

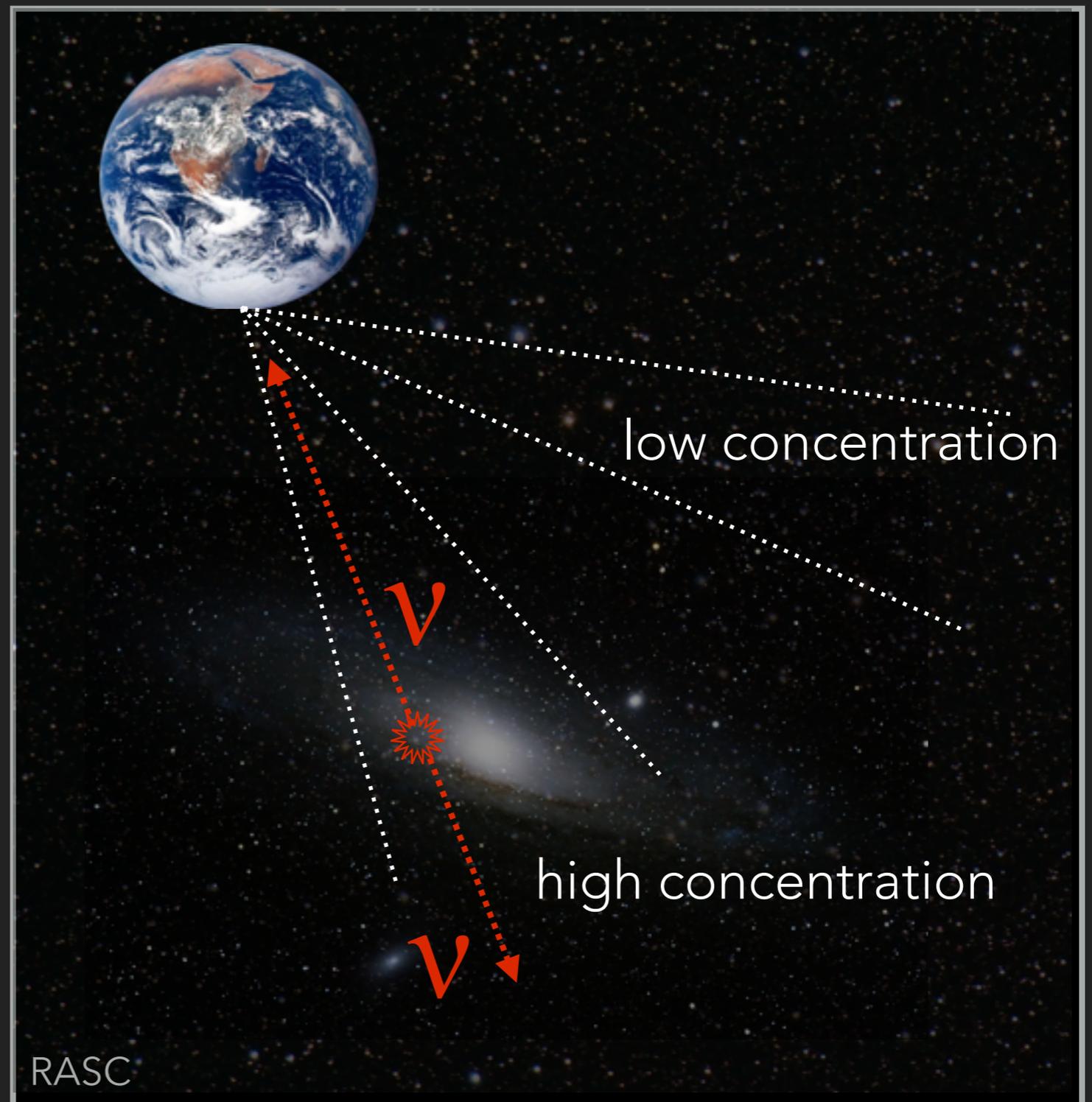
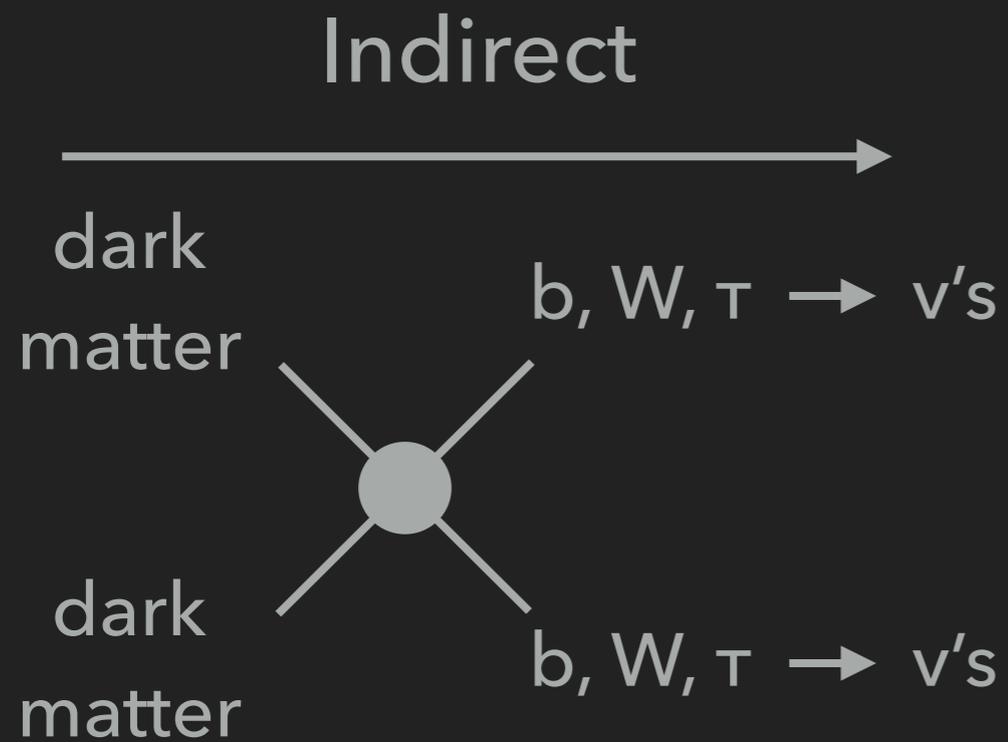


MORTEN MEDICI

DARK MATTER SEARCHES IN ICECUBE

TEV PARTICLE ASTROPHYSICS 2016

INDIRECT DETECTION WITH NEUTRINOS

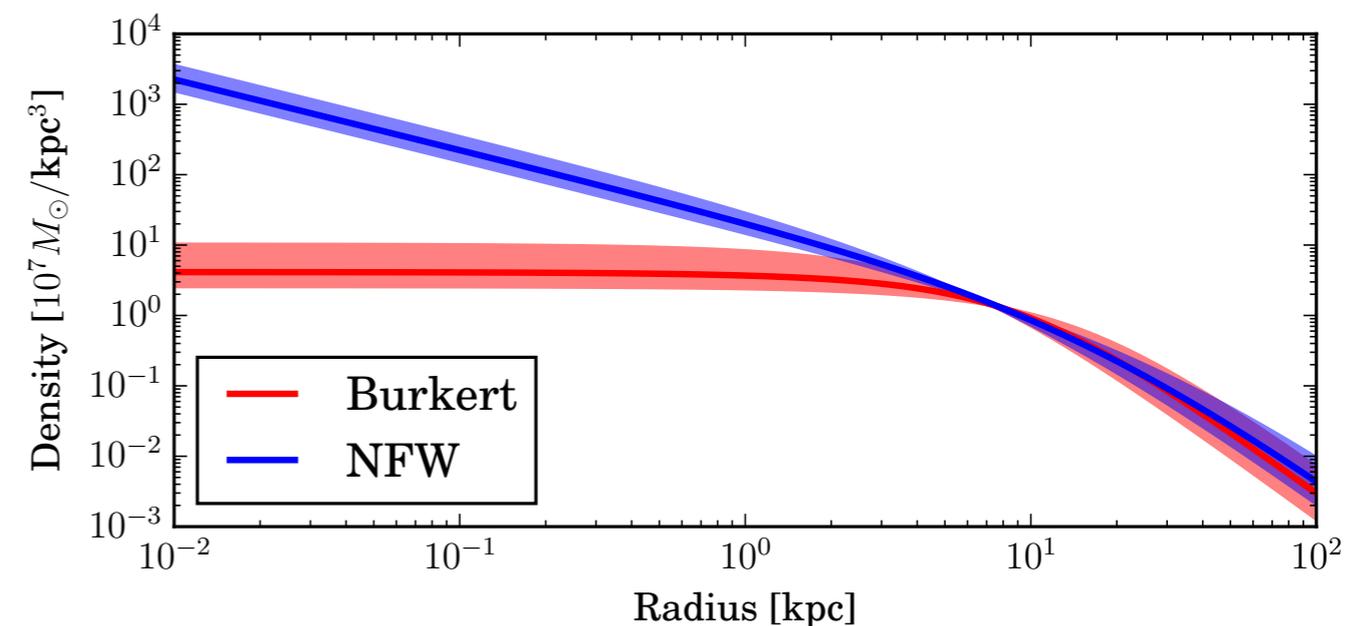
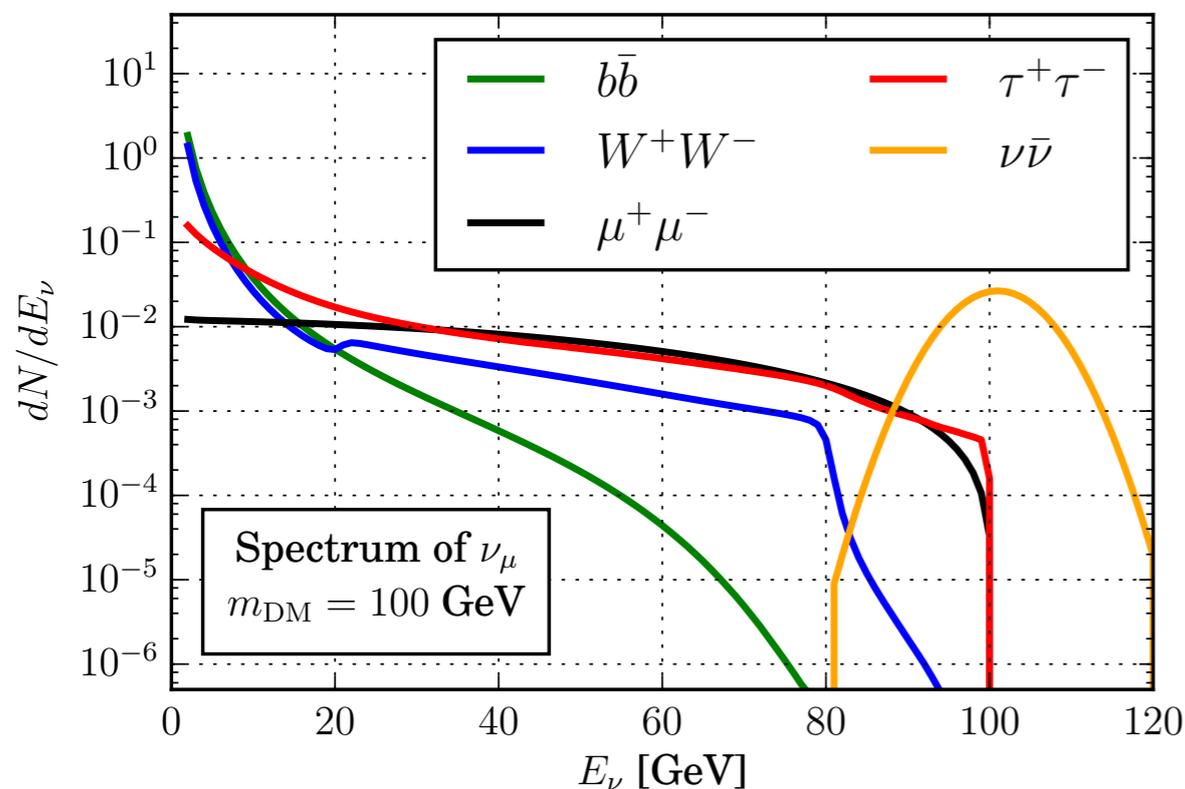


EXPECTED SIGNAL

- ▶ Spectrum model dependent
- ▶ Signal sensitive to assumed halo profile

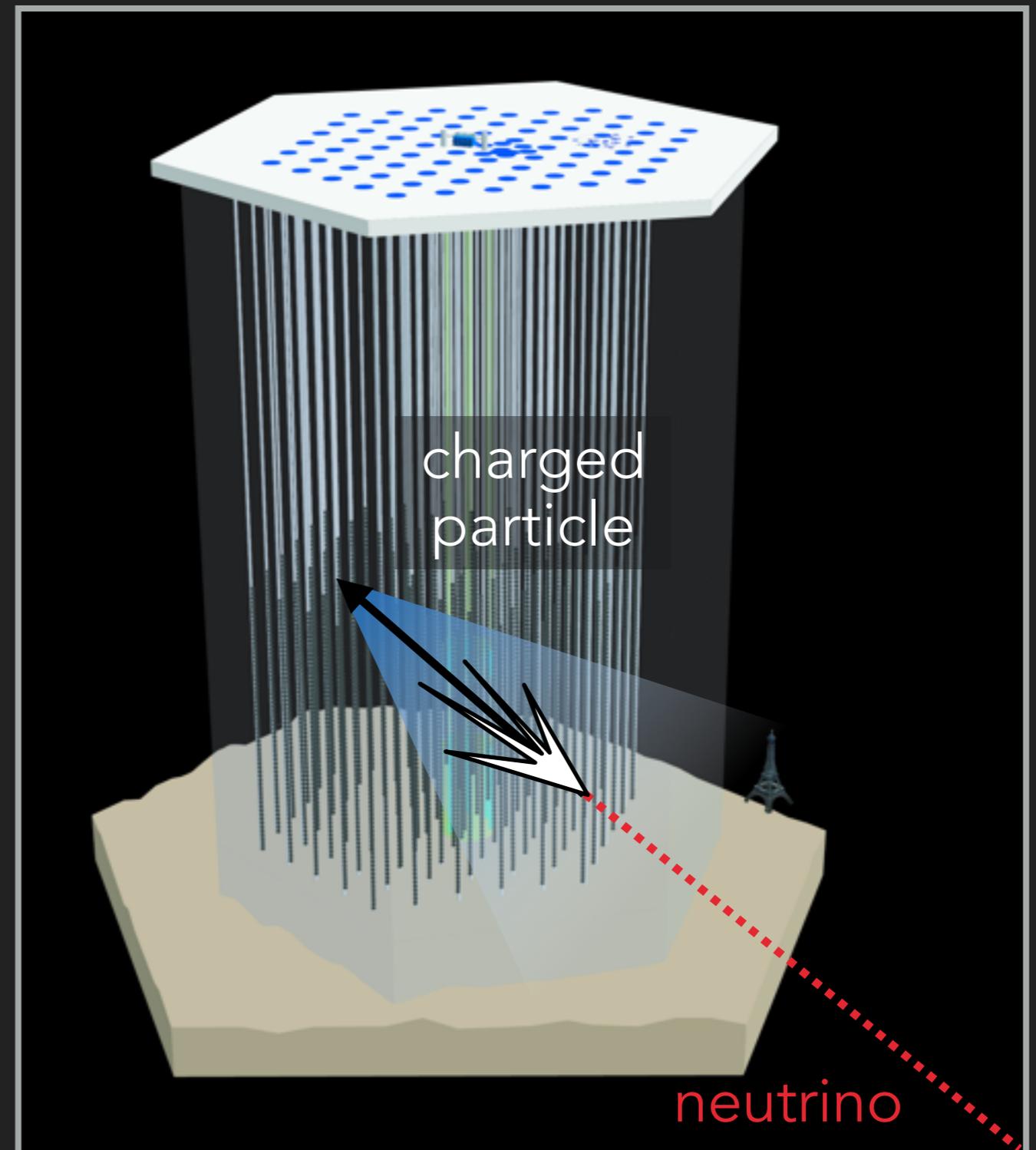


$$\Phi = \frac{\langle \sigma_{Av} \rangle}{4\pi \cdot 2m_{\text{DM}}^2} \frac{dN}{dE}(E_\nu) \int_{\text{los}} \rho_{\text{halo}}^2(\Psi)$$



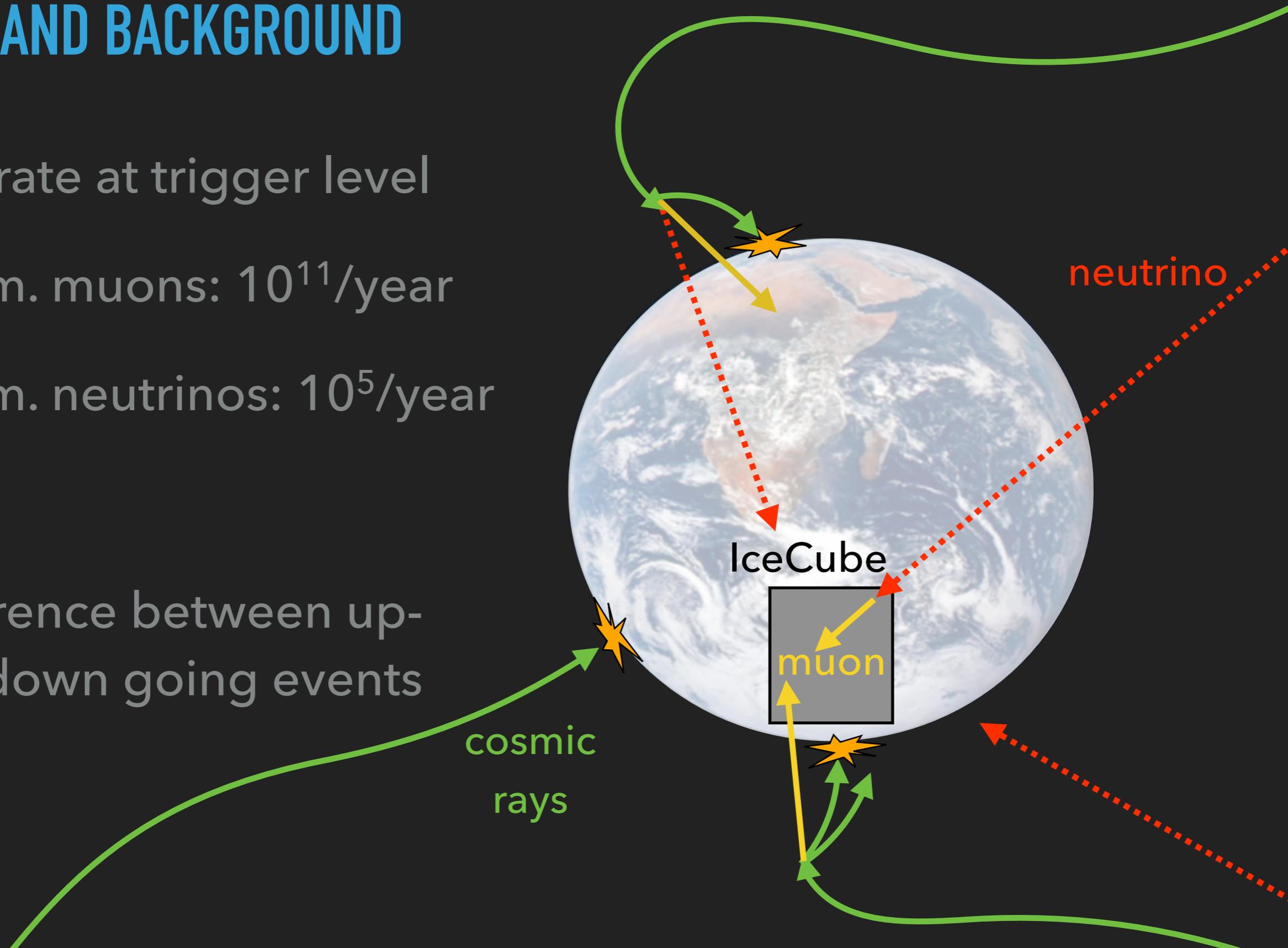
NEUTRINO PHYSICS WITH ICECUBE

- ▶ 1 km³ instrumented ice below the South Pole
- ▶ 5160 light sensors for detecting Cherenkov radiation
- ▶ Measuring neutrino-initiated events
- ▶ Energies down to 10s of GeV



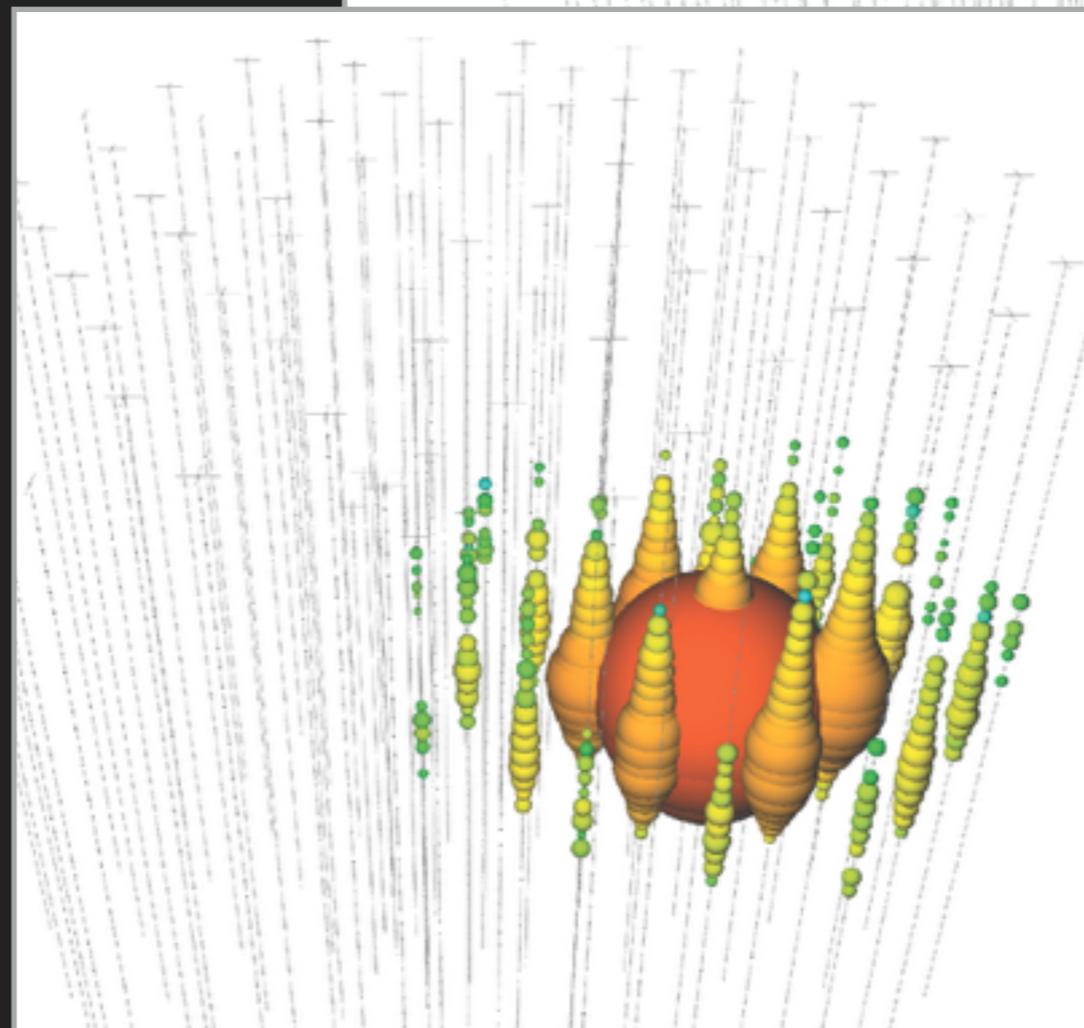
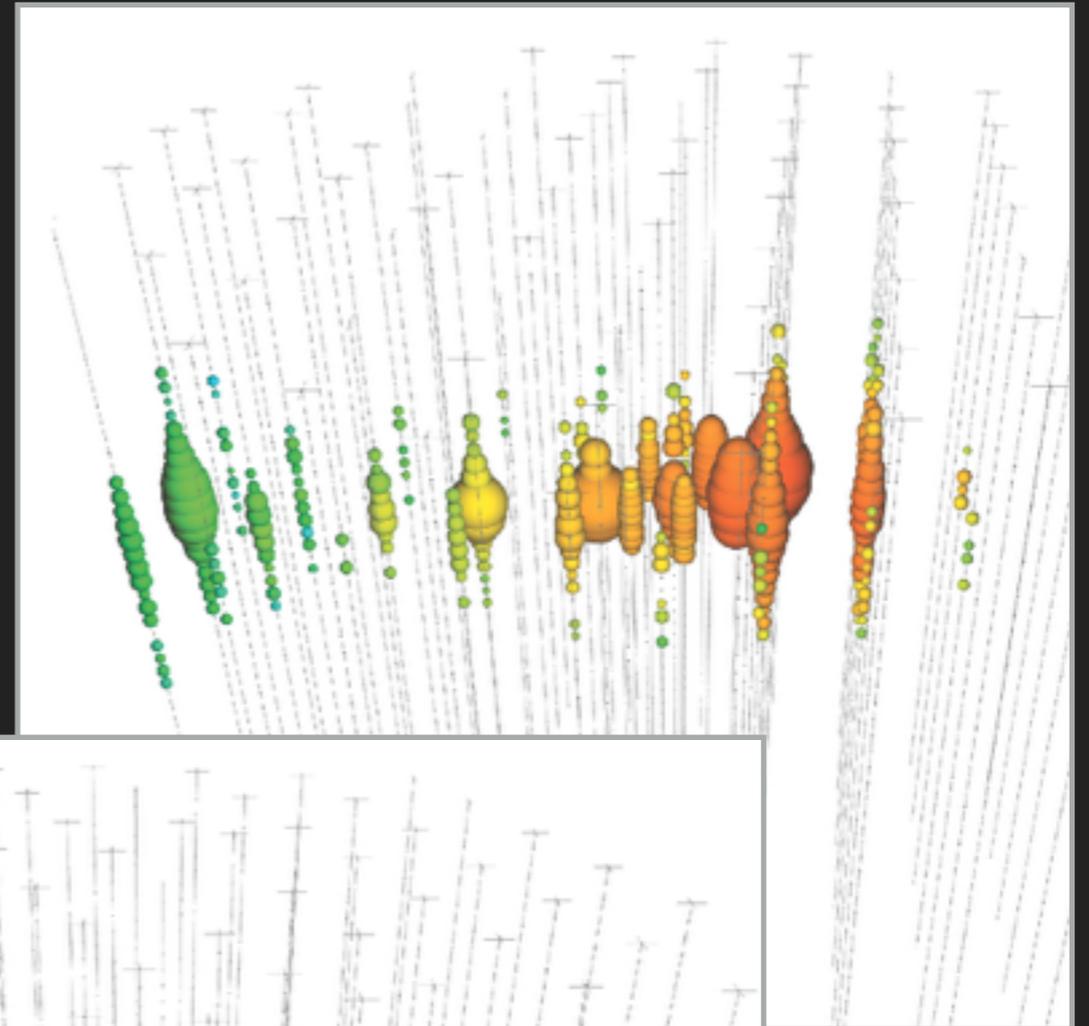
SIGNAL AND BACKGROUND

- ▶ Bkg. rate at trigger level
 - ▶ Atm. muons: 10^{11} /year
 - ▶ Atm. neutrinos: 10^5 /year
- ▶ Difference between up- and down going events



ICECUBE EVENTS

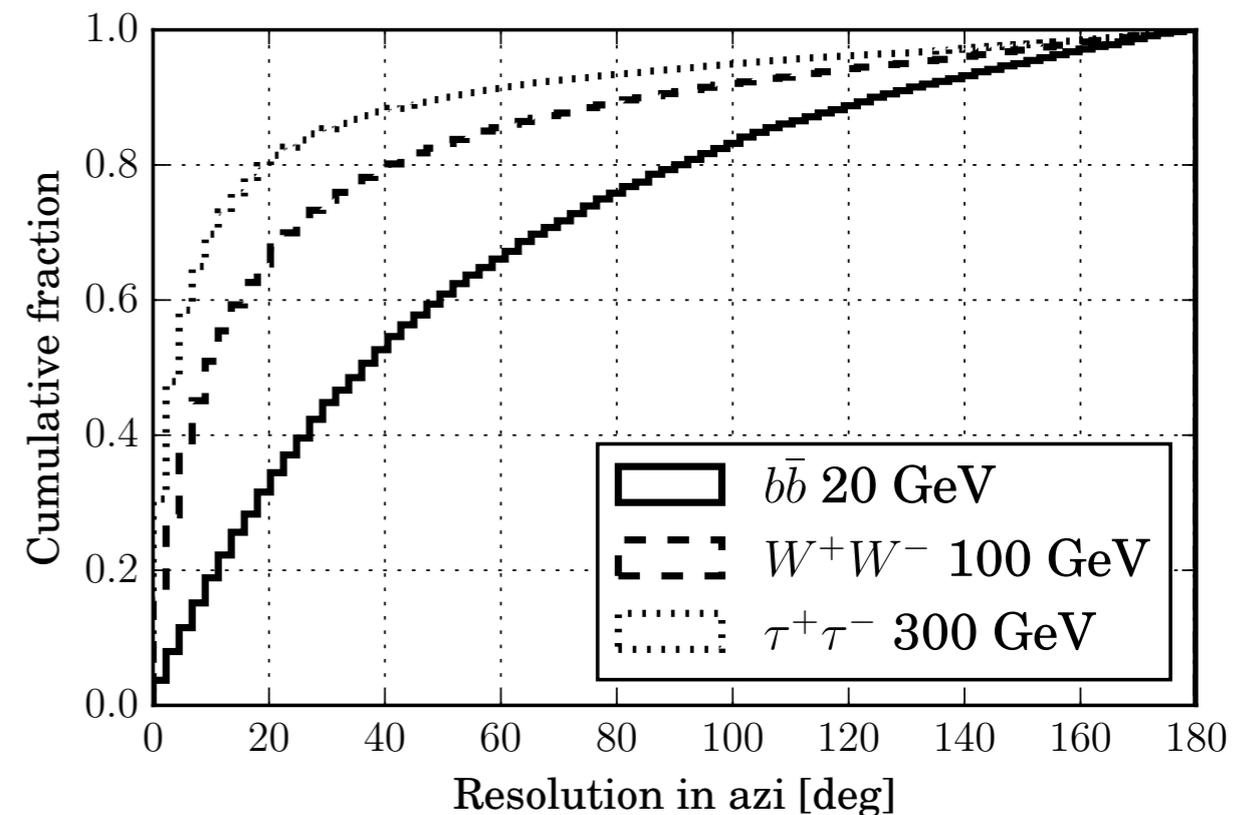
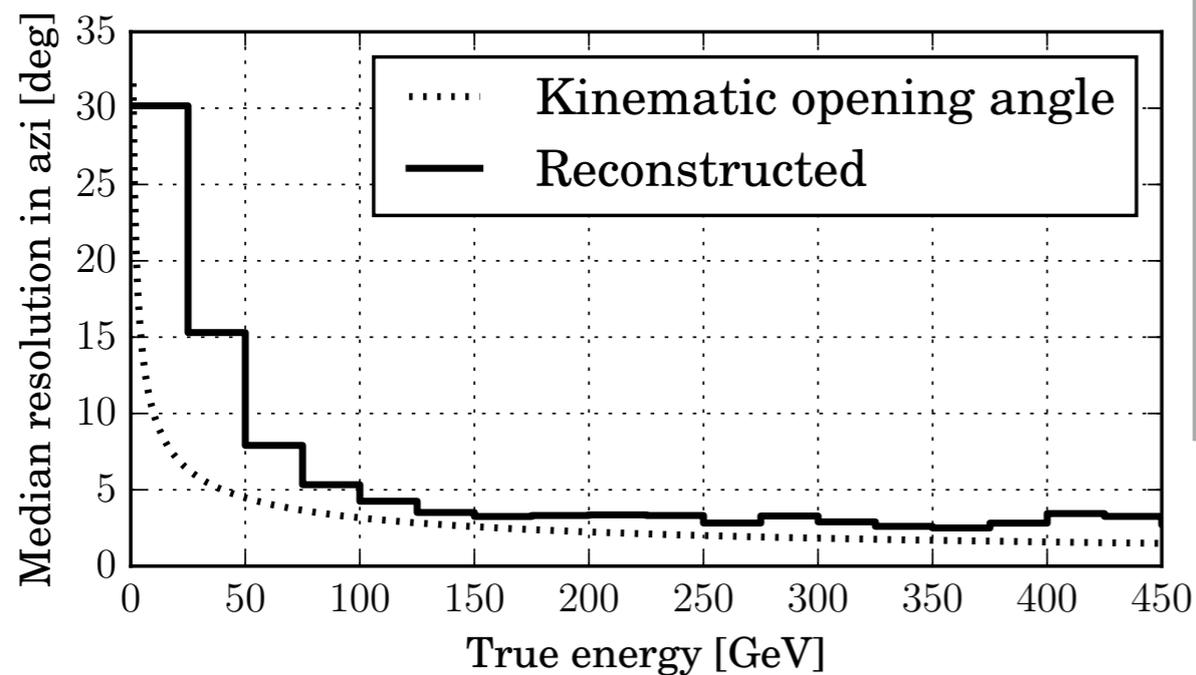
- ▶ Two topologies:
 - ▶ Tracks
 - ▶ Cascades
- ▶ Reconstruct neutrino:
 - ▶ Charge, time, position
 - ▶ Ice modelling



Science 342, (2013)

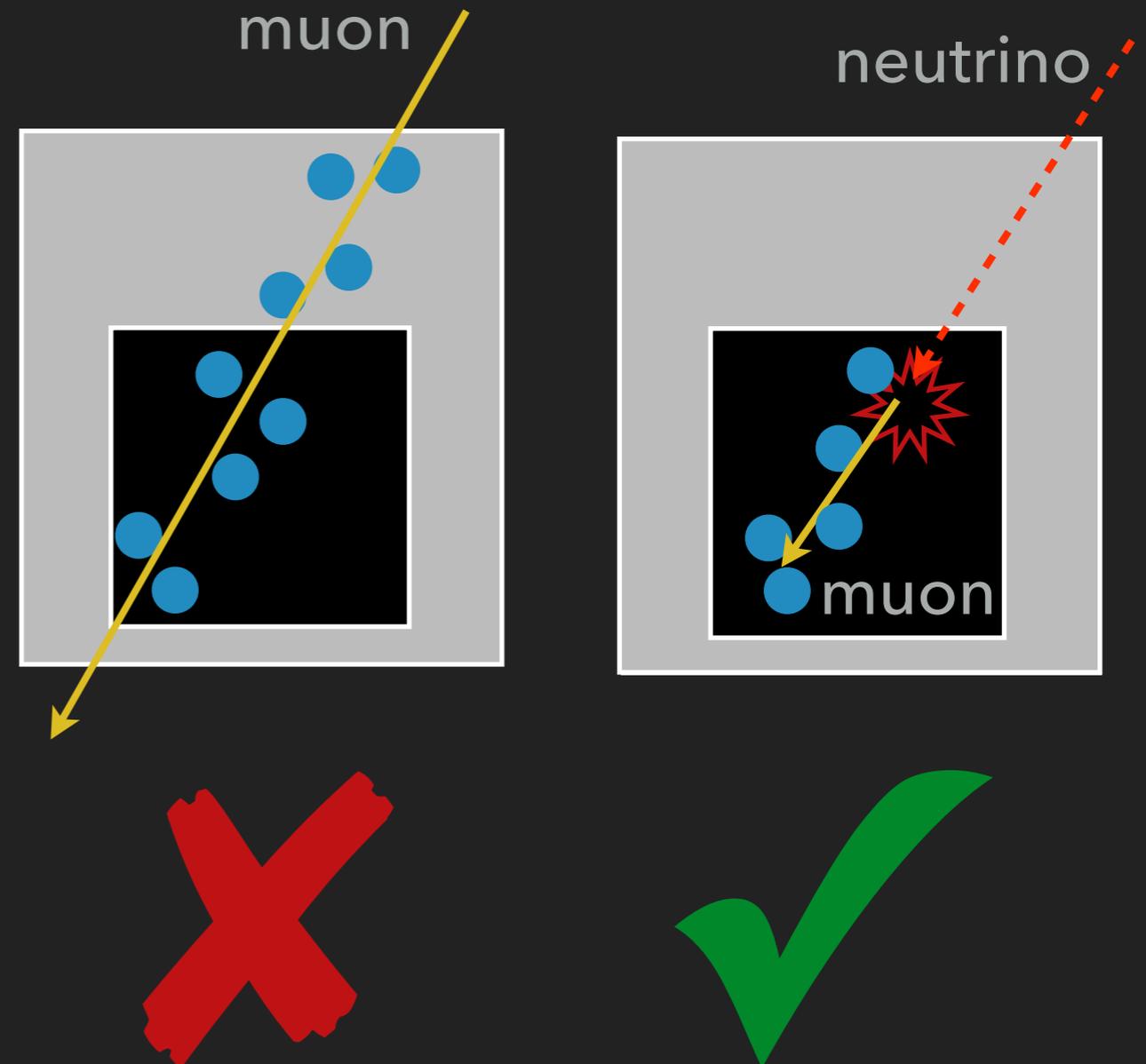
RECONSTRUCTION AND RESOLUTION

- ▶ Tracks reconstructed better for higher energies
- ▶ Worse pointing for low mass signal



VETO TECHNIQUE

- ▶ Exploit small fiducial volume in large detector
- ▶ Low energy WIMP annihilation studies use the DeepCore extension
- ▶ Use the surrounding volume to veto through-going muons



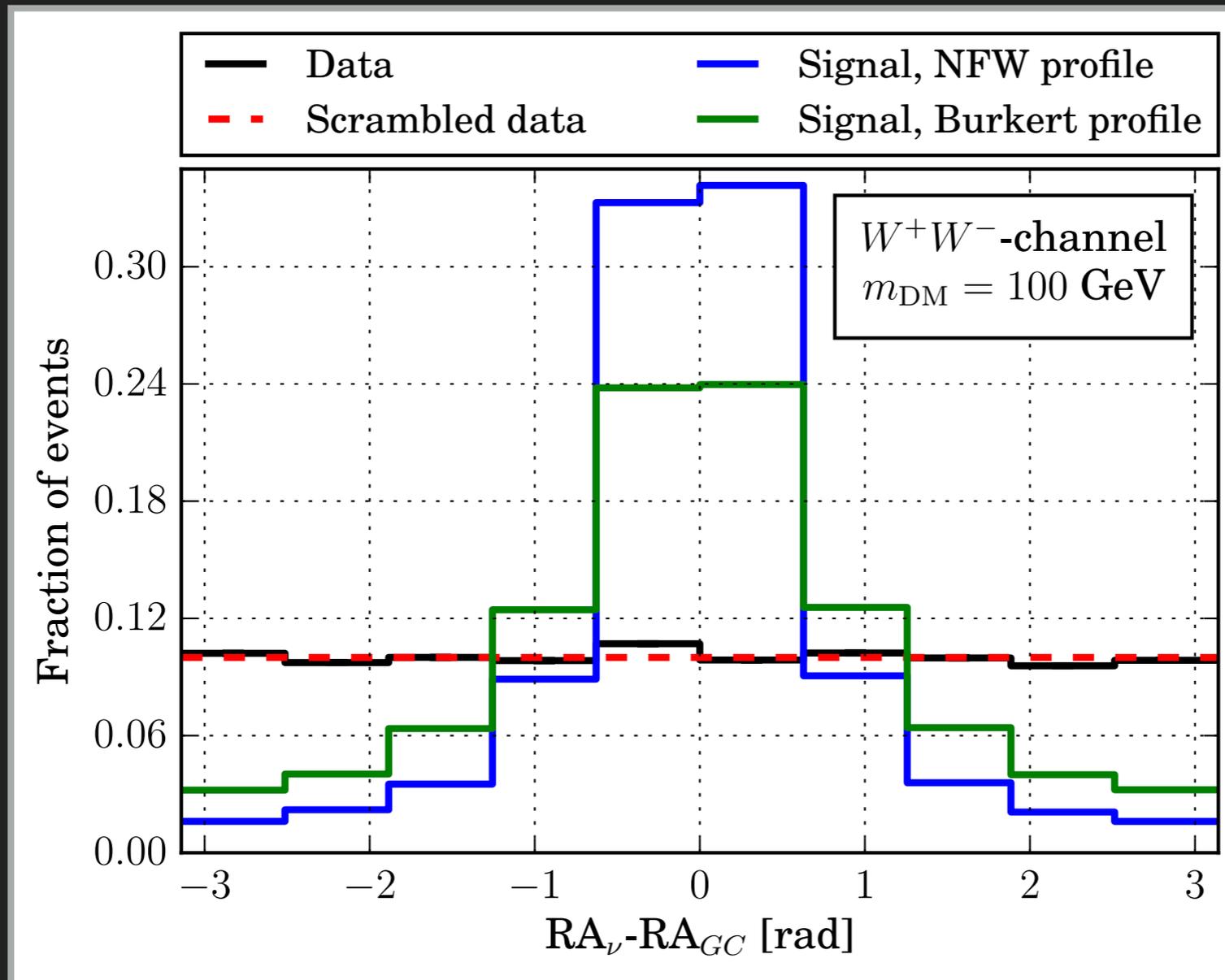
GALACTIC HALO WIMPS



- ▶ Published result: EPJC 75, 492 (2015)
- ▶ Update ready using the finished IceCube with 86 strings
- ▶ 3 years of data: 1007 days of livetime
- ▶ Located on the southern sky:
Rejection of atmospheric muons
- ▶ Using containment, veto techniques
- ▶ 2D shape likelihood function to estimate the signal fraction

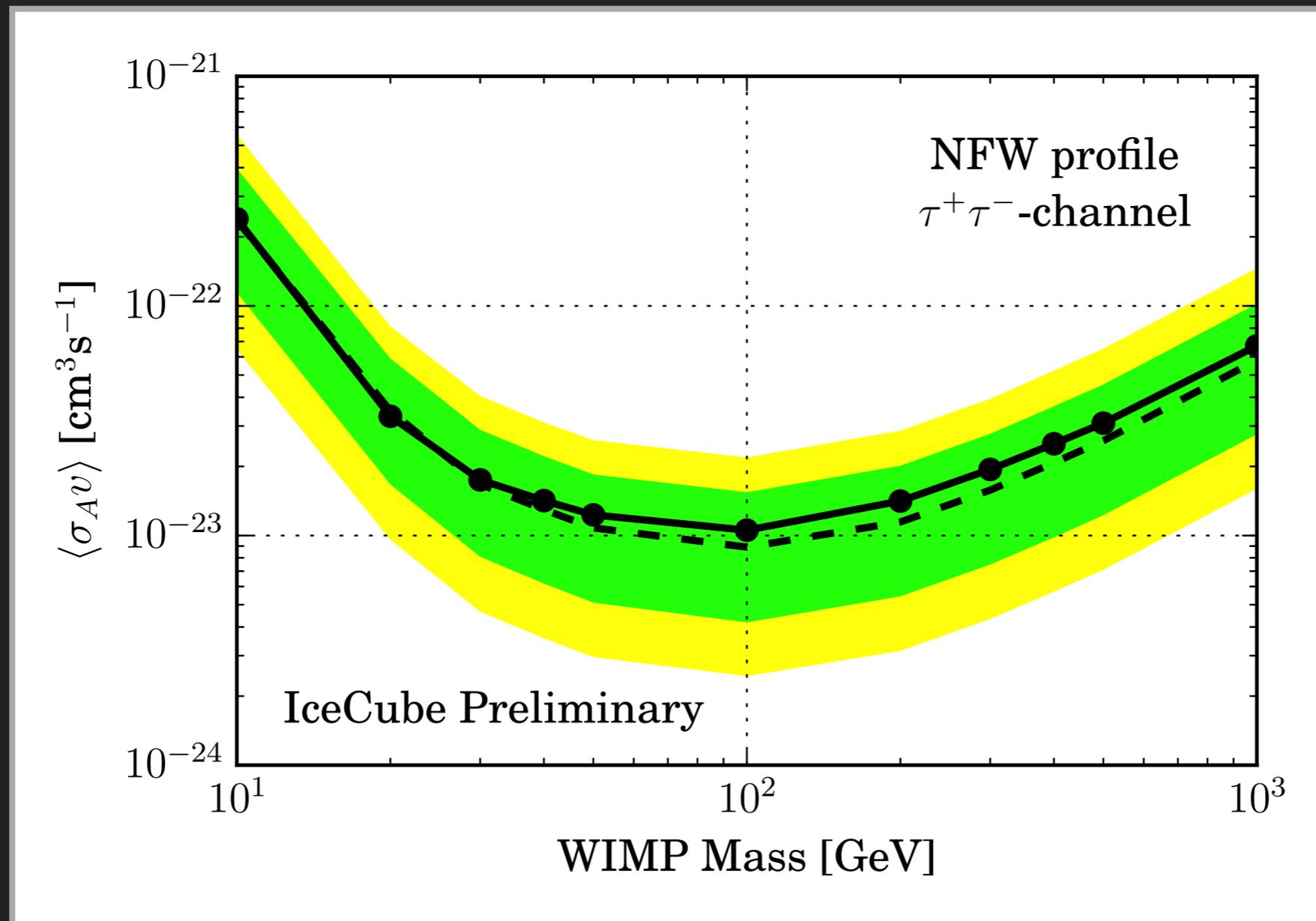
GALACTIC HALO WIMPS

- ▶ No significant excess above background



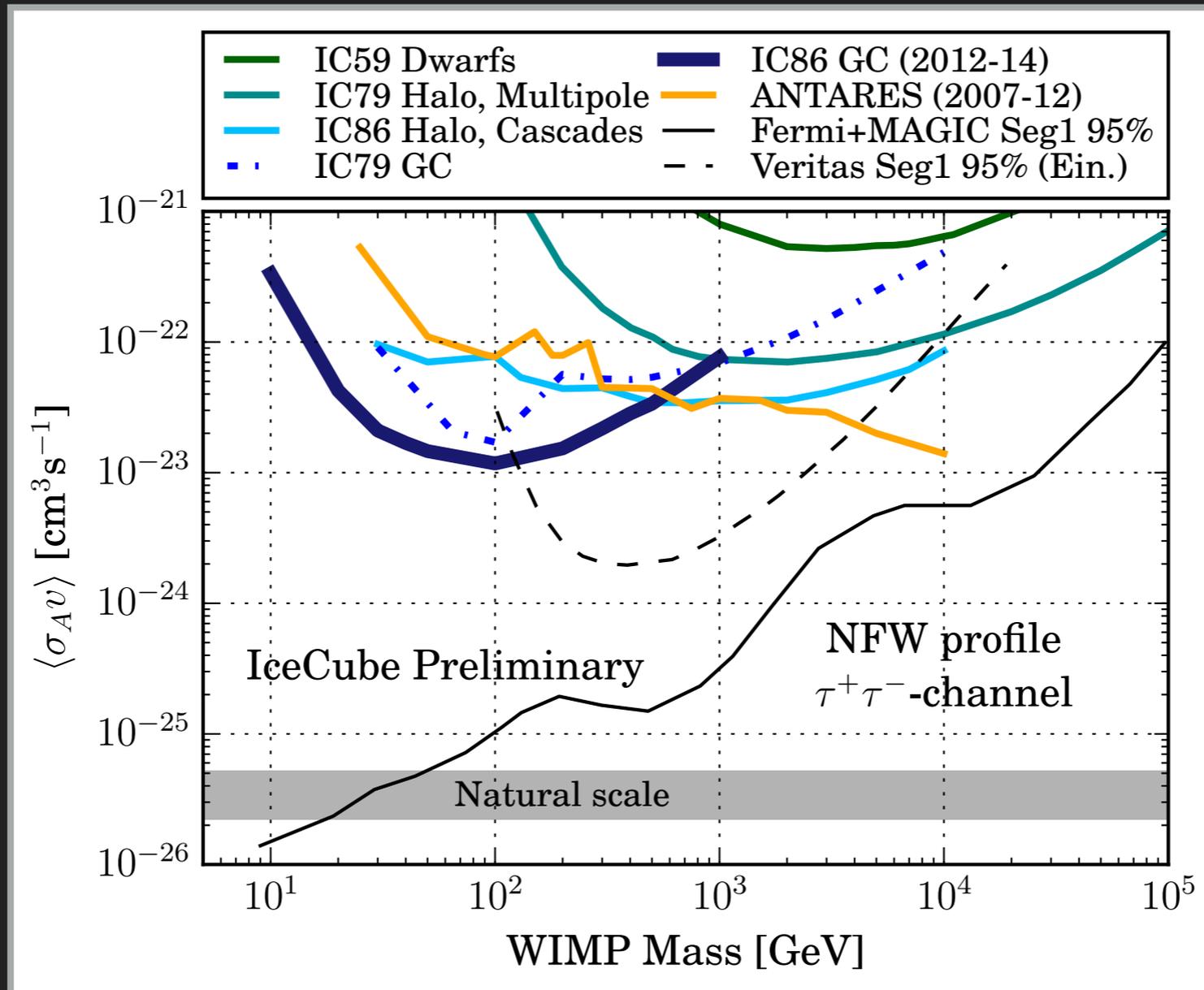
GALACTIC HALO WIMPS

- ▶ No significant excess above background



GALACTIC HALO WIMPS

- ▶ No significant excess above background



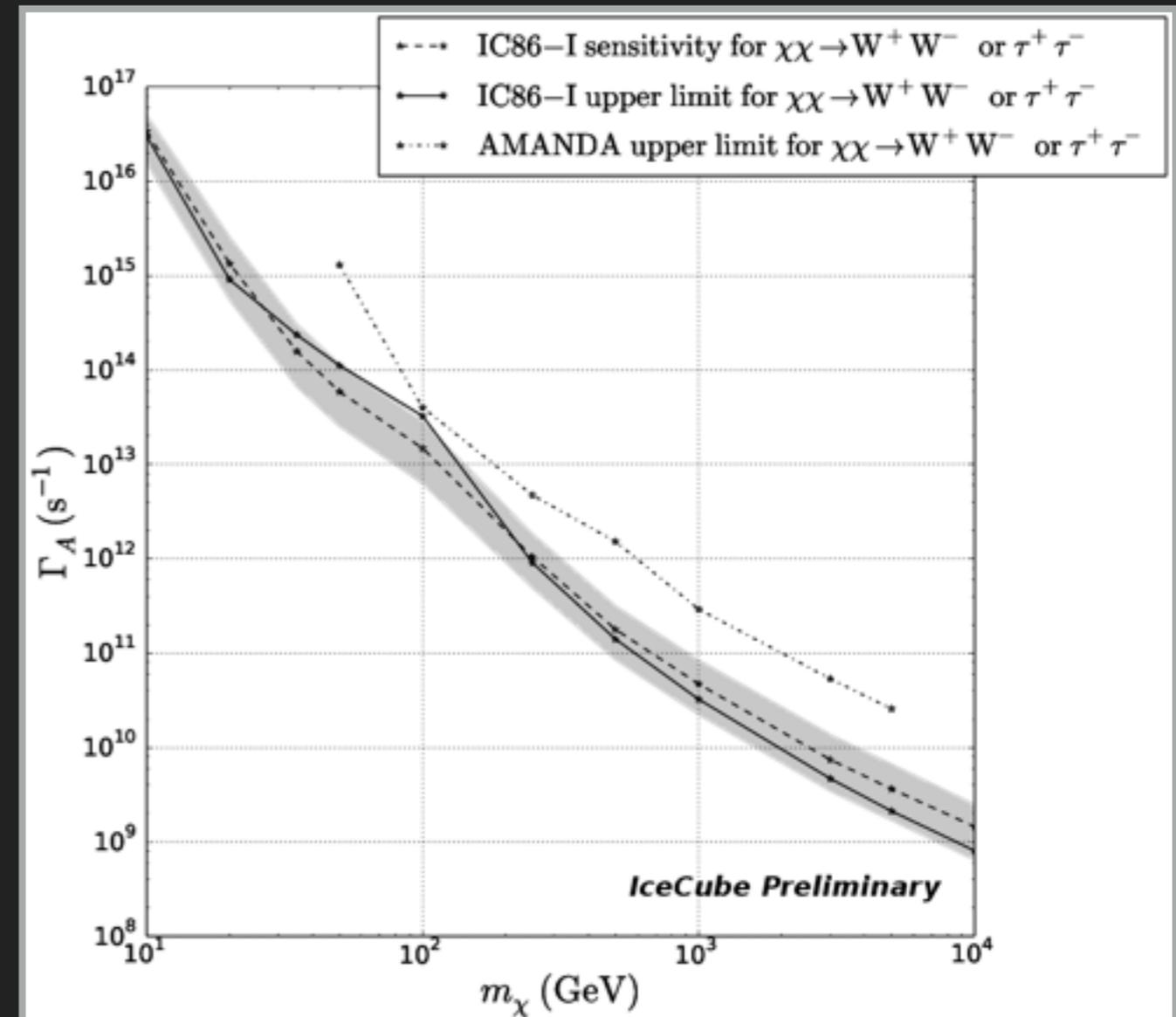
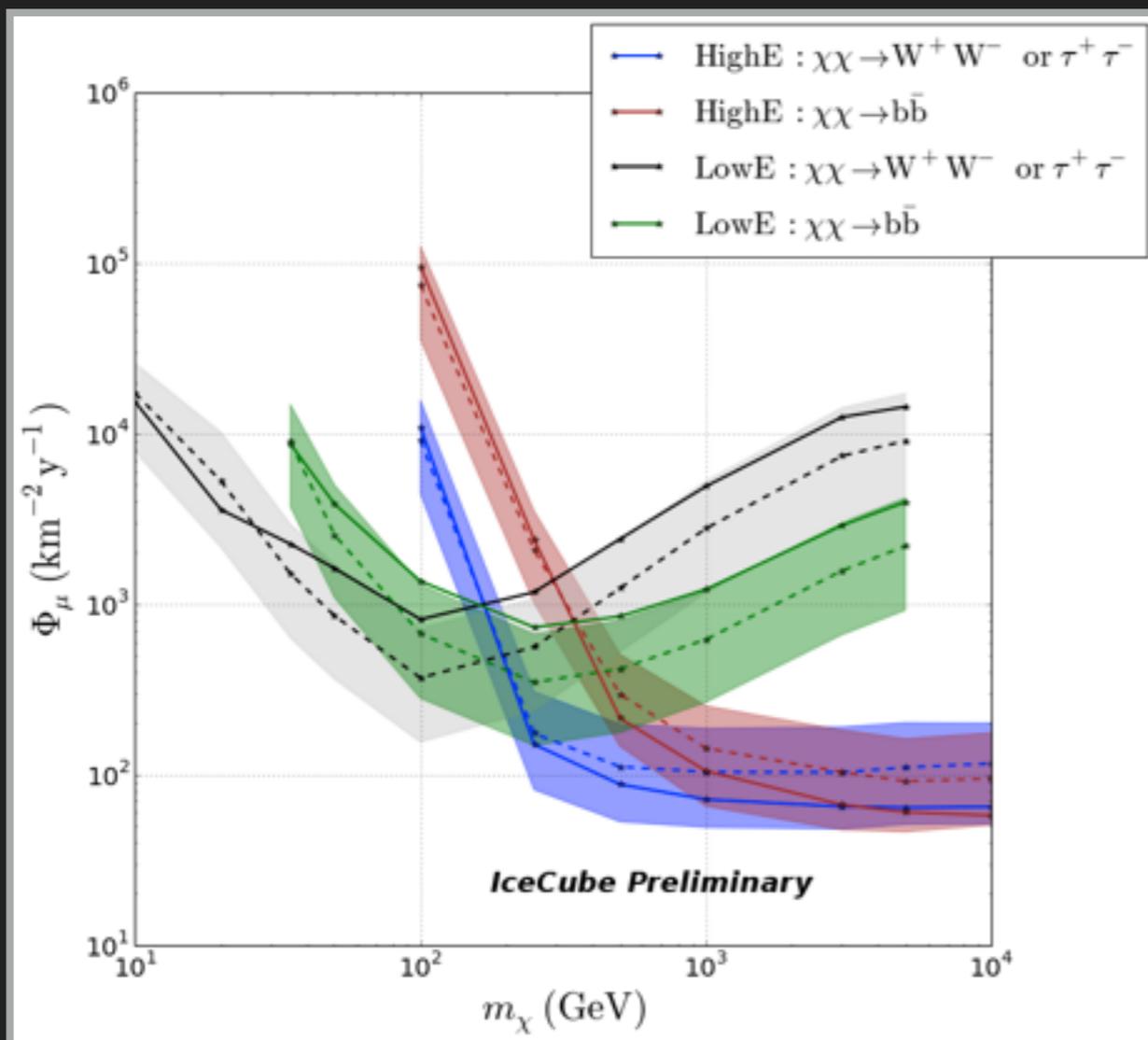
EARTH WIMP STUDIES



- ▶ Accumulation of dark matter by earth gravity
- ▶ First results from IceCube ready
- ▶ 1 year of data: 327 days of livetime
- ▶ Two statistically independent analyses with high and low WIMP mass focus
- ▶ Factor of 10 increase in sensitivity from AMANDA results
- ▶ Combined with other results to set bounds on spin-dependent WIMP-nucleon cross section

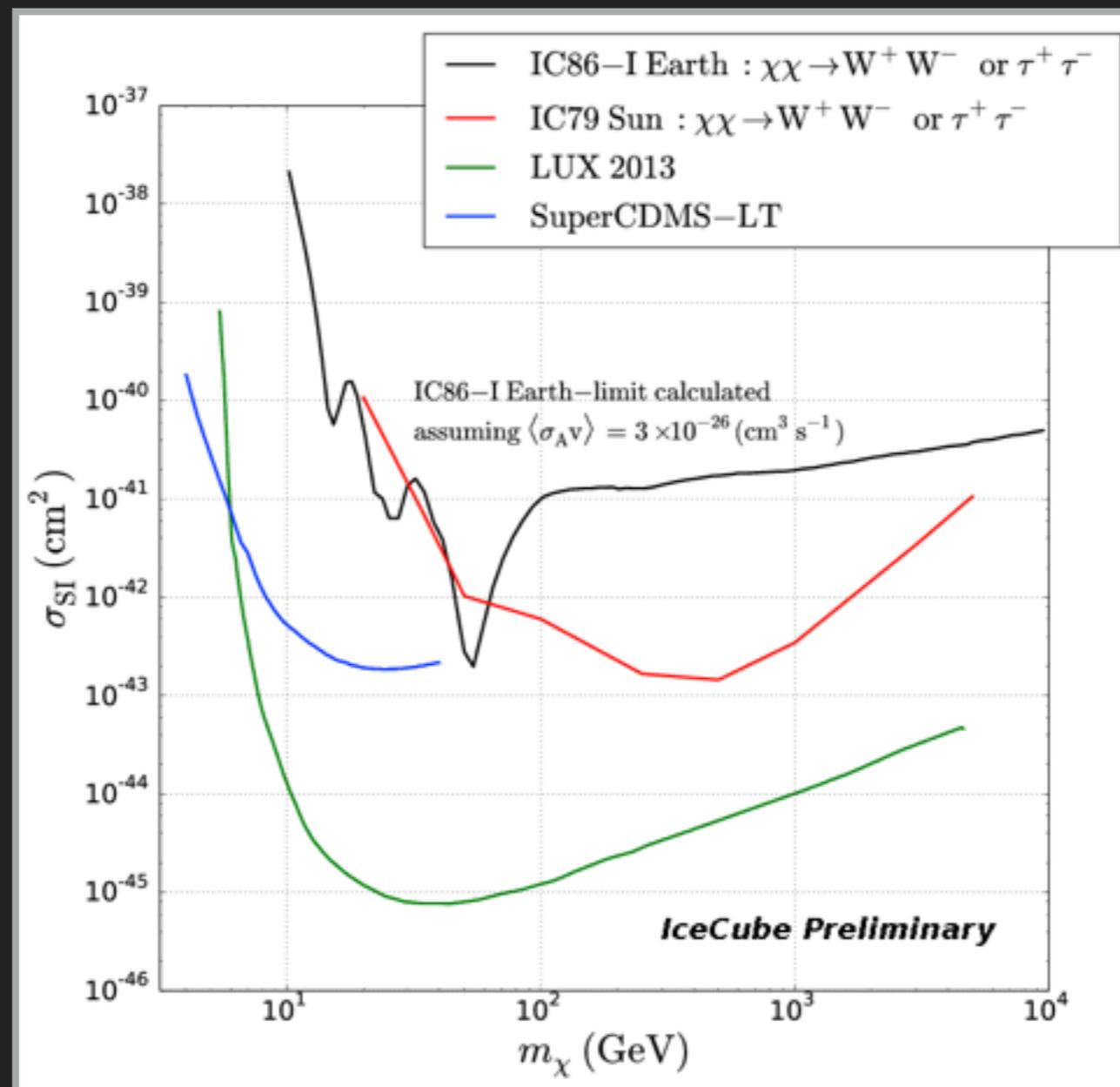
EARTH WIMP STUDIES

- ▶ No significant excess above bkg. expectation

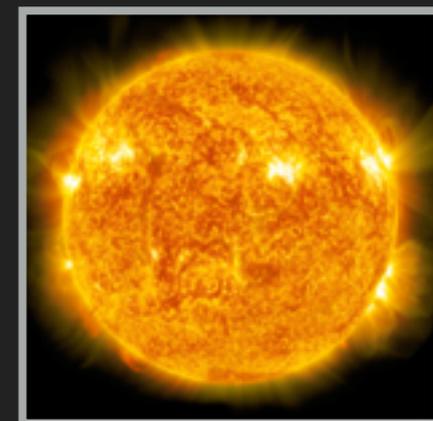


EARTH WIMP STUDIES

- ▶ Model dependent limits on WIMP-nucleon σ_{SI}



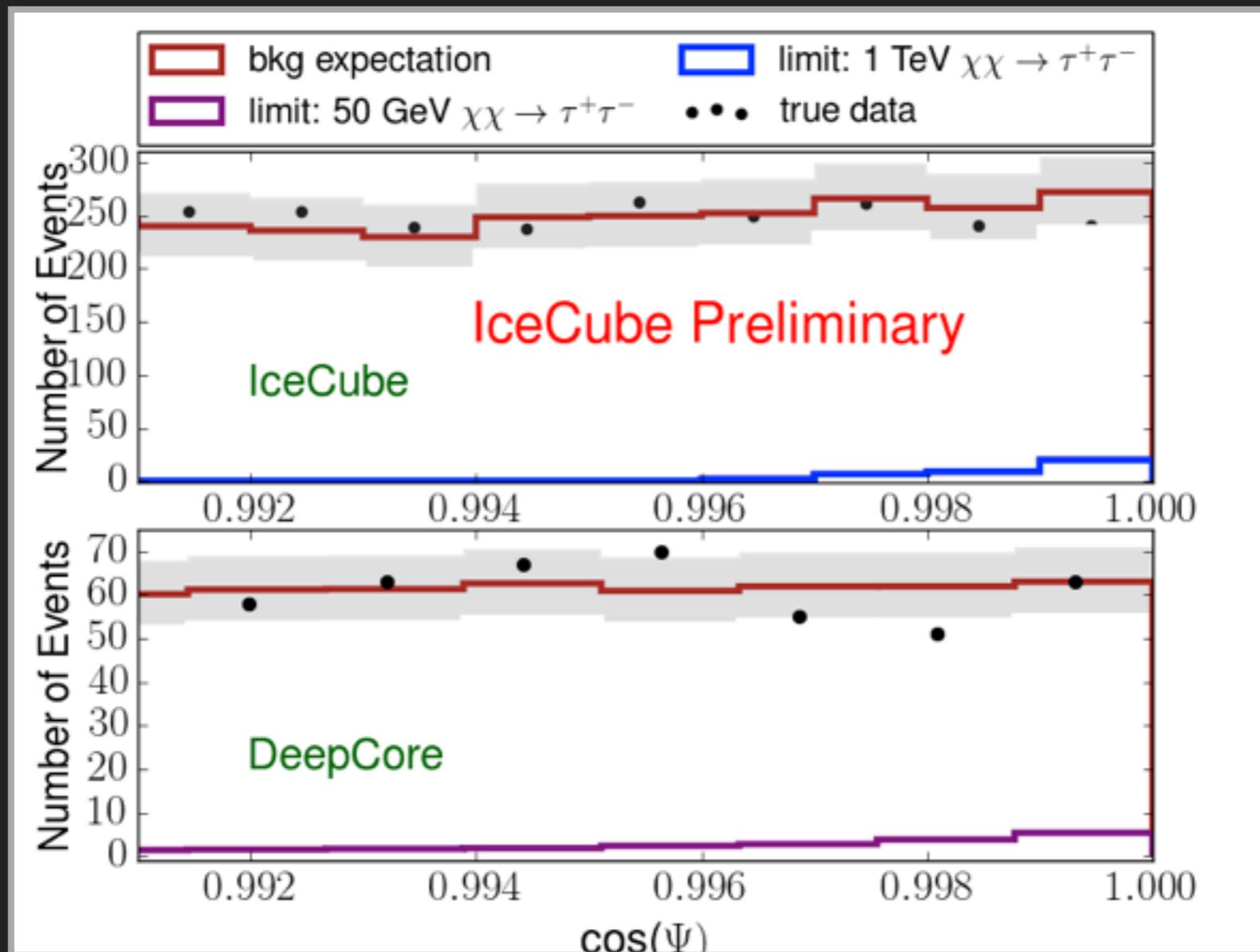
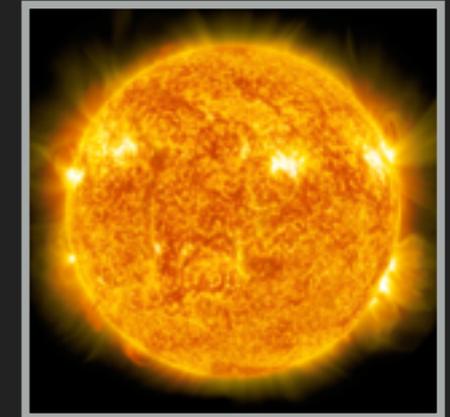
SOLAR WIMP STUDIES



- ▶ Accumulation of WIMP in the sun, assumed to be in equilibrium with the annihilation rate
- ▶ Published result: PRL 110, 131302 (2013)
- ▶ Update ready for finished IceCube 86-string configuration
- ▶ 3 years of data: 532 days of livetime
- ▶ Two independent analyses with high and low WIMP mass focus

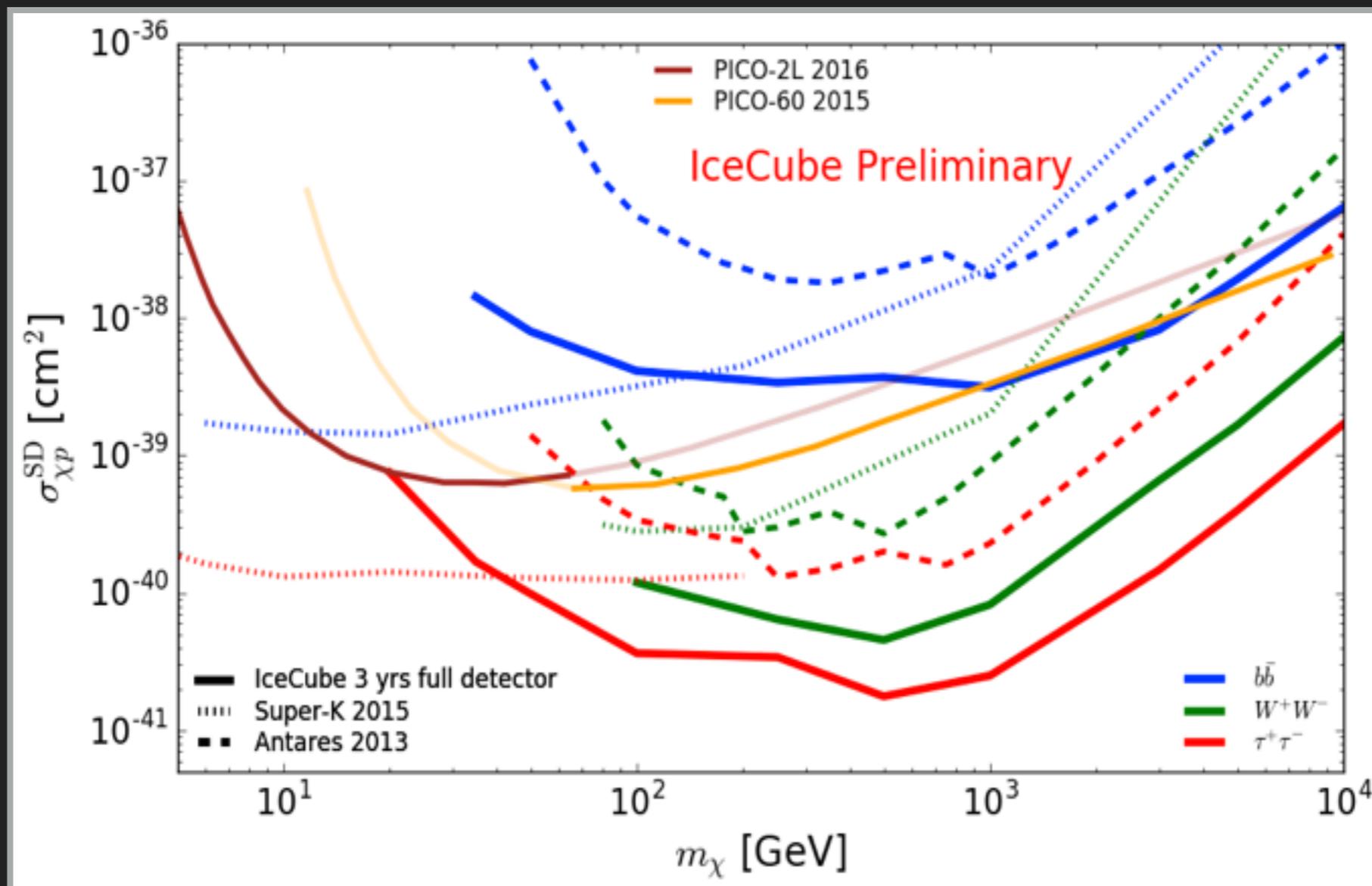
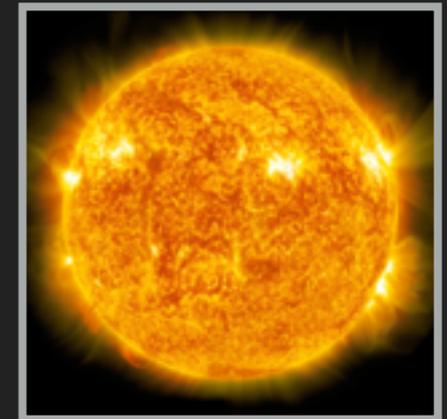
SOLAR WIMP STUDIES

- ▶ No significant excess above bkg. expectation



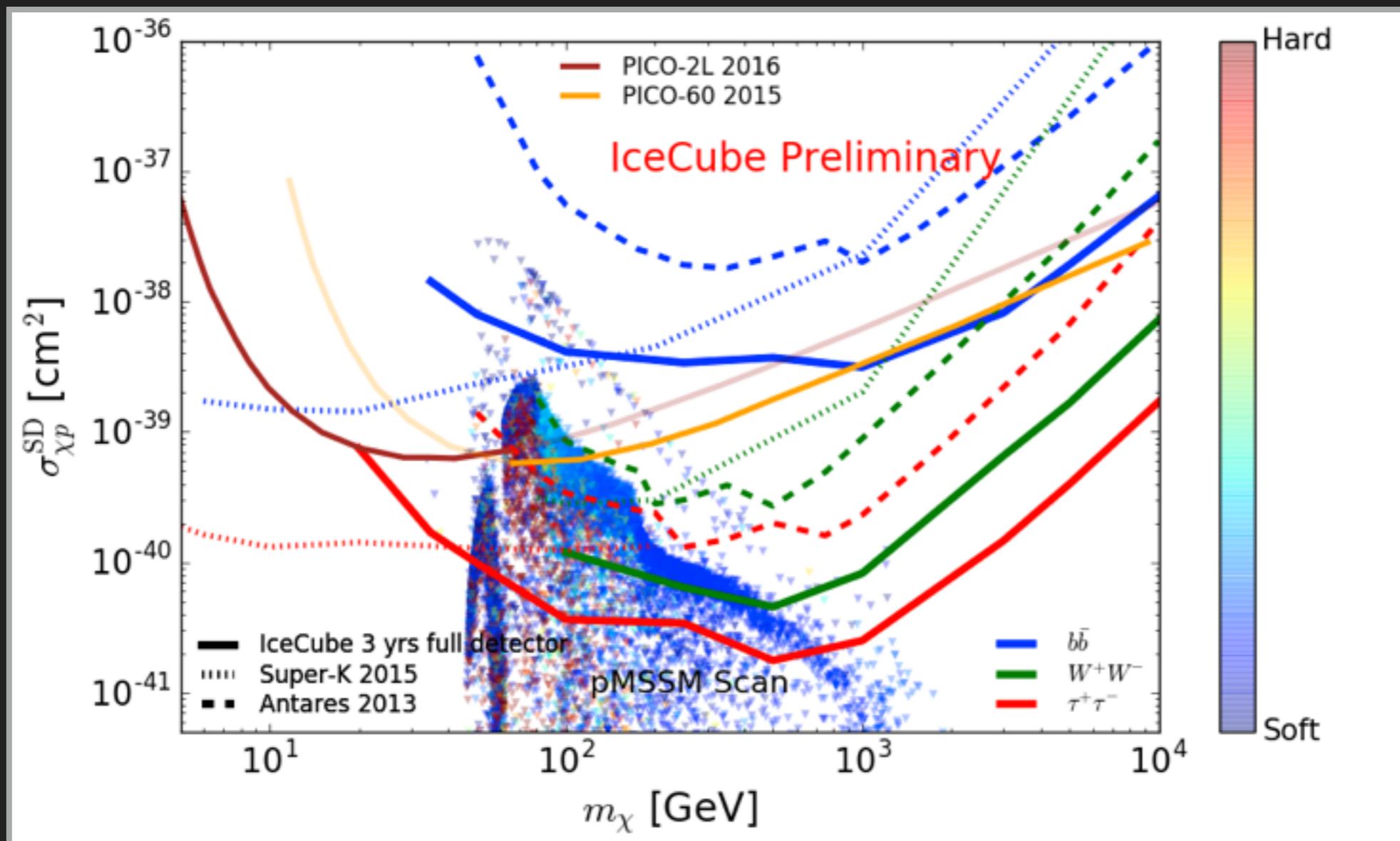
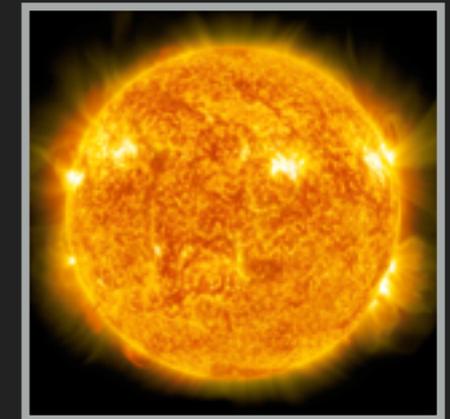
SOLAR WIMP STUDIES

- ▶ Presents competitive bounds



SOLAR WIMP STUDIES

- ▶ pMSSM model scans, indicating the fraction of hard and soft final states



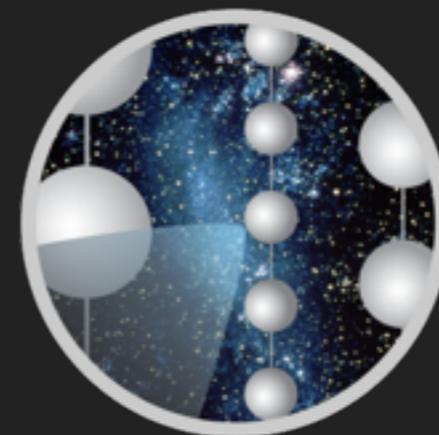
SUMMARY

- ▶ Many very competitive updates from IceCube on neutrino signals from WIMP annihilation
- ▶ Low mass WIMP results from the galactic halo
- ▶ Factor 10 increase in the IceCube earth WIMP search
- ▶ Constraints on pMSSM models with the solar WIMP search

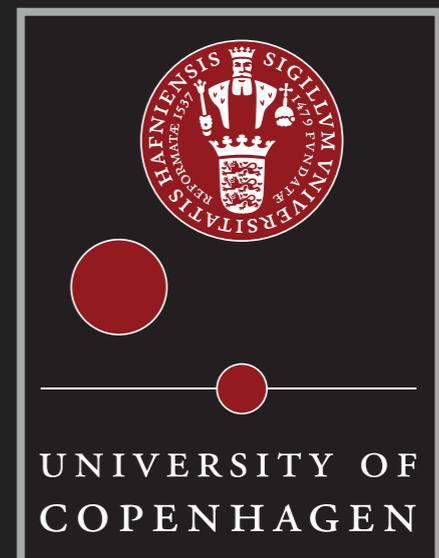




THANKS FOR YOUR ATTENTION!

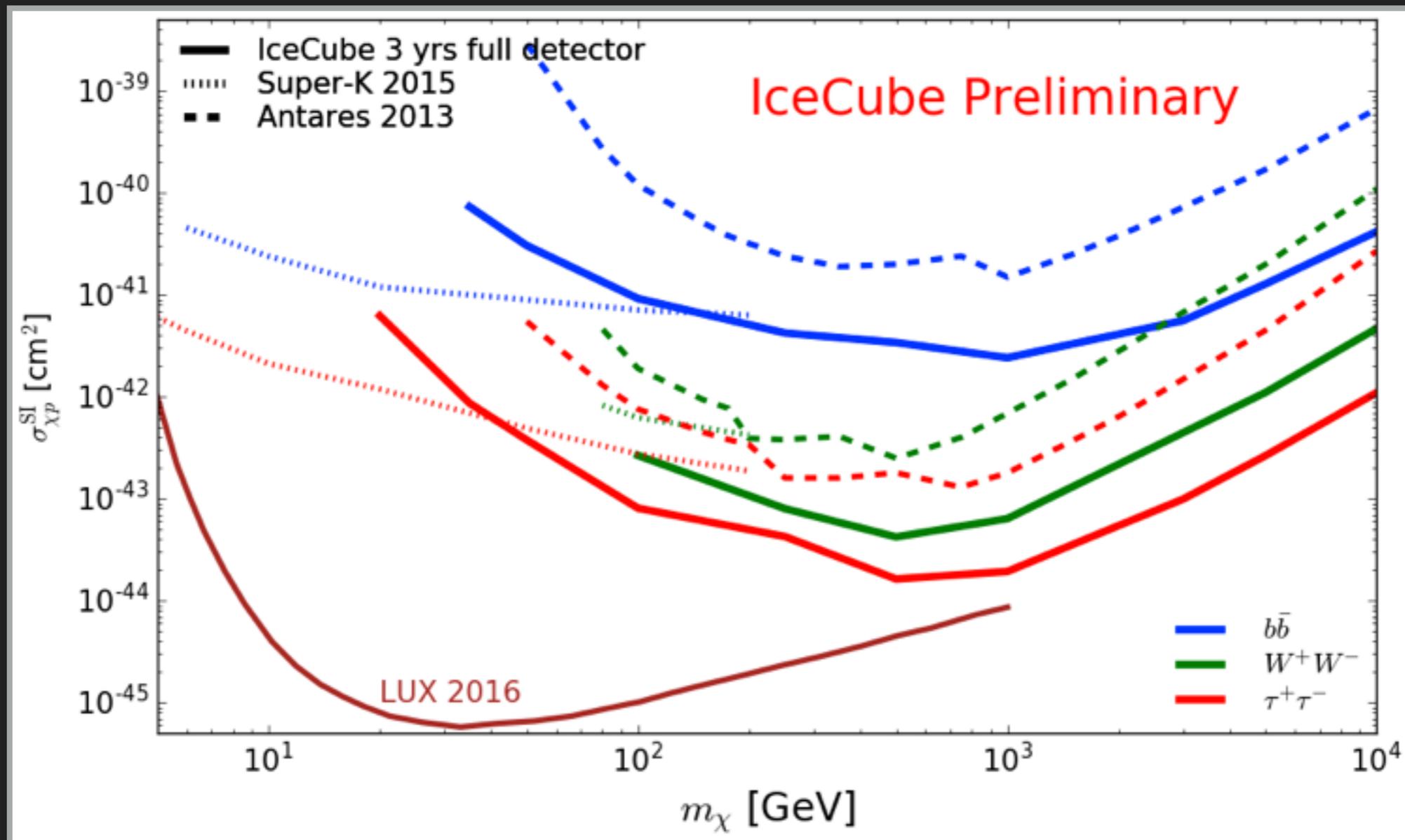
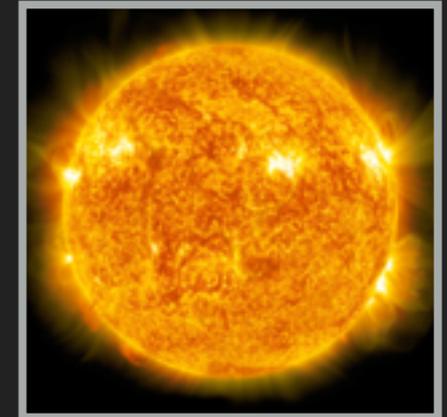


ICECUBE



SOLAR WIMP STUDIES

- ▶ Extremely competitive neutrino bounds



DECAYING DARK MATTER

- ▶ Significant excess of high energy neutrinos above backgrounds
- ▶ Used to look for decaying heavy dark matter

