CTA: the next generation Cherenkov Telescope Array. Prospect for SMBHs studies.

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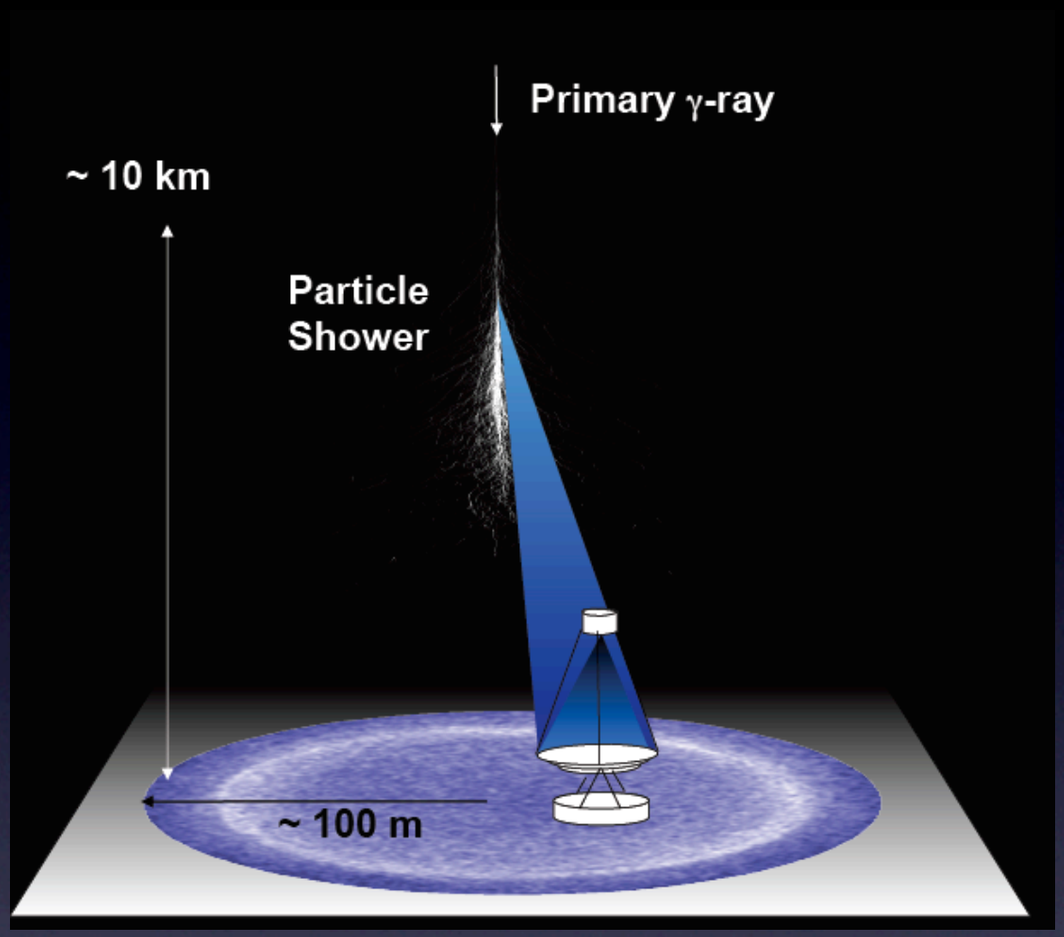
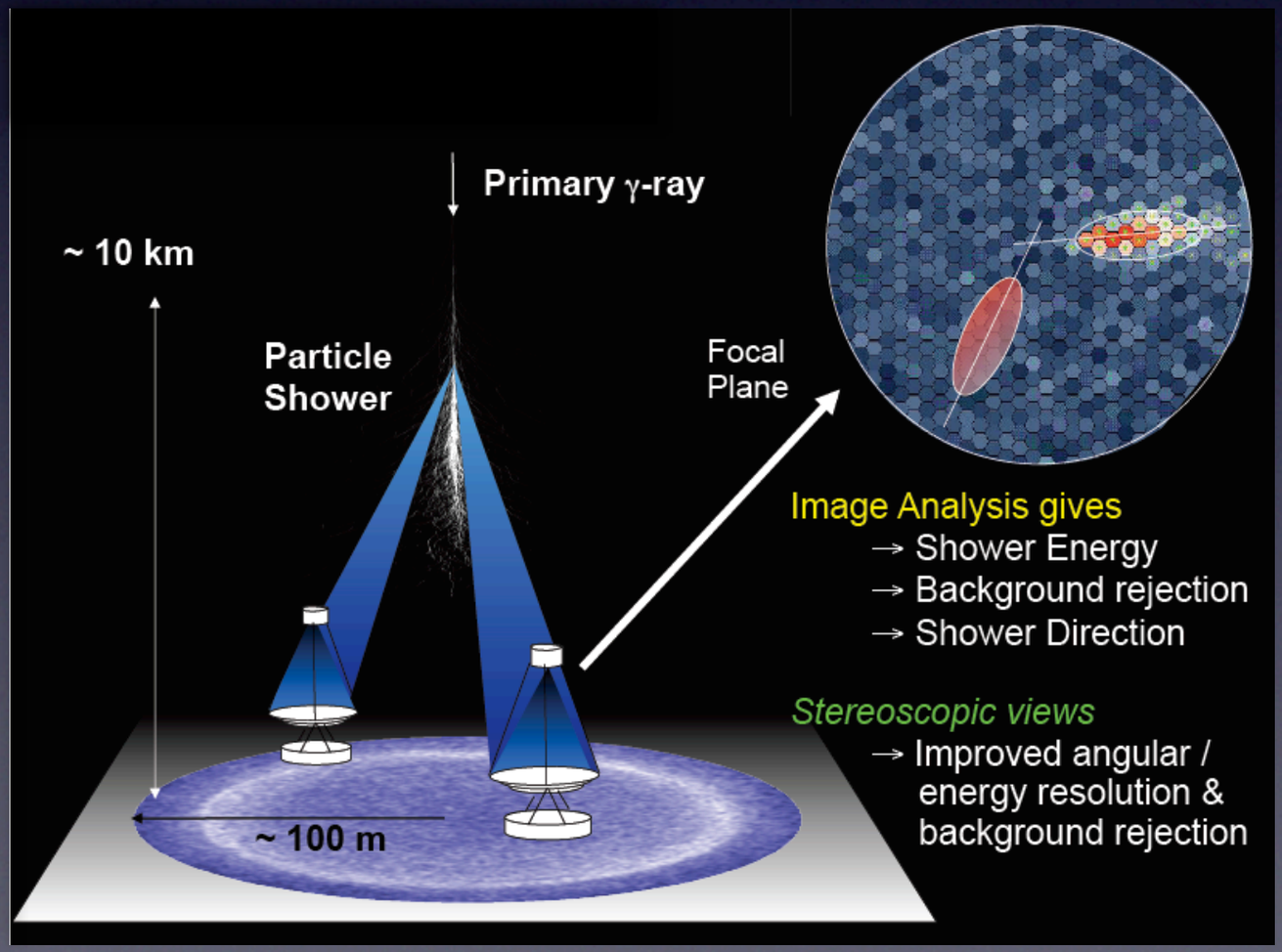
Cherenkov telescopes

cta
cherenkov telescope array



Adapted from J. Hinton, Texas 2010



The current arrays

Instrument	Lat (°)	Long (°)	Alt (m)	Telescopes #	Area (m^2)	Total (m^2)	Pixels	FoV FoV (°)	Thresh (TeV)	Sensi-tivity (% Crab)
H.E.S.S.	-23	16	1800	4	107	428	960	5	0.1	0.7
VERITAS	32	-111	1275	4	106	424	499	3.5	0.1	0.7
MAGIC I†+II	29	18	2225	2	234	468	576/1039	3.5	0.03	1.0
CANGAROO-III	-31	137	160	3	57.3	172	427	4	0.4	15
Whipple†	32	-111	2300	1	75	75	379	2.3	0.3	15
HEGRA	29	18	2200	5	8.5	43	271	4.3	0.5	5
CAT†	42	2	1650	1	17.8	17.8	600	4.8	0.25	15

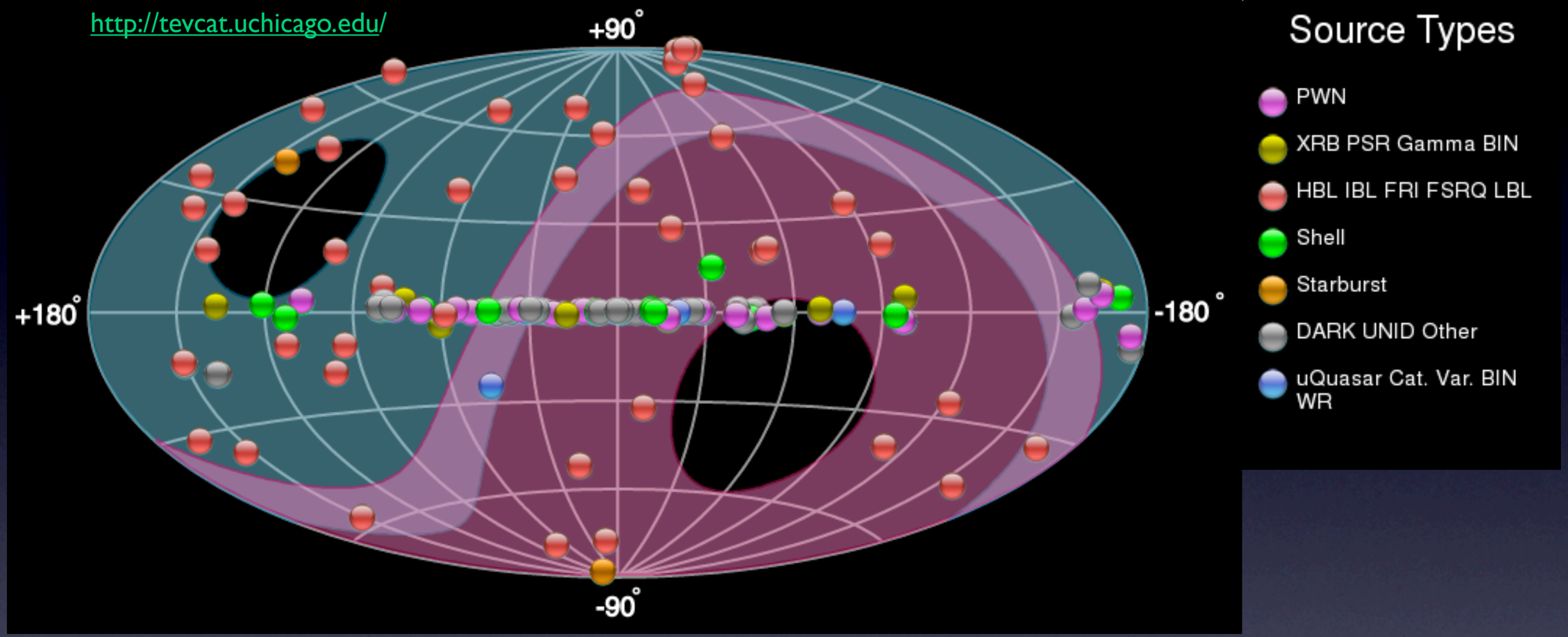
†: These instruments have pixels of two different sizes.

Hoffman & Martinez, ArXiv:1008.3703

Properties of selected air-Cherenkov instruments, including two of historical interest (HEGRA and CAT).

The current sky

http://tevcat.uchicago.edu/



About 140 sources detected so far, 46 AGNs:

29 HBLs, 4 IBLs, 4 LBLs, 3 FSRQs, 4 RGs, 2 SBGs

(A sample of) TeV AGN successes

Fast variability of tera-electron volt γ rays from the radio galaxy M87 - Science 314,1424 (2006)

Radio imaging of the very-high-energy γ-ray emission region in the central engine of a radio galaxy - Science 325, 444 (2009)

Detection of γ rays from a starburst galaxy - Science 326, 1080 (2009)

A connection between star formation activity and cosmic rays in the starburst galaxy M82 - Nature 462, 770 (2009)

A low level of extragalactic background light as revealed by γ rays from blazars - Nature 440, 1018 (2006)

Very-high-energy gamma rays from a distant quasar: how transparent is the Universe? - Science 320, 1752 (2008)

Limits on an Energy Dependence of the Speed of Light from a Flare of the Active Galaxy PKS 2155-304 - PRL 101, 170402 (2008)

CTA: the array

Low-energy section:
few O(24) m tel. (LST)
=> push low threshold
- Parabolic reflector
- FOV: O(5) degrees
- O(0.09 deg/pix)
- f/d: O(1.2)

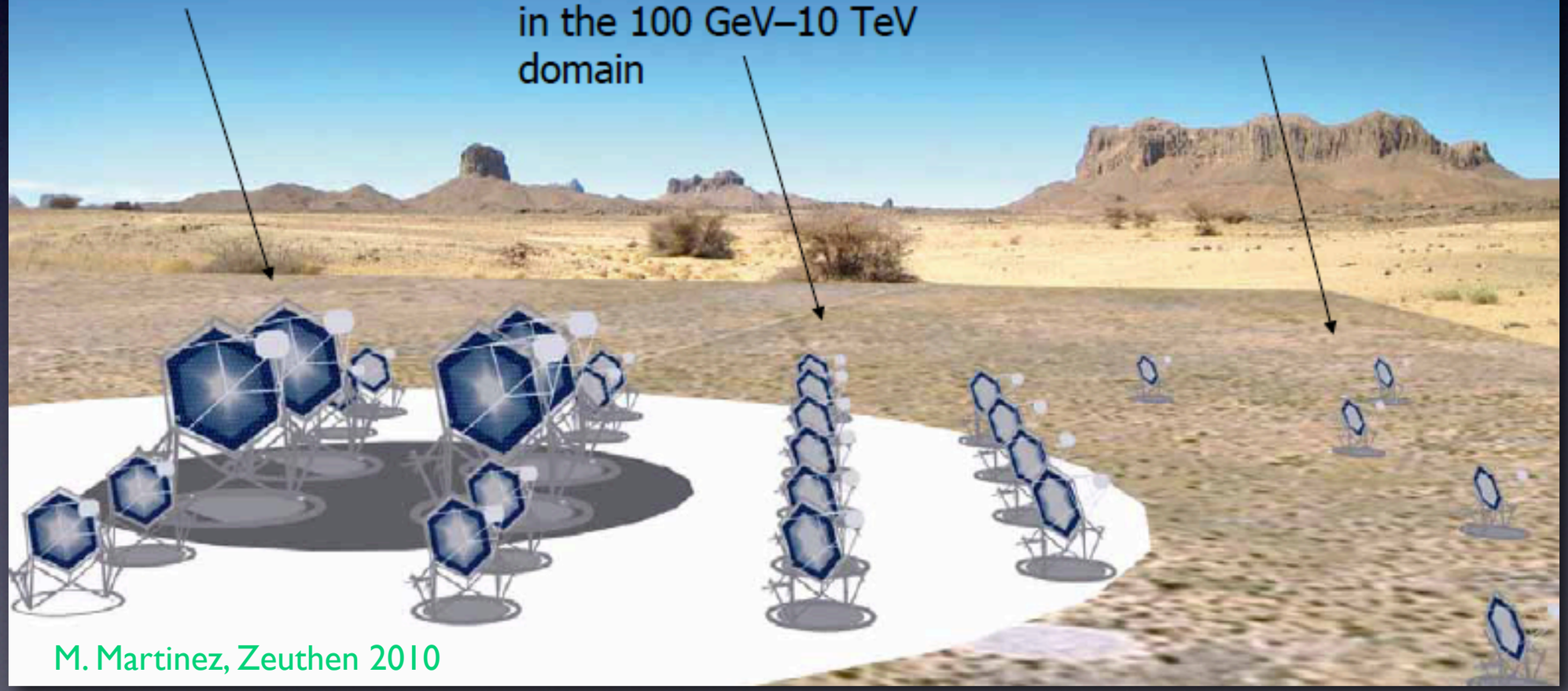
energy threshold
of some 10 GeV

Core-energy array:
many O(12) m tel. (MST)
=> workhorse of CTA
-> push cost & reliability
- Davies-Cotton reflector
- FOV: O(8) degrees
- O(0.18 deg/pix)
- f/d: O(1.4)

O(1 km^2) area
mCrab sensitivity
in the 100 GeV–10 TeV
domain

High-energy section:
many O(6) m tel. (SST)
=> push low-cost
- Davies-Cotton reflector
(or Schwarzschild-Couder)
- FOV: O(10) degrees
- O(0.25 deg/pix)
- f/d: O(1.2-1.5)

O(10 km^2) area at
multi-TeV energies



M. Martinez, Zeuthen 2010

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CTA: a few numbers

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A factor of 10 more sensitive than current IACT.

Substantially better angular & energy resolution, larger field of view and much wider energy coverage.

A ~150 MEuro International effort involving >700 Scientists in > 100 Institutes in 25 Countries.

Planning: 50-100 Telescope; design 2008-2011; prototyping 2011-2013; construction 2014-2018.

EU funded a 5.2 MEuro Preparatory Phase (Oct. 2010 - Oct. 2013).

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CTA: sensitivity and goals

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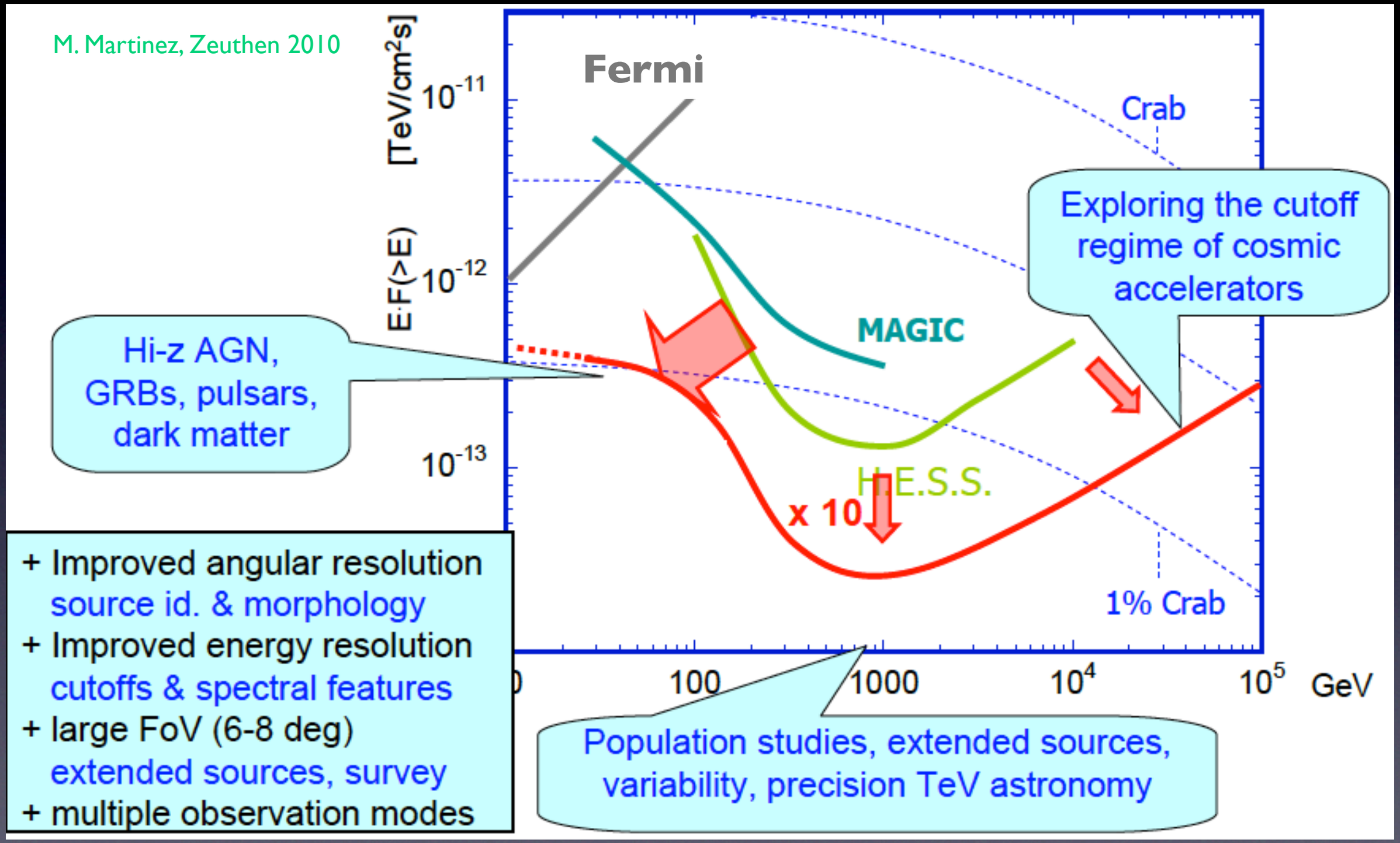
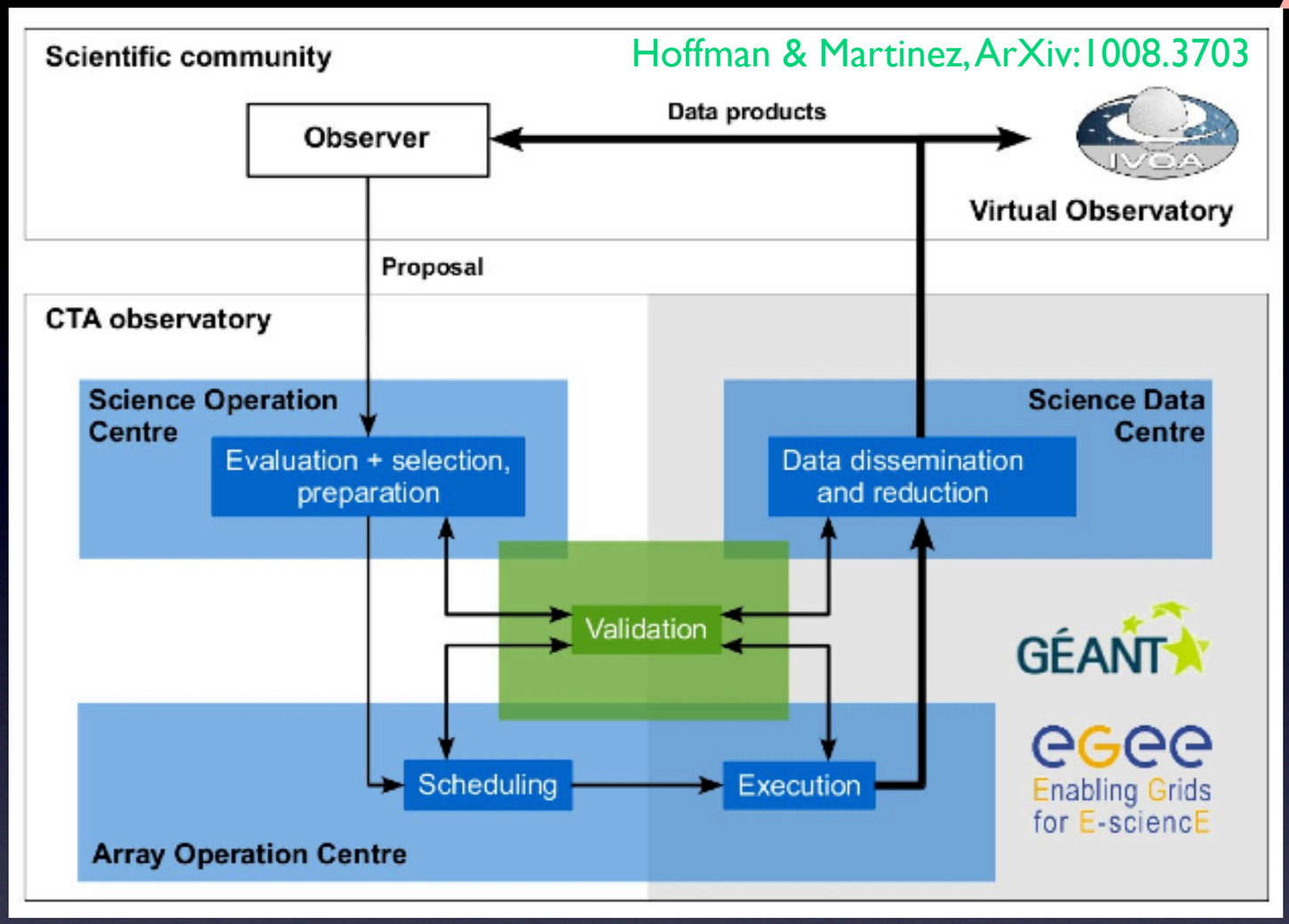


+ Improved angular resolution
  source id. & morphology
+ Improved energy resolution
  cutoffs & spectral features
+ large FoV (6-8 deg)
  extended sources, survey
+ multiple observation modes

CTA as an Observatory



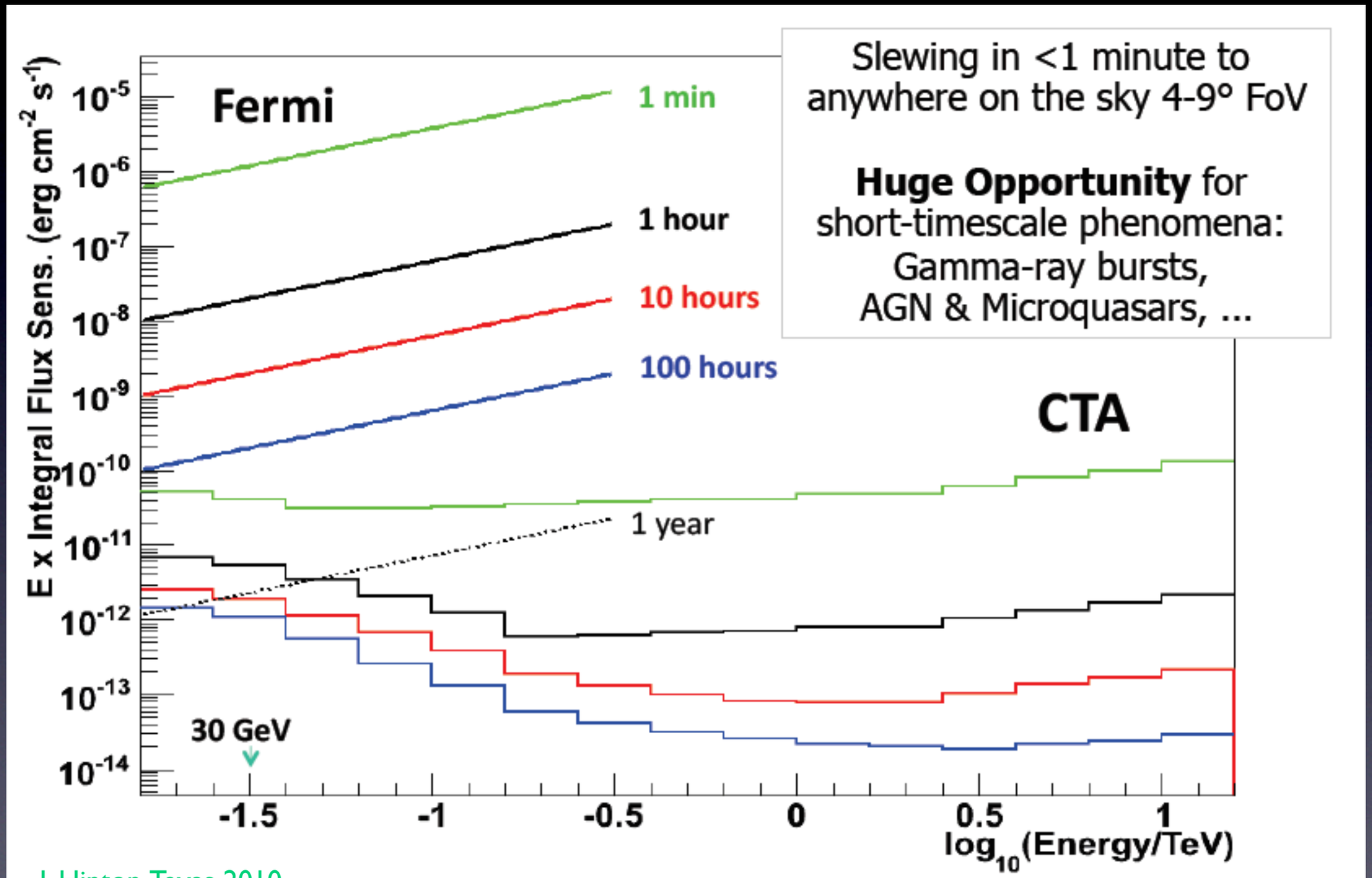
Operated as an "open" Observatory

Peer-reviewed process on submitted proposal.

Observations performed by Consortium experts.

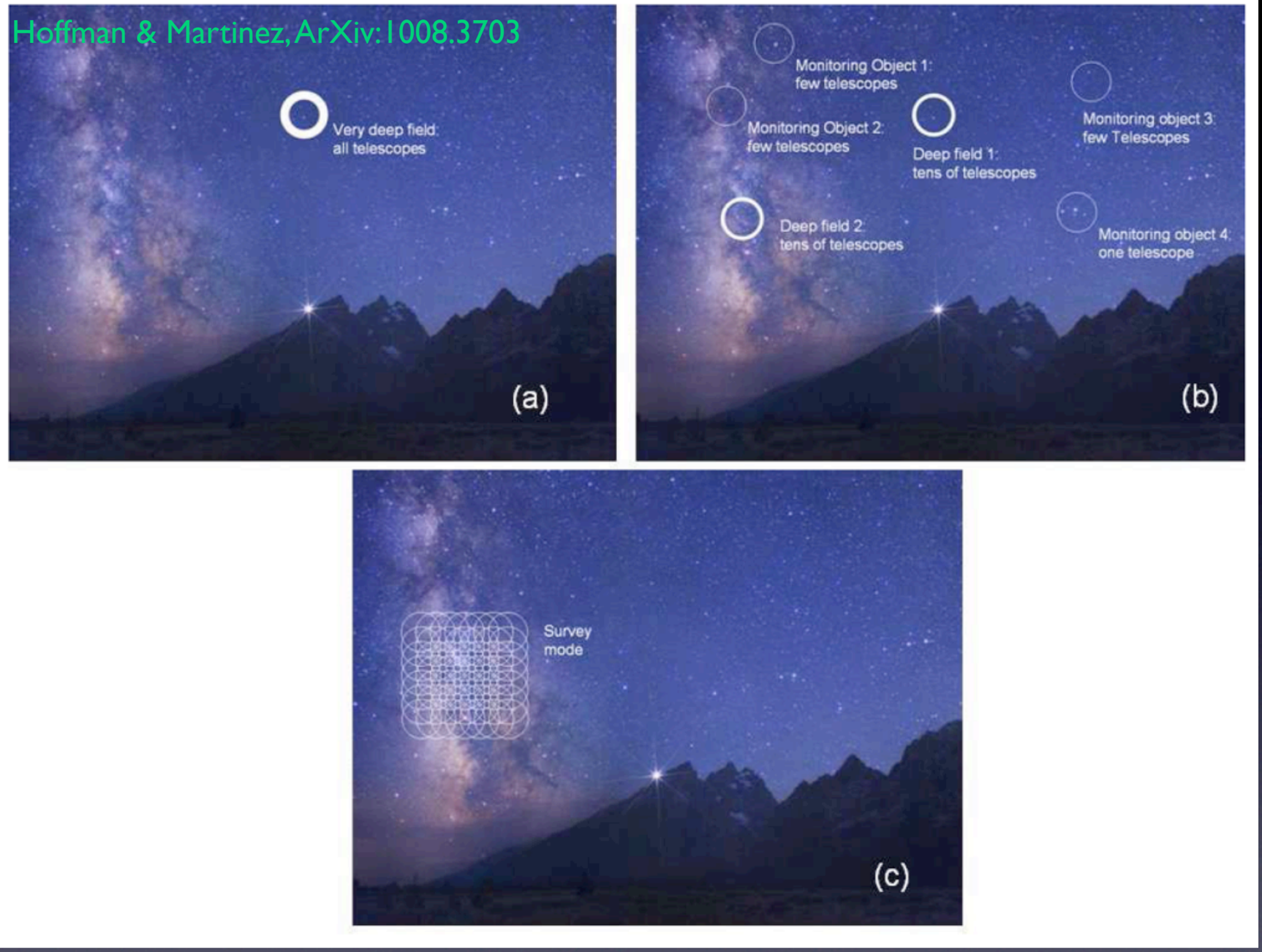
Foreseen "legacy" data (Galactic Plane, full-sky survey, ...).

CTA: variability studies



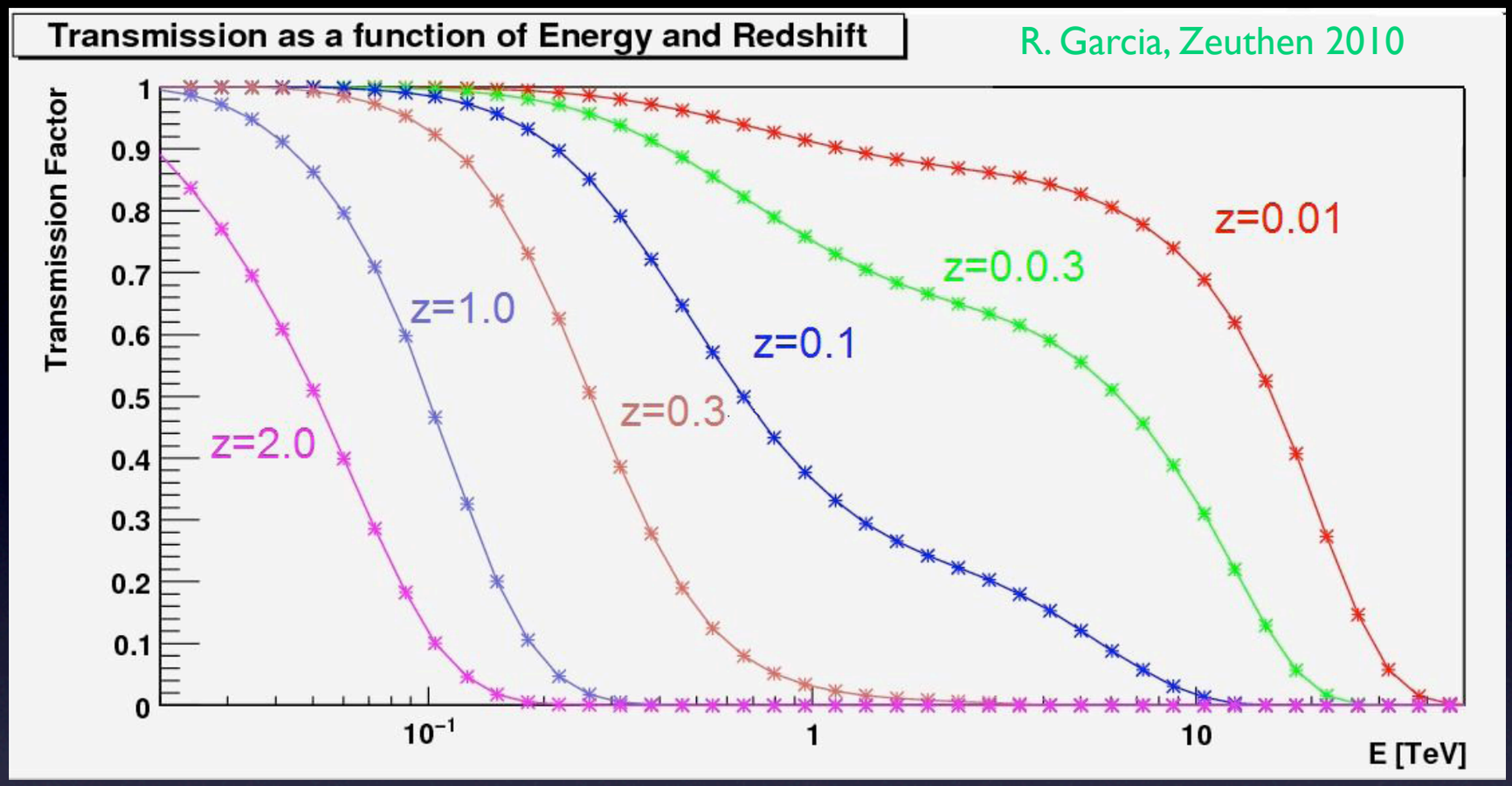
J. Hinton, Texas 2010

AGNs: survey



Different observing modes, from deep pointings to survey scans.

AGNs and energy ranges



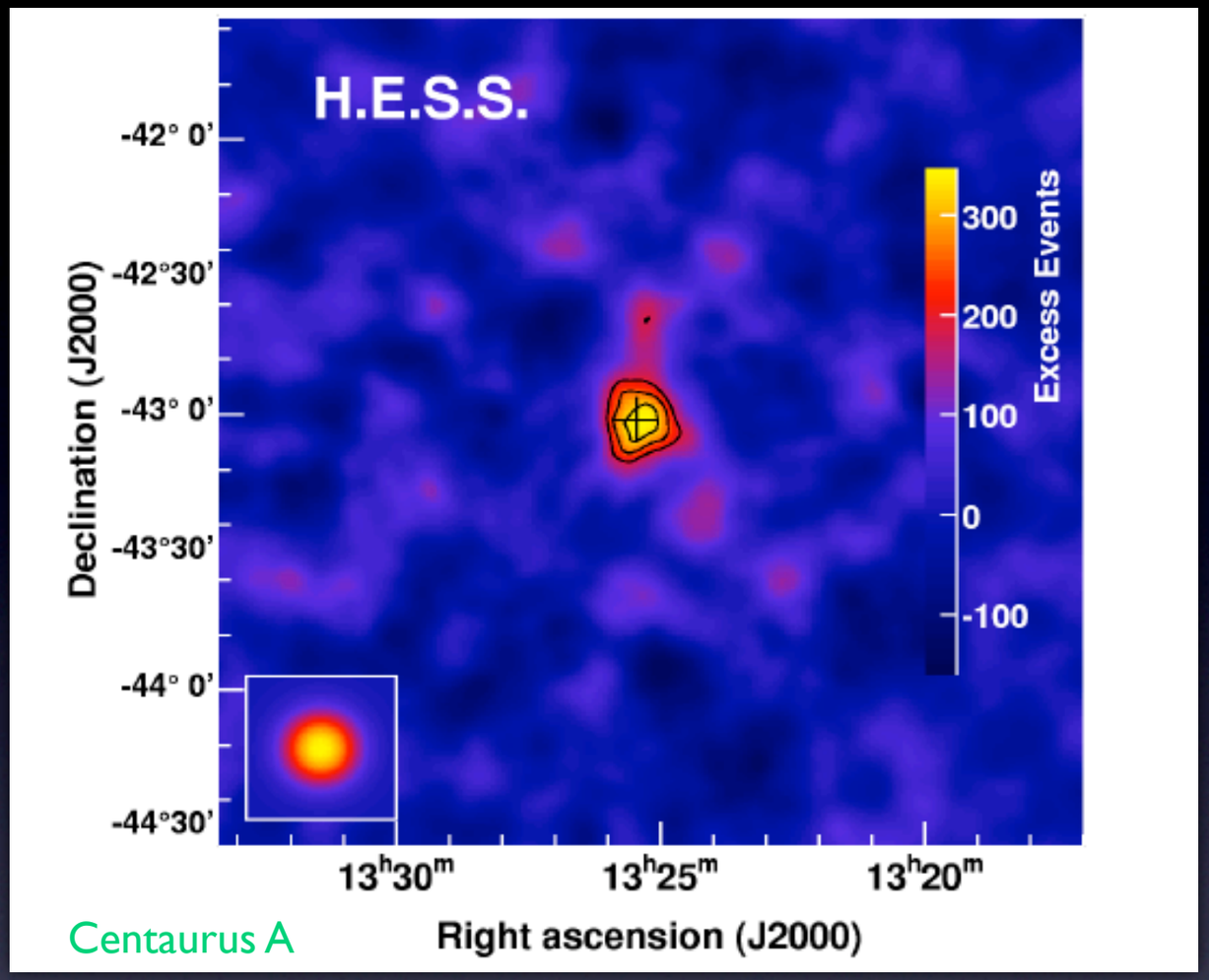
Low energies: exploitation of the unabsorbed portion of the spectrum.

Intermediate energies: accurate reconstruction of the spectral features.

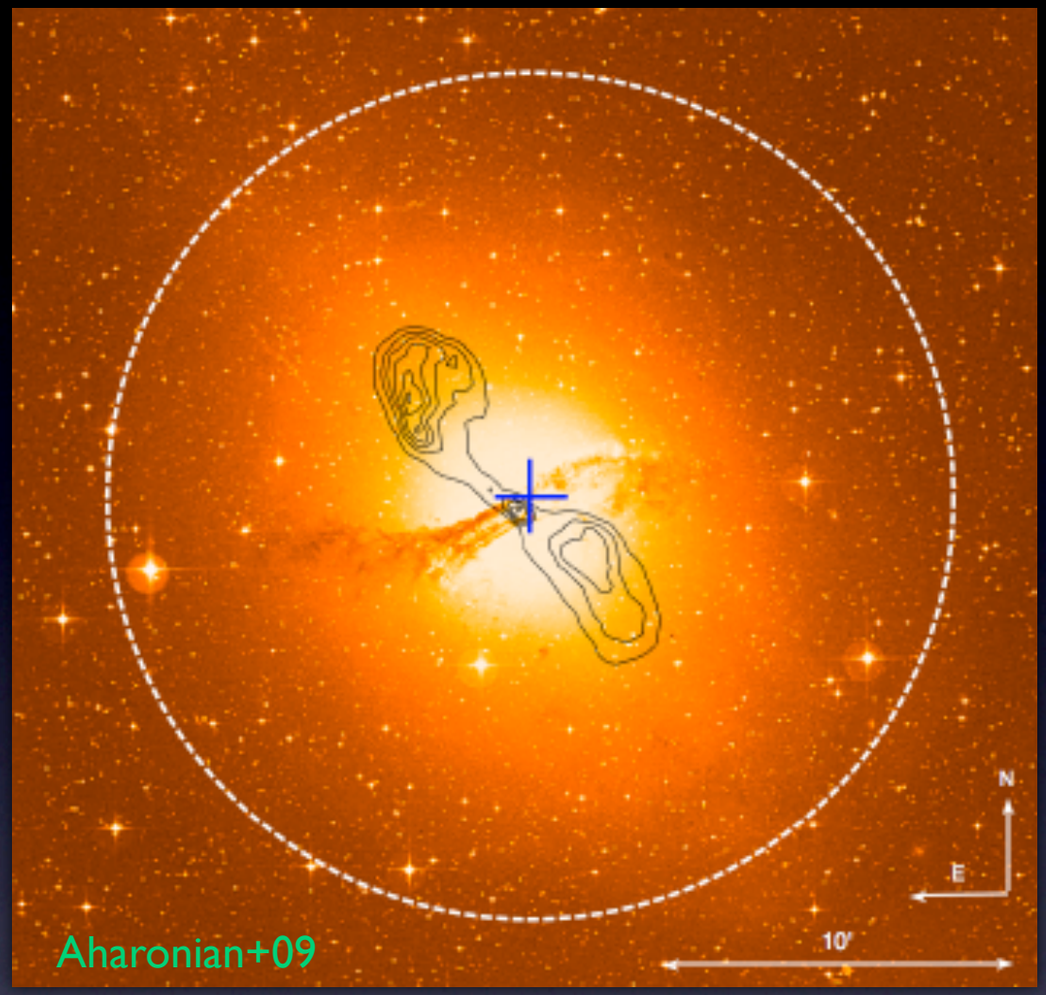
High energies: detection of the highest energy from an extragalactic source.

Capability of detecting objects up to z~2 → VHE blazar cosmology !

Nearby AGNs



Centaurus A



Aharonian+09

Given the proximity of the sources and the larger jet angle to the line of sight compared to BL Lac objects, the outer and inner kpc jet structures will be spatially resolved by CTA.

This will allow precise location of the main emission site and searches for VHE radiation from large-scale jets and hot spots

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AGN science

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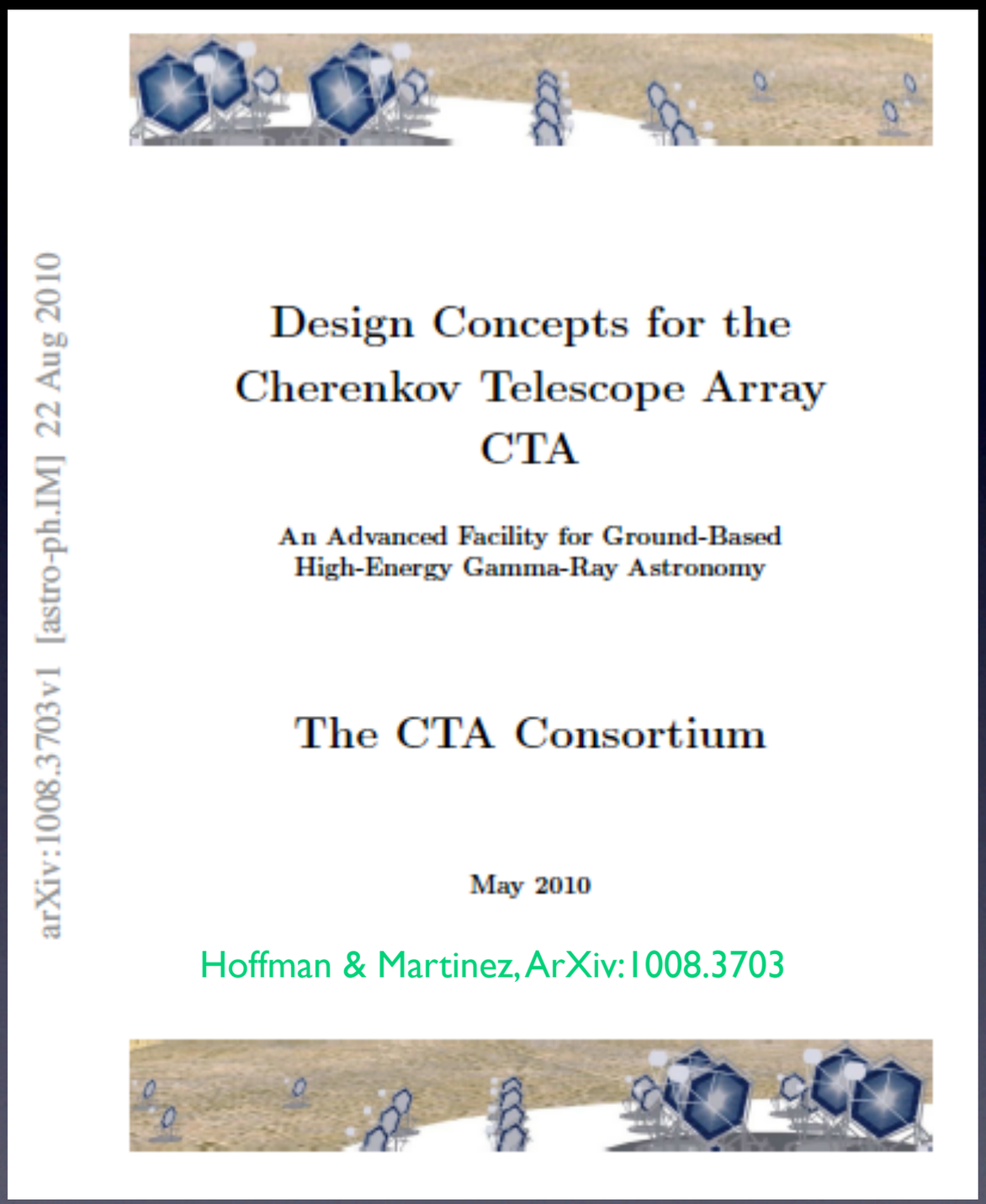
The extremely wide energy range (few tens of GeV to >100 TeV) and the accurate energy resolution will allow to perfectly extend the *Fermi*/LAT spectra of a large number of blazars, investigating possible spectral features (e.g., cut-off, radiation mechanisms, ...).

The improved timing and collecting area will allow variability studies on the time-scale of seconds rather than minutes for the brightest blazars, allowing to study the inner region of the nucleus.

The improved sensitivity will allow the study of the VHE extragalactic diffuse background, and to compare the results with the forthcoming *Fermi* studies.

For many of the sources, the SED will be determined at GeV energies, which are much less affected by the absorption and, thus, more suitable for the study of the intrinsic properties of the objects. CTA will provide robust predictions about the intrinsic spectrum above 10-100 GeV.

CTA info



Hoffman & Martinez, ArXiv:1008.3703

WEB Page:

http://www.cta-observatory.org/

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