

Gamma-Ray Astronomy

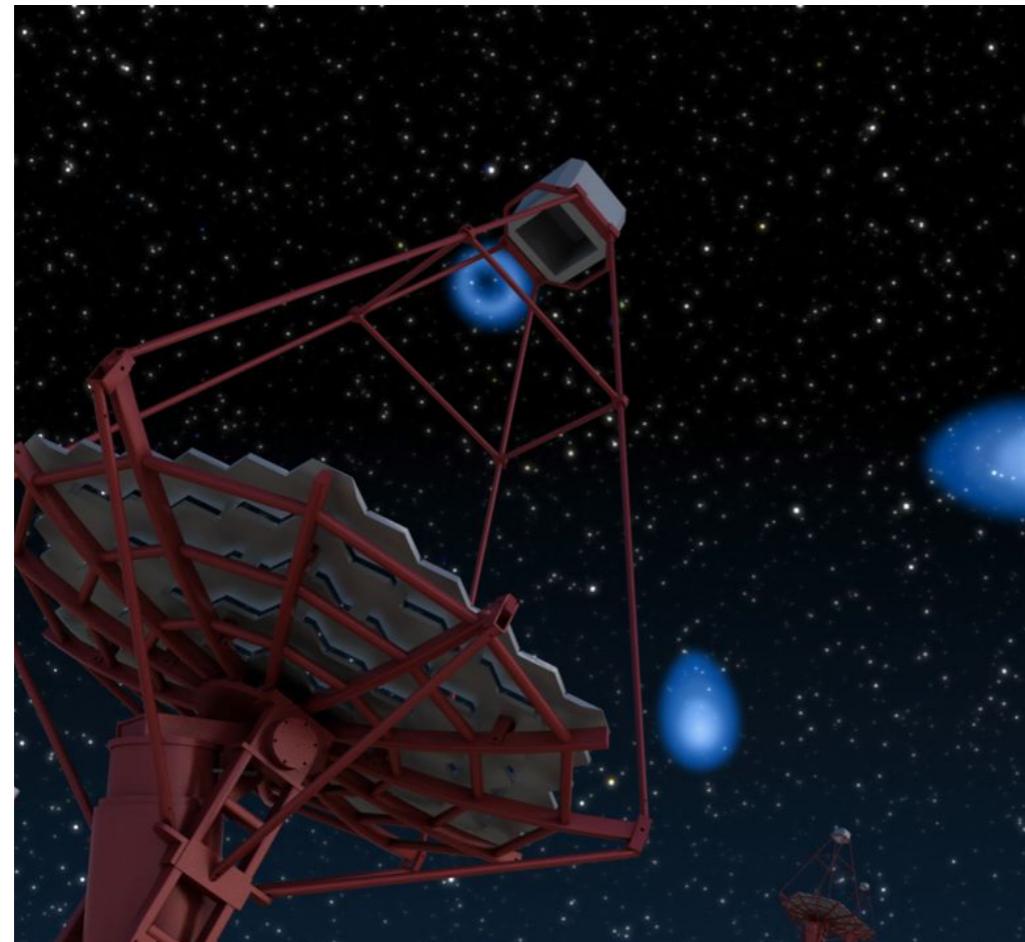
at DESY in Zeuthen



©Matthias Lorentz

Stefan Klepser
PRC meeting
Hamburg, April 2016

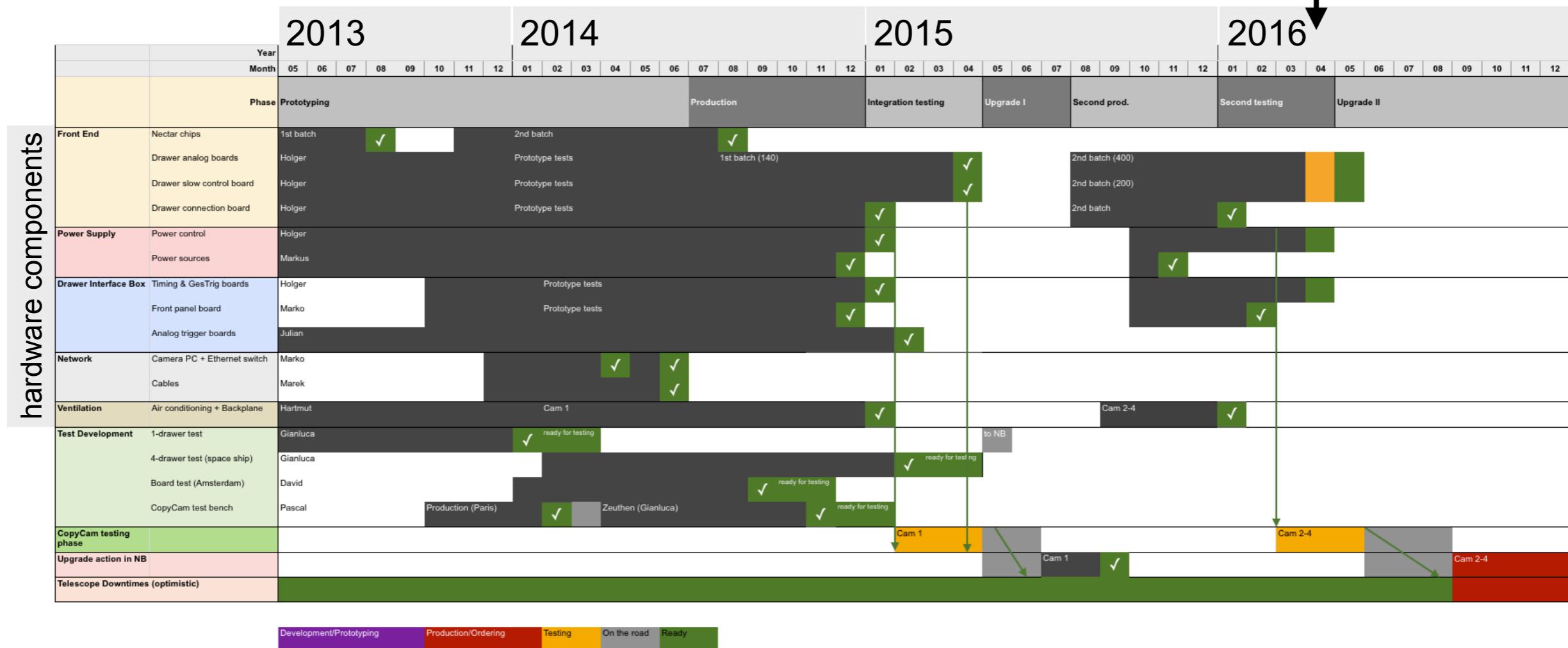
Staff Members of Gamma-ray Astronomy in Zeuthen



- > CTA
 - Bühler, Garczarczyk, Knapp, Maier, Schlenstedt, Stegmann
- > Fermi
 - Bühler, Ackermann, Franckowiak
- > H.E.S.S.
 - Klepser, Stegmann
- > MAGIC
 - Bernardini, Garczarczyk
- > VERITAS
 - Maier, Pohl, Schlenstedt
- > THAT (Theory)
 - Pohl, Winter, Yan

Building Stuff, part I: H.E.S.S. Camera Upgrade

- ## > Project status:



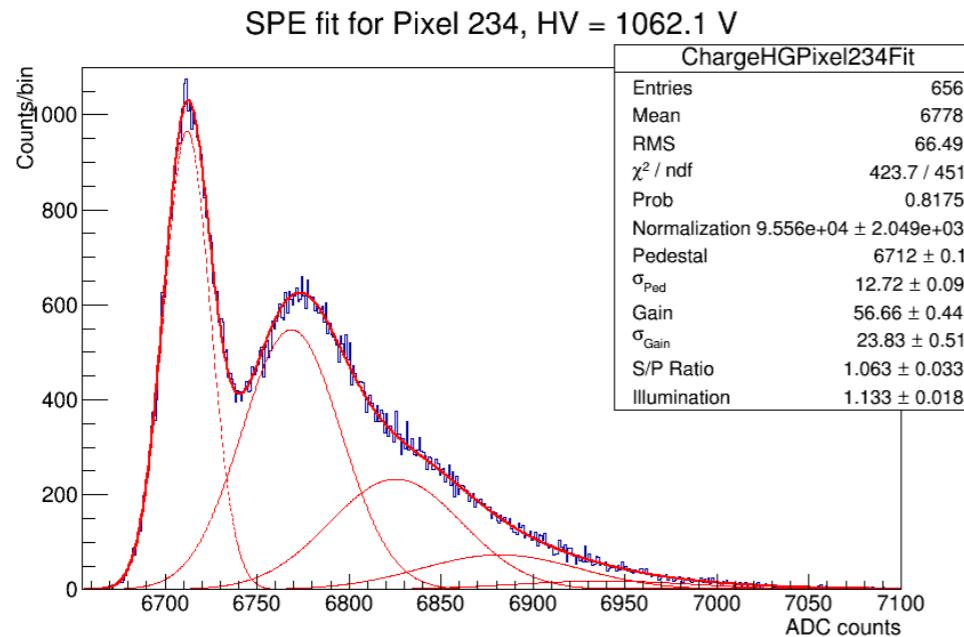
- First camera deployed last summer
 - Production of cameras 2-4 almost finished
 - Deployment in September, to be confirmed by H.E.S.S. coll.

Commissioning and Calibrating the First Camera

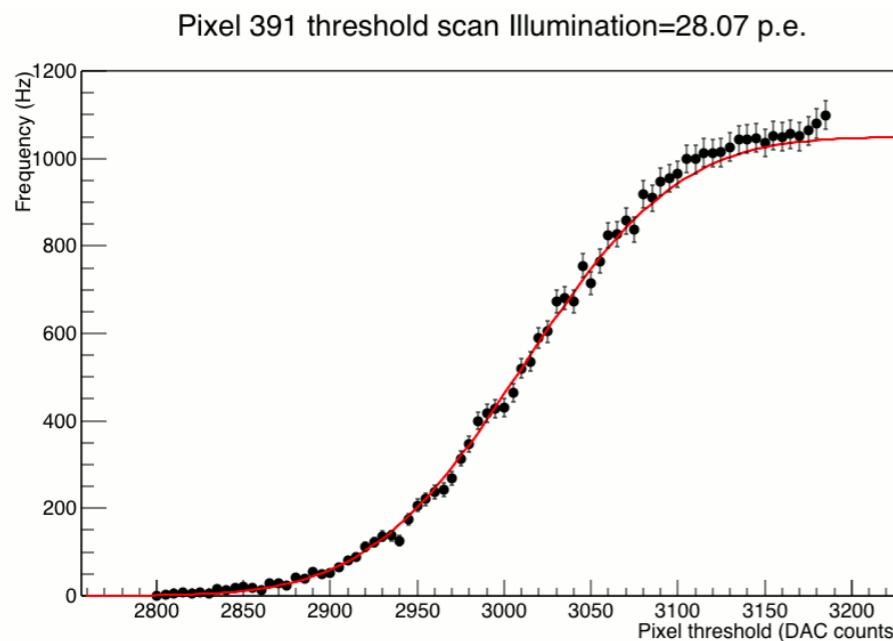
G. Giavitto, H.E.S.S. group

- Long list of tasks...

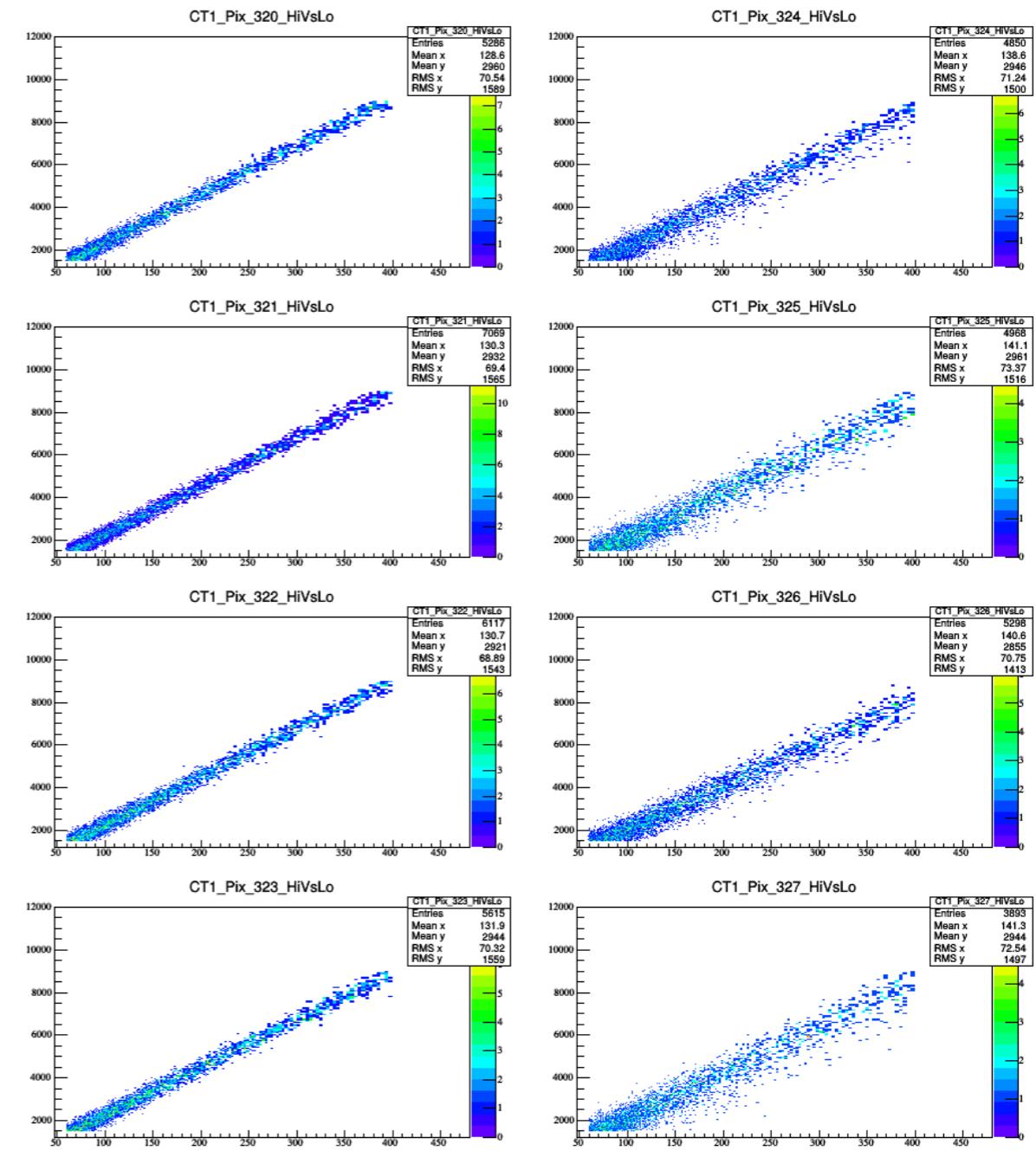
Single photo-electron calibration



Trigger threshold calibration

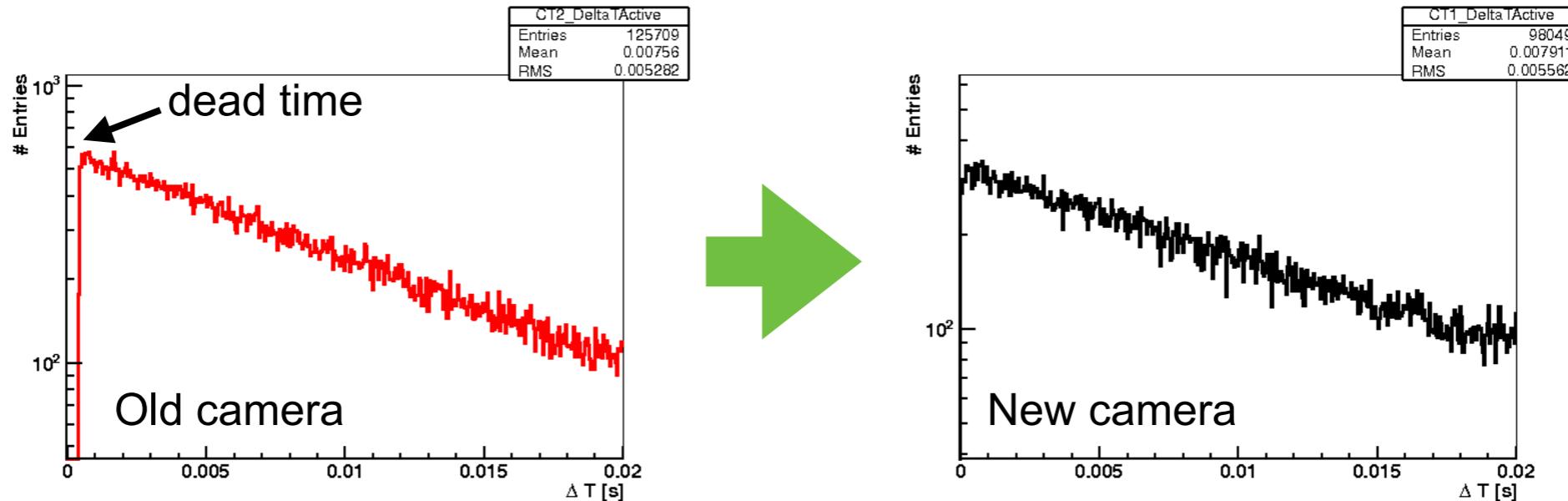


High-gain vs. Low-gain channel comparisons

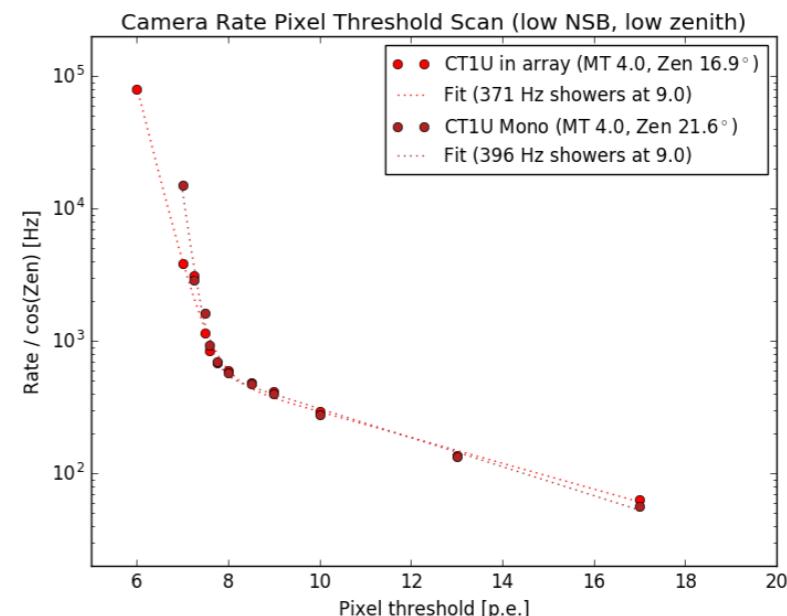


Trigger Scans and Dead Time

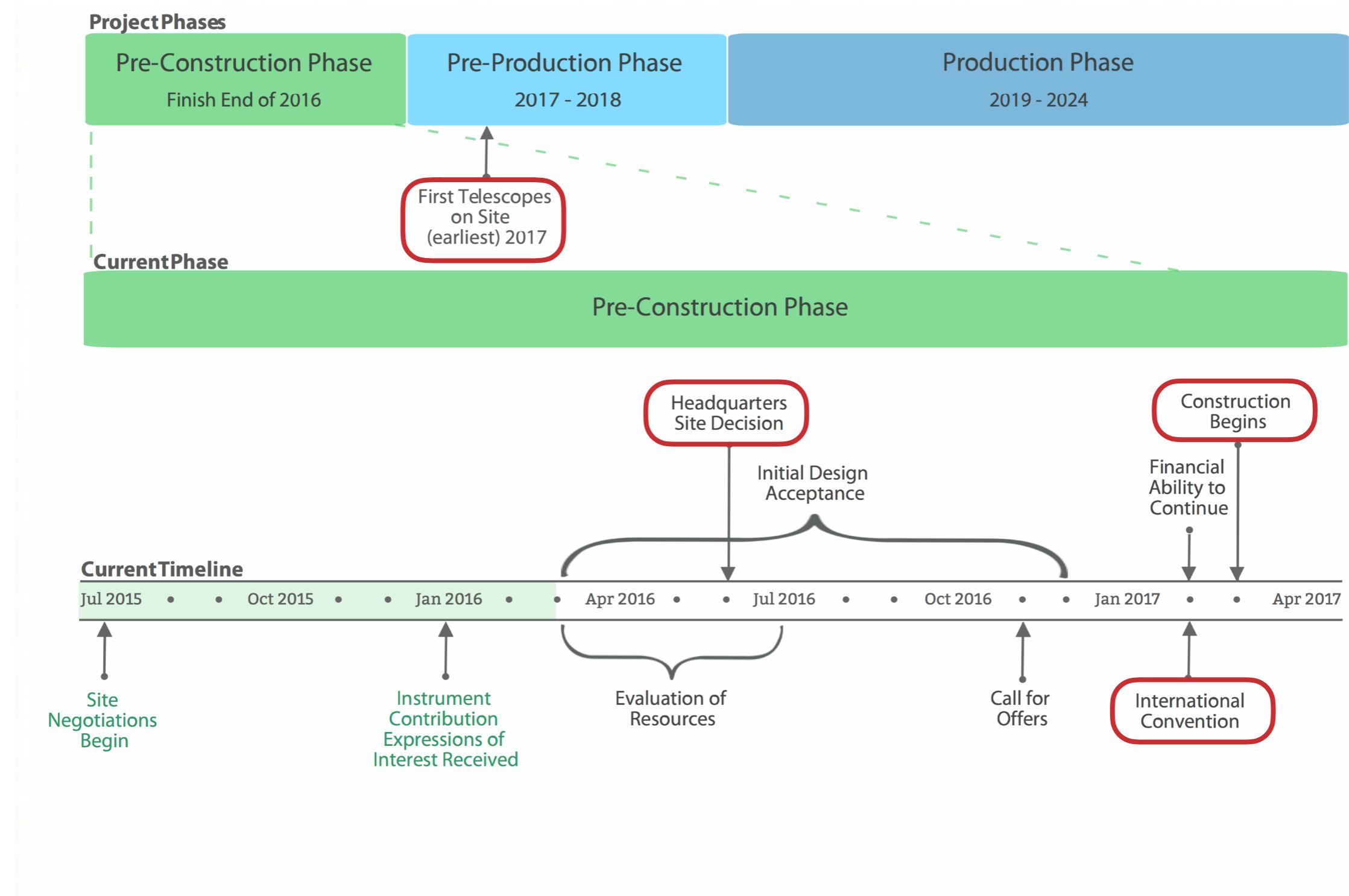
- Deadtime reduced from 450 μ s to < 6 μ s



- Trigger system works well →
- No show stopper, things work
 - Some delay in commissioning, though
 - Took measures to improve workforce situation

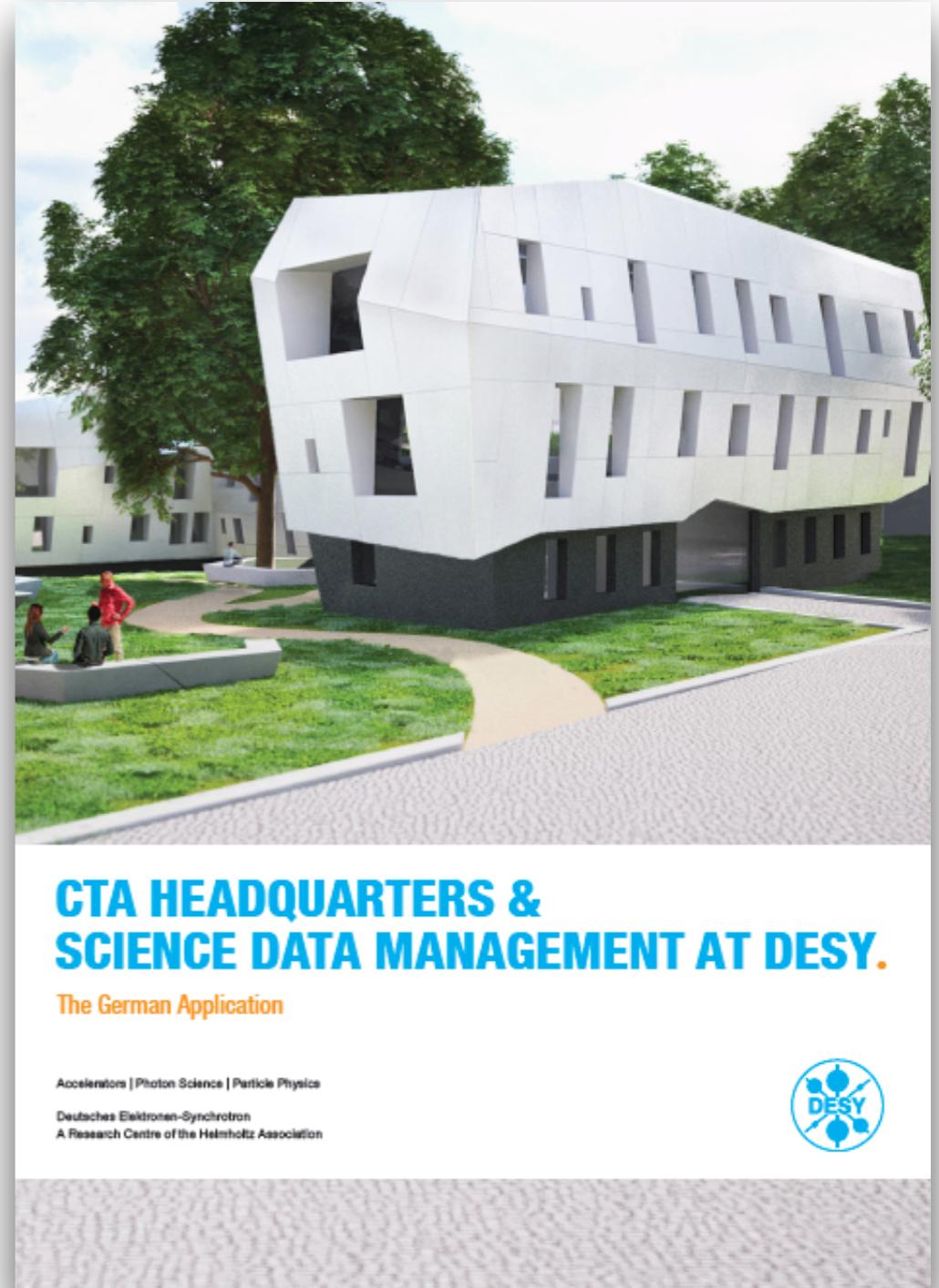


Building Stuff, part II: CTA



DESY Headquarters Application

- Headquarters
- Science Data Management Centre



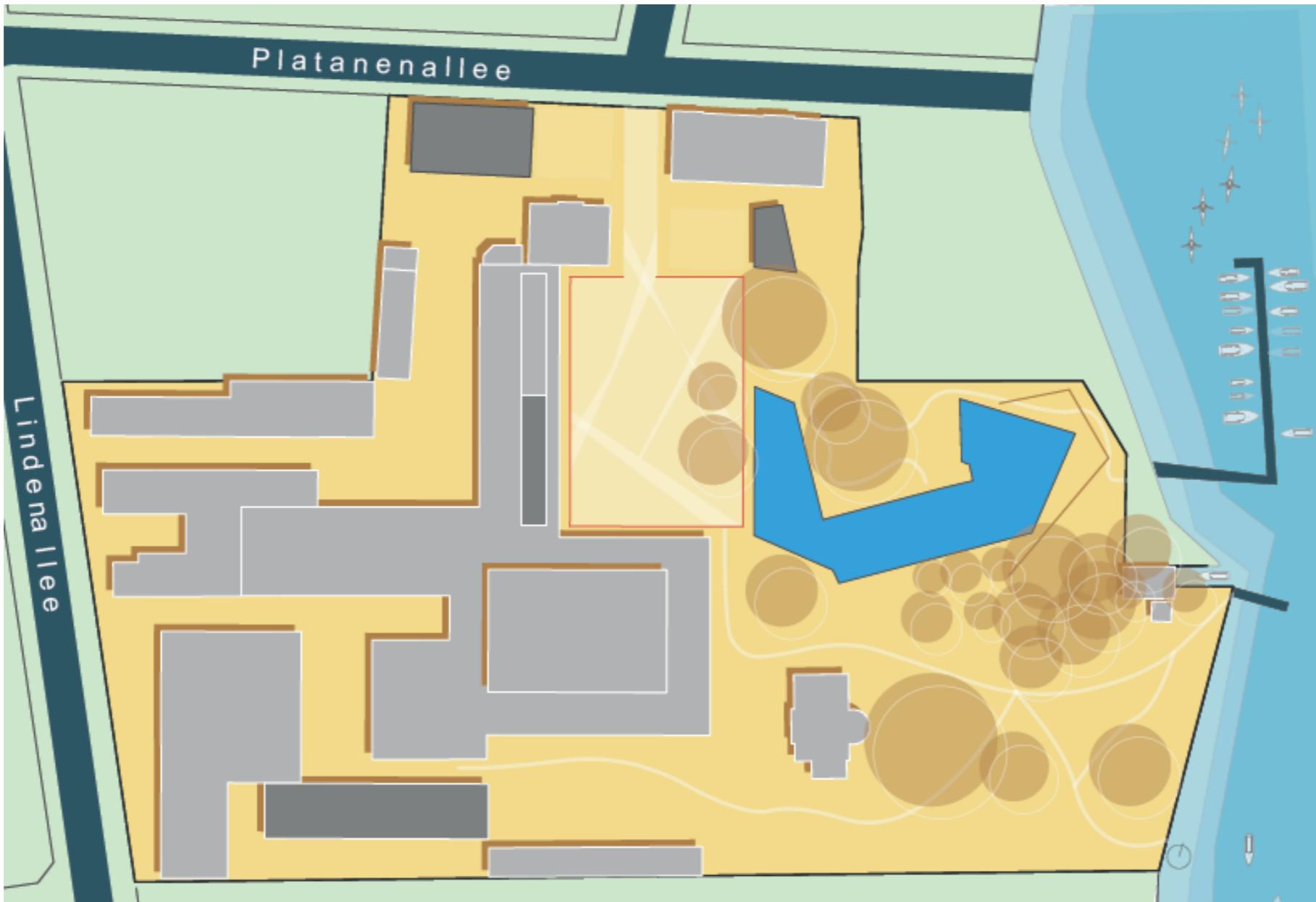
CTA HEADQUARTERS & SCIENCE DATA MANAGEMENT AT DESY.

The German Application

Accelerators | Photon Science | Particle Physics
Deutsches Elektronen-Synchrotron
A Research Centre of the Helmholtz Association



DESY Headquarters Application



DESY Headquarters Application

- > Official endorsements by
 - Federal Ministry of Education and Research
 - Brandenburg Ministry of Science, Research and Culture
 - Helmholtz Association
 - Max Planck Society
 - University Potsdam
 - Humboldt University Berlin

CTA Headquarters & Science Data Management at DESY

INFRASTRUCTURE

DESY has a wide range of scientific, engineering and technical services, including a fully equipped mechanical workshop, analogue and digital electronic labs and a powerful and well-staffed computing centre, with the know-how to design, build and maintain large, advanced detectors and research facilities. Also substantive expertise in legal and tax issues, procurement, project management, administration and human resources is available at DESY. An experienced outreach team, a conferencing service, a local hoster and a general building and maintenance group complement the DESY infrastructure at Zeuthen. CTA can benefit from these services.



LIVING IN THE BERLIN-BRANDENBURG AREA

Berlin is one of the major capitals of Europe, on a par with London, Paris or Rome. Berlin is recognised as a world city of culture, politics, media and science. There are many world-class museums, an unparalleled music scene (of every possible style) and nightlife, countless theatres and cinemas, and a thriving performing arts and film industry. There are plenty of festivals and international mega-events of all sorts. Berlin has 3.5 million inhabitants of more than 180 nationalities. 15% of its population are foreigners, producing a faceted mix of culture, religion, food and political, sociological and ethnic views. Berlin is a very liberal and open city where everyone can find his place. Berlin has an impressive and ever-changing history. Many places in the city still testify of eight eventful centuries, especially of the 20th century, with the heydays in culture and science in the 1920s, the two wars, the Nazi regime and the division of East and West for 45 years and the flourishing after the reunification. Berlin is Europe's greenest city. With more than 2,500 public parks and gardens and almost a fifth of the city being covered with trees, it is easy to forget that you are in a capital city of 3.5 million. There are more canals in Berlin than in any other city in the world (including Amsterdam and Venice). Berlin has an extended network of bike paths with a total length of more than 1500 km and about 710 bicycles per 1000 residents. Berlin offers excellent opportunities for its citizens with respect to family life, profession and leisure: there are plenty of options for schools (national and international), childcare, further education, vocational training, employment and businesses, for sports facilities, outdoor occupations and cultural activities. This makes Berlin a very good place to live, whatever your expectations for life are. Yet, the cost of living in Berlin is substantially lower than in other large (and smaller) cities in Germany and Europe. It is by far the cheapest capital city in Western Europe. Living in Zeuthen or the small, nearby towns (6,000 to 35,000 inhabitants), is a good option for families. At the lakeside and close to nature, it is living where others make holidays, yet still offering the benefits of the nearby metropolis Berlin.



- > Expert working group
 - First meeting: April 8
- > CTAO council
 - Decision: mid June

CTA at DESY

- > Medium-Sized Telescopes
 - From prototype to first telescopes on site
- > Array Control System
 - Software architecture
 - From prototype software to telescope operation
- > Data Pipelines
 - Monte Carlo and reconstruction pipeline
- > CTA array layout



CTA Array Layout

G. Maier, CTA/VERITAS group

> Huge impact on sensitivity

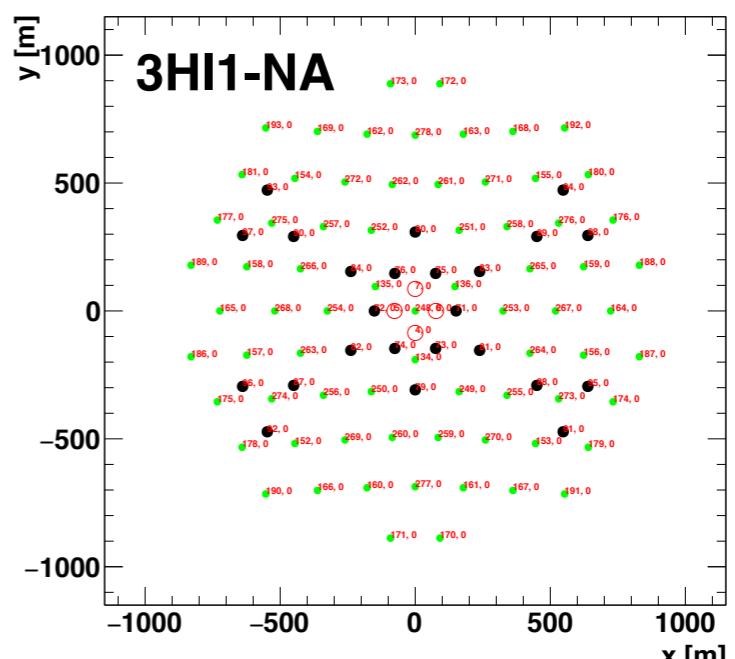
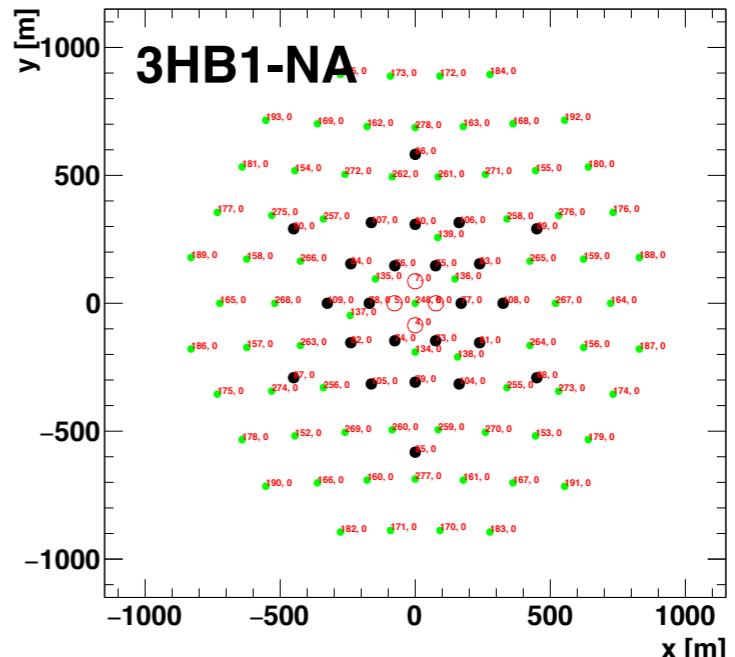
- 100 telescopes (Southern Site) and 25 telescopes (Northern Site)
- Competing physics cases

> Large computing effort

- >200 array layouts
- Task lead by MPIK HD and LUPM (Montpellier)
- Using GRID and Zeuthen farm resources
- ~1 PB of simulation files produced

> Two independent analyses from IFAE (Barcelona) and DESY groups

- Will provide final array layout until May to CTA consortium and infrastructure teams



Large-sized telescopes

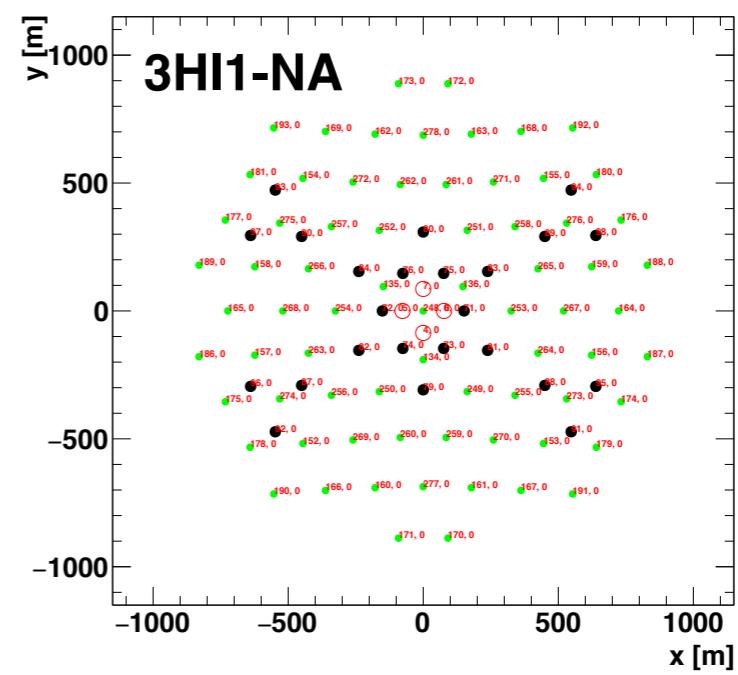
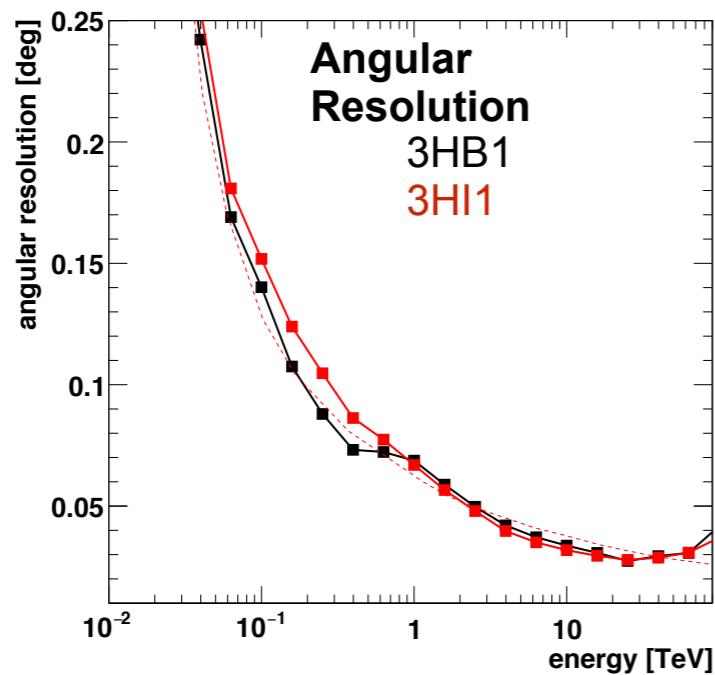
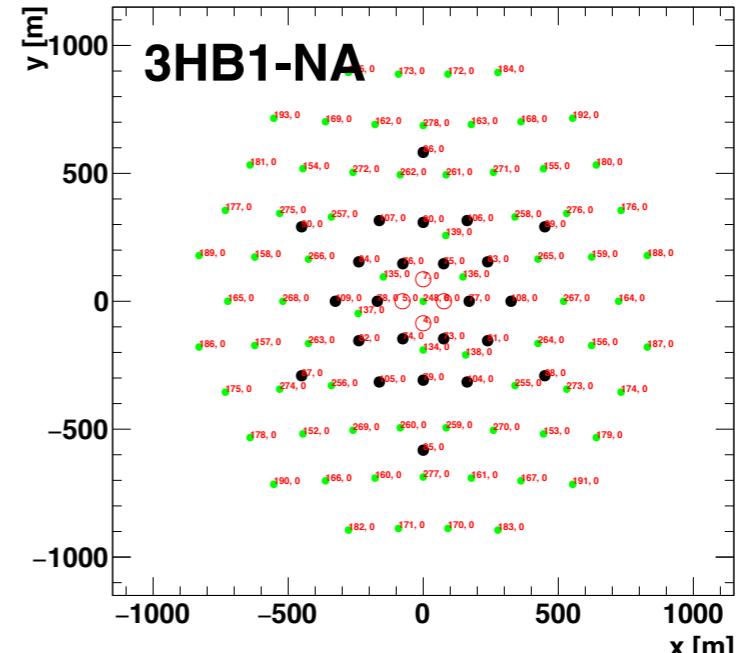
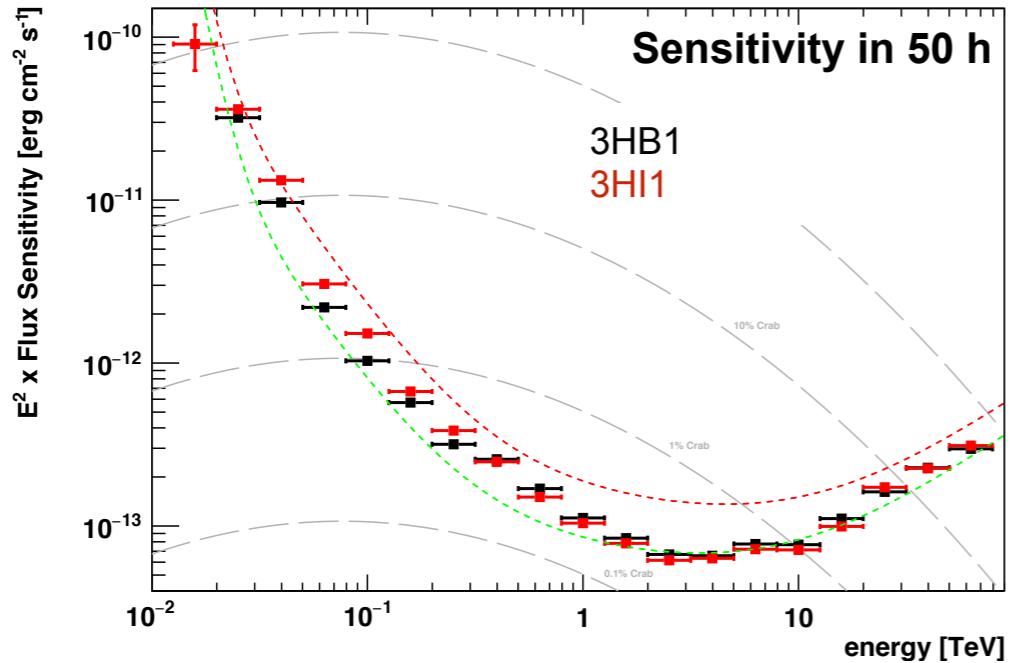
Mid-sized telescopes

Small-sized telescopes



CTA Array Layout

G. Maier, CTA/VERITAS group



Large-sized telescopes

Mid-sized telescopes

Small-sized telescopes

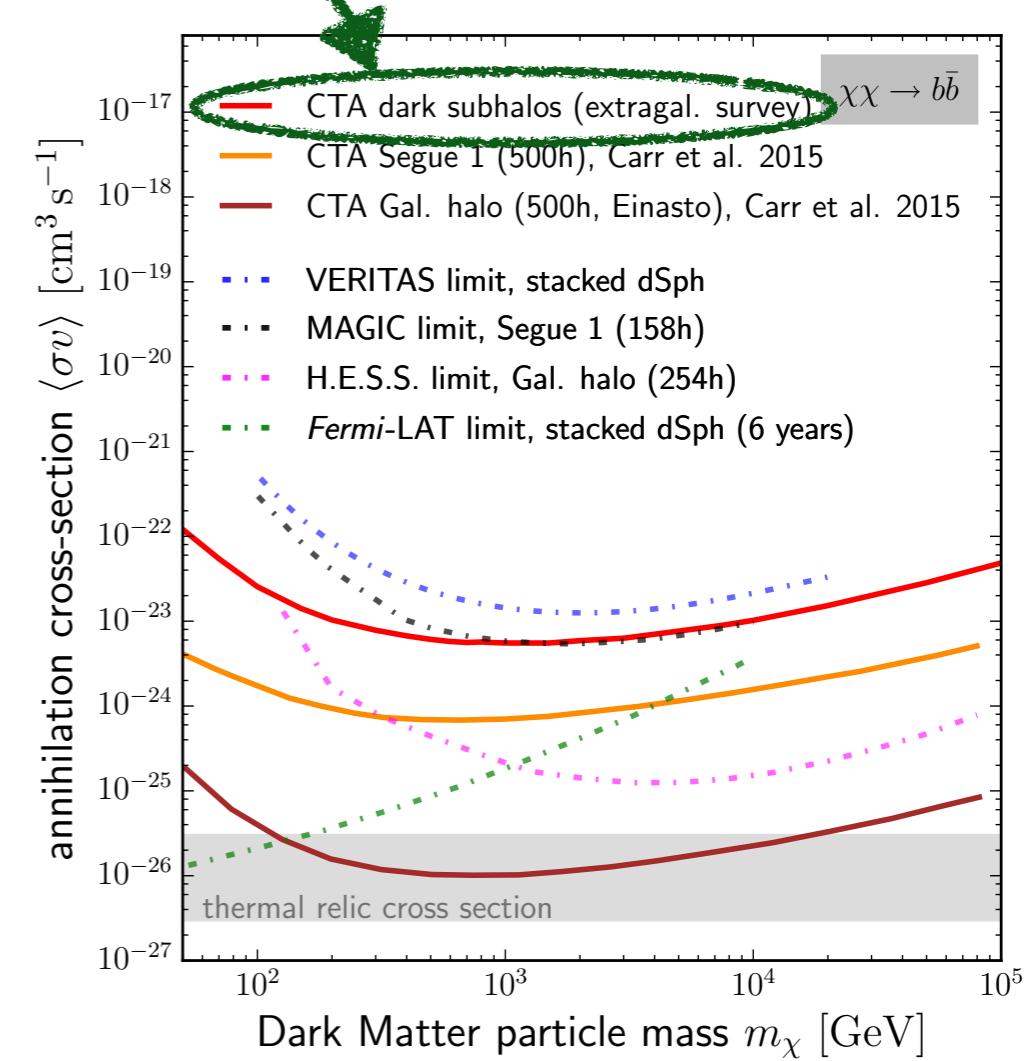
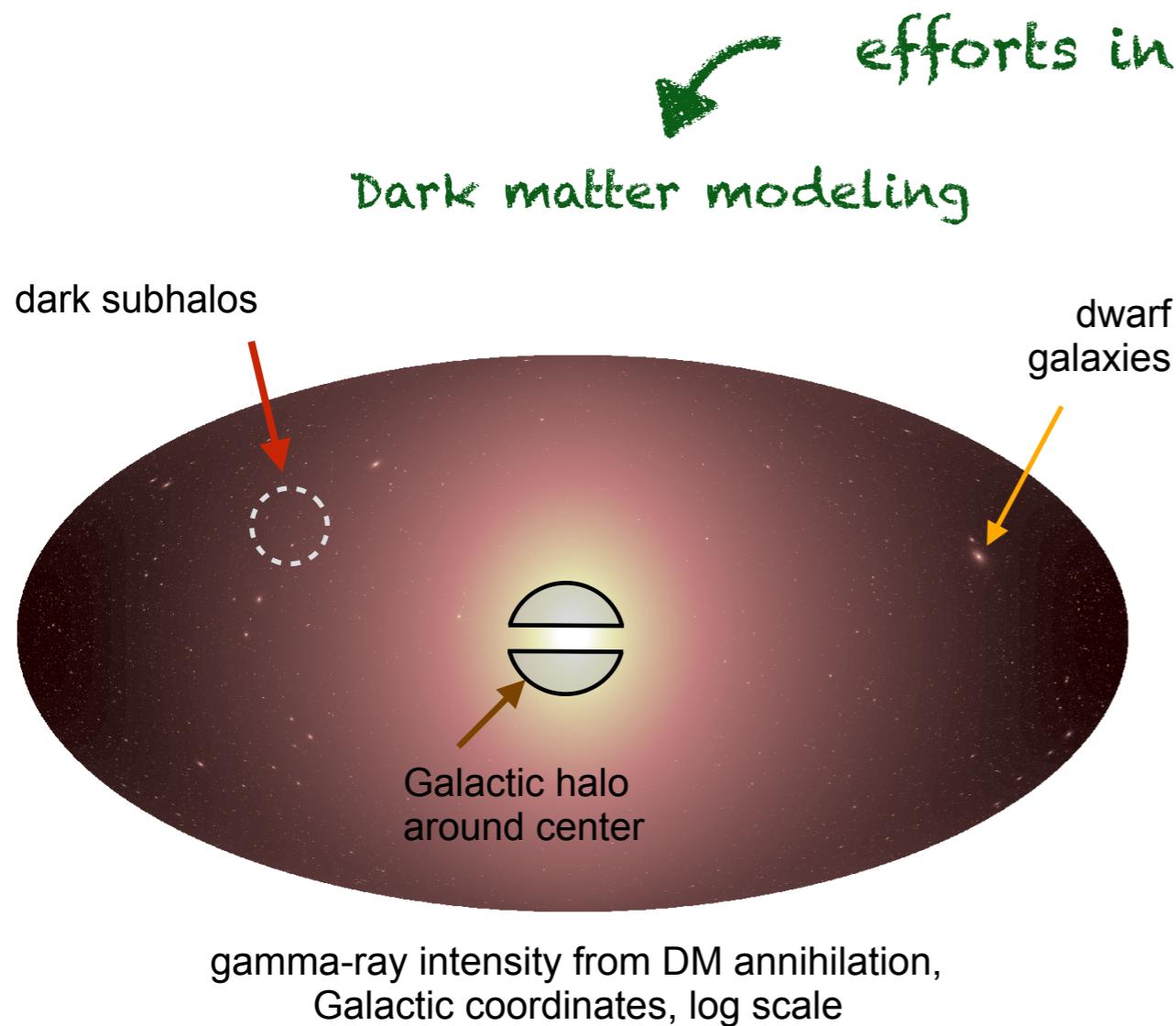


Physics for CTA: Dark Matter Strategies

M. Hütten, CTA/VERITAS group

> Evaluating competing concepts

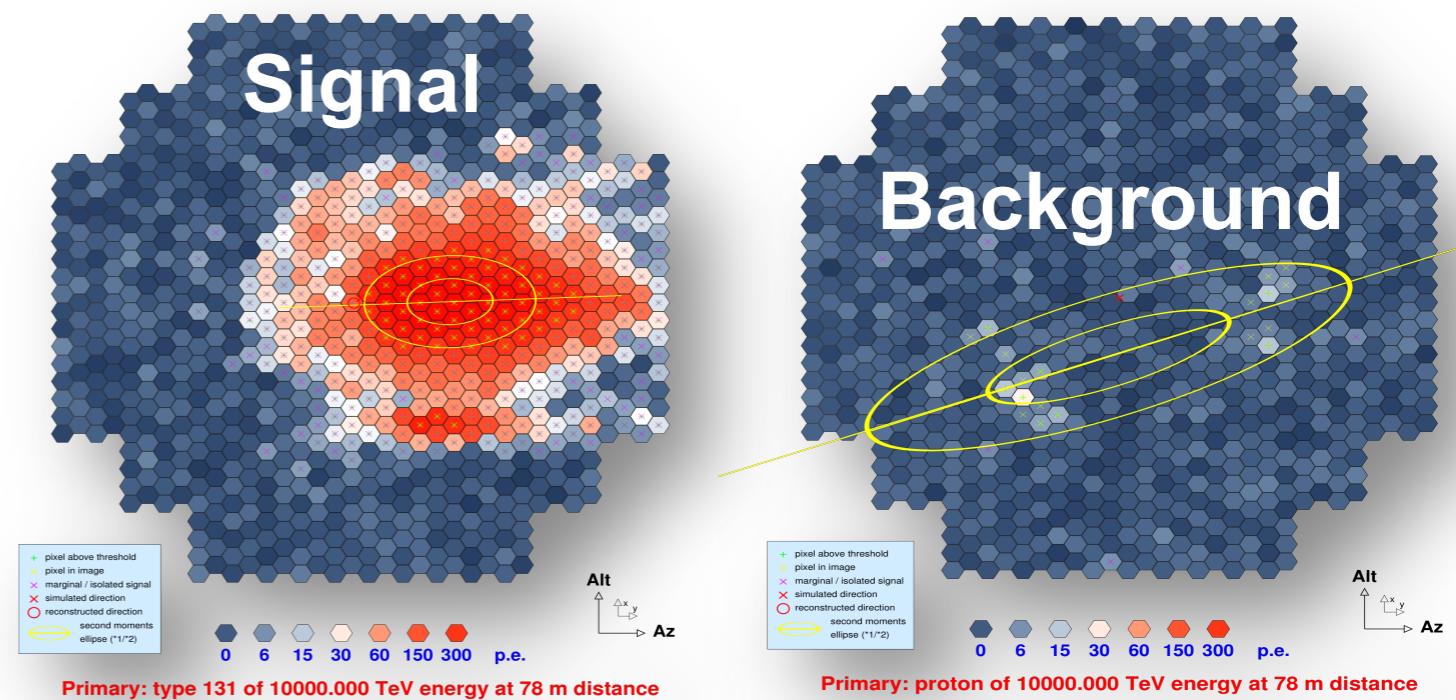
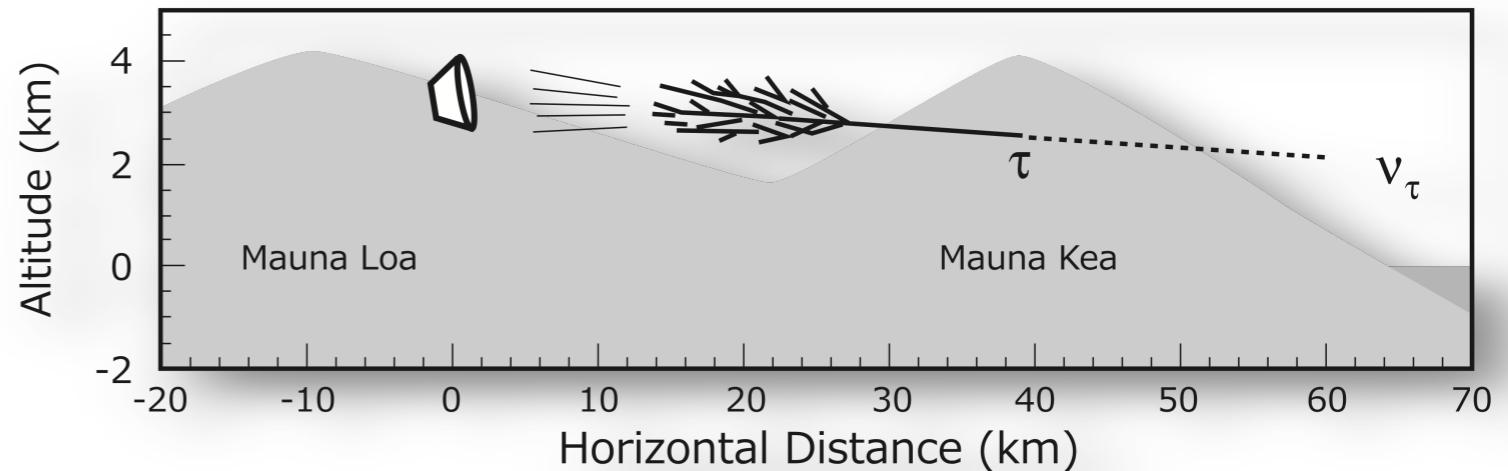
- Best projections for Galactic halo, but large background & modeling uncertainties
- Rely on dwarf galaxies/dark halos as alternative targets



Physics for CTA: Tau Neutrino Astronomy

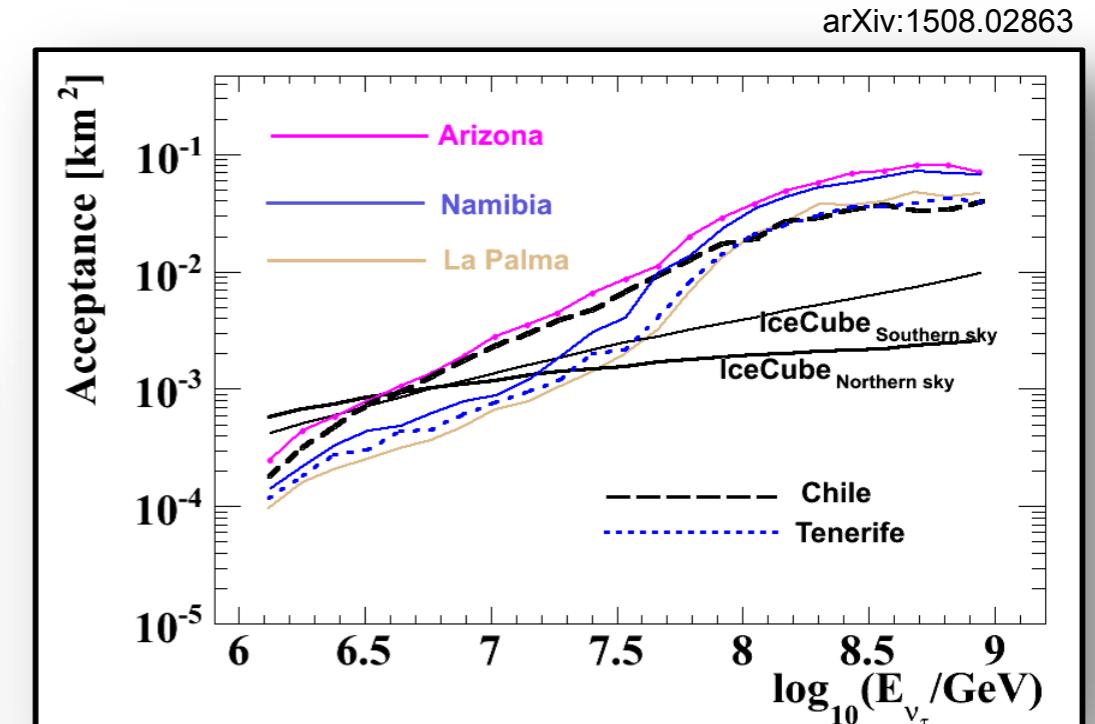
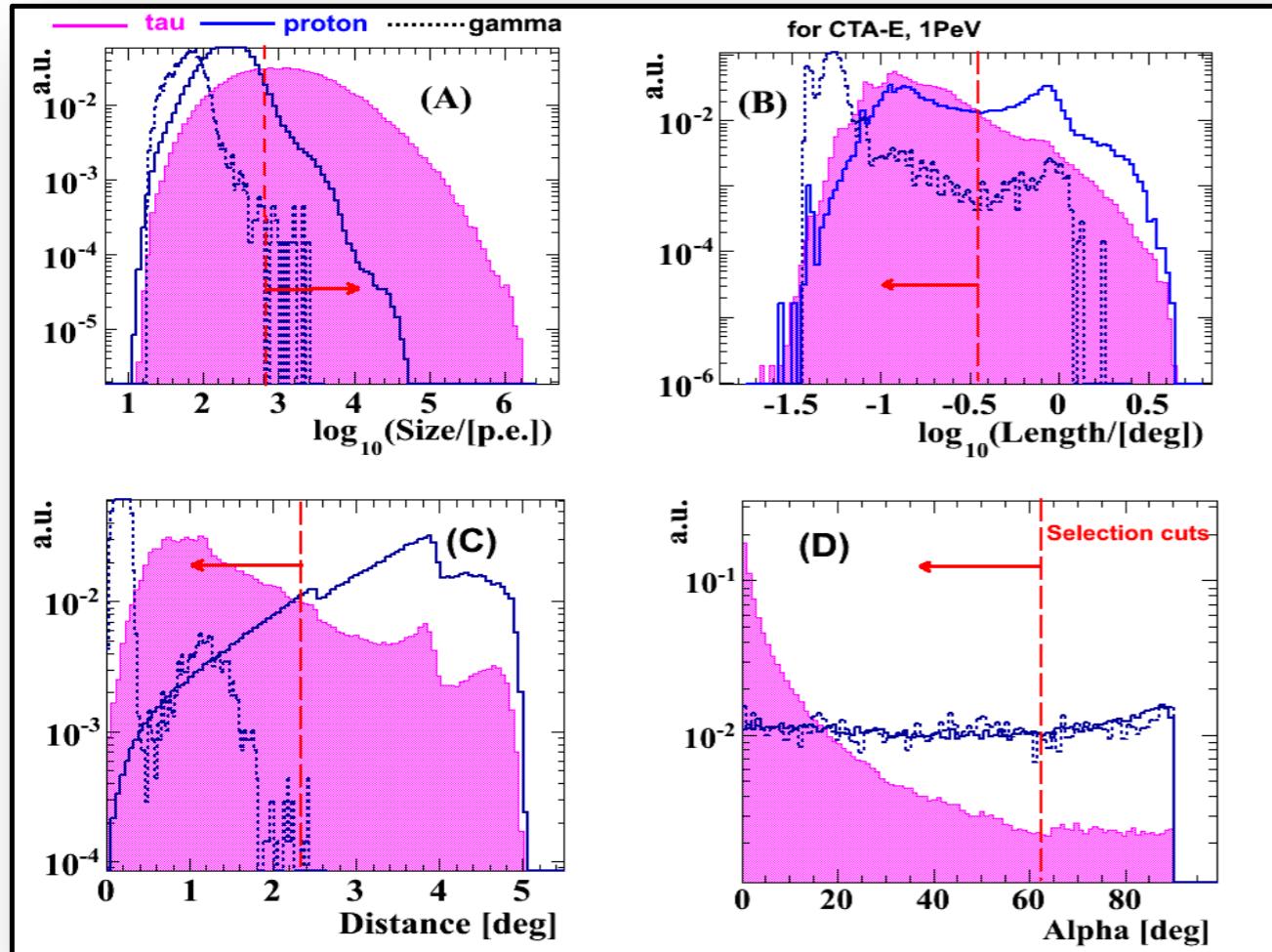
D. Gora, E. Bernardini MAGIC group

- > Use Mountain or Sea as Target material
- > Background: Protons
 - Different signatures (often dominated by muonic shower component)



Physics for CTA: Tau Neutrino Astronomy

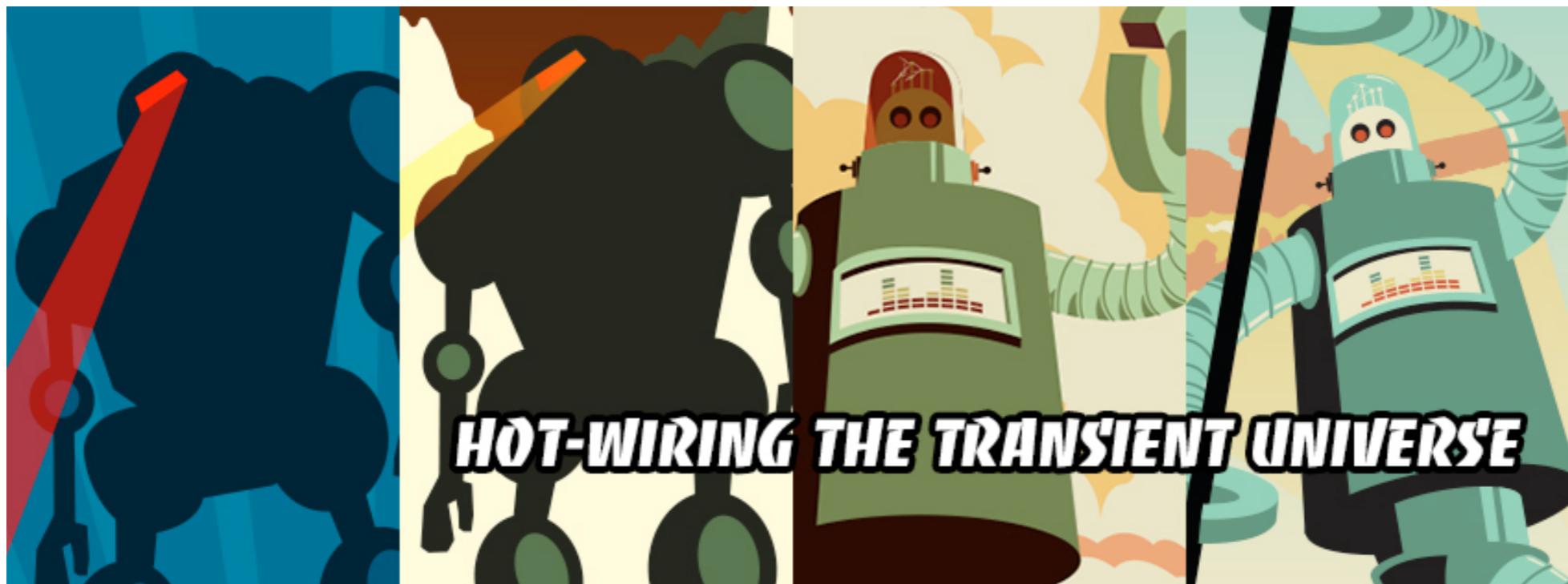
- Separation of Taus is good
- Acceptance depends on site type
 - Might be sufficient for transient outbursts!



DESY Physics Emphasis: Transient Phenomena

all groups

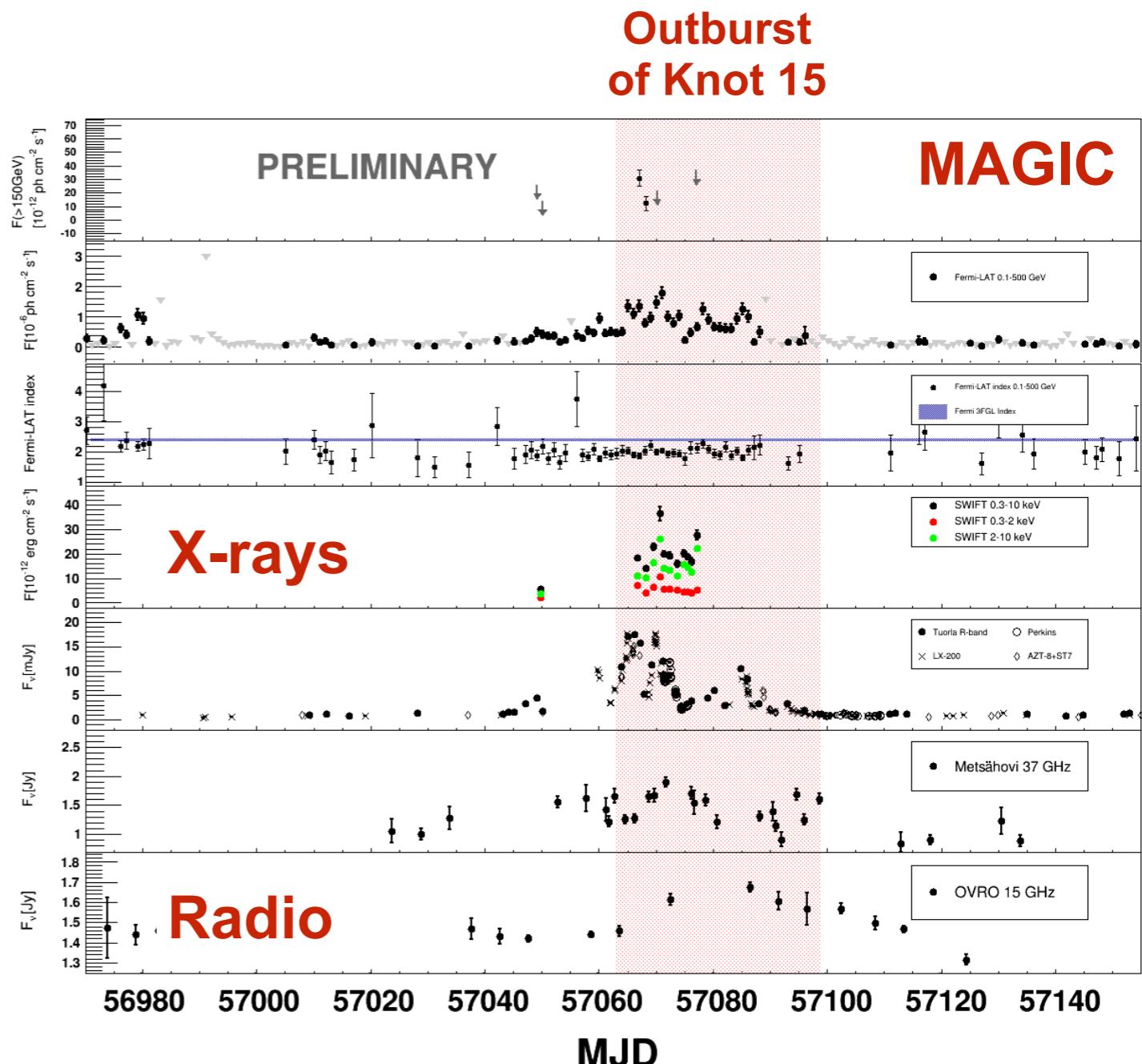
- > Two DESY-internal transients meetings
 - Contributions from CTA, H.E.S.S., VERITAS, MAGIC, IceCube, ZTF/LSST and Fermi groups
 - Exchange of experience and plans
- > New "Interdisciplinary transients group" in H.E.S.S., led by DESY [S. Ohm, H.E.S.S. group](#)
 - Goal: End-to-end optimisation of H.E.S.S. II response to transient phenomena
 - Kick-off Meeting Jan 20-22 in Zeuthen, 19 participants
 - Strong DESY contribution to new alert system



A New VHE Transient with MAGIC: S4 0954+65

G. Pedaletti, MAGIC group

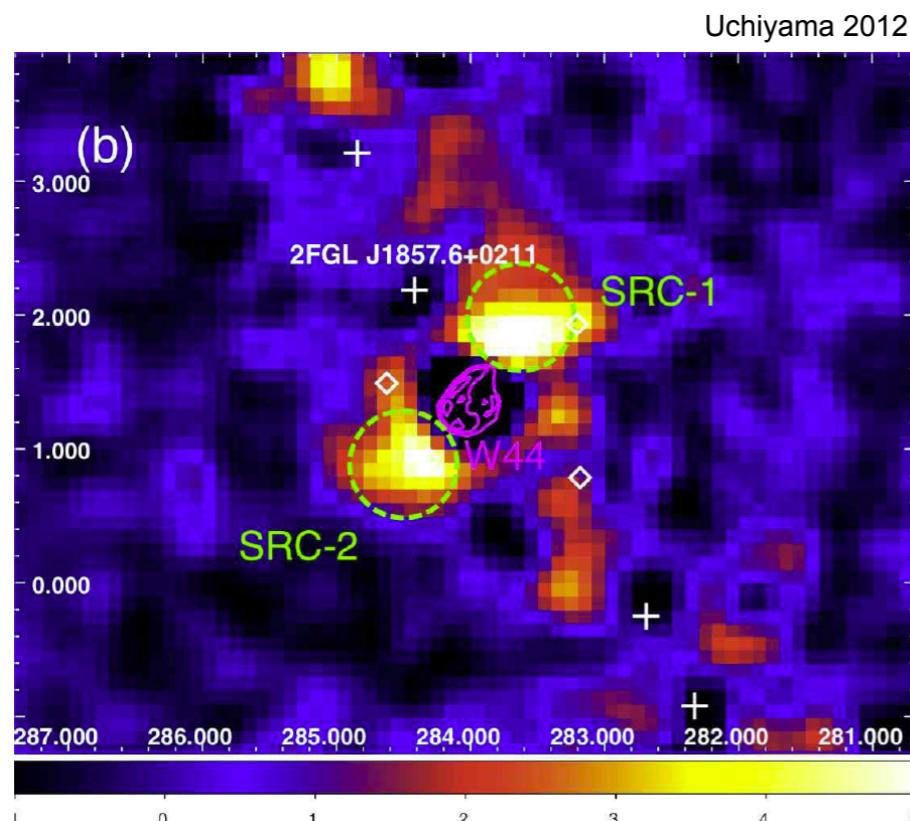
- > TeV detection coincident with a new knot emerging in the jet
 - Change of polarization angle
 - Spiral motion in a helical magnetic field?
- > Delayed peak emission at lower energies (X-ray, radio)
- > MAGIC: The flare factory keeps going
 - ATEL #6999 "MAGIC detects Very High Energy gamma-rays from S5 0716+714"
 - ATEL #7080 "Discovery of Very High Energy Gamma-Ray Emission from the FSRQ S4 0954+65 with the MAGIC telescopes"
 - ATEL #7542 "MAGIC detects an increased activity from PKS 1510-089 at very high energy gamma-rays"



Galactic Physics at DESY: W44 with MAGIC

G. Pedaletti, MAGIC group

- > W44 is a pion-bump convicted hadronic CR accelerator
- > 100h observations of "SRC-1" near SNR W44, a potential molecular cloud calorimeter of W44's output
- > Deep constraints on VHE emission and potential models



(blinded for all
online purposes)

A Pevatron in the Galactic Centre?

- > Nature paper by H.E.S.S. on diffuse emission in Galactic Centre Ridge region
- > Potential trace of a Pevatron accelerator

MailOnline Science & Tech article from April 1st, 2016, featuring a large image of a black hole and a diagram showing particle paths.

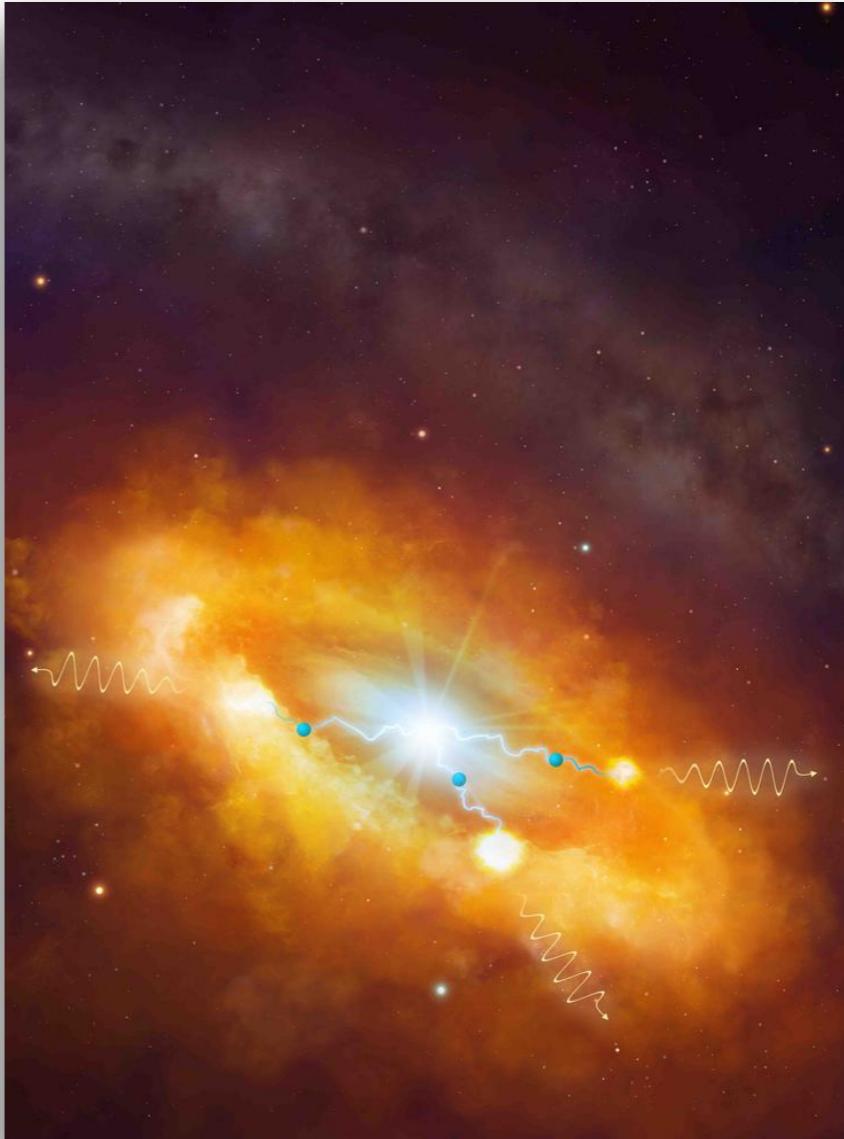
DESY website news article from March 16, 2016, discussing particle localization in the Galactic Center.

Astronomy magazine website article from March 16, 2016, about the source of most powerful cosmic rays.

Spektrum.de website article from March 16, 2016, about a cosmic accelerator in the Galactic Center.

The Sydney Morning Herald Digital Life section article from March 16, 2016, about mystery rays traced to a black hole at the galactic center.

THE TIMES OF INDIA website article from March 16, 2016, about a source of unprecedented energy found in the Milky Way.



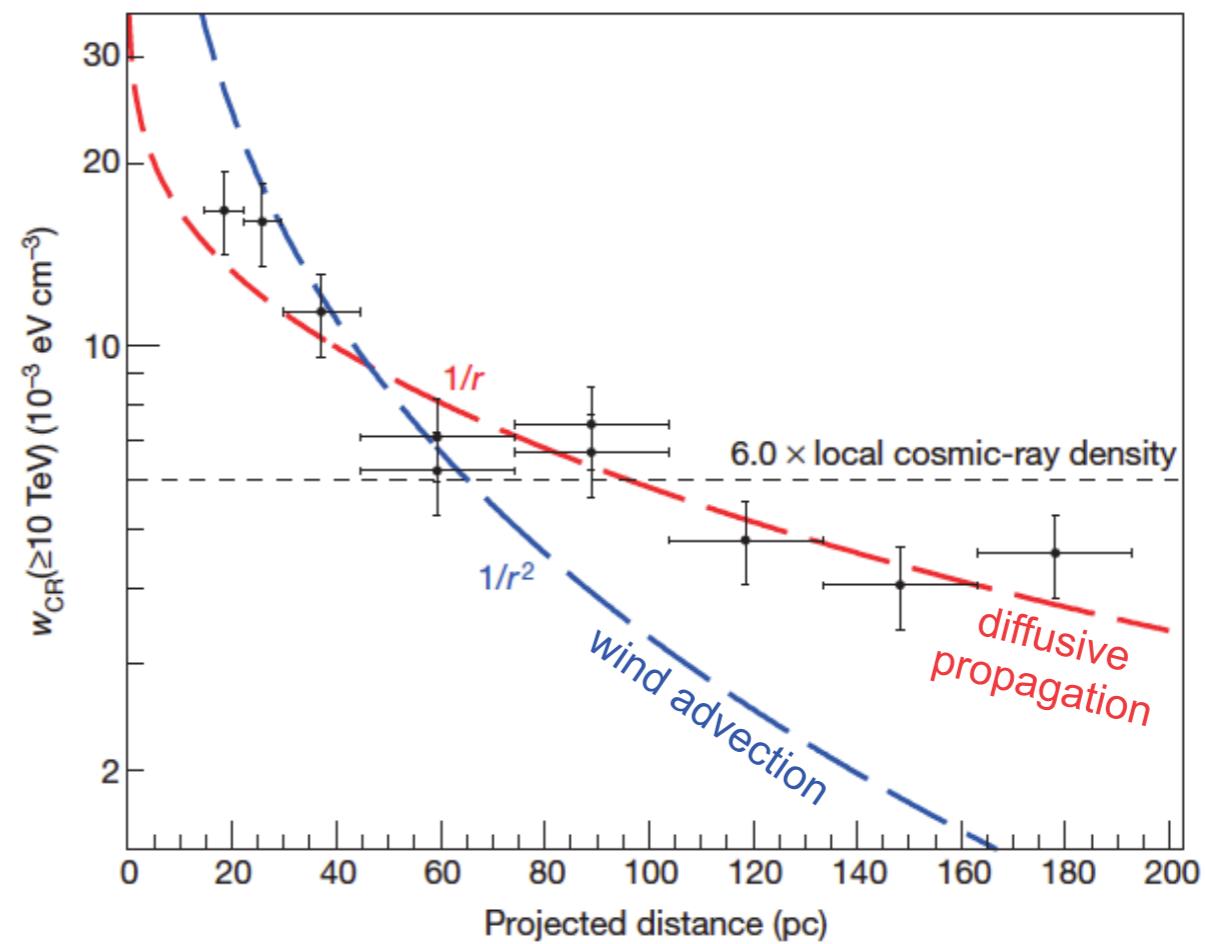
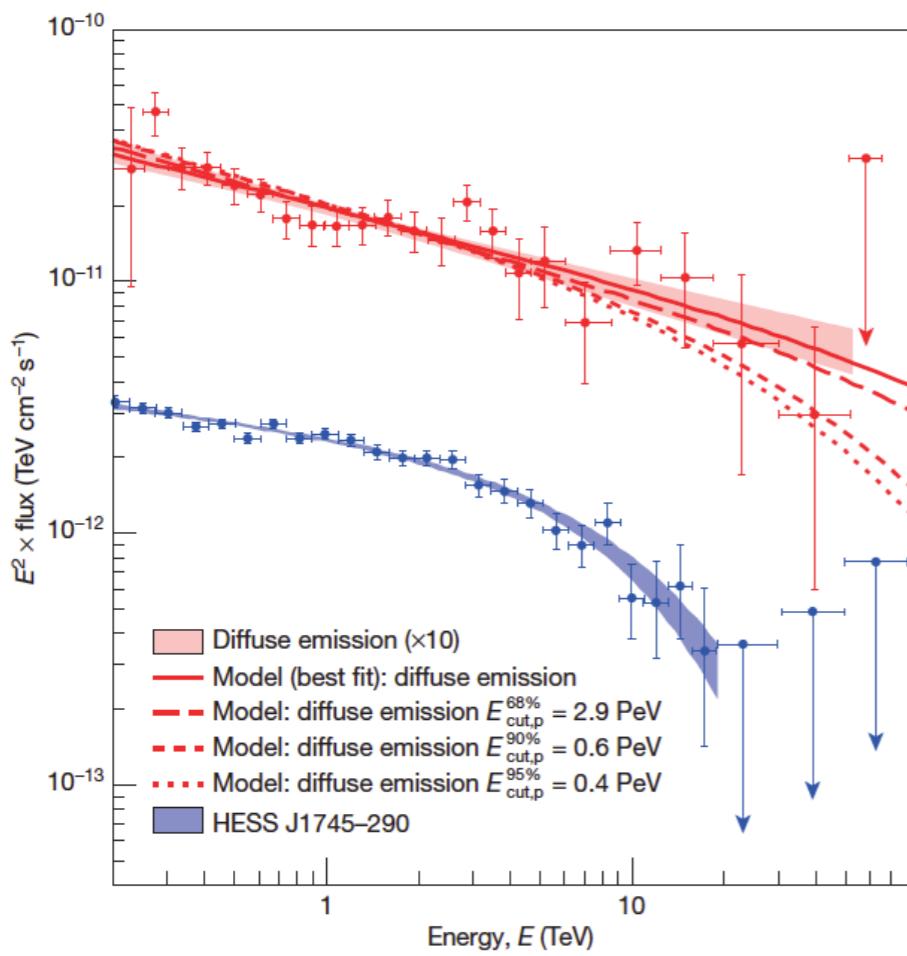
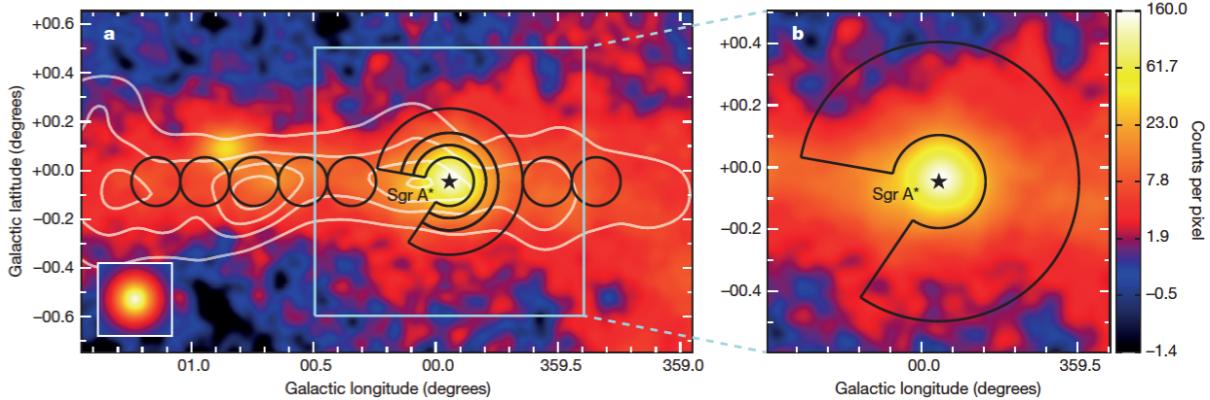
Traced by Morphology and Spectrum

> Cosmic ray density profile

- Calculated using matter densities from molecular line surveys

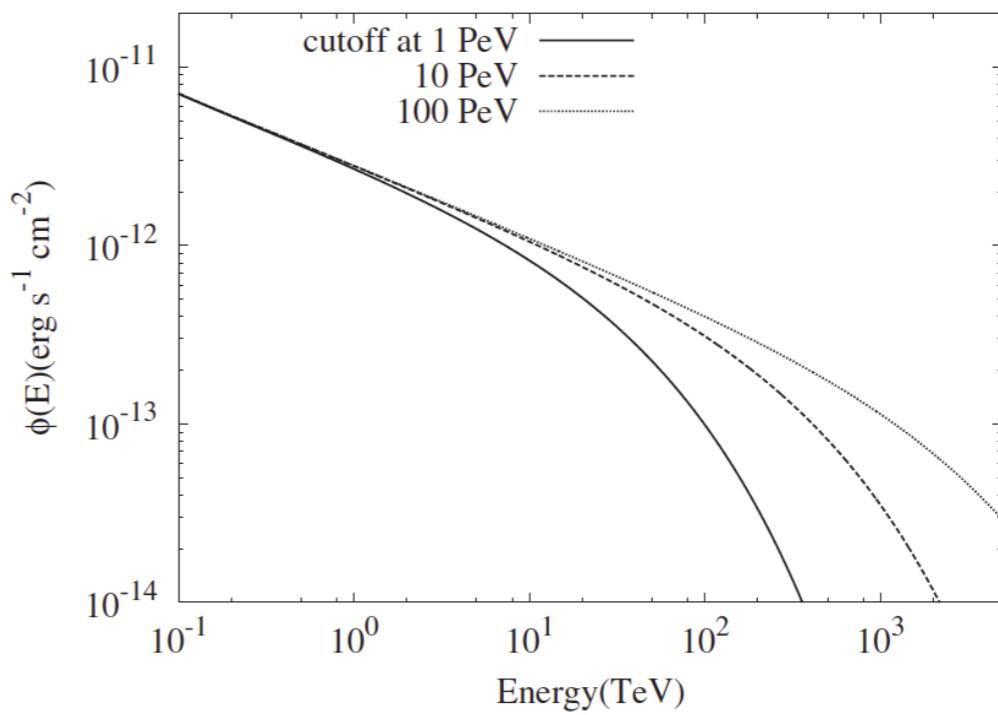
> Very hard emission w/o cutoff

- Unusual for such an extended emission



The Pevatron Scenario

- > There is a Pevatron in the Galactic Centre
- > Constant injection over at least 1000 years
- > Current luminosity of GC source does not suffice
 - But the source may be variable
- > On speculative grounds, the Pevatron might even be a relevant contributor to the total galactic cosmic rays
- > Neutrinos to be expected from the diffuse CRs
 - Might be detectable by IceCube after several years of observation



Summary

- > Major hardware and software activities dominate the lives of many gamma-ray DESYaners now
- > Physics prospects for CTA are being mapped out and look brilliant
- > CTA HQ and data centre application might substantially upgrade the Zeuthen campus
- > A transients physics emphasis is being built up at DESY
- > Physics results mostly come out of long-term observations or programs now