SuperBayes and H.E.S.S. Data

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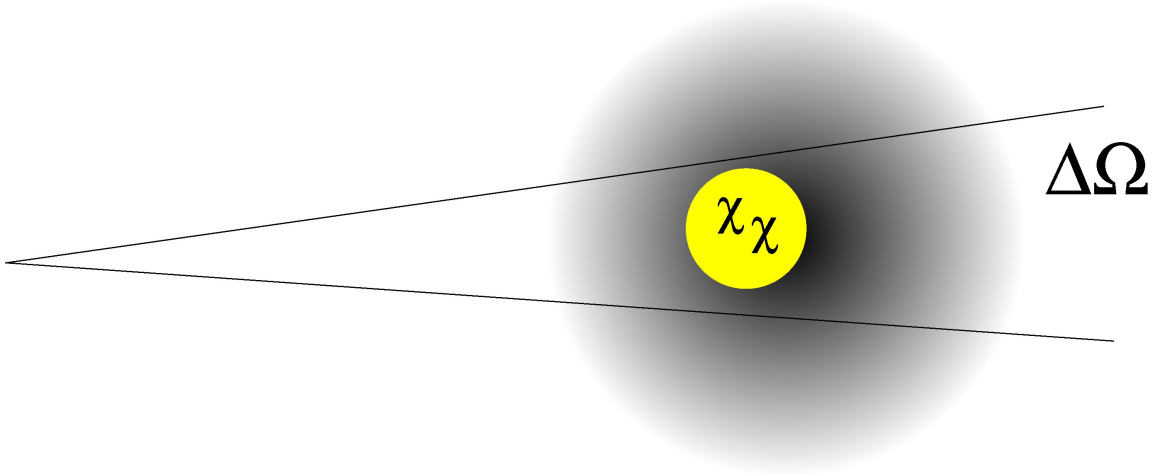
- The H.E.S.S. Experiment
- γ-radiation from dark matter annihilation
- Galactic Center
- Sagittarius dwarf

The H.E.S.S. experiment

- Stereoscopic system of air cherencov telesopes
- Located at Khomas highlands in Namibia (1800 m above sea level)
- Distinguish between hadronic and electromagnetic air showers
- Energy range: ~100 GeV - ~100 TeV
- Energy resolution: ~10% - 15%
- Angular resolution: ~0.1 deg per event

Dark matter could produce γ-rays



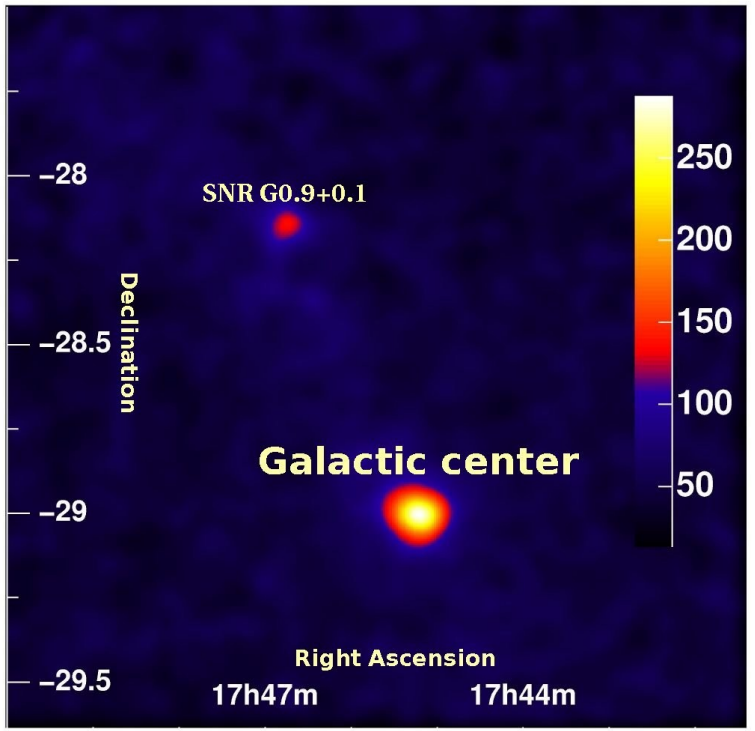
$$\Phi(E) = \frac{1}{2}\frac{1}{4\pi}\frac{dN_\gamma}{dE}\langle\sigma v\rangle\frac{1}{m_\chi^2}\cdot\bar{J}(\Delta\Omega)\Delta\Omega$$

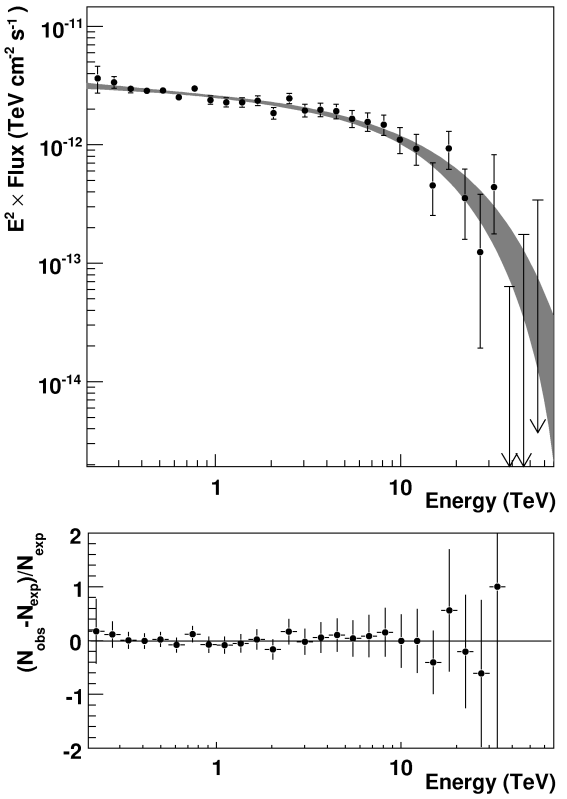
$$\bar{J}(\Delta\Omega)\Delta\Omega = \int_{\Delta\Omega} d\Omega \int_{\text{los}} ds\, \varrho^2(s)$$

Particle physics terms

Astrophysics terms

H.E.S.S. Observations of the GC region





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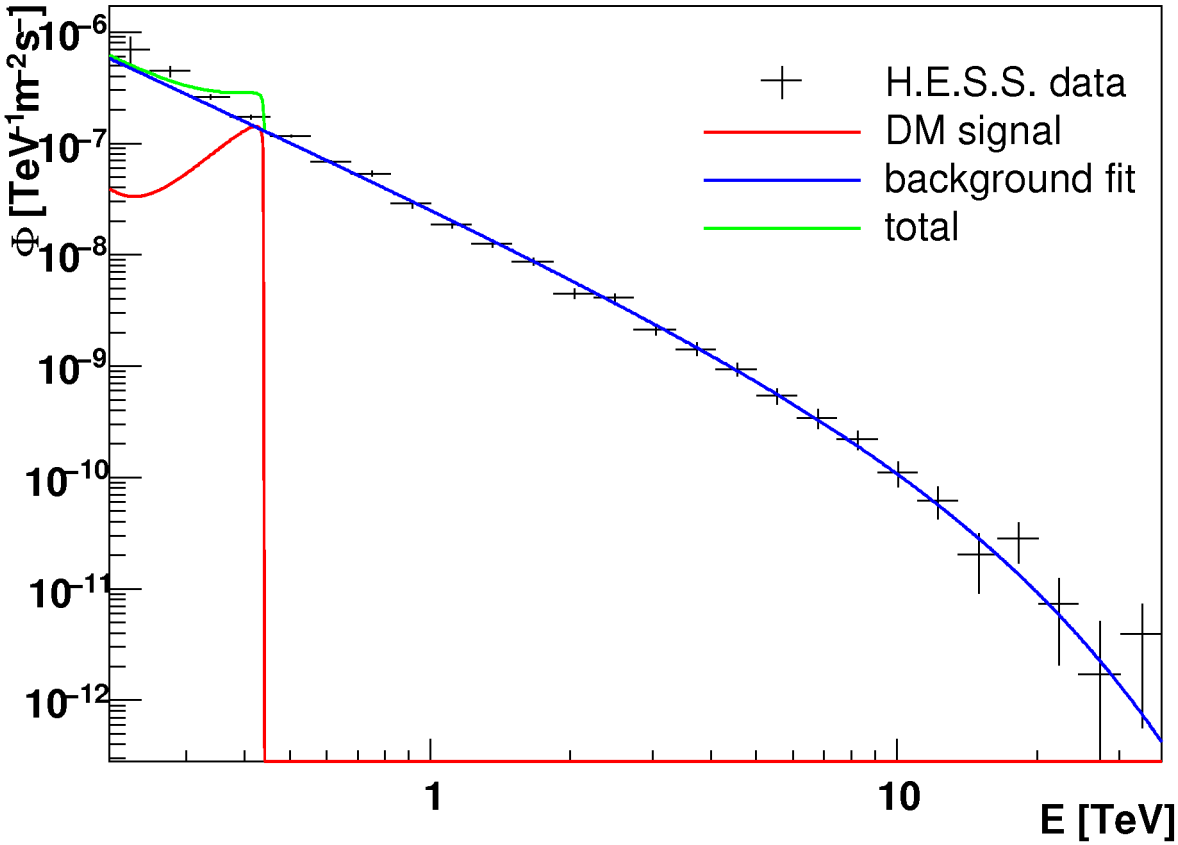
- ~100 h of observation
- Strong source of γ-radiation detected
- Not compatible with DM annihilation only
- Limits of DM annihilation fraction possible

H.E.S.S. Limits on DM in GC

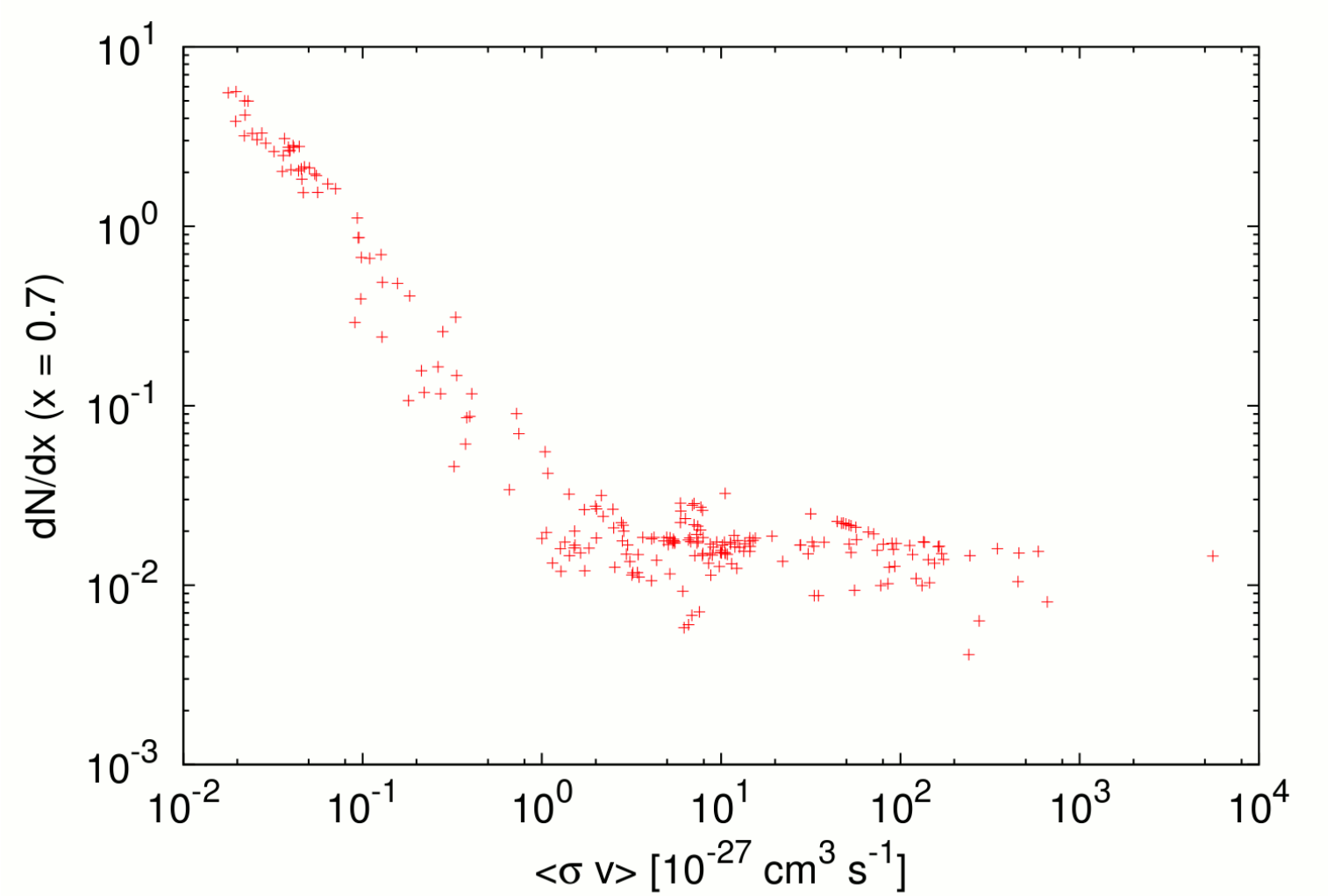


- Calculate DM annihilation spectrum $\Phi_{DM}(E)$ for given DM model and density profile (J-factor)
- Fit astrophysical background $\Phi_{bg}(E)$ (for GC power law with exp cutoff)

to minimize χ^2 of $\Phi_{DM}(E)+\Phi_{bg}(E)$

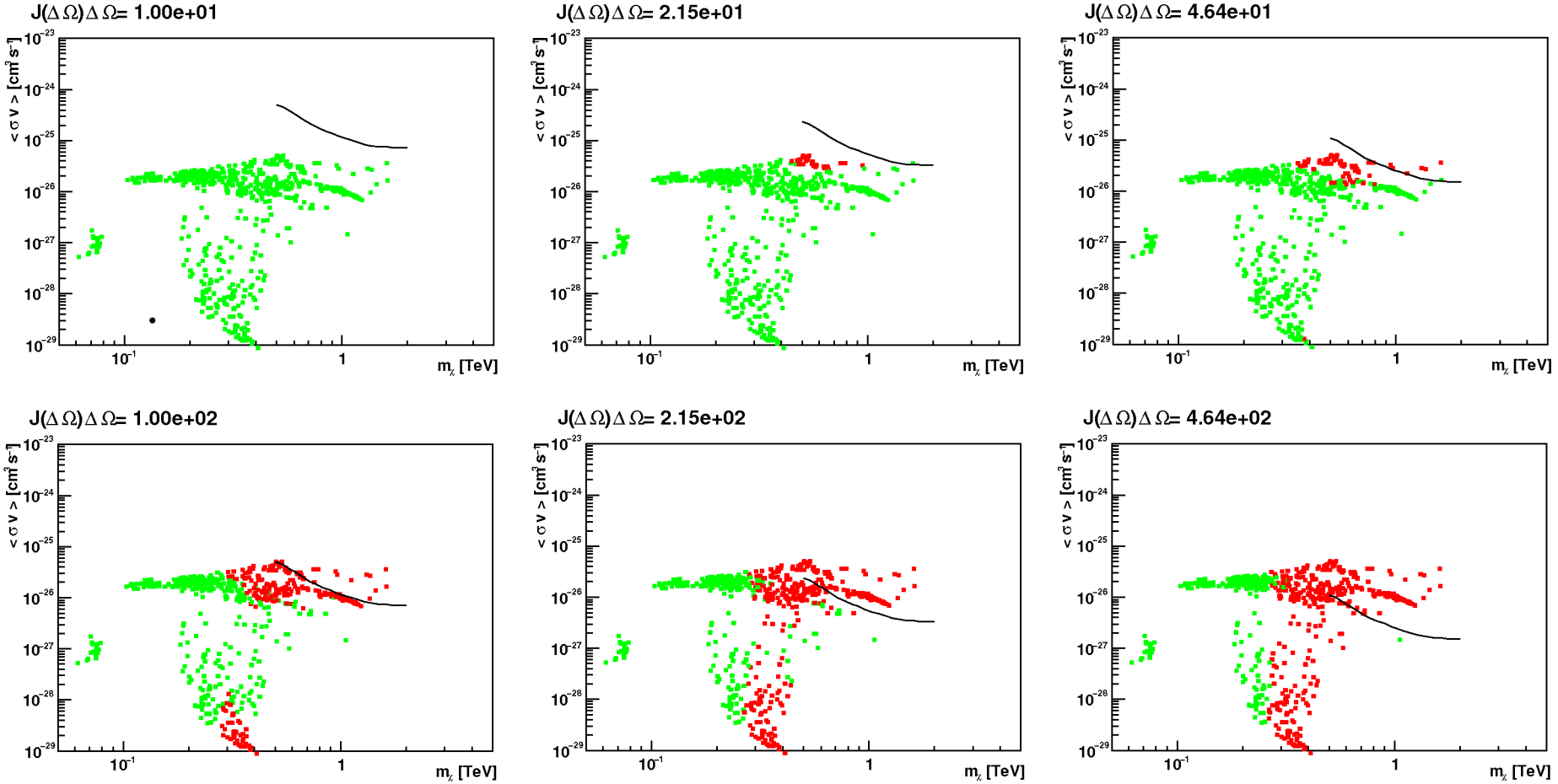
- Model compatible?
- Calculate Likelihood ($-\ln L = \chi^2/2$) – later for SuperBayes

One interesting correlation



- γ-ray yield at 0.7 m_{χ} is anti-correlated with annihilation cross section in used set of CMSSM models (internal bremsstrhalung)

H.E.S.S. Limits on DM in GC



Results with a set of CMSSM models (and using DarkSUSY)

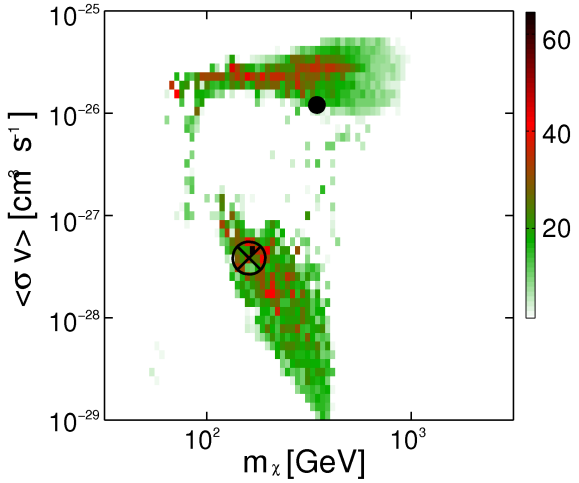
- Physical Constraints implemented in DarkSUSY 5.0.4 as well as WMAP compatible relic density

For comparison:

- NFW profile → $J(\Delta\Omega)\Delta\Omega = 0.15$ (reality likely even worse)
- Moore profile → $J(\Delta\Omega)\Delta\Omega = 350$

H.E.S.S. GC data and SuperBayes

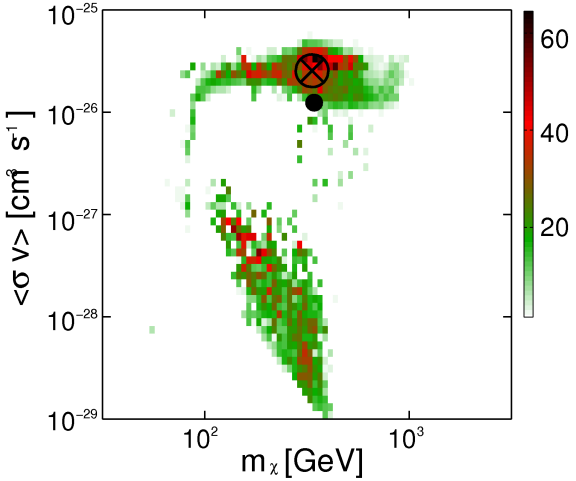
No H.E.S.S. data



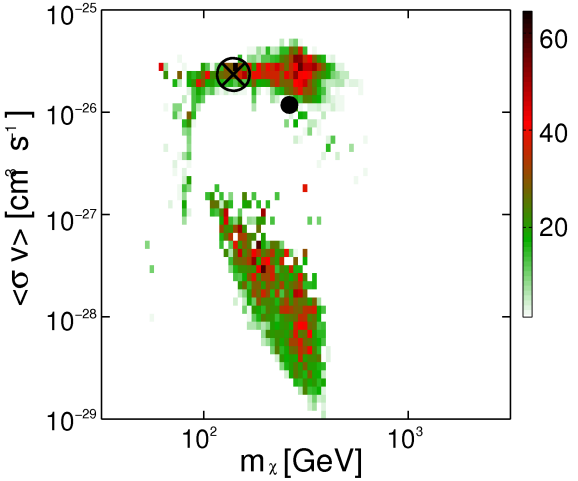
Results - profile likelihood - of scans for different (unrealistic) values for J

- Using MultiNest algorithm
- High mass neutralinos become unlikely
- Coannihilation region truncated due to internal bremsstrahlung

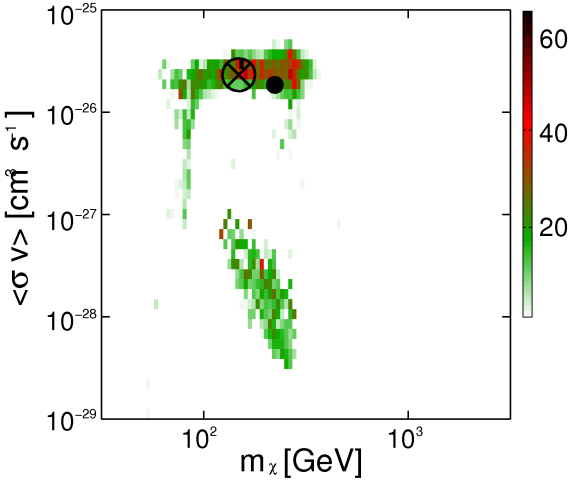
J = 10



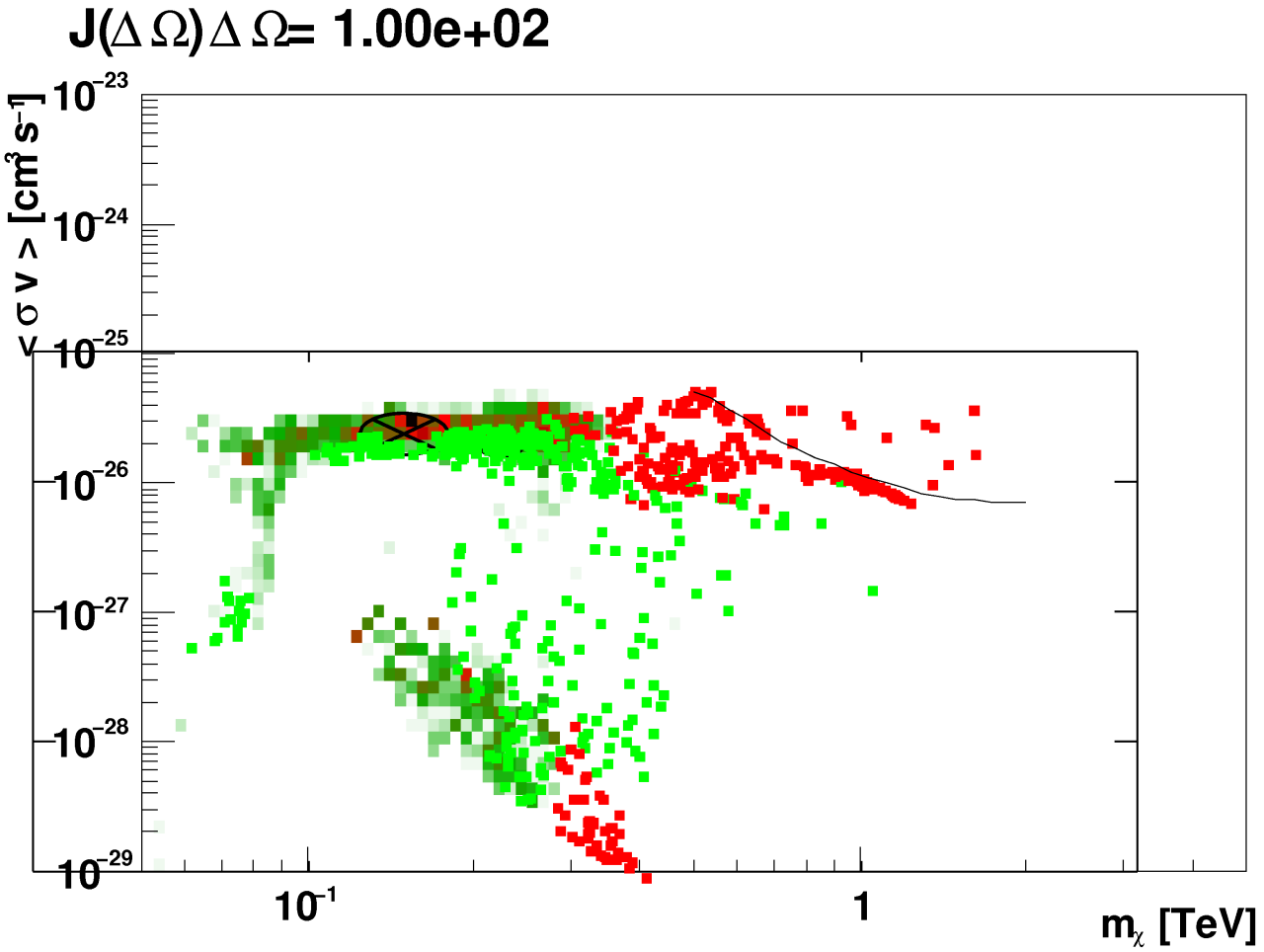
J = 32



J = 100

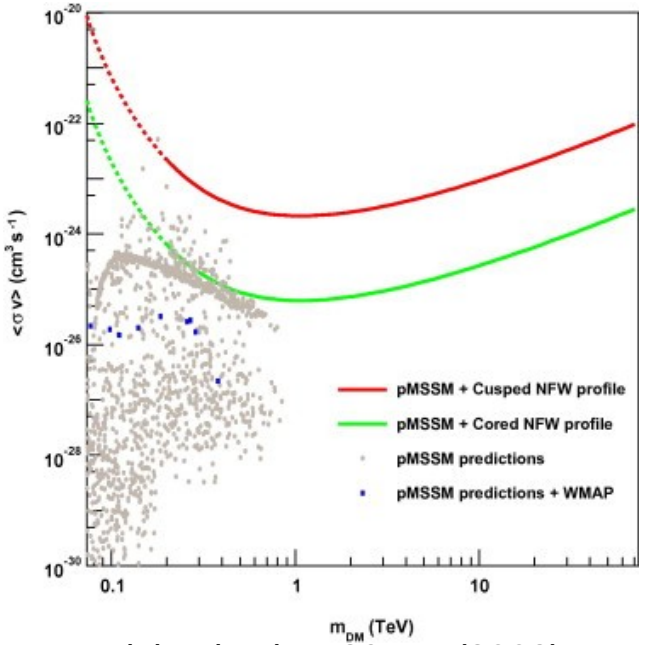


H.E.S.S. GC data and SuperBayes



SuperBayes scan and previous radnom scan compatible

H.E.S.S. Limits on DM in Sgr dwarf



Astroparticle physics, 29, 55 (2008) - Eratum

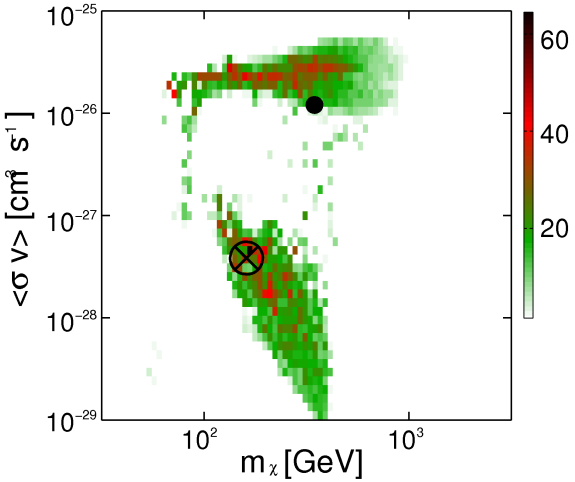
- ~12 h of observation time
- No signal detected
- Flux upper limit:

$\Phi(E>250\ \text{GeV}) < 3.6 \times 10^{-12}\ \text{cm}^{-2}\ \text{s}^{-1}$

- Upper limit of annihilation cross section calculated for two different scenarios, but generic spectrum
- Limits begin to cut in interesting parameter space

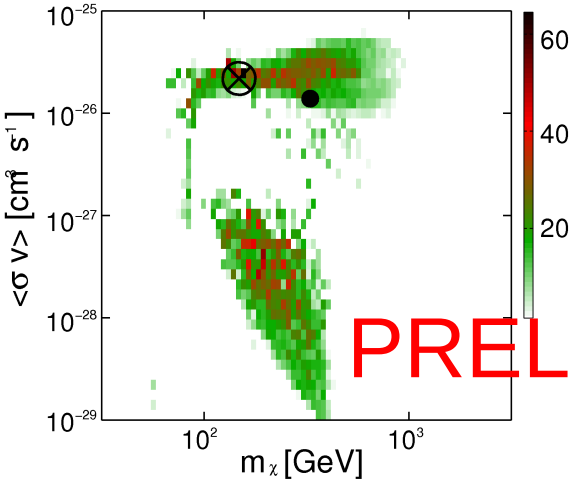
Scan with SuperBayes

No H.E.S.S. data

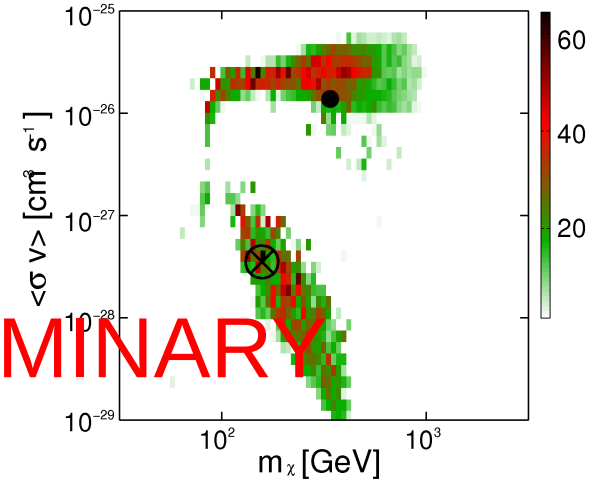


- Use flux upper limit to calculate likelihood with the ansatz $L(\Phi) = \lambda \exp(-\lambda\Phi)$
- No large effect visible in distribution
- Best fit point "jumps"

Cusped NFW profile



Cored NFW profile



PRELIMINARY

Summary and Outlook

- H.E.S.S. observed several targets of indirect dark matter search
- Limits for DM contribution calculated
  - For GC handicapped by a strong g-ray signal with non-DM origin
  - For Sgr dwarf limits begin to cut into interesting parameter space

- We used SuperBayes to perform a CMSSM parameter scan with the H.E.S.S. Data

- Further H.E.S.S. Data will follow