ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Indirect Search for Dark Matter with the Neutrino Telescope ANTARES

Friedrich-Alexander-Universität Erlangen-Nürnberg

Andreas Spies, on behalf of the ANTARES Collaboration

SUSY11,

Fermilab, Batavia 28.08.2011

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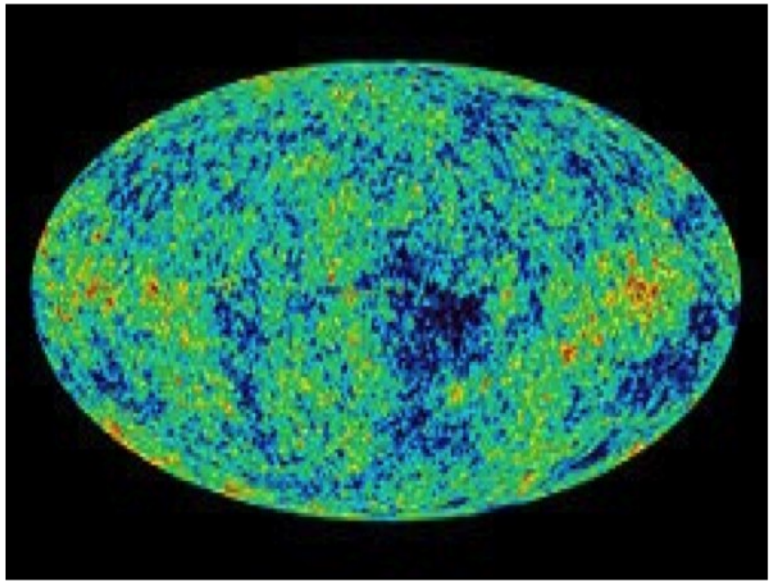
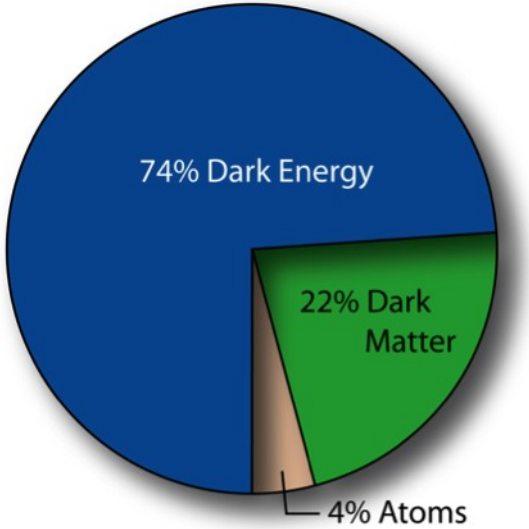
Dark Matter

Experimental Hints



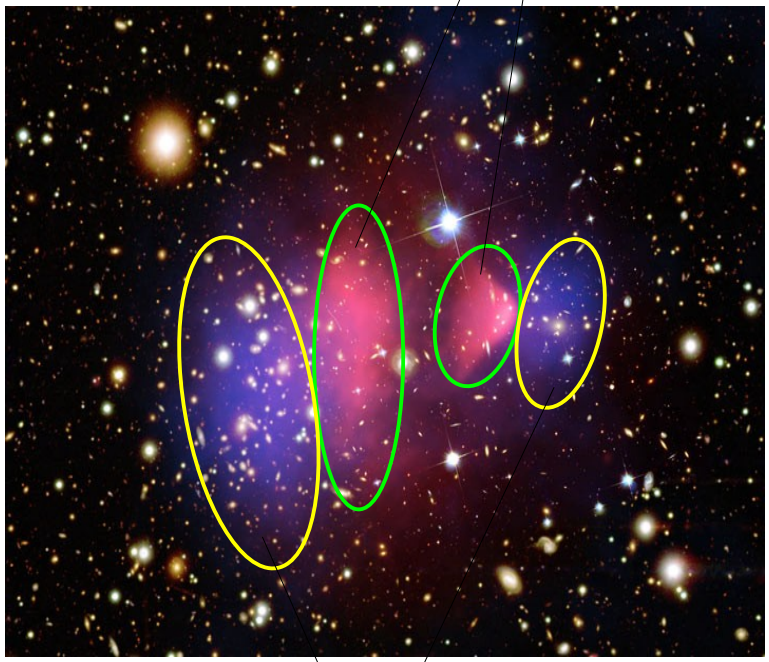


WMAP: $0.09 < \Omega_{DM} h^2 < 0.13$

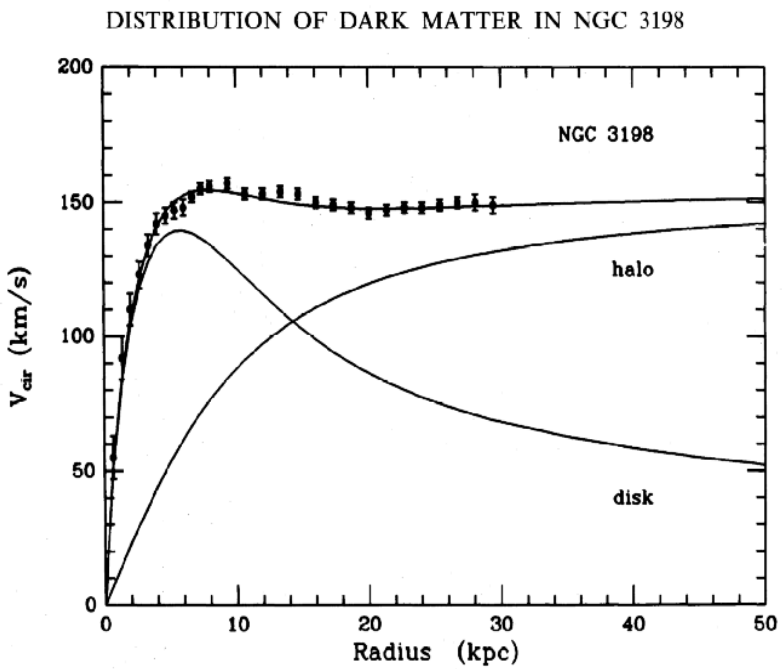
Dark Matter

Experimental Hints

Hot gas, baryonic matter



Dark Matter



Search for Dark Matter

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- Theories beyond the Standard Model (e.g. Kaluza-Klein, Supersymmetry) provide candidates for cold Dark Matter

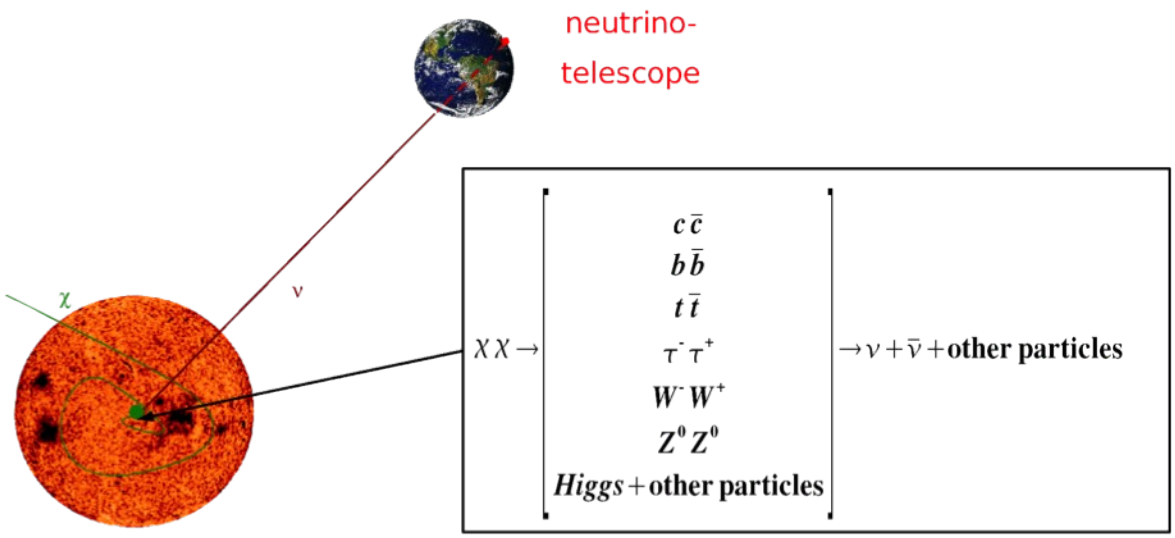
- WIMPs: Weakly Interacting Massive Particles
  masses in the order of O(100 GeV) – O(1TeV)

- In SUSY models one of these WIMPs is the Neutralino X

- Indirect detection of Neutralinos with Neutrino Telescopes

Search for Dark Matter with Neutrino Telescopes

Principle of Detection:

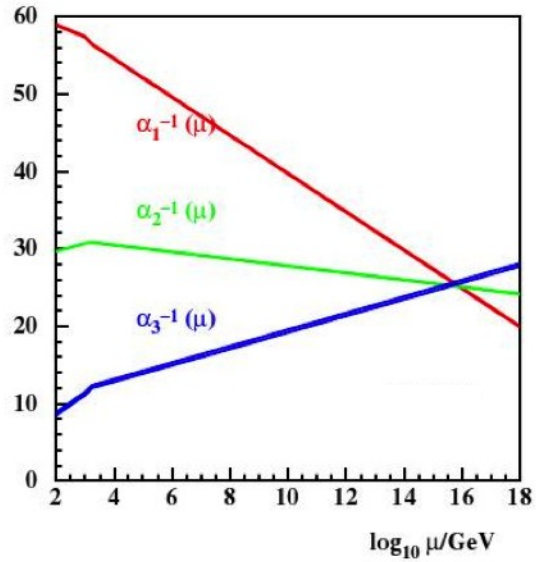


- WIMPs from the galactic halo lose energy through scattering and accumulate in massive bodies, e.g. the Sun
- Self annihilation products (Neutrinos) can be detected with Neutrino Telescopes

Supersymmetric WIMPs

Minimal Supersymmetric Standard Model (MSSM):

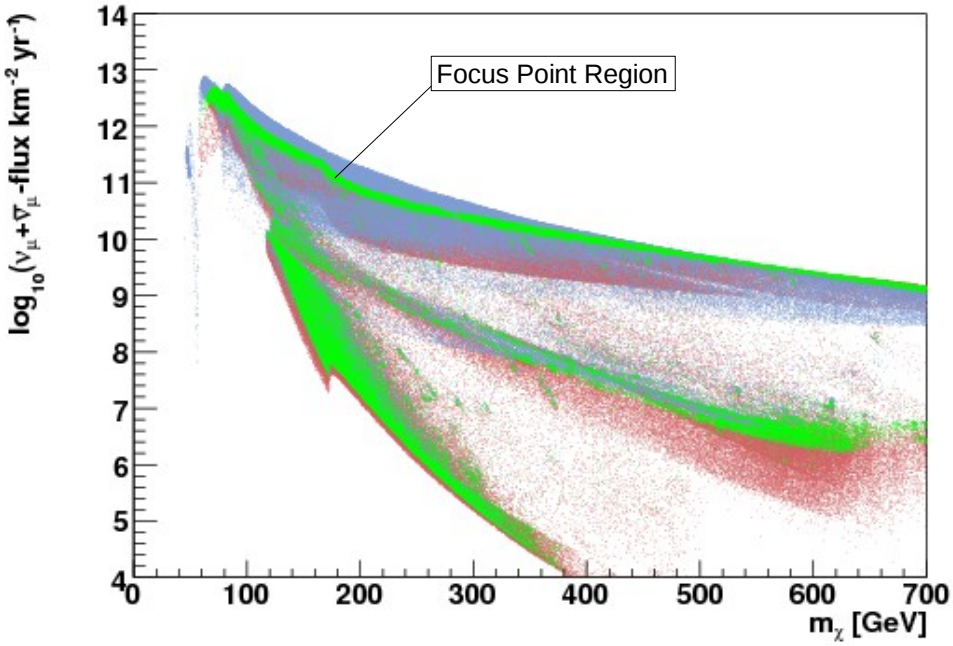
- Disadvantage: additional 105 free parameters
- Simplifying assumptions are neccessary to reduce number of parameters
- mSUGRA (minimal SUperGRAvity): defined on scale of gauge coupling unification



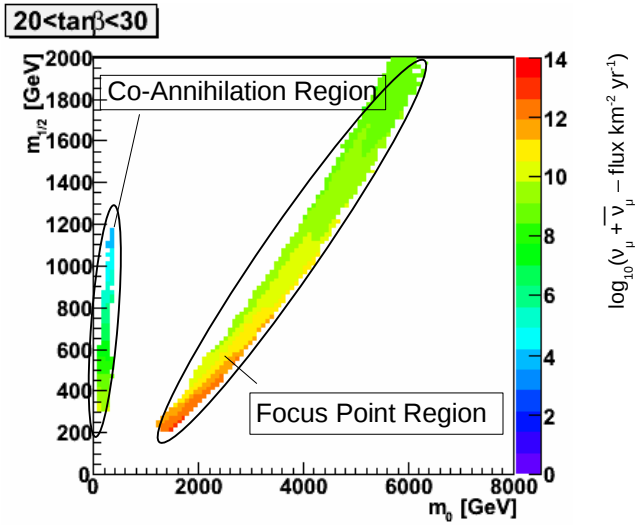
→ only 5 free parameters left

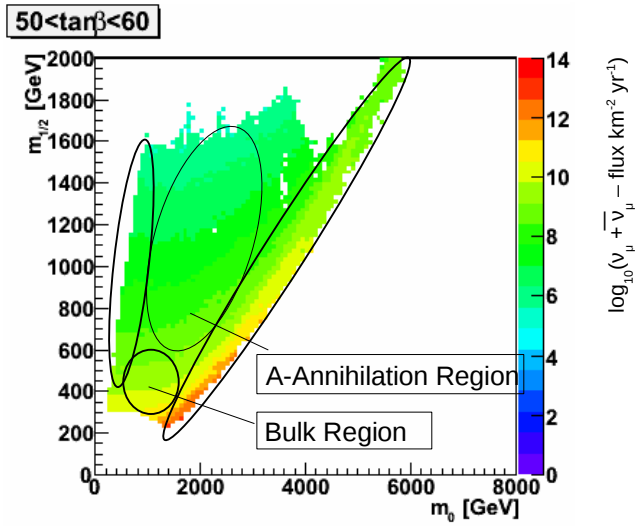
m_0 , $m_{1/2}$, A_0 , tan(β) , sign(μ)

Regions of mSUGRA parameter space (expected ν_μ - $\bar{\nu}_\mu$ flux from the Sun)



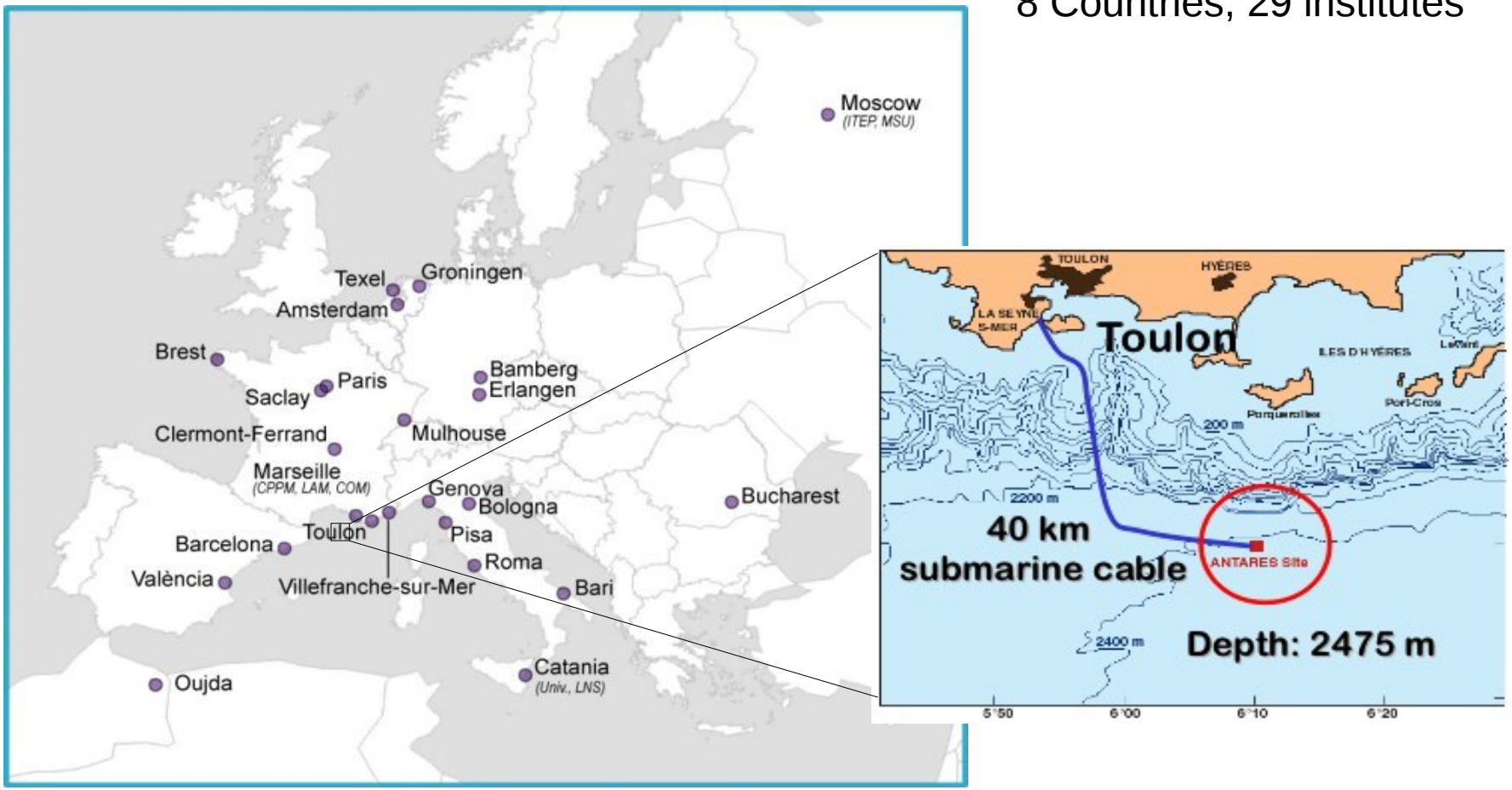
- $0.09 < \Omega h^2 < 0.13$
- $\Omega h^2 < 0.09$
- $0.13 < \Omega h^2 < 1$





The ANTARES Experiment

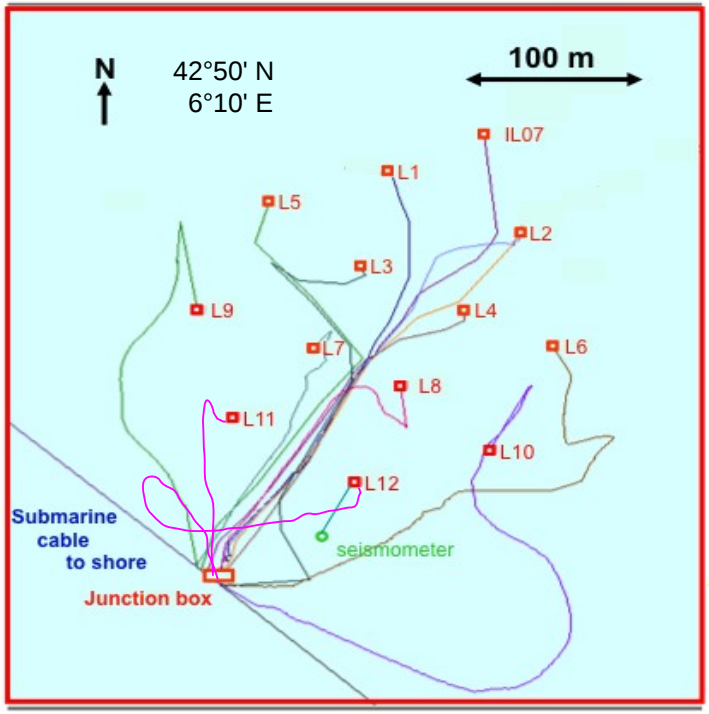
Collaboration:
8 Countries, 29 institutes

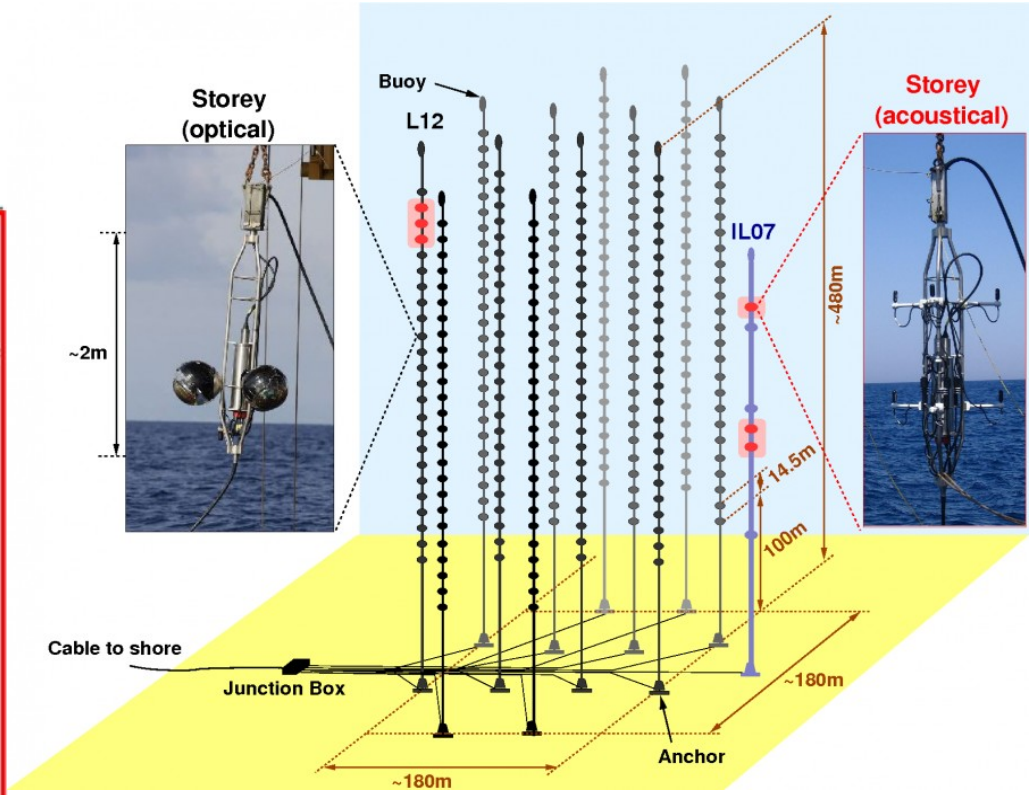


The ANTARES Experiment

Detector layout:

Fully operational since May 2008





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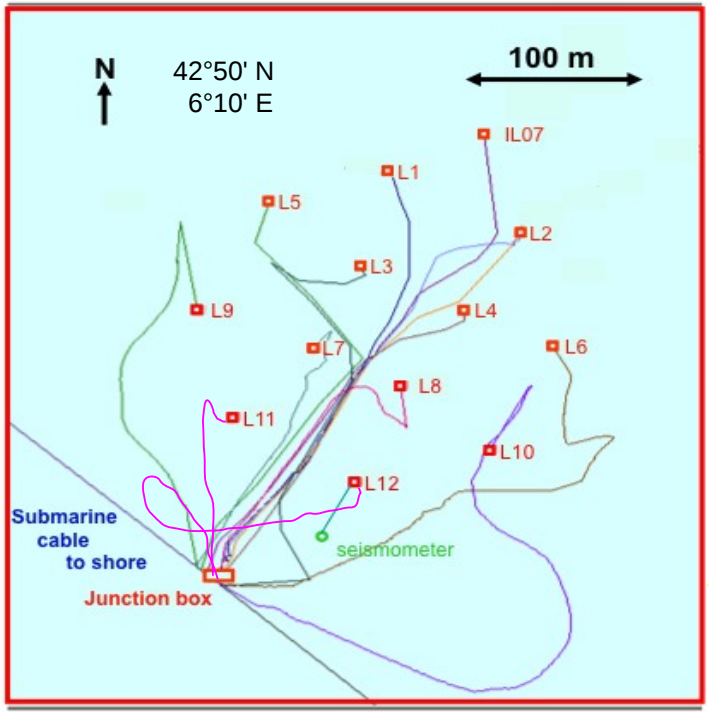

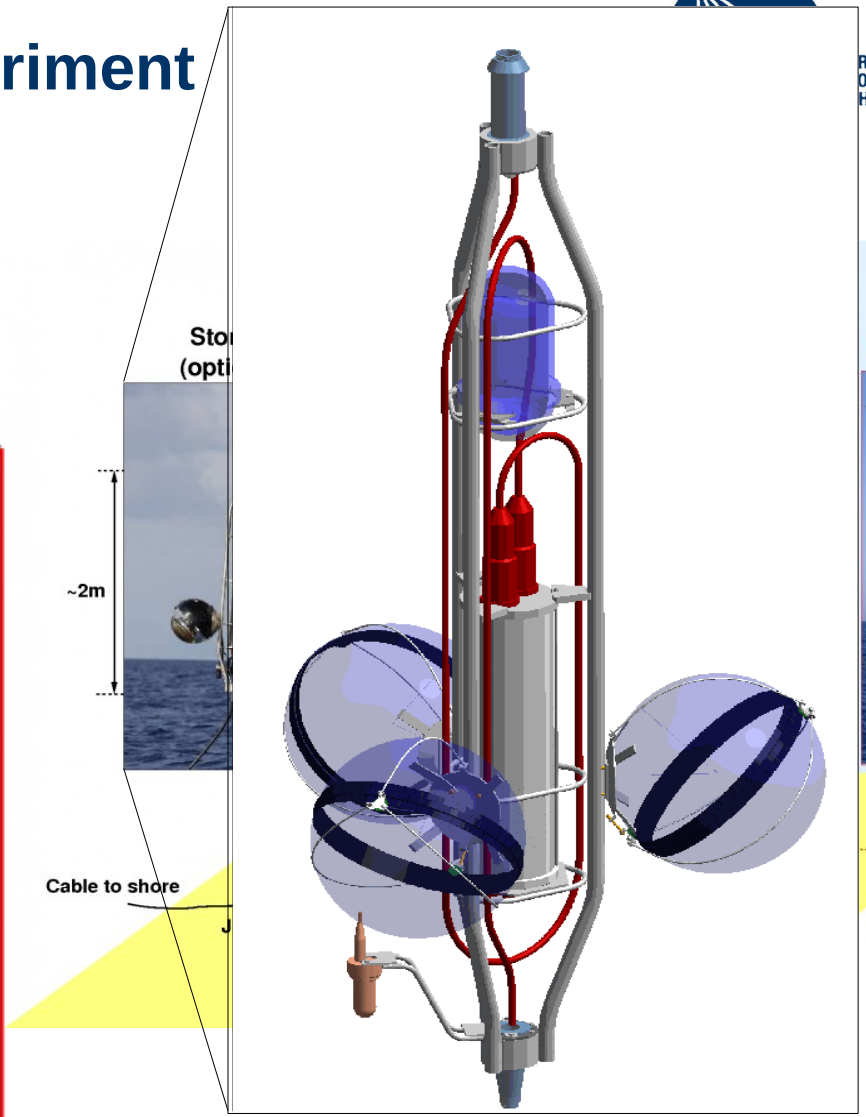

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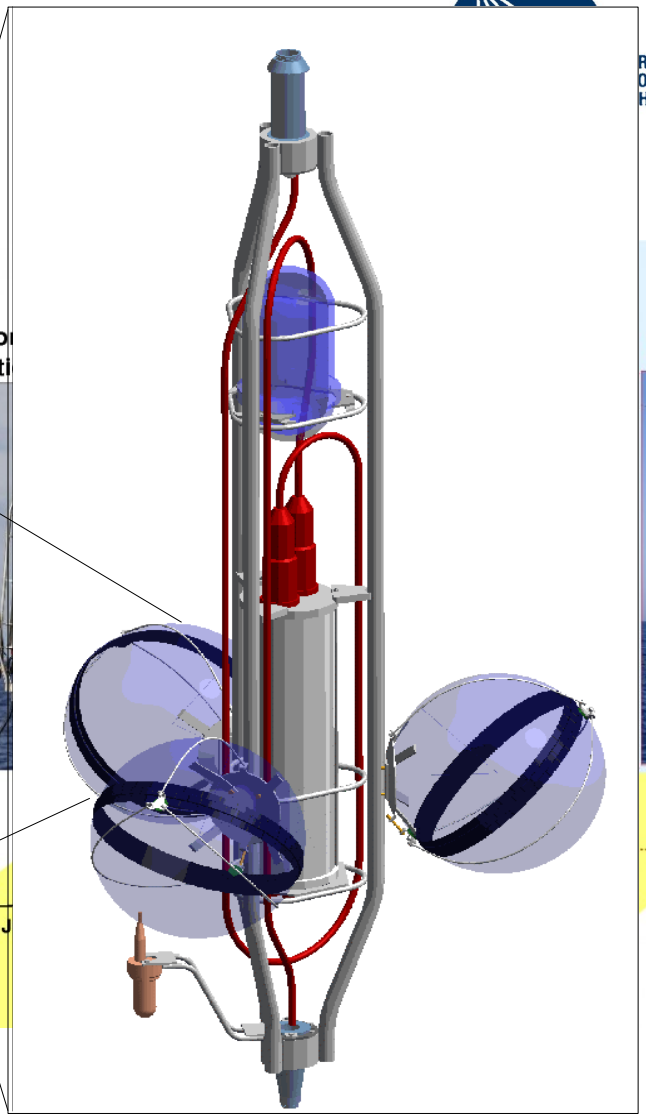
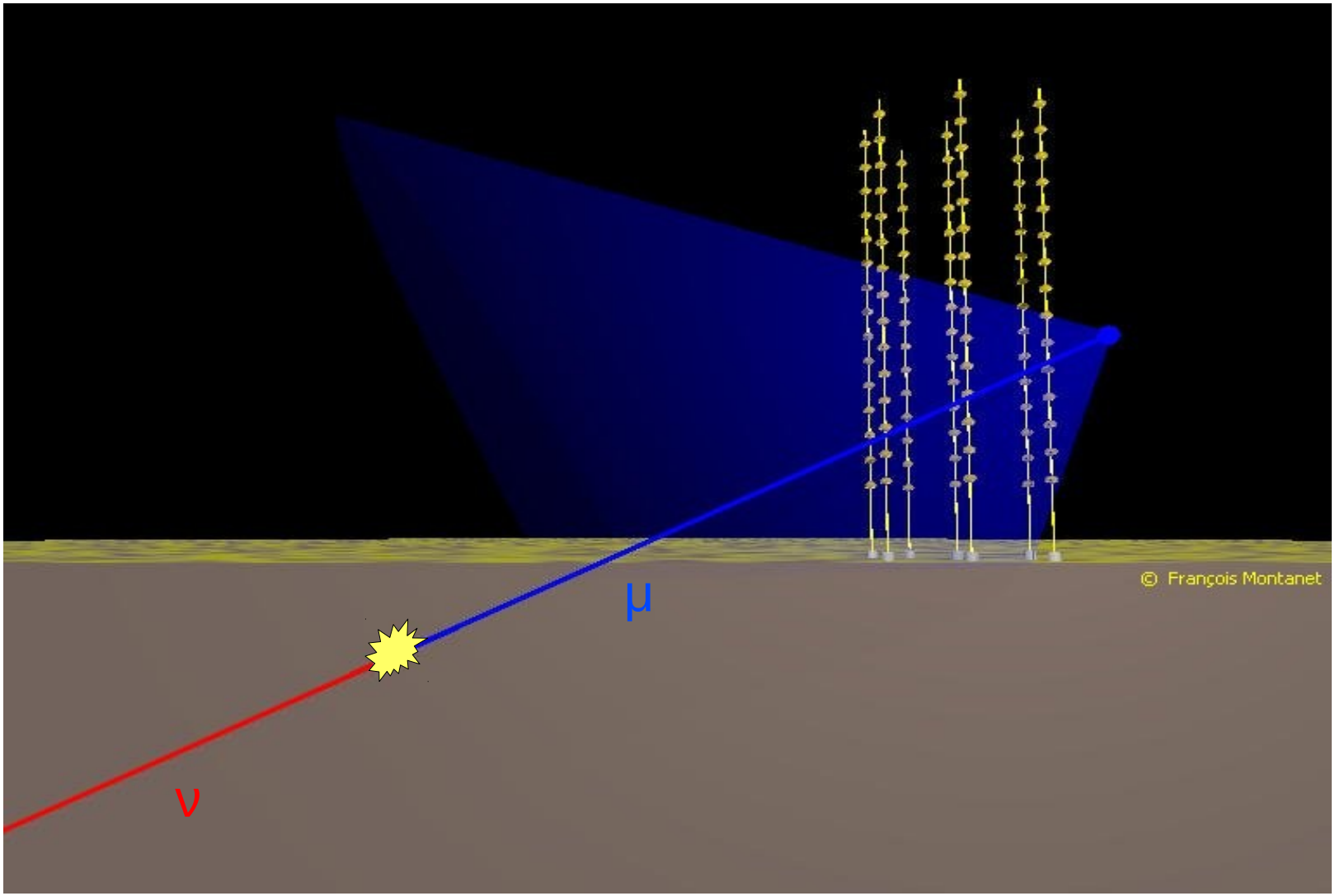


Principle of Detection



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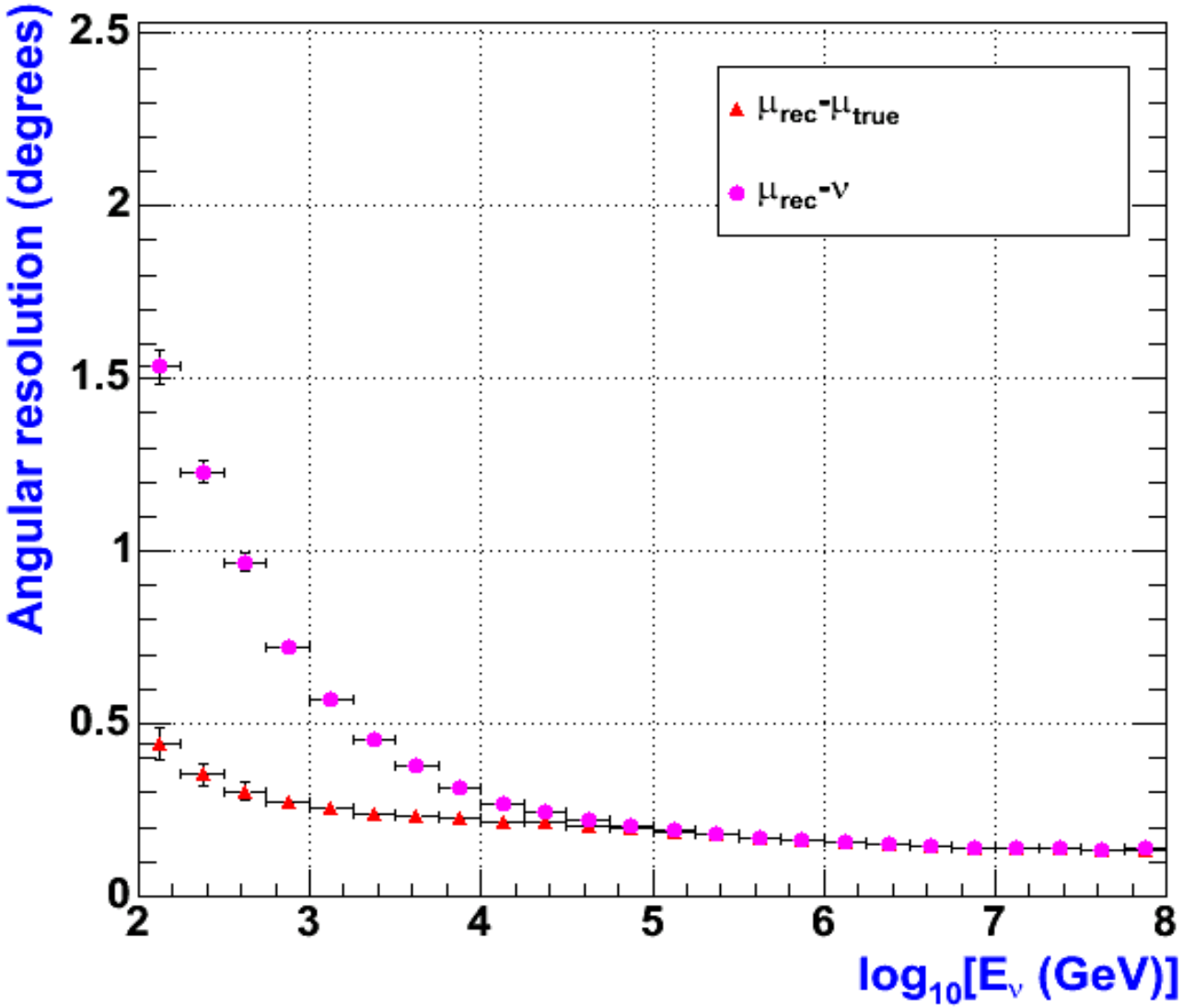
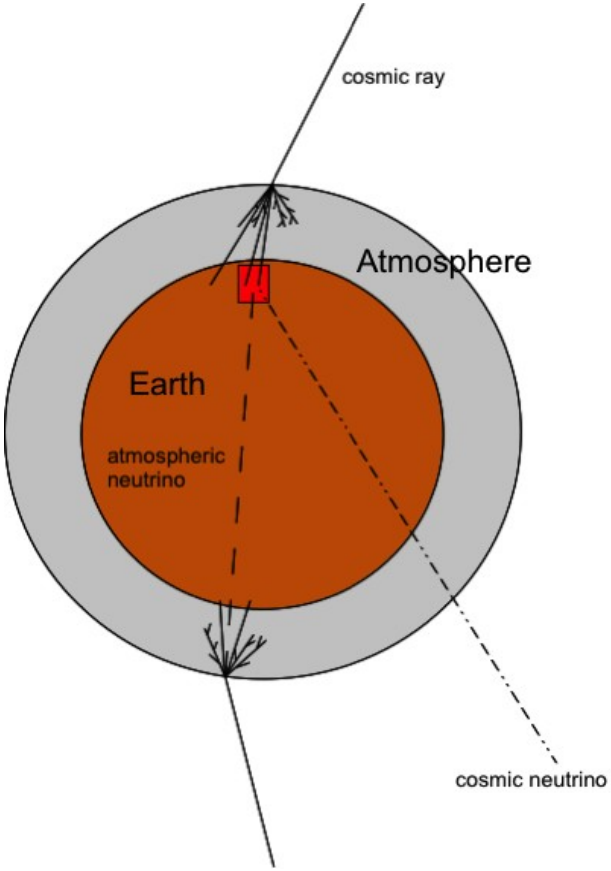
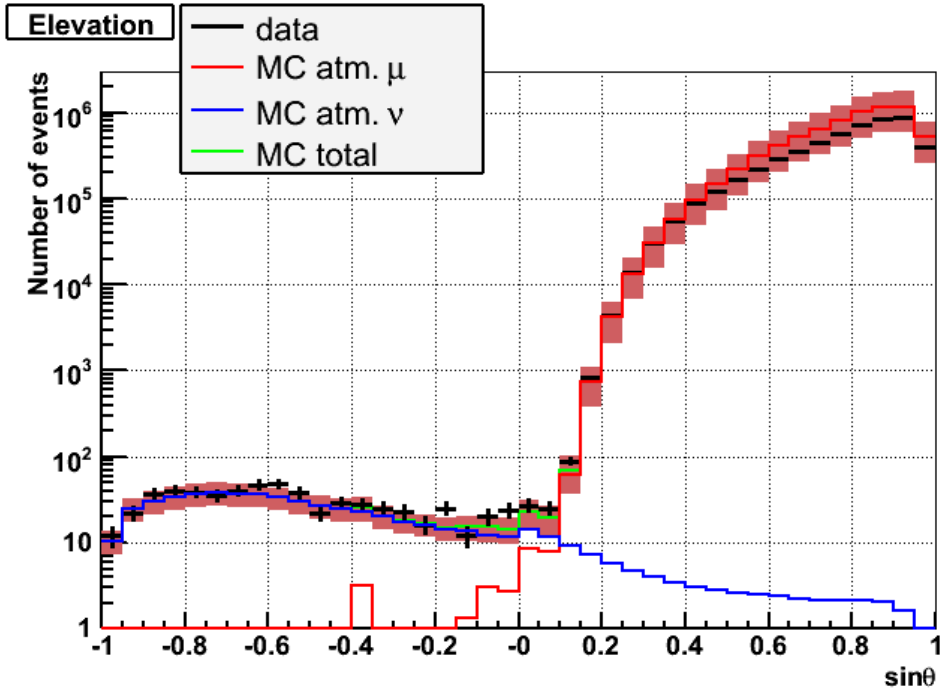
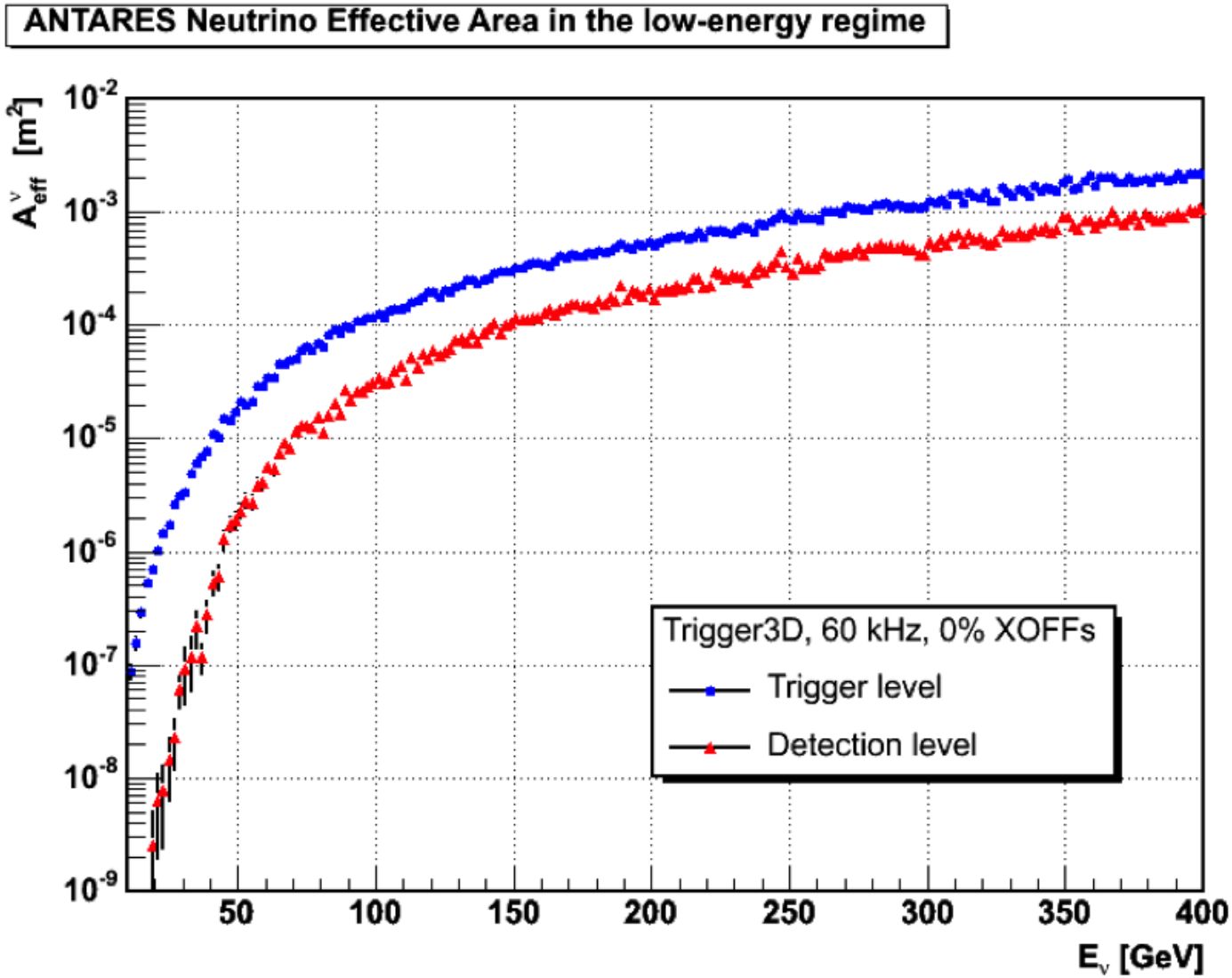


Background Rejection

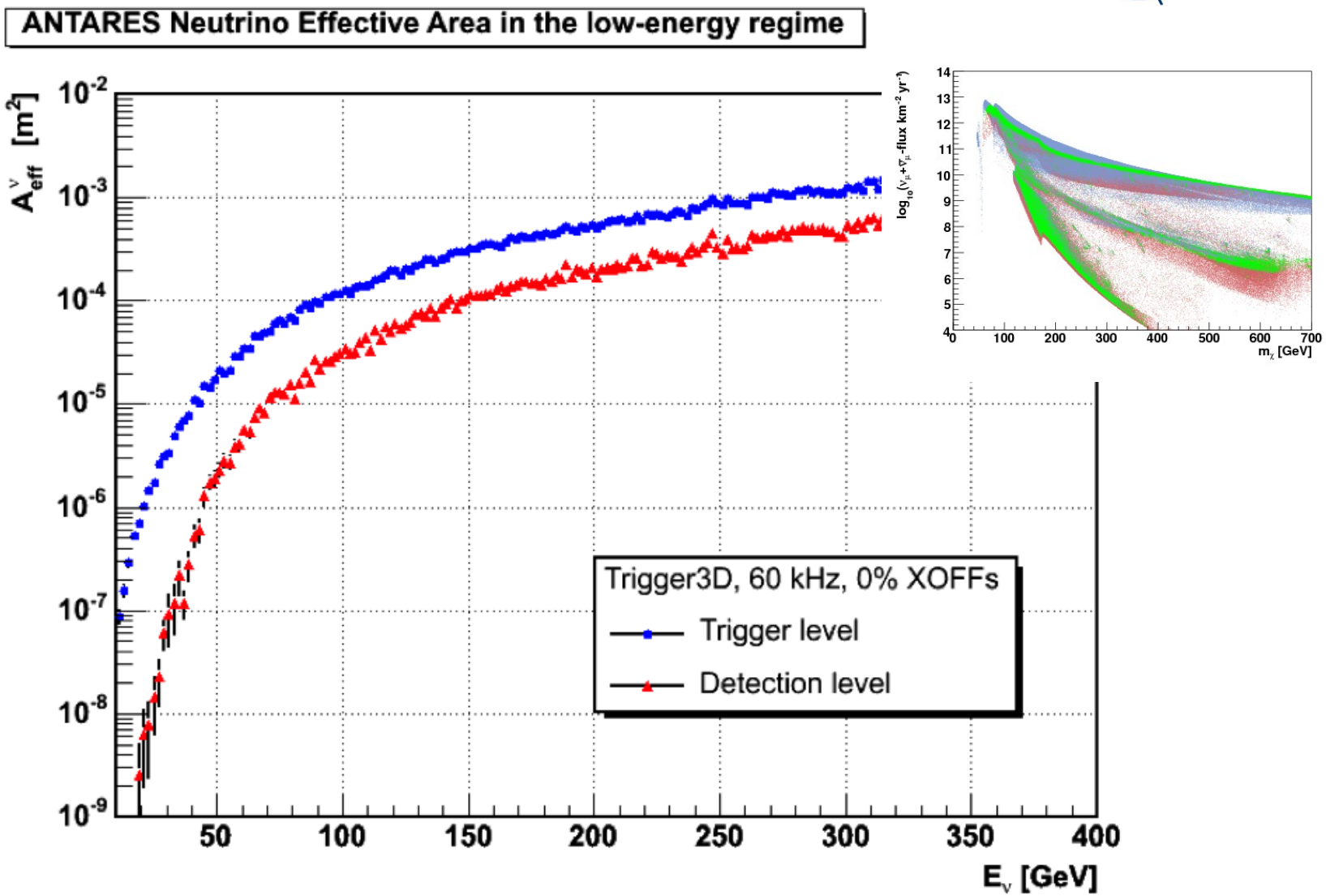




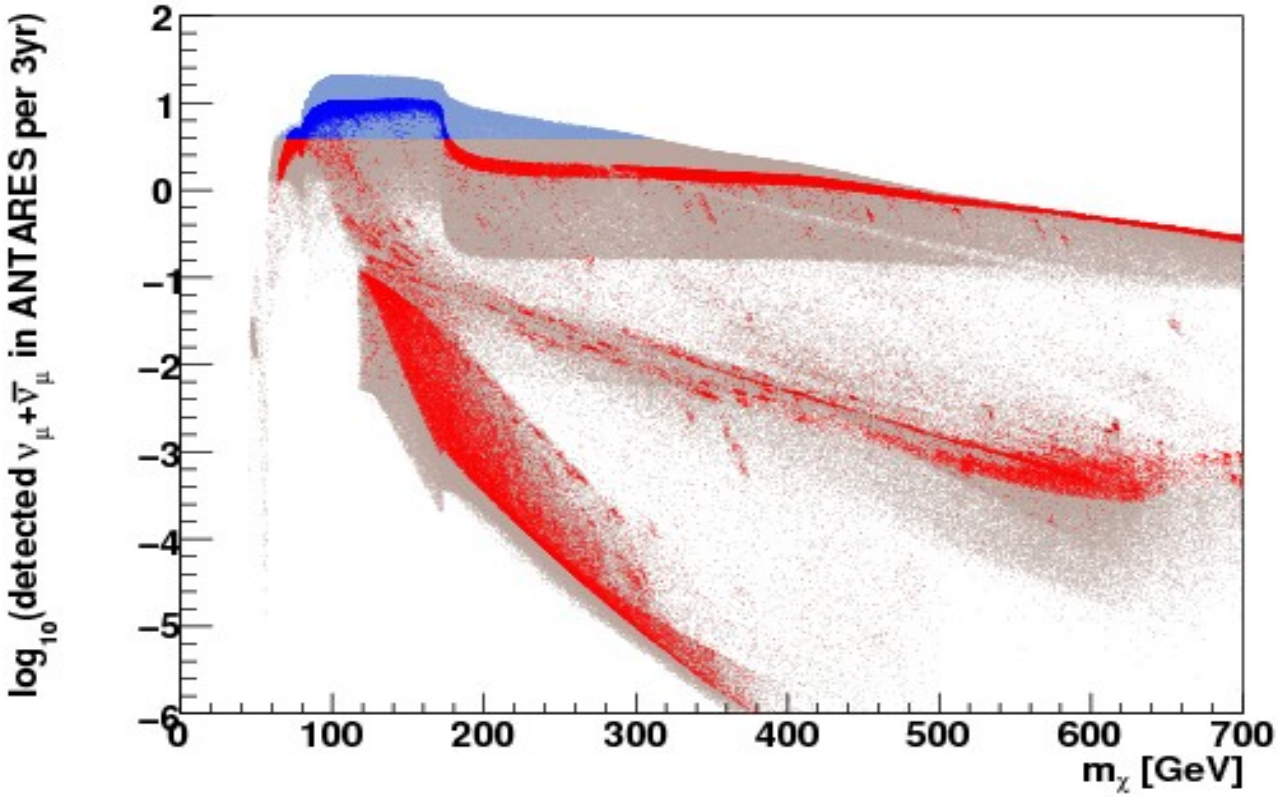
ANTARES Effective Area



ANTARES Effective Area



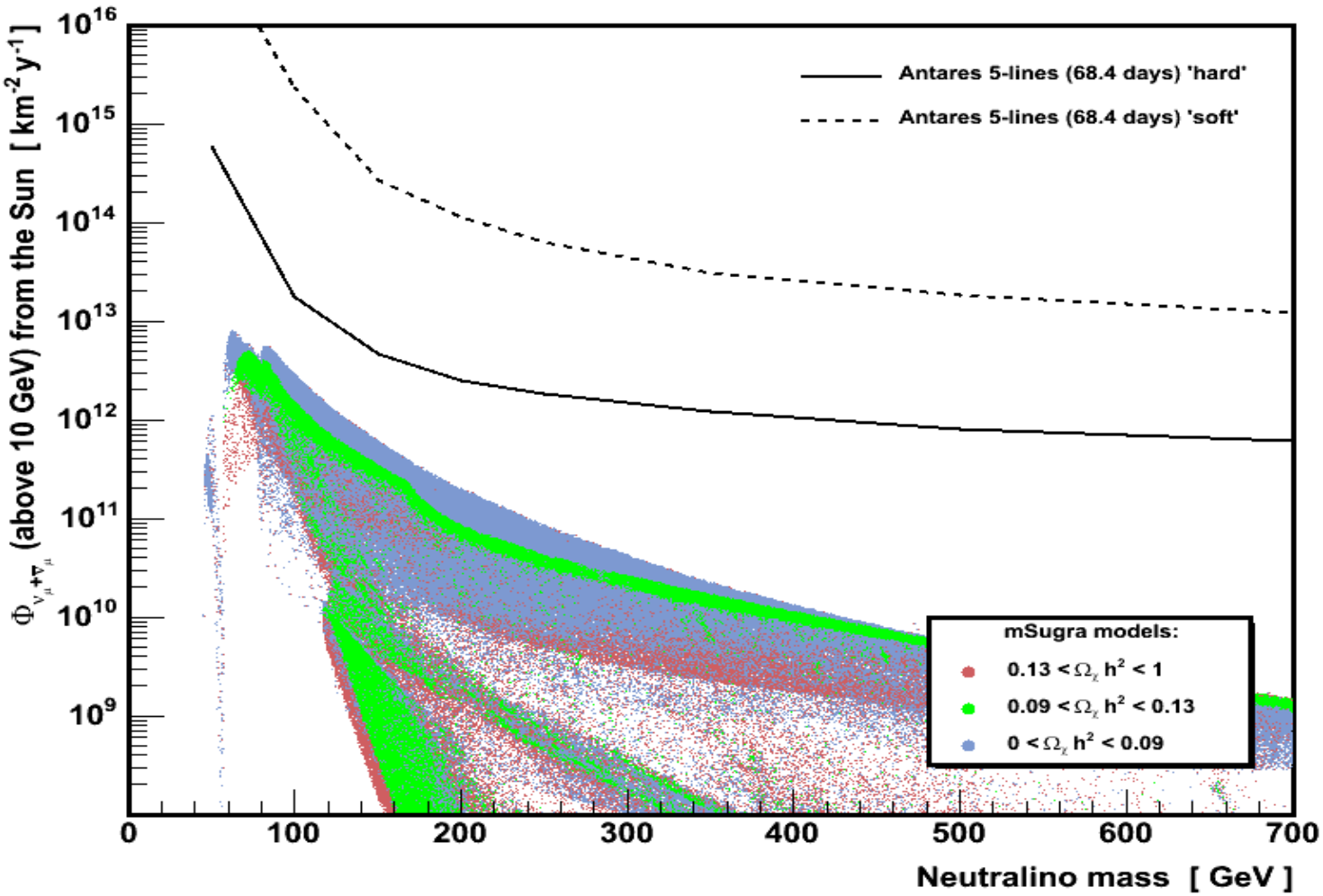
Expected Detection Rate from the Sun (Simulation)



- Search Cone: 3°
- 10% misreconstructed Events (assumed)
- Unified Approach of Feldman-Cousins

- WMAP favoured, 90% CL. excludable by ANTARES
- WMAP disfavoured, 90% CL. excludable by ANTARES
- WMAP favoured, not excludable by ANTARES
- WMAP disfavoured, not excludable by ANTARES

Limit on Neutrino Flux from the Sun (Data)



Summary and Future Prospects

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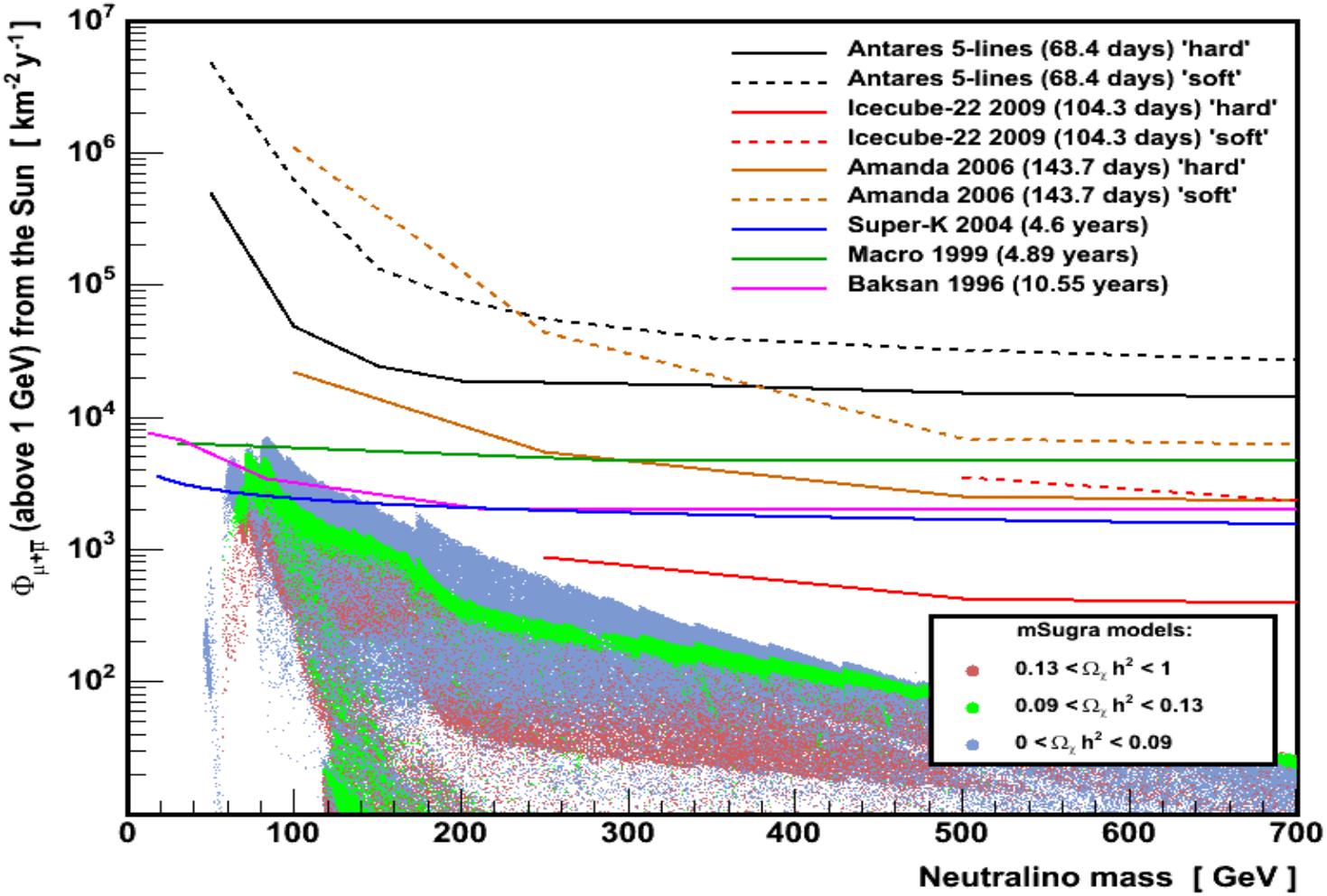
- ANTARES operational and taking data
- First Limit derived from 5 Line period
- Complementary method of SUSY/Dark Matter search to direct detection and LHC

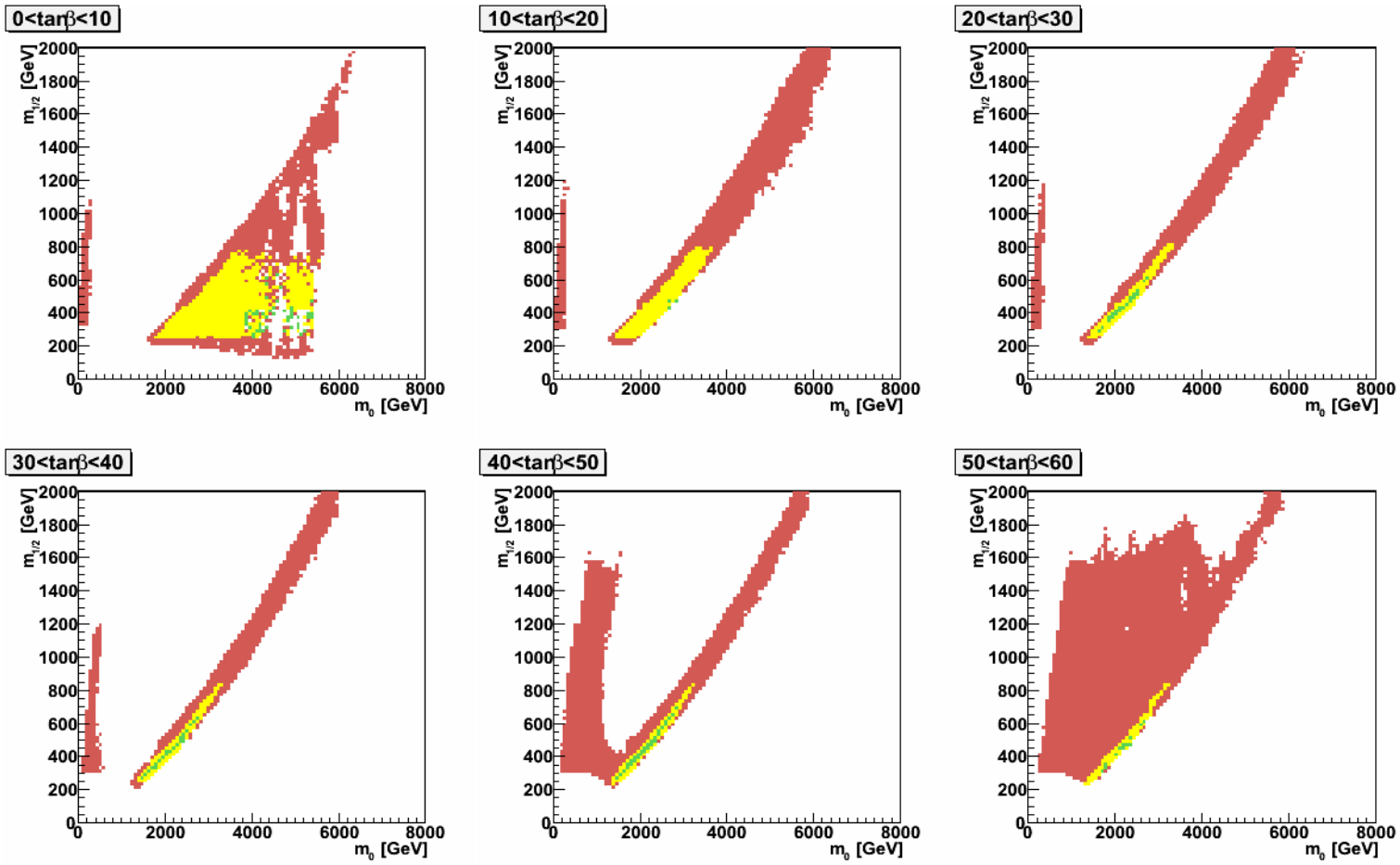
- Analysis of 10 and 12 Line data using dedicated Low Energy reconstruction algorithm in progress
- Search for annihilation signal from centre of Earth in progress

BackUp slides

Muon Flux limit



Excludable regions of mSUGRA parameter space



Excludable in 3 years (90% C.L.): all some none