

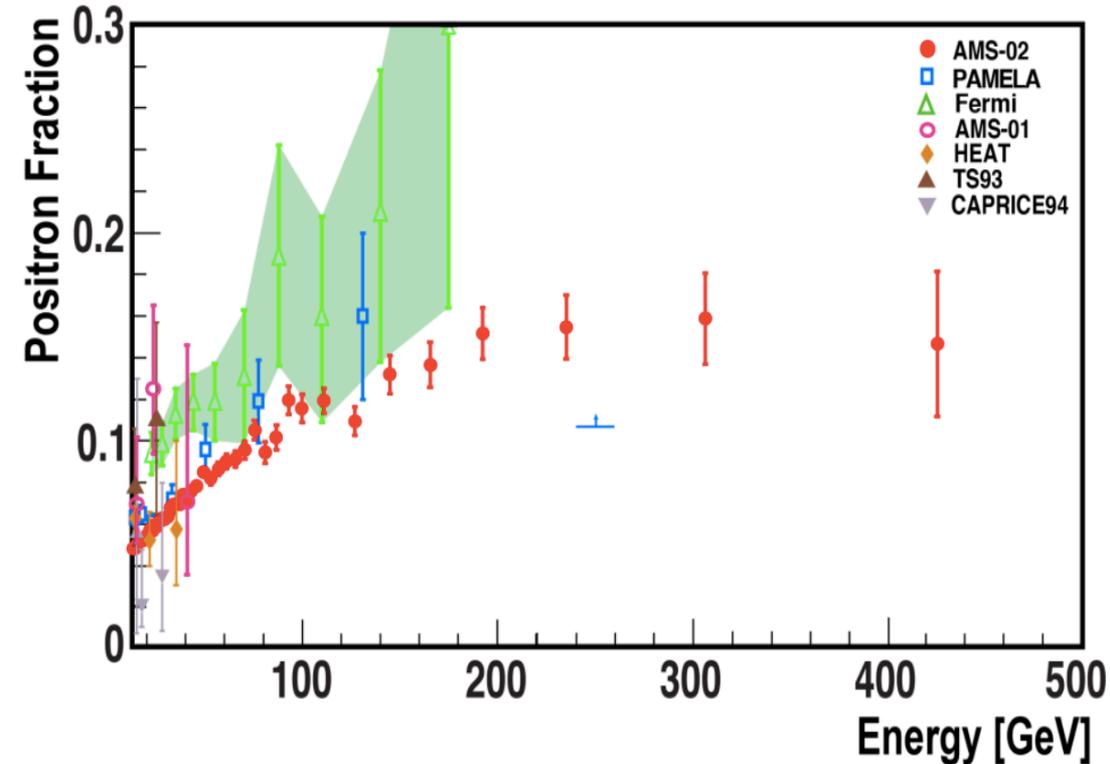
High-energy cosmic antiparticle excess vs. isotropic gamma-ray background problem in decaying dark matter Universe

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Cosmic antiparticle excess



Possible explanations:

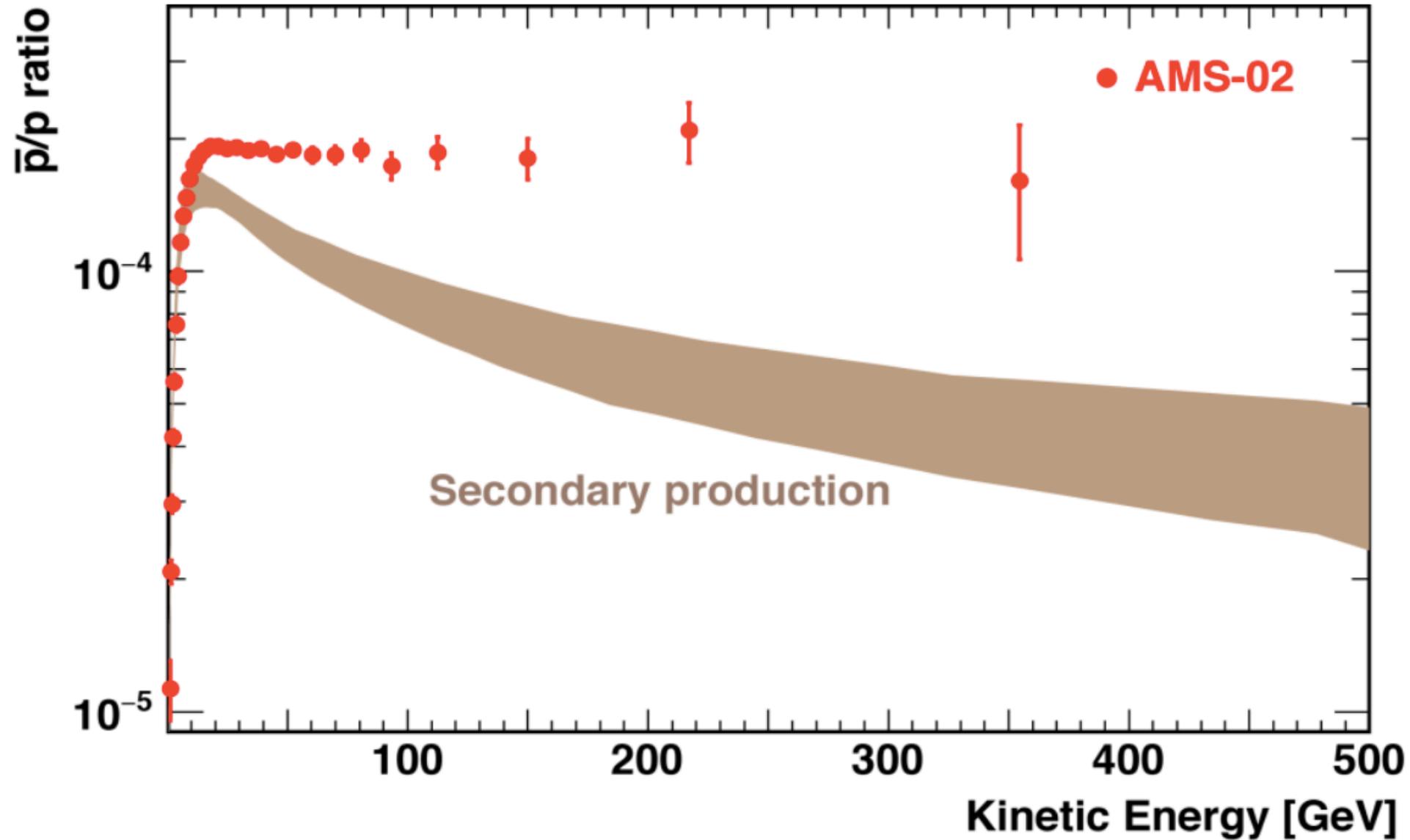
- Pulsars and SNR;
- Propagation parameters uncertainty;
- **Dark matter**

and etc.

High-energy **positron** anomaly

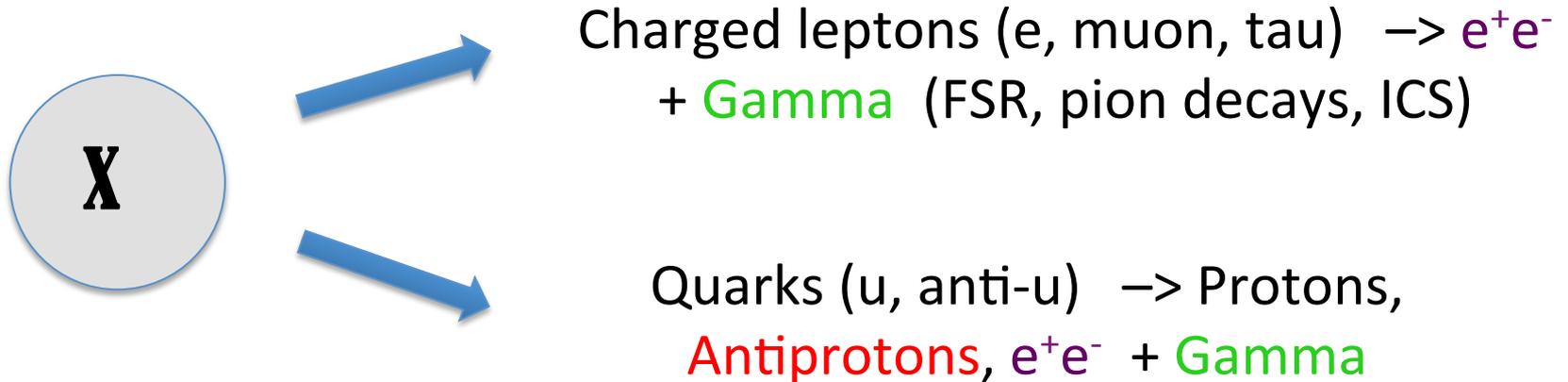
But what about antiprotons?

AMS-02 preliminary data (2015)



So, it seems like we have “extra”
particles in both hadrons and
leptons...

Decaying dark matter model



Parameters:

- Mass of the particle, M_x ;
- Lifetime, τ ;
- Fraction of unstable DM, ξ ;
- 3 Branching ratios: ee , $\mu\mu$, $\tau\tau$;
($uu = 1 - \sum Br$)

We assumed Navarro-Frenk-White (NFW) dark matter density profile

$$\rho_{\text{DM}}(r) = \frac{\rho_0}{(r/r_s)[1 + (r/r_s)]^2}$$

- r – Galactic radial distance;
- $r_s = 24$ kpc – scale radius;
- ρ_0 is obtained to reproduce the local DM density

$$\rho_{loc} = 0.39 \text{ GeV/cm}^3 \text{ at } R_{\odot} = 8.5 \text{ kpc}$$



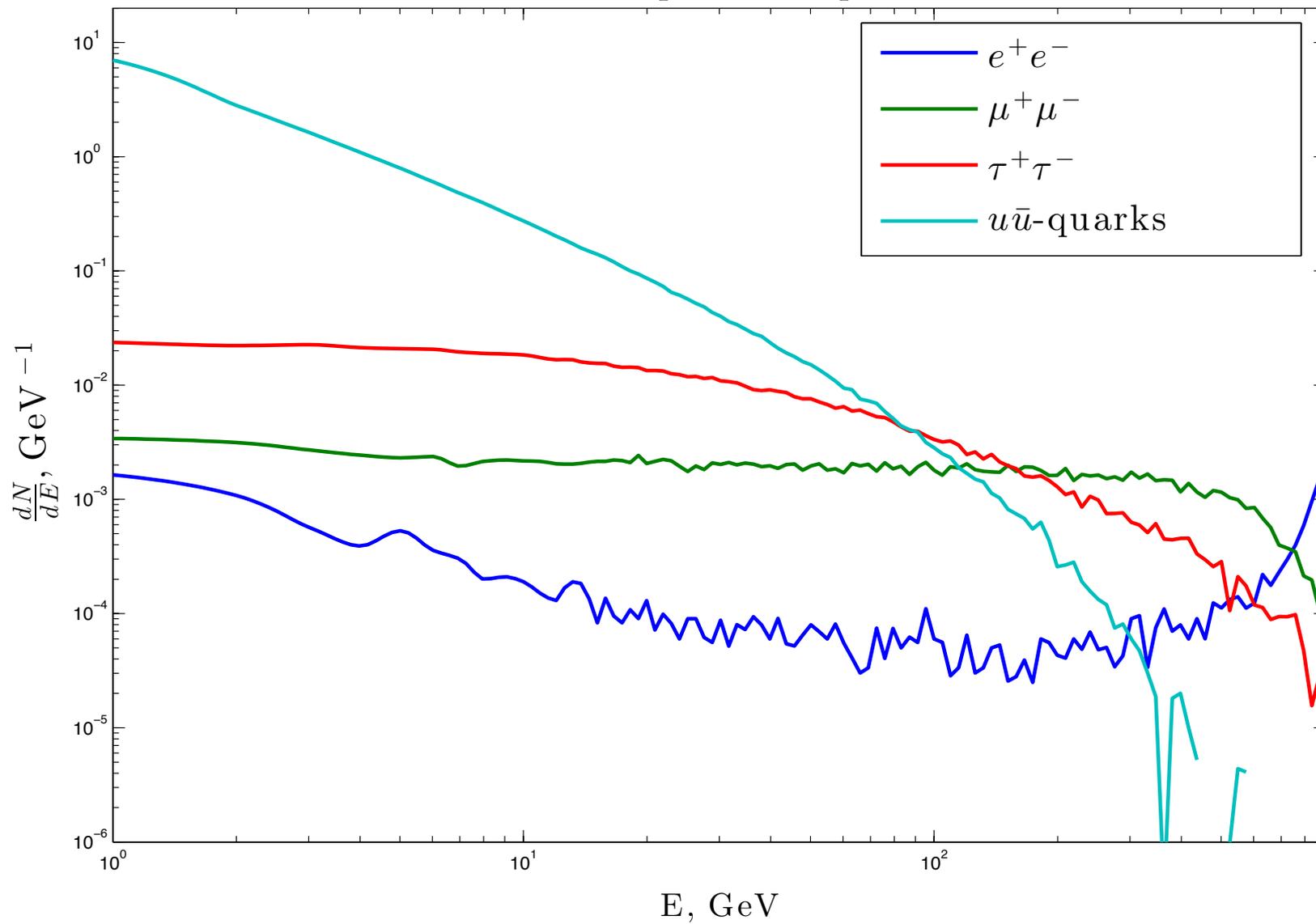
The effects of cosmic ray propagation in the Galaxy (diffusion, re-acceleration, energy losses, interactions with Galactic media and etc.) were calculated using **GALPROP**.

We used **MED** propagation model

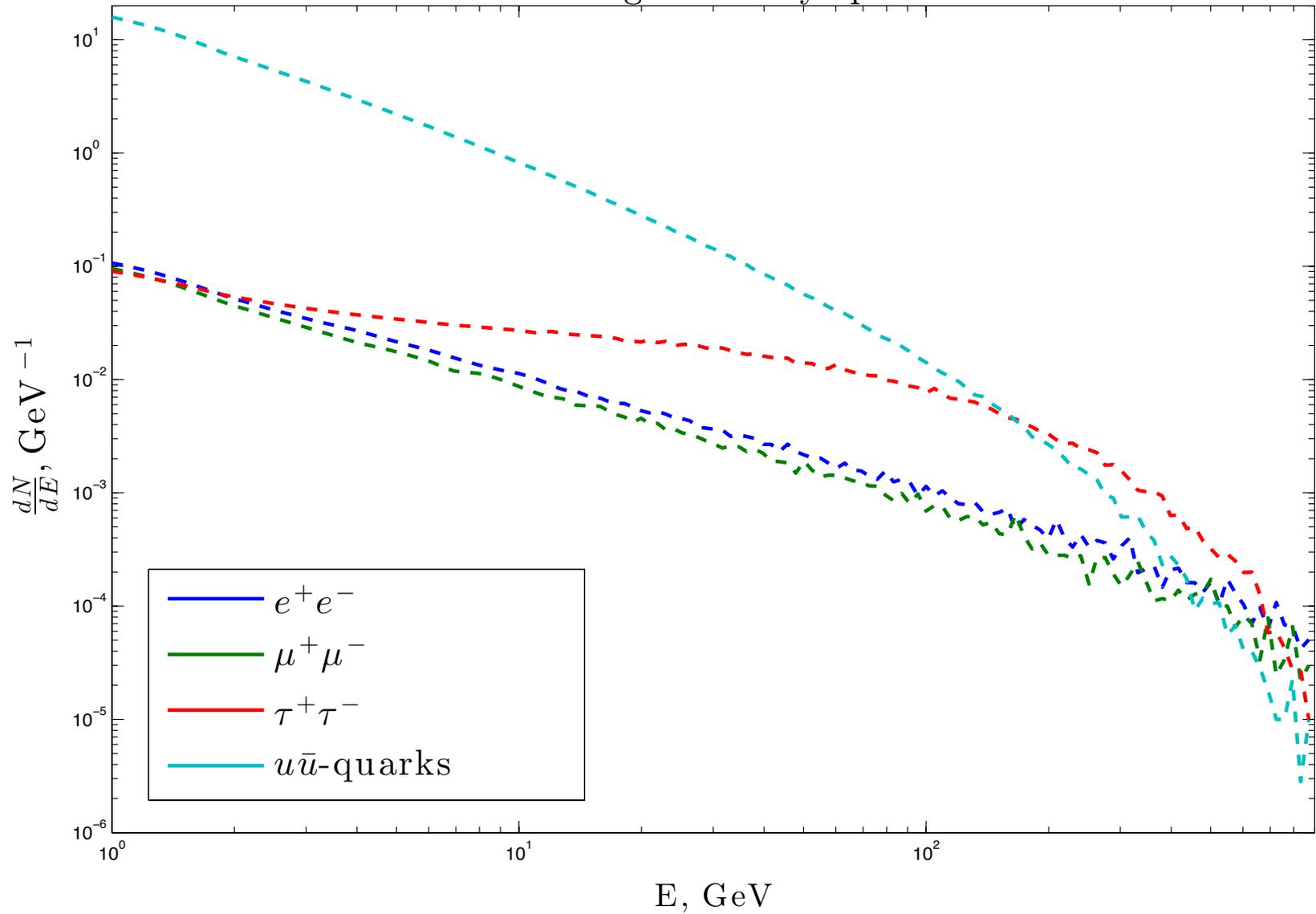
Model	δ	K_0 (kpc ² /Myr)	L (kpc)	V_c (km/s)
MIN	0.85	0.0016	1	13.5
MED	0.70	0.0112	4	12
MAX	0.46	0.0765	15	5

Initial (injection) spectra were simulated using **Pythia 8.1**.

Initial positron spectra



Initial gamma-ray spectra

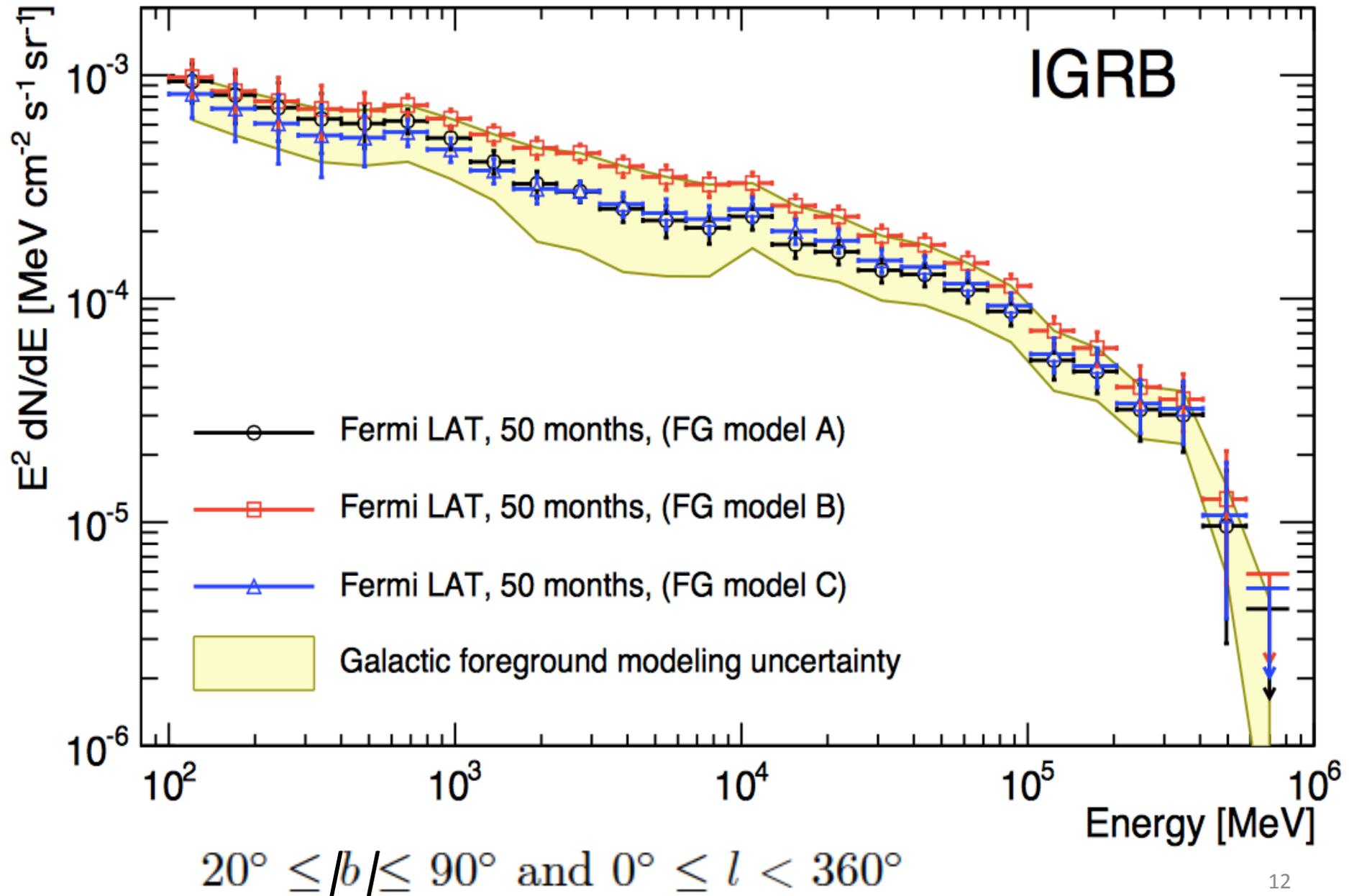


We compared our results to **PAMELA** and **AMS-02** data on cosmic

- Electrons
- Positrons
- Antiprotons
- Positron fraction

and **FERMI/LAT** data on isotropic diffuse gamma-ray background (2014).

FERMI/LAT data

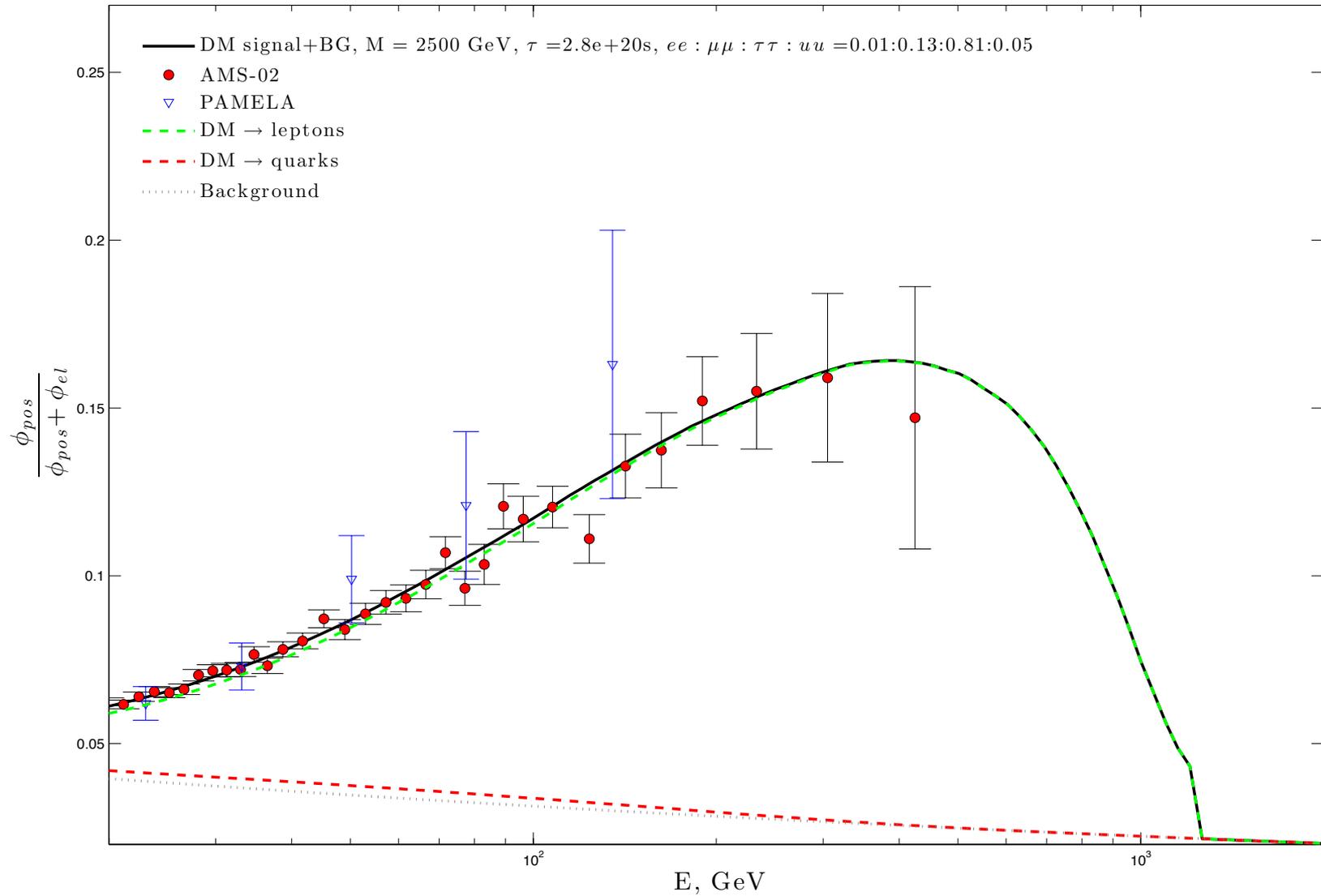


Let's consider a particle with

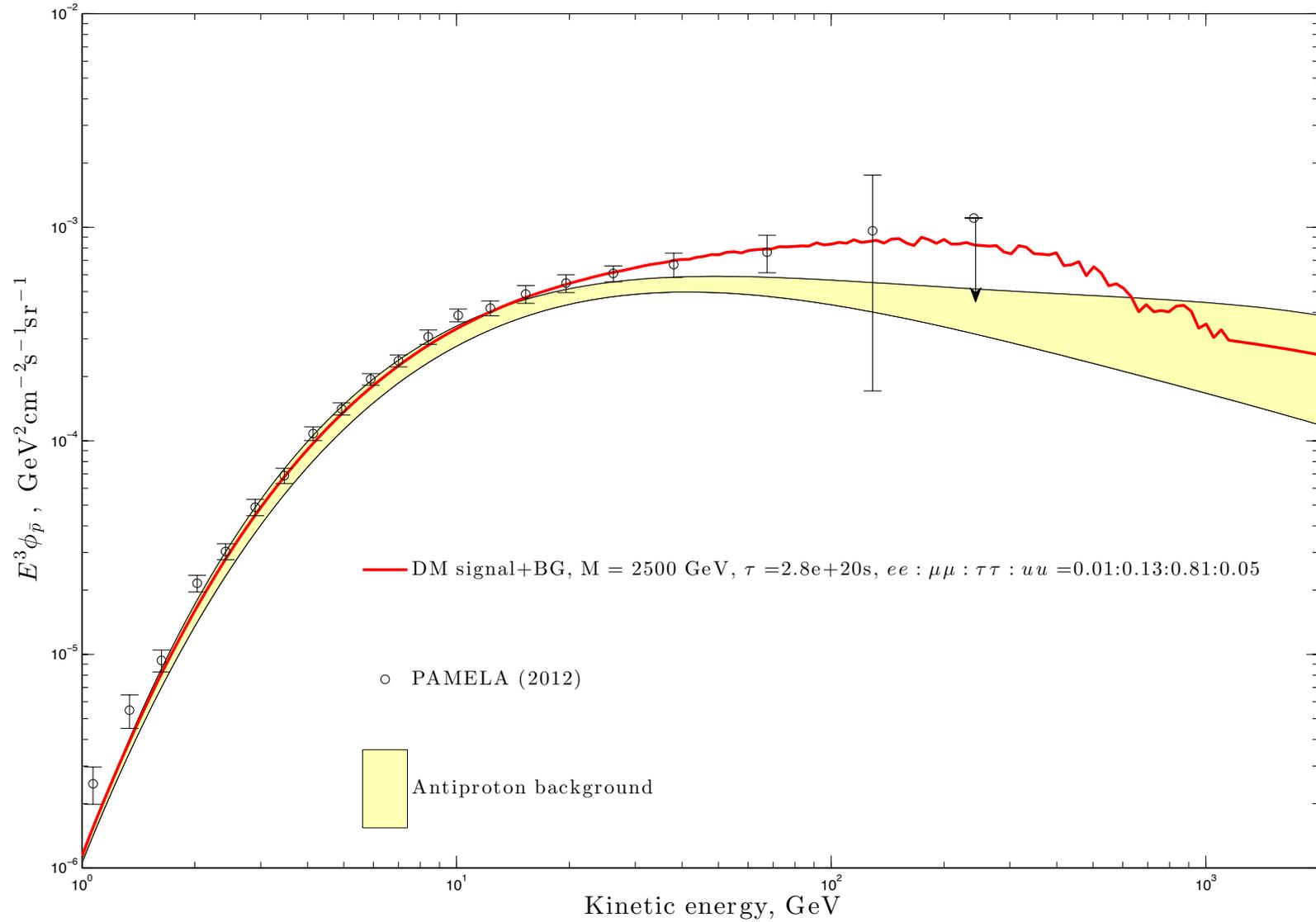
$$M_x = 2500 \text{ GeV}$$

Other parameters of the model are “tuned by hand” in a phenomenological way to fit the experimental data on cosmic charged particles

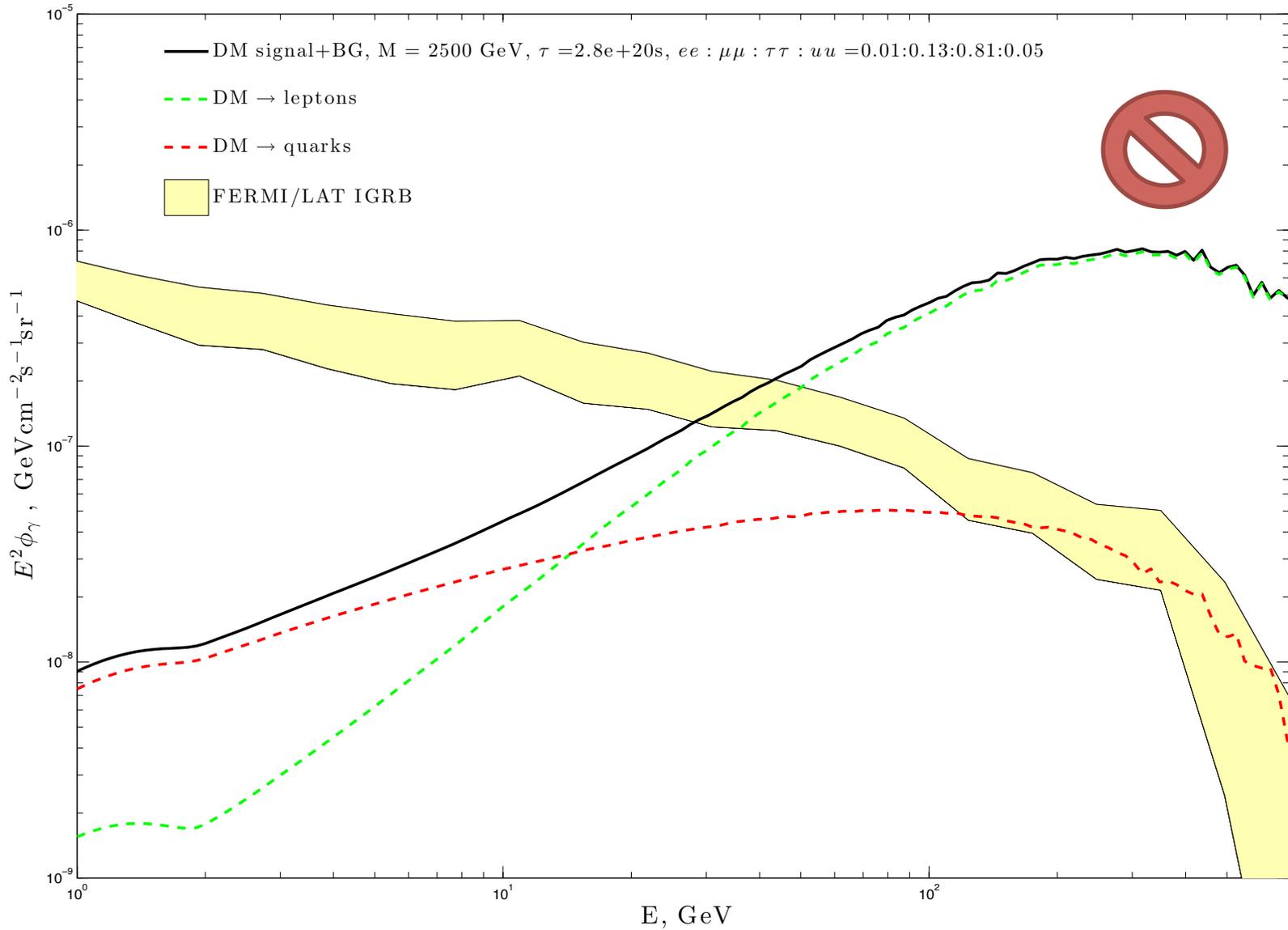
Positron fraction (2500 GeV)



Antiproton flux (2500 GeV)

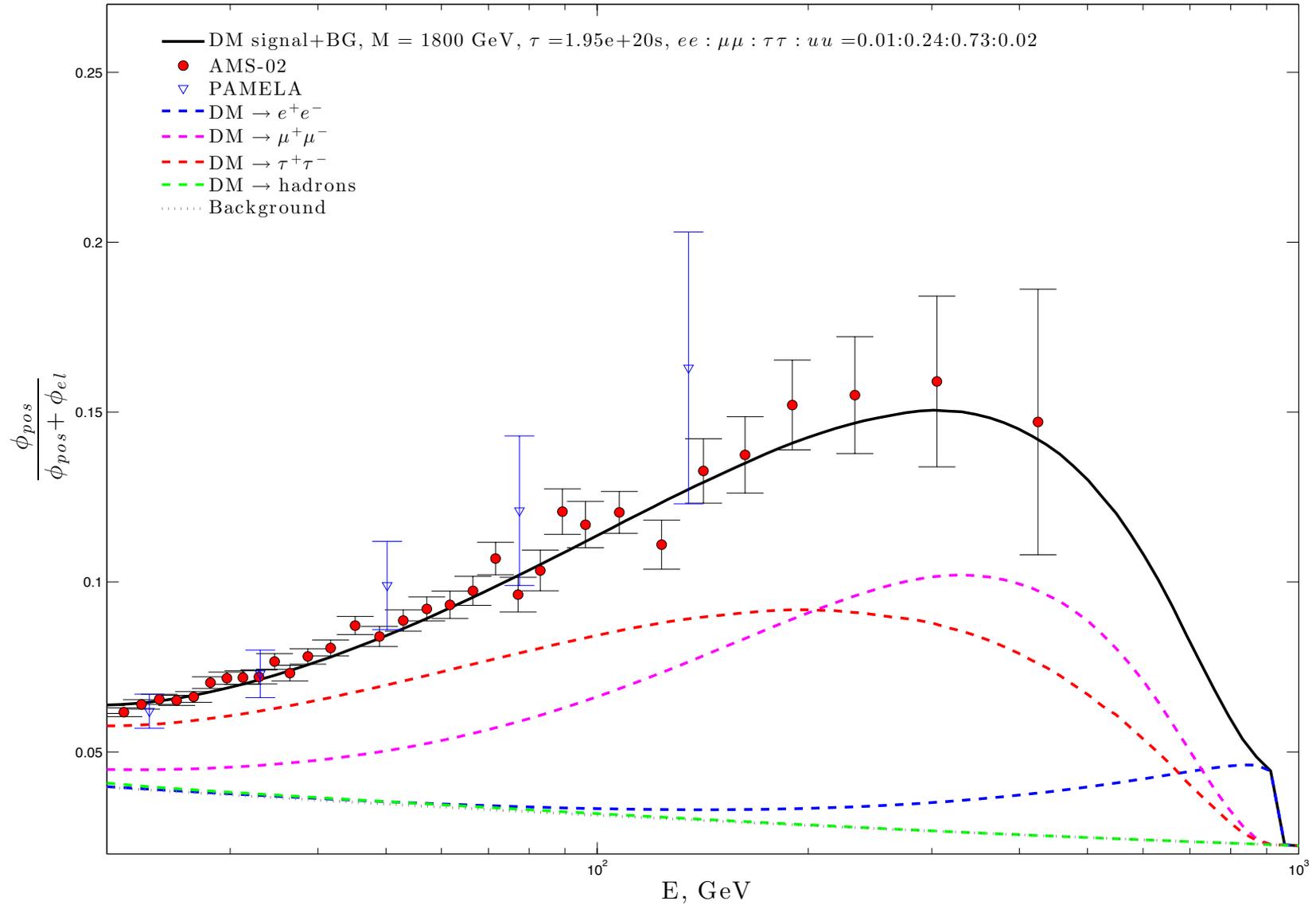


Gamma-rays (2500 GeV)

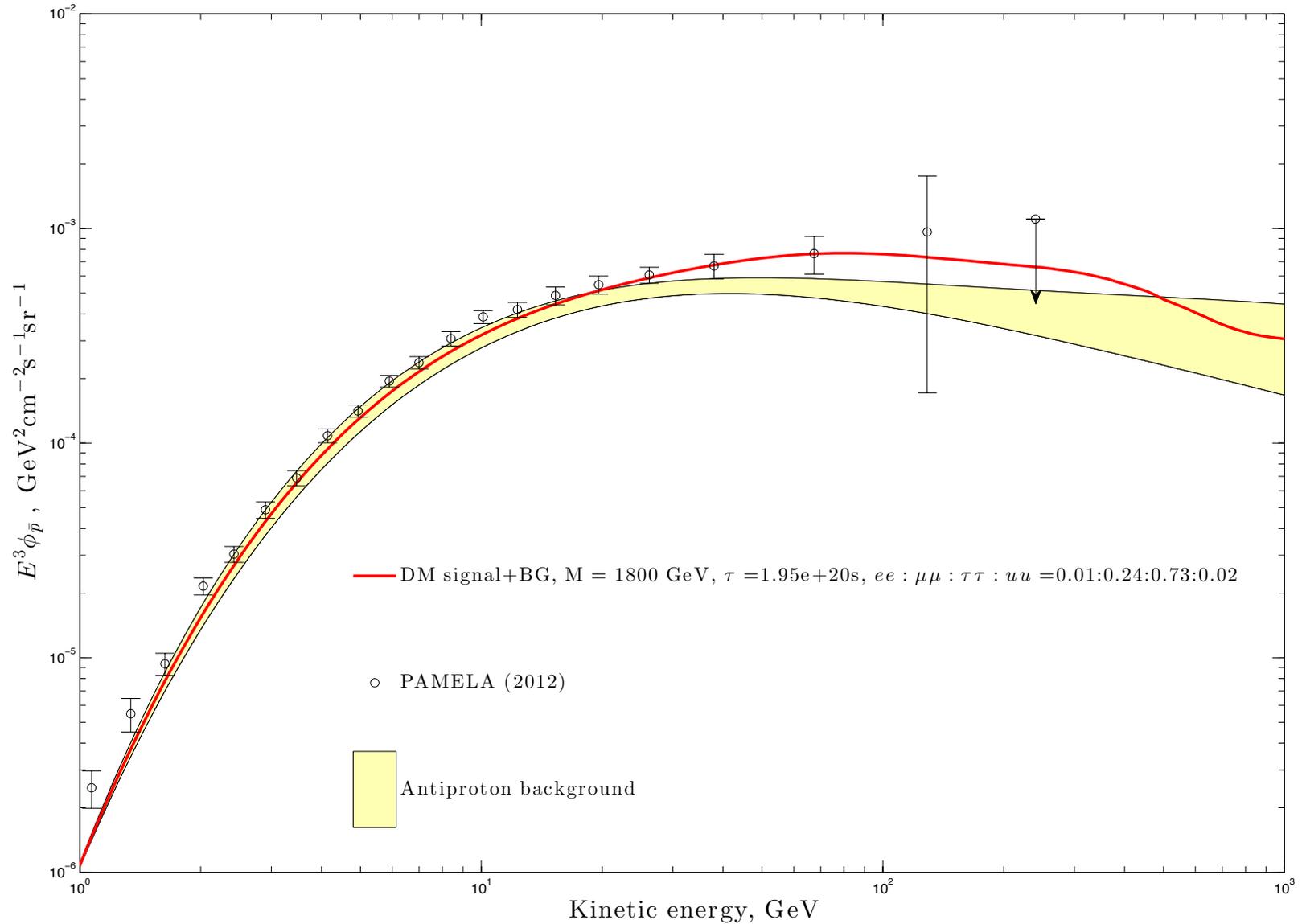


Let's try 1800 GeV...

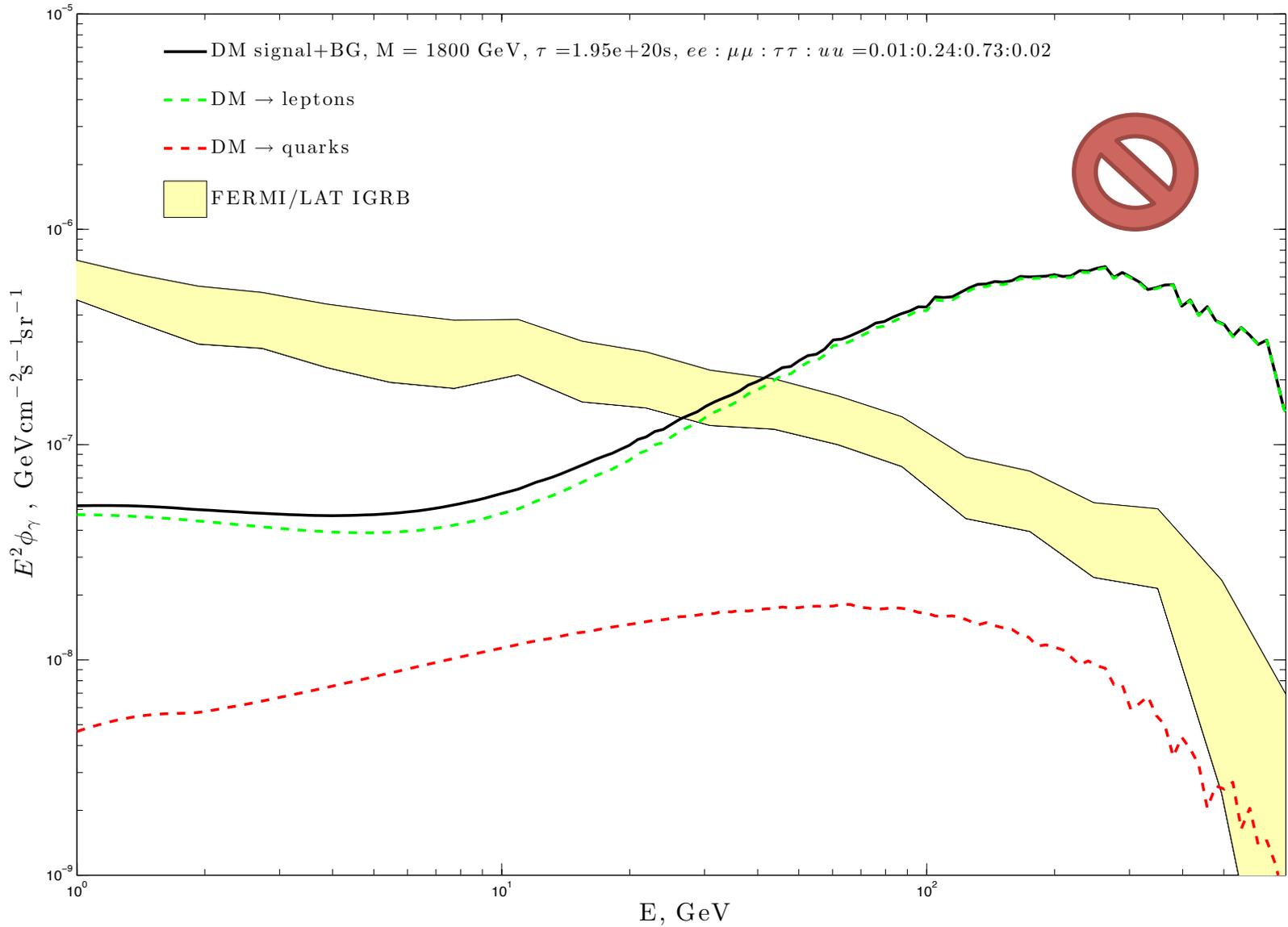
Positron fraction (1800 GeV)



Antiproton flux (1800 GeV)



Gamma-rays (1800 GeV)



Results:

- We raised **the problem** that any reasonable dark matter model providing a sufficiently good explanation of cosmic antiparticle excess **inevitably contradicts** FERMI/LAT data on isotropic diffuse gamma-ray background;

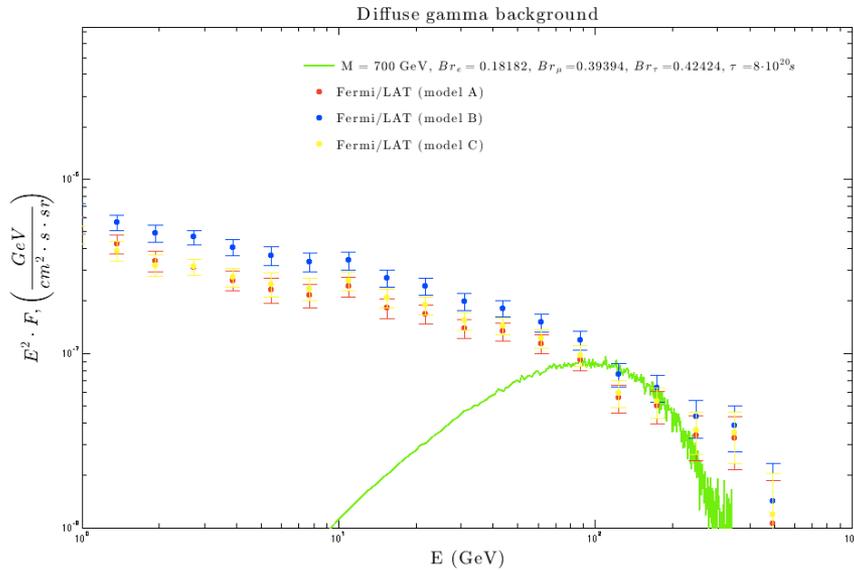


- Though we've considered only dark matter decays our results also **can be applied to annihilating dark matter**;
- **Variations** of dark matter model or propagation model parameters **couldn't significantly reduce** the problem we raised.

Thank you for attention!

Backup slides

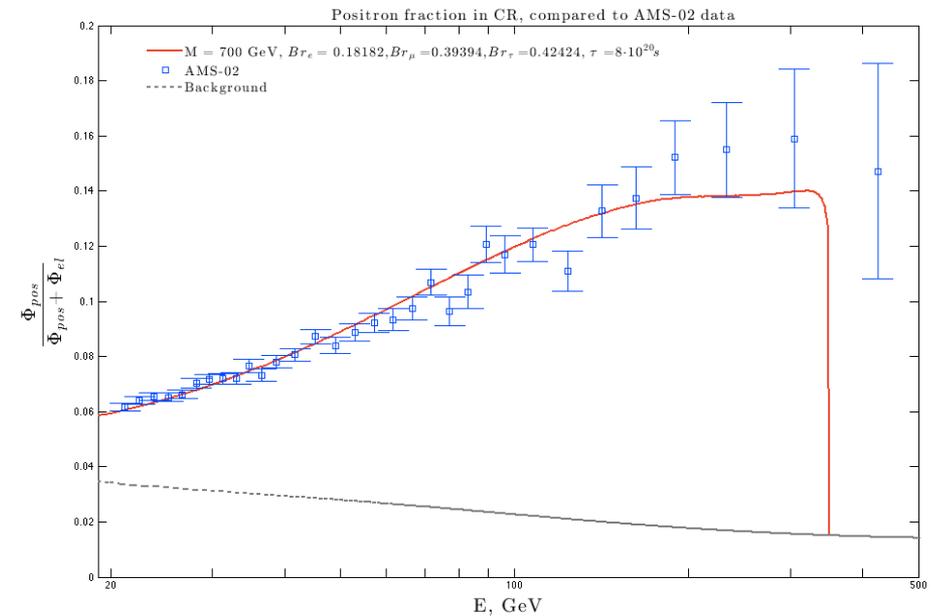
Our previous results (leptophilic decaying dark matter)



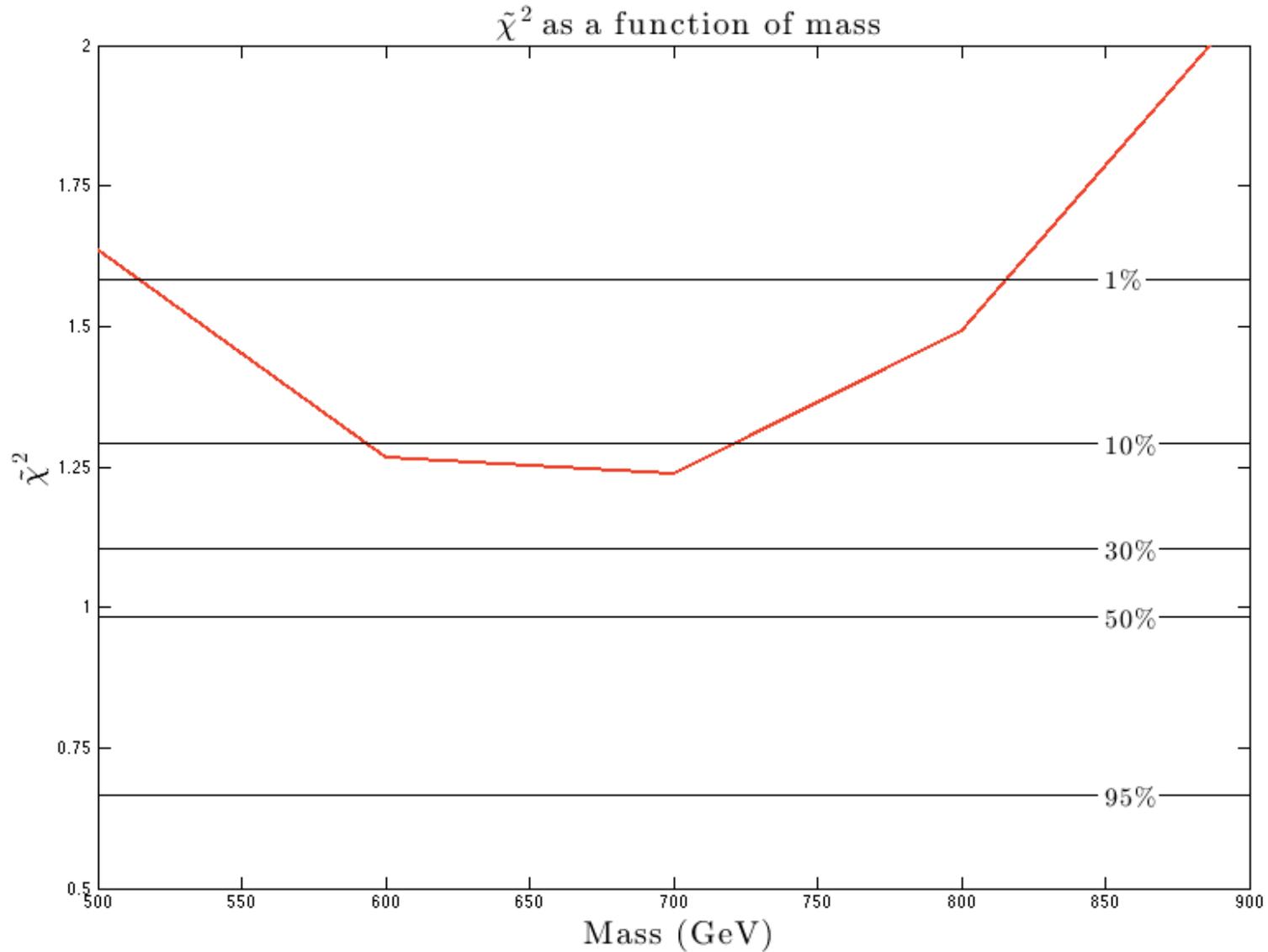
Diffuse gamma rays

$M_x = 700 \text{ GeV}$

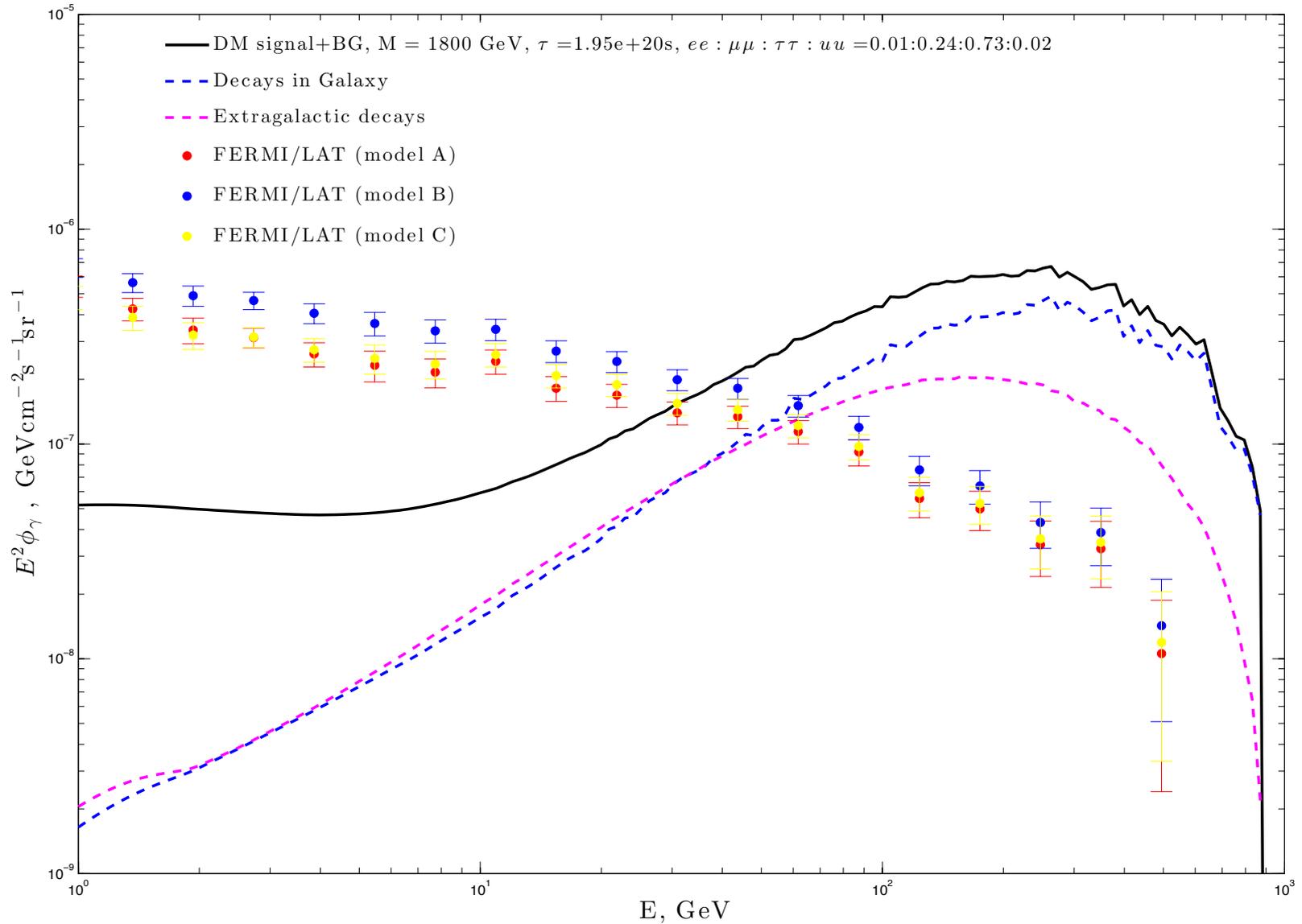
Positron fraction



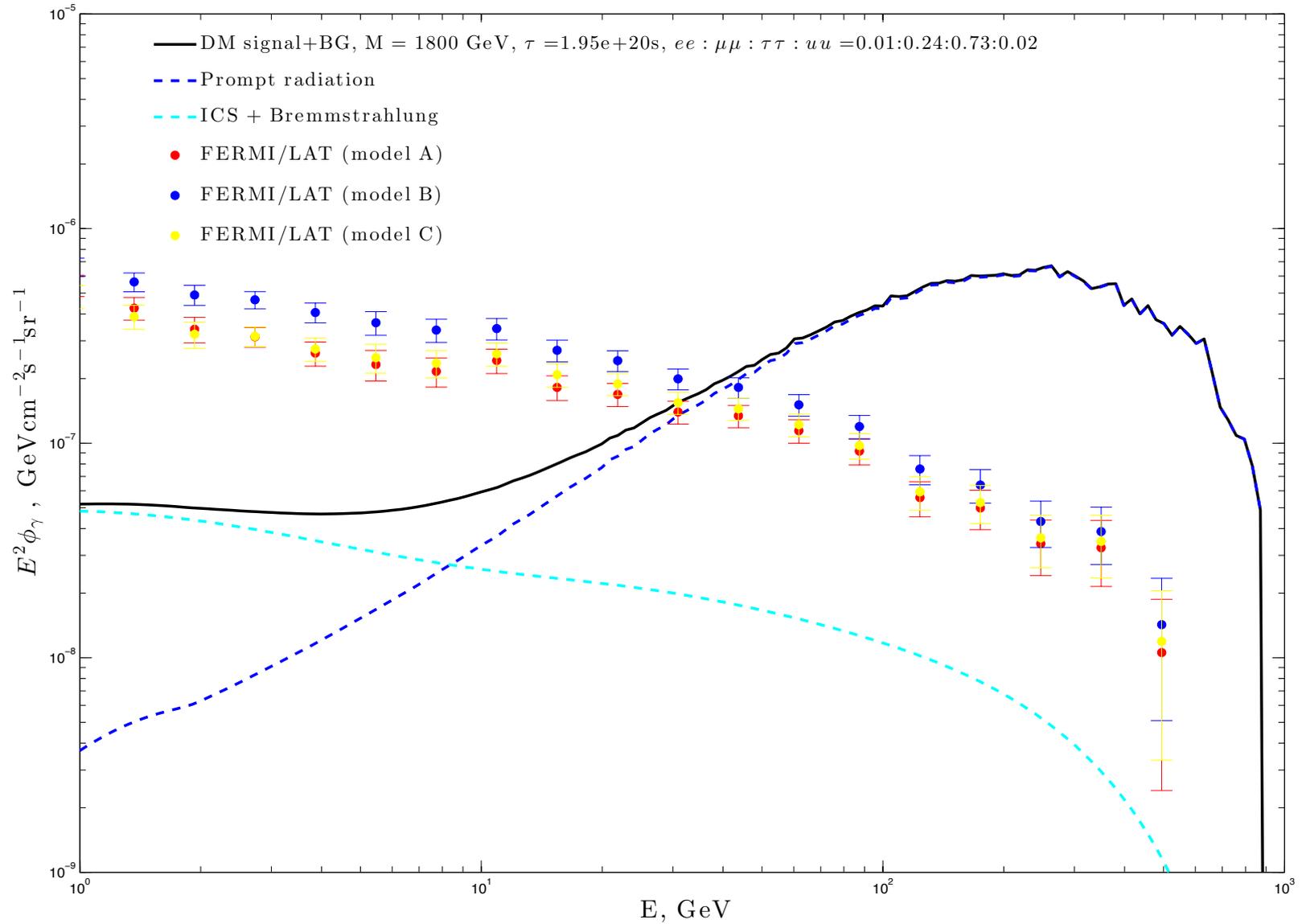
Our previous results (**leptophilic** decaying dark matter)



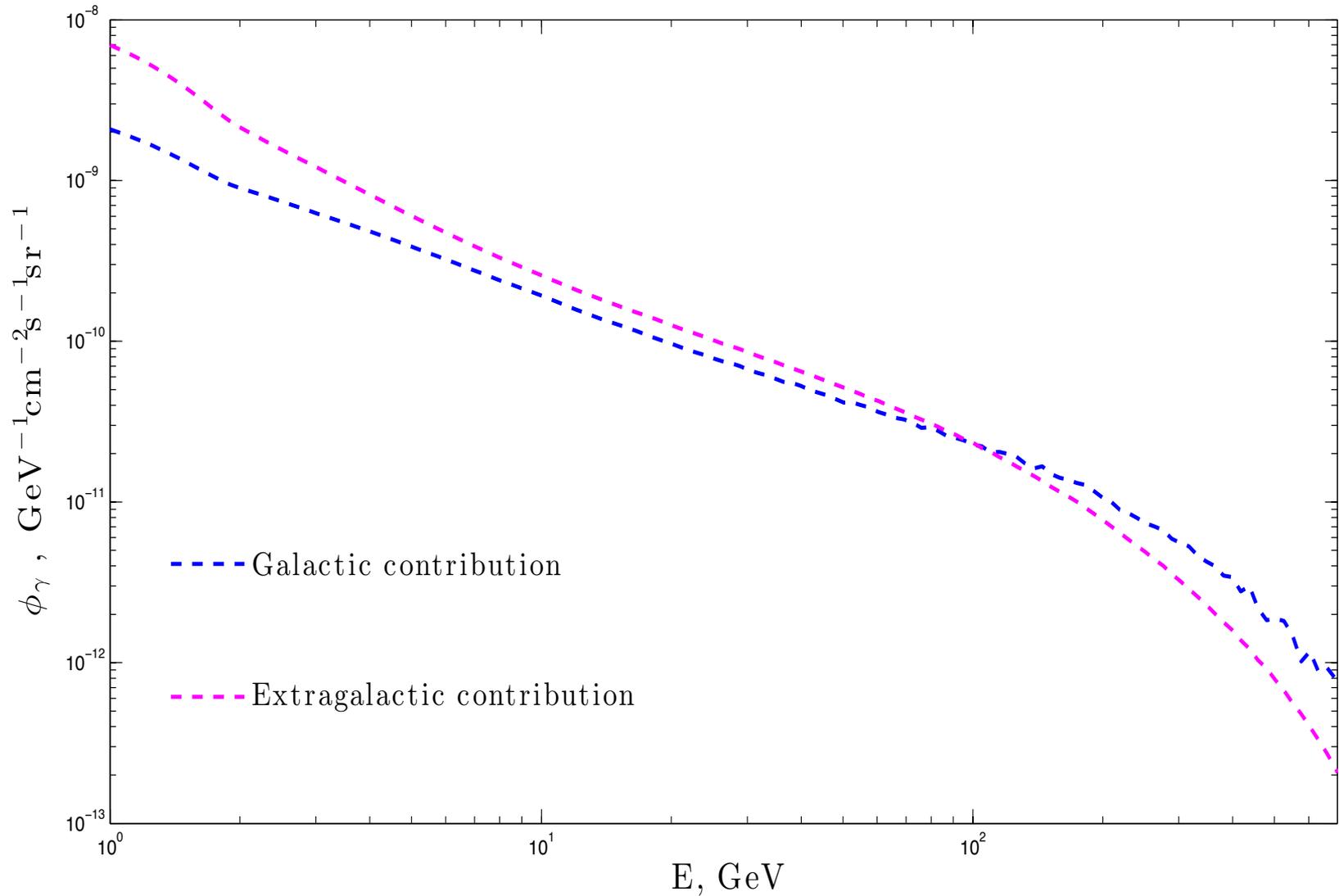
Gamma-rays (1800 GeV)



Gamma-rays (1800 GeV)



Galactic and extragalactic contributions to gamma (2500 GeV)



Some formulas

Galactic gamma-ray component:

$$F_{\gamma}^{\text{G}}(E) = \frac{\xi}{4\pi M_X \tau \Delta\Omega} \sum_i \text{Br}_i \frac{dN_{\gamma}^i}{dE} \int_{\Delta\Omega} d\Omega \int_{\text{line-of-sight}} ds \rho_{\text{DM}}[r(s, b, l)].$$

Extragalactic gamma-ray component:

$$F_{\gamma}^{\text{E}}(E) = \frac{c\xi\Omega_{\text{DM}}\rho_{\text{crit}}}{4\pi M_X \tau} \int_0^{\min[E_{\text{max}}/E, 1100]} \frac{dz}{H_0 \sqrt{\Omega_{\Lambda} + \Omega_m (1+z)^3}} \sum_i \text{Br}_i \frac{dN_{\gamma}^i}{dE} [(1+z)E]$$