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INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

TOPICAL MEETING
ON THE PHYSICS OF COLLIDING BEAMS

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(SUMMARIES AND CONTRIBUTIONS)

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THE ORSAY STORAGE RING PHYSICS PROGRAMME

J. Haïssinski

Laboratoire de l'Accélérateur Linéaire, Centre d'Orsay, France.

1. EXPERIMENTS PLANNED ON ACO

The high energy physics programme with ACO should come to an end in about a year and a half or two years from now.

The last series of measurements with this ring will be carried out with a magnetic detector which includes a series of 4 cyclindrical proportional wire chambers. The field is .9 Tesla. The chambers have a very low mass (10^{-3} radiation lengths) and provide both anode and cathode detections which permit simultaneous axial and azimuthal measurements without ambiguity. The outer chamber is 1 meter long and has a diameter of 1.61 meter.

The main goals of this experiment are as follows :

1. New measurements of the pion form factor with particular emphasis put on the low energy tail of the ρ resonance, down to $2E \approx 450$ MeV.

2. Detailed study of the ϕ resonance with the simultaneous detection of its three main decay modes. A precise comparison of the $K_0 \bar{K}_0$ and $K_+ K_-$ yields should allow the separation between the isoscalar (ϕ) and isovector (ρ) contributions to the kaon form factor.

3. Investigation of the $\pi^+\pi^-\pi^\circ$ and $\pi^+\pi^-\gamma$ channels, in particular at energies ranging between the ω and the ϕ masses.

4. Study of the rise of the $\pi^+\pi^-\pi^+\pi^-$ production cross section near threshold.

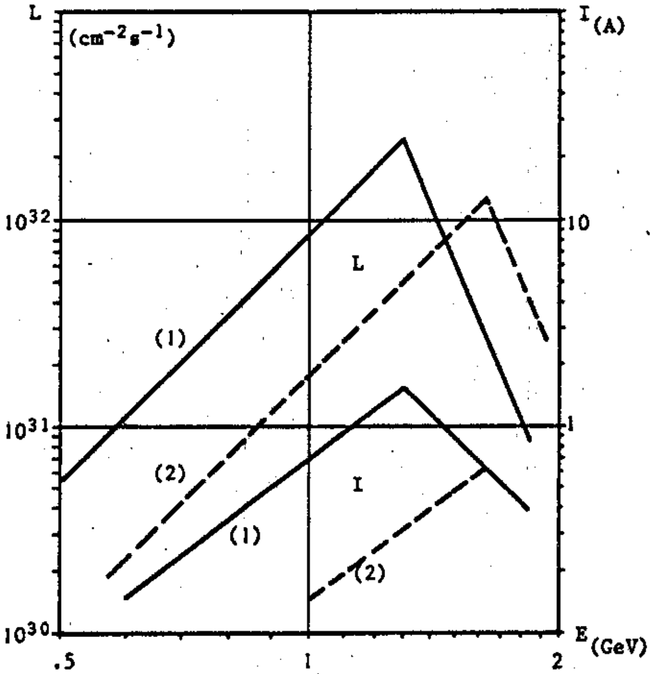
5. Identification of the $e^+e^- \rightarrow e^+e^-e^+e^-$ process (photon-photon collisions).

2. DESIGN AND STATUS OF DCI

DCI is a machine of intermediate energy ($E_{max} = 1.8$ GeV) with a design luminosity of about 10^{32} cm^{-2} s^{-1} at beam energies ranging between 1 and 1.7 GeV. Rather than using the low beta scheme, such luminosities will be achieved by taking advantage of space charge compensation between bunches circulating in two rings which have conventional β function (about 2 meters at the interaction point).

The main parameters of the machine are the following ones :

- Bending radius (magnets) : 3.82 m
- Mean radius ($L/2\pi$) = 15 m
- Length of the experimental straight section : 6 m
- Harmonic number of the RF system : 8
- Maximum RF power delivered to the beams (per ring) : 250 kW
- Number of bunches per ring : 1
- Typical transverse beam dimensions at the interaction point : .75 to 1.5 mm.



DCI - Two rings $e^{\pm}e^{\mp}$

$\beta^*_x = \beta^*_z = 2$ m

$K\Delta\nu_o = .3$

Curves (1) $\nu_x = 3.845$
$\nu_z = 2.845$

One bunch per beam

$P_{RF} = 125$ kW per beam

Curves (2) $\nu_x = 4.845$
$\nu_z = 2.845$

It is expected that the basic components of Ring 1, and of one of the 2 transport lines will be ready by the end of this year (1974), or the very beginning of next year. The second transport line should be installed 3 months later. Ring 2 will then require another year to be completed.

3. PHYSICS PROGRAMME WITH DCI

Physics with DCI is scheduled to begin in September 75 with Ring 1 operating alone, and in September 76 with the 2 rings. If the luminosity then achieved turns out to be close to its expected value, the programme will be threefold.
(1) Study of the hadron-anti-hadron channels (electro-magnetic form factors).
(2) Detailed study of the multi-body final states with a special emphasis put on neutral particle detection. The aim of such studies is to understand the contribution of the various channels which open up at high energies, and the role of the quasi-two body final states. (3) $\gamma\gamma$ collision processes.

All these experiments are still in the proposal stage. At the present time, there are 4 proposals.

3.1. An experiment with the magnetic detector presently operated with ACO. This apparatus would be used mainly to detect the following reactions :
$e^+e^- \to \pi^+\pi^-$, K^+K^-, $p\bar{p}$ and a few others such as : $\phi\,\eta$ or $\pi^+\pi^-\pi^+\pi^-$.
$\downarrow_{\to K^+K^-}$

The rejection of the background due to electron and muon pairs, and the particle identification would be fairly improved if the detector were transformed. Shower detectors could be inserted between the main coil made out of aluminum and the iron plates which are used for the flux return.

3.2 Measurement of the number of neutral particles (π°) present in the multihadron final states with the "M2N" apparatus. This apparatus which has already been used with ACO, consists of a series of cylindrical spark chambers interleaved with lead converters and has proven to be quite good for the identification of γ rays. The main purpose of this proposal is to determine accurately the ratio neutral/charged particles in the multihadron channels, in the range : 1.5 GeV < 2E < 3.6 GeV. Furthermore, a few final states such as $\pi^+\pi^-\pi^\circ$, $K^+K^-\pi^\circ$, $\pi^+\pi^-\pi^\circ\pi^\circ$ and $\pi^+\pi^-\pi^+\pi^-$ could be identified and the corresponding cross sections measured.

3.3 An investigation of $\gamma\gamma$ collisions. The proposal takes advantage of the fact that DCI can be run with 2 clashing positron beams. The luminosity is then reduced by an order of magnitude but is still high enough to allow for an interesting investigation of $\gamma\gamma$ processes. A double tagging system using the ring bending magnets as spectrometers would be build and operated in association with one or the other of the "central" detectors described in the preceding proposals.

3.4 An experiment which would combine a large magnetic detector with a set up detecting γ rays with a good efficiency. Such a weak field magnet would allow neutral particle detection beyond the coil. The main features of this proposed apparatus are similar to those of the SPEAR magnetic detector, but it presents a number of improvements, such as the introduction of Čerenkov counters to identify high momentum particles, and more sophisticated photon detectors. This large size project could be achieved by 1978.

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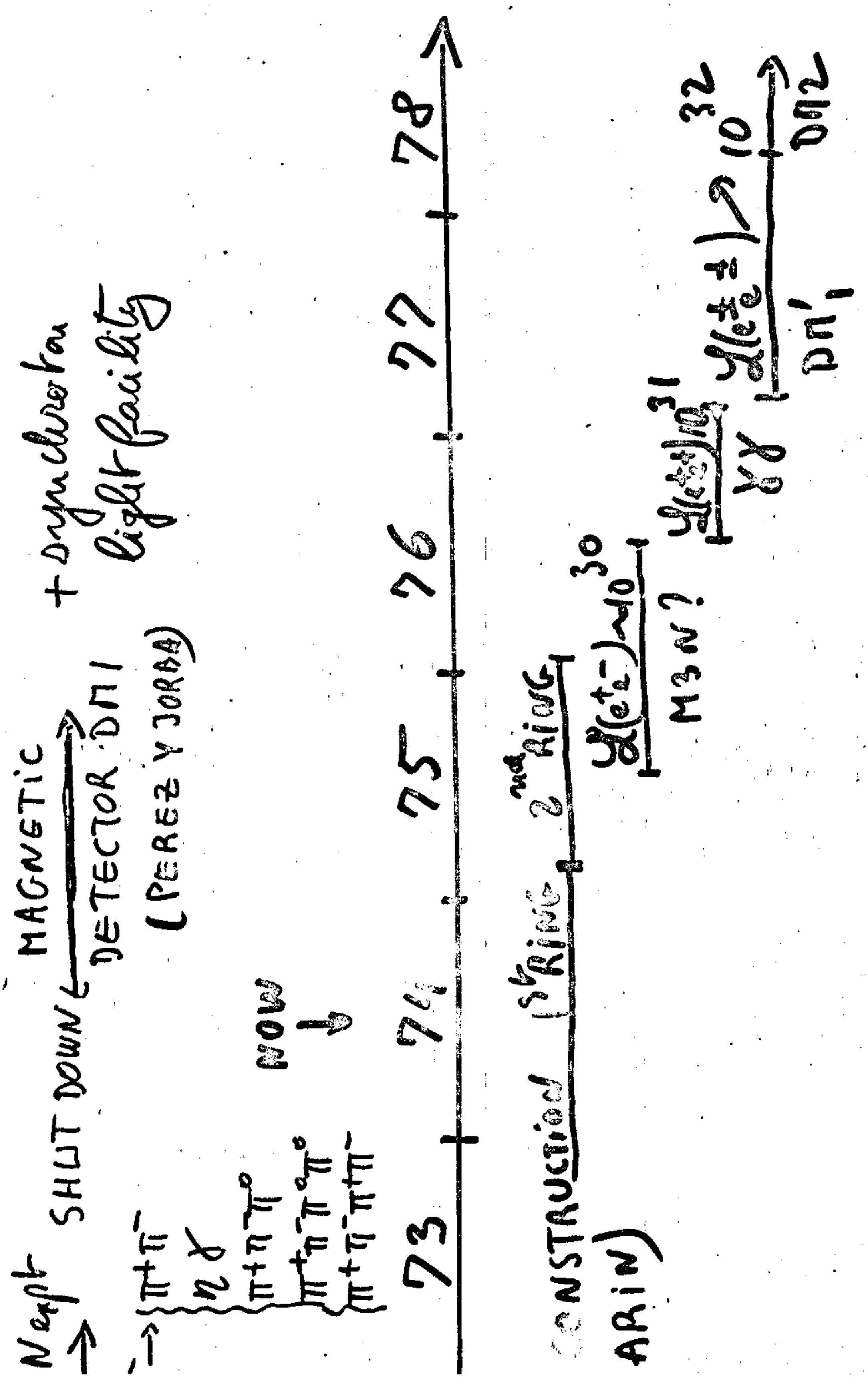
all: 1 ring, zero crossing angle	SUPER ADONE FRASCATI (BERNARDINI)	EPIC RUTH. LAB (TONER)	PEP SLAC (RICHTER)	PETRA DESY (WIIK)
mean radius (m)	136	349	344	366
energy per beam	3 ⟷ 10 (12)	14	5 ⟷ 15 (20)	17 (22)
number of bunches per beam	4 E<5 1 E>5	2	3	low E 40 high E 1
number of particles/bunch	$\leq 3.6\ 10^{12}$	$.8\ 10^{12}$	$1.5\ 10^{12}$	$.2\ 10^{12}$
filling time	10÷45 min	15 min	4 to 20 min	short
number of interac. regions	2 (4)	4	6	4 (8)
luminosity/crossing $cm^{-2}\ s^{-1}$	$\geq .5\ 10^{32}$ $(1.4 \cdot 10^{32})$	$.5\ 10^{32}$	$\left(\frac{E}{15}\right)^2 10^{32}$	$\geq 10^{31}$ a few 10^{32}
available free space for exp! setup	7 meters	17 meters	20 meters	10 meters
Transverse beam dimensions at X	H 1 mm V .1 mm	.6 mm .16 mm	1.5 mm .2 mm	1 mm .2 mm
bunch length (low I)	≤7.5 cm	3.5 cm	3 cm	3 cm
RF power (MW) to beams	1.4	1.4	5	1 (5)
RF power (MW) cavity losses	1.2		2	
Proton ring Energy (GeV)		200	200	

THE ORSAY STORAGE RING PROGRAMME

(J. Haïssinski)

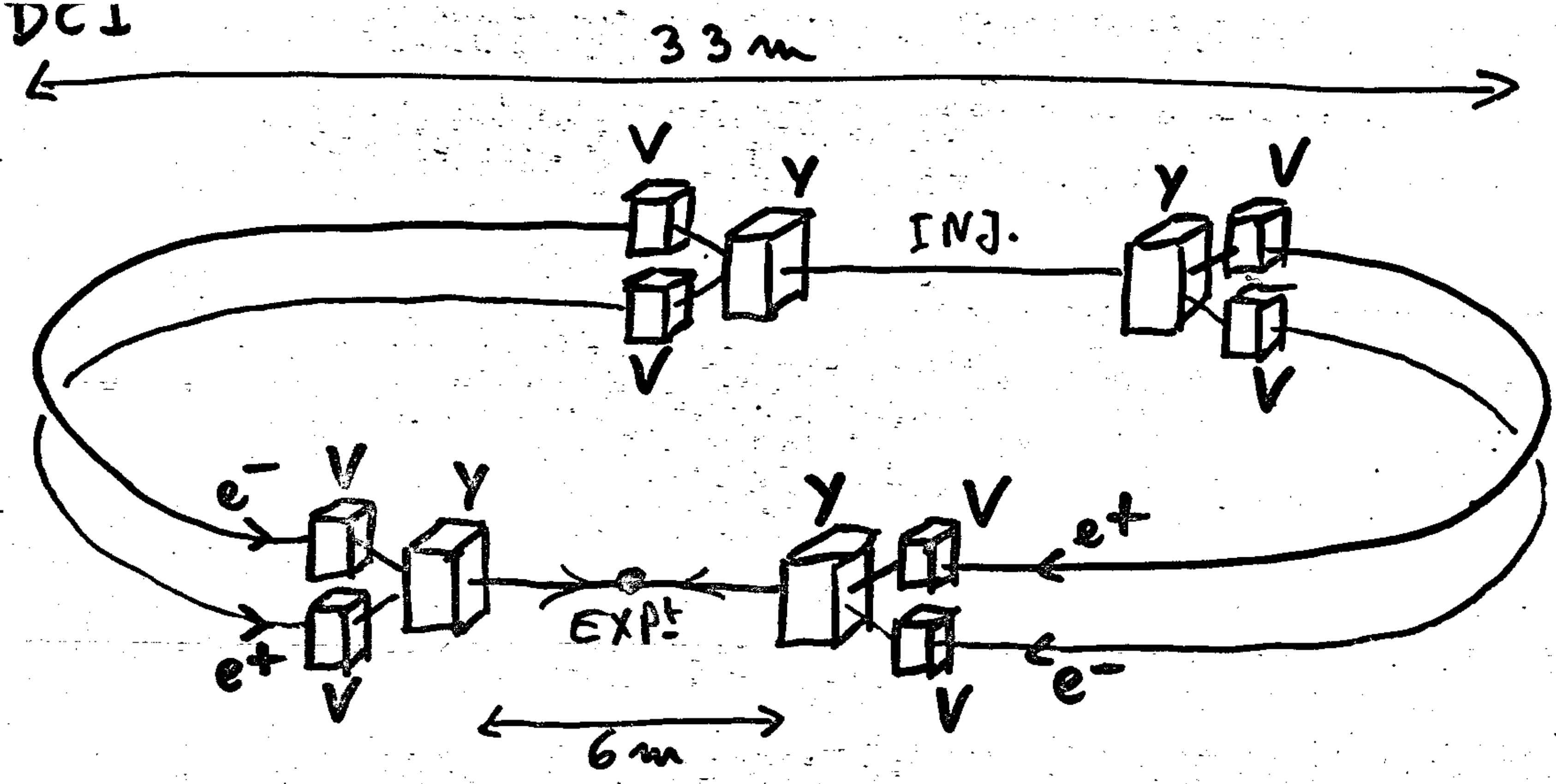
1. FROM ACO to DCI



DCI: 45 MF $\begin{cases} 1e^\pm \text{ bunch} \times 1e^\pm \text{ bunch}, 2\times1.8 \text{ GeV}, \mathcal{L} \sim 10^{32} \text{ cm}^{-2}\text{s}^{-1} \\ 8e^+ \text{ bunches} \times 8e^+ \text{ bunches}, 2\times1.8 \text{ GeV}, \mathcal{L} \sim 10^{31} \text{ cm}^{-2}\text{s}^{-1} \end{cases}$

DCI

(DORIS: 60m Straight sections)



Two rings
- 2×12 Horiz. bending magnets
- 2×28 Quad
- 2×4 V (10°)
- 2×2 Y (10°)

Orbit length: 100 m

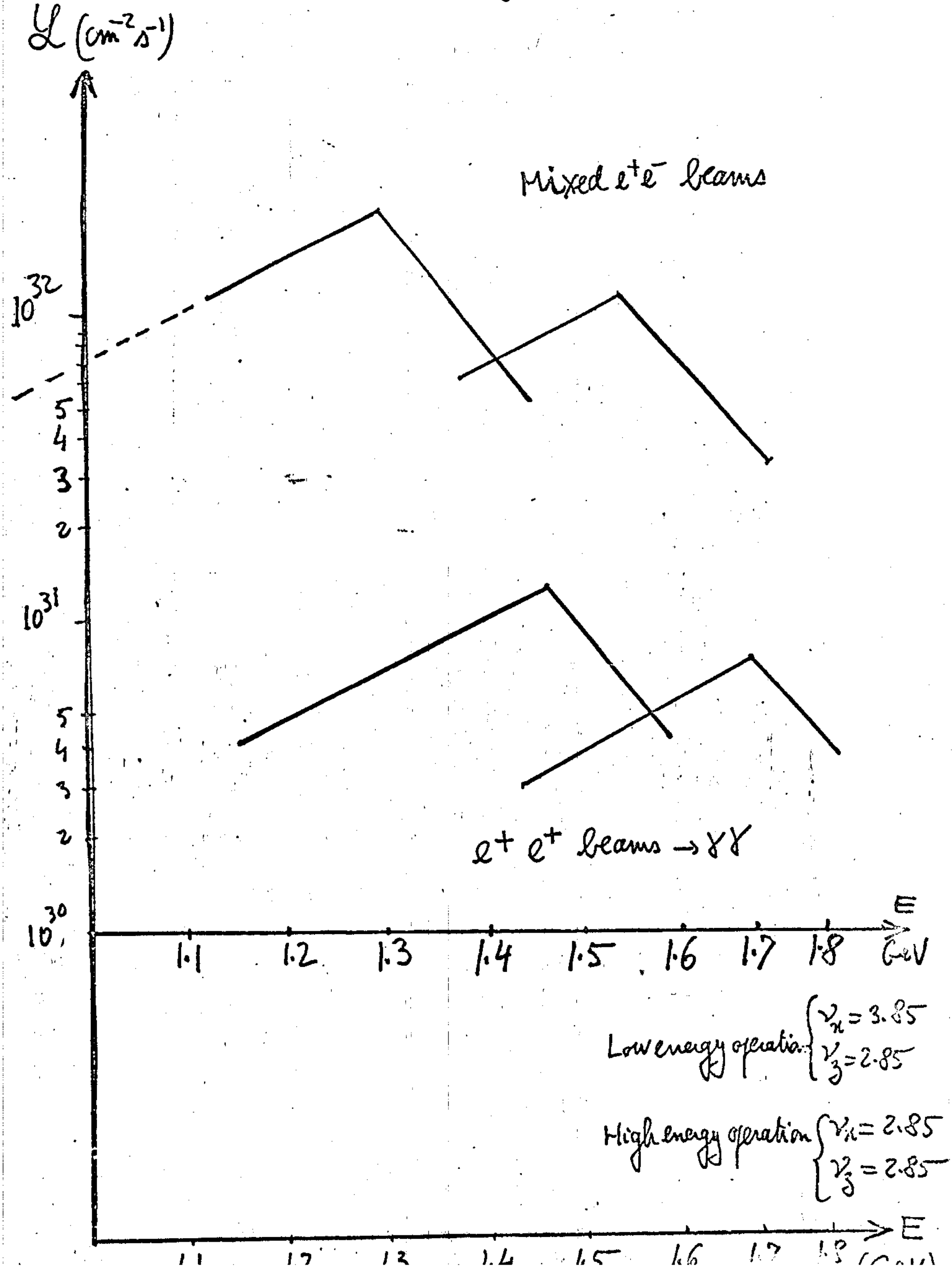
harmonic: 8

Useful RF power: 1 cavity / Ring → up to 250 kW to the beam(s)

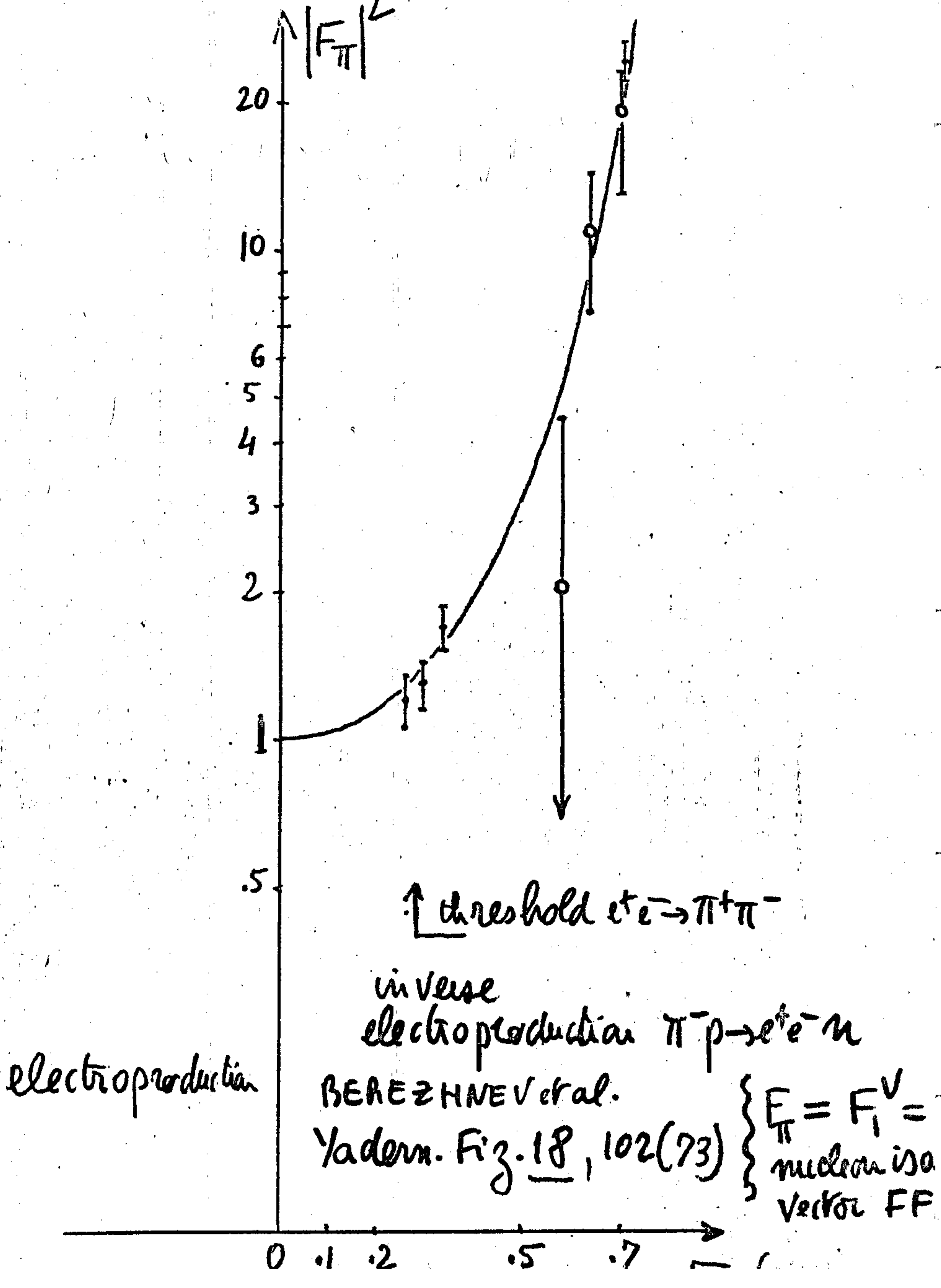
Max En. $E = 1.8$ GeV

$\beta^* = \beta^* \simeq 2$ m. $\sigma^* = .75$ to 1.5 mm

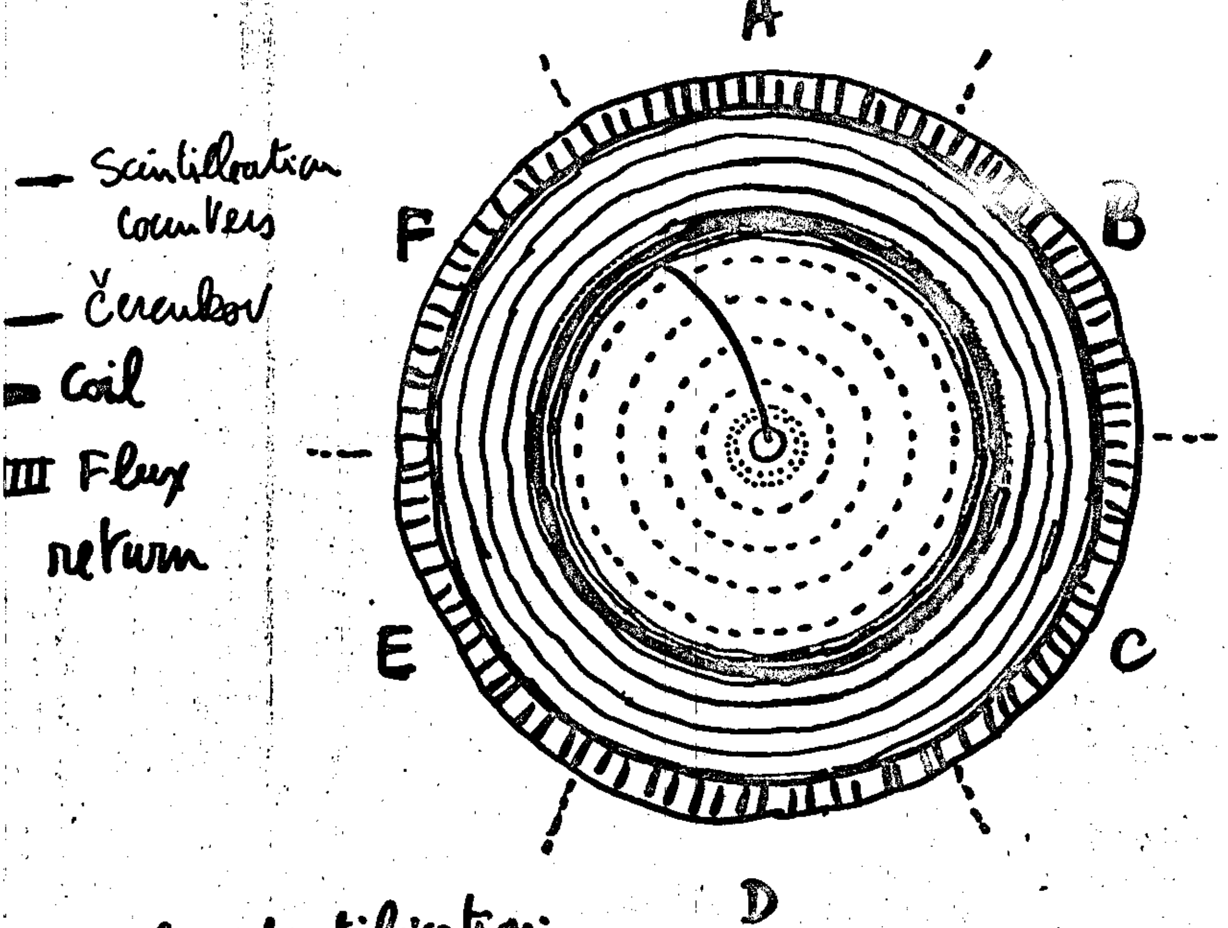
$\mathcal{L}(s)$ of DCI



The low energy tail of the ρ meson



DCI



Particle identification:

(i) kinematical analysis: proportional + magnetostrictive chambers: $\frac{\Delta p}{p} \simeq 6\%$ at $P = 1$ GeV

(ii) time of flight measurement: $\Delta\tau = .5$ ns

(iii) β measurement: Čerenkov   K: $P_K \geq .6$ GeV
p: $P_p \geq 1.1$ GeV

(iv) shower and K^- or $\bar{p}$ star detection with 13 chambers interleaved with 12 lead abs. $.5\,X_0$

<u>Trigger</u>: large flexibility according to channel and [illegible]

1. minimum number of charged parti.
2. origin of tracks of charged particle
3. minimum momentum of charged
4. minimum number of γ