



# High-energy deuteron measurement with the CAPRICE98 experiment

Presented by

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On behalf of  
the CAPRICE98 collaboration



# The Wizard/CAPRICE98 experiment

(Cosmic AntiProton Ring-Imaging Cherenkov Experiment)

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- **Launched on May 28 1998**

**Fort Sumner (New Mexico) → Holbroke (Arizona)**

- **Flight duration: 24h @ 36Km (~5.5g/cm<sup>2</sup>)**
- **Geomagnetic cutoff ~4.3 GV**



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- ◆ Antiprotons ( 5-37.5 GeV ) Boezio et al., ApJ 651 (2001), 787
- ◆ Positrons ( 4.5-26 GeV ) Boezio et al., AdSpR 27 (2001), 669
- ◆ Hydrogen and helium Boezio et al., AP 19 (2003), 583
- ◆ Atmospheric muons Boezio et al., PhRvD 67 (2003), 072003
- ◆ <sup>2</sup>H work) → Session OG 1.1 (This
- ◆ <sup>3</sup>He → Session OG 1.1
- ◆ Atmospheric nuclei → Session HE 3.1

# The CAPRICE98 apparatus

## ◆ Time-Of-Flight system

(230 ps)

## ◆ Spectrometer

\* Drift chamber tracking system

(18+12 position measurements with  $\sim 100 \mu\text{m}$

resolution)

\* Superconducting magnet

(0.1-1.8 T)

→ MDR  $\sim 400\text{GV}$

## ◆ Silicon-Tungsten calorimeter

( $7.2 X_0$  and  $0.33 \lambda_0$ )

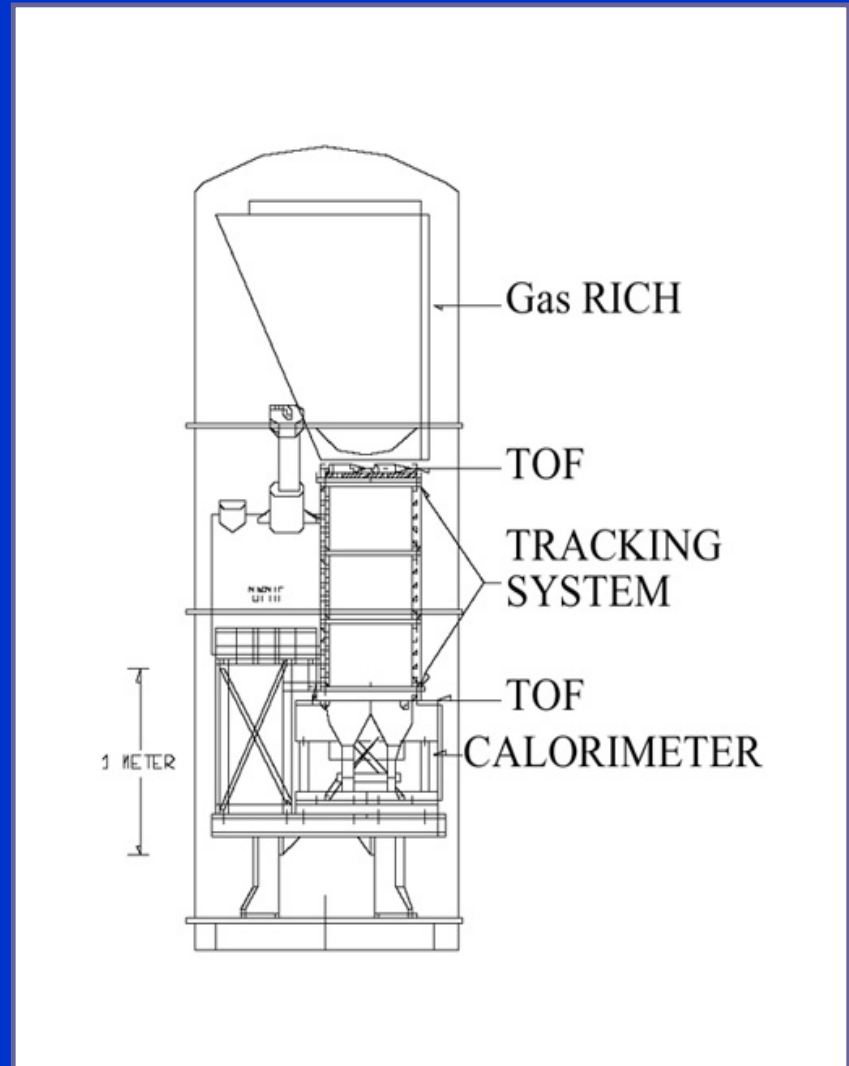
## ◆ Gas-RICH detector

\*  $\text{C}_4\text{F}_{10}$  radiator  $\sim 1\text{m}$

( $n \sim 1.0014$  @ flight)

\* MWPC ethane + TMAE

( $N_0 \sim 60 \text{ cm}^{-1}$  @ flight)



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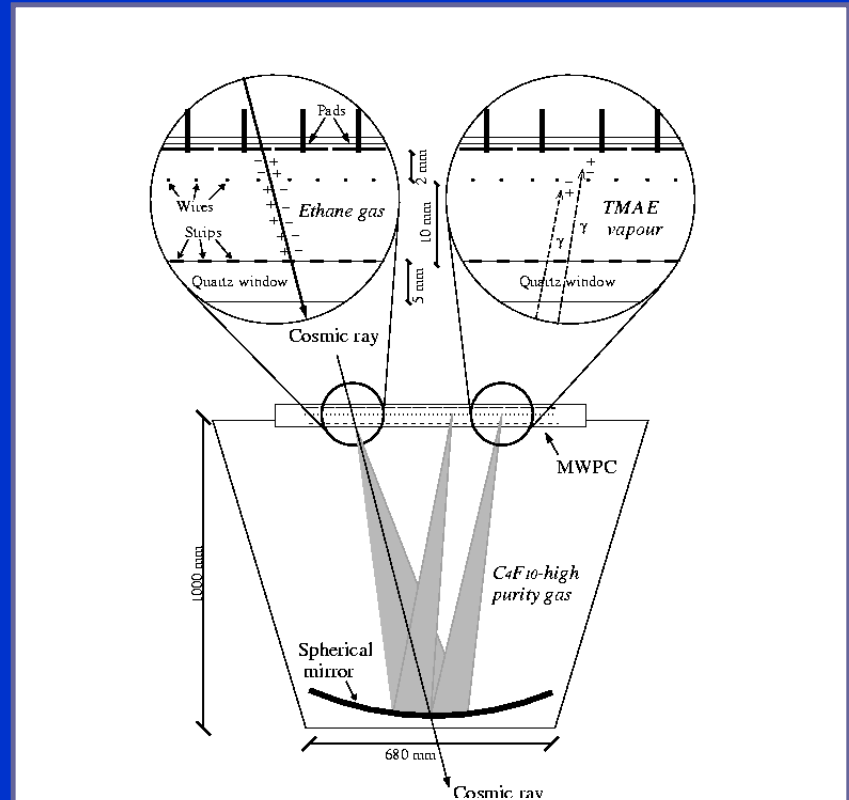
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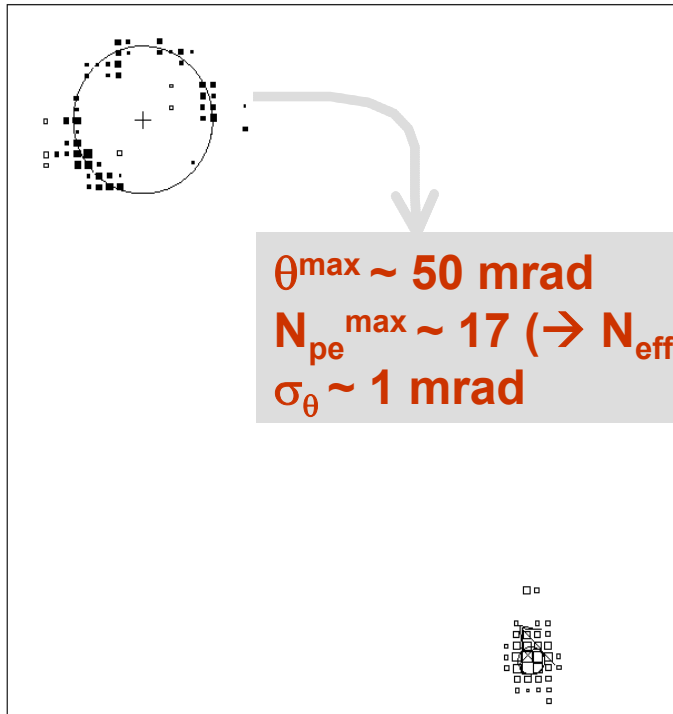
Elena Vannucchi ( $N_0 \sim 60 \text{ cm}^{-1}$  @ flight)



Cherenkov threshold rigidity:

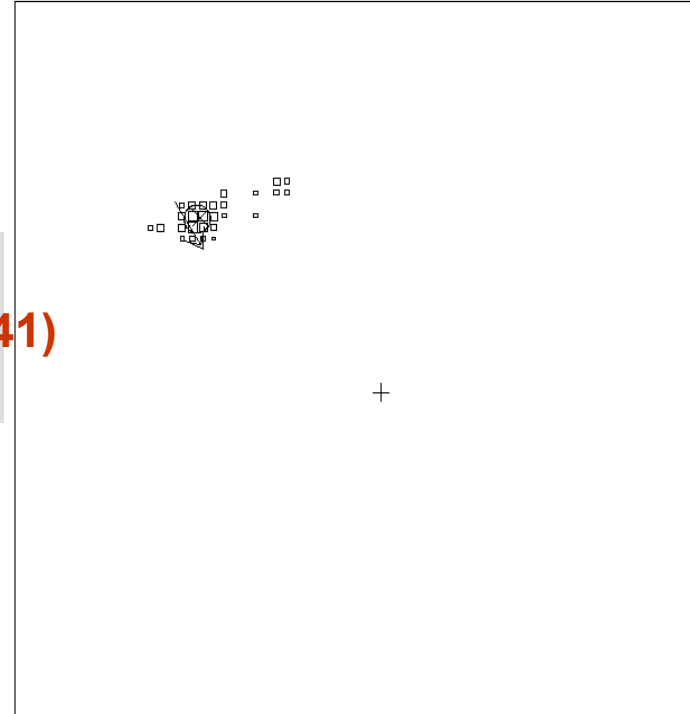
- Muons →  $\sim 2 \text{ GV}$
- Protons →  $\sim 18 \text{ GV}$
- Deuterons →  $\sim 35 \text{ GV}$

# Event topology in the RICH



$\theta^{\max} \sim 50 \text{ mrad}$   
 $N_{pe}^{\max} \sim 17 \text{ (} \rightarrow N_{eff} \sim 41 \text{)}$   
 $\sigma_{\theta} \sim 1 \text{ mrad}$

Rig -1.96	Thc 57.2	Theta 12.6	Xdiff 0.28
Beta 1.000	Errthc 2.4	Pile-up 0.	Ydiff 0.41
Mass 0.000	Neff 44.9	Noi/ch 0.40	



Rig 32.10	Thc 0.0	Theta 2.4	Xdiff 0.20
Beta 0.000	Errthc 0.0	Pile-up 0.	Ydiff 0.08
Mass 0.000	Neff 0.0	Noi/ch 0.00	

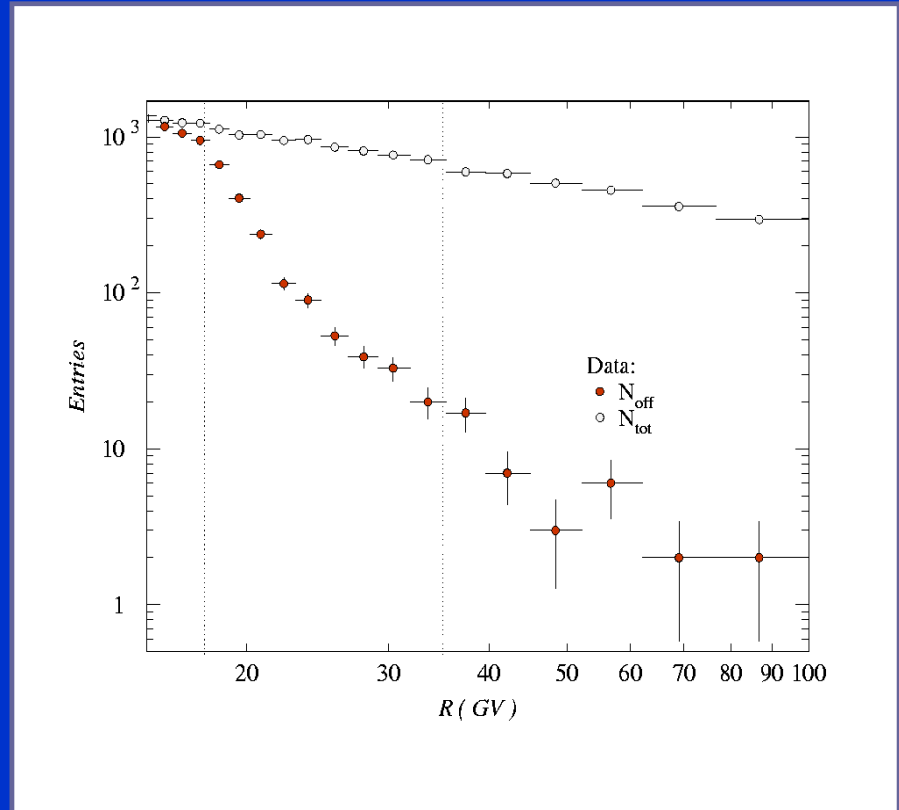
**Relativistic electron ( R~2 GV )**

**Z=1 particle ( R~32 GV )  
→ candidate deuteron**

# Deuteron selection

Deuterons selected out of singly charged particles by requiring:

- ◆ No Cherenkov signal in the RICH



# Deuteron selection

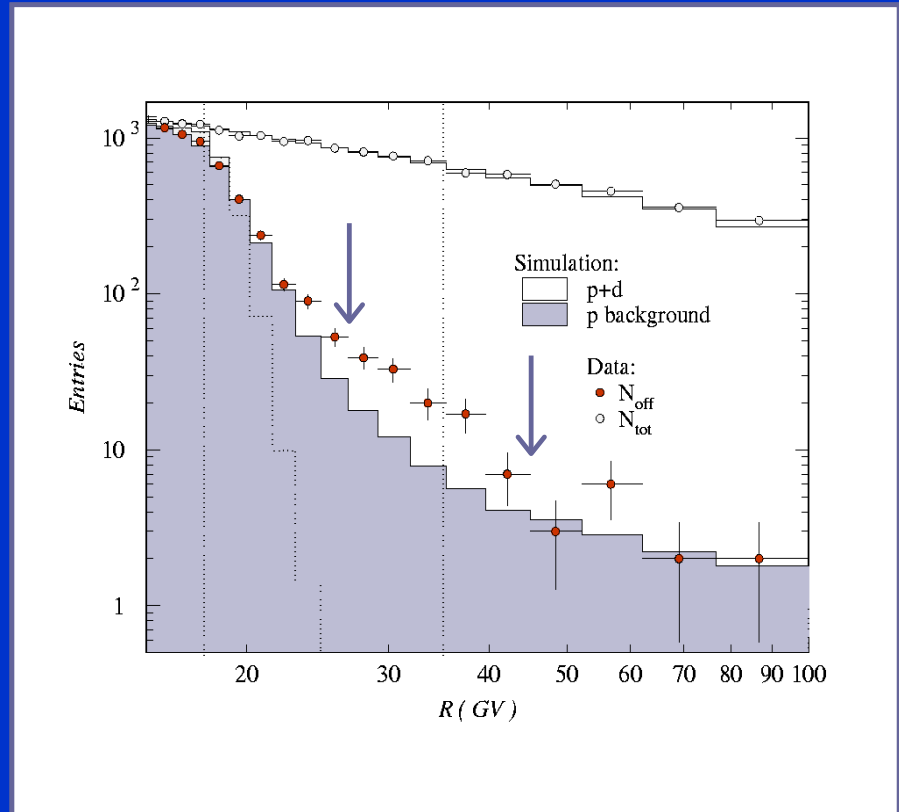
Deuterons selected out of singly charged particles by requiring:

## ◆ No Cherenkov signal in the RICH \*\*\*

Proton background distribution and deuteron selection efficiency estimated with Monte Carlo technique.

Simulation based on characteristic functions derived from experimental data:

- High-energy Spectrometer Resolution Function  $\rightarrow$  SRF
- Probability of having no Cherenkov signal  $\rightarrow P_{\text{off}}(\beta)$



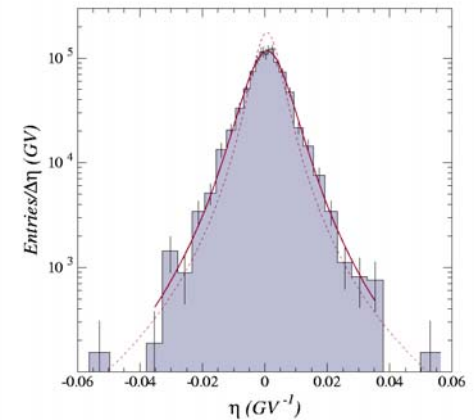
# Spectrometer resolution function

## Two independent estimates of the SRF

### 1) MAGNET-OFF METHOD

• SRF evaluated from relativistic ( $R > 5$  GV) ground muons collected with magnet off

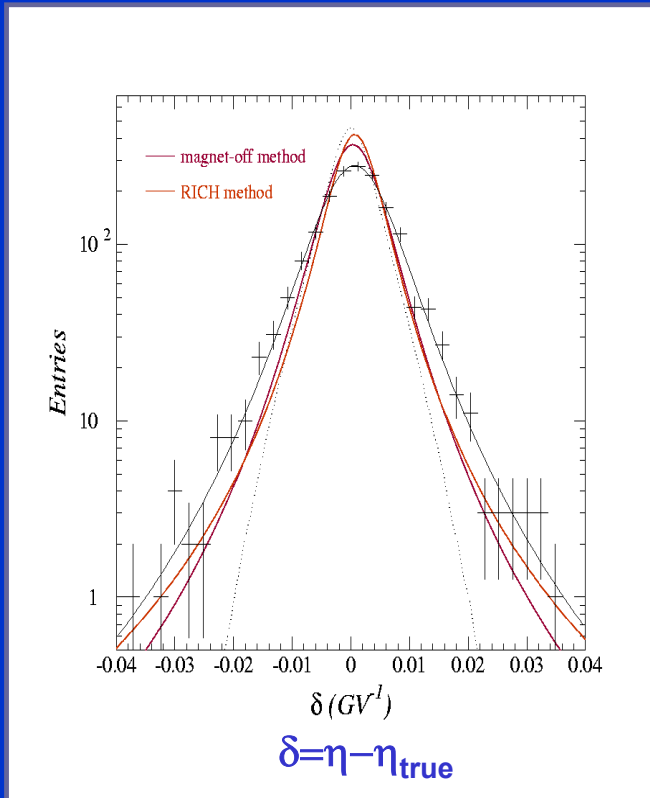
→ straight tracks ( $\eta = 0$ )



### 2) RICH METHOD

• SRF evaluated from flight protons above the Cherenkov threshold

→ Independent estimate of the deflection from the measured Cherenkov angle

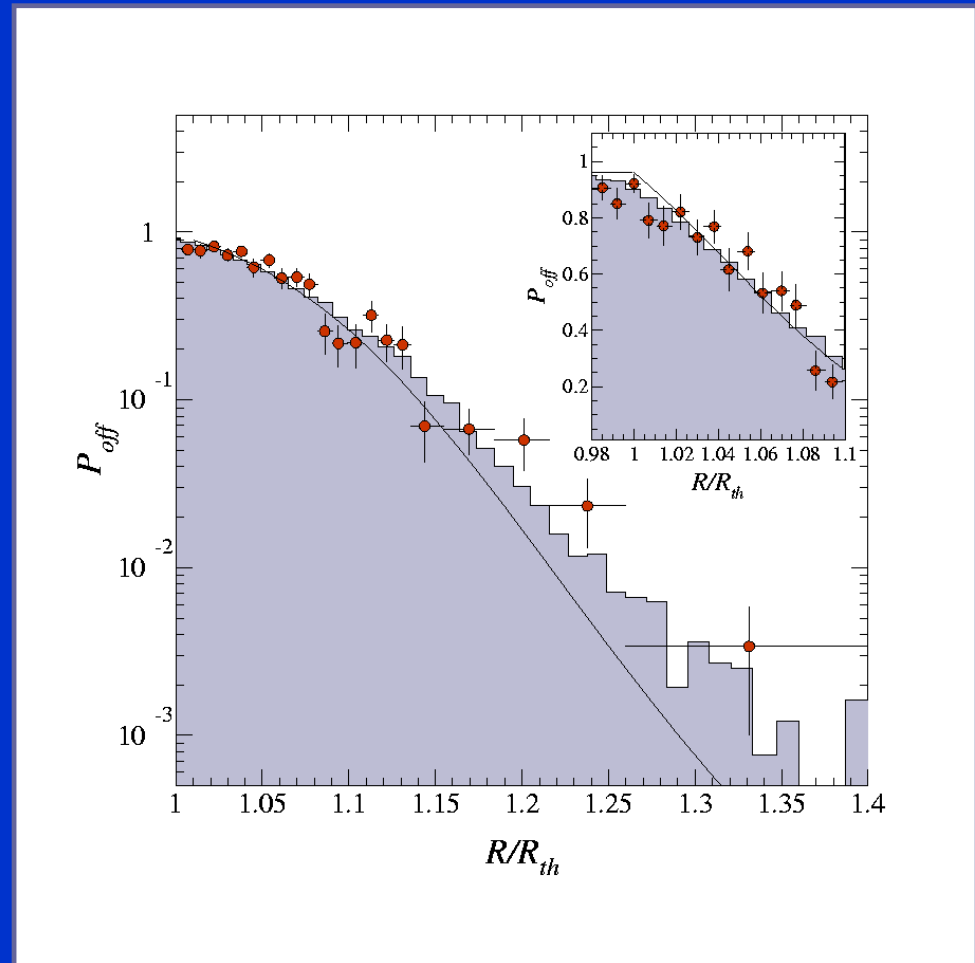


# Probability of having no Cherenkov signal

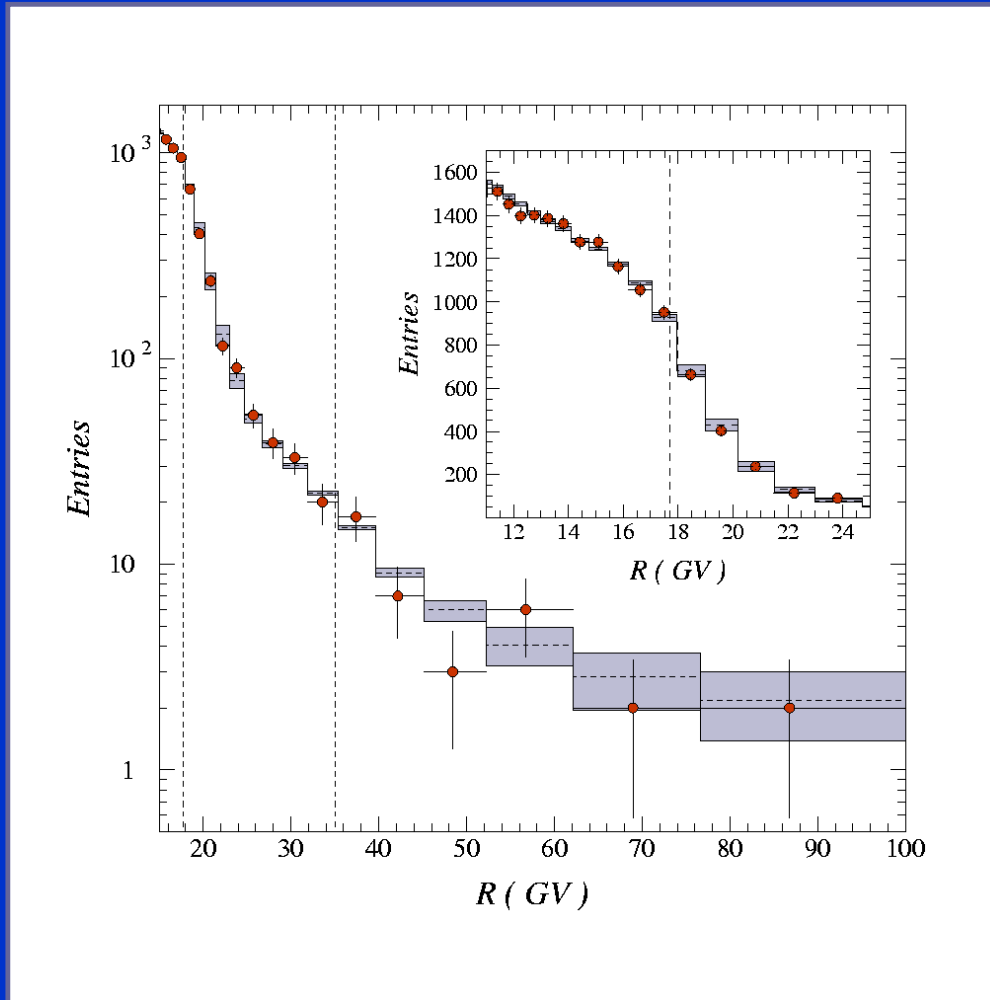
- ◆  $P_{\text{off}}$  parameterized using ground muons ( $R_{\text{th}} \sim 2$  GV)
- Spectrometer effect strongly reduced

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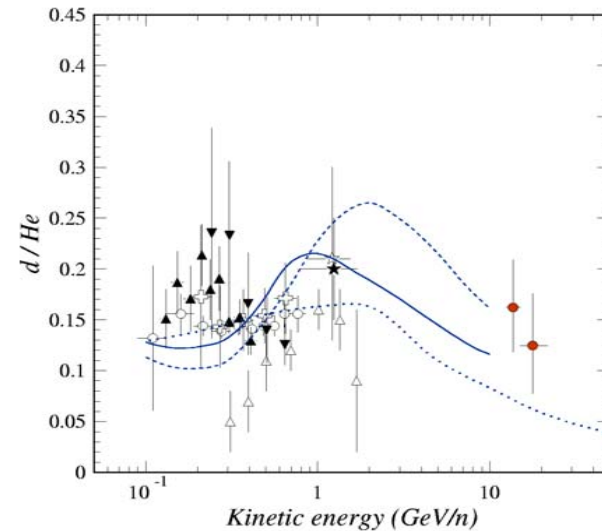
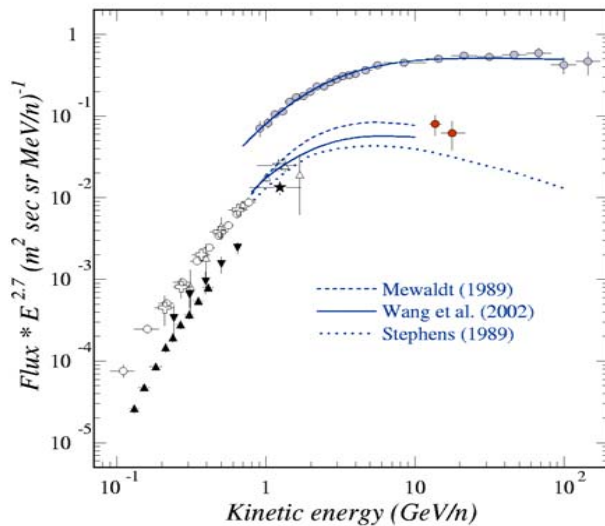
Spectrometer response unfolded from the experimental distribution of muons



# Comparison between data and simulation



# Deuterium abundance at the top of atmosphere



## Standard Leaky-Box Model predictions

Deuterium abundance consistent with the assumption that light CRs have the same propagation history of heavier CRs



# Conclusions

- ◆ First result on the deuterium flux above 10 GeV/n of kinetic energy
- ◆ d/He consistent with the assumption that the abundances of light cosmic rays are described by the same propagation parameters of heavier nuclei

