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Improved analysis of one Centauro candidate event

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Abstract. In a series of experiments of emulsion chambers exposed at Mt. Chacaltaya a remarkable event with high content of hadrons was observed. Moreover, this event has a hadron that interacts twice at deeper layers of the detector and that has energy between (16-20)% of the total energy of main interaction, the former figure for all particles and the last only for hadrons. Due to these facts it was interpreted as a surviving hadronic particle and its transverse momentum results between (460/k_γ and 680/k_γ)MeV/c. The last is obtained considering the center of only 40 particles identified as hadrons while the first one is obtained with all 60 particles, irrespectively of their identification as γ or hadron. Other results, mainly concerned with a γ-hadron identification will be presented, showing the reasons to classify this event as a Centauro type.

1 Introduction

The so-called Centauro events were first observed by Brazil-Japan Collaboration on Emulsion Chamber Experiment (B-J Collaboration), exposed during the period 1969-1970. Following this exposure a chamber denominated chamber no.16 was exposed in the period 1971-1972 and there was observed a second good example of Centauro candidate. This chamber is very thick in a lower part of the detector, till 30 r.l. and contains 2 X-ray films each 2 r.l., besides 10 Nuclear Emulsion plates. The upper part has 12 r.l., 2 X-ray films also inserted each 2 r.l. and 3 Nuclear Emulsion plates. Therefore the chamber is a good detector for hadrons recognition. The misfortune is that some Emulsion plates were dammaged by fading and the measurements was postponed for a couple of years. Concerning to the event observed in the upper chamber block S086, continuing to lower chamber block I037, the quality of 64 X-ray films and 13 Emulsion plates are quite good, with few exceptions. This event measurement was postponed to around 1979, by the reasons above mentioned and also due to the fact that the upper block is at Campinas and the lower block was at Rio's lab.

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As was presented in many occasions, the Centauro events are naively interpreted as multiple production of hadrons without π^0's. The interpretation was caused by the first Centauro analysis, due to the high content of hadrons compared with γ's, those produced mainly through π^0 decay. After Centauro I we looked for hadron rich events and so, Centauro events recognition is strongly dependent of hadron-γ's discrimination.

Then, careful and detailed re-measurements were done, by different scanners and improved devices. In paralel, improvements in the energy determination, analysis methods, etc. was carried out and reported at various conferences.

The main purpose of this paper is to present the last results on the Centauro V (C16S086I037), aiming to increase confidence on hadron identification. Together with the analysis to be reported in ((Search of Centauro like events. C.R.A.Augusto et al., 2001)) we complete the reasoning to justify the conclusions, there presented, mainly on the mean transverse momenta and rapidity density ($< P_T >$ - $N_{c,\gamma,h}/\Delta Y$) correlation, that shows a different figures for Centauro events compared with usual cosmic ray and acelerators events.

2 Hadron identification

It is a very difficult task in Emulsion Chamber experiments to identify a single ionizing track, because it traverses only the thickness (50 μm) of sensitive material. Moreover, many ionizing tracks, as background, are detected by Emulsion plates, difficulting single track recognition. The way to identify ionizing tracks is to look for groups of tracks (at least 100 paralel tracks in an area of $50^2 \mu m^2$) constituing showers of eletromagnetic particles. Then, a straightforward identification of hadrons is possible using some criteria for that purpose.

The most reliable one is through the behaviour of showers inside the chamber, i.e., usual γ induced showers have not two or more maxima in the transition curve. Another confident criterion is on probability arguments for showers starting deep in the detector, as the probability is $\sim \exp(-t)$, with t, measured in r.l., means the depth where the shower starts to be observed. We used t = 9 r.l. in the analysis of the event C16S086I037.

As this chamber have many Emulsion plates, the visual recognition of groups of showers separated at least by a distance of 20 μm is an additional criterion for hadron identification. So, the combination of these criteria with a best fitting, through computer software especially written for types of blocks used by B-J Collaboration, yields this improved analysis of the event described in the paper. For instance, shower #27 is observed in upper chamber and penetrates through lower chamber and clearly its fitting for only one transition curve is unreasonable. Besides, the observation of Emulsion plates shows 5 showers in the upper part and 3 in the lower. Separate transition curve are shown in Figures 1 and 2. To have the total transition of this shower, it is necessary to shift the horizontal axis of lower block plot by 0.59 r.l., shift that corresponds to the sum of air gap and asphalt pitch layers.

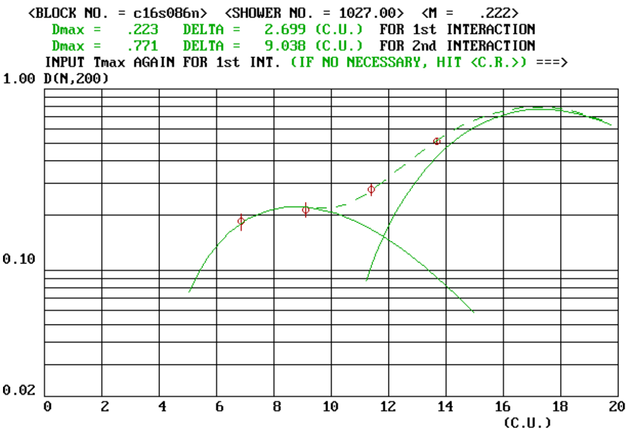

Fig. 1. Transition curve in upper block 086

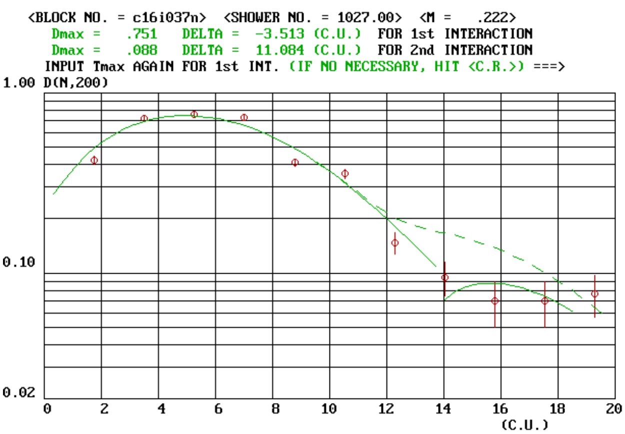

Fig. 2. Transition curve in lower block 037

Shower #62 is interpreted as a surviving particle. At the same time it carries 20% of the total energy of identified hadrons and so, it is also a leading particle. It is surviving because it has not observable signal in the upper part of the chamber and it presents two maximum only in lower chamber, as a Figure 3 shows.

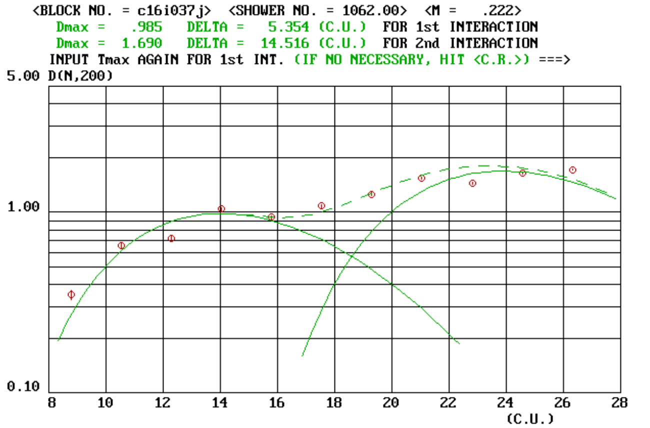

Fig. 3. Shower #62, interpreted as surviving and leading particle

3 Discussions

Zenital angle corrected map is presented in Figure 4 and condensed results are in the following Figure 5.

It is necessary to say that the we adopted a rather severe procedure, i.e. we classified as hadrons only if the shower obeys at least one criterion. This situation was relaxed for 3 showers classified in a H6 class, but in the other hand another 3 showers classified as G2 class, that is as γ's, seems hadronic originated ones. In fact doing a starting point integral distribution the best fit shows that also all 20 γ could be interpreted as hadronic origin particles and that decaied during its propagation in the atmosphere.

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References

C.R.A.Augusto et al., accepted to be presented to this conference.

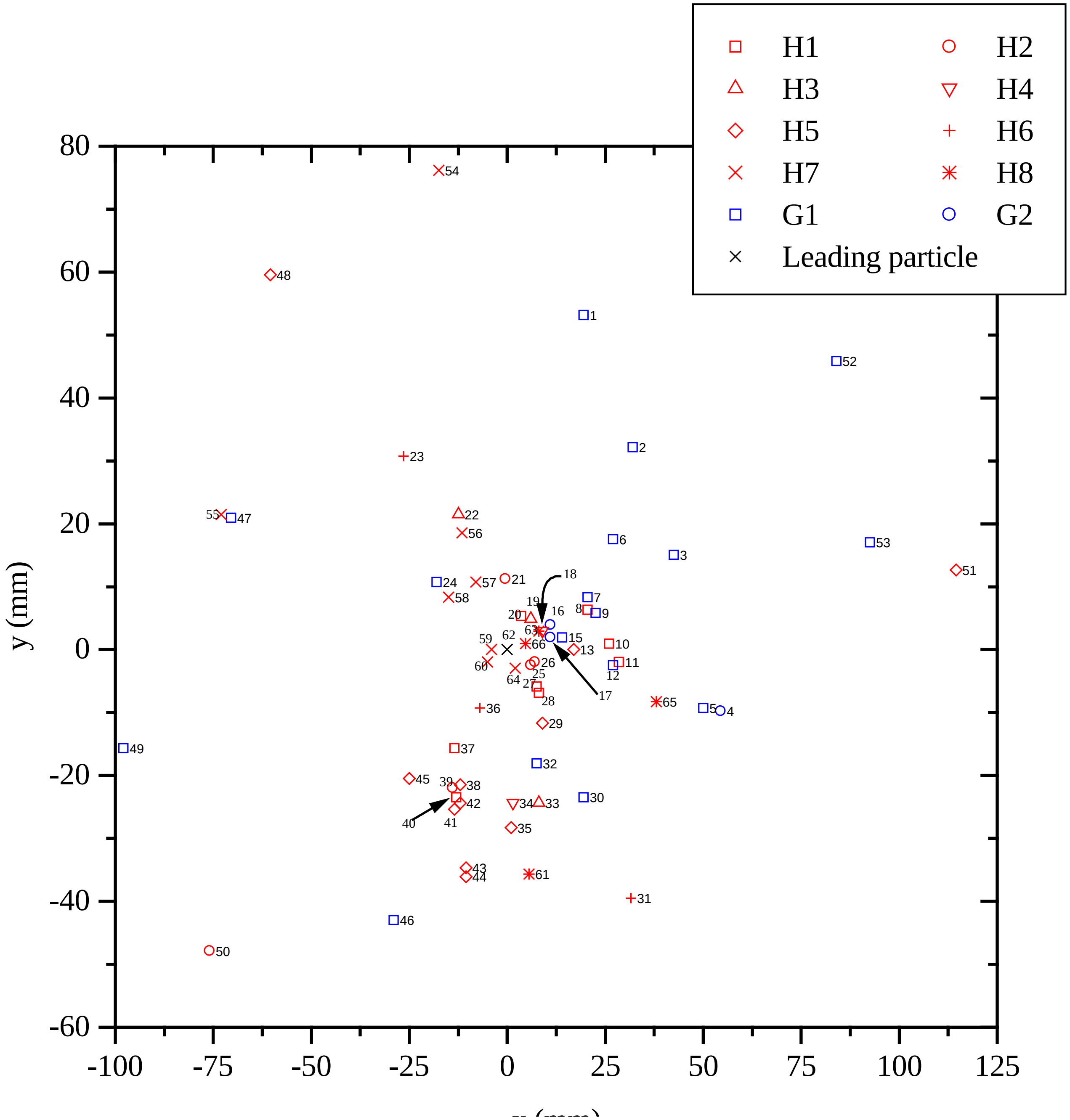

Fig. 4. Upper and Lower blocks superposed map

Centauro V (C16S086I037)

Classification of γ‘s

Upper Chamber		Lower Chamber	Total
G1	G2		
17	3	0	20

G1: fitted one curve in X-ray films
#: 1, 2, 3, 5, 6, 7, 9, 12, 15, 24, 30, 32, 46, 47, 49, 52 and 53
G2: two cores observed in Emulsion plate
#: 4, 16 and 17

Classification of hádrons

Upper						Lower		Total
H1	H2	H3	H4	H5	H6	H7	H8	
7	4	3	2	9	3	9*	4	41*

H1: it starts in upper, penetrates through lower and has multi-cores (at least 2 at upper and/or lower). #20 and #27 was used for height determination in both, X-ray films and Emulsion plate.
#: 8(1 up. and 2 lo.), 10(2 up. and 2 lo.), 11(2 up. and 1 lo.), 20(4 up. and 2 lo.), 27(5 up. and 3 lo.)+28(fits more than one curve), 37(2 up. and 1 lo.) and 40(4 up. and 2 lo.)
H2: no. of cores ≥ 3 (≡ A-jets).
#: 21(4 cores), 25(4 cores and fits with more than one curve)+26, 39(3 cores) and 50(3 cores and fits with more than one curve)
H3: no. of cores = 2 (≡ A-jets) and fits with more than one curve.
#: 19, 22 and 33
H4: it appears at ~9 c.u. and fits with more than one curve
#:18(1 core at 12 c.u.) and 34(2 cores at 12 c.u.)
H5: fits with more than one curve
#: 13, 29, 35, 41, 38+42, 43+44, 45, 48 and 51
H6: it seems that fits with more than one curve
#: 23, 31 and 36

H7: no single transition curve, shows multi-cores (≡ C-jets) and penetrates till 22 c.u. #62* was identified as ‘surviving particle’ because it is absent in upper chamber, penetrates from 6 c.u. till 30 c.u. in lower chamber where shows at least two curves and contents ~18% of total observed energy
#: 54, 55, 56, 57, 58, 59, 60, 62* and 64
H8: no single transition curve, observed only after ~6 c.u. till ~24 c.u. (≡ Pb-jets)
#: 61, 63(till 22 c.u.), 65(after 4 c.u.) and 66(after 4 c.u.)

Fig. 5. Table of all showers measured in the event