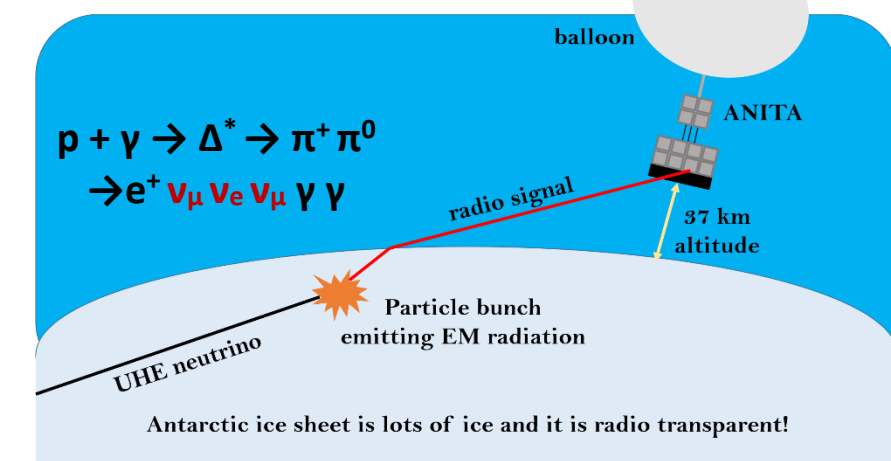# Astroparticle Experiments at OSU

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CCAPP CENTER FOR COSMOLOGY AND ASTROPARTICLE PHYSICS

Ohio Supercomputer Center — An OH·TECH Consortium Member

Welcome! At OSU we work on several Astroparticle Experiment projects including **IceCube, ANITA, ARA, T576, and HELIX**! They all look for high-energy particles of galactic, astrophysical or cosmogenic origins. All these projects are highly collaborative efforts. Here at OSU, we are involved in all aspects of each experiment: hardware, simulation and analysis.

$$p + \gamma \rightarrow \Delta^* \rightarrow \pi^+ \pi^0$$
$$\rightarrow e^+ \nu_\mu \nu_e \nu_\mu \gamma \gamma$$

radio signal

ANITA

37 km altitude

Particle bunch emitting EM radiation

UHE neutrino

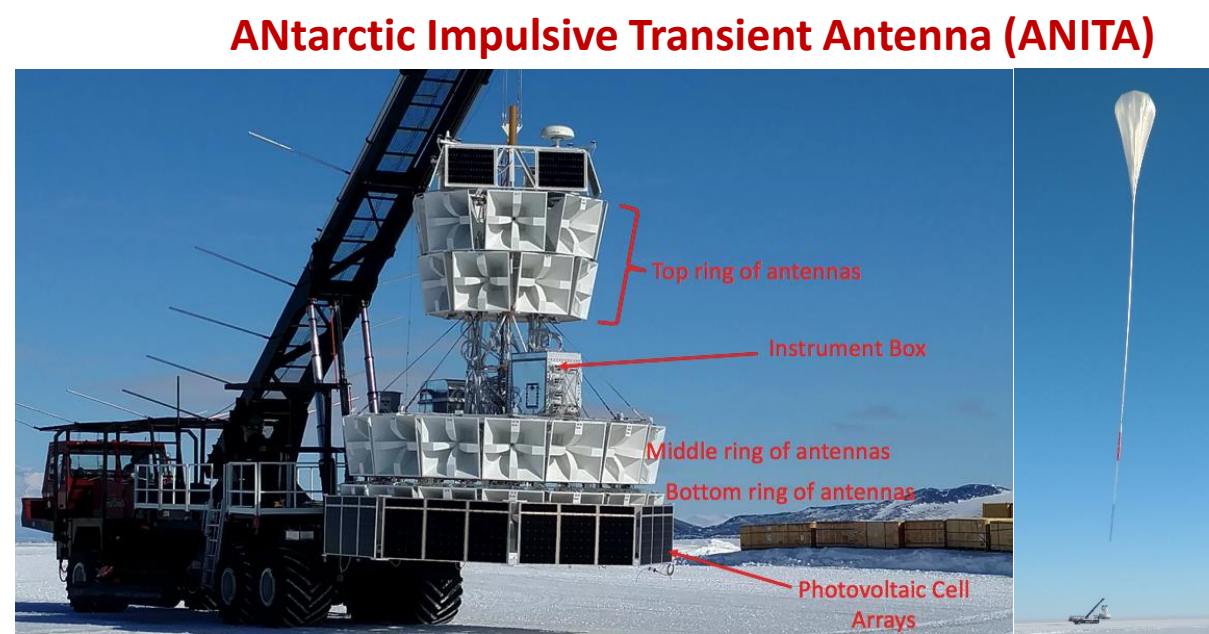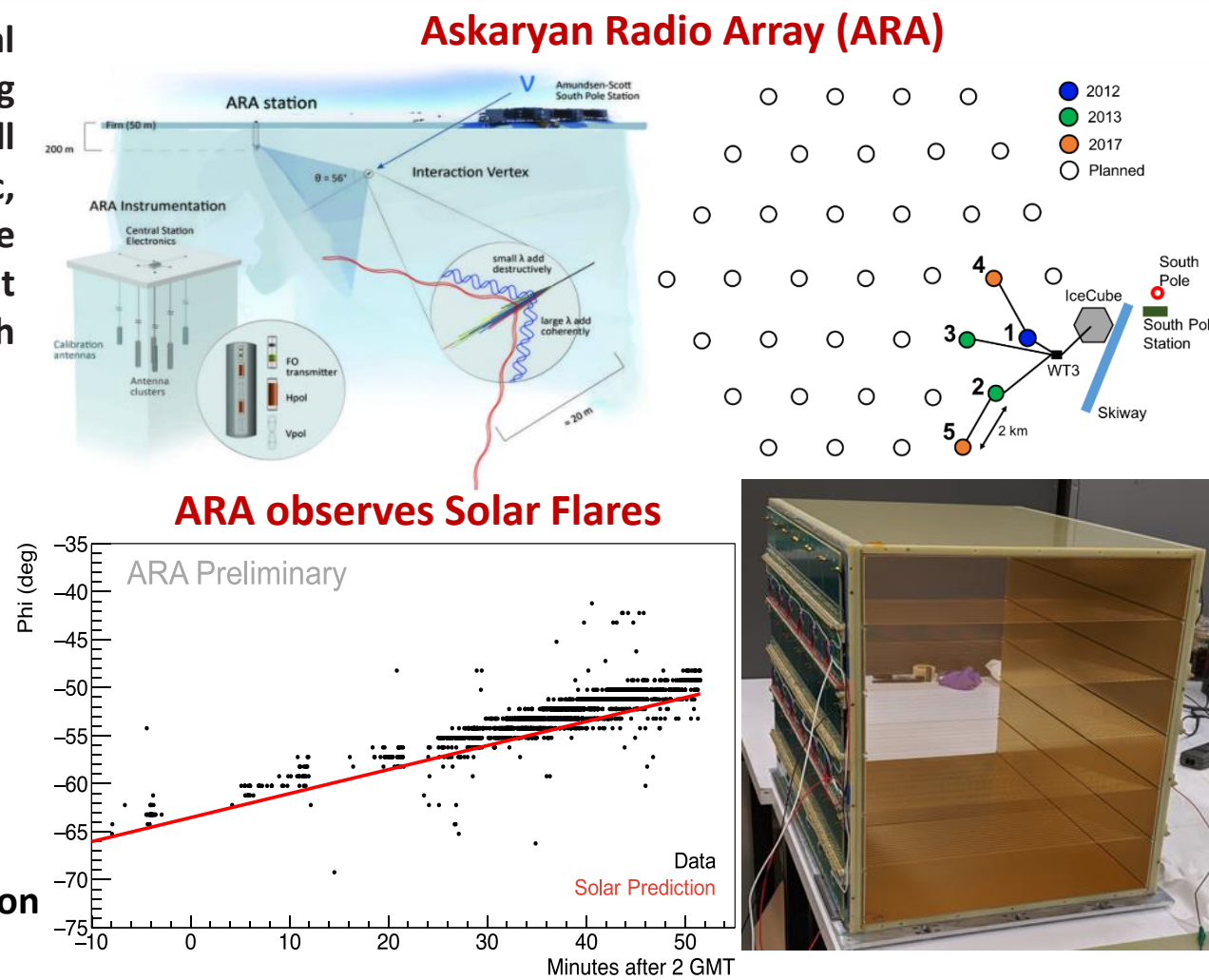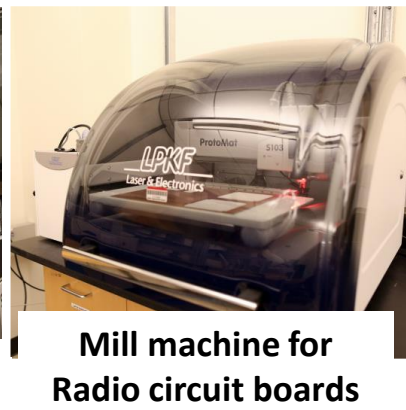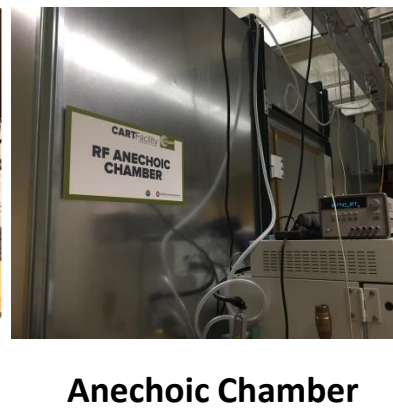Antarctic ice sheet is lots of ice and it is radio transparent!

Above is a cartoon showing Askaryan radio detection of theorized ultra-high-energy (UHE) neutrinos
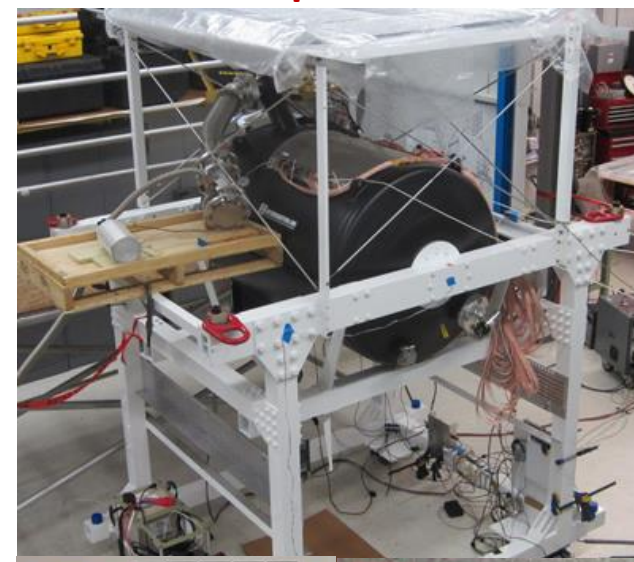
Why Antarctica?

☐ Has lots of ice for neutrinos to interact in and produce optical Cherenkov (IceCube) and radio Cherenkov (ANITA, ARA) light.

☐ It is radio-quiet compared to rest of the world so less noisy for radio experiments.

☐ Summer polar vortex allows balloon-borne ANITA and HELIX to fly in circles over the continent and stay at constant altitude. ANITA observes ~ **1 million km³** of Antarctic ice.
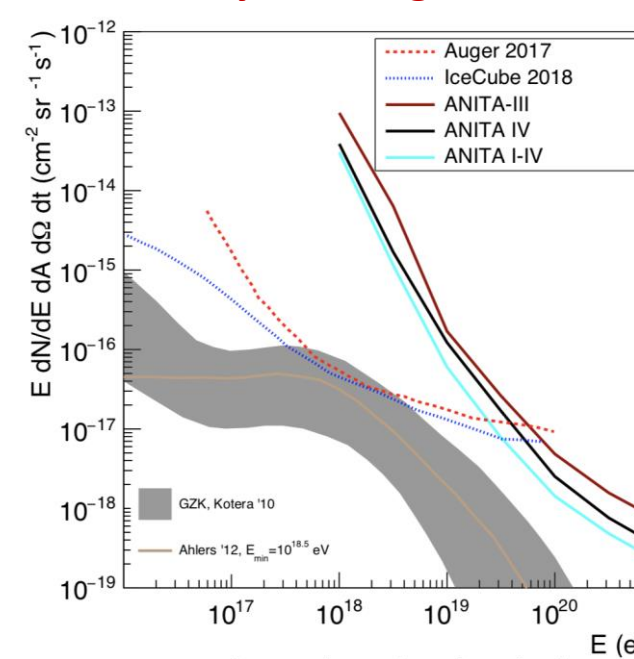
Askaryan Radio Array (ARA)

ARA station

Interaction Vertex

2012 / 2013 / 2017 / Planned

ARA observes Solar Flares

ARA Preliminary — Phi (deg) vs Minutes after 2 GMT — Data / Solar Prediction

ANtarctic Impulsive Transient Antenna (ANITA)

Top ring of antennas
Instrument Box
Middle ring of antennas
Bottom ring of antennas
Photovoltaic Cell Arrays

HELIX: High Energy Light Isotope eXperiment

OSU builds the HELIX master trigger boards

ANITA dominates Neutrino Astronomy at energies > 10^{19} eV

$E\, dN/dE\, dA\, d\Omega\, dt\ (cm^2\, sr^{-1}\, s^{-1})$ vs E (eV) — Auger 2017, IceCube 2018, ANITA-III, ANITA IV, ANITA I-IV, GZK Kotera '10, Ahlers '12 $E_{max}=10^{19.5}$ eV

IceCube, 1 km³ neutrino observatory at the South Pole, observes neutrino from flaring blazar

original GCN Notice Fri 22 Sep 17 20:55:13 UT
refined best-fit direction IC170922A
IC170922A 50% - area: 0.15 square degrees
IC170922A 90% - area: 0.97 square degrees
TXS 0506+056
3FHL / 3FGL
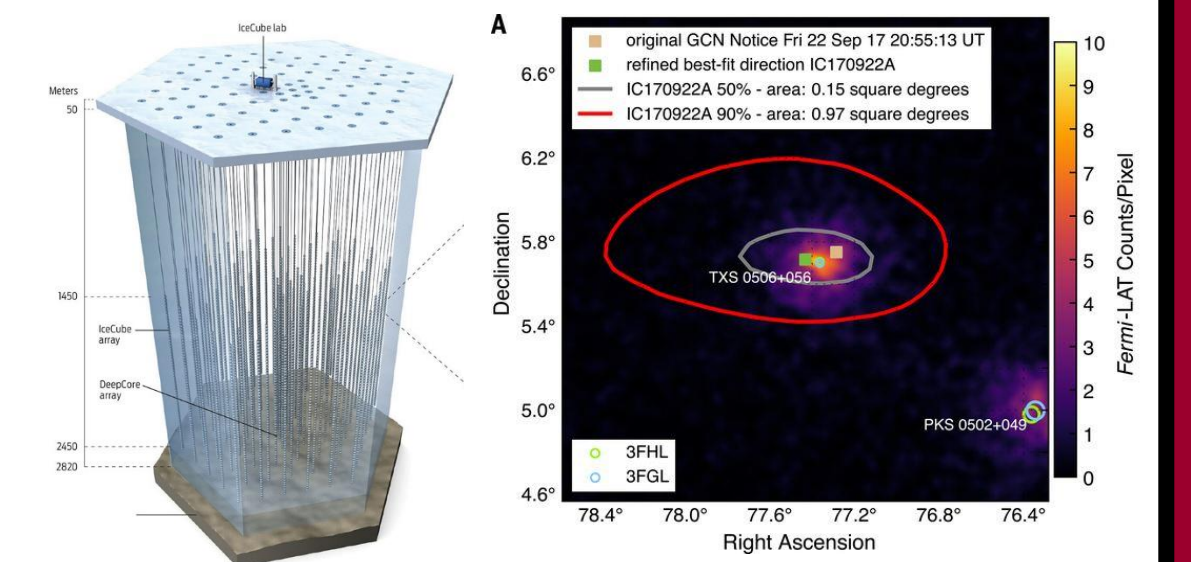
T576 experiment at SLAC detected radar reflections from particle-cascade-induced plasma → new neutrino detection technique!

Data / Null — Frequency [GHz] vs Time [ns]

Genetic Programming

CCAPP Antarctic RF Test Facility: We are well-equipped to build, test and deploy!

CARTFacility

Large thermal chamber for rapid thermal testing

Pick & Place Machine for rapid mass assembly

Anechoic Chamber

Mill machine for Radio circuit boards

DEPARTMENT OF PHYSICS
ASPIRE
http://u.osu.edu/aspire/
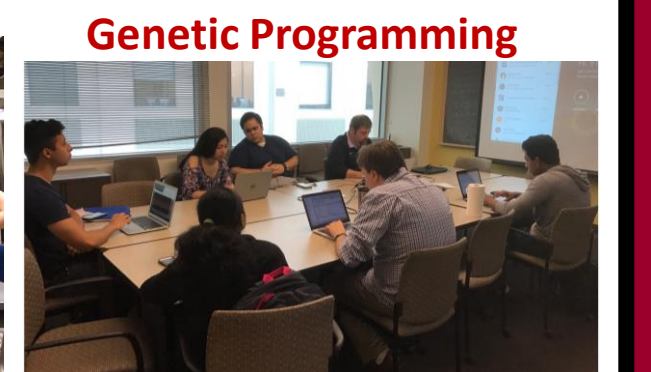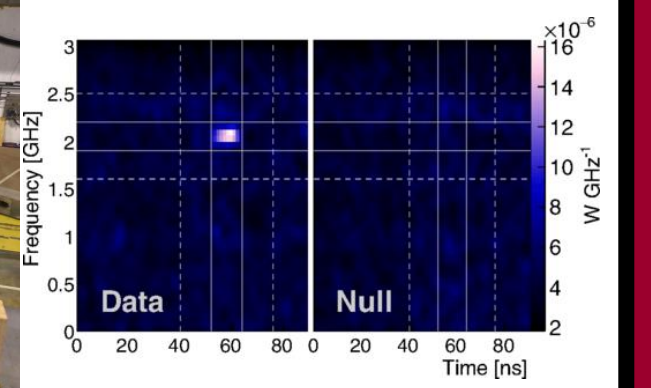
Our science workshop for high school women funded by NSF -- Hands on projects!

Oscilloscopes: perform radio interferometry

Arduino: program radios

Mathematica: do ANITA analysis

THE OHIO STATE UNIVERSITY

CURRENT GRAD STUDENTS
CONNOLLY GROUP: Dennis Calderon, Jorge Torres Espinosa, Justin Flaherty, Dylan Frikken and Julie Rolla
BEATTY GROUP: Keith McBride and Andres Medina

CURRENT POSTDOCS/STAFF
Patrick Allison and Steven Prohira