Bachelor / Master thesis

CTA, H.E.S.S., Fermi LAT

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

2020 / 2021

1. **High level data analysis**
    - Searching for photon – axion-like particles oscillations in Fermi-LAT data
    - Intergalactic magnetic field signatures at gamma-ray energies
    - Understanding the gamma-ray emission in blazars using multi-wavelength observations
    - Fermi bubbles: sensitivity study for CTA and a search in H.E.S.S. data
    - Search for gamma-ray variability in the Galactic Center
    - The H.E.S.S. real-time analysis for the detection of gamma flares
2. **Intensity interferometry**
    - Simulations and intensity interferometry measurements with IceAct telescopes
    - Study the shape of signal in photo-multipliers with neural networks
3. **Instrument development and low level data analysis**
    - Analysis of the data from FlashCam camera
    - Testing and optimization of ASICs for CTA cameras
    - Combined event energy reconstruction with H.E.S.S. and IceAct telescopes
    - Analysis of moonlight data of H.E.S.S.
    - Development of data reduction methods for CTA
    - Improving event reconstruction in H.E.S.S. at highest gamma-ray energies

Contact:
Prof. Dr. Stefan Funk, s.funk@fau.de
Büro 219, Erwin-Rommel-Str. 1

Master's Thesis
Spring 2020

The nature of dark matter, which makes up roughly 85 % of all matter of the Universe, remains unknown. One dark matter candidate is a so-called axion-like particle (ALP) which could interact with photons in the presence of external magnetic fields. This interaction would lead to oscillations between photons and ALPs similar to neutrino oscillations.

Searching for photon-ALP oscillations in *Fermi*-LAT data

The oscillations could be detected in the energy spectra of distant blazars observed at energies beyond 100 MeV with the Large Area Telescope (LAT) on board the *Fermi* satellite. Blazars are distant galaxies with an active galactic nucleus that produce jets of plasma outflows at velocities close to the speed of light. The jets also harbor strong magnetic fields in which photons could oscillate into ALPs. The aim of this thesis is to search for photon-ALP oscillations in the *Fermi*-LAT spectra of flat spectrum radio quasars, a certain sub-class of blazars, using newly developed statistical tools and potentially machine learning.

Physics topics related to this work:

- Physics beyond the standard model, in particular dark matter in the form of axion-like particles
- Astrophysical processes in blazar jets

Skills acquired during this work:

- Analysis of *Fermi*-LAT data using `python`
- Modelling photon-ALP oscillations in the astrophysical environments of blazar jets
- Statistical modeling and machine learning techniques

Interested? Please get in touch:

- Dr. Manuel Meyer, manuel.e.meyer@fau.de
  Büro 221, Erwin-Rommel-Str. 1
- Prof. Dr. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Master's Thesis

Spring 2020

Magnetic fields are omnipresent in the universe on all scales from magnetic moments of elementary particles to large-scale fields in the intergalactic space of clusters of galaxies. Astrophysical magnetic fields in galaxies and galaxy clusters are ubiquitously observed and are believed to have been seeded by an intergalactic magnetic field (IGMF), which should still be present at its seed field strength in cosmic voids. Such a field should have a small field strength, making it extremely difficult to observe directly. Observations of blazars — active galaxies that produce relativistic particle outflows closely aligned to the line of sight to the observer — at γ-ray energies beyond 10^9 eV, offer a unique alternative probe of the IGMF.

Searching for IGMF signatures at γ-ray energies

During their propagation, γ rays interact with photons of background radiation fields and produce electron-positron pairs. These pairs can in turn up-scatter cosmic microwave background photons to γ-ray energies, thereby initiating a chain reaction as these up-scattered photons again pair-produce. The deflection of the pairs in the IGMF delays the arrival of these associated γ-ray cascades, which should appear as an extended halo around the blazar and enhance its apparent brightness at lower γ-ray energies. The goal of this thesis is to simulate the γ-ray emission caused by the cascade using available Monte Carlo codes, and to compare these predictions with blazar observations obtained with the *Fermi* Large Area Telescope (LAT) and the High Energy Stereoscopic System (H.E.S.S.). The results will be used to derive sensitivity predictions for the future Cherenkov Telescope Array (CTA).

Physics topics related to this work:

- Propagation and interactions of cosmic rays and γ rays
- Astrophysical magnetic fields

Skills acquired during this work:

- Analysis and simulation of *Fermi*-LAT, H.E.S.S., and CTA data
- Using Monte Carlo codes and efficient handling of large amounts of data

Interested? Please get in touch:

- Dr. Manuel Meyer, manuel.e.meyer@fau.de
  Büro 221, Erwin-Rommel-Str. 1
- Prof. Dr. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Master's Thesis

Spring 2020

Most currently known extragalactic sources that emit high-energy γ rays (photons with energies beyond 100 MeV) are so-called blazars, i.e., active galaxies that produce outflows of relativistic particles (jets) which are closely aligned to the line of sight. Yet, the mechanisms leading to the acceleration of particles, the particle composition of the jet, as well as the site of γ-ray emission in the jet remain debated topics. Especially the brightest outbursts with variability time scales down to minutes pose a challenge for a variety of standard emission scenarios.

Towards an understanding the γ-ray emission processes in blazars using multi-wavelength observations

The goal of this thesis is to analyze mutli-wavelength data of blazars, in particular flat spectrum radio quasars, in order to gain a better understanding of how and where γ-rays are produced in the jet. The thesis will focus on observations at X-ray and γ-ray energies with X-ray satellites such as *XMM-Newton*, *Swift*, and *NuSTAR* as well as the *Fermi* Large Area Telescope (LAT) and the High Energy Stereoscopic System (H.E.S.S.). The combination of these data during bright γ-ray flares will enable a novel search for short-time variability which will in turn help to understand the underlying emission processes.

Physics topics related to this work:

- Non-thermal emission processes
- Properties of astrophysical jet environments

Skills acquired during this work:

- Multi-wavelength analysis of X-ray data and data taken with the *Fermi* LAT and H.E.S.S.
- Modelling of multi-wavelength emission from the jet
- Proposal writing for observations at X-rays and potentially sub-mm wavelengths

Interested? Please get in touch:

- Dr. Manuel Meyer, manuel.e.meyer@fau.de
  Büro 221, Erwin-Rommel-Str. 1
- Prof. Dr. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Master thesis

Spring 2020

The High Energy Stereoscopic System (H.E.S.S.) is a system of Imaging Atmospheric Cherenkov Telescopes (IACT) for the investigation of cosmic gamma rays in the photon energy range of 30 GeV to 100 TeV. The Cherenkov Telescope Array (CTA) is the next generation IACT observatory. With more than 100 telescopes located in the northern and southern hemispheres, CTA will be the world's largest and most sensitive high-energy gamma-ray observatory in the 20 GeV to 300 TeV band.

Fermi bubbles are two large lobes above and below the center of our Galaxy which are visible in gamma-rays. Possible mechanisms of creation of these bubbles are either an activity of the supermassive black hole at the center of the Galaxy or a period of intensive star formation in the vicinity of the Galactic center. Although the bubbles were discovered more than eight years ago, the question of their origin is still unresolved. Analysis of the Fermi LAT data between 1 GeV and 1 TeV shows that the bubbles have a larger intensity of emission and a hard energy spectrum near the Galactic center, which opens up a possibility of a detection with the future CTA instrument. H.E.S.S. instrument has a much smaller effective area than CTA, but in some models of the Fermi bubbles it may be possible to detect them already with existing H.E.S.S. data. A study of the Fermi bubbles at energies above 100 GeV near the Galactic center will help to resolve the puzzle of their origin.

Fermi bubbles: sensitivity study for CTA and a search in H.E.S.S. data

In the master thesis, we will use Monte Carlo simulations of CTA data to study the sensitivity of CTA to detect the Fermi bubbles near the Galactic center. Depending on the available time, we will also search for the Fermi bubbles in the existing H.E.S.S. data.

Physics topics related to this work:

- High-energy astrophysics
- Ground-based gamma-ray astronomy

Skills acquired during this work:

- Modern analysis of gamma-ray data
- Monte Carlo Simulations
- Programming in Python

Interested? Please get in touch:

- Dr. Dmitry Malyshev, dmitry.malyshev@fau.de
  Büro 324, Erwin-Rommel-Str. 1
- Prof. Dr. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Master thesis
Spring 2020

The dynamical center of the Milky Way is a complex region with many different astronomical objects. Kinematic measurements show strong evidence of the presence of a supermassive black hole in the center which is coincident with the object Sagitarius A* first discovered at radio frequencies. The compact nature of Sgr A* has also been demonstrated by the observation of near-infrared and X-ray flux outbursts oft short duration appearing typically four times/once per day in the infrared/X-ray regimes. The Galactic Center is also a source of very high energy gamma-rays ($\sim$100 GeV–50 TeV) as detected, e.g., with the H.E.S.S. telescopes.

Search for gamma-ray variability in the Galactic Center

The origin of the gamma-ray emission coming from the Galactic Center is currently unknown. One way to distinguish between different possible processes is to study the flux variability of the TeV emission of the Galactic Center. So far such studies were performed without success. Another way is to search for variability in the gamma-ray data during flares happening in other frequency ranges such as the X-ray regime. Simultaneous observations in both bands have been performed, e.g., with H.E.S.S. and *XMM-Newton*. The goal of this project is to analyse the H.E.S.S. data and to perform a correlation study of gamma-ray and multi-frequency data.

Physics topics related to this work:

- Non-thermal emission processes
- Properties of the Galactic Center, e.g., energy spectra, time variation.
- Properties of environments of supermassive black holes

Skills acquired during this work:

- Analysis of Imaging Air Cherenkov Telescope data from H.E.S.S.
- Correlation studies of multi-wavelength light curves and spectra

Interested? Please get in touch:

- Dr. Dorit Glawion, dorit.glawion@fau.de
  Büro 221, Erwin-Rommel-Str. 1
- Prof. Dr. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Bachelor & Master thesis

Starting 2019/2020

The High Energy Stereoscopic System (H.E.S.S.) is a system of imaging atmospheric Cherenkov telescopes situated in the Khomas Highlands in Namibia. The H.E.S.S. telescopes observe the night sky in the high-energy gamma regime (from 0.03 to 100 TeV), studying fascinating objects such as pulsars, binary stars and supernovae within our Galaxy and powerful sources such as active galactic nuclei, blazars or radio galaxies outside of our Galaxy.

The H.E.S.S. real-time analysis for the detection of gamma flares

While surveying the night sky, the H.E.S.S. telescopes may detect a gamma flare within their field of view, i.e. an extremely energetic explosion of an astrophysical source such as a gamma-ray burst (GRB). As those can be very short-lived, it is critical that we be able to identify them in real-time and initiate appropriate actions to maximize the physics potential of H.E.S.S. Your task within this project will be to develop efficient algorithms for the real-time detection of gamma flares with the H.E.S.S. telescopes. If you are Master's student and interested in deep learning, you could try to tackle the challenge with LSTMs (long short-term memory networks), which are great for anomaly detection.

Physics topics related to this work:

- High-energy astrophysics
- Gamma-ray astronomy with imaging air Cherenkov telescopes

Skills acquired during this work:

- Development of algorithms for real-time data analysis
- Programming in Python or C++
- Using deep learning (LSTMs) for anomaly detection (if you are a Master's student)
- Experience working in a large, international experimental collaboration

Interested? Please get in touch:

- Dr. Lenka Tomankova, lenka.tomankova@fau.de
  Büro 322, Erwin-Rommel-Str. 1
- Prof. Dr. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

Bachelor/Master Theses

Winter 2020

Intensity interferometers detect coincident photons ("bunching") from thermal light sources such as stars. The coincidence rate depends on the source's angular size and the baseline distance between the detectors, by measuring it between different telescopes the star's geometry can be reconstructed. The advantage in contrast to amplitude interferometers is the insensitivity against atmospheric turbulences which allows for kilometer-baselines offering a never before achieved resolution of the cosmic sources. Arrays of Cherenkov telescopes such as **H.E.S.S** or the future **CTA** provide a suitable environment for intensity interferometry.

Simulations and intensity interferometry measurements with IceAct telescopes

IceAct is a small ($d \approx 0.5\,\mathrm{m}$) Cherenkov telescope which can also be used for intensity interferometry. The use of a cost-effective Fresnel lens results in rather unprecise optics with a macroscopic focal spot as it is usual for Cherenkov telescopes. **Ray tracing simulations** can be carried out to investigate the light propagation. Here attached optics for intensity interferometry can be taken into account and the quality and transmission efficiency of these optics can be estimated.
From an experimental view **stellar intensity interferometry measurements with IceAct** can be executed during the winter time in Erlangen.

Physics topics related to this work:

- Intensity interferometry in astronomy
- Optics of Cherenkov telescopes
- Photo-detectors such as Photomultiplier Tubes and Silicon Photomultipliers

Skills acquired during this work:

- Learn hardware design, systematic experimental work
- Statistical analysis of data, programming

Interested? Please get in touch:

- Andreas Zmija, andi.zmija@fau.de, Büro 209
- Dmitry Malyshev, dvmalyshev@gmail.com, Büro 324
- Stefan Funk, s.funk@fau.de, Büro 219
- Gisela Anton, gisela.anton@fau.de, Büro 216

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Bachelor / master thesis

Spring 2020

Intensity interferometers detect coincident photons from thermal light sources such as stars. The coincidence rate depends on the source's angular size and the baseline distance between the detectors. The star's geometry can be reconstructed by measuring the coincidence of photons arriving at different telescopes. Compared to amplitude interferometry with optical telescopes, intensity interferometry is insensitive to atmospheric turbulences, which allows one to have kilometer-long baselines. This offers an unprecedented resolution of cosmic sources. Arrays of Cherenkov telescopes, such as H.E.S.S or the future CTA, have large optical collecting area and fast photon reconstruction capabilities, which makes them suitable instruments for intensity interferometry measurements.

Study the shape of signal in photo-multipliers with neural networks

One of the main problems in intensity interferometry is to detect individual photon pulses in photomultiplier read-out. The problem is that the shape of the pulses has random fluctuations and that the pulses overlap due to high expected rate of photons in Cherenkov telescopes. The goal of the bachelor or master thesis will be to use neural networks (e.g., 1D convolutional networks) to detect photon pulses and reconstruct the arrival time of the photons.

Physics topics related to this work:

- Optical astronomy
- Intensity interferometry with optical telescopes
- Cherenkov telescopes

Skills acquired during this work:

- Programming in Python
- Using neural networks for data analysis

Interested? Please get in touch:

- Dr. Dmitry Malyshev, dmitry.malyshev@fau.de
  Büro 324, Erwin-Rommel-Str. 1
- Prof. Dr. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Bachelor / Masterarbeit

Das Cherenkov Telescope Array (CTA) wird das größte bodengebundene Gammastrahlungsexperiment sein, das bisher gebaut worden ist. Es wird eine Verbesserung der Sensitivität um einen Faktor 10 im Vergleich zu den momentan exisiterenden Experimenten erreichen. Dies ist durch das Zusammenspiel von unterschiedlichen Teleskoptypen möglich. Wir arbeiten u.a. an der Entwicklung der FlashCam Kamera, deren erste Prototypkamera im Oktober 2019 in Namibia in das größte der H.E.S.S.-Teleskope eingebaut wurde.

The Cherenkov Telescope Array (CTA) will be the largest ground-based gamma-ray experiment ever built. It will reach sensitivities that are improved by 10 times with respect to currently running experiments. This can be achieved by the interplay of telescopes of different types. We are deeply involved among others at the development of the FlashCam camera. A full-scale prototype of the FlashCam camera was installed in Namibia in the largest H.E.S.S. telescope.

Analyse von Daten der FlashCam Kamera

Die erste FlashCam Prototypkamera wurde erfolgreich in Namibia in das größte H.E.S.S. Teleskop im Oktober 2019 eingebaut. Dies ermöglicht, den Betrieb der Kamera unter realistischen Beobachtungsbedingungen zu testen und erste physikalische Daten zu analysieren. Im Rahmen der Master-/Bachelorarbeit werden die ersten Daten der Kamera charakterisiert und die Performance überprüft, sowie erste Daten analysiert.

Analysis of first date of the FlashCam camera

The first prototype FlashCam camera was installed in the largest H.E.S.S. telescope in Namibia in October 2019. This allows for testing the operation of the camera under realistic observation conditions and for the analysis of first data. During the master/bachelor thesis, first data of the camera will be characterized. The performance of the camera will be determined and first data will be analysed.

Physikalische Themengebiete, die in dieser Arbeit behandelt werden:

- High-Energy gamma-ray astronomy

Fertigkeiten, die in dieser Arbeit erlernt werden:

- Programming, data analysis, hardware skills

Bei Interesse bitte melden bei:

- PD Dr. Ira Jung-Richardt, ira.jung@fau.de
  Büro 311, Erwin-Rommel-Str. 1
- Prof. Dr. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Bachelor / Master's thesis

Winter/Spring 2019/2020

The Cherenkov Telescope Array (CTA) is the next generation of telescope systems to observe high-energy gamma rays. In line with CTA, the ECAP/work group of Stefan Funk takes an active part in the development of a front-end electronics, based on the sampling and trigger ASIC (application-specific integrated circuit) TARGET (TeV array readout and Event Trigger). This is to take over the digitization of silicon photomultiplier signals in the Compact High Energy Camera (CHEC).

Bachelor thesis

- Measurement of the TARGET's analog bandwidth
- Characterisation of trigger and read-out chain of the newest TARGET module generation

Master's thesis

- Optimisation of the TARGET C timing parameters
- Understanding the temperature influence on the CHEC-S on-sky data

Physics topics related to this work

- Ground based gamma ray telescopes
- State-of-the-art electronics

Skills acquired during this work

- Statistical analysis of data
- Programming in Python
- Understanding of electronics instruments

Interested? Please get in touch!

- Adrian Zink, adrian.zink@fau.de
  Büro 323, Erwin-Rommel-Str. 1
- Prof. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Bachelor / Master’s thesis

Winter/Spring 2019/2020

H.E.S.S.

IceAct is a proposed surface array of cost effective and compact Silicon Photomultipliers (SiPM) based small-size (50 cm) Imaging Air Cherenkov Telescopes above the IceCube in-ice detector. In coincidence with the in-ice and surface components of IceCube it forms a hybrid detector that enables new measurements combining the information from the Cherenkov light image, the surface particle footprint and the in-ice muon tracks of extensive air showers. During March 2019 a prototype telescope measured in coincidence with H.E.S.S. to determine the energy threshold.

Master’s thesis

- Combined event energy reconstruction with H.E.S.S. and IceAct telescopes

Physics topics related to this work

- Ground based gamma ray telescopes
- State-of-the-art electronics

Skills acquired during this work

- Statistical analysis of data
- Programming in Python
- Understanding of electronics instruments

Interested? Please get in touch!

- Adrian Zink, adrian.zink@fau.de
  Büro 323, Erwin-Rommel-Str. 1
- Prof. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ecap ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Bachelor & Master thesis

Starting 2019/2020

H.E.S.S.

The High Energy Stereoscopic System (H.E.S.S.) is a system of imaging atmospheric Cherenkov telescopes situated in the Khomas Highlands in Namibia. The H.E.S.S. telescopes observe the night sky in the high-energy gamma regime (from 0.03 to 100 TeV), studying fascinating objects such as pulsars, binary stars and supernovae within our Galaxy and powerful sources such as active galactic nuclei, blazars or radio galaxies outside of our Galaxy.

Analysis of moonlight data of H.E.S.S.

The Cherenkov light flashes detected by the H.E.S.S. telescopes are extremely faint, therefore the telescopes are normally operated only during complete dark time, i. e. when both the Sun and the Moon are below the horizon. In order to grant more observation time and more importantly increased flexibility for observations of transient objects such as gamma-ray bursts, we are extending the observations into the moonlight time. Your task within this project will be to contribute to getting H.E.S.S. up and running during moonlight by analyzing the first data, which is currently coming in.

Physics topics related to this work:

- High-energy astrophysics
- Gamma-ray astronomy with imaging air Cherenkov telescopes

Skills acquired during this work:

- (Statistical) Analysis of astronomical data
- Programming in Python or a language of your choice
- Experience working in a large, international experimental collaboration

Interested? Please get in touch:

- Dr. Lenka Tomankova, lenka.tomankova@fau.de
  Büro 322, Erwin-Rommel-Str. 1
- Prof. Dr. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS

Bachelor & Master thesis

Starting 2019/2020

The Cherenkov Telescope Array (CTA) is the next-generation instrument for very-high-energy gamma-ray astronomy, currently in the prototyping and testing phase. With over a hundred telescopes distributed over two sites – one on the Northern (La Palma, Spain) and one on the Southern hemisphere (Cerro Paranal, Chile), CTA will achieve unprecedented performance in the energy range between 20 GeV and 300 TeV.

Development of data reduction methods for CTA

Due to the large number of telescopes, their wide fields of view and fast sampling, the CTA telescopes will generate unprecedented amounts of data that will need to be reduced on-the-fly before transmission off-site. Your task in this project will be to contribute to the development of methods and algorithms for the on-site reduction of CTA data. While this sounds very technical, solid knowledge of air shower physics is required to be able to develop efficient procedures that do not negatively affect the physics performance of the instrument. If you are a Master's student interested in deep learning, you could even try to tackle the challenge with LSTMs (long short-term memory networks).

Physics topics related to this work:

- High-energy astrophysics
- Gamma-ray astronomy with imaging air Cherenkov telescopes
- Air-shower physics

Skills acquired during this work:

- Development of data reduction methods and algorithms for CTA
- Programming in Python
- Using deep learning (if you are a master's student)
- Experience working in a large, international experimental collaboration

Interested? Please get in touch:

- Dr. Lenka Tomankova, lenka.tomankova@fau.de
  Büro 322, Erwin-Rommel-Str. 1
- Prof. Dr. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Masterarbeit

Frühjahr 2020

The High Energy Stereoscopic System (H.E.S.S.) is a system of Imaging Atmospheric Cherenkov Telescopes (IACT) to observe cosmic- and gamma-rays in the energy range of 0.03 to 100 TeV. H.E.S.S has collected a huge amount of high quality gamma-ray data for more than 15 years. These data consists of a variety of astrophysical objects emitting at gamma-ray energies such as pulsars, pulsar wind nebulae, supernovae and binary systems etc. in our Galaxy, and bright extragalactic sources as Active Galactic Nuclei, blazars and Radio-galaxies.

Improving H.E.S.S. reconstruction at Highest Energies

The air shower reconstruction of H.E.S.S. at energies above 10 TeV is adversely affected by the truncation of observed shower images. This leads to poor reconstruction of highest energy showers and hence limiting the performance of the observatory. The gamma-ray shower reconstruction in H.E.S.S is performed by using a Monte Carlo template based likelihood fit method together with a boosted decision tree method for background rejection due to cosmic ray showers. Currently, efforts are being made to properly incorporate the truncated shower images in the reconstruction and to improve the background rejection methods. The results of this effort will tentatively conclude to obtain an improved H.E.S.S galactic plane survey and to better understand the emission of the highest energy gamma-ray sources.

Physikalische Themengebiete, die in dieser Arbeit behandelt werden:

- High-energy astrophysics
- Ground-based gamma-ray astronomy
- Air shower physics

Fertigkeiten, die in dieser Arbeit erlernt werden:

- Monte Carlo Simulation
- Programming in C++/ROOT and python

Bei Interesse bitte melden bei:

- Dr. Vikas Joshi, vikas.joshi@fau.de
  Büro 322, Erwin-Rommel-Str. 1
- Prof. Dr. Stefan Funk, s.funk@fau.de
  Büro 219, Erwin-Rommel-Str. 1

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS