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# **Detector R&D in Astrophysics**

## **Introduction**

Juan Estrada

Fermilab Detector R&D Program Review

October 29, 2014

# Current Lines of Research

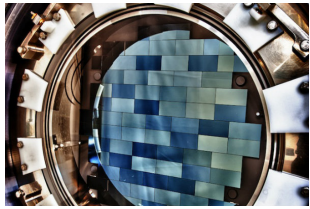
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- CCDs: → (few slides by JE)
  - Low threshold experiments (DAMIC-CONNIE)
  - Detectors for DESI
  - Calibrations of nuclear recoil a low energy
- MKIDs:
  - DAQ development for large arrays → (talk by Gustavo Cancelo)
  - Tests at Telescope → (talk by Chris Stoughton)
  - R&D instrument for SOAR (few slides by JE)
- ADR facility → (talk by Donna Kubik)
  - CDMS, STJ, SPT-3G
- CMB → (talk by Brad Benson)

# R&D program that enables experiments in astrophysics

Best limit at low masses for DM search.  
Now an international collaborations with funds from several institutions. 15 scientists, 3 postdocs, 10 students.

Detector R&D funds allowed FNAL to develop a facility for the fabrication and testing of 500um silicon packaged for spectrograph. This has now put is in conditions to build the detectors for DESI project.



DECam needed CCD R&D to produced a focal plane in 2005 .

DAMIC 2014  
100g @ SNOLAB

DAMIC 2012  
10 g @ SNOLAB

DAMIC 2011  
demo at NuMI

DESI packaging  
@ FNAL 2013

Seeded by general R&D program. Attracted collaborations in Europe and South America. With their own funding. FNAL now supporting with LDRD. "First dark" collected 10/16/2014

CONNIE 2014  
Installed at ANGRA

CCD  
R&D

1e- threshold

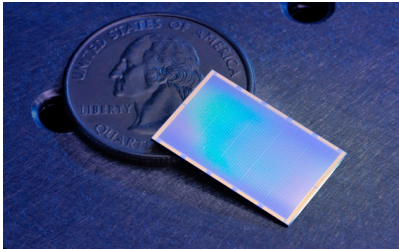
Massive detectors with 2e- noise developed at LBNL for astronomy.

Prototypes sensors exists. Would open a new window to MeV dark matter searches.

# R&D program that enables experiments in astrophysics

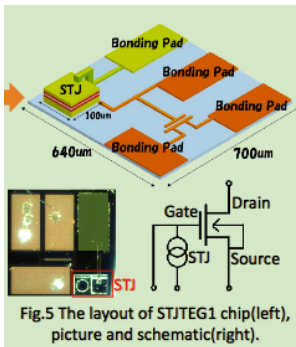
## MKIDs (Dark Energy)

(main driver for the facility)



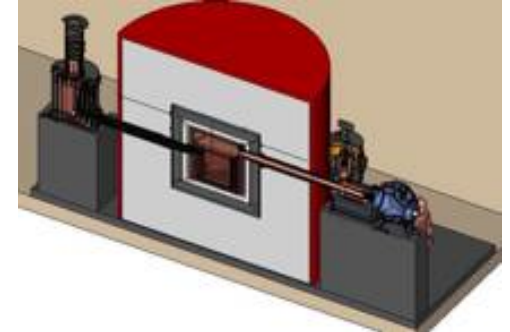
## STJ (neutrino decay)

Photon detector development  
with KEK group



## Super CDMS (Dark Matter)

Materials properties measurements



Adiabatic Demagnetization  
Refrigerator @ FNAL.



Operations start 2013.  
30mK at FNAL for the first time!

## SPT-3G (CMB)

Resonator tests



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

# R&D seeds collaborations and attracts funding

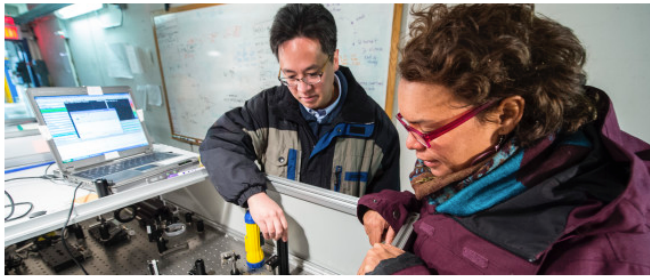
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- CCD:
  - Collaboration with Zurich, U.Chicago, U.Michigan, Brazil, Argentina, Mexico and Paraguay.
  - Permanent presence of students from these universities working at FNAL.
  - Experiments DAMIC and CONNIE seeded by detector R&D, now funded mostly from sources outside FNAL.
  - Grants for these experiments at Mexico, Argentina, Brazil. LDRD at FNAL. Seed grant with U.Chicago. Funding at U. Michigan. PECASE award.
  - R&D investment in packaging makes the production of DESI CCDs possible.
- CMB:
  - R&D investment in CMB allows us to bring SPT-3G at FNAL, and make the lab a player in CMB-stage4 project.
- MKIDs:
  - Early stage for FNAL, but now the lab is a key member of the efforts to develop large instruments with these new type of sensors.
  - Strong Collaboration with UCSB.

# R&D program alumni

## Freaky Physics Experiment May Prove Our Universe Is A Two-Dimensional Hologram

The Huffington Post | By David Freeman | Posted: 08/29/2014 8:22 am EDT | Updated: 08/29/2014 8:59 am EDT



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### Scalability, scintillation readout and charge drift in a kilogram scale solid xenon particle detector

**J. Yoo; H. Cease, W. F. Jaskierny, D. Markley, and R. B. Pahlka**

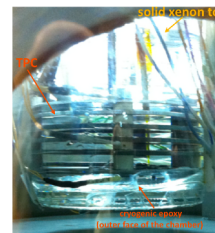
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**Figure 12.** The TPC installed in the xenon glass chamber. The TPC operation, such as pulsed photon emission through the optical fiber to the photo-cathode, can be viewed from the external window. In this particular sample, the amount of solid xenon in the chamber is about ~2kg. A little opaque area near the surface of the glass bottom edge is cryogenic epoxy. In this particular sample, some birefringence can be seen at the inner glass wall near the grid rings.