Astrophysics Projects at Fermilab

Brenna Flaugher, Astrophysics Department Head, Fermilab

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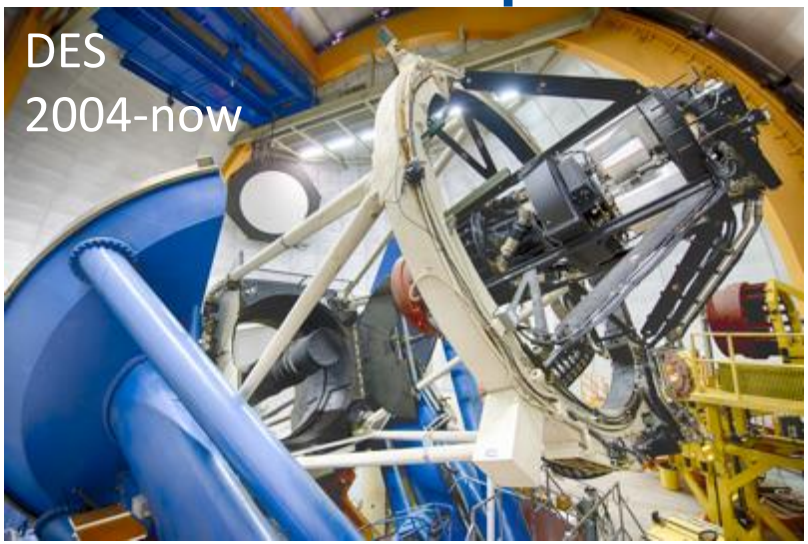
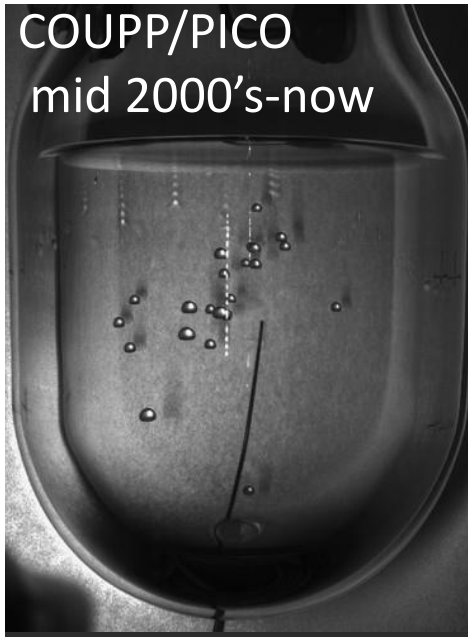
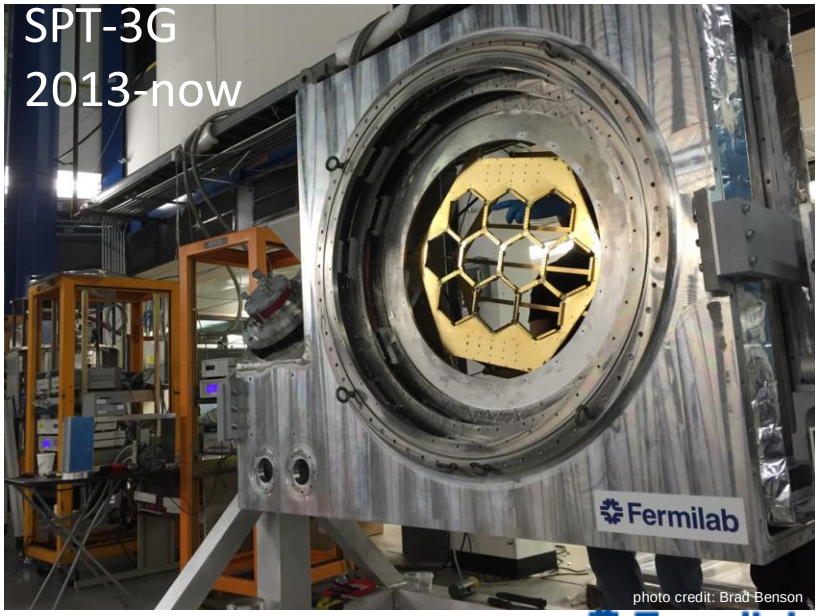
Strong theoretical and instrumentation capabilities drive Fermilab's Cosmic Frontier Program – a few examples







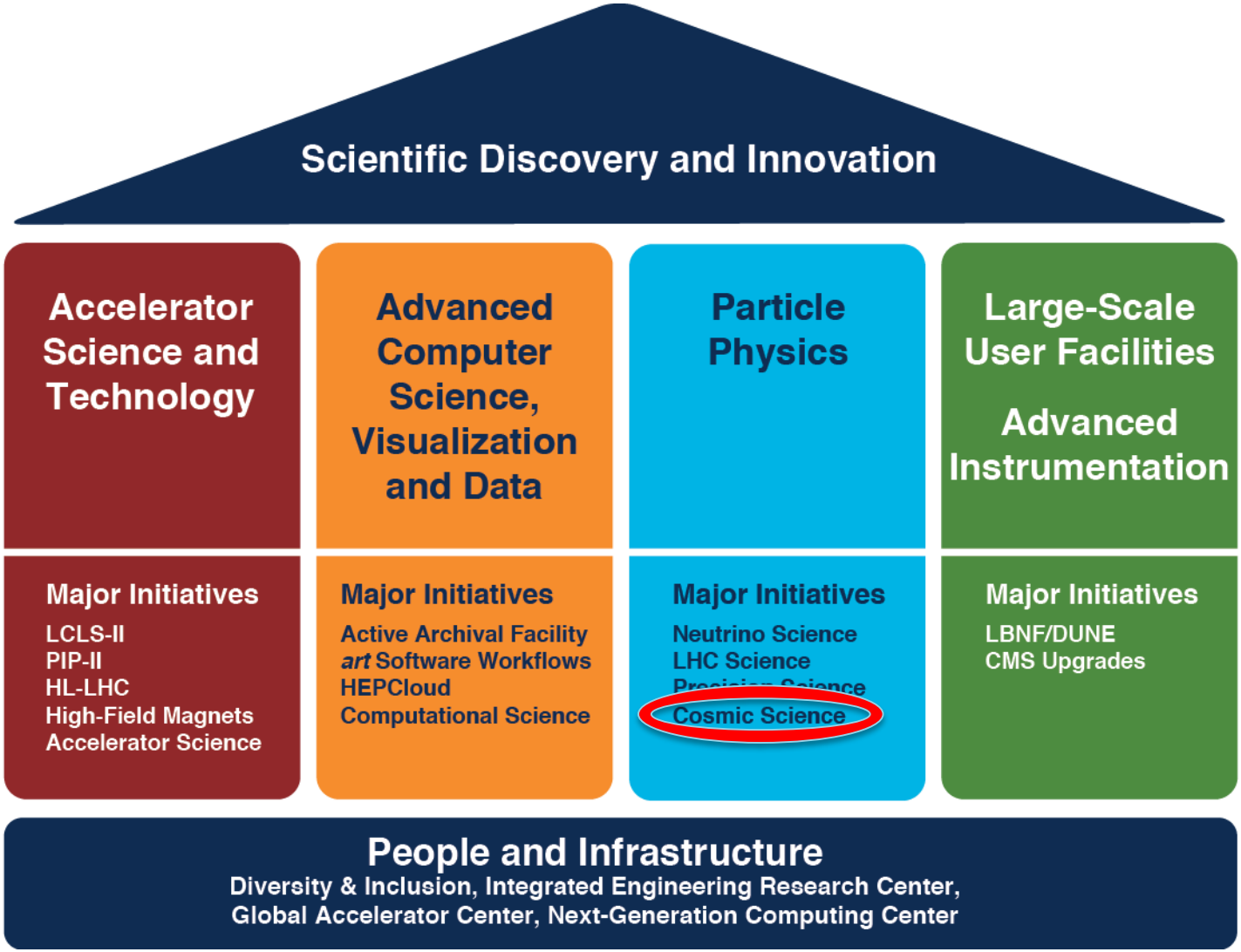
Cosmic Program at Fermilab

- Grew out of the connection of particle physics and cosmology (inner-space – outerspace) and the close ties between the theoretical astrophysics groups at Fermilab and Chicago in the early 1980's

- Capitalizes on scientific expertise, technical skills, and facilities developed for particle physics by applying them to cosmology projects
  - Data handling, analysis and quality control
  - Silicon detectors: precision assembly, testing/characterization, integration
  - Cryogenic engineering
  - Light Detection
  - Bubble Chambers
  - RF engineering

- Strong collaboration with university community brings students and postdocs into the lab to gain hands-on experience with detectors and readout systems

Cosmic Program is part of the Fermilab Strategic Plan



Cosmic Frontier Research is ~8% of the scientists and ~ 17% of the postdocs at the lab

Overview of the astrophysics projects

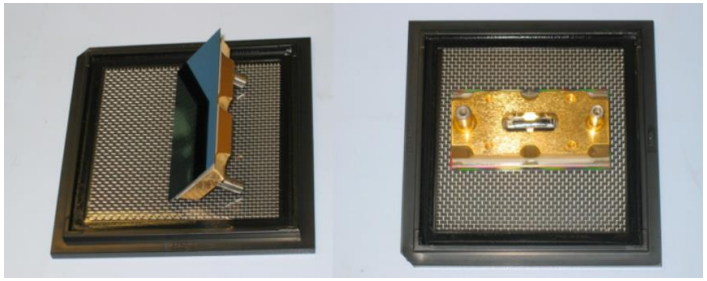
Dark Energy	Key R&D and roles at Fermilab
Dark Energy Survey (DES)	CCD R&D, CCD Packaging, detector integration and testing
Dark Energy Spectroscopic Instrument (DESI)	CCD R&D, CCD Packaging, Precise alignment of ~ton scale parts (optical corrector)
Large Synoptic Survey Telescope (LSST)	Dark Energy Science analysis Frame work Computing Infrastructure WG

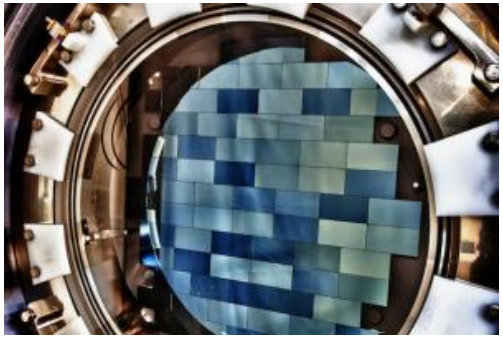
Dark Matter	Key R&D and roles at Fermilab
Super-Cryogenic Dark Matter Search at SNOLAB * (SuperCDMS-SNOLAB)	Cryogenic design, underground testing in NEXUS: low background testing of detectors, devel. of active cryogenic vetos and nuclear recoil calibrations
Liquid Xenon Dark Matter detection (LZ)	TPC engineering, process control
Axion Dark Matter eXperiment (ADMX) *, *	RF cavity development, quantum detection R&D

CMB	Key R&D and roles at Fermilab
South Pole * Telescope 3G	Camera design, fabrication, detector packaging, testing, and integration, cryostat assembly and testing
CMB- S4	R&D, design, collaboration development

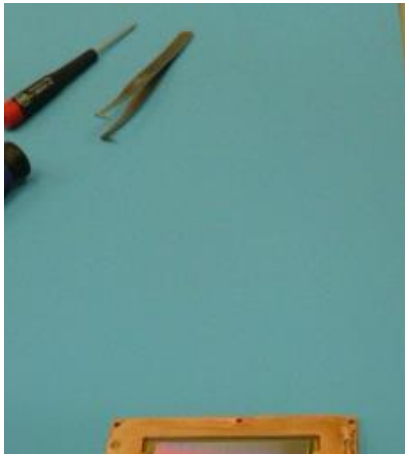
Strong Synergy with the Energy Frontier program: Precision Assembly, Detector Characterization

DECam CCDs and Imager



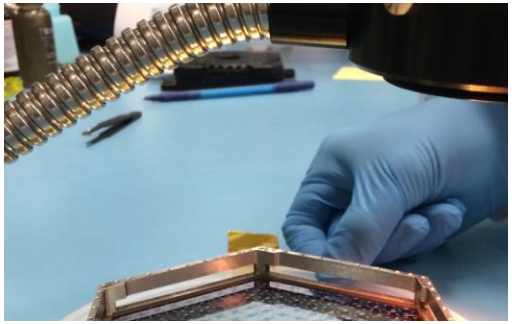


- Developed for Tevatron collider program: CDF, Dzero and now CMS
- Dark Energy Camera for DES
- Now being used for DAMIC, CDMS, DESI, SPT-3G and R&D



DAMIC

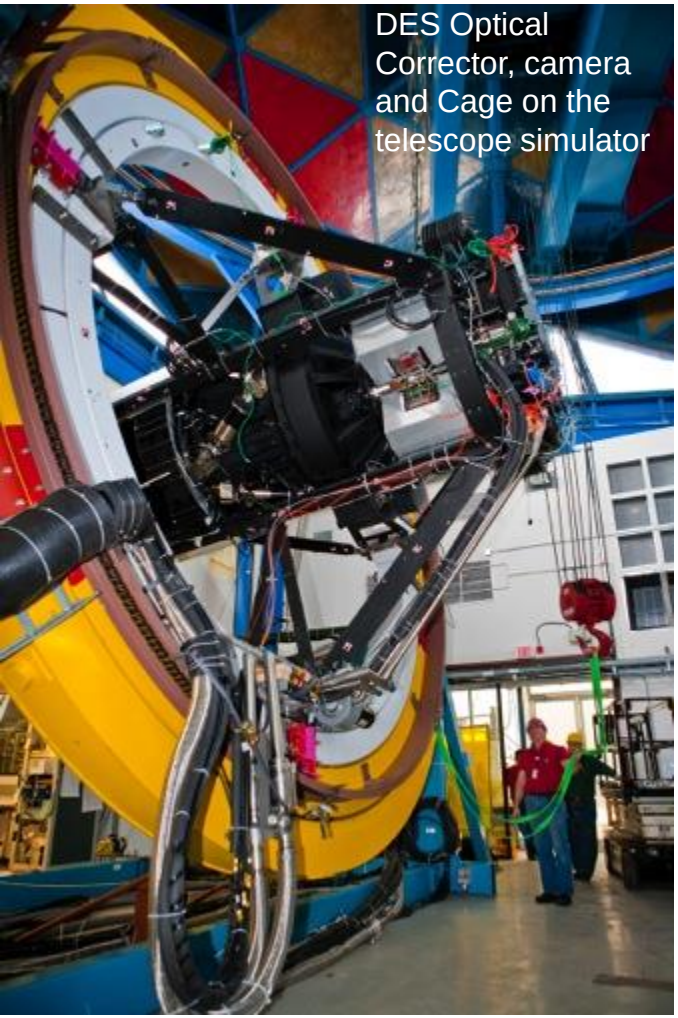
DESI



SPT-3G

Bare silicon is delivered from LBNL (CCDs) and ANL (SPT-3G). Fermilab builds the packages, tests them and integrates them into full systems

Strong Synergy with the Energy Frontier program: Precision assembly of large mechanical parts


DES Optical Corrector, camera and Cage on the telescope simulator


Gaston Gutierrez in New CMM


DESI Optical Corrector

Highlights of Dark Energy Survey results

(DM and CMB talks will follow)

- Dark Energy Survey (4th year of observations started Aug. 2016)
  - Observation of 6 new Strong Lenses
  - Search for optical counterparts to LIGO gravitational waves
  - First cosmology results
  - Discovery of new Milky Way dwarf satellites