

Limits on DM annihilation from a combined analysis of dwarf spheroidal galaxies with MAGIC

17th MultiDark Consolider Workshop

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- Expected gamma-ray flux from annihilating DM particles:

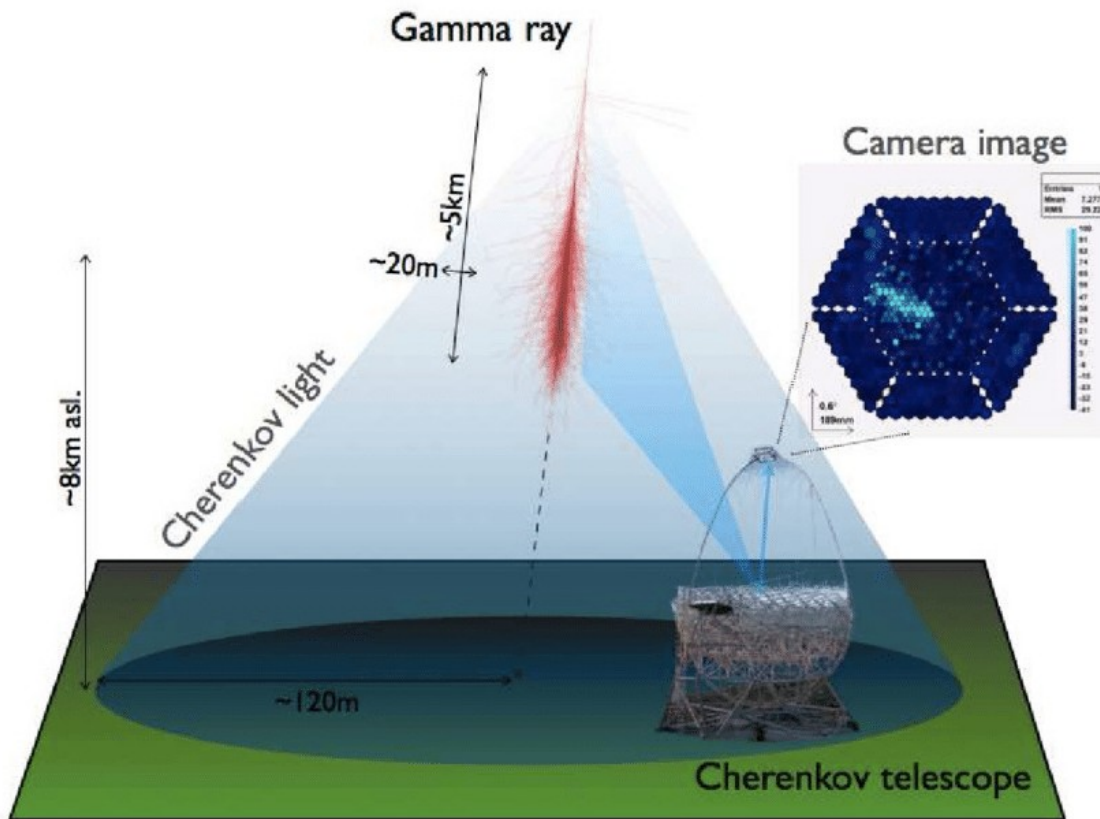
$$\frac{d\Phi(\Delta\Omega)}{dE} = \frac{1}{4\pi} \cdot \frac{\langle\sigma_{ann}v\rangle}{2m_{DM}^2} \cdot \frac{dN}{dE} \cdot J(\Delta\Omega)$$

- $\langle\sigma_{ann}v\rangle$ → velocity-averaged cross-section
- m_{DM} → dark matter mass
- $\frac{dN}{dE}$ → gamma-ray spectrum for the considered annihilation process, here simple quark/anti-quark or lepton/anti-lepton, for more diverse final states see the next talks on Branon DM
- $J(\Delta\Omega)$ → J-factor, measurement of the DM content along the line of sight

MAGIC Cherenkov telescopes



MAGIC: 2 Cherenkov telescopes on the Canary island of La Palma



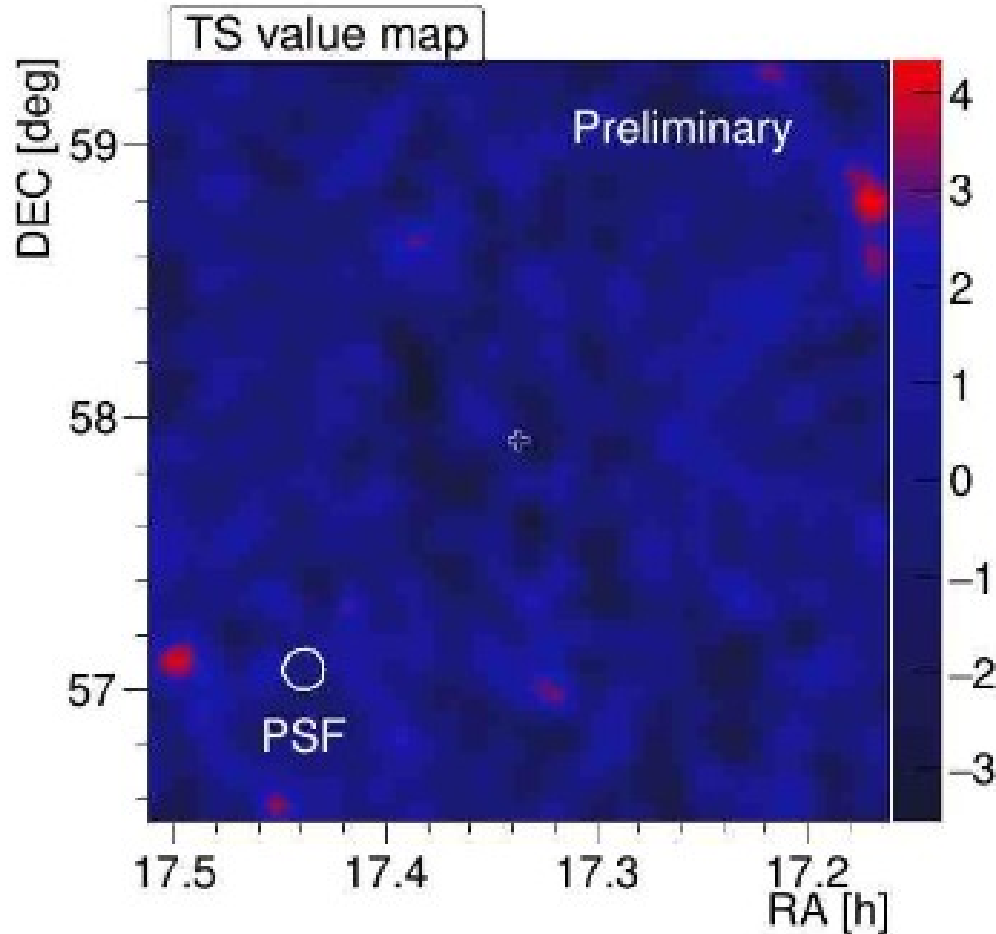
dSphs observations by MAGIC



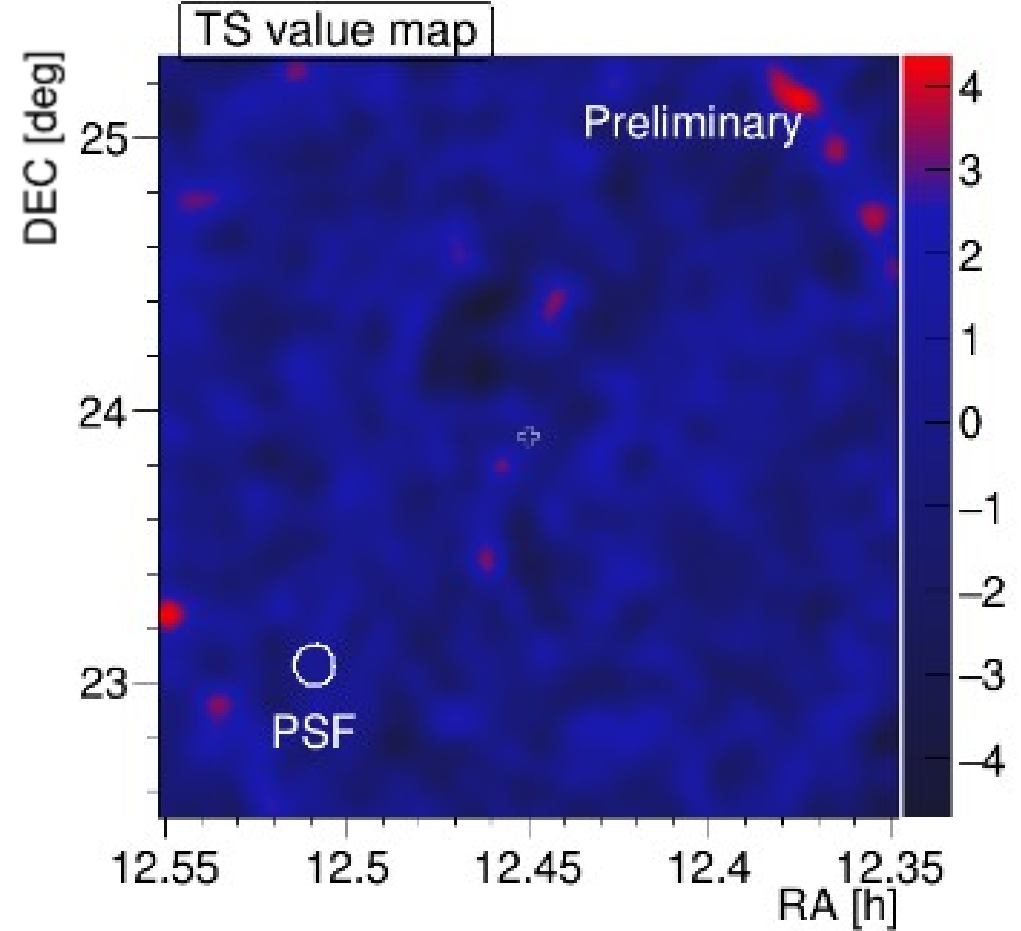
- MAGIC field of view: ~ 3.5 degrees \rightarrow Where to point?
- Usual targets:
 - Galactic Centre
 - Large DM content associated with large uncertainty, crowded astrophysical region
 - Galactic Halo
 - Good for DM decay search [D. Ninci et al PoS(ICRC2019)538]
 - Galaxy clusters
 - Moderate DM content, presence of a known astrophysical background
 - e.g. the Perseus cluster [Phys. Dark Universe, 22, 38-47]
 - Dwarf spheroidal galaxies (dSphs)
 - Moderate DM content and no known astrophysical background
 \rightarrow this presentation

- Benefit from an observational diversification strategy:
 - More statistics
 - Reduced weight from single target affected by possible large systematic error on the determination of its DM content
- Observed dSphs by MAGIC:
 - 2013: Segue 1 with $\log J = 19.36 \pm 0.35 \text{ GeV}^2 \text{ cm}^{-5}$
 - ~160 hours [JCAP, 1402:008, JCAP, 1602(02):039]
 - 2018: Ursa Major II with $\log J = 19.42 \pm 0.42 \text{ GeV}^2 \text{ cm}^{-5}$
 - ~95 hours [JCAP, 1803(03):009]
 - **NEW**: Draco with $\log J = 19.05 \pm 0.05 \text{ GeV}^2 \text{ cm}^{-5}$
 - ~52 hours
 - **NEW**: Coma Berenices with $\log J = 19.02 \pm 0.41 \text{ GeV}^2 \text{ cm}^{-5}$
 - ~50 hours

Skymaps



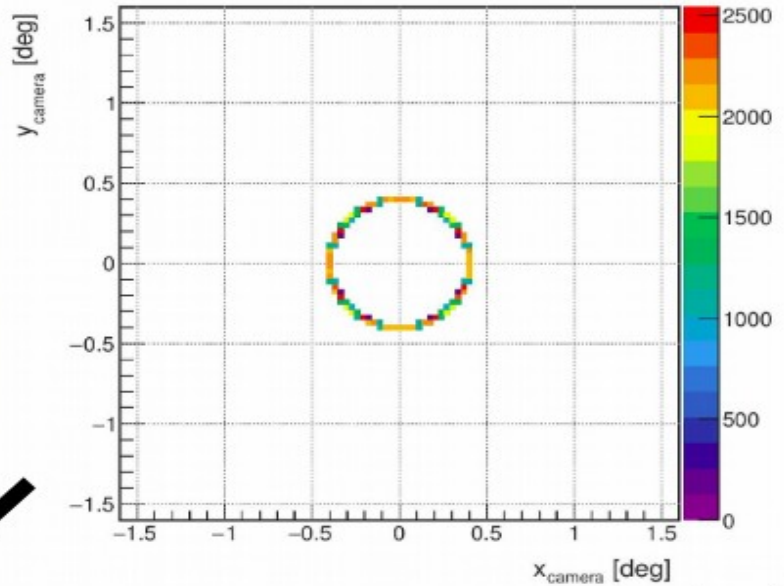
Draco



Coma Berenices

Morphology of the extended DM profile

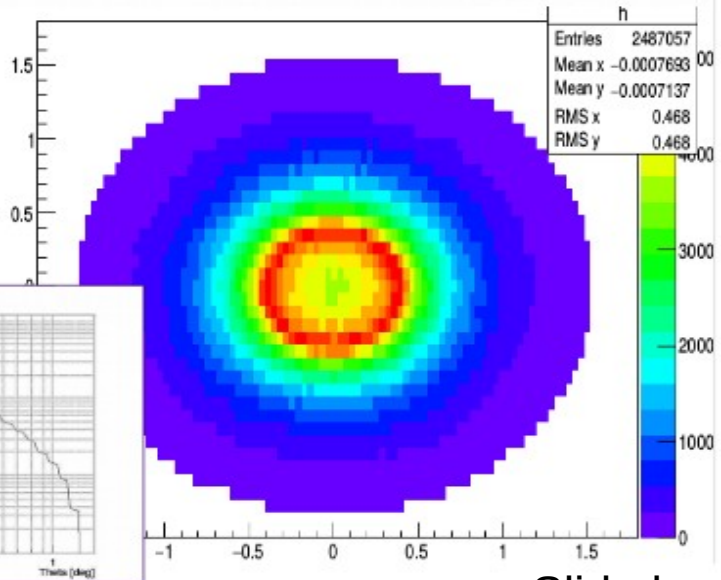
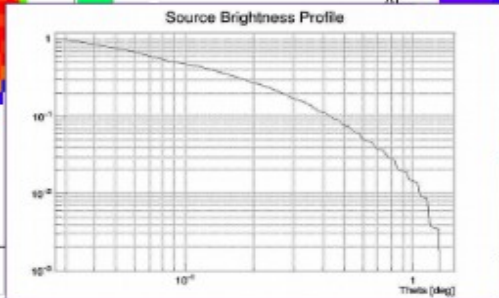
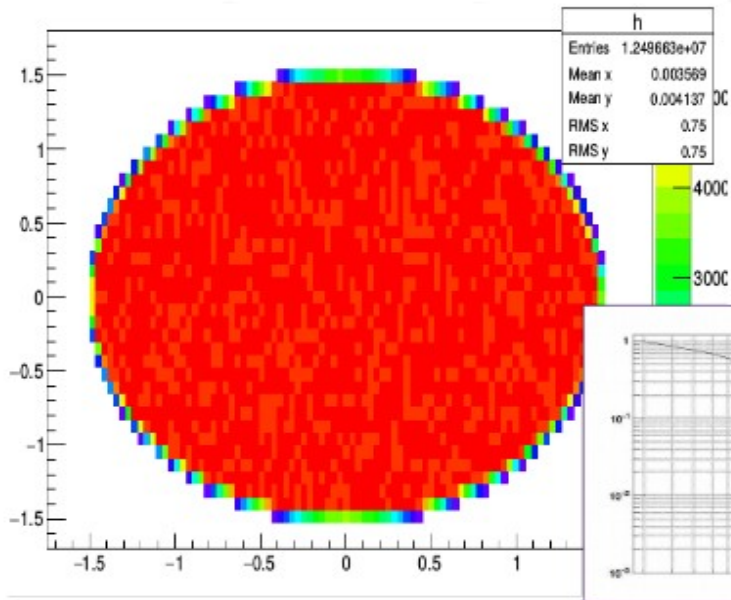
TARGET	EXTENSION θ_{\max} [deg]
Segue 1	0.35
Ursa Major II	0.53
Draco	1.30
Coma Berenices	0.31



POINTLIKE SOURCE

MAGIC PSF < 0.1deg

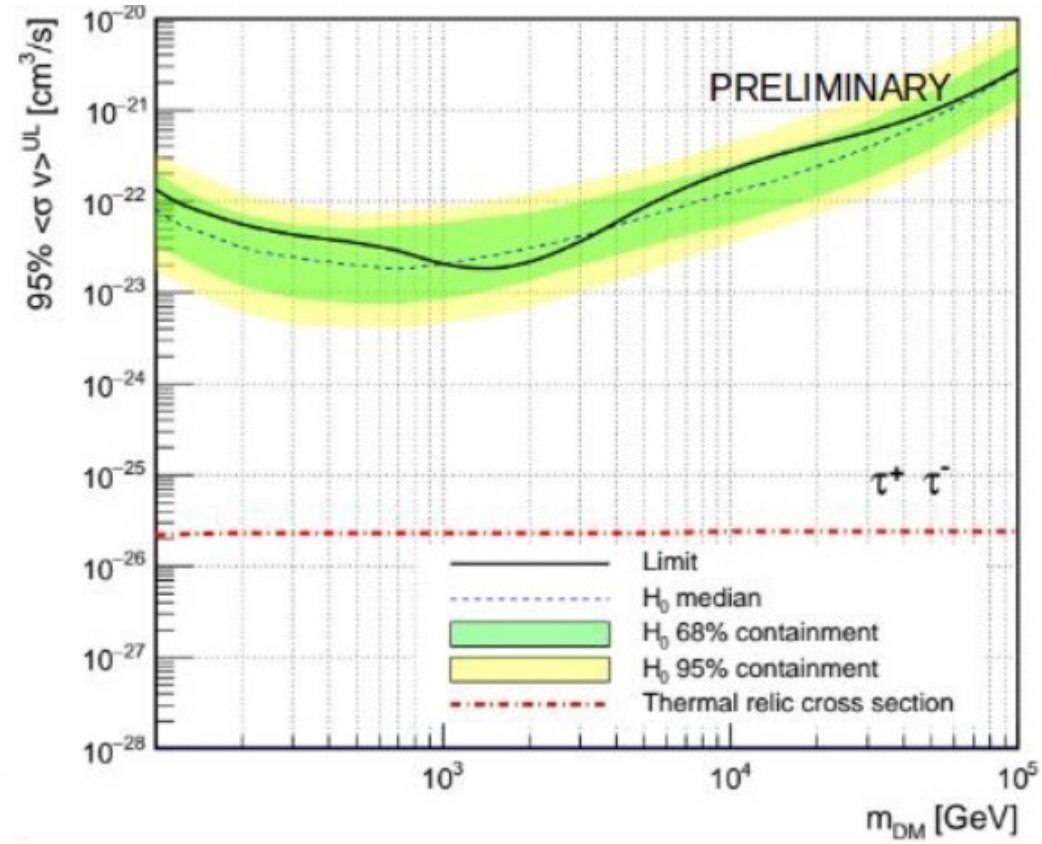
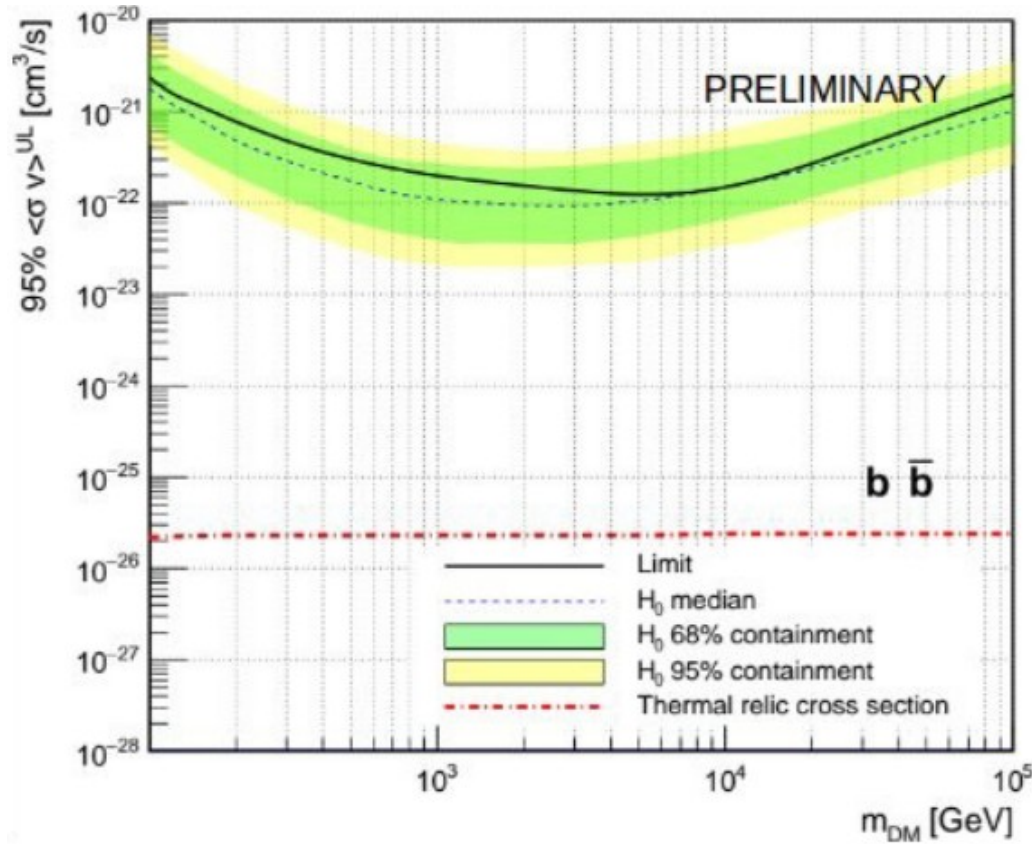
EXTENDED SOURCE



DONUT MONTECARLO METHOD

Slide by C. Maggio

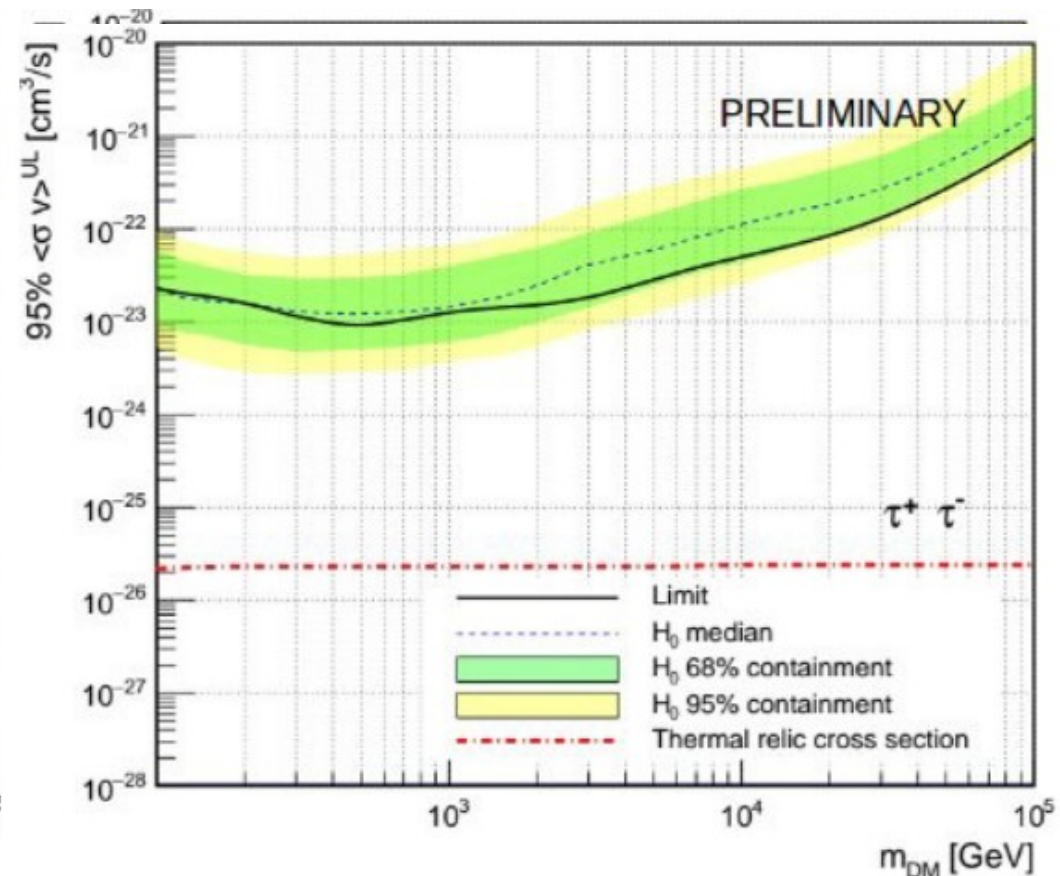
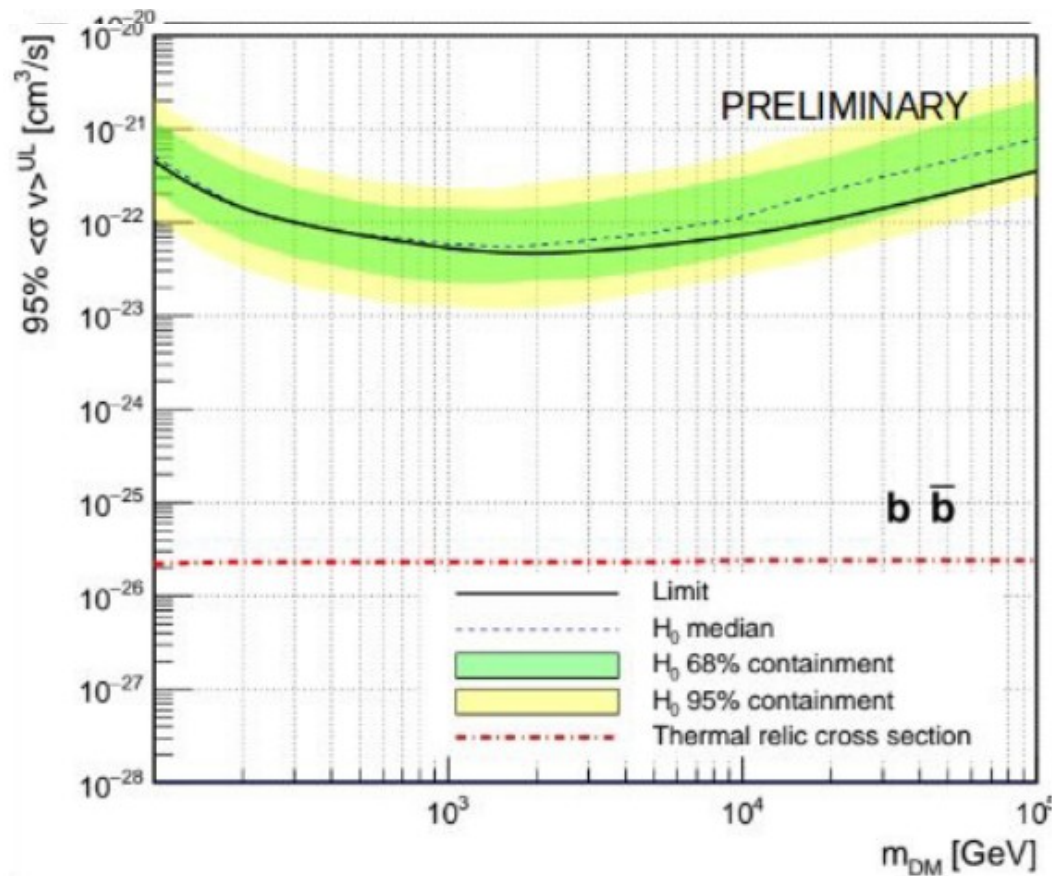
Draco: preliminary results



Draco limits with ~52 hours of data

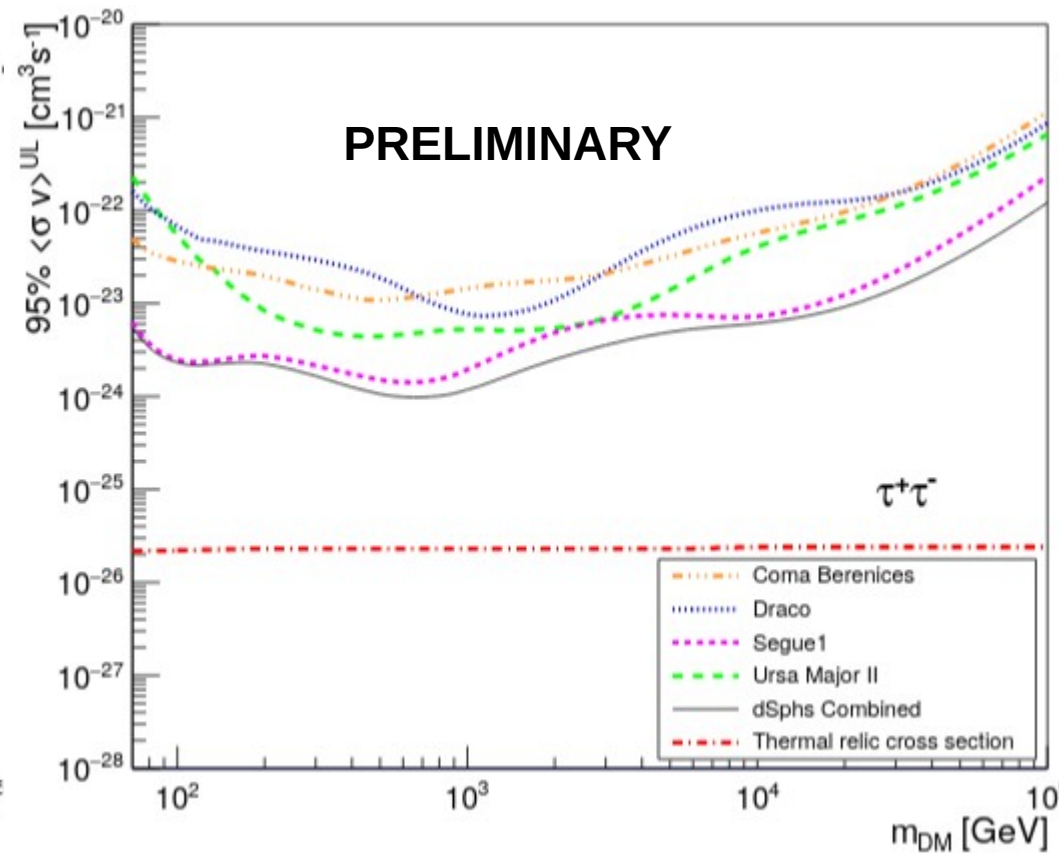
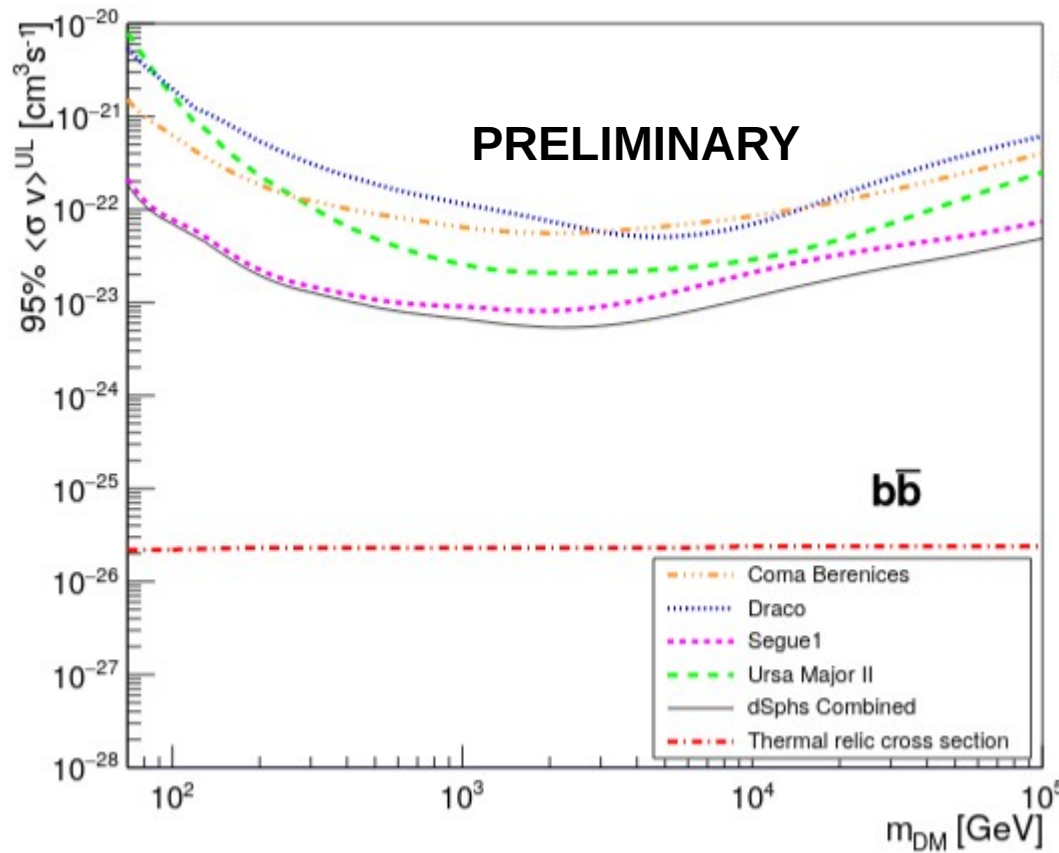
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Coma Berenices: preliminary results



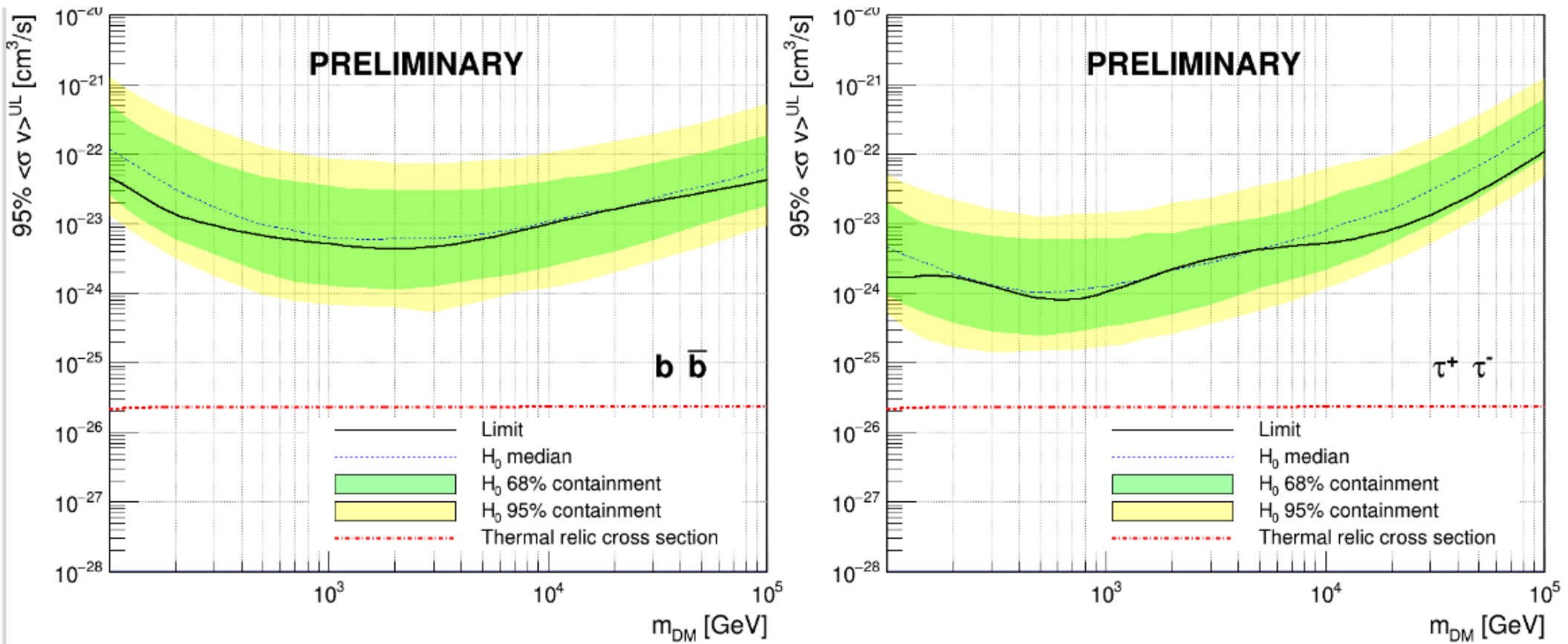
Coma Berenices limits with ~50 hours of data

Combined limits: preliminary results



Combined limits improved by a factor up to 40-50%

Combined limits: preliminary results



Total of 355 hours used in this analysis:

- largest data set on dSphs by Cherenkov telescopes
- best limits on DM annihilation with dSphs from Cherenkov telescopes

Summary and conclusion



- MAGIC extended the pool of observed dSphs in order to increase the available statistics and decrease the effect of possible systematics
- New dSphs observed include Draco for ~52 hours and Coma Berenices for ~50 hours → no sign of DM found
- In total MAGIC observed dSphs for ~355 hours, providing the best limits to date on dSphs from Cherenkov telescopes
 - combined limits improved by a factor up to 40-50% the best single one, in addition to greater robustness
- MAGIC also involved in a combination project for dwarf galaxies data with Fermi-LAT, HAWC, HESS, and VERITAS
- Currently discussing the possibility to extend the combination project to neutrino experiments, in part thanks to the previous workshop in Huelva!