

# GOE-DESY

# PARTICLE-COSMOLOGY

# GROUP

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2(Goe)+4(DESY)+5(SFB,AvH) PostDocs, ~10 students



# WHERE ARE WE ?



2,5 hours  
ICE train...

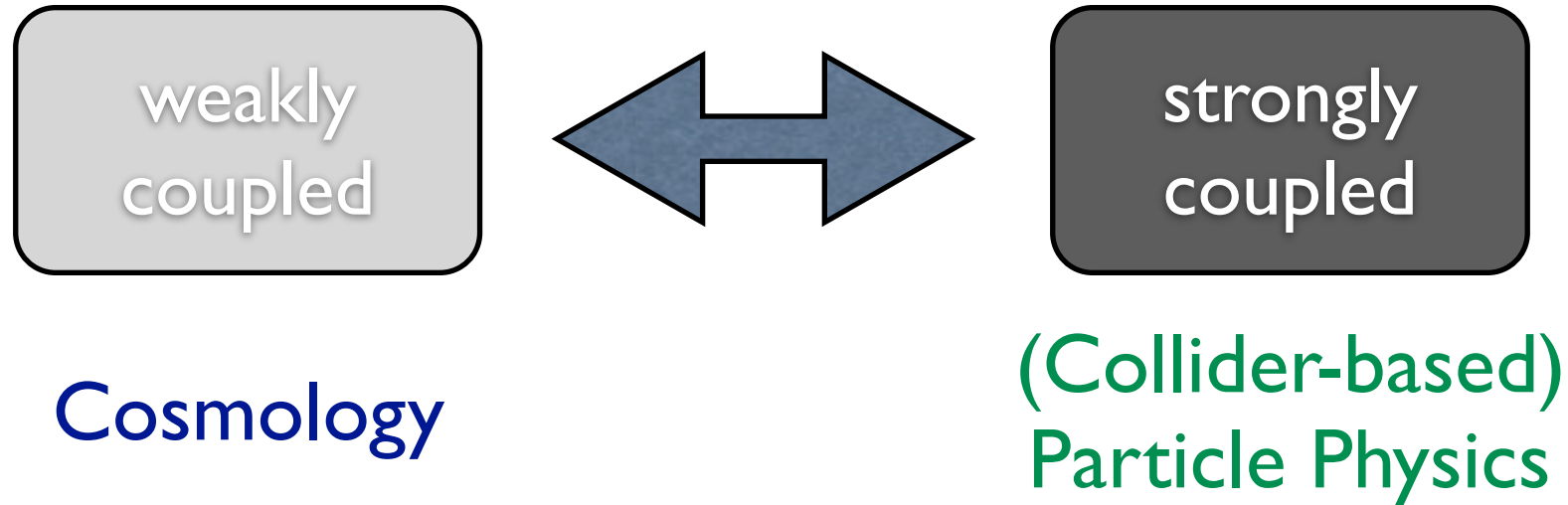
# WHERE ARE WE ?



2,5 hours  
ICE train...

... to most  
German  
cities !

# Why Cosmology at DESY ?



Exploit the complementarity between the fields to explore all the BSM sectors: the more weakly coupled to the SM and the more strongly coupled...

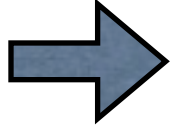
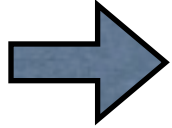
**Best results: information from both sides, e.g. neutrinos, axions, etc... ? WIMPs/SuperWIMPs ?**

# Many mechanisms, no model

- DE: cosmological constant, quintessence, ???
- DM: neutrinos, WIMP, superWIMP ???
- BA: EW baryogenesis, leptogenesis ???
- Inflation: single scalar field, hybrid, ???
- T: reheating, preheating, ???

All hints of physics beyond the Standard Model...,  
but no clear signature for a specific one yet !

# Our strategy:

- Look for connections between problems & signals and for a consistent and coherent picture, e.g. **SUPERGRAVITY...**
- Exploit information from all sides: cosmology, astroparticle, colliders, low energy data, etc...  **Collider Physics, SFB B,C**
- Exploit the theoretical developments and engage in model building top-down & bottom-up  **String Theory, SFB A**

Very wide interests building bridges between fields and thriving at the interface !

# Our goal:

- A better understanding of the history of our Universe and the mechanisms at work there
- Ultimately, a **new Standard Model** including and extending the present Standard Models of Particle Physics and Cosmology

# Activities in the last years...

- **Gravitino Dark Matter/Decaying DM:** consistent cosmological scenario for leptogenesis/DM
- **Hidden sector physics:** Weakly interacting sub-eV and axion-like particles from Strings
- **Thermal field theory:** full quantum mechanical description of non-equilibrium phenomena like leptogenesis
- **Indirect WIMP DM detection and CR:** Charged particles propagation codes, detection strategies
- **Moduli stabilization/Inflation in no-scale SUGRA:** consequences for the models & SUSY breaking

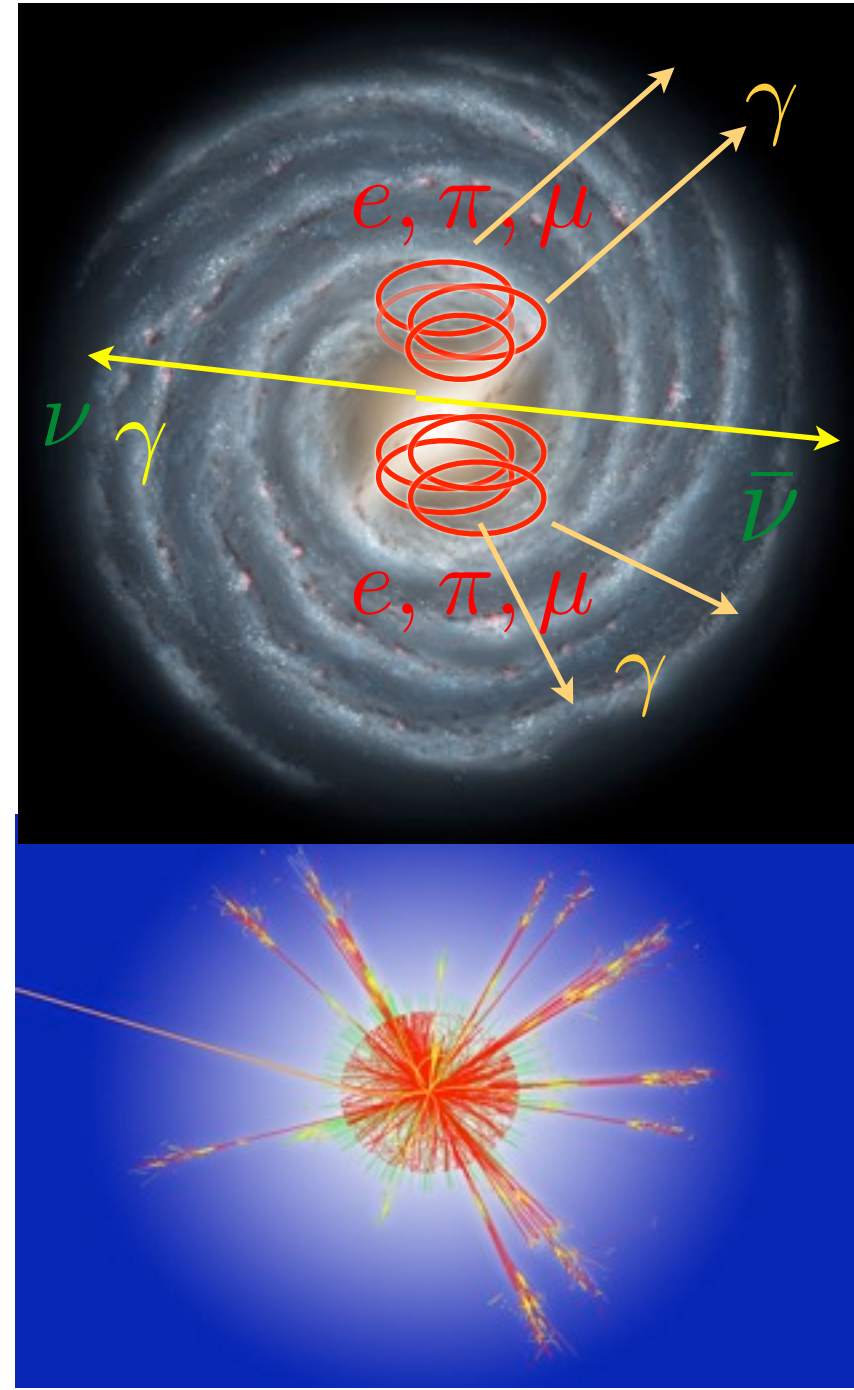


# A “consistent” history of time

$T(\text{GeV})$	
$\sim 0$	Inflation e.g. driven by a modulus ending in dS
	Reheating/preheating to MSSM sector
$10^{10}$	Gravitino LSP production $m_{3/2} \geq 10 \text{ GeV}$
$10^9$	Leptogenesis via RH neutrino decay
$\geq 10^2$	Sphalerons reprocess L into B, B-L conserved
$\sim 10$	NLSP freeze-out
1	NLSP decay via R-parity breaking
$10^{-2}$	
$10^{-3}$	Nucleosynthesis and Standard Cosmology

# Gravitino DM connection

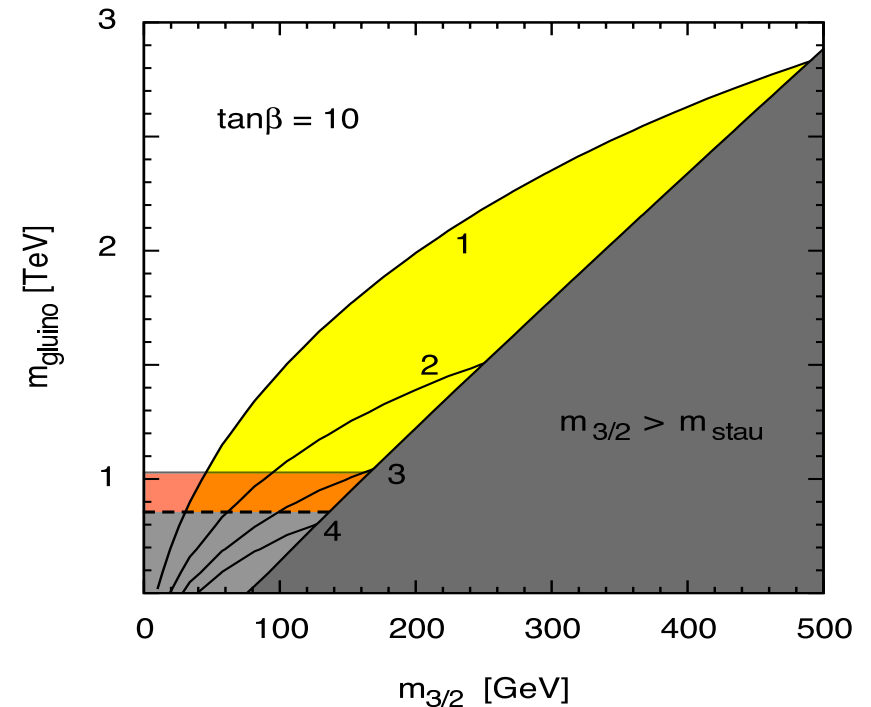
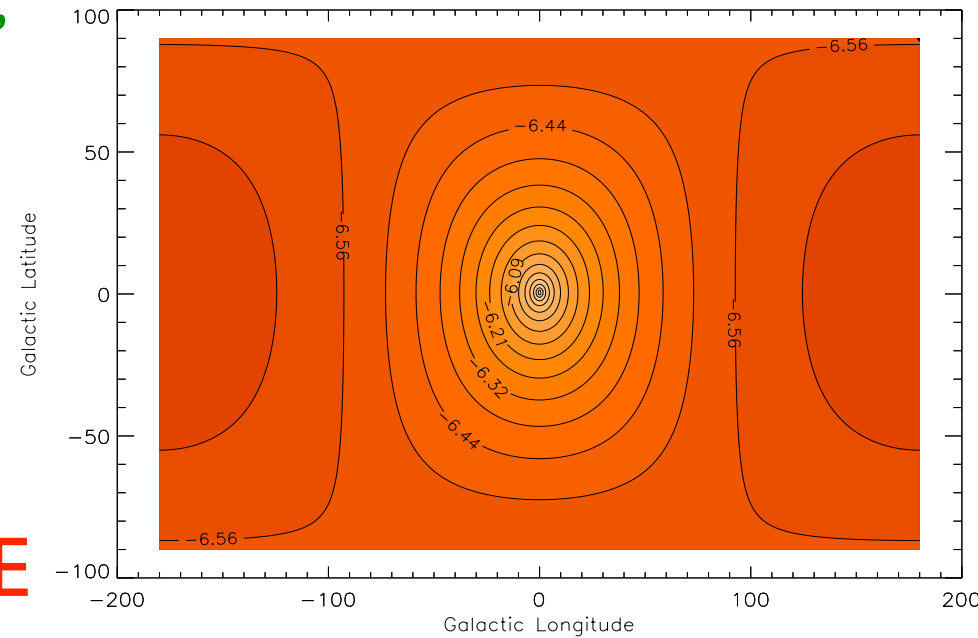
- Signal from DM decay in indirect detection channels: gamma-rays, positrons, antiprotons, neutrinos  
➔ **FERMI, PAMELA, ICECUBE**
- **Supersymmetry @ LHC** with NLSP as (meta)stable state: stau, neutralino, sneutrino, stop... with or without missing energy !



# Gravitino DM connection

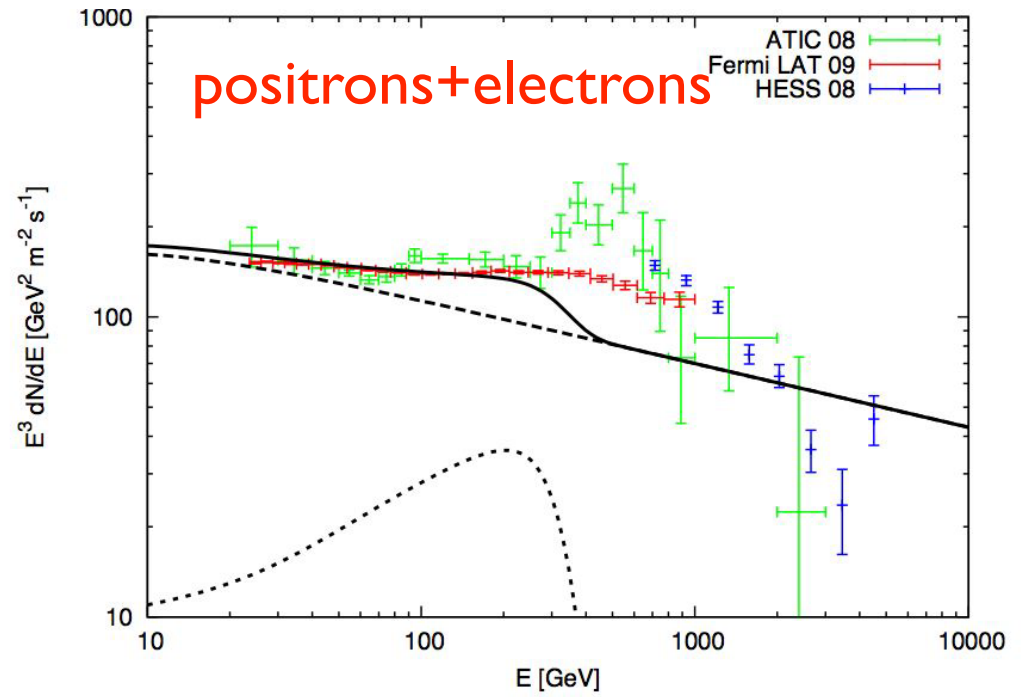
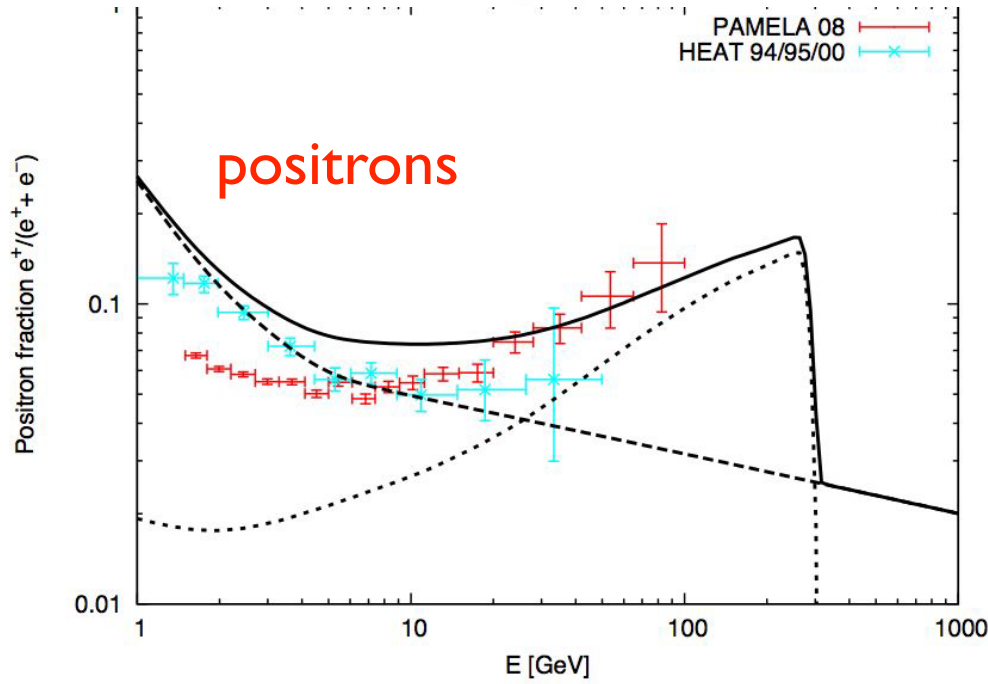
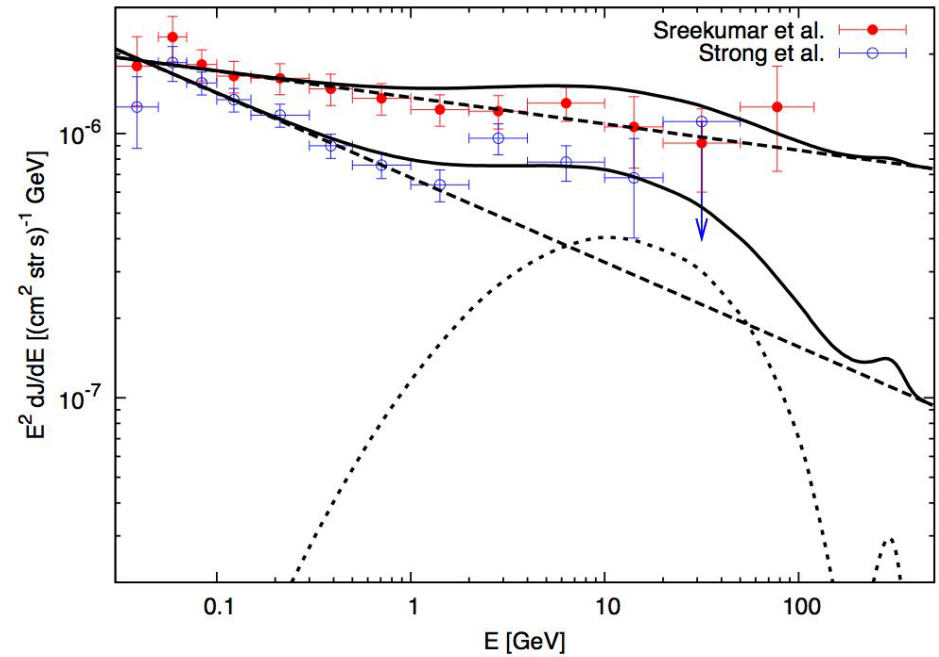
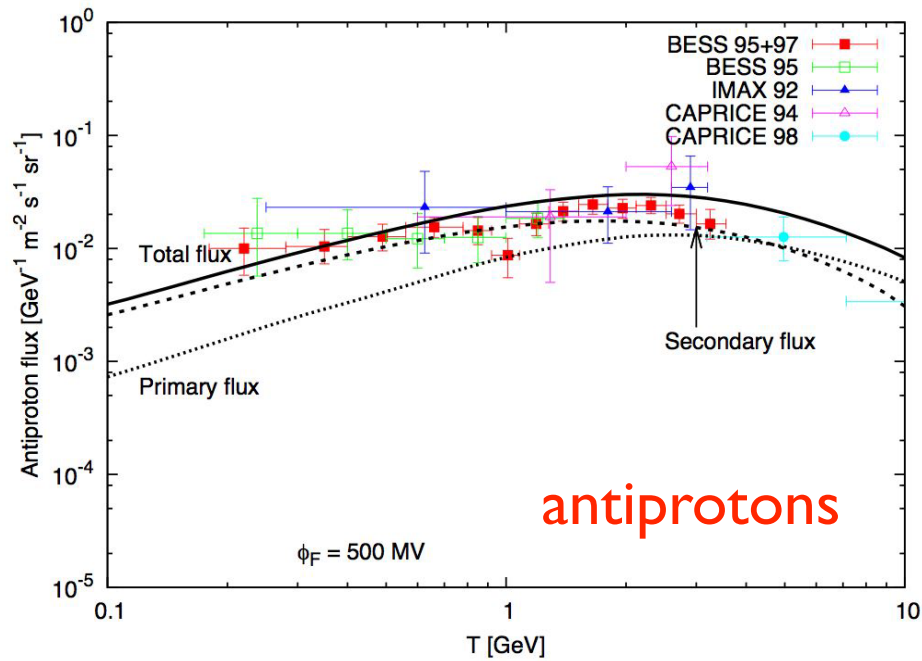
[W. Buchmuller, LC, G. Bertone, A. Ibarra, T. Shindou, F. Takayama, D. Tran]

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# Gravitino DM without $R_p$

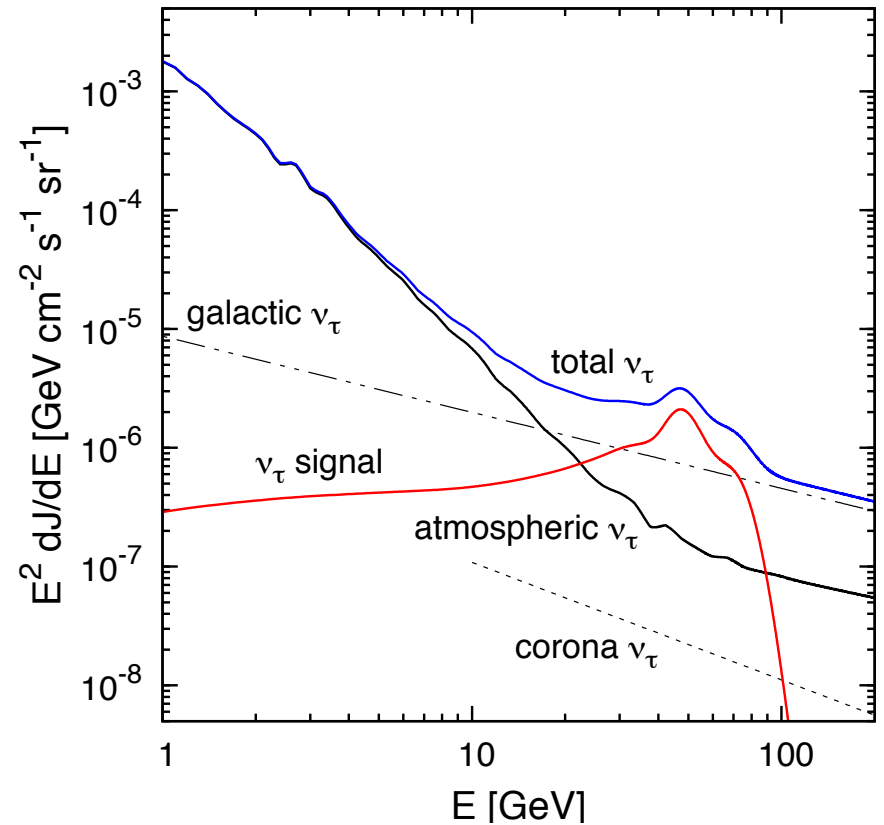
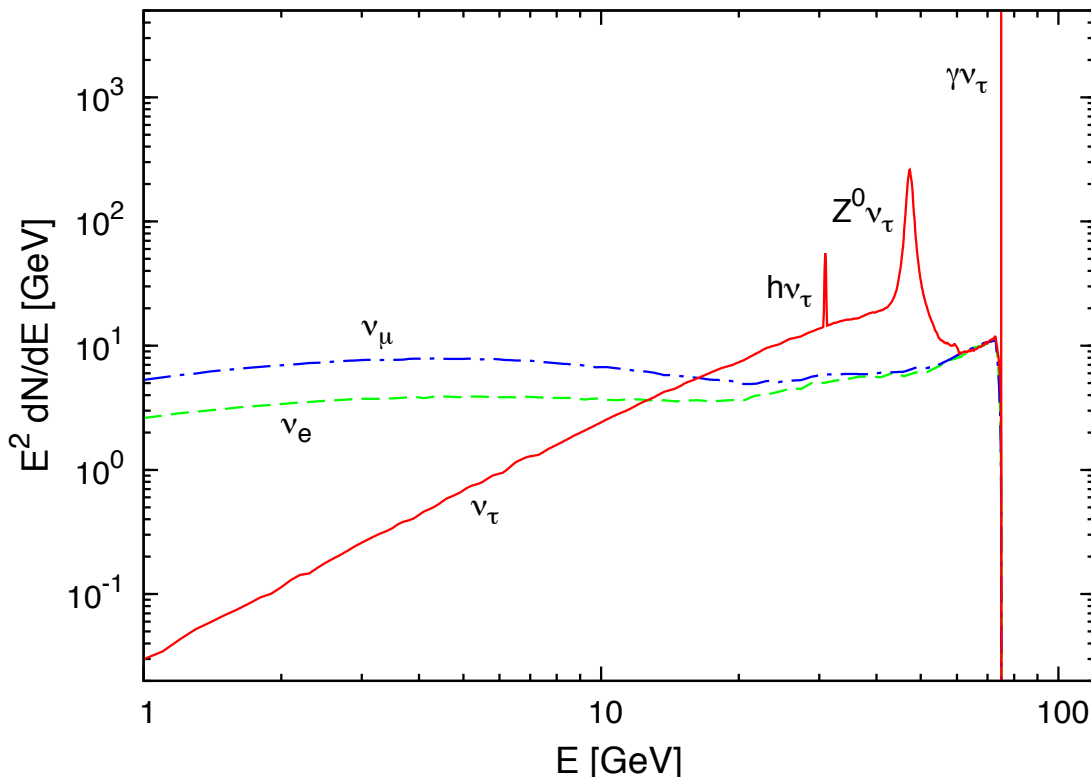
[Buchmuller, Ibarra, Shindou, Takayama, Tran 09]



# Gravitino DM: neutrino signal...

For light gravitino, wonderful signal with 3 peaks..., but neutrino detector's resolution not sufficient to see them

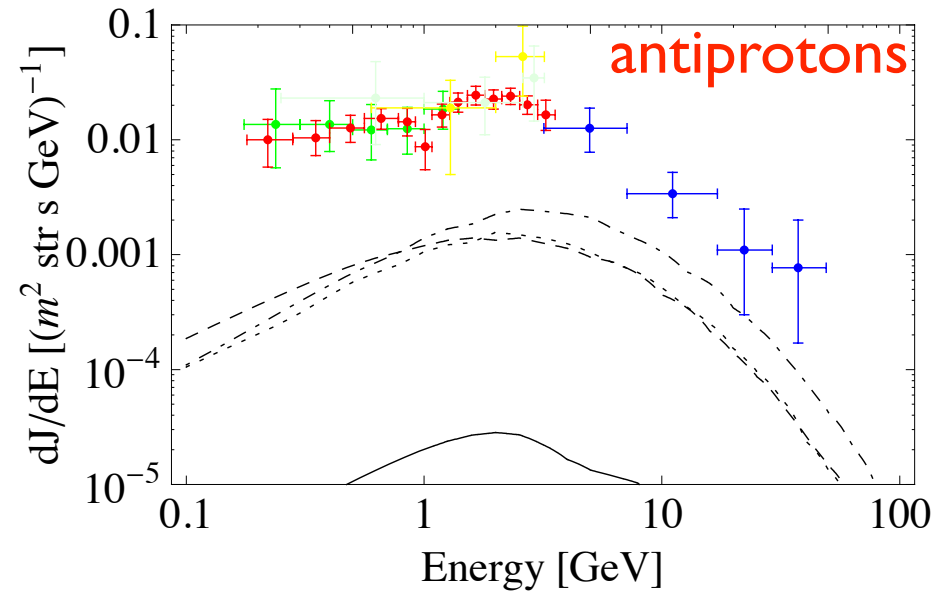
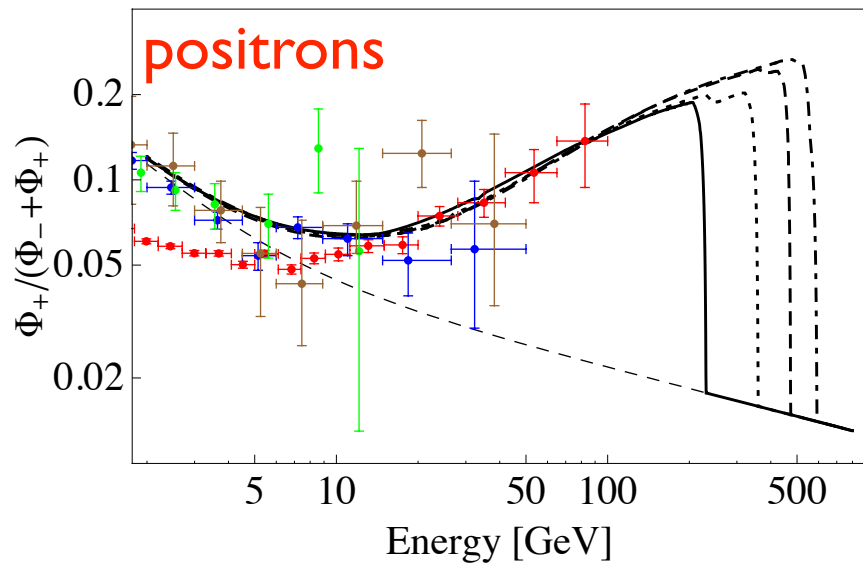
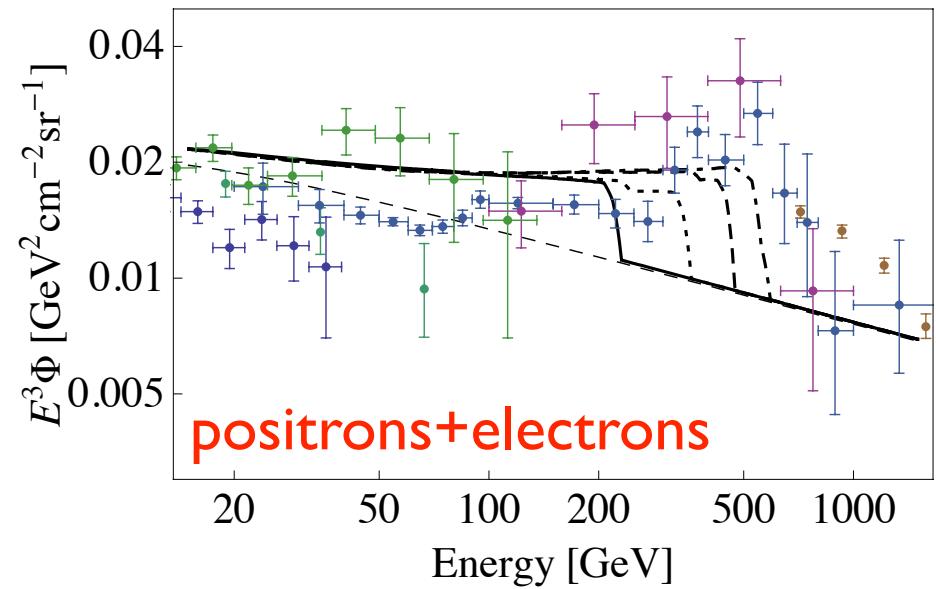
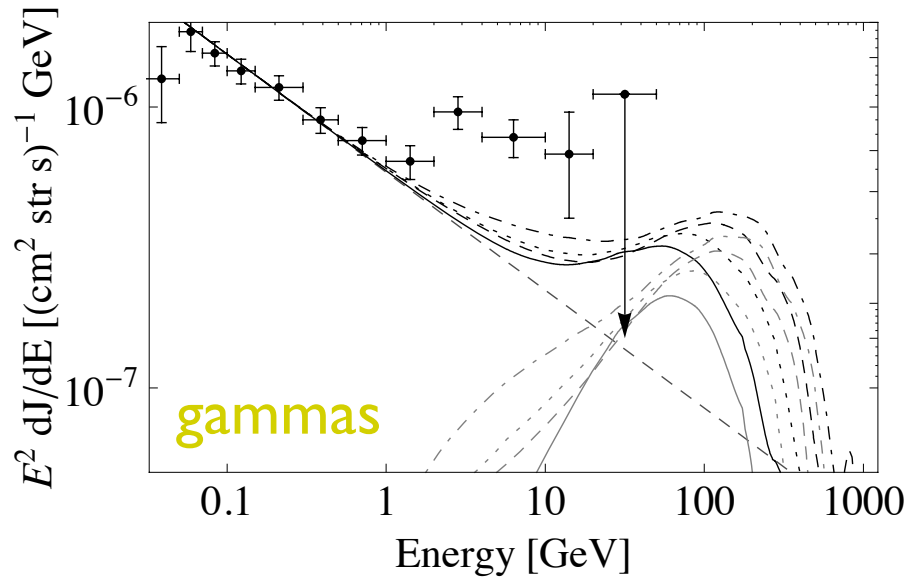
[LC, Grefe, Ibarra & Tran 08]



Best signal to background ratio for a tau neutrino looking up... Possible to detect in IceCube ?

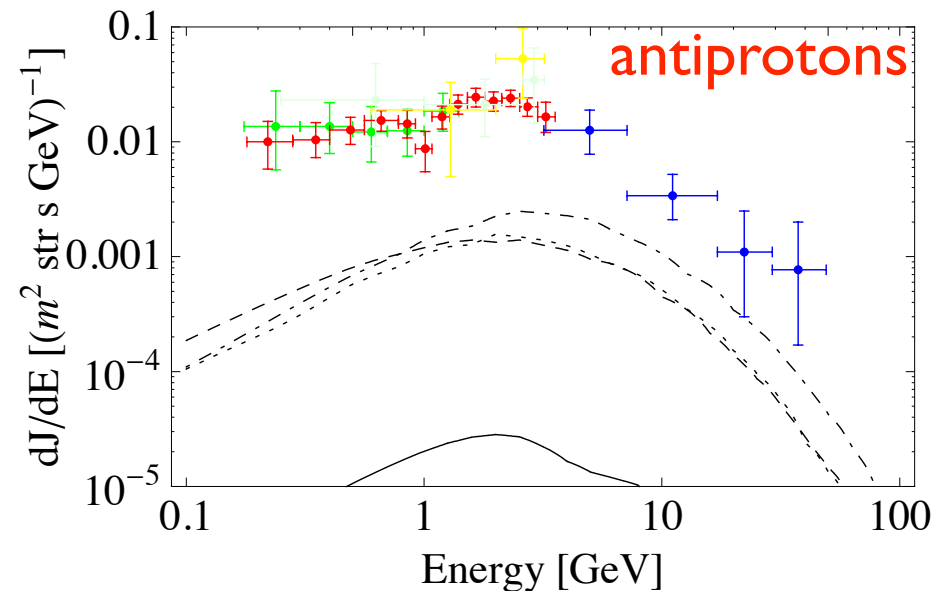
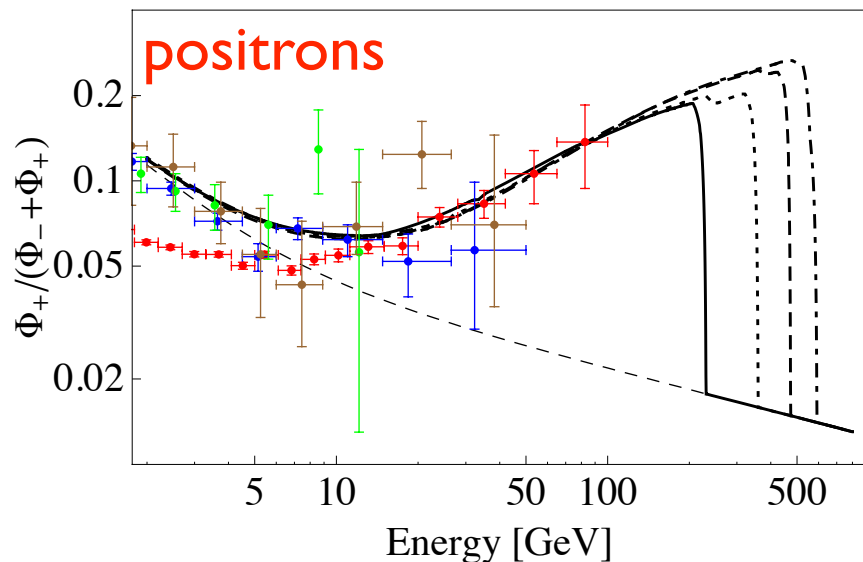
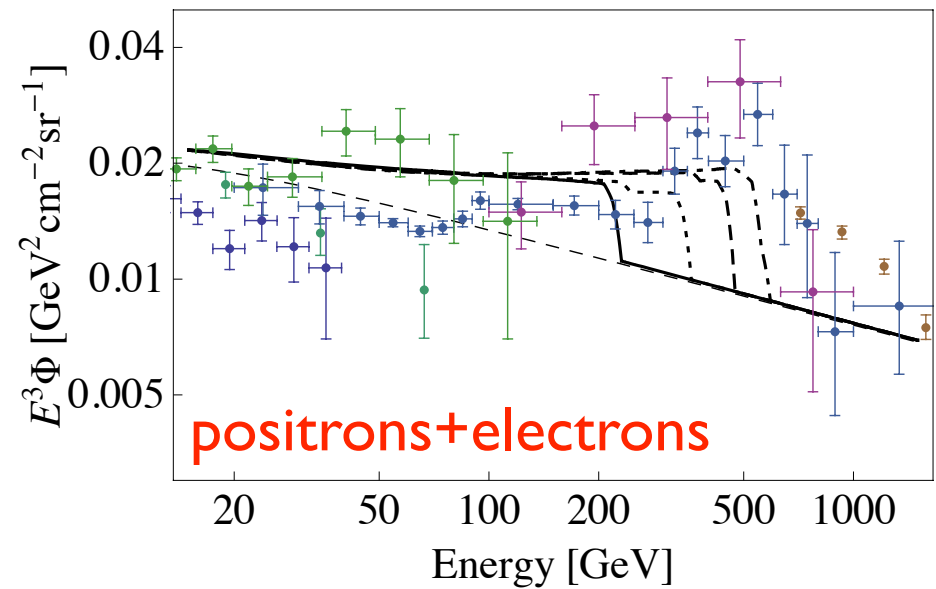
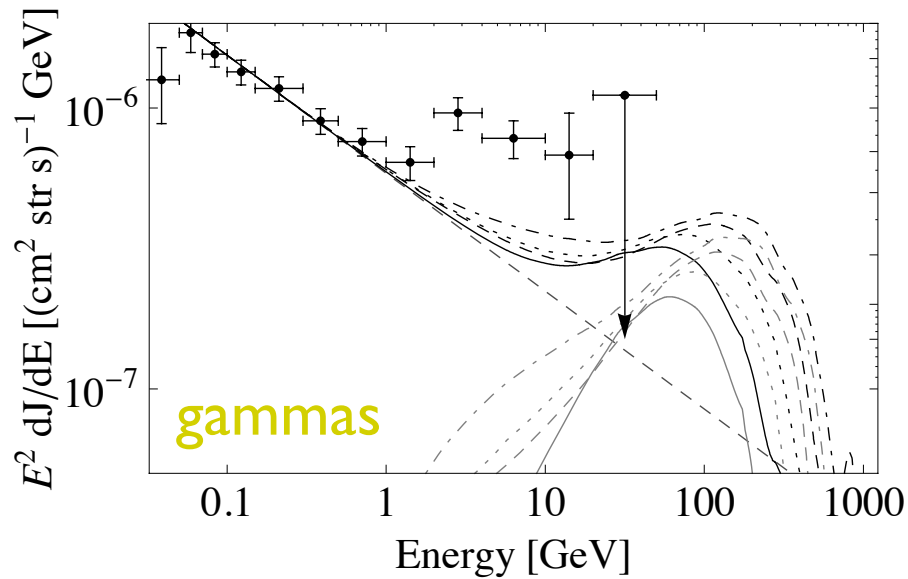
# Hidden Photino Dark Matter

[Ibarra, Ringwald, Weniger 09]



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**CONSISTENT WITH PAMELA and FERMI ...**

# Outlook

We are very happy to be part of the new ITN “Invisibles” and we look forward to a fruitful and successful collaboration !

Let us turn the

in**visibles**  
neutrinos, dark matter & dark energy physics

to

**visibles**

!