



Indirekte DM Suche + CR Satelliten



Was wissen wir über Dunkle Materie?

- DM = 23% der Energie des Universums
- DM = Weakly Interacting Massive Particle (WIMP)
- DM Annihilation mit $\langle \sigma v \rangle = 2 \cdot 10^{-26} \text{ cm}^3/\text{s}$ ->
- DM Annihilation in Quarkpaare -> Überschuss von Gammastrahlen, Positronen, Antiprotonen, ...

EGRET GeV Überschuss der Gammastrahlen konsistent mit DM Annihilation für WIMP Masse von 50-100 GeV und ist Tracer der DM

Zukünftige Experimente:

- TRACER (IEKP, Karlsruhe)
- GLAST (MPE, Garching)
- PAMELA (Univ. Siegen)
- AMS-02, (RWTH Aachen, IEKP, Karlsruhe)

From CMB + SN1a + survey



if it is not dark, it does not matter



DM Halo from weak lensing



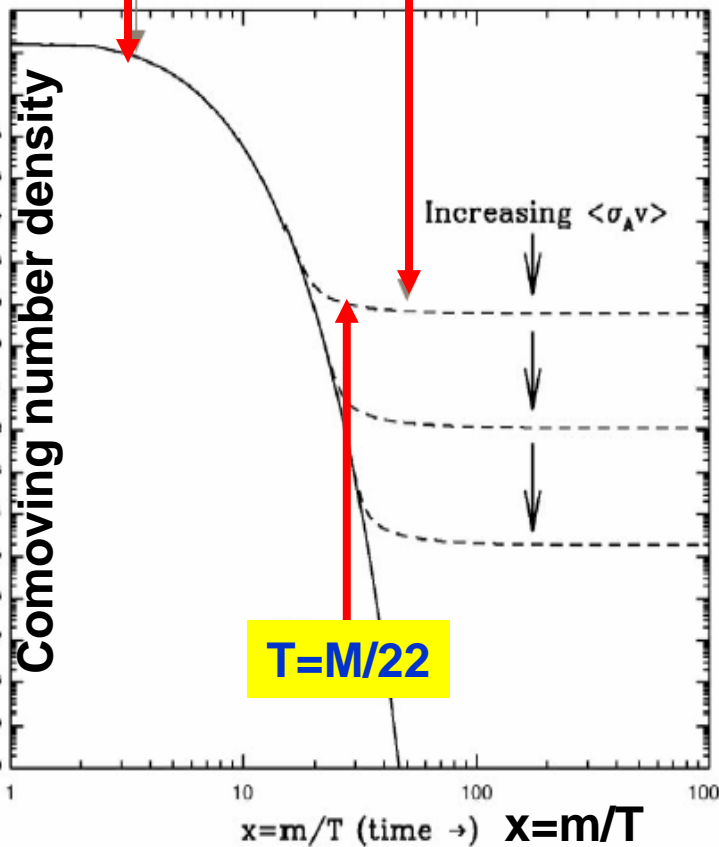
Expansionsrate bestimmt WIMP Annihilationswirkungsquerschnitt



Thermal equilibrium abundance

Actual abundance

Jungmann, Kamionkowski, Griest, PR 1995



Annahme: WIMP wurde am Anfang des Universums im thermischen Gleichgewicht mit allen anderen Teilchen produziert

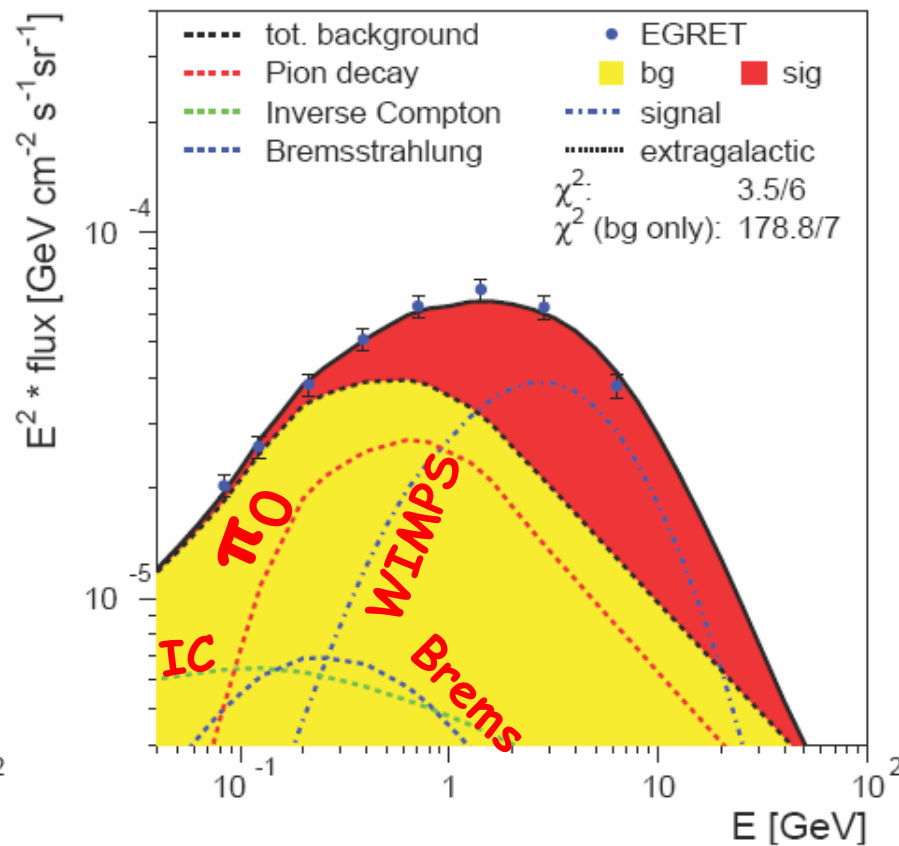
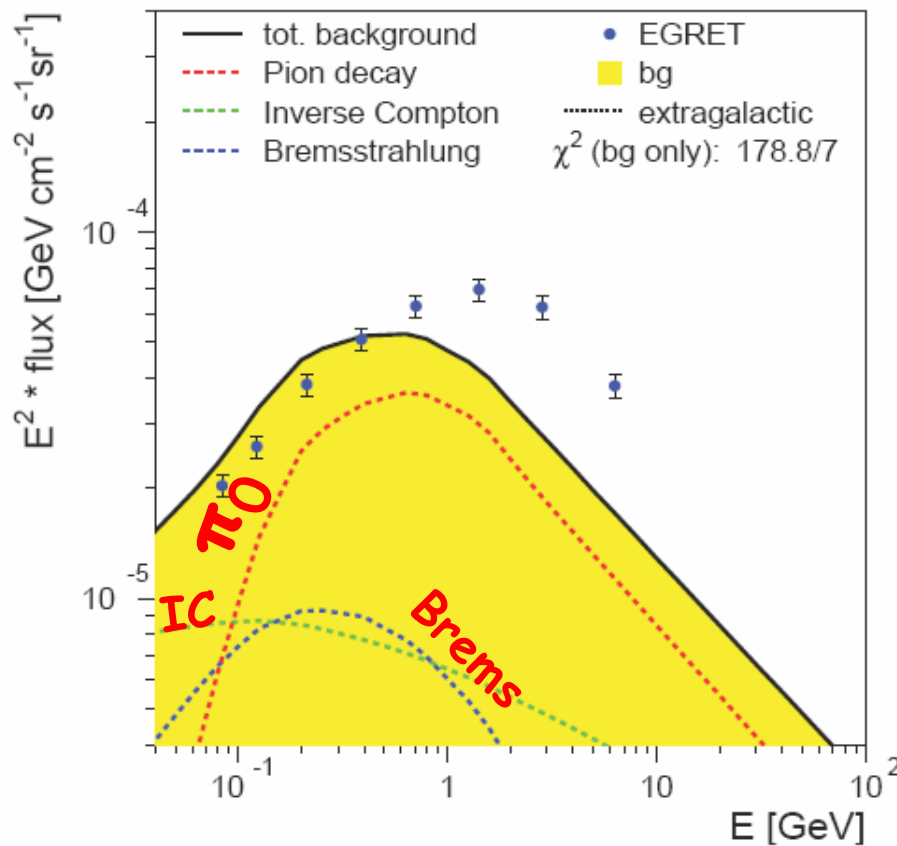
$T \gg M$: $f + \bar{f} \rightarrow M + \bar{M}$; $M + \bar{M} \rightarrow f + \bar{f}$
 $T < M$: $M + \bar{M} \rightarrow f + \bar{f}$
 $T = M/22$: M decoupled, stable density
 (wenn Annihilationrate \cong Expansionsrate, i.e. $\Gamma = \langle\sigma v\rangle n_\chi(x_{fr}) \cong H(x_{fr})$!)

WMAP -> $\Omega h^2 = 0.113 \pm 0.009$ -> $\langle\sigma v\rangle = 2 \cdot 10^{-26} \text{ cm}^3/\text{s}$

DM nimmt wieder zu in Galaxien: ≈ 1 WIMP/Kaffeetasse $\approx 10^5 \langle\rho\rangle$. DMA ($\propto \rho^2$) fängt wieder an.

Annihilation in leichteren Teilchen, wie Quarks und Leptonen -> π^0 's -> Gammas!

Untergrund und DMA beschreiben EGRET Daten!

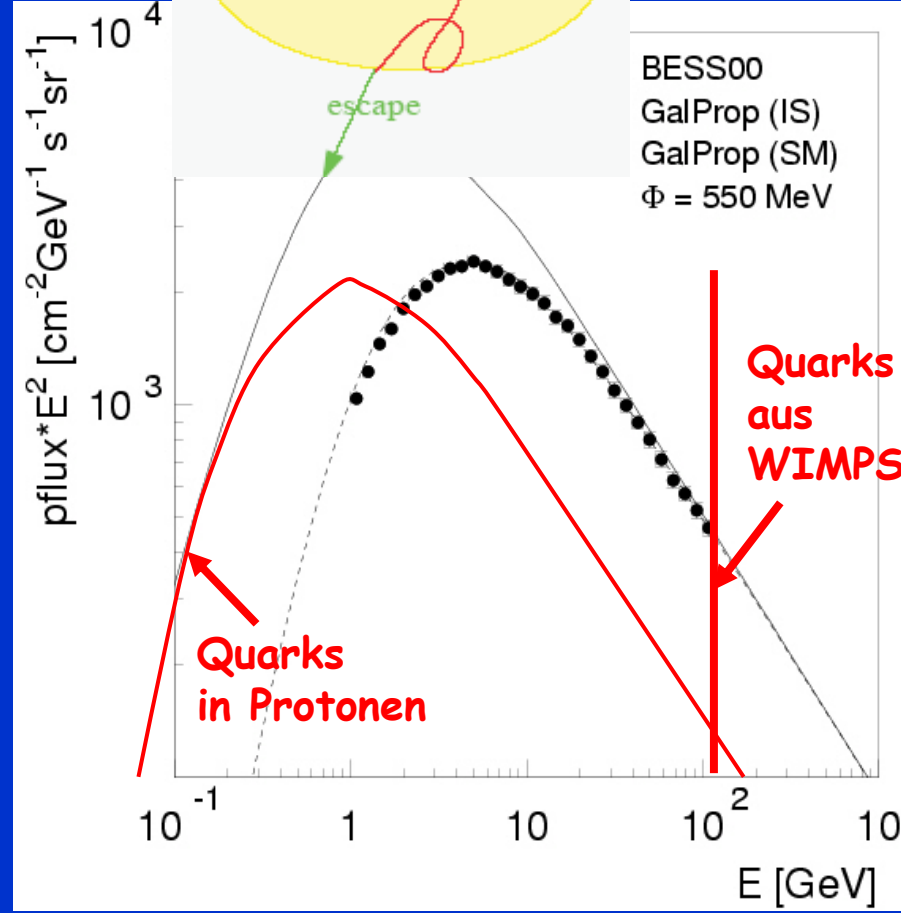
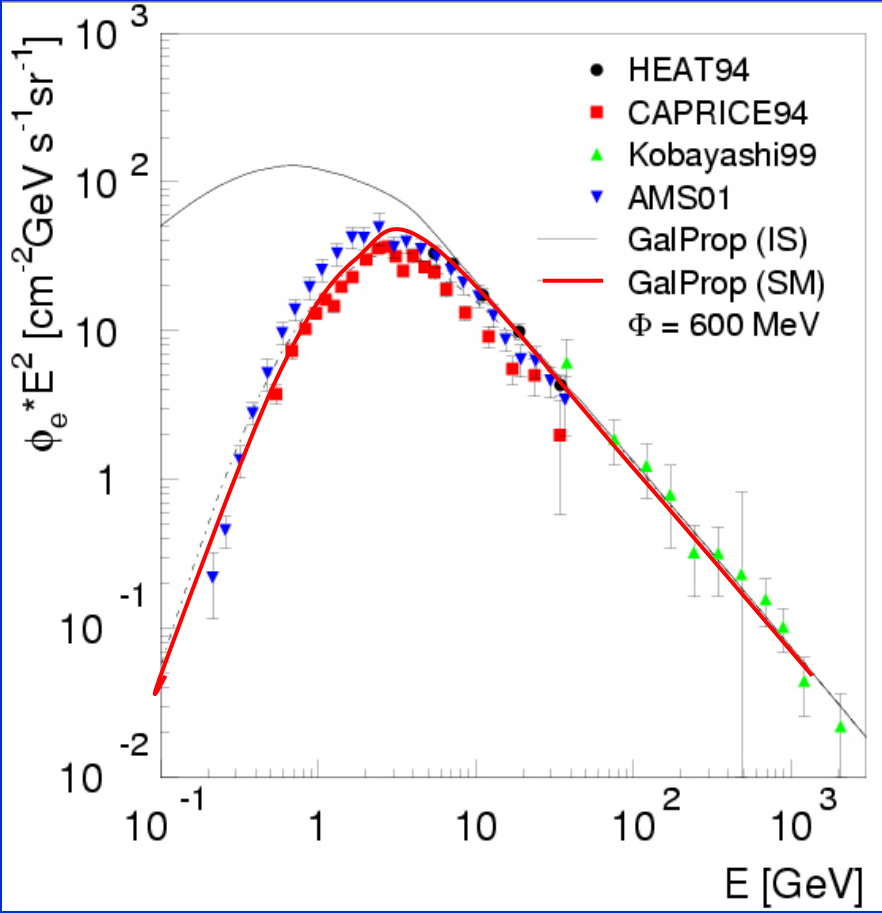


**Fitte NUR Form von Untergrund + DMA, d.h. 1 oder 2 Parameter Fit
Keine GALAKTISCHE Modelle notwendig. Prop. Gammas "straightforw."**

**Wenn Normalierung frei, nur Punkt-zu-Punkt Fehler von $\leq 7\%$ wichtig,
nicht absolute Normierungsfehler von 15%. Statistische Fehler klein.**



Woher erwartet man Untergrund?



Untergrund von nucleare Wechselw. (hauptsächlich $p+p \rightarrow \pi^0 + X \rightarrow \gamma + X$
 inverse Compton Streuung ($e^- + \gamma \rightarrow e^- + \gamma$)
 Bremsstrahlung ($e^- + N \rightarrow e^- + \gamma + N$)
FORM des Untergrundes bekannt wenn CR Spectra von p and e- bekannt!

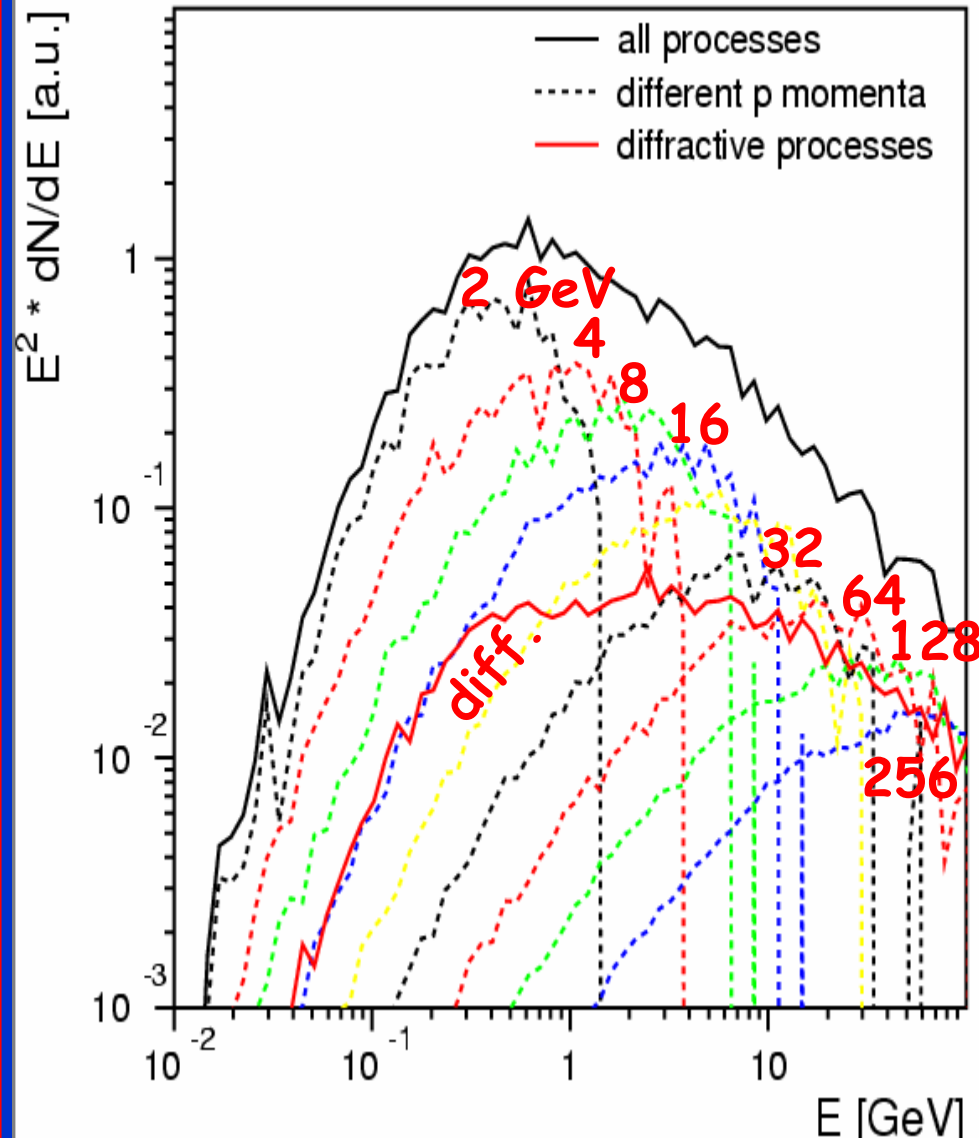


Beiträge der hadronischen Wechselwirkungen



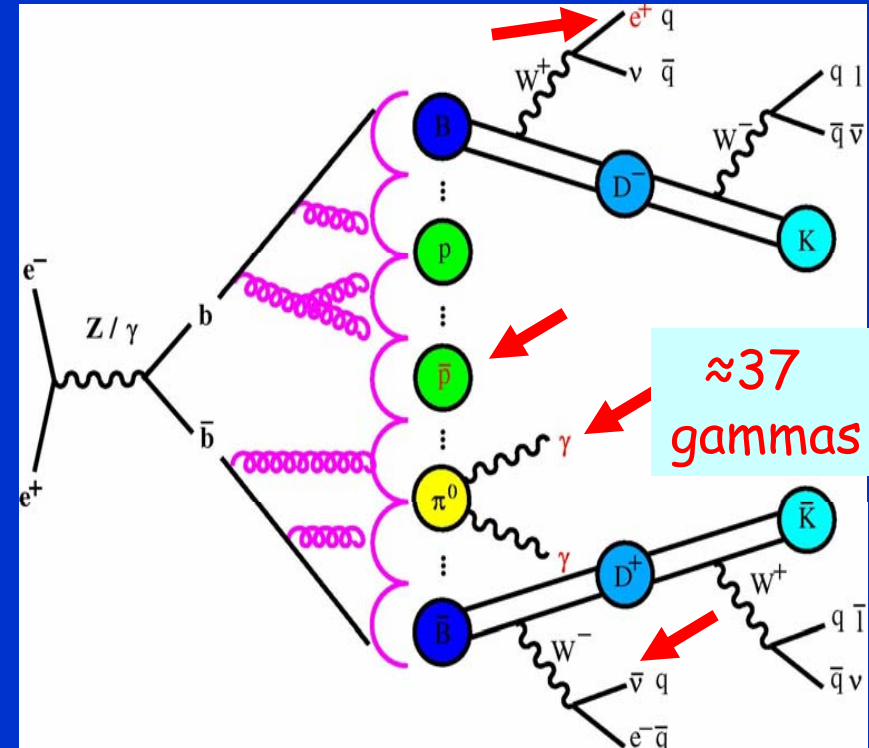
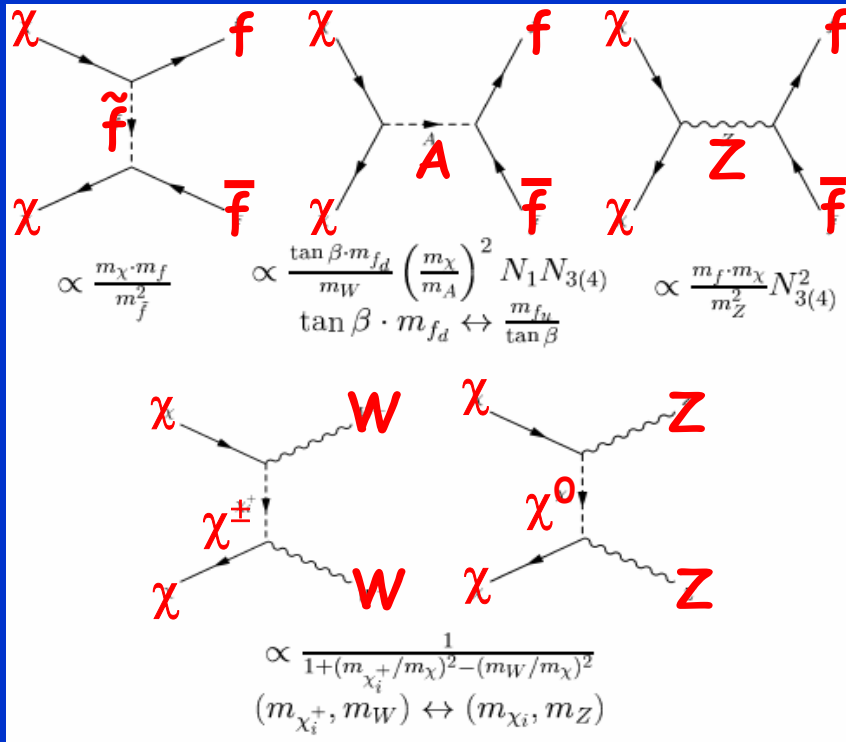
PYTHIA processes:

11 $f+f' \rightarrow f+f'$ (QCD)	2370
12 $f+fbar \rightarrow f'+fbar'$	0
13 $f+fbar \rightarrow g + g$	0
28 $f+g \rightarrow f + g$	2130
68 $g+g \rightarrow g + g$	1510
53 $g+g \rightarrow f + fbar$	20
92 Single diffractive (XB)	1670
93 Single diffractive (AX)	1600
94 Double diffractive	700
95 Low-pT scattering	0
Prompt photon production:	
14 $f+fbar \rightarrow g+\gamma$	0
18 $f+fbar \rightarrow \gamma + \gamma$	0
29 $f+g \rightarrow f + \gamma$	1
115 $g+g \rightarrow g + \gamma$	0
114 $g+g \rightarrow \gamma + \gamma$	0





DM Annihilation in Supersymmetrie



Dominant

$\chi + \chi \Rightarrow A \Rightarrow b \text{ bbar quark pair}$

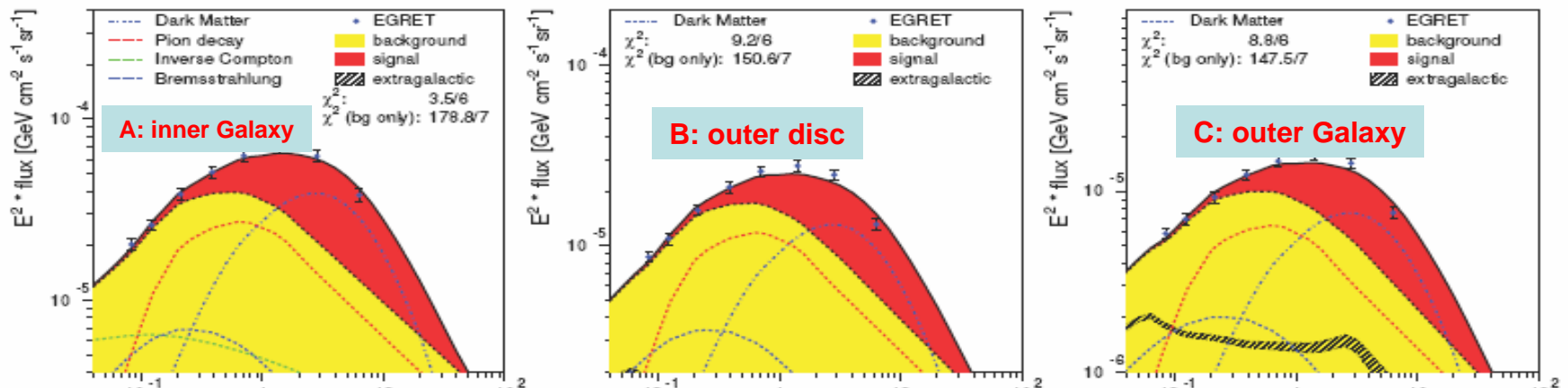
B-Fragmentation bekannt!

Daher Spectra der Positronen, Gammas und Antiprotonen bekannt!

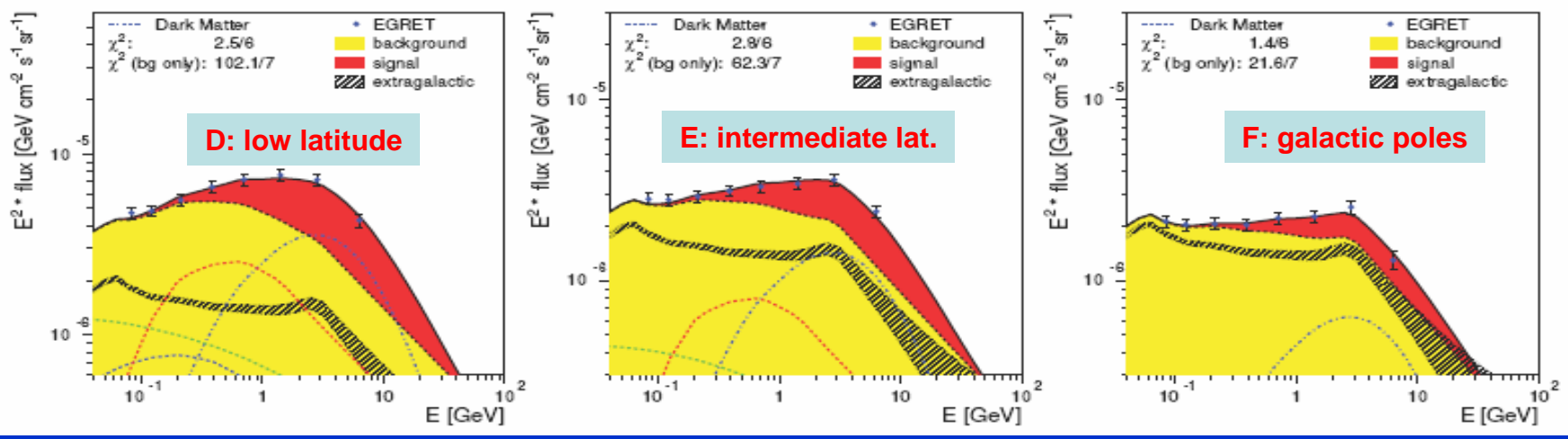
Galaxie = Super B-Fabrik mit Rate $10^{40} \times$ B-Fabrik



Analyse der EGRET Daten in 6 Himmelsrichtungen

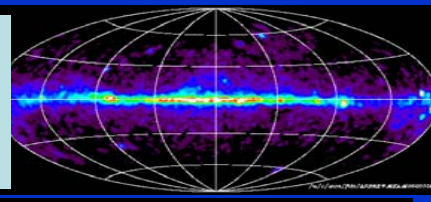


χ^2 für alle Regionen :28/36 \Rightarrow Prob. = 0.8; Signifikanz > 10 σ ! Astro-ph/0508617

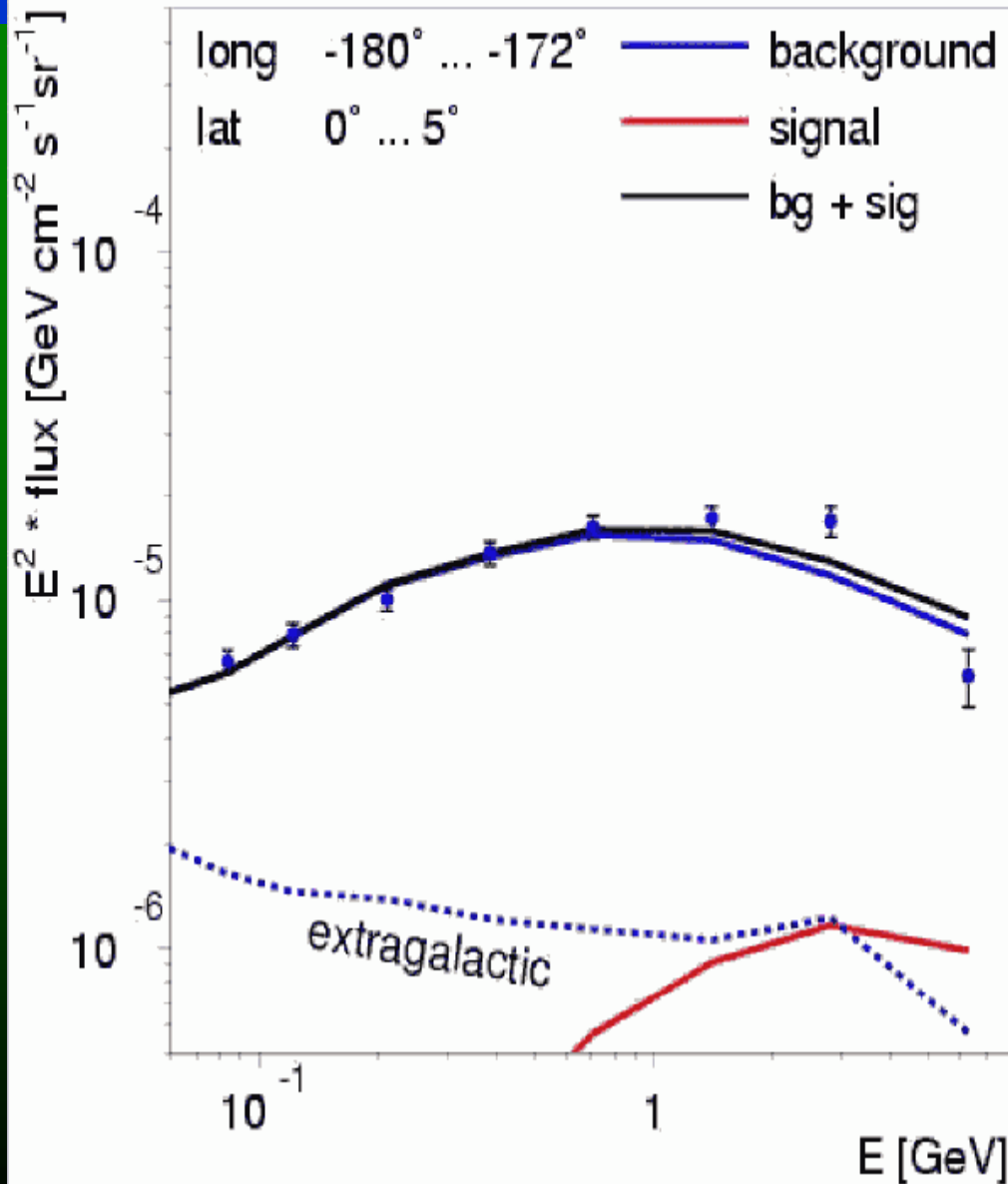


A: inner Galaxy ($l = \pm 30^\circ$, $|b| < 5^\circ$)
B: Galactic plane avoiding A
C: Outer Galaxy

D: low latitude ($10-20^\circ$)
E: intermediate lat. ($20-60^\circ$)
F: Galactic poles ($60-90^\circ$)



Fits für 180 statt 6 Regionen



180 Regionen:

8° in Längengraden. \Rightarrow 45 bins

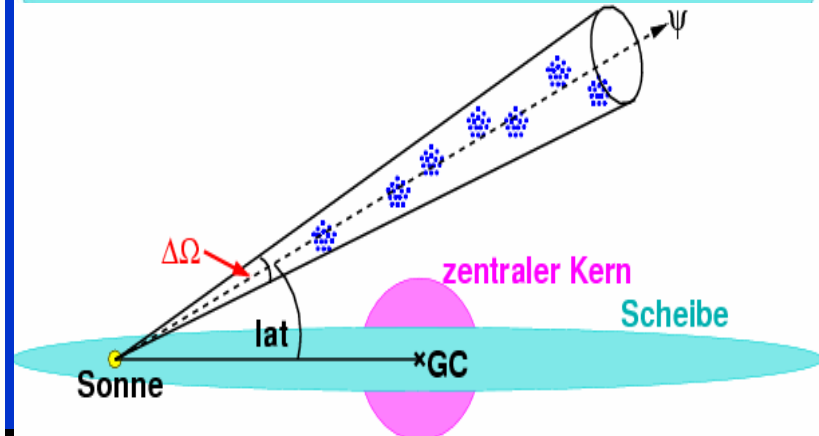
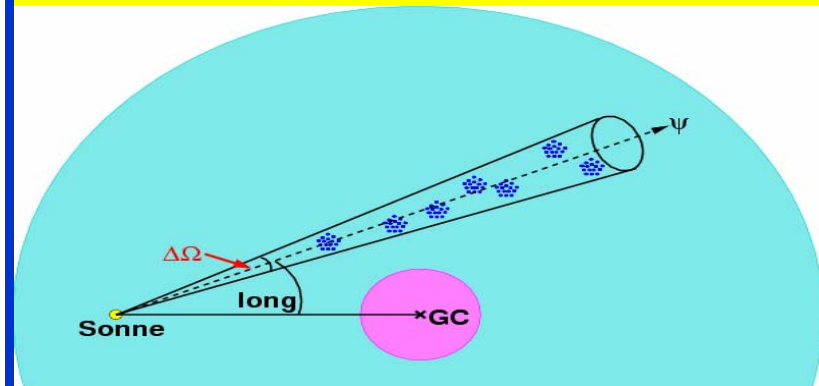
4 Bins in Breiteng. $\Rightarrow 0^\circ < |b| < 5^\circ$

$5^\circ < |b| < 10^\circ$

$10^\circ < |b| < 20^\circ$

$20^\circ < |b| < 90^\circ \Rightarrow$

$4 \times 45 = 180$ Bins



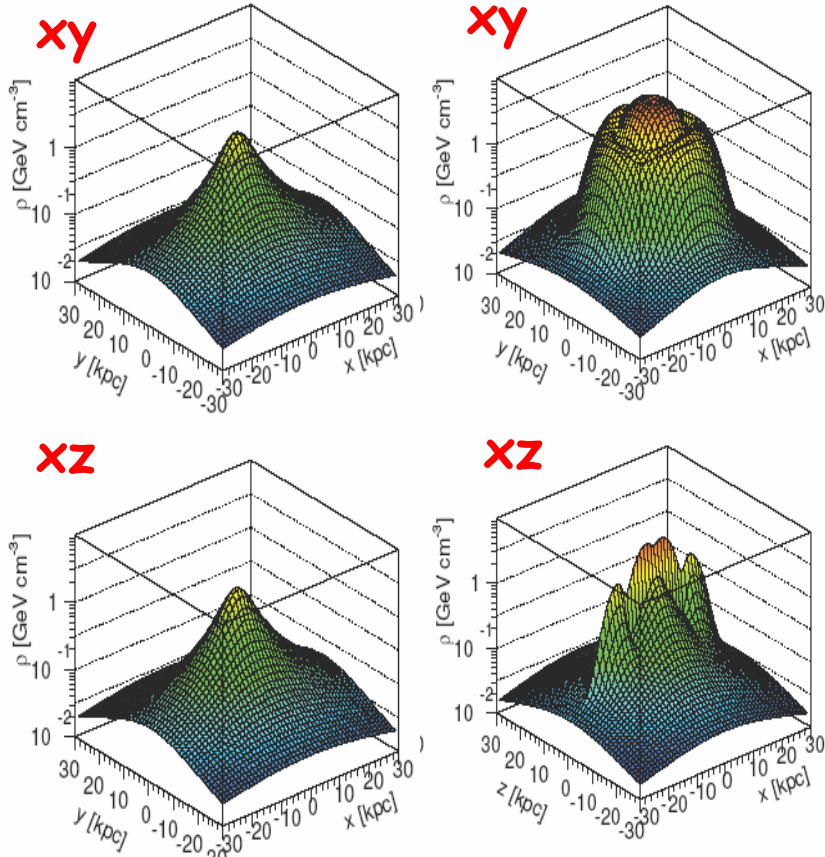


"Poster C. Sander"

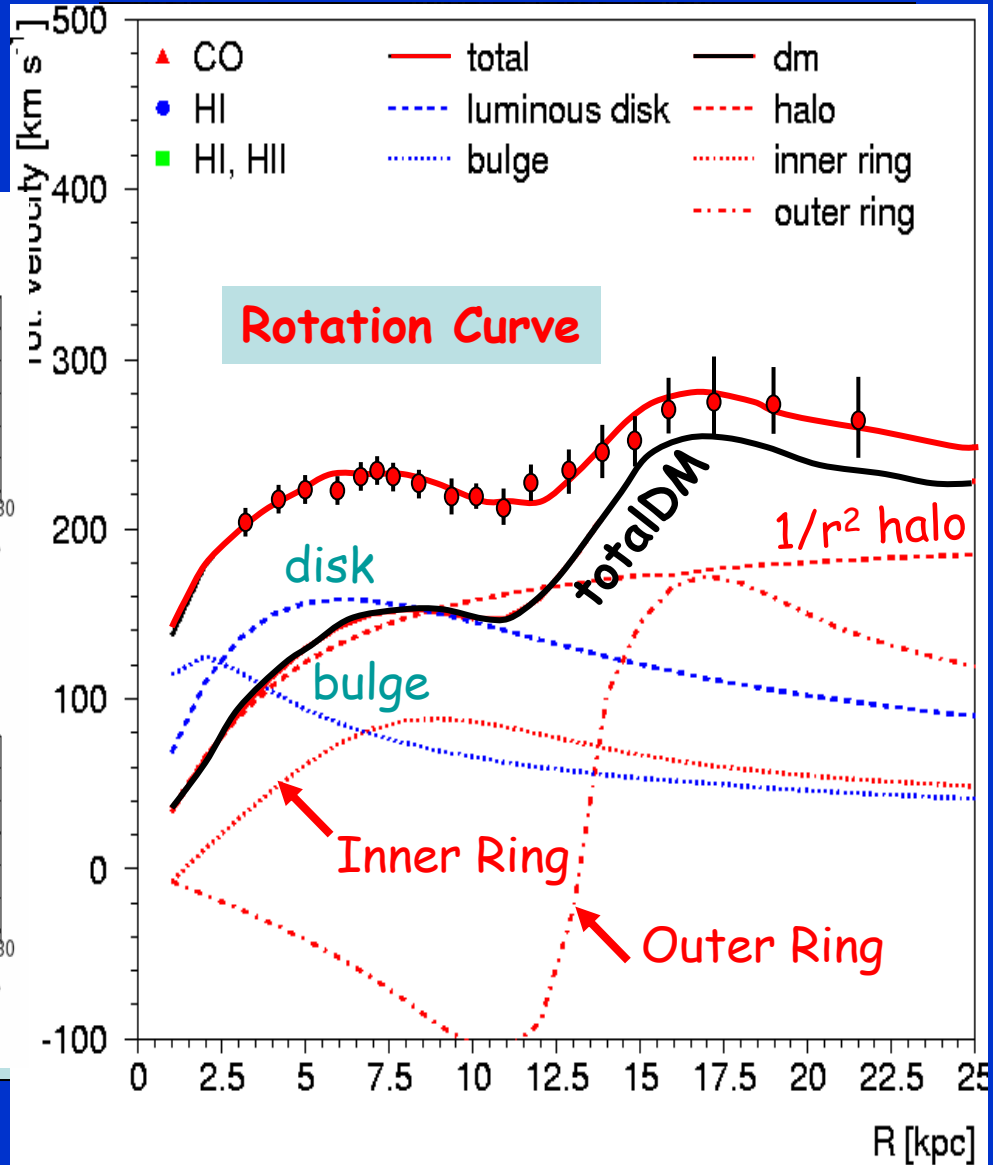


Expected Profile

Observed Profile

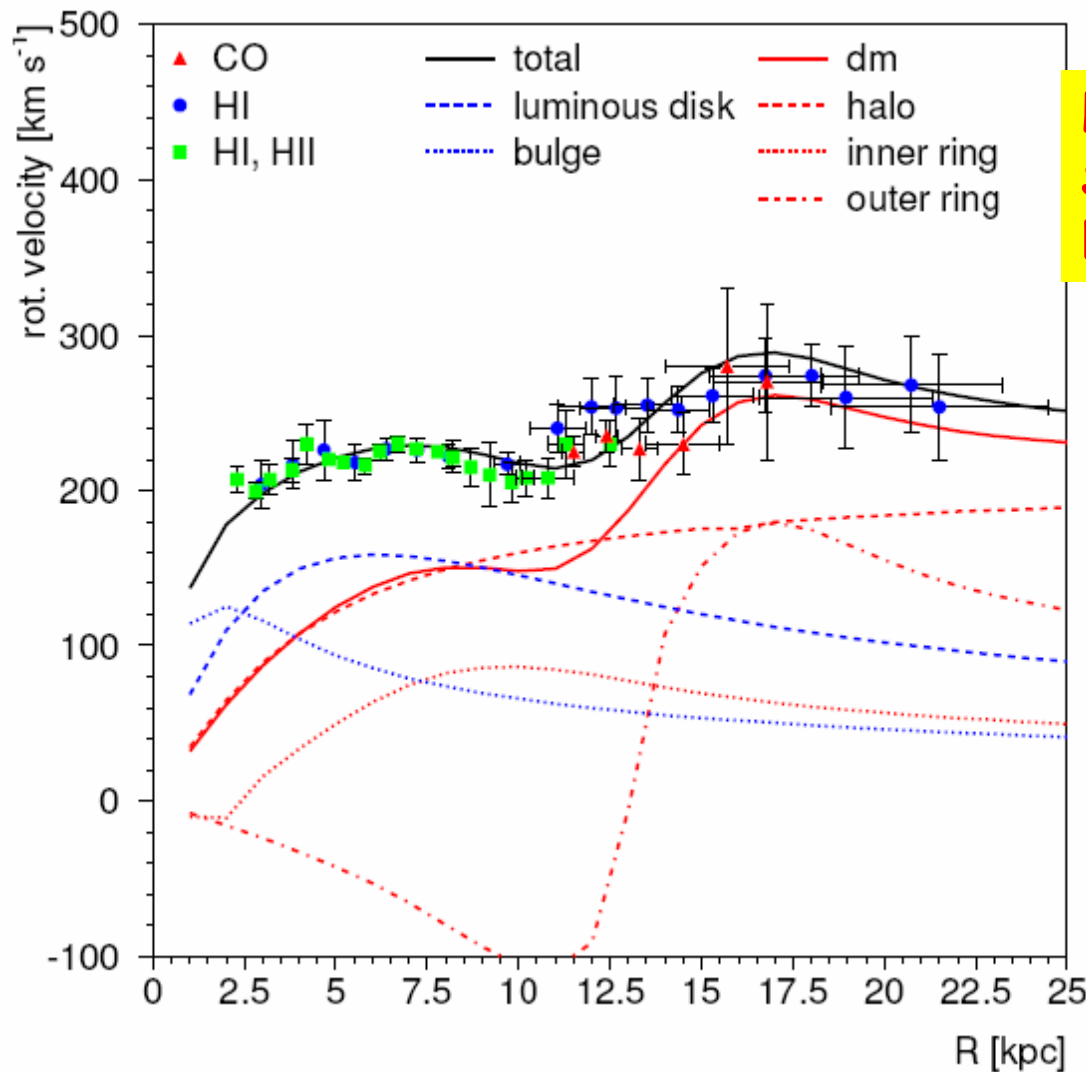


Halo profile





Rotationskurve der Milchstraße

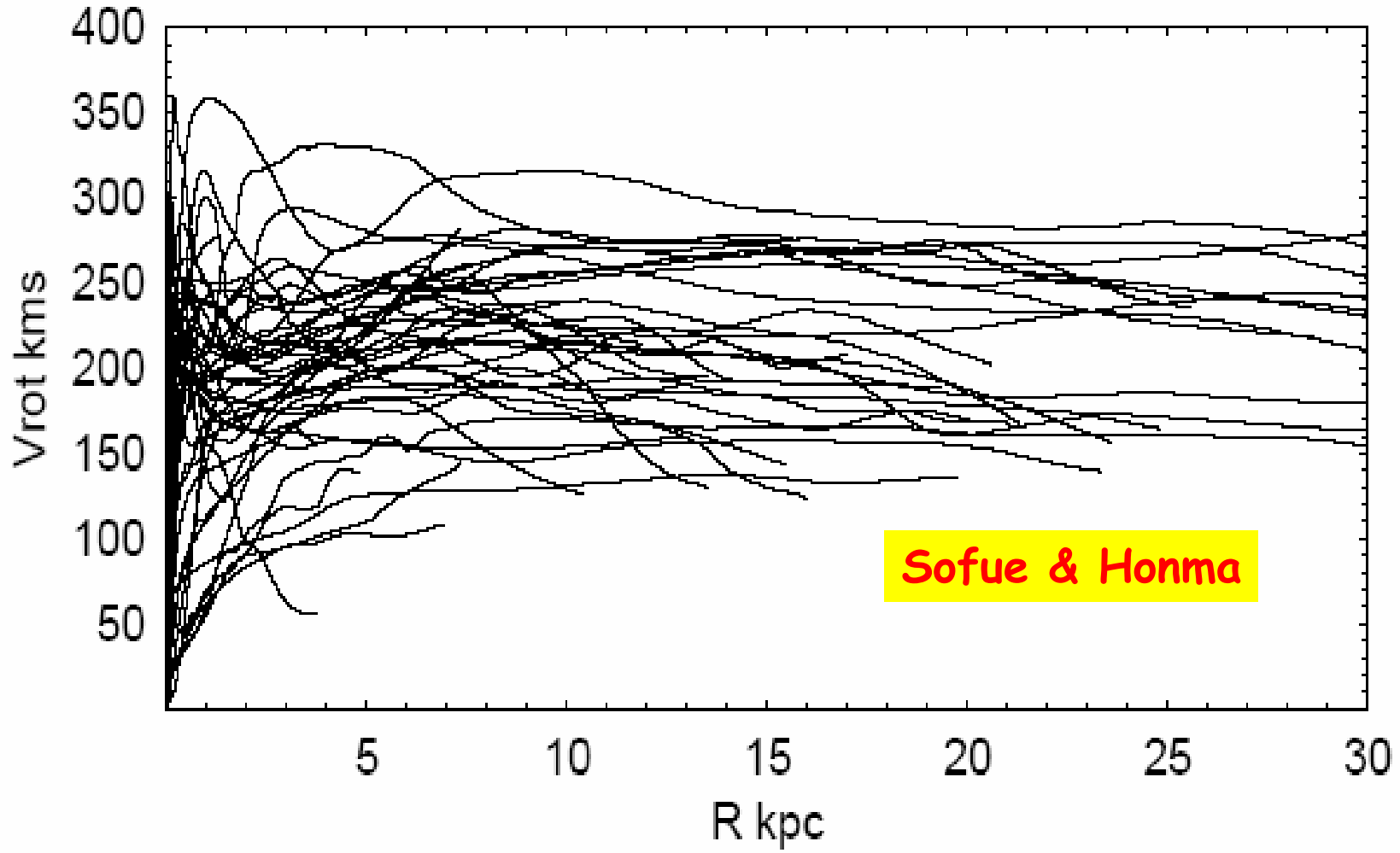


Honma & Sofue (97)
Schneider & Terzian (83)
Brand & Blitz(93)



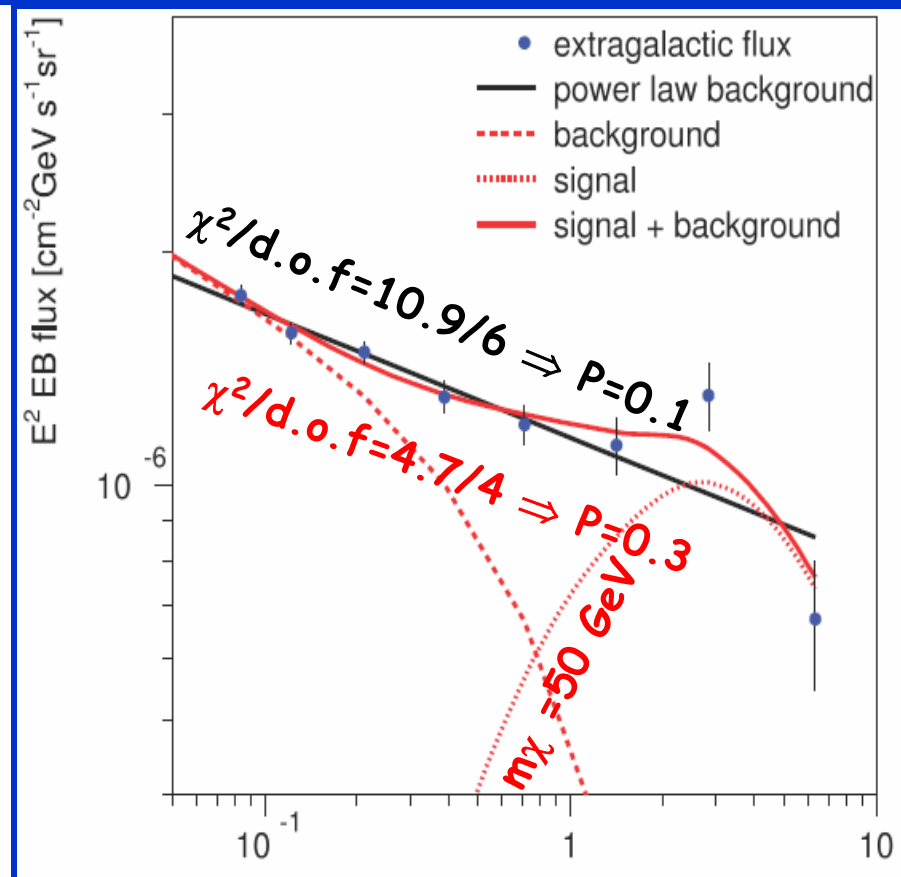
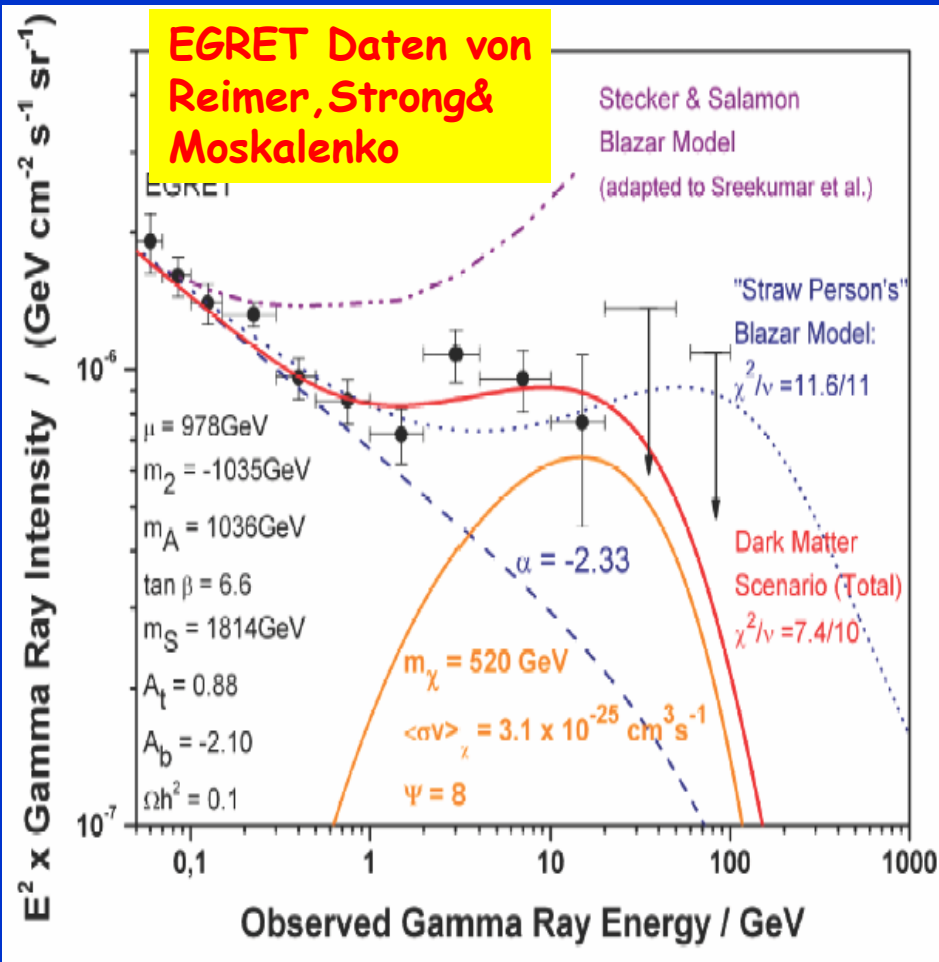
Wie sehen Rotationskurven anderer Galaxien aus?

Rotation Curves of Galaxies





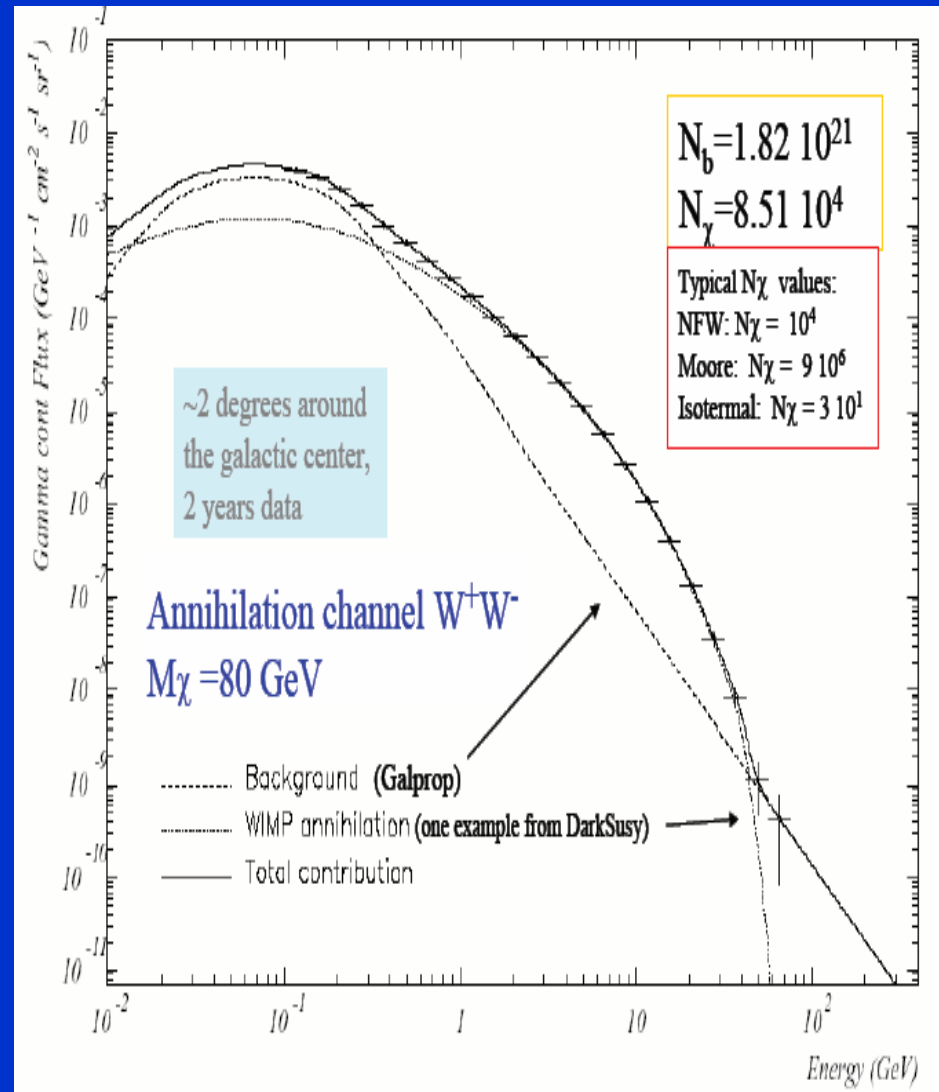
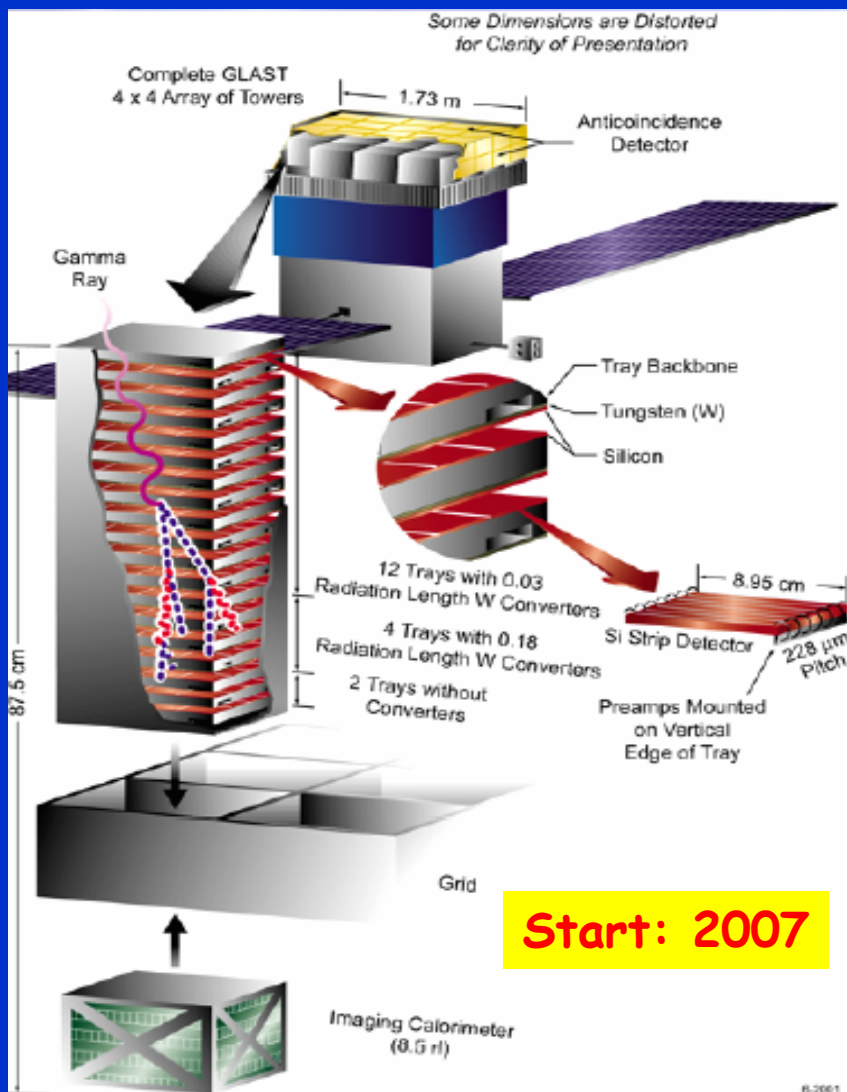
DM UND DER EXTRAGALAKTISCHE GAMMA RAY UNTERGRUND



D. Elsässer and K. Mannheim,
Phys.Rev.Lett.94:171302,2005

Signifikanz für DM im EGBG 2σ
Und konsistent mit DM der Gal.
W. de Boer et al.,
Comment to PRL, in press

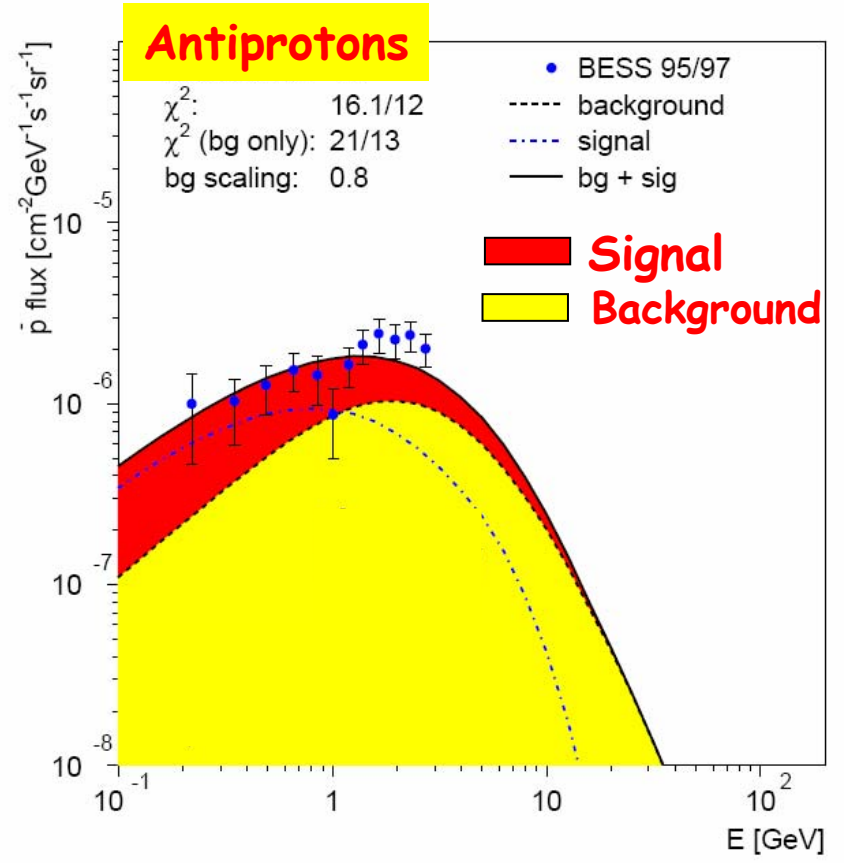
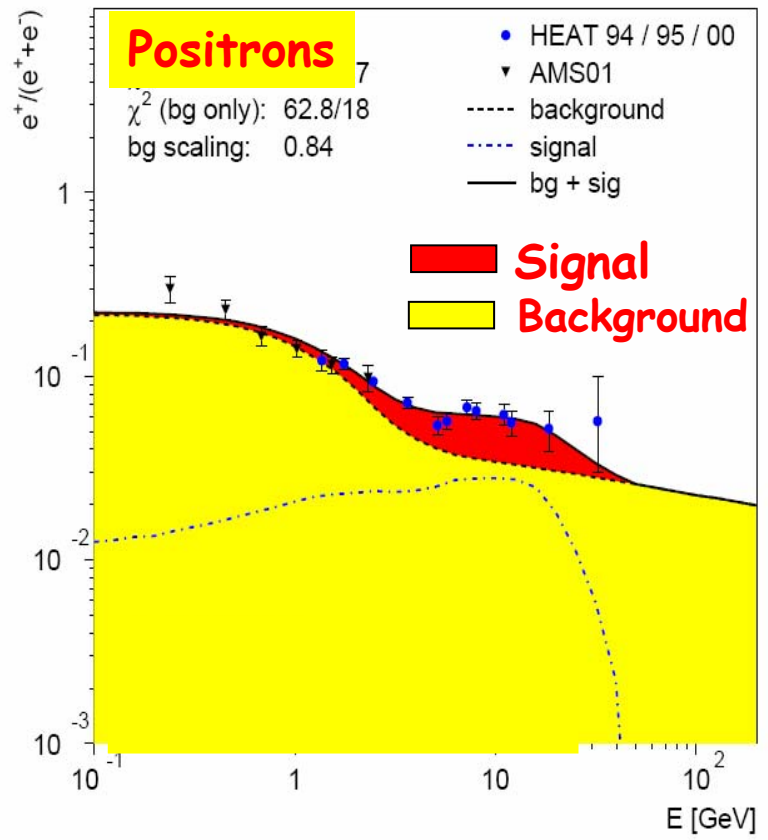
GLAST: Gamma Ray Large Area Space Telescope (Nachfolger von EGRET, Start 2007)



A. Cesarini, F. Fucito, A. Lionetto, A. Morselli, P. Ullio, [astro-ph/0305075]



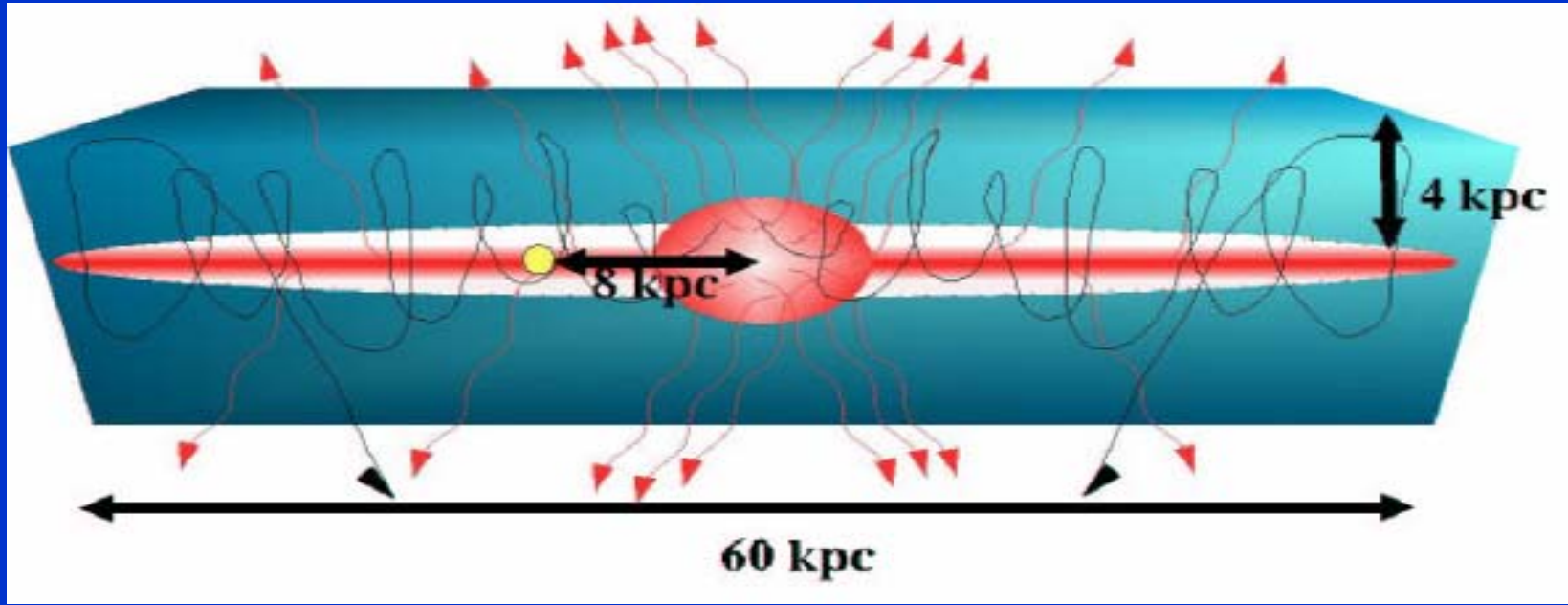
Positron Fraktion und Antiprotonen aus Ballon Exp.



HALO und WIMP Parameter aus EGRET Daten. Flüsse der geladenen Teilchen vom Propagationsmodell abhängig. Gamma Daten helfen sehr um DM Halo zu bestimmen um dann Propagations-Parameter aus geladenen Teilchen zu bestimmen!



Modell unserer Galaxie



Primary particles by supernovae explosions, pulsars, ...

Secondary particles nuclear interactions.

Diffusion parameters determined from sec./prim. ratios, e.g. B/C ratio

Halo size determined from radioactive isotopes, e.g. $^{10}\text{Be}/^9\text{Be}$ ratio
($\tau(^{10}\text{Be}) = 1.6 \cdot 10^6 \text{ yr}$)

Propagation der geladenen Teilchen



$$\frac{\partial \psi}{\partial t} = q(\vec{r}, p) + \vec{\nabla} \cdot (D_{xx} \vec{\nabla} \psi - \vec{V} \psi) + \frac{\partial}{\partial p} p^2 D_{pp} \frac{\partial}{\partial p} \frac{1}{p^2} \psi - \frac{\partial}{\partial p} \left[\dot{p} \psi - \frac{p}{3} (\vec{\nabla} \cdot \vec{V}) \psi \right] - \frac{1}{\tau_f} \psi - \frac{1}{\tau_r} \psi$$

Teilchendichte: $\psi = \psi(\vec{r}, p, t)$

Teilchen-Quellen: $q(\vec{r}, p)$

Diffusionskoeffizient: $D_{xx} = f(E, \theta, \varphi)?$

Konvektionsgeschw.: $\vec{V} = f(z)?$

Diffusive Wiederbeschl.: $D_{pp} \neq 0?$

Energieverluste: $\dot{p} \equiv dp/dt$

Radioaktive Zerfälle: τ_r

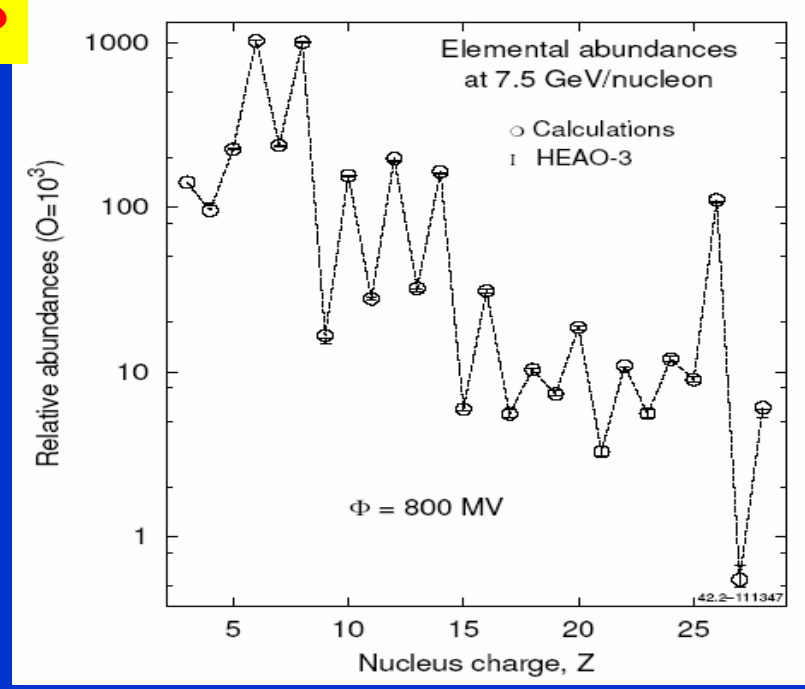
Fragmentation: τ_f

Source fct

$$q(R, z) = q_0 \left(\frac{R}{R_\odot} \right)^\eta e^{-\xi \frac{R-R_\odot}{R_\odot} - \frac{0.2|z|}{\text{kpc}}}$$

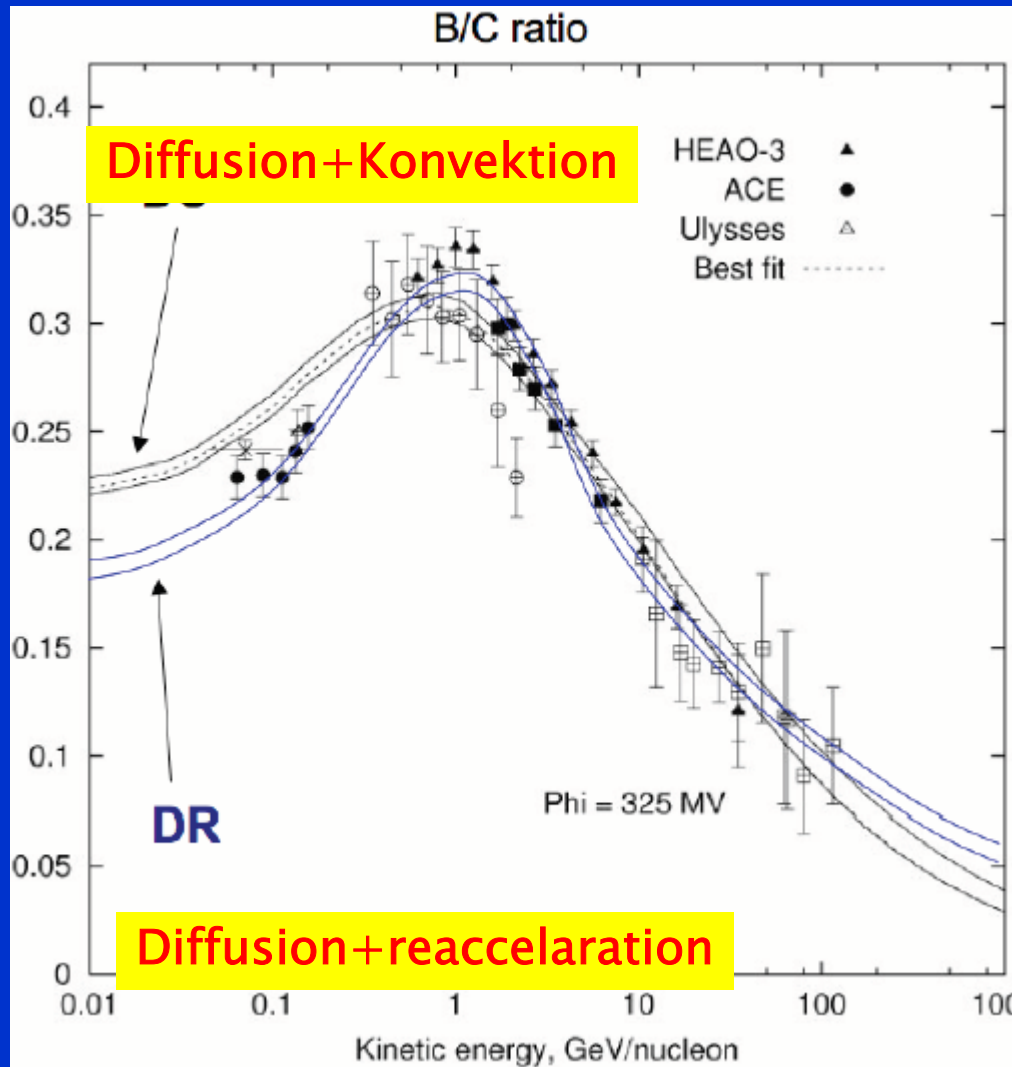
???

3D GALPROP Programm von Moskalenko und Strong liefert numerische Lösung dieser Gleichung mit Datenbank für über 2000 Wirkungsquerschnitten.



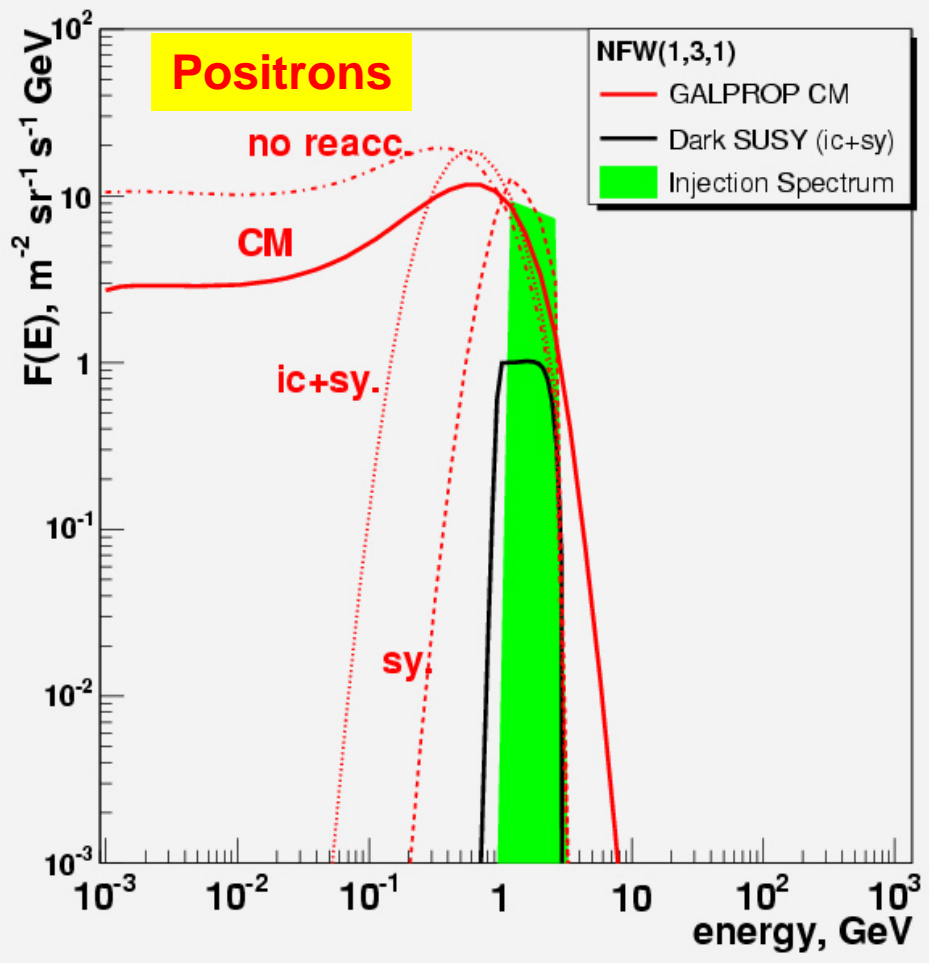
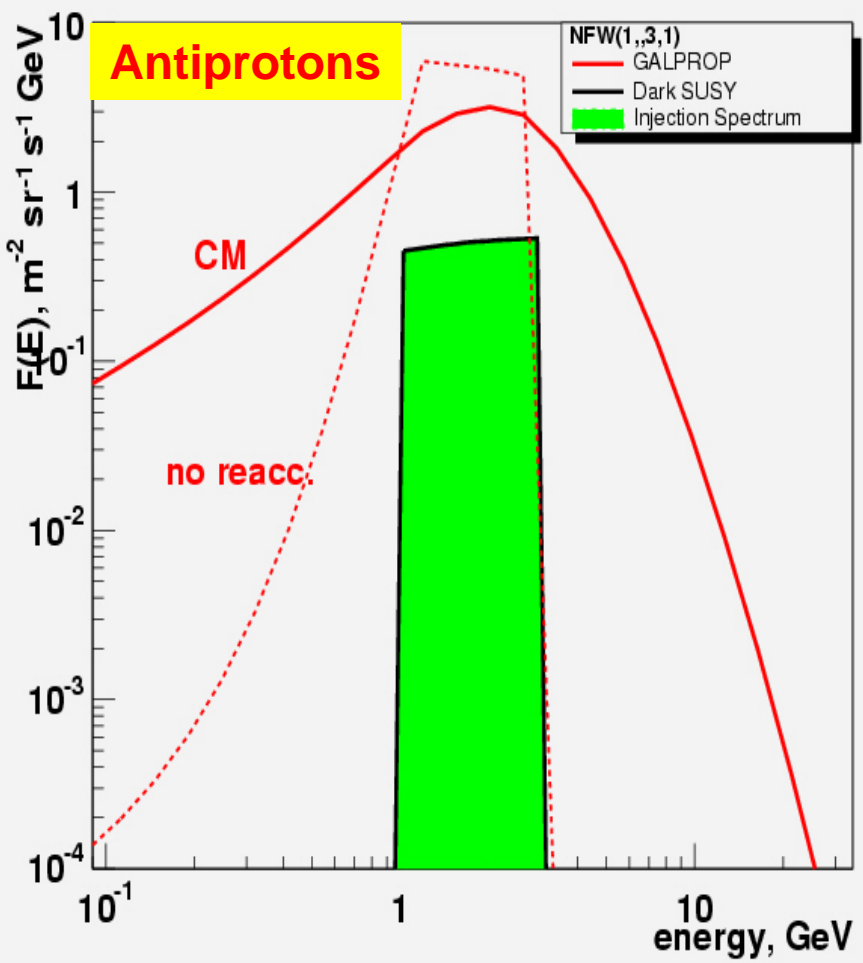


B/C Verhältnis \rightarrow Fermi 2. Ordnung Wiederbeschleunigung





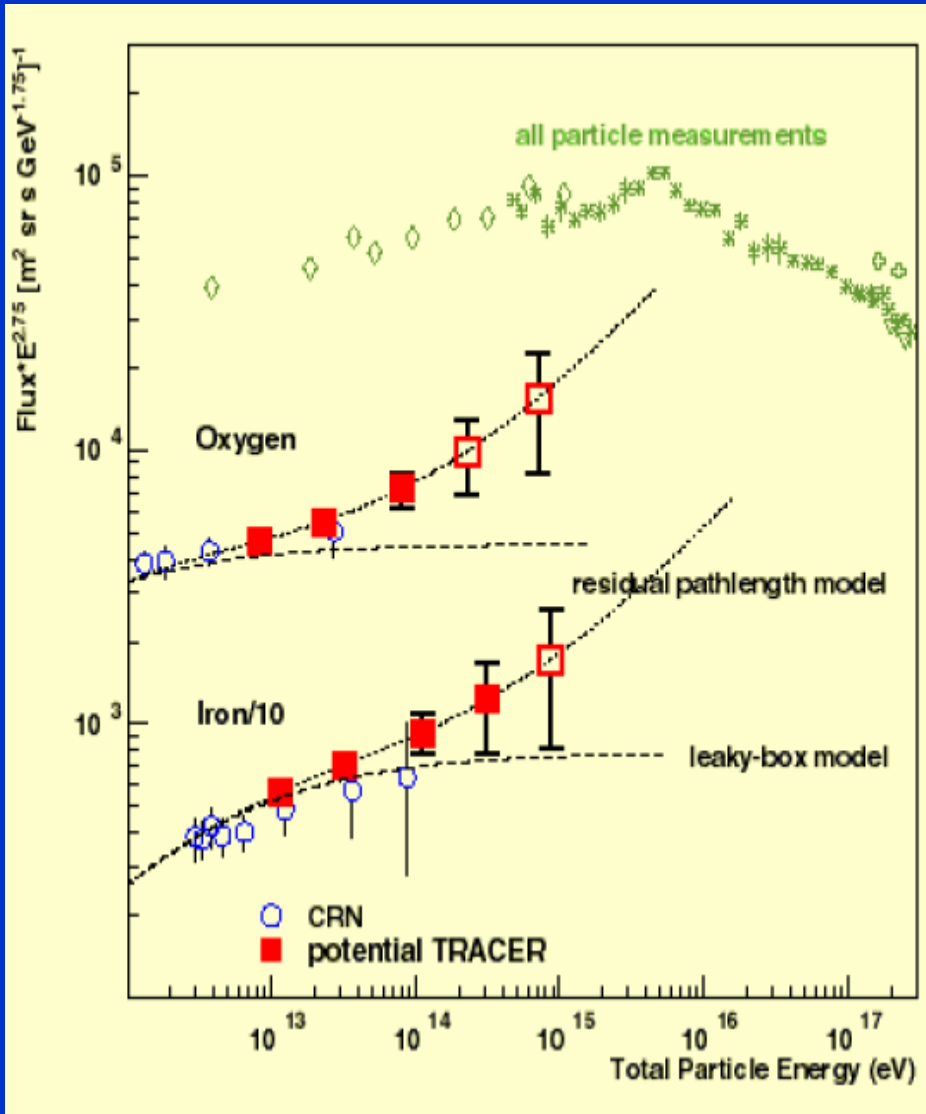
Propagation in GALPROP verglichen mit DarkSusy (Leaky Box) GROÙE UNTERSCHIEDE



Spectrum nach Propagation einer 1-3 GeV Quelle im Zentrum mit DarkSusy (leaky box Modell) und GalProp (numerische Lösung der Diffusionsgleichung mit allen Termen, wie Wiederbeschleunigung, usw.)



Transition Radiation Array for Cosmic Energetic Rays TRACER



Ziel: Messung der Spektren einzelner Elemente bis hohen Energien um Energie-Abhängigkeit der Diffusions-Koeffizient zu testen

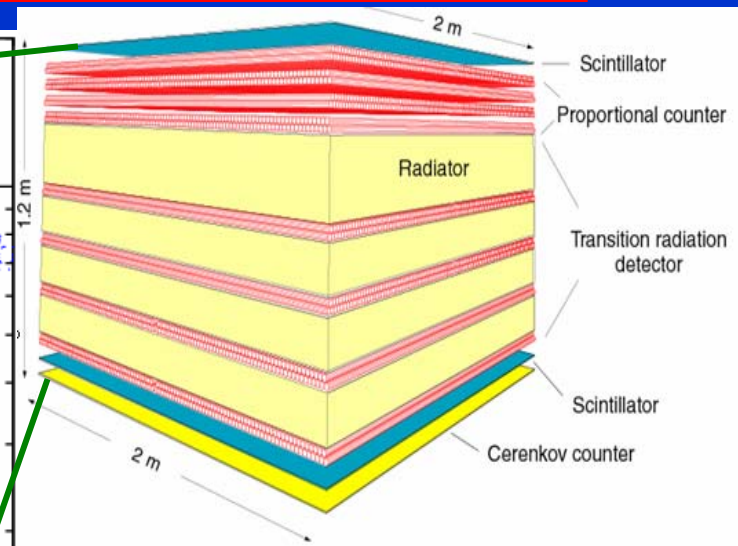
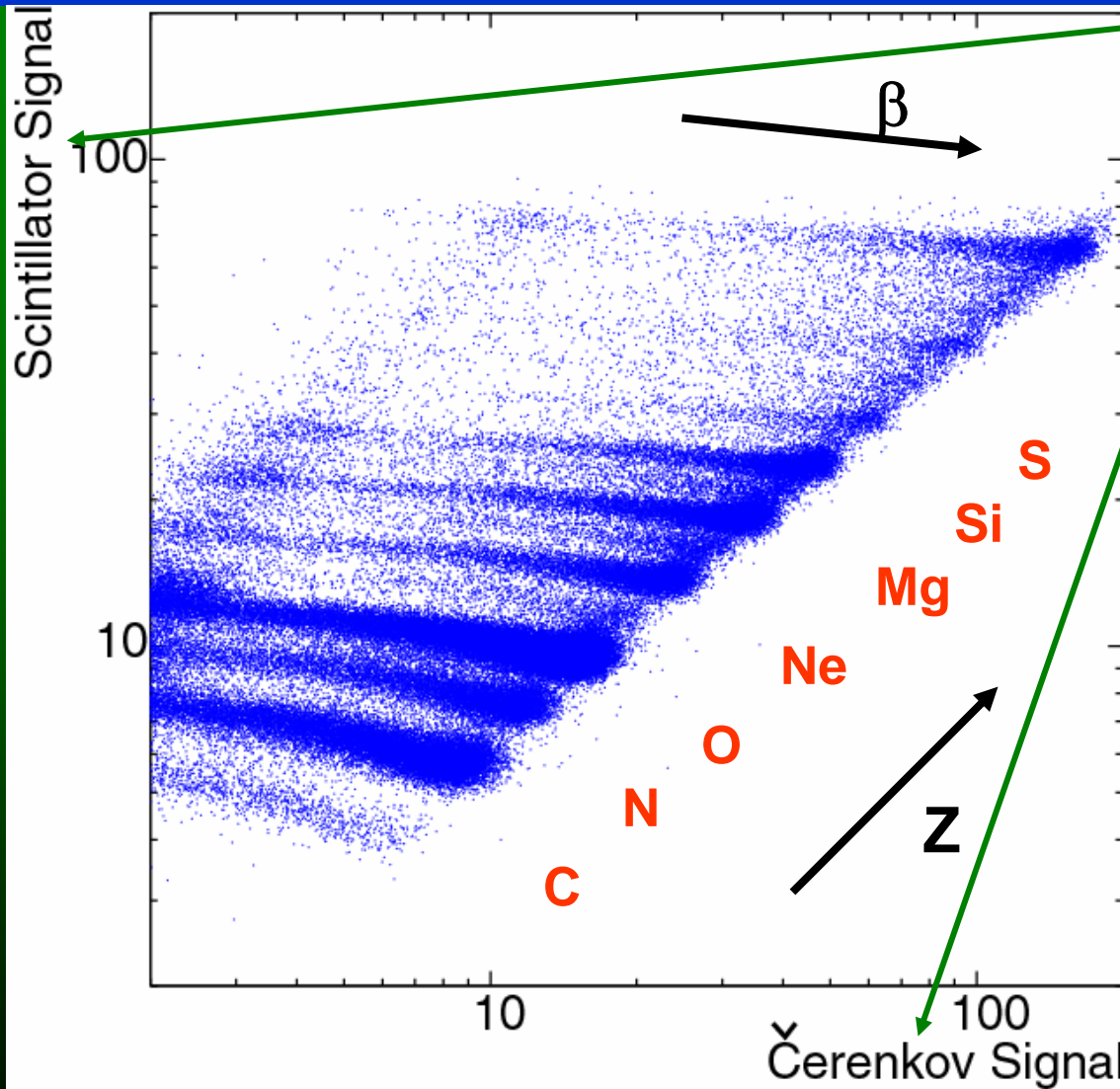
Methode: (D. Müller, Chicago)

Teilchenidentifikation mit Szintillatoren und Cherenkovlicht

Energiebestimmung mit Übergangsstrahlung ($\propto \gamma$)



Transition Radiation Array for Cosmic Energetic Rays TRACER



TRACER is a new instrument for direct measurements of heavy cosmic ray nuclei (oxygen to iron) in the energy range from 10^{13} to several 10^{14} eV.

TRACER measures the nuclear charge, the energy, and the trajectory through the instrument. For charge measurements, two layers of plastic scintillators (2×2 m²), and one Čerenkov counter (2×2 m²) are used. A major challenge is the energy measurement. TRACER uses a transition radiation detector system which determines the Lorentz factor. This approach permits the construction of large-area detectors without requiring an exorbitant detector mass.

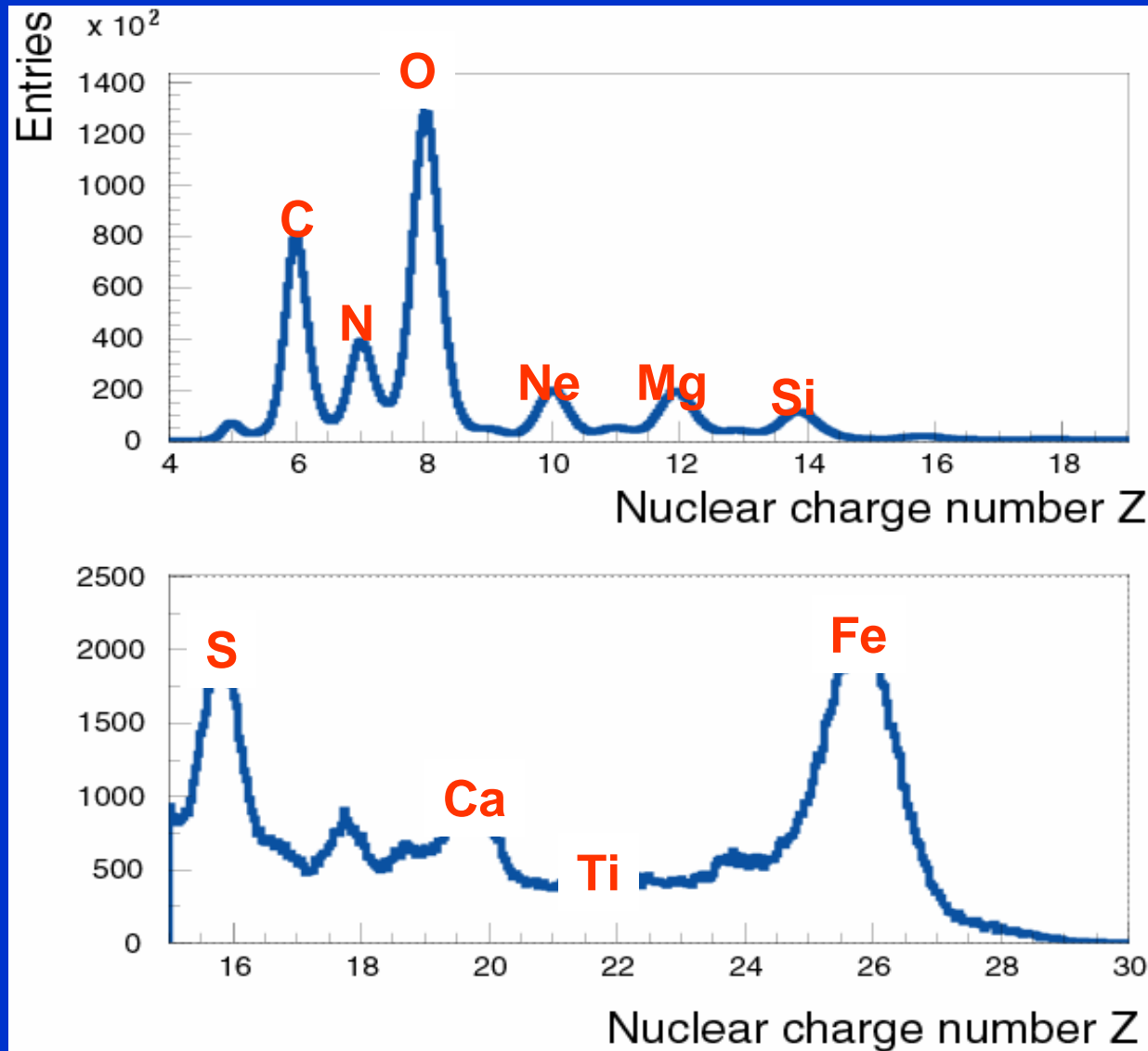
S
Wolf

TRACER LDB flight Antarctica 2003





Vorläufige Häufigkeiten der Elemente von TRACER





TRACER Energie Spektren



HEAO-3

CRN



Cherenkov

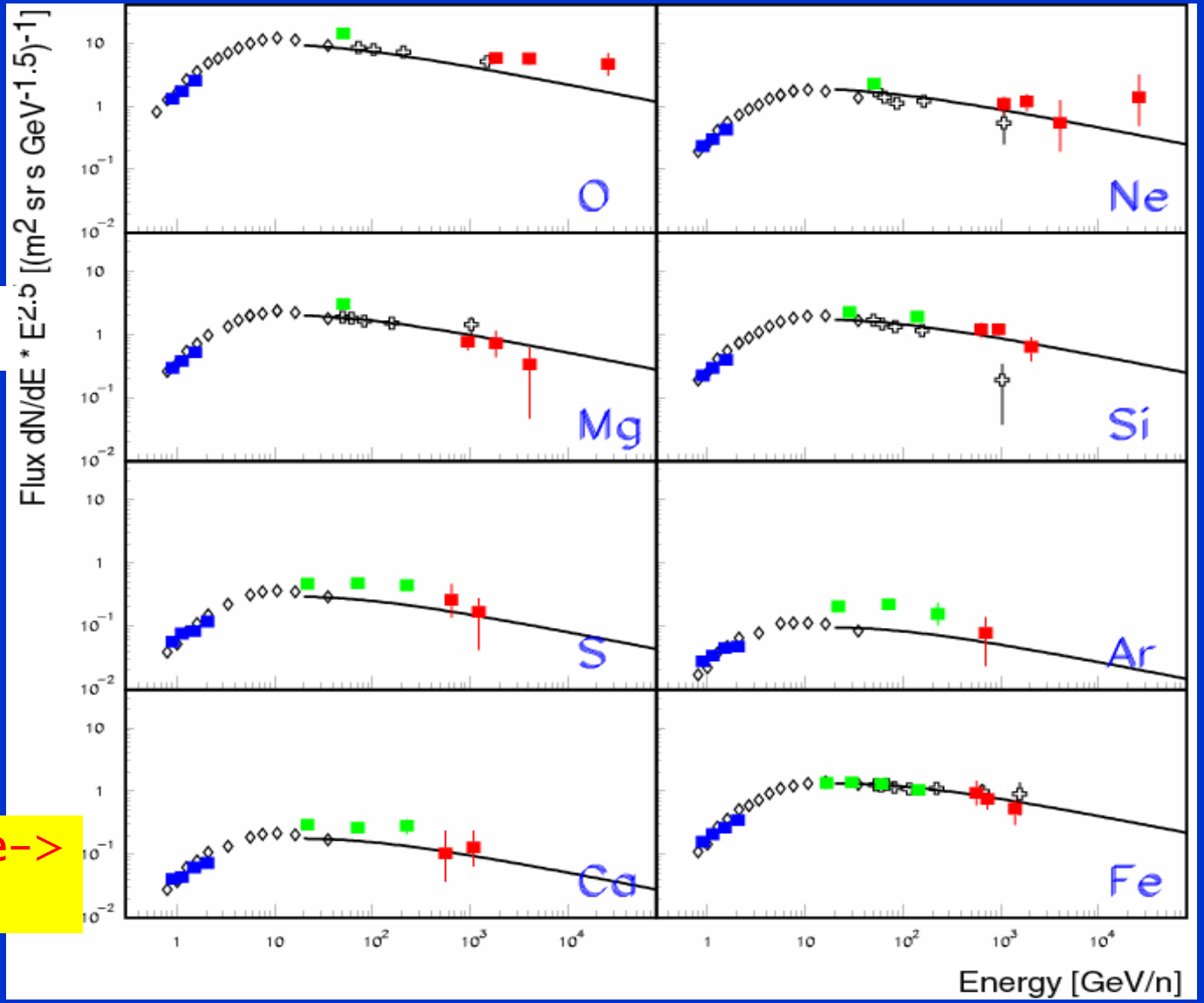


dE/dx TRD



TRD

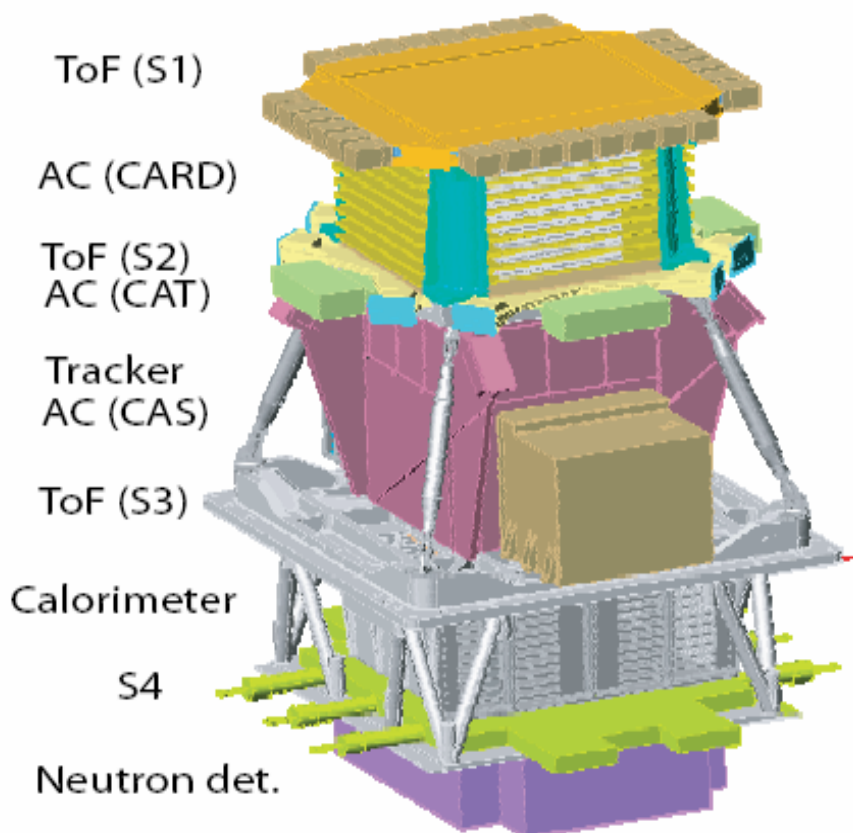
Modellvergleiche -> Jörg Hörandel





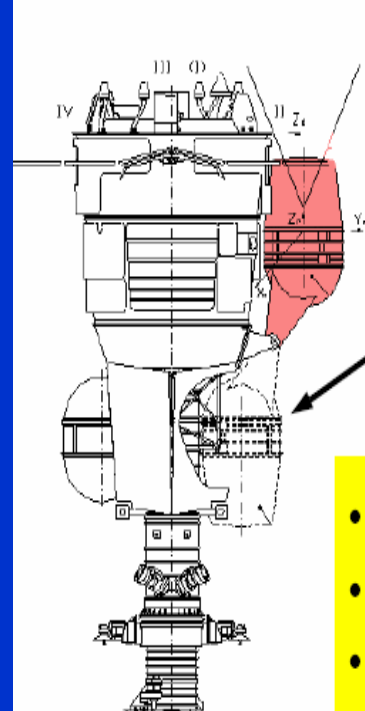
PAMELA

Payload for Antimatter Matter Exploration and Light-nuclei Astrophysics)



- Positrons 50 MeV - 270 GeV
- Antiprotons 80 MeV - 190 GeV
- Limit on antinuclei $\sim 10^{-8}$ ($\overline{\text{He}}$ / He)
- Protons 80 MeV - 800 GeV
- Nuclei ($Z \leq 6$) 100 MeV/n < 400 GeV/n
- Electrons 50 MeV - 3 TeV

Satellite and Orbit



Pamela operational

During launch / orbital manoeuvres



- Resurs DK1: earth observation
 - Altitude: 300 - 600 km
 - Inclination: 70°
- Start erwartet in Dezember 2005**

Scientific Objectives:

- Search für possible sources of antimatter: $\bar{p}, e^+, \overline{\text{He}}$
- Search for dark matter candidates
- Study the transport of particles in the galaxy



PAMELA

Payload for Antimatter Matter Exploration and Light-nuclei Astrophysics)



Italy:



Bari



Florence



Frascati



Naples



Tr. Vergata

Rome



Trieste



CNR, Florence

Russia:



Moscow
St. Petersburg

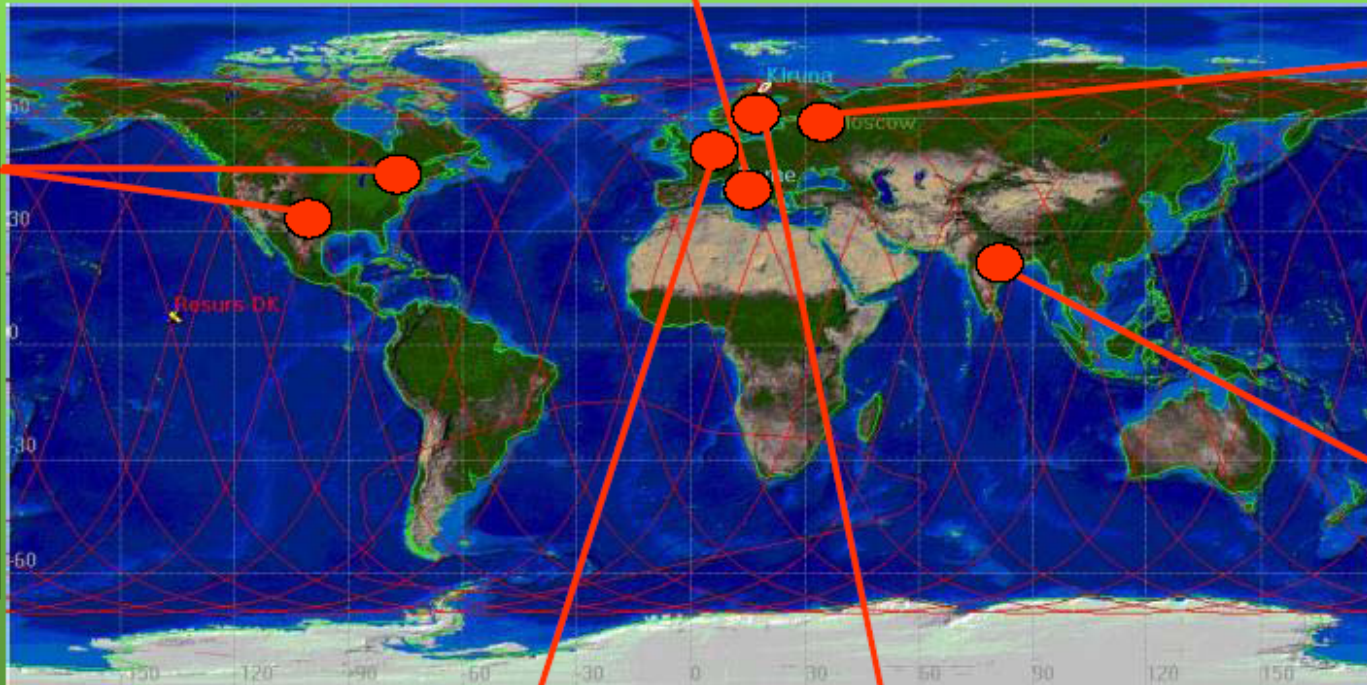
USA:



GSFC



NMSU



India:



Bombay

Germany:



Siegen

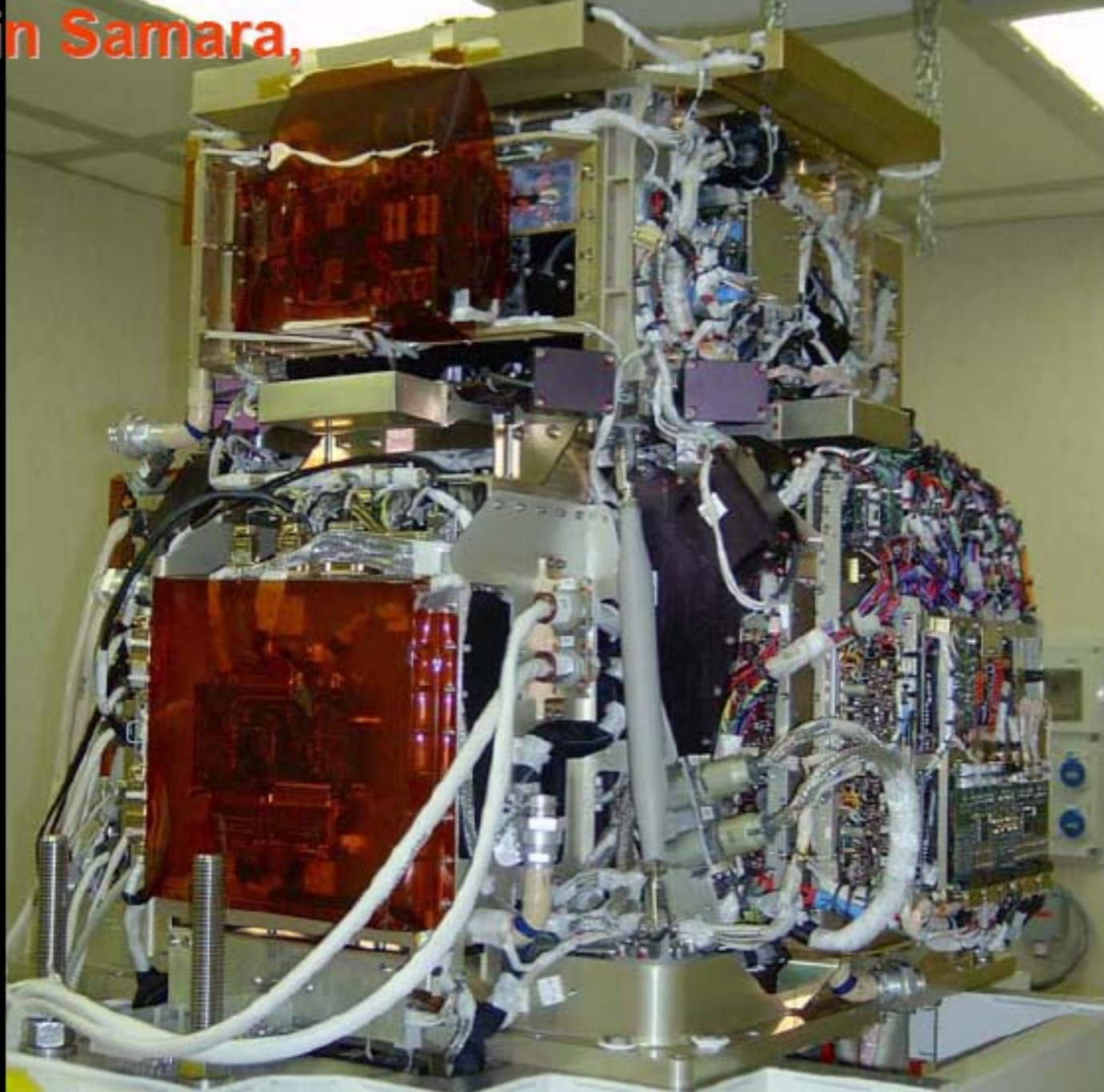
Sweden:



KTH, Stockholm

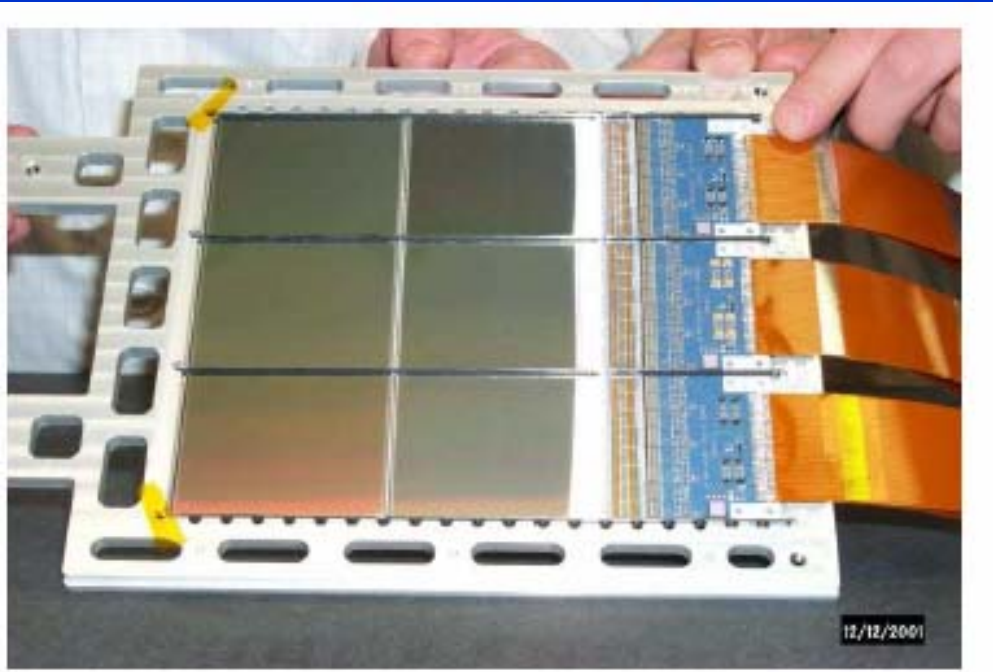
Pamela in Samara, Russia

4/09/05





Pamela Tracker: permanent magnet + Si-tracker



Field: 0.43 T
Bore: 13.2x16.2 cm²
Acceptance: 20.5cm² sr

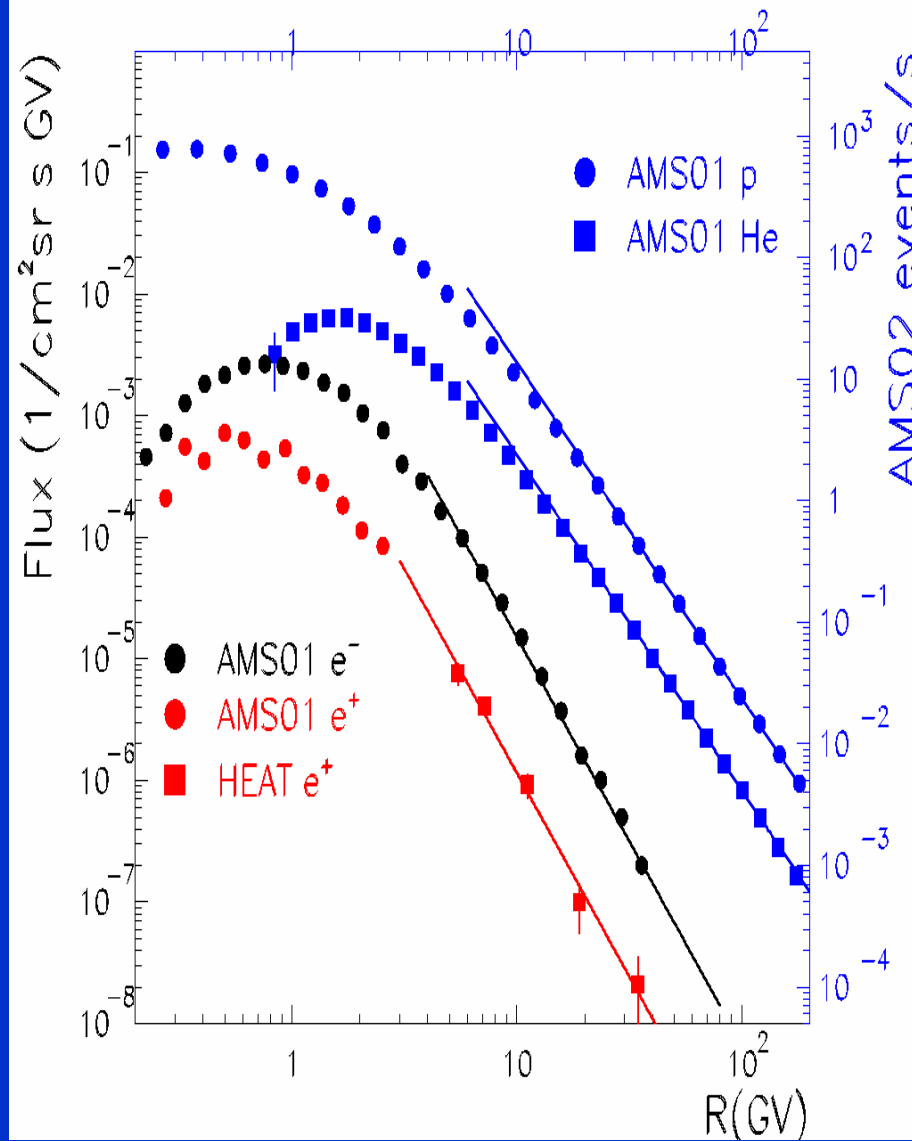
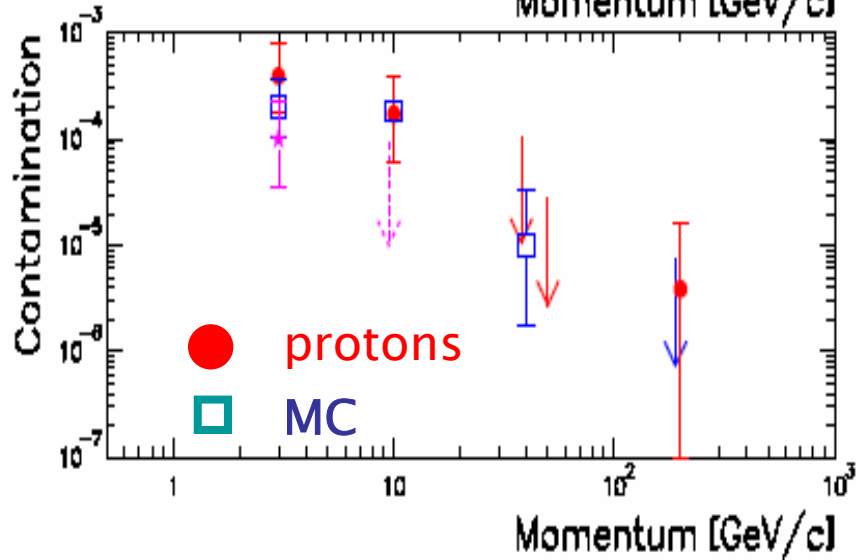
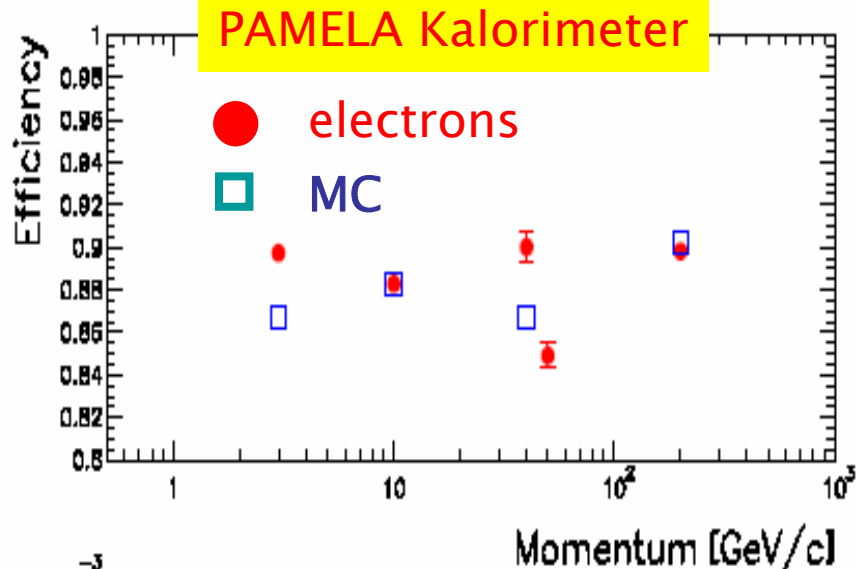
Tracker resolution: 3 μm

$$\eta = 1/R \text{ where } R = pc/Ze$$

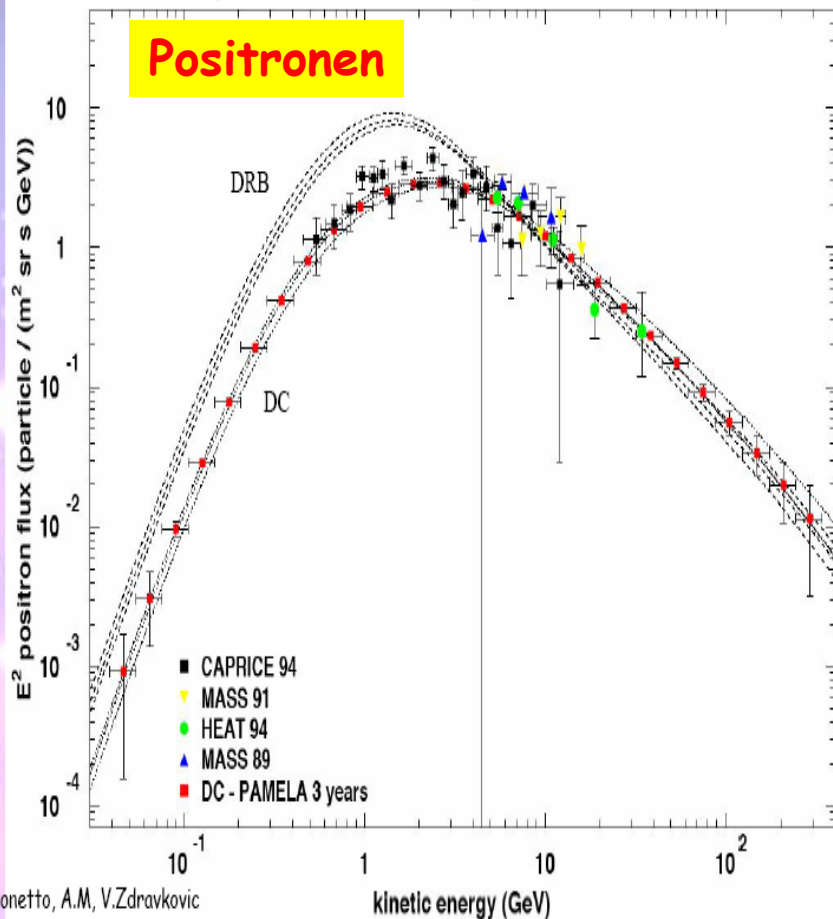
$$MDR = 1/\sigma_{\eta}^{he}$$

Max. Detectable Rigidity R: TeV

Positron Effizienz und Proton-Untergrund

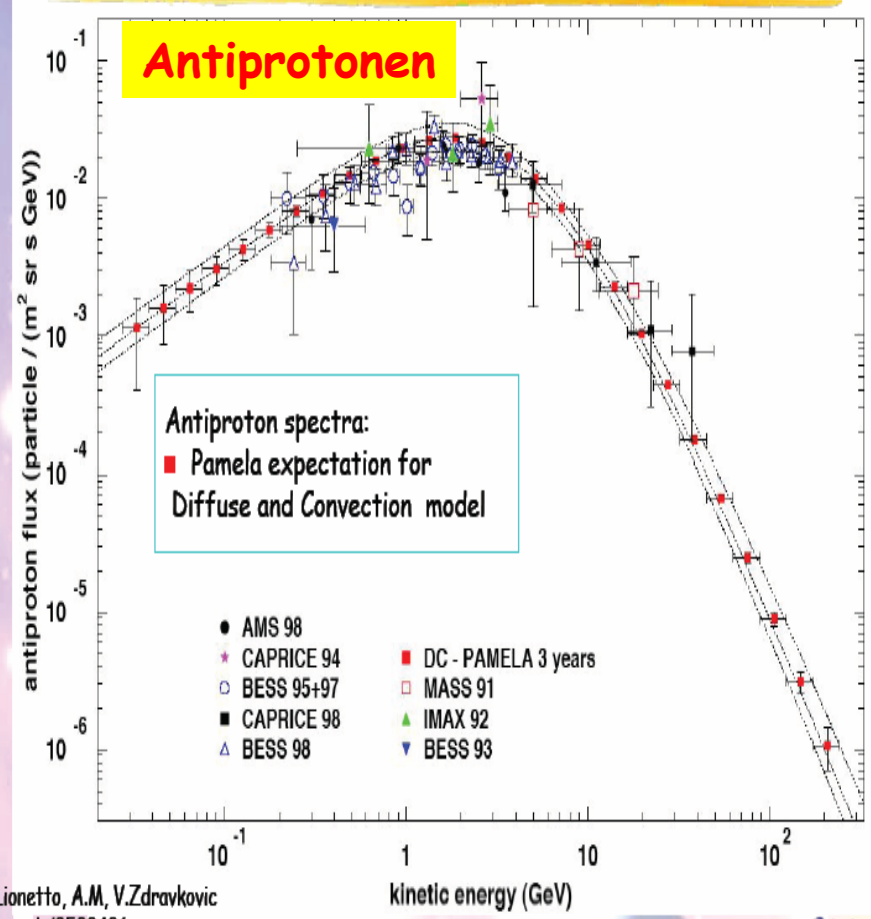


Pamela Erwartungen für Positronen und Antiprotonen



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Extraktion Beiträge der DMA schwierig, da Form durch mögliche Wiederbeschleunigung und solare Modulation beeinflusst wird. Fluss empfindlich für Clustering der DM. Brauche B/C, Gammas, usw.

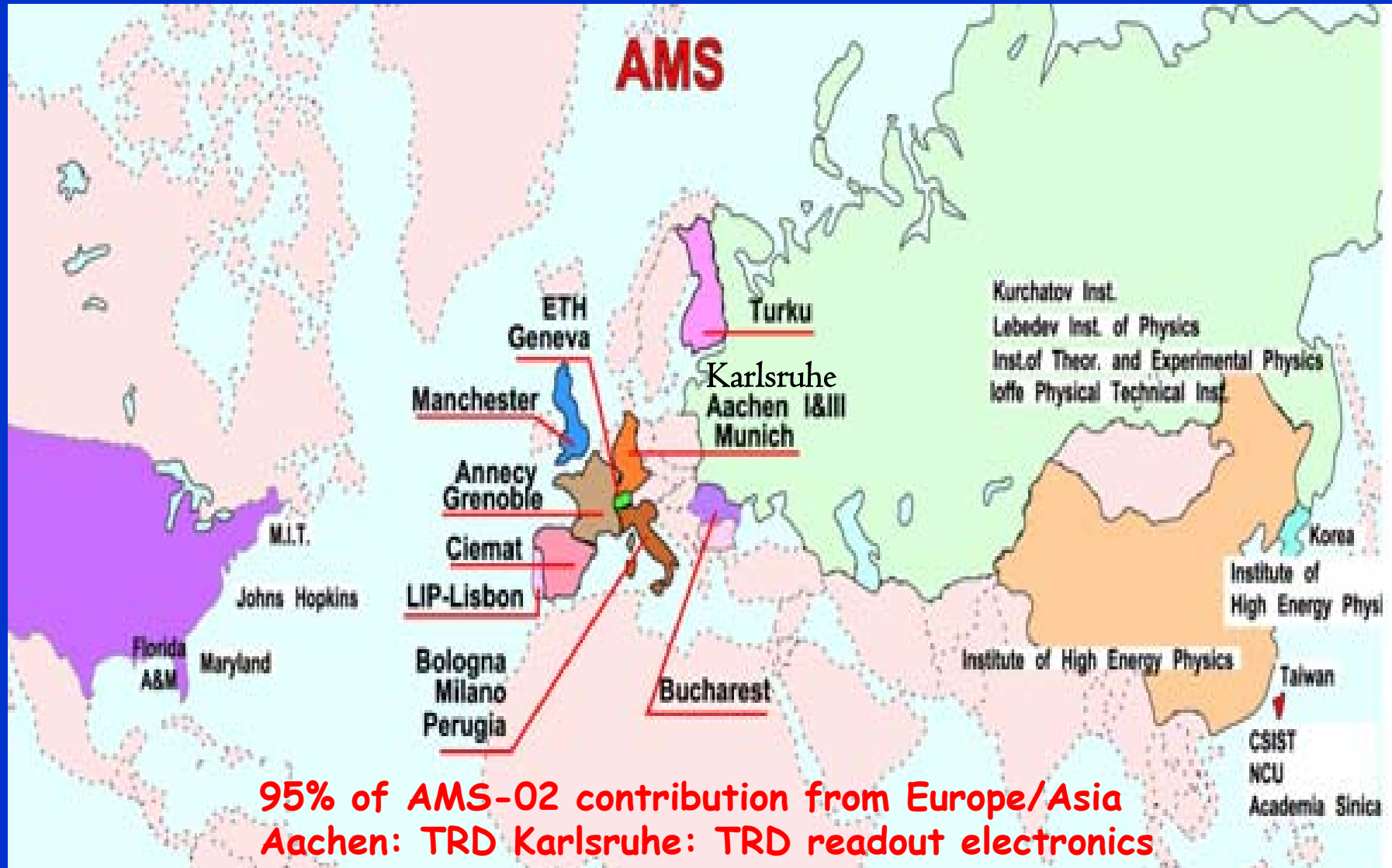


AMS-02: Alpha Magnetic Spectrometer





AMS-02: Alpha Magnetic Spectrometer



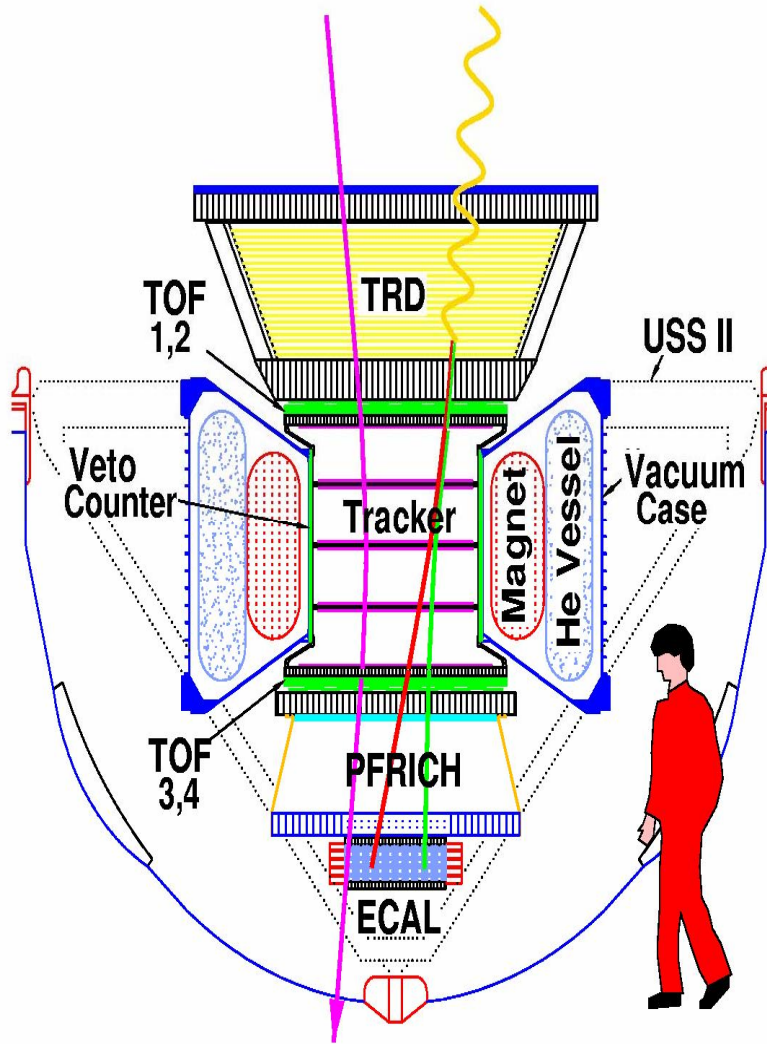


AMS-02 Particle Identification



AMS-02

**B=0.8T, MDR: >1 TeV
Akzeptanz: 0.4 m² sr**

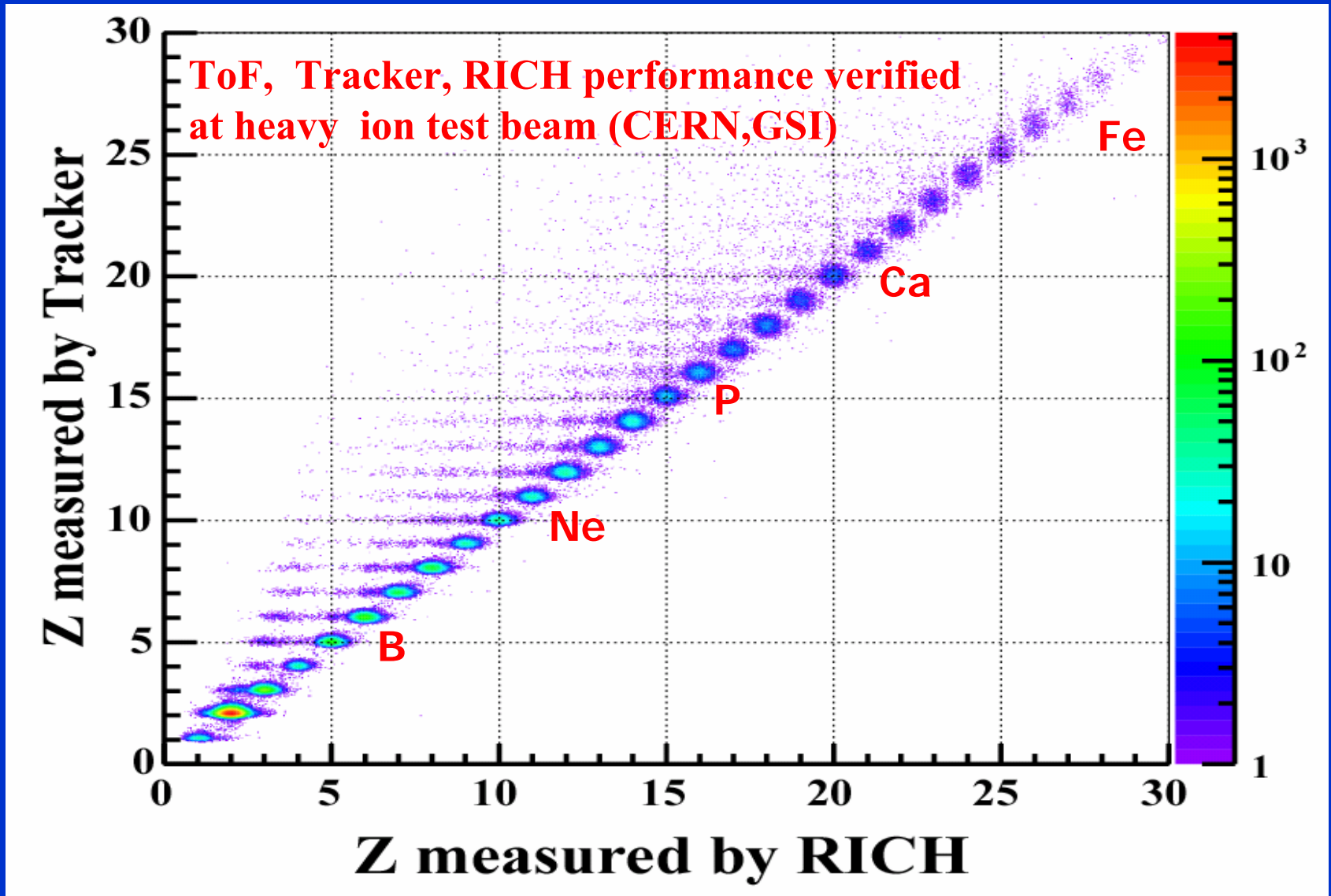


$P=mV, m=P/V$

300 GeV	e ⁻	e ⁺	P	He ⁻	γ	γ
TRD	⋮	∨			⋮	
TOF	∨	∨	∨	∨	∨	
Tracker	∪	∩	∩	∪	∩	
RICH	○	○	○	○	○	○
Calorimeter	∧	∧	∧	∧	∧	∧

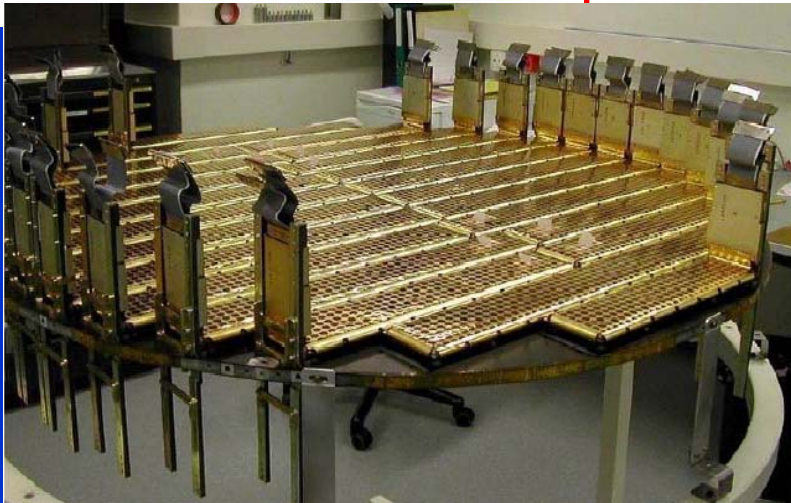
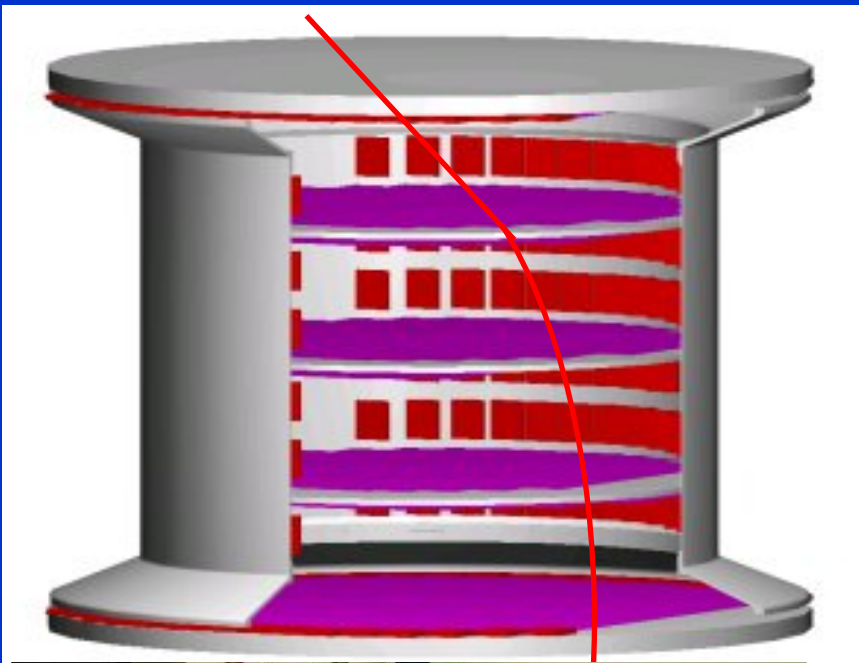


Ladungsmessungen





Silicon Tracker



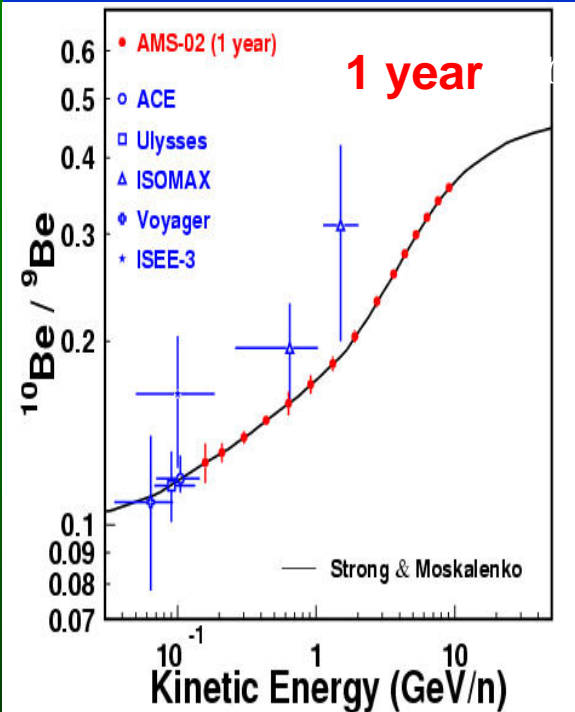
- Rigidity ($\Delta R/R \approx 2\%$ for 1 GeV Protons) with Superconducting Magnet (0.8T)
- Signed Charge (dE/dx)
- 8 Planes, $\sim 6\text{m}^2$
- Pitch (Bending): $110\ \mu\text{m}$ (coord. res. $10\ \mu\text{m}$)
- Pitch (Non-Bending): $208\ \mu\text{m}$ (coord. res. $30\ \mu\text{m}$)
- Charge measurement up to $Z \sim 26$



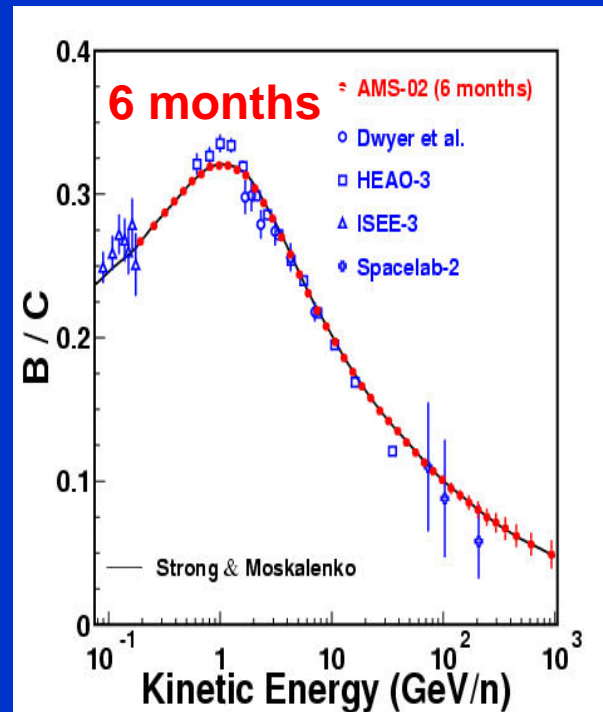
AMS-02 Erwartungen



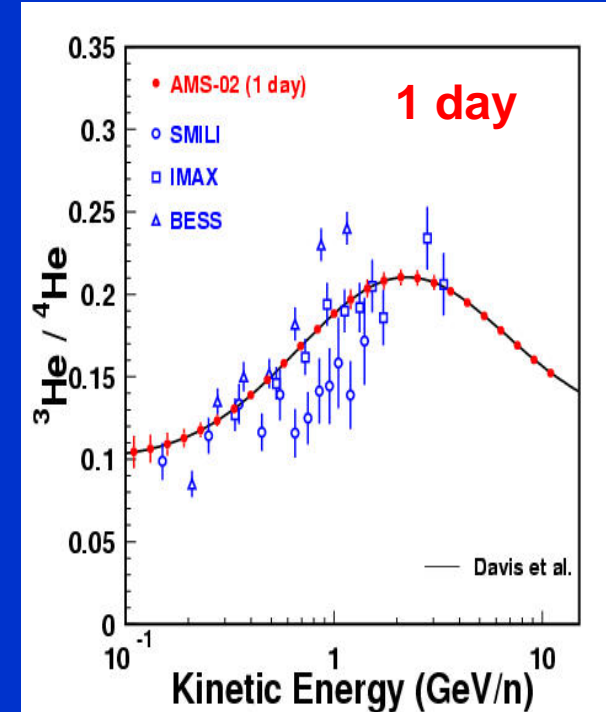
Beryllium



Boron



Helium



^{10}Be ($t_{1/2}=1.5\text{Myr}$) / ^9Be will allow to estimate the propagation time and size of the ISM

B is secondary produced in nuclear interaction, C is primary produced in stars. B/C is sensitive to the diffusion constant

$^3\text{He}/^4\text{He}$ ratio is sensitive to the density of the ISM

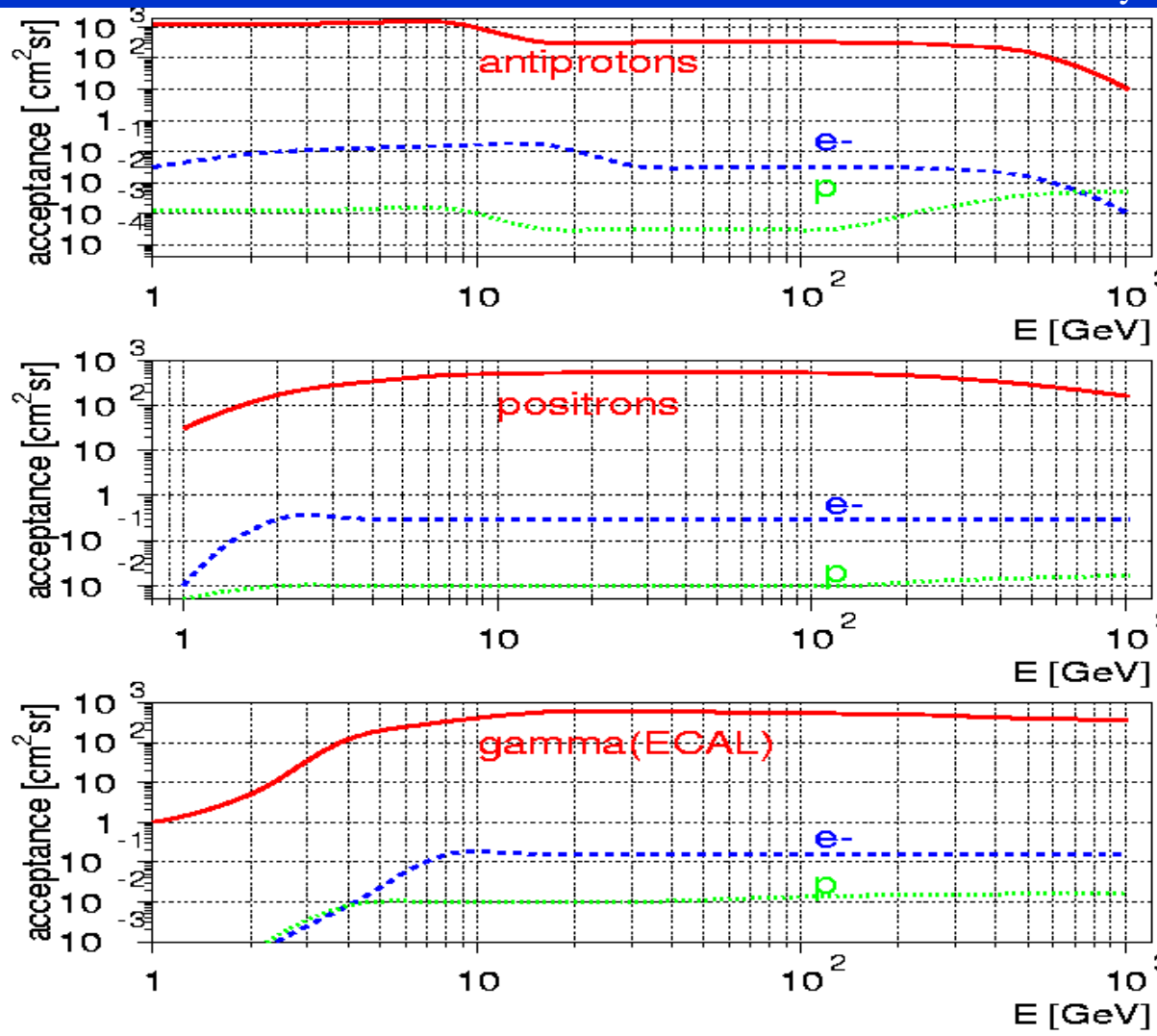
AMS02 : Detektor Erwartungen für DMA



Acceptances

defined by selection cuts during reconstruction

Preliminary



Antiprotons:

A(<16 GeV)	~ 1200 cm ² sr
>16 GeV	~ 330 cm ²
Rejection e-	~ 10 ⁴
p	~ 10 ⁶

Positrons:

Acceptance	~ 550 cm ² sr
Rejection e-	~ 10 ³
p	~ 10 ⁵

Gamma (ECAL mode):

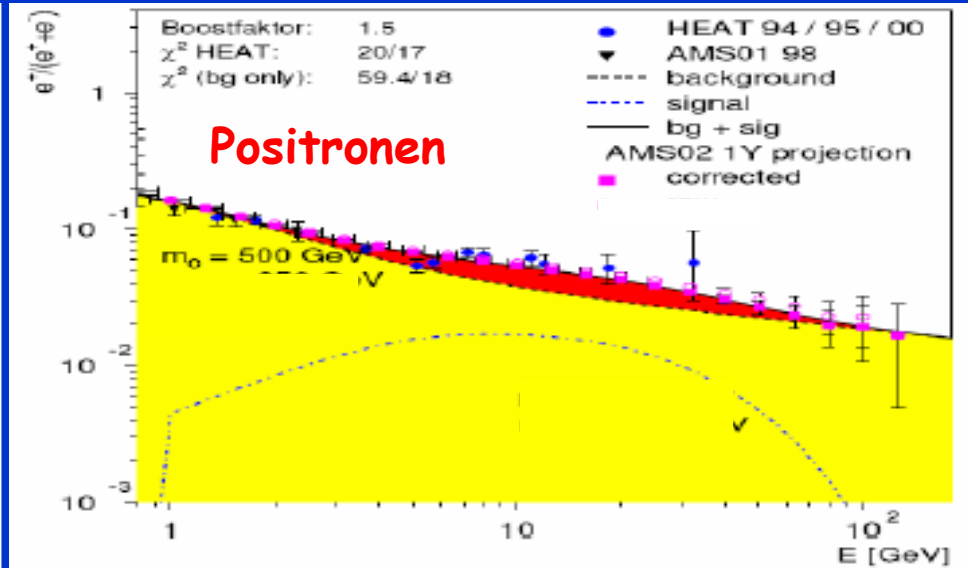
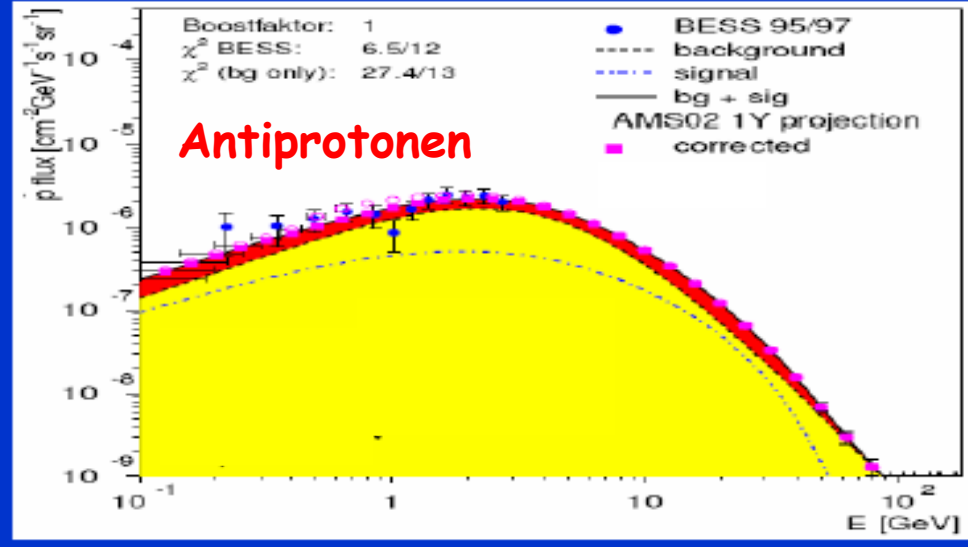
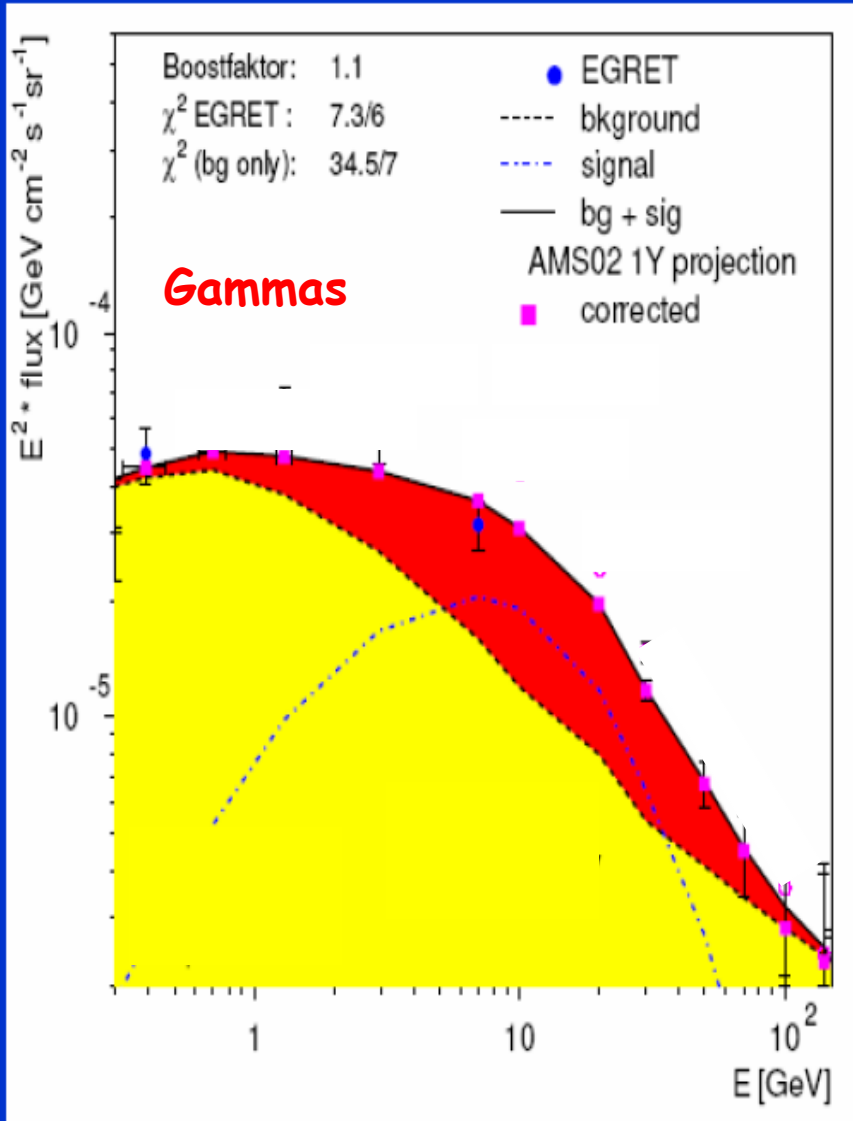
Acceptance	~ 600 cm ² sr
Rejection e+ -	~ 10 ⁴
p	~ 10 ⁵

Gamma (Conversion mode):

Acceptance	~ 550 cm ² sr
------------	--------------------------



Erwartete Statistik nach einem Jahr AMS-02



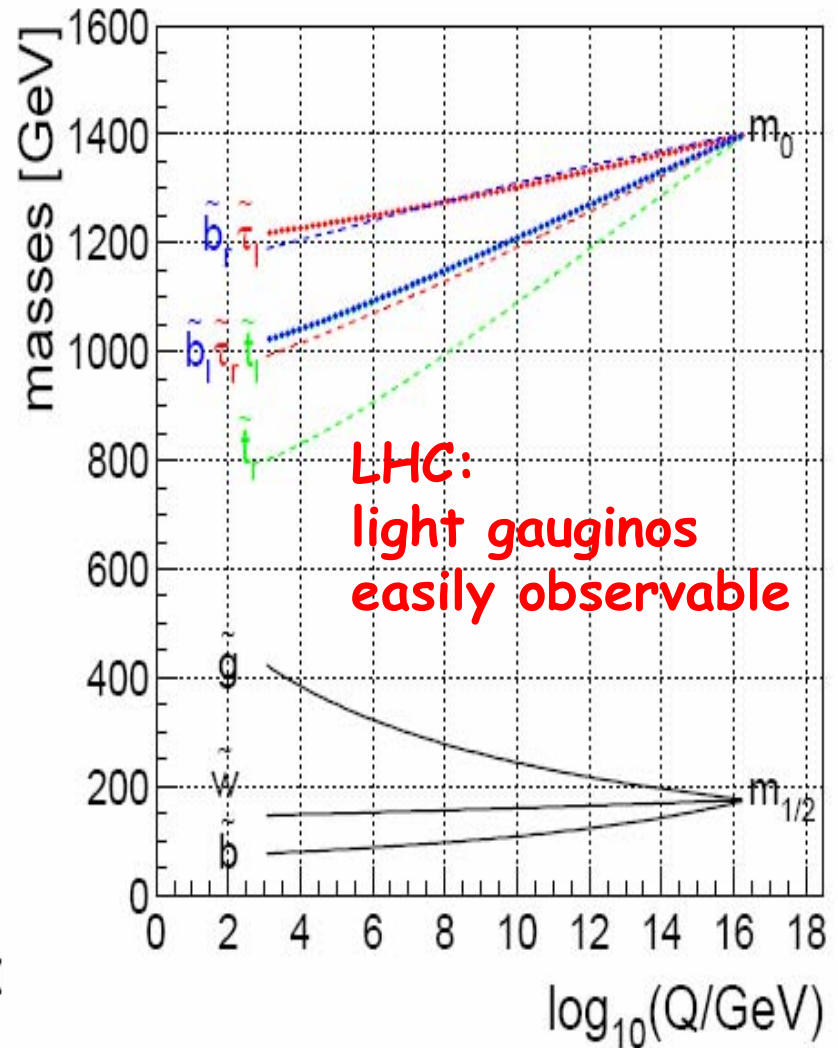
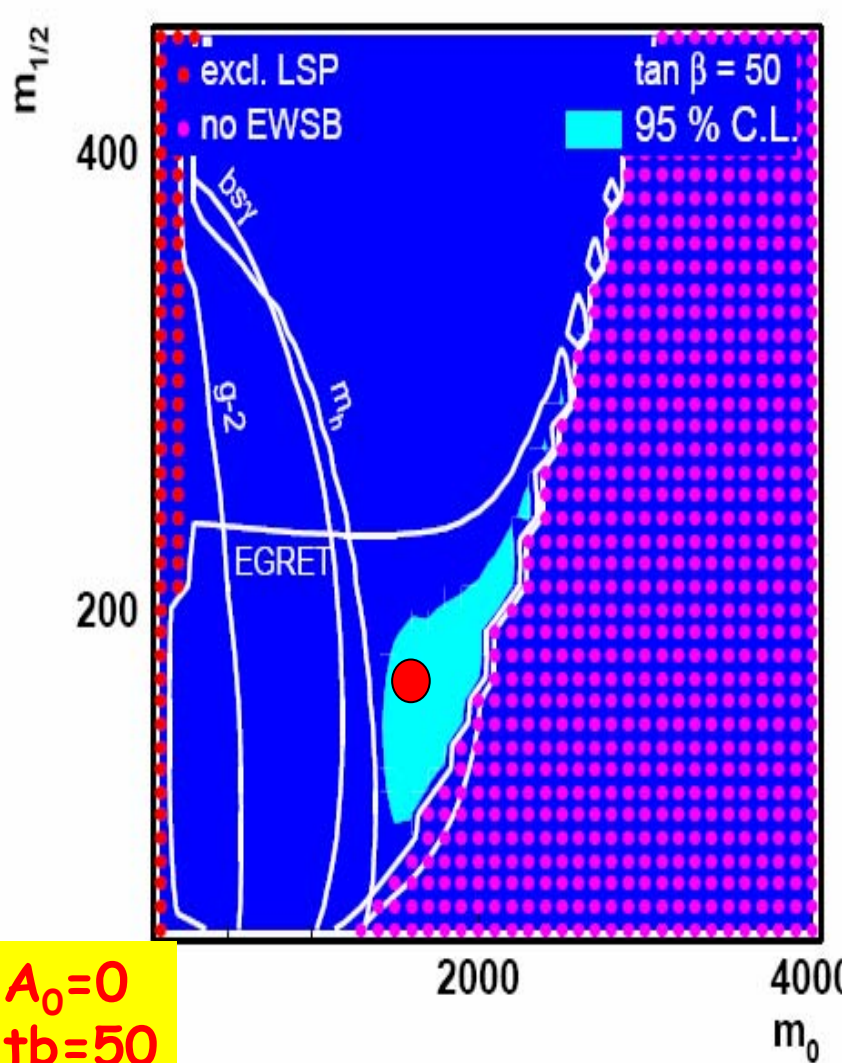


Zusammenfassung



- neue Satelliten-Experimente werden in nächster Zukunft CR und Gammastrahlen sehr genau von GeV bis TeV Energien vermessen
- Dies erlaubt
 - a) EGRET Überschuß als Signal der DMA zu bestätigen
 - b) Propagationsmodelle unserer Galaxie zu verbessern
 - c) Punktquellen zu untersuchen
 - d) extragalaktische Beiträge zu erforschen
 - e) Verknüpfungen mit direkten Suchen nach DM und Beschleunigerexperimenten zu ermöglichen.

SUSY Massenspektrum aus EGRET + Higgs

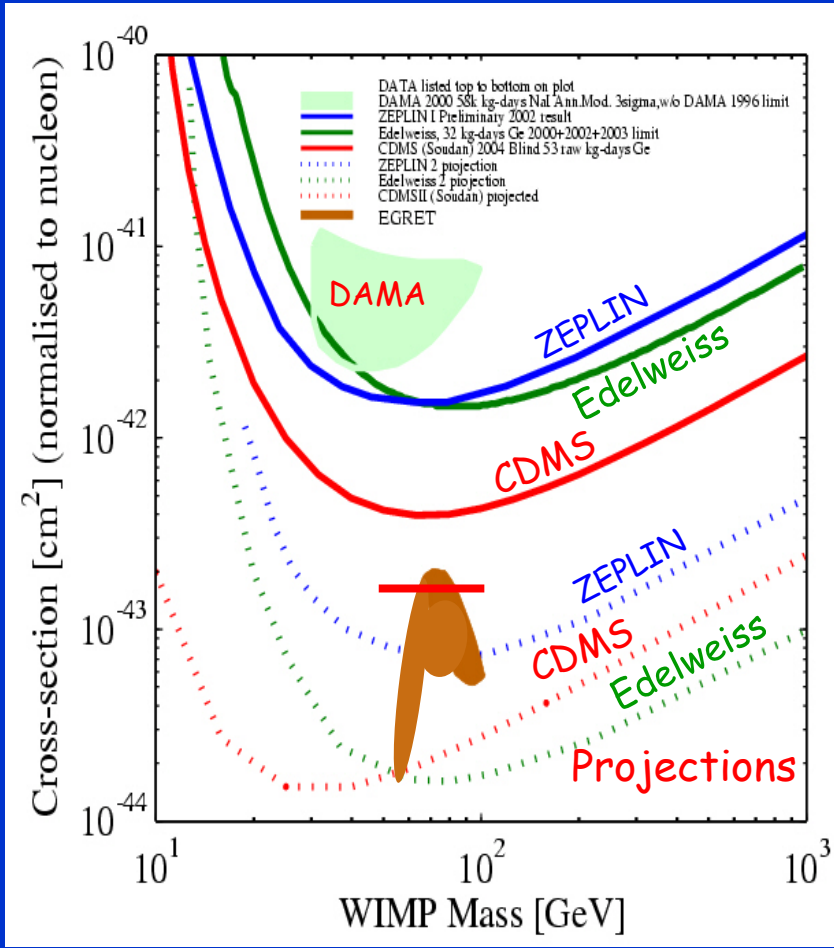




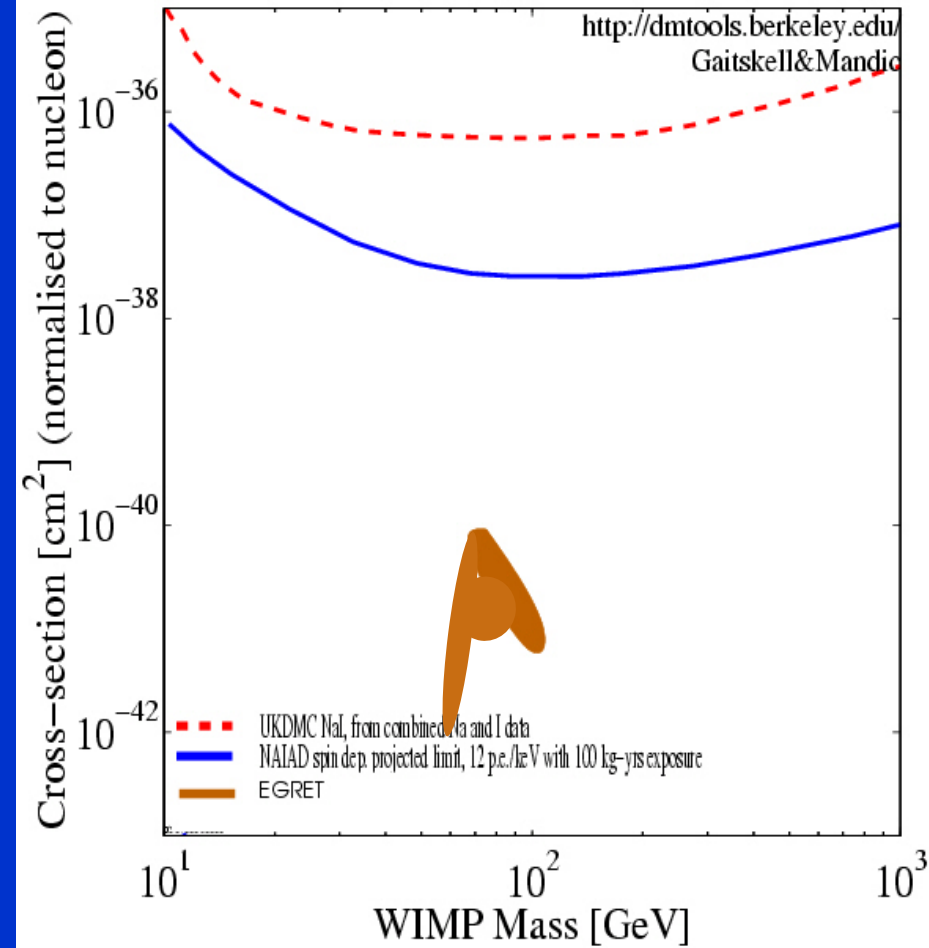
Zukunft: Direkte Suche nach DM



Spin-independent



Spin-dependent



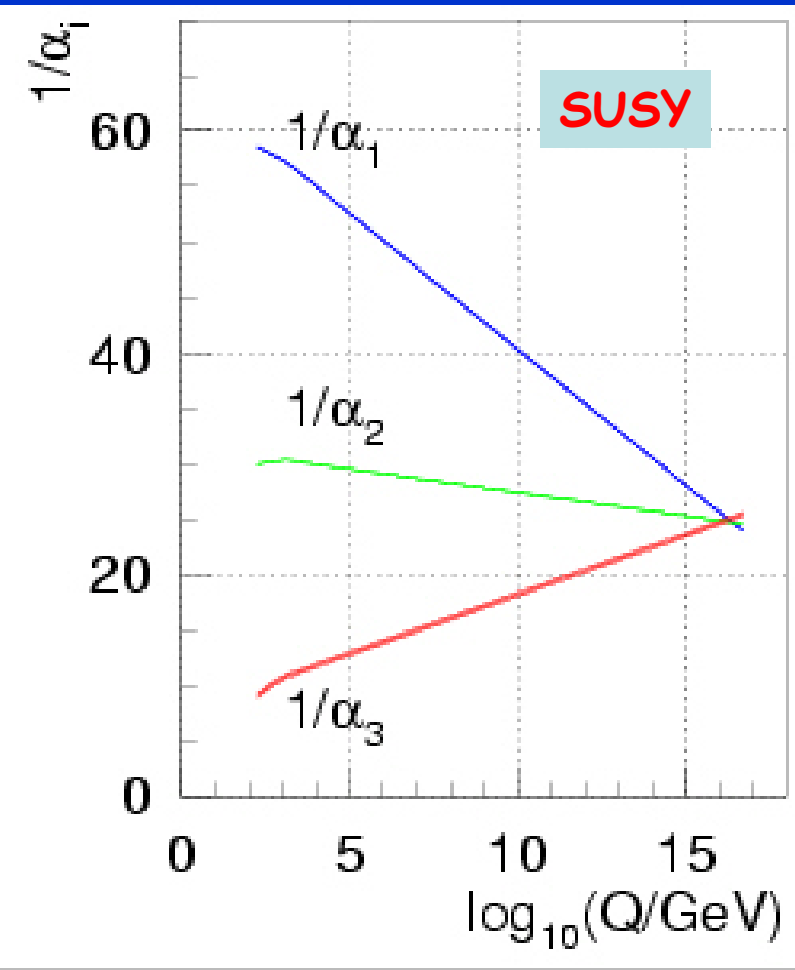
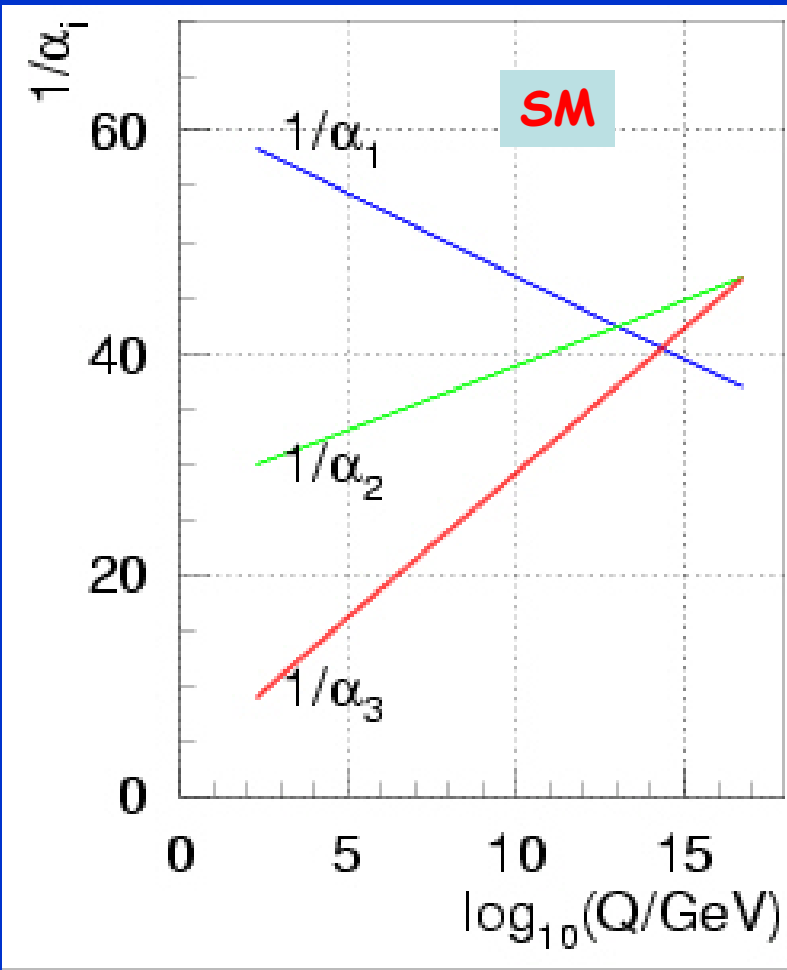
Vorhersagen von EGRET Daten plus Supersymmetrie



Vereinheitlichung der Eichkopplungen



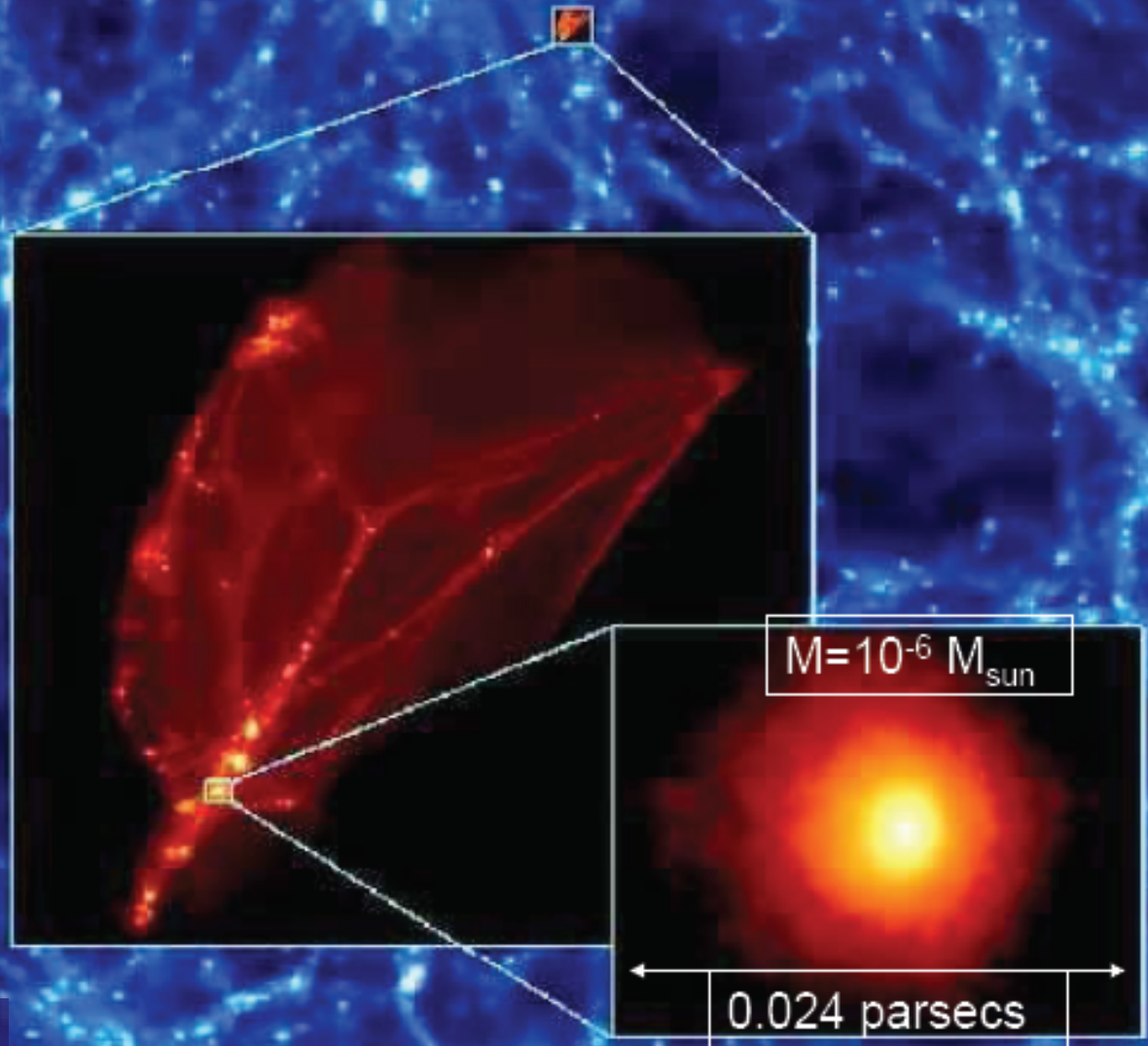
Update from Amaldi, dB,
Fürstenau, PLB 260 1991



Mit SUSY Massen aus EGRET Daten und Eichkopplungen von LEP -> KEINE freie Parameter für das Laufen der Kopplungskonstanten! Entweder man kriegt Vereinheitlichung oder man kriegt es nicht.

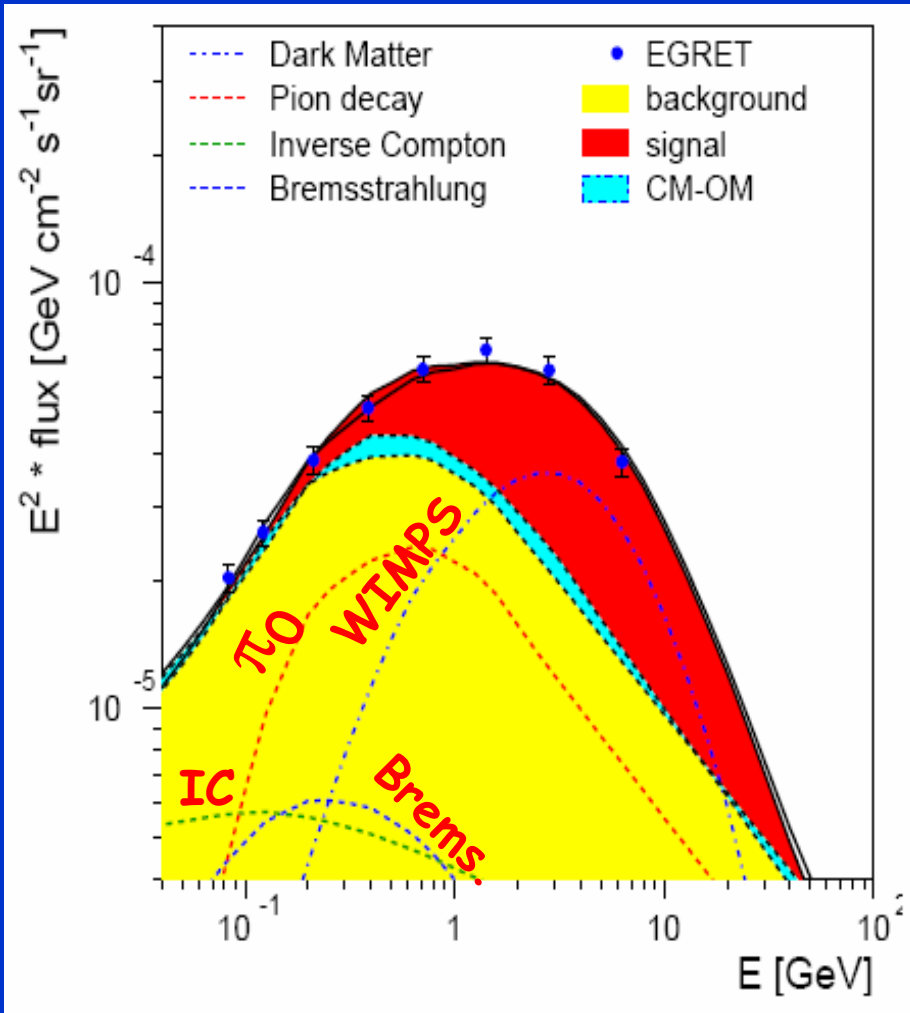
Earth-Mass halos "observed" in high-resolution simulations
Diemand, Moore & Stadel, *Nature* 433 (2005) 389-391

Z=26

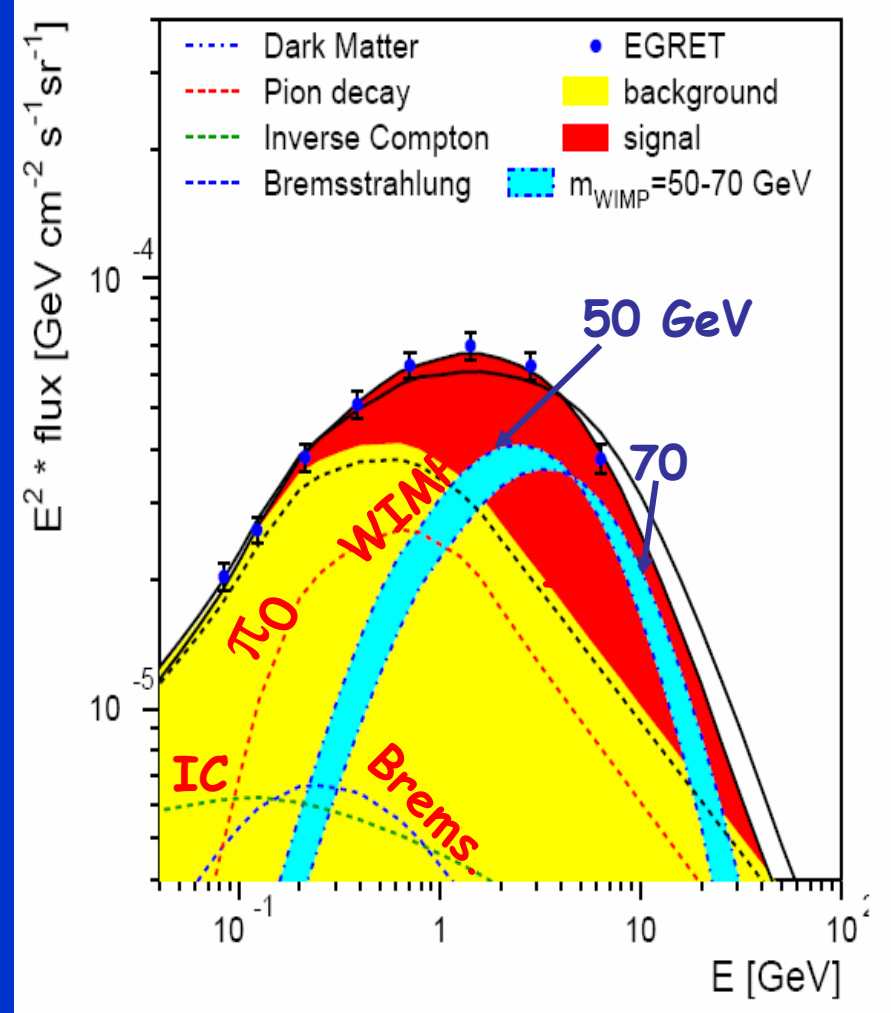




Unsicherheit in Form des Signals und Untergrundes



Blue: background uncertainty



Blue: WIMP mass uncertainty

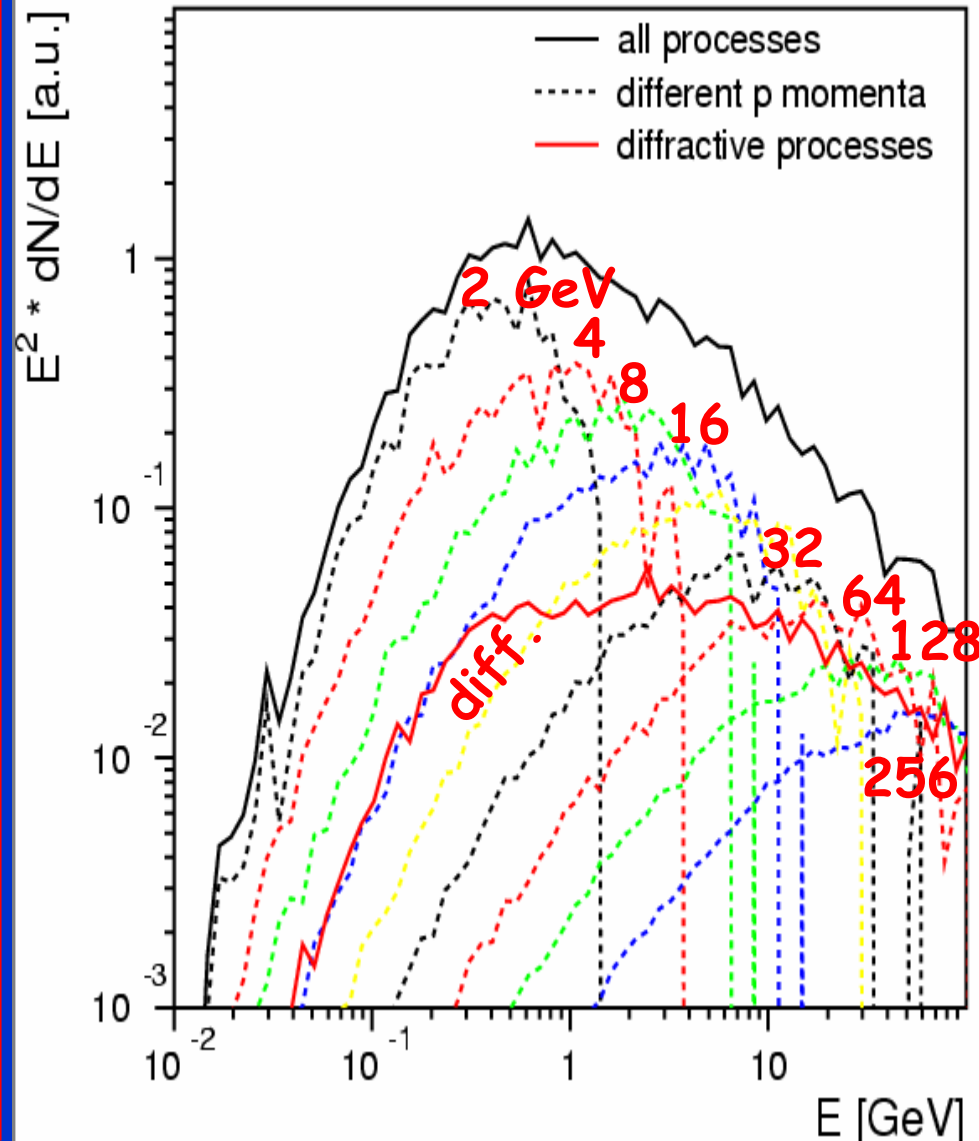


Beiträge der hadronischen Wechselwirkungen



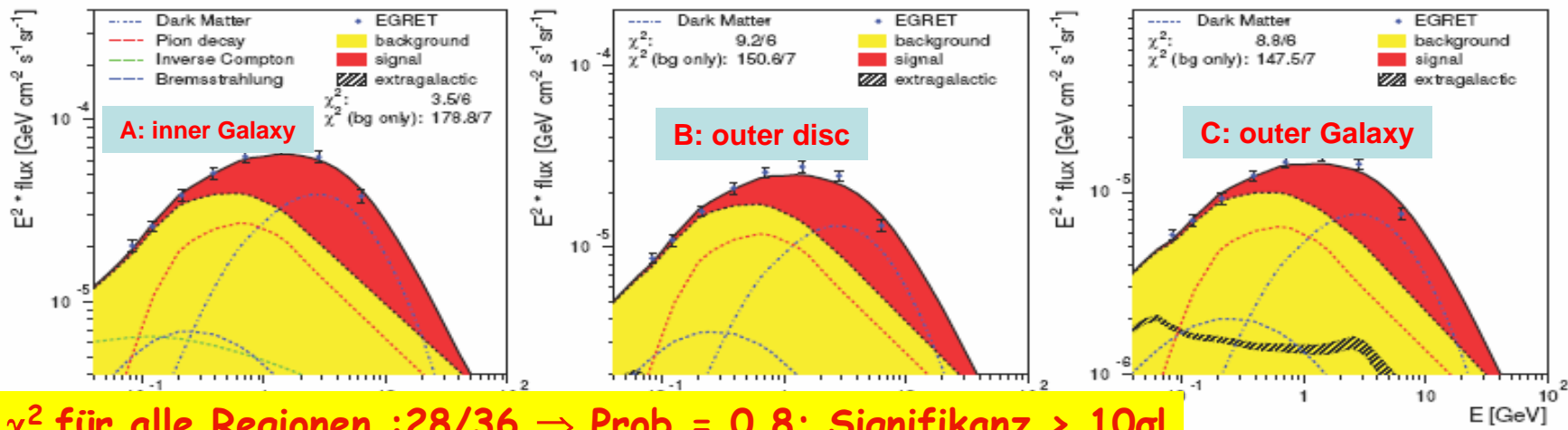
PYTHIA processes:

11 $f+f' \rightarrow f+f'$ (QCD)	2370
12 $f+f\bar{b}ar \rightarrow f'+f\bar{b}ar'$	0
13 $f+f\bar{b}ar \rightarrow g + g$	0
28 $f+g \rightarrow f + g$	2130
68 $g+g \rightarrow g + g$	1510
53 $g+g \rightarrow f + f\bar{b}ar$	20
92 Single diffractive (XB)	1670
93 Single diffractive (AX)	1600
94 Double diffractive	700
95 Low-pT scattering	0
Prompt photon production:	
14 $f+f\bar{b}ar \rightarrow g+\gamma$	0
18 $f+f\bar{b}ar \rightarrow \gamma + \gamma$	0
29 $f+g \rightarrow f + \gamma$	1
115 $g+g \rightarrow g + \gamma$	0
114 $g+g \rightarrow \gamma + \gamma$	0

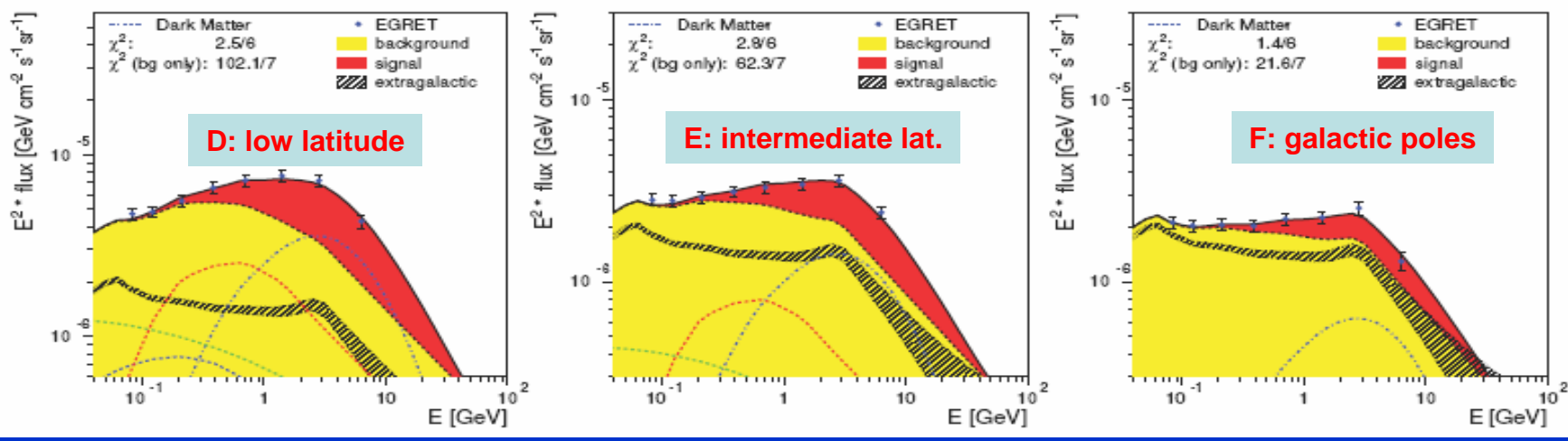




Analyse der EGRET Daten in 6 Himmelsrichtungen

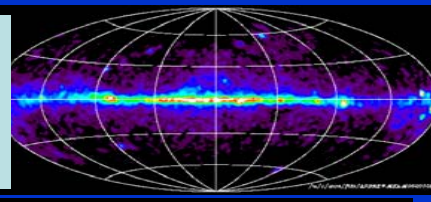


χ^2 für alle Regionen :28/36 \Rightarrow Prob. = 0.8; Signifikanz > 10 σ !



A: inner Galaxy ($l = \pm 30^\circ$, $|b| < 5^\circ$)
 B: Galactic plane avoiding A
 C: Outer Galaxy

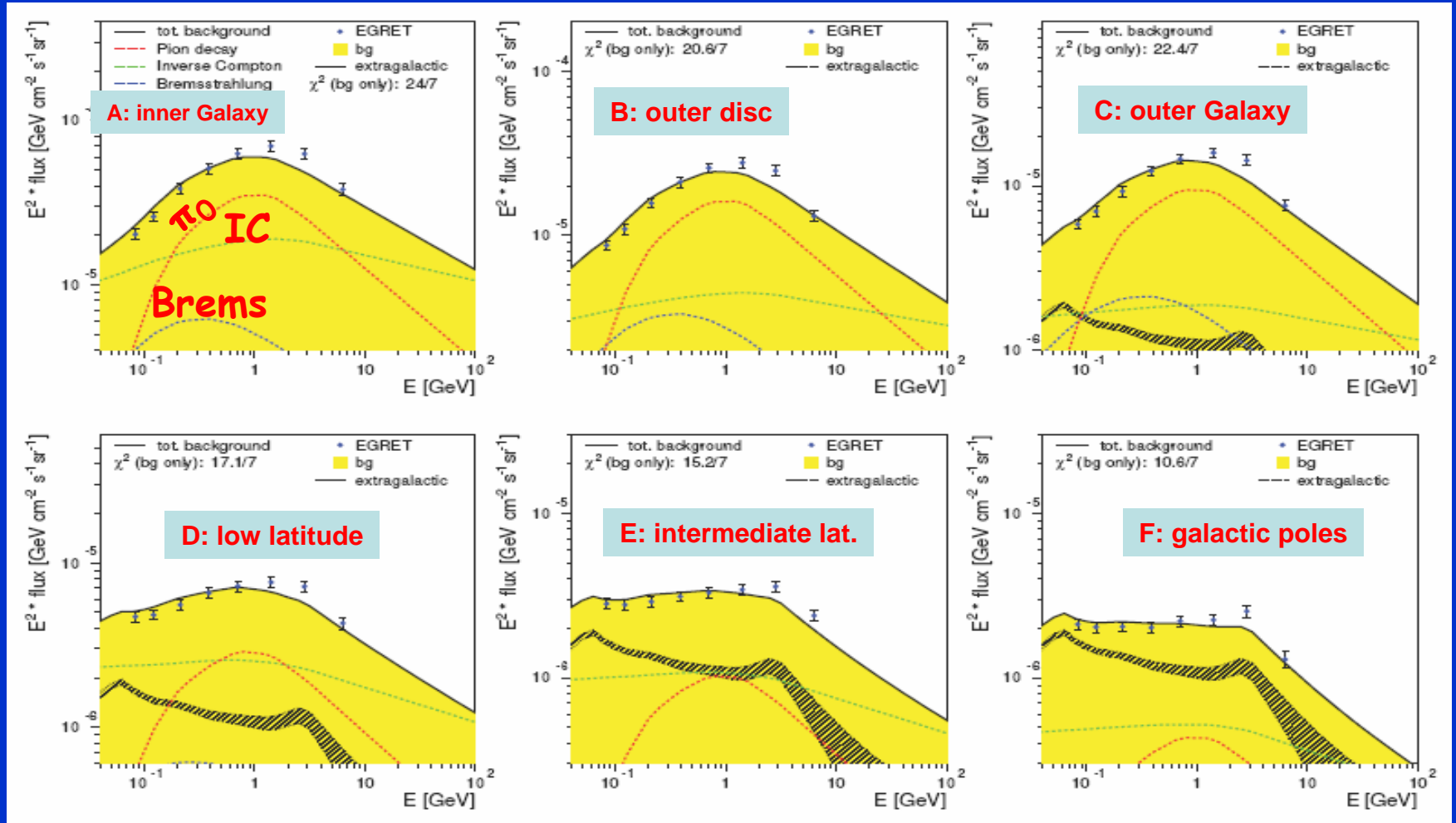
D: low latitude ($10-20^\circ$)
 E: intermediate lat. ($20-60^\circ$)
 F: Galactic poles ($60-90^\circ$)





Optimized Model von Strong et al. astro-ph/0406254

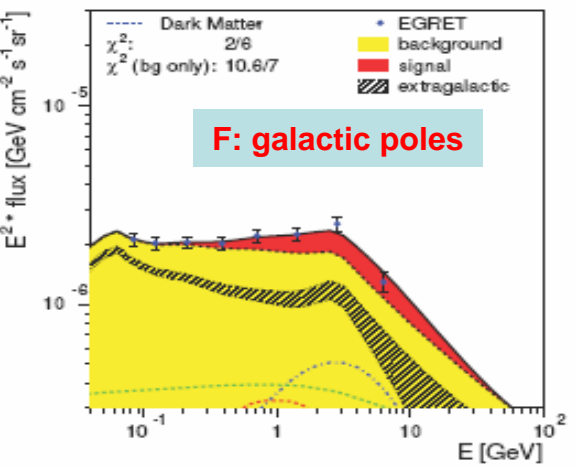
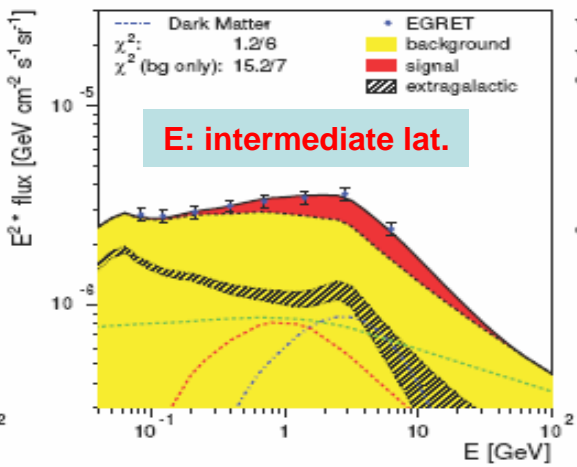
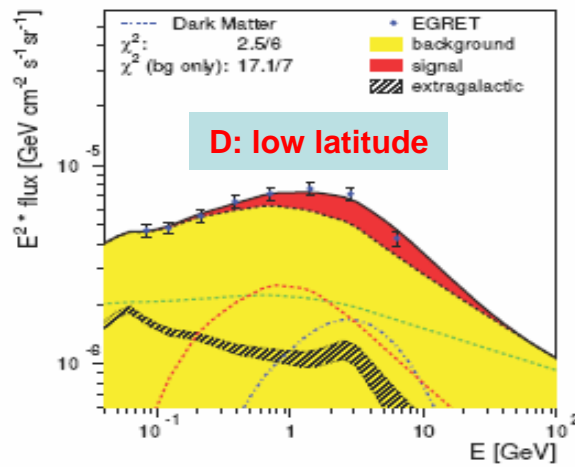
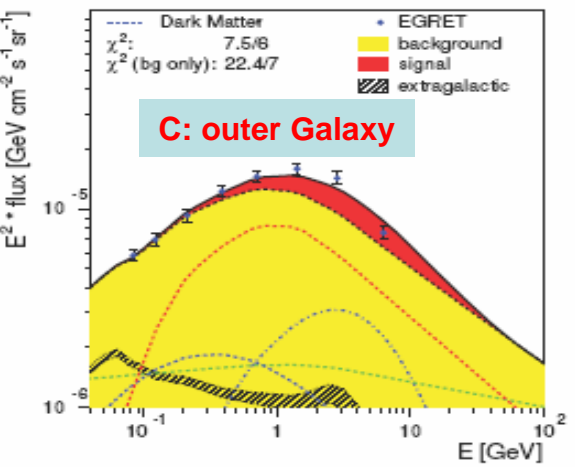
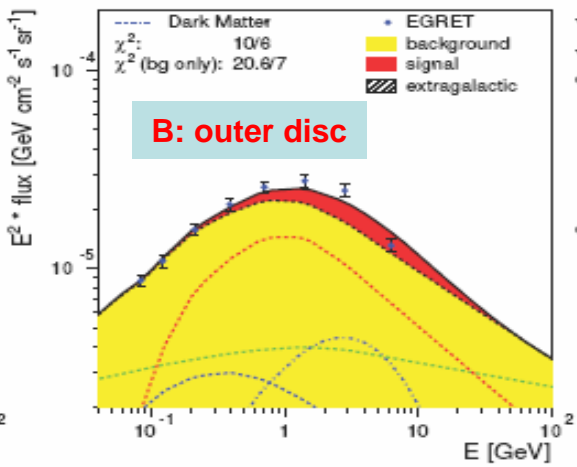
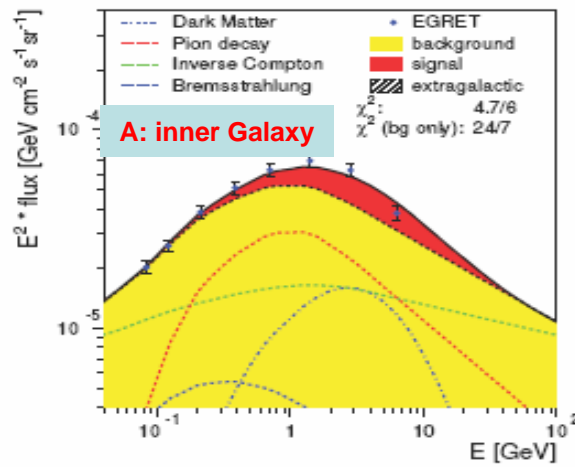
Ändere Spectren der Elektronen UND Protonen



χ^2 of optimized model: 110/42 \Rightarrow Prob. $< 10^{-7}$



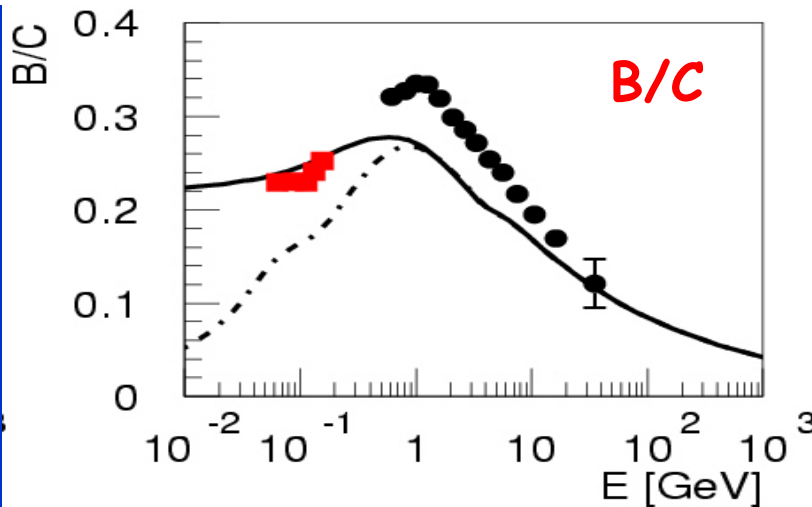
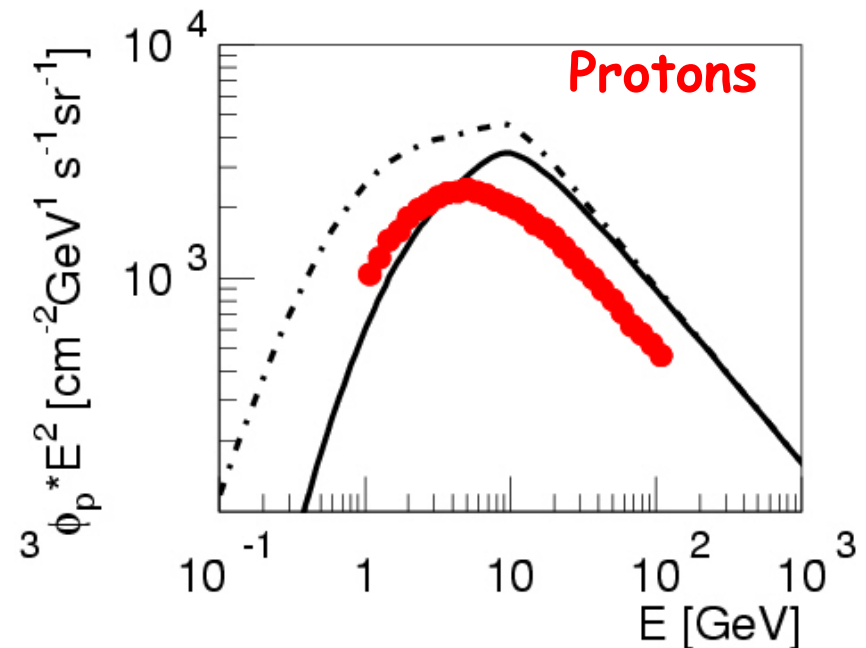
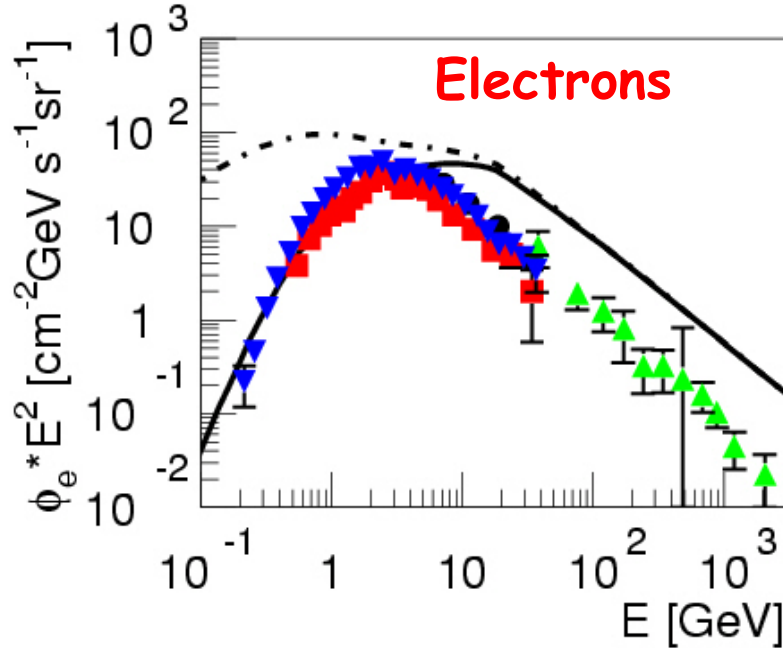
Fits für "optimiertes" Modell mit DM



**3 Komponenten: galactischer Untergrund + extragalaktisch Untergrund + DM Annihilation (mit gleicher WIMP Masse und gleicher Boostfaktor).
Fitwahrscheinlichkeit des optimierten Modells von 10^{-7} -> 0.8 mit DMA.**

Optimized Model from Strong et al. astro-ph/0406254

Change spectral shape of electrons AND protons

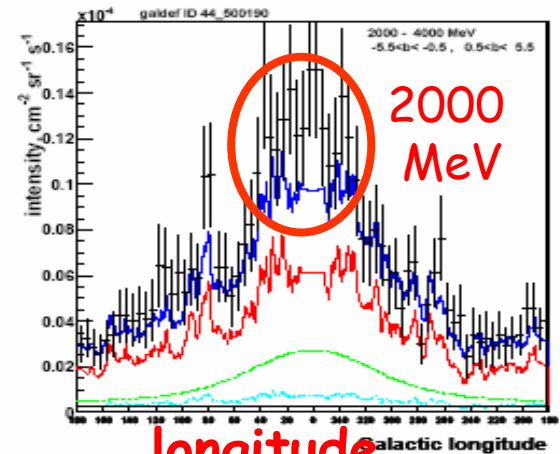
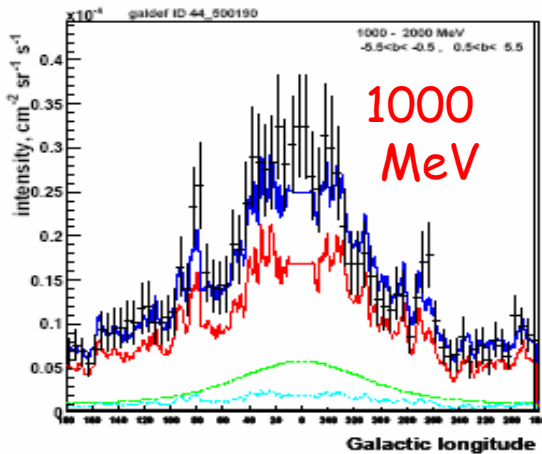
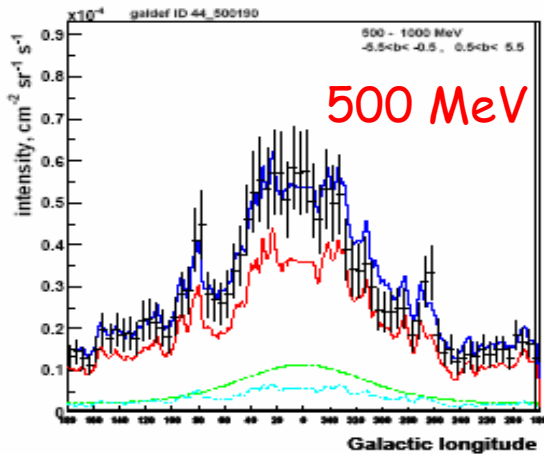
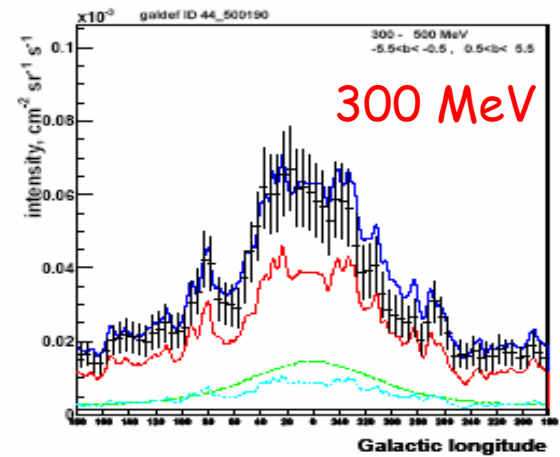
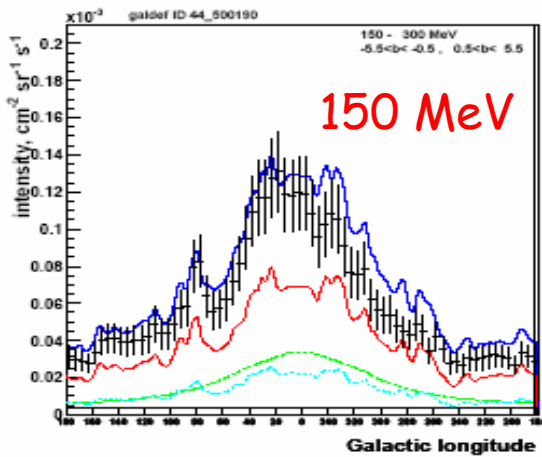
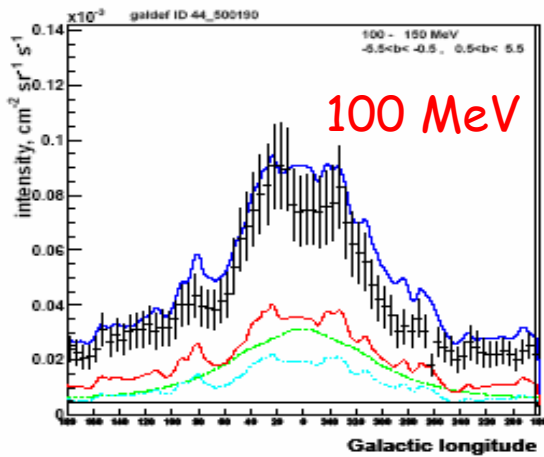


Nucleon and electron spectra tuned to fit gamma ray data.

Apart from the difficulty to have inhomogeneous nuclei spectra (SMALL energy losses!) the model does NOT describe the spectrum IN ALL DIRECTIONS!



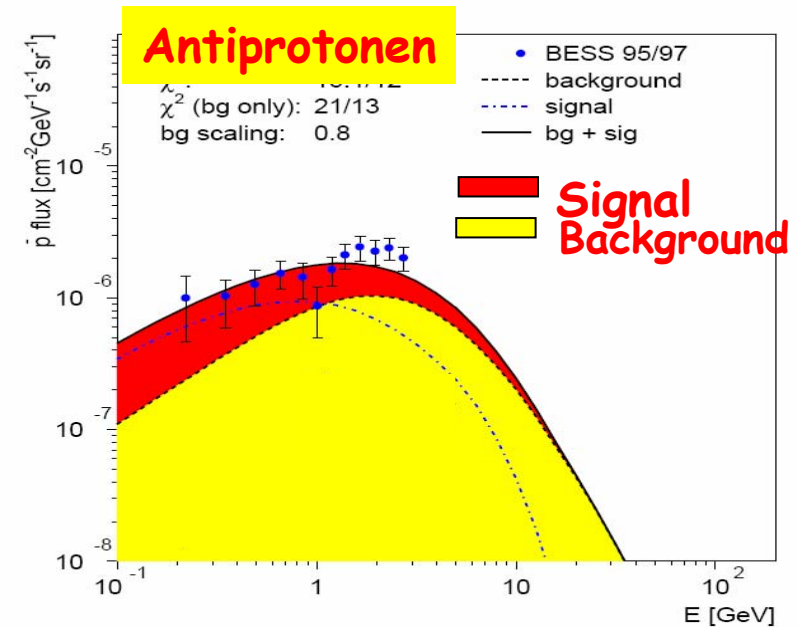
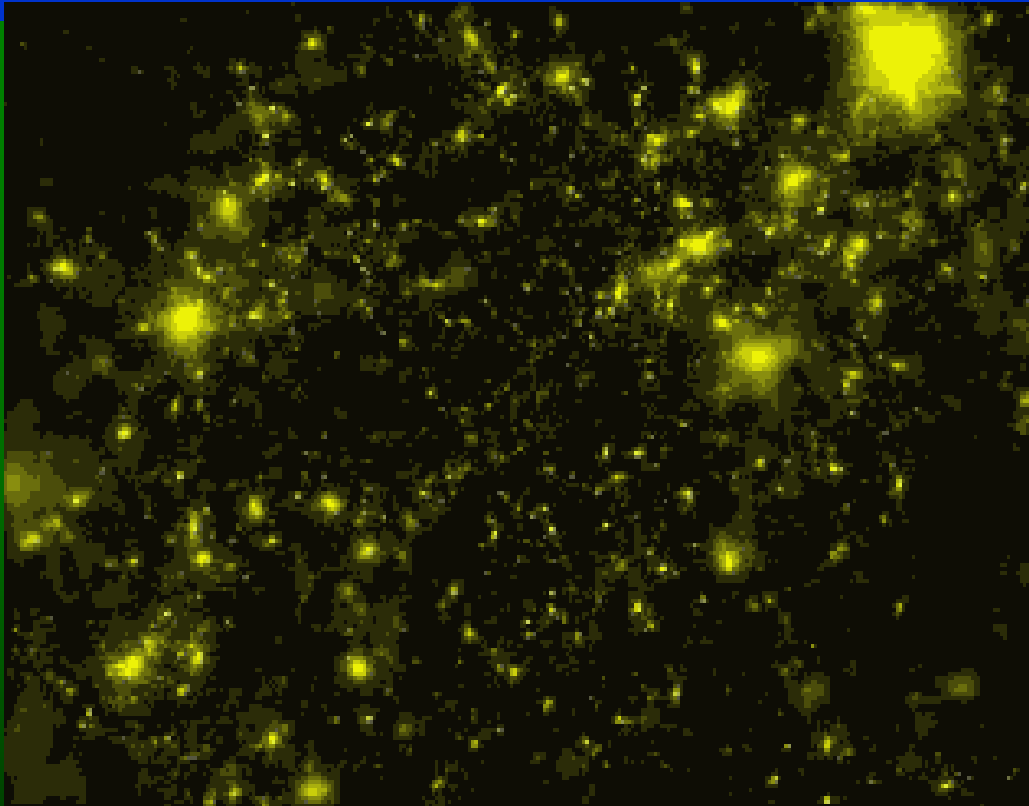
Aus Originalveröffentlichung des "Optimized Model" Strong et al. astro-ph/0406254



Problem des optimierten Modells: Daten am oberen Anschlag bei kleinen Energien und zu tief bei hohen Energien, d.h. Form des Spektrums falsch. Wenn nur Form gefittet wird, bekommt man Wahrscheinlichkeit $<10^{-7}$!

Clustering der DM -> verstärkt Annihilationsrate

Annihilation \propto Quadrat der DM Dichte



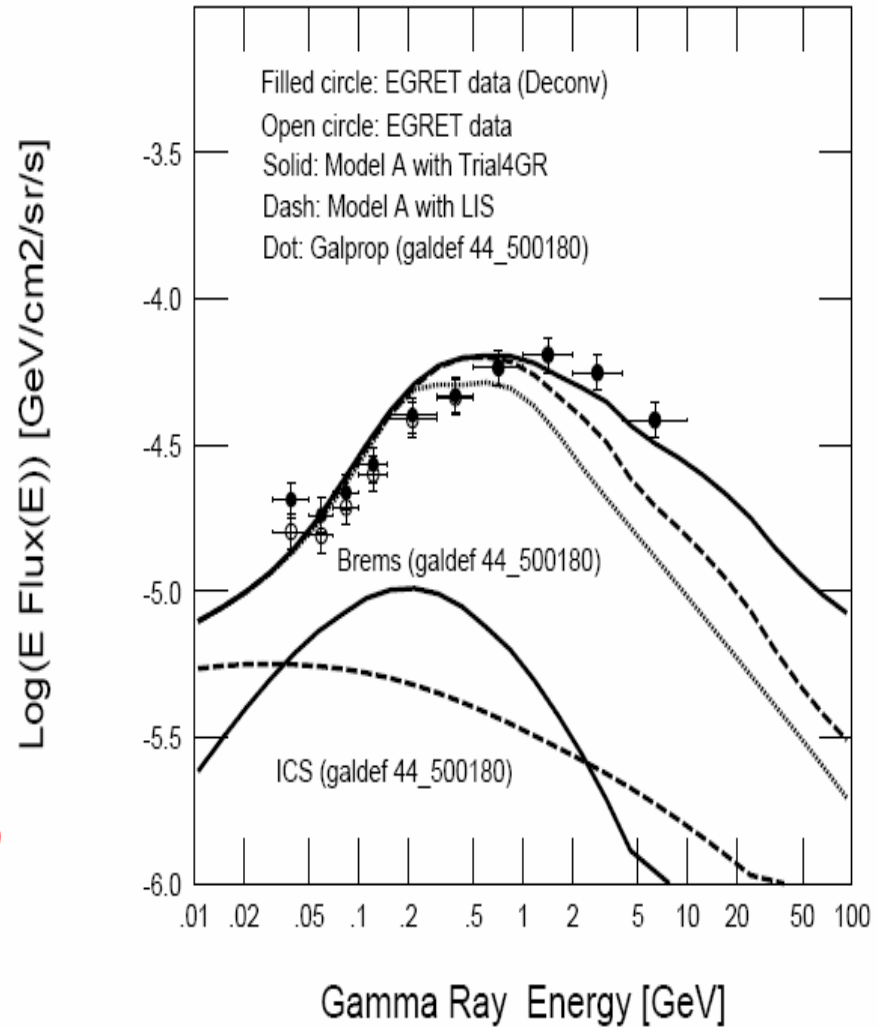
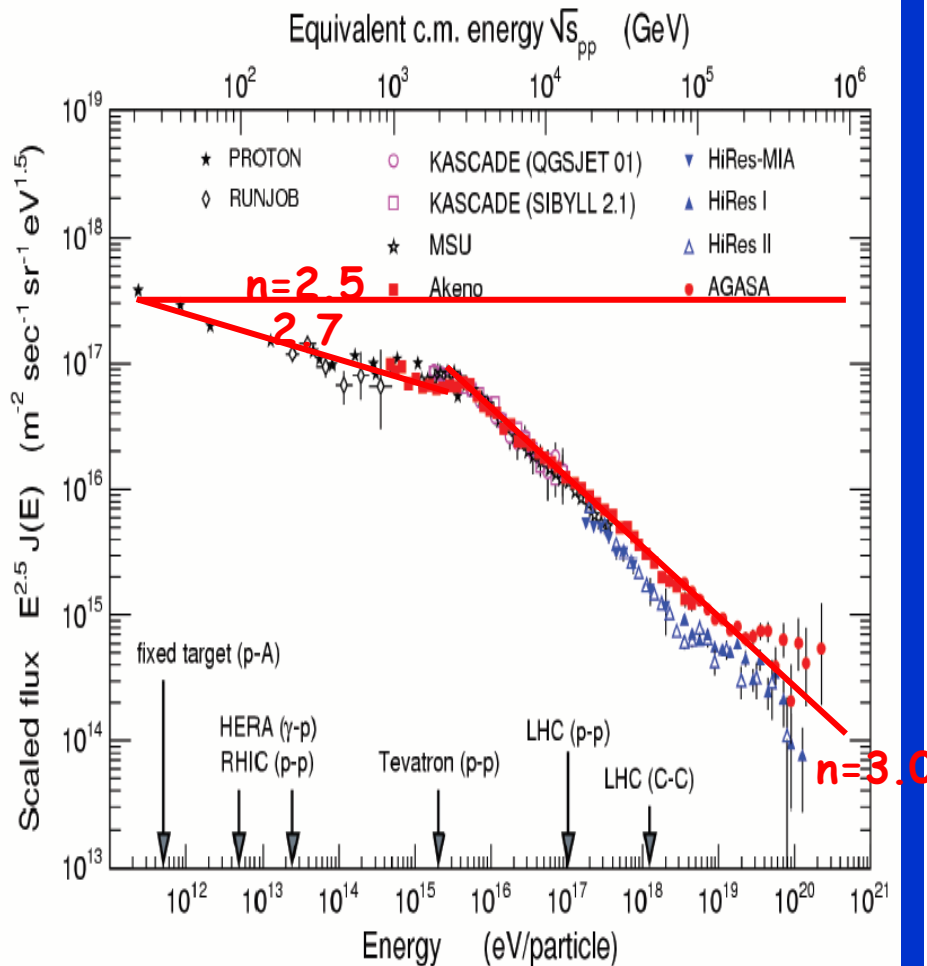
Clustergröße: \approx Solarsystem?
 $M_{\min} \cong 10^{-8} - 10^{-6} M_{\odot}$?
 (Moore et al.) (Dokuchaev et al.)
 Steil fallendes Spektrum.
 Boostfaktor $\sim \langle \rho^2 \rangle / \langle \rho \rangle^2 \sim 20-2000$
 Aus Fit: $B \approx 100$ für WIMP von 60 GeV

Annahme: baryonische Materie
 folgt Potential der DM ->
 Materie geklumpt -> verstärkte
 Annihilation der Antimaterie

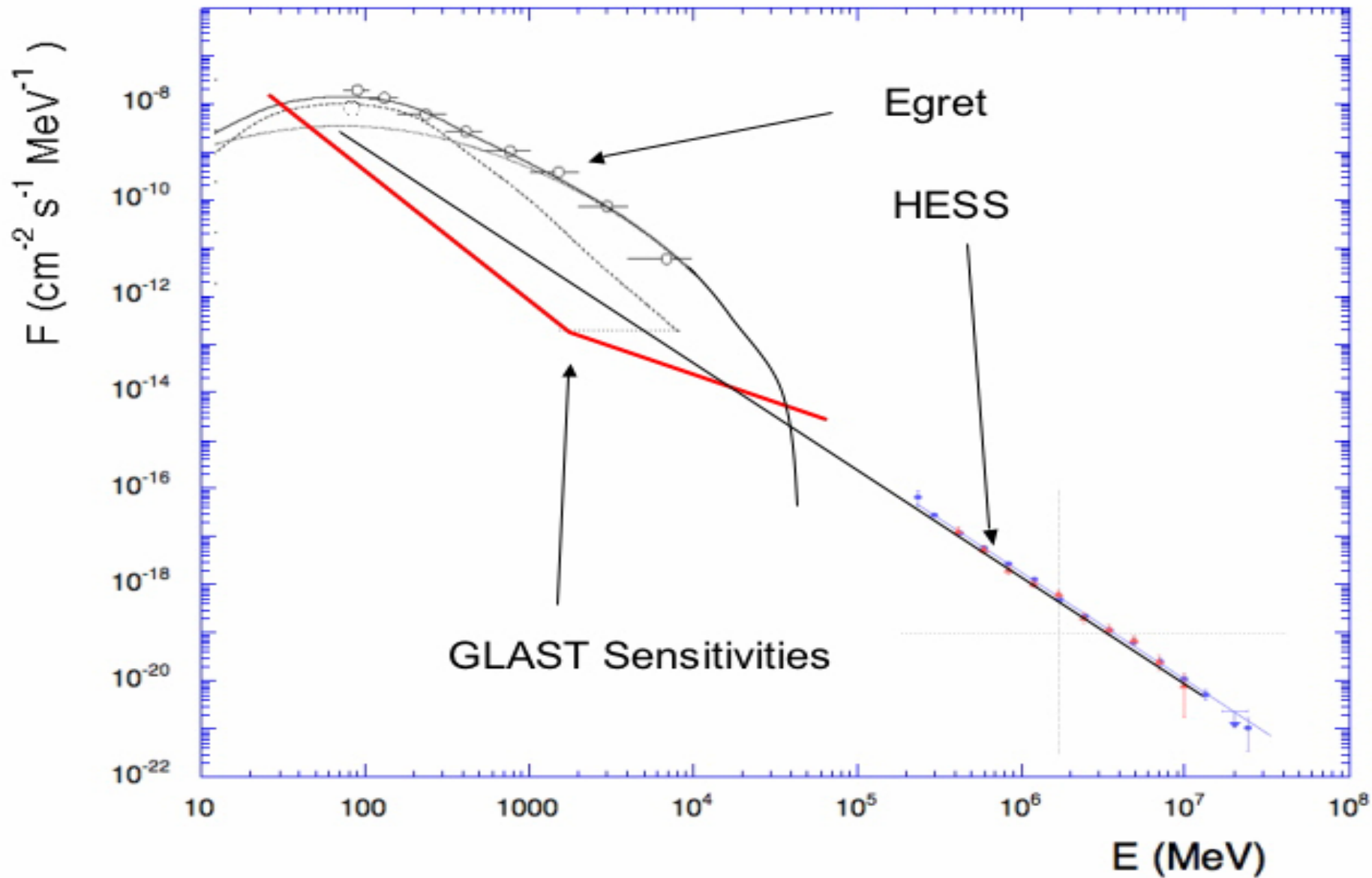
Klumpen mit M_{\min} -> dominant
 Daher VIELE KLUMPEN in
 bestimmte Richtung -> gleicher
 Boostfaktor in allen Richtungen



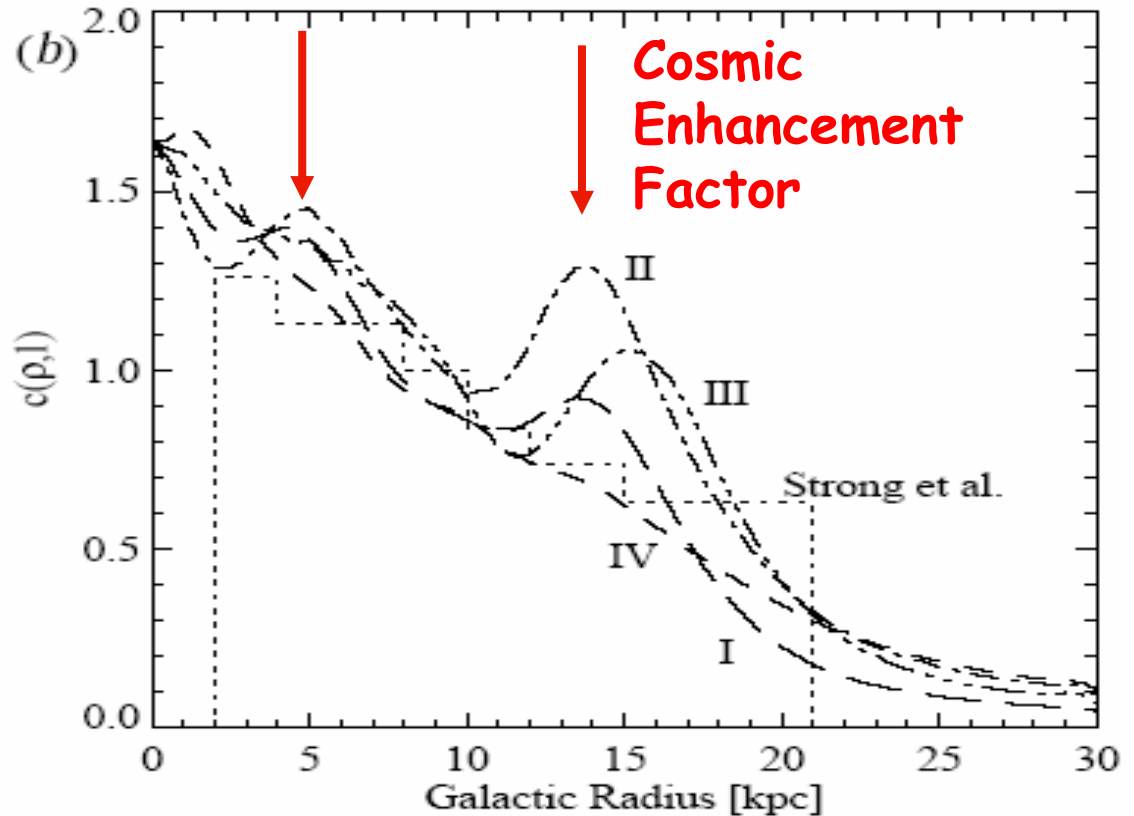
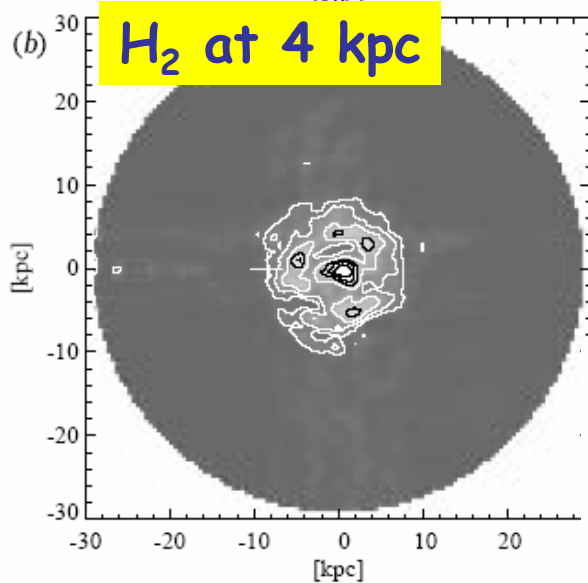
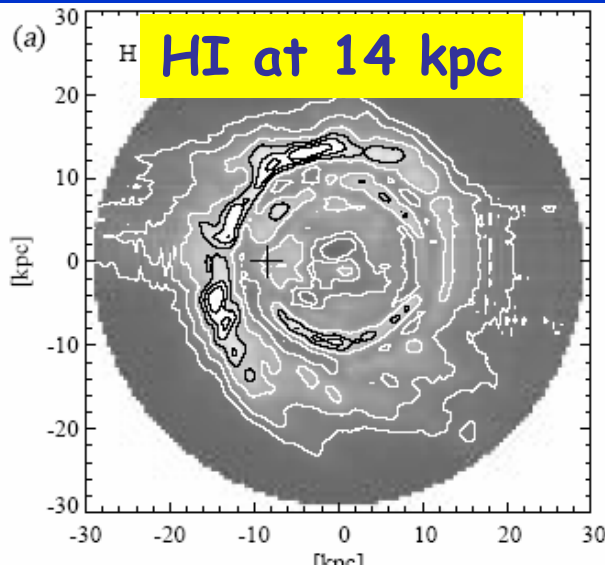
Primary cosmic ray flux $\propto E^{-n}$



Egret, GLAST and HESS



Ring auch früher schon gesehen von EGRET



THE ASTROPHYSICAL JOURNAL, 481 :205–240, 1997 May 20

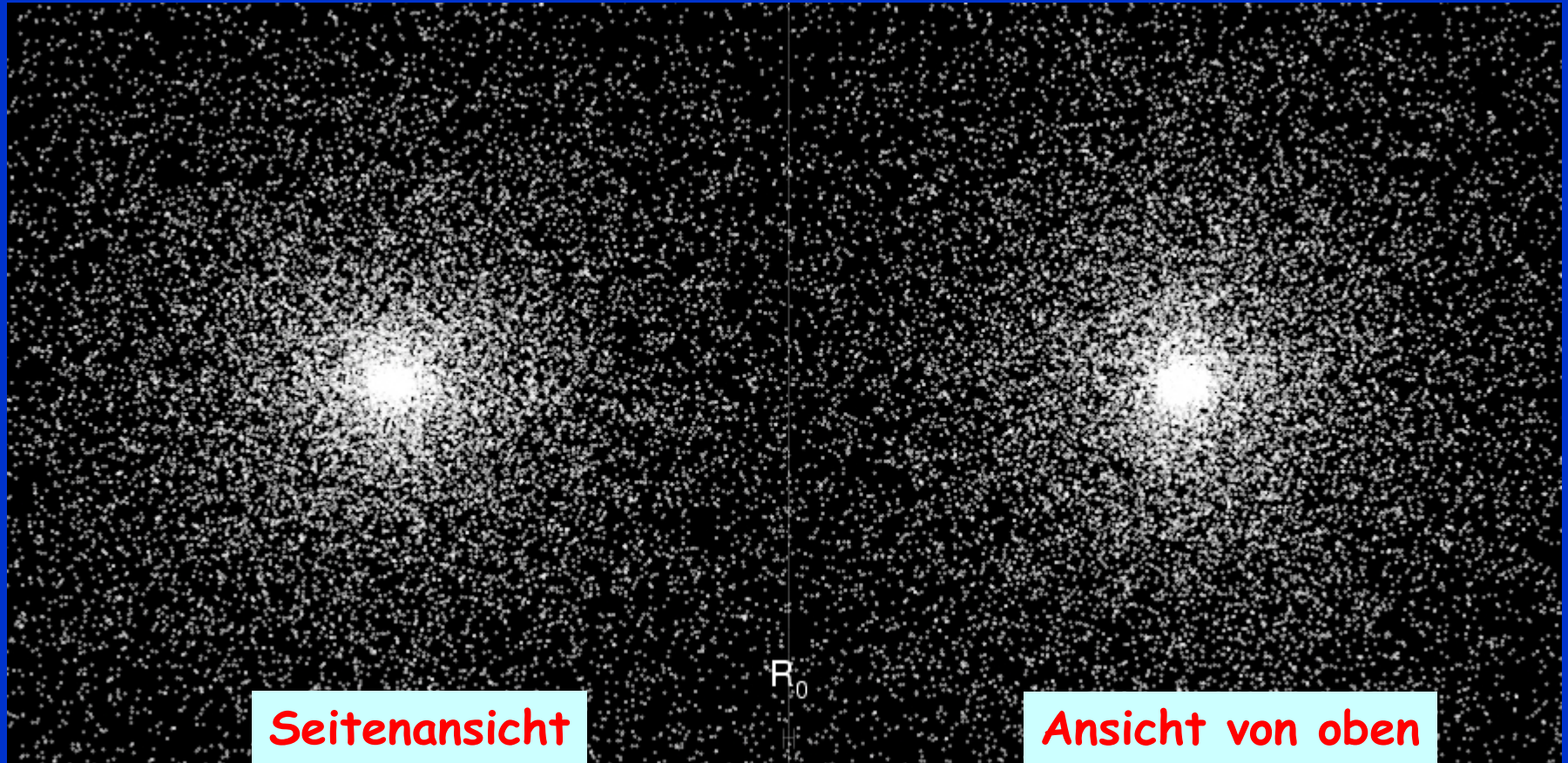
EGRET OBSERVATIONS OF THE DIFFUSE GAMMA-RAY EMISSION FROM THE GALACTIC PLANE

S. D. HUNTER,¹ D. L. BERTSCH,¹ J. R. CATELLI,^{1,2} T. M. DAME,³ S. W. DIGEL,⁴ B. L. DINGUS,^{1,5}
 J. A. ESPOSITO,^{1,5} C. E. FICHEL,¹ R. C. HARTMAN,¹ G. KANBACH,⁶ D. A. KNIFFEN,⁷ Y. C. LIN,⁸
 H. A. MAYER-HASSELWANDER,⁶ P. F. MICHELSON,⁸ C. VON MONTIGNY,^{1,9} R. MUKHERJEE,^{1,5}
 P. L. NOLAN,⁸ E. SCHNEID,¹⁰ P. SREEKUMAR,^{1,5} P. THADDEUS,³ AND D. J. THOMPSON¹

Received 1995 June 13; accepted 1996 December 5



DM Dichteverteilung auf Skale von 300 kpc



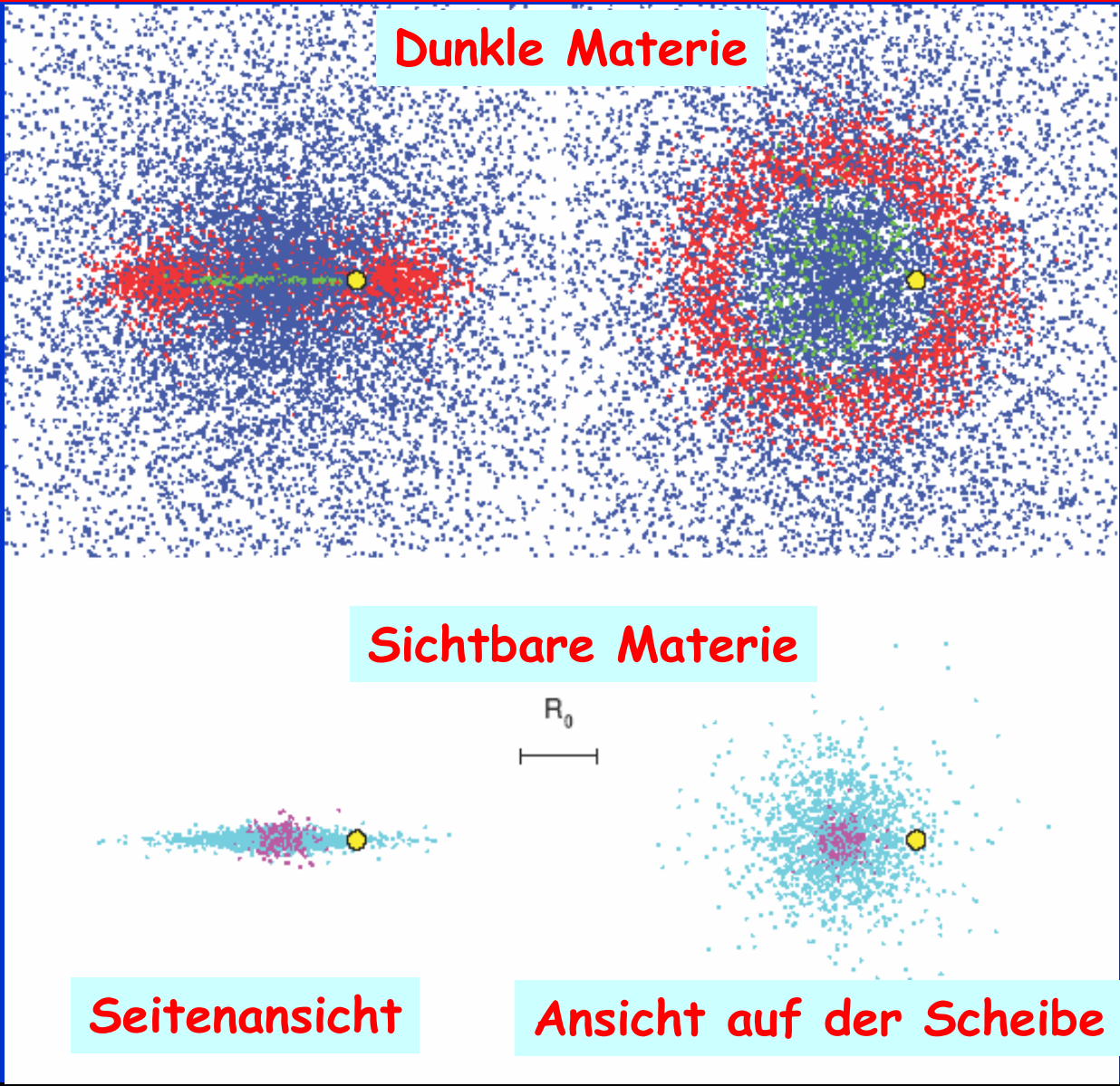
Seitenansicht

Ansicht von oben

**Isothermisches Profil mit Skale 5 kpc
Gesamtmasse: $3 \cdot 10^{12}$ Solarmassen**



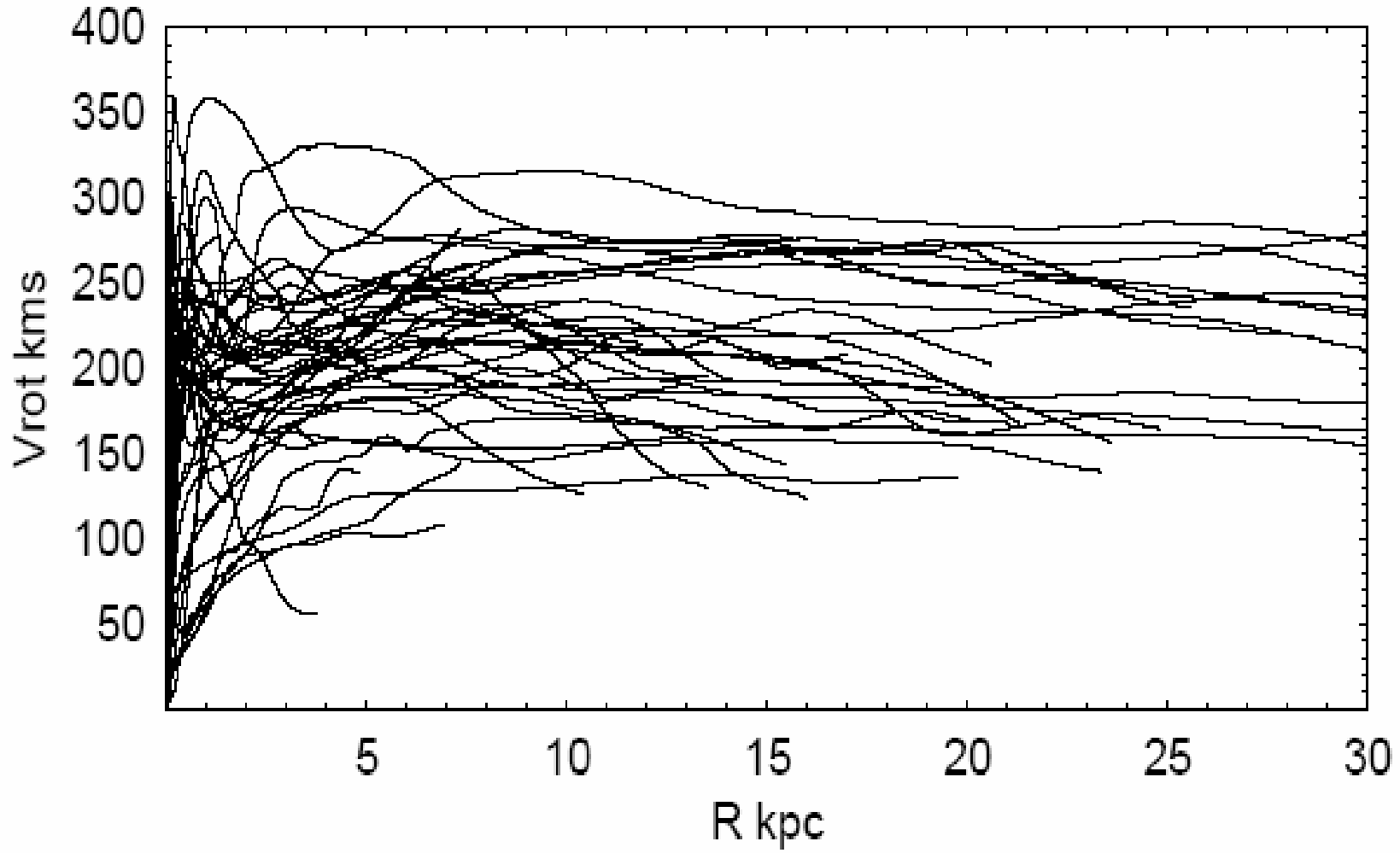
DM Dichteverteilung auf Skale von 30 kpc

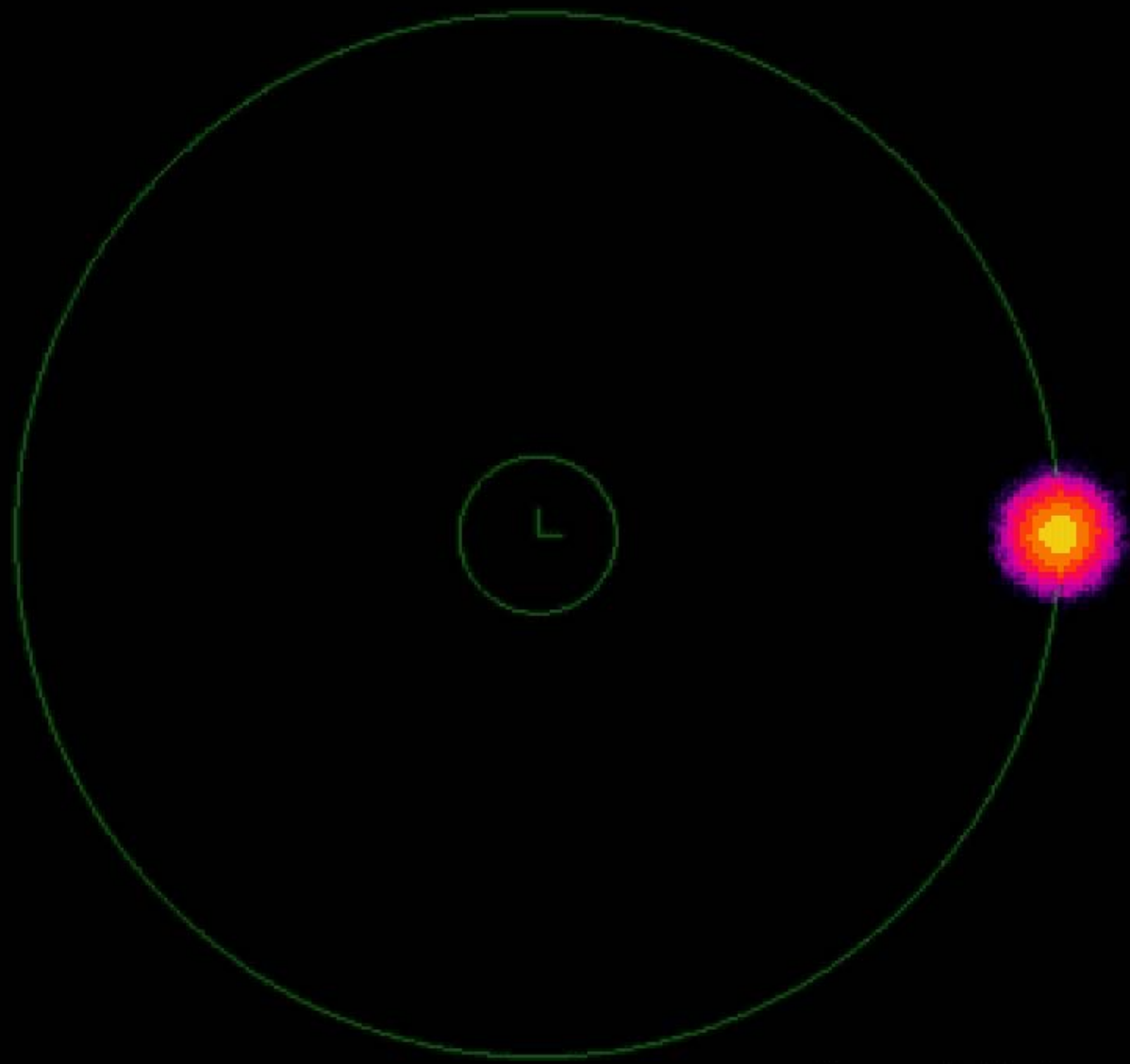




Wie sehen Rotationskurven anderer Galaxien aus?

Rotation Curves of Galaxies





time = 0.00 t_{orb}



Zusammenfassung



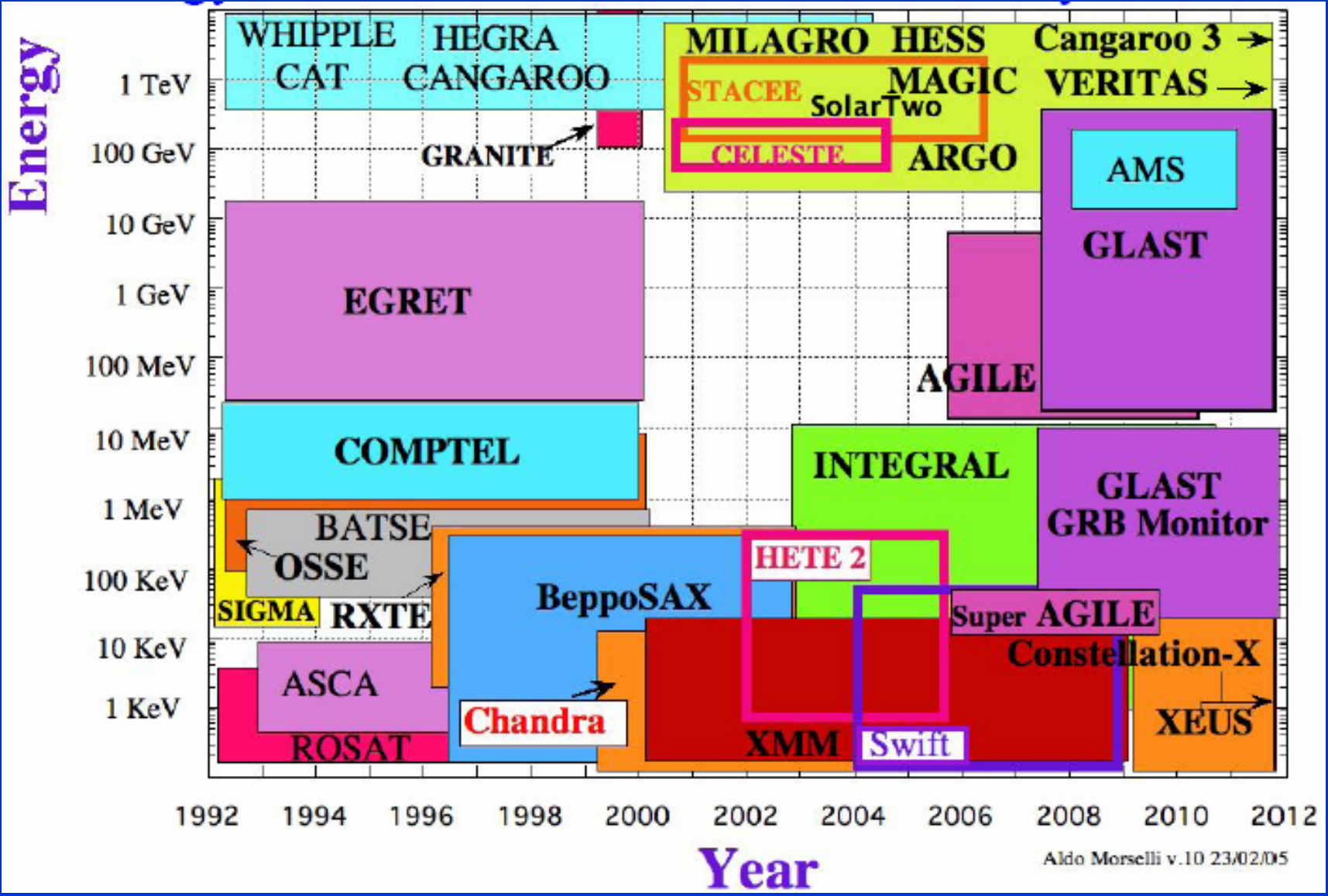
EGRET Überschuss kann:

- 1) Haloprofil bestimmen
- 2) damit äussere Rotationskurve erklären.
(hier gibt es kaum baryonische Materie)
- 3) WIMP Masse bestimmen (50-100 GeV)
- 4) Statistische Signifikanz $> 10 \sigma$

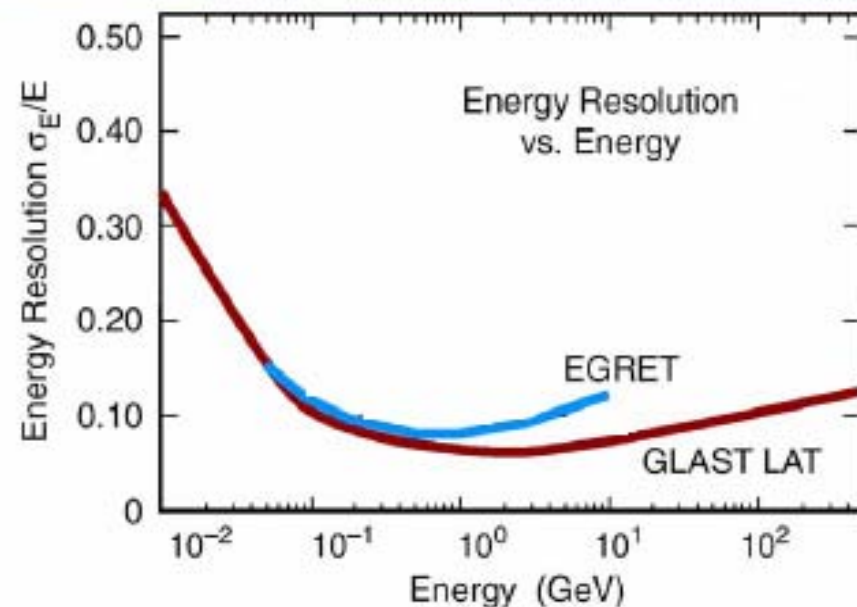
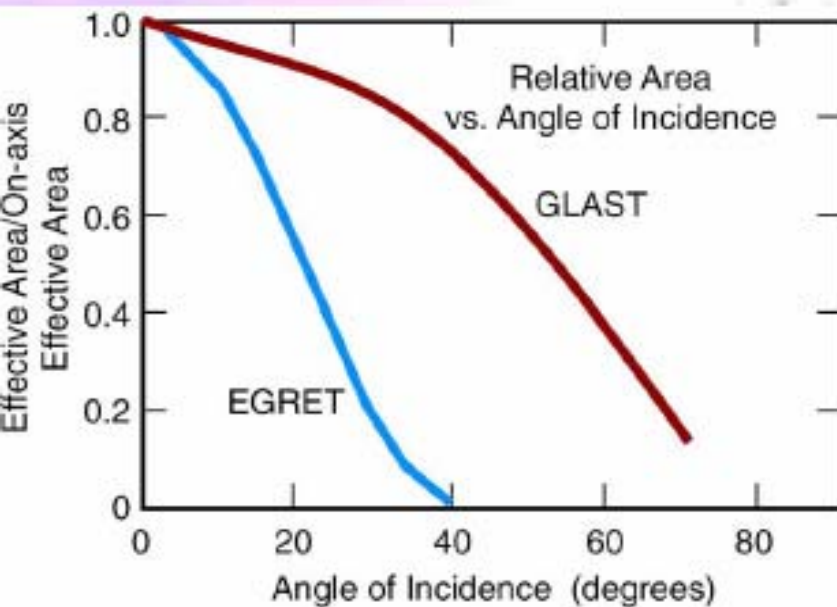
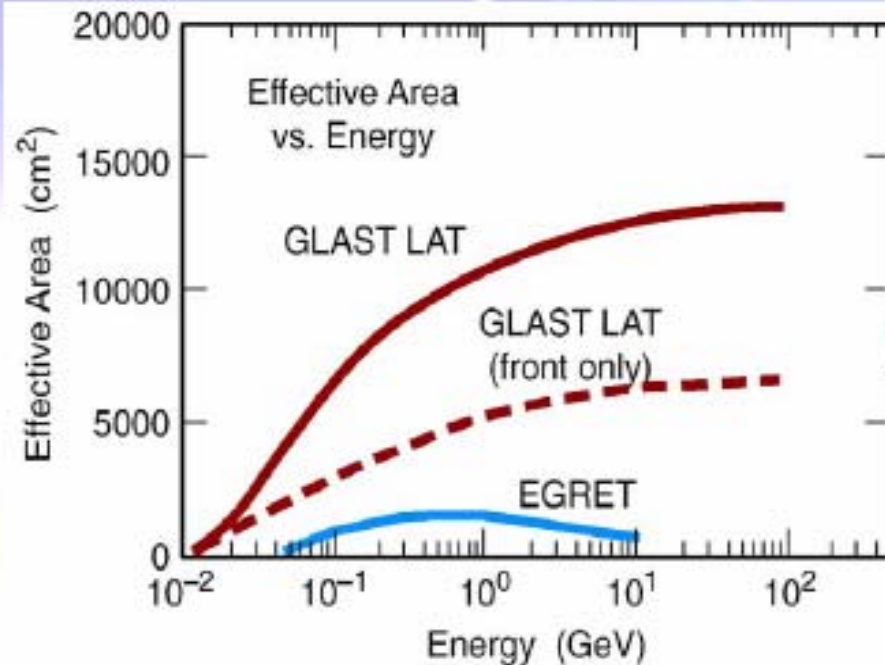
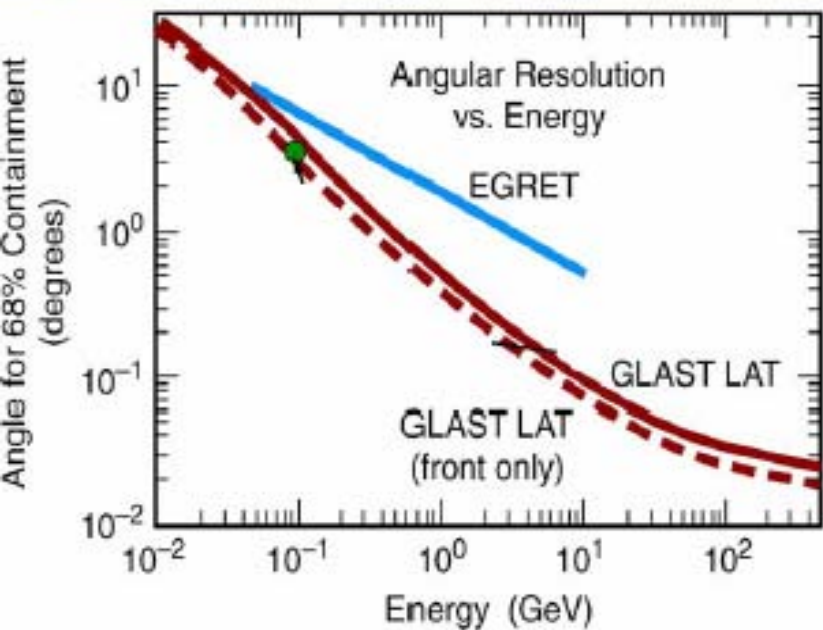
Rekonstruktion der Rotationskurve aus GAMMA Daten -> EGRET Überschuss = Tracer der Dunklen Materie!

Resultat praktisch modellunabhängig, denn nur bekannte spektrale Formen des Signals und Untergrundes benutzt, keine modellabhängige Flussberechnungen!

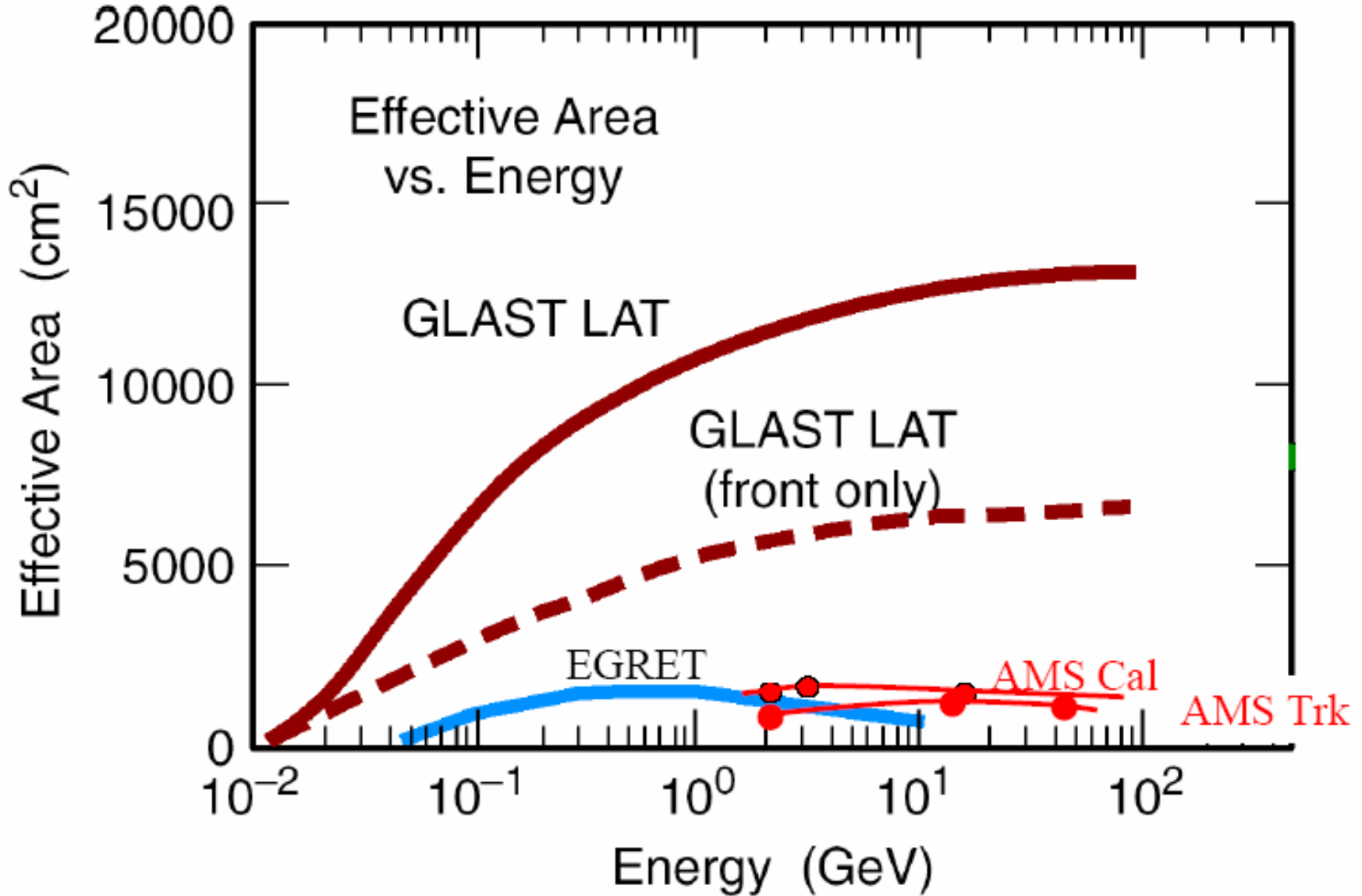
Modelle OHNE DM können nicht Spektren in ALLEN Richtungen gut bestimmen und liefern keine Erklärung für Rotationskurve und DM Strukturen bei 4 und 14 kpc.



GLAST Performance



GLAST Leistungsmerkmale



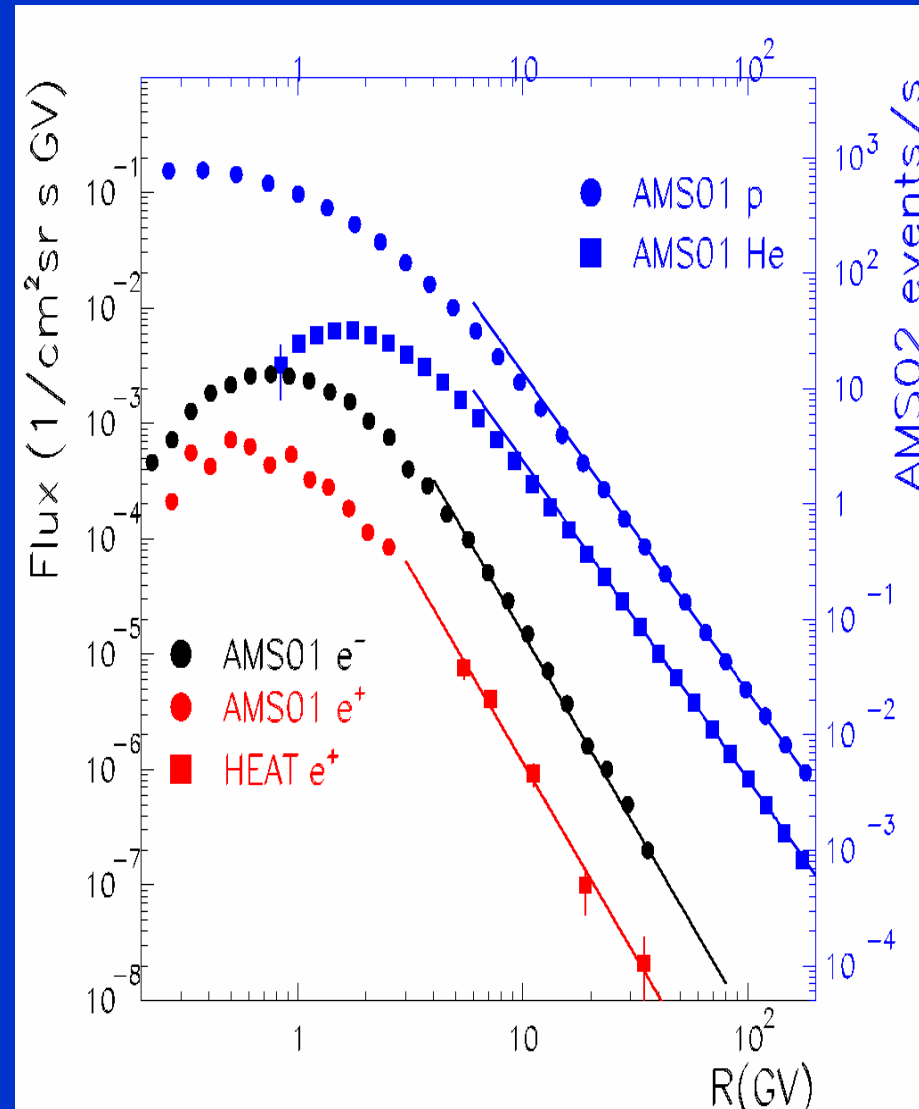


Any unidentified background produces a “WIMP” signal



Problems:

- For every antiproton at some energy there are 10,000-100,000 protons
- For every positron at some energy there are ~10,000 protons which have same charge sign
- Secondary particles (long and short lived) are locally produced
- Single scatters change apparent particle charge sign in simple trackers



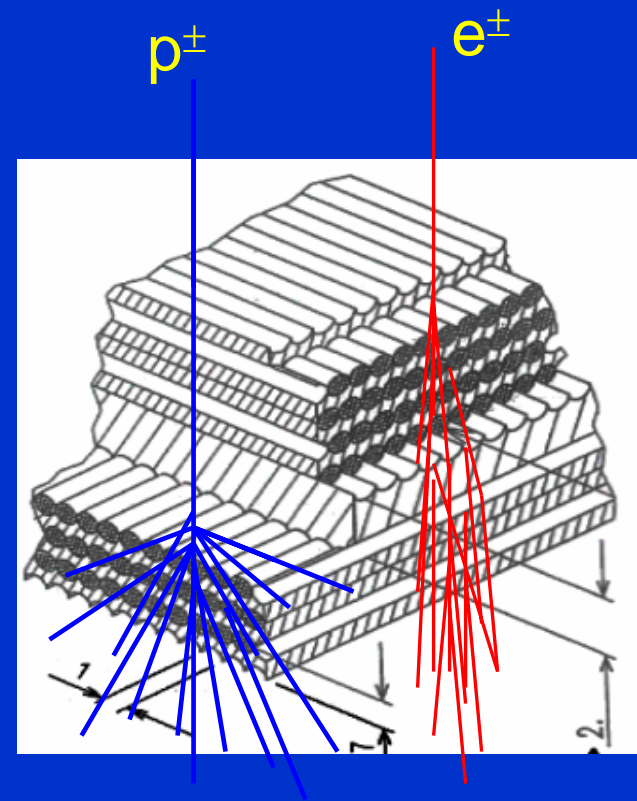


Elektromagnetisches Kalorimeter



3D sampling calorimeter

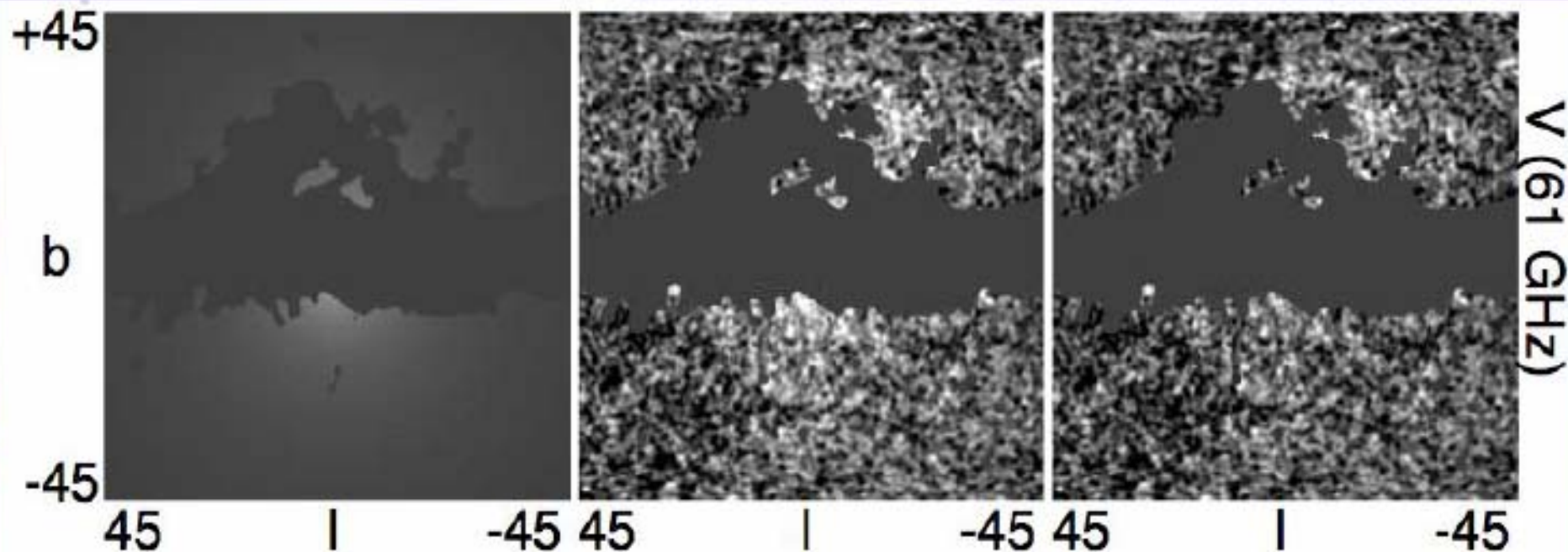
- 9 superlayers of 10 fiber/lead planes each alternate in x and y scintillating fibers viewed by PMT
- 16.4 X_0 radiation length
- Measure energy (few % resolution) and angle (1° - 0.5° angular resolution) of γ , e^+ , e^-



**10^{-3} p^\pm Rejection at 95% e^\pm Efficiency Via Shower Profile
1 GeV - 1 TeV**

Other hints?

WMAP data



Excess microwave emission observed in the inner Galaxy (1-2 Kpc, 7-14 deg) consistent with synchrotron emission from highly relativistic $e^+ e^-$ produced by 100 GeV dark matter particle annihilation.

D. P. Finkbeiner [astro-ph/0409027](#)



Beiträge der hadronischen Prozesse



PYTHIA processes:

11 $f+f' \rightarrow f+f'$ (QCD)	2370
12 $f+fbar \rightarrow f'+fbar'$	0
13 $f+fbar \rightarrow g + g$	0
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92 Single diffractive (XB)	1670
93 Single diffractive (AX)	1600
94 Double diffractive	700
95 Low-pT scattering	0
Prompt photon production:	
14 $f+fbar \rightarrow g+\gamma$	0
18 $f+fbar \rightarrow \gamma + \gamma$	0
29 $f+g \rightarrow f + \gamma$	1
115 $g+g \rightarrow g + \gamma$	0
114 $g+g \rightarrow \gamma + \gamma$	0

