Cosmic positron spectrum measurement from 1 to 50 GeV with AMS-01

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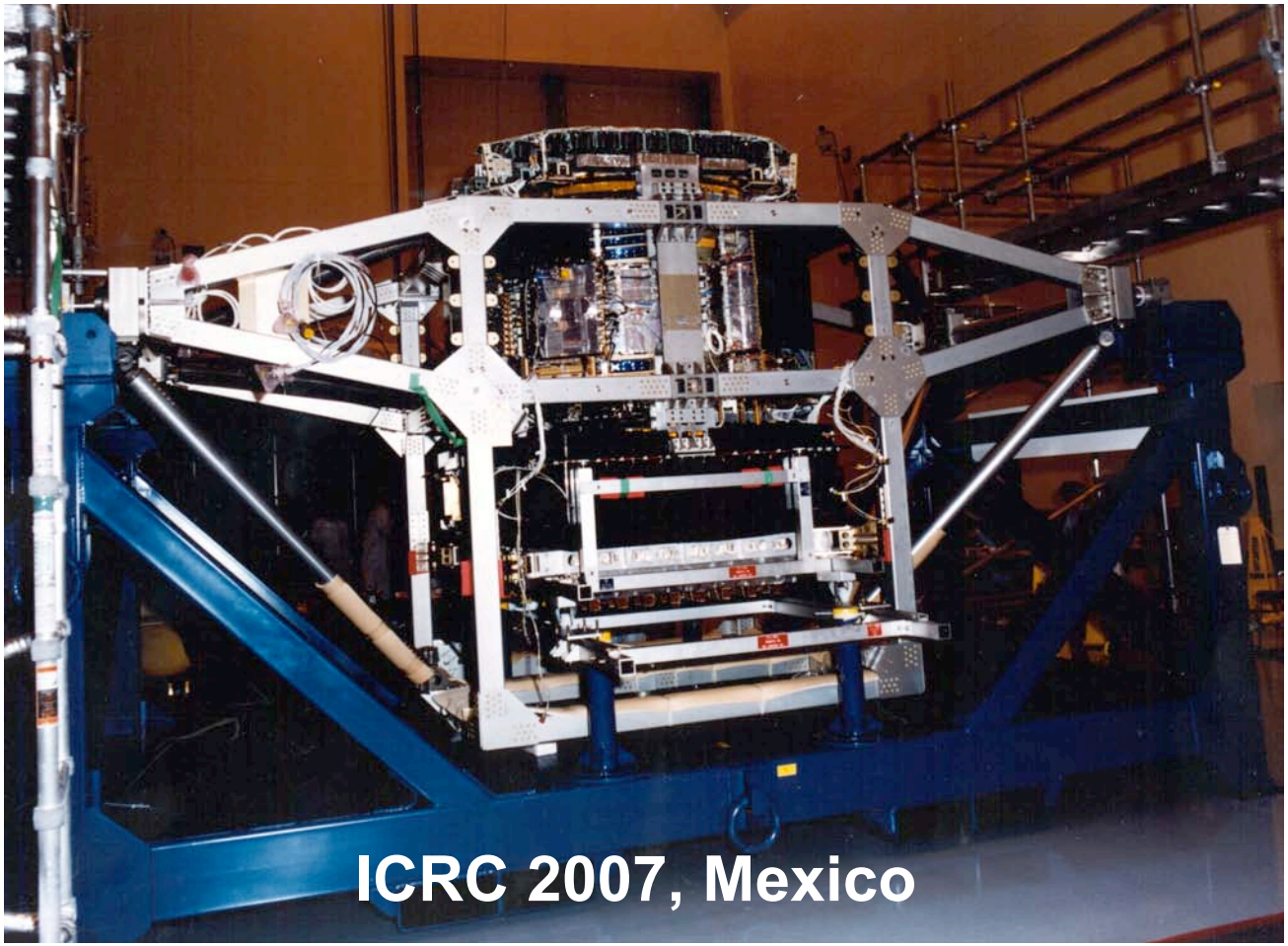
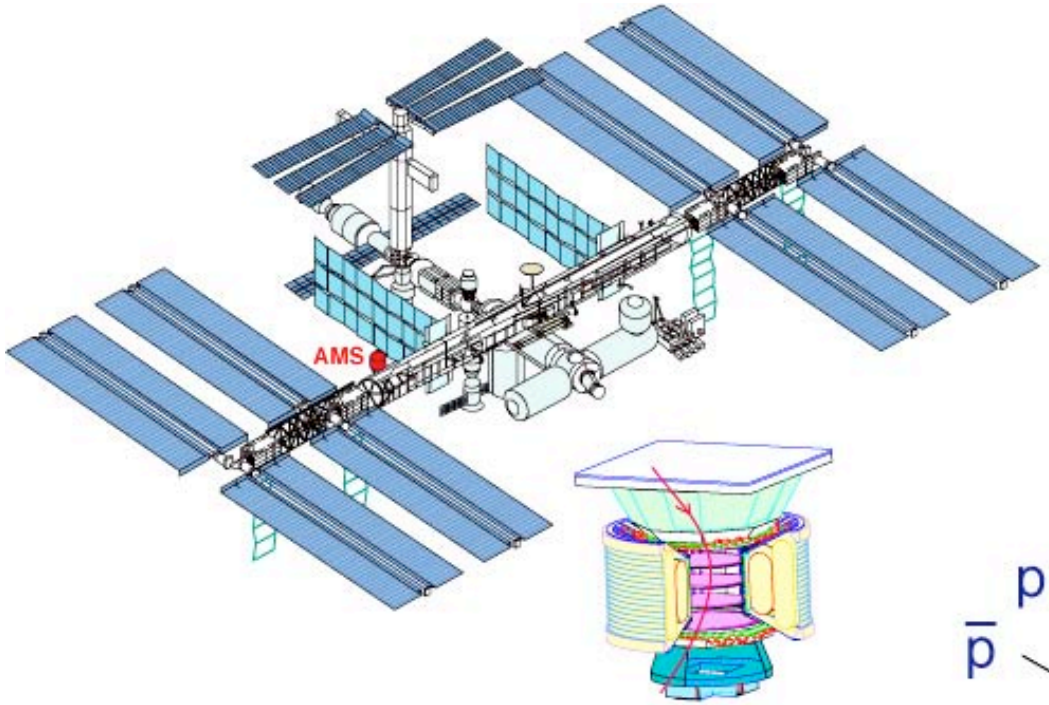


ICRC 2007, Mexico

Physics of AMS



1- Neutral component:

γ ,ν

Hubble, Chandra, GLAST, JWST, JDEM

Discoveries:
(1) Pulsar,
(2) Microwave,
(3) Binary Pulsars,
(4) X Ray sources, solar neutrinos
(5) Dark Matter, Dark Energy

… …

2- Charged component: He, Be, C, Fe

e^+ e^- p $\bar{p}$ $\overline{He}$,

WHIPPLE, HESS, VERITAS, …

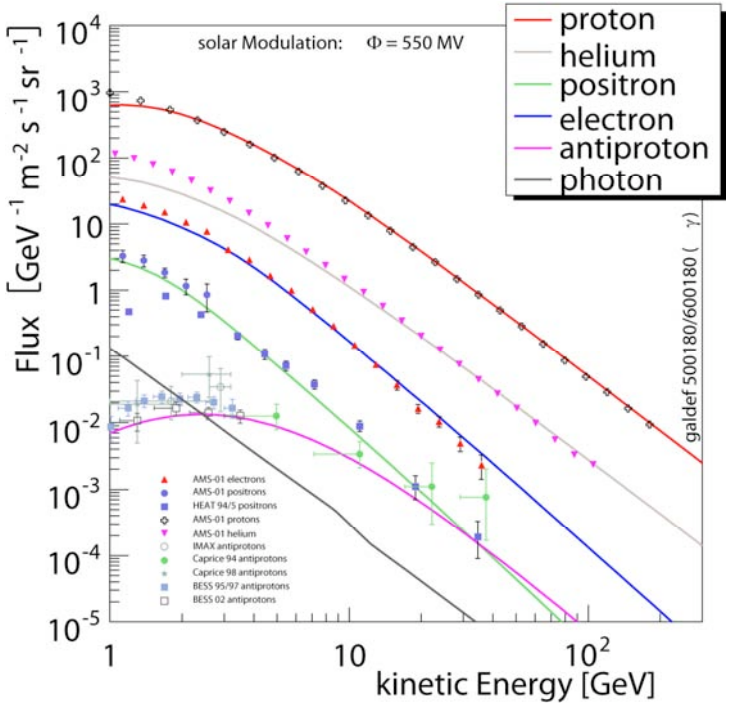
SUPER K

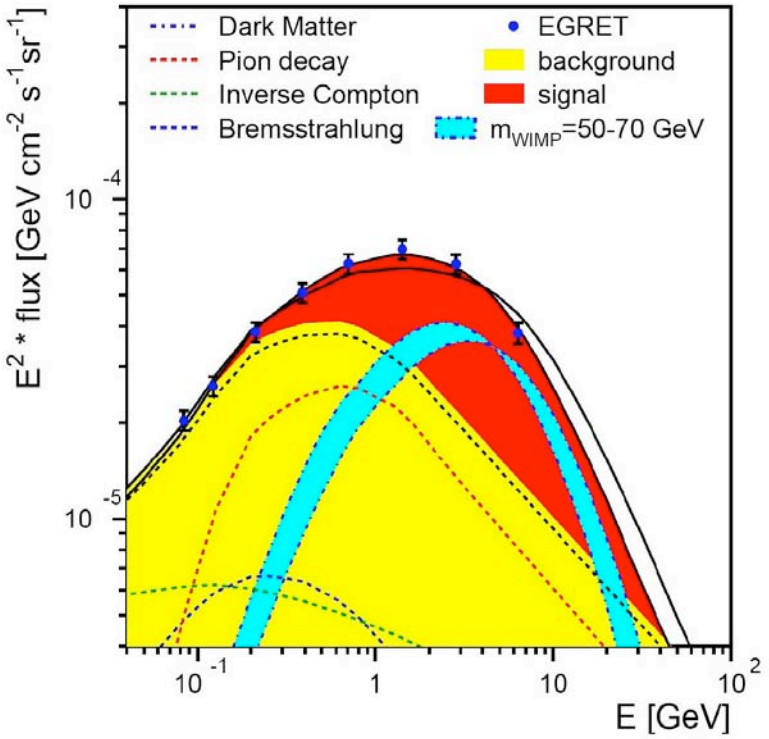
HiRes

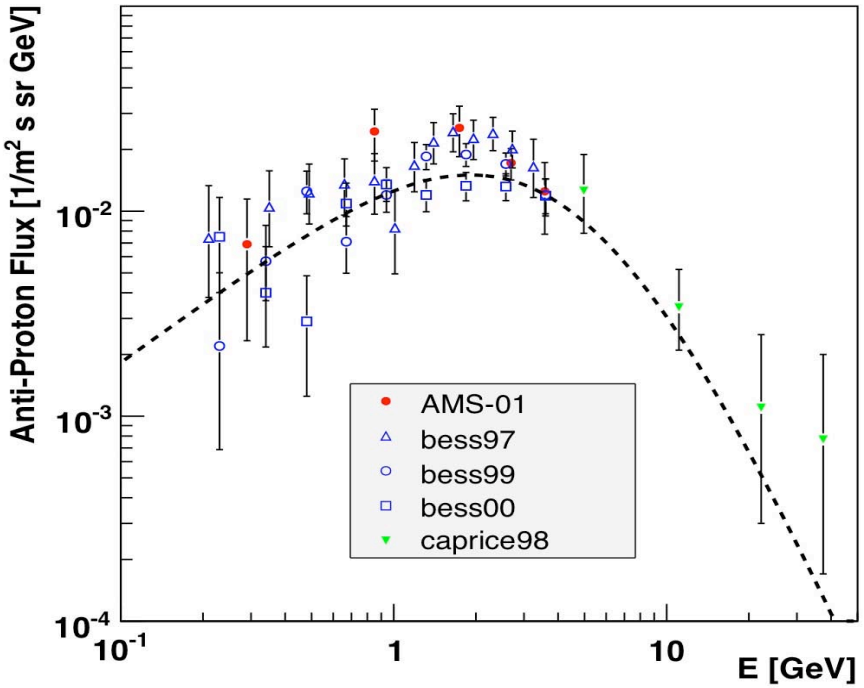
AUGER

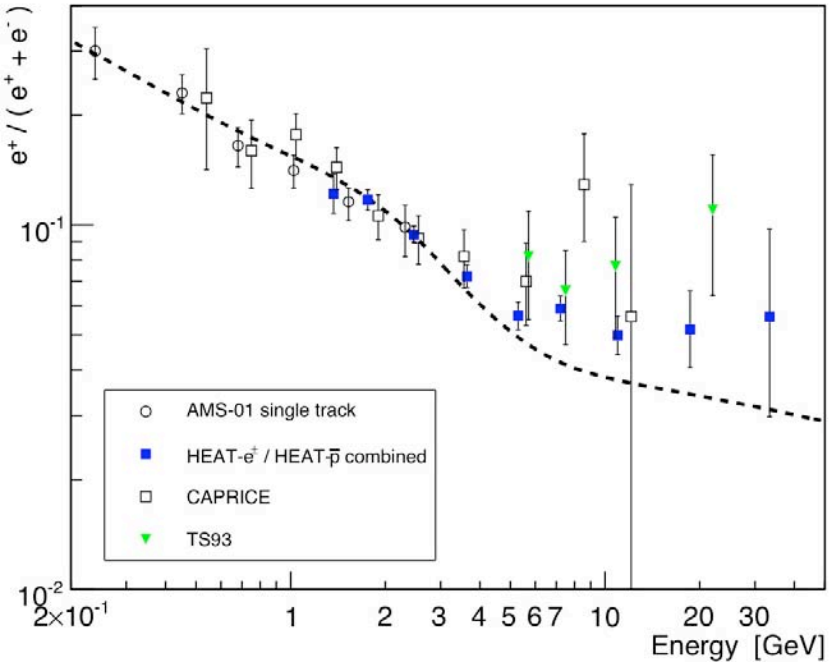
The highest energy particles are in Cosmic Rays

AMS will perform accurate measurements of energetic cosmic rays (0.1 GeV to 2 TeV)

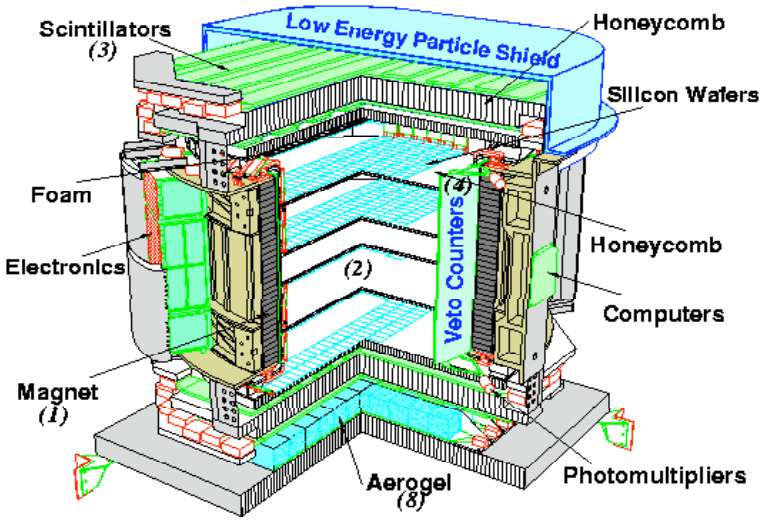

solar Modulation: Φ = 550 MV
proton
helium
positron
electron
antiproton
photon
Flux [GeV -1 m -2 s -1 sr -1]
kinetic Energy [GeV]
galdef 500180/600180 (γ)
AMS-01 electrons
AMS-01 positrons
HEAT 94/5 positrons
AMS-01 protons
AMS-01 helium
IMAX antiprotons
Caprice 94 antiprotons
Caprice 98 antiprotons
BESS 95/97 antiprotons
BESS 02 antiprotons


Dark Matter
Pion decay
Inverse Compton
Bremsstrahlung
EGRET
background
signal
m_WIMP=50-70 GeV
E² * flux [GeV cm⁻² s⁻¹sr⁻¹]
E [GeV]


Anti-Proton Flux [1/m² s sr GeV]
AMS-01
bess97
bess99
bess00
caprice98
E [GeV]

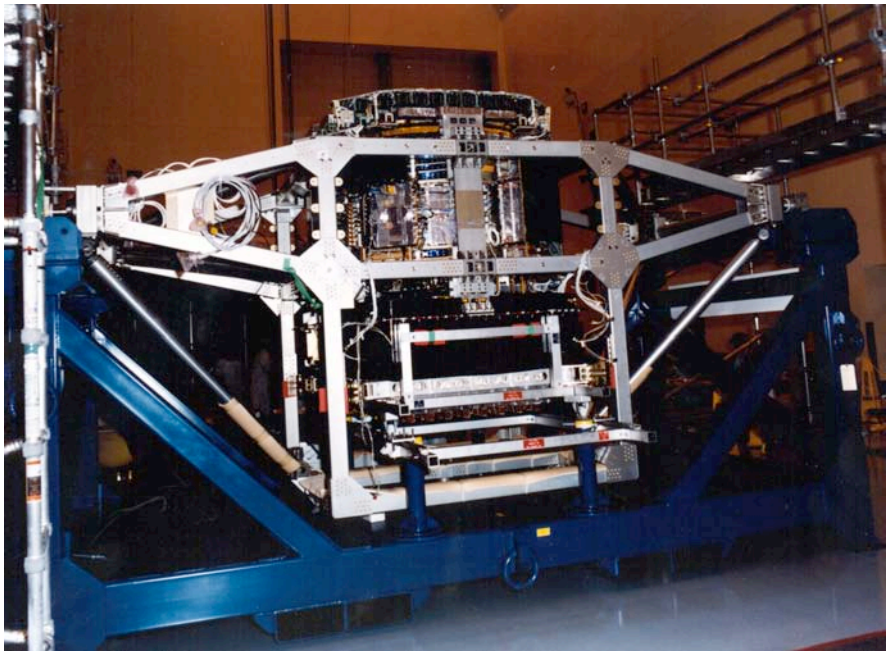

e⁺ / (e⁺ + e⁻)
AMS-01 single track
HEAT-e⁺ / HEAT-p̄ combined
CAPRICE
TS93
Energy [GeV]

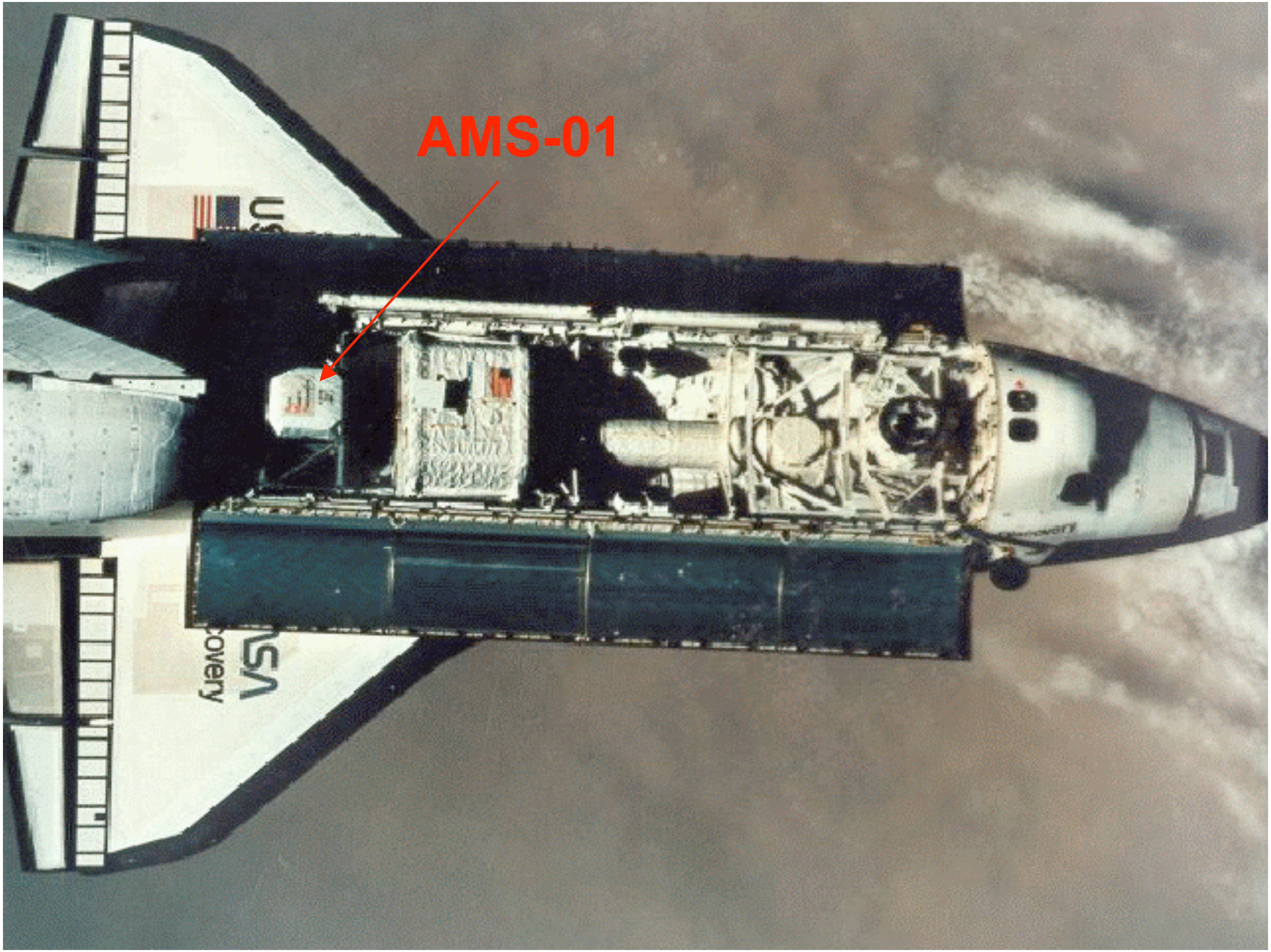
AMS-01: STS-91 1998 Flight Results



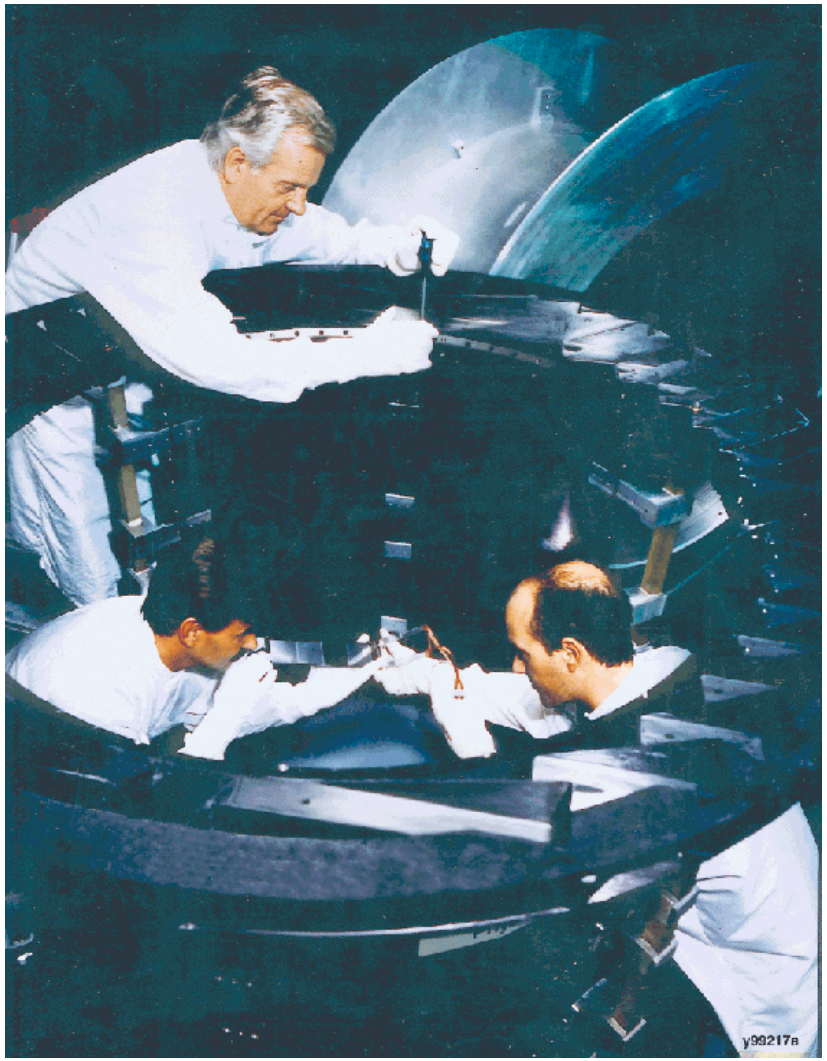
- Data taking ≈135 hours
- Shuttle altitude ≈370 km
- Trigger rate 100 – 700 Hz
- 100 million events recorded

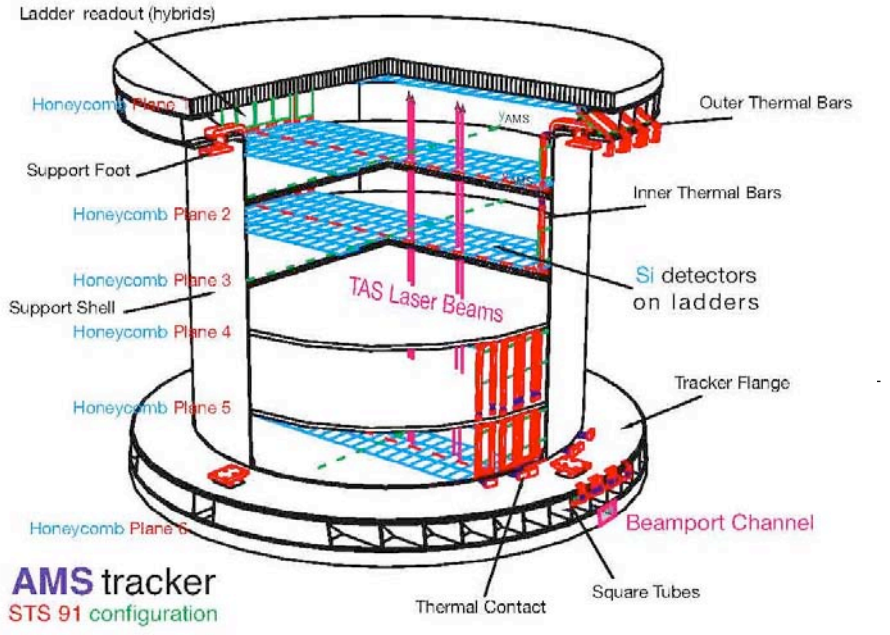
- Energy Range:
  100 MeV/n<E_k< 300 GeV/n
- Electronics channels: ≈ 70000
- Power: ≈ 1 kW
- Weight: 3 t

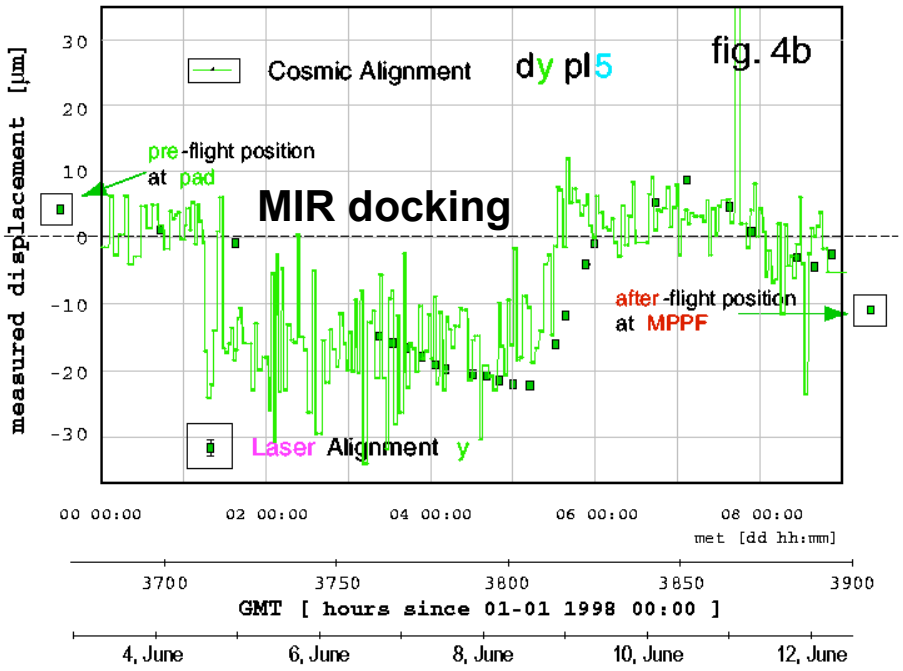



AMS-01

Tracker Mechanics & Alignment System

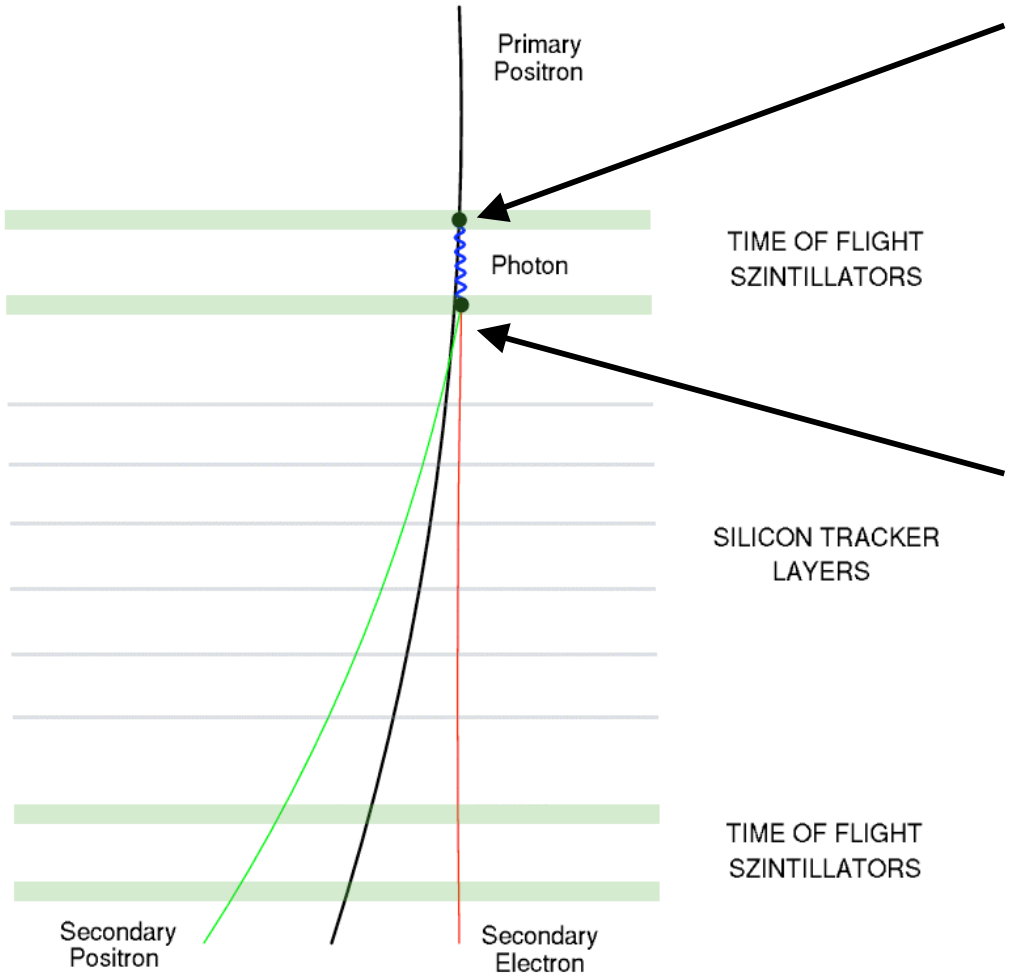


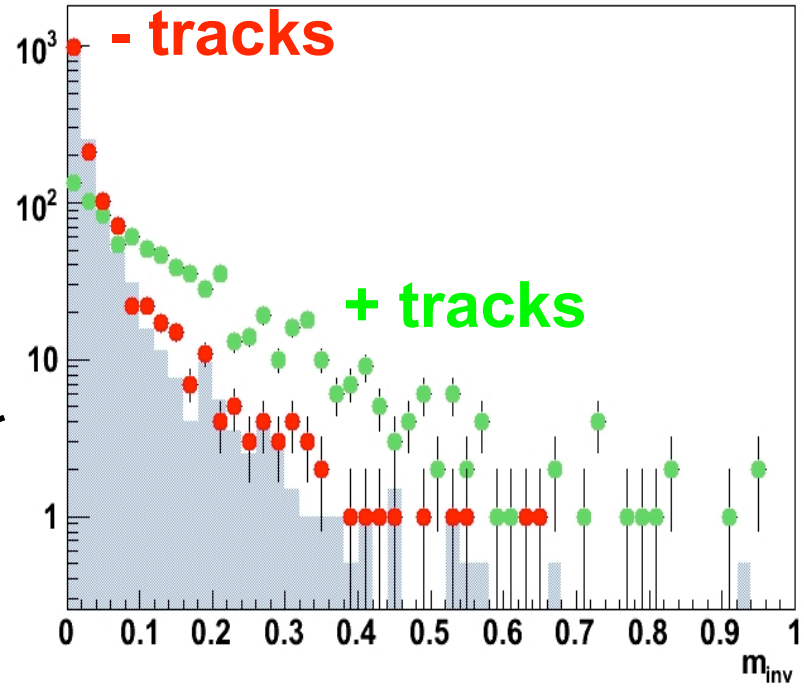


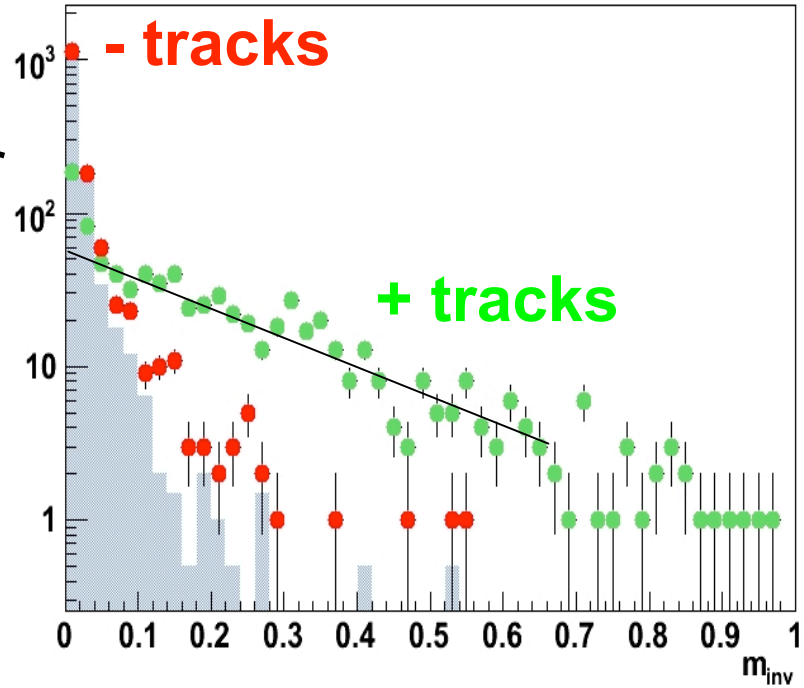


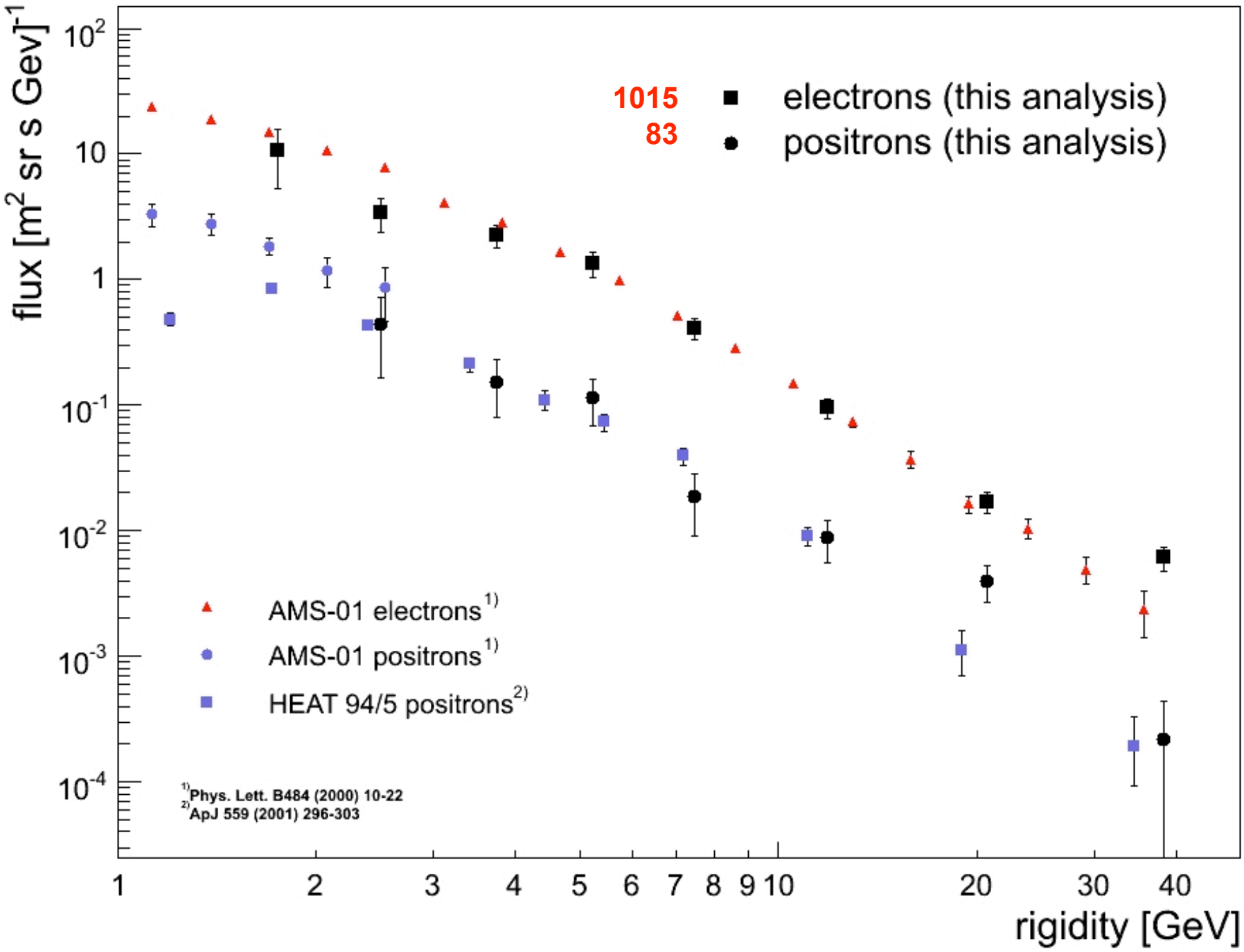
Positron Identification with AMS-01

Phys. Lett. B646 (2007), 145-154

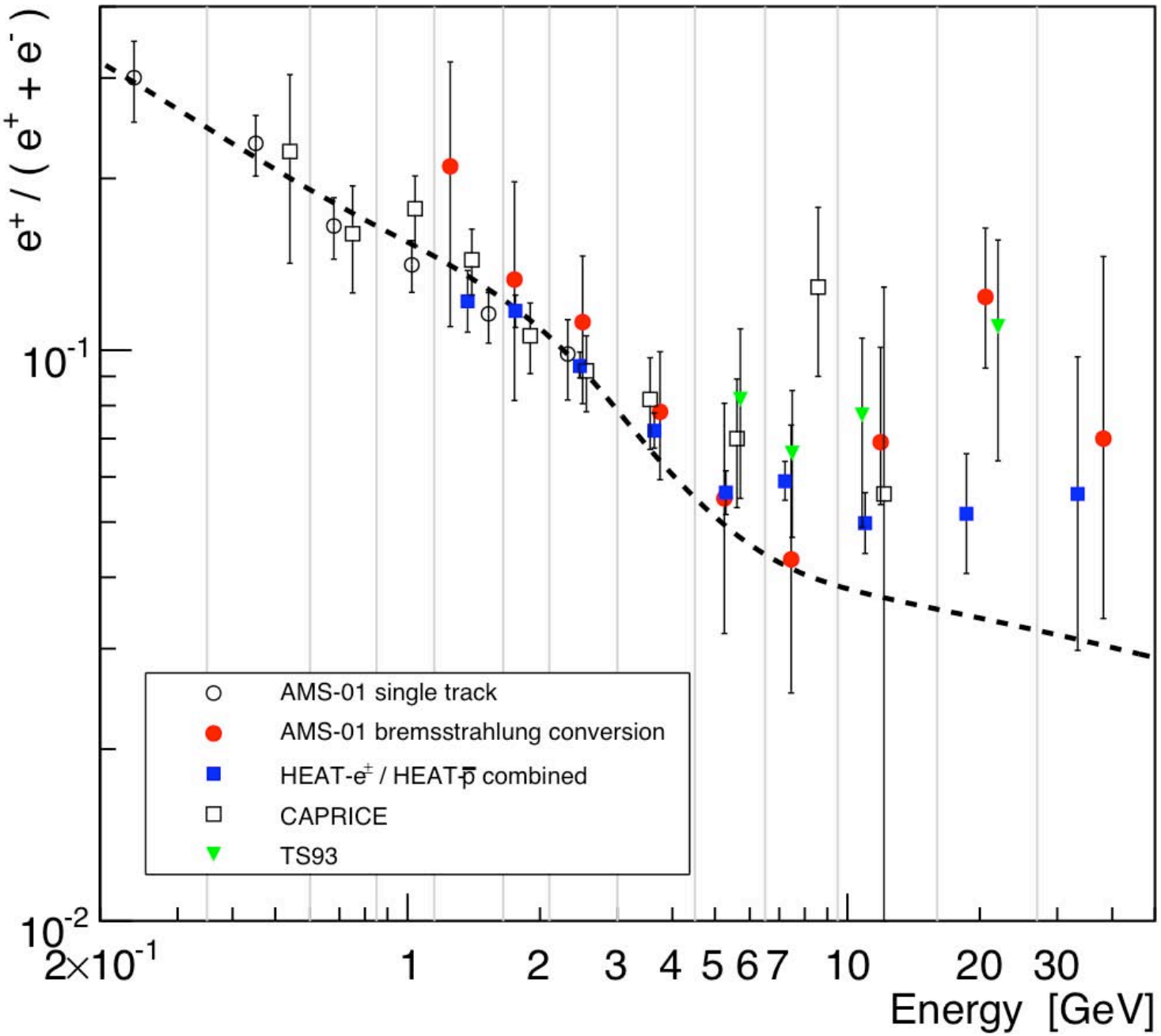




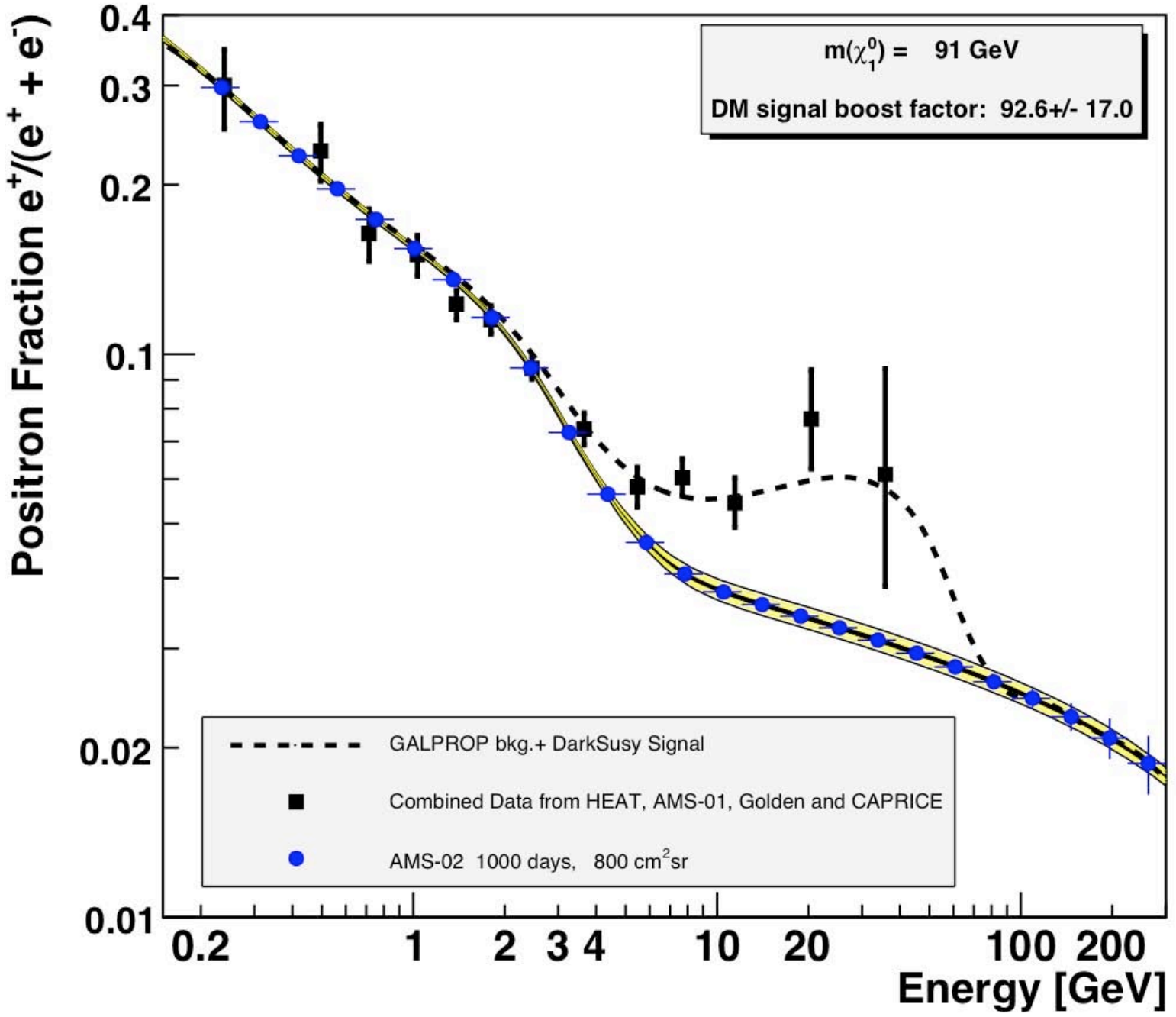


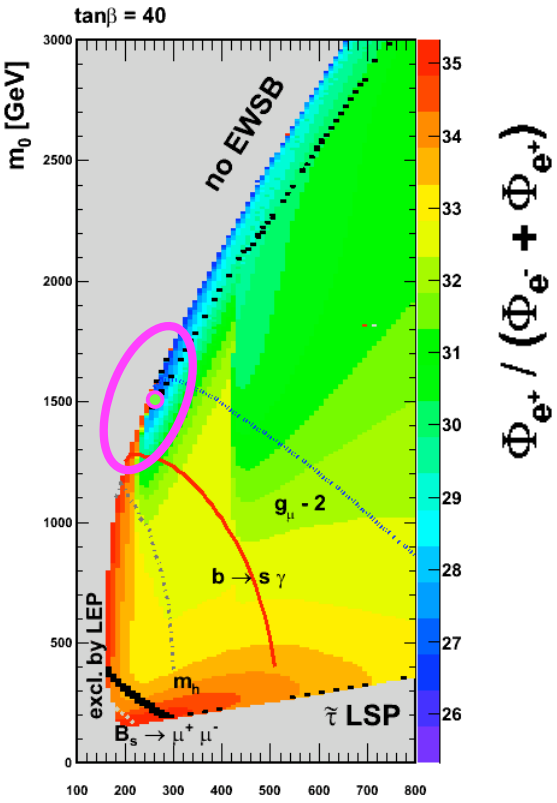

flux [m^2 sr s GeV]$^{-1}$
rigidity [GeV]
1015
83
electrons (this analysis)
positrons (this analysis)
AMS-01 electrons [1)]
AMS-01 positrons [1)]
HEAT 94/5 positrons [2)]
[1)] Phys. Lett. B484 (2000) 10-22
[2)] ApJ 559 (2001) 296-303

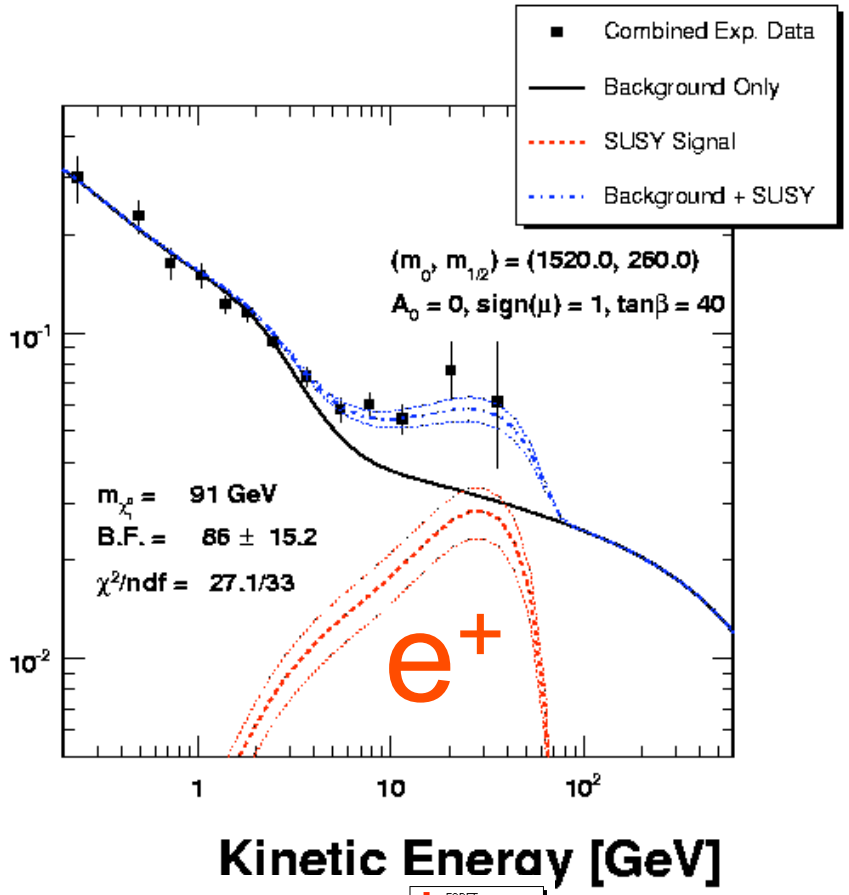
Positron Fraction



Positron Fraction







CR Preferred Point

(FP at tanβ= 40)

$M(\chi_1)$ = 91.3 GeV

f_g = 66%, f_h = 34%

$\chi\chi \rightarrow$ WW (79%)

$\chi\chi \rightarrow$ qq (13%)

$\chi\chi \rightarrow$ ZZ (3%)

χ^2/n.d.f = 27.1 / 33

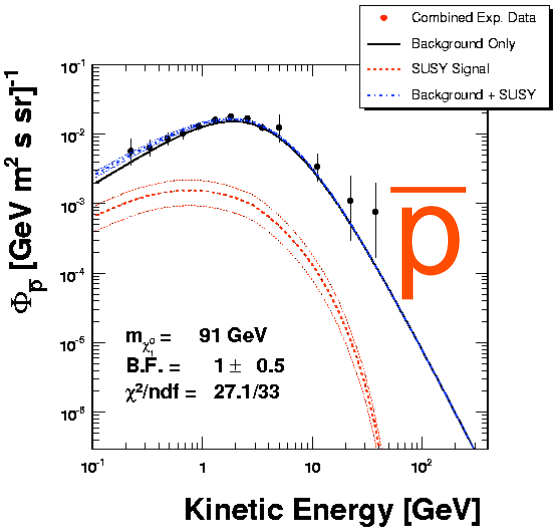
BF(e) = 86 ± 15.2

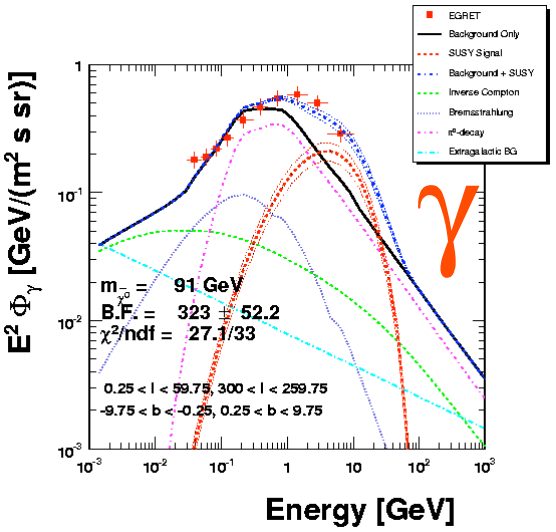
BF(p) = 1 ± 0.5

BF(γ) = 323 ± 52.2

m_h = 113.7 GeV

$m\chi^{\pm}$ = 131.2 GeV





$\Rightarrow \Omega_\chi h_2$ = 0.094

($0.0915 < \Omega_\chi h^2 < 0.1129$)

$\Rightarrow$ BR(b→sγ)/10^{-4} = 3.14

($2.87 <$ BR(b →sγ)/$10^{-4} < 4.21$)

$\Rightarrow \Delta a_\mu$ /10^{-10} = 7.35

($6.8 < \Delta a_\mu/10^{-10} < 43.6$)

$\Rightarrow$ BR($B_s \rightarrow \mu\mu$)/10^{-7} = 0.0287

(BR($B_s \rightarrow \mu\mu$)/$10^{-7} < 1.5$)

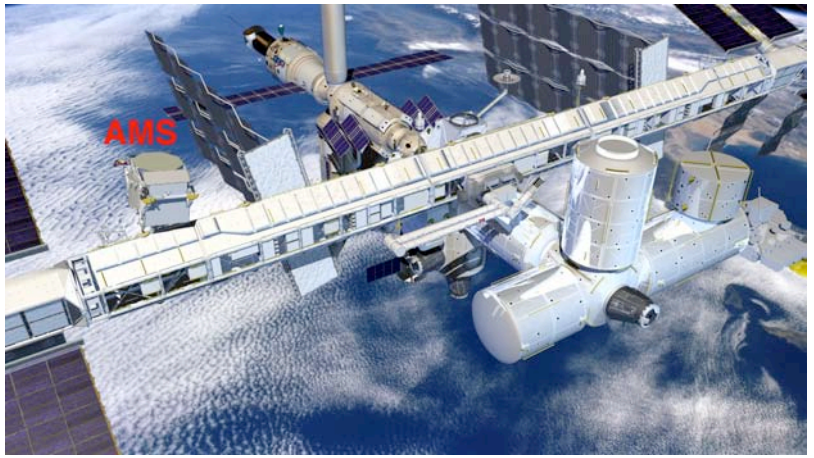
Summary

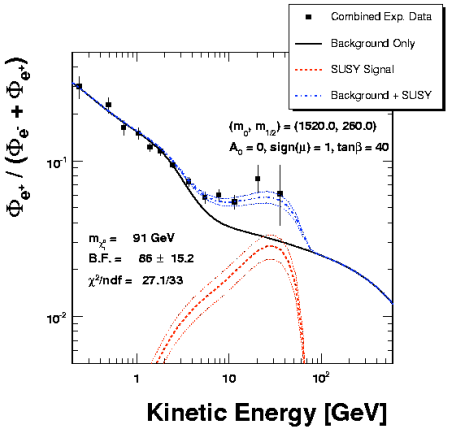
- We have indirect evidence for dark matter from various experiments:

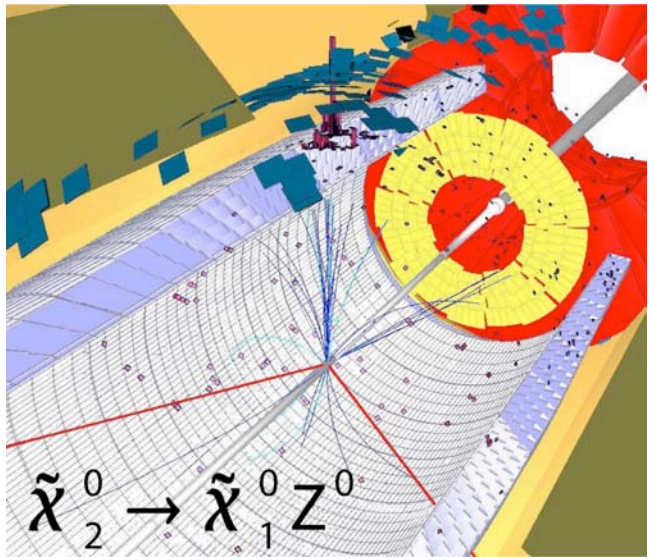
$$\Omega_{CDM} h^2 = 0.120 \pm 0.005$$
$$\Omega_b h^2 = 0.0227 \pm 0.0008$$

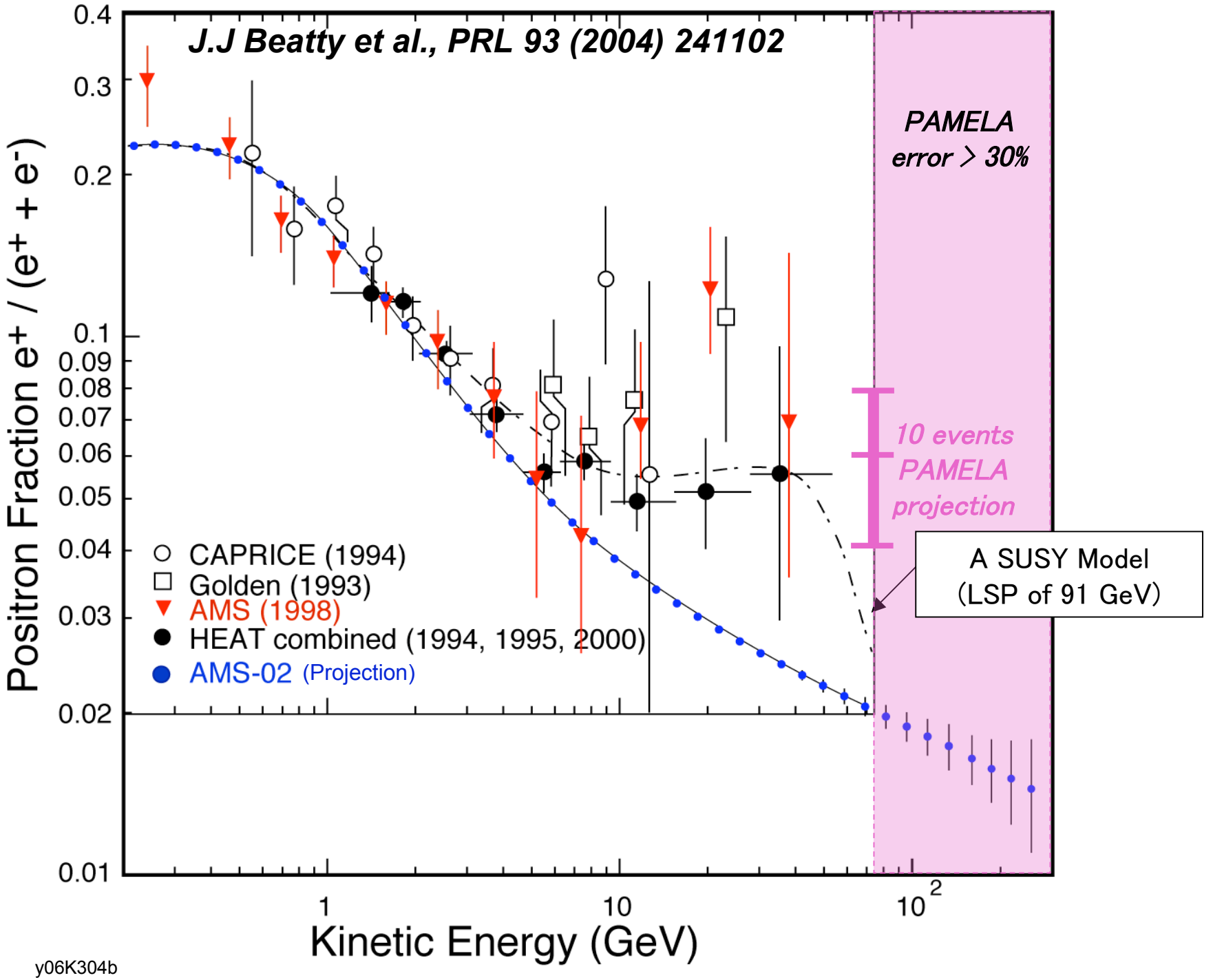
- We observe anomalies in cosmic ray spectra which could be explained by supersymmetric dark matter annihilation in our galaxy

- Within the next five years we expect answers from:
  - collider experiments:
    Tevatron (<2008), LHC (>2008)
  - direct dark matter search experiments:
    CMDS, Edelweis, CRESST, XENON, ...
  - Indirect dark matter search experiments:
    - In space: PAMELA, GLAST, AMS-02
    - Neutrino-Exp.: IceCube, ANTARES
    - Cherenkov-Telescopes: HESS, MAGIC








J.J Beatty et al., PRL 93 (2004) 241102
PAMELA
error > 30%
10 events
PAMELA
projection
A SUSY Model
(LSP of 91 GeV)
CAPRICE (1994)
Golden (1993)
AMS (1998)
HEAT combined (1994, 1995, 2000)
AMS-02 (Projection)
Positron Fraction e+ / (e+ + e-)
Kinetic Energy (GeV)
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
1
10
10 2

y06K304b