

Roma International Astroparticle Physics conference conclusions

Aldo Morselli
INFN Roma Tor Vergata

RICAP-22 Roma International Conference on AstroParticle Physics
Roma, 9 September 2022

Roma International Conference on RICAP'07 Astro-Particle physics

University "La Sapienza and INFN
Roma, Italy

RICAP'07 (Roma International Conference on Astro-Particle physics) is the first edition of a series of International Conferences dedicated to high energy cosmic rays study, organized by the three public Universities and INFN Sections of Rome (University and INFN of Roma "La Sapienza", University and INFN of Roma "Tor Vergata" and University and INFN of "Roma Tre").

Physicists by these institutions are deeply involved in major experiments on Astro-Particle physics, (AGILE, AMS, ANTARES, ARGO, Auger, GLAST, NEMO, PAMELA, ...) and in deep and fruitful theoretical speculations.

The RICAP Conference will be held every two years. The first edition will be held at the University of Roma "La Sapienza", the second at the University of Roma "Tor Vergata" and the third at "Roma Tre"

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00185 – Roma
Italy



RICAP'07

~ 1 month from
AGILE launch

**Perfect launch of the AGILE
satellite by ISRO from the
SHAR base (Chennai), India,**

April 23, 2007

AGILE in a very good shape
(see the talk by Carlotta Pittori)



RICAP'09



RICAP'09



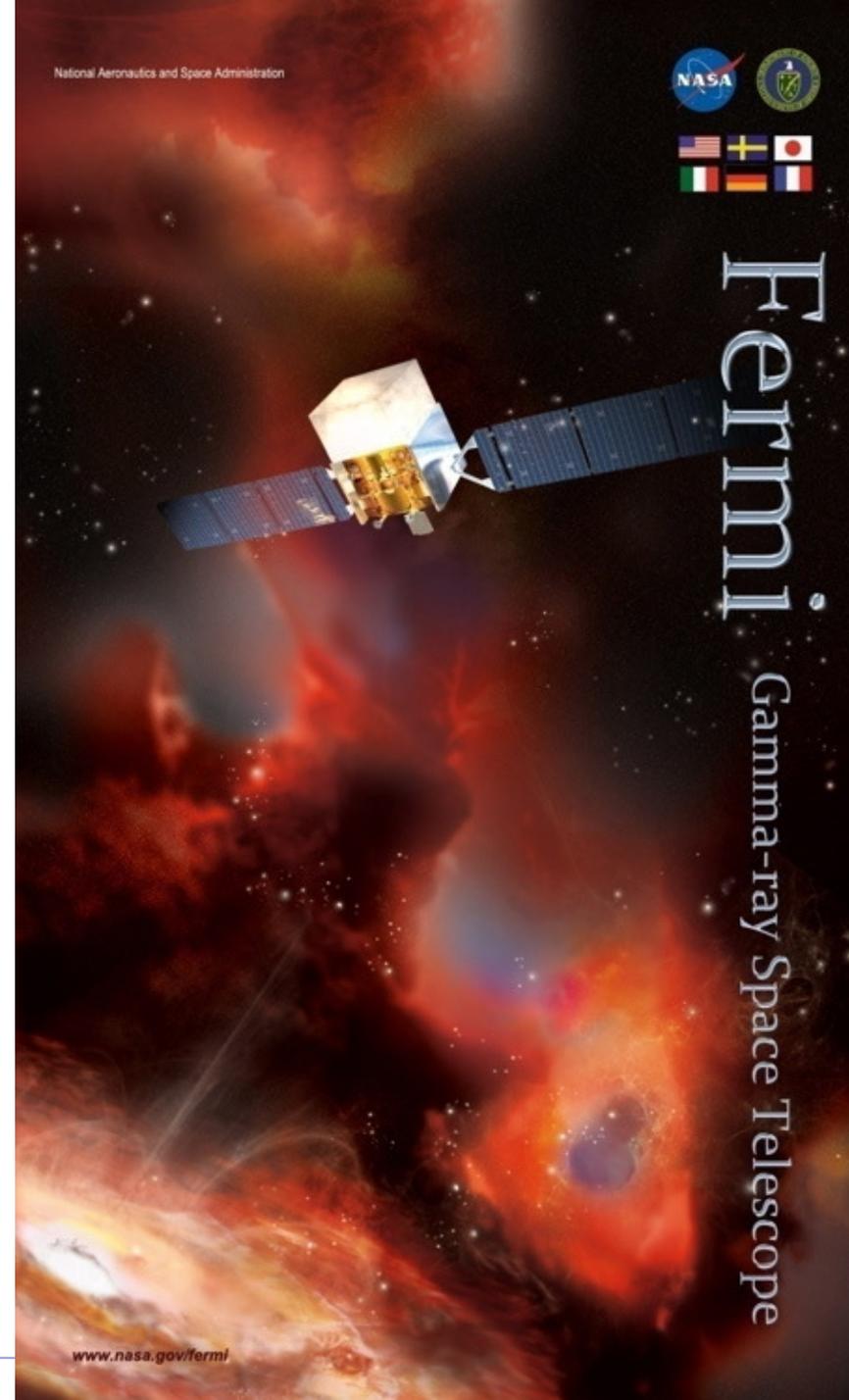
~ 1 year from Fermi launch

11 June 2008

Also Fermi in a very good shape

- Lots of presentations on gamma-rays alone or in a multi wavelenth – multi messenger connections

Fermi talk by Sara Cutini



RICAP'11



RICAP'11



~ 5 days from AMS-02 launch
19 May 2011

talk by Manuela Vecchi

RICAP-16





DAMPE talk by Ivan De Mitri

~ 9 months from DAMPE launch 17 Dec 2015

H.E.S.S. (Namibia)

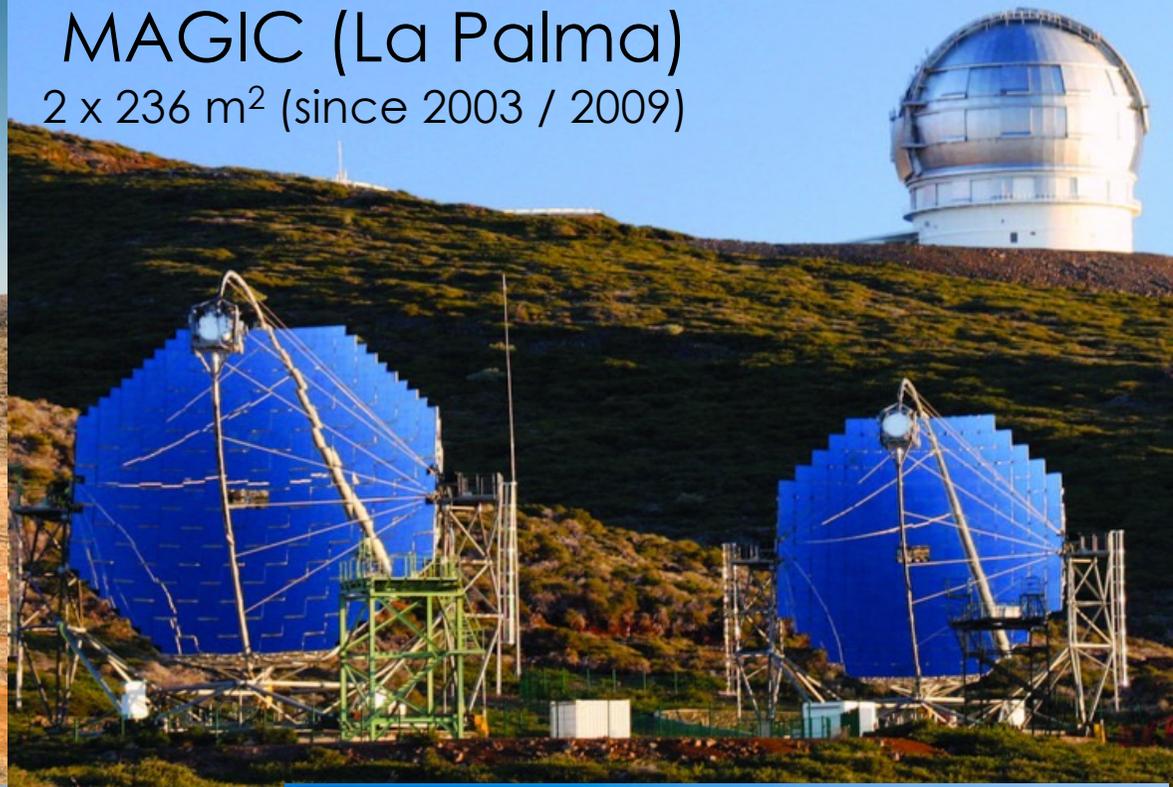
4 x 108 m² (since 2003)

1 x 614 m² (since 2012)



MAGIC (La Palma)

2 x 236 m² (since 2003 / 2009)

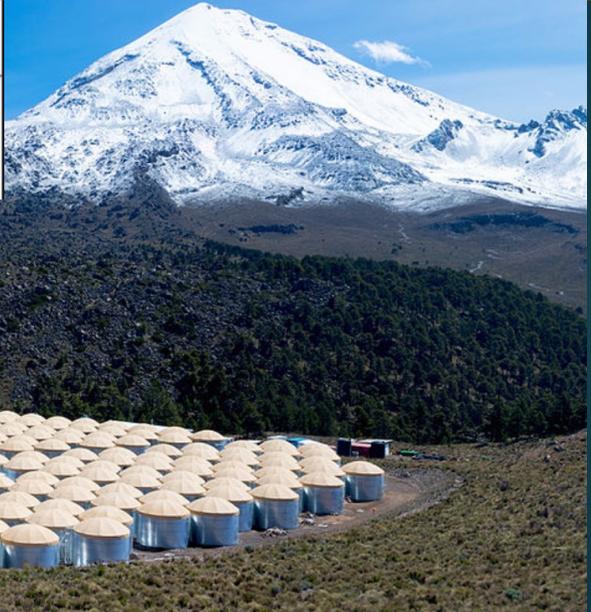


VERITAS (Arizona)

4 x 110 m² (since 2007)



(since 2013)



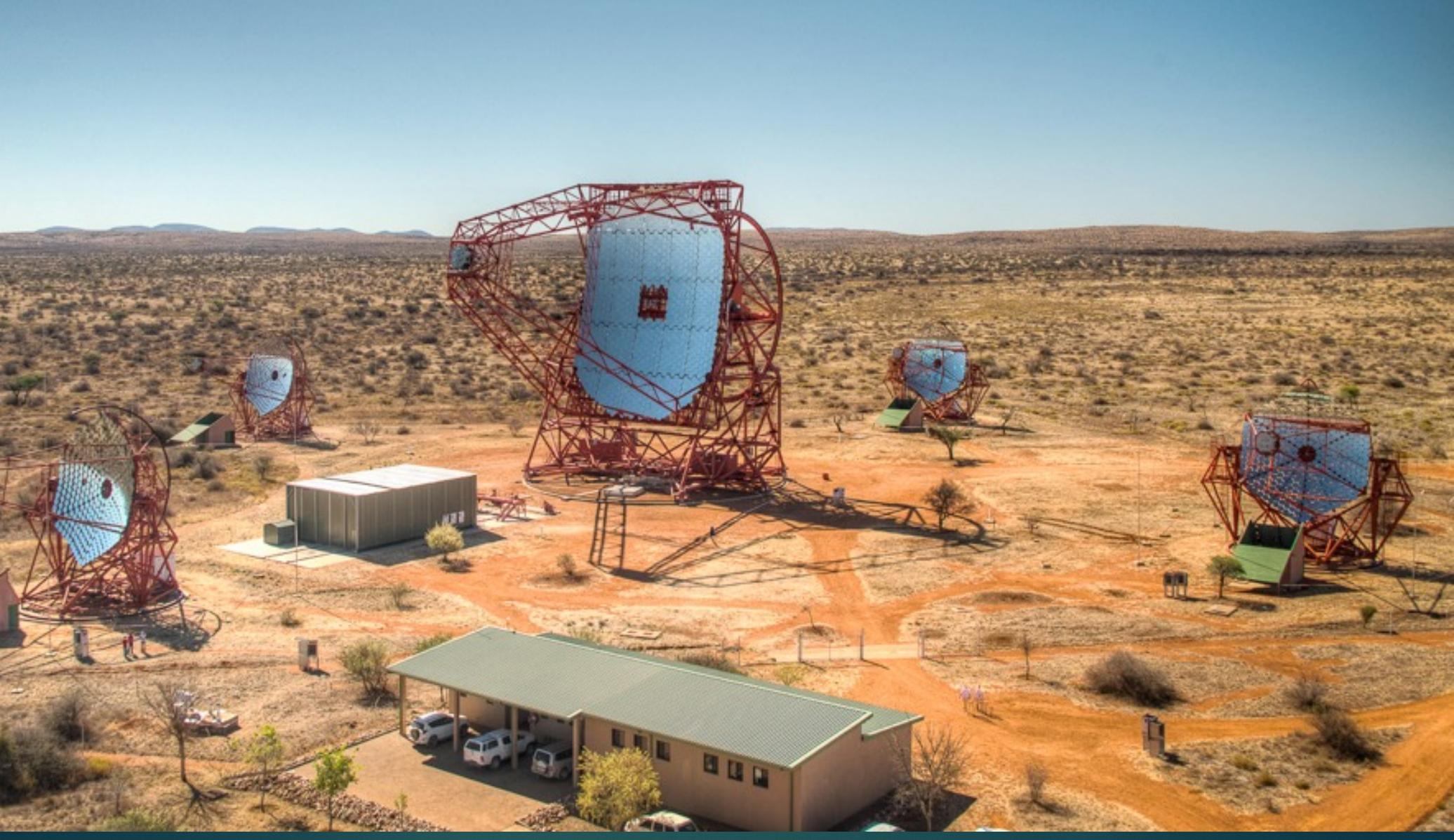
but in the meantime...

H.E.S.S. (Namibia)

4 x 108 m² (since 2003)

1 x 614 m² (since 2012)

H.E.S.S. Status talk by Emmanuel Moulin



MAGIC (La Palma)
2 x 236 m² (since 2003 / 2009)

MAGIC Status talk by Chiara Righi

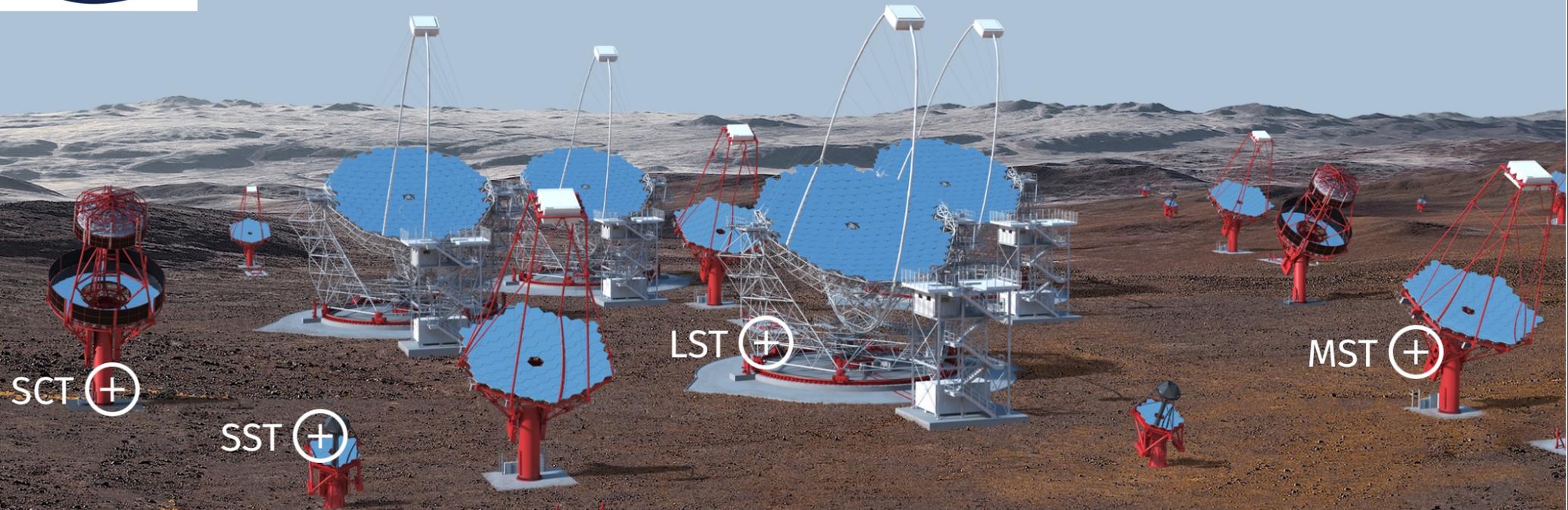


(since 2013)

CTA

CTA Status talk by Gareth Hughes





The Alpha Configuration

CTAO Northern Array

- 4 LSTs + 9 MSTs
- 0,25 km² footprint
- focus on extra-Galactic science

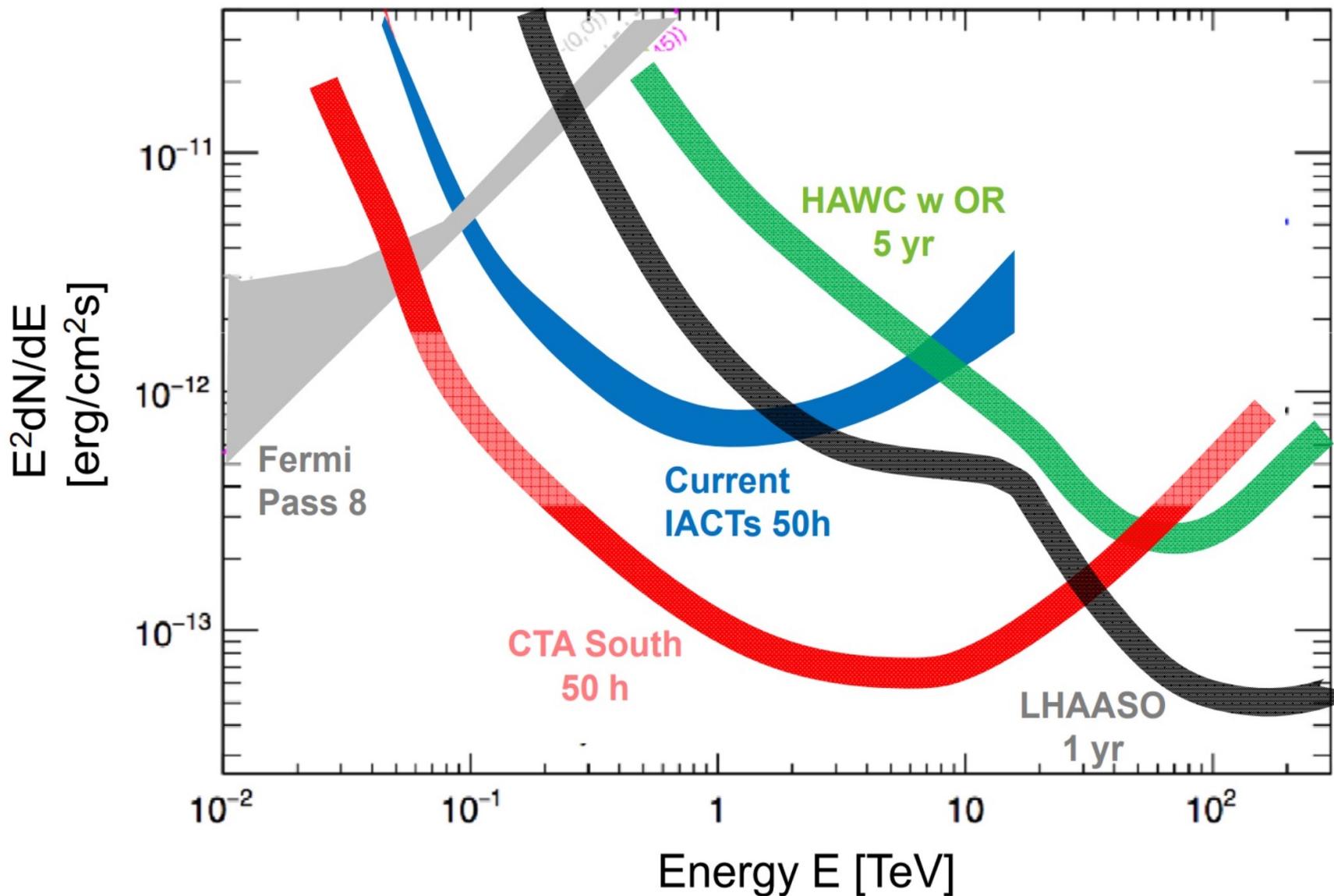
CTAO Southern Array

- 14 MSTs + 37 SSTs
- 3 km² footprint
- focus on Galactic science

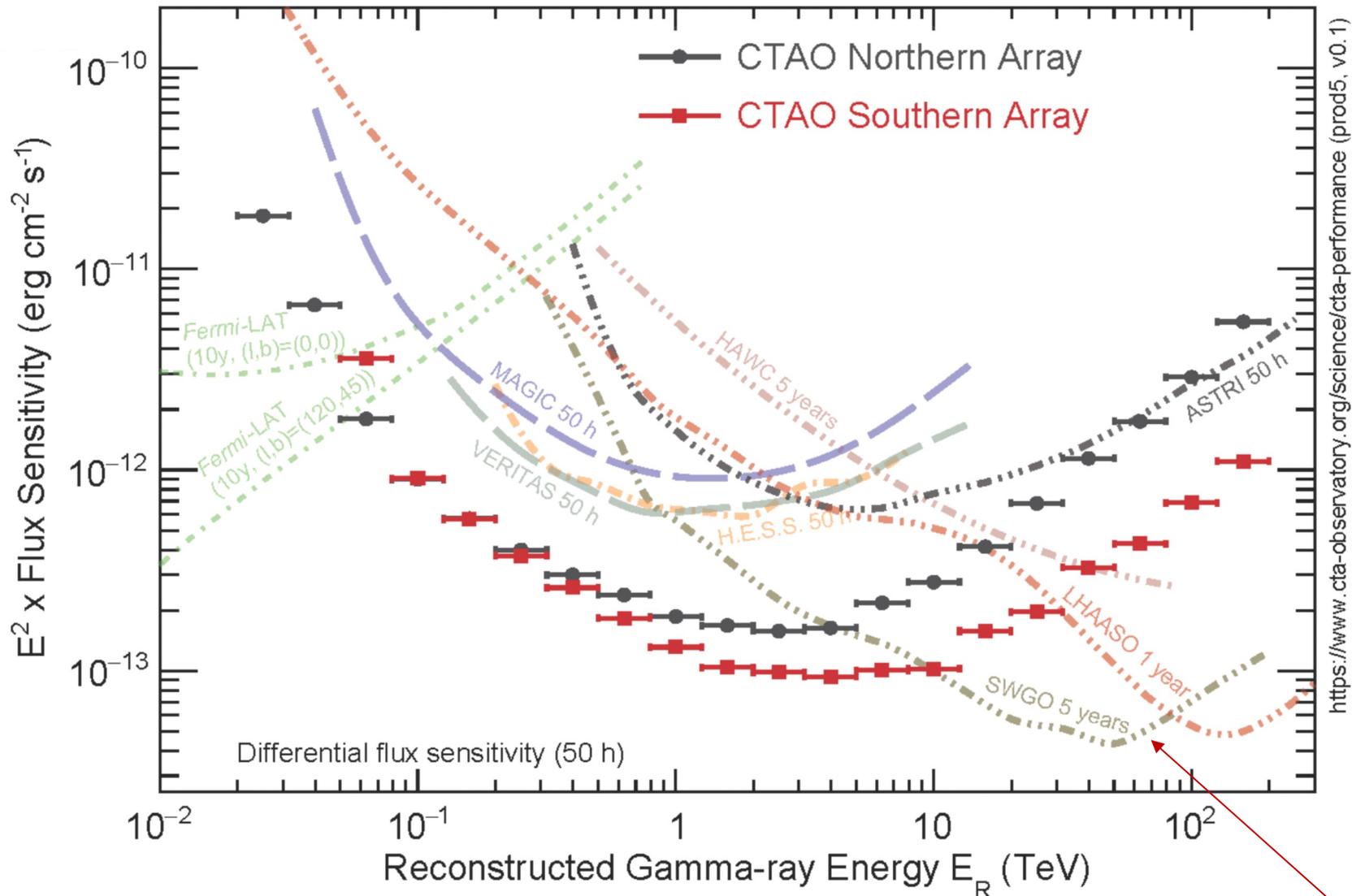
and a good news: INAF+INFN have secured funding for 2 LST in the South



γ -ray detectors sensitivities

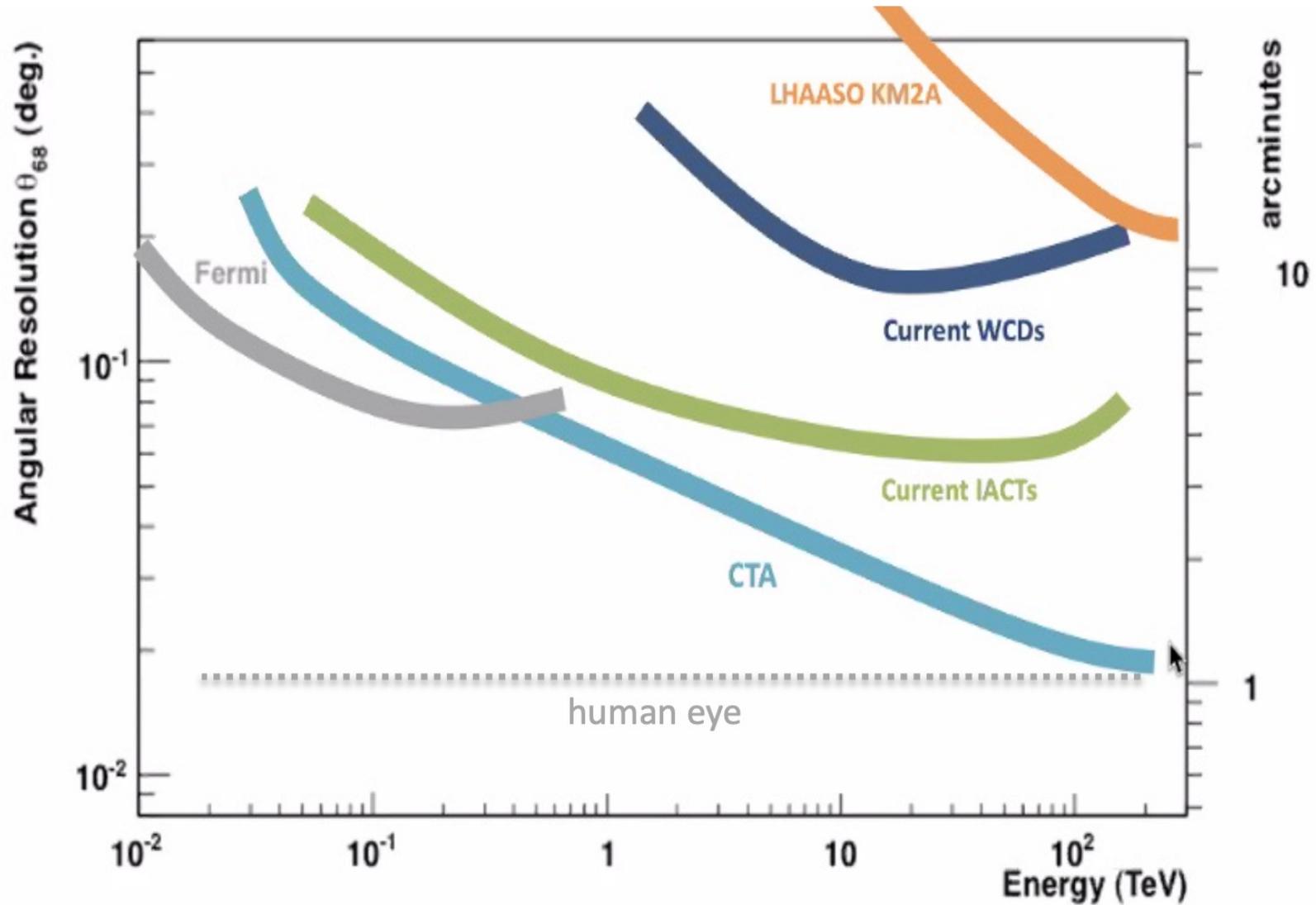


(more detailed) γ -ray detectors sensitivities

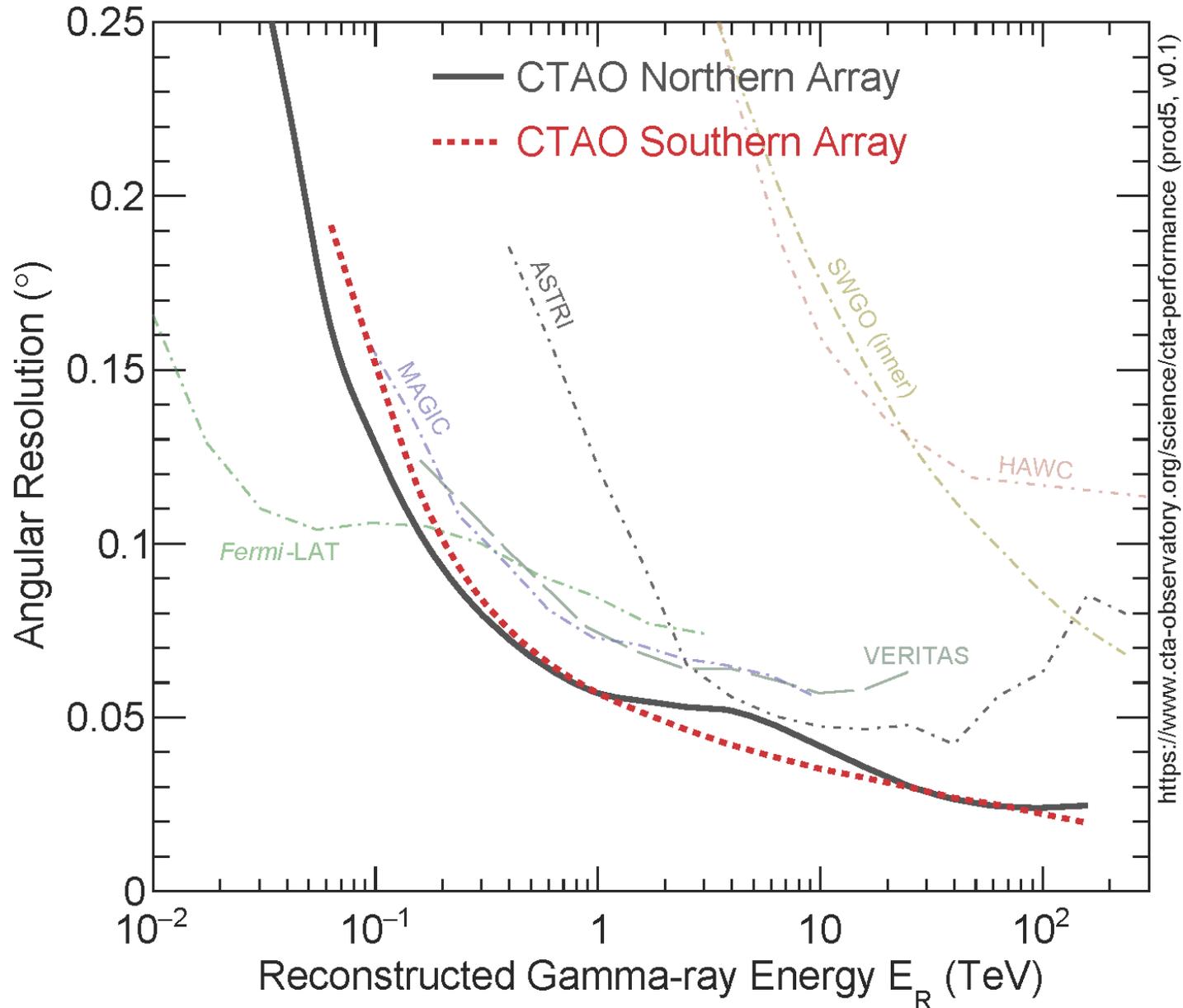


SWGO talk by Giovanni La Mura

Angular resolution



Angular resolution

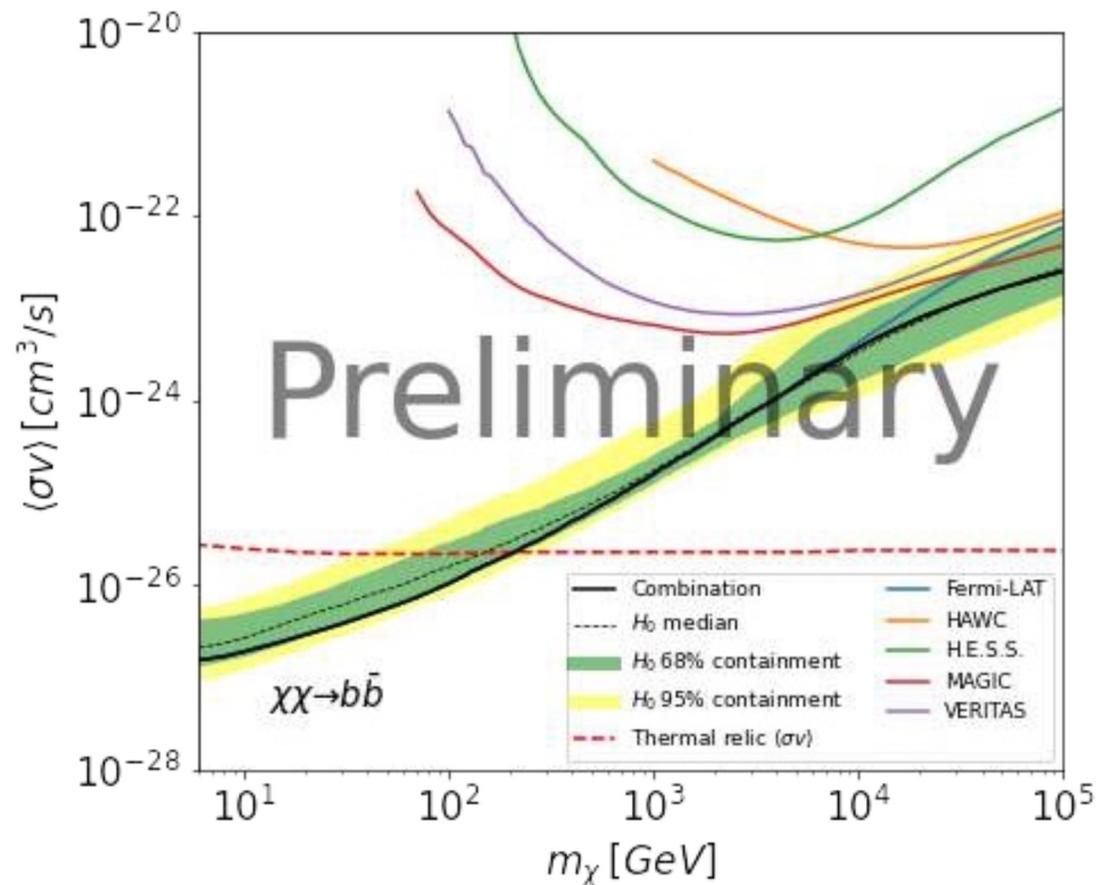


Dark Matter indirect search

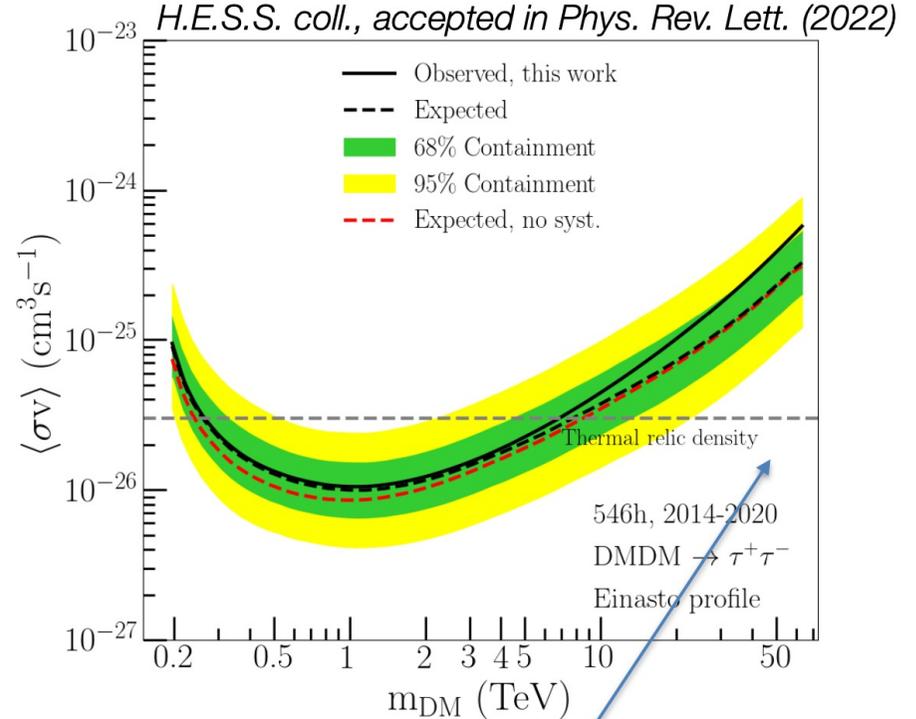
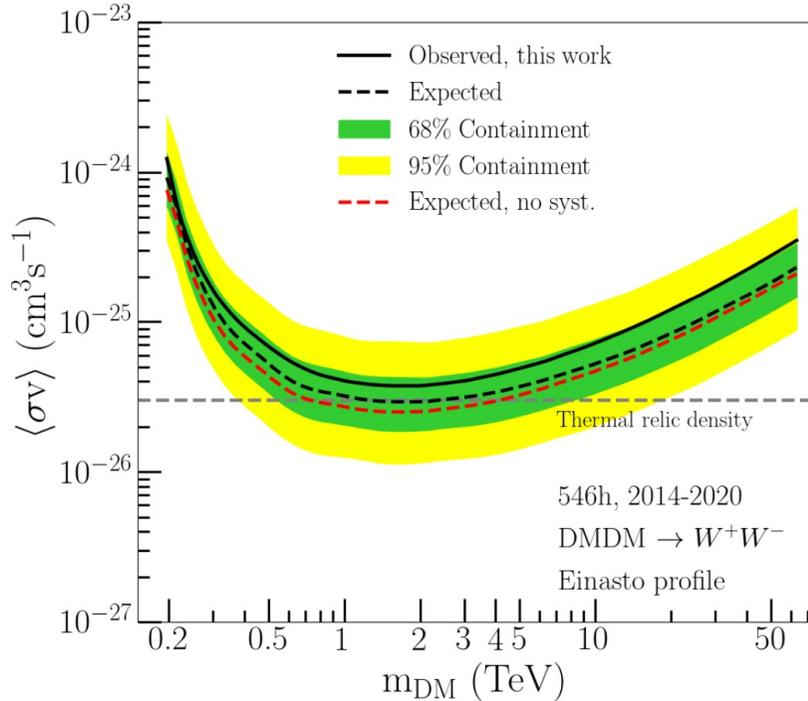
Combining all dSph observations



- Combination of the observation results towards 20 dwarf spheroidal galaxies (dSphs)
 - Significant increase of the statistics
 - > Increase the sensitivity to potential dark matter signals
 - Cover the widest energy range ever investigated : 20 MeV – 80 TeV
- Common elements :
 - Agreed model parameters
 - Sharable likelihood table formats
 - Joint likelihood test statistic



- No significant DM signal found in any ROI
 → 95% C.L. upper limits on $\langle\sigma v\rangle$

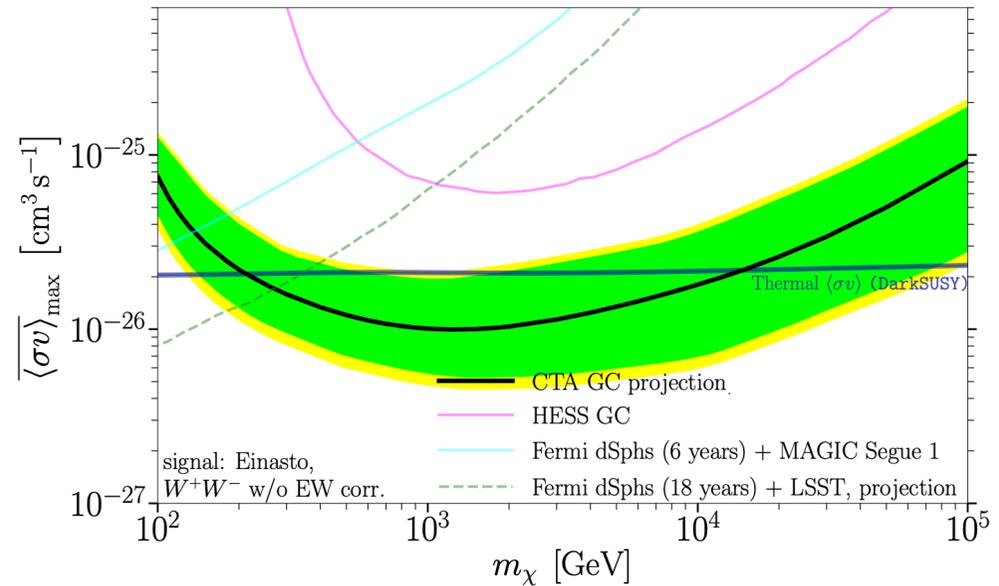
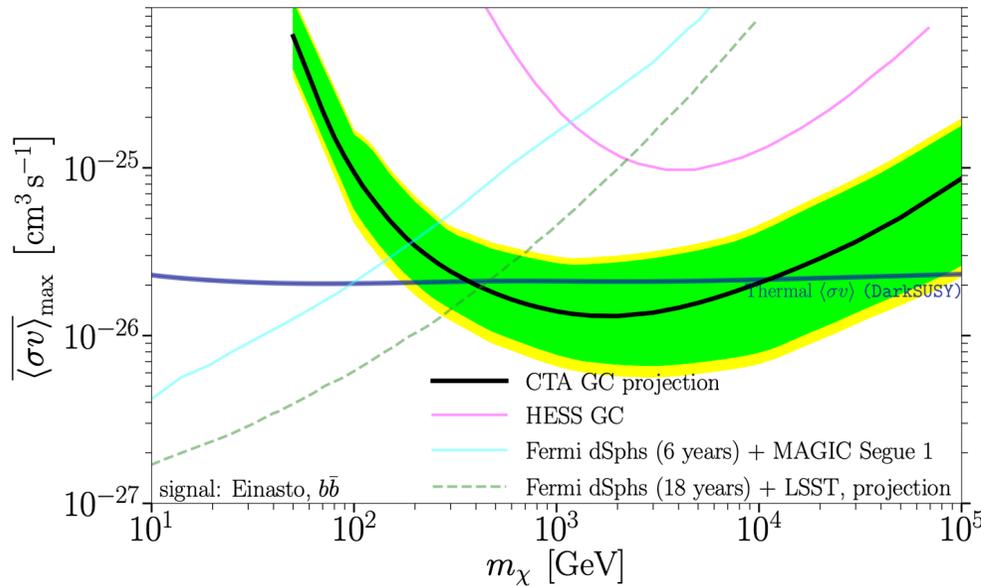


- Systematic uncertainty included in the limit computation

Thermal cross-section expected for vanilla (s-wave) annihilating WIMPs that account for 100% of DM



Galactic center CTA Sensitivity



- Einasto profile

520 h

$$\rho_{\text{DM}} = \rho_s \exp \left[-\frac{\alpha}{2} \left(\frac{r}{r_s} \right)^\alpha - 1 \right], \quad J \sim 7.1 \times 10^{22} \text{GeV}^2/\text{cm}^5$$

- Main source of background : sources, Fermi Bubble, interstellar γ , residual CR

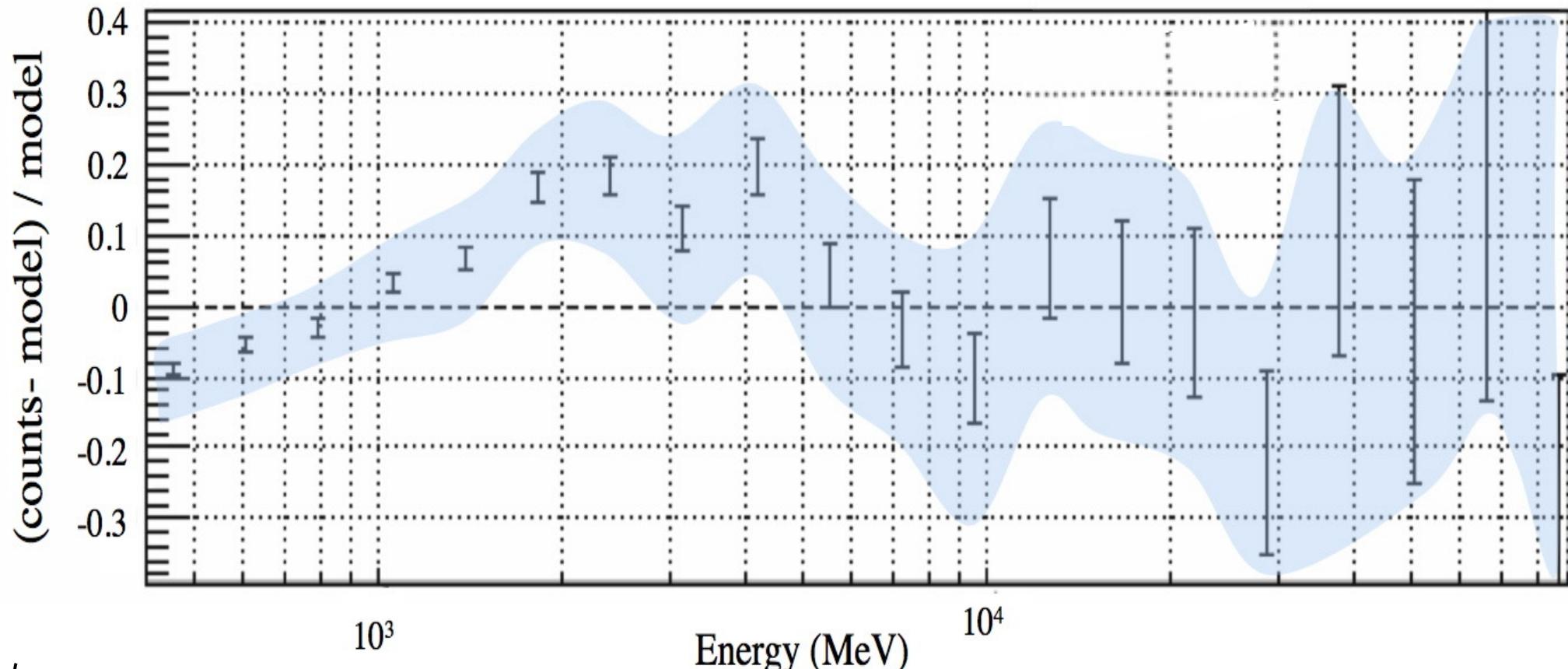


The CTA Consortium JCAP01(2021) 057 January 27, 2021 [arXiv:2007.16129]

The GeV excess $7^\circ \times 7^\circ$ region centered on the Galactic Center

11 months of data, $E > 400$ MeV, front-converting events analyzed with binned likelihood analysis)

- The systematic uncertainty of the effective area (blue area) of the LAT is $\sim 10\%$ at 100 MeV, decreasing to 5% at 560 MeV and increasing to 20% at 10 GeV

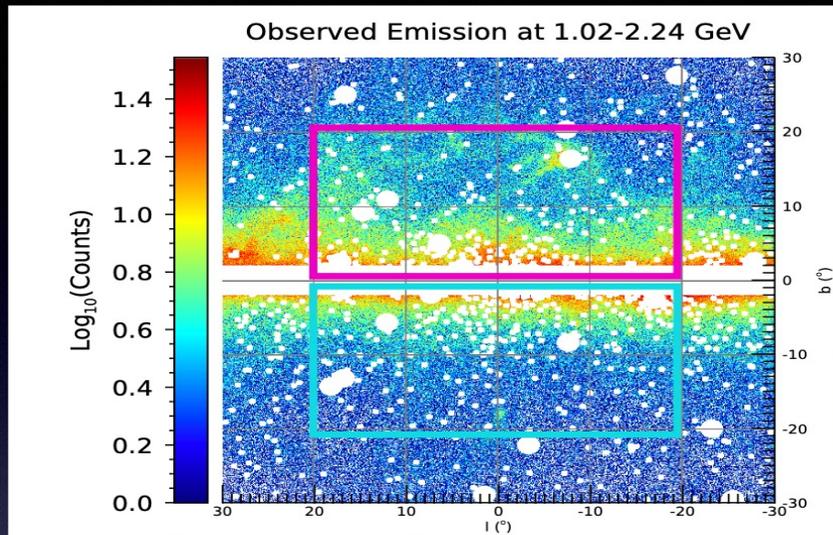


V.Vitale, A.Morselli, Fermi Coll. 2009 arXiv:0912.3828 [Fermi Symposium eConf Proceedings C091122](#)

The profile for the GCE. Does it look like a DM signal?

IC, Zhong, McDermott, Surdutovich, PRD 2022

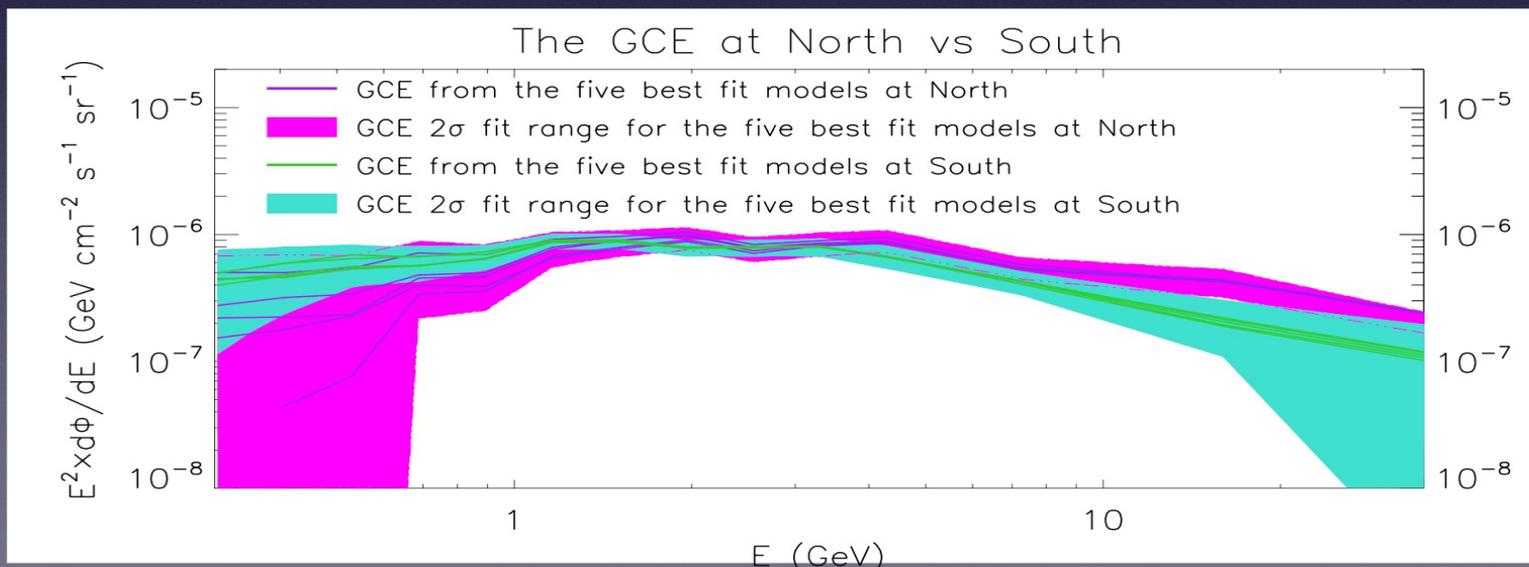
Talk by Ilias Cholis



North

South

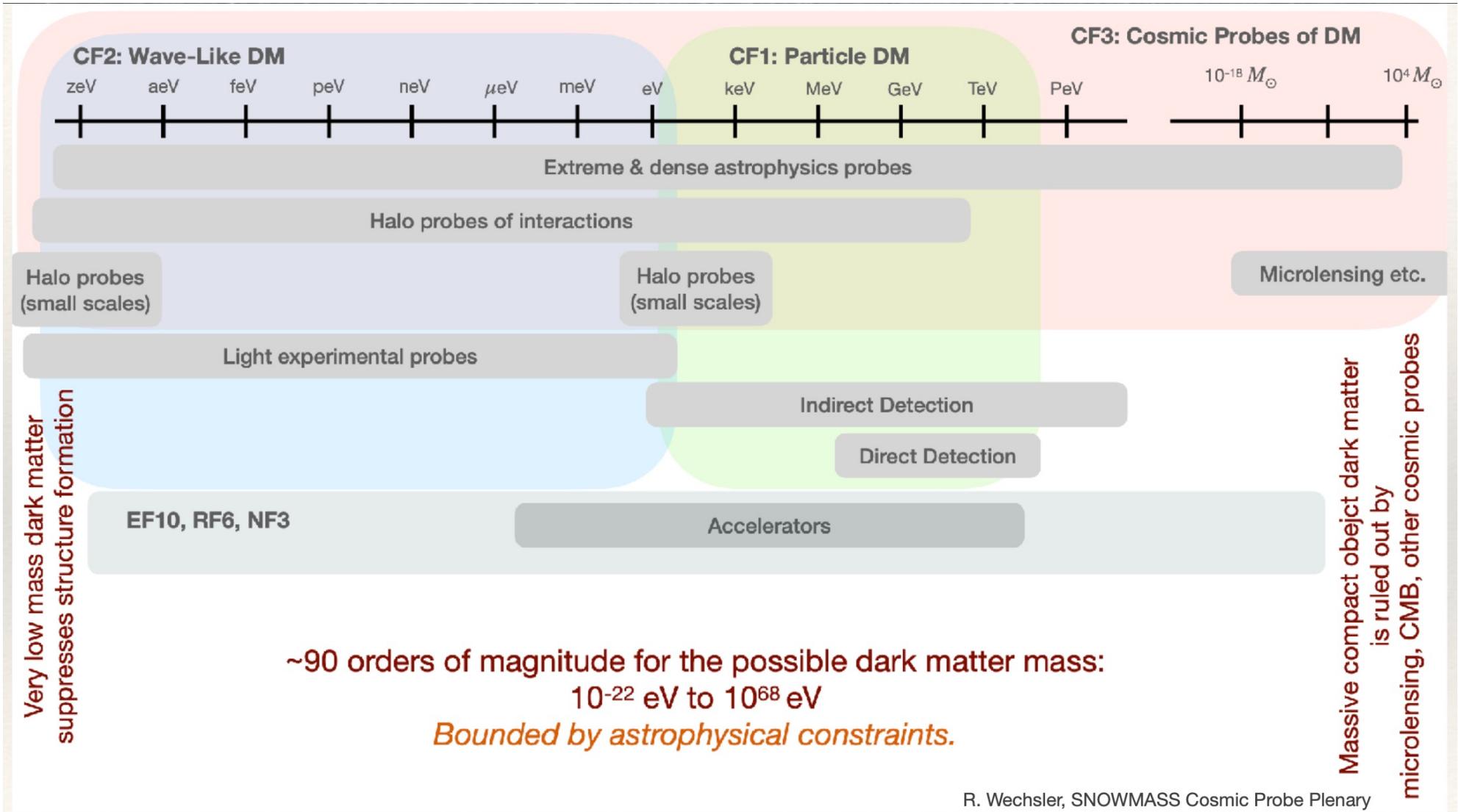
Roughly consistent between southern and northern galactic hemisphere as expected from dark matter



Galactic Center Excess still there. DM interpretation non ruled out but an experiment with better angular resolution at 100 MeV- GeV is necessary

Dark Matter Direct Detection Overview

Kimberly Palladino



The ANTARES detector



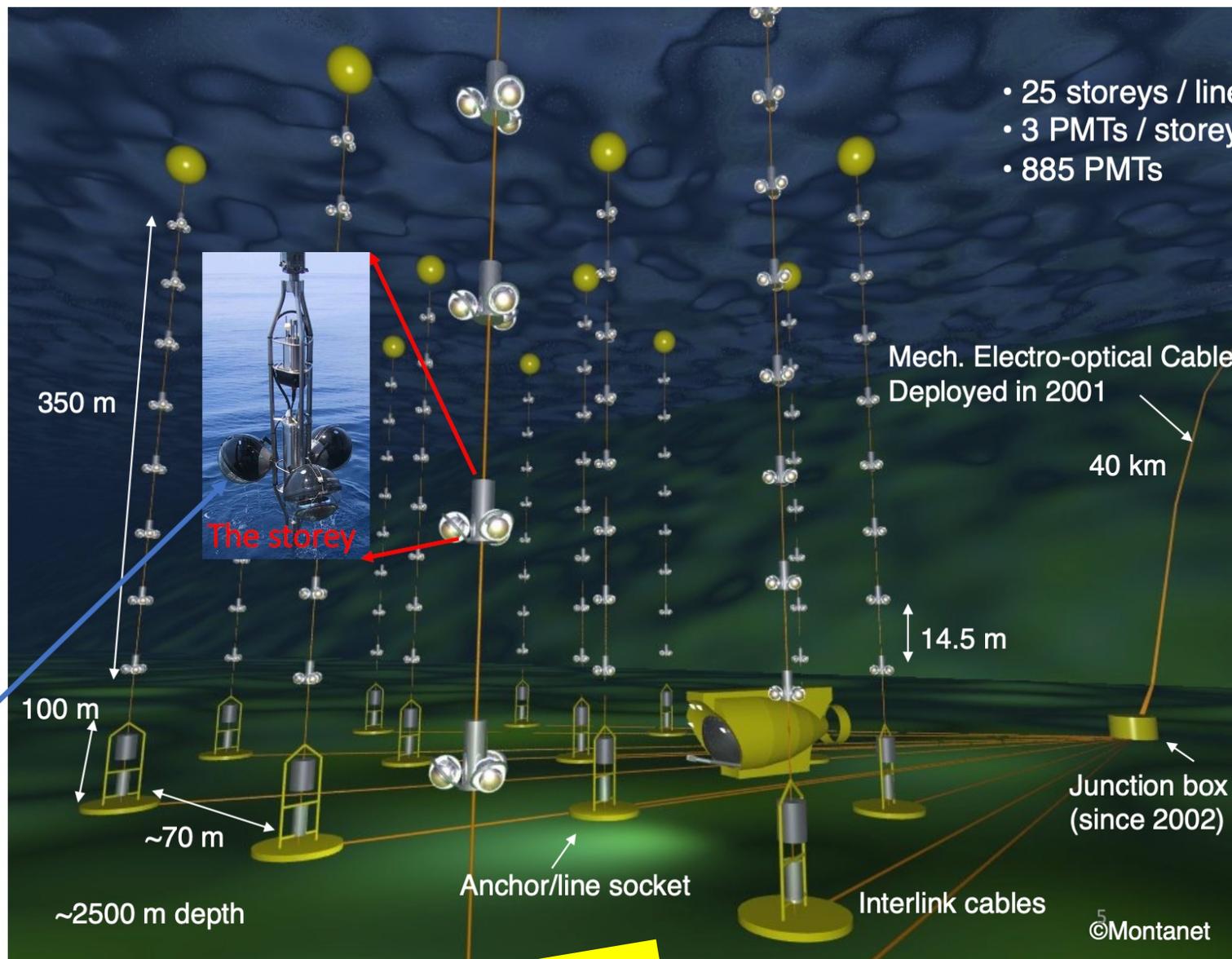
NIM A 656 (2011) 11



The Optical Module



NIM A 484 (2002) 369

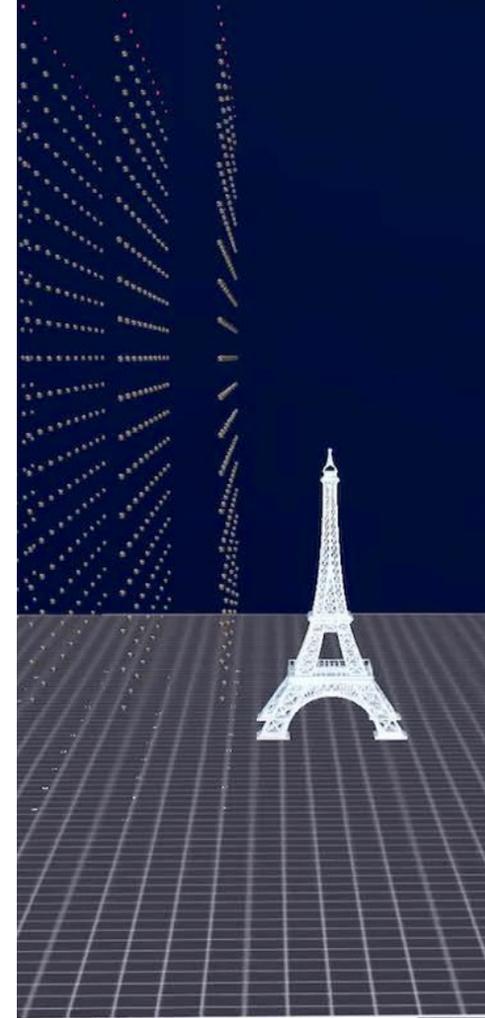


Talk by Annarita Margiotta



Summary

- KM3NeT is active and taking data!
- Detector performance as good as expected. First physics results.
- ORCA currently taking data with 10 lines.
~10 more lines ready for deployment late 2022, early 2023.
 - ◆ Funding assured, procurement and construction in progress, for ~50 strings.
- ARCA currently taking data with 19 lines.
 - ◆ Funding assured, procurement and construction in progress, for ~140 strings.
- Detector mass production in regime stage. Production rate will increase in the next years
- Interesting physics results in the next years!

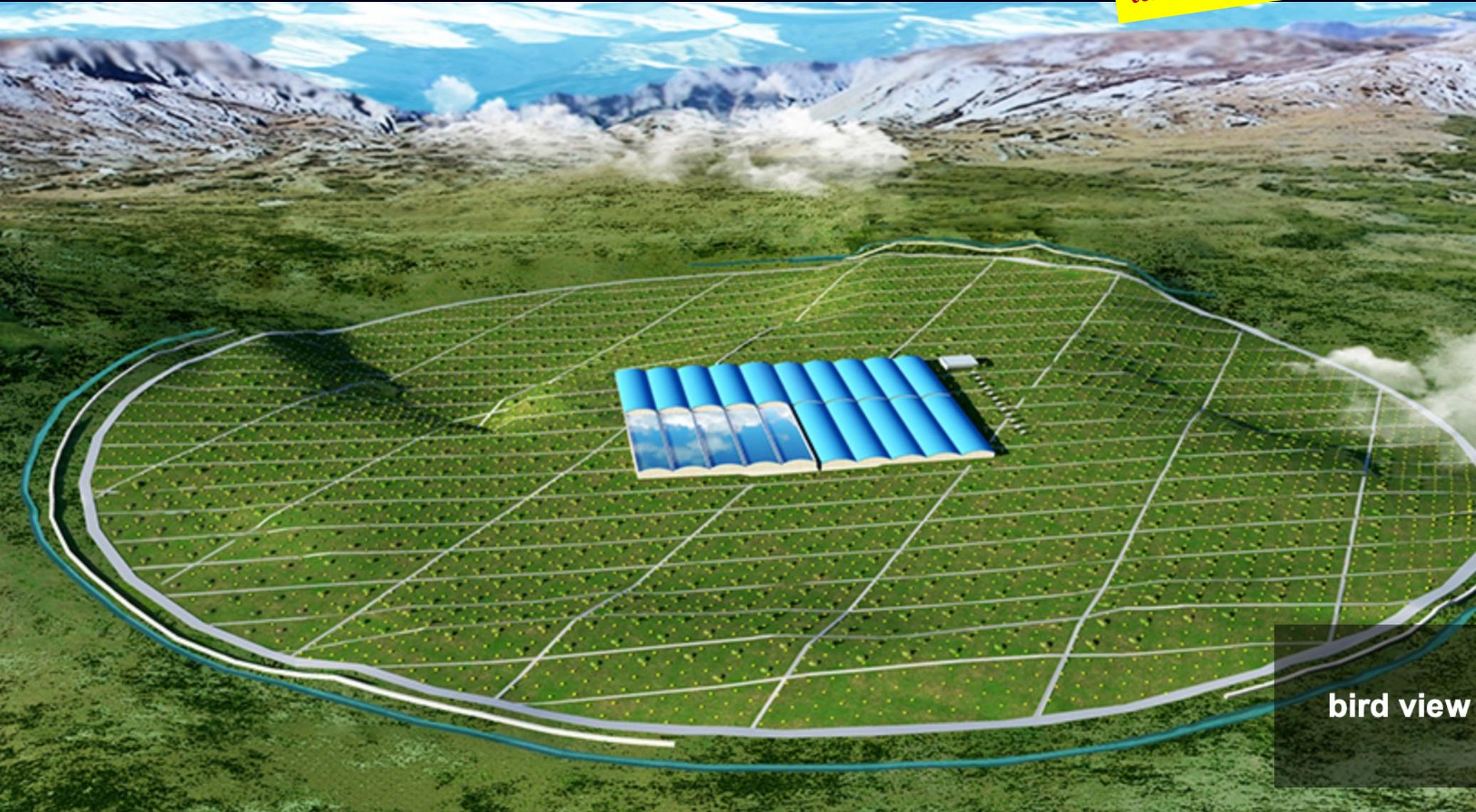


Simone Biagi

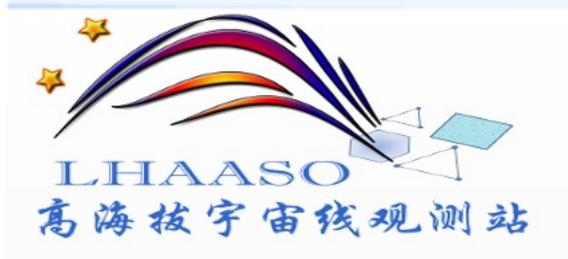


LHAASO

talk by Zhen Cao



bird view



talk by Zhen Cao

- LHAASO is completely built, and in full operation since July 2021
- Open-up “**UHE (>0.1 PeV) Astronomy**”
 - ① 12 PeVatrons are discovered in our galaxy
 - ② A photon at 1.4 PeV is recorded toward Cygnus constellation
- Discoveries:
 - ① Our galaxy is full of **PeVatrons** accelerating particles over 1 PeV
 - ② Potential **CR origins**: many type of candidates
 - ③ The Crab: extreme e-PeVatron emitting 1.1 PeV γ posing challenges
 - ④ Many new sources are discovered
- Precision Measurements of individual species CRs around knees will be measured at first time
- Fundamental rules, e.g. LIV, are tested in extreme condition

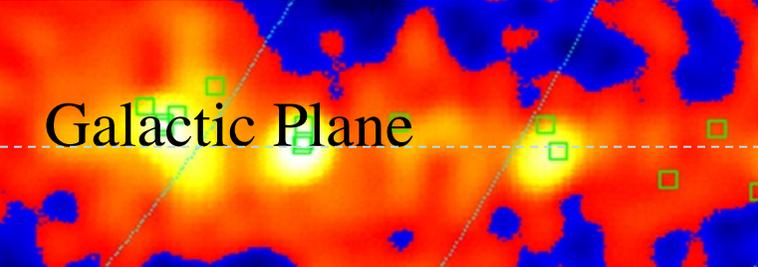
Cyg OB2



Mrk421



Galactic Plane



- ◆ Cygnus region: cosmic ray origin
- ◆ Extra galactic sources
- ◆ Diffuse γ -ray emission
- ◆ Spectra of individual CR species at “knees”

Gravitational Wave

Talk by Fulvio Ricci

The Global GW Detector Network

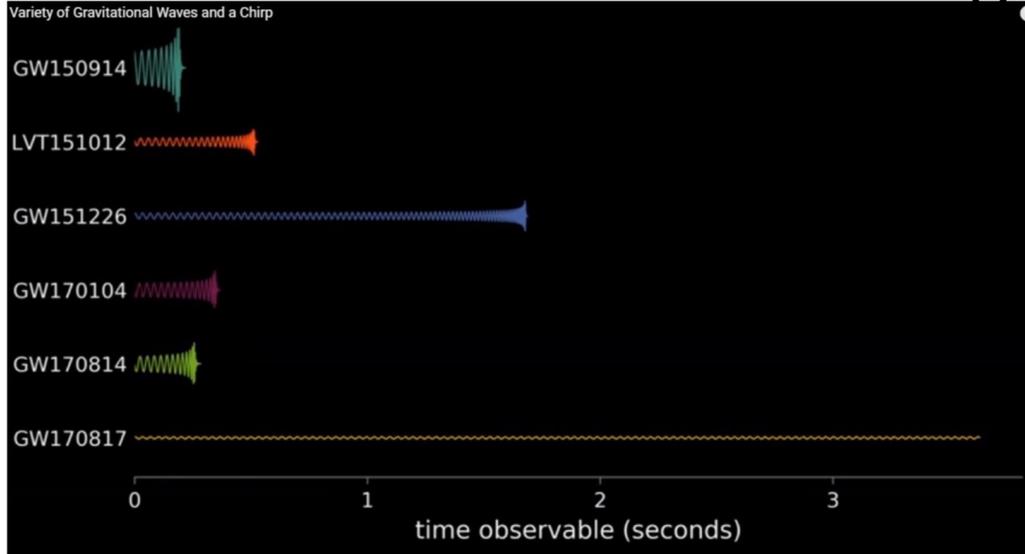


new run O4 will start at the beginning of the spring 2023

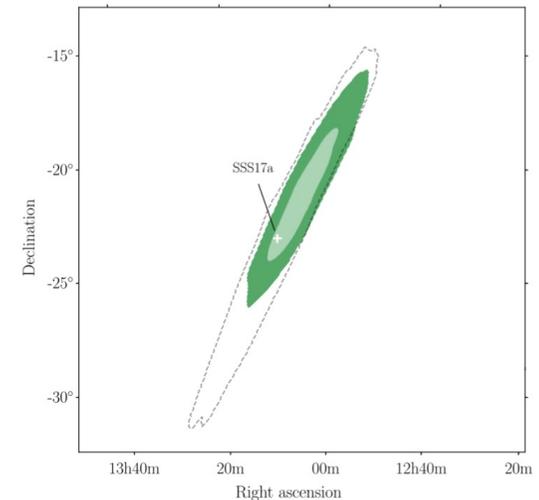
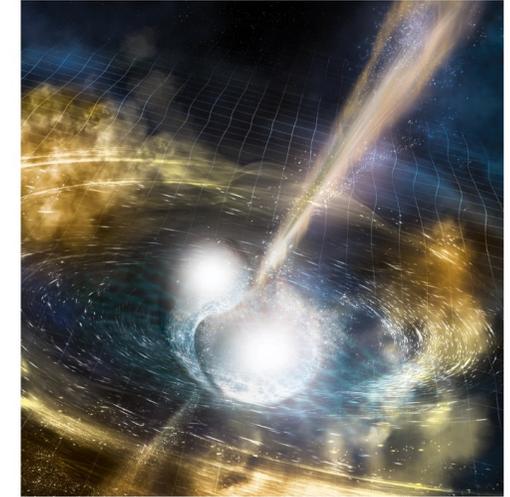
new run O4 will start at the beginning of the spring 2023

hopefully more events like GW170817

...and the first NS-NS merger GW170817



Event in
NGC 4993:
localisation
area ~ 19
deg²



	Low-spin prior ($\chi \leq 0.05$)	High-spin prior ($\chi \leq 0.89$)
Binary inclination θ_{JN}	146^{+25}_{-27} deg	152^{+21}_{-27} deg
Binary inclination θ_{JN} using EM distance constraint [108]	151^{+15}_{-11} deg	153^{+15}_{-11} deg
Detector-frame chirp mass \mathcal{M}^{det}	$1.1975^{+0.0001}_{-0.0001} M_{\odot}$	$1.1976^{+0.0004}_{-0.0002} M_{\odot}$
Chirp mass \mathcal{M}	$1.186^{+0.001}_{-0.001} M_{\odot}$	$1.186^{+0.001}_{-0.001} M_{\odot}$
Primary mass m_1	$(1.36, 1.60) M_{\odot}$	$(1.36, 1.89) M_{\odot}$
Secondary mass m_2	$(1.16, 1.36) M_{\odot}$	$(1.00, 1.36) M_{\odot}$
Total mass m	$2.73^{+0.04}_{-0.01} M_{\odot}$	$2.77^{+0.22}_{-0.05} M_{\odot}$
Mass ratio q	(0.73, 1.00)	(0.53, 1.00)
Effective spin χ_{eff}	$0.00^{+0.02}_{-0.01}$	$0.02^{+0.08}_{-0.02}$
Primary dimensionless spin χ_1	(0.00, 0.04)	(0.00, 0.50)
Secondary dimensionless spin χ_2	(0.00, 0.04)	(0.00, 0.61)
Tidal deformability $\tilde{\Lambda}$ with flat prior	300^{+500}_{-190} (symmetric) / 300^{+420}_{-230} (HPD)	(0, 630)

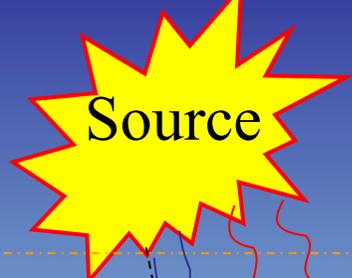
Abbott et al. Phys Rev. X 9, 011001 (2019)

The Astrophysical Journal 2018, 861:85 (10pp) [arXiv:1710.05450]

Some Open Problems

- Pevatrons : Felix Aharonian, Stefano Gabici
- Neutrino Astronomy : Eli Waxman, Elisa Resconi, Dafne Guetta
- Dark Matter Search still on going
(is the Galactic Center excess due to dark matter ?
at high energy we are starting to reach thermal relic value)

Astroparticle Physics



creation
acceleration
injection

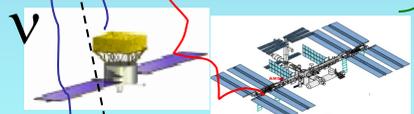
further
acceleration?

Propagation

Cosmic Rays

Modulation

Cosmic rays:
about 10 Myears
in the Galaxy
(6-7 g/cm²)



Space experiments ~ 400 km

Direct detection

Atmosphere

40 km

23 X₀

Balloons ~ 40 km
~3 g/cm² residual atmosphere

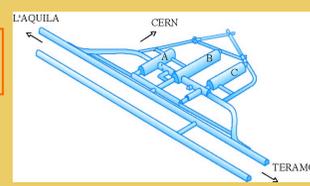
Extensive Air Shower
Detectors

Particle
Astrophysics
Experiments

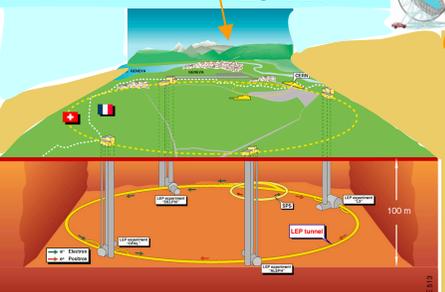
High Mountain
Detectors

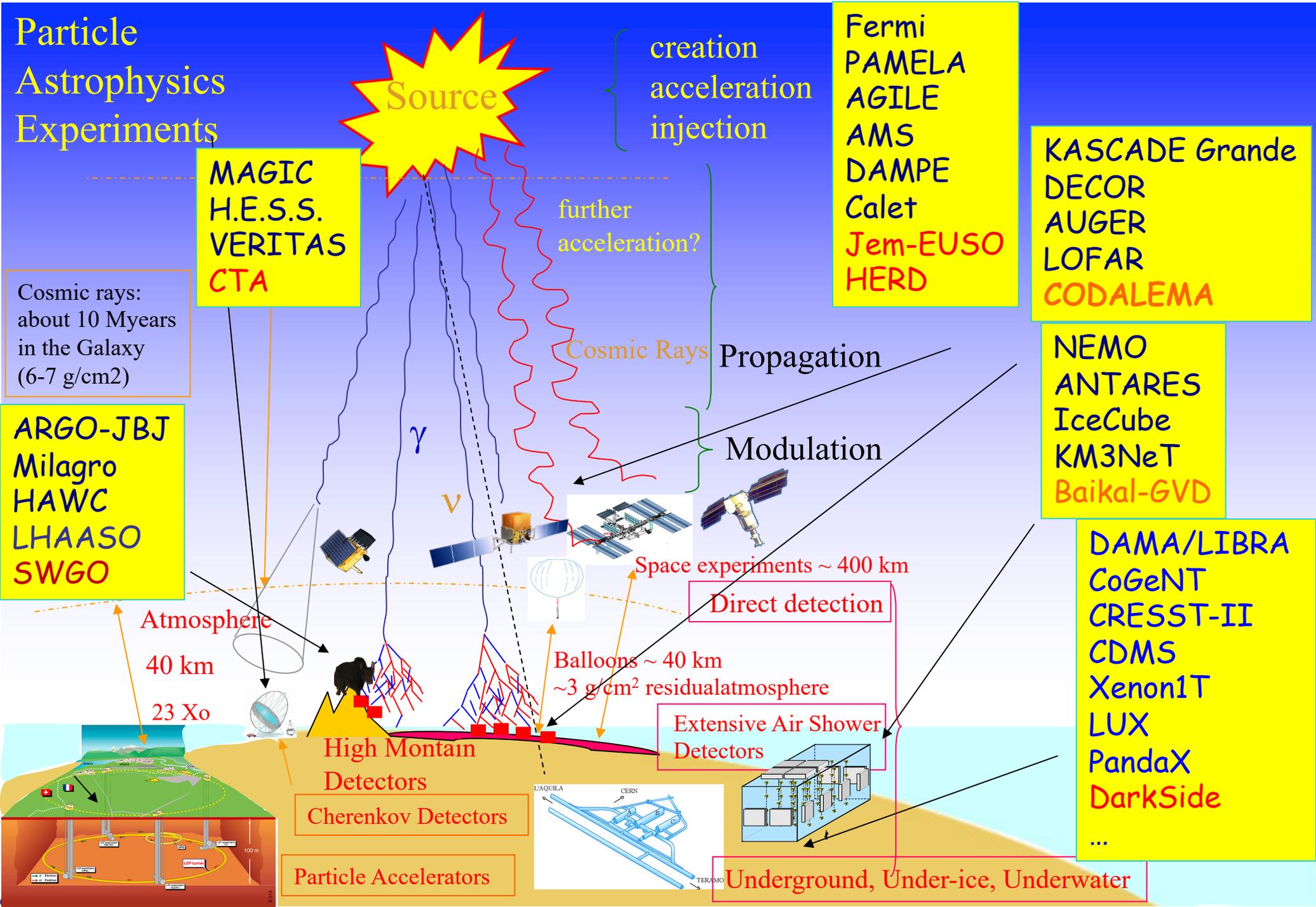
Cherenkov Detectors

Particle Accelerators

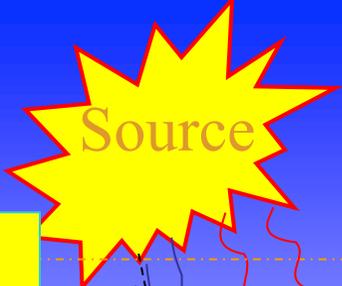


Underground, Under-ice, Underwater





Particle
Astrophysics
Experiments



creation
acceleration
injection

- Fermi
- PAMELA
- AGILE
- AMS
- DAMPE
- Calet
- Jem-EUSO
- HERD

- KASCADE Grande
- DECOR
- AUGER
- LOFAR
- CODALEMA

- MAGIC
- H.E.S.S.
- VERITAS
- CTA

further
acceleration?

Propagation

Modulation

Cosmic Rays

Cosmic rays:
about 10 Myears
in the Galaxy
(6-7 g/cm2)

- ARGO-JBJ
- Milagro
- HAWC
- LHAASO
- SWGO

- NEMO
- ANTARES
- IceCube
- KM3NeT
- Baikal-GVD

- DAMA/LIBRA
- CoGeNT
- CRESST-II
- CDMS
- Xenon1T
- LUX
- PandaX
- DarkSide
- ...

Space experiments ~ 400 km

Direct detection

Balloons ~ 40 km
~3 g/cm² residualatmosphere

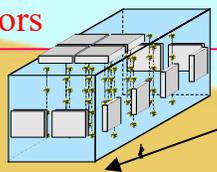
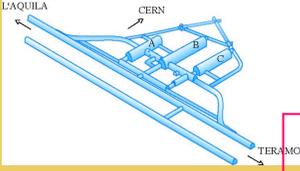
Extensive Air Shower
Detectors

Atmosphere
40 km
23 Xo

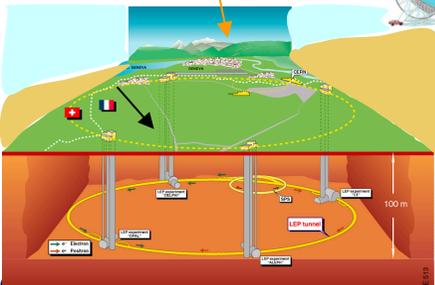
High Montain
Detectors

Cherenkov Detectors

Particle Accelerators



Underground, Under-ice, Underwater





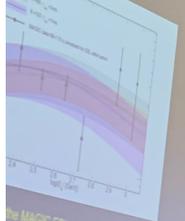
RICAP-22 Roma International Conference on AstroParticle Physics

6–9 Sep 2022

Physics Department, University "La Sapienza", Roma, Italy



Results: Photon spectrum



The MAGIC EBL-deconvolved
spectrum (65-110 eV) and the simulated
one (the π^0 -decay) after accounting for
absorption, for different parameter values, as
in Table 1.





see you in two years in Villa Tuscolana (Frascati) for

RICAP-24 Roma International Conference on AstroParticle Physics



already there for Ricap 16 , Conference and hotel in the same place and non far from Frascati center and from Roma Termini with train



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Angular and Energy Reconstruction



Direction via timing
(~ns timing yields 0.2°-1° resolution)



Primary energy via energy at ground
(shower fluctuations dominate resolution ~40%)

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