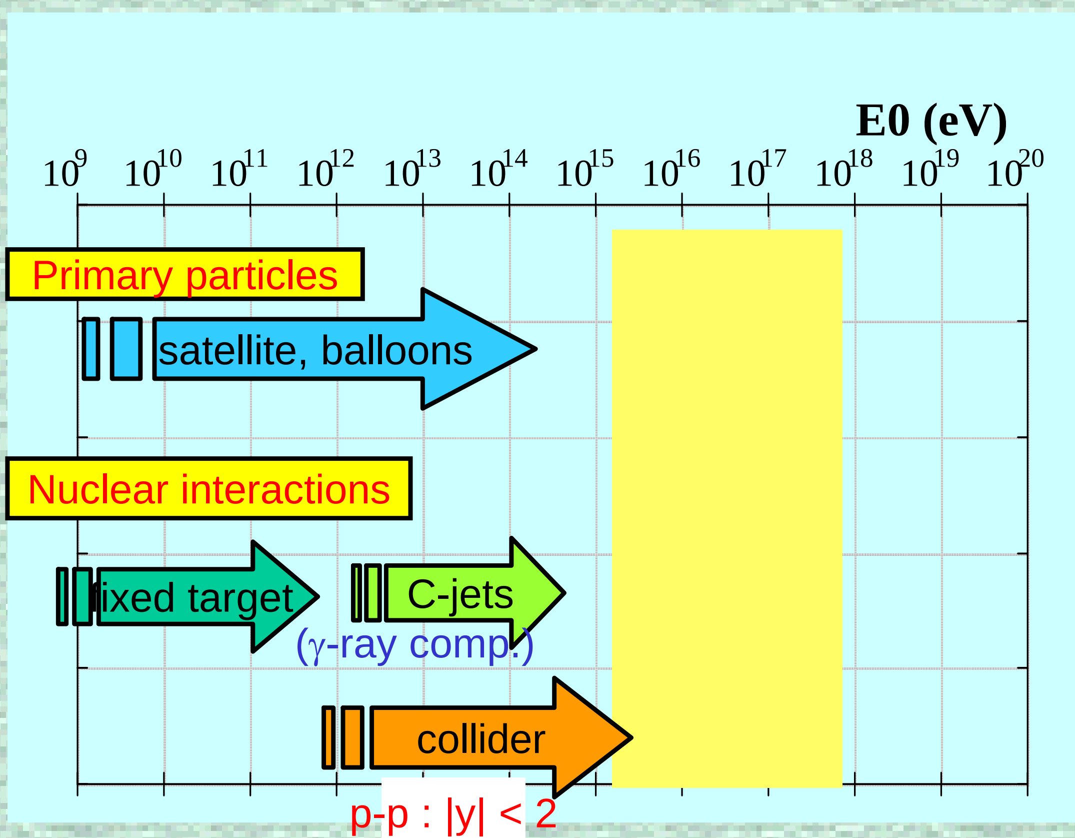
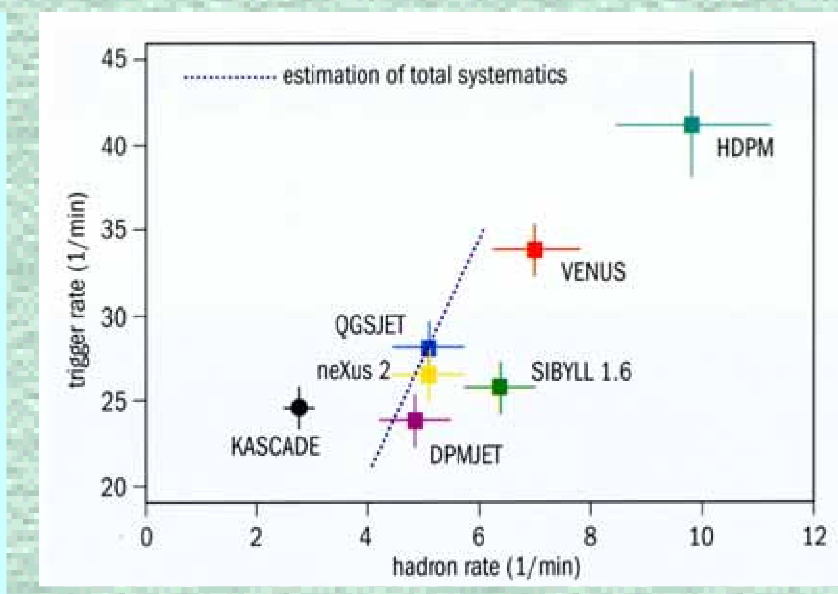
Chacaltaya における10^{15}eVから10^{17}eV領域での宇宙線の核相互作用と化学組成の研究

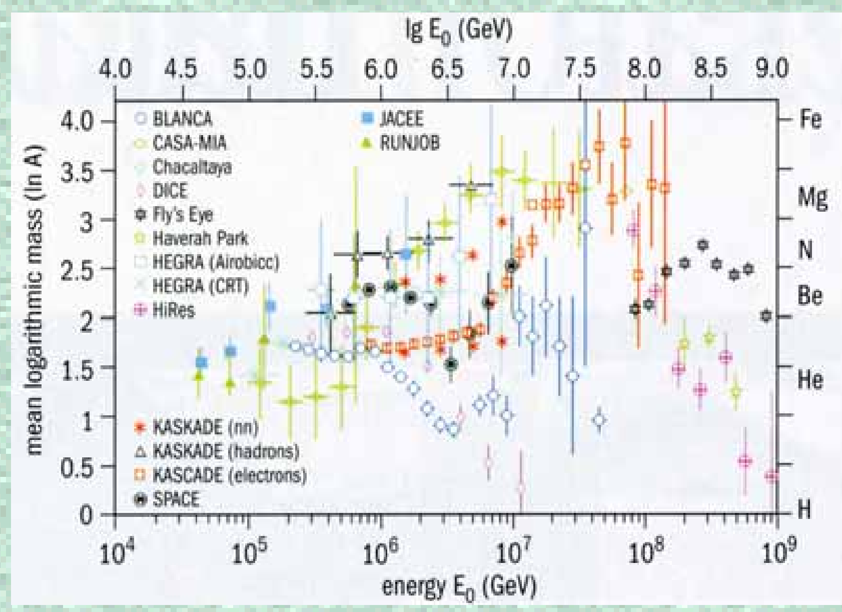
Chacaltaya EC-AS
連動実験グループ
（別紙参照）

●粒子相互作用の不透明さと現象論的特性の解明の必要性

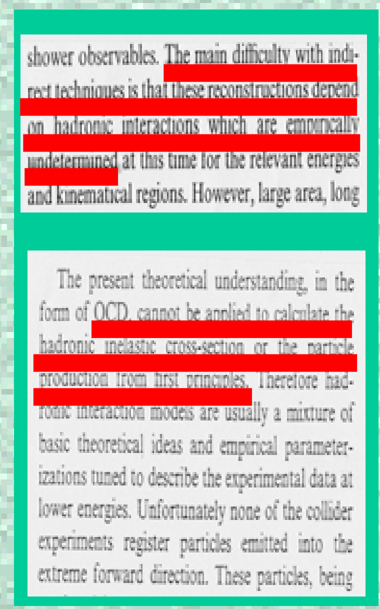




CERN COURIER 42-6(2002)



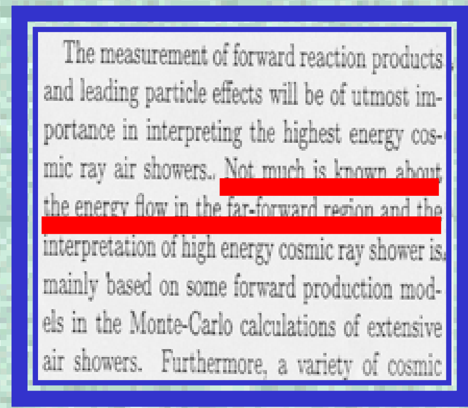
CERN COURIER 42-6(2002) : ICRC2001 (J.R.Horandel)


shower observables. The main difficulty with indirect techniques is that these reconstructions depend on hadronic interactions which are empirically undetermined at this time for the relevant energies and kinematical regions. However, large area, long

The present theoretical understanding, in the form of QCD, cannot be applied to calculate the hadronic inelastic cross-section or the particle production from first principles. Therefore hadronic interaction models are usually a mixture of basic theoretical ideas and empirical parameterizations tuned to describe the experimental data at lower energies. Unfortunately none of the collider experiments register particles emitted into the extreme forward direction. These particles, being

S.P.Swody et al. Astropart.Phys.18(2002)

K.Eggert; Nucl.Phys. Proc.52B(1997)


The measurement of forward reaction products and leading particle effects will be of utmost importance in interpreting the highest energy cosmic ray air showers. Not much is known about the energy flow in the far-forward region and the interpretation of high energy cosmic ray shower is mainly based on some forward production models in the Monte-Carlo calculations of extensive air showers. Furthermore, a variety of cosmic


Such interpretations of ground-level observations are heavily dependent on Monte Carlo simulations of the primary interaction in the upper atmosphere and the evolution of the resulting particle cascade. The cascade is dominated by lower-energy phenomena that are reasonably well understood. However, the primary and early subsequent interactions involve energies up through the PeV range, and existing Monte Carlos are almost entirely based upon data from fixed-target accelerator experiments below 1 TeV. A sense of the con-

L.W.Jones; CERN COURIER Vol.42 No.6 (2002)

空気シャワー：何がわかっているか？

[Well known]
- ★Electromagnetic interactions
- ★Weak interactions($\pi \rightarrow \mu$ decay)

[Not well known]
- ★Hadronic interactions(inelastic cross-section, particle production(forward),…
- ★Cosmic ray compositions

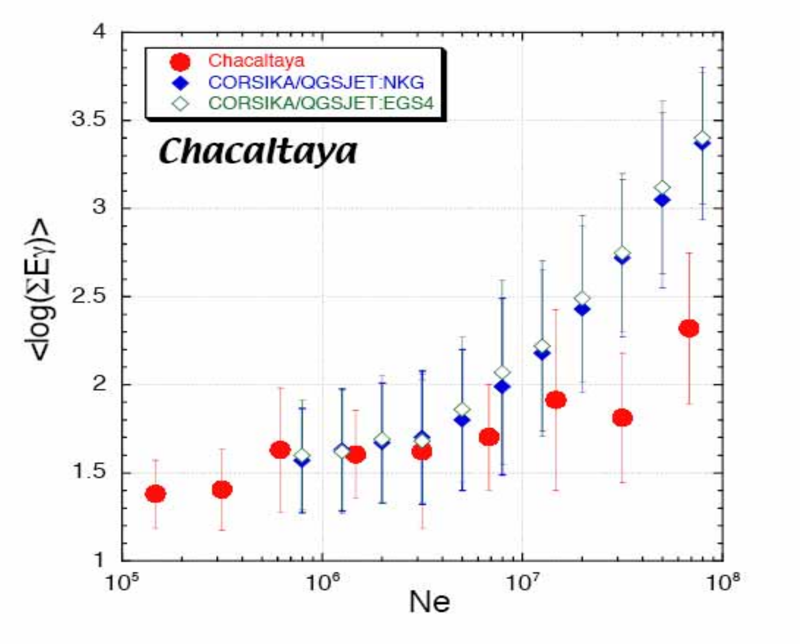
多くの結論は相互作用モデルに依存したものであり、モデルが変われば答えも変わる。QGSJET等のモデルの高エネルギー領域での妥当性→実験的に確かめられたものではない。

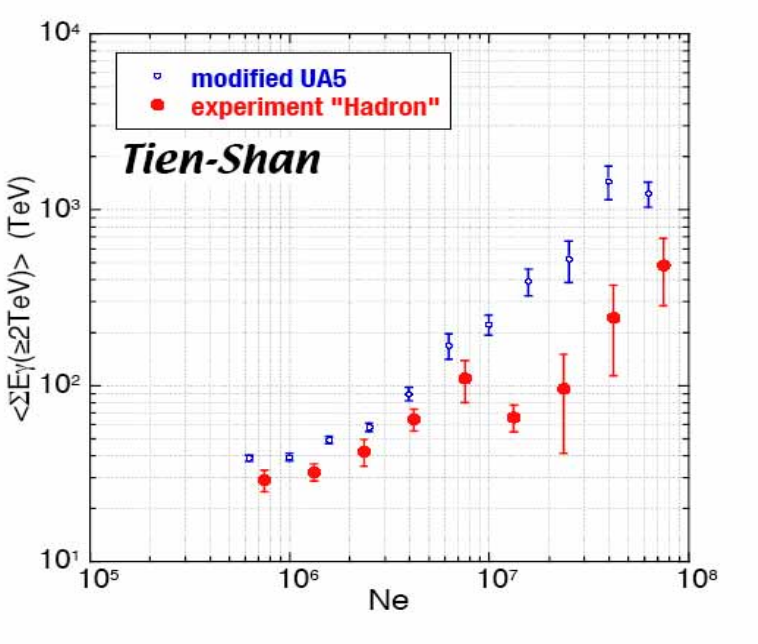
ChacaltayaEC-AS連動実験データ（一部別紙参照）

●ΣE_γ vs Ne: 一次宇宙線の化学組成の変化だけでは説明できない。
●宇宙線Energy推定: 粒子相互作用Modelの違いによる不確かさ（数10%）。バルーン実験からの直接測定とEAS実験の境界である10^{15}eVからEAS実験のみの10^{17}eVにおいて、Modelの解明が組成変化、Energy Spectrumを求める上で重要。諸空気シャワー実験データの解釈において、内包するシミュレーション仮定の曖昧さは実験精度に対する綿密な考察に比して劣らず問題視するべきもの。

●最近までの実験結果が示唆するもの

EAS triggered family





粒子相互作用について、その特性を限界まで追求する試みは必要性高く独自性を有している。

simulations

Problem:
if data and simulations disagree, it is difficult to find the reason and to identify which part of the assumption/simulation chain is responsible.

J.Knapp (NEED Workshop 2002)

We need phenomenological approach !?

Violent energy dissipation… Strong violation of Feynman scaling law at $E_0 \geq 10^{16}$eV !?

(1)$E_0=10^{15}$-10^{17}eV 領域での核相互作用の特徴を明らかにする。
(2) 宇宙線特異現象の可能な解釈を絞り込む。
(3) 核相互作用の知見に基づき、一次宇宙線の化学組成およびエネルギースペクトルを明らかにする。

●次期実験計画（世界最高所実験の意義と独自性）

★密度検出器(N-detector)　plastic scintillator 40台(0.25m^2 36台、1.0m^2 4台)
★ハドロンカロリメータ(B-detector): plastic scintillator (0.25m^2) 32台
emulsion chamber (15 cmPb : 8m^2)
★FT検出器
plastic scintillator 13台
(0.25m^2 8台、1.0m^2 5台)

10倍程度に拡張

★二段型エマルション・チェンバー
鉄製架台(8.5m x 4.2m=44.2m^2; 高さ237 cm)、
標的層(ポリエチレン 44.2m^2 x 30 cm)、鉛板 500 ton
→現有設備＋(新規：架台40m^2+ AS detectors：50台)
予算額：8000万(含、フィルム3露出サイクル分)