Participant Talk
Martin Schneider

Supervisor: Christopher van Eldik

Fun Facts about me

From Amberg

Not to be confused with Bamberg

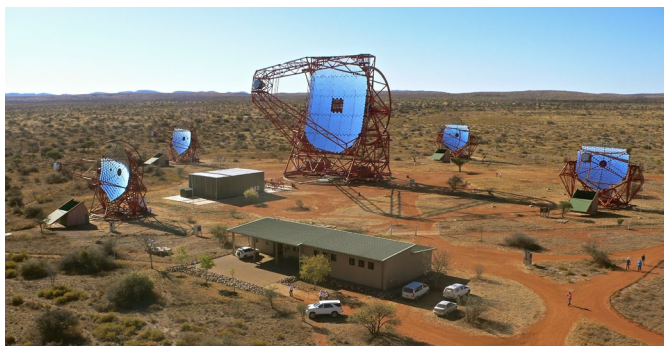Youngest PhD Student at ECAP

(for now)
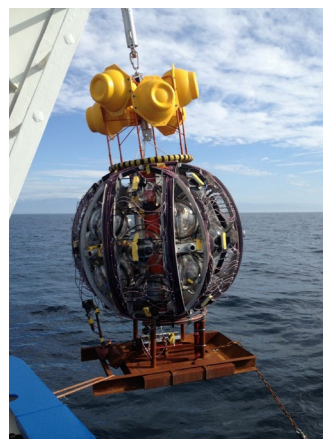
Identical twin brother

Scientific Background at ECAP

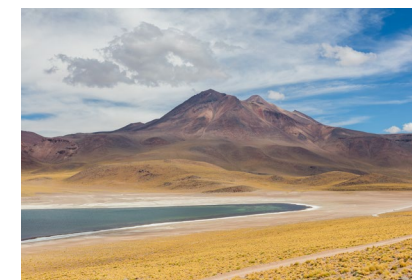Modelling diffuse TeV Gamma-ray emission in the Galactic Center

H.E.S.S. site in Namibia

Measuring the attenuation length of seawater in KM3NeT/ORCA with atmospheric muons

KM3NeT deployment in the Mediterranean sea
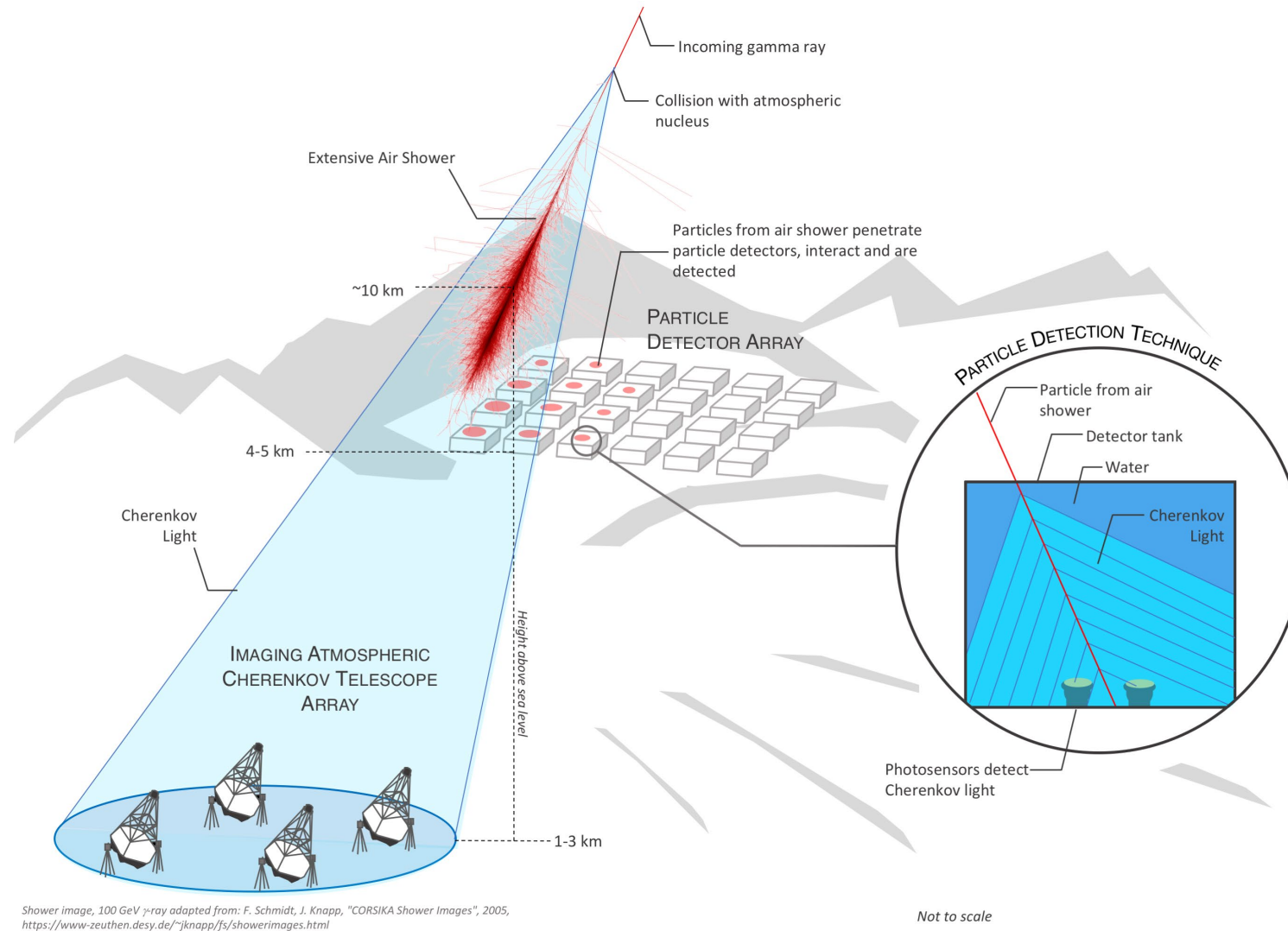
Gamma-Hadron Separation with Deep Learning

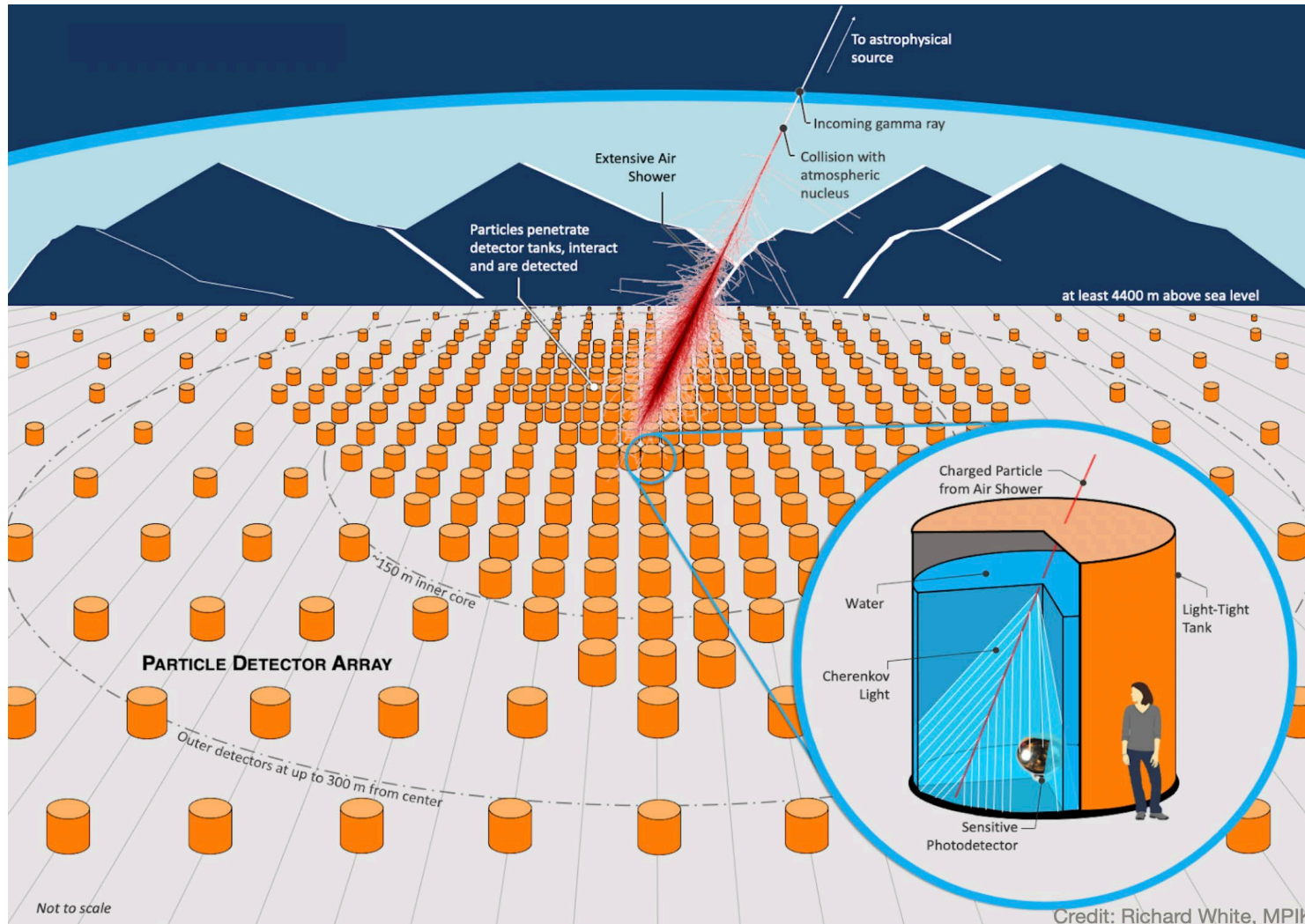Tbd, some place 4km above sea level (reference)

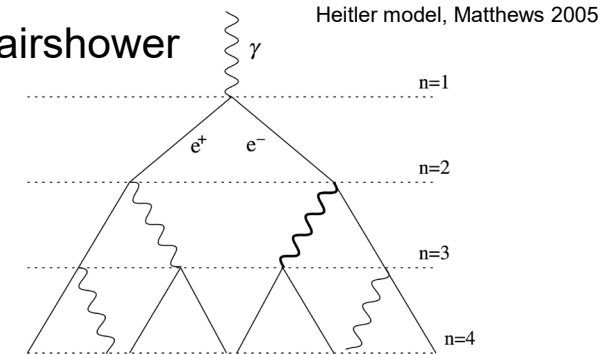Starting my physics journey → The heat death of the universe

Shower image, 100 GeV γ-ray adapted from: F. Schmidt, J. Knapp, "CORSIKA Shower Images", 2005,
https://www.zeuthen.desy.de/~jknapp/fs/showerimages.html

SWGO – The Southern Wide-field Gamma-ray Observatory

Credit: Richard White, MPIK

Heitler model, Matthews 2005

Electromagnetic airshower

Hadronic airshower
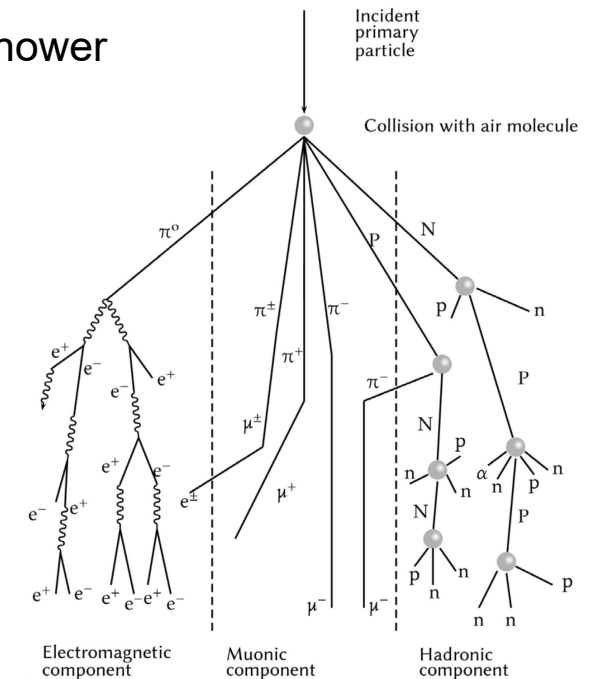
Barrantes et al. 2018

The SWGO Sky

THE FERMI BUBBLES

Image Credit: NASA

SWGO

Invisible to HAWC

Image Credit: HAWC Collab.
(Preliminary)

HAWC

Invisible to HAWC
& SWGO

THE GALACTIC CENTRE

Image Credit: SARAO
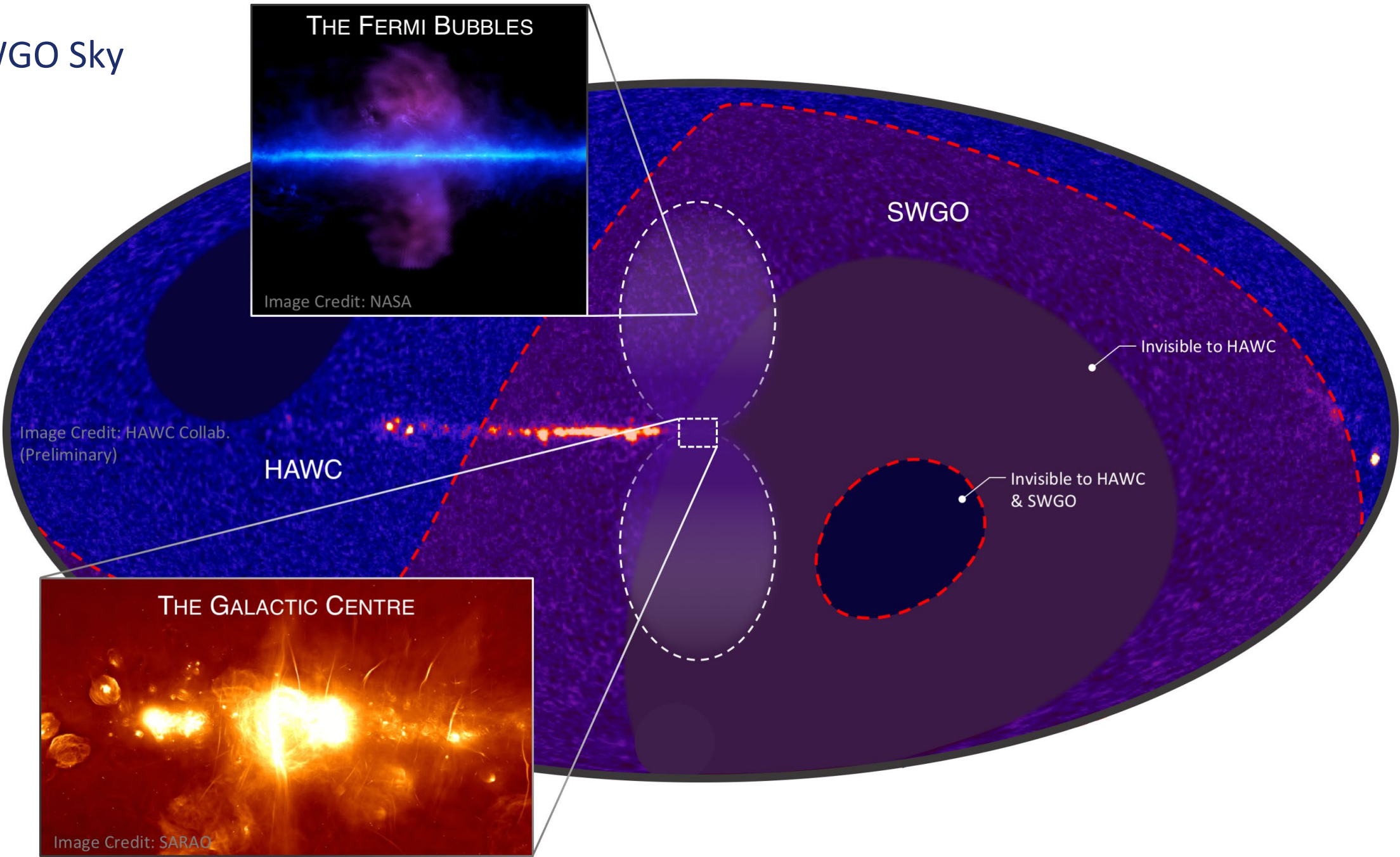
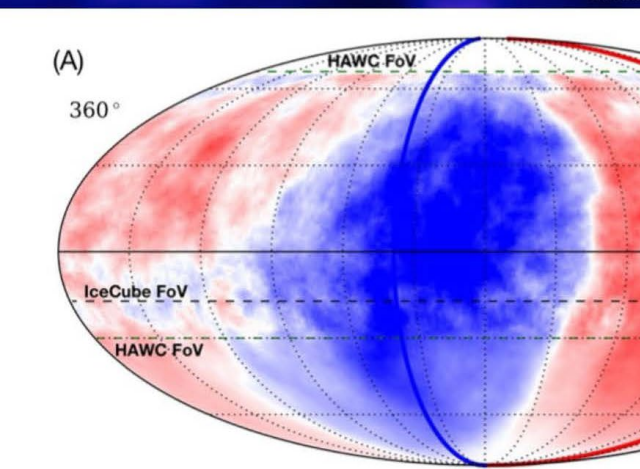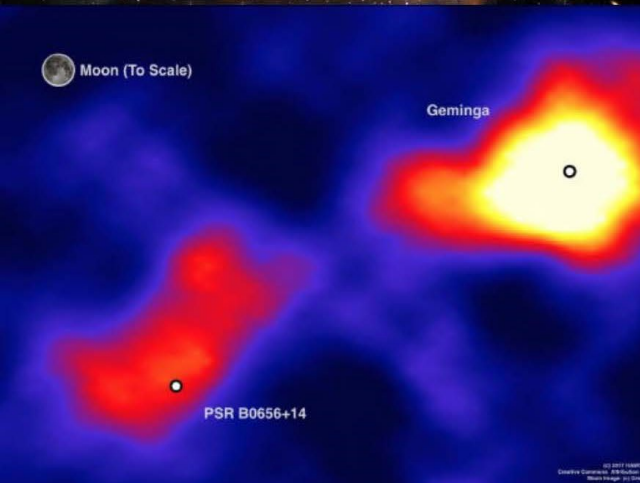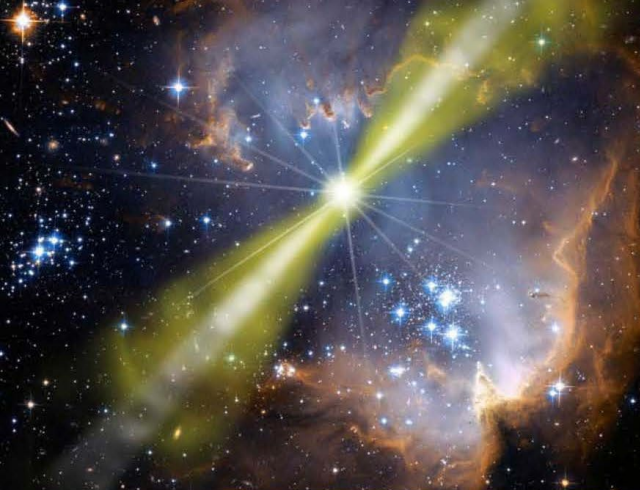| Science Case	Design Drivers
Transient Sources: Gamma-ray Bursts	Low-energy sensitivity & Site altitude
Galactic Accelerators: PeVatron Sources	High-energy sensitivity & Energy resolution
Galactic Accelerators: PWNe and TeV Halos	Extended source sensitivity & Angular resolution
Diffuse Emission: Fermi Bubbles	Background rejection
Fundamental Physics: Dark Matter from GC Halo	Mid-range energy sensitivity Site latitude
Cosmic-rays: Mass-resolved dipole / multipole anisotropy	Muon counting capability
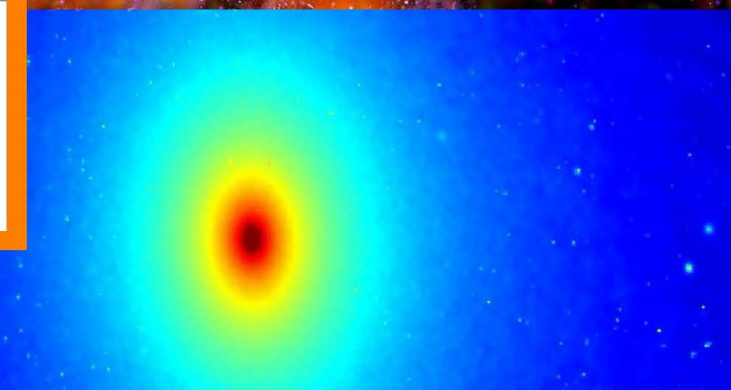
Gamma/Hadron Separation with Graph Neural Networks

Example Tank Layout SWGO
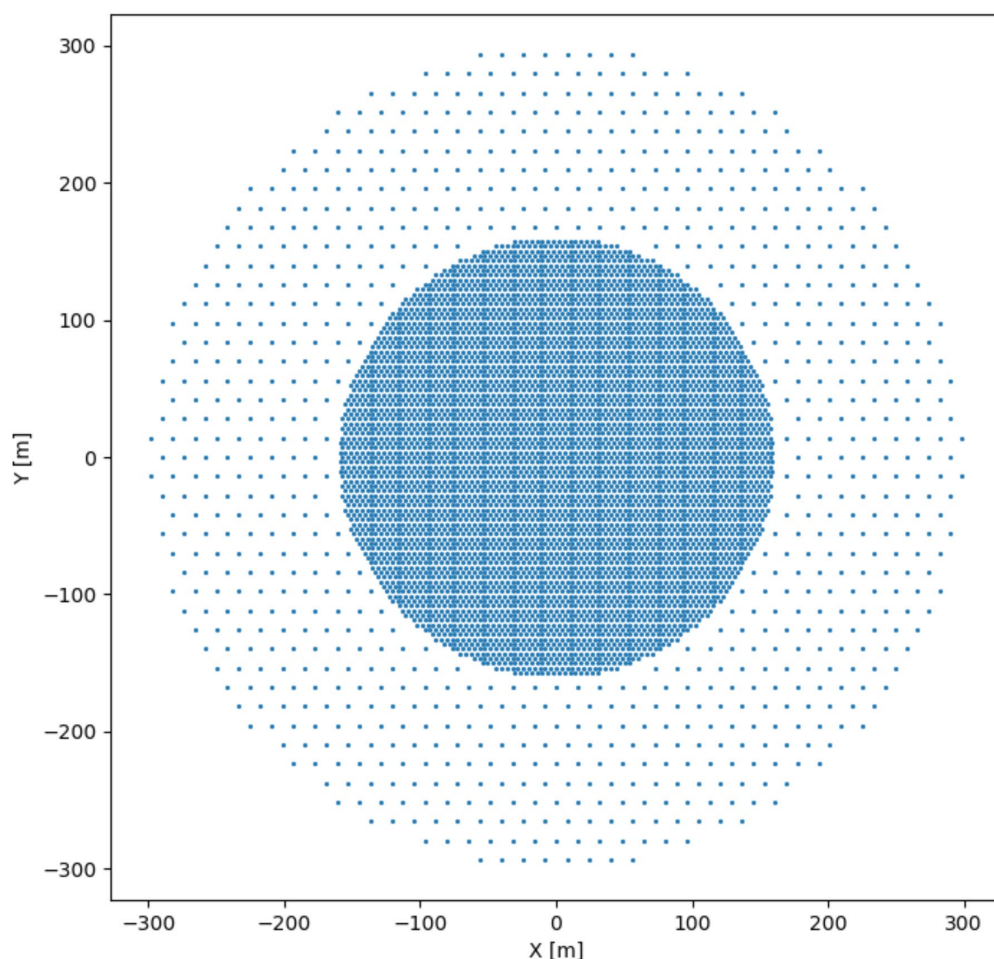
Input for DNNs:

Graph of triggered stations.

Features are:

- x and y coordinates

- time for lower and upper tank

- signal for lower and upper tank

Rescaling and normalization:

Want to have proper preprocessing for the input features.

For example: Normalize x and y coordinates w.r.t. the shower core

Pipeline for SWGO already implemented by our Deep Learning expert Dr. Jonas Glombitza

First benchmark network already works

EdgeConvLayers

⬇

DynamicEdgeConvLayers

⬇

Flatten

⬇

ResNet

My task is to find clever ways to improve this

GNNs in SWGO

- Gamma/Hadron separator will offer great improvement over the current method used in SWGO (MLP)

- Need reconstruction as input (Franzi's work, spoiler for tomorrow)

- Also plan to improve SWGO reconstruction with DNNs

- Want to test science benchmarks with them

- Need IRFs -> working on a standardized framework for that
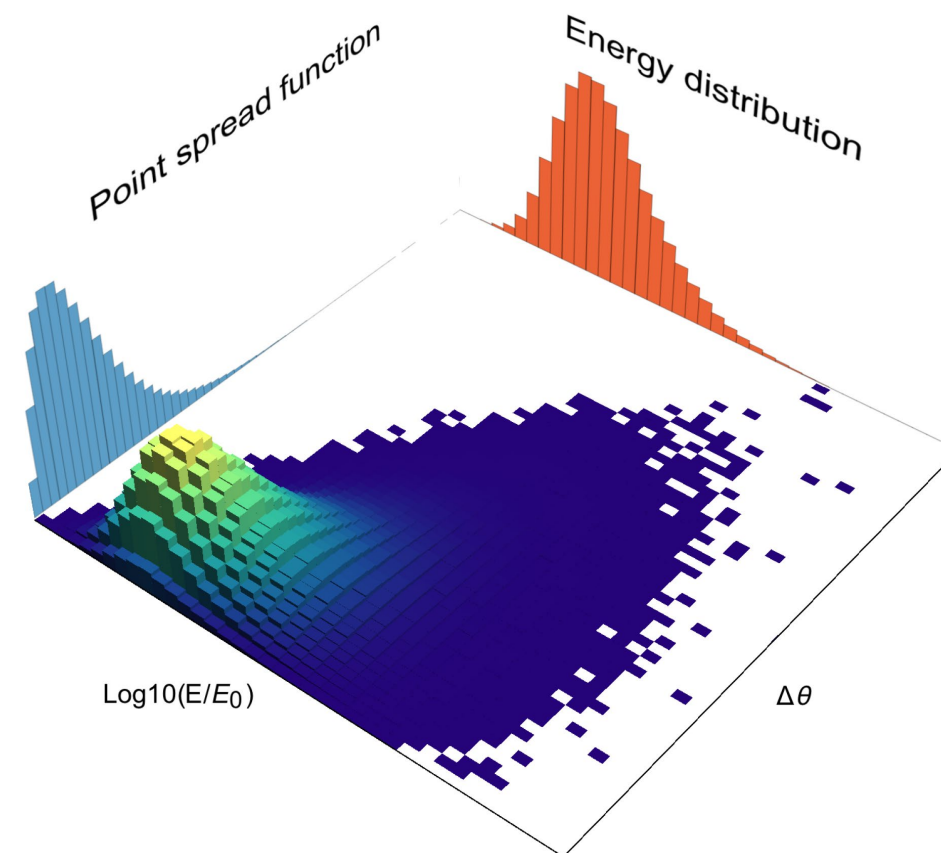
SWGO Instrument Response Functions …

… are still very much a work in progress. I joined the IRF task force late last year

I am helping to get the main ingredients ready

- Effective collection area

- Point spread function

- Energy dispersion

- Background model

But lots of validation is still needed to get to meaningful sensitivity plots.

With IRFs we will be able to benchmark different tank
and array configurations for SWGO and test our
Gamma/Hadron Separator

Thanks for your Attention!