Indirect Dark Matter search in the Sun direction with ANTARES for the two common theoretical framework (CMSSM, mUED)

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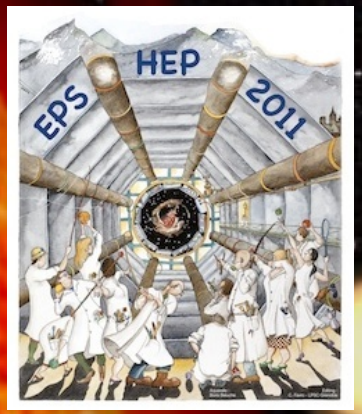
IFIC/CSIC/MultiDark

21/07/2011

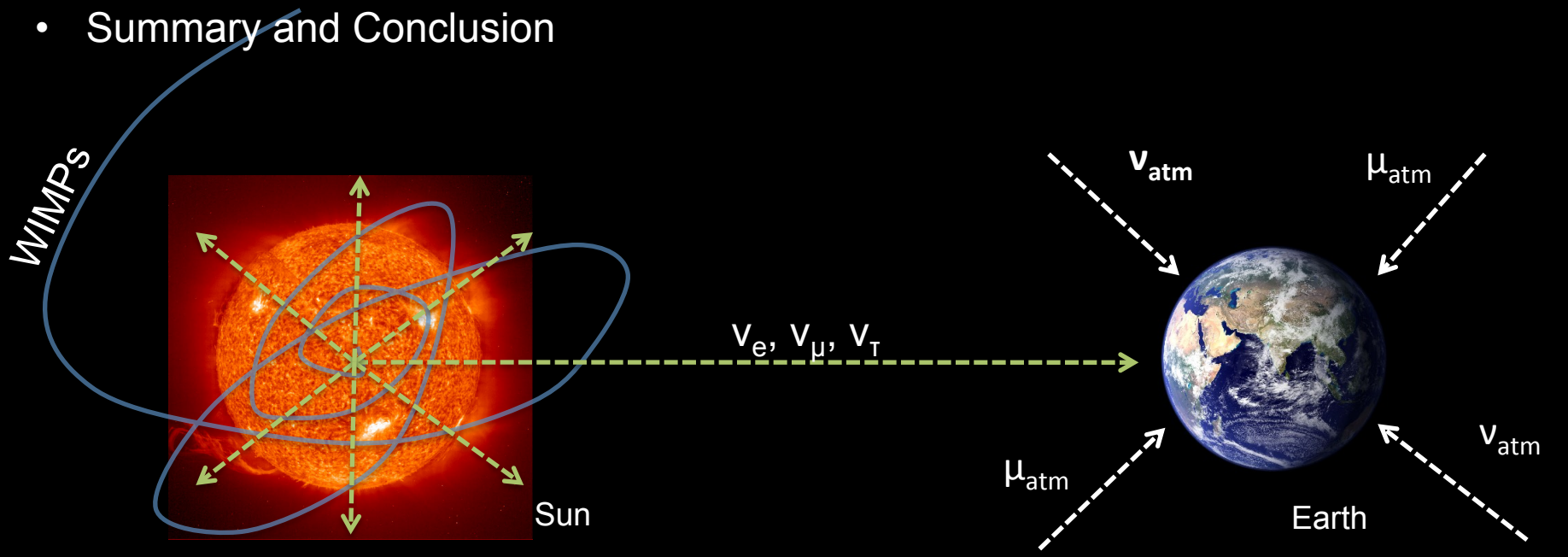


Plan

- ANTARES neutrino telescope (see ANTARES point sources talk by D. Dornic)

- Estimation of the background in the Sun direction
- Acceptance of the detector depending on the dark matter self-annihilation channels and the framework (CMSSM, mUED)
- Neutrinos, muons, and spin-dependent cross-section sensitivities

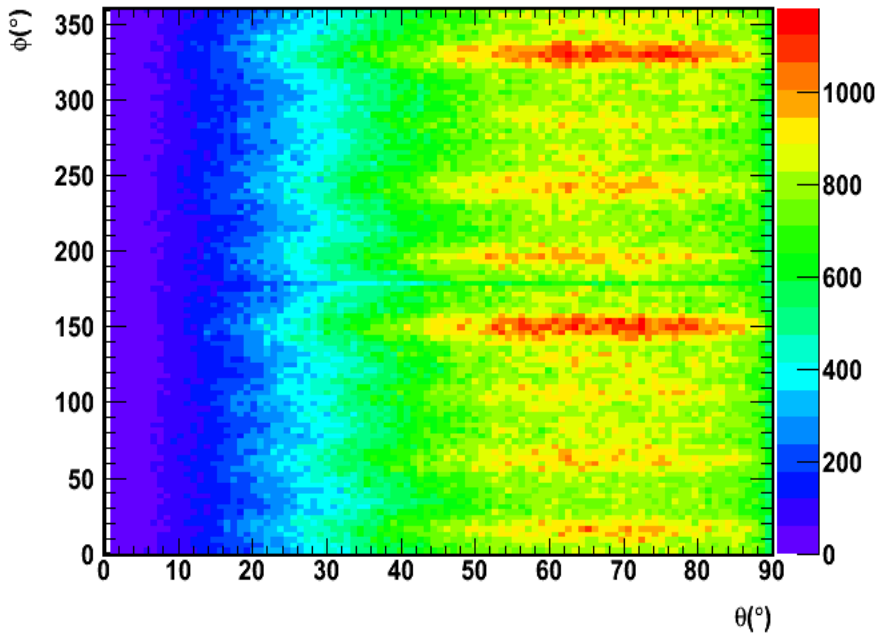
- Summary and Conclusion



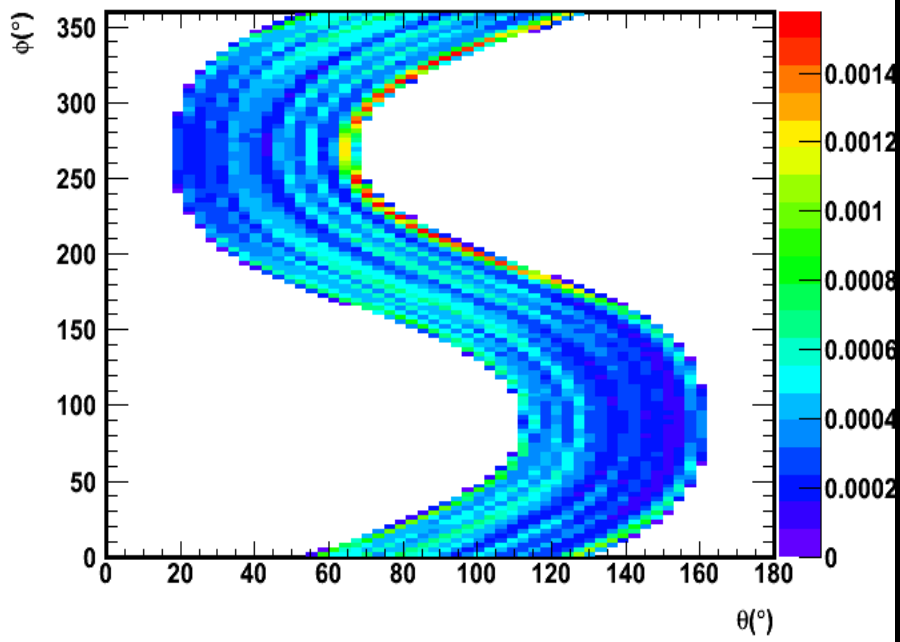
Background in the Sun direction I
Atmospheric neutrinos and muons

- Scrambled data in (θ,ϕ), and time from 2007-2008 period (~295 days)
- Fast algorithm for muon track reconstruction (Astro. Phys. 34 (2011) 652-662)
- Using the Sun visibility at the Antares location

All upward-going events from 2007-2008 data



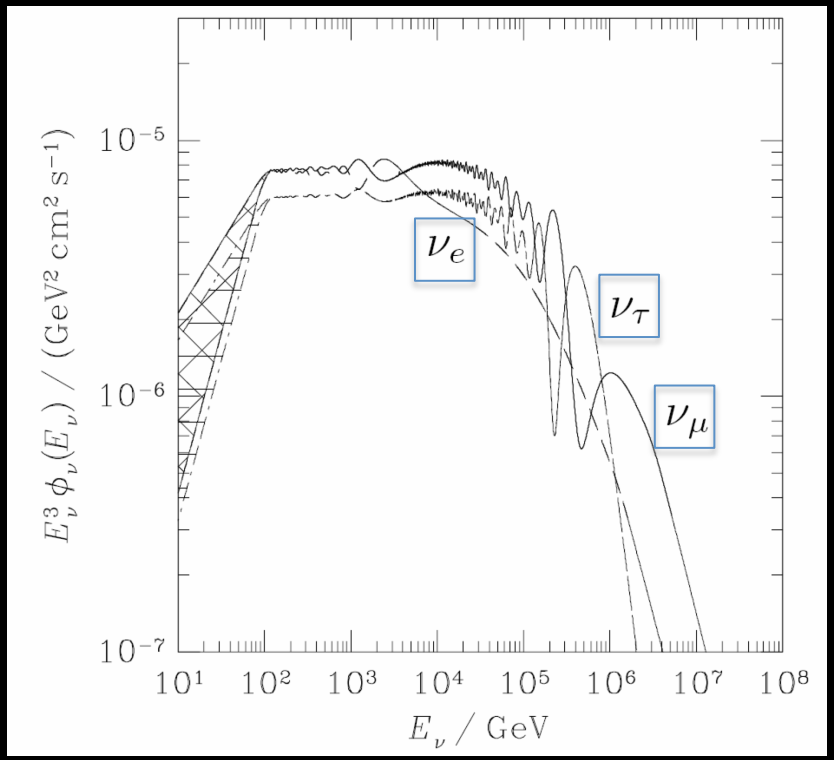
Example of Sun tracking in horizontal coordinates

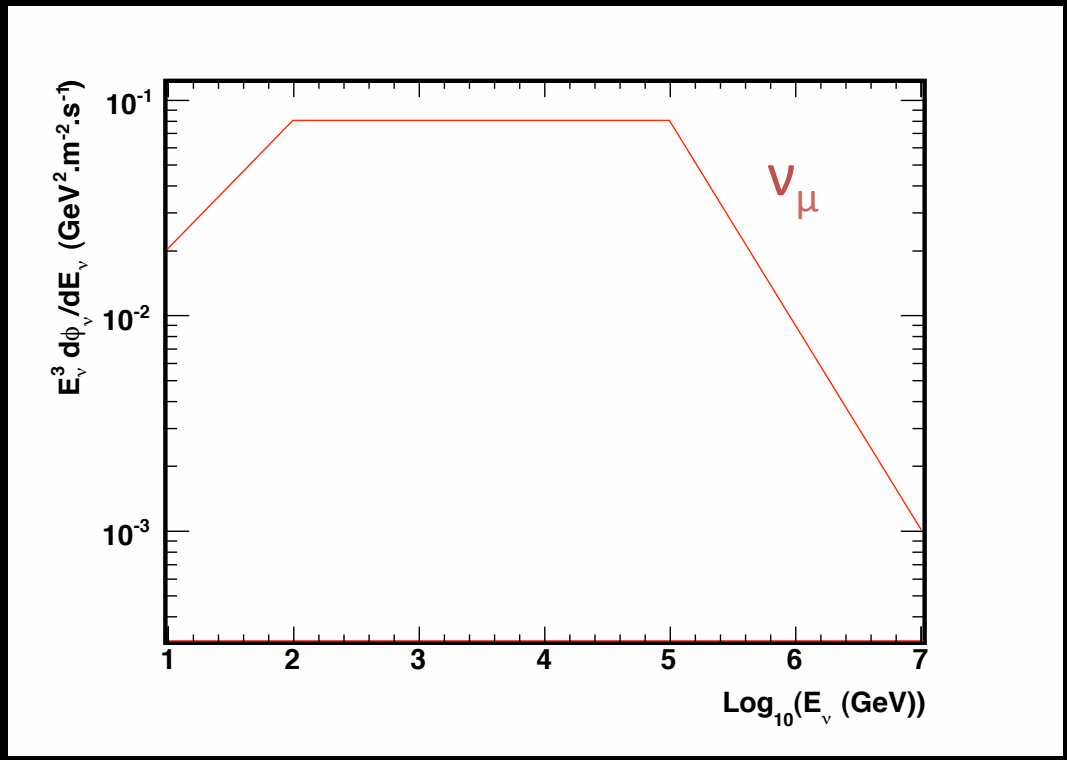


Background in the Sun direction II
CR and Solar atmosphere

- Interactions p-p give a production of neutrinos through the decay products

De C. Hettlage et al., Astropart.Phys. 13 (2000) 45-50 Simple parameterization averaged on the oscillations





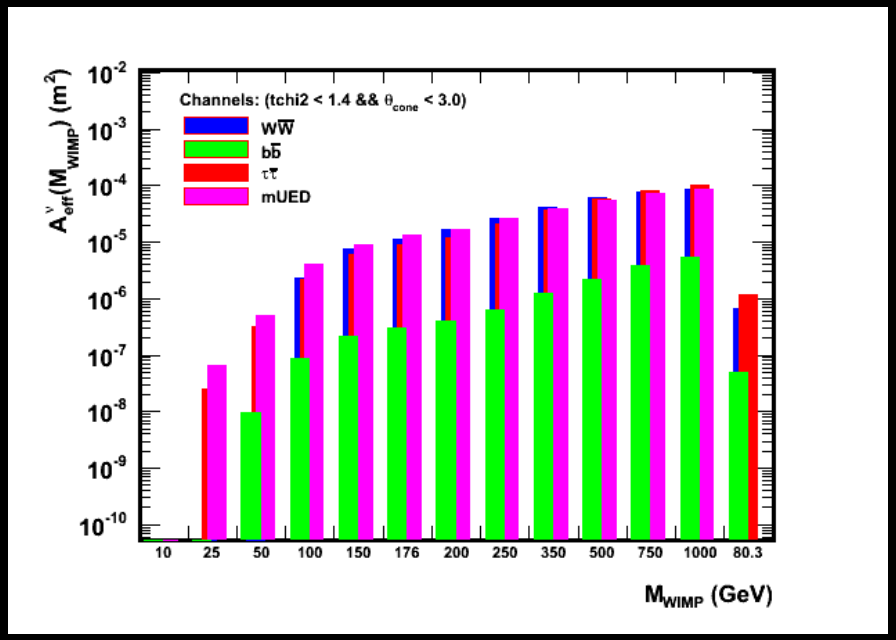
It doesn't represent more than 10^{-3} events per year in a 5 lines cofiguration (few events for a km³), 0.4% of the total atmospheric background…

Dark Matter signal I
Cuts optimization

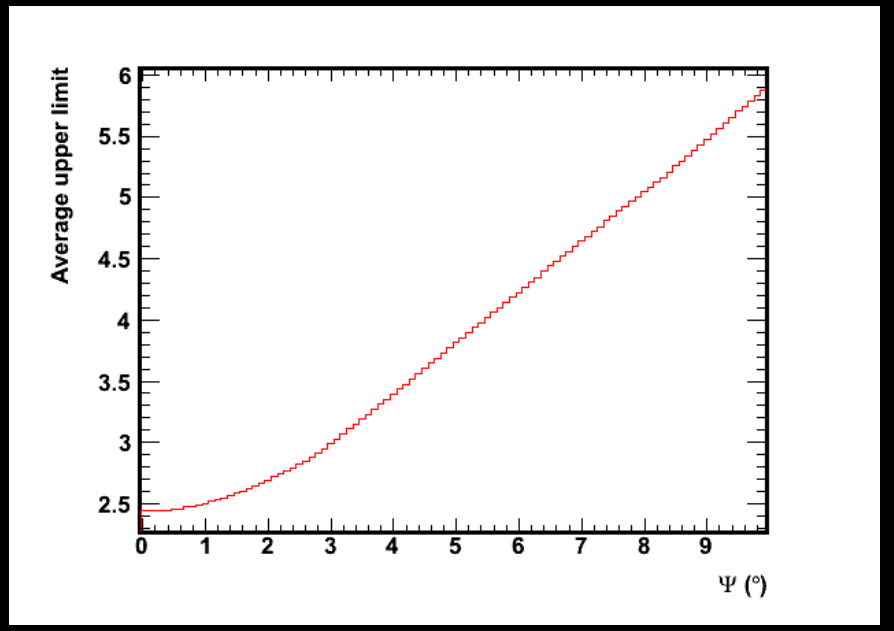
- Neutrino flux at the earth, from the Dark Matter coannihilation, are convoluated with the efficiency of the detector for a cuts parameter space (track fit quality cut Q,cone)
- Neutrino background from the scrambled data in the Sun direction is evaluated in the same space
- Minimize this quantity:

$$Sensitivity = \frac{\bar{\mu}_{90}}{Aeff\,(Mwimp) \times Teff}$$

Effective area to be estimated for different sets (Q,cone)

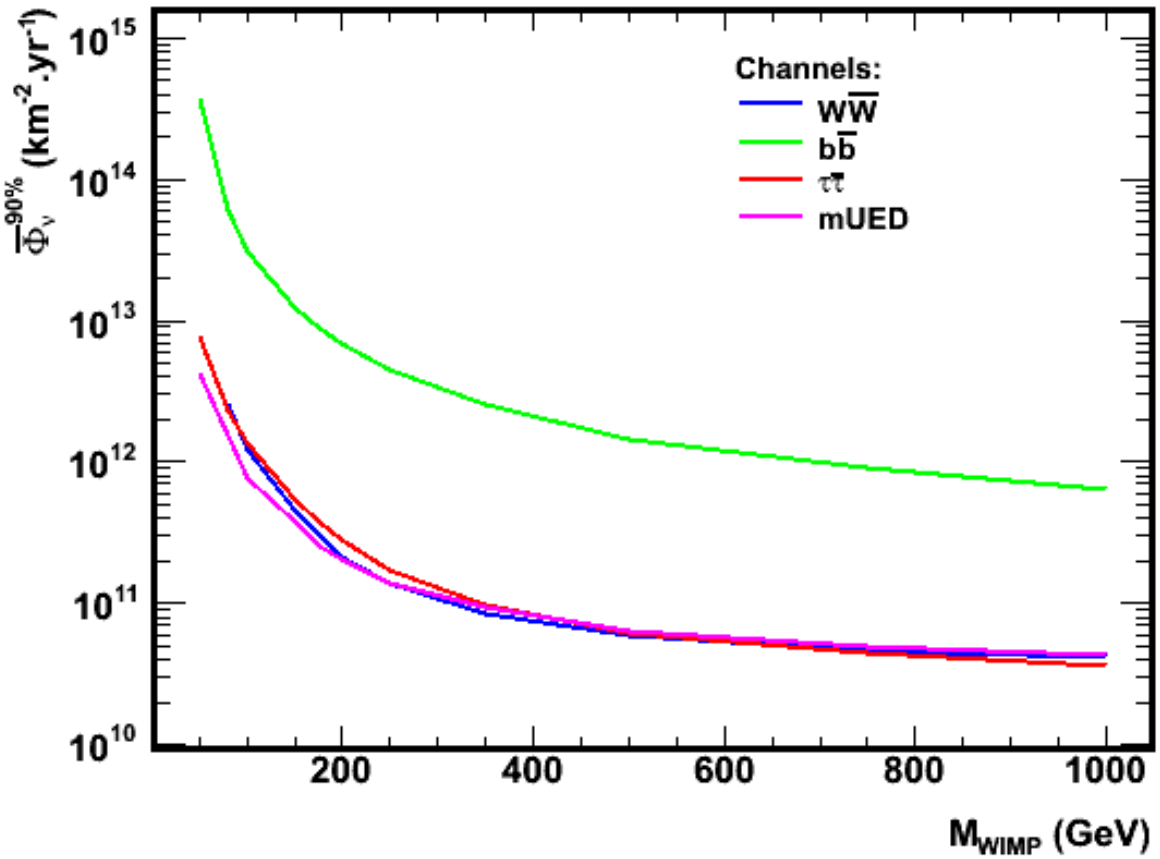


Average upper limit (Feldman-Cousins)



Dark Matter signal II
Neutrino flux sensitivity

Neutrino flux sensitivity for ANTARES 2007-2008



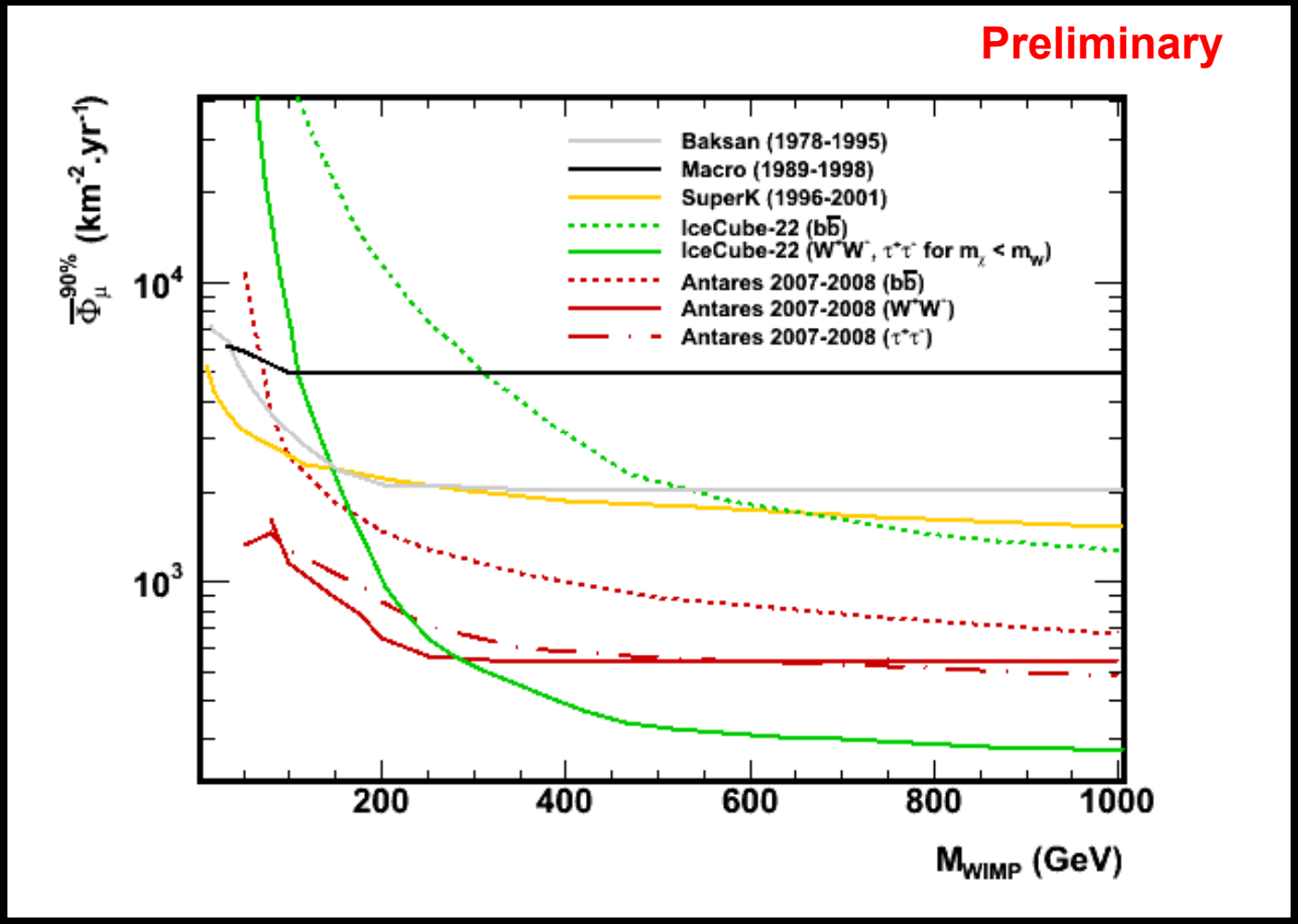
For CMSSM:
Branching ratios = 1
(WW, bb, ττ)

For mUED:
Theoritical branching ratios taken into account

Reason:
High dependence of branching ratios over CMSSM parameter space

Dark Matter signal III
CMSSM muon flux sensitivity

Muon flux sensitivity for ANTARES 2007-2008



Flux Φ_μ

↕

Annihilation rate Γ

↕

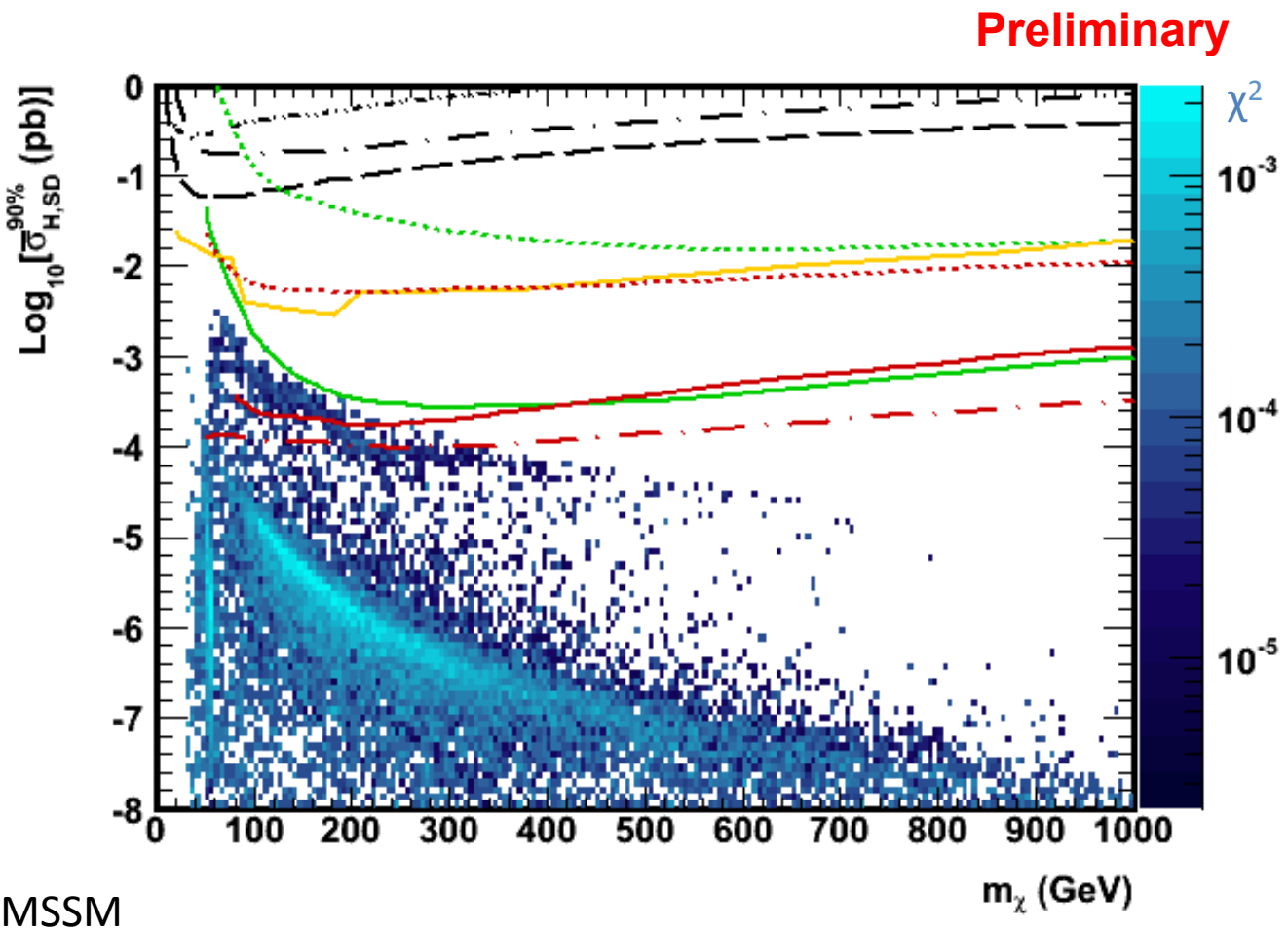
Capture rate C

↕

Cross-section σ_{SD}

Dark Matter signal IV
CMSSM cross-section sensitivity

Spin-dependent cross-section flux sensitivity for ANTARES 2007-2008



CMSSM

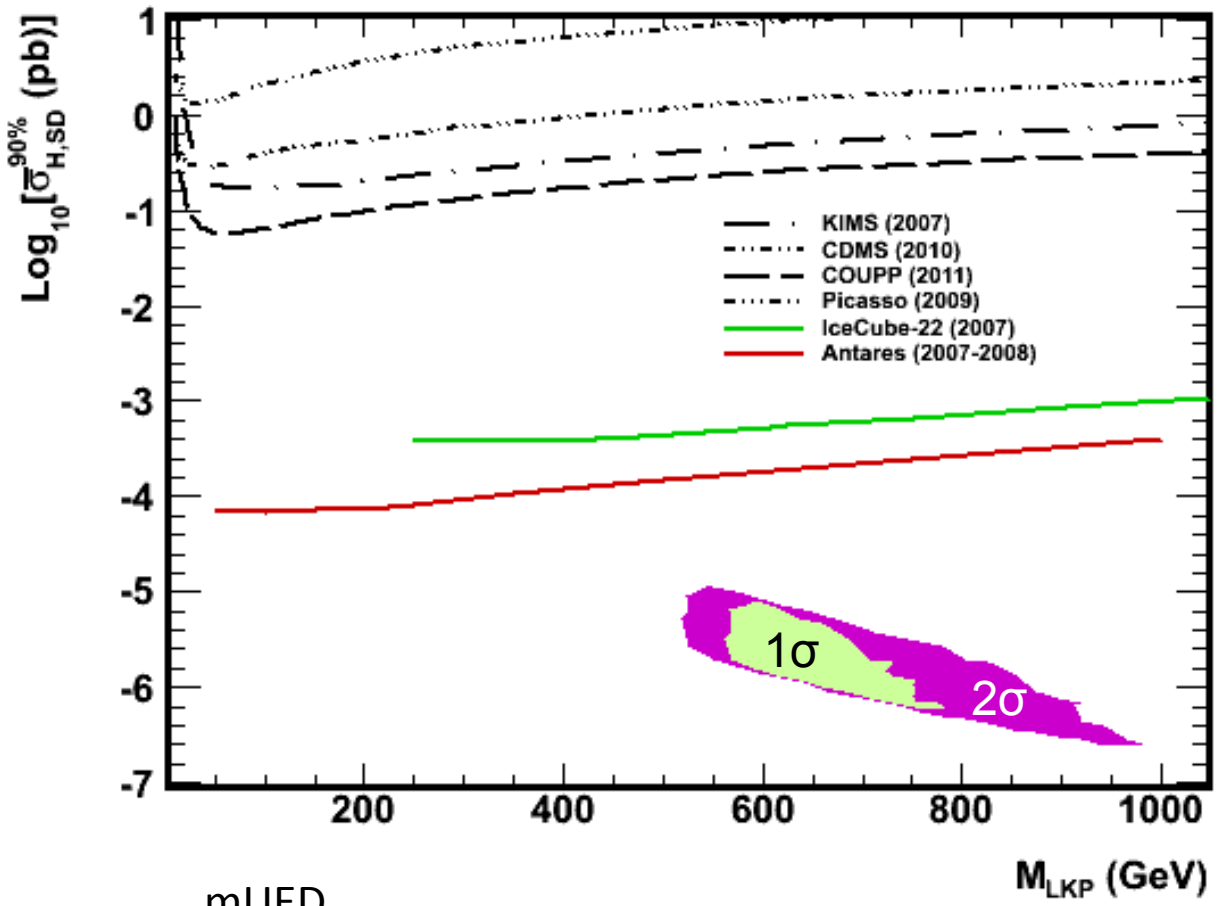
Compare SUSY predictions to observables as sparticles masses, collider observables, dark matter relic density, direct detection cross-sections, …

SuperBayes (arXiv:1101.3296)

Dark Matter signal IV
mUED cross-section sensitivity

Spin-dependent cross-section flux sensitivity for ANTARES 2007-2008

Preliminary



mUED

Compare mUED predictions to observables as KK masses, collider observables, relic density, direct detection cross-sections, …

SuperBayes *modified version*

(Physical Review D 83, 036008 (2011))

Summary & Conclusion

- Computed the detector efficiency for two common dark matter models (CMSSM, mUED)
- Evaluated background in the direction of the Sun in the parameter space (Q,Ψ)
- Reached the sensitivities for the CMSSM, and mUED, in muon flux, and spin-dependent cross-section…
- Antares 2007-2008 gives an opportunity to constraint the dark matter parameter spaces
- Important complement to the direct detection experiments
- Antares 2007-2010 study in progress…