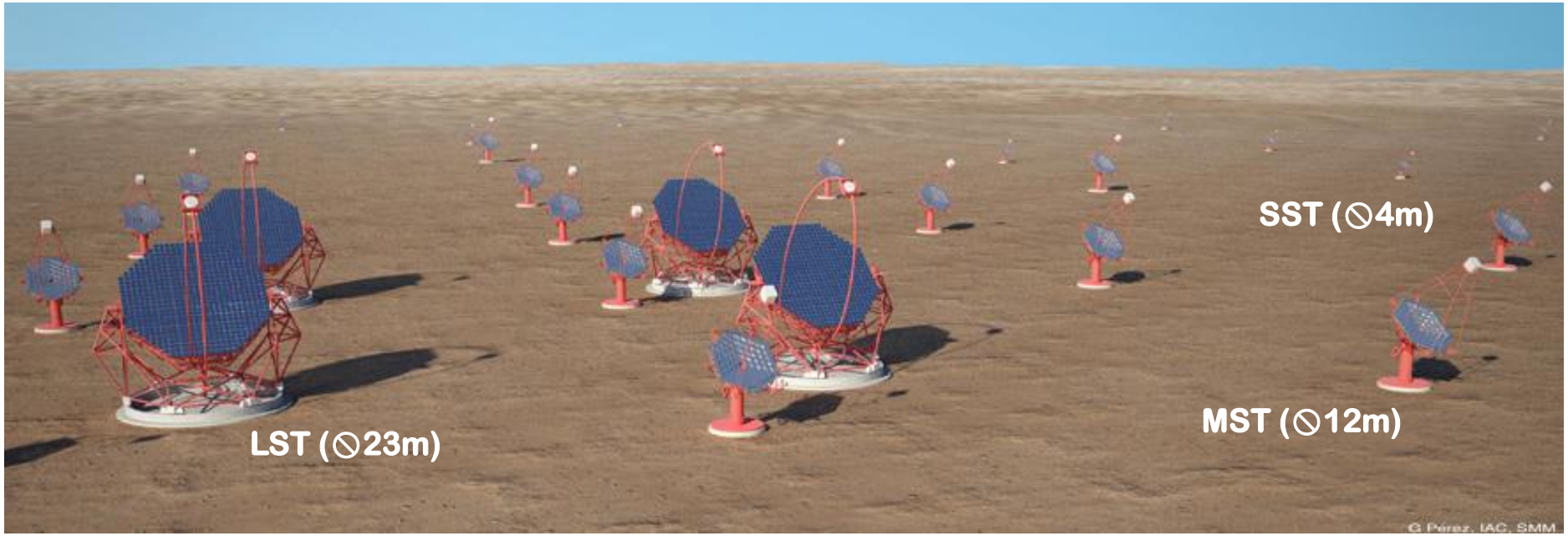
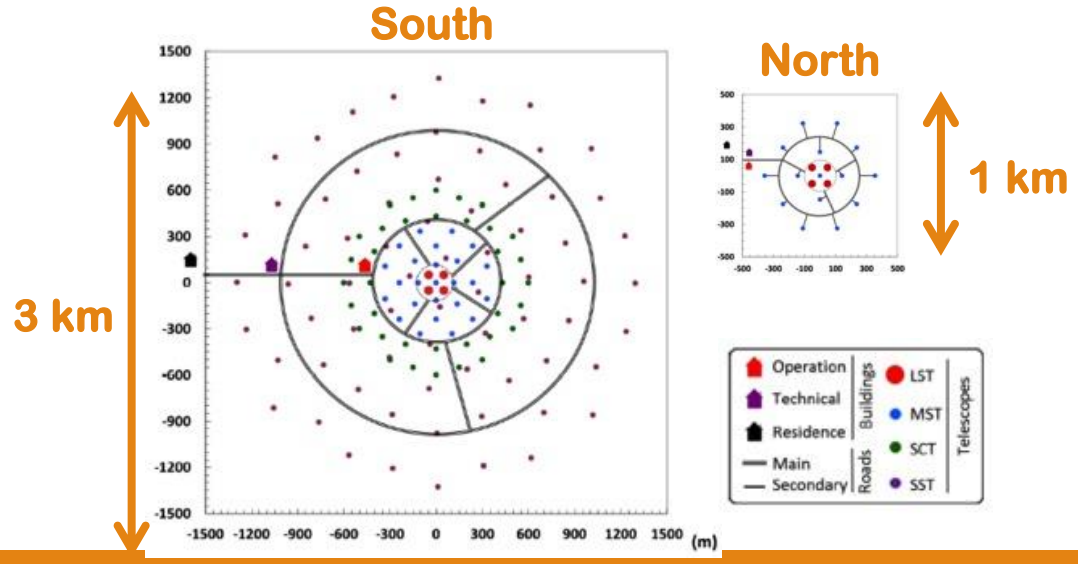
Cherenkov Telescope Array

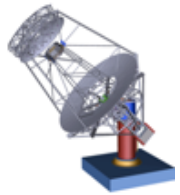
A SENSITIVE PROBE OF EXTREME UNIVERSE

The CTA Observatory





SCT (⦸10m)



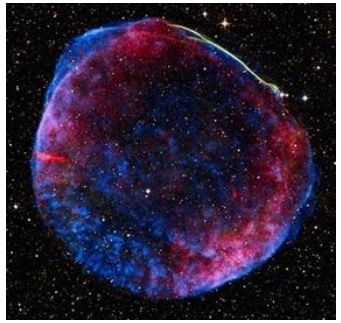
Characteristics

2 sites (north & south)
3 telescope size classes
118 telescopes in total
South U.S. extension with 24 SCT telescopes

CTA Key Science

Cosmic Particle Acceleration

How and where are particles accelerated?
How do they propagate?
What is their impact on the environment?

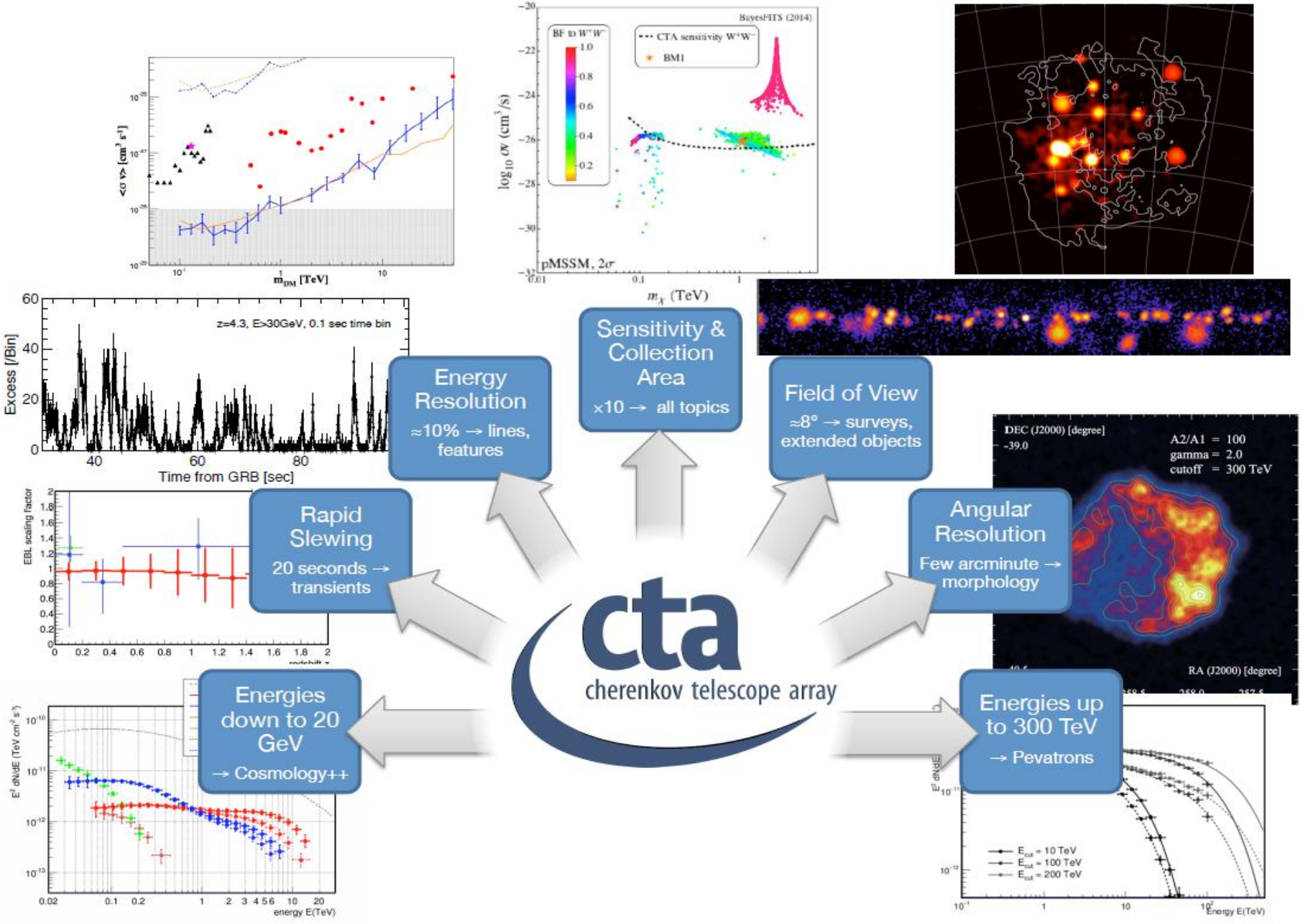


Probing Extreme Environments

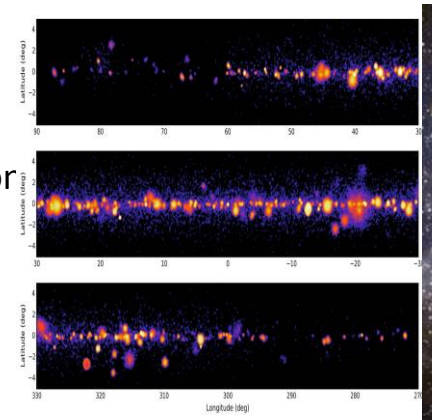
Processes close to neutron stars and black holes?
Processes in relativistic jets, winds and explosions?
Exploring cosmic voids

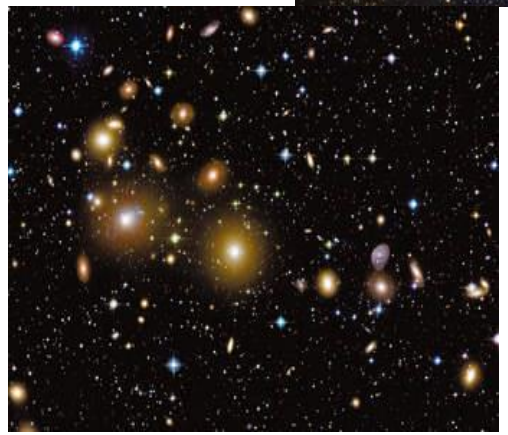
Physics frontiers – beyond the Standard Model

What is the nature of Dark Matter? How is it distributed?
Is the speed of light a constant for high-energy photons?
Do axion-like particles exist?


Energy Resolution
≈10% → lines, features
Sensitivity & Collection Area
×10 → all topics
Field of View
≈8° → surveys, extended objects
Rapid Slewing
20 seconds → transients
Angular Resolution
Few arcminute → morphology
Energies down to 20 GeV
→ Cosmology++
Energies up to 300 TeV
→ Pevatrons
cta
cherenkov telescope array
z=4.3, E>30GeV, 0.1 sec time bin
Excess [/Bin]
Time from GRB [sec]
EBL scaling factor
energy E(TeV)
DEC (J2000) [degree]
RA (J2000) [degree]
A2/A1 = 100
gamma = 2.0
cutoff = 300 TeV
pMSSM, 2σ
CTA sensitivity W+W−
BM1
BayesFITS (2014)

CTA Science Programme





Key Science Programmes (executed by consortium)

Ensure that important science questions for CTA are addressed in a coherent fashion with a well-defined strategy

Conceived to provide legacy data sets for the entire community

Surveys: galactic center, galactic plane, extragalactic and LMC

Transients

Cosmic Ray PeVatrons

Starforming systems

Active Galactic Nuclei

Galaxy Clusters

Proposal-driven User Programme

Deep investigation of known sources

Follow-up of KSP discovered sources

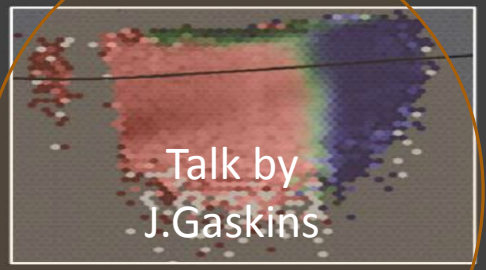
Multi-wavelength campaigns

Follow-up of ToOs from other wavebands or messengers

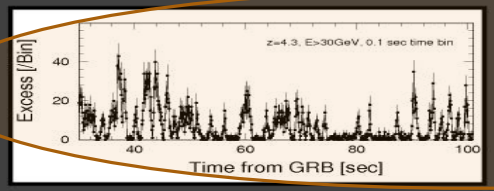
Search for new sources

…

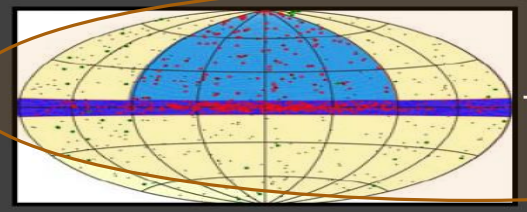
CTA KEY SCIENCE



Dark Matter Programme



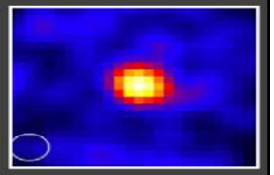
Transients



ExGal Survey

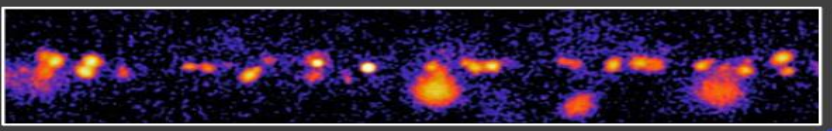
Extragalactic

Galaxy Clusters



Star Forming Systems

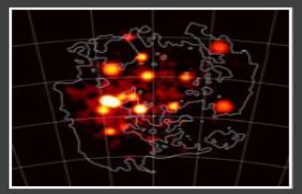
AGN



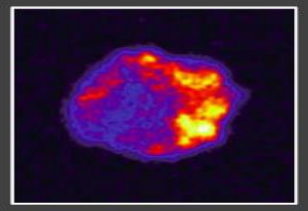
Galactic Plane Survey

Galactic

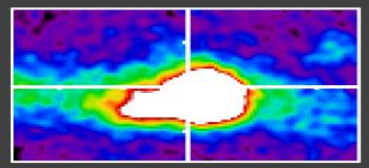
LMC Survey



PeVatrons



Galactic Centre



cta
cherenkov telescope array

Extragalactic Survey

Blind survey of 25% (10,000 deg2) of the extragalactic sky

- uniform exposure at ~6 mCrab

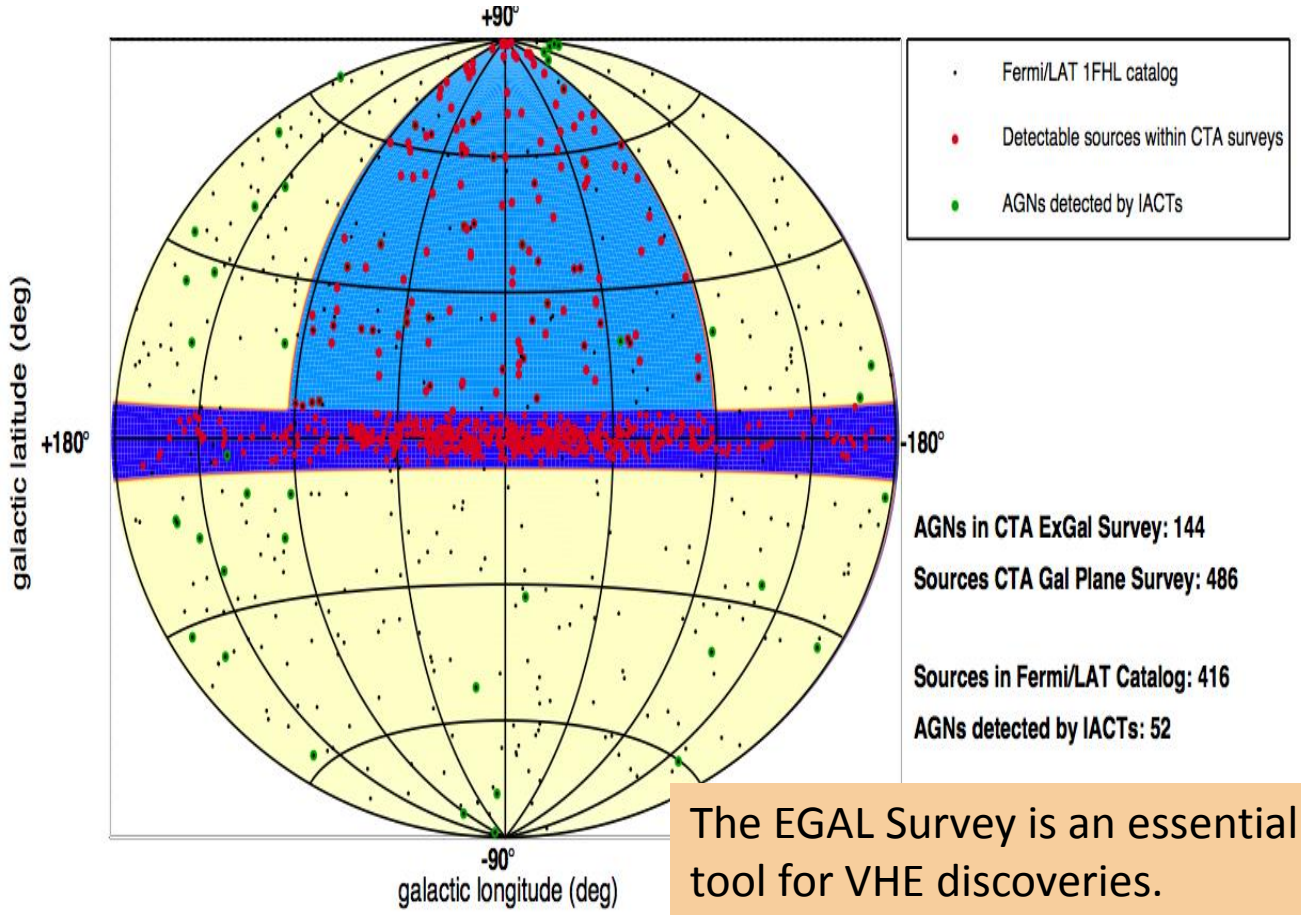
- observe each FoV with several pointings, spread over two years

-> average over source activity states

- first unbiased view of the egal. VHE sky with unique sensitivity between 100 GeV and 10 TeV

-> measurement of the luminosity function for nearby VHE blazars

-> estimate of diffuse γ-ray background

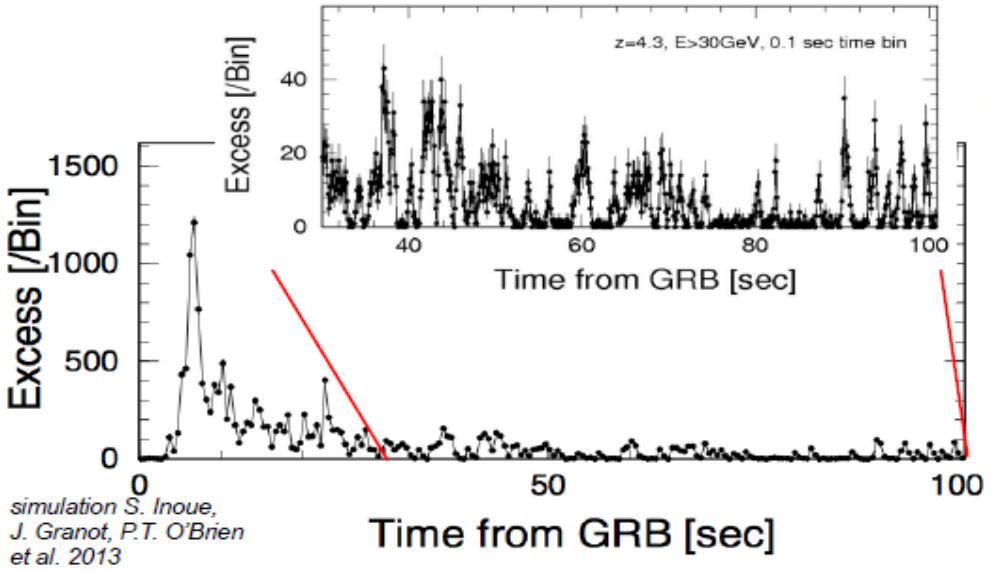


The EGAL Survey is an essential tool for VHE discoveries.

Transients

External Triggers

- Gamma-ray bursts
- Galactic Transients
  High Energy Neutrino transients
- GW transients
  Optical and radio transients
- Serendipitous VHE transients



Far superior photon statistics compared to Fermi-LAT above few GeV

Active Galactic Nuclei

Key Science Program will address:

-AGN physics at Very High Energies

-gamma-ray cosmology

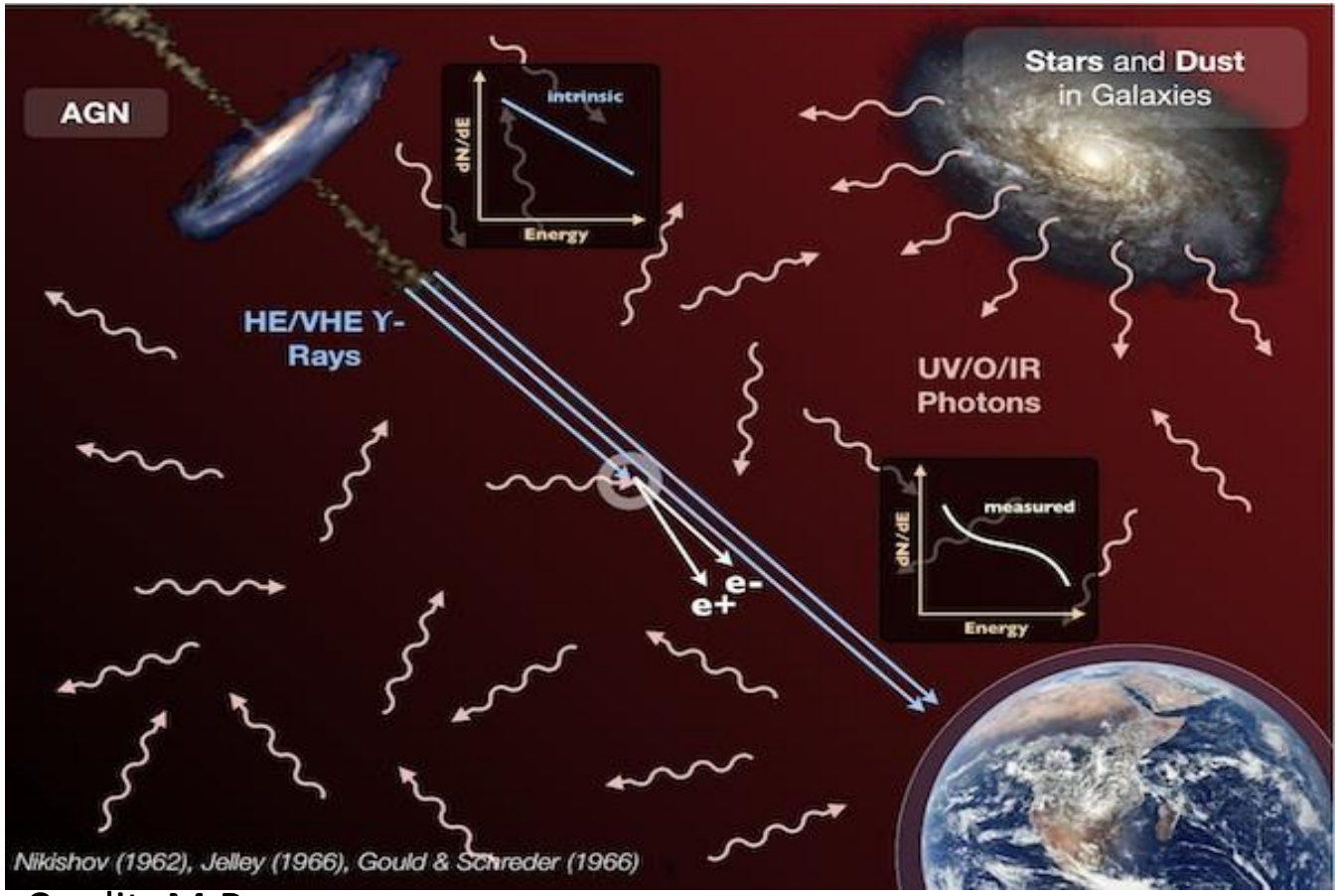
-ultra high energy cosmic rays and fundamental physics

Observational strategies:

1. long-term monitoring

2. high-quality spectra

3. AGN flare programme



Credit: M.Raue

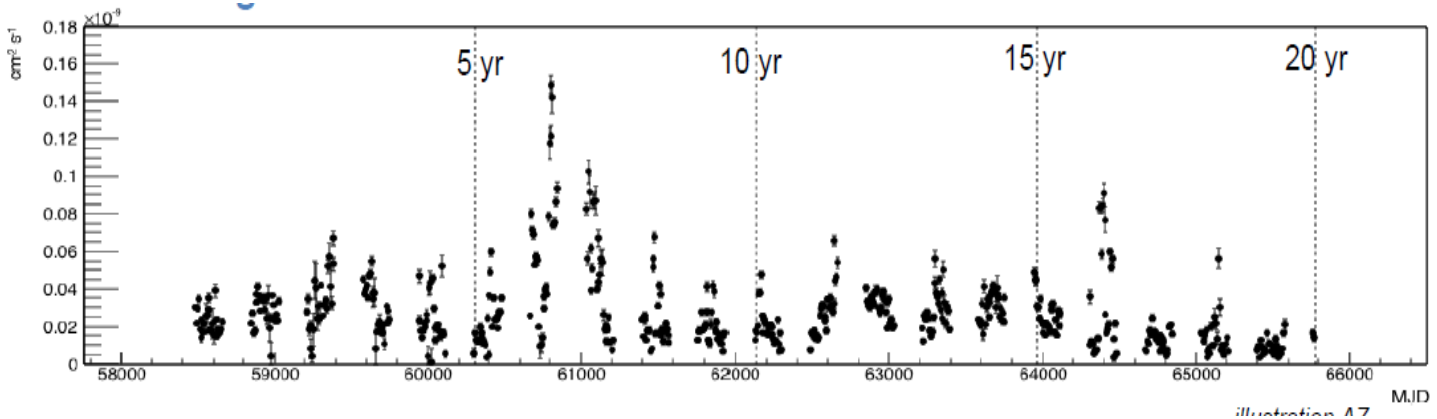
Active Galactic Nuclei

Variability from longest timescales:

-Duty Cycle

-(quasi) periodicities

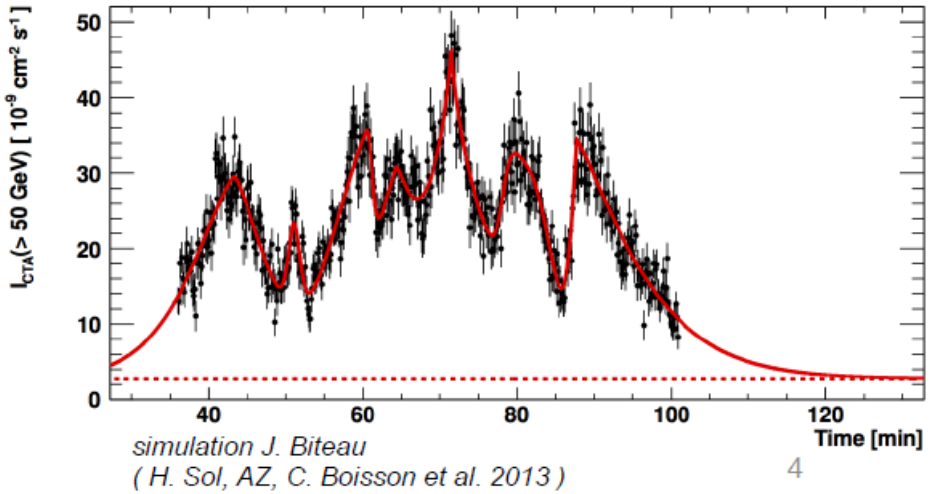
-breaks in the power spectra



to shortest:

-size (location, nature) of the emission region

-acceleration and cooling mechanisms



Active Galactic Nuclei

High quality spectra:

-signatures of leptonic/hadronic emission

-signatures of gamma-rays interacting with (intrinsic and external) photon fields

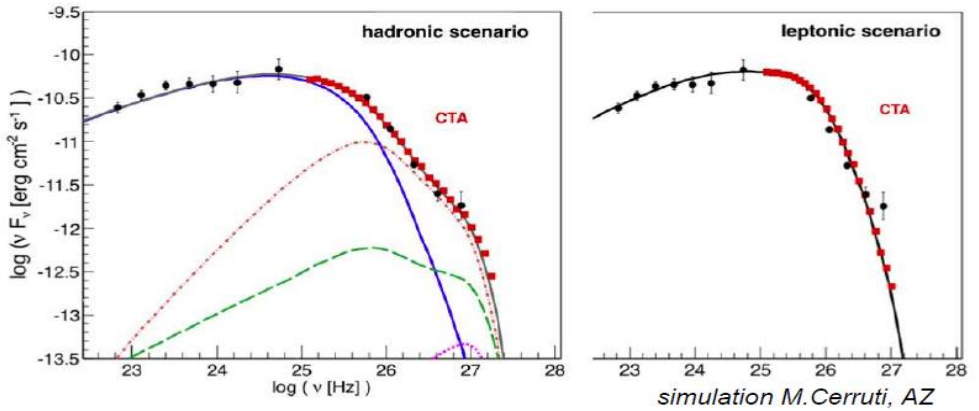
Strategy:

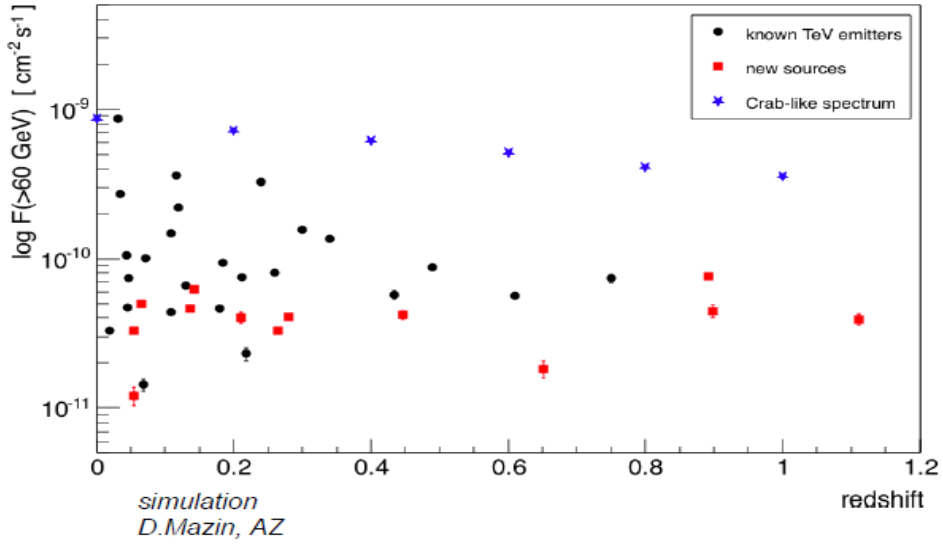
~ 40 AGN of different classes at 0.02 < z < 1.11 (*small subset of "detectable" Fermi sources - others covered by GO*)

-> uniform set of high-quality spectra

deep observations of two radio-galaxies: M87 , Cen A

-> spectra, extended emission ?





Active Galactic Nuclei

Extragalactic Background Light:

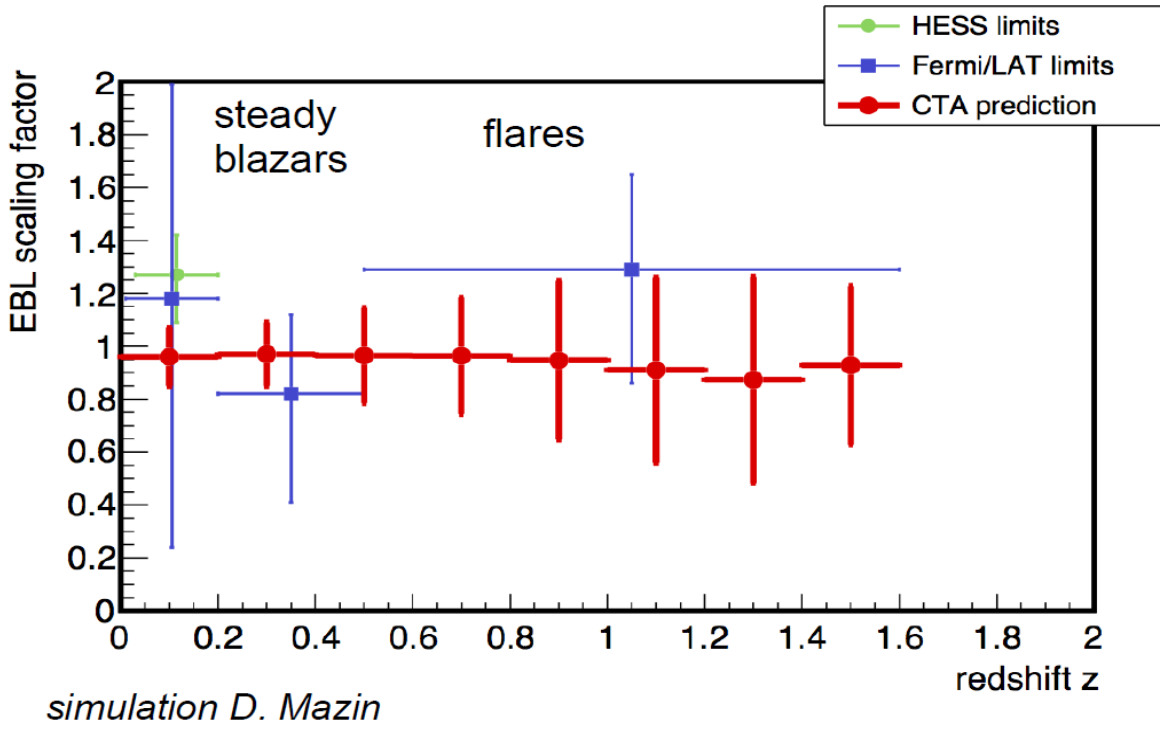
-measurement of EBL at z=0 with precision of 20%

-characterize the evolution up to z=1

Strategy:

-Steady blazars at low z

-At high z, **AGN flare programme**



simulation D. Mazin

Synergies

Many Key Science Programs have important synergies with other facilities:

- Alerts and triggers to/from CTA for variable objects

  Including gravitational waves and optical transient factories

- For GRBs - CTA requires (MeV) triggers

  Swift, Fermi GBM ->SVOM, ? …

- Triggers from CTA to a broad astronomical community

  Rate expected to be low – but identified events likely to be

  extremely important: GW sub-threshold, redshift measurement, …

Summary

- CTA will be a major research infrastructure for high-energy astronomy for the next decades, but will reach well beyond the traditional high energy community

- CTA Key science programs combine guaranteed scientific return with large discovery potential

- CTA will generate several legacy datasets for the use of wider astrophysics/astroparticle physics community