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Search for Open « Top » at the CERN $(p\bar{p})$ Collider.

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Summary. — A new method of observing the production of open « top » baryonic states at the CERN $(p\bar{p})$ Collider is presented. It is based on the « leading » production mechanism, extended to the heaviest-flavoured baryon and antibaryon states, and on the charge asymmetry of the leptons originating from their semi-leptonic decays.

1. – Introduction.

The purpose of this study is to investigate the observability of open « top » states at the CERN $(p\bar{p})$ Collider.

The guideline comes from our recent ISR results on heavy-flavour production at $\sqrt{s} = 62$ GeV. Evidence was found for both the charm baryon Λ_c^+ and the beauty baryon Λ_b^0 in the reactions [1,2]

$$(1) \qquad pp \to e^- + \Lambda_c^+ + \text{anything}$$

(1) M. BASILE, G. CARA ROMEO, L. CIFARELLI, A. CONTIN, G. D'ALÍ, P. DI CESARE, B. ESPOSITO, P. GIUSTI, T. MASSAM, R. NANIA, F. PALMONARI, G. SARTORELLI, G. VALENTI and A. ZICHICHI: *Nuovo Cimento A*, **63**, 230 (1981).
(2) M. BASILE, G. BONVICINI, G. CARA ROMEO, L. CIFARELLI, A. CONTIN, G. D'ALÍ,

and

$$\text{(2)} \qquad \mathrm{pp} \rightarrow \mathrm{e}^+ + \Lambda_b^0 + \text{anything}\,,$$

where the electron (positron) originated from the semi-leptonic decay of the associated antiflavoured state. Moreover, it was established that these Λ baryons were produced in a « leading » way, *i.e.* with an approximately flat $x_L(=2p_L/\sqrt{s})$ distribution ([3,4]) in association with an antimeson produced « centrally », *i.e.* with an $E(\mathrm{d}\sigma/\mathrm{d}x_L) \propto (1-x_L)^3$ behaviour.

On the other hand, we have also measured the longitudinal-momentum distribution of the D mesons observed in the same experiment ([5]). This appears to be compatible with a rather « central » production mechanism, both for the meson and the associated antimeson.

These results suggest that, in high-energy (pp) collisions, heavy-flavoured baryons are produced in a « leading » way, in association with a « central » antiflavoured meson, whilst in the case of meson-antimeson pairs both mesons are produced « centrally ».

In this paper we will extrapolate our findings to the search for particles with open « top » in ($\mathrm{p\bar{p}}$) interactions at $\sqrt{s} = 540$ GeV. Notice that, according to the above-specified heavy-flavour production mechanism, in ($\mathrm{p\bar{p}}$) interactions we should also observe « leading » antibaryons in association with « central » mesons, and « leading » antibaryons in association with « leading » baryons.

2. – How to detect an open t-state.

One possibility of detecting an open t-state in ($\mathrm{p\bar{p}}$) interactions would be via the detection of its hadronic decay. However, since the multiplicity increases when going from the energy of the CERN Intersecting Storage Rings (ISR)

P. Di Cesare, B. Esposito, P. Giusti, T. Massam, R. Nania, F. Palmonari, G. Sartorelli, G. Valenti and A. Zichichi: *Lett. Nuovo Cimento*, **31**, 97 (1981).

(3) M. Basile, G. Cara Romeo, L. Cifarelli, A. Contin, G. D'Alí, P. Di Cesare, B. Esposito, P. Giusti, T. Massam, F. Palmonari, G. Sartorelli, G. Valenti and A. Zichichi: *Lett. Nuovo Cimento*, **30**, 487 (1981).

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(5) M. Basile, G. Cara Romeo, L. Cifarelli, A. Contin, G. D'Alí, P. Di Cesare, B. Esposito, P. Giusti, T. Massam, R. Nania, F. Palmonari, G. Sartorelli, G. Valenti and A. Zichichi: *Lett. Nuovo Cimento*, **33**, 33 (1982).

to that of the Collider [6-8], an invariant-mass analysis applied to the ($p\bar{p}$) final state would be very difficult because of the amplification of the combinatorial background. Moreover, the detection of the decay chain $t \to b \to c \to s$, where first a b-state then a c-state are identified, would involve a prohibitively small branching ratio (of the order of 10^{-4}).

Another approach would be to take advantage of the sizable branching ratio ($\simeq 10\%$) of the semi-leptonic decay of the heavy-flavour states. In this study we will show that the «leading» production of heavy-flavoured baryons and their semi-leptonic decay provides a tool for disentangling the production of the «top» quark from the large physical background.

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(6) M. BASILE, G. CARA ROMEO, L. CIFARELLI, A. CONTIN, G. D'ALÍ, P. DI CESARE, B. ESPOSITO, P. GIUSTI, T. MASSAM, R. NANIA, F. PALMONARI, A. PETROSINO, V. ROSSI, G. SARTORELLI, M. SPINETTI, G. SUSINNO, G. VALENTI, L. VOTANO and A. ZICHICHI: *A prediction for the total charge multiplicity in hadronic interactions at extreme high energies*, preprint CERN-EP/81-147 (1981).

(7) G. ARNISON, A. ASTBURY, B. AUBERT, C. BACCI, R. BERNABEI, A. BÉZAGUET, R. BOCK, M. CALVETTI, P. CATZ, S. CENTRO, F. CERADINI, B. CHERTOK, J. CIBOROWSKI, S. CITTOLIN, A. M. CNOPS, C. COCHET, J. COLAS, M. CORDEN, D. DALLMAN, S. D'ANGELO, M. DEBEER, M. DELLA NEGRA, M. DEMOULIN, D. DENEGRI, D. DIBITONTO, L. DOBRZYNSKI, J. D. DOWELL, M. EDWARDS, K. EGGERT, E. EISENHANDLER, N. ELLIS, P. ERHARD, H. FAISSNER, G. FONTAINE, J. P. FOURNIER, R. FREY, R. FRÜHWIRTH, J. GARVEY, S. GEER, C. GHESQUIÈRE, P. GHEZ, K. L. GIBONI, W. R. GIBSON, Y. GIRAUD-HERAUD, A. GIVERNAUD, A. GONIDEC, G. GRAYER, P. GUTIERREZ, R. HAIDAN, T. HANSL-KOZANECKA, W. J. HAYNES, L. O. HERTZBERGER, C. HODGES, D. HOFFMANN, H. HOFFMANN, D. J. HOLTHUIZEN, R. J. HOMER, A. HONMA, W. JANK, P. I. P. KALMUS, V. KARIMÄKI, R. KEELER, I. KENYON, A. KERNAN, R. KINNUNEN, H. KOWALSKI, W. KOZANECKI, D. KRYN, F. LACAVA, J. P. LAUGIER, J. P. LEES, H. LEHMANN, R. LEUCHS, A. LÉVÊQUE, D. LINGLIN, E. LOCCI, G. MAURIN, T. MCMAHON, J. P. MENDIBURU, M. N. MINARD, M. MORICCA, H. MUIRHEAD, F. MULLER, Y. MURAKI, A. K. NANDI, L. NAUMANN, A. NORTON, A. ORKIN-LECOURTOIS, L. PAOLUZI, M. PERNICKA, G. PETRUCCI, G. PIANO MORTARI, M. PIMIÄ, A. PLACCI, P. QUERU, E. RADERMACHER, H. REITHLER, J. RICH, M. RIJSSENBEEK, C. ROBERTS, C. RUBBIA, B. SADOULET, G. SAJOT, G. SALVI, G. SALVINI, J. SASS, J. SAUDRAIX, A. SAVOY-NAVARRO, G. SCHANZ, D. SCHINZEL, W. SCOTT, T. P. SHAH, M. SPIRO, J. STRAUSS, K. SUMOROK, C. TAO, G. THOMPSON, E. TSCHESLOG, J. TUOMINIEMI, H. VERWEIJ, J. P. VIALLE, J. VRANA, V. VUILLEMIN, H. WAHL, P. WATKINS, J. WILSON, M. YVERT and E. ZURFLUH: *Some observations on the first events seen at the* CERN *proton-antiproton collider*, preprint CERN/EP 81-155 (1981).

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In the following, $B_{f(\bar{f})}$ and $M_{f(\bar{f})}$ indicate, respectively, the heavy-flavoured baryon (antibaryon) and meson (antimeson) states.

As mentioned before, the associated heavy-flavour production in $(p\bar{p})$ interactions would consist of the following components:

$$[(B_f)_{\text{leading}}(B_{\bar{f}})_{\text{leading}}]\,,$$

$$[(B_f)_{\text{leading}}(M_{\bar{f}})_{\text{central}}]\,,$$

$$[(B_{\bar{f}})_{\text{leading}}(M_f)_{\text{central}}]\,,$$

$$[(M_f)_{\text{central}}(M_{\bar{f}})_{\text{central}}]\,.$$

We have assumed that the production of $B_fB_{\bar{f}}$ pairs, in which both the B_f and the $B_{\bar{f}}$ are « central », is significantly depressed.

Let us consider, for simplicity, only the leptons in the outgoing-proton rapidity hemisphere. For the outgoing-antiproton rapidity hemisphere, the same results will apply if the electric-charge sign of the leptons is reversed.

The number of positive leptons ℓ^+ is expressed by

$$N(\ell^+) = LR[n_t(\ell^+) + n_b(\ell^+) + n_c(\ell^+)]\,, \tag{3}$$

where L is the total integrated luminosity, R is the semi-leptonic branching ratio (assumed to be equal for all flavoured states) and $n_f(\ell^+)$ (f = t, b, c) are the contributions from the direct production of top, beauty and charm states according to the diagrams shown in fig. 1*a*)-*f*):

$$\begin{aligned} n_t(\ell^+) = {} & \sigma(B_tB_{\bar{t}})[\varepsilon_{B_t}(\ell^+_t) + \varepsilon_{B_t}(\ell^+_{tbc}) + \varepsilon_{B_{\bar{t}}}(\ell^+_{\bar{t}\bar{b}})] + \\ & + \sigma(M_tM_{\bar{t}})[\varepsilon_{M_t}(\ell^+_t) + \varepsilon_{M_t}(\ell^+_{tbc}) + \varepsilon_{M_{\bar{t}}}(\ell^+_{\bar{t}\bar{b}})] + \sigma(M_tB_{\bar{t}})[\varepsilon_{M_t}(\ell^+_t) + \varepsilon_{M_t}(\ell^+_{tbc}) + \varepsilon_{B_{\bar{t}}}(\ell^+_{\bar{t}\bar{b}})] + \\ & + \sigma(B_tM_{\bar{t}})[\varepsilon_{B_t}(\ell^+_t) + \varepsilon_{B_t}(\ell^+_{tbc}) + \varepsilon_{M_{\bar{t}}}(\ell^+_{\bar{t}\bar{b}})]\,, \end{aligned} \tag{3a}$$

$$\begin{aligned} n_b(\ell^+) = {} & \sigma(B_bB_{\bar{b}})[\varepsilon_{B_b}(\ell^+_{bc}) + \varepsilon_{B_{\bar{b}}}(\ell^+_{\bar{b}})] + \\ & + \sigma(M_bM_{\bar{b}})[\varepsilon_{M_b}(\ell^+_{bc}) + \varepsilon_{M_{\bar{b}}}(\ell^+_{\bar{b}})] + \sigma(M_bB_{\bar{b}})[\varepsilon_{M_b}(\ell^+_{bc}) + \varepsilon_{B_{\bar{b}}}(\ell^+_{\bar{b}})] + \\ & + \sigma(B_bM_{\bar{b}})[\varepsilon_{B_b}(\ell^+_{bc}) + \varepsilon_{M_{\bar{b}}}(\ell^+_{\bar{b}})]\,, \end{aligned} \tag{3b}$$

$$\begin{aligned} n_c(\ell^+) = {} & \sigma(B_cB_{\bar{c}})[\varepsilon_{B_c}(\ell^+_c)] + \sigma(M_cM_{\bar{c}})[\varepsilon_{M_c}(\ell^+_c)] + \\ & + \sigma(M_cB_{\bar{c}})[\varepsilon_{M_c}(\ell^+_c)] + \sigma(B_cM_{\bar{c}})[\varepsilon_{B_c}(\ell^+_c)]\,. \end{aligned} \tag{3c}$$

The σ factors are the cross-sections for $B_fB_{\bar{f}}$, $M_fM_{\bar{f}}$ and $M_{f(\bar{f})}B_{\bar{f}(f)}$ production, and the ε factors are the detection efficiencies, in a given phase-space region $\Delta\Omega$, for the ℓ^+ originating from $B_{f(\bar{f})}$ or $M_{f(\bar{f})}$ decay. The subscript to ℓ^+ indicates the various possible decay chains. For instance, ℓ^+_{tbc} refers to the decay $t \to b \to c \to \ell^+$.

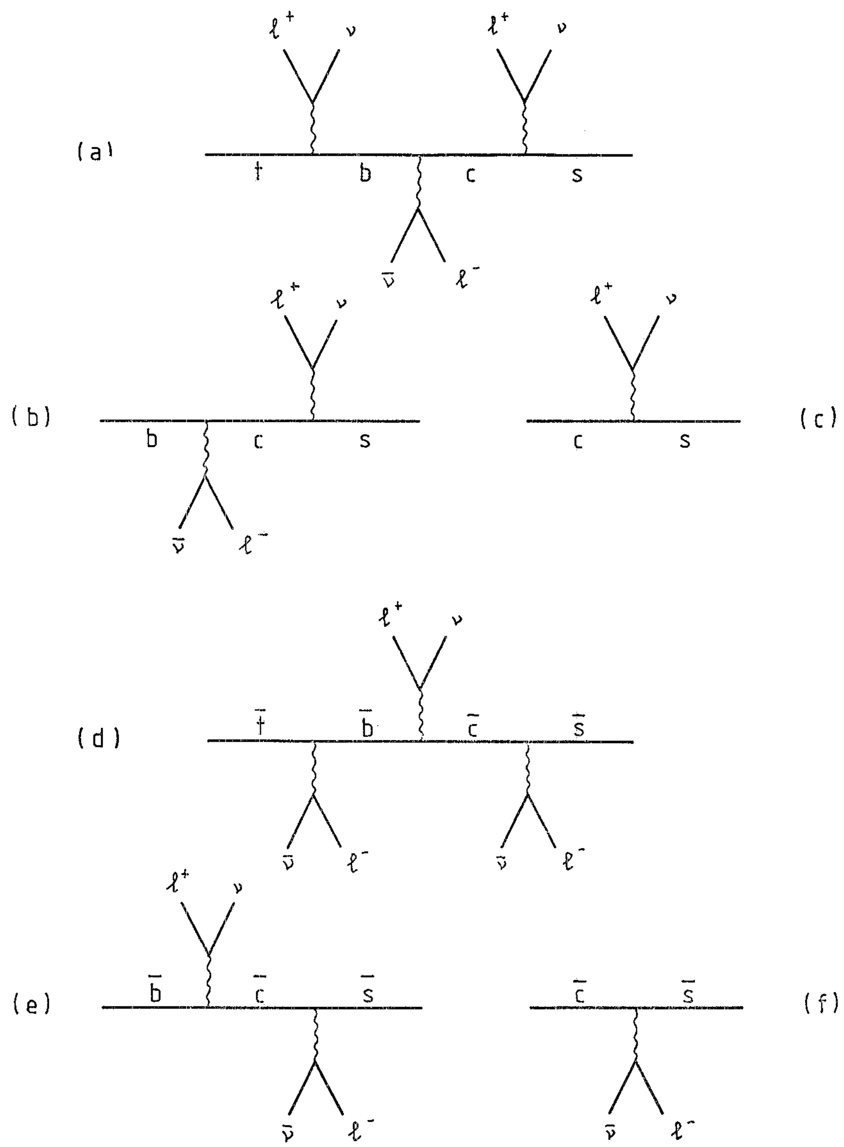

Fig. 1. – Diagrams illustrating all the possible electric-charge signs of the leptons originating from semi-leptonic decays of the chains $t \to b \to c \to s$ (*a*)), $b \to c \to s$ (*b*)), $c \to s$ (*c*)), $\bar{t} \to \bar{b} \to \bar{c} \to \bar{s}$ (*d*)), $\bar{b} \to \bar{c} \to \bar{s}$ (*e*)) and $\bar{c} \to \bar{s}$ (*f*)).

Analogously, the number of ℓ^- in the proton hemisphere is given by

$$N(\ell^-) = LR[n_t(\ell^-) + n_b(\ell^-) + n_c(\ell^-)]\,, \tag{4}$$

where, according to the diagrams shown in fig. 1*a*)-*f*),

$$\begin{aligned} n_t(\ell^-) = {}& \sigma(B_tB_{\bar t})[\varepsilon_{B_t}(\ell^-_{tb}) + \varepsilon_{B_{\bar t}}(\ell^-_{\bar t}) + \varepsilon_{B_{\bar t}}(\ell^-_{\bar t\bar b\bar c})] + \\ & + \sigma(M_tM_{\bar t})[\varepsilon_{M_t}(\ell^-_{tb}) + \varepsilon_{M_{\bar t}}(\ell^-_{\bar t}) + \varepsilon_{M_{\bar t}}(\ell^-_{\bar t\bar b\bar c})] + \sigma(M_tB_{\bar t})[\varepsilon_{M_t}(\ell^-_{tb}) + \varepsilon_{B_{\bar t}}(\ell^-_{\bar t}) + \varepsilon_{B_{\bar t}}(\ell^-_{\bar t\bar b\bar c})] + \\ & + \sigma(B_tM_{\bar t})[\varepsilon_{B_t}(\ell^-_{tb}) + \varepsilon_{M_{\bar t}}(\ell^-_{\bar t}) + \varepsilon_{M_{\bar t}}(\ell^-_{\bar t\bar b\bar c})]\,, \end{aligned} \tag{4a}$$

$$\begin{aligned} n_b(\ell^-) = {}& \sigma(B_bB_{\bar b})[\varepsilon_{B_b}(\ell^-_b) + \varepsilon_{B_{\bar b}}(\ell^-_{\bar b\bar c})] + \\ & + \sigma(M_bM_{\bar b})[\varepsilon_{M_b}(\ell^-_b) + \varepsilon_{M_{\bar b}}(\ell^-_{\bar b\bar c})] + \sigma(M_bB_{\bar b})[\varepsilon_{M_b}(\ell^-_b) + \varepsilon_{B_{\bar b}}(\ell^-_{\bar b\bar c})] + \\ & + \sigma(B_bM_{\bar b})[\varepsilon_{B_b}(\ell^-_b) + \varepsilon_{M_{\bar b}}(\ell^-_{\bar b\bar c})]\,, \end{aligned} \tag{4b}$$

$$\begin{aligned} n_c(\ell^-) = {}& \sigma(B_cB_{\bar c})[\varepsilon_{B_{\bar c}}(\ell^-_{\bar c})] + \sigma(M_cM_{\bar c})[\varepsilon_{M_{\bar c}}(\ell^-_{\bar c})] + \\ & + \sigma(M_cB_{\bar c})[\varepsilon_{B_{\bar c}}(\ell^-_{\bar c})] + \sigma(B_cM_{\bar c})[\varepsilon_{M_{\bar c}}(\ell^-_{\bar c})]\,. \end{aligned} \tag{4c}$$

Finally, let us define the « asymmetry » ratio

$$A^0 = \frac{N(\ell^+) - N(\ell^-)}{N(\ell^+) + N(\ell^-)}\,. \tag{5}$$

From our previous statements on $B_{t(\bar t)}$ and $M_{t(\bar t)}$ production distributions in a suitable forward region of the outgoing-proton rapidity hemisphere, we expect that the quantity A^0 will be a good tool for looking for a possible open « top » signal.

3. – Estimate of the « asymmetry » ratio A^0.

In order to estimate the value of the « asymmetry » ratio A^0, the following quantities are needed.

i) *The cross-sections values.* We have assumed $\sigma_c = 250\ \mu b$ for the total charm cross-section in the ISR energy range, a value which is consistent with our measurements [1,9,10], and a factor of 3 increase of this cross-section at the

(9) M. BASILE, G. CARA ROMEO, L. CIFARELLI, A. CONTIN, G. D'ALÍ, P. DI CESARE, B. ESPOSITO, P. GIUSTI, T. MASSAM, R. NANIA, F. PALMONARI, G. SARTORELLI, G. VALENTI and A. ZICHICHI: *Nuovo Cimento A*, **65**, 457 (1981).
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(pp̄) Collider energy. We have then assumed that the heavy-flavour cross-sections scale as the inverse ratio of the quark masses squared ([11]):

$$\sigma_b/\sigma_c = m_c^2/m_b^2\,,$$

and

$$\sigma_t/\sigma_b = m_b^2/m_t^2\,.$$

For the « top » quark, we assumed a mass $m_t = 25\ \text{GeV}/c^2$. The cross-

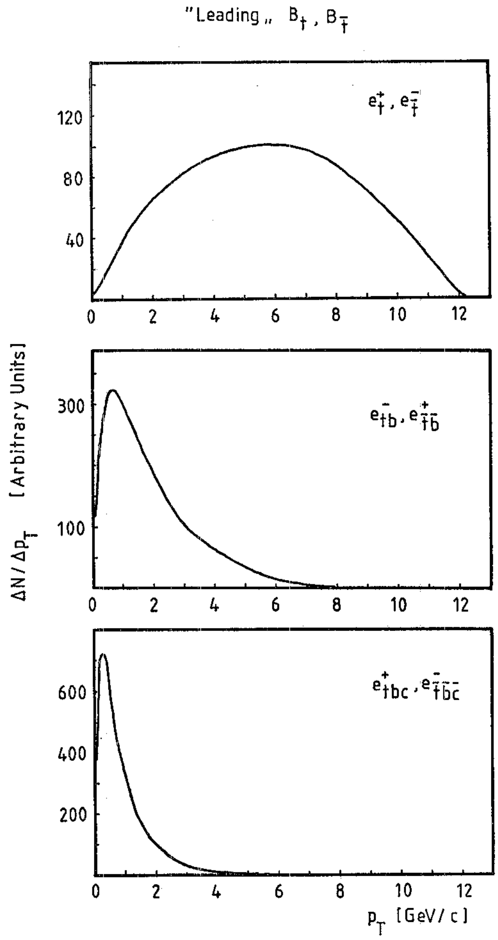

Fig. 2. – Transverse-momentum spectra of the leptons originating from the decay of t (t̄) « leading » baryon states, obtained as described in the text.

([11]) A. MARTIN: preprint CERN Th. 2980 (1980), and private communication.

section values at $\sqrt{s} = 540$ GeV are, therefore,

$$\sigma_c = 750\ \mu b\,, \quad \sigma_b = 75\ \mu b \quad \text{and} \quad \sigma_t = 3\ \mu b\,.$$

We also used, for all flavours, the hypothesis

$$\sigma(B_f B_{\bar{f}}) = \sigma(M_f M_{\bar{f}}) = \sigma(M_f B_{\bar{f}}) = \sigma(M_{\bar{f}} B_f) = \sigma_f/4\,.$$

ii) *The semi-leptonic branching ratio.* We have assumed the branching ratio of the semi-leptonic decay into a given lepton to be 10 % for all heavy-flavoured states.

iii) *The detection efficiency* ε. The detection efficiencies ε have been evaluated with a Monte Carlo simulation. The heavy-flavour state and its associated

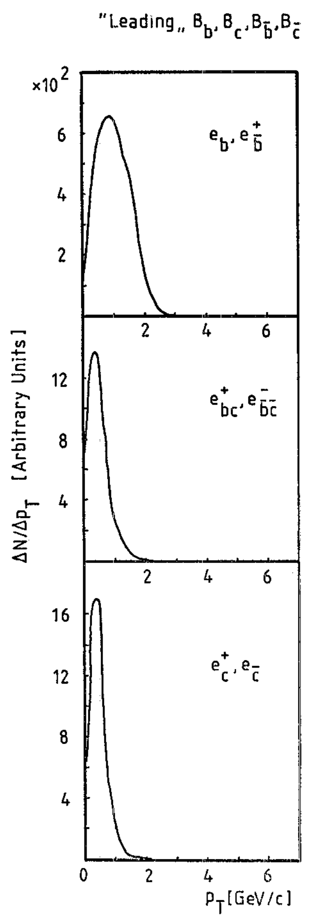

Fig. 3. – Same as fig. 2, but for b ($\bar{b}$), c ($\bar{c}$) «leading» baryon states.

antistate were assumed to be produced in an uncorrelated way. The generation was based on a flat-x_L distribution ($d\sigma/dx_L$ = const) for baryons and on a central-x_L distribution [$E(d\sigma/dx_L) \propto (1 - x_L)^3$] for mesons. The p_T dependence was assumed to be $(1/p_T)(d\sigma/dp_T) \propto \exp[-2.5p_T]$ for all flavours.

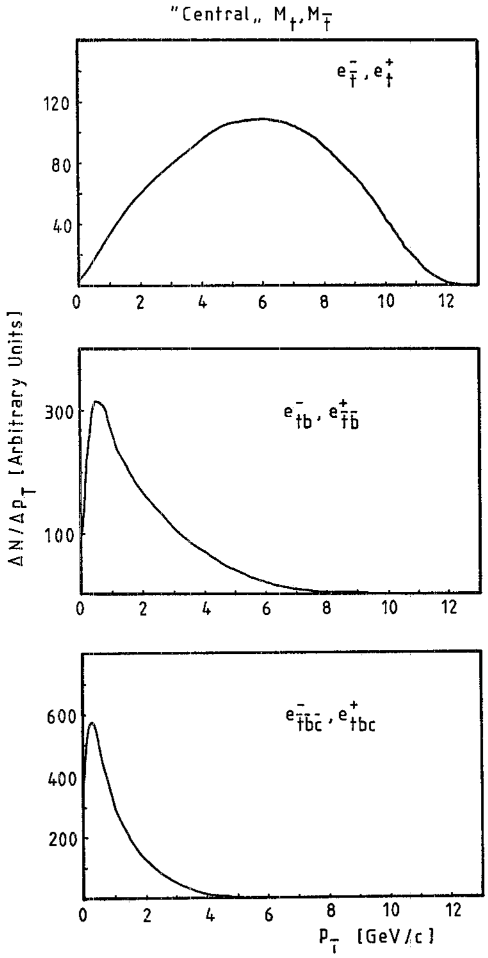

Fig. 4. – Same as fig. 2, but for t ($\bar{t}$) «central» meson states.

For each flavour the semi-leptonic decay was simulated by using a K_{l3} decay matrix. The p_T spectra from the various decays are shown in fig. 2-5. The choice of the phase-space region $\Delta\Omega$, defined by the conditions

$$\theta < 30° \quad \text{and} \quad p_T > 5 \text{ GeV/c},$$

was determined as a compromise between the efficiency for l^+ originating via

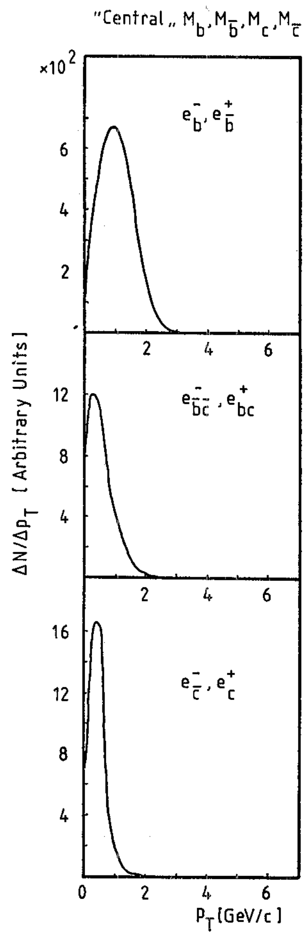

Fig. 5. – Same as fig. 2, but for b ($\bar{\text{b}}$), c ($\bar{\text{c}}$) « central » meson states.

the direct decay $t \to \ell^+$ of the « top »-flavoured baryons and the rejection of leptons from different sources. The detection efficiencies for the leptons originating from the various sources are summarized in table I.

The results of our analysis are the following:

$$N(\ell^+) = L(7.59 \cdot 10^{-2}\ \mu\text{b}) ,$$

$$N(\ell^-) = L(1.95 \cdot 10^{-2}\ \mu\text{b}) ,$$

$$A^0 = \frac{N(\ell^+) - N(\ell^-)}{N(\ell^+) + N(\ell^-)} = 0.59 .$$

Notice that this value corresponds to the ratio $N(\ell^+)/N(\ell^-) = 3.90$.

TABLE I. – *The* $\ell^{\pm}$ *detection efficiencies for* $\theta < 30°$ *and* $p_T > 5$ GeV/c *in the proton rapidity hemisphere (see corresponding equations in column* 3).

$\varepsilon_{B_t}(\ell^+_t)$:	$4.2\cdot 10^{-1}$	$\varepsilon_{B_{\bar{t}}}(\ell^+_{\bar{t}\bar{b}})$:	0	(3*a*)
$\varepsilon_{B_t}(\ell^+_{tbc})$:	$1.3\cdot 10^{-3}$			(3*a*)
$\varepsilon_{B_b}(\ell^+_{bc})$:	$< 10^{-4}$	$\varepsilon_{B_{\bar{b}}}(\ell^+_{\bar{b}})$:	0	(3*b*)
$\varepsilon_{B_c}(\ell^+_c)$:	~ 0			(3*c*)
$\varepsilon_{B_t}(\ell^-_{tb})$:	$4.5\cdot 10^{-2}$	$\varepsilon_{B_{\bar{t}}}(\ell^-_{\bar{t}})$:	0	(4*a*)
		$\varepsilon_{B_{\bar{t}}}(\ell^-_{\bar{t}\bar{b}\bar{c}})$:	0	(4*a*)
$\varepsilon_{B_b}(\ell^-_b)$:	$< 10^{-4}$	$\varepsilon_{B_{\bar{b}}}(\ell^-_{\bar{b}\bar{c}})$:	0	(4*b*)
		$\varepsilon_{B_{\bar{c}}}(\ell^-_{\bar{c}})$:	0	(4*c*)
$\varepsilon_{M_t}(\ell^+_t)$:	$7.6\cdot 10^{-2}$	$\varepsilon_{M_{\bar{t}}}(\ell^+_{\bar{t}\bar{b}})$:	$7.4\cdot 10^{-3}$	(3*a*)
$\varepsilon_{M_t}(\ell^+_{tbc})$:	$1.3\cdot 10^{-3}$			(3*a*)
$\varepsilon_{M_b}(\ell^+_{bc})$:	~ 0	$\varepsilon_{M_{\bar{b}}}(\ell^+_{\bar{b}})$:	~ 0	(3*b*)
$\varepsilon_{M_c}(\ell^+_c)$:	~ 0			(3*c*)
$\varepsilon_{M_t}(\ell^-_{tb})$:	$7.4\cdot 10^{-3}$	$\varepsilon_{M_{\bar{t}}}(\ell^-_{\bar{t}})$:	$7.6\cdot 10^{-2}$	(4*a*)
		$\varepsilon_{M_{\bar{t}}}(\ell^-_{\bar{t}\bar{b}\bar{c}})$:	$1.3\cdot 10^{-3}$	(4*a*)
$\varepsilon_{M_b}(\ell^-_b)$:	~ 0	$\varepsilon_{M_{\bar{b}}}(\ell^-_{\bar{b}\bar{c}})$:	~ 0	(4*b*)
		$\varepsilon_{M_{\bar{c}}}(\ell^-_{\bar{c}})$:	~ 0	(4*c*)

We have also evaluated the « asymmetry » ratio A^0, using a different extrapolation for σ_b and σ_t, assuming

$$\sigma_b = \sigma_c/m_b^2 \quad \text{and} \quad \sigma_t = \sigma_c/m_t^2 \,.$$

This leads to

$$\sigma_b = 30\ \mu\text{b} \quad \text{and} \quad \sigma_t \simeq 1\ \mu\text{b}$$

at $\sqrt{s} = 540$ GeV, with $\sigma_c = 750\ \mu$b.

In these conditions we get

$$N(\ell^+) = L(2.53\cdot 10^{-2}\ \mu\text{b}) \,,$$

$$N(\ell^-) = L(6.50\cdot 10^{-3}\ \mu\text{b}) \,,$$

$$A^0 = \frac{N(\ell^+) - N(\ell^-)}{N(\ell^+) + N(\ell^-)} = 0.59 \,.$$

The « asymmetry » ratio A^0 does not depend on the cross-section extrapolations, because the detection efficiencies for leptons from beauty and charm are negligible in the phase-space region specified in point iii). However, the value of the « top » production cross-section will be important for determining the integrated luminosity needed to reach a given statistical significance on the measurement of A^0 and for determining, as will be discussed in sect. **5**, the rejection power of the apparatus needed to obtain a given signal-to-background ratio.

4. – Background evaluation.

In what has been described so far, the background contamination in the sample of prompt ℓ^+ and ℓ^- has not been considered. It is mainly due to

i) the misidentification of charged and neutral hadrons in the experimental apparatus,

ii) the prompt ℓ^+ or ℓ^- production from sources other than open heavy-flavour states.

An attempt was made to evaluate the contribution i). To derive the pion production in $(p\bar{p})$ interactions at $\sqrt{s} = 540$ GeV, we have used a parametrization of the single-pion cross-section measured at the ISR [12]:

$$E(\mathrm{d}^3\sigma/\mathrm{d}p^3) = A\exp[-Bp_{\mathrm{T}}] + C\frac{(1-x_{\mathrm{T}})^D}{(p_{\mathrm{T}}^2+F)^4},$$

where $x_{\mathrm{T}} = 2p_{\mathrm{T}}/\sqrt{s}$.

A further conservative hypothesis was made by including a p_{T}^{-4} term in the expression for $E(\mathrm{d}^3\sigma/\mathrm{d}p^3)$, for $p_{\mathrm{T}} > 7$ GeV [13].

The extrapolated π rate, in the phase-space region defined in sect. **3** ($\theta < 30°$, $p_{\mathrm{T}} > 5$ GeV/c), should be multiplied by a reduction factor representing the achievable rejection of background source i) in the experimental apparatus.

As regard the prompt lepton background ii), we assume, as a first approximation, that it would be negligible when compared with the contribution i).

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5. – Estimate of the « asymmetry » ratio A^0 in experimental conditions.

In the presence of background, the experimental « asymmetry » ratio is given by

$$A^{\exp} = \frac{[N(\ell^+) + N_{bg}(\ell^+)] - [N(\ell^-) + N_{bg}(\ell^-)]}{[N(\ell^+) + N_{bg}(\ell^+)] + [N(\ell^-) + N_{bg}(\ell^-)]}.$$

Assuming $N_{bg}(\ell^+) = N_{bg}(\ell^-) = N_{bg}(\ell)$, and expressing $N(\ell^-)$ as

$$N(\ell^+)[(1 - A^0)/(1 + A^0)]$$

according to eq. (5), we have

$$A^{\exp} = \frac{A^0}{1 + (1 + A^0)/[N(\ell^+)/N_{bg}(\ell)]}. \tag{6}$$

The quantity $A^{\exp}$ is plotted in fig. 6 as a function of the signal-to-background ratio

$$S/B = N(\ell^+)/N_{bg}(\ell).$$

Notice that $A^{\exp}$ is substantially different from 0 as soon as S/B is greater than 1.

However, from eq. (6) it is clear that in order to keep the value of $A^{\exp}$

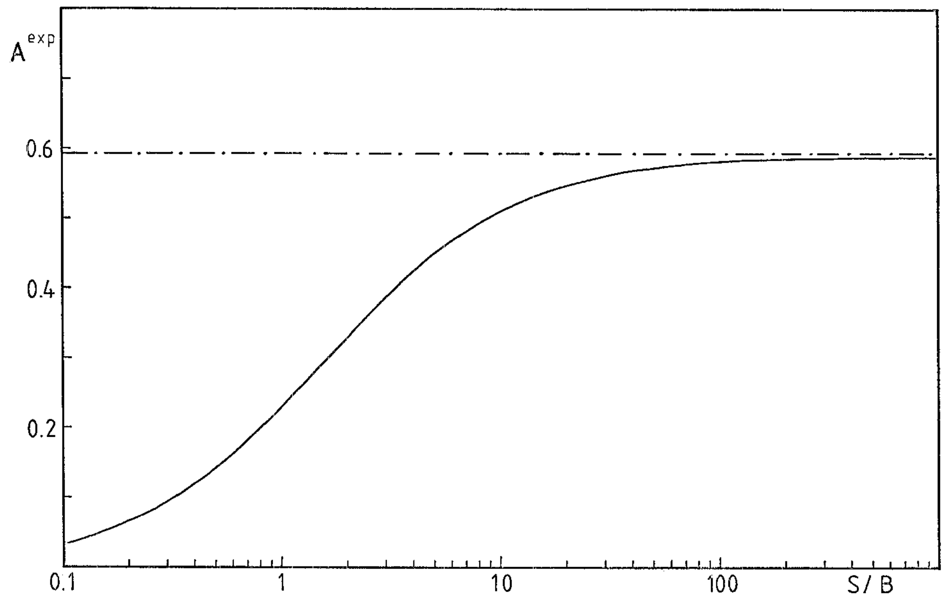

Fig. 6. – Behaviour of the experimental « asymmetry » $A^{\exp}$, as a function of $S/B = N(\ell^+)/N_{bg}(\ell)$.

constant, *i.e.* independent of the « top » production cross-section σ_t, the rejection power of the apparatus must increase linearly with decreasing σ_t.

On the basis of the background estimate, computed as specified in sect. 4, and for the range of σ_t considered, we have

$$1 < S/B < 10$$

for a rejection against charged and neutral hadron background ranging from 10^{-3} to 10^{-4}.

6. – Conclusions.

The above studies show a new way to investigate the production of the « top » flavour at the $(p\bar{p})$ Collider. They are based on the measurement of an excess of ℓ^+ on the proton side and of an excess of ℓ^- on the antiproton side, both asymmetries being due to the semi-leptonic decays of the « top » baryon and the « antitop » antibaryon, each produced in a « leading » way.

The main parameters for the observation of this effect are the background level (estimated on the basis of our knowledge) and the cross-section values for the production of the leading baryons.

With the previously specified assumptions, and by assuming a luminosity between 10^{28} and $10^{29}\,cm^{-2}\,s^{-1}$, a few hundred hours of running would be sufficient for determining the value of A^{exp} with a precision of a few percent, thus establishing clear evidence for (or against) the production of « leading » t-flavoured baryon (antibaryon) states.

● RIASSUNTO

Si presenta un nuovo metodo per studiare la produzione di particelle con « top » in interazioni $(p\bar{p})$ al Collider del CERN. Tale metodo si basa sul meccanismo di produzione « leading » esteso agli stati barionici e antibarionici dotati del piú pesante « flavour », e sull'asimmetria di carica dei leptoni originati dal loro decadimento semileptonico.

Поиски открытой « вершины » на $(p\bar{p})$ пучках в ЦЕРНе.

Резюме (*). — Предлагается новый метод наблюдения рождения барионных состояний на $(p\bar{p})$ пучках в ЦЕРНе. Этот метод основан на механизме рождения « лидирующей » частицы, обобщенном на наиболее тяжелые барионные и антибарионные состояния с ароматом, и на зарядовой асимметрии лептонов, образованных из их полулептонных распадов.

(*) *Переведено редакцией.*