Potential of the contribution of CTA to the study of starbursts.

C. Delgado

Motivation for high energy observation of star formation regions with CTA

- Cosmic rays!!!
  - Important star-formation regulators since they penetrate deep into molecular cloud cores.
    - **Affect astrochemistry via ionization**
    - **Mediate in ISM and B-field interaction**
    - **Linked to SN explosion:**
      - **Important source of pressure**
      - **B-field fluctuations amplification**
    - **Penetrate deeply in molecular clouds**

Standard model of VHE CR and γ production

- Vast majority of CR believed to be accelerated in SNR and PWN.

- Leptonic CR can be studied via
  - Synchroton emission of X-ray -> probe B-field
  - IC emission of GeV-TeV γ –> probe IR field-> probe dust

- Hadronic, majority of CR, studied via
  - p+N -> $\pi 0$ -> $\gamma + \gamma$

Standard model of VHE CR and γ production

Combined techniques allow to:

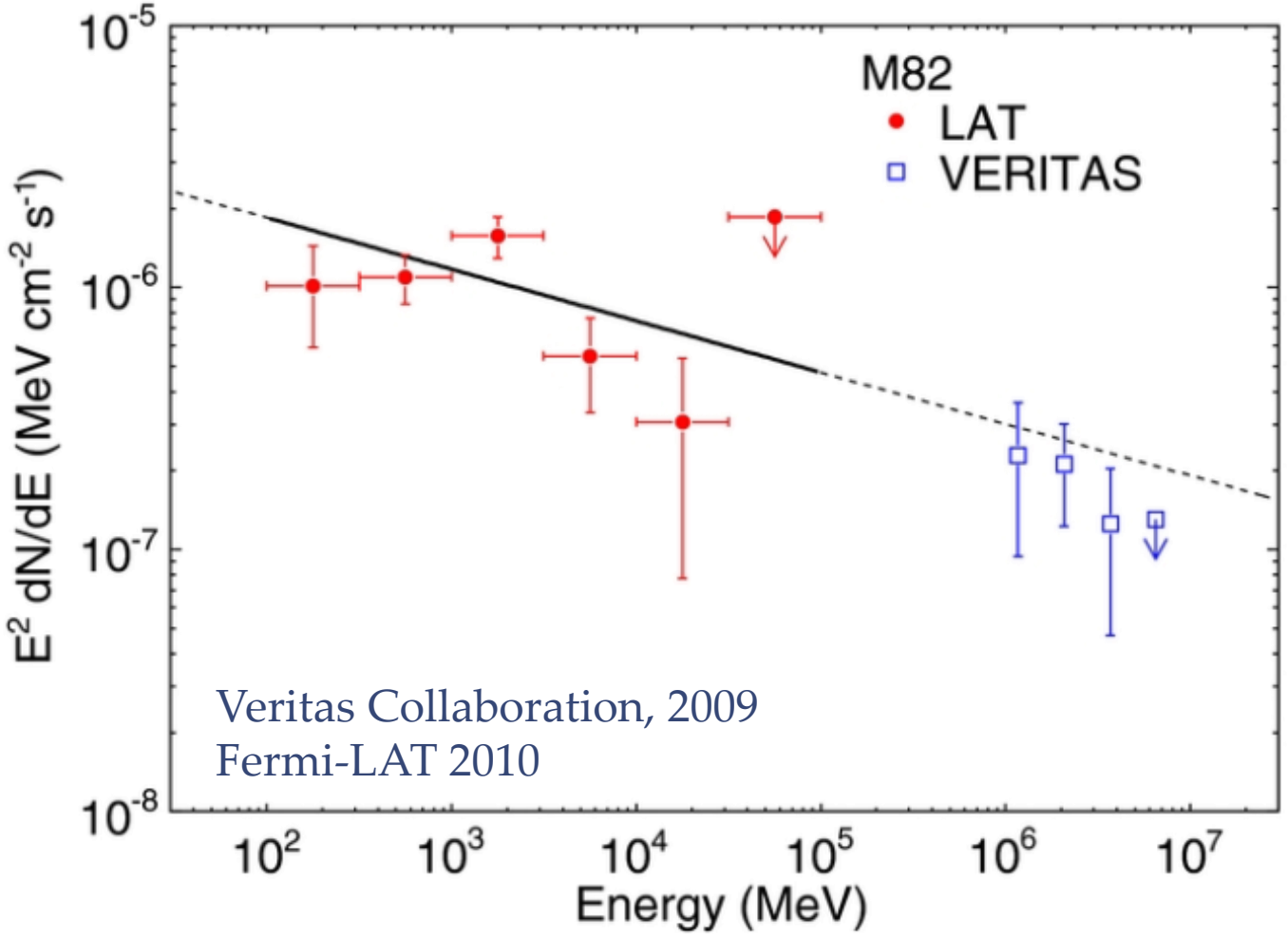
- Infer the efficiency of conversion of CR to γ in the starbust region
- Infer the environmental conditions
- Verify the equipartition of energy between CR, radiation fields and B-field

What is expected to be learnt from CR observation using γ as messengers?

- Relationship between star-forming and particle acceleration in all scales.
- How much energy is tranferred to CR in SN explosions (calorimetric fraction).
- What is the contribution to CR of different sources classes.

Observations

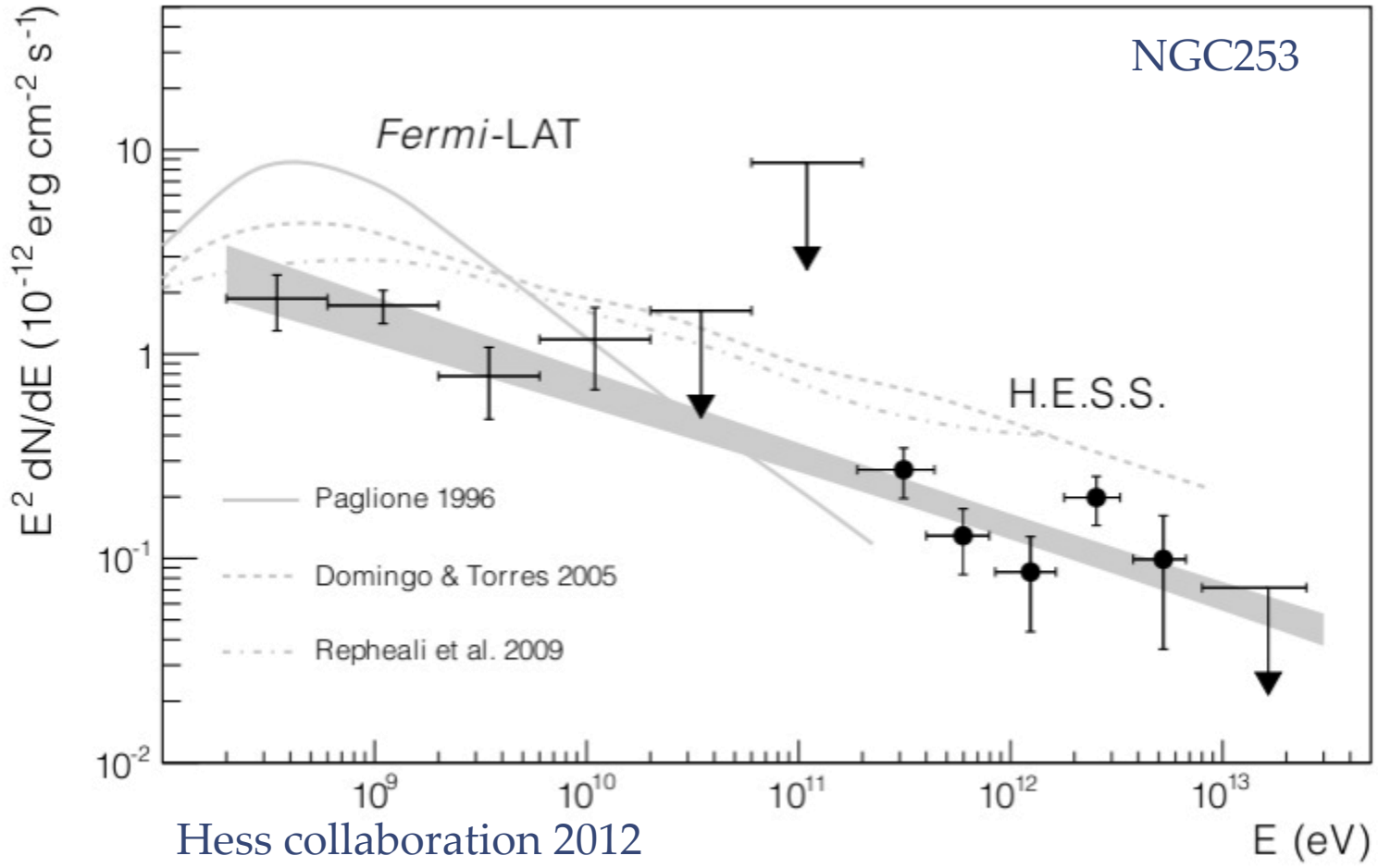
So far only possible for nearby Galaxies:



Veritas Collaboration, 2009
Fermi-LAT 2010

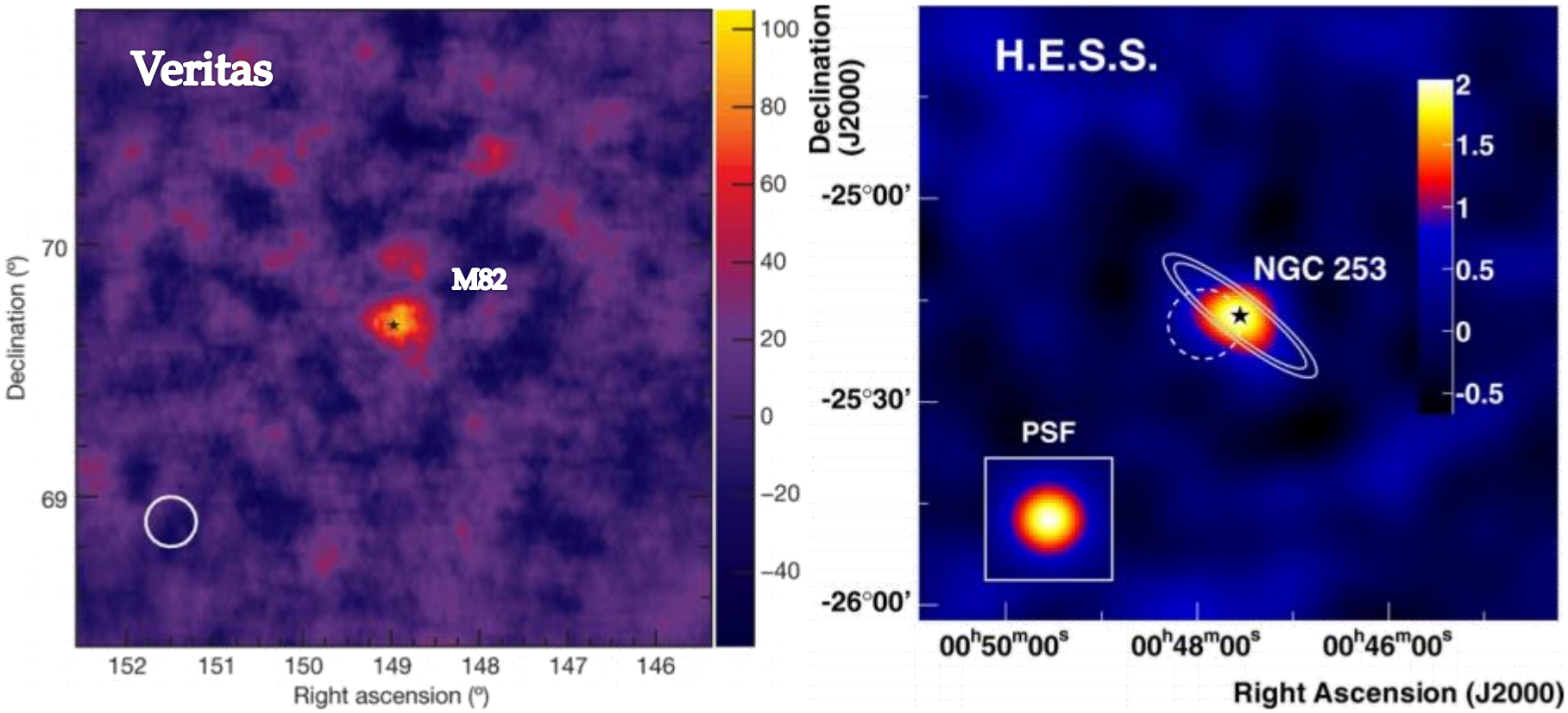
Observations

So far only possible for nearby Galaxies:



Hess collaboration 2012
Fermi-Lat collaboratio 2011

Observations

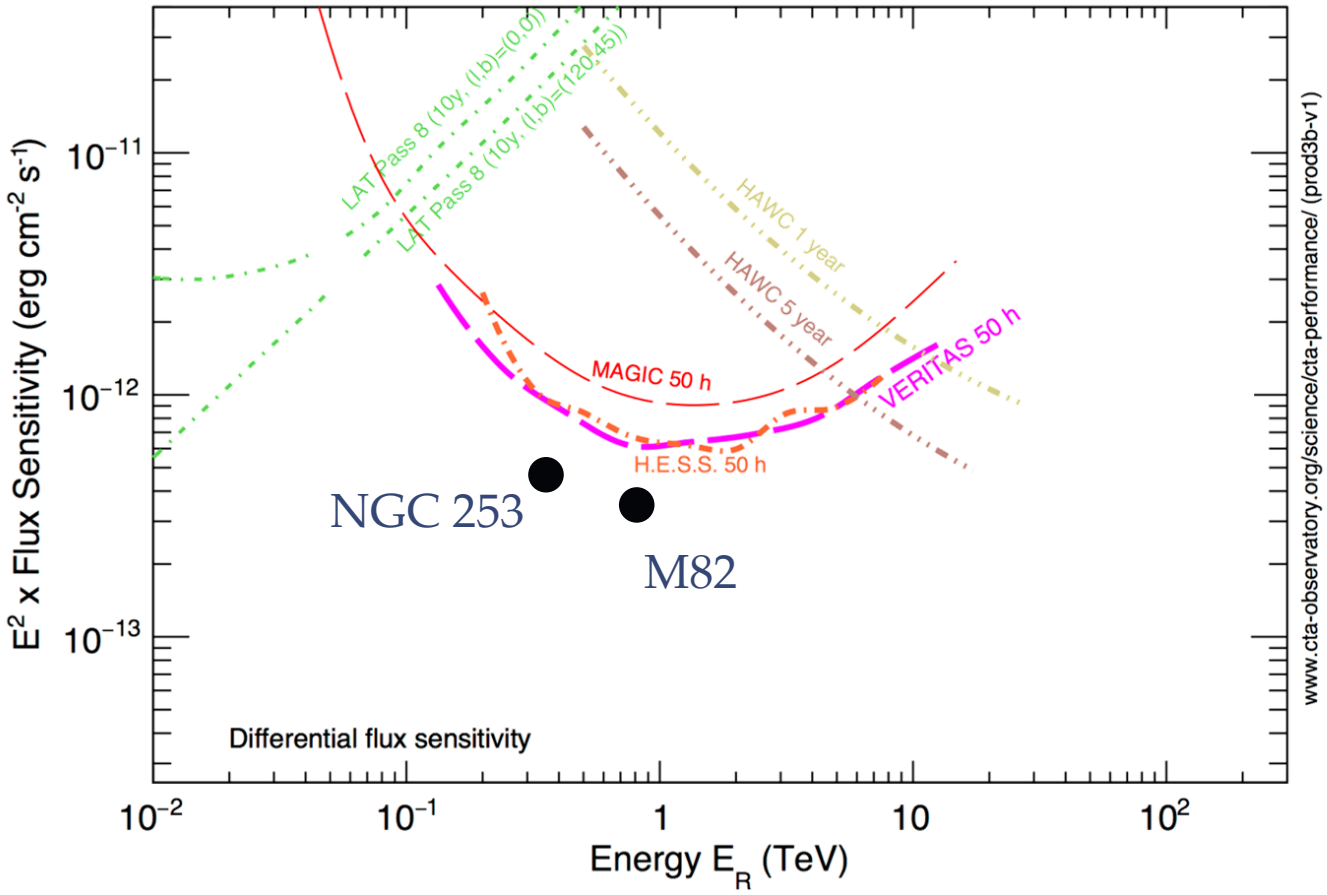


Number of photons map

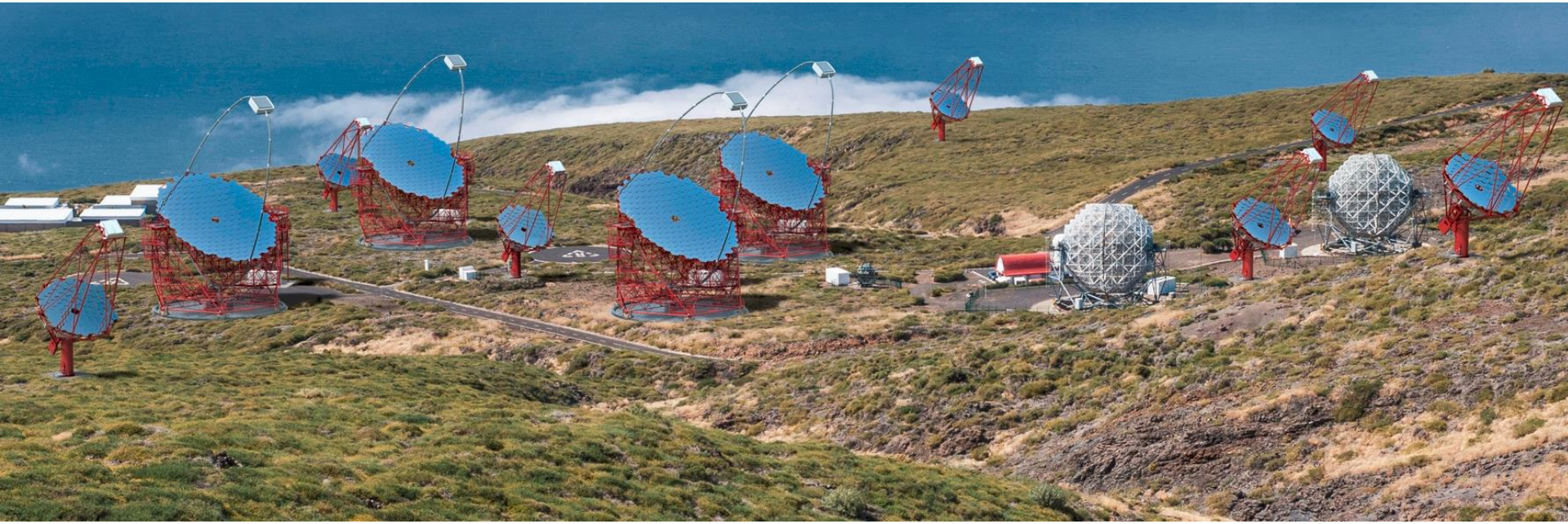
Significance map

Both are steady sources, centered in the galaxies, with a size compatible with a point like source for the instrumens used.

Observations: they are difficult due to low γ flux

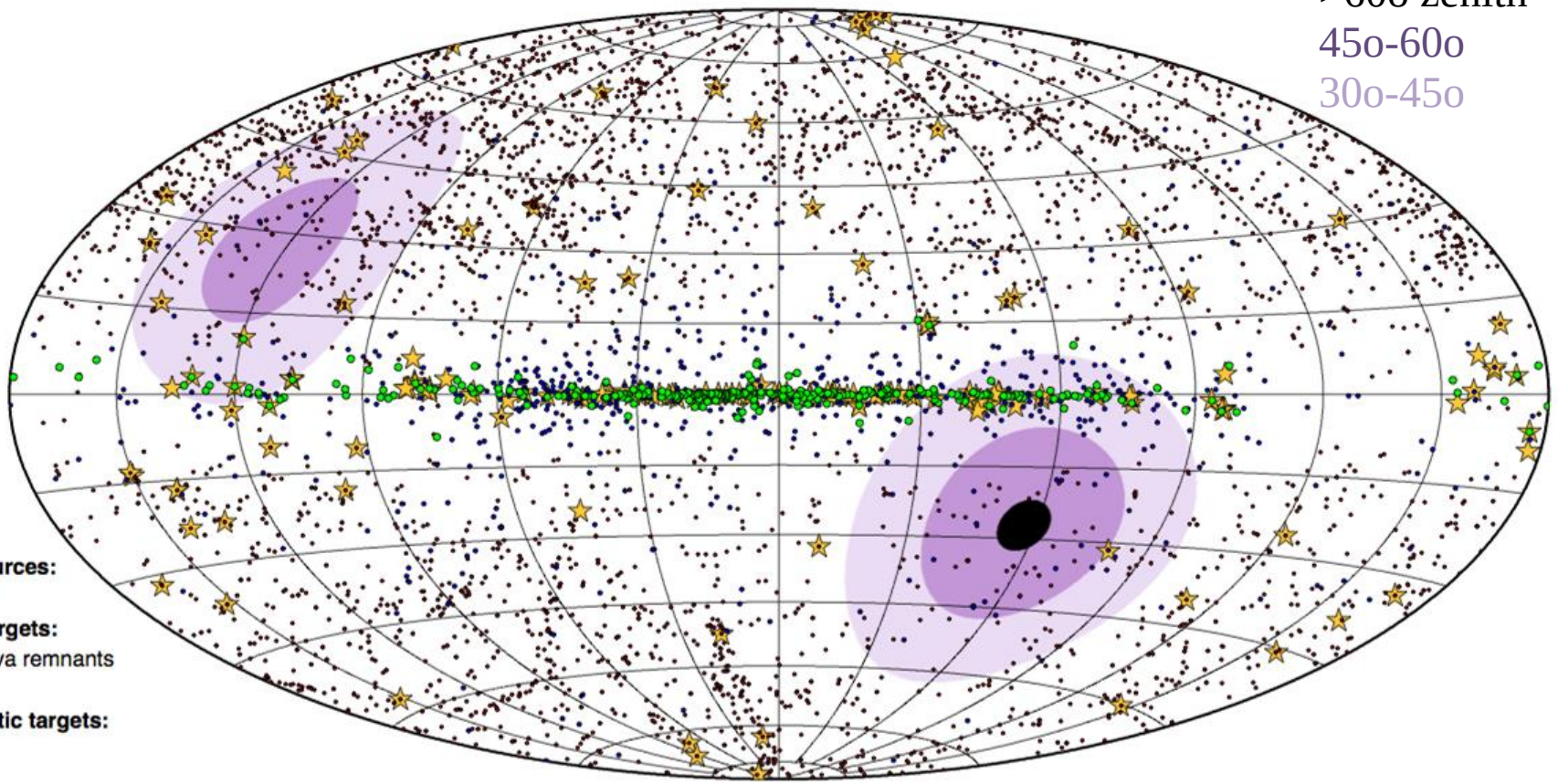


CTA



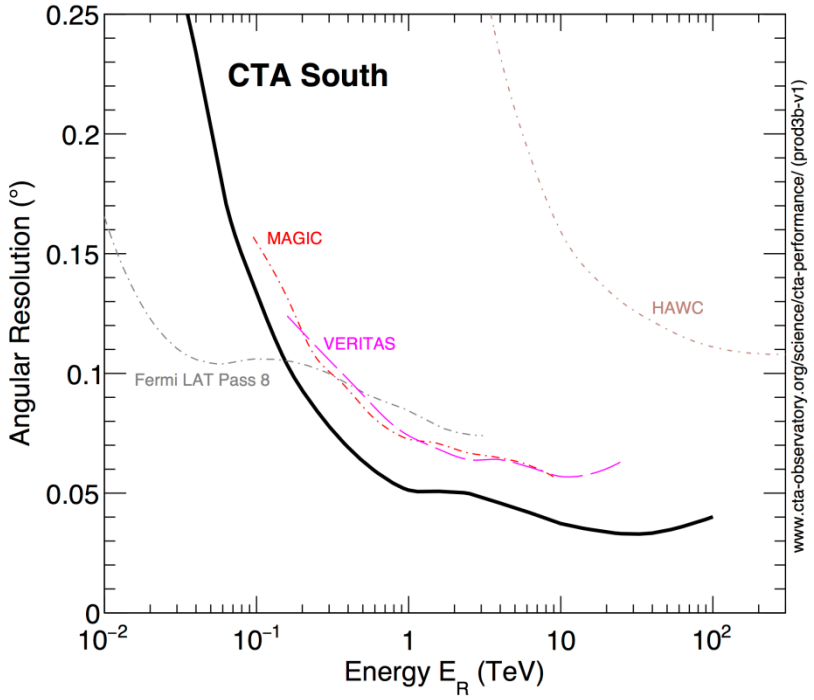
- At least 10 times more sensitive than current facilities.
- Two sites for full sky coverage

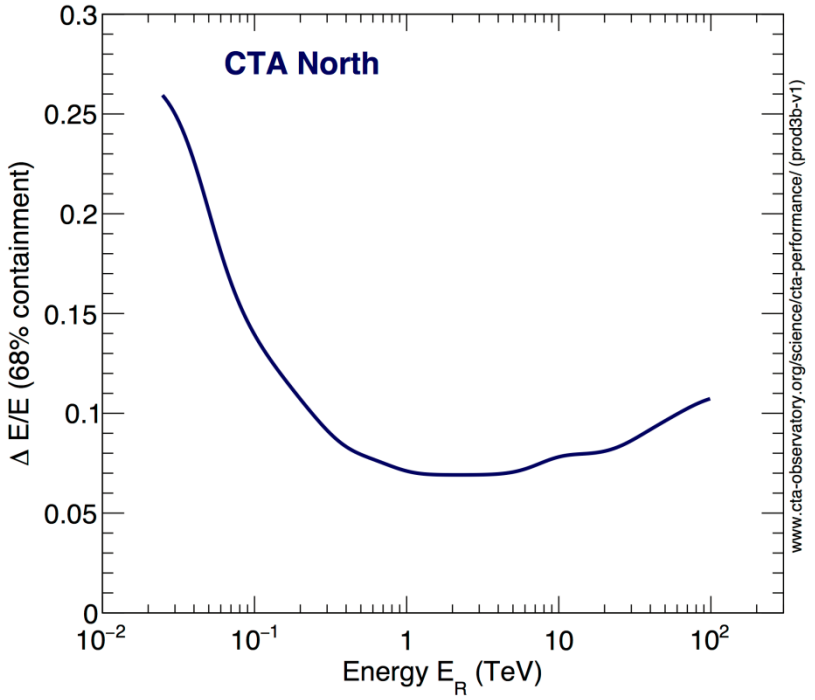
CTA: COVERAGE



CTA: RESOLUTION

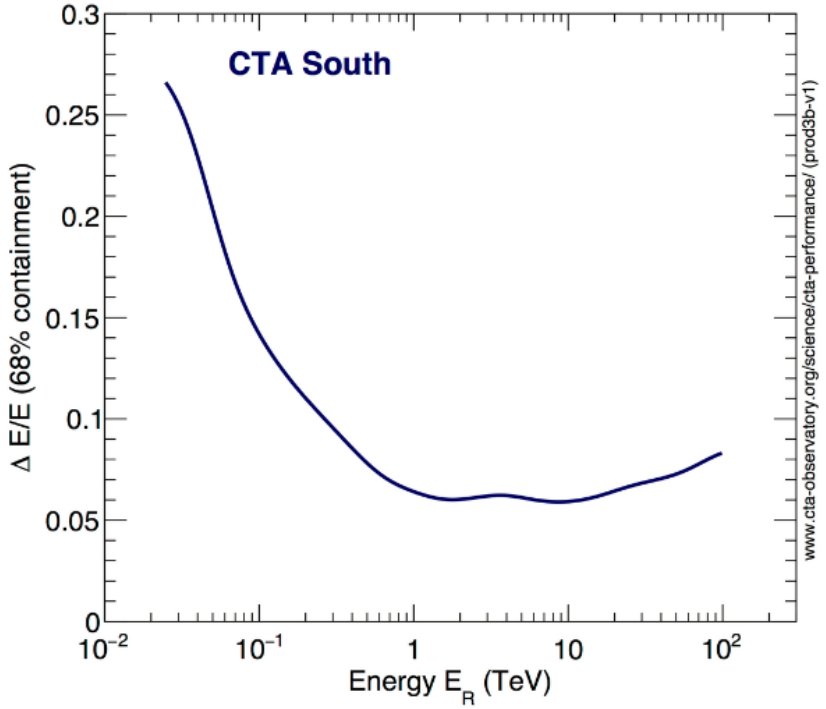
Angular resolution

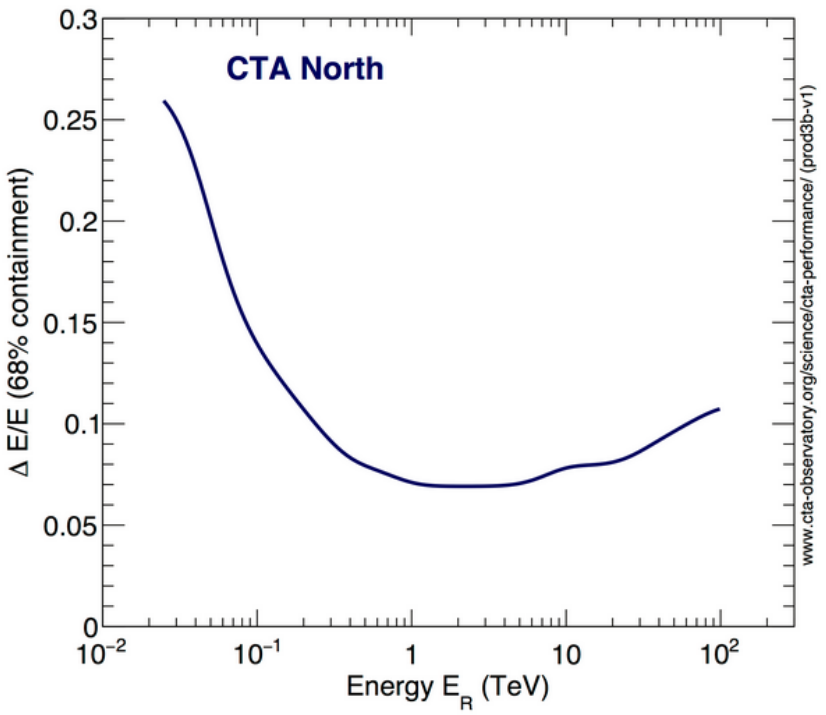




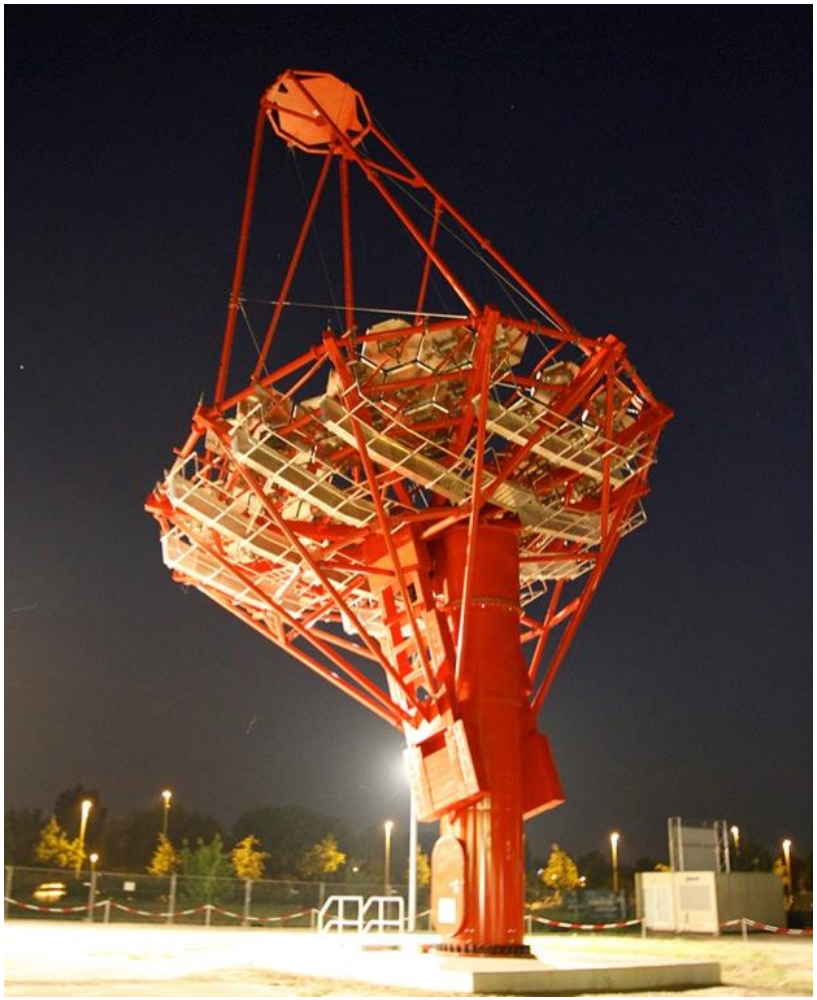
CTA: RESOLUTION

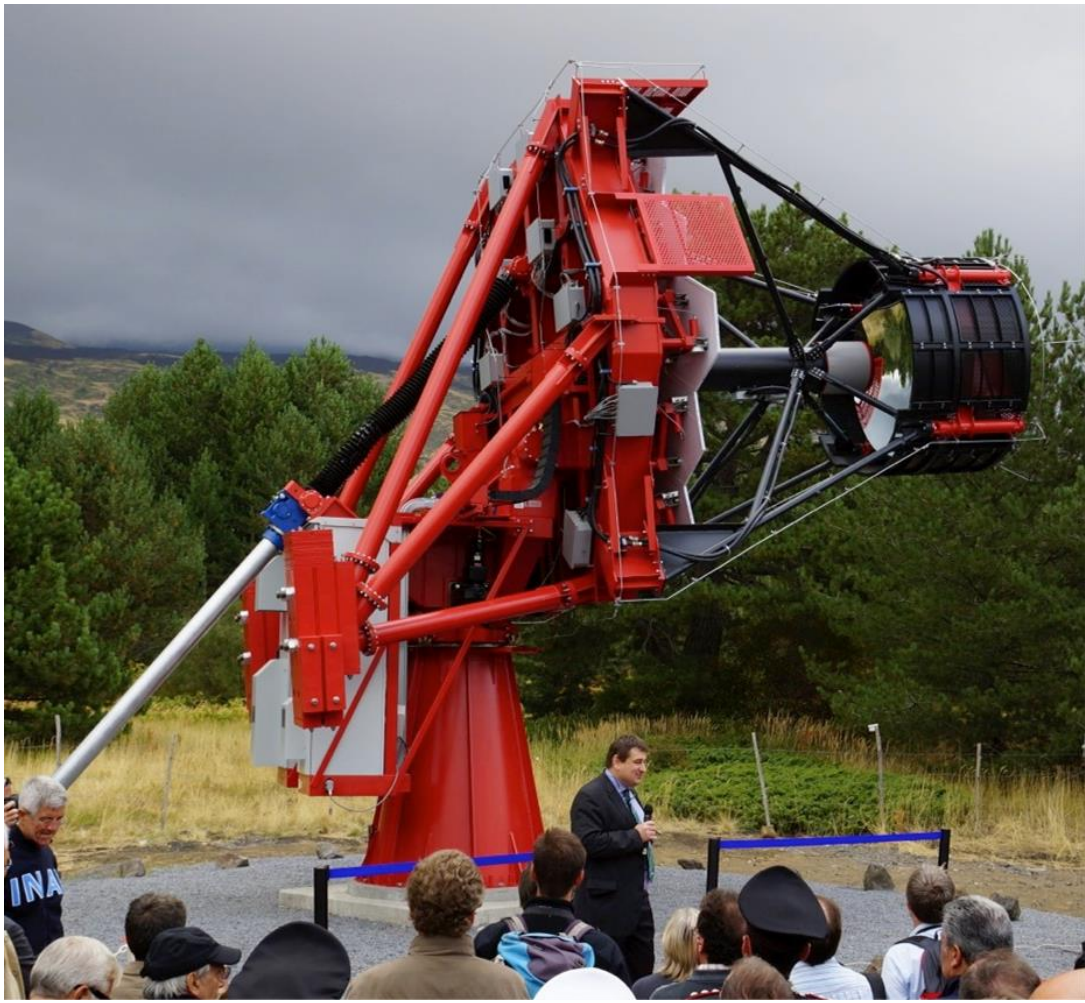
Energy resolution





CTA: STATUS





CTA: STATUS

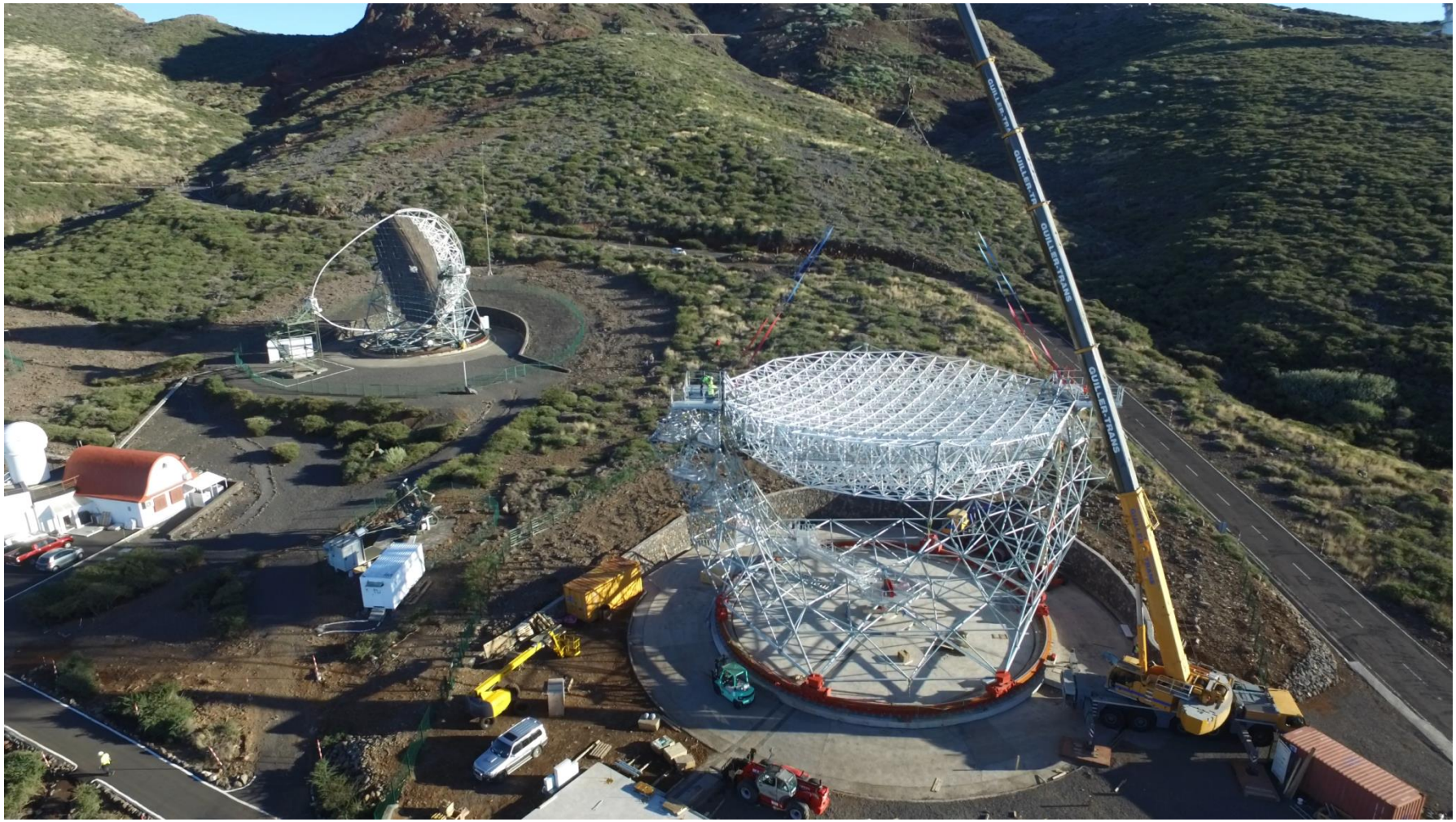


CTA: STATUS

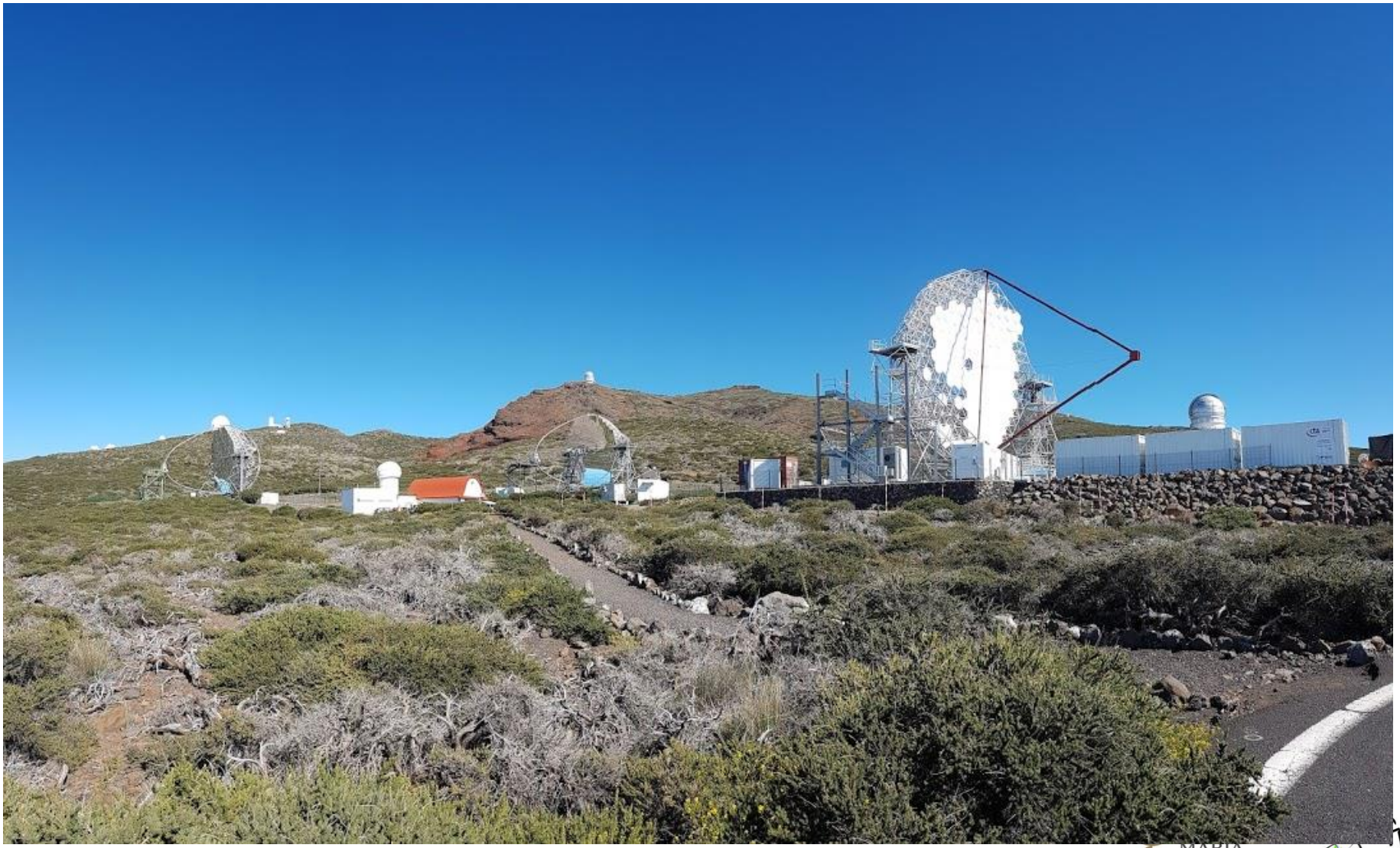


ELENCIA
MARÍA
DE MAEZTU
CIEMAT
física de partículas

CTA: STATUS



CTA: STATUS

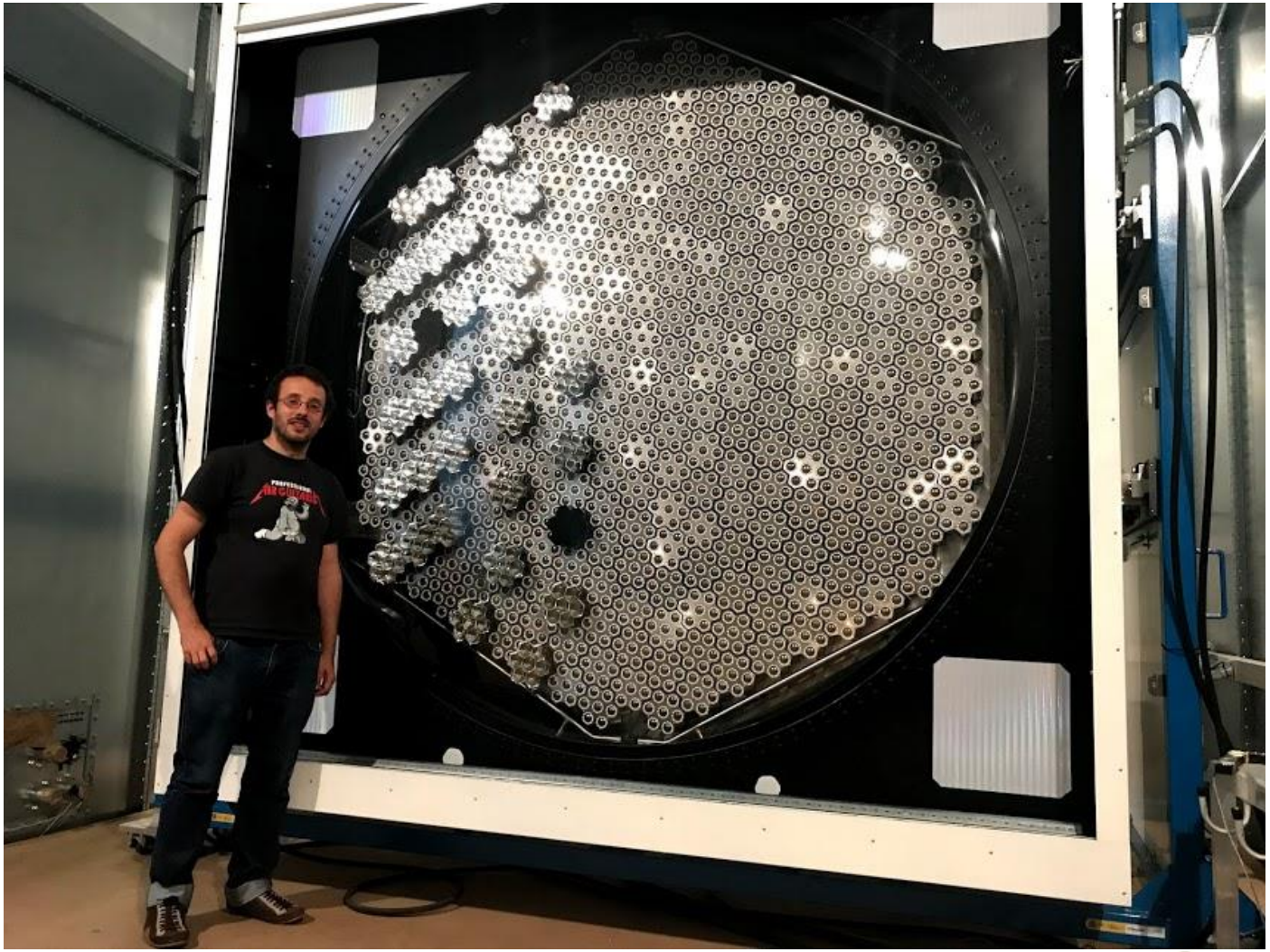


CTA: STATUS



cta
cherenkov telescope array
MARÍA DE MAEZTU
cfp CIEMAT física de partículas

CTA: STATUS



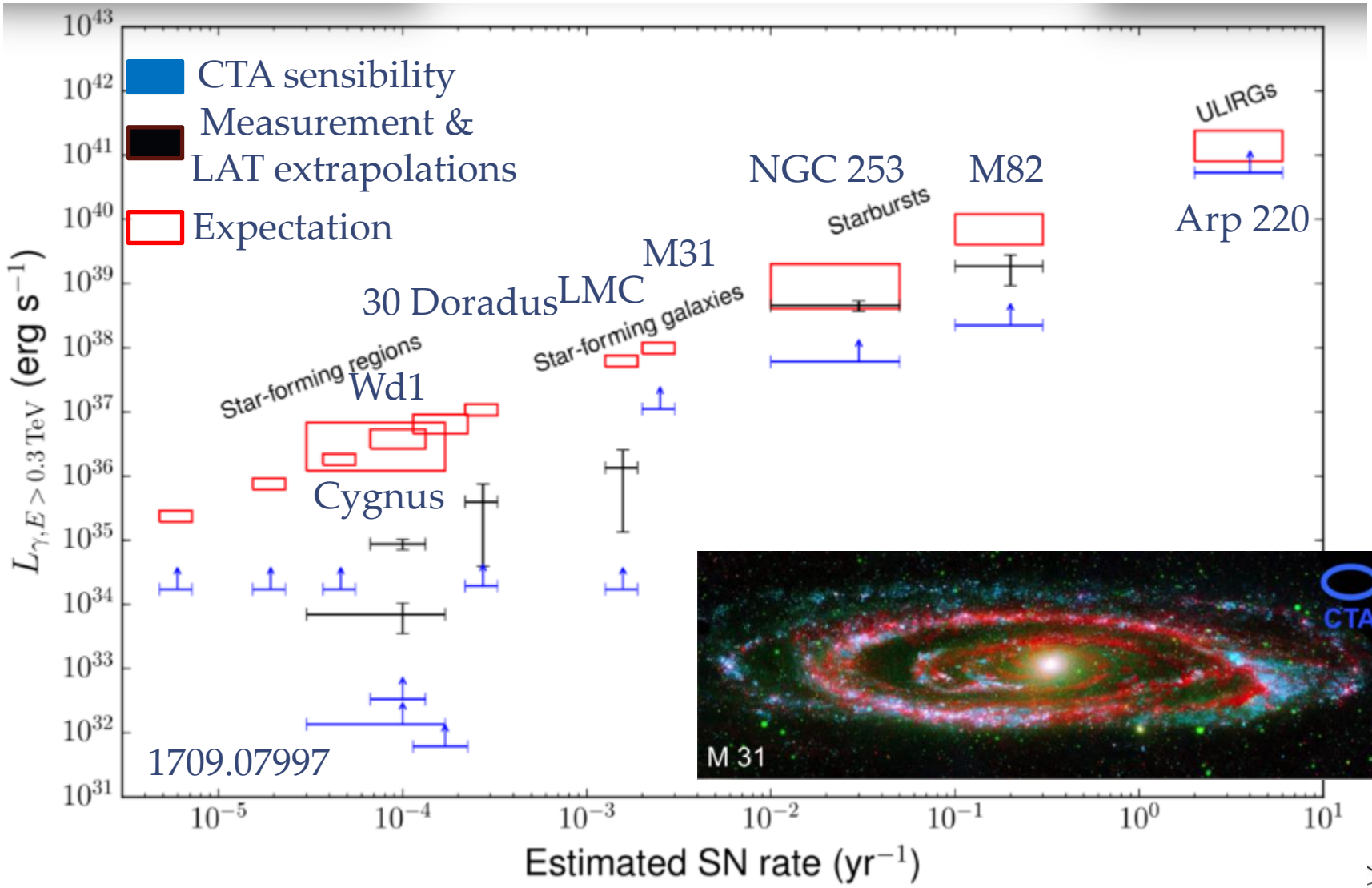
EXCELENCIA MARÍA DE MAEZTU
CIEMAT física de partículas

CTA plan for star formation regions: part of KSP

Target	Type	Extension	SN rate (yr^{-1})
Carina†	star-forming region	$\sim 1.5°$	1.7×10^{-4}
Cygnus†	star-forming region	$\sim 2.5°$	1.0×10^{-4}
Wd 1†	stellar cluster	$\sim 2.2°$	1.0×10^{-4}
M 31	galaxy	$\sim 2.0°$	2.5×10^{-3}
NGC 253	starburst	$\sim 0.1° \times 0.5° (20'' \times 45'')$	0.03
M 82	starburst	$\sim 4.8' \times 4.8' (15'' \times 50'')$	0.2
Arp 220	ULIRG	$\sim 2.5'' \times 1''$	4

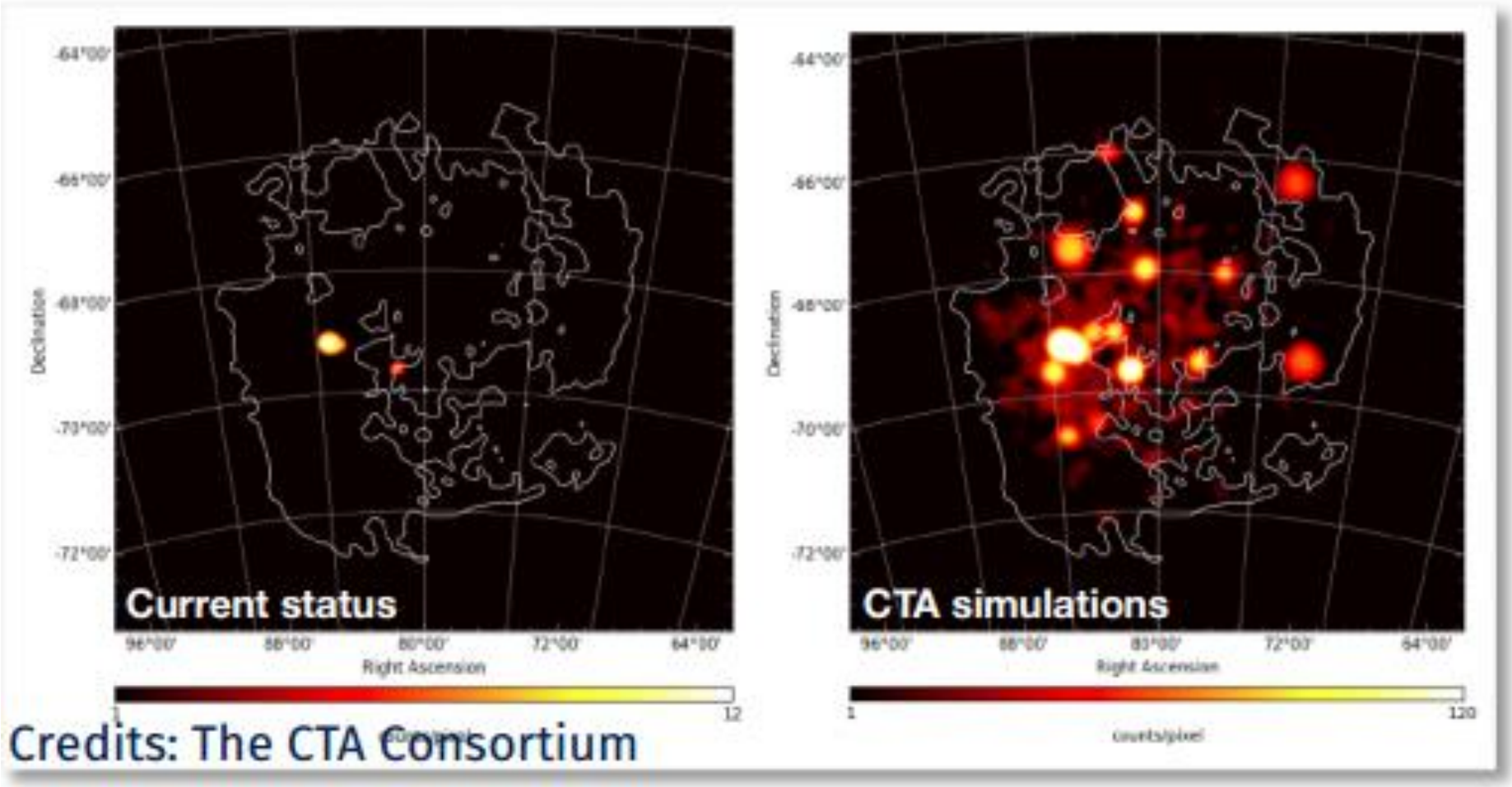
Target	Exposure (hrs)	Array	Year	Zenith	Moonlight fraction
Carina†	100	S	$1-3$	$< 45°$	0%
Cygnus (OB1/OB2)†	130	N	$1-2$	$< 50°$	0%
Wd 1†	40	S	$0-1$	$< 50°$	25%
M 31	150	N	$2-5$	$< 45°$	0%
NGC 253	100	S	$1-3$	$< 40°$	0%
M 82	100	N	$1-3$	$< 55°$	0%
Arp 220	100	S/N	$2-5$	$< 50°$	0%

CTA plan for star formation regions



CTA plan for star formation regions

LMC observations



Credits: The CTA Consortium

Bottom line

- Keep tuned for the future of VHE obervations
  - By 2023 all large size telescope should be already operative in CTA North
- Lots of potential for starburst physics
  - and the whole non-thermal astrophysics related fields
- On the way to a succesful simbiosis of astrophysics and experimental high energy physics field
  - Although its taking more than initially expected