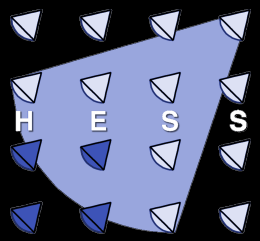
Searches for DM signals from the Galactic Center region with HESS

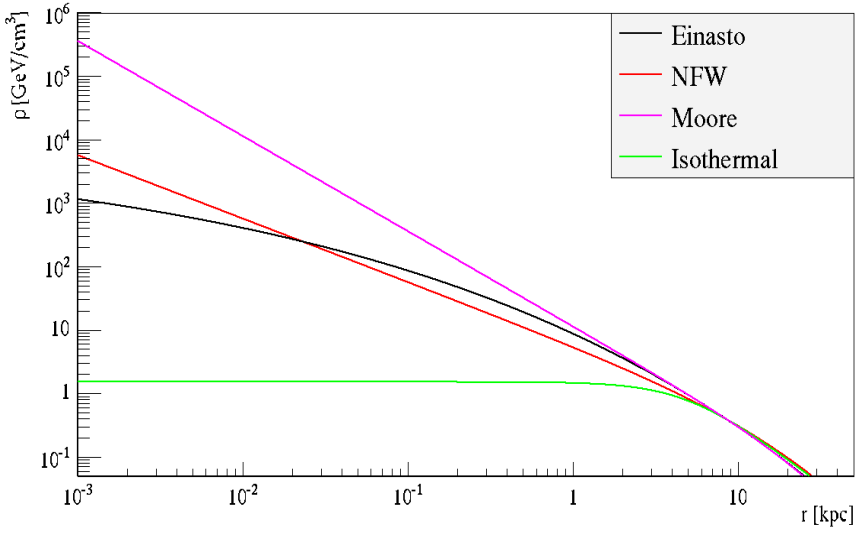
Daniil Nekrassov
on behalf of the
H.E.S.S. collaboration

IDM 2010
Montpellier
29.07.10



GC and search for DM

- GC for DM search in TeV γ-rays because:
  - DM density at maximum, least distance
    - Except for subhalos, but here no real prediction possible
  - TeV γ-rays with no foreground, no absorption
    - e.g. galaxy clusters suffer from EBL absorption
  - Connection to measurements of multiwavelength, $e^{\pm}$, p
    - Only photons (+neutrinos) from dwarf galaxies
- Drawbacks
  - Astrophysical background processes
  - DM density profile unknown

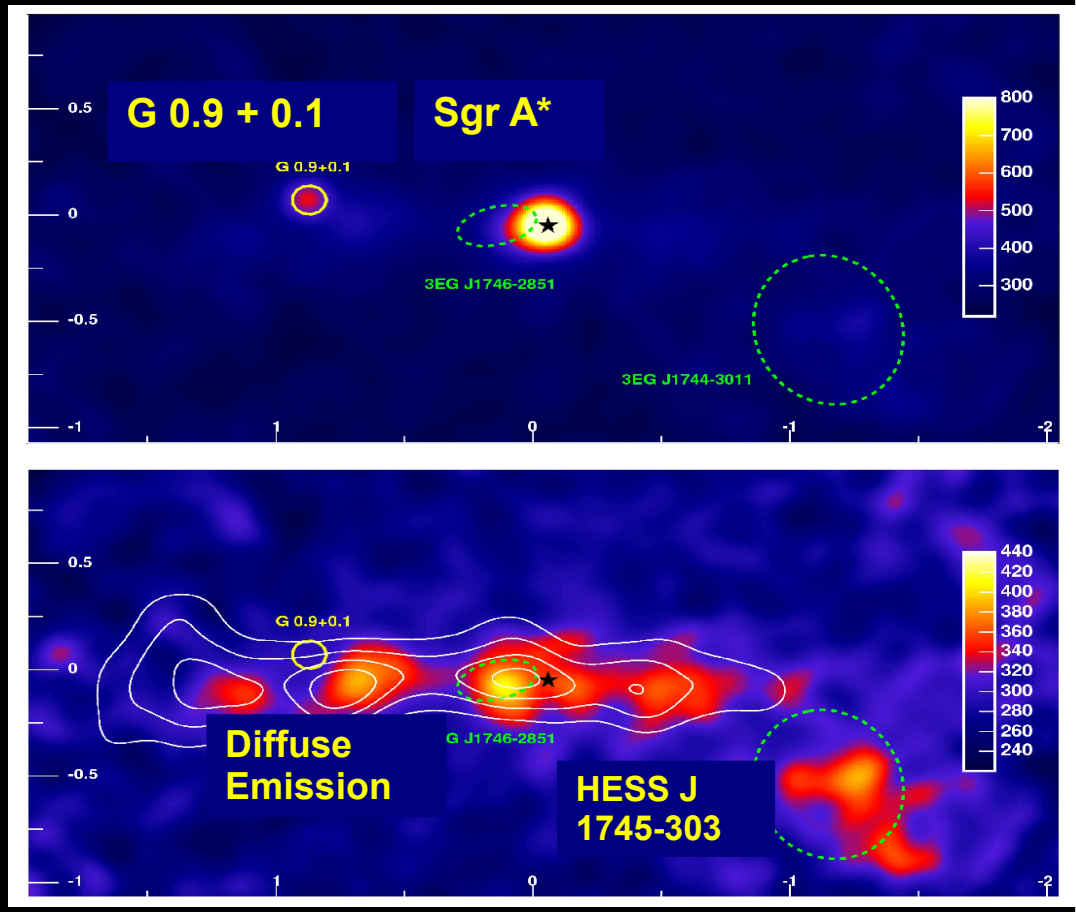


H.E.S.S. experiment

- Array of 4 Imaging Cherenkov Telescopes
- Energy range 0.1 – 100 TeV (!)
- Angular resolution ~ 0.1° (!)
- Energy resolution ~ 15 – 20%
- 1 % crab flux ($1*10^{-13}$ cm^{-2} s^{-1} TeV^{-1} at 1 TeV) in 25h (!)

TeV view of the GC region

- Central point source detected in 2004 (Whipple, Cangoroo, HESS, Magic)
  - Origin still not fully established (SMBH, PWN)
- Other sources detected only by HESS:
  - G 0.9 + 0.1 (PWN)
  - HESS J 1745 – 303 (UnID)
  - Diffuse emission (CR – MCs)
- All sources with astrophysical explanations

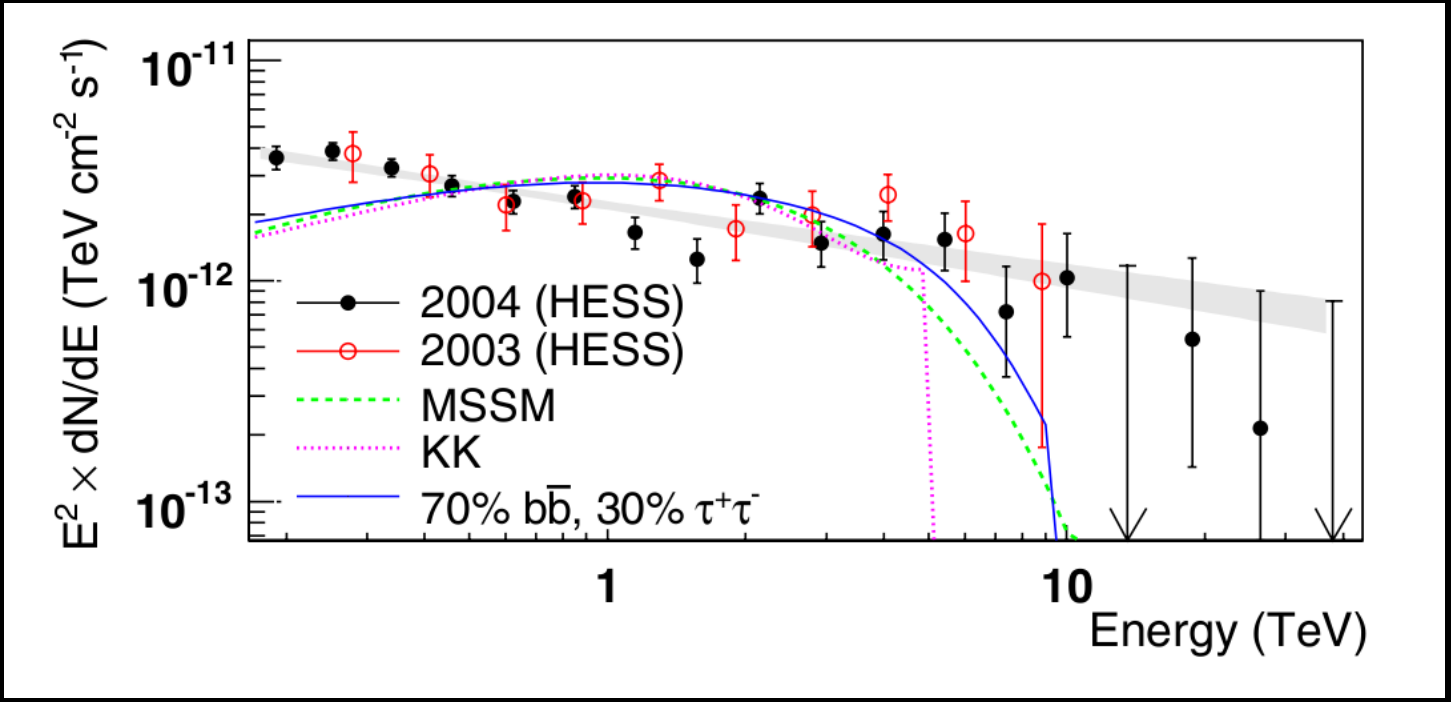


HESS Results and DM interpretation
GC point source

- HESS J1745 – 295 of main interest for DM search:

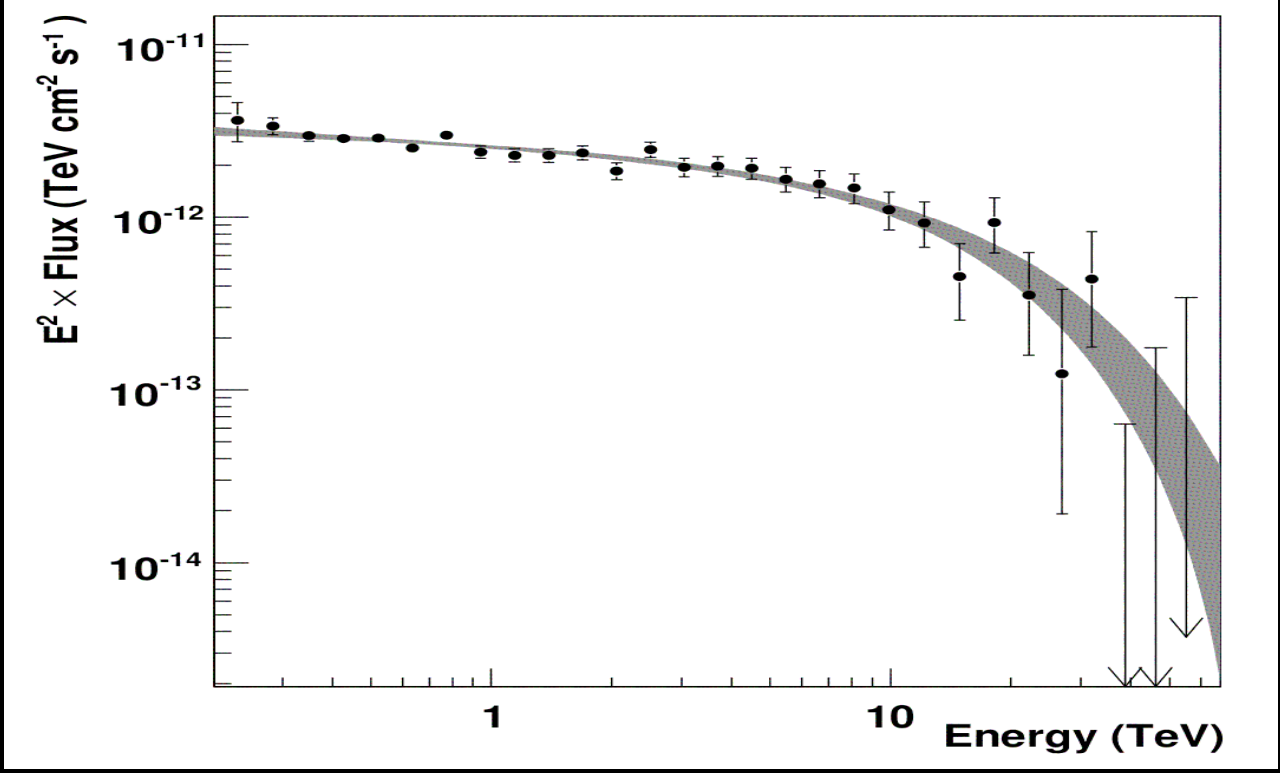
HESS Results and DM interpretation GC point source

- HESS J1745 – 295 of main interest for DM search:
  - HESS paper on DM interpretation (PRL 97, 221102, 2006):
    - Only weak limits possible, spectrum is a smooth power law



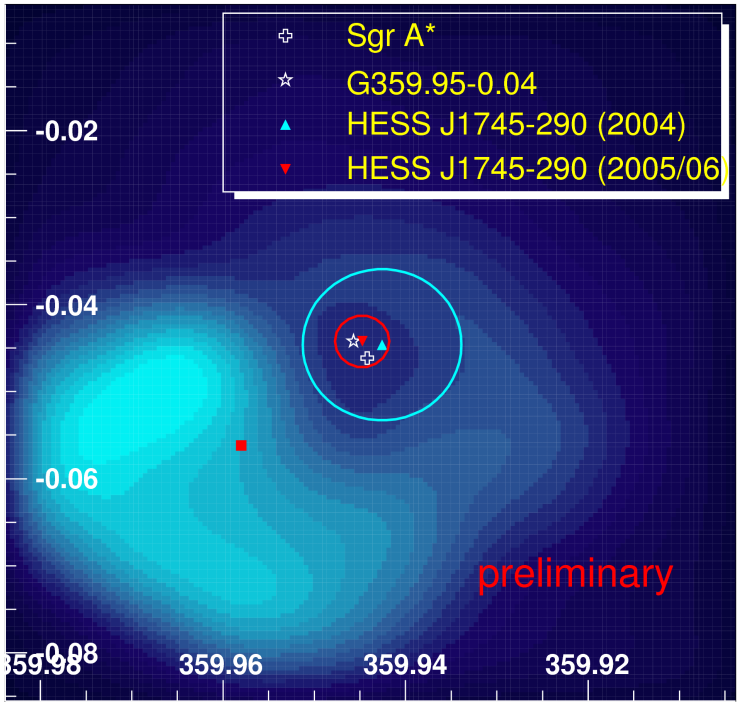
HESS Results and DM interpretation
GC point source

- HESS J1745 – 295 of main interest for DM search:
  - Update paper on the source spectrum (A&A 503, 817-825 (2009)):
    - Power law with exp. Cut-off, typical for particle accelerators --> Statistics improved, DM even more unlikely



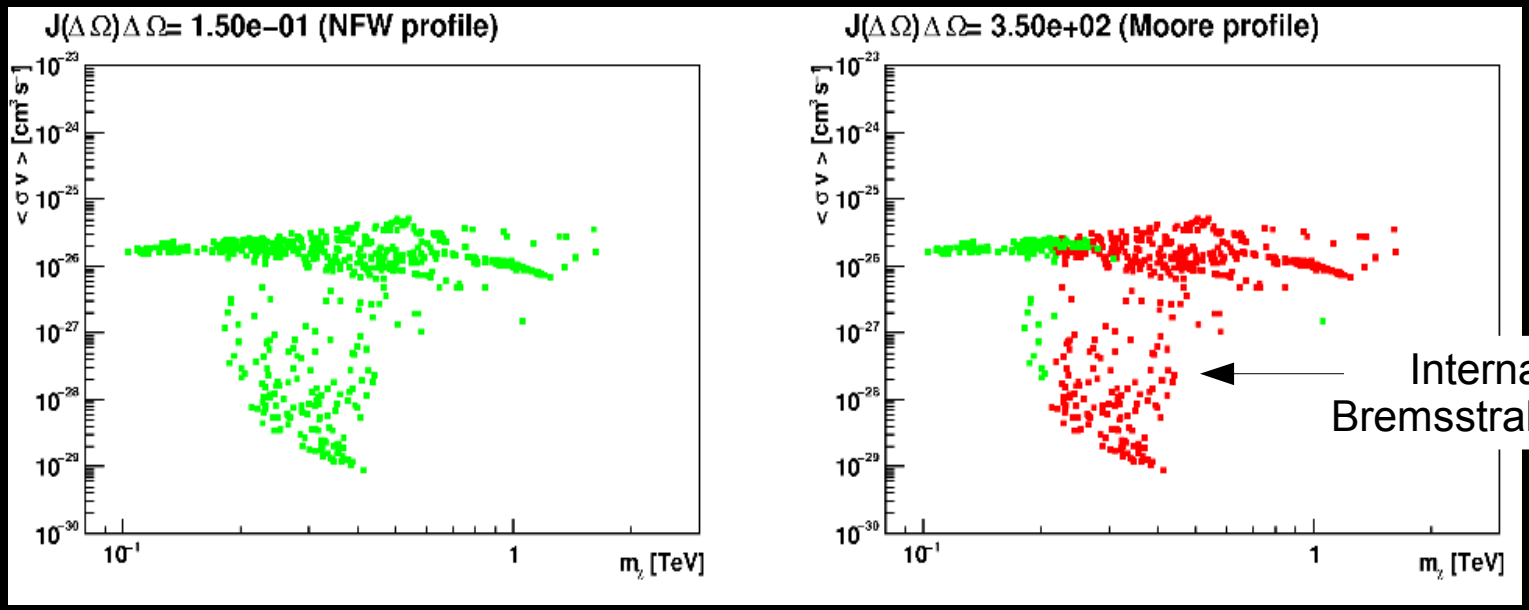
HESS Results and DM interpretation
GC point source

- HESS J1745 – 295 of main interest for DM search:
  - Update paper on the source location (MNRAS 402 (2010) 1877-1882):
    - Both SMBH SgrA* and PWN 359.95-0.04 are compatible with source position, both can reproduce the spectrum



HESS Results and DM interpretation
GC point source

- Most likely γ-ray source of astrophysical origin
- Data only constraining for special cases (cusped profiles, spectral features)
  - Ripken et al. (poster contribution at ICRC '09)



HESS Results and DM interpretation

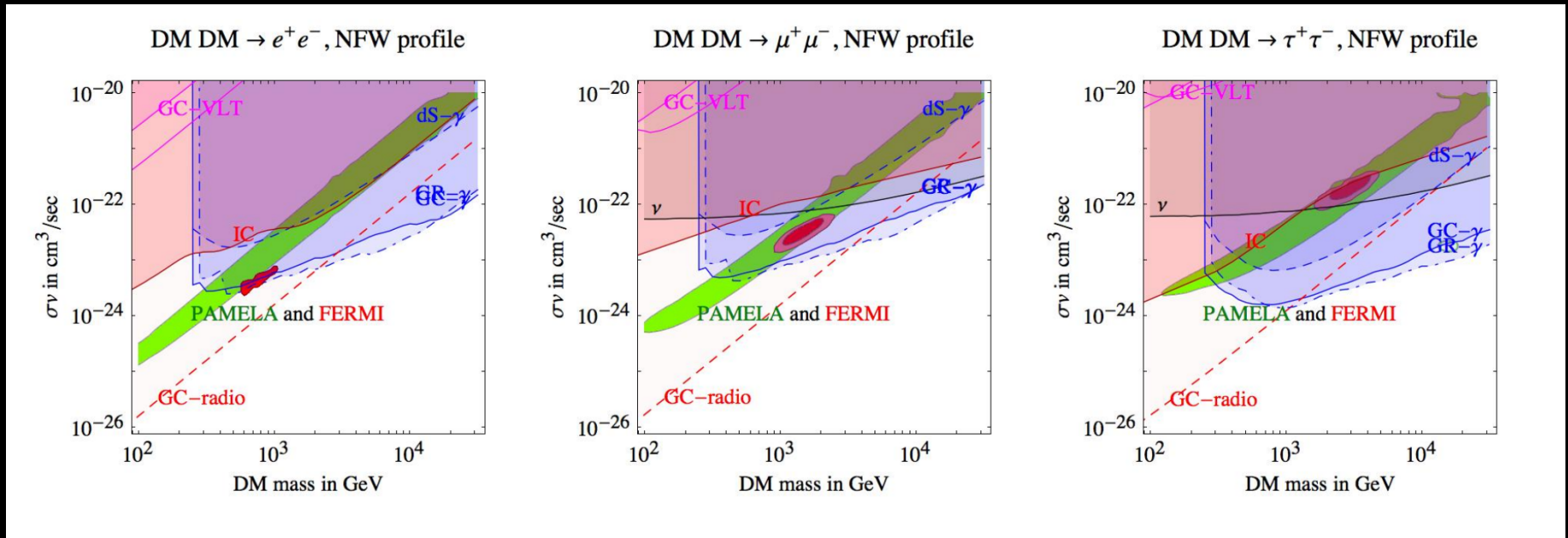
Triggered publications

- GC point source data not very promising if stand-alone, sensitive to the DM profile shape
- Combination of data: GC point source, GC diffuse emission, multiwavelength, $e^{\pm}$, p measurements

HESS Results and DM interpretation

Triggered publications

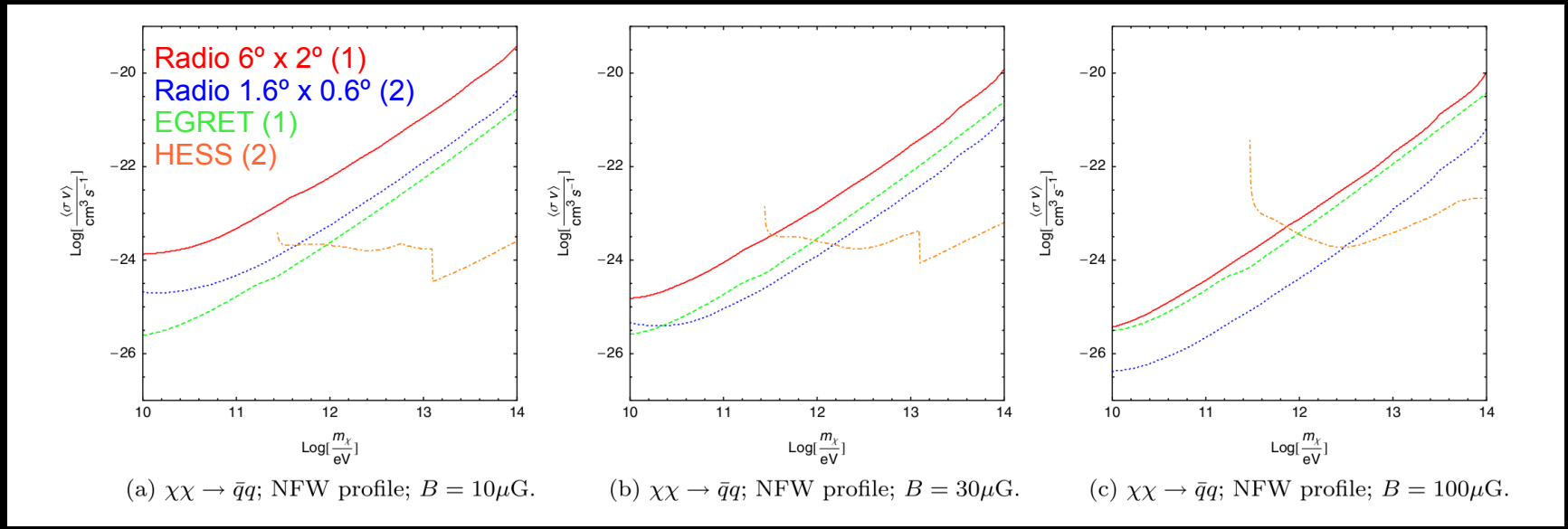
- GC point source data not very promising if stand-alone, sensitive to the DM profile shape
- Combination of data: GC point source, GC diffuse emission, multiwavelength, $e^{\pm}$, p measurements:
  - Meade et al. (astro-ph/0905.0480): Comparison with Pamela, ATIC, Fermi



HESS Results and DM interpretation

Triggered publications

- GC point source data not very promising if stand-alone, sensitive to the DM profile shape
- Combination of data: GC point source, GC diffuse emission, multiwavelength, $e^{\pm}$, p measurements:
  - Crocker et al.(PR D 81, 063516 (2010)): Constraints through radiation by cooling electrons in the GC area



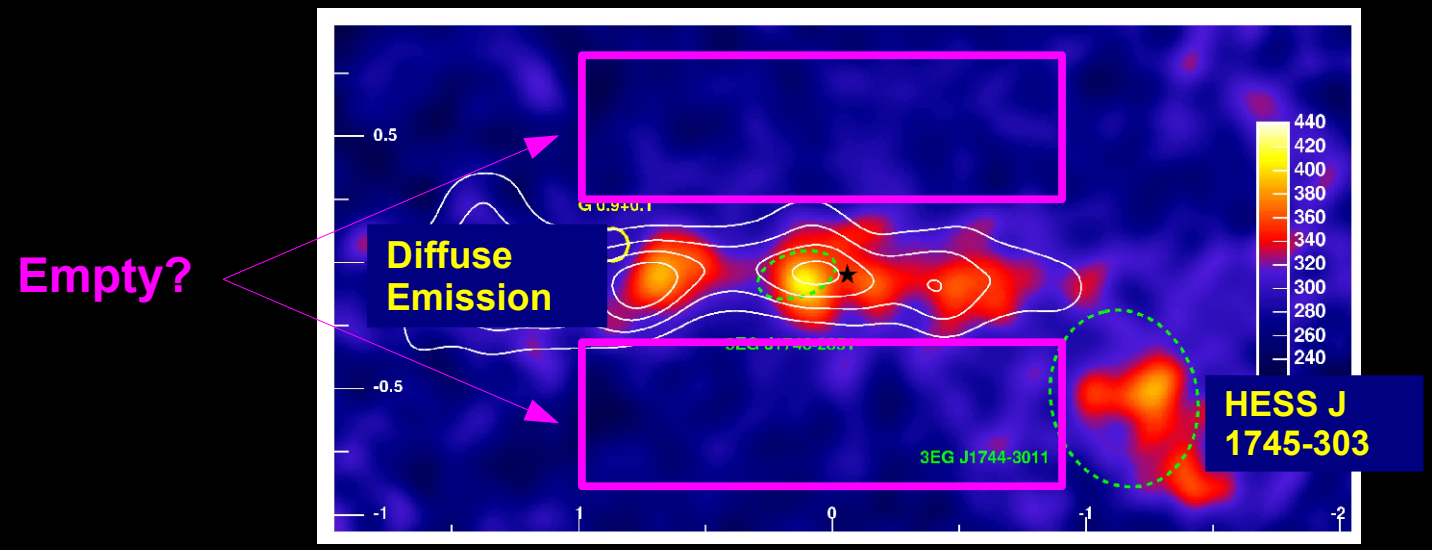
(a) $\chi\chi \to \bar{q}q$; NFW profile; $B = 10\mu$G. (b) $\chi\chi \to \bar{q}q$; NFW profile; $B = 30\mu$G. (c) $\chi\chi \to \bar{q}q$; NFW profile; $B = 100\mu$G.

HESS Results and DM interpretation Status

- GC γ-ray point source
  - Located where density is the highest
  - Strong source with astrophysical origin
  - Does not allow for tight limits (with exceptions)
- GC diffuse emission
  - Competative limits due to lower flux, relatively high DM density
- Some interesting results if used in a multimessenger context (ATIC/Pamela anomalies)

Current activities

- More than 100 hrs spent on GC region
  - Unlikely that existing results vastly improve
- But: Only regions with γ-ray sources used
  - Remaining field of view seems empty!
  - Constraints from regions free of astrophysical background?



Current activities

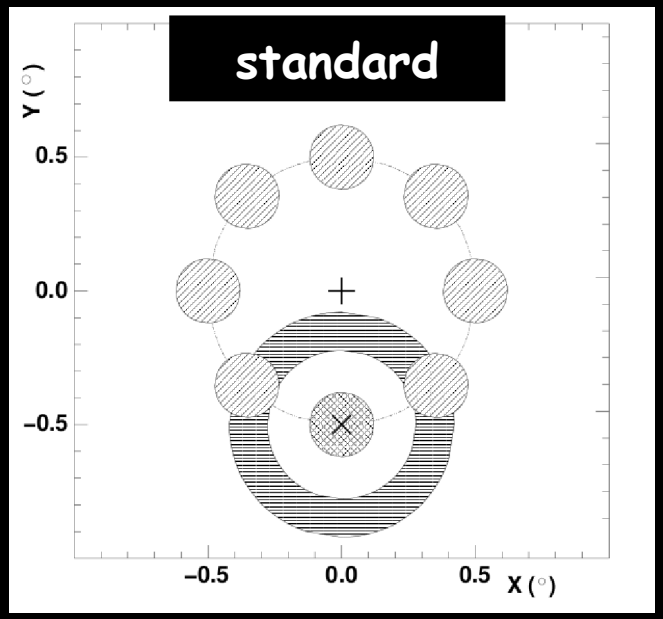
- More than 100 hrs spent on GC region
  - Unlikely that existing results vastly improve
- But: Only regions with γ-ray sources used
  - Remaining field of view seems empty!
  - Constraints from regions free of astrophysical background?
  - Results should improve upon limits from GC diffuse emission
- Need analysis of close-by regions!

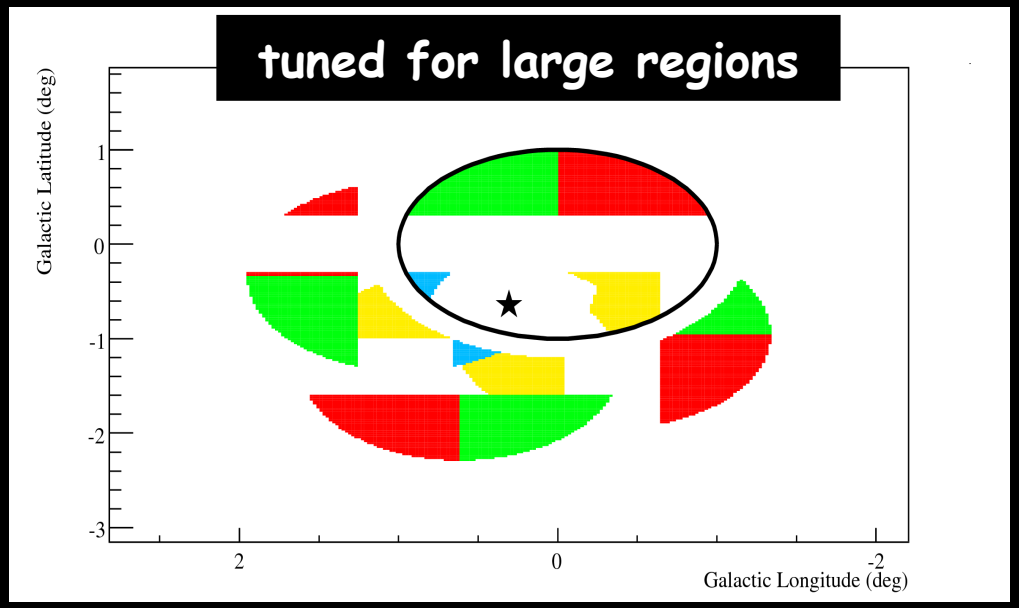
Current activities
Background issues

- Extraction of a background subtracted spectrum required
  - Empty field of view contains hadronic background
- Background subtraction for large source regions tricky
- Two ways (need background with same detector acceptance):
  - Background estimation from field of view
  - Background estimation from dedicated "off"-observations

Current activities
Background issues

- Background from field-of-view:
  - Use regions with the same distance to the observation position
  - Need lower DM density for background regions, larger distance to the GC
  - Observation positions mostly close to the GC

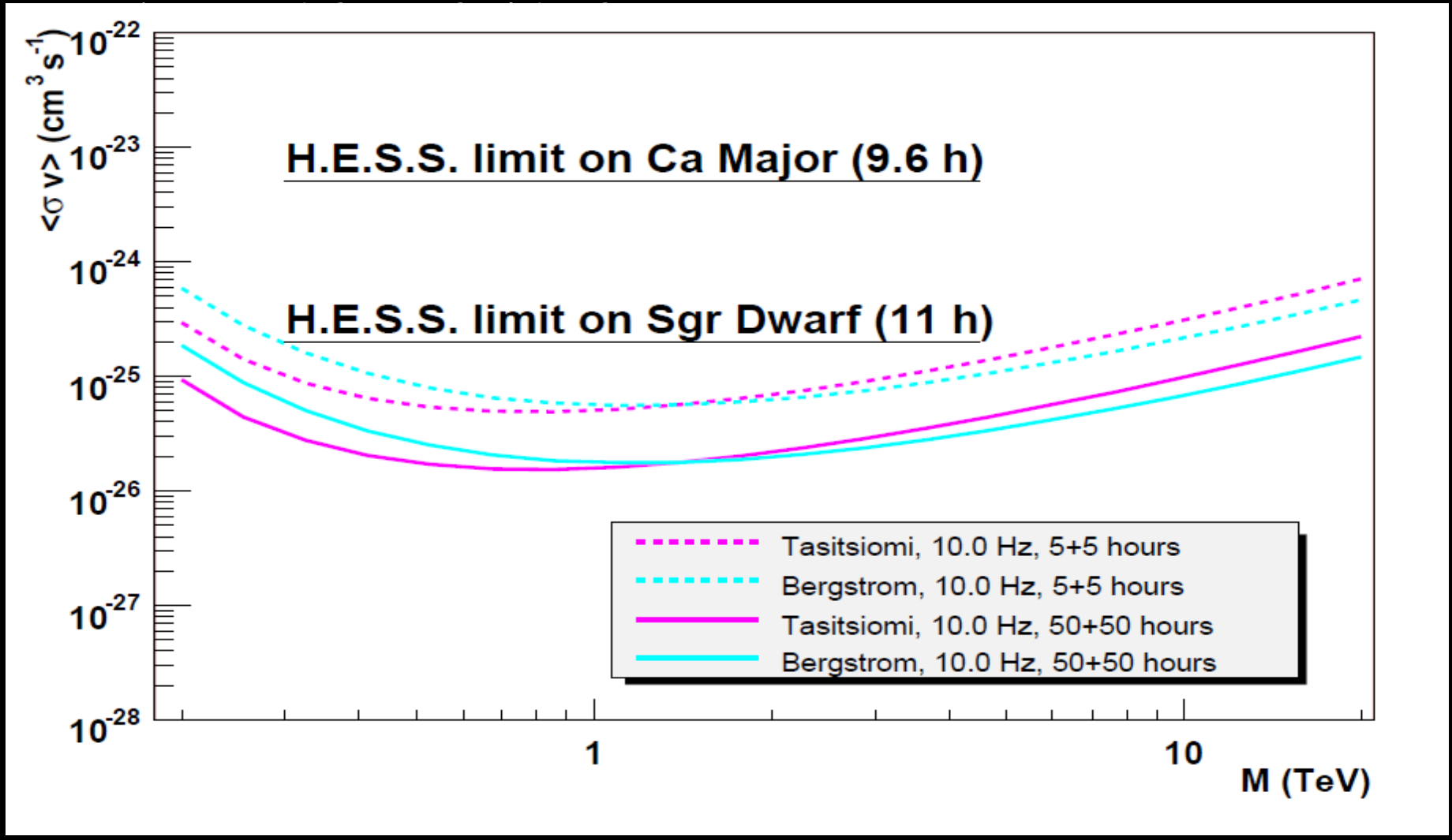




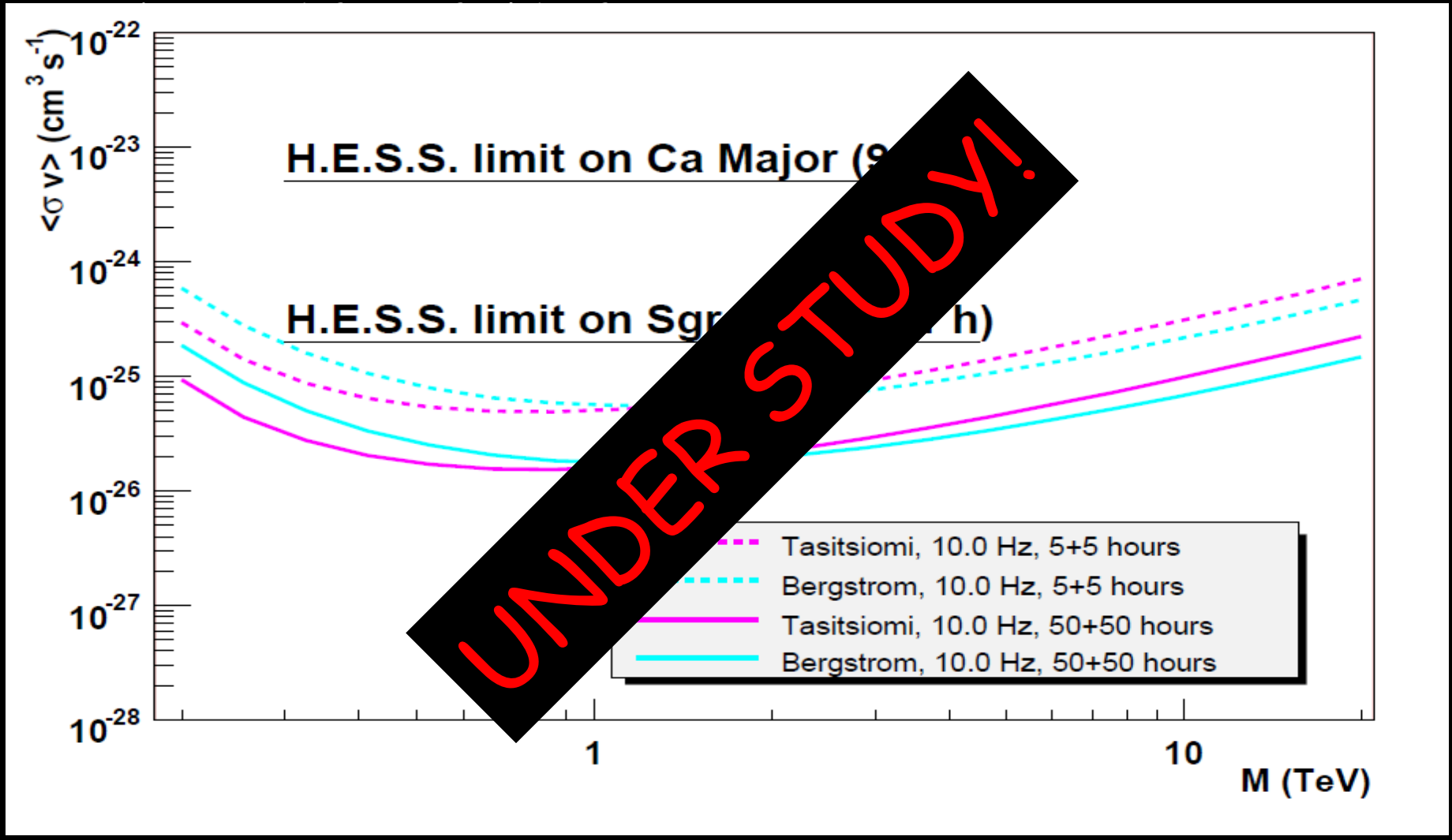
Current activities
Background issues

- Background from field-of-view:
  - Use regions with the same distance to the observation position
  - Need lower DM density for background regions, larger distance to the GC
  - Observation positions mostly close to the GC
- Background from "off"-observations
  - Perform "on" and "off" observations, match zenith angles
  - Equal number of "on" and "off" observations

Current activities
Background issues



Current activities
Background issues



Summary

- TeV observations of the GC region opened a new way to detect DM/constrain DM parameter space
  - Closest region of high DM density
- All detected sources of astrophysical origin
  - Data yields some interesting results, in particular in combination with other measurements
- On-going activities to obtain results from regions free of y-ray sources
- In the future: HESS II, CTA(!)