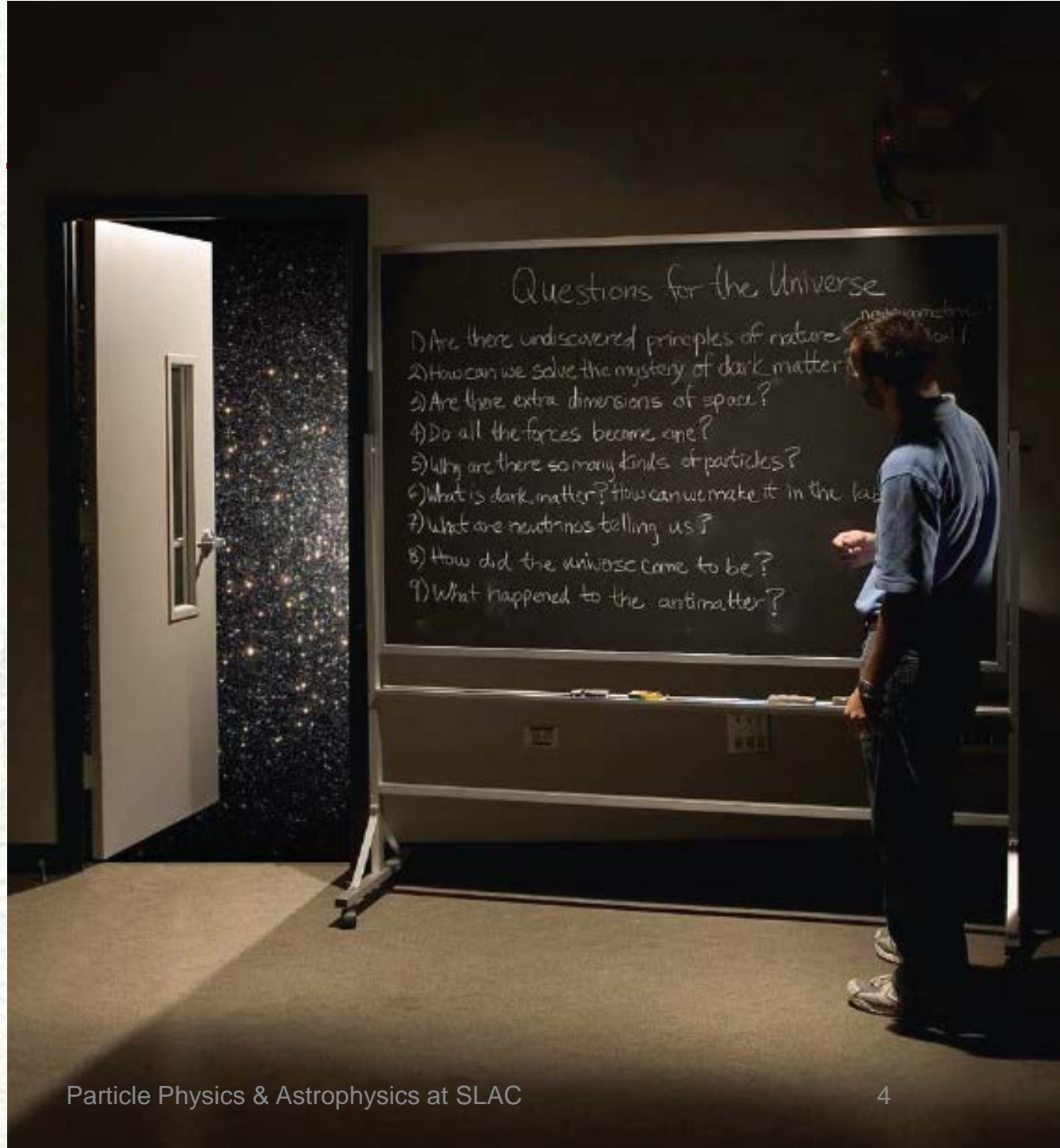
Associate Laboratory Directors

## Universal questions

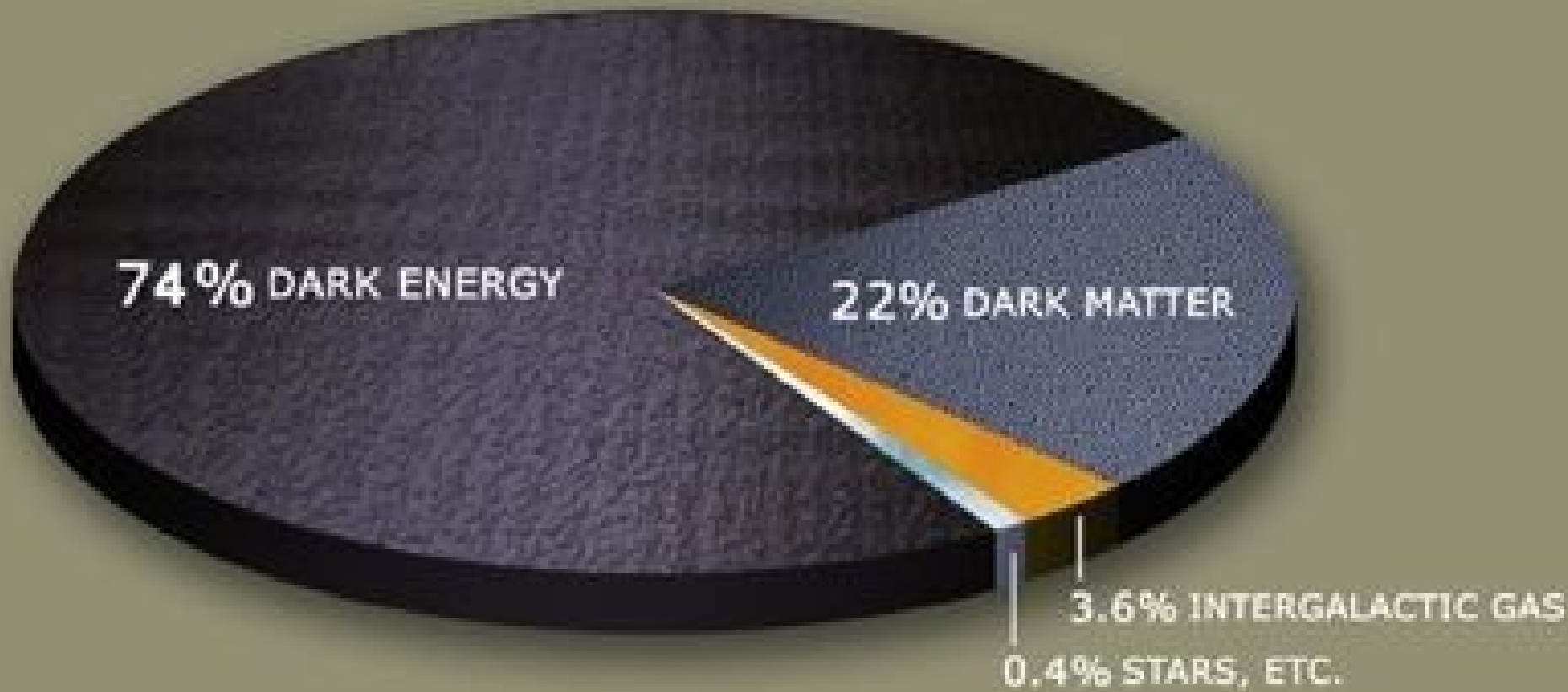
We are asking fundamental questions about the universe:

1. Are there undiscovered principles of nature?
2. How can we solve the mystery of dark energy?
3. Are there extra dimensions of space?
4. Do all the forces become one?
5. Why are there so many kinds of particles?
6. What is dark matter?  
How can we make it in the lab?
7. What are neutrinos telling us?
8. How did the universe come to be?
9. What happened to the antimatter?

The next-generation particle accelerators will help us to discover the answers.



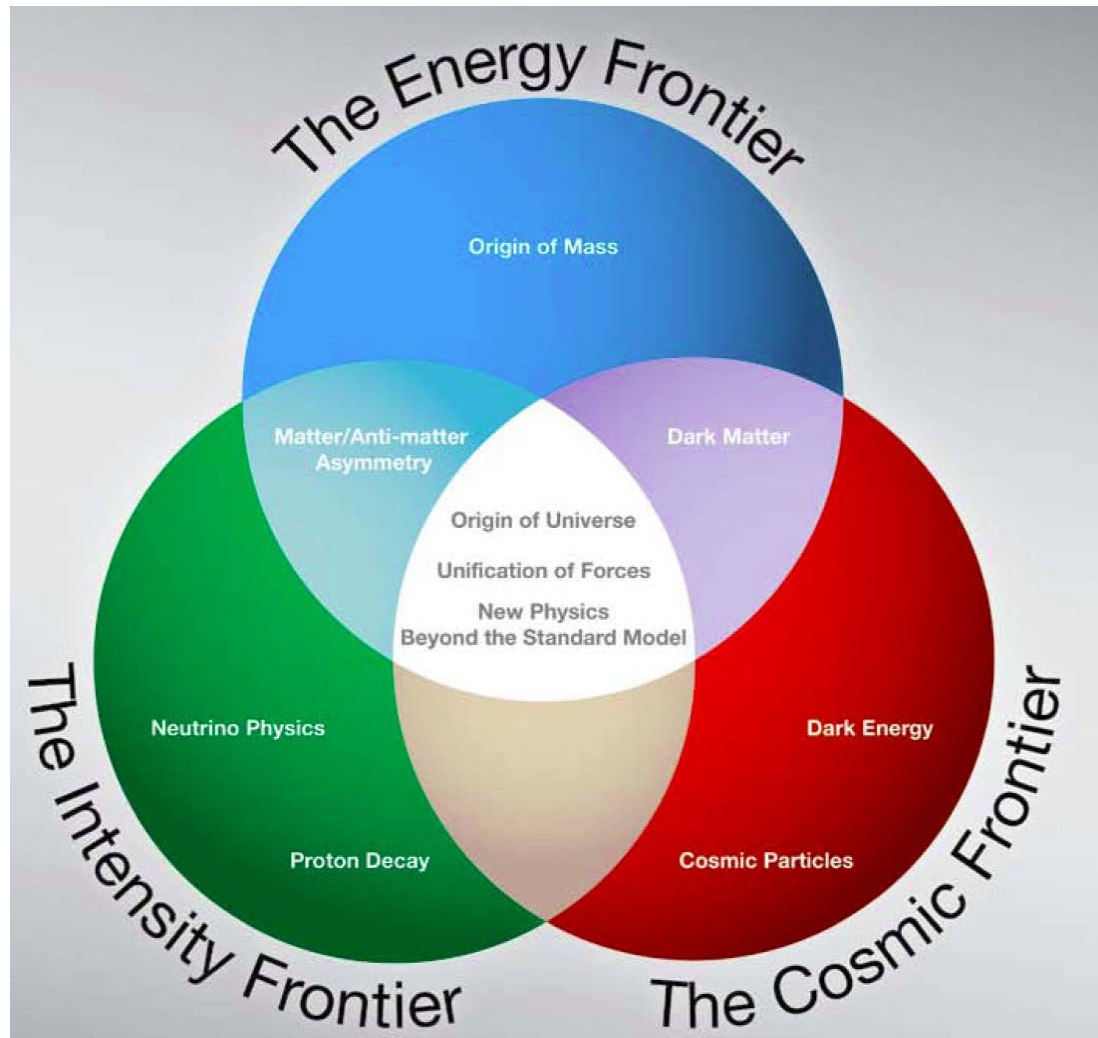
# Cosmic puzzle





**Rich science opportunities  
and a rich toolkit**

# Frontiers of particle physics and cosmology



From the P-5 HEPAP Subpanel Report, May 2008

Particle Physics & Astrophysics at SLAC

# SLAC PPA at a glance

- **Energy frontier:**

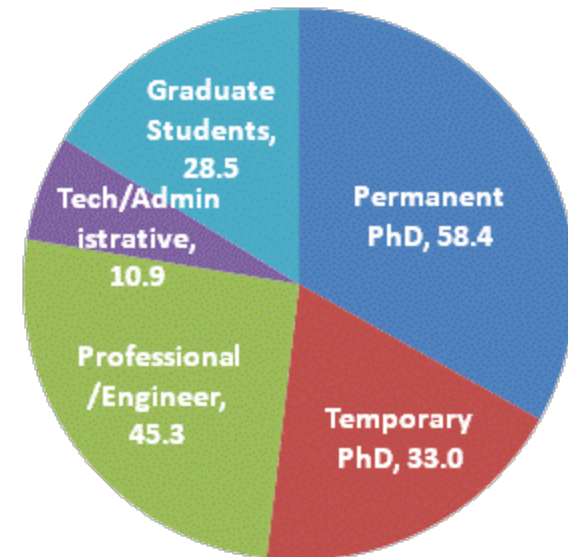
- ☑ Exploring TeV-scale physics with ATLAS
- ☑ Positioning community for future Lepton Collider

- **Cosmic frontier:**

- ☑ Dark energy with DES and LSST
- ☑ Dark matter with SuperCDMS, Fermi GST, CTA
- ☑ Nature of inflation with small CMB effort

- **Intensity frontier:**

- ☑ Nature of the neutrino with EXO
- ☑ Neutrino oscillations & CP violation with LBNE
- ☑ Potential new physics in flavor sector

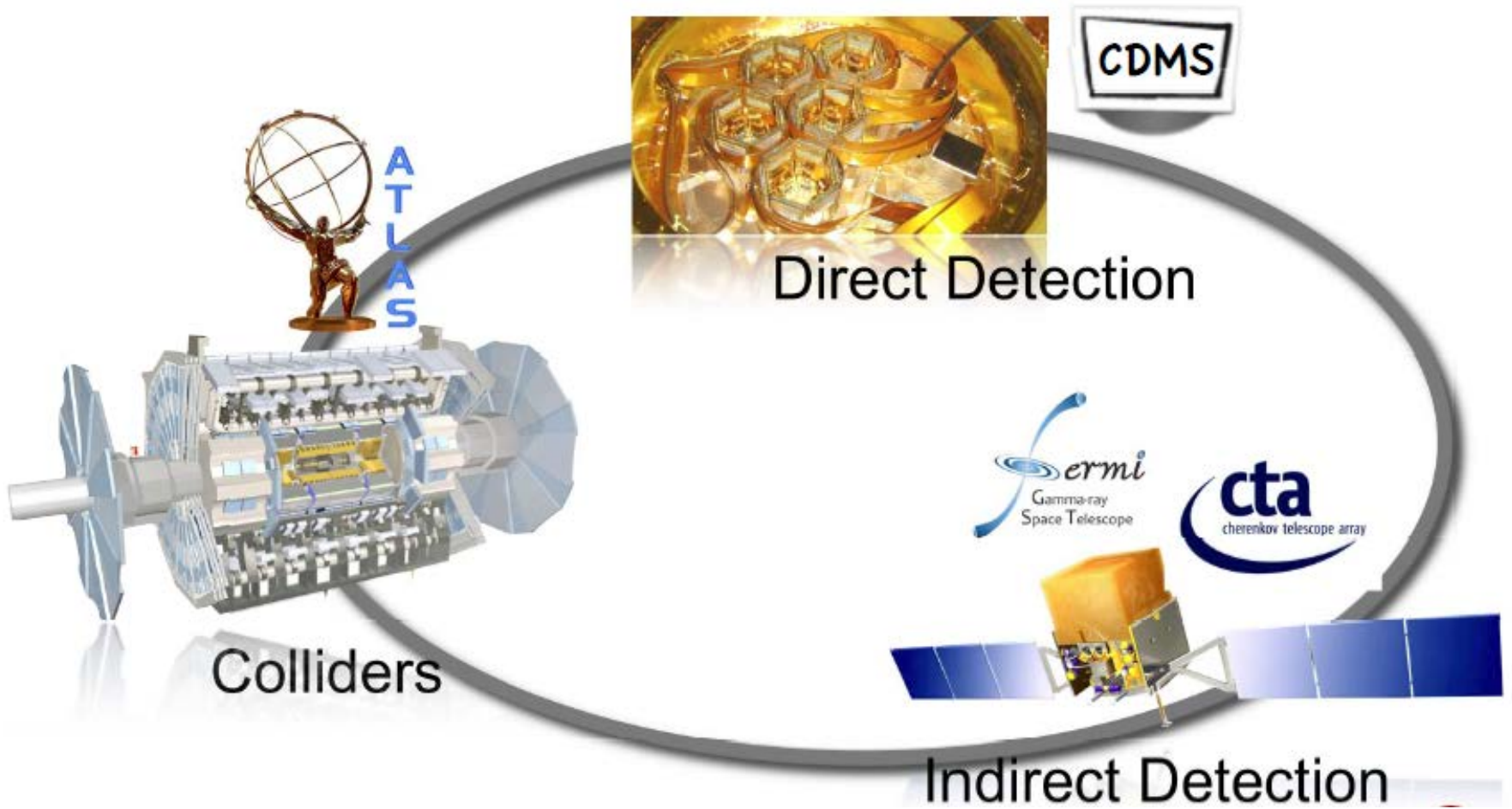


FY11: 176 FTE total

30%:50%:20%  
accelerator-based,  
non-accelerator based,  
& theory



# Connections: Particle Dark Matter

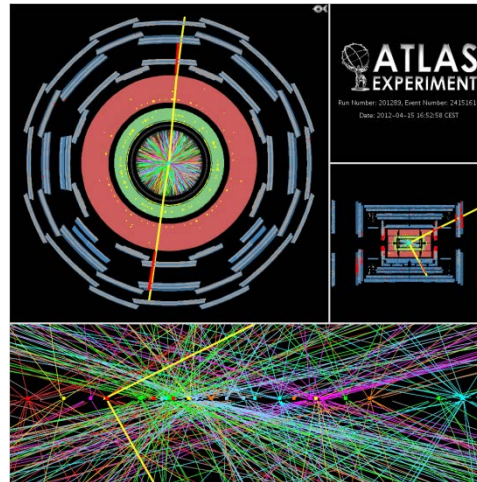


# Energy Frontier focus: ATLAS

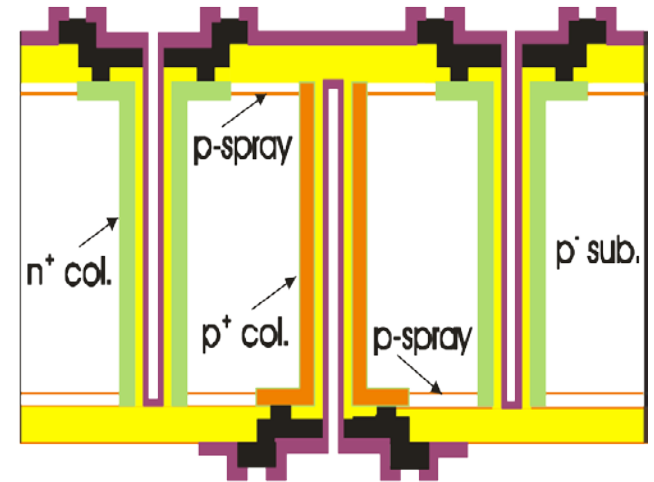
Energy Frontier

ATLAS  
Data: 2008-2020

ATLAS Upgrade  
Project: 2017-2022  
Data: 2022-2030



$Z \rightarrow \mu\mu$  with 25 vertices



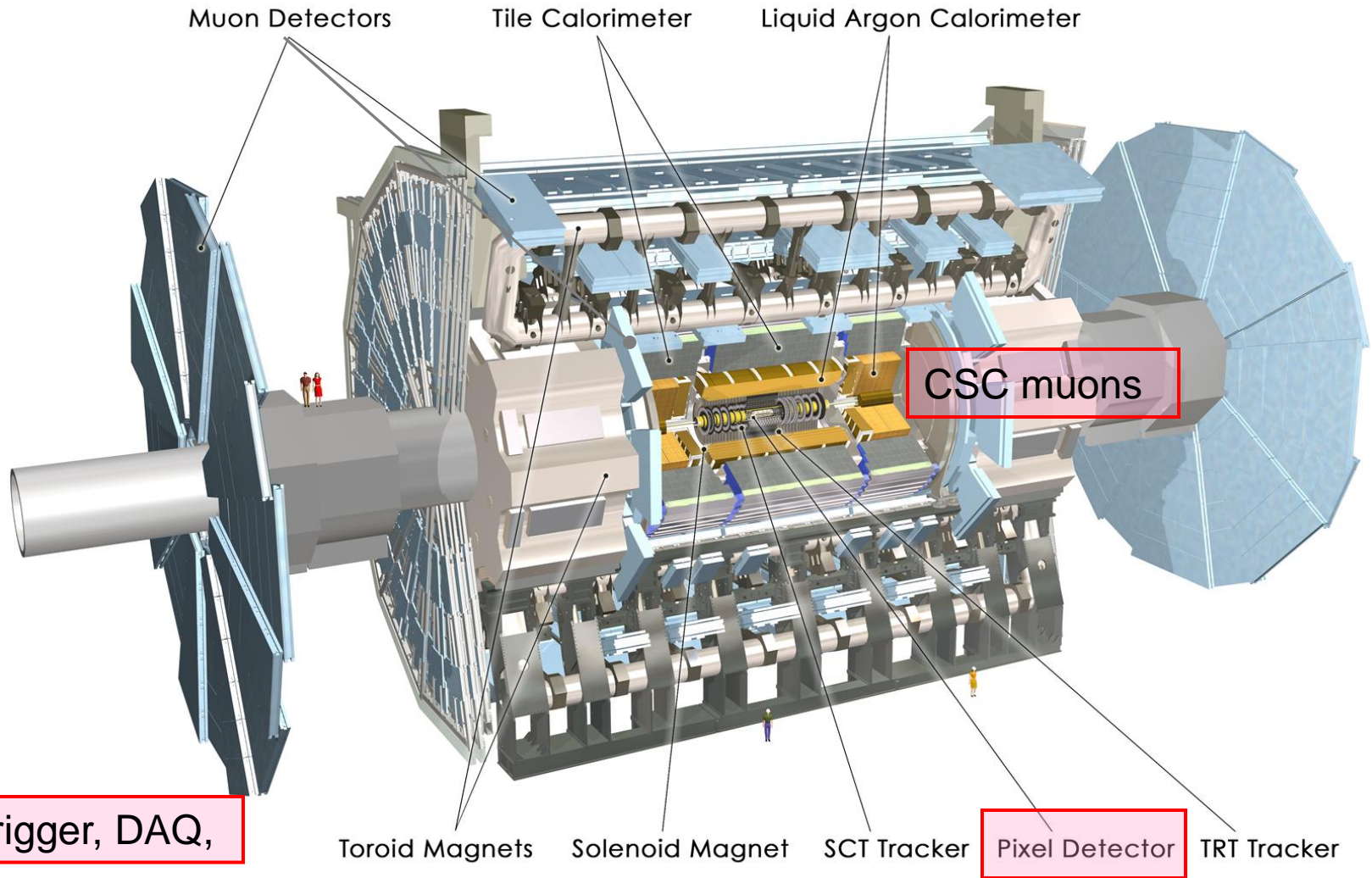
FKB 3-d pixel sensor design

[Likely] funded

Good funding prospects

Unknown funding prospects

# SLAC contributions to ATLAS

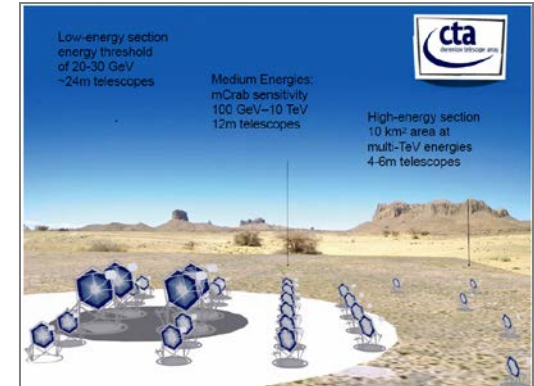
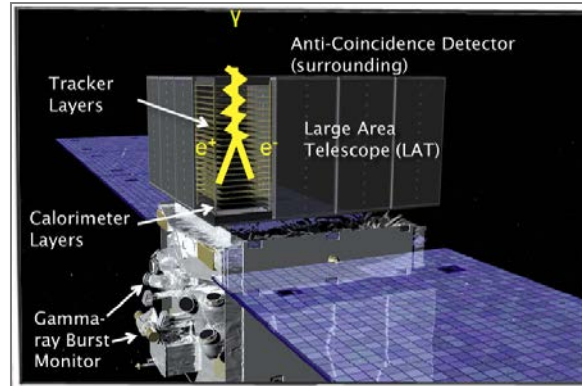


# Cosmic Frontier focus: Fermi, LSST & CDMS

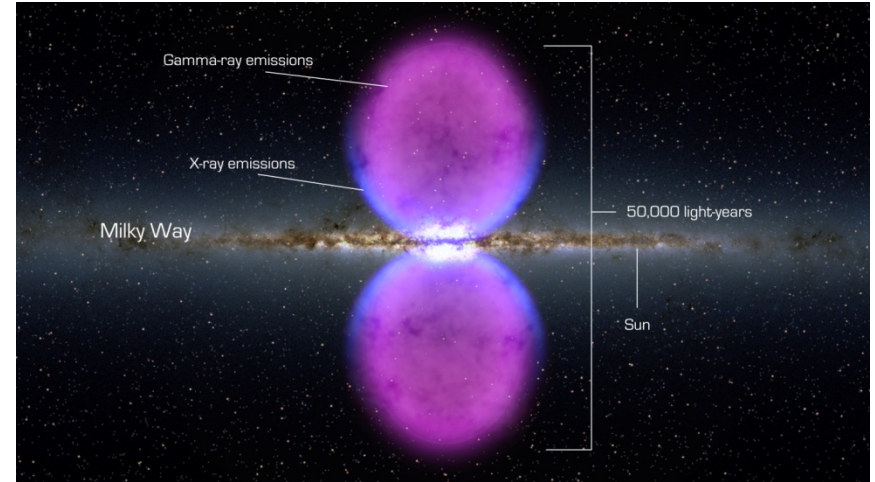
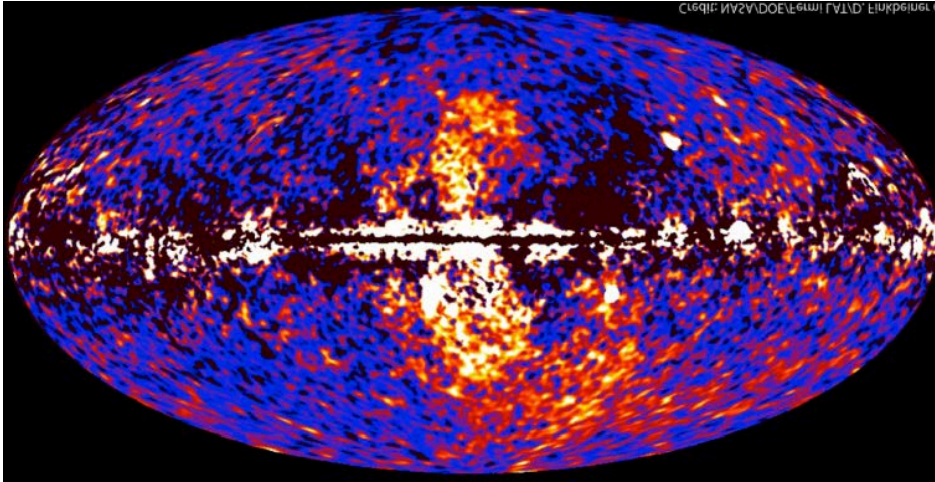
Cosmic Particles +  
Indirect Dark Matter

Fermi GST  
Data: 2008-2018

CTA  
Project: 2017-2021  
Data: 2017-2030

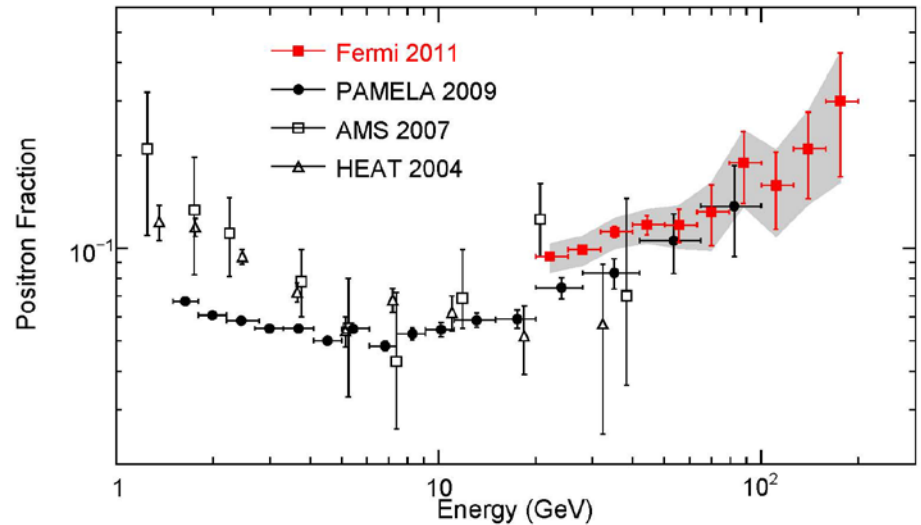
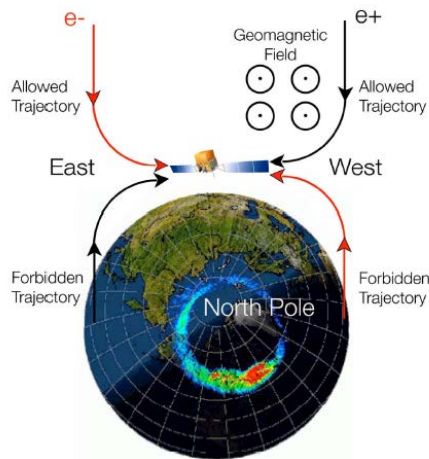


# Fermi science results



Discovery of x-ray lobes at center of Milky Way

Observed rise in positron spectrum with energy



# Cosmic Frontier focus: Fermi, LSST & CDMS

Cosmic Particles +  
Indirect Dark Matter

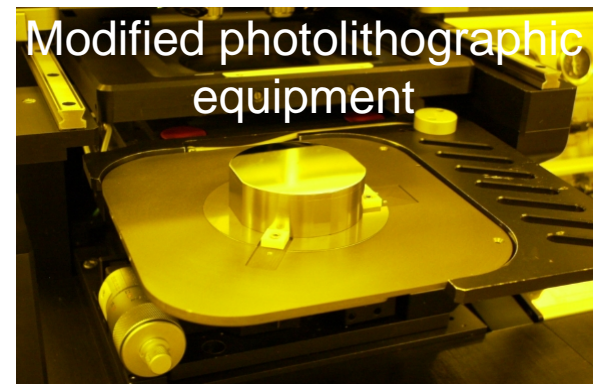
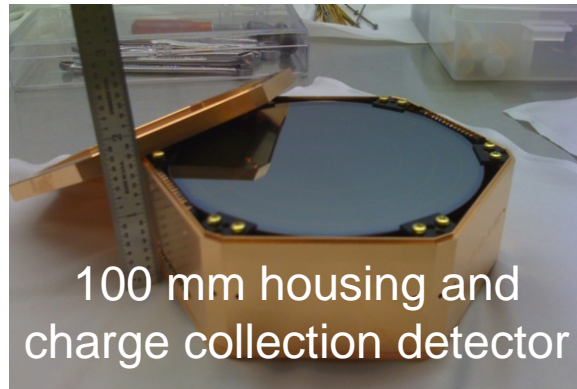
Fermi GST  
Data: 2008-2018

CTA  
Project: 2017-2021  
Data: 2017-2030

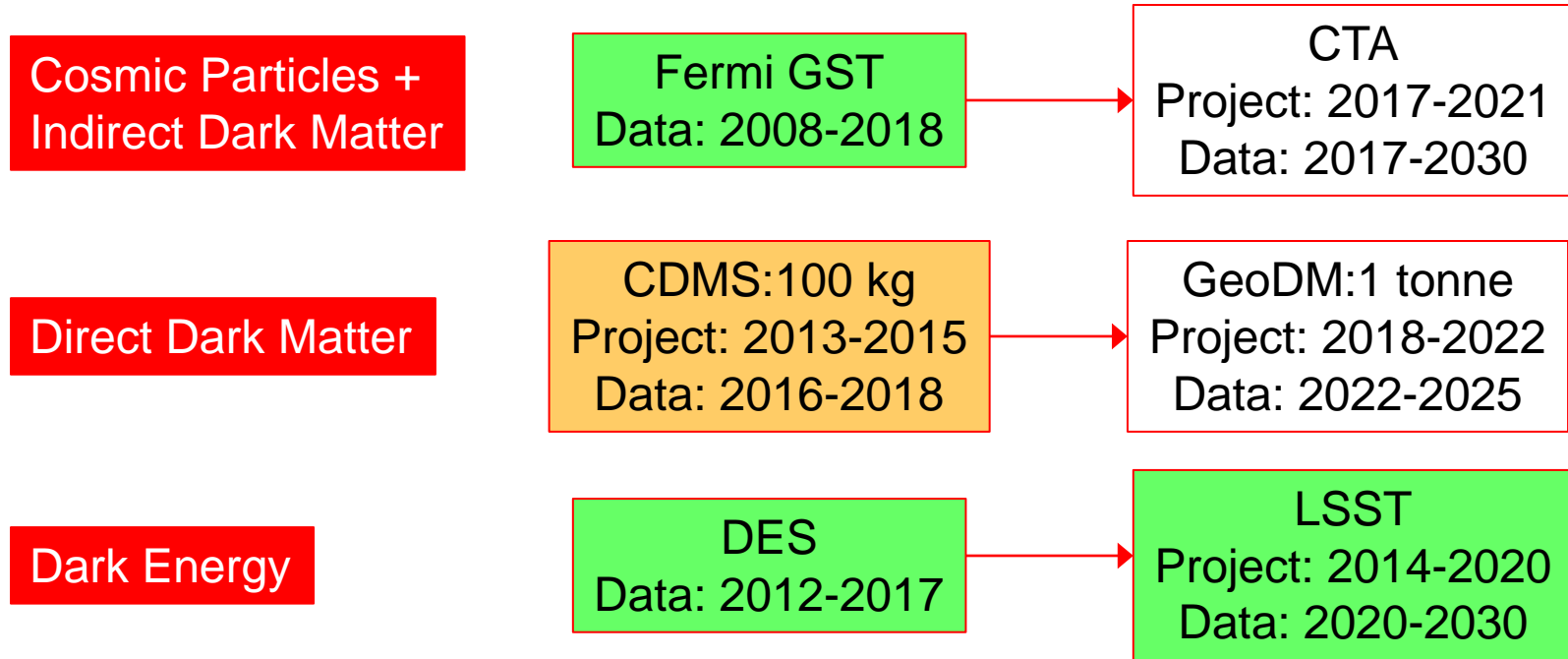
Direct Dark Matter

CDMS: 100 kg  
Project: 2013-2015  
Data: 2016-2018

GeoDM: 1 tonne  
Project: 2018-2022  
Data: 2022-2025



# Cosmic Frontier focus: Fermi, LSST & CDMS



[Likely] funded

Good funding prospects

Unknown funding prospects

# Future program: Large Synoptic Survey Telescope

- Provide a sensitive survey of the entire sky at visible wavelengths every few nights
  - Tight constraints on dark energy
  - Rich program of astrophysics & astronomy
- Highest priority for ground-based project in ASTRO2010
- **NSF and DOE-HEP moving forward to develop project**
  - NSF: PDR in Aug, 2011; NSB in July 2012 for FY2014 start
  - DOE: CD-1 review in Oct, 2011; R&D ongoing for construction start in FY2014



CD-1 approved April 12  
NSB approval July 18

DOE: \$160M, NSF: \$440M



# Intensity Frontier focus: EXO and LBNE

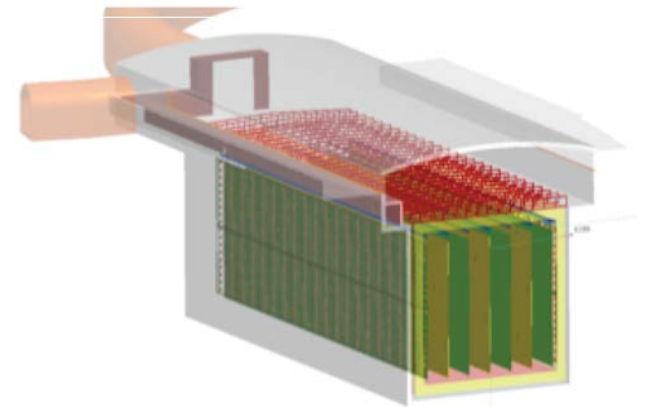
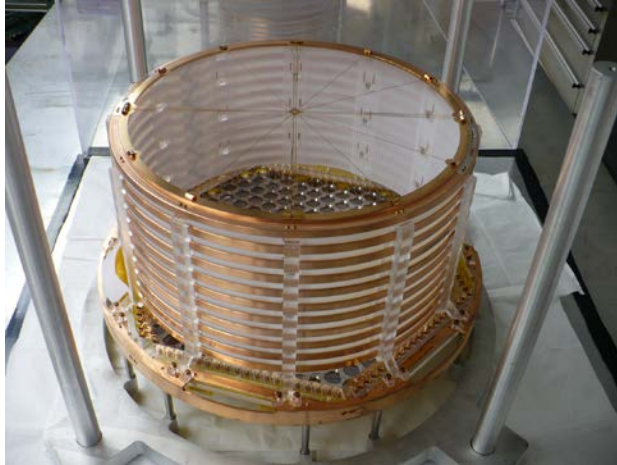
Nature of neutrino

EXO-200  
Data: 2011-2015

EXO  
Project: 2016-2020  
Data: 2020-2030

Neutrino oscillations  
and CP violation

LBNE  
Project: 2013-2020  
Data: 2020-2030

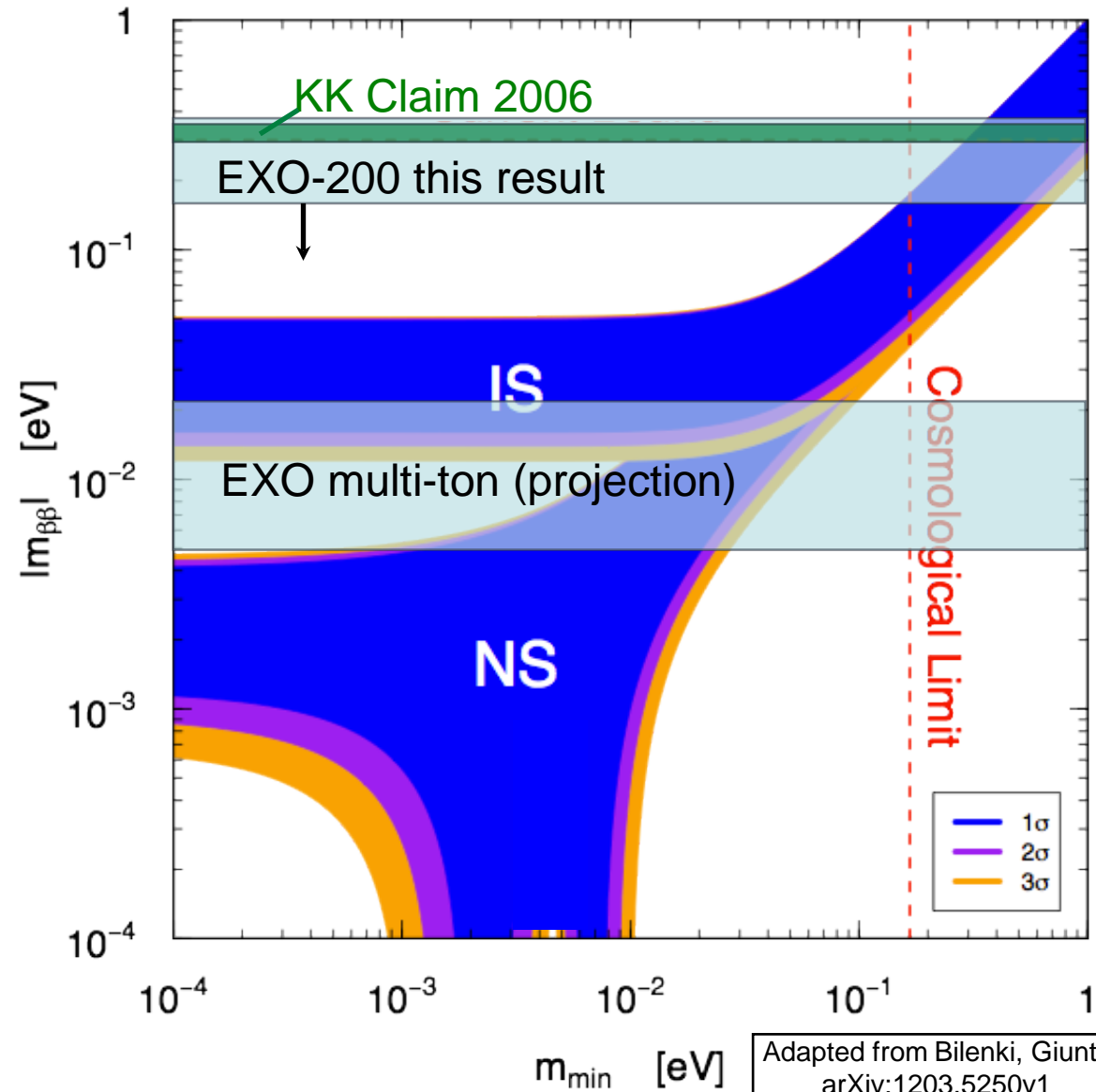
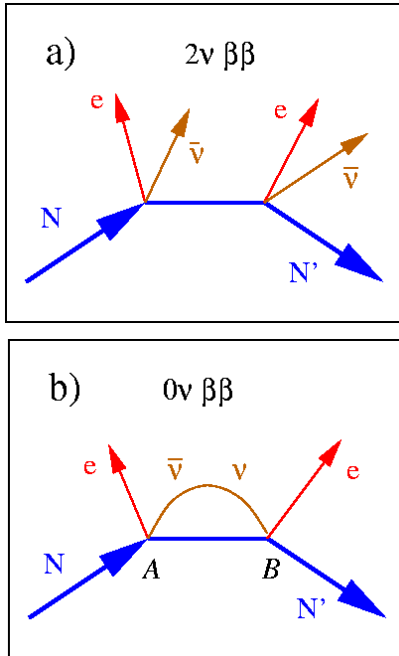


[Likely] funded

Good funding prospects

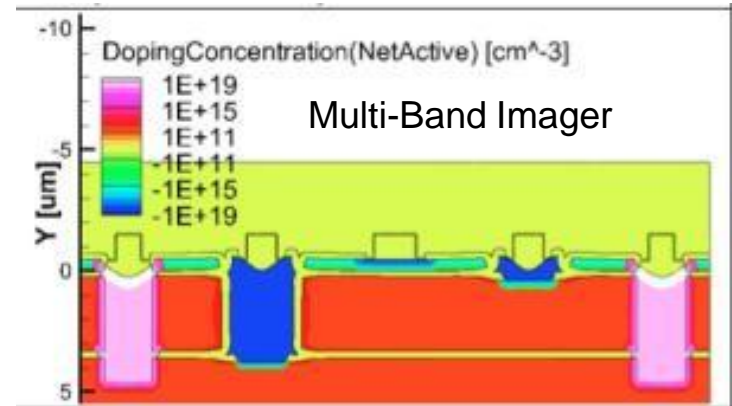
Unknown funding prospects

# Is the neutrino its own antiparticle?



# Overview of detector R&D capability

- Sensor and integrated electronics development
  - Sensor design, simulation, fabrication at Stanford Nanofabrication Facility
  - Full-custom mixed signal ASICs
- Detector systems
  - Analog/digital electronics, electro-mechanical systems, MDI studies, supported by test beams and facilities
- Data acquisition & computing
  - Data acquisition, detector simulation toolkit, PFA studies



Up to 480 Gbit/s of data from detector  
Up to 40 Gbit/s on-board switching

# Scientific computing applications

Product	Fermi	EXO	Super CDMS	LSST	Heavy Photon	LCSim	Geant4 Other <sup>2</sup>
Web Framework	Yes	Yes	Yes	Yes			
Data Monitoring	Yes	Yes		Yes			
Collaboration Tools	Yes	Yes					
Data Catalog	Yes	Yes	Yes				
Communication Tools	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Processing Pipeline	Yes	Yes	Yes	Yes			
Analysis Tools (AIDA)	Yes <sup>1</sup>	Yes <sup>1</sup>		Yes			Yes
Event Display (WIRED)	Yes					Yes	Yes
Analysis GUI (JAS)	Yes			Yes	Yes	Yes	

# Particle Physics & Astrophysics summary

