High-energy deuteron measurement
with the CAPRICE98 experiment

Presented by
Elena Vannuccini
National Institute of Nuclear Physics
and
University of Florence (Italy)

On behalf of
the CAPRICE98 collaboration
The WiZard/CAPRICE98 experiment
(Cosmic AntiProton Ring-Imaging Cherenkov Experiment)

- Launched on May 28, 1998
  Fort Sumner (New Mexico) → Holbrooke (Arizona)
- Flight duration:
  24h @ 36Km (~5.5g/cm²)
- Geomagnetic cutoff
  ~4.3 GV
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- 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
  → Session OG 1.1 (This work)
- $^2$H
- $^3$He
- 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 ~100 μm resolution)
  - Superconducting magnet
    (0.1-1.8 T)
    \( \rightarrow \) MDR ~ 400GV

- **Silicon-Tungsten calorimeter**
  (7.2 \( X_0 \) and 0.33 \( \lambda_0 \))

- **Gas-RICH detector**
  - \( C_4F_{10} \) radiator ~1m
    (n~1.0014 @ flight)
  - MWPC ethane + TMAE
    (\( N_0 \sim 60 \) cm\(^{-1} \) @ flight)
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  \[ \rightarrow \text{MDR} \sim 400 \text{GV} \]

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Cherenkov threshold rigidity:
- **Muons** \[ \rightarrow \sim 2 \text{ GV} \]
- **Protons** \[ \rightarrow \sim 18 \text{ GV} \]
- **Deuterons** \[ \rightarrow \sim 35 \text{ GV} \]
Event topology in the RICH

$\theta_{\text{max}} \sim 50 \text{ mrad}$

$N_{\text{pe}}^{\text{max}} \sim 17 \Rightarrow N_{\text{eff}} \sim 41$

$\sigma_{\theta} \sim 1 \text{ mrad}$

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
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- **No Cherenkov signal in the RICH**

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

Simulation based on characteristic functions derived form experimental data:

- **High-energy Spectrometer Resolution Function** $\rightarrow$ SRF
- **Probability of having no Cherenkov signal** $\rightarrow$ $P_{0\text{ff}}(\beta)$
Two independent estimates of the SRF

1) **MAGNET-OFF METHOD**
   - SRF evaluated from relativistic \((R>5\ \text{GV})\) 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

\[ \delta = \eta - \eta_{\text{true}} \]

\[ \xi = \eta - \eta_{\text{RICH}} \]
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

Elena Vannuccini
ICRC 2003

Tsukuba
Japan
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