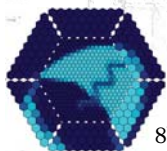




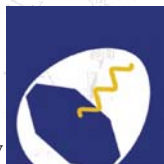
VHE observations with the MAGIC telescope

- Imaging Air Cherenkov Technique – How does it work?
- MAGIC telescope
 - short introduction
 - How is the data analysed?

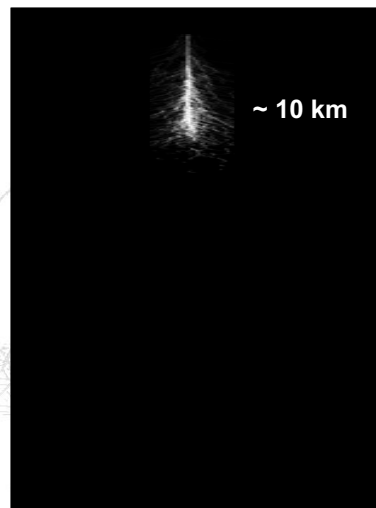


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IACT: Imaging Air Cherenkov Technique

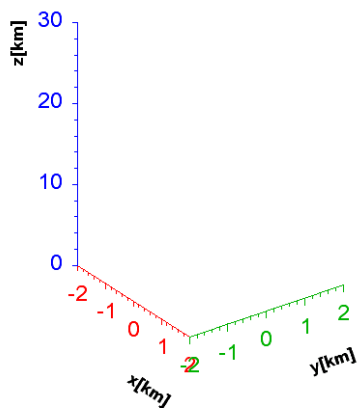


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SHOWER ID: 20031020_test12
 PRIMARY PARTICLE: GAMMA, 500.00 GeV
 ANGLE: 0° ZENITH, 0° AZIMUTH
 ALL PARTICLES
 # OF PARTICLES: 0
 SHOWER TIME: 0.00 - 0.00 [μsec]



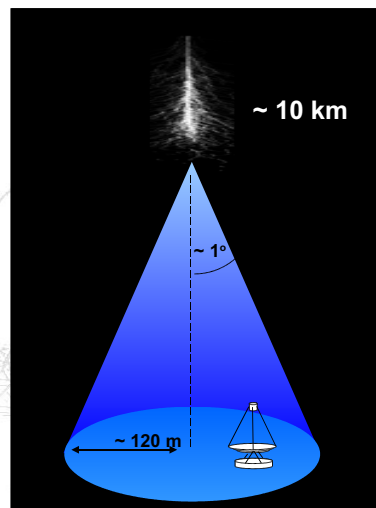
K.S. Kim ETHZ/EWHA

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IACT: Imaging Air Cherenkov Technique

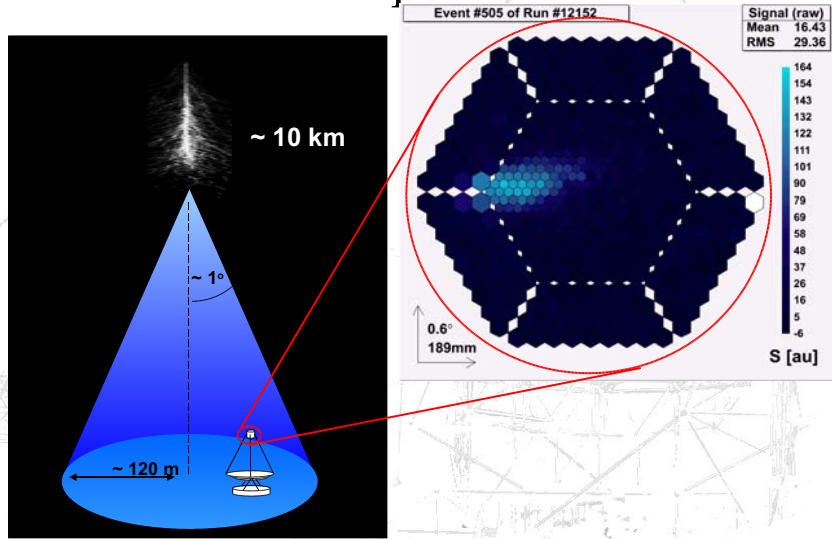


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IACT: Imaging Air Cherenkov Technique

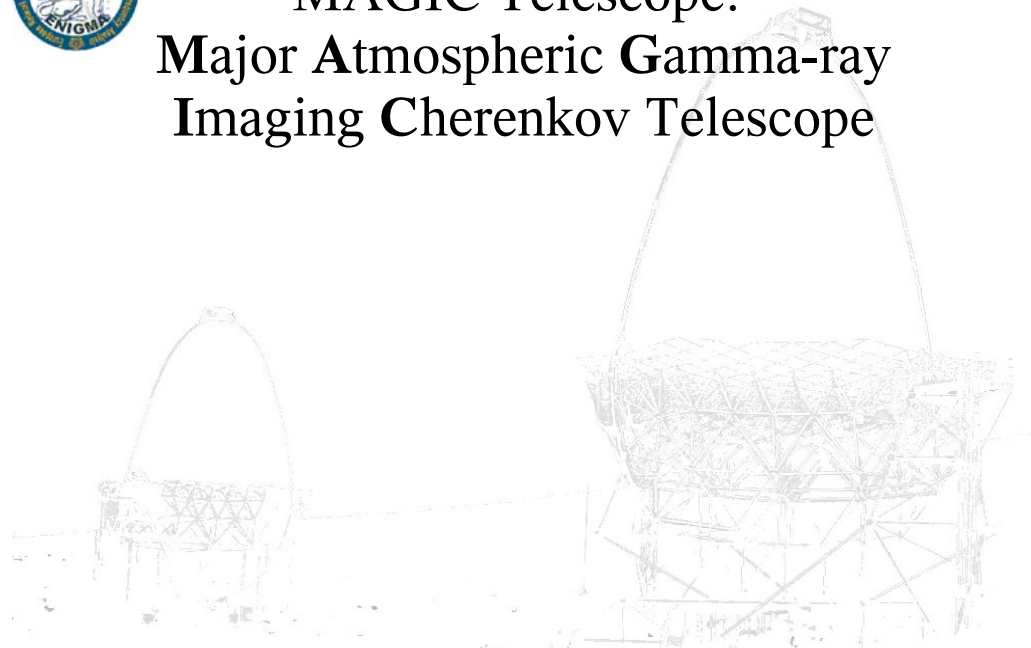


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MAGIC Telescope: Major Atmospheric Gamma-ray Imaging Cherenkov Telescope



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MAGIC Telescope:



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MAGIC Telescope



- Observatorio Roque de los Muchachos, La Palma, 2200 m a.s.l.
- isochronous mirror, diameter: 17 m
- weight: ~70 t
- tracking accuracy $< 0.1^\circ$
- fast repositioning (GRBs) $180^\circ/30\text{sec}$

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MAGIC Telescope



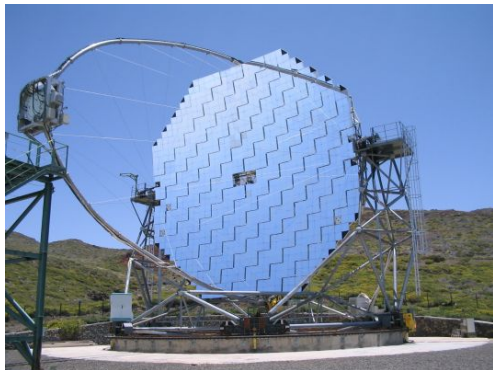
- PMT camera (577 pixels)
small pixels: 0.1°
large pixels: 0.2°
- optical cables
- digitization with 300MHz FADCs into ring buffer
- trigger (signal above threshold, time coincidence, pattern recognition)
- => data acquisition:
rate: 200-300Hz
read out time: 50ns
pulse integration: 5-10ns

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MAGIC Telescope



- background:
hadron, myons, ...
- gammas/background $< 1/1000$
- energy range: $> 100\text{ GeV}$
- sensitivity: 1 Crab/5 min
- zd-range:
low energies: $< 35^\circ$
higher energies: $< 60^\circ$
- observations during moon
- observation modes:
on/off-mode, wobble-mode

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MAGIC Telescope



- 577 pixel · 30 byte/pixel
=> ~17.3kB / event
- 200 events/s · 17.3kB/event
=> ~3.5MB/s
- 1.5TB/month => increasing with new read out and second telescope => ~20TB/month)
- changing conditions (environment, hardware)

=> flexible, robust, automatic analysis

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MAGIC Telescope



- results 1-2 days after data taking
- consistent analysis for all data
- results and status available in a database
- long term study of quality parameters
- test bench for development of new methods

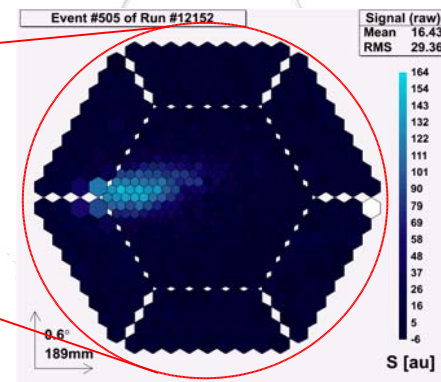
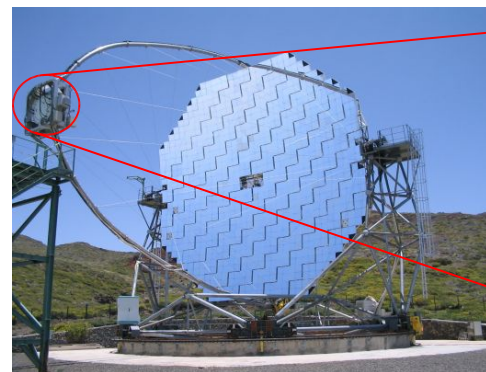
=> first step towards a cherenkov observatory

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MAGIC Telescope



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Analysis

- calibration
- calculation of image parameter
- quality cuts
- background suppression
- reconstruction of shower origin
- energy reconstruction, spectrum

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Analysis

- calibration
 - relative calibration with light pulses
 - absolute calibration with myons

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Analysis

- calibration
 - relative calibration with light pulses



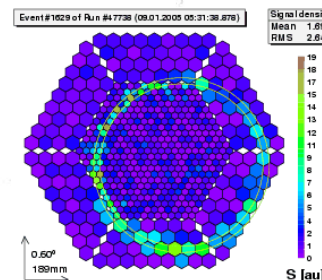
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Analysis

- calibration
 - relative calibration with light pulses
 - absolute calibration with myons



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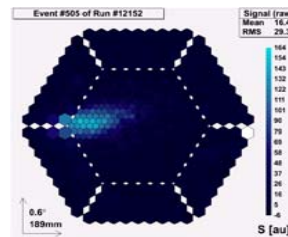


Analysis

- calibration
- calculation of image parameters
 - image cleaning
 - calculation of parameters describing the shower image
 - calculation of myon parameters

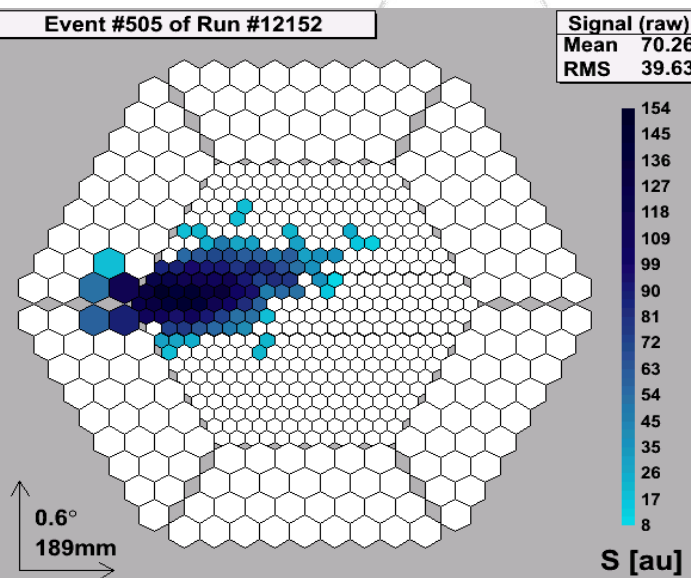
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image cleaning



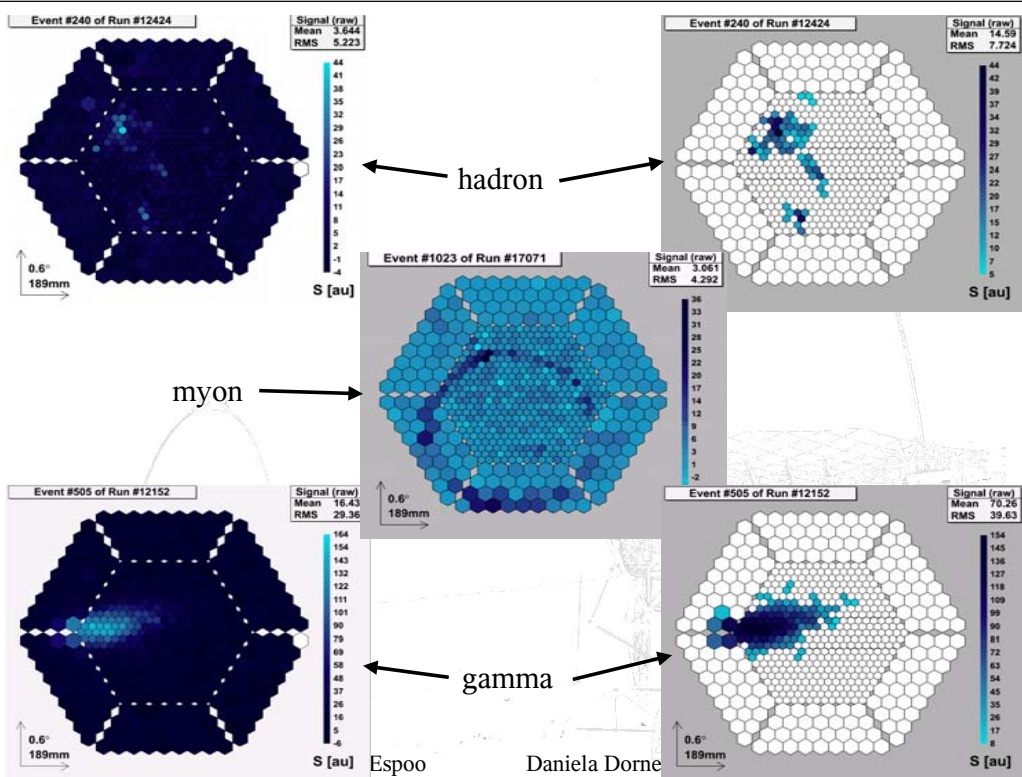
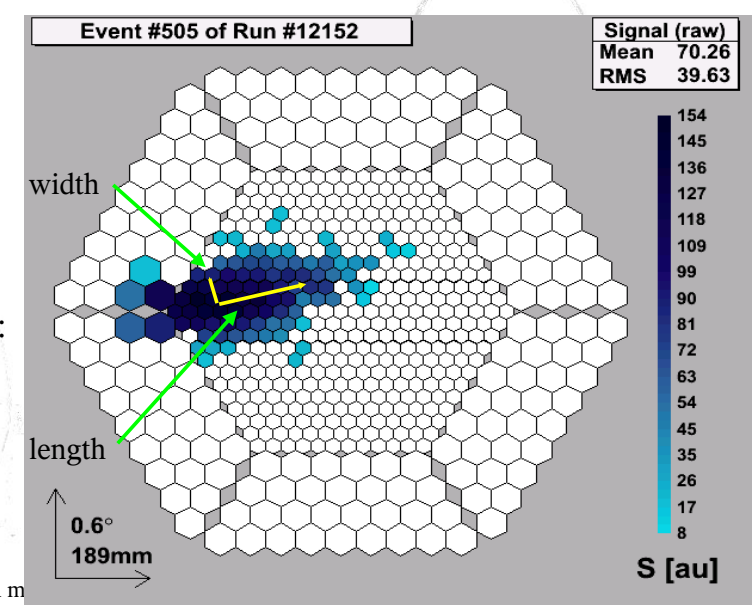


image parameters

- size: total number of photons of the shower
- standard deviations of the light distribution: width, length
- direction of the shower



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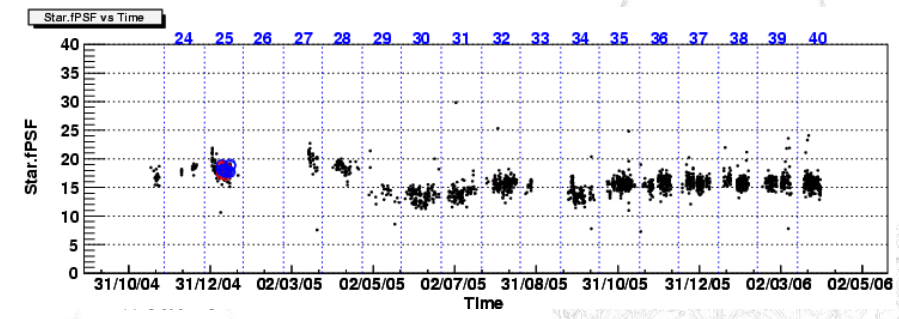


Analysis

- calibration
- calculation of image parameter
- quality cuts – exclude data with bad quality
 - weather
 - telescope performance (e.g. point spread function)



Analysis



- telescope performance (e.g. point spread function)



Analysis

- calibration
- calculation of image parameter
- quality cuts
- background suppression



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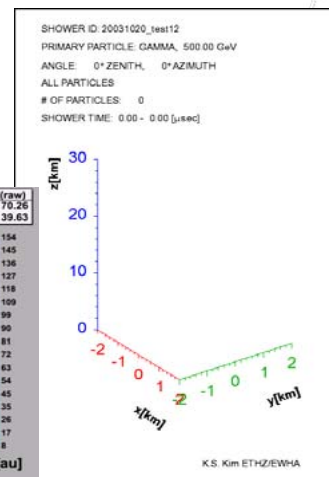
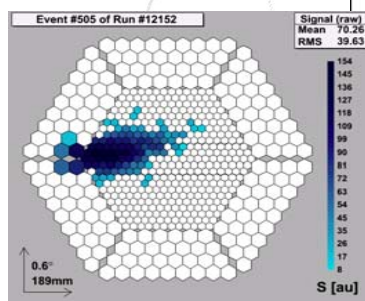
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gamma or hadron? different image parameters

methods for background suppression:

- static cuts
- dynamic cuts
- random forest
- neural net



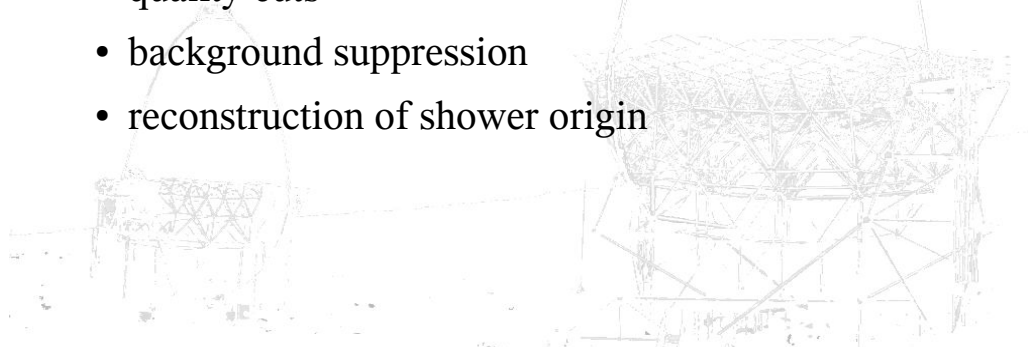
SHOWER ID: 20031020_test12
PRIMARY PARTICLE: GAMMA, 500.00 GeV
ANGLE: 0° ZENITH, 0° AZIMUTH
ALL PARTICLES
OF PARTICLES: 0
SHOWER TIME: 0:00 - 0:00 [μsec]

SHOWER ID: 20031020_test12
PRIMARY PARTICLE: PROTON, 500.00 GeV
ANGLE: 0° ZENITH, 0° AZIMUTH
ALL PARTICLES
OF PARTICLES: 0
SHOWER TIME: 0:00 - 0:00 [μsec]



Analysis

- calibration
- calculation of image parameter
- quality cuts
- background suppression
- reconstruction of shower origin



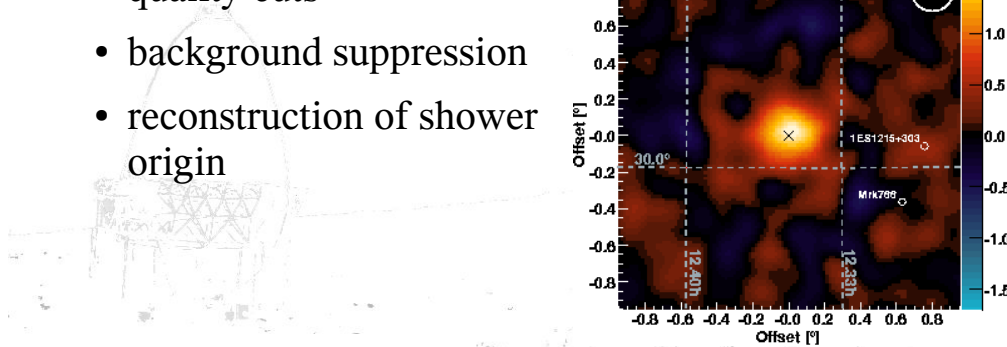
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Analysis

- calibration
- calculation of image parameter
- quality cuts
- background suppression
- reconstruction of shower origin



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Analysis

- calibration
- calculation of image parameter
- quality cuts
- background suppression
- reconstruction of shower origin
- energy reconstruction, spectrum
 - reconstruction of energy by comparison with simulated showers

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Results – see next talks

- Elina Lindfors: Discovery of VHE gamma-rays from Mkn 180 triggered by an optical outburst
- Thomas Bretz: Overview of AGN observation with the MAGIC telescope

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