

Trento Summary: **Antimatter & Dark Matter** **Search**

Th. Kirn & Th. Siedenburger

Status Dark Matter Search

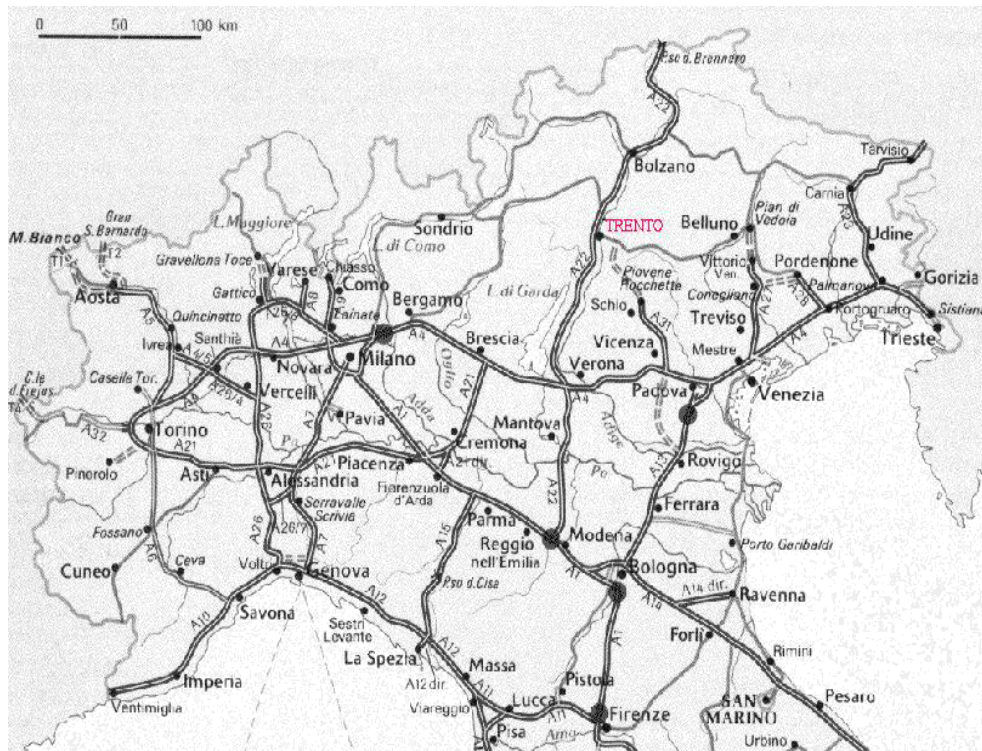
W. Wallraff

Hausseminar, November 9th 2001

Trento: Matter, Antimatter, Dark Matter

How to reach Trento by car

Along the A22 Brenner motorway and the S.S.12 Abetone and Brenner. The S.S.45 bis, Gardesana occidentale from Brescia and the Gardesana orientale from Verona; from Milan the S.S.42 to Tonale and Mendola; from Venice the S.S.47 of Valsugana; from Vicenza the S.S.46, all converge on Trento.



Villa Tambosi

II International Workshop on Matter, Antimatter and Dark Matter



ECT*, Villa Tambosi,
Trento, October 29 and 30th
2001



PROGRAM:

FIRST DAY, October 29th:

8.00 - 9.00 Registration

MORNING SESSION : 9.00 - 13.00

Chairman: M. Panasyuk

Recent Measurements on Cosmic Rays Spectra and Composition

9.00 Welcome by ECT* Scientific Secretary, Prof. Renzo Leonardi

9.05 - 9.40 R. Battiston (Perugia): Status of AMS on the ISS

9.45 - 10.10 J. Casaus (CIEMAT): Review of precision measurements on high energy hadrons

10.15 - 10.40 B. Bertucci (Perugia): Review of precision measurements on high energy leptons

10.45 - 11.00 **Coffee break**

11.00 - 11.25 P. Zuccon (Perugia): FLUKA simulation of the interaction of high energy CR with the atmosphere

11.30 - 11.55 T. Sanuki (Tokyo): Review on balloons muon measurements in the atmosphere

12.00 - 12.25 M. Gibilisco (ECT*): An analytical solution of the cosmic rays transport equation in the presence of the geomagnetic field

12.30 - 12.55 A. Sakharov (ETHZ): Macroscopically large antimatter regions in the Universe

13.15 **Lunch (Villa Tambosi)**

AFTERNOON SESSION : 14.30 - 18.30

Chairman: G. Battistoni

Interaction of Cosmic Rays with the Earth Geomagnetic Field

14.30 - 14.55 E. Fiandrini (Perugia): Trapped leptons measurement by AMS

- 15.00 - 15.25 M. Buenerd (Grenoble): Secondary atmospheric particle populations at balloon and satellite altitudes
- 15.30 - 15.55 D. Heynderickx (Belgium): Review on modelling of radiation belts
- 16.00 - 16.15 **Coffee break**
- 16.15 - 16.40 M. Casolino (Roma2): Review on NINA-1 and NINA-2 results
- 16.45 - 17.10 V. Mikhailov (Moscow): Low Energy Electrons and Positrons with Maria2 instrument
- 17.15 - 17.40 M. Panasyuk (MSU, Moscow): Review on anomalous trapped CR belts
- 17.45 - 18.10 M. Durante (Napoli): Review on biological implications of recent measurements of trapped CR on LEO
- 18.15 - 18.40 A. Masiero (SISSA): Neutrinos and cosmology today
- 20.00 **Social Dinner (Ristorante 'Orso Grigio')**

SECOND DAY, October 30th:

MORNING SESSION : 9.00 - 13.00

Chairman: F. Cervelli

Recent Developments on atmospheric neutrinos

- 9.00 - 9.25 M. Shiozawa (ICRR, Tokyo): Review of experimental results on cosmic rays neutrinos
- 9.30 - 9.55 M. Vietri (Roma3): Extreme Energy Cosmic Rays and their sources and neutrino astronomy
- 10.00 - 10.25 T. Stanev (Bartol): State of the art in calculations of the atmospheric neutrino flux
- 10.30 - 10.45 **Coffee break**
- 10.45 - 11.10 V. Plyaskine (ITEP): A recent new atmospheric neutrinos calculation
- 11.15 - 11.40 G. Battistoni (Milano): Calculation of secondary particle production in atmosphere and hadronic interaction
- 11.45 - 12.10 F. Vissani (LNGS): Massive neutrinos and theoretical developments
- 12.15 - 12.40 F. Ci (Pisa): Supernovae neutrinos (experimental status)
- 13.00 **Lunch (Villa Tambosi)**

AFTERNOON SESSION : 14.30 - 18.30

Chairman: B. Bertucci

Dark matter and gamma rays

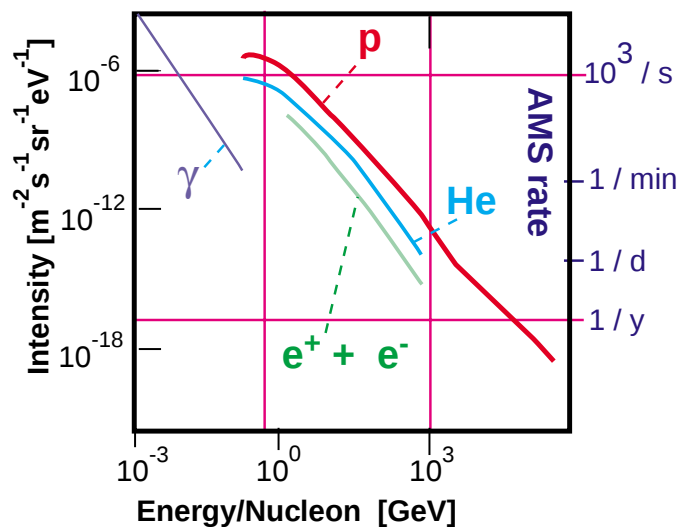
- 14.30 - 14.55 P. Ullio (SISSA): Review of CR and Dark Matter Searches
- 15.00 - 15.25 P. Giommi (ASI SDC): Review of previous X-rays missions
- 15.30 - 15.55 N. Produit (Versoix): INTEGRAL, a gamma ray observatory
- 16.00 - 16.15 **Coffee break**
- 16.15 - 16.40 M. Tavani (Milano): Theoretical review on physics with gamma rays
- 16.45 - 17.10 M. Pohl (Geneva): Gamma physics with AMS
- 17.15 - 17.40 V. Choutko (MIT): AMS background studies for positrons and gamma rays
- 17.45 - 18.10 A. Morselli (Roma2) : Dark Matter Search with gamma rays with EGRET and GLAST

Antimatter Search

Composition and Energy Spectrum of Cosmic Rays

Relative abundance of particles, elements and isotopes is related to:

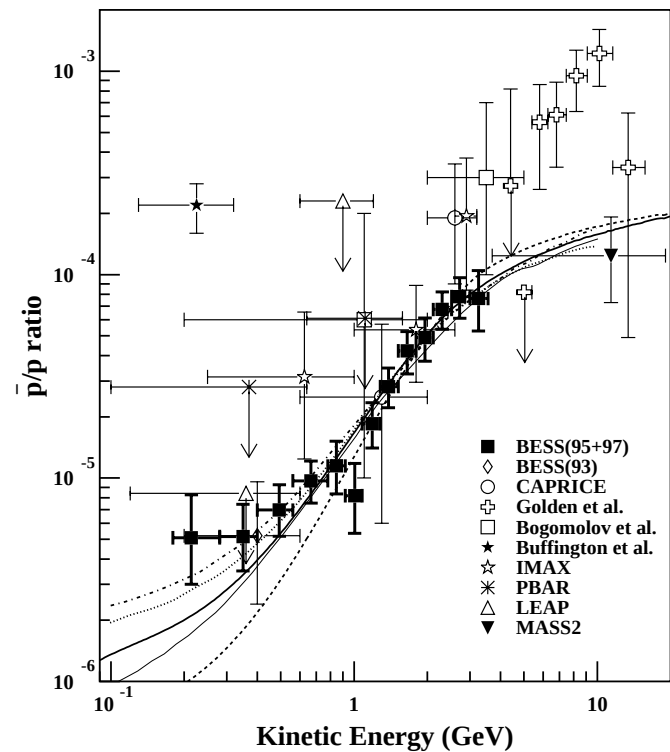
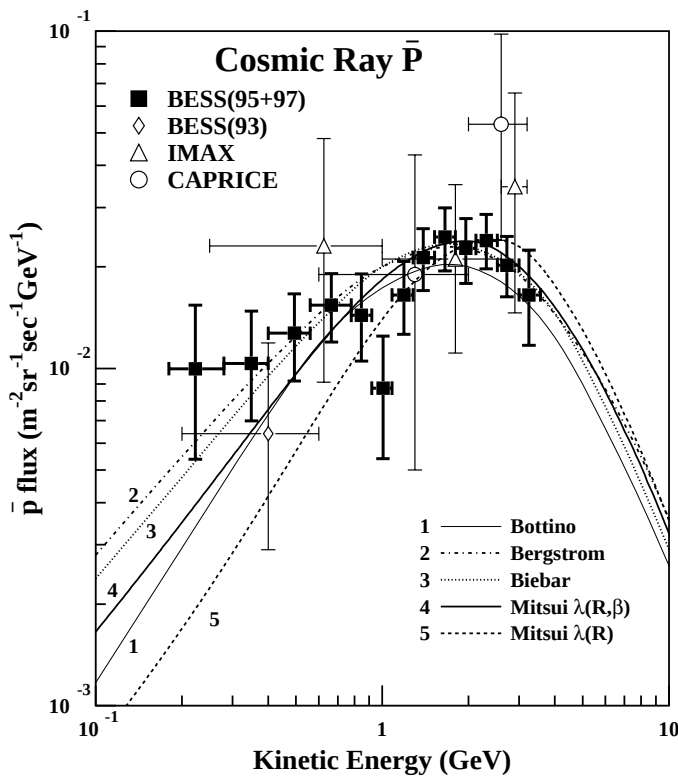
- **Primordial nucleosynthesis** for the particles created just after the Big-Bang:
 $\gamma, p, e, D, He^4, He^3, Li^7$
- **Astrophysical sources** accelerating primaries:
 e, p, He, C, O, Fe
- Interactions with **interstellar gas** create secondaries:
 $e^\pm, p, \bar{p}, Li, Be, B$
- propagation described by **Leaky Box model**



Direct Antimatter Search

- $\bar{p}$:

- Measurements do not provide evidence for extragalactic antimatter
- $\bar{p}$ -flux near earth can be explained mainly by secondary interactions of cosmic rays



Direct Antimatter Search

- antinucleon:

→ Discovery of antinucleus ($\overline{He}$) $\Rightarrow$ evidence for cosmologically significant amounts of antimatter

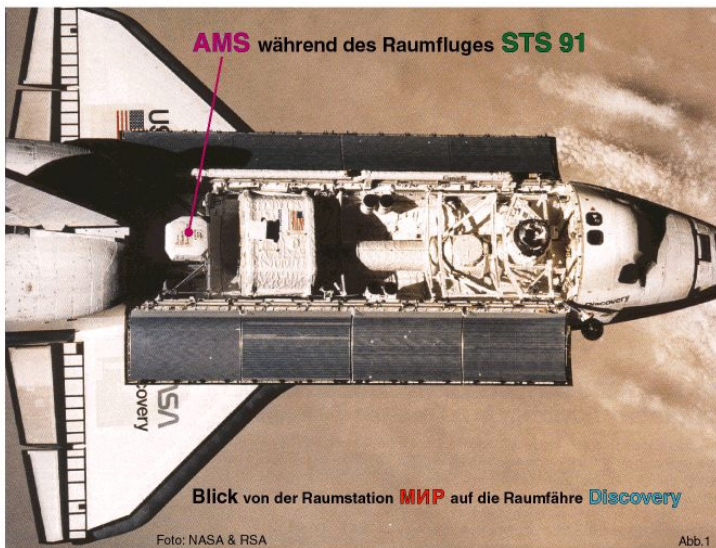
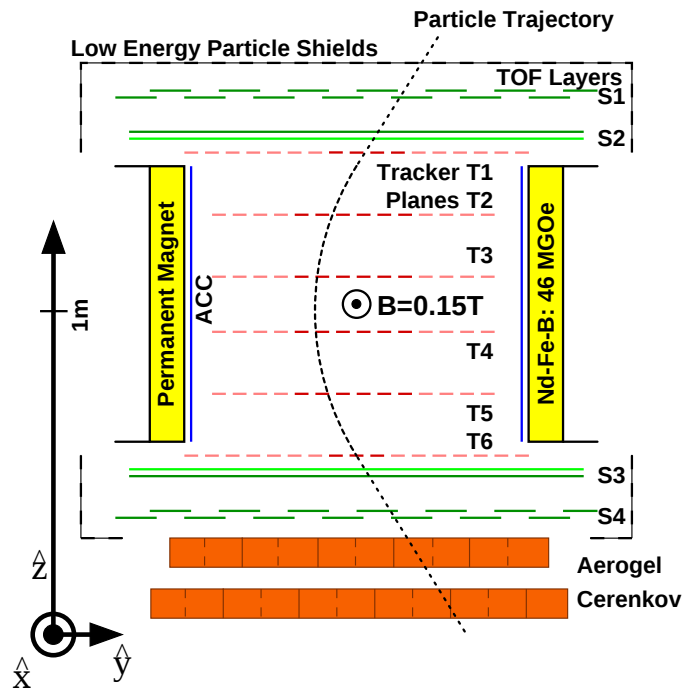
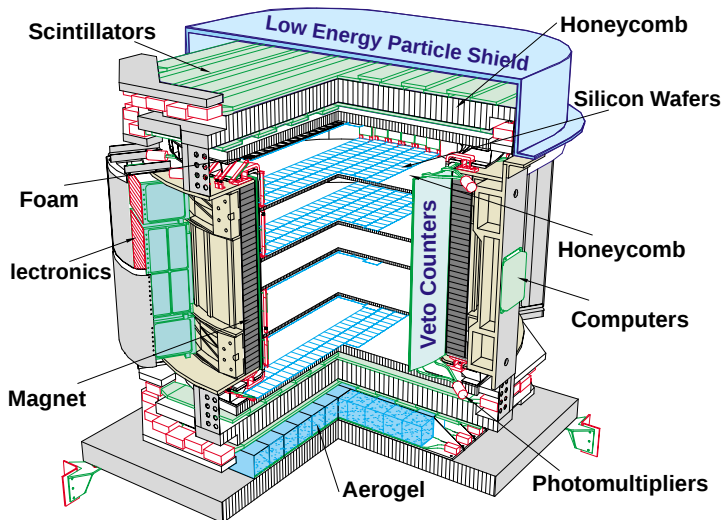
→ Discovery of $\overline{C}$ $\Rightarrow$ antistars

Presently, no antinucleus with $Z \geq 2$ has ever been found in cosmic radiation

- ASM-01 98: $\overline{He}/He < 1.1 \cdot 10^{-6}$; $R < 100GV$

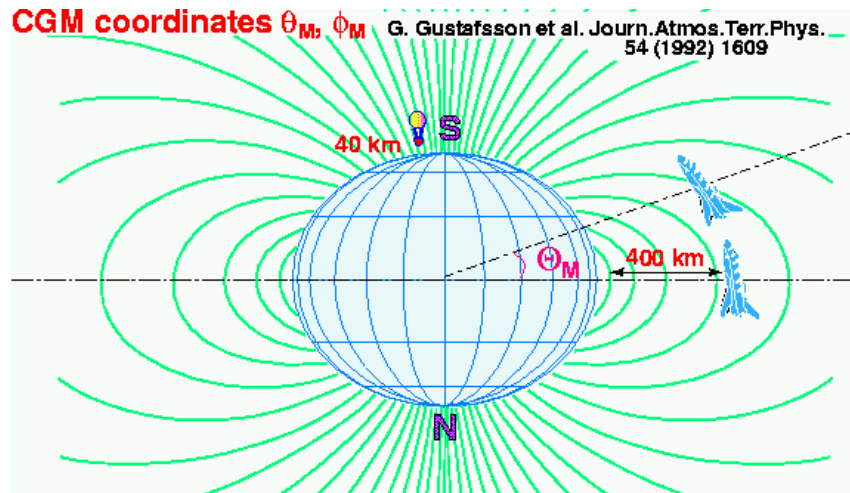
- BESS 93-98: $\overline{He}/He < 1.0 \cdot 10^{-6}$; $R < 16GV$

AMS01 STS-91 Precursor Flight

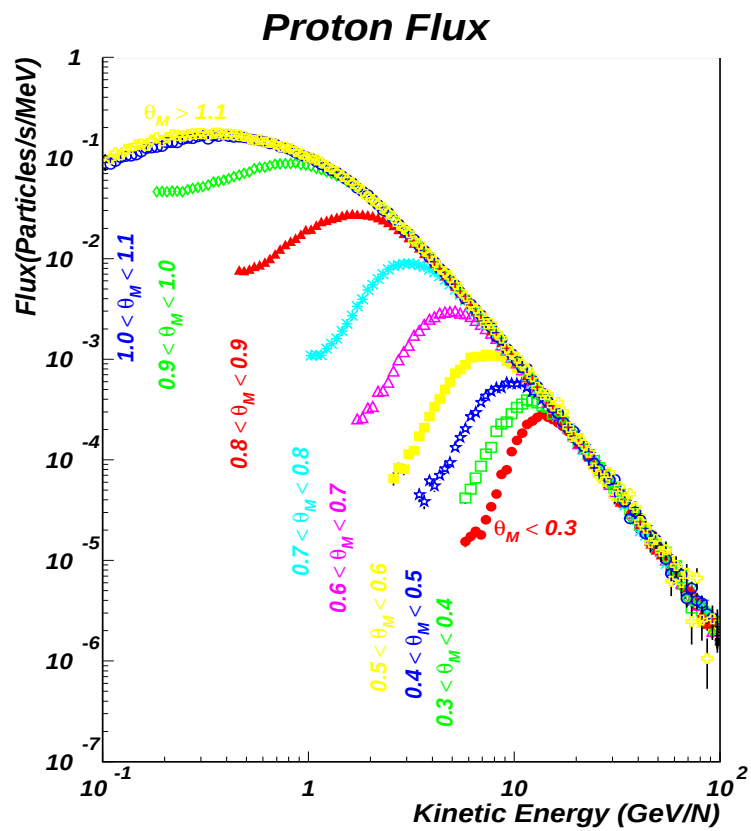


- STS91 2-11 June 1998
Shuttle Discovery
- Mean altitude 370 km
- 90 min orbit inclined at 51.7°
- Trigger-rate 100-700 Hz
- Recorded 10^8 events in 100 h

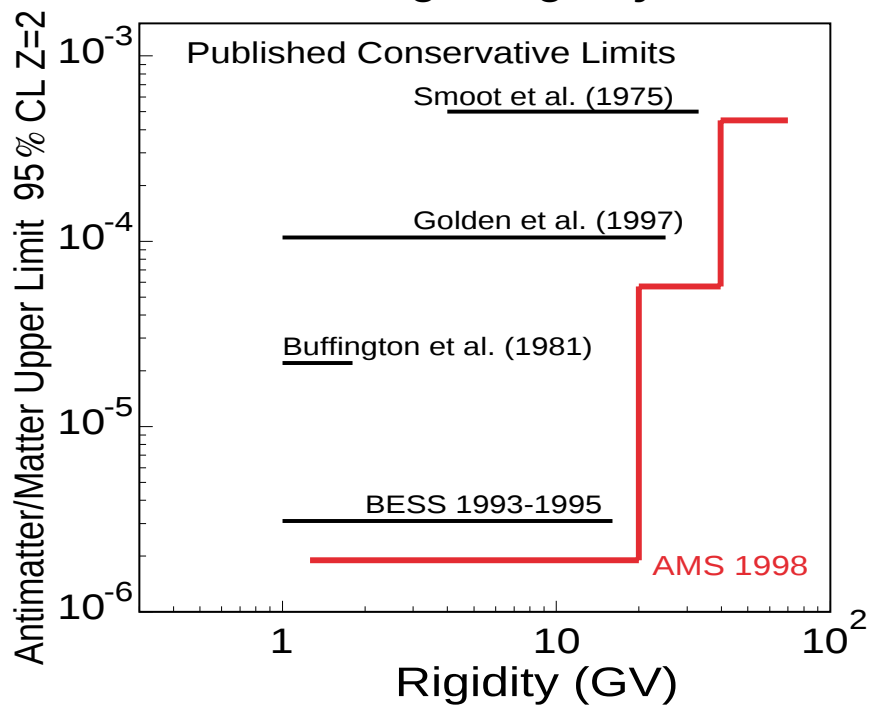
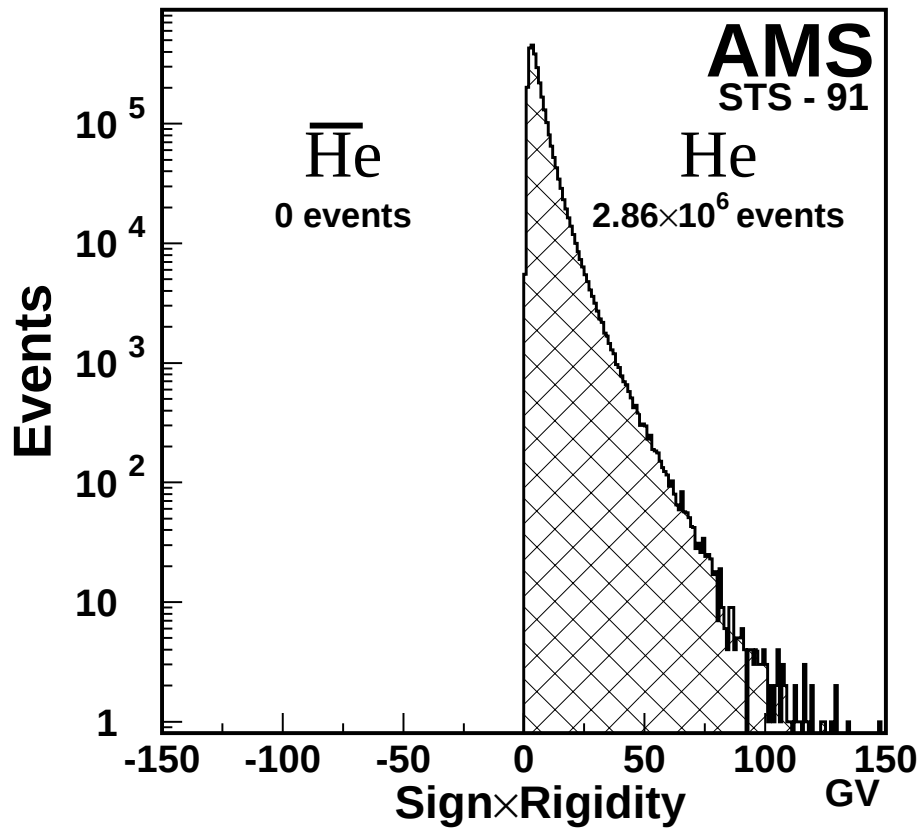
AMS01 Results



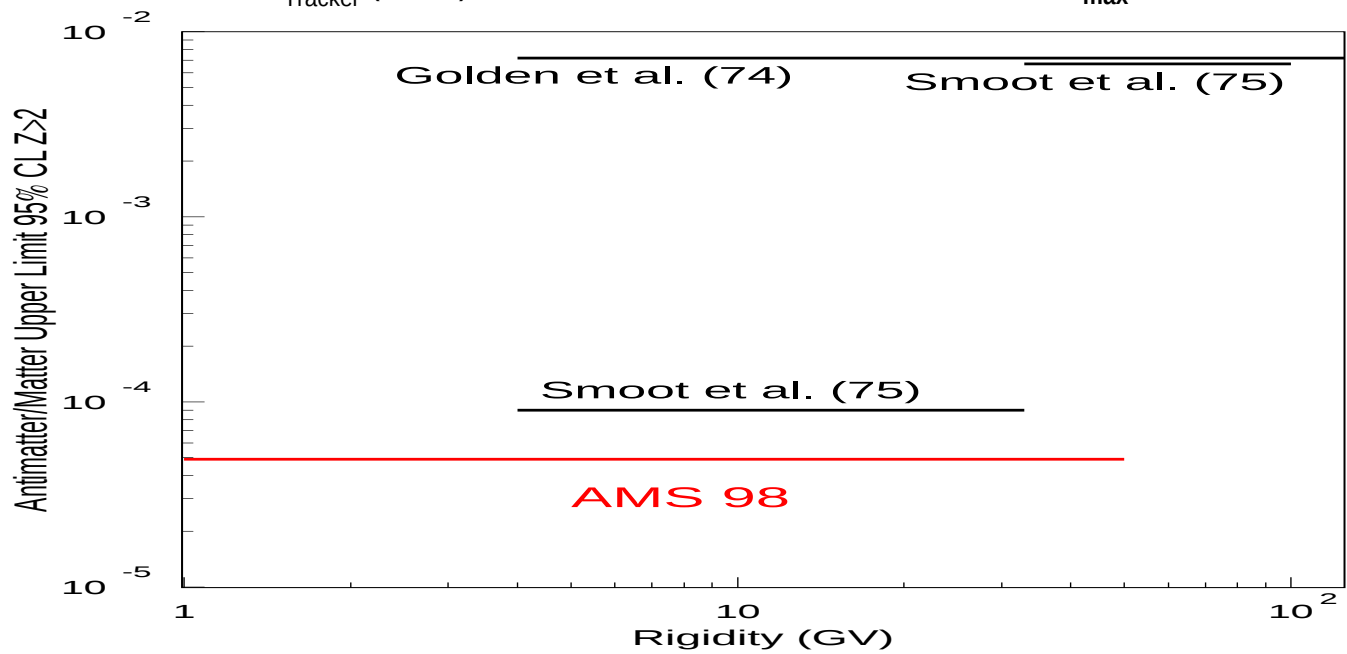
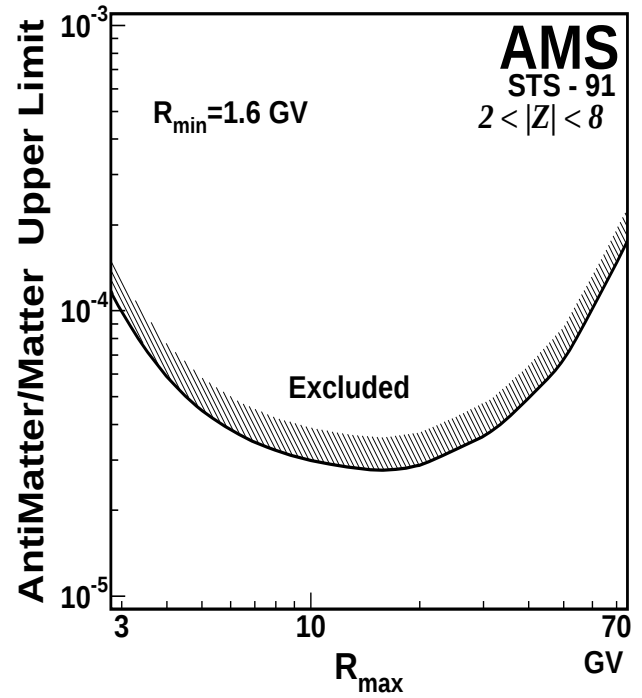
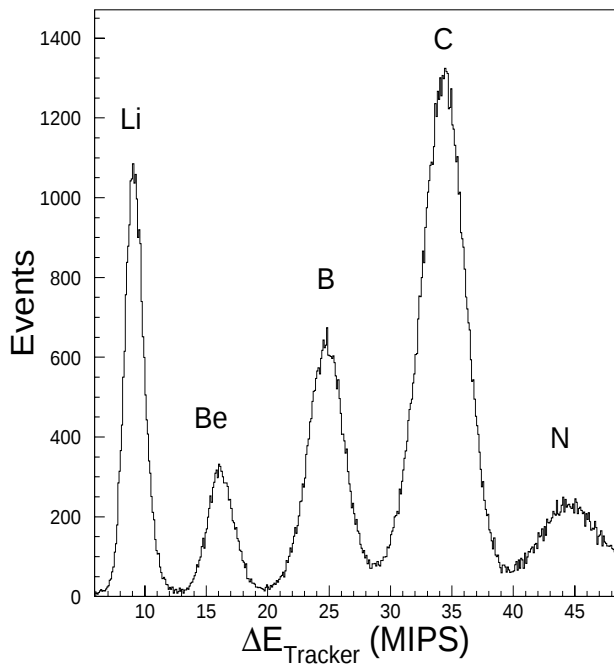
Maximum *rigidity* (p/Z) depends on *magnetic* latitude



AMS01 Results



AMS01 Results



AMS02 – A Particle Spectrometer for ISS

How to suppress proton background to 10^{-6} and perform high statistic tracking up to 1 TV?

Large acceptance $0.5 \text{ m}^2\text{sr}$ in orbit for 3 years

TRD Particle ID & 3D tracking

20 layers fleece + Xe/CO₂

5248 channels 6mm straw-tubes

$$p^+/e^+ < 10^{-2} \text{ (10 - 300 GeV)}$$

TOF 1,2 Trigger $\sigma_t \approx 125\text{ps}$

Anticoincidence (Veto) counter

Silicon strip tracker

with internal laser alignment

6 m^2 in 3 double + 2 single xy layers

1σ charge separation up to 1TV

Superconducting Magnet (ETH)

$$B = 0.9\text{T} \quad V = 0.6\text{m}^3$$

TOF 3,4 1.3m distance to TOF 1,2

$$p^+/e^+ > 3\sigma \text{ below } 2 \text{ GeV}$$

PFRICH AGL(+NaF) Radiator

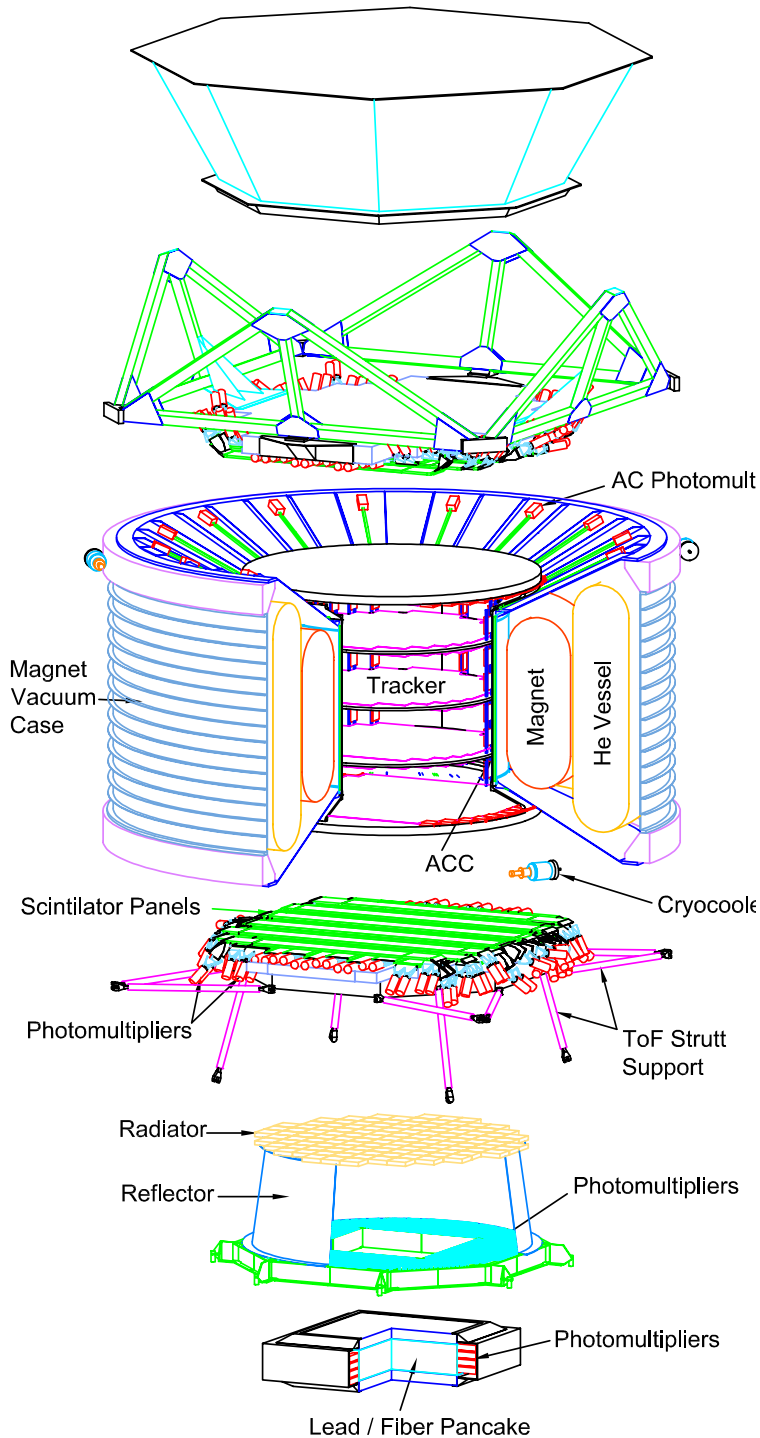
for $A \leq 27$ and $Z \leq 28$

separation $> 3\sigma$ from 1-12 GeV

ECAL 3D sampling lead/scint.-fibre

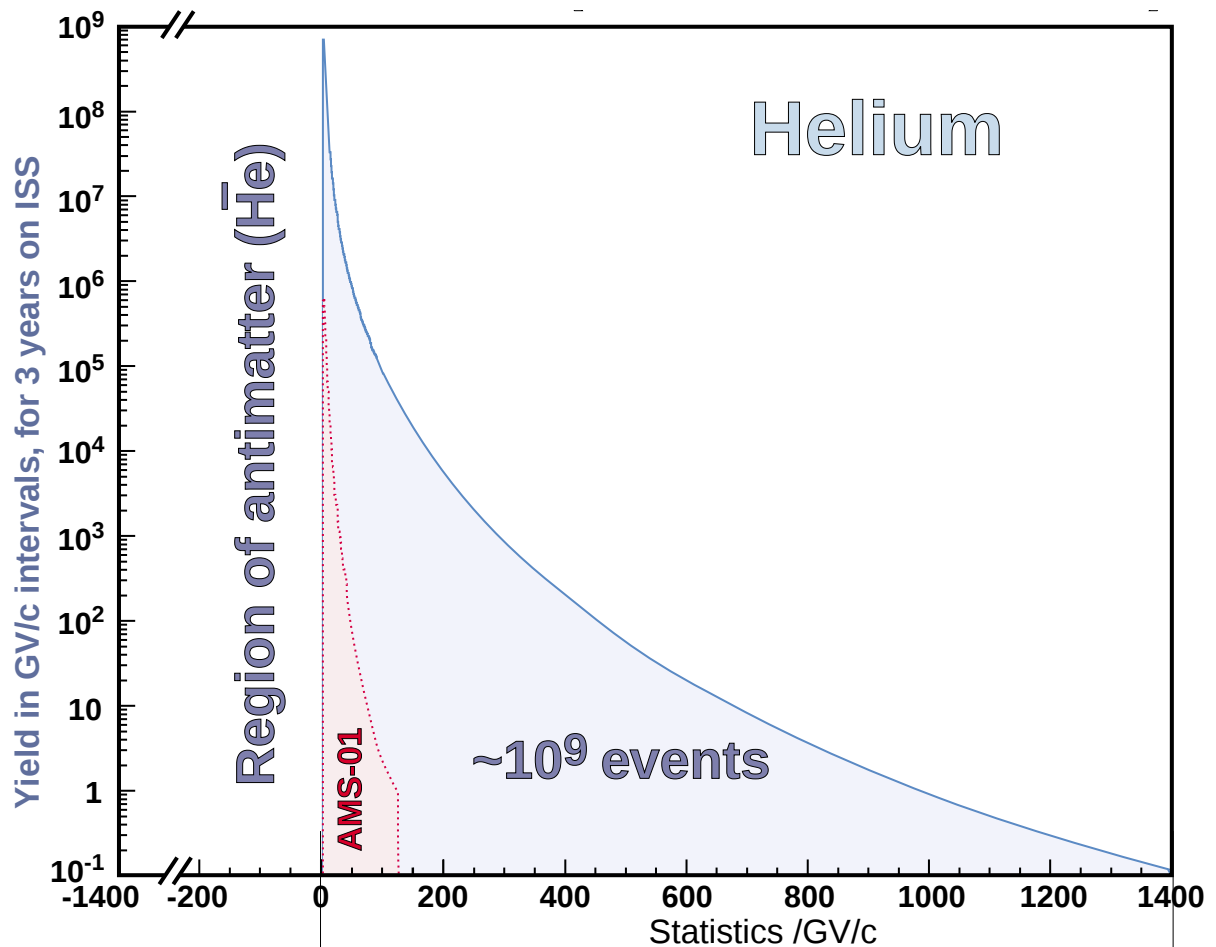
with p-E matching and shower-shape

$$p^+/e^+ < 10^{-4} \text{ (10 - 300 GeV)}$$



AMS02 Expectations

AMS01 statistics $\times 10^3$ momentum reach $\times 6$



$1 \cdot 10^9$ He 1 - 1400 GV

$3 \cdot 10^6$ p^+ > 1 TeV

$1 \cdot 10^7$ e^- > 10 GeV

AMS02 Expectations

