The Argonne Astrophysics and Cosmology HEP Program

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High Energy Physics (HEP) Division

Argonne National Laboratory

A. Stone visit

Argonne, July 15, 2010

Argonne HEP science program overview

Collider physics (Terascale)	Neutrino physics	Theory Pheno.	**Astro/ Cosmology**	Advanced Acc. R&D	Detector R&D	LC R&D
CDF Tevatron	MINOS analysis	BSM & QCD ⇔ Collider program	**VERITAS (gamma rays)**	AWA facility (dielec. wakefield, two beam)	DHCAL (digital gas HCAL)	SCRF
ATLAS past & future & computing	Nova very active	Need theory & exp. for physics	**DES (Dark Energy Survey)**	Accel. Physics	Large Area Photo Detectors (LAPD)	positron source,
LC longer term (R&D & SiD)	Double Chooz	Joint Chicago, NU	AGIS CMB	Layered SRF cavities	DAQ systems (no fibers, no wires)	Detector R&D: HCAL
	Long Baseline					

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Astrophysics/Cosmology is part of non-accelerator Program:
(Non-accelerator Program just had a site visit by Kathy & M.Salamon on June 21, 2010)

Argonne HEP science program overview

Neutrino physics

Double Chooz

Astro/ Cosmology

VERITAS (gamma rays)

DES (Dark Energy Survey)

AGIS
CMB

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Argonne HEP Astrophysics & Cosmology program

Astrophysics & Cosmology- I

Ground based Gamma Ray program:

VERITAS

- Analysis
- Trigger upgrade, closely worked with Iowa State

Future:

AGIS+ CTA → CTA

- Early involvement in CTA telescope design
- Design of new telescopes (mechanical)
- Topological Trigger (with Iowa State)
- Possibly new PMTs (LAPD)

Astrophysics & Cosmology II

Dark Energy Survey (DES)

- Building/Commission DECam, f/8 mirror handling system
- PreCam
- CCD special studies
- Supernova science
- Connection to CMB through South Pole Telescope (SPT) and
- Supercomputing: supernova & cosmology

Future:

- Supercomputing & Cosmology Group

Proposed for FY11

Astrophysics & Cosmology III

Cosmic Microwave Background (CMB)

Expertise at/ contribution from Argonne :

- Development of Transtion Edge Sensors (TES) for CMB polarization by SPT (LDRD for 3+1 yr)
- Joint positions: Carlstrom + one (in place for review)
- Lab supportive
- Unique capabilities for future sensor development

Future:

- Path to next generation

Argonne HEP Astrophysics & Cosmology program

Dark Energy Group (HEP) 1.5 Staff + 2PD FTEs

Physicists (HEP & ALCF): Joe Bernstein (PD-ALCF), Kyler Kuehn (PD), Steve Kuhlmann, Harold Spinka, Richard Talaga, New PD (Rahul Biswas)

Mech. Engineering: Victor Guarino, Tom Kasprzyk, Frank Skrecz, Alan Zhao + Bld 366 support team

Additional: Eve Kovacs, John Cunningham (Loyola), Ian Crane (UIUC) Savannah Insalaco (UIUC), Tara Hufford (Loyola), Dallas Turner (Rockford Schools)

VHE Gamma-ray Group (HEP) 1.4 Staff + 1PD (LDRD)

Physicists (HEP): Karen Byrum, Andy Smith (pd), Bob Wagner

Electrical Engineering: John Anderson, Gary Drake, Andrew Kreps

Mech. Engineering: Victor Guarino

Additional: Michael Hutson (SULI)

TES Group (supported through LDRD through FY10)

Physicists (HEP & MSD): John Carlstrom*, Clarence Chang*(pd), Aaron Datesman (pd), Val Novosad, Gensheng Wang (pd)

Materials Engineering: John Pearson, Volodymyr Yefremenko

Ground Based Gamma-Ray Program

Now: CTA- US

VERITAS is currently the most sensitive TeV Observatory in the world; Science data since Fall 2007; VERITAS upgrade underway.

Present: VERITAS Contributions:

- Data Analysis (Andy, Bob) **(Andy will talk about this)**
- L2 Trigger Upgrade (Karen, Andy, Gary, John + EE support, w/ISU)

Future: CTA-US (AGIS) Contributions:

- Design of Large Mechanical Telescope Structures (Victor, Karen, w/DESY,UCLA)
- Topological Trigger (Gary, John, Karen, Andy, w/ISU)
- Focal Plane Instrumentation (SiPM and possibly new LAPD PMTs) (Bob, Karen)

VERITAS Level 2 Trigger Upgrade: Funded w/NSF MRI

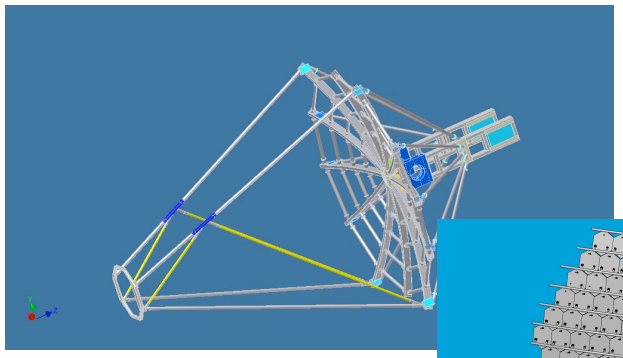
UTAH

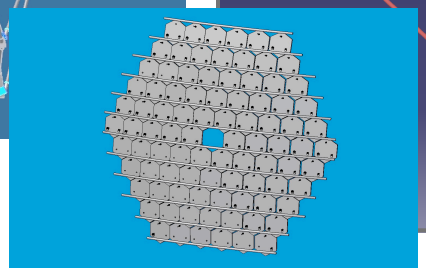
- Meant to be a drop in replacement to current aging L2
- With enhanced capabilities
  - Coincidence window improvement (down to 3-4ns)
  - Pixel timing alignment
  - Improved diagnostic capabilities
  - Reconfigurable trigger through downloadable firmware
  - Updates/improvements do not require access to hardware
  - Alternate/experimental triggers may be tested w/o access to hardware
- All the hooks in place for adding a future L4 topological trigger

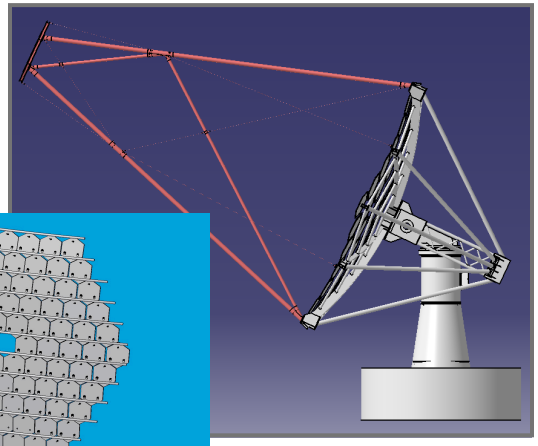
Status:

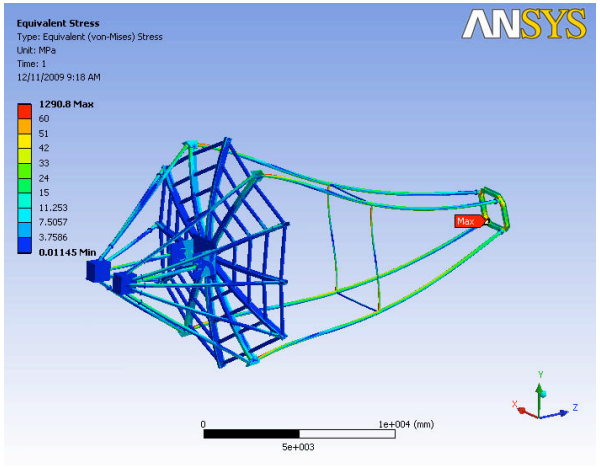
- Funding started mid April 2010
- First Telescope trigger delivered Sept/Oct
- Full Trigger Hardware delivered Nov/Dec

CTA Telescope Mechanical Design: Funded w/ LDRD, UC seed funds & DESY









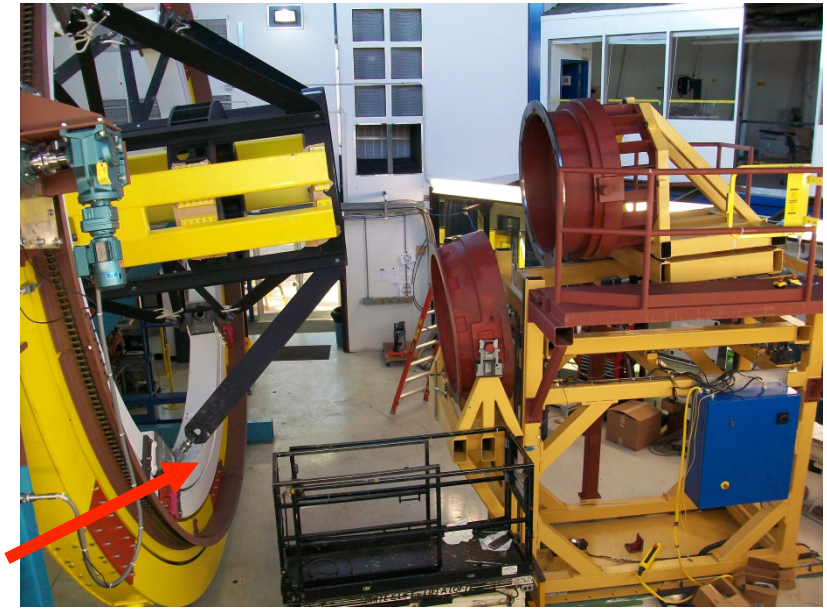
- Recent effort focused on mech. design of a 12m Davies-Cotton telescope in collaboration with DESY & Saclay
- Examined the entire structure to minimize internal forces and moments
- Integrating Mirror Mounts
- Mechanics of Dish Fabrication

Dark Energy Program: DES, LSST, SDSS

- Building/Commissioning DECam
- PreCam (e.g., "mini-DECam")
- Specialized studies of DECam CCDs
- Supernova Science (SDSS, DES, LSST)
- Supercomputing (Cosmology and Supernovae)
- DES Cluster Science and the South Pole Telescope

DECam: f/8 Handling System

- Used to install and remove the f/8 secondary mirror from DECam
- Lead Engineer Allen Zhao (ANL) led the design, procurement, assembly and testing at ANL, now leading mating tests with DECam at FNAL.
- Currently being tested at FNAL (completed)
- First piece of DECam to go through acceptance testing
- Will go through hand-off and shipping process to CTIO this summer (Underway)



White rings also engineered at ANL

Supercomputing at ANL: Cosmology and Supernovae

- ANL Blue Gene/P 160K processors, already used for FLASH SN.
- Previous 1-yr LDRD with UC/FNAL for cosmology.
- SK co-PI on successful joint ANL/UC/FNAL to push SN simulations forward and compare with data.
- J. Bernstein moved into Computational Fellowship Feb 15, working on both FLASH SN and cosmology.
- Offer being prepared for Salman Habib and Katrin Heitmann, leaders in computational cosmology.

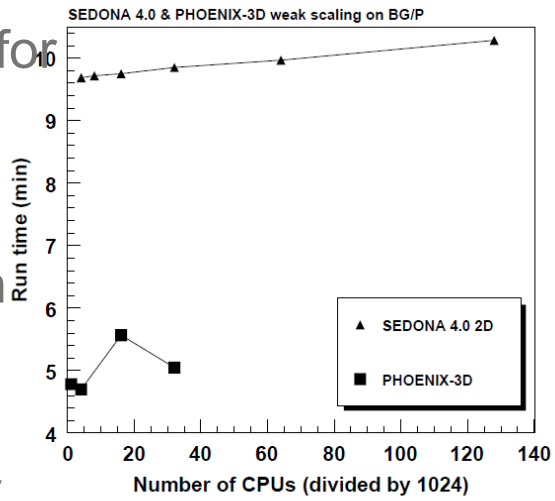
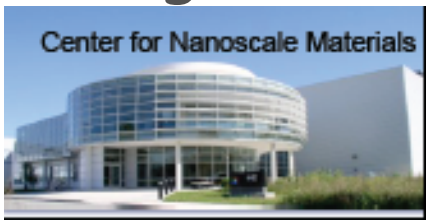


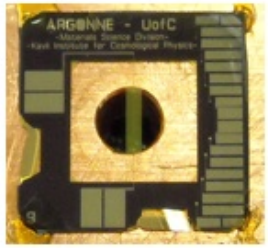
Figure 1: PHOENIX and SEDONA weak scaling on Blue Gene/P.

Lab Appointment through Leadership Computing Initiative (Funded w/Lab funds for 3 yrs)

Both Salman and Katrin are cosmologists!

Cosmic Microwave Background Program





Providing the Enabling Technologies to understand the Early Universe

Program established over last 4 years w/ astrophysics SI > $2.5M

New: 2 Jt. Appointments

Present: Providing Enabling Technologies

- Superconducting Transition-Edge Sensor (TES) Detectors
- Strong Science connections to Dark Energy Program

Future: New Focal Plane Instrumentation for South Pole Telescope

- Inflations Era Science using CMB B mode Polarization (J. Carlstrom, C. Chang, New PD)
- First SPTpol Focal Plane instrumentation (C. Chang, V. Novosad, A. Datesman, G. Wang)
- Path to Next Generation CMB Polarization

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Argonne, June 21, 2010, H.Weerts
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