

Presentation of Results for Dark Matter in ANTARES



Holger Motz for the ANTARES Collaboration
Erlangen Centre for Astroparticle Physics
University of Erlangen-Nuremberg
MANTS2009, Berlin, 26.9.2009

Presentation of Sensitivity/Limits

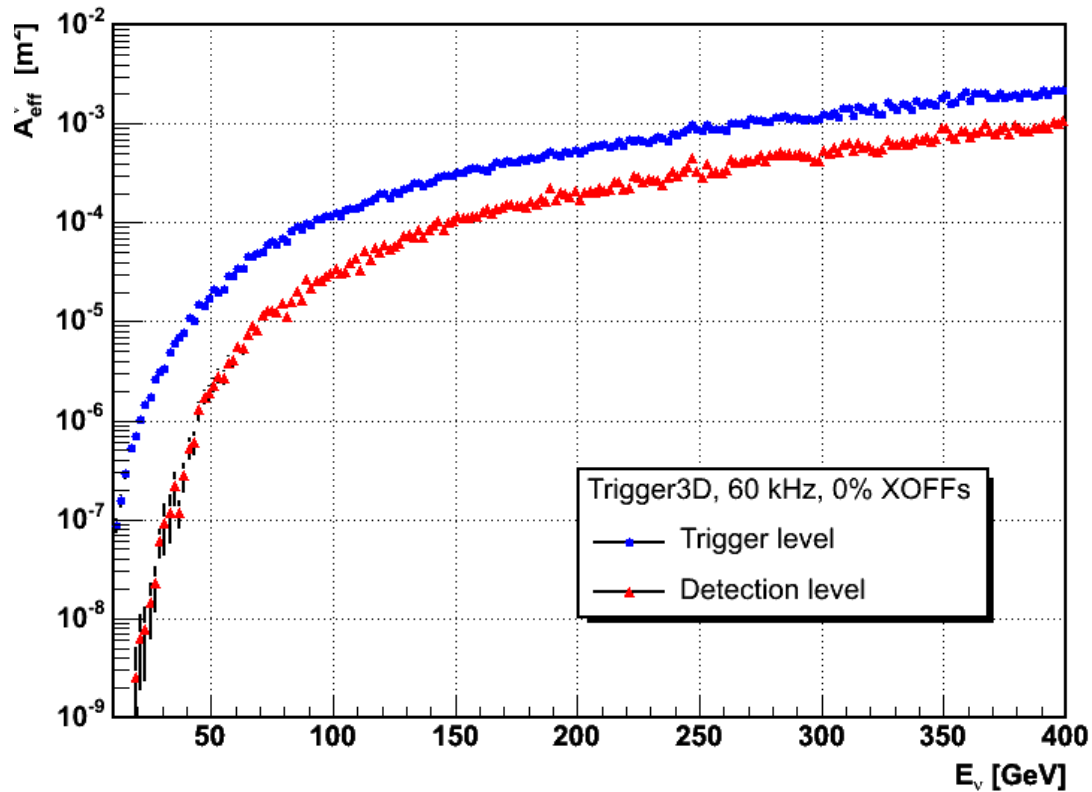
Sensitivity:

- Model specific approach (mSugra)
- Random walk scan of parameter space guided by relic density
- Comparison to other experiments (e.g. direct detection) without assumptions (e.g. annihilation channel) except for theory

Limits:

- Do not reach mSugra parameter space yet
- Two scenarios of hard and soft spectra used

ANTARES Neutrino Effective Area in the low-energy regime

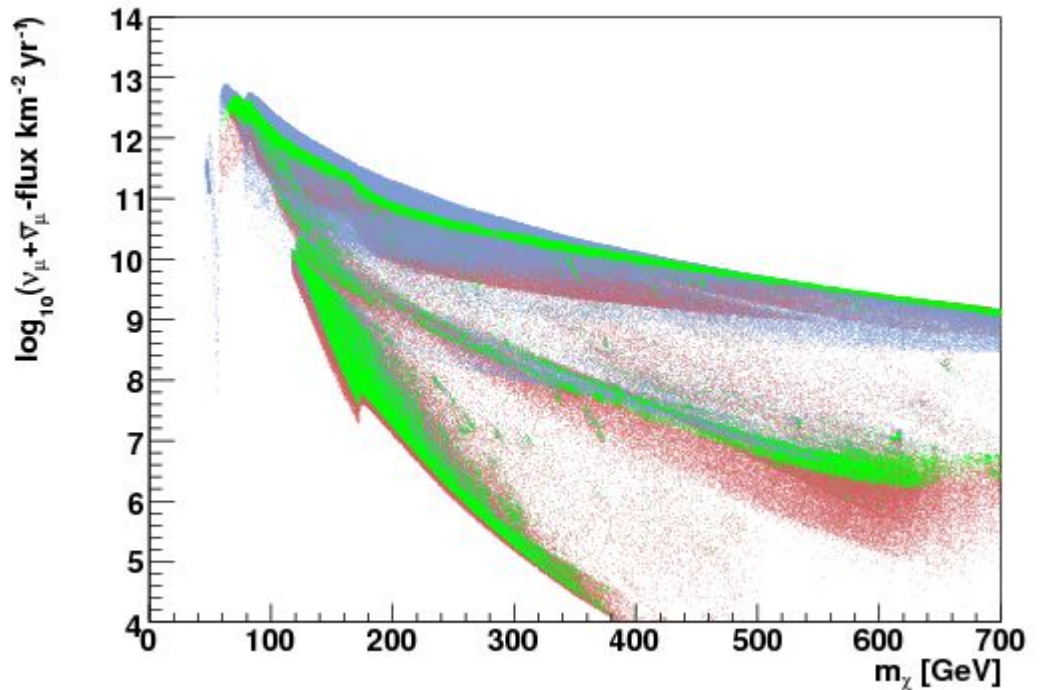


ANTARES Low-Energy Effective Area

60 kHz background rate from K-40 decay and bioluminescence

Neutrino Flux from mSugra Dark Matter Annihilation in the Sun

- Integrated ν_μ and $\bar{\nu}_\mu$ flux from 10 GeV to 400 GeV energy plotted against m_χ
- From random walk scan of mSugra Parameter Space
- Calculated with DarkSUSY
- Includes oscillation effects
- RGE-code: ISASUGRA
- Halo-model: NFW
- $m_{\text{top}} = 172.5$ GeV

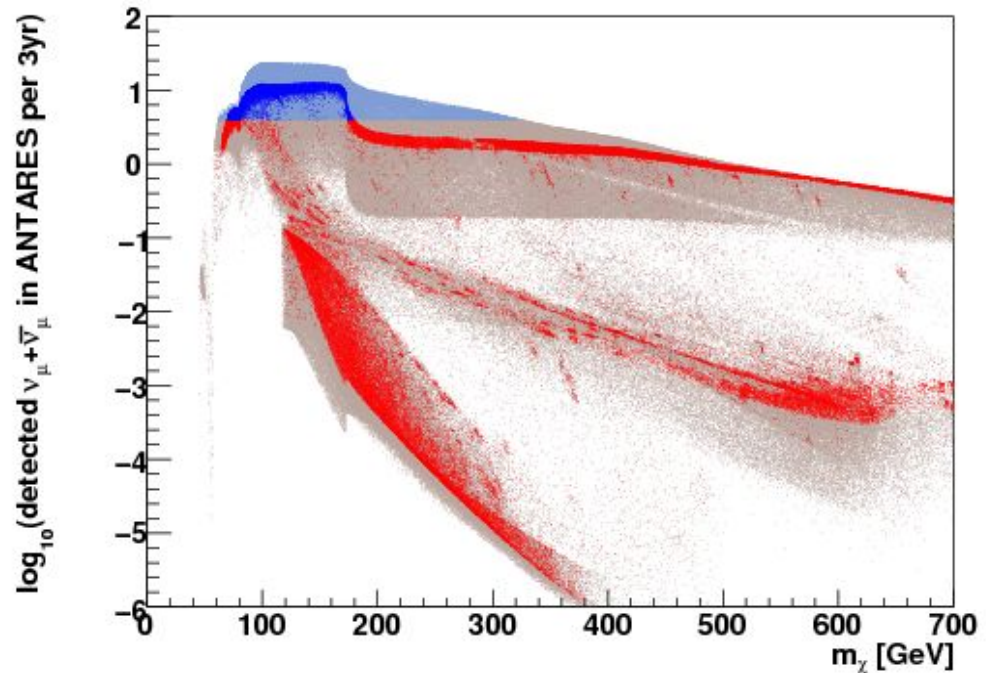


Relic density of mSugra models

- WMAP favoured (2 sigma)
- lower than WMAP
- higher than WMAP

Detection Rate from mSugra Dark Matter Annihilation in the Sun

- Sensitivity calculated for three years of taking data
- Unified approach of Feldman-Cousins used
- Background from atmospheric neutrinos and misreconstructed atmospheric muons
- 3° radius search cone



mSugra models favoured by WMAP

● 90% CL excludable by ANTARES

● not excludable

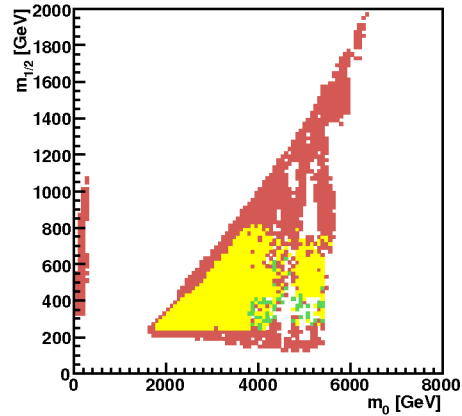
mSugra models disfavoured by WMAP

● 90% CL excludable by ANTARES

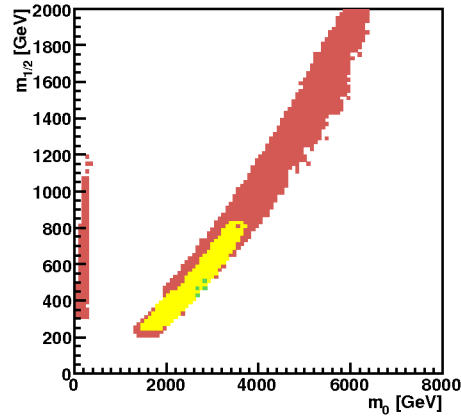
● not excludable

Exclusion Capabilities Parameter Space

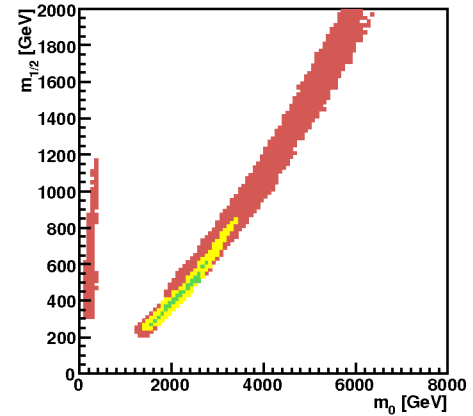
$0 < \tan\beta < 10$



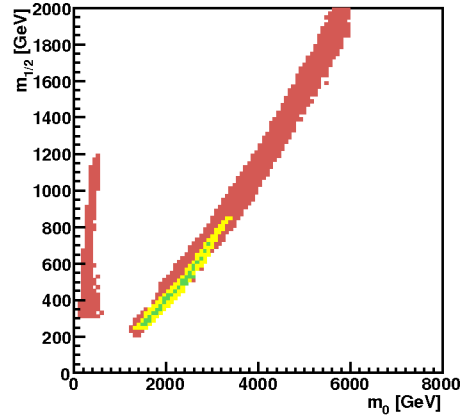
$10 < \tan\beta < 20$



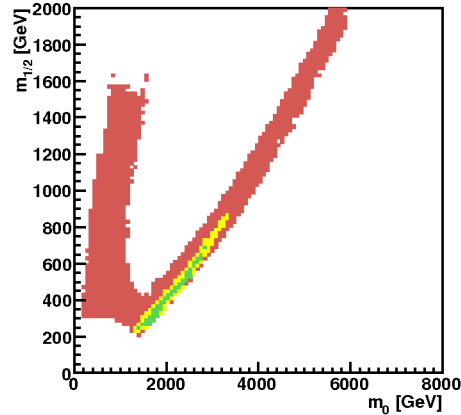
$20 < \tan\beta < 30$



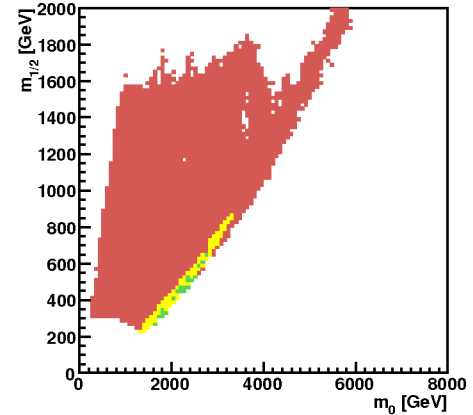
$30 < \tan\beta < 40$



$40 < \tan\beta < 50$



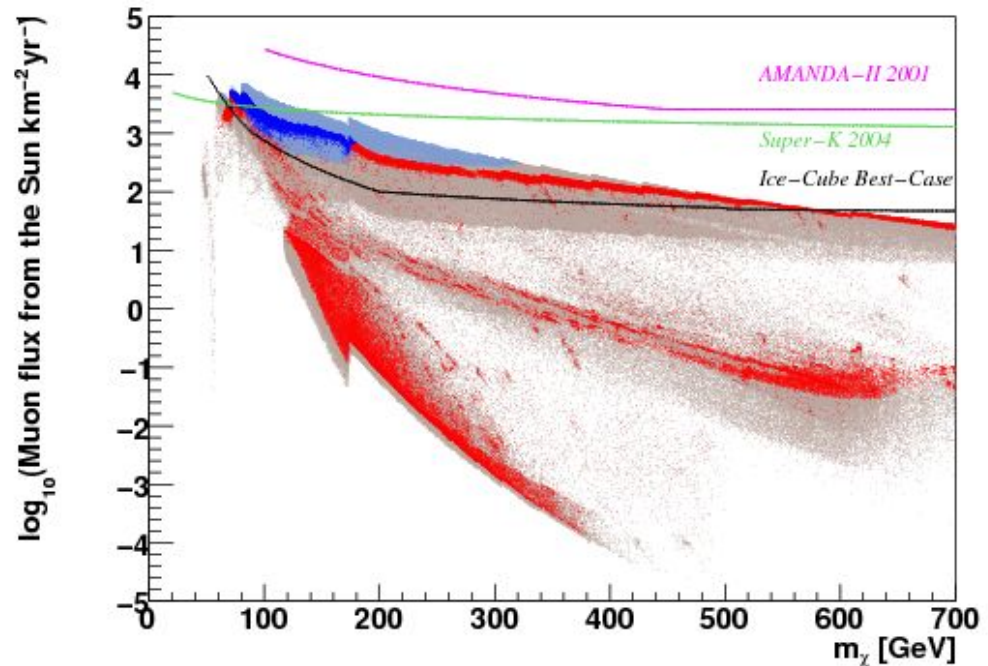
$50 < \tan\beta < 60$



Excludable in 3 years at 90% CL: **all** **some** **none**
(A_0 varied between $-3m_0$ and $+3m_0$ and $\tan(\beta)$ within indicated slice)

Muon Flux from mSugra Dark Matter Annihilation in the Sun

- Allows for comparison to other neutrino experiments
- Site dependent quantity
- Threshold muon energy 1 GeV



mSugra models favoured by WMAP

● 90% CL excludable by ANTARES

● not excludable

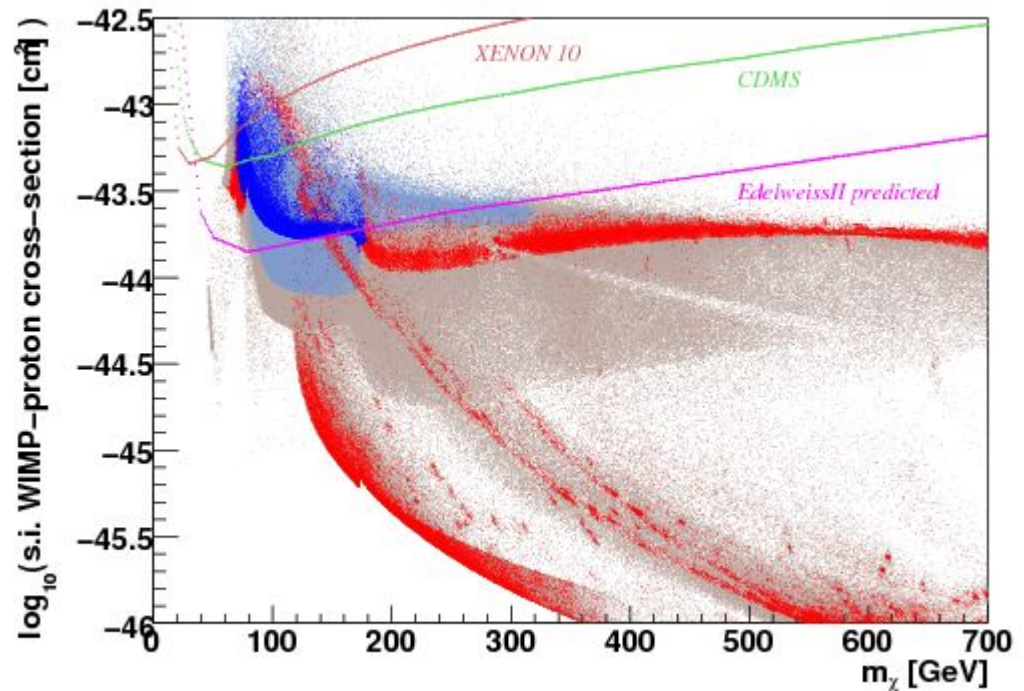
mSugra models disfavoured by WMAP

● 90% CL excludable by ANTARES

● not excludable

Direct Detection SI

- Comparison to direct detection experiments sensitive to spin-independent WIMP-nucleon cross-section
- No direct relation as seen from overlap of excludable and non-excludable models



mSUGRA models favoured by WMAP

● 90% CL excludable by ANTARES

● not excludable

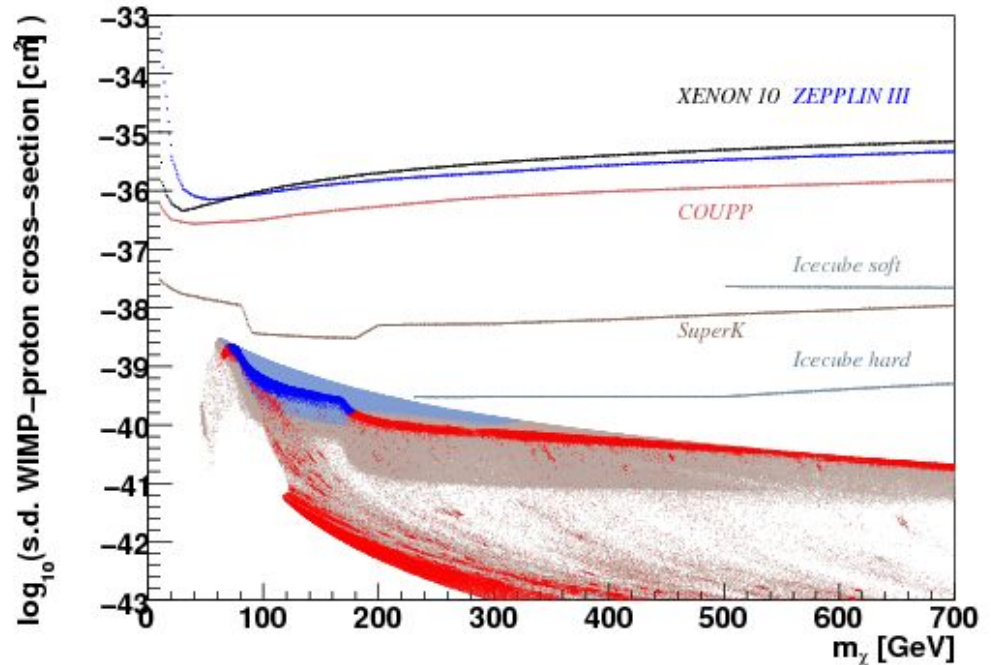
mSUGRA models disfavoured by WMAP

● 90% CL excludable by ANTARES

● not excludable

Direct Detection SD

- Comparison to direct detection experiments sensitive to spin-dependent WIMP-nucleon cross-section
- Almost direct relation since annihilation rate tied to WIMP interaction with hydrogen in the Sun



mSUGRA models favoured by WMAP

● 90% CL excludable by ANTARES

● not excludable

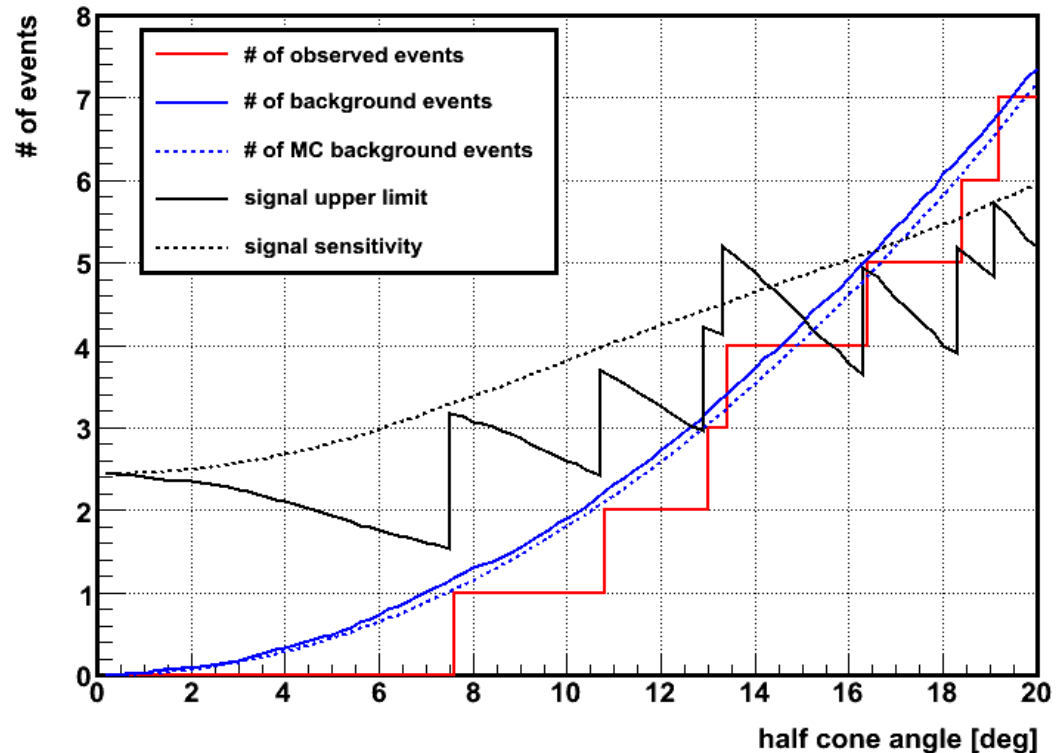
mSUGRA models disfavoured by WMAP

● 90% CL excludable by ANTARES

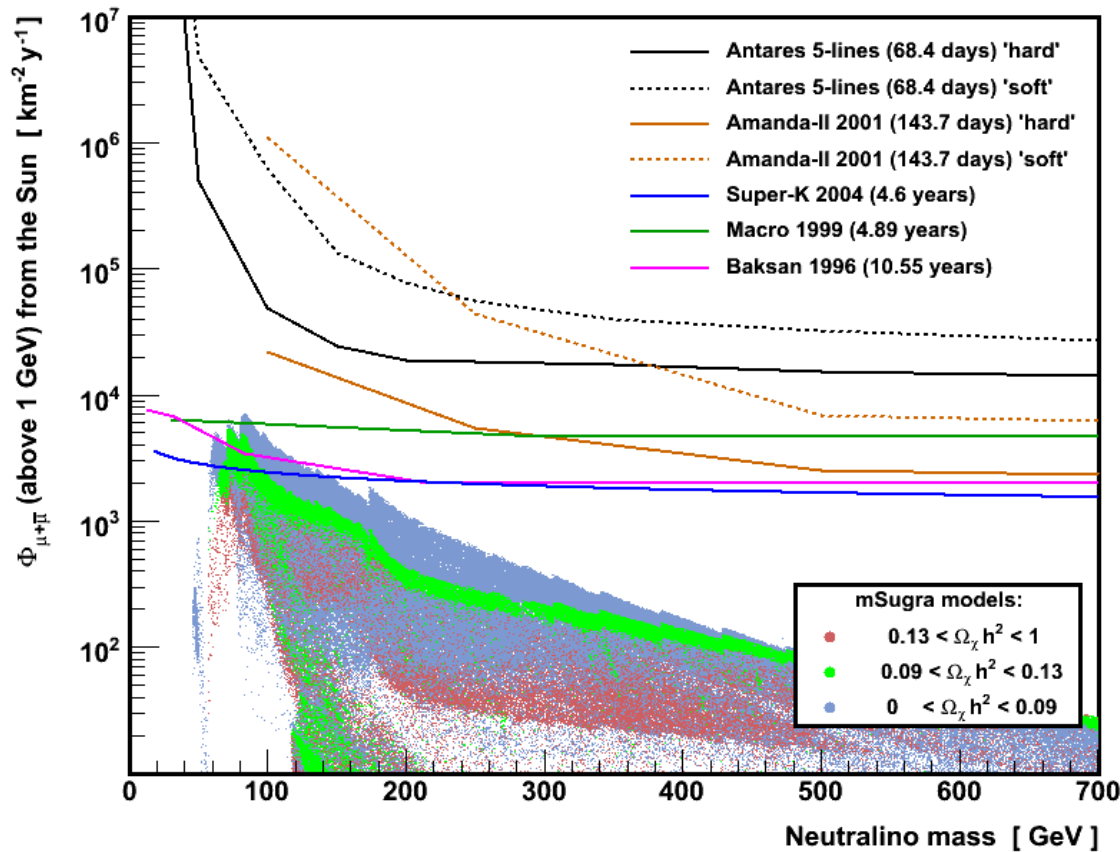
● not excludable

First Limit from 5-Line Period (Sun)

- Reconstructed neutrinos from an effective lifetime of 68.4 days as a function of angular distance from Sun's direction
- Consistent with background estimation from both full sky measurement and MC
- Search cone for actual limit optimized from MC prior to analysis for different neutralino masses and hard/soft neutrino energy spectrum

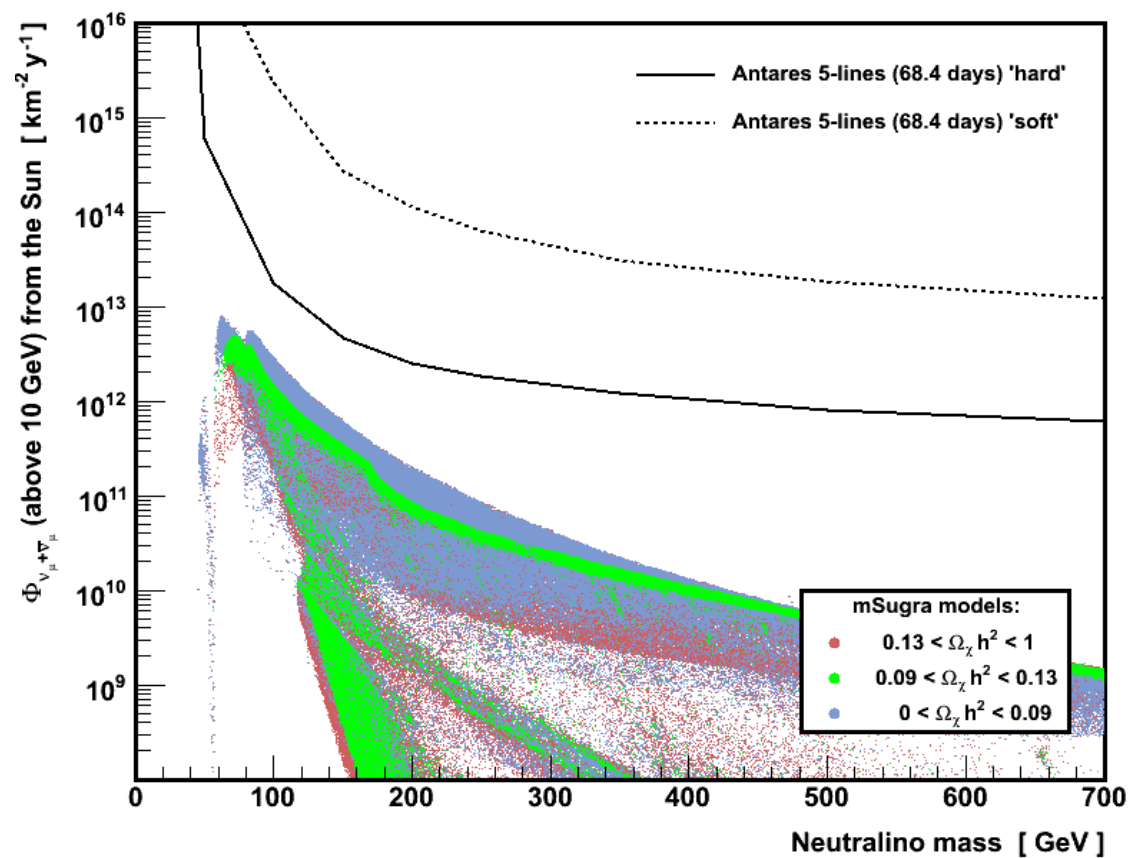


First Limit from 5-Line Period (Muonflux)



- Limits for soft (b-quark) and hard (W-boson) annihilation channel
- Limits from other experiments available, but same assumptions in neutrino to muon conversion etc.?

First Limit from 5-Line Period (Neutrino flux)



- No other limits to compare to

Future plans and what to discuss

- Other theories (pMSSM, Extra Dimensions) for model specific studies – possible cooperation?
- Model specific comparison to collider experiments – to show complementarity
- Common set of assumptions for generic spectra (WW/BB) limits and sensitivity curves (threshold energies, background model, interaction cross-sections, treatment of oscillation effects etc...)