technische universität
dortmund

MAGIC
Major Atmospheric
Gamma Imaging
Cerenkov Telescopes

autoMAGIC Basics

autoMAGIC Workshop Padova

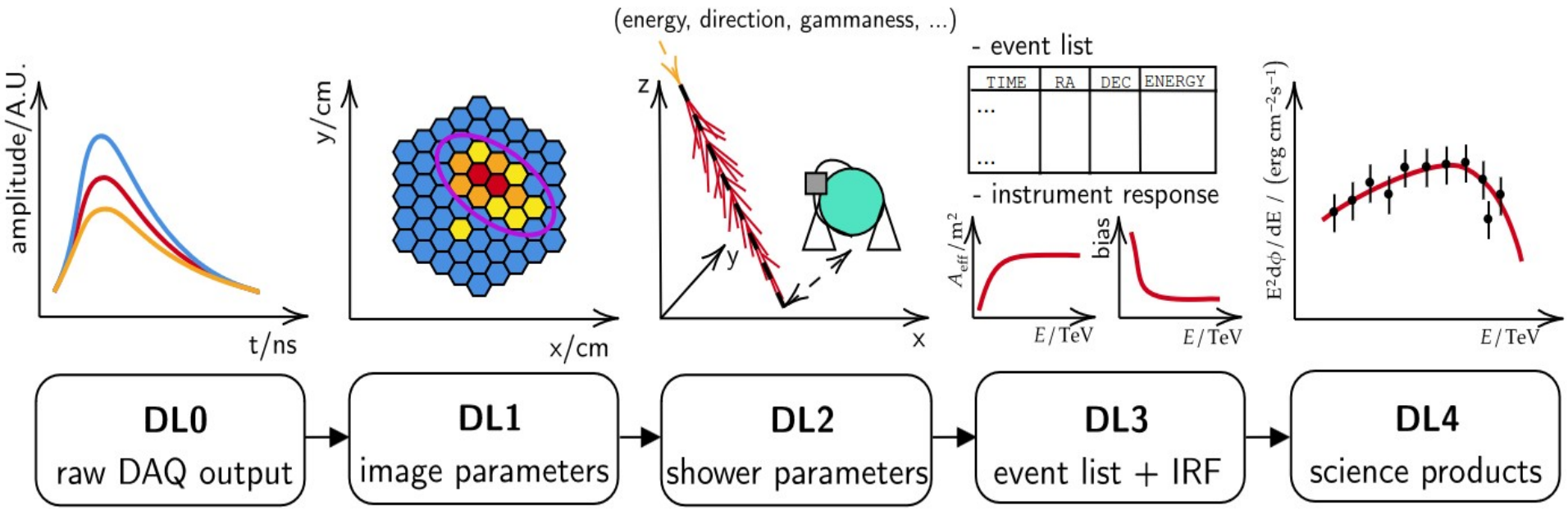
Jan Lukas Schubert

28th - 30th August 2024

Contents:

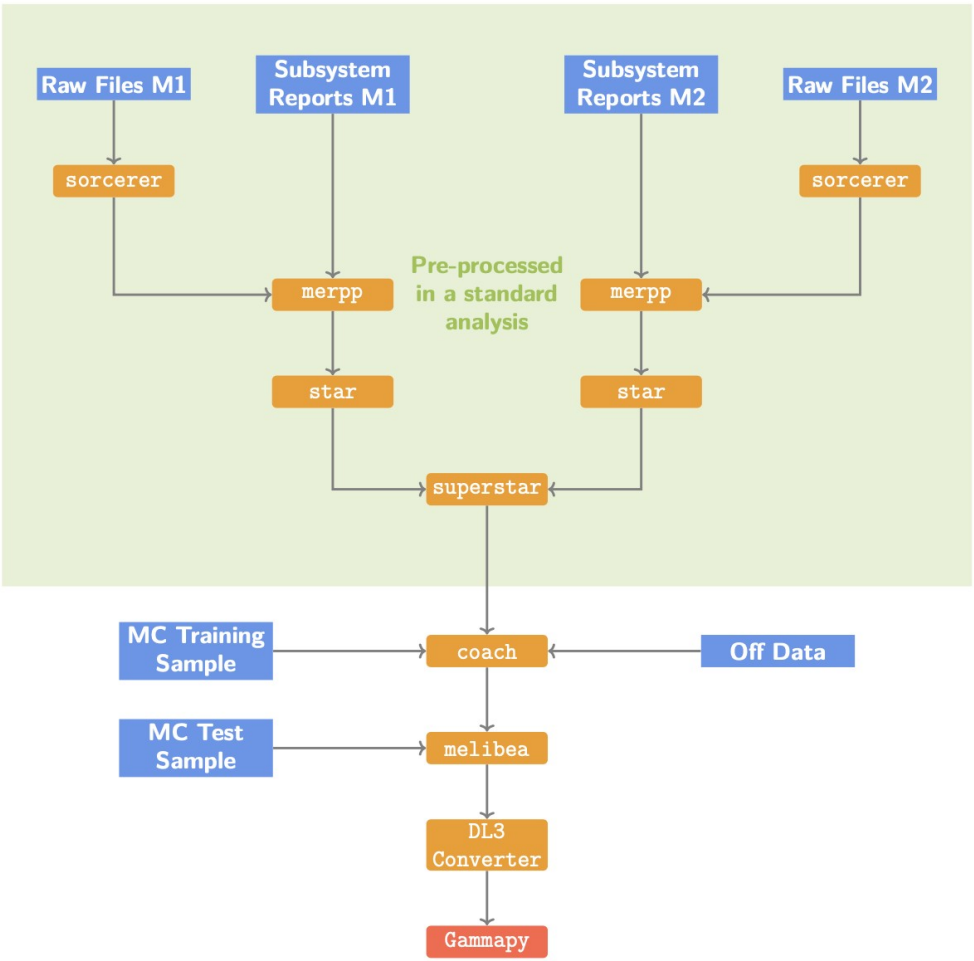
- Reminder: The MAGIC analysis chain
- Reminder: The Data Levels
- autoMAGIC's goal
- autoMAGIC's core-concept
- autoMAGIC's capabilities
- Results obtained with autoMAGIC

Data Levels


(energy, direction, gammaness, ...)
amplitude/A.U.
t/ns
y/cm
x/cm
z
y
x
- event list
TIME
RA
DEC
ENERGY
...
...
- instrument response
A_{eff}/m^2
E/TeV
bias
E/TeV
$E^2 d\phi/dE$ / (erg cm^{-2}s^{-1})
E/TeV
DL0
raw DAQ output
DL1
image parameters
DL2
shower parameters
DL3
event list + IRF
DL4
science products

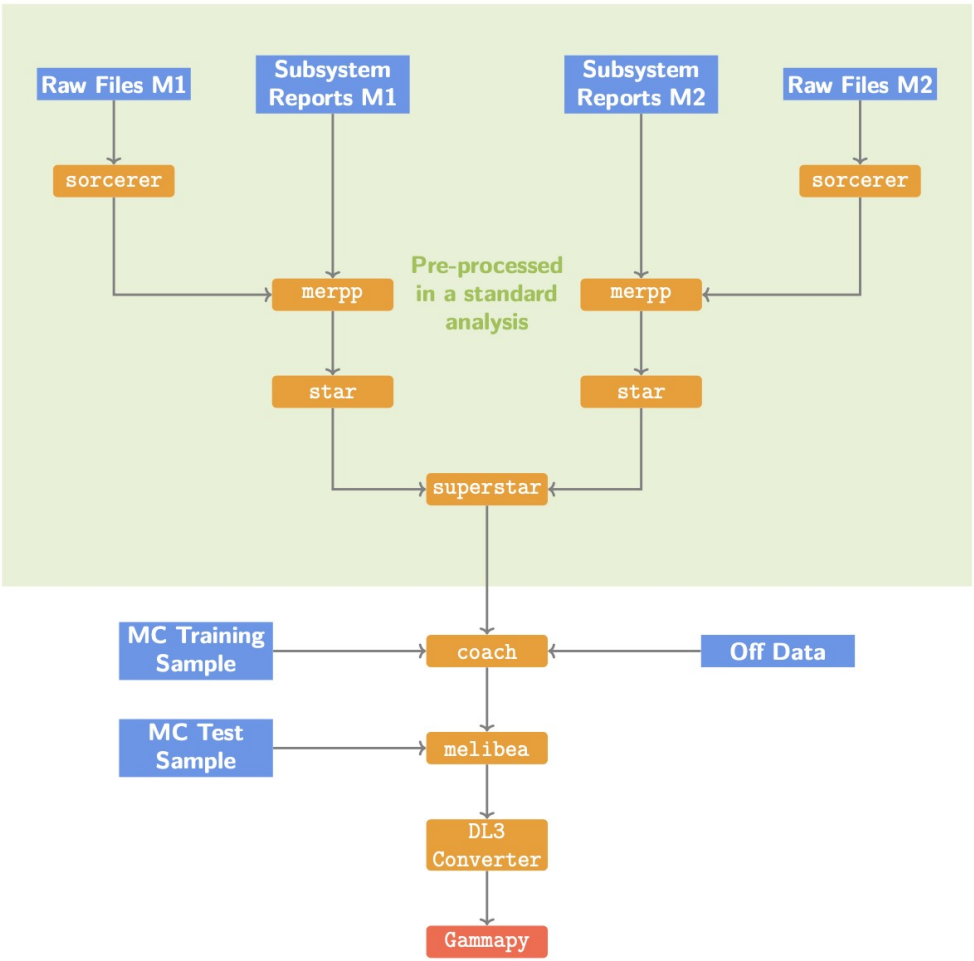
The MAGIC Analysis Pipeline

- Sorcerer: calibration
- Merpp: merge subsystem reports and data files
- Star: image cleaning and image parameterization
- Superstar: stereo reconstruction



The MAGIC Analysis Pipeline

- Coach: train models for the event reconstruction
- Melibea: apply models to the data
- DL3 Converter: Compute event lists and store them in DL3 format



AutoMAGIC Goals

- Main goal: automatize the MAGIC workflow at least for standard use cases
  - Save analyzer's time
- Reproducible Analyses
- Prevent storage and computation time waste
- Bigger picture: MAGIC legacy

AutoMAGIC Core-Concepts

- Wrap MARS executable in Python code
- Use a Database
- Use a huge cluster for computations
- Work on the PIC server (where the MAGIC data is stored)

AutoMAGIC – Wrapping MARS executables

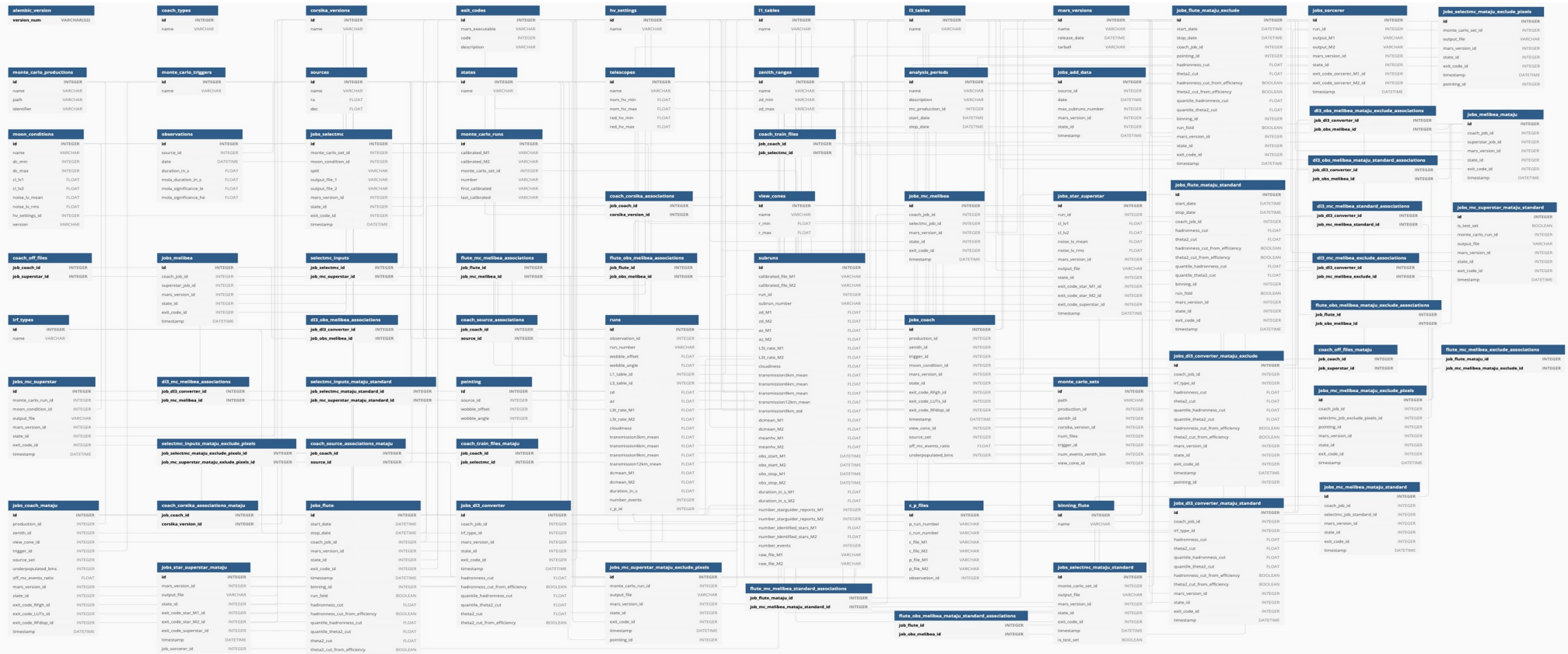
- For each analysis step (i.e. each MARS executable) we have a wrapper
  - Checks the input files
  - Checks the input parameters and creates a suiting .rc file
  - Runs the corresponding MARS executable
  - Saves the output
  - Writes information into the DB

- In principle, autoMAGIC is just an automated MARS!

AutoMAGIC – The Database

- Organizes and stores all analysis-related information
- Database: Tables with relationships
- Tables for different use cases:
  - Organizing the Data itself
  - Organizing the MC data
  - Organizing the Jobs for the MARS wrappers and keeping track of the job states
  - Organizing analysis-related information such as cleaning levels or moon conditions
- **The database is the absolute core of autoMAGIC**

AutoMAGIC - The Database



AutoMAGIC – The Cluster

- Cluster on the PIC server is equipped with HTCondor
- Allows for parallel processing of hundreds of jobs
- Jobs are submitted to the cluster, then HTCondor will manage to which working node the jobs are sent

AutoMAGIC – Working on the PIC Server

- Possibilities:
  - Use data stored on PIC - no copies necessary
  - Make use of the PIC Cluster
  - Immense amount of storage necessary for huge autoMAGIC productions

- Caveats:
  - Data availability for calibrated and raw data can be problematic
  - PIC is not the most stable server I know…

AutoMAGIC – Working Principle Overview

What autoMAGIC can do...

- Standard Analysis
- Moon Analysis
- MaTaJu analysis of standard trigger data
- MaTaJu analysis of Sum-Trigger-II data
- Diffuse analysis

What autoMAGIC cannot do (yet?)...

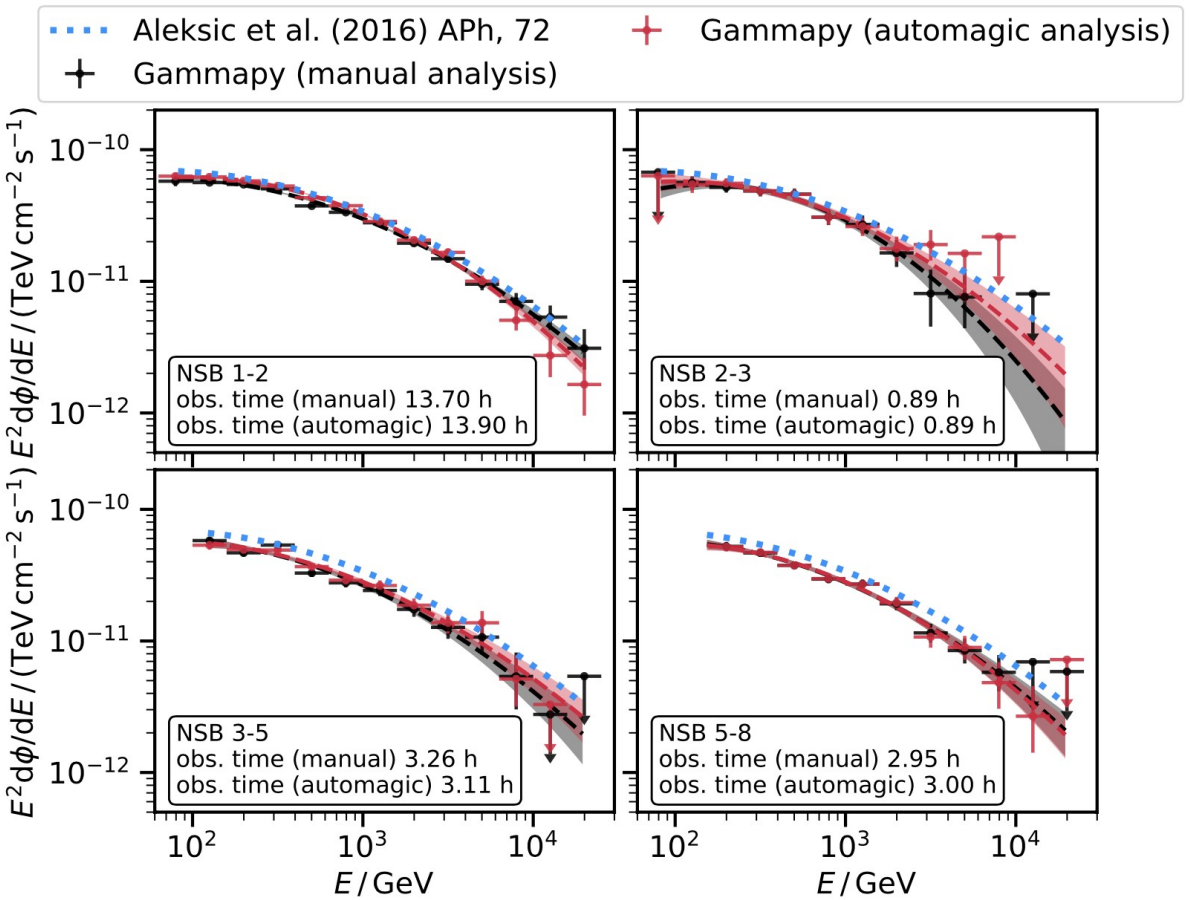
- Non-standard analyses “just changing one MARS parameter”
  - In autoMAGIC you cannot “just change” a parameter
  - If the parameter is changed often, it can be implemented without huge effort

- The DL3 + Gammapy doesn’t support the corrections for hazy atmosphere conditions (as far as I know
  - Stricter cuts on weather necessary (and hence less data available...)

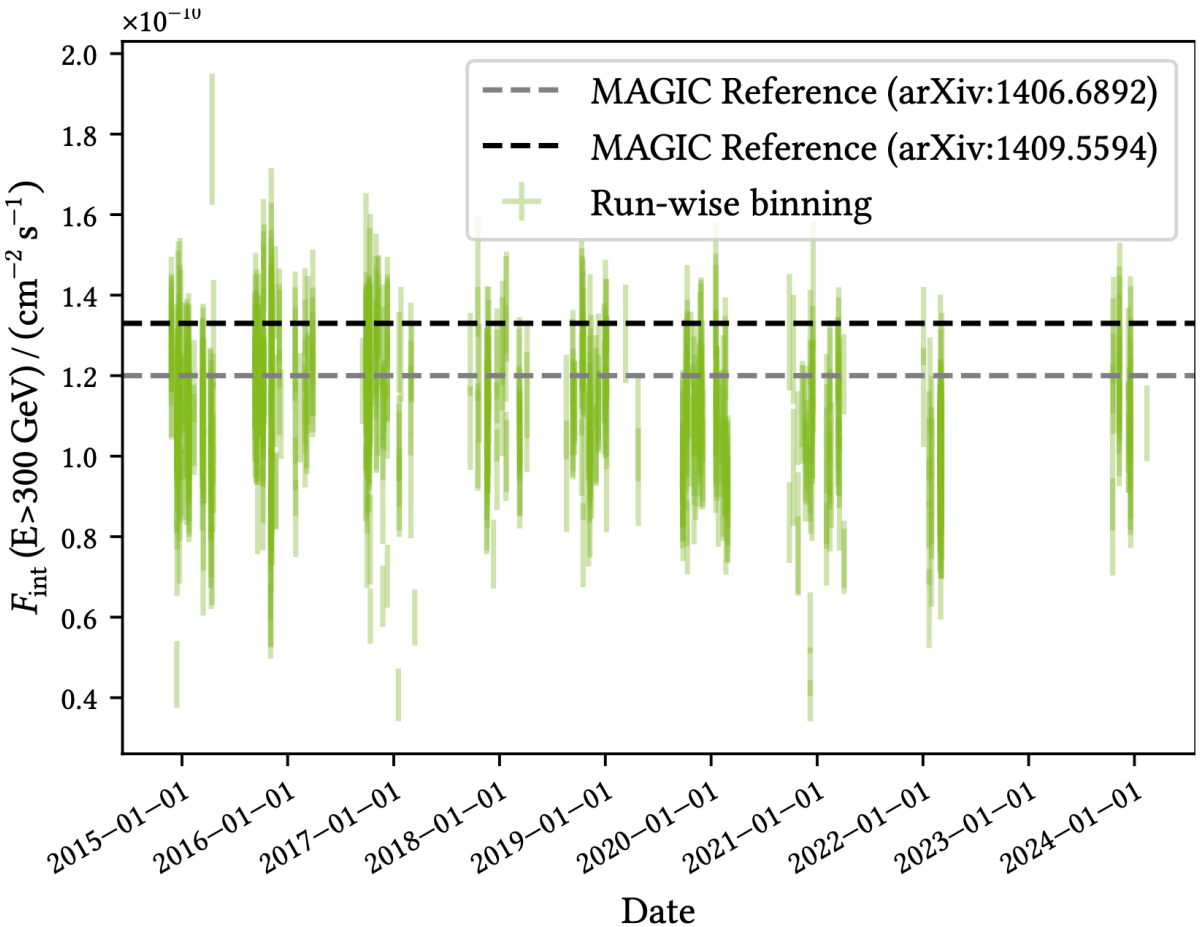
Limitations and Caveats of autoMAGIC

- Usage of Database with many users simultaneously can be problematic in the current setup
  - Need to design a workflow/concept to allow for this
- Main Bottleneck: Data availability at PIC
  - Find a smoother way for accessing the calibrated data together with the PIC admins
- There still might be bugs!

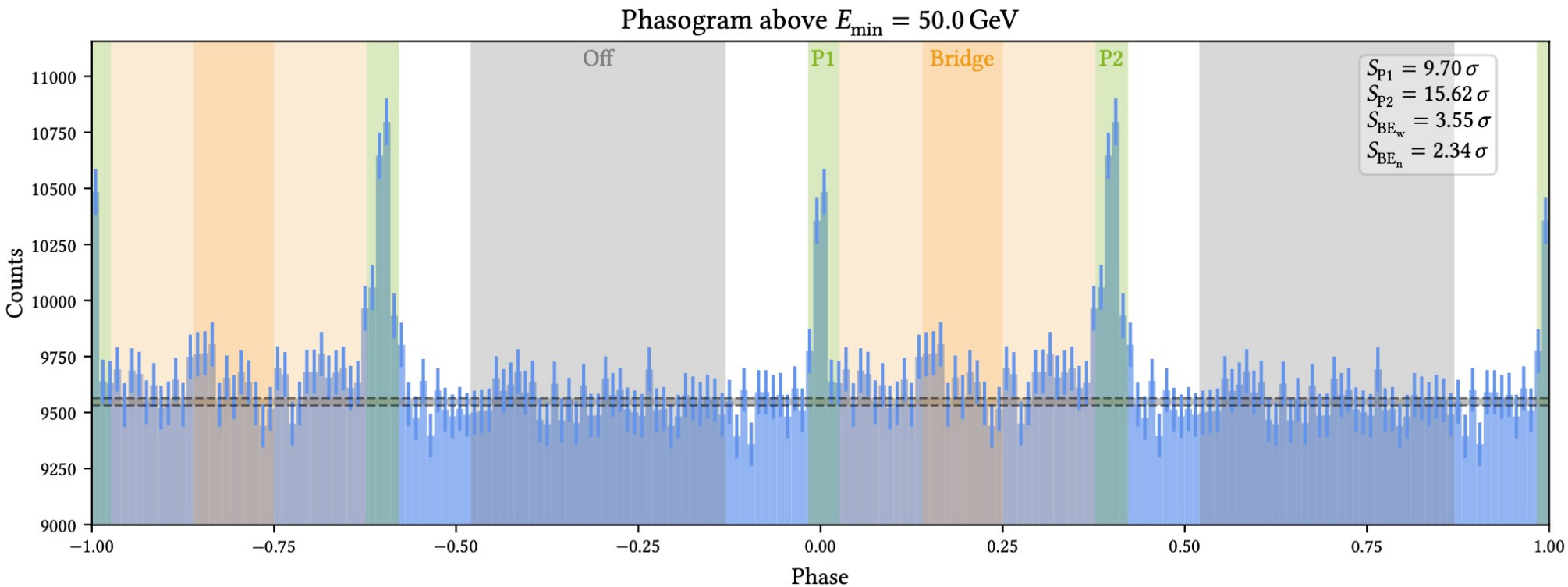
AutoMAGIC results: Crab Nebula in DL3 paper



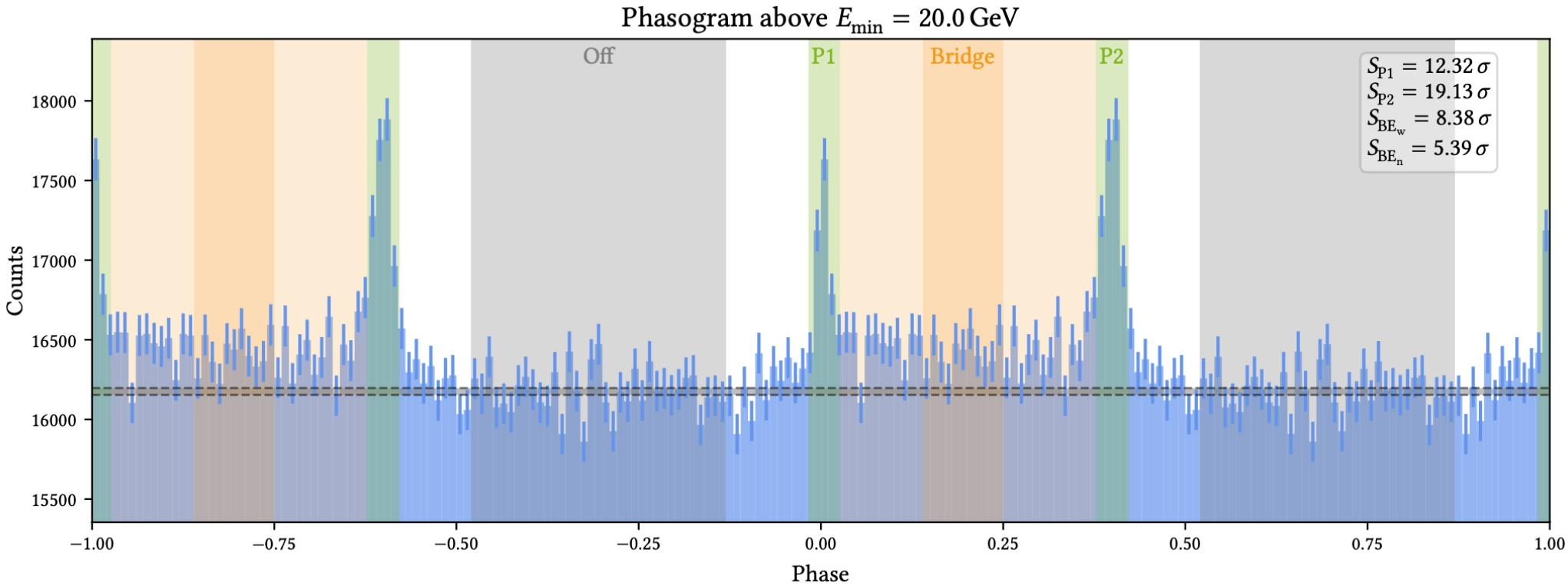
AutoMAGIC results: Crab Nebula Long-Term



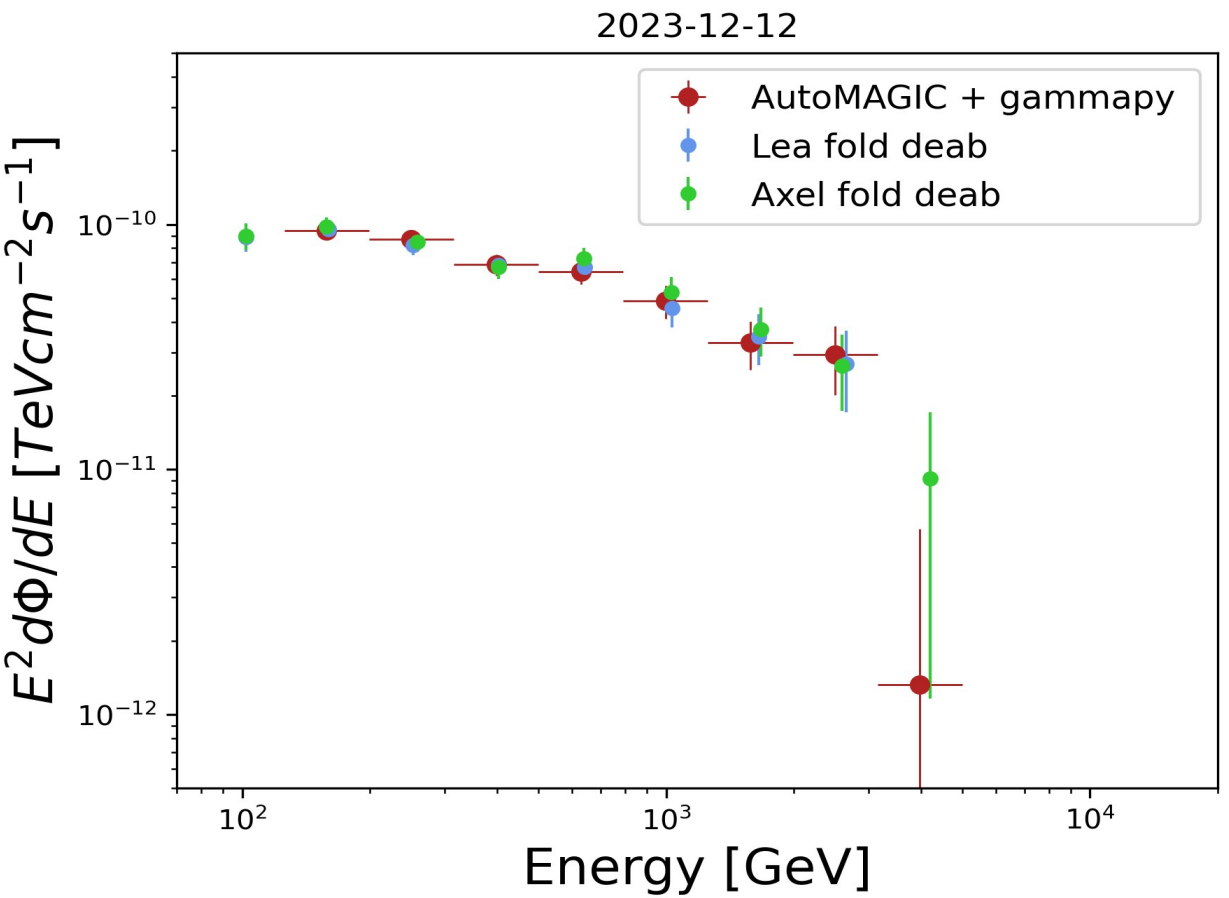
AutoMAGIC results: Crab Pulsar Long-Term



AutoMAGIC results - Sum-Trigger-II Crab Pulsar Analysis



AutoMAGIC results – Mrk421 SED



AutoMAGIC List of Recent Productions

- Crab DL3 validation Paper
- Crab Longterm ST.03.06-ST.03.20
- Crab Sum-Trigger-II ST.03.06-ST.03.12
- Mrk421
- Multiple analysis of dim sources for the EHBL catalog paper

AutoMAGIC Future Plans

- I'm going to quit science at the end of October :'(
- Cyrus Walther (cyrus.walther@tu-dortmund.de) is going to take over the project
- David Venker's (Master student in Dortmund) work:
  - Survey work on FSRQs based on dark data
- Cyrus' work:
  - Modeling of AGN spectra, focusing on BL Lacs